NASA Land Information System Multi-Model Ensemble Hydrological Predictions

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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**
- 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)

**Physics**
- Land Surface Models (LSM) Physical Process Models
  - Noah, CLM, VIC, SiB2, Catchment

**Data Assimilation Modules**
- (EnKF, EKF) Physical Space Analysis System (PSAS) 3-D VAR Rule-based

**Outputs**
- Surface Energy Fluxes (Qh,Qle)
- Evapo-Transpiration, Soil Moisture
- Surface Water Fluxes (e.g., Runoff)
- Surface States: Snowpack, LAI

**Applications**
- Water Supply & Demand,
- Agriculture, Hydro-Electric Power, Endangered Species, Water Quality
- Improved Short Term & 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

ARS micronet: http://ars.mesonet.org/sites/
Model Evaluation: An Example at Little Washita

Simulated Monthly Runoffs at a grid point

Simulated Annual Total Runoff (mm)

NLDAS Annual Rainfall (mm)

Simulated Annual Evaporation (mm)
Model Evaluation: An example at Little Washita

STATSGO Soil Texture

UMD 1KM Vegetation Type

Sand

Woodland
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

Courtesy: Rosero and Bastidas, Utah State
AMSRR-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

Each model may have multiple configurations:
1. Baseline
2. Optimal Calibration
3. Data assimilation

14-day ensemble forcing data

Ensemble Streamflow
Test site requirements:
- Energy Flux measurement
- Soil moisture measurement
- Watershed size

OK & DMIP Test Sites: Watersheds TBD

SGP flux tower
Black Bear Creek watershed (576 sq miles)
Little Washita watershed (236 sq miles)
Thank you!

Comments/suggestions/questions?