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Alternative Interpolation Methods For Regional TEC Maps in Local Content

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ABSTRACT

GNSS technology provides ionospheric sounding of wide areas all over the planet. The sampling data of the total electron content (TEC) sets are then used to constrain theoretical ionosphere models and parameters of data-assimilative models, feed data-driven empirical models (e.g. IRI) and as inputs for interpolation methods by which Global/ Regional Ionospheric Maps (GIMs/RIMs) are developed.

In radioastronomy, interferometric measurements between near radio-telescopes remove the ionospheric delay of the signal. This is possible only for short baselines. In LOFAR (LOw Frequency Array), a network of radio-telescopes in Europe, interferometry techniques may not remove such ionospheric delay. Indeed, due to the maximum baseline of several hundred kilometres, the variability of the ionosphere within the baseline yields an ionospheric delay on the signal that depends on the station location. Consequently, LOFAR needs information regarding the ionosphere, in other words, it needs a service that provides RIMs over the region.

In this regard, the present work introduces an assessment of three interpolation methods for the computation of RIMs: the distance-weighted interpolation method (henceforth the "standard" method); the quasi-natural neighbours (QNN) method, which is a standard method that computes the nearest neighbours by Voronoi tessellation; and the natural neighbours (NN) method, which estimates the weight coefficient by computing the area of the Voronoi cell associated to each data instead of the distance to the interpolated point location.

The comparison analysis is carried out on several stations of the EUREF Permanent Network (EPN) in Poland. Preliminary results show that the NN method is the most accurate, with an RMS value that is half of the RMS of the standard method. The improvement in the accuracy is due to the topological analysis of the NN method avoids biased estimates despite of the lack of homogeneity of the TEC data distribution.

On the other hand, the standard method is computed ten to thirty times faster than the NN methods. This introduces a trade-off between availability and accuracy that could become important for real-time services. Better trade-off balance may be provided by the QNN methods, which is less accurate than NN methods, but faster even than standard one.

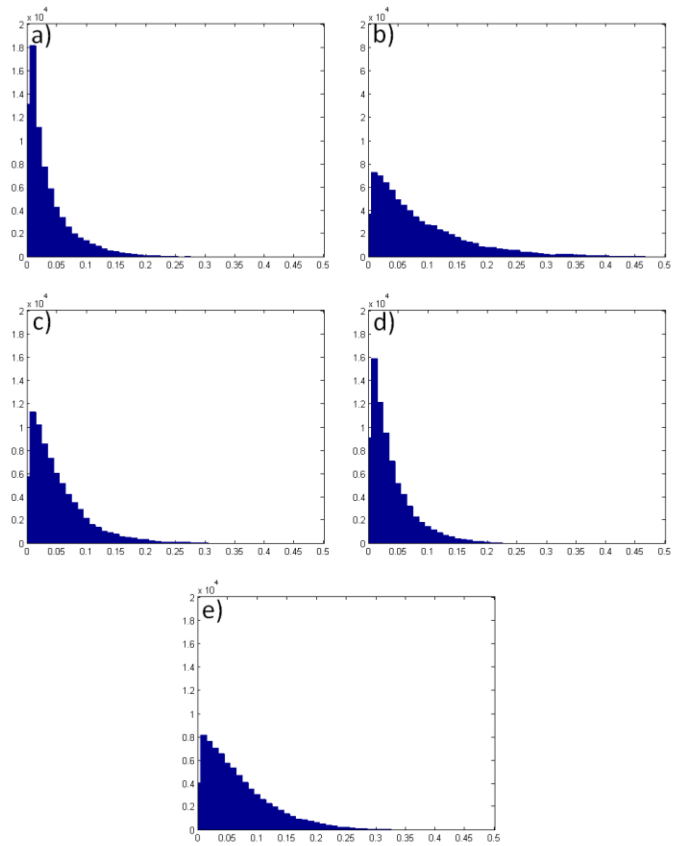

Figure 1. Histograms of standard deviations for (a) natural sibsonian, (b) nearest neighbour, (c) quasi-natural, (d) non-sibsonian and (e) polynomial methods for the set of 74 400 interpolated ionosphere pierce points.

Key words: Ionosphere, TEC Maps, Voronoi diagram, Natural Neighbour Interpolation