Domestic and International Applications of LAPS at WDT

WEATHER DECISION TECHNOLOGIES, INC.

Brent L. Shaw, Sr. Vice President
Meteorological Content

Overview

- WDT Background
- Domestic Applications
  - High Resolution Maps and Weather Operation
  - Data Assimilation for NWP
  - Daily Summaries
  - Synthetic Observations
  - Wind Energy Applications
- LAPS in International Systems
- Key Issues and Interests

Mission Statement

"WDT provides weather content and tools that help consumers and enterprises make timely and better decisions; saving lives, property, resources and helping people plan their day."

Weather Decision Technologies, Inc.

- Founded 2000 in Norman, OK
- 70 employees, 35+ PhD and Masters – Meteorology & Computer Science, 3 CCMs

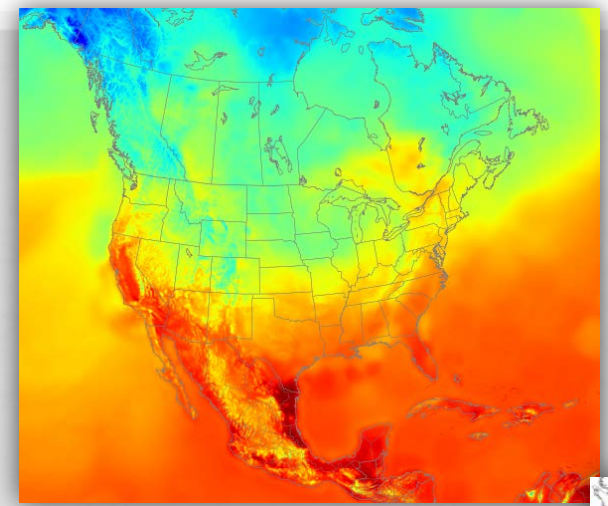
2011 AMS Award Winner for Outstanding Services to Meteorology by a Corporation

"For ten years of exceptional service in transferring innovative science and technologies from research and development to customer-focused operational meteorological products and services."

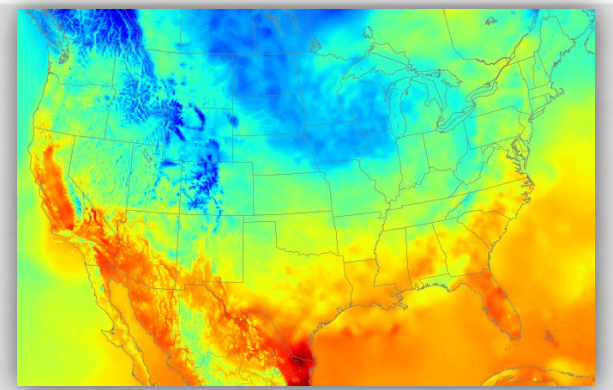
2012 "Appy" Award for iMap Weather Radio iPhone App

INTERNATIONAL
ENTERPRISE
WDT
WeatherOps
Safety. Security. Savings.tm
DIGITAL MEDIA
iMap
DATA & MAP SERVICES
MOBILE & WEB APPS
ALERT ENGINE
POLARIS
Severe Weather Detection and Prediction
CONTENT
Global Aggregation
MODELING
High Resolution 7 day Forecasts

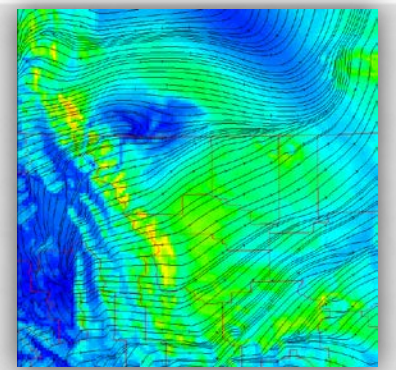
Domestic LAPS Domains



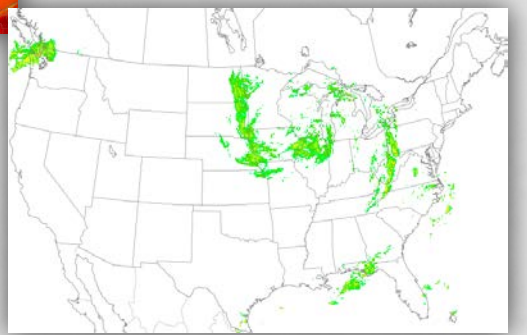
12-km Data Assimilation



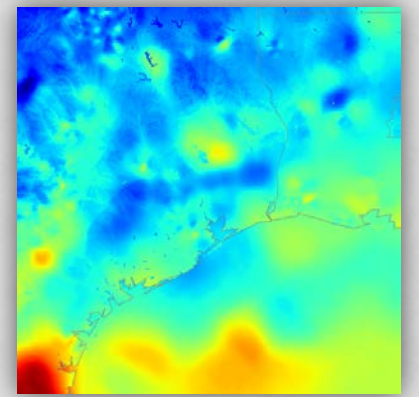
5 km US Maps



3 km DA/Wind



5 km Synthetic Obs



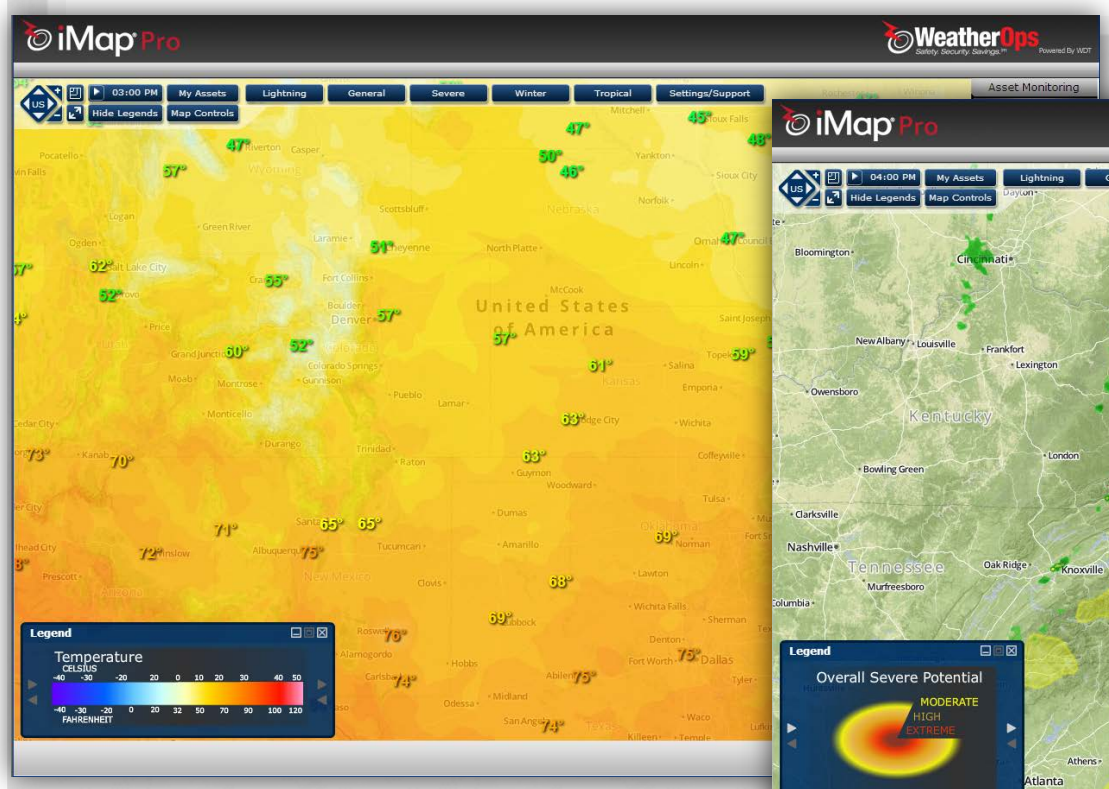
1 km WxOps

Customized by Application

WeatherOps

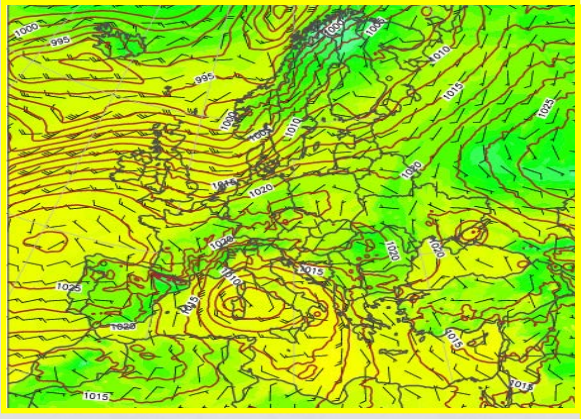
iMap

High Resolution Weather Maps

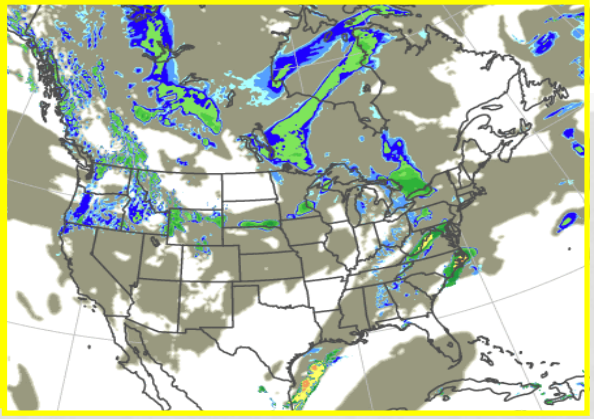


SWARM Image Tile Service

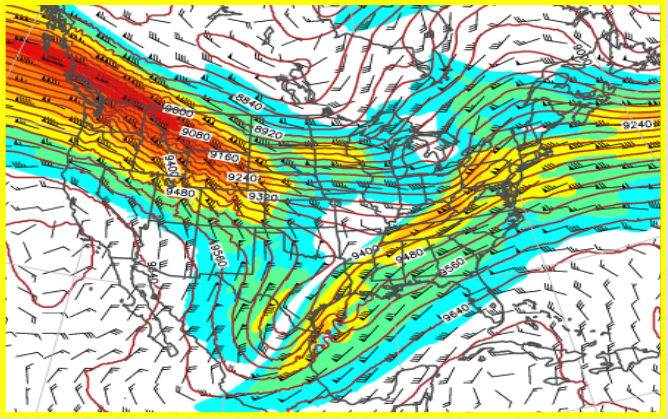
WDT Numerical Weather Prediction



European 12 km



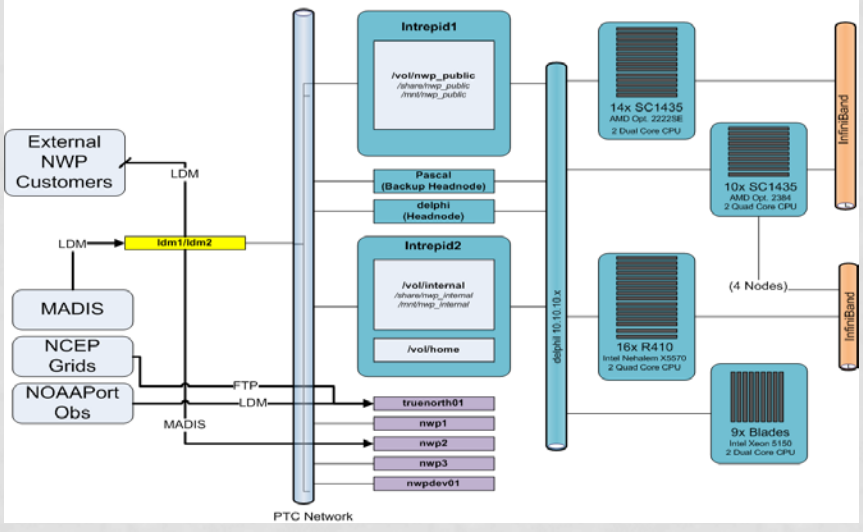
Hourly RR 10 km



N. American 11 km

HPC Environment

- 20 Intel Nehalem Servers
- 27 AMD Opteron Servers
- 9 Intel Xeon Servers
- 5 TB of Shared Storage
- PGI Compilers+OpenMPI
- InfiniBand Interconnect

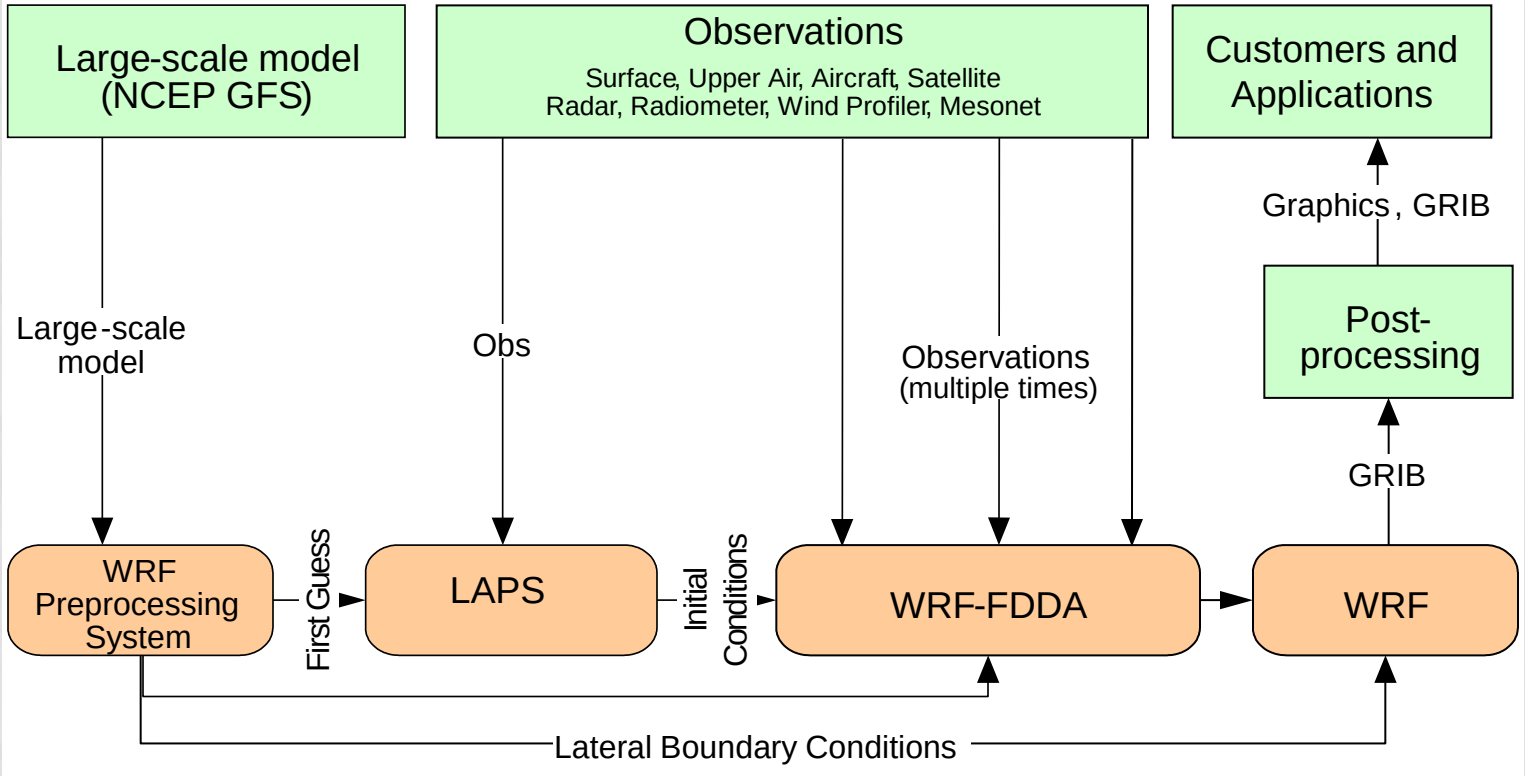


WeatherOps

WDT

WDT NWP Overview

Data Ingest and Product Generation

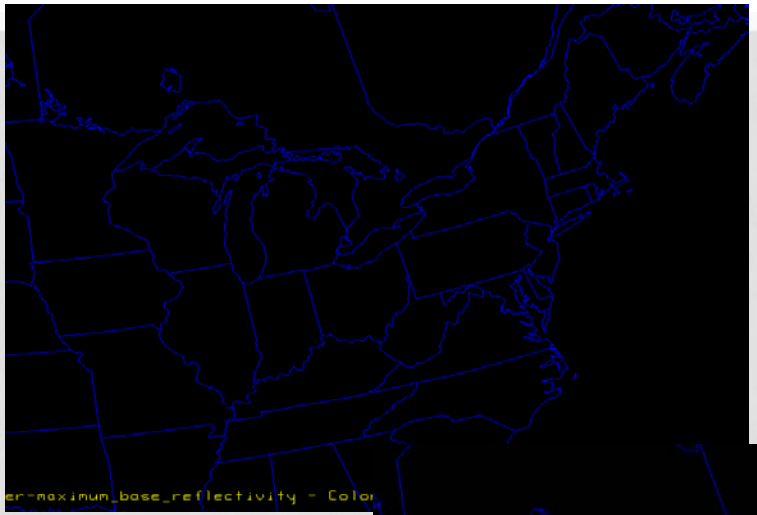


LAPS DA Value: 29 June 2012 Derecho

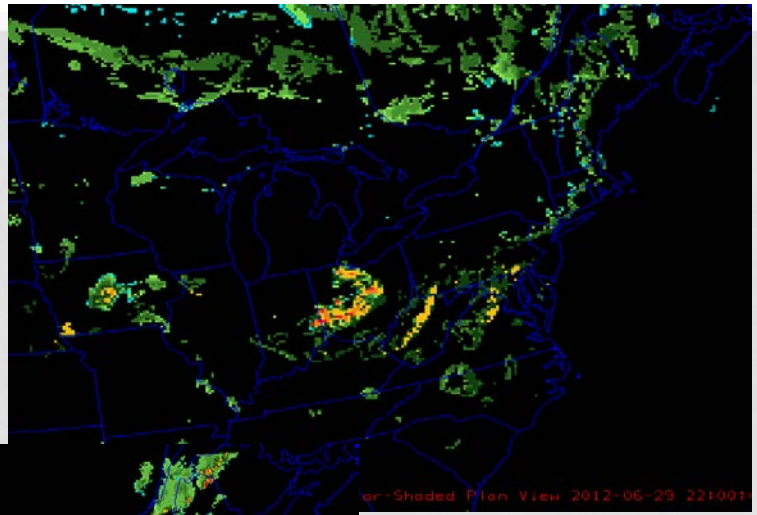
- Data Assimilation
  - LAPS + FDDA
  - Includes GOES Satellite Imagery, 3D Radar Mosaics, Conventional Data
- No Data Assimilation – Cold Start from GFS
- Both runs use same boundary conditions (18Z GFS), resolution, and physics

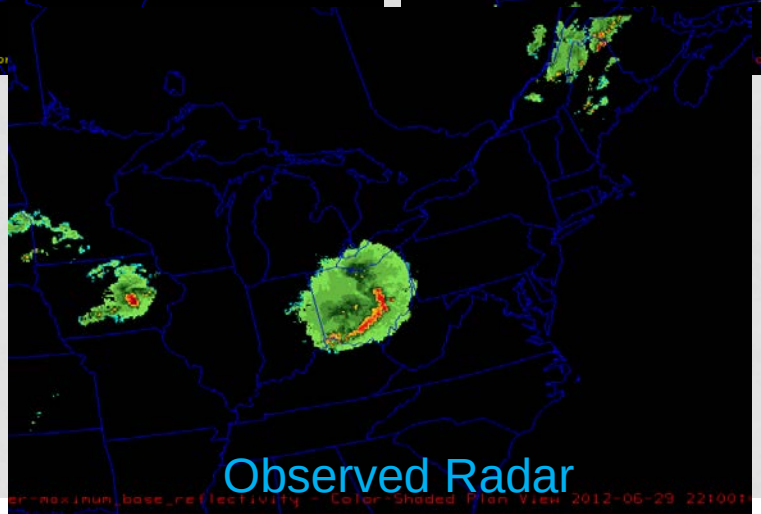
Initial Time – 2012-06-29 22:00

No Data Assimilation



Data Assimilation

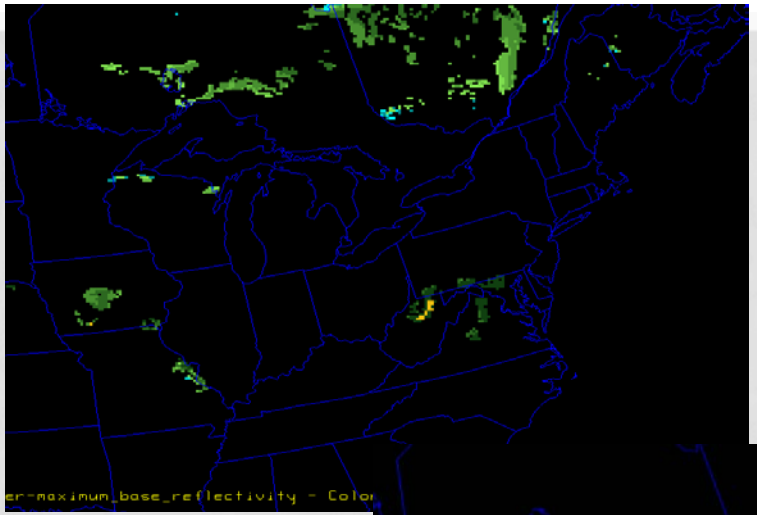




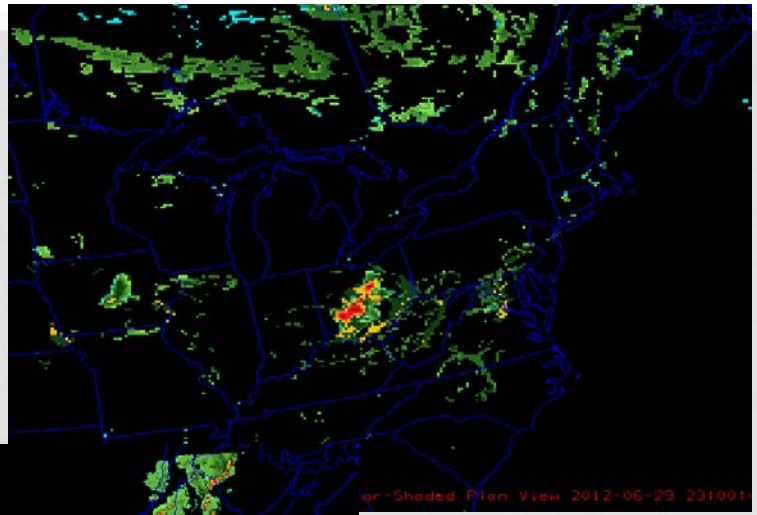
Observed Radar

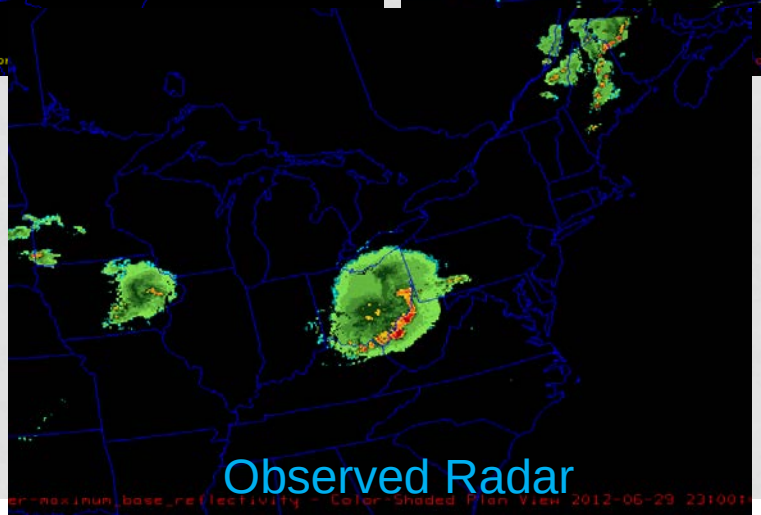
1 h Forecast – 2012-06-29 23:00

No Data Assimilation



Data Assimilation

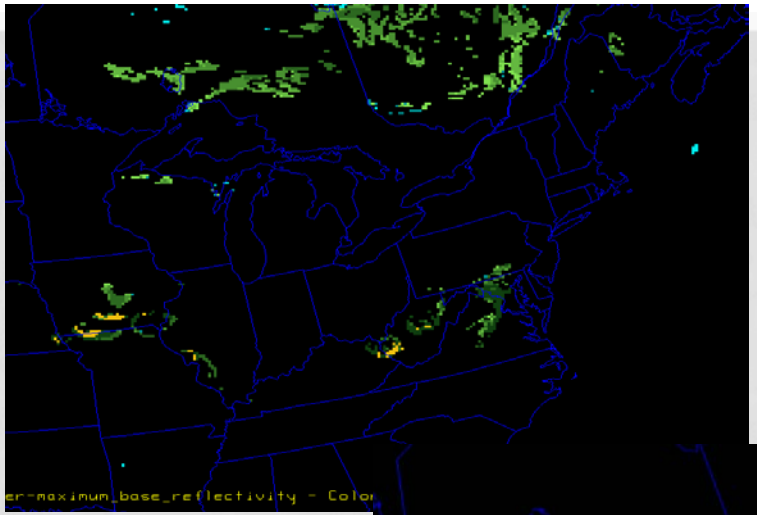




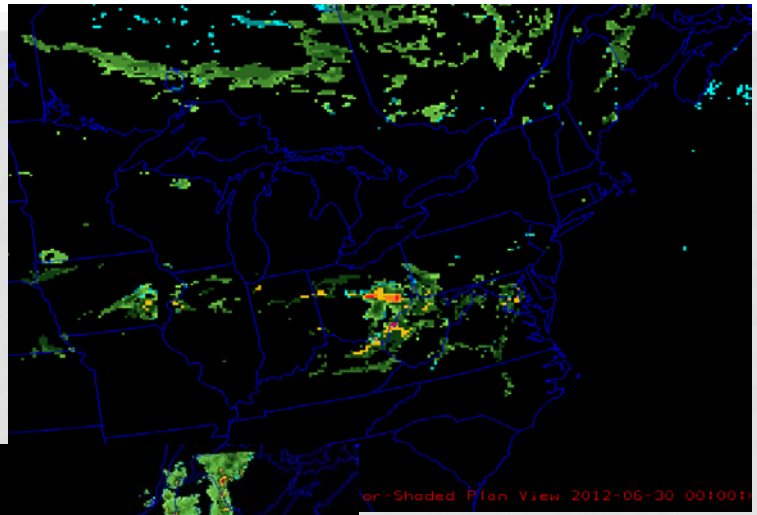
Observed Radar

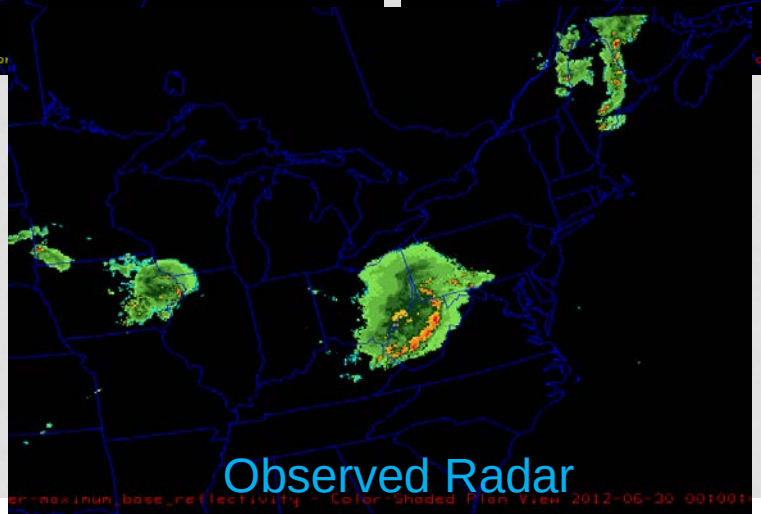
2-h Forecast 2012-06-30 00:00

No Data Assimilation



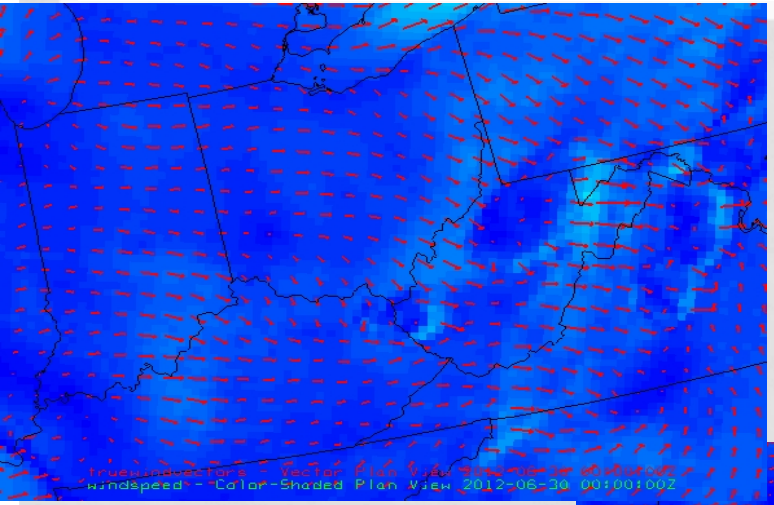
Data Assimilation





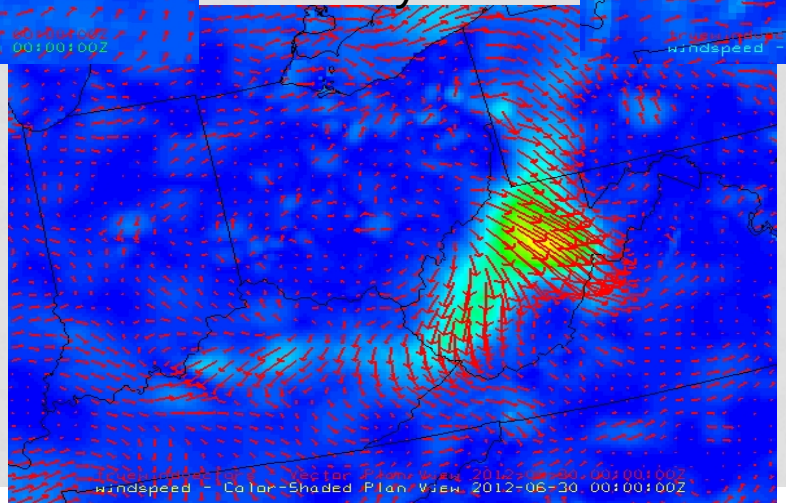
Observed Radar

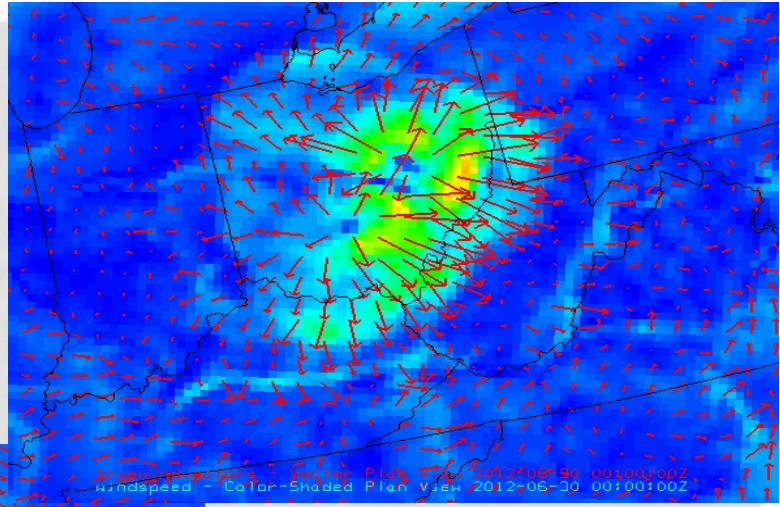
Valid 29 June 2012/2200 UTC



WRF 2-h: No Data Assim.

Analysis





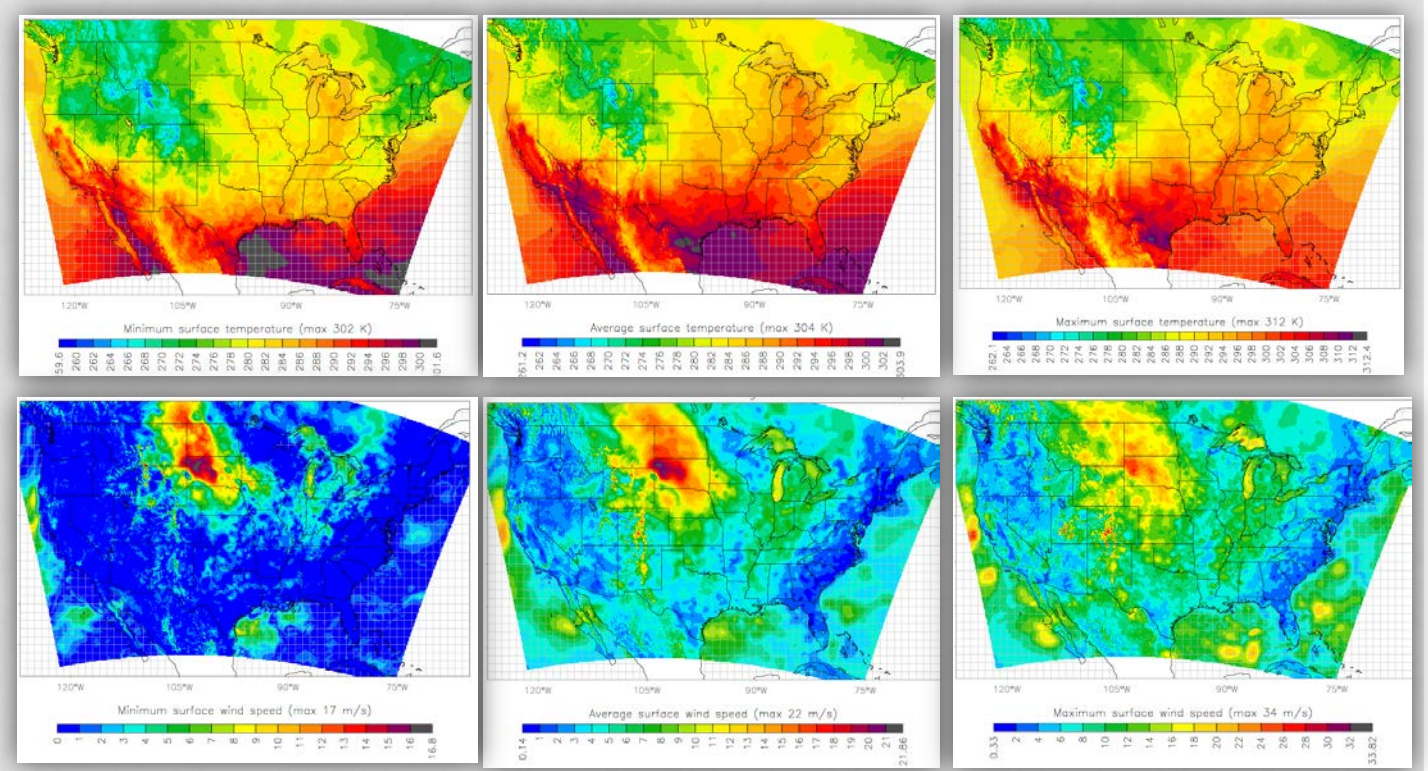
WRF 2-h: With Assim.

WeatherOps

iMap

Daily Summaries

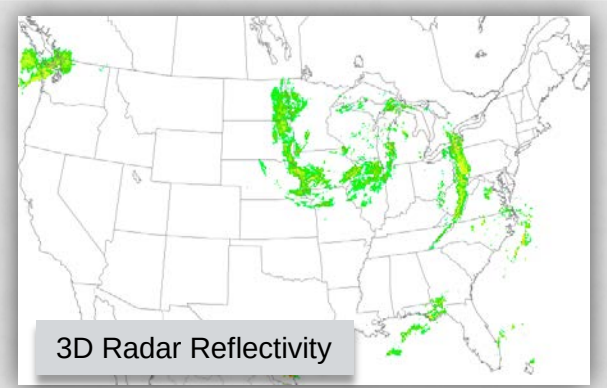
- Built from 48 analyses, 1200Z-1130Z daily
- Archived
- Min/Max/Average Temperature and Winds
- 5-km Grid
- Includes MADIS, GOES, 3D QC Radar Mosaics
- Compliments hail, lightning, and tornado tracks daily analyses

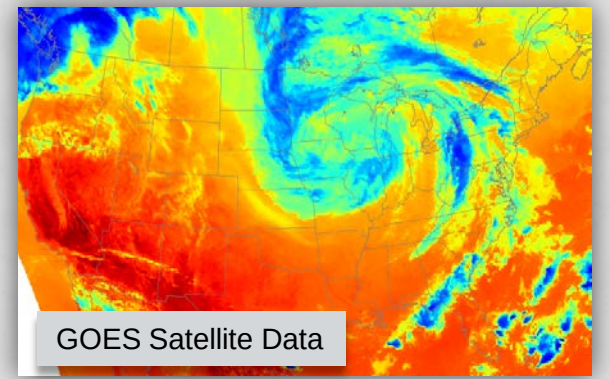


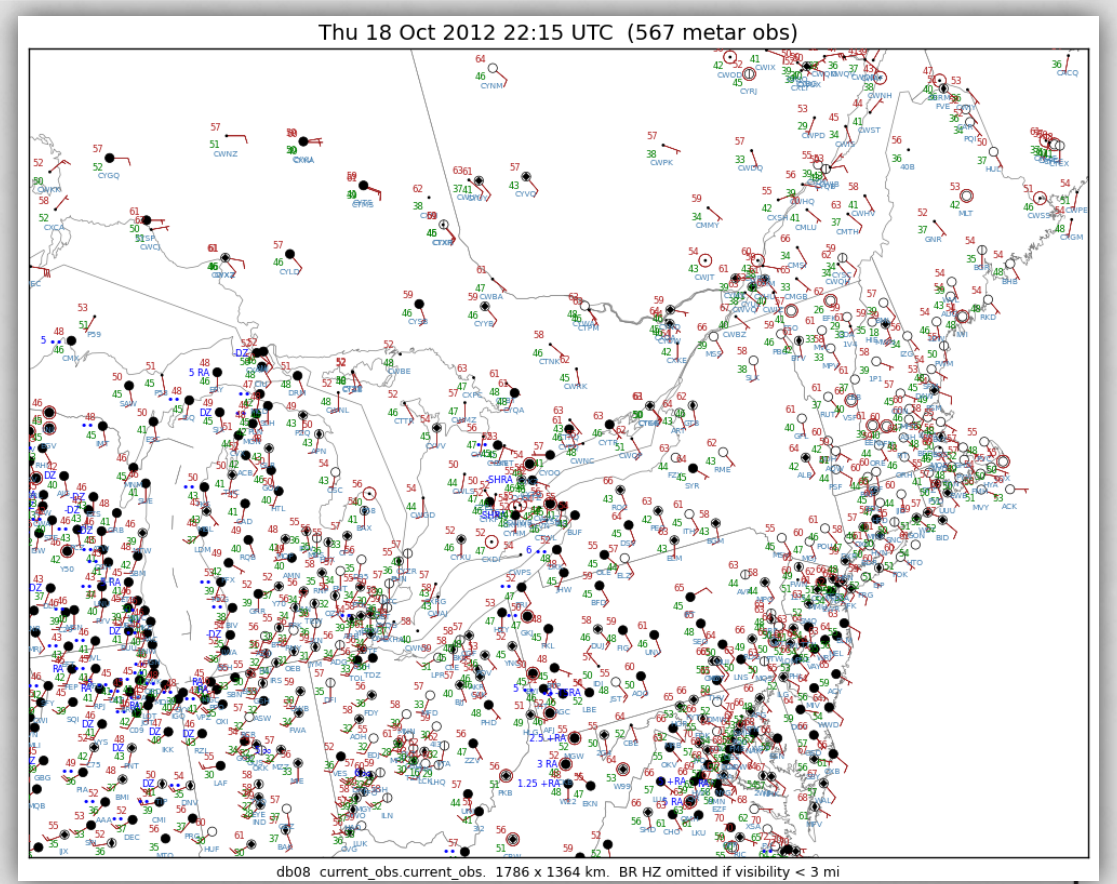
Synthetic Observations

- Use LAPS to create “new” observations
  - Downtown vs. airport
  - Fill in for a missing observation
  - Dense grid of observations – Weather at YOUR location
- Fill in missing portions of observations
  - Mesonet stations don’t report clouds or weather
  - METARs often don’t report mid-high clouds
  - Provided estimated weather conditions

Raw Observations

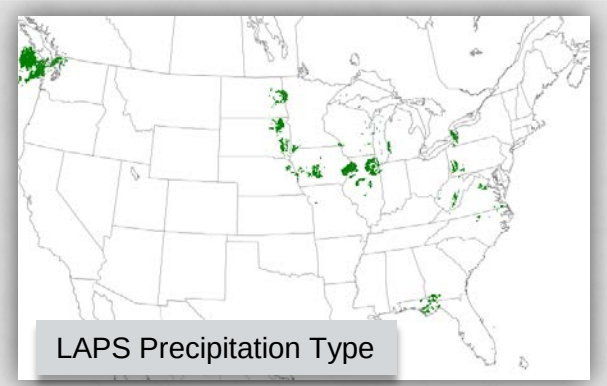


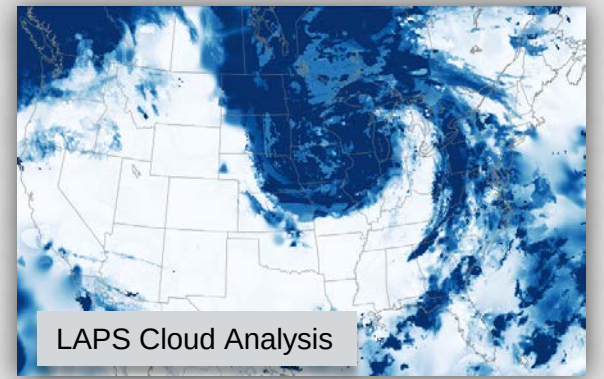


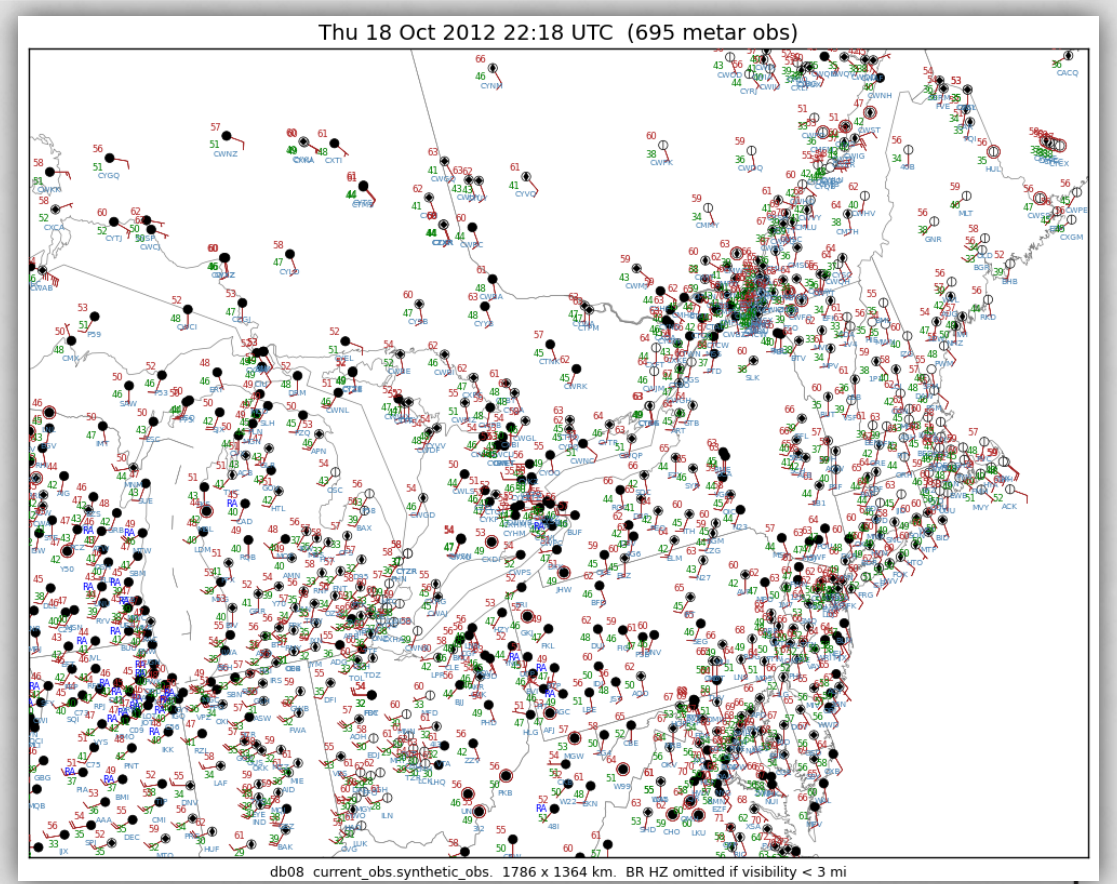


WeatherOps

Enhanced Observations





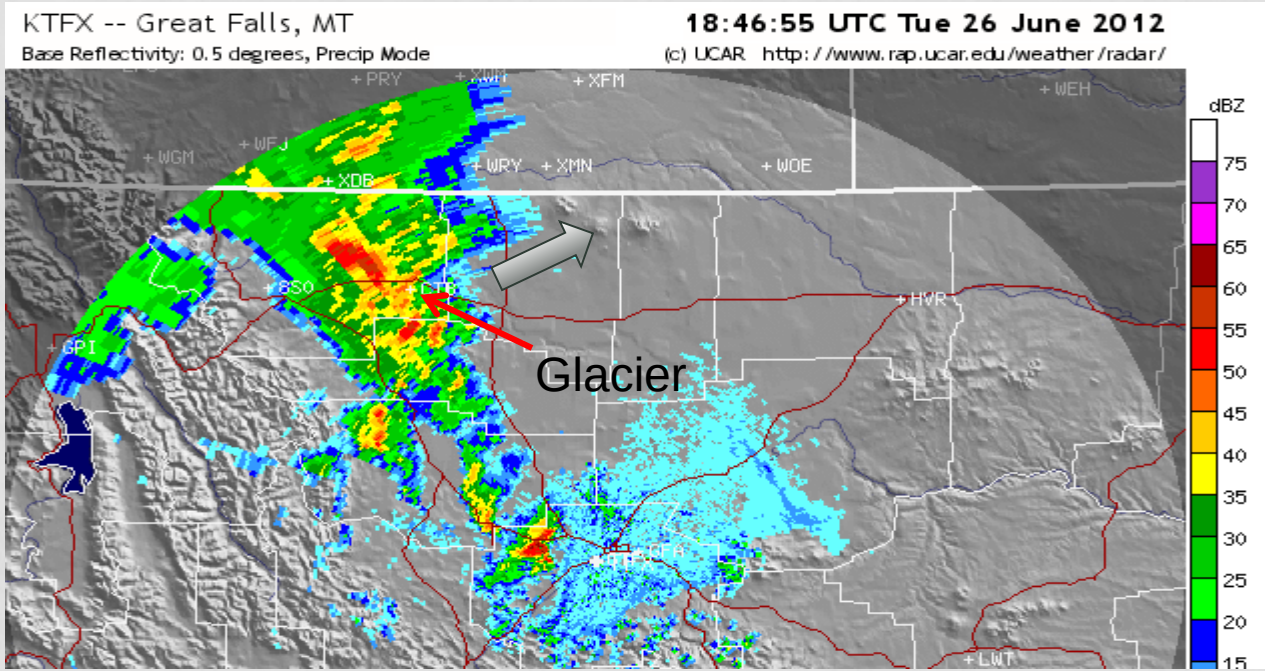


WeatherOps

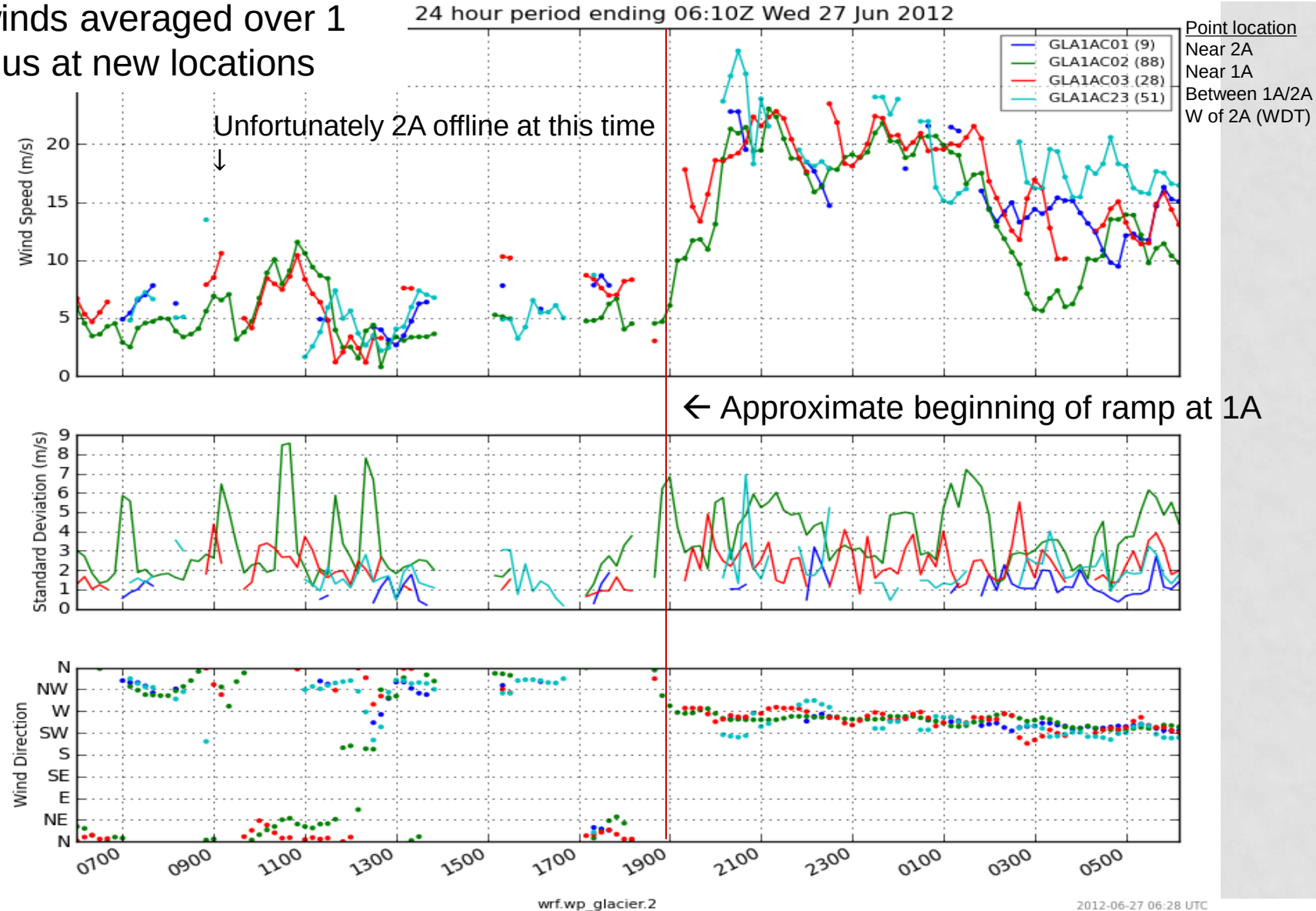
Wind Energy

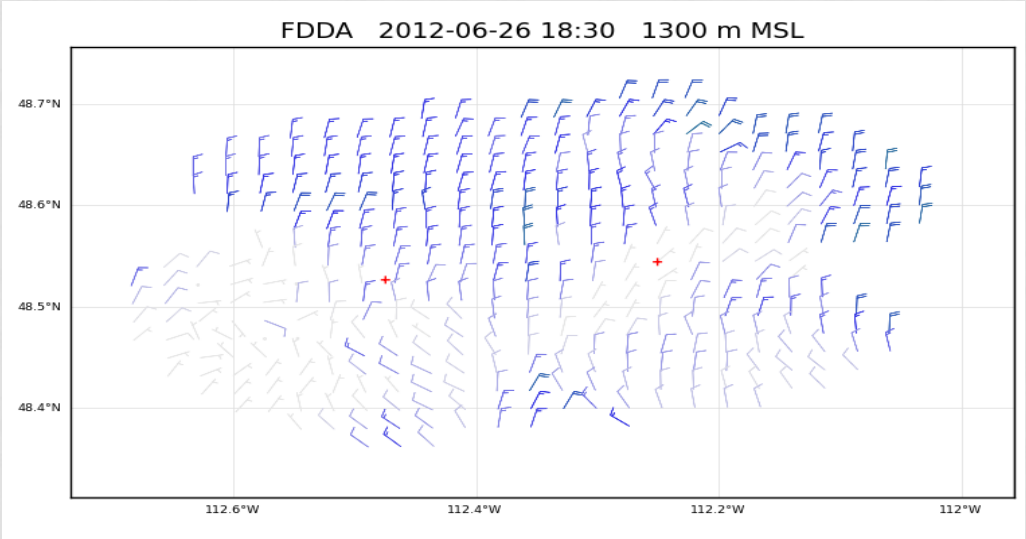
- Need for rapid update, high-res, short-range forecasts
- WDT developed WRF-based WindPredictor™ system
  - State of Oklahama EDGE Grant Recipient
  - WRF + statistical correction
- Data assimilation key to capturing ramps
  - LAPS can use radar and other advanced instrumention
  - WindTracer Project

Line of severe thunderstorms moved WNW across Glacier around 1845Z 26 June 2012

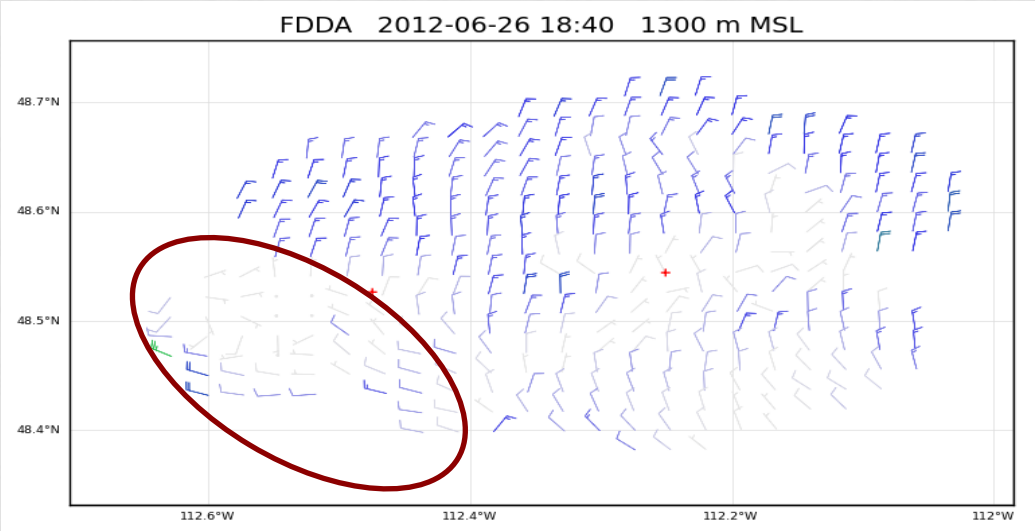


80-m winds averaged over 1 km radius at new locations

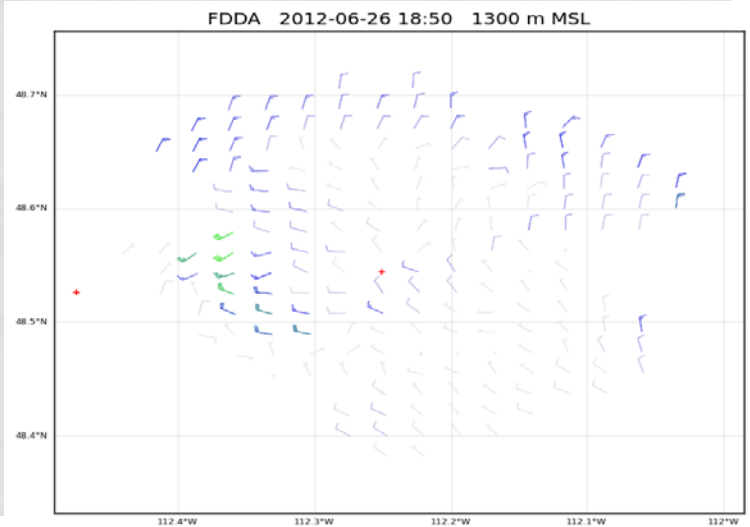




Mostly N winds at 1830Z

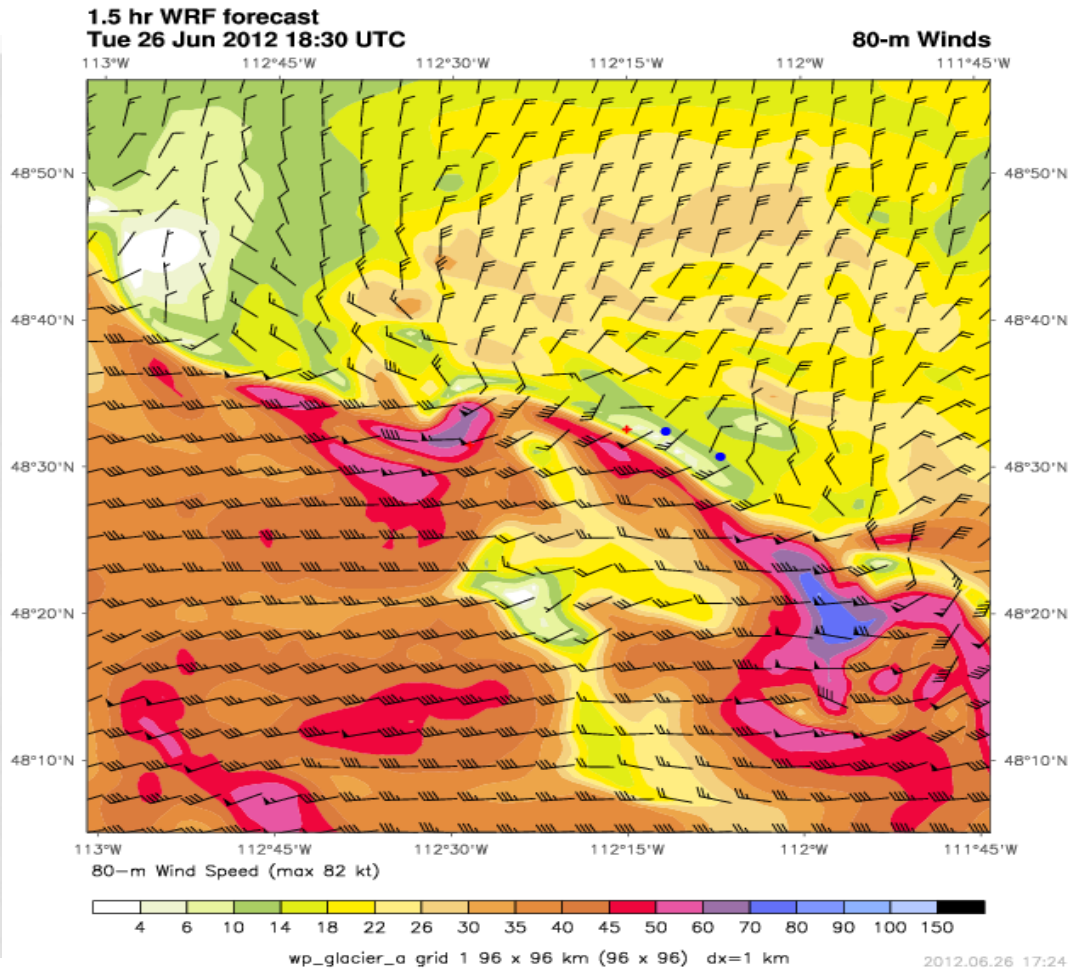


W winds at 1A (2A offline) at 1850Z



W winds appear at edge of coverage by 1840Z

Event well represented by WRF model



WeatherOps

iMap

Post-processing and verification

- Post-processing
  - Bias correction
  - Trending first part of forecast to observations
  - Smoothing
- Results
  - Forecasts are better than persistence after about 1.5 hours
- **Next: LAPS Assimilation**
  - **Radial winds vs. retrievals**
  - **Nowcasting Input**
  - **Model Initialization**

Verification for Hour 2 (2:00 to 2:59)

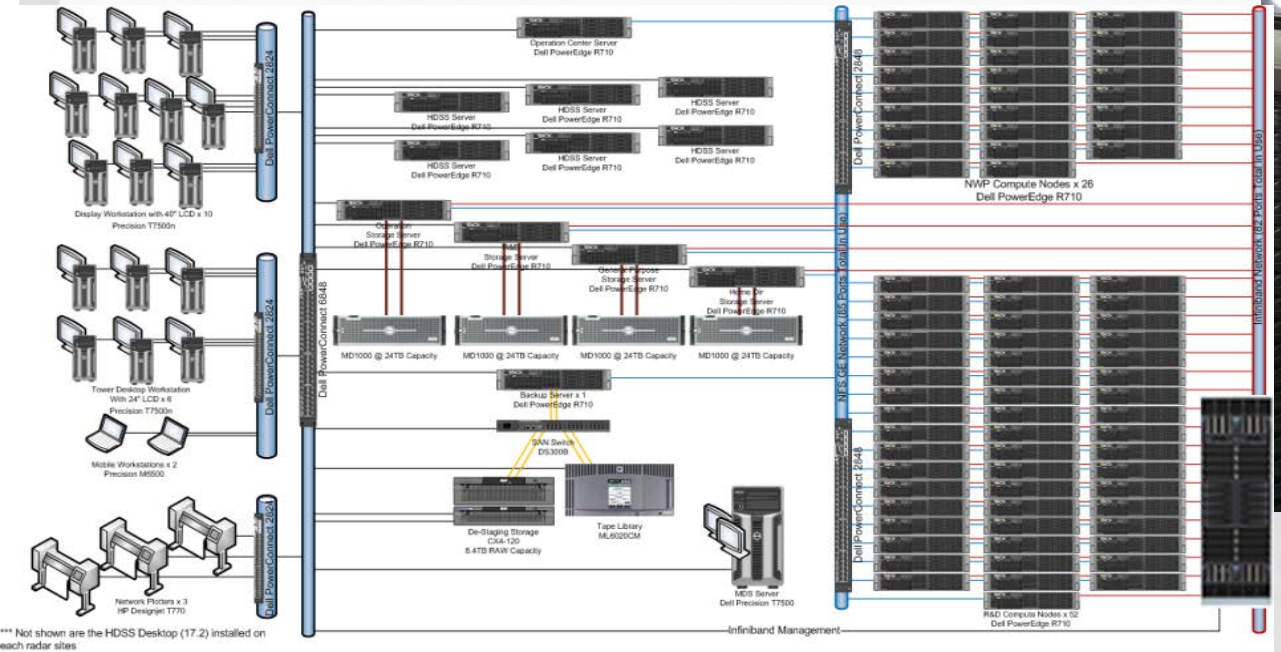
Model	Bias	MAE	StDev
WRF no WindTracer	-0.13	2.06	2.66
WRF +WindTracer	-0.10	2.02	2.62
WRF +WindTracer +bias/trending	0.11	1.92	2.50
Persistence	0.03	2.17	2.97

International Applications

- Philippines – PAGASA NWP System
  - LAPS+FDDA (MTSAT, 3D Radar, AWS surface obs)
- UAE - Dubai International Airport Met Office NWP
  - LAPS+FDDA (MSG, 3D Radar, Radiometer, Wind Profiler, AWS observation)
- *Thailand – Commercial Flood Warning System*
  - *In development – will assimilate MTSAT and 3D Mosaics*

PAGASA Project: Began July 2010

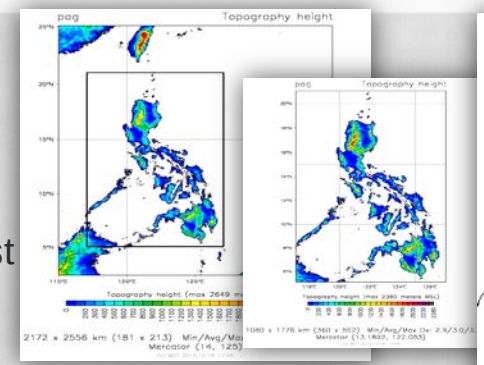
PAGASA: December 2010

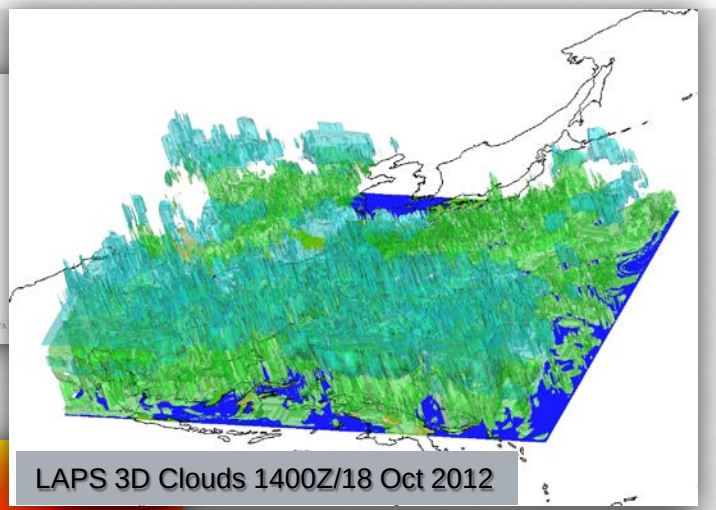


First InfiniBand Switch in Philippines!

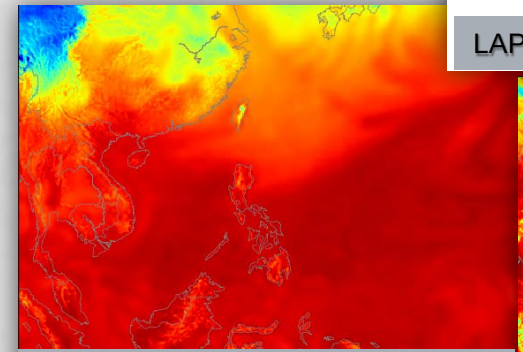
Current Operational Configuration

- WRF-ARW v3.3.0
- Nested Grids (12/3 km)
- Two Configurations
  - Hourly, short-range forecast
    - 24/12-h on outer/inner grid
  - 3-hour mid-range
    - 84/48-h on outer/inner grid
- LAPS+FDDA Assimilation
  - MTSAT
  - 3D Radar Mosaics
  - AWS Observations

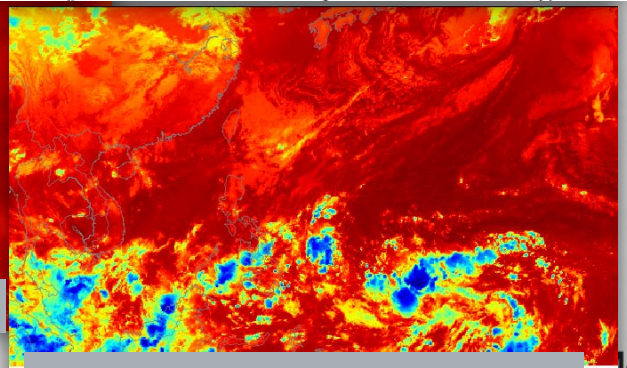




LAPS 3D Clouds 1400Z/18 Oct 2012

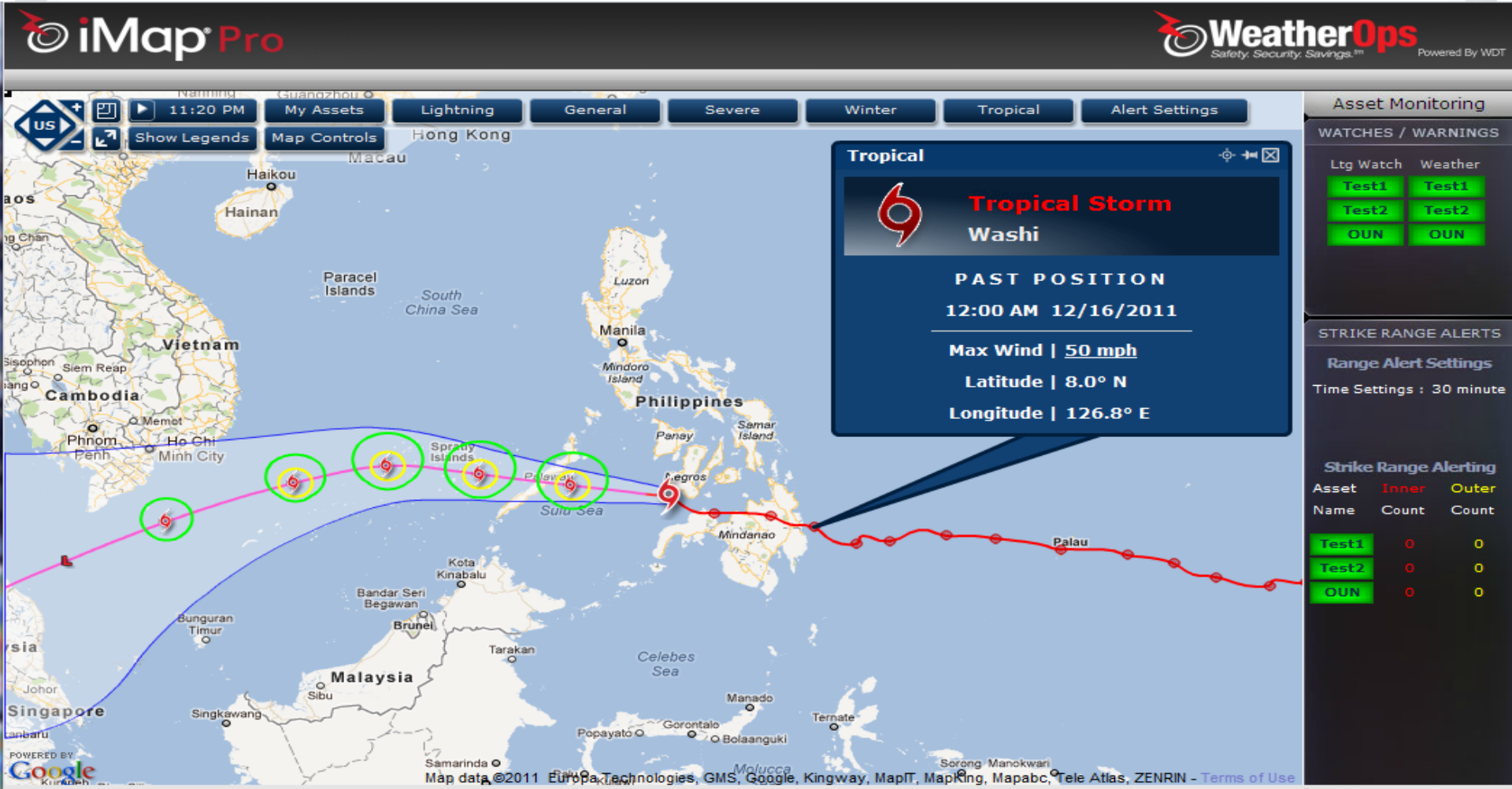


LAPS 2m Dewpt 1400Z/18 Oct 2012

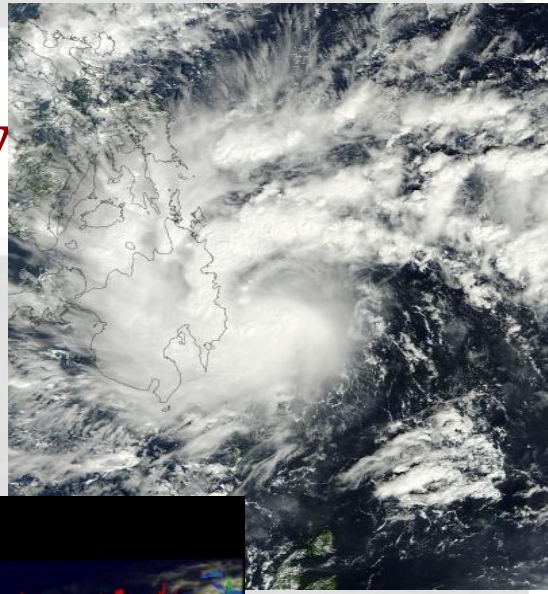


LAPS IR Bright Temp 1400Z/18 Oct 2012

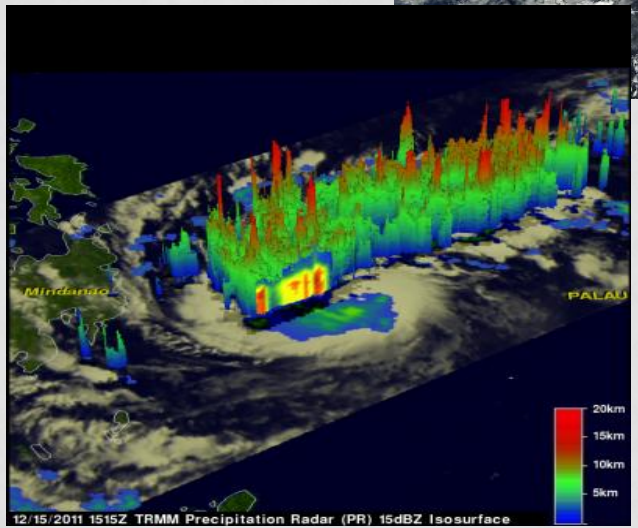
TS Washi 2011-12-17



TW Washi Summary

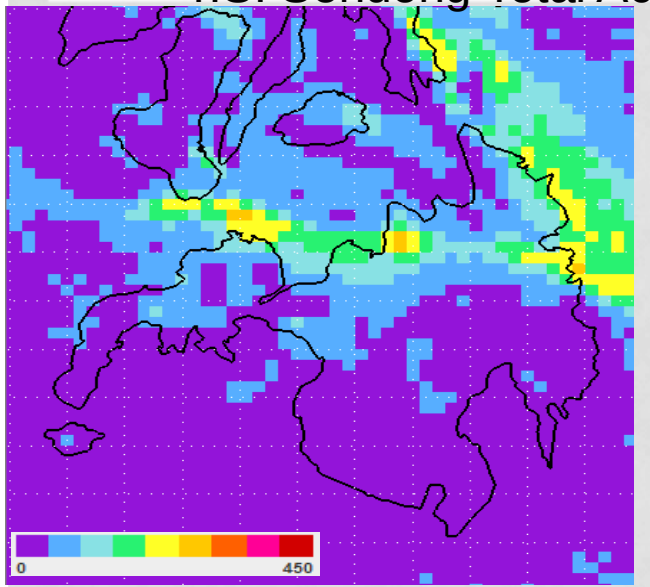


- **Impacts**
  - Cayagon de Oro and Iligan hit hard
  - Rapid and sudden flash flooding
  - Nearly 1000 fatalities
  - Over 388,000 affected
  - Broadcaster Enie Alsonado killed helping neighbors
  - 12+ Hours of Heavy Rain
  - Max Wind: 83 km/h
  - TRMM Precip Rate: 50 mm/h

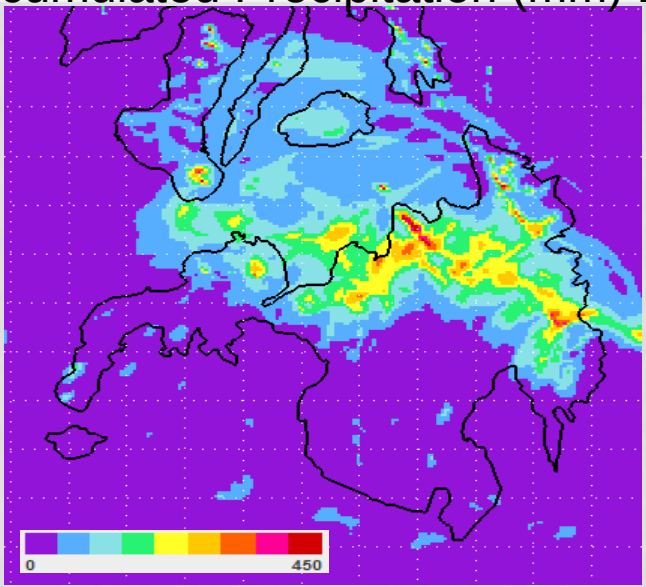


TS Washi – Forecast vs. Observed Rain

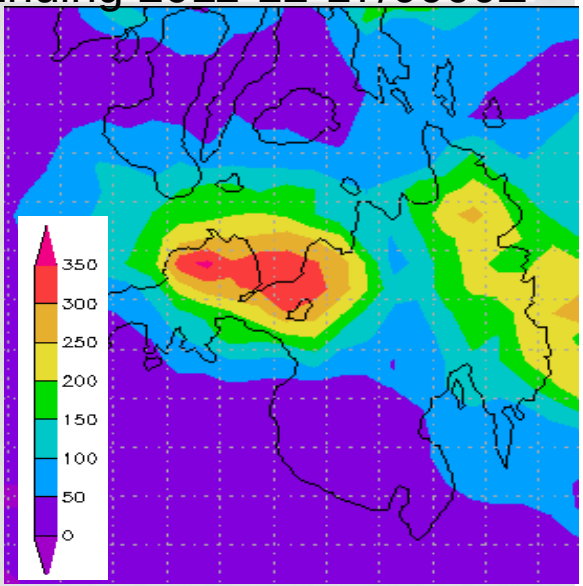
T.S. Sendong Total Accumulated Precipitation (mm) Ending 2011-12-17/0000Z



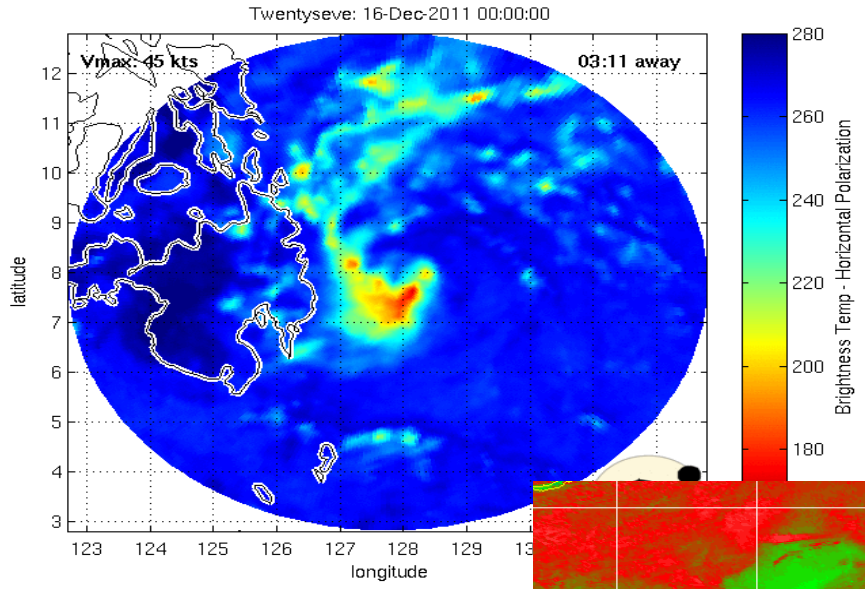
WRF 12-km 72-h Forecast
Initialized 2011-12-14/0000Z

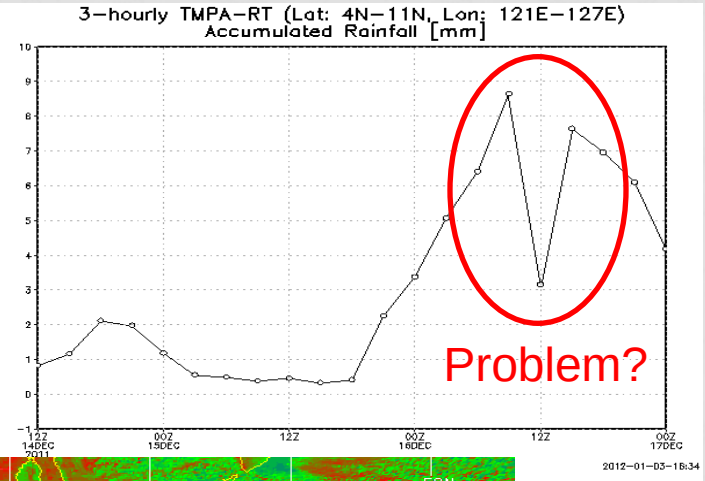


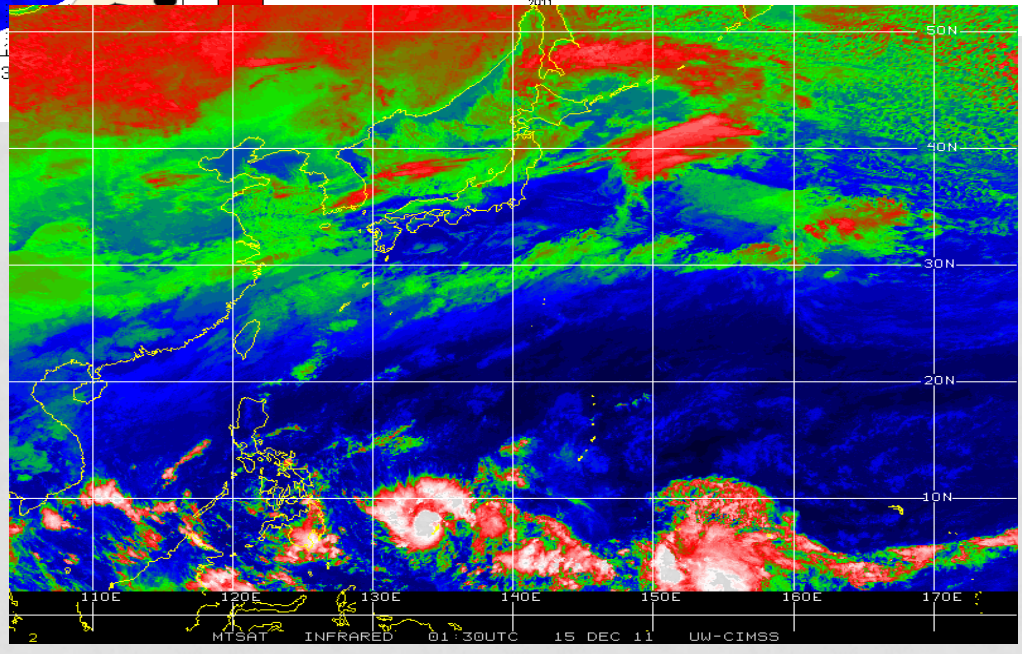
WRF 3-km 60-h Forecast
Initialized 2011-12-14/1200Z



TRMM 0.25° Multisensor Analysis
2011-12-14/1200Z – 2011-12-17/0000Z


Twentyseve: 16-Dec-2011 00:00:00
Vmax: 45 kts
03:11 away
latitude
longitude
Brightness Temp - Horizontal Polarization


3-hourly TMPA-RT (Lat: 4N-11N, Lon: 121E-127E)
Accumulated Rainfall [mm]
Problem?
2012-01-03-16:34


50N
40N
30N
20N
10N
110E
120E
130E
140E
150E
160E
170E
MTSAT INFRARED 01:30UTC 15 DEC 11 UW-CIMSS

WDT's Key LAPS Issues/Interests

- Cloud Analysis Artifacts
- Enhanced Analysis Methods (STMAS, GSI, etc.)
- Satellite Ingest Updates (GOES, MTSAT, MSG)
  - Flexibility, documentation, etc.
- General Architecture and Documentation
  - Repositories and Code Sharing
  - Code structure