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Continuous formulation of atmospheric state parameters for ray-traced GNSS signals

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In order to improve the modeling of the propagation of GNSS electromagnetic signals through the neutral atmosphere and achieve millimetric accuracy at low elevation, the GRGS (Groupe de Recherche de Géodésie Spatiale) in collaboration with CLS (Collecte Localisation Satellite) has developed a new set of mapping functions called AMF (Adaptive Mapping Functions) for applications in geodesy. The idea is to fit tropospheric ray-traced delays using a few numbers of coefficients for a given site at a given time.
The ray tracing algorithm is based on the integration of the eikonal system which governs the ray propagation in the refractive atmosphere. During ray tracing, the current point refractivity and its gradient are computed using model level data assimilations produced by the ECMWF (European Center for Medium-range Weather Forecast). With the aim to improve our transformation between model level data and the atmospheric refractivity, we describe a new scheme which permits to interpolate separately each thermodynamical parameter necessary to precisely rebuild the refractivity along the ray path. To allow for the atmospheric part between the lowest model level and the Earth's surface during the ray tracing, we propose in addition an extrapolation of physical parameters below the lowest model level. These continuous formulations are implemented in the IFS (Integrated Forecasting System) at ECMWF. It assures the coherence between model level data and our precise formulation of the geometrical shape of the atmosphere.