Assimilation of Aerosol Observations in the NASA GEOS Model

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Current GEOS forecasting and Data Assimilation System

Bulk (Mass) scheme

-Dust
-Sea salt
-Carbonaceous
-Sulfates
-Nitrates

Aerosols
GOCART

Atmosphere

Grell-Freitas Deep,
Bretherton-Park Shallow
Locke Turburlence
Chou-Suarez radiation
1M Cloud Microphysics

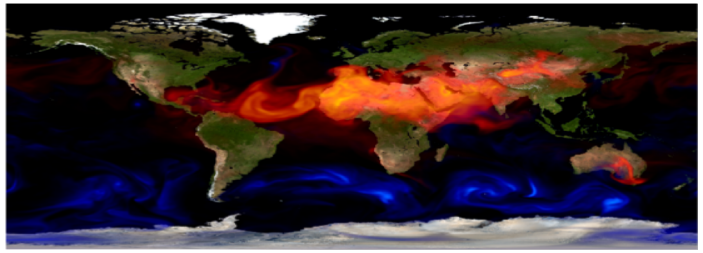
GEOS

Land
Catchment

Dynamics
Finite Volume/ Cubed-Sphere

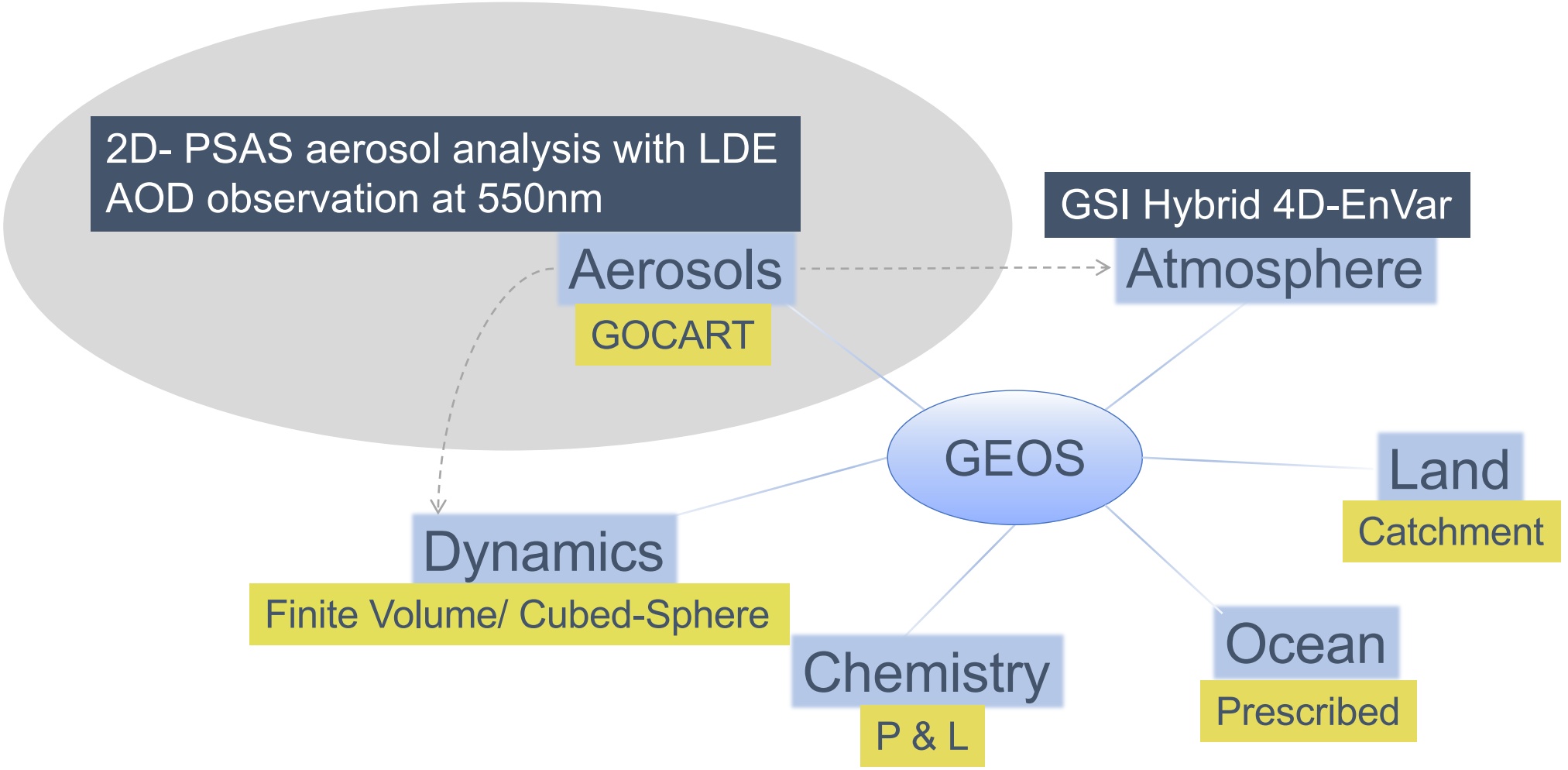
Chemistry
P & L

Ocean
Prescribed



Global, 12.5 km , 72 Levels, top at 0.01 hPa

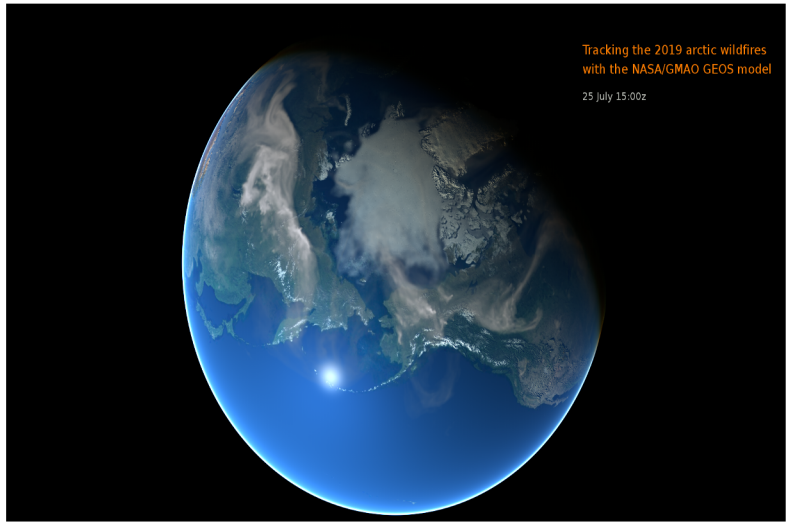
Current GEOS forecasting and Data Assimilation System



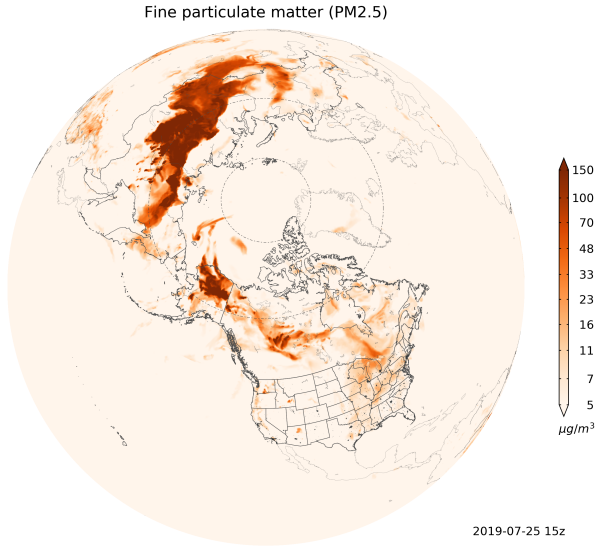
Global, 12.5 km , 72 Levels, top at 0.01 hPa

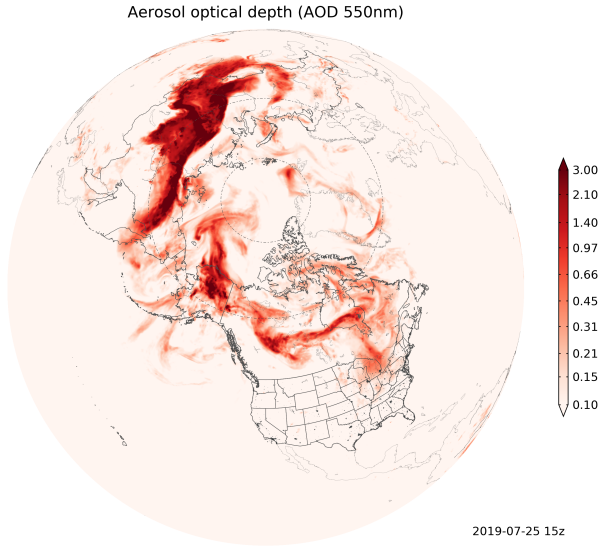
GEOS aerosols in the Near Real Time system

2019 Boreal Forest Fires



- Example for July 25, 2019, using analyses from the NASA/GMAO near real-time atmospheric assimilation system GEOS-FP
- Fine particulate matter at the surface (PM2.5, top) and aerosol optical depth (AOD at 550nm, bottom) from fires in North America and Eurasia.





https://gmao.gsfc.nasa.gov/research/science_snapshots/2019/Arctic_fires_2019.php

GEOS aerosols in the Near Real Time system

Aerosols optical depth and surface PM2.5 from FP can be visualized: https://fluid.nccs.nasa.gov/weather/

Home | Datagrams | WxMaps | Chem Maps | Obs Sys Stats | Radiances | Obs Impacts

METEOGRAMS

Relative Humidity

AEROSOLS

Organic Carbon

Black Carbon

Sea Salt

Dust

Sulfate

Nitrate

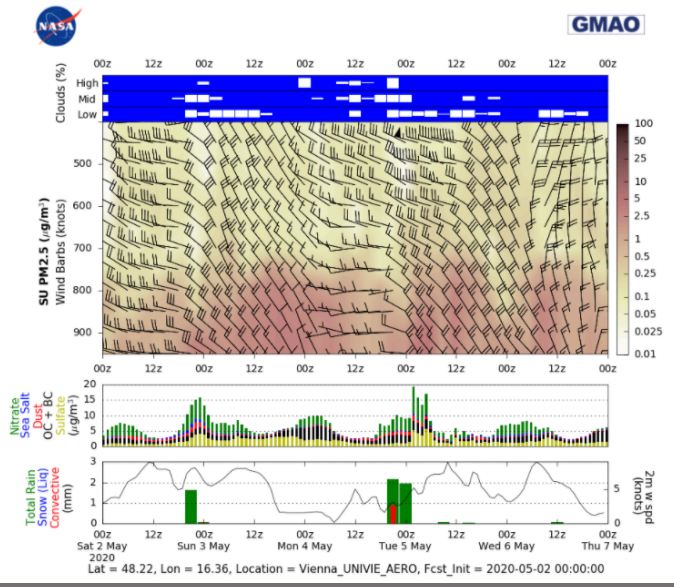
TOTAL

Carbon Species

GMAO GEOS FP Aerograms

Sulfate at Vienna UNIVIE AERO (48.22, 16.36)

Extinction | **Concentration**



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FIELDS

Dust AOT

REGIONS

Atlantic | Australia | Global | Mid Atlantic | North America | N Polar | Pacific | Seven Seas | S Polar

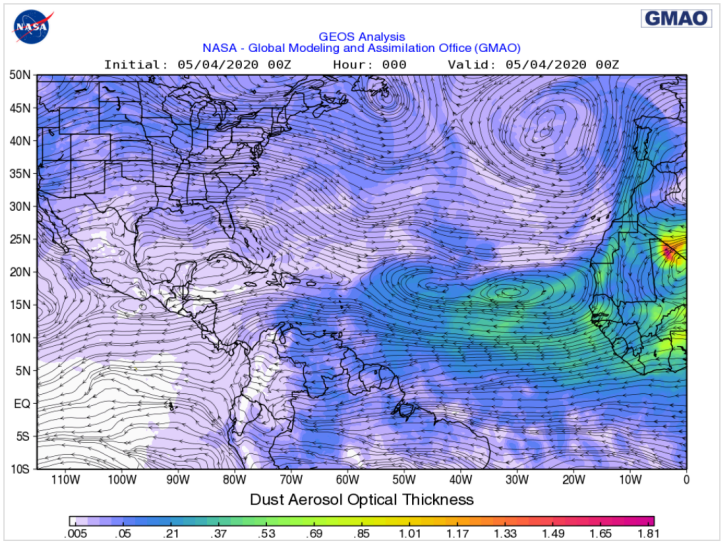
FORECAST INITIAL TIME

04May2020 00z

FORECAST LEAD HOUR

000h 04May2020 0(

Atmospheric Composition (2D) Maps



Joint Effort for Data assimilation Integration (JEDI)

The Joint Effort for Data assimilation Integration (JEDI) is a collaborative development led by the Joint Center for Satellite Data Assimilation (JCSDA) in conjunction with NASA, NOAA and the Department of Defense (NAVY and Air Force).

The core goals are to develop a software infrastructure for data assimilation that:

- Is generic and portable, from toy models running on laptops to operational Earth system coupled models running in the cloud.
- Enables native model grid data assimilation.
- Provides a framework for rapid uptake of new observations into operations with generic observation handling and modeling.
- Is enveloped in modern working practices that enable rapid community development.
- Is adaptable to exa-scale computing.
- Shares as much as possible without imposing one approach.

Ongoing work: Aerosol Assimilation System using JEDI

Using the ensemble members produced by the GEOS hybrid meteorological data assimilation system, we are updating the aerosol component of our assimilation system to a variational ensemble type of scheme using JCSDA/JEDI framework:

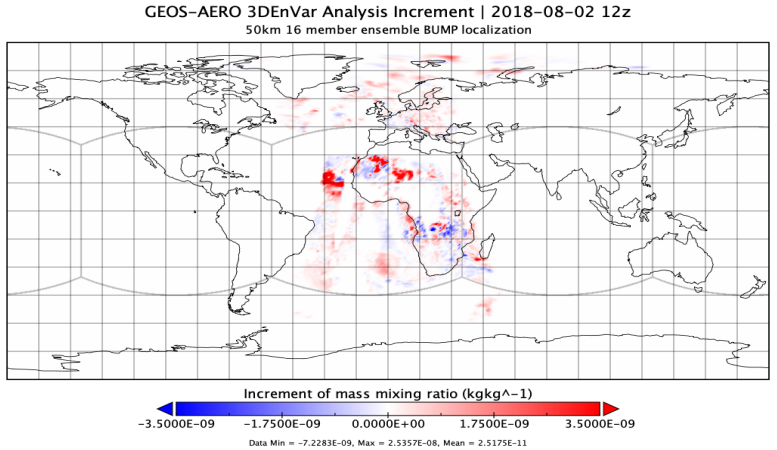
- An observation operator has been added to the JEDI Unified Forward Operator (UFO) to support the assimilation of **AOD observations** at **one** or **multiple wavelengths**.

- JEDI 3D-EnsVar static analysis has been tested on a low resolution (~100km) model grid:
  - Observing system: NNR AOD
  - Control variable: 3D aerosol concentrations

-> scalability tests need to be performed for higher resolution model simulations

- Considering multi-wavelength aerosol extinction profiles as a control variable to reduce computational cost

- Opens door to new observables: multi-wavelength AOD, lidar data



Example of total aerosol mass increment for one model layer (close to the surface)