

Long-range transportation of contaminants from the Asian Continent to The Northern Japan Alps, recorded in snow cover on Mt. Nishi-Hodaka-Dake

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Abstract

Vertical profiles of chemical components in snow cover at Mt. Nishi-Hodaka-dake, the Northern Japan Alps, were obtained over three consecutive winters (2001/02, 2002/03 and 2003/04) for the investigation of long-range transportation of chemical substances from the Asian continent to high mountainous areas in Japan. The $\delta^{34}\text{S}$ value of non sea-salt (NSS) SO_4^{2-} ions in 2002/03 snow was also measured. Concentrations of anthropogenic components such as NSS- SO_4^{2-} and NO_3^- in snow range from almost 0 to over 100 $\mu\text{eq l}^{-1}$. Soil derived components (NSS- Ca^{2+} and NSS- Mg^{2+}) were also observed in snow, especially in dirt layers, suggesting the transportation of Asian continental desert dust. The NSS- $\text{SO}_4^{2-}/\text{NO}_3^-$ (S/N) ratio in snow typically ranges from 0.3 to 6.3. A considerable number of samples had higher S/N ratios than those found in Tokyo, Japan (about 2), while some samples had a much higher ratio (about 4–6), more akin to values found in Beijing, China (about 4). Snowfalls at Mt. Nishi-Hodaka-Dake are considered to include acid contaminants transported from both the Asian continent and the industrial areas of Japan, with a variable proportion depending on weather conditions. High S/N ratios seem to be caused by severe winter pressure patterns. The NSS- $\delta^{34}\text{S}$ values range from +3‰ to +7‰. These ratios are evidently higher than that afforded by petroleum usage in Japan (−1‰), and is in accord with that of coal used in both northern China (+7.4‰) and the Russian Far East (+3.4‰). These $\delta^{34}\text{S}$ values also suggest the occurrence of long-range transportation of NSS- SO_4^{2-} from the Asian continent, independent of chemical composition.