OU MAP Lab Research

Multiscale data Assimilation and Predictability

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OU MAP LAB

- MAP currently has **17**-members: 1 research scientist, 7 postdoc researchers, 8 graduate students. Still growing!
- Prof. Wang has advised 16 postdocs, 12 Ph.D. students, 10 M.S. students at OU and 4 international visiting students

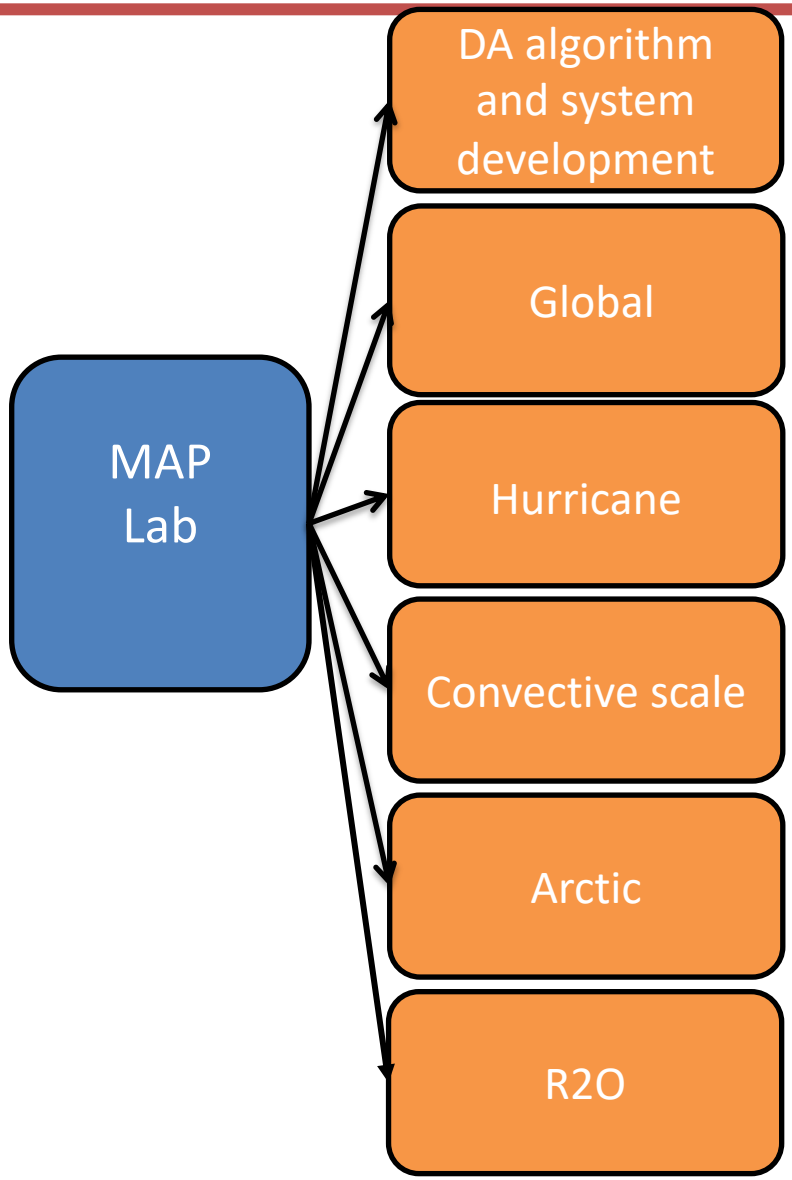
* Denote sample papers led by students/postdocs of MAP lab

MAP Student Awards

- MAP students have won **21**
- **awards**
  - OU Provost Ph.D. dissertation award (1)
  - AMS fellowship (1)
  - SoM best student publication award (5)
  - SoM best student performance award (2)
  - National conference presentation award (7)
  - International/national conference travel award (5)

Prof. Wang Inspires students to be highly curious and highly motivated.

MAP Lab Research Highlights



i) developing **new techniques and novel methodologies** for data assimilation and ensemble prediction;

ii) applying these techniques to **global scale to convective scale** modeling systems **assimilating a variety of observations** (radar, satellite, ground based remote sensing platforms, aircraft borne observations, in-situ, etc.) to **improve numerical prediction** skill;

iii) improving the understanding of atmospheric **predictability and dynamics** through data assimilation and ensemble approaches **from global to storm scales**;

iv) Interfacing between basic research and US NWS operational numerical weather prediction (NWP) or say transitioning research into operations (**R2O**).

Data Assimilation Algorithm and Theory

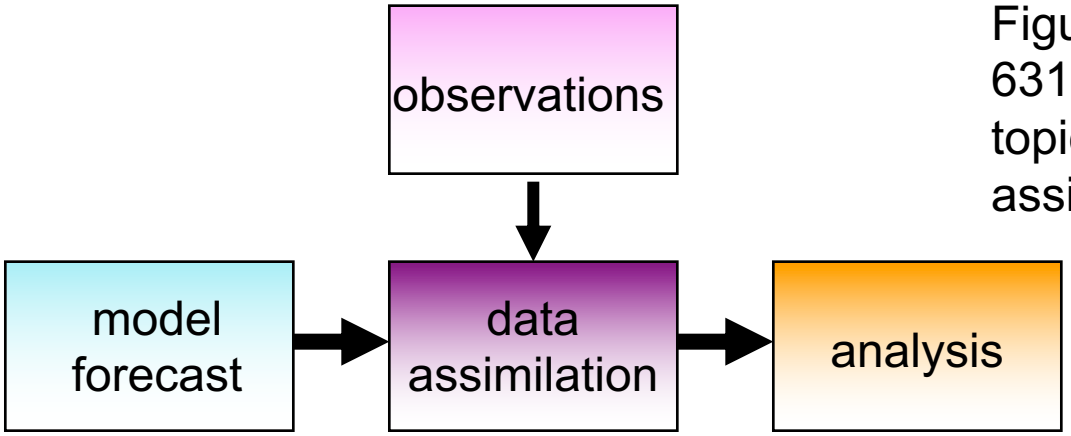


Figure from METR 6313: Advanced topics in data assimilation

- Advanced the ensemble transform Kalman filter (ETKF) theory and algorithm (e.g. Wang and Bishop 2003, Wang et al. 2004, Huang et al. 2018)

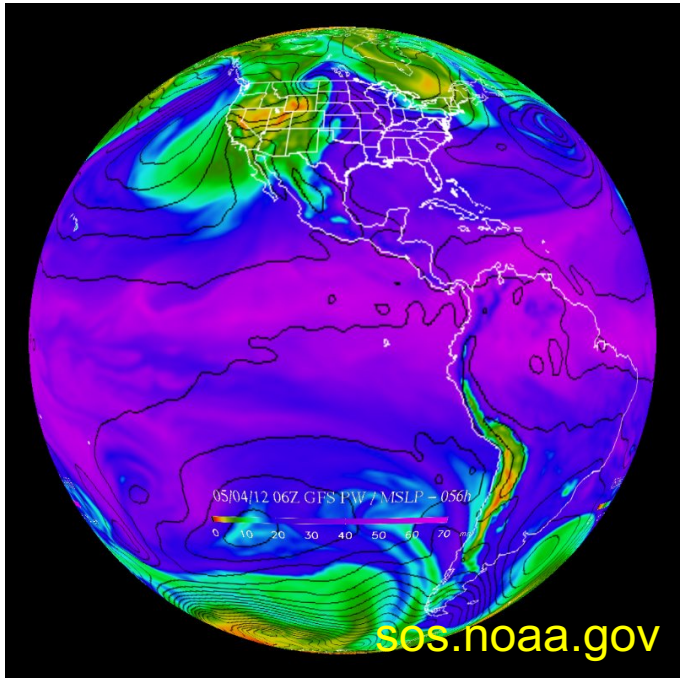
- Advanced hybrid ensemble-variational (EnVar) data assimilation theory and algorithm (Wang et al. 2007, 2008ab; Wang 2010, Wang and Wang 2017, Huang* and Wang 2018; Kay* and Wang 2019)

Global data assimilation and NWP

- Multi-institutional collaborative efforts (NOAA, NASA, OU MAP lab) on the development of the hybrid data assimilation system based on the US NWS operational data assimilation system GSI.

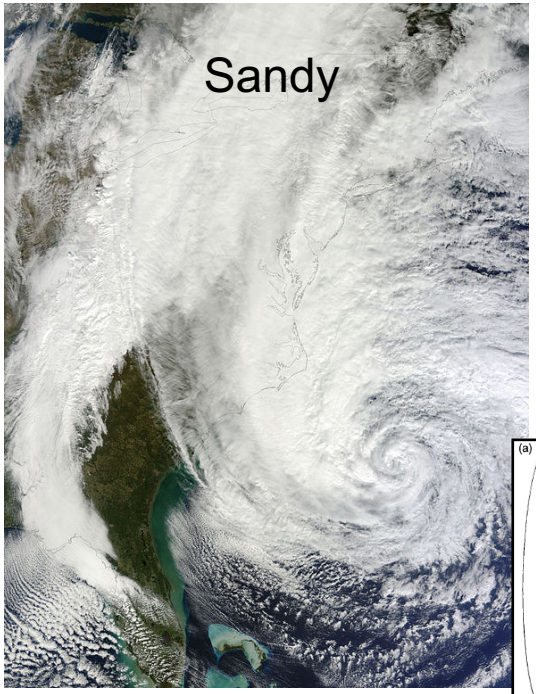
- This collaborative effort led to ***operational implementation of the 3D and 4D hybrid data assimilation system for US NWS global NWP system GFS*** in 2012 and 2014 respectively.

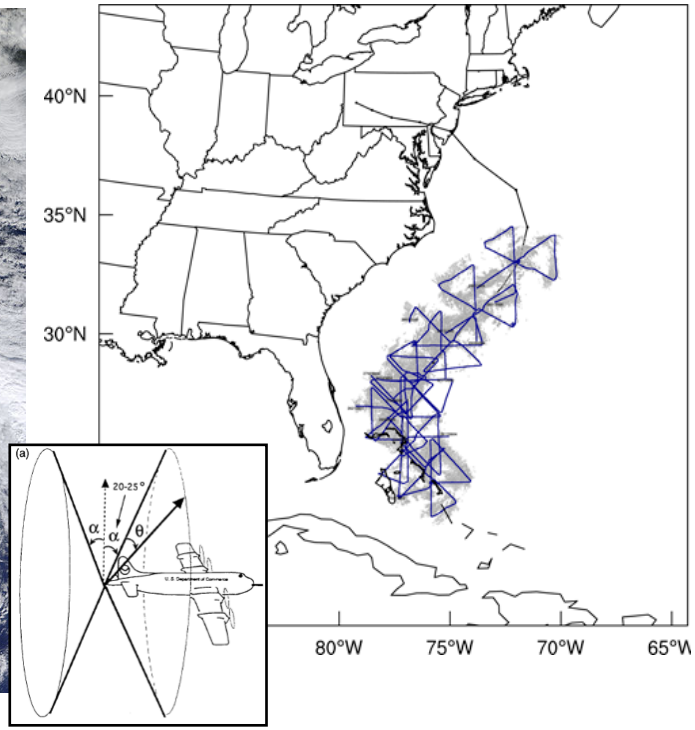
- Research revealed how and why the hybrid system improved global and hurricane track forecasts (e.g., Wang et al. 2013; Wang and Lei* 2014)

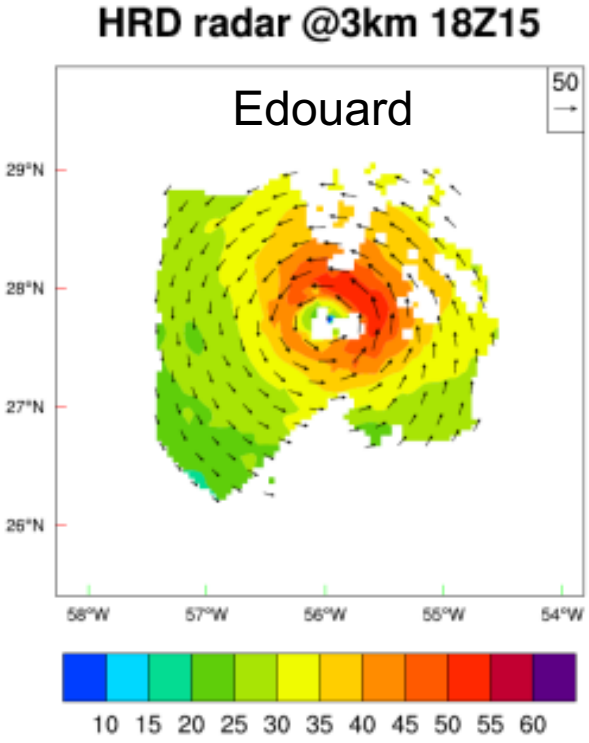


Convection allowing hurricane data assimilation

- **Developed fully cycled GSI hybrid data assimilation system for US operational convection allowing hurricane prediction system HWRF (**Lu* et al. 2016, 2017; Davis* et al. 2019)
- ***The new DA system for HWRF became operational at NWS summer 2017, influencing US real time numerical prediction of hurricanes*.**







What are the impacts of variety of new observations?

Patricia (2015) 12-h forecast

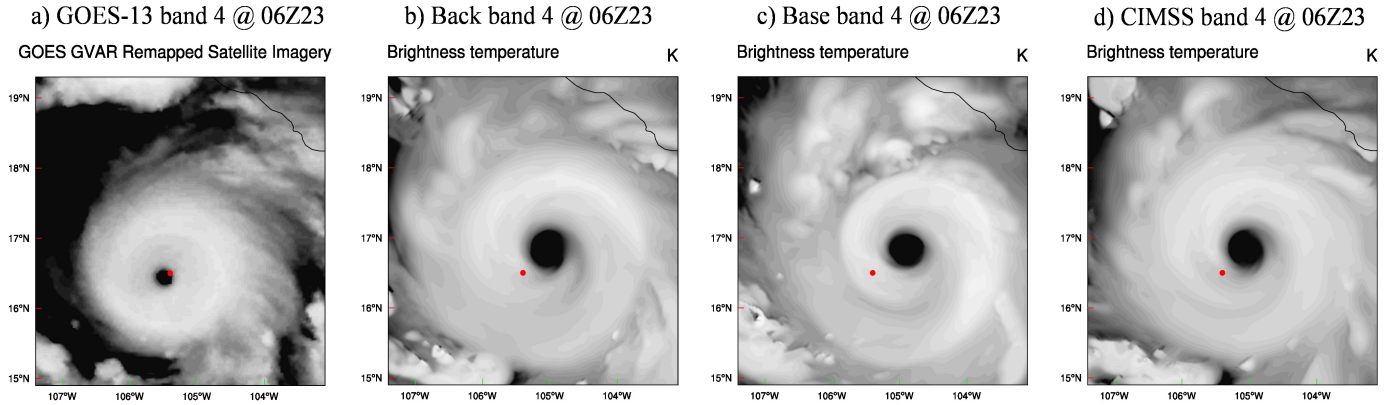
Lu* and Wang, 2019a

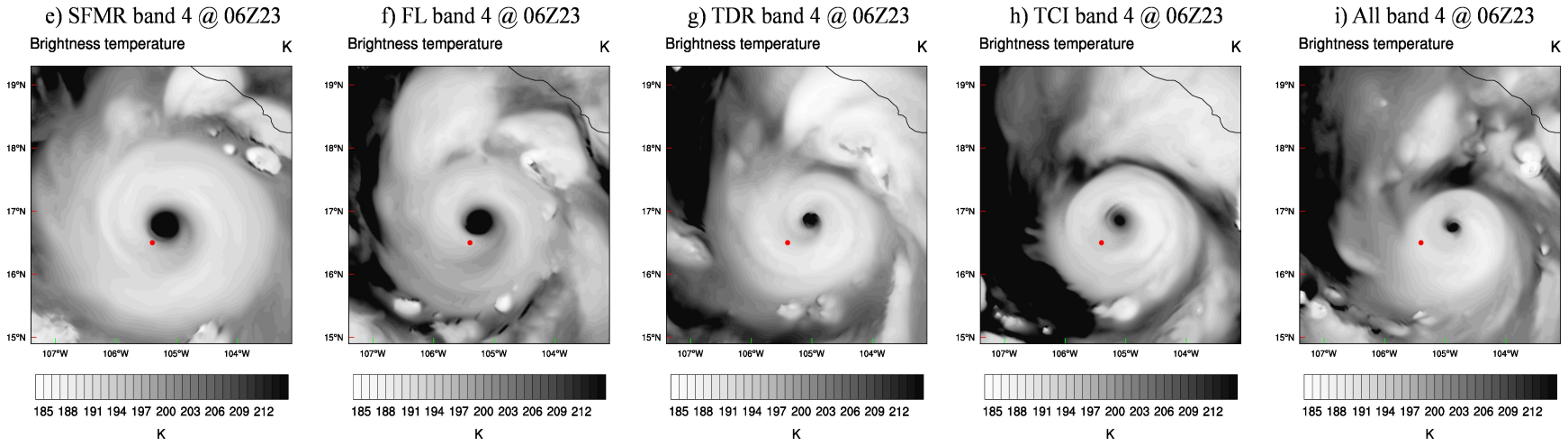
GOES-13

Back

Operational obs.

CIMSS AMV





SFMR

FL

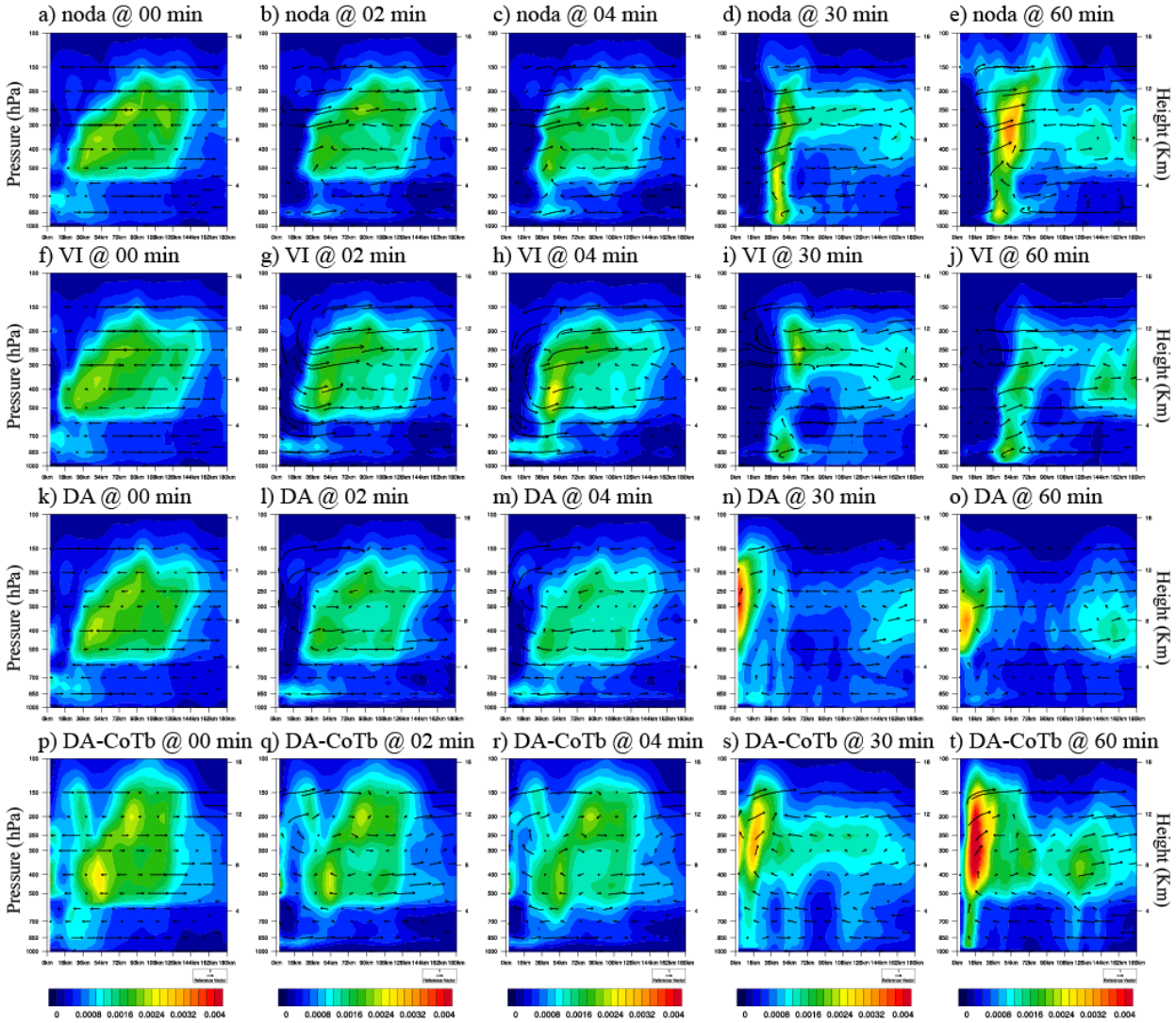
TDR

TCI drop.

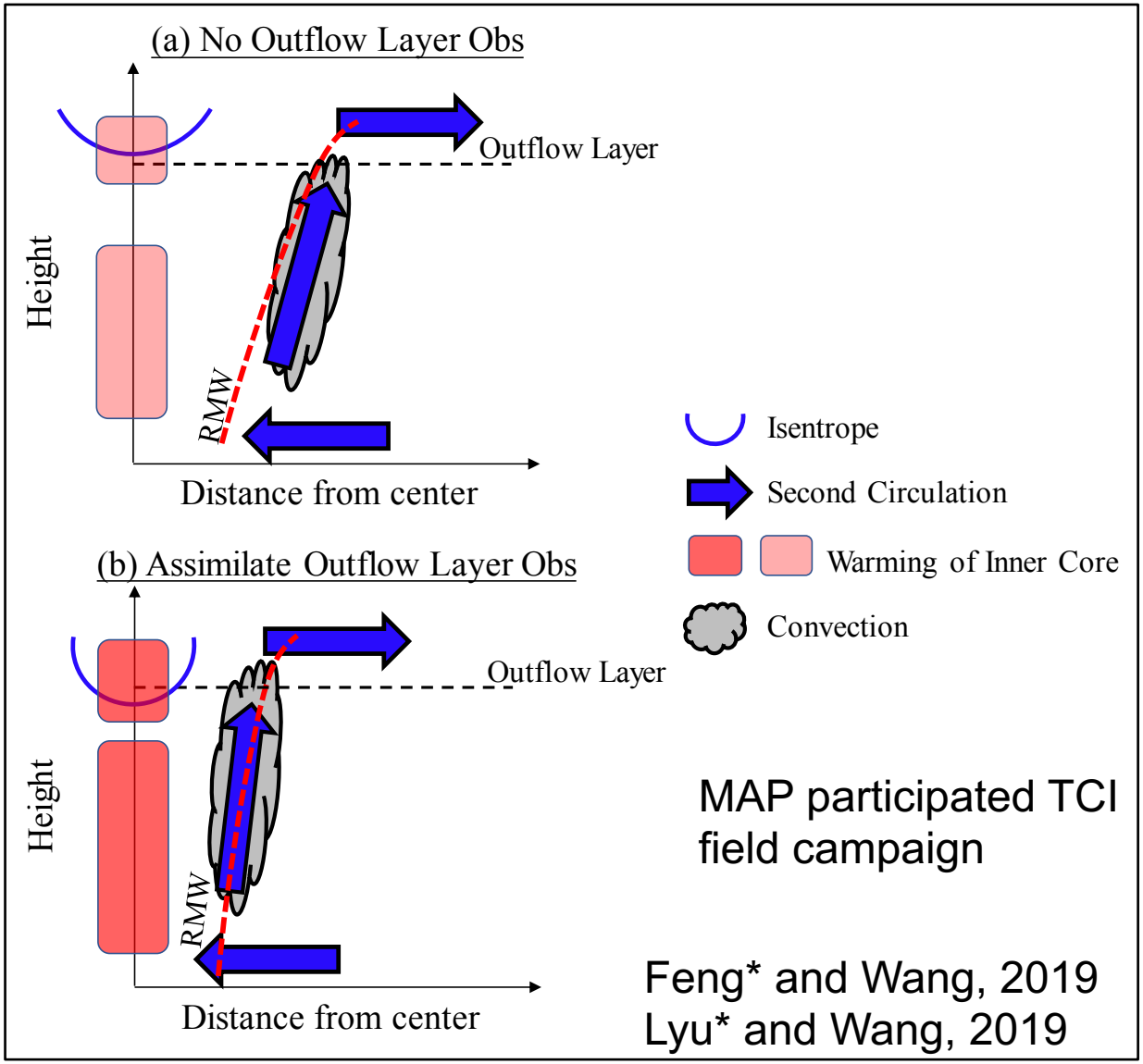
ALL

What is the issue in model physics?

Lu* and Wang, 2019b

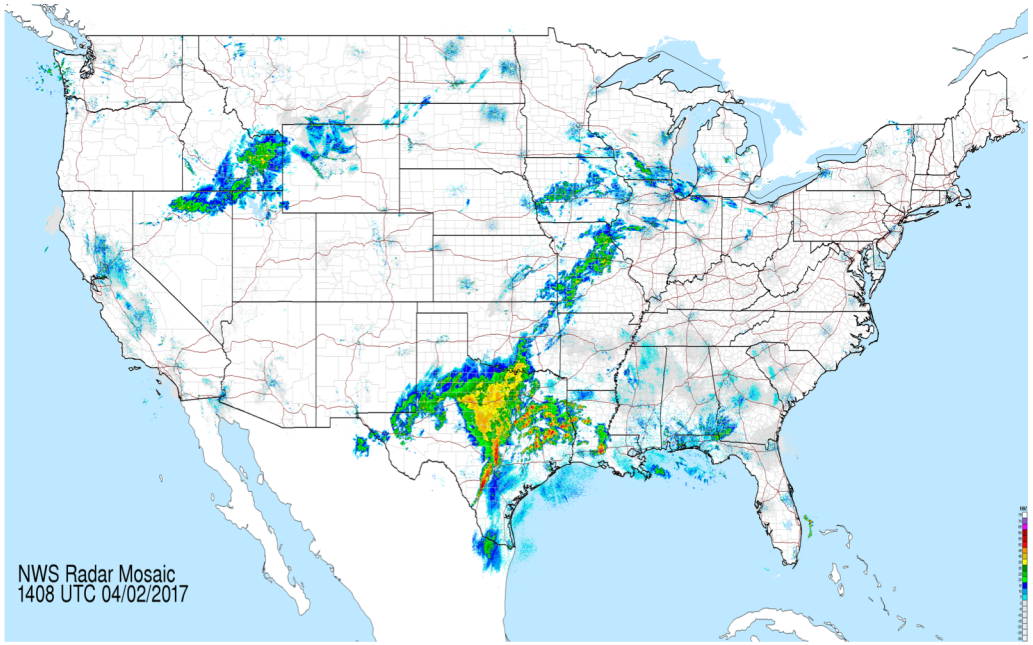


What is causing rapid intensification of hurricane?

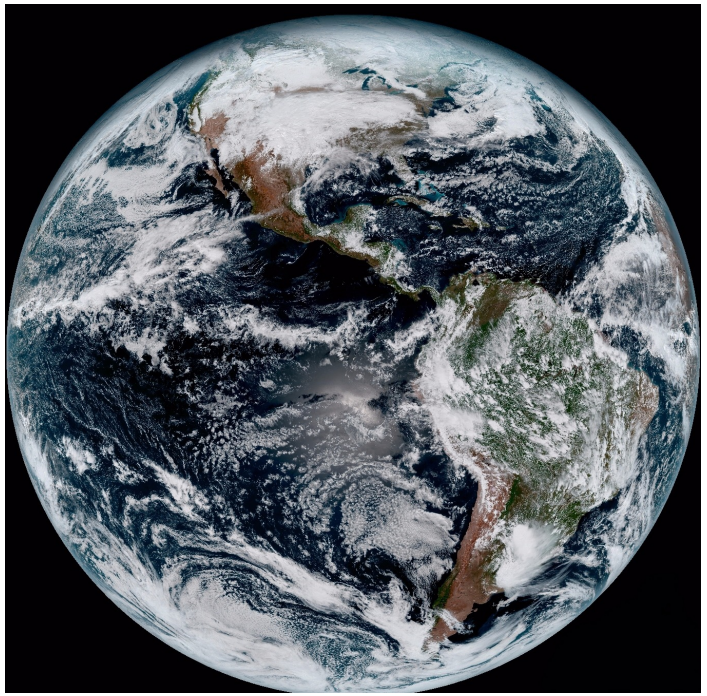


High resolution, voluminous observations for convective scale data assimilation

Ground based radar

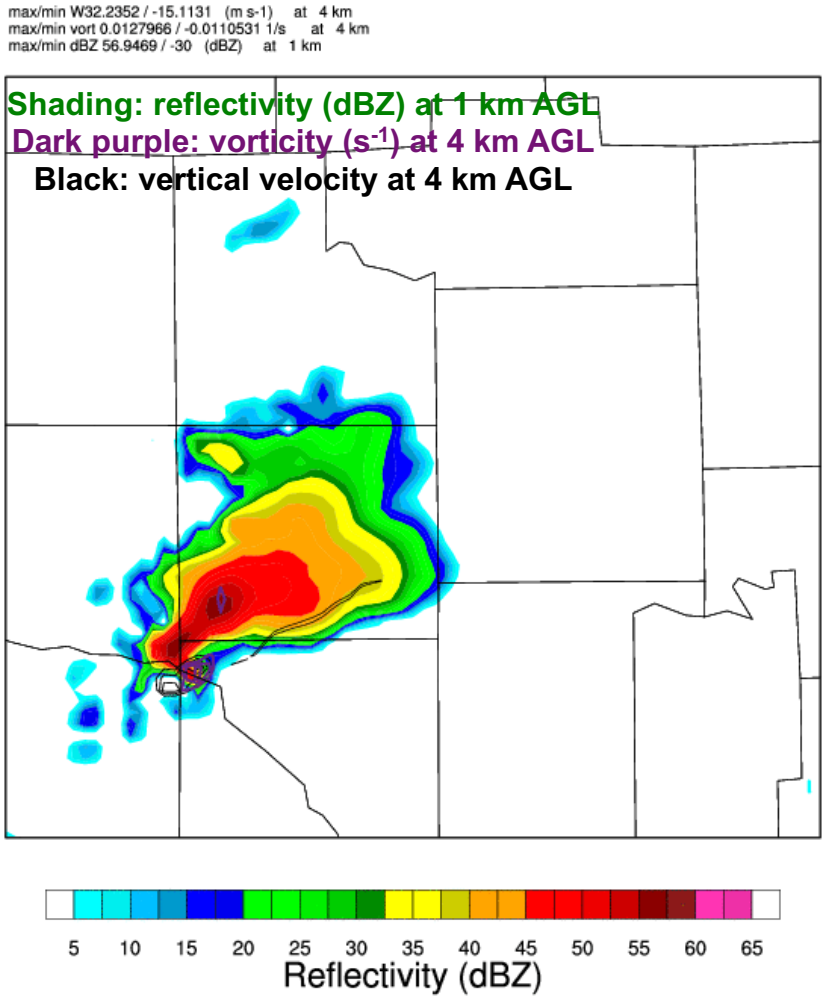


GOES-16



https://www.nasa.gov/feature/goddard/2017/goes-16-sends-first-images-to-earth

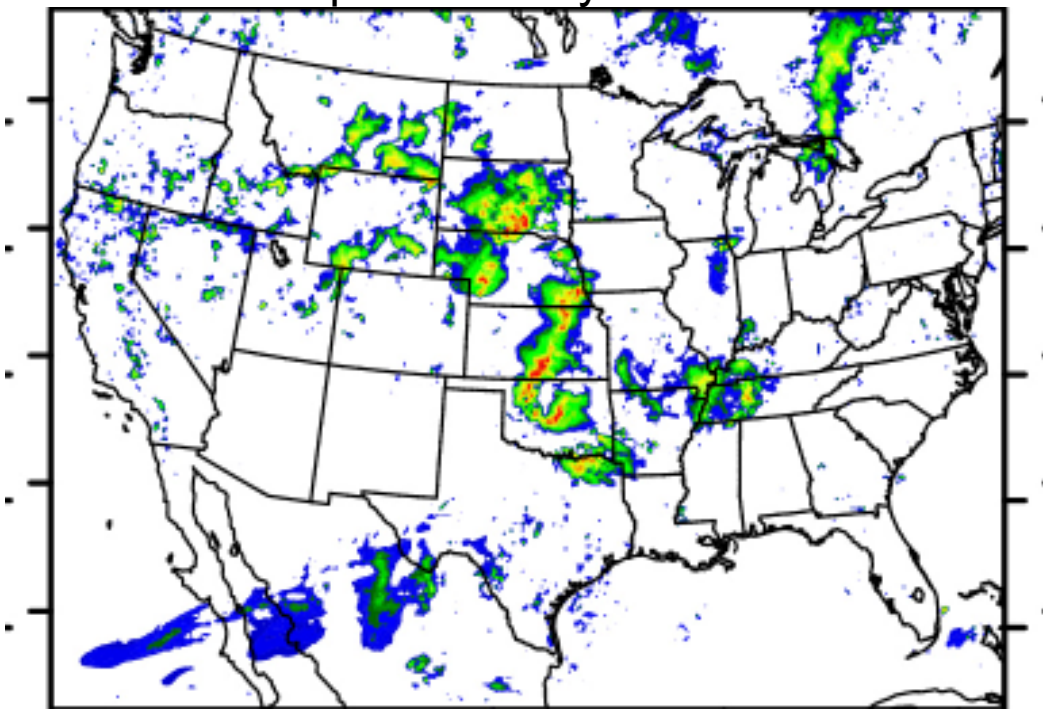
May 8th 2003 OKC Tornadic Supercell data assimilation and prediction



- A new radar data assimilation algorithm is developed and implemented in the US NWS GSI hybrid DA system (Wang* and Wang 2017)
- May 8th 2003 case animation: simulated tornado producing supercell follows the observed tornado track and maintains the strong updraft and vorticity over 1-hour forecast period.

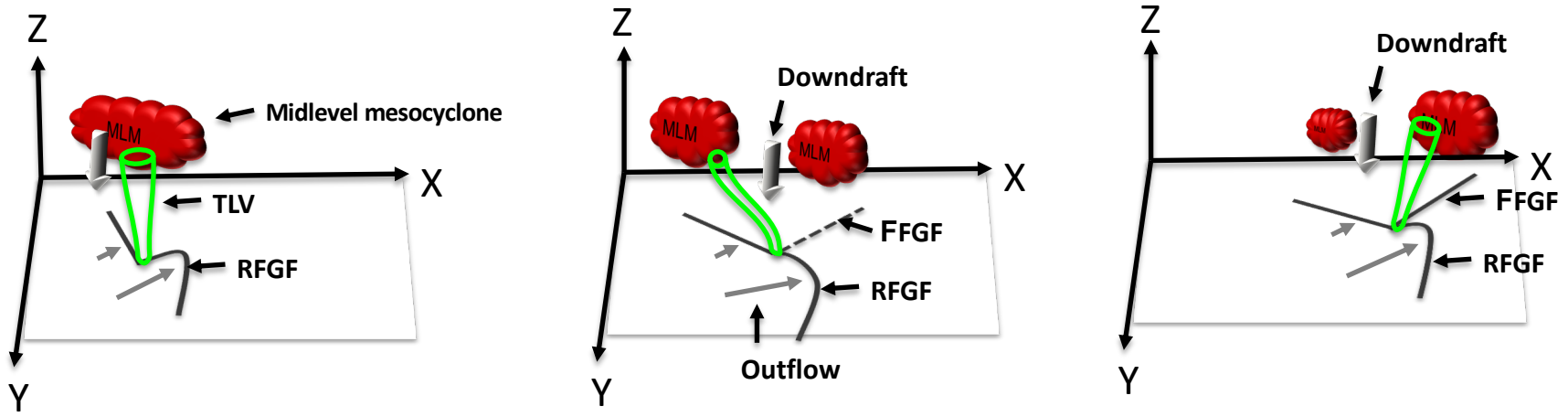
Development of hybrid data assimilation system to improve convective scale prediction over the CONUS

May 25, 2016 convection-allowing prediction by MAP



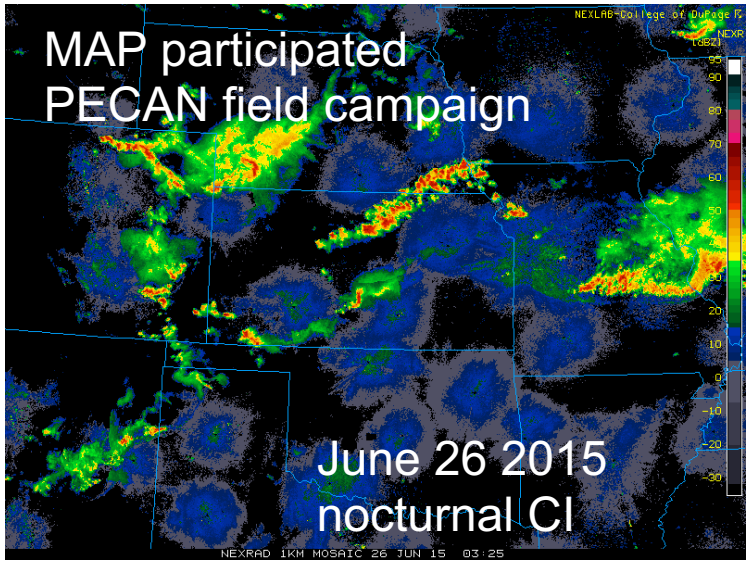
- Develop and implement new radar data assimilation algorithm to improve CONUS wide convective scale prediction
- New radar reflectivity method is found to improve precipitation forecast compared to the operational cloud analysis (Duda* et al. 2018)
- ***This new radar DA system is expected to be adopted by the US NWS to improve the nation's operational convective scale numerical prediction***

Improving the understanding of tornadic supercell dynamics using DA



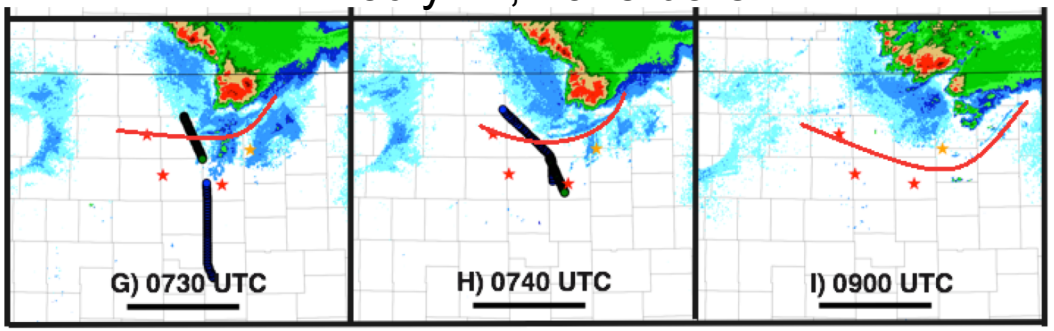
Wang Y. and X. Wang 2018

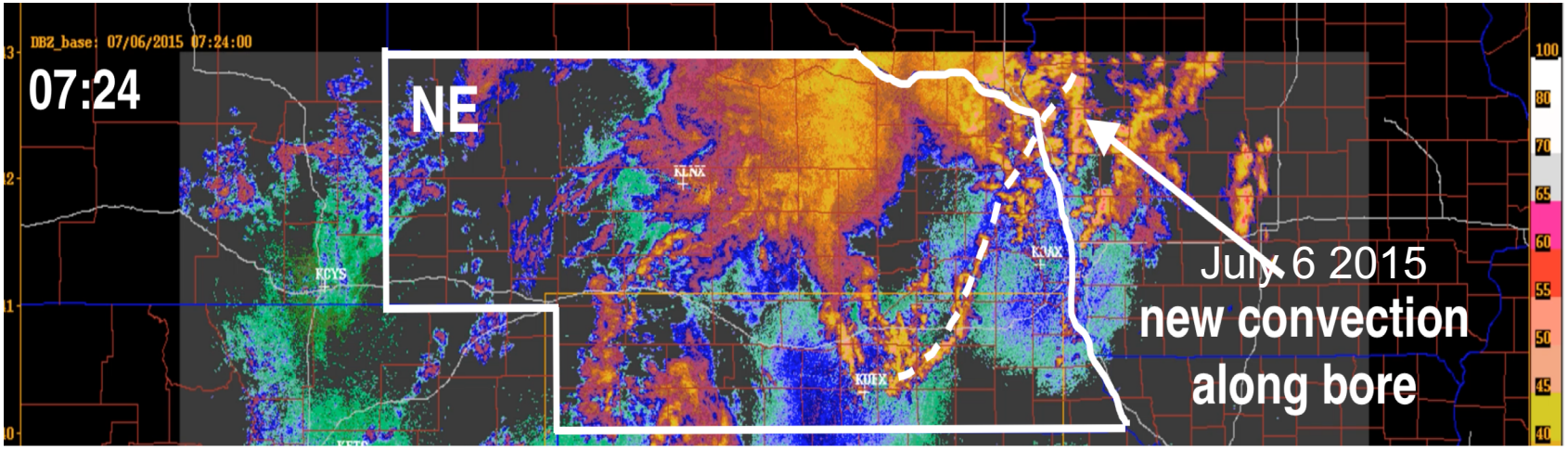
Understanding and improving the prediction of nocturnal convection



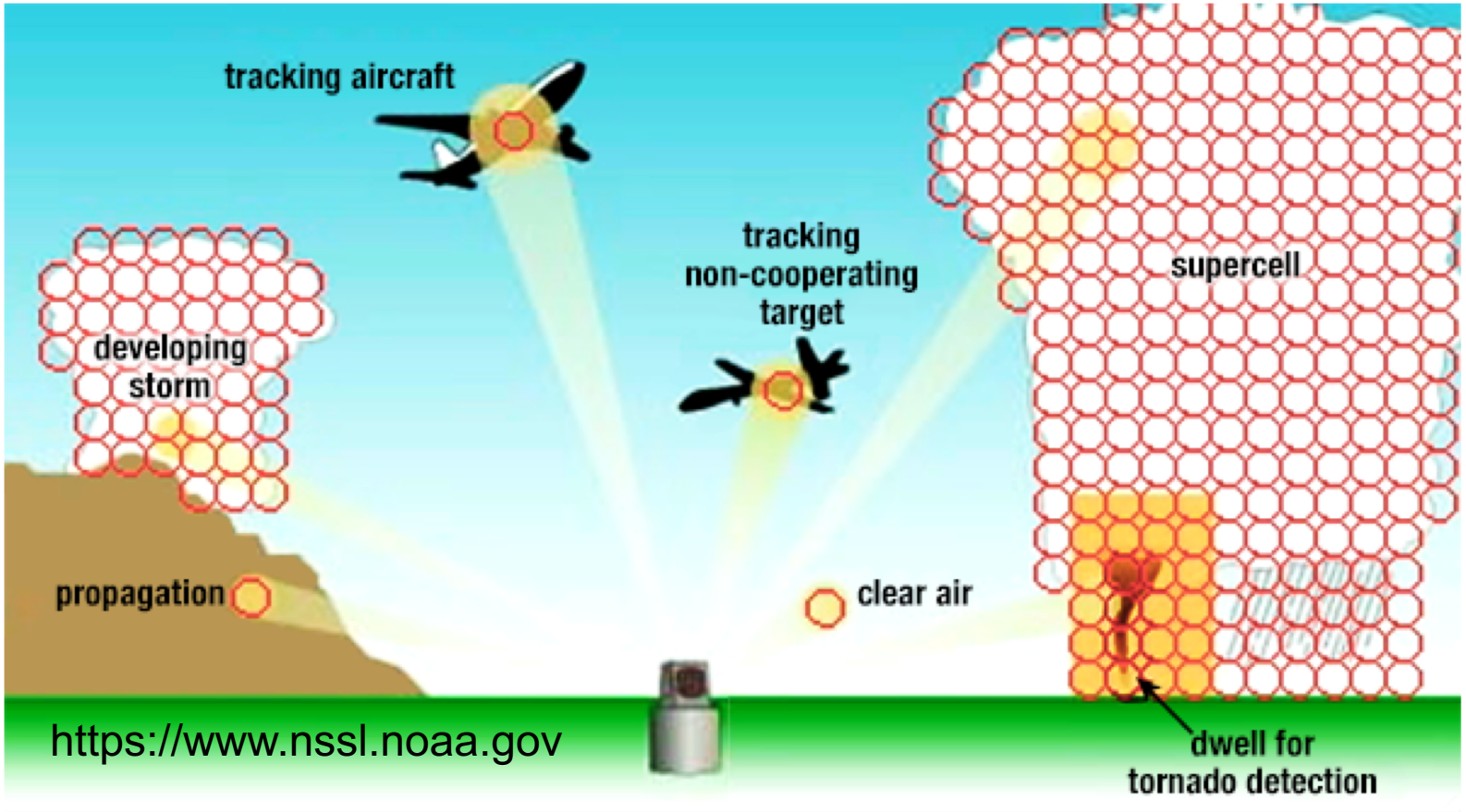
Johnson* et al. 2018, Degelia* et al. 2018, Chipilski* et al. 2018

July 11, 2015 bore





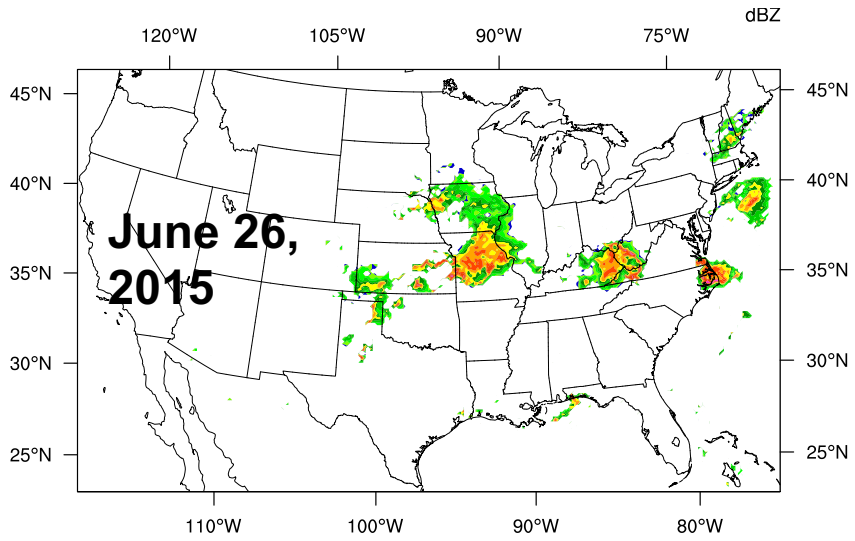
Assimilate observation from advanced remote sensing platforms

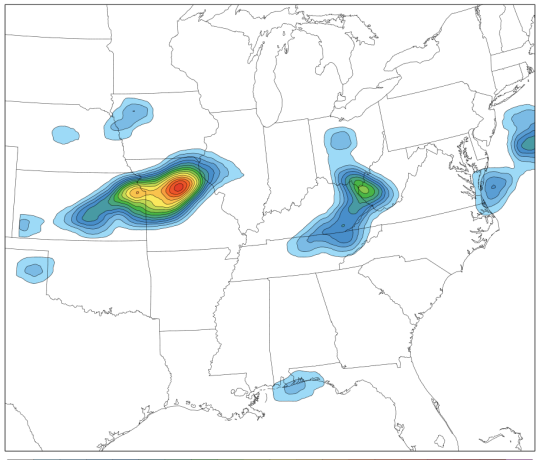


Study convective scale “targeted observations” for multi-function phased array radar (Kerr* and Wang 2018)

Ensemble Prediction

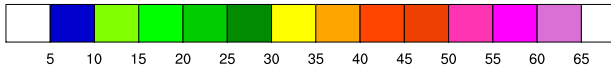
- How to optimally design the ensemble to effectively sample the errors in the numerical forecasts?
- How to generate, calibrate and evaluate the probabilistic forecasts?

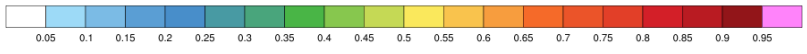




Probabilistic forecast of reflectivity

dbz





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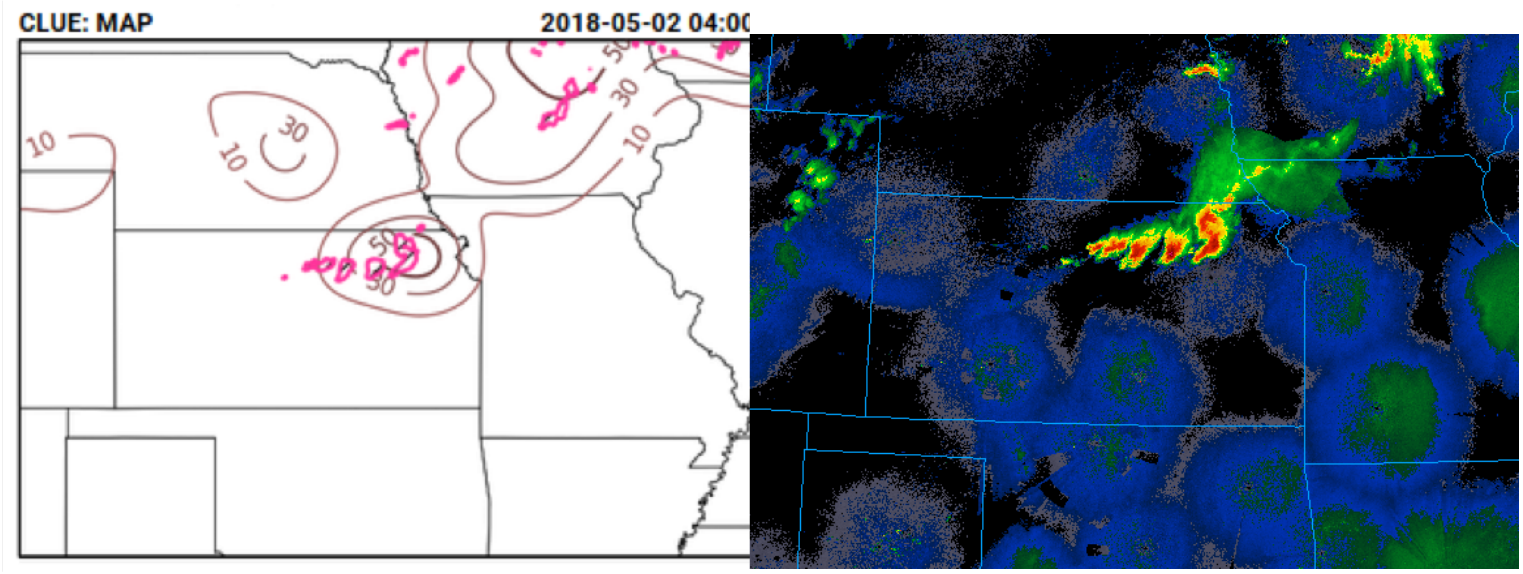
Johnson* et al. 2011ab, 2013,2014; Johnson* and Wang 2012, 2013, 2016; Gasperoni* et al. 2018

OU MAP 2018 HWT real time CONUS multiscale GSI based EnVar DA (with direct radar reflectivity assimilation) and ensemble forecast

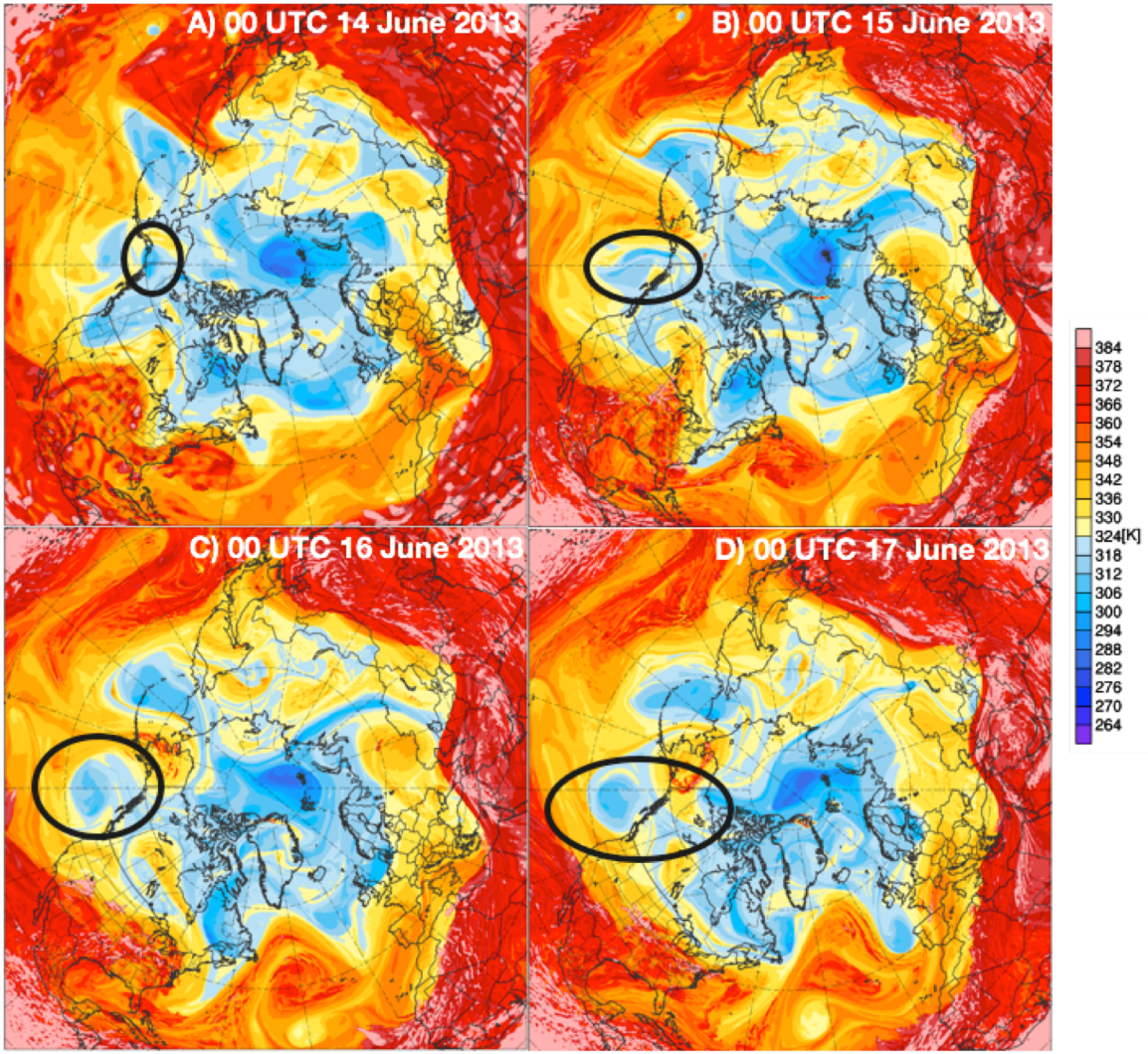
http://weather.ou.edu/~map



https://hwt.nssl.noaa.gov

The 27-h forecast initialized at 0000 UTC 1 May 2018.

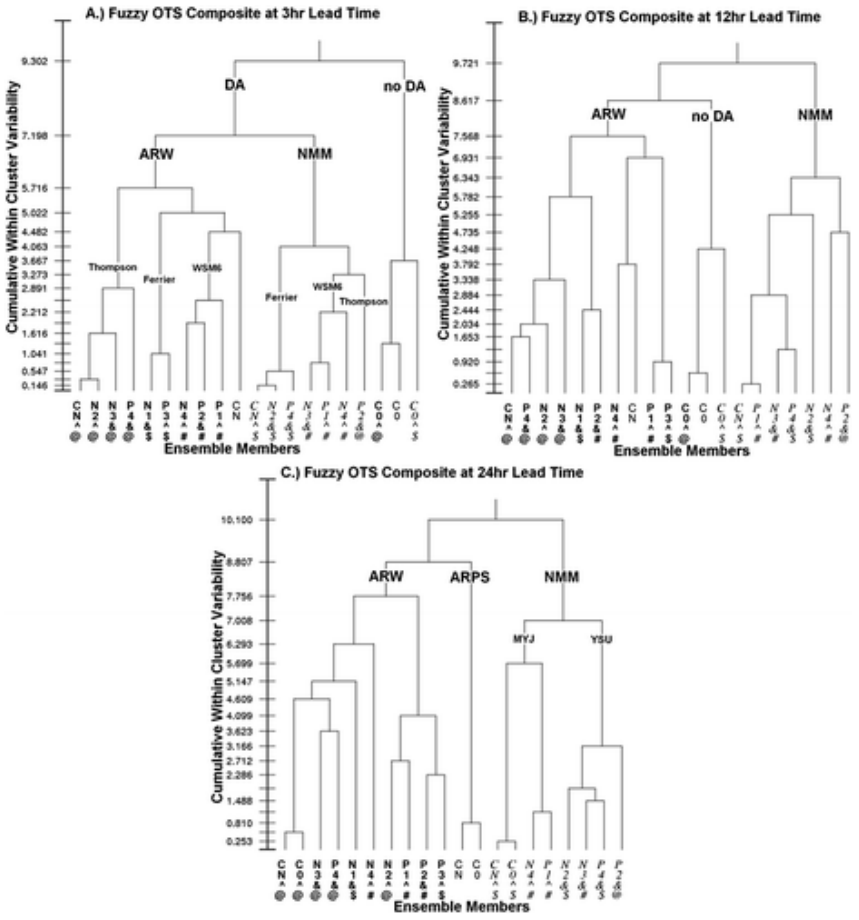
Data Assimilation for Numerical Prediction of Arctic Weather



Johnson* and Wang 2018

Interdisciplinary research

- Hydrological data assimilation
- Machine learning and data mining
- Economic value of numerical weather forecast
- Etc.



Johnson* et al. 2011ab

MAP Fun Activities

MAP Fall Outing 2017

MAP Spring Outing 2018

Opportunities

Please contact Prof. Xuguang Wang for opportunities to join MAP!

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