Towards an Improved Single-Frequency Ionospheric Correction: Focus on Mid-Latitudes

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The NeQuick Ionospheric Model

- Ionosphere affecting radio propagation and hence GNSS
  - Positioning errors exceeding 100 m in extreme cases
  - Total Electron Content (TEC, integral of the electron density Ne) = main driver
- Importance of TEC modelling
  - Crucial especially for single frequency receivers, the most common ones constituting the mass market
  - By means of a 3D method using the NeQuick model for GALILEO (Orus et al., 2007a)
- NeQuick = empirical model of the electron density Ne
  - "Profiler" = several mathematical functions fitted on anchor points corresponding to the maxima of the layers of the ionosphere (Radići et al., Leitinger, 2001)
  - Peaks and profile characteristics calculated on the basis of monthly median measurements
- New version (NeQuick 2): main modification regarding the description of the higher part of the ionosphere ("topside")
  - two formulas for shape parameter k (each for six months of the year) replaced by a single one (Nava et al., 2008)

To be added: a table with the relevant data and parameters for each method.

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Tools and Method

- Investigation of NeQuick profile formulation
  - Monthly median measurements replaced by actual ones \( \rightarrow \) model constrained by means of ionosonde data (Bidaine et Wannam, 2007)
  - Vertical TEC compared to GPS TEC \( \rightarrow \) collocated ionosonde and GPS receiver needed
- Ingestion: adapt NeQuick TEC to GPS TEC by means of effective parameters (Nava et al., 2006)
- Data types
  - Manually validated digisonde data
  - Slant TEC data levelled using Global Ionospheric Maps (Orus et al., 2007b) and mapped to vertical + elevation filter and average to obtain vertical TEC
- Tests for mid-latitudes and high solar activity
  - Year 2002
  - Three European locations with (nearby) collocated digisonde and IGS/EUREF station

Yearly Statistics

- Yearly TEC mean
- Yearly relative TEC standard deviation

TEC Splitting

- Integrate bottomside Ne profile from digisonde to obtain bottomside TEC
- Subtract bottomside TEC to GPS TEC to obtain estimate of topside TEC (caution with interpretation about topside because resulting TEC value containing whole GPS TEC uncertainty)
- Big proportion of TEC within topside (3/4, 1/4)
- Bottomside: low bias (at least in absolute value) and relatively high standard deviation, no big evolution between NeQuick versions
- Topside: higher relative bias and standard deviation than bottomside, bias/standard deviation evolution between NeQuick versions corresponding to global statistics

Slant TEC Ingestion

- Effective ionization level Az: compute solar flux value leading to the minimum daily Mean Square (MS) slant TEC difference
- Tests for Dourbes using Az of the day and Az of the day before (similar to GALILEO algorithm) and comparison with previous statistics
- Az of the day
  - Bias about three times lower thanks to ingestion
  - Standard deviation lower for NeQuick 1 and comparable for NeQuick 2
  - Improvement both in bias (15%) and standard deviation (10%) for NeQuick 2
- Az of the day before: standard deviation increasing by about 35%

Conclusion and Perspectives

- Investigation of NeQuick profile formulation for mid-latitudes and high solar activity
  - Standard deviation decreasing by 20% to reach less than 20% with NeQuick 2, bias increasing by 20% up to 25% but caution with GPS TEC data
  - Major role of the topside
- Slant TEC ingestion
  - Improvement with NeQuick 2 (15% in bias and 10% in standard deviation)
  - Deterioration using Az of the day before
- Further research
  - Ingestion for other stations and of other parameters eg foF2
  - Investigate GALILEO Single Frequency Ionospheric Correction Algorithm

Find material about this poster on http://orbli.ulg.ac.be/handle/2268/1551

Acknowledgements

- Research undertaken under F.R.S.-FNRS fellowship
- Sandra Radičić, Pierrick Colin and Bruno Nava from ICTP in Trieste for providing NeQuick latest version and comments about it
- Higo Blanco Alegre from INTA (El Arenosillo), David Altadill from Observatori de l’Ebre (Roquetes), Elise Van Maleeren and Luc Lejeune from MRM (Dourbes) for providing ionosonde data and comments about them
- Grigori Khnyurov and Bodo Reinisch from UNIKAR in Bonn for providing access to the DIBbase (digisonde database)
- Roberto Prieto Cerdárea and Raul Orús from ESA/ESTEC for providing TEC data and comments about them

References