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

C. Sotomayor-Beltran[1], C. Sobey[2], J. W. T. Hessels[3,4], G. de Bruyn[3,5], A. Noutsos[2], A. Alexov[4,6], J. Anderson[2], A. Asgekar[3], I. M. Avruch[7,5,3], R. Beck[2], M. E. Bell[8,9], M. R. Bell[10], M. J. Bentum[3], G. Bernardi[5], P. Best[11], L. Birzan[12], A. Bonafede[13,14], F. Breitling[15], J. Broderick[9], W. N. Brouw[3,5], M. Brüggen[13], B. Ciardi[10], F. de Gasperin[13,10], R.-J. Dettmar[1], A. van Duin[3], S. Duscha[3], J. Eislöffel[16], H. Falcke[17,3], R. A. Fallows[3], R. Fender[9], C. Ferrari[18], W. Frieswijk[3], M. A. Garrett[3,12], J. Grießmeier[3,19], T. Grit[3], A. W. Gunst[3], T. E. Hassall[9,20], G. Heald[3], M. Hoeft[16], A. Horneffer[2], M. Iacobelli[12], E. Juette[1], A. Karastergiou[21], E. Keane[2], J. Kohler[2], M. Kramer[2,20], V. I. Kondratiev[3,22], L. V. E. Koopmans[5], M. Kuniyoshi[2], G. Kuper[3], J. van Leeuwen[3,4], P. Maat[3], G. Macario[18], S. Markoff[4], J. P. McKean[3], D. D. Mulcahy[2], H. Munk[3], E. Orru[3,17], H. Paas[23], M. Pandey-Pommier[12,24], M. Pilia[3], R. Pizzo[3], A. G. Polatidis[3], W. Reich[2], H. Röttgering[12], M. Serylak[19,25], J. Sluman[3], B. W. Stappers[20], M. Tagger[19], Y. Tang[3], C. Tasse[26], S. ter Veen[17], R. Vermeulen[3], R. J. van Weeren[27,12,3], R. A. M. J. Wijers[4], S. J. Wijnholds[3], M. W. Wise[3,4], O. Wucknitz[28,2], S. Yatawatta[3], and P. Zarka[26]

[1] Astronomisches Institut der Ruhr-Universität Bochum, Universitätsstr. 150, 44780 Bochum, Germany
e-mail: sotomayor@astro.rub.de
[2] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany
[3] ASTRON, the Netherlands Institute for Radio Astronomy, Postbus 2, 7990 AA, Dwingeloo, The Netherlands
[4] Astronomical Institute "Anton Pannekoek," University of Amsterdam, Science Park 904, 1098 XH Amsterdam, The Netherlands
[5] Kapteyn Astronomical Institute, PO Box 800, 9700 AV Groningen, The Netherlands
[6] Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA
[7] SRON Netherlands Insitute for Space Research, Sorbonnelaan 2, 3584 CA, Utrecht, The Netherlands
[8] ARC Centre of Excellence for All-sky astrophysics (CAASTRO), Sydney Institute of Astronomy, University of Sydney Australia
[9] School of Physics and Astronomy, University of Southampton, Southampton, SO17 1BJ, UK
[10] Max Planck Institute for Astrophysics, Karl Schwarzschild Str. 1, 85741 Garching, Germany
[11] Institute for Astronomy, University of Edinburgh, Royal Observatory of Edinburgh, Blackford Hill, Edinburgh EH9 3HJ, UK
[12] Leiden Observatory, Leiden University, PO Box 9513, 2300 RA Leiden, The Netherlands
[13] University of Hamburg, Gojenbergsweg 112, 21029 Hamburg, Germany
[14] Jacobs University Bremen, Campus Ring 1, 28759 Bremen, Germany
[15] Leibniz-Institut für Astrophysik Potsdam (AIP), An der Sternwarte 16, 14482 Potsdam, Germany
[16] Thüringer Landessternwarte, Sternwarte 5, D-07778 Tautenburg, Germany
[17] Department of Astrophysics/IMAPP, Radboud University Nijmegen, P.O. Box 9010, 6500 GL Nijmegen, The Netherlands
[18] Laboratoire Lagrange, UMR7293, Université de Nice Sophia-Antipolis, CNRS, Observatoire de la Côte d'Azur, 06300 Nice, France
[19] Laboratoire de Physique et Chimie de l'Environnement et de l'Espace, LPC2E UMR 7328 CNRS, 45071 Orléans Cedex 02, France
[20] Jodrell Bank Center for Astrophysics, School of Physics and Astronomy, The University of Manchester, Manchester M13 9PL,UK
[21] Astrophysics, University of Oxford, Denys Wilkinson Building, Keble Road, Oxford OX1 3RH
[22] Astro Space Center of the Lebedev Physical Institute, Profsoyuznaya str. 84/32, Moscow 117997, Russia
[23] Center for Information Technology (CIT), University of Groningen, The Netherlands
[24] Centre de Recherche Astrophysique de Lyon, Observatoire de Lyon, 9 av Charles André, 69561 Saint Genis Laval Cedex, France
[25] Station de Radioastronomie de Nançay, Observatoire de Paris, CNRS/INSU, 18330 Nançay, France
[26] LESIA, UMR CNRS 8109, Observatoire de Paris, 92195 Meudon, France
[27] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA
[28] Argelander-Institut für Astronomie, University of Bonn, Auf dem Hügel 71, 53121, Bonn, Germany

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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

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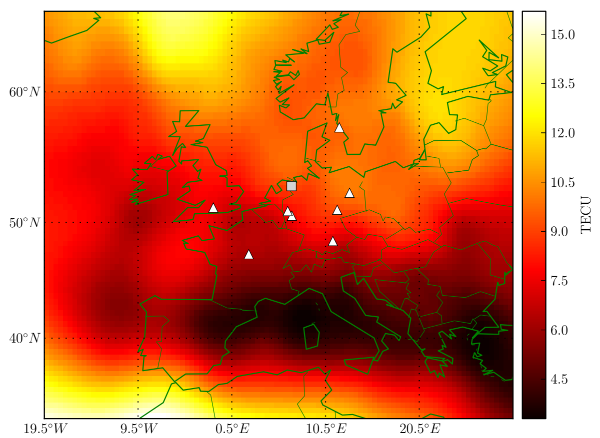

Fig. 3. The VTEC across Europe for March 23rd, 2012 (the date of the third LOFAR campaign, see §5) at 00:00 UT, obtained courtesy of ROB. The square indicates the LOFAR core stations and the triangles represent the locations of the international stations.

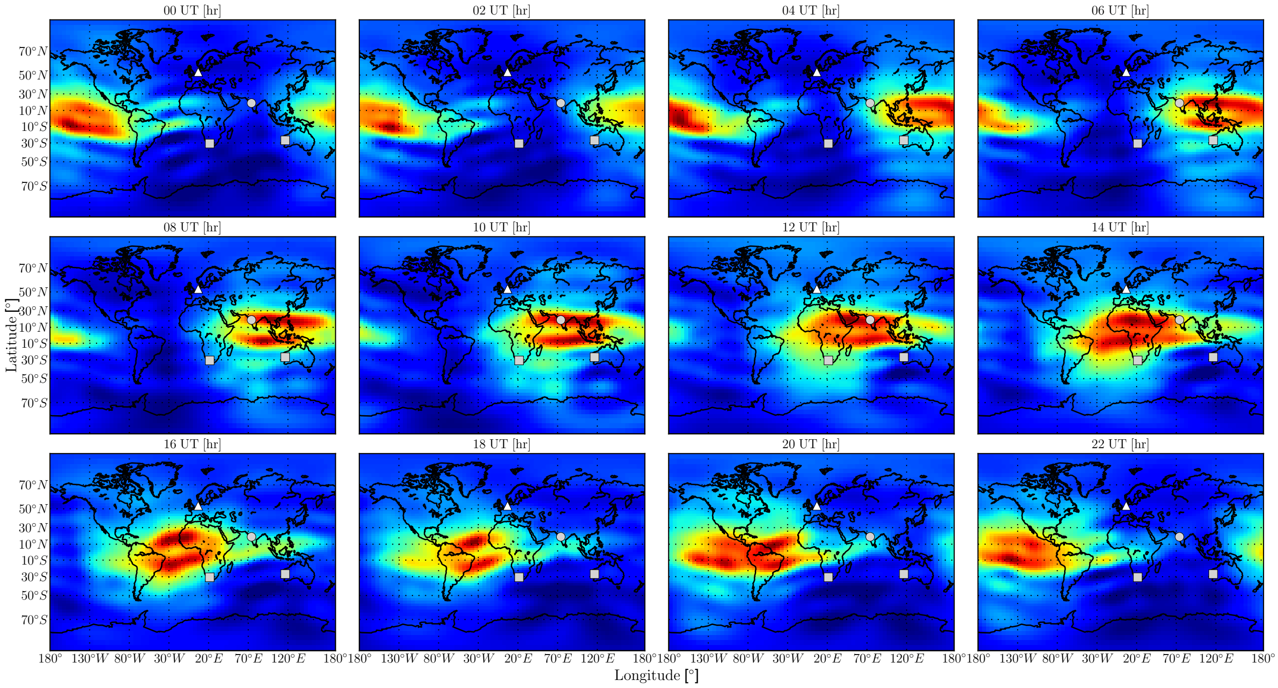

Fig. 2. GIMs representing the VTEC across the globe for April 11th, 2011 (the date of the first LOFAR observing campaign, see §5) obtained courtesy of CODE. The maps range from minimum (blue) to maximum (red) VTEC values of 0.0 – 87.2 TECU (1 TECU = 10^{16} electrons/m^2). The triangles indicate the 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.