GEODYSSEA 94–96 : Data processing at ENS, Paris

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The results of the GEODYSSEA GPS campaigns 1994 and 1996 achieved at ENS in Paris are the GEODYSSEA station positions, the station velocities in different reference frames and the distribution of strain and spin in the network.

Our input data were the GPS data of the 2 GEODYSSEA campaigns 28/11 - 02/12/94 and 18 - 22/04/96, inclusive data from additional Sulawesi stations observed in the main sessions and appended sessions in the Sulawesi area. GPS data of the 5 recommended IGS stations KIT3, TAIW, TIDB, TSKB and YAR1 and of available AUSLIG stations COCO, KARR, XMAS, DARW were included in the analysis. The data acquired at a measurement interval of 30 s have not been decimated during the whole processing procedure. Precise GPS satellite orbits from the IGS solution were employed.

The processing software used at ENS are the MIT software packages GAMIT 9.4, GLOBK 4.0 and FONDA 1.1 (*King R. and Y. Bock, Documentation for the MIT GPS analysis software GAMIT, internal publication, 1991* and *Herring T., GLOBK: Global Kalman filter VLBI and GPS analysis program, internal publication 1991* and *Dong D., FONDA: FOrward modeling Network Deformation Analysis software, internal publication 1993*). The processing strategy we applied is to calculate first for both of the measurement campaigns daily solution in 24 hours sessions by GAMIT. In each session the theoretical values for phase and pseudorange observables are modelled. The model parameters such as station coordinates, phase biases and zenith parameters are adjusted by a least square method to minimize difference between observables and calculated values.

The observables are examined in the ionosphere–free combination (LC) and in double differences between two satellites and two stations. The modelling includes the antenna phase center variation tables by *Rothacher and Mader [1996]* to limit the error introduced by different antenna types in the network. The signal delay by the troposphere is taken into account by the tropospheric model of *Saastamoinen [1972]* with meteorological standard values transfered to the altitude of each station. The variability of the humidity which cannot be modelled is compensed by the estimation of tropospheric parameters. There is a zenith delay evaluated in the solution for every station every 3 hours.

In the solution for each individual session we keep the IGS orbits fixed. A very robust solution is established in minimising the residuals between modelled and theoretical observables in double differences on all of the baselines in the network. The modelling parameters to adjust apart of the zenith parameters are the station positions and the phase ambiguities, which are allowed to be real valued in a first step of the solution. Then we attempt to resolve the phase ambiguities by a routine after *Dong and Bock (J. Geophys. Res., 94, 3949–3966, 1989).*

The average amount of biases resolved on all independent baselines is 15 %. This amount of bias resolution increases the stability and the precision of the solution. On this solutions is based the following analysis.

The scatter of independent results of the 24 hours sessions for each baseline component shows the repeatability of the measurement. The mean repeatability of the solution including the antenna model and bias fixing is for the 1994 campaign with 48 stations, 5 sessions of 24 hours and 2246 baselines in all daily solutions 5.9 mm, 7.5 mm and 14.7 on the North, East and Up component of the baselines.

For the campaign in 1996 we calculated 12 daily solutions for 55 stations. To the 5 sessions of 24 hours in the main observation periode on 44 stations were appended 7 sessions on 14 stations in the follow on measurements on Sulawesi, with 2138 baselines observed in total. The mean repeatability is 7.2 mm, 8.6 mm and 18.5 mm on the North, East and Up component.

As the next step, global campaign solutions are established by GLOBK, which is a Kalman filter applied to the analyses of solution vectors and associated covariance matrices generated during daily GAMIT solutions (*see Herring et al.,J. Geophys.Res, 95, 12561 – 12581, 1990*). The independent daily GAMIT solutions are combined by the Kalman filter to global (multisession) free network solutions for 94 and 96 with loose constraints on positions and fixed IGS orbits. A representation of the positions in both of the solutions in ITRF94 has been done by constraining the IGS stations included in the analysis to their positions in ITRF94. The velocity solution is obtained in combining the 2 epochs. The displacements over the interval of 17 months between the two measurement campaigns is attributed to a linear velocity on each station. A free network solution is established showing a formal precision of 2, 2 and 5 mm/yr in the average on the North, East and Up components of the velocities. To represent the velocity solution in ITRF94, high constraints have to be applied. That shows that there might be an incompatibility between the GEODYSSEA measurements and ITRF94 for the 5 IGS stations used in the analysis.

The network adjustment program FONDA developed at MIT and JPL is now used to calculate the distribution of strain and spin in the network (*see K. Feigl, J. Geophys. Res., 95, 2679–2699, 1990*). Input are the station coordinates and velocities from the free network GLOBK solution. Three GEODYSSEA (Biak, Irian Jaya; Tomini, Sulawesi; and Laoago, Philippines) stations showing clearly coseismic displacements are excluded from this study.

Further investigations of the co-seismic deplacements and modelisations of the earthquakes are presentely carried on. The deformation patterns are computed in the smallest and most symetric triangles between the stations. The station distribution with often one single site for a tectonic block makes the representation of strain sensitive of the triangles' geometry, but the spin is well resolved. Both parameters show clearly the limits of influence of the major tectonic plates. The limit of resolution is estimated at 6 mm/yr on 1000 km baseline lengths.

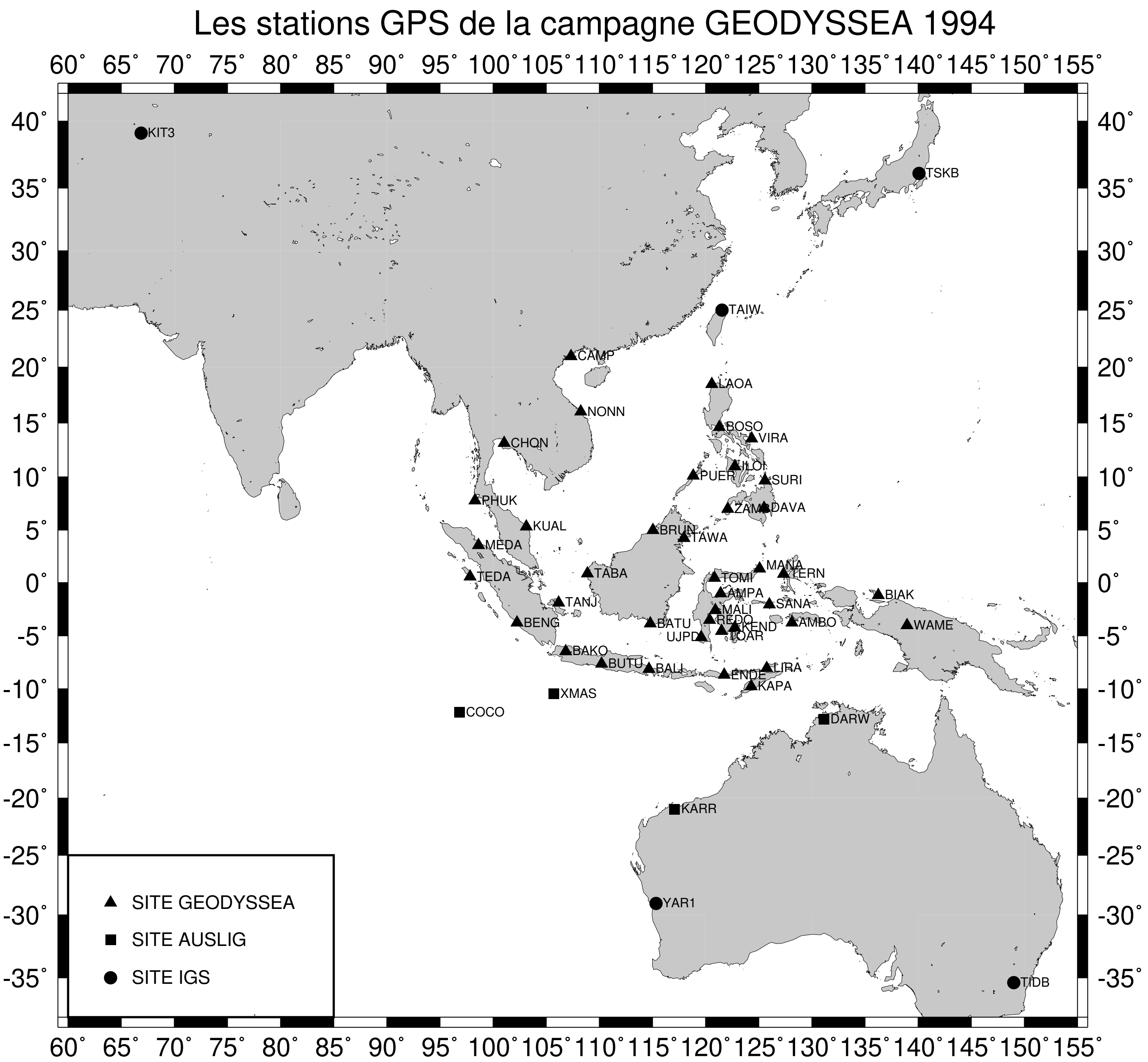

Fig. 1 global GEODYSSEA GPS network, including fiducial stations from IGS and AUSLIG networks.

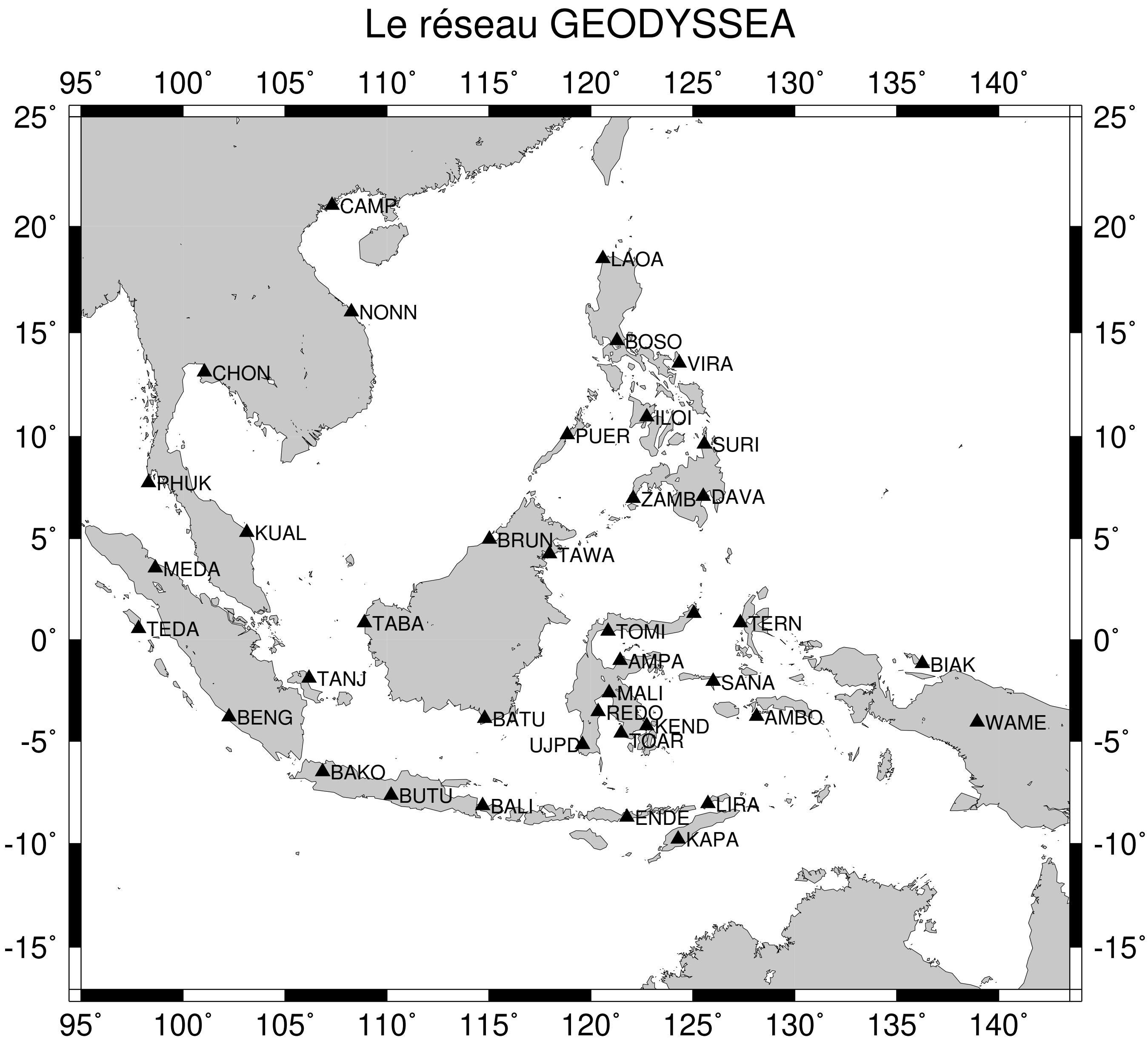

Fig. 2 global GEODYSSEA GPS network, as actually measured in November 1994.

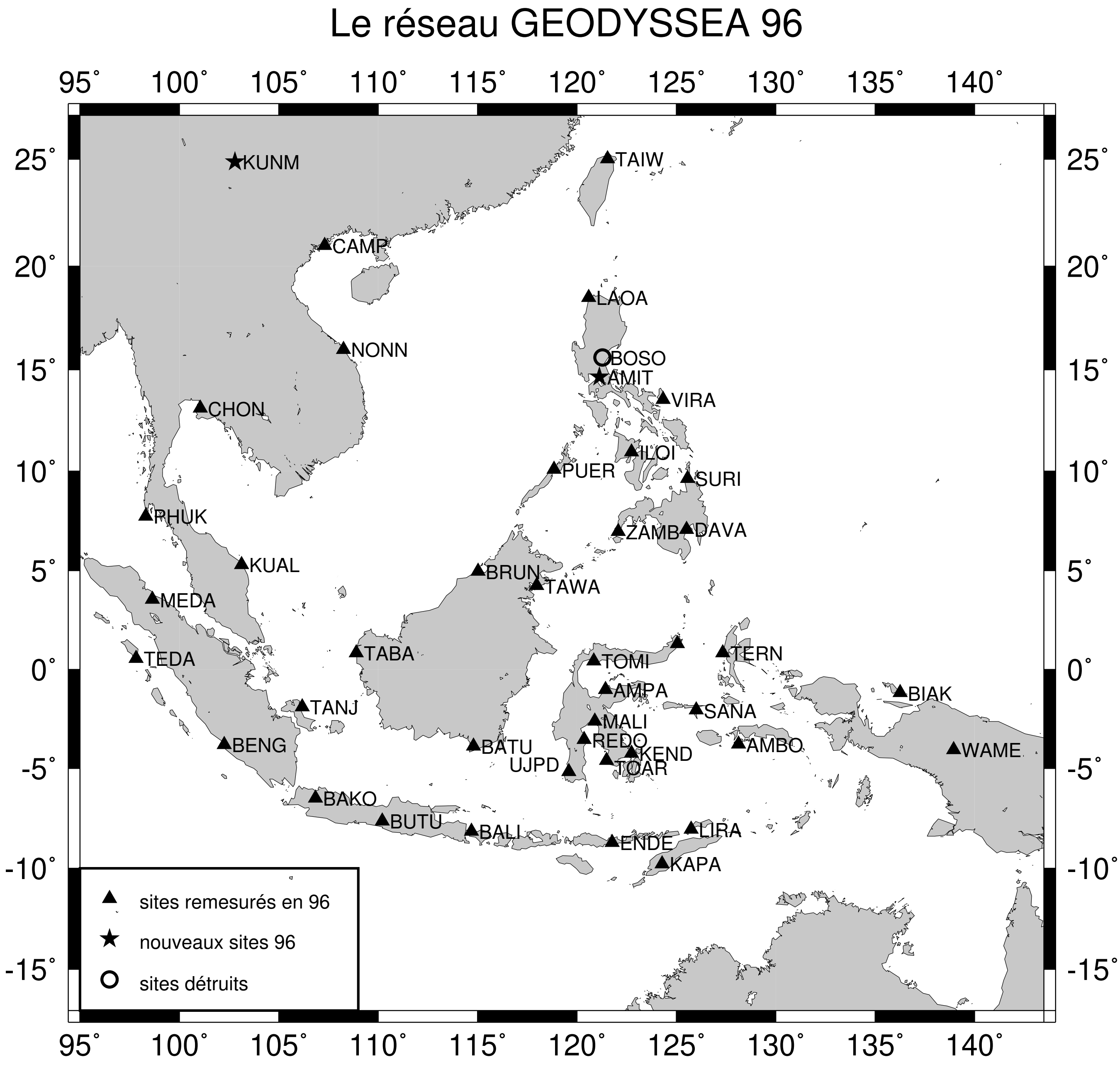

Fig. 3 global GEODYSSEA GPS network, as actually measured in April 1996.

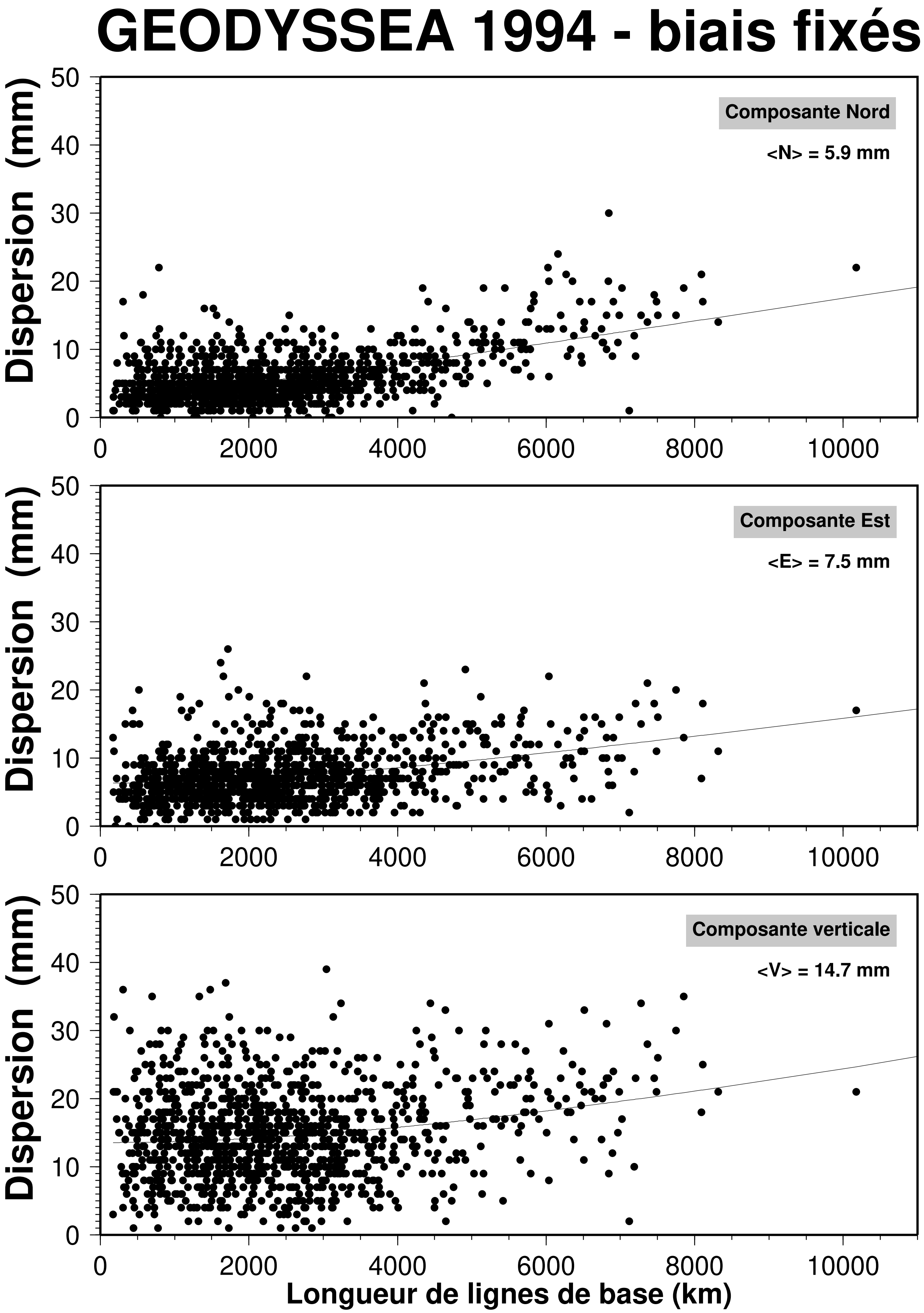

Fig. 4 1994 campaign repeatabilities.

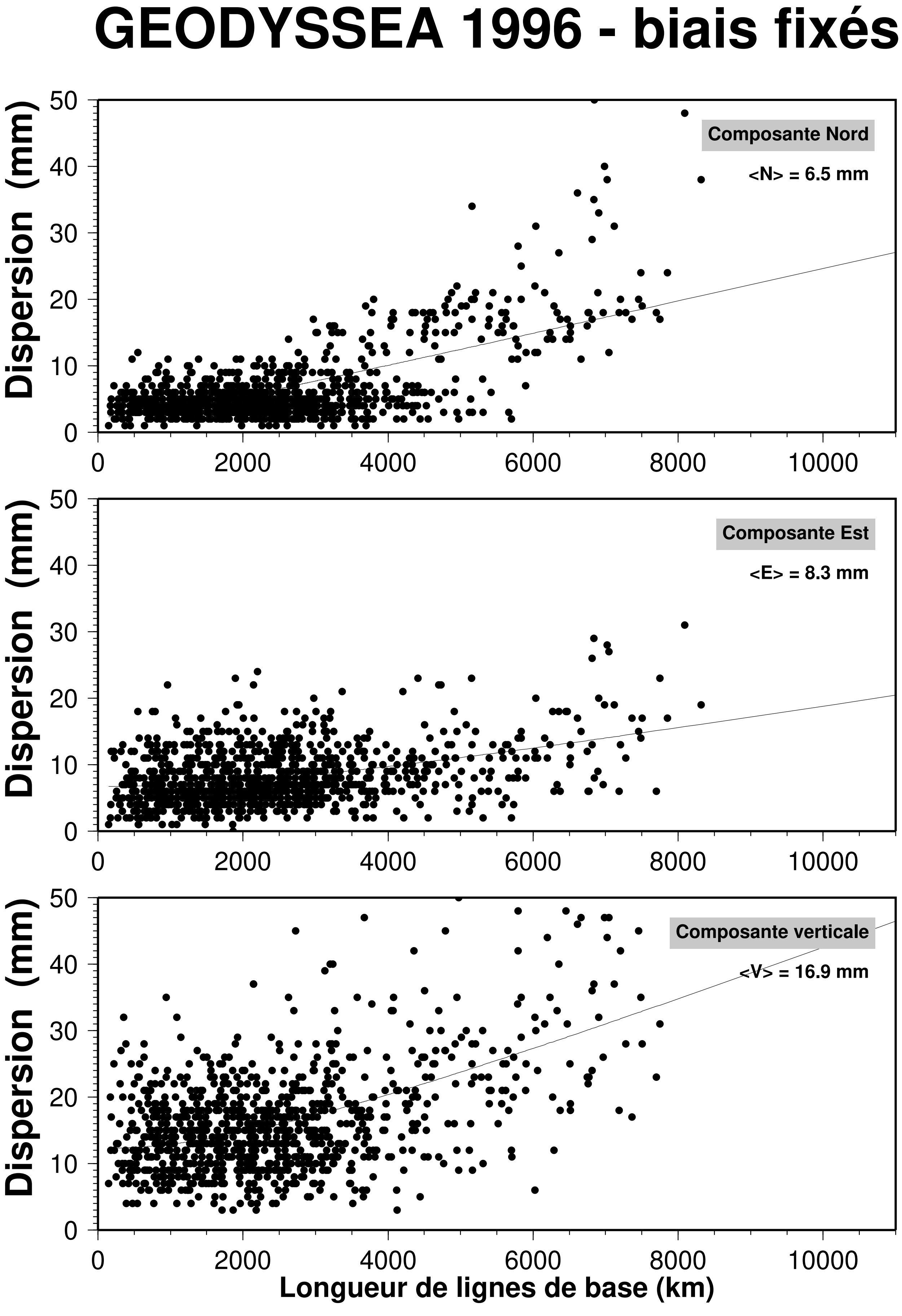

Fig. 5 1996 campaign repeatabilities.

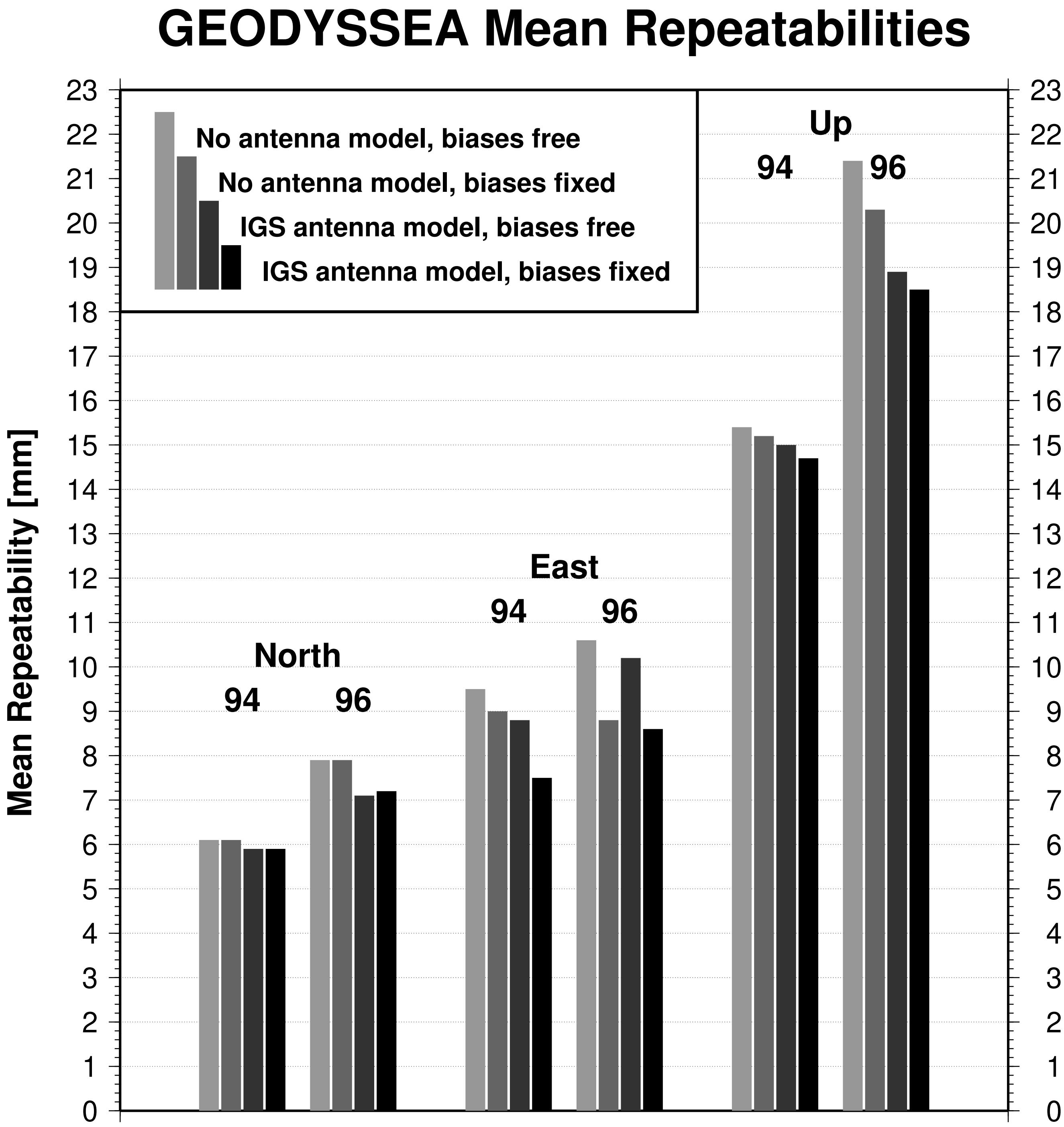

Fig. 6 2 campaigns repeatabilities with and without antenna phase center tables and resolved and/or unresolved phase ambiguities.