Proving Ground goals are to improve NOAA and partner services through optimizing the use of satellite data along with other sources of data & information.

Observations/Products to Services to Stakeholders

Purpose of the Summit:
Panel discussions for wide range of applications areas with users, developers and audience to discuss needs and capabilities.

Addressing needs across NOAA

Weather Ready Nation
- Aviation Weather
- Fire Weather
- Hydrology and Water Resources
- Marine Weather and Coastal Events
- Hurricane / Tropical Storms
- Routine Weather
- Severe Weather
- Space Weather
- Tsunami
- Winter Weather

Resilient Coasts
- Coastal Water Quality
- Marine Transportation and Planning
- Monitoring
- Resilience to Coastal Hazards and Climate Change

Healthy Oceans
- Ecosystem Monitoring, Assessment and Forecast
- Fisheries Monitoring, Assessment and Forecast
- Habitat Monitoring and Assessment
- Protected Species Monitoring

Climate
- Assessment of Climate Change and its Impacts
- Climate Mitigation and Adaptation Strategies
- Climate Science and Improved Understanding
- Climate Predictions and Projections
A Holistic View of the Use of Satellite Data in the National Weather Service

Dr. Louis W. Uccellini, NWS Director

JPSS/GOES-R Proving Ground/Risk Reduction Summit
February 24, 2020
Outline

● NWS Mission and Vision

● GEO-LEO: Ongoing Historic Transition in Use of Satellite Data in Forecast Offices and Models.

● Ongoing and Upcoming Satellite Product Advancements

● Reflections
NWS Mission and Vision
The National Weather Service

MISSION of Today

Provide weather, water, and seasonal data, forecasts and warnings for the protection of life and property and the enhancement of the national economy.

VISION for Tomorrow

A Weather-Ready Nation where society is prepared for and responds to weather and water events; where communities are “Ready, Responsive and Resilient”
NWS Forecast Offices and National Centers
Seamless Suite of Model Forecasts
From Mesoscale to S2S
Increasingly Based on Multi-Model Ensembles

Spanning Weather and Climate

Forecast Lead Time

- Outlook
- Guidance
- Threats Assessments
- Forecasts
- Watches
- Warnings & Alert Coordination

Benefits

Forecast Uncertainty

- North American Multi-Model Ensemble
- Climate Forecast System
- North American Ensemble Forecast System
- Global Ensemble Forecast System
- HEFS
- Global Forecast System
- Global Dust
- Short-Range Ensemble Forecast
- Wave Ensemble
- North American Mesoscale
- Space Weather Prediction Models
- NWM
- Fire Wx
- Regional Hurricane
- Real Time Ocean Forecasts
- Rapid Refresh/HRRR/HRRE
- SSEO (Storm Scale Ensemble of Opportunity)
- Dispersion (smoke)
Most Recent Drop-off for GFS, GEFS, & NAEFS

NH Anomaly Correlation for 500hPa Height

Period: February 1st 2019 - January 31st 2020

- GFS 8.24d
- GEFS.v11 9.60d
- NAEFS 10.09d
GEO-LEO

Ongoing Historic Transition in Use of Satellite Data in Forecast Offices and Models.
Historically

**GEO**
- Situational awareness drives warning requirements.
- Data used in local forecast offices; national centers
- Low latency Required (Minutes)

**LEO**
- Model initialization requirements drives primary use.
- Backbone of the global observing network
- Higher latency (1 to 1.5 hours); factored into 6 hr to 12 hr model cycles

**Currently:** These distinctions being blurred. GEO being used in models. LEO used by forecasters.
Recent Advances: Situational Awareness

GOES-R: Redefining Mesoscale Meteorology
GOES-East Geocolor Hurricane Harvey 25-26 August 2017
GOES-East Water Vapor
03-05 January 2018 Blizzard
Geostationary Lightning Mapper

NASA-SPoRT “Stoplight” Lightning Safety Product

- **Red** – 0-9 minutes since last flash
- **Orange** – 10-19 minutes since last flash
- **Yellow** – 20-29 minutes since last flash

An example of the 30 minute lightning hazard product over New England on 26-27 September 2019 between 2240 and 0010 UTC.
Hurricane Dorian
03 September 2019

- GOES-East ABI Geocolor Imagery
- GLM
- Winds
  - Upper level winds (100-400 hPa) shown in red
  - Mid level winds (400-700 hPa) in cyan
  - Low level (below 700mb) in yellow
GOES East Full Disk Winds Derived from ABI Band 14 (11um) 00Z 20 February 2020
GOES West
Full Disk Winds
Derived from
ABI Band 14
(11um)
00Z 20 February 2020
Recent Advances: LEO and GEO Satellite Data Used in Numerical Weather Prediction Models

Sensors/Satellite Data Assimilated into NWS Operational Models

- HIRS sounder radiances
- AMSU-A & B sounder radiances
- ATMS sounder radiances
- MHS sounder radiances
- AIRS* sounder radiances
- IASI sounder radiances
- CrIS sounder radiances
- GOES sounder radiances
- GOES, Meteosat, GMS winds

- GOES precipitation rate
- SSM/I precipitation rates
- TRMM* precipitation rates
- SSM/I ocean surface wind speeds
- Quikscat* ocean surface wind vectors
- MT SAPHIR*
- JASON ocean surface altimetry
- AVHRR SST
- AVHRR vegetation fraction
- AVHRR surface type
- Multi-satellite snow cover
- Multi-satellite sea ice
- SBUV/2 ozone profile & total ozone
- MODIS* polar winds
- GPS Radio Occultation – COSMIC, METOP/GRAS, CNOFS, GRACE,* SAC-C*, TerraSAR-X*, KOMPSAT5, COSMIC2 (soon)
- SSMIS sounder radiances
- Aura/OMI*
- AMSR/E*
- MSG SEVIRI
- GOES—R/S, Himawari winds
- VIIRS Polar Winds

In Development
- VIIRS SST radiances
- GOES-R ABI radiances
- GPM/GMI*
- SMAP*
- ADM/Aeolus*
- SSMIS imaging channels
- ASCAT OSWV

Denotes Research Satellites *

Made possible through the Joint Center for Satellite Data Assimilation. Accelerate the use of research and operational satellite data in operational numerical weather predict modeling systems.
<table>
<thead>
<tr>
<th>Sounder Type</th>
<th>Sounder</th>
<th>Launch Date</th>
<th>Assimilation Date</th>
<th>Time Elapsed</th>
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<tr>
<td><strong>Microwave Sounders</strong></td>
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<tr>
<td>AMSU (POES)</td>
<td></td>
<td>Multiple</td>
<td>Multiple</td>
<td>2 Years +</td>
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<tr>
<td>SNPP ATMS</td>
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<td>22 May 2012</td>
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<td>NOAA 20 ATMS</td>
<td>18 Nov 2017</td>
<td>30 May 2018</td>
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<td>193d</td>
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<td><strong>Hyperspectral IR Sounders</strong></td>
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<td>Aqua AIRS</td>
<td>04 May 2002</td>
<td>31 May 2005</td>
<td></td>
<td>2 Years +</td>
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<tr>
<td>Metop 1 IASI</td>
<td>19 Oct 2006</td>
<td>24 Feb 2009</td>
<td></td>
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<td>297d</td>
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<tr>
<td>NOAA 20 CrIS</td>
<td>18 Nov 2017</td>
<td>30 May 2018</td>
<td></td>
<td>193d</td>
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<tr>
<td><strong>GNSS Radio Occultation</strong></td>
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<tr>
<td>COSMIC</td>
<td>15 April 2006</td>
<td>01 May 2007</td>
<td></td>
<td>382 days</td>
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<tr>
<td>KOMPSAT-5</td>
<td>08 Aug 2013</td>
<td>10 Oct 2019</td>
<td></td>
<td>6 Years +</td>
</tr>
<tr>
<td>COSMIC-2A</td>
<td>25 Jun 2019</td>
<td>~May 2020</td>
<td></td>
<td>~10 months</td>
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<tr>
<td><strong>GOES-R Series AMVs</strong></td>
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<tr>
<td>GOES-16 (East)</td>
<td>19 Nov 2016</td>
<td>05 Jan 2018</td>
<td></td>
<td>412 days</td>
</tr>
<tr>
<td>GOES-17 (West)</td>
<td>01 Mar 2018</td>
<td>10 Oct 2019</td>
<td></td>
<td>588 days</td>
</tr>
</tbody>
</table>
Example of LEO data used in forecast offices

QuikSCAT > ASCAT

Introduced New Warning Category for Extratropical Ocean Storms

“Hurricane Force Winds”
QuikSCAT

Intense, non-tropical cyclones with hurricane force winds
09 February 2007 North Atlantic
ASCAT

“Dennis”
~1700 UTC
15 February 2020

ASCAT A, B, and C overlaid on MSG-11 10.8 um infrared imagery

(Courtesy of Michael Folmer and James Kells)
Hurricane Force Extra-Tropical Cyclones 2001–2020
Warning Polygons for Extreme Maritime Weather

Nov 26 Eastern Pacific Hurricane Force Storm

- Ship positions at 1800 UTC 26 Nov
- Vessels heeding the warnings
- Coastal traffic minimal
- 2 vessels exiting Hurricane Force area

Warnings
1200 UTC 26-27 Nov 2019
GALE STORM
HURRICANE FORCE Sig Wave Heights > 30 ft

Vessel Types
- Cargo
- Tanker
- Tow
- Cruise
- Pleasure
- Fishing

U.S. Government Seavision

PROTOTYPE - Warning Polygons
VIIRS, CrIS, OMPS, ATMS

Not just for numerical weather prediction model inputs!

Enhancing the spectral and spatial resolution of the earth system with

- Satellite-derived soundings (convective destabilization)
- High-resolution nighttime visible imagery (fog)
- Ozone sensing of aerosols and volcanic emissions (air quality)
- Passive microwave cloud and precipitation detection (hurricanes)
- Improved monitoring of the arctic (river ice and flooding)
Monitoring San Francisco Fog

GOES-West MVFR Probability (Mike Pavolonis)

Suomi NPP VIIRS DNB / Fog Difference
Alaska River Ice

Eagle, Alaska
7 April 2019
GEO and VIIRS Woodbury Burn Scar

Low-earth orbiting satellites add details

Burn scars present unique challenges during heavy rain events

Credit: NASA SPoRT
Normalized Burn Ratio from GOES/VIIRS

VIIRS Image
Woodbury Burn Scar
8 July 2019

Soil Burn Severity Map from BAER Team

Credit: NASA SPoRT
Ongoing and Upcoming Advancements

1. COSMIC-2: 1800 T, Td between 30° N and S per day.
2. GOES ABI: quantitatives use in models
3. “Small Sats”: the commencement of the “Cube Sat” era
4. Use of AI to select data for real-time data assimilation
5. Broader use of LEO and GEO satellite data addressing the total Earth System (models and forecaster use)
Challenges

- Latency in the transmission of all satellite data to the users
  - The more that GEO & LEO satellites are used for situational awareness, the more the demand will be to reduce latency from hours/minutes to minutes/seconds.
Reflections

• I was at the UW when Professor Suomi and his team pioneered the use of satellites for meteorological research and real-time access for operational use.
• We continue to realize Suomi’s vision.
• Even though this historic journey has been 60+ years in the making, we are just scratching the surface.
• **Biggest next step is the GEO hyperspectral sounder! Address the high resolution ΔT opportunity observed across the entire Earth System.**
  o Europe and Asia are leading the effort to launch and operate Geostationary Sounders.
  o We are now the followers… we should be reasserting our past leadership position.
Thank you!
Decision Support at Regional Scales: Connecting Products and Technologies to User Needs in a NOAA Services Framework

Ellen Mecray, NOAA Regional Climate Services Director- Eastern Region

NOAA/NESDIS/NCEI Regional Climate Services
Rising Demand for Information with Regional Perspectives

NOAA’s Societal Challenge Areas

- COASTS
  Community Resilience
- CLIMATE
  Extremes
- WATER
  Drought and Flooding
- S2S
  Icing, wind, heat

Application of NOAA’s Information by Sector

- Agriculture
- Energy
- Health
- Transportation
- Sustainability of Marine Ecosystems
R2S- Lingo on the role of services

User-driven, use-oriented, use-inspired, problem-focused

Environmental Intelligence

Actionable Science

Information for decision-makers

Partnerships, collaboration, can’t do it alone

THE USER

Co-production of knowledge

DSS
**Vision:** U.S. residents understand and use the breadth of NOAA’s information for their decisions

**Mission:** NOAA will build a network of trusted agents who engage internally and with partners to inform NOAA’s product and service development to be useful, usable, and used.

Assembled by a team across NOAA line offices, all services entities

User-focused, interconnected model

Two-way, ongoing communication
Connecting Science, Services and People: NOAA’s Services Enterprise

**State and Local Engagement, Education & Service Delivery**
- Weather Forecast Offices
- Sea Grant Education & Extension
- Marine Sanctuaries, Monuments & Estuarine Reserves
- River Forecast Centers
- Data Centers
- Relevant state-level presence from other agencies (e.g., National Science Foundation, Dept. of Education, Health & Human Services, Dept. of Energy, Dept of Interior, Dept of Agriculture)
- Dept. of Agriculture Extension
- State Climatologists
- Federal Protect Area Programs
- USGCRP Climate Literacy Partners, etc.

**Regional Services Partnerships**
- NOAA Regional Offices and Programs
- Regional offices (NWS and NMFS)
- Regional Climate Services (NCEI)
- NOS/OCM regional offices
- River Forecast Centers
- Regional Collaboration Teams
- Data Centers
- Relevant Regional Offices from other agencies (e.g., Environmental Protection Agency, Dept. of Agriculture, Dept. of Interior, Health and Human Services, Dept. of Transportation, Dept of Energy, etc.)

**National and Regional Science**
- Regional Integrated Science & Assessments
- NOAA Labs (OAR & NMFS)
- Sea Grant
- Cooperative Institutes
- Applied Research Centers
- Data Centers
- Climate Prediction Center
- Other science/research agencies (e.g., National Aeronautics and Space Administration, Dept. of Interior, Dept. of Agriculture, National Science Foundation & other USGCRP agencies)
- Etc...

**USER ENGAGEMENT**
- Development, Delivery & Evaluation of Products & Tools
- Understanding and Translating User Needs
- Informing Program Requirements

**Connecting Science, Services and People:**
- NOAA’s Services Enterprise

**Government**
- Private Sector
- Academia
- NGO’s
Services by Sector

- Energy
- WATER
- CLIMATE
- COASTS
- Health
- Transportation
- Sustainability of Marine Ecosystems
- Agriculture
Transportation

Climate Variables
- Precipitation frequency (design storms)
- Temperature projections (road salt, potholes)
- Accounting for extremes
- Seasonal road posting
- Research on wind and other variables

Infrastructure and Climate Network: http://theicnet.org/

Average Annual Daily Max Temperature
Augusta, ME
NOAA is working in a government to government relationship to offer weather and climate information to meet the requirements of DOE and its core partners

**Mission Interests** - Grid Sustainability and Critical Infrastructure Security

**Weather and Climate Information Requirements:**
- Icing events,
- Temperature extremes,
- Wet bulb temperatures,
- Wind speed and duration
- Water availability (drought impacts)
- Sea level rise

Sample frames from the Story Map - http://arcg.is/1jOLCb
Water Resources - too much and too little

River observation and forecast information: [https://water.weather.gov/ahps](https://water.weather.gov/ahps)
Snow Information: [https://www.nohrsc.noaa.gov](https://www.nohrsc.noaa.gov)
Precipitation Frequency Estimates: [http://www.nws.noaa.gov/oh/hdsc](http://www.nws.noaa.gov/oh/hdsc)

The U.S. Drought Monitor is a weekly map based on measurements of climatic, hydrologic and soil conditions as well as reported impacts and observations from more than 350 contributors around the U.S.

U.S. Drought Monitor
September 19, 2017 (Updated Thursday, Sep. 21, 2017)
Valid 8 a.m. EDT
http://droughtmonitor.unl.edu/
User Engagement as the Foundation—

Nurtured relationships based on a foundation of trust and mutual respect

User requirements are derived from an understanding of their decision challenges

Timely response to their requirements form the basis of ongoing engagement and use-inspired product improvement

- Include user engagement as the impetus for the idea
- Ensure co-production with the user community through each phase:
  - Does it do what you need it to do? Do you need different features? Can you work it, or can we offer training?
  - Is it USEFUL?
  - Is it USABLE?
  - Will it be USED?
Backups
Why now?

NOAA must coordinate a unified service delivery/decision support mechanism that carefully leverages partnerships and informs the development of use-inspired products and services. This mechanism is a timely effort meant to best serve our customers, particularly under changing weather, water, and climate conditions.
What will this plan mean for NOAA?

Effective implementation of our service delivery plan can transform how NOAA:

- Prioritizes its product lines (observations, data, and services);
- Develops new, and refines existing, products; and
- Transmits and translates information for decision-makers across multiple sectors
Billion Dollar Disasters

U.S. 2018 Billion-Dollar Weather and Climate Disasters

Western Wildfires, California Firestorm Summer—Fall 2018
Rockies and Plains Hail Storms August 6–7
Southwest/Southern Plains Drought 2018
Colorado Hail Storm June 19–19
Texas Hail Storm June 6
Southeastern Tornadoes and Severe Weather April 13–16
Central and Northeast Severe Weather April 1–4
Northeastern and Eastern Winter Storm January 3–8
Northeastern and Eastern Winter Storm March 1–3
Central and Northeast Severe Weather May 1–4
Central and Eastern Tornadoes and Severe Weather July 19–22
Central and Eastern Severe Weather May 13–15
Hurricane Florence September 13–16
Hurricane Michael October 10–11

This map denotes the approximate location for each of the 14 separate billion-dollar weather and climate disasters that impacted the United States during 2018.

Billion-Dollar Disaster Event Types by Year (CPI-Adjusted)

- Winter Storm
- Wildfire
- Trop. Cyclone
- Severe Storm
- Freeze
- Flooding
- Drought

https://www.ncdc.noaa.gov/billions/
NCEI: A Nationwide Presence
Weather and Climate Timescales

Forecast Lead Time

- Minutes
- Hours
- Days
- 1 Week
- 2 Week
- Months
- Seasons
- Years

Forecast Uncertainty

Climate Prediction Products

Weather Prediction Products

Projections
Outlooks
Guidance
Threats
Assessments
Forecasts
Watches
Warnings & Alert Coordination

Benefits

- Life & Property
- Aviation
- Maritime
- Space Operations
- Fire Weather
- Emergency Mgmt
- Commerce
- Energy Planning
- Hydropower
- Reservoir Control
- Agriculture
- Recreation
- Ecosystem
- Health
- Environment

Life & Property
Aviation
Maritime
Space Operations
Fire Weather
Emergency Mgmt
Commerce
Energy Planning
Hydropower
Reservoir Control
Agriculture
Recreation
Ecosystem
Health
Environment

NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION
Provision of information is highly dependent on the customer.

- Government to government- technical assistance, user engagement, refinement of information products
- Private sector enterprise- tailored tool development
Nurtured relationships based on a foundation of trust and mutual respect

User requirements are derived from an understanding of their decision challenges

Timely response to their requirements form the basis of ongoing engagement and use-inspired product improvement
The Value of Satellite Data

Chris J. Lauer, Ph.D

NOAA Chief Economist Team
Performance, Risk and Social Science
Office of the Chief Financial Officer

performance.noaa.gov/economics
Contents

1. Why is measuring benefits important?
2. How does satellite data create value?
Question for Audience?

PROVIDERS
- observations

INTERMEDIARIES
- value-added products

END USERS
- emergency managers,
  developers, city planners,
  private sector

Source: IOOS Ocean Enterprise Presentation
Why is Measuring Benefits Important?

Valuation is important in order to:

• Understand impact of past investments

• Justify budget requests for future investments

• Align agency operation and investments with public value
How Does Satellite Data Create Value?

• Cost effective ways to increase benefits of environmental data (Williamson et al 2002)
  • Investments in understanding our users
  • Improving the flow of information to these users

• Data have value when they are used in decision making. If not, then the economic value of such data/information is effectively zero
The Theory Of “Change”

Existing information → Decisionmaker actions → Outcomes for people and the environment

New information → Decisionmaker actions → Outcomes for people and the environment

Benefits = Outcomes for people and the environment - Outcomes for people and the environment
Key Questions

- What do we produce?
- Who uses it?
- What gets better? How much better?

Significant collaboration is required to answer these questions.

Figure Courtesy of RFF Valuables
Value Chain

- Tool for analysis of linkage between all activities that lead to creation of value
- Useful as a communication tool
- Creates a common understanding of value creation process.
Value Chain

Observational Platforms (Satellites, Marine Vessels, Aircraft, Buoys)

Societal Impact of NOAA's Weather, Climate, and Observational Products and Services

Businesses Generating Value-Added Products

End Users: Business, Researchers, Government, General Public

Dissemination of Products and Services

Information

Analysis

Research

Data

Data Stewardship

Sensors
NOAA Value Tree

+ 183 other observing systems
Current NOAA Valuation and Customer Engagement Efforts

NESDIS

- Space Weather Impact Study
- GOES-R Improvements Valuation Study
- Benefits of Hyperspectral Sounder
- GEO-XO Planning
- TPIO NOSIA refresh and user engagement
- NCEI Customer Engagement

Other Satellite related valuation work

- NWS IDSS study
- Social Coast valuation study
- IOOS user survey
- OAR funded studies of value for severe weather forecasts
NOAA Administrative Order for Chief Economist

NOAA Administrative Order 216-124

.02 To ensure agency-wide methodological standard and alignment in the following:

a. **All Line/Staff Offices (LO/SO) should consult with the Chief Economist during the design phase and schedule follow up(s) as needed for the following analyses:**

i. Regulatory Impact Analyses of significant rulemakings [as defined by Executive Order’s 12866 (Regulatory Planning and Review) and 13563 (Improving Regulation and Regulatory Review)];

ii. Economic analyses developed for budget justification, such as economic impact analyses, cost-benefit analysis, and return on investment;

iii. Economic analyses requested by the Department of Commerce, Congress, or the Executive Office of the President;

iv. Economic analyses developed to support performance measures and the Foundations for Evidence-Based Policymaking Act of 2018; and

v. Any other significant studies, on a case-by-case basis, as determined by NOAA leadership.
Conclusions

• Valuation work can help you better serve your users

• This requires knowing your users and investing in collecting data about them.

• Value chains can help identify product inputs and user decisions

• Collaboration between information providers, users and economists is crucial for valuation efforts.
Contact Information

Chris J. Lauer, Ph.D.
Economist
Performance, Risk and Social Science Office
Office of the Chief Financial Officer
National Oceanic and Atmospheric Administration (NOAA)
christopher.lauer@noaa.gov
phone: 240-533-9045