GSL, CSL and ARL collaborated to produce a significant upgrade to NOAA’s global aerosol modeling capability – GEFS-Aerosol

ARL implemented a new dust emission algorithm into the new FV3GFS-Aerosol global model.

The operational configuration of the new aerosol model is slated to become part of the Global Ensemble Forecast System, v12.

ARL is creating a unified system to supply all UFS ACC models with emissions data (global and regional)
New UFS Aerosol and Atmospheric Composition Models

FV3-Chem

NUOPC coupled WRF-Chem-based suite for **global model**

- GOCART
- GOCART RACM
- RACM SOA

Simplified sulfur chemistry.

More sophisticated aerosol modules including secondary organic aerosols (SOA).

NUOPC coupled CMAQ suite for **regional-scale model** (e.g., NAQFC; CAM-CMAQ)

Operational CMAQ EPA modules in progress (CB06, AERO6)

GFS physics, including sub-grid scale tracer transport

GEFS-Aerosol

GOCART

FV3-Chem
Motivation

• Unified Forecast System (UFS) → Aerosols and Atmospheric Composition (AAC) models.

• Emissions of gases and aerosols → critical components of AAC models.

• Flexible system to provide AAC models with emissions inputs.

• Consistency between emissions and other surface-atmosphere exchange processes in UFS
NOAA Emissions and eXchange Unified System (NEXUS)

Operations

Research

Barry Baker, Patrick Campbell, Daniel Tong and Rick Saylor (ARL)

Community emissions processing system for UFS atmospheric composition models (both global and regional)

Collaborators: Harvard, NASA, NCAR
Rapid Inclusion of new emission datasets

Nexus Provides a streamlined process to include new emission inventories quickly. As an example, Updates from the CEDS 2014 emission dataset to CEDS2017

- Large changes can be seen over northern Africa and Saudi Arabia
- Decreases in ship emissions around the USA and Canada
- Decreased emissions in eastern Asia
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Blending of emission datasets

NEXUS is also very flexible to blend different emission datasets. As an example, blending the CEDS 2017 (McDuffie et al. 2020) with the OMI-HTAP 2019 (Liu et al. 2018)

- Large Changes in western China
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CEDS 2017

Blended CEDS 2017 & OMI-HTAP 2019
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# HEMCO Tests with GEFS-Aerosols/GOCART

**GEFS-Aerosol v088-Beta, C384 Grid (~25 km resolution)**

**Warm-start, 1-month, July 2019 Simulation (10-days spin-up removed)**

<table>
<thead>
<tr>
<th>Run</th>
<th>Global Emissions</th>
<th>Regional Emissions</th>
</tr>
</thead>
</table>
| PREP-Chem Sources (Base) | CEDS 2014 - SO$_2$, OC, BC  
HTAP 2010 - Unspeciated PM$_{2.5}$ | None                        |
| HEMCO             | Same as in Base                                      | None                        |
| HEMCO-Plus        | CEDS 2014 - SO$_2$ (Shipping), OC, BC  
HTAP 2010 - Unspeciated PM$_{2.5}$  
HEMCO Tests with GEFS-Aerosols/GOCART

Absolute Values

Relative % Difference Plot

Total AOT: HEMCO

Total AOT: HEMCO-Plus - HEMCO

Difference Values

Relative % Difference Plot

Total AOT: HEMCO-Plus - HEMCO Absolute

Sulfate AOT: HEMCO-Plus - HEMCO

UFS Users’ Workshop – July 27-29, 2020
Open-AQ Surface PM$_{2.5}$ Bias and Statistics: July 2019

HEMCO Mean PM$_{2.5}$ Bias ($\mu$g m$^{-3}$)

- **WNA**: NMB=+41%, NME=72%, IOA=0.59
- **CNA**: NMB=-22%, NME=76%, IOA=0.18
- **ENA**: NMB=-49%, NME=60%, IOA=0.53
- **EAS**: NMB=-37%, NME=57%, IOA=0.51

HEMCO-Plus Mean PM$_{2.5}$ Bias ($\mu$g m$^{-3}$)

- **WNA**: NMB=+28%, NME=66%, IOA=0.60
- **CNA**: NMB=-22%, NME=76%, IOA=0.18
- **ENA**: NMB=-49%, NME=60%, IOA=0.53
- **EAS**: NMB=-37%, NME=57%, IOA=0.51

Reduces Bias/Error

Similar
A Roadmap for NEXUS

- HEMCO-based emissions and evaluate over an extended period.
- Create emissions for FV3-SAR (stand-alone regional)-CMAQ.
- Implement new NOAA wildfire emissions as extension/ensemble.
  - *Blended Global Biomass Burning Emissions Product (GBBEPx)*
- Implement ensemble gas/aerosol dry deposition extensions.
- Implement biogeochemical/agroecosystem model extensions.
  - *Environmental Policy Integrated Climate (EPIC) model*
  - *Daily time-step CENTURY biogeochemical (DAYCENT) model*
- Further develop NEXUS emissions and interface with other AAC models.
New UFS Aerosol and Atmospheric Composition Models

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**GEFS-Aerosol**

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**NEXUS**