

Commercial applications driven by WRF at The Weather Company

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28 June 2016

WRF-based “RPM” System

- **Numerical Weather Prediction System**
 - Forecasts out to 3 days
 - Provides global 13km coverage, regional 4km
 - Forecasts updated every 1 - 6 hours
- **Multi-million dollar ongoing research and development**

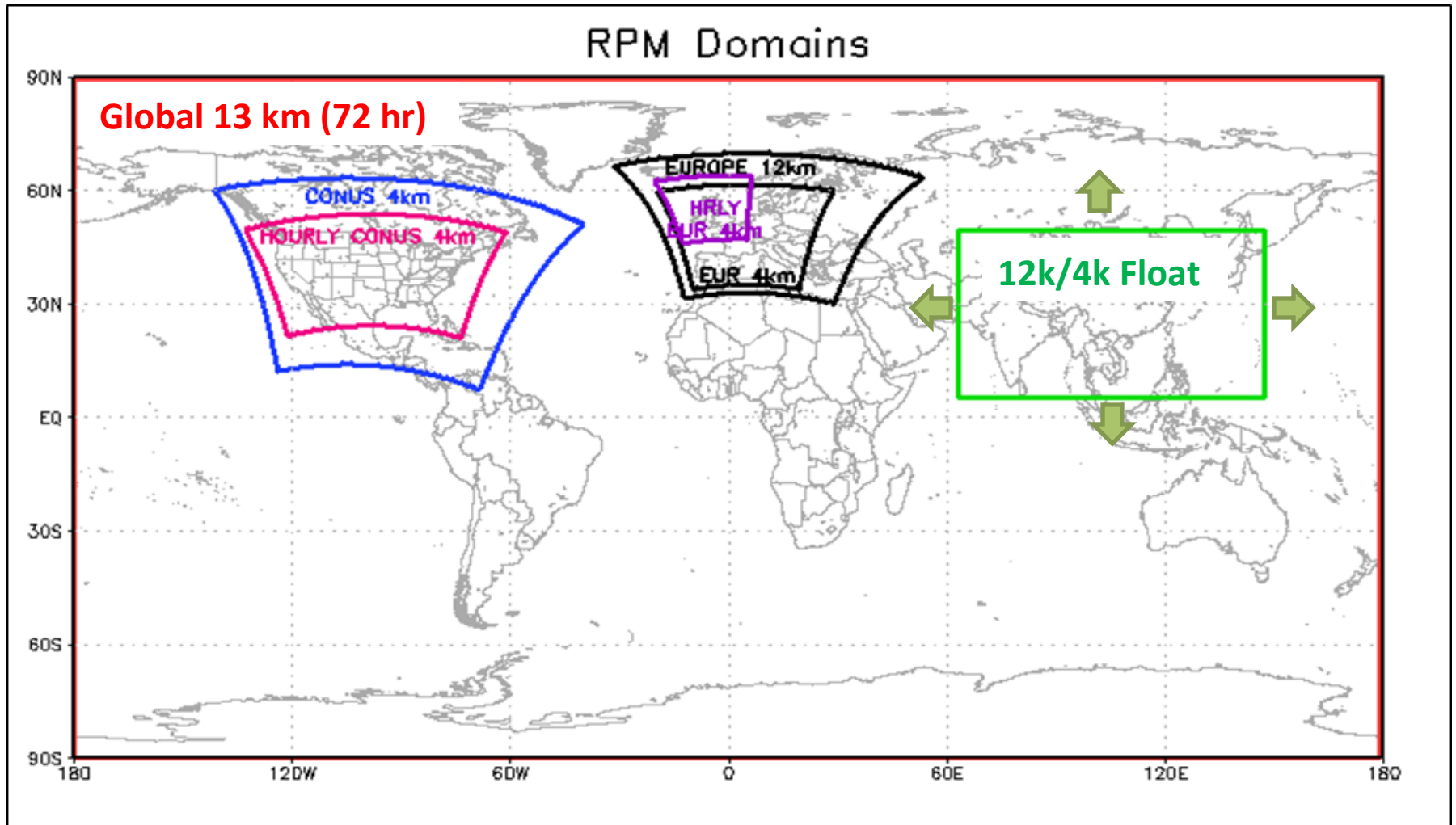


- **Operational since 2003; supported 7x24**



- **Brand name “RPM”**

Domains



Domains run every 1 – 6 hours

WRF contributes to many applications

- **Consumer Forecasts**

- Web, Digital Devices

- Give the consumer a simple forecast
 - And, let the user tailor the information

- **Media**

- TV production quality forecast graphics

- Tell the weather story to consumers

- **Commercial Aviation**

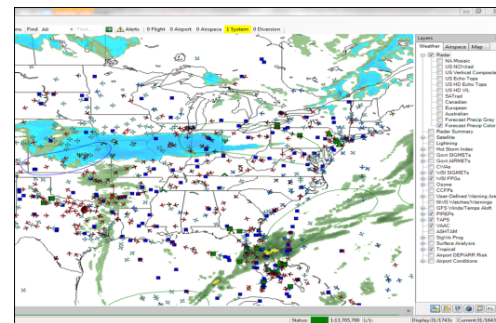
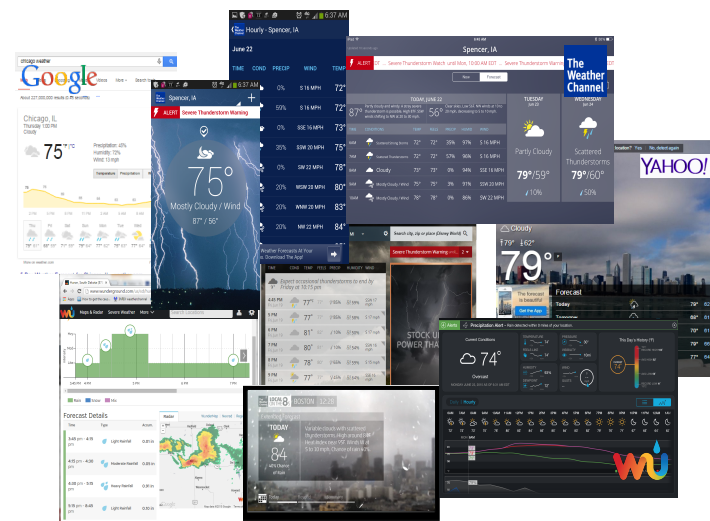
- Flight planning guidance (turbulence, convective hazards, TAF forecasts)

- Help professional aviation make decisions
 - Provide forecast data for general aviation

- **Energy and Risk**

- Electricity and Natural Gas Trading

- Solar, Wind, Temperature Guidance



A large, semi-transparent blue circle is positioned in the top right corner of the slide, partially overlapping the white background and the blue sky image.

SAMPLE APPLICATIONS AND PRODUCTS

Consumer: TWC Forecast-On-Demand

Drives Billions of Forecasts per day through TWC and partner applications

Some Key Characteristics

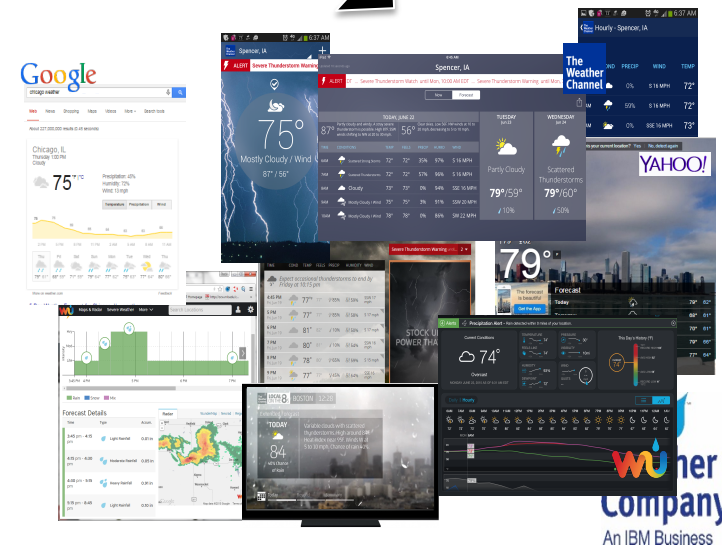
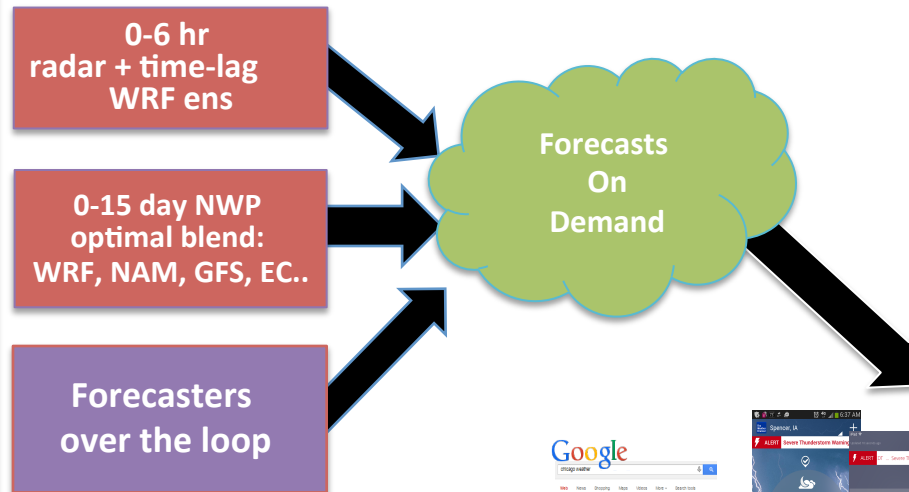
Personal: Every forecast is created and delivered “on demand” for each user.

Human Input: Forecaster influence retained.

Fresh: Forecasts always reflect the latest collection of relevant inputs from all sources.

Precise: Forecasts built from full resolution input data.

Optimized: Various statistical and scientific methods govern optimal forecast assembly.



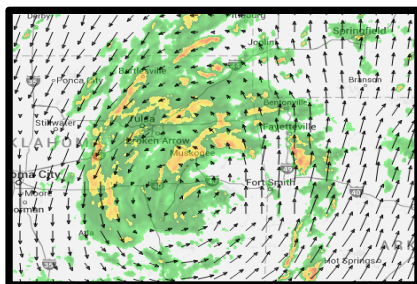
Consumer: WRF contributions to FoD

Spatial analysis of Radar
Extrapolation: POP +
precip rate

Weighted average of subsequent runs
spatially analyzed precipitation fields
provides POP; latest run provides precip rate

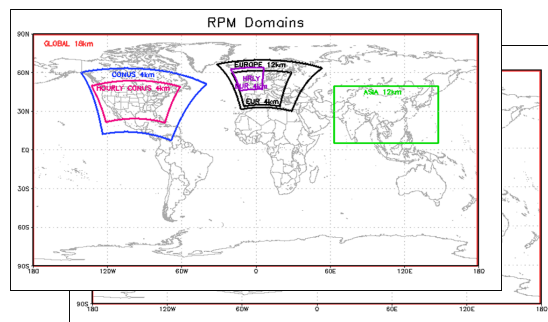
Every 5 min

0-6 hr
radar + time-lag
WRF ens



+

Blend



=

TODAY, JUNE 22

87° 56°

Fairly cloudy and windy. A strong evening thunderstorm is possible. High 87°. SW winds shifting to NW at 20 to 30 mph.

Clear skies. Low 56°. NW winds at 10 to 20 mph, decreasing to 5 to 10 mph.

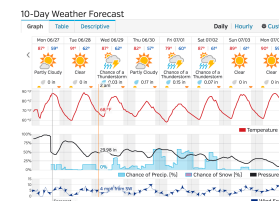
TIME	CONDITIONS	TEMP	FEELS	PRECIP	HUMID	WIND
6AM	☁ Scattered Strong Storms	72°	72°	35%	97%	S 16 MPH
7AM	☁ Scattered Thunderstorms	72°	72°	57%	96%	S 16 MPH
8AM	☁ Cloudy	73°	73°	0%	94%	SSE 16 MPH
9AM	☁ Mostly Cloudy / Wind	75°	75°	3%	91%	SSW 20 MPH
10AM	☁ Mostly Cloudy / Wind	78°	78°	0%	86%	SW 22 MPH

Updated when new
data arrives

0-15 day NWP
optimal blend:
WRF, NAM, GFS, EC..

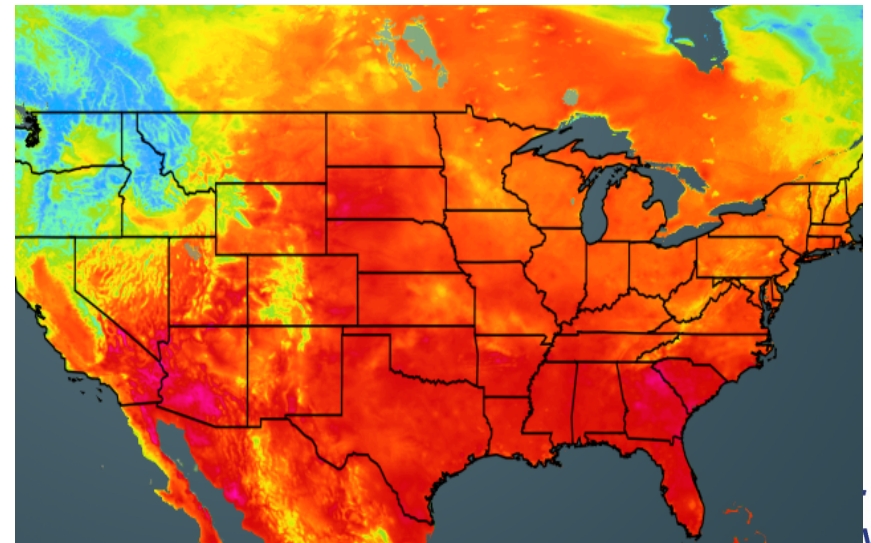
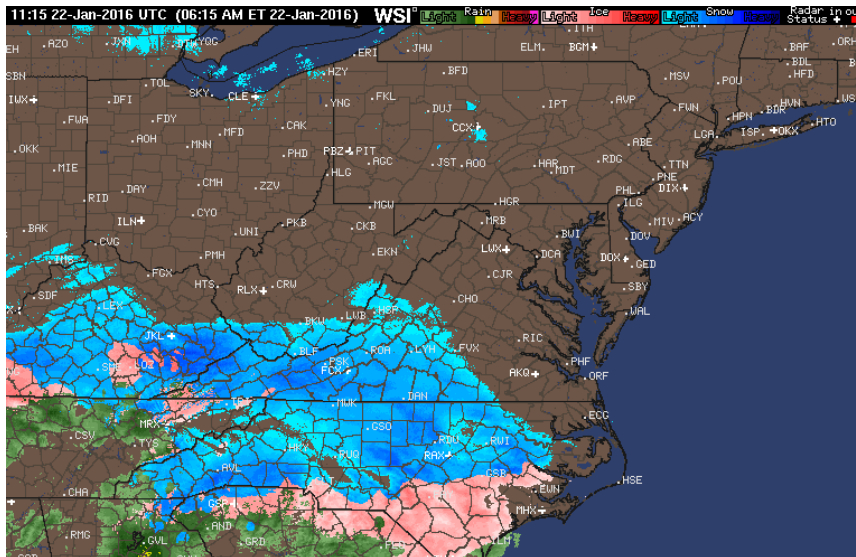
Optimally weighted,
dynamic blend of 162
Model members

WRF contributes to blend,
and is often the most
highly weighted (0-72 hrs)
for precipitation



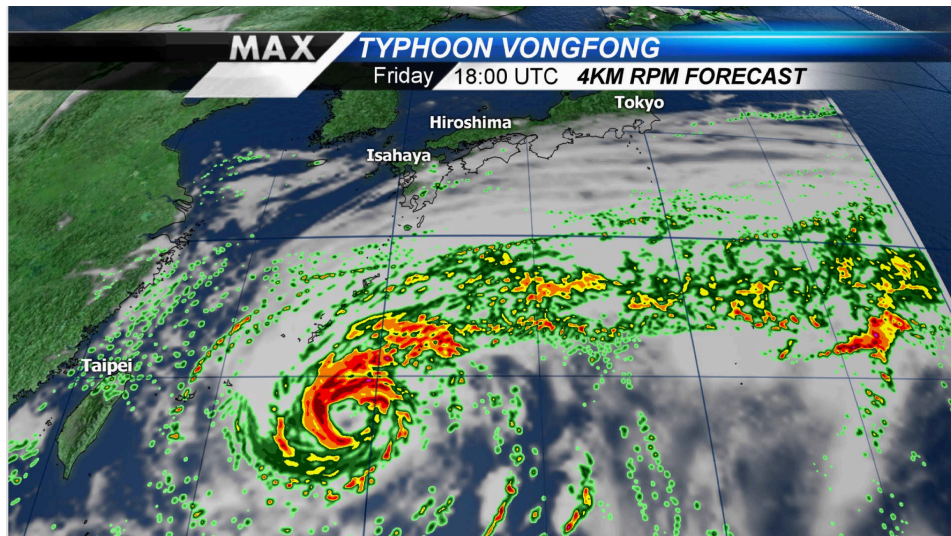
Media: Global Precipitation Type and Temperature

- 1km Precip Type analysis
- applied to radar analysis within “NOWRAD” product
- derived from 13/4km WRF vertical temp/moisture
- adjusted with surface observations, elevation
- Produced every 5 minutes Globally



Media: Forecast Precipitation

- Forecast Precipitation
- Widely used in television media
- Often labeled “Futurecast” or “RPM”
- Globally available at 4-13 km resolution

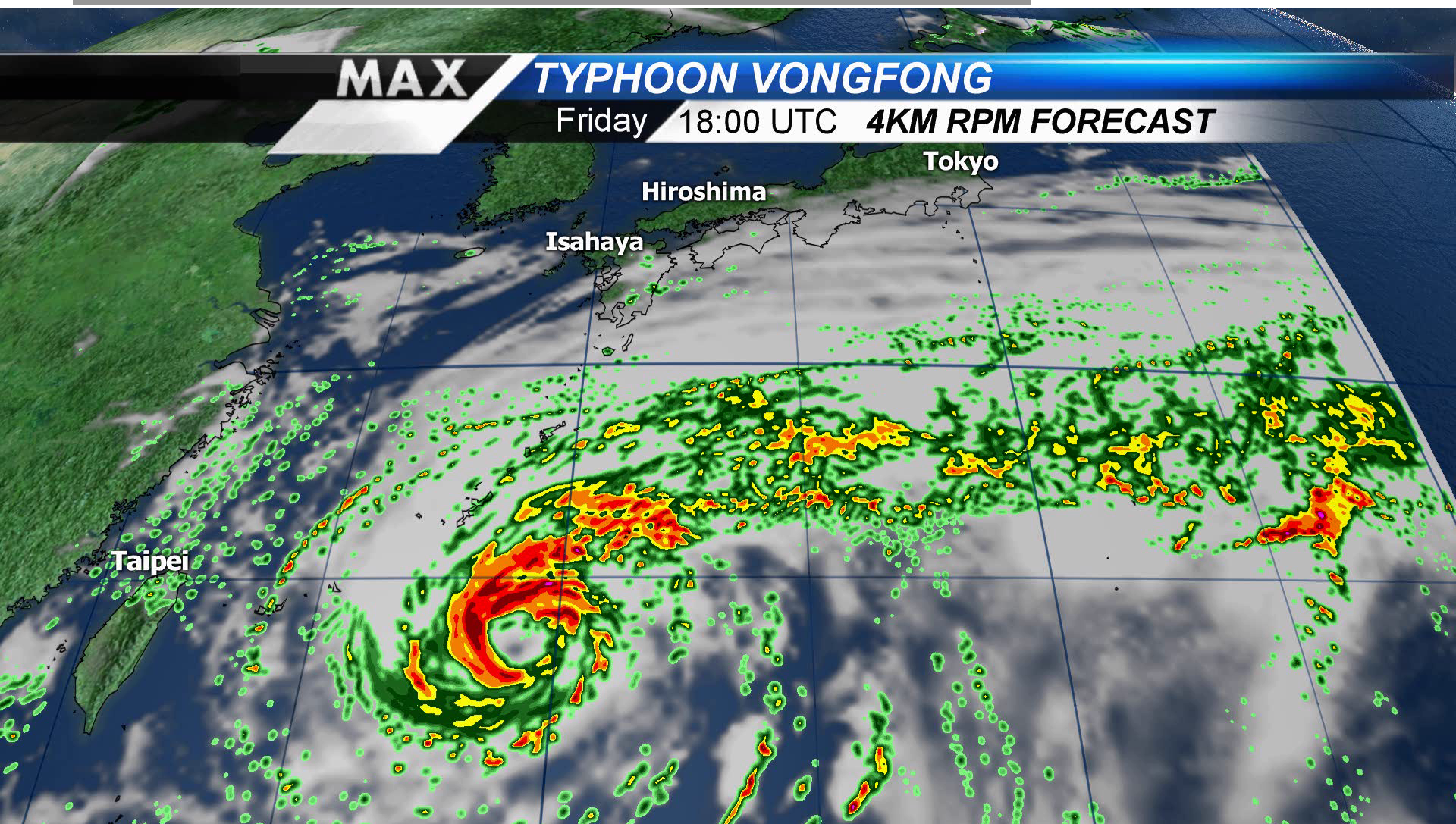


Media: Forecast Precipitation

MAX

TYPHOON VONGFONG

Friday 18:00 UTC **4KM RPM FORECAST**



Media: Max Sky: A visualization of tomorrow's weather

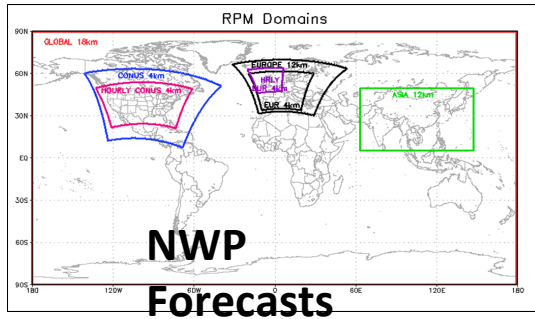
- WRF provides forecasts to define cloud type, flow, height, precipitation intensity
- Artists generate cloud textures
- Computer Graphics engineers use Sun location to properly light clouds



Media: Max Sky: A visualization of tomorrow's weather

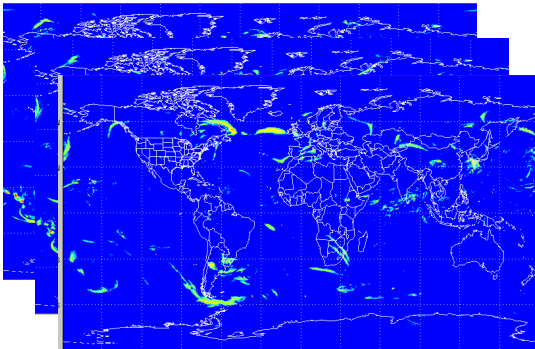


Aviation: Enroute turbulence

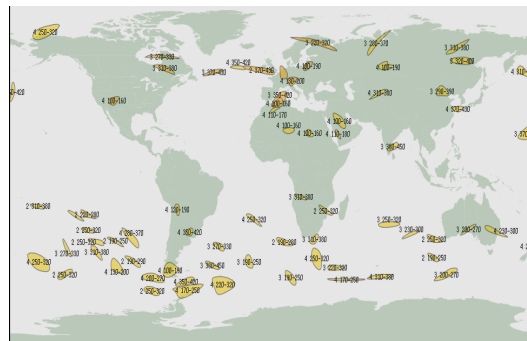


Post-processing: Turbulence
algorithms (Sharman et al)

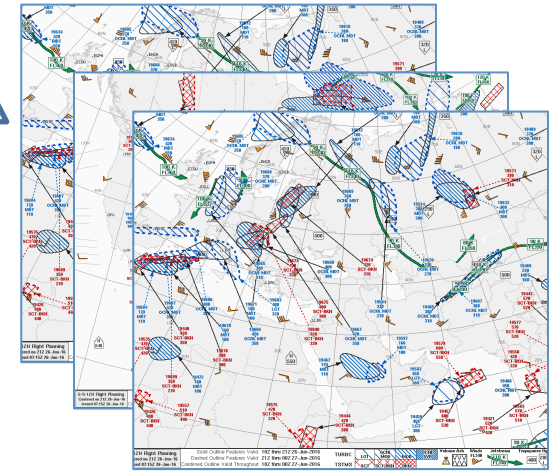
Turbulence Forecasts on flight levels



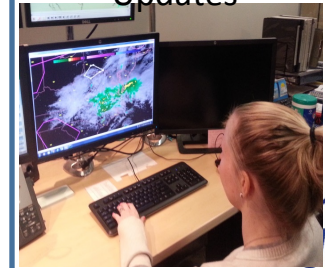
Condensed into 2-D polygonal products



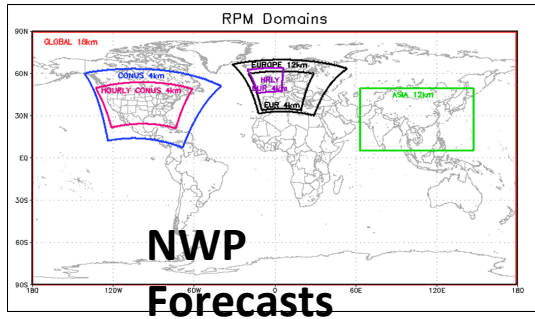
Contribute to Products



Forecaster
Updates



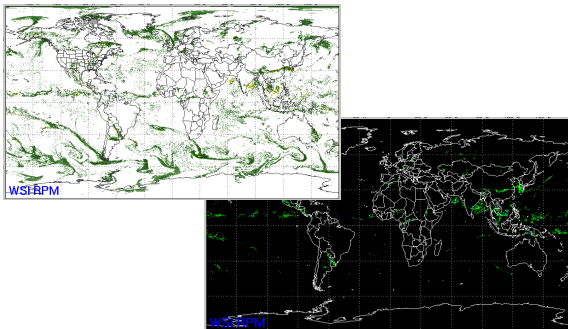
Aviation: Enroute convection



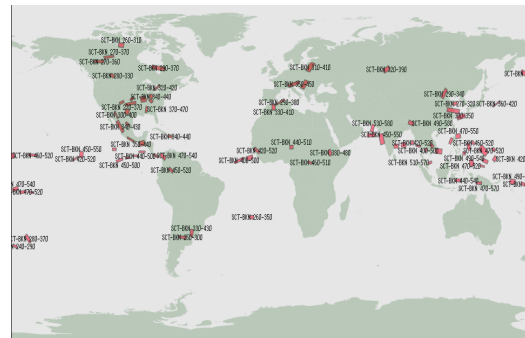
Post-processing:
Meld Domains, Convective Mask



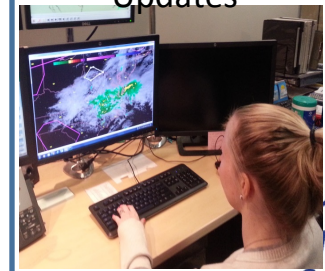
Convective Forecasts



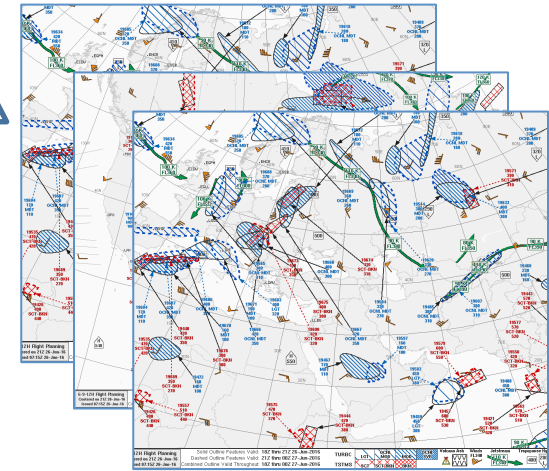
Condensed into 2-D polygonal products



Forecaster
Updates



Contribute to Products



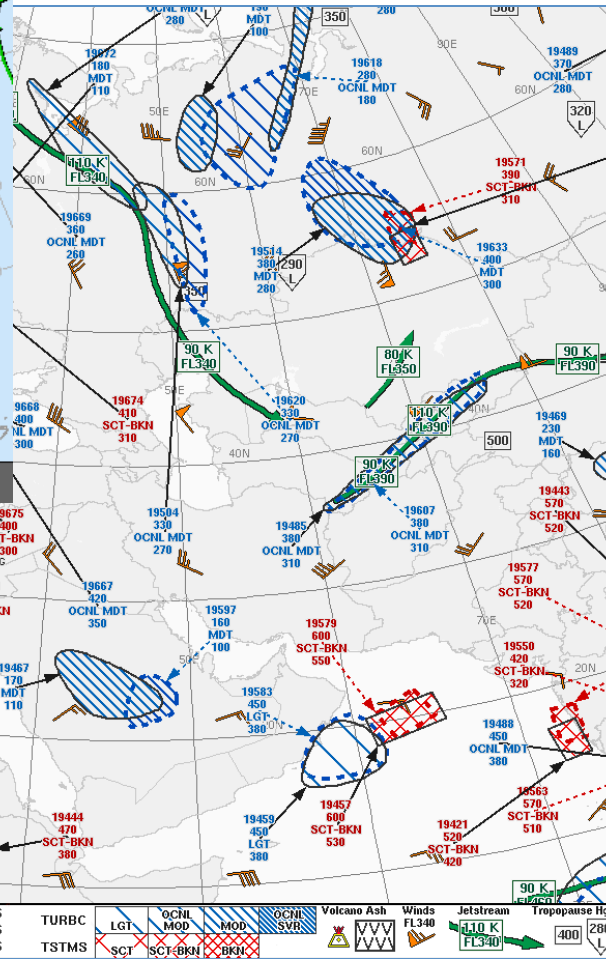
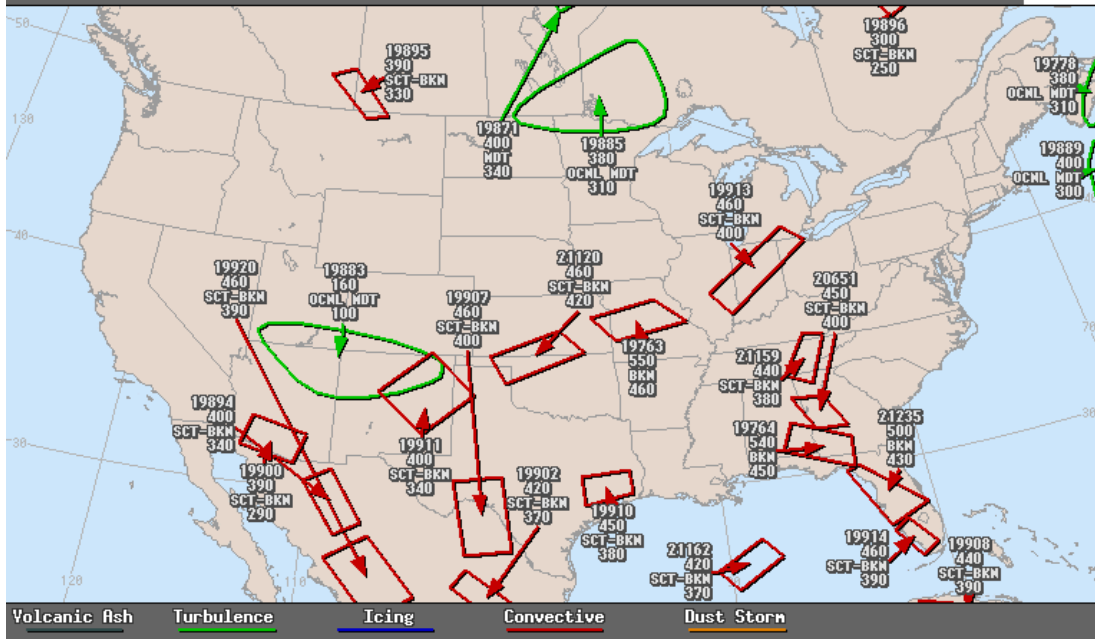
Aviation: Enroute products

Flight Plan Guidance 03hr

Valid 21:00z 26-Jun-2016

Updated: 20:13z 26-Jun-2016

WSI°



12H Flight Planning
Valid on 21Z 26-Jun-16
Valid 07:15Z 26-Jun-16

Solid Outline Features Valid: 18Z thru 21Z 26-Jun-2016
Dashed Outline Features Valid: 21Z thru 00Z 27-Jun-2016
Combined Outline Valid Throughout: 18Z thru 00Z 27-Jun-2016

TURBC
TSTMS

LGT
SCT

OCNL MOD
SCT-BKN

MOD
BKN

OCNL SVR
FL340

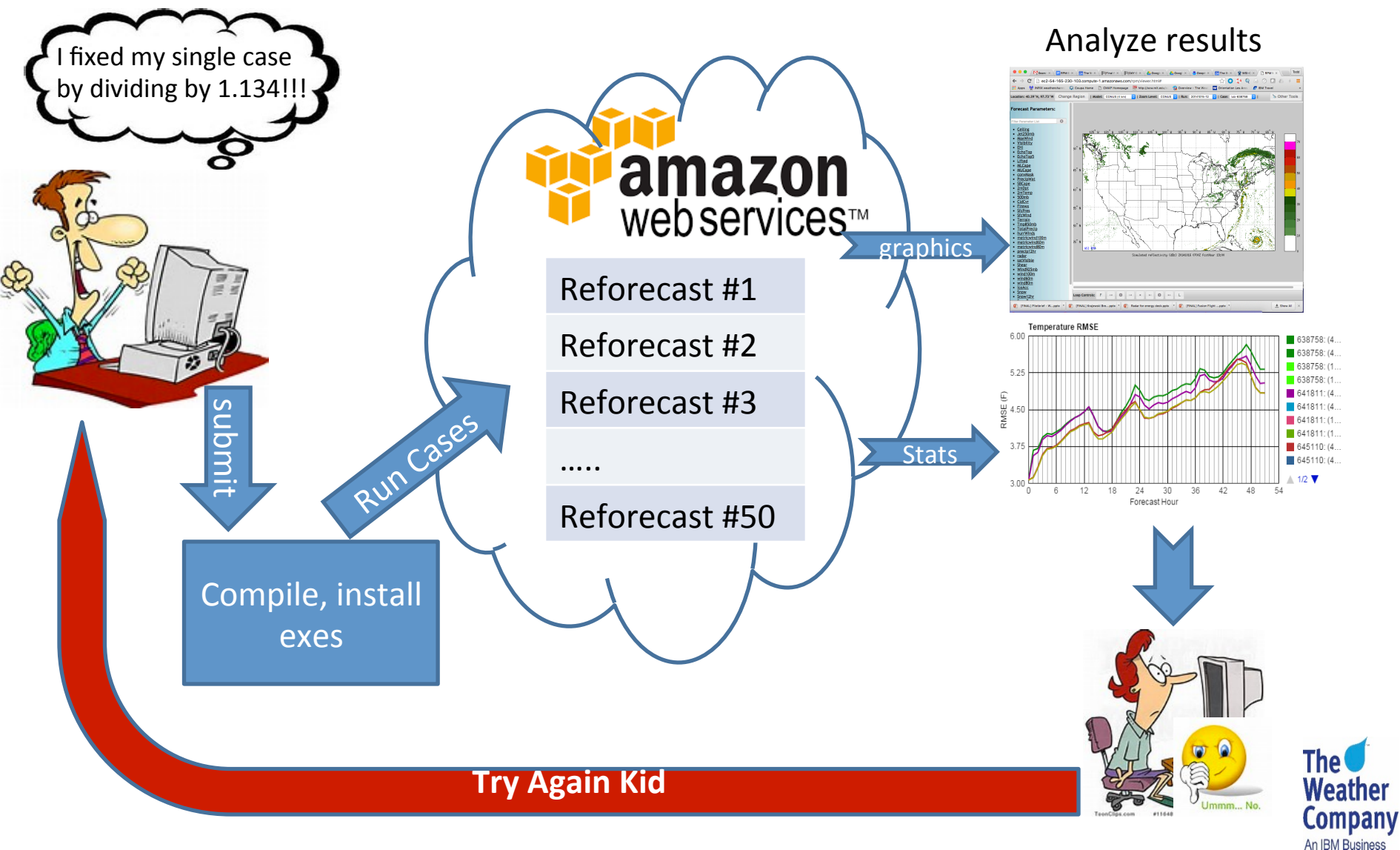
Volcano Ash
Winds

Jetstream
FL340

Tropopause Hg
400

DEVELOPMENT PROCEDURES

Development and Testing on AWS



Development and Testing on AWS

This time, it's real science!!!



submit

Compile, install
exes

Run Cases



Rereforecast #1

Rereforecast #2

Rereforecast #3

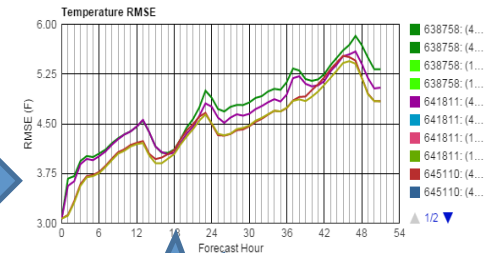
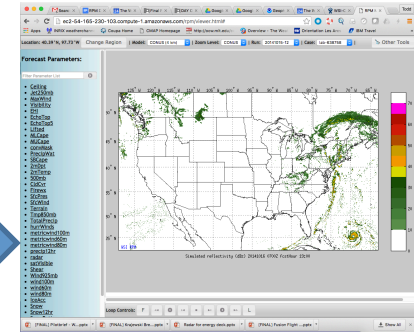
.....

Rereforecast #50

graphics

Stats

Analyze results

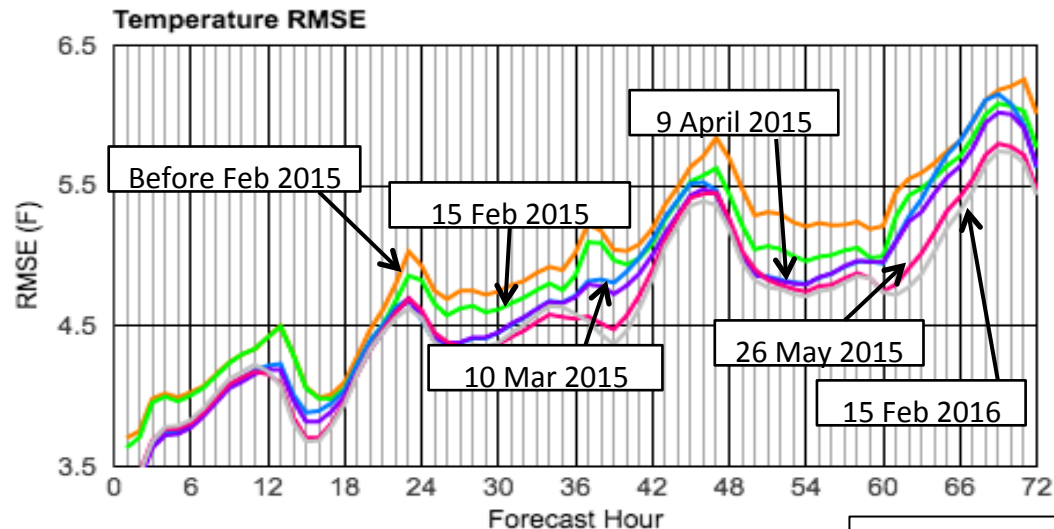


Operationalize
In 2 Weeks

Weather
Company
An IBM Business

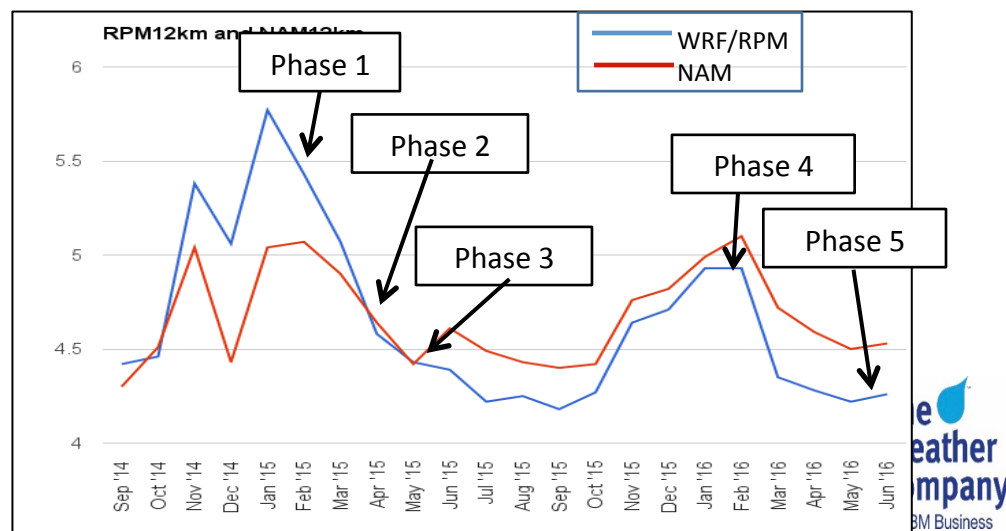
Improvements past 2 years

• Continuous 2m Temperature Improvement



50-case verifications for updates that were promoted to operations

Ph.	Upgrade
-	Urban soil init. to eliminate moisture sinks
1	NAM snowcvr + updated snow thermal eqns
2+3	Updated surface layer equations
4	Updated to RRTMG Radiation
5	Initialize with 2 km sea-surface temperature
6	Initialize with 1km snow depth



Looking Ahead: RPM is now Deep Thunder



Jan 29, 2016



WSI[®]

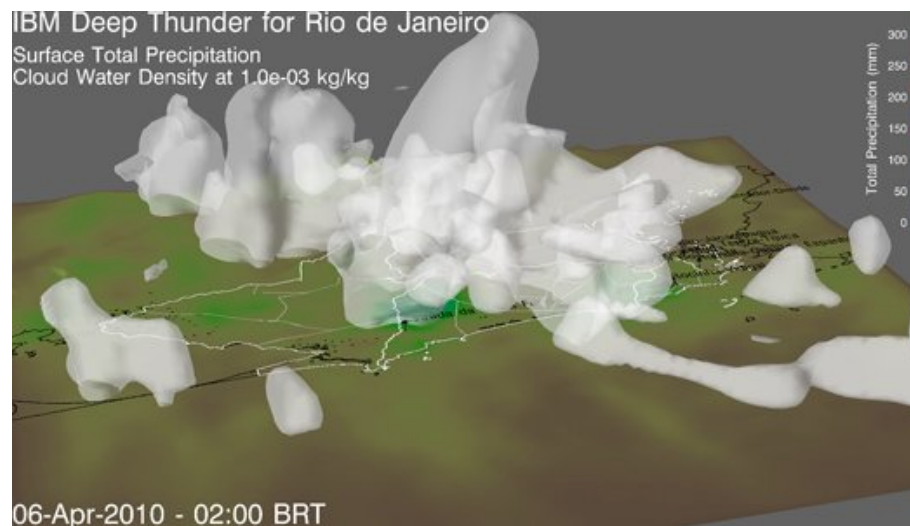
Deep Thunder

Deep Thunder excels with **Local-scale Forecast** Applications

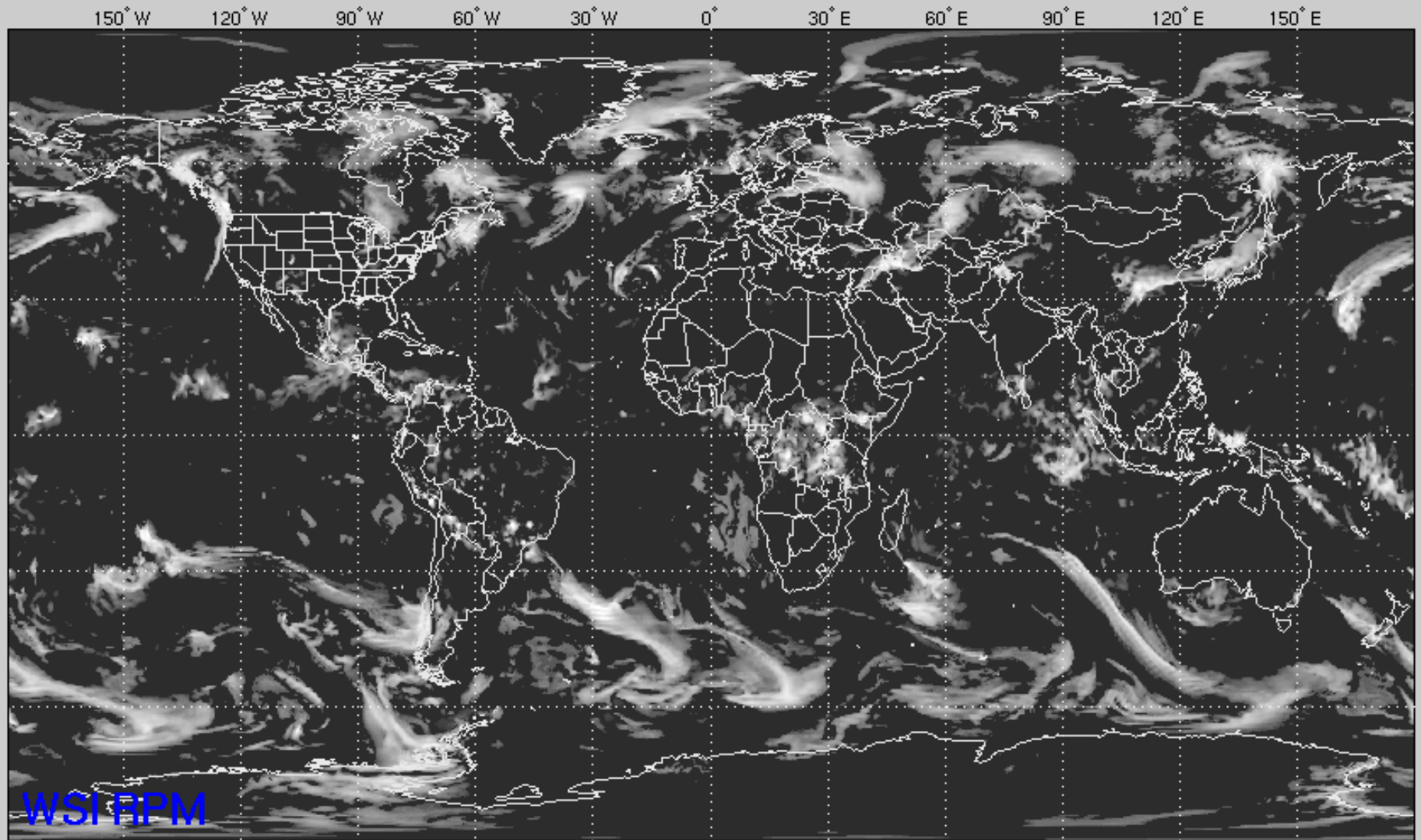
Deep Thunder couples **Renewables & Air Quality** capabilities

Deep Thunder brings **Additional Investments** In Data Assimilation and Outcome Models

TWC **Operational scalable** NWP will incorporate these technologies



Global Clouds



Visible Satellite 20141020 0100Z fcstHr 01:00