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A new atmospheric ray-tracing algorithm and its use in VLBI analysis

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Due to recent improvements of numerical weather models (NWM), ray-tracing has become an interesting and feasible method for different scientific purposes. One application in geosciences is the estimation of tropospheric delays for the correction of space geodetic techniques. Here, we present and discuss the recently developed ray-tracing algorithm from the Institute of Geodesy and Geophysics (IGG) at Vienna University of Technology. We use numerical weather model data from the European Centre for Medium-Range Weather Forecasts (ECMWF) to estimate the tropospheric total delay by solving the Eikonal equation. In addition we discuss different methods and characteristics, such as interpolation methods, resolution of the data set and the use of different refractivity constants, and we present results and differences between a 2D- and 3D-ray-tracing algorithm.
As quality validation we enter the derived tropospheric delays as a priori information in our VLBI analysis software package (Vienna VLBI Software). We analyze IVS Intensive sessions from July 2010 to October 2011 which are carried out for the estimation of UT1-UTC (DUT1). The measurement of this Earth rotation angle is needed in near real-time for the accurate prediction of Universal Time (UT1) as well as for navigation purposes. Due to the small number of observables per session most parameters, which are usually estimated in VLBI analyses, are fixed to their a priori values, which should be known as accurately as possible. As an external validation of our ray-traced delays we calculate Length-of-Day (LoD) from the VLBI-derived DUT1 values and compare these to LoD from GPS.