This document provides general information for <u>Version 3 and Version 4</u> of NDACC model support files generated by the GMI CTM using MERRA2 meteorology.

Model support files have been created for the Dobson, FTIR, Lidar, and Sonde working groups based on their stations' locations, the temporal frequency of sampling, and the atmospheric species (constituents) each instrument type measures. The Dobson, lidar, and sonde files all contain the same fields. The files are combined in a single directory and do not include the instrument working group in their name but do note that the outputs are hourly (e.g., 'GMIHourly_Boulder_2000.nc'). The FTIR file content has different species from Lidar (for example). Most fields are written out once per day (at 12Z or at 1-2 pm local time) but a few fields are only available as monthly means. FTIR file names take the form 'GMIFTIR_station_year.nc'.

The content and formatting of GMIHourly files are in Version 4 ('MR2V4') are unchanged from Versions 2 and 3.

The content of GMIFTIR files, which are MR2V3, has minor changes compared to version 2. Previously all daily species were saved from model output at 12Z. Most still are except for the following daily species that are now saved at local 1-2 pm: O, CO, CH_2O, NO, NO_2, and temperature. In addition, CF_2Cl_2 (CFC12) is now a monthly mean, not daily field.

The support files include vertical profiles for constituents and meteorological fields. For each instrument type, each constituent measured is included in the support file <u>*if it is part of GMI's chemical mechanism*</u>. Meteorological fields useful for interpreting the measurements are also included: pressure, temperature, potential vorticity, and tropopause pressure.

Details on the specific file content for each file can be found using the 'ncdump –h filename' command on a linux system.

<u>***The GMI Model Version used for this output***</u>

The NDACC GMI 'MR2V3' and 'MR2V4' outputs come from the GMI Hindcast simulation 'HindcastMR2V2' (previously, 'MR2V2' outputs came from the 'HindcastMR2' simulation). This is a simulation of the NASA Global Modeling Initiative (GMI) chemistry transport model (CTM) integrated for 1980-2020. The simulation was integrated with NASA MERRA2 meteorology at 1^ox1.25^o lat x lon horizontal resolution with 72 hybrid sigma-pressure ('eta') levels spanning the surface to 0.01 hPa. We use time-dependent surface emissions for biomass burning, biofuels, and fossil fuels. Tropospheric aerosol fields come from MERRA2. The aerosol fields are used as inputs and do not interact with GMI chemistry. Below are the major changes with respect to the previous Hindcast:

1. Updated stratospheric surface area densities (SADs) from CMPI6 (thru 2015) with new stratospheric sulfate climatology. Climatological means used for years 2016-2020.
2. Corrections to the PSC parameterization to make it consistent with the other GEOS models.
3. Updated to the most recent sunspots for GCR inputs
4. Emission inventories updated
5. CMFMC bug fix - affects flashrate
6. Updated boundary conditions to reflect new ground-level observations on CFCs and CH4. CFCs were not declining as quickly as expected.
7. Uses most recent solar cycle for fastJX
8. Fixed Cly family packing/unpacking that caused a small sink for Cl in the stratosphere; has a small effect on polar ozone loss
9. Corrected hstar wet & dry values (swapped in the HindcastMR2)
10. Fixed the production of HO2 on a surface + aerosol -> water (not peroxide)
11. Using MERRA-2 surface albedo for FastJX
12. New setkin for Fast-JX (does not affect science)
13. Daily aerosol fields inputs derived from MERRA-2

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GMI References

For general model information and model evaluation, see this paper (and references therein): S.E. Strahan et al., (2013), The contributions of chemistry and transport to low Arctic ozone in March 2011 derived from Aura MLS Observations, J. Geophys. Res., 118, doi:10.1002/jgrd.50181.

See also: Strahan, Susan E., Anne R. Douglass, and Megan R. Damon (2019), Why do Antarctic ozone trends vary?, J. Geophys. Res., 124, 8837–8850, https://doi.org/10.1029/2019JD030996

For details on the surface emissions, see S. A. Strode et al. (2015), Trends and variability in surface ozone over the United States, J. Geophys. Res., 120, doi:10.1002/2014JD022784.

For information on MERRA2, see Gelaro, R., et al. (2017), The Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2). J. Climate, 0, doi: 10.1175/JCLI-D-16-0758.1.

For information on MERRA, see Rienecker, M.M. et al. (2011), MERRA: NASA's Modern Era Retrospective Analysis for Research and Applications, J. Climate, 24, 3624-3648., 2011.

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