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Downslope windstorms in Russia

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Downslope windstorms occur on the leeward slopes of mountain ranges in many mountain areas of the world when the optimal combination of synoptic and orographic conditions appears. Such phenomenon is characterized by gusty wind with maximum velocity up to 60 m/s and rapid changes in temperature.At the present time, the most studied downslope winds are Adriatic bora, winds of the Rocky Mountains in the United States (including chinook), the Alpine fohn. In Russia, such winds are observed on Novaya Zemlya archipelago, on Lake Baikal (Sarma), in the Urals (Kizelovskaya bora), in the Crimea, in Pevek, at the Black Sea coast of the Caucasus (Novorossiysk bora).
The aim of this work is to study the role of different physical mechanisms in the formation of the strongest and most illuminated by observational data downslope windstorms in Russia, which is Novorossiysk bora, Novaya Zemlya bora and windstorm in Pevek. These winds are located in different climatic zones and orographic conditions, however, they may have similar mechanisms and physical characteristics.
Analysis of three-dimensional structure of these phenomena, including the structure of upstream flow, disturbances on the leeward side of the range, flow behavior above the ridges, was performed on the basis of observational data, MERRA reanalysis data and the results of mesoscale modeling using WRF-ARW model. The analysis identified characteristics common to all of the studied winds that allow us to classify them as a single phenomenon. Also the applicability of hydraulic and internal gravity wave theory, that are commonly used for downslope windstorms, was evaluated for studied winds. The hydraulic theory predicts the occurrence of hydraulic jump and the flow regime transition from subcritical to supercritical over the leeward slope, which leads to increased wind speed. On the other hand, the wave theory for some cases successfully explains these phenomena. It was shown that mesoscale pressure perturbations associated with these winds are partly due to the generation of internal gravity waves, and relation between amplification of wind speed on the leeward side and the value of gravity wave drag may be approximated by a quadratic dependence for many cases. At the same time despite the significant similarities of studied windstorms, a ratio between the wave and hydraulic mechanism for these winds is different. For windstorm in Pevek the contribution of wave processes is the biggest (60-70% in average), while for Novorossiysk bora the contribution of the hydraulic mechanism is more significant.