Atmospheric ray-tracing using numerical weather models for space geodetic positioning: Current activities at the University of New Brunswick, Canada

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Atmospheric ray-tracing using numerical weather models estimates zenith and slant radio-propagation delays, as well as mapping functions relating the two. These data products improve space geodetic positioning techniques, such as GPS, VLBI, SLR, DORIS, and InSAR. Their utilization is made as either a priori corrective models for biased observed range or phase observations, or as partial derivatives relating individual observations with redundant parameters (zenith delay). The need for such pre-processed data products stems from the high computational demand in using high-resolution NWMs, notably for real-time applications.

The University of New Brunswick (UNB) has been investigating the use of NWMs for high precision space geodesy positioning and applications since 2004, in collaboration with research groups around the world. We have developed ray-tracing software and applied it various NWMs. We are currently developing a public online service to provide ray-traced neutral-atmosphere delay estimates to improve GNSS positioning. This service will run under the auspices of the International Association of Geodesy. Also developed as part of our software are abilities to use Canadian, American, and European NWMs (CMC, NCEP, and ECMWF, respectively). We report highlights of current activities at UNB, focusing on:

- Developing an online service to provide time- and location-dependent mapping function coefficients, as a backup for the IERS-recommended Vienna Mapping Functions, using completely independent NWMs and ray-tracing software;
- Comparisons of global, regional, and local versions of the Canadian Meteorological Centre’s NWM, using enhanced temporal and spatial resolutions;
- Comparisons of Canadian, American, and European NWMs;
- Assessment of different assumptions regarding vertical atmospheric stratification and the underlying applied Earth model (e.g., ellipsoidal vs. spherical osculating);
- A fast-converging perturbative ray-tracing approach based on a climatology of ray-paths.