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Using a global network of temperature lidars to identify temperature biases in the upper stratosphere in ERA-5 reanalysis and in the ECMWF's seasonal forecast model.

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Stratospheric lidars use Rayleigh scattering to measure density in the upper atmosphere, allowing temperature profiles to be derived for altitudes from 30km (where Mie scattering due to stratospheric aerosols becomes negligible) to 80-90km (where the signal-to-noise begins to drop rapidly). The Network for the Detection of Atmospheric Composition Change (NDACC) contains several lidars at different latitudes that have measured atmospheric temperatures since the 1990s, resulting in a long running upper-stratospheric temperature dataset. Thus, these temperature datasets can prove vital for validating numerical weather prediction models in the stratosphere.

Here we take stratospheric temperature data from six lidars spanning latitudes from 70°N to -20°S and compared it with the European Centre for Medium-Range Weather Forecasts' (ECMWF) ERA-5 and the seasonal ensemble prediction model SEAS5. In comparison to the lidar, ERA-5 reanalysis has a cold bias of -2 to -5K over much of the upper stratosphere. In contrast, SEAS5 has a warm bias of +5 to +10 K in the upper stratosphere compared to lidar.

To further demonstrate how the temperature lidar can be used to validate numerical weather prediction models in the atmosphere, a staggered-start four year free-running model (ECMWF's The Integrated Forecast System) initiated at yearly intervals between 2004 and 2011 was run in four different configurations. Three of the configurations varied the strength of the parametrized non-orographic gravity wave drag, whilst the fourth contained a stochastic physics parametrisation, where physics tendencies are perturbed with synoptic-scale, correlated in time noise. Initial results show smaller temperature bias for runs with reduced parametrized non-orographic gravity wave drag.