NASA Earth Science Division
Perspectives on THORPEX

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NASA Earth Science Division (ESD) Goals

• ESD Science Plan Questions:
  – How is the global Earth system changing?
  – What causes these changes?
  – How will the Earth system change in the future?
  – How can Earth system science provide societal benefits?

• ESD Science Plan Goals Relevant to THORPEX Include:
  – Improve capability to predict weather and extreme weather events.
  – Improve ability to predict climate change through better understanding of the roles and interactions of the ocean, atmosphere, land and ice in the climate system.
  – Further the use of Earth system science research to inform decisions and provide benefits to society.

• NASA Modeling, Analysis, and Prediction Program Goals:
  – Understand Earth as a complete, dynamic system.
  – Observation-driven modeling.
17 NASA Earth Science Operating Missions 2014

- Suomi NPP (NOAA)
- Terra
- Aqua
- Aura
- QuickSCAT
- TRMM
- OSTM/Jason 2 (NOAA)
- GPM (JAXA)
- EO-1
- Landsat-7 (USGS)
- ACRIMSAT
- SORCE
- GRACE (2)
- CALIPSO
- CloudSat
- Landsat-8 (USGS)
- CloudSat
3 ESD-developed EO missions launch in CY 2014
2 ISS-developed EO instruments in 2014, 1 in 2016
9 more ESD EO launches before 2022
NASA Observations in Context of THORPEX

• Many uses of NASA observations for improving weather/climate models:
  – NASA ESS mission - focus on developing “seamless” models spanning all time and spatial scales.
  – Many NASA observations useful to improve process representation in models.

• Observations directly useful for NWP/analysis:
  – Current: AMSU-A, AIRS (Aqua), OMI, MLS ozone (Aura), ATMS, CrIS (Suomi-NPP), TMI (TRMM), GMI (GPM).
  – Future: GMI (GPM, launched this year), RapidScat, SMAP.

• NASA observations are a powerful tool for advancing THORPEX follow-on goals.
Influencing the observational system

• Opportunity to influence observational system at NASA is limited –
  – NASA “dance card” is full.
  – NASA depends on “decadal survey” to determine future missions

• NASA “Earth Venture” program provides shorter-term, competed opportunities that THORPEX might exploit:
  – EV/S: suborbital missions (e.g. HS3, Hurricanes and Severe Storms Sentinel).
  – EV/M: small complete missions, cost-capped @ $150M (e.g., CYGNSS, Cyclone Global Navigation Satellite System).
  – EV/I: hosted payload (e.g, TEMPO, atm chem mission).
NASA GMAO NWP/Assimilation Development Plans

• Improved Utilization of Observations:
  – All sky radiance assimilation (to exploit GPM/GMI).
  – Adjoint/OSSE model-based sensitivity testing and tuning.

• Higher resolution model and analysis – move toward convective and mesoscale resolution.

• Implement hybrid-4D var.

• Model improvements:
  – better representation of land surface to improve use of surface-sensitive channels.
  – cloud, aerosol and precipitation microphysics
GMAO 7-km Global Mesoscale Simulation for OSSEs

- 2-year free-running global mesoscale simulation scheduled (May 2005 - April 2007)
- AMIP-type constrained SST + high res (10 km) aerosol emissions. Nonhydrostatic.
• GEOS-5 forecasts from 09Z 26 October 2012:

• 7-km resolution run better at forecasting Sandy's track and intensity than the typical 1/4-degree resolution configuration of GEOS-5.
NASA Participates in NMME for ISI Forecasting

NMME (National Multi-Model Ensemble) is a system to improve intra-seasonal to interannual (ISI) operational predictions based on the leading US and Canada climate models.
Regions of the U.S. experienced extreme drought and heat waves during the summers of 2011 and 2012. A series of simulations performed with GEOS-5 show that:

- Drought and heat waves across the Southern Plains in 2011 appear to have been a response to cool tropical Pacific sea surface temperatures (SSTs).

- GEOS-5 simulations initialized in May, June, and July of 2012 did not fully capture the severity of the 2012 drought and heat wave until the forecast initialized in July, suggesting the extreme hot and dry conditions of 2011 were not a precursor for the excessive heat and drought experienced in 2012. There is some evidence, however, that dry soils in 2011 played a role in the development of 2012 temperature anomalies through soil moisture feedbacks.

- Drought and heat waves across the Central Plains in 2012 cannot be attributed to SST anomalies, and were most likely a response to the development of a phase locked Rossby wave over the region.

Reference:

The 2012 drought and heat wave, as represented by anomalies found in MERRA-Land. July 2012 anomalies are relative to the 1980-2010 climatology.
Summary/Conclusions

• NASA interests overlap with THORPEX.
• All Proposed THORPEX legacy projects (PPP, S2S, HIW) of interest to NASA ESD.
• NASA current observational system is in good shape, with a lot in the pipeline.
• Many relevant NASA observations to utilize.
• Earth Venture program provides near-term opportunity
• NASA Global Modeling and Assimilation Office is focus of THORPEX-related efforts.
• NASA NWP efforts focused on developing all sky DA, better utilization of current obs, increased resolution, implement hybrid 4D-Var.