Optimization of GPM Precipitation Estimates for Land Data Surface Modeling Applications
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PROJECT GOALS

The precipitation estimates from the planned Global Precipitation Measurement (GPM) mission will complement a host of existing rainfall products. This RPC experiment is investigating and evaluating intelligent techniques to merge various precipitation sources and optimize them for land surface and hydrological modeling applications.

EXPERIMENTAL APPROACH

The decision making agencies, such as NOAA, USBR and USGS, are faced with the problem of inadequate rainfall estimates in the western regions of the United States which does not have a adequate network of in-situ measurements. Besides, the NEXRAD estimates also suffer from elevation effects leading to poor coverage (Fig 2). Hence, satellite-based rainfall estimates offer the promise of improving the precipitation estimates in this region which difficult water management problems.

In this RPC experiment, different precipitation products will be merged using intelligent techniques and optimally merged for hydrological applications that support water resources management. A suite of GPM proxy data will be produced using different combinations of existing satellites, currently in orbit. The optimized precipitation products will be evaluated for their ability to force hydrological model predictions closer to observed fluxes and states (e.g. evapotranspiration, streamflow, runoff, etc.). The results of this evaluation will provide an important lead-in for the GPM Mission in order to readily meet the societal application needs.

The initial efforts will be concentrated in the Arkansas Red River Basin due to the rich set of data and operational expertise available in this region. The experimental approach involves the following steps to: (a) develop dynamic four dimensional objective analysis techniques (such as EnKF) and intelligent methods (ANN, Bayesian merging) to optimally merge various precipitation estimates; (b) to evaluate and implement spatial downscaling and temporal disaggregation techniques to derive precipitation forcings for land surface modeling; (c) to evaluate the optimized and downscaled products by running land surface model experiments at 1 -10 km resolutions in selected domains; and (d) to characterize uncertainties in merged products and in land surface modeling (LSM) simulations using the Noah LSM in the NASA Land Information System (LIS). This approach can also be readily extended to use other models that are a part of LIS.
PRELIMINARY RESULTS

The precipitation data sets collected for the complementary “GPM Evaluation” project are being reused in this RPC experiment. GPM proxy data, based on the NRL-Blended algorithm, was implemented for data collection over the continental United States. Every 3-hours, the NRL-Blend builds 3, 6, 12 and 24-hour accumulations from the time integration of all PMW and geostationary-derived rainrates. The NRL-Blend is being run in 10 parallel modes, each simulating a different GPM-Era “satellite constellation”. Since the exact configuration of which satellites and sensors will be orbiting during the GPM era is unknown, and will not be known until near or during the GPM lifetime, this enables the impact of omitting particular sensor types (radar, radiometer, across-track scanning, conically scanning), or crossing times (morning, afternoon, or TRMM-like asynchronous, etc), and to simulate various types of potential GPM-era constellations. For the RPC project the 10 simulated constellations include, (a) all satellites (baseline constellation); (b) omit all crosstrack sounders from baseline constellation; (c) omit morning crossing crosstrack sounders; (d) omit afternoon crossing crosstrack sounders; (e) omit both TRMM radar and radiometer, and (f) various combinations of TRMM & AMSR-E in Aqua. In addition, the NOAA CMORPH and GOES-HE products will also be included in the study.

ANTICIPATED SOCIOETAL BENEFITS

The United States Bureau of Reclamation (USBR) is “the nation's largest wholesale water supplier”, managing water resources that support irrigation and hydroelectric plants. The USBR makes critical water management decision using a suite of Decision Support Tools (DSTs) including RiverWare (for water demand) and AWRDS-ET for water supply decision making. The GPM data are expected to improve the soil moisture and evapotranspiration inputs of DSTs. In addition, the capabilities can also support the conservation efforts of the USDA NRCS.

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Figure 3: Precipitation data for a light to moderate rain case (left) and moderate to heavy rain (right). The NEXRAD Stage IV precipitation data (middle) reveal more features than the gage analysis (top) and the CMORPH (bottom). CMORPH also has higher estimates.