The potential impact of assimilating cloud-affected visible and infrared satellite observations for convective-scale numerical weather prediction

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Accurate forecasts of deep convection require accurate initial conditions provided by data assimilation. Visible satellite imagery is largely unused in data assimilation, even though it detects deep convection earlier than radar. In this work, we estimate the potential impact of assimilating cloud-affected satellite observations in the visible (0.6 µm) and near thermal infrared wavelengths (6.2 µm and 7.3 µm) relative to the impact of assimilating radar reflectivity observations.
We performed idealized observing system simulation experiments (OSSE) using the Weather Research and Forecasting model (WRF) at 2-km grid resolution, the radiative transfer model RTTOV/MFASIS, and the Ensemble Adjustment Kalman Filter in the Data Assimilation Research Testbed (DART). The forecast impact was evaluated in two cases: isolated and scattered supercells with different assumed prior uncertainties.
The main result is that satellite observations can be nearly as beneficial as three-dimensional radar reflectivity observations, depending on the degree of prior forecast uncertainty. We conclude that there is a large potential for assimilating cloud-affected satellite observations when the location of convection is uncertain and a low potential when the stage of convective development is uncertain.