Calibrating High-Precision Faraday Rotation Measurements for LOFAR and the Next Generation of Low-Frequency Radio Telescopes (Corrigendum)


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ABSTRACT

Faraday rotation measurements using the current and next generation of low-frequency radio telescopes will provide a powerful probe of astronomical magnetic fields. However, achieving the full potential of these measurements requires accurate removal of the time-variable, ionospheric Faraday rotation contribution. We present ionFR, a code that calculates the amount of ionospheric Faraday rotation for a specific epoch, geographic location, and line-of-sight through the atmosphere. ionFR uses a number of publicly available, GPS-derived total electron content maps and the most recent release of the International Geomagnetic Reference Field. We describe applications of this code for the calibration of radio polarimetric observations, and demonstrate the high accuracy of its modeled ionospheric Faraday rotations using LOFAR pulsar observations. These show that we can accurately determine some of the highest-precision pulsar rotation measures ever achieved. Precision rotation measures can be used to monitor for rotation measure variations — either intrinsic or due to the changing line-of-sight through the interstellar medium — and this calibration is particularly important for nearby sources, where the ionosphere can contribute a significant fraction of the observed rotation measure. We also discuss planned improvements to ionFR, as well as the importance of ionospheric Faraday rotation calibration for the emerging generation of low-frequency radio telescopes, such as the SKA and its pathfinders.

Key words. Polarization – Techniques: polarimetric – errata, addenda
This erratum corrects Figures 2 and 3 of our original paper (Sotomayor-Beltran et al. 2013). Due to a simple error in plotting the input data, these maps of ionospheric total electron content (TEC) were inverted north-south and improperly stretched to match the underlying cartographic projection. The properly mapped figures are presented here (see also the Appendix of Arora et al. 2015). The ionospheric prediction code, ionFR, and other figures presented in the paper were not affected by this inversion error, which was purely a plotting error applying to Figures 2 and 3.

This mapping error led to the incorrect conclusion that the Equatorial Ionization Anomaly (EIA) can sometimes pass directly over the planned sites of the Square Kilometre Array (SKA). Though ionospheric calibration is a challenging problem, it is a challenge that is being met (e.g., Arora et al. 2015). Unfortunately, the incorrect assertion that the EIA passes over the chosen sites for the SKA overstated the severity of the problem for these locations, which have been meticulously chosen and proven to be excellent sites for low-frequency radio astronomy.

All other conclusions in the paper remain unaffected.

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References


Fig. 3. The VTEC across Europe for March 23rd, 2012 (the date of the third LOFAR campaign, see §5) at 00:00 UT, obtained courtesy of ROB. The square indicates the LOFAR core stations and the triangles represent the locations of the international stations.
Fig. 2. GIMs representing the VTEC across the globe for April 11th, 2011 (the date of the first LOFAR observing campaign, see §5) obtained courtesy of CODE. The maps range from minimum (blue) to maximum (red) VTEC values of 0.0–87.2 TECU (1 TECU = 10^{16} electrons/m^2). The triangles indicate the location of the LOFAR core stations in the Netherlands, the squares mark the SKA core sites in South Africa and Western Australia, and the circles indicate the site of the GMRT.