JCSDA Atmospheric Composition Activities Overview and Preparation for TEMPO DA

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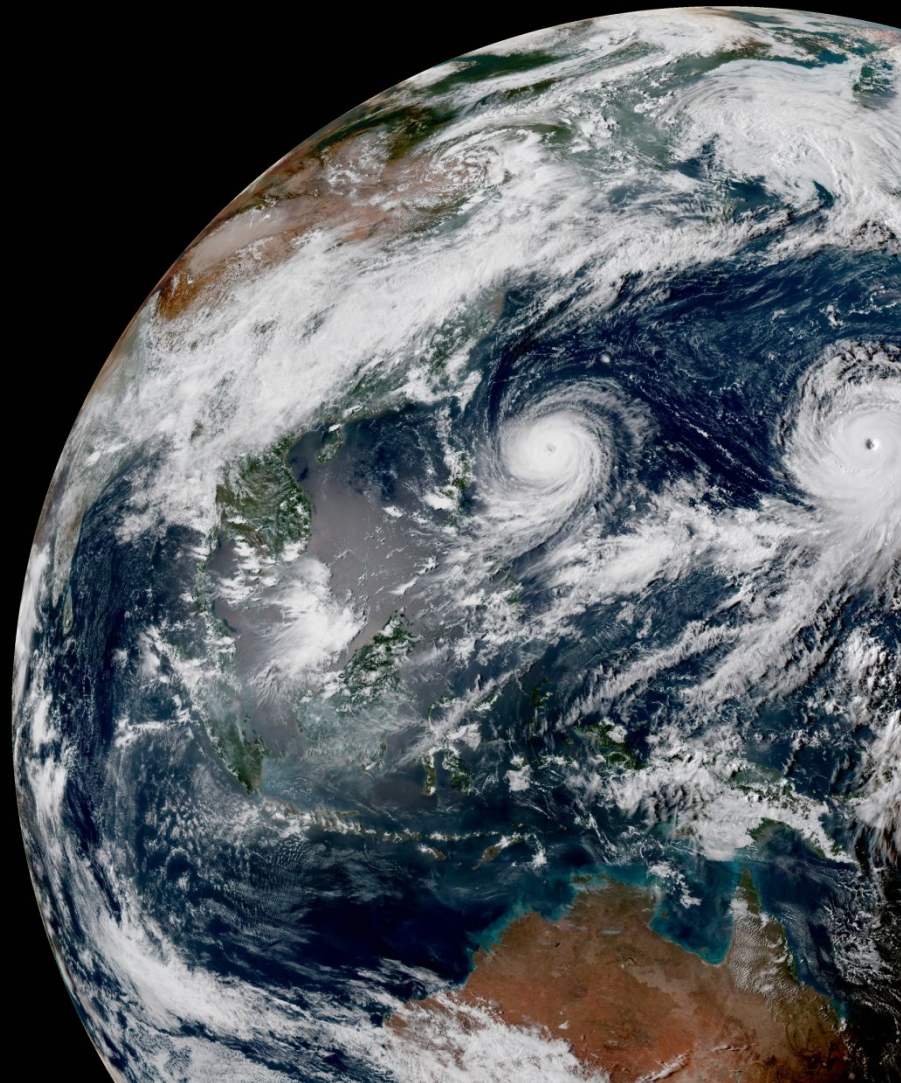
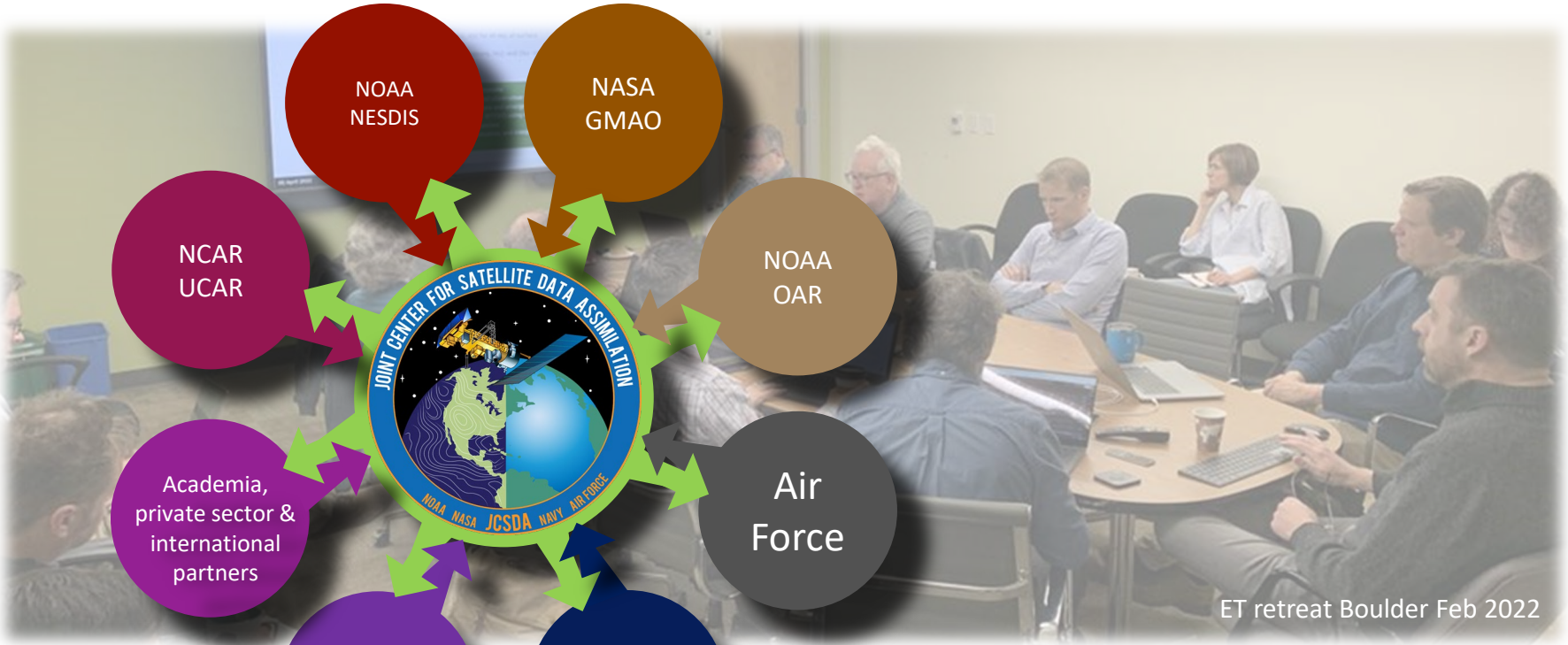


Joint Center for Satellite Data Assimilation (JCSDA)

Interagency partnership dedicated to improving and accelerating use of research and operational satellite data in weather, ocean, **climate and environmental analysis** and prediction systems



ET retreat Boulder Feb 2022

WHO
Distributed staff

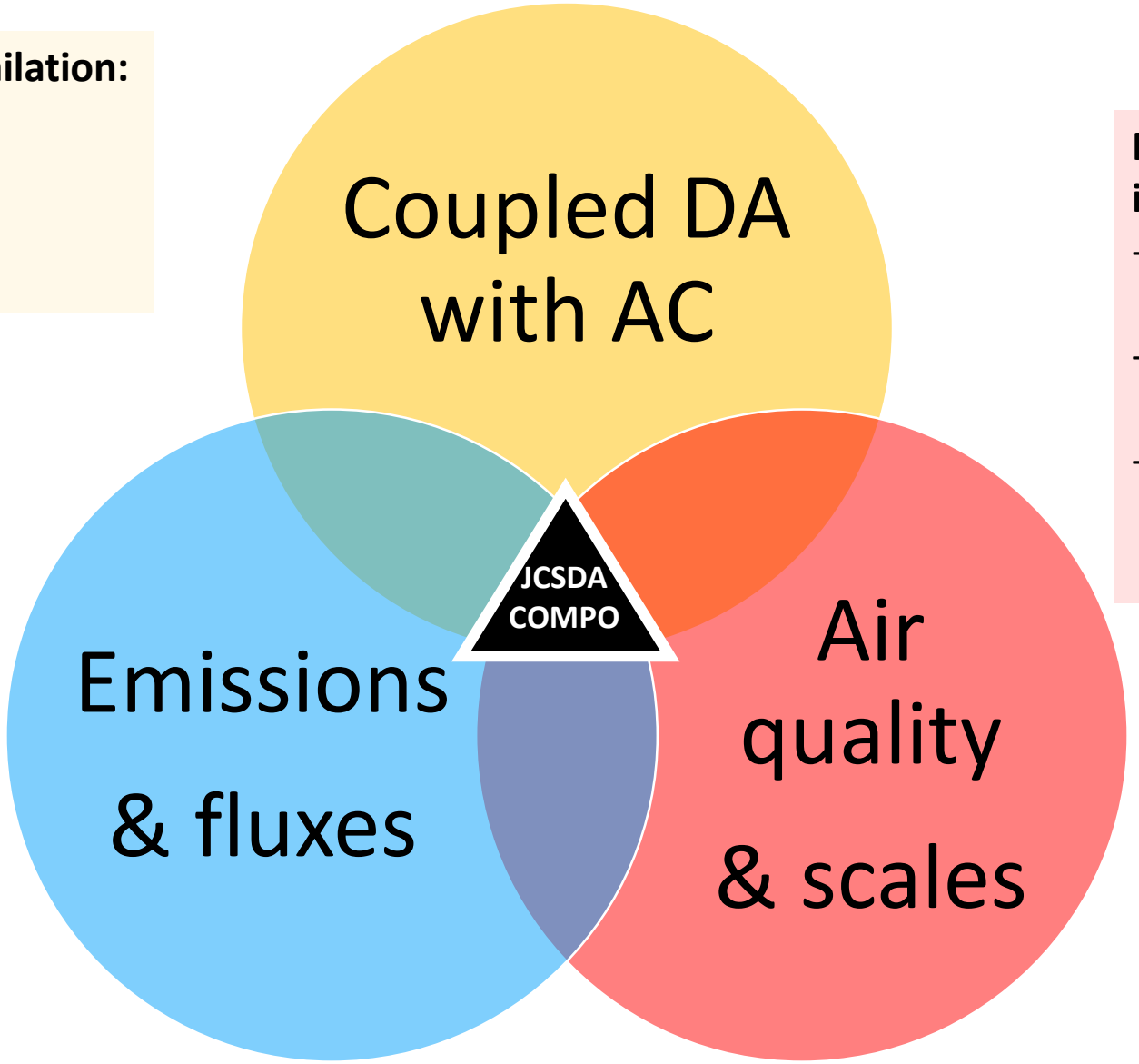
HOW
Joint operating plan

WHAT
Critical path to oper.

The JCSDA Atmospheric COMPOsition – "palette"

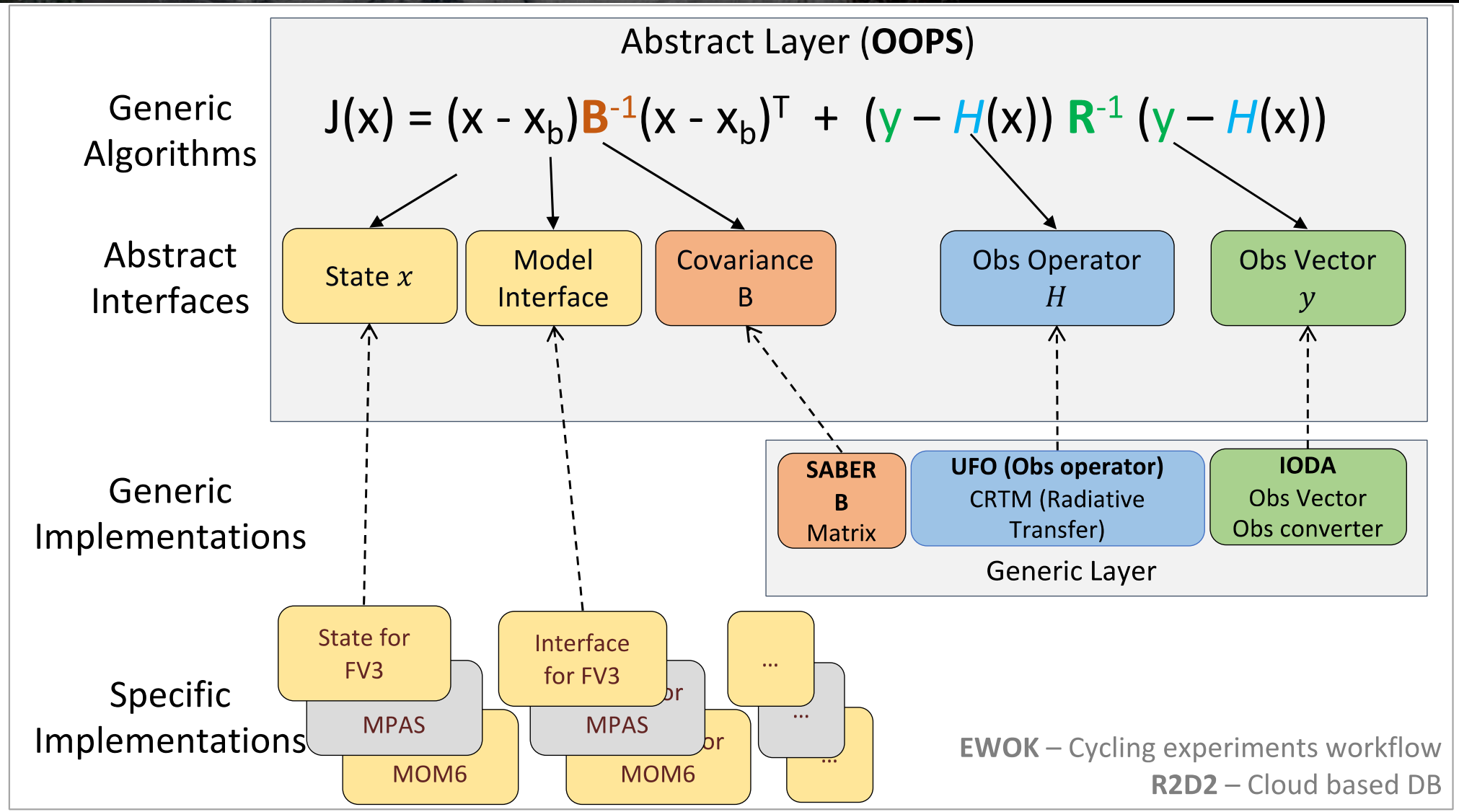
Enhance Coupled Data assimilation:
- Aerosols
- Stratospheric Ozone
- Other sensitive trace gas
- L1 DA

Extend DA for fluxes and emission constraint:
- Anthropogenic emissions
- Fires
- Vegetation
- Chemical reactions



Facilitate high resolution data integration:
- New sensors i.e. TEMPO, S4, GEMS, (GeoXO)
- Novel geometries, stretched and refined grids
- Surface observations

JEDI principles:
Build DA blocks once and update for all components of earth-system in one DA system



EWOK – Cycling experiments workflow
R2D2 – Cloud based DB

AQ and global AC model interfaces

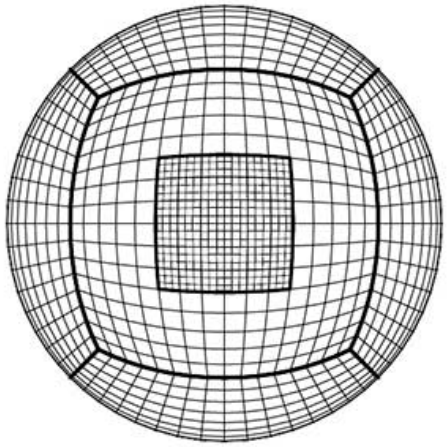
Modelling configurations

FV3 – nested domain

FV3 stretch grids

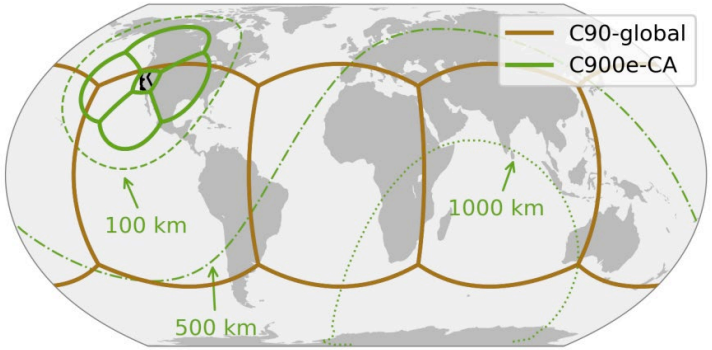
MPAS refined grid

NOAA

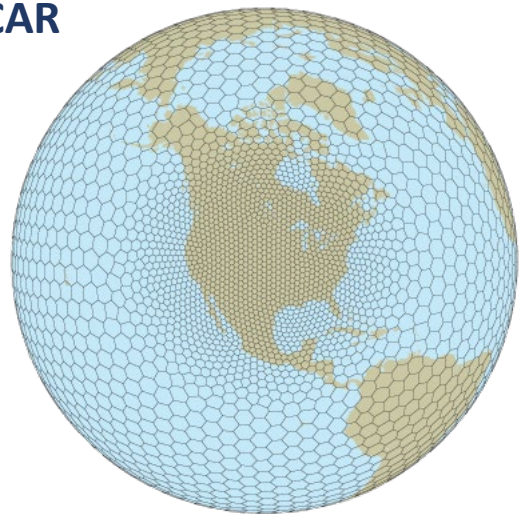


3:1 nested grid

NASA



NCAR



GOCART global, CMAQ regional
3DFGAT

GMAO GEOS-CF
3DFGAT

Implementation of GOCART aerosols in development

IODA and UFO for atmospheric composition

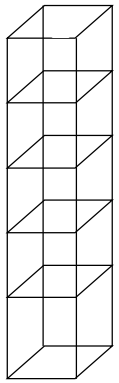
IODA-converters:
Obs native format to IODA format

IODA (observation traits)

lon, lat

OOPS (abstract layers)

Model profile at obs location



IODA (observation traits)

pressure vertices, averaging kernel, apriori

Model Interface

(e.g FV3, MPAS, etc)

UFO

GCRO

Any trace gas nadir retrieval

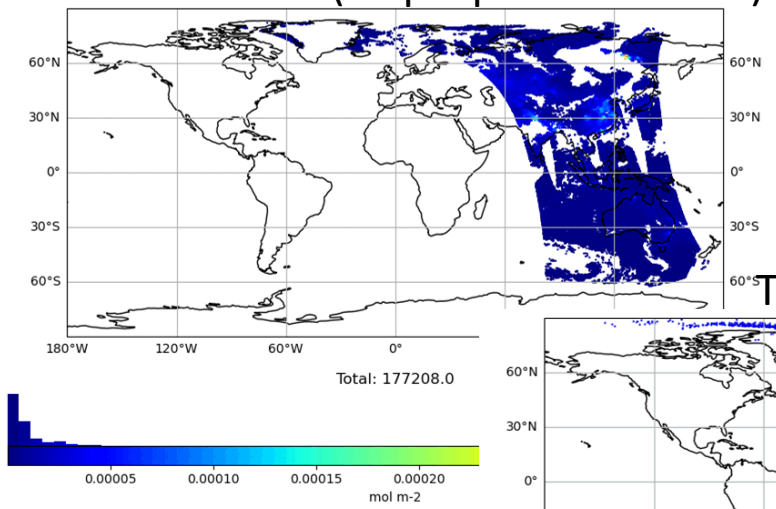
CRTM

Any AOD retrieval with variable LUTs

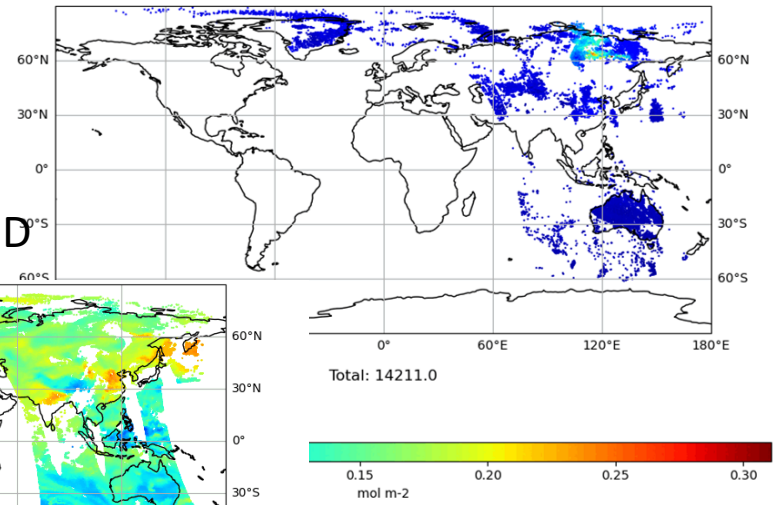
Tested and/or Assimilated observation products in JEDI

- VIIRS NPP AOD
- VIIRS NOAA 20 AOD
- MODIS Aqua AOD
- MODIS Terra AOD
- TropOMI NO2 (tropospheric and total columns)
- TropOMI CO total column
- MOPITT CO total column
- **TEMPO Proxy NO2 and HCHO tropospheric columns**
- MLS O3 limb profile
- OMPS LP O3 limb profile
- OMPS TC O3 total column

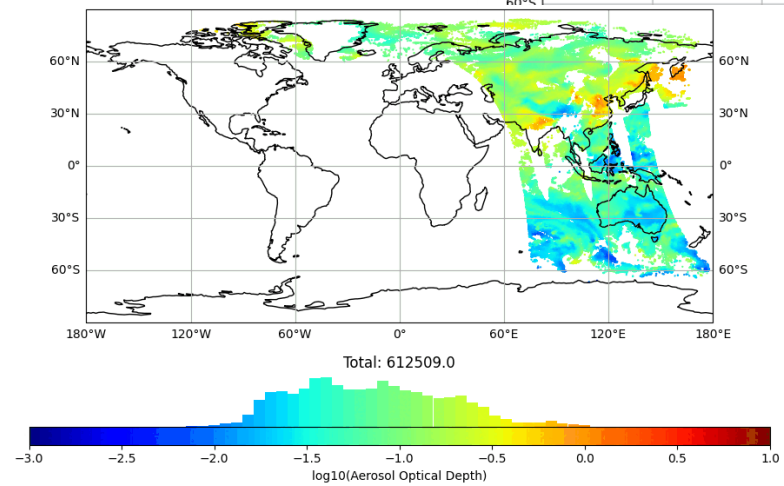
TROPOMI NO2 (tropospheric column)



TROPOMI CO



VIIRS NPP AOD



JEDI-SkyLab

- Turnkey solution for *real-world* experimental testbed for the community.
- Point of convergence for rapid prototyping & validation of developments.
- Continuous delivery of functional system for downstream operational applications.
- Quarterly release of the code associated demonstrations experiments. Current is JEDI-Skylab v7

What is in the last JEDI-Skylab v7 release?

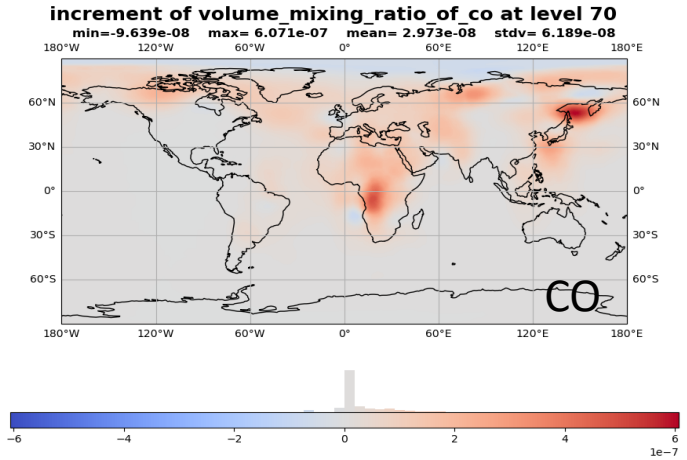
V7 New features:

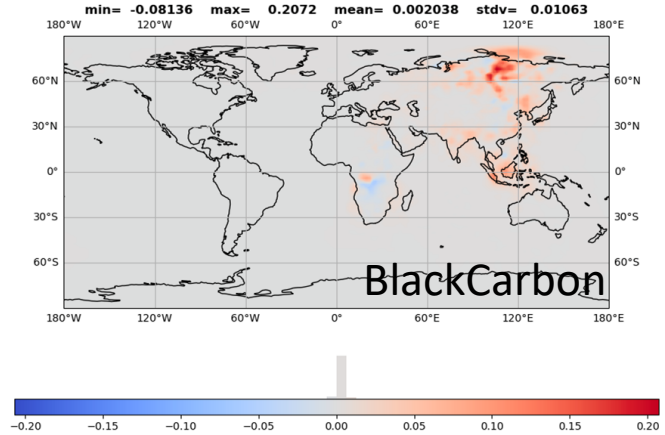
- 3DFGAT
- GEOS Stretch grid
- TEMPO proxy

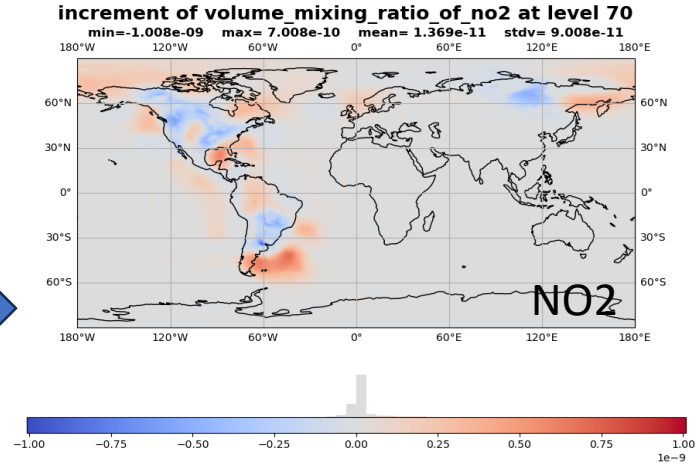
V6:

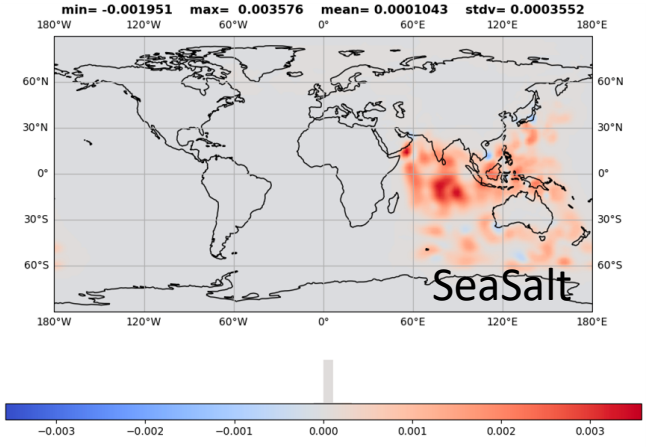
- 3DVar
- Trace gas and aerosol DA
- UFS and GEOS DA

Examples of 3DVar increments









JEDI-Skylab v7 release: stretch grid & 3D-FGAT

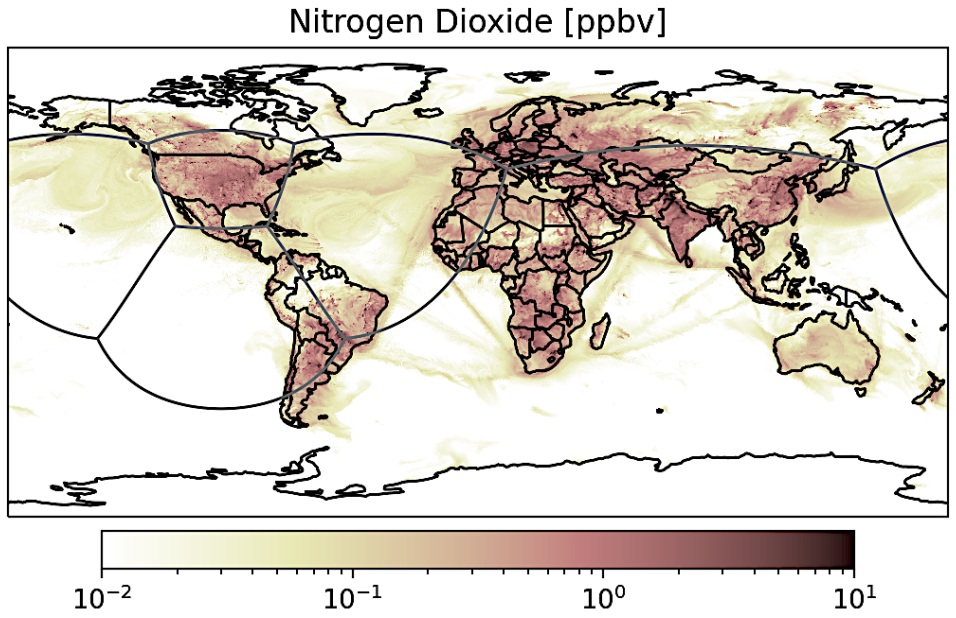
- FV3 Stretched Grid (SG)

Tested c540r25 high resolution backgrounds produced by C. Keller (GMAO) : ~7km over CONUS

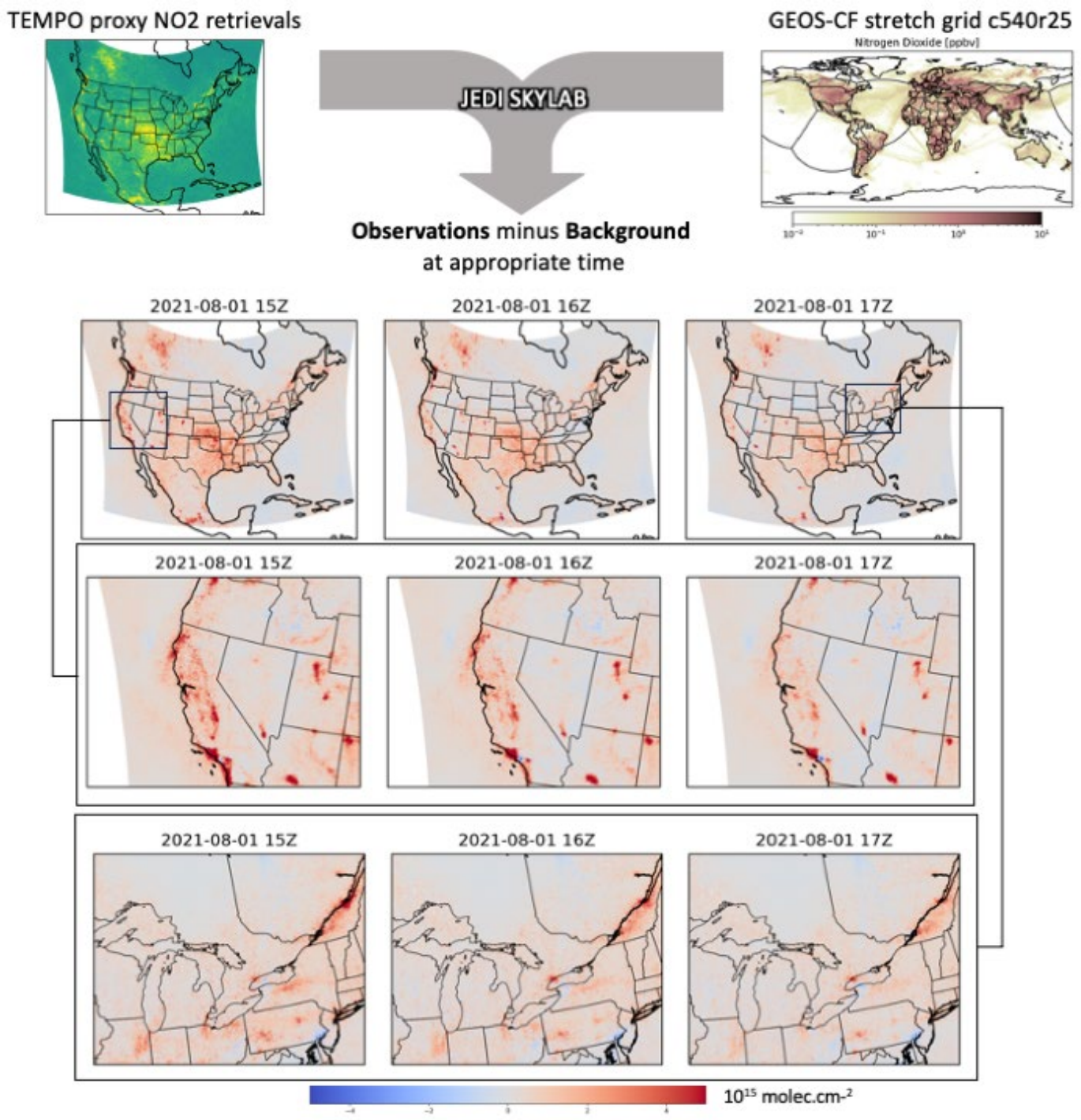
Tested with TROPOMI NO2 3DVar and then 3DFGAT

Implemented FGAT with hourly model outputs as background.

GEOS-CF stretch grid c540r25



TEMPO NO2 proxy data demo



Integrated TEMPO proxy NO2 retrievals:

- IODA converter for NO2 and HCHO retrievals
- Testing in UFO
- Integrated the TEMPO proxy retrievals in monitoring only with the stretch grid backgrounds
- Joint experiment with TROPOMI NO2
- Proxy data means no scientific relevance but means that the JEDI system is getting ready to assimilate TEMPO for the official product release in Apr 2024.
- **Next**: test with a real data sample to ensure readiness of the system for official release

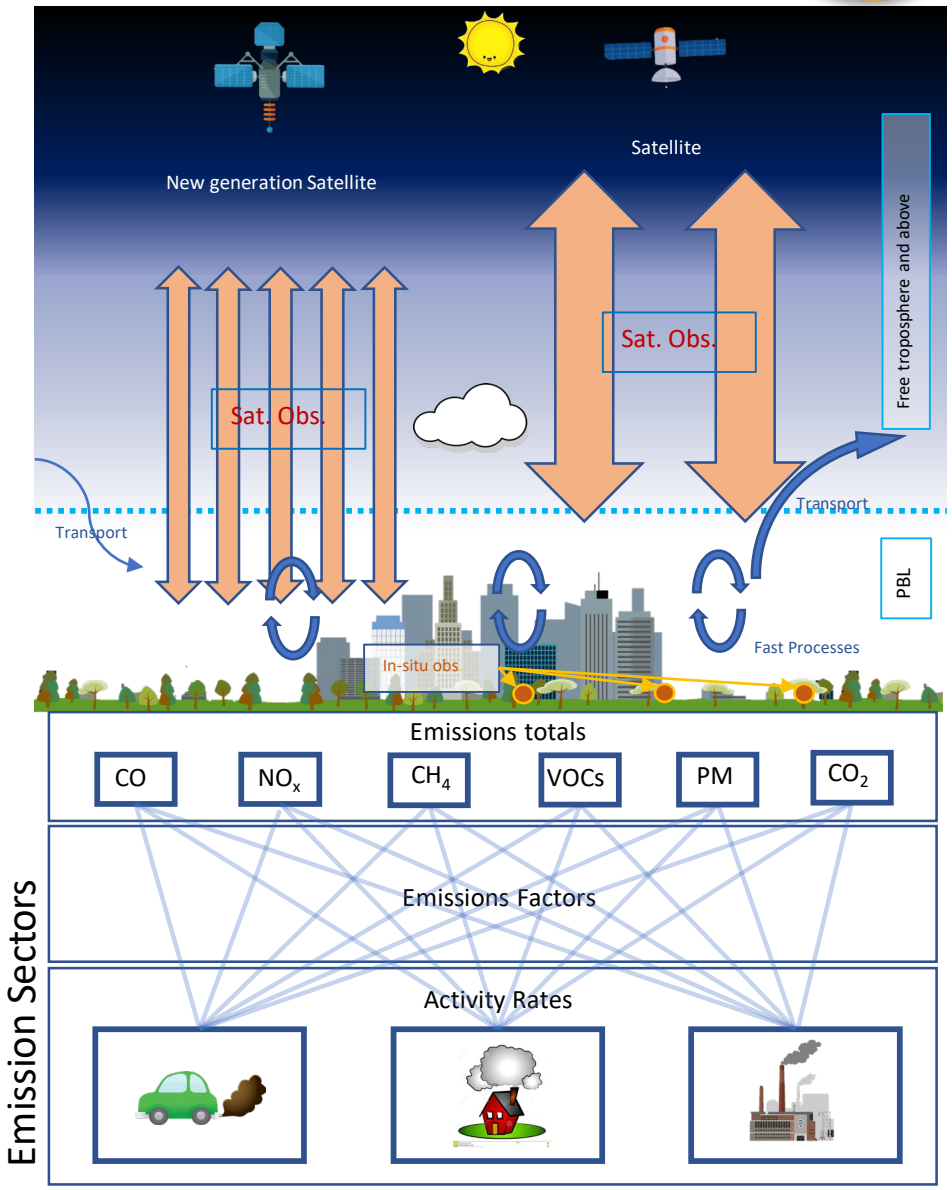
Towards Emissions and fluxes capability

Towards a human emissions monitoring verification and support (MVS) capability in JEDI:
Assess what is the most suited DA flavor for source inversions and fit the needs of our partner agencies NASA and NOAA.

- We just finished setting up a TL/AD for any tracer tracers, i.e. we can do 4DVar now with JEDI for AC, bot no chemistry in.
- Add emissions in the CV
- Use 4D-HTLM-Var to add chemistry + physics tendency terms with ensemble info
- 4DEnVar will also be assessed: no need for a TL/AD

- Develop interface and workflow to handle emission post and pre processing in JEDI
  - Project emission perturbations from analysis to the next window
  - Increment/constraint on sectorial information

- **Ramp up with GHG capability**



Coupled DA and L1b assimilation

- JCSDA is building a earth system DA capability that includes, weather, atmospheric composition, land and ocean.
- We are working towards demonstrating **joint assimilation of weather and AC** (AOD and then trace gas).
- Using radiances and AOD but we will experiment with assimilating **L1b for aerosol**. Having direct **CRTM** support at JCSDA makes it possible.
- There is also flourishing ideas of looking at the DA coupling between aerosol and ocean color. The **PACE** mission is an opportunity for JCSDA.