Real Time 3D Ionospheric Modelling with Ray Tracing Application over Mediterranean Area

INGV

Carlo Scotto, Alessandro Settimi, Cesidio Bianchi
Istituto Nazionale di Geofisica e Vulcanologia, Via di Vigna Murata, 605 - 00143 Rome, Italy
cesidio.bianchi@ingv.it

This poster deals with some practical examples of instantaneous 3D modelling of regional ionosphere, based on ionosondes data from the Istituto Nazionale di Geofisica e Vulcanologia, INGV.
Characteristic anchor points have been chosen for each ionospheric region. These points are joint by an adaptive ionospheric profiler derived from the one used in Autoscala. For the F2 region the anchor point is given by the real height *hmF2* of the layer and its critical frequency *foF2*. These values are obtained basing on the observed heights (*hmF2*ROME[OBS] and *hmF2*GIBILMANNA[OBS]) and critical frequencies (*foF2*ROME[OBS] and *foF2*GIBILMANNA[OBS]) of the F2 layer, which are compared with the corresponding monthly median given by CCIR maps using Shimazaki's formulation.

The differences

δ*hmF2*ROME = *hmF2*ROME[OBS] - *hmF2*ROME[CCIR]

δ*hmF2*GIBILMANNA = *hmF2* GIBILMANNA [OBS] - *hmF2* GIBILMANNA [CCIR]

are thus computed and used in Kriging method to update the values given by CCIR maps.

For the F1 region the critical frequency is derived form a solar zenith angle dependent model adjusted to match the values of *foF1* measured in Rome and Gibilmanna.
For the E region the height is set to 110 km, while the critical frequency is estimated by a standard solar zenith angle and solar activity dependent model.
The model produces as an output a 3D matrix which can be profitably used as an input for a Matlab/Fortran based ray tracing program recently developed at INGV.

CLIMATOLOGICAL MODEL

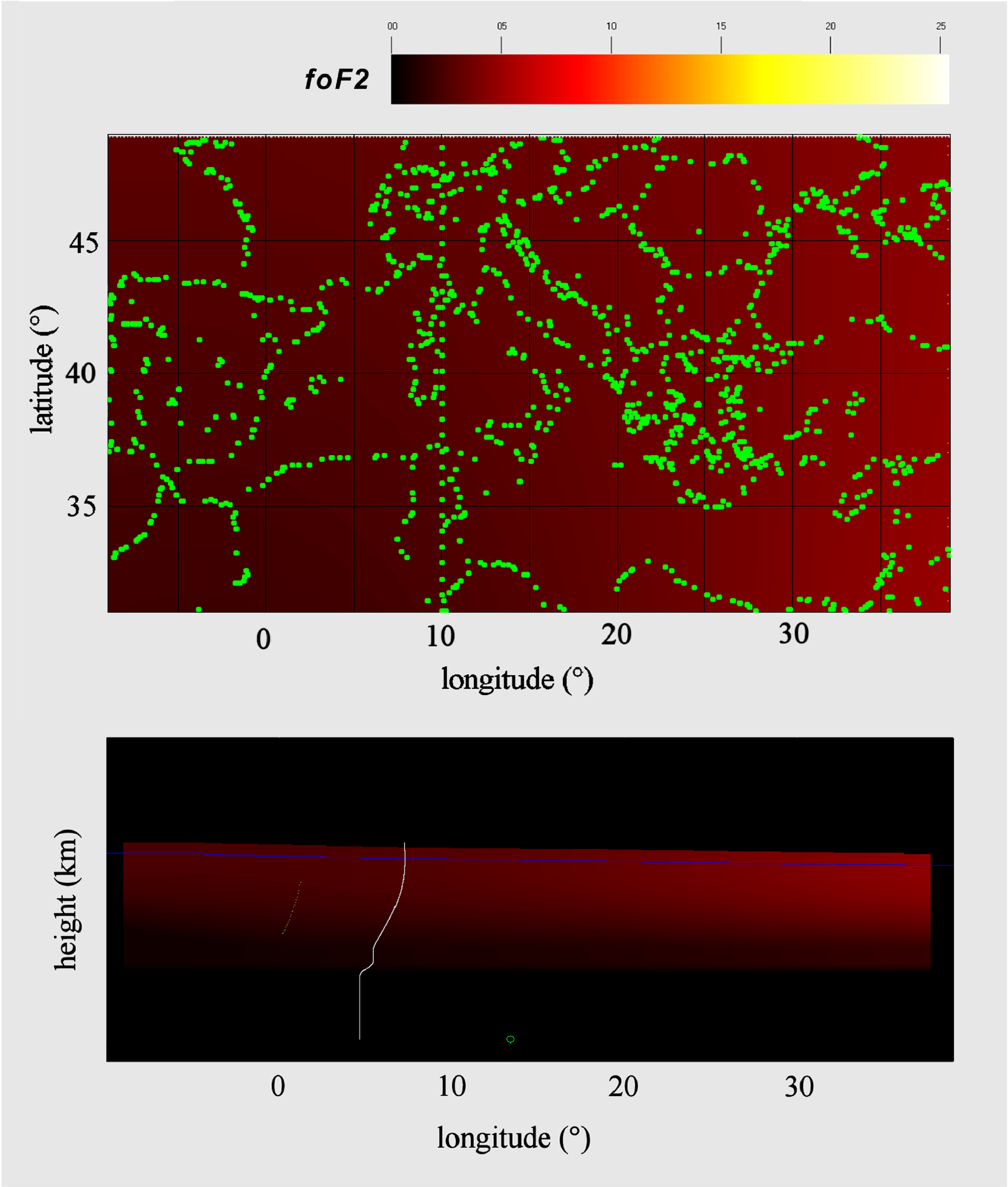

***Fig.1**. An example of 3D climatological electron density estimation over mediterranean area. (a) critical frequency of foF2 and (b) latitudinal section of the ionosphere.*

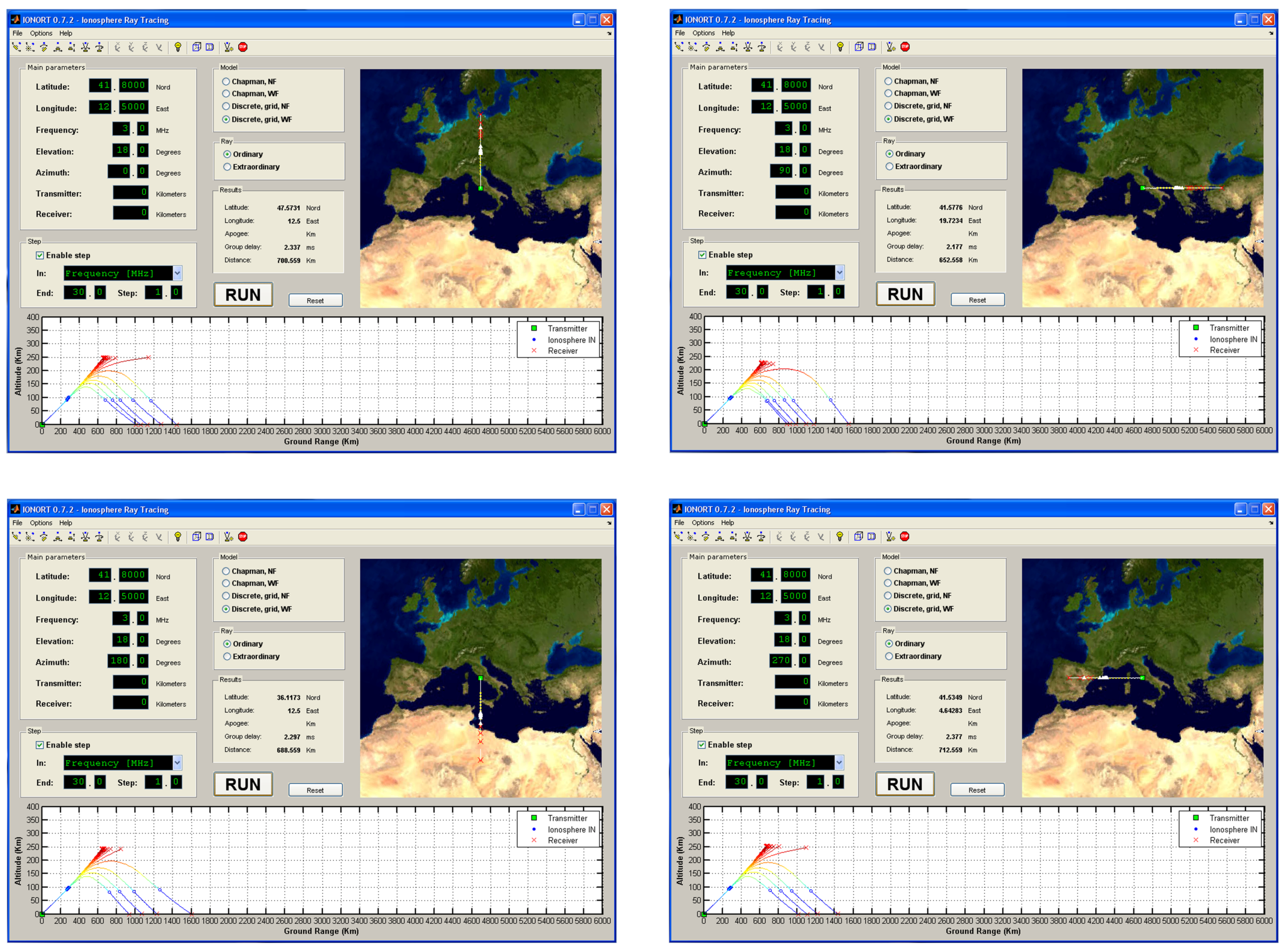

***Fig 3.** Results obtained by a Matlab/Fortran based ray tracing program during January 1 2009 at h 05:00 UT. The program runs with four different propagation azimuths and in a frequency range from 3 to 30 MHz with 1 MHz step.*

UPDATED MODEL

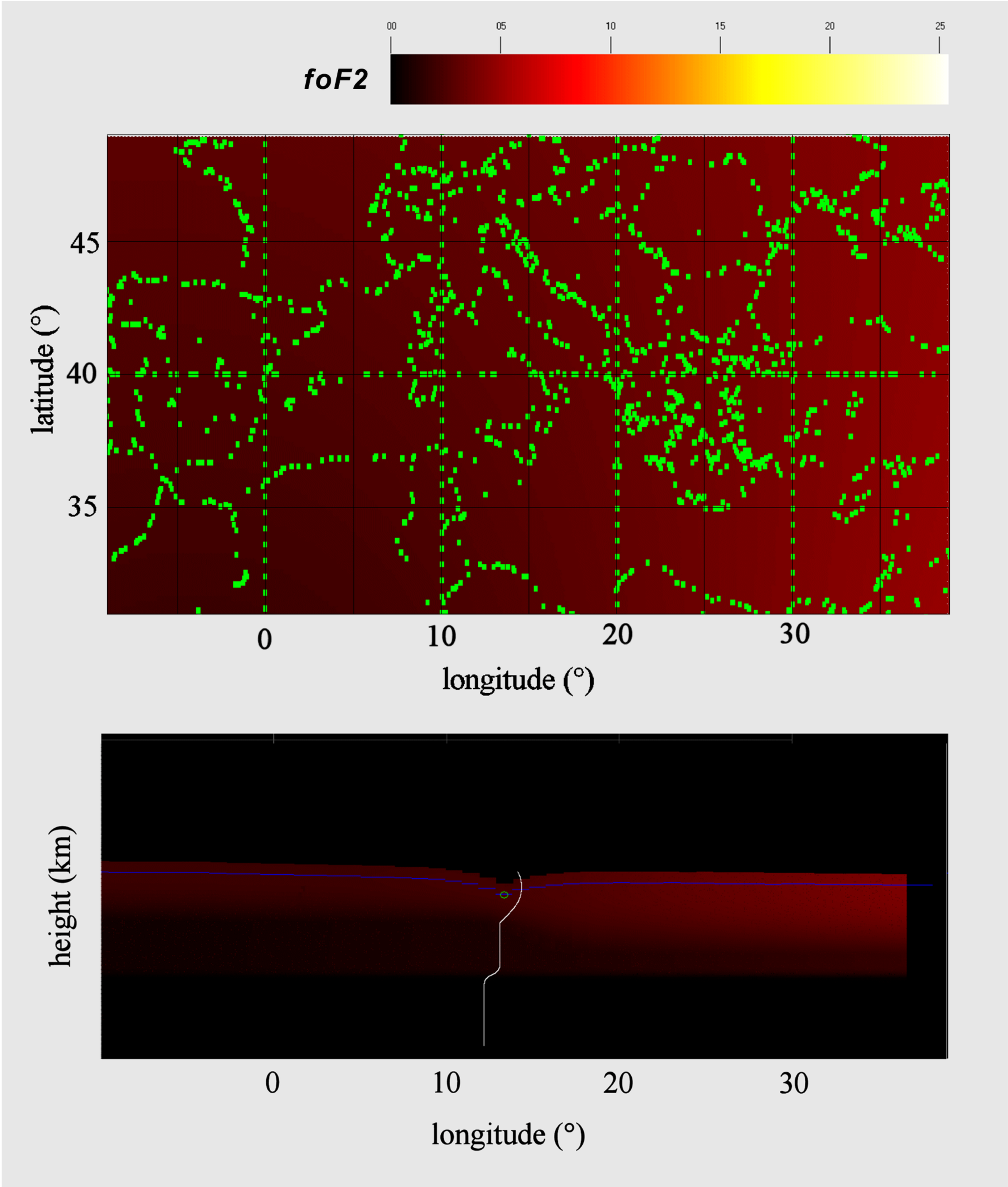

***Fig.2**. An example of 3D electron density estimation over mediterranean area updating the model using foF2, hmF2 and foF1 values observed in Rome and in Gibilmanna. (a) critical frequency of foF2 and (b) latitudinal section of the ionosphere.*

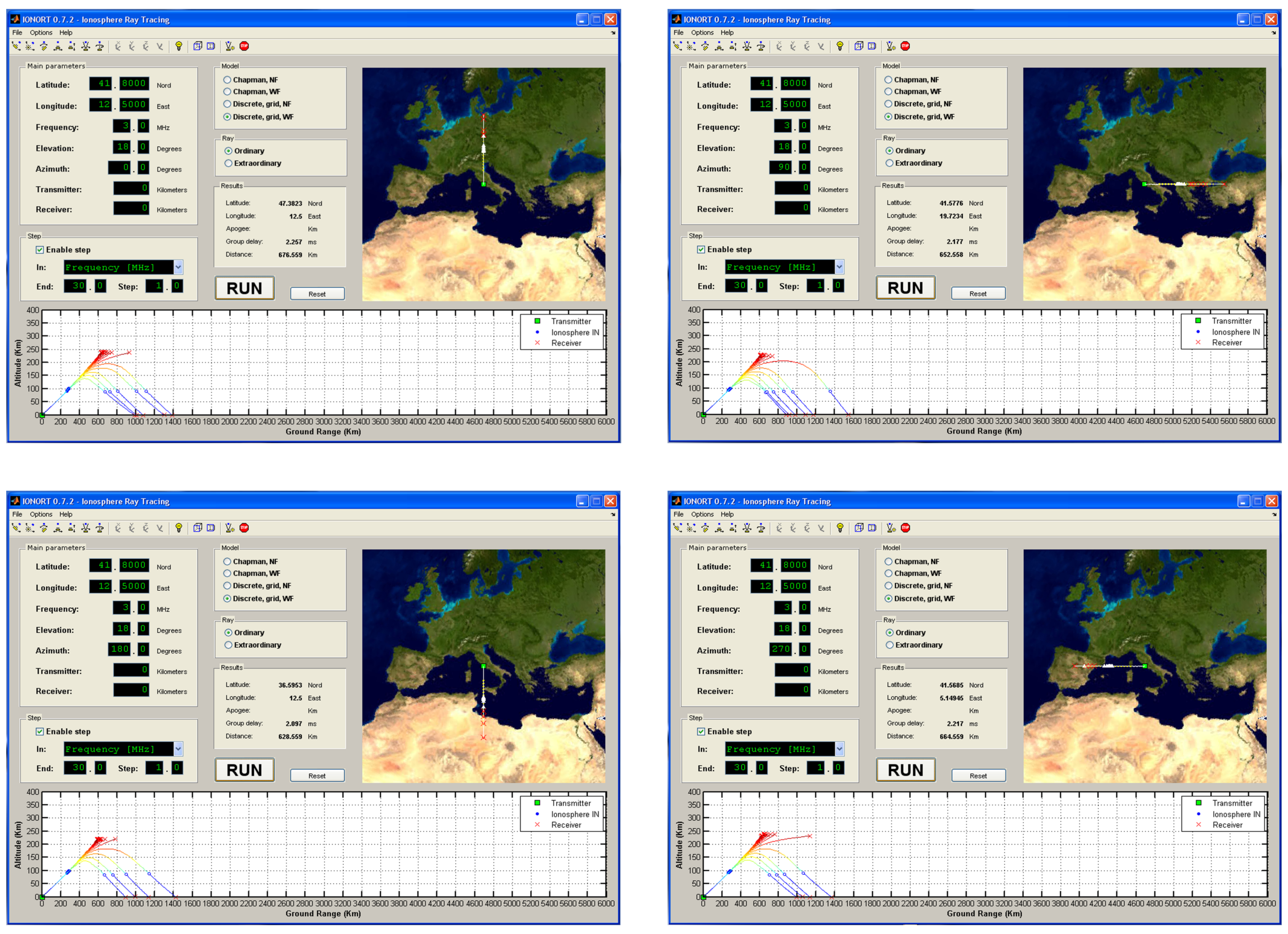

***Fig 4.** Results obtained by a Matlab/Fortran based ray tracing program during January 1 2009 at h 05:00 UT, updating the ionospheric model with real time data. The program runs with four different propagation azimuths and in a frequency range from 3 to 30 MHz with 1 MHz step.*

The output of this model, i.e. the electronic density 3D matrix, has been employed in the IONORT ray tracing algorithm in some examples where the horizontal gradient of electron density was also present in order to check the performance of the model. This first test is promising mainly to integrate both IONORT ray tracing algorithm and the described model.

REFERENCES

• Bianchi, C., Settimi, A., Azzarone, A., IONORT - Ionosphere Ray-Tracing (Programma di ray-tracing nel magnetoplasma ionosferico), INGV Technical Report N. 161, INGV Printing Office, Rome, Italy, 2010.

• Bilitza, D., International Reference Ionosphere IRI-90 (ed.), NSSDC 90-22, Greenbelt, Maryland, 1990.

• Scotto, C., Electron density profile calculation technique for Autoscala ionogram analysis, Space Res. 44, 756–766, 2009.

ACKNOWLEDGEMENT

These tests were performed with the precious help of Adriano Azzarone.