Session 6:
Remote sensing and data assimilation of hydrological components in the coming era of Earth Observation

Introductory Remarks

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Hydrology delivering Earth System Science to Society
28th February, 2007 ~ 2nd March, 2007

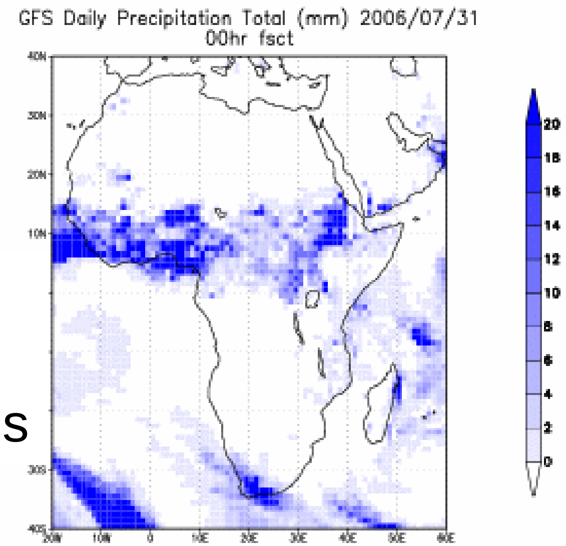
Tsukuba, Japan

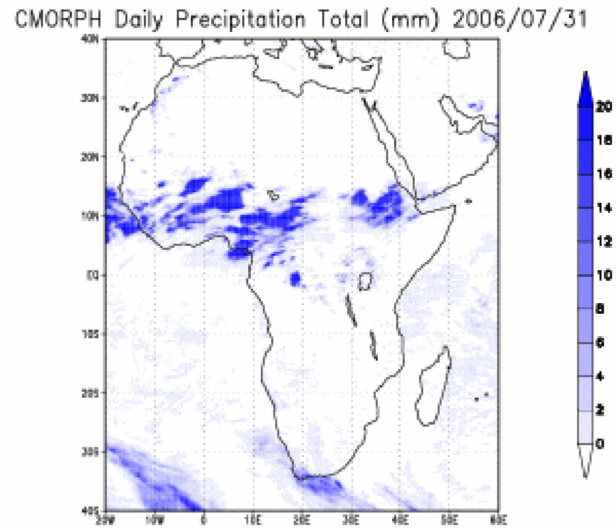
The need for remote sensing Earth Observations

1. We can't measure everywhere using in-situ measurements, so space observations offer consistent, global observations (e.g. precipitation)

Real-time data availability for hydrology – the options

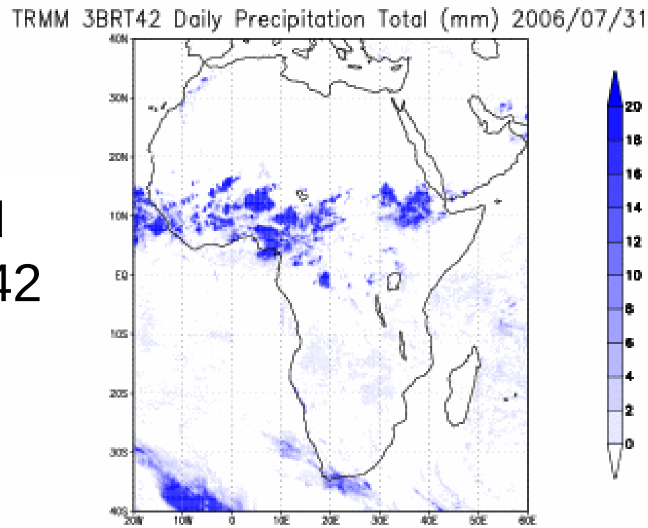
GFS
4-DDA
predictions

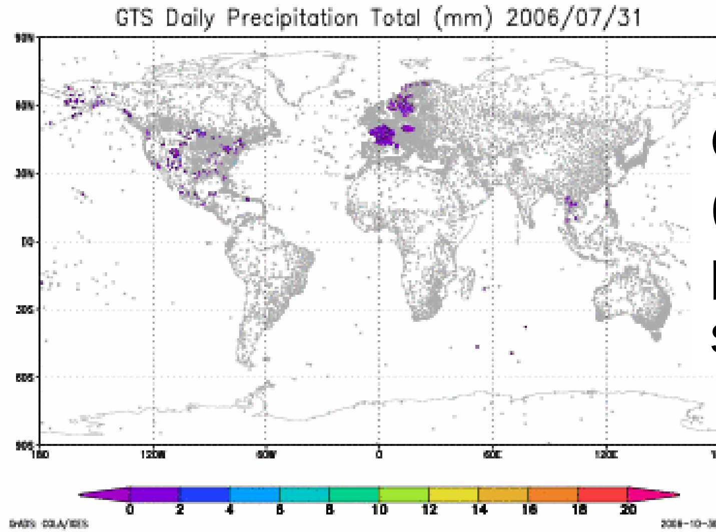




CMORPH

TRMM
3BRT42



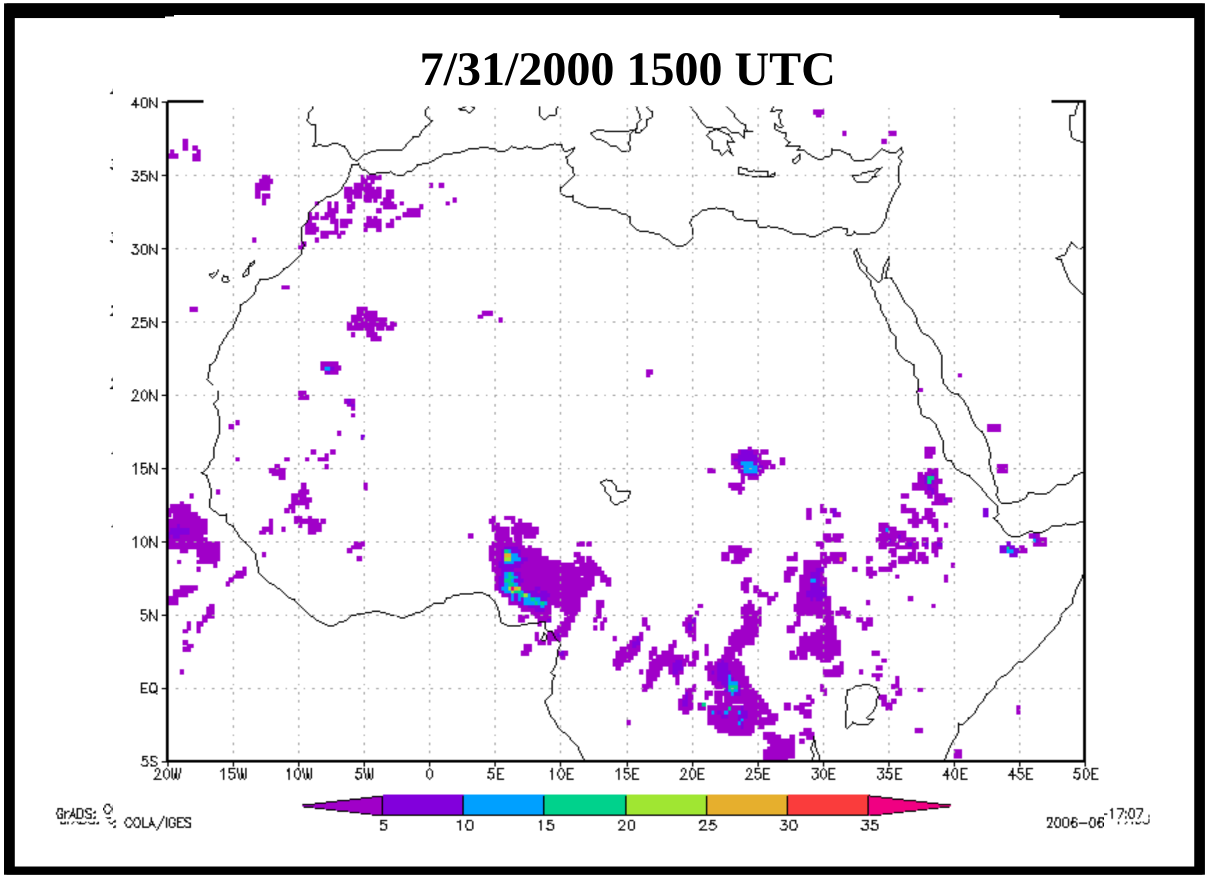


GTS
(in-situ) daily
precipitation
stations

Data availability for hydrology – satellite precipitation

TRMM 3B42 merged high quality infrared precipitation product- 3hrly 0.25 x 0.25 degree gridded estimates of global precipitation [mm/hr] (instantaneous precipitation rate at the nominal observation time)

algorithm available at: http://trmm.gsfc.nasa.gov/3b42.html

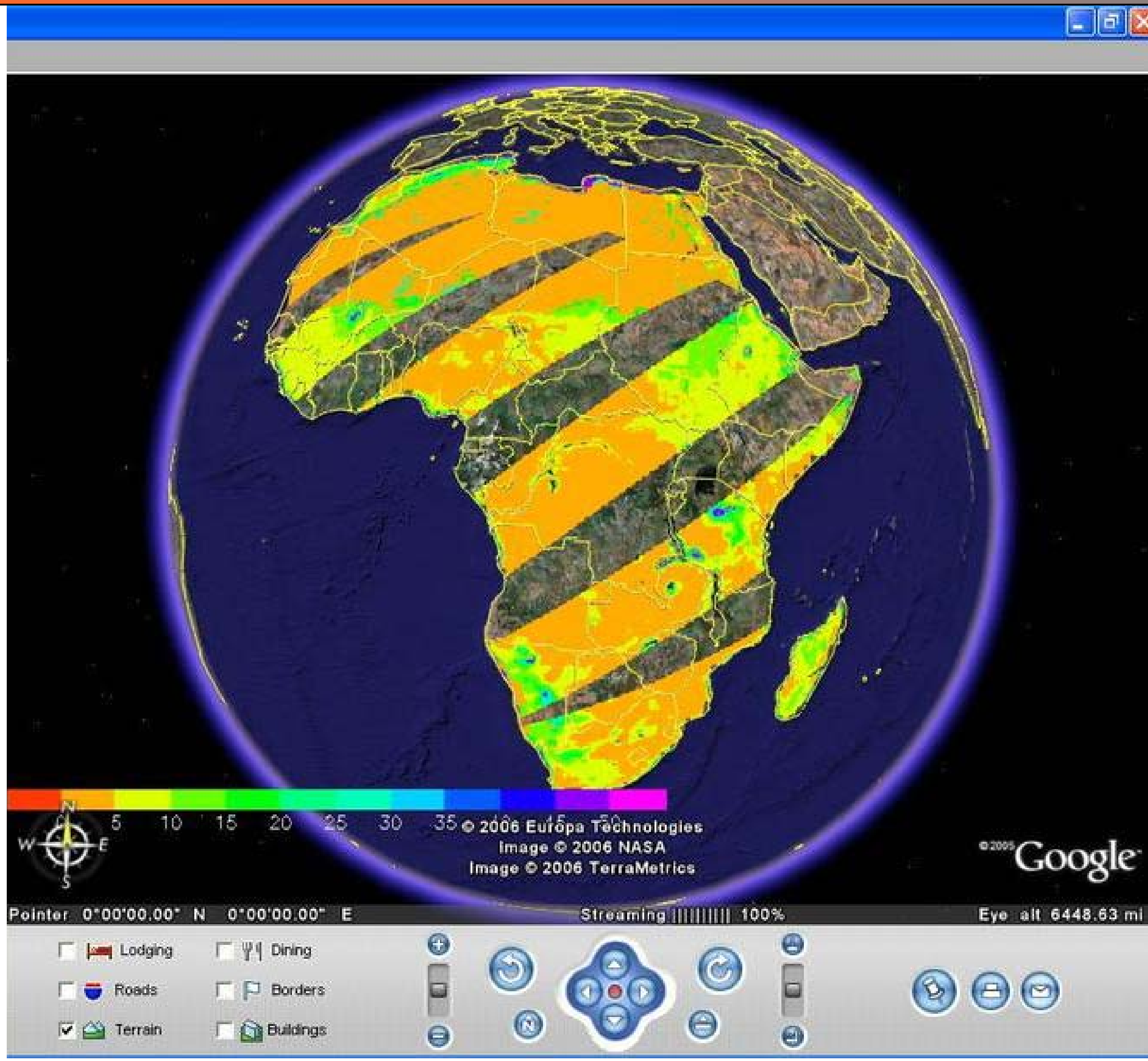


The need for remote sensing Earth Observations

1. We can't measure everywhere using in-situ measurements, so space observations offer consistent, global observations (e.g. precipitation)

2. Some variables rarely or sparsely measured in-situ – e.g. surface soil moisture and evapotranspiration, so satellite observations offers the only feasible measurement system.

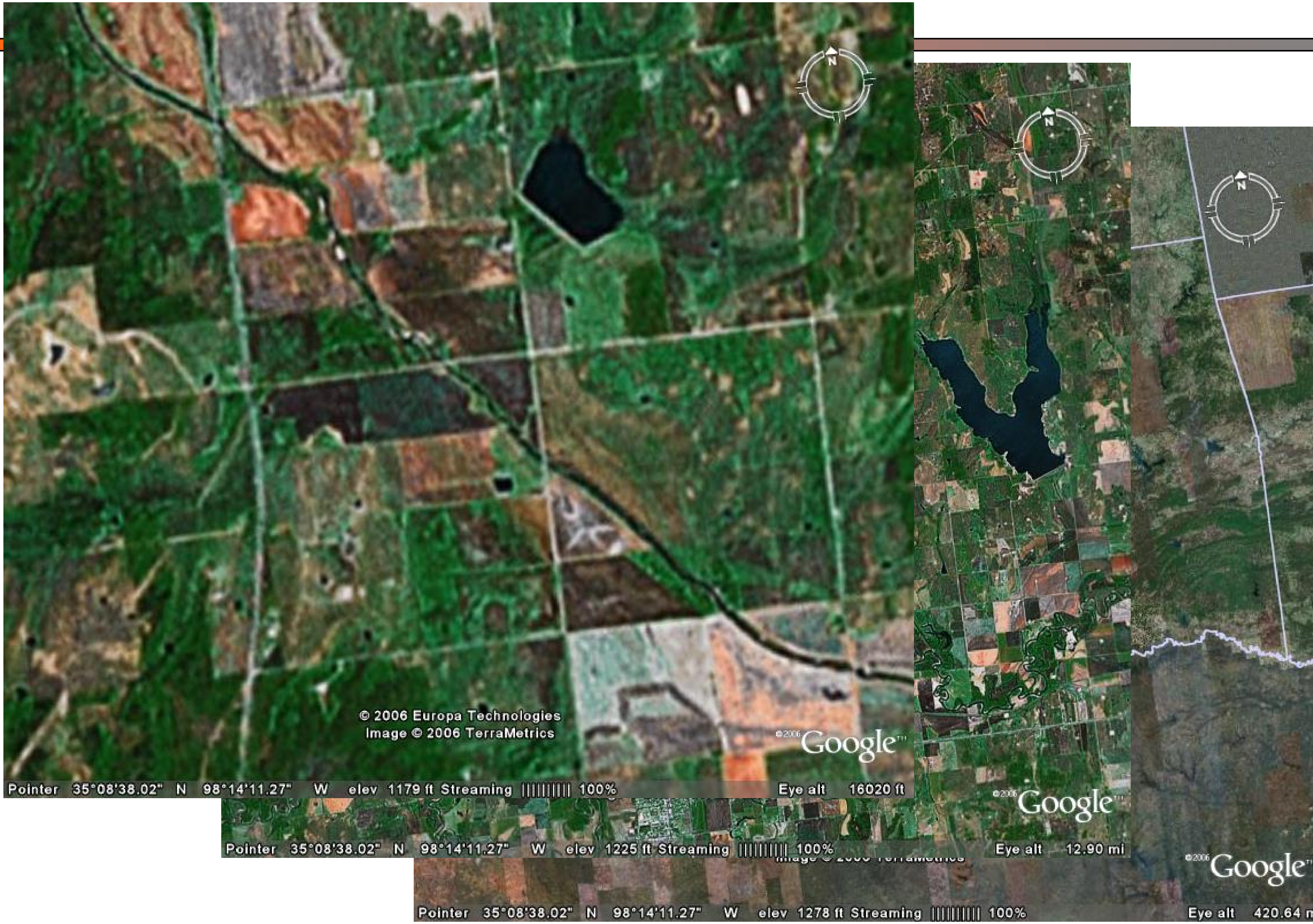
Soil Moisture from Space



Challenges facing remote sensing

1. Issues of scale, and sub-pixel “contamination”

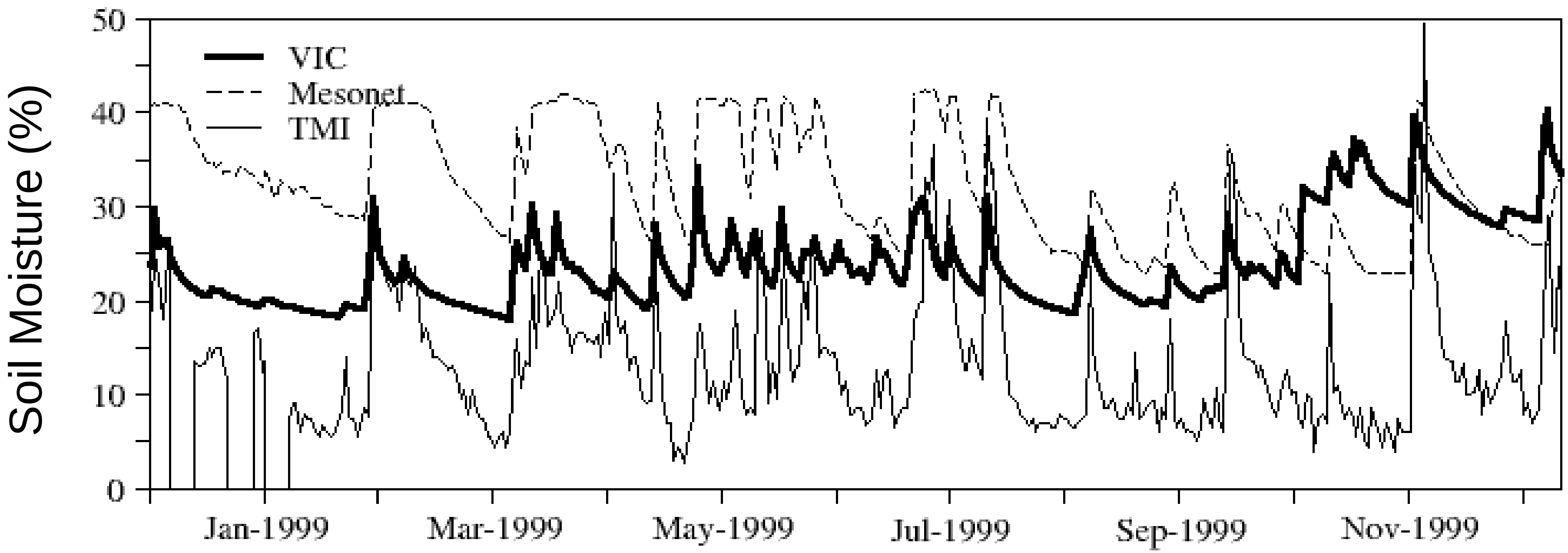
Spatial Variability of Land Surface



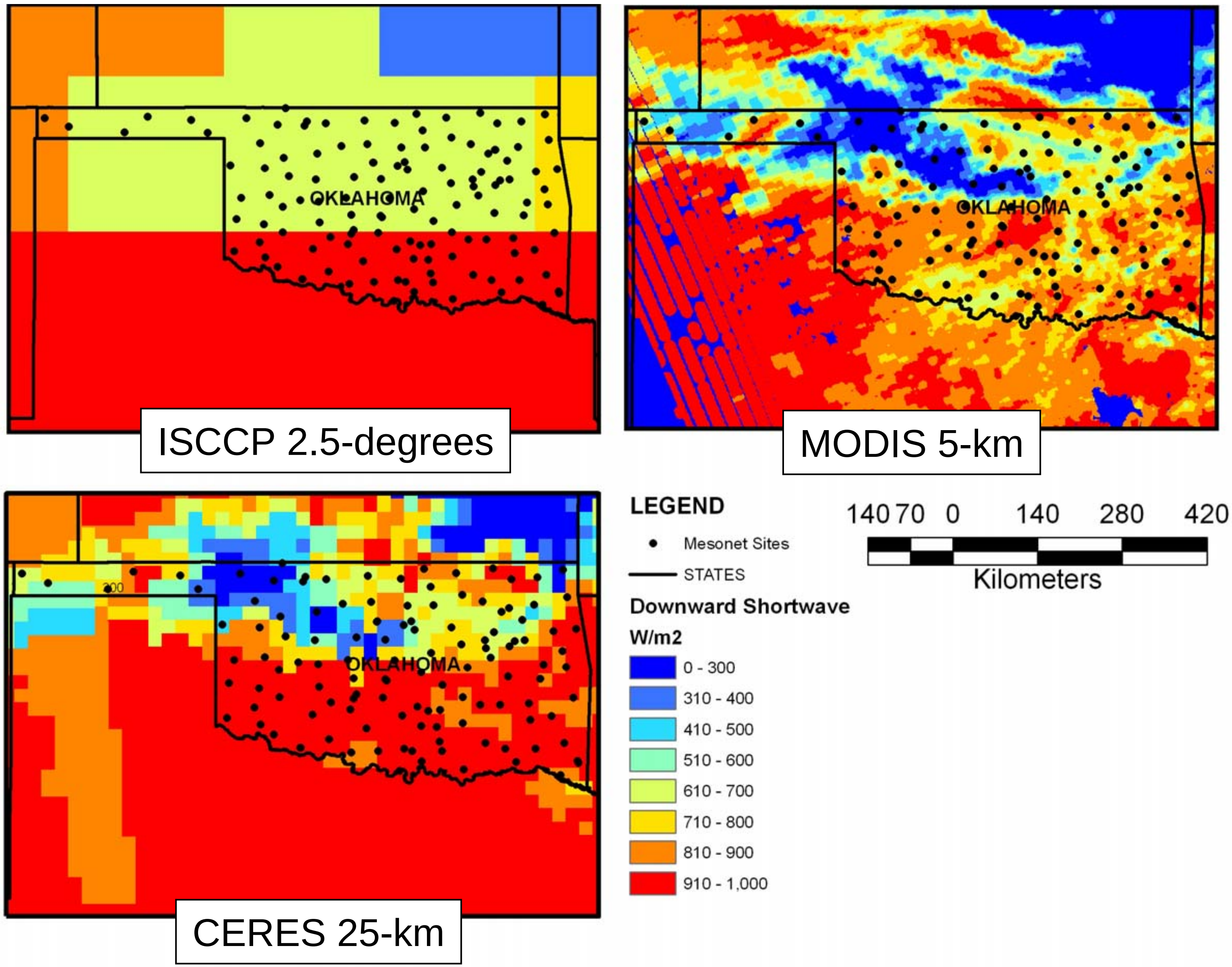
Soil moisture retrievals and in-situ measurements

Time series from different sources, measured at different scales behave differently; yet they are correlated and show skill in data assimilation – how to evaluate them?

In-situ (points over the region); VIC (10 km); TMI (~35 km)



Surface insolation products for estimating ET (land heat fluxes)

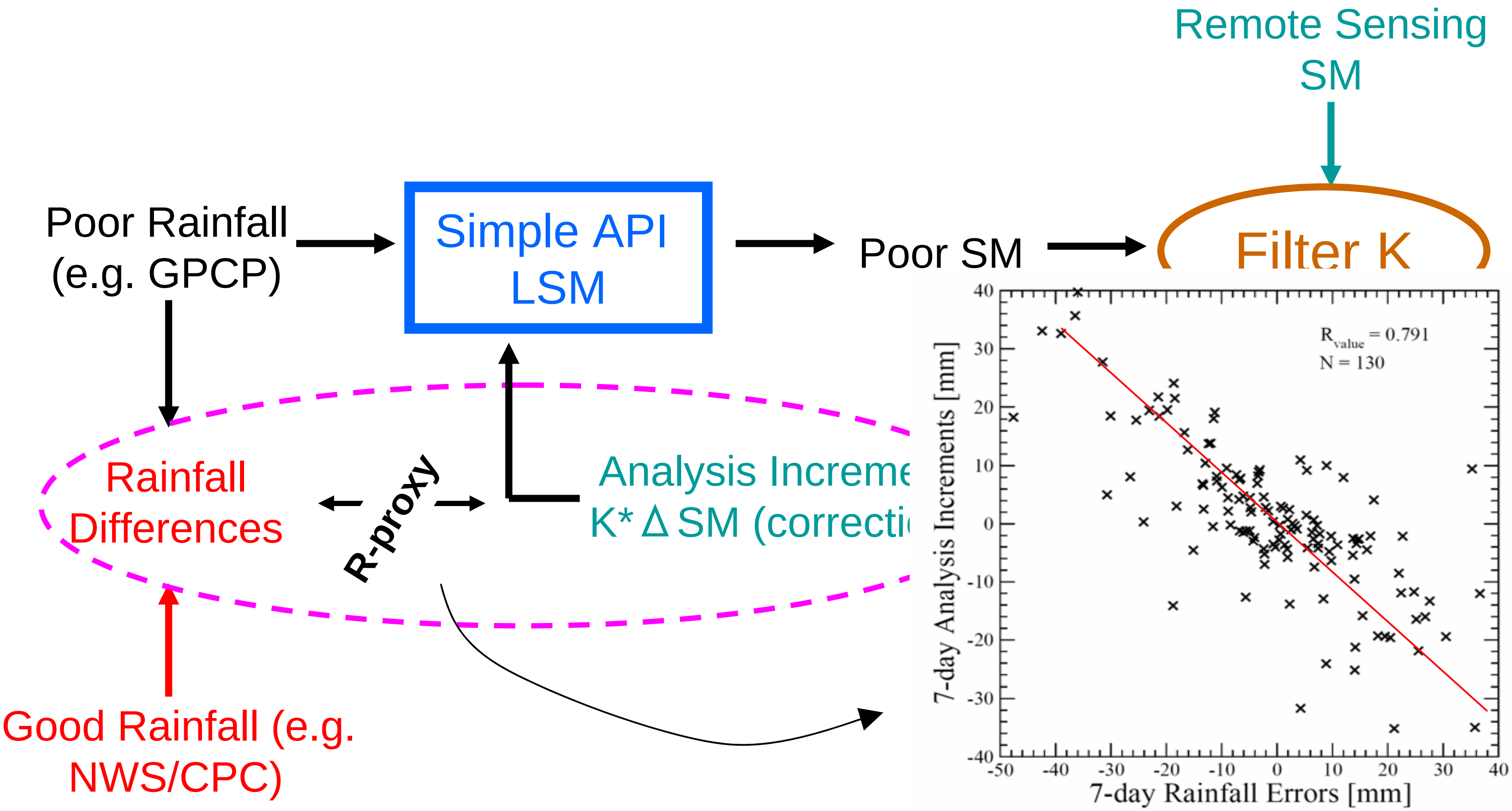


Challenges facing remote sensing

1. Issues of scale, and sub-pixel “contamination”
2. Remote sensing validation (and calibration) at large-scales: a new paradigm is needed.

Soil Moisture "Value" in Data Assimilation

Instead of comparing remotely-sensed soil moisture to ground measurements, look for **how much the soil moisture product can contribute when it is assimilated into a (simple) land surface model (LSM) driven by poor rainfall forcings (after Crow, 2007)**.



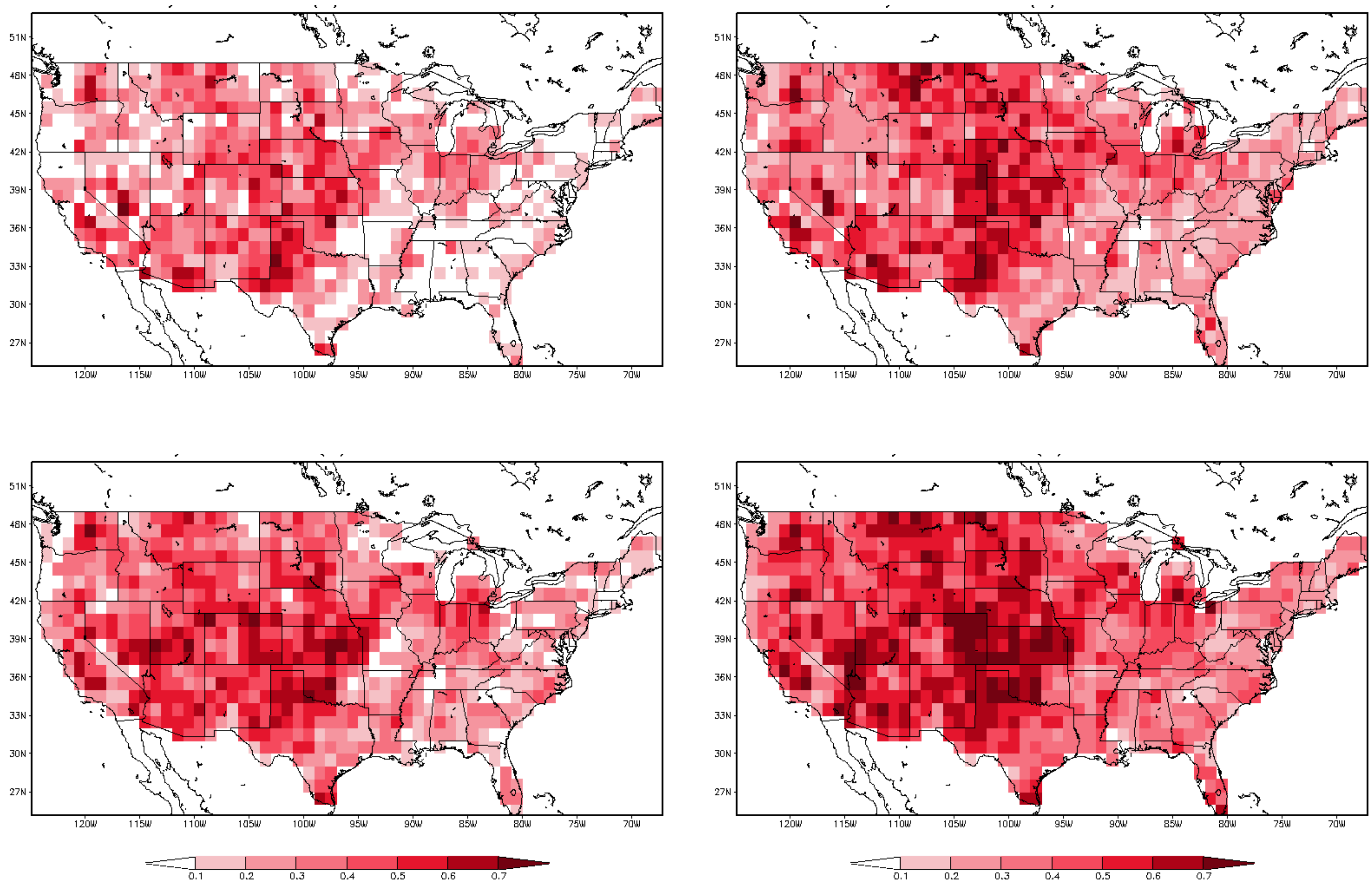
“R Proxies” using VIC and AIRS Ts for soil moisture retrievals

Before Calibration

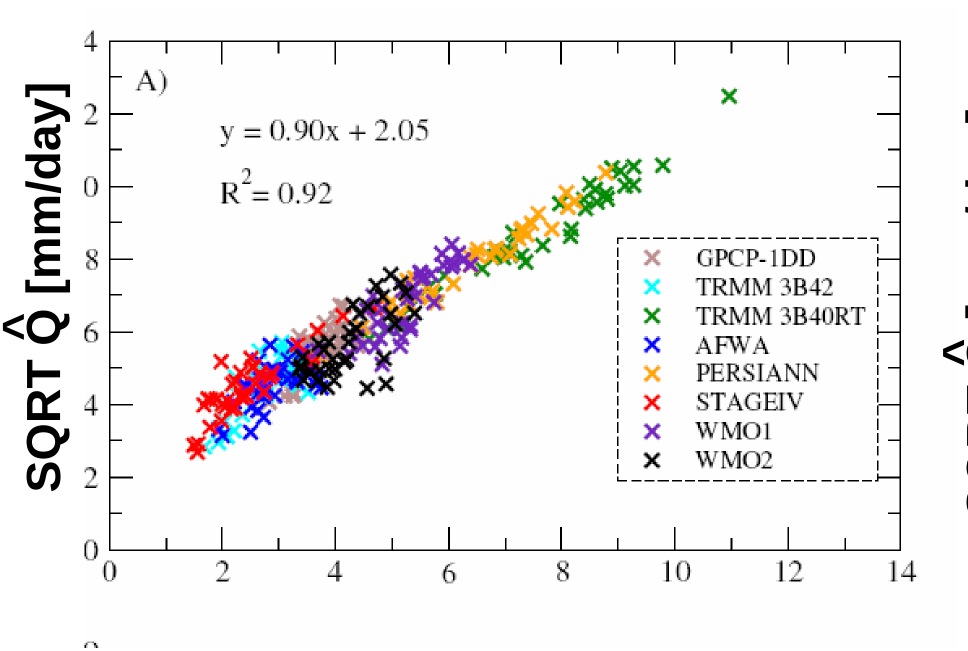
After Calibration

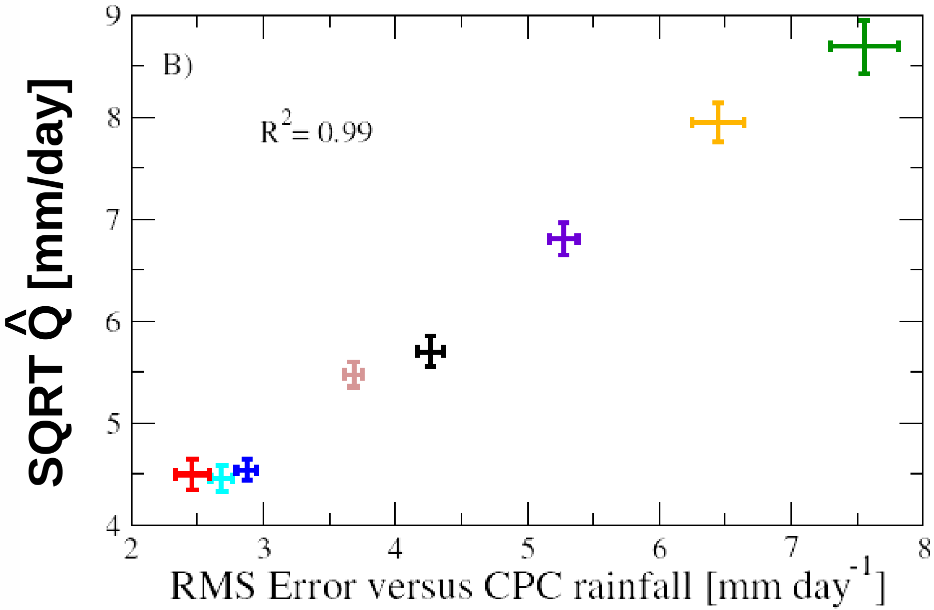
AIRS Ts Driven

VIC Ts Driven



Using adaptive filtering to estimate errors from satellite-retrieved precipitation (from Crow and Bolton, 2007)

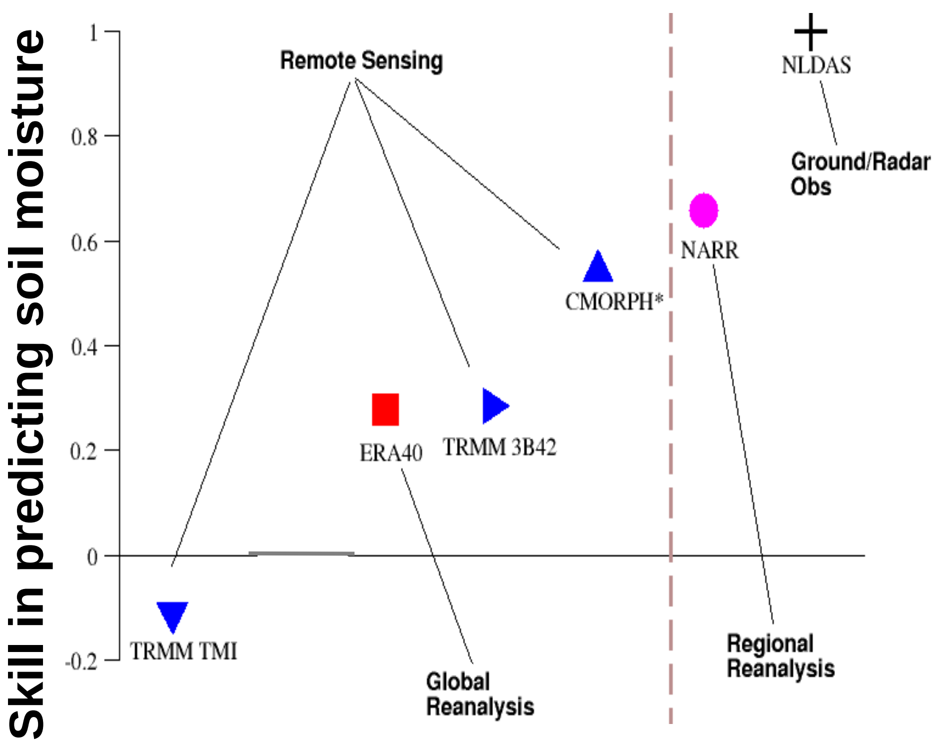


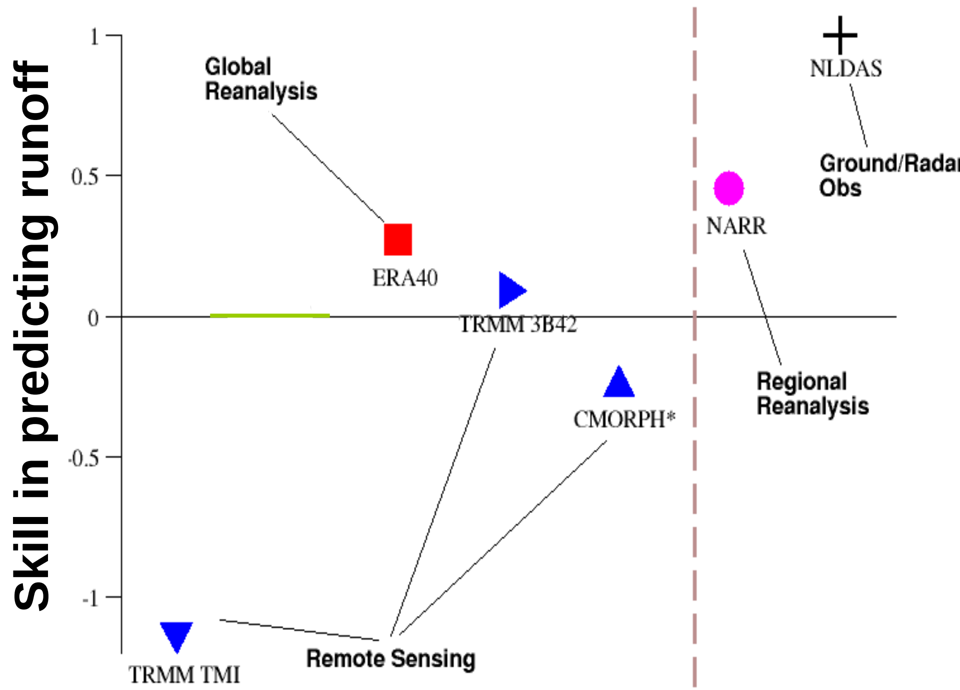


Estimated forecast error versus CPC for all 1-degree SGP boxes (July 1, 2002 to Dec 31, 2005)

Estimated forecast error versus CPC spatially averaged for all boxes and retrievals.

Estimated skill scores in using satellite-retrieved precipitation in hydrologic models





Skill depends on the land surface model, and the scales (spatial and temporal) used in the analysis.

Challenges facing remote sensing

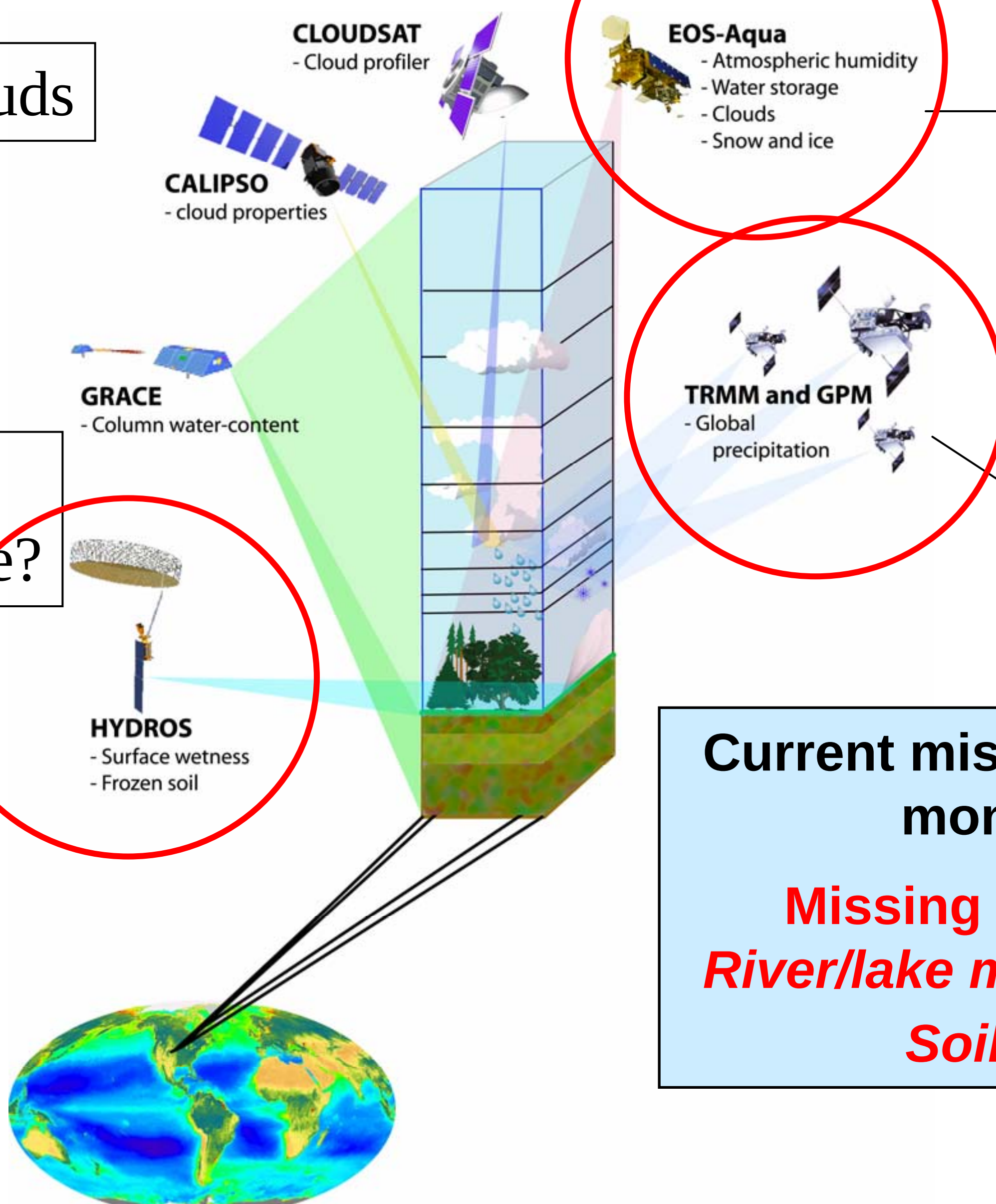
1. Issues of scale, and sub-pixel “contamination”

2. Remote sensing validation (and calibration) at large-scales: a new paradigm is needed.

3. Efficient algorithms for data assimilation that considers scale and dynamics: multi-scale data assimilation

The potential for a space-borne Global Water Cycle observation system

Clouds



Soil Moisture?

Radiation (CERES)
Snow (AMSR)
Vegetation (MODIS)
Soil moisture (AMSR)
Evaporation (MODIS)

Liquid precipitation

Current missions have a capacity to monitor water cycle.

Missing global observations:
River/lake monitoring, Precipitation, Soil Moisture, Snow