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

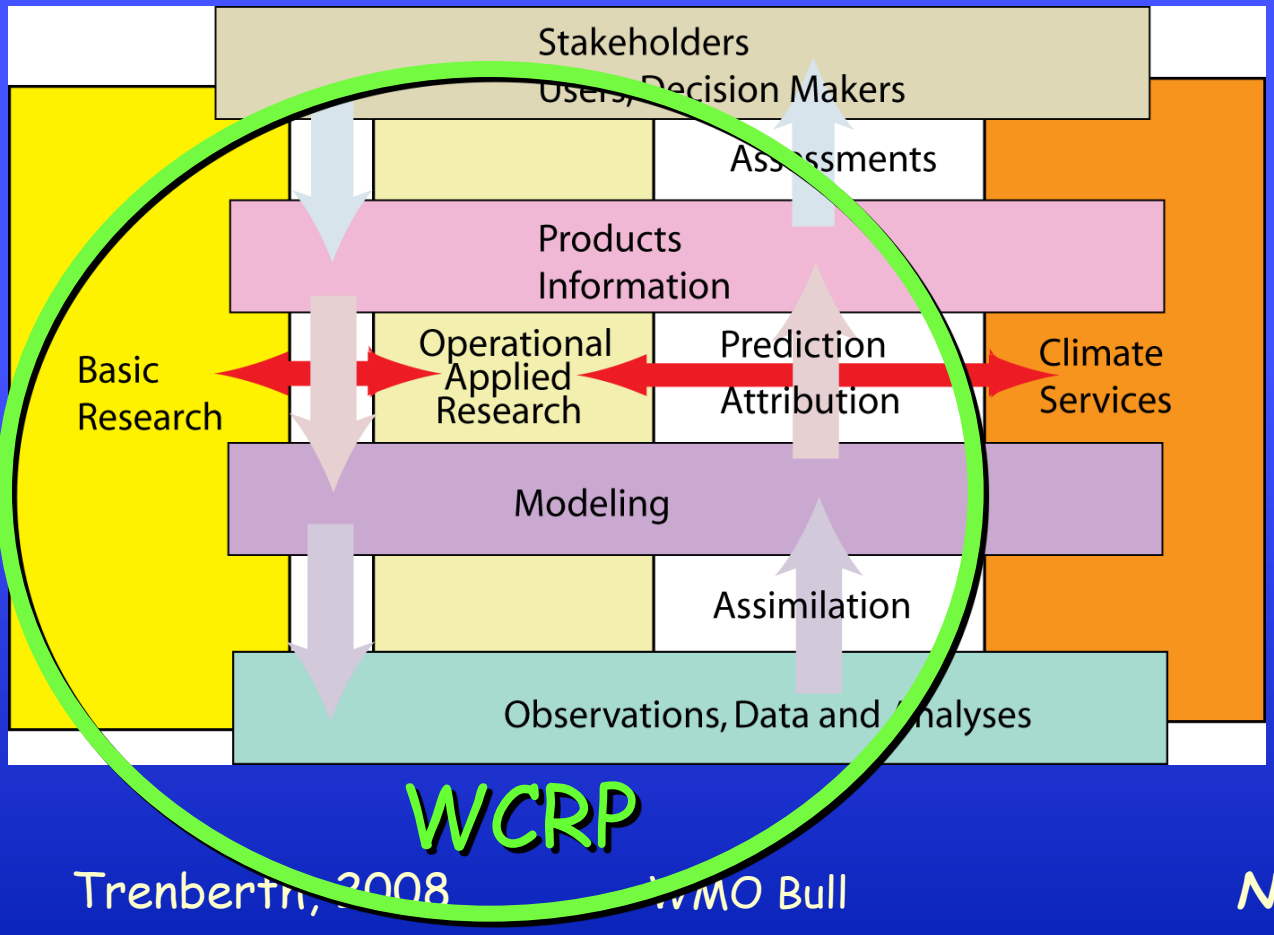
Requires information

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

Climate Information System



Trenberth, 2008 WMO Bull

Nature 6 December 2007

WOAP:
WCRP Observations and Assimilation Panel

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

World Climate Research Programme

WCRP
World Climate Research Programme

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: paraphrased

- 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 of results
- Importance of **calibration**, **accuracy**, **benchmarks**,
- Space and in situ observations;

GRUAN, GPS RO, CLARREO

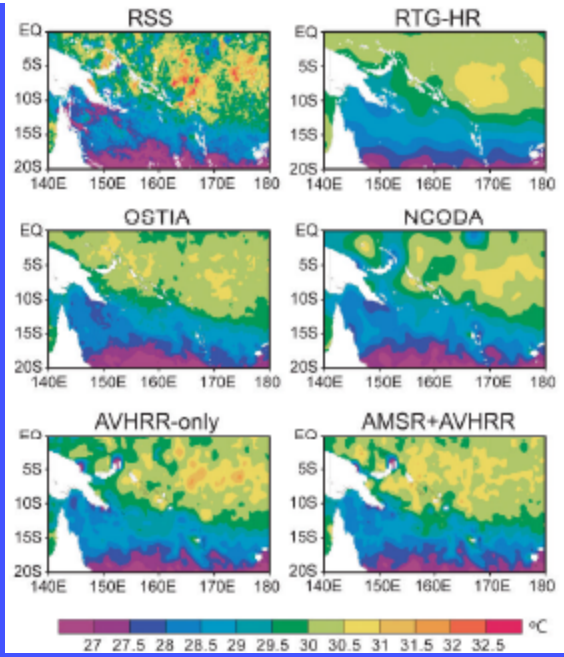
- **Reanalysis** to produce global gridded fields

WCRP World Climate Research Programme

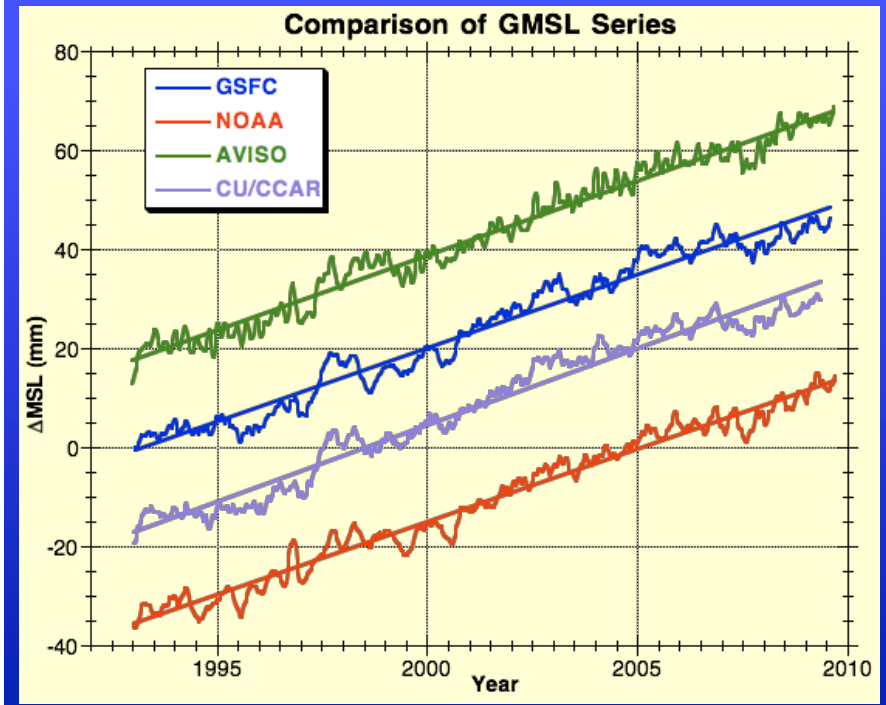
Large disparities among different analyses

Daily SST (1 Jan 2007)

Reynolds and Chelton 2010 JC

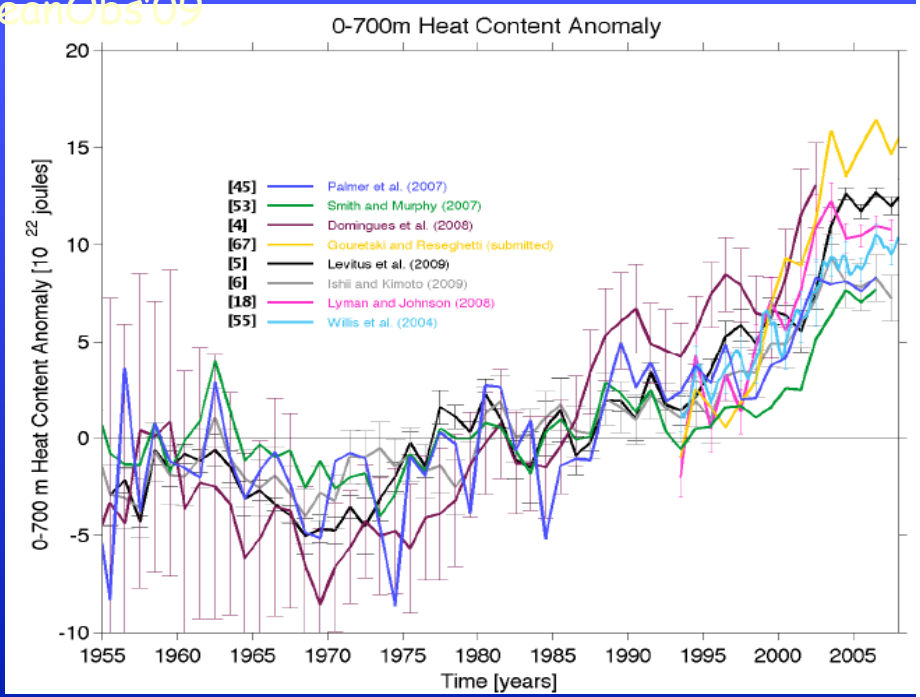


Sea Level

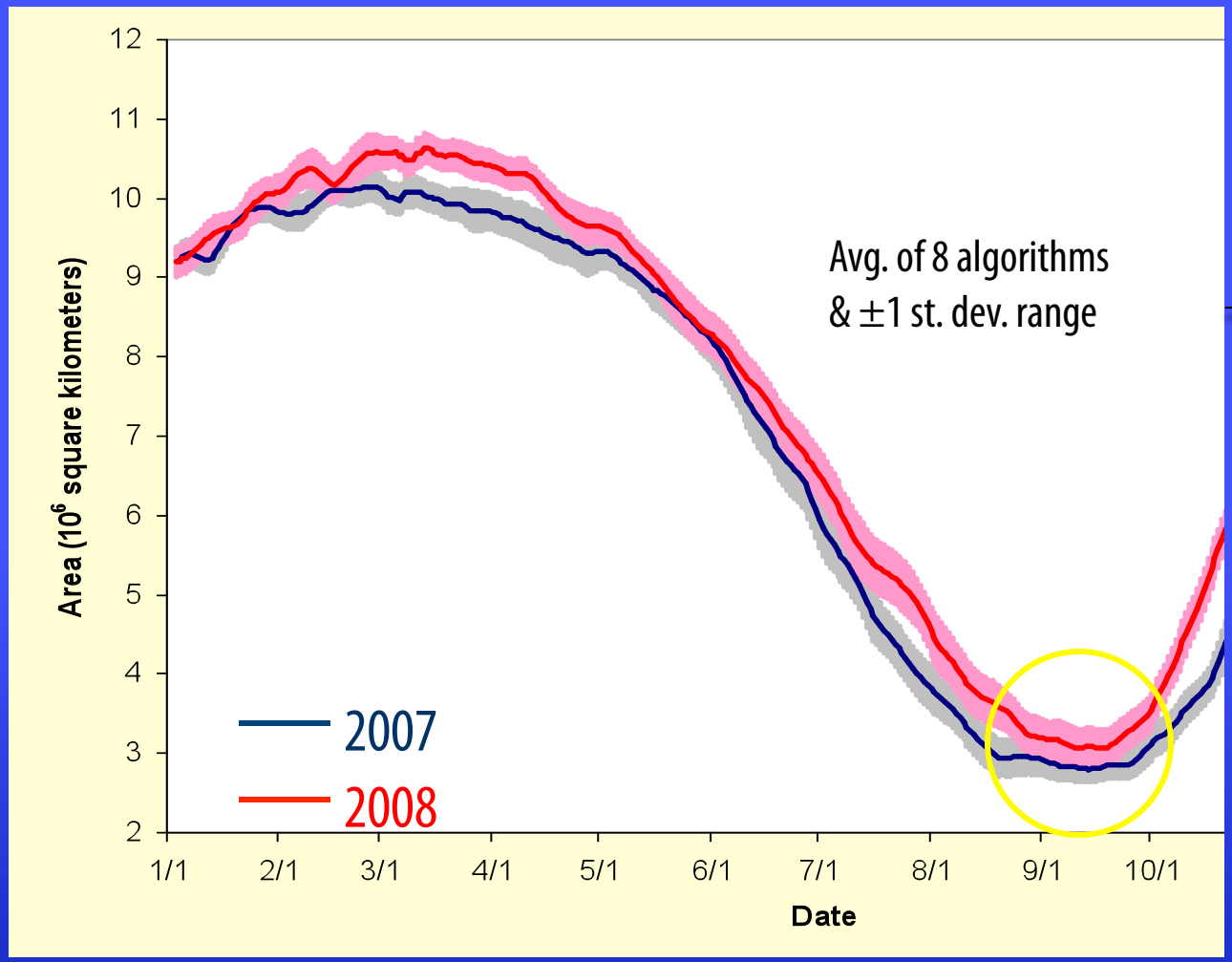


OHC

Palmer et al 2010 OceanObs'09



Total sea ice area, 2007 and 2008



NASA Team
NASA Team 2
SSM/I Bootstrap
AMSR Bootstrap
ASI
Cal/Val (York)
Bristol
Norsex

No single algorithm clearly superior

The largest factor for ice concentration/extent consistency is intercalibration of the products through transitions through different generations of satellite-borne sensors.

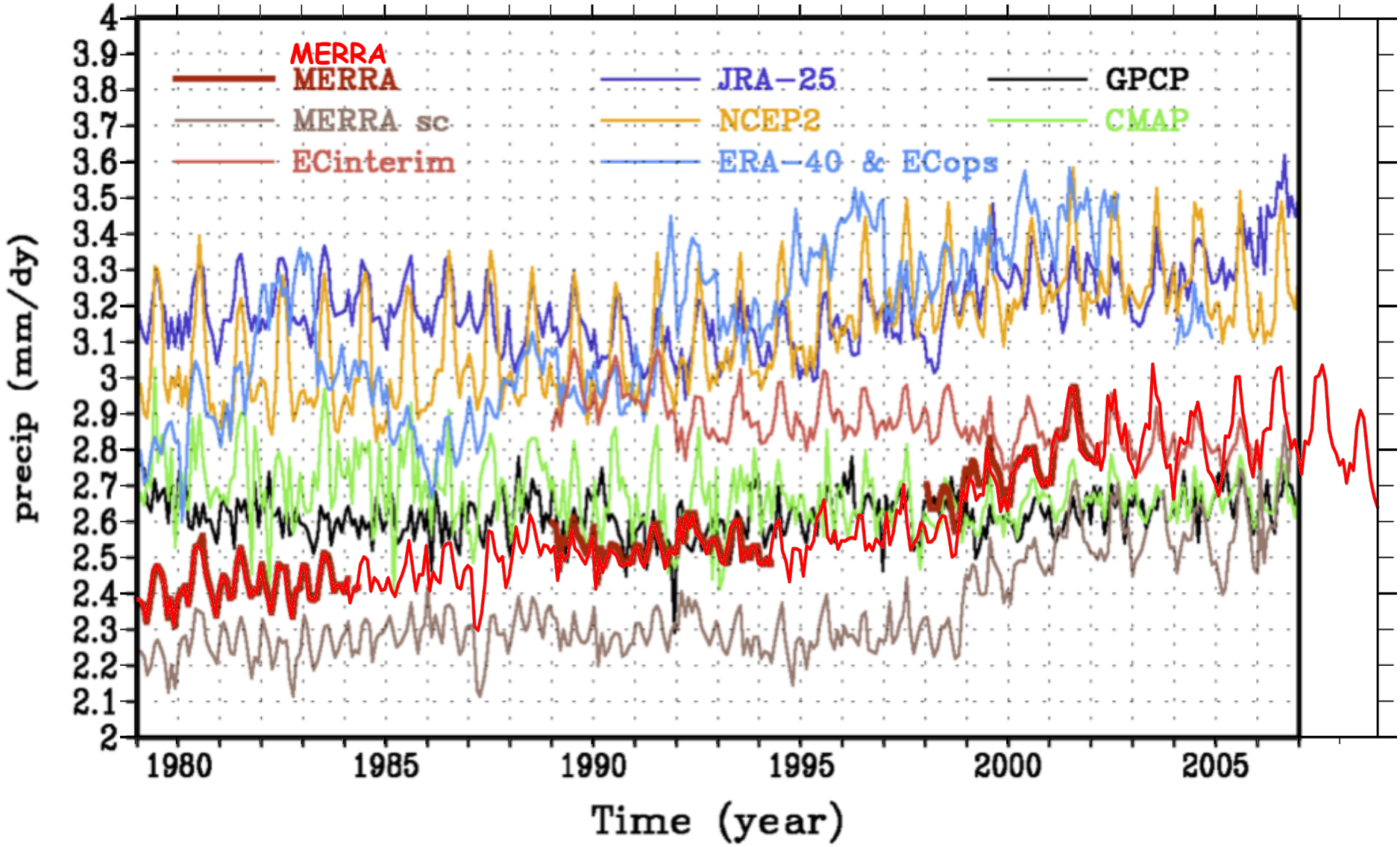
Reanalysis

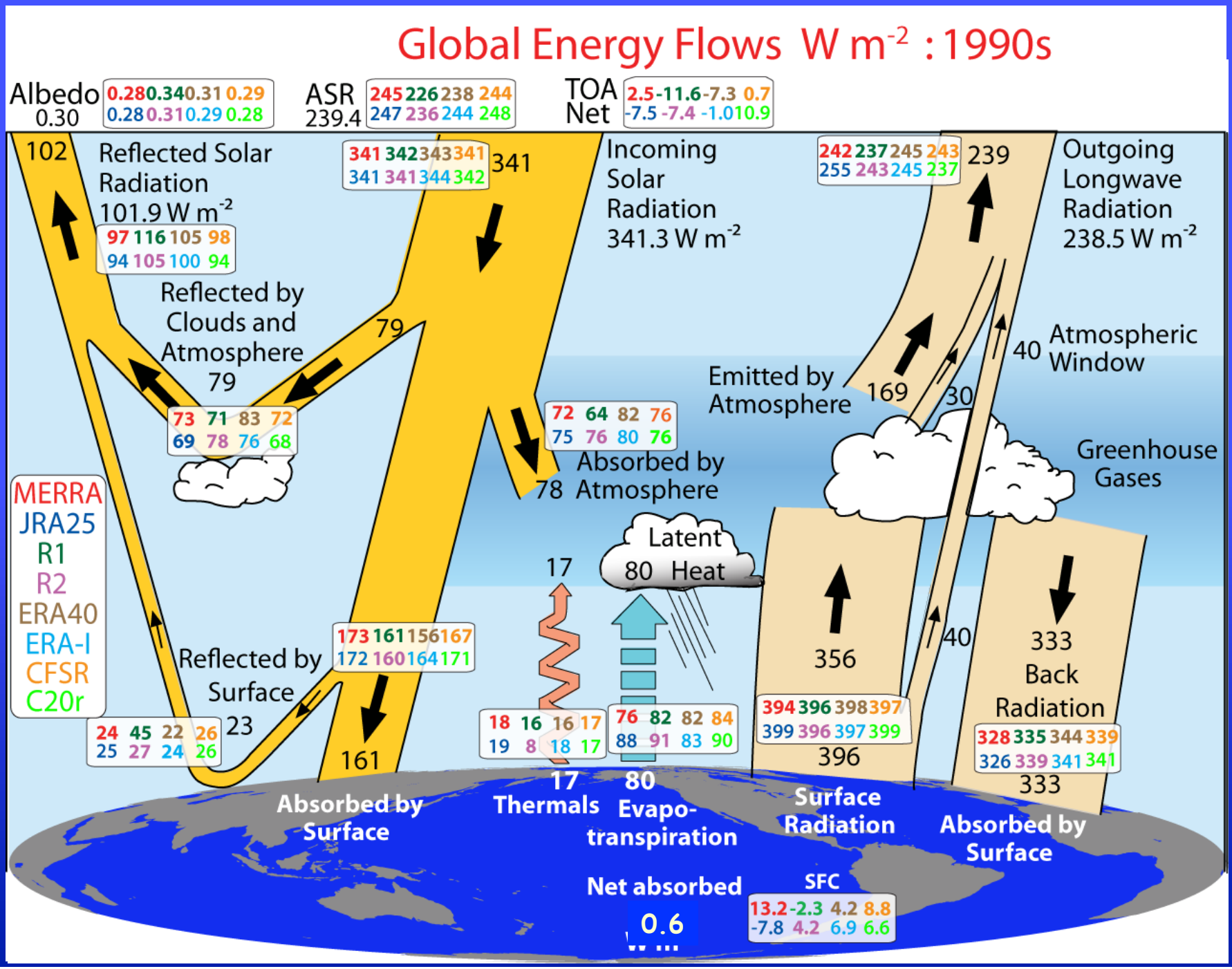
1. There is not a problem with lack of reanalyses, indeed there is a proliferation. The problems are:
    1. Lack of an end to end program with adequate vetting and evaluation of products (and the funding for that), and
    2. Reanalysis is all done in a research domain and not sustained, so that key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

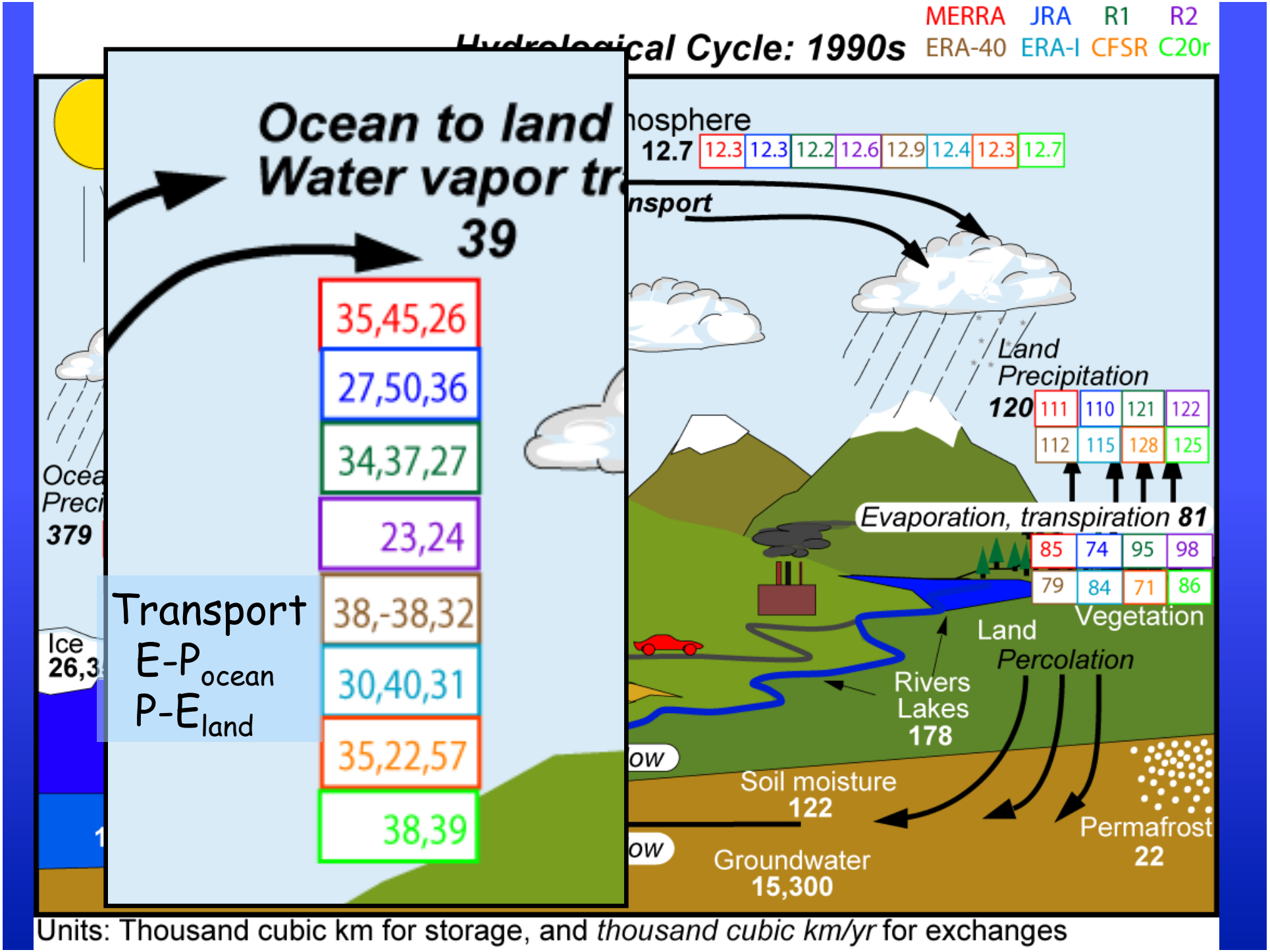
Atmospheric Reanalyses

*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.*

Reanalysis	Horiz.Res	Dates	Vintage	Status
NCEP/NCAR R1	T62	1948-present	1995	ongoing
NCEP-DOE R2	T62	1979-present	2001	ongoing
CFSR (NCEP)	T382	1979-present	2009	thru 2009, ongoing
C20r (NOAA)	T62	1875-2008	2009	Complete, in progress
ERA-40	T159	1957-2002	2004	done
ERA-Interim	T255	1989-present	2009	ongoing
JRA-25	T106	1979-present	2006	ongoing
JRA-55	T319	1958-2012	2009	underway
MERRA (NASA)	0.5°	1979-present	2009	thru 2010, ongoing


Global mean precipitation
MERRA
MERRA
MERRA sc
ECinterim
JRA-25
NCEP2
ERA-40 & ECops
GPCP
CMAP
precip (mm/dy)
Time (year)
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2
1980
1985
1990
1995
2000
2005


Global Energy Flows W m-2 : 1990s
Albedo
0.30
0.28 0.34 0.31 0.29
0.28 0.31 0.29 0.28
ASR
239.4
245 226 238 244
247 236 244 248
TOA
Net
2.5 -11.6 -7.3 0.7
-7.5 -7.4 -1.0 10.9
102
Reflected Solar
Radiation
101.9 W m-2
97 116 105 98
94 105 100 94
341 342 343 341
341 341 344 342
341
Incoming
Solar
Radiation
341.3 W m-2
242 237 245 243
255 243 245 237
239
Outgoing
Longwave
Radiation
238.5 W m-2
Reflected by
Clouds and
Atmosphere
79
79
73 71 83 72
69 78 76 68
72 64 82 76
75 76 80 76
Absorbed by
78 Atmosphere
Emitted by
Atmosphere
169
30
40
Atmospheric
Window
Greenhouse
Gases
MERRA
JRA25
R1
R2
ERA40
ERA-I
CFSR
C20r
Latent
80 Heat
17
356
40
333
Back
Radiation
173 161 156 167
172 160 164 171
Reflected by
Surface
23
24 45 22 26
25 27 24 26
161
18 16 16 17
19 8 18 17
76 82 82 84
88 91 83 90
394 396 398 397
399 396 397 399
396
328 335 344 339
326 339 341 341
333
17
Thermals
80
Evapo-
transpiration
Absorbed by
Surface
Surface
Radiation
Absorbed by
Surface
Net absorbed
0.6
SFC
13.2 -2.3 4.2 8.8
-7.8 4.2 6.9 6.6



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)

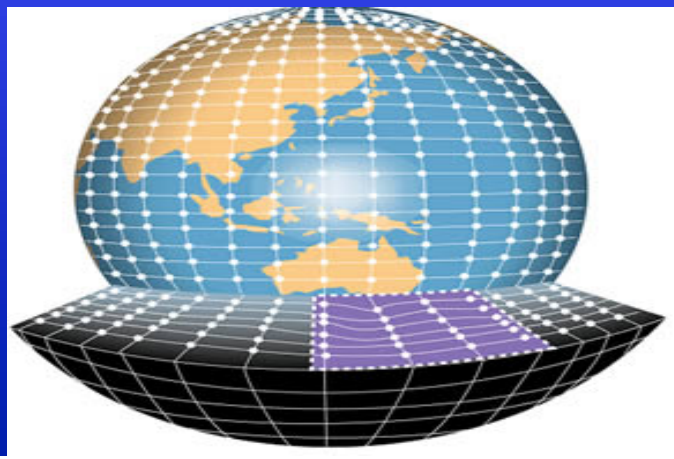
Randy Dole talk Tuesday

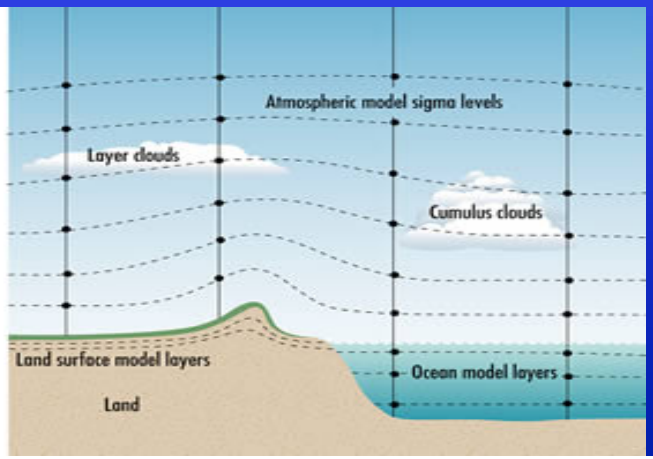
Future needs: Observations and Analysis

- 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 [illegible] relevant future [illegible]
6) Va[illegible]
7) se[illegible] multiple time scales
8) h[illegible]mation for informed planning and [illegible]
9) h[illegible] 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

Information System

From Trenberth et al 2002