Atmospheric Delay Reduction Using KARAT for GPS Analysis and Implications for VLBI

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Content

- KARAT
- PPP processing results
- KARATS
- Concluding Remarks
- Outlook

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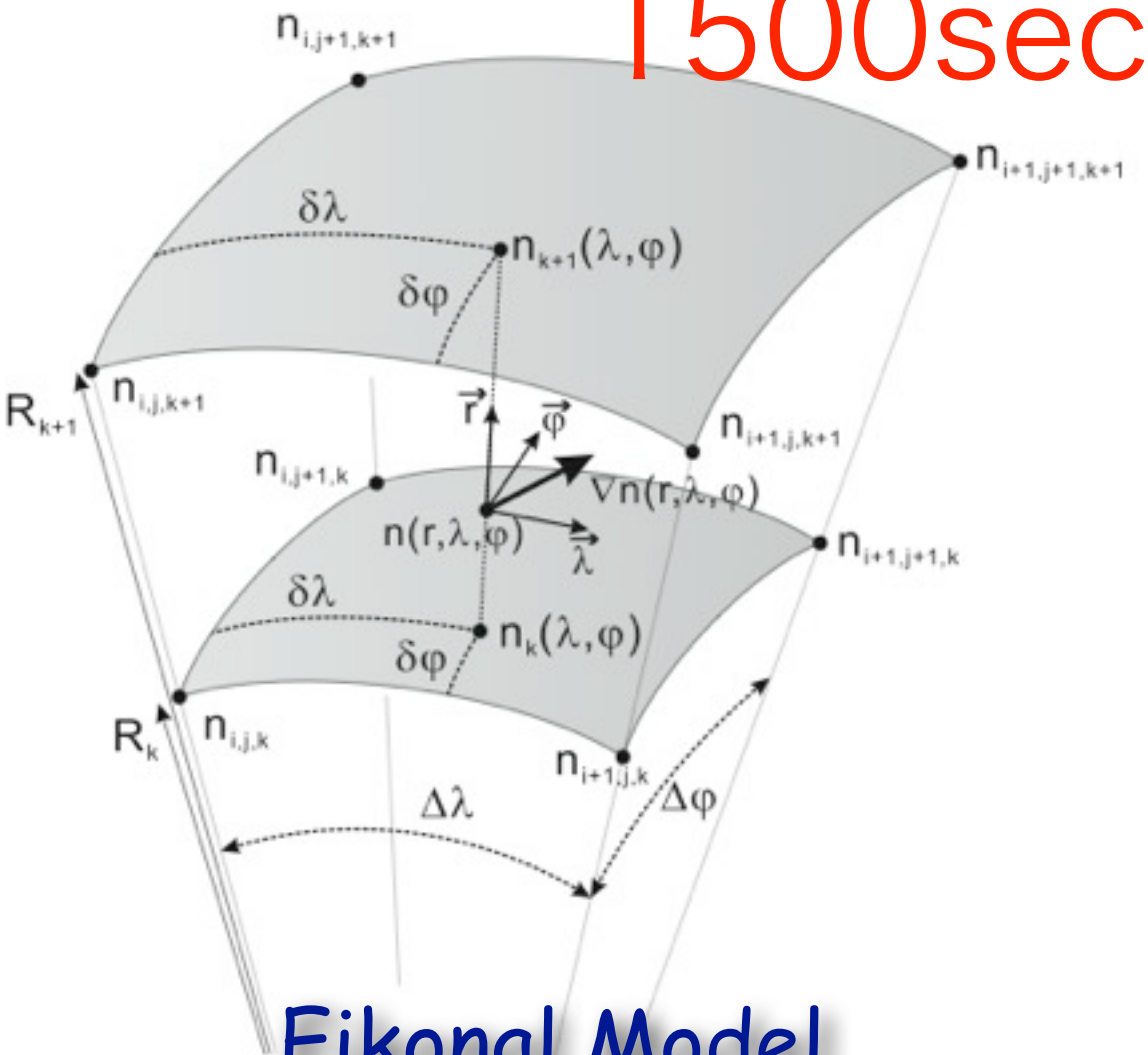
KARAT

- Kashima RAy Tracing Tools
  - slant delay calculated using ray tracing
- JMA Meso-scale Analysis Data
  - 10km grid interval (until Apr. 6th, 2009)
  - 5km grid interval (after Apr. 7th, 2009)

- Hobiger et al., Ray-traced troposphere slant delays for precise point positioning, Earth Planets Space, 60, e1-e4, 2008a.
- Hobiger et al., Fast and accurate ray-tracing algorithms for real-time space geodetic applications using numerical weather models, J. Geophys. Res., doi:10.1029/2008JD010503, 2008b.
- Hobiger et al., Computation of Troposphere Slant Delays on a GPU, IEEE Transactions on Geoscience and Remote Sensing, Vol. 47(10), pp. 3313-3318, 2009.
- Hobiger et al., Improving GPS positioning estimates during extreme weather situations by the help of fine-mesh numerical weather models, Journal of Atmospheric and Solar-Terrestrial Physics, vol. 72, no. 2-3, pp. 262-270, 2010.

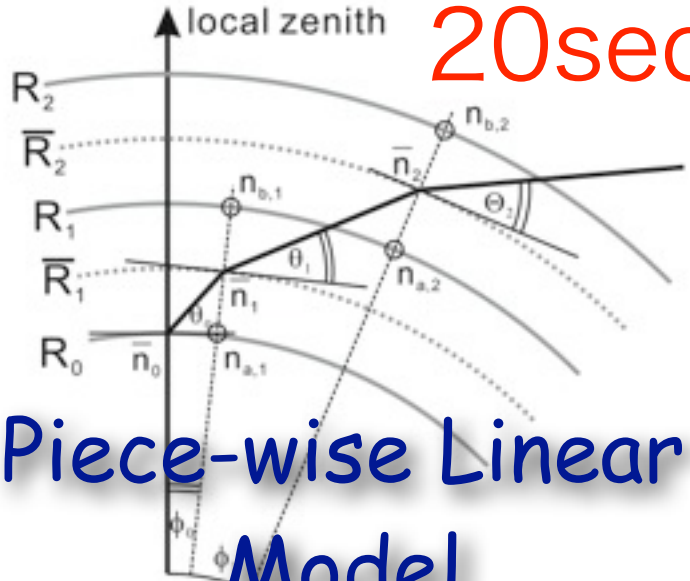
KARAT calculation schemes

1500sec.



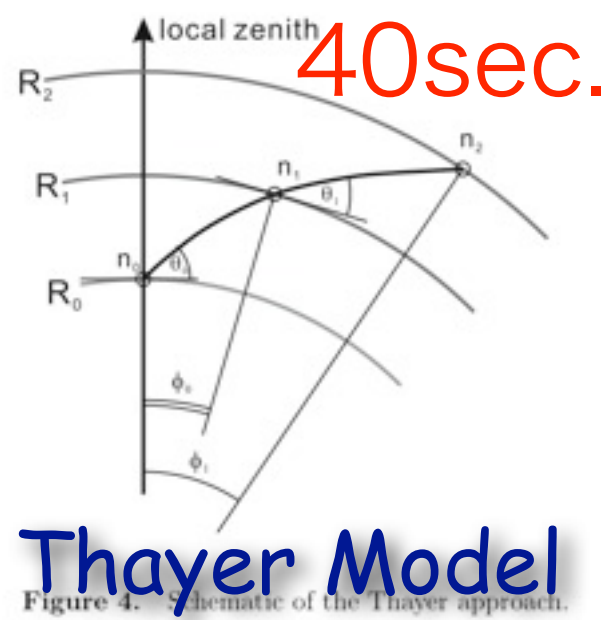
Eikonal Model

20sec.



Piece-wise Linear Model

40sec.

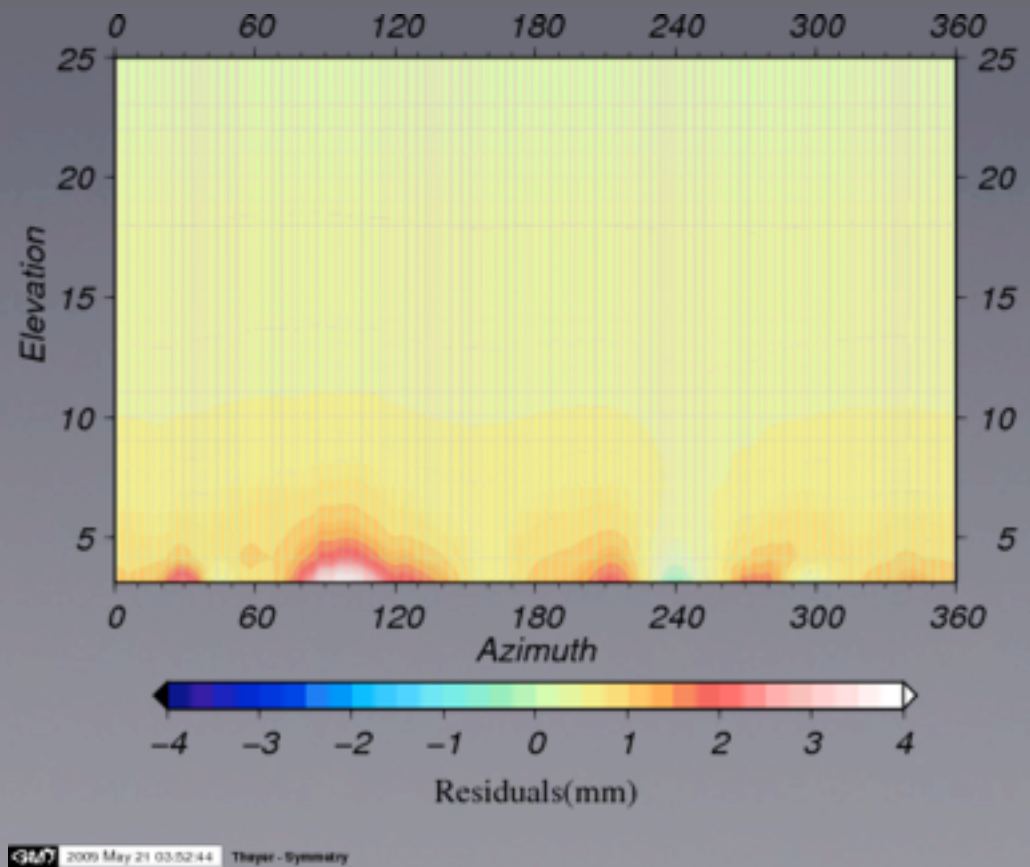


Thayer Model

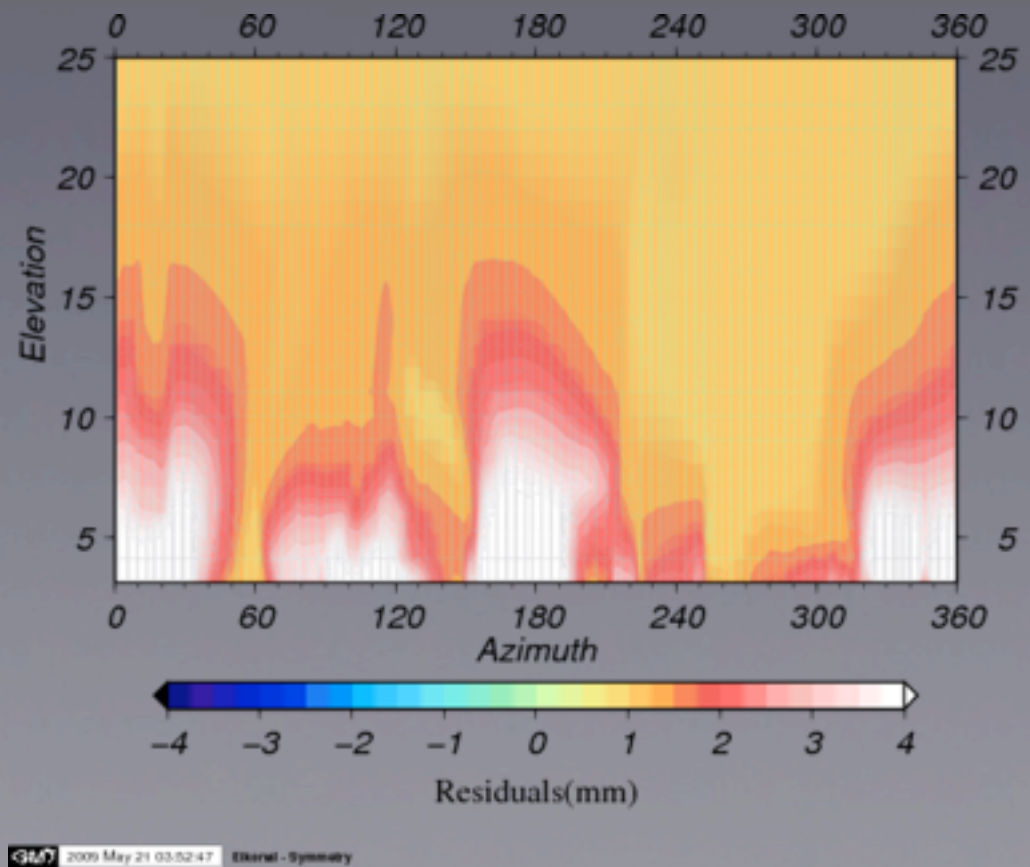
Figure 4. Schematic of the Thayer approach.

Azimuthal Residuals

Thayer - Symmetry



Eikonal - Symmetry



Hobiger et al. [2009]

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GPS/PPP Analysis

- DATA: GEONET/RINEX
  - KARAT reduced and Original
- period: 2008.1.1-12.31 (interval: 300sec.)
- Stations: 58 GEONET Stations
- mapping functions: VMF1, GMF
  - with gradient & w/o gradient
- Elevation cut off: 10°
- processing: GPStools Ver. 0.64(Takasu and Kasai [2003])

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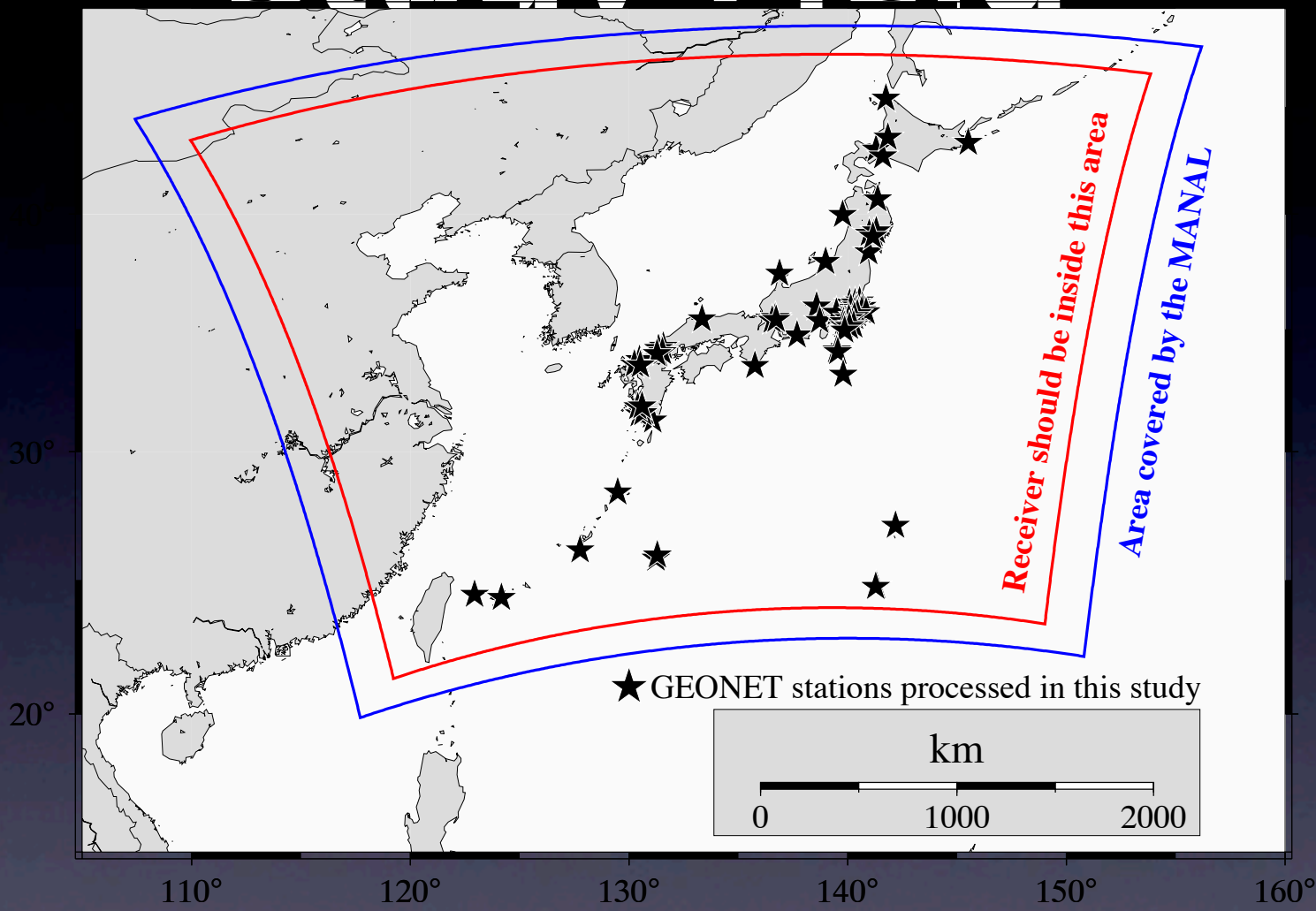
Study Field



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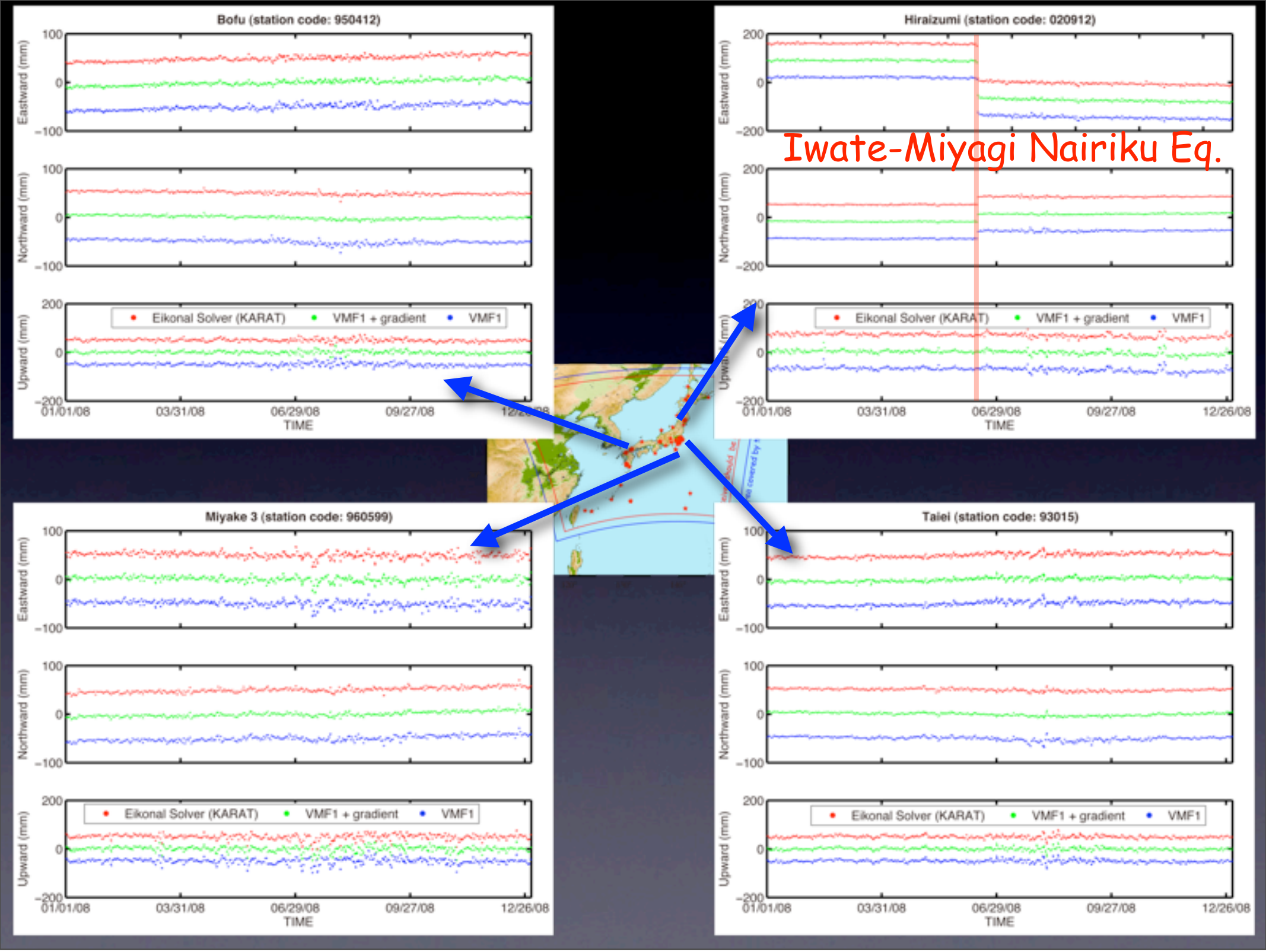
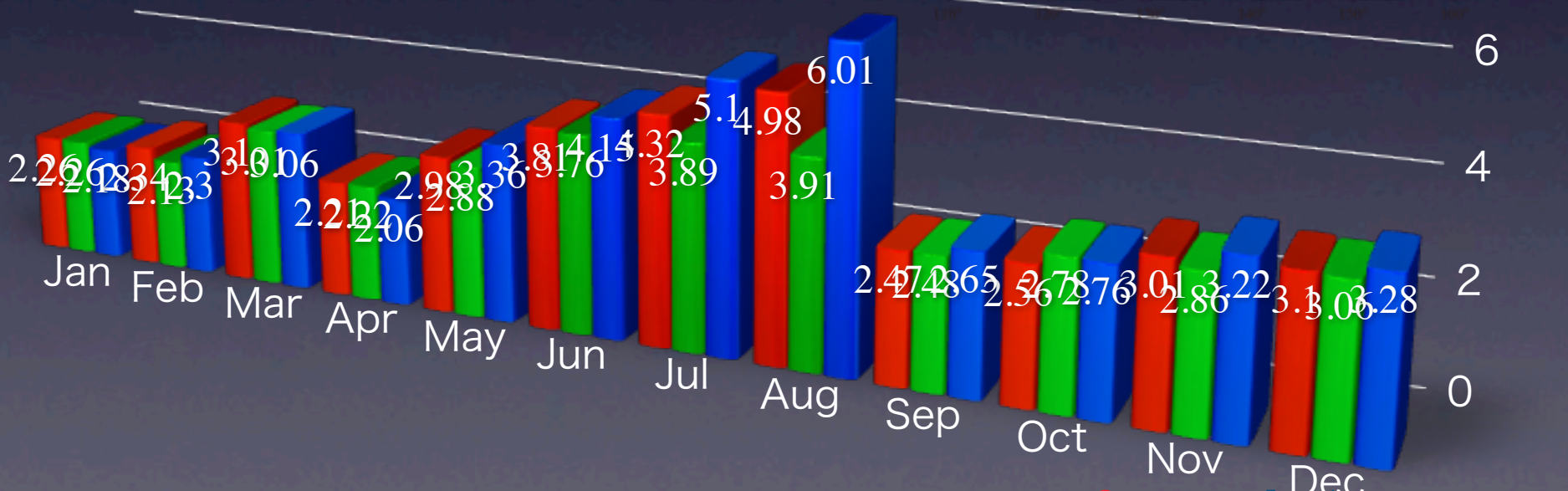

Bofu (station code: 950412)
Hiraizumi (station code: 020912)
Iwate-Miyagi Nairiku Eq.
Miyake 3 (station code: 960599)
Taiei (station code: 93015)
Eastward (mm)
Northward (mm)
Upward (mm)
Eikonal Solver (KARAT)
VMF1 + gradient
VMF1
01/01/08
03/31/08
06/29/08
09/27/08
12/26/08
TIME

93015 -EW-

Eikonal EQ. VMF1+grad VMF1



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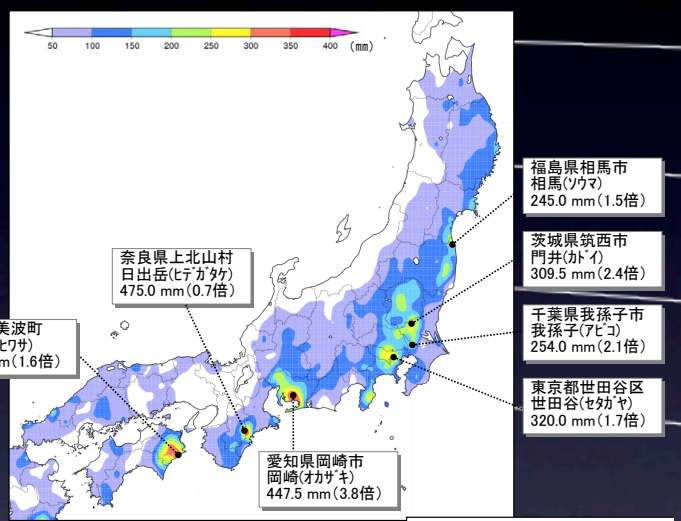
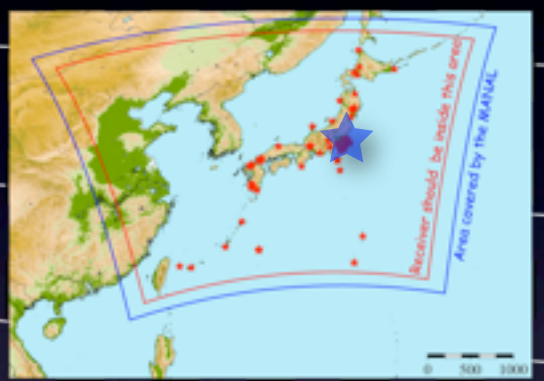
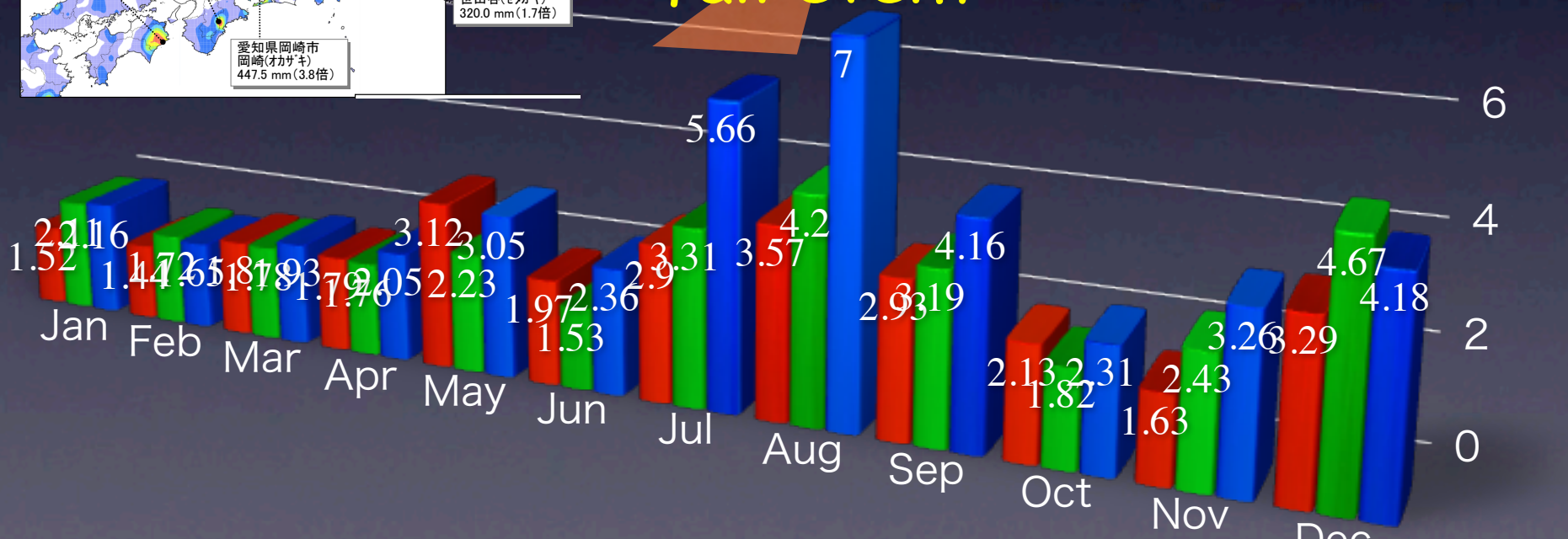
93015 -NS-

Eikonal EQ. VMF1+grad VMF1





Heavy rain fall event



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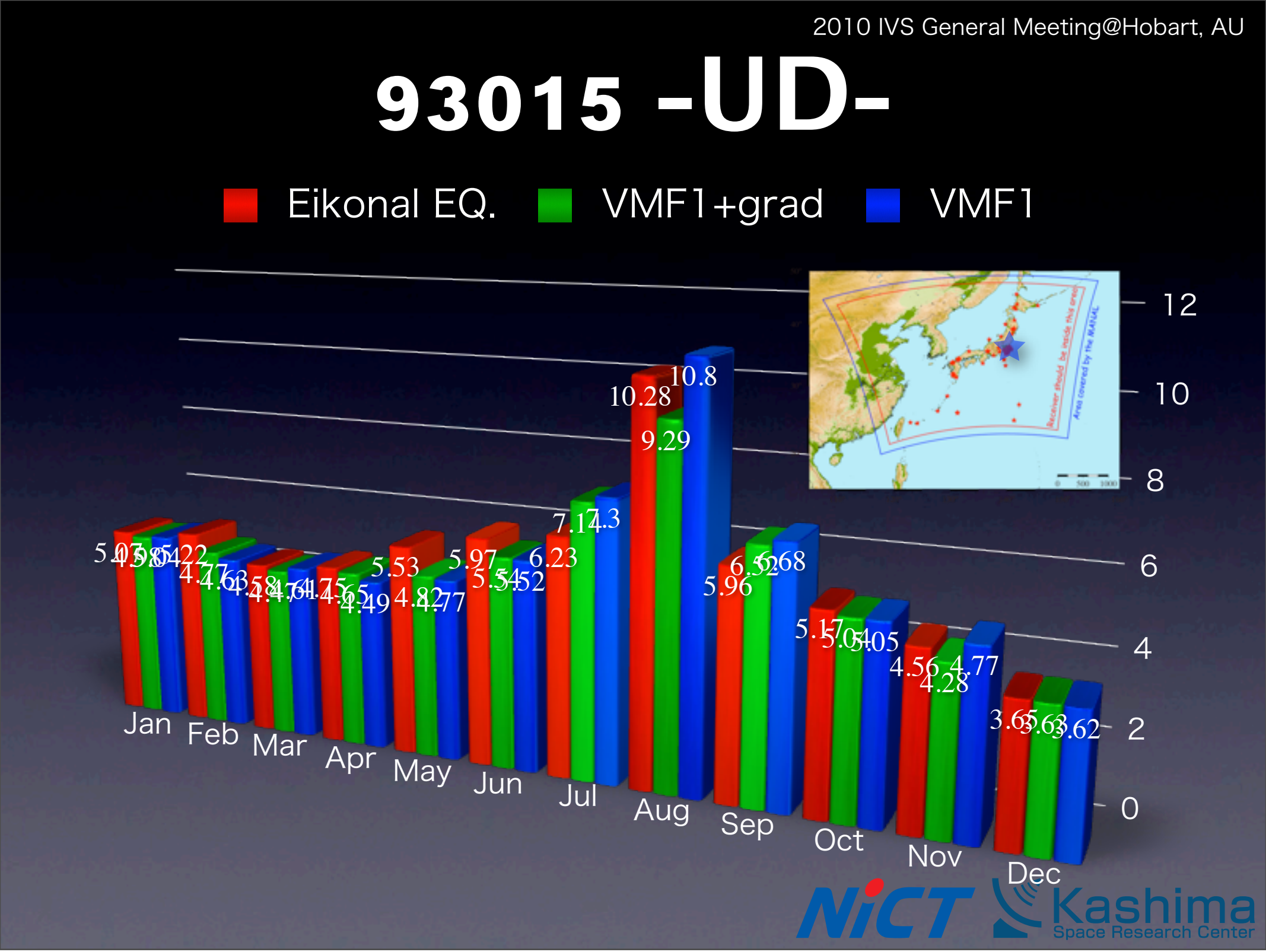
93015 -UD-



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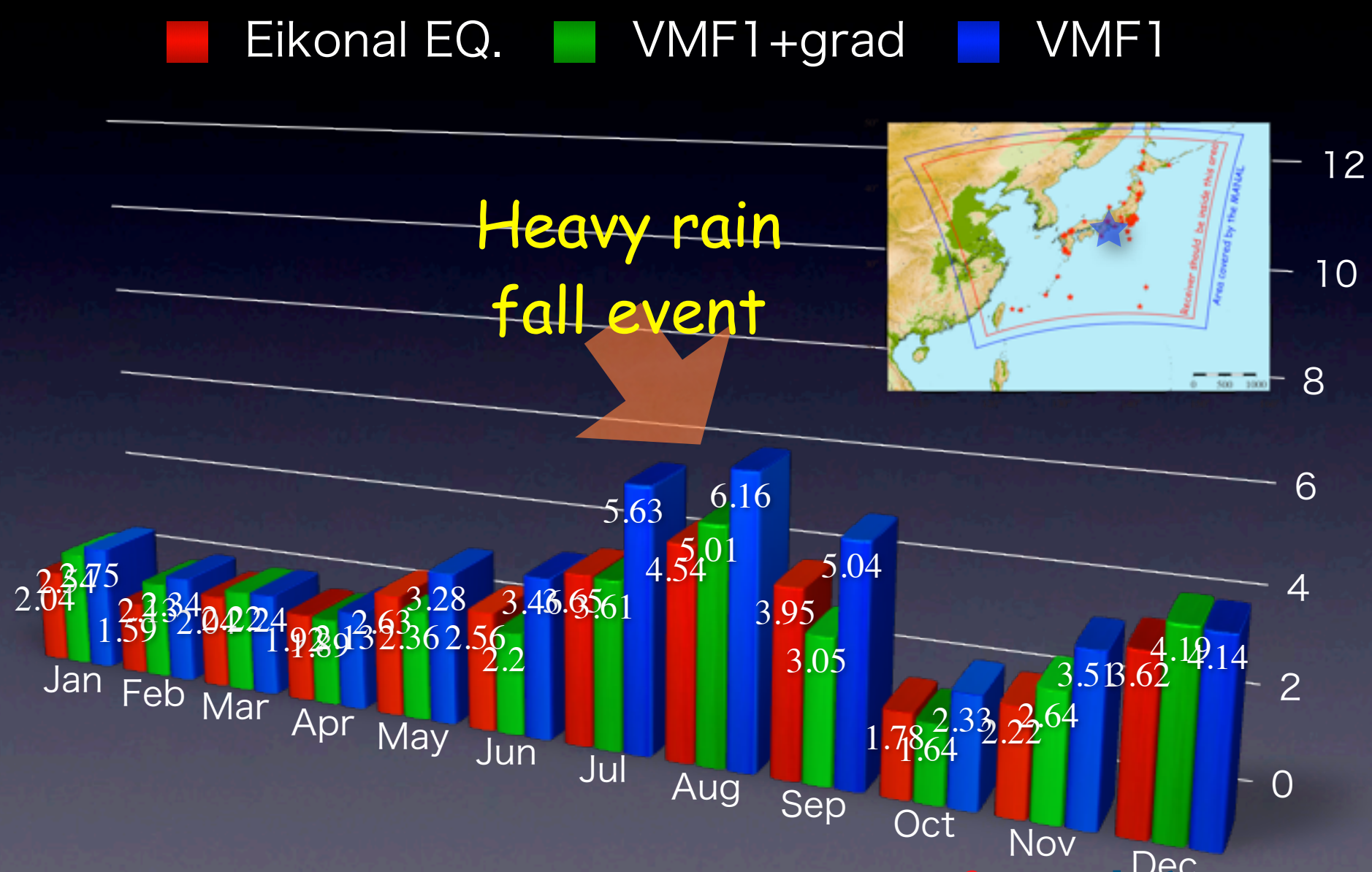
950291 -NS-



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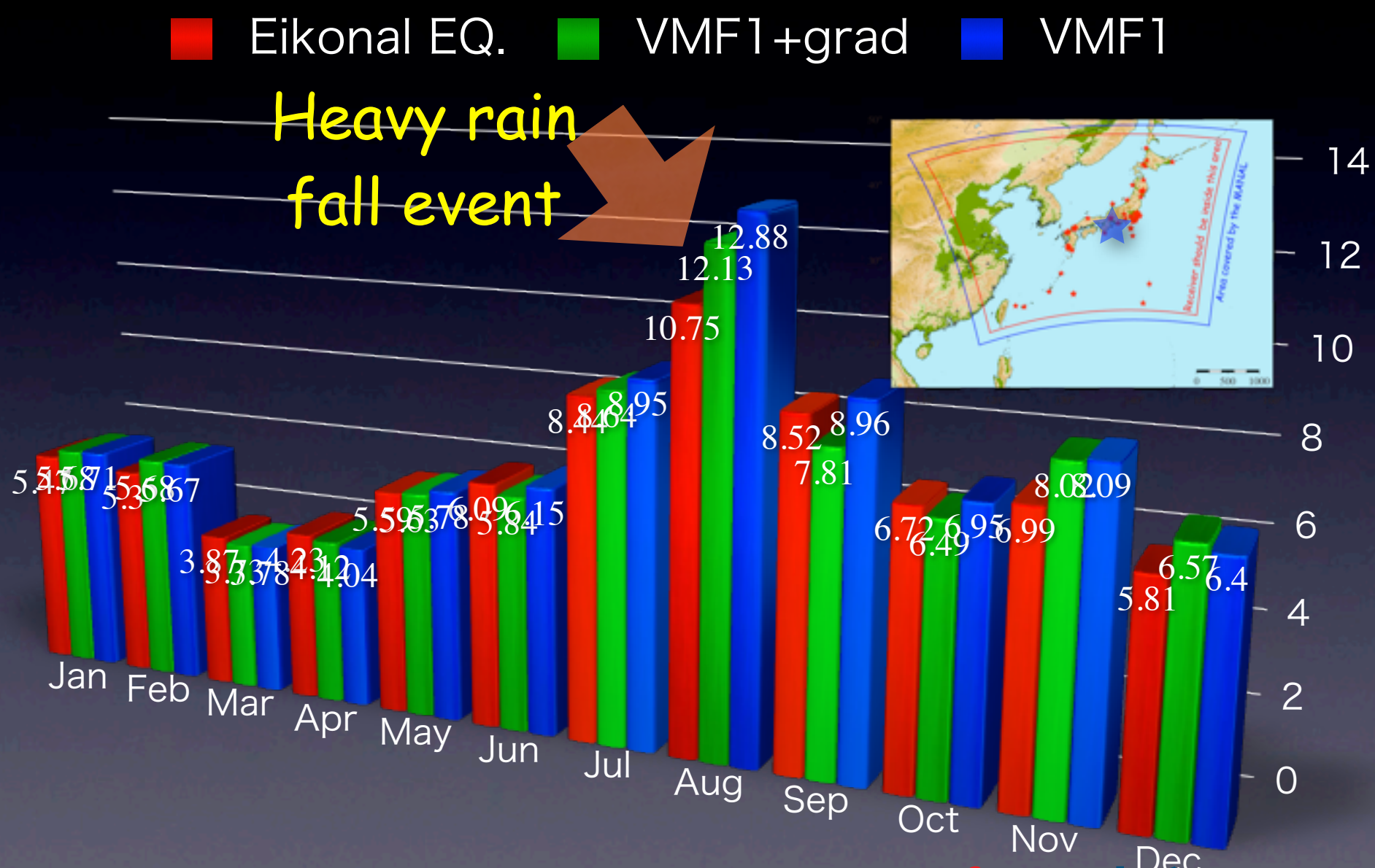
950291 -UD-



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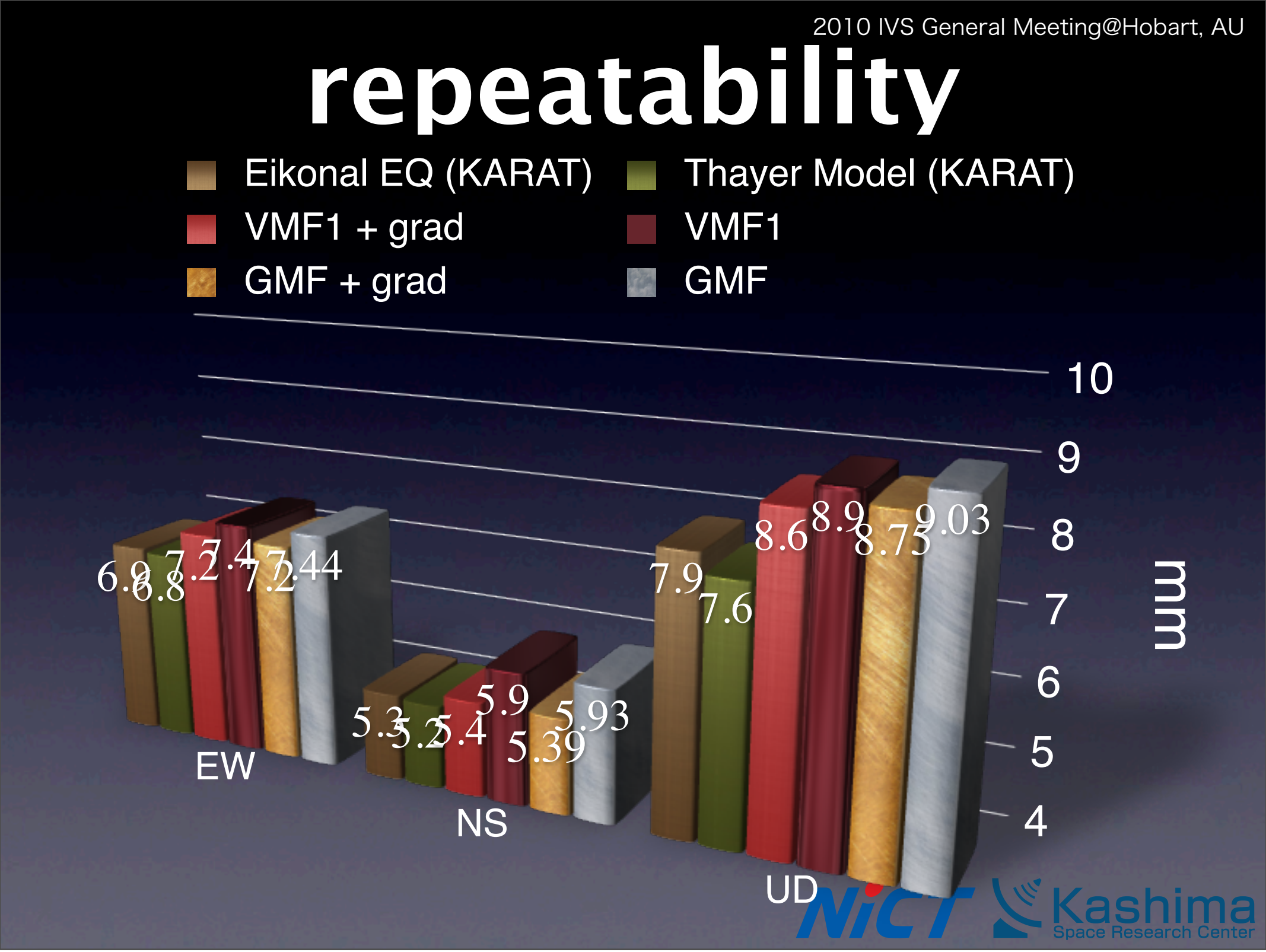
repeatability



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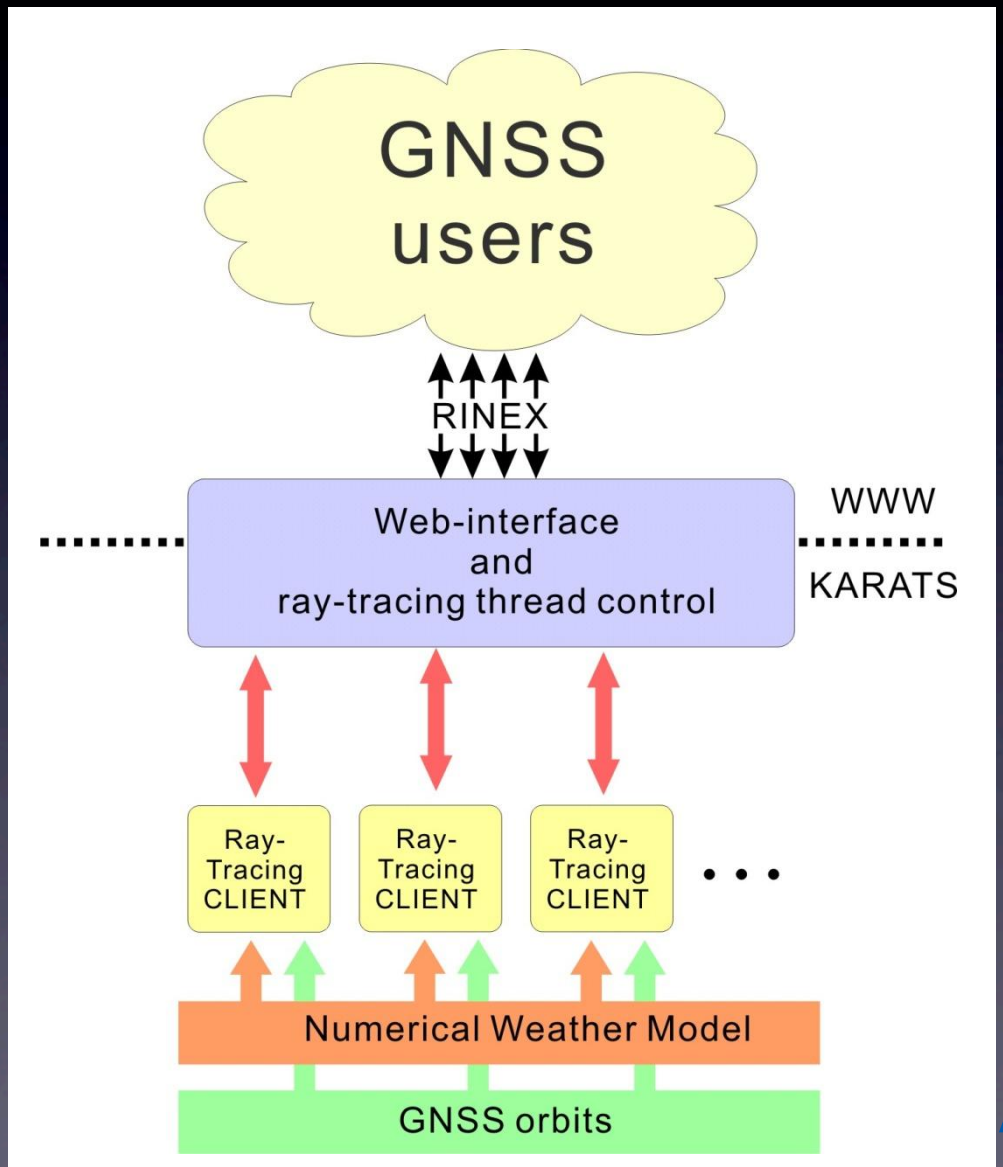
KARATS

Atmospheric delay correction for users



after Hobiger et al. [2009]

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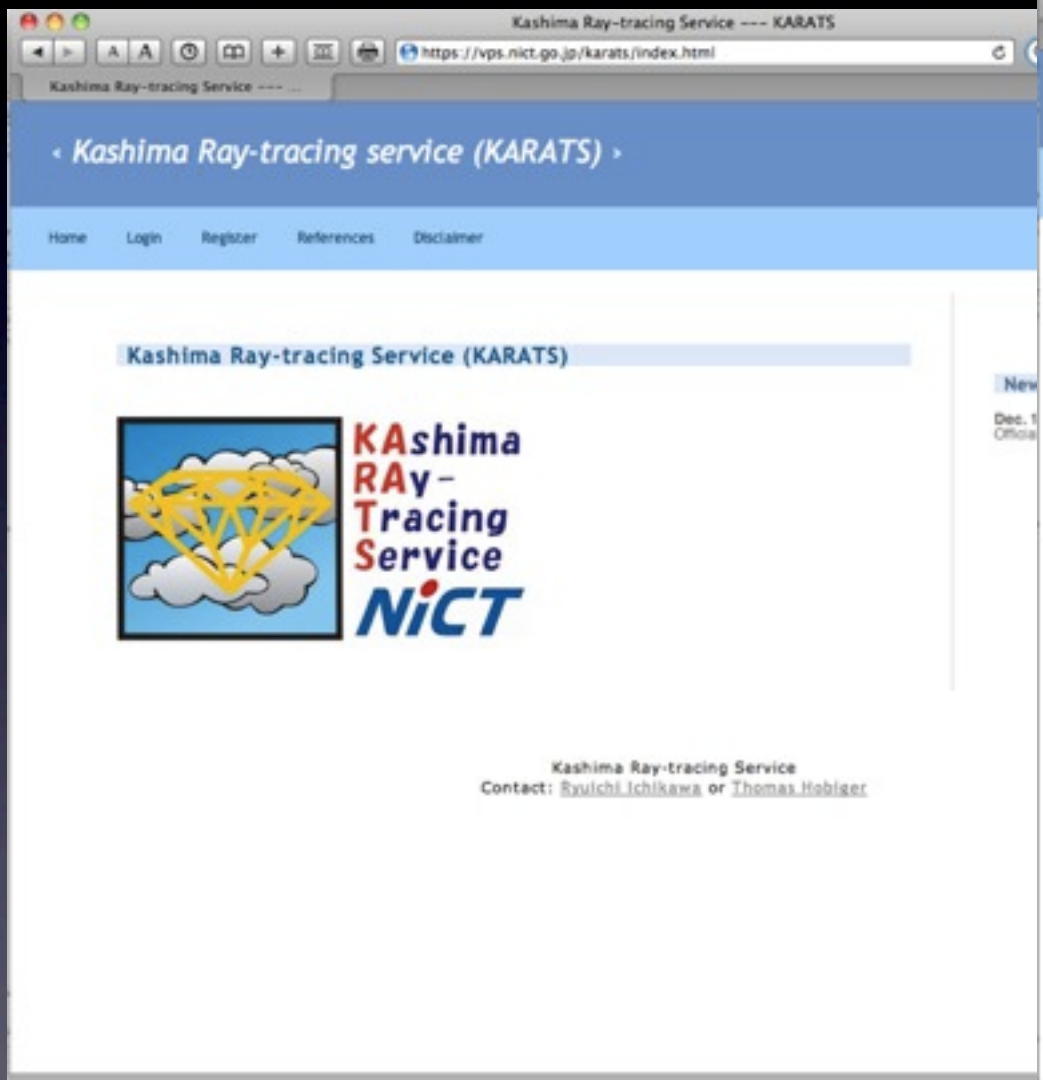
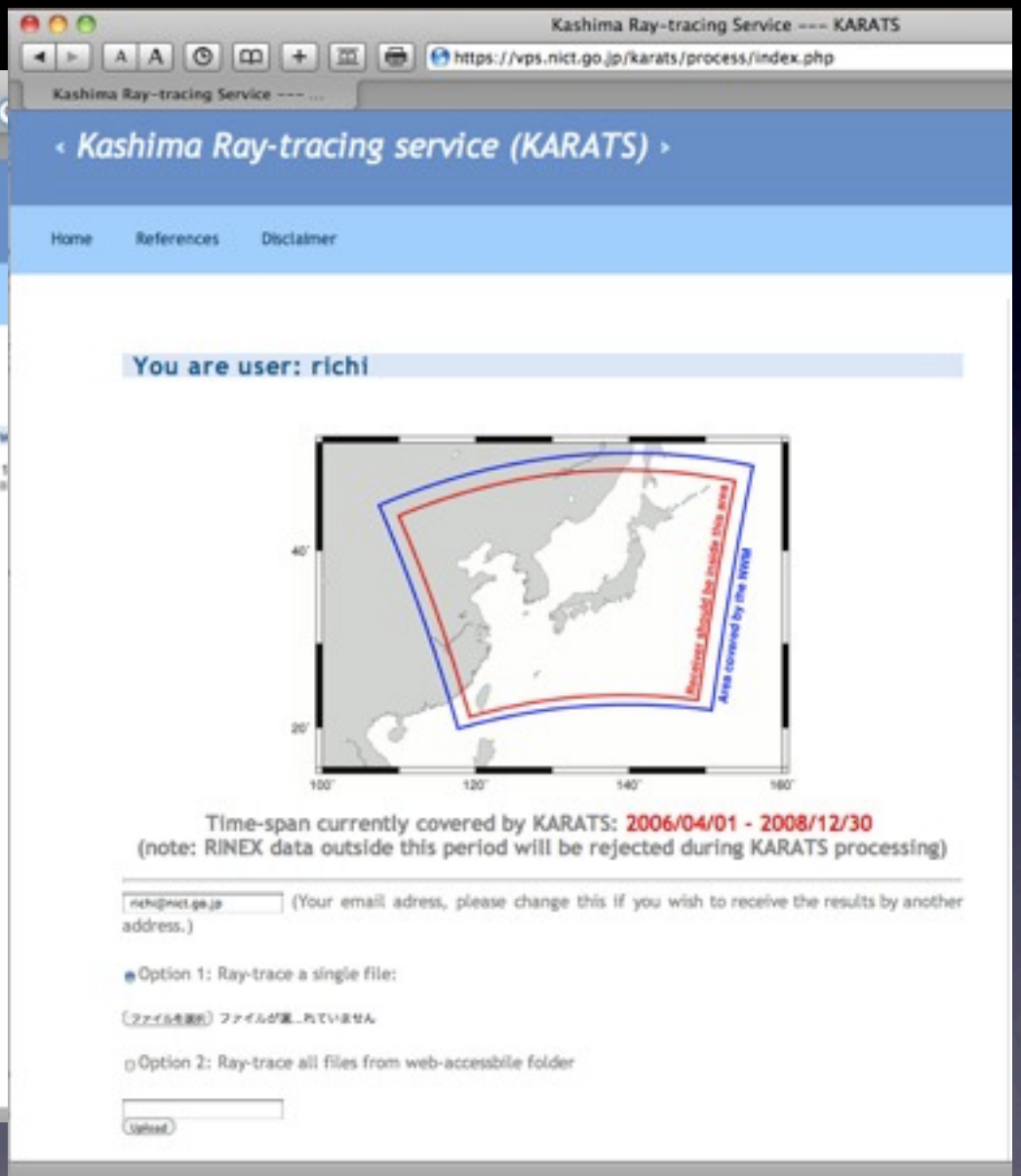
KARATS(cont'd)





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for VLBI

The direct ray-tracing has the potential to improve UT1 estimates. [Boehm et al., JoG, 2010]

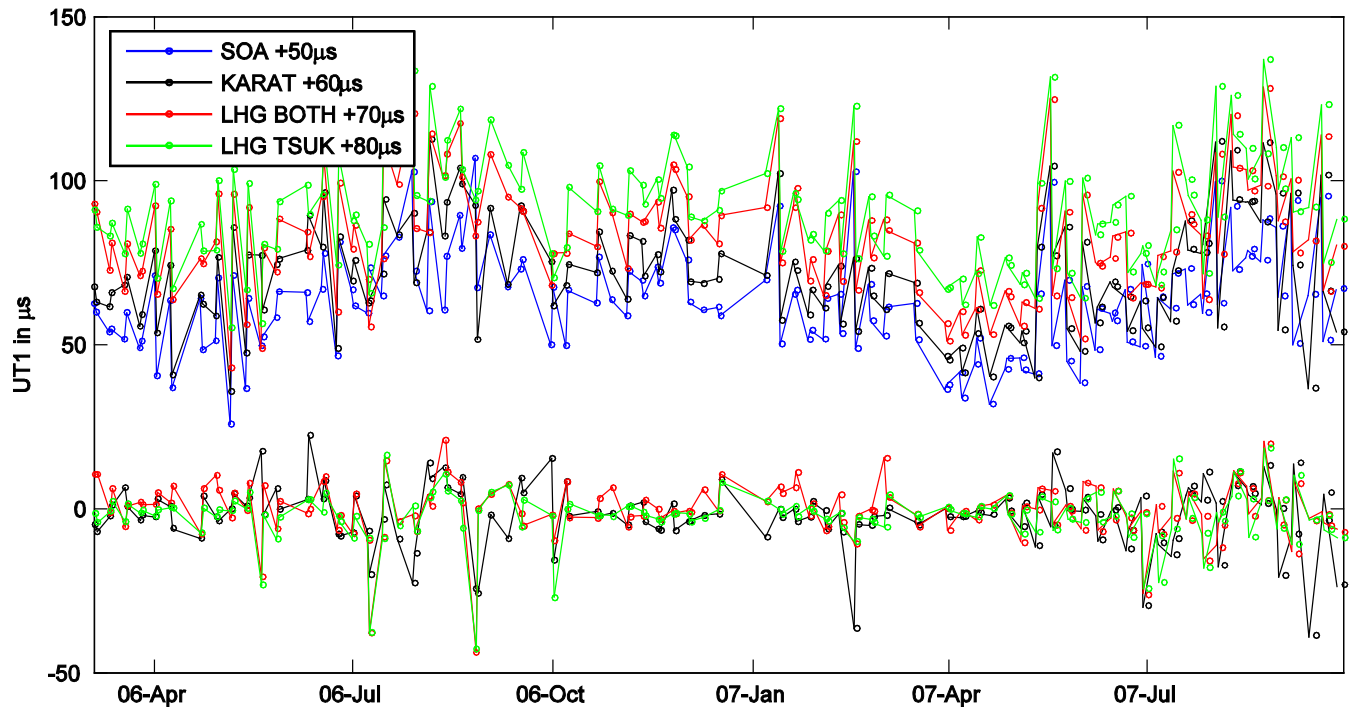

Figure 4 Hourly offsets of UT1 values for the INT2 sessions w.r.t. IERS 05 C04 (shifted by 50, 60, 70, and 80 μs for clarity). The differences are shown in the three lower lines (around zero) and they are in the sense KARAT/LHG minus SOA. The standard deviation of the differences is about 10 μs.

after Boehm et al.[2010]

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Concluding Remarks

- The KARAT solution is almost identical to the solution using VMF1 with linear gradient model
- The advantage of KARAT is an efficient reduction of atmospheric path delay with the numerical weather model improvement
- No big difference between Thayer Model and Eikonal Solver

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Outlook

- We need more high speed for Eikonal solver processing!!
  - GPGPU technique
- MANAL improvements
  - 5 km grid (after Apr. 7th, 2009)
  - Data assimilation of GPS PWV (after Oct. 28, 2009)

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Thank you for your attention

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