The Abdus Salam International Centre for Theoretical Physics

GNSS derived TEC ingestion into IRI 2012

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IRIW13: GNSS derived TEC ingestion into IRI 2012

- Goal of the work: to apply data ingestion technique (Nava et al, 2005) into IRI 2012 to generate grids of ‘inferred’ IG index and to validate the foF2 values obtained.

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- "Data assimilation is an analysis technique in which the observed information is accumulated into the model state by taking advantage of consistency constraints with laws of time evolution and physical properties". ***Bouttier and Courtier, 1999.***

- Considering the increasing availability of experimental data even in real time (ground and space-based GPS, ionosondes), many assimilation techniques have been developed. They differ in their numerical cost, complexity and suitability for different kind of data.

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Data Ingestion Method

- This is one of the simplest assimilation method that directly minimize the mismodelings, ‘forcing’ iteratively the model to ‘match’ the experimental vertical TEC at any given location and time.

- The concept of errors is central: error estimation and error modeling. The observations have errors arising from various sources: e.g. instrumental, calibration, interpolation, etc.

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- The IRI is a climatological model that describes monthly averages for each ionospheric parameter.
- Main data sources of IRI: ionosondes, Alouette and ISI topside sounders, incoherent scatter radars and in situ instrument on several satellites and rockets.
- For research purposes and practical applications, in order to pass from “climate” to “weather”, there is a need to have models able to reproduce the current conditions of the ionosphere.

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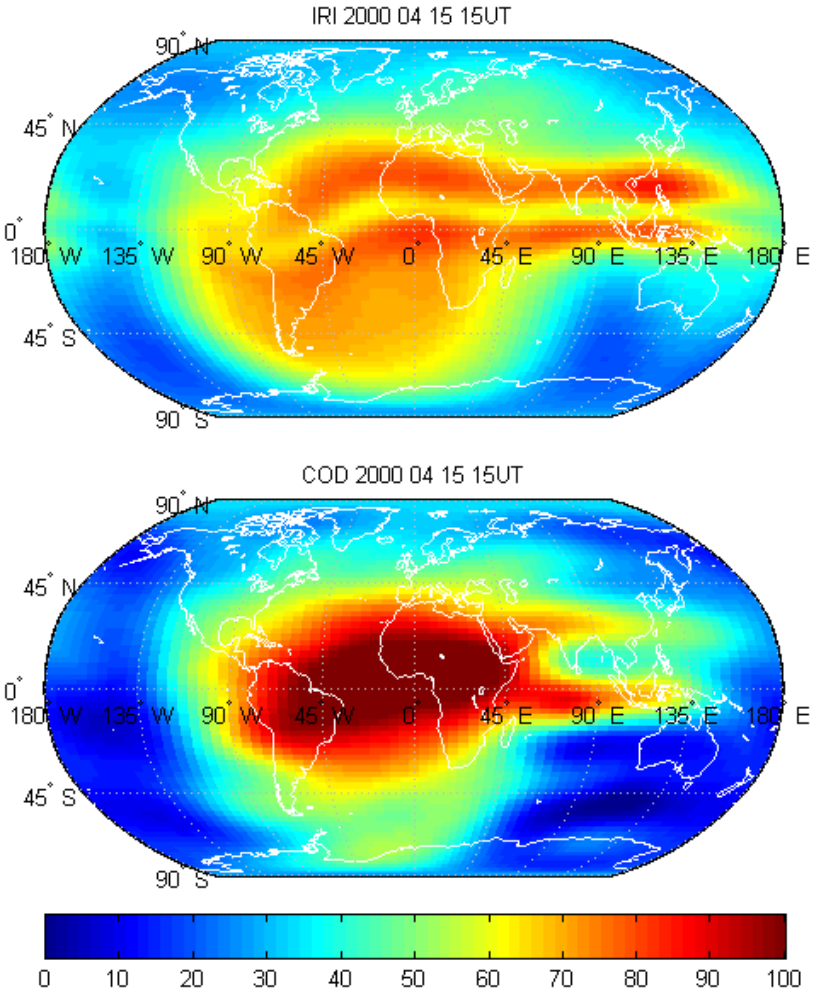
- Comparison IRI (IG12) TEC and CODE VTEC map



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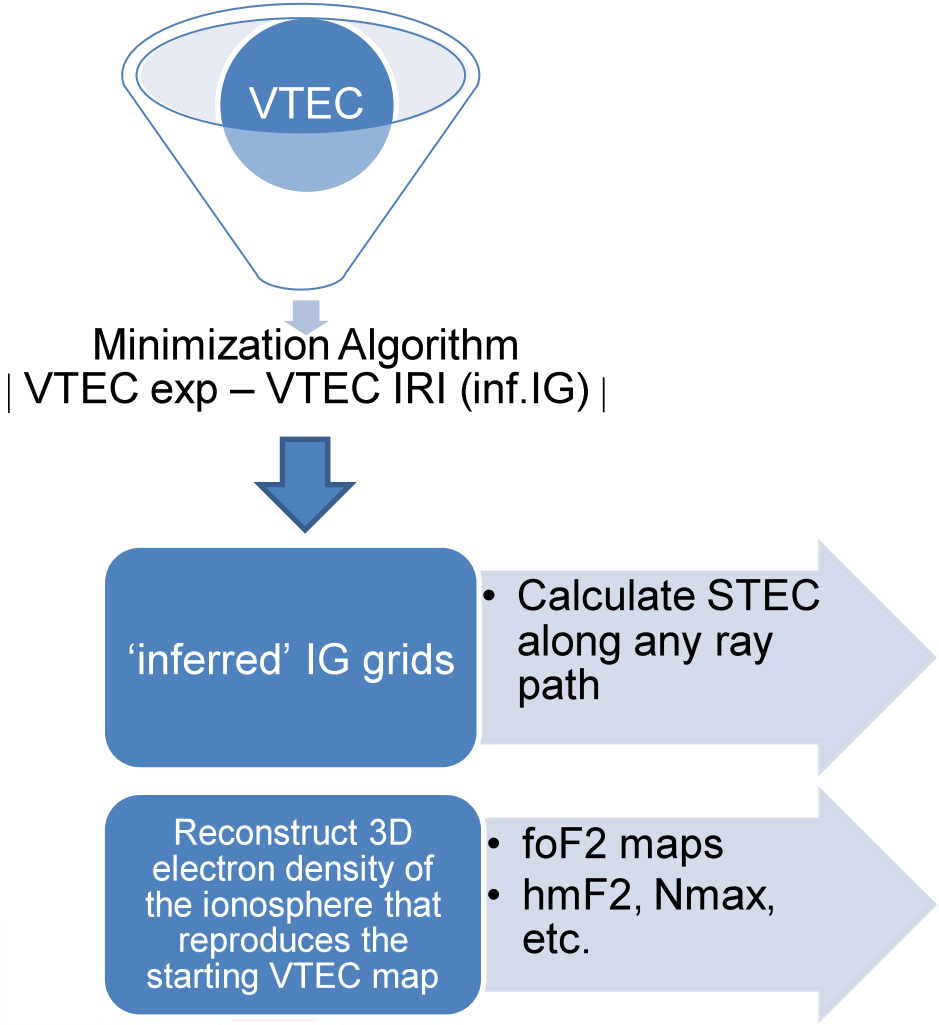

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Validation

- After ingestion of global CODE VTEC maps, foF2 maps have been retrieved.
- We have used manually scaled foF2 values from 22 ionosondes stations for April 2000 (HSA) and September 2006 (LSA).
- ΔfoF2 = foF2 IRI I – foF2exp
  ΔfoF2 = foF2 IRI R12 – foF2exp
  ΔfoF2 = foF2 IRI F10.7 – foF2exp
  and corresponding statistics have been computed.

NOTE: Validation is on:
sTEC calibration + mapping function + spherical harmonics expansion +
+ ITU-R coefficients + model formulation +
+ VTEC data ingestion technique

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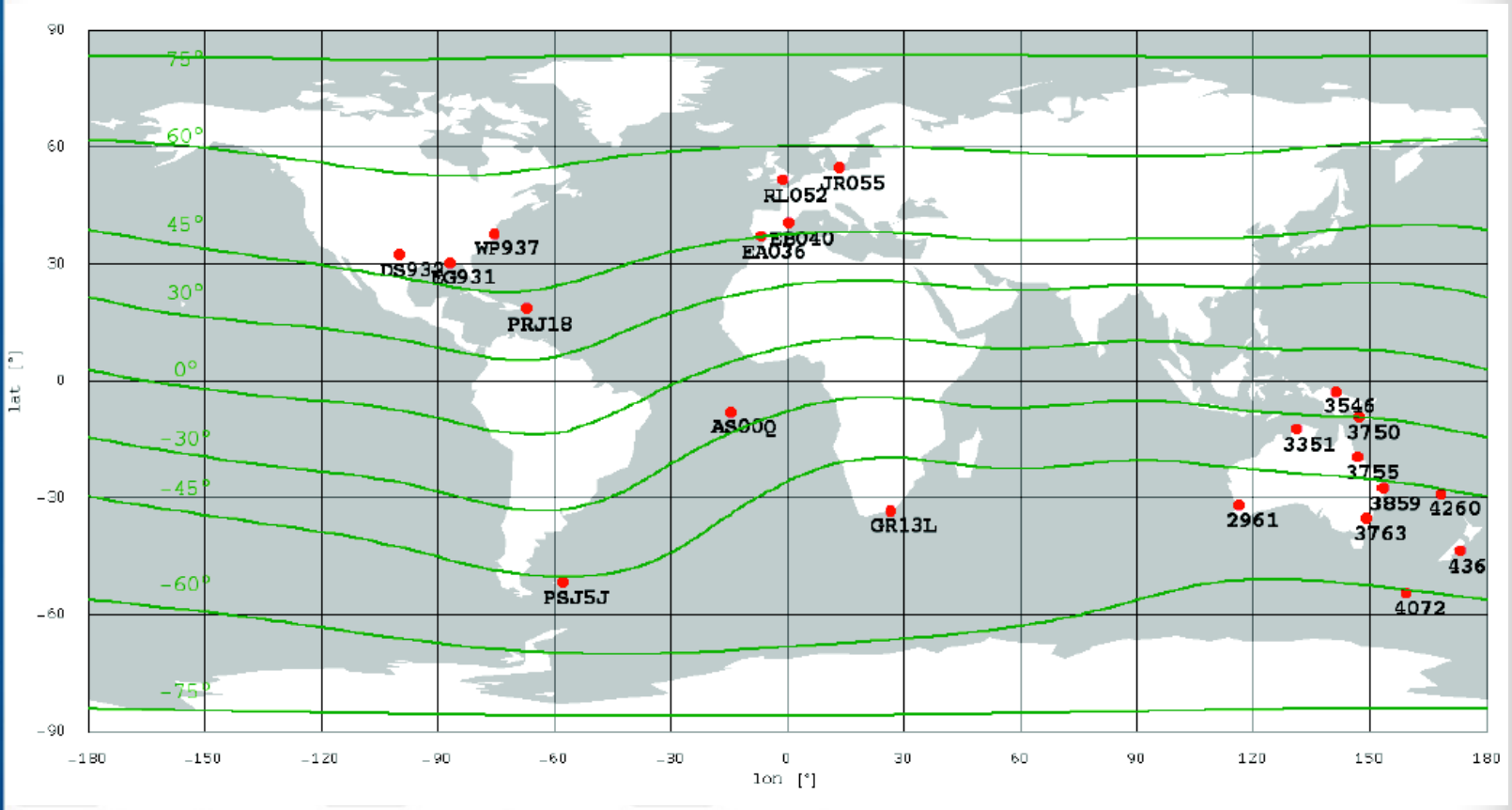
Stations used for validation of foF2 for April 2000



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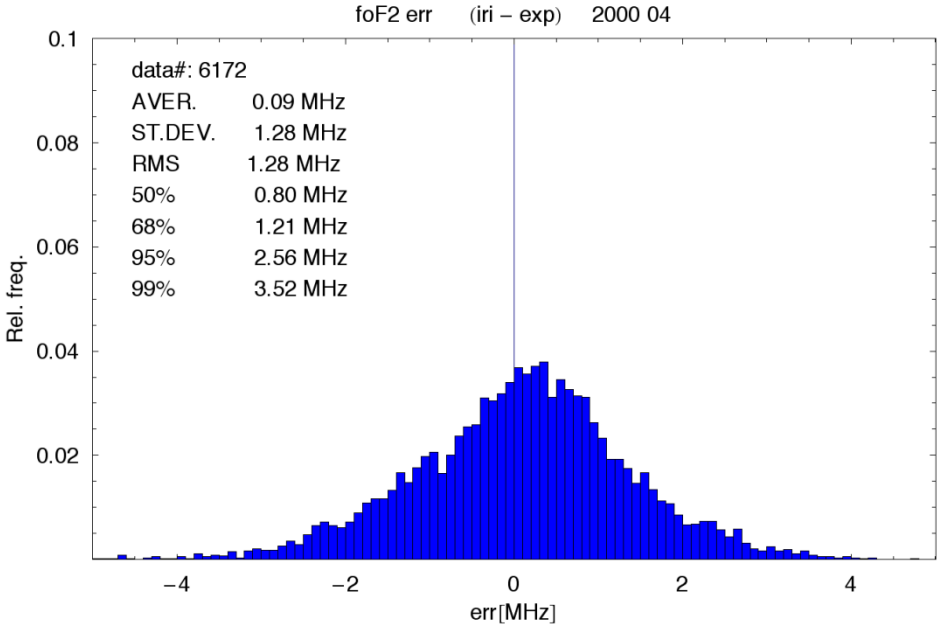

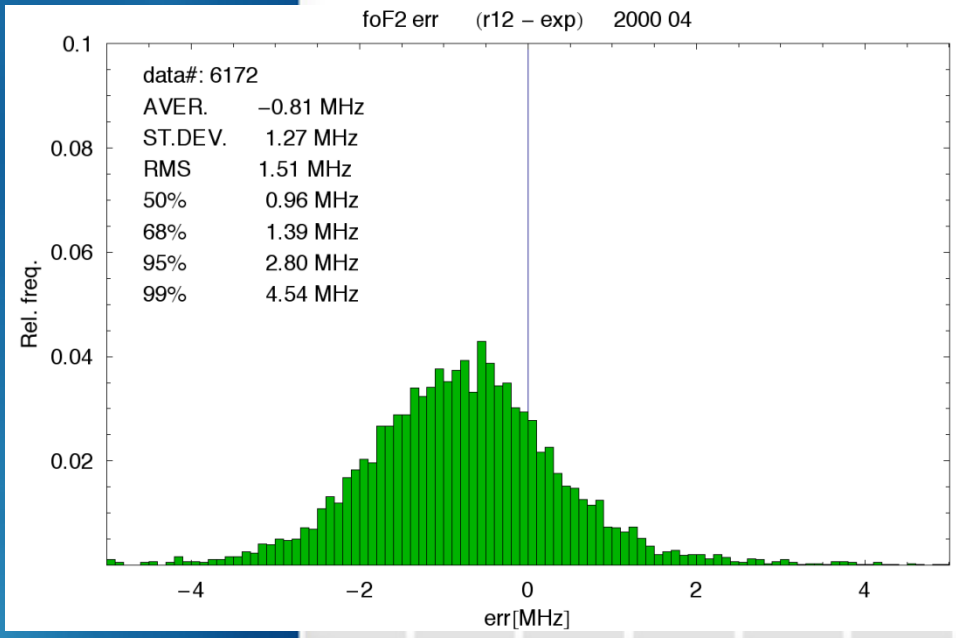

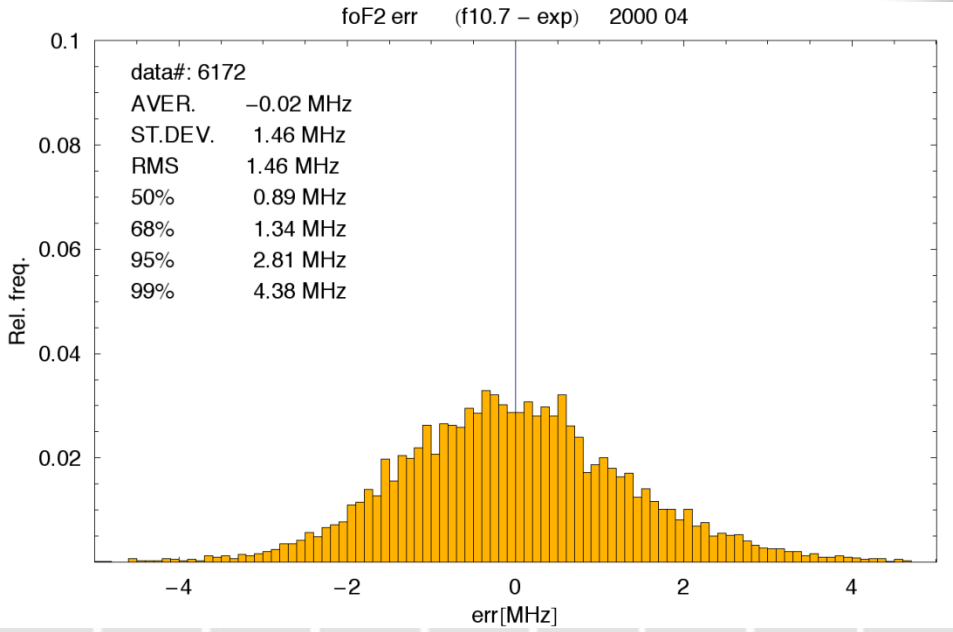

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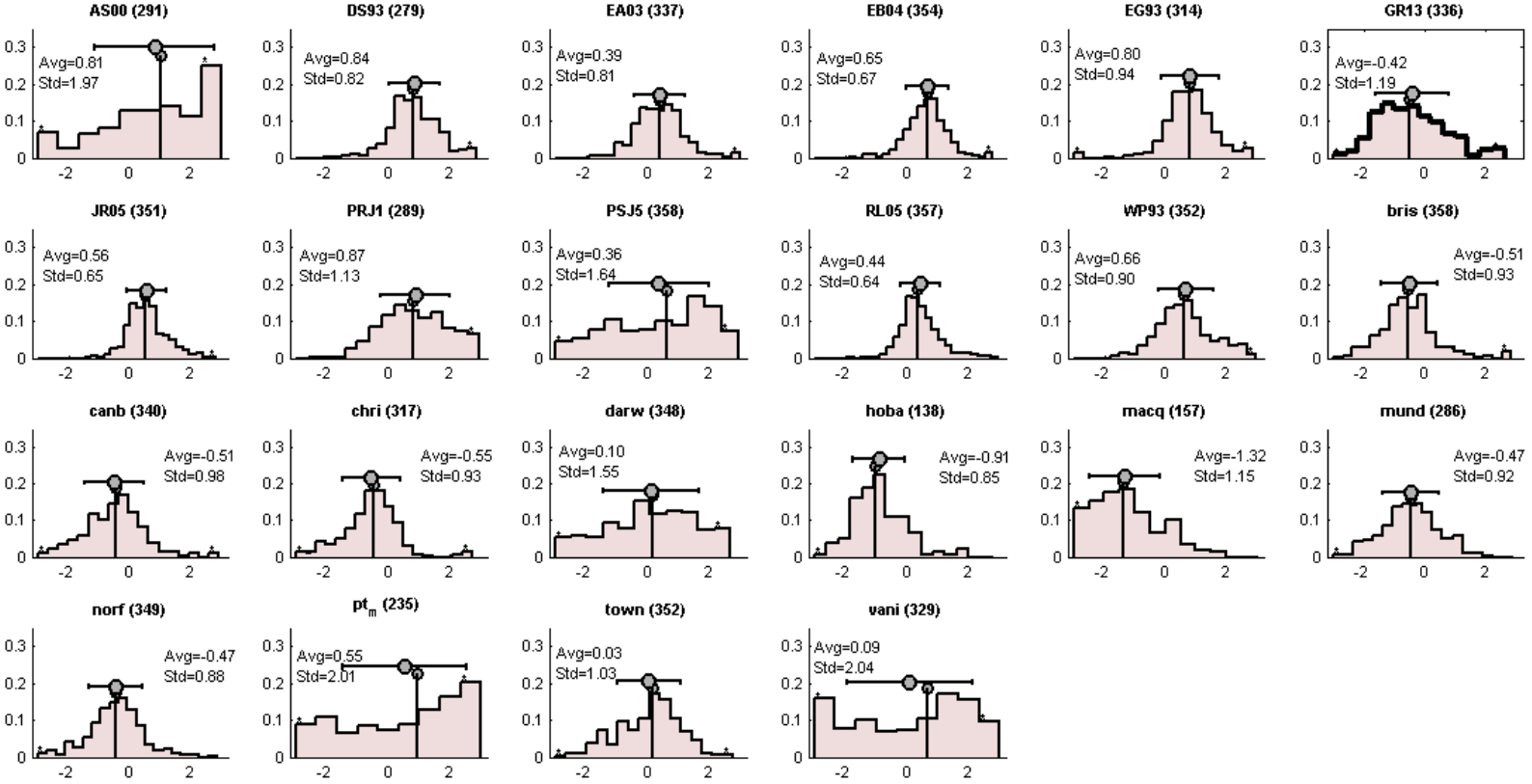
Statistics by station foF2exp – $foF2_{IRI\_i}$ differences for April 2000



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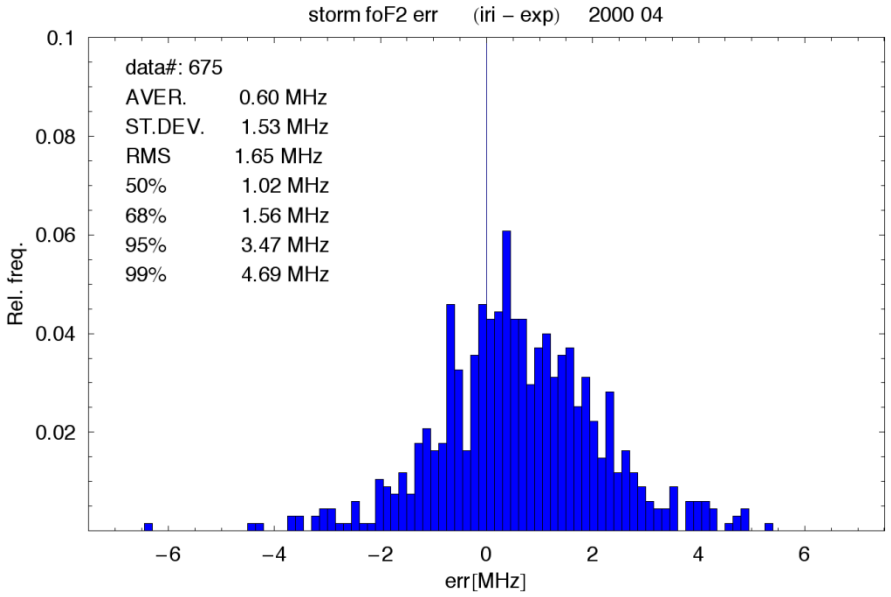

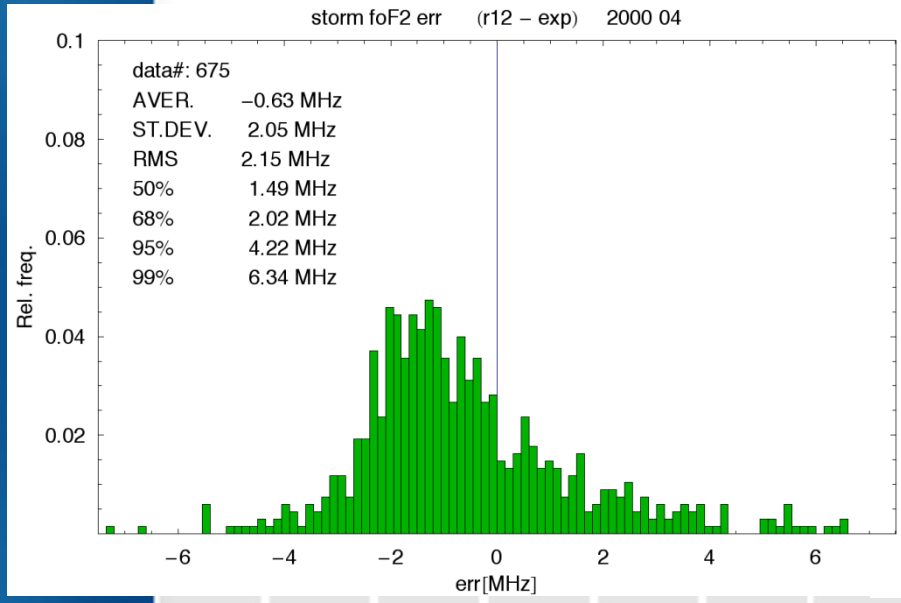

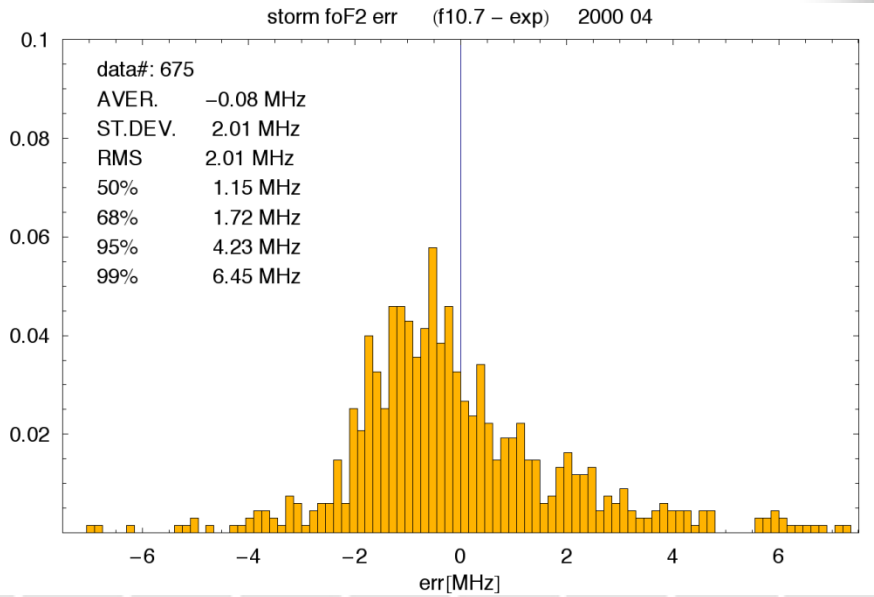

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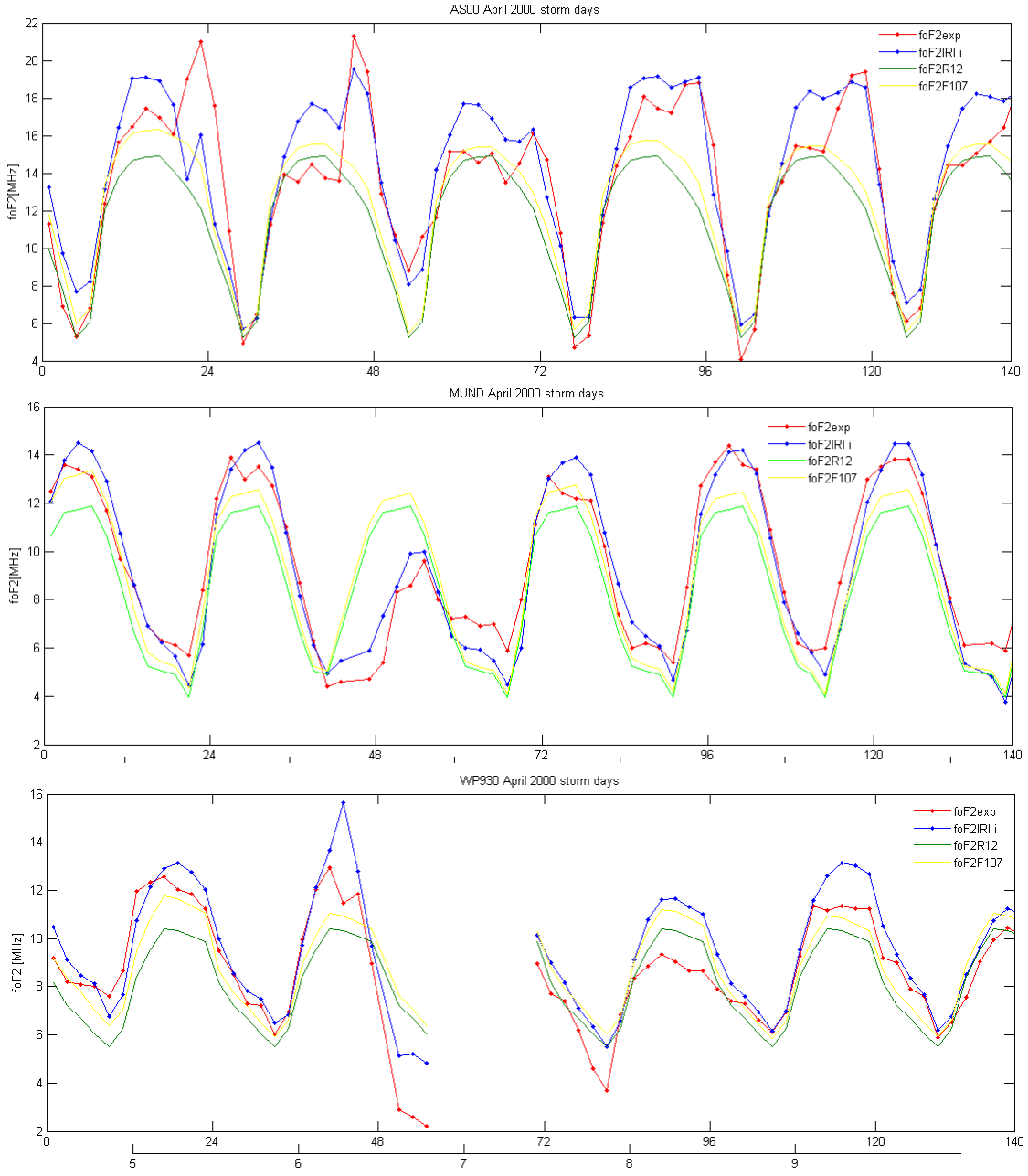

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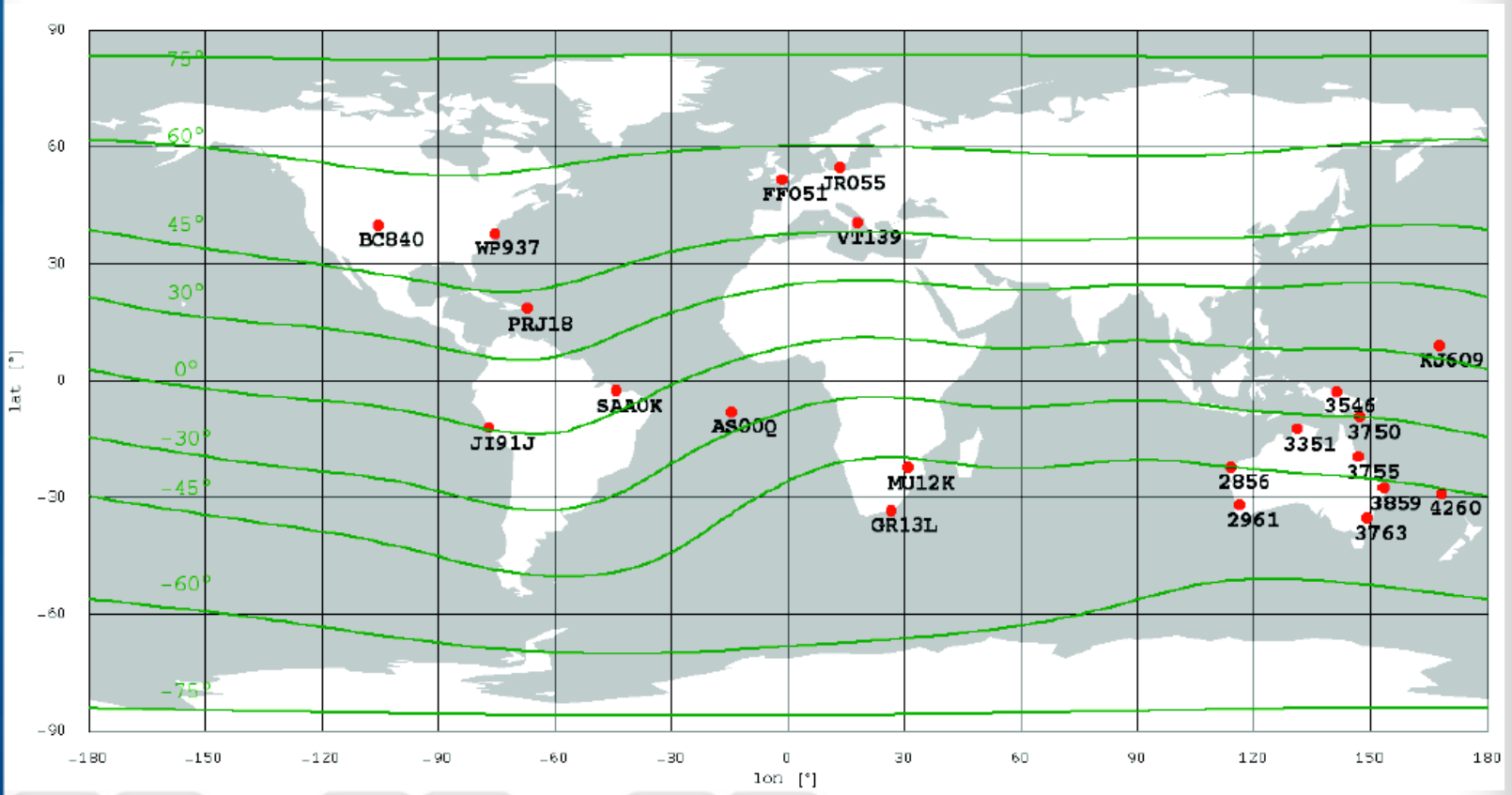
Stations used for validation of foF2 for September 2006



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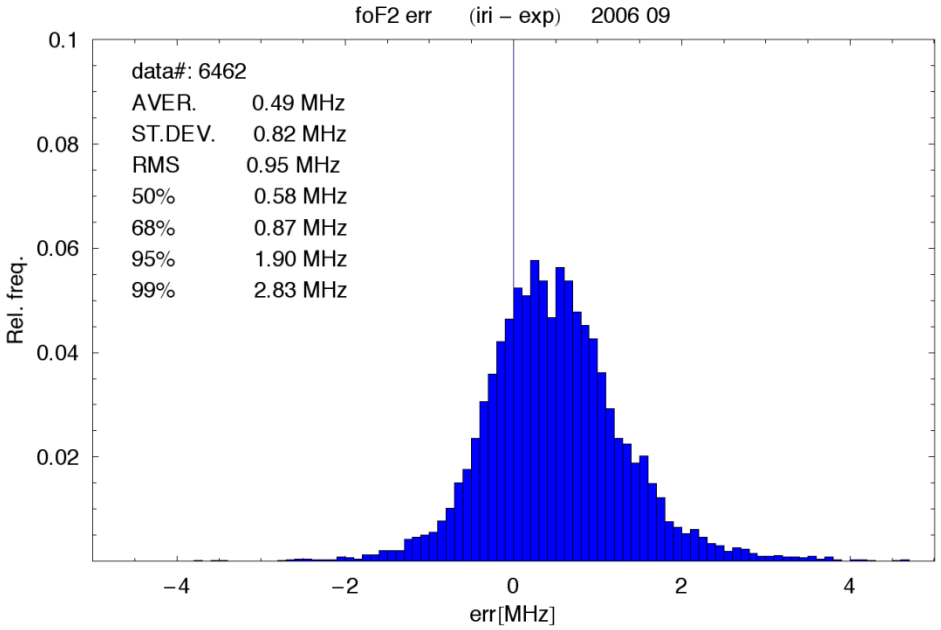

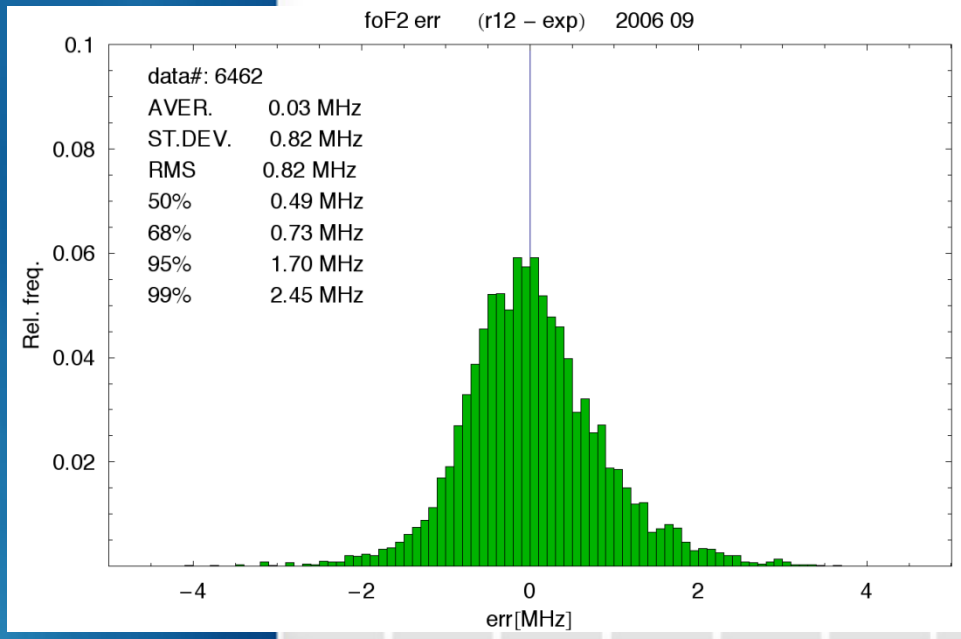

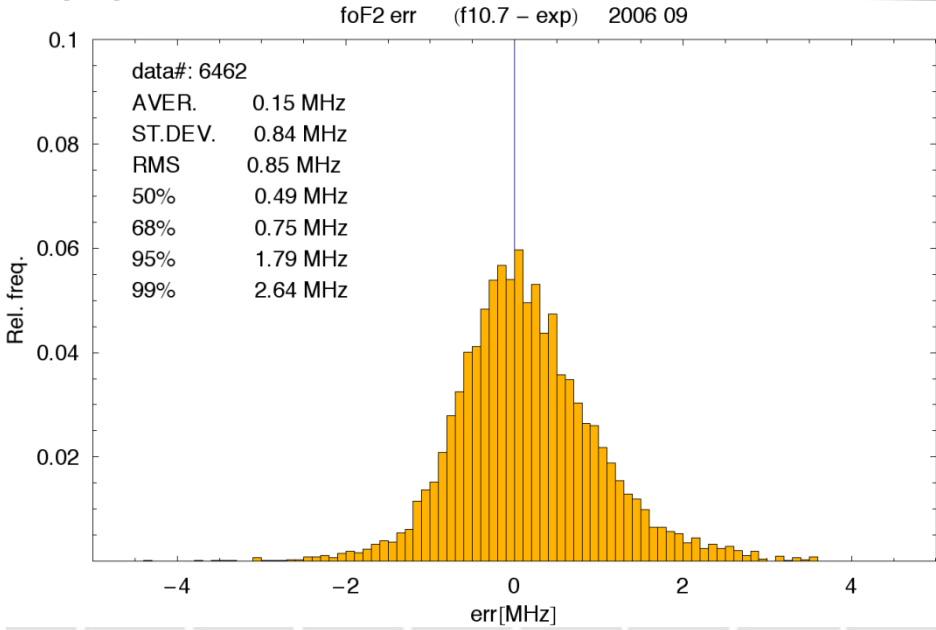

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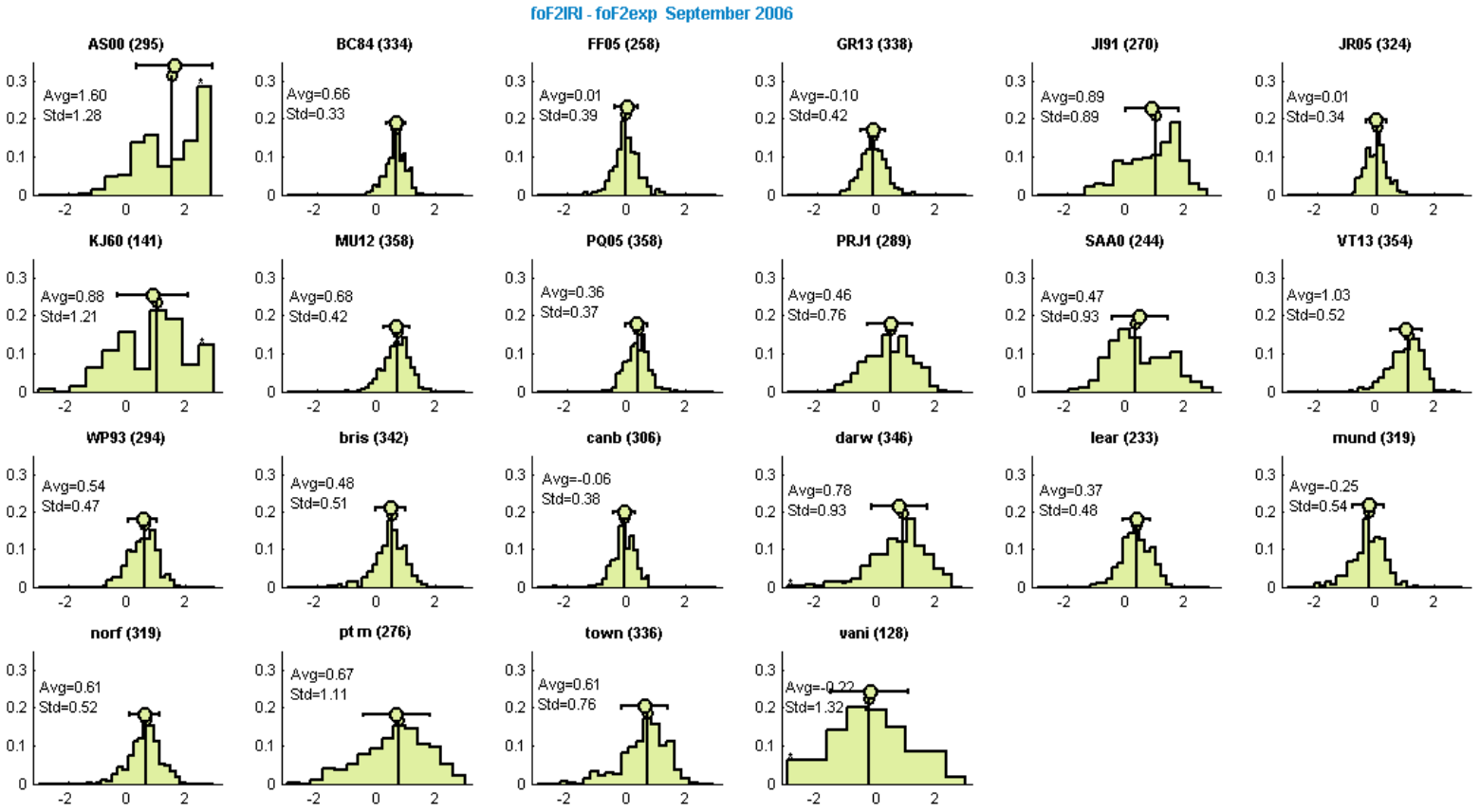

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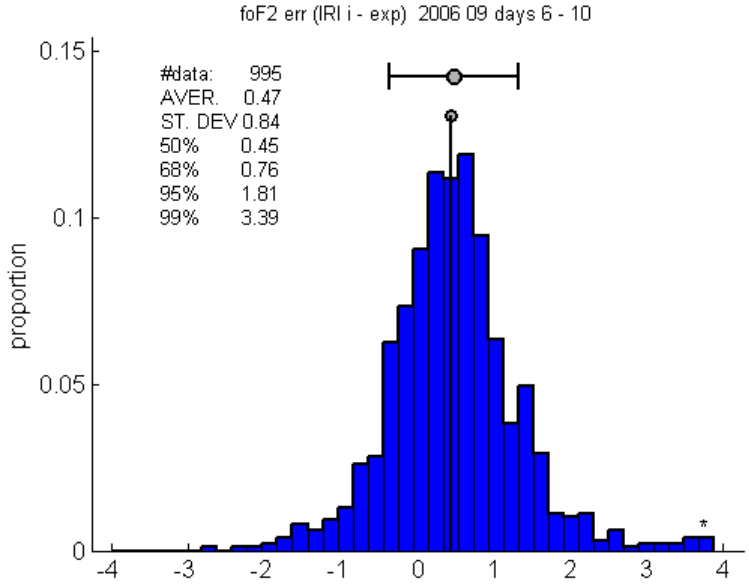

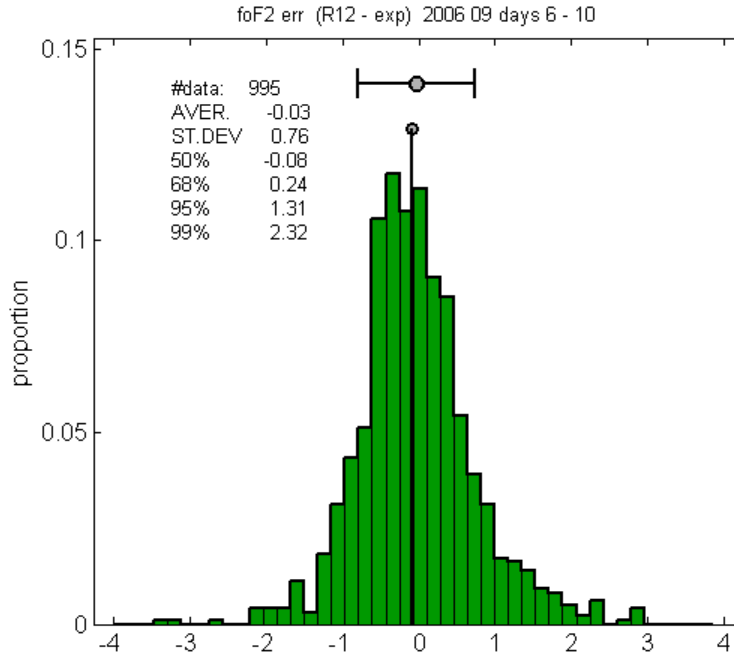

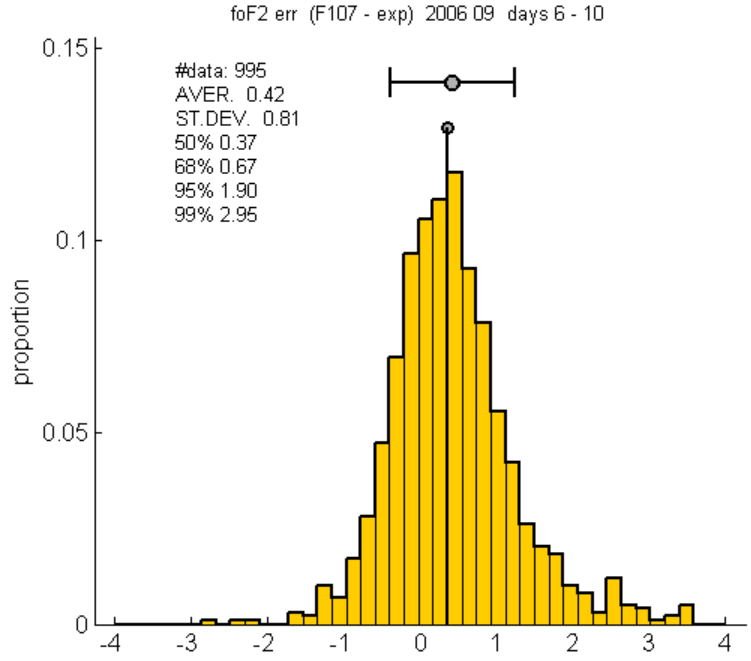

foF2 comparison during 5 days September 2006

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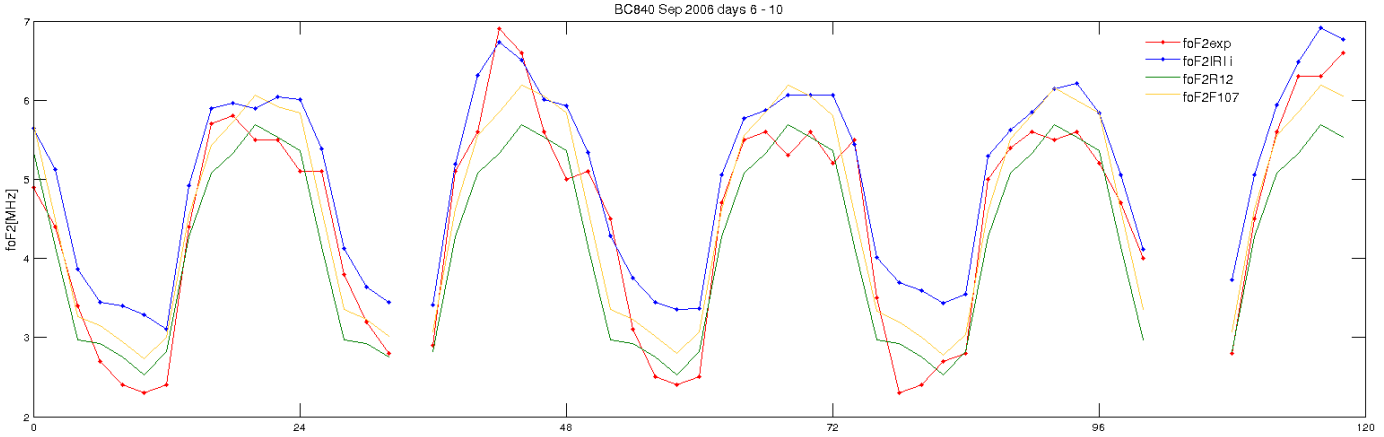

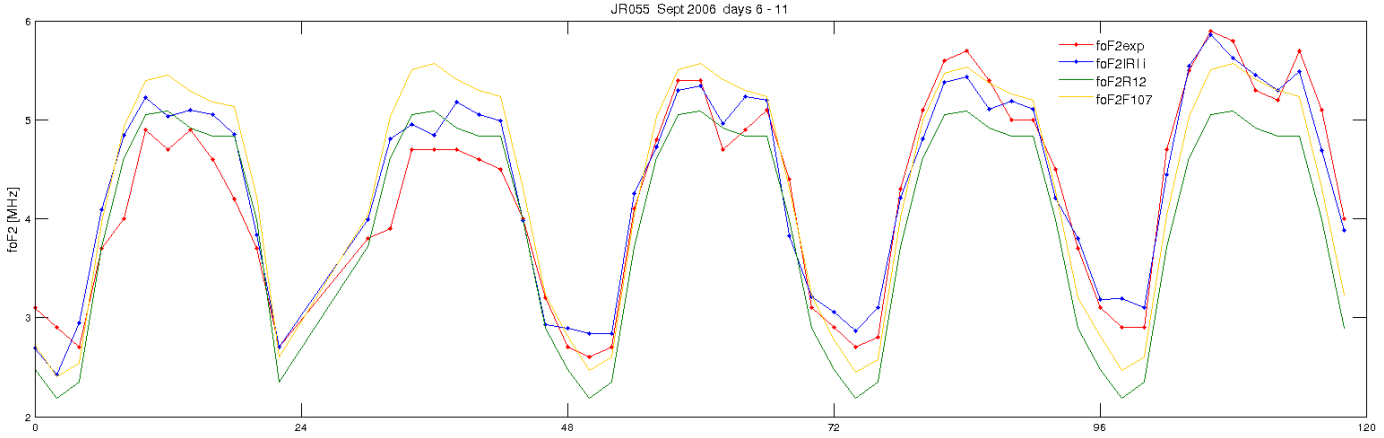

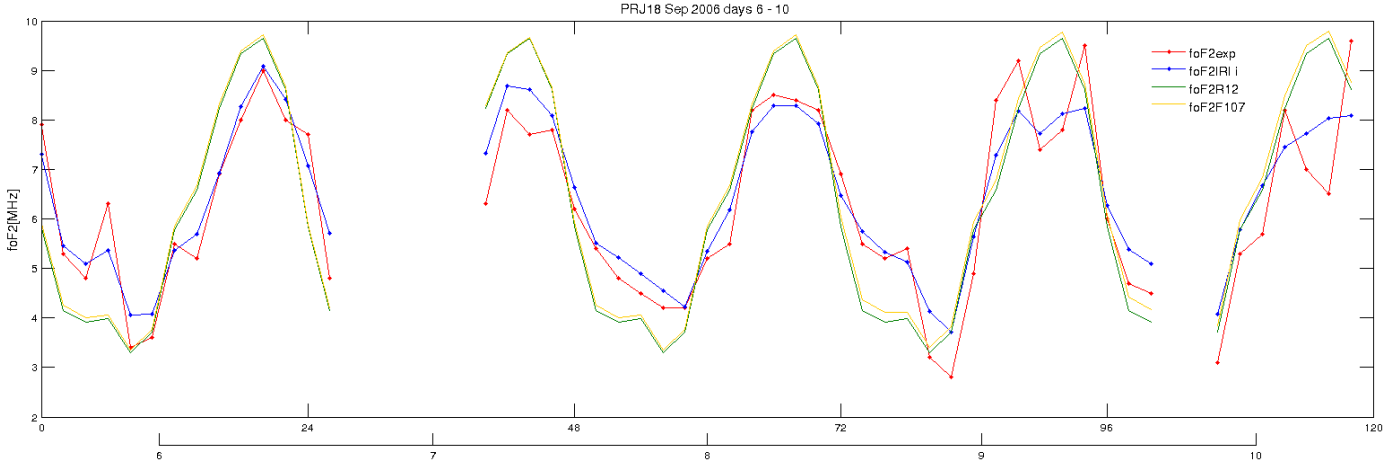

Summary

- The ingestion of VTEC maps into IRI2012 allows to provide a global 3D specification of the electron density of the ionosphere.

- The present work shows the reconstruction of foF2 with IRI2012 from global VTEC maps and its comparison with experimental (ionosonde) values.

Conclusions

- Results show that the described adaptation technique is able to improve the reproduction of the ‘weather’ variability of the F2 peak frequency.
- This is more evident in HSA than LSA, and it depends on location and LT.
- When the retrieved foF2 is different from the ground values it can be said that IRI has problems in estimating the experimental slab thickness.

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References

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B. Nava, P. Coïsson, G. Miró Amarante, F. Azpilicueta, and S. M. Radicella, A model assisted ionospheric electron density reconstruction method based on vertical TEC data ingestion, Ann. Geophys.48(2),313–320. (2005).

B. Nava, S. M. Radicella, F. Azpilicueta, Data ingestion into NeQuick 2, Radio Science, DOI: 10.1029/2010RS004635, (2011).

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Thanks for your attention!