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Orographic cirrus in a future climate

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Abstract. A cloud resolving model (CRM) is used to investigate the formation of orographic cirrus clouds in the current and future climate. The formation of cirrus clouds depends on a variety of dynamical and thermodynamical processes, which act on different scales. First, the capability of the CRM in realistically simulating orographic cirrus clouds has been tested by comparing the simulated results to aircraft measurements of an orographic cirrus cloud. The influence of a warmer climate on the microphysical and optical properties of cirrus clouds has been investigated by initializing the CRM with vertical profiles of horizontal wind, potential temperature and equivalent potential temperature, respectively. The vertical profiles are extracted from IPCC A1B simulations for the current climate and for the period 2090–2099 for two regions representative for North and South America. The influence of additional moisture in a future climate on the propagation of gravity waves and the formation of orographic cirrus could be estimated. In a future climate, the increase in moisture dampens the vertical propagation of gravity waves and the occurring vertical velocities in the moist simulations. Together with higher temperatures fewer ice crystals nucleate homogeneously. Assuming that the relative humidity does not change in a warmer climate the specific humidity in the model is increased. This increase in specific humidity in a warmer climate results in a higher ice water content. The net effect of a reduced ice crystal number concentration and a higher ice water content is an increased optical depth. However, in some moist simulations dynamical changes contribute to changes in the ice water content, ice crystal number concentration and optical depth. For the corresponding dry simulations dynamical changes are more pronounced leading to a decreased optical depth in a future climate in some cases.

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