Modelling the Ionosphere over Europe: Investigation of NeQuick Formulation

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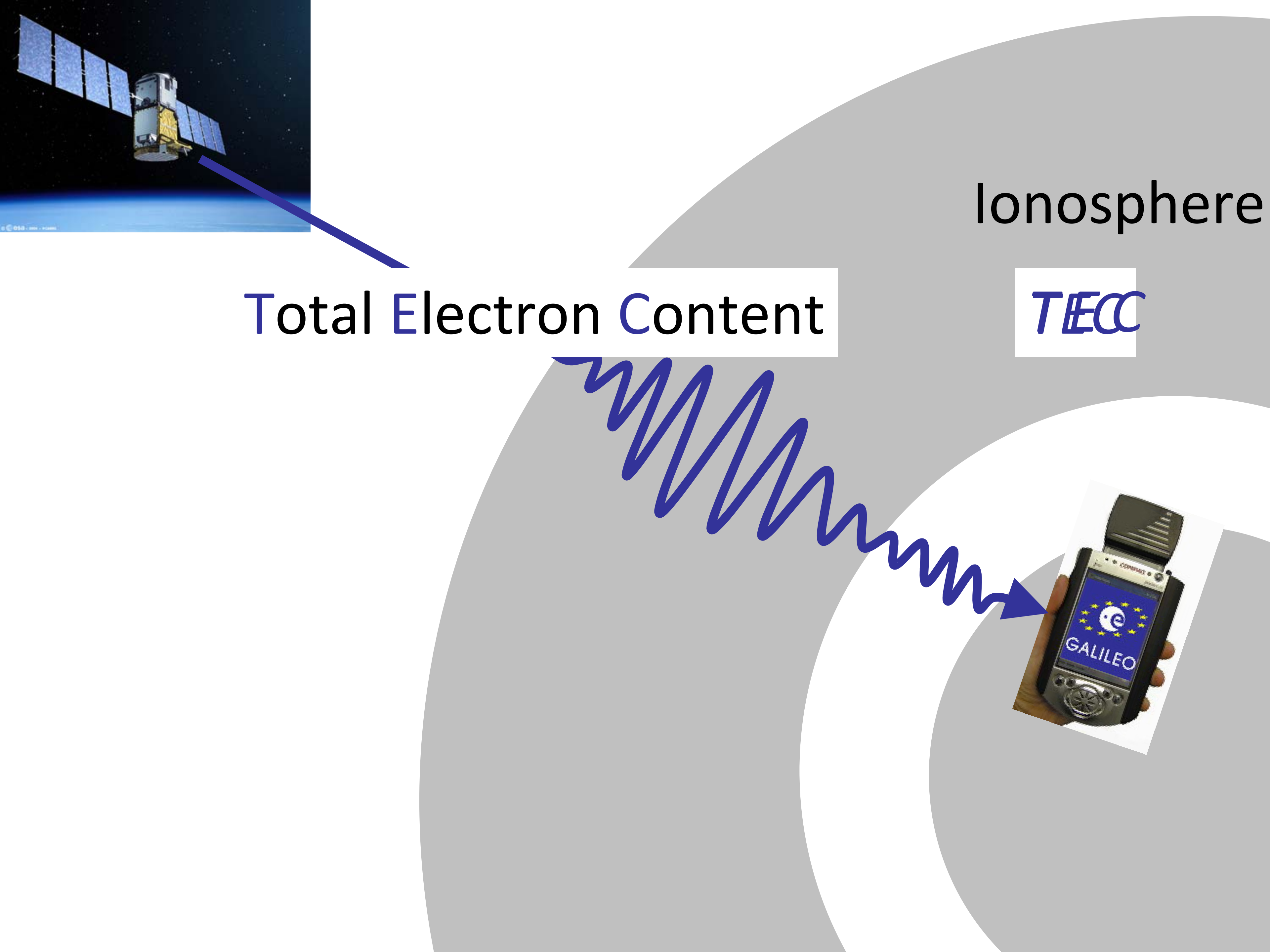
Ionosphere
Total Electron Content
TEC
GALILEO

TEC has to be modelled for single frequency receivers.

- GALILEO algorithm using NeQuick model
- Validate and improve
  - → algorithm
  - → NeQuick 1 → 2

First step: let’s investigate NeQuick profile formulation.

NeQuick 2 improves TEC estimation over Europe.

1. Tools and Method

Modelling and measuring the ionosphere

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2. Yearly Statistics

   Global scheme

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3. Influence of k Unification

   Main modification in NeQuick 2

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   Main modification in NeQuick 2

4. TEC Splitting

   Distinguishing bottomside and topside

1. Tools and Method
2. Yearly Statistics
3. Influence of k Unification
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1. Tools and Method

NeQuick is an empirical « profiler ».

ICTP / U Graz / COST 296 and before

- Output = *Ne*

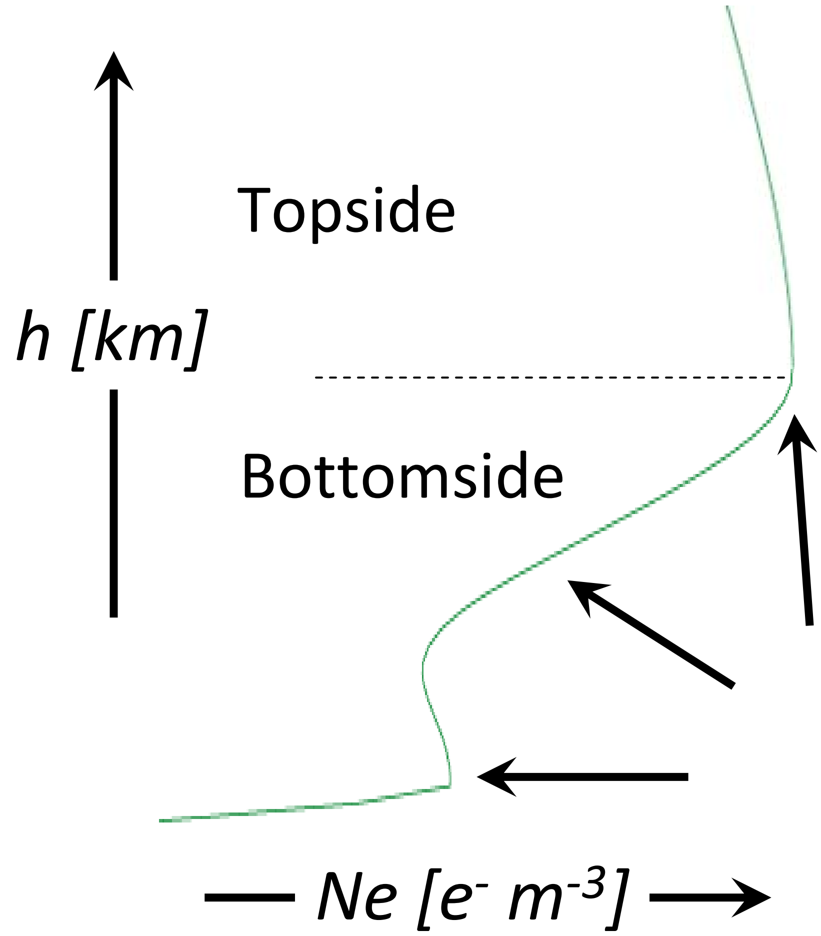
  → *TEC* with integration

- Layer peaks = anchor points

  → monthly median maps

- NeQuick 2 (Nava et al., 2008)

  → topside modification



1. Tools and Method

We investigate NeQuick formulation using collocated data.

- Actual measurements instead of monthly median maps
  → constrain by means of ionosonde data
  → manually validated digisonde data

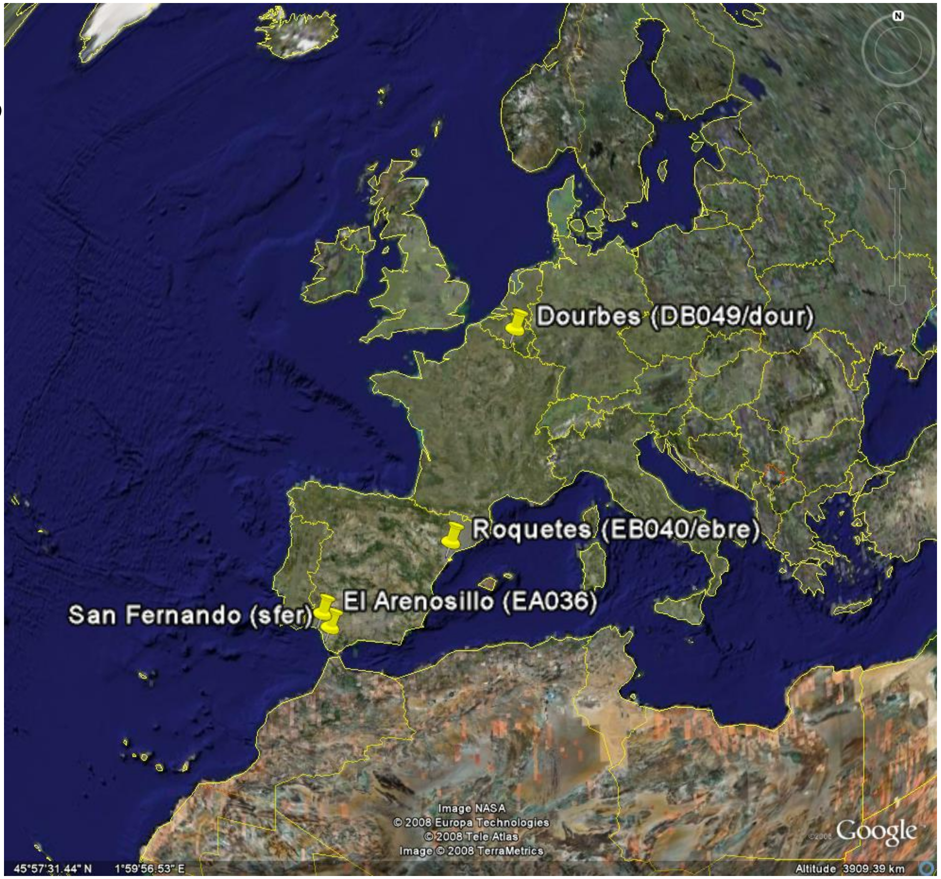
- Modelled vertical TEC vs GPS TEC
  → collocated ionosonde and GPS receiver
  → GIM levelling (Orus et al., 2007)

1*TECu* → 16 *cm* error for L_1

1. Tools and Method

We focus on mid-latitudes and high solar activity.

- Year 2002 (HSA)
- Three European locations with (nearly) collocated digisonde and IGS/EUREF station



1. Tools and Method

2. Yearly Statistics

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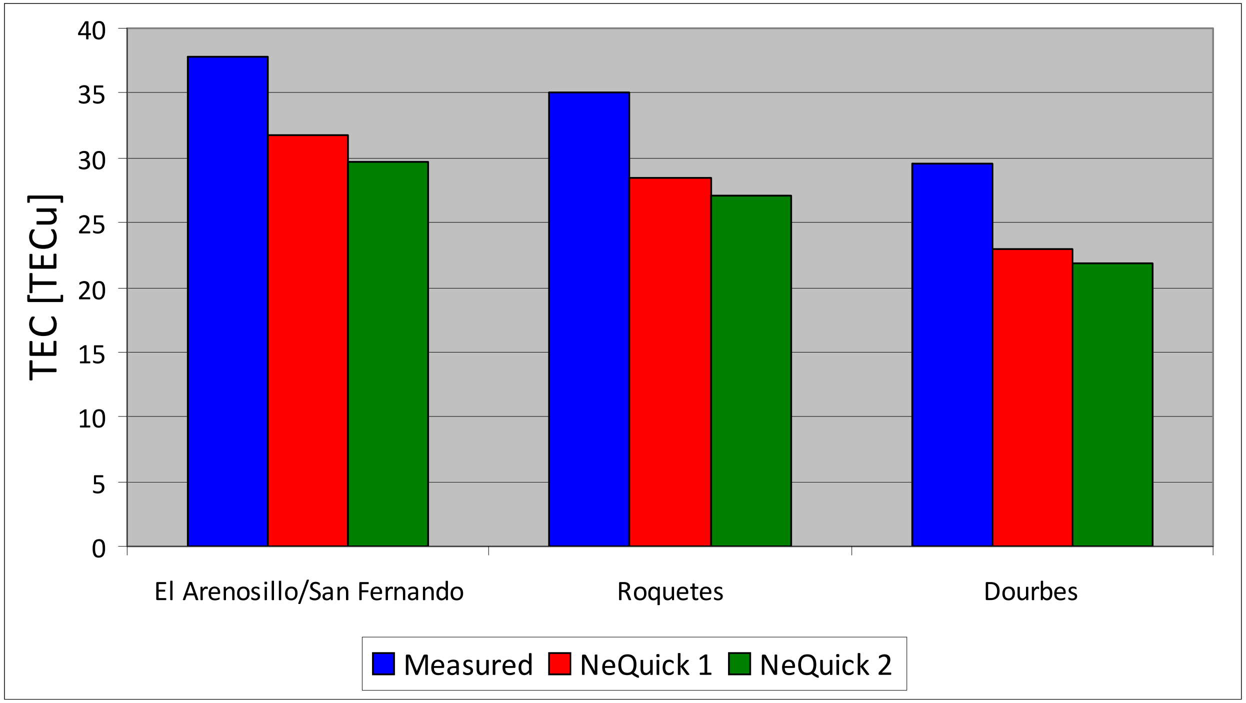
2. Yearly Statistics

TEC modelling improves on a yearly basis.

Yearly TEC mean

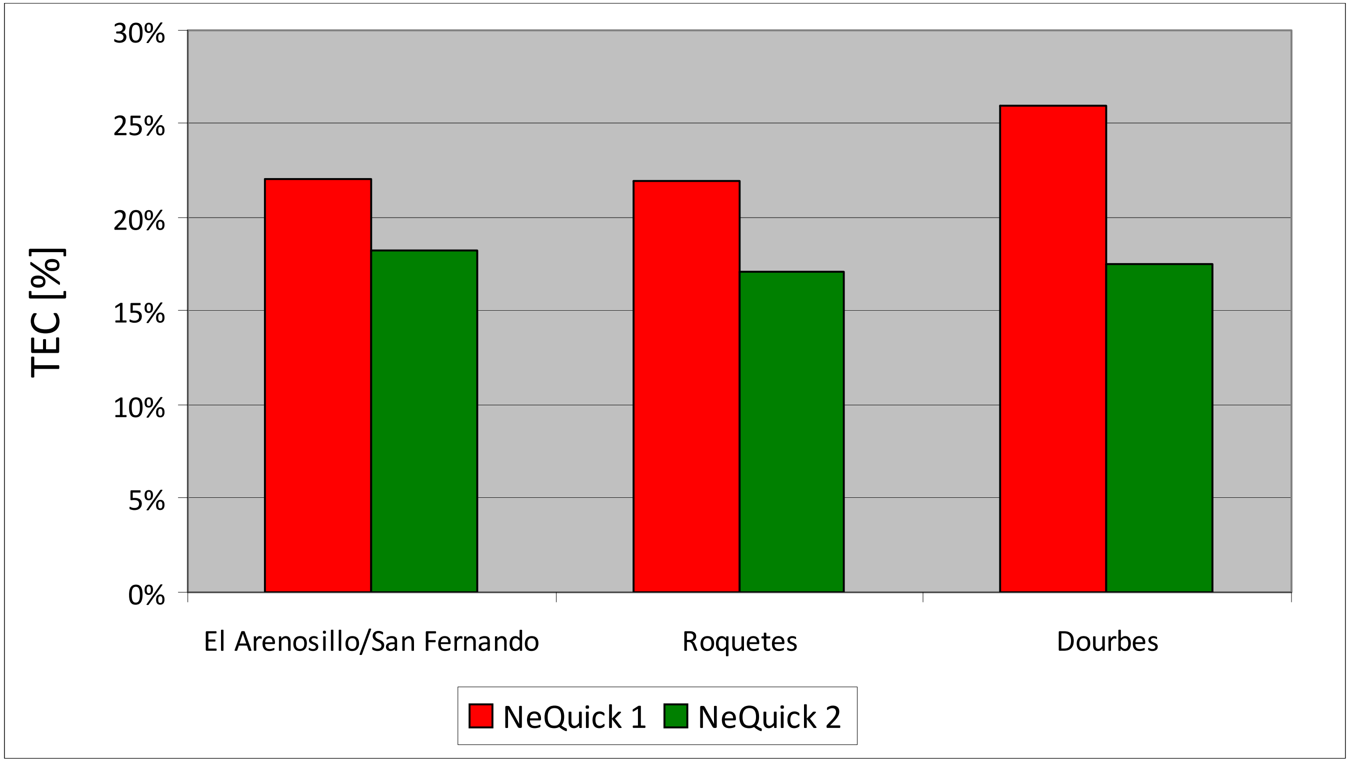


- TEC underestimated on average
  (! potential bias in GPS TEC data !)
- Bigger (around 20%) underestimation with NeQuick 2

2. Yearly Statistics

TEC modelling improves on a yearly basis.

Yearly relative TEC standard deviation



- Lower (around 20%) standard deviation with NeQuick 2

1. Tools and Method
2. Yearly Statistics
3. Influence of k Unification
4. TEC Splitting

The topside shape parameter k was unified in NeQuick 2.

- k involved in height-dependent scale height
- NeQuick 1: 2 formulas for k (April to September and October to March)

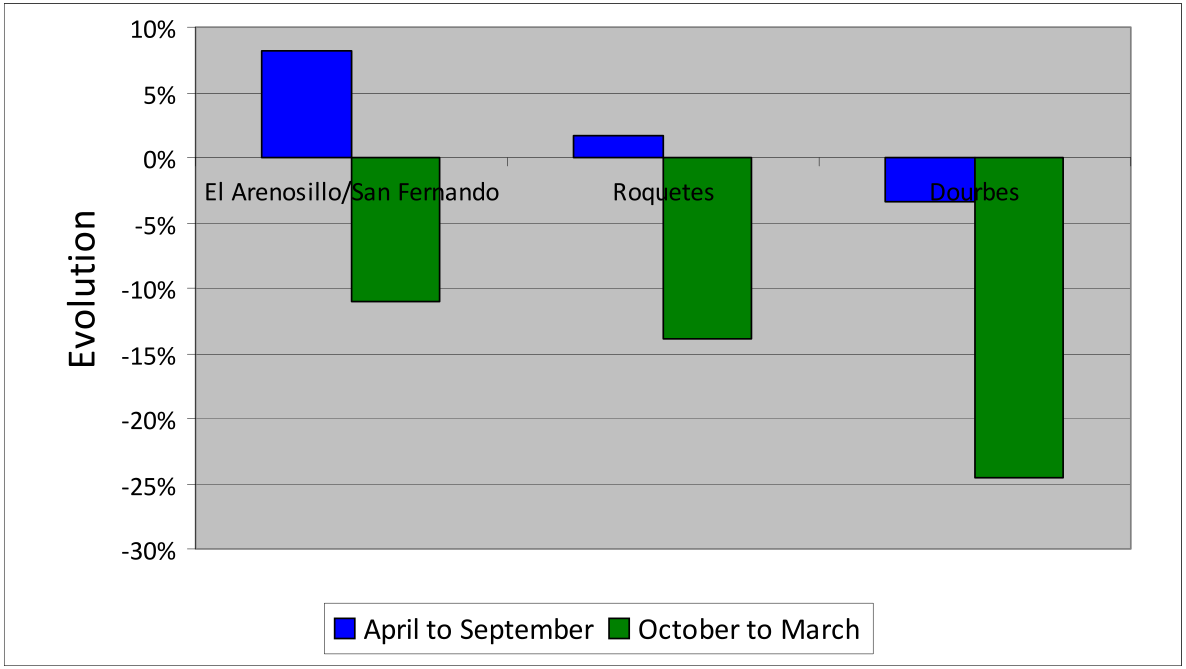
  → different statistics for each period

- NeQuick 2: 1 formula based on topside soundings

3. Influence of k Unification

The improvement comes mainly from the topside modification.

Evolution of TEC standard deviation from NeQuick 1 to 2



• October to March: lower (15%) standard deviation with NeQuick 2

→ More homogenous with other period

1. Tools and Method
2. Yearly Statistics
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4. TEC Splitting

4. TEC Splitting

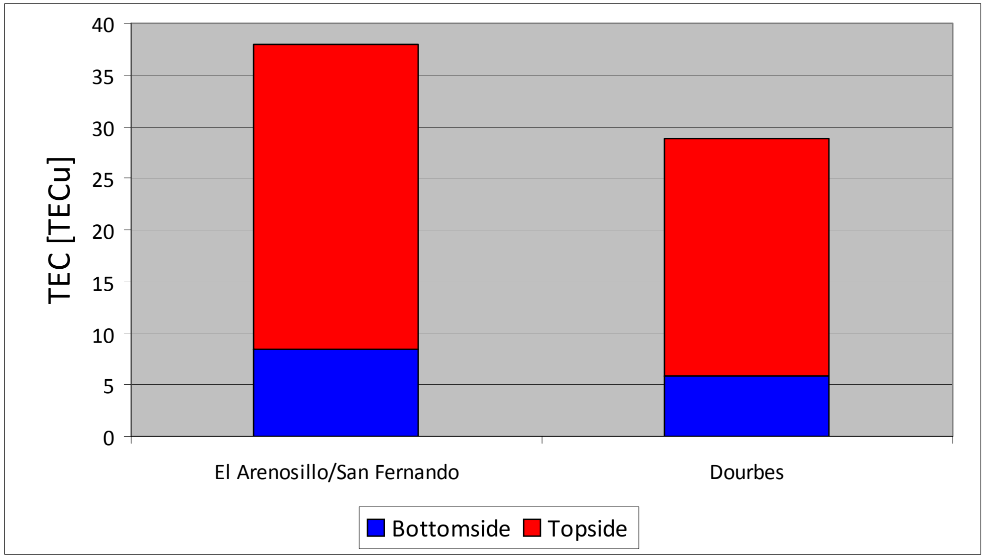
The topside plays a major role.

- Integrate bottomside Ne profile from digisonde

  → bottomside TEC

- Subtract to GPS TEC → topside TEC

- Big proportion of TEC within topside (3/4, 1/4)



4. TEC Splitting

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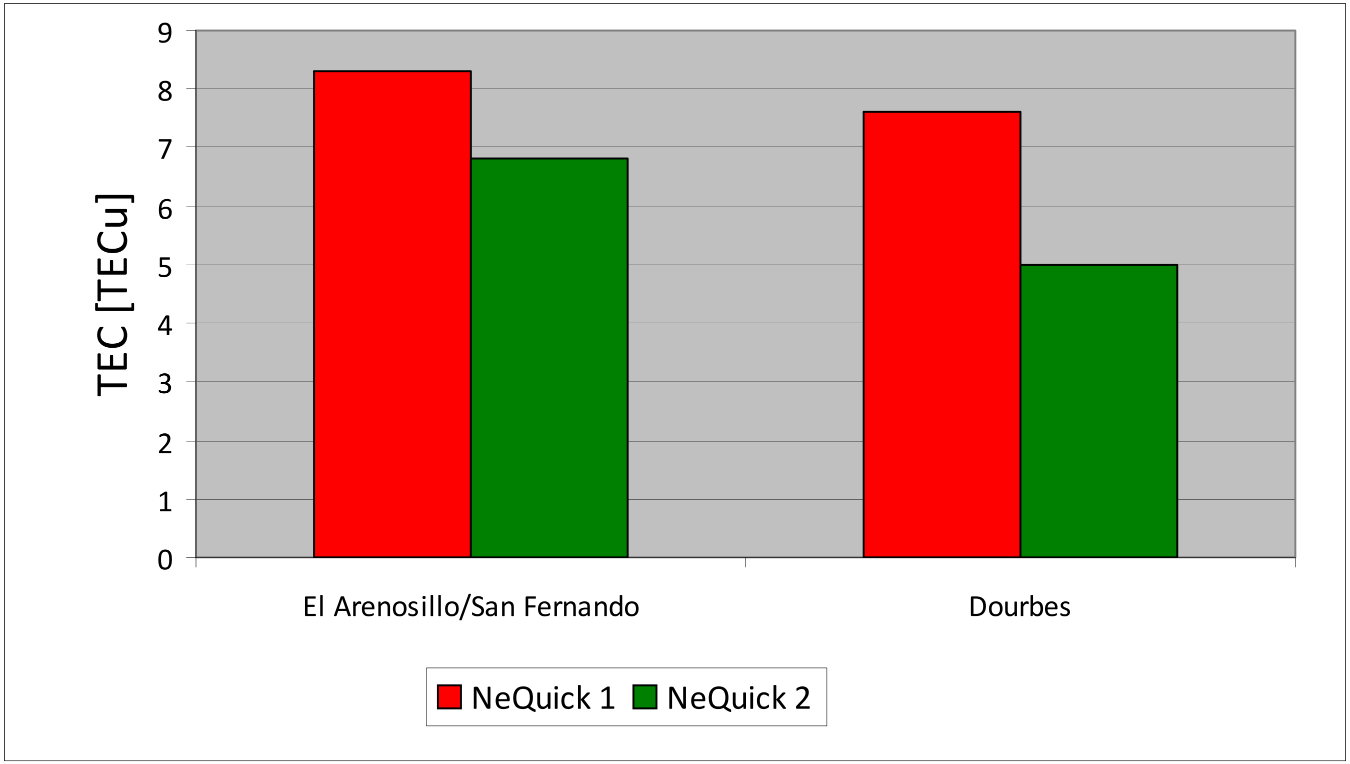
Yearly topside TEC standard deviation



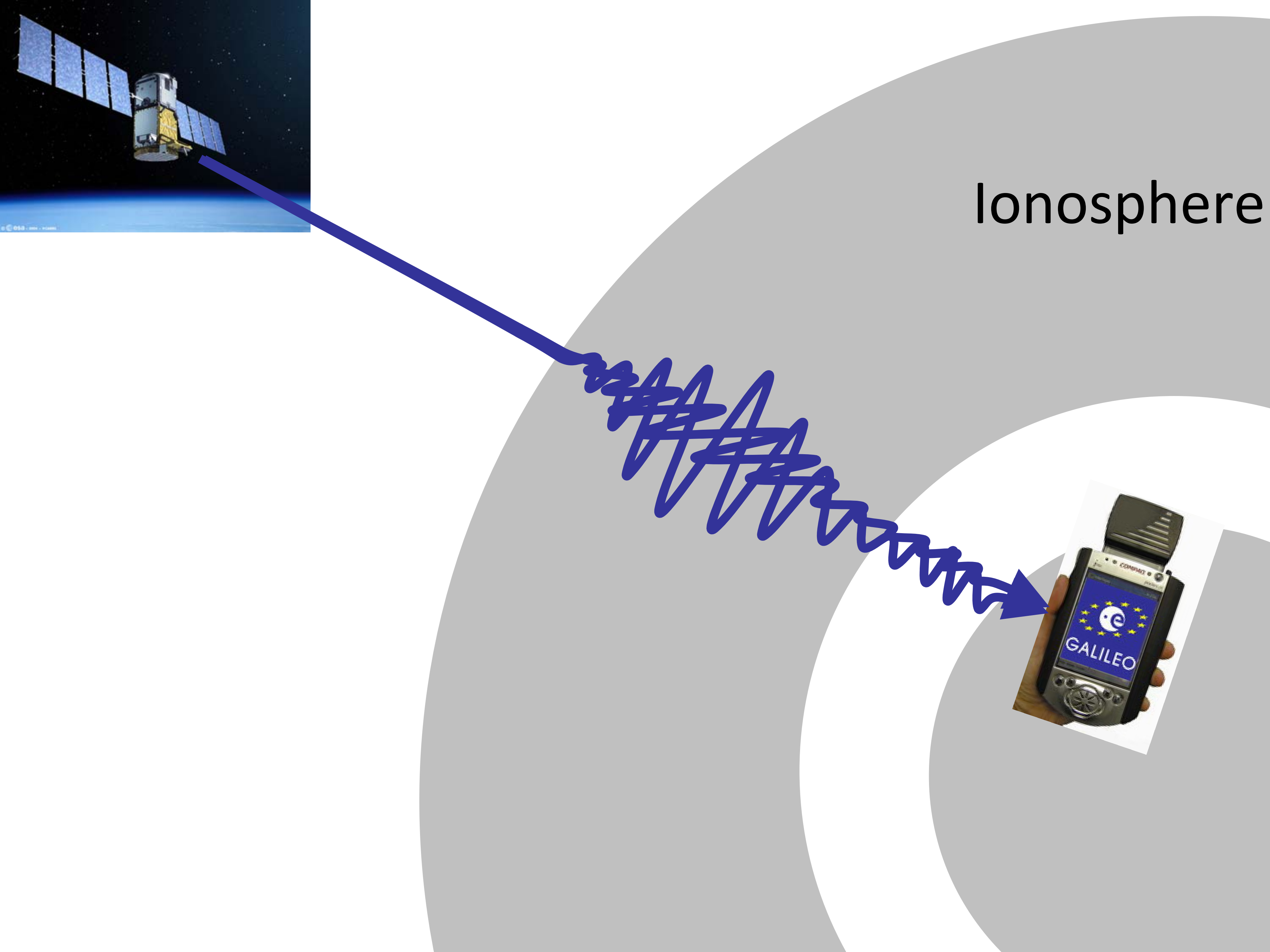
- Bias/standard deviation evolution for topside between NeQuick versions corresponding to global statistics

NeQuick 2 improves TEC estimation over Europe.

- Benefit from collocated data
- TEC statistics: standard deviation decrease by 20% to reach less than 20% with NeQuick 2 (mid-latitudes stations, high SA)
- Homogenisation thanks to topside modification
- Major role of topside

TEC has to be modelled for single frequency receivers.

- Comparison of different GPS TEC data sets
- Ingestion: use of effective parameters to adapt NeQuick TEC to GPS TEC
- GALILEO Single Frequency Ionospheric Correction Algorithm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