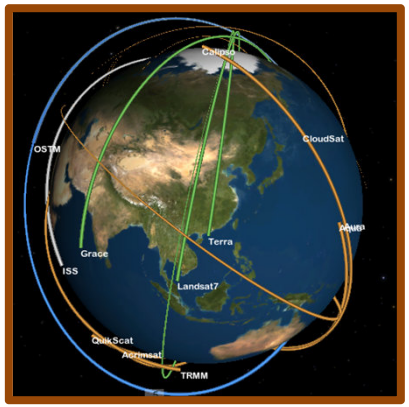
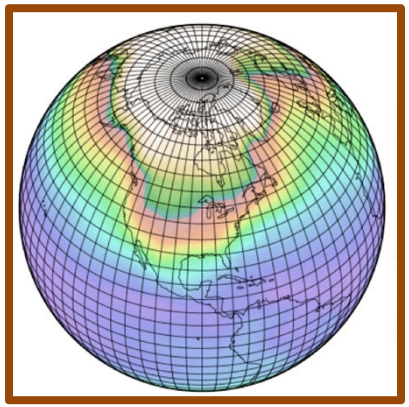
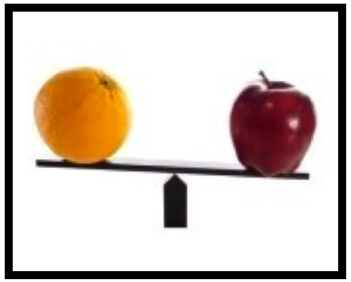
Satellite observations for CMIP5/IPCC Model Evaluation







Wikipedia: A comparison of **"apples and oranges"** occurs when two items or groups of items are compared that cannot be validly compared.

Robert Ferraro – NASA JPL – CMUG 2012

Contributors

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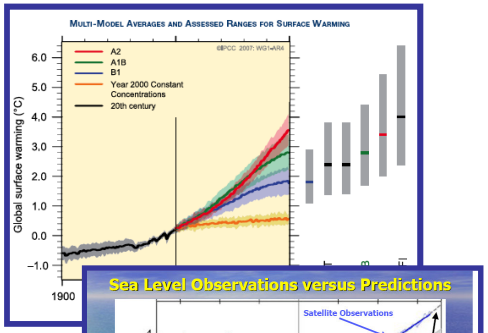
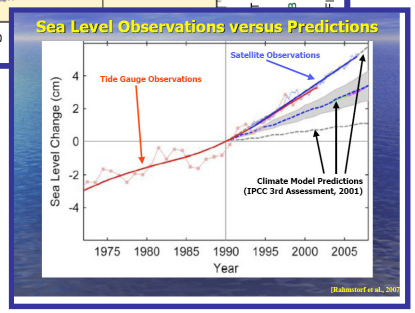
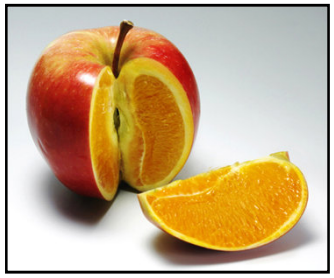
AIRS, AMSR-E, CERES, MLS, MODIS, OSTM, OVW, TRMM, (PO)DAAC, others…

Continued Challenges & New Opportunities



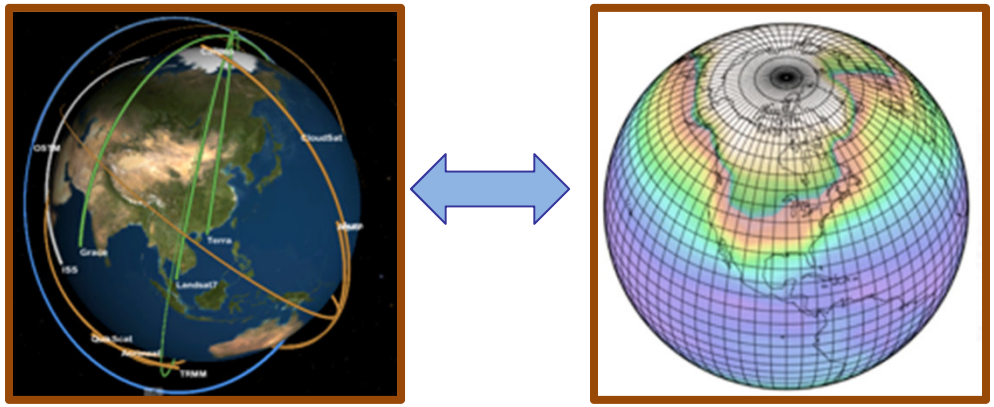


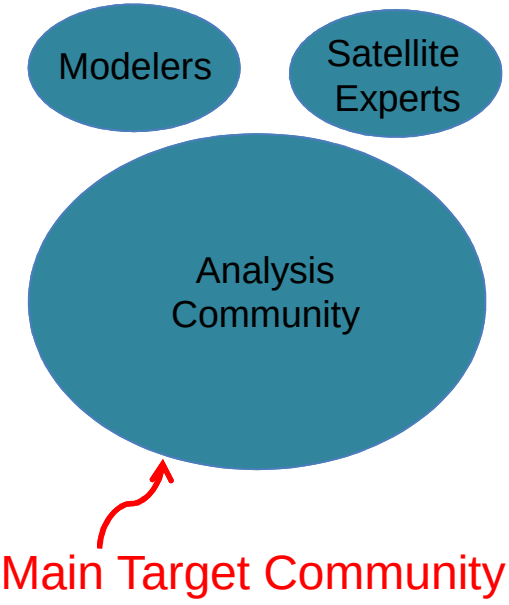


- More national and international assessments planned (e.g. US NCA, IPCC AR5) that will rely on CMIP-like activities.
- Significant model errors still evident
- Model errors imply climate projection uncertainties – can these be reduced?
- Models continuing to evolve in complexity and need evaluation.
- Satellite observations have been under utilized by the model and model-analysis community.
- New observations becoming available.

Making Better Use of Observations for IPCC

- JPL/NASA is leading an effort with PCMDI/DOE to identify and deliver a number of NASA satellite data tailored for IPCC model-data comparison.
- Community to have simultaneous access to model output and satellite observations similarly formatted to facilitate model evaluation.
- Need is expected to be ongoing for model evaluations and timely submission of research articles –> IPCC AR5 to be published in 2013.





Model and Observation Overlap

For what quantities are these comparisons viable?

Taylor et al. 2008

~120 ocean
~60 land
~90 atmos
~50 cryosphere

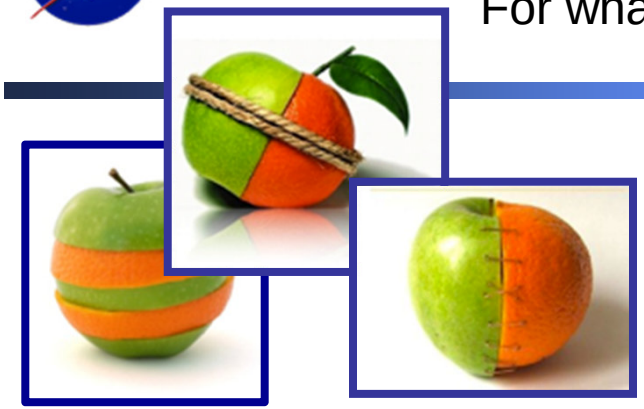
Current NASA Missions ~14
Total Missions Flown ~ 60
Many with multiple instruments
Most with multiple products (e.g. 10-100s)
Many cases with the same products

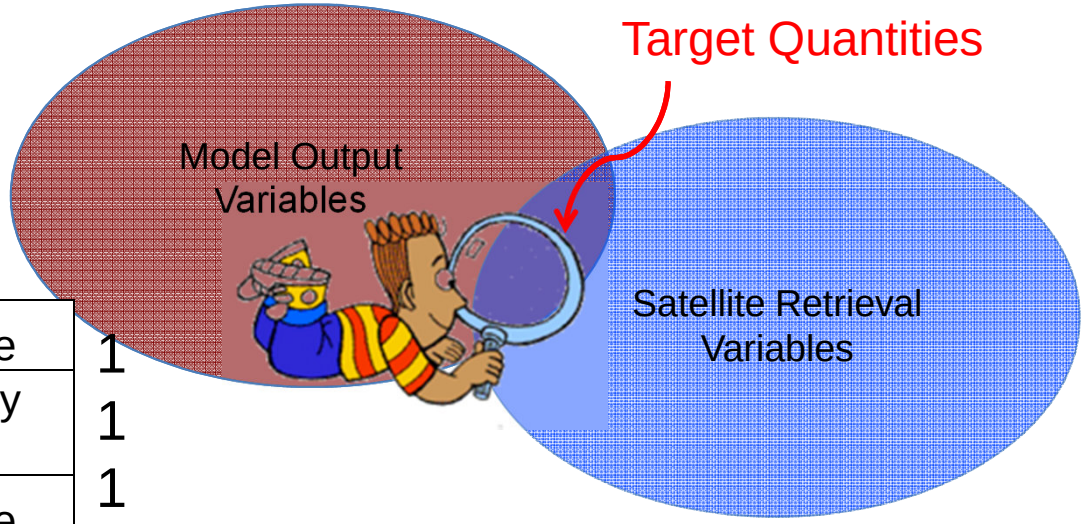
Over 300 Variables in (monthly) CMIP Database

Over 1000 satellite-derived quantities

Model and Observation Overlap

For what quantities are these comparisons viable?





AIRS (≥ 300 hPa)	Atm temp profile	1
	Specific humidity profile	1
MLS (< 300 hPa)	Atm temp profile	1
	Specifc humidity profile	1
QuikSCAT	Ocean surface winds	3
TES	Ozone profile	1
AMSR-E	SST	1
TOPEX/JASON	SSH	1
CERES	TOA radiation fluxes	5
TRMM	Total precipitation	1
MODIS	Cloud fraction	1
	Leaf Area Index	1

After much scrutiny and two workshops, only ~20 variables were identified as being “safely” comparable in this first round – although still with caveats!

- Continue to consider additional datasets
- **Model-pull for additional satellite observations**
- **Model-push for additional model output variables.**

Some Basic Tenets of this Activity

1. Use the CMIP5 simulation protocol (Taylor et al. 2009) as guideline for deciding which observations to stage in parallel to model simulations.
   Target is monthly averaged (OMON, AMON) products on 1 x 1 degree grid
2. Convert Satellite Observations to be formatted exactly the same as CMIP Model output
   CMOR output, NetCDF files, CF Convention Metadata, CMIP standard pressure levels, CMIP standard data file organization
   Not a new product. At most – bin and average L2 data to produce the L3 product. Independent QC check before release.
3. Includes a 6-8 page Technical Note describing strengths/weaknesses, uncertainties, dos/don'ts regarding interpretations comparisons with models. (at graduate student level)
4. Host side by side on the ESG with CMIP5
5. Advertise availability of observations for use in CMIP5 analysis.

NASA Datasets for CMIP5

Datasets are Gridded Monthly Averages – Unless otherwise noted

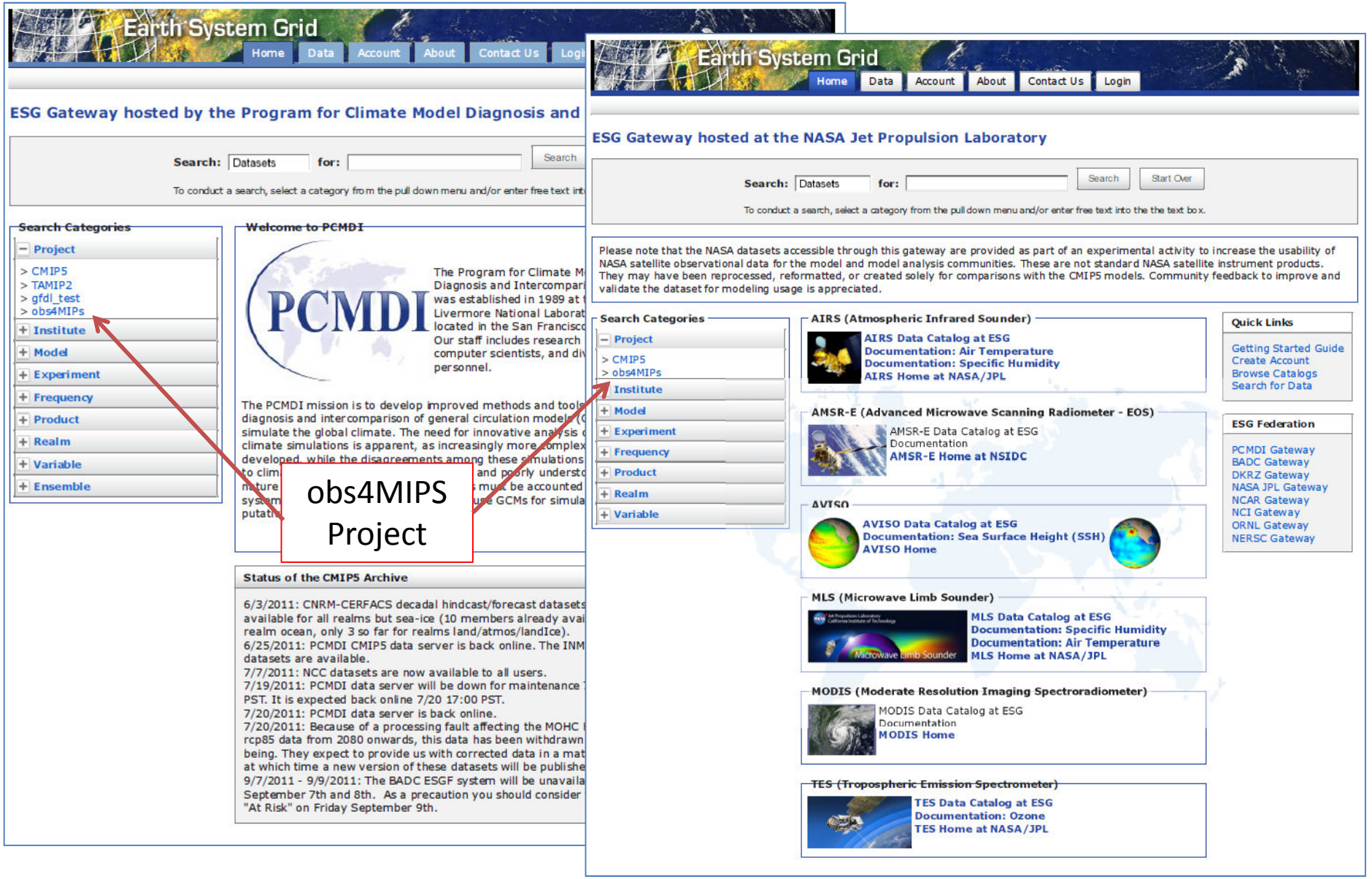
Separate files containing Nobs & StdErr for each grid cell are available

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

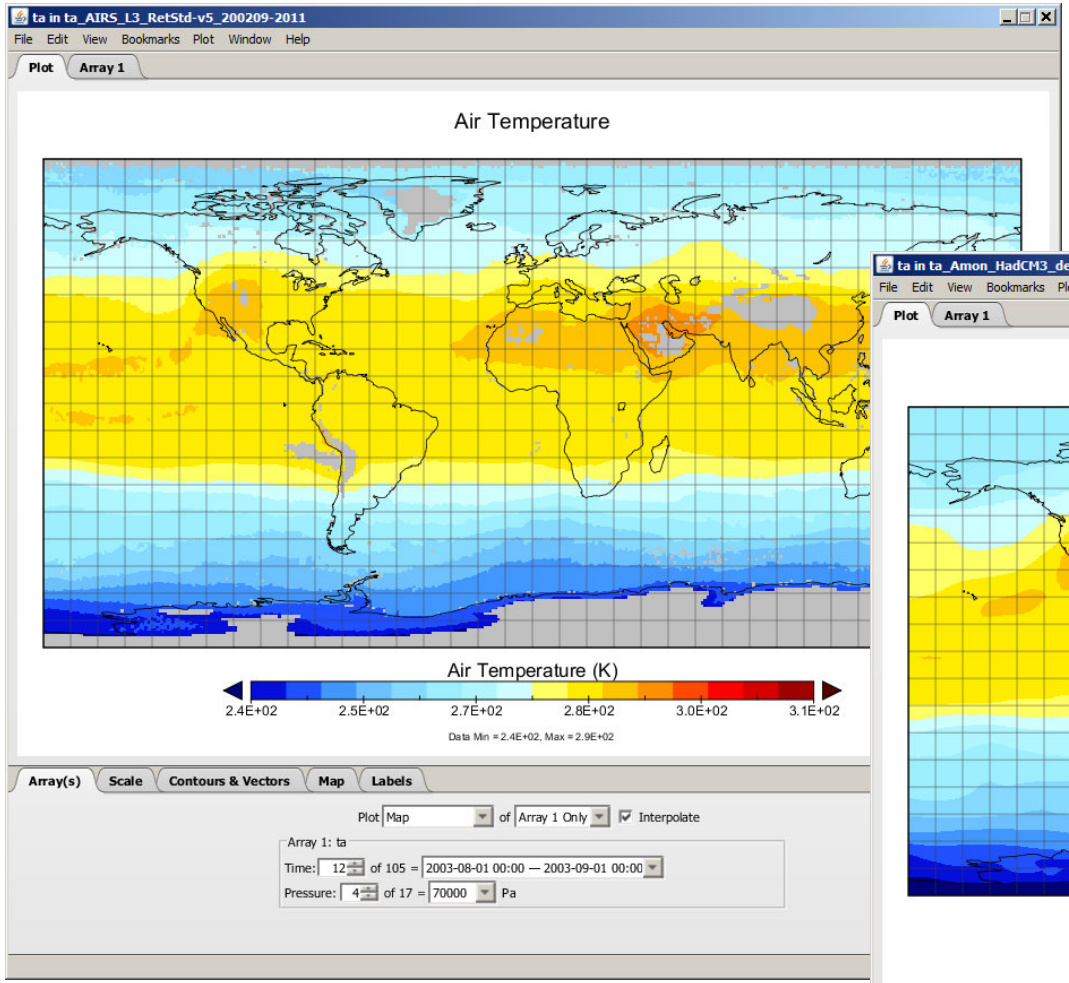
Match up of available NASA datasets to PCMDI priority list

Orange datasets are still in process

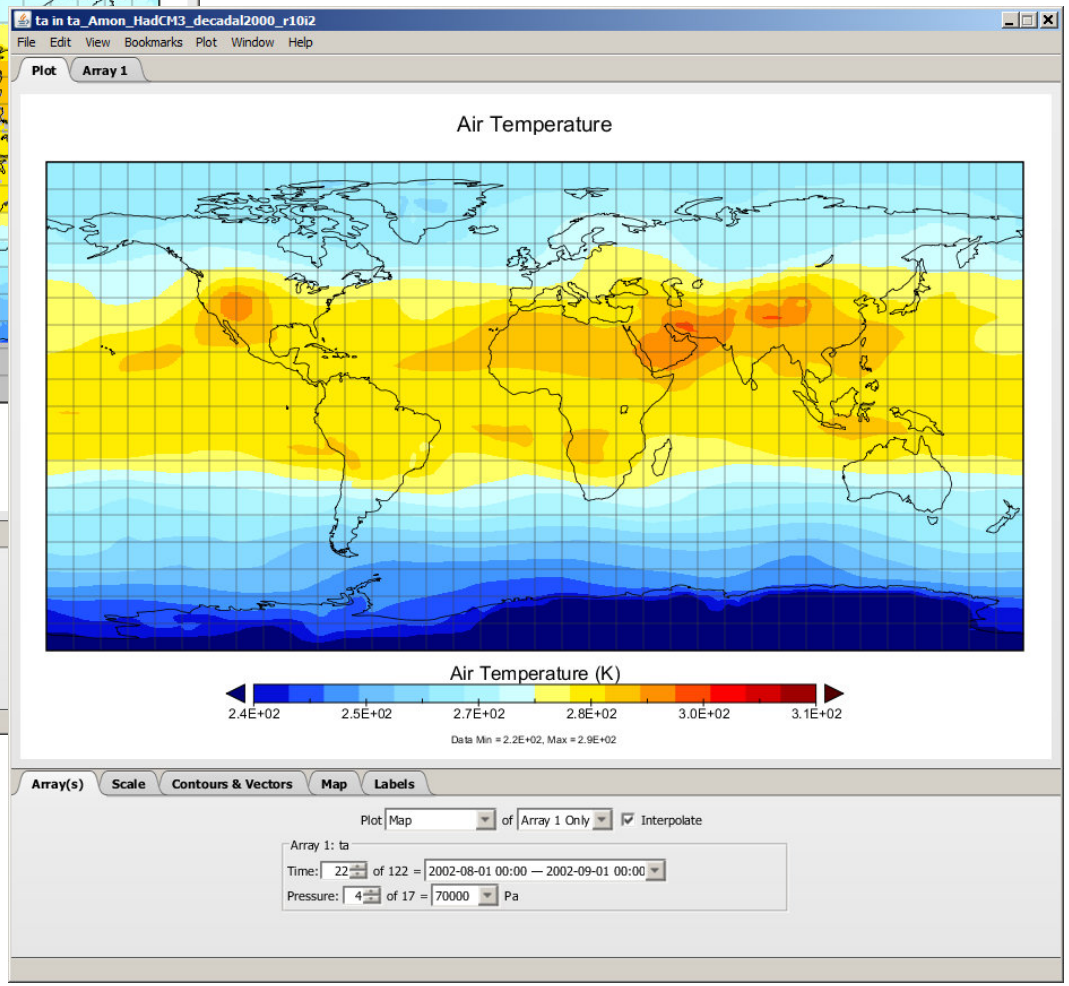
ESG Gateway : Side by Side Archive with CMIP



Model – Observations Example

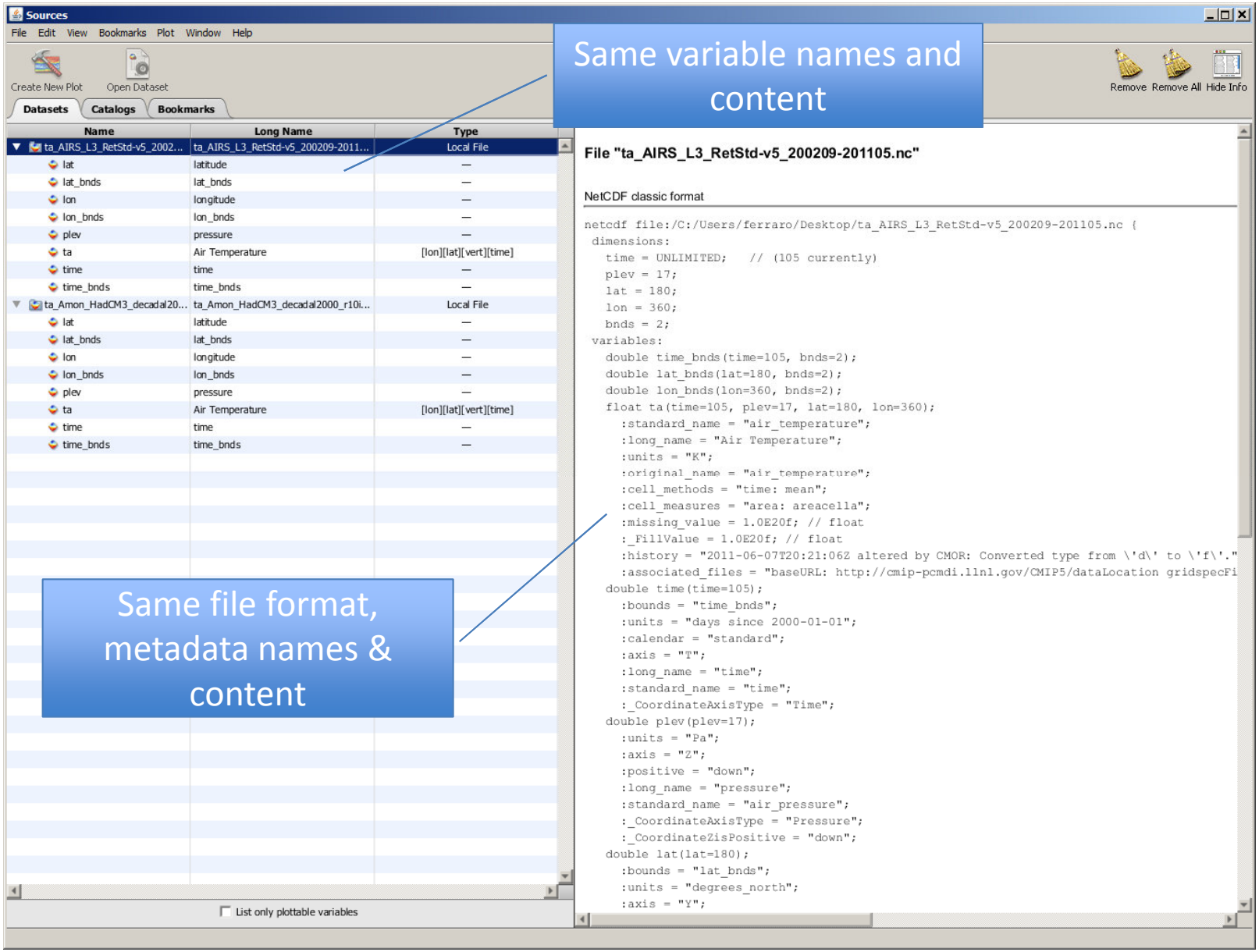


AIRS – ta, 2003-08, 700 hPa



Met Office Hadley Centre, decadal2000 – ta, 2003-08, 700 hPa

Model – Observations Example



"Technical Note"

Each Dataset has an accompanying Technical Note

Target audience is modeling community members who have little experience with NASA datasets

Contents

- Intent of the Document/POC
- Data Field Description
- Data Origin
- ➡ Validation and Uncertainty Estimate
- ➡ Considerations for Model – Observation Intercomparison
- Instrument Overview
- References
- Revision History

Satellite Observations for Evaluating CMIP5 SUMMARY

- Pilot Project to establish a NASA-wide capability for the climate modeling community to support model-to-data intercomparison. This involves IT, satellite retrieval, data set, modeling and science expertise. Satellite observation data sets being published now.

- 16 Datasets currently available on the ESG – more are coming

- We are interested in collaboration with other agencies and international partners to expand this for AR6
  - Potential International Workshop in Fall 2012/Winter 2013?

- We welcome feedback from the model analysis community

- This would not have been possible without help from AIRS, MLS, TES, QuikSCAT, MODIS, TRMM, REMSS, PODAAC, NCCS, and AVISO – many other people also contributed to this effort

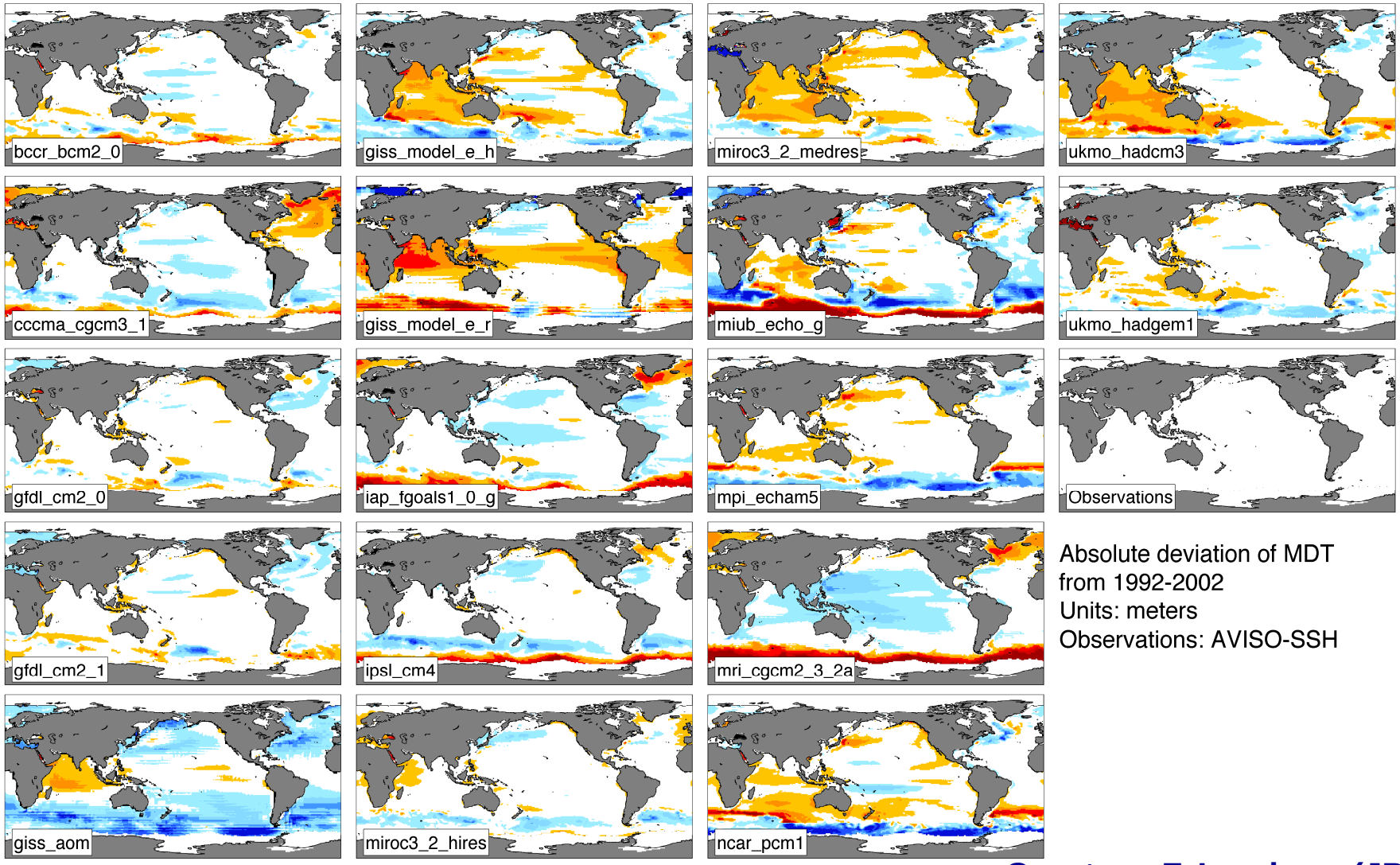
Links to Explore

- Obs4MIPs Front Page http://obs4mips.llnl.gov:8080/wiki/
- NASA ESG Gateway http://esg-gateway.jpl.nasa.gov/home.htm
- New ESG Interface (Beta) http://esg-datanode.jpl.nasa.gov/esgf-web-fe/

Addition Stuff ….

CMIP3 Sea Level vs TOPEX/JASON

Mean dynamic topography (GCMs 1992-2002); Obs: Maximenko et al. [2005]) Absolute values (each field has zero mean)

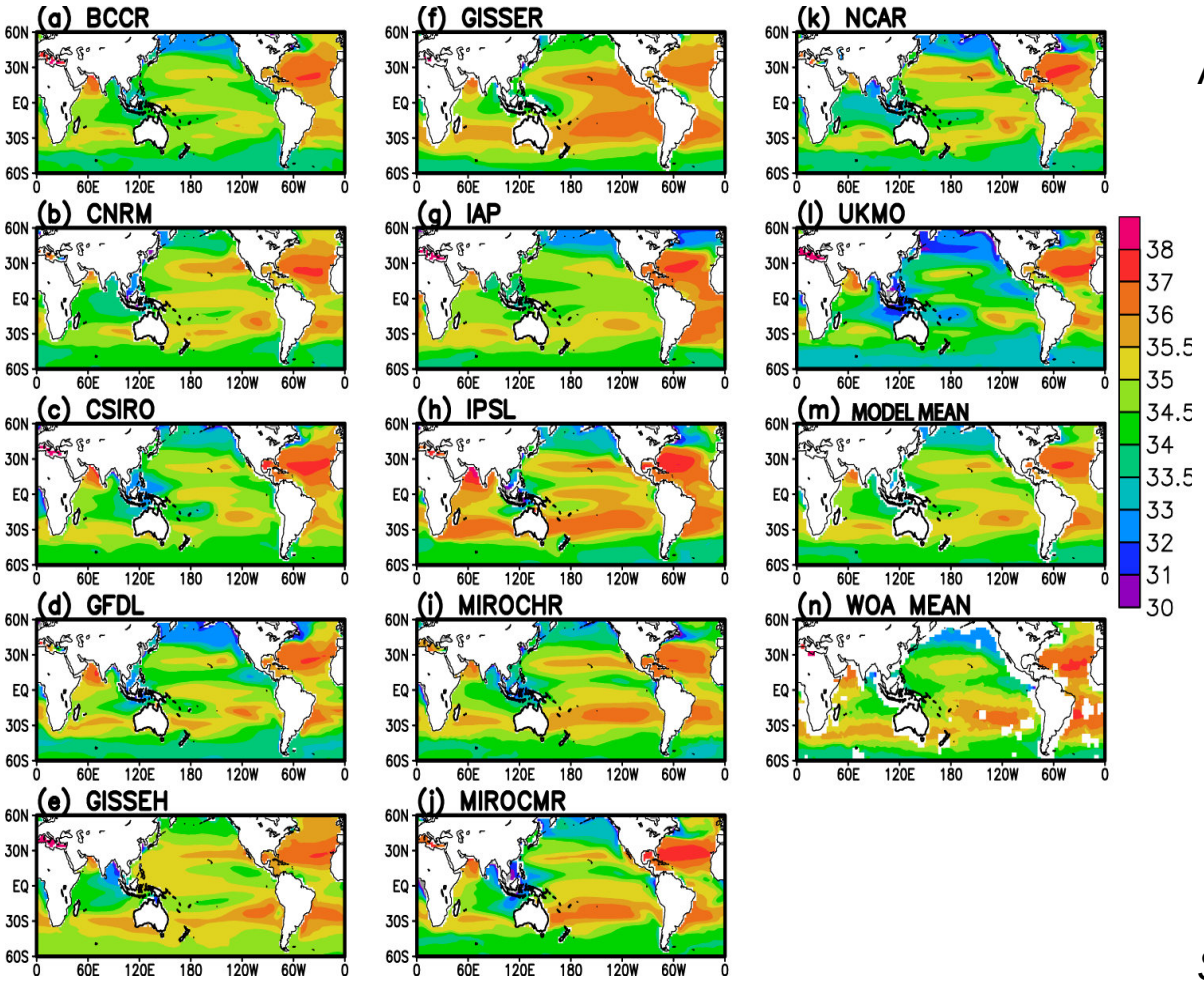


Absolute deviation of MDT
from 1992-2002
Units: meters
Observations: AVISO-SSH

Courtesy F. Landerer (JPL)

F. Landerer: 24-Aug-2011

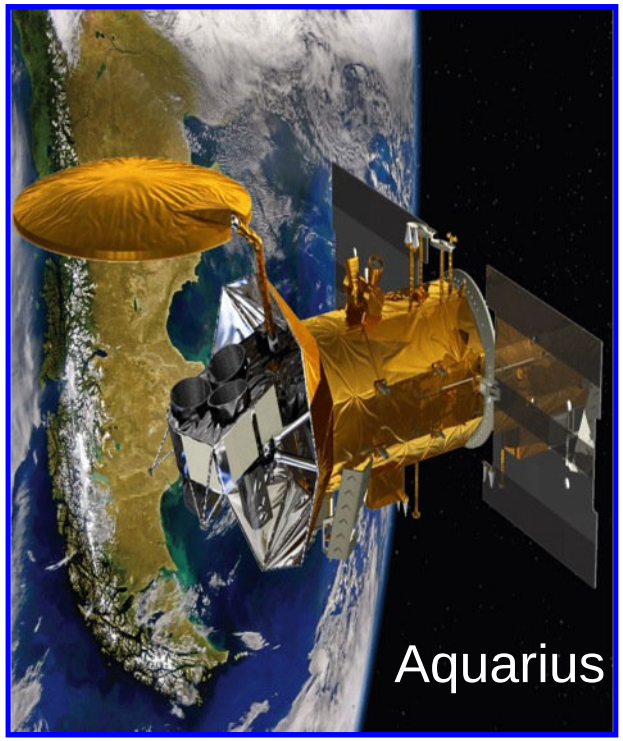
Next NASA Earth Science Mission: Aquarius – June 2011 – Ocean Salinity



Mean *Salinity* from 12 CMIP3 Model Simulations of 20th Century Climate: POOR MODEL AGREEMENT

Courtesy D. Waliser, Y. Chao & F. Li

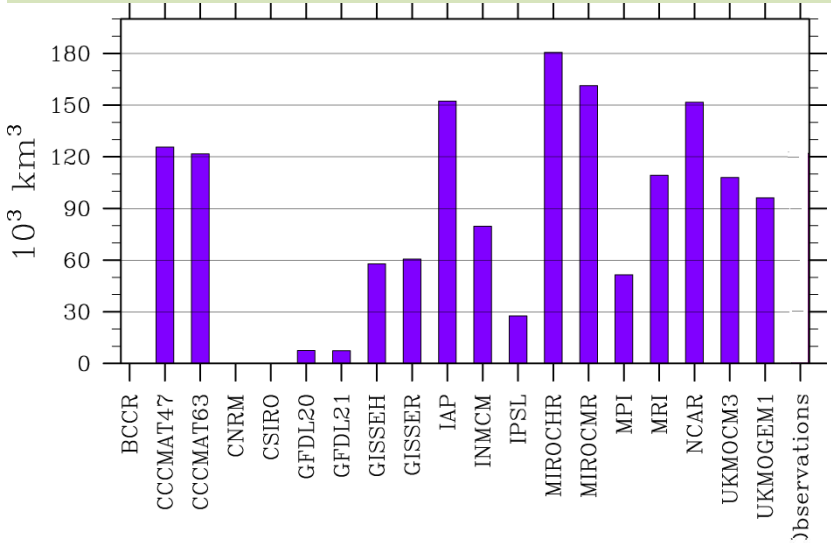
Aquarius will provide the first NASA spaceborne global data of salinity.



Salinity: Characterization of ocean thermohaline circulation and global water budget

Other Critical Climate Variables:
Model Disagreement & Future Mission Horizon

CMIP3 Models: Global Average Soil Moisture



CMIP3 Models: Global Average Snow/Ice Mass