INFLUENCE OF THE IONOSPHERE MODEL ON THE SOLUTION OF A VLBI GEODETIC EXPERIMENT

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ABSTRACT. The GRIG-2 geodetic VLBI experiment was conducted in 1985, linking for the first time South America, Europe and Africa. At the single frequency band of 1.66 GHz which was used, the monitoring of the ionosphere is a critical aspect and several predictions of Total Electron Content (TEC) were used. One of them is derived from dual band Doppler observations of TRANSIT satellites, which were simultaneously conducted. The influence of these models on the solution is presented, with comparisons with other VLBI solutions. Decimetric accuracy has been achieved.

1. THE EXPERIMENT

The participating stations were Atibaia (Brazil), Hartebeesthoeck (S.Africa), Madrid (Spain, Deep Space Station 63), Nançay (France, a quasi meridian antenna of 94m equivalent diameter), and Onsala (Sweden). Some constraints in the available equipment led to the following set-up : L-band observations (1.66 GHz), with Mark II recording of two channels 18 MHz apart and switched at 1 pps to construct BWS delay. To minimize the ionospheric effect in taking advantage of the common night time at all stations, two 6.5 hour sessions were conducted starting June 29. 1985 at 20h45 UT and July 4, 1985 at 21h00 UT.

2. THE IONOSPHERE MODELS

The post-correlation processing was done with the JPL software MASTERFIT [1]. It allows to introduce ionosphere models in the form of lists of zenithal TEC values versus time. This value is then mapped to the relevant longitude with an hour angle dependence, and to the direction of the source. Five different models were used to derive the TEC values. They are thereafter represented by the symbols I0, to I4.

I0 is the absence of any model
I1 is the default MASTERFIT model
I2 is the Bent model [2]
I3 is derived from dual band Doppler observations (see below)
I4 incorporates ionosonde data from South Africa

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3. TEC FROM DUAL FREQUENCY DOPPLER

The NNSS TRANSIT satellites transmit two frequencies around 150 and 400 MHz. Dual frequency receivers allow to derive the ionospheric delay in the direction of the satellite, in fact its variation with time. The absolute value of the delay is then computed either from a theoretical assumption on the time variation of the delay or, when two stations observe the same satellite, without this uncertainty. Several authors have presented the method, for exemple [3]. A program developed at the Geodetic Institut in Bonn [4] has been adapted to derive the TEC model I3.

4. COMPARISON OF TEC MODELS

The I3 model has been derived from Doppler data collected by TRANET stations or by receivers specially operated for the experiment. However, only the South African zone could be covered with two stations. The I4 model has been derived from ionosonde measurements in South Africa, with Dudeney model up to F2 layer plus Chapman Alpha model for top-side ionosphere. These two models agree reasonably well over the South Africa zone : they differ by about 20 to 30%. They have also the same kind of agreement with model I2. Thus, the confidence in the ionosphere model for the Hartebeesthoeck station is important.

In comparison, there are serious doubts on the TRANET data, which model on the European zone seems to degrade the results. It has not been used in the final I3 solution.

5. COMPARISON OF RESULTS

Three out of the five stations (DSS63, Onsala and Hartebeesthoeck) have already participated in high precision VLBI experiments. The GSFC solution [5] has been used as a "fiducial" one to compare our different solutions : we have adjusted a single translation between each GRIG-2 solution and the GSFC one. The RMS of the residuals of the coordinate differences is then a good estimate of the quality of the GRIG-2 solution. All I2, I3 and I4 solutions achieve RMS of residuals in the range 10-15cm.

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