Observations of boundary-layer convergence lines in the southern Great Plains (USA)

Daniel Kirshbaum (McGill University, Montreal, Canada)

Abstract:

Observed boundary-layer convergence lines (CLs) are known to be highly effective at deep-convection initiation, which implies that their associated updraft properties differ from those of more widespread turbulent updrafts in the planetary boundary layer (PBL). This study exploits observations at the ARM Southern Great Plains (SGP) observatory in Oklahoma from 2011-2016 to quantify CL properties and their relation to turbulent PBL eddies preceding CL arrival. Two independent methods for estimating CL properties are developed at two locations in the SGP region, using different combinations of instruments. The first method (the radar method) relies mainly on scanning radar data and is applied to 61 CLs passing near a high-resolution scanning radar based in Nardin, OK. In contrast, the second method (the surface method) relies mainly on surface wind data and is applied to 68 CLs crossing the SGP facility in Lamont, OK. Both methods assume a 2D circulation in the CL-normal plane. Mean daytime CL width (~2 km) and strength (~0.003 s-1) are similar for both methods, and mean daytime CL depth is ~0.75 km. The two methods disagree at night, where the surface method estimates wider and weaker CLs than the radar method. This difference may stem from the radar beam overshooting the shallow, highly stable nocturnal PBL. The largest CL updrafts are only slightly wider and stronger than the largest PBL updrafts in the pre-CL period, generating 50-100% larger updraft mass fluxes over most of the PBL depth. Although these marginal increases surely aid deep-convection initiation, they likely do not capture all of the effects of CLs in promoting thunderstorm development.