Numerical simulation of orographic gravity waves observed over Syowa Station

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A high-resolution model in conjunction with realistic background wind and temperature profiles has been used to simulate gravity waves (GWs) that were observed by an atmospheric radar at Syowa Station, Antarctica on 18 May 2021. The simulation successfully reproduces the observed features of the GWs, including the amplitude of vertical wind disturbances in the troposphere and vertical fluxes of northward momentum in the lower stratosphere. In the troposphere, ship-wave responses are seen along the coastal topography, while in the stratosphere, critical-level filtering with the directional shear causes significant change of the wave pattern. The simulation shows the multi-layer structure of small-scale turbulent vorticity around the critical level, where turbulent energy dissipation rates estimated from the radar spectral widths were large, indicative of GW breaking.

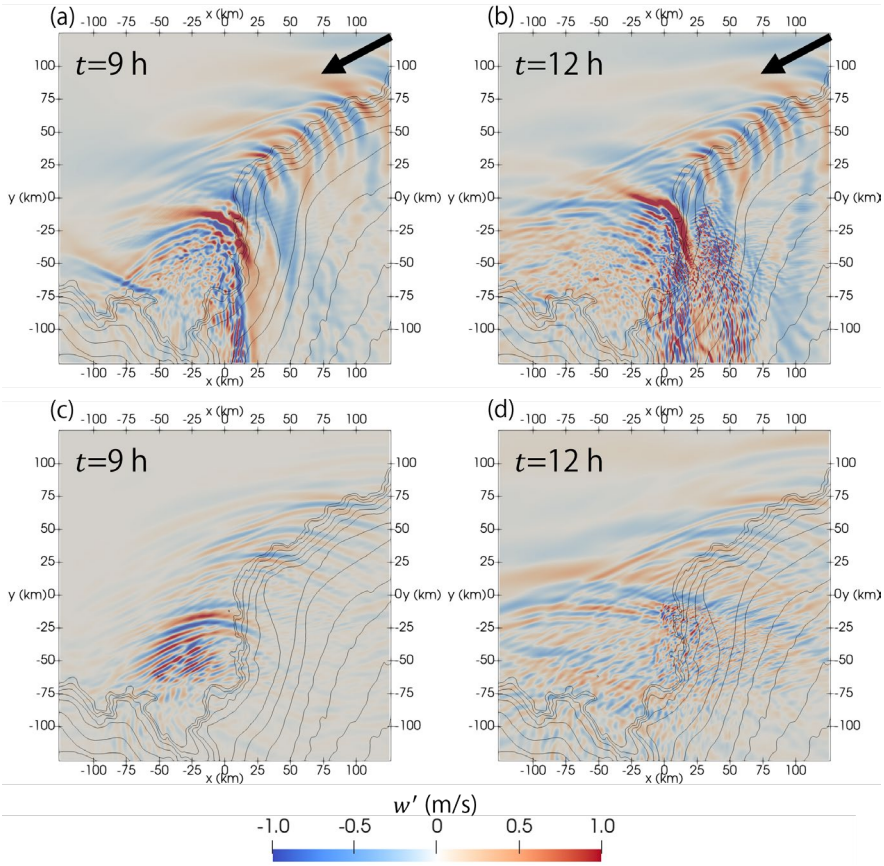

Fig. 1: (a–b) Horizontal maps of vertical winds at an altitude of 7.5 km at (a) t = 9 h and (b) 12 h. A black arrow at the upper-right corner of each panel indicates the direction of surface wind. Gray contour indicates the terrain height with an interval of 150 m. (c–d) Same as (a–b) but for vertical winds at an altitude of 15 km.