NASA GMAO S2S Prediction System

Hindcast and Near-Real Time Operations Strategy

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Motivation

➢ Computational strategy for producing a data suite for the GEOS S2S System

- GMAO has produced Seasonal (nine-month) forecasts for about a decade
- Date are contributed to NMME, Sea-Ice Outlook, and other major projects
- Subseasonal 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.

JANUARY

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

FEBRUARY

Month	Day
1	1
1	6
1	11
1	16
1	21
1	26
1	31

MARCH

Month	Day
2	5
2	10
2	15
2	20
2	25

APRIL

Month	Day
3	2
3	7
3	12
3	17
3	22
3	27

MAY

Month	Day
4	1
4	6
4	11
4	16
4	21
4	26

JUNE

Month	Day
5	1
5	6
5	11
5	16
5	21
5	26
5	31

JULY

Month	Day
6	5
6	10
6	15
6	20
6	25
6	30

AUGUST

Month	Day
7	5
7	10
7	15
7	20
7	25
7	30

SEPTEMBER

Month	Day
8	4
8	9
8	14
8	19
8	24
8	29

OCTOBER

Month	Day
9	3
9	8
9	13
9	18
9	23
9	28

NOVEMBER

Month	Day
10	3
10	8
10	13
10	18
10	23
10	28

DECEMBER

Month	Day
11	2
11	7
11	12
11	17
11	22
11	27

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

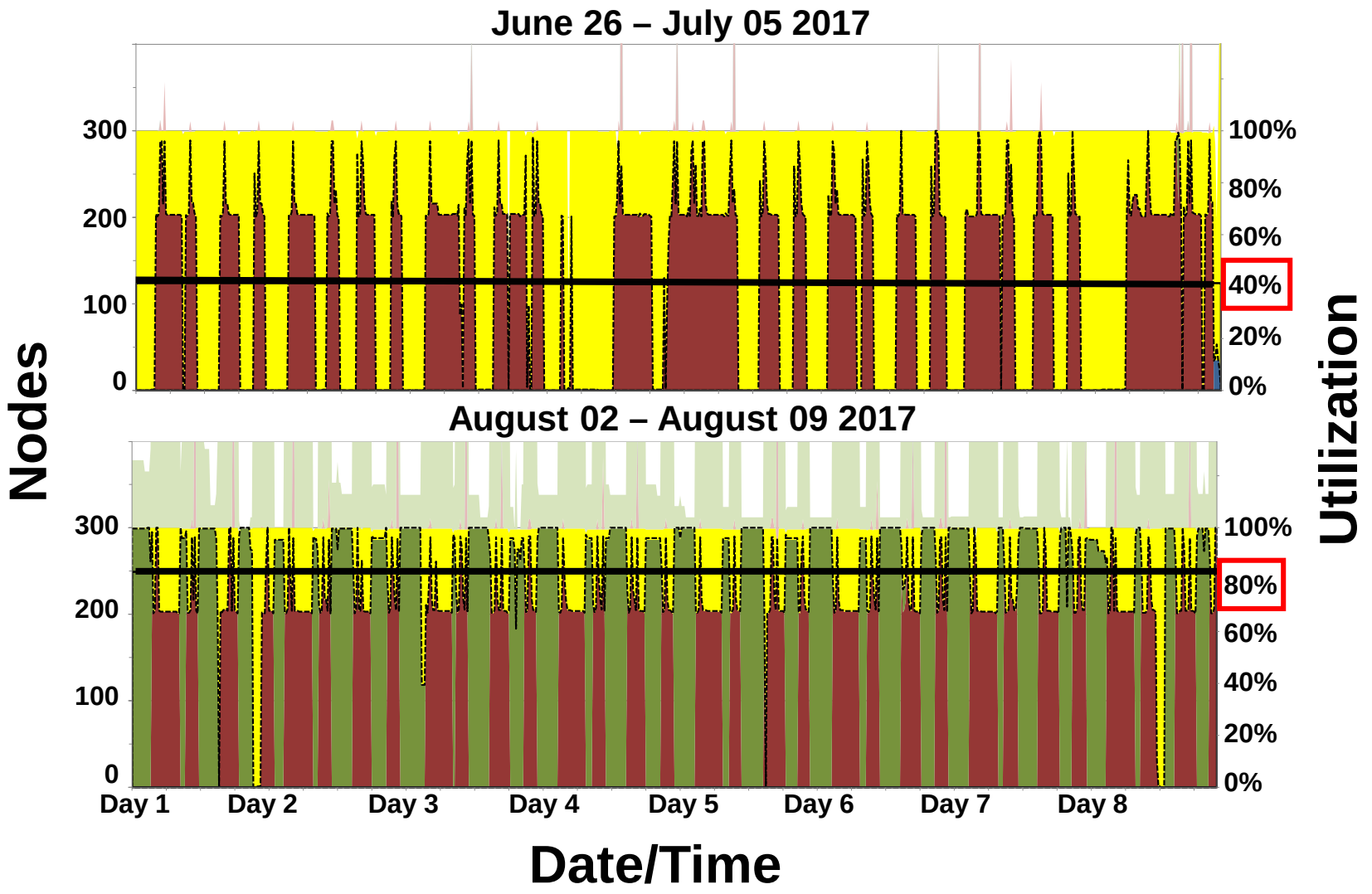
- **Idle Time**

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 **¼ 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