

Hail accumulation depth depends on hail production and storm motion

The Lightning and Dual-Polarization Radar Characteristics of Three Hail Accumulating Thunderstorms

Robinson Wallace¹, Katja Friedrich¹, Wiebke Deierling², Evan A. Kalina^{3,4}, Paul Schlatter⁵
¹Dept. of Atmospheric and Oceanic Sciences, University of Colorado, Boulder, CO. ²National Center for Atmospheric Research.
³Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO. ⁴NOAA Global Systems Division, Boulder, CO. ⁵National Oceanic and Atmospheric Administration, Boulder National Weather Service
 Correspondence: Robinson Wallace wallacer@colorado.edu

Introduction

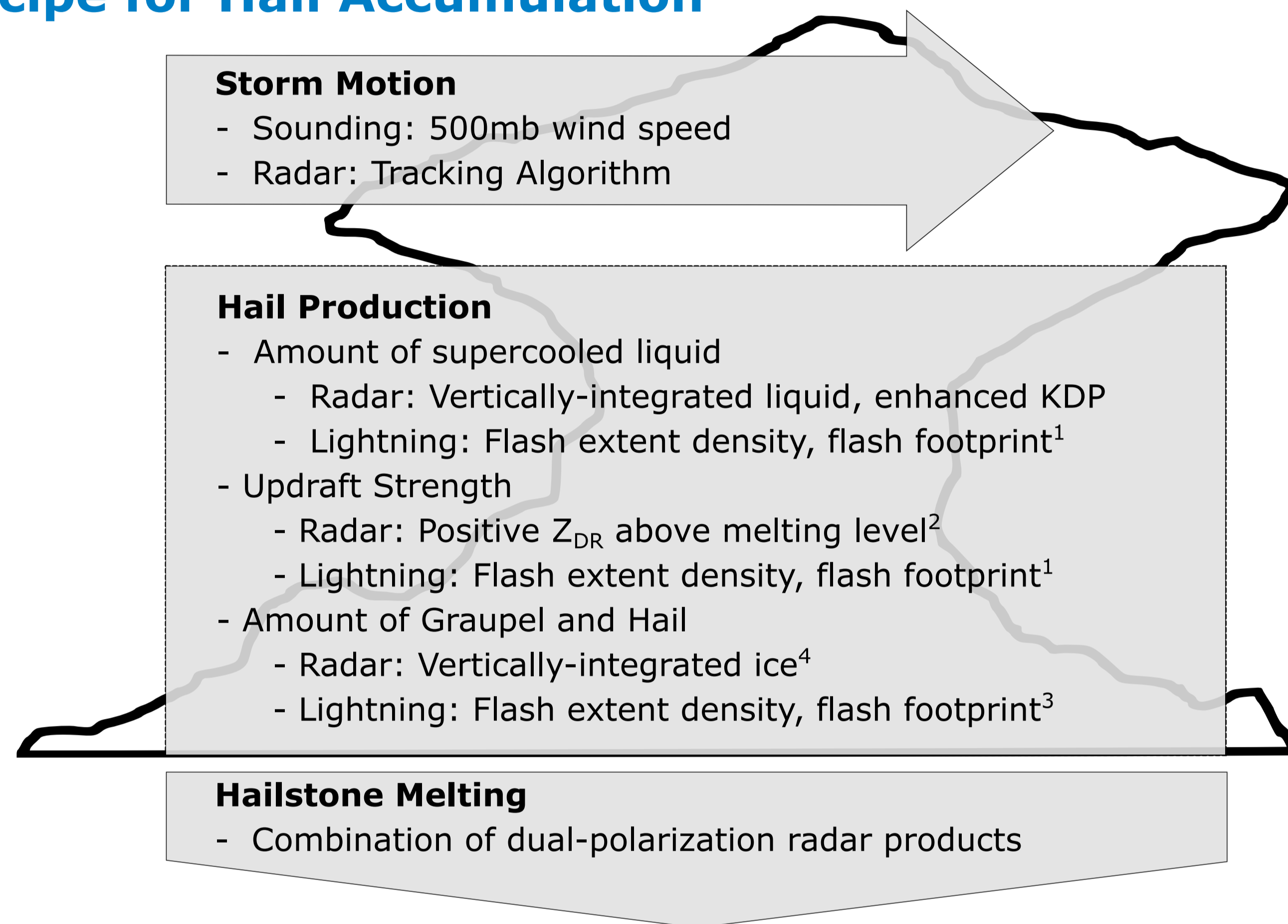
Motivation:

- Hailstorms have been reported to generate depths of up to 50 cm of hail.
- Deep hail accumulations can impede road and air travel, cause localized flooding, and risk lives.
- Differentiating between storms that do and do not produce deep hail accumulations is difficult.

Goal:

- Discover the most useful storm characteristics to differentiate storms that generate significant hail accumulations from those that do not.

Recipe for Hail Accumulation

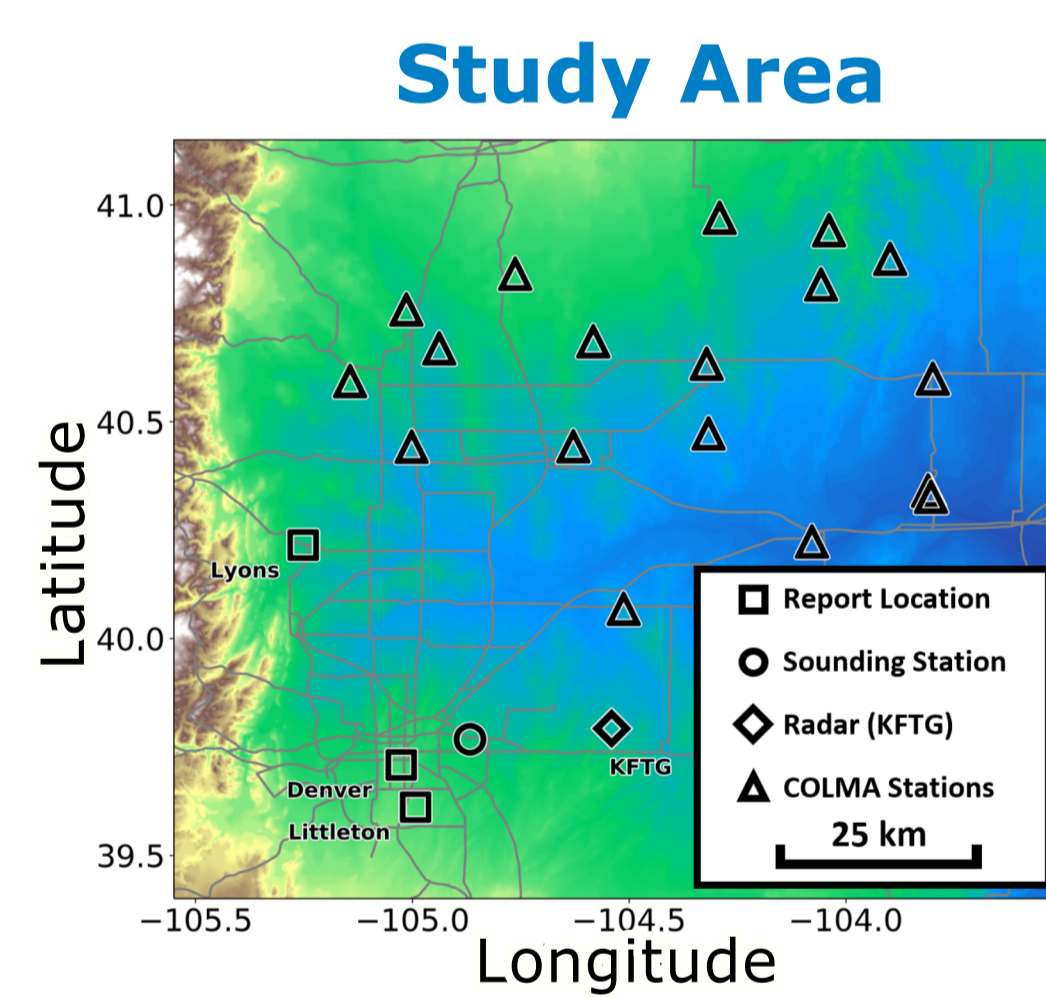


Hypothesis:

- Storms that produce the deepest hail accumulations will possess elevated hail production, reduced storm speed, and limited hailstone melting.

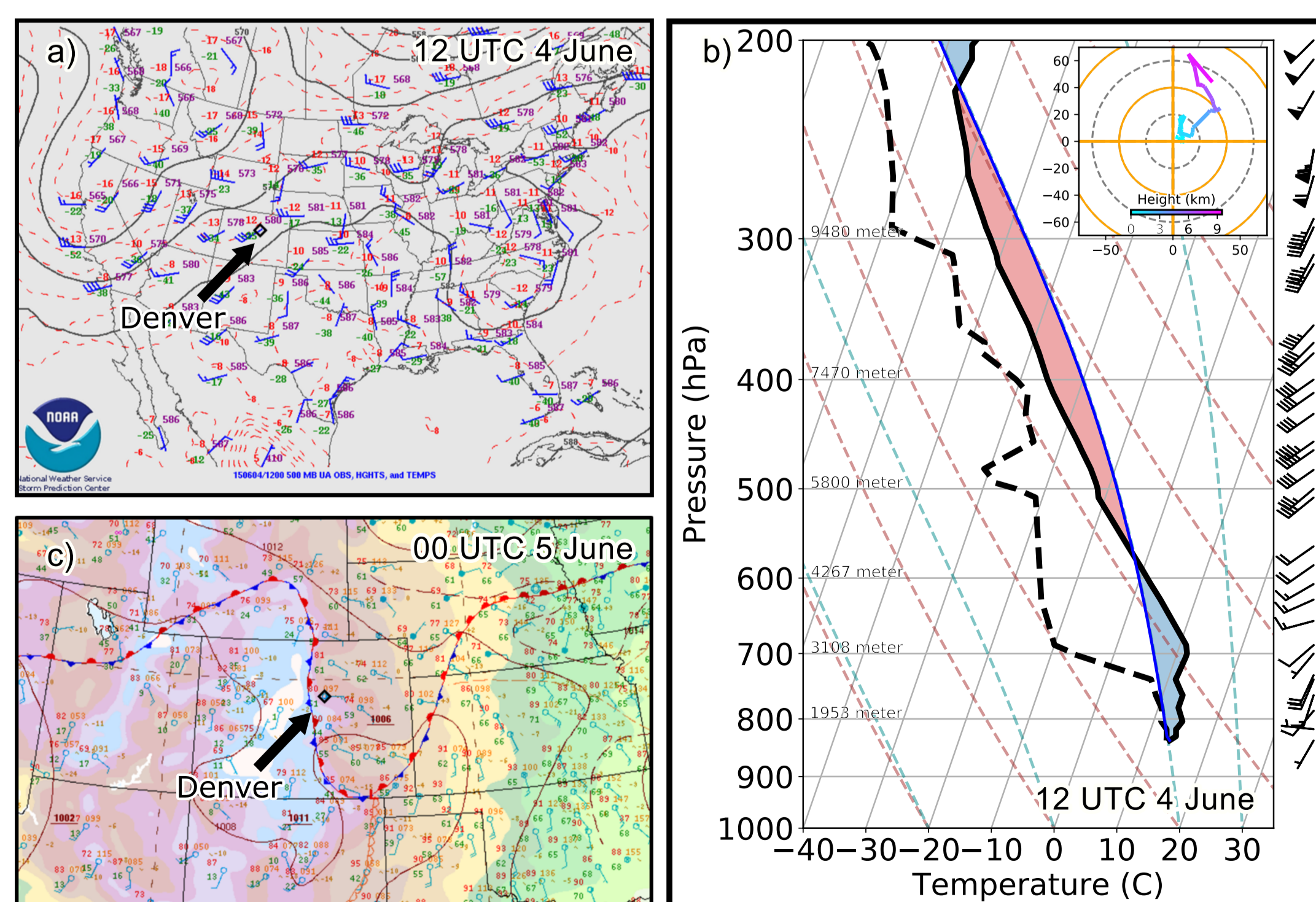
Storm Selection

Hail Depth Reports on 5 June 2015



- Three storms occurred on the same day that produced a variety of accumulations
- Denver depth report was made from topographic depression where hail rode downhill on rainwater

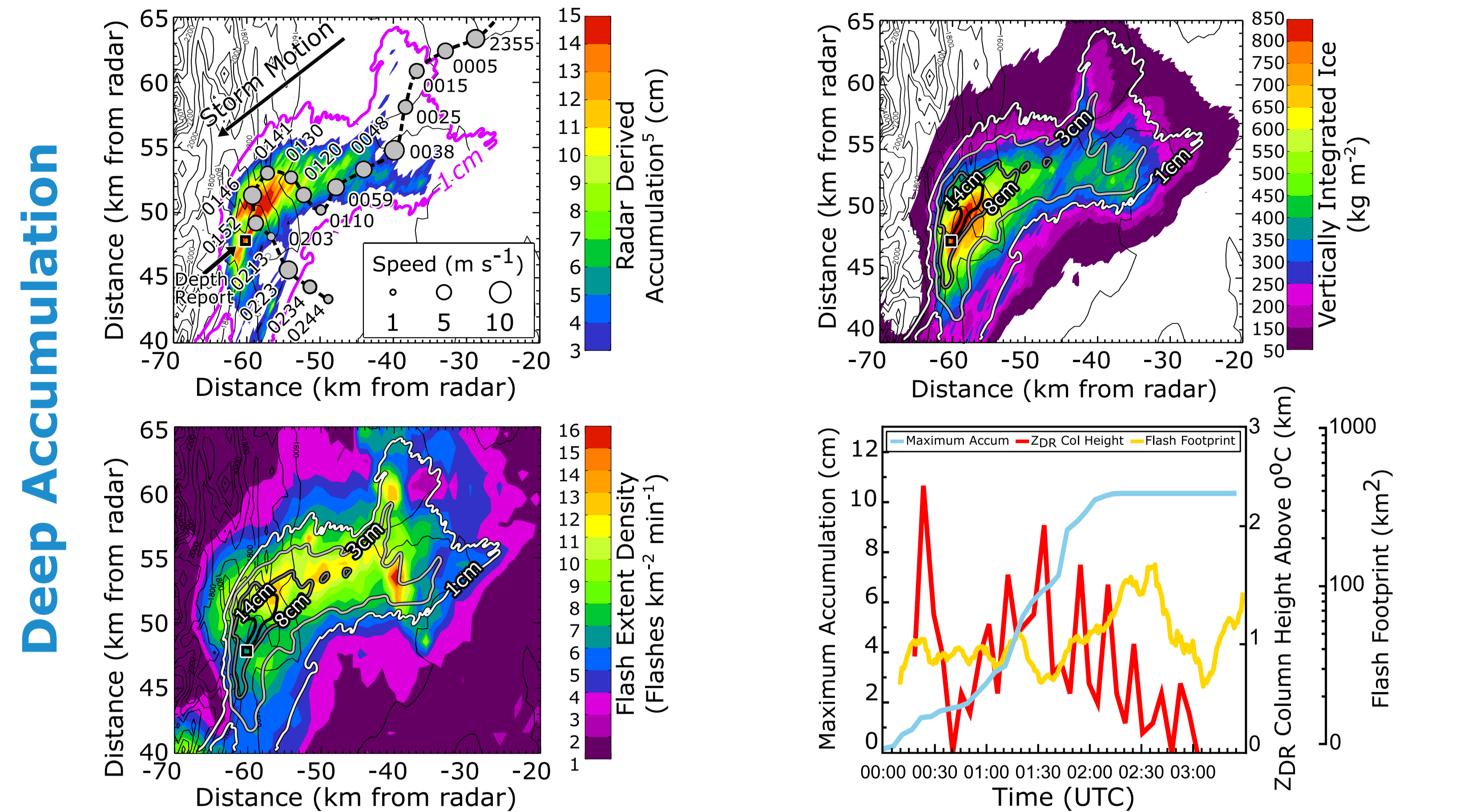
Environment



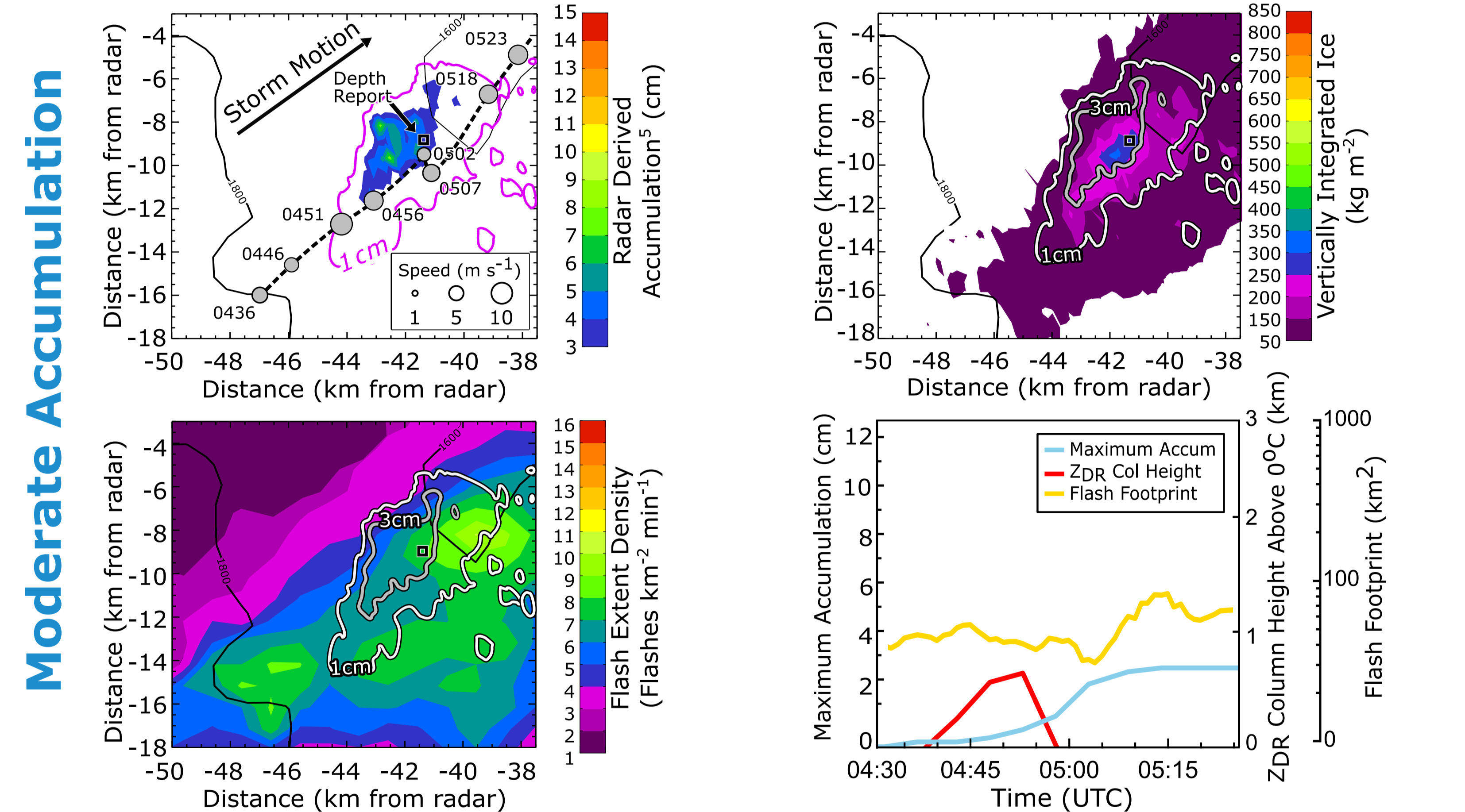
- Storms are expected:
 - Upper level divergence
 - Lower level convergence
 - Low level moisture
 - Veering winds
 - Substantial CAPE

- Similar conditions found in previous research on hail accumulating storms⁵

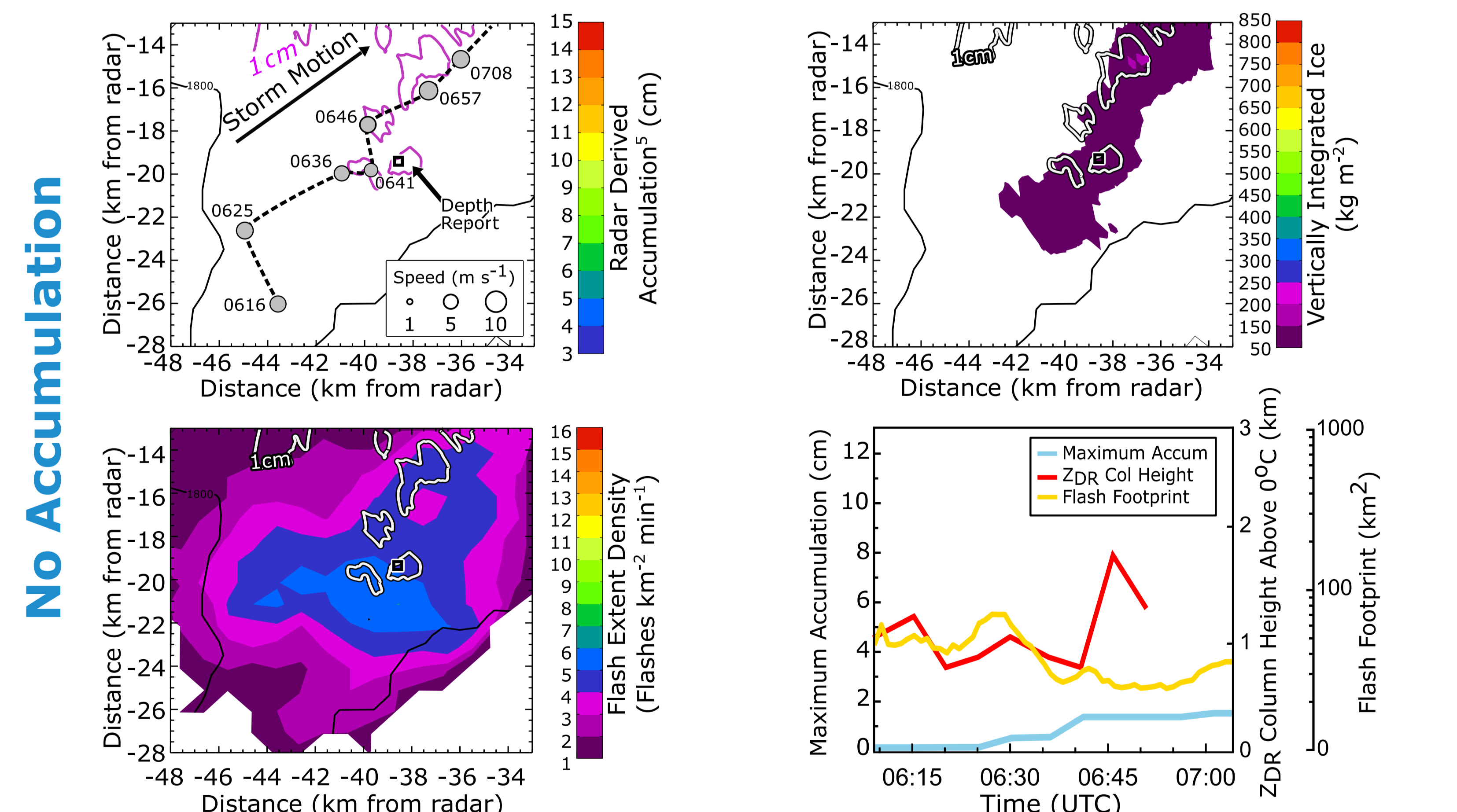
Storm Evolution



- Storm motion alone is a poor indicator of accumulations
- Enhanced hail production during slow storm motion yields >15 cm accumulations
- Enhanced hail production during fast storm motion generally yields smaller accumulations
- Accumulations can increase when storm speed increases if hail production also increases



- Moderate hail production during slow storm motion yields ~7 cm accumulations



- Low hail production and persistent storm motion results in no measurable accumulation

Summary

When identifying the hail accumulation potential:

- Storm speed and hail production perform poorly when used alone
- The combination of each characteristic yields the most skill
- The optimal combination is slow storm motion and enhanced hail production
- Time evolution of hail production gives 0-15 minutes lead time to increasing accumulations

References

- Shultz, C., Carey, L., Shultz, E., Blakeslee, F., 2015: Insight into the Kinematic and Microphysical Processes that Control Lightning Jumps. *Wea. Forecasting*, 30, 1591-1621
- Kumjian, M.R., A.P. Khain, N. Benmoshe, E. Ilotoviz, A.V. Ryzhkov, and V.T. Phillips, 2014: The anatomy and physics of ZDR columns: investigating a polarimetric radar signature with a spectral bin microphysical model. *J. Appl. Meteor. Climatol.*, 53, 1820-1843
- Deierling, W., Petersen, W. A., Latham, J., Ellis, S., and Christian, H. J. (2008). The relationship between lightning activity and ice fluxes in thunderstorms. *J. Geophys. Res.*, 113, D15210
- Mosier, R. M., C. Schumacher, R. E. Orville, and L. D. Carey, 2011: Radar nowcasting of cloud-to-ground lightning over Houston, Texas. *Wea. Forecasting*, 26, 200-212.
- Kalina, E. A., K. Friedrich, B. C. Motta, W. Deierling, G. T. Stano, and N. N. Rydell, 2016: Colorado plowable hail storms: Synoptic weather, radar and lightning characteristics. *Wea. Forecasting*, 31, 663-693