Galileo Single Frequency Ionospheric Correction: Performances in Terms of Position

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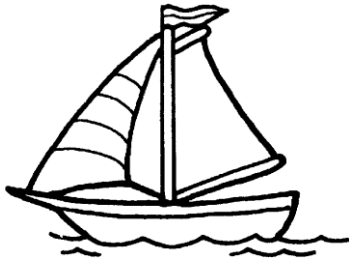
Navigation?



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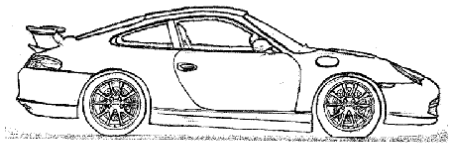
Satellite navigation?



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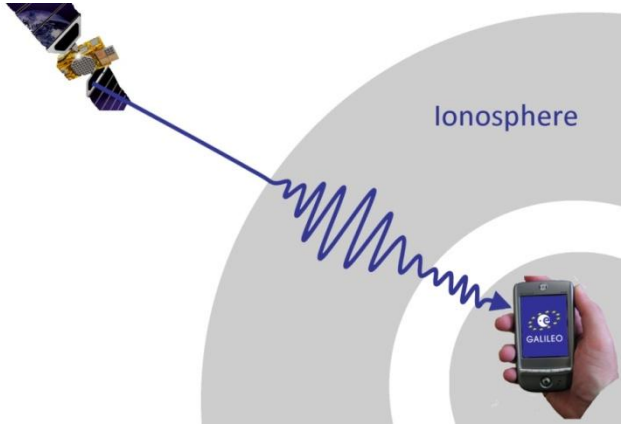
Ionosphere!



How do ionospheric residual errors impact Galileo absolute positioning?

- Standard point positioning
  with Klobuchar, NeQuick 1 and NeQuick 2
- NeQuick: simulated IOV broadcast coefficients
- Mid-latitudes (Brussels), high solar activity (2002)

TEC mismodelling gradients

limit Galileo positioning accuracy.

1. Performances

   In terms of ionospheric residual and positioning errors

2. Influence

   Of the ionosphere on uncorrected coordinates

3. Discrepancies

   Of NeQuick correction

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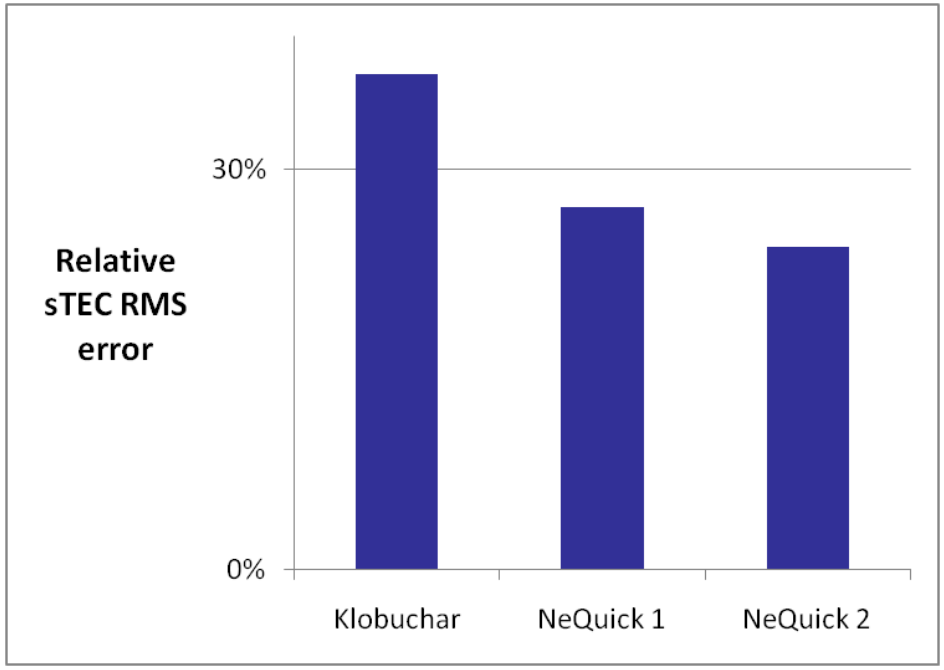
1. Performances

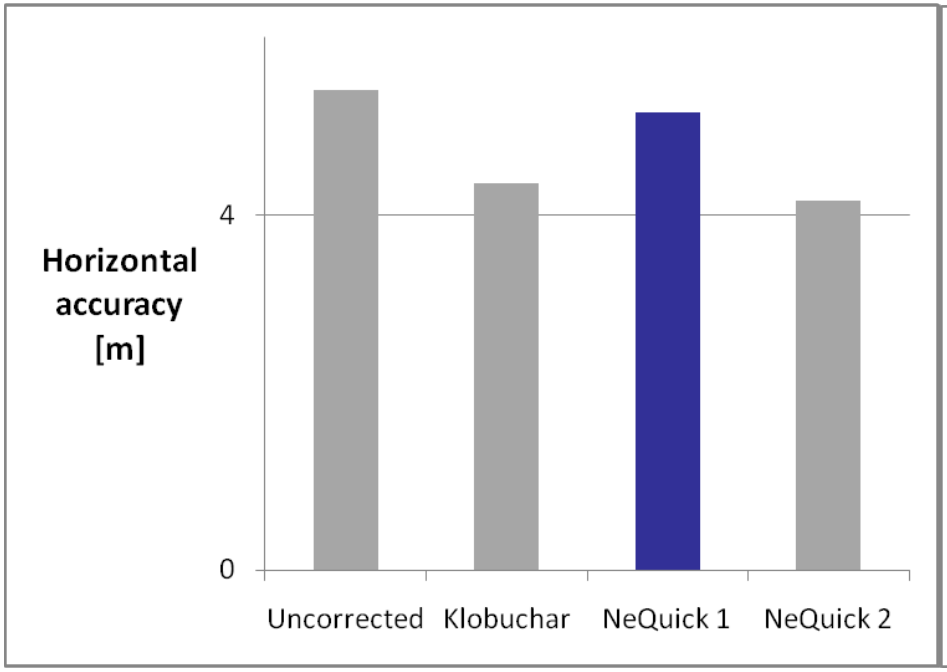
sTEC residual errors amount 24 to 37%.

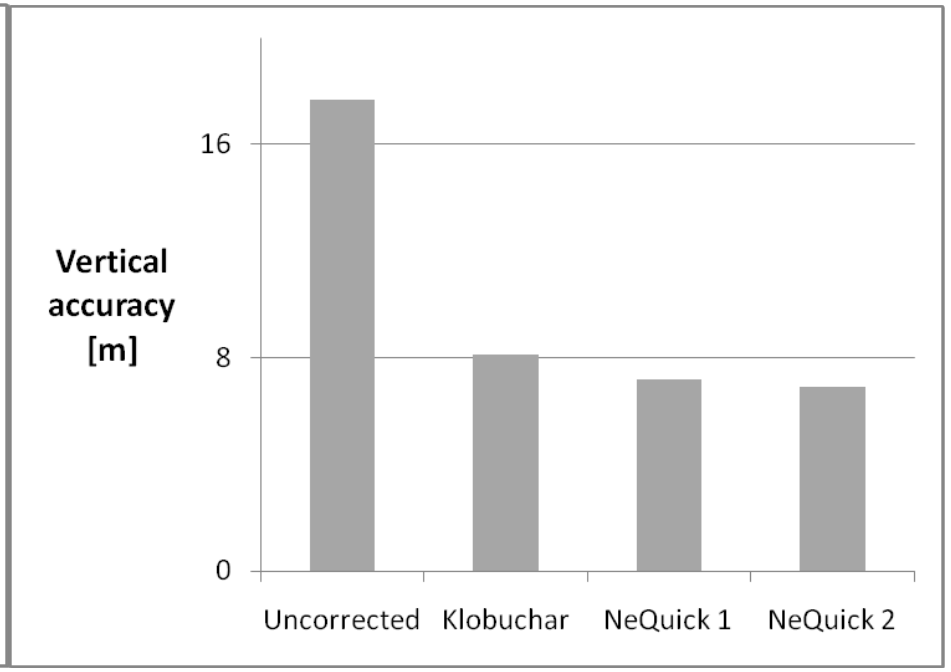


NeQuick performing better than Klobuchar

1. Performances

Horizontal positioning errors only decrease by 5 to 23%.





NeQuick 1 not so good!

Similar to sTEC

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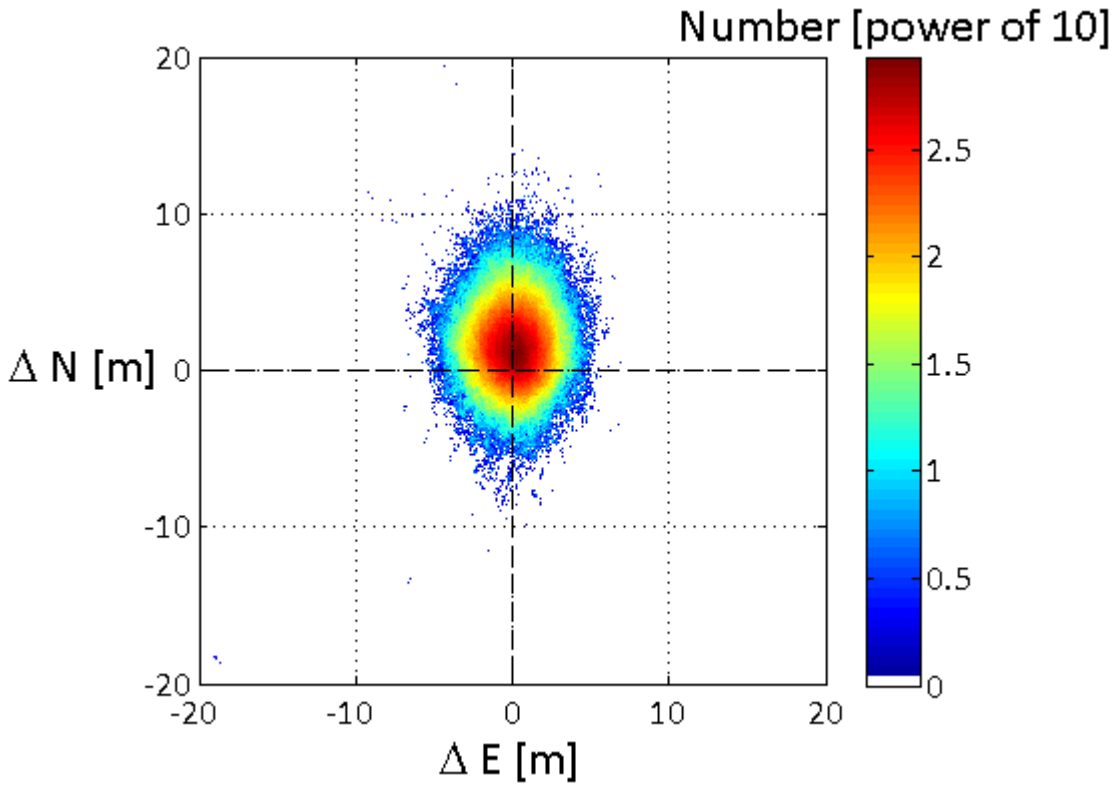
2. Influence

Uncorrected positions are shifted northwards.



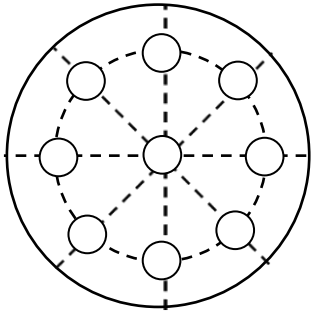
2. Influence

A symmetric satellite distribution reveals the role of ionospheric delays.

- Positioning solution: $\underline{\Delta x} = \underbrace{\left(A^T A\right)^{-1} A^T}_{\text{geometry}} \underline{\Delta P}$

→ Ionosphere influence: $\underline{\Delta x}_I = \left(A^T A\right)^{-1} A^T \underline{I}$

- Analytical solution for

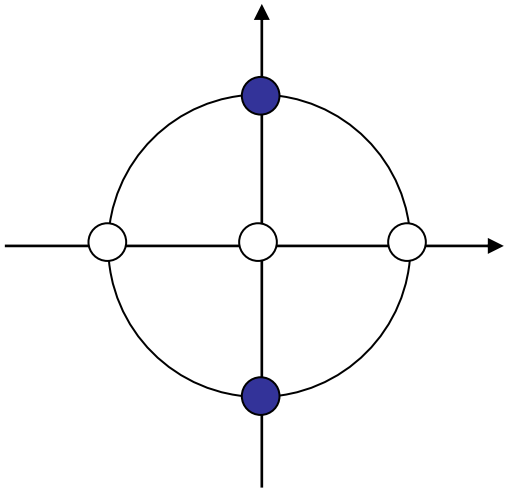


→ Maximal simplification: 5 satellites

2. Influence

Horizontal positioning errors relate to horizontal TEC gradients.

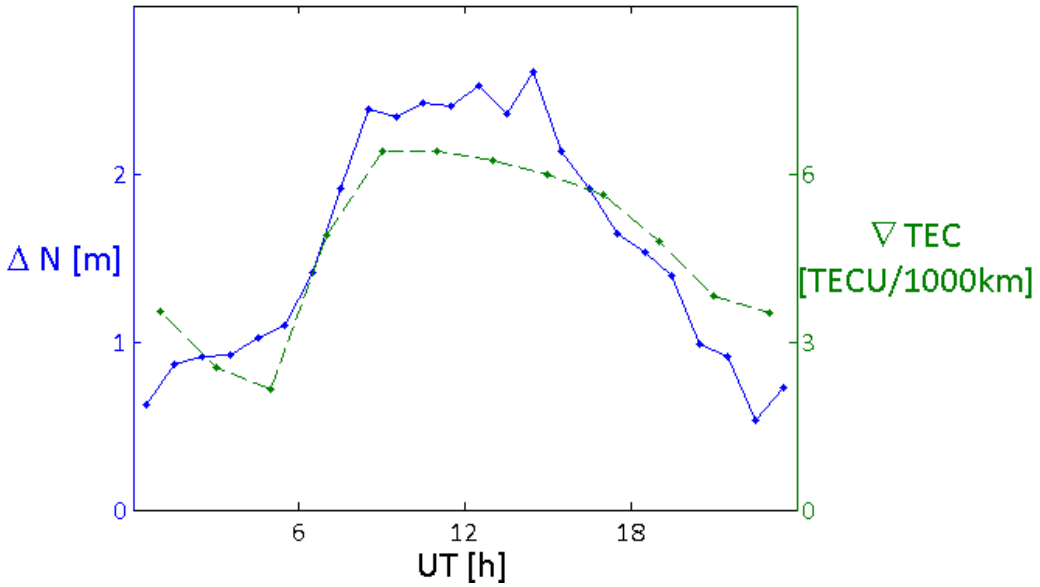
$$\Delta n = \frac{1}{2\cos\eta}\left(-I^2 + I^4\right)$$



Northern mid-latitudes:

larger TEC southwards

→ Expected northward error



TEC mismodelling gradients

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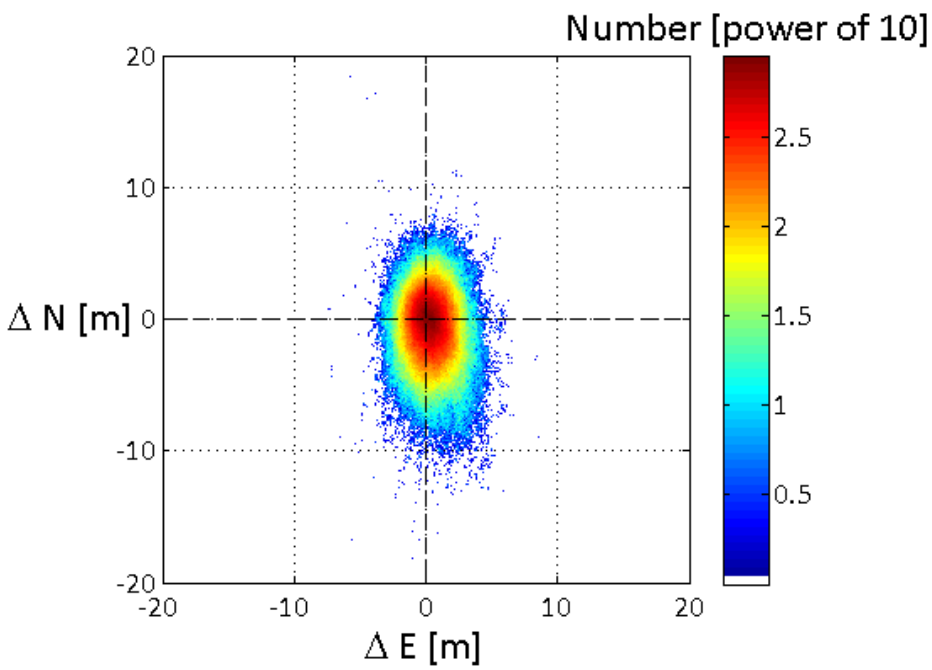
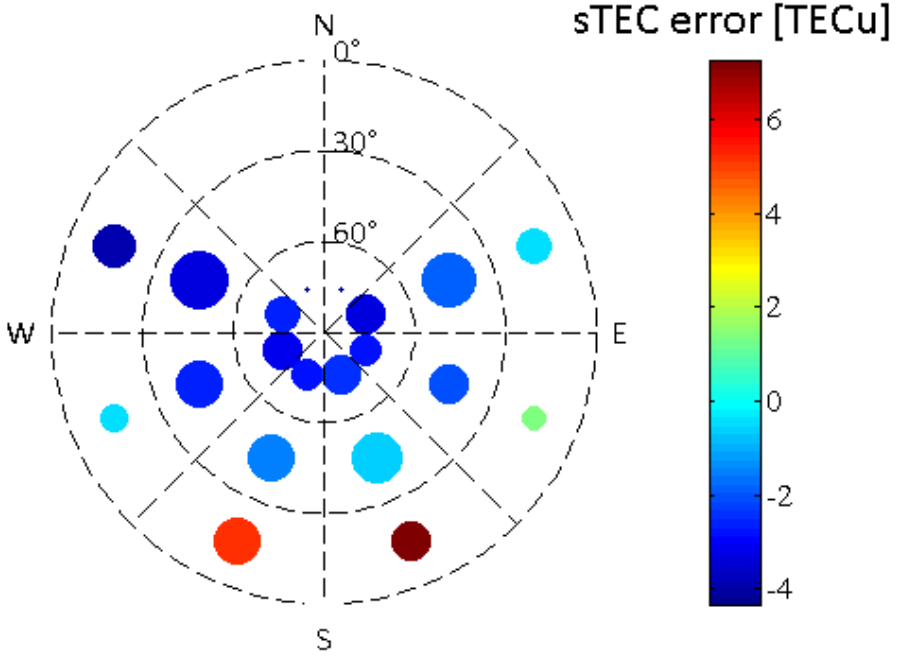
3. Discrepancies

Of NeQuick correction

3. Discrepancies

NeQuick 1 overcorrects the north error.





3. Discrepancies

The 3 elements of Galileo algorithm influence positioning accuracy.

- Az from broadcast coefficients

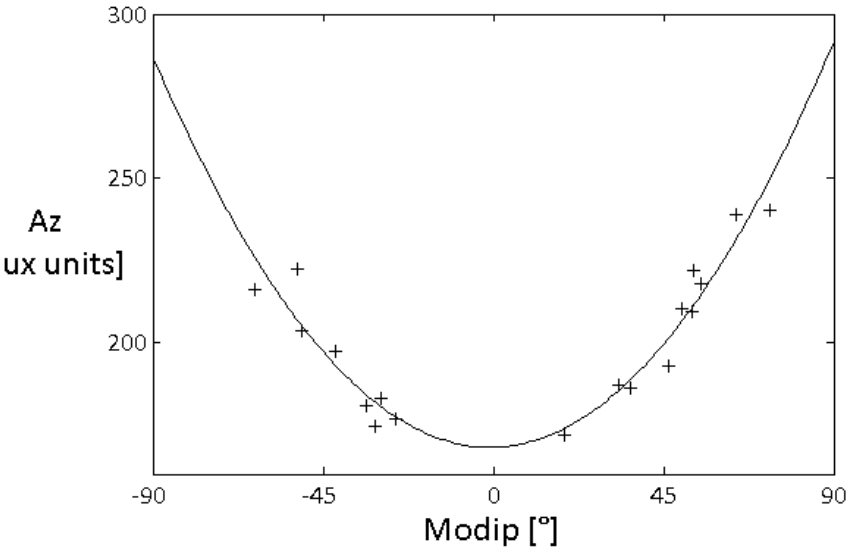
→ Excessive sTEC towards equator (at mid-latitudes)

- sTEC ingestion at GSS

→ Estimation of hardware biases

- NeQuick electron density profile formulation

→ Topside improvement with NeQuick 2



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Given NeQuick Galileo version…

- Consider additional stations

- Characterise impact of sTEC measurements

Let’s investigate
the effective ionisation level definition.

Web service providing
Galileo single frequency positioning accuracy

…looking forward to 2 first Galileo satellites!

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