Building a Climate Information System

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NCAR
Global warming is “unequivocal”:
Adaptation to climate change

- Assess vulnerability
- Determine impacts of possible changes
- Devise coping strategies
- Plan for future changes

Requires information
Imperative: A climate information system

- **Observations**: forcings, atmosphere, ocean, land
- **Analysis**: comprehensive, integrated, products
- **Assimilation**: model based, initialization
- **Attribution**: understanding, causes
- **Assessment**: global, regions, impacts, planning
- **Predictions**: multiple time scales
- **Decision Making**: impacts, adaptation

An Integrated Earth System Information System
Last meeting late March 2010

http://wcrp.wmo.int/AP_WOAP4.html

Kevin Trenberth
Chair (2004–2010)
WCRP Observation and Assimilation Panel
WCRP/GCOS: WMO/IOC/ICSU
WOAP

WOAP is primarily sponsored by WCRP but is also co-sponsored by GCOS.

WOAP is a coordination Panel in WCRP
Preferred channel for interactions GCOS and WCRP
AOPC, OOPC, TOPC are also co-sponsored by WCRP
WOAP helps to coordinate GCOS panels and issues
WOAP serves to help with GEOSS workplans.

Much material and background docs on WOAP website

Last mtg: March 2010, Hamburg, Germany
TOR for WOAP:

- Identify climate observational requirements
- Help optimize observations
- Act as a focal point for WCRP interactions with other groups
- Promote and coordinate analysis, reprocessing, reanalysis and assimilation
- Promote and coordinate information and data management activities, including web sites.

Observations include those from space platforms.
**WOAP: Key climate issues**

**Climate data records**

- Continuity, continuity, continuity;
- The need for **reprocessing and reanalysis** of past data and coordination of these activities among agencies and variables;
- Includes evaluation results;
- Importance of **calibration, accuracy, benchmarks**;
- Space and in situ observations;

- Reanalysis to produce global gridded fields

**GRUAN, GPS RO, CLARREO**
Large disparities among different analyses

Daily SST (1 Jan 2007)
Reynolds and Chelton 2010 JC

Sea Level
Palmer et al 2010
OceanObs’09

Comparison of GMSL Series

- ΔMSL (mm)
- Year

0-700m Heat Content Anomaly
- Time [years]
- Palmer et al. (2007)
- Smith and Murphy (2007)
- Dominguez et al. (2008)
- Dürre et al. (2008)
- Leckler et al. (2006)
- Willis and Romanowicz (2009a)
- Lyman and Johnson (2008)
- Willis et al. (2004)
The largest factor for ice concentration/extent consistency is intercalibration of the products through transitions through different generations of satellite-borne sensors.
Reanalysis

1. There is not a problem with lack of reanalyses, indeed there is a proliferation. The problems are:
   1. Lack of an end to end program with adequate vetting and evaluation of products (and the funding for that), and
   2. Reanalysis is all done in a research domain and not sustained, so that key personnel can be lost.
   3. Lack of adequate vetting and diagnosis

2. Reanalysis is an essential part of climate services, especially in monitoring, attribution and prediction
Atmospheric Reanalyses

Current atmospheric reanalyses, with the horizontal resolution (latitude: T159 is equivalent to about 0.8°), the starting and ending dates, the approximate vintage of the model and analysis system, and current status.

<table>
<thead>
<tr>
<th>Reanalysis</th>
<th>Horiz.Res</th>
<th>Dates</th>
<th>Vintage</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCEP/NCAR R1</td>
<td>T62</td>
<td>1948-present</td>
<td>1995</td>
<td>ongoing</td>
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<tr>
<td>NCEP-DOE R2</td>
<td>T62</td>
<td>1979-present</td>
<td>2001</td>
<td>ongoing</td>
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<tr>
<td>CFSR (NCEP)</td>
<td>T382</td>
<td>1979-present</td>
<td>2009</td>
<td>thru 2009, ongoing</td>
</tr>
<tr>
<td>C20r (NOAA)</td>
<td>T62</td>
<td>1875-2008</td>
<td>2009</td>
<td>Complete, in progress</td>
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<tr>
<td>ERA-40</td>
<td>T159</td>
<td>1957-2002</td>
<td>2004</td>
<td>done</td>
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<tr>
<td>ERA-Interim</td>
<td>T255</td>
<td>1989-present</td>
<td>2009</td>
<td>ongoing</td>
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<td>JRA-25</td>
<td>T106</td>
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<tr>
<td>JRA-55</td>
<td>T319</td>
<td>1958-2012</td>
<td>2009</td>
<td>underway</td>
</tr>
<tr>
<td>MERRA (NASA)</td>
<td>0.5°</td>
<td>1979-present</td>
<td>2009</td>
<td>thru 2010, ongoing</td>
</tr>
</tbody>
</table>
Global mean precipitation

![Graph showing global mean precipitation from 1980 to 2005 with various datasets representing different data sources like MERRA, MERRA sc, ECinterim, JRA-25, NCEP2, ERA-40 & ECops, and GPCP. The x-axis represents time (year) from 1980 to 2005, and the y-axis represents precipitation (mm/d).]
Ocean to land water vapor transport

Transport

E-P_{ocean}

P-E_{land}

38, 38, 32

35, 22, 57

23, 24

35, 37, 27

27, 50, 36

35, 45, 26

Land Precipitation 120

Evaporation, transpiration 81

Units: Thousand cubic km for storage, and thousand cubic km/yr for exchanges
An Informed Guide to Climate Datasets with Relevance to Earth System Model Evaluation

Objectives:

• Evaluate and assess selected climate datasets
• Provide “expert-user” guidance addressing strengths & limitations
• Fills and major community gap and an immediate need

Features:

• Facilitate and enhance access to relevant datasets for diagnostic analyses and model evaluation (including CMIP5/AR5)
• Web-based guide, including a means for enabling additional informed commentary and datasets outside of our own expertise
• Atmosphere, Ocean, Land, Cryosphere, Biosphere
• Expertise on datasets

NCAR proposal
IESA: US program

- Integrated Earth System Analysis
- Comprehensive reanalysis
  - Trenberth and Olson (1988)
  - Bengtsson and Shukla (1988)
  - Arkin et al. (1993)
  - Trenberth et al (2002; 2006; 2008)
    BAMS; J CL; Eos
  - CCSP/USGCRP SAP 1.3 (2008)

Randy Dole talk Tuesday
Future needs: Observations and Analysis

- Observations: in situ and from space (that satisfy the climate observing principles);
- A performance tracking system;
- Climate Data Records (CDRs)
- The ingest, archival, stewardship of data, data management;
- Access to data
- Data processing and analysis
- The analysis and reanalysis of the observations and derivation of products,
- Data assimilation and model initialization
Future needs: Models

- Data assimilation and model initialization
- Better, more complete models
- Assessment of what has happened and why (attribution) including likely impacts on human and eco-systems;
- Prediction of near-term climate change over several decades: ensembles
- Statistical models: applications
- Downscaling, regional information
- Responsiveness to decision makers and users.
Climate Observations

- Process studies: atmosphere, ocean, land, cryosphere and their interactions
- Sustained observations: the climate record
- Enhanced monitoring

- Analysis, assimilation and data products
- Data stewardship, data access, QC

For JSC 2010: Observations white paper
Role of WCRP

- Advocate **improved observations and analysis** suitable for climate (satisfying the GCOS Climate Monitoring Principles to ensure continuity of record). This especially includes those from space.

- **Data set development**: evaluating observations and promoting global reprocessing and reanalysis. Develop new products and datasets, analytical and diagnostic techniques, high level derived products: for use in understanding and analyzing climate variability and change, and for evaluating models.

- **Mechanisms and modes of variability in climate anomalies**: operational **attribution**, **numerical experimentation** in near real time to allow reliable statements to be made not only about what the state of the climate is, but also why it is the way it is and the mechanisms involved.
Role of WCRP

- **Data assimilation and analysis**: initializing of coupled models for prediction.
- Provide advice on best datasets for various purposes (climatologies and time series) and their merits and limitations. (Error bars are greatly needed.)
- High priority needs are to have assessments of datasets for use in evaluating climate models, and specifically those used in the AR5 IPCC report that will participate in the CMIP5 activity.
Role of WCRP

- Help improve and promote sound data stewardship, including data archiving, management, and access. This includes making sure that climate-related data variables are reaching data archives, and that standards are set for archiving new types of data.

- Help make data accessible and available e.g., through the internet. Promote shared efforts for data quality control.
Climate Information System: WOAP role

- **Observations**: advocating improved observations and analysis suitable for climate (satisfying the climate principles that are designed to ensure continuity of record). This especially includes those from space.

- **Data set development**: evaluating observations and promoting their reprocessing and reanalysis into global fields. Developing new products and datasets.

- **Model datasets**: promoting numerical experimentation

- **Making data available** through the internet.

- **Diagnostics**: developing analytical and diagnostic techniques to process observations and model data, and facilitate their comparison and evaluation. New products.
Climate Information System: WOAP role: continued

- **Attribution**: develop capabilities that contribute to attribution capability via studies and numerical experimentation to allow reliable statements to be made not only about what the state of the climate is, but also why it is the way it is and the mechanisms involved.

- **Predictability and prediction**: PDO, NAO, AMOC; improve initialization of models, improve observations for this purpose; regional models (downscaling).

- **High impact events and extremes**: exploring drought, flooding, precipitation intensity and frequency, hurricanes, storms

- **Model evaluations**: model vs observations; water and energy cycles, forcings
The **challenge** is to better determine:

1) how the **climate** system is changing
2) how the **forcings** are changing
3) how these **relate** to each other (incl. feedbacks)
4) attribution of anomalies to causes
5) what they mean for today, the current and distant future
6) Validate and improve models
7) seamless predictions on multiple time scales
8) how to use this information for informed planning and decision making
9) how to manage the data and **reanalyze** it routinely
10) how to disseminate **products** around the world
11) how to interact with **users** and stakeholders and add regional value

*From Trenberth et al 2002*