

## **The use of two-dimensional observation operators when assimilating GPS radio occultation measurements**

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GPS radio occultation (GPSRO) measurements are now an important component of the Global Observing System. They have consistently produced a significant positive impact on upper tropospheric and stratospheric temperatures at the major operational numerical weather prediction centres, and they are now routinely used in climate reanalyses. However, the impact on tropospheric humidity has proved more difficult to demonstrate. One possible reason is that the GPSRO measurements are generally assimilated with one-dimensional (1D) operators, which ignore the actual two-dimensional (2D) planar nature of the measurements, and introduce large forward model errors in the troposphere. Therefore, this talk will review work at ECMWF on the development and use of a two dimensional bending angle observation operator. The 2D operator will be described, and this approach will be compared with the “non-local” phase and refractivity methods which have also been suggested. We will estimate the reduction in forward model errors as a result of using a 2D operator, and present the latest forecast impact experiments with the ECMWF NWP system.