P-wave tomography beneath Greenland

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The Greenland landmass has a long and complex tectonic history (~4 billion years). However, most of the continent is covered by the extensive inland ice cap, and so it is hard to access its geology and the underlying tectonics. The Greenland Ice Sheet Monitoring Network (GLISN) is an international project between 11 countries to establish a seismic network in and around Greenland (Toyokuni et al., 2014). The project was initiated in 2009, and now it provides broadband, continuous, and real-time seismic data from 33 stations. This study aims to reveal the 3-D mantle structure beneath Greenland by using the GLISN data.

We inverted P-wave arrival-time data of both local and teleseismic events recorded at 33 GLISN stations to estimate 3-D P-wave velocity (Vp) tomography beneath Greenland and surrounding areas. We integrated two sets of first P-wave arrival-time data. The first data are selected from a catalog compiled by the International Seismological Centre, which include 35,553 arrival times from 5,240 teleseismic events and 934 local earthquakes. The second data are newly picked from seismograms by ourselves using the cross-correlation technique (Liu & Zhao, 2016), which include 4,322 P-wave relative travel-time residuals from 159 teleseismic events. We used the seismic tomography method by Zhao et al. (2012).

In the polar region, if grid nodes are arranged on the basis of geographic coordinates, the distance between two adjacent nodes in the same latitude decreases as it gets closer to the pole. In order to overcome this problem, we converted our study region from the geographic coordinates to ecliptic coordinates. This scheme enables to solve equations in quasi-Cartesian coordinates (e.g., Kobayashi & Zhao, 2004; Gupta et al., 2009; Takenaka et al., 2017). We set up a 3-D grid with a horizontal grid interval of 2˚ and a vertical grid interval of 15–30 km (at depths of 5–700 km).

The results of this study are summarized as follows.
There is a prominent low-Vp anomaly beneath Iceland (at depths < 500 km), which is related to the current Iceland plume. In the shallow mantle (at depth of 40-250 km) beneath central and offshore eastern Greenland, Vp is relatively lower than those in the other inland areas of Greenland in the depth range, which may reflect the ancient motion path of the Iceland plume. This feature coincides with the known basalt areas at the central western and eastern coasts of Greenland.

References:

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