NASA Land Information System Multi-Model Ensemble Hydrological Predictions

Dave Toll

NASA/GSFC

Bailing Li

SAIC/NASA/GSFC

Brian Cosgrove

NOAA/OHD

Paul Houser

CREW/GMU

Luis Gustavo de Goncalves

UMBC/GEST

Overall Goal

- Multi-model ensemble streamflow prediction based on the Land Information System (LIS)
 - Noah (NOAA/NCEP)
 - SAC-distributed (NOAA/OHD)
 - Catchment-distributed (NASA/GSFC)
 - VIC (UW)

Specific Objectives

- Model evaluation and inter-comparison
 - In situ Soil moisture measurements
 - Surface heat measurements
- Multi-parameter model calibrations
- Assessment of AMSR-E soil moisture products and LIS data assimilation
- 14-day ensemble streamflow prediction
- To improve the LIS 'Test Bed' for NOAA applications

Related NASA Projects

- NOAA/NWS River Forecasting Center Decision Support
 - NASA data (i.e., MODIS snow and cloud cover) and LIS modeling to improve river forecasting
 - Implementation of SAC/SNOW-17 in LIS
 - NOAA/OHD streamflow router in to LIS
- NASA/BoR Middle Rio Grande Project
 - 7-day ET forecasting using GFS forcing
- NASA LIS implementation (e.g., NOAA NCEP, AFWA and new NOAA NOHRSC)



NASA Land Information System

Inputs

Physics

Outputs Applications

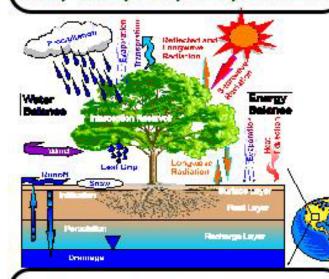
Topography, Soils (Static)

Land Cover, Leaf Area Index (MODIS, AMSR, TRMM, SRTM)

Meteorology
Modeled
(NOAA-NASA)
Observed (TRMM,
GOES, Station)

Observed States (MODIS Snow, Landsat ET, AMSR-E Soil Moisture) Land Surface Models (LSM)
Physical Process Models

Noah, CLM, VIC, SiB2, Catchmen



Data Assimilation Modules

(EnKF, EKF)

Physical Space Analysis System (PSAS) 3-D VAR Rule-based Surface Energy Fluxes (Oh,Ole)

Evapo-Transpiration, Soil Moisture

Surface Water Fluxes (e.g.,Runoff)

Surface States: Snowpack LAI Water Supply & Demand,

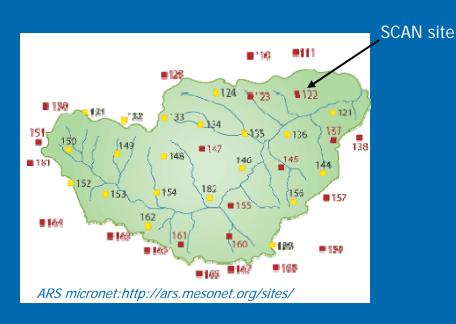
Agriculture,
HydroElectric
Power,
Endangered
Species,
Water

Improved Short Term

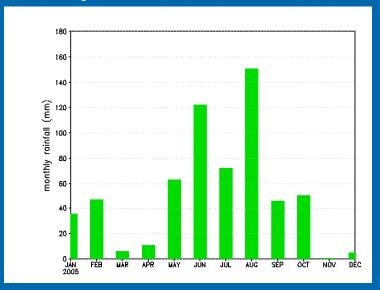
Quality

Long Term Predictions

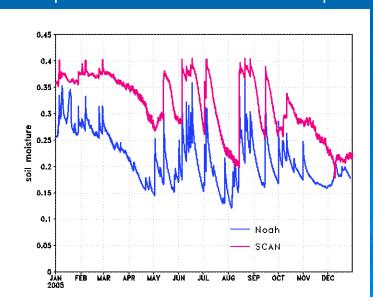
Model Evaluation: An example at Little Washita



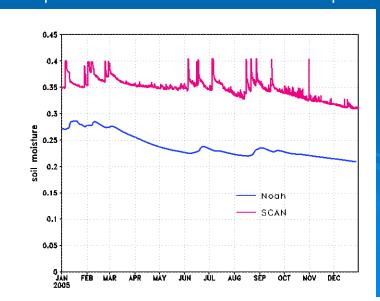
Monthly Rainfall (NLDAS) Amount (mm)



Comparison of Soil Moisture at 5 cm Depth

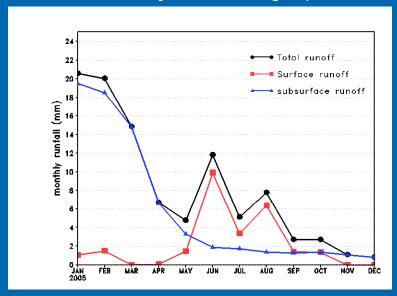


Comparison of Soil Moisture at 100 cm Depth

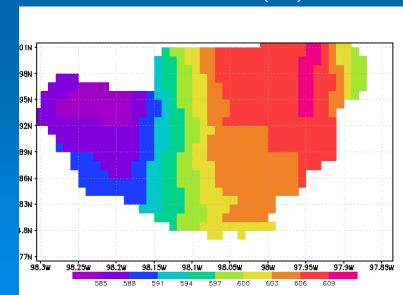


Model Evaluation: An Example at Little Washita

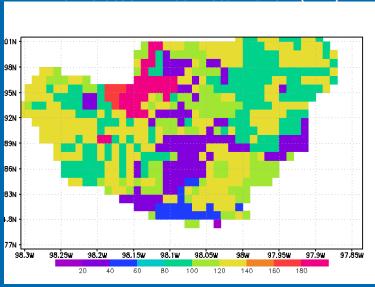
Simulated Monthly Runoffs at a grid point



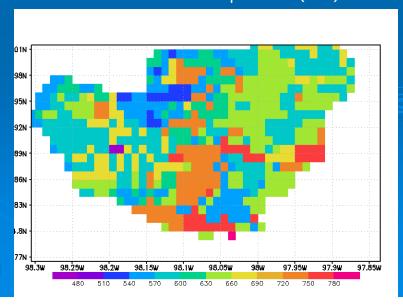
NLDAS Annual Rainfall (mm)



Simulated Annual Total Runoff (mm)

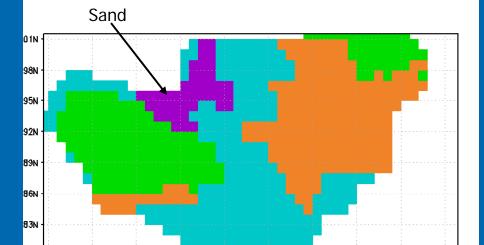


Simulated Annual Evaporation (mm)

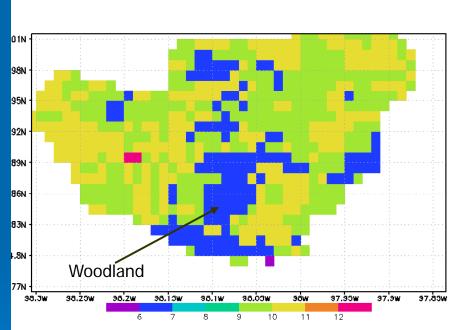


Model Evaluation: An example at Little Washita

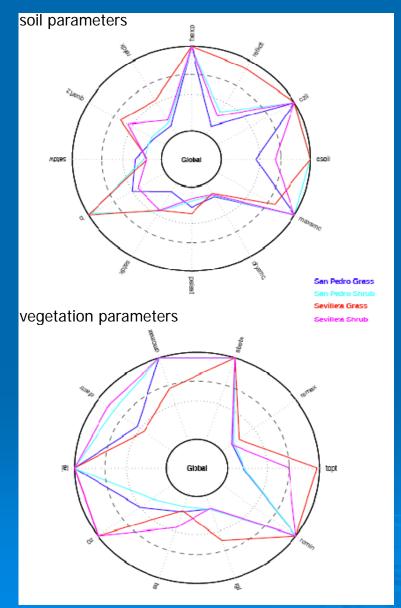




UMD 1KM Vegetation Type



Multi-objective/Multi-parameter Model Calibration

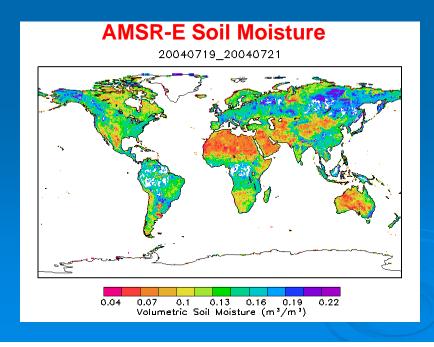


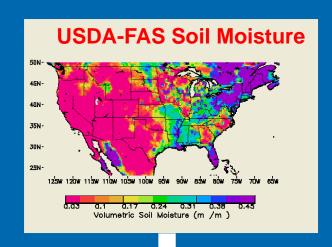


- Sensitivity analysis is performed using Monte Carlo simulation (MOGSA, *U. of Arizona*)
- Multi-objective/multi-parameter calibration
 - Calibration on Latent heat and sensible heat
 - Measured Soil moisture as initial condition
 - MOSCEM (*U. of Arizona*) for model calibration

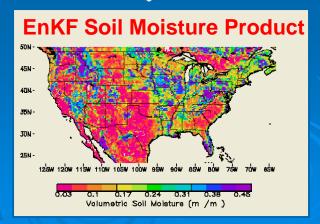
AMSR-E and LIS Data Assimilation

- ☐ The effect on soil moisture & streamflow
- **□**Better versions of AMSR-E
- □LIS data assimilation ability



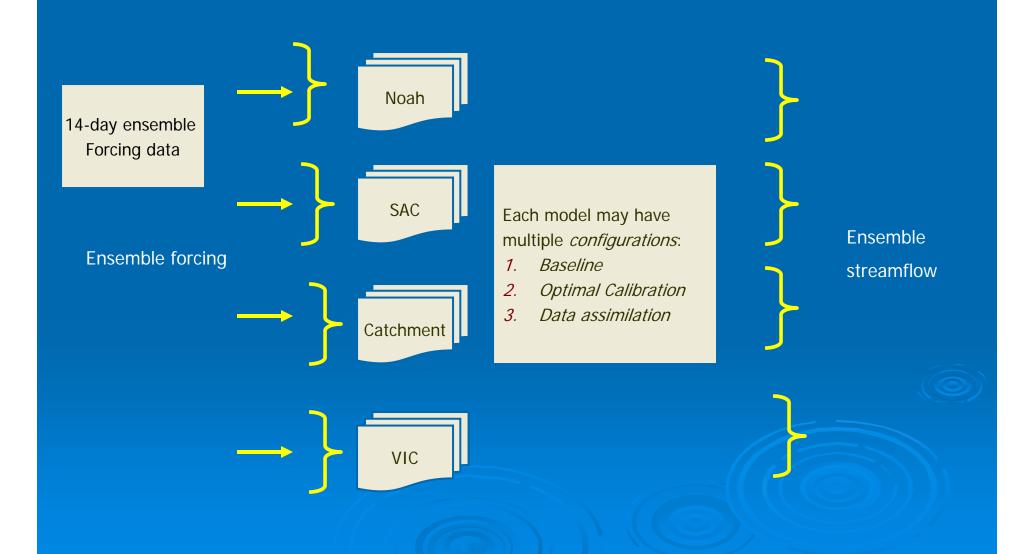




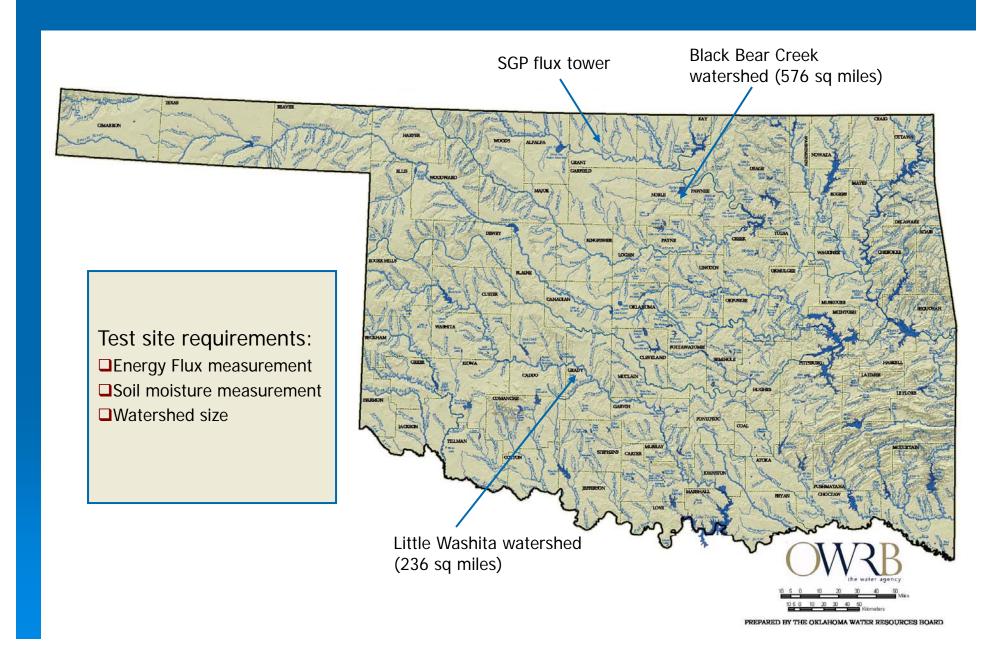


Courtesy: Bolten et al. (USDA-ARS)

Ensemble Streamflow Prediction



OK & DMIP Test Sites: Watersheds TBD



Thank you!

Comments/suggestions/questions?