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Study of the error sources in GPS data from the IGS network in Africa and potential for applications in the AMMA project.

A. Walpersdorf (1), M.-N. Bouin (2) and O. Bock (3)

(1) LGIT, Maison des Geosciences, BP 53, F- 38041 Grenoble Cedex 9 (andrea.walpersdorf@obs.ujf-grenoble.fr, fax: +33-4-76828101), (2) ENSG/LAREG, 6 et 8, Av. Blaise Pascal, 77455 Marne-la-Vallee, (3) Service d'Aeronomie du CNRS, Universite Pierre et Marie Curie, 4, place Jussieu, 75252 Paris Cedex 5

This study has been conducted to assess the availability and quality of data from the IGS (International GPS Service) - Global Positioning System (GPS) network in Africa, in view of application to the AMMA (African Monsoon Multidisciplinary Analysis) project. The GPS data consist in phase measurements transmitted from a constellation of satellites at 20200 km altitude. The final product to be used in the AMMA project is integrated water vapour (IWV) in the troposphere, which is especially important for the study of the water cycle at timescales ranging from diurnal to interannual. The GPS data analysis consists in the estimation of station coordinates and tropospheric delays (from which IWV is derived), and requires the knowledge of accurate satellite orbits and a proper correction for the radio delay induced by the ionosphere. These are two major errors sources in Africa, mainly because the IGS network is very sparse in that region of the world (10 stations in Africa and 5 in the AMMA domain, most of which have large data gaps). Results are presented from the analysis of GPS data from African stations over the 2001-2004 period. The analysis was performed with the GAMIT (GPS at MIT) software and the IGS precise orbits. Weak degradation of baseline precision with increasing baseline lengths suggests that the average orbital error is less than 1 cm and therefore not limiting the GPS analysis in Africa. The impact of the ionosphere is three-fold in the equatorial band: (i) a very large total electron content, (ii) the loss of the L2-frequency GPS signal at nightfall due to scintillation effects, (iii) the variability of these effects due to magnetic storms and the solar cycle (which was at a maximum in 2001). The loss of L2 data has actu-

ally been observed. It amounts to 2% on average for 2001, with maxima of 8% during magnetic storm events (average over a few days). GPS data have been analysed in a conventional way. The accuracy has been assessed through position repeatability and residuals from the transformation into the International Terrestrial Reference Frame 2000. Repeatability is at a few millimetre level while residuals with respect to ITRF2000 positions is between -2 and 2 mm for horizontal components, up to 6 mm for the vertical component. No specific diurnal cycle was observed in the phase residuals and ZTD formal accuracy. This indicates that scintillation effects are not a major limitation. The impact of ocean loading has also been assessed. It is found to be significant on ZTD estimates (up to +/- 2 kg/m2 in equivalent IWV). The use of a proper ocean loading model has shown to eliminate this effect. In conclusion, the results demonstrate that GPS is capable of providing data of good quality in West Africa which can be used for meteorological applications such as planned in AMMA. It is thus proposed to densify the existing network for the AMMA project.