Assessment of the NeQuick model at mid-latitudes using GPS TEC and ionosonde data

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First Colloquium Scientific and Fundamental Aspects of the Galileo Programme (Toulouse, France)
TEC has to be modelled for single frequency receivers.

- GALILEO algorithm using NeQuick model
- Validate and improve
  - algorithm
  - NeQuick + evolutions

First step: let’s assess NeQuick behaviour at mid-latitudes.
NeQuick v2 improves TEC estimation at mid-latitudes.

1. Tools

*Modelling and measuring the ionosphere*
NeQuick v2 improves TEC estimation at mid-latitudes.

1. Tools
   Modelling and measuring the ionosphere

2. TEC Analysis
   NeQuick vs GPS TEC data
NeQuick v2 improves TEC estimation at mid-latitudes.

1. Tools
   Modelling and measuring the ionosphere

2. TEC Analysis
   NeQuick vs GPS TEC data

3. Profiles Analysis
   NeQuick vs ionosonde data
1. Tools

2. TEC Analysis

3. Profiles Analysis
NeQuick is an empirical « profiler ».

1. Tools

- **Output** = \( Ne \)
  - \( TEC \) with integration
- **Layer peaks** = anchor points
  - \( \text{monthly} \) median maps
  - \( \text{measured} \) values
We obtain Ne from an ionosonde and TEC from GPS.

- Vertical soundings
  - parameters (scaling)
  - Ne profiles (inversion)

- GPS
  « geometric free » combinations
  - TEC

1 TECu → 16 cm error for $L_1$
We can learn a lot from collocated data.

- **Dourbes**: digisonde + GPS station
- **Data**: 2002 for high solar activity, 2006 for low solar activity
- **Statistics**: \( RMS = \sqrt{\left( TEC_{\text{meas}} - TEC_{\text{mod}} \right)^2} \)
1. Tools

2. TEC Analysis

3. Profiles Analysis
2. TEC Analysis

TEC modelling improves on a yearly basis.

RMS evolution: 31.4% → 21.1% → decrease of a third

RMS evolution: 55.1% → 31.0% → decrease of a half
We observe a double behaviour on a monthly basis.

- **Double** behaviour with v1 $\rightarrow$ disappears with v2
- **Focus:** December 2002 (highest RMS)
The clearest evolution appears for the maximum around local noon.

2. TEC Analysis

v1

Daily TEC
29/12/2002

v2

11 UT
1. Tools

2. TEC Analysis

3. Profiles Analysis
2. Profiles Analysis

The improvement comes from the new topside formulation.

v1  Ne(h) 29/12/2002  v2  11 UT

- Too high TEC
- Bottomside slightly too dense

→ Too dense topside
Bottomside and topside needs to be further investigated.

- **TEC dissociation**
- **Bottomside**
  - TEC from ionosonde
  - slightly too high
- **Topside**
  - $\text{TEC}_{\text{GPS}} - \text{TEC}_{\text{bot}}$
  - still far too high

29/12/2002 11UT
NeQuick v2 improves TEC estimation at mid-latitudes.

- Benefit from collocated data
- **TEC** statistics: RMS decrease
  - 36% in 2002 (high SA)
  - 44% in 2006 (low SA)
- Profiles comparison:
  - *topside* improvement
  - topside/bottomside interaction
  - bottomside to investigate
TEC has to be modelled for single frequency receivers.

- Statistics from TEC dissociation
- Assessment for other stations/latitudes
- Use of CCIR maps to compute the profile parameters
- GALILEO algorithm
TEC has to be modelled for single frequency receivers.

- **PhD thesis** at ULg – Unit of Geomatics sponsored by FNRS
- **Collaborations**
  - RMI (Brussels)
  - ESA/ESTEC (Noordwijk)
  - ICTP (Trieste, Italy)
  - Others to come…
Ionosphere
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