CEOP Data Integration and the Global Land Data Assimilation System (GLDAS)

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GLDAS Overview

Goal:

Produce optimal output fields of land surface states and fluxes

Problem:

Biases in modeled forcing →

Error accumulates in land stores →

Incorrect surface water and energy partitioning

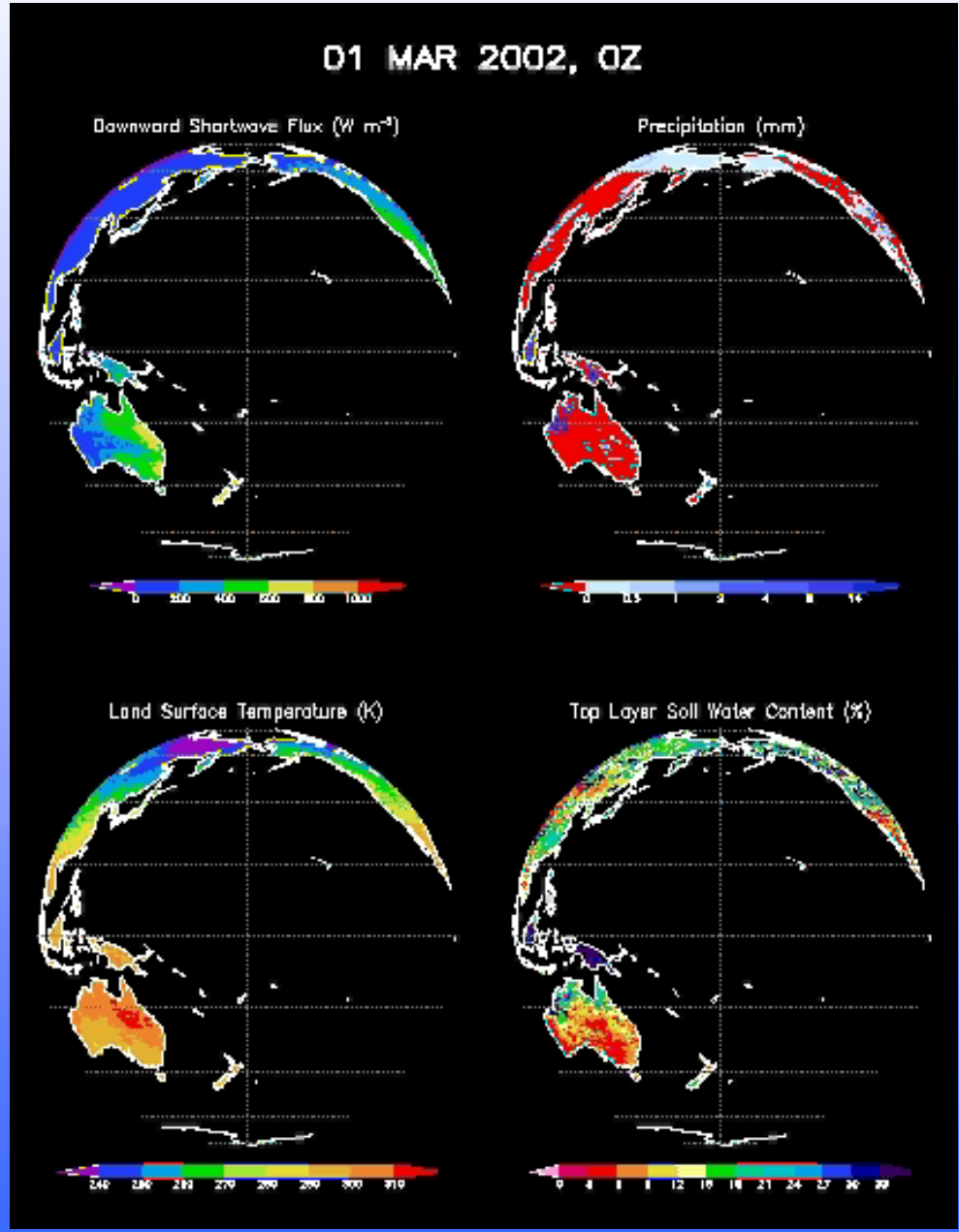
Inaccurate initialization of weather and climate models

Approach:

Force and constrain LSMs with data from new observing systems

Specifications

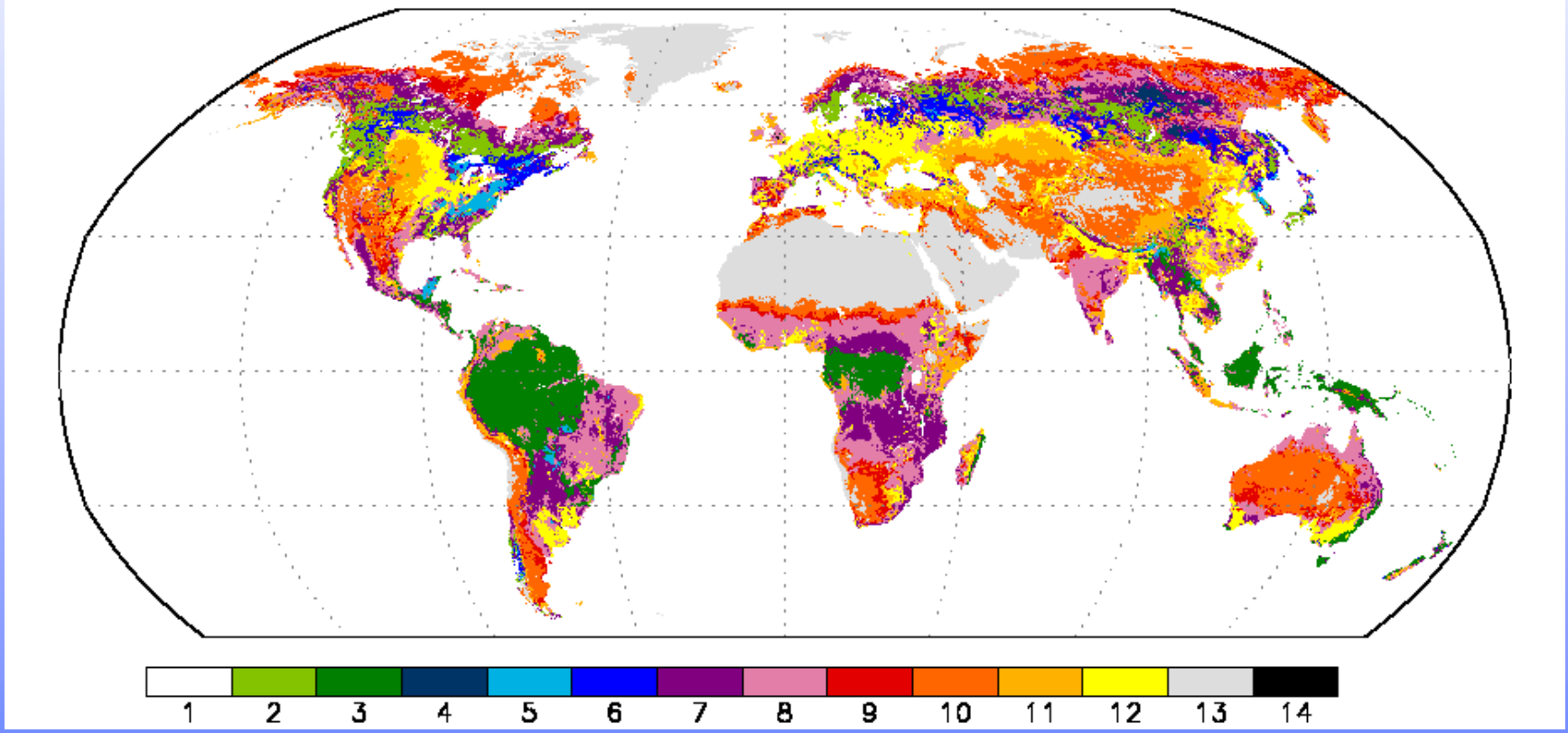
- LSMs: Mosaic, CLM, NOAH, *Catchment, VIC …*
- Resolutions: 0.25º, 0.5º, 1.0º, and 2.0ºx2.5º spatial; 15 minute timestep
- Mosaic-type subgrid tiles
- Operational runs within 24-48 hours of real time began 1 January 2001
- Multiple retrospective simulations



Summary of Data Sources for GLDAS

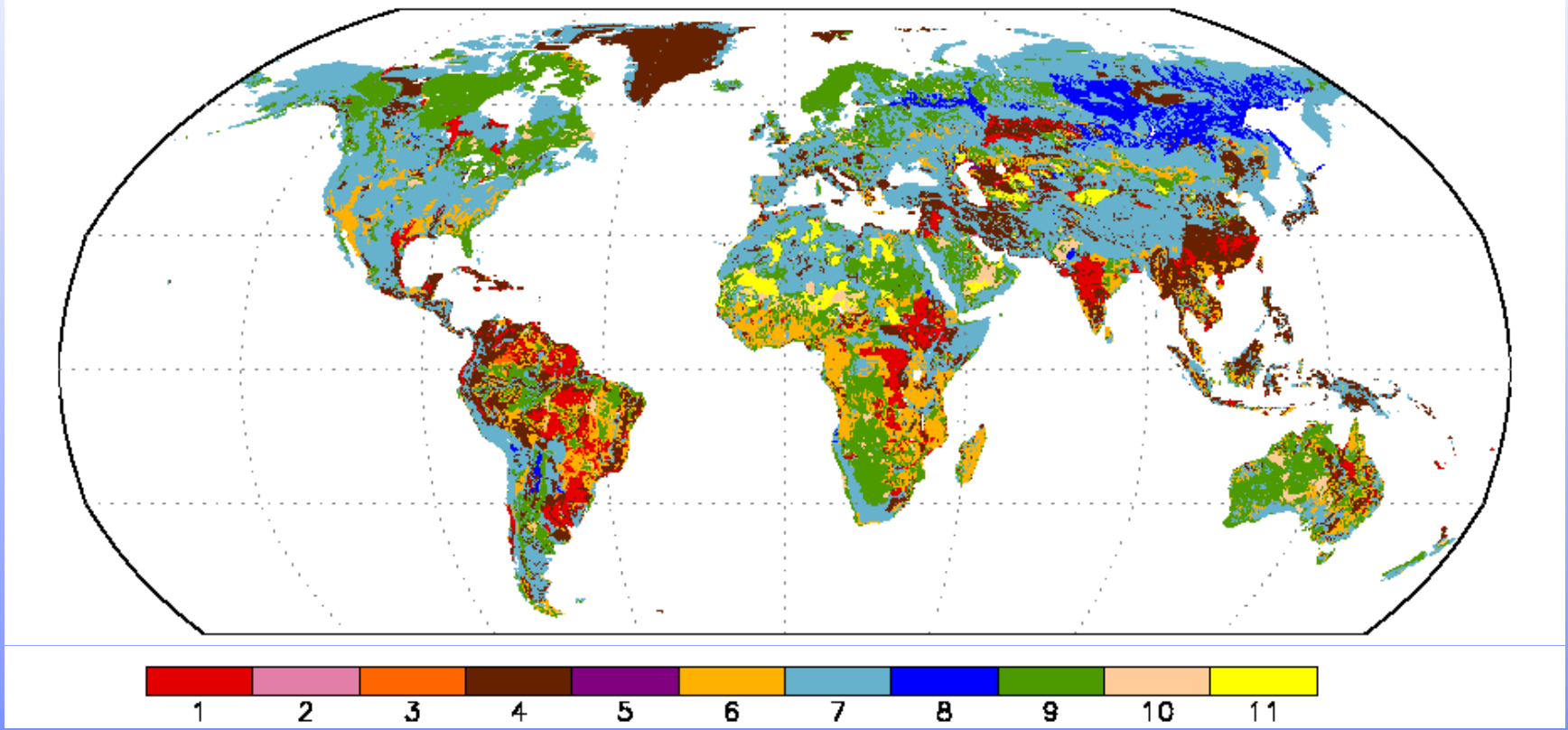
Type of Data	Source	Original Spatial Resolution	Time Period	Near Real-Time
Modeled Forcing	NASA Goddard Earth Observing System (GEOS)	1.0°	12/2000 – present	Y
	NOAA Global Data Assimilation System (GDAS)	~ 0.7°	1/1999 – present	Y
	ECMWF forecasts and analyses	~ 39 km	10/2001 – present	Y
	Berg et al. (2002) bias corrected ECMWF reanalysis	0.5°	1/1979 – 12/1993	
	Berg et al. (2002) bias corrected NCEP/NCAR reanalysis	0.5°	1/1985 – 12/1993	
Observation-Based SW and LW Radiation Forcing	Derived at NASA/GSFC using U.S. Air Force Weather Agency cloud and snow analyses	0.25°	3/2001 – present	Y
Observation-Based Precipitation Forcing	U.S. Naval Research Laboratory	0.25°	4/2001 – present	Y
	NASA/GSFC Mesoscale Atmospheric Processes Branch	0.25°	3/2002 – present	Y
	NOAA Climate Prediction Center	2.5°	1/1979 - present	
Observation-Based Snow Cover	Derived at NASA/GSFC using Terra-MODIS satellite observations	0.125°	11/2000 - present	
Observation-Based Leaf Area Index	Boston University Department of Geography	16 km	7/1982 – 5/2001	
Observation-Based Surface Temperature	Television Infrared Observation Satellites (TIROS) Operational Vertical Sounder (TOVS)	~ 15 km	1/1998 – 12/1998	
Vegetation Class	University of Maryland, AVHRR-derived	1 km	static	
	Boston University, MODIS-derived	1 km	static	
Soils	USDA Agricultural Research Service	5’	static	
Elevation	GTOPO30 digital elevation model	30”	static	

U. Maryland AVHRR-derived Land Cover



1 = Water
2 = Evergreen Needleleaf Forest
3 = Evergreen Broadleaf Forest
4 = Deciduous Needleleaf Forest
5 = Deciduous Broadleaf Forest
6 = Mixed Cover
7 = Woodland
8 = Wooded Grassland
9 = Closed Shrubland
10 = Open Shrubland
11 = Grassland
12 = Cropland
13 = Bare Ground
14 = Urban and Build-Up

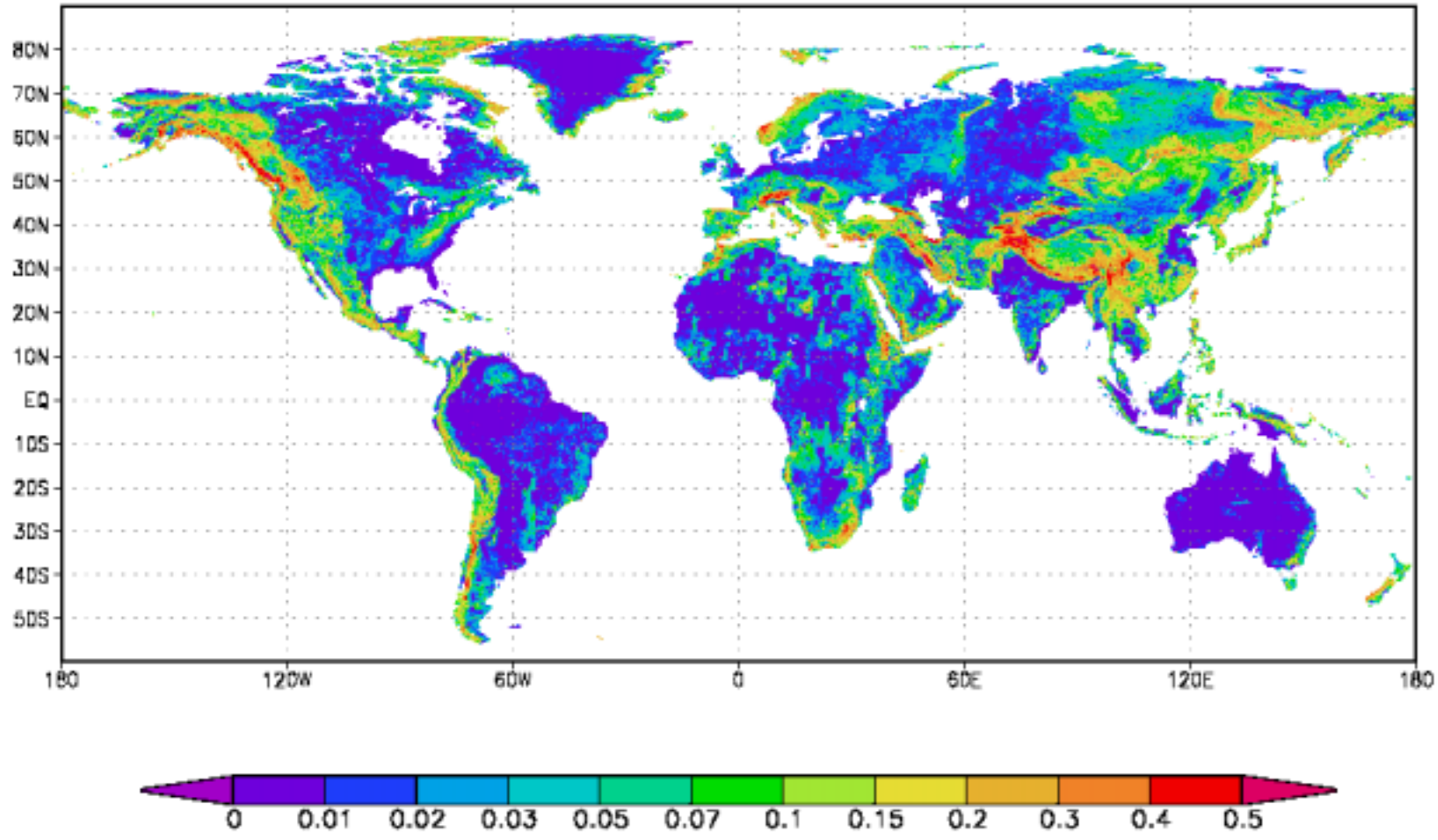
USDA Texture Class, 0 – 2 cm



1 = Sand
2 = Loamy Sand
3 = Sandy Loam
4 = Silty Loam
5 = Loam
6 = Sandy Clay Loam
7 = Silty Clay Loam
8 = Clay Loam
9 = Sandy Clay
10 = Silty Clay
11 = Clay

Derived from Reynolds, Jackson, and Rawls [1999]

Slope Angle [radians]



Derived From GTOPO30

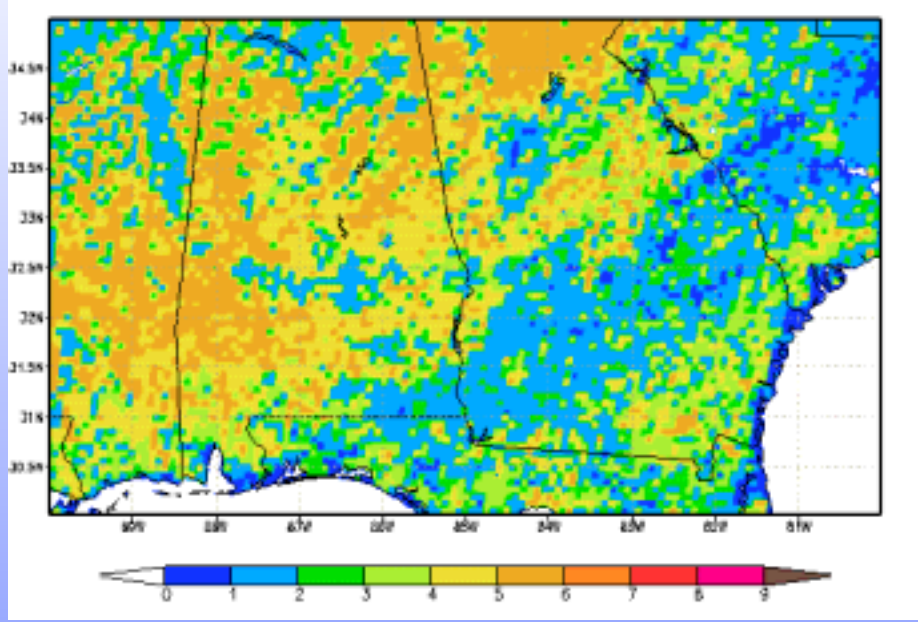
Observation-based Leaf Area Index

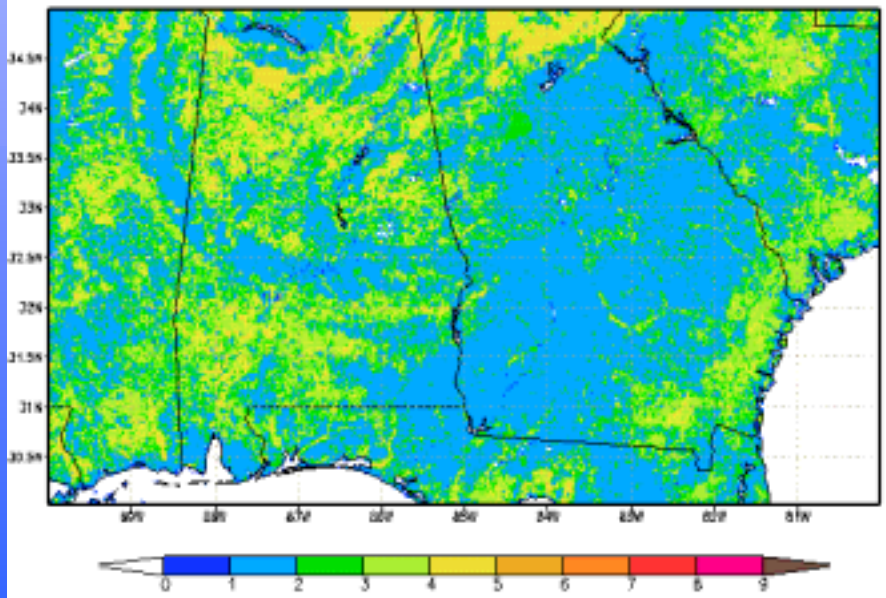
July Leaf Area Index

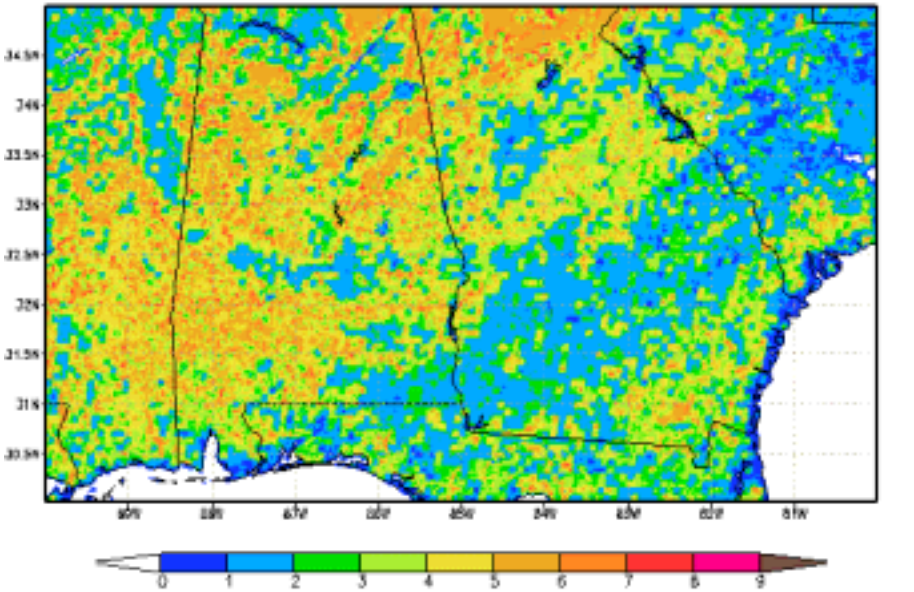
Satellite observation of LAI on 8 km grid (upper right)

Climatological average LAI on a 1 km grid, based on predominant vegetation type at 1 km, latitude band, and month (lower left)

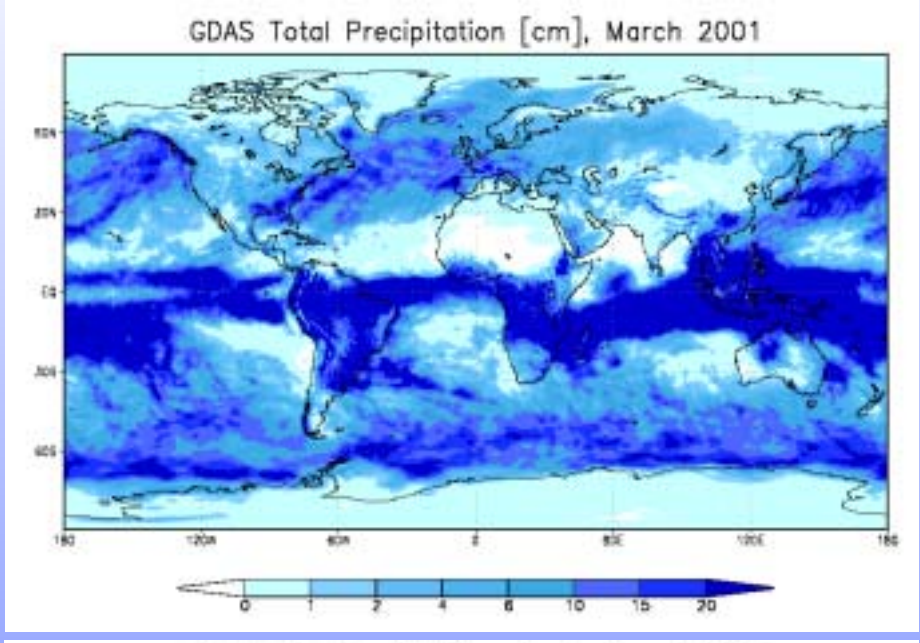
1 km LAI, where 8 km average equals observation, 1 km pixels weighted by vegetation-specific climatology (lower right)

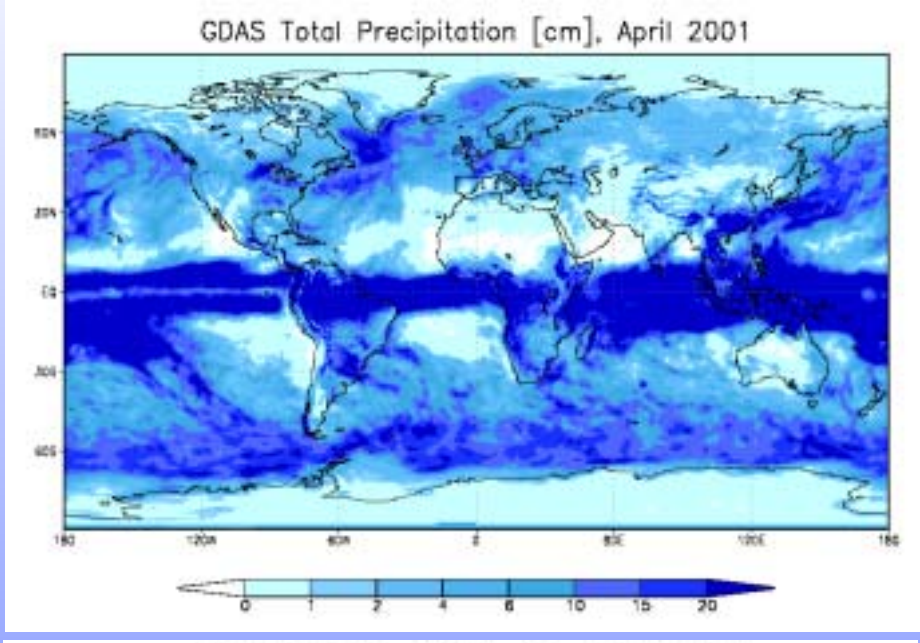


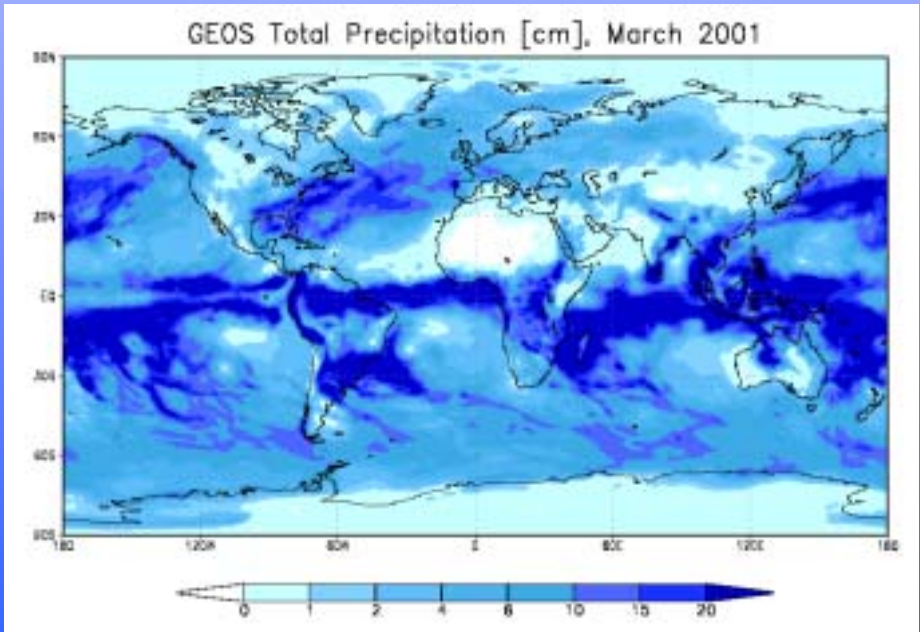


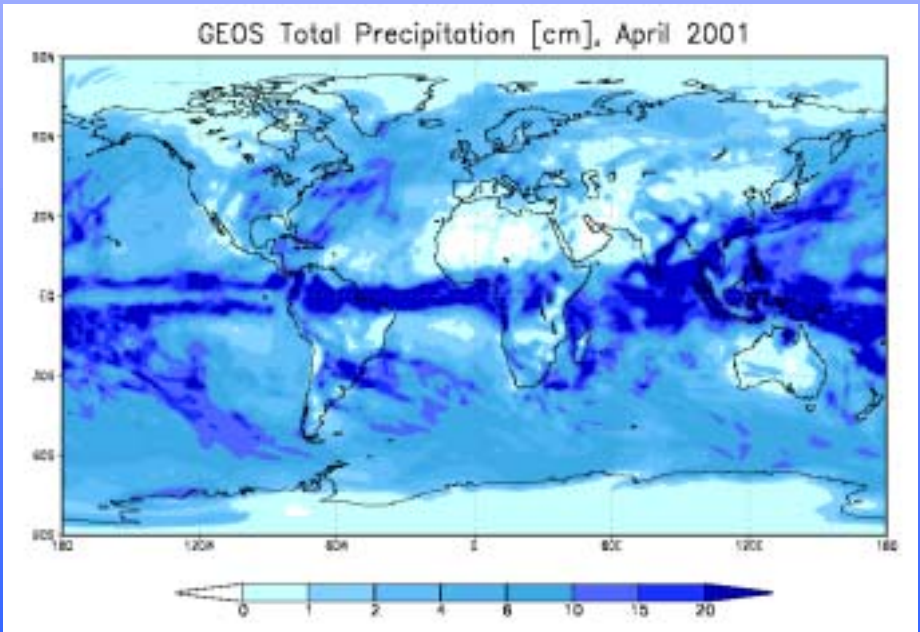


Comparison of Modeled Precipitation Forcing

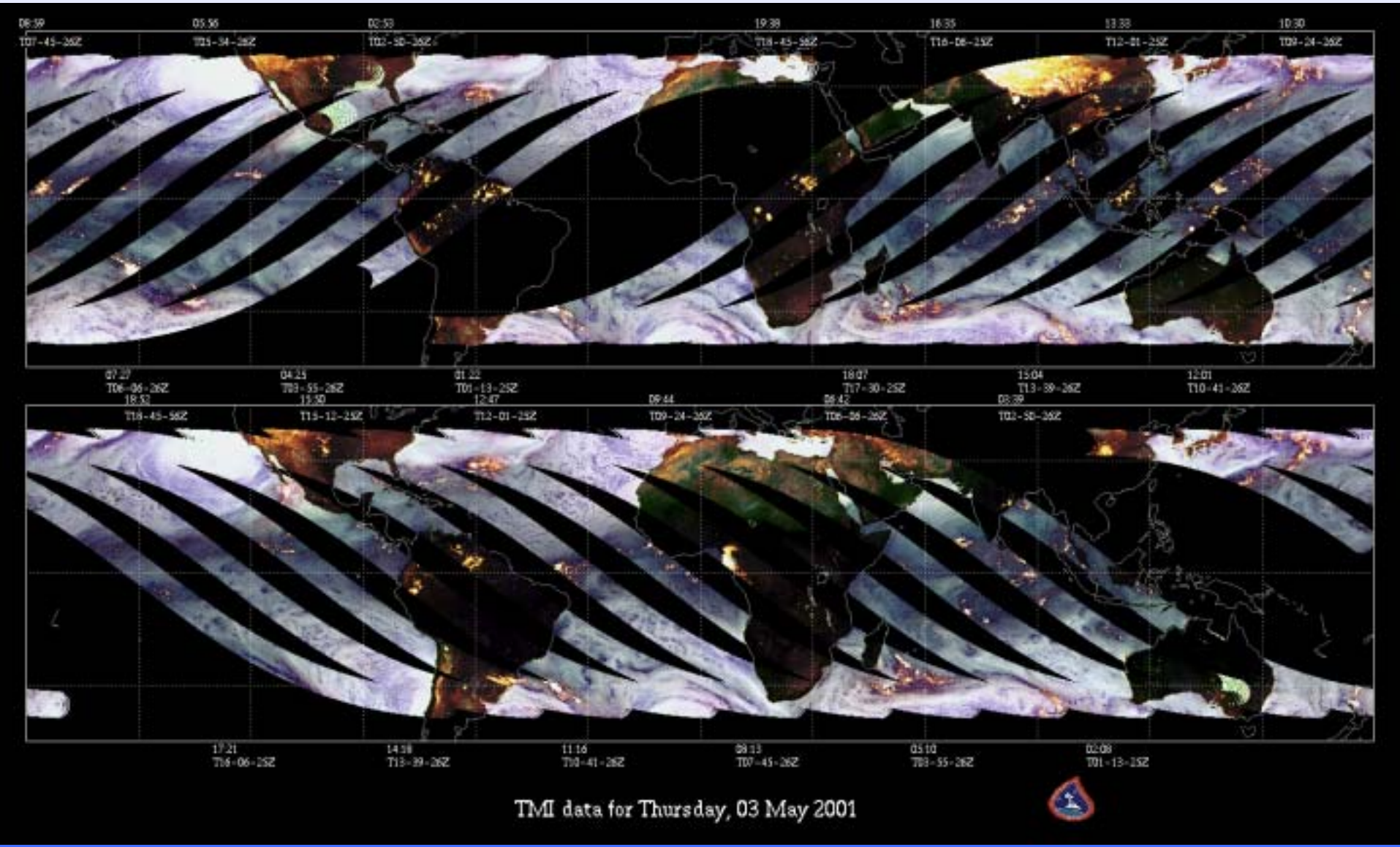




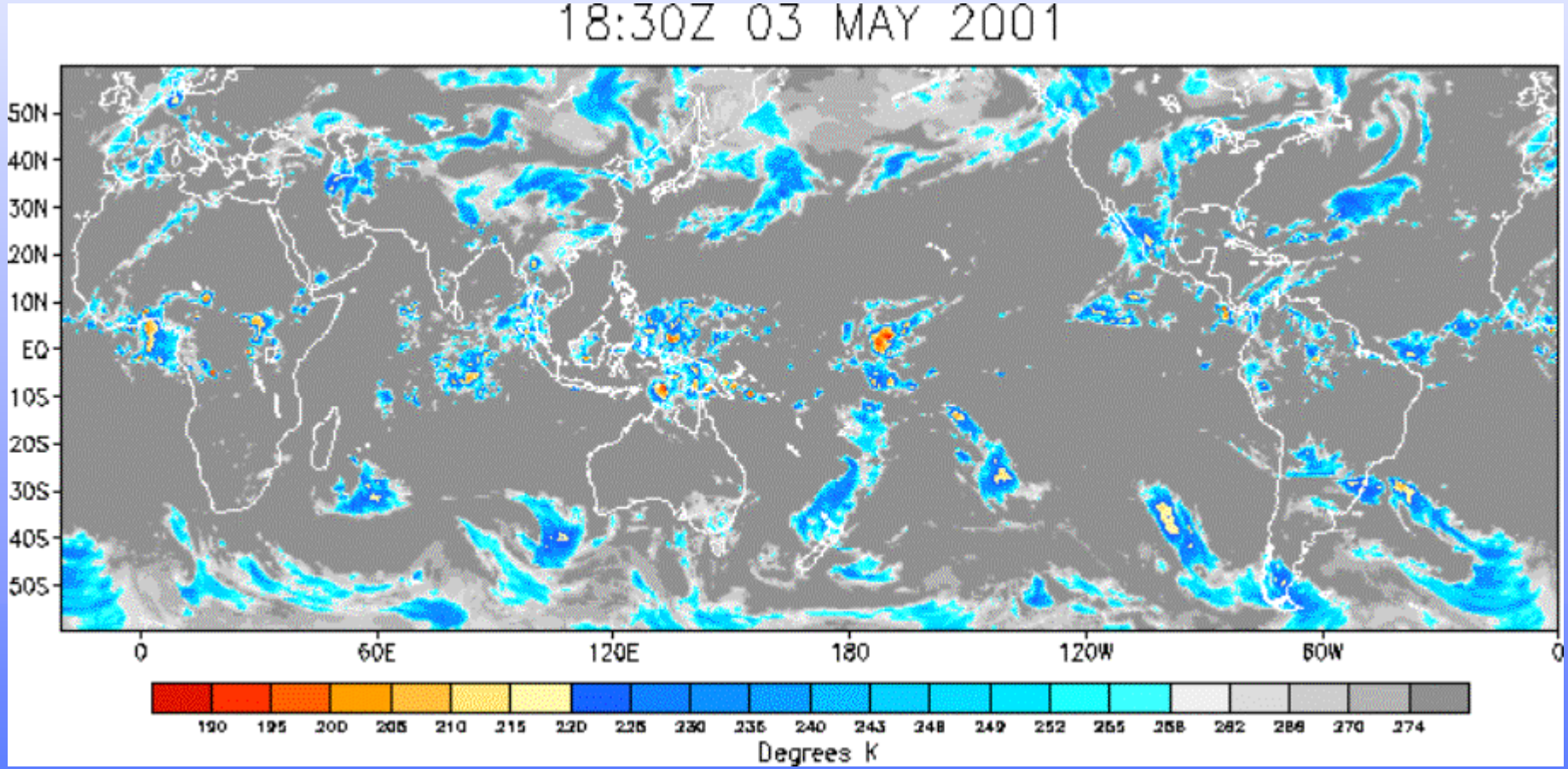




Near-Real Time TRMM Microwave Image Field



Near-Real Time IR Temperature Field

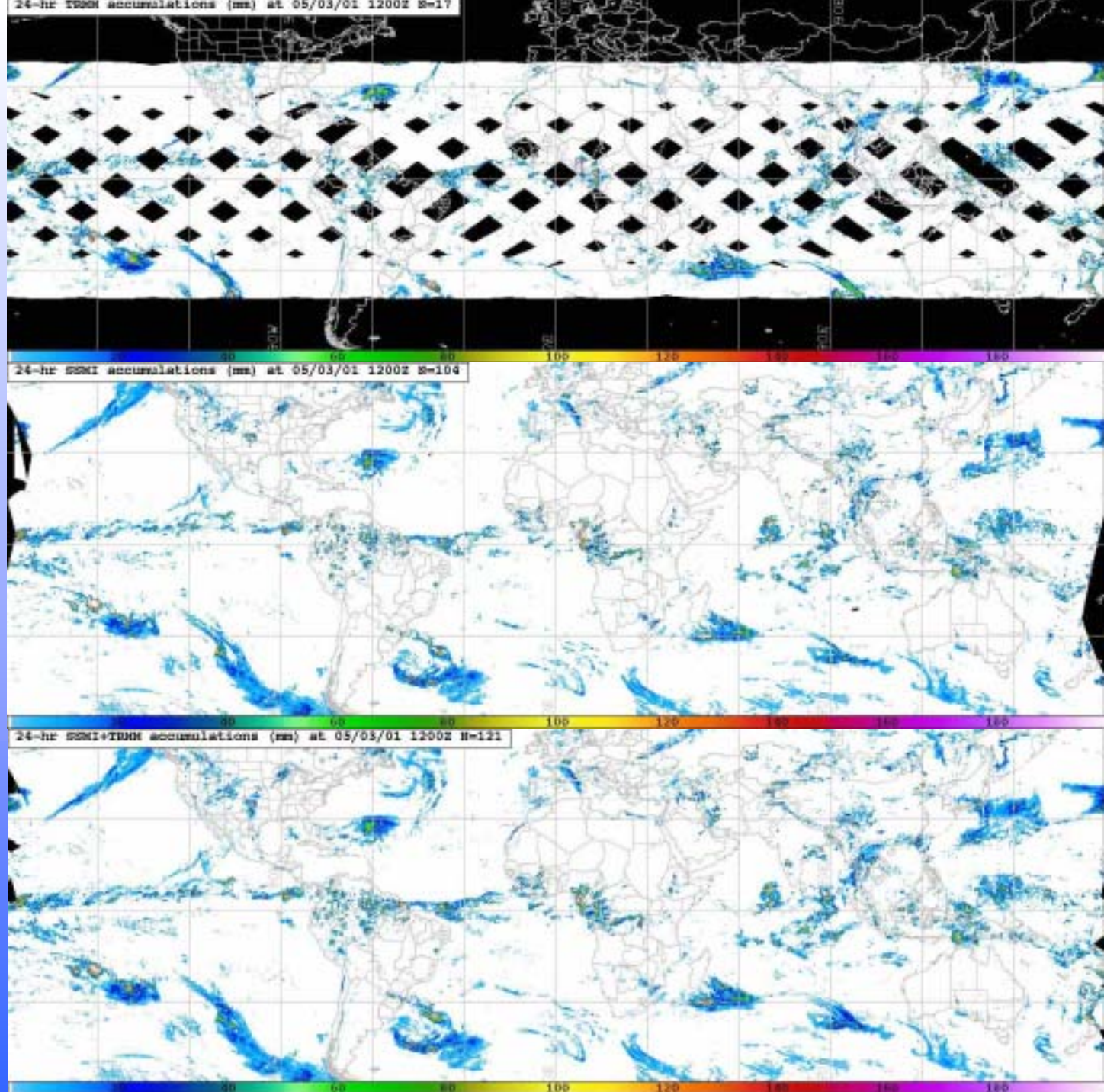


U.S. Navy Near-Real Time Precip

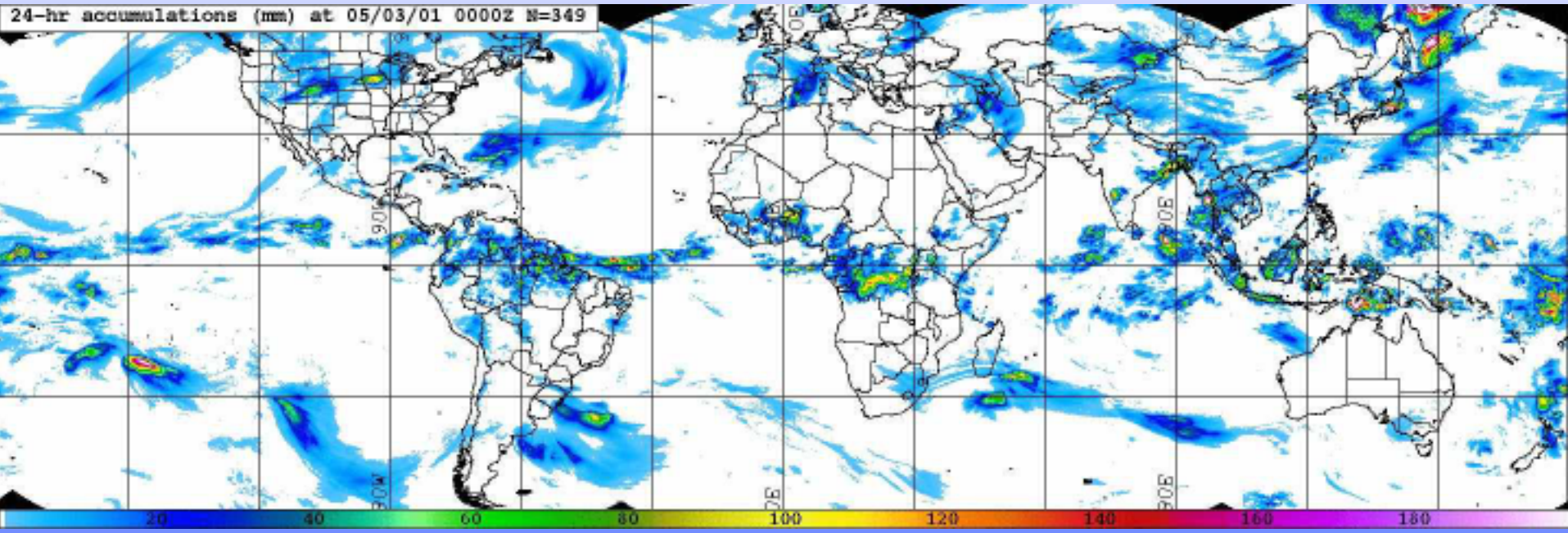
TRMM

SSM/I

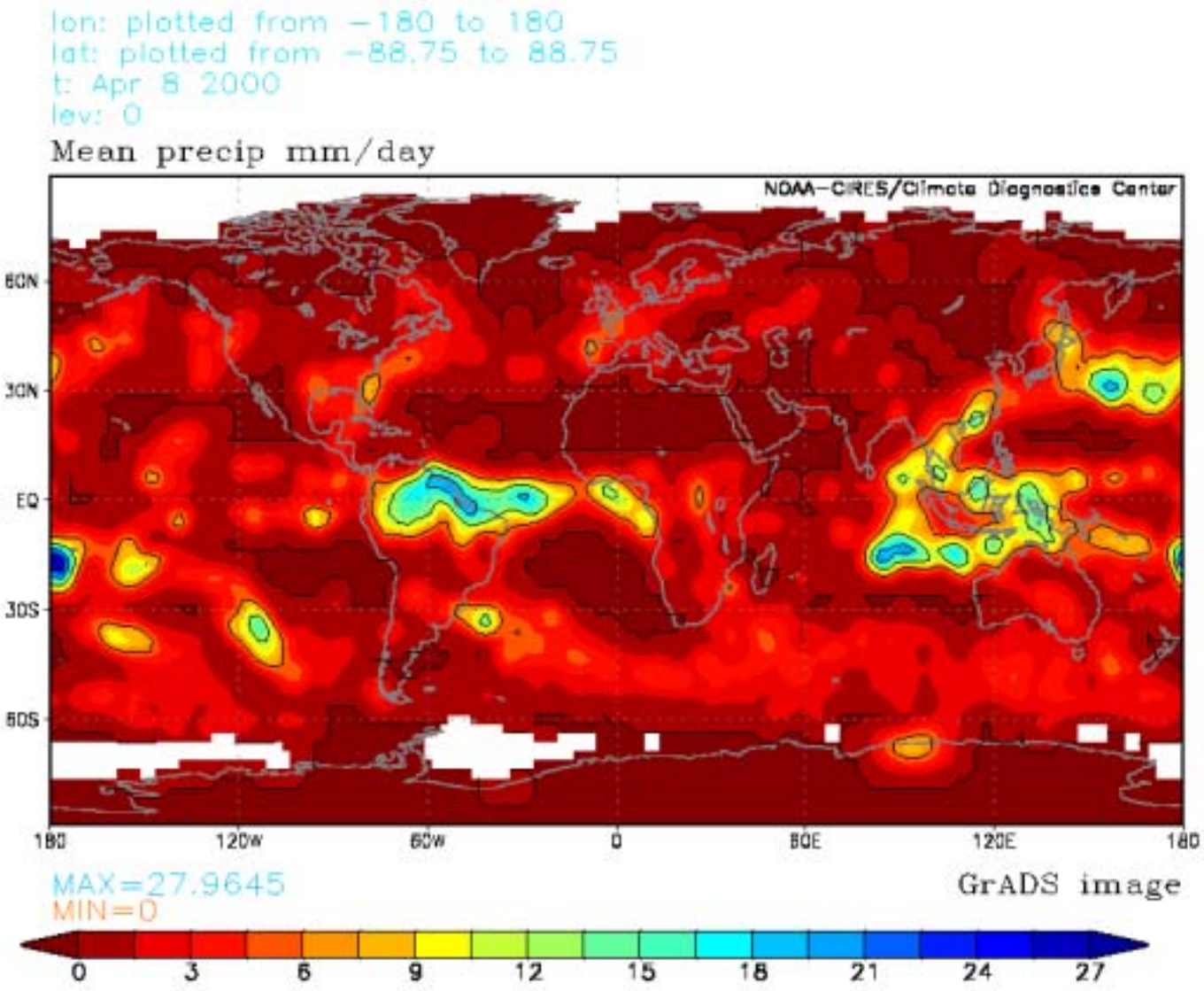
Merged TRMM + SSM/I



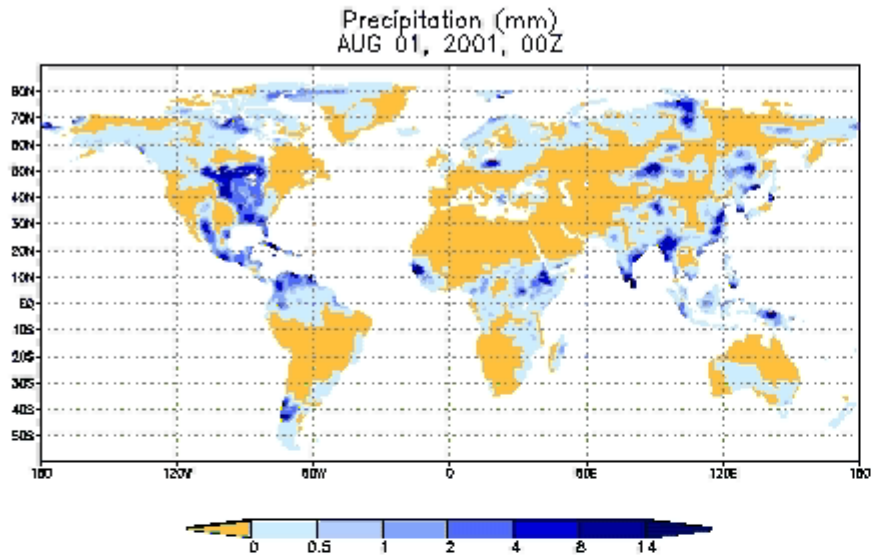
U.S. Navy Near-Real Time Blended Geostationary Satellite IR, TRMM, and SSM/I Precipitation

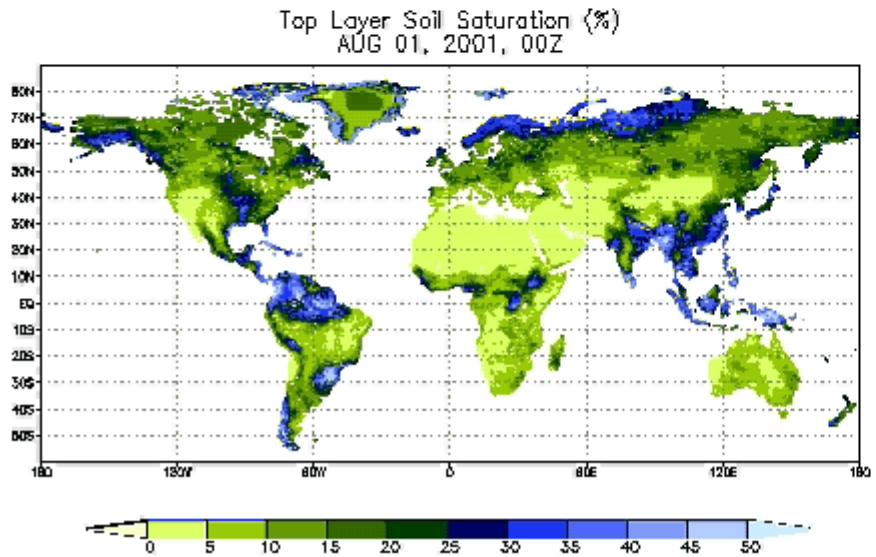


CMAP Blended Precipitation Pentad Field

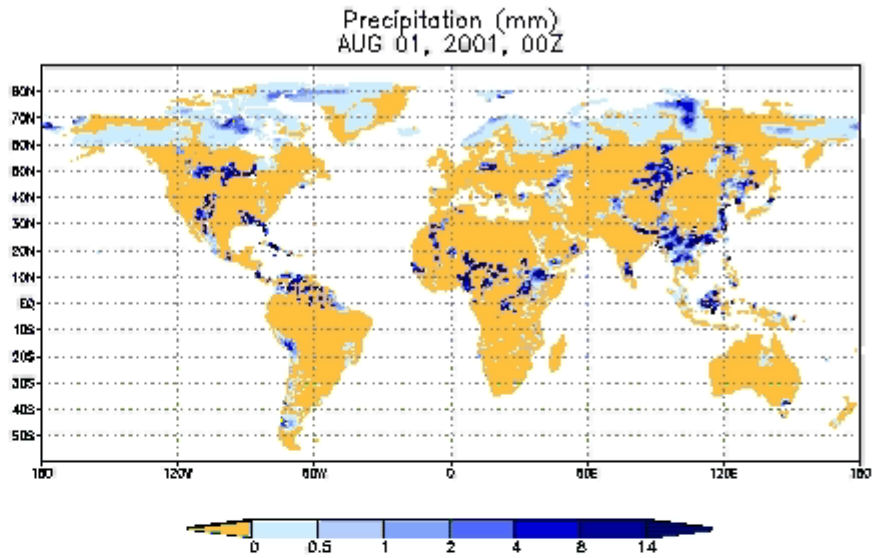


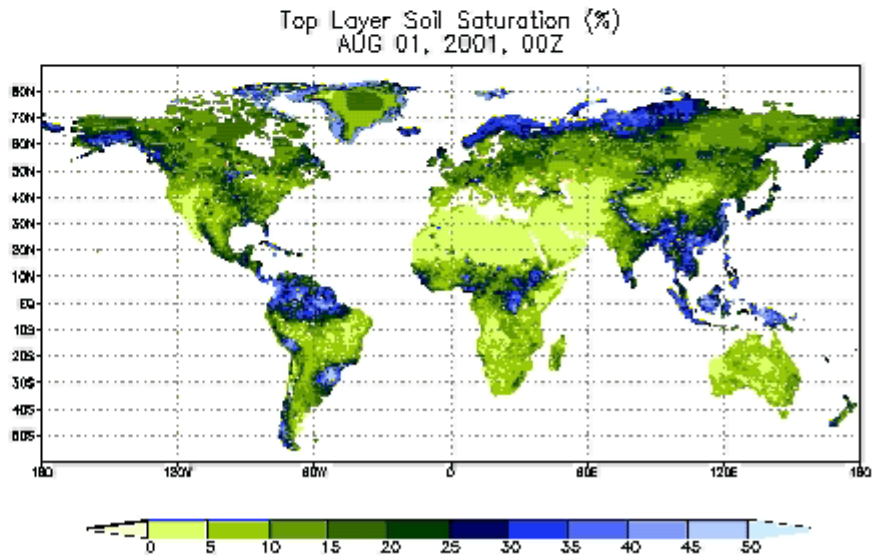
GEOS Model Forcing



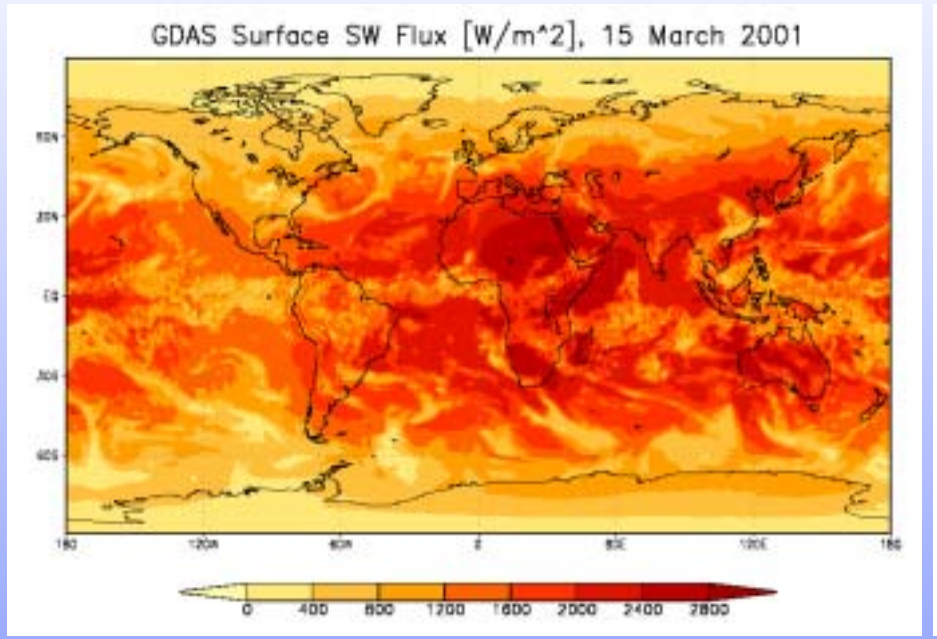


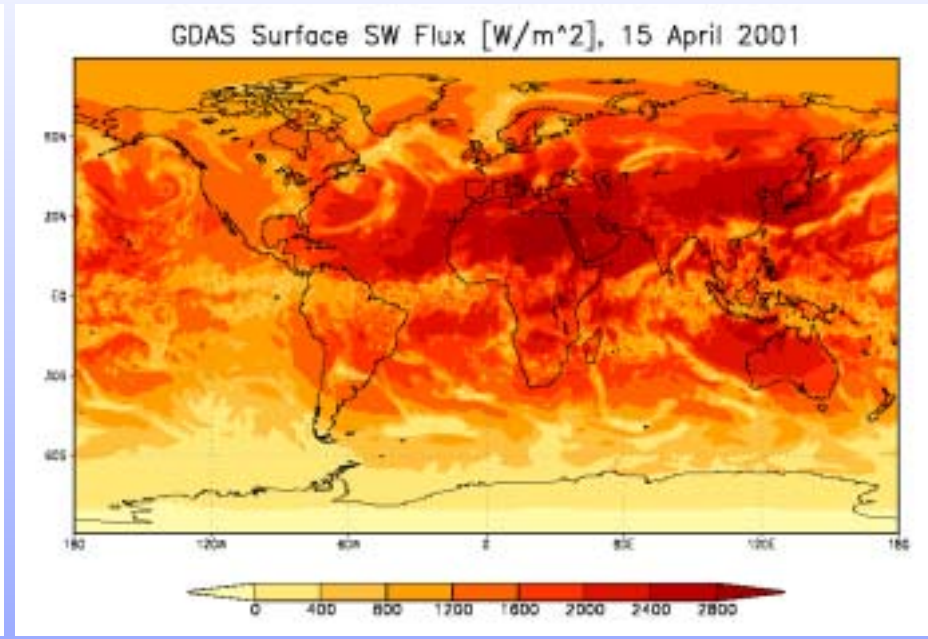
Satellite-derived Precipitation Option

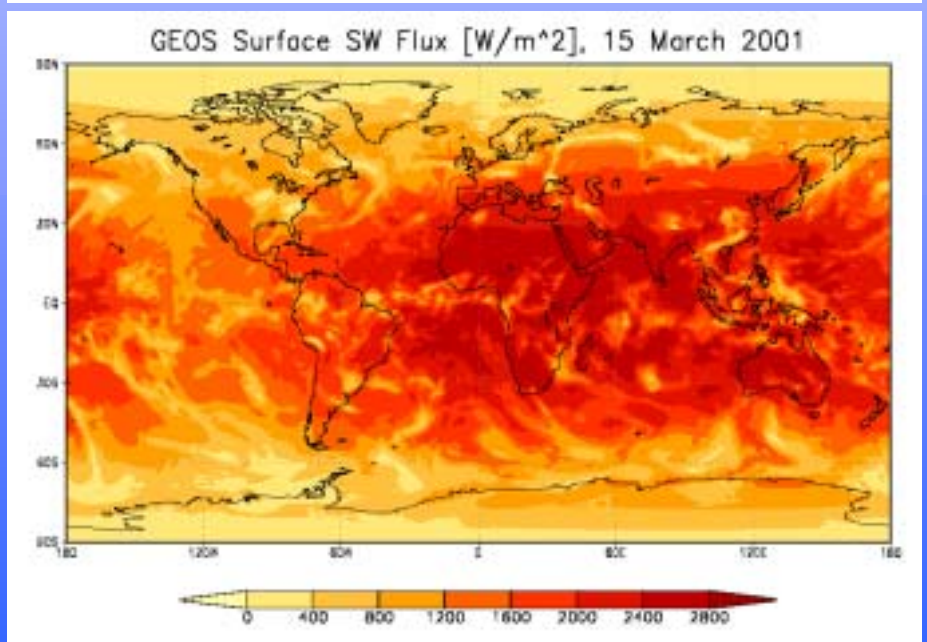


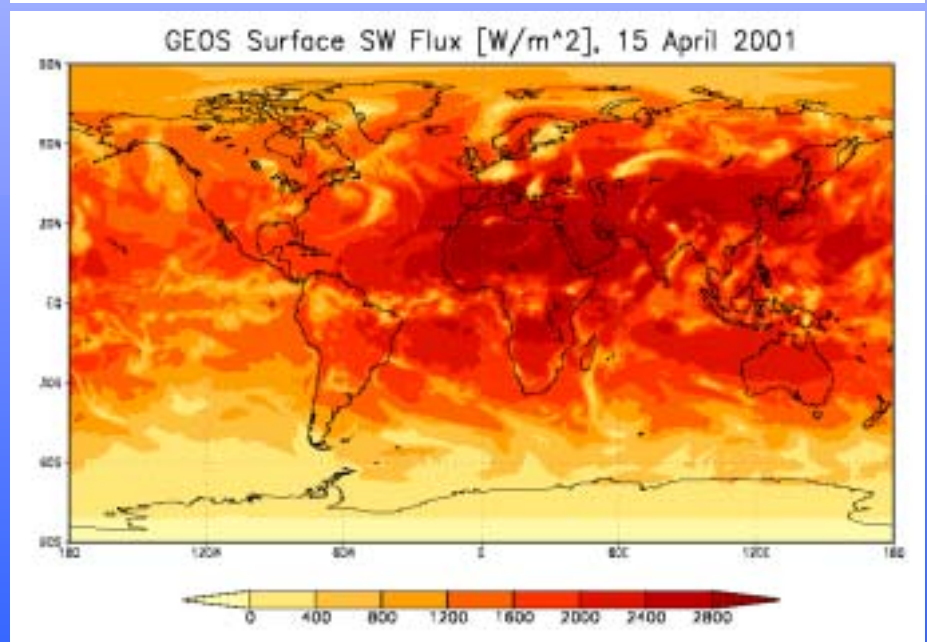


Comparison of Modeled SW Radiation Forcing

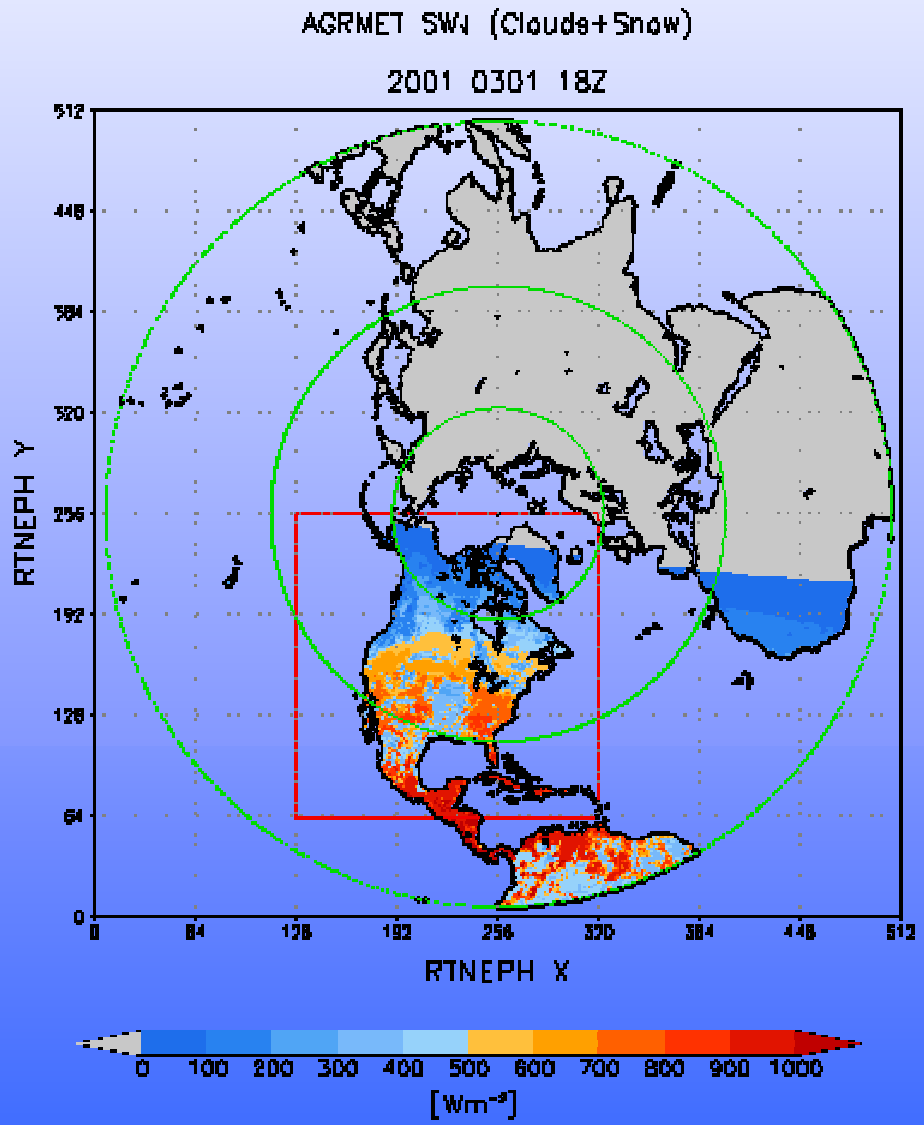






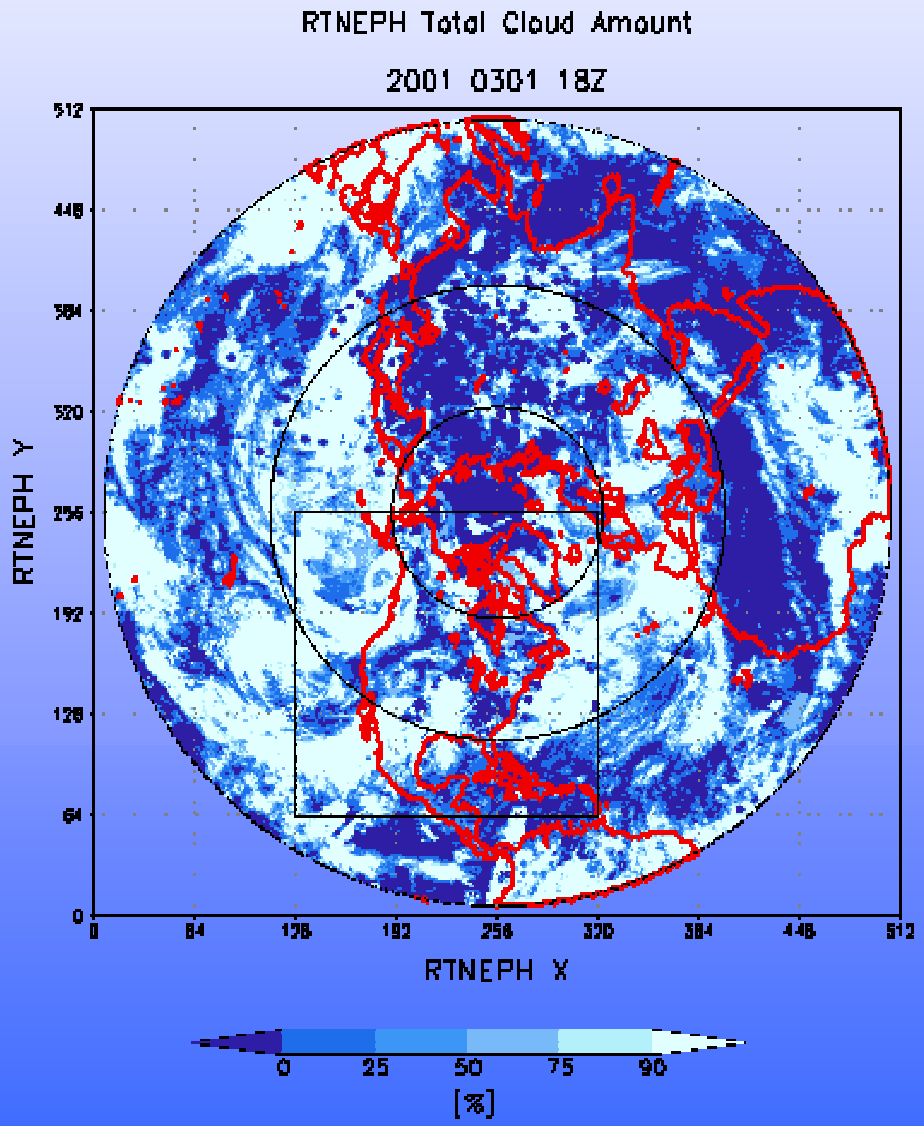


U.S. Air Force AGRMET Surface Insolation Scheme



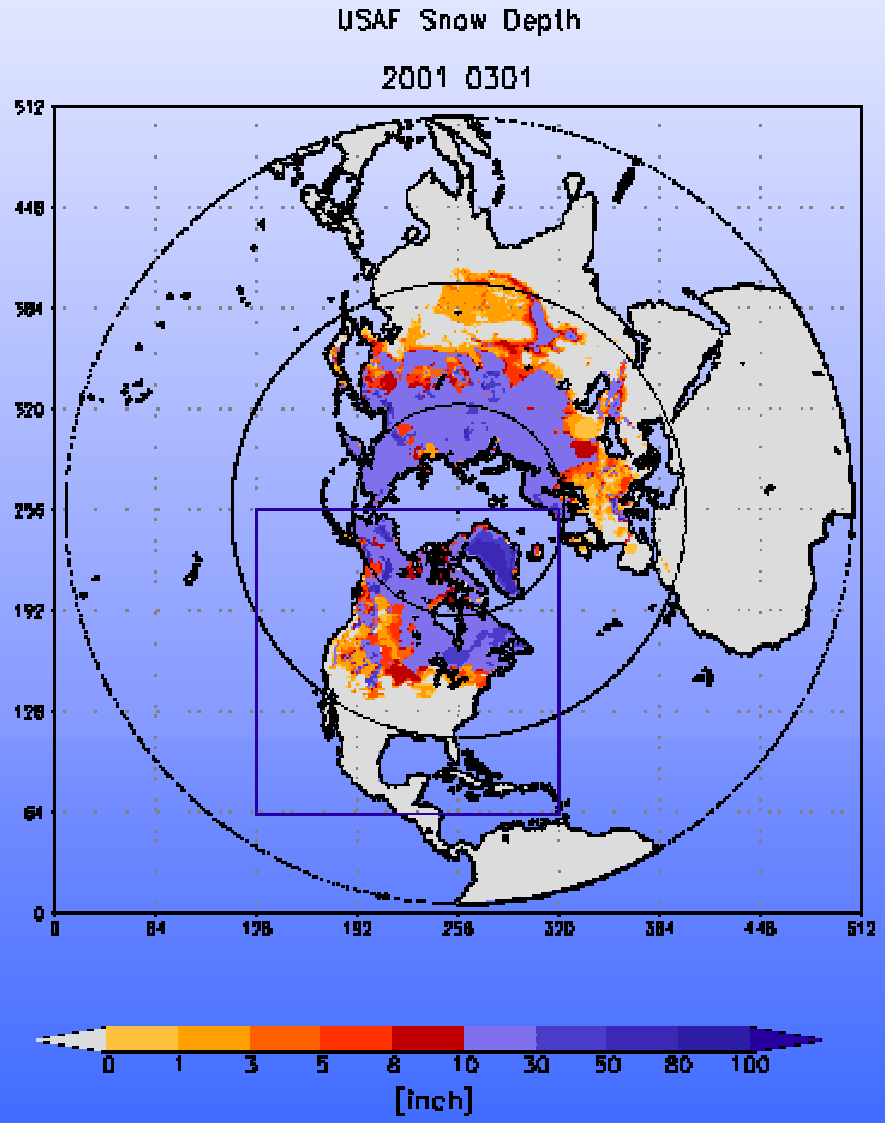
- Shapiro (1987) model
- 13 vegetation types (Dorman and Sellers, 1989)
- Seasonal, snow-dependant surface albedo (NCEP)
- Monthly greenness fraction (Gutman and Ignatov, 1998)

U.S. Air Force RTNEPH Real-Time Cloud Analysis



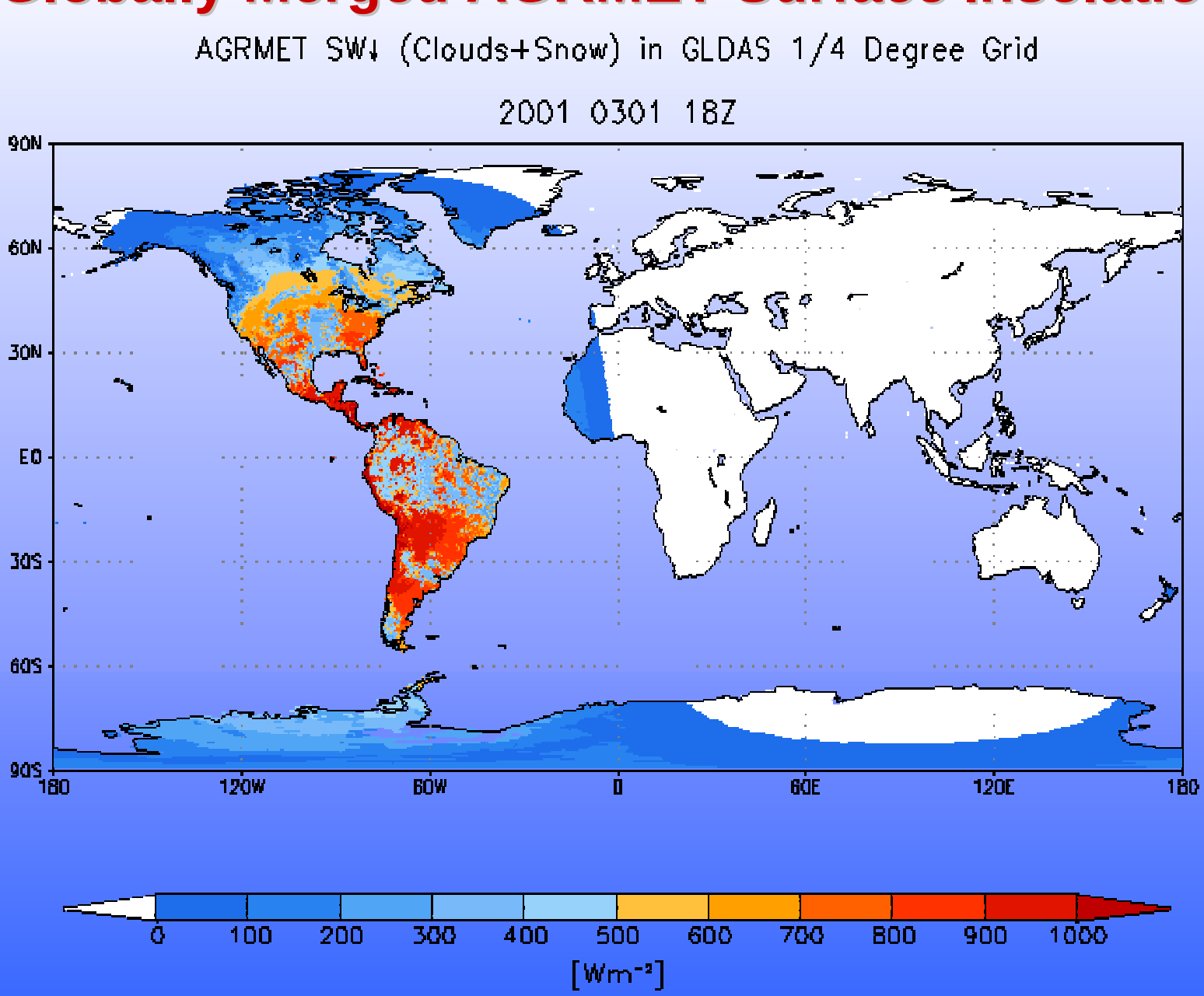
- Based on DMSP and geostationary satellites, surface obs, and aircraft reports.
- 2 polar stereographic maps.
- 1024 x 1024 grids each hemisphere.
- 24 km resolution, true at 60 degree latitude.
- Updated every 3 hours at synoptic times.

U.S. Air Force Snow Analysis



- **Updated daily at 00Z**

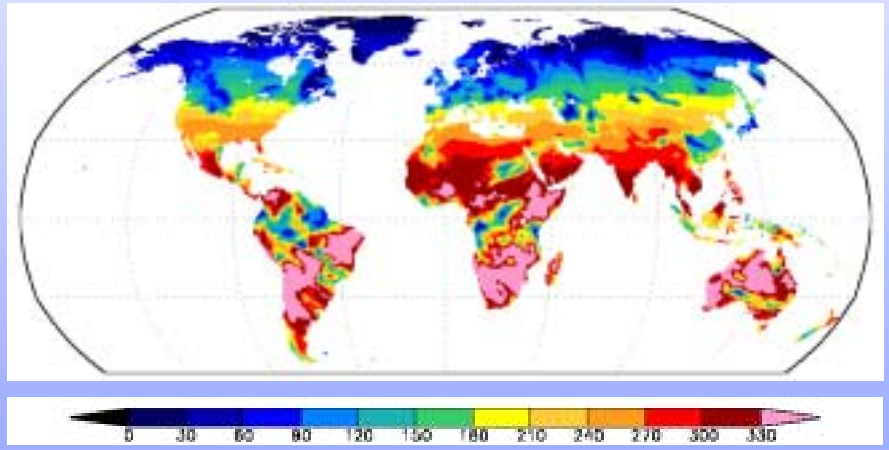
Globally Merged AGRMET Surface Insolation



Modeled vs. Observation-based Forcing

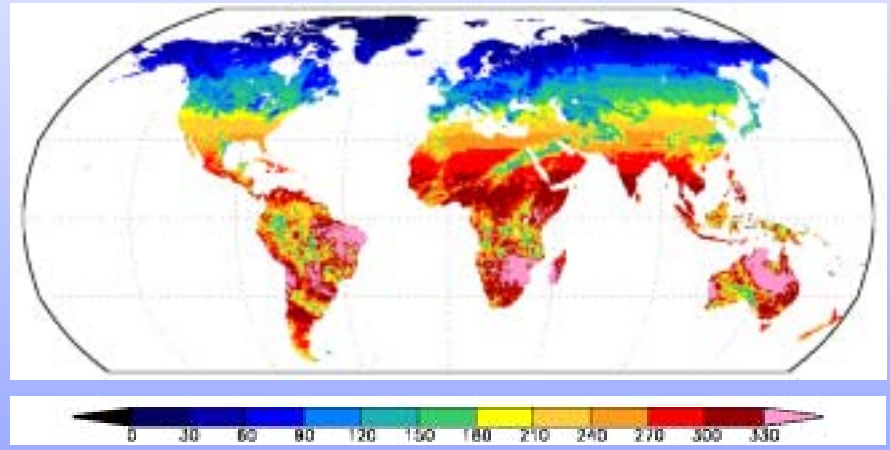
GEOS Model Forcing

Mean Downward SW (W/m^2)



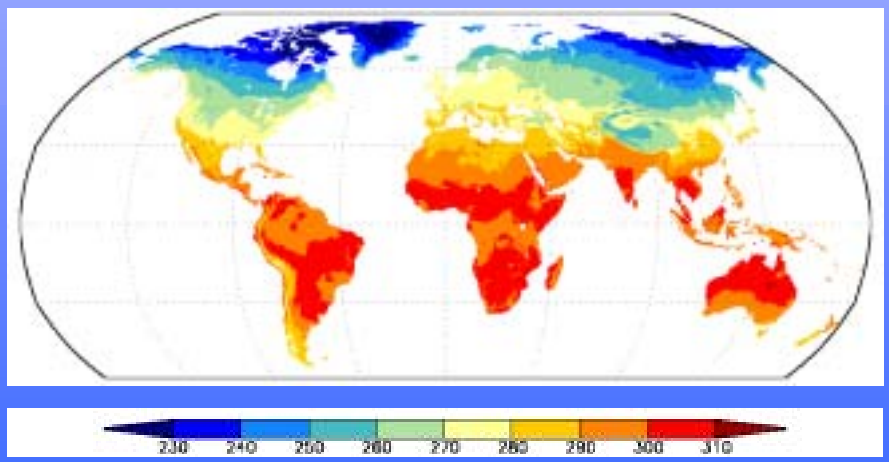
AGRMET Radiation Option

Mean Downward SW (W/m^2)

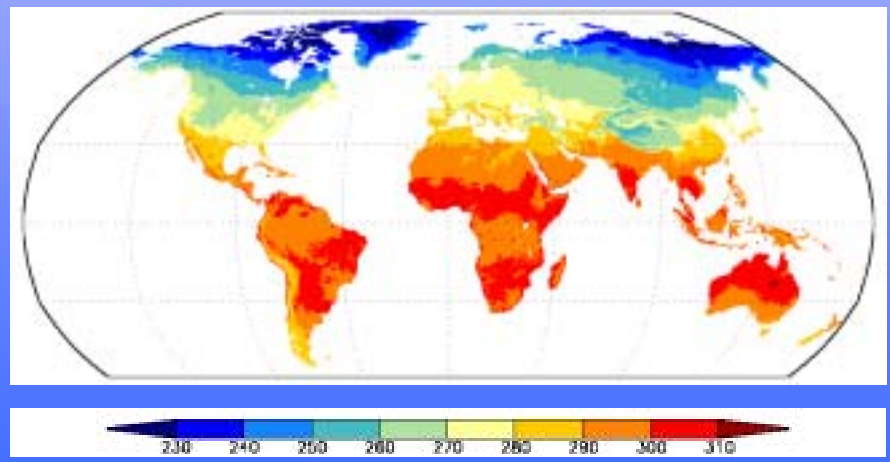


28 February 2002

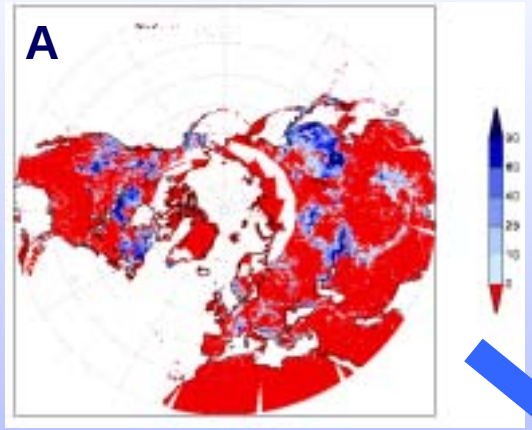
Mean Output Surface Temp (K)

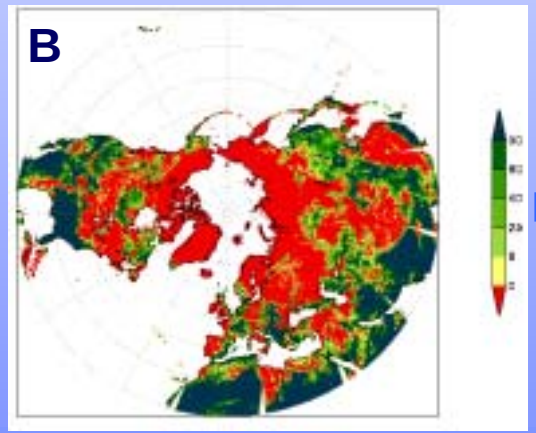


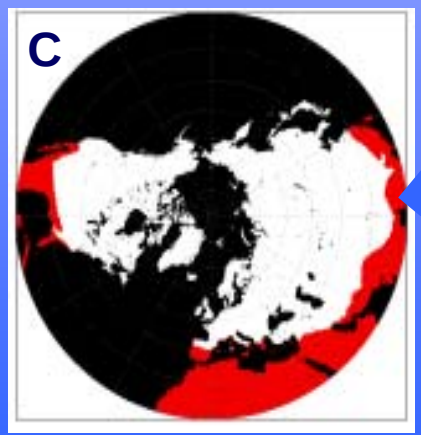
Mean Output Surface Temp (K)



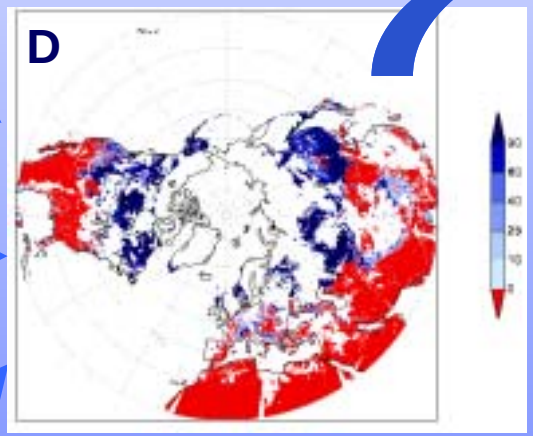
GLDAS Observation-based Snow Correction



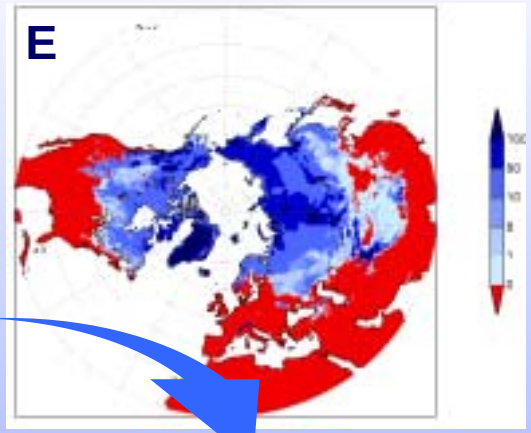


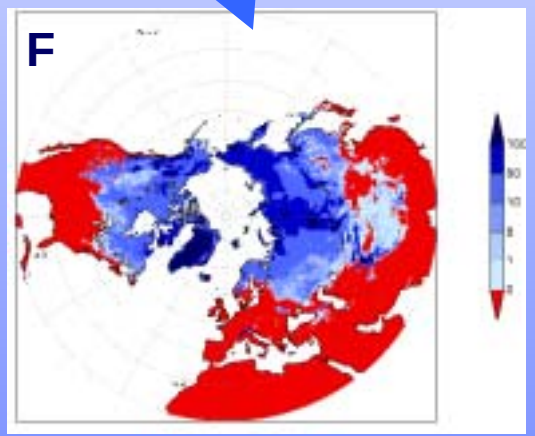


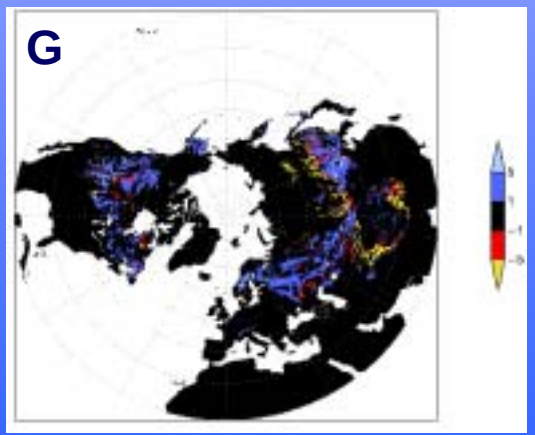
Original MODIS visible snow cover (%) *A* is modified using MODIS confidence index (total visibility; %) *B* and a snow impossible mask *C* in order to produce an enhanced snow field *D*.



This is used to update the modeled snow on a daily basis. Output snow depth (mm H2O) is shown for 30 November 2000, after running the Mosaic LSM without *E* and with *F* the snow correction for 30 days. Map *G* shows the difference (mm H2O) between the two results.

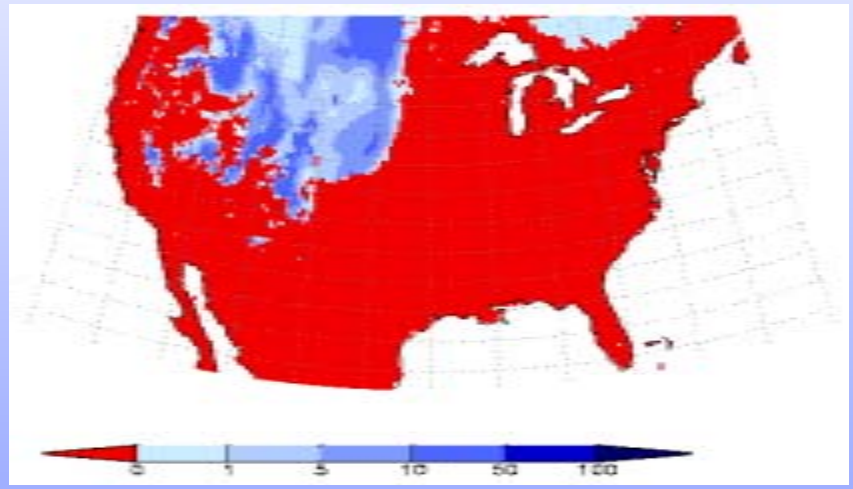




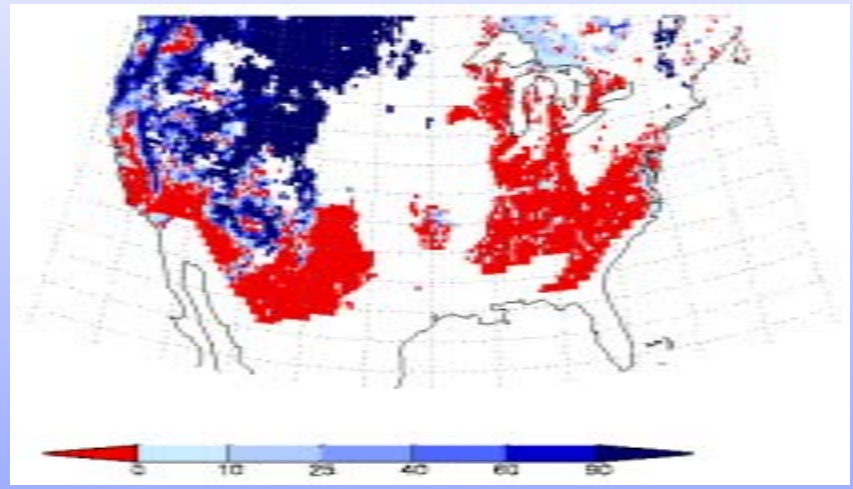


GLDAS Observation-based Snow Correction

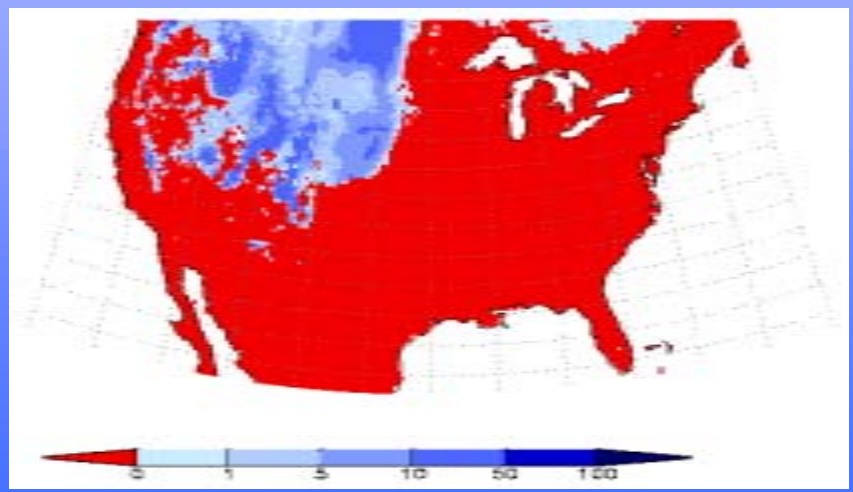
Uncorrected Mosaic snow (mm)



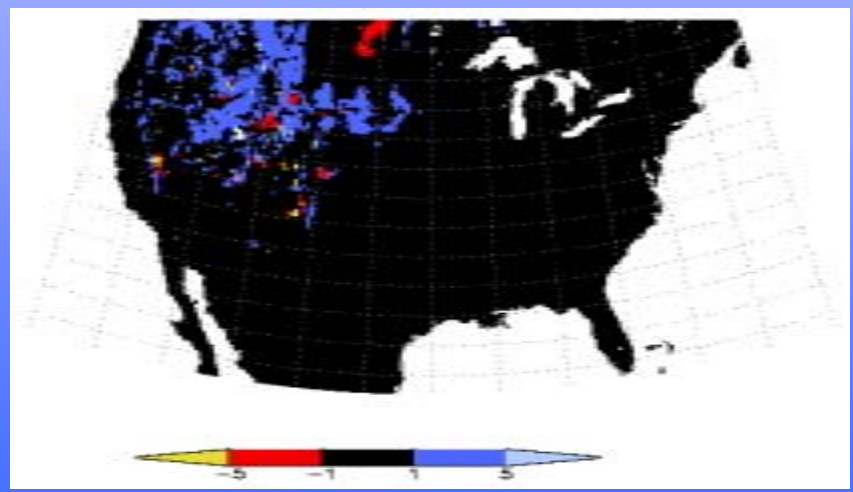
Enhanced MODIS Snow Cover (%)



11 November 2000

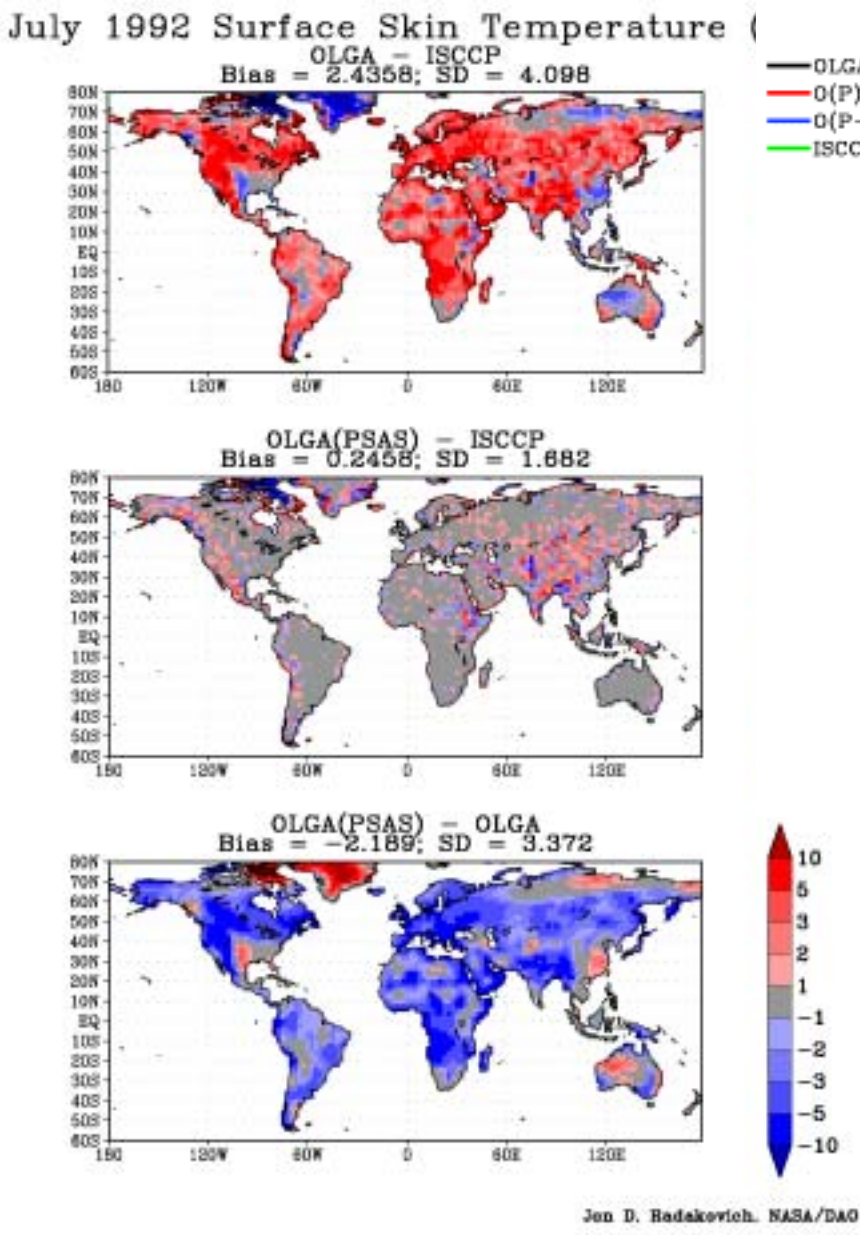


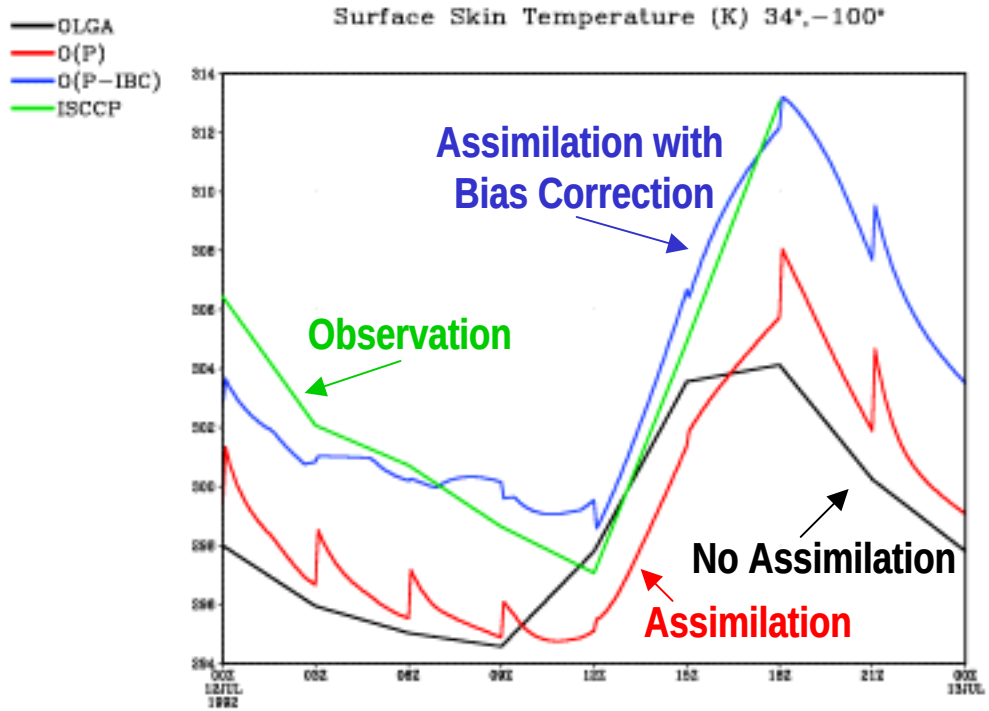
Corrected Mosaic snow (mm)



Mosaic Snow Difference (mm)

GLDAS Surface Temperature Assimilation





Physical Space Analysis System (PSAS) 3-D VAR (optimal interpolation) data assimilation

GLDAS Simulations

Ongoing Real-Time:

- Mosaic, GEOS forcing, 0.25°, 1/01-present
- Mosaic, GDAS forcing, 0.25°, 1/01-present
- Mosaic, Observation-based forcing (precip, ↓ SW & LW), 0.25°, 1/01-present
- NOAH, GEOS forcing, 0.25°, 1/01-present
- NOAH, Observation-based forcing, 0.25°, 1/01-present

Retrospective:

- Mosaic, Bias-corrected ECMWF reanalysis forcing, 2° x 2.5° & 0.5°, 1979-1993
- Mosaic, Bias-corrected NCEP/NCAR reanalysis forcing, 2° x 2.5° & 0.5°, 1979-1993

NWP and Climate Model Initialization Testing:

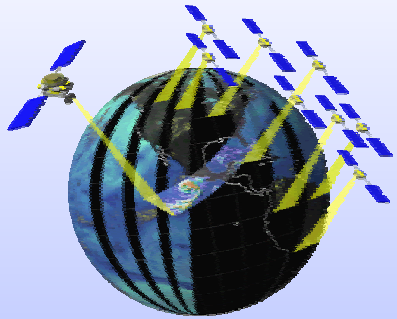
- NASA Seasonal to Interannual Prediction Project (NSIPP)
- NASA Data Assimilation Office FVDAS NWP model

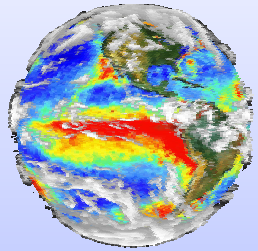
Planned Near-Future Simulations:

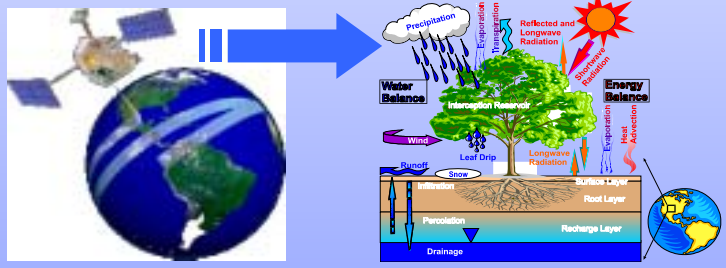
- Real-time CLM2
- Retrospective NOAH and CLM2
- ECMWF model forcing
- Numerous experimental studies including assimilation

GLDAS Data Integration for CEOP

INTERCOMPARISON and OPTIMAL MERGING of global land surface forcing and state fields

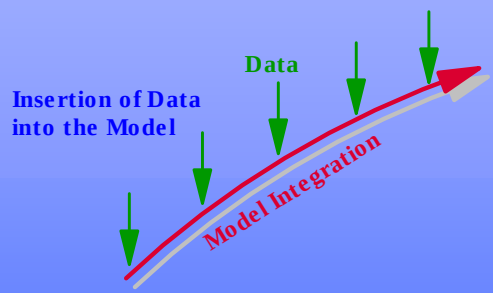


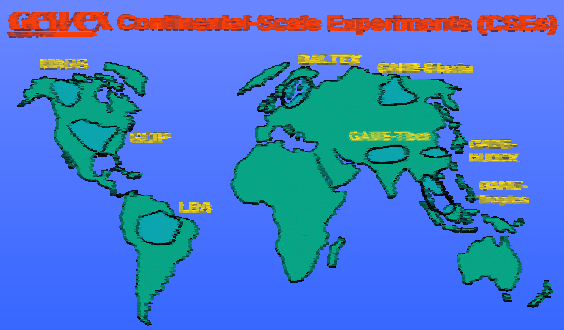




Satellite observations of meteorological variables used as land surface model FORCING

ASSIMILATION of satellite observations of land surface states into land surface models

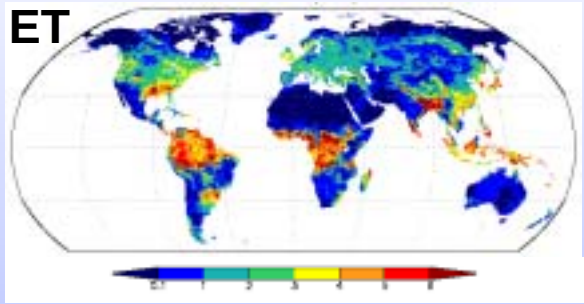


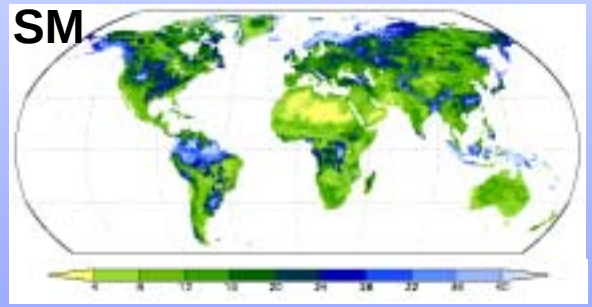


Ground-based observations and results from field experiments used to VALIDATE model output

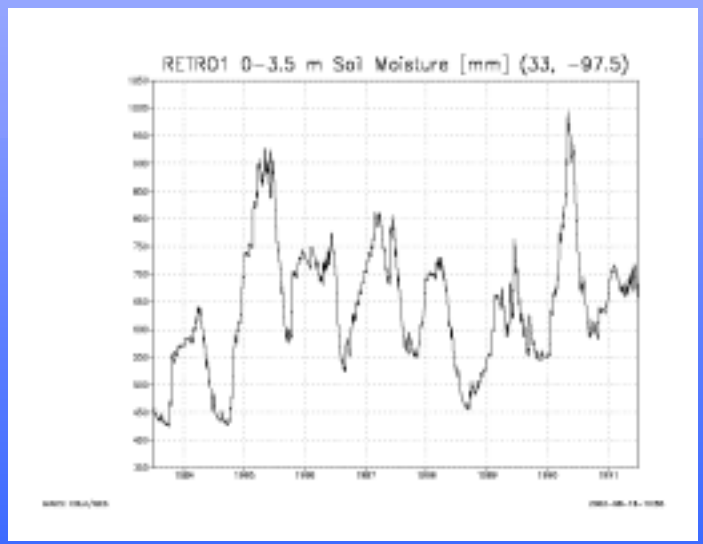
Potential GLDAS Contributions to CEOP

Secondary archive of selected global land surface data to complement NASDA CSDIC (primary CEOP archive)





GLDAS products for land model intercomparison, mesoscale model initialization, and additional experiments



Model location time series (MOLTS) that are vegetation-specific