



Hail formation in pre-frontal environments: A long-term study over Switzerland

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This study investigates the formation of hail in environments pre-conditioned by synopticscale cold fronts. In addition the link of pre-frontal dynamics as trigger for the hail cell initiation is characterized climatologically over Switzerland. The study is based on a high-resolution analysis dataset (COSMO-2/-7) for the extended hail season May-September between the years 2002 - 2013 and a radar-based hail identification and tracking scheme. An automated identification method for fronts is used to compile a climatology of fronts for the COSMO-2 domain, encompassing Switzerland and parts of its neighboring countries, e.g., the Italian Alpine foothills and the Black Forest in southwestern Germany. The informations are used to quantify the relative portion of hail cell initiation in a pre-frontal environment and to study in greater detail the temporal evolution of selected variables (CAPE, CIN, wind shear) in a 20 hour period prior.

Pre-frontal hail initiations accounts for up to 40% of all hail formation in northwestern Switzerland, the southern Prealps, and upstream of the Jura and Black Forest mountains. We suggest that fronts trigger hail formation in particular in regions where hail is less frequently observed (with the exception of southern Switzerland). Adiabatic cooling due to pre-frontal lifting lead an increase of CAPE, a reduction of CIN and an increase of the wind shear. Additional lifting by flow convergence along the Alps or by the front itself above the level of free convection leads to the development of strong convection.