CYBERINFRASTRUCTURE INTEGRATION RESEARCH CENTER

PERVASIVE TECHNOLOGY INSTITUTE

Spring 2020 Project Follow-up & LEAD Introduction

January 23rd 2020

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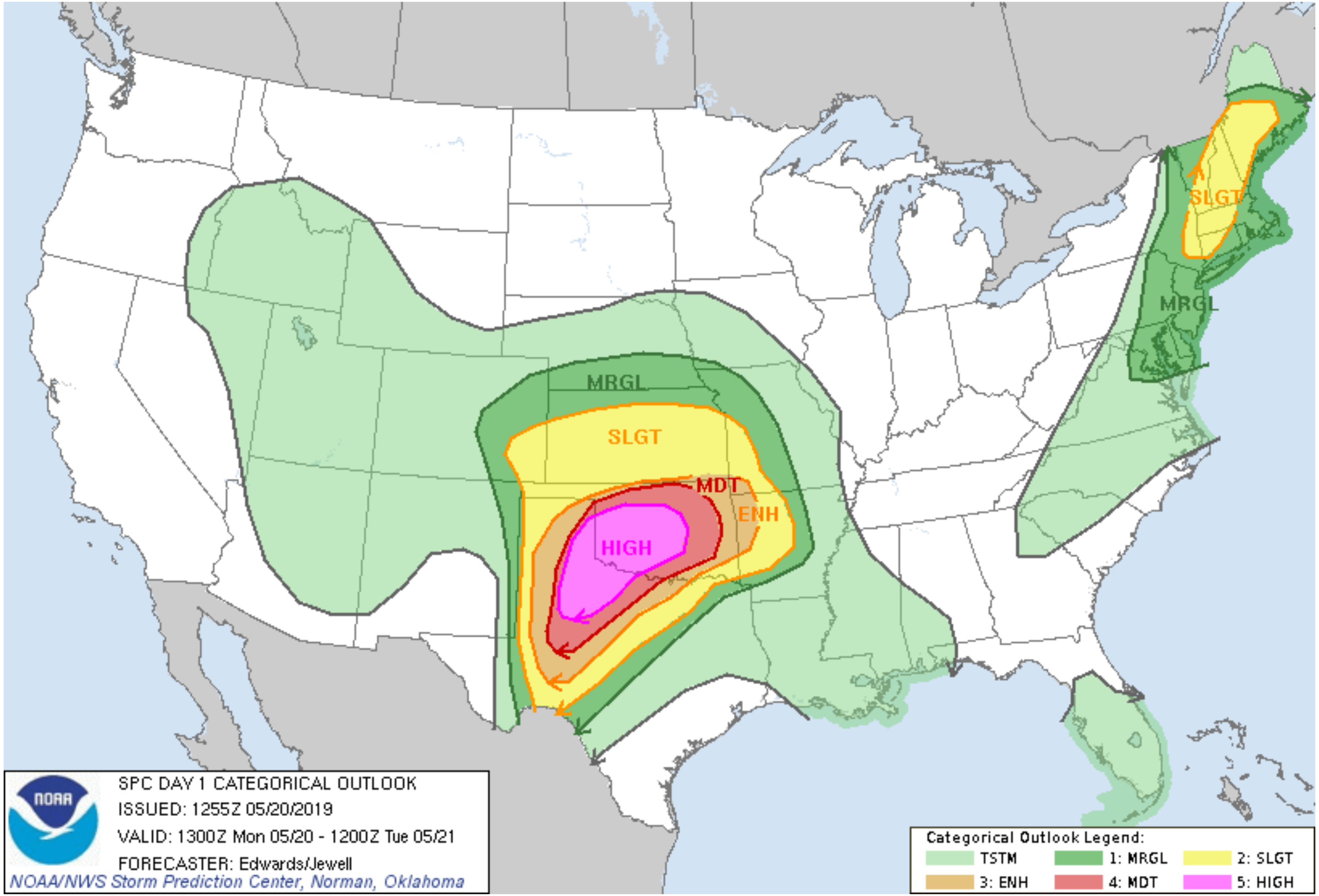
Next week classes will be in WH 003

Weather Forecasting Summary

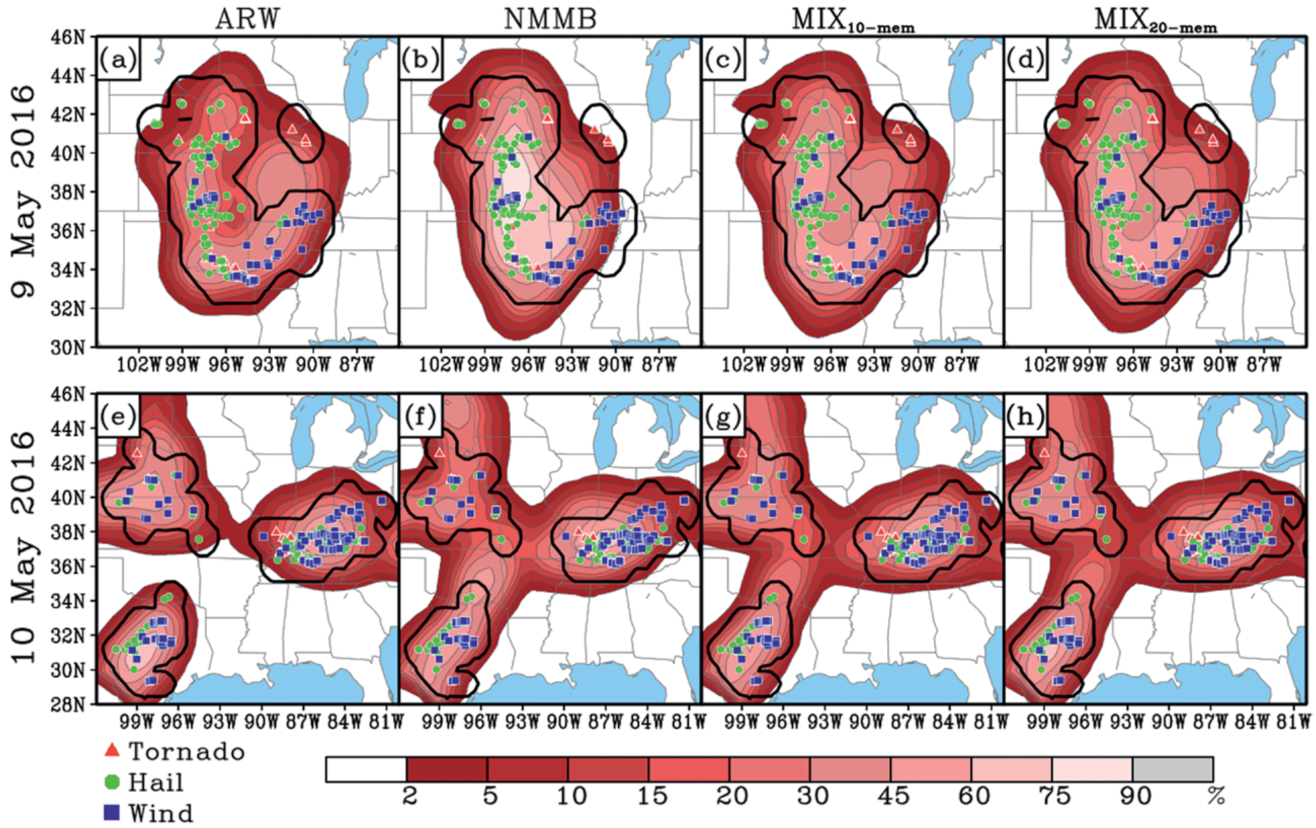
- Current weather determined by observations is the initial state.
- The atmosphere is a physical system governed by the laws of physics
  - these laws are expressed as mathematical equations.
  - models start from initial state (observations) and calculate state changes over time.
  - Models are very complicated (non-linear) and require supercomputers to do the calculations.
- Forecast duration defines temporal boundary conditions
  - the accuracy decreases as the range increases; there is an inherent limit of predictability.



MRGL
SLGT
MDT
ENH
HIGH
SLGT
MRGL
SPC DAY 1 CATEGORICAL OUTLOOK
ISSUED: 1255Z 05/20/2019
VALID: 1300Z Mon 05/20 - 1200Z Tue 05/21
FORECASTER: Edwards/Jewell
NOAA/NWS Storm Prediction Center, Norman, Oklahoma
Categorical Outlook Legend:
TSTM
1: MRGL
2: SLGT
3: ENH
4: MDT
5: HIGH

Tornado Prediction Data Sizes

- Center for Analysis and Prediction of Storms (CAPS) at the University of Oklahoma runs high resolution simulations as part of HWT - https://hwt.nssl.noaa.gov/
  - Domain: Continental United States (CONUS): 1683x1155x53 with 3 km grid spacing (starting from center with 3km space, move 1683 in x direction, 1153 in y direction and 53 steps in z direction – vertical, above the earth).
  - Time steps: 6 minutes – every 6 minutes from forecast initialization do an I/O of model outputs.
  - A single forecast writes 1639 GB of data.
  - 20 ensembles of simulations are run with varying emphasis on initial conditions, changes to physics.
  - Collectively a single day forecast produces 132 TB.


ARW
NMMB
MIX$_{10-mem}$
MIX$_{20-mem}$
9 May 2016
10 May 2016
(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
46N
44N
42N
40N
38N
36N
34N
32N
30N
28N
102W 99W 96W 93W 90W 87W
99W 96W 93W 90W 87W 84W 81W
Tornado
Hail
Wind
2 5 10 15 20 30 45 60 75 90 %

AWS NEXRAD Data

- https://registry.opendata.aws/noaa-nexrad/
- https://docs.opendata.aws/noaa-nexrad/readme.html
- https://s3.amazonaws.com/noaa-nexrad-level2/index.html

Plot NEXRAD Data

- Example Library: Py-ART - http://arm-doe.github.io/pyart/
- A concrete example - https://arm-doe.github.io/pyart/dev/auto_examples/plotting/plot_nexrad_reflectivity.html

Example

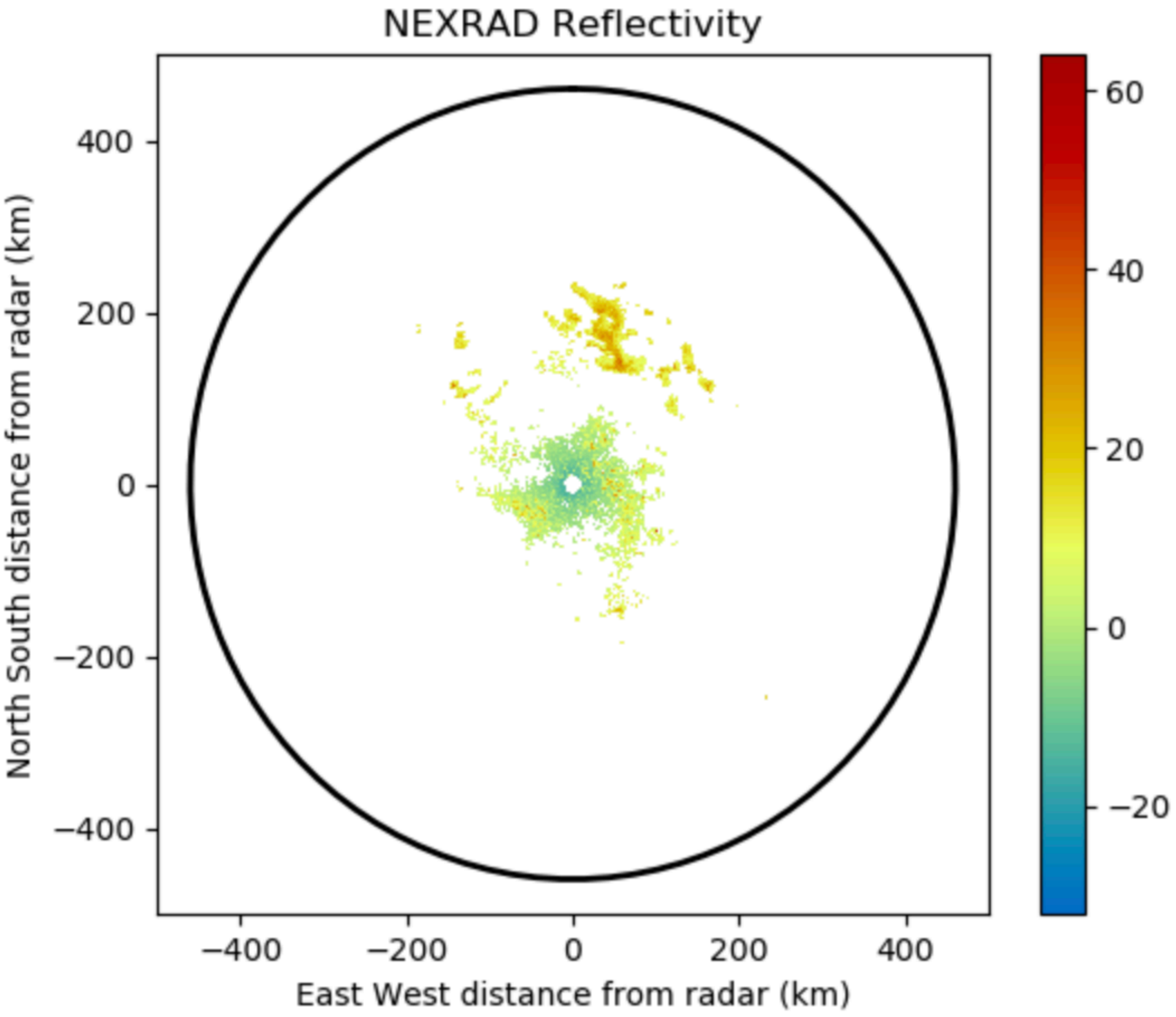
```
print(__doc__)

# Author: Jonathan J. Helmus (jhelmus
# License: BSD 3 clause

import matplotlib.pyplot as plt
import pyart

# open the file, create the displays
filename = 'Level2_KATX_20130717_1950
radar = pyart.io.read_nexrad_archive(
display = pyart.graph.RadarDisplay(ra
fig = plt.figure(figsize=(6, 5))

# plot super resolution reflectivity
ax = fig.add_subplot(111)
display.plot('reflectivity', 0, title
             vmin=-32, vmax=64, color
display.plot_range_ring(radar.range['
display.set_limits(xlim=(-500, 500), 
plt.show()
```



Assignment 1 Description on Canvas

- For Assignment 1, develop the system described in the January 21st lecture (slide 14 of http://courses.airavata.org/slides/Spring2020-CS649-Assignment1.pdf).
- You must develop the following services:
  - Data Retrieval Service
  - Model Execution Service
  - Post-Processing and Analysis Service
  - User Management Service
  - Session Management Service
  - API Server
  - Web Interface
- Each service must run as a separate process that communicate over network connections.
- You must use at least 3 different programming languages
  - For example, one service in Python, one in Go, one in Java, ...
- You must use at least one DB technology
  - Only one microservice can connect to each DBMS
- You must choose and implement an internal communication strategy for your microservices, including internal service APIs and/or message formats and data models for each service's inputs and outputs.
- You must define your API based on this lecture and other discussion
- You must provide a continuous integration and deployment system for deploying your services
- The entire system must work end-to-end
  - Users must be able to log into the web interface
  - Users must be able to provide inputs, submit a data retrieval-model execution-analysis pipeline.
  - User sessions should be recorded and saved
  - Users should be able to view, copy and resubmit previous jobs with new parameters.
- Your entire system must be easily deployable by your peers, graders, and instructors

More Weather motivation

the university of OKLAHOMA

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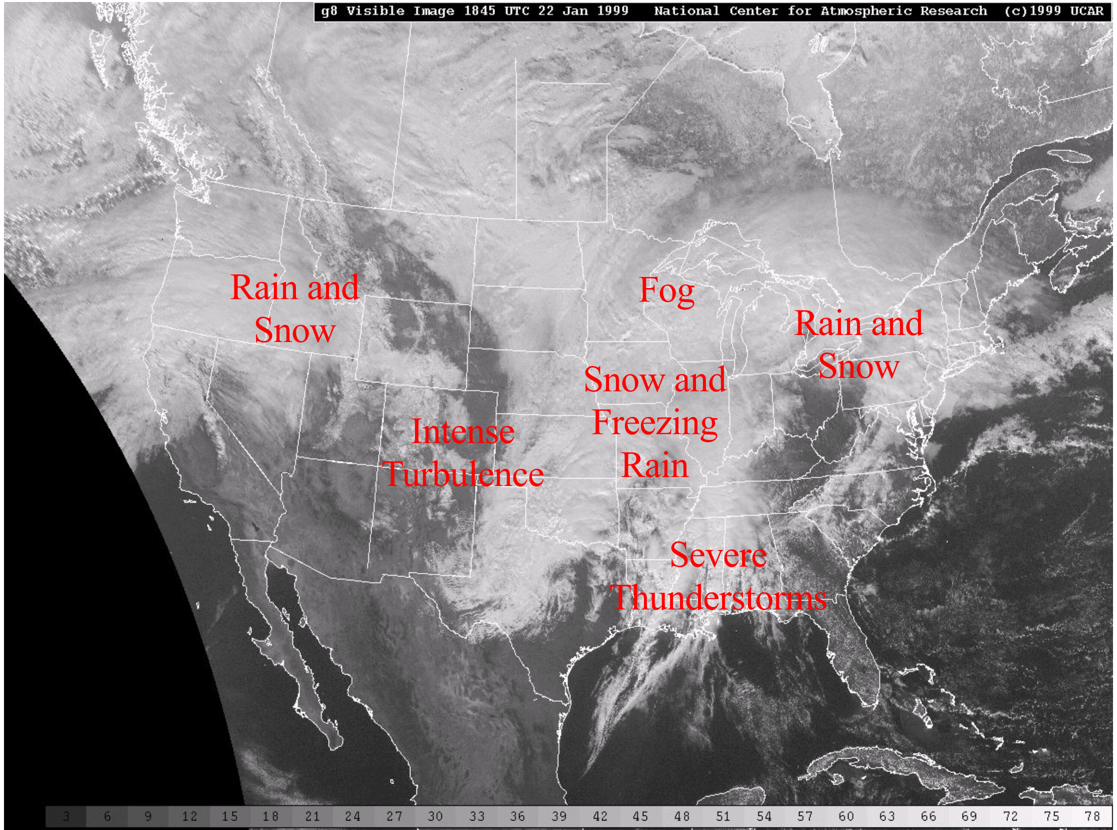
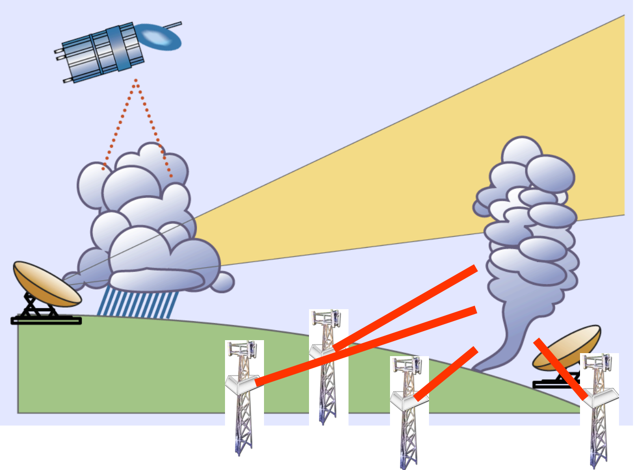
MILLERSVILLE UNIVERSITY 'Ville

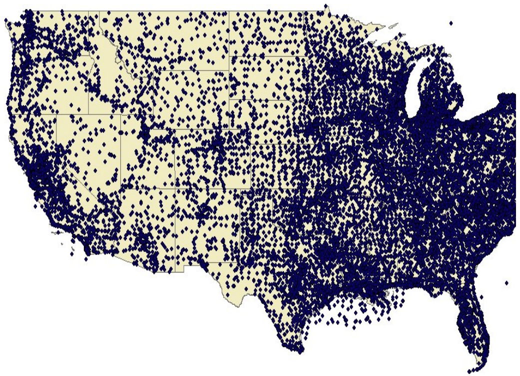
Weather is Local, High-Impact, Heterogeneous and Rapidly Evolving…Yet Our Technologies and Thinking are Static

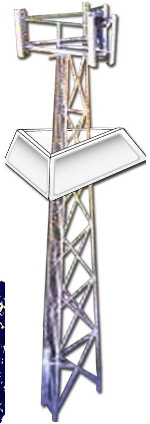


NSF Engineering Research Center
for Collaborative Adaptive Sensing of the Atmosphere (CASA)

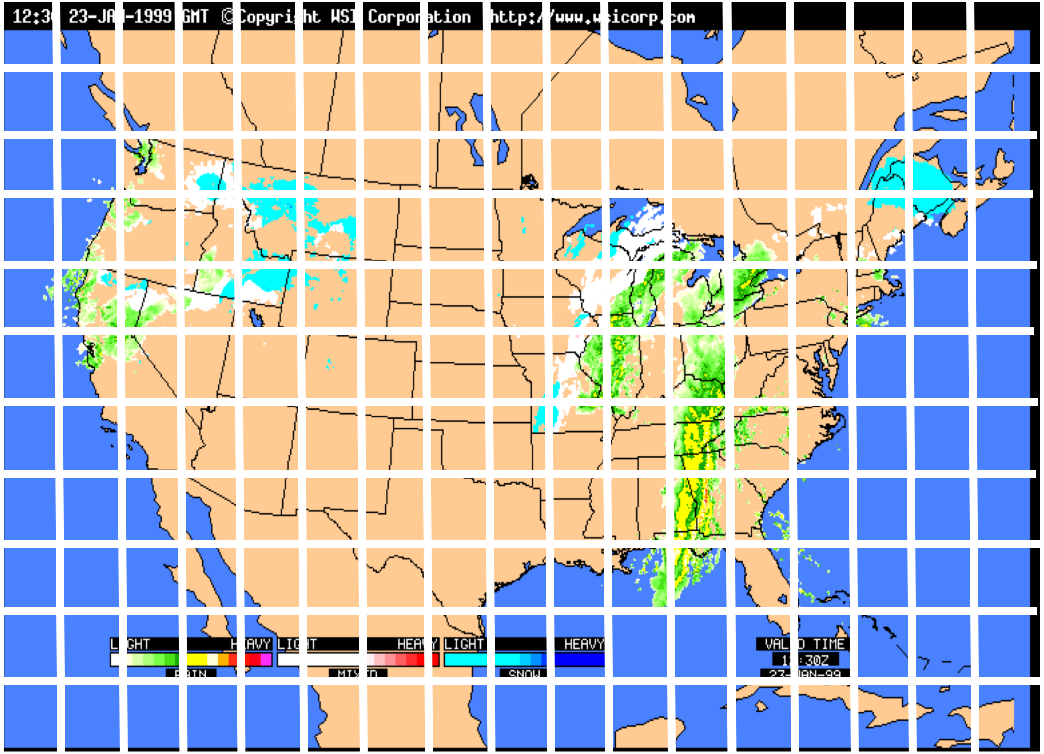
- UMass/Amherst, OU, CSU, UPRM
- Concept: inexpensive, phased array Doppler radars on cell towers and buildings
- Dynamically adaptive sensing of multiple targets while simultaneously meeting multiple end-user needs



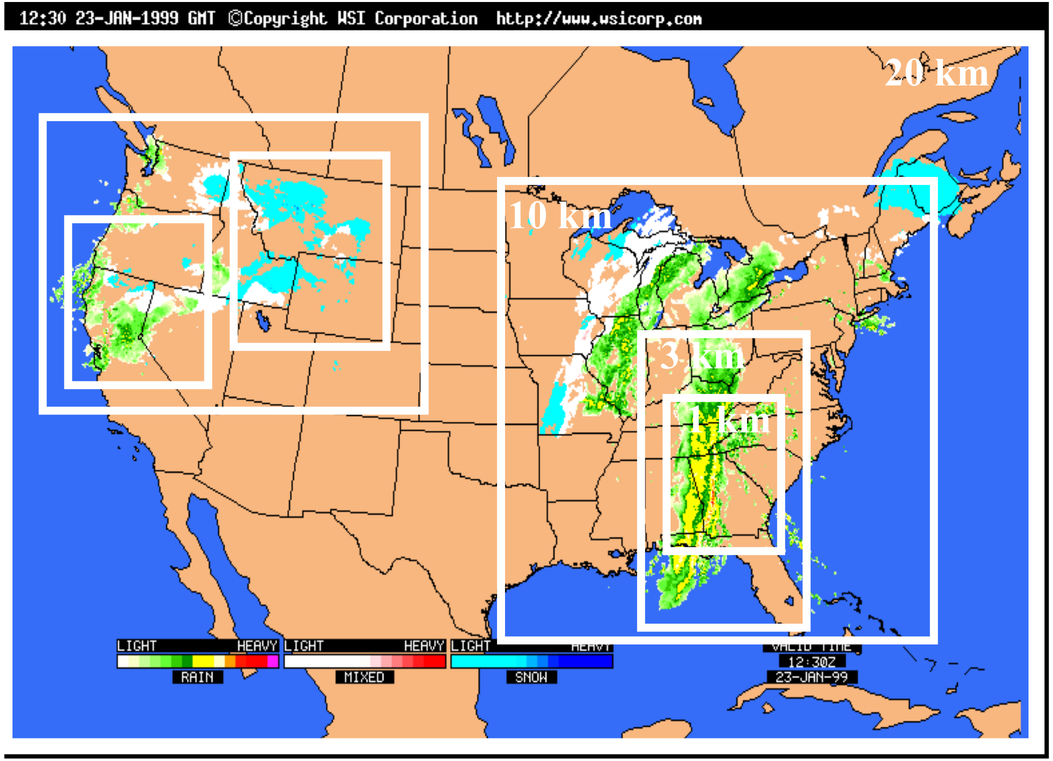




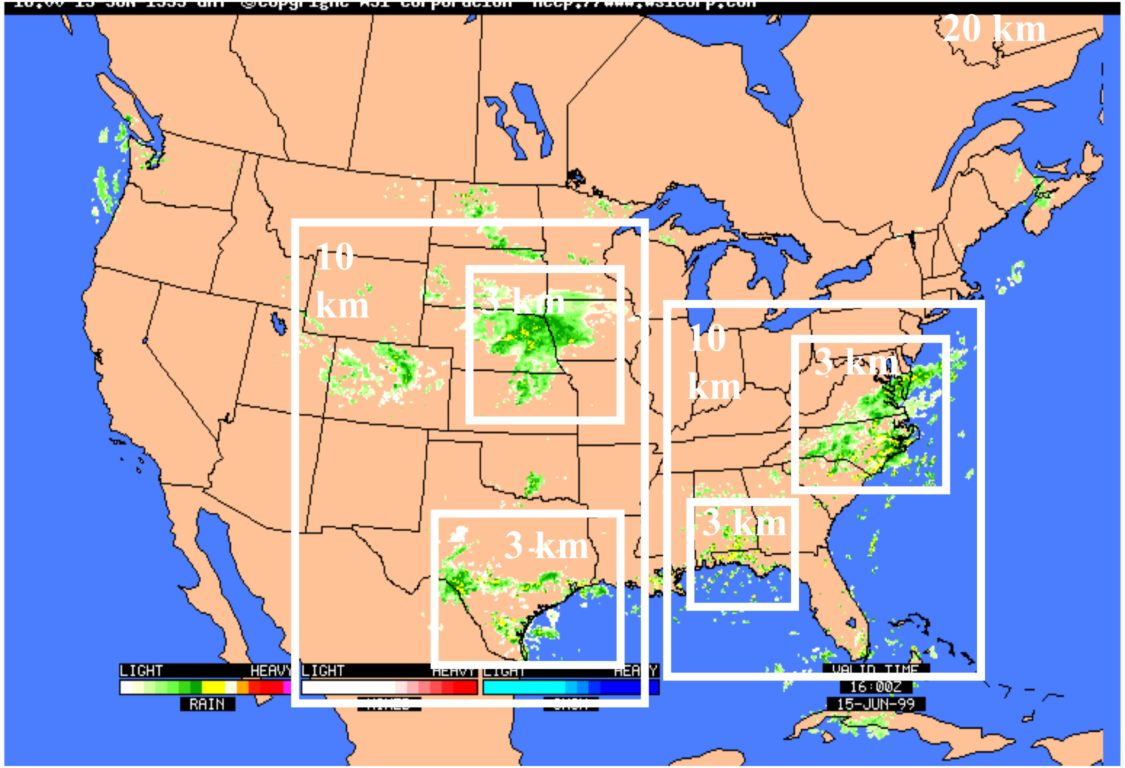
Fixed, Coarse Model Grids



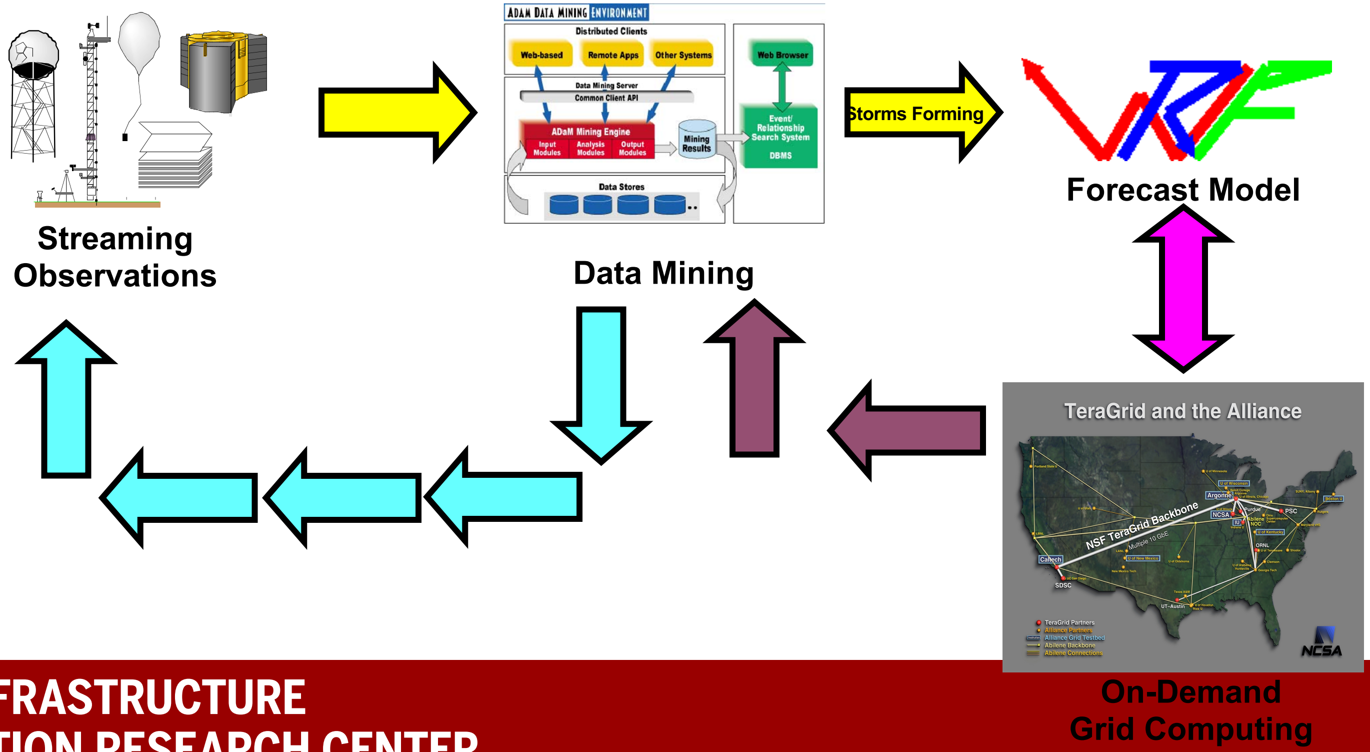
Future Work: Nested Models



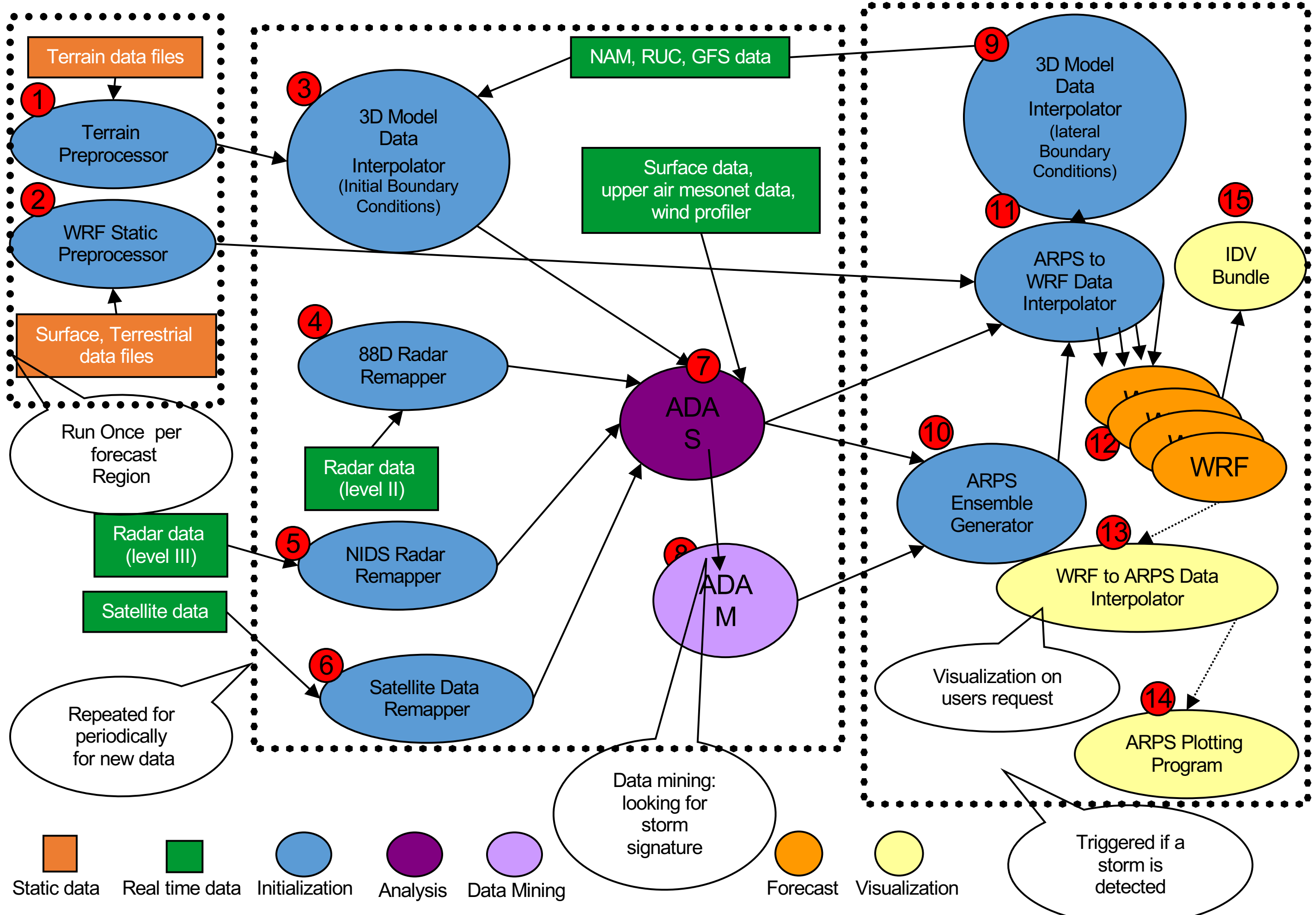
Future Work : nested models



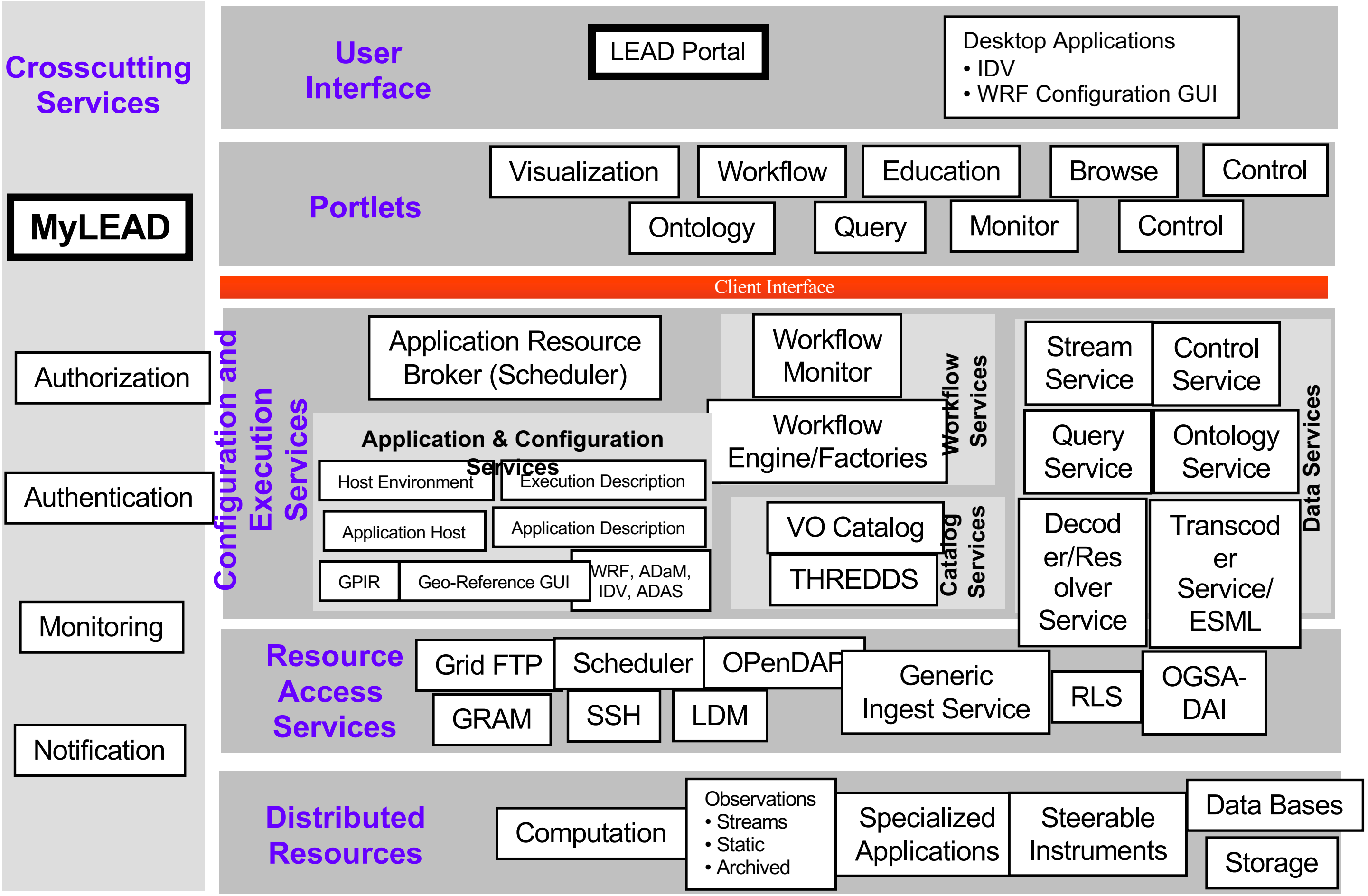
Example: Adapting Weather Prediction to Observational Sources Using Dynamic Adaptivity



Dynamic Workflow in LEAD



LEAD Architecture

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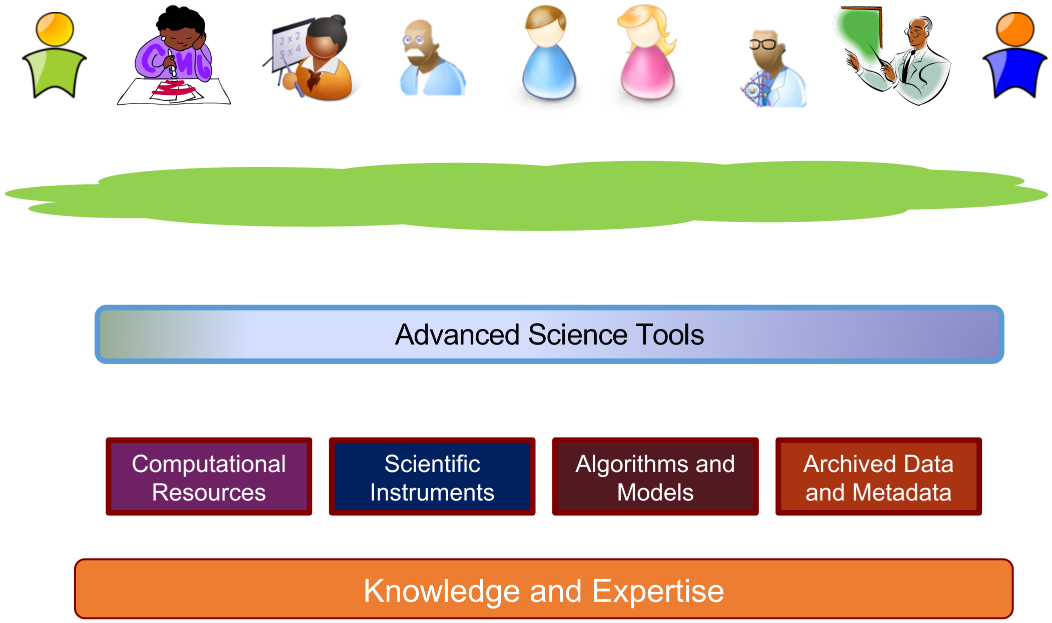

Adapting Weather Prediction to Observational Sources Using Dynamic Adaptivity