Towards Local Tomography Models with Uncertainties

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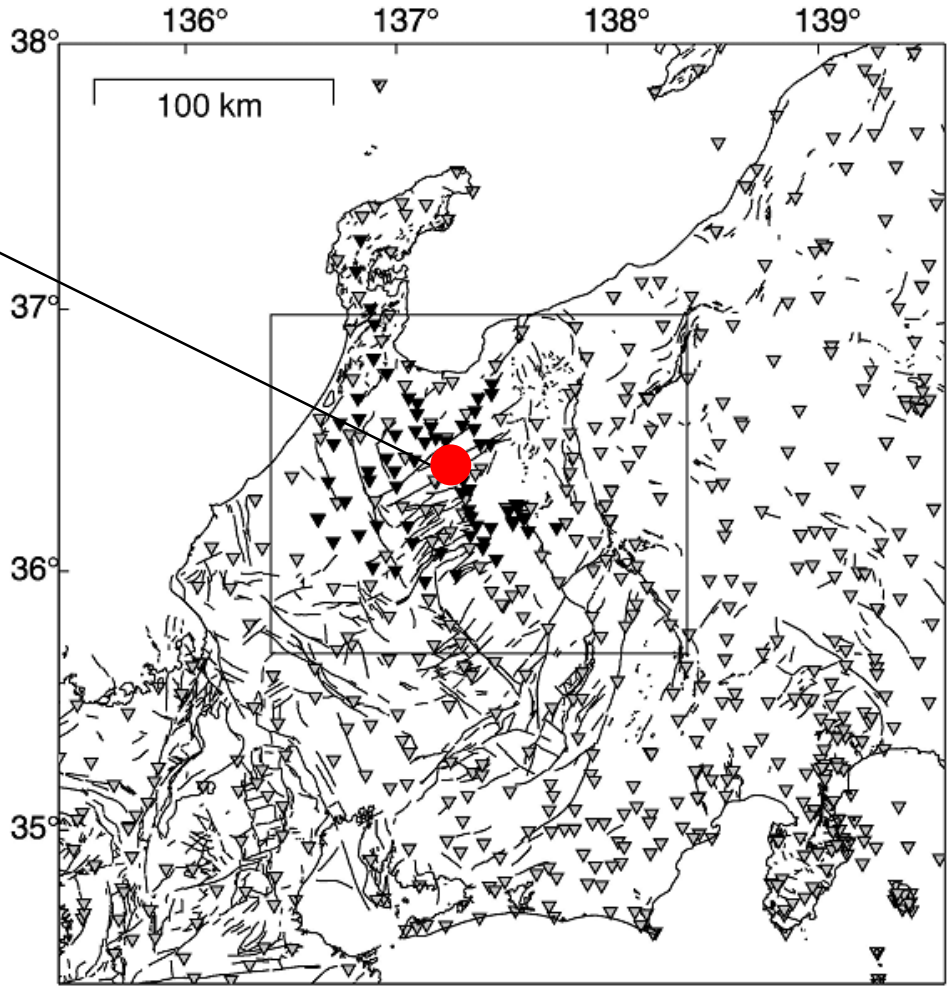
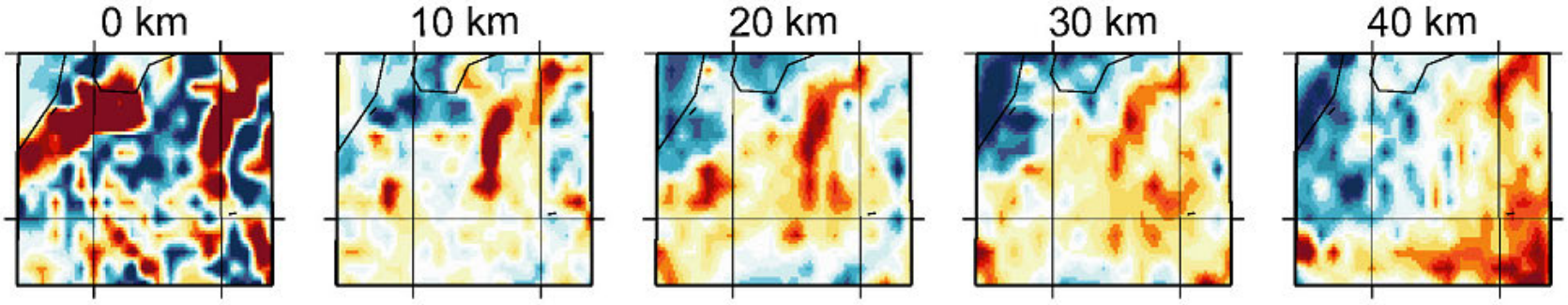
Station Distribution Around KamLAND



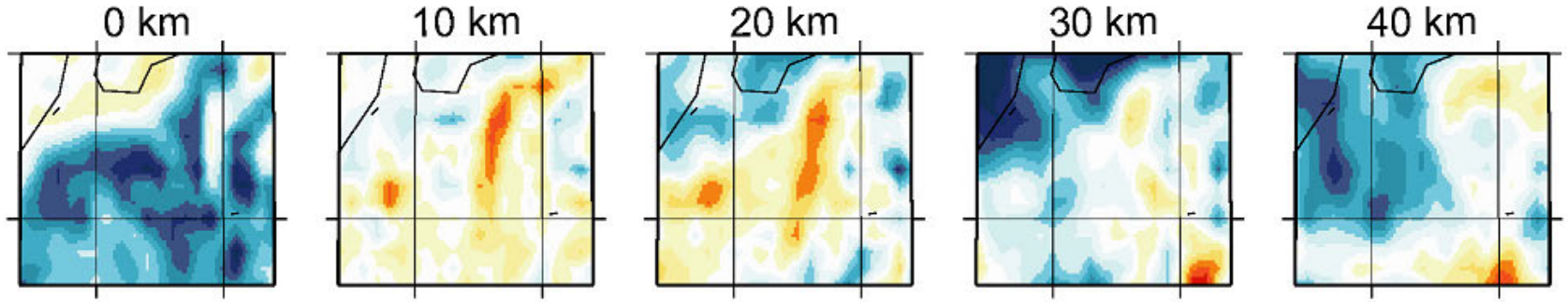
Nakajima et al. (2010)

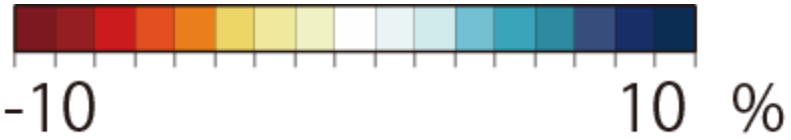
Comparison of Tomography Models

δVp/Vp Local Model (Nakajima et al. 2010)



δVp/Vp All Japan Model (Matsubara et al. 2008)

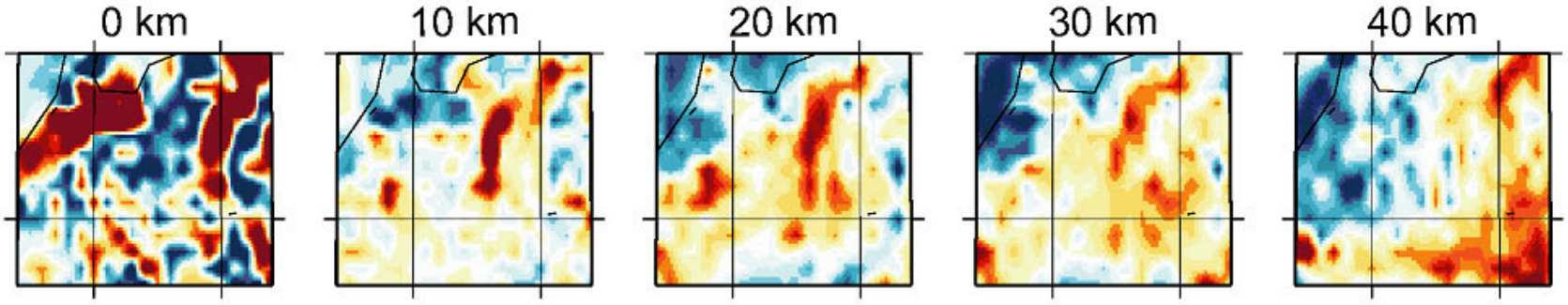




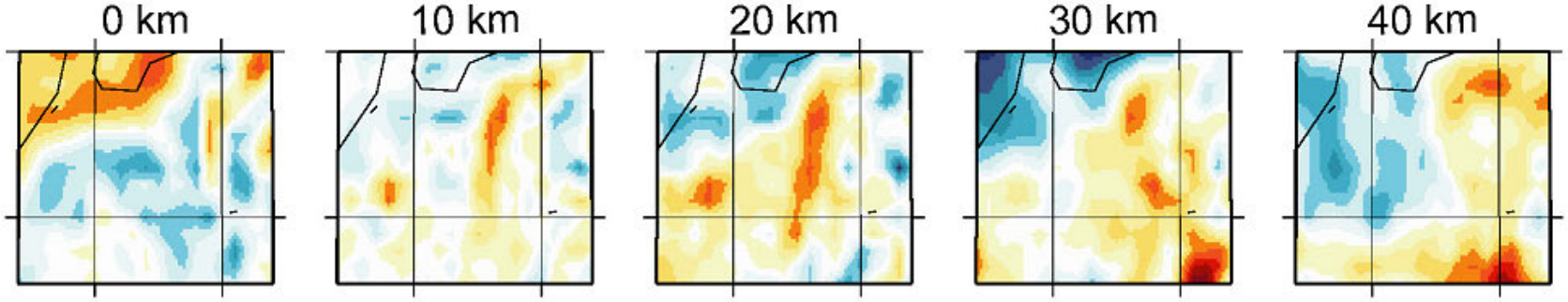
Comparison of Tomography Models

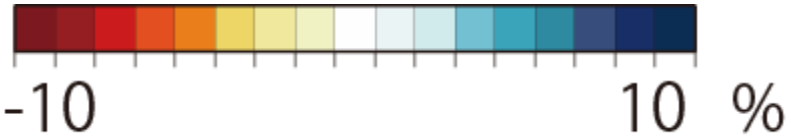
systematic offsets corrected

δVp/Vp Local Model (Nakajima et al. 2010)



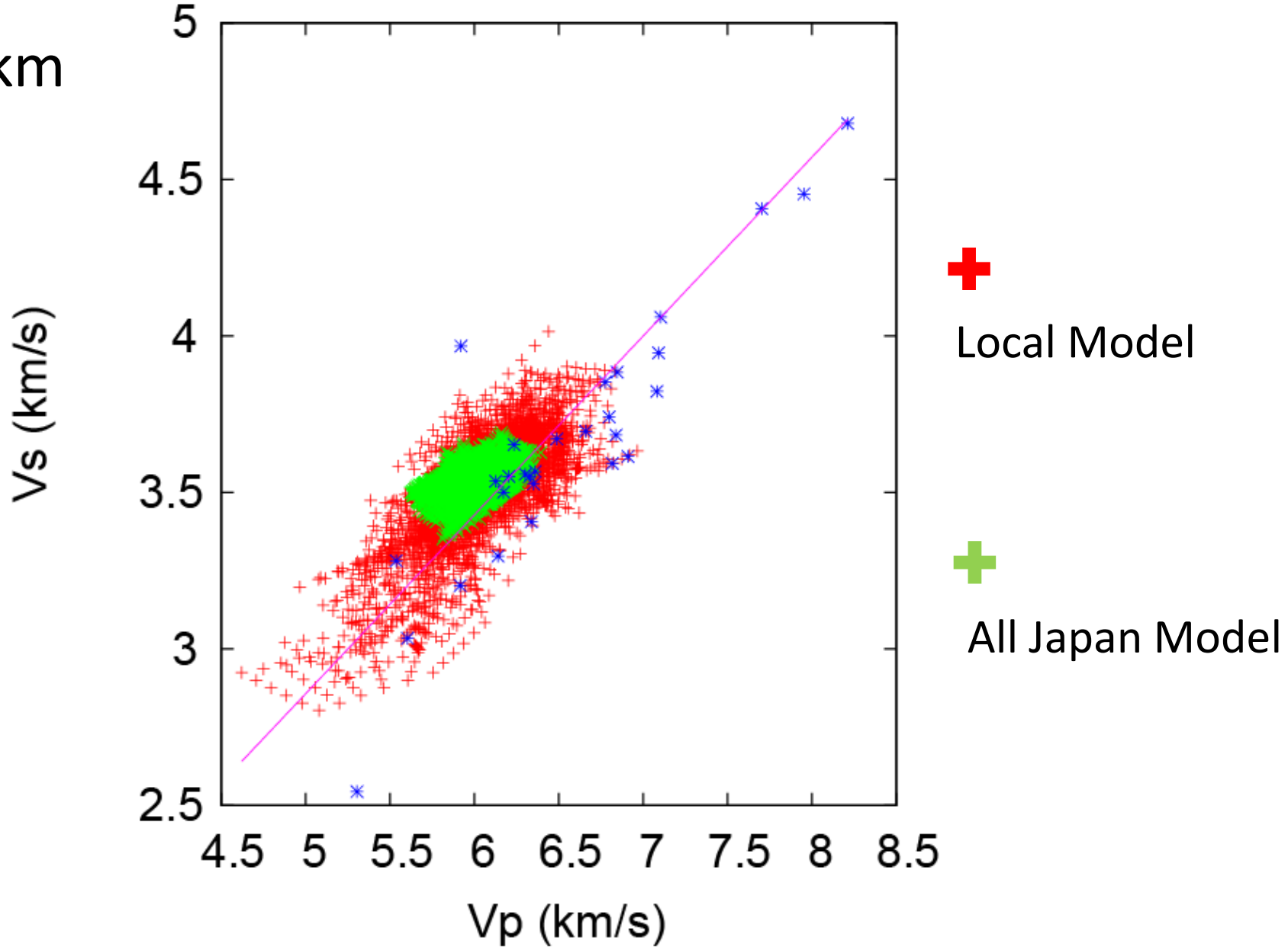
δVp/Vp' All Japan Model (Matsubara et al. 2008)



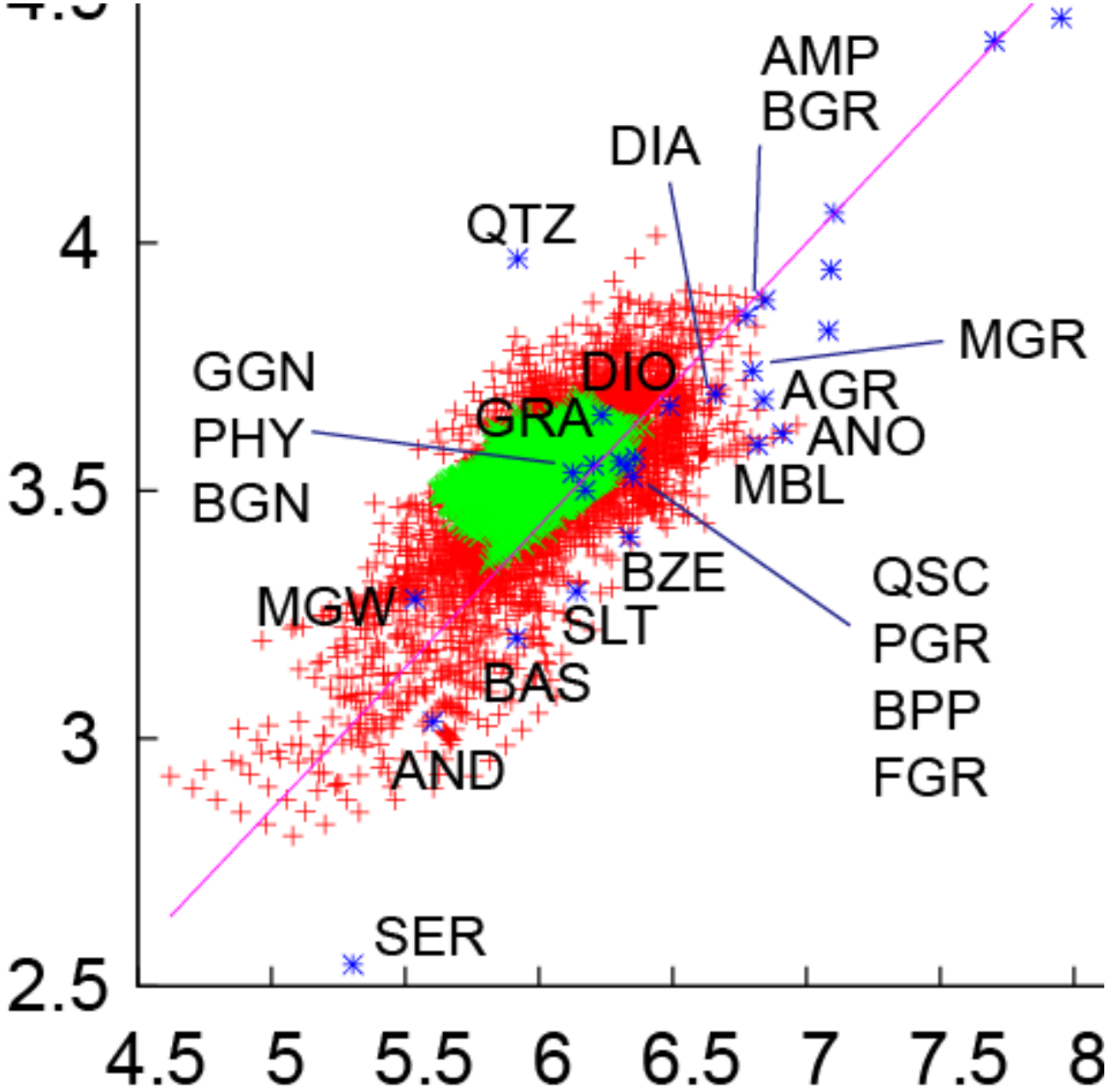


Comparison of Tomography Models

10 km



Impact on the Lithology Identification



Cause for the Discrepancies

Scheme for Geophysical Inversion

ad hoc assumption

observed data : **d** & C_d (uncertainty of the data)

initial model : $\mathbf{m_0}$ & C_{m0} (uncertainty of the initial model)

Bayesian Inference

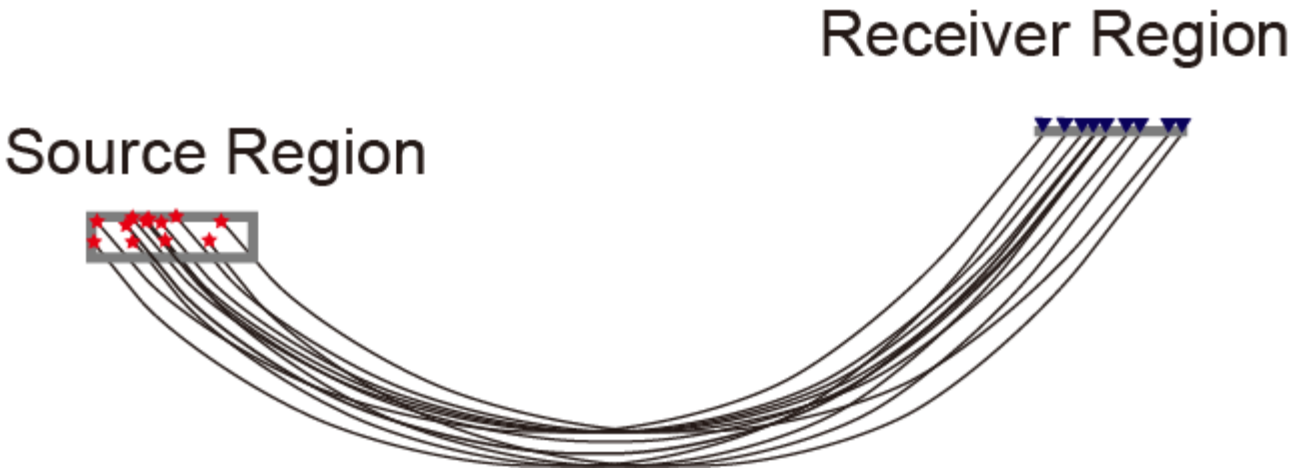
junk

final model: **m** & C_m (uncertainty of the final model)

Method for Uncertainty Evaluation

Gudmundsson et al. (1990)

Bundle of seismic rays
with common source and receiver regions



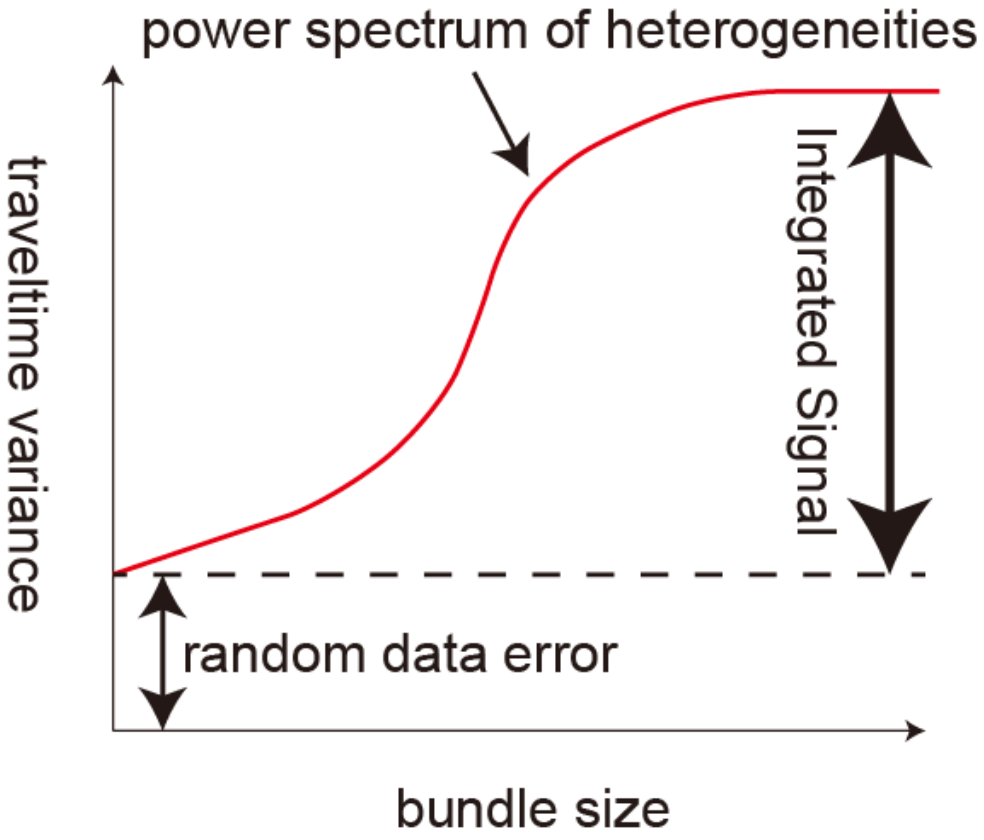
variance of traveltime anomalies

$$\left\langle \left(\delta t_i - \overline{\delta t}\right)^2 \right\rangle$$

depends on

random data error C_d
&
lateral heterogeneities C_{m0}
with scale length
smaller than the bundle size.

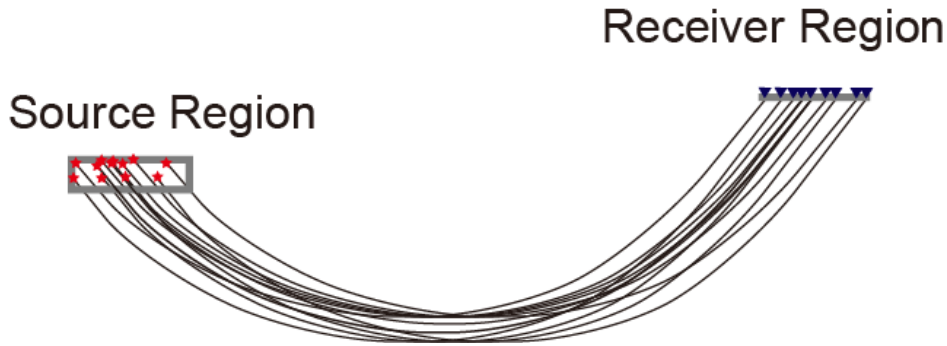
Bundle Size Dependence of the Traveltime Variance



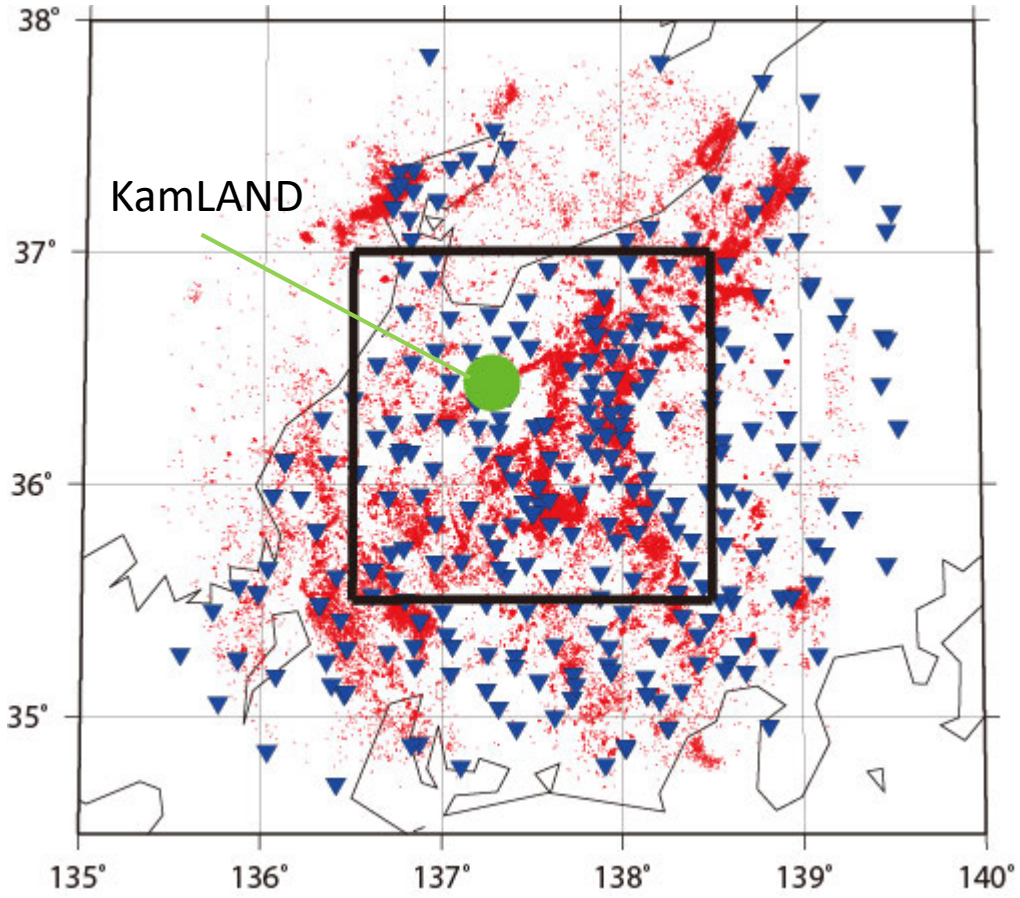
Implementation in this Study

- Discuss only the integrated signals as a first step.
- Discuss the ensemble average of the variance curves.

  (stacking all the curves with common source depth and distance.)



Dataset Used in This Study

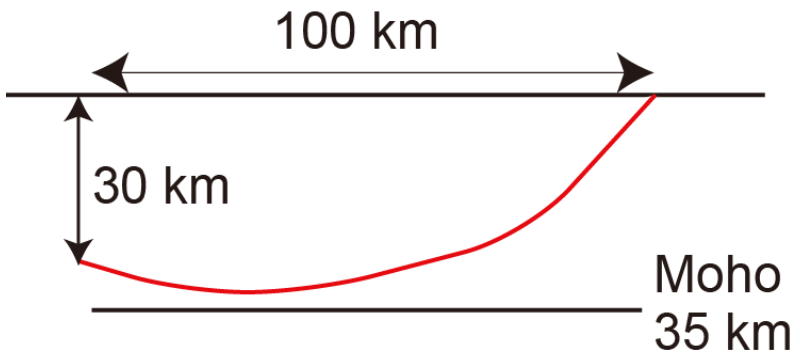


1,468,894 P arrival time measurements

in the JMA unified catalogue

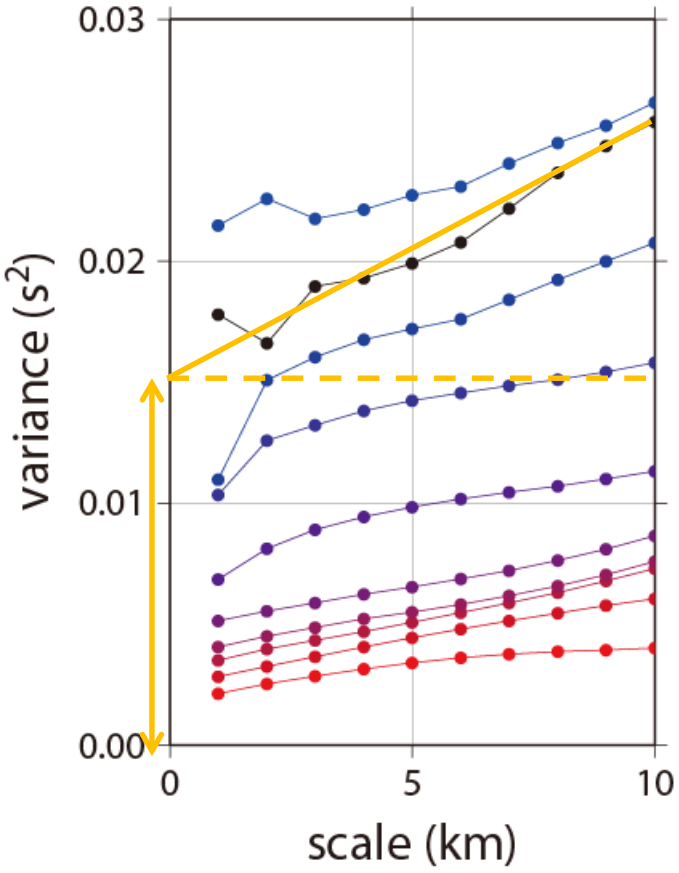
event depth: 0 – 30 km

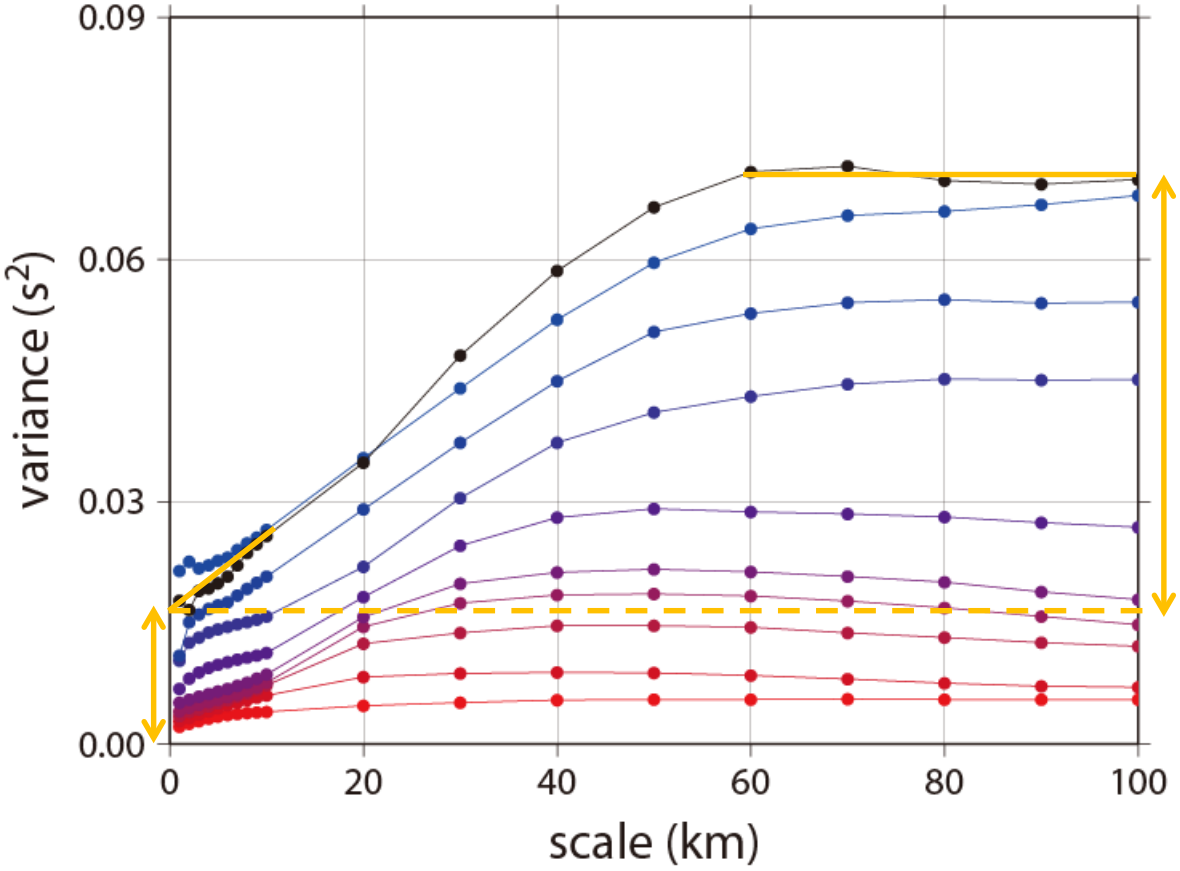
distance : 0 – 100 km



Example Traveltime Variance Curve

Source Depth: 5-10 km

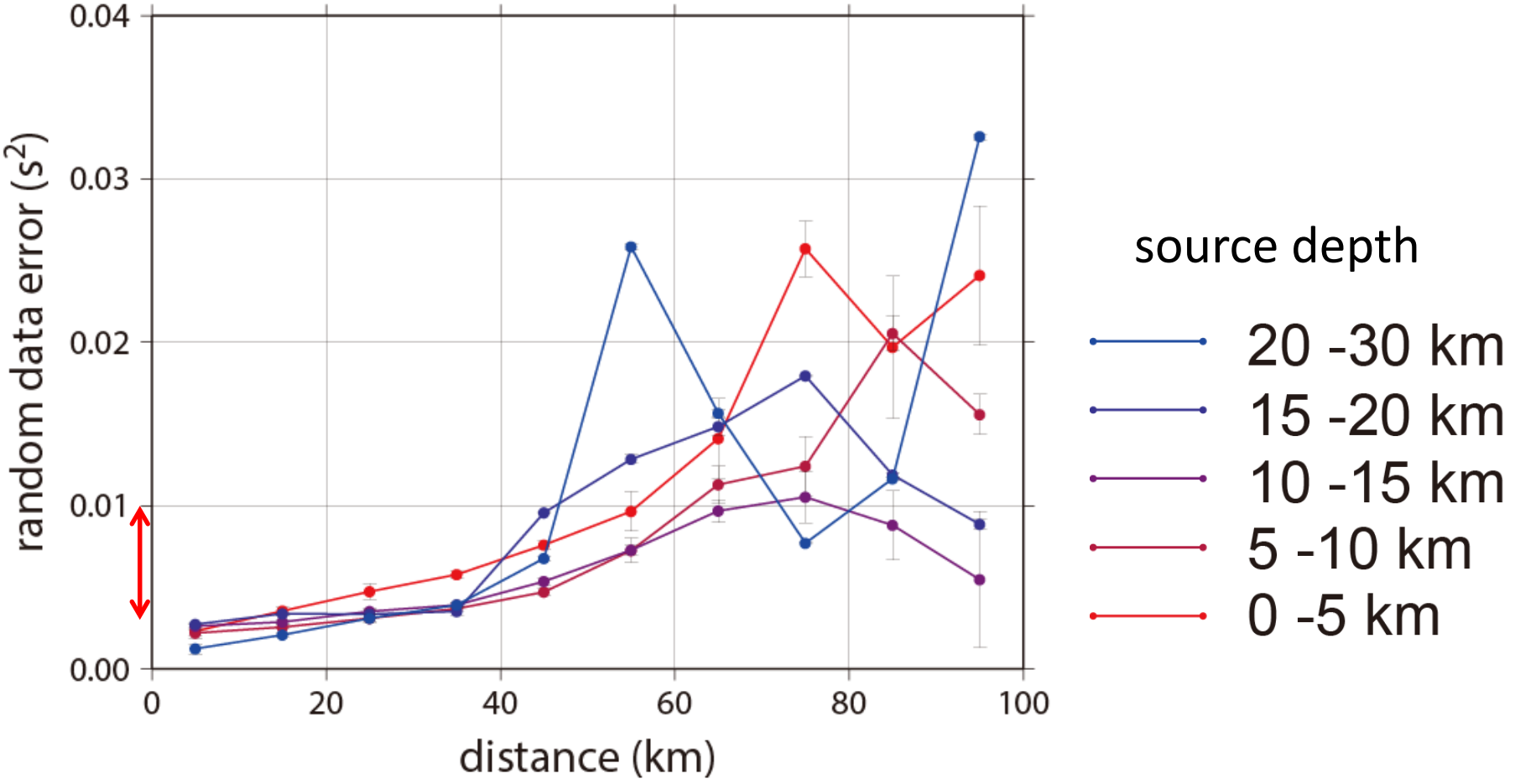




distance

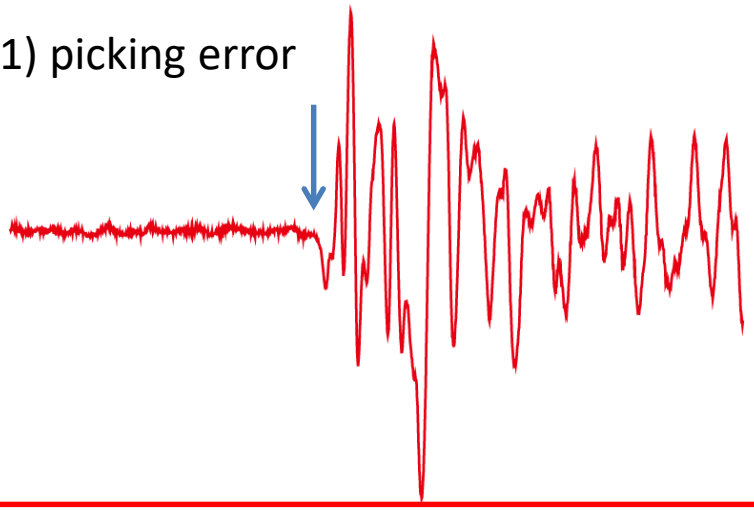
- 90-100 km
- 80-90 km
- 70-80 km
- 60-70 km
- 50-60 km
- 40-50 km
- 30-40 km
- 20-30 km
- 10-20 km
- 0-10 km

Evaluated Random Data Errors

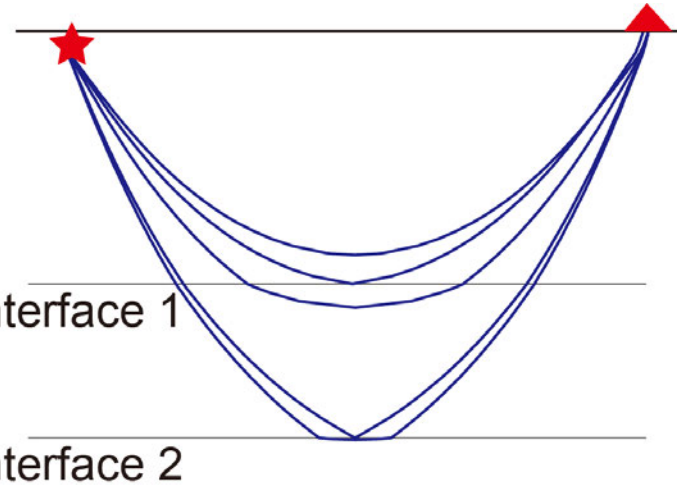


Cause for the Random Errors

(1) picking error

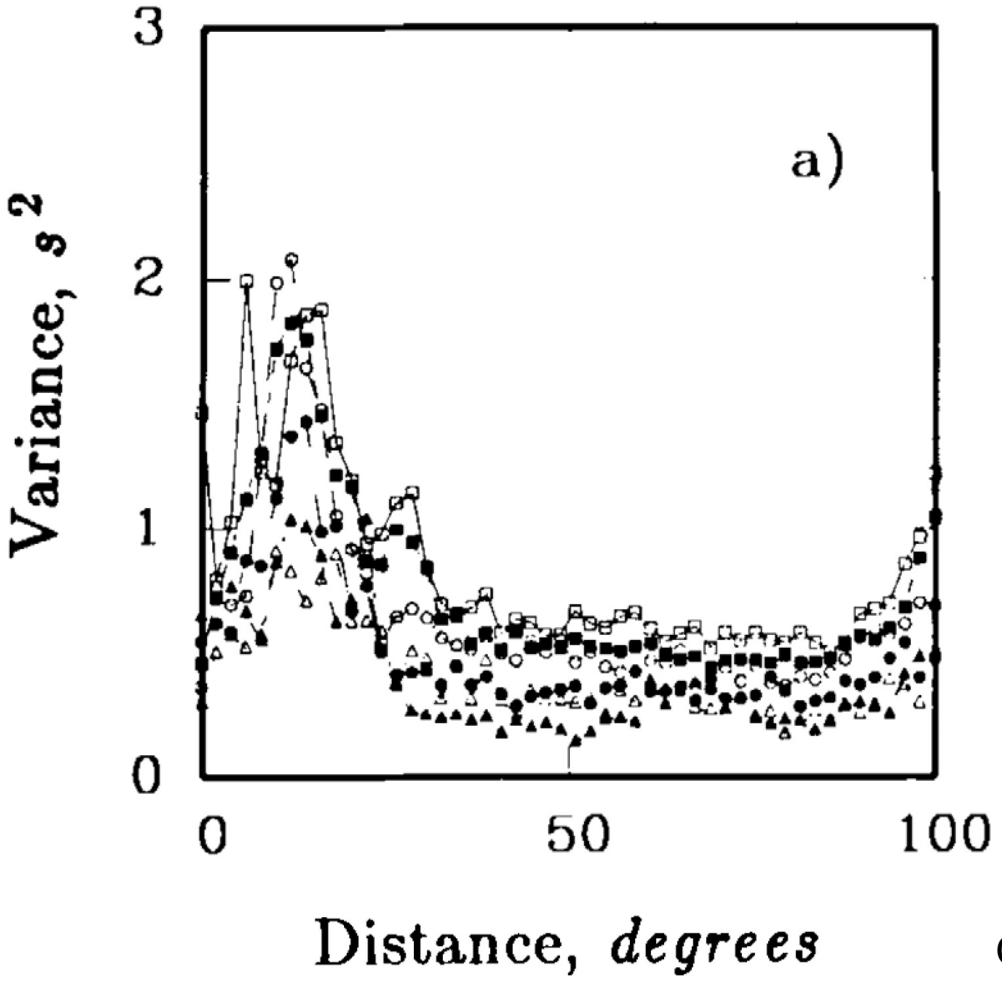


(2) phase misidentification



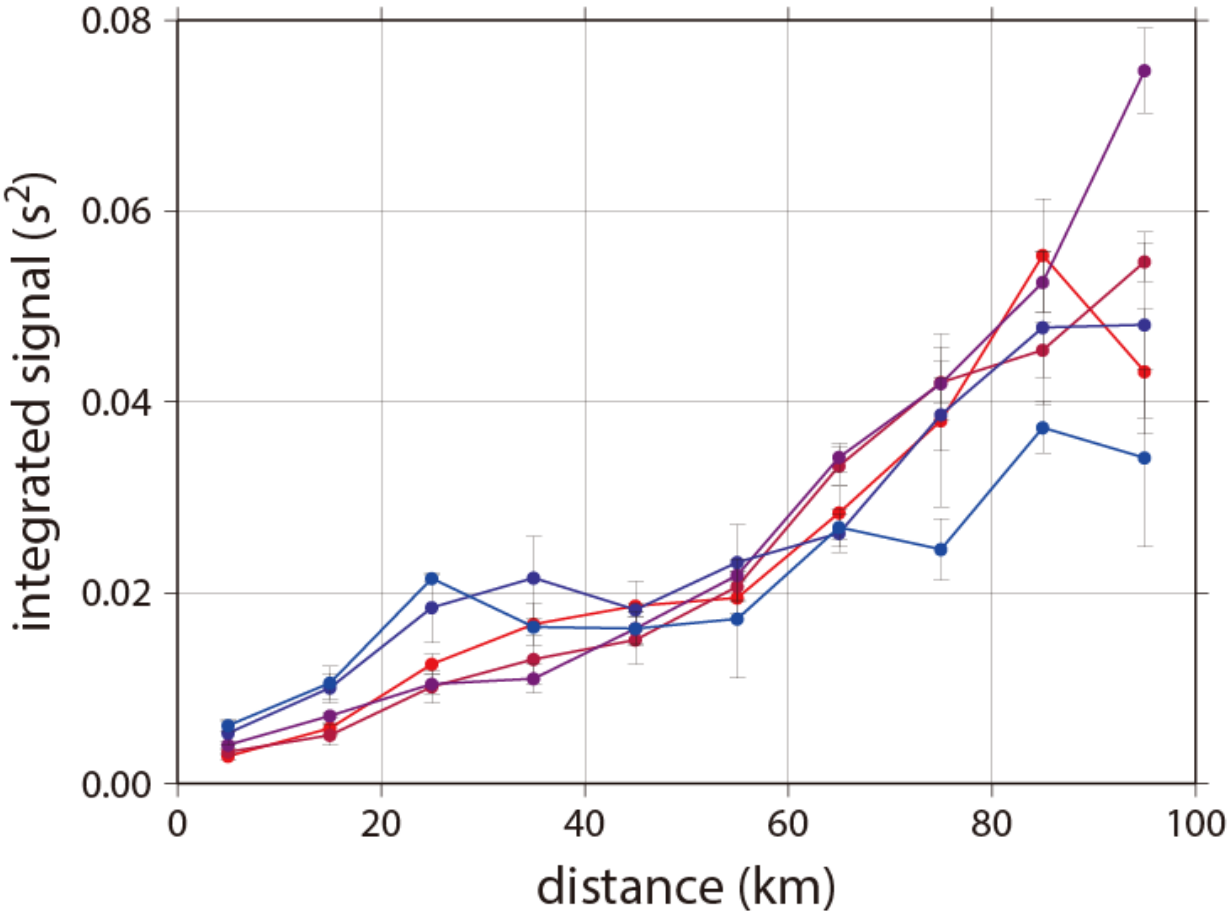
(3) event mislocations

Evaluated Random Data Errors For Global Data



Gudmundsson et al. (1990)

Evaluated Integrated Signals



source depth

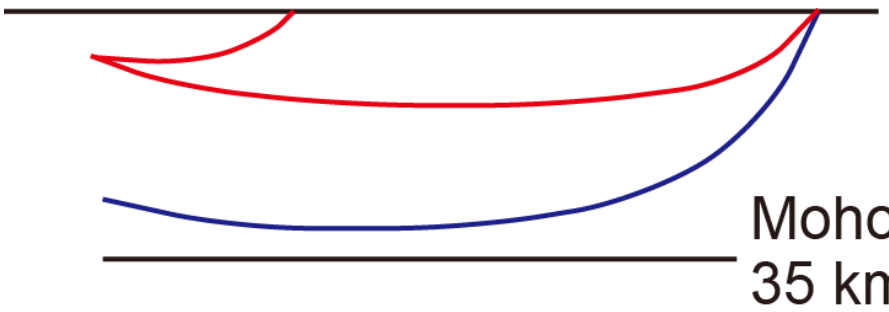
20 -30 km

15 -20 km

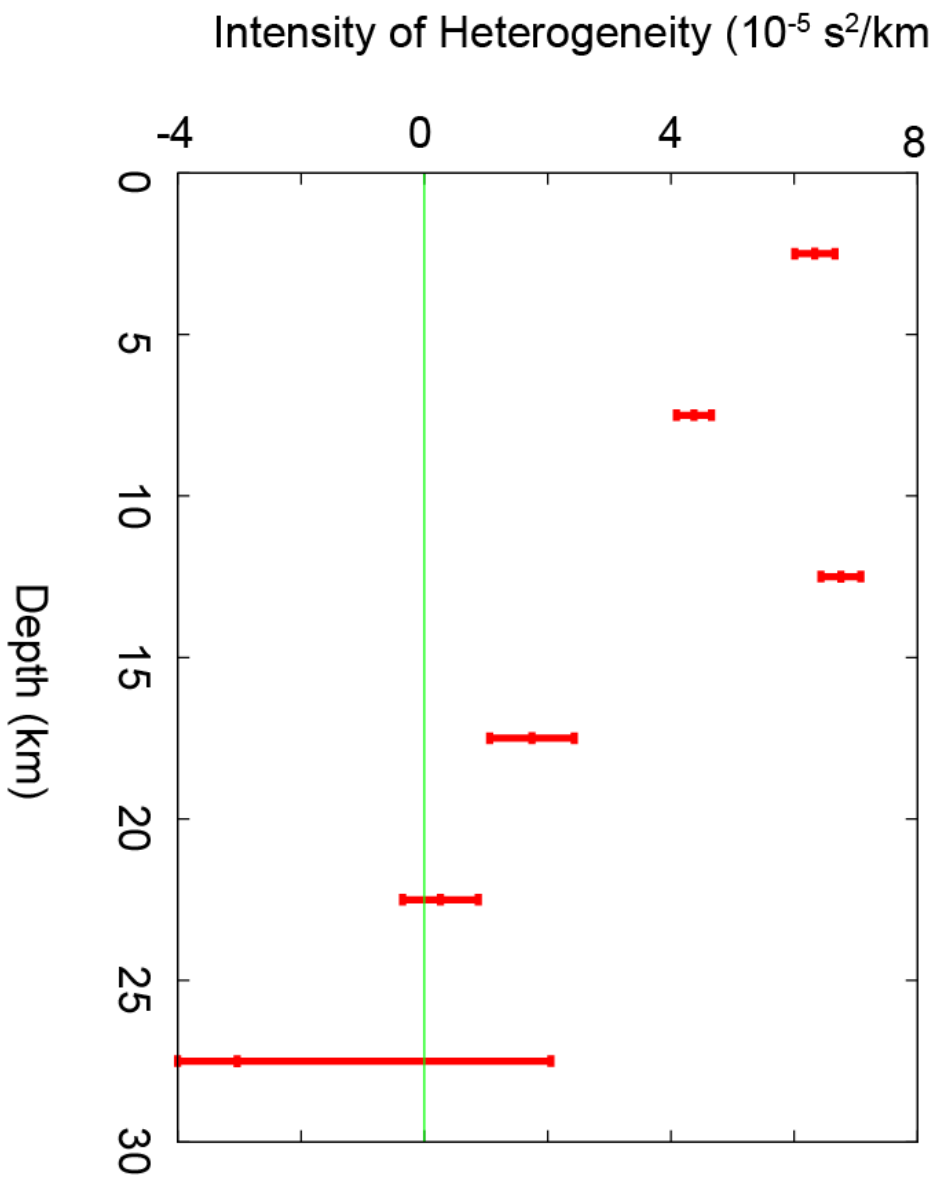
10 -15 km

5 -10 km

0 -5 km

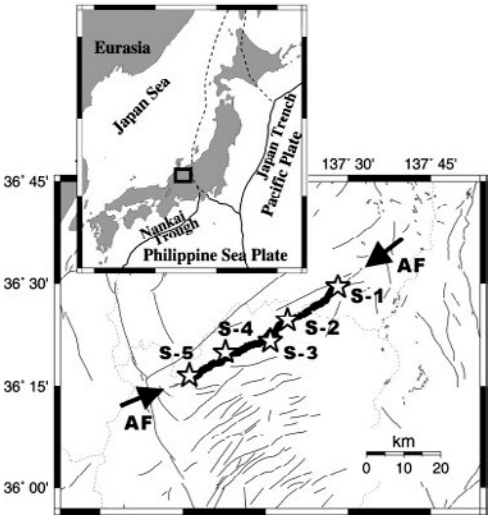


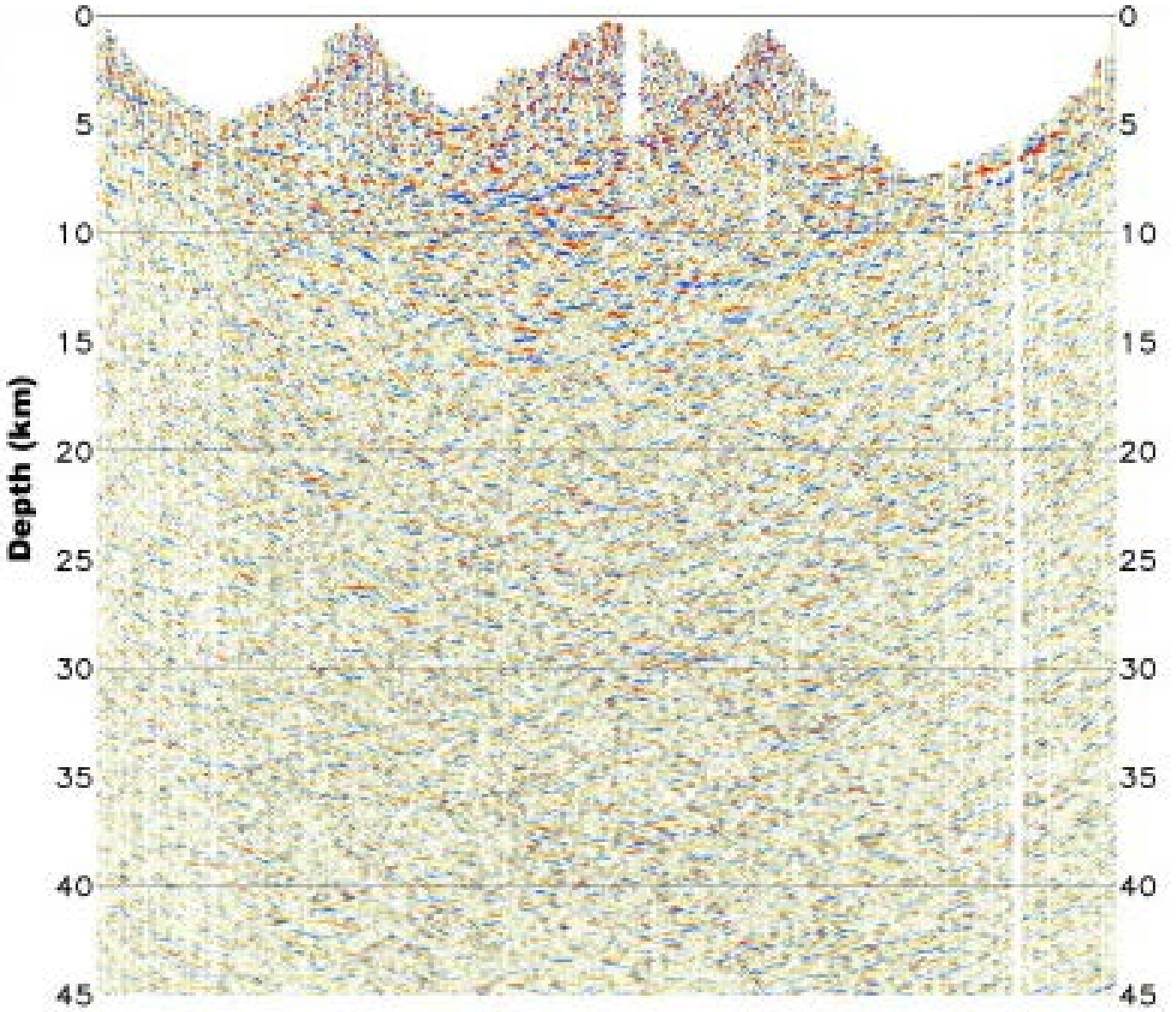
Inverted Heterogeneity Intensities



$\propto a\,\epsilon^2$

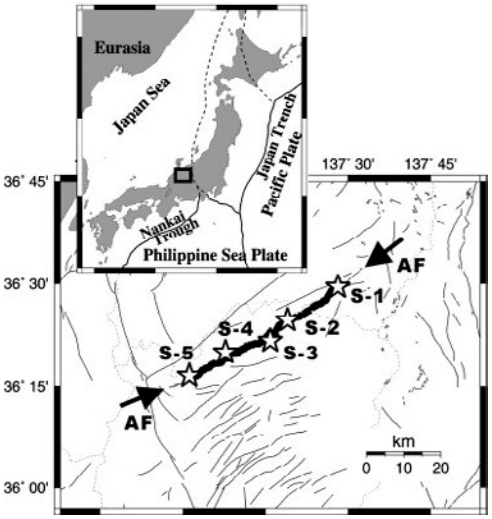
Reflector Imaging in This Region

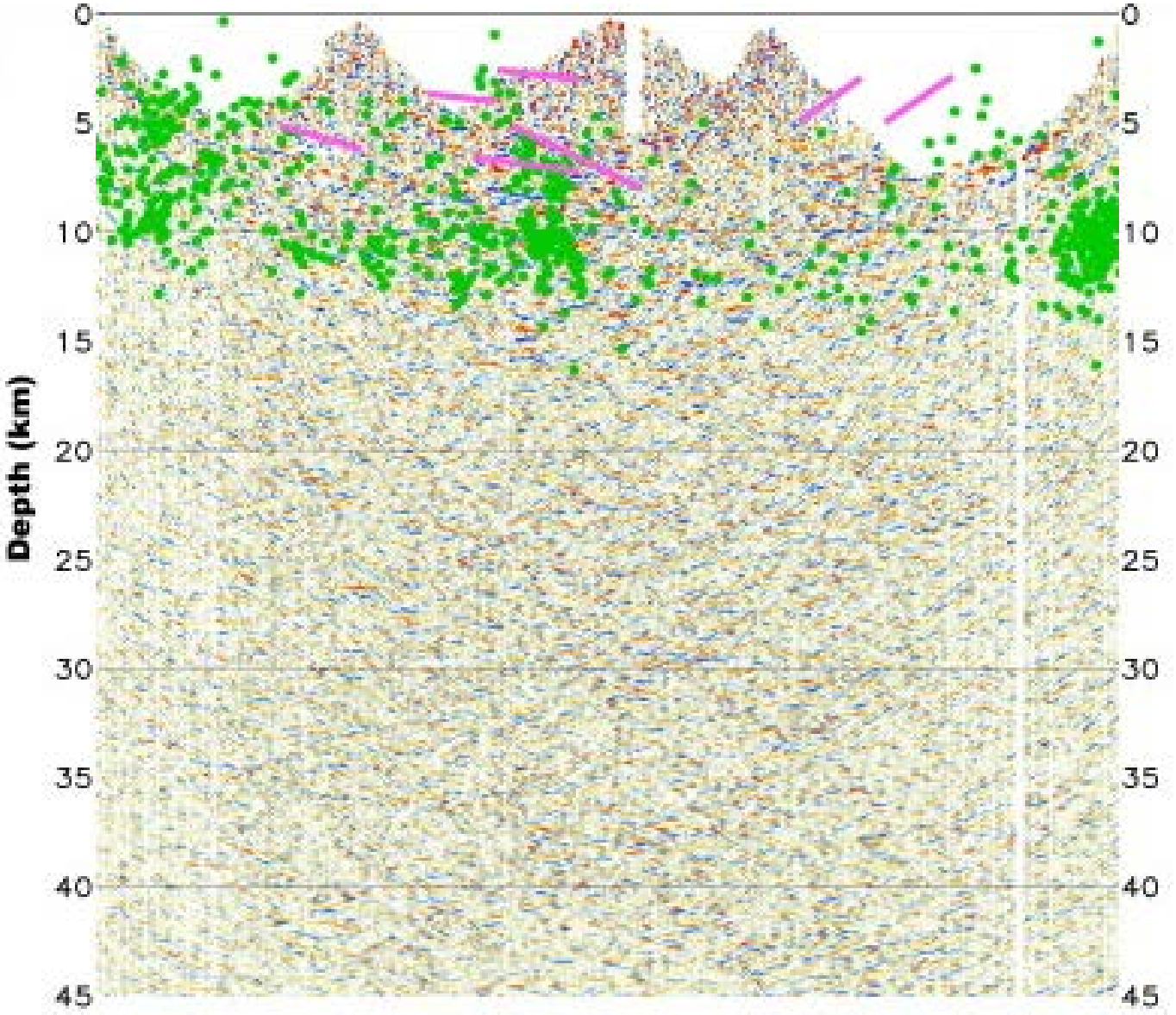




Iidaka et al. (2009)

Reflector Imaging in This Region





Iidaka et al. (2009)

Summary

- Summary residuals in the Japanese catalogue contains useful information for data error and Earth's heterogeneities.

- The regions with strongly heterogeneity / dense reflectors / higher seismicity are highly correlated.

  ⟶ The effects of cracks need to be considered to identify the lithology.