Stratosphere, Stratopause, and Lower Mesosphere in the JRA-55 and JRA-3Q reanalyses: Insights and Discrepancies

C. Pérez Souto[1], J. A. Añel[1], A. Kuchar[2], L. de la Torre[1] (celia.perez@uvigo.gal)

[1] EPhysLab, Universidade de Vigo, Ourense, SPAIN [2] Institute of Meteorology, BOKU, Vienna, AUSTRIA

INTRODUCTION

The representation of the stratosphere in reanalyses is crucial for various issues such as atmospheric transport, sudden stratospheric warmings, the polar vortex, and studying the impact of climate change. High-top and latest reanalyses are designed with the aim of being able to reproduce the high stratosphere better than previous generation of low-top reanalyses, thus being better equipped to capture issues such as elevated stratopause events.

In this study, we examine how various variables behave in both reanalyses, JRA-55 and JRA-3Q , showing notable differences when comparing various parameters such as correlations and trends. We show that JRA-3Q exhibit substantial differences in their representation of the middle and upper stratosphere compared to its predecessors. Different latitudinal bands have been compared for this purpose. For instance, negative correlations in stratopause height have been observed in the subtropical zone between both reanalyses.

Data & Methods

- **Reanalysis:** Japanese Reanalysis for Three Quarters of a Century (JRA-3Q), Japanese 55-year Reanalysis (JRA-55) – both in model levels.
- **Satellite:** MLS-Aura, SABER/TIMED.
- **Variables:** Temperature (K), geopotential height (m), ozone mixing ratio ($kg \cdot kg^{-1}$)
- **Period:** 1980–2023

Conclusions

The comparison between the JRA-55 and JRA-3Q reanalyses for selected pressure levels (1980-2023) reveals significant differences in temperature, geopotential height, and ozone. The largest variations occur at higher pressure levels (from 2.690 hPa), with temperature differences being more pronounced globally than in the tropics. Geopotential height fluctuations are more synchronized in the tropics, while global fluctuations are more scattered.

The irregular behavior at the 0.100 hPa level in JRA-55 is due to its location at the top of the model, where a lack of data above this level limits reliability. Differences in ozone concentrations are key to these discrepancies, with more notable variations at higher altitudes, likely due to differences in ozone assimilation methods between the reanalyses.

In the tropics, ozone and temperature correlations are mainly negative, especially at higher altitudes. Standard deviation analysis shows higher temperature variability in the polar regions for JRA-3Q, whereas JRA-55 shows more pronounced spatial differences between the polar and tropical regions. Ozone variability is greater in JRA-3Q, particularly in the polar regions.

References

- Kosaka, Y., et al. (2024). The JRA-3Q Reanalysis. JMSJ, 102(1), 49–109, doi: 10.2151/jmsj.2024-004
- Kobayashi, S., et al. (2015). The JRA-55 Reanalysis. JMSJ, 93, doi: 10.2151/jmsj.2015-001

Results

Figure 1. Global (top) and tropical (bottom) T, Z and O_3 differences between JRA-3Q and JRA-55 for 1980–2023.

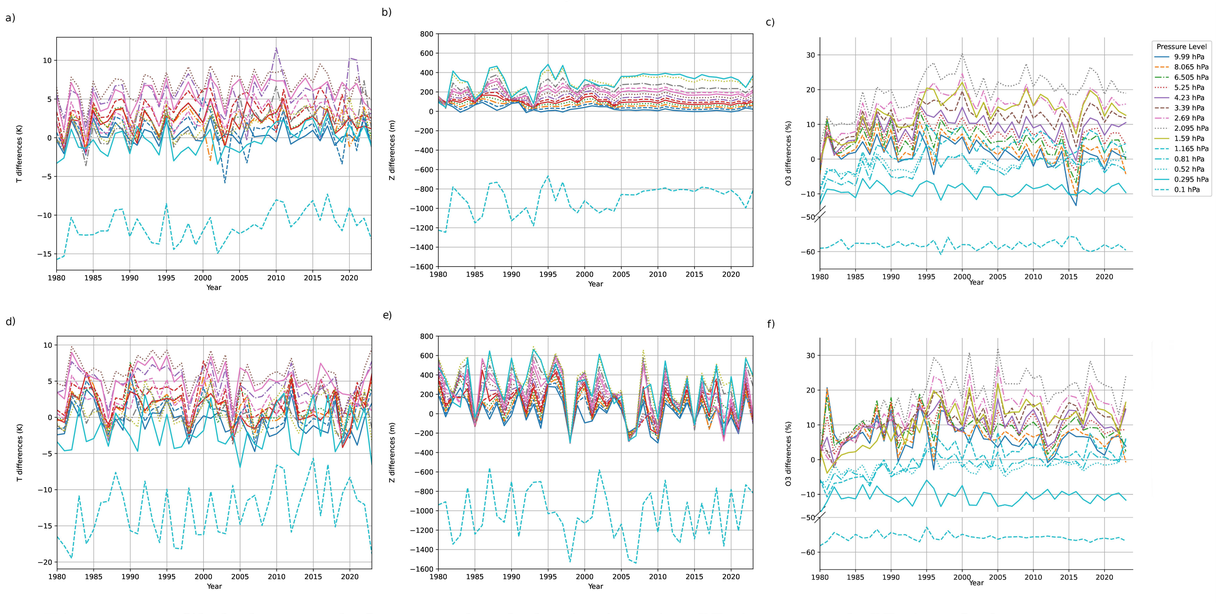
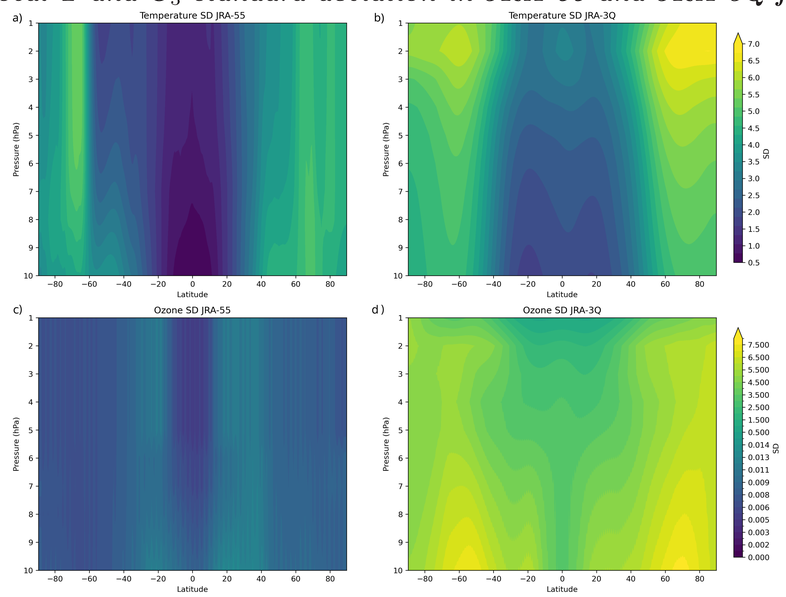


Figure 2. Global T and O_3 standard deviation in JRA-55 and JRA-3Q for 1980-2023.



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