GRACE Follow-On Mission Status

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Outline

• The science rationale for GRACE Follow-On mission

• Recent programmatic developments

• The technical approach to GRACE Follow-On mission
Mission Status

– Gravity Model Release
  • RL4 Mean field (GGM03C and Eigen-GL 05C)
  • Time Variable Signals (100 monthly solutions through Sep 10)
  • Multidisciplinary science results are demonstrating importance of “global mass flux measurements”

– NASA 2009 Senior Review Completed

– NASA/DLR MOU Renewed

Flight Segment

– Nearly 100% of scientific measurements during 8.5 yrs have been collected and analyzed
– Certain sub-systems are single-string on both s/c
– New thermal regimes to conserve battery
– Instrument performance meeting mission requirements

Orbit and Satellites

Launched: March 17, 2002
  Over 8 years in orbit
Initial Altitude: 500 km
  Current Altitude: ~460 km
Inclination: 89 deg
  Eccentricity: ~0.001
Separation Distance: ~220 km
  Currently 220 km
Nominal Mission: 5 years
Non-Repeat Ground Track, Earth Pointed, 3-Axis Stable
Predicted Lifetime: 2013-15(?)
Trends Estimated from GRACE 2002-2009

Images of GRACE trends show several influences of inter-annual variability
Variability in Ice-Mass Change

(from Velicogna et al, 2009)

From Watkins et al, 2009
• GRACE measures the change in all of the water stored on land after precipitation has been stored as snow, infiltrated into the ground, evaporated, or left the basin as streamflow.

• Accounting for these inflows, outflows and storage changes is called **water balance**.

**Storage Change = Inflows (Precipitation) - Outflows (Evaporation + Streamflow)**
GRACE is tracking water storage in large river basins

Mississippi

Trend: 11.7 mm/year

Nile

Trend: -9.3 mm/year

Congo

Trend: -21.6 mm/year

Zambezi

Trend: -16.3 mm/year

Colorado

Trend: 37.5 mm/year
Broad Acceptance of Science Justification

• There is broad scientific consensus about the high value of GRACE measurements of mass flux, including the manifestations of critical climate change processes at long time-scales.
  – Ice sheet mass trends
  – Regional water storage variability and trends
  – Ocean mass trends and their impact on sea-level rise

• GRACE has measured regional patterns of mass flux variability in a globally consistent manner.
  – Long duration GRACE observations will help in discriminating regional patterns of mass flux resulting from (decadal time-scale) climate teleconnections and from anthropogenic contributions.
GRACE Follow-On Status: 2007-2010

• NASA had accepted GRACE-II as a Decadal Survey mission, but the launch date (~>2020) would create a significant gap in this critical climate dataset
  – Similar gap would result from the nominal ESA plans

• GRACE Follow-On studies were split into two (sequential) parts
  – Quick gap-filling GRACE for launch ~2015
  – Longer term more capable/more satellites for launch >~2020 (not further discussed here)

• As of spring 2010, NASA has included the rapid follow-on to GRACE in its budget for a start in FY 2011, with launch by 2016
  – This budget (like the overall NASA budget) is still subject to approval by the US Congress
GRACE Follow-On

• The GRACE Follow-On mission is heavily focused on maintaining data continuity from GRACE and minimizing any data gap after GRACE.

• The baseline is to therefore to maintain maximum heritage from GRACE, and to minimize project schedule, along with technical risk and cost risk
  – Significant technical and cost analysis was performed along this path in 2009-2010
  – NASA understands the value in carefully considering a technical demonstration of a laser interferometer system that could reduce risk for higher spatial resolution missions on the 2020+ time frame
    • Several ESTO Instrument Incubators to get system to TRL to 6 (JPL, Ball, CU, Hannover)
      • Subnanometer performance demonstrated

• NASA welcomes continuation of the highly successful GRACE partnership with DLR and GFZ