A diagram of the Galileo satellite constellation. It shows a central Earth globe with several satellite orbits around it. Each orbit contains multiple satellites, represented by small satellite icons. The orbits are shown as white lines with yellow and purple satellite icons. The background is a light gray.

Galileo Single Frequency Ionospheric Correction: Performances in Terms of Position

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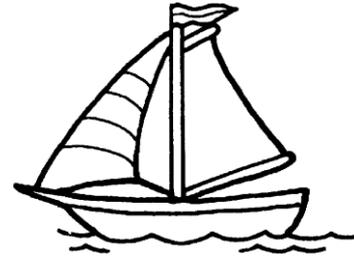
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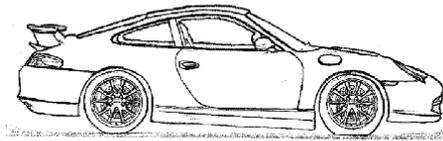


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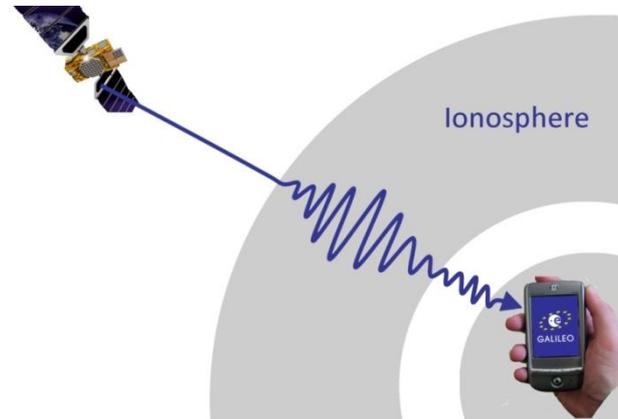
Navigation?



Satellite navigation?



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

TEC mismodelling gradients limit Galileo positioning accuracy.

1. Performances

In terms of ionospheric residual and positioning errors

Influence

Of the ionosphere on uncorrected coordinates

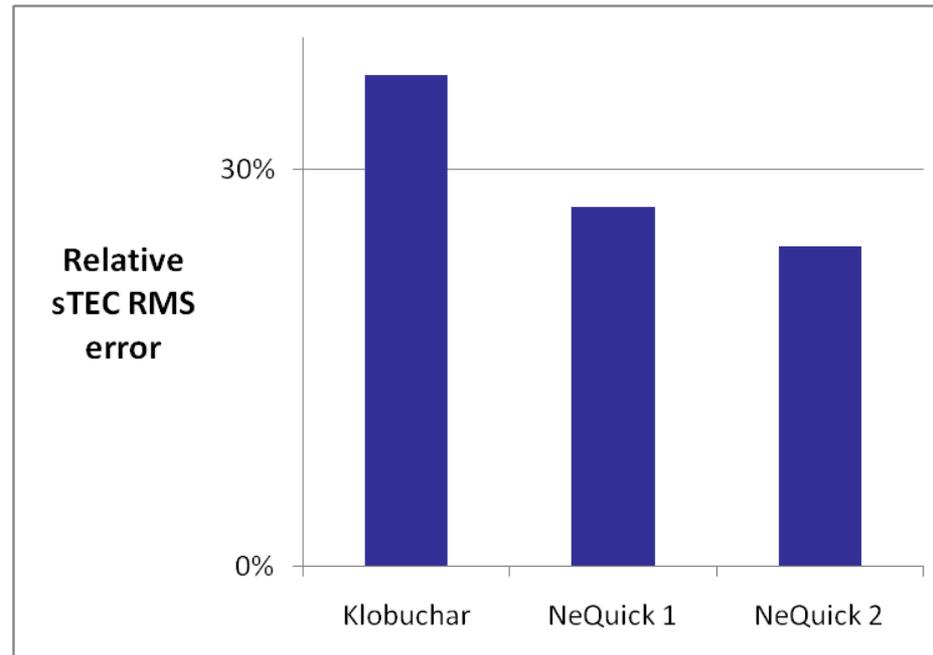
Discrepancies

Of NeQuick correction

1.

Performances

sTEC residual errors amount 24 to 37%.

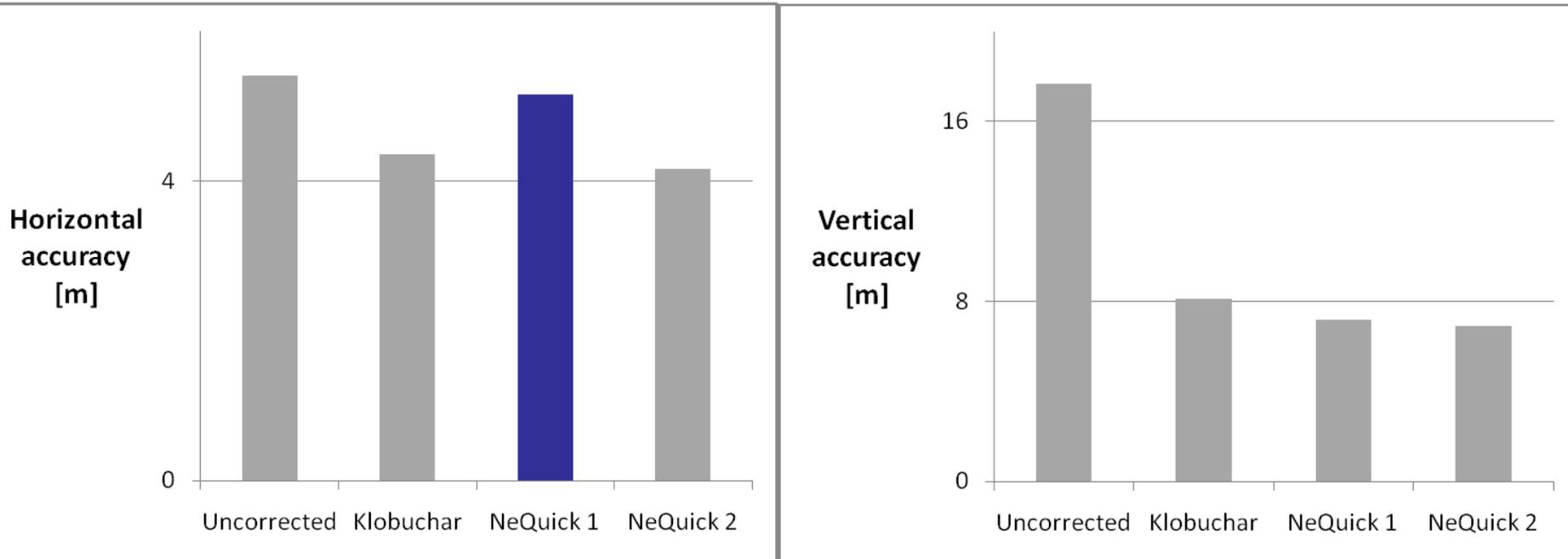


NeQuick performing better than Klobuchar

1.

Performances

Horizontal positioning errors only decrease by 5 to 23%.



NeQuick 1 not so good!

Similar to sTEC

TEC mismodelling gradients
limit Galileo positioning accuracy.

Performances

In terms of ionospheric residual and positioning errors

2. Influence

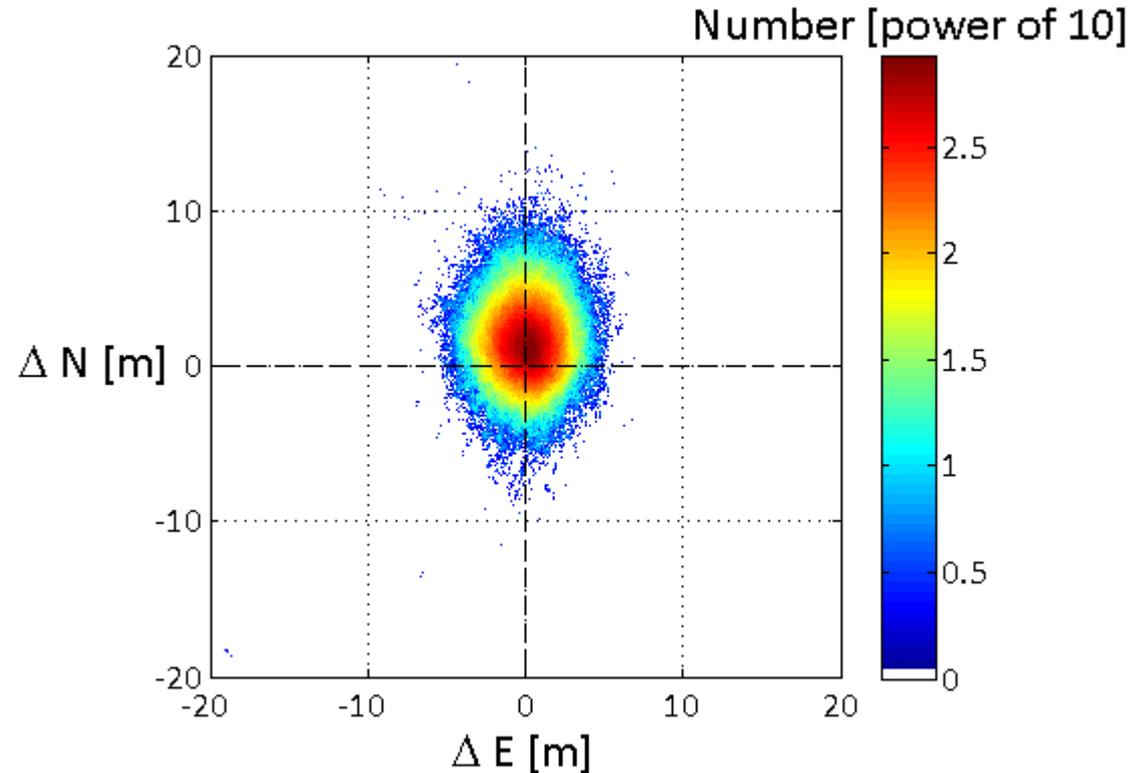
Of the ionosphere on uncorrected coordinates

Discrepancies

Of NeQuick correction

2. Influence

Uncorrected positions
are shifted northwards.



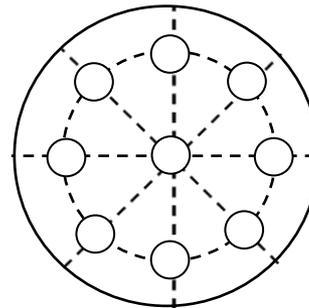
2. Influence

A symmetric satellite distribution reveals the role of ionospheric delays.

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

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

- Analytical solution for

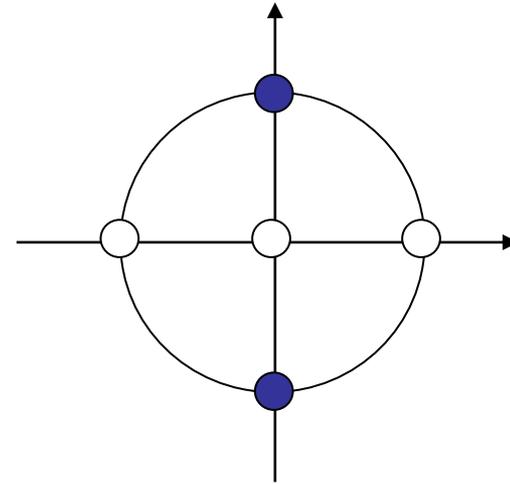


→ Maximal simplification: 5 satellites

2. Influence

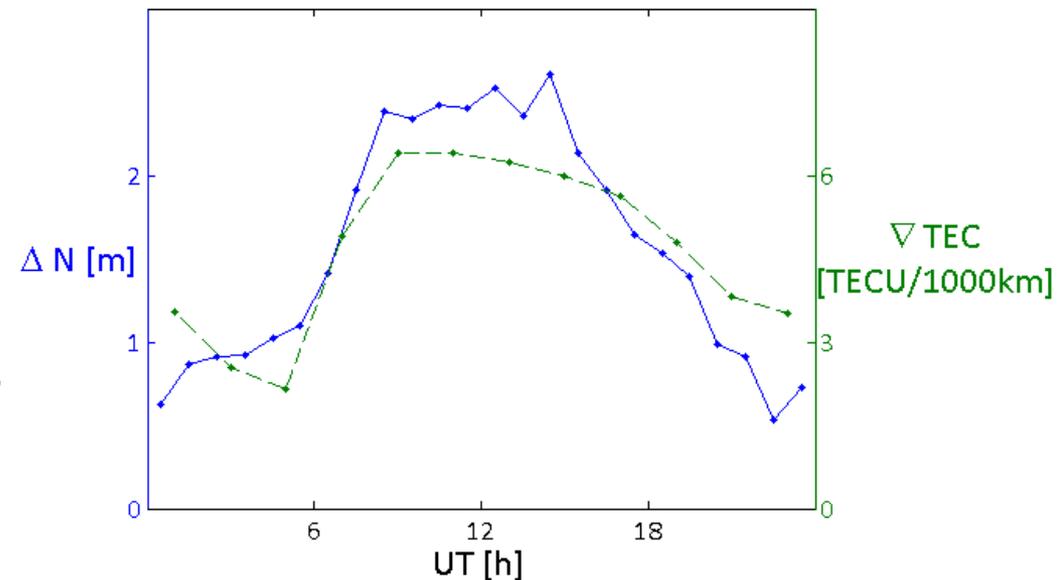
Horizontal positioning errors relate to horizontal TEC gradients.

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



Northern mid-latitudes:
larger TEC southwards

→ Expected northward error



TEC mismodelling gradients
limit Galileo positioning accuracy.

Performances

In terms of ionospheric residual and positioning errors

Influence

Of the ionosphere on uncorrected coordinates

3. Discrepancies

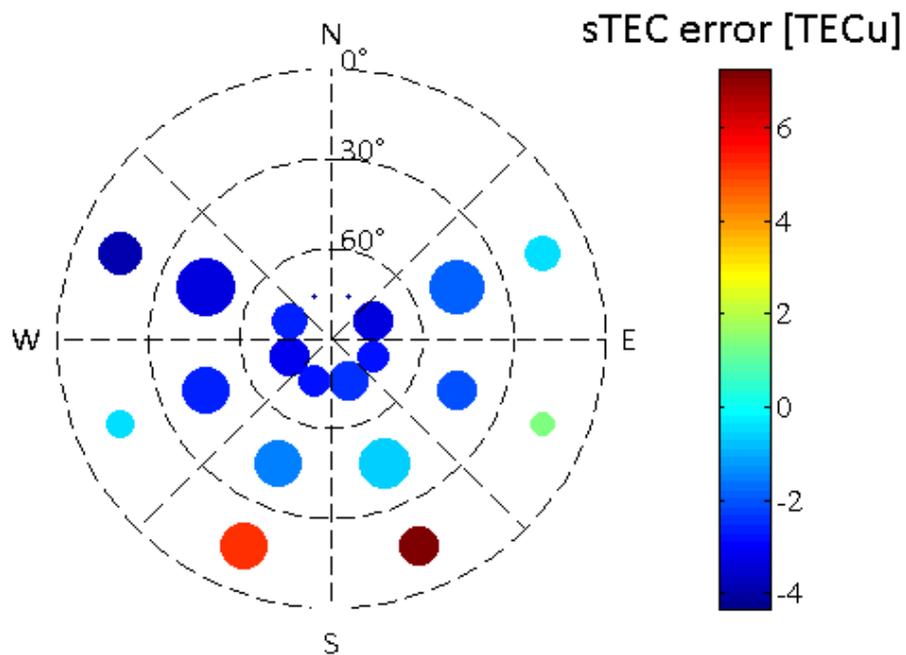
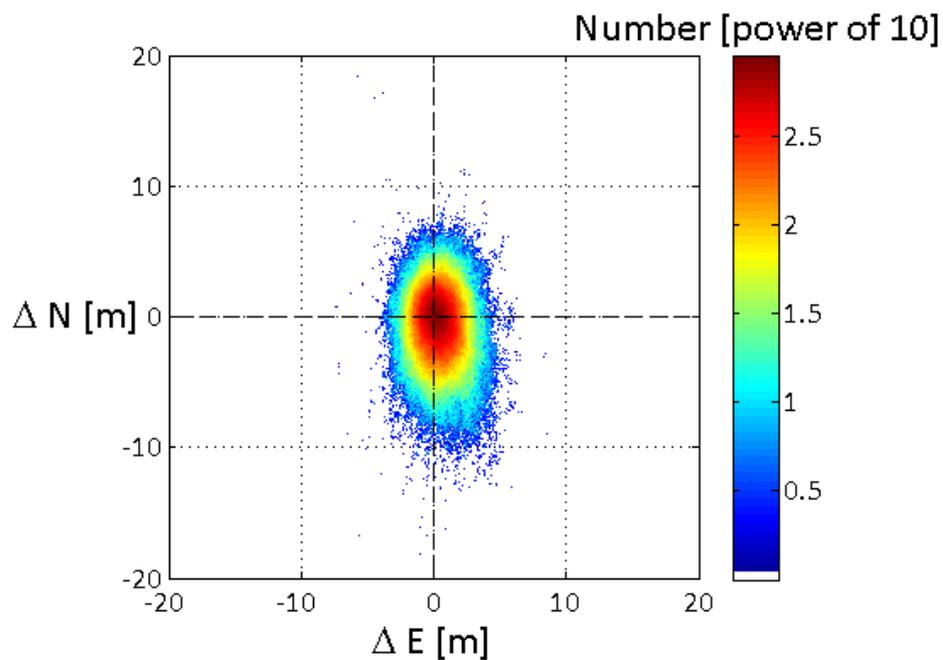
Of NeQuick correction

3.

Discrepancies

NeQuick 1

overcorrects the north error.

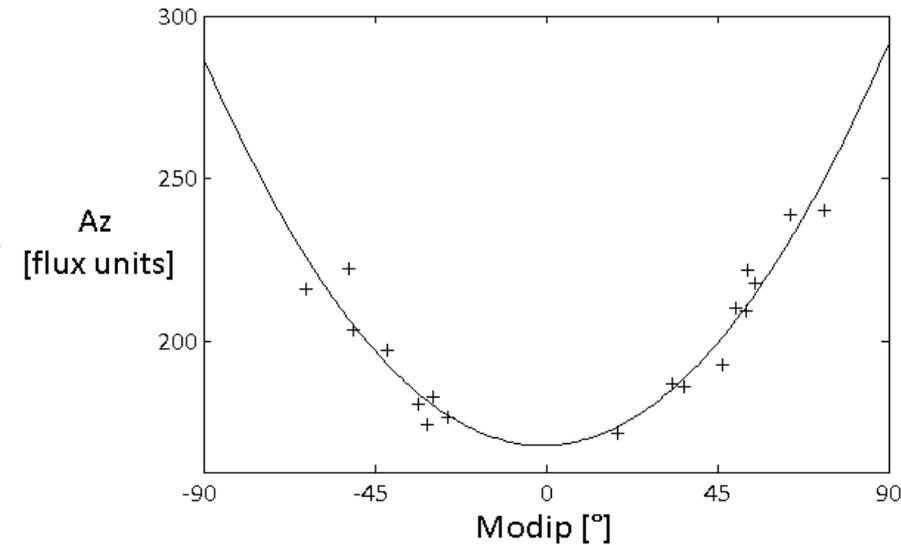


3.

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



TEC mismodelling gradients limit Galileo positioning accuracy.

1. Performances

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Of NeQuick correction

Given NeQuick Galileo version...

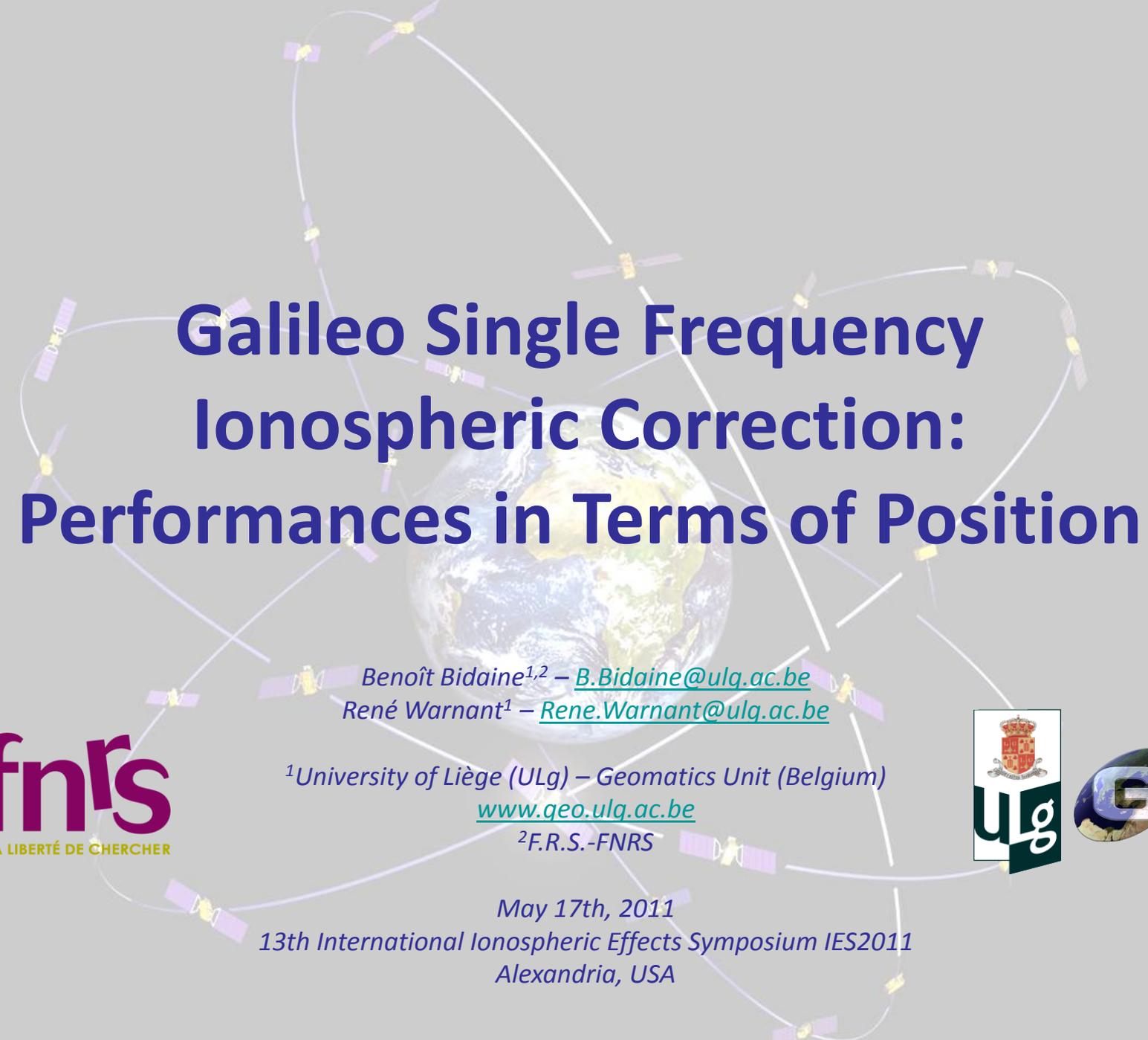
- Consider additional stations
- Characterise impact of sTEC measurements

Let's investigate
the effective ionisation level definition.

Web service providing
Galileo single frequency positioning accuracy



...looking forward to 2 first Galileo satellites!

A diagram of the Galileo satellite constellation showing multiple satellites in various orbits around the Earth. The Earth is shown in the center, and the satellites are connected by lines representing their orbits. The title text is overlaid on this diagram.

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