

Examining the role of horizontal advection on convective boundary layer dynamics across complex interfaces using lidar and radiosonde observations

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08- Atmospheric boundary layer processes

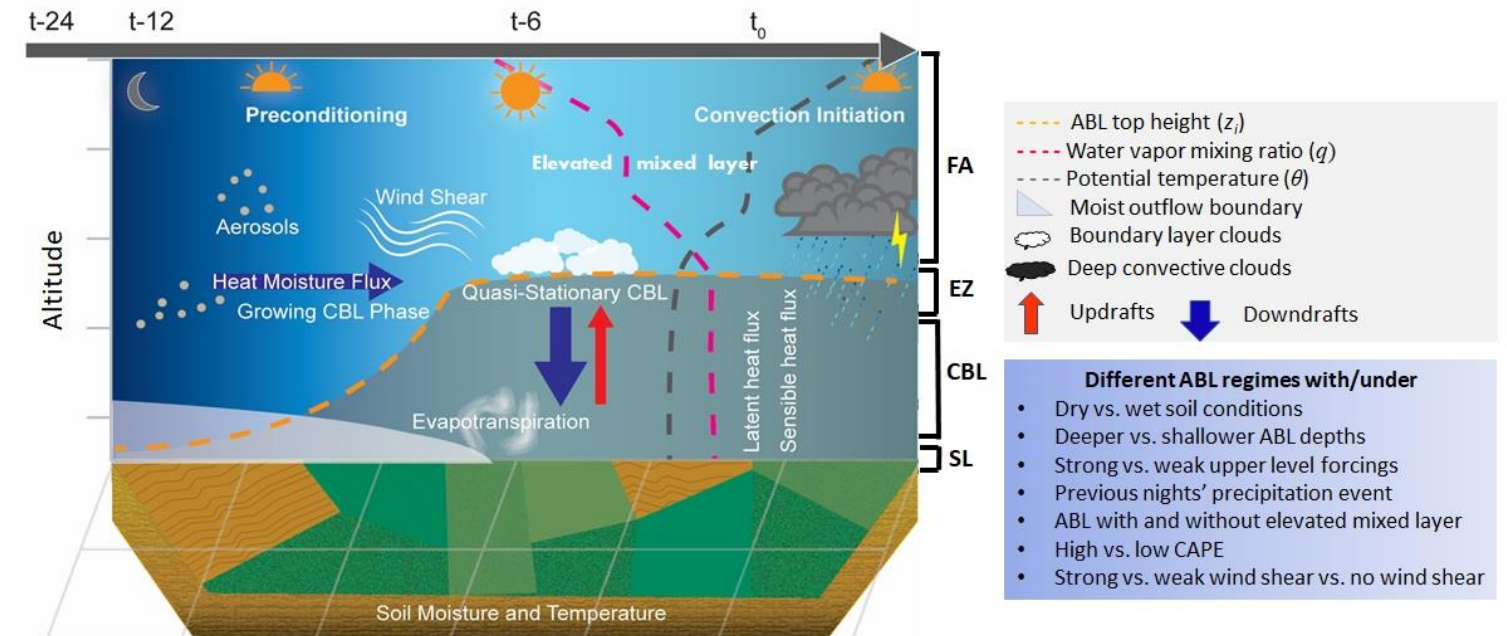
Impact of Advection on ABL

ABL depth growth rate or z_i tendency:

$$\frac{dz_i}{dt} = -u_j \frac{dz_i}{dx_j} + w_e + w_l$$

Entrainment velocity (w_e), subsidence velocity (w_l), and the horizontal changes in z_i via mean wind (e. g., $-u_j \frac{dz_i}{dx_j}$)

The slope of z_i can be significant, and its neglect can cause forecast errors in ABL depth tendency as great the magnitude of the entrainment velocity



Research article

24 Apr 2015

Study of a prototypical convective boundary layer observed during BLLAST: contributions by large-scale forcings

H. P. Pietersen¹, J. Vilà-Guerau de Arellano¹, P. Augustin², A. van de Boer¹, O. de Coster¹, H. Delbarre², P. Durand³, M. Fourmentin², B. Gioli⁴, O. Hartogensis¹, F. Lohou³, M. Lothon³, H. G. Ouwersloot⁵, D. Pino⁶, and J. Reuder⁷

Let's Imagine three-four extreme scenarios

I. **Urban-rural interface:** Urban boundary layer advecting over adjacent rural areas and modifying ABL features



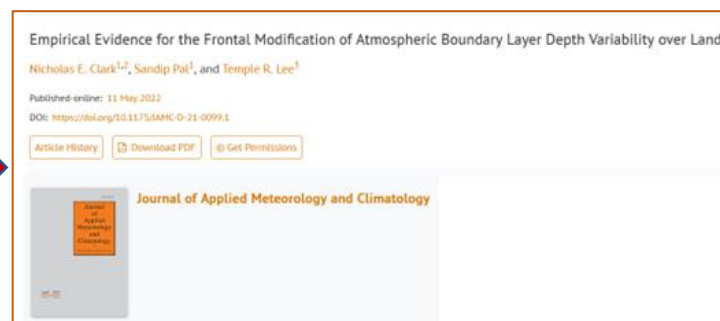
II. **Land-sea interface:** Horizontal transport of marine boundary layer airmass over coastal areas and further inland



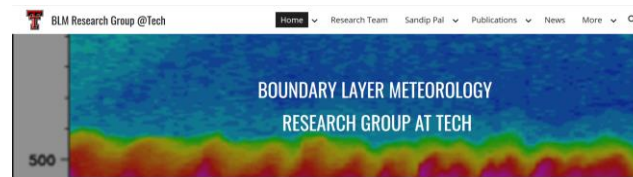
III. **Complex terrain and adjacent plains:** elevated mixed-layer advecting off the complex terrains on the adjacent plains



IV. **Frontal environment:** Mid-latitude cyclones affecting ABL processes via passages of cold and warm frontal boundaries.



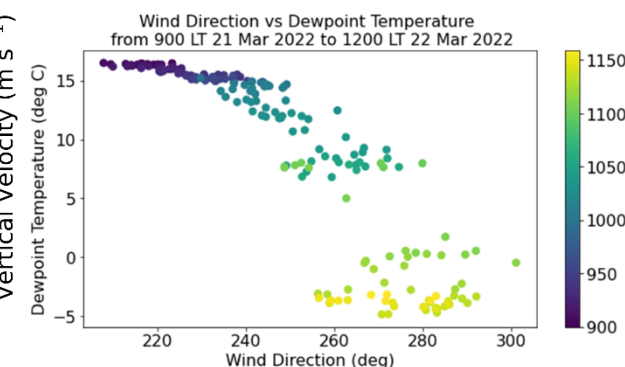
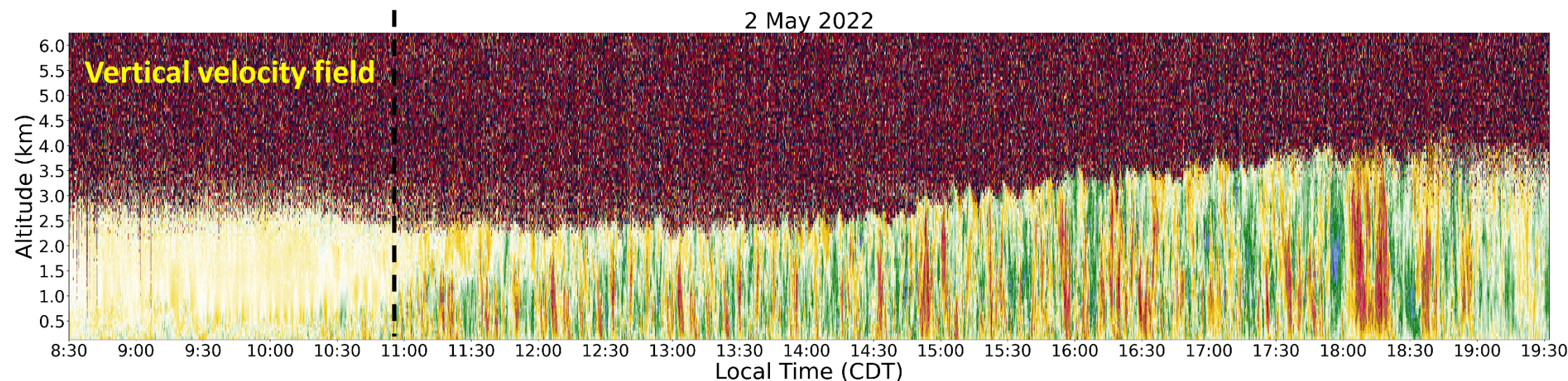
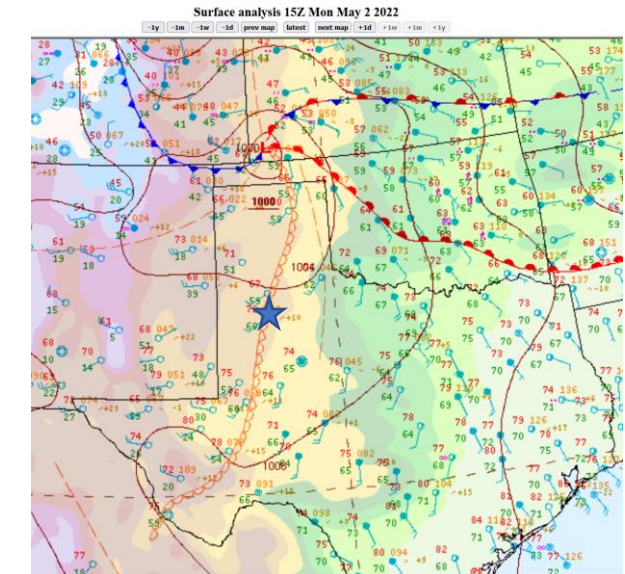
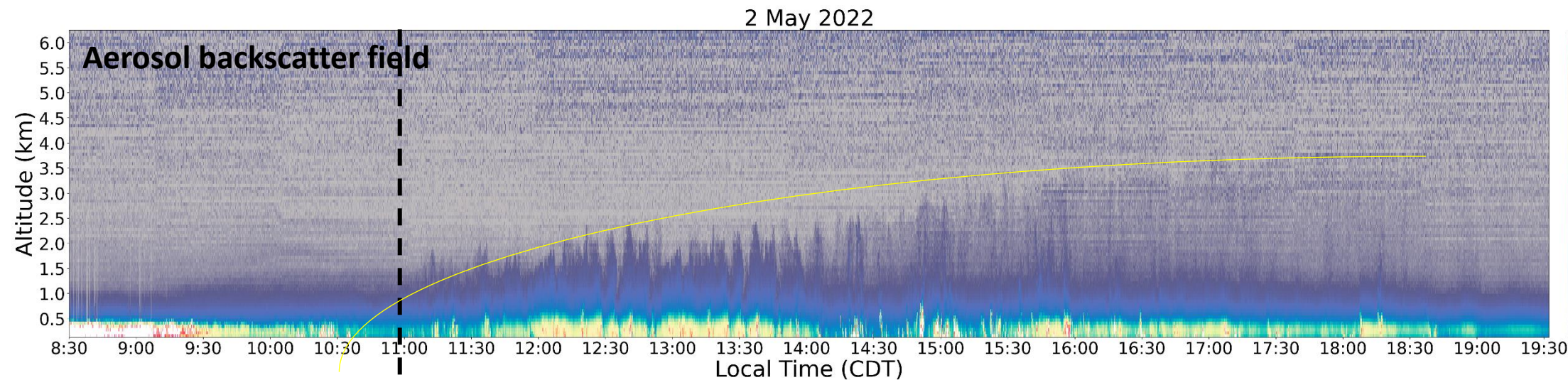
ABL features under the impact of **dryline passage** (2 May 2022)



<https://sites.google.com/view/sandippal-ttu/>

Texas Tech Scanning Doppler Lidar (T²-SDL)

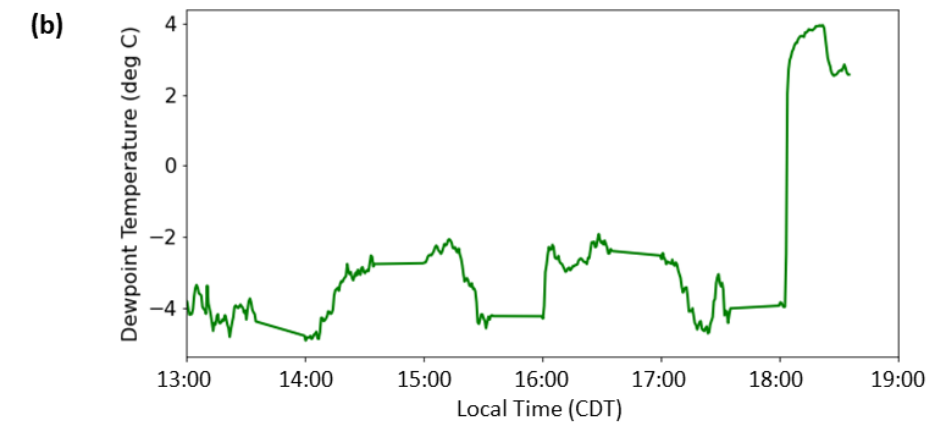
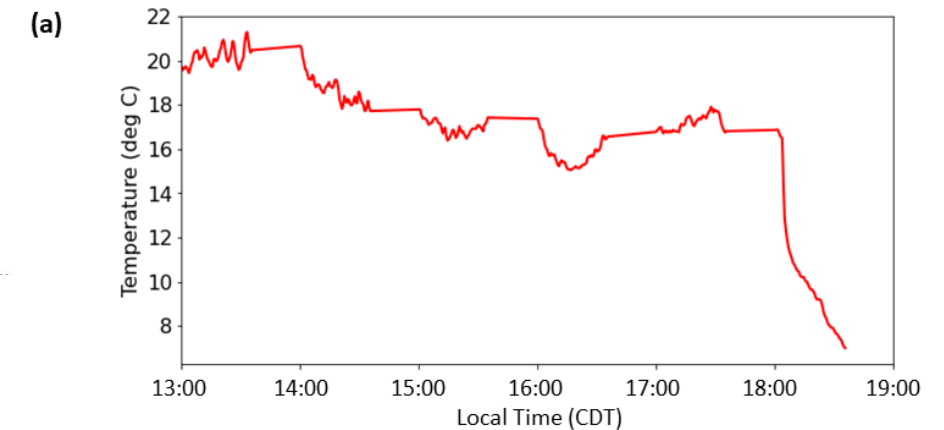
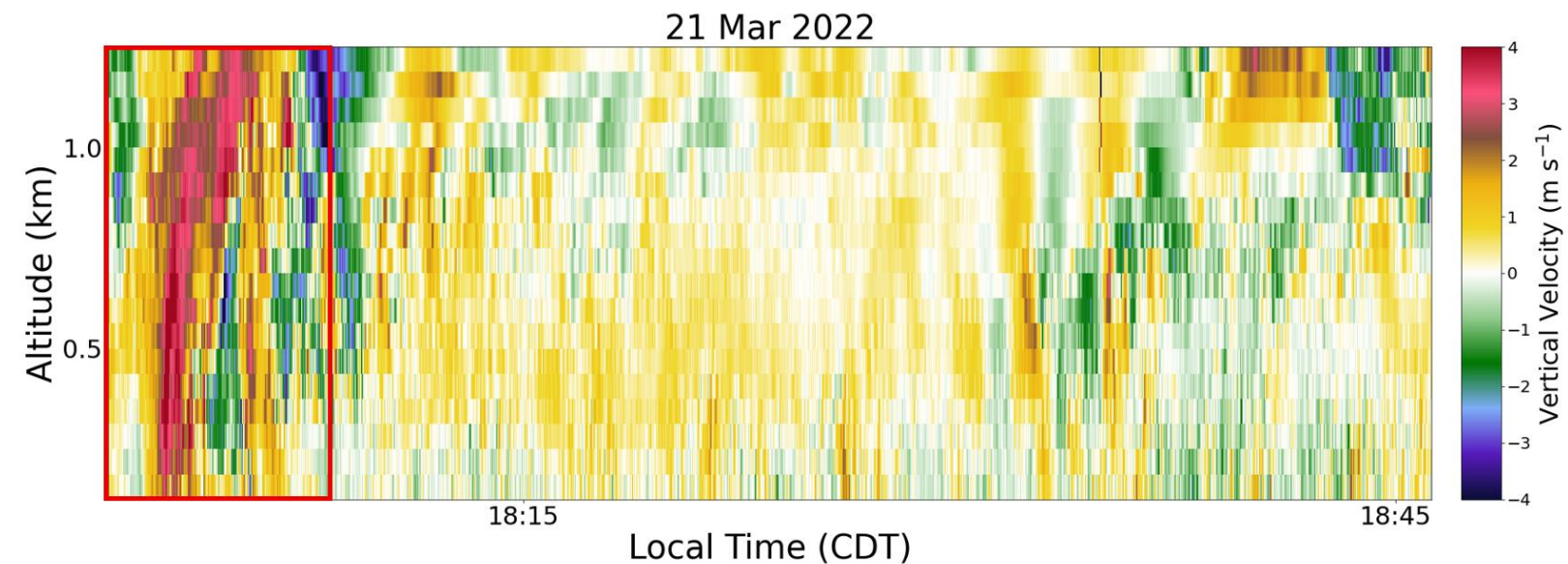
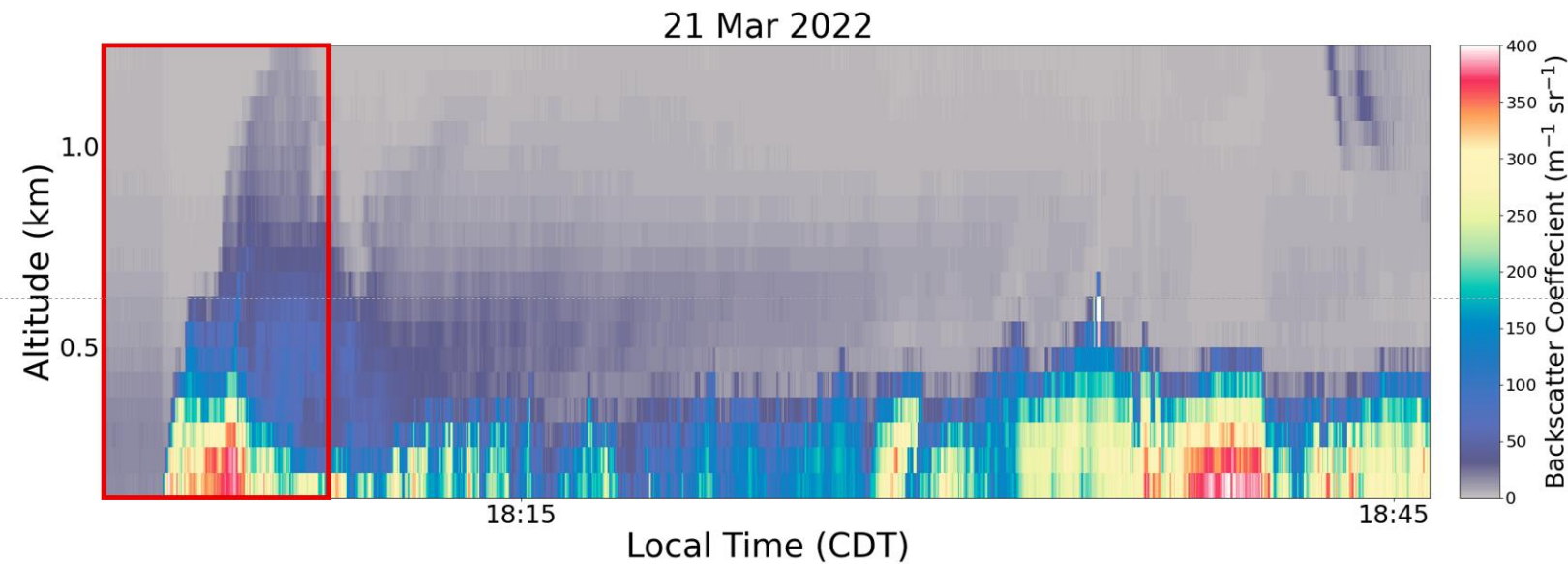
- u,v,w component
- Aerosol backscatter
- Turbulence features,
- BL depth estimation



ABL features under the impact of cold front passage (21 Mar 2022)

A ZOOM-IN VIEW

Time height cross-section of aerosol backscatter coefficient measured using T²-SDL on 21 Mar 2022



Take home messages (Summary)

- ✓ A conceptual framework has been developed to examine the impact of advection on ABL kinematics and thermodynamics
- ✓ New empirical evidence => Contrasts in ABL dynamics at and across frontal boundary
- ✓ New results are encouraging and provides enough confidence to develop new/advanced parameterization schemes for models
- ✓ Mid-latitude cyclones and associated frontal boundaries affect ABL features
- ✓ Lidar measurements provided strong evidence: Front-relative changes in ABL features



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