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Atmospheric gradients from GNSS, VLBI, and DORIS analyses and from Numerical Weather Models during CONT14

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Observations from space-geodetic techniques are nowadays increasingly used to derive atmospheric information for various commercial and scientific applications. A prominent example is the operational use of GNSS data to improve global and regional weather forecasts, which was started in 2006.

Atmosphere gradients describe the azimuthal asymmetry of zenith delays. Estimates of geodetic and other parameters significantly improve when atmosphere gradients are determined in addition. Here we assess the capability of several space geodetic techniques (GNSS, VLBI, DORIS) to determine atmosphere gradients of refractivity. For this purpose we implement and compare various strategies for gradient estimation, such as different values for the temporal resolution and the corresponding parameter constraints. Applying least squares estimation the gradients are usually deterministically modelled as constants or piece-wise linear functions. In our study we compare this approach with a stochastic approach modelling atmosphere gradients as random walk processes and applying a Kalman Filter for parameter estimation.
The gradients, derived from space geodetic techniques are verified by comparison with those derived from Numerical Weather Models (NWM). These model data were generated using raytracing calculations based on European Centre for Medium-Range Weather Forecast (ECMWF) and National Centers for Environmental Prediction (NCEP) analyses with different spatial resolutions. The investigation of the differences between the ECMWF and NCEP gradients hereby in addition allow for an empirical assessment of the quality of model gradients and how suitable the NWM data are for verification.
CONT14 (2014-05-06 until 2014-05-20) is the youngest two week long continuous VLBI campaign carried out by IVS (International VLBI Service for Geodesy and Astrometry). It presents the state-of-the-art VLBI performance in terms of number of stations and number of observations and presents thus an excellent test period for comparisons with other space geodetic techniques. During the VLBI campaign CONT14 the HOBART12 and HOBART26 (Hobart, Tasmania, Australia) VLBI antennas were involved that co-locate with each other. The investigation of the gradient estimate differences from these co-located antennas allows for a valuable empirical quality assessment. Another quality criterion for gradient estimates are the differences of parameters at the borders of adjacent 24h-sessions. Both are investigated in our study.