Remote Sensing Products: NCEP Land Model Requirements

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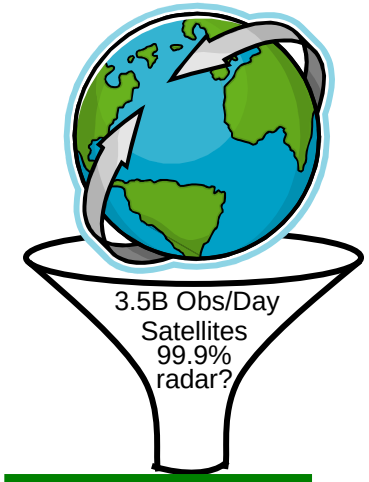
Environmental Modeling Center (EMC)
National Centers for Environmental Prediction (NCEP)
NOAA/NWS

NOAA Satellite Science Week Virtual Meeting
10 – 14 March, 2014

Noah Land Model Connections in NOAA's NWS Model Production Suite



Global Data Assimilation

Regional Data Assimilation

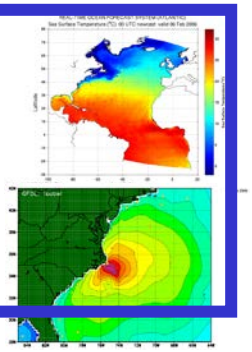
Climate CFS
MOM3

Global Forecast System

Hurricane
GFDL
HWRF

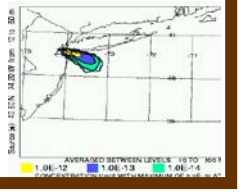
2-Way Coupled

Oceans
HYCOM
WaveWatch III

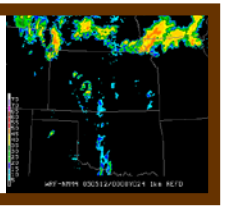


Regional NAM
WRF NMM
(including NARR)

Dispersion
ARL/HYSPLIT

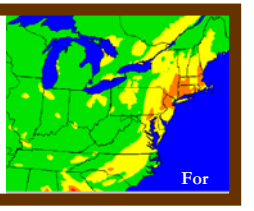


Severe Weather
WRF NMM/ARW
Workstation WRF



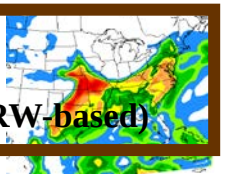
Short-Range Ensemble Forecast
WRF: ARW, NMM
ETA, RSM

Air Quality
NAM/CMAQ

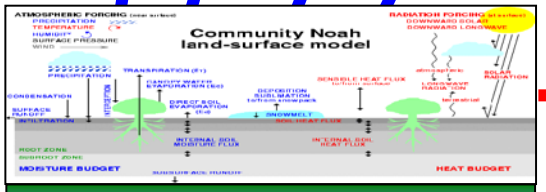


North American Ensemble Forecast System
GFS, Canadian Global Model

Rapid Update for Aviation (ARW-based)



NCEP, NCAR, UT-Austin, U. Ariz., & others

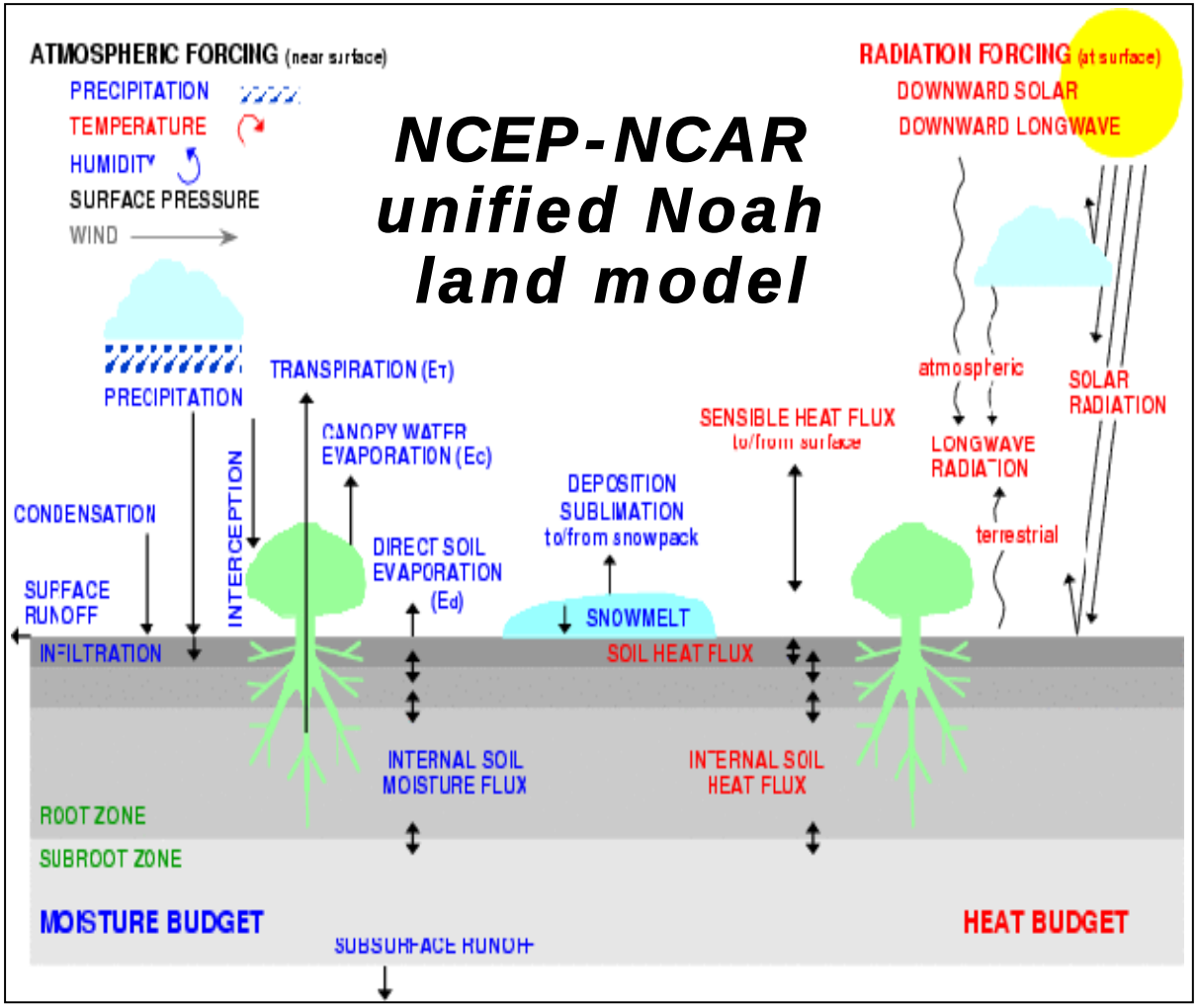


NOAH Land Surface Model

Uncoupled "NLDAS" (drought)

Role of Noah Land Model

- Close surface energy & water budgets,
- Determine **heat**, **moisture**, and **momentum** exchange between surface & atmosphere,



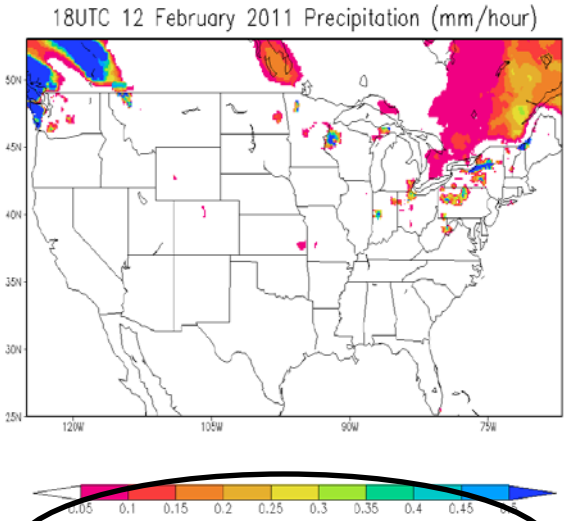
- Noah land model provides surface boundary conditions to parent atmospheric model, e.g. NAM, GFS, CFS.

Land Model Requirements

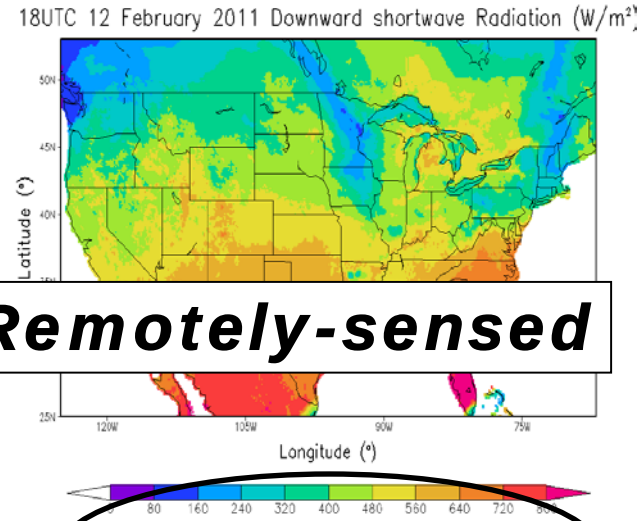
To provide these proper boundary conditions, land model must have:

- **Atmospheric forcing** to drive land model,
- Appropriate **physics** to represent land-surface processes,
- **Initial land states**, e.g. soil moisture/ice and snow, analogous to initial atmospheric conditions, though land states may carry more “memory”, especially deep soil moisture, similar to SSTs,
- **Land data sets** e.g. land use/land cover (vegetation type), soil type, surface albedo and emissivity, and associated parameters, e.g. surface roughness, soil and vegetation properties.

Atmospheric Forcing

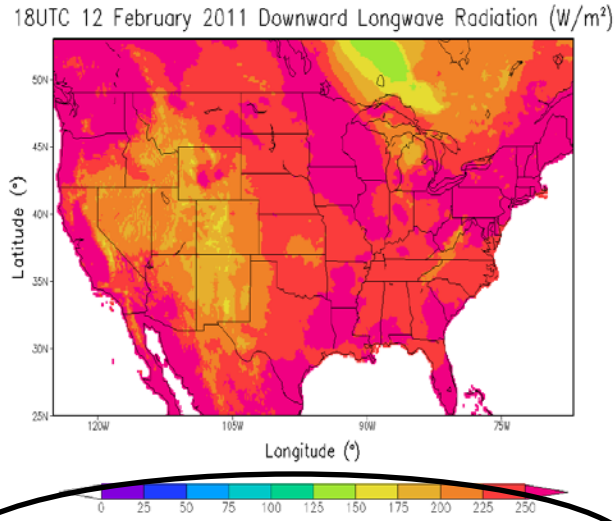


Precipitation

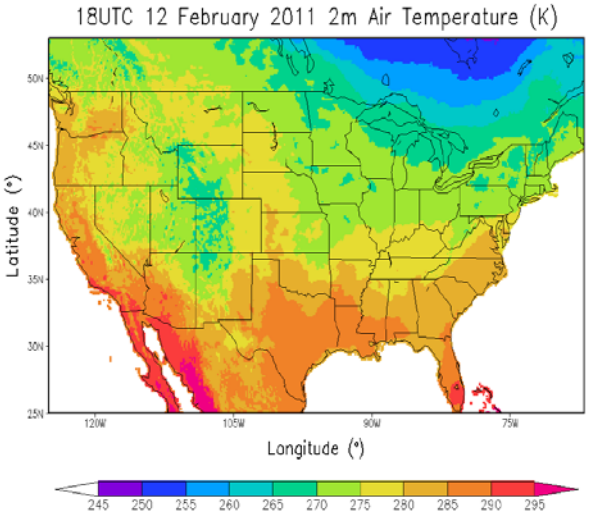


Remotely-sensed

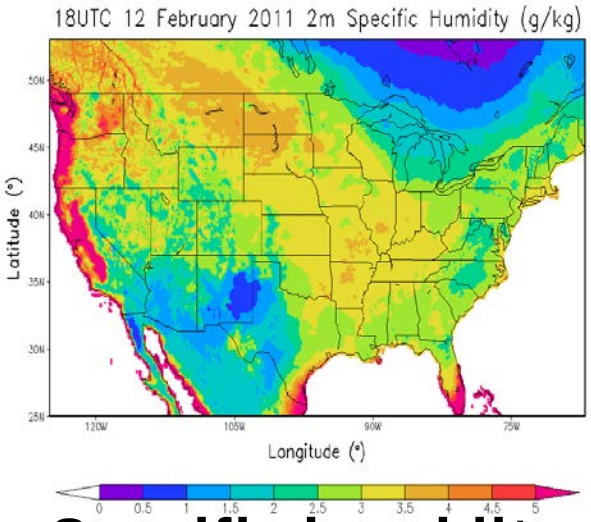
Incoming solar



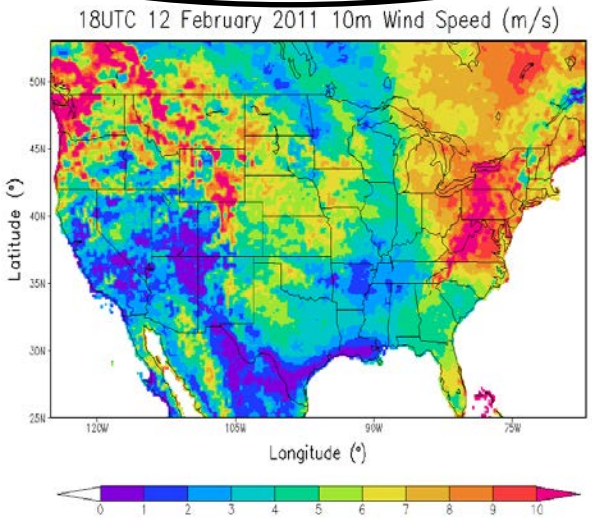
Incoming Longwave



Air temperature



Specific humidity



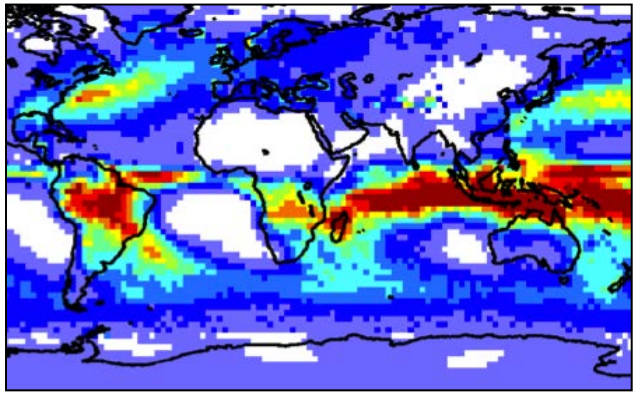
Wind speed

+ Atmospheric Pressure

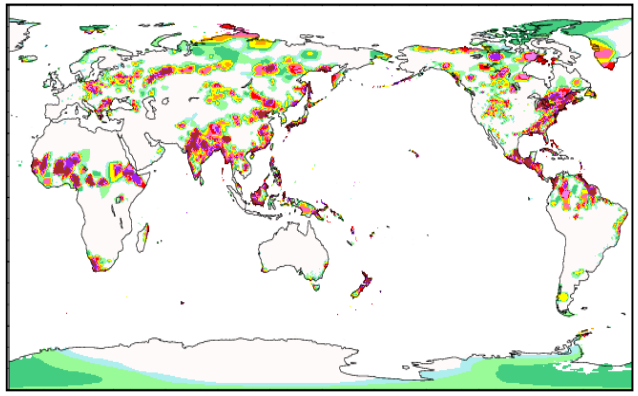
Example from 18 UTC, 12 Feb 2011

Atmospheric Forcing: Precipitation

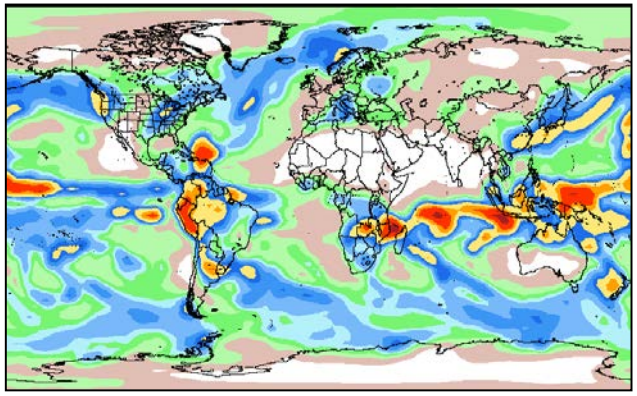
- Global Land Data Assimilation System (GLDAS) used in the NCEP Climate Forecast System (CFS) relies on a “blended” precipitation product, a function of:
- **Satellite-estimated precipitation** (CMAP), heaviest weight in tropics where gauges sparse.
- Surface gauge network, heaviest in mid-latitudes.
- High-latitudes: Model-estimated precipitation based on Global Data Assimil. System (GDAS).



CMAP

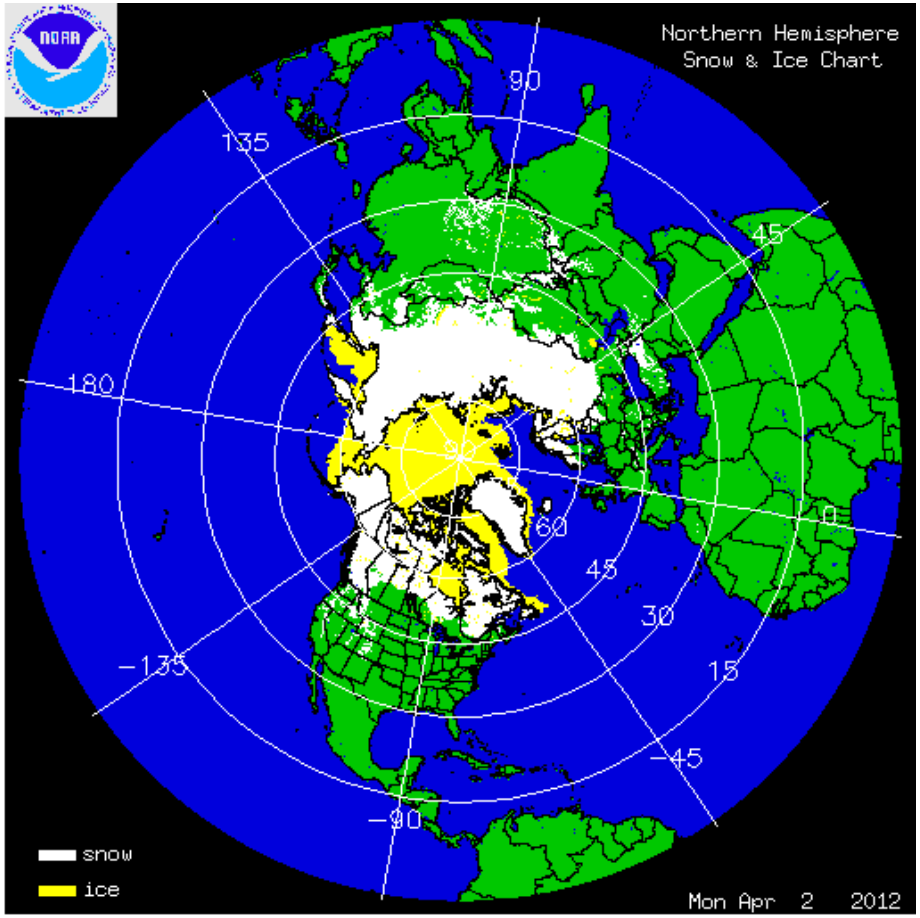


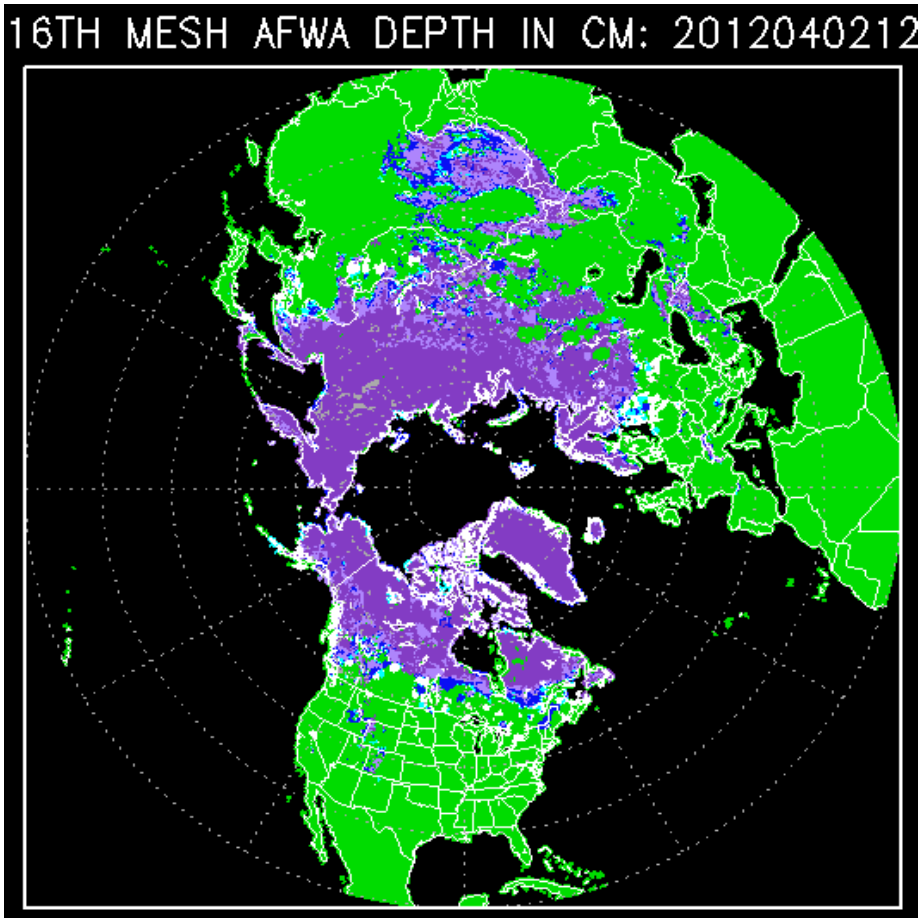
Surface gauge



GDAS

Initial land states: Snow Products



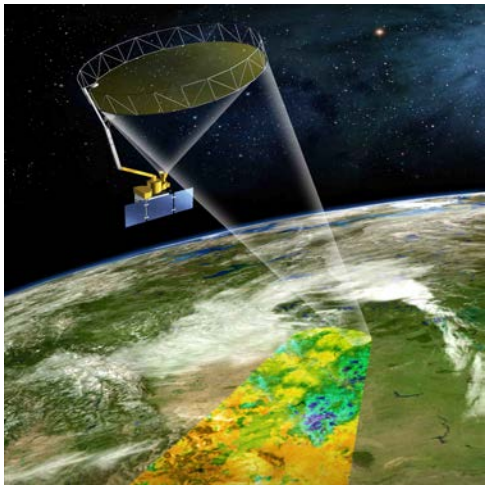


02 April 2012

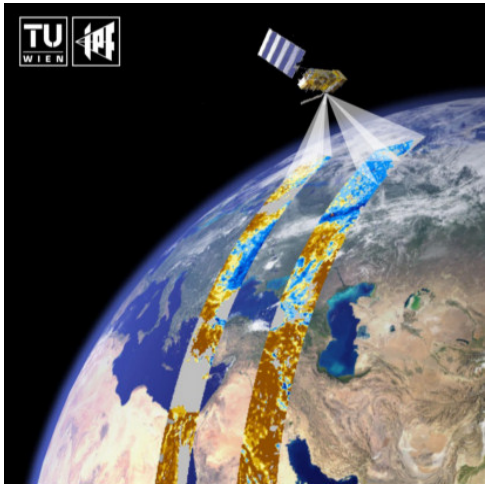
4-km Snow Cover
(daily integrated
NIC IMS product)

24-km Snow Depth
(daily integrated
AFWA product)

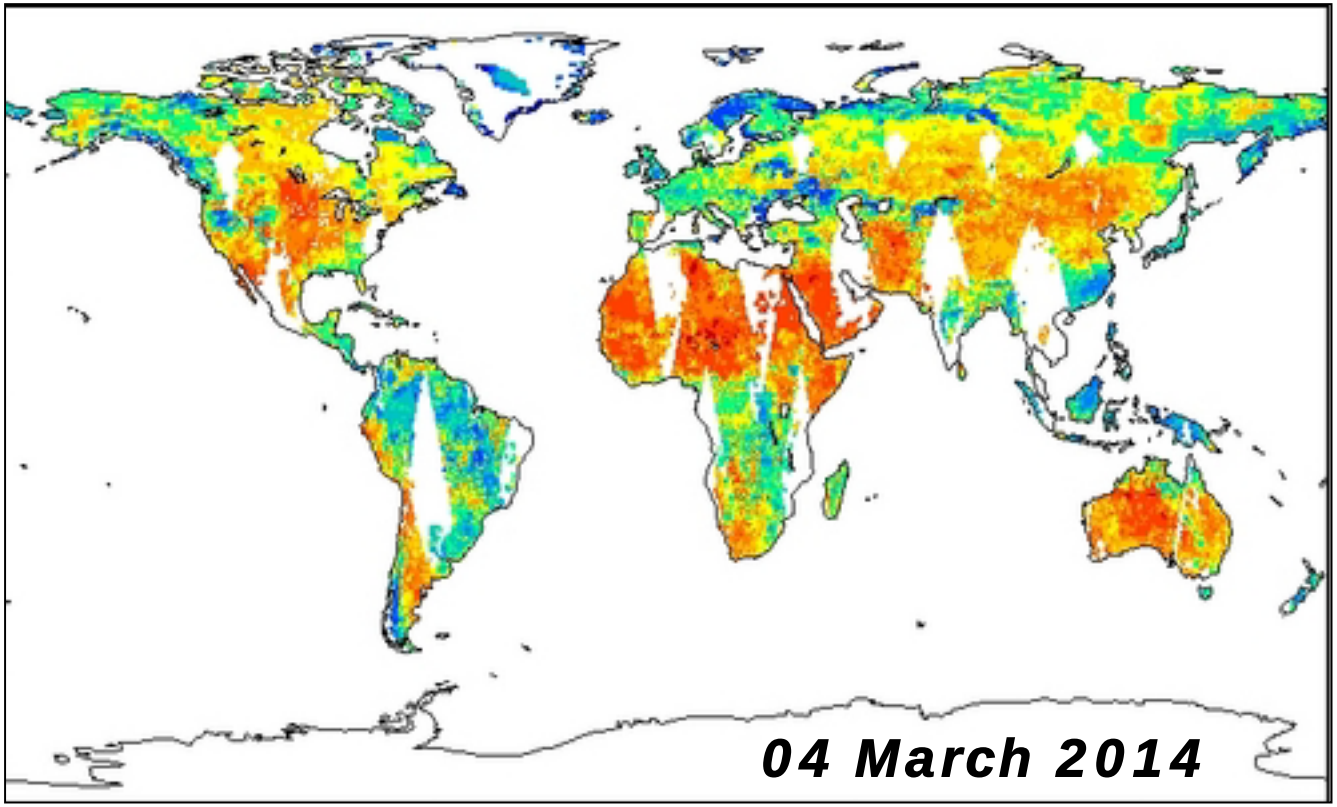
Initial land states: Soil Moisture



ESA SMOS



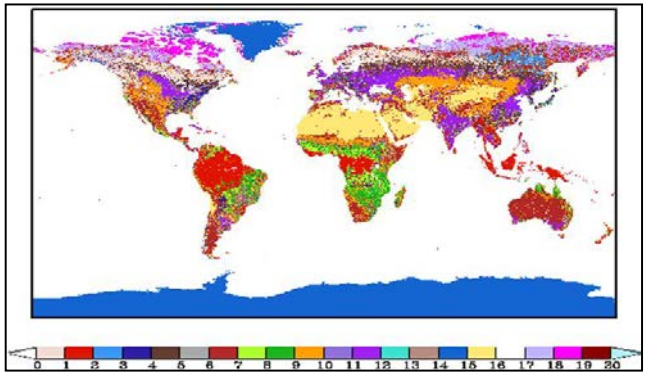
NASA SMAP
(Oct 2014 launch)



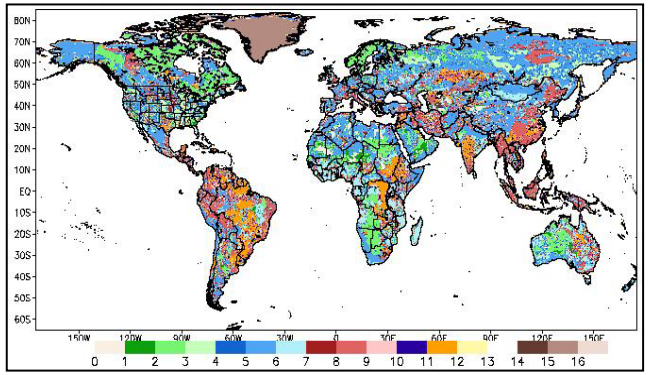
SMOPS Blended Daily Soil Moisture

- **Testing assimilation of SMOPS into NCEP global model.**

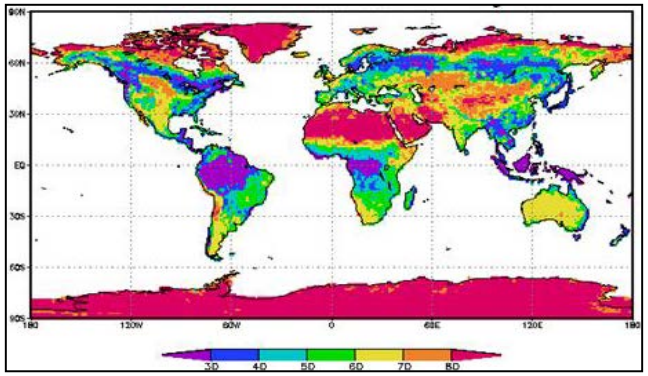
Land Data Sets *(e.g. meso NAM ~12/4/1-km)*



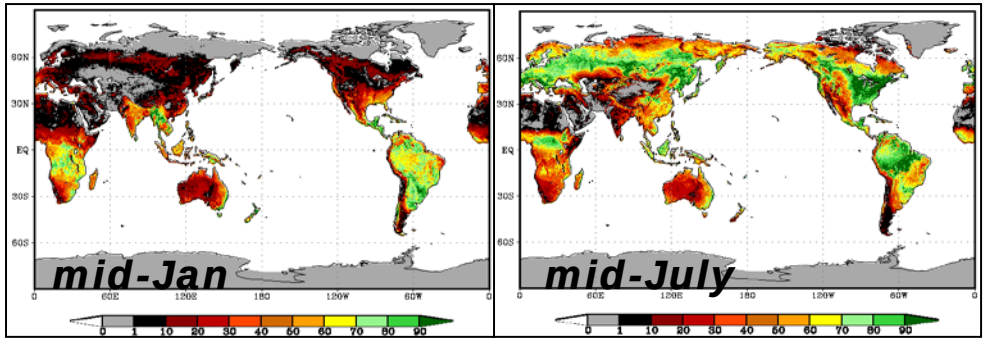
Vegetation Type
(1-km, IGBP-MODIS)



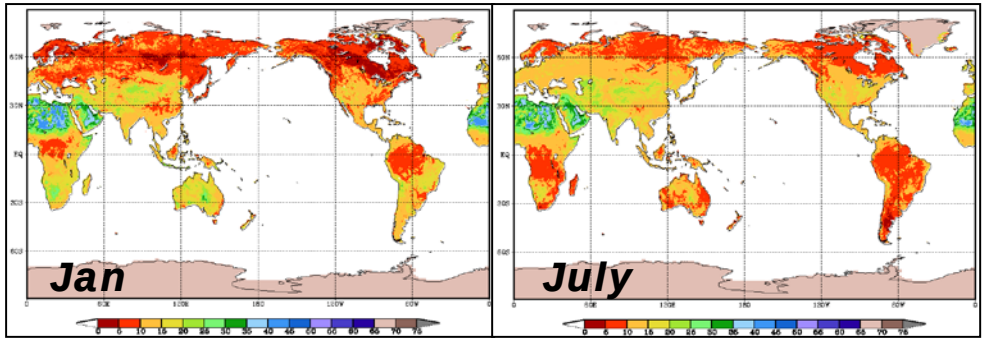
Soil Type
(1-km, STATSGO-FAO)



Max.-Snow Albedo
(1-km, UAz-MODIS)



Green Vegetation Fraction
(weekly, 1/8-deg,
new NESDIS/AVHRR)

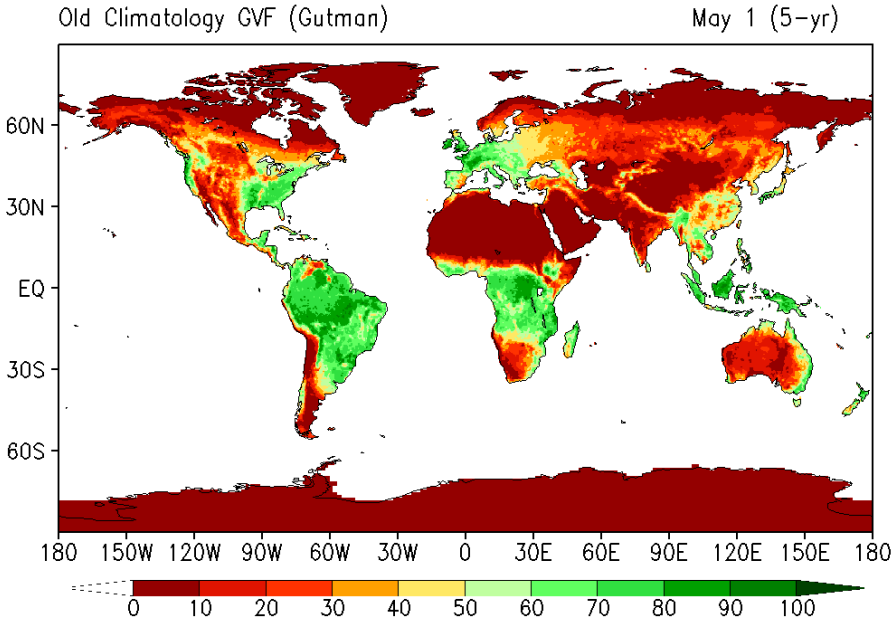


Snow-Free Albedo
(monthly, 1-km,
BU-MODIS)

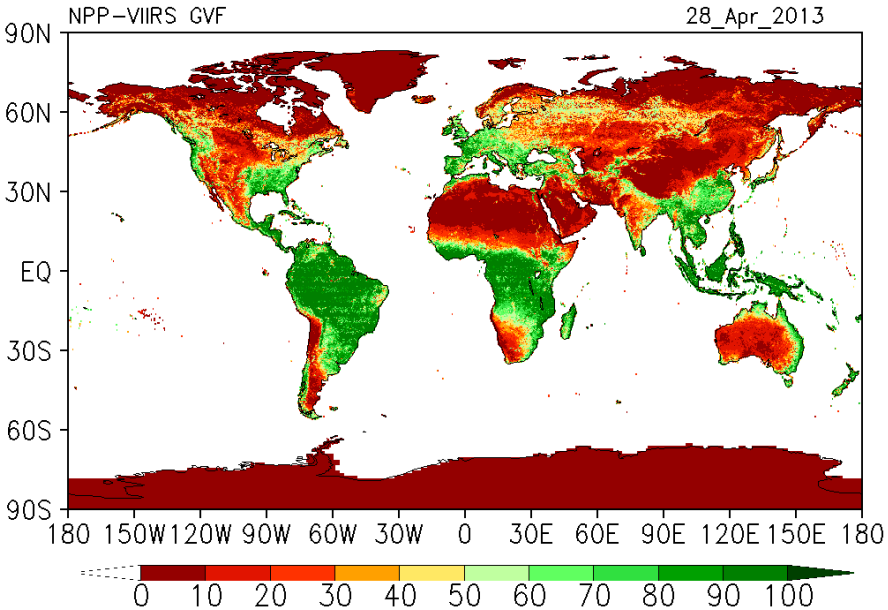
- Fixed annual/monthly/weekly climatologies, or near real-time observations; some quantities may be assimilated into Noah, e.g. soil moist., snow.

Green Vegetation Fraction

- **Climatology vs. near real-time GVF**.



AVHRR 5-year Climatology

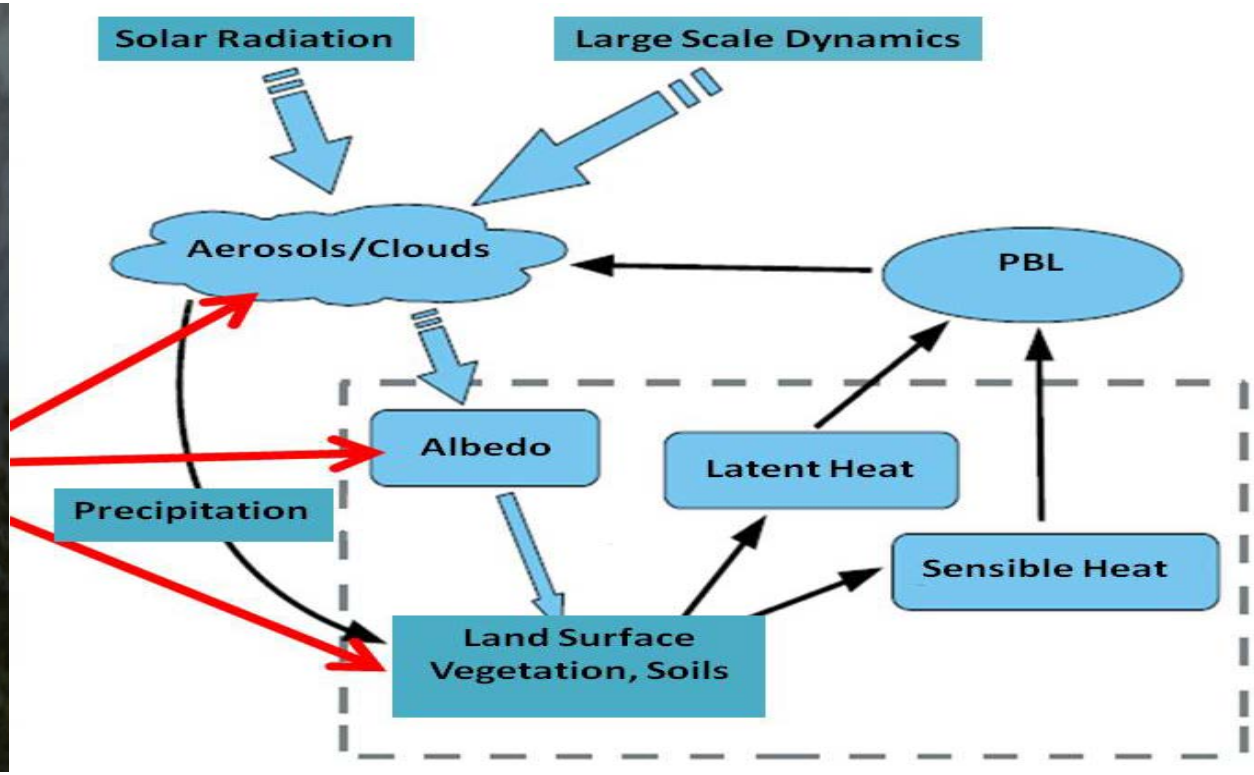


VIIRS

- **Ingest into NCEP models** where near real-time GVF leads to better partition between surface heating & evaporation --> impacts surface energy budget, PBL evolution, clouds & convection.
- Note: *VIIRS GVF in Midwestern US much lower than AVHRR GVF Climatology.*

Land Conditions: Wildfire Effects

Wildfires affect weather/climate systems:
(1) atmospheric circulations
(2) aerosols and clouds
(3) **land surface states** (green vegetation fraction, albedo and surface temperature etc.) --> impact on surface energy budget, boundary-layer evolution, clouds & convection.



Burned Area Product

- **Surface Reflectance** used to derive Burned Area

- **Two** fire burned area **products** (NESDIS/STAR):
  - 1 km resolution, 2x/day, 20N-70N
  - 12 km resolution, 4x/day, Equator-NP

- **Ingested into mesoscale NAM**, with adjustments to surface characteristics:

- reduced: albedo, GVF, roughness, soil moisture

- increase: surface & soil temperatures

Remotely-Sensed Land Data Sets Summary:

- Highest temporal and spatial resolution available.
- “Blended” LEO and GEO products; include in situ.
- Global domain, consistent use between NCEP global and regional models.
- Full consistency between all products, e.g. a “burned area product” also reflected in green vegetation fraction (GVF), albedo, emissivity, surface temperature, soil moisture, etc.
- Future: account for lakes, wetlands, water bodies.
- Land data assimilation in Noah land model using NASA Land Information System (LIS), i.e. snow, soil moisture, GVF (future Noah with dynamic/growing vegetation).

THANK YOU!