PS4-Tu38 Impact of Atmospheric Delay Reduction using KARAT on GPS/PPP Analysis

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1. Introduction

We have been developing a state-of-art tool to obtain the delays by ray-tracing through the meso-scale analysis (MANAL data) data for numerical weather prediction developed by Japan Meteorological Agency (JMA). The tool, which we have named 'KAshima RAytracing Tools (KARAT)', is capable of calculating total slant delays and ray-bending angles considering real atmospheric phenomena. Hobiger et al. [2008a] compared PPP processed position solution using KARAT with that using the Global Mapping Function (GMF) for the data sets of GEONET (GPS Earth Observation Network System) operated by Geographical Survey Institute (GSI). Under the extreme atmospheric condition due to the Baiu front and the typhoon passing, their results imply that the performance of KARAT is almost equal to the solution using the GMF with gradient.
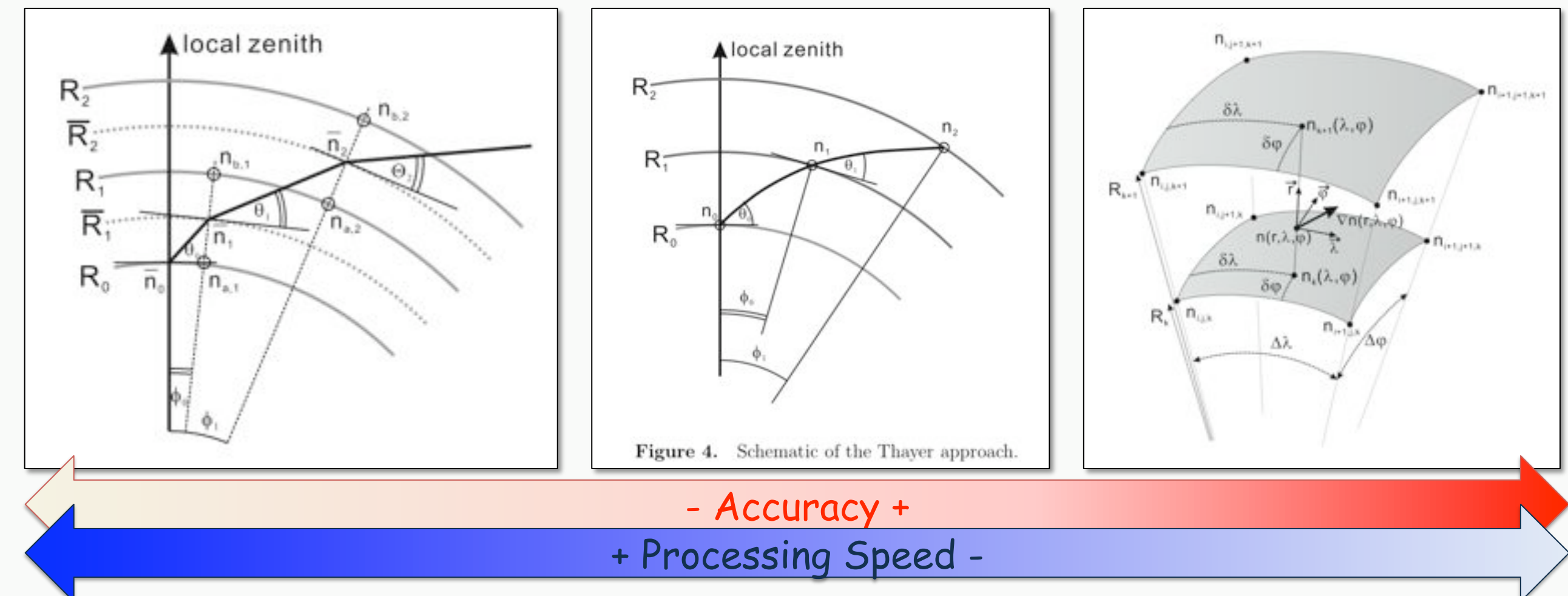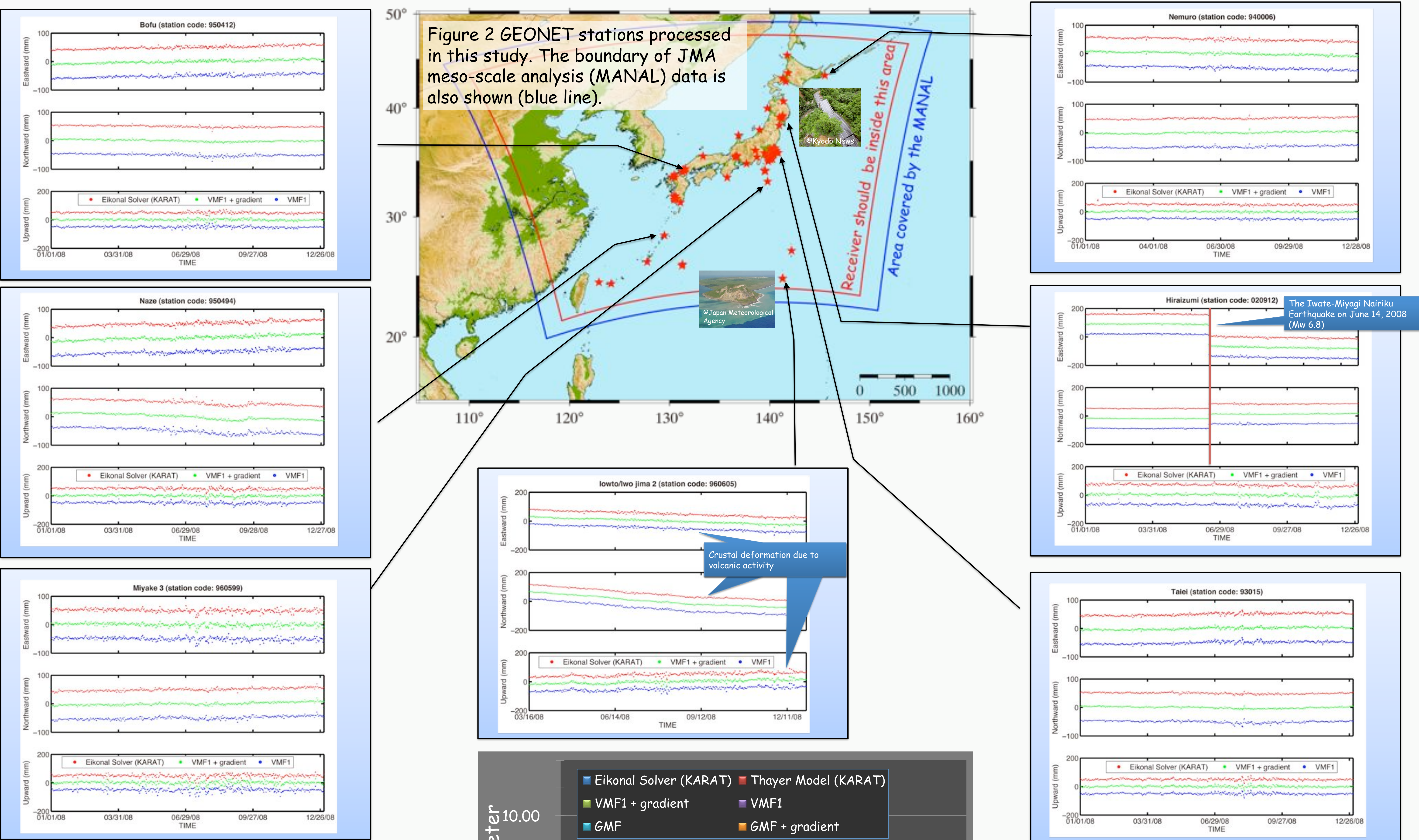

- Accuracy +
+ Processing Speed -

Figure 1 Three schemes of KARAT calculation ([A] piece-wise linear, [B] Thayer model, [C] Eikonal solution strategy).

2. Eikonal Solver and PPP Results for GEONET Stations

The KARAT can estimate atmospheric slant delays by three different calculation scheme. These are (1) a piece-wise linear propagation, (2) an analytical 2-D ray-propagation model by Thayer [1967], and (3) a 3-D Eikonal equation [Hobiger et al., 2008b]. The third scheme gives the most accurate solution and it can predict small scale perturbations which are not retrieved using both Thayer and linear models. We compared PPP processed position solutions using KARAT with those using the latest mapping functions for the data sets of GEONET. In our comparison 66 stations of GEONET data during a year of 2008 were processed.

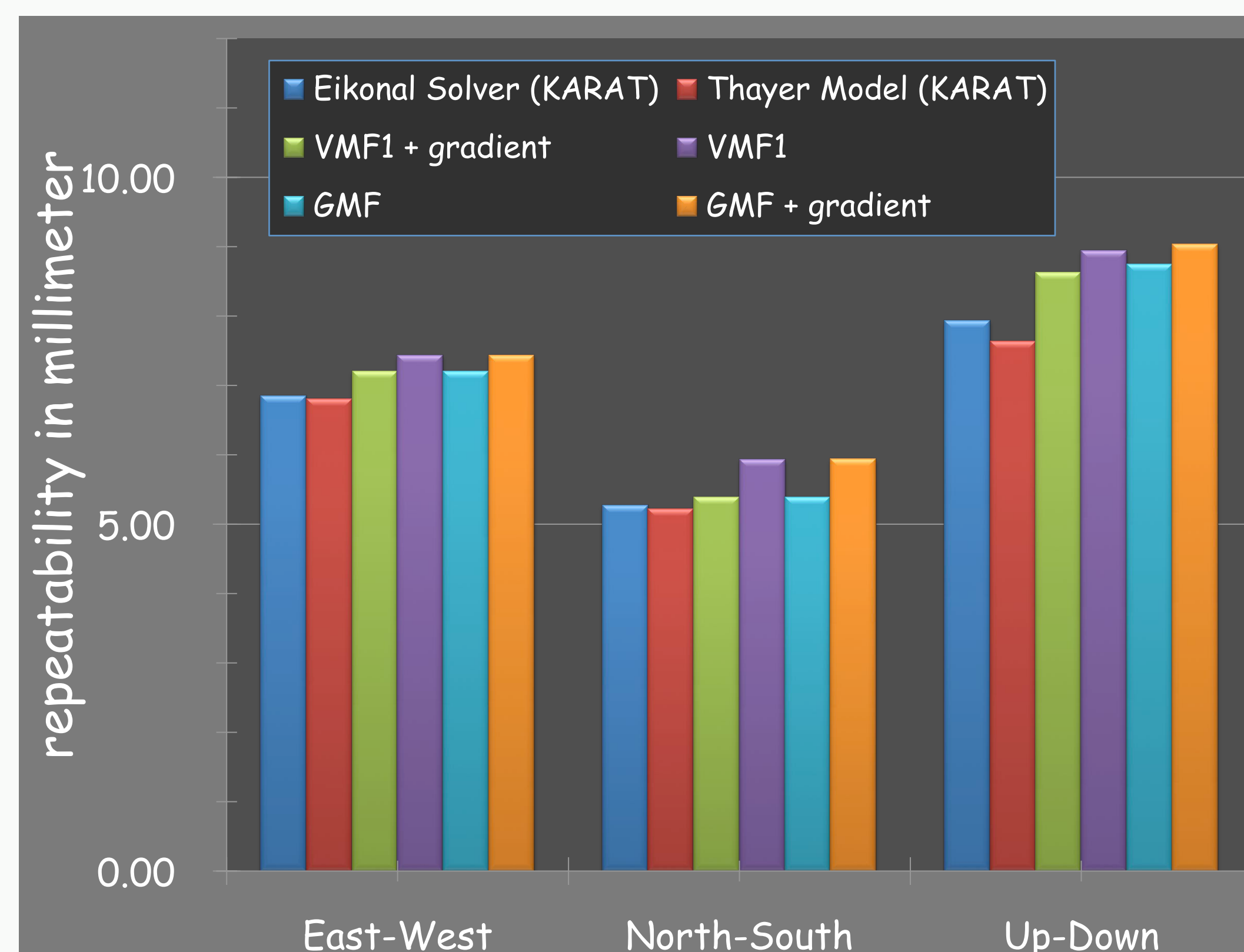Figure 2 GEONET stations processed in this study. The boundary of JMA meso-scale analysis (MANAL) data is also shown (blue line).

Figure 3: Averaged repeatability of station position during year of 2008 for 66 GEONET stations shown in Figure 2.

3. Summary

The KARAT solution is almost identical to the solution using VMF1 (Vienna mapping function 1) with linear gradient model and some cases tends to be slightly better. The advantage of KARAT is an efficient reduction of atmospheric path delay with the numerical weather model improvement (i.e. time and spatial resolution, including new observation data). In spite of the present model imperfectness and coarse time resolution, we hope KARAT will liberate station position determination from numerical instability of unknown parameters.

REFERENCES

(1) Boehm, J. and H. Schuh, Vienna Mapping Functions in VLBI analyses, GRL., 31, L01603, doi:10.1029/2003GL018984, 2004.
(2) Boehm, J., A. Niell, P. Tregoning, and H. Schuh, Global Mapping Function (GMF): A new empirical mapping function based on numerical weather model data, GRL., 33, L07304, 2006
(3) Chen, G. and T. A. Herring, Effects of atmospheric azimuthal asymmetry on the analysis of space geodetic data, GRL., 102, 20489-20502, 1997.
(4) Hobiger, T., R. Ichikawa, T. Takasu, Y. Koyama and T. Kondo, Ray-traced troposphere slant delays for precise point positioning, Earth Planets Space, 60, e1–e4, 2008.
(5) Hobiger, T., R. Ichikawa, Y. Koyama and T. Kondo, Fast and accurate ray-tracing algorithms for real-time space geodetic applications using numerical weather models, JGR., 113(D203027):1.14, 2008.
(6) Takasu, T. and S. Kasai, Evaluation of GPS Precise Point Positioning (PPP) Accuracy, IEIC Technical Report, 105(208), 40-45, 2005.