



NASA GMAO GEOS S2S Prediction System

Hindcast and Near-Real Time Operations Strategy

Robin Kovach

NCCS (NASA Center for Climate Simulation)

Lyn Gerner, Bruce Pfaff

GMAO Seasonal Prediction Development Team

Deepthi Achuthavarier, Santha Akella, Lauren Andrews, Donifan Barahona, Anna Borovikov, Yehui Chang, Richard Cullather, Eric Hackert, Randal Koster, Zhao Li, **Rob Lucchesi, Jelena Marshak, Andrea Molod,** Steven Pawson, **Bill Putman,** Siegfried Schubert, Max Suarez, **Matt Thompson,** Atanas Trayanov, Guillaume Vernieres, Yury Vikhliayev, Hailan Wang, Bin Zhao



Motivation

- **Computational strategy for producing a data suite for the GEOS S2S System**
 - GMAO has produced Seasonal (nine-month) forecasts for about a decade
 - Data are contributed to NMME, Sea-Ice Outlook, and other major projects
 - Sub-seasonal forecasts have been added to the GMAO's product portfolio in the past year
 - Forecasts use a coupled atmosphere-ocean-land-ice version of the GEOS model
 - Atmospheric and land models build on the GEOS-FP model (used for weather prediction)
 - MOM5 is used for the ocean and CICE for sea ice (recent upgrade from MOM4)

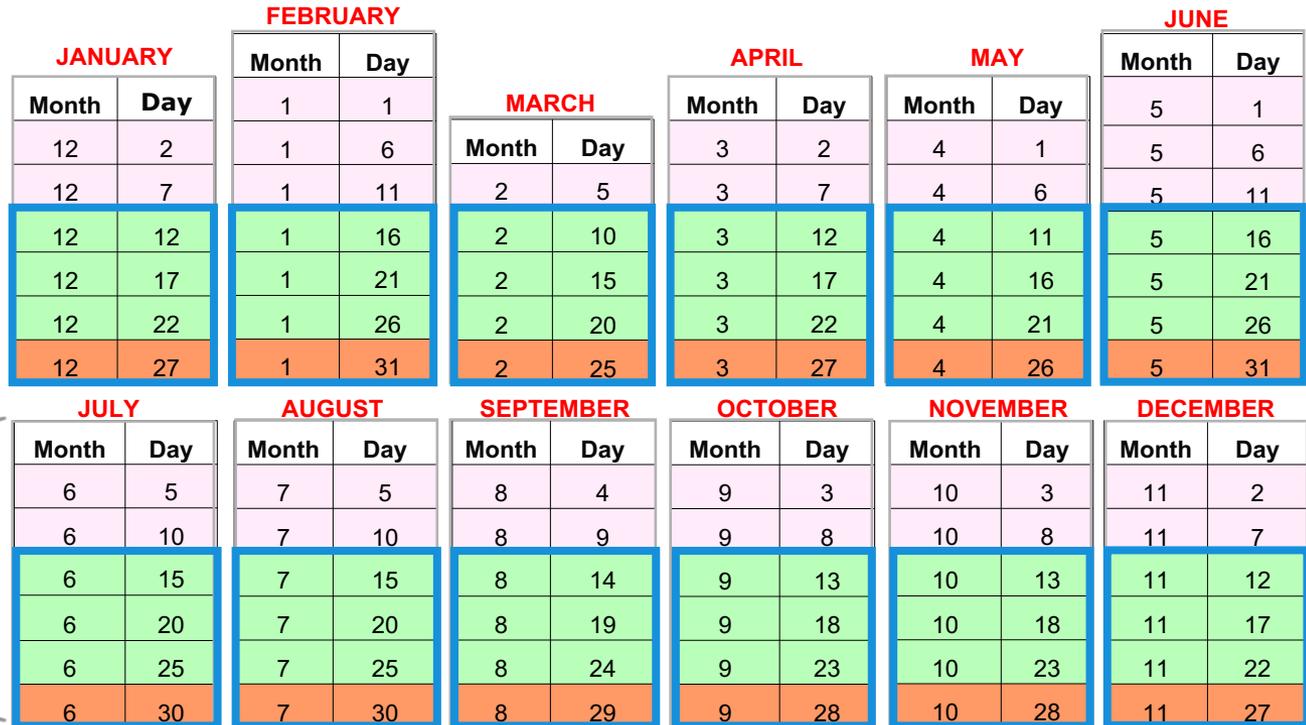
- **Unique demands for S2S forecasting systems**
 - S2S forecasts require at least **36 years of hindcasts** to provide a baseline for computing anomalies (account for model drift).
 - This takes more than **six months to complete** with the bare minimum of ensembles.
 - Ocean reanalysis can take **up to a year** to complete all 36 years.
 - With higher resolution models and more components, it will only get more challenging.

- **Present Computing Strategy for Hindcasts and Forecasts**
 - Developed for GMAO's "new" GEOS-S2S v2 system, which went into production in December 2017



Forecast/Hindcast Production Schedule

- SubX only forecast
- seasonal and SubX
- forecast ensemble of 7 members
- composite ensemble of 10 members submitted to NMME



Takes one month to complete one month of hindcasts.



Forecast Computation Strategy

JANUARY

Month	Day
12	2
12	7
12	12
12	17
12	22
12	27

➤ Problem

Need to generate full set of January hindcasts (36 years) to run the real-time January forecast.

- Takes **one month** to generate full set of hindcasts (running subX and seasonal in parallel)
- Not enough time for post-processing and delivery to NMME
- Original plan was 6 dates per month > **reduced to 4 dates to make NMME delivery**

➤ Current Solution

Use the spare nodes on the **GEOS-FP** queue for continuous running in 1-hour segments.

- GEOS-S2S Forecast was changed to run in 5 day segments instead of 30 or 45 days.

Queue	cpus	Availability	# jobs	Time to Run
Production (gmaodev)	8,500	24/7 when GMAO's "GEOS-FP" (weather forecast) system is not running	23 always running or in queue	~7 days/job
Transitional (preops)	10,000	24/7 when available (depends on other major developments)	20-30	3-4 days/job

GMAO's GEOS-FP "Production" Queue Usage

Substantial blocks of

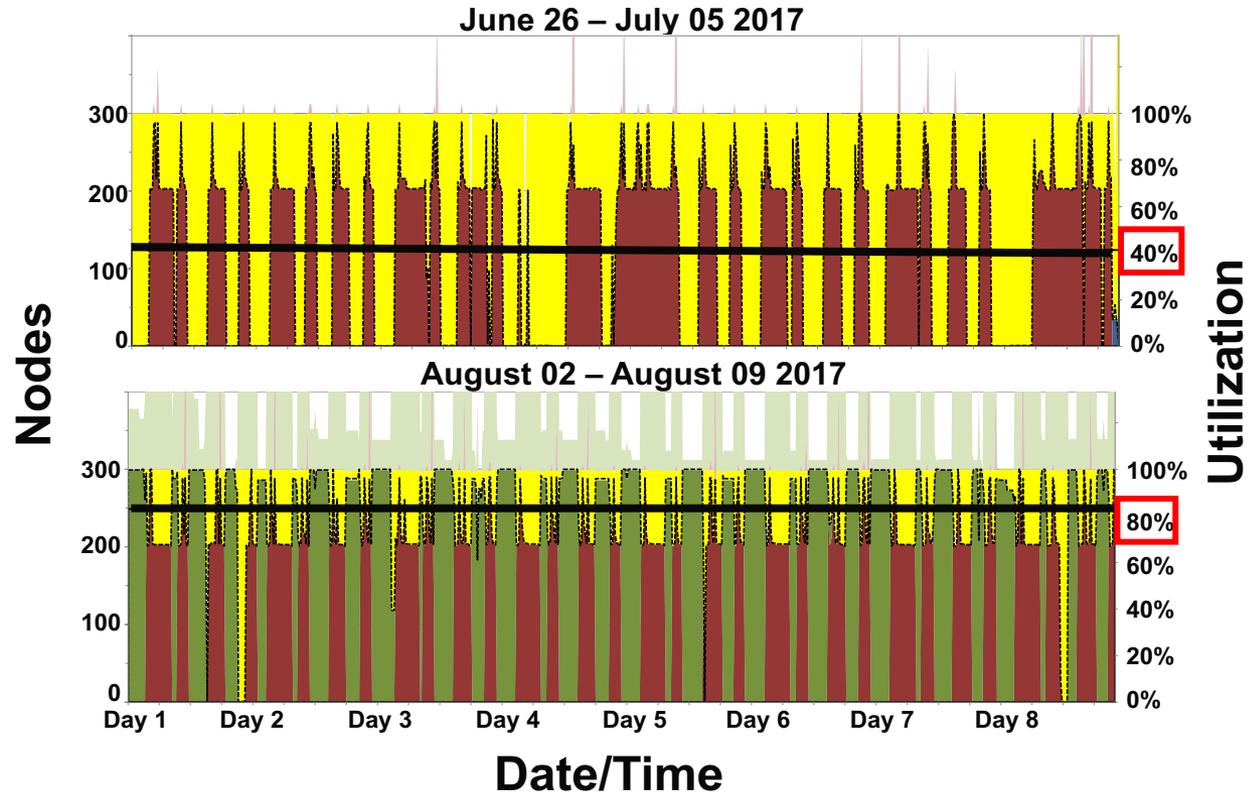
■ Idle Time

are available between periods of

■ GEOS-FP product generation

■ S2S Runs were partitioned into small segments and could be run in this otherwise wasted capacity

Mean Utilization of this 300-node partition of the NCCS Discover platform increased from 40% to 85%





Going Forward

Development of the GMAO S2S-3 (system freeze circa January 2019)

- More ensembles (alternative perturbations, artificial intelligence, breeding)
- Hindcasts every 5 days for **seasonal** and sub-seasonal
- Hindcasts back to 1982 for seasonal and **sub-seasonal**
- Full ocean reanalysis at **1/4 degree, 50 levels**
 - Ice extent and thickness
 - Satellite salinity
 - Tskin analysis
- Numerous other updates will be included in the GEOS modeling system, including
 - Shallow convection
 - Catchment CN
 - Bias corrected forecasts
 - Predictive biomass burning emissions
 - Ice sheet runoff to proper location
 - “Snow darkening” parameterization
 - “skin later” – diurnal warming and cooling layer