# Assessment of upper tropospheric and stratospheric water vapour and ozone in reanalyses as part of S-RIP

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Reanalysis datasets are widely used to understand atmospheric processes and past variability, and are often used as “observations” for comparison with climate model output. Because of the central role of water vapour (WV) and ozone ($O_3$) in climate change, it is important to understand how accurately these species are represented in the existing global reanalyses, and whether or not significant differences exist amongst them. We present results from the WV and $O_3$ intercomparisons that were performed as part of the SPARC (Stratosphere-troposphere Processes and their Role in Climate) Reanalysis Intercomparison Project (S-RIP). Comparisons are made over a range of timescales between the different reanalyses, and between reanalyses and observational datasets.

In addition to the intercomparisons, we discuss the treatment of WV and $O_3$ in reanalyses to aid future research and guide the interpretation of differences between the reanalysis fields. Because total column ozone (TCO) is assimilated in the newer reanalyses, these reanalyses generally reproduce TCO well except when data coverage is lacking, such as during polar night. We find that the vertical distribution of ozone is relatively well represented in reanalyses, particularly given that for most reanalyses there are only weak constraints on the vertical profile of ozone from observations, and that most have a simplistic representation of ozone photochemical processes.

In contrast to $O_3$, stratospheric WV data are not currently assimilated, with humidity observations typically used only in the troposphere below a specified vertical level at or near the tropopause. Thus, the fidelity of reanalysis stratospheric WV is sensitive to how accurately the fundamental drivers of stratospheric WV such as tropical tropopause layer temperatures, methane oxidation, and the stratospheric overturning circulation are represented. Because of these issues and the known deficiencies in the representation of stratospheric transport in reanalyses, we find much poorer agreement both amongst reanalyses and between reanalyses and independent observations. For these reasons, stratospheric WV from the current generation of reanalyses should not be used in scientific studies.

Keywords: ozone, water vapor, stratosphere, reanalyses, SPARC Reanalysis Intercomparison Project

 