Integrating GRACE and GRACE Follow On Data into Flood and Drought Forecasts for the Continental U.S.

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Problem Statement

• Reliable drought forecasts would be more valuable than maps of current drought conditions.
• River flow forecasts would benefit from more accurate antecedent wetness conditions.
• We have previously demonstrated that terrestrial water storage data from GRACE can be spatially and temporally downscaled and vertically disaggregated via integration with other observations within a land surface model, and that the resulting soil moisture and groundwater fields are useful for drought monitoring.
• Terrestrial water storage has significant “memory”, hence it contains valuable information on antecedent conditions that, in part, control drought and flood severity.

Goal

Build upon our current suite of soil moisture and groundwater wetness indicators, which are already at ARL 9, to develop 30-90 day, 0.125° gridded predictions of water storage conditions and runoff for the continental U.S., and test them as inputs to existing drought, river flow, and flood decision support systems.
GRACE-based Flood and Drought Forecasts

Project Team

NASA/Goddard Space Flight Center: Overall project coordination; GRACE data assimilation; wetness indicator development; forecast simulations.

Johns Hopkins University: Generate hindcast and forecast forcing fields; evaluation of forecast simulations; transition of forecast system.

University of Texas Center for Space Research: Develop GRACE and GRACE-FO products that are optimized for the region and objectives, including low latency products and associated error analyses.

University of Nebraska, Lincoln: Evaluate, distribute, and promote the use of GRACE based wetness (drought) indicators and forecasts.

NOAA North Central RFC: Incorporate GRACE-DA products as inputs to NCRFC forecast models, evaluate their utility and aid in refinement, and implement into operations; deliver experimental and final river flow forecasts to USACE; promote use by other RFCs.

U.S. Army Corps of Engineers: Simulate routing of river flow data from NCRFC through USACE reservoirs; evaluate results; provides feedback; evaluate changes in emergency measures that would result and associated costs and economic savings.
Background: GRACE Based Drought Indicators

- Data assimilation combines modeled and observed estimates and error info to compute optimal estimates
- Catchment land surface model; 20 member ensemble
- Ensemble smoother data assimilation (Zaitchik et al., J. Hydromet., 2008)
- Output has improved spatial, temporal, and vertical information
New process integrates data from GRACE and other satellites to produce timely information on wetness conditions at all levels in the soil column, including groundwater. For current maps and more info, see http://www.drought.unl.edu/MonitoringTools.aspx


Drought indicators from GRACE data assimilation (wetness percentiles relative to the period 1948-present) for 25 June 2007.
GRACE-based Flood and Drought Forecasts

Key Datasets: Terrestrial water storage anomalies from GRACE and GRACE-FO; Princeton and NLDAS-2 meteorological forcing; NASA GEOS-5 seasonal forecasts.

Land Surface Model: NASA’s Land Information System driving the Catchment Land Surface Model with gridded GRACE data assimilation.

Technical Approach:
1. 1948-present retrospective simulation for background climatology.
2. Gridded GRACE (and GRACE FO) data assimilation for 2002-present.
3. Downscale GEOS-5 seasonal forecasts using 3 approaches.
4. Evaluate and refine seasonal forecast approach.
5. Drive Catchment LSM with downscaled forecasts, starting from data assimilation based initial conditions.
6. Drought forecast development and testing.
7. River flow forecast development and testing.
8. Data distribution and transition to operations.
Transition Plan

**Drought:**
- Products will be transferred to NDMC and distributed via USDM and NIDIS portals.
- Follows on 2+ years of success with the GRACE-DA monitoring products
- Possible A.45 Intrinsic Merit activity with RFF?

**Floods:**
- Transition begins with a verification/validation exercise: NCRFC applies forecasts as input to Sacramento, USACE evaluates for reservoir management options
- Operational transition will include automating the handoff between GRACE-DA Forecasts and Sacramento simulations at NCRFC