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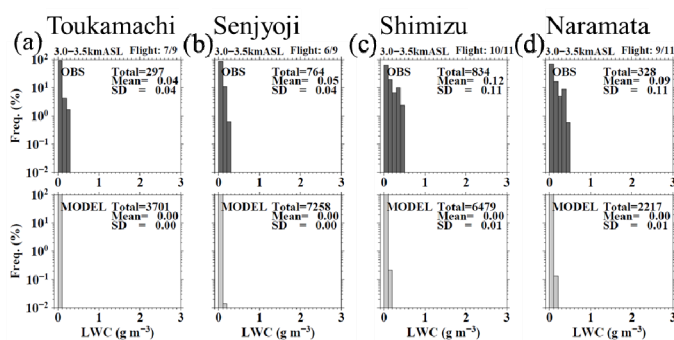


Figure 1. Comparison of the occurrence frequency of liquid water content (LWC) between the numerical simulations (gray; lower panel) and the aircraft observations (black; upper panel) during the IOP in March and December 2007 at (a) Toukamachi, (b) Senjyoji, (c) Shimizu, and (d) Naramata in the upper part of the clouds (from 3.0 km to 3.5 km ASL). “Flight” in each panel refers to the number ratio of the flights with data available for analysis to the total number of selected flights. “Total,” “Mean,” and “SD” refer to the sample number, average, and standard deviation.

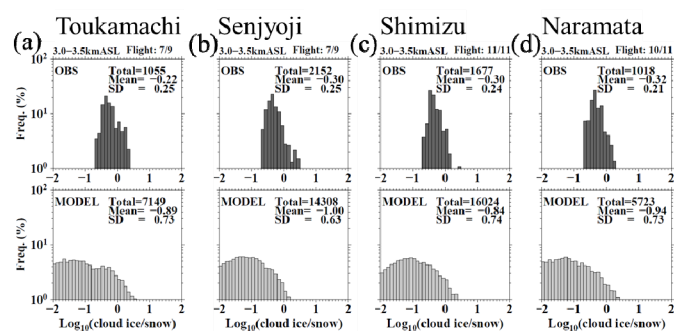


Figure 2. Same as Figure 1 but for the logarithm of the number concentration ratio of cloud ice to snow.

- Cold rain processes simulated with a non-hydrostatic cloud-resolving model developed by the Japan Meteorology Agency / Meteorological Research Institute and run at 1 km horizontal resolution (1-km-NHM) with a two-moment bulk parameterization scheme are validated using in-situ aircraft observations for orographic snow clouds.
- To statistically validate the cold rain processes simulated by the 1-km-NHM, aircraft observations collected during two winter seasons (March and December 2007, a total of 21 flights) over the Echigo Mountains are analyzed and compared with the model.
- The horizontal wind direction, wind speed, and vertical wind velocity exhibit reasonable agreement between the numerical simulations and the aircraft observations.
- The simulated liquid water contents at every height interval and over every analysis area are significantly underestimated compared to the aircraft observations (Fig.1).
- The ratios of simulated cloud ice number concentrations to snow number concentrations are less than unity and much smaller than the corresponding ratios obtained from the aircraft observations (Fig.2).
- This suggests that the overall conversion from cloud ice to snow in the 1-km-NHM, which occurs primarily through depositional growth, is faster than that in real clouds.