What is the question we want to answer?

<u>NASA/GSFC Land Information System (LIS) group</u>

Christa Peters-Lidard, Sujay Kumar, David Mocko

GEWEX Water Availability Grand Challenge for North America Workshop, May 3-5, 2016

NASA’s Land Information System supports hyperresolution modeling, data assimilation, uncertainty estimation and benchmarking

Goddard Space Flight Center

Land Information System

1979 – Present Updated w/ Larger Domain Forcings and Parameters at 3.125-km

<u>Satellite EDRs*</u>

SM, SCA, SWE, TWS, and II

Parameters (Topography, Soil properties, vegetation properties)

Meteorological Boundary Conditions (Forcings)

Observations (Soil Moisture, Snow, Skin Temperature)

Noah-3.6, Noah-MP, CLSM-F2.5, VIC-4.1.2.l, SAC-HTET-3.5.6/SNOW-17

Water and Energy Fluxes, Soil Moisture and Temperature profiles, Land surface states

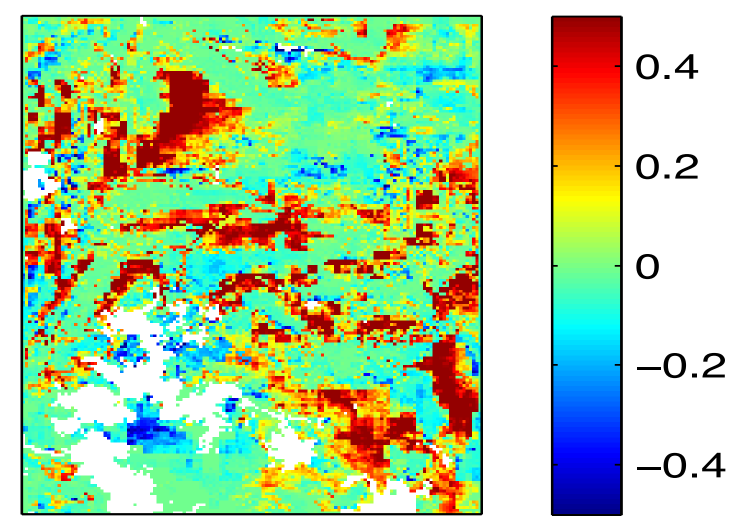
Data Assimilation, multi-variate (EnKF, EnKS)

* Satellite-based Environmental Data Records (EDRs): soil moisture (SM), snow-covered area (SCA), snow water equivalent (SWE), terrestrial water storage (TWS), & irrigation intensity (II)

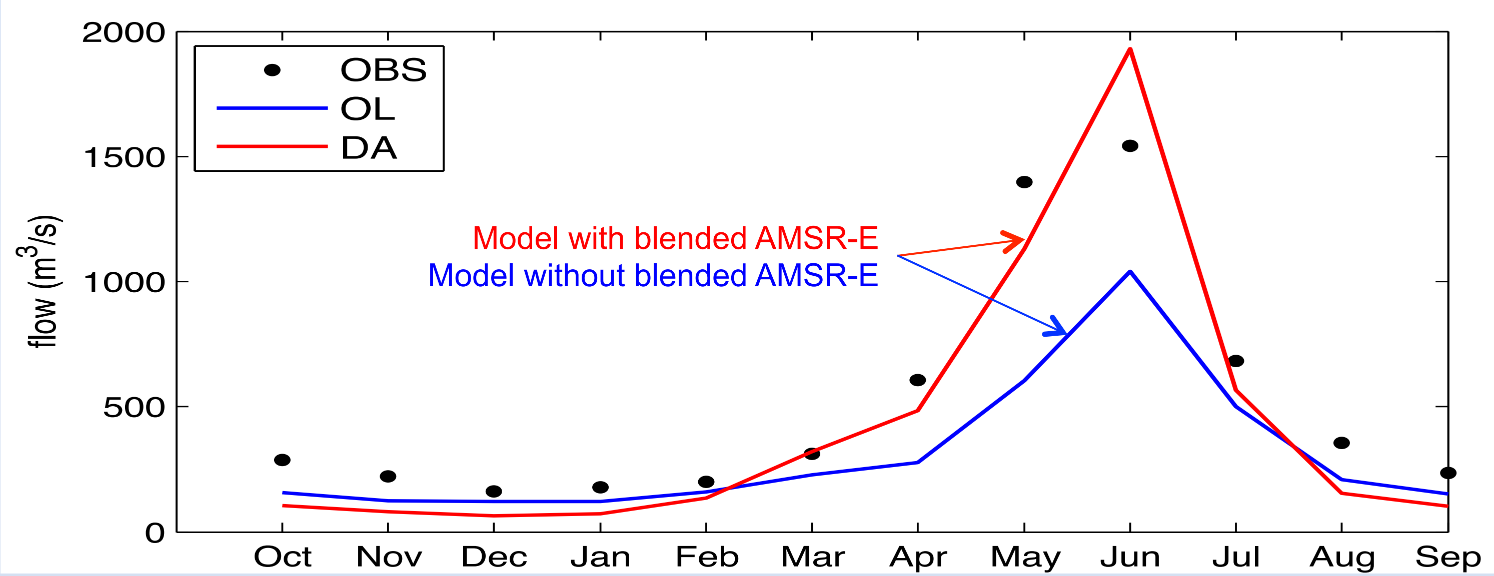
What is the value of remotely sensed snow observations for streamflow predictions?

Yuqiong Liu, Christa Peters-Lidard, Sujay Kumar, Kristi Arsenault, and David Mocko
Hydrological Sciences Laboratory, Code 617, NASA/GSFC; University of Maryland, College Park; Science Applications International Corporation

Improvement in Snow Cover Probability of Detection (POD) When Assimilating Blended AMSR-E



Improvement in Streamflow When Assimilating Blended AMSR-E (Upper Colorado River at Lees Ferry)

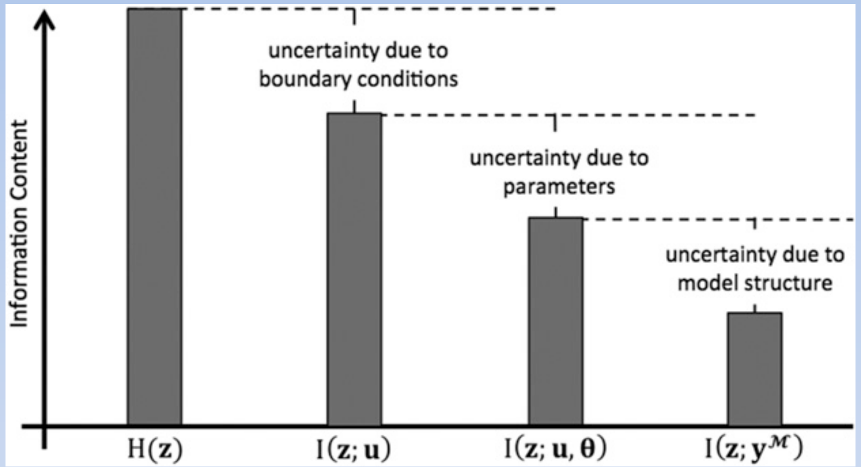


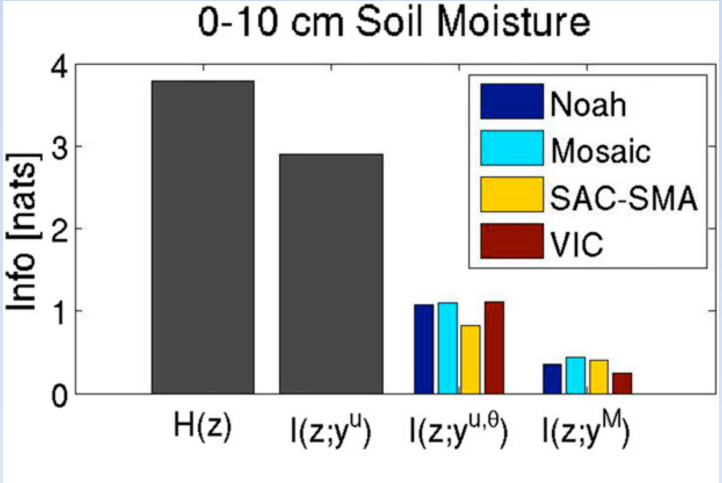
Assimilating AMSR-E snow depth data blended with in-situ snow observations while incorporating terrain aspect and MODIS snow cover leads to considerably improved snow and streamflow predictions in the Upper Colorado River Basin.

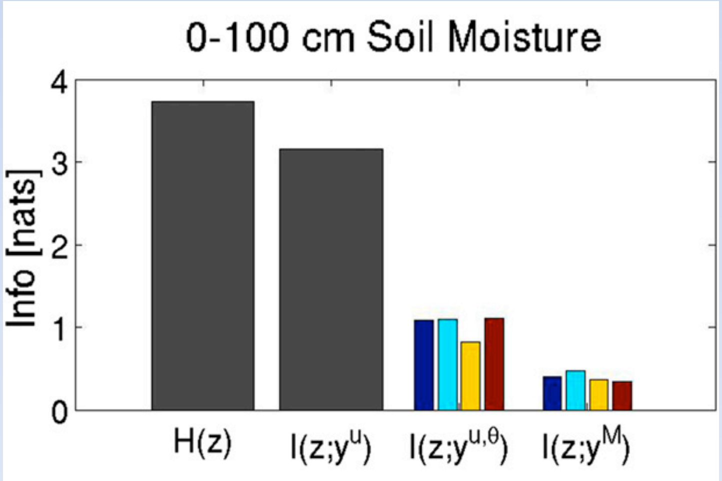
Liu, Y., C. D. Peters-Lidard, S. V. Kumar, K. R. Arsenault, and D. M. Mocko. 2015. "Blending satellite-based snow depth products with in situ observations for streamflow predictions in the Upper Colorado River Basin." Water Resour. Res. 51 (2): 1182-1202 [10.1002/2014WR016606]

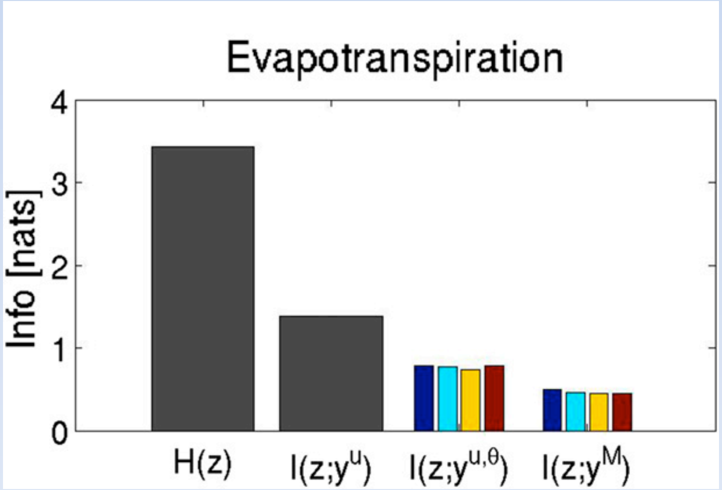
Liu, Y., C. D. Peters-Lidard, S. Kumar, J. L. Foster, M. Shaw, Y. Tian, and G. M. Fall, 2013. Assimilating satellite-based snow depth and snow cover products for improving snow predictions in Alaska, *Adv. Water Resour.*, *54*, 208–227.

What are sources of uncertainty?: Benchmarking



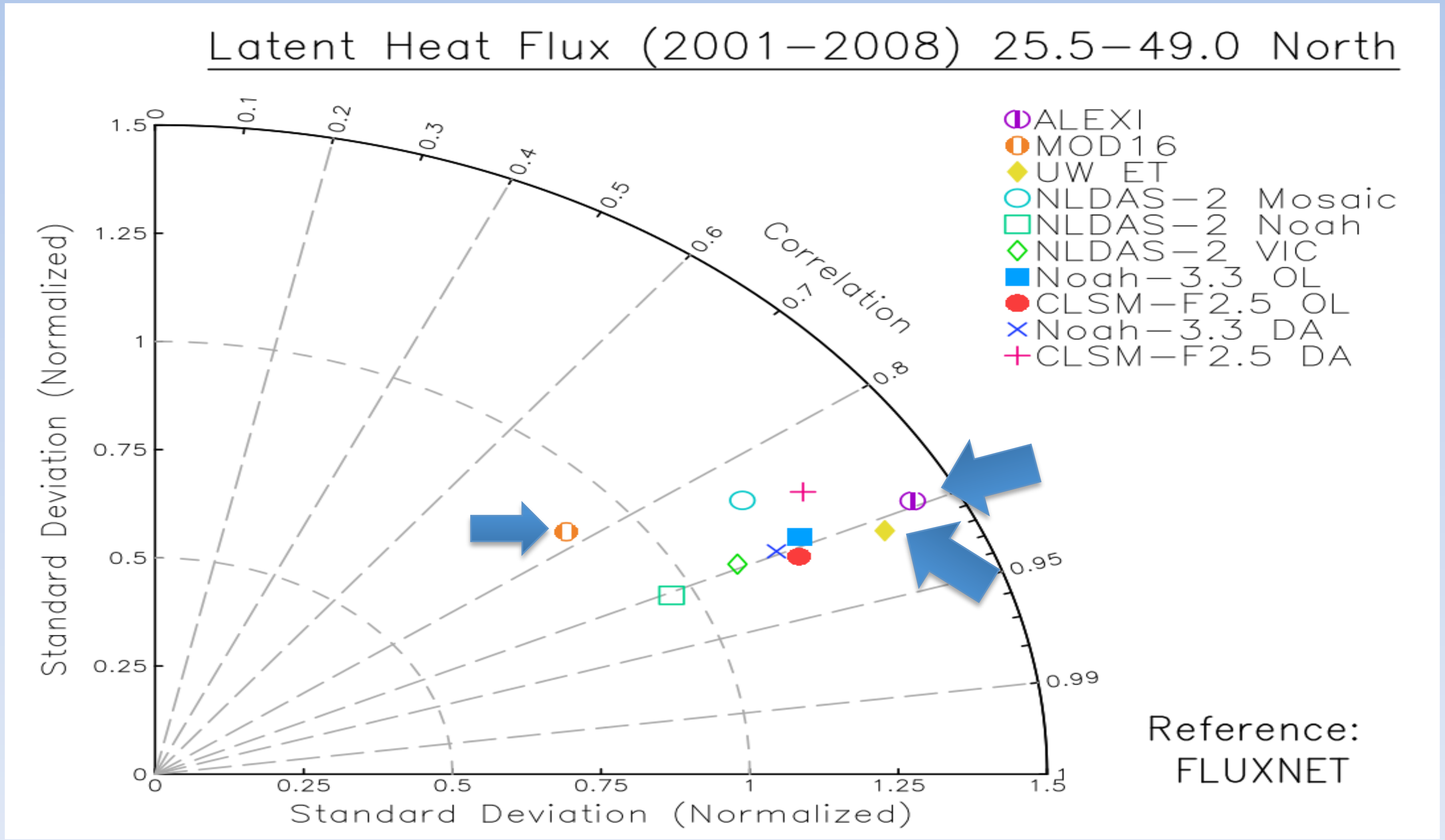






Nearing, Grey S., David M. Mocko, Christa D. Peters-Lidard, Sujay V. Kumar, and Youlong Xia, 2016: Benchmarking NLDAS-2 Soil Moisture and Evapotranspiration to Separate Uncertainty Contributions Journal of Hydrometeorology, 17:3, 745-759 , DOI: http://dx.doi.org/10.1175/JHM-D-15-0063.1.

Benchmarking requires observations



Taylor diagram using FLUXNET product as reference dataset.

ALEXI, MOD16, and UW ET compared to FLUXNET are shown.

NLDAS-2 LSMs shown with open marks.

Noah-3.3/CLSM-F2.5 OL runs shown with closed marks.

Noah-3.3/CLSM-F2.5 DA runs shown with "X" and "+".

Reference(s): Jung et al. (2009) – FLUXNET – *Biogeosci.*; Mu et al. (2011) – MOD16 – *Rem. Sens. Environ.*; Tang et al. (2009) – UW ET – *JGR*; Anderson et al. (2007) – ALEXI – *JGRa*

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Limitations: 1) Insufficient number/quality of precipitation gauges and streamflow monitoring sites in western U.S. and Canada (especially high-terrain regions)
2) Incomplete consideration of surface water and of anthropogenic water usage/diversions (irrigation, reservoirs, floodplains, etc.)
3)Insufficient high resolution observations for model evaluation and benchmarking.

Objectives/Tasks: 1) Higher resolution LSMs with improved forcing/observations (such as the next phase of NLDAS, including a larger domain) using the Land Information System (LIS)
2) Integrated multivariate hydrologic data assimilation to improve over data poor regions as well as to capture natural/anthropogenic heterogeneity (soil moisture, snow, GRACE, SWOT)
3) Improved physical modeling capabilities (ET, floodplains, river stage, lakes, etc.)

Benefits: 1) Improved drought monitoring as well as initial conditions for forecast models
2) Higher-quality datasets for water availability trends and indicators (e.g., NCA-LDAS)

Other critical issues: Soil texture and parameter databases, model calibration/optimization