



Goddard Space Flight Center

Land Information System

Satellite-Based Assessment of Water Resources and Agricultural Productivity

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Contributions:

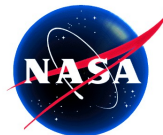
NASA/GSFC: John Bolten, Molly Brown, Matthew Rodell, David Toll

USGS/EROS: Chris Funk, James Verdin

<http://wmp.gsfc.nasa.gov>

<http://lis.gsfc.nasa.gov>

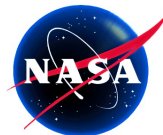
<http://ldas.gsfc.nasa.gov>





Water, Agriculture and NASA

1. Water and agriculture: rocket science?
2. Water availability
3. Water use
4. Crop health
5. Future directions



NASA's Water and Energy Satellites


Water Cycle Missions

- ICESat**
 - Ice elevation
 - Cloud height
 - GRACE**
 - Column water-content
 - TRMM and GPM**
 - Global precipitation
- 
- 

Water and Energy Cycle Missions

- EOS-Aura**
 - Atmospheric humidity
 - Clouds
 - EOS-Terra**
 - Snow and ice
 - Vegetation
 - CALIPSO**
 - Cloud properties
 - CloudSAT**
 - Cloud profiler
 - EOS-Aqua**
 - Atmospheric humidity
 - Water storage
 - Clouds
 - Snow and ice
- 

Energy Cycle Missions

- TOMS**
 - Total column ozone
 - SORCE**
 - Total Irradiance measurements
 - SAGE**
 - Air quality
 - Climate change
 - UARS**
 - Carbon management
 - Air quality
- 

- Planned (not Approved)
- SWOT (Streamflow)
 - SCLP (Snowpack)

Complementary Water and Energy Cycle Missions

QuikSCAT
- Sea-surface wind velocity



EO-1 LANDSAT and NMP EO-1
- Land cover



NPOESS
- Global environmental conditions



GOES
- Weather

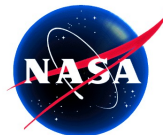
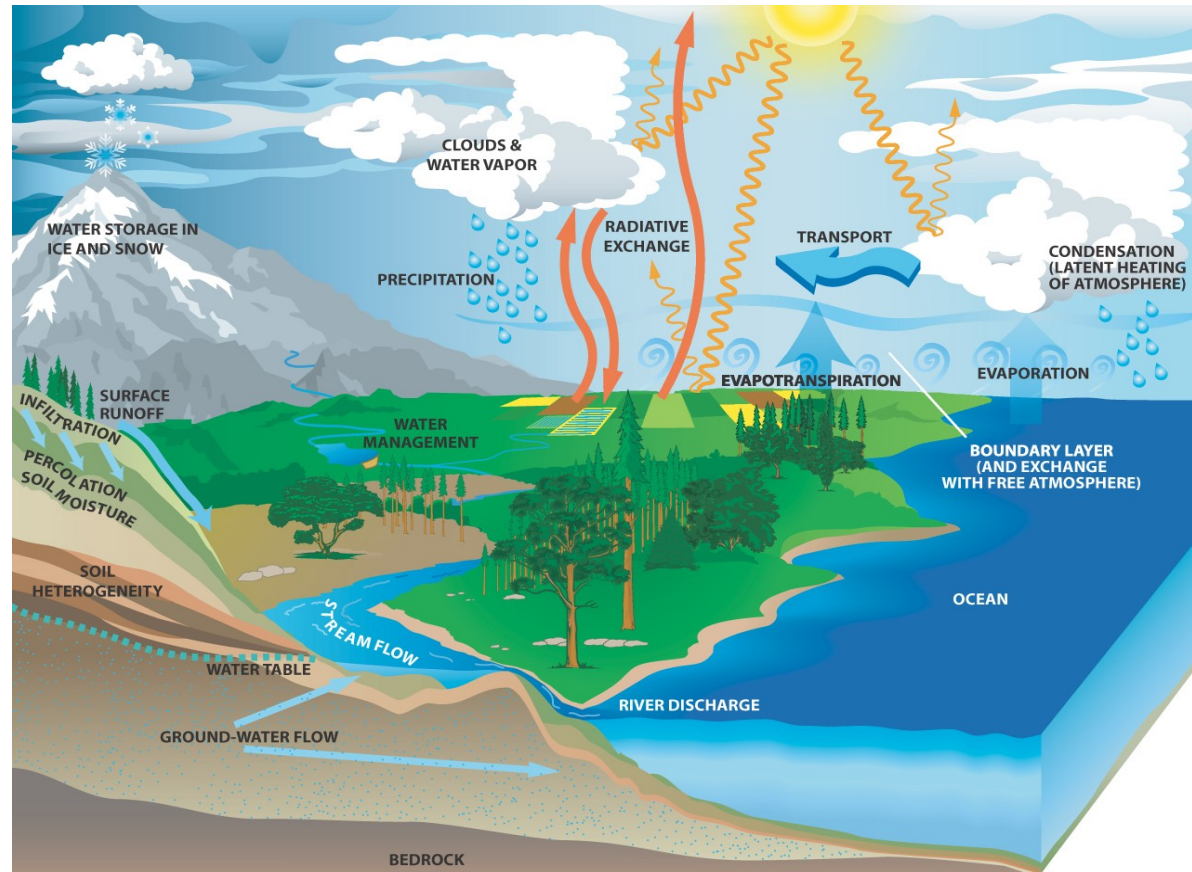


Aquarius
- Global sea surface salinity



Water Supply

- Precipitation
- Lakes and Reservoirs
- Soil Moisture
- Snow Pack
- Groundwater



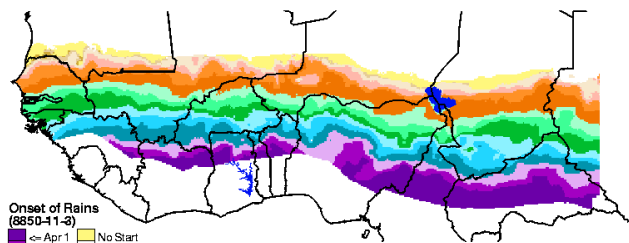


Satellite-based Precipitation

Current (1997-present)
Tropical Rainfall
Measurement
Mission
(TRMM)



Future (2013):
Global
Precipitation
Measurement
(GPM)



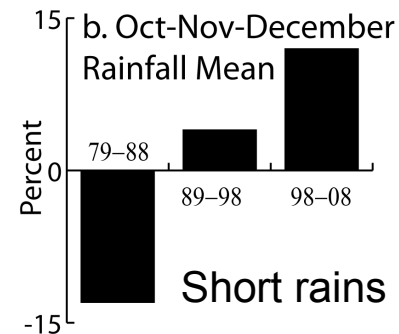
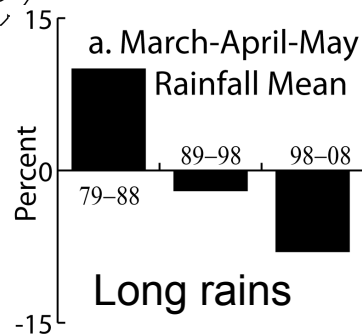
Rain Onset

Rainfall Analysis for Central-Eastern Kenya



Rift Valley
Central
Nairobi
Eastern
N. Eastern

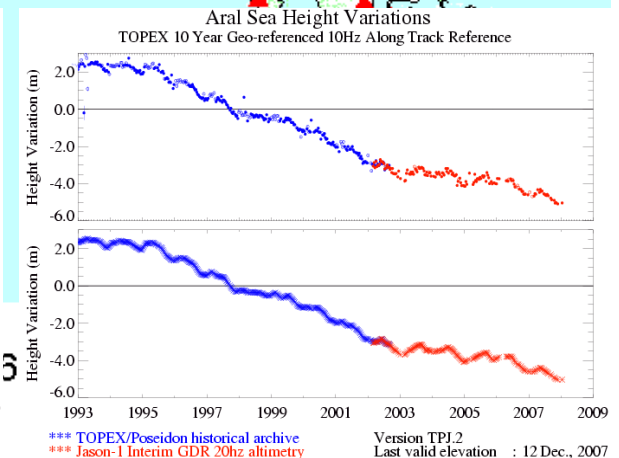
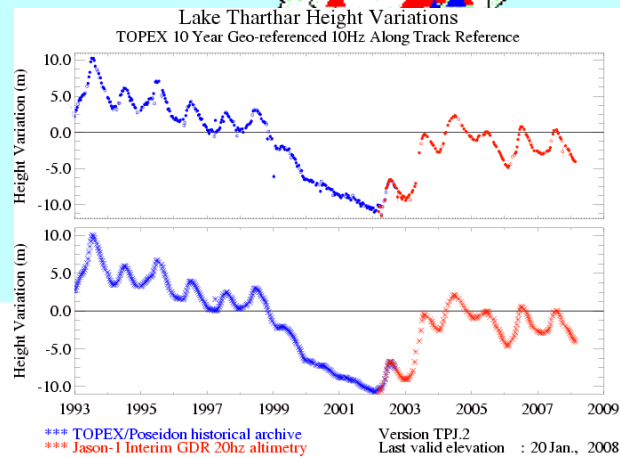
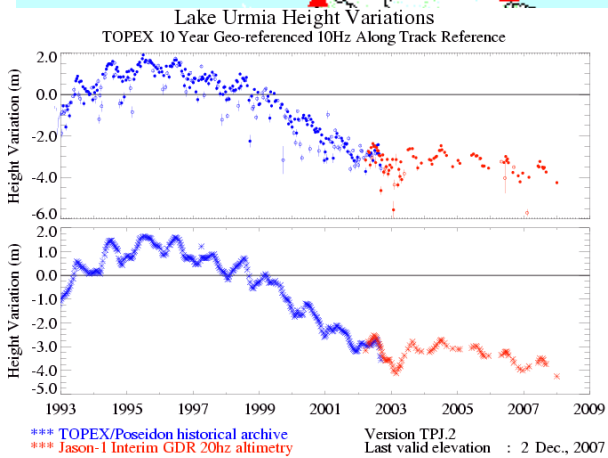
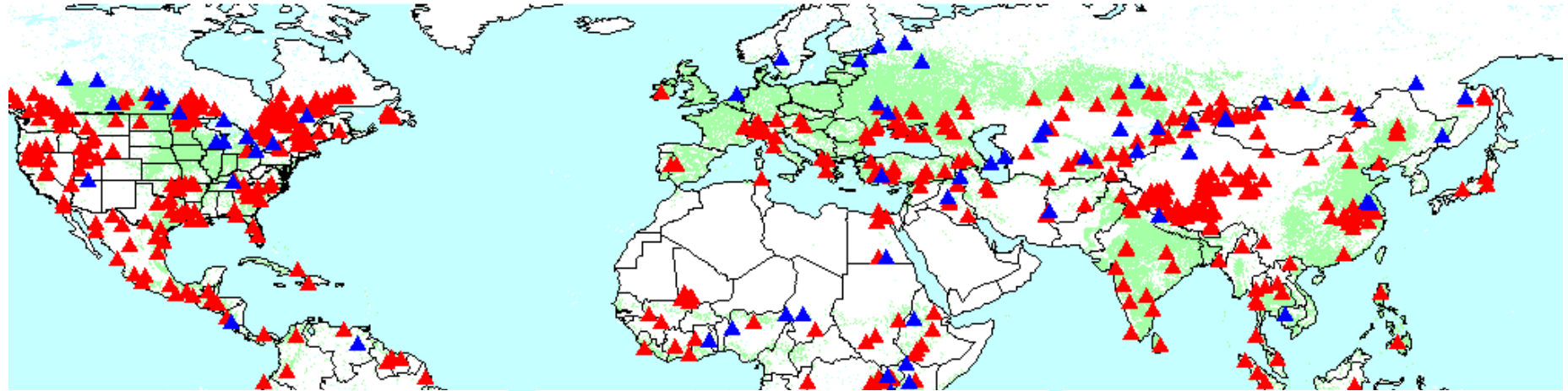
Trends



Funk, C et al. (2008) Proc., Nat. Academy of Sci.

Lake and Reservoir Monitoring

Current Lakes Monitored by Jason-1 and Potential Lakes Monitored by ENVISAT



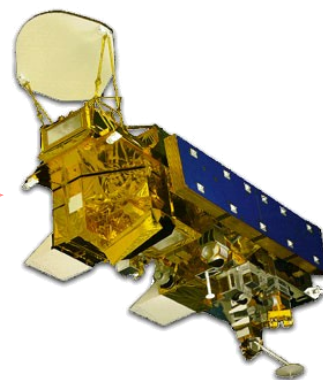
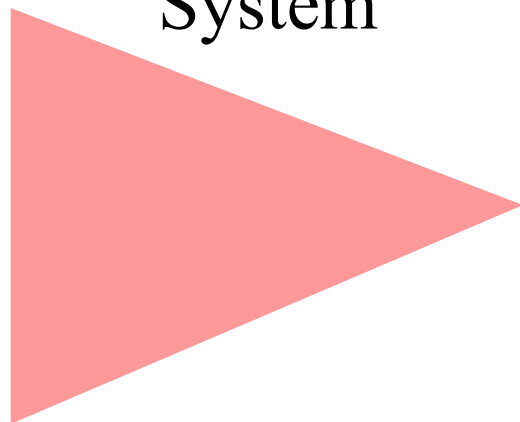
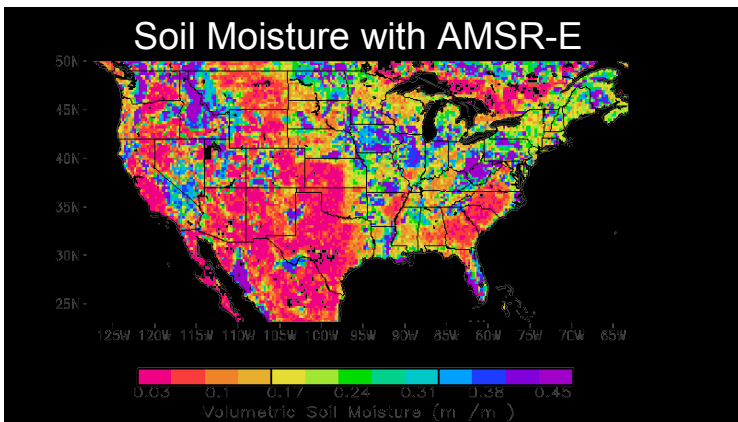
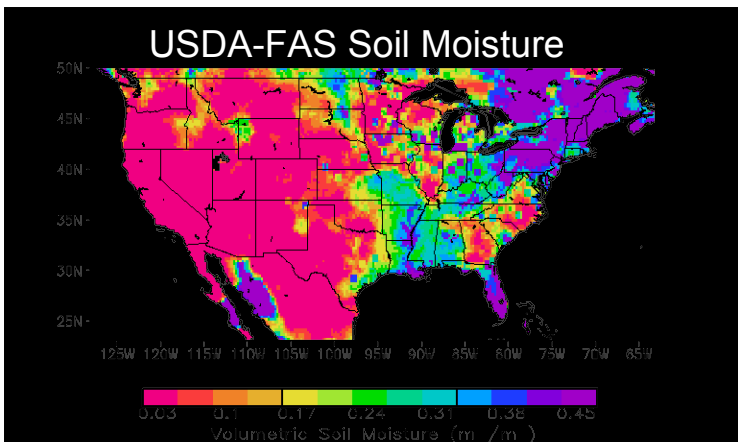
http://www.pecad.fas.usda.gov/cropexplorer/global_reservoir





Soil Moisture Monitoring & Assimilation

Integrating satellite-based soil moisture from Aqua/AMSR-E into the USDA-FAS Global Crop Production Decision Support System

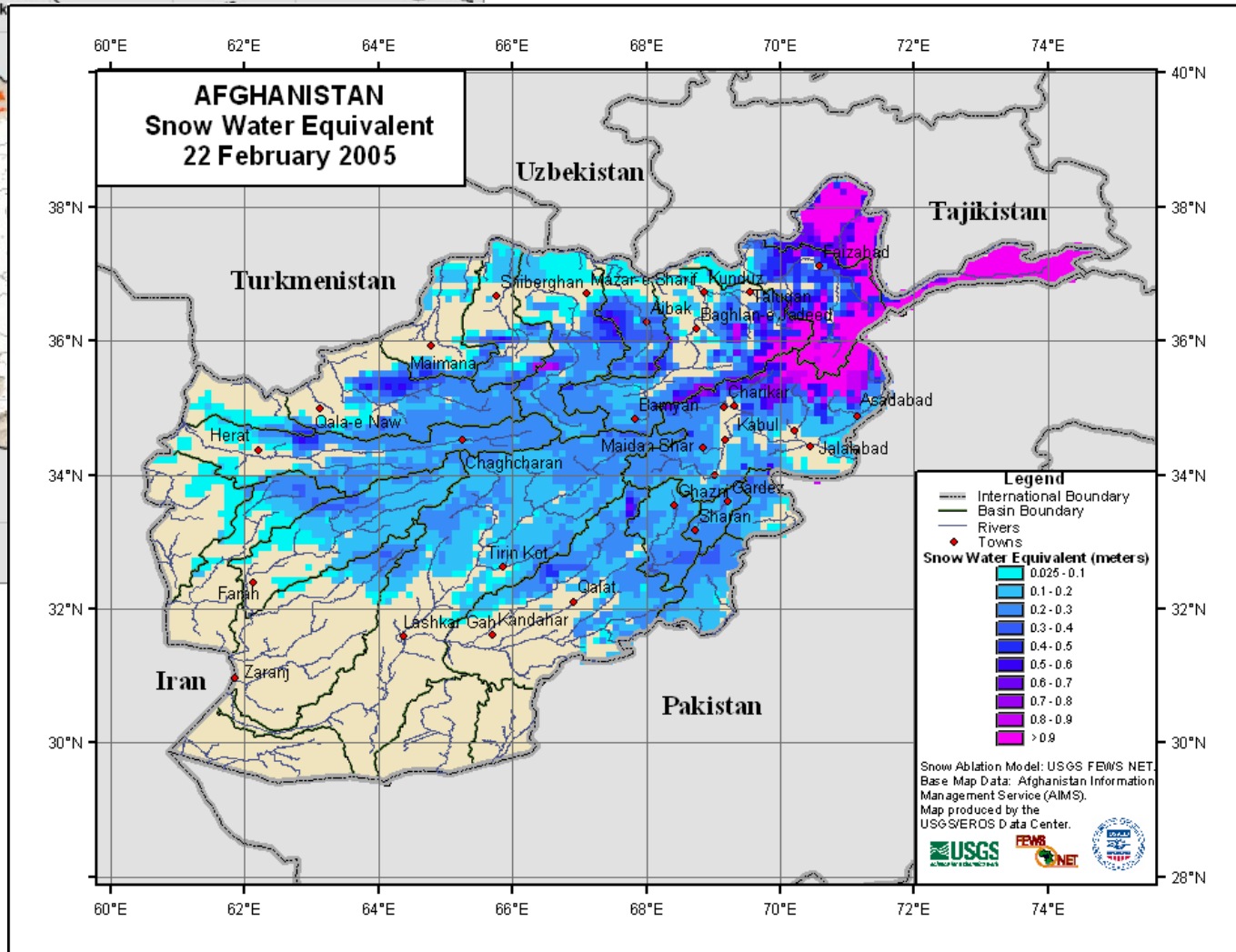
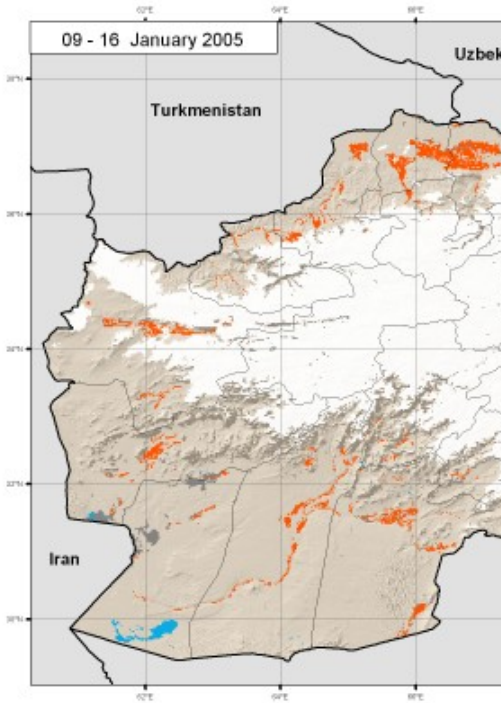


Bolten & Crow



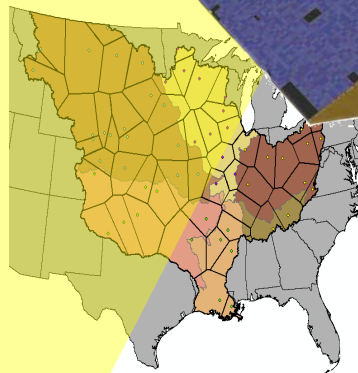
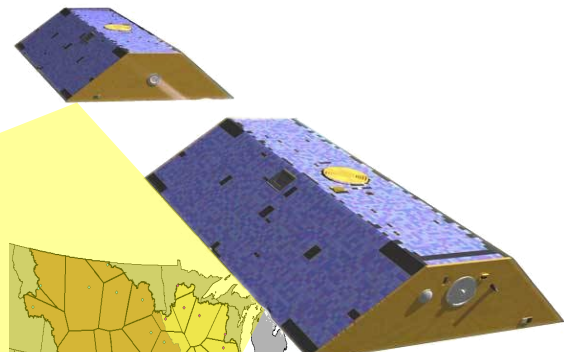
Snow Cover Monitoring & Assimilation

MODIS 8-day Snow Cover Extent - Current Period 2006 vs 2005

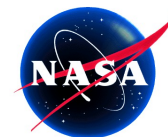
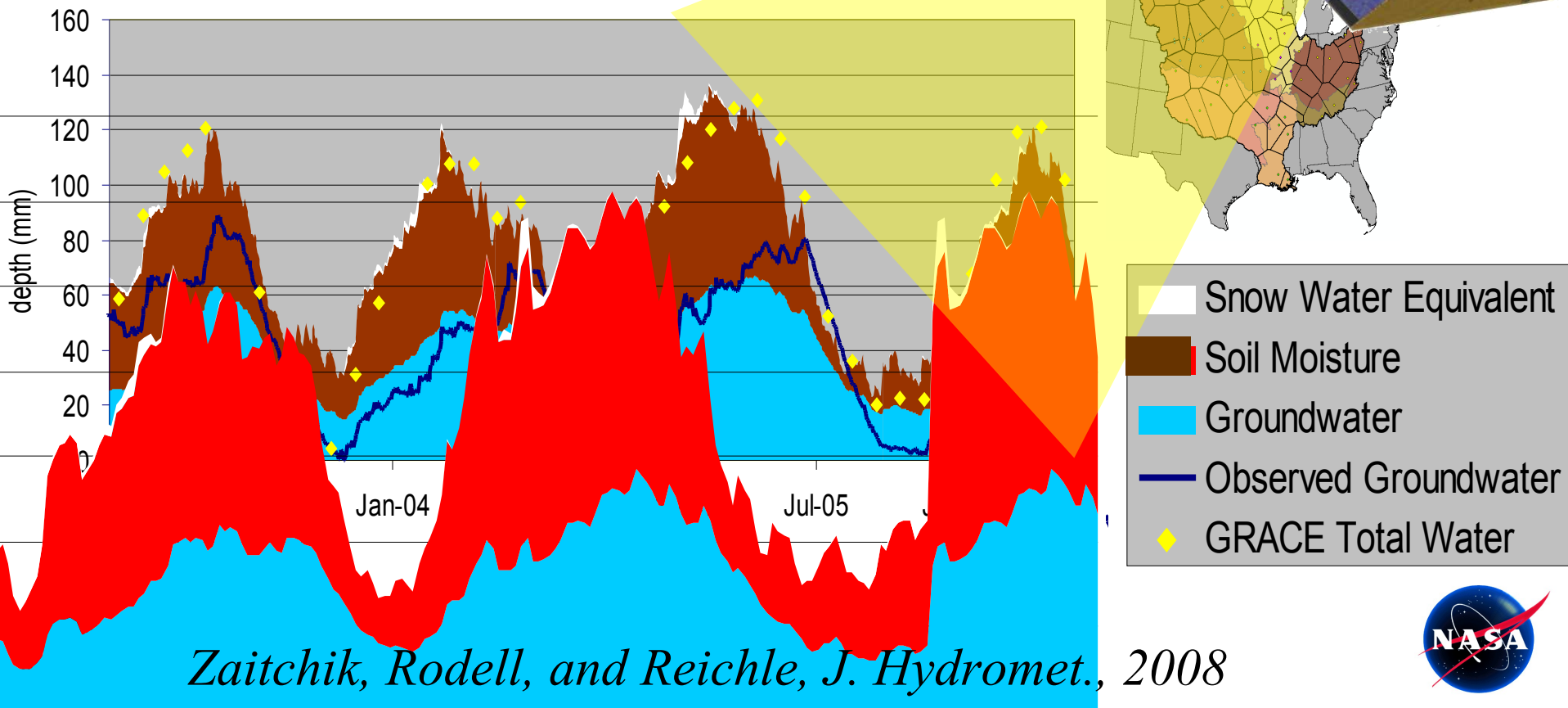




Groundwater Monitoring

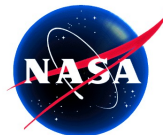


GRACE: The Gravity Recovery and Climate Experiment



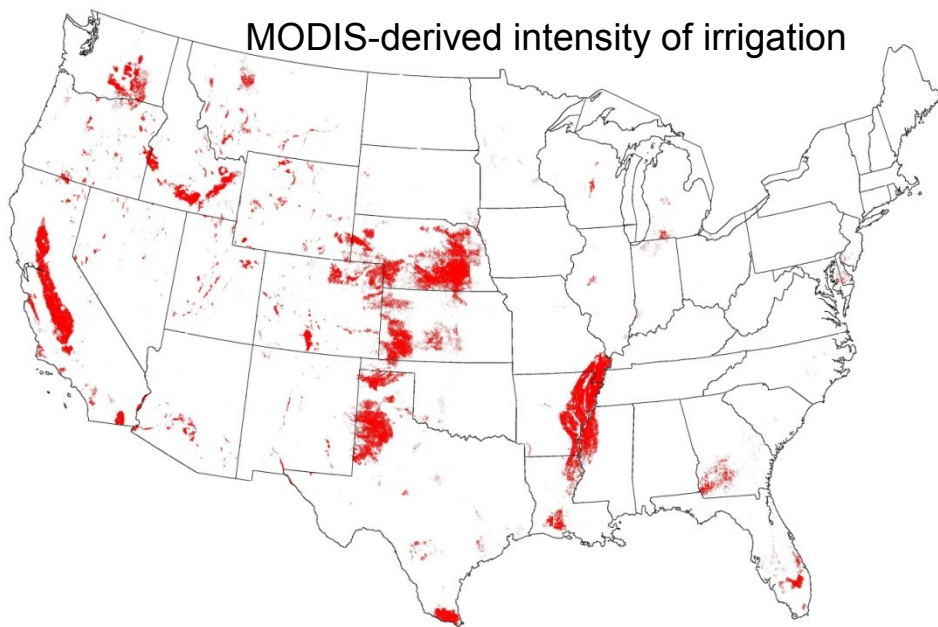
Water Use

- Irrigation
- Evapo-
transpiration

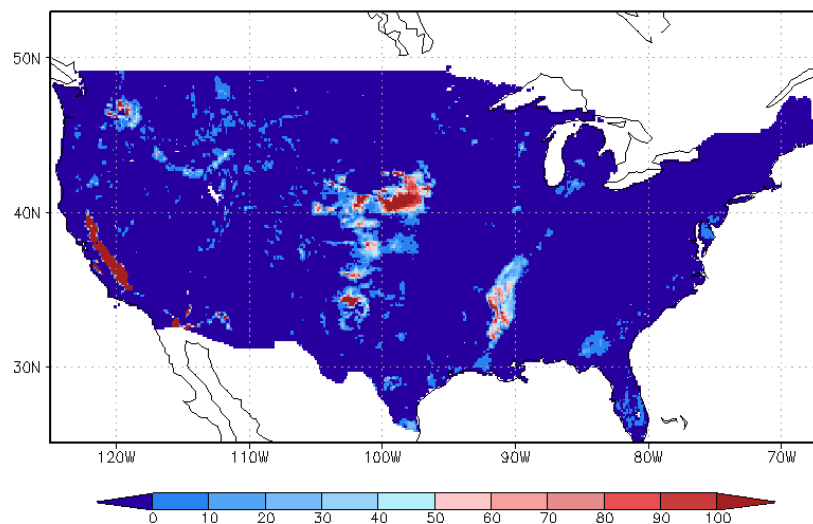


Irrigation monitoring and modeling

MODIS-derived intensity of irrigation



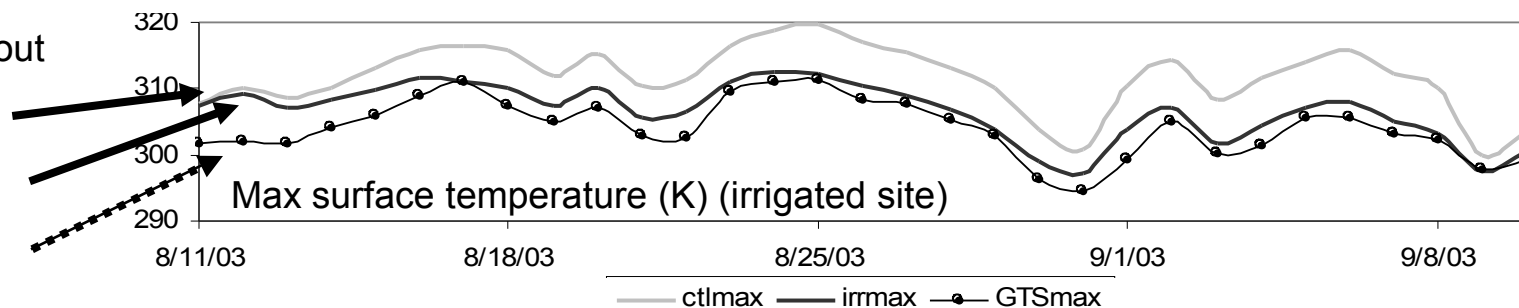
Difference (%) in evapotranspiration between irrigation and control runs, Aug-Sep 2003



Temperature without irrigation

Temperature with irrigation

Observations



Ozdogan and Gutman (2008) *Remote Sens Environ*
 Ozdogan, Rodell, and Kato (2009) *J Hydrometeorol*,





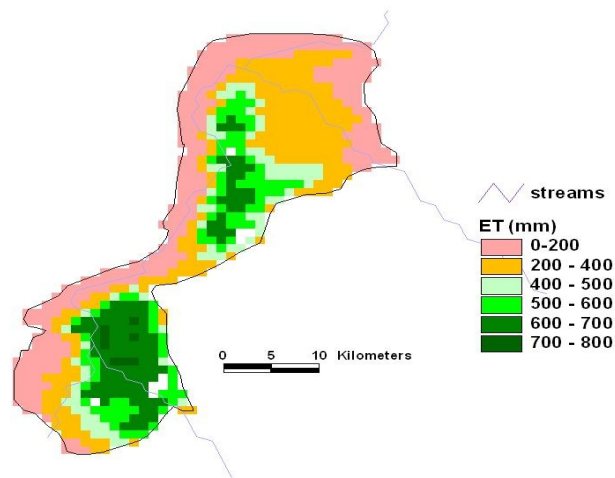
Crop Evapotranspiration (ET) Monitoring

Irrigated Study Area

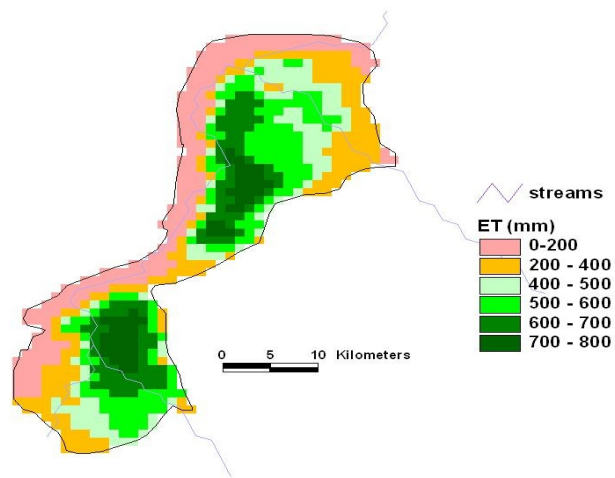


Landsat 7 ET

Seasonal Irrigated Crop ET Distribution in 2000
(June 2 - Sept 6)



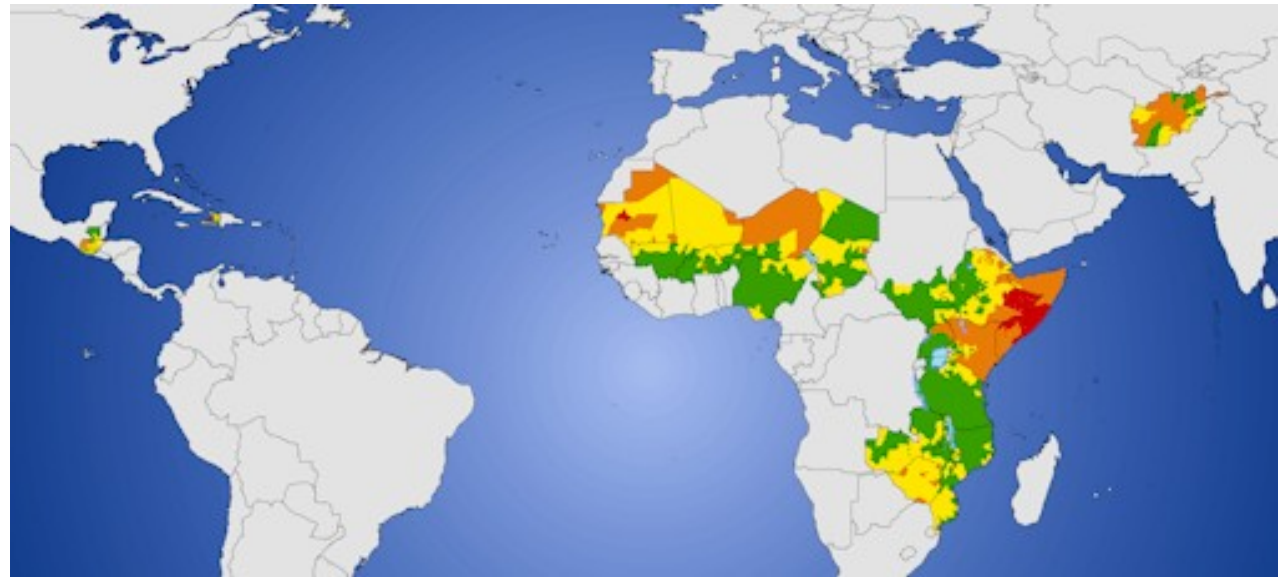
Seasonal Irrigated Crop ET Distribution in 2003
(June 2 - Sept 6)





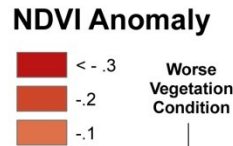
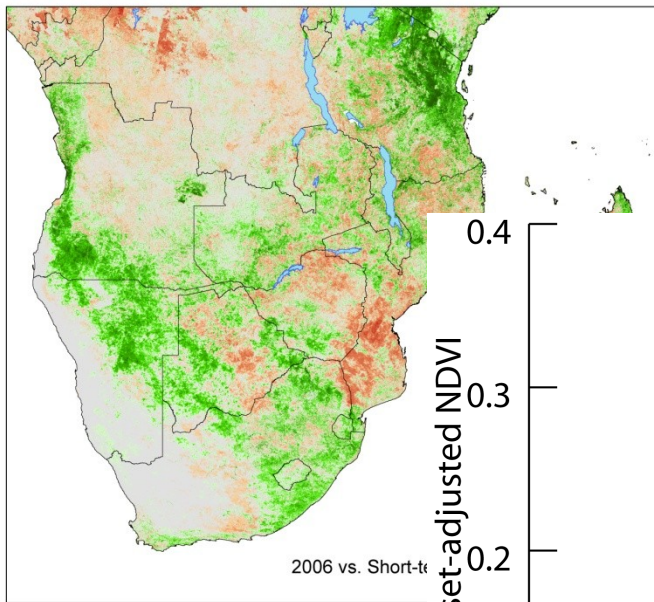
Crop Health

- Vegetation Greenness
- Yield Forecasting

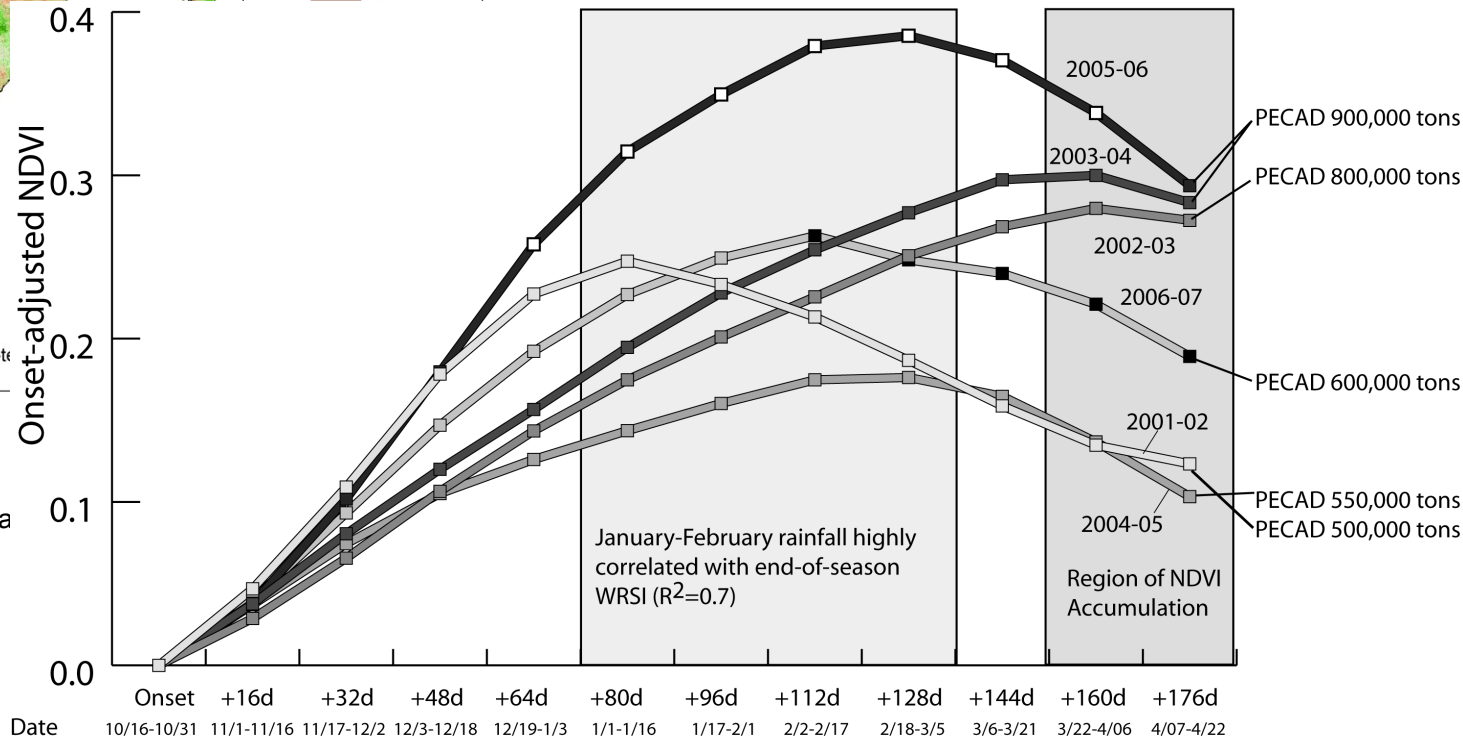


Crop and Productivity Monitoring and Forecasting

Projecting MODIS NDVI data 4 months ahead will give advance warning to food and fodder production shortfalls.

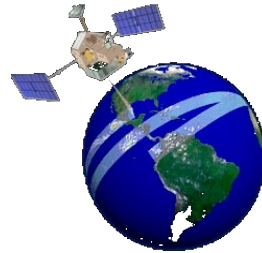


Southern Africa
Funk and Brown,

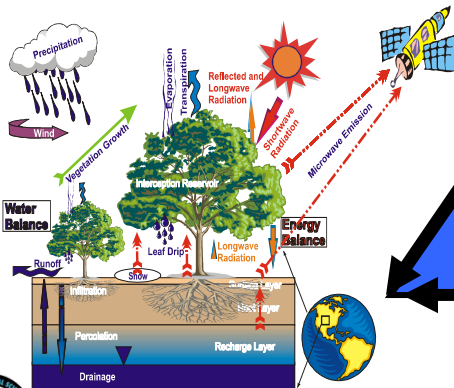


Future Directions: Integrated Water, Agriculture and Energy Assessment

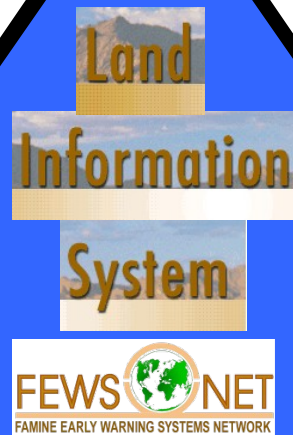
1. Observations



2. Modeling and Data Assimilation



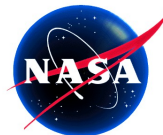
3. Applications & Decisions





Summary: Water, Agriculture and NASA

- **Water and agriculture: rocket science?**
 - YES! NASA Earth science satellite sensing and assimilation
- **Water availability monitoring:**
 - Precipitation, lake/reservoir, soil moisture, snow pack, groundwater
- **Water use monitoring:**
 - Irrigation, evapotranspiration
- **Crop health monitoring:**
 - Greenness, yield forecasting
- **Future directions:**
 - Integrated water-agriculture-energy assessment



Integrated Assessment

Inputs

Topography,
Soils

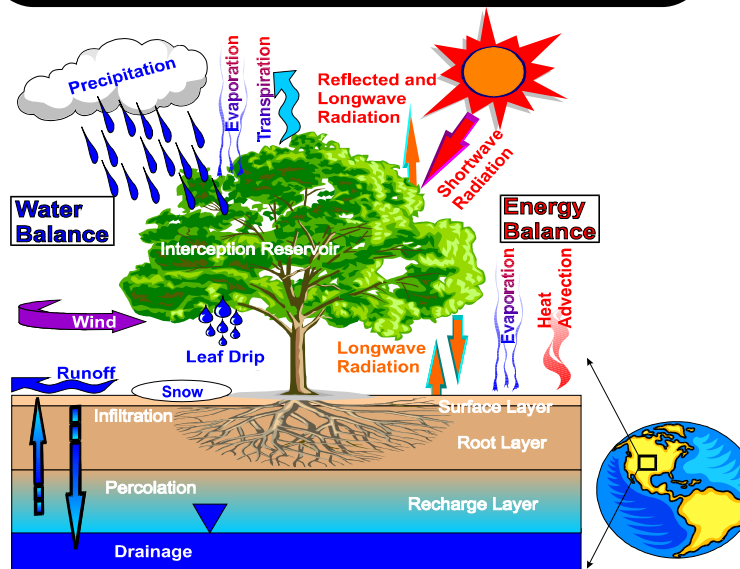
Land Cover,
Vegetation
Properties

Meteorological
Forecasts,
Analyses, and/or
Observations

Snow
Soil Moisture
Temperature

Physics

Land Surface Models



Data Assimilation Modules

Outputs

Soil
Moisture &
Temperature

Evaporation
Sensible Heat
Flux

Runoff

Snowpack
Properties

Applications

Weather/
Climate

Water
Resources

Agriculture

Drought

Military
Ops

Natural
Hazards

