

4th WCRP International Conference on Reanalysis

7-11 May 2012, Silver Spring MD

Full Agenda with presentations and posters
is available at: <http://ICR4.org>

ICR4 Objectives

1. Sharing understanding of the **major challenges facing reanalyses**: the changing observing system and Integrated Earth system.
2. **Assessing the state** of the disciplinary atmospheric, ocean and land reanalyses, including the needs of the research community for weather, ocean, hydrology and climate reanalyses.
3. Reviewing the **new developments** in the reanalyses, models and observations for study of the Earth System.
4. Exploring **international collaboration** in reanalyses including its role in regional and global climate services.

Program Committee

- Michael Bosilovich, Chair, NASA/GMAO, Maryland, USA
- Ghassem Asrar, WCRP JPS, WMO, Switzerland
- Gilbert Compo, University of Colorado, NOAA/ESRL, Colorado, USA
- Dick Dee, ECMWF, UK
- Bart van den Hurk, KNMI, Netherlands
- Kazutoshi Onogi, JMA, Japan
- Robert Kistler and Suranjana Saha, NCEP, Maryland, USA
- Roger Saunders, UKMO, UK
- Adrian Simmons, ECMWF, UK
- Detlef Stammer, University of Hamburg, Germany
- Kevin Trenberth, NCAR, Colorado, USA
- Russ Vose, NCDC, North Carolina, USA
- Peter van Oevelen, IGPO, Maryland, USA
- Michael Ek, NCEP, Maryland, USA
- Keith Haines, Reading University, UK
- Ana Nunes, Universidade Federal do Rio de Janeiro, Brazil
- Siegfried Schubert, NASA/GMAO, Maryland, USA

Sessions

Monday, 7 May 2012

Status and Plans

Atmospheric Reanalyses

Tuesday, 8 May 2012

Integrated Earth System Analysis

Ocean and Sea Ice Reanalyses

Wednesday, 9 May 2012

Land Reanalysis

Data Assimilation

Thursday, 10 May 2012

User Applications | In Situ Observations | Remotely Sensed Observations

Friday, 11 May 2012

Advancing Reanalyses

Agency Priorities Panel Discussion

Keynote: Adrian Simmons

Ongoing business remains challenging and important

- recovery of observational data from past years
- improvement of assimilating models
- improvement of assimilation methods, including the treatment of model error
- developing longer-window data assimilation, in which reanalysis can benefit from additional observations made after the analysis time

And there are questions to be asked

- should we expect a single method to be optimal across the centuries?
- how quickly and fully should coupling be introduced with the ocean circulation, with atmospheric chemistry, ...?
- should global producers **provide** global downscaling to higher resolution?

To what extent is international coordination needed?

- ***development of input datasets*** (observations, forcing fields, emissions, ...)
- over timing of mainstream production - **Output data requirements**
- over running of supplementary data assimilations and model integrations
- over linking of activities with climate modelling (**ESG-ongoing**)
- ***Contributions to State of the Climate***

and how formal can or should this be?

Status and Plans

- GMAO - Developing IESA components; Innovations quick look
- NCEP - CFSRL underway with noted improvements - Hybrid 3D-V EnKF
 - Collaborations with GMAO on Assim. e.g. cloud affected radiances
- ESRL - Sfc based reanalysis shows skill throughout the Trop., need long record - extremes and CMIP5
- JRA **go go!** shows improvement - planned are a family of experiments

Status and Plans Cont.

- ECMWF - ERA CLIM - Building a succession of reanalyses - ensemble model, pressure, land, satellite era
- Ocean Reanalyses - Thriving - data record issues, new data opportunities GRACE, SMOS Aquarius
- Are there too many? No
- When to run a new reanalysis? If a development represents a contribution beyond current capability

Atmospheric Reanalysis

- **Arctic Studies** shows variability among global reanalyses; uncertainty
- **Regional Modeling and Reanalysis**
 - Ensemble mean provides some additional benefit, uncertainty
 - Systematic bias in the forcing reanalysis can have adverse impact on regional downscaling
- **Reanalyses initialize model simulations**
 - Can expose errors in GCMs
 - Need assimilated obs (**and Innov./Feedback**)
 - Better characterization of reanalysis uncertainty
- **An underlying objective of reanalysis is to improve the background models**

Integrated Analysis

As reanalyses have evolved a broad range of Earth system research activities are growing

- Aerosol - Sulfate, pollution, fire assimilated and interacting - Increments provide assessment
- Land - SM, Snow, T - Coupling strength
- Isotope - Proxy modeling for Paleo
- Arctic - need to get at the rapid changes in sea ice - Glacier mass budgets

Ocean Reanalyses

- A large number of ocean reanalyses are being produced - ensembles have benefit
- Need to control biases, but how:
 - e.g. bias correcting forcing data, variational correction via EnKF
- Biases also affected changing observing system, how to address the radical variations of the ocean observations
- Historical reanalyses El Niño looks promising; High ensemble skill
- Resolution may improve MOC

Land Reanalysis

- **Precipitation bias correction** of atm reanalysis needed for hydrologic application
- ET from recent global reanalysis products, e.g., CFSR, MERRA, MERRA-Land, ERA-Interim, JRA, can be useful in land-atmosphere coupling studies.
- Hourly surface data should have benefit, resolve the diurnal, evaluate parameterizations
- NCEP CFSR GLDAS replay to improved spin-up initial conditions and one continuous simulation to support the proposed Global Drought Monitor activities.
- Full assimilation: soil moisture, snow, temperature to be realized; but subject to observing system variations

Data Assimilation

- emerging hybrid Var/EnKf, but also other, non-Gaussian techniques such as Particle Filters being explored
- some potential identified in ocean-atmosphere coupling
- stratosphere/mesosphere and deep ocean: poorly observed, need some "anchoring"
- model and obs covariances: many open questions (background, update, inflation, localization, multivariate, balance)
- bias correction: several methods but noted both models and obs have biases
- implementation specifics: cycling method matters, new systems have probs with older data
- seamless nesting to work across scale with heterogeneous grids

User Applications

- Examples were presented:
 - drought
 - precipitation extremes
 - tropical cyclones
 - climate projections
 - regional downscaling
 - reprocessing surface temperature
 - wind farm investment and reinsurance

But there exist discrepancies between reanalyses, need to factor this into the decision making

Given the diversity of research, sharing knowledge is critical, not just peer review, but reanalysis.org wiki and climatedataguide.ucar.edu become crucial

In Situ Observations

- Homogenization of radiosondes has had tremendous positive impact, further developments are crucial
- Integrated Global Radiosonde Archive (IGRA): potential to double data base, focus on 'big wins'
- changes in radiosonde hardware and processing sometime difficult to identify
 - humidity homogenization important, but very difficult
- ICOADS input to almost all reanalyses, essential for community; proposing further developemnt
- GRUAN essential because non ref observations have biases, need some redundancy to constrain structural uncertainty and detect trends; How to best use GRUAN?

Remotely Sensed Observations

- Conflicting goals in atmospheric reanalyses
 - time homogeneous data sets
 - utilization of the best newest data sets
 - response: Families of reanalyses
- Reprocessings are critical (e.g. AMV)
- Intercalibrations of radiances (GSICS etc)
- Rescuing early satellite data
- How to make better use of sat data bias estimates?

Next Steps

- Next Conference? 4-5 years, likely Europe
- Other potential meetings?
 - Reanalysis "Summer School"; grad/ECS training
 - User's Workshop - perhaps geared more toward ECS (including assimilated observations)
 - Observations for Reanalyses (symposium/workshop)
- International Coordination (potential)
 - **Input Observations** - share best practices, expertise among all reanalysis developers and data developers
 - Production Output / Processing timing coordination?
 - An "All-things Reanalysis" Panel?
 - State of the Climate - coordinated comparisons - possibly through reanalysis.org / ESG / GDAP?
 - Reanalysis projects should only use data that can be passed through e.g. feedback files

Coordination of Observations for Reanalyses

- Expertise is spread around international community
- Previous committee under WOAP
 - Primary focus – conventional observations (surface stations and sondes)
 - Objectives too broad (everything)
 - Run under WOAP, should be in a panel?
- Representation from development centers, but also observation community (feedback, eg GSICS, radiosondes, ECV Invent.? etc.)
- A central group to share the latest information on all observations assimilated in reanalyses
 - Perhaps a meeting (sym/workshop) could better define this coordination effort

Report

Excellent work from the rapporteurs!

Zeroth Draft review by Rapporteurs - June 14

First Draft reviewed by Program Committee -
June 28

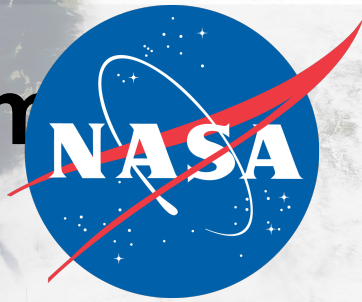
Second Draft to Program Committee - July 13
Last call for comments July 31

Final Draft (Aug 3) will be a WCRP report,
summary submitted to EOS

Acknowledgements

Session	Chair	Senior rapporteurs	Junior rapporteurs
Status and plans	Katzutoshi Onogi Michael Bosilovich Surujana Saha	Jack Wollen Toshiyuki Ishibashi	Margarida Lopes Rodrigues Liberato Joshua Roundy Ma. Gabriela Escobar
Atmospheric Reanalyses	Gil Compo Ana Nunes	Andrea Molod	Aaron Kennedy Linling Chen
Integrated Earth System Ana.	Michael Bosilovich	Rongqian Yang	Shannon Capps Linling Chen
Ocean and Sea Ice Reanalyses	Detlef Stammer Keith Haines	Dave Behringer	Maria Valdivieso Bhuiyan Tanvir Hossain
Land Reanalysis	Michael Ek	Jesse Meng	Craig R. Ferguson Lucho Suarez
Data Assimilation	Dick Dee Robert Kistler	Michel Rixen	S.H.M. Fakhruddin Shannon Capps
User Applications	Siegfried Schubert	Junye Chen	Lucho Suarez Ma. Gabriela Escobar
In Situ Observations	Russell Vose	Kate Willett	Mariana Barrucand Nicole Colasacco-Thumm
Remotely Sensed Observations	Roger Saunders	Paul Poli	Ayan Chaudhuri S.H.M. Fakhruddin
Advancing Reanalyses	Michael Bosilovich	Michael Bosilovich	Nicole Colasacco-Thumm Maria Valdivieso
Agency Priorities Panel Disc.	Ghassem Asrar	Ghassem Asrar	Bhuiyan Tanvir Hossain Ayan Chaudhuri

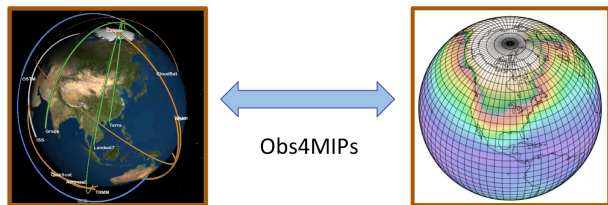
Reanalysis on the Earth System Grid Federation (ESGF)



- The ESGF is the primary repository for the CMIP5 data.
- To enhance this resource, NASA Goddard Space Flight Center has agreed to host a **subset** of the primary reanalysis data on their ESGF Portal in a similar format to the CMIP5 archive. The ESGF portal is managed by the NASA Center for Climate Simulation (NCCS).
- Participating institutions/reanalysis
 - NASA-GSFC-GMAO/ MERRA
 - NOAA-NCEP/ CFSR
 - ECMWF/ ECMWF – Interim
 - JMA/ JRA – 25
 - NOAA ESRL - CIRES/ 20CR
- Data will need to be translated to the CMIP5 format

ESG Impact

- Assess the variance and **uncertainty** of the available variables (consider super ensemble)
- Adjacent to CMIP/AMIP and Obs4MIP, reanalyses can be more easily assessed by users
- Could facilitate a SotC comparison
- Limitations (perhaps OK for a pilot study)
 - Not holding the full set of reanalysis data
 - Reanalysis data consistent definitions?
 - Spatial Res., Temporal Freq.,



Obs4MIPs is a pilot effort to improve the connection between data experts and scientists involved in climate model evaluation. It is closely aligned with CMIP5, with encouragement from the WGCM and WGENE. NASA and the U.S. DOE have initiated the project with significant contributions of appropriate NASA products. An overarching goal is to enable other data communities to contribute data to Obs4MIPs, but guidance and endorsement of this activity is now needed.

for presentation to the
WCRP Data Advisory Group (WDAC)
Prepared June 2012

Datasets are Gridded Monthly Averages – Unless otherwise noted
Separate files containing Nobs & StdErr for each grid cell are available

CMIP Protocol Variables	Data Source	Time Period	Comments
ta - Atm Temp	AIRS (≥ 300 hPa) MLS (< 300 hPa)	9/02 – 8/04 -	AIRS +MLS needed to cover all pressure levels
hus - Specific Humidity	AIRS (≥ 300 hPa) MLS (< 300 hPa)	9/02 – 8/04 -	
tro3 – Mole Fraction of Ozone	TES	2004 -	Undergoing QC checks
tos - Sea Surface Temperature	AMSR-E	6/02 -	SST science team recommends multiple products
rlut, rlutcs, rsdt, rsut, rsutcs – TOA outgoing LW & SW Radiation, Incident SW Radiation	CERES	3/00 -	
clt – Total Cloud Fraction	MODIS	2/00 -	
zos - Sea Surface Height Above Geoid	TOPEX/JASON series	10/92 -	AVISO Product
pr - Total precipitation	TRMM	1997 -	Monthly Ave + 3 hourly products
sfcWind, uas, vas - Surface (10m) zonal wind	QuikSCAT	1999 – 2009	Oceans only. No land products.
Land Surface products (TBD)	MODIS	2/00 -	Perhaps 2 CMIP variables, TBD

Match up of available NASA datasets to PCMDI priority list

Orange datasets are still in process

9



ESG Gateway : Side by Side Archive with CMIP



Recommendation



The screenshot shows the Earth System Grid website interface. On the left, there is a 'Search Categories' sidebar with options like Project, CMIP5, gfdl_test, obs4MIPs, etc. A red box highlights 'obs4MIPs Project' in the main content area. The main content area includes a 'Welcome to PCMDI' message, a search bar, and a 'Status of the CMIP5 Archive' section with various dates and updates. A red arrow points from the sidebar to the highlighted project name.

What role could WDAC play for Obs4MIPs?

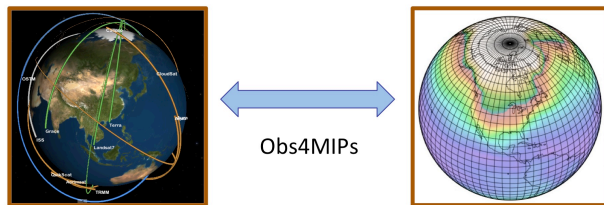
- General oversight on the advancement of Obs4MIPs e.g., via annual updates to WDAC, similar to AMIP/CMIP panels established by the WGENE and WGCM to guide climate model intercomparisons.

WDAC establish an Obs4MIPs panel to:

- Ensure that datasets contributed to Obs4MIPs are appropriate for model evaluation
- Advance guidelines that are used to recommend, select and document the data
- Identify the highest priority observations for model diagnostics and evaluation
- Encourage additional contributions to Obs4MIPs and promote activity

WDAC Obs4MIPs panel membership and organization

- NASA volunteer to chair the group and provide some support for annual meetings, PCMDI volunteers continued support, membership and/or co-chair responsibilities
- Membership should consist of a mix of observation providers and model experts
- WDAC/WCRP to recommend members
- Obs4MIPs to report annually to WDAC and WMAC



Obs4MIPs is a pilot effort to improve the connection between data experts and scientists involved in climate model evaluation. It is closely aligned with CMIP5, with encouragement from the WGCM and WGNE. NASA and the U.S. DOE have initiated the project with significant contributions of appropriate NASA products. An overarching goal is to enable other data communities to contribute data to Obs4MIPs, but guidance and endorsement of this activity is now needed.

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- NASA-PCMDI pilot Project to establish a (satellite) observation capability for the climate modeling community to support model-to-data intercomparison. This involves IT, satellite retrieval, data set, modeling and science expertise.
- ~13 satellite-based datasets currently available on the ESG – more coming; including sea ice, with near-term effort to identify a snow cover, aerosol, additional land and composition products, and CFMIP cloud products.
- We are seeking inputs with CMUG/ESA, have engaged CEOS-Climate Working Group and work closely with the WGNE/WGCM Climate Metrics Panel.
- **A priority now is to increase collaboration with other agencies and international partners to expand this effort and solicit feedback from model analysis community.**
- NASA has formed a Science Working Group, including rep from PCMDI and NOAA to help guide the expansion and direction of this activity. The activity has already expanded to include ARM and reanalysis data sets.

- Identify additional observations to include in this activity.
- Continue to develop cultivate collaboration / data utilization from NOAA and international (e.g. ESA CCI) partner data sets.
- Maintain/Strengthen links to WGCM/WGNE Climate Metrics Panel.
- Continue to work with the ESG community and PCMDI to facilitate the *means* to utilize the observations for model evaluation.
- Encourage satellite and other observing programs to develop products analogous to model output.
- Encourage modeling community to develop the means to output quantities analogous to satellite retrieved or other observed quantities.
- Encourage satellite programs to provide modeling community with satellite simulators for more direct comparisons with observations (e.g. CFMIP).
- Provide guidance on future funding solicitations.
- Cultivate more coherent input from the modeling community on observations critical to model development/evaluation.

Specific areas that present challenges and questions include:

- What observations go into obs4MIPs? *A fundamental criteria is there has to be a 1-to-1 correspondence with a CMIP model output variable. A second criteria is that the product be well documented with peer-reviewed publications, ideally with examples of use for model evaluation.*
- What to do when there is more than one observation product for a given variable – 1) keep it simple for the user and attempt to choose the “best”, 2) select the “best” two to account for some observational uncertainty, 3) select more than two if available but run the risk of the offerings become overly complex for the non-expert. For 1) and 2) – by what criteria is this decided?
- What if the data sets don’t quite match e.g. product is total column (ozone) but CMIP only requests the vertically resolved profile?
- What guidelines should there be regarding update frequency and process?
- Who provides quality control over the technical documentation and data set content?
- Thus far technical documents were made one per variable, in some cases it may be advantageous to document more than one in the same technical note, how is this decided?