JCSDA Atmospheric Composition Activities
Overview and Preparation for TEMPO DA

COMPO core team:
Jérôme Barré, Sarah Lu, Maryam Abdi-Oskouei, Shih-Wei Wei

JEDI/OBS/CRTM teams:

In-kinds NASA/GMAO, NOAA/NCEP, NOAA/OAR:
C. Keller, V. Buchard, D. Holdaway, M. Pagowski, B. Huang, C. Martin, A. Tangborn
Interagency partnership dedicated to improving and accelerating use of research and operational satellite data in weather, ocean, **climate and environmental analysis** and prediction systems.
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

Abstract Layer (OOPS)

\[ J(x) = (x - x_b)B^{-1}(x - x_b)^T + (y - H(x)) R^{-1} (y - H(x)) \]
AQ and global AC model interfaces

Modelling configurations

FV3 – nested domain
GOCART global, CMAQ regional
NOAA

FV3 stretch grids
GMAO GEOS-CF
NASA

MPAS refined grid
3DFGAT
Implementation of GOCART aerosols in development
NCAR

3:1 nested grid
IODA and UFO for atmospheric composition

**IODA** (observation traits)
- lon, lat

**IODA-converters**:
- Obs native format to IODA format

**OOPS** (abstract layers)
- Model profile at obs location

**Model Interface**
- (e.g. FV3, MPAS, etc)

**IODA** (observation traits)
- pressure vertices, averaging kernel, apriori

**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
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

JEDI-Skylab is like a “concept car” for DA.
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.
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, but 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.