EnKF Assimilation of Synthetic ABI Infrared Radiance Observations at Storm Scales with Vertical Localization

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Satellite Radiance Assimilation

- Widely used in global models (IR, MW, retrievals)

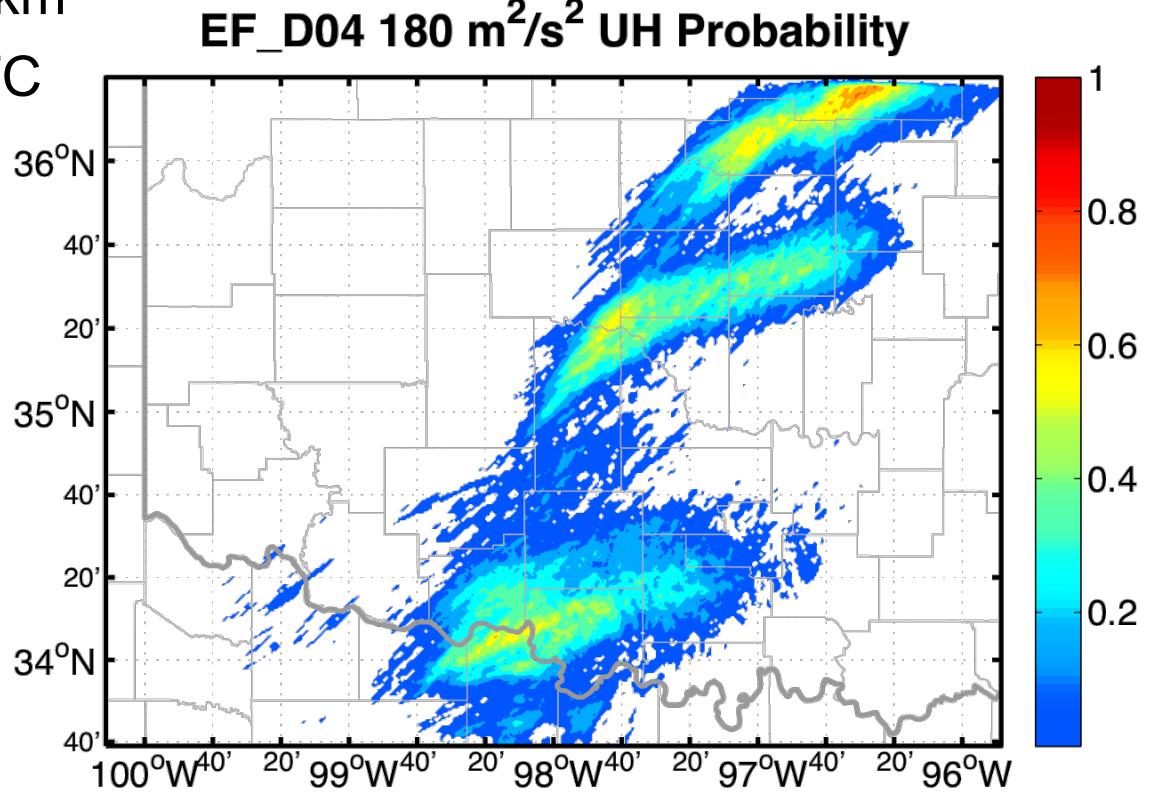
- GOES-16 in production as GOES-E this November
  - High spatiotemporal resolution, more channels in infrared

- Geosynchronous, infrared, regional model, EnKF applications:
  - Frontal systems: Otkin (2010, 2012), Zupanski et al, (2011), Jones et al. (2013. 2014)
  - Tropical cyclones: Zhang et al. (2016), Minamide and Zhang (2017)
  - Thunderstorms (retrievals): Jones and Stensrud (2012), Kerr et al. (2015), Jones et al. (2015)
  - No direct assimilation of infrared using EnKF on thunderstorms

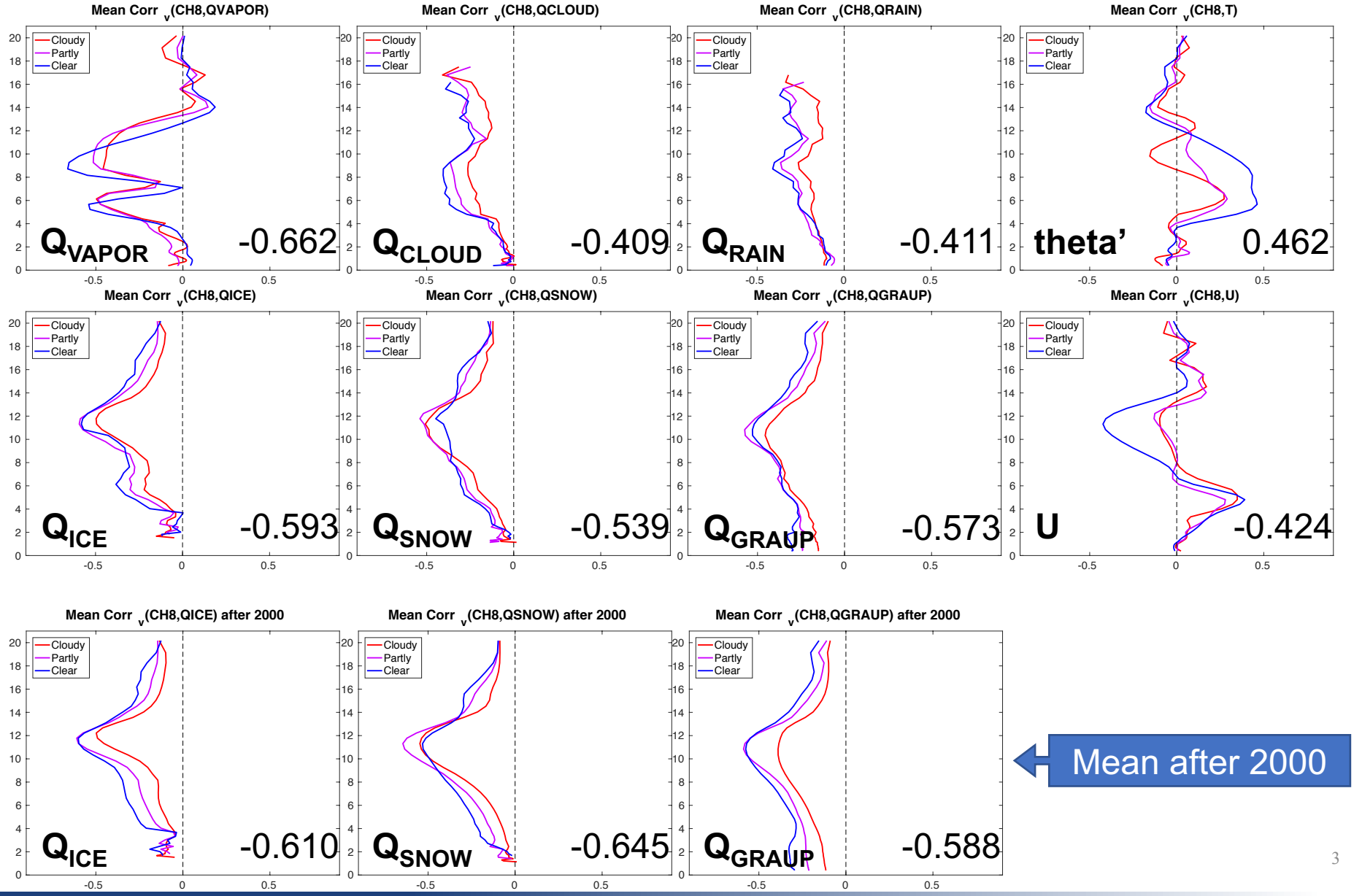
- Vertical localization of radiance observations
  - Campbell et al. (2010), Lei and Whitaker (2015) and Lei et al. (2016)
  - No vertical localization in most data assimilation experiments

Calculating Vertical Correlation of Radiance

- Ensemble of 20 May 2012 Oklahoma tornadic thunderstorm
  - Tornado: 1956~2033 UTC
- WRF V3.5, 60-member, 1-km
- Simulation: 1700~2300 UTC
- CI: 1800~1900 UTC

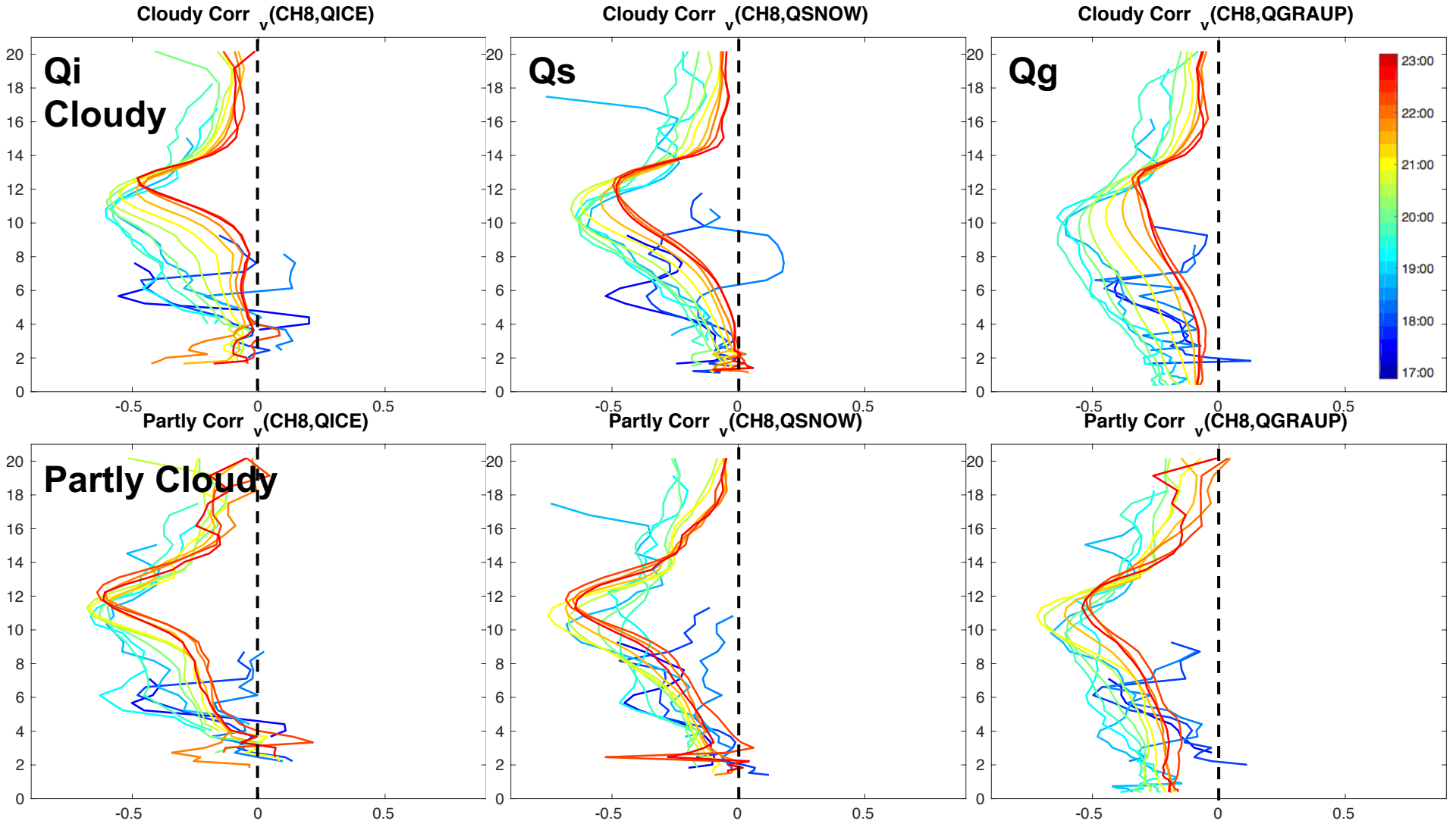


Mean Vertical Correlation of ABI CH-8



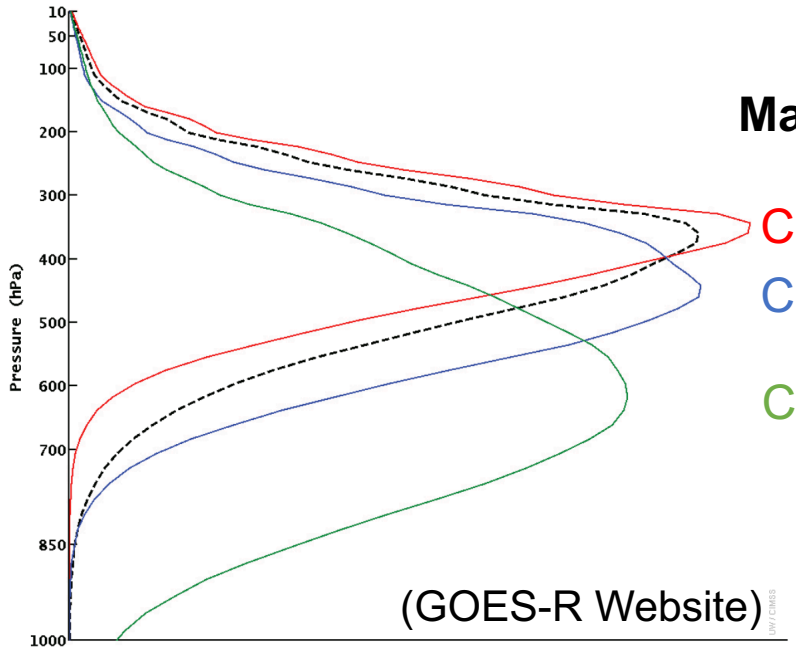
Mean after 2000

Time Evolution of Correlation with Ice Particles



Design of Vertical Localization

- Assign vertical location with weighting function and cloud condition



Maximum weighting function

CH-8: 340 hPa

CH-9: 440 hPa

CH-10: 620 hPa

Cloud Top

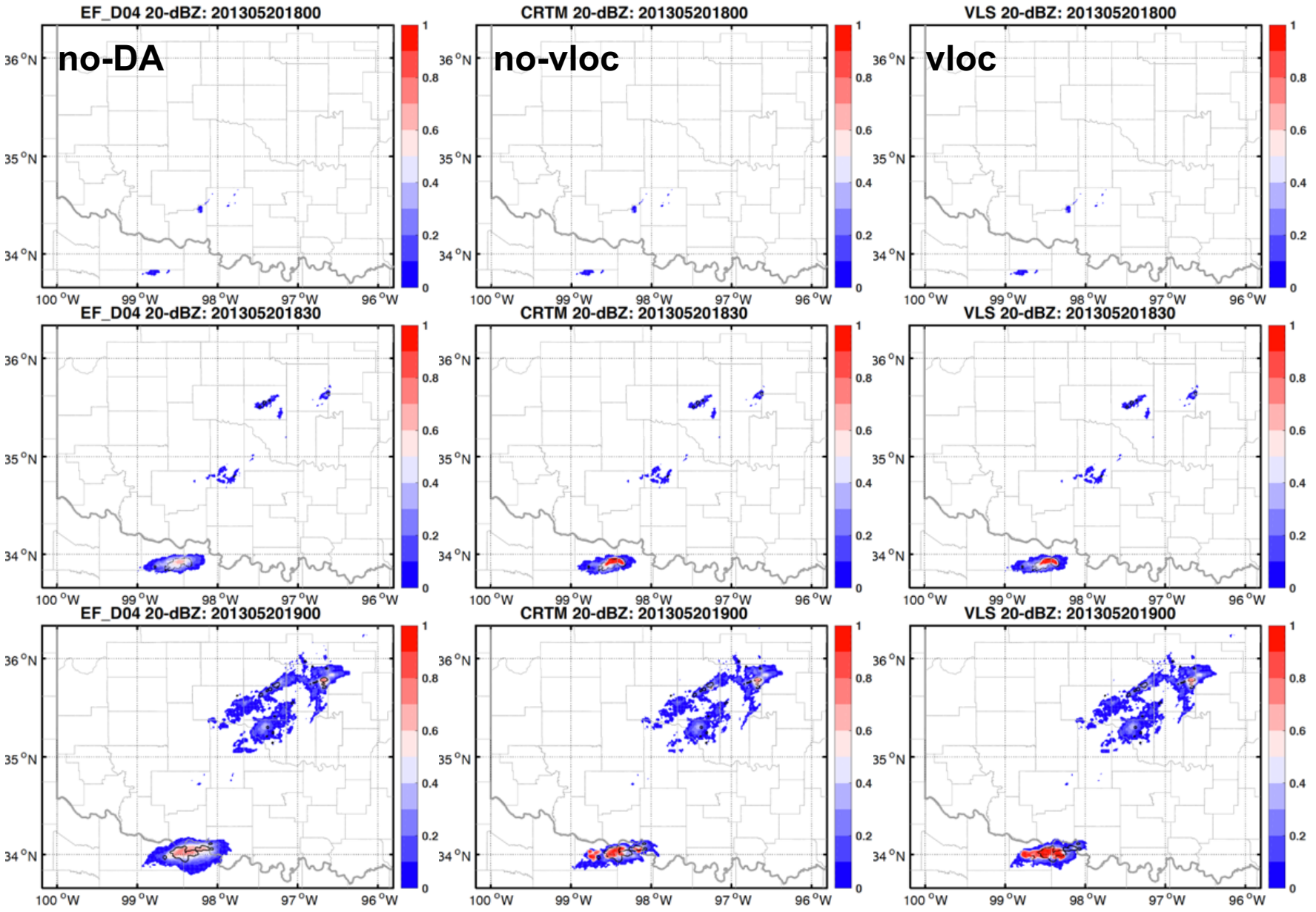
250 hPa

Cloudy region
(CH-14 < 285 K)

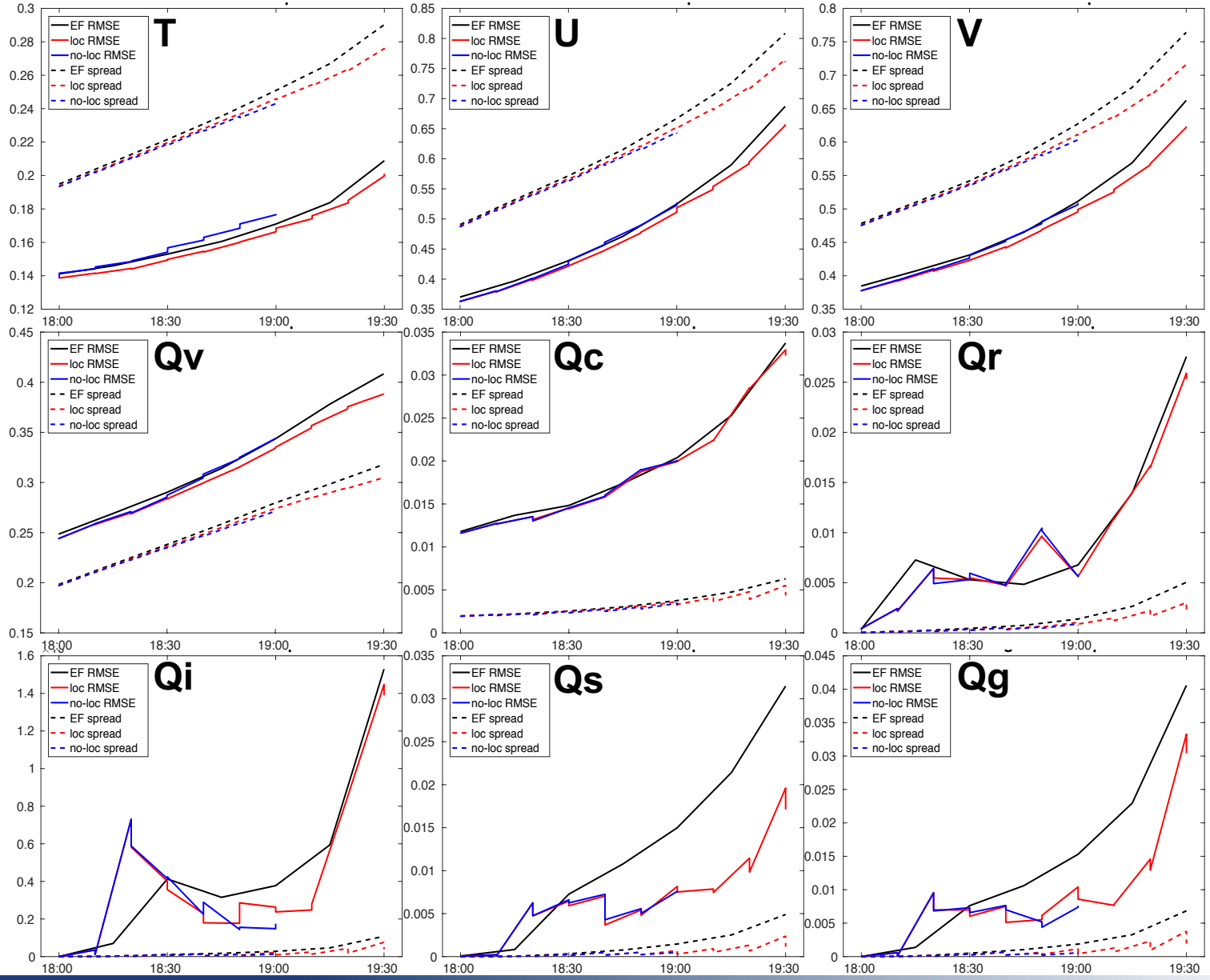
Clear-air region
(CH-14 > 285 K)

- Adaptive vertical ROI:
  - Influence reduced to 0 at surface
  - Influence on surface variables remain 100%
- EnKF starting from 1800 UTC (before CI)
- Synthetic ABI CH-8 observations in 3-km resolution with AOEI

Comparison of 20-dBZ Probability

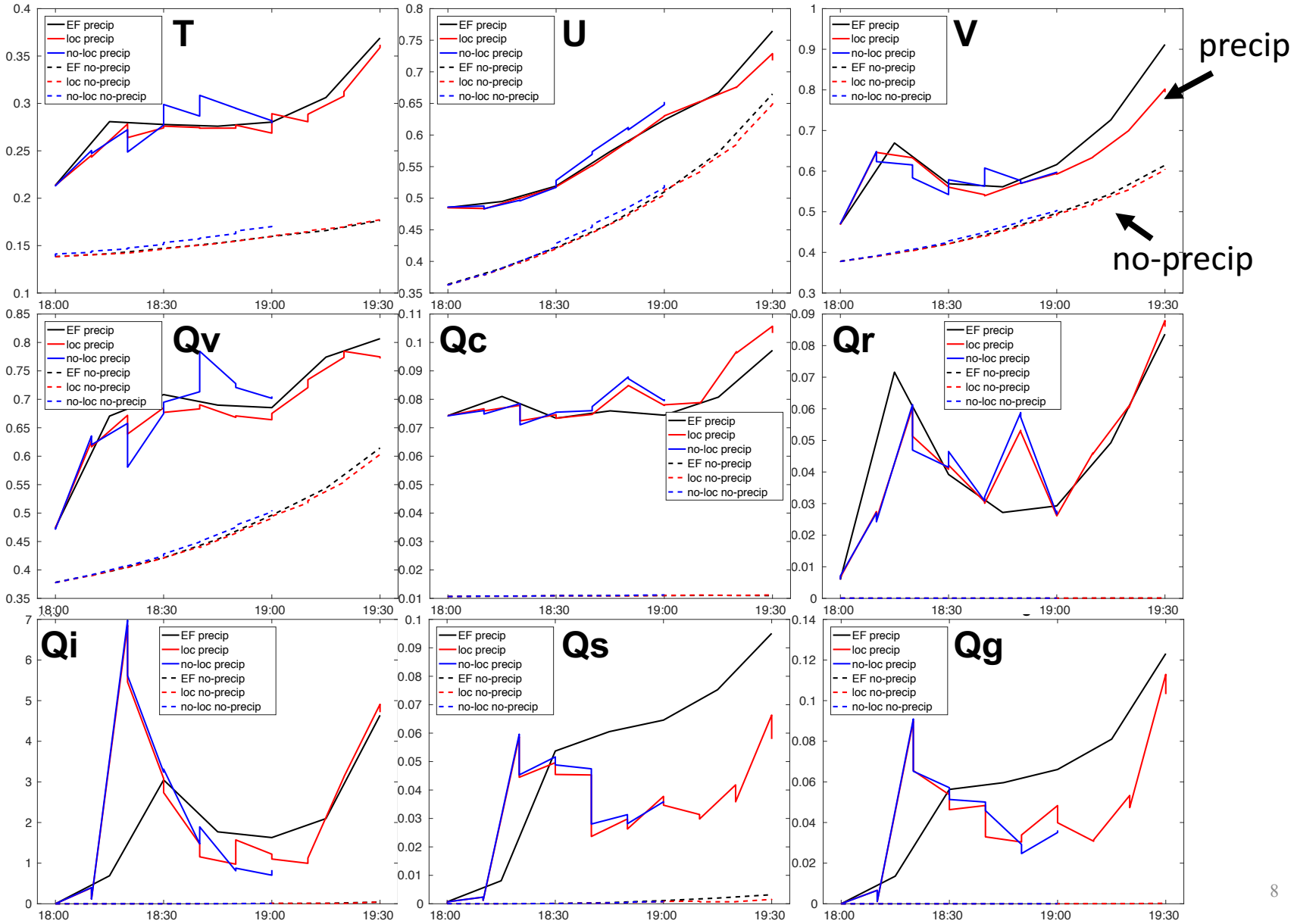


Comparison of RMSE and Ensemble Spread

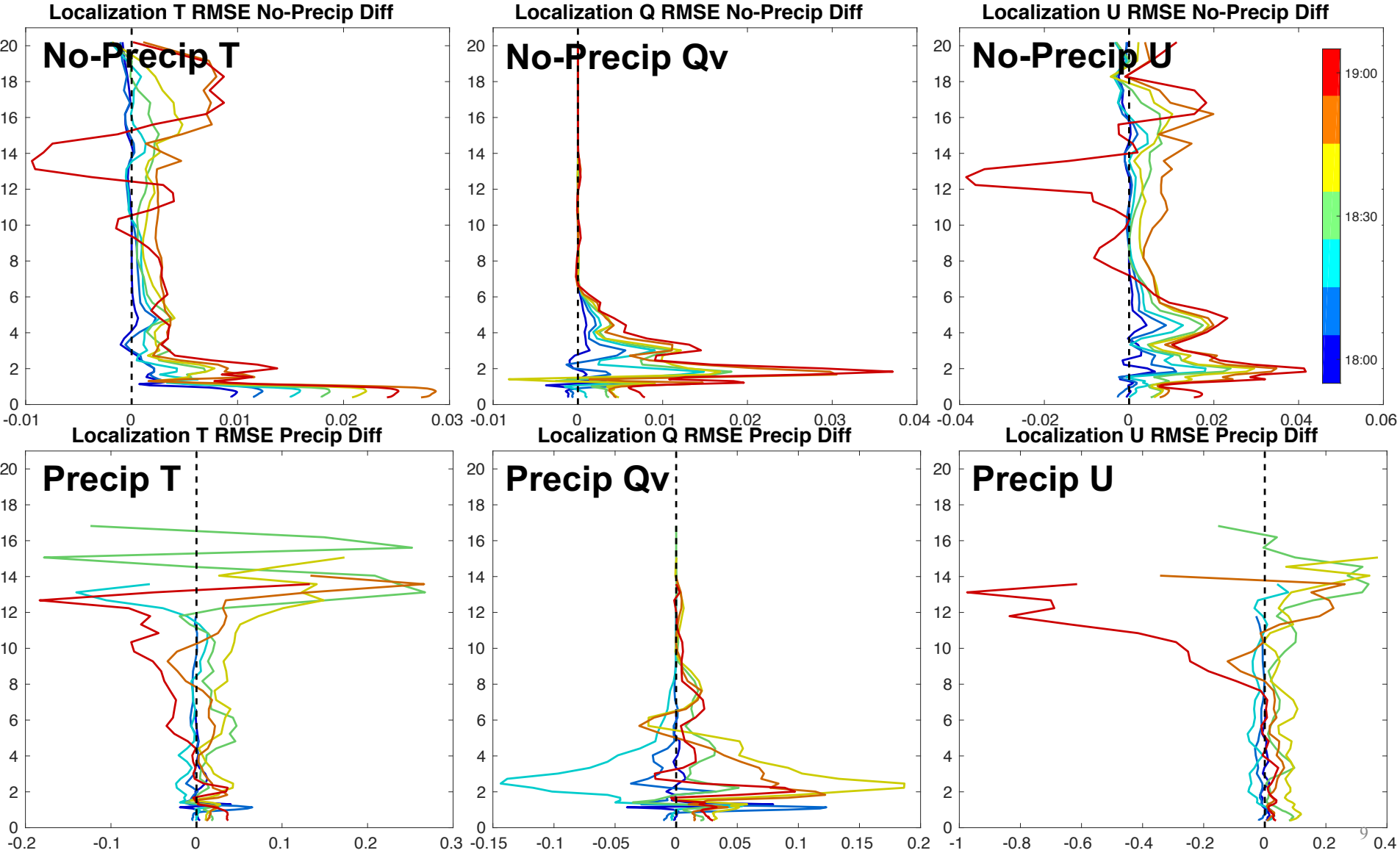


no-DA
no-vloc
vloc

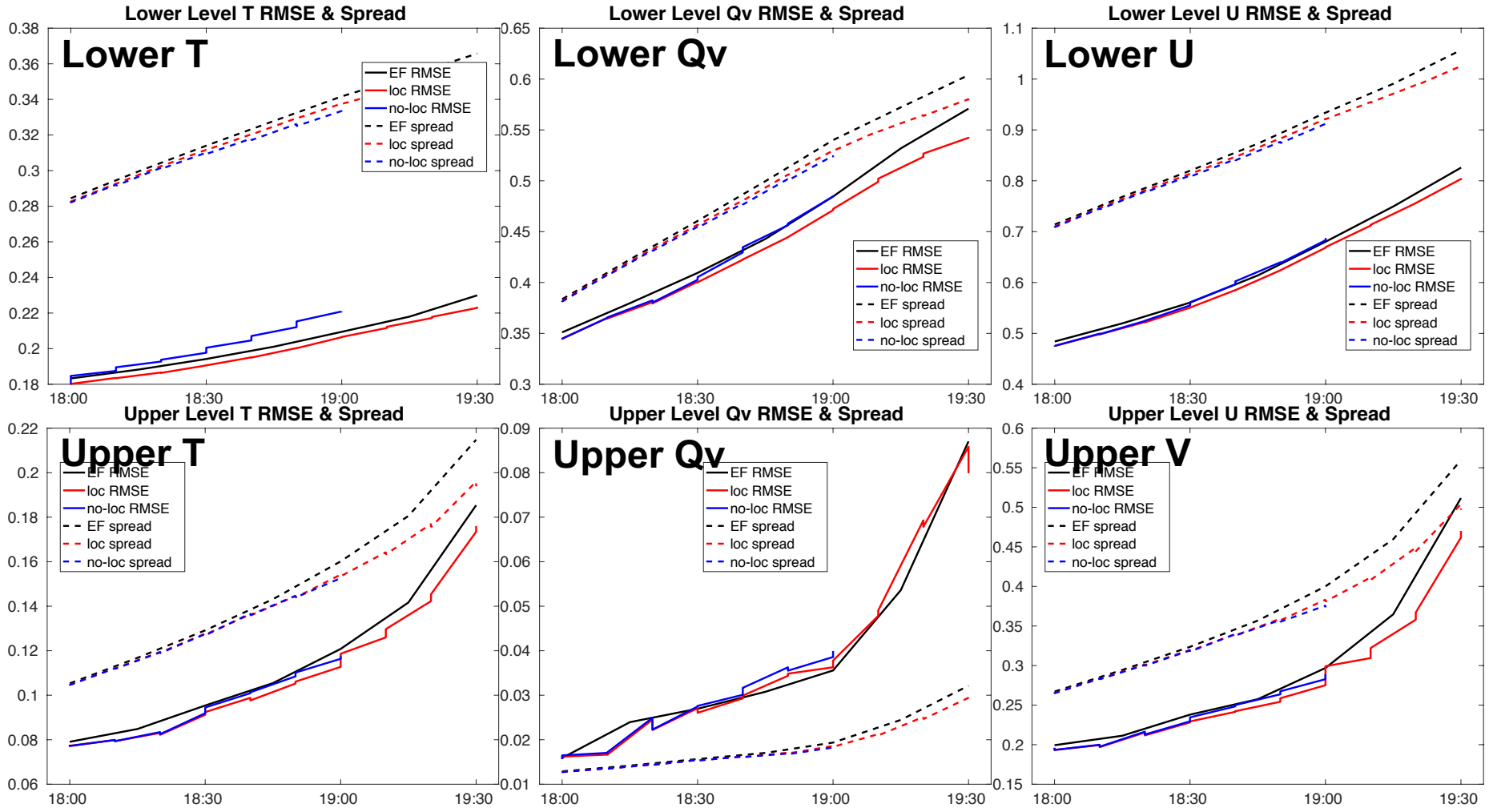
Precipitation vs. No-Precipitation Regions



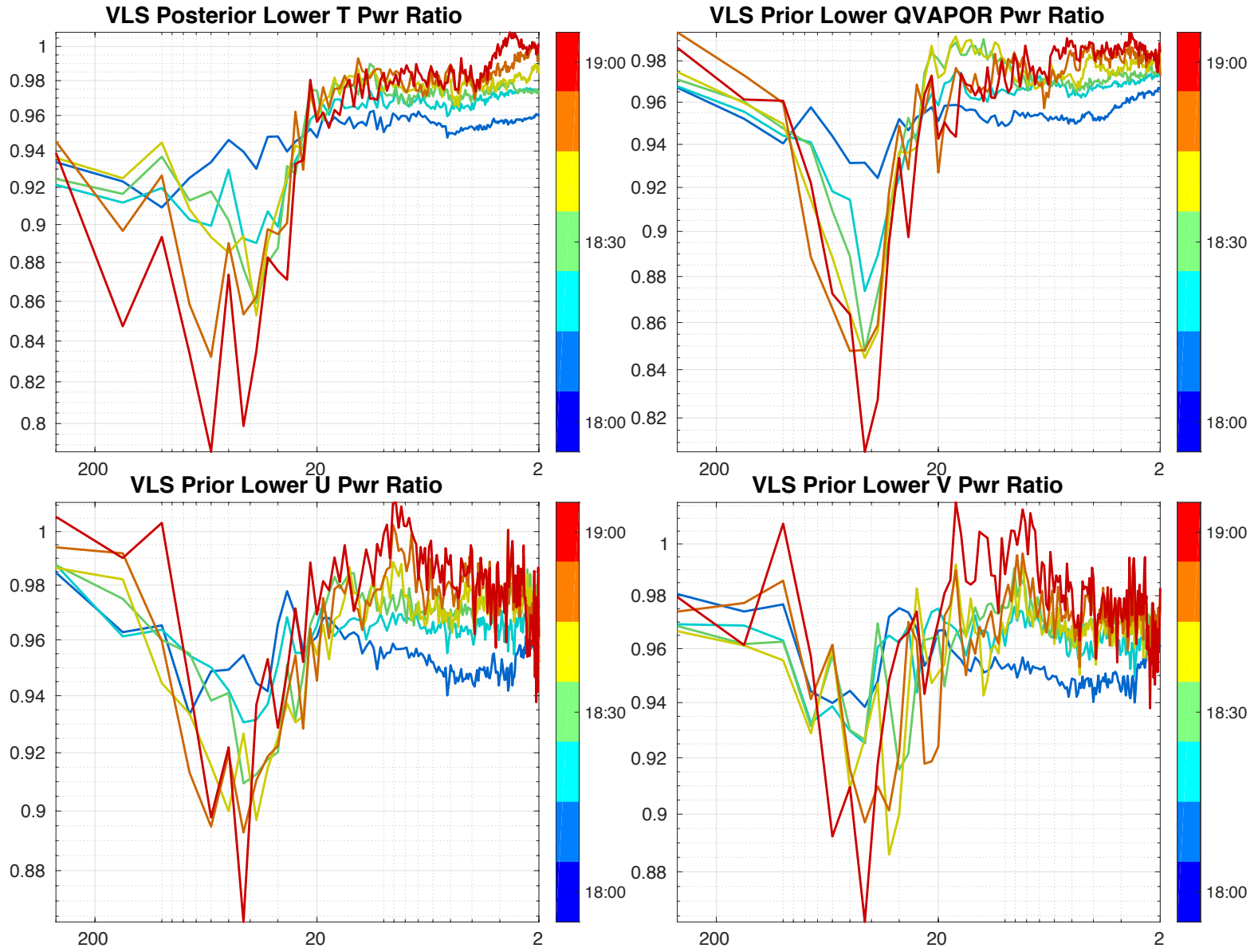
Error Reduction in Different Regions w/ VLOC



Lower vs. Upper Levels



Ratio of Error Power Spectra in Low Levels



Summary

- Applying cloud-adaptive vertical localization in EnKF of infrared radiance can
  - Reduce errors in lower levels in clear region
  - Reduce errors in upper levels in precipitating region
  - Mostly influential in meso-β-scale

- Assimilating infrared radiance using EnKF might benefit CI prediction of thunderstorms

- Ongoing works:
  - Longer extension of EnKF
  - Ensemble forecast and evaluation from EnKF analysis