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

Benoît Bidaine (FNRS/ULg – Geomatics, Belgium)
René Warnant (RMI, Belgium)

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First Colloquium Scientific and Fundamental Aspects of the Galileo Programme (Toulouse, France)

Ionosphere

Total Electron Content

TEC

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

1. Tools

NeQuick is an empirical « profiler ».

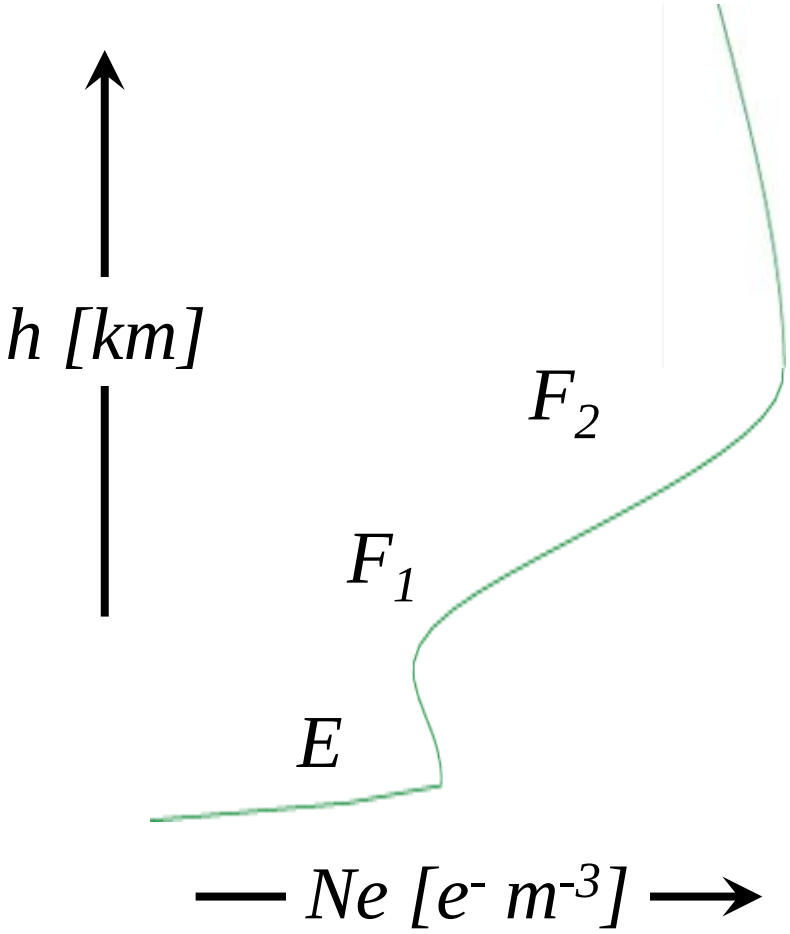
- Output = *Ne*

  → *TEC* with integration

- Layer peaks
  = anchor points

  → monthly median maps

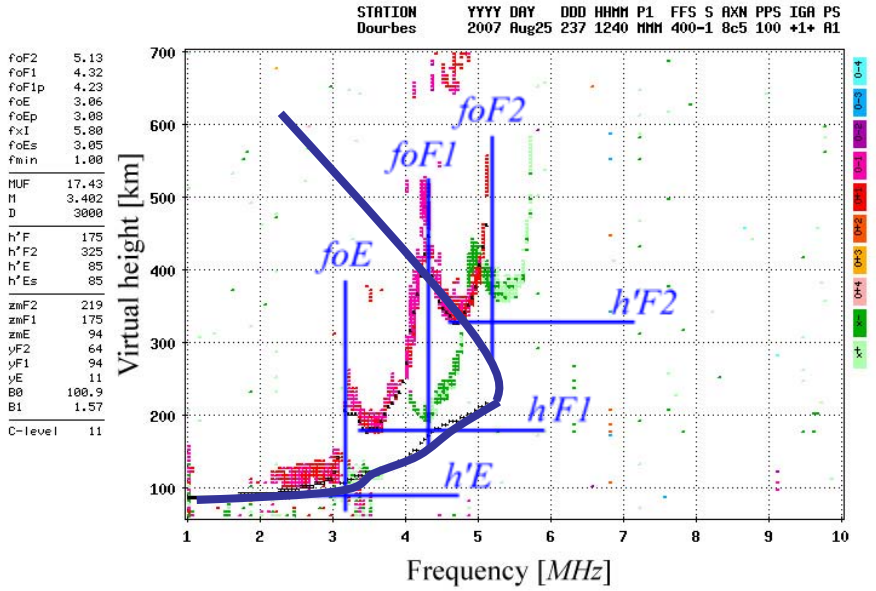
  → measured values



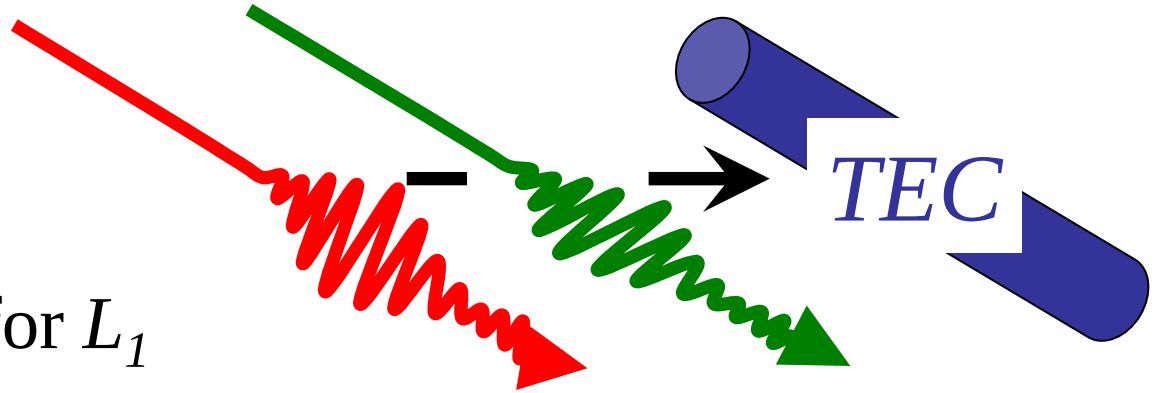
1. Tools

We obtain Ne from an ionosonde and TEC from GPS.

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



- GPS
  « geometric free »
  combinations
  → TEC

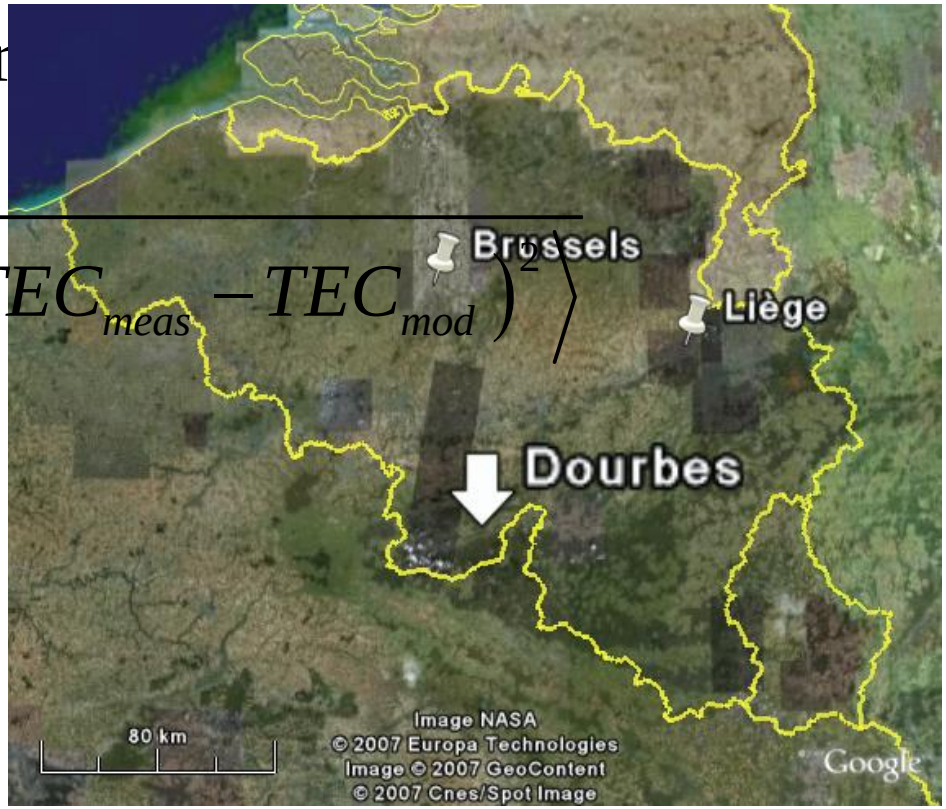


$1 TECu$ → 16 cm error for L_1

1. Tools

We can learn a lot from collocated data.

- Dourbes: digisonde + GPS station
- Data: 2002 for high solar
  2006 for low solar
- Statistics: $RMS = \sqrt{\left\langle \left(TEC_{meas} - TEC_{mod} \right)^2 \right\rangle}$



1. Tools

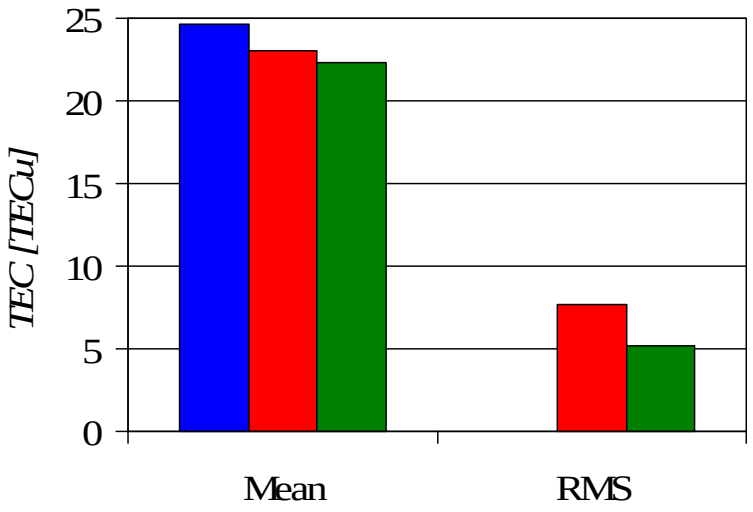
2. TEC Analysis

3. Profiles Analysis

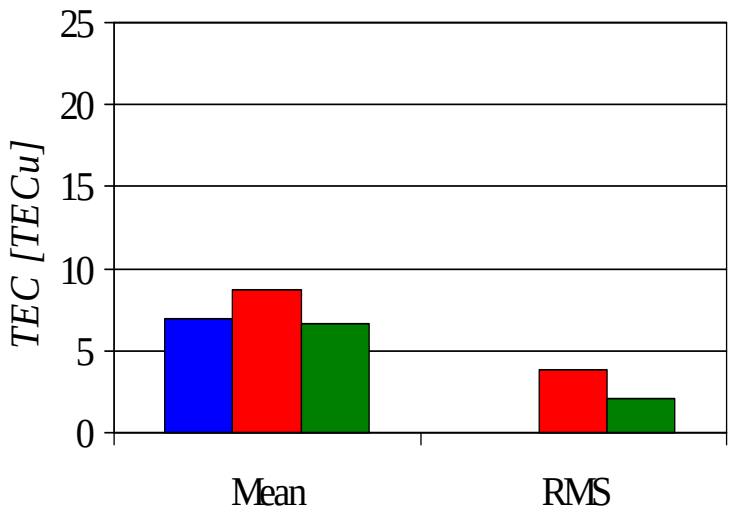
2. TEC Analysis

TEC modelling improves on a yearly basis.

2002



2006



RMS evolution: 31.4% → 21.1%

→ decrease of a third

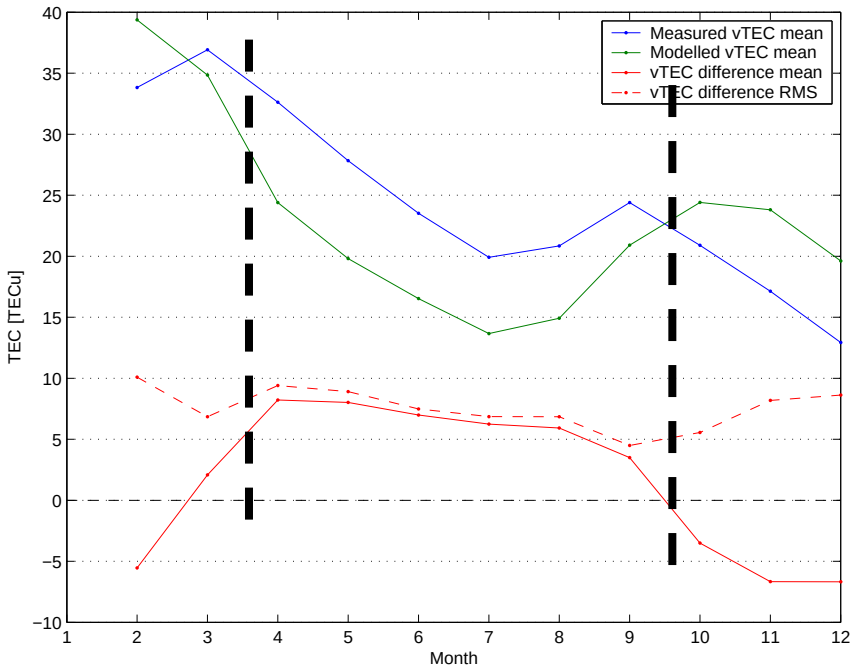
RMS evolution: 55.1% → 31.0%

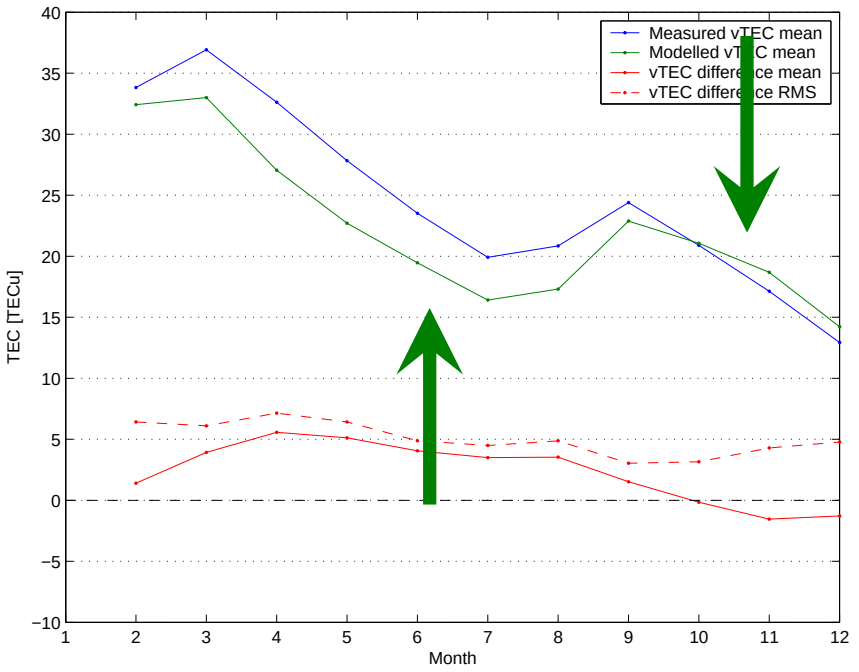
→ decrease of a half

2. TEC Analysis

We observe a double behaviour on a monthly basis.

v1 2002 v2





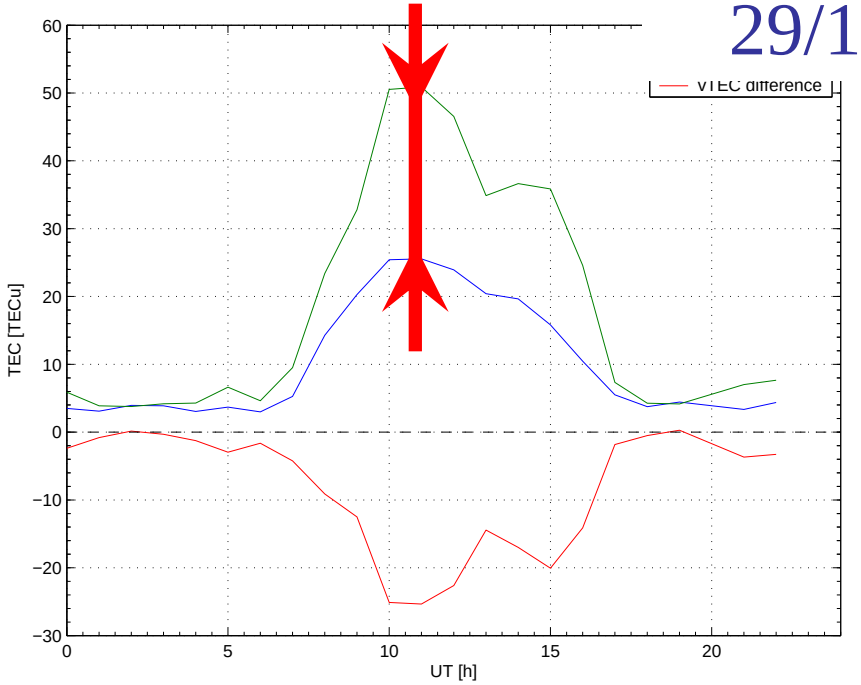
- Double behaviour with v1 → disappears with v2
- Focus: December 2002 (highest RMS)

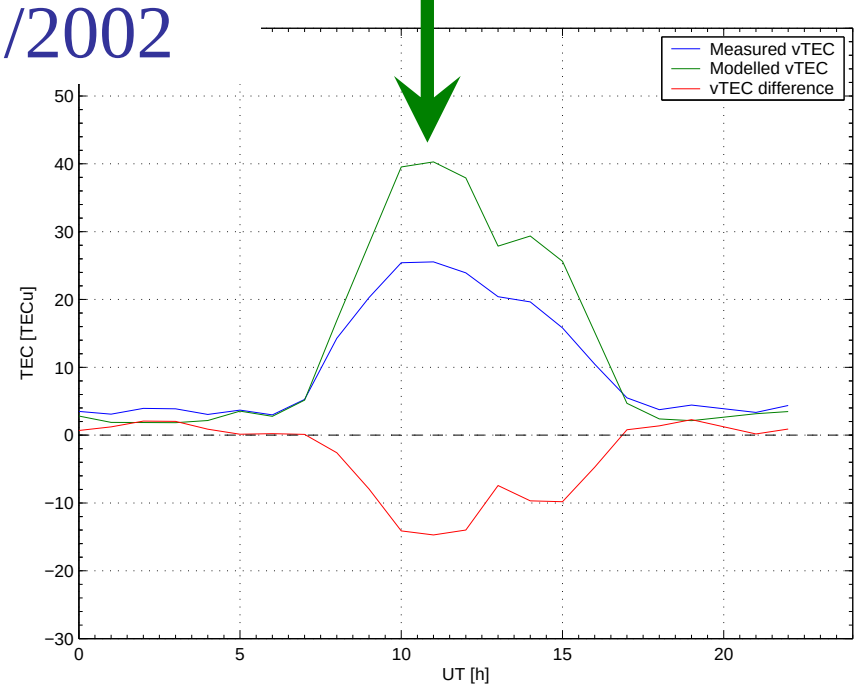
2. TEC Analysis

The clearest evolution appears for the maximum around local noon.

v1 Daily TEC v2

29/12/2002





11 UT

1. Tools

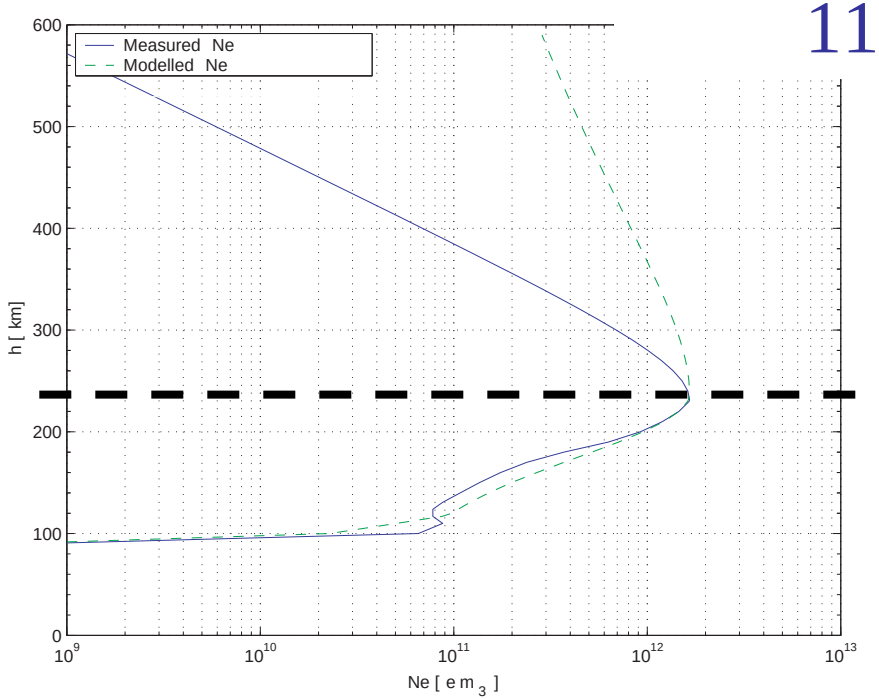
2. TEC Analysis

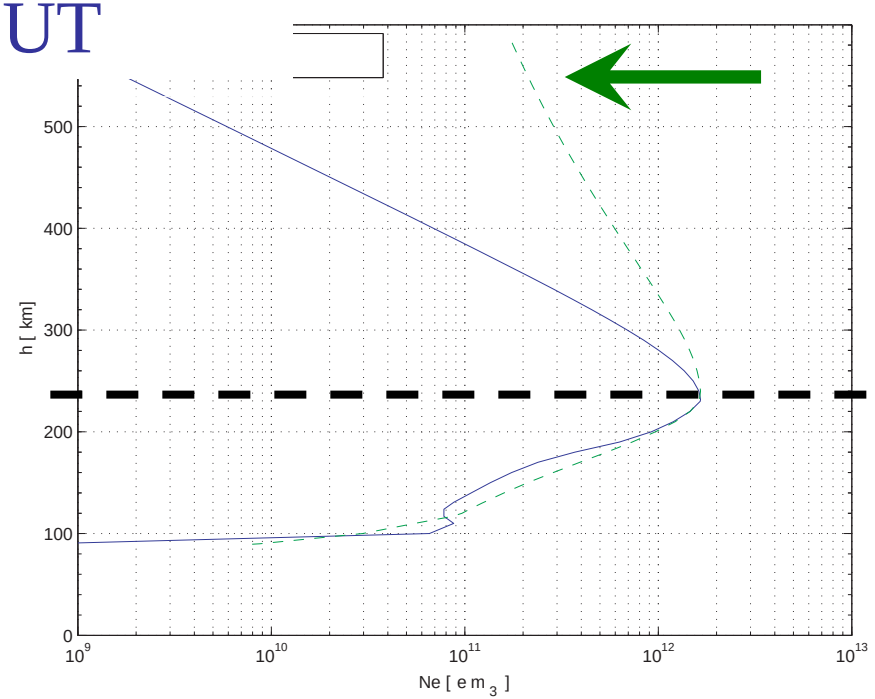
3. Profiles Analysis

2. Profiles Analysis

The improvement comes from the new topside formulation.

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





- Too high TEC
- Bottomside slightly too dense

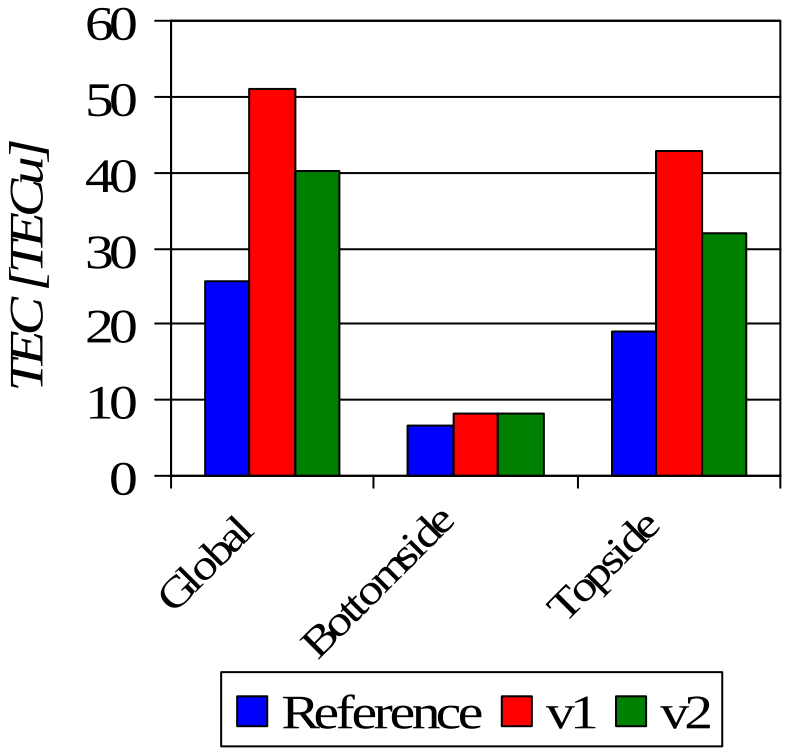
→ Too dense topside

2. Profiles Analysis

Bottomside and topside needs to be further investigated.

- TEC dissociation
- Bottomside
  - → TEC from ionosonde
  - → slightly too high
- Topside
  - → $TEC_{GPS} - TEC_{bot}$
  - → 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…

Session 5b Thursday

Ionosphere

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