The international ACRE initiative (http://www.met-acre.org/) is run by a consortium of nine core partners, and is part of the Global Framework for Climate Services.

The international Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative

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Background and Research Goals?

The international ACRE initiative provides an umbrella that links together some 40+ projects, institutions, organisations, and data rescue and climate applications activities around the globe -

In support of its first role in providing an international umbrella to facilitate, coordinate and undertake historical surface terrestrial and marine instrumental data recovery, imaging, digitization, quality control, archiving, access and preservation in a sustainable manner, ACRE is also developing a range of regional data foci as follows:

International Projects, Sources & Repositories linked to ACRE

In support of its first role in providing an international umbrella to facilitate, coordinate and undertake historical surface terrestrial and marine instrumental data recovery, imaging, digitization, quality control, archiving, access and preservation in a sustainable manner, ACRE is also developing a range of regional data foci as follows:
ACRE Chile - Initial funding EC FP7 ERA-CLIM
- APEC SPHERE proposal

ACRE Pacific - Via NIWA, NZ
- Initial French Pacific Fund project

ACRE India - British Library - India initiative
- AHRC Collaborative Research on the Meteorological and Botanical History of the Indian Ocean, 1600-1900
- MoU with Indian Meteorological Department?

ACRE Arctic - Being developed by the Atmosphere/Climate Working Group (WG) of the International Arctic Science Committee (IASC)

ACRE Africa - Link to new Met Office Hadley Centre-UK DfiD Climate Science Research Partnership (CSRP) contract

ACRE China - Part of the new Met Office MoU with both the China Meteorological Administration (CMA) and Beijing Climate Centre (BCC)
- plus an AHRC proposal via Bristol University, UK

ACRE SE Asia - APN CAPaBLE proposal
- FCO Singapore proposal

ACRE Southern Ocean - Links to Southern Ocean Observing System (SOOS) International Project Office (IPO), Tasmania, Australia and Gateway Antarctica, NZ

As with all of ACRE’s international activities and regional foci (noted above), the historical instrumental weather observations will feed into international terrestrial and marine weather data repositories, and will be freely available.
These data will in turn be assimilated into all reanalyses (http://reanalyses.org/), especially the freely available 3D global dynamical historical weather reanalyses (see current timeline on the next page) of its main US partner, the US National Oceanic and Atmospheric Administration (NOAA) Earth System Research Laboratory (ESRL) and Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado, - the ACRE-facilitated 20th Century Reanalysis (20CR).

**ACRE-facilitated Historical Reanalyses**

*20th Century Reanalysis Project (20R)v1: 1891-2008 (Autumn 2009)*

- Global historical reanalysis
- Assimilates only surface synoptic pressure, monthly sea surface temperature (SST) and sea-ice distributions
- 56 realisations of 32 (20Crv1) - 41 (20Crv2) variables at 24 pressure levels every 3 and 6 hours
- Ensemble mean and spread forecast (first guess) fields (T62 ~ 200 km x 200 km spatial resolution)

*20th Century Reanalysis Project (20R)v2: 1871-2010 (Dec. 2011)*

- Global historical reanalysis
- Assimilates only surface synoptic pressure, monthly sea surface temperature (SST) and sea-ice distributions
- 56 realisations of 32 (20Crv1) - 41 (20Crv2) variables at 24 pressure levels every 3 and 6 hours
- Ensemble mean and spread forecast (first guess) fields (T62 ~ 200 km x 200 km spatial resolution)

**Sparse Input Reanalysis for Climate Applications (SIRCA):**

*1850-2014 – Autumn 2014*

- Higher resolution (T126 ~ 100 km x 100 km spatial resolution or higher)
- Improved methods (e.g. quality control, bias correction)
- More input data (e.g. ACRE)
- Latest model from NCEP
- Include uncertainty in forcings (e.g. ensemble of SSTs and sea-ice, CO2, solar)

**Ocean-Atmosphere Reanalysis for Climate Applications (OARCA):**

*1800-2017 – Autumn 2017/8*

- Higher resolution (T382 ~ 35 km spatial resolution or higher)
- Improved methods (e.g. coupled Cryosphere-Ocean-Land-Atmosphere-Chemistry system, link with SODA advances, possibly NOAA CarbonTracker advances)
- More input data (e.g. ACRE-facilitated: maybe winds, T, storm position, trace gases)
- Latest NCEP model, multi-model with other models (e.g. NASA, NCAR, GFDL, ESRL)

Dynamical downscaling by the Met Office PRECIS (http://www.metoffice.gov.uk/precis) team dynamical models will then take 20CR output down to finer resolution (25 km to 100 m), for use by the climate science community, wide ranging climate applications and services, policy makers, planners, environmental managers, educational and public sectors - the schematic on the next page provides an overview of the full ACRE initiative.
The 20CR ensemble mean and spread fields are freely available via the NOAA ESRL and CIRES CDC (http://www.esrl.noaa.gov/psd/data/gridded/data.20thC_ReanV2.html), the NCAR Research Data Archive (http://rda.ucar.edu/datasets/ds131.1/), the NERSC Science Gateways (every-member netCDF4 files: portal.nersc.gov), and NERSC HPSS Science Gateway (every-member GRIB files: http://portal.nersc.gov/cgi-bin/get_tape?/home/projects/incite11/www). Eventually, all of 20CR outputs will be available on this British Atmospheric Data Centre (BADC) WWW site that is still being developed and finalised - the top level catalogue entry can be seen at: http://badc.nerc.ac.uk/view/badc.nerc.ac.uk__ATOM__DE_6ae84cbc-177b-11e2-9c9c-00163e251233

The following link is to papers published in the literature that have referred to and/or used 20CR: http://www.esrl.noaa.gov/psd/data/20thC_Rean/pubs/.

The link at the end of this sentence, is to a set of visualisations of the results of both ACRE’s historical weather data activities plus 20CR outputs that are dynamically generated from the historical weather observations that ACRE and its partners recover, image and digitise: https://vimeo.com/channels/345571
How does interdisciplinary collaboration benefit ACRE and its users?

As shown below, ACRE also links closely with Citizen Science, Social Sciences, Humanities and Arts projects, which extend its activities far beyond climate science into inter/cross/multidisciplinary engagements, and provide the basis for access to expertise for training in data rescue, scanning and digitisation tools and techniques for analyses and interpretation of historical documentary weather observations. This is an ongoing ACRE activity evolving as the initiative itself grows and expands its interactions and collaborations.

Currently, the initiative is part of two new proposals to the UK Arts & Humanities Research Council (AHRC) ‘Environmental Change and Sustainability area of the Care for the Future’ theme:

Climate Histories of the West African Monsoon  Led by Professor David Nash, University of Brighton, UK

Representing and communicating uncertainty: climate change and risk  Led by Professor Georgina Endfield, University of Nottingham, UK
In what collaborative work is ACRE already involved?

As shown on the previous page, the international ACRE initiative, by its very nature, already embraces inter/cross/multidisciplinary engagements and collaborations under the following specific data rescue and related activities.

Although at various stages of development, when taken together, ACRE’s most coherent regional data rescue foci, ACRE Chile, ACRE Pacific, ACRE China, ACRE India, ACRE Africa and ACRE SE Asia, already effectively cover a large part of the globe and embrace a strong inter/cross/multidisciplinary network.

ACRE Chile was the first regional foci developed under ACRE, and is part of the EU FP7 European Reanalysis of Global Climate Observations (ERA-CLIM) project (http://www.era-clim.eu/) (see map below, including ACRE collaborations with other partners in ERA-CLIM) with the digitisation of historical Chilean terrestrial and marine weather observations being coordinated by the Universidad del Pacifico in Santiago. Several visits to Chile since 2009, have paved the way for these activities and the identification of over 6,000 Chilean ship logbooks with historical weather observations in them in the period from 1860, similarly around 100 lighthouse records over a similar time frame, and potentially huge amounts of hydrographical data for the seas bordering Chile.

ACRE Pacific is being run out of the National Institute of Water and Atmospheric Research (NIWA) in New Zealand. It was begun following an Asia-Pacific Network for Global Change Research (APN) CAPaBLE funded workshop at NIWA in Auckland in 2010 entitled Improving Pacific Island meteorological data rescue and data visualisation capabilities through involvement in emerging climate research programmes (http://www.metacre.org/meetings-and-workshops-1/ACREPAC-APNBulletin_Issue1_March2011.pdf?attredirects=0&d=1).
These data rescue and digitisation activities have since been expanded under a French Pacific Fund project in 2011-2012 involving Météo-France in both New Caledonia and French Polynesia. An ongoing project under ACRE Pacific, Samoa Archive Rescue and Development, is focusing on the recovery, imaging and digitisation of old German colonial weather observations from the old Apia Observatory, which are held by the Samoa Meteorological Services (SMS) (see panel below for the potential data recovery from the wider SW Pacific domain). This is a joint activity between ACRE Pacific, the SMS, NIWA, and both the University of Giessen and Deutscher Wetterdienst (DWD) in Germany.

Apia Observatory, Samoa

“The Observatory is actively engaged in an extensive programme of meteorology, seismology, terrestrial magnetism, upper air observations, and atmospheric electricity, and acts as the co-ordinating centre for six wireless reporting stations in the south-west Pacific. These stations are Tahiti, Vila, Norfolk Island, Rarotonga, Nukualofa, and Suva, which extend over a range of 45 degrees in longitude and about 15 degrees in latitude.”

Andrew Thomson & C. Coleridge Farr (1924): Apia Observatory, Samoa Nature 113, pg 355 (8 March 1924) | doi:10.1038/113355b0

In 2008, the then Met Office Hadley Centre’s Integrated Climate Program and a UK AHRC Knowledge Catalyst Scheme grant allowed ACRE to fund an initiative in conjunction with Bristol University’s Chinese Maritime Customs Project (http://www.bristol.ac.uk/history/customs/), to produce an inventory of sources of historical Chinese and South China Sea region terrestrial and marine daily to sub-daily meteorological data. Building on from this, a new ACRE-Bristol University collaboration via the British Inter-university China Centre (BICC), funded by the AHRC's Language Based Area Studies Scheme, is now in place as part of its 2012-14 Phase 2 activities. The new initiative will form one of BICC's partnerships for knowledge exchange with business and public policy organisations. A Chinese-speaking postdoctoral researcher will support the initiative, and provide liaison between ACRE and the ACRE China team as it sets up operations, and in particular will look to develop relationships with other repositories in China holding historic data, particularly in Shanghai.

As of 2012-13, the above ACRE-Bristol University collaboration will link into an ACRE China regional focus that is part of a new Memorandum of Understanding (MoU) between the Met Office and the Chinese Meteorological Administration/Beijing Climate Centre (CMA/BCC). Current ACRE digitisation activities are focusing on the wider South China Sea region over the period before World War 2 (WW2), using the historical weather observations published in old Chinese newspapers and by both the Hong Kong Observatory and the Jesuit observatory in Shanghai (see station distribution on the next page). Future plans are being developed in conjunction with CMA/BCC for further engagements under the framework of the international ACRE initiative in the new MoU.
ACRE China will also work closely with ACRE SE Asia (see below) and the National Meteorological Services of the Netherlands and Indonesia (KNMI-BMKG) Digitisasi Data Historis (DiDaH) project (http://www.didah.org/). Such interactions will allow ACRE China to utilise the data repository developed by DiDaH, the Southeast Asian Climate Assessment and Dataset (SACA&D) (http://saca-bmkg.knmi.nl/). This will also involve ACRE’s main Japanese data rescue partner, and their developing Japan-Asia Climate Data Project (JCDP) to recover and digitise meteorological data from historical Japanese mainland, various Japanese colonial territories in China and Korea during WW2, plus counties and islands in the NW Pacific.

Under ACRE India, apart from activities linked to the UK AHRC-funded Network Project: "Collaborative research on the meteorological and botanical history of the Indian Ocean, 1600-1900," the initiative’s other efforts have been in trying to develop an MoU, or similar, with the Indian Meteorological Department (IMD)/Indian Ministry of Earth Sciences (aided by the UK FCO in New Delhi), respond to interest by the Sri Lankan Meteorological Service in a data rescue project, and develop a specific data rescue task with ‘The Mauritius Project’ (outlined on the next page). The latter is now likely to be part of a wider project looking at renewable off-shore wind energy potentials for the Government of Mauritius through an enhancement of the historical regional marine weather data feeding into dynamically downscaled (using the PRECIS system) 20CR and SIRCA/OARCA reanalyses across the region.
THE MAURITIUS PROJECT
Recovering, imaging, digitising, archiving and preserving of old weather observations extracted from ship logbooks in 188 volumes of Charles Meldrum's 'anemological' journals from 1853 to 1914 and terrestrial weather observations for Mauritius (including data from Colonel Lloyd's Colonial Observatory at Port Louis) from the late 18th to the early years of the 20th century held by the Mauritius Meteorological Services (MMS).

With ACRE Africa, apart from more integration with the new Met Office Hadley Centre-UK DfID Climate Science Research Partnership (CSRP) contract, the initiative is part of a Met Office funding proposal to DfID for a major data rescue project for the Tanzanian Meteorological Agency, is looking to link with Germany's National Meteorological Service, the Deutscher Wetterdienst (DWD), with their Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL) - a Regional Science Service Centre (RSSC) in Southern Africa project (http://www.sasscal.org/) involving Angola, Botswana, Namibia, South Africa and Zambia in southern Africa, is working with the South African Weather Service on data rescue in their country, and looking to link with the International Research Institute for Climate and Society (IRI) and the expansion of the concept of their IRI-Google.org project (http://portal.iri.columbia.edu/portal/server.pt?open=18&objID=7959&qid=44812383&rank=1&parentname=SearchResult&parentid=21&mode=2&in_hi_userid=2&cached=true), Building Capacity to Produce and Use Climate and Environmental Information for Improving Health in East Africa, to other areas of the African continent.
The primary goals of the Atmospheric Circulation Reconstructions over the Earth (ACRE) SE Asian are:

- To build both capabilities & capacities within SE Asian institutions, agencies & National Meteorological Services (NMS) to improve & extend historical instrumental, documentary & palaeo databases of SE Asian weather/climate.
- New historical SE Asian instrumental weather observations will contribute to the mass of global weather data being used by new generations of high-resolution historical global weather reanalyses (especially EC FP7-funded ERA-CLIM [http://www.era-clim.eu] & the ACRE-facilitated 20th Century Reanalysis Project [20CR] [http://www.esrl.noaa.gov/psd/data/20thC_Rean/]).
- These new global reanalyses will be downscaled to provide scientists & policy makers across the region with high resolution baselines that are able to address weather/climate extremes, impacts & risks in ways & over time spans not previously possible.

On the 8th of October 1881, a massive typhoon struck Haiphong.
- Up to 300,000 people were thought to have been killed.
- It is considered to be one of the deadliest cyclonic storms in history.
- Winds were estimated at 185 km/hour over the Gulf of Tonkin, it generated a 7 metre storm surge.
- It is currently not in the International Best Track Archive for Climate Stewardship (IBTrACS) database nor in 20CR.
- An improved 20CR could resolve the 1881 and similar events

Finally, the initiative is working to develop an ACRE SE Asia data rescue and regional foci, ‘kicking off’ with a joint workshop involving the National Meteorological Services of the Netherlands and Indonesia (KNMI-BMKG) DiDaH project (http://www.didah.org/) at the Universiti Kebangsaan Malaysia (UKM) in Kuala Lumpur in 2014. Funding proposals to support such activities have been made to the APN CAPaBLE call (ACRE SE Asia – towards new weather and climate baselines for assessing weather and climate extremes, impacts and risks over SE Asia), and to the UK FCO in Singapore in response to a request from them for an environmental network meeting in the region (Environmental History and Bio-diversity in Southeast Asia: A Collaborative Workshop). The panel above shows the aims of ACRE SE Asia, and the potential for using the 20CR output to assess weather extremes and climate drivers across the region (further refinement through PRECIS system-downscaling of 20CR output is also being developed).