

Assessing and projecting surface air temperature conditions required to sustain permafrost in Japan

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Permafrost covers a wide area of the Northern Hemisphere, including high-altitude mountainous areas and even at mid-latitudes. There is concern that the thawing of mountain permafrost can cause slope instability and substantially impact alpine ecosystems, and because permafrost in mountainous areas is difficult to observe, detailed analyses have not been performed on its current distribution and future changes. Although previous studies have observed permafrost only at a limited number of points in Japan (e.g., Daisetsu Mountains, Mt. Fuji, and Mt. Tateyama in the Northern Japan Alps), we show that permafrost potentially exists in nine domains in Japan (Daisetsu Mountains, Mt. Fuji, Northern and Southern Japan Alps, Hidaka Mountains, Mt. Shiretoko, Sharidake, Akandake, and Yotei). In the Daisetsu Mountains and Mt. Fuji, the environmental conditions required for maintaining at least some permafrost are projected to remain in the future if a decarbonized society is achieved (RCP2.6 or RCP4.5). However, if greenhouse gas emissions continue to increase (RCP8.5), the environmental conditions required for sustaining permafrost are projected to disappear in the second half of the 21st century. In other domains, the environmental conditions required for maintaining permafrost are either projected to disappear in the next ten years (Hidaka Mountains, Northern Japan Alps) or they have almost disappeared already (Southern Japan Alps, Mt. Shiretoko, Sharidake, Akandake, and Yotei). Our projections show that climate change has a tremendous impact on Japan's mountain permafrost environment and suggests the importance of monitoring the mountain environment and considering measures for adapting to future climate change.

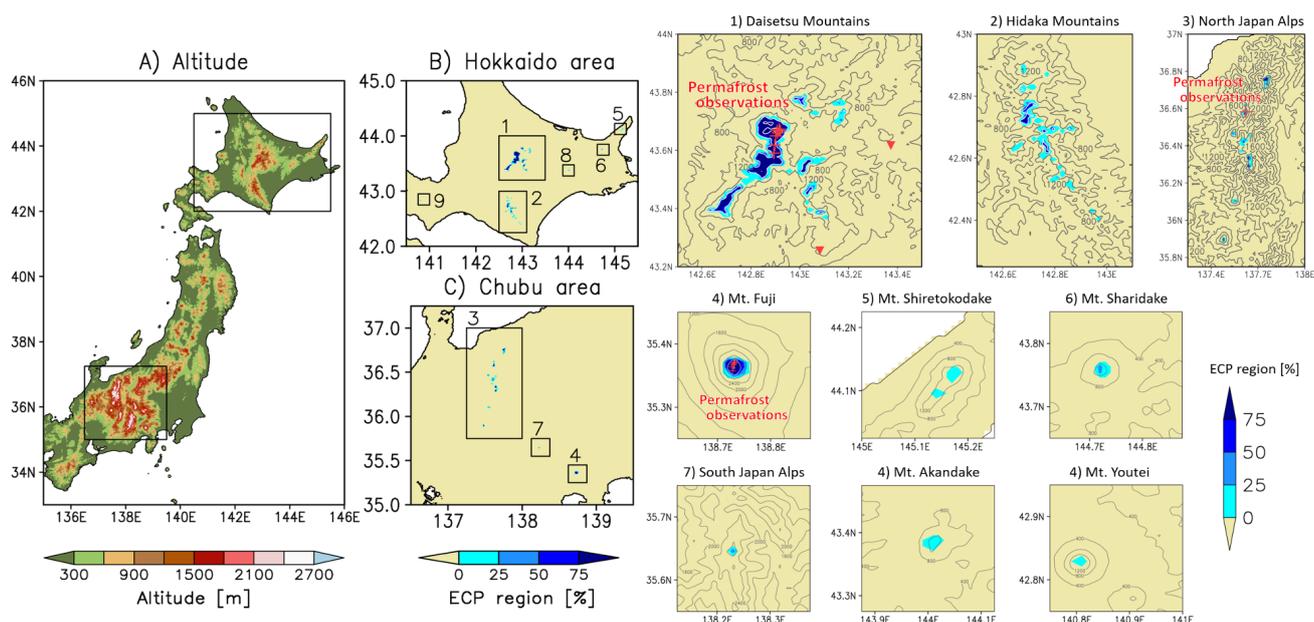


Figure 1. **Left:** A) Map showing the altitude [m] of northern and eastern Japan, and the distribution of regions with surface air temperatures that favor the maintenance of permafrost (the Environmentally Conditioned Permafrost regions) in Japan; B) Hokkaido and C) the Chubu. The numbers indicate (1) Daisetsu Mountains, (2) Hidaka Mountains, (3) Northern Japan Alps, (4) Mt. Fuji, (5) Mt. Shiretoko, (6) Mt. Shari, (7) Southern Japan Alps, (8) Mt. Akandake, and (9) Mt. Yotei. **Right:** Environmentally Conditioned Permafrost regions in Japan under the current climate conditions (averaged over 1999–2018). The distribution of the environmentally conditioned permafrost region is based on probabilities estimated by nine bias-corrected climate scenarios. Red points indicate sites where permafrost has been observed. The observations of sporadic permafrost in Shikaribetsu and Oketo are shown as ▼, and other observations are shown as +. The contour interval is 400 m

References

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