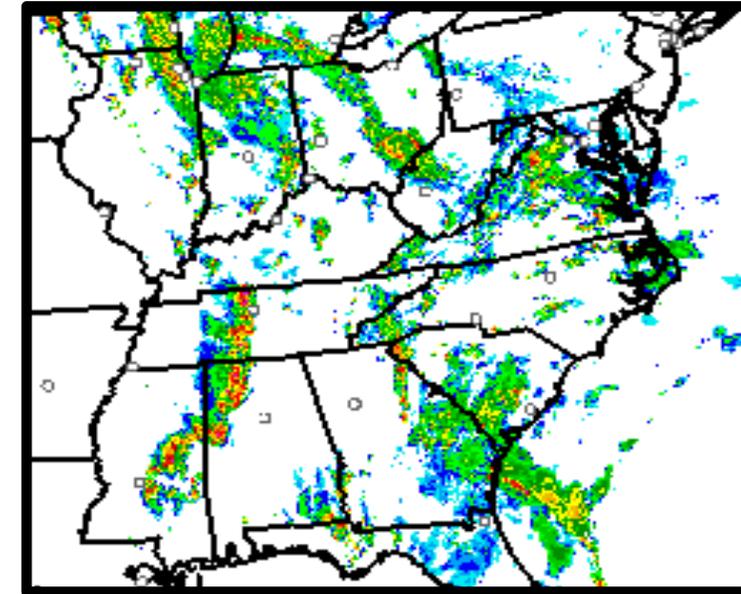




# NOAA Weather Modeling Analysis and Forecast Unification

Terra Ladwig, Curtis Alexander,  
Steve Weygandt, Stan Benjamin,  
and the RAP/HRRR development  
team at GSD

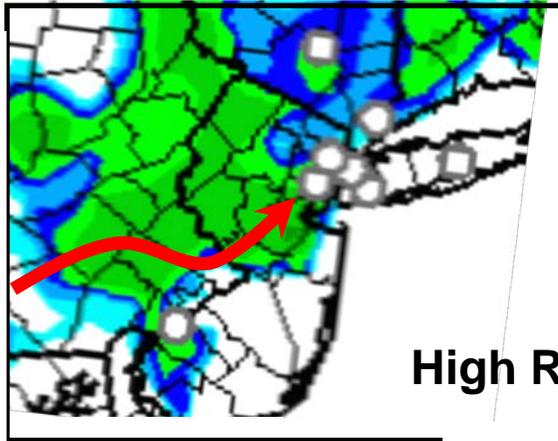
NOAA/ESRL  
GLOBAL SYSTEMS  
DIVISION



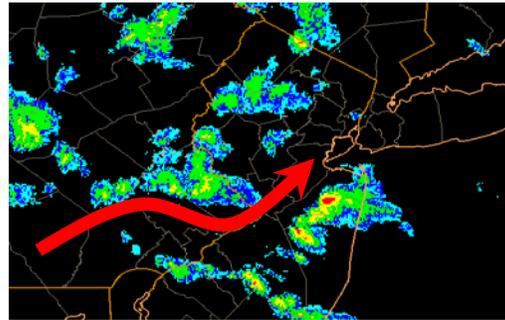
# Weather Data for Tactical and Strategic Aviation Decisions

Major progress in past 10 years for short-range prediction of atmospheric convection and other localized phenomena

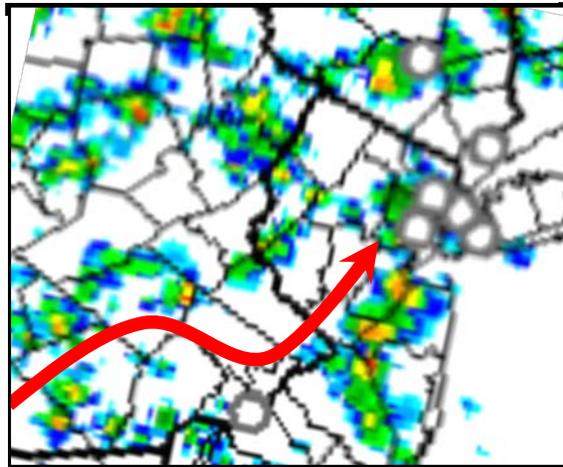
Rapid Refresh (RAP)



Radar Observations



High Resolution Rapid Refresh (HRRR)



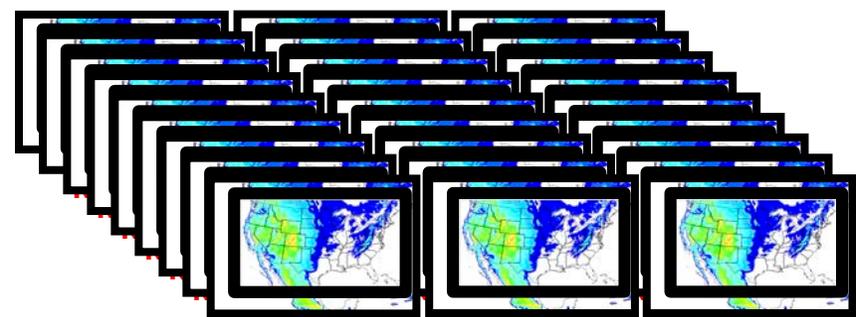
13-km parameterized  
Convection

3-km explicit  
Convection

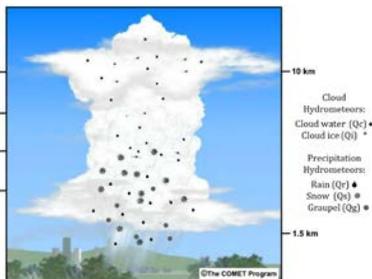
1. Final RAP/HRRR Implementation → June 2020
2. NOAA Analysis Unification → RTMA-3D
3. NOAA Forecast Unification → RRFS

# HRRR version 4 Improvements

## New Ensemble Data Assimilation



## More Accurate Physical Parameterization



## Improved Analyses

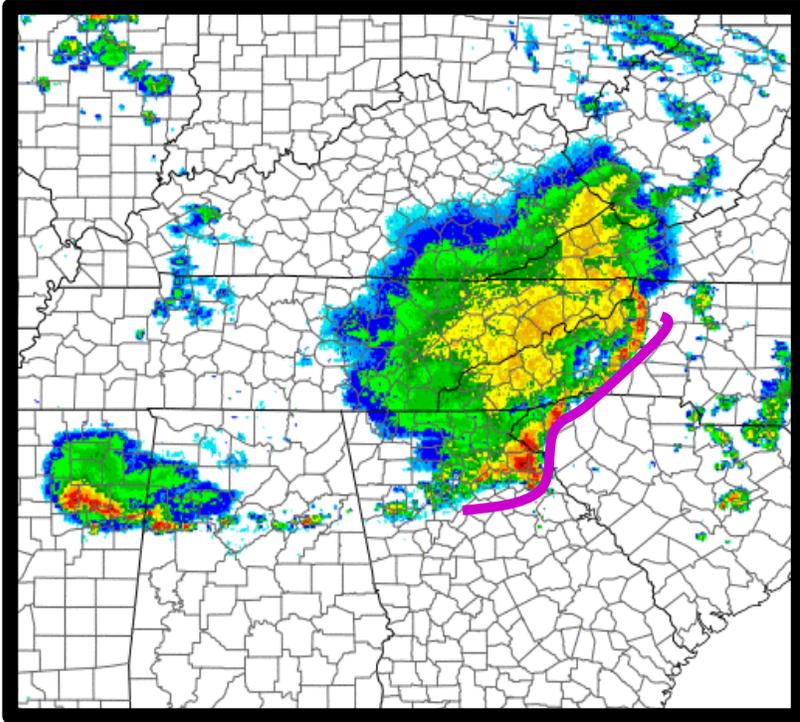


## Improved Forecasts

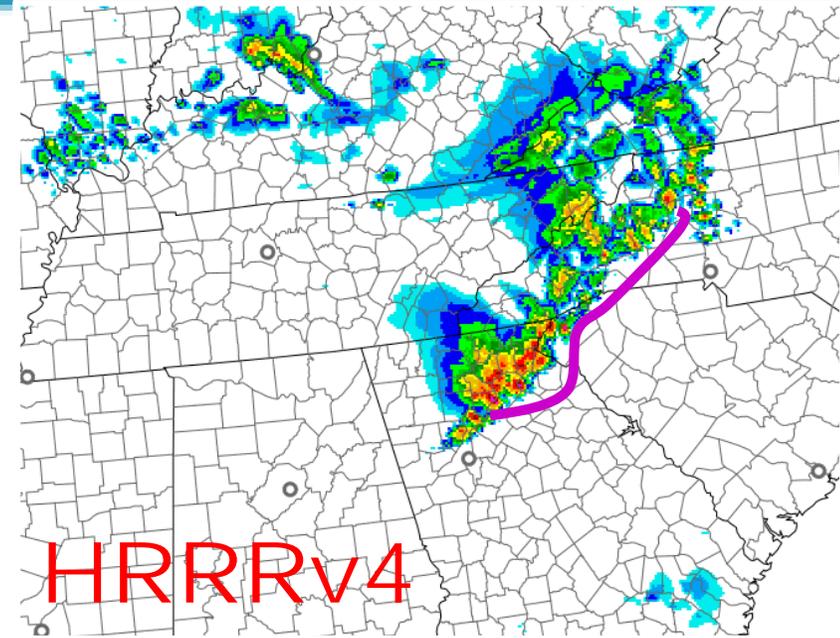


# HRRR version 4 Forecast Improvement Example

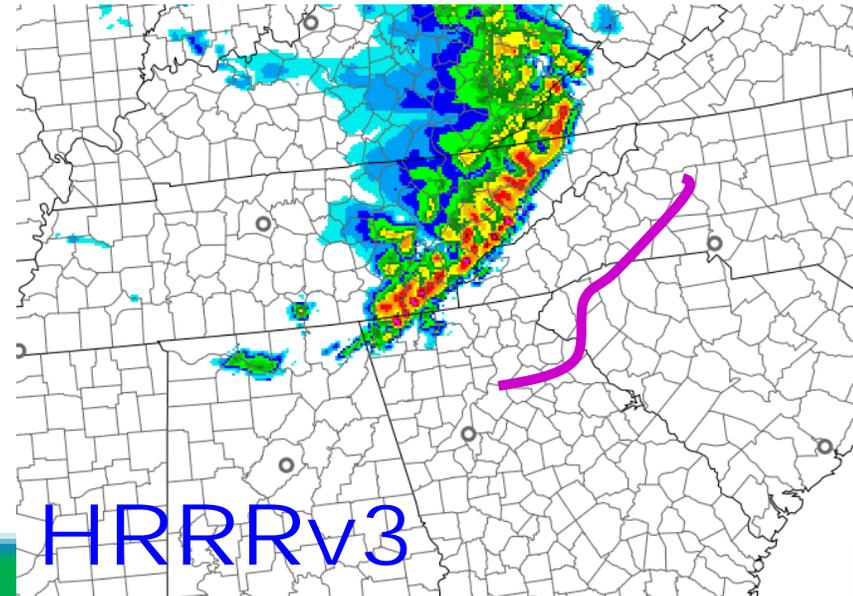
Radar observations  
06z 22 June 2019



18h Forecasts



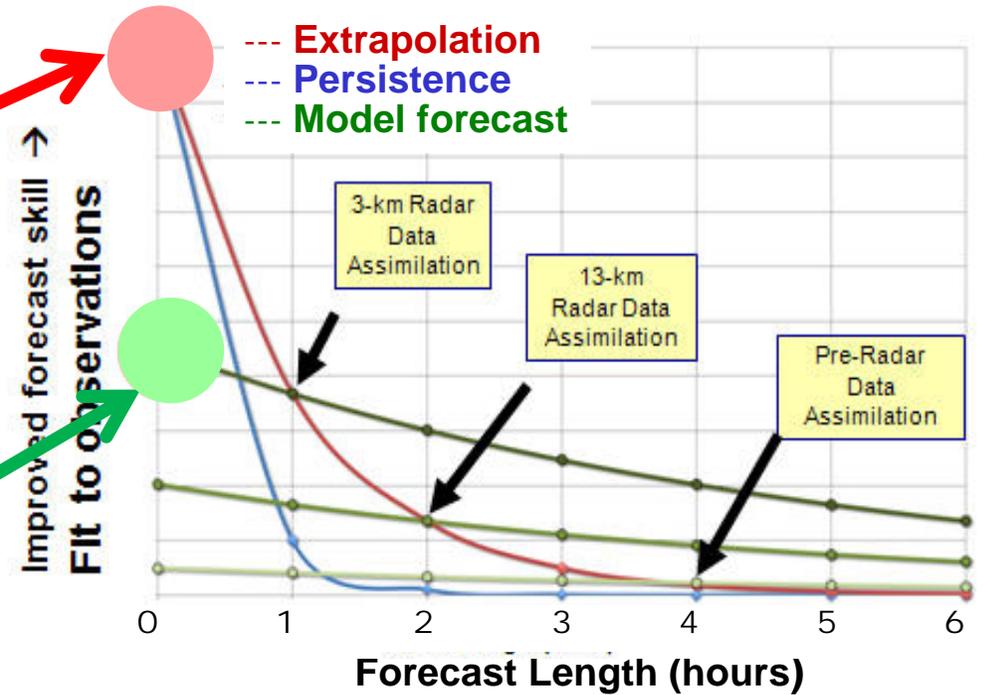
HRRRv4



HRRRv3

1. Situational Awareness, Nowcasting
  - Close “fit” to all QC’ed observations
  - RTMA-3D

2. Initial Conditions for a hydrodynamic model
  - Multivariate balance for max forecast skill
  - RRFS



The RTMA-3D is a landing spot for aviation analysis tools

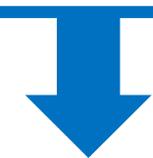
Development is ongoing toward a high resolution, 3D full-atmospheric analysis / nowcast system that will replace / use input from many existing analysis / nowcast products

- RTMA-3D will provide rapidly updated (~15 min) gridded analysis of 3D atmospheric fields
- Use existing observational inputs (surface, aircraft, radar, snocover, etc.), add new sources
- HRRR background for analysis
- Most accurate analysis (fit to observations) for NOWCASTING applications
- Early prototype:

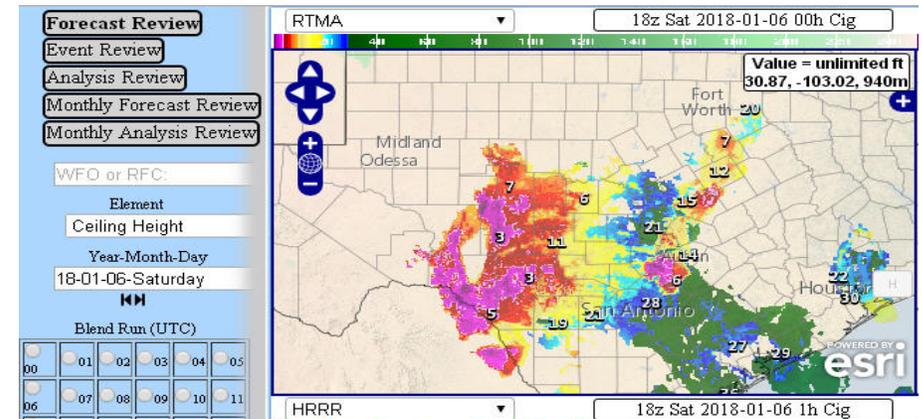
<https://rapidrefresh.noaa.gov/hrrr/HRRRrtma/>

*Some existing analysis products*

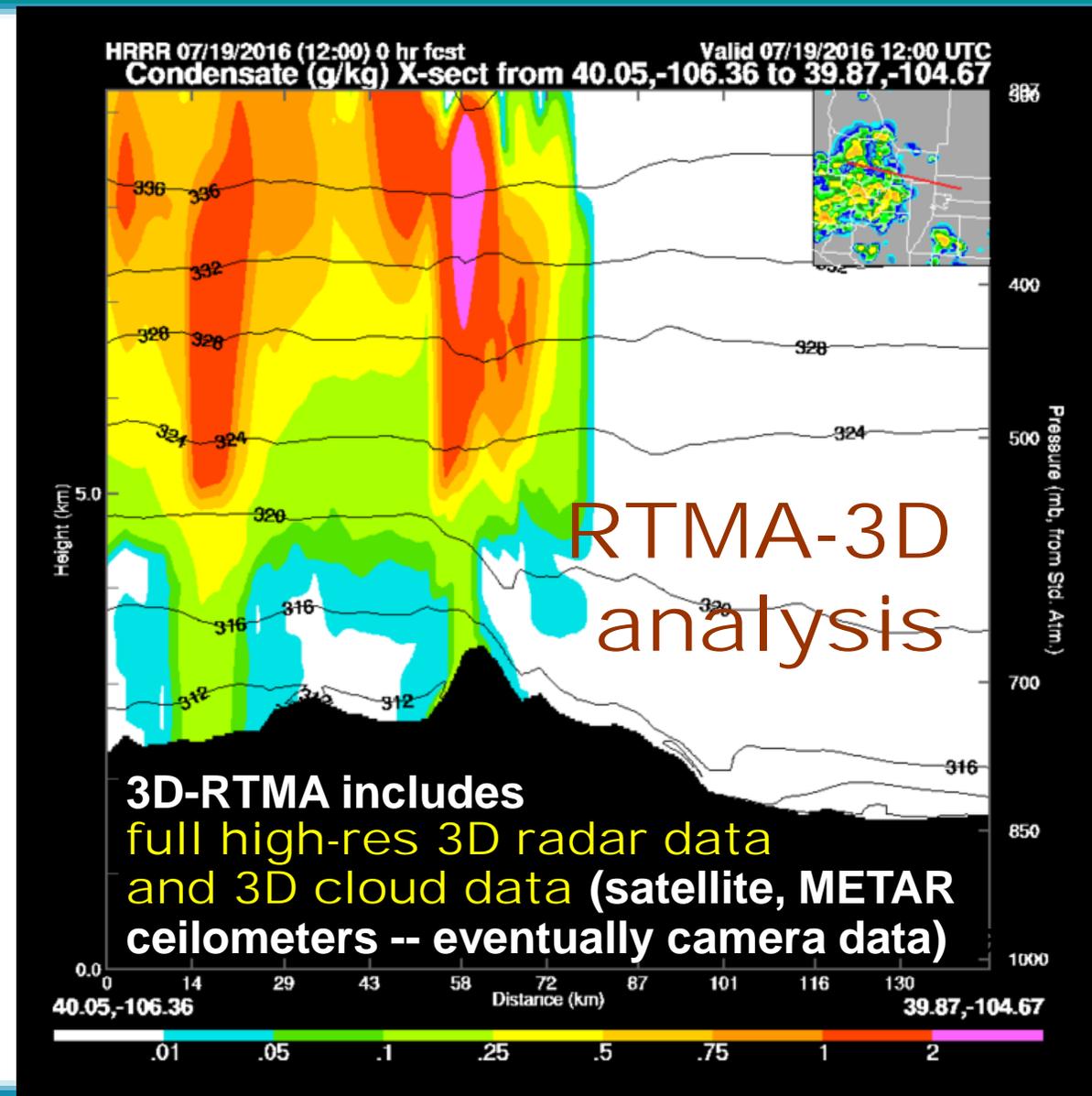
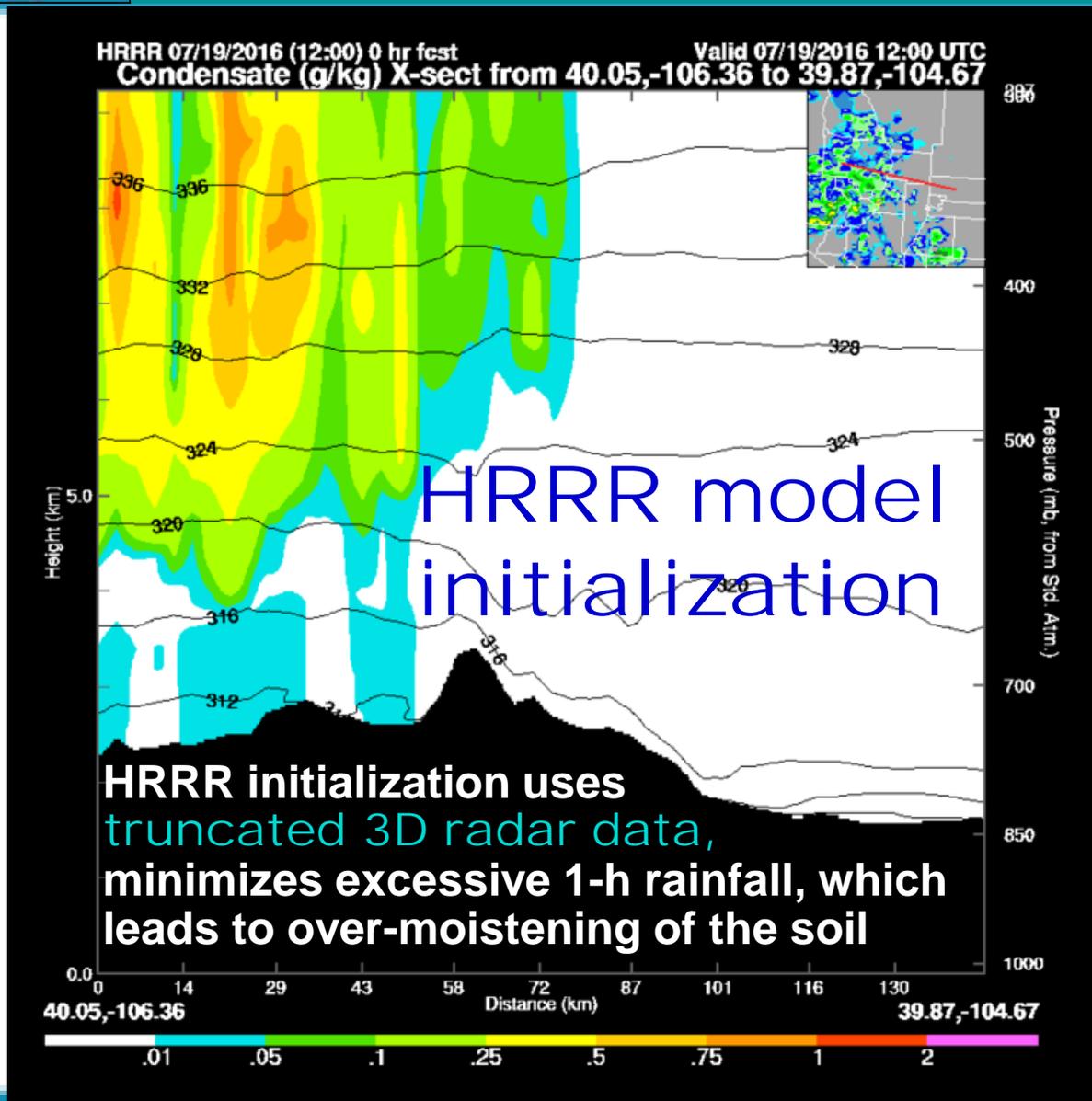
2D (surface) RTMA  
 MADIS analysis  
 SPC “sfcOA” analysis  
 NOHRSC snow analysis  
 MRMS radar mosaic



**3D-RTMA**



**RTMA ceiling in National Blend of Models Viewer**



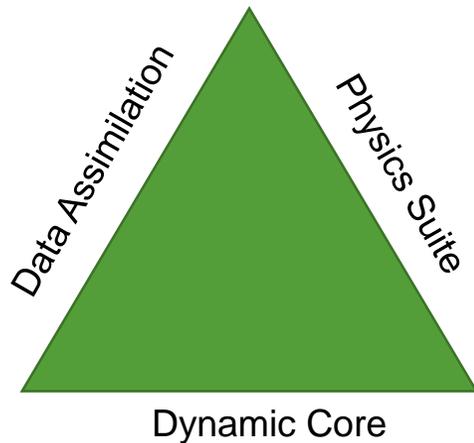
# UFS What is it?



<http://ufs.rap.ucar.edu/index.html>

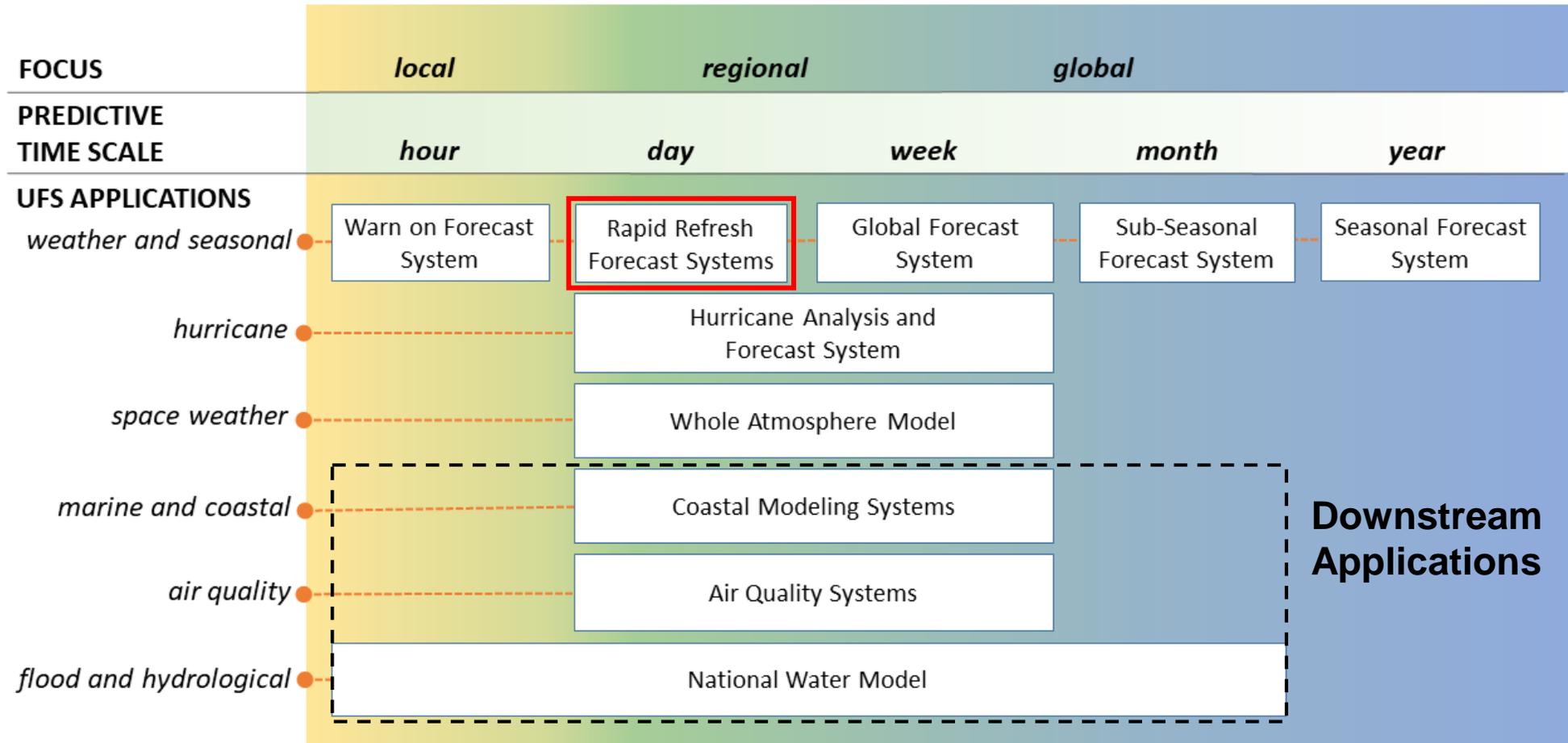
The Unified Forecast System (UFS) is a:

- community-based, coupled, comprehensive Earth modeling system
- numerical applications span local to global domains
- predictive time scales from sub-hourly analyses to seasonal predictions
- designed to support the [Weather Enterprise](#)
- the source system for [NOAA](#)'s operational numerical coupled prediction applications



Increasingly modular components  
Agnostic interactions through enabling software technologies

# UFS Applications (draft)



Rapid Refresh Forecast System → To replace HREF, HRRR, NAM + nests, HiResWs

## RRFS Vision:

- Convective Allowing Model using UFS & Mesoscale Physics
- Rapidly Updating (hourly, sub-hourly?)
- Deterministic & Probabilistic Guidance for Weather Hazards

GSD committed to

- transition of all rapid refresh aviation hazard prediction technologies to FV3 SAR system to ensure
- no degradation of prediction skill and working with users of gridded fields to
- ensure a smooth transition to FV3 for aviation hazard guidance products (icing, turbulence, C&V, etc.)

# Approximate Timeline → Rapid Refresh Forecast System

\*Timeline may be revised as development matures/progresses\*

RAPv5/HRRRv4  
Implementation

Development Continues  
ensemble DA + forecast system

Q3FY20

FY21

FY18/19

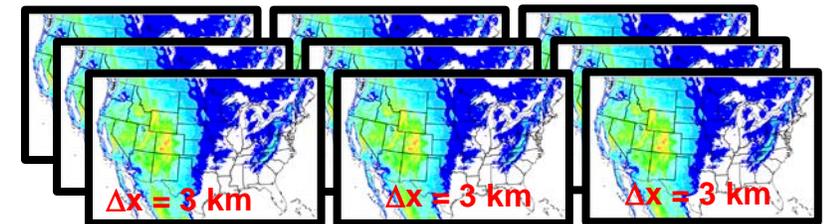
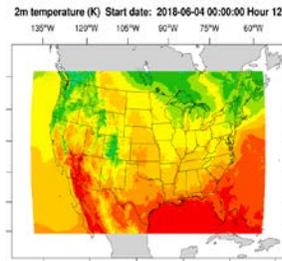
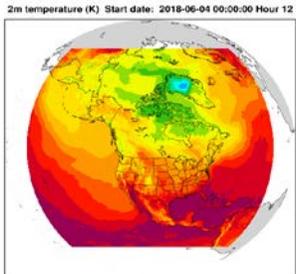
Q4FY20

~FY23

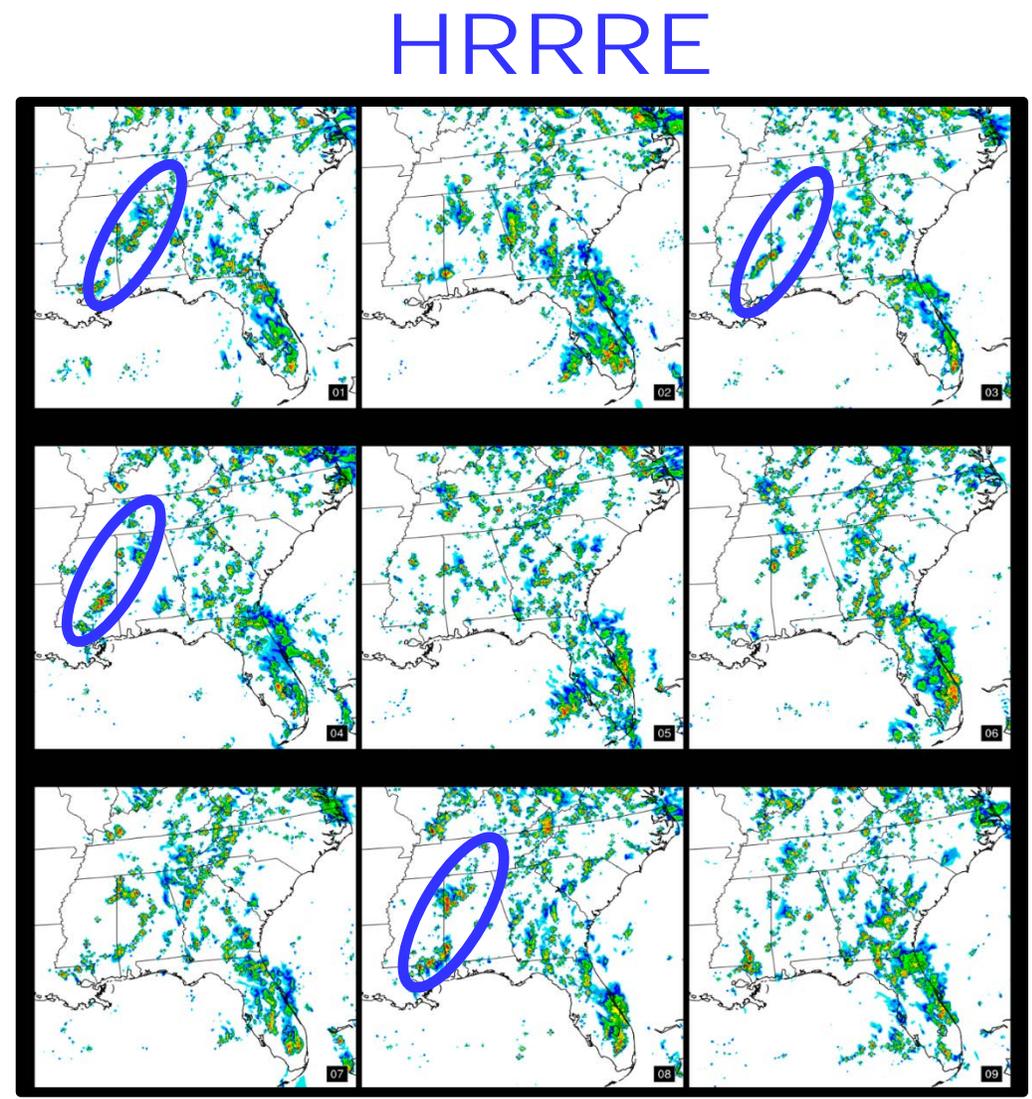
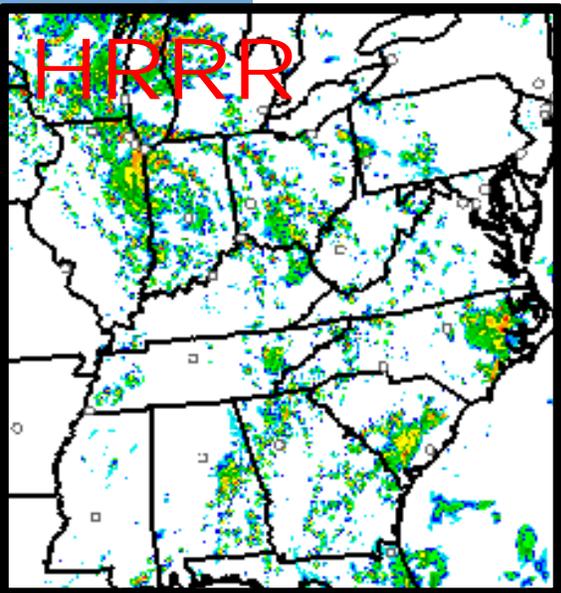
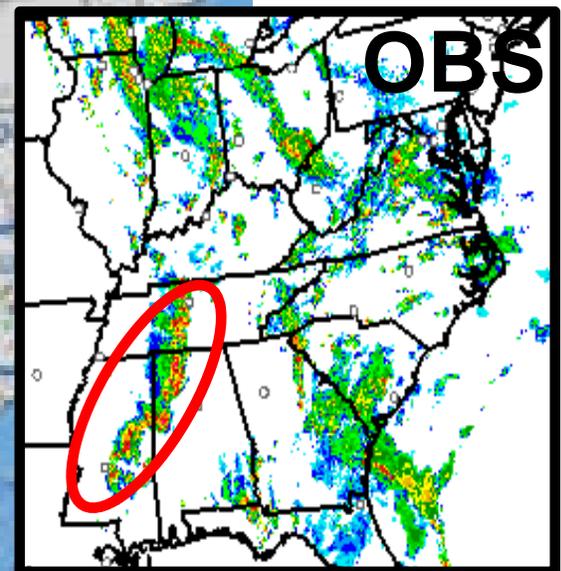
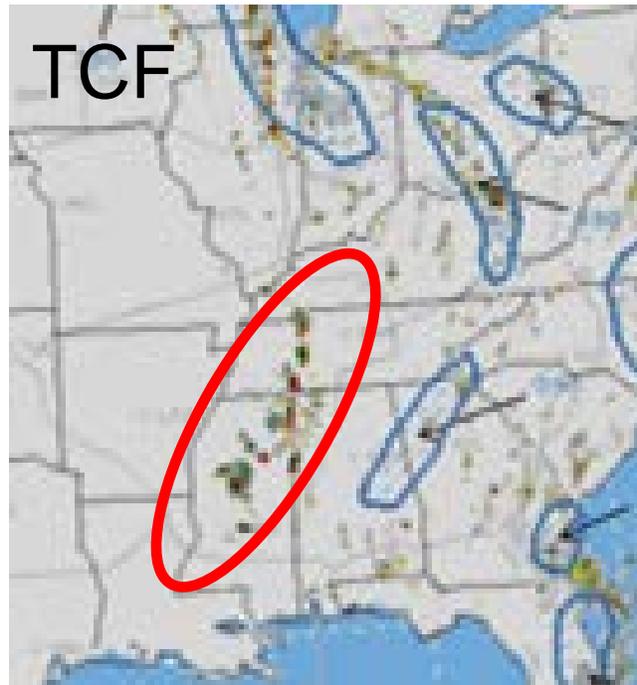
Development Underway

HREFv3  
UFS forecast capability

Implement RRFSv1  
pending favorable  
evaluation



# A Real Life Example: Deterministic vs. Ensemble



COMMENTS: TODAY WAS A CHALLENGING DAY AT ZME. A LINE OF WX DEVELOPED IN EASTERN ZME FROM JUST WEST OF BNA ALL THE WAY INTO ZHU... THE WX WAS NOT FORECASTED ON THE TCF OR ANYWHERE FOR THAT MATTER.

4 of 9 HRRRE members captured the squall-line to some degree!

# Questions?

GSD subject matter experts: [GSD.Model.QA@noaa.gov](mailto:GSD.Model.QA@noaa.gov)



*This research is in response to requirements and funding by the Federal Aviation Administration (FAA). The views expressed are those of the authors and do not necessarily represent the official policy or position of the FAA.*