Geoscientific Model Development Discussions

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Comment on gmd-2021-246

Anonymous Referee #1

Referee comment on "Coupling a weather model directly to GNSS orbit determination – case studies with OpenIFS" by Angel Navarro Trastoy et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-246-RC1, 2022

The authors present a study about the correction of neutral atmospheric delays in GNSS signal processing by ray-tracing through numerical weather model data and compare their results to a "default system". In contrast to most papers, it is not a rigorous *canonization* of a new method but a fair comparison including strength and weaknesses. The proposed "experiments" are promising and with further improvements in numerical weather prediction, it has great potential to enhance GNSS signal processing. However, the current manuscript does not give a clear answer whether current limitations are caused by the ray-tracing approach or deficiencies in the OpenIFS refraction field. Thus, I cannot recommend the paper for publication without further corrections, as detailed in the following:

Major recommendations:

Line 205ff: "A test was carried out by segregating the receiver stations to three zones: Northern Hemisphere, Southern Hemisphere and the Tropics. This test does not reveal the sources of the positive bias …". As reader of the manuscript, I am not very happy that the analysis stops at this point. I would have expected that the developed ray-tracer is compared to other existing ray-tracers, e.g. as provided by TU Vienna: https://vmf.geo.tuwien.ac.at/. On line 240 it is concluded that the positive bias "is very likely due to an approximation made in the LTT code". However, no justification for this statement is provided in the manuscript yet. In addition or as alternative, the forecasted refraction field from the OpenIFS system could have been compared to operational forecast data to make clear whether the positive bias is caused by ray-tracing or the input field.

Line 250f: The statement that the "azimuthal asymmetries of the tropospheric delay that are present in the experimental system but are missing from the default system do matter and contribute to the orbit solutions" is not supported by the data. The same is valid for line 277f. Please provide the corresponding justification, i.e. by repeating the analysis without azimuthal asymmetries (remove them from the ray-traced delays priori to GNSS data processing).

Minor recommendations:

Lines 1-6: This part is a bit confusing. I suggest: “Neutral gas atmosphere bends and delays propagation of microwave signals in satellite-based navigation. Weather prediction models can be used to estimate these effects by providing 3-dimensional refraction fields to ray-trace the signal delays. In this study, a global numerical weather prediction model (Open Integrated Forecasting System (OpenIFS) licensed for Academic use by the European Centre for Medium-RangeWeather Forecast) is used to generate the refraction fields. The ray-traced slant delays are supplied as such for an orbit solver (GROOPS (Gravity Recovery Object Oriented Programming System) software toolkit of the Technical University of Graz) which applies the raw observation method.

Lines 10-11: Remove “as measured with the midnight discontinuity of Global Navigation Satellite System (GNSS) satellite orbits” since it is not relevant at this point.

Line 14: What is meant by “precision-reducing mapping”? Please rephrase.

Line 155: “Here the LTT solver is applied such that instead of computing ray paths exactly in direction of the GNSS satellites in view, so-called sky-views are generated.”