

A Personal Journey from Severe Weather Research to Improving the Forecast and Providing Impact-Based Decision Support Services

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Outline

- Starting the Journey: Research Phase
- Joining the NWS Modernization and Associated Restructuring
- Evolving the NWS to Build Weather-Ready Nation
- Building off the Operational And Workforce Analysis
- Summary



Starting the Journey: Research Phase

Gravity Wave Research

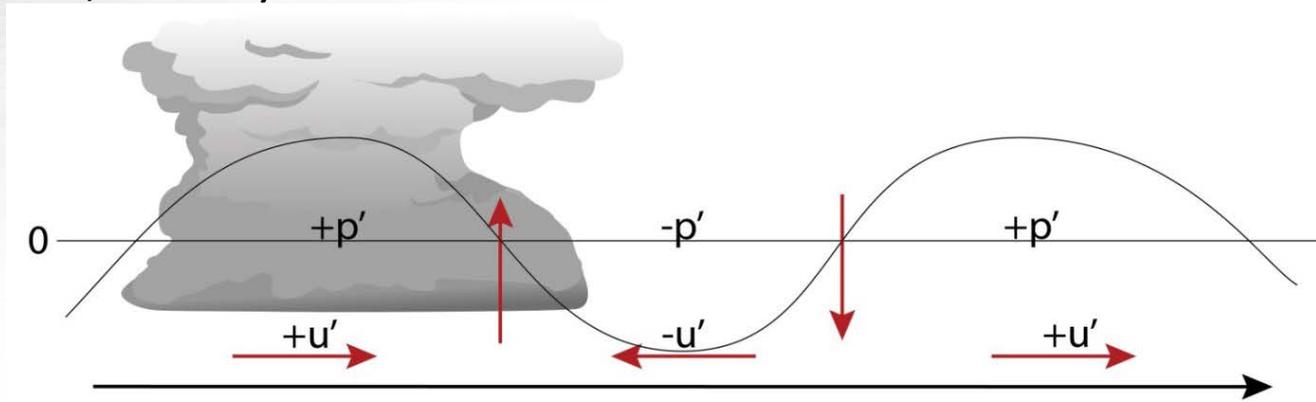
All of my research started/completed with operational data;
ideas originated in the 14th floor fax room



· LOUIE UCCELLINI ·
MEMORIAL ROOM

Gravity Wave Research

- A discussion with Ogura in 1970 directed me to Matsumoto and Akiyama (1969), Matsumoto and Tsuneuka (1969)
- Bosart and Cussen (1973) and Eom (1975): Gravity wave door is reopened
- All my research started/completed with operational data
- Initial focus on the release of convective instability:
 - 3-hour periodic nature of storms as diagnosed with surface convergence and radar data (Senior Thesis, 1971)
 - Isolated the role of 2 to 4 hour period gravity waves in the release of the convective instability using detailed p' analysis (Master's Thesis, 1972)- My first formal publication: (Uccellini 1975, MWR)



- Tabulated pressure traces then passed through a band pass filter

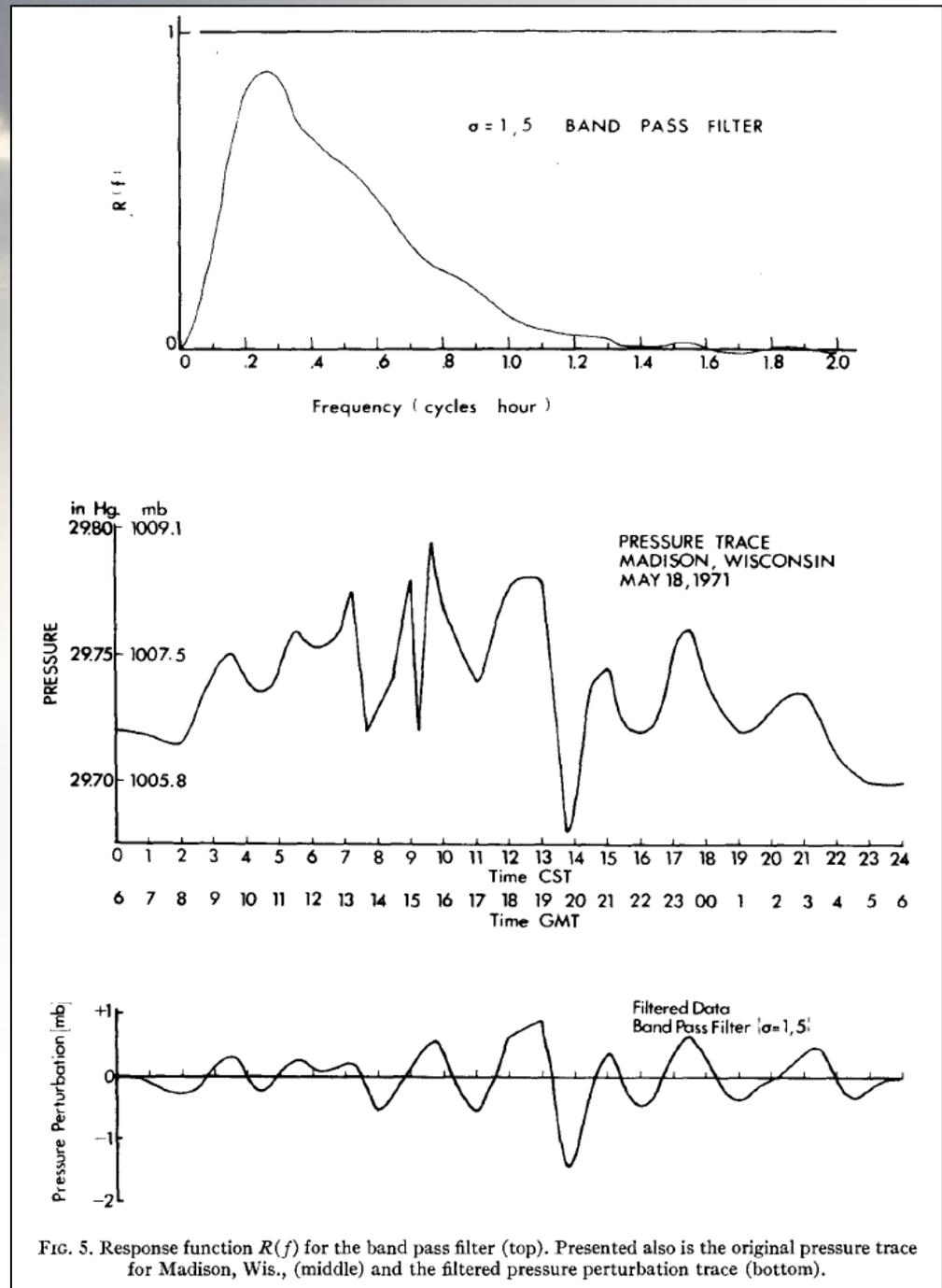


FIG. 5. Response function $R(f)$ for the band pass filter (top). Presented also is the original pressure trace for Madison, Wis., (middle) and the filtered pressure perturbation trace (bottom).

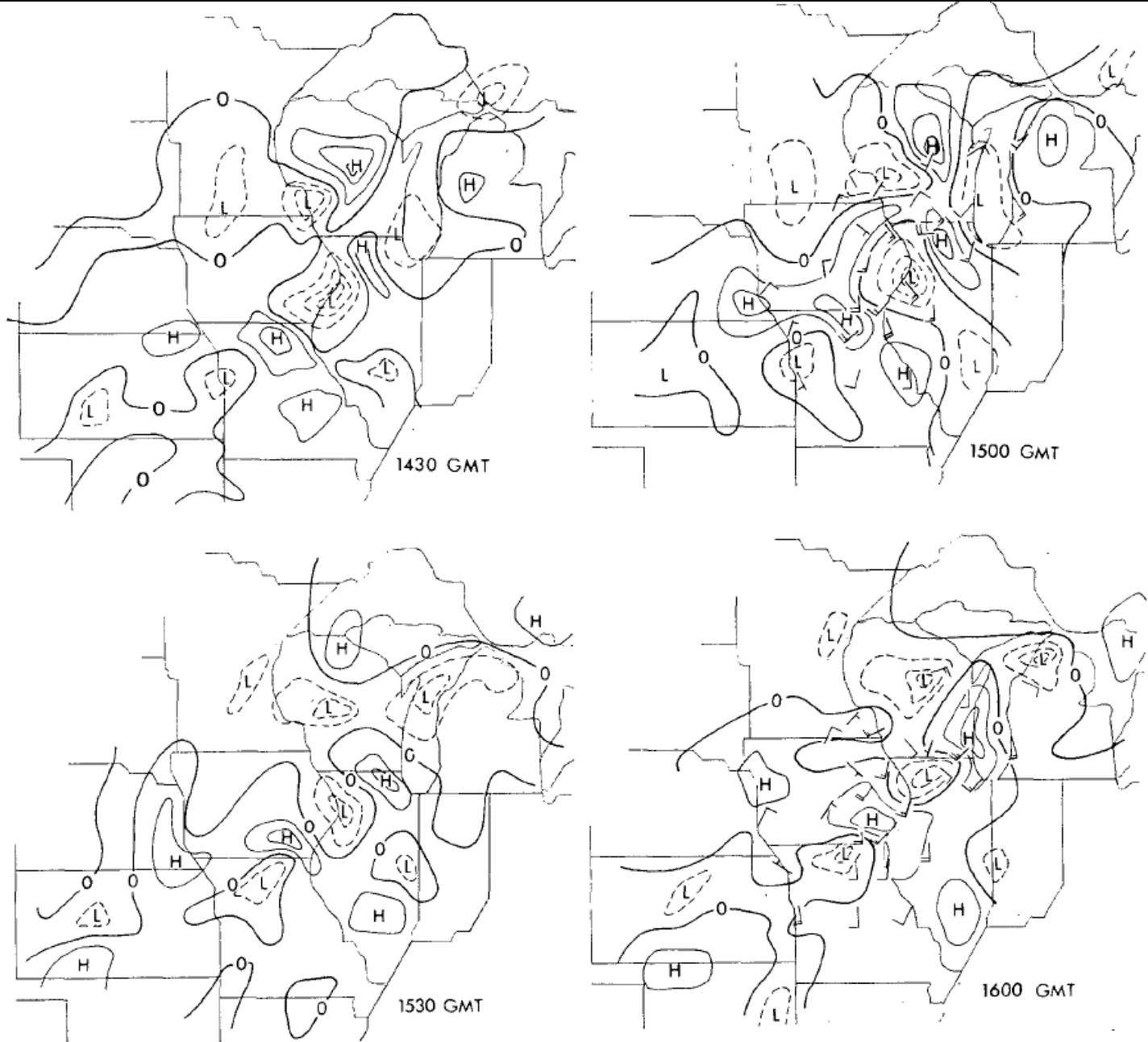


FIG. 6. Successive p' maps analyzed at 0.5 mb interval and surface wind barbs. Negative p' , thin dashed; positive p' , thin solid; $p'=0$, thick solid. The locations of the minimum and maximum p' values are indicated by L and H respectively.

Why is This Important?

- Forecasters are now starting to account for gravity waves in forecast and warnings

Example from WFO Raleigh, NC:

(1:54 PM) nwsbot: RAH issues [STRONG WIND GUSTS POSSIBLE IN THE SANDHILLS AND SOUTHERN PIEDMONT EARLY THIS AFTERNOON](#) for Alamance, Chatham, Davidson, Durham, Forsyth, Franklin, Granville, Guilford, Orange, Person, Randolph, Vance, Wake, Warren [NC] till 5:00 PM EST

(2:28 PM) nwsbot: RAH issues [STRONG WIND GUSTS POSSIBLE ACROSS THE PIEDMONT AND COASTAL PLAIN THIS AFTERNOON](#) for Chatham, Cumberland, Durham, Edgecombe, Franklin, Granville, Halifax, Harnett, Hoke, Johnston, Lee, Moore, Nash, Orange, Sampson, Vance, Wake, Warren, Wayne, Wilson [NC] till 5:00 PM EST

(2:34 PM) nws-barrett.smith: We issued an SPS for the apparent gravity wave that has been tracking north from Georgia earlier this morning. there was a report of damage in Darlington, SC earlier this hour, and several observations of 35-40kt accompanying the pressure/rise couplet.

TRACK OF THE MID-LEVEL LOW AND NORTHERN STREAM WAVE PASSING TO OUT NORTHWEST) AND ALSO EAST OF I-95 (NEAR AND EAST OF THE SURFACE LOW). ADD IN A POSSIBLE GRAVITY WAVE NOTED IN SURFACE OBS IN SOUTHWEST GEORGIA THIS MORNING...WHICH MAY BE A PART OF WHY THE HRRR SHOWS A RAPID SPLIT IF QPF WITH NORTHERN EXTENT THIS AFTERNOON. HIGHS WILL RANGE FROM MID 40S NW TO MID 50S SE.

1 Minute surface observations (ASOS) are on the way!

Jet Streak Coupling

- Presence of upper and lower level jets recognized by many to be important for pre-convective environment (from Fawbush and Miller, and many others)
- Provides the differential moisture and temperature advections, as well as veering of wind with height required to convectively destabilize pre-thunderstorm environment
- Upper and lower-level jets treated as separate entities
- Uccellini and Johnson (1979) showed they are coupled entities
- Uccellini and Kocin (1987) showed lateral coupling of jets critical for East Coast snowstorms

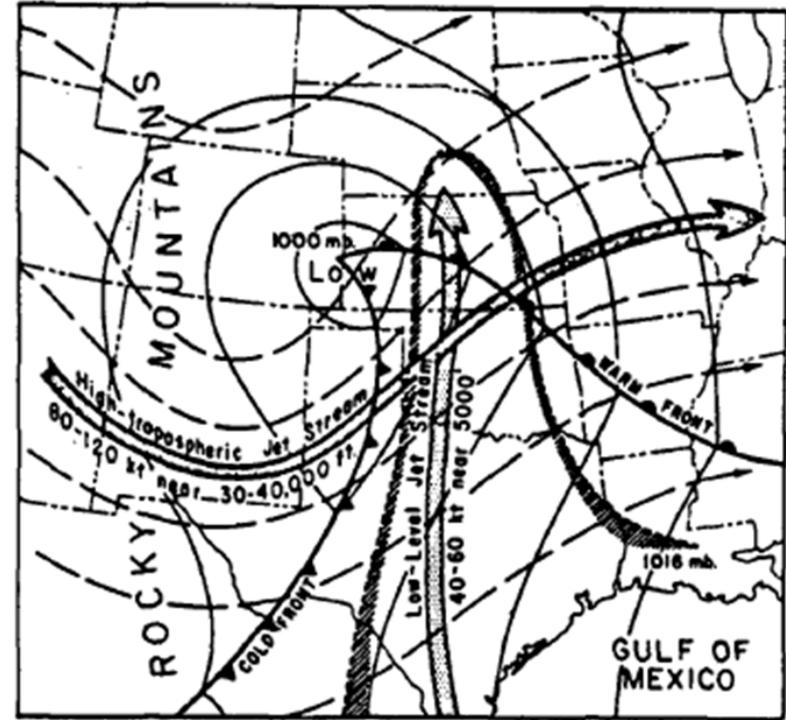
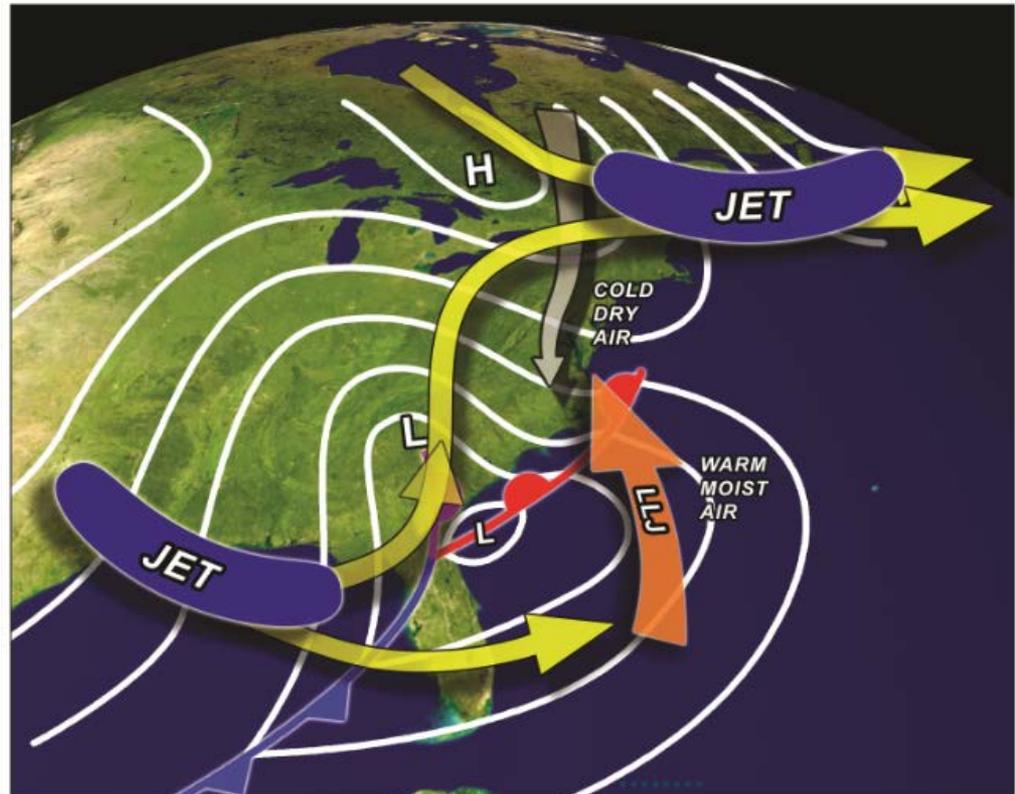
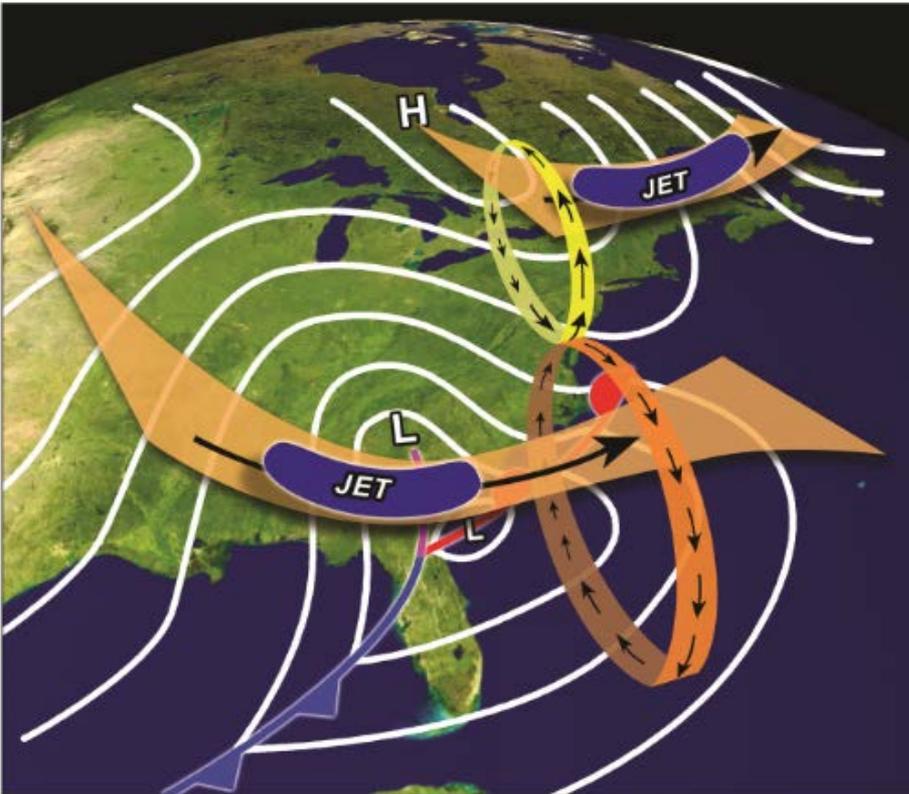


FIG. 1. Schematic features of a severe weather outbreak. Solid lines are sea level isobars; dashed lines streamlines of upper tropospheric flow. Shading outlines general area of low-level moisture tongue and region of potential instability (from Newton, 1967).

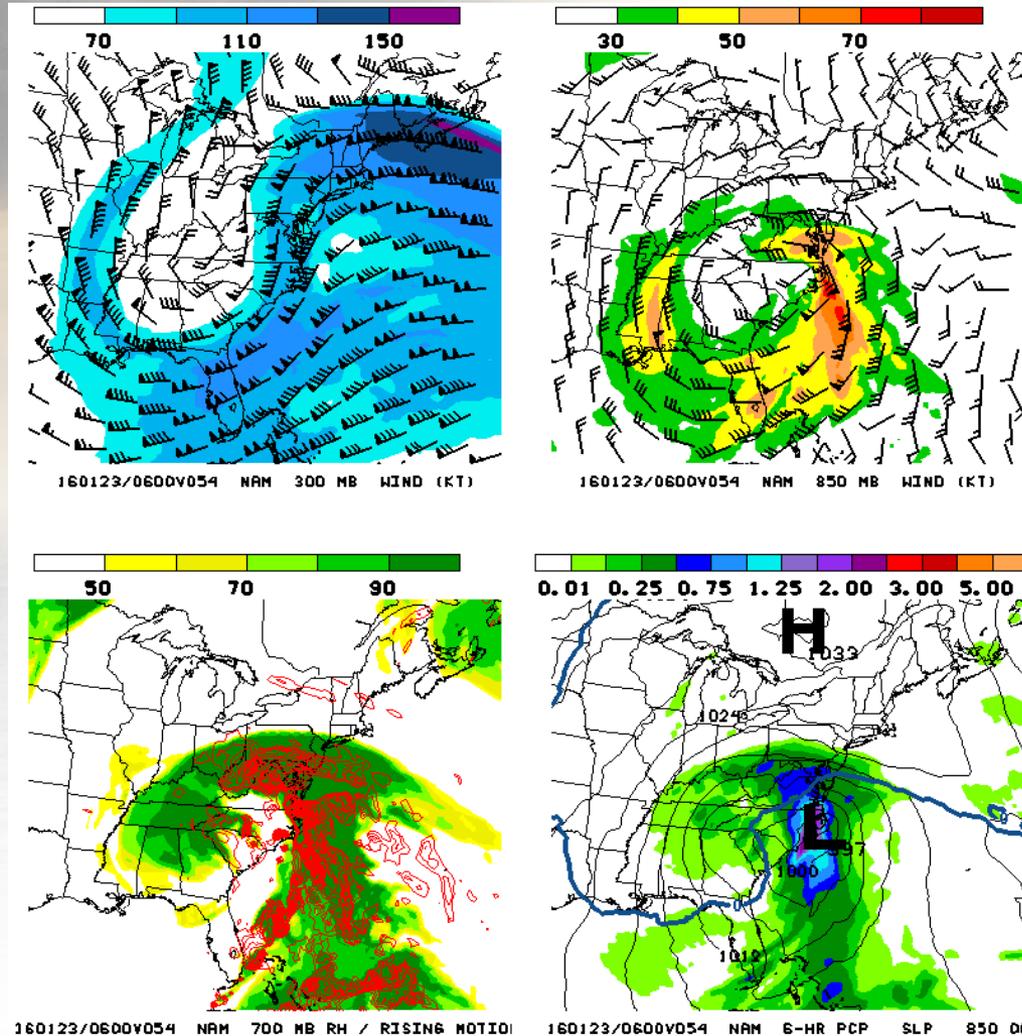
Newton, 1967

Application of Jet Streak Dynamics to NE Snowstorms

SCHEMATICS OF JET-RELATED CIRCULATIONS UPPER- AND LOW-LEVEL JETS



Double Jet Pattern for January 2016 NE Blizzard



54-hour NAM valid at 1800 UTC 23 Jan 2016



Joining the NWS:

- **My Interest in Research to Operations**
- **Modernization and Associated Restructuring**

Continuing the Journey: Research to Operations Phase

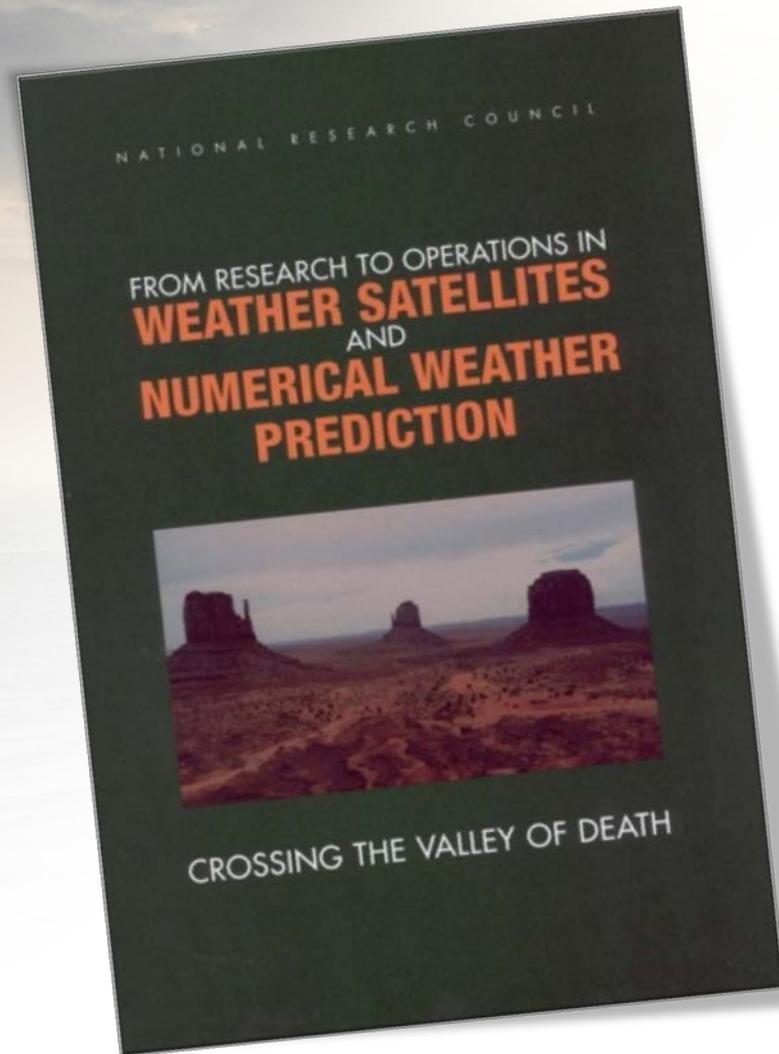
“The Application of the Hydraulic Analogy to Certain Atmospheric Flow Problems” by Morris Tepper; Weather Bureau Research Paper #35

*“In studying a meteorological paper, the reader is prone to classify it in his mind either as ‘theoretical’ or ‘practical’; and, depending on his own background, interest, and specific professional assignment, may peruse it in the minutest detail or leaf through it with hardly more than the mildest of interest. This is quite understandable. **Meteorology, today, is split between two groups. One is characterized by a researcher who is primarily interested in the physical aspects of cause and effect and in the understanding of the mechanics of weather processes. He attacks his problem by the mathematical manipulation of basic physical principles which he has applied to some model considered to contain the essence of the meteorological situation. The second group, on the other hand, is characterized by the practicing meteorologist whose primary concern is in the interpretation of the weather today in terms of a prognosis for the weather tomorrow. His tools may not have mathematical rigor nor adhere to strict physical principles, but they are time-tested and for the most part, they work. It is only natural then that the theoretical meteorologist would tend to have little patience with the empiricism of a ‘practical’ paper and the practicing meteorologist would consider of little value the mental exercise of a ‘theoretical’ paper.**”*

This situation is unfortunate. Although the immediate efforts of these two groups are directed along different lines, the final goal is basically the same, namely, to unravel the intricate pattern of the cause and effect of the weather.”

October 1952

Continuing the Journey: Research to Operations Phase



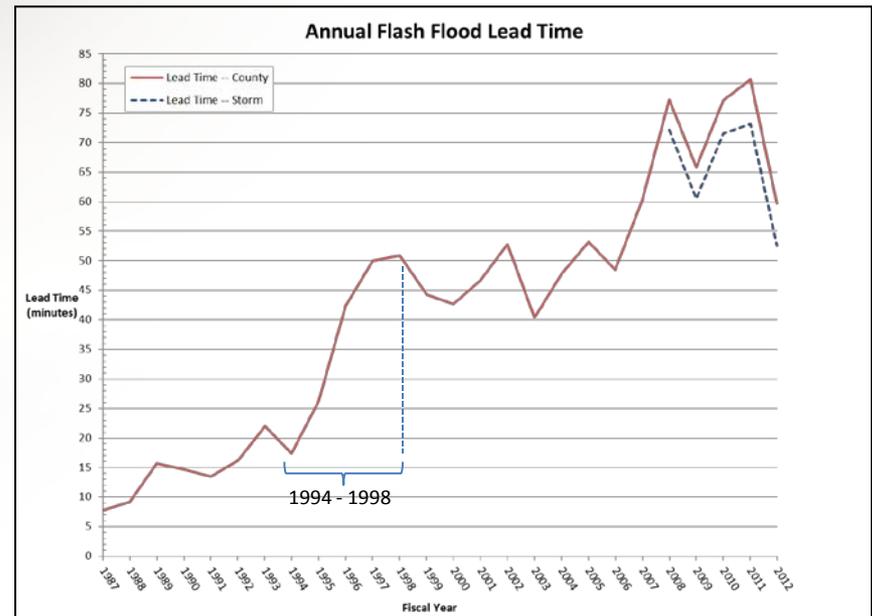
Joining the NWS: (September 1989)

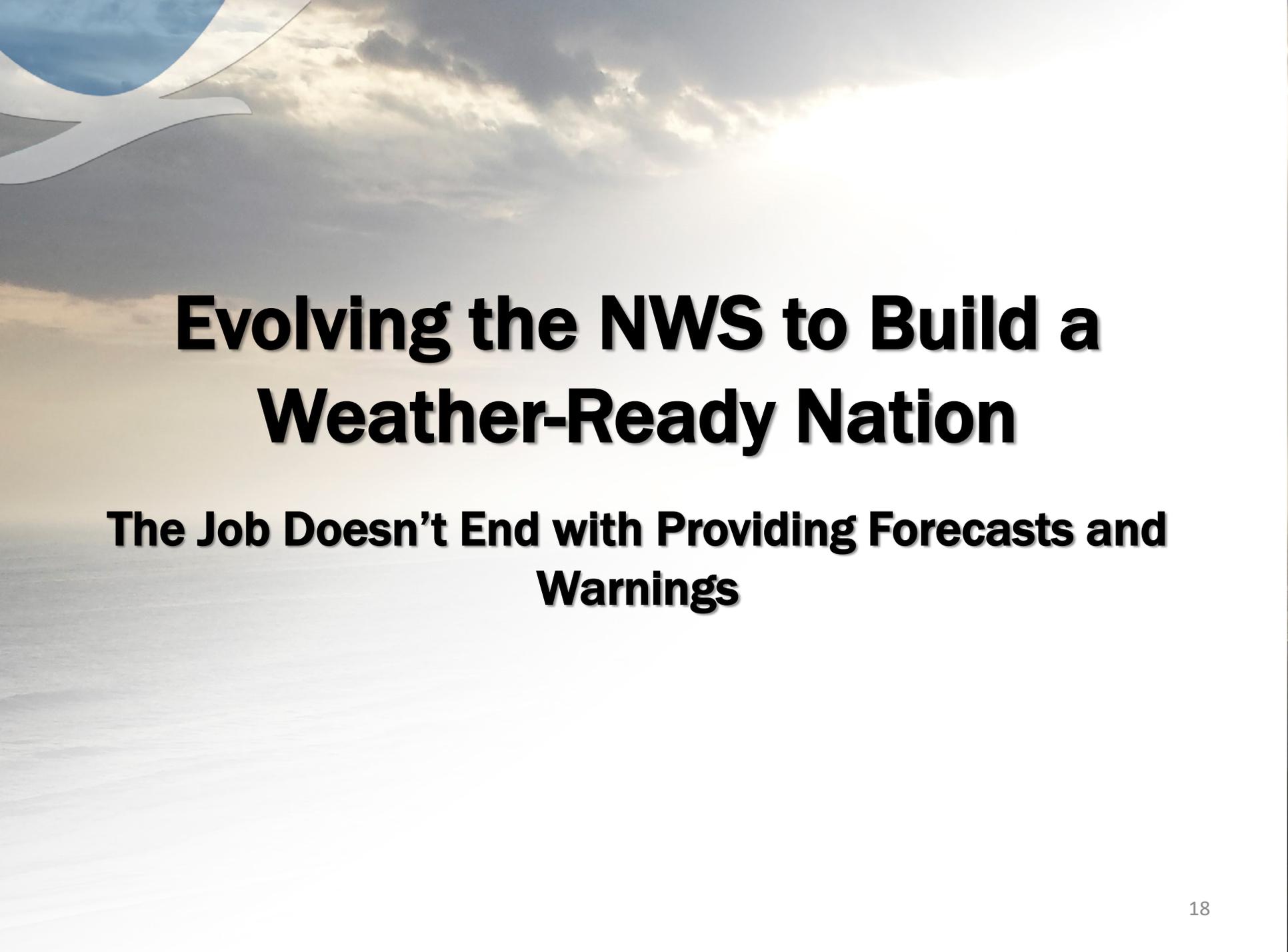
- Pulled in by the newly announced **Modernization and Associated Restructuring (MAR)**
 - An extensive example of an agency-wide R2O
 - Attended a Ron McPherson briefing on the MAR at a cyclone workshop (with a keg of beer in the back to soften up the crowd)
- Based on improving forecasts and warnings of severe convective storms
- Built around the NEXRAD and GOES NEXT satellites
- Completely restructured the field offices – Birth of the WFO
- Brought the Science Operations Officer and Warning Coordination Meteorologist into every forecast office
- Joined as the Chief of the Meteorological Operations Division at NMC – which was not part of the MAR!

Joining the NWS: Modernization and Associated Restructuring

The Modernization and Restructuring succeeded in many ways:

- NEXRAD, GOES NEXT, trained workforce, all contributed to extending tornado warnings beyond 10 minutes
- Flash flood warning lead time goes from ~15 min to ~45 min
- Forecast/warnings improved across all service areas (fire weather, aviation, marine, etc.)
- Can now predict extreme events days in advance for many cases





Evolving the NWS to Build a Weather-Ready Nation

**The Job Doesn't End with Providing Forecasts and
Warnings**

Comparing the 1974 and 2011 Severe Weather Outbreaks



April 3-4, 1974 Super Outbreak

- 150 tornadoes across 13 states
- 6 F5 (2 in AL), 24 F4
- **Tornado Track Length: 2500 mi**
- **Tornado Time: 50 hours**
- **Fatalities: 310-319 (72-77 AL)**

April 27-28, 2011 Super Outbreak

- 200 tornadoes across 16 states
- 4 F5 (3 in AL), 11 F4
- **Tornado Track Length: 2500 mi**
- **Tornado Time: 50 hours**
- **Fatalities: 316 (235 AL)**



The Job Doesn't End with Forecasts and Warnings



“First, it should be understood that forecasts possess no intrinsic value. They acquire value through their ability to influence the decisions made by users of the forecasts.”

“What is a Good Forecast? An Essay on the Nature of Goodness in Weather Forecasting”

– by Allan H. Murphy; Weather and Forecasting (June 1993)

NWS Strategic Outcome: *A Weather- and Water-Ready Nation*



“Ready, Responsive, Resilient”

Becoming a Weather-Ready Nation is about **building community resiliency in the face of increasing vulnerability** to extreme weather, water and climate events

Better forecasts and warnings

Consistent products and services

Actionable environmental intelligence

Connecting forecasts to decisions

Involves the entire US Weather, Water and Climate Enterprise WORKING TOGETHER

We have 3453 WRN Ambassadors

Realizing the Full Value of Forecasts:

Connecting Forecasts to Critical Decisions

* *Completing the Forecast, National Academies of Science, 2006*

Generating forecasts and warnings



Connecting those forecasts & warnings with impacts (IDSS)
"Impact-based Decision Support Services"



Realizing Intrinsic Value



The best hydrometeorological forecasting in the world



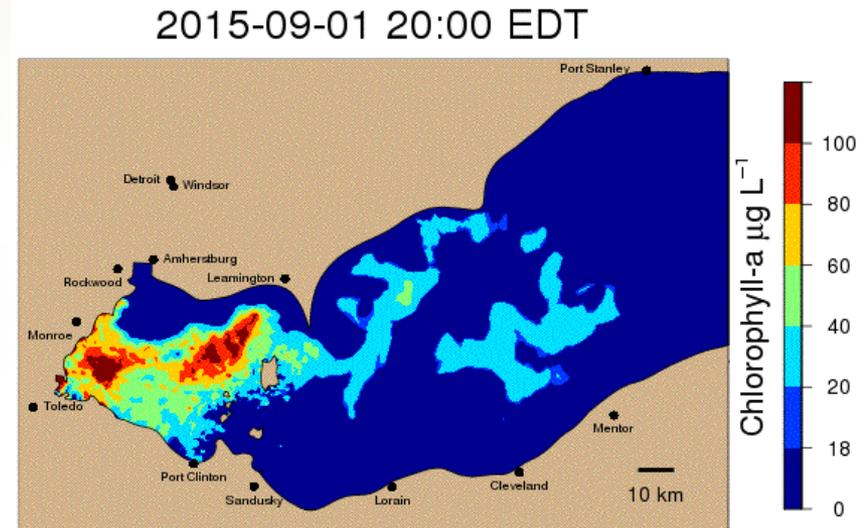
BUILD TRUST
Develop relationships, know partner needs



What Does it Mean to the NWS?

Building a Weather- & Water-Ready Nation will change the way we work—and change the nature of our products:

- **Becoming more oriented toward Earth System Sciences (atmosphere, ocean, land, cryosphere)**
- **Social Science - ensure message delivered = message received for desired outcomes (e.g. How to describe and display “storm surge?”)**
- **Understanding decision makers and their “shifting risk preferences” before/during/after an event**
 - *“Organized” – Government (NWS Focus Area)*
 - *“Loosely Coupled” – Social Organizations*
 - *“Organic” – Individuals*
- **Connecting observations/forecasts/warnings to “Key Decision Points” in all service areas**



The NWS must evolve to complete these goals

Report Card: Remarkable Forecasts of Extreme Events and Provision of Impact-Based Decision Support Services (IDSS)

- **October 2015 South Carolina 20" Rain**
 - Record setting rain predicted a week in advance
- **Central U.S. Post Christmas 2015 Storm**
 - 6-8 day lead time for heavy rain, snow, severe weather
- **January 2016 East Coast Blizzard**
 - 8 day lead time drove IDSS at the state and local levels
- **June 2016 Southwest Heat Wave**
 - Excessive Heat Watches issued a week in advance



Successful IDSS Provided to Local, State and National Partners

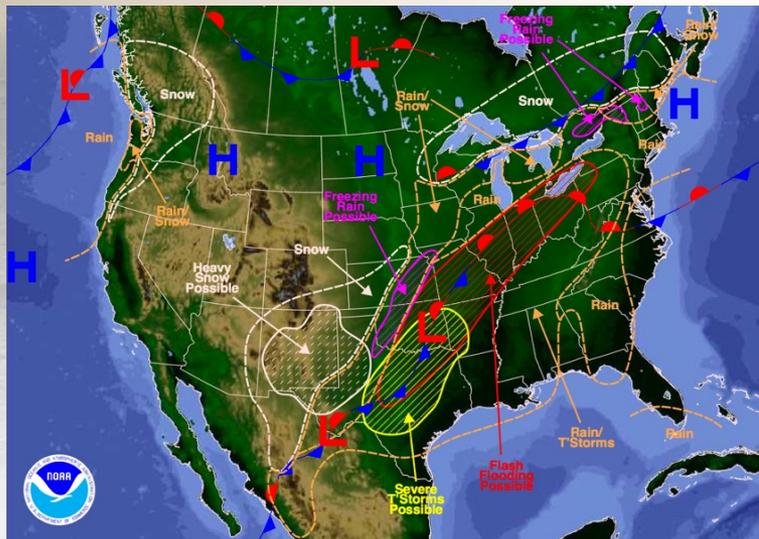


Post Christmas Storm (Dec. 25-28, 2015): The Spectrum of IDSS

Preparedness

Federal and State Actions

- NWS provided situational briefings days ahead of event
- FEMA alerted response teams and assets for possible deployment
- Increased coordination with federal, state and local jurisdictions



Weather Forecast for Sat, Dec 26, 2015, issued 4:29 PM EST
D/C/NOAA/NWS/NCEP/Weather Prediction Center
Prepared by Santorelli based on WPC, SPC and NHC forecasts

Immediate Response

Tornadoes

NWS created preliminary tornado tracks; FEMA analyzed impacts to support deployment decisions



Blizzard

State and local municipalities mobilized to address road conditions and open shelters



Photo: News Channel 10 – Amarillo, TX

Flooding

Emergency Response Specialist (ERS) deployed to FEMA VII Regional Response Coordination Center



Photo: St. Louis Post Dispatch

States of Emergency Declared

TX, NM, MO, OK, IL, MS, LA

Appreciation for IDSS

“I want to first fully thank the dedicated professionals here at the National Weather Service for providing us with the most updated forecast briefing this afternoon and for their continued hard work as part of the effort to protect lives and property. Folks here are incredibly professional. We rely on them, and they don't let us down. We tremendously appreciate, especially over the holidays, how they're always there and always helpful, doing the best they can to help law enforcement and others.”

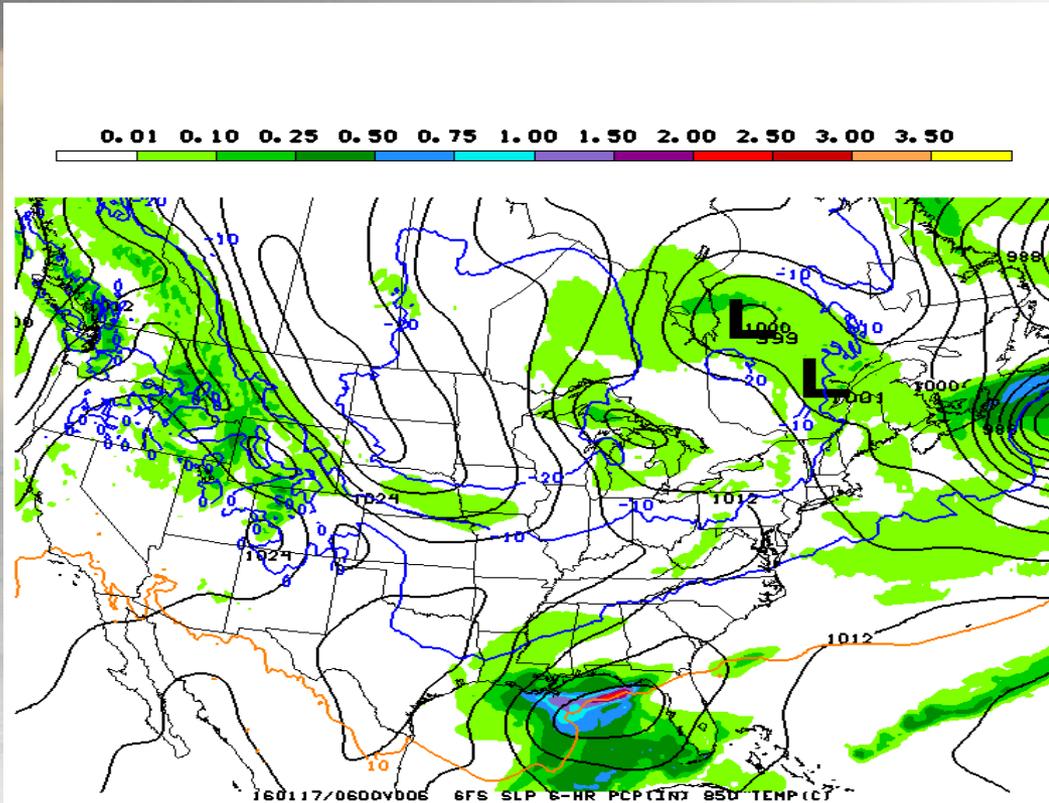
Missouri Governor Jay Nixon following the 2015 December Holiday storm and January 2016 Flooding



GFS Model Loop

January 17-24 Mid Atlantic Blizzard

Forecast For:



Sunday, Jan 17

Monday, Jan 18

Tuesday, Jan 19

Wednesday, Jan 20

Thursday, Jan 21

Friday, Jan 22

Saturday, Jan 23

Sunday, Jan 24

January 2016 Blizzard & Coastal Storm: Connecting All of the Pieces

Jan 15 - 18

Jan 19

Jan 20

Jan 21

Jan 22

Medium range products begin identifying snowstorm threat for the end of next week

NWS offices begin briefing partners on potential storm

Confidence increasing

Partner Coordination/
Briefings

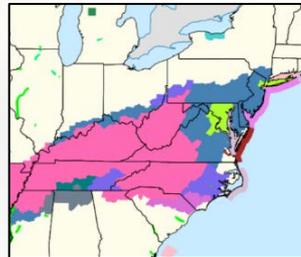


Media interviews



Partner Coordination/
Briefings

Blizzard Watches Issued



Media interviews

Fed./state/local govts make critical decisions **before** the snow begins

State of Emergency Declared:

- North Carolina
- Virginia
- West Virginia
- District of Columbia
- Maryland
- Pennsylvania
- New Jersey
- New York

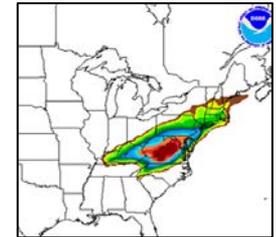
Blizzard Warnings Issued

1 pm: Press Briefing



Snow begins in the Mid-Atlantic

Snow forecast adjusted to include NYC in Blizzard Warning



Schools/Govt Close
Flights Canceled
Roads Closed



Connecting All the Pieces

Long Island Expressway - January 2016

2013 Snowstorm

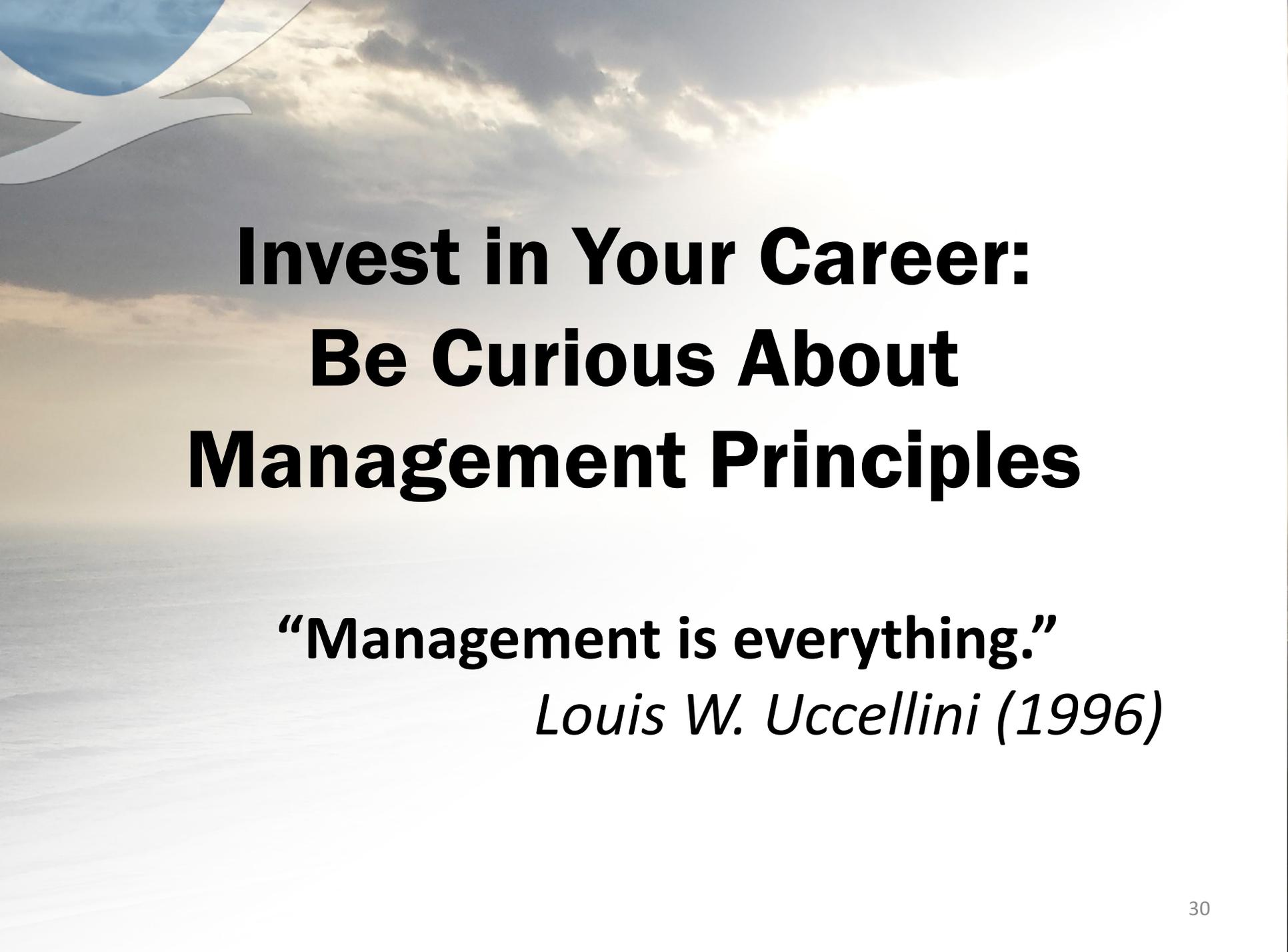


The Past

2016 Snowstorm



With NWS Decision Support



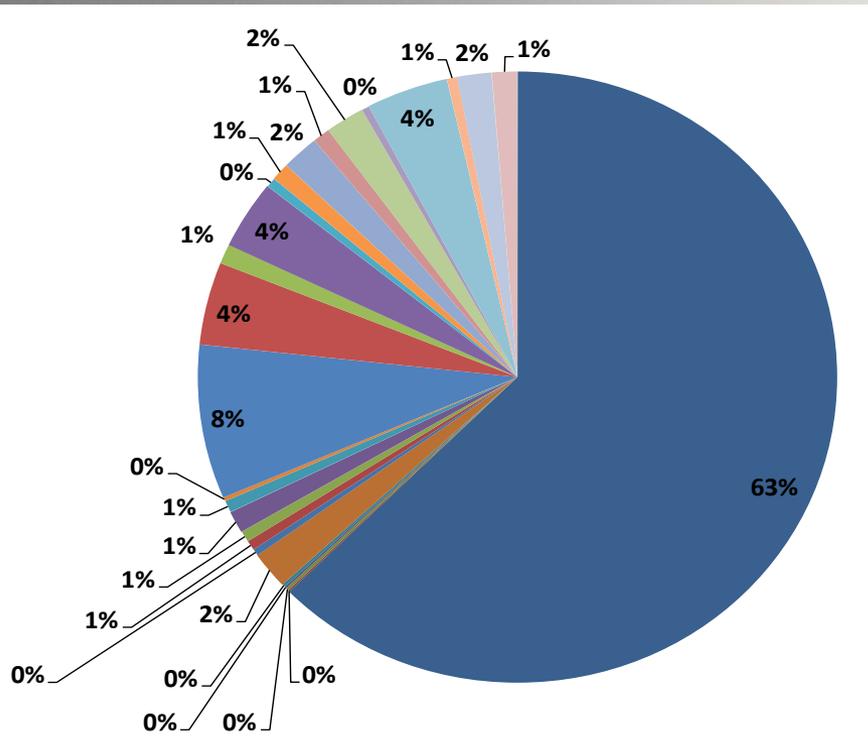
Invest in Your Career: Be Curious About Management Principles

“Management is everything.”

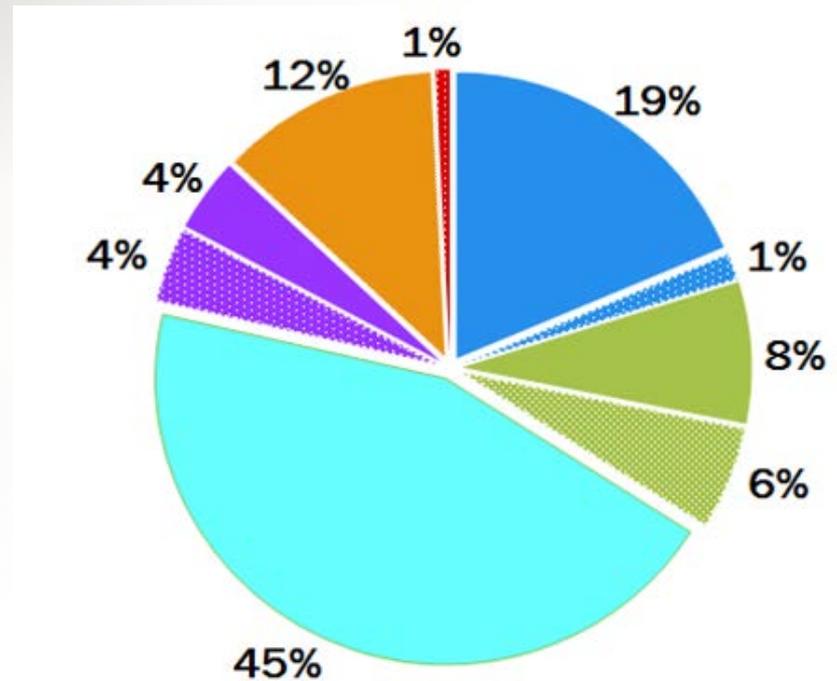
Louis W. Uccellini (1996)

Restructured NWS Budget

FY15 Enacted Budget



FY16 Enacted Budget

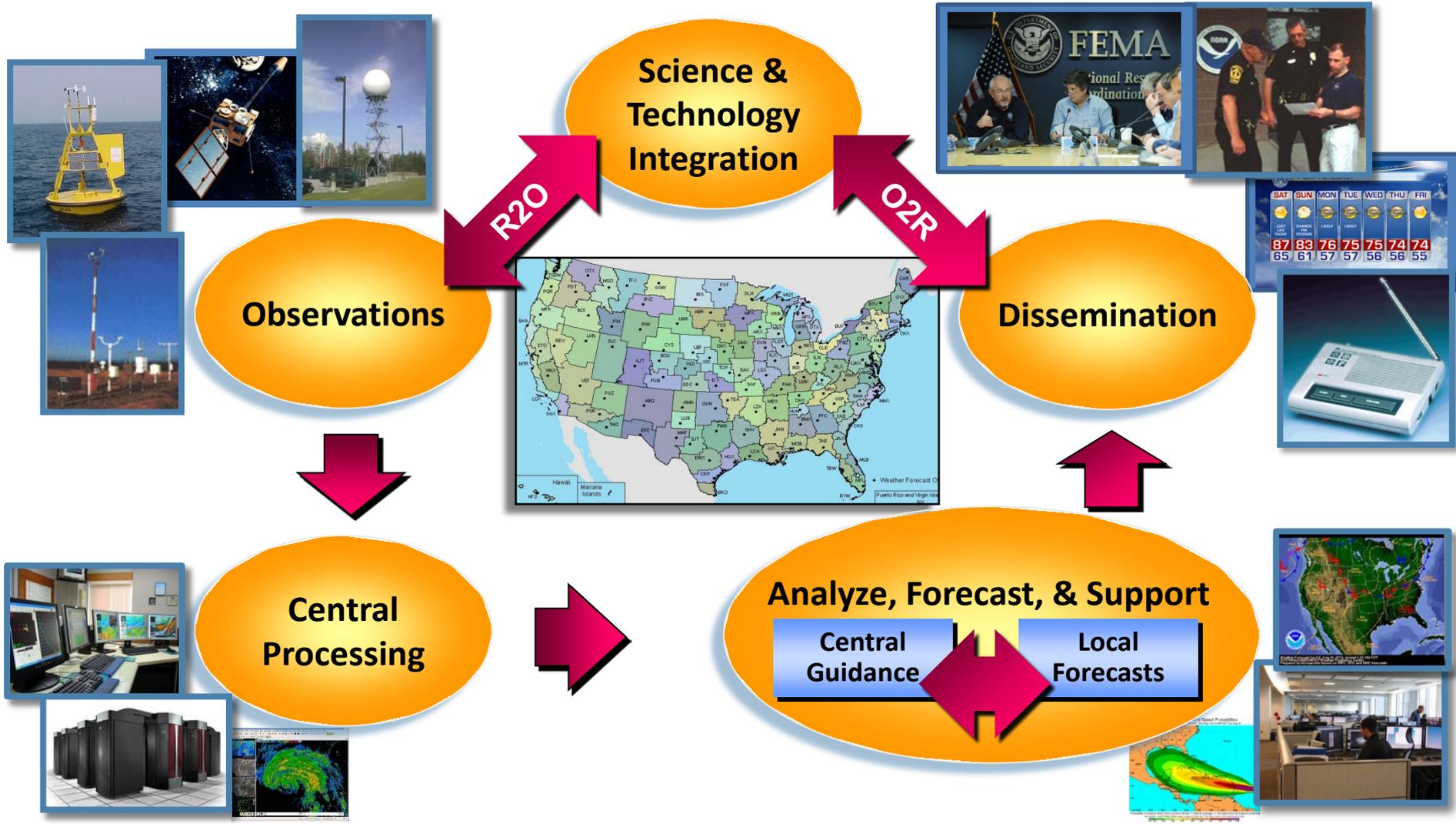


26 Portfolios (ORF + PAC)



6 Portfolios

Establishing the Budget Structure Based on: The Forecast Process



New Planning & Budget Structure Increases Transparency and Enhances Service Delivery

Observations

Joe Pica

Sustains & integrates all observations to support the NWS mission and ensure continuous situational awareness

Central Processing

David Michaud

Fully integrates the central and distributed computing system from central computer to AWIPS/AHPS

AFS

Andrew Stern

Analyze, Forecast, Support includes all NWS forecast offices:
- Works toward “fully integrated field structure” providing consistent products & services
- Supports local/national IDSS, outreach, & social science integration

Dissemination

Luis Cano

Provides better managed, reliable, centralized, and more responsive network, especially during high impact events.

STI

Ming Ji

Accelerates numerical model advances, supports forecaster training/development
- Provides a centralized development environment to enable Research to Operations (R2O) & a visible “catcher’s mitt” for the rest of the research community interested in the R2O process (e.g., CSTAR, SOO/DOH ...)

Facilities

Deirdre Jones

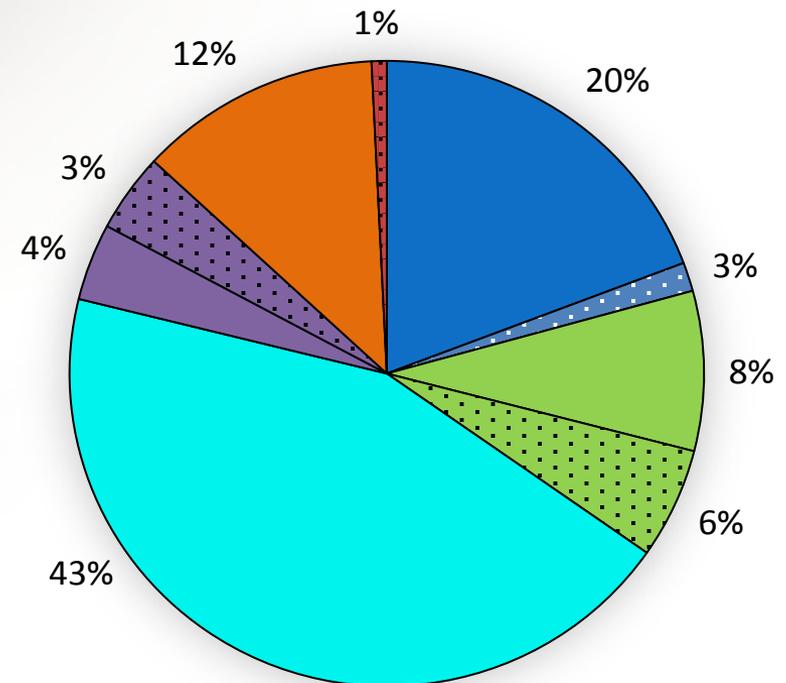
Sustains all NWS facilities as a fundamental part of the NWS mission execution

FY2016 Enacted Budget Composition by Portfolio

PPA	Funds*	Full Time Employees (FTE)
Observations ORF	222,996	933
Observations PAC	32,755	-
Central Processing ORF	88,388	134
Central Processing PAC	66,761	22
Analyze, Forecast and Support ORF	485,931	2,908
Dissemination ORF	47,236	82
Dissemination PAC	34,619	-
Science and Technology Integration ORF	131,956	470
Facilities PAC	8,650	-
TOTAL	1,119,292	4,549

* In thousands of dollars

Funds Breakdown

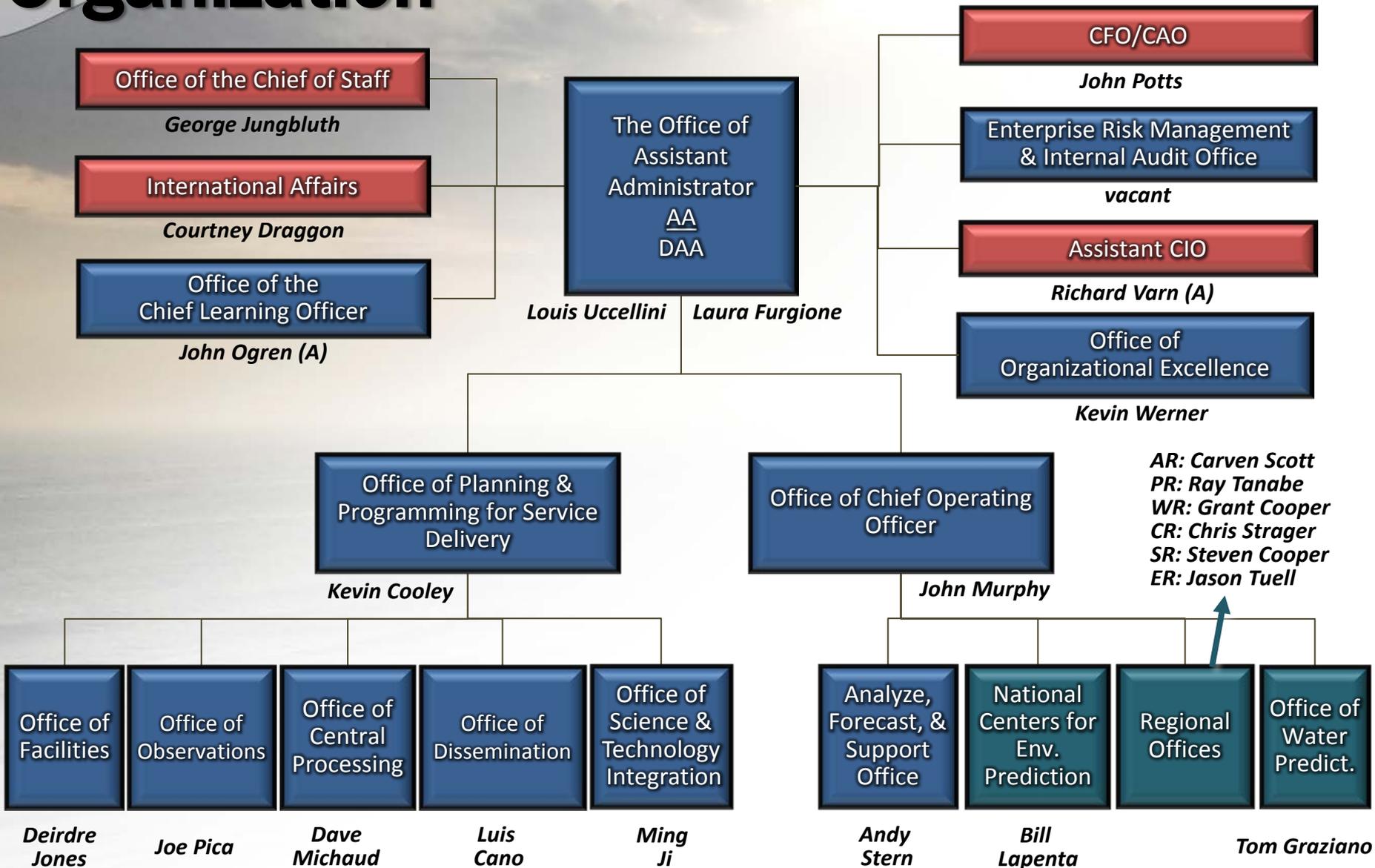


New NWS HQ Organization

New HQ Office

Field Office

Existing HQ Office



AR: Carven Scott
 PR: Ray Tanabe
 WR: Grant Cooper
 CR: Chris Strager
 SR: Steven Cooper
 ER: Jason Tuell

FY2016 Priorities

Observations

- JPSS/GOES-R Readiness
- NEXRAD Service Life Extension
- Autosonde testing
- Buoys sustained
- ASOS SLEP

Science & Technology Integration

- Model upgrades: GEFS, HWRF, NWPS, HRRR, NWM
- HEFS implementation in RFCs
- Exp. Winter Weather Days 4-7 Outlook
- Exp. Arctic Sea Ice Outlooks,
- Grants: CSTAR/NGGPS/HFIP/Testbeds (\$4.7M FY16)
- National Blend of Models V1/Virtual Lab
- Exp. Week 3-4 Temp and Precip
- Geospace Model Transitioned
- Nearshore Wave Prediction System (NWPS)
- NGGPS

Facilities

- Relocation with partners, if possible
- Second one-third Facility Condition Assessments
- WFO Relocations: Phoenix & Cleveland

Central Processing

- Central computer upgrade
- AHPS locations added
- AWIPS/NAWIPS Merger
- Hourly GFS



WRN Ambassador Initiative
3453 Ambassadors

Dissemination

- “One NWS Network”
- NOMADS, MAG, MADIS, MRMS, nowCOAST, FTPPRD, www.weather.gov

Analyze, Forecast, Support

- Impact-based Decision Support
- Hazard Simplification
- National Impacts Catalog
- Enable Ecological Forecasting
- Impact-based Warning Demo expanding nationally
- National Water Model Exp. products
- Weather/Climate linkage (e.g., week 3-4 outlooks)
- Operational Tropical Potential Storm Surge Flooding Map
- Extratropical Storm Surge Requirements
- Probabilistic winter outlooks and snowfall predictions

NWS Councils Support HQ Organization and Collective Decision-Making

Executive Council

Chair: Director

- Consists of 5 most senior NWS leaders: Director, Deputy Director, COO, OPPSD, CFO
- Provides NWS strategic direction
- Approves NWS planning and budgeting documents
- Serves as decision maker for high visibility issues

Portfolio Integration Council

Chair: OPPSD Director

- Ensures cross-Portfolio planning & integration to support needs of mission execution
- Integrates the “left side” under OPPSD with the “right side” under OCOO

Mission Delivery Council

Chair: COO

- Transparently validates and prioritizes Field mission requirements
- Discusses and approves operational and service policies to ensure successful and consistent mission operations

Enterprise Risk Council

Chair: Deputy Director

- Identifies and monitors internal and external enterprise risks and issues
- Approves mitigation strategies for enterprise risks

Evolving the NWS:

Building Off the Operational & Workforce Analysis

OWA Findings:

Positives:

- Exceptionally dedicated workforce
- Workforce already embraces IDSS
- Core partners use and love the IDSS we provide - they want more!

*“We have to know what the NWS can do for us, but **we also have to know what they can’t do, or we’ll ask them to do everything**, and, God help them, they’ll try and give it to us.”*

Negatives:

- Variations observed in IDSS/Products and services/delivery from office to office
- Mismatch in workload and skills for many offices
- Redundancy and inefficiency in internal processes

Improving Service through IDSS

FROM TODAY...

Inconsistent service which, at times, do not go “beyond the forecast” to explain impacts



TO THE FUTURE...

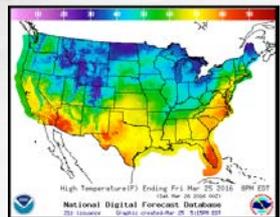
NWS provides consistent levels of decision support before & during events



Mismatch in workload & skills



Variation in partners served



Variation in products and services;
Redundancy in internal processes



Healthy org. culture & structure



Defined IDSS partner types



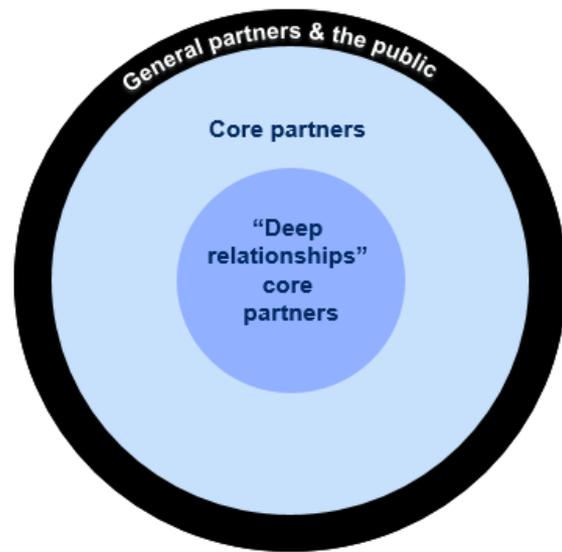
Clearer & enhanced core services

Evolving the NWS Building Off the OWA

Need to Unlock Resources to Meet IDSS Demand

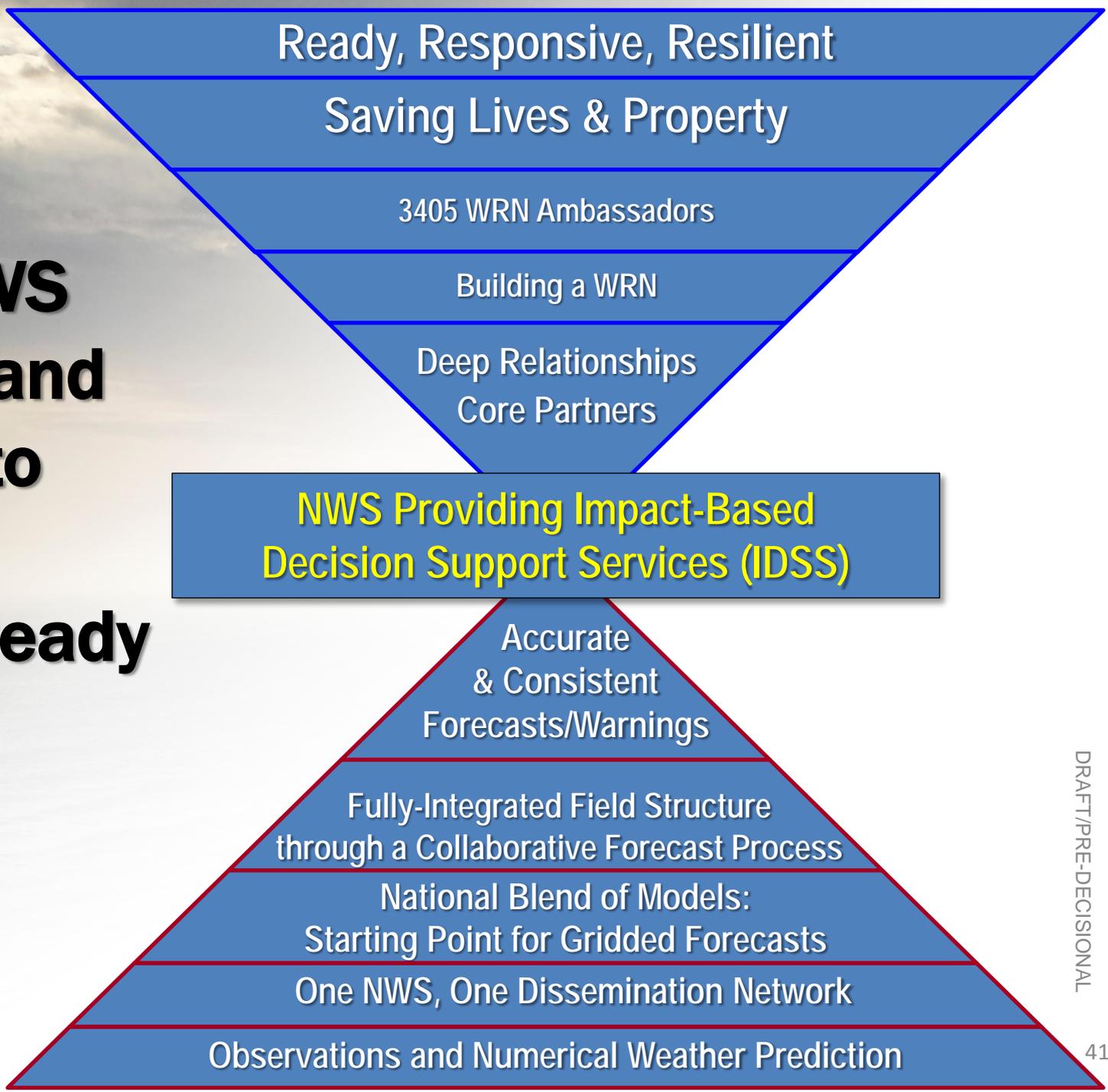
- Collaborative forecast process – National Blend of Models
- Autosondes
- Shift scheduling flexibility: strategic staffing

**All Directed at Serving
“Deep Relationship” Core Partners**





Linking NWS Forecasts and Warnings to Building a Weather-Ready Nation



Vision Becoming a Reality

- Making tremendous progress in building a Weather-Ready Nation
- The field has embraced IDSS and our partners are using it
- There are many examples of accurate forecasts and warnings for extreme events communicated to decision makers days in advance
- The future will be built on a greater focus on IDSS applied to weather, water and climate events
- Working to enhance the entire NWS infrastructure, training, professional development

THANK YOU!



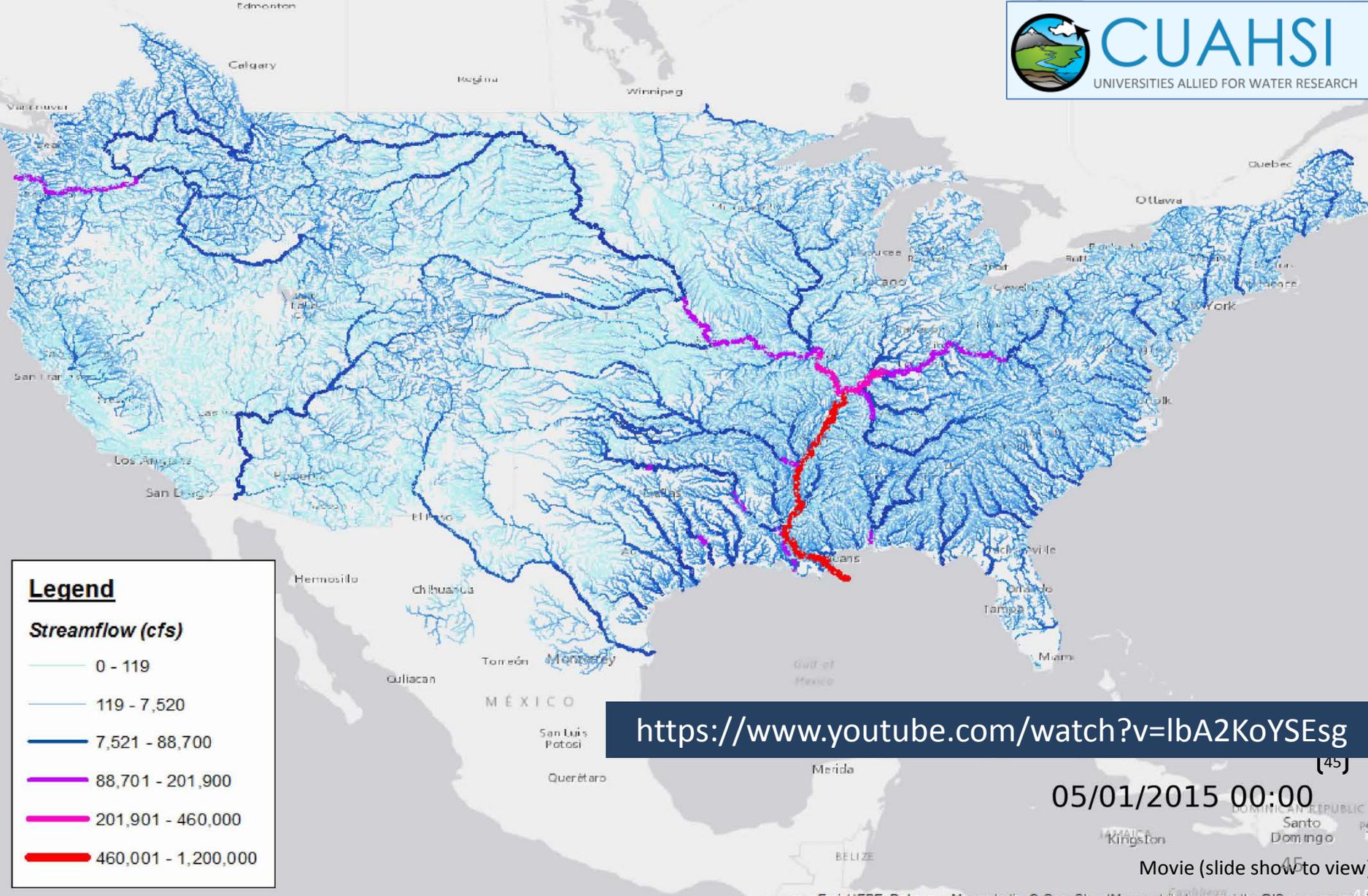


Appendix



National Water Model

This will be operational in mid-Summer 2016



Legend

Streamflow (cfs)

- 0 - 119
- 119 - 7,520
- 7,521 - 88,700
- 88,701 - 201,900
- 201,901 - 460,000
- 460,001 - 1,200,000

<https://www.youtube.com/watch?v=lbA2KoYSEsg>

05/01/2015 00:00

Movie (slide show to view)