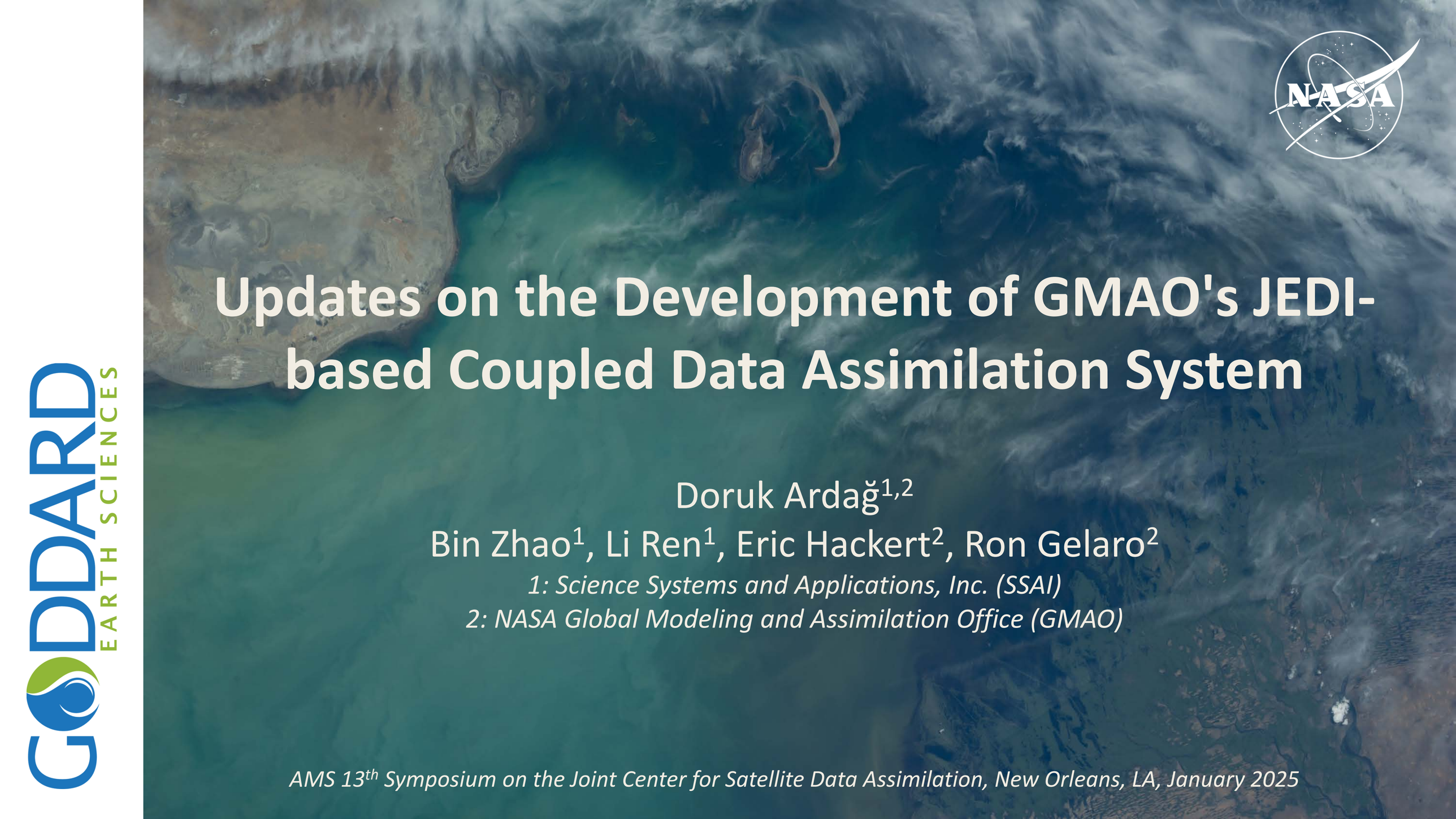

Updates on the Development of GMAO's JEDI-based Coupled Data Assimilation System

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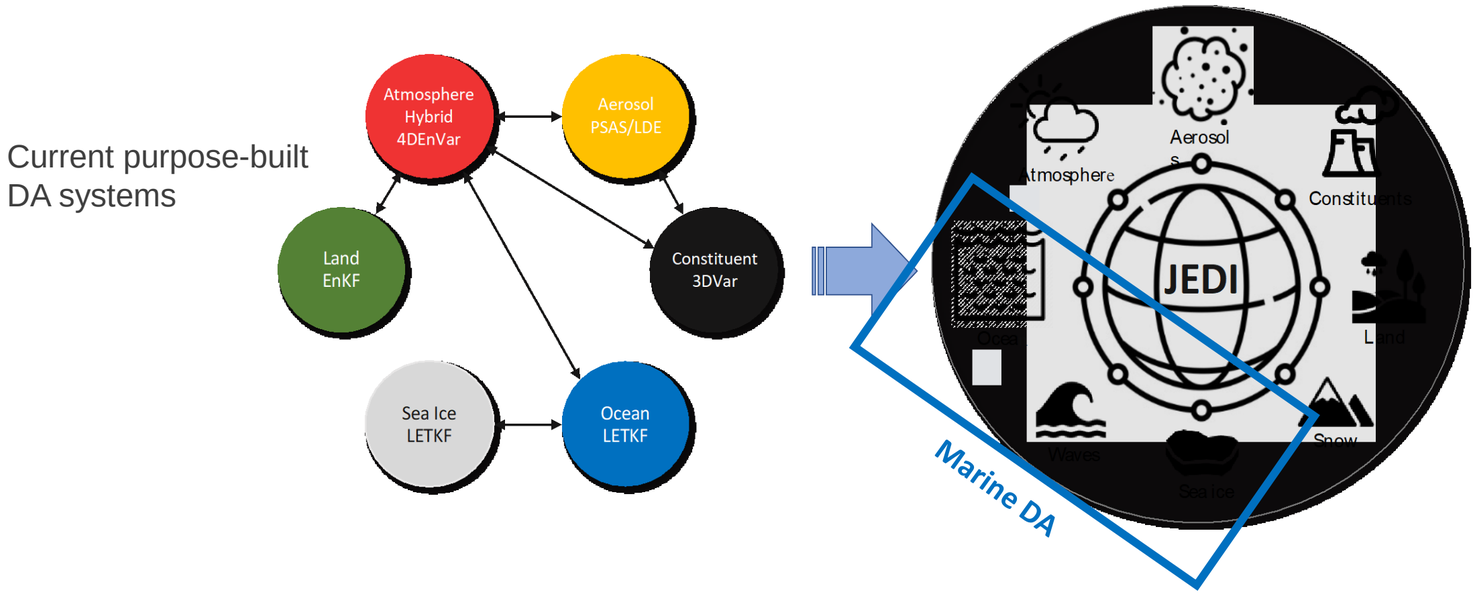
1: Science Systems and Applications, Inc. (SSAI)

2: NASA Global Modeling and Assimilation Office (GMAO)

AMS 13th Symposium on the Joint Center for Satellite Data Assimilation, New Orleans, LA, January 2025

GMAO is developing a unified coupled data assimilation system based on the GEOS model and JEDI, for weather analysis and prediction, reanalysis, composition forecasting, and S2S prediction.



- Eliminate GMAO's dependence on legacy, purpose-built assimilation systems
- Use coupled models to exploit the full range of NASA's diverse set of Earth-system observations
- Capitalize on JEDI's multi-agency adoption to accelerate R2O transition of NASA's observations

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See Ron Gelaro's talk for more details: **Session 9.4, Wednesday 9:15AM**

Development of SWELL, the new DA workflow ecosystem

- Orchestrates all DA related tasks and scheduling
- Uses Cylc engine for workflow management

Substantial update over the existing GMAO/ODAS including:

- New types of observation sources
- Ocean and sea-ice model upgrades: MOM5/CICE4 -> MOM6/CICE6
- Full adaptation to JEDI/SOCA framework
- Two-way weakly-coupled DA

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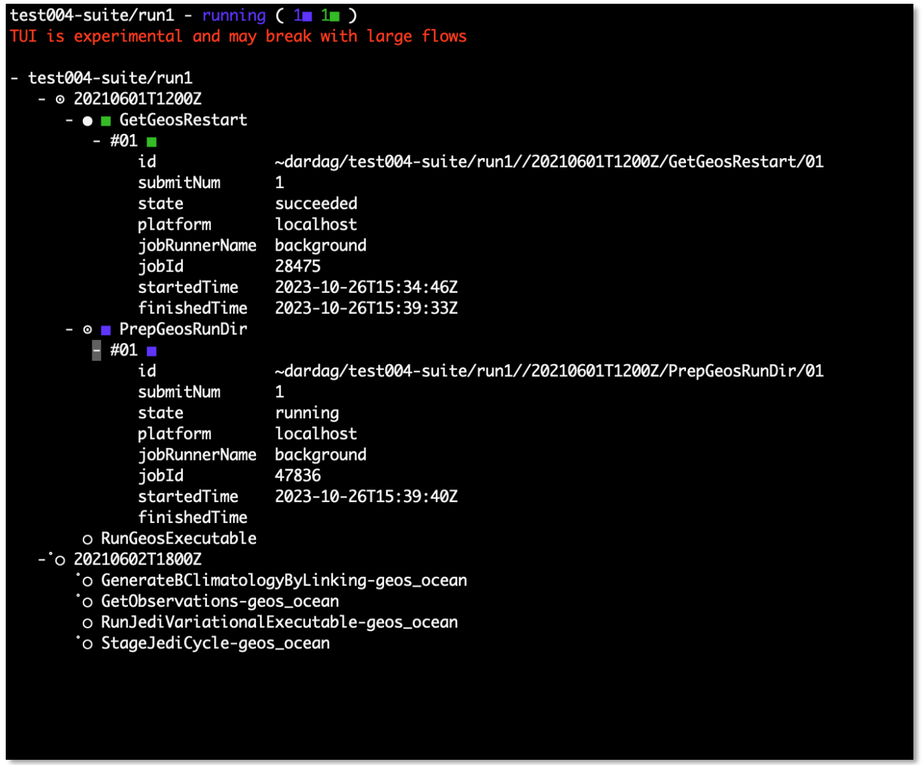
- Workflows operating for 3DVar/3DFGAT atmosphere and ocean, plus LETKF atmosphere
- Shared YAML templates/tasks across GMAO applications
- On-prem Github CI is fully functional:
  - Tier-1 tests against “pinned” JEDI version for GEOS implementation targets
  - Tier-2 nightly tests against latest JEDI-develop version to maintain synchronization with JCSDA
- Integrated diagnostics (EVA) and observation-handling (R2D2) developed collaboratively with NOAA and JCSDA



Cylc TUI for a cycling ocean DA workflow with 6-hr window

Doruk Ardağ, Alexey Shiklomanov, Michael Anstett, GMAO; Dan Holdaway, NCEP

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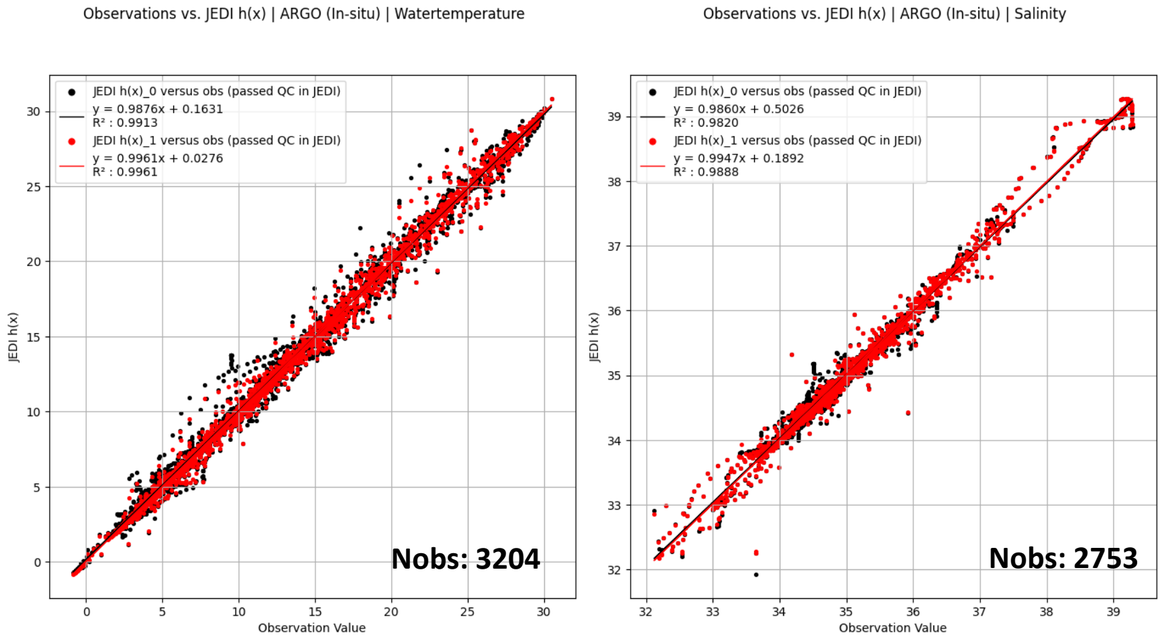
- GMAO/ODAS observation sources were converted to IODA format for July/September 2021:
  - **ADT:** Sentinel 3a/b, Jason-3, Cryosat-2n, Saral
  - **SSS:** SMOS, SMAP
  - **In-situ:** ARGO, CTD, PIRATA, RAMA, TAO, XBT

- New obs. sources obtained from NOAA/EMC:
  - L3 SST retrievals (AVHRR, VIIRS, ABI, AHI) and sea-ice concentration
  - IODA format allows utilization of JEDI experiment outputs



ARGO observations on July 1st,2021 between 9z and 15z

- NOAA/NASA Joint Archive (NNJA) of Observations for Earth System Reanalysis (1979-)
  - Includes ocean, ice, land, and atmosphere observations

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- 3DFGAT with static **B** (NEMOVAR-like multivariate balances, Weaver et al. 2005)
  - Default SOCA configuration during development
  - Explicit diffusion for horizontal and vertical correlation lengths (Weaver and Courtier, 2001)

- 6-hr DA window, allows use of GEOS atmospheric reanalysis forcing

- IAU for MOM6, direct insertion for CICE6

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Coupled Model

- GEOSgcm
  - **Atmosphere:** AGCM, C180 L72
  - **Ocean + Sea-ice:** MOM6 + CICE6, 0.25^{o} L75

- Atmospheric forcing configurations:
  - Replay to GEOS-IT
  - Future tests with ERA5, JRA55-DO

JEDI Test Setup

- Restarts from 31 May 2021 with one-month spin-up
  - **Ocean:** WOA18 (potential temperature and salinity)
  - **Atmosphere, land, sea-ice:** GiOcean* (except for CICE6)

- Observing system nearly identical to GiOcean, with notable differences
  - **SST:** JEDI tests assimilate L3; GiOcean relaxation to OSTIA L4
  - **SIC:** JEDI tests assimilate AMSR2 L3

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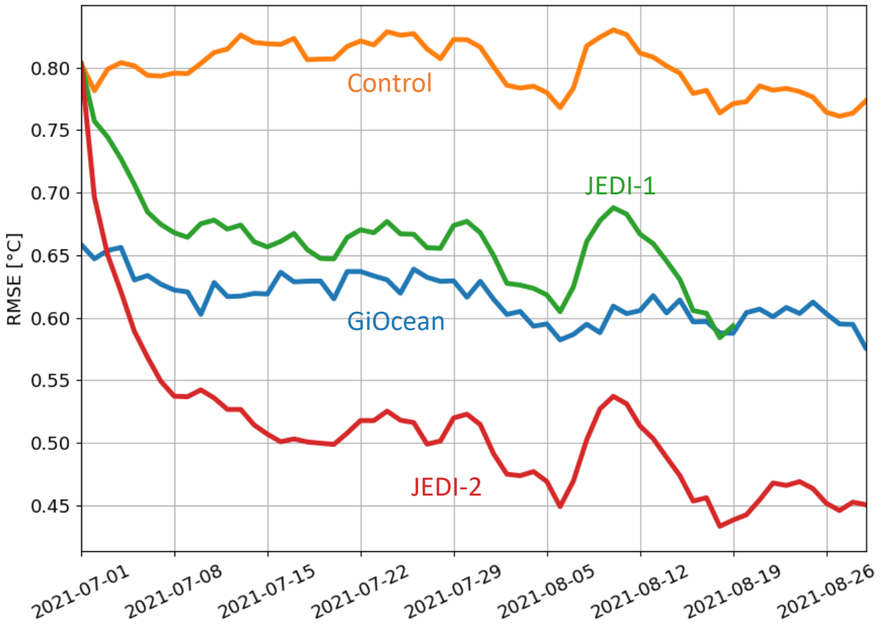
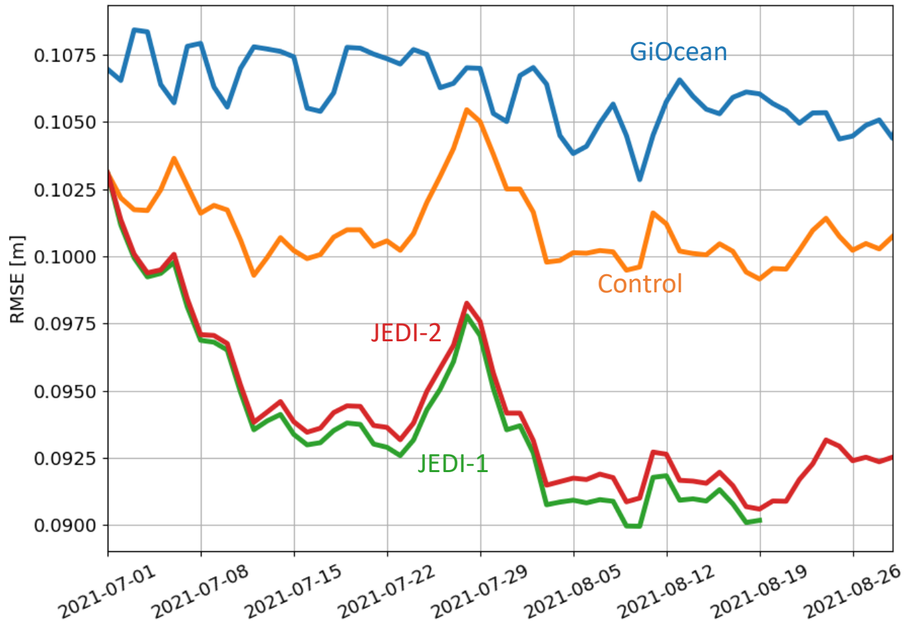
**GiOcean is GMAO's current ocean reanalysis product, forced by GEOS-IT atmosphere*

Sea Surface Temperature RMSE (OSTIA)



Sea Surface Height RMSE (Copernicus)



Experiment	Model	Atmos Forcing	DA Method	Observations
Control	MOM6+CICE6	GEOS-IT	None	None
JEDI-1	MOM6+CICE6	GEOS-IT	3DFGAT	JEDI
JEDI-2	MOM6+CICE6	GEOS-IT	3DFGAT	JEDI no-insitu, more SST
GiOcean	MOM5+CICE4	GEOS-IT	LETKF	GMAO ODAS

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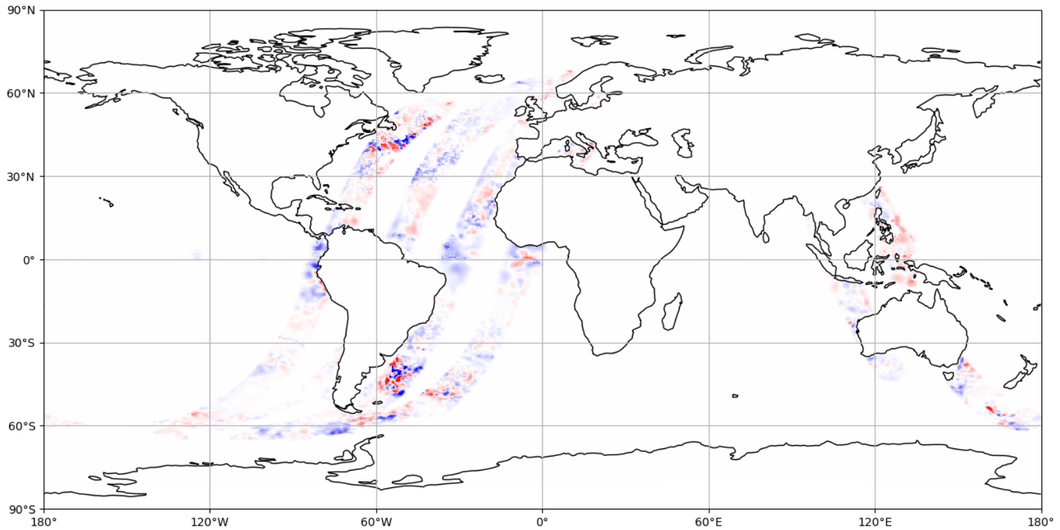
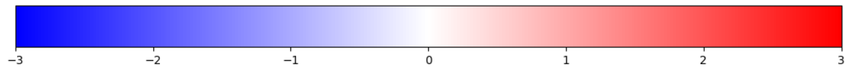
SST Increment on July 15th, 2021 at 00Z

JEDI-1: Single SST source (GMI)

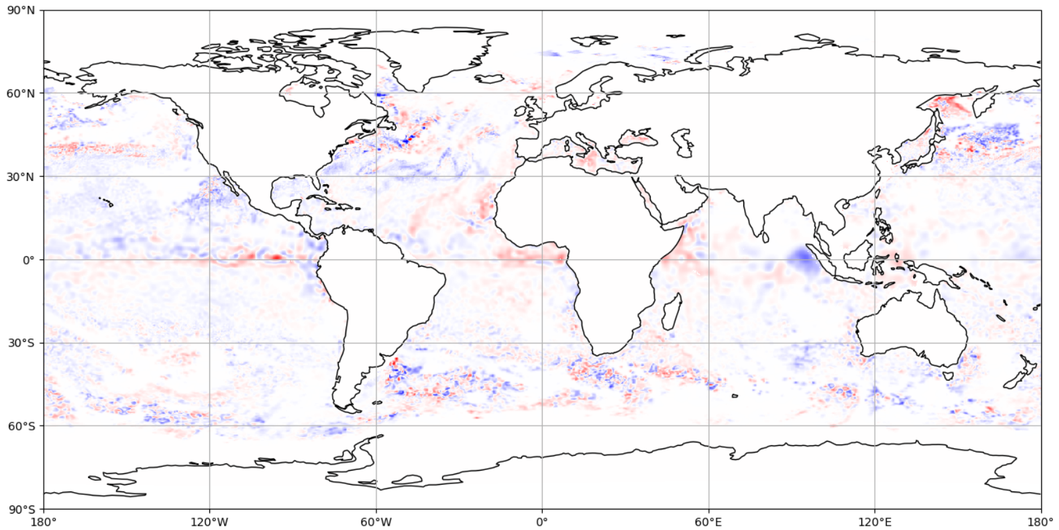


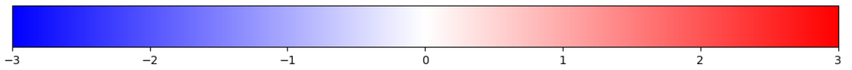


SST increment [ºC]

Obs. count ~80k

JEDI-2: Multiple SST sources





SST increment [ºC]

Obs. count ~880k

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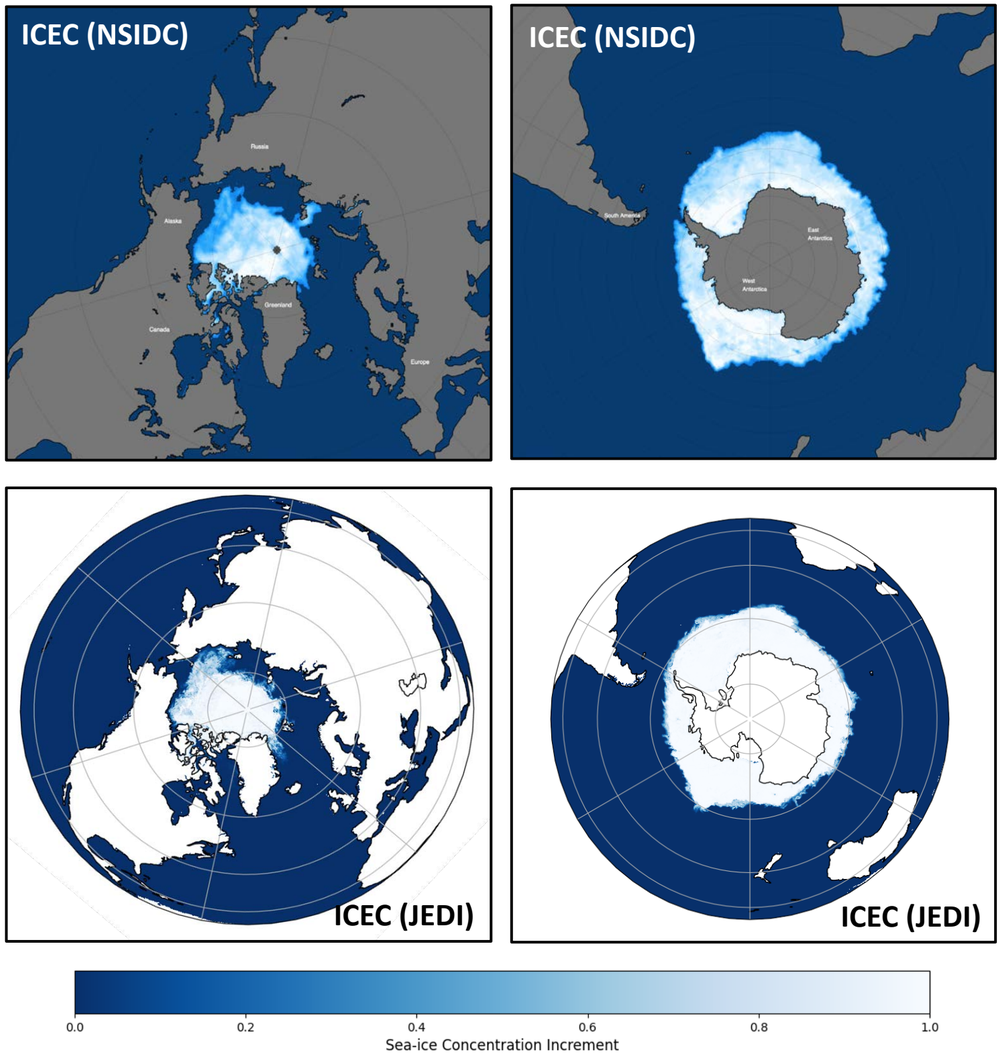
Preliminary results of assimilating AMSR-2 sea-ice concentration with GEOS/MOM6/CICE6 plus JEDI cycled for 45 days

- Arctic results show that most of the large-scale features were accurately depicted
- Antarctic results show that the winter sea-ice growth was captured

Sea-ice concentration on 14 August 2021



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- Testing with hybrid background error covariance
- Conducting long spin-up runs for ocean and sea-ice
- Implementing the LETKF from JEDI/SOCA into the SWELL workflow
- Expanding data sources through collaboration with partners and incorporating PACE and SWOT data

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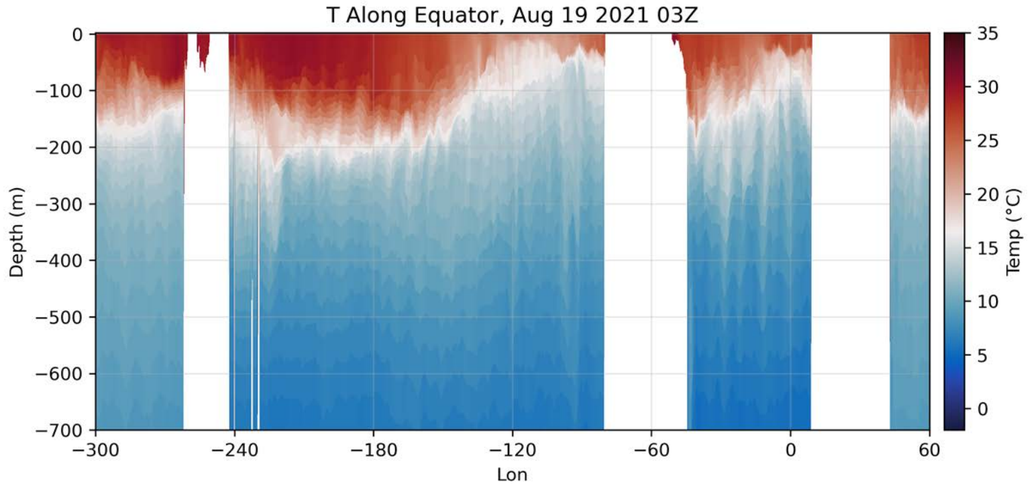
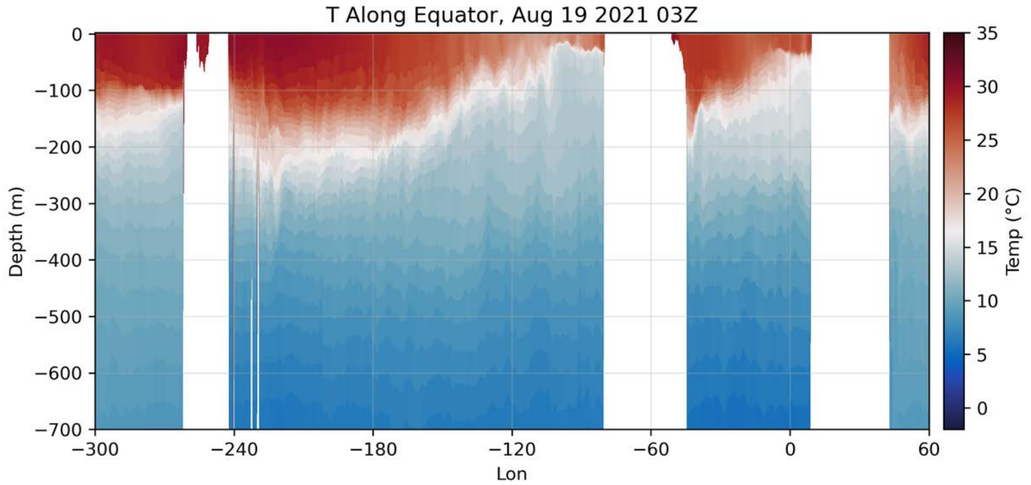
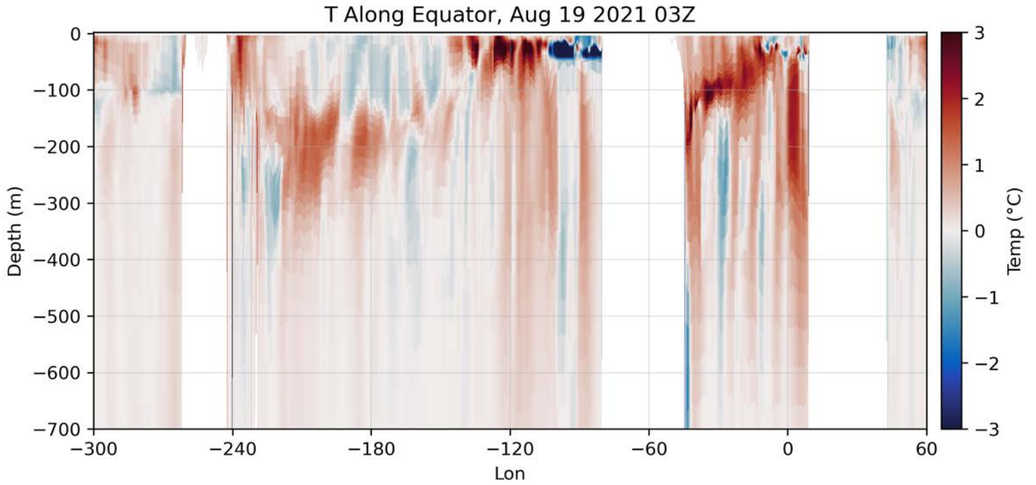
Jianjun Jin
Guillaume Vernieres
Santha Akella
Travis Sluka

SST + ADT



No DA





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