Assimilation of GOES-derived Cloud-top Cooling Rate as a Convection Indicator in the Rapidly Updating HRRR atmospheric model

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SUMMARY

Evaluation of impact from cloud top cooling assimilation as a convection indicator into the HRRR

CTCR and strength-of-signal data from University of Alabama Huntsville (UAH)

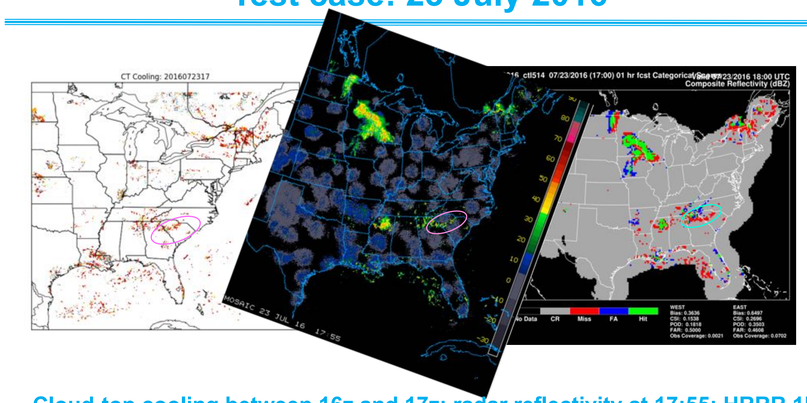
Used lower bound of CTCR of -3K/15 min

Using experimental (soon operational) HRRRv3

5 hours of a test case during summer 2016 were run to 6 forecast hours, both with and without SOS filtering

Results indicate usefulness of CTCR for short-term prediction of precipitation onset

Test case: 23 July 2016

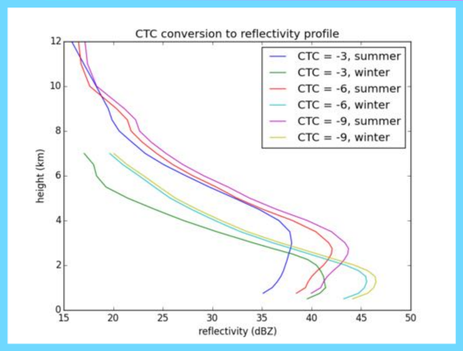


Cloud-top cooling between 16z and 17z; radar reflectivity at 17:55; HRRR 1hr forecast reflectivity verification at 18z

CTC as convection indicator

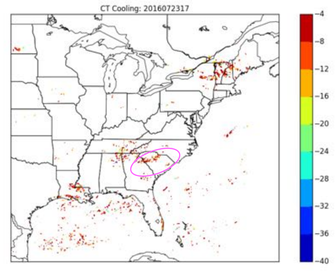
- Decreasing cloud top temperature bespeaks rising cloud top height
- Rising cloud top height symptom of vertical motion and convection
- Thus, cloud-top cooling may indicate convection before the onset of precipitation
- Cloud top temperature monitoring must be paired with cloud tracking for efficacy

Assimilation into the HRRR



- Radar reflectivity obs assimilated as latent heat
- Relationship between column max reflectivity and LH profile varies seasonally
- CTC is reported in deg. K per 15 minutes
- CTC converted to reflectivity at a seasonally-varying rate

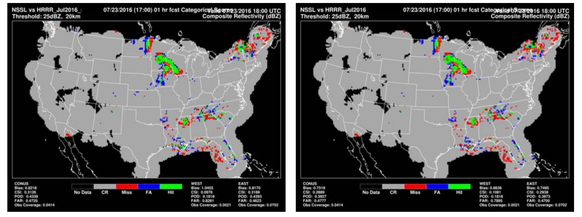
Strength-of-signal filtering



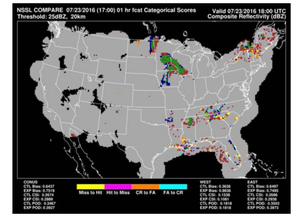
SOS-filtered cloud-top cooling between 16z and 17z during the test case

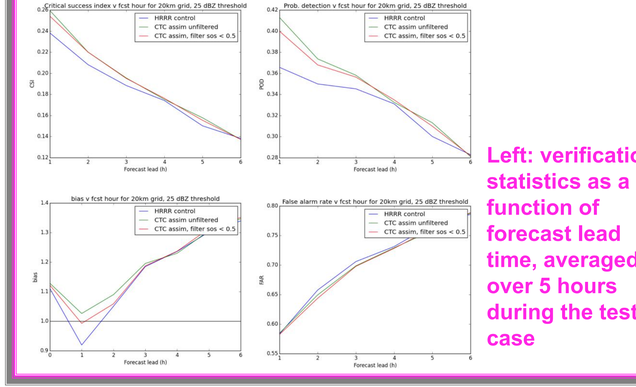
- UAH SATCAST algorithm provides a strength-of-signal (SOS) index for tracked CTC cloud objects
- SOS indicated likelihood of heavy rain (0 unlikely, 1 most likely) within the coming hour
- Used here to filter the raw CTC information.

Results



Clockwise from top left: verification vs NSSL CREF mosaic for CTC run without SOS filtering; filtering sos<0.5; filtering sos<0.5 with differences from control run highlighted





Left: verification statistics as a function of forecast lead time, averaged over 5 hours during the test case

Discussion and future work

- In the test case, CTC assimilation improved the HRRR ability to forecast precipitation in the short term
- value of SOS filtering was unclear
- CTC/SOS advantage diminished after first few hours
- Statistically, gains were small and must be weighed against computing resources
- Apply CTC with SOS filtering to a wider variety of cases, including winter
- Examine method of assimilation for possible improvements (to conversion rates or overall approach
- Investigate interaction with other HRRR processes that may suppress convection