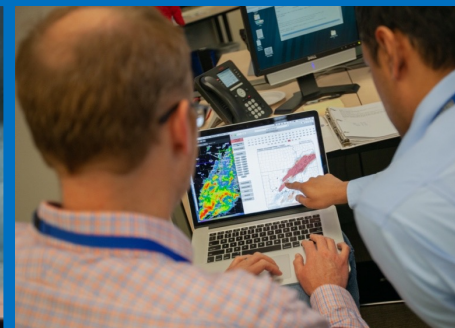
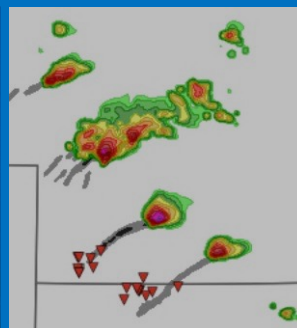




Forecast/Warning Tools and Techniques

Warn-on-Forecast in the 2020s

Patrick C. Burke MS, NSSL WoF Program Lead, FRDD

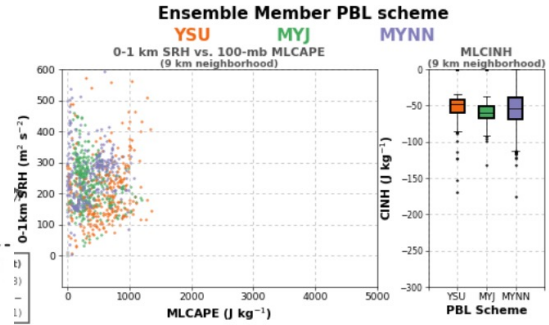
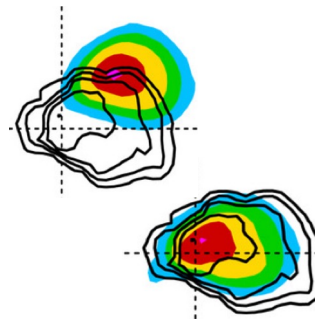
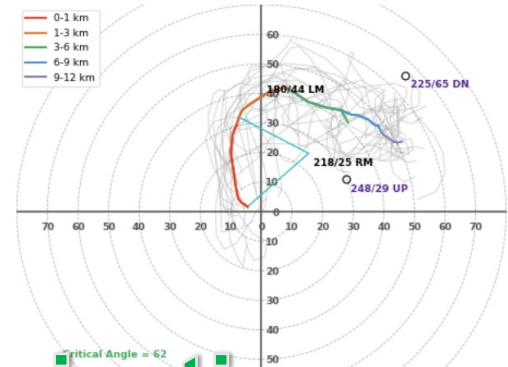


The NSSL Foundational Approach

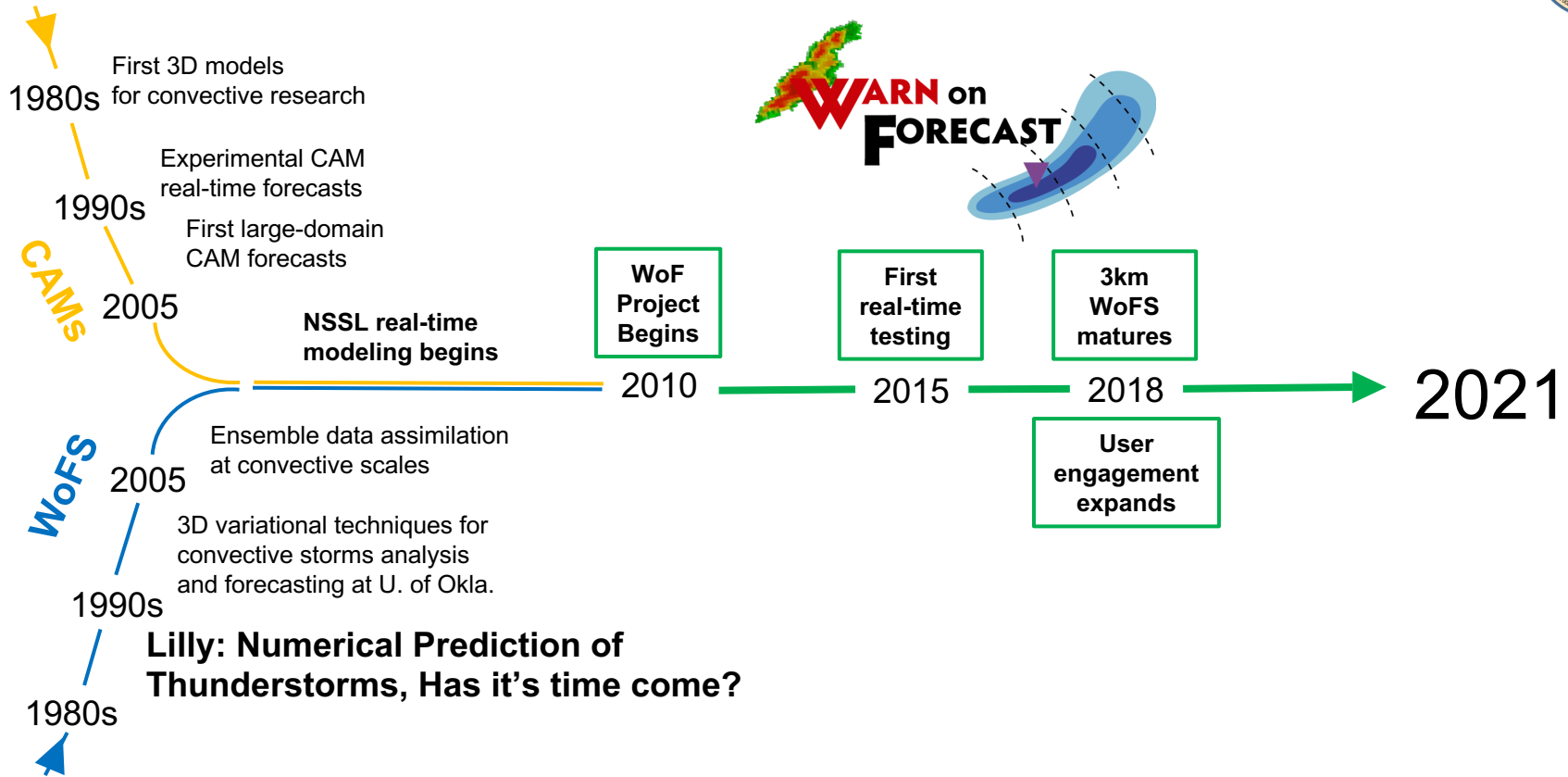
Process Studies Inform...

Data Assimilation

& Physical Parameterization



WoFS Advances Convection Allowing Models



What is Warn-on-Forecast?



An ensemble analysis and forecast system at 3km grid spacing that makes probabilistic forecasts of individual thunderstorms and their hazards, 0-6 hours.

- Rapid data assimilation
- Rapid forecast delivery
- Output visualized at 5-minute resolution



Severe Weather
Flash Flooding
Tropical
Lightning



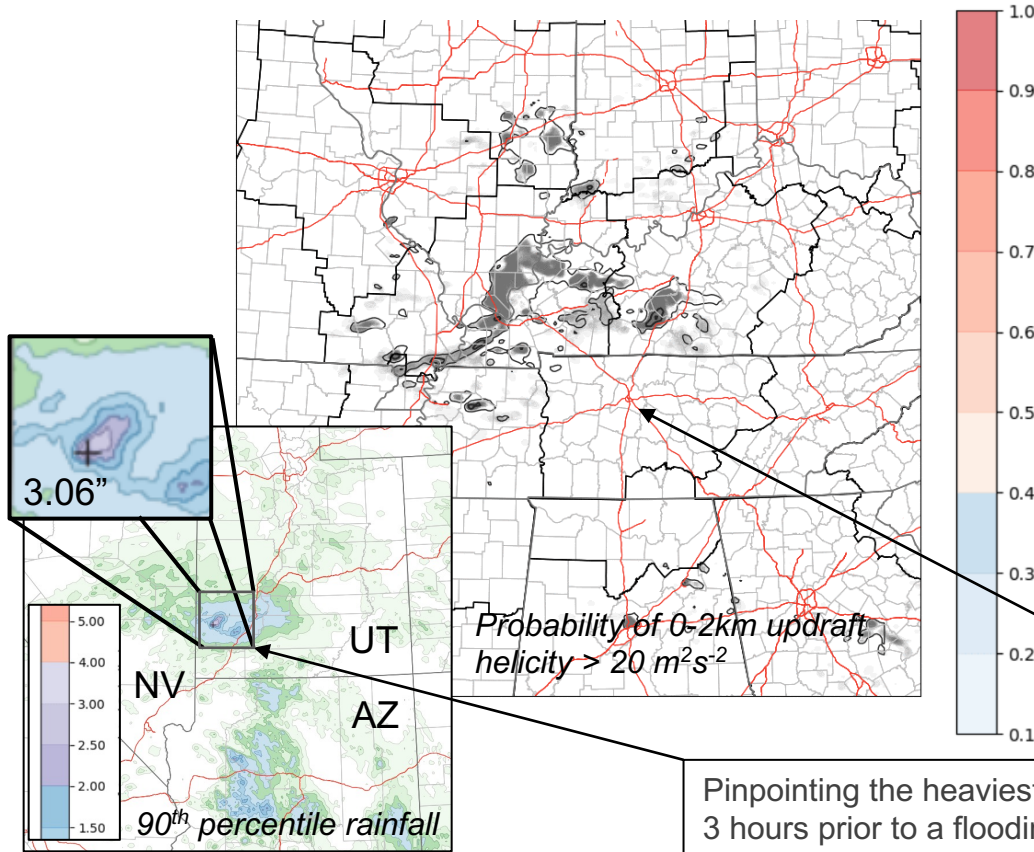
Aviation
Fire Weather
Coastal Convection



Winter Weather



Groundbreaking Accuracy at Greater Lead Time



Increased lead time means earlier and more accurate communication of:

- 1) probabilities
- 2) uncertainties
- 3) unfolding scenarios

2 to 3 hour lead time on strongly rotating storms coming into Nashville (March 2020)

Pinpointing the heaviest rain that will occur in the 900km x 900km domain 3 hours prior to a flooding-induced train derailment (July 2021)

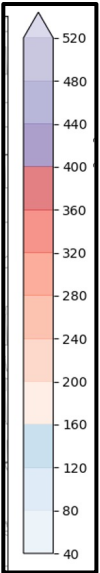
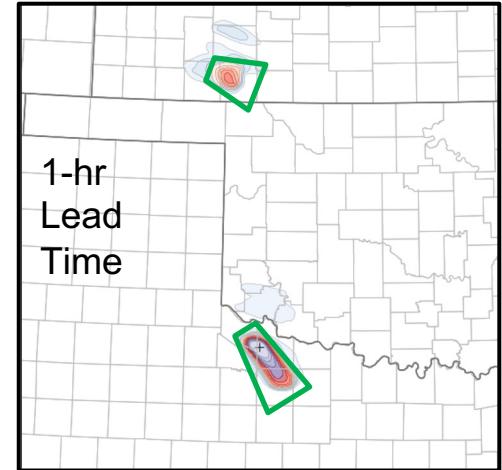
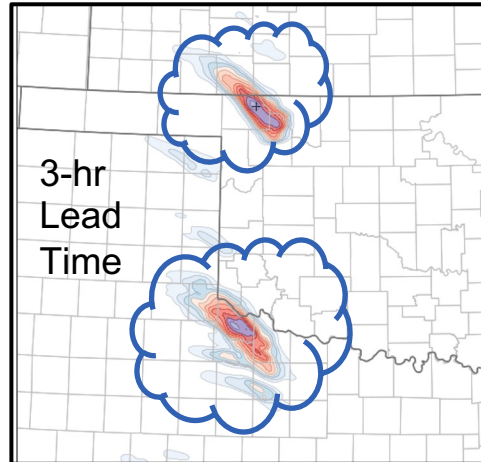
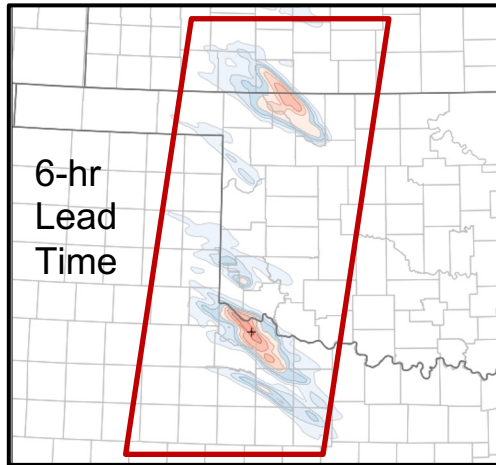


Filling the Watch-to-Warning Gap

WATCH



WARNING



m^2s^{-2}

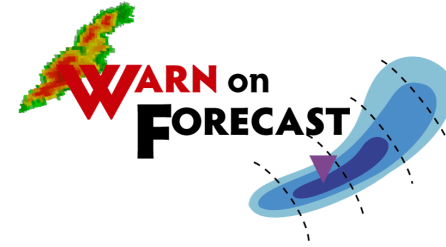
- WoFS fills a critical gap in which newly arriving NWP guidance has been lacking
- National and local offices tell us WoFS provides a common starting point for collaboration in the Watch to Warning time/space
(2021 WoFS Virtual HWT Experiment)

90th percentile of mid level updraft rotation from three different WoFS runs; these show the swath of max updraft helicity at each grid point ending at the same time (0100 UTC), but of differing duration.

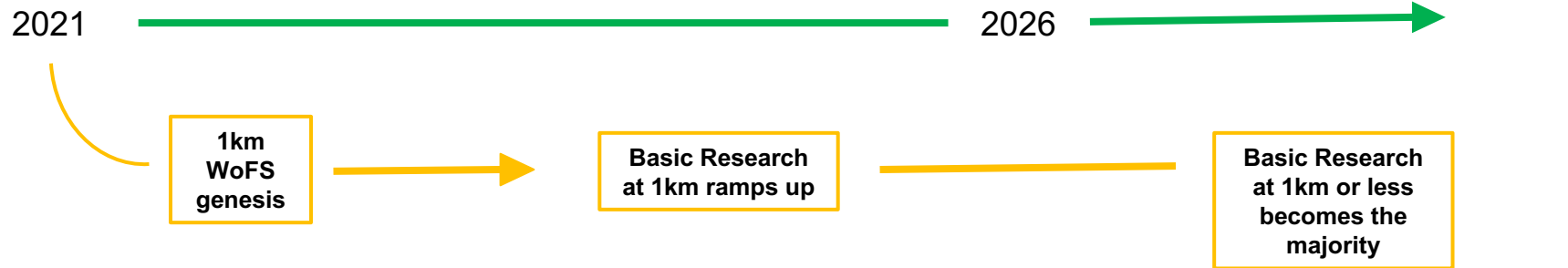




WoFS Becomes Operational

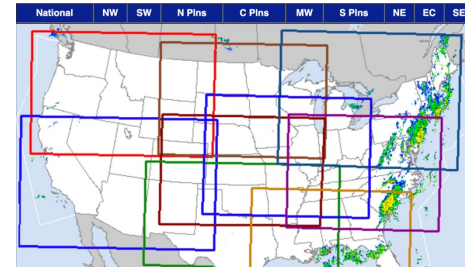


A LOT of work to be done in this space...
to move 3km WoFS to operations



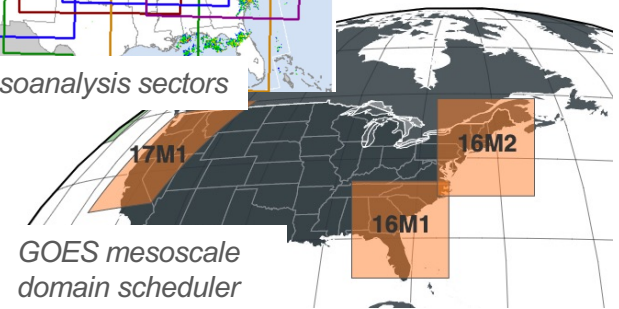
The Biggest Hurdles

- Keeping sufficient compute power for parallel transition of 3km WoFS and development of 1km WoFS
- How to scale-up the availability of WoFS runs across the U.S. ?
- Can FV3 and JEDI prove skillful for this application?
- Deliver WoFS to AWIPS
- Developing calibrated probabilistic guidance, based in machine learning, that plays within a FACETS paradigm
- Documentation of workflows / best practices / culture shift in NWS warning operations



SPC Mesoanalysis sectors

Options for targeted model domains could take many forms.



GOES mesoscale domain scheduler





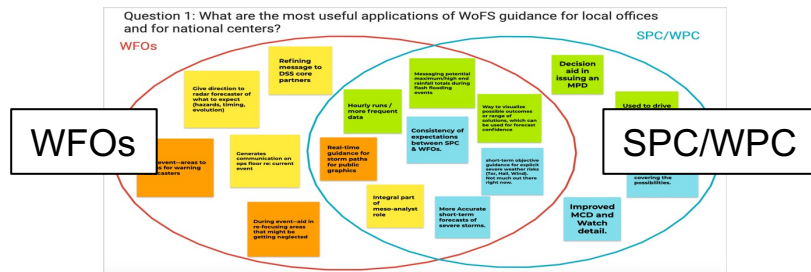
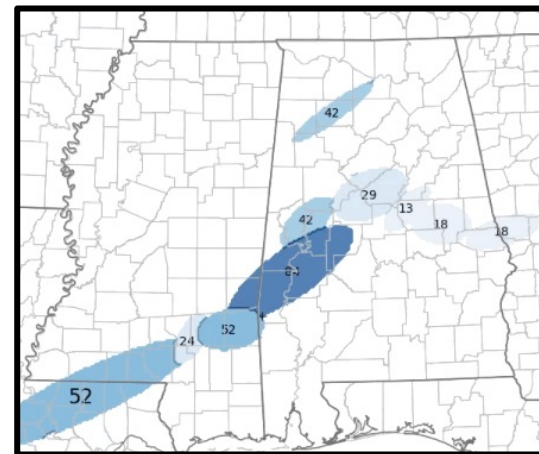
What we're currently doing

- Assembled an FV3 team; submitted JTTI w/ GSL to improve FV3 convection.
- Transitioning real-time WoFS runs from in-house HPC to Azure cloud-based computing. NSSL/Joshua Martin has built the architecture for this.
- Monte Flora / Corey Potvin developed an object-based, calibrated probabilistic prediction system using a traditional ML approach and are working towards developing 3-6 hr calibrated guidance using deep learning.
- Eric Loken / Katie Wilson led a testbed proposal to develop 0-3 hr severe weather hazard probabilities, combining WoFS with ProbSevere and some existing PHI products, in support of WoFS/FACETs goals.
- User engagement continues annually, notably a recent 2-year Southern Region NWS working group and a virtual HWT experiment involving local and national offices.



Examples of current work

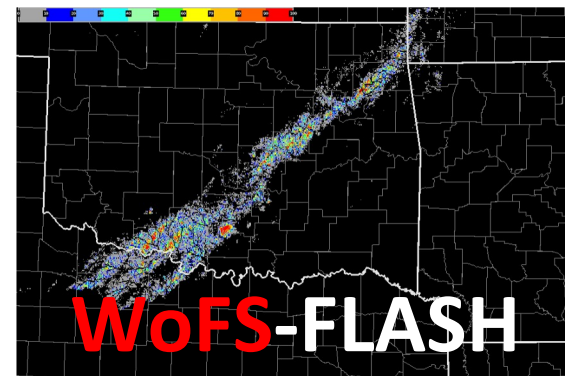
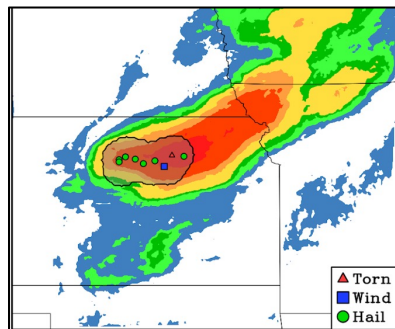
- Cloud computing: cloud-based WoFS → cb-WoFS
 - Research system is 99% complete. Real-time system 90% complete
 - Plan is to run real-time on Azure cloud for 2022 activities
- Machine-learning based probabilities
- WoFS use in national / local collaborative forecast process



What we'd like to do

- Expand collaborations, training, and real-time WoFS use across NWS
- Focus on work to blend PHI across the watch-to-warning time and space scales
- Better quantify WoFS' impact and identify novel uses
- Use WoFS rainfall as hydrologic forcing

- Incorporate additional novel observations
- Continued emphasis on PBL study



Gridded probabilities derived from machine learning





Thank you! We look forward to collaborating.

PROGRAM LEADS



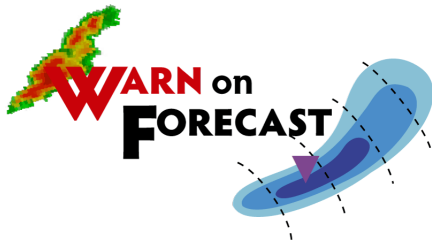
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