Observations that Support Weather-Ready Nations: Looking to the Future

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GEO Week 2017 Side Event – Vision for the WMO Global Observing System in 2040
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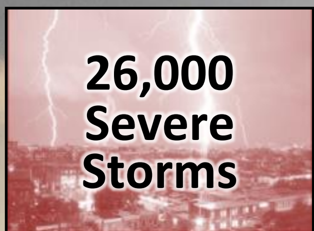
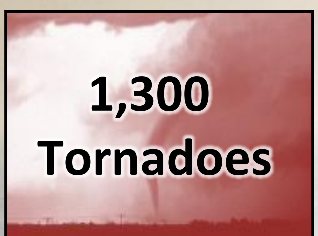
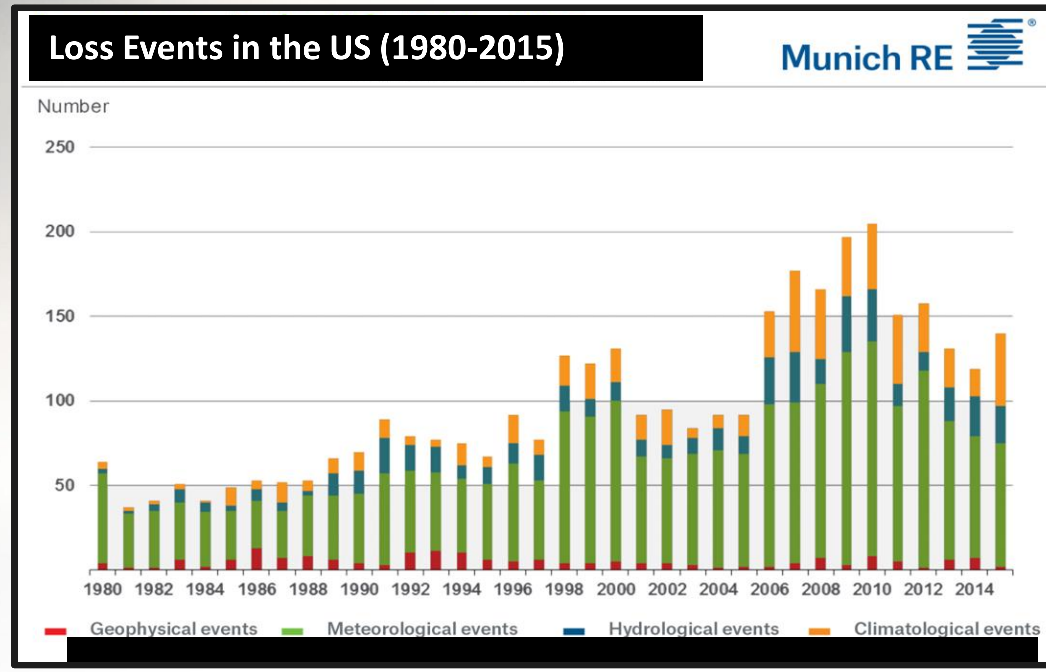
Increasing Societal Vulnerability to Environmental Hazards

Average Year







4 out of 5 Americans live in counties that have been declared weather-related disaster areas in the past six years*

Factors contributing to increased risk

- ✓ Increasing population
- ✓ Increasing vulnerability
- ✓ More infrastructure at risk
- ✓ Signs of climate change

*Source: Environment Amer

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)

Building Weather-Ready Nations

Building Weather Ready Nations will change the way we work– and change the nature of our products:

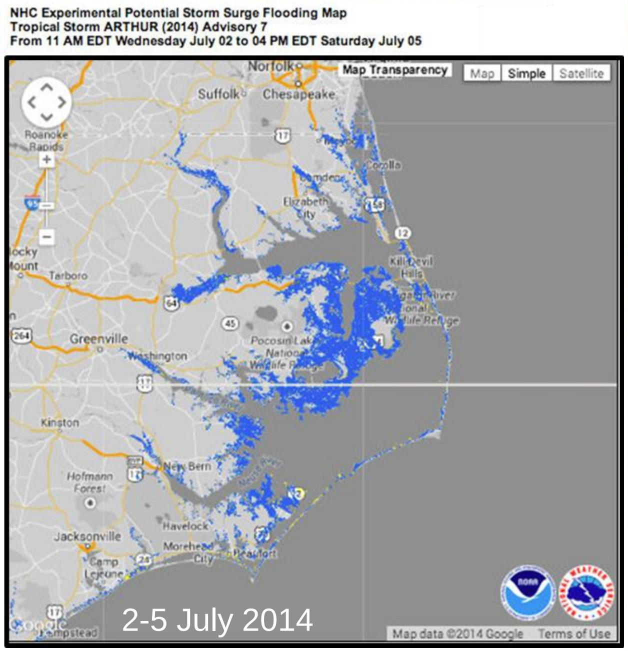
- **Becoming more oriented toward Earth System Sciences (atmosphere, ocean, land, cryosphere)**
- **Social Science - to ensure message delivered = message received for desired outcomes (e.g. How to describe and display "storm surge?")**
- **Understanding decision makers and their "shifting risk preferences"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

Enterprise Value Chain

Monitoring & observation → **Modeling & forecasting** → **Service Delivery**

- How we measure success: **determining intrinsic value**

Hurricane Arthur
Potential Storm Surge Mapping
'Best Guess, Worst Case Scenario'



Involves the entire Weather, Water and Climate Enterprise WORKING TOGETHER

Weather Research and Forecasting Innovation Act

Sec. 101 – Directed toward the NWS Mission

15 USC 85011. **SEC. 101. PUBLIC SAFETY PRIORITY.**

In conducting research, the Under Secretary shall prioritize prioritize improving weather data, modeling, computing, forecasting, and warnings **for the protection of life and property and for the enhancement of the national economy.**

- Reauthorizes USWRP, HFIP, Tornado Research

- **201 – Improving Sub-seasonal and Seasonal Forecasts**
- **301 – Weather Satellite and Data Innovation**
- **401 – Federal Weather Coordination**
- **501 – Tsunami Warning, Education, and Research**

Signed into law on April 18, 2017

Weather Research and Forecast Innovation Act of 2017

Signed into law on April 18

Public Law 115–25
115th Congress

An Act

To improve the National Oceanic and Atmospheric Administrat[...]
through a focused program of investment on affordable an[...]
in observational, computing, and modeling capabilities t[...]
improvement in weather forecasting and prediction of high i[...]
to expand commercial opportunities for the provision of [...]
other purposes.

*Be it enacted by the Senate and House of [...]
the United States of America in Congress assemble[...]*

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited [...]
Research and Forecasting Innovation Act of 2017”.
(b) TABLE OF CONTENTS.—The table of cont[...]
is as follows:

(b) PRIMARY ROLE OF WARNING COORDINATION METEOROLOGISTS.—The primary role of the warning coordination meteorologist shall be to carry out the responsibilities required by this section.

(c) RESPONSIBILITIES.—

(1) IN GENERAL.—Subject to paragraph (2), consistent with the analysis described in section 409, and in order to increase impact-based decision support services, each warning coordination meteorologist designated under subsection (a) shall—

(A) [...] responsible for providing service to the geograph[...] area of responsibility covered by the weather foreca[...] office at which the warning coordination meteorologist [...] employed to help ensure that users of products of [...]he National Weather Service can respond effectively [...] improve outcomes from weather events;

(B) liaise with users of products and services of the National Weather Service, such as the public, media outlets, users in the aviation, marine, and agricultural communities, and forestry, land, and water management interests, to evaluate the adequacy and usefulness of the products and services of the National Weather Service;

Collaboratio[...]

(C) collaborate with such weather forecast offices and State, local, and tribal government agencies as the Director considers appropriate in developing, proposing, and imple-

(1) IN GENERAL.—Subject to paragraph (2), consistent with the analysis described in section 409, and in order to increase impact-based decision support services, each warning coordina-

Increasing Demand for Weather Information

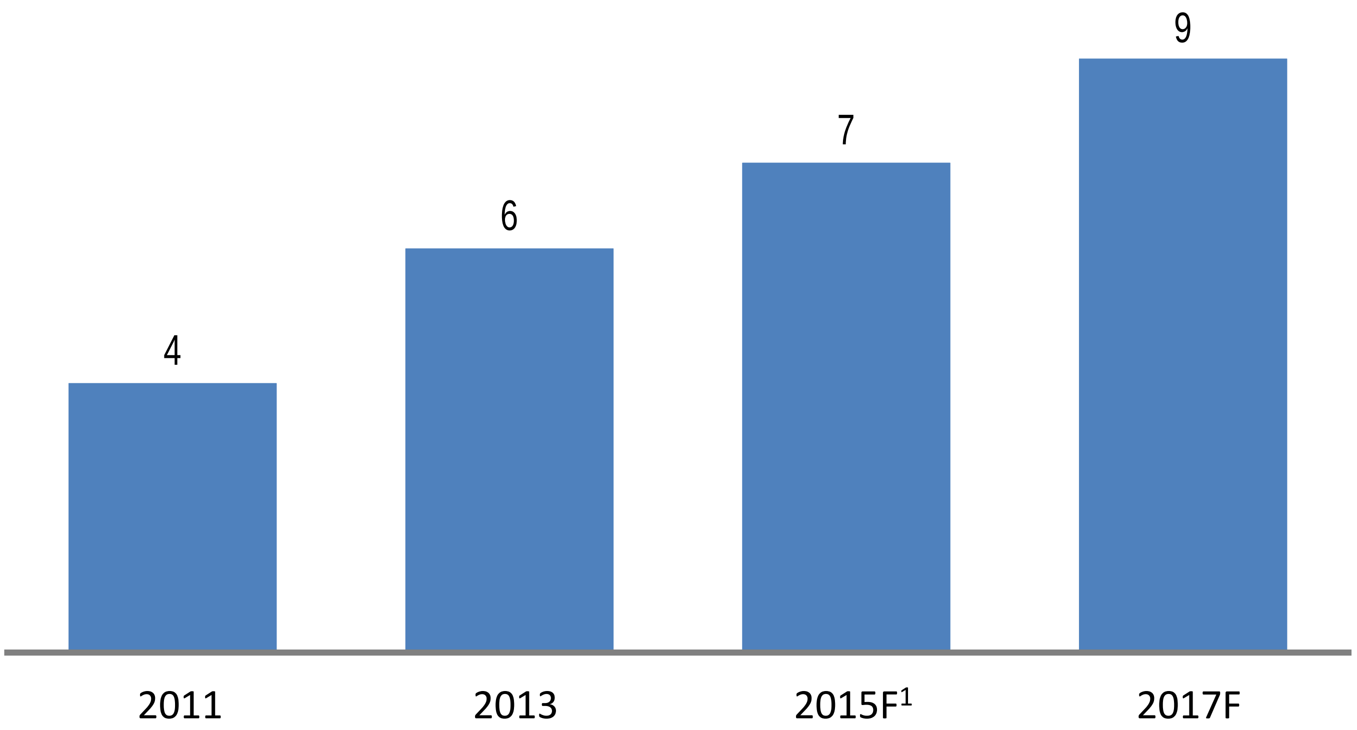
- **Growing recognition of sensitivity of business performance to weather**

- **Increased cost of disaster damage**, estimated to impact 1/3 of U.S. GDP

- **Significant unmet user needs** for improved weather predictions (accuracy and lead times) and decision support
  - Hyperlocal nowcasts
  - Greater lead time for mesoscale forecasts
  - Seasonal and longer timescale forecasts

A UCAR report from 2013 estimated the industry capitalization at $6 billion, growing 10-15% annually

Estimated private weather industry market capitalization, $ bn



Capitalization could be conservative in view of recent acquisitions in the sector and given multiple of estimated revenues to capitalization

1 Assumes 10% growth per year as forecasted (F) by UCAR. Estimation is needed given almost all companies in the weather enterprise are private and do not disclose financials

SOURCE: MarketWatch, Princeton, University Corporation for Atmospheric Research (UCAR), Wharton School of Business – Univ. of PA, "Today's Forecast for the Weather Business: Increased Revenues and a Focus on Innovation"; IBIS 2014 Report

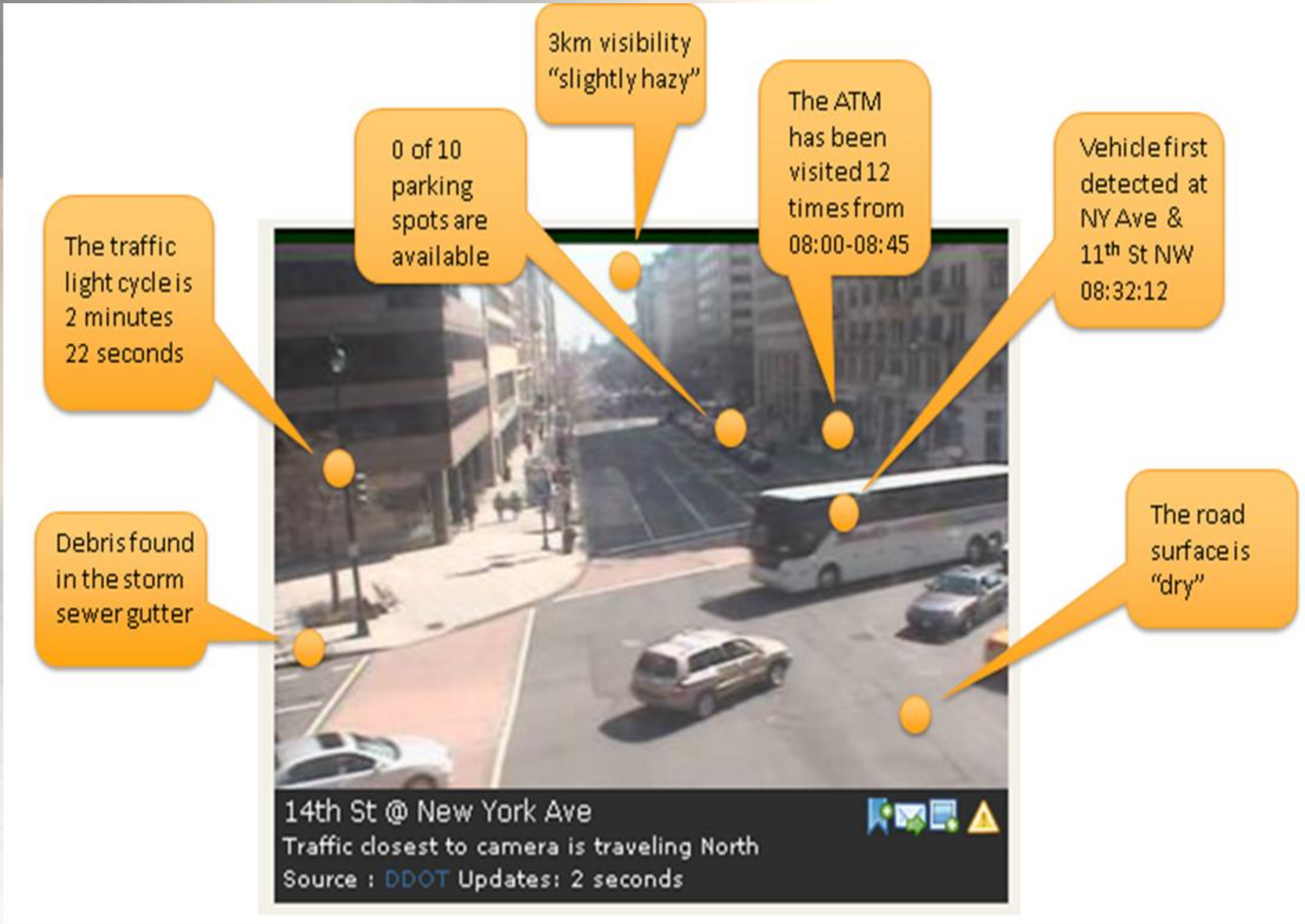
The speed at which technology rolls out is accelerating

SOURCE: Various press reports; McKinsey Global Institute analysis

Meeting the Demand with Technological Advances

- **Internet of Things, robotics and automation** are addressing current gaps in weather data collection, potentially at lower cost.
- **Supercomputing, big data and machine learning** are enabling unprecedented data assimilation to weather forecasts and models.
- **Analytics and big data** are combining vast amounts of weather, business and operational data for **better decision-making.**
- **Cloud, mobile computing, improved visualization, smart devices,** and more focus on 'user experience' are making weather **data easier to access and digest, often at lower cost.**
- **Miniaturization** trends have the potential to lower observation costs.

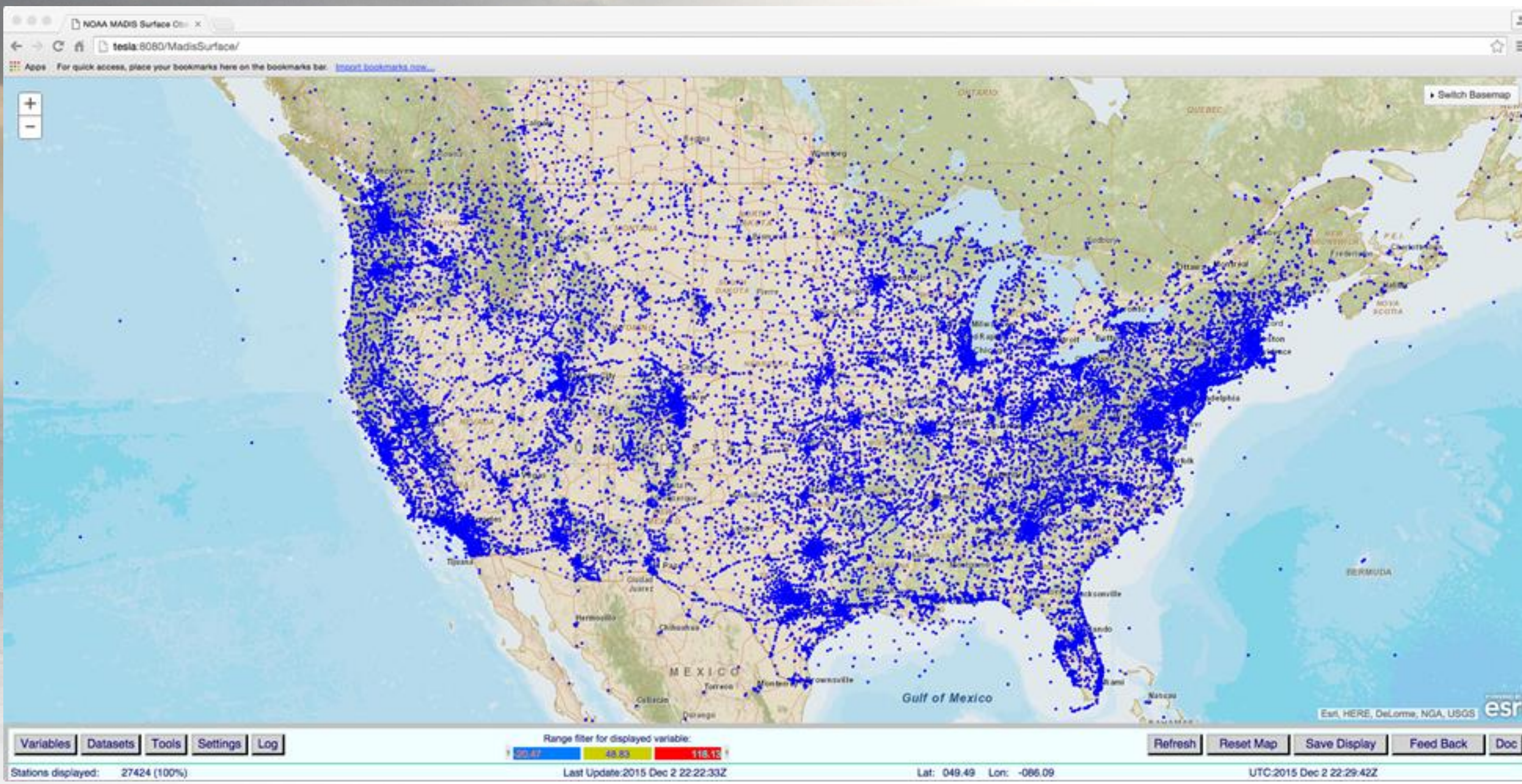
Trend Example: “Internet of Things”, Analytics



Transform under-utilized imaging and observation assets to create a more *“intelligent”* world. – Internet of Things (IoT)

Trend Example: Increasing Data Assimilation

National Mesonet Program

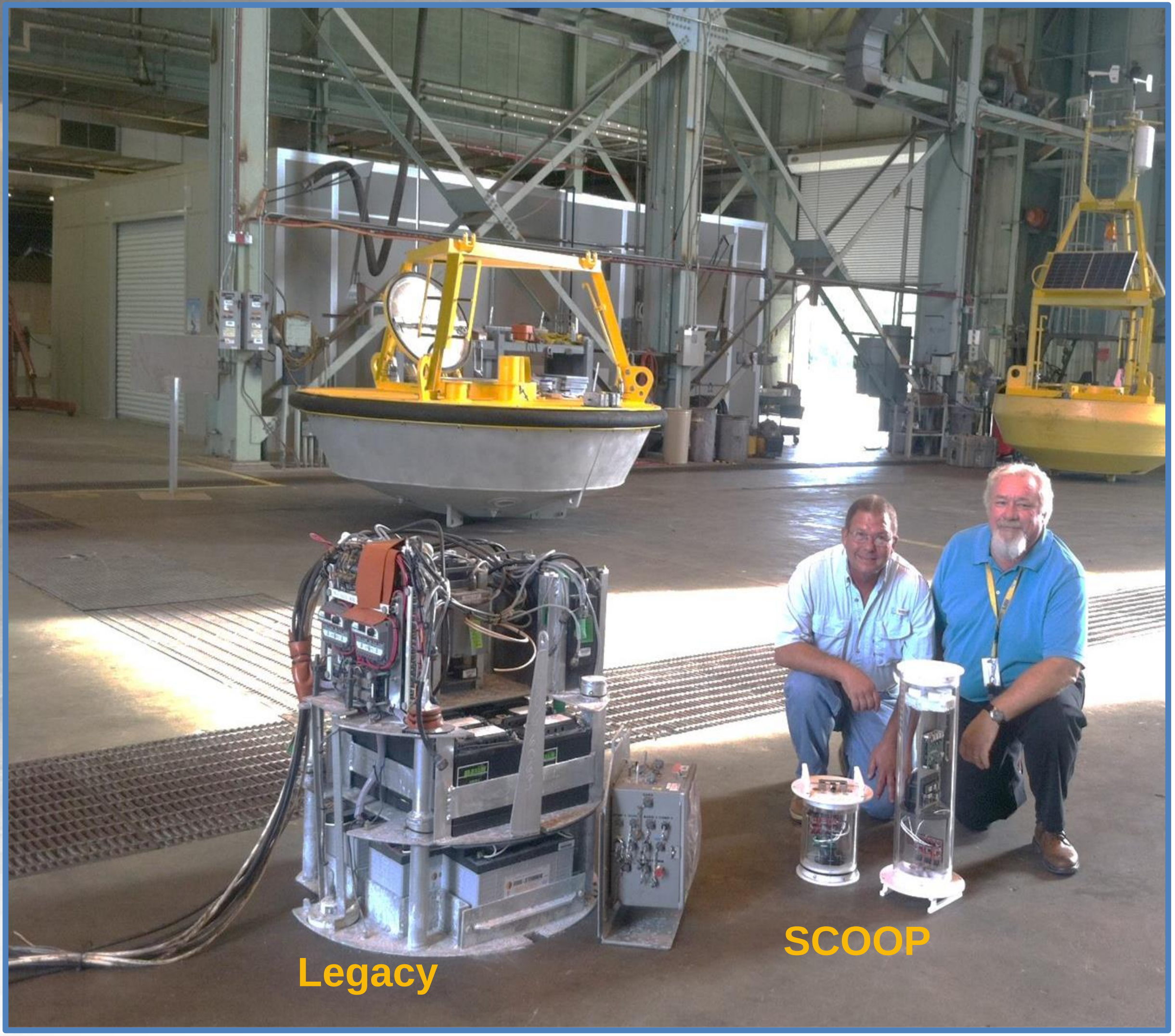


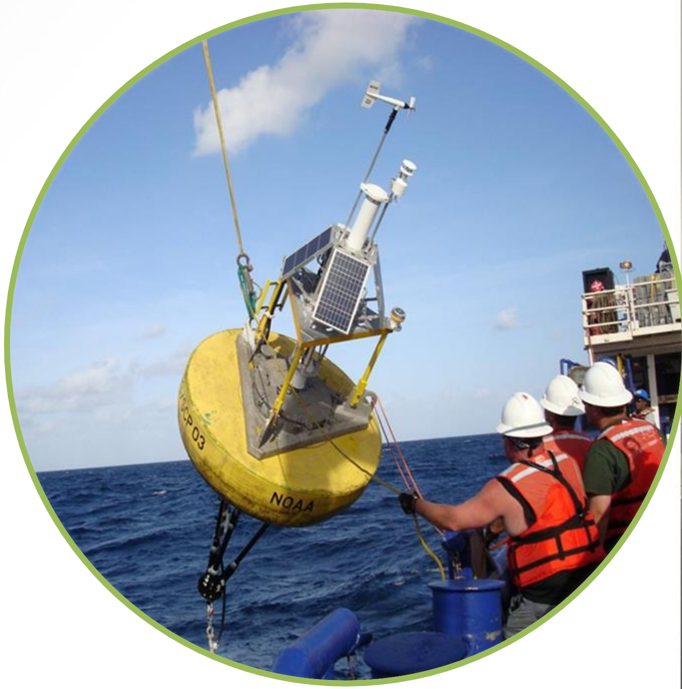
Trend Example: Automation Technology

Frequency spectrum is required to support observations; however, spectrum sales are providing a source of funding for observing infrastructure investment, including technology advancements.

Trend Example: Miniaturization for Wx Buoys

Self-Contained Ocean Observations Payload (SCOOP) Systems





Trend Example: Unmanned Systems

Coyote Unmanned Aircraft System:

- Coyote is a canister launched, unmanned air vehicle (UAV)
- Developed in 2004 to augment manned aircraft capabilities
- UAV is stored and deployed similar to current dropsondes & sonobuoys
  - Sleeve discarded and flight surfaces deployed ~ 15 seconds
  - GPS and autopilot initiated ~ 20 seconds
  - Chute discarded after approximately 25-35 seconds
- UAV flight duration ~ 60min today (up to 4h in 2-3 years)
  - Extend aircraft time on-station
  - Extend aircraft sensor range and coverage
  - Provide extended horizontal profiling at low altitude
  - Increase aircraft and crew survivability

Raytheon

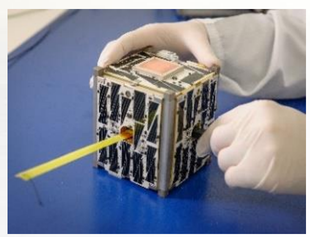
Trend Example: Miniaturization for Satellites

GPS-RO Satellites

- Penetrate through clouds and storms to make critical observations for weather forecasting

- Increase number of weather observations made above the oceans

- Leverage small, inexpensive, satellites that can be replaced every 1 - 2 years (versus every 8 -10 years for larger satellites)



Commercial announcements

> "[Spire] … is launching over 100 shoebox-sized satellites—called CubeSats—that use a technology called GPS Radio Occultation to generate 10,000 weather condition readings each day. Today's large, billion-dollar weather satellites only provide 1,500 readings each day" - **Spire CEO Pete Platzer**

> We look forward to demonstrating that commercial satellite data purchases can enable the unmatched efficiencies of the private sector to help NOAA accomplish its vital mission to protect and inform the public. - **GeoOptics chief executive Conrad Lautenbacher**

These companies have plans to launch satellites soon…

spire
- 20 satellites launched
- Plans to launch 50+ more

PLANETIQ — CRITICAL DATA FOR A SMARTER PLANET
GeoOptics
- Both companies hope to launch 18+ satellite constellations

SOURCE: Press search, Company websites

Managing the Observations Portfolio

With all the technological change with respect to Observations and the entire value chain, how do we find our way forward?

One solution is to consider guiding principles:

- Mission-Effective
- Superior Service and Reputation
- Adaptable
- Cost-Effective, Affordable & Sustainable
- Integrated
- Global Context and Commitments *(Data Sharing)*
- In-House Expertise
- *Well-governed, Understood & Trusted*

Concluding Thoughts

If the experience of other sectors that have faced technological advance is any indicator, we can expect change and innovation in the Weather Enterprise to accelerate.

The collective goal of the all parties in the enterprise can be to harness the potential from these advances for the common good – to strengthen our national safety and to increase our prosperity.

Questions?