NOAA Climate Forecast System Reanalysis (CFSR) model-level data

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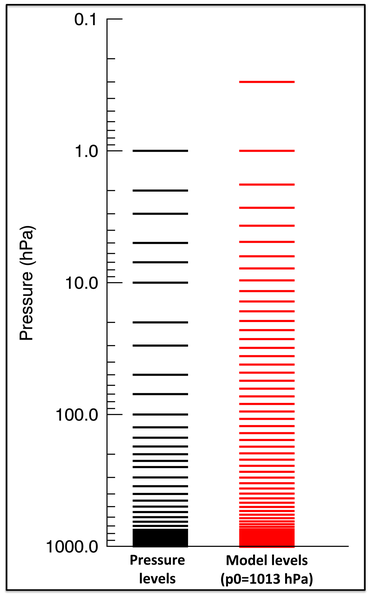
Introduction

- 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 CSFRv1 (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, provided on a regular latitude-longitude grid (0.5° x 0.5°) instead of its native horizontal resolution of T382, from 1979-2014.
- 64 model levels compared to 37 pressure levels.



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.

(1) Analysis and (2) 6-hour forecast	(3) 6-hour Ancillary
Specific Humidity (hus), pressure on model levels (pfull), surface pressure (ps), Relative divergence of wind (reld), Relative vorticity (relv), Air temperature (ta), Ozone mixing ratio (tro3), Eastward wind (ua), Northward wind (va), Geopotential height (zg), relative humidity (rh), stream function (strm), velocity potential (vpot), cloud mixing ratio (clwmr)	Convective gravity wave drag zonal acceleration (cngwdu), Convective zonal momentum mixing acceleration (tnmmuc), Gravity wave drag zonal acceleration (tnmmugwd), Longwave heating rate (tntlw), Shortwave heating rate (tntsw), Vertical diffusion zonal acceleration (vdfua), vertical diffusion heating (vdfhr), deep convective heating (cnvhr), shallow convective heating (shahr), large scale condensation heating (lrghr), vertical diffusion moistening (vdfmr), deep convective moistening (cnvmr), shallow convective moistening (shamr), large scale moistening rate (lrgmr), ozone vertical diffusion (vdfoz), ozone production (poz), ozone tendency (toz), ozone production from T term (pozt), ozone production from column ozone term (pozo), vertical diffusion meridional acceleration (gwdv), convective meridional momentum mixing acceleration (cnvv), convective gravity wave drag meridional acceleration (cngwdv), non-convective cloud (cdlyr)

Table 1. The 3 categories of model-level data available in netcdf format. Names in black show currently available data.

Advantages of CFSR Model-Level data for UTLS studies

Improved detection of tropopause height/cold-point temperature

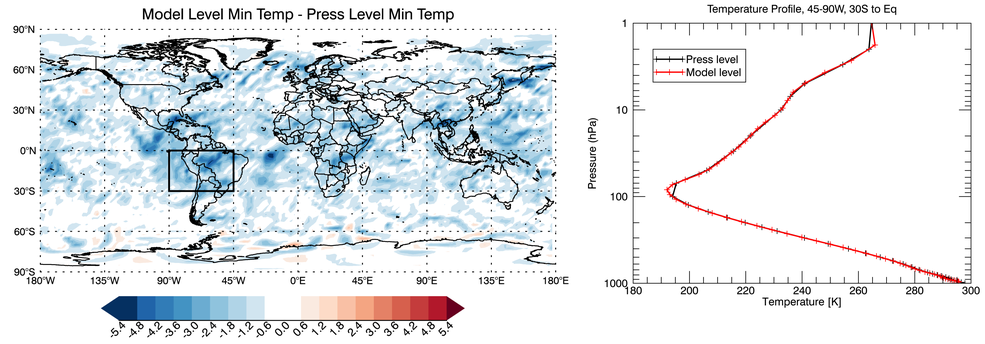


Figure 1. For the date 2000-01-01-00Z, (left) Difference in minimum vertical profile temperature between model-level and pressure-level CFSR at every grid point; (right) Vertical temperature profile over the 45-90W, 30S-Eq region (shown by black box on left) for model-level and pressure-level CFSR.

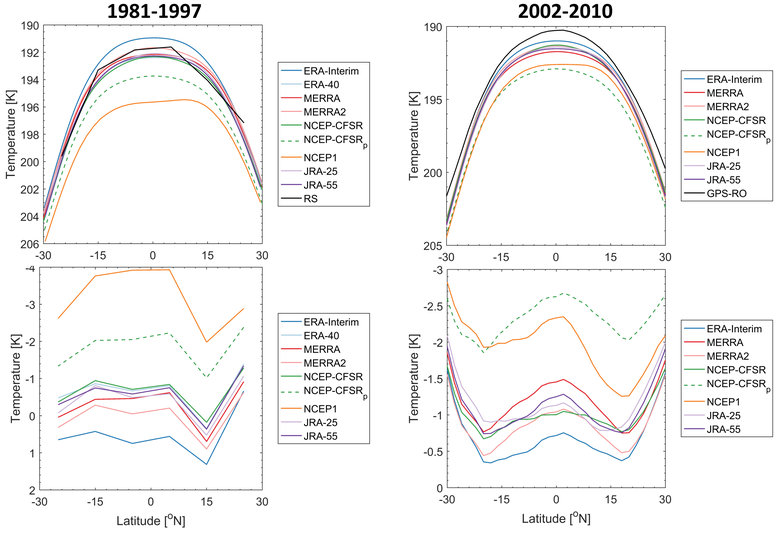


Figure 2. (top) Reanalysis comparison of Cold Point Temperature, and (bottom) difference between reanalysis and observations for (left) 1981-1997 and (right) 2002-2010. RS = radiosondes; pressure-level CFSR is shown by the green dashed line. All other reanalyses are based on model-level data.

Improved characterization of single versus multiple tropopauses

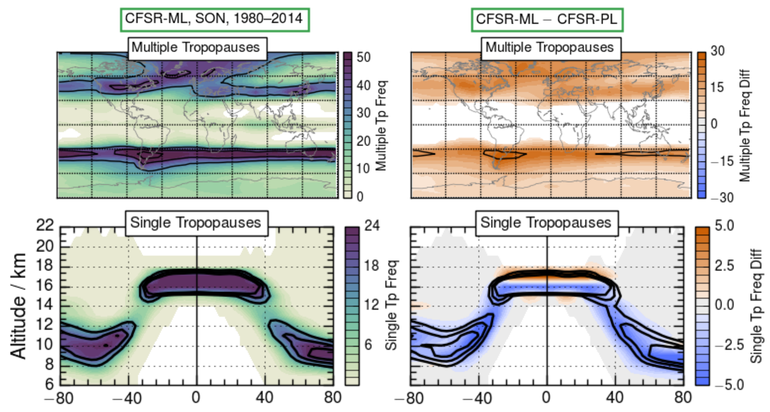


Figure 3. CFSR frequency maps for SON 1980-2014, for (left) model-level data and (right) model-level minus pressure-level. Top row shows the mapped frequency of multiple tropopauses; bottom row shows the latitude-pressure frequency of single thermal tropopauses. Note, model and pressure-level data have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

- 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).

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.

Conclusions

- Model-level data are now available in a documented netcdf format for the NOAA Climate Forecast System Reanalysis product.
- Biases in CPT/tropopause height substantially reduced in model-level data compared to pressure-level data.
- Modern reanalysis model-level products show a colder, higher tropical tropopause that more closely captures observed values compared to the pressure-level product.
- Model-level data detect more frequent multiple tropopauses.
- This dataset will be useful for number of additional analyses, including gravity wave characterization (personal comm, James Anstey) and improved tropopause dynamics.

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