Geophysical Research Abstracts
Vol. 20, EGU2018-12166, 2018
EGU General Assembly 2018


# The Role of Coastlines and Orography in the Formation of Convergence Zones in Cold-Air Outbreaks

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During cold air outbreaks, low-level atmospheric convergence zones often emerge over relatively warmer seas downstream of coastlines, sea ice edges, and mountains. We investigate the formation mechanism of such convergence zones using idealized numerical experiments and analytic theory. In the numerical experiments, a cold air outbreak is simulated in a simplified setup including a coastline and a mountain, where the former has a kink. The numerical simulations show that varying the angle of the kink in the coastline as well as changing the height of the mountain, or removing it, cause a difference in the fetch (traveling distance over sea) of the cold airmass. A warm wedge is formed due to the difference of the fetch, because the longer fetch causes more warming by the sensible heat flux. In the experiments including orography, adiabatic warming due to descent in the lee of the mountain intensifies the warm wedge. Hydrostatically, the warm wedge results in a low-pressure trough, which induces a pressure gradient force towards the warmest area. The turbulent momentum transport in the convectively mixed layer is important for the formation of the convergence zone, because it enhances frictional convergence into the pressure trough. The moisture enhances the convergence by intensifying vertical motion due to diabatic heating. We also present an analytic model for the setup with the kink in the coastline using the basic state flow and the bulk formula for the surface sensible heat flux. The theoretical estimates of the pressure trough and convergence agree well with the results of the numerical experiments.