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Remnants of shifting early Cenozoic Pacific lower mantle flow imaged beneath the Philippine Sea Plate

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Contents of this file

Figures 1 to 29

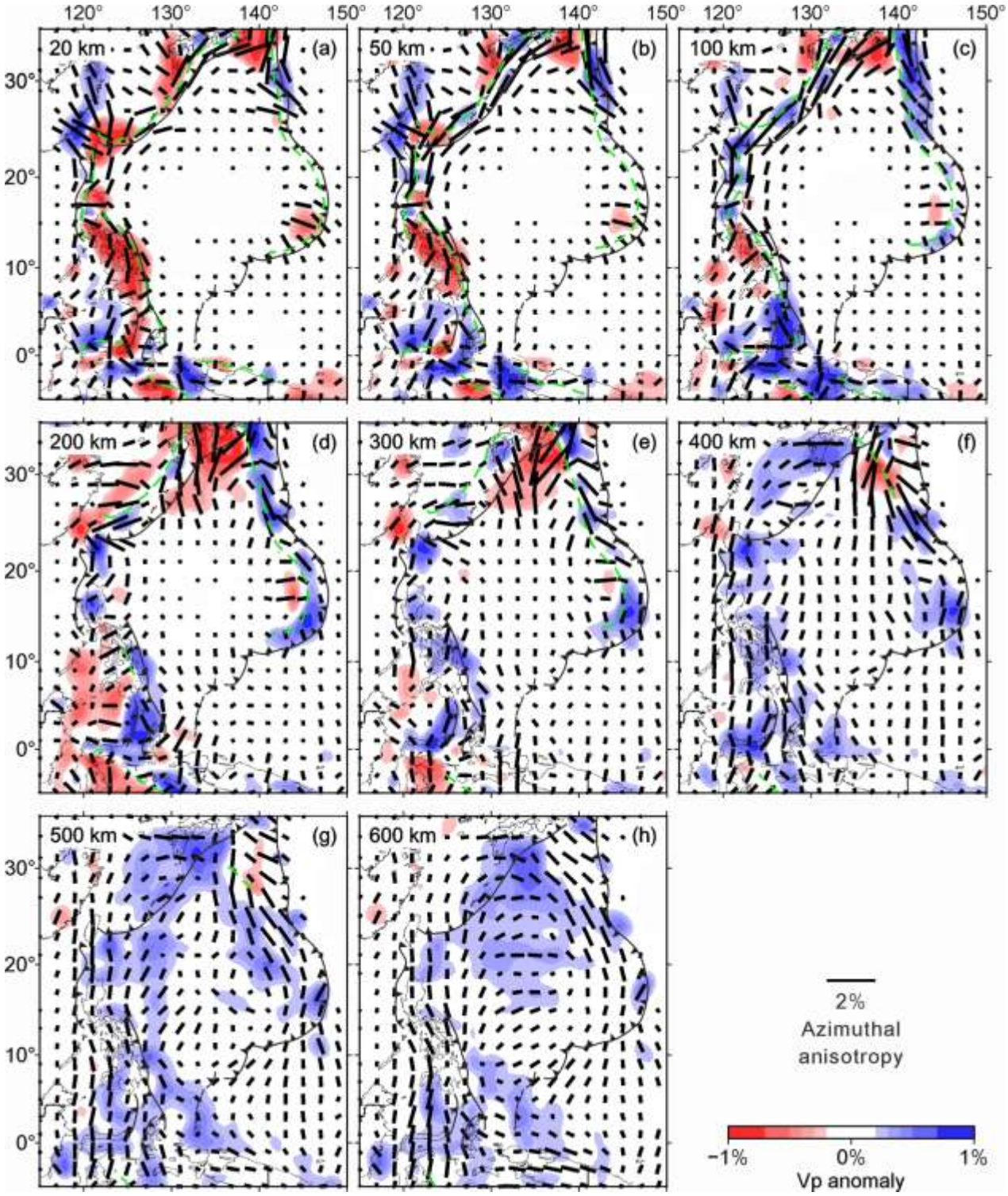

Figure 1. | (a-h) Map views of Vp azimuthal anisotropy tomography at depths of 20-600 km. The layer depth is shown at the upper-left corner of each map. The red and blue colors denote low and high isotropic Vp perturbations, respectively, whose scale is shown below (f). The orientation and length of the black bars represent the fast-velocity direction (FVDs) and amplitude of the azimuthal anisotropy, respectively, whose amplitude scale is shown below (f). The green dashed lines on each map denote locations of the upper boundaries of the subducted slabs at each depth, according to the Slab2 model[55]. Other symbols are the same as those in Figure 1 in the main text.

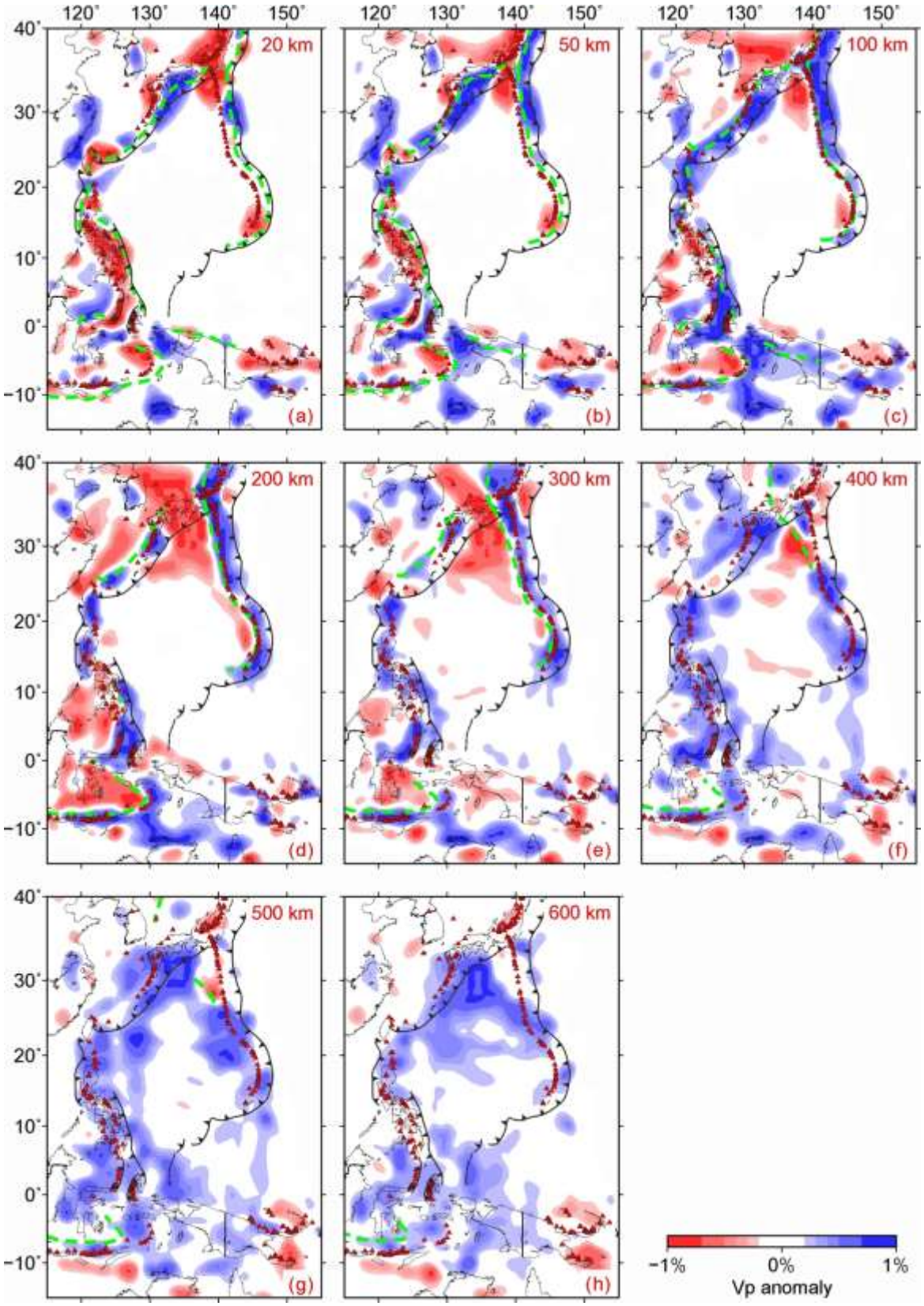

Figure 2. | Map views of isotropic Vp tomography at depths of 20-600 km. The layer depth is shown at the upper-right corner of each map. Red and blue colors denote low and high isotropic Vp perturbations, respectively, whose scale is shown below (f). Red triangles denote active volcanoes. Other symbols are the same as those in Figure 1.

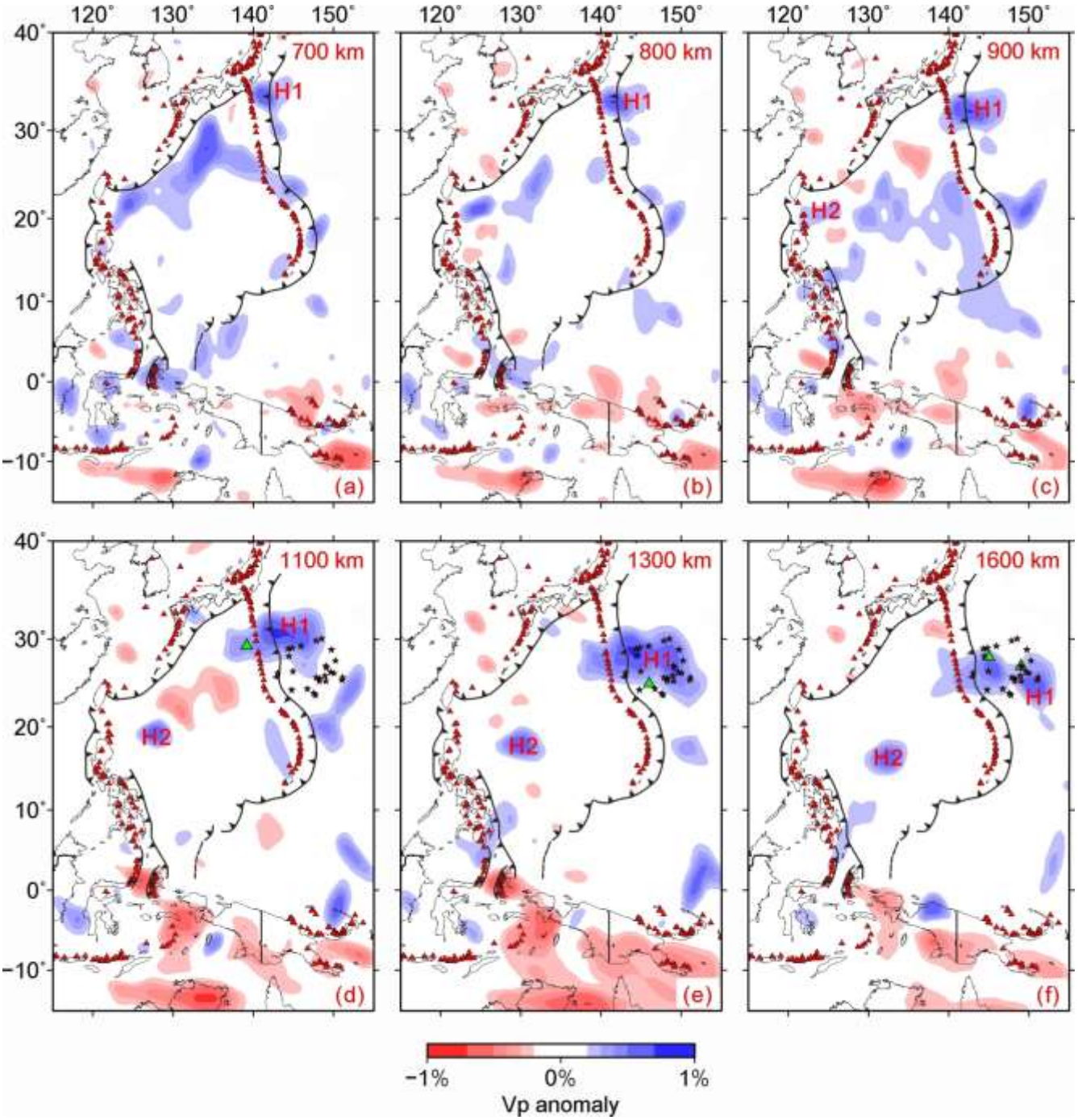

Figure 3. | The same as Figure 2, but for isotropic Vp tomography at depths of 700-1600 km. The green triangles and black stars denote seismic scatterers below 1000 km depth modified from refs.[32,33].

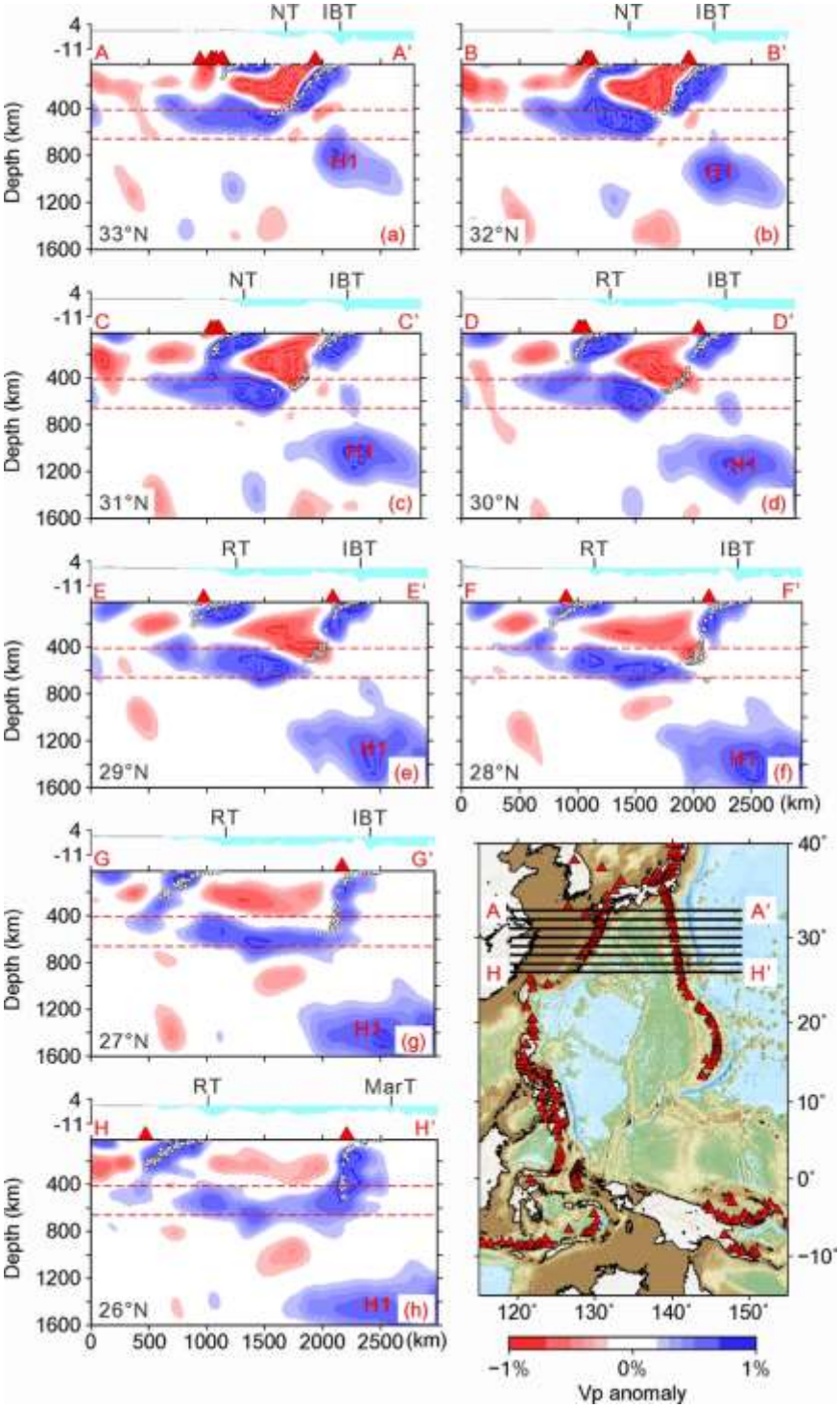

Figure 4. | (a-h) East-west vertical cross-sections of isotropic Vp tomography along the profiles at 26°-33°N latitudes as shown on the insert map. Red and blue colors denote low and high isotropic Vp perturbations, respectively, whose scale is shown at the bottom-right. The latitude of each profile is shown at the lower-left corner of each panel. The white dots denote seismicity (1964-2019) that occurred within a 30-km width of each profile from the ISC-EHB bulletins. The two red dashed lines in each panel represent the 410- and 660-km discontinuities. The surface topography along each profile is shown above the cross-section. IBT, the Izu-Bonin Trench; MarT, the Mariana Trench; NT, the Nankai Trough; RT, the Ryukyu Trench.

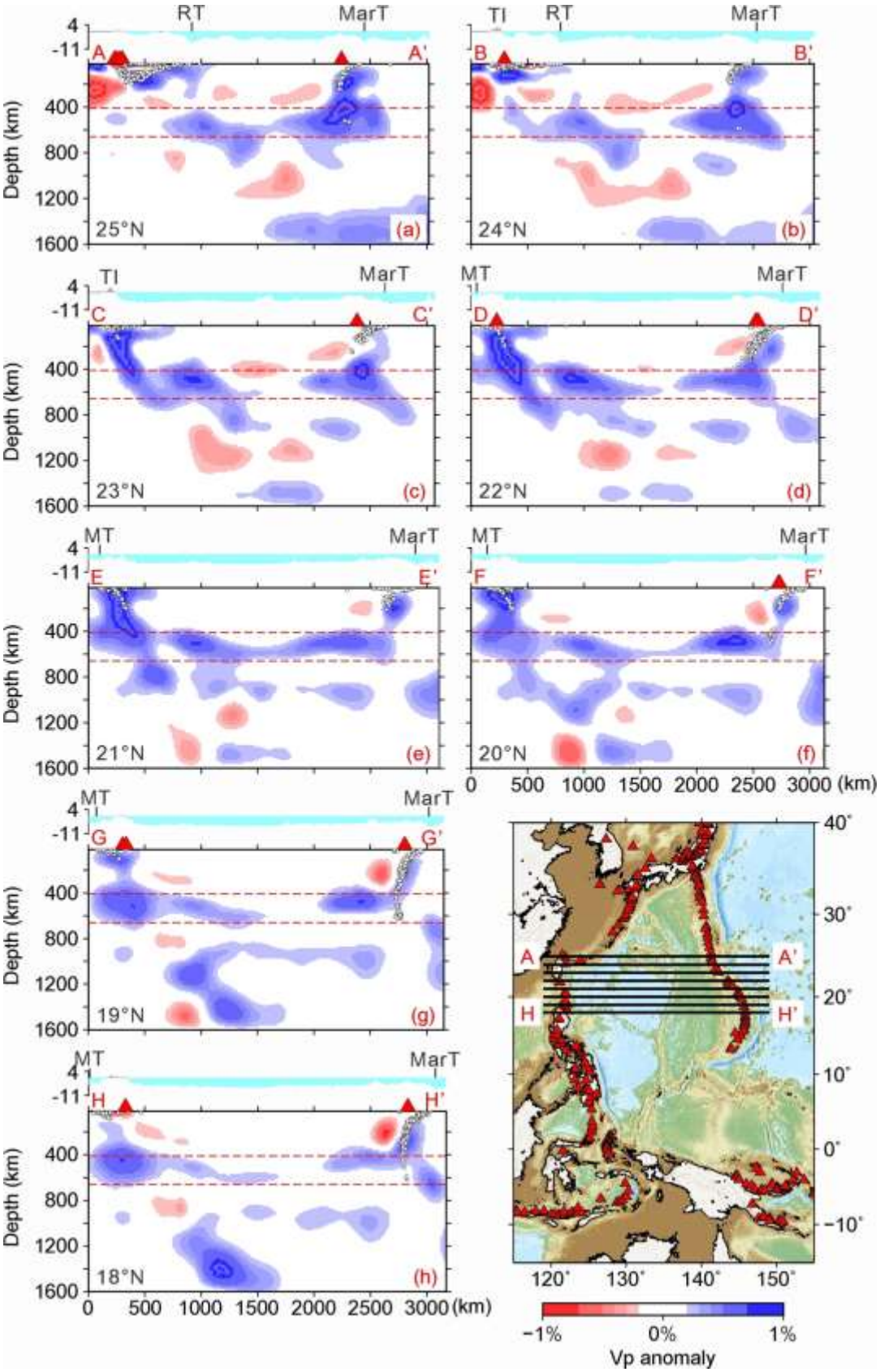

Figure 5. | The same as Figure 4 but along the profiles at 18°-25°N latitudes. MarT, the Mariana Trench; MT, the Manila Trench; RT, the Ryukyu Trench; TI, the Taiwan Island.

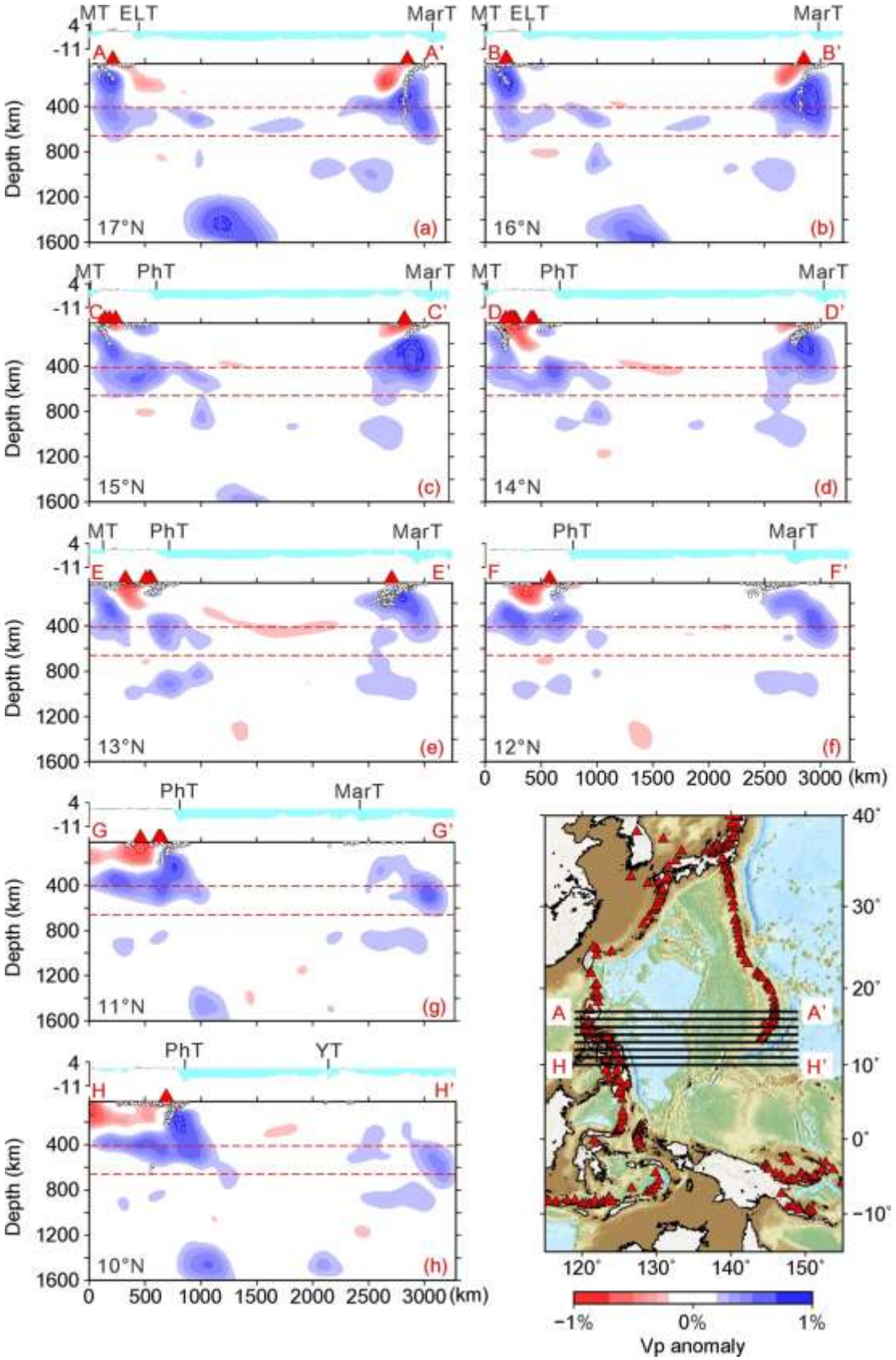

Figure 6. | The same as Figure 4 but along the profiles at 10°-17°N latitudes. ELT, the East Luzon Trough; MarT, the Mariana Trench; MT, the Manila Trench; PhT, the Philippine Trench; YT, the Yap Trench.

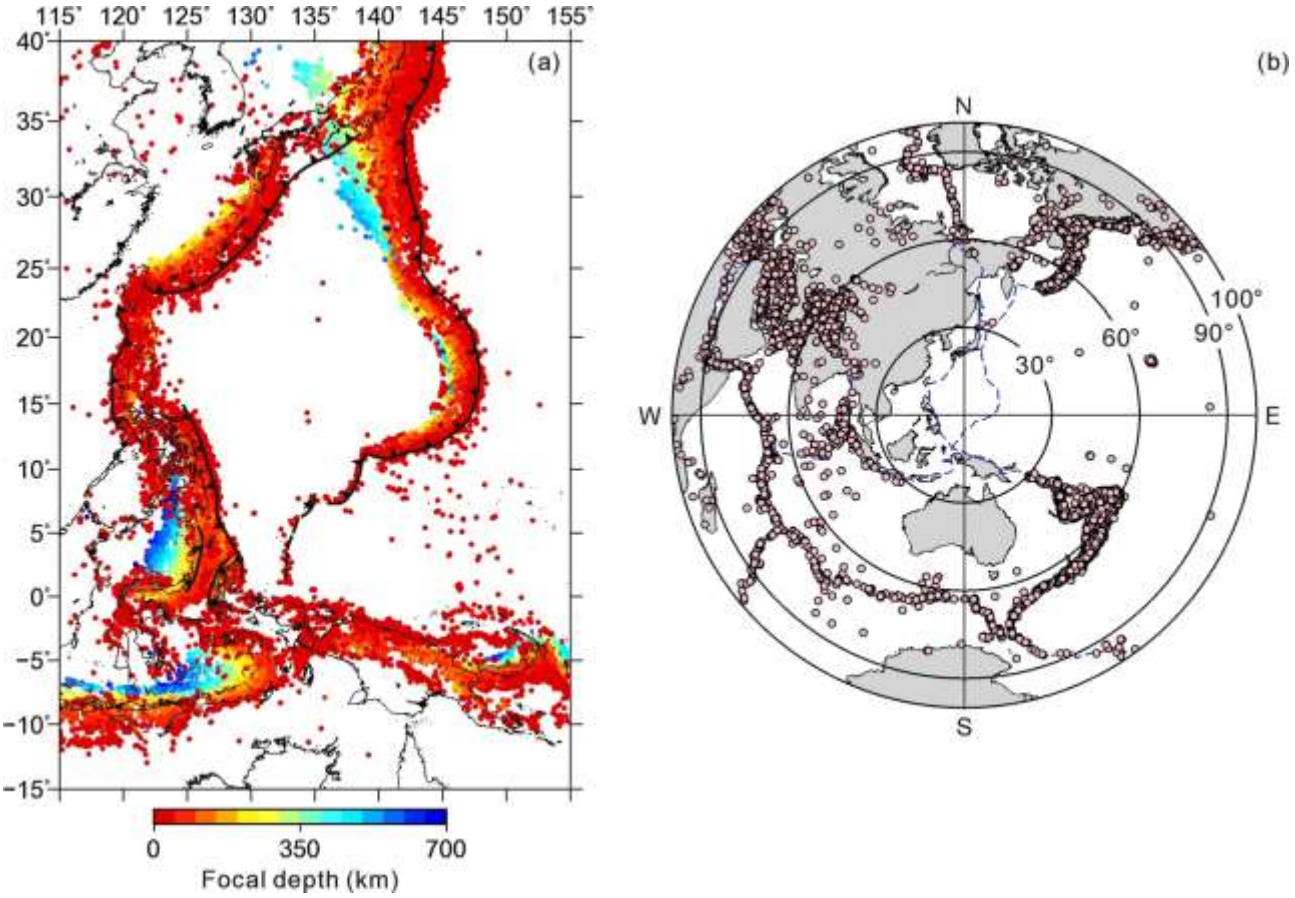

Figure 7. | Epicentral distribution of (a) local and regional earthquakes (color dots) and (b) teleseismic events (pink dots) used in this study. The dot colors in (a) denote the focal depths whose scale is shown below (a). The dashed lines in (b) denote plate boundaries at the surface. Other symbols are the same as those in Figure 1 in the main text.

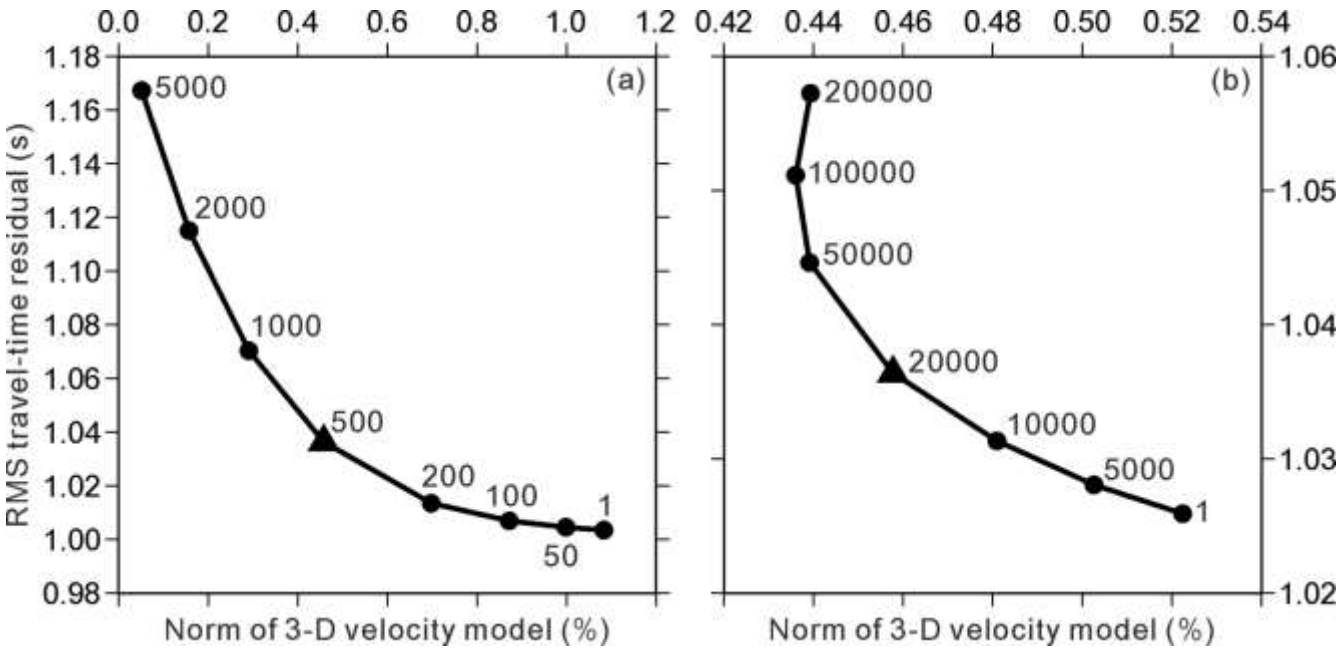

Figure 8. | Trade-off curves between the norm of the 3-D isotropic Vp model and the root-mean-square (RMS) travel-time residual, with different values (the numbers beside the dots and triangles) of the (a) damping parameter and the (b) smoothing parameter. The numbers beside the triangles denote the optimal (a) damping and (b) smoothing parameters.

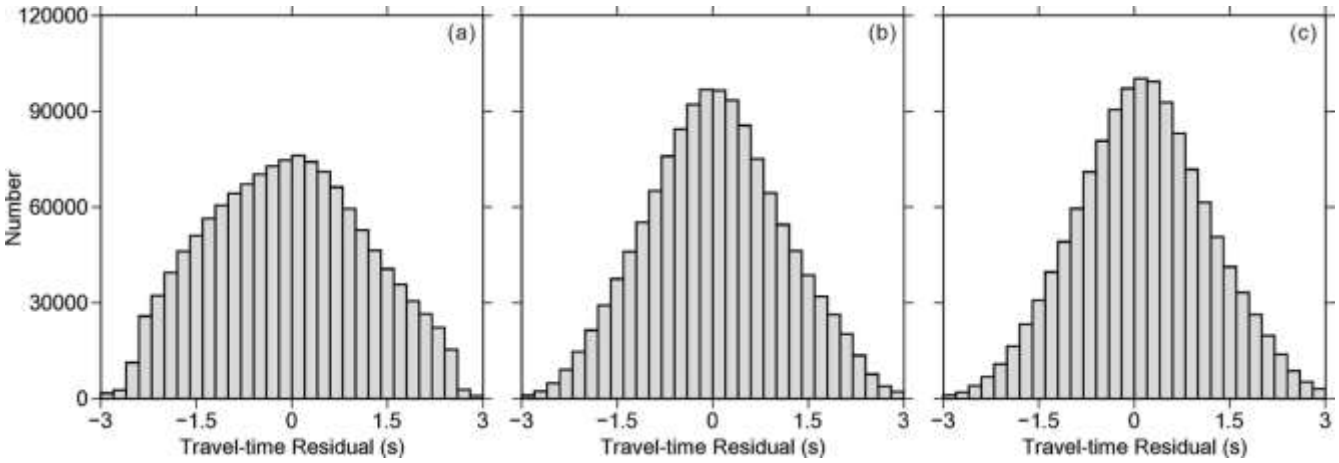

Figure 9. | Histogram of travel-time residuals (a) before and (b) after isotropic and (c) azimuthal anisotropic tomographic inversions.

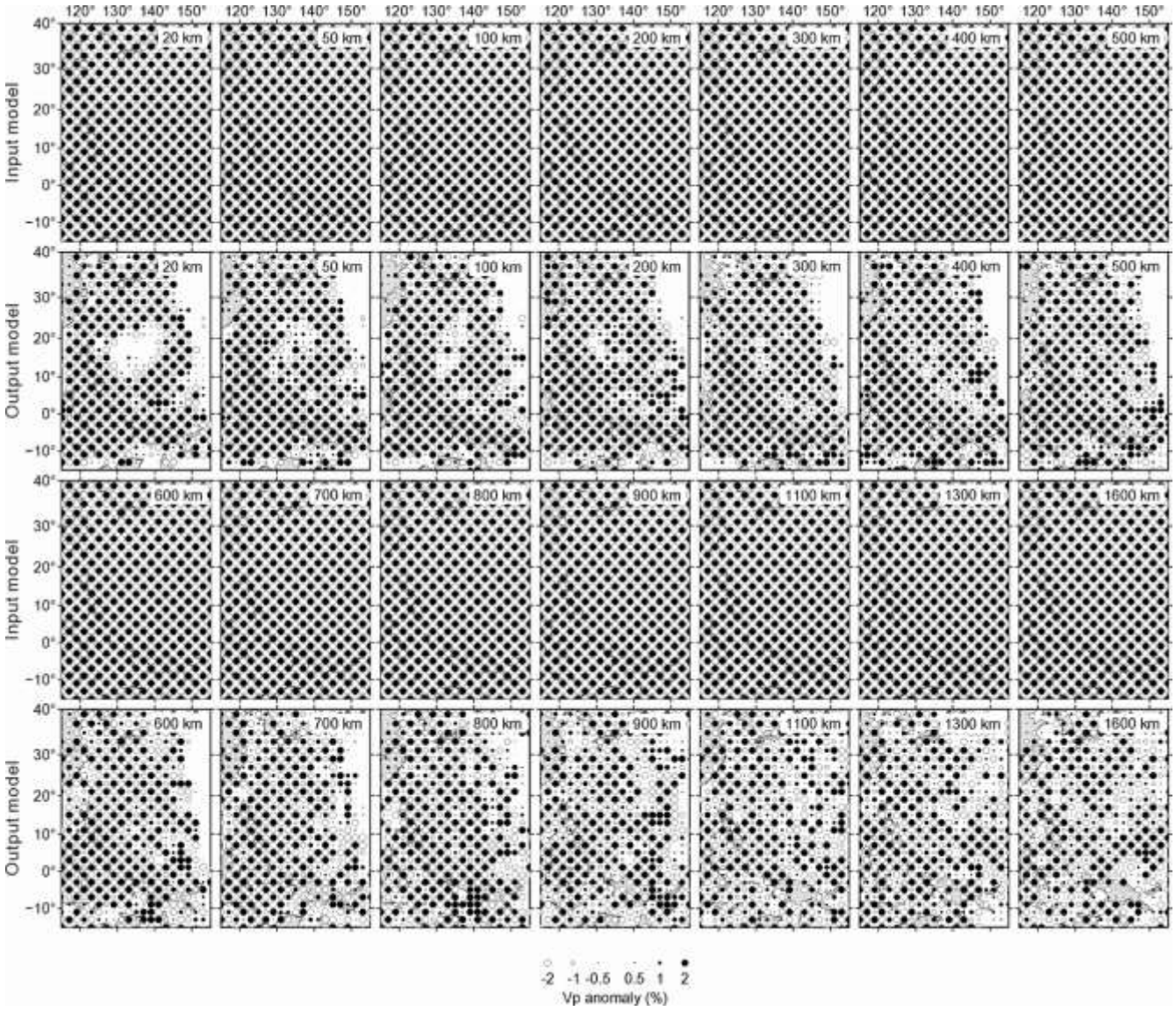

Figure 10. | Isotropic results of a checkerboard resolution test for Vp azimuthal anisotropy tomography with isotropic Vp perturbations of ±2% and azimuthal anisotropic perturbations of ±2% in the input model. The lateral grid interval is 2.0° for both isotropic Vp and azimuthal anisotropy. The white and black dots denote low and high isotropic Vp perturbations, respectively. The upper and lower panels denote the input and output models, respectively. The layer depth is shown at the upper-right corner of each map. The scale of the isotropic Vp perturbation is shown at the bottom.

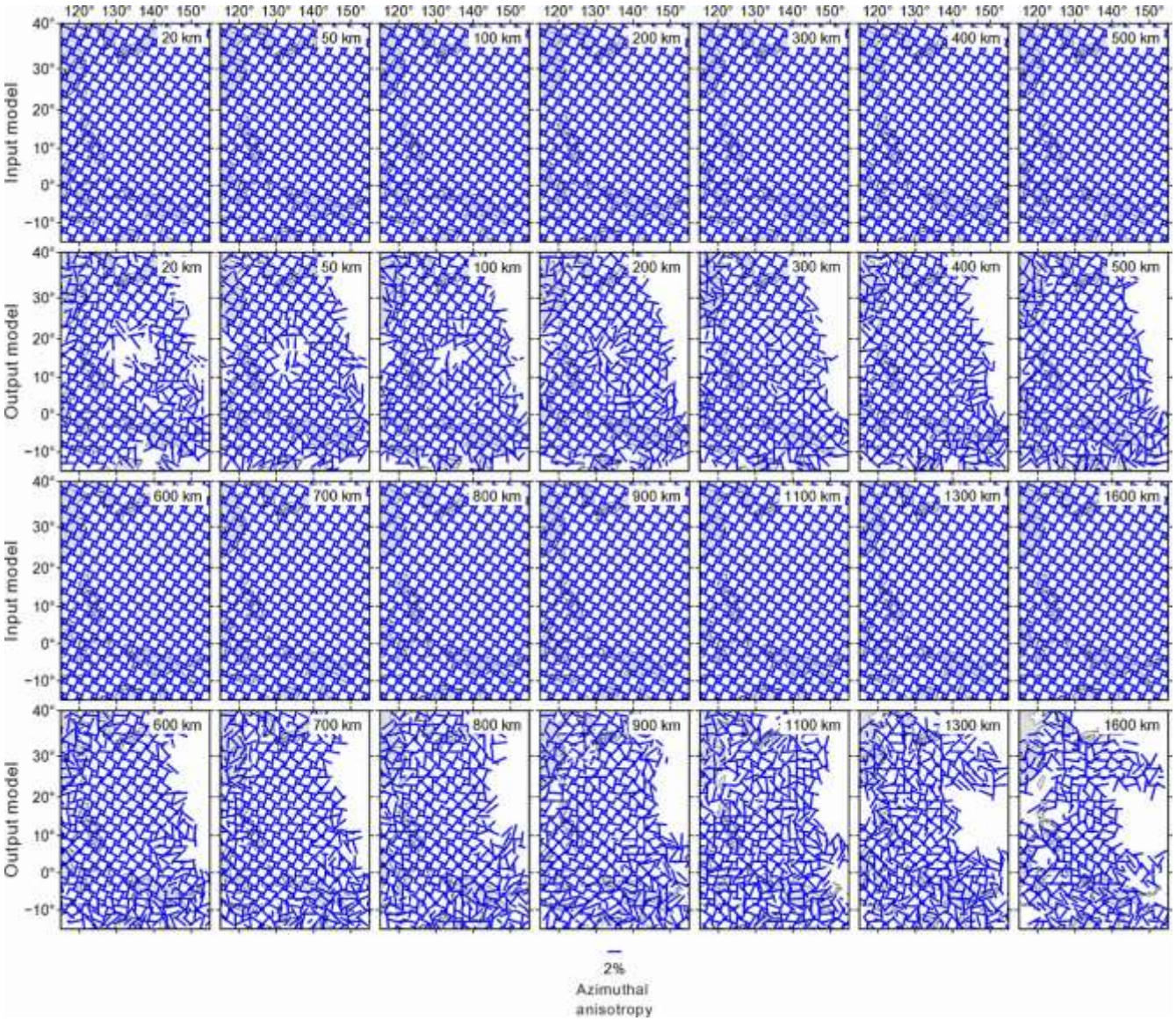

Figure 11. | The same as Figure 10 but for the anisotropic results. The orientation and length of the blue bars denote the FVDs and the amplitude of Vp azimuthal anisotropy, respectively. The scale of the Vp anisotropic amplitude is shown at the bottom.

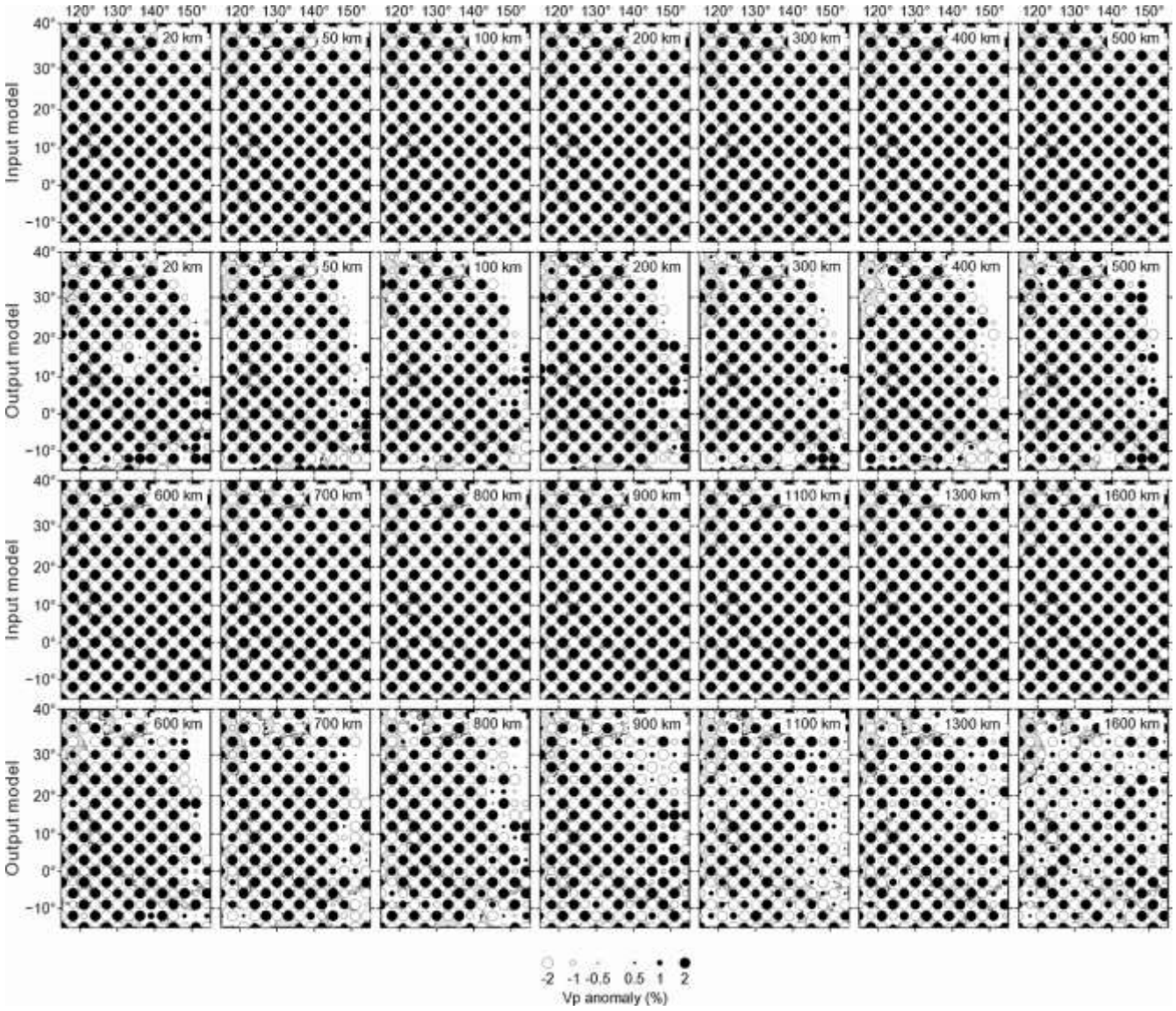

Figure 12. | The same as Figure 10 but the lateral grid interval is 3.0° for isotropic Vp and 4.0° for azimuthal anisotropy.

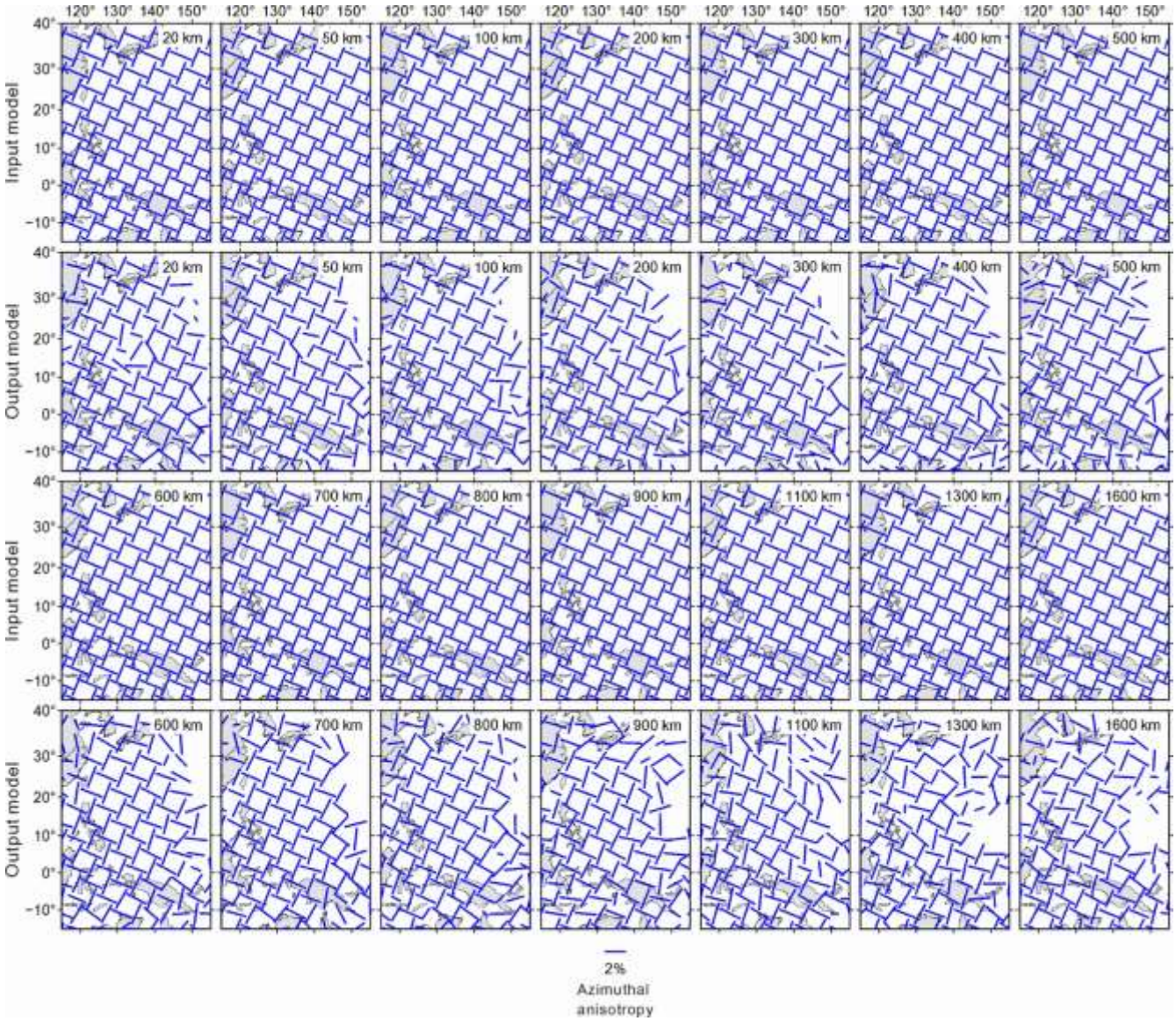

Figure 13. | The same as Figure 12 but for the anisotropic results.

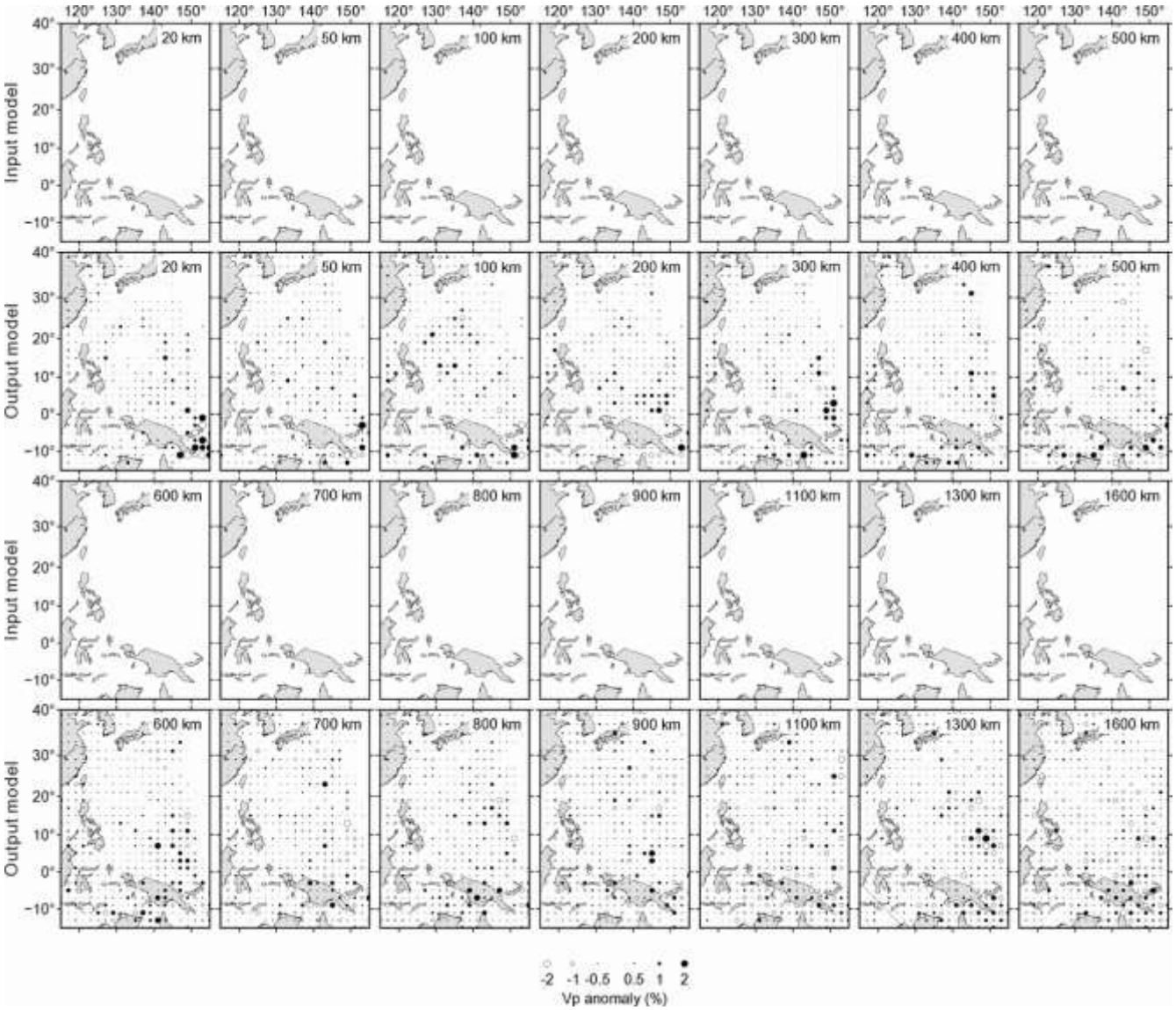

Figure 14. | The same as Figure 10 but in the input model, perturbations of Vp azimuthal anisotropy parameters are ±2%, whereas isotropic Vp perturbations are all zero.

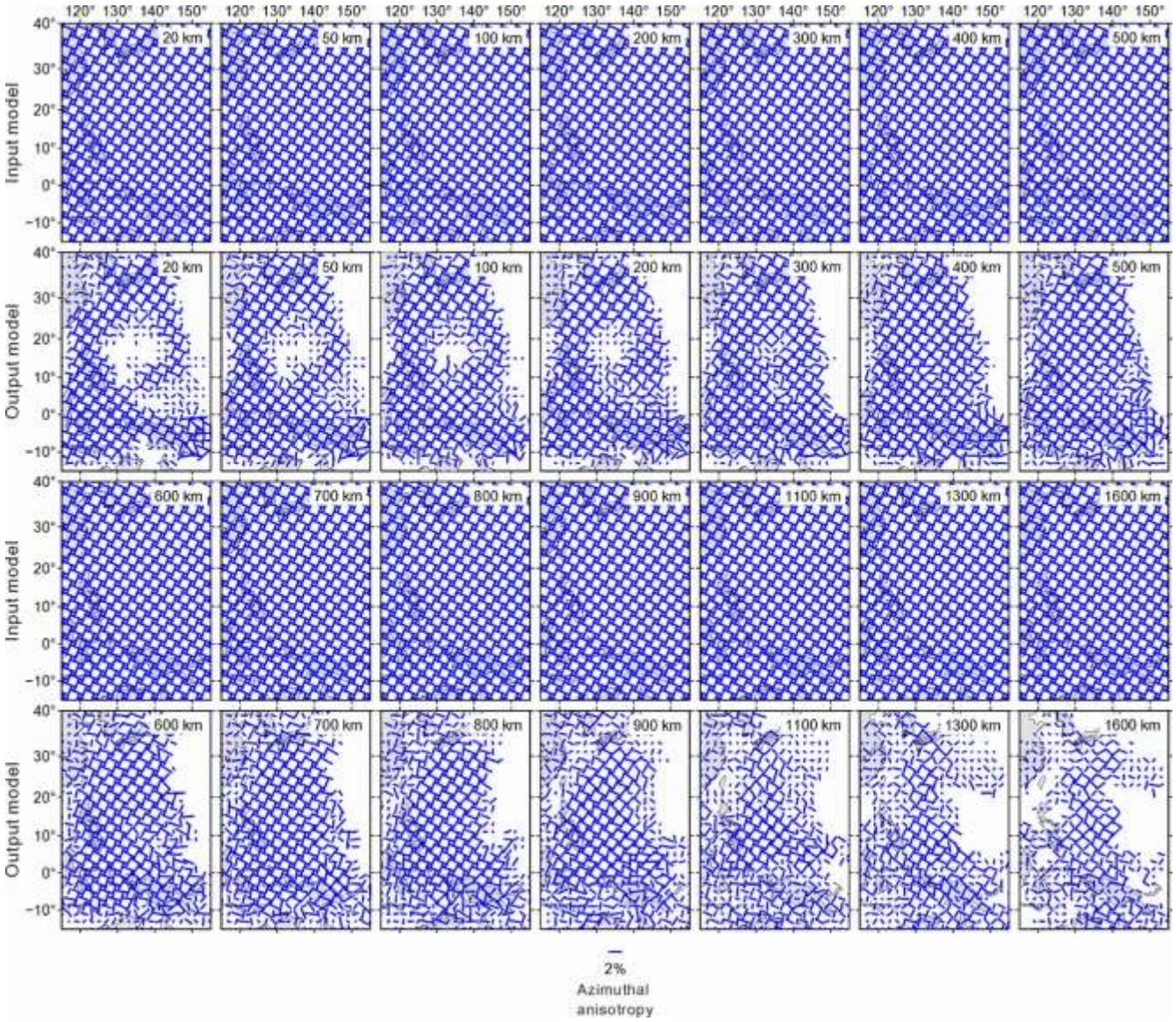

Figure 15. | The same as Figure 14 but for the anisotropic results.

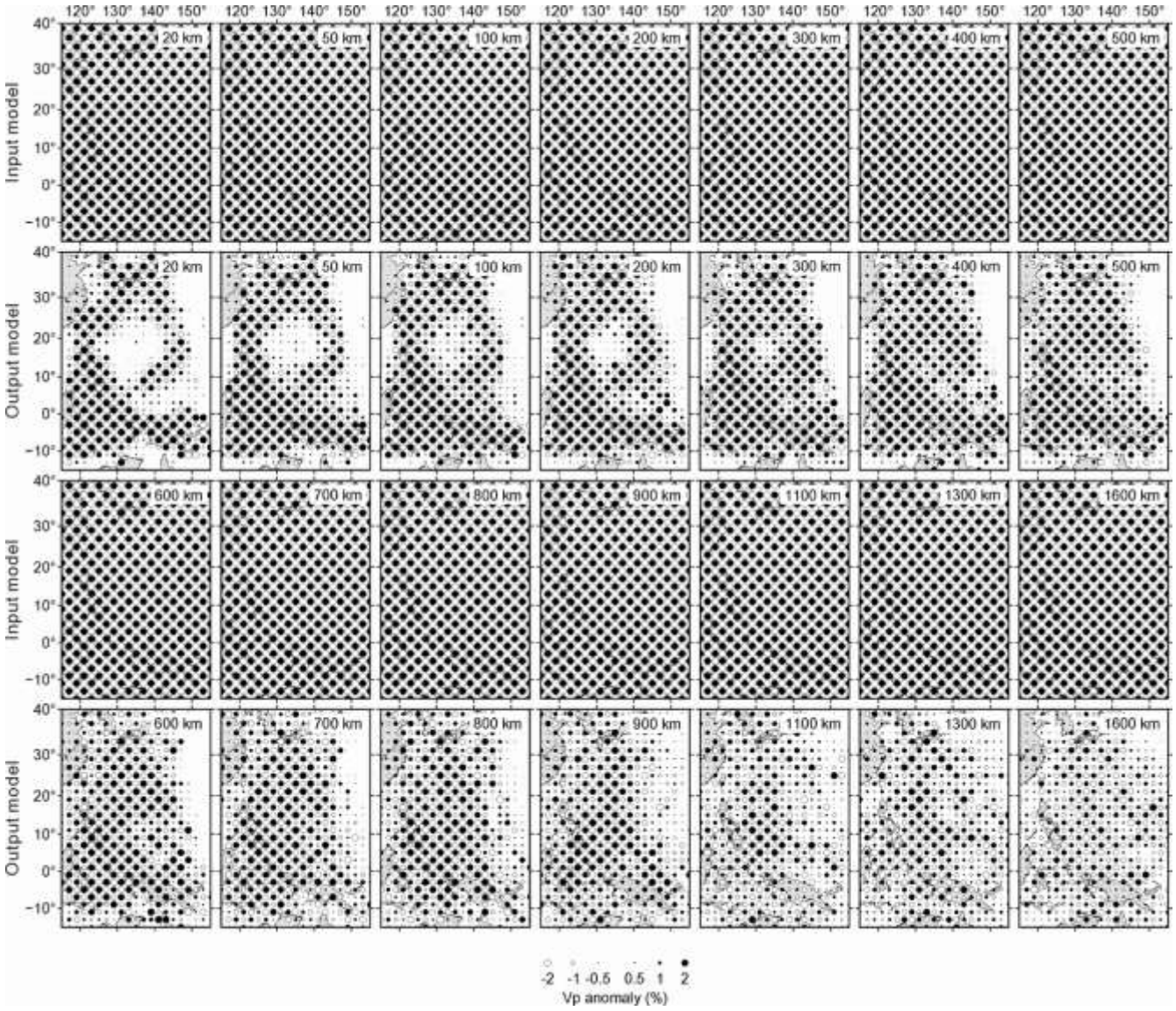

Figure 16. | The same as Figure 10 but in the input model, isotropic Vp perturbations are ±2%, whereas azimuthal anisotropy is zero.

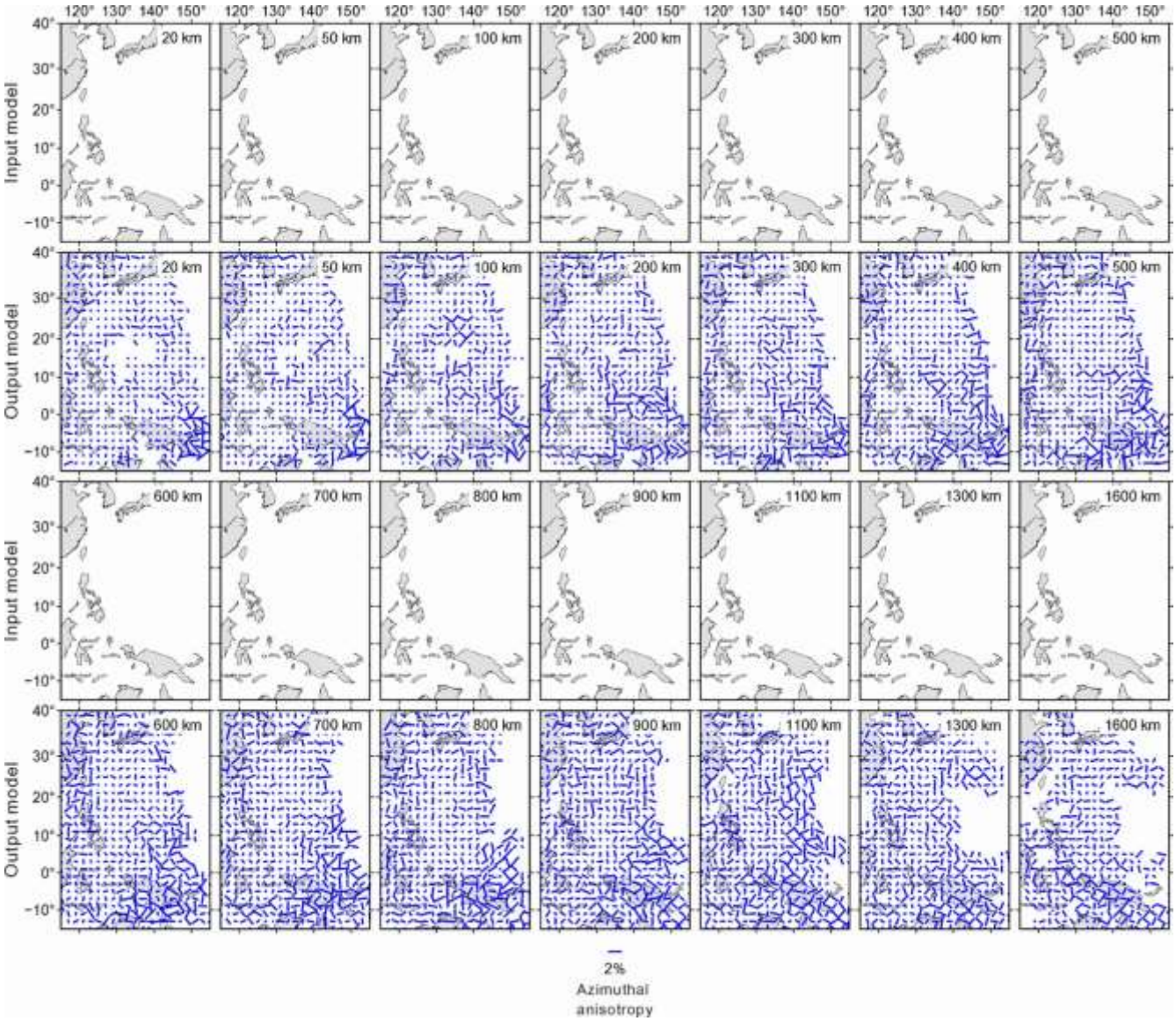

Figure 17. | The same as Figure 16 but for the anisotropic results.

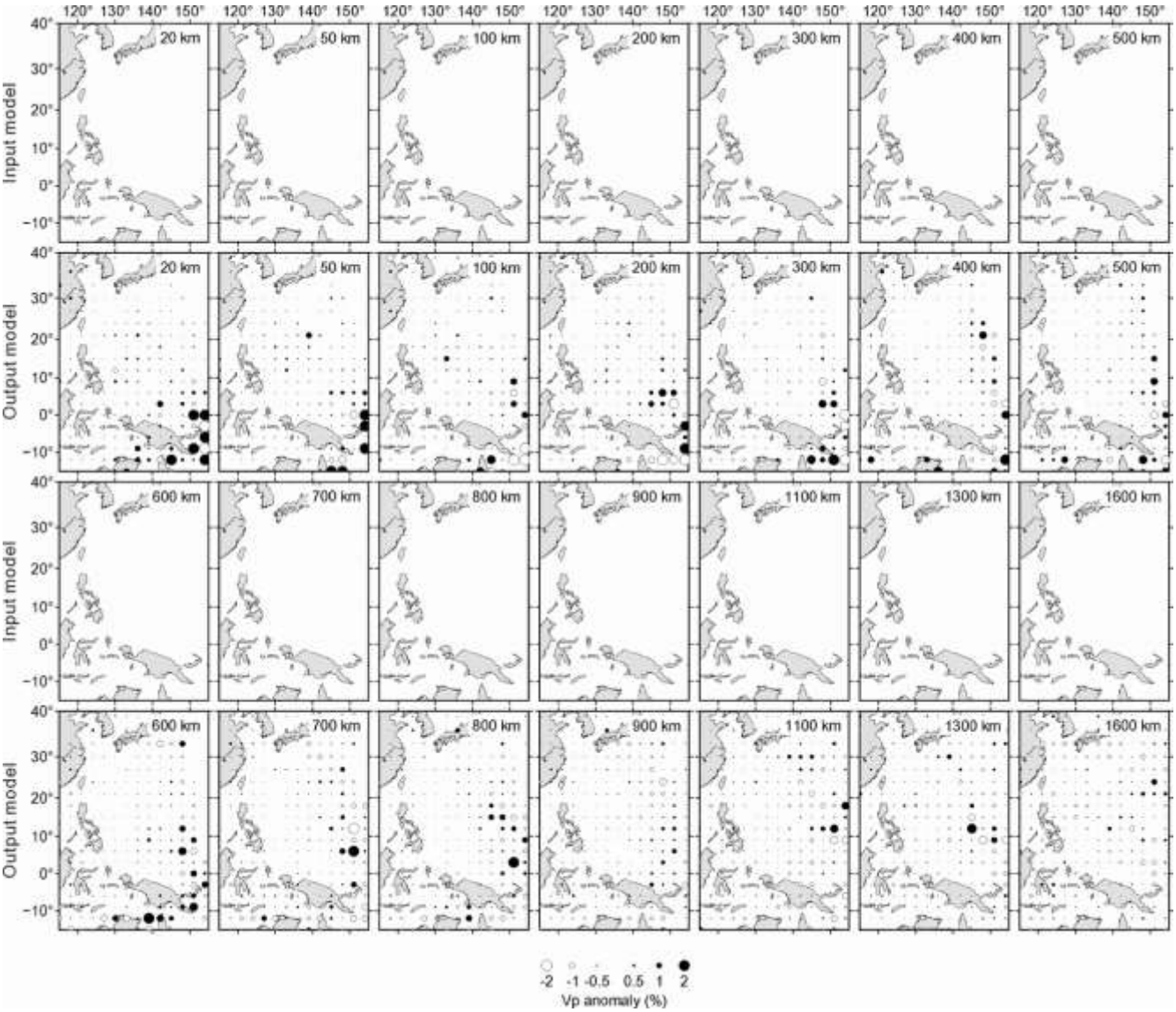

Figure 18. | The same as Figure 12 but in the input model, perturbations of Vp azimuthal anisotropy parameters are ±2%, whereas isotropic Vp perturbations are all zero.

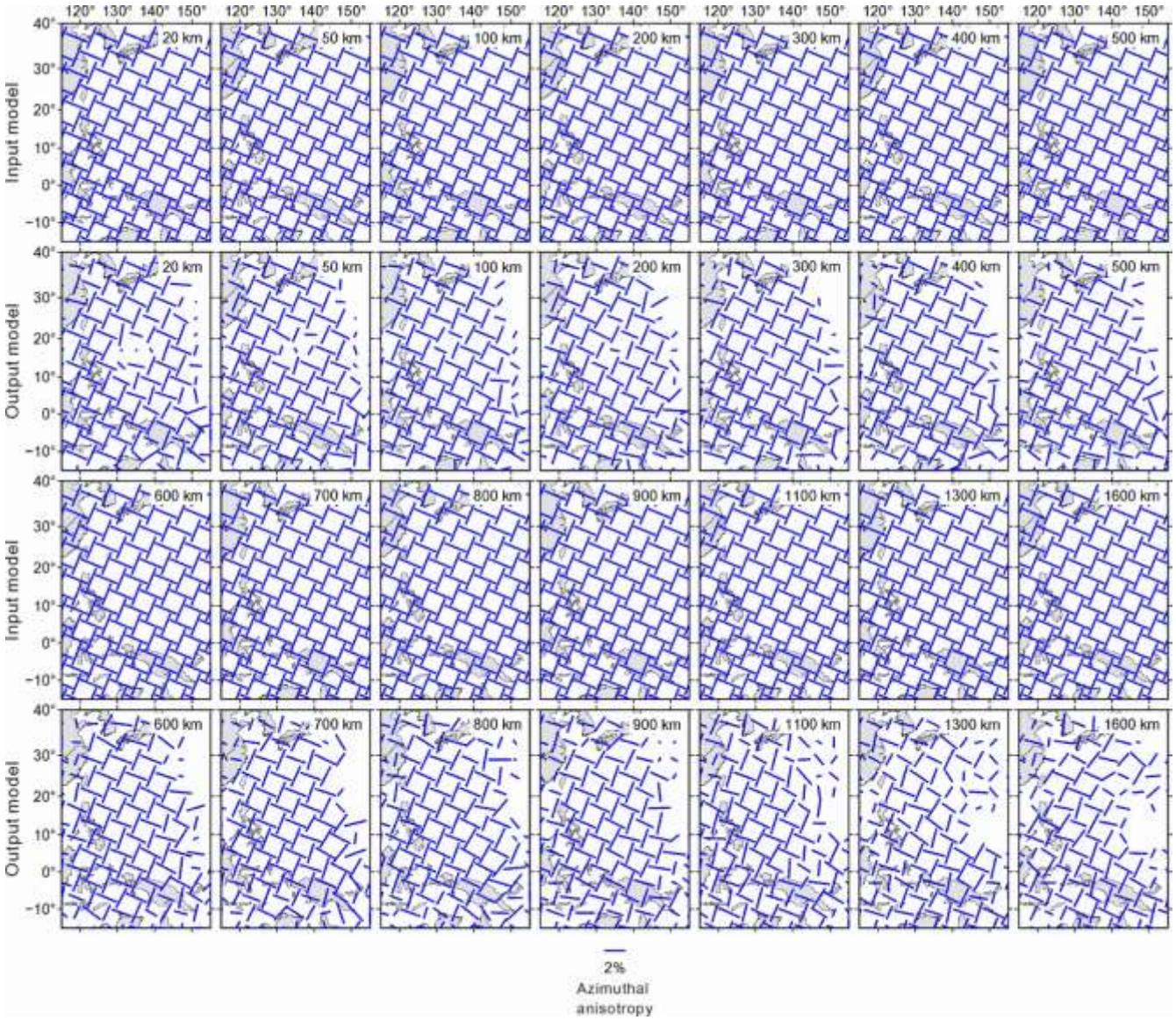

Figure 19. | The same as Figure 18 but for the anisotropic results.

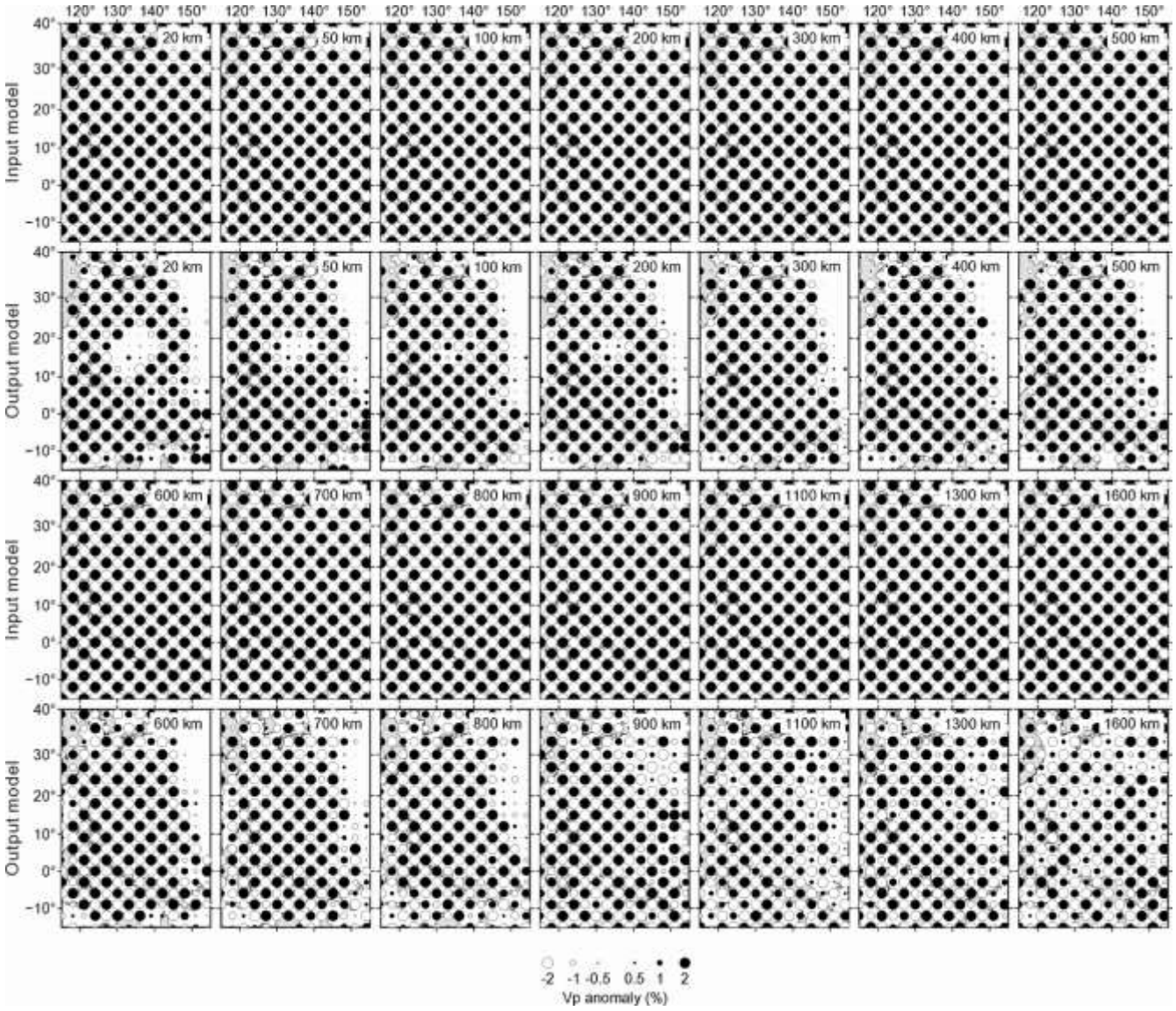

Figure 20. | The same as Figure 12 but in the input model, isotropic Vp perturbations are ±2%, whereas Vp azimuthal anisotropy is zero.

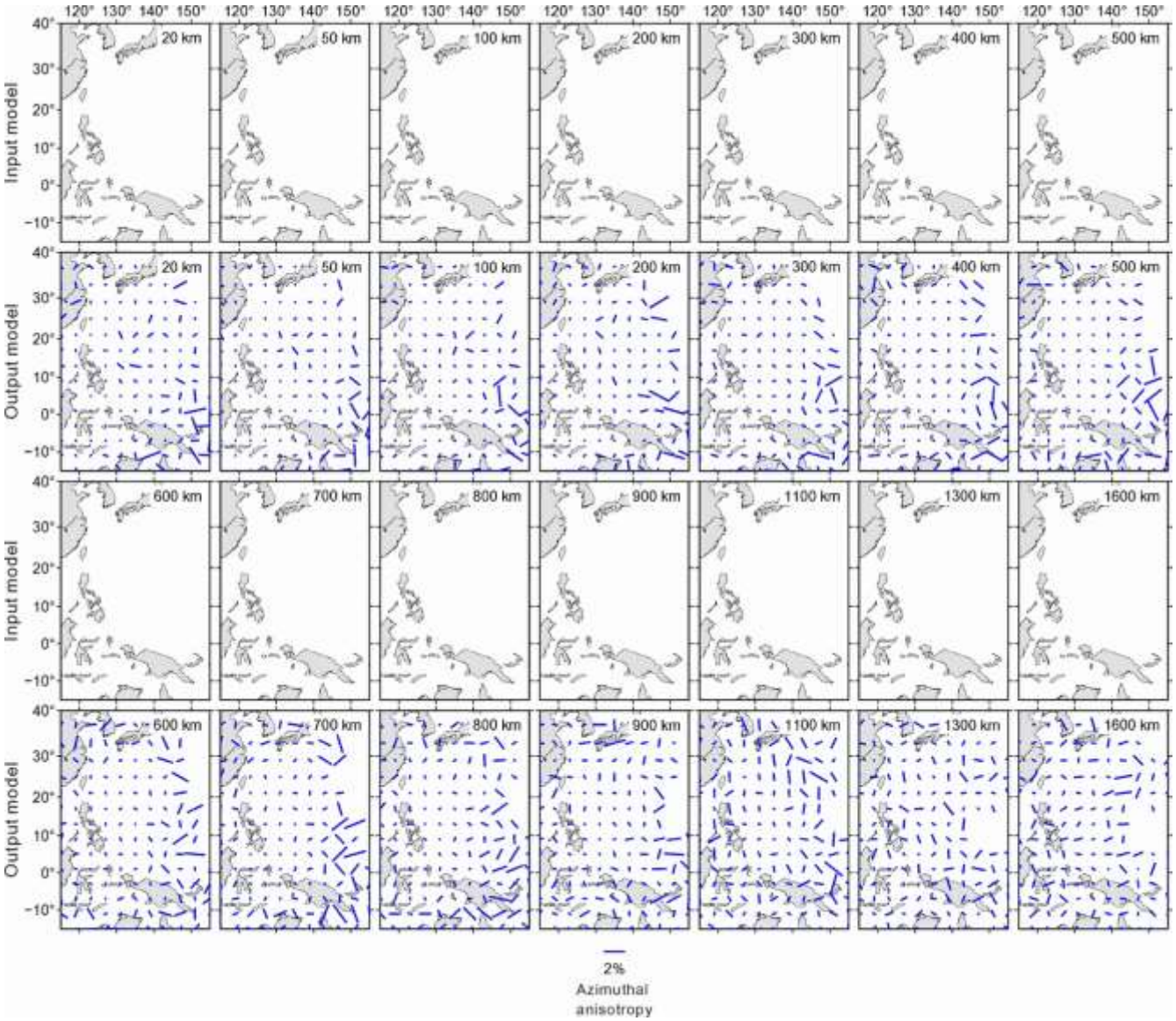

Figure 21. | The same as Figure 20 but for the anisotropic results.

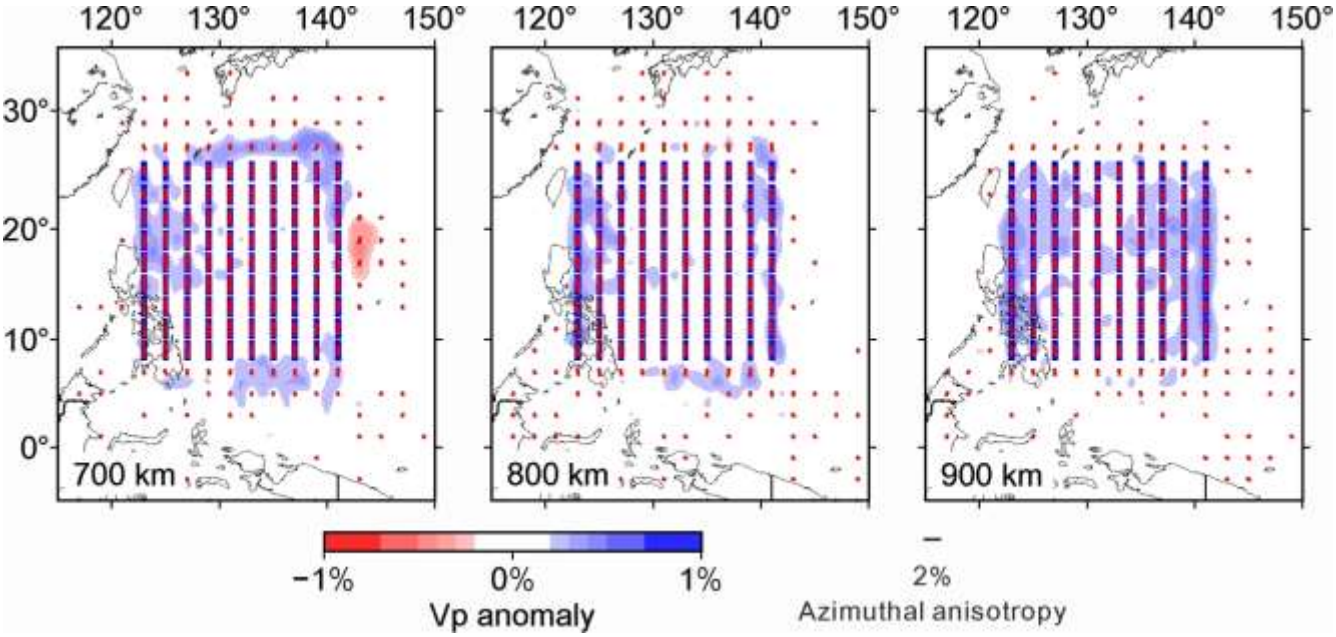

Figure 22. | Results of a restoring resolution test for Vp azimuthal anisotropy with N-S FVDs at depths of 700-900 km beneath the middle Philippine Sea Plate. The isotropic Vp anomalies are assumed to be zero. The blue and red bars denote FVDs in the input and output models, respectively. The bar length denotes the azimuthal anisotropy amplitude, whose scale is shown at the bottom.

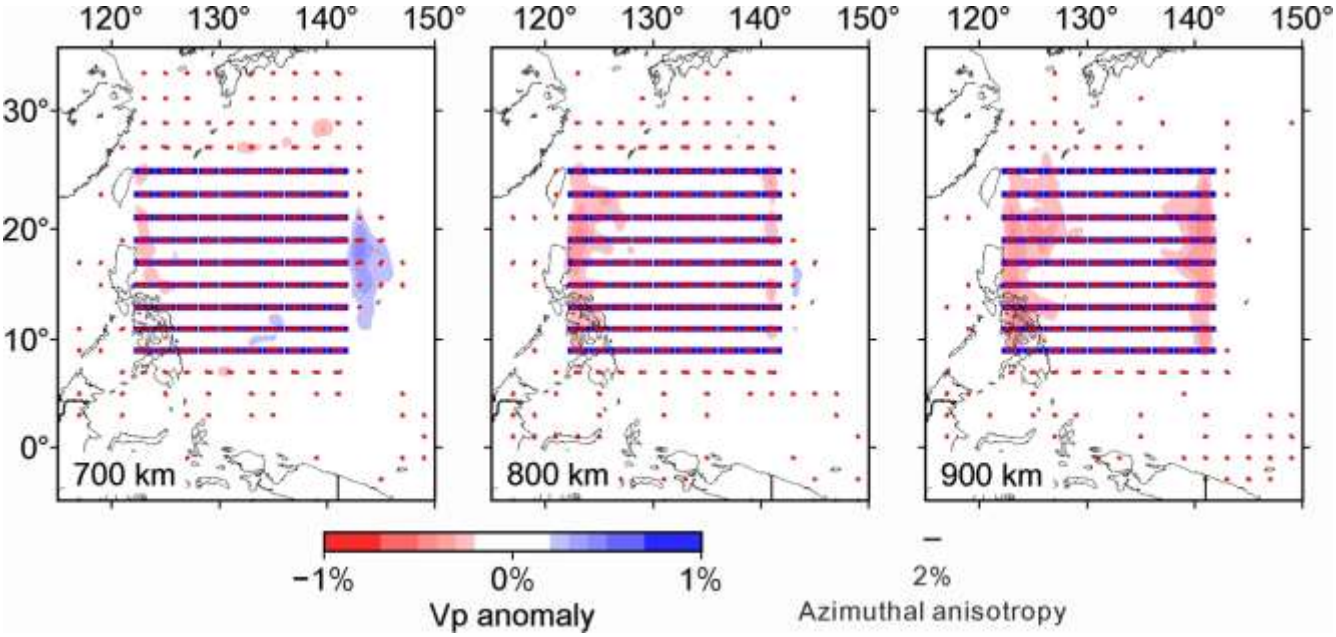

Figure 23. | The same as Figure 22 but the input model includes Vp azimuthal anisotropy with E-W FVDs.

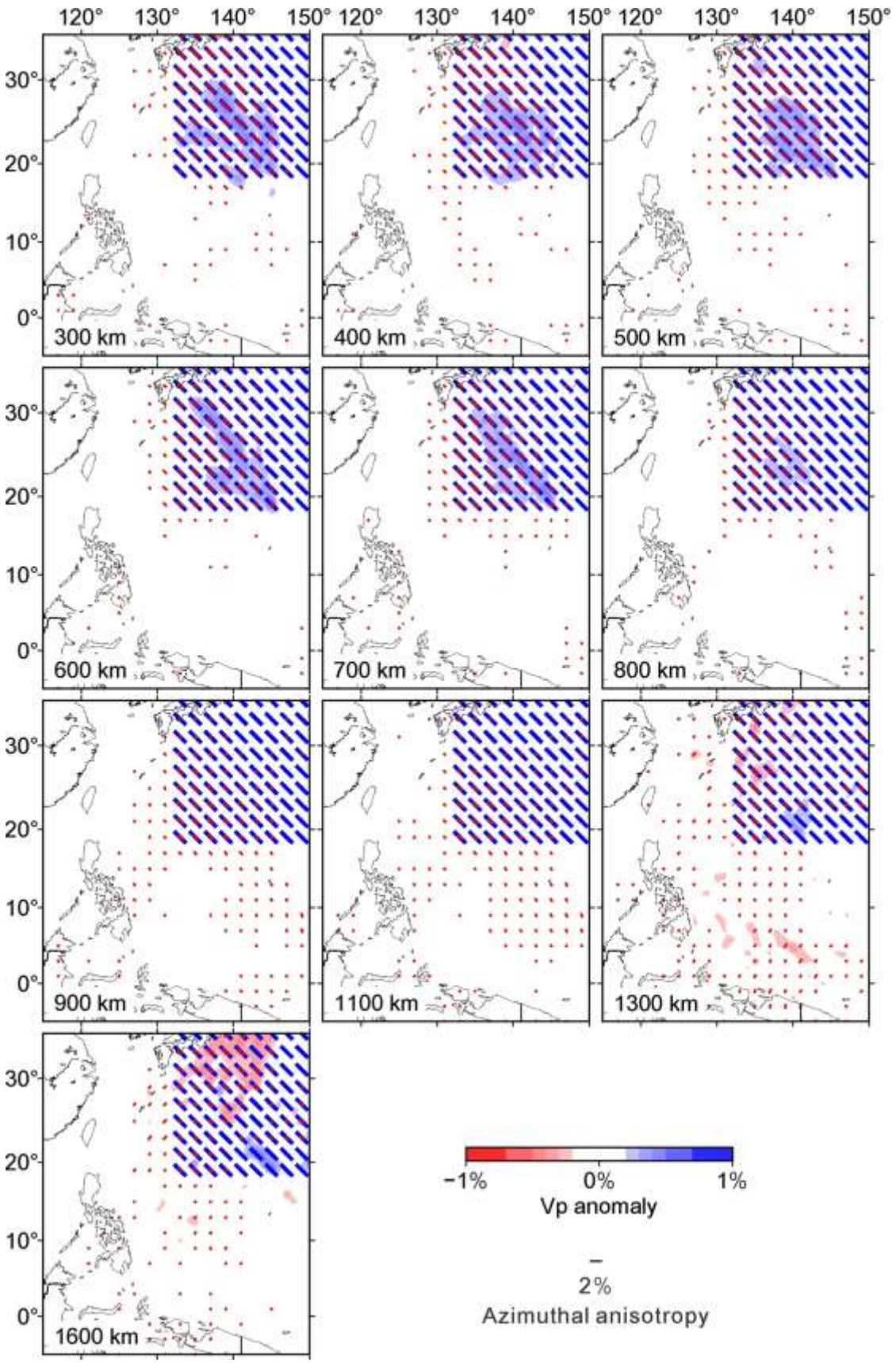

Figure 24. | The same as Figure 22 but the input model includes Vp azimuthal anisotropy with NW-SE FVDs at depths of 300-1600 km beneath the northern Philippine Sea Plate.

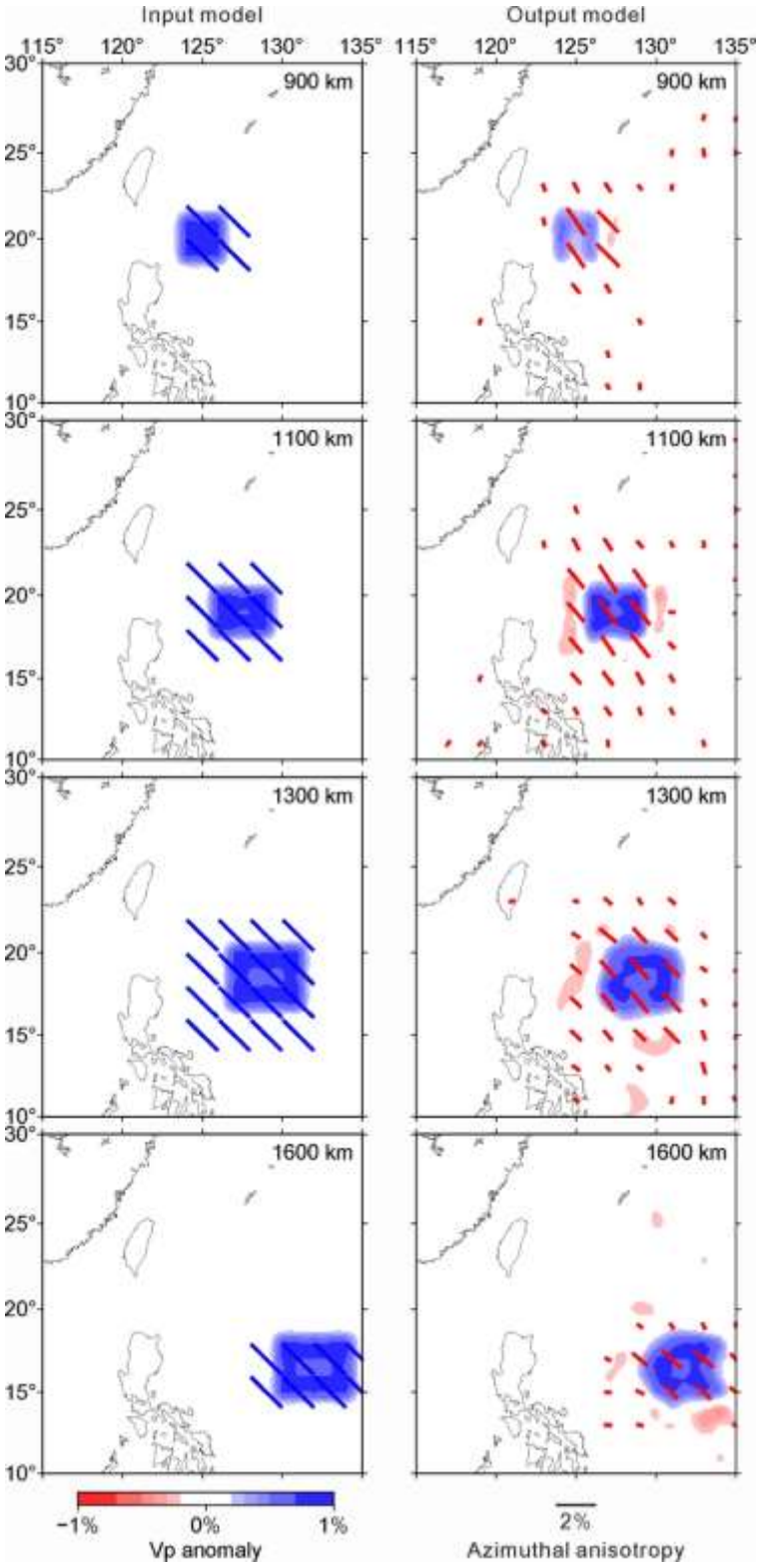

Figure 25. | Results of a restoring resolution test for the high-V anomaly H2 and NW-SE azimuthal anisotropy in and around H2 at depths of 900-1600 km beneath the middle Philippine Sea Plate. Red and blue colors denote low and high isotropic Vp perturbations, respectively, whose scale is shown at the bottom-left. The blue and red bars denote FVDs in the input and output models, respectively. The bar length denotes the azimuthal anisotropy amplitude, whose scale is shown at the bottom-right.

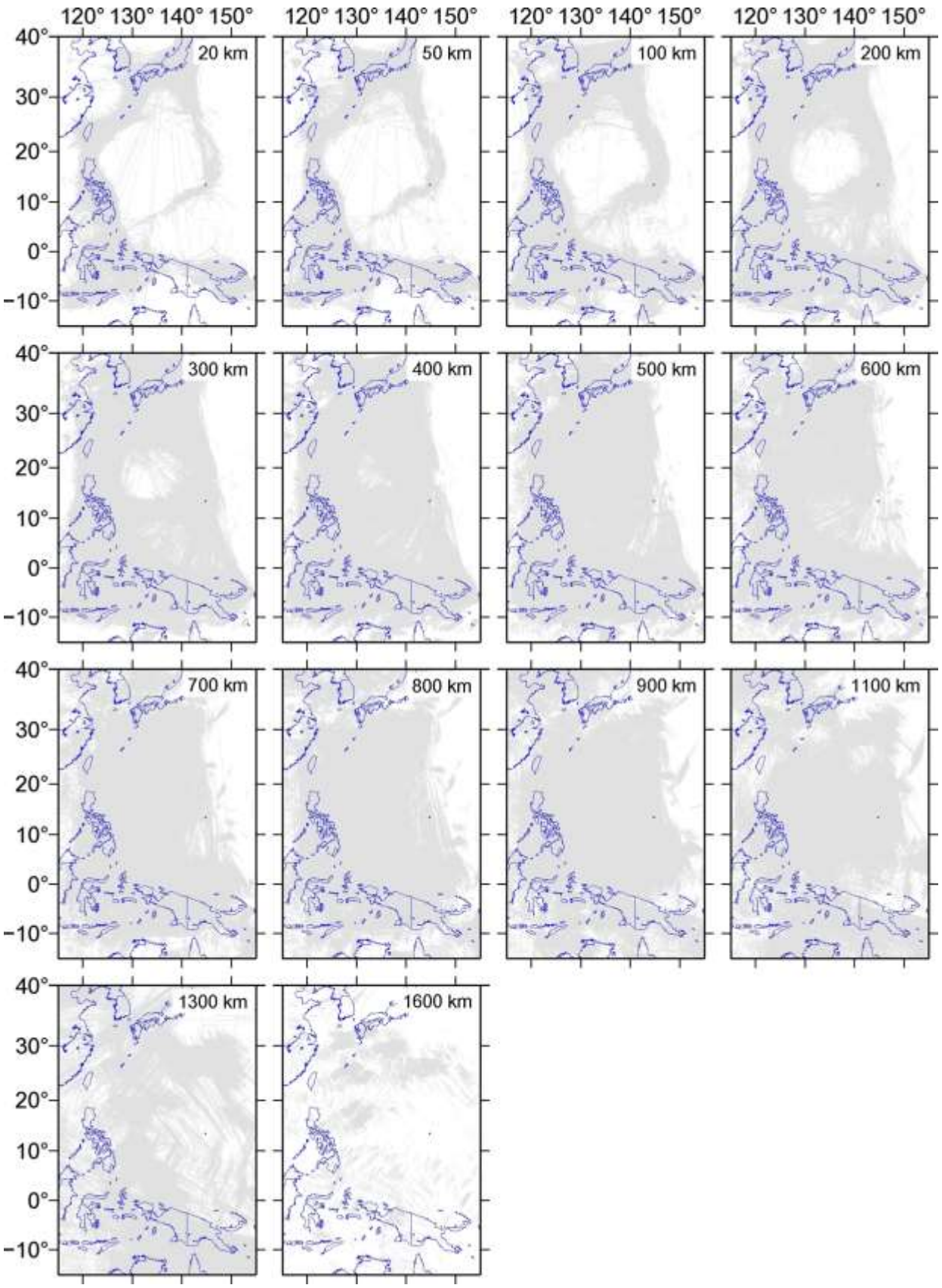

Figure 26. | Distribution of P-wave rays at different depth as shown at the upper-right corner of each map. Only 1/4 randomly sampled rays are plotted because of the great amount of data in the entire data set.

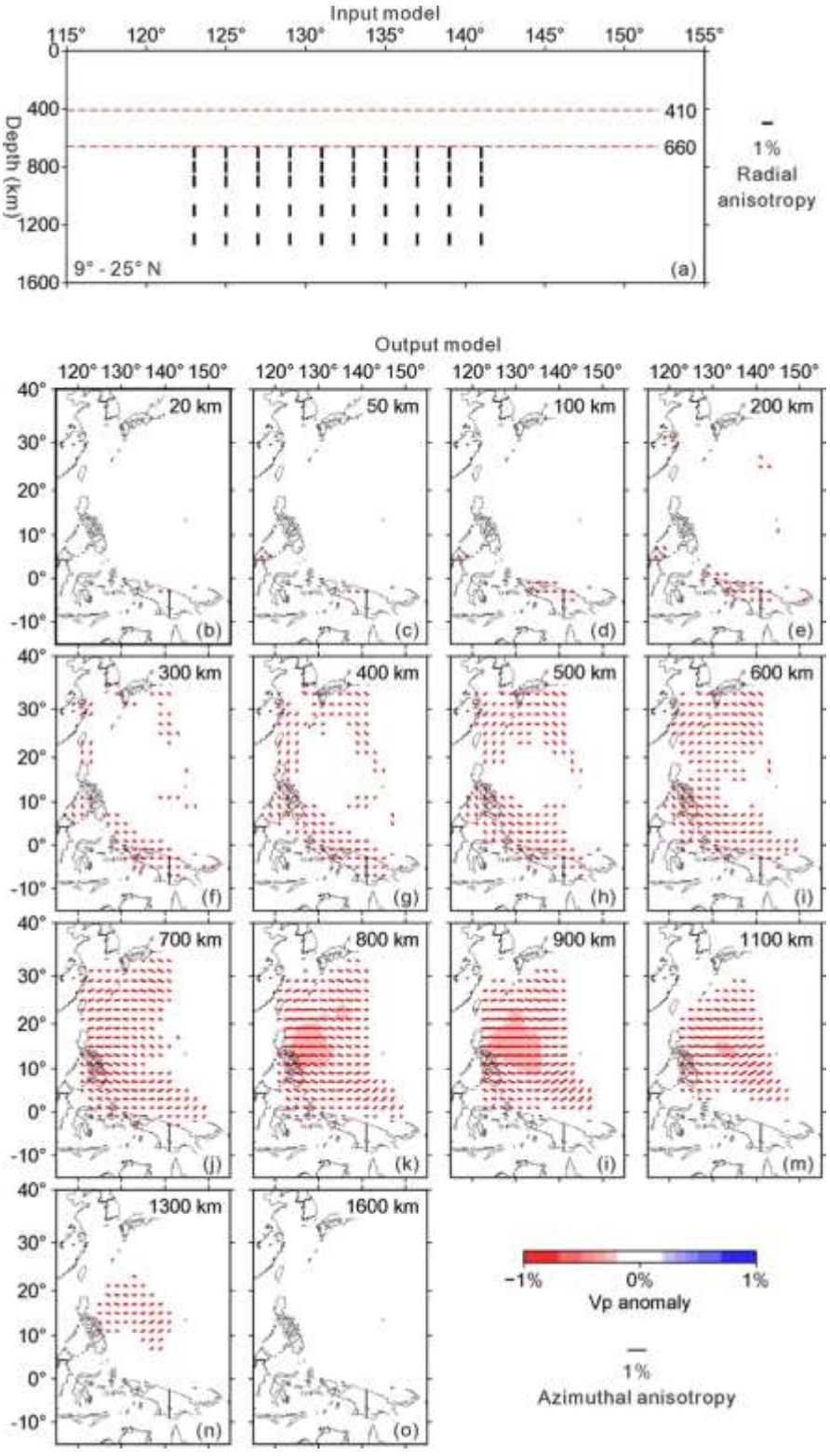

Figure 27. | Results of a restoring resolution test to investigate the effect of radial anisotropy on azimuthal anisotropy with N-S FVDs at depths of 700-900 km beneath the middle Philippine Sea Plate obtained by this study. The input model (a) contains negative radial anisotropy (i.e., vertical Vp > horizontal Vp) at depths of 700-900 km under the

area of 9°-25°N latitudes. Then azimuthal anisotropic inversion is conducted, and the test results are shown on maps (b) to (o).

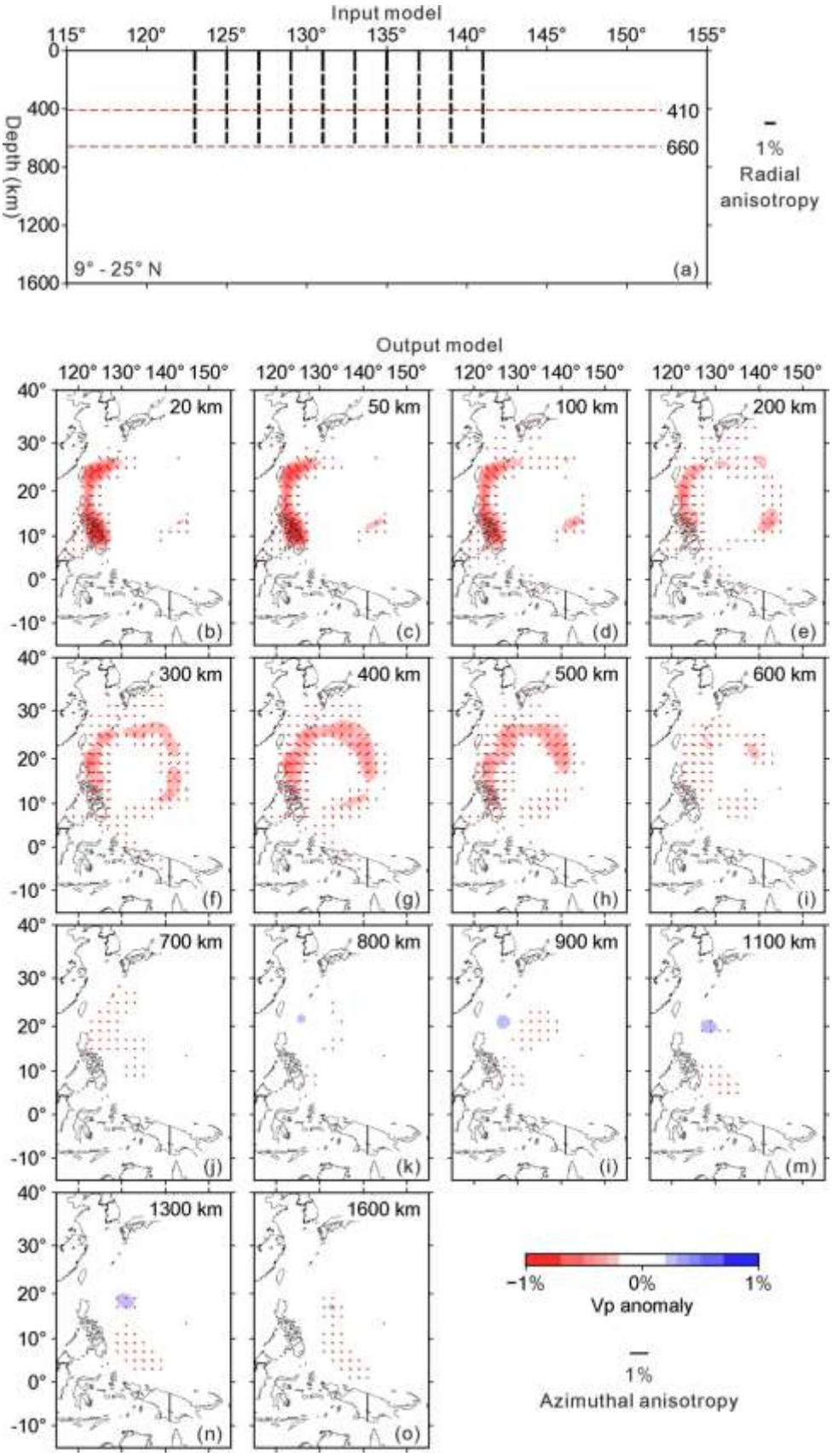
Input model
115° 120° 125° 130° 135° 140° 145° 150° 155°
0
400
800
1200
1600
Depth (km)
410
660
9° - 25° N
(a)
1%
Radial
anisotropy
Output model
120° 130° 140° 150°
40°
30°
20°
10°
0°
-10°
20 km
50 km
100 km
200 km
300 km
400 km
500 km
600 km
700 km
800 km
900 km
1100 km
1300 km
1600 km
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)
(j)
(k)
(l)
(m)
(n)
(o)
−1%
0%
1%
Vp anomaly
1%
Azimuthal anisotropy

Figure 28. | The same as Figure 27 but the input model (a) contains negative radial anisotropy at depths of 20-600 km under the area of 9°-25°N latitudes.

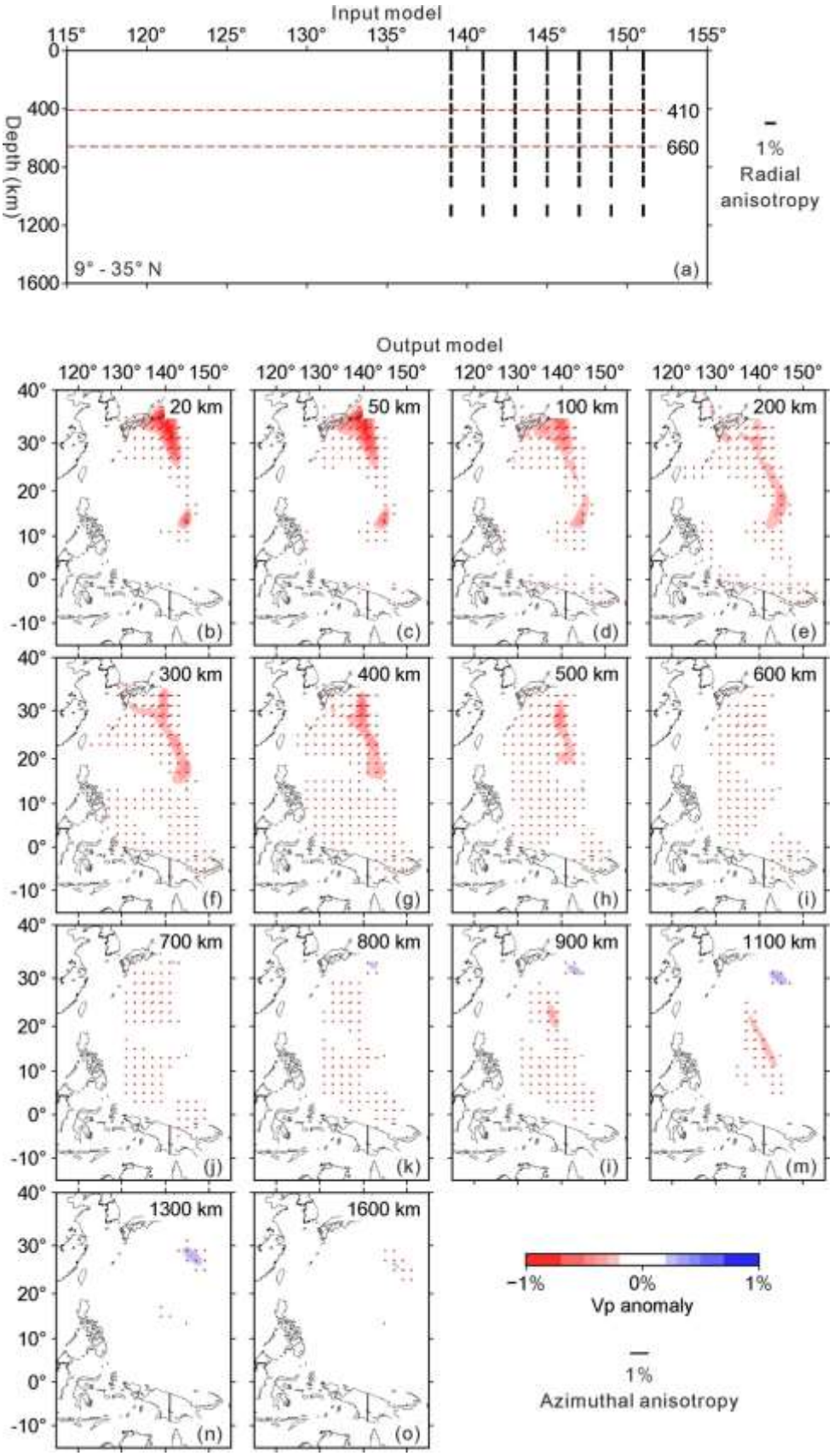

Figure 29. | The same as Figure 27 but the input model contains negative radial anisotropy in the subducted Pacific slab at depths of 20-1100 km under the area of 9°-25°N latitudes.

Reference

55. Hayes, G. P. et al. Slab2, a comprehensive subduction zone geometry model. *Science* **362**, 58–61 (2018).