

Data to the rescue

The founders of two international climate data rescue organisations talk passionately about their goals and the collaborative work they are undertaking together – expounding their belief that only by understanding historical climatic trends can we fully understand the future

Dr Rob Allan

Founder, Atmospheric Circulation Reconstructions over the Earth

Broadly speaking, what are the objectives that the International Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative sets out to achieve?

The ACRE initiative both undertakes and facilitates the recovery, imaging, digitisation, processing and archiving of historical instrumental surface terrestrial and marine global weather observations. Data recovered under ACRE are particularly useful for projects involving global weather reconstructions or reanalyses, particularly 3D global reanalyses spanning the last 200+ years. A notable example is the ACRE-facilitated 20th Century Reanalysis Project (20CR) run by our major US partner, the 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.

Dynamical downscaling, such as that provided by the Providing Regional Climates for Impacts Studies (PRECIS) model of the UK Met Office, is then used to take the reanalyses output down to a finer resolution. We engage in close and ongoing consultations with local, regional and international users,

and make all of this material freely available to climate science and services (extremes, risks and impacts) communities for planning, environmental management, educational and public needs worldwide. In order to address the above aims, ACRE is also developing a range of regional data rescue services under its broad international umbrella.

What is your background, and how has this benefited you in your current role?

My under- and postgraduate studies, plus postdoctoral work, were primarily in the fields of fluid Earth Sciences, Geography and History at both universities in Adelaide, South Australia. I worked in the Climate Impact Group at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Marine and Atmospheric Research agency in Melbourne, Australia for 10 years; and then the Met Office Hadley Centre.

I developed the concept that became ACRE in 2006, in conjunction with colleagues in the primary industry sector under the State Government of Queensland, Australia. This involved gaining wide support from the international weather and climate data community, and building up all aspects of the initiative in order to serve the needs of the organisations supporting it.

Without the above background, which provided me with experience across many disciplines both in the physical sciences, humanities and social sciences, I doubt that I would have been in a position, or had the ability, to develop ACRE as I have.

Can you describe what your position as Project Manager entails?

Basically, I see my role as making ACRE 'happen' and continuing to develop, broadening its horizons and working more and more closely with national

Dr Rick Crouthamel

Founder, International Environmental Data Rescue Organization

What inspired you to found the International Environmental Data Rescue Organization (IEDRO) back in 2005? What were the first actions you undertook?

I was inspired by a combination of frustration and opportunity. I had been managing hydrometeorological data rescue programmes for the International Activities Office of the US National Weather Service for the previous eight years. Then the National Oceanic and Atmospheric Administration (NOAA) cut the budget for our critical work, so I retired to form a nonprofit organisation and carry on that work.

The first action I undertook was to re-establish a working relationship with NOAA, who found some limited financing to continue the work I had been doing. I also assembled a few colleagues to map out our organisation strategy.

How did your background and experience aid in the formation of such an organisation?

Although my undergraduate degree is in Meteorology, my doctorate is in Environmental Management. While working on that degree I became aware of environmental issues outside the scope of hydrometeorology and became more aware of the relationships that exist between all environmental disciplines. Meteorology is linked to hydrology and to oceanography and those three fields to biology etc.

Why is environmental data rescue so important?

In the opinion of our members no other single endeavour will save more human lives and prevent more suffering than locating, imaging, digitising and archiving the world's historic environmental records, especially old weather records. These records can give the 1.6 billion subsistence farmers on this planet a true statistical idea as to the frequency of drought in their areas. If only one farmer in a thousand took these data and altered his/her planting or crop saving practices accordingly, nearly 6 million people could be saved from starvation every year. Those same rescued data enable health officials to calculate where airborne diseases like malaria, dengue and yellow fevers will spread, assist forecasters to make more accurate flood and mudslide predictions and literally hundreds of other uses.

Is there enough understanding from the public, and indeed from governments, of the importance of analysing historical data?

They have to have the data in digitised form before they can hope to analyse it, and most of the world's historic hydrometeorological data is still on paper waiting to be rescued before a fire, flood or

to international bodies to see it become established in a more sustainable form as a truly multi/cross/inter-disciplinary entity. This ranges from finding the funds and developing the logistics to support ACRE's annual international meetings and workshops each year, planning and making each of the ACRE regional foci develop and take shape, to seamlessly linking together the initiative's basic structure of data feeding reanalyses and the outputs of all being available to and in forms that any users can work with.

How involved has the UK Met Office been in the formation of ACRE? Is this initiative unique in its goals and function?

The Met Office is now a core partner in the initiative, but it all occurred in response to colleagues from the primary industries sector in Queensland, Australia asking me if it were possible to create a better, longer, more spatially and temporally complete database of the weather that could be used to feed directly into crop, livestock and production models. As a consequence, the Queensland State Government funded me in a Met Office position to develop ACRE for the first three years of its existence.

ACRE is not only unique in the manner of its creation, but also because it is a response to elements within the user community, rather than being a climate science initiative looking to find applications for what it is producing. From the outset, ACRE was developed to serve the

widest possible needs of the international user community. It is also meant to provide not only the best state-of-the-art baseline of observational data, but also to facilitate its use in the production of dynamically-generated, gridded, global 3D reanalysis fields of weather variables throughout the depth of the atmosphere for as far back in time as possible. ACRE thus aims to serve any users wanting to address issues where climate, natural climatic variability and/or anthropogenic climate change may impact their activities, commodities, products or lives.

Can you give an idea of the scale of the ACRE project – the different projects and organisations that it encompasses and how they are all coordinated?

ACRE links together over 100 projects, institutions and organisations, as well as assorted data rescue, reanalysis and climate applications activities around the globe. It is coordinated by me, but responds to, and is refined by, its partners' wishes and needs. The extent and depth of any collaboration between ACRE and its partners and/or linked activities can be as closely aligned or as ephemeral as desired. We all look to support one another's activities and contribute to the initiative – but all have to find the resources needed to sustain their own individual efforts as well.

Where do you source your data from? Do you encounter difficulties when acquiring

THE IMPORTANCE OF DATA RESCUE

"We estimate the world loses 500,000 old records each day"
 – Dr Rick Crouthamel

One of the most tragic misunderstandings of climate science is the idea that short-term fluctuations in global climate indicate broader climatic trends. Misinterpretation of such phenomena has often led worldwide governments, media sources and members of the public to form opinions on important issues such as global warming and the subsequent melting of polar ice caps which, in reality, have very little grounding. Rather, long-term datasets are needed in order to document changes in the global climate extending beyond the past couple of decades.

Another popular misconception is that climate records only exist for modern times, during which researchers have taken a scientific approach to understanding changes in the world around us, documenting these alterations. In fact, there are historical records that date back much further. It is merely a question of finding them and converting them to a format which can be more easily utilised by climate scientists working today. This is where data rescue organisations come in.

"The bulk of historical surface weather observations being recovered, imaged and digitised by ACRE extend back to the latter part of the 19th Century," reveals Dr Rob Allan. In addition, the ACRE-facilitated 20CR output that has been generated from these data extend back to 1871, but the group ultimately intends to push such reanalyses back to 1800. A problem that arises from working with historical data is its durability – with records that stretch back hundreds of years likely to be lost. This gives these organisations a great sense of urgency in achieving their mission.

Providing a longer temporal basis through which to assess the Earth's climate is an important task, and one which may be crucial in generating realistic climate models. In an age when our future is clouded with uncertainty, and the environment places humanity under a pressure greater than ever before, it is imperative that we look back, as well as forward.

insects destroy it. Governments and members of the public can easily see the benefit of buying a starving family 100 pounds of rice, but they find it hard to see the benefits in investing the same amount of money in rescuing and digitising old data – even though that data could provide 100 families with the information needed to prevent starvation.

What kind of data are you recording? How do you go about collecting and cataloguing such a broad array of data?

We are concentrating on locating, imaging and digitising old weather data, primarily from the 1800s and 1900s, although some data date back earlier than that. These are readings of precipitation,

temperatures, humidity, wind direction and speed, barometric pressure, cloudiness and a host of other parameters. We primarily rescue data now resident within the archives of many of the numerous national meteorological services in the world. We send teams to parts of the world – many of which are developing countries – with cameras and computers, to teach local staff to photograph these old data and send the images to us. We digitise the resulting information and eventually the data are placed in an open and unrestricted database for the use of the world's scientists, educators, researchers and general public. Currently the database we use is run by National Oceanic and Atmospheric Administration (NOAA), a US Federal agency.

Are there any specific problems that arise from collecting data

data from such an array of sources?

ACRE recovers data from all potential sources of global historical instrumental surface terrestrial and marine global weather observations. The initiative looks to work closely with libraries, archives and museums around the world, in order to unearth new historical weather observations. To date, this has particularly involved the National Archives in the UK and US, the National Meteorological Library and Archive of the UK Met Office and the British Library. The plan is to eventually investigate any holdings in various national, regional and colonial archives in countries around the world.

The main difficulties that arise are not just from making contact with new sources, or knowing which potential repositories to target, but sometimes communicating to them the benefit of working with us to recover their old colonial data. Many meteorological services in developing countries may not even know that such observations were made in their countries during colonial times, or if they do they have no funds to recover, let alone image and digitise them. Alternatively it may be that they have only focused on data since independence - often from the 1950s-1960s.

The latter is a perennial problem, as even in developed countries there can be a perception that any earlier data prior to the Second World War

are of poor quality and quantity, don't exist or are inadequate for climate change analysis. From my experience with ACRE, prior to that period there exist at least as many global surface weather observations that haven't been recovered and digitised as have been. This has come about as a result of many factors, such as a focus on weather prediction and climate models based on the last 50 years or so, and a tendency to sample a limited set of data, or only certain variables. It can simply be that there wasn't the time, funds or staff to enable such work to be done.

The latter factors come up time and time again when looking through the histories of various data rescue efforts for the past 100-150 years – so lessons are still not learnt, and great potential not realised.

Aside from your focus on climate science, you cover areas as diverse as citizen science, social sciences, humanities and arts projects – how does collaboration with such initiatives benefit your institution?

Such engagements benefit ACRE because embracing and working with a wider community of disciplines allows the initiative to be as comprehensive as possible when recovering historical climate data. In turn, this also provides the basis for non-climate science disciplines, which can have various interests in climate, to obtain access to volumes of material that can be used in their own work – this would not otherwise occur.

THE COLLABORATION

Drs Rob Allan and Rick Crouthamel outline the purpose of the collaborative work carried out by their two organisations

RC: There is a Memorandum of Understanding between ACRE and IEDRO. Unlike many international programmes, the various projects under both our organisations work in total cooperation, not competition.

RA: The Memorandum was set up to formalise our interactions and work towards common data rescue goals and funding possibilities.

RC: Collaboration is essential to our work. If we can piggyback on someone's work and efforts, we will, and we welcome them working with us. We all have the same mission – to rescue, digitise and archive critical historic environmental data.

RA: IEDRO has traditionally worked directly on data rescue missions focusing on more contemporary records with members of various National Weather Services (NWS) in developing countries around the world, particularly in Africa and South America. ACRE somewhat compliments IEDRO, by focusing on data rescue of historical instrumental surface terrestrial and marine weather observations, mainly prior to the Second World War. These data come from both NWS and other repositories of such data – from collections in the Old World and countries around the world that were colonies of the European powers at various times in the past.

RC: If we find something that works for us, we let the ACRE programme managers know. We are about to embark on a programme to solicit funding not only for IEDRO projects but also to see if we can find funds for ACRE's important work. By having a unified presence, ACRE and IEDRO can reach more people (and hopefully funding organisations) with publicity.

from historical as opposed to contemporary sources?

Contemporary sources such as modern weather observation stations have equipment that automatically digitises the parameter values, and sends them into a communications network that reaches most of the world's national meteorological services. However, those modern digital systems have only been around since the 1980s, giving us about 35 years of really high quality digital data.

However, weather observations were being taken before the US became a nation, so in order to understand what happened for the previous 250 years – which is extremely important for trend analysis – we must rely on data from paper records. Some of the first weather observers in this

country were George Washington, Thomas Jefferson and Benjamin Franklin who recorded weather and temperatures in their personal diaries.

The main problem is lack of time and funds to rescue billions of these historic records before they deteriorate and are lost forever. We estimate the world loses 500,000 old records each day.

Are you involved with developing and implementing new methodologies for data rescue?

IEDRO has developed a dual-keying workstation where volunteers key the data into the database from the original photograph of the old weather observation form. We are also about to complete

Citizen science projects with a climate basis have the potential to not only involve the wider, non-academic community and general citizens in science activities, but to expose them to the nature of the science and the scientists involved. This is helpful because it makes them feel part of the enterprise and more comfortable with climate concepts, as well as the uses and limits of that knowledge.

Clearly ACRE is built upon collaboration; do you work with any other large international climate organisations to facilitate the exchange of ideas and information?

Throughout the years, ACRE has been seen more and more as important to major international weather and climate bodies, such as the World Meteorological Organisation (WMO) and the growing push in the climate community for climate services. This has been on the back of a general move in recent years towards concepts such as 'big data', and international governments' need to sort out data policy in general. Ideally, ACRE would like to forge links with various UN bodies, and for its activities to be taken up more widely on the international stage.

Is open access to data important to your organisation? How do you ensure that the right groups get access to your findings so as to inform policy and make an impact?

As noted previously, for ACRE outputs open access is a given. In the UK, various institutions are trying to deal with the consequences of 'big data' and open access coming down from governmental level. There is no issue with 'right groups' from an ACRE perspective, probably because the initiative does not have a distinct push for data specifically concerning climate change.

Do you feel your project has improved understanding of climate change trends? Are there any tangible impacts you have had on Government policy?

ACRE is an initiative that is simply trying to produce the best long-term global database and reanalyses of the weather as is possible – so there is no specific push for it to inform government policy as it stands. It has created, and is continuing to improve, a state-of-the-art baseline 3D global historical weather reconstruction that researchers and users now have to address and readdress the full range of questions about climate, natural climatic variability and anthropogenic climate change. That work will provide knowledge about climate impacts, extremes and risks, which will shape future management decisions, Government policy, and environmental and resource management.

Do you think that there is a lack of understanding amongst the public and

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a programme that will digitise graphs of weather data (called strip charts), such as rainfall, that are recorded over a 24-hour period and provide a digital output of values for every 5 minutes of time (288 readings in a day) in 5 seconds. This is a process that manually would take 30 minutes per chart. We estimate that there are about 200 million of these charts beginning in the early 1800s around the world waiting for the data locked on them to be rescued.

IEDRO works on a variety of projects across the world, how do you select the areas that you work in and is there a common theme linking them all?

Funds are a factor. If someone needs historic data from an area, we perform data detective work, find the owner of the required data

and negotiate for its imaging and digitisation. It costs about \$23,500/country to set up a digitisation program. With no direct benefactors, our limited funds focus on data in the poorest of countries since they will have absolutely no extra revenue to rescue their data.

What has changed the most in the eight years that this initiative has been running – in terms of both the technologies and manpower available, and also the attitudes of the people you have worked with?

There has been a slow, but steady increase in the awareness of people of the importance of these old data. Manpower in most projects is still 90 per cent covered by volunteers who have given

media regarding many aspects of climate science? How can this be remedied?

Yes, most certainly. The whole international climate science community is working to provide the best quality science and scientific advice to all. This is a major and ongoing challenge in the face of much attention and media focus on climate change issues over the last decade or so, and in an environment where some people now hold very polarised views about climate and climate change based on very few facts and a lot of hype. In some countries, the challenge is even greater, as this polarity has reached the stage where changes in government can easily result in a complete swing towards or away from concerns about climate issues, particularly any related to climate change.

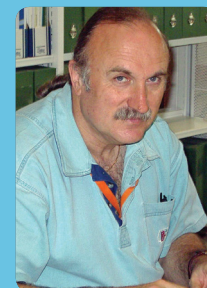
With ACRE, as I have said, we endeavour to produce a better product that can be used for reasoned and informed studies of the climate system, and what any natural or anthropogenic changes in that system might have for civilisation and the planet as a whole.

What do you see as being the future for ACRE?

I am hopeful that we will be able to eventually put ACRE on a more sustainable basis as the results coming from it are taken up and the value

of its activities are realised at the highest levels. I feel that it has already shown what can be achieved by an initiative coming from the 'grassroots' climate community with little funds and staff support, why it is important to engender wider cross-disciplinary engagements and the 'two-way' benefits that come from this, and that there is a vast potential role for citizen science in not just supporting scientific endeavours but in providing citizens with the chance to be an integral part of scientific activities and solutions.

www.met-acre.org



CORE ACRE PARTNERS

- International Environmental Data Rescue Organization (IEDRO)
- University of Southern Queensland, Australia
- Met Office Hadley Centre (MOHC), UK
- US National Oceanic and Atmospheric Administration (NOAA) Earth System Research Laboratory (ESRL) and Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, USA
- National Climatic Data Center (NCDC) of NOAA, USA
- University of Sussex, UK
- The British Library
- University of Giessen, Germany
- University of Bern, Switzerland

thousands of hours of their efforts to the betterment of humanity through our projects. Someday, we hope that governments and those individuals who have funds will consider giving a hand.

Are there any achievements that you are particularly proud of?

We located, rescued and, with the help of NOAA, digitised over 500,000 surface weather observations that were located in a museum in Punta Arenas, Chile, the southernmost city on the planet. These old weather observations were taken by Jesuit priests at a school since the 1850s. Once digitised, these data added a tremendous amount of understanding to the historic weather knowledge in the southern hemisphere. While working on that

rescue program, we found over 500 glass photographic slides dating from the 1870s to the 1920s of glaciers throughout the region. We are now trying to obtain funding to rescue and digitise this climate treasure trove.

www.iedro.org

