1. Nudging (water vapor and/or temperature) where lightning is observed but convection is absent in the model. (Fierro et al. 2012, 2014)

Nudging tested on 67 daily NSSL real-time forecasts during spring 2013. Generally improved low biases in accumulated rainfall. Needs further tuning to avoid increasing high biases. (Fierro, Clark, Mansell et al. 2015)

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2. Ensemble Kalman Filter: Ensemble relationships provide adjustments to all state variables. (Mansell 2014, Allen 2014)

May 8, 2003 tornadic supercell storm
GOES-R Lightning Density derived from Mapping Array data

Good preliminary results were found with a simple linear flash density operator: $LD = (0.017)*$ (grapel volume) [Will try to use with 3DVAR, as well.]

What can total lightning data provide for forecasts and analyses, in lieu of or in addition to radar?

Radar assimilation (3DVar)

Lightning nudging

6-hr forecasts of radar reflectivity of a severe wind storm (derecho) with lightning nudging (ENTLN) or cycled radar 3DVAR methods.