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Atmospheric turbulence modelling for space geodesy

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Atmospheric turbulence causes fluctuations in the atmospheric delay of space geodetic signals used e.g. in Very Long Baseline Interferometry (VLBI) and Global Navigation Satellite Systems (GNSS). These atmospheric fluctuations limit the accuracy of the geodetic parameters estimated in space geodetic data analysis, e.g. station coordinates. Simulation of atmospheric delays using turbulence models can be used to both assess the impact of atmospheric turbulence on the estimated parameters, and also to improve the atmospheric modelling in the actual data analysis. The turbulence model can be described by the refractivity structure constant C_n. The vertical profile of this parameter can be estimated from high resolution radiosonde data. We use data from a number of high resolution radiosonde stations around the world to determine the variability of C_n as function of time and space. The temporal aspect includes the variability on different time-scales (sub-diurnal to seasonal), and the spatial aspect includes variability in 3-dimensions (with respect to altitude and climate regions). Typically, C_n is larger for warmer locations closer to the equator (i.e. areas with high humidity) and at lower altitudes. The effects of different modelling approaches on VLBI results are investigated. We show that the atmospheric turbulence typically limits the accuracy of the estimated coordinates to several millimetres.