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REPORT FROM THE WORLD CLIMATE RESEARCH PROGRAM (WCRP)

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This document provides an update on the WCRP structure, activities, challenges and opportunities pertinent to CGMS.

A new WCRP Data Advisory Council (WDAC) has been established, with a role to coordinate data aspects within the program and partner organization. The WDAC includes a member from the CGMS community, which facilitates the coordination of WCRP-CGMS relevant matters.

The WDAC identified a future ECV inventory as an important tool for climate research. The WDAC also emphasized the advantages of collaborative efforts between research and operational groups in the transitions of research data sets into operational environments and SCOPE-CM

Regional satellite products are increasingly used for climate monitoring, modeling and assessment, in particular within the WCRP Coordinated Regional Climate Downscaling Experiment (CORDEX).

The WCRP 4th International Reanalysis Conference concluded that the reprocessing and intercalibrations of observed records (e.g. through GSICS) are critical to improve the quality and consistency of reanalyses. The continuing support of CGMS Members to these activities, including through SCOPE-CM and GSICS, is therefore essential.

Actions/Recommendations proposed:

ACTION: CGMS to confirm the designation of the WCRP Data Advisory Council EUMETSAT representative as the CGMS liaison with WCRP for matters related to WCRP's need for and provision of climate data (Due date: CGMS-40):
RECOMMENDATION: CGMS Members to support WCRP activities (such as reanalyses) by ensuring the continuous provision of data products (such as those from SCOPE-CM) and (fundamental climate) data records (such as those from GSICS):
RECOMMENDATION: CGMS to facilitate the harmonization between the GOSIC and CEOS/CGMS/WMO Architecture initiatives that would provide a composite ECV inventory of in situ and satellite observations:
RECOMMENDATION**:** CGMS Members to consider contributing global and regional observational data sets to the Earth System Grid (ESG) so as to further facilitate model-data comparisons for climate monitoring, modelling and assessment.

Report from the World Climate Research Program (WCRP)

1 INTRODUCTION

Satellite data represent an invaluable source of information to study climate variability and change. Earth observations, and meteorological data transcend and support the many research activities of the World Climate Research Program covering all land, ocean, atmosphere and cryosphere domains. Observations are used for model initialization, model evaluation, process studies, etc. In this regard, the role of the atmospheric data in climate research cannot be overstated. Satellite meteorological data in particular are critical to the success of the WCRP's mission.

2 WCRP UPDATE

The WCRP Joint Scientific Committee (JSC) has finalized the new structure for WCRP with the four pillars (the four WCRP core projects) focussed on key climate interactions and the Grand Challenges serving as integrating themes. Modeling groups cover the various time scales from weather to climate. The WCRP Modeling Advisory Council (WMAC) and WCRP Data Advisory Council (WDAC) serve as single entry point for resp. modelling and resp. data aspects of the program.

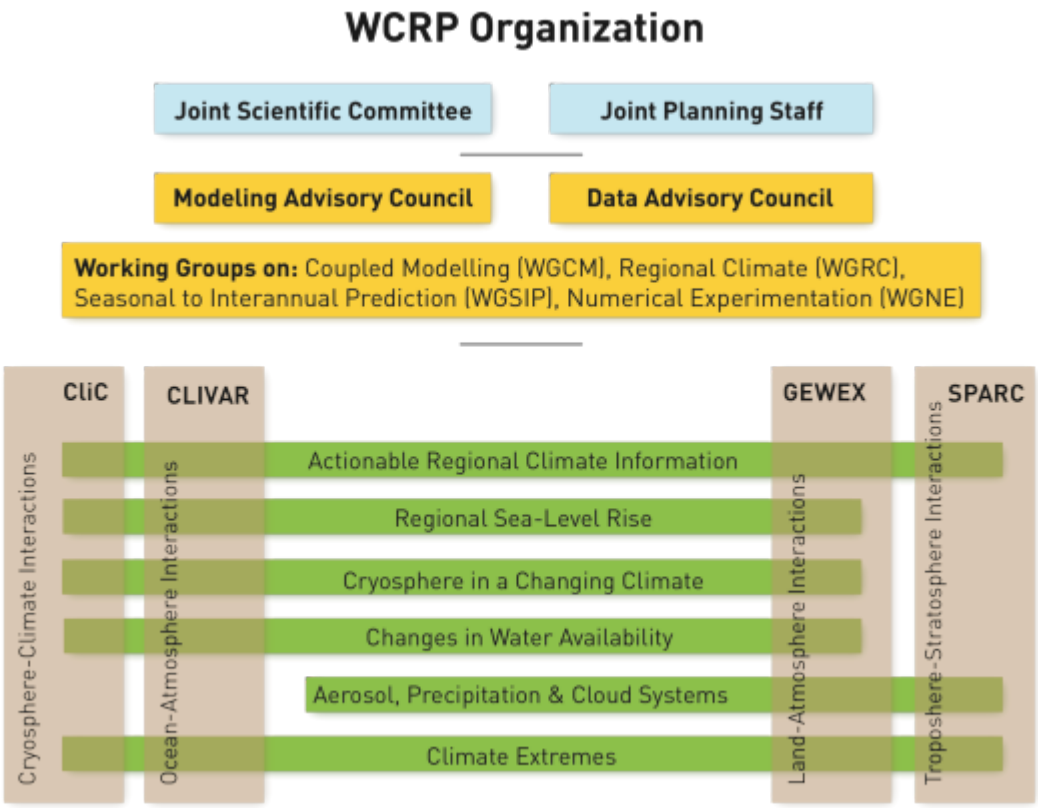

Fig. 1: WCRP new organizational structure (pending final titles of Grand Challenges).

Grand Challenges are comprised of research efforts that are likely to demonstrate significant progress in the next 5-10 years. The Grand Challenges will be used to integrate the outcome of scientific activities which will be supported by the WCRP core Projects.

The WDAC and WMAC have met for the first time the day before the JSC. A Working Group on Regional Climate (WGRC) that would serve to coordinate regional climate efforts across the whole programme is currently being established. Regional aspects of the WCRP Grand Challenges will be managed by the responsible WCRP projects where applicable. WGRC will act as a main interface with the Global Framework for Climate Services (GFCS).

Major recent WCRP activities include the Open Science Conference in Denver in October 2011, the CMIP5 Analysis Workshop in Honolulu in March 2012, the CORDEX South Asia Planning Meeting Workshop in Pune in February 2012, the Workshop on Stratospheric Sudden Warmings in February 2012 in Kyoto, the Planet Under Pressure Conference in London in March 2012, the Polar Climate Predictability Initiative Workshop in Toronto in April 2012, and the 4th International Reanalysis Conference in Silver Spring, MD, in May 2012.

The full report of the JSC 33rd session in Beijing is available at http://www.wcrp-climate.org/documents/JSC33_Report_Final.pdf.

3 WCRP DATA ADVISORY COUNCIL

The WDAC held its 1st meeting in Beijing on 16 July, in conjunction with the WCRP JSC 33rd session the same week. The council sought some adjustments to their terms of reference (see Annex 1). The SCOPE-CM collaboration between research and operational groups on the transition of data sets was highlighted. This initiative was worthy of wider participation by WCRP projects, and significant scientific support from WCRP was needed to make the operational processing tasks successful. The Council also reviewed the plans for an inventory of Essential Climate Variables (ECVs) proposed at the recent meeting co-sponsored by WCRP and GCOS in Frascati and to be hosted at NCDC within GOSIC. The council noted similar developments within the CEOS/CGMS community and assigned a subgroup of its members to facilitate the harmonization between the GOSIC and CEOS/CGMS initiatives that would provide a composite inventory of in situ and satellite observations. NCAR has developed the Climate Data Guide (http://climatedataguide.ucar.edu - CDG) that has been initiated to be “the go-to source for scientifically sound information and advice on the strengths, limitations and applications of climate data”. The platform contains a lot of useful information and comments on existing data records and would benefit from objective assessments to suitably complement the inventory.

The report of the 4th WCRP International Conference on Reanalyses indicated a distinct need for international coordination of the input observations (in situ and remotely sensed and covering atmosphere, ocean and land) for climate reanalyses. Given the complexity and depth of the issues involved, the WDAC finds that an appropriate way forward is to develop a proposal for a WCRP co-sponsored

workshop addressing these issues which would likely be planned within about 2 years at ECMWF. The WDAC would take responsibility for organizing the next reanalysis conference that would most likely be held in Europe within 4-5 years.

The Earth-System Grid Federation (ESGF) is the primary repository for the Coupled Model Intercomparison Project 5 (CMIP5) data. NASA presently hosts relevant satellite-based datasets for model evaluation (i.e. like-variables in the same format as the CMIP model output) on their ESGF Portal (esg-gateway.jpl.nasa.gov). This activity developed in concert with PCMDI and now termed Obs4MIPs, can facilitate the evaluation of global climate models and provide useful observation-based metrics information for the Climate Metrics Panel. NASA has formed an Obs4MIPs Science Working Group that includes membership from PCMDI and NOAA, and is seeking inputs from ESA-CCI, EUMETSAT and CEOS WG. Included in the discussion of the expansion of the Obs4MIPs activity is the addition of ARM in-situ observations as well as reanalysis products. Some reanalyses, such as MERRA are already available and permission is given for additional reanalyses to be included as part of the ongoing effort called Ana4MIPS. Additional information Obs4MIPs can be found at the activity's home page http://obs4mips.llnl.gov:8080/wiki.

The WDAC was also already planning for its next meeting that would include on the agenda a wider discussion of the Earth System Grid and possible need for further governance.

The full WDAC report is available from http://www.wcrp-climate.org/reports.shtml.

4 WCRP 4TH INTERNATIONAL REANALYSIS CONFERENCE – KEY RESULTS

The World Climate Research Programme (WCRP) International Conference on Reanalyses (ICR4) held on 7-11 May 2012 in Silver Spring, Maryland, provided an opportunity for the international community to review observational and modeling research, as well as process studies and uncertainties associated with reanalysis of the Earth system and its components. Presentations and the WCRP published Conference report with a listing of all authors and contributors are available at: http://icr4.org/.

Atmospheric, oceanic and land reanalyses have become fundamental tools for weather, ocean, hydrology and climate research. They continue to evolve with improvements in data assimilation, numerical modeling, and observation recovery and quality control, and have become long-term climate and environmental records. Reanalyses are natural integrative tools, yet coupling the components of the Earth system in reanalyses remains a challenge.
Observations are the key resource in producing reanalyses, and improvements in algorithms and quality control are still advancing. Additional challenges remain to account for model bias as new data are assimilated and the observation record evolves (e.g., new instruments replace old ones). These issues are especially important for using reanalyses in climate research. Extending the reanalysis record back in time is a fundamental need of the weather and climate research community.

The importance of observing systems cannot be overstated, especially in the

stratosphere and deep ocean to anchor the reanalyses. Assessing robust observational and model error covariances, preferably varying over time, is complex and expensive. While many producing and research agencies have developed and investigated bias correction methods, it should be stressed that both models and data contain biases. Preliminary results indicate the potential benefit of coupling the ocean and atmosphere domains for improved forecasts and reanalyses. Data assimilation is also helpful in designing observing systems and in identifying erroneous data but should be consistent with the processes it aims to resolve and requires appropriate model development for that purpose. Air-sea fluxes and deep-sea circulation remain challenging quantities to be estimated. Given the discontinuous nature of the observational record, data assimilation techniques will be the primary way to develop more temporally continuous reanalysis output data.

As the reanalysis system assimilates observations, the output includes the assimilated observations, as well as the forecast error and the analysis error (so-called feedback files). These reports quantify how the observations were used, and have in turn, been used to identify and correct problems with radiosonde stations. Such data also exist for the satellite radiances and other forms of conventional observations. It seems quite possible that other observing systems may benefit from evaluation with the feedback files.

In situ observations are fundamental to reanalyses in many aspects and vice-versa. They complement the remote sensing network and provide reference data sets for calibration, validation and bias correction purposes. Reanalyses would benefit from a greater range of high quality monitoring products for validation purposes such as those from archives (ICOADS, IGRA, ISTI, etc). Reanalyses are used to identify and correct particular data sets, such as those from radiosondes. The identification of breakpoints in data time series is critical to the success of adjustment methods and subsequent derivation of climate trends.

Remote sensing provides useful input data for reanalyses, mostly for the last three decades; however, older imagery might be exploited as well with ad-hoc processing. Yet, satellite data present some unique challenges. They require intercalibration and regular reprocessing. Spectral response functions may require corrections as well. Climate data records are becoming available to the scientific community. A proper long-term evolution of forcing fields is important for all pilot reanalyses.

There is a move towards using reanalyses for monitoring some aspects of the climate. The potential value of reanalyses in this respect is great. However, there are still some considerable limitations regarding long-term monitoring that do need to be addressed. These are mainly temporal homogeneity across the entry and drop out of various observing systems [e.g., Advanced TIROS Operational Vertical Sounder entry in 1997], and balancing the water budget especially over the oceans. Used with caution, reanalyses are highly valuable as long-term records and it is recognized that some level of review may be useful to provide context for future use as monitoring products.

Reanalyses will most likely increase in number and complexity in the coming years. Incorporating reanalyses in improved data systems, such as the Earth System Grid designed to facilitate the Intergovernmental Panel on Climate Change assessments,

would also facilitate the comparisons among reanalyses and independent observations, and would shed more light on the quality and variability among reanalyses. International coordination across the disciplines and centres is needed to improve communications across the community of users and developers. In addition, input observations are improving and increasing (through data rescue efforts), and reanalyses projects need clear guidance on the latest developments in the observations community.

Amongst the four recommendations of the conference:

Reanalyses, Observations and Stewardship

While the observational records have been greatly improved since the first reanalyses through research, reprocessing and homogenizations, research and improvements continue their development. Reprocessing and intercalibrations of observed records are critical to improve the quality and consistency of reanalyses. In situ and satellite data need to be found, rescued and archived into suitable formats to extend the reanalysis record back in time. Reanalysis system data for the atmosphere, ocean, cryosphere, land, and coupled earth system are needed that maximize the use of observations as far back as each instrumental record will allow. It is important for the observational data developers and reanalysis developers to maintain communication, so the latest observations are used in reanalyses, and also that the output of reanalyses may contribute to the understanding of the observations. Such an endeavor should be coordinated at an international level.

The full report is available at http://www.wcrp-climate.org/documents/ICR4_Report.pdf.

5 REGIONAL CLIMATE DOWNSCALING: MODEL EVALUATION

Despite recent advances in the horizontal resolution of most global climate models, there are still limitations in their ability to represent important local forcing features, such as complex topography, land surface heterogeneity, coastlines and regional water bodies, all of which can modulate the large-scale climate on regional to local scales. Coarse resolution also precludes an accurate description of extreme weather events, which are of fundamental importance in assessing the societal impact of changes in climate variability.

The goal of the Coordinated Regional Climate Downscaling Experiments (CORDEX) is to foster an international coordinated effort to produce improved regional multi-model high-resolution climate change information and related uncertainties. The framework is facilitating the evaluation and where possible the improvement of Regional Climate Downscaling (RCD) techniques for use in regional climate projections over many regions worldwide, and the provision of input to Vulnerability, Impact and Adaptation (VIA) work.

Many of the CORDEX regions are self-organizing already and are developing matrices of regional climate change projections. However, in a number of regions of the world, access to reliable regional climate change information is extremely limited. One

example is Africa. It is in these regions that the collaboration developed through CORDEX is expected to bring the largest benefits. With this in mind the international community decided to target Africa for an intensive collaboration. Such cooperation is already producing a significant matrix of African climate change projections, both to support the 5th Assessment report of the IPCC (IPCC AR5) and to provide useful climate information to decision-makers involved in African climate risk management and adaptation planning.

The figure below illustrates the use of observations and derived products in the validation of Regional Climate Models. The Global Precipitation Climatology Project (GPCP, version 1.1, 1998-2010) satellite-gauge combinations covers the entire African domain with a 1° spatial and daily temporal resolution. TRMM-3B42 precipitations include precipitation rates from precipitation radar, microwave imager and their combination. Details can be found in Nikulin et al, J. Clim, 2012).

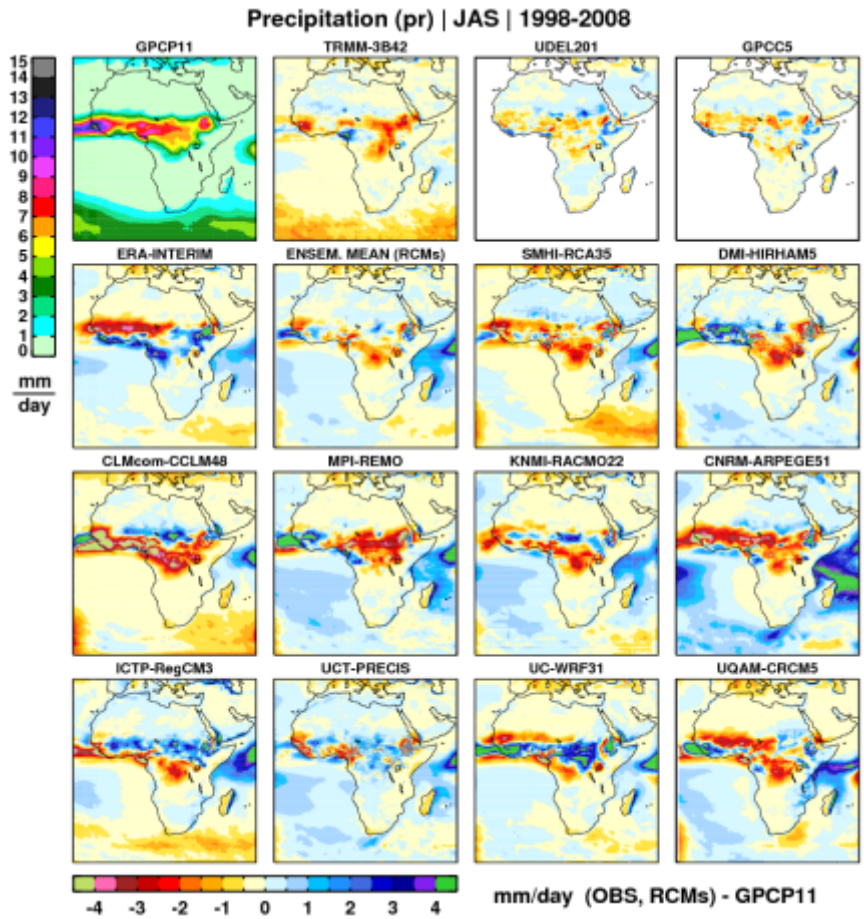

Fig. 2: CORDEX multi-model data available for Africa. From Top to bottom and left to right: Observed mean July-August-September precipitation for 1998-2008 (GPCP11) and differences compared to other observations (TRMM-3G42, UDEL201, GPCC5), the ERA-Interim reanalysis, Regional Climate Models (RCM) ensemble average and the individual RCMs.

6 CONCLUSION: SUGGESTED ACTIONS/RECOMMENDATIONS

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RECOMMENDATION: CGMS Members to support WCRP activities (such as reanalyses) by ensuring the continuous provision of data products (such as those from SCOPE-CM) and (fundamental climate) data records (such as those from GSICS)

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Annex I

WCRP Data Advisory Council - Terms of Reference

Mandate

A combination of climate observations and models are resulting in significant amount of data and information. Research on and development of Earth observing systems, models and field experiments comprise an intrinsic part of WCRP activities and contribute to continuation and expansion of global environmental monitoring. Every WCRP project develops data and information and has a set of observation activities. The WCRP Data Advisory Council (WDAC) will act as a focal point for all WCRP data, information, and observation activities with its sister programmes, and will coordinate their high-level aspects across the WCRP, ensuring cooperation with main WCRP partners such as GCOS and other observing programmes. WDAC will work with the WCRP Modelling Advisory Council to promote effective use of observations with models and to address issues related to the coordinated development of data assimilation, reanalysis, Observing System Sensitivity Experiments, and paleoclimatic data and their assessments.

Terms of Reference:

- To serve as a focal point for observations and data in WCRP;
- To advise JSC and coordinate with WCRP Projects and Working Groups on issues pertaining to observations and climate data;
- To promote research using sustained observations and data from process studies across the WCRP;
- To promote assessment of the adequacy of sustained observations and derived products to support climate research,
- To promote assessment of gaps in the global observing system in cooperation with observation programmes;
- To promote coordinated assessment and comparison of climate-data products, including those from reanalyses,
- To promote research for continuing improvement in the processing and reprocessing of climate data,
- To promote development of mechanisms for archival and preservation of, access to and analysis of data, and associated meta data;
- To promote standards for product generation, including global and regional reanalyses,
- To promote development of coupled data assimilation and a coordinated approach to reanalysis across all domains.

Meeting schedule:

The Data Council meets annually and reports to the subsequent JSC session and partner programmes. Dates will be chosen by consensus of membership.

Membership:

Members will be appointed by JSC for a 3-year term with a possibility of two 2-year extensions:

- Chair and vice-chair (both independent);
- Representative from each of the 4 projects (SSG nominates, JSC confirms);
- Representative from each of the 3 GCOS panels (chairs or their nominees);
- Representative of the WCRP Modelling Advisory Council;
- Representative from the Working Group on Regional Climate;
- Representative of IGBP (IGBP SC nominates);
- Representative of SOLAS (SOLAS SSC nominates);
- Representative of CEOS (chair or vice-chair of WG Climate);
- Representative of CGMS (CGMS secretariat nominates);
- Representative of PCMDI (PCMDI nominates, JSC confirms).

All representatives are *ex-officio* appointments representing their respective organizations. Other international agencies and observations coordinating bodies may participate as observer members of the Council.

Mode of functioning:

The WCRP Data Advisory Council is expected to:

- Communicate regularly by email, teleconference or videoconference;
- Meet in person, annually as a minimum;
- Encourage joint meetings of working groups and/or panels to promote communication or to launch focused joint initiatives.

WDAC should have the flexibility and resources to promote action within existing WCRP projects and panels or by appointing limited duration task teams to accomplish its tasks.

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