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Dear Sir or Madam

I am writing to you as Chairman of the World Climate Research Programme (WCRP) Observation and Assimilation Panel (WOAP), which is also co-sponsored by the Global Climate Observing System (GCOS), to advise you about the state of progress and issues, as well as to encourage your support for the continuing research, development and execution of **reanalyses** of past data into globally gridded products. Atmospheric reanalyses of past observations have greatly improved our ability to determine climate variability. Further improvements to reanalyses, including expansion to encompass key trace constituents and the ocean, land and sea-ice domains, hold promise for extending their use in climate change studies, research and applications. An important unfinished task includes continuing to recover and make available past observations.

The Third WCRP International Conference on Reanalysis held in Tokyo from 28 January to 1 February 2008 was the third in a series of international meetings to showcase results of progress in reanalysis products and research and to discuss future goals and developments. The 260 participants from 21 countries gave 61 oral and 73 poster presentations. A very positive aspect of the conference was the coming together of so many scientists from different areas. A strong contingent of observationalists involved in improving the basic observations was joined by experts in data processing, management, access and archival. Many modelers were present, including those who carry out reanalysis as well as data assimilation experts. Although atmospheric scientists were in the majority at the meeting, a number of oceanographers, land surface and polar experts broadened the discussion of methods and coupled aspects leading to many positive interactions.

A panel discussion on the last day of the conference considered where reanalysis goes next, and a conference statement, which was available in draft form at the beginning of the meeting and open for comments, was approved. I am attaching this conference statement for your consideration. Essentially the statement highlights the developments and progress over the past 20 years, but also recognizes areas where further progress is required and possible. It goes on to point out opportunities that can be taken advantage of with adequate resources for ongoing research and production of improved reanalyses, and the great promise of and need for such improved reanalyses.

I wish to remind you that the importance of reprocessing past data and its reanalysis into products to better describe the climate record has been highlighted in a number of high level fora, with implied commitments made to support these efforts. For instance:

1) GEO Cape Town Declaration (GEO Ministerial Summit 30 Nov 2007)
"… sound policymaking for addressing the environment and sustainable development must be based on understanding, describing and predicting a complex and interdependent world, and therefore requires terrestrial, oceanic, airborne and space-based Earth observations, data assimilation techniques and Earth-system modelling"

2) The Editorial by the GEO Co-Chairs (http://earthobservations.org/) called for **"**A global revolution in Earth management"
Guoguang Zheng, Administrator, China Meteorological Administration;

Conrad Lautenbacher, Administrator, US National Oceanic and Atmospheric Administration;
Philemon Mjwara, Director General, South Africa's Department of Science and Technology;
Zoran Stancic, Deputy Director-General for Research, European Commission

"… Addressing these threats to our common home will require effective national policies plus international collaboration on a grand scale. Global action must always be based on political agreements supported by the best scientific information available, including comprehensive and timely data about the Earth's physical, chemical and biological systems.

For this reason, over 70 governments and administrations, together with more than 40 participating organizations, have joined forces through the Group on Earth Observations (GEO) to build a Global Earth Observation System of Systems that will generate the information we need to understand our rapidly changing planet."

3) GEO 2006 Work Plan and GEO 2007-2009 Work Plan

The GEO Work Plans (and hence Reanalysis Task CL-06-01, see below) have been approved by successive GEO Plenaries in 2005 (Geneva), 2006 (Bonn), and 2007 (Cape Town).

"CL-06-01: *Sustained Reprocessing and Reanalysis Efforts*:
Ensure the development of international mechanisms to coordinate and maintain sustained climate data reprocessing and reanalysis efforts. With regard to the reprocessing of historical datasets (to obtain consistent long-time series of satellite records), make relevant synergies with Task CL-06-02". *This Task is co-led by GCOS, WCRP, and CEOS.*

Related tasks under GEO include
CL-06-02: *Key Climate Data from Satellite Systems;*
DA-07-06: *Data integration and Analysis System;* and
CL-07-01: *Seamless Weather and Climate Prediction System*

In addition, regular reanalysis is cited as a key action in the *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC* of GCOS, and the GCOS Atmospheric Observation Panel for Climate has a major role in atmospheric reanalysis. These international endeavors, with the WCRP on the research side, provide a framework for collaboration of these vital efforts that can provide a better basis for understanding climate change variability and changes in extremes. However, international coordination of these efforts is highly desirable. It is exciting to see so much being planned, and the question is whether adequate resources will be available to realize the promise. We thank you for past support and encourage you to continue to support reanalysis research and fulfill the commitments made.

Yours sincerely,

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Third WCRP International Conference on Reanalysis
Conference Statement

Atmospheric reanalyses have greatly improved our ability to analyse the past climate variability. Further improvements to reanalyses, including expansion to encompass key trace constituents and the ocean, land and sea-ice domains, hold promise for extending their use in climate change studies, research and applications.

The Third International Conference on Reanalysis held in Tokyo from 28 January to 1 February 2008 is the third in a series of international meetings to showcase results of progress in reanalysis products and research and to discuss future goals and developments.

Reanalysis of atmospheric observations using a constant state-of-the-art assimilation model has helped enormously in making the historical record more homogeneous and useful for many studies. Indeed in the twenty years since reanalysis was first proposed, there have been great advances in our ability to generate high-quality temporally-homogeneous estimates of the past climate. The World Climate Research Programme (WCRP) and the Global Climate Observing System (GCOS) have provided continuing leadership in promoting the underpinning research and observational needs for reanalysis. With the ongoing development of analysis and reanalysis in the ocean, land and sea ice domains, there is huge potential for further progress and improved knowledge of the past climate record.

The climate record is made up of analysis of observations taken for many other purposes, such as weather forecasting in the atmosphere, or core oceanographic research. It is now recognised that global climate can only be understood by ensuring that there are climate-quality observations taken in the atmosphere, ocean and land surface including the cryosphere. A consequence of past practices is that the climate record often displays biases that mask long-term variations. Many climate data sets are inhomogeneous: the record length is either too short to provide decadal-scale information or the record is inconsistent owing to operational changes and absence of adequate meta-data. Hence major efforts have been required to homogenize the observed data for them to be useful for climate purposes.

GCOS has specified the GCOS Climate Monitoring Principles (GCMP) that should be followed by all agencies wishing to contribute to the climate record. The GCOS Implementation Plan (2004) recognises the importance of both *in situ* and satellite data in providing global coverage of the atmosphere, ocean and land. It is encouraging to note that the Committee on Earth Observation Satellites (CEOS) has prepared its Response to the GCOS Implementation Plan, which describes its proposed actions to ensure that future climate-related satellite missions yield climate-quality data. Global analyses are an essential tool to enable the optimal use of global Earth observations in a number of the domains covered by the Group on Earth Observations (GEO); indeed reanalyses for climate along with the improvement of corresponding observation data sets are identified as a specific GEO Work Plan task. Further, the GCOS Plan describes the required actions to improve the future climate data and it includes strong support for reanalysis of the past record using state-of-the-art analysis systems. However, progress in implementing the Plan has not been as great as hoped.

Global reanalysis of the climate system requires substantial infrastructure and intellectual resources to establish and enhance the basic database of observations, to carry out the computations, to analyse the output to ensure the quality of the products, and to archive and distribute the products, but it can often draw on much of the infrastructure and other resources established for global numerical weather prediction. Climate and weather prediction research and applications have benefited enormously from the products of atmospheric and ocean reanalysis, and so the support of the sponsors of reanalysis has been well rewarded.

The products of global reanalysis have provided the basis for advances in many areas, including providing the essential foundation for an accurate assessment of current climate ("climate nowcasts"), diagnostic studies of features, such as weather systems, monsoons, El Niño-Southern Oscillation, and other natural climate variations, seasonal prediction, and climate predictability. Moreover, the basic assimilation and prediction systems are improved as deficiencies are identified and corrected by applying them both in reanalysis and routine weather and climate prediction. Global reanalysis is also the foundation for regional reanalysis projects and downscaling where detailed climatologies can be prepared to support studies of local climate and climate impacts. There has been some progress in the use of reanalysis to investigate the difficult problem of the detection and attribution of long-term climate trends and variability. Reanalysis in the ocean and atmosphere has helped identify and correct deficiencies in the observational record, including the recovery of additional observations.

Trace constituents of the atmosphere influence the thermodynamics and dynamics of climate through both short-lived constituents, such as aerosols (tiny particulates) and ozone, and longer lived gases, such as carbon dioxide and methane. As assimilation techniques for observations related to these constituents are refined and extended, it is expected that reanalysis will eventually provide the means to develop consistent climatologies for the chemical components of the atmosphere, including the carbon cycle, and thus help to address key uncertainties in the radiative forcing of climate, as identified for example in the recent Fourth Assessment Report of the IPCC.

While the origins of reanalysis have been in atmospheric climate and weather, there have been significant studies of reanalysis (or synthesis) of ocean data. Because of the limited size of the historical ocean data sets, it has been necessary to develop novel techniques for increased homogeneity of ocean reanalysis. Other promising developments are occurring in sea ice, Arctic, and land surface reanalysis. There has also been initial development of coupled atmosphere-ocean data assimilation, which is laying the foundation for future coupled reanalysis studies that may lead to more consistent representations of the energy and water cycles. A challenge is to improve estimates of uncertainty in the reanalysis products.

Global atmospheric reanalysis results in high-quality and consistent estimates of the short-term or synoptic-scale variations of the atmosphere, but variability on longer time scales (especially decadal) is not so well captured by current reanalyses. The primary causes of this deficiency are the quality and homogeneity of the fundamental data sets that make up the climate record and the quality of the data assimilation systems used to produce reanalyses. However, research into bias corrections and advanced reanalysis techniques is showing promise, and further reanalysis efforts are needed.

Improvements in reanalysis depend upon continuing support for the underpinning strategic research, the development of comprehensive Earth system models required to expand the scope of reanalysis, and for the infrastructure for data handling and processing. The magnitude of the resources required for global reanalysis is such that only a small number of centres of expertise are expected to be able to support the whole process. Moreover, there needs to be continued close cooperation among these centres, as well as the broader community involved in aspects of global reanalysis, to ensure that the global benefits are maximized and that each new reanalysis learns from the knowledge gained from all the previous efforts. In particular, future global reanalyses should be coordinated and, if possible, staggered to ensure that the basic observational data record is improved before each reanalysis, and so that there is time to analyse and hence learn from the output of the past efforts. Reanalysis centres and sponsors should continue to be responsive to user needs.

Reanalysis has proved to be as valuable for monitoring climate, climate research and applications as was believed when it was proposed twenty years ago. However, as the scope of global reanalysis grows, the research effort needed to optimise the benefits is so large that international cooperation will be essential. Further challenges remain and we urge sponsors to continue their support for further reanalysis efforts in all domains spanning the instrumental record, and for the climate system as a whole.

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