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Comparison of *P*-, *SV*- and *SH*-wave velocity models below Japan and Northeast China

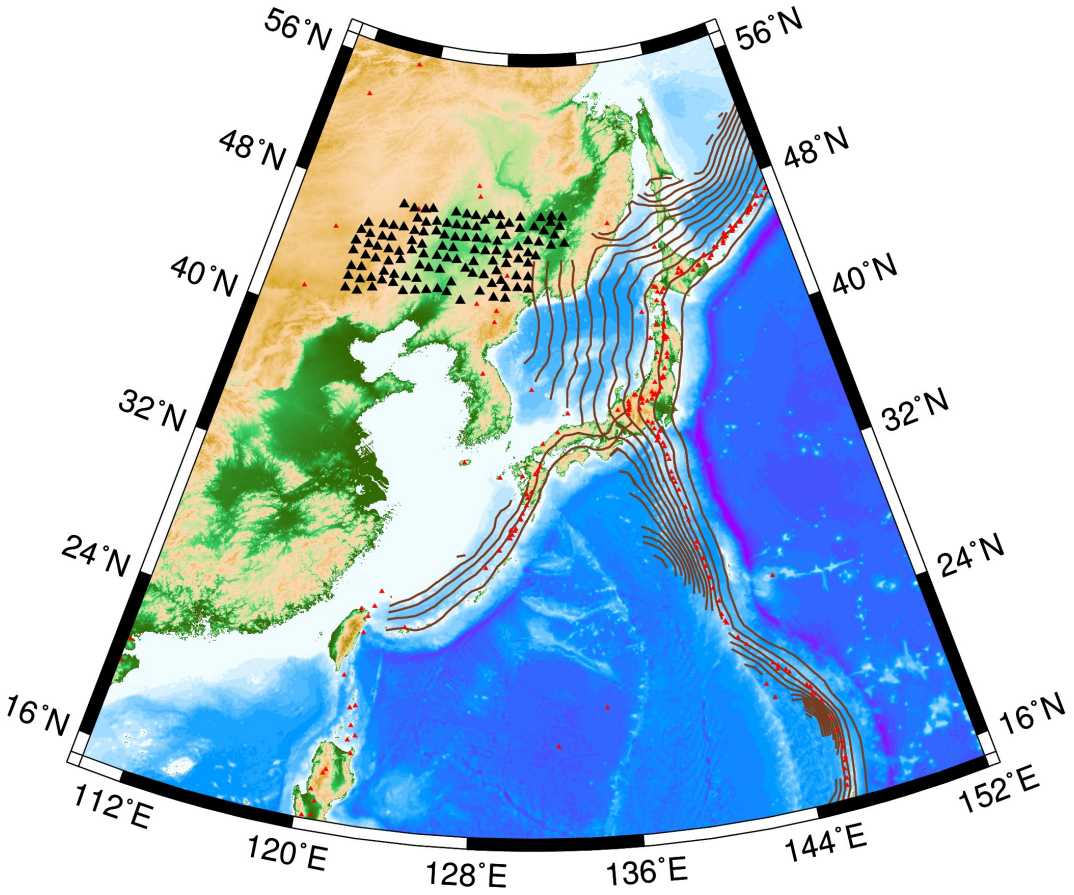
日本及び中国東北部下の P 波・SV 波・SH 波速度構造の比較

Fall Meeting of the Seismological Society of Japan,
October 8th, 2013

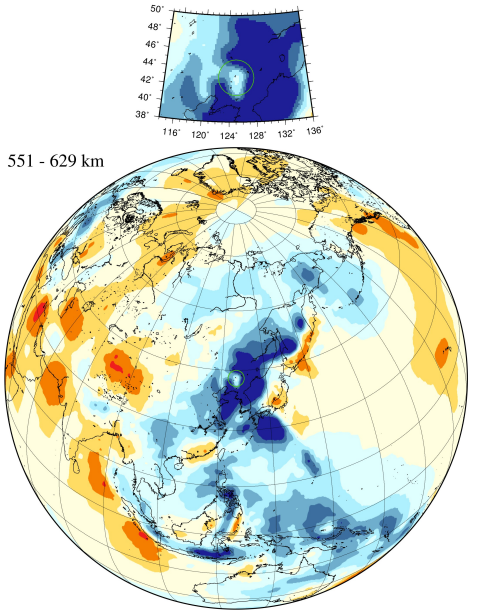
公益社団法人
日本地震学会
The Seismological Society of Japan (SSJ)

Introduction

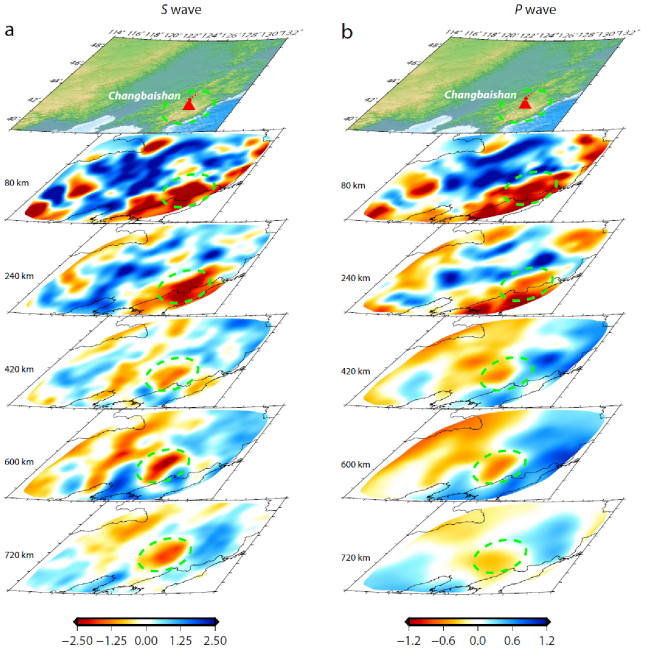
NorthEast China Extended SeiSmic Array (NECESSArray)



M. Obayashi (JpGU, 2013) : Gap in the stagnant slab



S. Grand (JpGU, 2013) : Plume in the gap



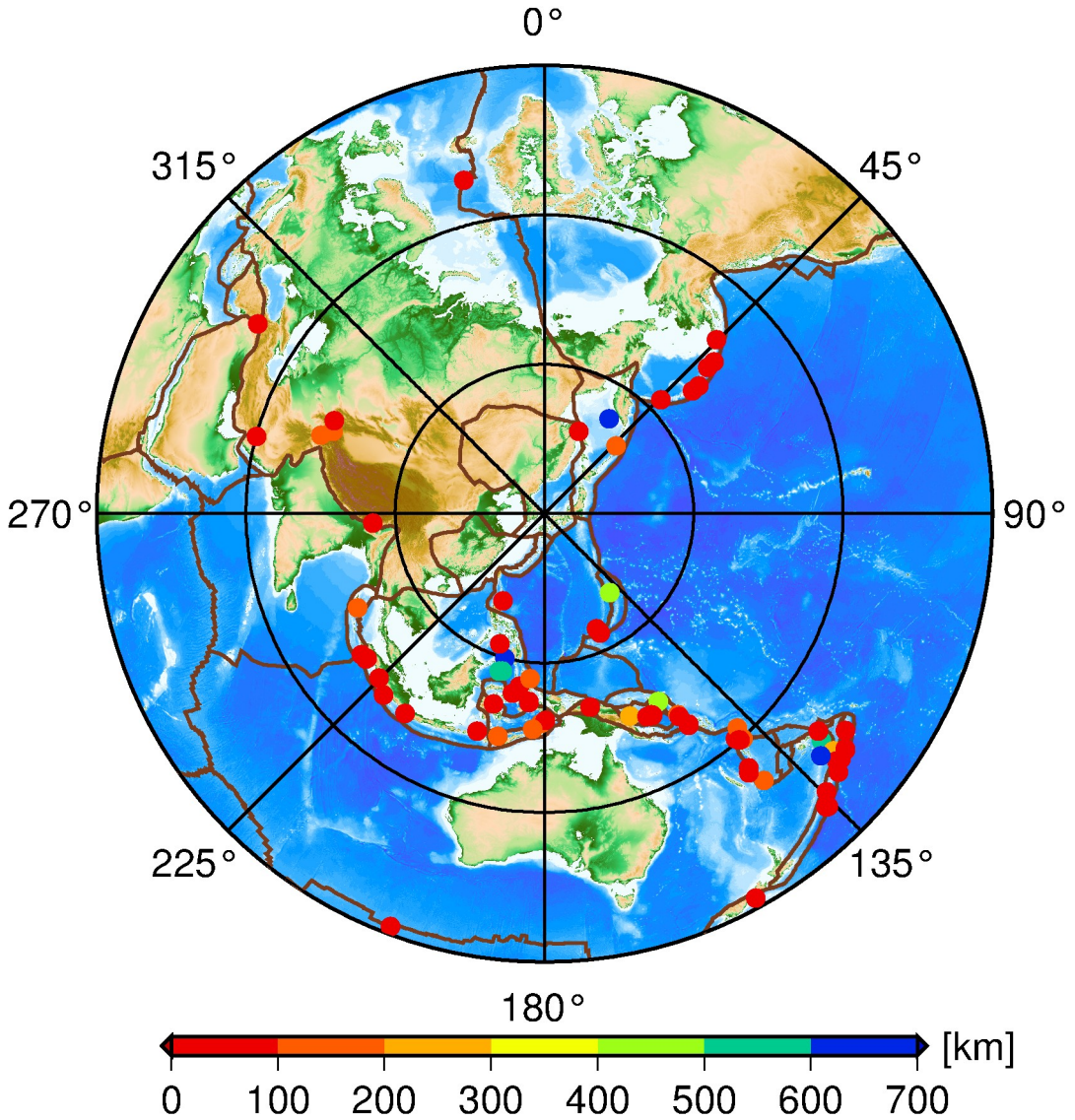
Measurements of traveltime residuals

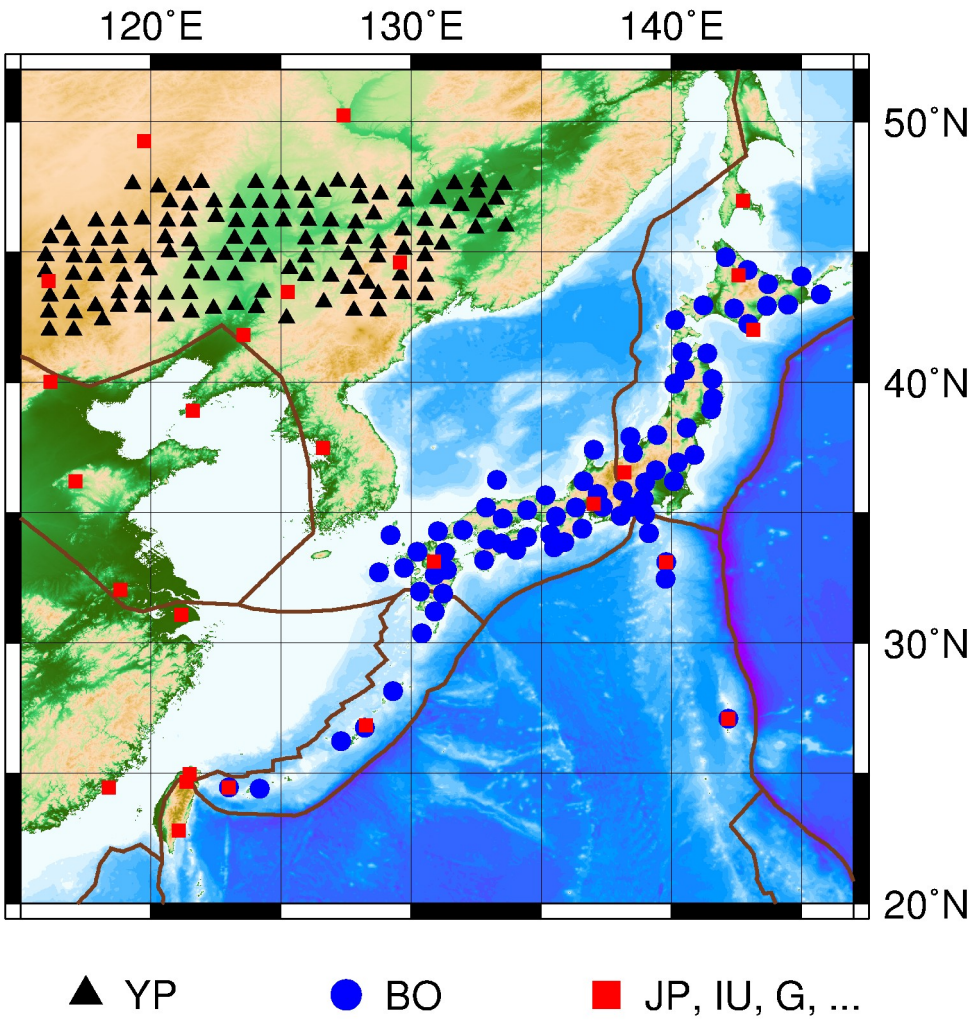
Comparison of *P*- and *S*-wave velocity models

Comparison of *SV*- and *SH*-wave velocity models

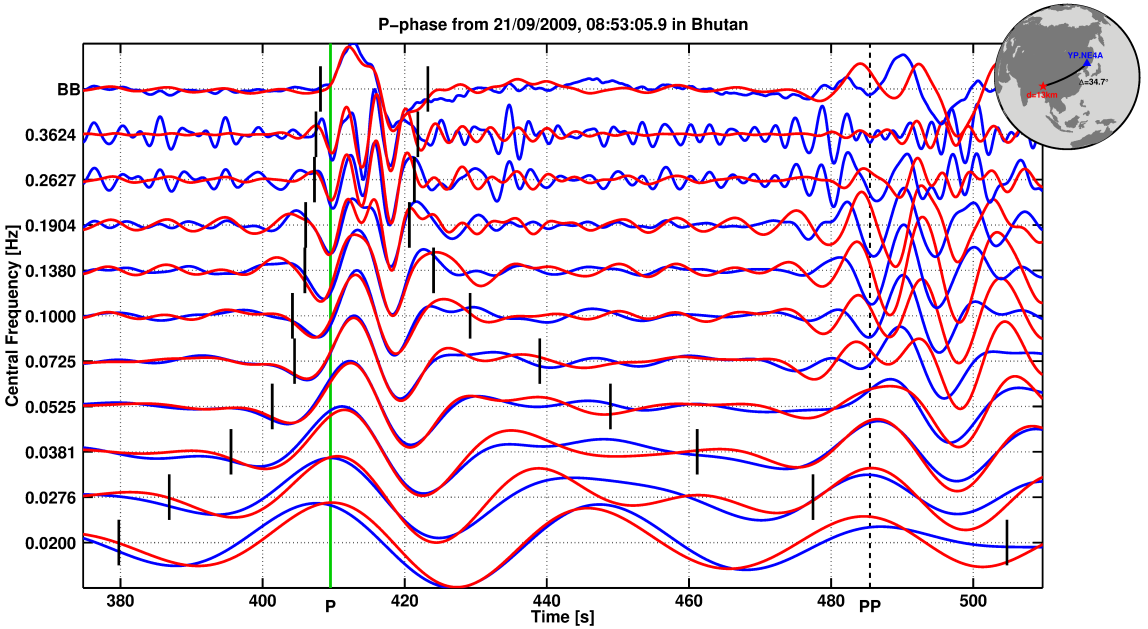
Station-event configuration

80 teleseismic events recorded by 121 temporary stations from NECESSArray (**YP**) deployment, 74 permanent stations from F-NET (**BO**) network, and 24 stations from other permanent global networks (**JP, IU, G, ...**)



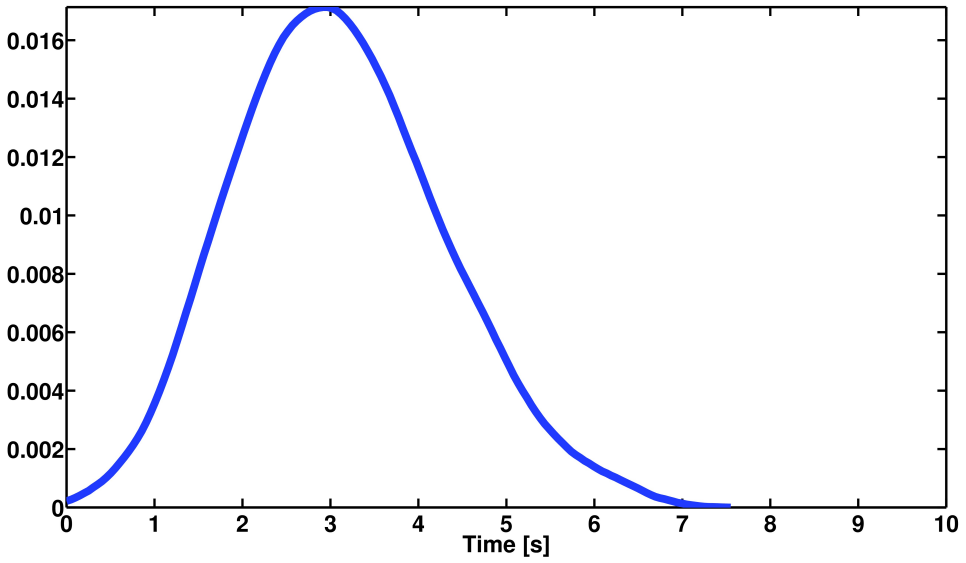


Multi-frequency traveltime residuals



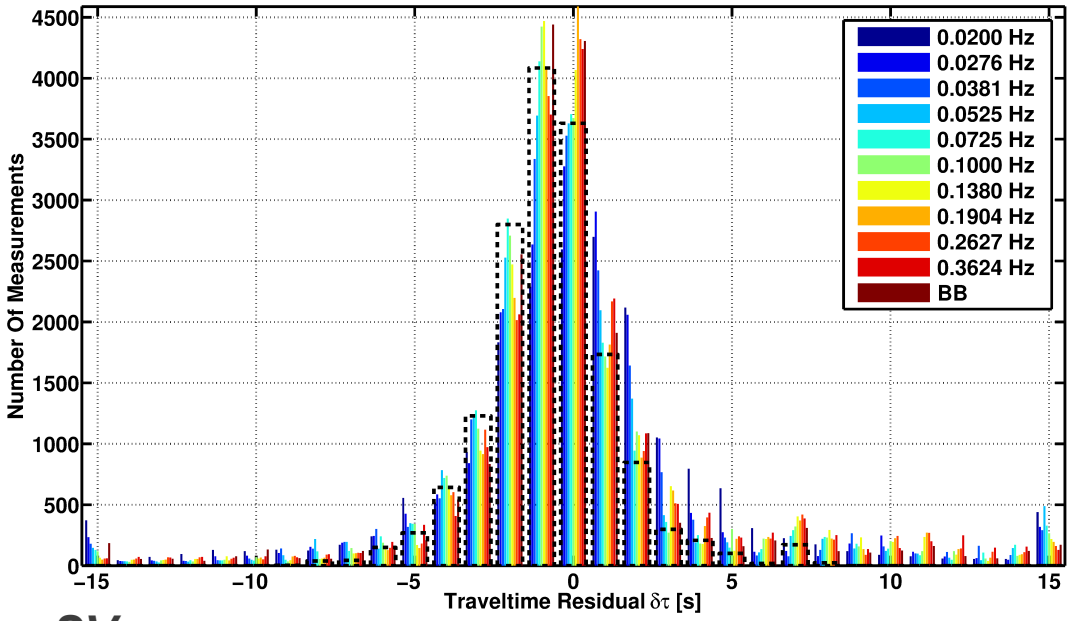
Cross-correlation of **observed** and **synthetic** waveforms in a frequency-dependent **time window** designed from the synthetic's envelop amplitude around the **theoretical arrival** of the seismic phase of interest

Synthetic waveforms include accurate source parameters (depth and HF **source-time function**) determined by SAWIB (*Garcia et al., 2013*)



Distributions of traveltime residuals

P



Selection of traveltime residual datasets at **0.0725 Hz** (~14 sec.) used for tomographic inversions :

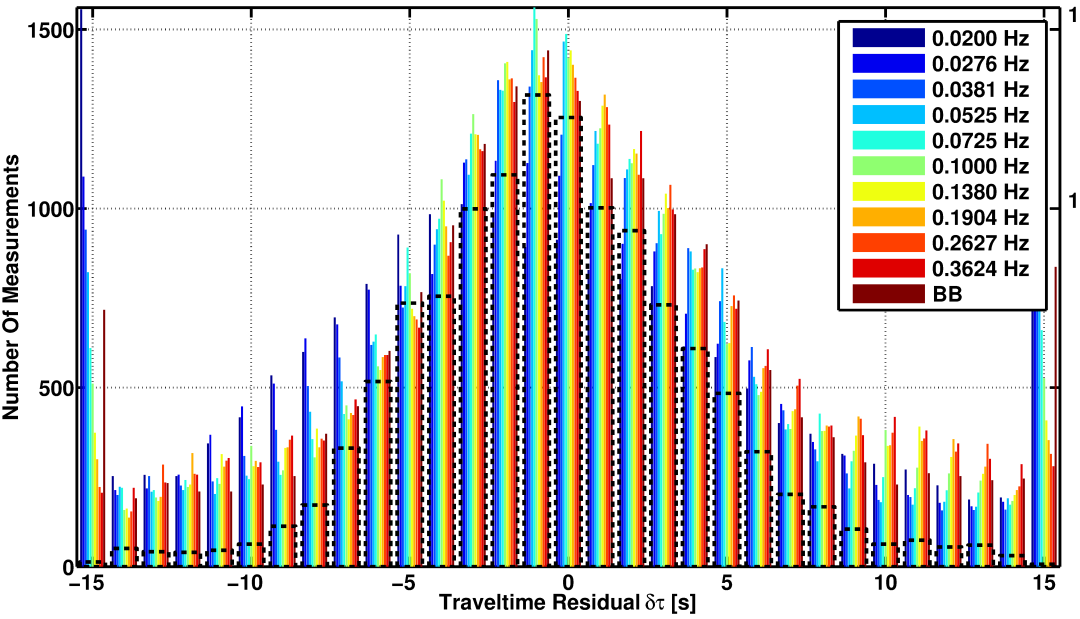
P : 16192

SV : 12118

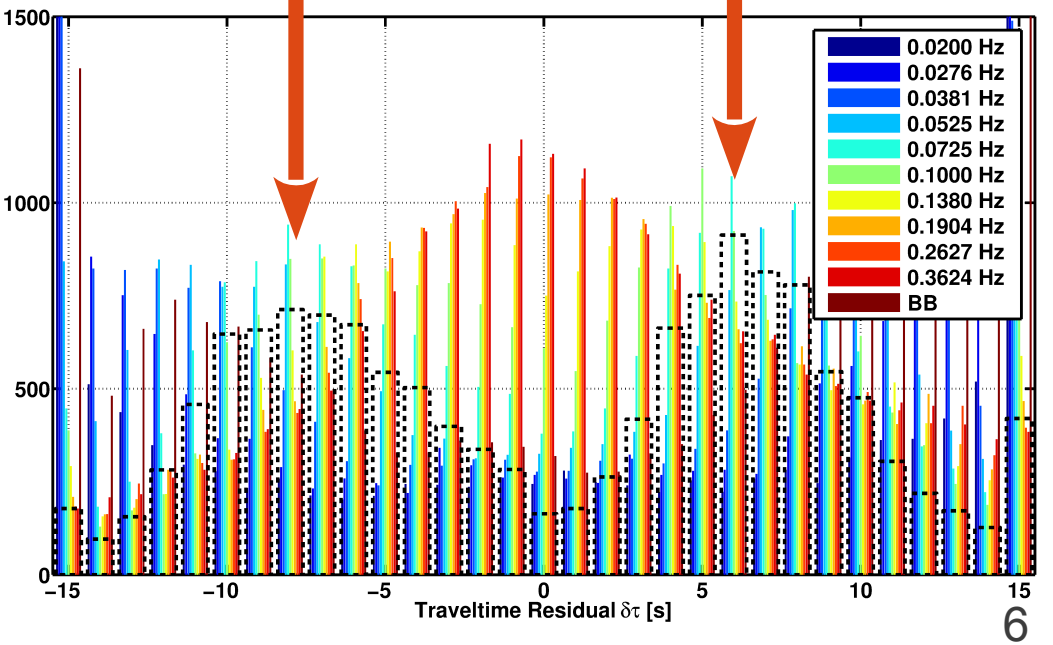
SH : 13355

Traveltimes from *SH*-waves show an uncommon frequency-dependent behavior

SV



SH



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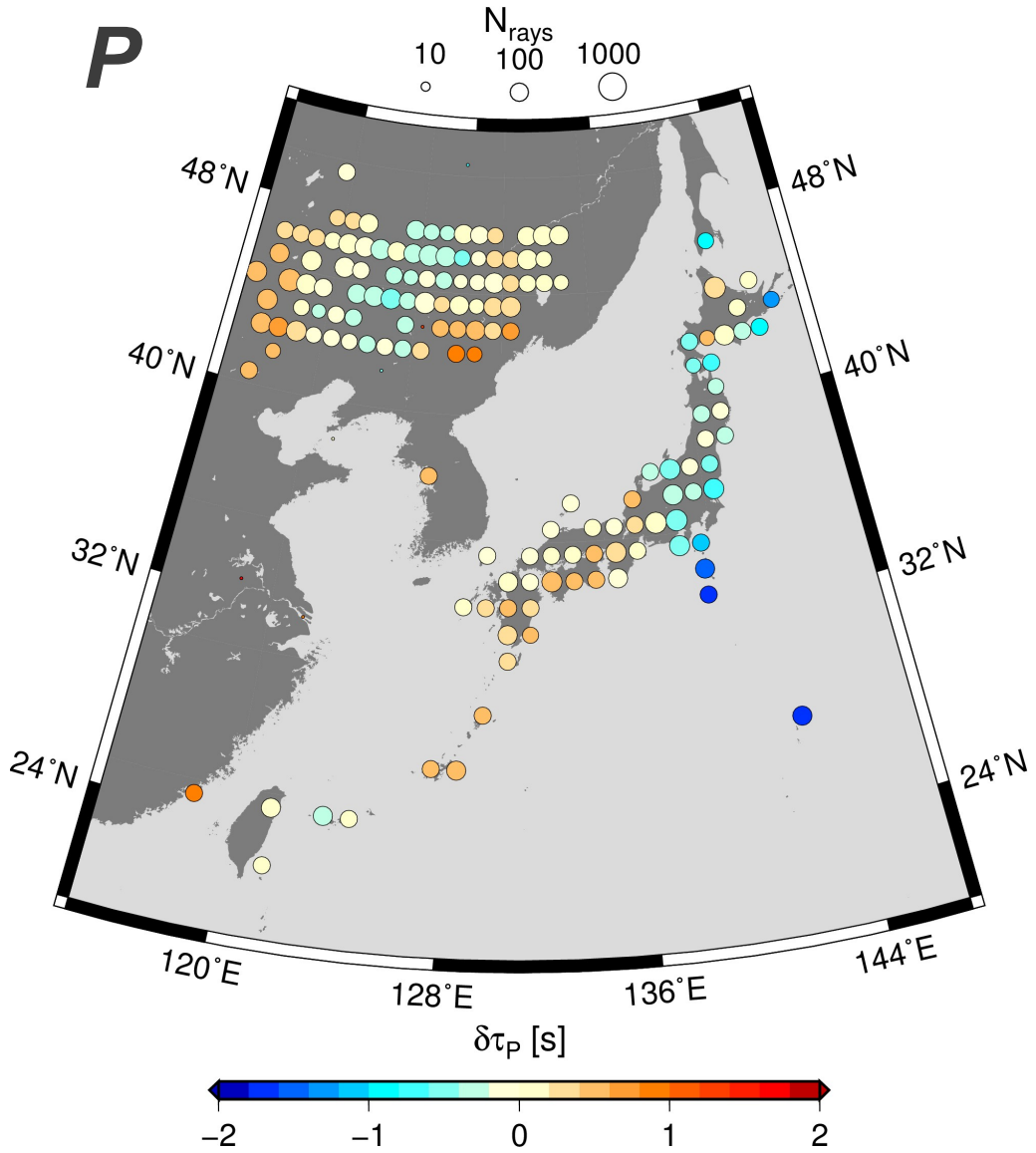
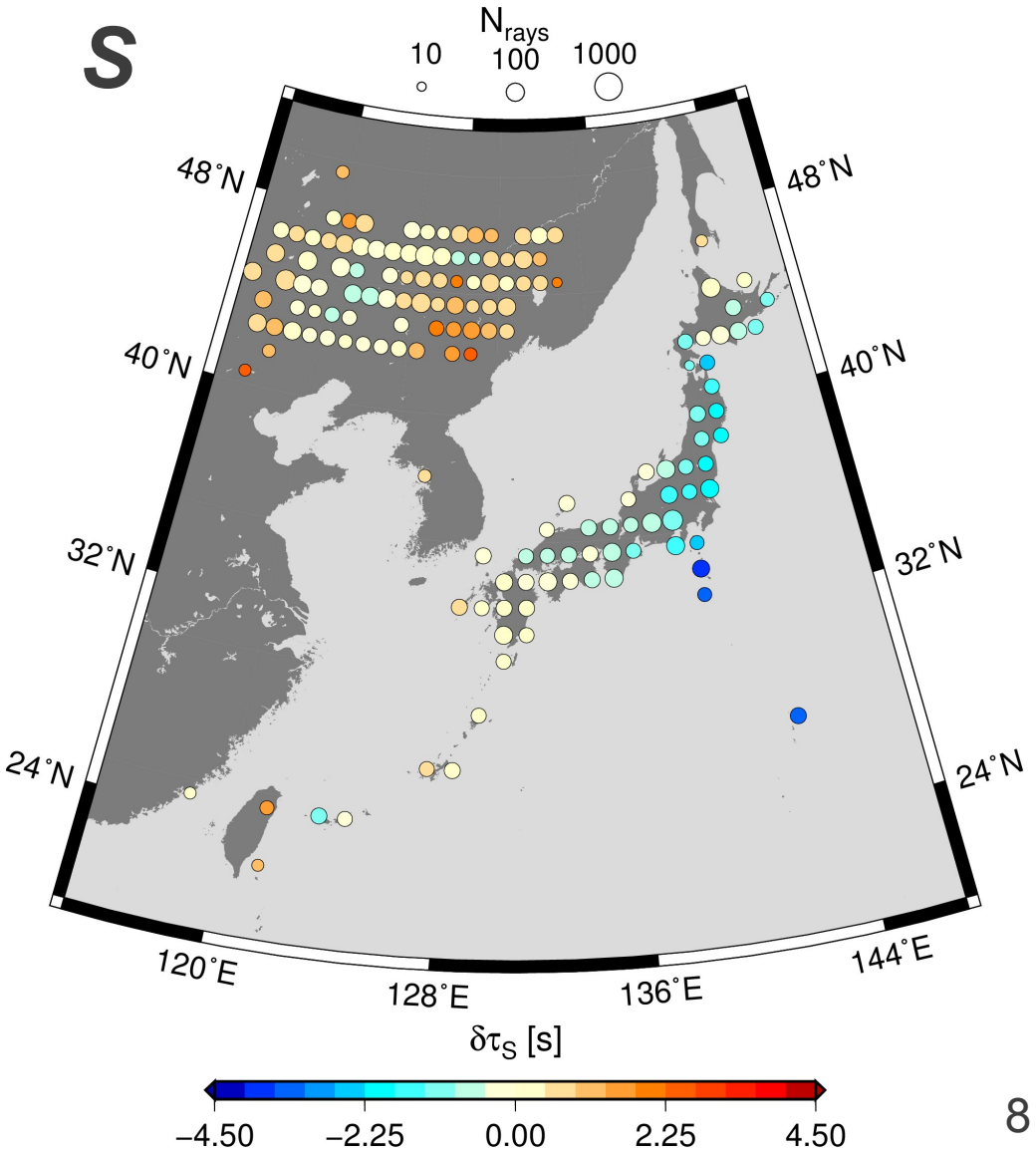
Traveltime maps

Great coherency in the maps (1° bins) of traveltime residuals between measurements on direct *P*- (left) and *S*-waves (right), with $\delta\tau_S = < \delta\tau_{SV}, \delta\tau_{SH} >$

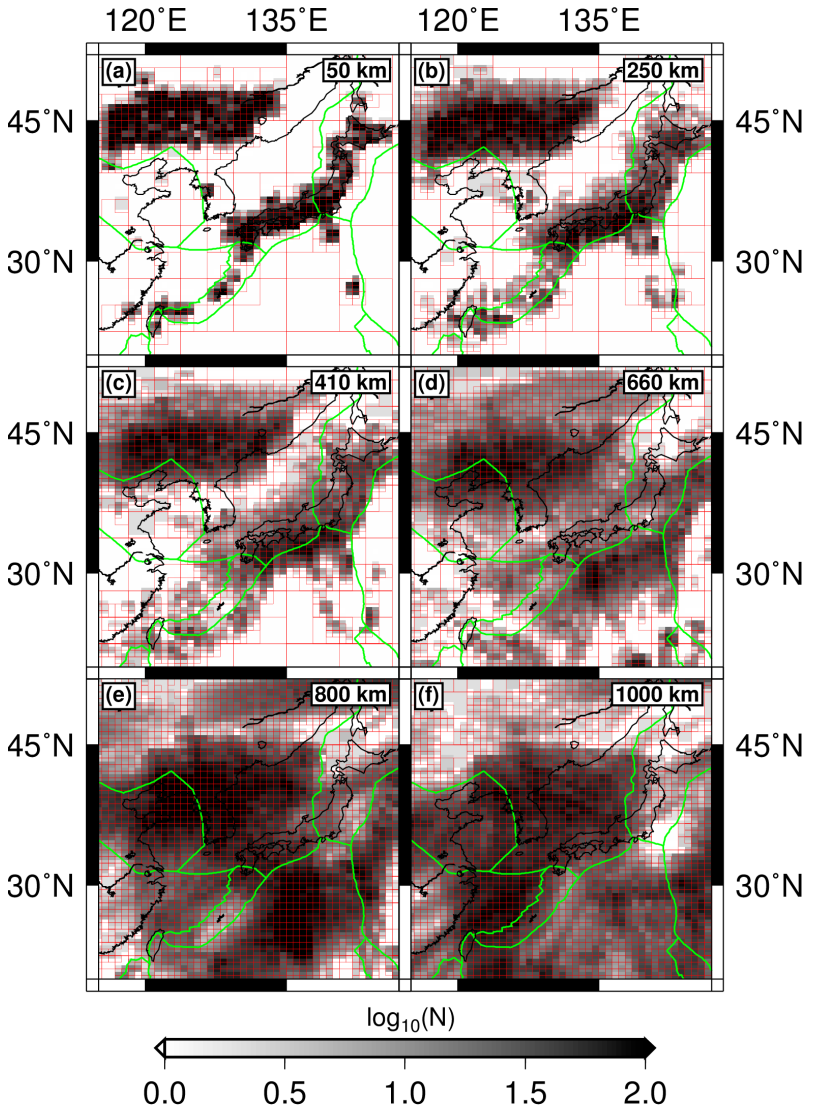


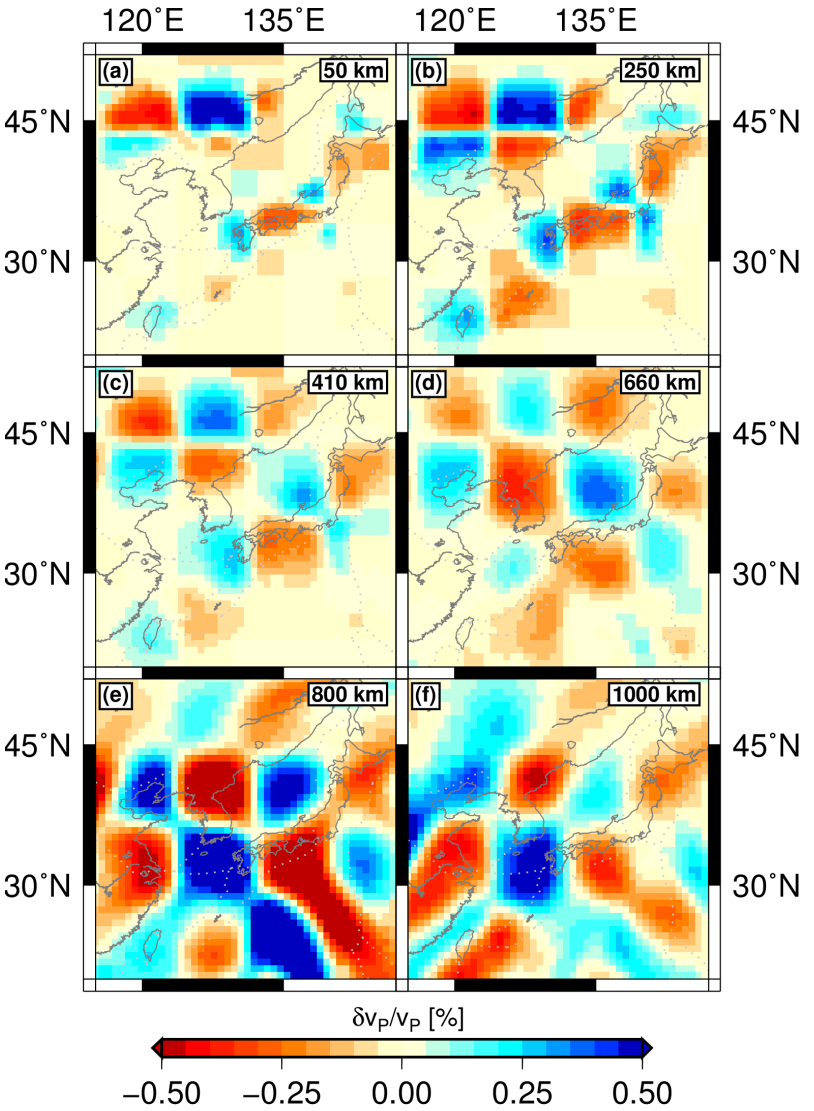


Inversion method

$$\mathbf{G\,m = d}$$

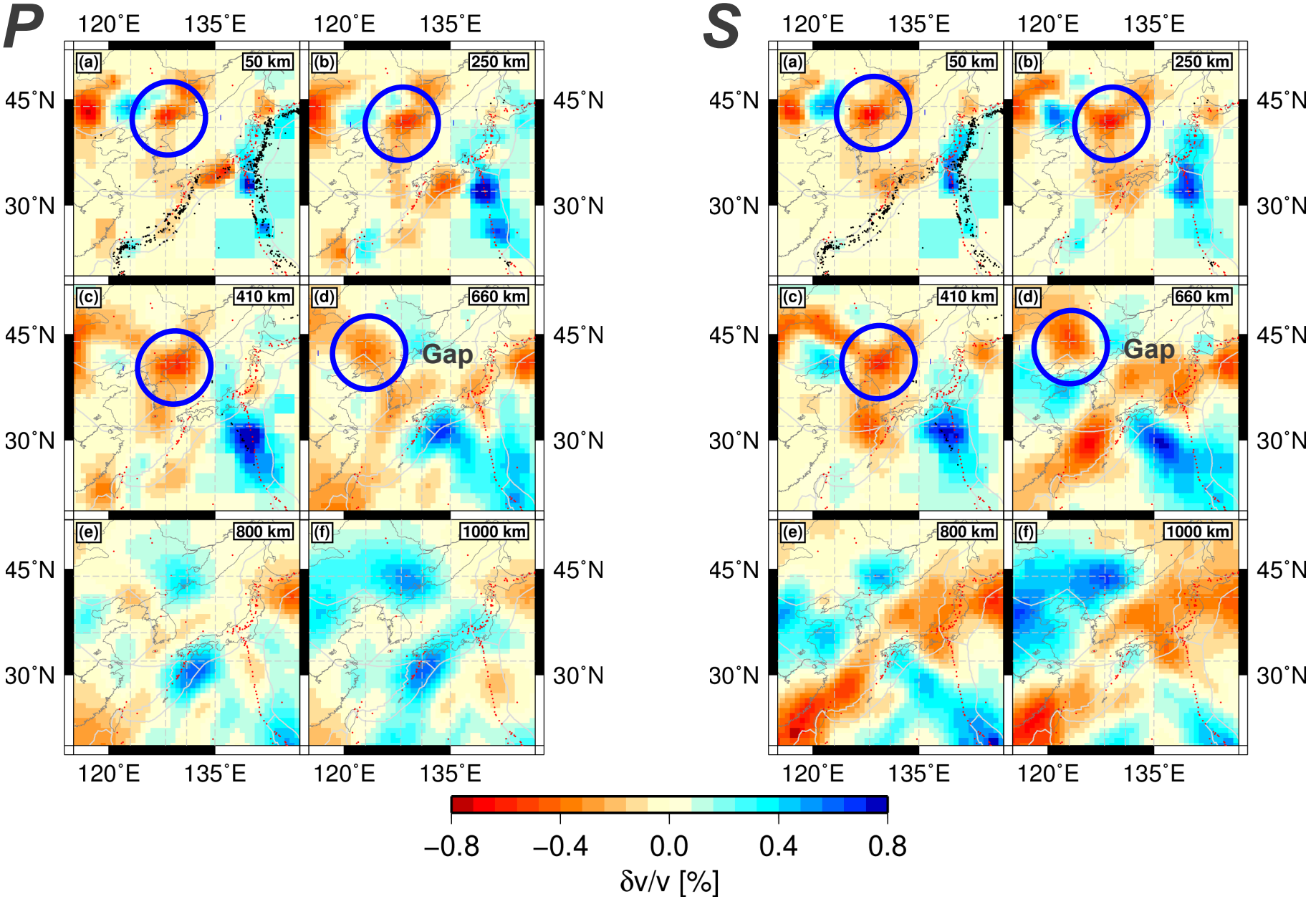
d : relative (event's mean removed) traveltime residuals
G : length of 1-D rays traced in ak135 (*Kennett et al., 1995*), inside a global irregular grid designed from hitcount
m : inverted using LSQR method (*Paige & Saunders, 1982*)





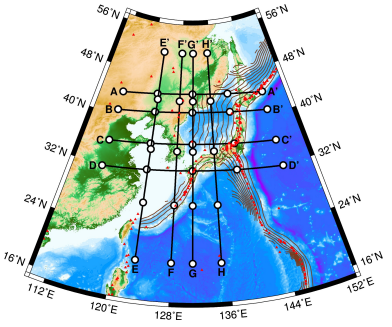
Tomographic models

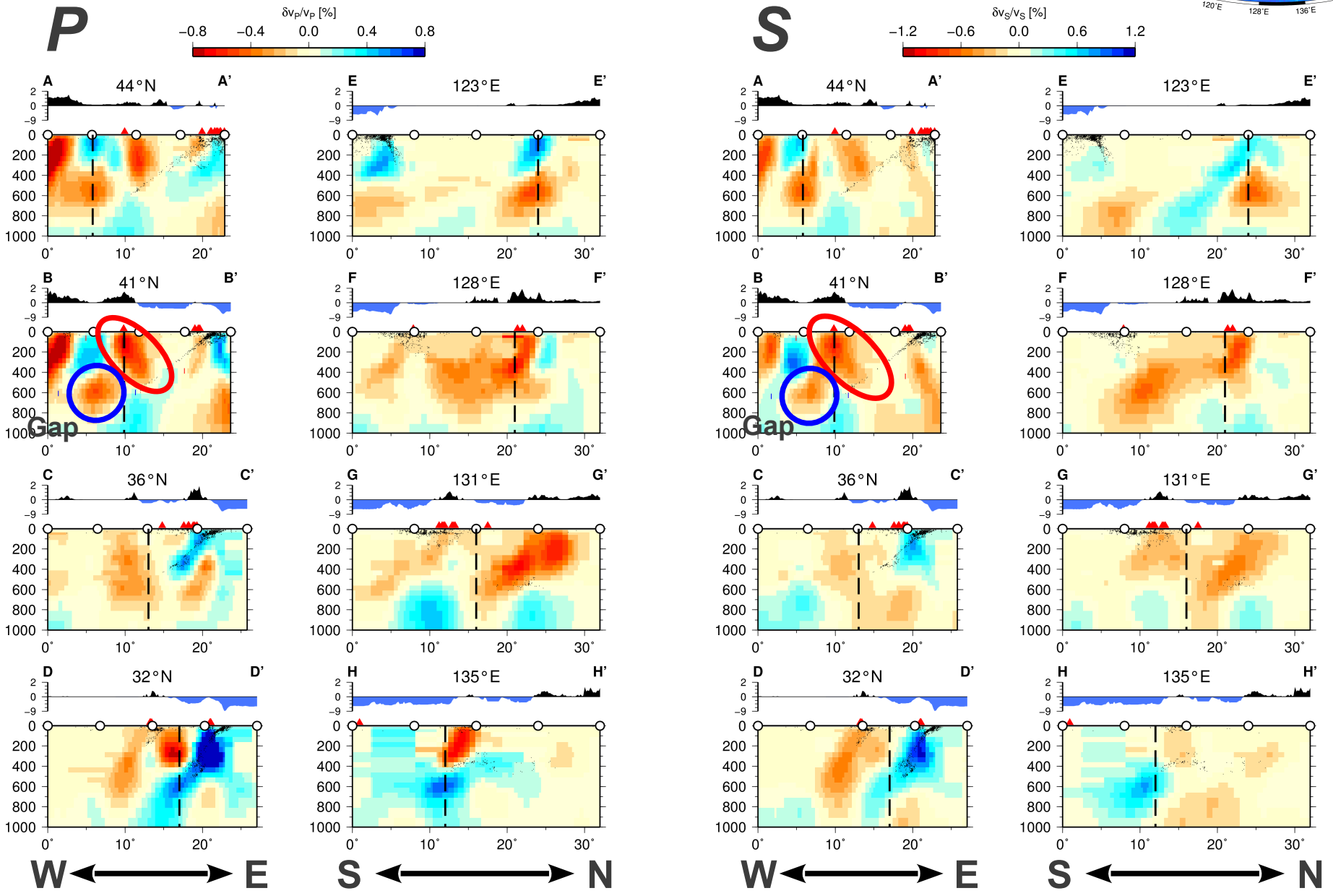
Very good spatial coherency between the *P*- and *S*-wave velocity models, also in global agreement with the results from Prs. Obayashi and Grand



Vertical cross-sections

Observation of a plume-like anomaly dipping towards West below Changbaishan area, as well as another one dipping towards East





Measurements of traveltime residuals

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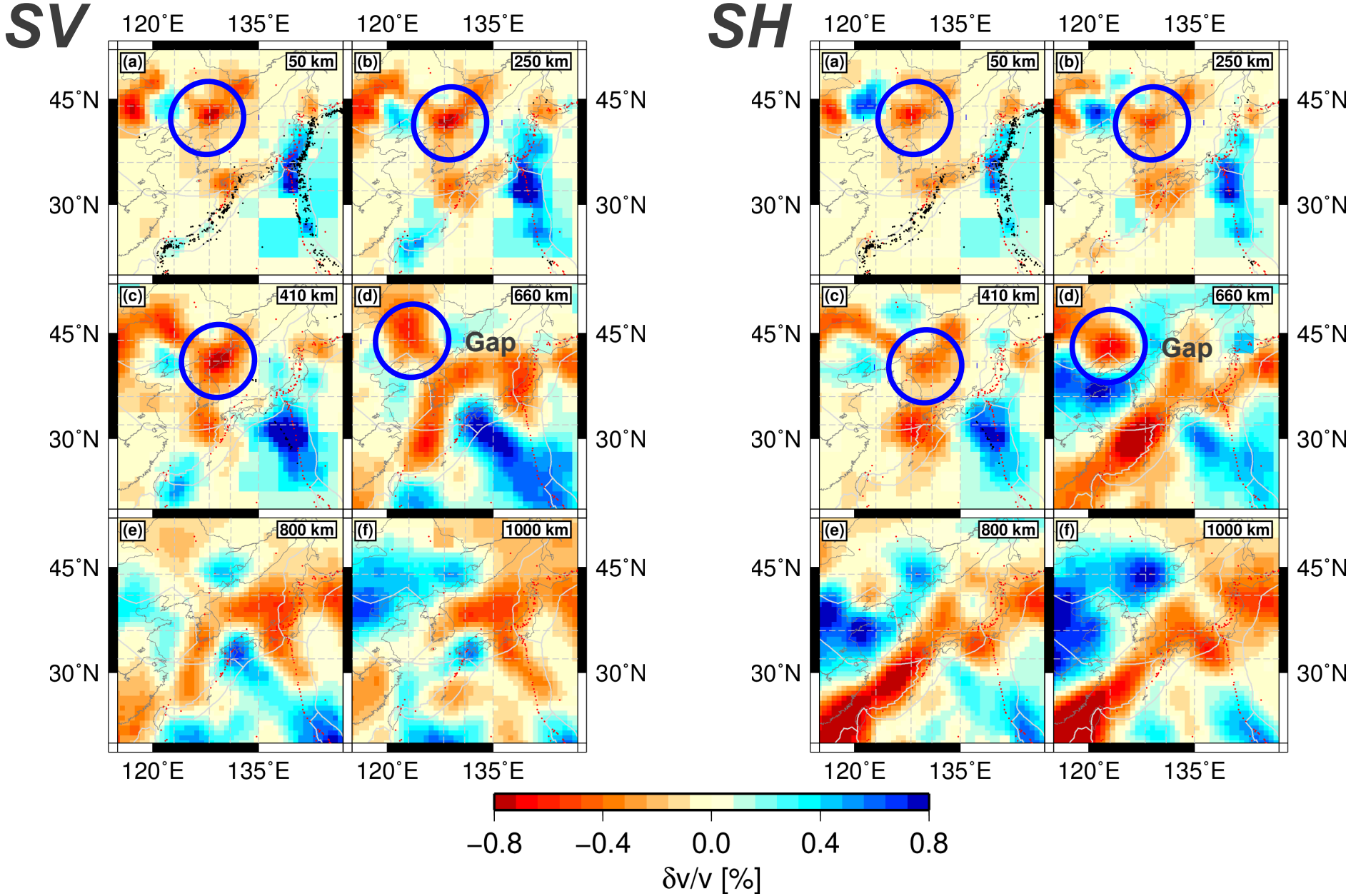
Comparison of *SV*- and *SH*-wave velocity models

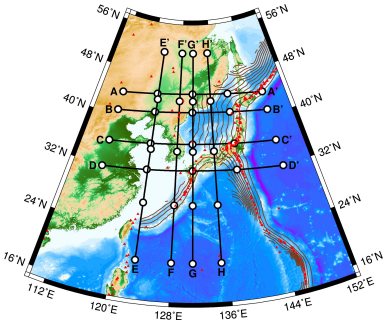
Tomographic models

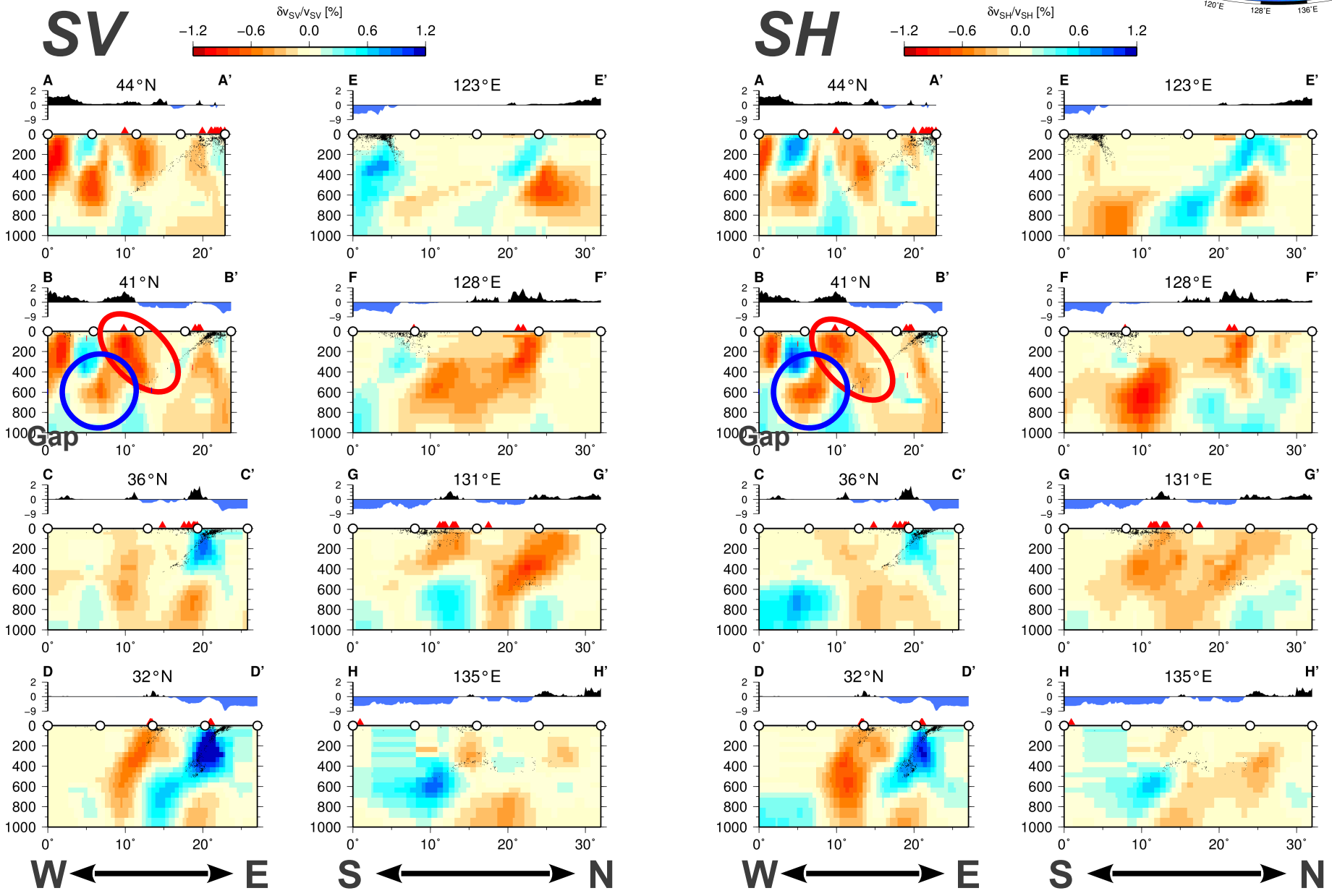
Consistency of the two models in the upper mantle,
some changes appear below 660 km



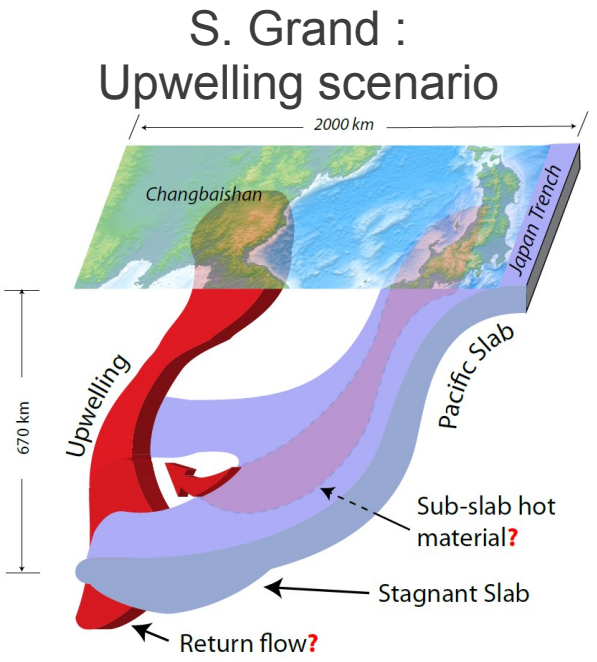
Vertical cross-sections

The Western plume-like anomaly is more clearly observed in *SH* model than in *SV* model





Conclusions



- We have built reliable models for *P*-, *SV*- and *SH*-wave velocity by using the same data processing and inversion scheme
- We could detect a plume-like low-velocity anomaly rising westward from a depth of 660 km to the Changbaishan area, as expected from previous studies
- We also detected another anomaly rising eastward from a shallower depth to the Changbaishan area, which can be interpreted as another mantle upwelling joining the previous one below the volcanic area
- Future work : inversion including Obayashi's model as the initial model

どうもありがとうございました !!

Principal references

M. Obayashi, JpGU Meeting 2013, oral communication

S. Grand, JpGU Meeting 2013, oral communication

L. Schardong, S. Chevrot & R. Garcia, in preparation

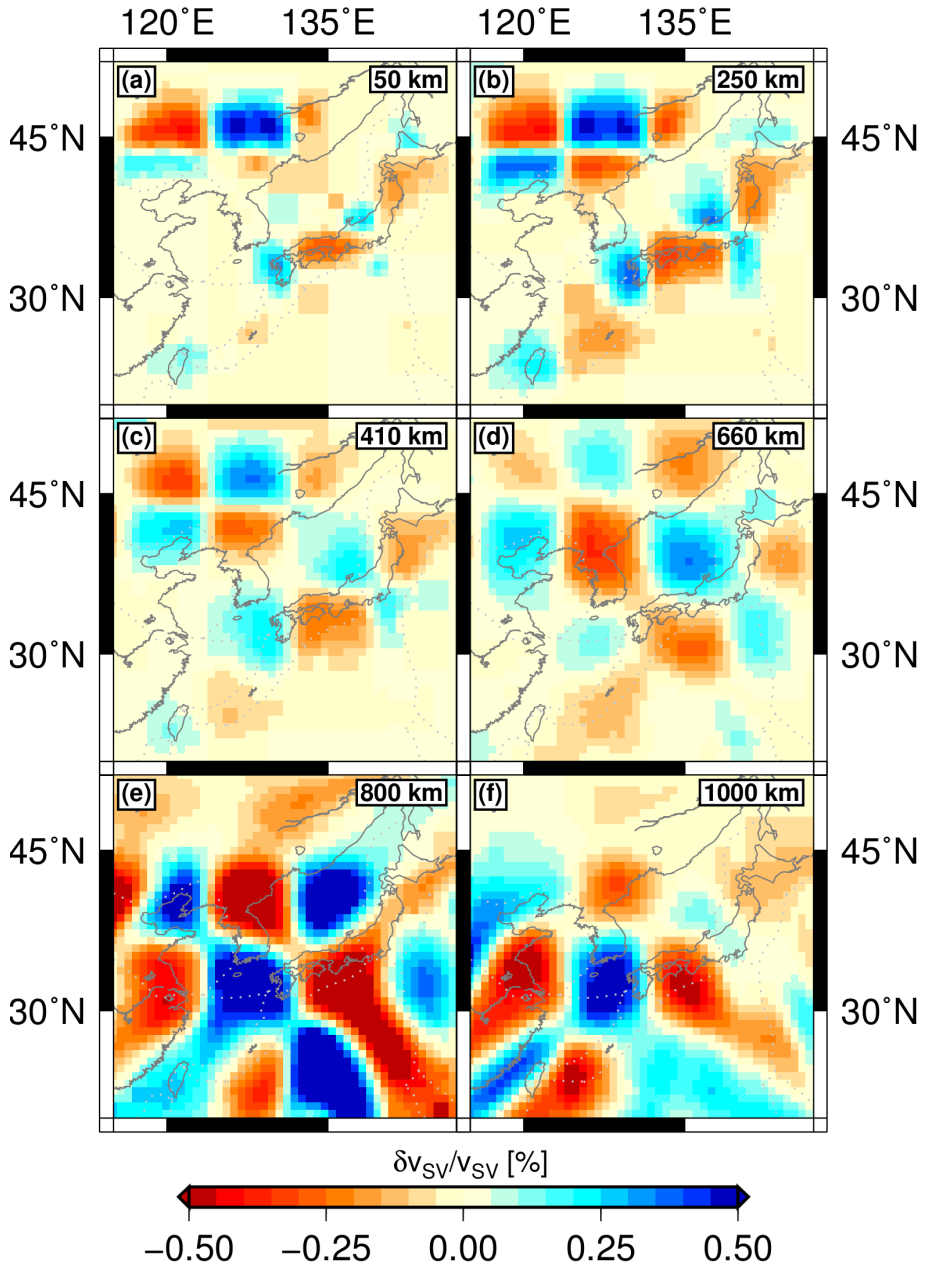
R. Garcia, L. Schardong & S. Chevrot (2013), *A nonlinear method to estimate source parameters, amplitude and traveltimes of teleseismic body waves*, BSSA, **103**

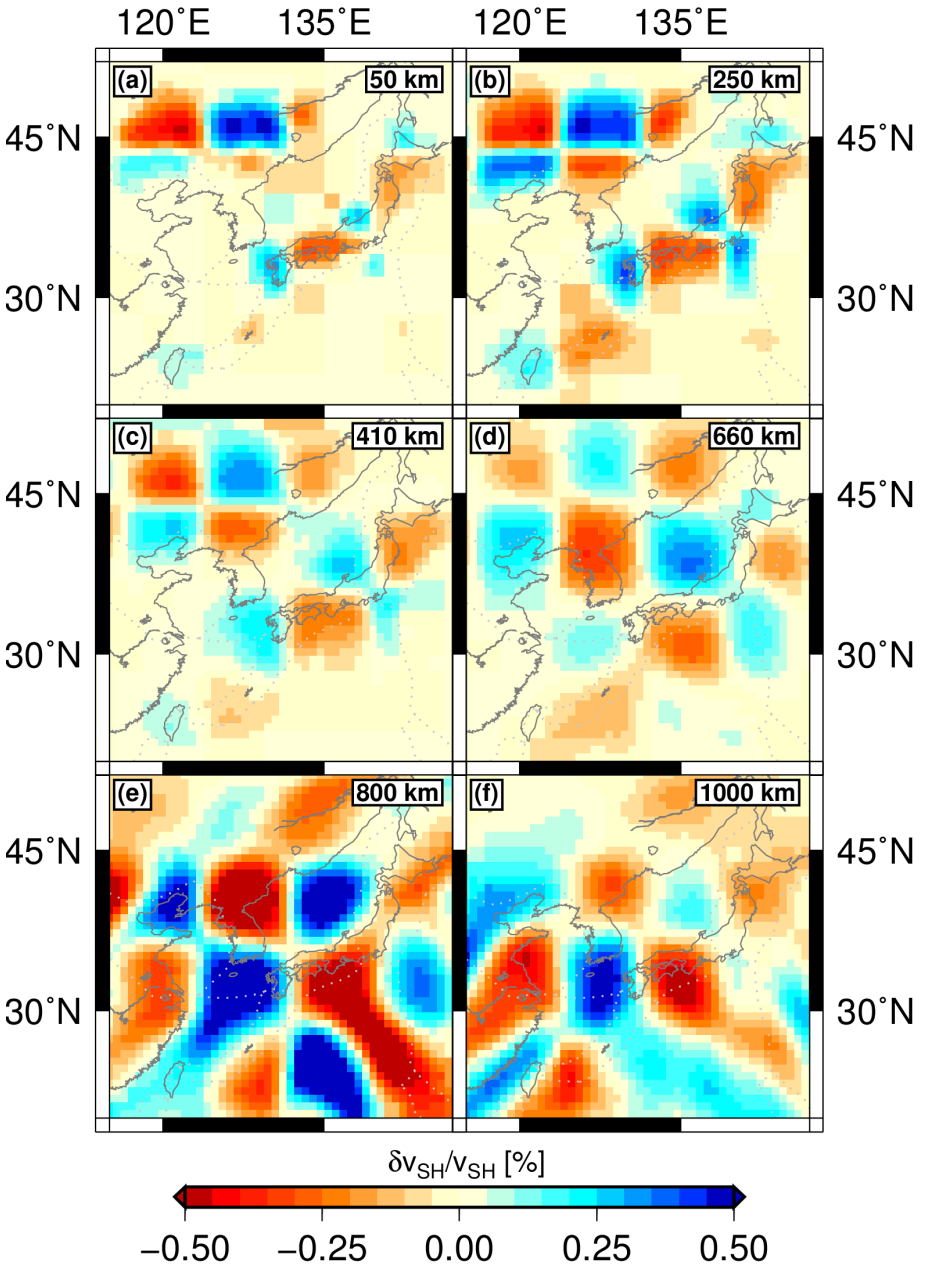
C. Paige & M. Saunders (1982), *LSQR: an algorithm for sparse linear equations and sparse least squares*, ACM Trans. Math. Software, **8**

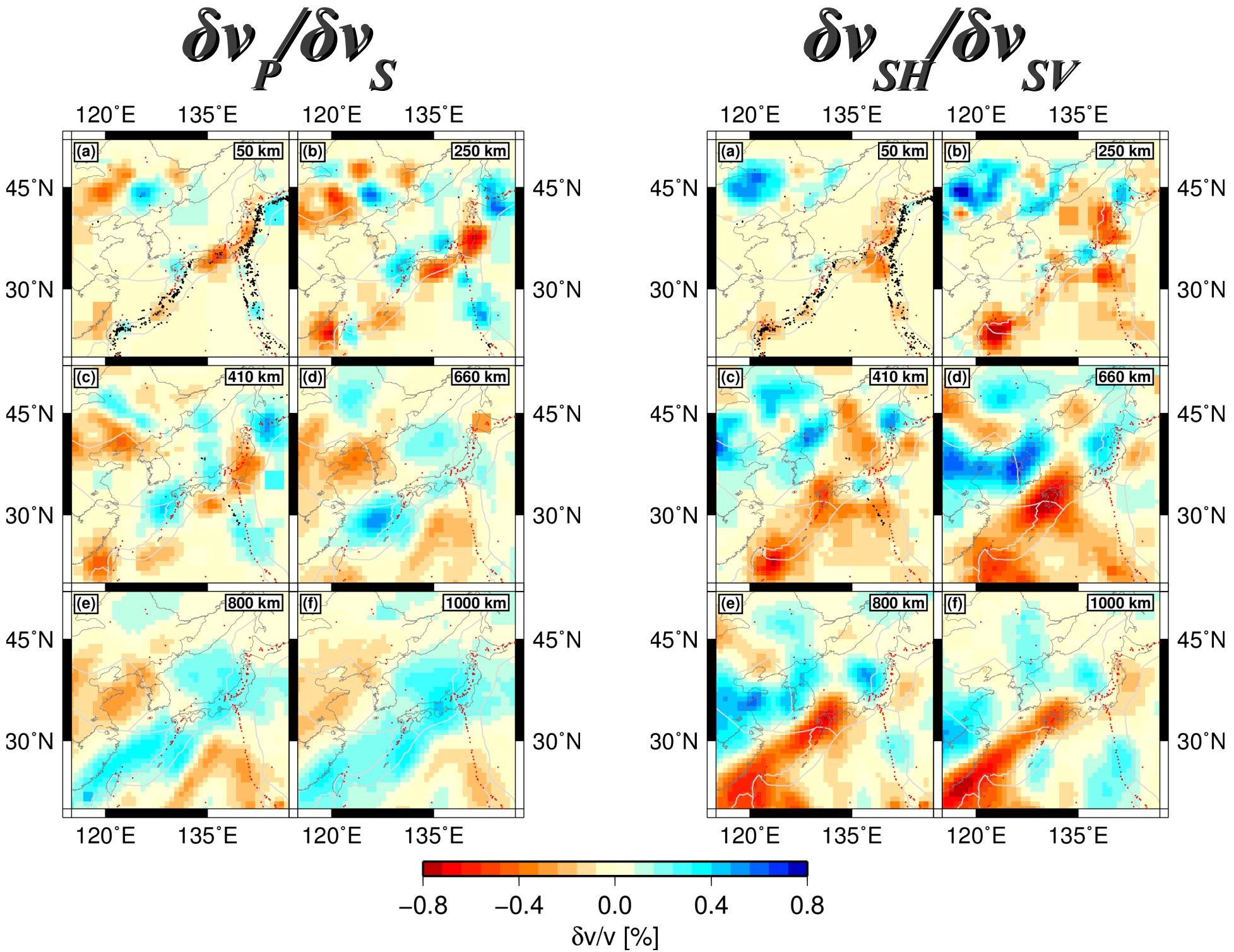
B. Kennett, E. Engdahl, & R. Buland (1995), *Constraints on seismic velocities in the Earth from traveltimes*, GJI, **122**

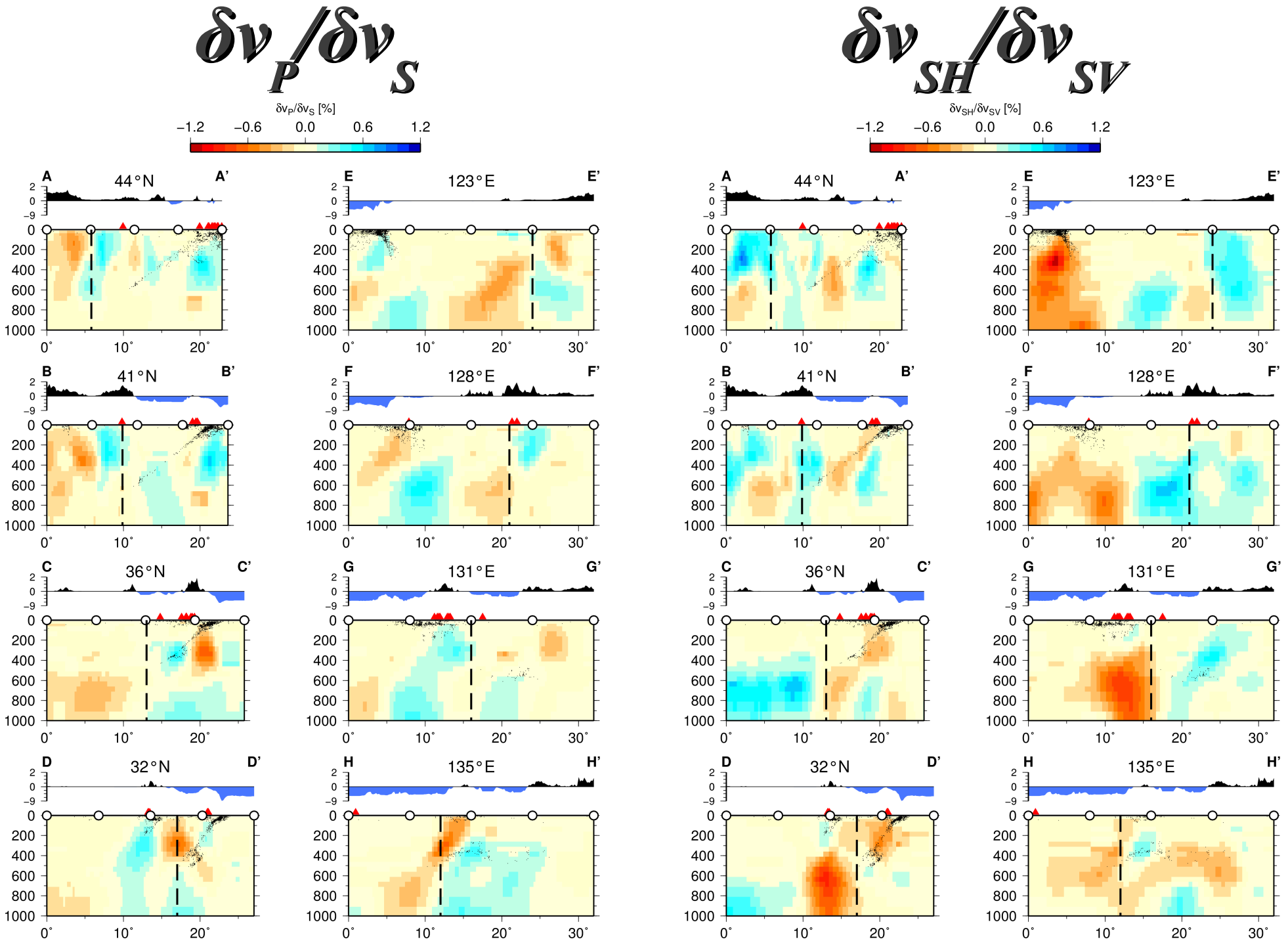
Supplementary material

Resolution tests for *SV* and *SH*






δv_P/δv_S
δv_SH/δv_SV
120°E
135°E
45°N
30°N
(a)
50 km
(b)
250 km
(c)
410 km
(d)
660 km
(e)
800 km
(f)
1000 km
−0.8
−0.4
0.0
0.4
0.8
δv/v [%]


δvP/δvS
δvP/δvS [%]
−1.2 −0.6 0.0 0.6 1.2
δvSH/δvSV
δvSH/δvSV [%]
−1.2 −0.6 0.0 0.6 1.2
A 44°N A'
E 123°E E'
B 41°N B'
F 128°E F'
C 36°N C'
G 131°E G'
D 32°N D'
H 135°E H'
2 0 −9
0 200 400 600 800 1000
0° 10° 20° 30°