Introduction

- Analysis of the Upper Troposphere-Lower Stratosphere (UTLS) requires sufficient vertical resolution in the region of the tropopause, but most reanalysis products are interpolated onto a limited number of pressure-levels.

- Model-level output has much higher vertical resolution and is available for most reanalyses, and has been useful for the SPARC Reanalysis Intercomparison Project (S-RIP; Fujiwara et al. 2017).

- NOAA CFSR (Saha et al. 2010) model-level output was previously only provided in an undocumented binary file format using spectral coefficients, with different formats between CFSRv1 (1/1979-3/2011) and v2 (4/2011-12/2014). We have created a 6-hourly global CFSRv1/v2 reanalysis model-level data set in CF-compliant netcdf format available for most reanalyses, and has been useful for the SPARC Reanalysis Intercomparison Project (S-RIP; Fujiwara et al. 2017).

1981-1997

2002-2010

Figure 1. For the date 2000-01-01-00Z, (left) difference in minimum vertical profile temperature between model-level and pressure-level CFSR at every grid point; (right) Vertical temperature profile over the 45-90W, 30S-Eq region (shown by black box on left) for model-level and pressure-level CFSR.

Advantages of CFSR Model-Level data for UTLS studies

- Improved detection of tropopause height/cold-point temperature
- Improved characterization of single versus multiple tropopauses

Methodology and Data Accessibility

- Binary CFSR model-level data are available at NCEI/NOMADS: https://nomads.ncdc.noaa.gov/data/
- We downloaded a subset of the data (Table 1). CFSRv2 (2011-2014) only includes category (1) and (2) data.
- We regridded the data to a regular 0.5° x 0.5° lat/lon grid.
- We converted the data to CF-compliant netcdf files with clear metadata.
- We can share the data from our servers where the data is currently hosted at NOAA ESRL. Full dataset size is ~ 1TB/yr from 1979-2014. Contact Sean.m.davis@noaa.gov.

<table>
<thead>
<tr>
<th>Table 1. The 3 categories of model-level data available in netcdf format. Names in black show currently available data.</th>
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<tbody>
<tr>
<td>(1)</td>
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<td>Analysis and 6-hour forecast</td>
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<td>Specific humidity (hs), pressure on model levels (pfull), surface pressure (ps), Relative divergence of wind (reld), Relative vorticity (relv), Air temperature (ta), Ozone mixing ratio (ro3), Eastward wind (uE), Northward wind (vN), Geopotential height (zh), relative humidity (rh), stream function (strm), velocity potential (vpot), cloud mixing ratio (clmr)</td>
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Conclusions

- Model-level data show many more multiple tropopauses compared to pressure-level data, and also many fewer single tropopauses.
- The single tropical tropopause shows a low altitude bias in the pressure-level data.
- Additional biases in upper tropospheric and subvortex jets from using pressure-level data (not shown).

Figure 2. (top) Reanalysis comparison of cold point temperature, and (bottom) difference between reanalysis and observations for (left) 1981-1997 and (right) 2002-2016. RS = radiosondes; pressure-level CFSR is shown by the green dashed line. All other reanalyses are based on model-level data.

Figure 3. CFSR frequency maps for SON 1980-2014. for (left) model-level data and (right) model-level minus pressure-level. Top row shows the mapped frequency of multiple tropopauses; bottom row shows the latitude-pressure frequency of single thermal tropopauses. Note, model and pressure-level data have the same horizontal resolution. Bold contours highlight model-level values on left, pressure-level values on right.

This figure is from: Manney, G.L. et al., Reanalysis comparisons of upper tropospheric/lower stratospheric jets and multiple tropopauses, ACPD, doi:10.5194/acp-2017-400, 2017.

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