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Strong Ocean Influence on Seasonal Changes in Shallow Shear-Modulus Structure in Alaska

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We have developed a method to determine shear-modulus (rigidity) structure for the upper 20-50m of the Earth. The method is based on the analysis of co-located pressure and seismic instruments. We applied this method to about 200 (co-located) stations in Alaska and examined seasonal variation in shallow shear-modulus structure at each site; in this report we quantify this seasonal change by taking the ratio (R) of the highest shear-modulus to the lowest throughout a year and use it as a characteristic feature for each station.

R is smaller than 2 at many stations but there are some stations in and near the Arctic zone that have R larger than 10. Such a large seasonal change implies that there occurs massive melting of shallow permafrost and a significant development of the active layer every summer. As a side product, because of such a huge reduction in near-surface shear-modulus, horizontal amplitudes in seismic noise become 30 times larger in summer than amplitudes in winter.

These seasonal changes may not be surprising because thawing of ice is common every summer in the permafrost region. But regions with large R show a systematic geographic pattern on a large-scale map; large-R stations are typically found near the coast (ocean) and tend to decrease toward the interior of the continent (Alaska and NW Canada). Large R stations are found in the NW Territories in Canada, the North Slope region northern side of the Brooks Range, near the Seaward Peninsula (west), and the Yukon-Kuskokwim Delta (west). These locations suggest a strong influence by the nearby ocean on the climate at each station. Proximity to the ocean (coast) seems to be an important factor in evaluating periglacial hazards.

There are a few exceptions in the northernmost coastal stations as they show small R despite the fact that they are at the coast. But the ICEsat-2 (satellite) data show that sea ice seems to remain thick near the peninsula (near Barrow, Alaska) much longer than other coastal areas in this study; temperature is colder because of thicker sea ice and the amount of melting at these exception sites remains low. This would strengthen the hypothesis that near-coastal ocean has strong influence on the climate of continental interior.