Comparison of the reanalyses in the stratosphere

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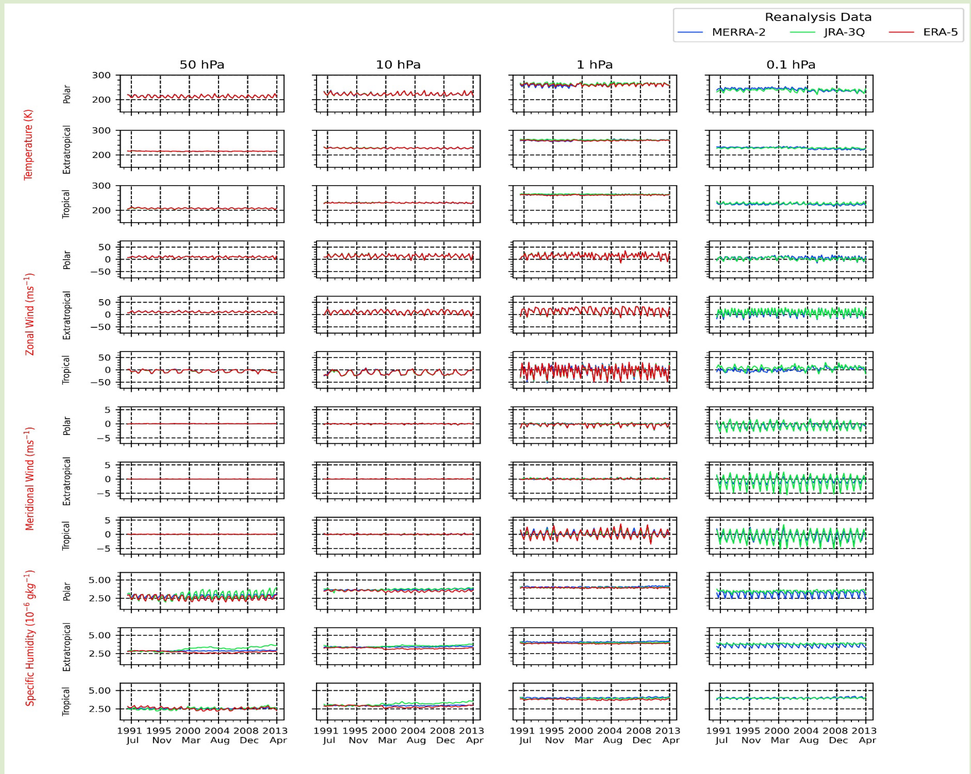
Abstract

Reanalysis are widely used in atmospheric studies because they provide regular gridded time series without gaps. JRA-3Q (Japanese Reanalysis for Three Quarters of a Century) is the newest reanalysis which was released (but only limited period) in late December as a next generation Japanese reanalysis. This study compares basic parameters with ERA-5 (ECMWF Re-Analysis) of ECMWF (European Centre for Medium-Range Weather Forecasts) and MERRA-2 (The Modern-Era Retrospective analysis for Research and Applications, Version 2 from NASA (National *Aeronautics and Space Administration), which are the most used datasets.* We found some disagreement, mainly for temperature in higher pressure levels (1 and 0.1 hPa). The main problem is identified for specific humidity comparison where we found significant disagreement even at 50 hPa. Our analysis shows that JRA-3Q agrees well with recent reanalysis in the main feature, but this need not be the case in specific regions.

Data and method

In this study, we use data from 3 reanalysis ERA-5 (ECMWF Re-Analysis) of ECMWF (European Centre for Medium-Range Weather Forecasts) can be downloaded from https://cds.climate.copernicus.eu/cdsapp#!/home. MERRA-2 (The Modern-Era Retrospective analysis for Research and Applications), Version 2 of NASA (*National Aeronautics and Space Administration)* can be downloaded from https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/data_access/. The last and the newest reanalysis is JRA-3Q (Japanese Reanalysis for Three Quarters of a Century), which should be the improved version of JRA-55 and can be downloaded from https://search.diasjp.net/en/dataset/JRA3Q. ERA-5 is available up to 1 hPa, but MERRA-2 up to 0.1 hPa and JRA-3Q up to 0.01 hPa. That is why we can use only two reanalysis for comparison at higher levels (above 1 hPa). We use monthly data for the whole available period of JRA-3Q from January 1991 to April 2013. We selected temperature, zonal and meridional wind, and specific humidity as a measure of water vapor and computed the averages throughout the whole period for each grid point. These parameters are usually used for the basic analysis of stratospheric dynamics. Geographical distribution can show the distribution of selected parameters, and we can identify areas where reanalysis differ. We also compute time series for three regions: polar (90-60°N/S), extratropics (30-60°N/S) and tropics (30°S-30°N).



Time series in three regions (polar, extratropics and tropics) for four parameters (Temperature, Zonal and Meridional wind and Specific humidity) of ERA-5(red), MERRA-2(blue) and JRA-3Q (green) at four pressure levels. 50 and 10 hPa, temperature, zonal wind and meridional wind – only ERA5 data are presented, other reanalysis agree with ERA5.

Acknowledgement

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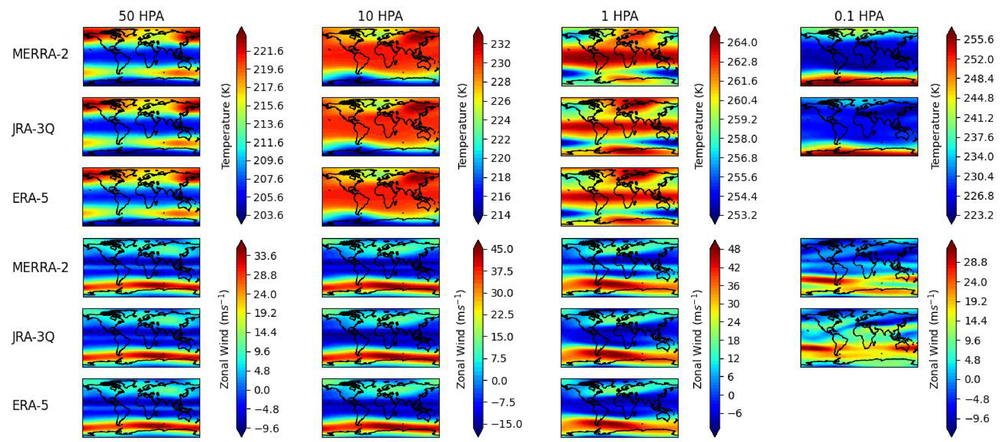
Conclusion

The main results of this poster is the following:

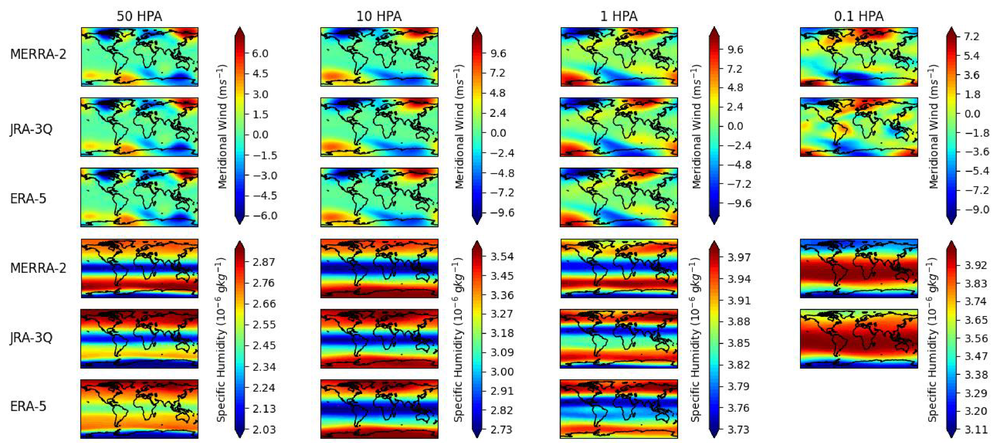
- Temperature: Lower pressure levels (50 and 10 hPa) shows very good agreement (including geographical distribution). Differences at 1 and 0.1 hPa before 2000 in the polar region are relatively small (up to 3 K). Larger differences in JRA-3Q (between 2000 and 2008) . At 0.1 hPa the biggest disagreement in polar regions before 2004 can be about 5 K.

- Zonal wind: Polar region at 1 and 0.1 hPa after 2000 shows bigger disagreement (connection with SSW and polar jet) Tropics region indicates some discrepancies at 1 and 0.1 hPa (connection with QBO)

- Specific humidity: Large disagreement after 1998, especially in the tropics at 10 hPa. The biggest issue is found in the polar region and extratropics at 1 and 0.1 hPa, where JRA-3Q shows almost no variability while MERRA-2 shows standard behavior. The same conclusion can be found in the SPARC report from 2022.



Geographical distribution of the whole period (1991-2013) average values at four pressure levels (50, 10, 1and 0.1 hPa). Temperature (top three rows) and zonal wind (bottom three rows)



Geographical distribution of the whole period (1991-2013) average values at four pressure levels (50, 10, 1and 0.1 hPa). Meridional wind (top three rows) and specific humidity(bottom three rows)