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Data Rescue Activities

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EuroGOOS
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EUMETNET
EUROPEAN METEOROLOGICAL SERVICES NETWORK

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	Name(s)	Affiliation
Coordinated by:	Denis STUBER	Météo-France
Contributions:	See the list hereafter in the document	
Approval:		

Prepared for:	European Environment Agency (EEA)
Represented by: (Project Manager)	Henrik Steen Andersen
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Contributors of the report

- ✓ **Rob Allan**, In charge of the Atmospheric Circulation Reconstructions over the Earth (ACRE) and lead of the C3S Data Rescue Service and member of the ET-DRC
- ✓ **Monica Drazba**, from the International Environmental Data Rescue Organization (IEDRO)
- ✓ **Urip Haryoko**, Acting Deputy Director of the Climatology Directorate at the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG)
- ✓ **Peer Hechler**, Scientific Officer, Climate Monitoring and Policy Services Division, Services Department, World Meteorological Organization (WMO).
- ✓ **Hans Hersbach**, C3S Reanalysis Team Leader, Copernicus Department, European Centre for Medium Range Weather Forecast (ECMWF)
- ✓ **Sylvie Jourdain**, Head of the Department on "Expertise, historical Data and climatic References" (EDR), and Member of the C3S Data Rescue Service (Météo-France)
- ✓ **Christina Lief**, Physical Scientist, co-Chair of the SERCOM WMO Expert-Team on Data Requirements for Climate Services (ET-DRC); Member INFCOM Standing Committee on Information Management; Lead of the WMO ClimSA[1] Activity 3.3; Retired from NOAA
- ✓ **Jesse Moore**, Archive Branch, NOAA's National Centers for Environmental Information (NCEI)
- ✓ **Nancy Ritchey**, Archive Branch Chief, NOAA's National Centers for Environmental Information (NCEI)
- ✓ **Peter Siegmund**, Research Scientist, Royal Netherlands Meteorological Institute (KNMI)
- ✓ **Sunaryo Tri Nurmayati,** Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG)
- ✓ **Ge Verver**, Research Scientist, Royal Netherlands Meteorological Institute (KNMI)
- ✓ **William Wright**, Physical Scientist, Member of the WMO SERCOM Standing Committee on Climate Services, as well as the WMO INFCOM Expert-Team on Information Management; Retired from the Bureau Of Meteorology (BoM) of Australia

Review of the document

- ✓ **Sylvie Jourdain**
- ✓ **Christina Lief**
- ✓ **Denis Stuber,** EDR Department (Météo-France), and co-lead of the WMO Expert-Team on Data Requirements for Climate Services (ET-DRC).
- ✓ **Nancy E. Westcott**, Midwestern Regional Climate Center, Illinois State Water Survey, Prairie Research Institute, University of Illinois
- ✓ **William Wright**

Introduction and Perspectives writers

- ✓ **Sylvie Jourdain**
- ✓ **Christina Lief**
- ✓ **Denis Stuber**
- ✓ **William Wright**

In charge of the coordination

- ✓ **Denis Stuber**

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1 Introduction

1.1 Introduction, objectives and outline of the report

The scientific community has placed great importance on Data Rescue as a means to increase knowledge of earth and atmospheric processes to improve our understanding of past climates and to better predict future weather and climate. Global, regional, and national governmental and non-profit organizations have contributed to this effort. Beginning in the mid-1900s, WMO and many of the world nations have created an infrastructure to collect and transmit meteorological observations to digital databases for ingest to monitor and predict weather. Various NMHS also began to collect, copy to microfiche and microfilm and store original paper charts. As digital databases grow and transmission of data improves, original paper forms useful for correcting and filling gaps in data series (from data lost in transmission) original forms are valued less, and sometimes stored in poor conditions or lost due to moves, wars and weather. In many regions where local NMHSs did not or do not have the resources to properly store, copy and digitize their data, there is an increasing need for data rescue, as old data get older and are at more risk for being lost.

This report responds to the European Environment Agency's request to:

(a) liaise with others dedicated to Data Rescue, such as the World Meteorological Organization (WMO), Copernicus Climate Change Service (C3S), National and Hydrological Meteorological Services (NMHSs), and non-profit organizations) to establish an understanding of past and current data rescue activities; and to

(b) Identify potential future data rescue activities.

Under the coordination of Météo-France, and its continued close collaboration with the WMO Expert Team on Data Requirements for Climate Services (ET-DRC), the concept of this report was to give the floor to the main actors on Data Rescue activities. The first step for this report consisted in contacting those major actors who were prepared to, and interested in contributing. Due to time constraint and the difficult COVID period, not all them were able to answer in a timely way.

Below are listed eight organizations who were able to participate and present both their vision and their on-going activities and future vision of data rescue. These organizations are:

1. The WMO Expert Team on Data Requirements for Climate Services (Section 2);
2. The Royal Netherlands Meteorological Institute, KNMI (Section 3);
3. The Meteorology, Climatology, and Geophysical Agency of Indonesia, BMKG (Section 4)
4. The European Centre for Medium-Range Weather Forecasts, ECMWF along with Copernicus Climate Change Service (C3S) (Section 5);
5. The International Atmospheric Circulation Reconstructions over the Earth, ACRE (Section 6);
6. NOAA/NCEI (Section 7);
7. Météo-France (Section 8);
8. The International Environmental Data Rescue Organization, IEDRO (Section 9).

A total of 15 persons from these organizations were involved in this report; they are identified here .

In addition to these perspectives of current and future plans, two retrospective case-studies of data rescue projects are presented: Mauritius (by ACRE. section 10) and Madagascar (by Météo-France, section 11).

To complete this big picture, and attempt to illustrate lessons learned and best practices. The section 12 provides a perspective on current and future activities, including suggestions for a way forward (see here)

1.2 Definition, historic, context and Data Rescue actors

"*Data rescue is the discovery, preservation, quality control, digitization and consolidation of past observations of the Earth system, including land surface, ocean and upper air data. It is not just about discovering and digitizing the data, but also involves bringing those data together in a consistent way and making them available to all*" ECMWF, (https://www.ecmwf.int/en/about/media-centre/focus/role-ecmwf-and-c3s-historical-data-rescue, as 12/12/2021).

Climate Data rescue is an inherent and fundamental activity of Climatology. As early as the 19th century, climatologists undertook Data Rescue actions. For example, Alfred Angot, head of the Climatology Department at the French national meteorological service, published the first catalog of meteorological instrumental observations made in France before 1850 and tried to recover the catalogued data.

Data Rescue (DARE) belongs to the long-standing strategic priorities of WMO. WMO DARE activities are threefold: i) Publication and promotion of DARE good practices; ii) coordination of international DARE activities with international partners; and iii) concrete support to national and international DARE efforts.

The Data Rescue term appears for the first time in the World Meteorological Congress reports in 1979. It emphasized that the concept of using microcomputer technology for climate data processing and Data Rescue was possible for most developing countries. The Eighth Commission for Climatology in 1982, urged donor countries to support the African Dare I project. And the Ninth Commission for Climatology in 1985 established for the first time a Working Group on Climate Data Management including in its terms of reference "*to guide the Data Rescue Project of the World Climate Data Program*".

The first guidelines on best practices for Climate Data Rescue were published in 2004 (revised 2016 as WMO-No 1182) and the International Data Rescue Initiative (I-DARE) portal was launched by WMO in May 2017, as a means of coordinating and promoting global data rescue efforts being undertaken by WMO, ACRE, IEDRO, multilateral partnerships, and providing resources such as links to international databases, reports and research regarding rescued data, best practices and tools for practitioners of data rescue.

Today, WMO with the assistance of the KNMI is maintaining the I-DARE portal which is synchronized with the C3S Data Rescue Portal. Both organizations have written guidelines, developed tools,

produced inventories and give assistance to users. A plan is proposed during the C3S phase II to rationalize the materials of both organizations.

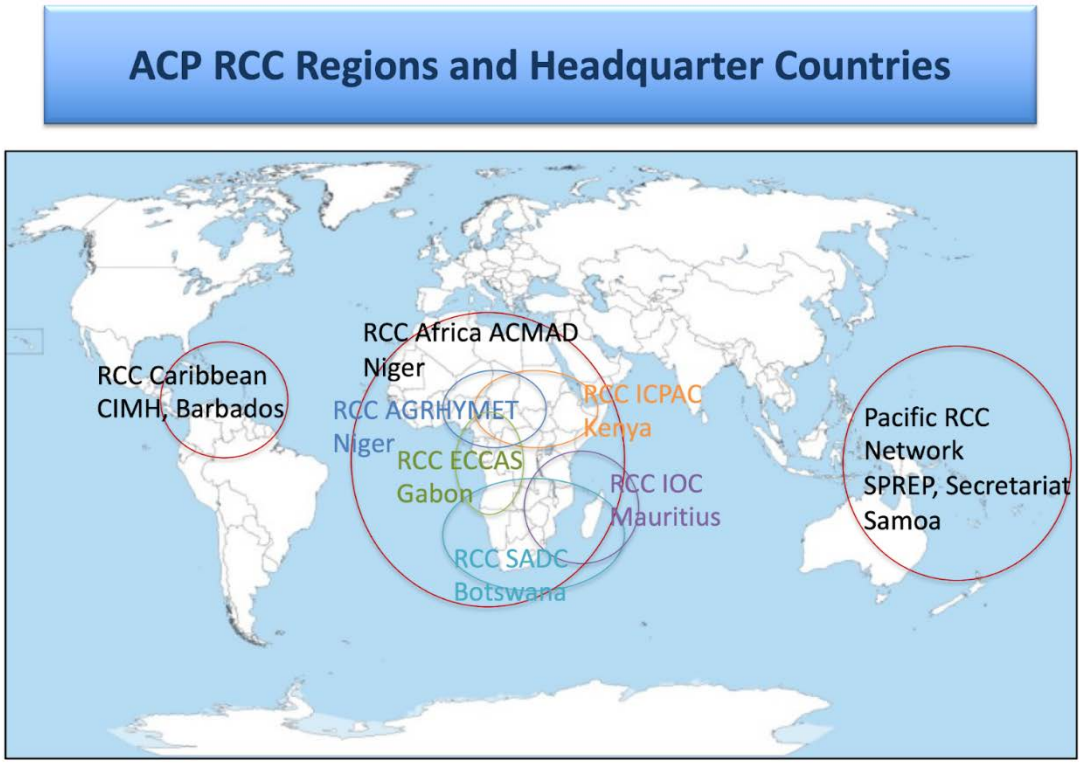
Relevant activities of two of the main actors include:

- ✓ The WMO ET-DRC has, as part of its terms of reference, to guide and make recommandations for Climate Data Management Systems and Data Rescue Project implementation. And also, to maintain and update the different WMO guidelines that are relevant to these activities (among others).
- ✓ The C3S Data Rescue Service team "is designed to facilitate and coordinate the rescue of weather and climate data from around the world. The service runs an online user-based system that provides access to information on past, current and planned data rescue projects, as well as tools and guidance to facilitate each stage of the data rescue process." (https://datarescue.climate.copernicus.eu/about).

Since the beginning of the 2000s, it has been recognized that Data Rescue is an integral part of Climate Data Management.

2 WMO and the ClimSA Activity 3.3 project

Contribution: Christina Lief, WMO Services Commission



The Intra-ACP Climate Services and Related Applications Programme – ClimSA, is an initiative of the Organization of the African, Caribbean and Pacific States (OACPS) funded by the European Union and aims to support the climate information services value chain with technical assistance, financial assistance, and infrastructure and capacity building support to improve wide access and use of climate information and applications for decision making processes at all levels, in the six regions of the OACPS through eight Regional Climate Centers (RCC): Pacific RCC Network, Caribbean RCC, ACMAD (designated RCC), IGAD RCC (ICPAC) (designated RCC), IOC (RCC under consideration), AGRHYMET (proposed RCC), ECCAS (proposed RCC), SADC (proposed RCC).

Under the ClimSA program, the WMO grant has the goal to improve the climate services value chain in five priority sectors: agriculture, disaster risk reduction, energy, health, and water. Underpinned by capacity development and knowledge management, WMO technical guidance addresses observations, data, predictions, models, and the mainstreaming of climate services into policy processes. The WMO has several ClimSA activities and activity 3.3 assesses the maturity of how data and products are managed at RCCs and related National Meteorological and Hydrological Services (NMHSs), to identify data gaps for disaster risk reduction, and to provide recommendations to fill data gaps and improving data availability. This activity includes data rescue. Interviews and assessments were conducted with the 8 RCCs and some related NMHSs in 2021. Below is a preliminary summary of the data rescue activities of interest (final report with complete assessments and strategy recommendations is planned for Q3 2022):

- **Caribbean RCC** at the Caribbean Institute for Meteorology and Hydrology (CIMH) (Anguilla, Antigua and Barbuda, Barbados, Belize, British Virgin Islands, Cayman Islands, Dominica, Grenada, Guyana, Jamaica, Montserrat, St. Kitts/Nevis, St. Lucia, St. Vincent and the Grenadines, Trinidad and Tobago, Turks and Caicos Islands):
    - Caribbean Development Bank and EU have funded data rescue projects. Data are archived in the CIMH database.
    - The CIMH Applied Meteorology and Climatology Section (AMCS) completed a Caribbean Meteorological Organization (CMO) Climate and Hydrological Data Rescue Initiative in recent years.
- **Pacific RCC** Network at the South Pacific Regional Environment Programme (SPREP) include 21 Pacific Island member countries and territories (American Samoa, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, Niue, Northern Marianas, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu and Wallis & Futuna) and Australia, France, New Zealand, Uk and US with direct interests in the region.
    - Most of Pacific Island countries members have been assisted by Australia and New Zealand, namely through the BoM CliDE DBMS (supported by BoM and CSIRO) and the National Institute of Water and Atmospheric Research (NIWA), regarding training on climate data, and in the past some of the countries (e.g., Samoa, Vanuatu, and Fiji) have participated in the Climate and Oceans Support Program in the Pacific (COSPPac) project for improving mitigation and adaptation of climate change activities, which also involves data rescue activities. It was reported that there still is a need for digitizing additional climate data records as well as training on data rescue.
- **The Southern African Development Community (SADC) is a Regional Economic Community and a Proposed RCC**, comprising 16 Member States: Angola, Botswana, Comoros, Democratic Republic of Congo, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Zambia, and Zimbabwe.
    - SADC plans to equip all countries in its community with Data Rescue functionality and has request ClimSA to help with identifying equipment that needs to be purchased.

- **Indian Ocean Commission (IOC) RCC:**
  - (Following information taken from the International Atmospheric Circulation Reconstructions over the Earth (ACRE) produced report on the Mauritius Project, a ACRE's Indian Ocean initiative). The WMO/ACRE/GFCS Indian Data Rescue initiative (INDARE) was launched as part of an International Workshop on the Recovery of Climate heritage in the Indian Ocean rim countries and islands in 2014. This was followed INDARE steering committee meetings in 2014 and 2015. Although INDARE lost impetus due to a lack of ongoing funding, and has been in hiatus since 2016, the above laid the grounds for the development of a specific data rescue initiative focusing on historical terrestrial and marine instrumental weather observations from the island of Mauritius under the auspices of the ACRE initiative. The resulting Mauritius Project, which has taken nearly 8 years to come to fruition, sees ACRE partnering with the Meteorological Society of Mauritius (in conjunction with the Mauritius Meteorological Services) to recover, image, digitize, archive, and preserve old terrestrial and marine weather observations held in the National Archives of Mauritius and the Mauritius Meteorological Services. (https://community.wmo.int/indian-ocean-data-rescue-initiativeindare).
  - Also, part of the INDARE project, is recovering of climate records and to improve the quality of climate datasets from Madagascar, Mayotte and Comoros involving both meteorological service of Madagascar (DGM) and Météo-France. This project is presently ongoing. (https://www.idare-portal.org/fr/data/west-indian-ocean-data-rescue)

3 The WMO iDare and the Copernicus Data Rescue Portals

Contribution: Peter Siegmund & Gé Verver, KNMI

The WMO iDare portal (https://idare-portal.org/) and the C3S Data Rescue Portal (https://datarescue.climate.copernicus.eu/) aim to improve the recovery of in-situ climate observations worldwide. The portals provide overviews of finished and ongoing data-rescue projects as well as an inventory of to-be-rescued data. Obviously, it is based on information that is put on the portal and will therefore not be complete. The contents of both portals are daily synchronized and essentially provide the same information.

3.1 Summary of the gaps report C3S

The Copernicus Climate Change Service (C3S) published a report "Identifying Data Rescue Gaps and Issues" (C3S, 2020). This report provides an overview of historical climate records that are available in digital format in global data repositories and proposes criteria for prioritization of data rescue activities based on current data gaps.

The global climate data repositories that are examined are for instance the temperature, precipitation, and pressure datasets from the Climate Research Unit at the University of East Anglia (Norwich, UK), GPCC from the Deutscher Wetterdienst, and GHCN and ISPD from NOAA/NCEI and CIRES. It is likely that more digital data exists, but these data holdings are not always easily accessible and available for examination.

The gaps and data rescue priorities given in the Copernicus Climate Service report

'*Identifying Data Rescue gaps and issues*' (C3S, 2020) are:

- ✓ Air pressure data to feed global reanalysis like the NOAA/CIRES/DOE Twentieth Century Reanalysis (see figure … for the pressure data coverage from 1850 onward);
- ✓ Observations over the Southern Hemisphere land surface from the mid-19th century to the mid-20th century, and from regions showing data scarcity, i.e. the African land surface, part of Central and South America, and Southeast Asia and the Western Pacific;
- ✓ Marine surface observations, from the mid-19th century to the mid-20th century taken by ships in the Southern Oceans;
- ✓ Gaps in data coverage continued after 1950 in Central Africa, Parts of South America, and across most of the SH oceans.

3.2 Extraction data rescue portals

From the priorities proposed in the gaps report we selected data rescue projects from the data rescue portals that satisfy at least one of the following two criteria:

- ✓ Projects that contain observations from before 1950 outside the European land surface
- ✓ Projects that indicated a need for assistance

Pressure data was not used as a criterium, although it was listed as a priority in the gap report, but by far most projects on the list also propose to recover pressure data. In the table below the results are listed and when a criterium is met this is indicated with yellow.

It should be realized that other criteria might be applied depending on the specific needs (region, period) of an application.

Contact details and other information of these projects can be found at https://idare-portal.org

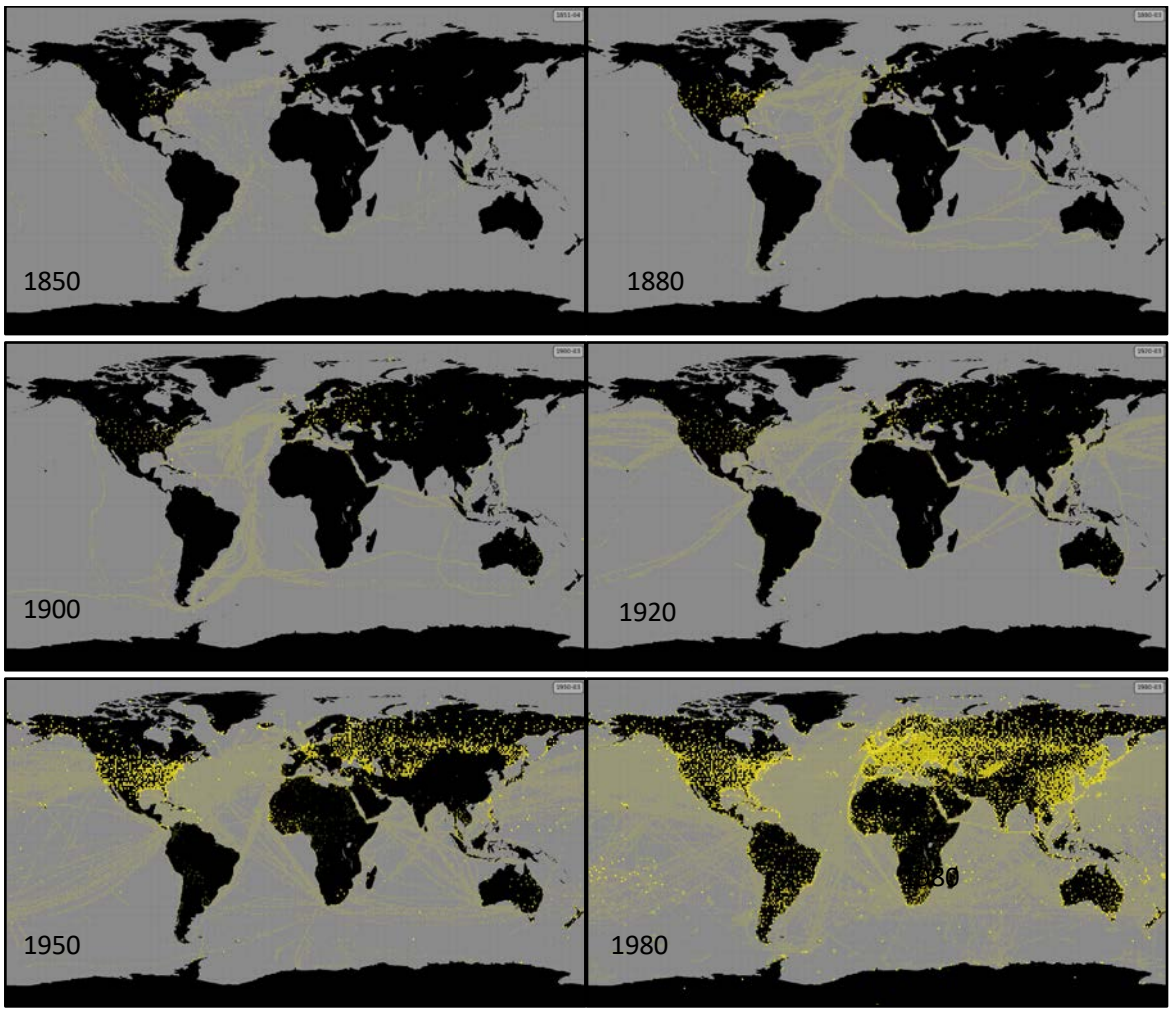


Figure 2 - Surface pressure observations used in the Twentieth Century Reanalysis (20CR) Project (Compo et al. 2011, Slivinski et al. 2019), visualized by Philip Brohan (philip.brohan @ metoffice.gov.uk). In each 1x1 degree grid-cell, a bright yellow circle is shown if at least one pressure observation is available every 6 hours (one in each assimilation run). Paler yellow circles indicate observations in some, but not all assimilation periods (partial coverage). (From https://oldweather.github.io/20CRv3-diagnostics/obs_video/obs_video.html)

Name	Data categories	Data Start & End Date	Institute (or other) name	Need assistance	Parameters	Period	Project Status	WMO-Region	Rescue Method	Stage of data rescue	Type of assistance required	Country
ACRE MESOAMERICA	Atmospheric		Pablo Imbach	Yes		2015	Ongoing	Region IV (North and Central America, and the Caribbean)			Economic resources	Costa Rica
Canadian Volunteer Rescue Project	Atmospheric	04-Jan-2010 to 01-Jan-2016	ACRE-Canada	Yes	Temperature, Surface Pres., Wind	2019	Postponed	Region IV (North and Central America, and the Caribbean)	Citizen Science		Merging data into inventories and adding metadata	Canada
DARE in National Center for Hydrology and Meteorology	Atmospheric, Hydrological, Terrestrial		National Center for Hydrology and Meteorology,Bhutan	Yes	Temperature, Precipitation, Surface Pres., Wind, Other	2016		Region II (Asia)			Funding for the project and the experts. DARE infrastructure.	Bhutan
Data Rescue in Senegal	Atmospheric		Agence Nationale de l'Aviation Civile et de la Météorologie (ANACIM)	Yes		2016		Region I (Africa)			See attached report	Senegal

Name	Data categories	Data Start & End Date	Institute (or other) name	Need assistance	Parameters	Period	Project Status	WMO-Region	Rescue Method	Stage of data rescue	Type of assistance required	Country
Data Rescue Initiative for the Southern Alps	Atmospheric	01-Jan-1800 to 15-March-1921	Yuri Brugnara	Yes	Temperature, Precipitation, Surface Pres., Wind, Other	2014	Ongoing	Region VI (Europe)			Volunteers to type the data	Switzerl.
-	Atmospheric	1920-1969	WMO	Yes	Temperature, Precipitation, Surface Pres., Wind, Other	2019		Region I (Africa)			Technical and financial	Libya
Digitalizacion de bandas registradoras	Hydrological, Terrestrial		SENAMHI	Yes	Temperature, Precipitation, Other	2018		Region III (South America)				Peru
Escaneo de planillas climatologicas			SENAMHI	Yes		2019		Region III (South America)				Peru
Estaciones Centenarias	Atmospheric		Servicio Meteorológico Nacional (Argentina)	Yes	Temperature, Precipitation, Surface Pres., Wind, Other	2018		Region III (South America)		Processed	Specific scanners to digitize all types of documents: e.g. microfiche, paper records.	Argentina

Name	Data categories	Data Start & End Date	Institute (or other) name	Need assistance	Parameters	Period	Project Status	WMO-Region	Rescue Method	Stage of data rescue	Type of assistance required	Country
Pakistan's Climate Data Rescue	Atmospheric	01-Jan-1891 to 12-Nov-2019	Pakistan Meteorological Department	Yes	Temperature, Precipitation, Surface Pres., Wind, Other	2019		Region II (Asia)		Keyed	Technical & financial	Pakistan
Rescate de diagramas de higrotermogramas y pluviogramas en Quinta Normal	Atmospheric Terrestrial	01-Jan-1957 to 31-Dec-2014	Dirección Meteorológica de Chile	Yes	Temperature, Precipitation, Other	1957 to 2014	Onhold	Region III (South America)		Identified and documented	Financing and support to rescue data from diagrams	Chile
Rescuing and recovery of climate data in Slovenia	Atmospheric	01-Jan-1859 to 31-Dec-1948	Slovenian Environment Agency	Yes	Temperature, Precipitation, Surface Pres., Wind, Other	2013 to 2019	Ongoing	Region VI (Europe)	Search foreign archives (Austria, It.), imaging, keying		Recovering the meteorological data in foreign archives	Slovenia
Sample French Guiana Data Rescue Project	Atmospheric		Météo-France	Yes	Temperature, Precipitation, Surface Pres., Wind, Other		Planned	Region III (South America)				France

Name	Data categories	Data Start & End Date	Institute (or other) name	Need assistance	Parameters	Period	Project Status	WMO-Region	Rescue Method	Stage of data rescue	Type of assistance required	Country
Sauvetage des anciennes données climatologiques			Institut National de la Météorologie	Yes	Temperature, Precipitation, Surface Pres., Wind, Other			Region I (Africa)			Technical and material assistance	Tunisia
-	Atmospheric, T Terrestrial	01-Jan-1960 to 01-Jan-2020	instituto nacional de Meteorologia - INAMET	Yes	Temperature, Precipitation, Surface Pres., Wind, Other	1960 to 2020		Region I (Africa)		Identified and documented	Assistance on digitalize data from paper	Angola
The Parana-Uruguay River Basin Project		01-Jan-1875 to 31-Jul-2017	Andrés Antico	Yes	Temperature, Precipitation, Surface Pres., Wind, Other	2014	Ongoing	Region III (South America)		Processed	Financial	Argentina
ACRE Oceans (Antarctic and Southern Ocean 20C)	Atmospheric, Oceanic	mainly 1900-1980	CSW Associates Data Services	No	Temperature, Precipitation, Surface Pres., Wind, Other	2019	Ongoing	Polar regions, Atlantic, Pacific, Indian Ocean		Imaged		UK
ACRE Oceans (Arctic)	Atmospheric, Oceanic	1850-1914	CSW Associates Data Services	No	Temperature, Precipitation, Surface Pres., Wind, Other	2018	Ongoing	Region VI (Europe), Polar reg., Atl. Ocean	Photography	Imaged		UK

Name	Data categories	Data Start & End Date	Institute (or other) name	Need assistance	Parameters	Period	Project Status	WMO-Region	Rescue Method	Stage of data rescue	Type of assistance required	Country
ACRE Oceans (Asia Pacific)	Atmospheric, Oceanic	~1850-1950	CSW Associates Data Services	No	Temperature, Precipitation, Surface Pres., Wind, Other	2016	Ongoing	Region II (Asia), Global (marine), Atlantic, Pacific, Indian. Ocean	Photography	Imaged		UK
ACRE Oceans (Japan)	Atmospheric, Oceanic	~1850 century onwards	CSW Associates Data Services	No	Temperature, Precipitation, Surface Pres., Wind, Other	2018	Ongoing	Region II (Asia), Global (marine), Atlantic, Pacific, Indian Ocean	Photography	Imaged		UK
ACRE Oceans (Pacific)	Atmospheric, Oceanic	~1859-1950	CSW Associates Data Services	No	Temperature, Precipitation, Surface Pres., Wind, Other	2019	Ongoing	Global (marine), Polar reg., Atlantic,Pacific, Indian Ocean	Photography	Imaged		UK
ACRE Oceans (Remark Books)	Atmospheric, Oceanic	18th-20th century	CSW Associates Data Services	No	Temperature, Precipitation, Surface Pres., Wind, Other	2021	Ongoing	Global (marine), Polar reg., Atlantic,Pacific, Indian Ocean	Photography	Imaged		UK
ACRE Oceans (Southern Africa)	Atmospheric, Oceanic	1844-1912	CSW Associates Data Services	No	Temperature, Precipitation, Surface Pres., Wind	2017	Ongoing	Region I (Africa), Atlantic Ocean, Indian Ocean	Photography	Imaged		UK

Name	Data categories	Data Start & End Date	Institute (or other) name	Need assistance	Parameters	Period	Project Status	WMO-Region	Rescue Method	Stage of data rescue	Type of assistance required	Country
DARE Activities India		03-apr-32	Umesh Joshi	No				Region II (Asia)				India
Data Rescue in Mozambique		> 1908	Nancy Westcott	No		2017		Region I (Africa)				Mozambique
Data Rescue in Tanzania	Atmospheric	>100 year length	Tanzania Meteorological Agency	No	Temperature, Precipitation, Surface Pres., Wind, Other	2016 to 2020		Region I (Africa)				Tanzania
Data rescue Myanmar		>1875	ACRE China	No		2017		Region II (Asia)				Myanmar
Historical Southern Australian Lighthouse Weather Observations		01-Jan-1850 to 31-Dec-2015	Rob Allan	No				Region V (South-West Pacific)				Australia

Name	Data categories	Data Start & End Date	Institute (or other) name	Need assistance	Parameters	Period	Project Status	WMO-Region	Rescue Method	Stage of data rescue	Type of assistance required	Country
Historical Southern Ocean and Antarctic Weather Observations		01-Jan-1800 to 18-May-2015	Clive Wilkinson	No				Region VI (Europe)				UK
Japan-Asia Climate Data Program		01-Jan-1829 to 31-Dec.-1889	Seikei University	No	Temperature, Precipitation, Surface Pres., Wind, Other	2019		Region II (Asia)				Japan
Recovery of Historical Meteorological Data in Hong Kong	Atmospheric, Oceanic, Terrestrial	01-Jan-1884	Hong Kong Observatory	No	Temperature, Precipitation, Surface Pres., Wind, Other	2018	Ongoing	Region II (Asia)				People's Republic of China
The Mauritius Project		01-Jan-1770 to 31-Dec-1950	Rob Allan	No				Region I (Africa)				UK

Table 1- List of (potential) data rescue activities registered in the iDare and C3S Data Rescue portals, selected on the reported need for assistance and period and area covered by the observations (as for August 2021).

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4 SACA&D Indonesia

Contribution: Sunaryo Tri Nurmayati (Coordinated by Dr. Urip Haryoko), BMKG

4.1 The Organization

BMKG is a non-ministerial government agency that is assigned the task based on Law Number 31 of 2009 to carry out meteorological, climatological and geophysical activities. Its activities include meteorological, climatological and geophysical observations, data collection, data processing, data archiving, analysis, information generation and dissemination.

BMKG has been carrying out observations since around 1860. The data is archived well after around the 1960s, so that before 1960 with a span of almost 100 years, the data has not been collected and archived properly. In the context of climate analysis and climate change, data in the form of documents (books and publications) need to be saved and converted into digital data.

Data rescue activities have not been completed, there is still a lot of data in the form of documents. In the future, BMKG will continuously continue to save data so that data is properly archived in the form of digital data.

4.2 Mission, Philosophy-Vision, Strategy

4.2.1 Vision

Realizing a reliability, responsive and capability of BMKG in order to support public safety and the success of national development, and play an active role at the international level.

The terminology in the vision can be explained as follows:

- ✓ Reliable meteorological, climatological, air quality, and geophysical information services are BMKG services for the presentation of data, information on meteorological, climatological, air quality, and geophysical services that are accurate, on target, effective, fast, complete, and accountable;
- ✓ Responsive and capable means that BMKG can capture and formulate stakeholder needs for meteorological, climatological, air quality and geophysical data, information and services and be able to provide services according to the needs of service users;

4.2.2 Mission

In order to realize the BMKG Vision, a clear vision is needed, namely in the form of BMKG steps to realize the mission that has been set, namely:

- ✓ Observing and understanding meteorological, climatological, air quality and geophysical phenomena;
- ✓ Providing reliable meteorological, climatological, air quality and geophysical data, information and services.

- ✓ Coordinate and facilitate activities in the fields of meteorology, climatology, air quality and geophysics;
- ✓ Actively participates in international activities in the fields of meteorology, climatology, air quality and geophysics.

4.2.3 Strategy on Data Rescue

BMKG has been carrying out observations since around 1860. The data is archived well after around the 1960s, so that before 1960 with a span of almost 100 years, the data has not been collected and archived properly. In the context of climate analysis and climate change, data in the form of documents (books and publications) need to be saved and converted into digital data.

Weather, climate and geophysical data are the records of the earth, so it is very important to have complete data. Each data has a different meaning in its era. In the past, data may only produce one piece of information, and now or in the future, with the development of technology, data can produce tens or even hundreds. In addition, future conditions can be predicted using historical data for appropriate policy making. Climate weather phenomena and geophysics are not administratively limited, but are closely related globally, so climate and geophysical weather data are a global need and data rescue must also be on a global scale.

Data rescue activities have not been completed, there is still a lot of data in the form of documents. In the future, BMKG will continuously continue to save data so that data is properly archived in the form of digital data

4.3 Activity and Partnerships

- ✓ Meteorological, Climatological and Geophysical data rescue (BMKG);
- ✓ Climate data rescue (data for 1860 - 1970): collaboration on DIDAH Project (BMKG – KNMI);
- ✓ Climate data rescue (data for 1970 - 2012): collaboration on DATACLIM Project (BMKG GIZ).

Indonesia, especially BMKG was doing to initiate the Indonesia data rescue in cooperation with KNMI Hollands.

Data rescue activities in BMKG is going to finish of precipitation monthly data from 1917 to 1972 for more than 3400 observation stations around of Indonesia and daily precipitation data from 1879 until 1917 for about less than 600 observation stations throughout Indonesia. The other data rescue is Batavia Station (Jakarta station with WMO id 97745), this is one of stations which had being operated more than 100 years.

The recovery data was being done in digital and hardcopy data. BMKG has developing programs to make historical database and data library as a priority program. The challenges in the future is arrangement of old metadata and adapted with new metadata to arrange of historical database, it needs to consolidate with the internal and external institution. The outcome of this data rescue is long-term data series availability and standard metadata as the basic need for BMKG Database System.

4.4 DIDAH (Digitization of Historical Data) PROJECT:

4.4.1 Brief summary and expectations

Since early 2009 the Indonesia Agency for Meteorology Climatology, and Geophysics, BMKG has worked together with the Royal Netherlands Meteorological Institute KNMI on project Didah (for "Digitisasi Data Historis"). This cooperation project focused on the digitization of historical climate data from the Indonesian region from the period 1840 -1970. Three years later, millions of handwritten and printed historical weather and climate observations from the period 1850 – 1980 have been digitized and stored in a web oriented regional database and software system. "The south East Asian Climate Assessment & Dataset ", SACA&D (https://sacad.database.bmkg.go.id)

The objectives of the project are:

1. To digitize the handwritten and printed historical weather and climate observations into a digital format which is suitable to international standard
2. To increase the data availability of BMKG database system
3. To make easy and fast access to climate data from the BMKG database system

In the future, it is hoped that data rescue activities will continue to be carried out, especially digitizing hourly surface weather observation data (synop) which is still in book form starting from 1960 to 2015, readings of rainfall intensity, temperature, pressure, solar radiation and sunhsine duration of irradiation.

4.4.2 Domain of the Data

Domain of the data consists of all-around Indonesia region.

4.4.3 Periods and Parameters

- ✓ Daily Data Batavia some parameters from 1866 1997 and magnetic data;
- ✓ Monthly Rainfall Data of Indonesia from 1917 to 1974;
- ✓ Secondary stations is historical observation stations with number 73 stations around Indonesia which was observed more than 1 parameter. Form of data is in bulletin with some analysis in English, Holland and French languages.

4.4.4 State of the project

The Didah project was completed around 2012, and was continued by BMKG itself, namely digitizing hourly surface weather data and document data rescue. One of the efforts made is to create an application program to extract the strip-chart of rainfall, temperature, humidity and radiation data.

4.4.5 Rough estimation of the budget and of the assistance needed

The budget for implementing this project is a combination of the budget of KNMI and BMKG. The project budget is used to finance the following activities:

1. Visiting scientists between countries
2. Training in the Netherlands and in Indonesia
3. Cost for data digitization
4. Workshops and seminars
5. Travel to 10 ASEAN countries
6. Climate Data book printing

The total cost is approximately 8 billion rupiah.

To continue data rescue activities in the future, Indonesia needs a funding for data digitization and the construction of a standard data warehouse to store documents or data records.

4.5 Data Rescue Project 2

CLIM DATA Project is a project of recovery climate daily data and voluntary rainfall data in cooperation between GIZ Germany and BMKG for 1960/1970 ~ 2010

Activities:

- ✓ Collecting of daily climate data and voluntary rainfall data over Indonesia
- ✓ Quality control of climate daily data and voluntary rainfall data.
- ✓ Scanning of climate report into document
- ✓ Capacity building

Dataclim Project Results:

- ✓ Daily climate data from 164 Stations are stored at Database Management System / DBMS (BMKGsoft)
- ✓ Voluntary Rainfall Data (4866 stations) are stored at DBMS (BMKGSoft)

Metadata:

Metadata of meteorological station and voluntary rainfall station have been defined with a standard metadata based on WMO guidelines.

5 Data rescue activities within the Copernicus Climate Change Service.

Contribution: Hans Hersbach, ECMWF

The Copernicus Climate Change Service (C3S) is operated by the European Centre for Medium-Range Weather Forecasts (ECMWF) on behalf of the European Commission. Amongst a wide range of activities, C3S also operates services related to collection and processing of *in situ* observations in support of climate services development. The overall objective is to improve access to available *in situ* instrumental data records and to data streams from observing networks, as needed for climate change monitoring and climate science. One important element is data rescue for which C3S has funded selected data rescue activities. Part of these were employed by the Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative, in particular in three key regions of the southern hemisphere: ACRE South Africa digitised over 1.5 million sub-daily, daily and monthly observations from several sources including the Royal Astronomical Observatory in Cape Town and colonial records in Maputo, Mozambique; ACRE Antarctica digitised more than 118 thousand marine observations from 219 ships' logbooks; ACRE Argentina digitised observations from the Argentine Daily Weather Report for 1902-1919 and from the yearbooks of the Argentine Weather Office from the period 1801-1912.

In addition, C3S had set up a project with the Royal Meteorological Institute of Belgium (RMI) to image historical meteorological records over Africa that originated from the African Centre of Meteorological Applications for Development (ACMAD). Following two previous projects, IDCC (in 1979) and Dare I (1989 to 1996), the RMI is the owner of 1,655 microfilms and 503 boxes of microfiches that contain these data. In total about 4 million pages of meteorological observations from c were successfully imaged and are now secured onto stable media. The next step will be the digitization of these historical records such that they can be publicly shared and also ingested in future climate reanalysis activities.

Figure 1 : Micro fiches and micro films of the ACMAD dataset that reside at RMI and that were recently imaged onto stable media.

In addition to these activities, C3S concentrates on the coordination of data rescue activities as a whole. For this the C3S Data Rescue Service was established, which provides an overview of existing data rescue activities worldwide. This portal aims to be an authoritative source of information on the state of data rescue activities. It provides an overview of existing data rescue projects, what data have been rescued so far, what is known to exist but has not yet been digitized, what records have been only imaged, etc. The inventories provide information on metadata, rather than access to the observations themselves. The portal allows users worldwide to register and add information on their projects and to upload metadata to the inventories. In addition, the portal provides access to tools and training material to prospective data rescuers, including a job-dispatch system for data rescue projects. This portal is synchronised with the KNMI/WMO International Data Rescue Portal (I-DARE).

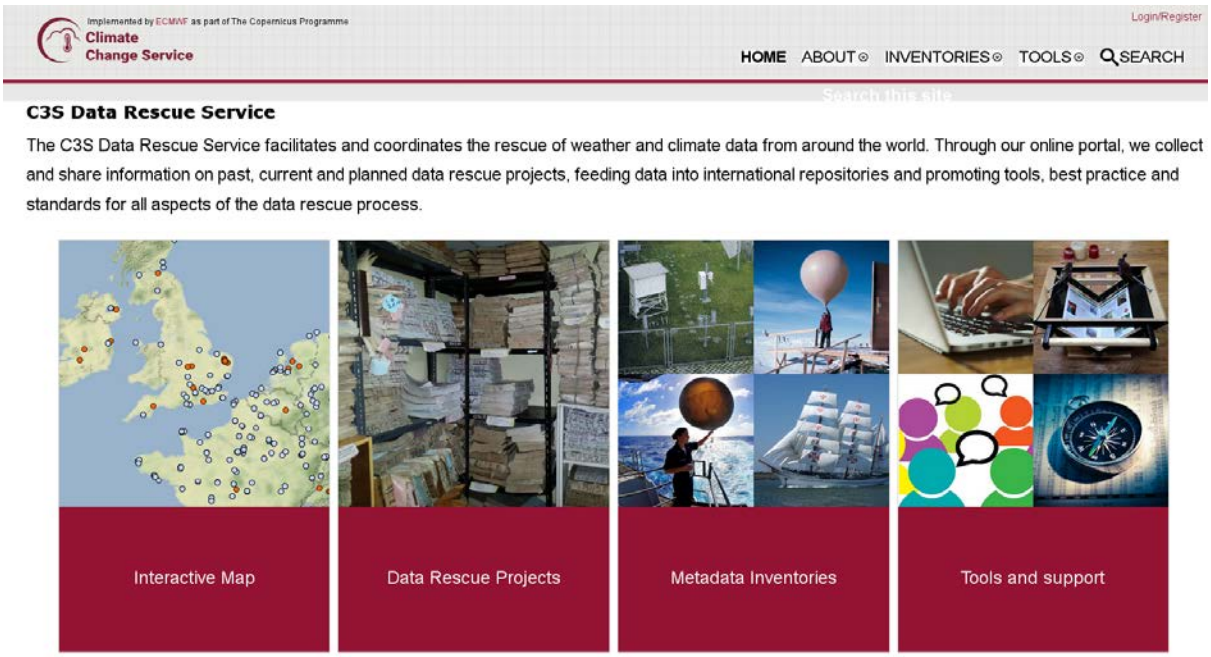

Figure 2 : access point of the C3S Data Rescue Service at https://datarescue.climate.copernicus.eu/.

In addition, C3S has established the C3S Data Deposition Service, which is an upload service that allows providers from anywhere in the world to contribute to the C3S *in situ* databases. Behind the public eye, this part of the service includes the ingestion of such submitted records into future versions of consolidated archives and the improvement and harmonisation of such versions. This portal is also used as the entry point for historical data that have become available via bilateral agreements on data sharing with the European Commission, such as from Canada, Chile and recently Brazil.

Final step in the process of data rescue is the public release of these datasets into consolidated comprehensive well-maintained repositories as dedicated catalogue entries in the C3S Climate Data Store (CDS). Recently a comprehensive land dataset was released, which contains historical meteorological observations reaching

back to 1755. A marine dataset, which is based on a recent version of the International Comprehensive Ocean-Atmosphere Data Set (ICOADS), is to be published soon. This activity is an essential part of the service since 1) it provides an easy-to-use, quality controlled, collated dataset from many sources in a unified format to anyone in the world and 2) prevents that previously rescued data gets lost again. In particular, the latter is a real danger when this final step of collation is not performed.

The consolidated datasets form an important source of information on the details of our weather and climate over the last few centuries. In particular, these datasets are a prime source of information for climate reanalysis, which, by combining observations with a recent state-of-the-art weather model and the resulting maps-without-gaps provide a full overview of the atmosphere, land and ocean over a number of recent decades. Climate reanalysis is very popular with many users in the academic, public, private, NGO and other sectors. An example is the C3S ERA5 reanalysis that is produced at ECMWF and provides hourly snapshots of the global atmosphere from 1950 onwards at a horizonal resolution of 31km.

In recent decades the observing system is quite mature since many satellite observations are available that are sensitive to a host of geophysical quantities. Further back in time the situation is quite different. Before the 1980s there are many sparsely observed regions, in particular over the southern hemisphere. This is illustrated in Figure 3 which shows the skill of 10-day re-forecasts that were issued from the ERA5 reanalysis. Since better initial conditions (ERA5 reanalysis) result into better forecasts their skill provides information on the quality of the ERA5 reanalysis itself.

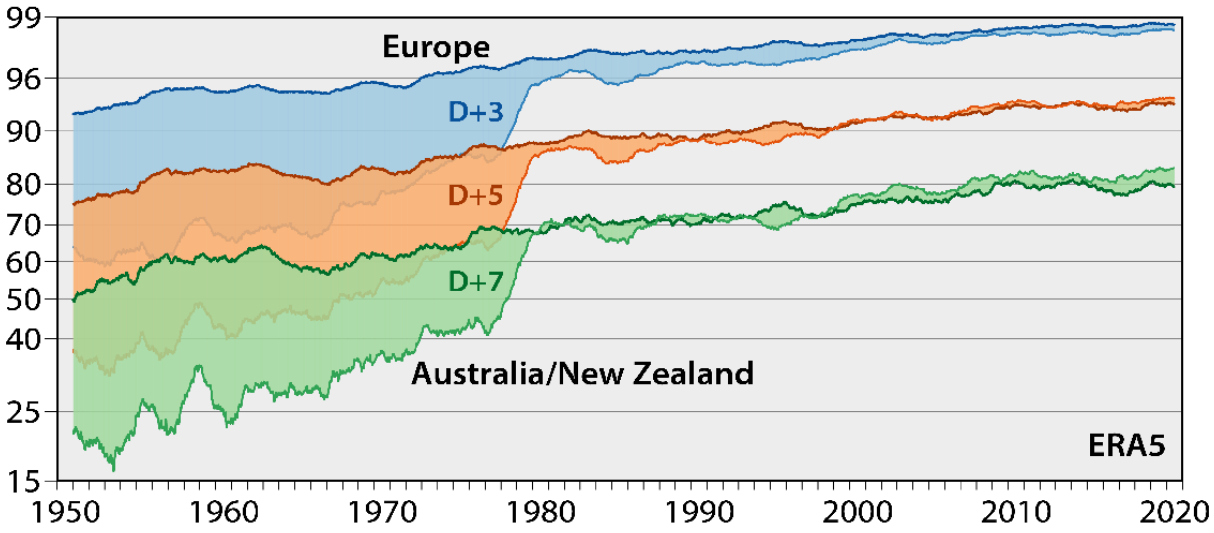

Figure 3: 731-day running mean anomaly correlation of 500 hPa height forecasts (%) that provide a measure of the quality of 10-day reforecasts that were initiated from the ERA5 global reanalysis. Higher values represent better skill; 90% is regarded as an excellent forecast, 80% as a good forecast and 60% on the edge of usability.

The figure clearly shows that data rescue activities over sparsely sensed areas have a large potential in enriching our knowledge on historical weather. This is the reason why C3S has concentrated on datasets as mentioned above, i.e., over the Southern Hemisphere and Africa. Although over Europe the quality of ERA5 looks quite promising even in 1950, it must be noted that, when going further back in time, available records do decline everywhere, and the rescue from any existing sources is important. In particular, the availability of observations on historical extreme events will enable us to better assess the frequency of such events and how their statistics is evolving in a changing climate.

In addition to the need of data rescue activities, it must be stressed that the availability of meta data is key. Not only location and observed value is important, but also station height, details on the instrumentation and original units of reporting. For instance, the usefulness of a wind or pressure observation is complicated when the observation height is unknown. Knowledge on the move of a station or change in instrumentation greatly helps the correction of sudden jumps in station time series (a process that is called homogenization). In order to cater for this, C3S has developed a common data model that allows for retaining any meta data that has been recorded and which can be made available to users.

To summarize, for C3S, the collection and processing of historical weather records forms an important element of the service. C3S engages in the complete trajectory from the provision of an overview of data rescue activities worldwide, providing guidelines and tools to data rescuers, funding of selected data rescue activities, collection into well-maintained repositories and their provision of public access.

6 ACRE

Atmospheric Circulation Reconstructions over the Earth

Contribution: Rob Allan, ACRE

The international Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative, based at the UK Met Office, is a 'grassroots' 'end-to-end' entity that both undertakes and facilitates the recovery, imaging, digitisation and curation of historical instrumental surface terrestrial and marine global weather observations that underpin 3D weather reconstructions (reanalyses) spanning the last 200-250 years for climate applications and impacts needs worldwide. It tends to focus on pre-World War 2/1950s weather observations, with all the historical surface weather data and the reanalyses outputs being freely available.

ACRE also works closely with the World Meteorological Organisation (WMO), World Climate Research Programme (WCRP), Group on Earth Observations (GEO), Global Climate Observing System (GCOS), Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, NOAA's National Centers for Environmental Information (NCEI), International Environmental Data Rescue Organization (IEDRO) and various National Meteorological Services (NMSs), particularly Royal Netherlands Meteorological Institute (KNMI), German Weather Service (Deutscher Wetterdienst – DWD) and Météo-France.

ACRE's digitised terrestrial data are currently held in the International Surface Pressure Databank (ISPD) (https://reanalyses.org/observations/international-surface-pressure-databank) and marine data in the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) (https://icoads.noaa.gov/), but will eventually all be held in the Global Land and Marine Observations Dataset (GLAMOD) (https://climate.copernicus.eu/global-land-and-marine-observations-database-0). The distribution of global terrestrial stations with digitised data for each year in the ISPD can be seen at: https://psl.noaa.gov/data/ISPD/. Further details of ACRE and various international and regional data rescue activities can also be found on the WMO I-DARE portal. A review of historical marine data rescue is provided in the WMO Bulletin for 2021.

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ACRE also has a social media presence on Facebook and Twitter. Due to continuing Covid-19 restrictions, the next ACRE Annual Meeting is a virtual event spread across the 4th and 5th of October 2021.

6.1 The interlinked ACRE, MO UK Newton Fund foci and the Copernicus Climate Change Service (C3S) Data Rescue Service (DRS)

These initiatives are major components of international data rescue activities within the weather/climate science community and provide essential funds for data rescue activities in various ACRE regional foci/chapters detailed below. They provide users in various climate applications and services with new information and data baselines with which to plan for and manage current and future global to regional physical and socio-economic impacts.

As a result of the Copernicus funding of C3S DRS, there are now Best Practice Guidelines and Annual State of Data Rescue Assessments (2019) created by that Service which are available.

ACRE centrally held Data and Images/Scans Holdings

The following links are to the images/scans held centrally by ACRE (https://data.ceda.ac.uk/badc/corral/images/metobs/), with those to weather observations available online NOAA Central Library, University of Chile, SIGN, Hong Kong, Singapore, International Bull Simultaneous Met Obs,.Salvá Sinobas,.French Daily Weather Reports: 1857-1923 Bulletins climatiques quotidiens, French Academy of Medecine- ANR-CHEDAR, Old Dutch Data in Newspapers,.Old Hong Kong Newspapers Collection, Macau Government Gazette, NCDC searchable online catalogue of their data holdings, China Meteorological Publications 1872 - 1951.

Links to digitised data from various countries and regions around the world undertaken by ACRE since its inception in 2007, are shown below. These data were imaged and digitised by a mixture of volunteer and paid contractors under the UK Newton Fund ACRE China and ACRE South Africa and the EU Copernicus C3S DRS. Special thanks to Gail Kelly (and supervised UK Met Office volunteer workers Ban Bickle and Alister Ferguson), Met Office Library and Archives staff, Christa Pudmenzky (University of Southern Queensland, Australia) (*Weather Detective* volunteers), the University of Giessen in Germany (led by Juerg Luterbacher and Elena Xoplaki), and the University of Bern in Switzerland (Stefan Brönnimann and Yuri Brugnara).

Other projects linked to ACRE are the weather data imaged and digitised by COBECORE (http://cobecore.org/map/) for the old Belgian Congo (https://www.dropbox.com/home/AFRICA/BELGIAN%20CONGO) and the Mauritius Project, with funding from the UK Newton Fund CSSP China, sees ACRE partnering with the Meteorological Society of Mauritius (in conjunction with the Mauritius Meteorological Services) in order to recover, image, digitise, archive, and preserve old terrestrial and marine weather observations held in the National Archives of Mauritius and the Mauritius Meteorological Services.

AFRICA

https://www.dropbox.com/sh/ofrq5vu89cntz4u/AADVm5ZEux1FofO6E1T6DPZna?dl=0

https://www.dropbox.com/sh/eomie6hhk6ycveh/AACBjdyCyYt2pUSihijh3N7da?dl=0

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ALASKA

https://www.dropbox.com/sh/lthdiyj9rp82wtu/AABB1priEvvBH4i0vr-mNb3Na?dl=0

ALDERNEY - CHANNEL ISLANDS

https://www.dropbox.com/sh/18i4ssgz60x5psw/AACt_B6JJZ-7Agrv5ga5Y-O0a?dl=0

ANTARCTIC EXPEDITIONS

https://www.dropbox.com/sh/aipodw4mx1iiawn/AAAwnUwduoBRUU7YF1FRXRdYa?dl=0

ANTARCTIC ISLANDS

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ARCTIC

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ATLANTIC

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AUSTRALIA

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https://www.dropbox.com/sh/a9ftoxqm16dfgax/AAABMKOHlTf_vyTVOrEwbfHQa?dl=0

AUSTRALIAN LIGHTHOUSES

https://www.dropbox.com/sh/nvu1sy9b8zdi9o5/AAC3i6blMKSR8ydLLv4jlJH9a?dl=0

AUSTRALIAN SEA LEVEL PROJECT

https://www.dropbox.com/sh/ws11ksxskksyyy5/AADZReS3BTYK7IGt-KacWJc3a?dl=0

BURMA

https://www.dropbox.com/sh/jwoq73gtk9ucx3k/AABP_QEwboHYGO8wfaYkn6nfa?dl=0

CANADA

https://www.dropbox.com/sh/82dj0saczemx0b2/AAAy9L3zc7m4jlWTs-knxT4ra?dl=0

CARIBBEAN

https://www.dropbox.com/sh/drklmivns45ivej/AACAceXZGZ_O_JUW97t4ov51a?dl=0

CENTRAL AMERICA

https://www.dropbox.com/sh/l33am0rsfmga1de/AACAN8vDBYhsprjOu2QPALwga?dl=0

https://www.dropbox.com/sh/sjwk7l79mk0kzsy/AAB4TkZR_A2P9GI60OVU3TCAa?dl=0

CHINA

https://www.dropbox.com/sh/3xojfpc1k6zztxk/AAAzESdqIMr-7vjiMRZIj7kYa?dl=0

https://www.dropbox.com/sh/g2oaco30kqg4phx/AADyzRjSwCciJ-XMv3vS-b6Ea?dl=0

https://www.dropbox.com/sh/e25gz2rg1yfq16w/AADTHJtogdgE1b5HH6UTI7Dxa?dl=0

https://www.dropbox.com/sh/0ilpvz3yyk1q5ac/AABq1xYNpjL93nfQamDKKAWua?dl=0

CHRISTMAS ISLAND - INDIAN OCEAN

https://www.dropbox.com/sh/vf4vylbtih0s66b/AACXSPVN4TZ_lUulJHztDEjUa?dl=0

CUMBERLAND BAY - SOUTH GEORGIA

https://www.dropbox.com/sh/klhhw16ht39nsht/AAABzxrIXfnaiYLjimyR8PmUa?dl=0

EXETER - UK

https://www.dropbox.com/sh/4gnmcysv2u6fw8x/AABpAin_I1k-t3P1gYXm5p12a?dl=0

FALKLAND ISLANDS

https://www.dropbox.com/sh/tf459vz4cgqib1g/AACwUr7Lsj6Skz2FT4XgV7Pma?dl=0

GREENLAND

https://www.dropbox.com/sh/oc76cntxx6poa0q/AACOdzIImpfChW1TTEAU9GcVa?dl=0

GUERNSEY - CHANNEL ISLANDS

https://www.dropbox.com/sh/b03qjtq8hhv3udy/AABN-LSNM7VeN-83VJHr9Auka?dl=0

GUYANA

https://www.dropbox.com/sh/36zknvm6b9jgi7g/AADQG-fzs63niRPy0c_pUvPfa?dl=0

HISTORICAL - MAINLY TERRESTRIAL

https://www.dropbox.com/sh/mmtb9cxo62ev7a0/AAC4glnHH4ayytyIAE1CIPtPa?dl=0

HISTORICAL VOYAGES

https://www.dropbox.com/sh/0zumj8otcx6xqmq/AABN0BWkFyW7cP9Y3z5bnzJEa?dl=0

HONG KONG

https://www.dropbox.com/sh/d11p6i0uawed6wj/AABpJaZxPrwPfXxhSrbyftfga?dl=0

HURRICANES

https://www.dropbox.com/sh/dosgs829zzmfdj3/AAArDWMqtjsjlMWRDkm6vYT-a?dl=0

ICELAND

https://www.dropbox.com/sh/05r0o260m3vlhmj/AACsH9v4m2Pt9p4QzvGHbBVMa?dl=0

INDIA

https://www.dropbox.com/sh/noe9ey6dntirfwa/AAAB1hWqUBjOmMRL5OFgO1M3a?dl=0
https://www.dropbox.com/sh/vqgs6482pvo9ybo/AAC9gH4B8GsWmbUDg8s9Ygd0a?dl=0

https://www.dropbox.com/sh/gk95dyj48qtu78g/AAAun1Z4ew6JkzuW8X2F7QYAa?dl=0

https://www.dropbox.com/sh/gy6kd4oc5z37e2o/AACFCgU88e8xvXHkiP6q4-Pra?dl=0

https://www.dropbox.com/sh/rp0ip0aoh4kw8ep/AACmd5LC_rv8embrmc8NYfA2a?dl=0

https://www.dropbox.com/sh/tqhyfe77rgvh6zw/AABXVPr9Fjl2uQnRlgAEtMpXa?dl=0

INDOCHINA

https://www.dropbox.com/s/5lnzat2xtzuvlei/INDO%20CHINA%201898-1904-LD_COMPETE.xlsx?dl=0

INDONESIA

https://www.dropbox.com/sh/wh70075dk6pw1vh/AACnVgOfQPDS8r8FnwQdLARPa?dl=0
https://www.dropbox.com/sh/0tchkcbebhdwdv6/AAAz81m4CdXF5nnHRcnxHS92a?dl=0

INT BULL MET OBS

https://www.dropbox.com/sh/i0xrp96so6orxz1/AAD6Bu0u3AD4FTSTc169X9Xua?dl=0

IRELAND

https://www.dropbox.com/sh/8t32mr0bo9w7k0u/AABIPrgrj7fw3Zr8l_22R5bRa?dl=0

JAPAN

https://www.dropbox.com/sh/o71slqscxlyo19c/AAC0hqJd2QY-zJt6mFKoxiyxa?dl=0

https://www.dropbox.com/sh/ez2mqzbli5u1swe/AAAG0Klu2vcIkoSgKD9ZbvdFa?dl=0

LIVERPOOL

https://www.dropbox.com/sh/xwc04wj091l3tay/AAAOCGos7lAn8c5GLFcGQB1_a?dl=0

LUXEMBOURG

https://www.dropbox.com/sh/2ier5n3261bzylt/AADLvyBUeC1IUv1bwlt8Cqy4a?dl=0

MALTA

https://www.dropbox.com/sh/hxnh3da5to4nvij/AACUnPRuKeBkIYxwlUN71riza?dl=0

MAURITIUS

https://www.dropbox.com/sh/omvf6rmpj9m2ffw/AABjIIMIl33eAPnco5AD_epOa?dl=0

MEDITERRANEAN

https://www.dropbox.com/sh/tc7nm5whbmlsi1j/AABi1B4jGVCucQkseg3OhFina?dl=0

MIDDLE EAST

https://www.dropbox.com/sh/s8cf5di26siggwb/AAAXiEaKfMukeGFBfYiS5ZTsa?dl=0

MONACO

https://www.dropbox.com/sh/2srz0jcpl7h6coe/AACfn86pEFKNYIqzXP1Njpb8a?dl=0

NORWAY

https://www.dropbox.com/sh/dsquwdg5sje9fiz/AACxEGCyeQkdD59Qg29AFATra?dl=0

PACIFIC ISLANDS

https://www.dropbox.com/sh/l8cg4078pgffnjh/AACcquqNOLxfPMJmm5KaYV2oa?dl=0

PHILIPPINES

https://www.dropbox.com/s/3ged9b6u0h55k8l/PHILIPPINE%20STATIONS%20-%20NOVEMBER%20AND%20DECEMBER%201880.xlsx?dl=0

https://www.dropbox.com/sh/0f8r3ooug9nwwhk/AADTs4iKXtyTn0nU884q_kx0a?dl=0

PORTUGAL

https://www.dropbox.com/s/cina1i4c9hi3mcq/FUNCHAL%2C%20MADEIRA%20-%20FEBRUARY%201825%20TO%20DECEMBER%201826.xlsx?dl=0

RUSSIAN EMPIRE

https://www.dropbox.com/sh/ewwqtm8xmhqlyyj/AABOTeKaS_x1d02k7-h6qbOpa?dl=0

SAUDI ARABIA

https://www.dropbox.com/sh/u1au7qba6hbewty/AADH7zpUz30rIUFsJsyYLZala?dl=0

SOUTH EAST ASIA

https://www.dropbox.com/sh/19kgt5di82sfif1/AADjWhPpWjinczr9LyrZnY3Ga?dl=0

SOUTH AMERICA

https://www.dropbox.com/sh/8d2iiqytl5p31ul/AADOTcDi3u6ehRSMN79cldw8a?dl=0

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SRI LANKA

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STORMS

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https://www.dropbox.com/sh/etsb9n9w6ec7psg/AAC_8D-FduJvhNXh2-CN9xNja?dl=0

STRAITS SETTLEMENTS

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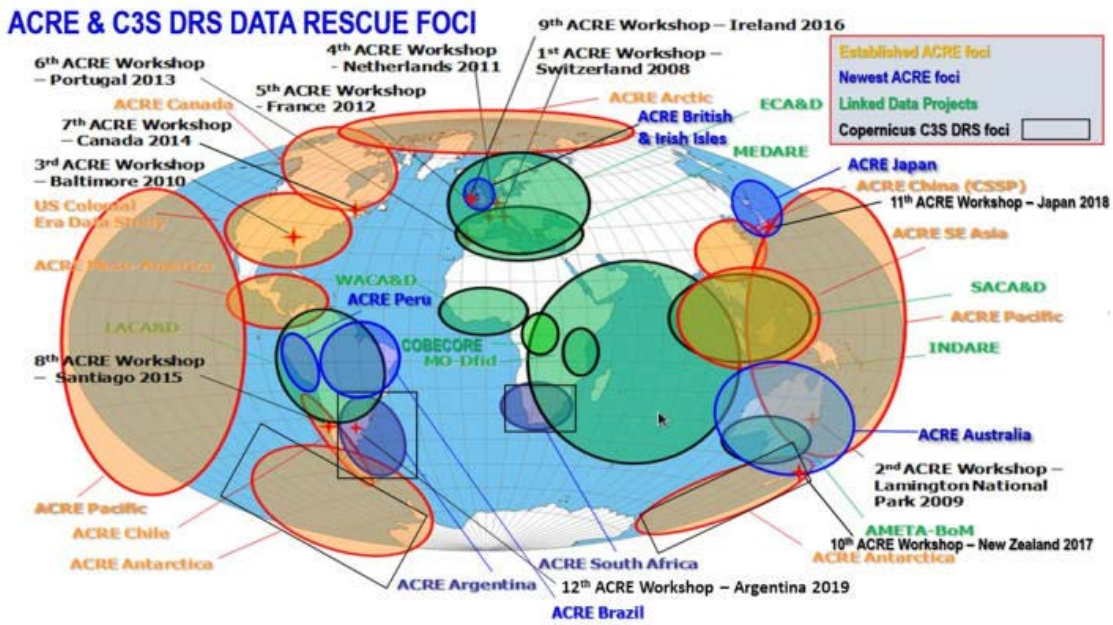
WALES

https://www.dropbox.com/sh/v7oqirp47teaa77/AAAfJrW6uPWeTe-AvYMd_Pqla?dl=0

6.2 ACRE regional foci/chapters

Under the broad international ACRE initiative, the entity has fostered various ACRE regional data rescue foci/chapters that link closely with similar projects around the world. Several of the foci/chapters are supported strongly by UK Newton Fund and Copernicus C3S DRS funding. The distribution of such activities can be seen in the following map, including each of the venues of ACRE annual workshops from 2008 to 2019.



ACRE Regional foci and associated data rescue projects: see top right hand side key for details (ECA&D, SACA&D, WACA&D and LACA&D - http://www.ecad.eu/icad.php; INDARE - http://www.wmo.int/pages/prog/wcp/wcdmp/INDARE.php; MEDARE - http://www.omm.urv.cat/MEDARE/; CSSP China - http://www.metoffice.gov.uk/research/collaboration/cssp-china; WCSSP South Africa - https://www.metoffice.gov.uk/research/approach/collaboration/newton/wcssp-southafrica; AMETA-BoM - http://en.wikipedia.org/wiki/Todd_Weather_Folios; C3S DRS - https://datarescue.climate.copernicus.eu/Also shown in black type are the locations and dates of the annual ACRE Workshops since the initiative began.

The UK Newton Fund provides funding support for data rescue activities through CSSP China and WCSSP South Africa, while C3S DRS supports data rescue and the testing of new data rescue tools and procedures in three ACRE regional data rescue regions in the Southern Hemisphere centring on Argentina, South Africa and the higher latitude Pacific sector of the Antarctic continent.

The specific details about each of the data rescue activities in the ACRE regional foci/chapters are provided below.

6.3 ACRE/C3S DRS Antarctica

Critical past weather observations are being rescued for the purpose of extending Southern Hemisphere coverage within global reanalyses as far back as possible into the 1800s. Primary work consists of identifying data resources, digital scanning, keying data, quality control, and archiving observations at NIWA. The augmented reanalyses will be used to:

- investigate poorly understood aspects of New Zealand regional climate that are linked to high-latitude atmospheric and oceanic dynamics
- examine daily synoptic type trends, and
- establish a baseline more representative of pre-industrial conditions against which current and future climate can be compared.

The synoptic type classification completed in Point 2 above is being binned into multi-decadal intervals according to phases of the Interdecadal Pacific Oscillation. Rescued data are being archived and made publicly available through the International Surface Pressure Databank (ISPD) and NIWA's database. The initiative is funded under the New Zealand Deep South National Science Challenge

6.3.1 Domain of the Data

Southern Hemisphere mid to high latitude region from Tasmania via New Zealand to Drake Passage to Antarctica

6.3.2 Periods and Parameters

1800-1960; atmospheric pressure, air temperature, SST, rainfall, sea ice.

Southern Weather Discovery

At NIWA we have spent the latest phase of the C3S contract working with a new hire who has keyed in ship log locations, dates and times from Southern Weather Discovery (SWD) phase I. It was incredibly challenging to retrieve those data, but we managed to do so. The reason for that challenge, is that the free form entry for people to submit their responses comes back in a code that makes differentiating numbers with separators (e.g. 30.29” hg) difficult when commas are used (which is normal in Europe).

The second stage of SWD now uses a much cleaner user interface with individual cells separating each data item that is entered and is therefore easier to retrieve and parse together into a time series using an automated code.

We digitised data from 219 logbooks for years between 1923 and 1950.

- ✓ 1,510 unique logbook images supplied data that we captured. This represents about 1-2% of the resource that we obtained in our first phase of research. Our collaborator, Dr. Clive Wilkinson, has supplied more than 100,000 images to us. We hope that we will be able to accelerate the progress and get them all done.
- ✓ 15,524 total segments of logbooks were keyed by SWD volunteers.
- ✓ 93,851 unique observations related to sub-daily pressure were captured (uncorrected barometer, attached thermometer, and corrected barometer)
- ✓ 54,312 unique observations of air temperature and sea surface temperature
- ✓ 81% of log segments with pressure observations were comprehensively passed and retired
- ✓ 90% of individual pressure observations passed with a 60% or greater consensus among citizen scientists who keyed the data (minimum no. of entries = 5 people)
- ✓ 56% of log segments with temperature observations were comprehensively passed and retired
- ✓ 67% of individual temperature observations passed with a 60% or greater consensus among citizen scientists who keyed the data (minimum no. of entries = 5 people)

All of these logbooks were from steamships that travelled from the United Kingdom - with outward bound sailing to Australia and New Zealand via the Suez Canal or the Cape of Good Hope. In some cases, ships stopped at ports in Brazil, Uruguay and Argentina. Ships eventually reached New Zealand and/or Australia before unloading and reloading their goods and headed back towards the Northern Hemisphere, transiting the South Pacific Ocean through high seas around Cape Horn. Few ships travelled via the Panama Canal, and the vast majority of the logbooks show ship tracks in waters around the ocean south of New Zealand.

Overall, we ended up with >118K unique observations recovered from SWD Stage I. A vast majority of these data entries have a location, date and time; those that do not we are investigating now. The following raw data have been added to the GitHub repository:

- ✓ 32,579 entries for uncorrected barometer
- ✓ 31,911 entries for corrected barometer
- ✓ 27,071 entries for air temperature
- ✓ 26,762 entries for sea temperature

Plans are in place to convert these data into the IMMA standard format.

For SWD phase II, we also ran an experiment during lockdown that examined the optimal number of replicate keying required for citizen science data recovery. We did this by requesting that the participants key in data 20 times over. Our work in the most recent financial quarter analysed the findings from that experiment and examined statistical analyses of percentage complete and Type I and Type II errors (using randomly selected examples). Setting the replicated retirement limit to 8 entries allows us to achieve at least >99.2% accuracy

for the data recovery and a 100% complete data set. With additional screening of vetted data using data assimilation (where any "bogus" values are rejected) this should help to set a new standard for citizen science meteorological data rescue.

We also worked with the Climate History Australia team and provided training to them on how to use Zooniverse for citizen science meteorological data rescue (https://climatehistory.com.au/). We were able to communicate our findings from our recent experiments to them prior to the launch of their programme, which we believe has been of great assistance.

Outlook

Our ongoing work will be focused on a project called "Great El Niños" under the UK Newton Fund CSSP China, which will focus on the recovery of Southwest Pacific and Chilean meteorological data, with automation of both clipping for meteorological register images and uploading them to Zooniverse. We expect to see an acceleration of data recovery for archived images previously sent to us, with the thought that at least ~2M additional observations can be obtained.

We have also been commissioned to write a peer-reviewed article for the journal "Cell - Patterns" (in the Cell stable; Elsevier) about our citizen science effort for ACRE and telling about our efforts in C3S Data Rescue Service. This manuscript will be ready for submission by August 2021, and this will include co-authorship with other ACRE and C3S Data Rescue Service participants we work with.

6.3.3 Oldest/longest data series scanned and digitised

Oldest series – 1878-1890 "Almirante Cochrane" (current project with ACRE Chile)

Longest series – 1879-1901; 22 years across 24 logbooks Monitor Huáscar

6.3.4 URLs for data scans/images, data digitised and metadata

Rescued data under C3S DRS 2020

6.3.5 Citizen Science and volunteer activities

Southern Weather Discovery

6.3.6 Current Partners

Mariela Guzman (ACRE Chile); Microsoft NZ

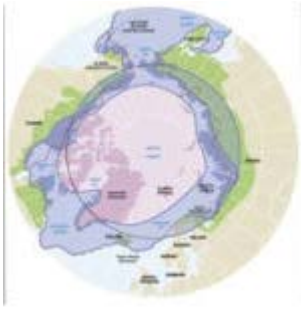
6.3.7 State of the project

Project has recently seen a comprehensive metadata catalogue from Chilean resources compiled, and a limited (but promising) number of scans from ships.

6.3.8 Rough estimation of any assistance needed (€)

Any additional funding will be put toward personnel who are undertaking keying of meteorological data and metadata related to the observations (including ship location, date and time)

Contact: Dr Drew Lorrey, National Institute of Water and Atmospheric Research, Auckland, New Zealand



6.4 ACRE Arctic

Millions of handwritten weather and ocean observations from 150 years ago have been carefully preserved in ship logbooks. They contain weather and sea ice information which promises new insight into the historical climactic conditions in the Arctic. The *Old Weather* citizen science program transformed the large number of crucial handwritten observations into digital forms that can be assimilated by sparse-input reanalysis systems. The output of these systems extends our baseline knowledge of the Arctic's historical climate. The Arctic is currently experiencing rapid loss of sea ice and other environmental changes. It's imperative to know how unusual these events are and whether some part can be explained by the large range of natural variability that is characteristic of the climate system or some other factor. Sorting out and explaining the different regional effects that play out in the Arctic is a difficult problem. Greatly assisting this process, the detailed perspective provided by the logbook data after it is passed through a reanalysis system provides the baseline information necessary to begin to make these kinds of distinctions.

6.4.1 Domain of the Data

Arctic and worldwide

6.4.2 Periods and Parameters

Historical records containing instrumental weather and/or sea-ice observations, from the 1840s to the mid-20th century.

6.4.3 Oldest/longest data series scanned and digitised

The earliest record begins in 1844, the most modern extends into the 1980s – though we focus primarily on records earlier than 1955, especially with reference to transcription efforts. With *Old Weather* volunteers have completed a near-comprehensive transcription and high-resolution renavigation of U.S. federal ship logbooks that operated regularly in the Pacific Arctic between 1879 and 1955 – more than 600,000 observations.

6.4.4 URLs for data scans/images, data digitised and metadata

Earlier data extracted via *Old Weather* have been integrated into ICOADS Deck 710

Version 1 of our sea-ice data set is available via the Arctic Data Center:

Kevin Wood, Michael Purves, Joan Arthur, Milton Davis, Annette De Havilland, et al. 2019: Pacific arctic sea-ice observations from U.S. Federal logbooks (1900-1938). Arctic Data Center. doi:10.18739/A2S46H60V.

We are in the process of creating a comprehensive index of U.S. Federal ship logbooks and related assets; we expect this to be completed within the year. The index currently has more than 20,000 entries. Volume-level URLs to primary assets are included, along with supporting information like ship histories from the U.S. Navy History and Heritage Command.

6.4.5 Current Partners

ACRE

University of Washington, Cooperative Institute for Climate, Ocean & Ecosystem Studies

University of Colorado, Cooperative Institute for Research in Environmental Sciences

University of Reading, National Centre for Atmospheric Science

NOAA Pacific Marine Environmental Research Laboratory

NOAA Earth System Research Laboratories

U.S. National Archives and Records Administration

U.S. National Archives Foundation

UK Met Office, Hadley Centre (via ACRE)

6.4.6 Citizen Science and volunteer activities

Old Weather

https://www.oldweather.org/

https://www.zooniverse.org/projects/krwood/old-weather-ww2 (active online project)

https://oldweather.wordpress.com/

Off-line projects:

Old Weather – Whaling

Old Weather – Arctic

National Archives Foundation education and outreach:

https://www.archivesfoundation.org/digitalweather/

6.4.7 State of the project

The digital imaging activity at the National Archives (*Seas of Knowledge*), supported by a grant from the Council on Library and Information Resources (CLIR) and the Andrew W. Mellon Foundation, is on hold during the COVID-19 pandemic. During this period, we have been working on the Federal Index and other project-

adjacent activities, in part to provide support to our student-interns and staff working remotely during this trying period. We will have resources to carry out a one-year extension to recover lost time.

Additional adjacent work during the pandemic has been to set up and run an Old Weather project focused on an investigation the World War II Warm Anomaly (e.g. Chan & Huybers, 2020). As part of this project we have also been able to restore platform IDs and other lost metadata to the relevant U.S. Navy data in ICOADS: Decks 110, 195, and 281, thought to be the (non-physical) source of the anomaly. We can now trace these data back through the primary documents (ship's logbooks, aerographers' reports, and contemporary observer manuals) to specific ships and sometime particular instrument installations. Ultimately this will affect between 1.5 and 3 million weather records during the mid-20th century. This intersects the Arctic in several ways, not least in the expression of early 20th c. Arctic warming in the Pacific sector, but also in the potentially artificial influence of the WWII anomaly on derived climate research products like globally-complete gridded datasets and reanalyses.

6.4.8 Rough estimation of any assistance needed (€)

First, the current partnership model with the U.S. National Archives is not reliable over the long term and will need to be bolstered by higher-level advocacy to continue beyond July 2022. Second, the scale of the imaging program is limited by dependence on cyclical grant funding from private philanthropy (currently the Andrew W. Mellon Foundation). Third, even now the thousands of logbooks already imaged (> 4000 volumes, 2.5 million pages) defy full transcription by means of citizen-science. Here we require an advancement in machine-based auto-transcription of handwritten tabular forms. Finally, given recent progress restoring metadata mentioned above it may be necessary to reprocess or replace the existing U.S. Navy data from 1930-1950 originally punched on decks of IBM cards in the 1950s.

To maintain the current rate of imaging requires ~$120,000 (€100,000) yearly, primarily for staff and student interns.

Contact: Dr Kevin Wood, University of Washington, Cooperative Institute for Climate, Ocean & Ecosystem Studies (CICOES) *and* NOAA Pacific Marine Environmental Laboratory (PMEL), Seattle, USA

6.5 ACRE/C3S DRS Argentina

The Universidad Tecnológica Nacional (UTN), Facultad Regional Buenos Aires, in the city of Buenos Aires will coordinate data rescue activities with other national organisations such as Armada de la República Argentina, Prefectura Naval Argentina, Servicio Meteorológico Nacional, MinCyT and national and provincial archives. Contacts will also be sought with private shipping companies or the institutes of no longer existing companies as well as estancias, historical ship logbooks and weather records. Various actions will look at:

- Logbooks from Argentine ships and 'stationary' ships in port, starting 1894.
- Observations from lighthouses.
- Digitisation of Buenos Aires observations from the 1820s onwards, Bahia Blanca and Corrientes 1860.
- Gaps in DWD old German colonial observations between 1903 and 1930.
- Observations from old railway companies

Argentine Daily Weather Reports (DWRs) from 1902-1980, which are held by the Met Office Archives in the UK, not only contain daily observations of many ECVs for Argentina (e.g. pressure, temperature, winds, relative humidity and precipitation) but also contain similar records for neighbouring countries, and are being scanned and digitised in order to improve historical weather data coverage across Argentina and the wider South American sphere.

Current activities include digitization of the XIXth Century daily and subdaily records through 1912 published in the Anales de la Oficina Meteorologica Argentina (OMA). A listing of stations run by the OMA in Argentina (including Orcadas/Laurie Is.), Paraguay and Uruguay and their metadata has been compiled for Copernicus C3S. work with the Argentine Daily Records is under way at Universitat Giessen, Germany. Imaging of Argentine Navy logbooks was under way until the beginning of the COVID-19 pandemia. 1960´s radiosonde records are being imaged.

Research activities looking into climate variability and climate processes are being carried out both with the recovered datasets and with derived historic reanalysis products to characterize the evolution of the climate system in the region.

6.5.1 Domain of the Data

Argentina, southern South America and Antarctica (Argentina Antarctic stations beginning 1903, in Weddell Peninsula, and Weddell Sea coastline)

6.5.2 Periods and Parameters

Argentine Daily Weather Reports (digitised by University of Giessen)

An important focus of the South American effort has been the series of Argentine Daily Weather Reports (DWRs) for 1902-1980, which are held by the Met Office Archives in the UK. These DWRs not only contain daily observations of many essential climate variables for Argentina (e.g. pressure, temperature, winds, relative humidity and precipitation) but also contain similar records for neighbouring countries. Digitisation of the DWRs have been completed up until 1919.

Table 1 gives an overview of the number of stations digitised for each year. The huge amount of data that have been rescued means that the work on metadata compilation and data formatting will extend far beyond the end of the C3S Data Rescue Service contract. So far, only data for the year 1902 have been formatted into SEF.

Table 1 – Overview of data keyed from the Daily Weather Reports

Table 1 – Overview of data keyed from the Daily Weather Reports

Year	Number of stations	Meteorological variables	Observation time	Number of stations with rainfall measurements	Number of stations with hydrometric measurements
1902	122	10	2pm/7am	274	-
1903	155	10	7am/6am	423	-
1904	144	10	8am	542	38
1905	162	10	8am	551	57
1906	184	10	8am	742	46
1907	196	10	8am	664	49
1908	183	10	8am	693	59
1909	179	10	8am	647	58
1910	191	10	8am	1034	58
1912	224	10	8am	1431	50
1913	236	10	8am	1617	48
1914	251	10	8am	1909	65
1915	230	10	8am	1470	57
1916	106	10	8am	1540	62
1917	109	10	8am	1628	67
1918	111	10	8am	1841	64
1919	111	10	8am	2227	63

Activity at the Universidad Tecnológica Nacional (UTN)

Argentine Weather Office yearbooks

Data rescue and imaging continued throughout 2019-2020. It was possible to locate and recover all of the Anales de la Oficina Meteorológica Argentina (yearbooks of the Argentine Weather Office). The last missing volume was located in the Biblioteca Meteorológica Nacional, which reopened after being moved to the new national weather service premises. We now hold all the yearbooks in pdf format.

A full listing of the daily/subdaily data contained in the fifteen volumes for the period 1801-1912 was drawn up. These span most of the 19th century stations reported in the 2018 report. For each station, the yearbooks contain fairly detailed information on station location, instrument make and number (particularly for barometers) calibration and observer name. That metadata is being processed and currently is set to be verified. Some of the station sites can be geolocated given the references provided in the books.

Main OMA Stations	Año Inicio	Lat.	Lon.
Buenos Aires	1853	34.6°S	58.37°O
Tucumán	1856	26.82°S	65.21°O
Bahia Blanca	1860	38.75°S	62.25°O
Pilciao/Aconquija	1865	27.45°S	66.2°O
Mendoza	1866	32.55°S	68.51°O
San Juan	1870	31.54°S	68.5°O
Córdoba	1872	31.67°S	63.56°O
Salta	1873	24.51°S	65.29°O
Corrientes	1873	27.28°S	58.49°O
Santiago del Estero	1873	30.02°S	64.18°O
San Luis	1874	33.16°S	66.21°O
La Rioja	1875	29.41°S	66.86°O
Rio Cuarto	1875	33.07°S	64.14°O
Rosario	1875	32.55°S	60.47°O
Paraná	1875	31.73°S	60.53°O
Concordia	1875	31.23°S	58.02°O
Goya	1876	29.14°S	59.27°O
Carcaraña	1876	32.5°S	61.15°O
Tandil	1876	37.3°S	59.13°O

Villa Hernandarias	1877	31.22°S	59.98°O
Harberton	1877	54.87°S	67.33°O
Formosa	1879	26.11°S	58.13°O
San Antonio de Areco	1879	34.25°S	59.47°O
Catamarca	1881	28.47°S	65.78°O
Bell Ville	1882	32.38°S	62.41°O
Paramillo de Uspallata	1886	32.47°S	69.13°O
Villa María	1886	32.41°S	63.24°O
San Juan de Salvamento Is. de los Estados	1886	54.71°S	63.85°O
San Antonio Oeste	1888	40.44°S	64.57°O
Colonia Chubut/Sarmiento	1888	45.60°S	69.08°O
Chos Malal	1892	37.23°S	70.17°O
Ingenio Ledesma	1895	23.47°S	64.49°O
Esquina	1895	30.02°S	59.32°O
Andalgalá	1895	27.60°S	66.30°O
Colonia Ceres	1896	29.53°S	61.57°O
Gualeguay	1897	33.06°S	59.16°O
Patagones	1898	40.48°S	62.59°O
Jujuy	1899	24.11°S	65.18
Paso de los LIbres	1900	29.43°S	57.06
Esperanza	1900	31.26°S	60.56
Azul	1900	36.45°S	59.50
Base Orcadas	1903	60.73°S	44.77

Daily/subdaily data for Buenos Aires (prior to 1860), Bahia Blanca and Corrientes have been digitised and must be verified before submittal. Due to the Covid-19 lockdown and the ongoing closure of universities it has not been possible to access the data to complete the processing.

One of the volumes contains a fairly complete set of hourly observations and sea-ice/iceberg sighting made during the cruises of Scotia and ARA Uruguay to the Antarctic Base Orcadas for the period 1903-1911. These records are currently being digitised.

Argentine Navy logbooks

Imaging of the Argentine Navy logbooks has continued throughout 2019 but stopped during 2020 due to lockdown. As yet, the COVID-19 limitations have not allowed the return to this activity. Cataloguing and sorting of these images will restart once we can hire the students that were selected and trained for this work in March 2020, prior to the lockdown. Processing of their contracts was put on hold by the UTN until ACRE Argentina activities on campus and the Naval Archive can be restarted.

During this period, a software system called RETINA (https://meritoki.github.io/retina-desktop-application/) was developed in order to simplify both the preparation and ordering of images for processing in Zooniverse and the ordering of the digitised products thus obtained. The software breaks down the tables with data either from the Anales OMA or the Navy logbooks into blocks that contain a single block of information, for example a given temperature or pressure value. RETINA stores information on the location within the chart or table of each single block. This single block can be visualised in Zooniverse and, once digitised, RETINA stores the data in the correct position within the table. Thus, a considerable amount of work and time can be saved in the pre- and post-processing of imaged records. Experimental runs with RETINA and Zooniverse have yielded excellent results. We plan to launch the ACRE Argentina Zooniverse page shortly.

6.5.3 Oldest/longest data series scanned and digitised

Buenos Aires observations from the 1820s onwards

6.5.4 URLs for data scans/images, data digitised and metadata

Rescued data under C3S DRS 2020

6.5.5 Current Partners

ACRE, C3S DRS

6.5.6 Citizen Science and volunteer activities

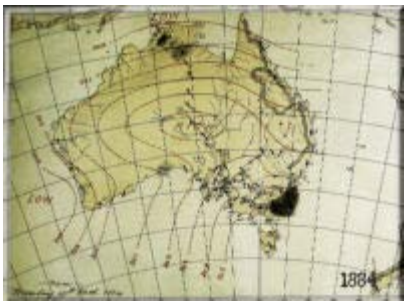
WWW URL yet to be implemented.

6.5.7 State of the project

On Going.

6.5.8 Rough estimation of any assistance needed (€)

Contact: Dr Pablo Canziani, Unidad de Investigación y Desarrollo de las Ingenierías, Facultad Regional Buenos Aires, Universidad Tecnológica Nacional, Argentina



6.6 ACRE Australia

ACRE Australia brings together scientists, historians, and volunteers from across Australia working in data rescue and historical climatology. Data have so far been rescued through several citizen science and research initiatives, including South Eastern Australian Recent Climate History (SEARCH, 2009–2012), Weather Detective (2014), TeamTodd (active), New England and Hunter Historical Weather Data (active) and Climate History Australia (active) with more currently underway. ACRE Australia aims to be a focal point for interdisciplinary discussions and projects on rescuing historical weather, climate and environmental data across the country and its nearby seas. We are also aiming for close collaboration with neighbouring ACRE Foci/Chapters and relevant environmental history organisations, to promote a stronger community in the region. For more information on current projects and data sources, visit the ACRE Australia projects list.

Ashcroft, L., R. Allan, H. Bridgman, J. Gergis, C. Pudmenzky, and K. Thornton, 2016: Current climate data rescue activities in Australia. *Adv. Atmos. Sci.,* **33:** 1323**.** doi: 10.1007/s00376-016-6189-5. https://link.springer.com/article/10.1007%2Fs00376-016-6189-5

Ashcroft, L., Gergis, J. and Karoly, D. J., 2016: Long-term stationarity of El Niño–Southern Oscillation teleconnections in southeastern Australia. *Clim. Dyn.,* **46,** 2991–3006. https://doi.org/10.1007/s00382-015-2746-3

Ashcroft, L., Gergis, J. and Karoly, D. J., 2014: A historical climate dataset for southeastern Australia, 1788–1859. *Geosci. Data J.*, **1**, 158-178. https://doi.org/10.1002/gdj3.19

Ashcroft, L., Karoly, D. J. and Dowdy, A. J., 2019: Historical extreme rainfall events in southeastern Australia. Weather and Climate Extremes. **25**, 100210. DOI: 10.1016/j.wace.2019.100210.

Ashcroft, L., Karoly, D. J. and Gergis, J., 2012: Temperature variations of southeastern Australia, 1860–2011. Australian Meteorological and Oceanographic Journal **62**, 227–245.

Ashcroft, L., Karoly, D.J. and Gergis, J., 2014a: Southeastern Australian climate variations 1860–2009: a multivariate analysis. *Int. J. Climatol,* **34** (**6**), 1928–1944. DOI: 10.1002/joc.3812.

Bridgman, H., **Ashcroft, L.,** Thornton, K., Di Gravio, G., and Oates., W., 2019: Meteorological observations for Eversleigh Station, near Armidale, New South Wales, Australia: 1877–1922. Geoscience Data Journal. DOI: https://doi.org/10.1002/gdj3.80.

Fenby, C. and Gergis, J., 2013: Rainfall variations in south-eastern Australia part 1: consolidating evidence from pre-instrumental documentary sources, 1788–1860. *Int. J. Climatol,* **33**, 2956-2972.

Gergis J., Ashcroft L., Garden D., 2018: Recent Developments in Australian Climate History. In: White S., Pfister C., Mauelshagen F. (eds) *The Palgrave Handbook of Climate History.* Palgrave Macmillan, London. https://doi.org/10.1057/978-1-137-43020-5_21

Gergis, J. and **Ashcroft, L.**, 2013: Rainfall variations in south-eastern Australia part 2: a comparison of documentary, early instrumental and palaeoclimate records, 1788–2008. Int. J. Climatol., **33** (**14**), 2973–2987. DOI: 1002/joc.3639.

Gergis, J., Ashcroft, L. and Whetton, P., 2020: A historical perspective on Australian temperature extremes. *Clim. Dyn.,* **55,** 843–868 (2020). https://doi.org/10.1007/s00382-020-05298-z

Gergis, J, Baillie, Z, Ingallina, S, Ashcroft, L, Ellwood, T. A., 2021: A historical climate dataset for southwestern Australia, 1830–1875. *Int. J. Climatol.*, 1– 22. https://doi.org/10.1002/joc.7105

Gergis, J., Karoly, D. J. and Allan, R. J., 2009: A climate reconstruction of Sydney Cove, New South Wales, using weather journal and documentary data, 1788–1791. *Australian Meteorological and Oceanographic Journal*, **58**, 83-98.

Ritman, M., and **Ashcroft, L.** 2020: Revisiting the 1888 Centennial Drought. Proceedings of the Royal Society of Victoria. **132**, 39–64. DOI: https://doi.org/10.1071/RS20004.

Thornton, K., **Ashcroft, L.**, Bridgman, H., Oates, W, and di Gravio, G., 2018: Algernon Henry Belfield and the Eversleigh weather diaries, 1877–1922. Journal of Australian Colonial Meteorology. **20**, 139–154.

6.6.1 Domain of the Data

Australia and surrounding oceans

6.6.2 Periods and Parameters

Climate History Australia is currently focusing on recovering temperature, pressure and rainfall observations from the period before official digitised Australian Bureau of Meteorology records begin. For temperature, the BoM records begin in 1910, for rainfall it is 1900 and for pressure it is around 1950. We are focusing our efforts on southern Australia.

6.6.3 Oldest/longest data series scanned and digitised

The oldest data series scanned and digitised is the meteorological diary of William Dawes, taken from 1788 to 1791 in Sydney (Gergis *et al.,* 2009). The longest is the series we are currently working on for Perth, Western Australia. When complete, the series will extend from 1830 to the present day.

6.6.4 URLs for data scans/images, data digitised and metadata

ACRE-MERIT

Hunter Living Histories

6.6.5 Citizen Science and volunteer activities

South Eastern Australian Recent Climate History (SEARCH)

TeamTodd

TeamBelfield

Climate History Australia also on social media: Facebook and Twitter

Convict ships 1817-1868

Settler ships 19th Century

19th century expeditions

6.6.6 Current Partners

6.6.7 State of the project

Climate History Australia

Climate History Australia recently digitised (via Zooniverse) the Adelaide Survey Office record which covers the period 1843-1856. When this record is combined with the existing digitised temperature observations it provides a nearly continuous daily record from 1836-present for Adelaide.

Climate History Australia will soon finish digitising (via Zooniverse) the Perth Gardens record which covers the period 1880-1900. This combined with the recently published Swan River record (1830-1875) will provide temperature, pressure and rainday observations for most of the 19th century. When these recovered historical records are combined with modern temperature and rainfall records it provides a near continuous temperature and rainday dataset from 1830-present.

We are currently still searching for daily pressure observations from around 1900-1950 for both sites.

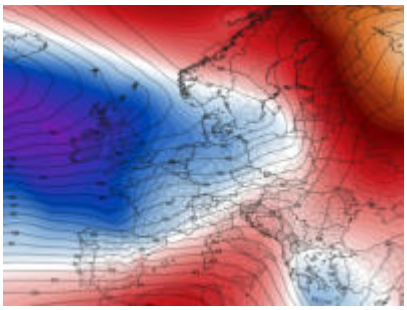
We are indebted to the team at Southern Weather Discovery for the advice they provided when we set up our Zooniverse project. They were instrumental to our project's success.

6.6.8 Rough estimation of any assistance needed (€)

All ACRE Australia work is done through short term research contracts. Ongoing support of 1FTE would ensure the continuation of many of these important activities.

Contact: Dr Joëlle Gergis, Fenner School of Environment and Society, Australian National University, Canberra, Australia.

Contact: Dr Linden Ashcroft, School of Geography, Earth and Atmospheric Sciences, University of Melbourne, Victoria, Australia.



6.7 ACRE British and Irish Isles

The UK and Ireland have some of the longest and most detailed weather and other climate-related records anywhere in the world, with high spatial density over land and large archives of ship observations taken across all ocean basins. Millions of pages of observations, from the 18th century onwards, remain in paper archives and require rescue. ACRE British & Irish Isles aims to create a network of researchers to coordinate efforts to catalogue what data is available, scan logbooks, transcribe and quality control the data, before adding it to international archives. The focus is on meteorological observations and related metrics such as tide gauge and auroral observations. The network also includes researchers working on more qualitative data such as crop yields, flooding and drought records, damage from extreme storms and human stories of how weather influenced lives and livelihoods.

6.7.1 Domain of the Data

Britain, Ireland and surrounding seas

6.7.2 Periods and Parameters

ACRE British and Irish Isles is primarily interested in observations of pressure, temperature and rainfall, from the 18th century until the mid-20th century.

6.7.3 Oldest/longest data series scanned and digitised

Recently, temperature and pressure data from Exeter has been digitised from 1755-1775, and from the 1790-1840s. Further work to extend these series is ongoing. For Oxford, a new monthly rainfall series has been produced from 1767 onwards, with daily temperature observations continuous from 1814 to present. A sub-daily pressure series from Durham has been produced from 1843 to 1950.

6.7.4 URLs for data scans/images, data digitised and metadata

The main source for data scans and images is the National Meteorological Archive:

https://digital.nmla.metoffice.gov.uk

although many other smaller sources exist. A large set of ship logbook images are not yet online.

6.7.5 Citizen Science and volunteer activities

Operation Weather Rescue

Rainfall Rescue

6.7.6 Current Partners

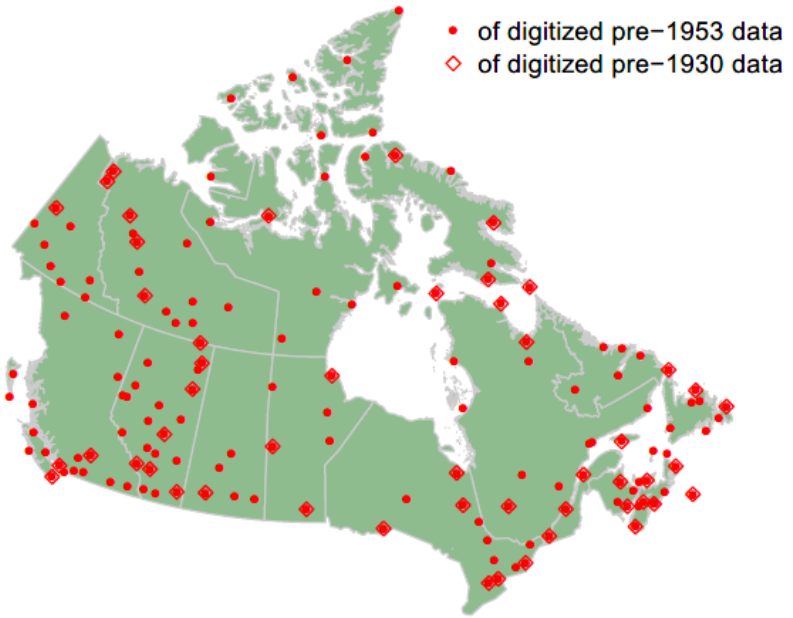
Met Office, Met Eireann, Royal Society, National Centre for Atmospheric Science, Centre for Ecology and Hydrology, National Oceanography Centre, Universities of Reading, Lincoln, Maynooth, Southampton, and East Anglia.

6.7.7 State of the project

Rainfall Rescue – recently digitised >5 million monthly rainfall observations using volunteer citizen scientists, with the first data release now available (doi: 10.5281/zenodo.4754575). This will allow the extension of the UK gridded rainfall series back to 1836. The NERC GloSAT project is performing data rescue of observations in ship logbooks, with a citizen science project to launch shortly. Other ad-hoc projects are ongoing, including collaborations with the University of Colorado to utilise the 20th Century Reanalysis to demonstrate the value of data rescue (e.g. http://www.climate-lab-book.ac.uk/2021/storm-ulysses/).

6.7.8 Rough estimation of any assistance needed (€)

Contact: Prof Ed Hawkins, Department of Meteorology, University of Reading, United Kingdom



6.8 ACRE Canada

ACRE Canada is a network of scientists, researchers, archivists and volunteers aiming to coordinate efforts to locate and catalogue images, transcribe and quality control historical Canadian weather observations. Data are then added to international archives. Major ACRE-Canada partners are Environment and Climate Change Canada (ECCC; previously known as Environment Canada), McGill University's DRAW project, and Open Data Rescue, a not-for-profit data rescue organization. Past and current projects focus on the digital imaging and process of transcribing Canada's wealth of historical weather observations. Much remains to be done, however, with tens of thousands of pages of observations and millions of data points remaining in paper form or not machine-readable, especially in regions of Canada's north, west and marine regions. ACRE-Canada is currently looking for opportunities to partner with citizen science and community data rescue projects. In close collaboration with neighbouring ACRE Foci/Chapters, ACRE Canada is calling on volunteers across the world to help transcribe the tens of thousands of pages of weather observations captured over the last 180 years or so.

6.8.1 Domain of the Data

Canada and surrounding oceans

6.8.2 Periods and Parameters

Stations transcribed. All pressure data has contributed to the ISPD. Other variables have been sent to the Copernicus Reanalysis project.

ECCC Surface Pressure Data Rescue Project		
Location	**Period**	**Variables digitized**

153 stations across Canada (see the figure above ACRE Canada)	1828 or later to 1952 (with data gaps)	Surface (station and sea level) pressure for all stations. Other variables have also been digitized
ECCC – Open Data Rescue project: Transcribing Historical Canadian Climate Records		
Location	**Period**	**Variables digitized**
Red River Settlement	1844-1861 (gaps)	See Parameters below
York Factory	1874-1884	See Parameters below
Canadian Volunteer Data Rescue 2010-2014 (~500,000 data points)		
Location	**Period**	**Variables digitized**
Quebec City	1742-1754/1798-1818/1844-1859	See Parameters below
Montreal	1776-1779/ 1813-1873	See Parameters below
Halifax (with U Giessen)	1786-1796/ 1828-1865	See Parameters below
St John's (with U Giessen)	1843-1870 (gaps)	See Parameters below
York Factory	1828-1840/1855 (gaps)	See Parameters below
Hoffenthal (U Giessen)	1883-1887	See Parameters below
Nain (U Giessen)	1883-1887	See Parameters below
Okak (U Giessen)	1883-1887	See Parameters below
Hebron (U Giessen)	1883-1887	See Parameters below
Zoar (U Giessen)	1883-1887	See Parameters below

Stations currently being transcribed 1 (2015-present) : the McGill DRAW project

ECCC Surface Pressure Data Rescue Project		
Location	**Period**	**Variables digitized**
McGill Observatory, Montreal	1874 to 1964	Pressure, Temperature, Humidity, Precipitation, Cloud Cover, Weather, Others (see below)

Stations currently being transcribed 2 (2021) : the ECCC – Open Data Rescue project: Transcribing Canadian Weather Data from Smithsonian Records

project	ECCC-Open Data Rescue (~490,000 data points)	**Variables digitized**

location	period	
Winnipeg	1869-1873	Pressure, Temperature, Humidity, Wind, Weather, Precipitation, Cloud Cover
Wolfville	1855-1875	Pressure, Temperature, Humidity, Wind, Weather, Precipitation, Cloud Cover
Michipocoton,	1860-1864	Pressure, Temperature, Humidity, Wind, Weather, Precipitation, Cloud Cover
Fort Simpson	1849-1850; 1859-1862	Pressure, Temperature, Wind, Weather, Precipitation, Cloud Cover
Habour Grace	1871-1876	Pressure, Temperature, Humidity, Wind, Weather, Precipitation, Cloud Cover
Rigolet	1861-1864	Pressure, Temperature, Wind, Weather, Precipitation, Cloud Cover
St John's	1849-1875	Pressure, Temperature, Weather, Precipitation, Cloud Cover

6.8.3 Parameters

Barometric pressure and attached thermometer

Air temperature: hourly, min and max

Precipitation

Humidity

Wind direction

Wind force

Cloud cover

Cloud type

Blackbulb and grass minimum (radiation)

Weather and remarks

Aurora

Weather indices (freezing rain, thunder, extreme weather events)

6.8.4 Oldest/longest data series scanned and digitised

St Lawrence Valley daily temperature series (composite) 1798-present (1742 with gaps): transcribed. DRAW is completing this series with further subdaily observations from Montreal. Montreal has daily minimum and maximum temperatures from 1813 to present and subdaily pressure from 1831 to present. Toronto has daily pressure, temperature and precipitation readings from 1840 to present, while Halifax has subdaily temperature and pressure data from 1828 to present.

Slonosky, V.C., 2019: Hazardous weather events in the St Lawrence Valley from the French regime to Confederation: descriptive weather in historical records from Quebec City and Montreal, 1742–1869 and 1953—present. *Nat Hazards.*

Slonosky, V.C., 2014: Historical climate observations in Canada: 18th and 19th century daily temperature from the St. Lawrence Valley, Quebec. *Geoscience Data Journal* **1**, 103–120.

Slonosky, V.C., 2014: Daily minimum and maximum temperature in the St-Lawrence Valley, Quebec: Two centuries of climatic observations from Canada. *Int. J. Climatol.,* **35**, 1662–1681.

Slonosky, V., 2003: The meteorological observations of Jean-François Gaultier, Québec, Canada: 1742-56. *J. Climate*, **16**, 2232–2247.

6.8.5 URLs for data scans/images, data digitised and metadata

https://opendatarescue.org/ (in progress)

DRAW: https://citsci.geog.mcgill.ca/

6.8.6 Citizen Science and volunteer activities

DRAW https://citsci.geog.mcgill.ca/

6.8.7 Current Partners

Environment and Climate Change Canada (Contact: Dr. Xiaolan Wang, Xiaolan.Wang@ec.gc.ca)

McGill University (DRAW: Data Rescue: Archives and Weather) (draw.archives@mcgill.ca)

Open Data Rescue - a not-for-profit data rescue organization (admin@opendatarescue.org)

6.8.8 State of the project

ECCC Surface Pressure Data Rescue Project: completed.

ECCC – Open Data Rescue project: Transcribing Canadian Weather Data from Smithsonian Records: in progress.

DRAW: in progress. An 1.25 million data points out of an estimated 4 to 5 million data points have been transcribed, and a traceable post-processing data system is being tested. Machine learning recognition of the handwritten logbooks is being explored, either in conjunction with citizen science or with citizen scientists providing a quality review of ML data. A survey of community attitudes towards ML in data rescue in in preparation. No current funding

ECCC image scanning project of historical weather logbooks and station reports: protype completed.

6.8.9 Rough estimation of any assistance needed (€)

DRAW is currently looking for funding to maintain and complete the citizen science site and post-processing (quality control) of the transcribed data.

Contact: Dr Victoria Slonosky (victoria.slonosky@mail.mcgill.ca), Centre for Interdisciplinary Studies for Montreal, McGill University, Montreal, Quebec, Canada.

See also contact details under partner information

6.9 ACRE Chile (with CSSP China funding)

Chile, a long and narrow ribbon of land, with its exceptional natural borders of the arid Atacama desert to the north, extension to the Antarctic ice in the south, the Andes mountain range to the east and the Pacific Ocean in the west, encapsulates most climatic regimes on Earth. In Chile, more than in any other country, meteorological observations are vital to the whole spectrum of national and international interests. Nevertheless, the terrestrial and maritime areas of Chile and the south-east Pacific are one of the least represented areas in terms of historical weather and climate data.

Supported by formal agreements between ACRE and agencies of the Chilean Government, a first step has been completed to catalogue the repositories of meteorological and oceanographic data. They cover the full scope from across the offices of the national archives, the naval, oceanographic and meteorological services, and include lighthouse records and British and Spanish logbooks. There is a vast and necessary task for ACRE Chile to address the recovery, imaging and digitisation of its historical weather and climate records, as part of a wider data rescue initiative in South America.

6.9.1 Domain of the Data

Chile and surrounding seas

6.9.2 Periods and Parameters

- **Data Rescue 2017. Antarctic Sea Ice Observations.**

Logbooks from vessels of the Chilean Navy that participate in Antarctic missions from 1946 to 1971.

Amount of Vessels (as data source)	=	12
Amount of Logbooks Photographed	=	85
Amount of Images Obtained	=	20143
Parameters Contained in the Logbooks	=	Wind (direction & speed) Sea state SST (if) Clouds (kind & amount) Atmospheric pressure Dry thermometer temperature Wet thermometer temperature Relative humidity.
Frequency of Recorded Observations	=	Every hour during navigation, Every 4 hours in port (if).

- **Data Rescue 2020 - 2021 Focused on XIX Century.**

1) Historical Logbooks of the Chilean Navy from 1843 to 1900.

Amount of Vessels (as data source)	=	17
Amount of Logbooks Photographed	=	133
Amount of Images Obtained	=	22651
List of all parameters in Logbooks	=	Wind (direction & speed)
		Sea state
		SST (if)
		Sea current direction (1 logbook)
		Weather state
		Atmospheric pressure
		Temp. from attached thermometer
		Dry thermometer temperature (if)
		Wet thermometer temperature (if)
Frequency of Recorded Observations	=	Every hour during navigation, Every 4 hours in port (if).

2) Historical Pluviometrics Records from CORFO-Chile.

Data photographed and keyed by the Universidad de Chile (Geophysic Department).

Amount of Stations	=	337
Time Covered	=	1853 to 1939
Frequency	=	Monthly averages
Precipitation Instrument	=	Pluviometer
Precipitation Units	=	mm.

3) Records from Biological Coastal Station “Montemar”, Universidad de Valparaiso.

Location	=	Lat S 32º 57` 25`` Long W 71º 33`00``
Time Covered	=	1956 to 2005
Parameters	=	Air Temperature
		Atmospheric Pressure
		SST
		Sea State
		Weather State (past and present)
		Wind (speed & direction)
		Visibility
		Cloudiness
Frequency	=	3 times/day
Amount of Images	=	10065

4) Records from Chilean lighthouses.

Working at the moment in the data.

Area Covered	=	From Latitude South 29º 56` to 53º 47`
Time Covered	=	From 1941 to 1990.

Parameters	=	Air Temperature (wet and dry thermometer) Atmospheric Pressure Relative Humidity Wind (speed & direction) Cloudiness Precipitation Visibility Sea State Weather State (past and present)
Frequency	=	3 times/day

Due to the pandemic situation the older lighthouse collection that covers the years 1914 to 1940 has not been photographed yet. It will be done as soon as the Chilean Meteorological Service authorities allow it.

6.9.3 Oldest/longest data series scanned and digitises

Historical Pluviometrics Records from CORFO-Chile (1853 to 1939)

6.9.4 URLs for data scans/images, data digitised and metadata

https://climatologia.meteochile.gob.cl/application/informacion/listadoDeElementos/
In Spanish

6.9.5 Citizen Science and volunteer activities

6.9.6 Current Partners

- ACRE
- Direccion Meteorologica de Chile (MeteoChile)
- Museo Marítimo Nacional. Archivo y Biblioteca Histórica de la Armada (National Maritime Museum. Historical Archive and Library of the Chilean Navy)

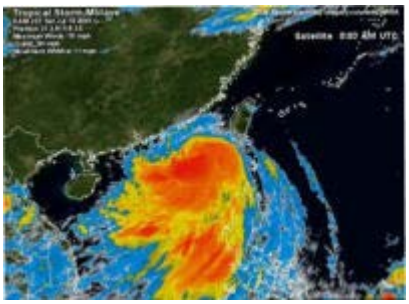
6.9.7 State of the project

On Going.

6.9.8 Rough estimation of any assistance needed (€)

Included also human resource

Contact: Mariela Vásquez Guzmán, Chile.



6.10 ACRE China (under CSSP China and MOST)

As an integral part of WP1 within the Climate Science for Service Partnership China, ACRE China is tasked to recover, image and digitise historical daily to sub-daily terrestrial and marine data. Data comes from stations in China and surrounding countries and from the logbooks of ships in the region. All data is stored in international repositories, including ICOADS, ISTI, GPCC, and the ISPD. As the data is used in reanalyses systems including 20CR, ACRE China scientists conduct verification and applications reanalysis outputs. To date, digitisation work has included:

- ✓ Sub-daily surface air pressure data of 6 stations in eastern China for the periods before 1951 (submitted)
- ✓ Daily records of surface air pressure, temperature and precipitation of 19 stations in eastern China pre-1951 (submitted soon)
- ✓ Ancient records of soil moisture (Yuxuefencun) for 6 stations for time periods 1730-1900 (to be submitted)
- ✓ Digitization of surface air pressure, temperature and precipitation of Beijing station for 1757-1762, and it may be among the earliest weather records of the world (underway).

Completed works include the analyses of long-term change in extreme temperature indices at Changchun and Yingkou, Northeast China, applying the digitized data, severe droughts of the last 1000 years in Baiheliang in upper Yangtze River using data of rock-fish appearance, and a preliminary investigation of extreme temperature variation at a pre-industry era (1757-1762) in Beijing.

Planned work includes high resolution downscaling of 20CR output over the Chinese region via the Met Office PRECIS team. This would vastly enhance the value of 20CR output for the Chinese climate science community, plus wide-ranging climate applications and services, policy makers, planners and environmental managers.

Ren, Yuyu, Guoyu Ren, Rob Allan, Siqi Zhang. 2021: Extreme temperature of the mid-eighteenth century as compared to todays in Beijing. *Climatic Change,* **165**: 45. doi.org/10.1007/s10584-021-03063-7

Qin, Jun, Ailin Shi, Guoyu Ren, Zhenghong Chen, Yuda Yang, Xukai Zou, *and* Panfeng Zhang. 2020: Severe historical droughts carved on rock in the Yangtze. *Bull. Amer. Met. Soc.,* **102**, (**6**), E905-E916. https://doi.org/10.1175/BAMS-D-19-0126.1

Scaife, Adam, Elizabeth Good, Ying Sun, Zhongwei Yan, Nick Dunstone, Hong-Li Ren, Chaofan Li, Riyu Lu, Peili Wu, Zhuguo Ma, Zongjian Ke, Kalli Furtado, Tongwen Wu, Tianjun Zhou, Tyrone Dunbar, Chris Hewitt, Nicola Golding, Peiqun Zhang, Rob Allan, Kirstine Dale, Fraser Lott, Peter Stott, Sean Milton, Lianchun Song and Stephen Belcher, 2021: The Climate Science to Service Partnership – China. *Bull. Amer. Met. Soc.,* **102**, (**6**), 1-37. https://doi.org/10.1175/BAMS-D-20-0055.1

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6.10.1 Domain of the Data

China and surrounding regions and seas

6.10.2 Periods and Parameters

Digitisation of daily (subdaily) air pressure, temperature and precipitation of 19 stations was finished.

Table 1. Subdaily surface air pressure records at 19 stations in the mainland of China

Station	Archive ID	Code of sources	Start	End	Months with data	Months with data missed	Missing rate (%)	Observational time (UTC)
Harbin	1001	4	190001	195103	160	455	74	03、04、05、07、08
Dalian	3001	2	190701	195012	378	150	28	03、06
Shenyang	3002	4	188701	195012	465	303	39	00、03、04、06、08
Hohhot	4027	2	193501	195312	99	129	57	02、03、08
Wulumuqi (Urumqi)	5025	3	193001	193309	21	24	53	03
Lanzhou	6001	3	193209	195012	218	2	1	00、03、04、24
Taiyuan	11023	7	192601	195312	222	114	34	00、03、06、08

Qingdao	12001	4	190201	195312	412	212	34	03、06、08
Jinan	12003	6	192101	195312	325	71	18	00、01、03、06
Nanjing	13010	5	190701	195112	310	230	43	03、24
Fuzhou	16003	3	192901	195012	202	62	23	01、02、03
Wuhan	19012	9	188003	195410	710	186	21	00、02、03、04、05、06、07、08、09、10
Nanning	22012	3	193201	194811	123	80	39	03、05、08
Guangzhou	23002	7	191501	195212	319	137	25	00、02、03、04、24
Kunming	25022	4	192901	195312	293	7	2	00、03、04、05、08、19、20、24
Beijing	29001	7	186804	195309	547	479	46	00、03、04、06、08、24
Shanghai	30001	3	192001	195312	265	143	35	03、08、24
Tianjin	31006	6	190701	195312	413	151	27	00、03、08
Chongqing	32041	9	189101	195406	754	8	1	00、02、03、04、05、06、08、10、12、24

6.10.3 Oldest/longest data series scanned and digitised

Table 2. The earliest observations with daily records continuously > 1 month in China

Time	Station	Location (N, E)	Height	Element	Observer	Source	Digitized
1698-1699	Xiamen (Amoy)	24.20 N, ?		P, W	James Cuningham	Philos. Trans. 1699 p. 323-330	Yes/no
1700-1702	Zhoushan (Insel Chusan)			P, W?	James Cuningham	Philos. Trans. 1704 p. 1648-1698	No

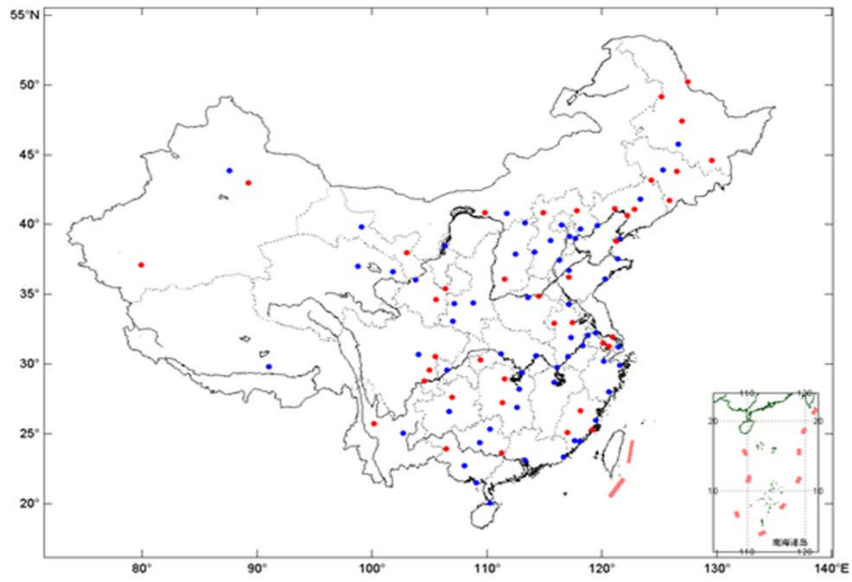
1743-1743	Beijing (Peking)	39.9, 116.3		T	S. J. Gaubil	Antoine le P. Correspondance de Pekin, 1722-1759	Yes
1757-1762	Beijing (Peking)	39.933, 116.283	55m	T, R, P, W	Joseph Amiot (fr. Missionary und Jesuit)	"Observations météorologiques faites à Pekin pendant six années, depuis le 1 janvier 1757 jusqu'au 31 dec. 1762" (Mém. d. math. Et d. phys., présentés à l'acad. T. VI)	Yes
1787-1787	Macao and Kanton				Chr. L.J. de Guignes	Mém. d. Paris 1789, Mém. p.597	No

Historical climate data in Beijing:

The observation was from January 1757 to December 1762 in Beijing, probably the earliest continuous observations with data longer than one year in China and Asia. Two times a day (matin.= afternoon, and soir.= early morning). Variables observed include temperature, pressure and wind, and also weather phenomena. Digitisation completed by BCC/CUG, and preliminary analysis completed.

6.10.4 Other data series scanned and to be digitised

(1) About 3.3 million pages imaged, some of which have been or will be digitised;
(2) Precipitation and temperature data for 100 cities;
(3) Pressure, relative humidity and wind data for 60 cities is underway.



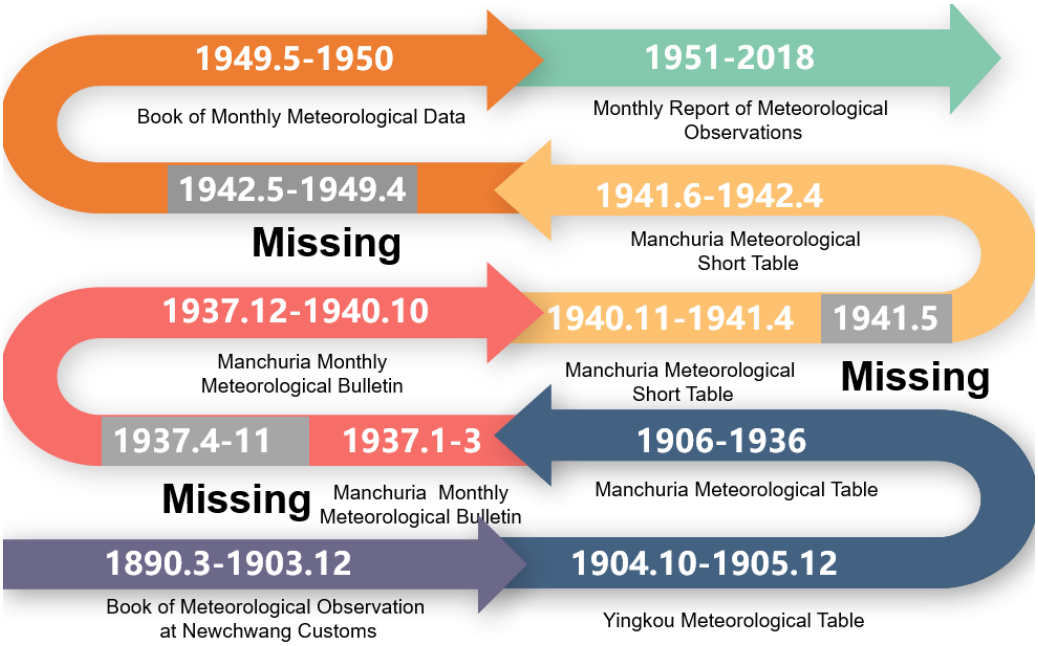
Legend: Daily data of T and R (100 cities); 40 cities already finished (red); 60 cities will be finished soon (blue)

Northeast China records since 1880:

Daily temperature and precipitation records digitised for 68 stations, 6 with records >30yr, 11 >20yr, and 25 >10yr. The most frequent records in 1935-1939, and the least frequent records in 1940-1949.

History of observations at Yingkou Station:

Sources and breaks of observational data at Yingkou Station:



History of observations at Shenyang City:

A daily climate dataset of Shenyang Station from 1905 to 2014 has been developed, by combining the recently digitised records to the aft-1951 data.

Table 3. History of observations at Shenyang Station

No.	Date	Station name
1	1905.5.1	The 8th temporary observatory of Mukden
2	1908.4.5	Meteorological observatory of Mukden
3	1916.1.1	Mukden Branch
4	1930.1.1	Mukden Branch
5	1954.1.1	Shenyang Central Meteorological Observatory; Liaoning Provincial Meteorological Bureau Observatory
6	1990.1.1	Shenyang Observatory

7	2006.1.1	Shenyang Observatory

History of observations in Dalian City:

Lighthouse, Laotieshan Mount, 1894/04—1898/04, by British, now kept in CMA Achieve. Russian established a station in 1902 at Shengli Bridge. Japanese started observation in 1904 at Shengli Bridge first and Ciergou/Nanshan till 1940. CMA observation began in 1952/01 in Met Street, Nanshan.

Table 4. Sources of data and variables observed at Dalian Station

No.	Year	Data source	Element
1	1905-1934 monthly	Manchuria Meteorological Report	pressure, temperature, relative humidity, water vapor tension, cloud cover, precipitation, wind, sunshine duration, evaporation, ground temperature, season, weather days
2	1905-1936 monthly	Manchuria Annual Meteorological Report	pressure, temperature, relative humidity, water vapor tension, cloud cover, precipitation, wind, sunshine duration, evaporation, ground temperature, season, weather days
3	1933.1-1941.4 daily	Monthly Meteorological Bulletin	pressure, temperature, relative humidity, precipitation, sunshine duration, evaporation, cloud cover, cloud patterns, wind speed and direction
4	1933-1940 daily	Annual Meteorological Report	pressure, temperature, relative humidity, water vapor tension, cloud cover, precipitation, wind, sunshine duration, evaporation, ground temperature, season, weather days
5	1942 daily	Annual Report of Guan Dongzhou Upper Airflow Observation	observation times, average wind speed, maximum wind speed, most wind direction, cloud cover, cloud patterns, ground temperature
6	1905-1932 monthly	Manchuria Meteorological Data	pressure, temperature, relative humidity, water vapor tension, cloud cover, precipitation, wind, sunshine duration, evaporation, ground temperature, weather days, the deepest snow season
7	1926.1-1932.12 daily	Manchuria Meteorological Table	pressure, temperature, relative humidity, precipitation, cloud cover, cloud patterns, wind direction, wind speed, sunshine duration, evaporation
8	1938.1-1940.12 daily	Manchuria Aviation Weather Conditions	wind, cloud, the maximum visibility, weather

6.10.5 URLs for data scans/images, data digitised and metadata

http://data.cma.cn/

http://www.rengy.org/

6.10.6 Citizen Science and volunteer activities

A WeChat public account was created in December 2018, which has run for more than 2 years, and has been followed by more than 500 WeChat users. More than 110 articles have been disseminated, and more than 200 reads recorded. In addition, median reports on ACRE China activities were also released at the websites of CMA, CUG and BCC.

6.10.7 Current Partners

BCC (NCC)/CMA, China

National Meteorological Information Centre (NMIC), CMA

UKMO Hadley Centre, UK

China University of Geosciences (Wuhan)

Chinese Academy of Sciences (CAS)

National Maritime Information Centre (NMIC), China

Bristol University, UK

German Weather Department (DWD)

Japan Met Agency (JMA)

JAMSTC, Japan

Seikei University, Japan

Tokyo Metropolitan University, Japan

Hong Kong Observatory

Singapore Management University

Shenyang Climate Centre, China

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6.10.8 State of the project

Well performed. A national research project includes a component of early-year data digitization and analysis in East Asia monsoon region. Cooperation with colleagues from other countries/regions of East Asia is going smoothly. A working meeting of domestic component is planned on 25th August 2021 in Guiyang, China.

6.10.9 Rough estimation of any assistance needed (€)

Problems with ACRE China include: (1) Missing records, especially for 1940s; (2) Data sharing among different groups; (3) Application of the digitised data; (4) Lack of special national or international projects.

It is our hope to apply for a new national or international project from the China Natural Science Foundation, hopefully in next three years, to help in continuing the future ACRE China work. It would be good if the WMO or any other organization gives support in this regard.

6.10.10 Contact

Prof. Guoyu Ren, National Climate Centre, China Meteorological Administration (CMA), Beijing, China; China University of Geosciences, Wuhan, China

6.11 ACRE Japan

A joint network of Japanese Universities and Institutes aims to expand the understanding of climate change and variability in the Asian monsoon region through the data rescue of instrumental meteorological observations since the 19th century. Digitized meteorological data have been provided to ISPD (The International Surface Pressure Databank) and contributed to the improvement of the 20th century reanalysis dataset. Japan Climate Data Project (JCDP) is one of the active programs under the ACRE-Japan. Target activities are:

- ✓ Data rescue of daily rainfall data in Japan, East, Southeast and South Asian countries back to the late 19th century for Asian monsoon researches.
- ✓ Data rescue of meteorological data in stations since the 1860s and ship logs sailing along the coastal region of East and Southeast Asia since the 1780s including the tropical cyclone tracks since the 1880s for tropical cyclone researches.
- ✓ Data rescue of instrumental meteorological data observed in Japan by lighthouses and individual personnel before the official weather station were operated for climate studies in the 19th century. That of former local observatories of the current JMA since the 1880s.
- ✓ Data rescue of upper air observations in Japan, East, Southeast Asia and Western North Pacific Islands since the 1920s.
- ✓ Data rescue of civil and military meteorological observations and their history and background during World War II including their historical perspective.
- ✓ Investigation of early instrumental meteorological observation in Japan deployed by foreign visitors since the 18th century.

6.11.1 Domain of the Data

Japan, China and surrounding regions and seas

6.11.2 Periods and Parameters

Land surface observation

Japan

Tokyo 1824-1828, 1838-1855, 1872-1875 temperature and pressure (3 times a day)
Yokohama 1859-1864 temperature
1864-1871 temperature and pressure (3 times a day)
1873-1874 temperature and pressure

Yokosuka 1866-1868 temperature and pressure (2 times a day)
Osaka 1828-1833 temperature and pressure (2 times a day)
1869-1871 temperature and pressure (3 times a day)
Kobe 1869-1871, 1875-1888 temperature and pressure (once a day)
Nagasaki 1819-1825 temperature
1826-1828 temperature and pressure (3-6 times a day)
1845-1858 temperature and pressure (3-4 times a day)
1871-1878 temperature and pressure (3 times a day)
Hakodate 1859-1862 temperature, humidity and pressure (3 times a day)
Mito 1852-1868 temperature
Japan remote islands 7 stations 1890-1945 daily rainfall and pressure (1-8 hourly)
Lighthouses 38 stations 1877-1882 temperature, pressure (3-12 hourly), daily rainfall, wind direction and wind force
Hundreds of stations in the central Japan area since the 1890s to the 1970s daily precipitation
21 stations in Shikoku Island 1894-1978 daily rainfall
72 stations in Shikoku Island 1951-2002 daily snow depth

China
Beijing 1841-1855, 1868-1883 temperature
279 stations 1891-1941 daily rainfall, digitized from "Zi-Ka-Wei"
Hundreds of stations 1880s-1940s, monthly temperature, rainfall, , digitized from "Rainfall Records in China", "Temperature Records in China"
10 stations 1901-1930s, sub-daily (3-12 hourly) pressure, dry bulb temperature, wet bulb temperature, rainfall, wind direction, wind force, digitized from "China Meteorological Return"

Philippines
Manila 1866-1941 temperature, pressure (1-24 hourly), wind direction, wind speed, daily rainfall, relative humidity, cloud amount, water vapor, visibility, sunshine duration, evaporation
40 stations 1890-1941 temperature, pressure (4-12 hourly), wind direction, wind speed, daily rainfall
17 stations 1942-1944 temperature, pressure (1-4 hourly) and daily rainfall

Vietnam
5151 stations 1880-1954 daily rainfall

Myanmar
3232 stations 1891-1941, 1947-1956 daily rainfall, digitized from "Rainfall of India"

Malaysia
hundreds of stations 1879-1958 monthly rainfall, digitized from "Hydrological data, Rainfall Records, 1979-1958"

Bangladesh
2323 stations 1891-1947 daily rainfall, digitized from "Rainfall of India" and "Daily Rainfall Recorded in Burma"

Taiwan, Korea, Manchuria, China, Sakhalin, Kuril Islands
34 stations 1897-1941 temperature, pressure (1-8 hourly), daily rainfall

Western North Pacific Islands
44 stations 1923-1945 pressure (1-12 hourly) and daily rainfall
Ruotto Island (Kwajalein Atoll) 1941, 1943 pressure (6 times a day)

Pratas Island 1940-1944 temperature, pressure (4-12 hourly), wind direction, wind speed, daily rainfall

China coast meteorological register
1882, 1884, 1886, 1888-1892 temperature, pressure (2 times a day), dew point temperature, wind direction and wind force

Tropical cyclone tracks over the western north Pacific
Philippine Weather Bureau 1902-1940
Central Meteorological Observatory Tokyo Japan 1892-1950
Hong Kong Observatory 1884-1950
Zi-Ka-Wei Observatory 1884-1948

Upper-air observations
Palau 1925-1940 pilot balloon wind direction and wind speed
1939 Aug radiosonde temperature, water vapor, relative humidity, mixing ratio, potential temperature, equivalent potential temperature
1939 Jul and Aug 21 stations pilot balloon wind direction and wind speed
Tateno, Japan 1944-1949 radiosonde temperature and water vapor

Ship logs
US Navy *USS Mississippi* 1852-1855 temperature, sea surface temperature, pressure (1-4 hourly), wind direction, wind force, and weather
UK Navy 11 ships 1862-1865, 10 ships 1872-1877 temperature, sea surface temperature, pressure (4 hourly), wind direction, wind force, and weather
Dutch Navy *Medusa* 1862-1865 temperature, sea surface temperature, pressure (4 hourly), wind direction, wind force, and weather
Japan Antarctica expedition *Kainan Maru* 1910-1912 temperature, sea surface temperature, pressure (4-24 hourly), wind direction, wind force, weather, humidity, and wave height

6.11.3 Oldest/longest data series scanned and digitised

Temperature data at Nagasaki from 1819 observed by von Siebold (Können et al. 2003). Continuous observation is available from 1872 to now at Nagasaki, Tokyo and Hakodate.

6.11.4 URLs for data scans/images, data digitised and metadata

Japan-Asia Climate Data Program
https://jcdp.jp/daily-diary-weather-records/

6.11.5 Citizen Science and volunteer activities

WWW URL

6.11.6 Current Partners

ACRE
Japan Meteorological Agency
Philippine Atmospheric Geophysical and Astronomical Services Administration
Hong Kong Observatory
Central Weather Bureau Taiwan

Met Office
Liden University

6.11.7 State of the project

Japanese KAKENHI Project
Recovery of tropical cyclone activity around Japan from the foreign ship logs during Edo era (2018-2023) PI: Hisayuki Kubota
History of South China Sea monsoon variability based on the meteorological observation data recorded in ship logbooks (2019-2022) PI: Jun Matsumoto
Homogenization of temperature observation and its long-term time series during the 19th century (2019-2021) PI: Masumi Zaiki

6.11.8 Rough estimation of any assistance needed (€)

Contact: Hisayuki Kubota, Faculty of Science, Hokkaido University Sapporo, Japan.

6.12 ACRE Oceans (with funding from CSSP China and C3S DRS)

About 70% of the Earth's surface is covered by oceans. Oceans and their interaction with the atmosphere and with land masses are critical to understanding the climate system. Sea temperatures are used to set boundary conditions for atmospheric reanalyses. The most severe weather systems, typhoons, cyclones and hurricanes are generated over the oceans. ACRE-Oceans links other terrestrial ACRE foci, as well as being a focus of activity in its own right. All the other ACRE regional foci have maritime borders. Descriptive marine weather observations can be found as far back as the 16th century, instrumental observations from the 18th century. State archives contain records of their naval forces, including many logbooks. Commercial shipping records are also rich source of data. From the 19th century meteorological services, and scientific institutions began the systematic collection of meteorological, oceanographic and glaciological observations. All these records are sources of historical surface synoptic pressure and wind data, the latter now also a variable to be assimilated into reanalyses. Many records also contain sea-ice data. There is far more data in state archives, museums and academic and scientific institutions, than in current digital data depositories, and more sources are being discovered every year. Most recently Norwegian and Finnish archives have been mined for Southern Ocean data, and as a result other significant sources have been found in archives in both countries and throughout Scandinavia. ACRE-OCEANS in conjunction with the NOAA linked RECovery of Logbooks and International Marine data (RECLAIM) Project, identifies sources of marine data (usually with a regional data focus such as the Southern Ocean or Asia/Pacific), and arranges for the records to be imaged and catalogued as the first stage towards making the observations available for scientific study. ACRE-OCEANS works closely with Old Weather and Weather Detective, digitising marine weather observations via citizen science projects linked to ACRE.

6.12.1 Domain of the Data

Global Oceans

6.12.2 Periods and Parameters

c. 1750 to 1950. All marine meteorological and oceanographic parameters including sea ice

6.12.3 Oldest/longest data series scanned and digitised

6.12.4 URLs for data scans/images, data digitised and metadata

ACRE Oceans (Antarctic and Southern Ocean) https://datarescue.climate.copernicus.eu/projects/8

ACRE Oceans (Arctic) https://datarescue.climate.copernicus.eu/projects/9

ACRE Oceans (Asia Pacific) https://datarescue.climate.copernicus.eu/projects/11

ACRE Oceans (Japan) https://datarescue.climate.copernicus.eu/projects/12

ACRE Oceans (Pacific) https://datarescue.climate.copernicus.eu/projects/5

ACRE Oceans (Royal Navy Remark Books) https://datarescue.climate.copernicus.eu/projects/4

ACRE Oceans (Southern Africa) https://datarescue.climate.copernicus.eu/projects/10

6.12.5 Citizen Science and volunteer activities

WWW URL – none.

6.12.6 Current Partners

UK Met Office

NIWA, New Zealand

Reading University, UK

Hokkaido University, Japan

6.12.7 State of the project

On-going

6.12.8 Rough estimation of any assistance needed (€)

Contact: Clive Wilkinson, CSW Associates, Climatic Research Unit, University of East Anglia, Norwich United Kingdom.

6.13 ACRE Pacific (with some funding from CSSP China)

The South Western Pacific is a region that is critical for us to examine if we wish to understand how Earth's climate system works. We can expand our knowledge using historical climate data. New visualization tools can bring these data to life. The extended reanalysis without radiosondes effort (ACRE-facilitated 20th Century Reanalysis Project [20CR]) allows huge data integrations that no one else can do by themselves. It gives everyone global context for local conditions via circulation reconstructions (past climate and weather) to pair with in-situ station data, shipboard measurements, and traditional knowledge. The veracity of the 20CR reconstruction is dependent on the temporal and spatial density of observations. We need to contribute by providing more data to ACRE Pacific. We have continued funding of ACRE Pacific via the New Zealand National Institute of Water and Atmospheric Research Ltd (NIWA) for the future.

Chappell, P. and Lorrey, A.M. 2013: Identifying New Zealand, Southeast Australia and Southwest Pacific historical weather data sources using Ian Nicolson's Log of Logs. *Geoscience Data Journal*, doi: 10.1177/0959683613484612.

Cram, Thomas; Compo, Gilbert; Yin, Xungang; Allan, Rob; Lorrey, Andrew and 40 others. 2015: The International Surface Pressure Databank. *Geoscience Data Journal*, **2**, **1**, 31-46.

Diamond, H.J., Lorrey, A.M., and Renwick, J.A. 2013: A Southwest Pacific Tropical Cyclone Climatology and Linkages to the El Niño Southern Oscillation. *J. Climate*, **26**, 3-25, DOI:10.1175/JCLI-D-12-00077.1

Diamond, H.J., Lorrey, A.M., Knapp, K.R., and Levinson, D.H. 2012: Development of an enhanced tropical cyclone tracks database for the southwest Pacific from 1840 to 2010. *Inter. J. Climatol.*, DOI:10.1002/joc.2412.

Harvey, T., Renwick, J.A., Lorrey, A.M., and Ngari, A. 2019: The representation of the South Pacific Convergence Zone in the 20th Century Reanalysis. *Mon. Wea. Rev.*, **147**, **3**, 841-851.

Kruk, M., Lorrey, A, Griffiths, G., Lander, M., Gibney, E., Diamond, H., Marra, J. 2014: On the State of the Knowledge of Rainfall Extremes in the Pacific Basin. *Inter. J. Climatol.*, DOI: 10.1002/joc.3990.

Lorrey, A.M., Dalu, G., Renwick, J., Diamond, H., and Gaetani, M. 2012: Reconstructing the South Pacific Convergence Zone during the pre-satellite era: A La Niña case study. *Mon. Wea. Rev.*, **140**, 3653-3668.

Lorrey, A.M. and Chappell, P.R. 2016: The "Dirty Weather" diaries of Reverend Richard Davis: insights about early Colonial-era meteorology and climate variability for Northern New Zealand, 1839–1851. *Climate of the Past*, **12**, 553-573, doi:10.5194/cpd-12-553-2016.

6.13.1 Domain of the Data

SW Pacific Ocean, especially SW Pacific island nations and territories and New Zealand

6.13.2 Periods and Parameters

Atmospheric pressure and rainfall observations; SST, SSS and air temperature, qualitative wind direction and strength are secondary; tropical cyclone track data; South Pacific Convergence Zone; indices (eg SOI)

6.13.3 Oldest/longest data series scanned and digitised

Richard Davis 1839-1844; 1845-1851

Longest – multiple from New Zealand extending into the 1850s and 1860s

6.13.4 URLs for data scans/images, data digitised and metadata

Held on digital archive drives at NIWA

6.13.5 Citizen Science and volunteer activities

Southernweatherdiscovery.org

6.13.6 Current Partners

Pacific Islands National Meteorological Services, Papers Past, Auckland Museum, Auckland Library, Archives New Zealand, Alexander Turnbull Library, Hocken Library; NIWA; Clive Wilkinson (UEA) and UKMO

6.13.7 State of the project

Restarting efforts to capture SW Pacific island and New Zealand data from 1 July 2021.

6.13.8 Rough estimation of any assistance needed (€)

Any additional support will be used to key critical data held in New Zealand archives or transferred to NIWA by international partners.

Contact: Dr Drew Lorrey, National Institute of Water and Atmospheric Research, Auckland, New Zealand.

6.14 ACRE/C3S DRS/WCSSP South Africa

The southern African initiative aims to recover instrumental climate data for the African sub-continent, and also the SW Indian Ocean region. It is also one of three Southern Hemisphere core regions for data rescue under the EU-funded Copernicus C3S Data Rescue Service. Given the important historical replenishment stations at the Cape of Good Hope and others in Madagascar, Mauritius etc, meteorological observations began as early as the 18th century in some places, but usually for only brief periods of time. During the course of the 19th century, colonial stations were established across much of South Africa, and so too, the gradual introduction of meteorological registers. A further valuable source of information is from ship logbooks, particularly those docked at ports for longer periods of time. ACRE South Africa aims to find as yet unknown or seemingly 'lost' records and have these digitized. There are also many known records that require digitization. Work has already started on some of these, such as the long record kept by the Royal Astronomical Observatory at the Cape of Good Hope (now SAAO), which started in the mid- 1830s.

Lakhraj-Govender, R. and Grab, S.W. 2019: Assessing the impact of ENSO on South African temperatures. *Int. J. Climatol.*, 39, 143-156. DOI: 10.1002/joc.5791

Lakhraj-Govender, R. and Grab, S.W. 2019: Temperature trends for coastal and adjacent high lying interior regions of KwaZulu-Natal, South Africa. *Theor. Appl. Climatol.*, 137, 373-381, https://doi.org/10.1007/s00704-018-2602-6

Ndebele, N.E., Grab, S.W. and Turasie, A. 2020. Characterizing rainfall over the southwestern Cape, South Africa: 1841-2016. *Int. J. Climatol.*, 40, 1992-2014. DOI: 10.1002/joc.6314

Picas, J., S. Grab and Allan, R., 2018: A 19th century daily surface pressure series for the Southwestern Cape region of South Africa: 1834-1899. *Int. J. Climatol.,* 1-11, https://doi.org/10.1002/joc.5890

Picas, J., and Grab, S.W. 2020: Potential impacts of major nineteenth century volcanic eruptions on temperature over Cape Town, South Africa: 1834–1899. *Clim. Change*, 159, 523-544. https://doi.org/10.1007/s10584-020-02678-6

Picas, J. and Grab, S.W. 2021. Reconstruction of cold front frequency over Cape Town, South Africa, using

daily mean sea level pressure values: 1834-1899. *Int. J. Climatol.*, 41, 1784-1800.

https://doi.org/10.1002/joc.6930

6.14.1 Domain of the Data

Southern Africa and surrounding seas (SW Indian Ocean, Mid and Southern Atlantic Ocean)

6.14.2 Periods and Parameters

Completed work

The Royal Astronomical Observatory record

The primary objective of ACRE southern Africa, since the start of the C3S Data Rescue Service contract, has entailed the collection, photography and digitisation of the Royal Astronomical Observatory record in Cape Town. The record varies from daily to sub-daily resolution and covers barometric pressure, temperature and wind parameters. This process was completed during 2019-2020 with the final coverage including the years 1950 to 1958. This is now a completed set from 1834 to 1958. Most of the record (up until 1932) has already been formatted into the Station Exchange Format (SEF) and submitted to the C3S Global Land and Marine Observations Database.

Cape Town Harbour Master's Record

This is potentially the earliest and second longest existing sub-daily instrumental weather record for southern Africa. However, only portions of the original Harbour Master Record books have been found at the Cape Town Archives. It is not known whether the missing years/months do in fact still exist somewhere. The sub-daily (3 x) records include wind direction, barometer and thermometer readings. The years scanned and digitized include: 1829-1833; 1841-1850; 1855-1857; 1870-1873; 1890-1893, 1904 (there are some gaps in these years).

Cape Colonial records

During the 19th century the Cape Government of South Africa set up meteorological stations in key district governmental centers. The original daily records have never been found but monthly summaries for temperature, barometric pressure, humidity and rainfall were published by the Meteorological Commission, but had never been digitised. Given that these are some of the earliest multi-station records for southern Africa, they have been included as part of the ACRE SA effort through the C3S Data Rescue Service contract. The following have been digitised and sent to the work package leader:

- ✓ Grahamstown: 1866; 1879-1891
- ✓ King William's Town: 1875-1891
- ✓ Queenstown: 1866; 1880-1891
- ✓ Aliwal North: 1866; 1875-1906
- ✓ Beaufort West: 1879-1883
- ✓ Ceres: 1879-1891
- ✓ Colesburg: 1878-1880
- ✓ Kimberley: 1875-1903
- ✓ Cradock: 1881-1898
- ✓ Graaf-Reinet: 1881-1903

The *Natal Witness* (Newspaper based) records

The *Natal Witness* is one of the world's oldest and still publishing newspapers, established in 1846. The newspaper published '*Weekly Meteorological Reports*' which included daily to sub-daily values of temperature, barometric pressure and wind from a variety of meteorological stations that were established in the former Natal (currently KwaZulu-Natal) Province of South Africa. These are the earliest meteorological records for southern Africa outside of the Cape Colony, and the earliest for easternmost southern Africa. The records are relatively brief and contain data gaps. All published 19th century records have now been digitised and sent to the work package leader; these include:

- ✓ Botanical Society Gardens: Oct/Nov 1880 (sub-daily)
- ✓ Durban: August 1850 to February 1853 (daily)
- ✓ Pietermaritzburg: 1870-1872 (daily)
- ✓ Byrne: January 1878 to September 1879 (sub-daily)
- ✓ Fort Napier: Jan/Feb 1878 (daily)
- ✓ Inkutu: December 1882 to December 1883 (daily)
- ✓ Pietermaritzburg Botanic Society: January 1890 to July 1890 (daily)

Lourenco Marques, Mozambique

Lourenco Marques, Mozambique, was established as a colonial center by Portugal – now known as Maputo. A set of daily temperature, barometric pressure and wind data were found and have been digitised and submitted for the period October 1876 to June 1878. These are possibly the earliest instrumental records for the sub-tropical east coast of Africa (south of the equator) and Mozambique. In 2021-2022, it is hoped that more data for this location may be found in old Portuguese records held at the University of Lisbon that will be scanned and digitised under WP 1 of the UK Newton Fund project CSSP China. The digitised 1876-1878 data have already been formatted into the SEF and submitted to the C3S Global Land and Marine Observations Database.

Ascension Island Records

Monthly rainfall summaries for a variety of stations scattered across Ascension Island were found in hard copy format on St Helena Island. These have been digitised and sent to the work package leader – all at monthly resolution unless otherwise indicated:

Ascension Island Garrison: 1854-1865; 1889-1895

Green Mountain: 1859-1865; 1884-1922 (annual)

Two Boats: 1968-1977

Travellers Hill: 1987-1989

HMS Tortoise: 1853-1866

Ascension: 1929-1935; 1955-1959; 1968-1970

Ascension Airhead: 1962-1989

Ascension Georgetown: 1929-1935; 1955-1959; 1968-1970

Meldrum's Meteorological Journal of the Indian Ocean record

ACRE's Mauritius Project, which has taken nearly 8 years to come to fruition, is focusing initially on images from Charles Meldrum's 153 'anemological' volumes (1853 to 1914) of extracted weather observations in ship logbooks held by the National Library of Mauritius which are being recovered, imaged/scanned and digitised. These volumes contain important historical ship weather observations from vessels travelling around southern Africa on the old shipping routes through Mauritius to India, China, and Australia. This material also contains Indian Ocean island station records from Mauritius, La Réunion, Rodrigues, the Seychelles, and Diego Garcia in the 19th and early 20th centuries. This collection includes ship information, location data and a variety of meteorological parameters. These are daily records from ~ 15 vessels (i.e. locations) travelling across the Indian Ocean per day. The activity is currently being undertaken with funding from the UK Newton Fund CSSP China via ACRE to the Meteorological Society of Mauritius and the Mauritius Meteorological Service and involves close cooperation with Météo-France for the Comoros and La Réunion. The data are being digitised by ACRE/C3S DRS/WCSSP South Africa and sent to the work package leader.

6.14.3 Ongoing and forthcoming efforts

Monthly rainfall values for multiple stations in the country of Lesotho

Hard copy published monthly rainfall values for the Kingdom of Lesotho (formerly known as Basutoland) were found in a basement archive of the South African Weather Services. These are the earliest rainfall records for this landlocked kingdom (country) in South Africa. Digitisation is now completed and include 13 stations covering the period 1886-1970 (with data gaps). Quality control is ongoing.

St Helena Island Records

Hard copy rainfall and temperature summary tables were found in documents held on St Helena Island. These cover multiple stations and periods – but for the most part are at monthly resolution. Rainfall and temperature records generally fall within the period 1881-1989, with stations having variable recording lengths and data gaps. However, some records of daily resolution were also found on the Island, including a rainfall record at the Governor's private residence (1910-1921; 1959-1966), and some held at the St Helena Archives. The sub-daily Mural Circle barometric pressure and temperature record from November 1829 to June 1830 is possibly the oldest and longest of its kind for the central Atlantic Ocean. These are all digitised now, but in need of quality control.

***HMS London* (Indian Ocean sector)**

Sub-daily temperature, barometric pressure and wind have been digitised for this vessel from when it was anchored as a 'stationary ship' in Zanzibar, Tanzania for the period April 1874 to March 1878.

***HMS Orestes* (Indian Ocean Sector)**

Sub-daily temperature, barometric pressure and wind have been digitised for this vessel voyaging in the Indian Ocean for the period 25 March 1862 to 21 January 1863.

Island of Reunion records (Indian Ocean Sector)

19th Century records not digitised by Météo-France are being digitised as part of the ACRE South Africa effort under the C3S Data Rescue Service contract. Work has started and is currently ongoing to digitise daily barometric pressure, temperature and rainfall records for the Island over the period 1861 to 1909.

Island of Mauritius Meldrum meteorological record (Indian Ocean Sector)

The 19th century Meldrum record (noted in Section 1.1 above) will continue to be digitised by ACRE/C3S DRS/WCSSP South Africa as part of the C3S2_311 Lot 1 Phase 2 contract. The aim is to digitise as much of this record as the current time and budget permits.

Data formatting

Formatting of data into SEF is currently being carried out mainly at the University of Lisbon, with limited capacity. Attempts to hire a collaborator at the University of Witwatersrand to work on formatting will continue, despite not having been successful so far.

6.14.4 Oldest/longest data series scanned and digitised

The oldest and longest data series scanned and digitized is that for the South African Astronomical Observatory: 1834-1958. This is indeed the longest daily (to sub-daily) and continuous instrumental weather record for Africa.

6.14.5 URLs for data scans/images, data digitised and metadata

Rescued data under C3S DRS 2020

6.14.6 Citizen Science and volunteer activities

WWW URL

6.14.7 Current Partners

Meteorological Society of Mauritius

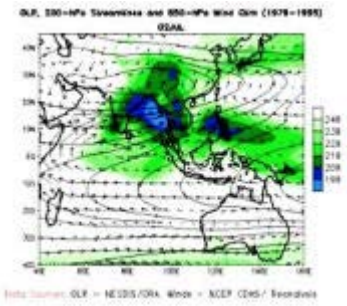
6.14.8 State of the project

On Going.

Will start collecting long farm records and will be engaging with farmers this July 2021.

6.14.9 Rough estimation of any assistance needed (€)

Contact: Prof. Stefan Grab, School of Geography, Archaeology & Environmental Studies, University of the Witwatersrand, South Africa



6.15 ACRE Southeast Asia (with some funding from ACRE China)

The primary goal of this regional foci is to build both capabilities and capacities within Southeast Asian institutions, agencies and National Meteorological Services to improve and extend historical instrumental, documentary and paleo databases of SE Asian weather/climate. The databases will contribute to the generation of high-quality, high-resolution historical weather reconstructions (reanalyses). These new baselines will allow scientists and policy makers across the region to address weather/climate extremes, impacts and risks in ways and over time spans not previously possible. Activities of the project include:

- ✓ Compiling a data inventory of all known data for the region - from ACRE sources or our partners
- ✓ Awareness raising about ACRE and recovery activities.
- ✓ Taking part in conferences and workshops
- ✓ Developing a network of regional multi-disciplinary and academic contacts in humanities and sciences
- ✓ Research into extreme weather: storms, floods, and typhoons in archival resources
- ✓ Working on projects to trace particular extreme weather events, or comparative histories of events

Gao, E., Bertrand Timbal and Fiona Williamson, 'Creating Singapore's Longest Monthly Rainfall Record from 1839 to the Present', MSS Research Letters 2 (2018

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Williamson, F., Guoyu Ren and Allan, R., 2017: The Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative ACRE China workshop: Recovery, Digitization and Analysis of Pre-mid-20th Century Climate Observational Data in East Asia workshop 23-24th August, Beijing, China. *Earth and Space Science,* **4**, **1**, 40-43. https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2016EA000215 DOI: 10.1002/2016EA000215.

Williamson, F., Allan, R., Ren, G., Lee, T-C., Lui, W-H., Kubota, H., Matsumoto, J., Luterbacher, L., Wilkinson, C. and Wood, K., 2018: Collating Historic Weather Observations for the East Asian Region: Challenges, Solutions, and Reanalyses. *Advances in Atmospheric Sciences* (Special CSSP China Issue) http://159.226.119.58/aas/EN/10.1007/s00376-017-7259-z

6.15.1 Domain of the Data

Southeast Asia and surrounding seas

6.15.2 Periods and Parameters

Straits Settlements:

Province Wellesley, 1882-1915

Singapore, 1824-1924

Penang Island, 1815-1917

Dindings, 1890

Malacca, 1885-1915

Sarawak, 1906-1927

Borneo, 1837

Christmas Island 1901-1952

Bencoolen, 1819-20

Indonesia:

Batavia 1860

Aceh 1874-5

Medan 1909-1940

Philippines:

Manila, 1868-1884

Hong Kong:

Harbour Timeseries, 1860-1883

Victoria Peak, 1860-1883

Civil Hospital, 1865- 1876

Lock Hospital, 1876; 1879

Gap Rock, 1876-78; 1919-1938

Gunpowder Depot, 1874-1876

World War 2 Diaries, 1941-45

6.15.3 Oldest/longest data series scanned and digitised

Singapore 1824 – 1924 mixed stations, with some gaps.

6.15.4 URLs for data scans/images, data digitised and metadata

https://www.dropbox.com/sh/2at0r3cu4soxyno/AAAT6W3c8GwCbHPtnaKptjSZa?dl=0

6.15.5 Citizen Science and volunteer activities

None currently.

6.15.6 Current Partners

Badan Meteorologi, Klimatologi, dan Geofisika (BMKG), Indonesia

Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), Philippines

Japan Meteorological Agency (JMA), Japan

Hong Kong Observatory (HKO), Hong Kong

6.15.7 State of the project

The project has been focussing on reclaiming long-term data from across Southeast Asia with a particular focus on Malaysia, East Malaysia and Singapore. Work for these areas is almost complete. Over the past years, research work across Cambodia, Lao PDR, and Indonesia has identified more resources in need of recovery, but coherent and large-scale top-down projects are required to enable this work to be undertaken. Government buy-in is needed from these countries, as are monies for recovery work. For Indonesia, a large amount of data is available and BMKG are willing to share this valuable information. However, funds are needed for the large-scale digitisation work required. Currently, much archival work is stalled due to international travel restrictions, as much information for Southeast Asia is held globally as well as within the region. This is because of historical circumstances, whereby Britain, Japan, and France held imperial stakes in various Southeast Asian countries, with the exception of Thailand. The majority of stations are urban and based around government or military facilities, including hospitals and prisons. A full run-down of the Singapore and Penang stations are available here. Published research undertaken on Singapore's long-term rainfall records is available here.

This project has also focused efforts on Hong Kong, though the region is not geographically or politically within the scope of Southeast Asia but interlinked to ACRE China. Records of weather exist from the 1840s, after British colonisation and are fairly consistent throughout the whole 1840s-1940s period, albeit across different stations. The majority of stations are urban for the period.

The project intends to focus on the recovery, imaging/scanning and digitisation of available images for the region over the next year, where available. New country-based research will not be possible until travel restrictions end. This may include images held at BMKG and at JMA archives for Southeast Asia, as well as completing online datasets for Hong Kong.

6.15.8 Rough estimation of any assistance needed (€) 111,000

Human resources to continue research over 3 years: 36,000

Digitisation work over 3 years: 30,000

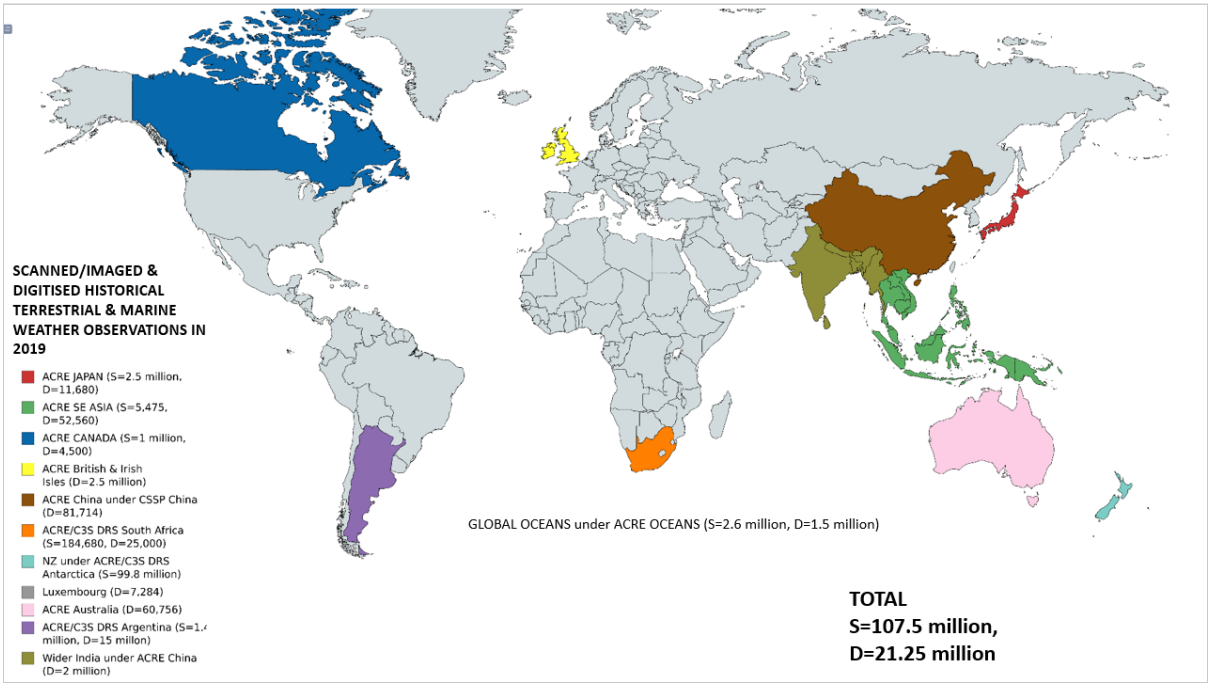
Travel: 10,000

Large scale data reclamation projects for Cambodia and Lao PDR: 35,000

Contact: Dr Fiona Wiliamson, Associate Professor, Singapore Management University

6.16 ACRE Regional Foci/Chapter scanning and digitisation activities in 2019

The global distribution and totals of Scanned (S) and Digitised (D) historical terrestrial and marine weather observations from ACRE data rescue activities (including Newton Fund [CSSP China] and EU Copernicus C3S DRS) in 2019 can be seen below.



Global distribution and totals of Scanned (S) and Digitised (D) historical terrestrial and marine weather observations from ACRE data rescue activities (including Newton Fund [CSSP China] and EU Copernicus C3S DRS) in 2019.

7 Data rescue activities within NOAA's NCEI Analog Collection

Contribution: Jesse Moore, Nancy Ritchey, NOAA

7.1 Background

NOAA's National Centers for Environmental Information (NCEI) is the official archive for data collected by NOAA scientists, observing systems, and research initiatives or data collected to meet NOAA's mission. NCEI manages a large volume of environmental data in digital and analog formats, including historical weather data, charts, and publications that are located in the NCEI facility in Asheville, North Carolina.

Overall, the NCEI analog collection contains 222 collections of data from the United States and locations around the world. While the NCEI analog collection includes data in a variety of formats, the majority of its records are managed on four media types: microfiche, microfilm, paper records, and publications. There are over 39,000 boxes of documents, 130,000 reels of microfilm, and 800,000 pieces of microfiche. These four media types account for 97% of all data in the analog collection.

7.2 Overview

About 26% of the records managed in the NCEI analog collection have been imaged. This is equivalent to approximately 124,000 of the 469,000 records that are described in the archive's tracking database. These images were scanned from collections of historic weather data and are accessible through databases managed by NCEI, including the Environmental Document Access and Display System, Version 2 (EV2) and the Image and Publications System (IPS). NCEI is developing new systems that will improve the process of ingesting scanned historical data from the analog collection and will provide users with better online portals for discovering and accessing data.

Although the remaining analog records may be digitized in the future, it is not currently feasible to scan and ingest all of the holdings. However, in 2020, NCEI staff completed a significant project to develop a Data Rescue Management Plan for the analog collection. The goal of this plan was to better characterize the holdings and collections managed, and to gather more information that will inform NCEI's efforts for scanning and managing its collections going forward.

7.3 Recent Data Rescue Activities

In recent years, NCEI has collaborated with national and international agencies to complete data rescue activities:

- ✓ Atlantic tropical cyclone records (2015): The U.S. National Hurricane Center (NHC) conducted a reanalysis of Atlantic tropical cyclone seasons for 1960-1975. NCEI and NHC partnered to

scan thousands of printed polar-orbiting mosaics and geostationary images, which helped NHC identify dozens of storms previously unknown to the scientific community.

- ✓ Polar ice records (2016): NCEI partnered with the U.S. National Snow and Ice Data Center (NSIDC) to scan additional polar-orbiting satellite prints and negatives. With these images, NSIDC produced a dataset that allows for research into the polar ice extent dating back to the 1960s.

- ✓ New Caledonia surface observations (2014): Météo-France en Nouvelle-Calédonie approached NCEI wishing to acquire scanned records of weather observations taken by the U.S. military during World War II. NCEI scanned and provided roughly 5,000 files.

Ongoing Data Rescue Activities

- ✓ NCEI scanned 55,000 observation forms with data collected by the U.S. Coast Guard between 1966 and 1995. These forms are being added to the EV2 database, where users can search and access them.

- ✓ As part of the Data Rescue Management Plan completed in 2020, records were designated with priority levels based on their condition or potential value. Records with a high risk of loss or a high stakeholder priority were identified and assigned either a red or an orange priority level. Collections with these priority levels will be prioritized for data rescue activities first. Lesser priority levels are classified as yellow or green and will be processed at a later date.

- ✓ Approximately 69,000 records, or 20% of the data on analog media that have not been imaged, were classified with either a red or orange priority level. The most common formats for these records were consistent with the four main media types in the analog collection: microfiche, microfilm, paper records, and publications.

- ✓ NCEI created a Microfilm Management Plan in 2021. This plan specifically addresses the stewardship of data stored on approximately 130,000 reels of microfilm and proposes a timeline to scan the microfilm over the next eight years. Microfilm in the collection will be prioritized for data rescue primarily based on condition, with reels that are currently showing signs of deterioration or that are most at-risk being scanned first.

Conclusion

The NCEI analog collection contains collections of historical weather data, charts, and publications that are available in a variety of formats. The majority of these materials are managed on four media types including microfiche, microfilm, paper records, and publications. While about 26% of the holdings have been imaged, the remaining data are only available in analog formats.

Over the past two years, NCEI has prioritized the management of data in its analog collection. This includes developing a Data Rescue Management Plan to evaluate all media types and identify collections with a high risk of loss and/or a high stakeholder value to be scanned or converted to electronic formats. NCEI also created a data management plan to specifically address the condition of its microfilm and prioritize scanning records that are stored on microfilm.

Furthermore, NCEI is developing new systems that will improve the process of ingesting historical data that have been scanned from analog collections. These systems will also make it easier for users to discover and access data from the archive through online portals.

8 Météo-France

Contribution: Sylvie Jourdain, Météo-France

Météo-France is the French national meteorological service.

The Directorate of Climatology and Climate Services (DCSC), based in Toulouse oversees the French memory of climate. A dedicated Department, the "Expertise on historical data and on Climatic references Department" (DCSC/EDR) is involved in Climate data rescue activities.

DCSC/EDR leads the enrichment of the national climatological heritage by organizing the research, the preservation, the digitization and the management of historic data or data of partners of the observation. It acts in coherence with the organizations responsible for archiving and heritage, and with those holding possible sources of information. It coordinates the French contribution to the various international climatological databases and ensures the supply of past data useful for the various useful for the various global atmospheric reanalyses.

DCSC/EDR coordinates inventorying and preserving Météo-France climate archives. DCSC/EDR undertakes recovering, imaging, digitising and curation of historical instrumental surface terrestrial for France mainland and French oversea territories, stored at Météo-France and at the French National Archives.

Climate records stored at Météo-France: 7 linear km, period 1850-today, domain: France (https://idare-portal.org/data/m%C3%A9t%C3%A9o-france-climate-archives-france)

French Polynesia data Rescue is described on https://idare-portal.org/data/french-polynesia-data-rescue

Climate records stored at the French National Archives: 1 linear km, period 1800-1980: France and former French colonies.

Several projects have been carried out within the framework of the partnership between Météo-France and the French National Archives. Three of them are described on the I-DARE portal:

- ✓ France semaphore and lighthouse meteorological data rescue 1868-1940: Inventorying of hard copy, records imaging, data digitising and data insertion into the database https://www.idare-portal.org/data/france-semaphore-and-lighthouse-meteorological-data-rescue-1868-1940
- ✓ West Indian Ocean data rescue: Inventorying of hard copy, imaging. Digitising https://idare-portal.org/data/west-indian-ocean-data-rescue.
- ✓ French settlements in India 1876-1931: Inventorying of hard copy, records imaging, data digitising. Measurements made in the French colonial hospitals.

Météo-France also works with WMO: report on Data Rescue at Madagascar (2017) and participates to ACRE initiative (Reunion Island and New Caledonia). Data has been provided to the ISPD Databank by Météo-France (Cram et al., 2015). Météo-France has been involved in upper-air data rescuing within the framework of ERA-CLIM and ERA-CLIM2 projects (Stickler et al., 2014). Météo-France has participated in the global inventory of early instrumental meteorological measurements (Brönnimann, 2019).

French digitised data and metadata are held in the French national climate database BDClim.

An open web-portal (http://archives-climat.fr/) provides catalogues and associated images of climate records stored at Météo-France and at the French national Archives: more than 81500 files containing meteorological records catalogued.

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8.1 France mainland pre-1800 data

8.1.1 Brief summary and expectations

Name of Project: Recovery of French early pre-1800 observations

Focus on the Société Royale de Médecine network 1776-1793

Records have been imaged within the framework of ANR Chedar project. Images of meteorological records are available on http://meteo.academie-medecine.fr/

130 meteorological French stations have been catalogued (Brönnimann et. al. 2019), but only sub-daily and daily data of 13 stations are already digitised.

Assistance is needed to continue this project and to provide early French series to the scientific community.

Expectations: digitisation of the 30 French longest series within the period 1776-1793

8.1.2 Domain of the Data

France mainland

8.1.3 Periods and Parameters

Period: 1776-1793

Parameters: sub-daily pressure, temperature, wind direction, daily precipitation, daily snow occurrence and daily fog occurrence.

8.1.4 State of the project

Sub-daily and daily data of 13 stations already digitised. Assistance needed to continue this project and to provide early French series to the scientific community.

8.1.5 Rough estimation of the assistance needed (€)

Human resources for preparation of digitisation, quality check: 6 months = 24 k euro

Human resources for digitisation: 10 k euro

Assistance needed: 34 k euro

8.2 African and Asian former French colonies

8.2.1 Brief summary and expectations

Name of project: African and Asian former French colonies and French settlements 1855 -1937

Hardcopy records are stored at the French National Archives: 24 boxes (around 3000 pages/ box)

Label of Boxes: FRAN19820606/1-16, 19-26

The catalogue of some series can be found in the global inventory Brönnimann (2019).

8.2.2 Domain of the Data

French former colonies or settlements: Canaries Island, Gabon, French settlements of India, Ivory Coast, Mali, Madagascar, Niger, Palestine, Senegal, Syria, Togo, Turkey

8.2.3 Periods and Parameters

1853-1921 Sub-daily pressure, temperature, humidity and daily temperature and precipitation

8.2.4 Current Partners

French National Archives

8.2.5 State of the project

- ✓ Inventorying and Imaging of the 3 boxes of Indian records (FRAN19820606/24-26) is complete: 4 long series of Indian records prior 1931 available. Images are available to be viewed online (http://archives-climat.fr/), Digitising of Pondichéry (Pondicherry) hospital data has been launched (funded by Météo-France, 4, 000 euro).
- ✓ Inventorying and Imaging of 3 boxes concerning Madagascar and Mayotte (FRAN19820606/13-15), period 1864-1918 is in process (https://www.idare-portal.org/data/west-indian-ocean-data-rescue).

8.2.6 Rough estimation of the assistance needed (€)

Human resources for exhaustive inventorying: 2 months = 8, 000 euro

Human resources for preparation of imaging and quality-check of images: 6 months = 24, 000 euro

Financial resources for Imaging: 15,000 euro

Financial resources for digitising: 95,000 euro

Total of assistance needed for the project: 142, 000 euro

9 International Environmental Data Rescue Organization (IEDRO)

Contribution: Monica Drazba, IEDRO

The International Environmental Data Rescue Organization, IEDRO, a U.S. based 501(c)(3), non-profit organization was founded to ensure data rescue and digitization of historical climate data funded through charitable contributions, grants and government awards. Today, IEDRO is a major player in the international climate services field specializing in climate data rescue and digitization, working closely with the World Meteorological Organization, NOAA, and the National Weather Services of developing countries.

9.1 Mission, Philosophy-Vision, Strategy

IEDRO's mission is to locate, rescue (image), digitize, archive, and share historic weather data across the globe, in areas of need, for the purpose of supporting applications in agriculture, infrastructure planning, disease prevention and climate change.

To achieve this Mission, IEDRO aims to be a global leader in the pursuit of rescuing (imaging), digitizing and sharing all historic weather data, for the purposes of analysis and prediction, before it's lost forever. To develop data rescue applications and systems that can decrease the cost and time required for digitization, while increasing accuracy of data entry. To make these systems and applications available for use in every geographic region by anyone with a vested interest – from the meteorologist and environmental science researcher to the farmer and local decision maker in an underdeveloped country.

9.2 Activity and Partnerships

Activities include

- ✓ International Climate Data Rescue (IC-DARE) Inventory
- ✓ On-site and On-Line Training – Data Analysis and Visualization
- ✓ Climate Data Digitization Tools
- ✓ Alpha-Numeric Data Entry (workstations and crowdsourcing)
- ✓ Strip Chart Digitization Application

Partners (past and current) include:

- ✓ The World Meteorological Organization **(WMO)**
- ✓ United States Agency for International Development **(USAID)**
- ✓ National Oceanic and Atmospheric Administration of the United States **(NOAA)**
- ✓ The United Nations Food and Agriculture Organization (**FAO)**
- ✓ Summit Business Technologies (a partnership to develop crowd-sourcing digitizing technologies for alpha-numeric and strip chart media)
- ✓ Climate Services Partnerships
- ✓ Atmospheric Circulation Reconstructions over the Earth (**ACRE)**
- ✓ African Center of Meteorological Applications for Development (**ACMAD)**

9.3 Future: Issues and Solutions

IEDRO has focused on both training of national hydro-meteorological services (NMHS) to develop internal capacities for data inventory, rescue, and digitization throughout the world as well as the actual inventory and data rescue processes. Through its own crowd-sourcing activities, "Weather Wizards" IEDRO develops digitizing technologies with its partner, Summit Business Technologies, and coordinates volunteer activities to digitized rescued data from worldwide sources.

After more than a decade of international work, IEDRO believe**s** that a more realistic solution to the data rescue and digitization process includes not only training of NMHS, but support identifying funding for these activities, followed by continual supervision and support to actually finish the data rescue and ultimate digitization process with the NMHS.

9.4 Data Rescue Project I

DATA RESCUE, GUATEMALA

9.4.1 Brief summary and expectations

Data Rescue for Guatemala.

IEDRO has had initial meetings with representatives of INSIVUMEH (The National Meteorological and Hydrological Service of Guatemala) and the Rafael Landivar University in Guatemala to begin the process of data rescue for environmental data held by INSIVUMEH, as well as research and rescue other environmental data held in hard copy by universities, private agricultural concerns, and other players within Guatemala.

9.4.2 Domain of the Data

Guatemalan national territory, encompassing the years 1940 to 2000. Records held by INSIVUMEH, as well as private agricultural enterprises.

9.4.3 Periods and Parameters

This project will exclude data already scanned and held by the DWD (Deutscher Wetterdienst) roughly covering periods and locations from 1891-1939; these periods and locations will be excluded from the proposed Data Rescue project. All other at-risk Data yet to be scanned/imaged will be included, based on urgency of rescue (deterioration) and importance for disaster and agricultural management for Guatemala.

9.4.4 State of the project

Meetings have initiated to discuss the possibility of rescuing data in Guatemala, particularly data held by INSIVUMEH, but no funding has been identified as yet. ACRE-Mesoamerica has created a rough inventory of data from 1900 – 1970.

9.4.5 Rough estimation of the budget and of the assistance needed

Estimate that imaging will take approximate two years of full time work, overseen by IEDRO technicians, either via in-person visits or via online oversight, or a combination of both.

Cost Center	Number of Units	Time Period	Annual Cost	Sub-Total
Full time Technician	4	2	$ 32,000	$ 128,000
IEDRO oversight (including travel)	1	2	$ 20,000	$ 40,000
Laptop/peripherals	4		$ 1,500	$ 3,000
Cameras, tripods, scanners			$ 8,000	$ 8,000
Total				$ 179,000

9.5 Data Rescue Project 2

Within the ACRE Mesoamerican project, there is no inclusion of Data from Nicaragua. The Nicaraguan National Meteorological Institute, INETER, has already created an inventory or records and formats held with funding from the World Bank. INETER has also received training on Data Rescue and creation of interactive inventories to access imaged data. The Data Rescue process itself has not been initiated for lack of funding. Although there are approximately 12.8 million hard copy records, INETER has identified approximately 2.11 M as priority records for rescue.

There are also another 1.2M precipitation strip charts, which may also be scanned using a high speed scanner, based on time and funds availability.

The Project would encompass four persons working at INETER working full time for two years, imaging and inventorying (via an interactive inventory), with IEDRO oversight for technical and administrative progress.

Budget:

Cost Center	Number of Units	Time Period	Annual Cost	Sub-Total
Full time Technician	4	2	$ 10,440	$ 83,520
IEDRO oversight	1	2	$ 20,000	$ 40,000
Laptop/peripherals	4		$ 1,500	$ 6,000
Cameras, tripods, scanners			$ 20,000	$ 20,000
Total				$ 149,520

9.6 Data Rescue Project 3

IEDRO has worked with various countries to train and implement a Data Rescue process that includes creating an “interactive” inventory which includes hyperlinks to all rescued data images, thus facilitating almost instantaneous access to the images.

Although the World Meteorological Organization has created a set of guidelines for Data Rescue, IEDRO proposed the creation and dissemination of detailed procedures manuals, to include illustrated step-by-step instructions for creating images, image quality parameters, inventory creation, renaming files, creating directories, and creating an interactive, hyperlinked inventory. The procedures manual would also include access to step-by-step videos that provide visual reinforcement of the written procedures. IEDRO has created such a guide for Angola and has found it extremely useful for reinforcing training. A one-two week technical visit, without the manual and video are soon forgotten if the Data Rescue process is not immediately initiated.

Furthermore, the procedures manuals and videos would also be available to meteorology services and other institutions that would like to initialize the Data Rescue process but whose funding does not permit access to outside consulting and travel.

IEDRO would make these manuals and videos available at no cost via the IEDRO website. Proposed funding also includes the cost of translation into Spanish, French, and Portuguese, that would enable most users in the developing world to access the information easily.

Procedures Manuals	$ 22,000
Video (with translated subtitles)	$ 15,000
Translations	$ 8,000
Total	$ 45,000

10 Real case-study: Mauritius

Contribution: Rob Allan, ACRE

10.1 Background

The WMO/ACRE/GFCS Indian Data Rescue initiative (INDARE) was launched as part of an *International Workshop on the Recovery of Climate heritage in the Indian Ocean rim Countries and Islands*, held at Maputo, Mozambique from the 21st-24th of April 2014. This was followed by the First meeting of the steering committee of INDARE at WMO in Geneva from the 29th of September-1st of October 2014, and the Second meeting of the steering committee of INDARE held at Ebène, Mauritius, from the 19th-20th of October 2015. (https://community.wmo.int/indian-ocean-data-rescue-initiativeindare).

Although INDARE lost impetus due to a lack of ongoing funding, and has been in hiatus since 2016, the above laid the grounds for the development of a specific data rescue initiative focusing on historical terrestrial and marine instrumental weather observations from the island of Mauritius under the auspices of the International Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative.

The resulting Mauritius Project, which has taken nearly 8 years to come to fruition, sees ACRE partnering with the Meteorological Society of Mauritius (in conjunction with the Mauritius Meteorological Services) in order to recover, image, digitise, archive, and preserve old terrestrial and marine weather observations held in the National Archives of Mauritius and the Mauritius Meteorological Services. These are specifically:

- ✓ Observations extracted from ship logbooks in 188 volumes of Charles Meldrum's 'anemological' journals from 1853 to 1914
- ✓ Ship logbooks from 1848-1874
- ✓ Terrestrial weather observations for Mauritius, La Réunion, Rodrigues, Seychelles and Diego Garcia Islands (including data from Colonel Lloyd's Colonial Observatory at Port Louis) from the late 18th to the early years of the 20th century

The 'anemological' journals contain important historical ship weather observations from vessels travelling around southern Africa on the old shipping routes through Mauritius to India, China, and Australia. This material also contains Indian Ocean island station records from Mauritius, La Réunion, Rodrigues, the Seychelles, and Diego Garcia in the 19th and early 20th centuries. This collection includes ship information, location data and a variety of meteorological parameters. These are daily records from vessels travelling across the Indian Ocean. The ship logbooks from 1848-1874, add to the above.

This entire activity is currently being undertaken with funding from the UK Newton Fund CSSP China via ACRE to the Meteorological Society of Mauritius and the Mauritius Meteorological Service and involves close cooperation with Météo-France for the Comoros and La Réunion. The data are being digitised by ACRE/C3S DRS/WCSSP South Africa and sent to the work package leader.

10.2 The history of instrumental meteorological observations on Mauritius

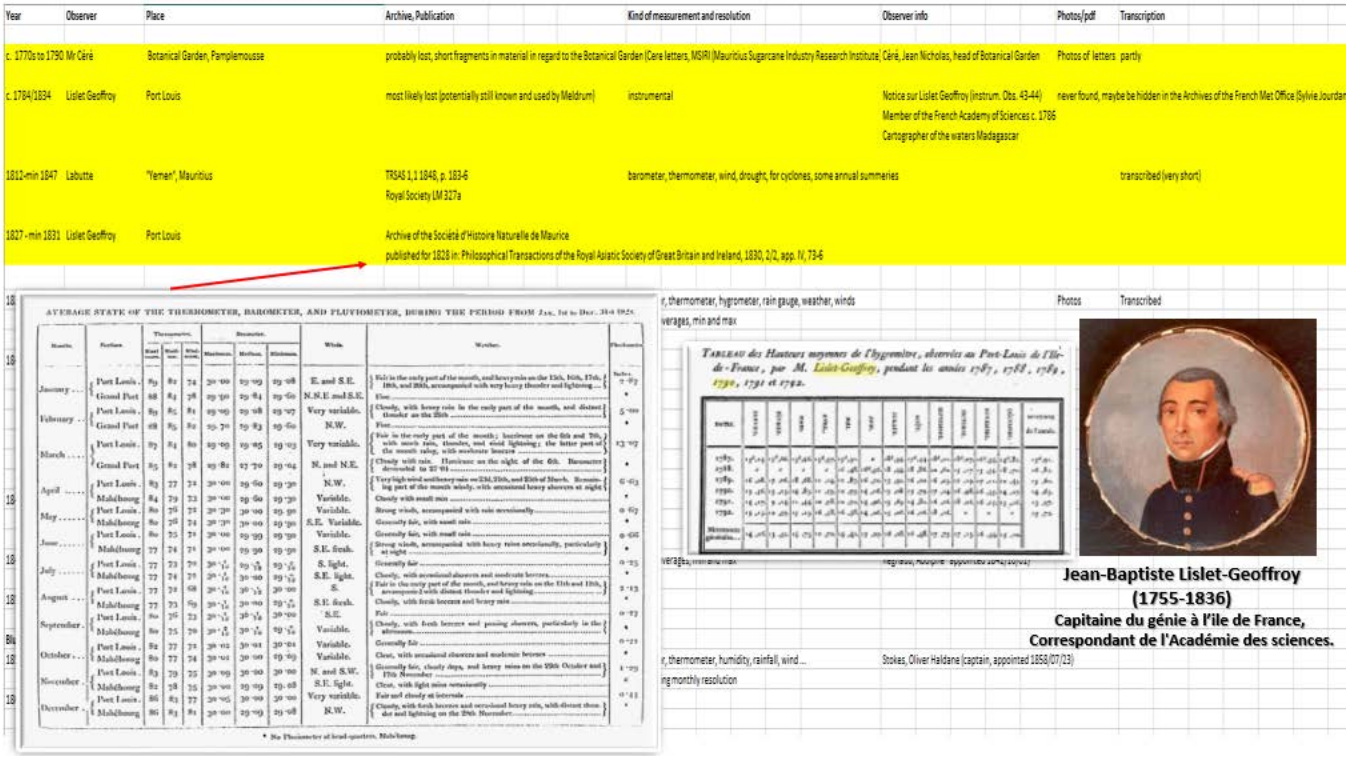
Coordinated instrumental meteorological observations have been taken on the island of Mauritius since 1774, when a meteorological station was installed at Pamplemousses by Mr Céré, Director of the Botanical Gardens. The most comprehensive overviews of the history of meteorological observation activities since 1774 can be found in publications such as Mülnier and Padya (1974) and Mahony (2018), and on the Mauritius Meteorological Service WWW pages at http://metservice.intnet.mu/about-us/historical-background/.

Mahony, M., 2018: The 'genie of the storm': Cyclonic reasoning and the spaces of weather observation in the southern Indian Ocean, 1851–1925. *The British Journal for the History of Science, 51*(4), 607-633. doi:10.1017/S0007087418000766.

Mülnier, K. and Padya, B.M., 1974: Mauritius: Two Hundred Years of Meteorology. WMO Bulletin, **XXIII**, **4**, 228. https://library.wmo.int/doc_num.php?explnum_id=6621

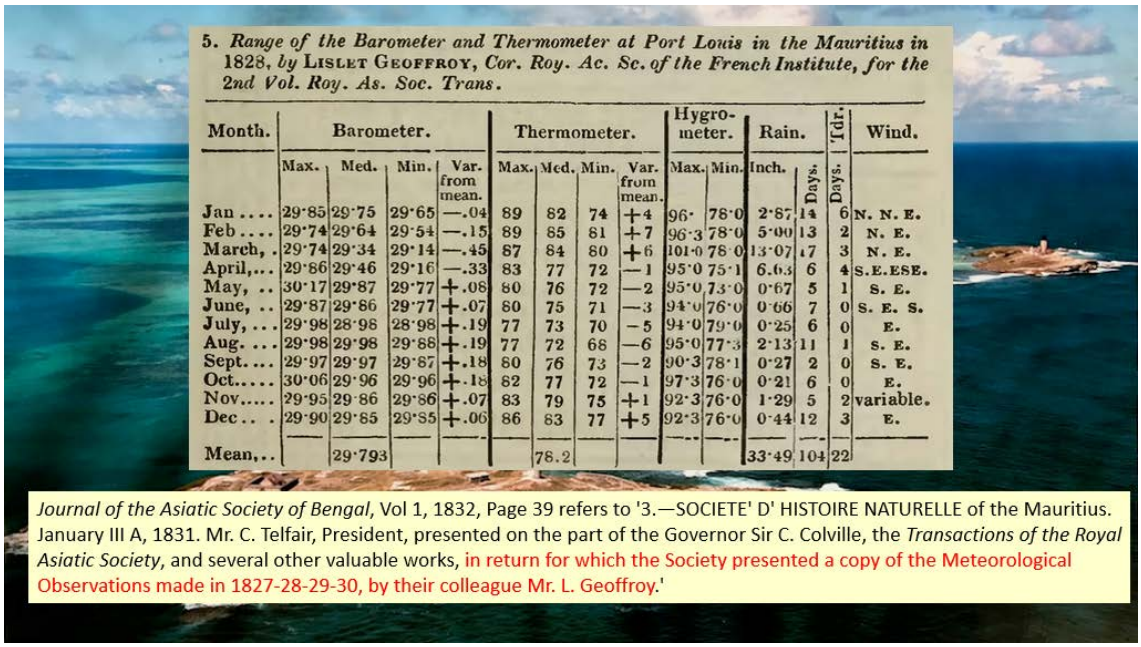
Some particular highlights in the history of Mauritian meteorology are as follows:

- ✓ Early long-term weather observations are highlighted in yellow below, especially those made by Jean-Baptiste Lislet-Geoffroy in the period from c.1784-1834, from which we have found only scattered published tables of monthly means.



Year	Observer	Place	Archive, Publication	Kind of measurement and resolution	Observer info	Photos/pdf	Transcription
c. 1770s to 1790	Mr Céré	Botanical Garden, Pamplemousse	probably lost, short fragments in material in regard to the Botanical Garden (Cere letters, MSIRI (Mauritius Sugarcane Industry Research Institute)		Céré, Jean Nicholas, head of Botanical Garden	Photos of letters	partly
c. 1784/1834	Lislet Geoffroy	Port Louis	most likely lost (potentially still known and used by Meldrum)	instrumental	Notice sur Lislet Geoffroy (instrum. Obs. 43-44) Member of the French Academy of Sciences c. 1786 Cartographer of the waters Madagascar		never found, maybe be hidden in the Archives of the French Met Office (Sylvie Jourdan
1812-min 1847	Labutte	'Yemen', Mauritius	TRSAS 1,1 1848, p. 183-6 Royal Society LM 327a	barometer, thermometer, wind, drought, for cyclones, some annual summeries			transcribed (very short)
1827 - min 1831	Lislet Geoffroy	Port Louis	Archive of the Société d'Histoire Naturelle de Maurice published for 1828 in: Philosophical Transactions of the Royal Asiatic Society of Great Britain and Ireland, 1830, 2/2, app. IV, 73-6				

- ✓ Evidence that early Mauritian meteorological observations were exchanged during visits from British colonial administrators from India. See the example immediately below re 1827-1830 data. Efforts to find any of this material (probably in manuscript form) in Indian archives are continuing.

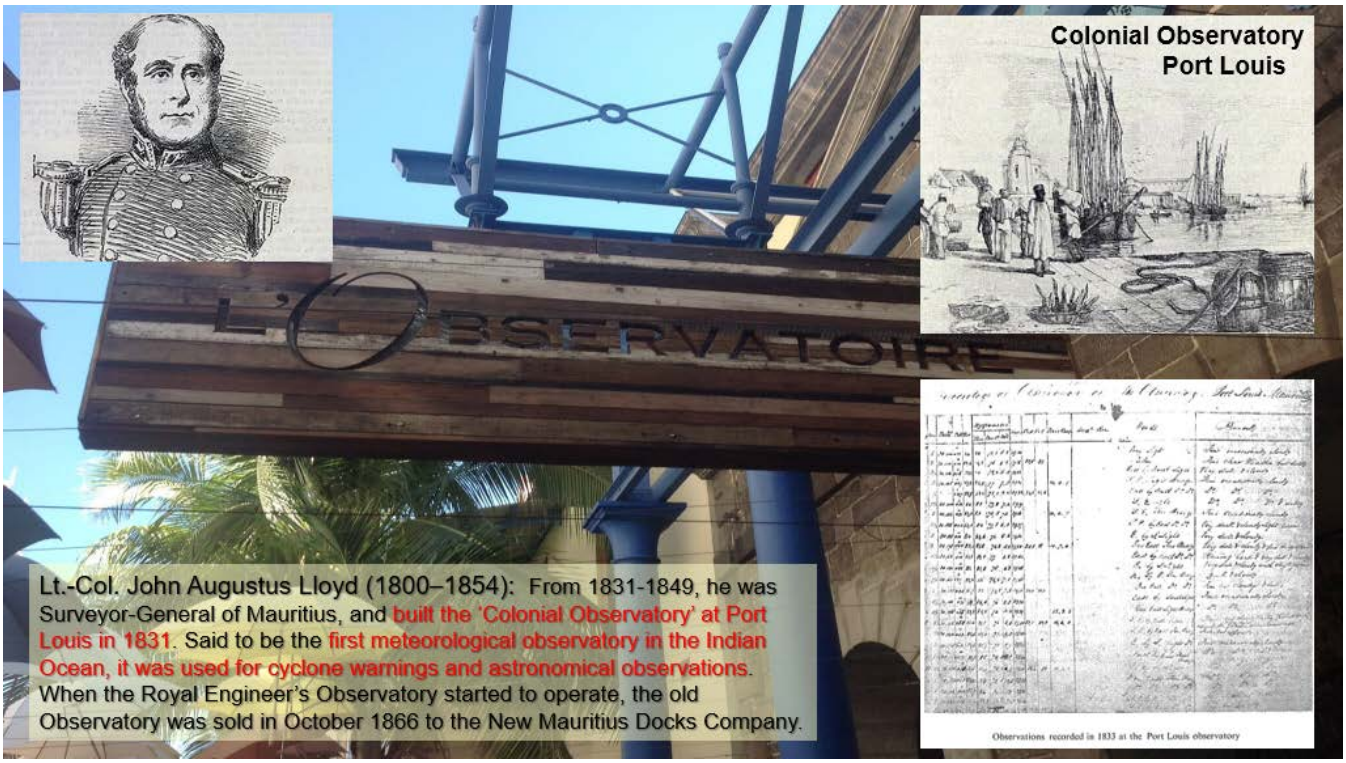


5. *Range of the Barometer and Thermometer at Port Louis in the Mauritius in 1828, by* Lislet Geoffroy, *Cor. Roy. Ac. Sc. of the French Institute, for the 2nd Vol. Roy. As. Soc. Trans.*

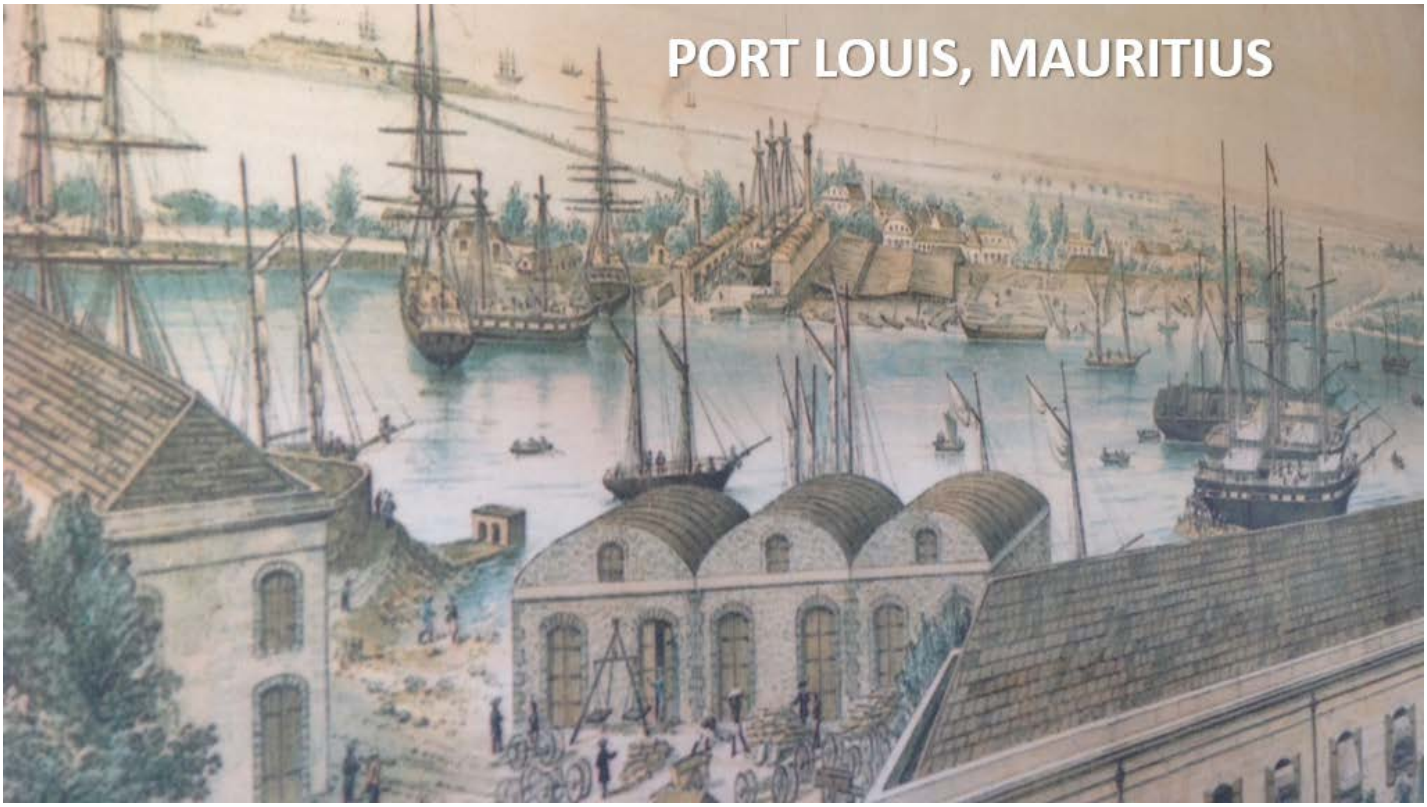
Month.	Barometer.				Thermometer.				Hygrometer.		Rain.		Tdr.	Wind.
	Max.	Med.	Min.	Var. from mean.	Max.	Med.	Min.	Var. from mean.	Max.	Min.	Inch.	Days.	Days.	
Jan	29·85	29·75	29·65	—.04	89	82	74	+4	96·	78·0	2·87	14	6	N. N. E.
Feb	29·74	29·64	29·54	—.15	89	85	81	+7	96·3	78·0	5·00	13	2	N. E.
March, .	29·74	29·34	29·14	—.45	87	84	80	+6	101·0	78·0	13·07	17	3	N. E.
April,...	29·86	29·46	29·16	—.33	83	77	72	—1	95·0	75·1	6.63	6	4	S.E.ESE.
May, ..	30·17	29·87	29·77	+.08	80	76	72	—2	95·0	73·0	0·67	5	1	S. E.
June, ..	29·87	29·86	29·77	+.07	80	75	71	—3	94·0	76·0	0·66	7	0	S. E. S.
July, ...	29·98	28·98	28·98	+.19	77	73	70	—5	94·0	79·0	0·25	6	0	E.
Aug. ...	29·98	29·98	29·88	+.19	77	72	68	—6	95·0	77·3	2·13	11	1	S. E.
Sept. ...	29·97	29·97	29·87	+.18	80	76	73	—2	90·3	78·1	0·27	2	0	S. E.
Oct.....	30·06	29·96	29·96	+.18	82	77	72	—1	97·3	76·0	0·21	6	0	E.
Nov.....	29·95	29·86	29·86	+.07	83	79	75	+1	92·3	76·0	1·29	5	2	variable.
Dec.. .	29·90	29·85	29·85	+.06	86	83	77	+5	92·3	76·0	0·44	12	3	E.
Mean,..		29·793				78.2					33·49	104	22	

Journal of the Asiatic Society of Bengal, Vol 1, 1832, Page 39 refers to '3.—SOCIETE' D' HISTOIRE NATURELLE of the Mauritius. January III A, 1831. Mr. C. Telfair, President, presented on the part of the Governor Sir C. Colville, the *Transactions of the Royal Asiatic Society*, and several other valuable works, in return for which the Society presented a copy of the Meteorological Observations made in 1827-28-29-30, by their colleague Mr. L. Geoffroy.'

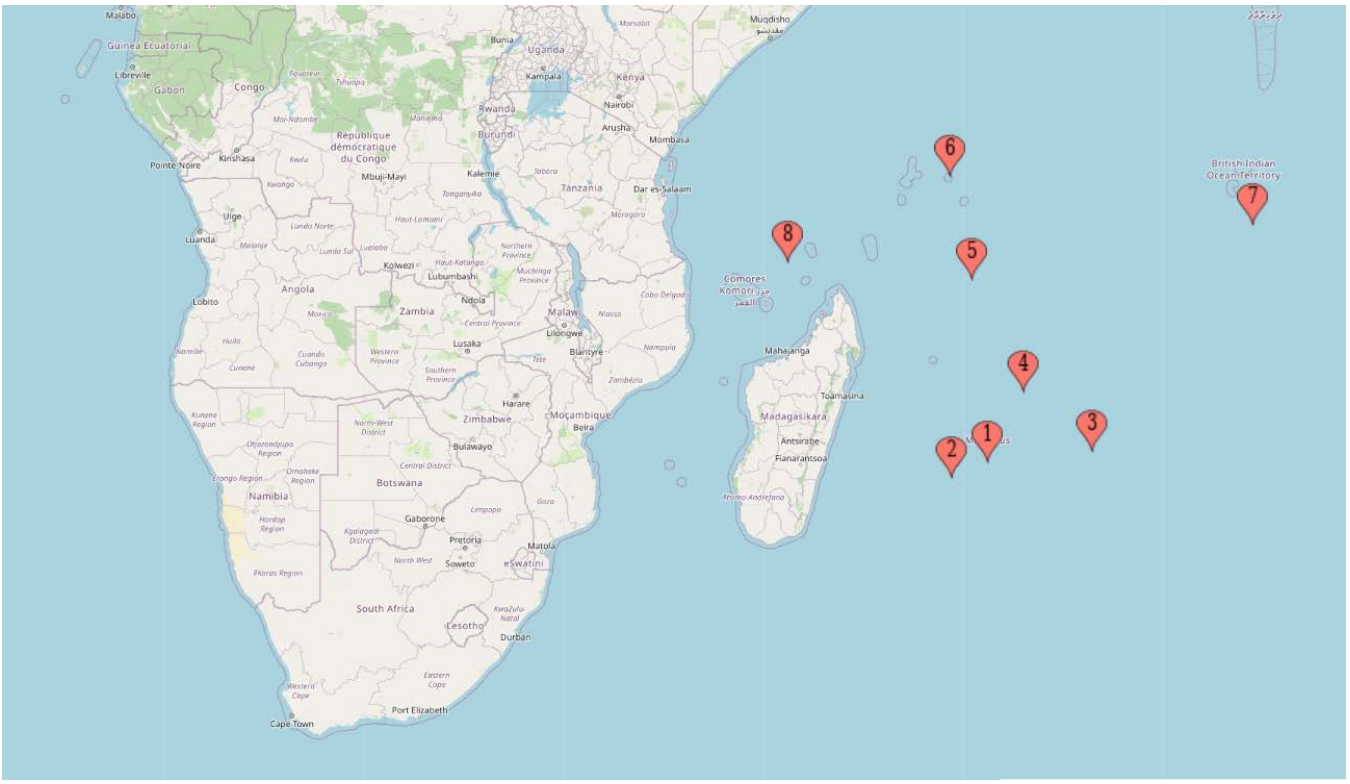
- ✓ Early instrumental weather observations were made at the Colonial Observatory in Port Louis that was set up by Lt. Col. John Augustus Lloyd (Colonial civil engineer and Surveyor-General on Mauritius from 1831-1839) in 1831. An image of a page in one of Lloyd's meteorological registers was reproduced by Mülnier and Padya (1974) (see immediately below), but the original registers have yet to be found. The site is now an Indian Restaurant.



- ✓ As detailed in Mülnier and Padya (1974): 'A parallel observatory [to the Colonial Observatory] was built in 1852 by the British Army some two hundred metres from the existing one. This was part of the network of stations which was being established throughout the British Empire. It carried out six-hourly observations until 1858 when it was pulled down, presumably because it lay in the path of the railway system which was being constructed. In 1854, the three functions of Government Observer, officer-in-charge of the Army Observatory, and Secretary of the Meteorological Society were given to the same man, Lieutenant Fyers of the Royal Engineers Corps of the Army. There was thus no disruption of observations when the Army station was demolished: observations continued to be made in the original Government Observatory'.



- ✓ The Meteorological Society of Mauritius was established in 1851 by Dr Charles Meldrum (a young professor of mathematics who came to the Royal College, Mauritius in 1848) and some senior government officials, scientists, planters, and military Officers. It was under the patronage of the Governor. The Meteorological Society recommended to the Governor that a central observatory be established to make hourly or two-hourly observations day and night together with subsidiary observations at the islands of Rodrigues, La Réunion, St. Brandon, Agalega, Diego Garcia and Seychelles. Aldabra is a recent addition. See locations immediately below:



1. Mauritius 2. La Réunion 3. Rodrigues 4. St. Brandon 5. Agalega 6. Seychelles 7. Diego Garcia 8. Aldabra

- ✓ Charles Meldrum set up a system where each day one of his clerks visited any ships anchored in Port Louis and to engage the masters of these vessels in order to transcribe a copy of any instrumental meteorological observations in the ship's logbooks. By 1853, the *Transactions of the Meteorological Society of Mauritius* reported that 'The mass of facts gathered from Ships' Journals, is steadily increasing, and, since September 1852 to 1st May 1853, I have obtained about 4,000 extracts, and collated those belonging to the same day in the form of a journal…..' and 'With a view to uniformity in our register of collated" extracts, we have adopted a particular form for the "Anemological Journal," so as to suit it for the reception of the facts such as the present style of sea-journal ….' plus 'An application to the General S. S. S. Company, requesting to have copies of the journals of their vessels in the Indian Ocean sent to the Society, has been at once courteously acceded to, and we are now to have the blank forms adopted by the Society filled up on board of their vessels, and returned to us.'

"The objects which the Meteorological Society laid down for itself were: to procure instruments of the best description; to provide for meteorological observations being made in Mauritius and its dependencies; to tabulate meteorological observations taken daily on board vessels in the Indian Ocean and to encourage these to be made on a systematic basis ……. " [Only the January to March charts over the Indian Ocean for 1861 were ever published]

"A clerk was employed by the Society to visit every ship anchoring in Port Louis harbour. He used to present a letter from the Secretary of the Society to the master to obtain access to the ship's log, and copy the meteorological observations it contained. It is interesting to note that the Meteorological Service continued this practice right up to the 1960s."

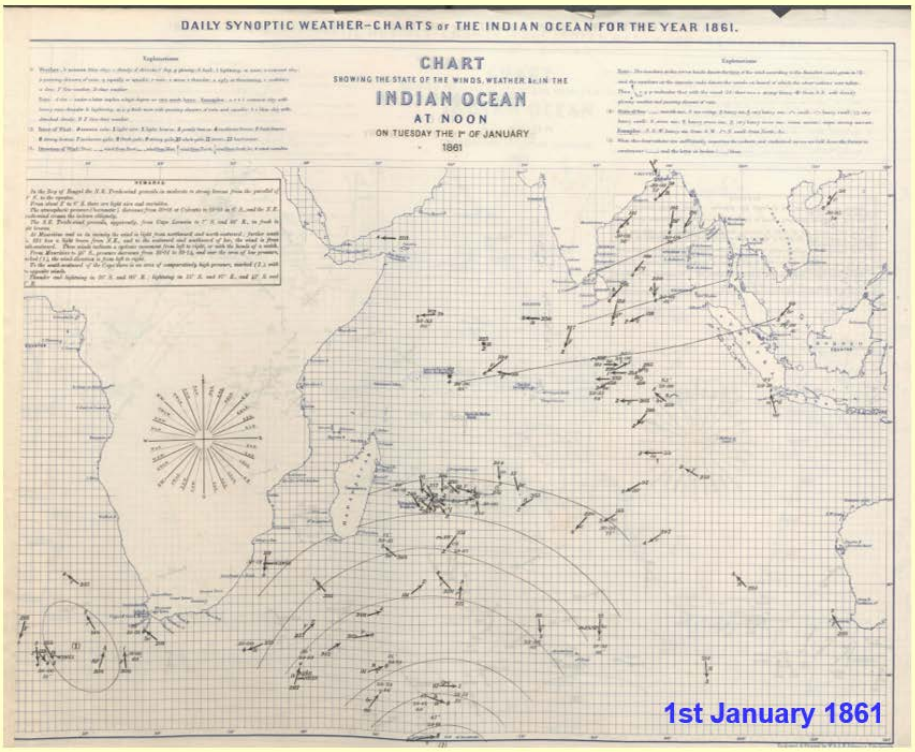
Source: Mülnier, K. and Padya, B.M. (1974): Mauritius: Two Hundred Years of Meteorology. *WMO Bulletin*, **XXIII**, **4**, Pg 228.

The practice of extracting weather observations from ships in harbour was at least also undertaken by:

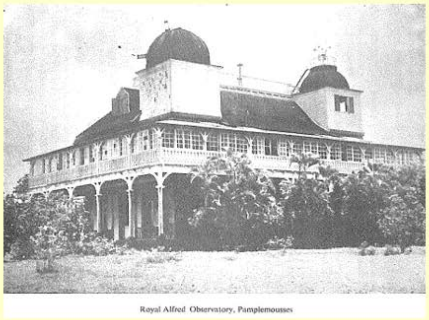
Georg von Neumayer: Flagstaff Observatory, Melbourne, Australia - 1850s-1860s
Indian Meteorological Department: Calcutta, Bombay and Madras – 1890s=>
Hong Kong Observatory: 1890s-1940 at least
Jesuit Observatories: Shanghai and Manila

- ✓ The meteorological observations extracted from the ship's logbooks produced a wealth of marine weather observations from vessels travelling around southern Africa on the old shipping routes through Mauritius to India, China, and Australia. Thus, together with the land data from Mauritius and the other islands mentioned above, Meldrum was able to build up an Indian Ocean-wide picture of the daily weather conditions across that domain. An example of the daily synoptic maps/weather charts that were produced from these data for the entire Indian Ocean is shown below for the 1st of January 1861. Note the attempt to draw isobars from the weather observations. Unfortunately, financial restrictions meant that Meldrum was only able to have these charts produced and published for January, February, and March in 1861. Fortunately, the original 'Anemological Journals' still exist in the National Archives of Mauritius and are a major focus of the Mauritius Project.

MELDRUM's HISTORICAL DAILY INDIAN OCEAN CHARTS

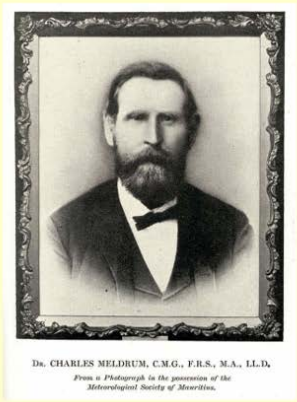


- ✓ The Royal Alfred Observatory was opened in 1874 with Charles Meldrum as its first Director. The Observatory was demolished in 1961 and its meteorological work transferred to Vacoas. See immediately below:



Royal Alfred Observatory, Mauritius

The Meteorological Society of Mauritius, with a small government grant, established an observatory in 1851, some 200 yards away from the Colonial/Government Observatory.



The Royal Alfred Observatory at Pamplemousses was opened in 1874, with **Dr Charles Meldrum** as its first Director.

10.3 Sources of hardcopy data (paper, microfiches)

National Archives of Mauritius

Mauritius Meteorological Services archives

UK National Meteorological Library & Archive

South African Weather Service (SAWS) under the UK Newton Fund WCSSP South Africa.

10.4 Sources of images and digitisation

- ✓ Imaging of the 'Anemological Journals' is underway in ACRE's Mauritius Project by the Meteorological Society of Mauritius in conjunction with the Mauritius Meteorological Service. It is being funded from the UK Newton Fund CSSP China. Digitisation is being undertaken by ACRE/C3S DRS/WCSSP South Africa, based at the University of the Witwatersrand in South Africa, and will be supplemented by similar work at the University of Giessen in Germany if additional funds are available from the 'Long historical weather observations digitisation in and around the African and Indian Ocean regions' project being funded by WMO, initially from September 2021 to August 2022. An example of digitised daily weather observations that were extracted from ship logbooks, and various island stations, recorded in the 'Anemological Journal' of 1901, and published in the *Proceedings and Transactions of the Meteorological Society of Mauritius* in January 1901, is shown immediately below:

Tabulation of weather observations for a storm in January 1901 in Charles Meldrum's 'anemological' volumes and published in the *Proceedings and Transactions of the Meteorological Society of Mauritius*

Various Ship Log Book Extracts

YEAR	MONTH	DAY	HOUR	NO. ON CHART	LAT (S)	LONG (E)	WIND DIRECTION	STATE OF SEA FORCE	BAROMETER	AIR TEMP
1901	1	4	1200	1	19.50	57.50	E by N	2 Calm	30.02	
1901	1	4	1200	4	20.44	55.53	E by N	1 Calm	30.06	
1901	1	4	1200	6	3.18	67.29	WSW	6 High	29.92	82.0
1901	1	4	1200	7	25.06	67.31	Calm	0	29.95	82.0
1901	1	4	1200	10	8.55	71.28	SE	6 High	29.68	
1901	1	4	1200	11	16.55	61.27	SE	4 Moderate	29.94	81.0
1901	1	4	1200	13	38.48	54.17	W	6 High	30.08	
1901	1	4	1200	14	23.09	90.16	E	5 Moderate	30.11	
1901	1	4	1200	16	8.33	55.24	Var	4 Moderate	29.90	
1901	1	4	1200	17	26.15	45.04	ESE	2 Heavy	29.90	
1901	1	4	1200	19	32.15	86.00	N by W	2	30.12	
1901	1	5	1200	4	20.52	55.30	SE by E	2 Calm	30.06	
1901	1	5	1200	6	5.30	67.57	Var	5 Rough	29.86	83.0
1901	1	5	1200	7	25.16	67.27	NW	1 Calm	29.98	81.0
1901	1	5	1200	10	8.52	71.15	WNW	10 Dangerous	29.70	
1901	1	5	1200	11	20.13	57.28	SE by E	4 Moderate	29.84	83.0
1901	1	5	1200	13	38.11	57.46	WSW	4 Calm	30.18	
1901	1	5	1200	14	23.03	88.38	E by N	5 Calm	30.08	
1901	1	5	1200	16	7.03	55.45	WNW	8 High		
1901	1	5	1200	17	26.15	45.38	WSW	1 Heavy	29.86	
1901	1	5	1200	18	32.05	82.30	NW by W	5	29.95	
1901	1	6	1200	4	20.14	57.00	SE by E	2 Calm	30.06	
1901	1	6	1200	5	30.13	33.45	ENE	1 Calm	29.79	
1901	1	6	1200	6	6.31	68.20	Var	5 Rough	29.85	81.0
1901	1	6	1200	7	25.12	67.33	Calm	0 Calm		
1901	1	6	1200	10	9.11	72.45	NW	9 High	29.70	
1901	1	6	1200	13	36.57	59.26	ESE	2	30.18	

Island Stations

YEAR	MONTH	DAY	HOUR	LAND SITES	WIND DIRECTION	STATE OF SEA FORCE	BAROMETER	AIR TEMP
1901	1	4	1200	Mauritius	E by N	2	29.98	81.0
1901	1	4	1200	Rodriques	ENE	2 Smooth	30.17	85.0
1901	1	4	1200	Seychelles	NW	3 NWly swell	29.91	82.0
1901	1	4	1200	Bourbon	E	3 Calm	29.94	83.0
1901	1	5	1200	Mauritius	E	2	29.99	82.0
1901	1	5	1200	Rodriques	ESE	2 Smooth	30.14	84.0
1901	1	5	1200	Seychelles	NW	3 NWly swell	29.88	82.0
1901	1	5	1200	Bourbon	SE	3 Calm	29.96	82.0
1901	1	6	1200	Mauritius	ESE	3	29.96	81.0
1901	1	6	1200	Rodriques	ENE	1 Smooth	30.13	85.0
1901	1	6	1200	Seychelles	NW	3 Moderate swell	29.87	83.0
1901	1	6	1200	Bourbon	Var	High	30.00	82.0
1901	1	6	1200	Diego Garcia	NW	9 High	29.71	

10.5 Sources of data in digital format

National Centers for Environmental Information (NCEI) archive of data collected by National Oceanic and Atmospheric Administration (NOAA) scientists, observing systems, and research initiatives.

10.6 Identification of data to be recovered (black font digitised; red font not digitised)

- ✓ Port Louis 1832 (gap filling), 1833-1840 (we have), 1852-1861 (we have), 1863-1945 (gap filling), 1876-1879, 1909, 1912, 1914-1916 (we have), 1949-2013 (we have)
- ✓ Rodrigues Island 1874-1881 (gap filling), 1915-1917 (we have), 1923-1950 (gap filling), 1949-2013 (we have)
- ✓ St Brandon 1944-1948 (gap filling), 1949-1954 (we have), 1955-1972 (gap filling), 1973-2013 (we have)
- ✓ Aldabra 1967-1982 (gap filling), 1974-2004 (we have)
- ✓ Agalega 1944-1947 (gap filling), 1949-1954 (we have), 1955-1972 (gap filling), 1973-2013 (we have)
- ✓ Seychelles 1894-1899 (we have), 1909-1946 (gap filling), 1912-1919 (we have), 1948-1950 (gap filling), 1949-1961 (we have), 1960-1972 (gap filling), 1973-2013 (we have)
- ✓ La Réunion/Port Royal/St Denis 1855-1947 (gap filling by Météo-France and ACRE/C3S DRS/WCSSP South Africa), 1883-1885 (we have), 1948-1972 (gap filling), 1973-2013 (we have)
- ✓ Diego Garcia 1942-1946 (gap filling), 1949-1954 (we have), 1955-1970 (gap filling), 1971-2013 (we have)

10.7 Prioritisation of future data rescue activities

The ship logbooks from 1848-1874 that are held in the National Archives of Mauritius.

Any outstanding terrestrial weather observations for Mauritius, La Réunion, Rodrigues, St Brandon, Agalega, Seychelles and Diego Garcia Islands (including data from Colonel Lloyd's Colonial Observatory at Port Louis) from the late 18th into the 20th century.

10.8 Benefits of the data rescue effort

Having the above historical weather observations for the southwestern Indian Ocean digitised, made available to international terrestrial and marine data repositories, and then to the wider climate community, will enhance and improve regional to global climate modelling, seasonal forecasting plus monitoring and attribution studies. It will also provide users in various climate applications and services with new information and baselines with which to plan for and manage current and future global to regional physical and socio-economic impacts.

11 Real case-study: Madagascar

Contribution: Sylvie Jourdain, Météo-France

11.1 Background

As part of the WMO GFCS (Global Framework for Climate Services) project, the INDARE initiative was launched in Maputo, Mozambique, in April 2014 with the objective of accelerating the rescue of climatological data in the Indian Ocean and the implementation of specific methods and tools for the analysis of long data series for the study of climate change.

The project steering committee in September 2014, in Geneva, defined a few national projects on data rescue.

The World Meteorological Organization (WMO) and Météo-France (MF) signed in 2016 a letter of agreement whose terms were:

- ✓ to restart the Climate Data Management System (CDMS) CliSys at the National Meteorological Service, named in French Direction Générale de la Météorologie (DGM) of Madagascar and
- ✓ to develop an implementation plan for:
  a) the rescue of climatological data (Data Rescue) from Madagascar
  b) the updating of the CDMS, its sustainability and its adequacy with the expectations of DGM.

11.2 Météo-France's report for Climate Data rescue in Madagascar (2017)

Météo-France sent a report to WMO and DGM in 2017. This report dealt with point 2.a on the rescue of Madagascar's climate data.

This document was a synthesis and analysis working document intended to assist Madagascar's future climate data rescue efforts. It was based on the reports of missions to Madagascar carried out by Météo-France experts from 2004 to 2017, and results from research work, source collection and analysis of Sylvie Jourdain, in charge of the activities to rescue old climate data at Météo-France.

Météo-France developed a Data Rescue implementation plan for the recovery of climate records from Madagascar, involving both meteorological service of Madagascar (DGM) and Météo-France.

Météo-France 's Climate Data Rescue implementation plan for Madagascar (2017)

An in-depth analysis of the state of the existing system was conducted in order to develop an implementation plan. a realistic work that recommends seven fundamental and priority actions for the rescue of climatological data from Madagascar. Météo-France's implementation plan proposed seven priority actions to implement the foundations for Climate Data Rescue in Madagascar and to

set up all the necessary Data Rescue activities: conservation and storage, records imaging, digital data recovering and data keying for import into the CDMS Clisys.

Background information on Physical media:

- ✓ Climatological archives from Madagascar stored at DGM Antananarivo: the climatological archives are stored in a dedicated room and the size of the room 200m2 archive seems suitable for the preservation of the climatological archives of the DGM. Paper documents are already logically organized, but the current packaging of the archives is not adequate, and the documents are in danger.
- ✓ The electronic catalogue of original DGM climate records available at the end of the year 2016 was clearly insufficient and did not allow Data Rescue activities to be initiated

Temperature/humidity strip charts stored on wooden shelves at DGM (©Météo-France, 2017)

- ✓ The oldest climatological archives from Madagascar are held in France, start in 1864.

<u>Priorities of the Climate Data Rescue Implementation plan for Madagascar</u>

Priority 1: The original readings must be undusted and then packaged in boxes archives of neutral paper or bound in neutral paper.

Priority 2: Provide a digital inventory with dust collection, filing and storage, conditioning of physical supports. Priority to the inventory of original measurements copies.

Priority 3: Météo-France assesses the health status of original historical and meteorological documents from Madagascar, refurbishes them and ensures that they are in good condition. Météo-France develops a digital catalogue of these preserved original documents held in France.

Priority 4: Scanning and indexing of 7295 microfiches in Madagascar stored at ACMAD

Priority 5: Météo-France organizes the image scanning of a first selection of original measurements document

Priority 6: Import all digitized data into the CDMS used at DGM

Priority 7: Recover all TCM and DH data available on support paper since 1961. There is still a lot of old TCM and DH data to recover available since 1961. According to calculations made by Météo-France International (MFI) in early 2017, only 11% of the expected data would have been recovered

11.3 The history of early instrumental meteorological observations on Madagascar

Madagascar's meteorological history is very rich. The first observations began in the middle of the 19th century and a first network was in place in 1889. Most of the synoptic stations still operational in 2016 were created at the beginning of the 20th century.

Period 1863-1889

Nosy Bohara Island (Île Sainte-Marie) Island and Nosy Be Island became French colonies before 1850. The oldest observations were made by doctors in the military hospitals in Nosy Be from 1855 and in Nosy Bohara from 1863. The records were regularly sent to the Ministry of Marine.

Observations were made from 1872 to 1878 in Antananarivo (Tananarive) by the French consul. After his death, observations would be continued by the Roman catholic mission in Tananarive until 1883. Observations started from 1882 with observations made by Reverends in Toamasina (Tamatave). G. Shaw, member of the London Missionary Society made observations in Tamatave from 1881 to 1882.

Antananarivo Observatory 1889-1908

Regular Observations at the Antananarivo Observatory conducted by the founder of the Royal Observatory E. Colin, who wanted to create a Madagascar national meteorological service, required at first the service of his religious brothers from the Catholic Mission and created few stations: 3 stations in 1889, 11 stations in 1890 and 13 stations in 1891. The war will stop this organization in 1895. Monthly climatological tables containing daily and sub-daily observations were sent to the French national meteorological service (Bureau central météorologique) from 1889 to 1895.

Daily meteorological observations made at Antananarivo Observatory have been regularly published in the Journal Officiel during the period 1896-1906 and in Annales du Bureau central météorologique during the period_1889-septembre 1895, 1897-1914.

Meteorological Service for Agriculture 1901-1907

The general governor Galliéni created the meteorological service for Agriculture and the first national network in Madagascar in 1901. The network consisted of 33 stations in 1902 (Poisson, 1926). Monthly bulletin containing daily observations of rainfall and temperature were sent to France mainland during this period.

Maritime Meteorological Service 1903-1906

Because of cyclones in 1902 and 1903, another service, the Maritime Meteorological service for weather forecast (Service météorologique maritime de Prévision du Temps) was created in 1903: 11 stations with observations telegraphed to the governor every day and regularly published in the Journal officiel de Madagascar.

Maritime Meteorological Service 1907-1911

E.Colin became the director of the Maritime Meteorological service for weather forecast in 1907: 24 stations for the national network. Meteorological observations were published in the Bulletin official during the period. No meteorological records were sent to France mainland during this period, except Tamatave. Circular of Ministry of colonies mentioned that meteorological observations should be free published in the colony and sent to the Ministry of Colonies on monthly basis (no traces of the meteorological tables in France for the period 1907-1911).

Meteorological services 1911-1920

Two meteorological services and networks (two types of stations), one for Agriculture, the other for Weather Forecast worked in parallel. Two types of stations: Observations from Records from stations dedicated to the Weather forecast were stored centrally by the Antananarivo observatory. Records from stations dedicated to the agriculture were stored centrally by the Service of colonization.

Meteorological Service of Public Works 1921-1923

The meteorological service was attached to the Public Works Service, who centralized the meteorological records. Antananarivo observatory retained the responsibility on cyclone advisories.

Precise information on the history of early instrumental meteorological observations on Madagascar from 1855 to 1960 can be found in the Part I of Météo-France's report (2017).

11.4 Data sources in publications online

In 2016, Météo-France searched, recovered and catalogued the digital publications, available online with free access, containing historical weather data for Madagascar, Mayotte and Comoros over the period 1889-1960: The catalogue of publications is available on IDARE portal https://www.idare-portal.org/data/west-indian-ocean-data-rescue,
file METFR_Publications_meteo_obs_Madagascar.pdf

Two main sources on the web with free access for meteorological data from Madagascar are the French National Digital Library Gallica (http://gallica.bnf.fr/) and the NOAA Digital library (http://www.lib.noaa.gov/collections/foreign_climate_data_pages/foreign_climate_data_madagascar.html)

11.5 Data sources on physical media paper held in France

11.5.1 National Archives of France, Pierrefitte-sur-Seine

Three deposits from Météo-France to the National Archives of France, containing Madagascar historical meteorological records, are held by the National Archives of France (FRAN)

- ✓ Deposit FRAN19910603 period 1947-April 1961, microfiche medium, 44 professional stations

- ✓ Deposit FRAN19760002 period 1947-April 1961, paper medium, 42 professional stations
- ✓ Deposit RAN198200606 period 1864-1918, paper medium, 30 stations in Madagascar, Mayotte and Comoros

11.5.2 Météo-France Archives in Toulouse

The Direction of Climatology and Climate services (DCSC) holds few original weather records from Madagascar on paper and on microfiche media in the archives room in Toulouse:

- ✓ Paper medium: sub-daily upper-air data for the period 1952 à 1965, 3 synoptical stations
- ✓ Microfiche medium: period 1947-April 1961, sub-daily and daily surface meteorological observations 44 synoptical stations.

11.6 Data sources on physical media paper held in Madagascar

Sources: Report of Météo-France's mission in 2016 (Météo-France's report, 2017)

Brief description of historical weather records held in the Antananarivo DGM archives room i

- ✓ Daily observations since 1896 (two very long series: Antananarivo and Tamatave)
- ✓ Logbooks since 1938 for synoptical stations;
- ✓ Hourly observations from 1976 for synoptical stations;
- ✓ Strip charts since 1932;
- ✓ Upper-air data since 1956;
- ✓ Monthly rainfall;
- ✓ Monthly climatological Tables with daily data and some sub-daily data since 1976 for professional stations.

11.7 Microfiches of the DARE I project

11.7.1 Background

WMO-supported DARE I (Data Rescue for Regional Association I) project and coordinated by the Belgian Meteorological Service (RMI) started in January 1989 and lasted 9 years from January 1989 to June 30, 1997.

The project has microfilmed millions of manuscript climate documents from 41 African countries (WMO, 2001). Countries received microfilming equipment and a microfiche reader/printer to continue activities at a national level. All the countries have received all microfiches made at the International Data Rescue Coordination Center and countries received the inventory of microfiche in book form and on diskette.

11.7.2 DARE I Microfiches Transfer to ACMAD in 1997

Coordination of the DARE I project, microfilming equipment and 94158 microfiches for 46 countries were transferred to ACMAD in May 1997.

WMO (2009) indicates that the original microfiches were kept at the IDCC in Brussels and that the diazo copies were held at the ACMAD (African Center of Meteorological Applications), Niamey), that an inventory were available on CD for each of the 41 African countries concerned by DARE and DARE I but that ACMAD did not have the means to recover the data.

Kanga (2007) gave the alert at the 1st MEDARE workshop (WMO initiative) in indicating that most of the original documents used for DARE I have disappeared, and some countries have destroyed their microfiche.

West Africa Climate DR&D Project

The international organization IEDRO has launched an international Data Rescue project in West Africa, the first phase of which is to support the ACMAD in inventorying and scanning the microfiche of the DARE I project, then to scan the data in text format (IEDRO, 2017; Kamga, 2015)

Funding from international organizations has made it possible to install computers, microfiche scanners at ACMAD and to train technicians on site. IEDRO has wrote an instruction manual for scanning microfiche stored at ACMAD (Crouthamel, 2013). According to information received from ACMAD and IEDRO, the project has been stopped since 2015 and the inventory and digitization only concerned 100,000 images, the equivalent of images of a single country (Crouthamel, 2015).

11.7.3 Madagascar microfiches of the DARE I Project

Microfilming in Madagascar has involved many paper archives over all the period of archive until 1989. In November 2016, the microfiches could not be found at DGM in Antananarivo, but the catalogue on paper form was available at DGM.

DGM maintains a paper version of the 1996 inventory of Madagascar carried out as part of the project (IDCC, 1996). The catalogue consists of 163 pages and the microfilming has concerned 357 stations in Madagascar.

Microfiches are sorted by type of document, station and date:

- ✓ Fiches S: Synoptical observations (50 pages);
- ✓ Fiches C: Climatological observations (40 pages);
- ✓ Fiches R: Rainfall observations (41 pages);
- ✓ Fiches D: Diverse, mainly strip charts for Madagascar (32 pages).

Météo-France's analysis of this catalogue lead to conclude that all types of weather records have been microfiched including diagrams and for the entire period of the GM meteorological archives.

Below, the summary table for Madagascar synoptical stations indicating the name of the station, the IDCC station number and the period of observations. Very few gaps.

Table 1: Catalogue of Microfiches DARE I for Madagascar synoptical stations

Station	N° IDCC	Fiches S Période	Fiches C Période	Fiches R Période	Fiches D Période
Ambohitsilaozana	0034	1928-1989	1928-1985		
Antsirabe	0005	1957-1989		1958-1989	1957-1989
Antsohihy	0035	1928-1989	1927-1986		1966-1967
Besalampy	0007	1933-1989	1928-1933	1956-1989	1954-1989
Diego-Suarez (*Antisiranana)*	006	1897-1989		1932-1989	1933-1989
Farafangana	0008	1902-1989		1941-1989	1940-1989
Fianarantsoa	0010	1902-1989		1957-1988	1948-1989
Fort-Dauphin *(Taolagnaro)*	0016	1903-1989		1937-1988	1932-1989
Ivato	0011	1948-1989		1949-1989	1947-1989
Mahanoro	0017	1903-1989		1957-1989	1957-1989
Maintirano	0014	1902-1989		1941-1989	1939-1989
Majunga *(Mahajanga)*	0013	1897-1989		1932-1989	1932-1989
Mananjary	0015	1901-1989	1903-1903	1955-1989	1949-1989
Morombe	0018	1928-1989		1959-1989	1949-1989
Morondava	0021	1901-1989		1955-1989	1941-1989
Nossi-Be	0020	1901-1905, 1913-1989		1969-1989	1949-1989
Ranohira	0022	1951-1989		1935-1989	1939-1989
Sainte-Marie	0037	1921-1989		1958-1962	1952-1989
Sambava	0024	1951-1989	1932-1951	1961-1989	1951-1989
Tamatave	0025	1898-1989		1932-1989	1932-1989
Tananarive	0026	1896-1989		1934-1966	1939-1989
Tulear *(Toliary)*	0036	1908-1989		1889-1913, 1938-1982	
Vohémar	0040	1908-1989			1949-1951

11.8 Outcomes of Météo-France's Data Rescue implementation plan

11.8.1 West Indian Ocean data rescue project

Météo-France aims to develop and enhance the national heritage of climatological data stored at Météo-France and the National Archives of France. Météo-France and the National Archives of France have been working in close collaboration since 2011 to make historical meteorological records accessible (Climate initiative BNP Paribas Access to climate archives despite Abestos, Hervieu (2017).

The **"West Indian Ocean data rescue project"** has been created as a response of the Priorities 3 and 5 of the Météo-France's report (2017).

Météo-France has been running the West Indian Ocean data rescue project since 2016 in collaboration with the National Archives of France and Météo-France's funding

Geographical area concerned**:** La Réunion, Madagascar, Mayotte, Comoros, Tromelin and Europa

Objectives of the project:

- ✓ reconditioning and inventorying all the paper records held at National Archives of France (in process);
- ✓ imaging all the pre-1918 meteorological records held at National Archives of France (in process);
- ✓ imaging monthly climate tables, period 1947-1961 of currently open synoptical stations held at the National Archives of France (action completed in 2018);
- ✓ sharing resources with foreign meteorological services and international projects: development of a public web portal making available catalogues images of the paper records online. Publication of the web expected in 2022;
- ✓ digitization of the French meteorological data available on the imaged documents (La Réunion, Mayotte, Europa, Tromelin) and integration of data in the French national database BDClim.

Météo-France borrowed from the National Archives of France 32 boxes, containing historical records of meteorological observations for Madagascar, Comoros, Mayotte, Europa and Tromelin over the periods 1864-1918 and 1947-April 1961.

Progress of the project can be followed on I-DARE portal: https://www.idare-portal.org/data/west-indian-ocean-data-rescue

11.8.2 Imaging Microfiches of the DARE I project

This action corresponds to the priority 5 of the Climate Data Rescue Implementation (cf. chapter 2.)

In December 2016, ACMAD gave information about the inventoried microfiches to WMO:

- ✓ about 50% of all microfiche boxes at ACMAD was inventoried with the UNDP and IEDRO support;
- ✓ statement for Madagascar: 7295 inventoried microfiches containing a total of 333 693 images.

In 2017, DGM send letter to ACMAD asking for Madagascar microfiches inventory held at ACMAD. ACMAD sent the list of inventoried Madagascar microfiches to WMO in 2019: 625 microfiches

This amount of Madagascar inventoried microfiches corresponded **only to 8% as would be expected a**ccording Météo-France's report (2017) and the letter from ACMAD to WMO in 2016.

Météo-France' analysis of ACMAD inventory in 2019: ACMAD inventoried 9 synoptic stations, but 17 synoptic stations were missing. And most part of climatological and rainfall stations were missing.

On the other hand, in 2017, Météo-France has learnt that a copy may have been preserved in Belgium, but it was difficult to find the trace of the microfiches kept by the IDCC.

In 2019, the Resolution 8 (Sauvetage de millions de relevés climatologiques en Afrique archivés sur microfiches obsolètes) of WMO (2019) decided to establish a DARE project for Africa under the auspices of WMO, in order to accelerate rescue of all microfiches, held at ACMAD and in different countries.

In 2021: Copernicus Climate Change Service C3S Volume II Collection and Processing of In Situ Observations C3S2_311

We can find in the Invitation to Tender: *Part 2 Lot 1. Access to a comprehensive archive of historical surface observations, with support for data rescue: Provision of support for digitization activities on high-priority data records, to be selected in coordination with ECMWF. A prime candidate is the digitization of about 4 million images of the ACMAD dataset that will be delivered in 2021 by the Cop1 COP_062 contract. A maximum of 300,000 EURO can be allocated to such activities. All rescued data within the contract are to be submitted to the C3S data deposition service.*

Conclusion: Priority 5 of the Climate Data Rescue Implementation (2017) will be soon completed, under the auspices of Copernicus.

11.9 Identification of data to be recovered

Analysis of the inventory of Copernicus Global Land and Marine Observations Database GLAMOD (30/04/2021): **no Madagascar data before 1973 in the database**, except daily temperature in Mahajanga (Majunga) during the period 1892-1902 Inventories available on https://datadeposit.climate.copernicus.eu/inventories/.

Prioritization of future data rescue activities: imaging records and data digitization from images of the 23 long series open synoptical stations (cf. table 1) :

- ✓ Imaging records:
  - all the microfiches within the Cop1 COP_062 contract, in process,
  - all the historical records pre-1918 stored in France, in process
- ✓ Data digitization:
  - Sub-daily and daily data from microfiches, expected within future contract C3S2_311;
  - data from pre-1918 historical records: Antsirabe, Diego-Suarez (*Antisiranana),* Farafangana, Fianarantsoa, Fort-Dauphin *(Taolagnaro),* Mahanoro, Maintirano, Majunga (*Mahajanga*), Mananjary, Morondava, Nossi-Bé (*Nosy Be*), Sainte-Marie, Tamatave (*Toamasina*), Tananarive (*Antananarivo*), Tuléar (*Toliary*), Vohémar.

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12 Perspective on historic and future activities

12.1 Assisting currently known projects

12.1.1 Projects on the Portals

Currently, as of 16/08/2021, there are 32 projects highlighted by the I-DARE and C3S Data Rescue Portals, as identified by Peter Sigmund and Ge Verver. Those 32 projects satistfy at least one of the following two criteria:

- ✓ Projects that contain observations from before 1950 outside the European land surface;
- ✓ Projects that indicated a need for assistance.

Of those projects, 25% are from Africa, 25 % from Asia, 19% from South America, 9% from North America, 3% from Pacific, 3% from Europe and 16% from Polar and Ocean regions.

The ACRE projects represent 25%, and among those 25%, 88% concerns Ocean data.

2 projects include hydrological data, that means 6% over the 32 projects.

All percentages are computed from the table here.

Some issues:

1. An issue arises with attempting to prioritize projects where assistance is needed, as there is no robust mechanism for assessing competing priorities (should it be based on Data Category, period, parameter, type and/or amount of assistance needed, and others?). Nor is there an identified person or group to assign these priorities;
2. It is important to ensure that the status of the projects is regularly updated on the Portals (and new information added) to be able to help decision makers;
3. Important also to have more guidelines on the project template, and to encourage contributors to fill in fields as far as possible. Currently, failure to do this results in inconsistencies between project descriptions.

12.1.2 IEDRO

IEDRO is currently proposing 2 projects, one in Guatemala (180K $) and the other in Nicaragua (150 K $), both in collaboration with the Members' National Meteorological and Hydrological Services (NMHSs).

IEDRO also proposes to develop training materials (45 K $) that we will discuss later on in this report.

12.1.3 Météo-France

The remaining tasks for the Data Rescue component for the African and Asian former French colonies is estimated to be 142 K €.

A precise roadmap for the Climate Data rescue needs for Madagascar is described (See here). In 2017, a budget study has been undertaken, but needs to be renewed. This project is still waiting for donors.

12.2 Collaboration with Copernicus on the African DARE I project with the Meteorological Institute of Belgium, RMI

C3S has collaborated with the RMI to image the huge amount of microfilms and microfiches of the most ambitious data rescue project in the 80's which dates back to the 19th century. C3S will now concentrate on the digitization of those data that spans more than 40 countries. The aim of C3S is the sharing of those data and their use in reanalysis activities.

It would be helpful if COINS can somehow assist NMHSs in inserting their data into their national climate record (via, for instance, training, workshops, user friendly instructions). Doing so will better enable the creation of exchange links between African countries and Europe. It will of course strengthen the capacities of the NMHSs of Africa.

The mutual exchange of data is to the benefit of everyone – NMHSs and climate scientists and climate modelers.

12.3 Enhancements

The following are several recommendations for steps that would improve the efficiency and scope of data rescue activities globally, and the sharing of rescued data.

1. Examine data rescue projects inventory to assure there is no overlap in projects. A report should raise any such instances so that teams can work in collaboration.
2. Confirm for known data project there is not already archived rescued data in the main Global Data Centers such as NOAA/NCEI which holds the largest amount of rescued data in the world, and in repositories identified in the Data Rescue Portals. We also recommend that NMHSs are alerted to the presence of their data in such databases, as they very likely would like to have a copy themselves.
3. Importance of identifying gaps: where there is known data that needs to be imaged/digitized, and where there is missing data that may possibly be held in an archive elsewhere, such as a Global Data Centre, or the archives of a former colonial power (there were several instances of this in relation to Pacific Island countries).
4. As a necessary condition of the two previous points, Include World Data Centers and other partners into this synergetic partnership on Data Rescue.
5. Enlarge as far as possible the scope of Data Rescue to include Marine and Hydrology Data. The roles inside the WMO Services Commission, and especially for the Standing Committees on Climate Services, on Hydrological Services and on Marine Meteorological and Oceanographic Services should be better informed in regard to Data Rescue activities.
6. Enlarge contributions from other non-traditional partners such as National Archive bodies, citizen science groups, etc.
7. Maintain an inventory for data already digitized and archived in World Data Centers and other organizations. This inventory should be added to the main Data Rescue Portals.
8. Link the portal to the CIS2 data base, the Copernicus In Situ Component Information System: https://cis2.eea.europa.eu/.

9. Conduct a merger of the I-DARE and C3S portals, including producing a combined version of the Guidance documents on data rescue (these activities are covered under the scope of Copernicus Phase 2, but will require efficient collaboration between the WMO Secretariat, WMO Commissions, Europe, etc.).

12.4 The need for a standard

Another activity that would improve efficiency and security is to apply standards for the archival and management of data that has been imaged, and/or digitized. Such standards should be based on commonly-accepted principles for data and information management, such as the FAIR principles or the GEOSS Data Management principles, both of which emphasize Findability (or Discovery), Accessibility, Useability, Interoperability and preservation.

These standards underpin the WMO Regulations around Climate data management as embodied in the Manual on High-Quality Global Data Management Framework for Climate (WMO No 1238).

Secondly, it would be helpful to investigate efficient methods of exchanging data rescue information between the Portals and other entities, including the CIS2 data base (the Copernicus In Situ Component Information System). The WMO Information System (WIS) may provide a good vehicle for such exchange and coordination.

12.5 Synergies & Capacity building

A prerequisite for the eventual recovery of all accessible climate data still to be rescued is to strengthen the Data Rescue Community. Suggestions in this regard include:

1. Assisting in training in the use of the portals, and being a contributor to, and user of, the Portals: regional workshops such as the EUMETNET Data Management Workshop held every 2 years.
2. Liaise with Copernicus and WMO Training Departments to create and include a Data Rescue thematic "on-line" workshop/training course. Also include other initiatives such as IEDRO's video processes for data recue.
3. User support help desk including guidance and training? It is recommended that such a help desk should be located at each of the Regional Climate Centres to ensure long-term viability.
4. Ensuring that there is a logical synergy between CDMSs and Data Rescue activities (refer to WMO publication "*A proposed long-term plan for climate data management and rescue activities*" (WMO, 2017). In particular, where a new Climate Data Management system is being implemented (or training on updates to an existing one is being conducted), use the opportunity to also assist staff with data rescue activities.
5. Continue to provide this type of report (and incorporate it into the Portals) in order to bring new stakeholders on board.

13 Reference Documents on Data Rescue

13.1 WMO

Reference	Edition	Title	Authors
WMO	2016	INDARE, Indian Ocean Data Rescue Initiative	
WMO	2017	A Proposed Long Term Resource Plan for Climate Data Management and Rescue Activities	Lead author: Dr William James Wright
WMO Bulletin 70	2021	Learning from the past to understand the future: historical records of change in the ocean	Rob Allan, Kevin Wood, Eric Freeman, Clive Wilkinson, Axel Andersson, Andrew Lorrey, Philip Brohan, Martin Stendel, John Kennedy
WMO	1993	The data rescue project of the World climate data and monitoring programme	
WMO WCDMP-No 49	2002	Report of the CLICOM-DARE Workshop, & of the International Data Rescue Meeting	
WMO WCDMP-No 55	2004	Guidelines on climate data rescue	
WMO WCDMP-No 67	2008	Proceedings of the International workshop on rescue and digitization of climate records in the Mediterranean basin, 2008	
WMO WCDMP-No 69	2008	Meeting of the CCl Expert Team on the Rescue, Preservation and Digitization of Climate Records	
WMO WCDMP-No 79	2012	International Workshop on Data Rescue and Digitization of Climate Records for countries in West Africa	
WMO	2017	Making a Difference on the Ground: Data Rescue in Burkina Faso, Mali and Niger	
WMO	2016	INDARE, Indian Ocean Data Rescue Initiative	

Reference	Edition	Title	Authors
WMO-No.1146	2014	Guidelines for Hydrological Data Rescue	Harry Dixon, Gregorsz Słota, Theo Brandsma, Bogdan Ozga-Zieliński, Ross James
WMO-No.1182	2016	Guidelines on Best Practices for Climate Data Rescue	

13.2 Copernicus Climate Change Service (C3S)

Reference	Edition	Title	Authors
C3S	2020	Identifying Data Rescue gaps and issues	Manola Brunet, Alba Gilabert, Phil Jones, Peter Siegmund
C3S	2020	Best Practice Guidelines for Climate Data and Metadata Formatting, Quality Control and Submission	Brunet, Manola; Brugnara, Yuri; Noone, Simon; Stephens, Ag; Valente, Maria Antónia; Ventura, Clara; Jones, Phil; Gilabert, Alba; Brönnimann, Stefan; Luterbacher, Juerg; Allan, Rob; Brohan, Philip; Compo, Gilbert P
C3S	2019	Best Practice Guidelines on Archive Work, Imaging, and Digitising	

13.3 Others

Journal of Applied and Service Climatology	2021	Status and Climate Applications of the 19th Century Forts and Volunteer Observer Database	Nancy E. Westcott, Jason Cooper, Karen Andsager, Leslie A. Stoecker, and Karsten Shein

14 Links

14.1 The Data Rescue portals

The WMO International Data Rescue (I-DARE) Portal: https://www.idare-portal.org/content/international-data-rescue-i-dare-portal

The Copernicus data rescue projects: https://datarescue.climate.copernicus.eu/map

14.2 Copernicus Climate Change Service (C3S)

C3S Data Rescue Service: https://datarescue.climate.copernicus.eu/

C3S Guidelines and Resources: https://datarescue.climate.copernicus.eu/best_practice_guidelines

Copernicus in situ component: https://insitu.copernicus.eu/

e-learning: http://giub-torrent.unibe.ch/weather-simulation/#assimilation

14.3 Others

Météo-France, l'apport des archives pour la mémoire du climat : http://archivesduclimat.meteofrance.fr/intro.html

15 Acronyms

Acronym	Meaning
ACMAD	African Center of Meteorological Application for Development, WMO RCC
ACP	African, Carribbean and Pacific
ACRE	Atmospheric Circulation Reconstruction over the Earth
AGRHYMET	
BMKG	Meteorology, Climatology, and Geophysical Agency of Indonesia
BoM	Bureau of Meteorology of Australia
C3S	Copernicus Climate Change Service
CIIFEN	International Research Center on El Nino y Regional Climate Center for Western South America
CIMH	Caribbean Institute for Meteorology and Hydology
CLIMSA	Intra-ACP Climate Services and Related Applications
Coins Consortium	Comprised of EUMENET, EUROGOOS and NILU – the Norwegian Atmospheric Research Institute
COPERNICUS	European Union's Earth observation programme
DARE	Data Rescue
DIDAH	Digitization and use of high-resolution historical climate data from Indonesia over the period 1850-present
ECA&D	European Climate Assessment & Dataset project
ECCAS	Economic Community of Central African States
ECMWF	European Centre for Medium-Range Weather Forecasts
ERA5	fifth generation ECMWF atmospheric reanalysis of the global climate covering the period from January 1950 to present
ET-DRC	WMO Expert Team on Data Requirement for Climate Services, Services Commission (SERCOM)

Acronym	Meaning
EUMETNET	European Meteorological Network
ICOADS	International Comprehensive Ocean-Atmosphere Data Set
IEDRO	International Environmental Data Rescue Organization
IGAD - ICPAC	Climate Prediction and Application Center, in the Greater Horn of Africa
IOC	Indian Ocean Commission
KNMI	Royal Netherlands Meteorological Institute
LACA&D	Latin America as the Climate Assessment & Dataset
MEDARE	The MEditerranean climate DAta REscue
NCEI	National Centers for Environmental Information
NOAA	National Oceanic and Atmospheric Administration of the USA
OACPS	Organization of the Afrcan, Caribbean and Pacific States
RCC	Regional Climate Centre
SACA&D	Southeast Asian Climate Assessment & Dataset
SADC	Southern African Development Community
SASSCAL	Southern African Science Service Centre for Climate Change and Adaptative Land Management
SPREP	South Pacific Regional Environment Programme
WACA&D	West-African Climate Assessment and Dataset
WMO	World Meteorological Organization

16 Tools

Acronym	Meaning
IMMA	International Maritime Meteorological Archive format
SEF	Station Exchange Format for Copernicus