Abstract

The mitigation of space borne radio signal perturbations in the neutral atmosphere is necessary for high precision position applications. Over the years there have been many methods for dealing with these perturbations, but the most popular modern method to deal with such effects is to model the signal delay at zenith with a corresponding mapping function that describes the elevation angle dependency of the signal. There have been many formulations and realizations of mapping functions, but the Vienna Mapping Functions (VMF) have proven to be most accurate to date. The Vienna Mapping Functions (VMF) are unique in that they rely solely on information from an external data source, namely a numerical weather prediction model (NWP). The development of the VMF represents a shifting paradigm in which geodetic corrections are moving from simple mathematical closed form type solutions to solutions based on large amounts of external data. However, there have been many differing institutions creating many differing corrections based on many differing underlying models and datasets.

The intent of this work is to investigate the influence of differing external datasets and modelling algorithms with a new realization of the VMF1. This is accomplished with the creation of a UNB Vienna Mapping Functions Service (VMF1) where several VMF1 products have been created with an independent data source (NCEP and CMC) and independent ray-tracing algorithms (UNB Ray tracer). The new service will not only improve the redundancy of currently available corrections, stimulate the use of the VMF1 corrections and add to the creation of a consistent set of corrections based on the same underlying external datasets, but the new service will help to appreciate the influence of the application of these external datasets.

The resulting UNB-VMF1 service has been validated against the existing service operated at TU Vienna. Three realizations have been created: (a) an NCEP based product, (b) CMC (GDPS) based product, and a (c) forecast products based on 24-42h hour forecast from the CMC. The validation of the NCEP based product has been conducted over an 11- year period and the remaining products have been evaluated over an 8-month period. All products have been evaluated in the gridded domain and the position domain with the comparison of PPP solutions. With respect to the existing VMF1 service, all products are considered equivalent at the 1 level, but the NCEP based product exceeds the accuracy of the VMF1 at the 3 level. In particular, the NCEP based product performs poorly in regions of steep topography due to limitations of the model's integration of the underlying orography.

In addition to the validation of the service, the NCEP and CMC numerical weather prediction models (NWP) and an empirical model known as the GPT have been assessed against measured in-situ meteorological measurements (pressure, temperature and humidity) and hydrostatic zenith delays computed by in-situ measurements. The NCEP dataset performed the worst out of the NWPs and the GPT performed worse in general. The GPT and NCEP exhibited a latitude dependent bias in the RMS of the difference in pressure and hydrostatic zenith delay. The CMC results did not exhibit any noticeable latitude dependency for these parameters. Each dataset exhibited a seasonal trend where the RMS of the difference is larger during the winter months for the pressure parameter. Both the CMC and NCEP models exhibited a trend where the RMS of the difference in humidity correlated with the season and latitude. In regions and times of the year when water vapour content is largest, both NWPs experienced a degradation in their ability to model the humidity parameter.