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Middle atmosphere water vapour and dynamical features in aircraft measurements and ECMWF analyses

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The European Centre for Medium-Range Weather Forecasts (ECMWF) provides global analyses of atmospheric humidity from the ground to the lower mesosphere. Unlike in the troposphere, in the stratopshere no humidity observations are assimilated. Humidity analyses here are essentially the results of a free-running model constrained by the ECMWF's well-analysed wind fields.

So far only the broad-scale features of the resulting stratospheric water vapour distribution have been validated. This study provides the first in-depth comparison of stratospheric humidity from ECMWF with observations from an airborne microwave radiometer that has measured the distribution of stratospheric water vapour over an altitude range of roughly 15–60 km on several flight campaigns since 1998. The aircraft measurements provide a horizontal resolution that cannot be achieved by current satellite instruments.

This study examines dynamical features in the moisture fields such as filamentation and the vortex edge, finding that features in the ERA-40 humidity analyses often do correspond to real atmospheric events that are seen in the aircraft measurements. However, the comparisons also show that in general the ECMWF model produces an unrealistically moist mesosphere. As a result it cannot replicate the descent of relatively dry mesospheric air into the polar vortex in winter and spring.