

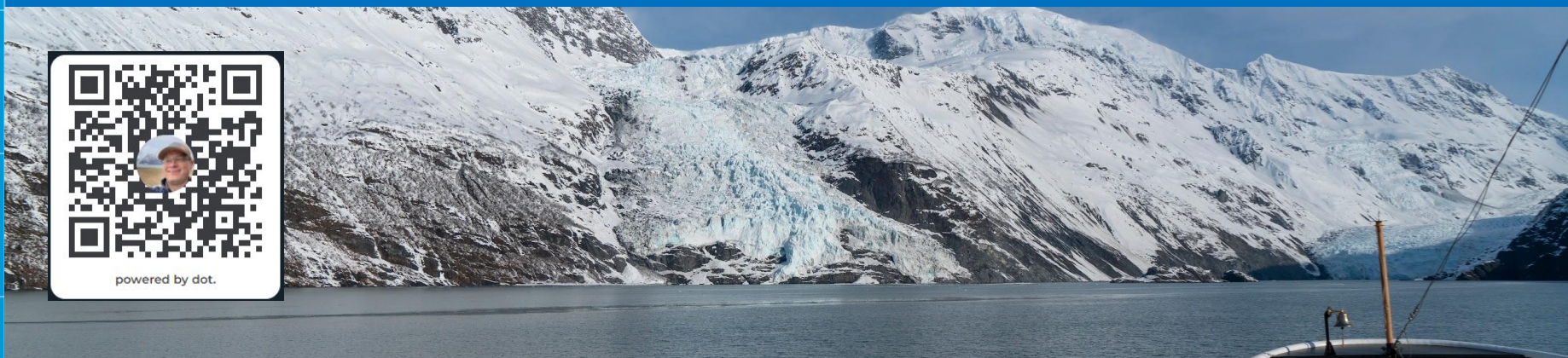


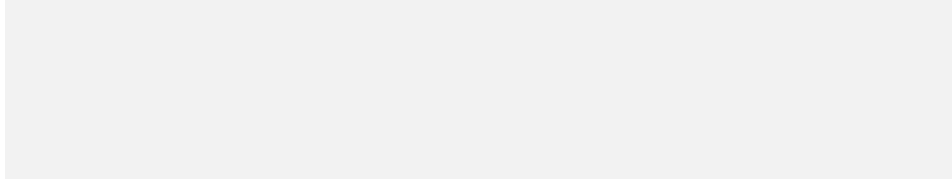
NOAA
National
Weather
Service



2024 Mission Briefing

National Tsunami Warning Center





11 : Duty Scientists (Tsunami Watch)

4 : Information Technology/ Electronic Support



1 : Administrative Support



4 : Management





About 40 personnel between Operational Watch, Support, & Management



National Tsunami Warning Center
Pacific Tsunami Warning Center



Focus areas:

Geophysics, Oceanography, Physical Science,
Geology, Communications & Emergency
Management, Computer science / IT, Electronics,
Observation Systems



Program Management & Support



International Tsunami Information Center
NWS Headquarters staff

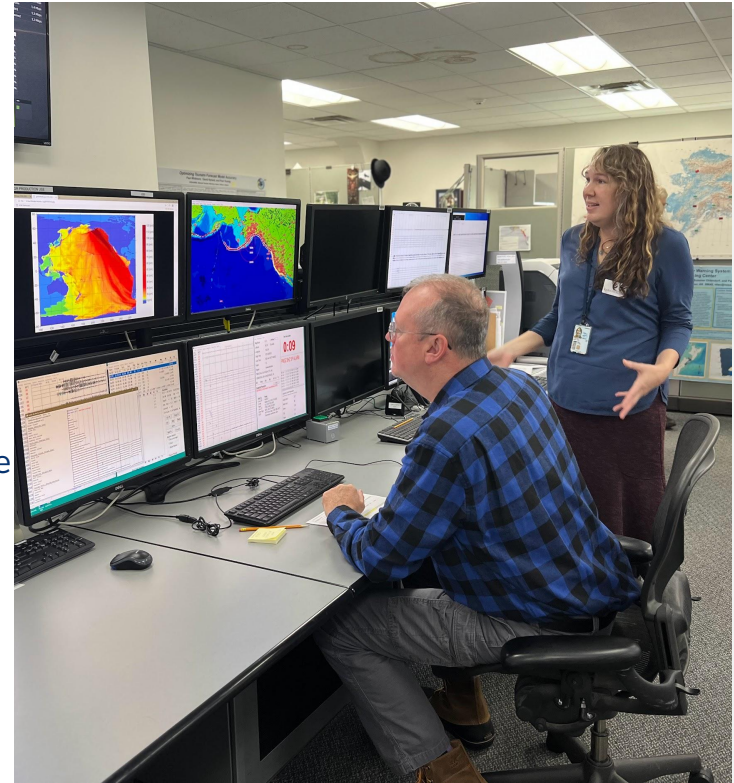




Tsunami events in the last 4 years

Close call events that don't reach alert/message status are critical decision events, too.

- 10-08-2023 M5.0 Izu Islands, Japan
- 07-16-2023 M7.4 Sand Point, Alaska
- 02-06-2023 M7.8 Turkey
- 03-16-2022 M7.3 Honshu, Japan
- 01-15-2022 Hunga Tonga- Hunga Ha'apai eruption
- 08-12-2021 M8.1 South Sandwich Islands
- 07-29-2021 M8.2 Chignik /Perryville, Alaska earthquake
- 03-04-2021 M8.1 Kermadec Islands earthquake
- 02-10-2021 M7.9 Loyalty Islands earthquake
- 10-19-2020 M7.6 Sand Point, Alaska earthquake
- 07-22-2020 M7.8 Simeonof, Alaska earthquake





Barry Arm, AK, landslide tsunami



Well-known threat:

Landslides in glacial fjords within Prince William Sound may create local tsunamis.



The Barry Arm landslide is ~500 Million cubic meters of rock that could create a tsunami reaching Whittier, Alaska, in about 20 minutes.



<https://dggs.alaska.gov/hazards/barry-arm-landslide.html>

CONTINENTAL ALERTING RESPONSIBILITY

NATIONAL TSUNAMI WARNING CENTER

Palmer, Alaska

PACIFIC TSUNAMI WARNING CENTER

Honolulu, Hawai'i

PACIFIC OCEAN

ATLANTIC OCEAN

*Continental US and
Canada*

*Hawai'i,
American Samoa, Guam, the
Northern Mariana Islands
and International Partners*

*Puerto Rico, US Virgin
Islands and International
Partners*





NTWC informs Federal and State partners



Who serve their local communities and coastlines



NORTH AMERICAN COAST PACIFIC

Alaska

*Canada

Washington

Oregon

California

ATLANTIC

Maine

Massachusetts

Rhode Island

Connecticut

New York

New Jersey

Delaware

Maryland

Virginia

North Carolina

South Carolina

Georgia

Florida

Alabama

Mississippi

Louisiana

Texas





United States Code Title 33 Navigation and Navigable Waters Chapter 45



Tsunami Warning and Education

Sections 3201 - 3208

Tsunami forecasting and warning program.

National tsunami hazard mitigation program.

Tsunami research program.

Global tsunami warning and mitigation network.

Tsunami Science and Technology Advisory Panel.

Authorization of appropriations.

Outreach responsibilities.

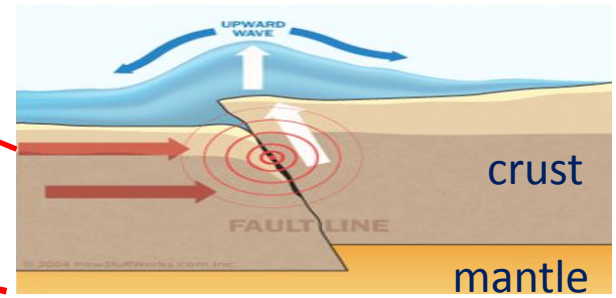
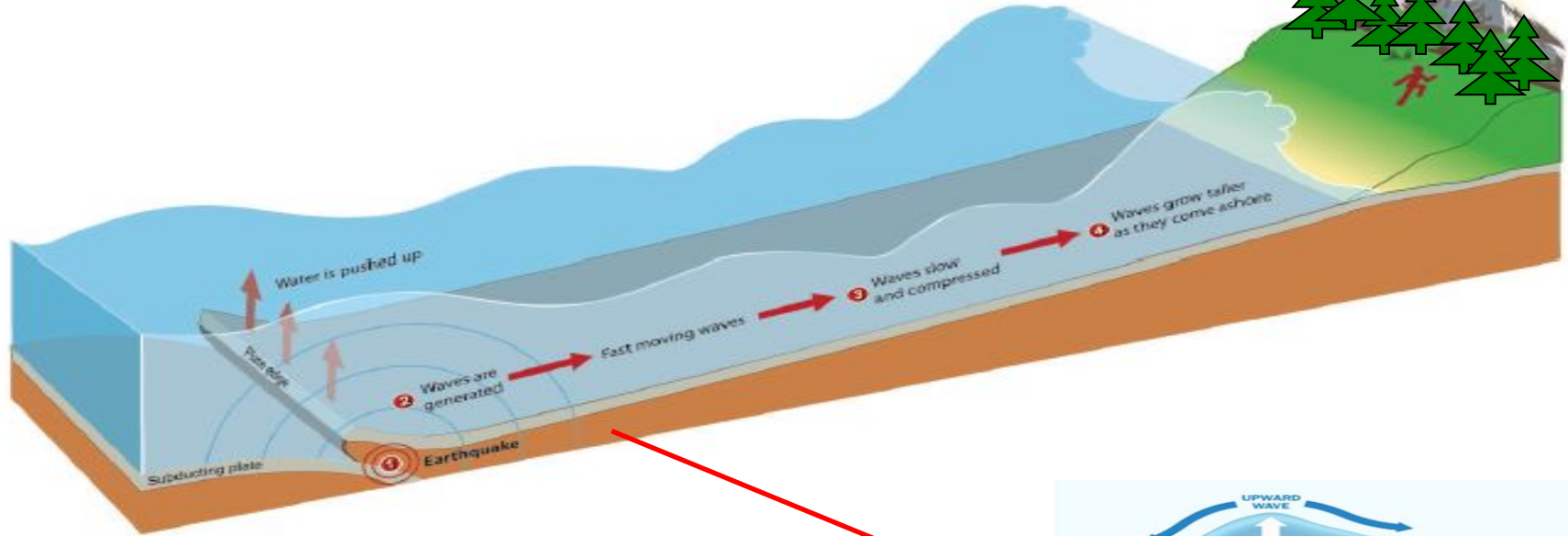


Tsunami partners organize through NTHP





How does a tsunami form?



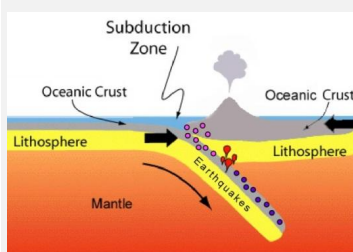
Tsunami sources

~85% of tsunamis are caused by earthquakes.

[The Tsunami Warning Centers are designed to alert for this threat].

The remaining ~15% comes from landslides, volcanic eruptions, meteors, and meteotsunamis (weather), and other significant water disruptions.

[The Tsunami Warning Program has special procedures for some of these events. Additional work is required to adequately detect, analyze, forecast, and alert for these threats].

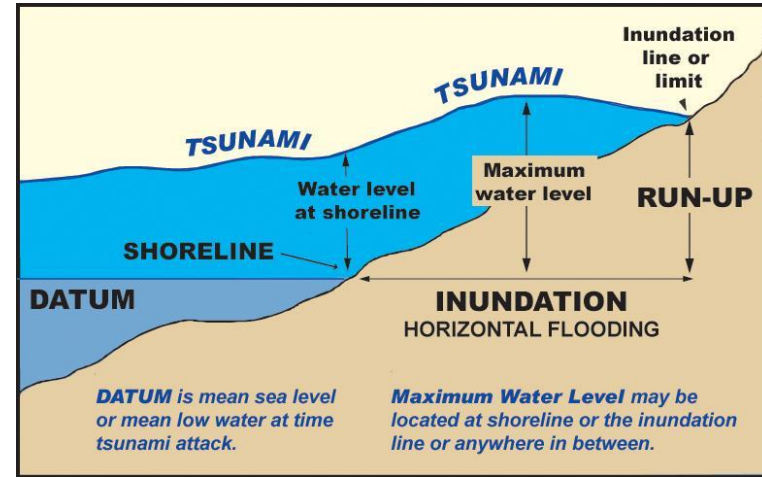


Coastal flooding/ inundation

- Tsunamis can also travel up low-lying coastal waterways
- Tsunami arrival at high tide will be worse than at low tide
- Subsidence during the earthquake will result in more inundation

Strong Currents

- Danger from even “small” or distant source tsunamis
- Change in shipping channels and harbors



Santa Cruz Harbor, 2011: 13 knot current



Santa Cruz harbor, California damage:
\$16 M harbor infrastructure
\$60 M personal property

Hunga Tonga-Hunga Ha'apai eruption and
tsunami damage during a
Tsunami Advisory
January 15, 2022



TSUNAMI IMPACTS

Sound a lot like storm surge impacts



PLAN FOR THE TSUNAMI CARD- IT'S IN THE DECK



and might not stay at the bottom of the pile

FOLLOWING A SIGNIFICANT SEISMIC OR NATURAL EVENT,
THE NATIONAL TSUNAMI WARNING CENTER
HAS




5
MINUTES



TO ANALYZE AND ISSUE AN ALERT OR
NO THREAT- MESSAGE



TSUNAMI ALERTS

Alert level	Action	Hazard	
WARNING	Get to high ground or inland IMMEDIATELY! Follow evacuation signage	DANGER! A TSUNAMI IS IMMINENT. Flooding & dangerous currents	3+ feet or 1+ meter 
ADVISORY	Stay out of the water and away from the shore	STRONG CURRENTS & DANGEROUS WAVES! In or near coastal waters	1 - 3 feet  or 0.3 - 1 meter
WATCH	Prepare to take action. Monitor local TV, radio, social media, NOAA weather radio	A TSUNAMI IS POSSIBLE. Arrival time is several hours away. Prepare now. Alert level may change.	Prepare 
INFORMATION STATEMENT	NO action needed	NO tsunami impact expected.	Relax 

THREAT MESSAGE: Issued for International Partners; NOT for U.S. Coasts

TSUNAMI FORECASTS NEED TIME



1) SIGNIFICANT EARTHQUAKE OR LANDSLIDE
(WHICH DISTURBS A SIGNIFICANT VOLUME OF WATER)

2) WAVE REACHING A DEEP-WATER SENSOR:
DART BUOY

FORECAST

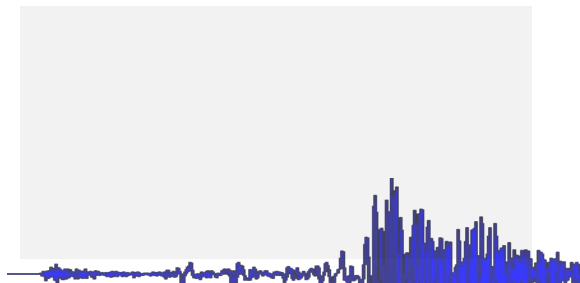
3) WAVE REACHES THE COAST :
COASTAL TIDE STATION OR TSUNAMI GAUGE

OBSERVATION

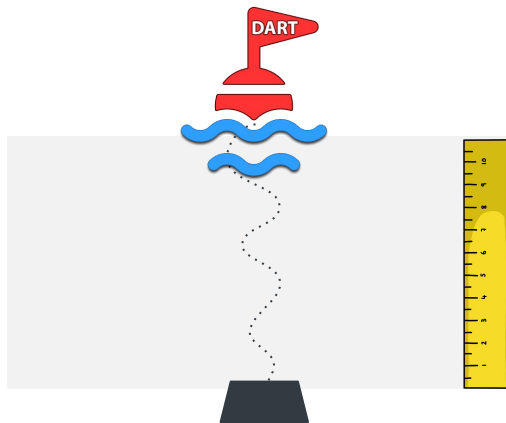
C O N F I D E N C E



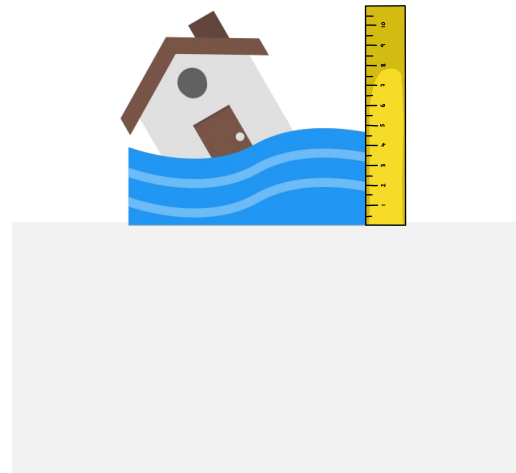
Observation networks inform tsunami alert decisions



NTWC-operated and worldwide partner networks detect local and global earthquakes



NOAA-operated DART underwater pressure sensors plus worldwide partner-supported networks detect deep-ocean water changes indicating a tsunami is present



NTWC-operated stations plus NOAA and worldwide-supported tide gauges networks measure a tsunami once it reaches the coast

2022: Unusual tsunami currents damage harbors

- Tsunami means “harbor wave”
- Resonating waves create fast currents that can be dangerous to impossible to navigate
- Currents change the harbor channels
- Damage to vessels and docks is likely
- Vessels underway may encounter debris and hazards to navigation





8 Years since Aleutian Islands M8.6 earthquake and tsunami



HILO, Hawai'i 1946, April Fool's Day Tsunami, and Scotch Cap Tsunami



60 Years since the Great Alaska Quake: M9.2



KODIAK, Alaska (AP) 1964



20 Years since the Sumatra M9.1 earthquake & tsunami



South-West suburb of Banda Aceh, Indonesia. Village of Lampisang (US Navy) 2004

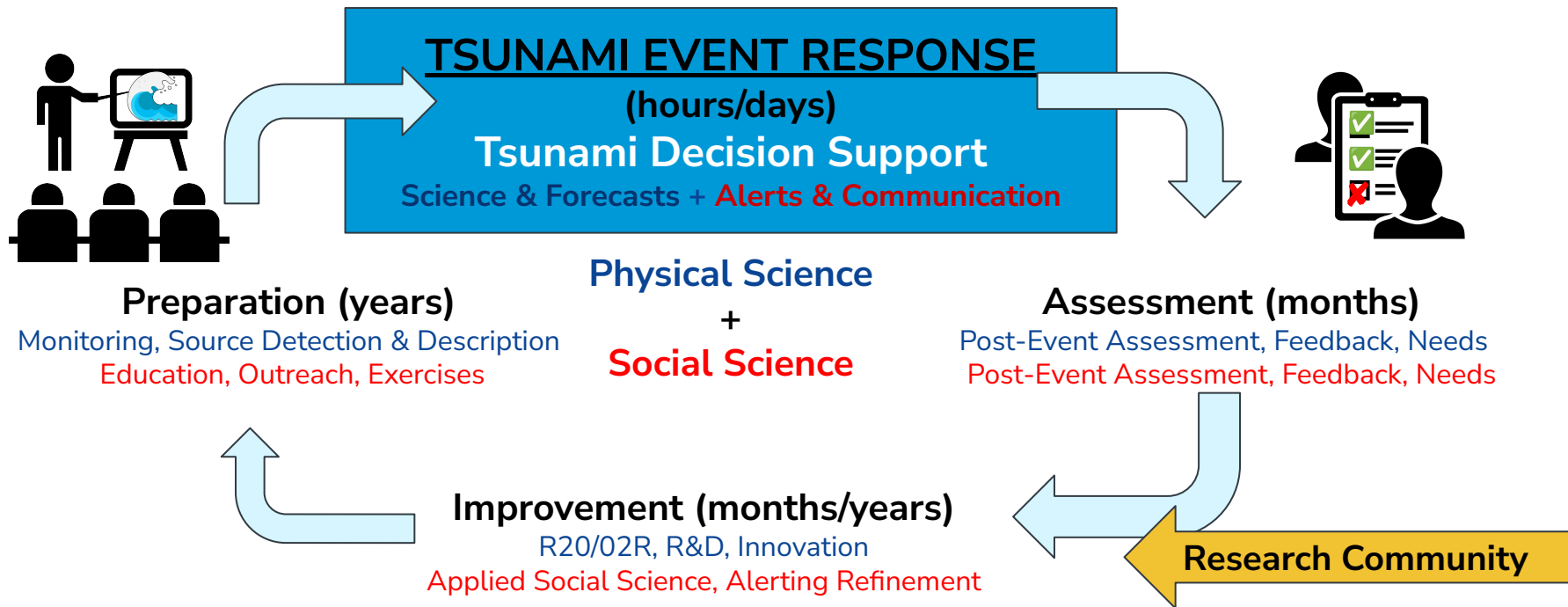


13 Years since the Tohoku M9.0 earthquake & tsunami



Damage near Rikuzentakata, Japan.
Mass Communication Specialist 3rd Class Alexander Tidd, U.S. Navy

Tsunami event is a small part of the cycle





NOAA
National
Tsunami
Warning
Center

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Science Officer

[Data, Analysis, Science, Staff Training]

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Dave Snider,
Warning Coordinator

[Alert & Dissemination, Decision Support,
Partner Outreach, Media & Public Affairs]

david.snider@noaa.gov





The Climate Prediction Center: Mission overview and the Global Tropics Hazards (GTH) Outlook

Jon Gottschalck

Chief, Operational Prediction Branch
NOAA / NWS / Climate Prediction Center

National Hurricane Conference

March 26, 2024

Orlando, FL



CPC Mission



Deliver real-time products and information that predict and describe climate variations on timescales from weeks out to a year

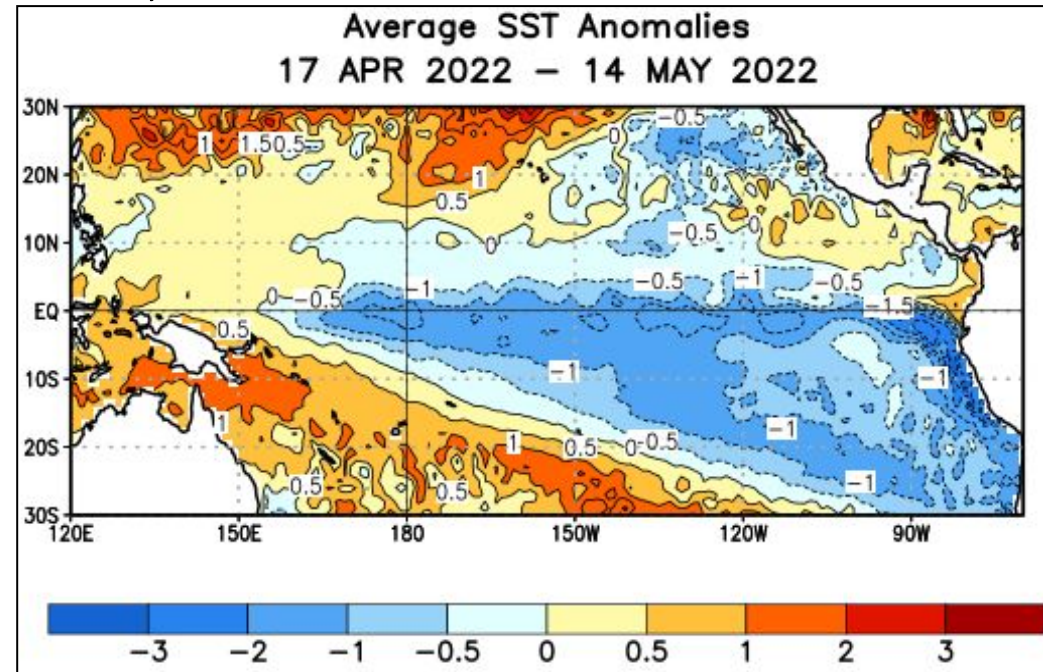
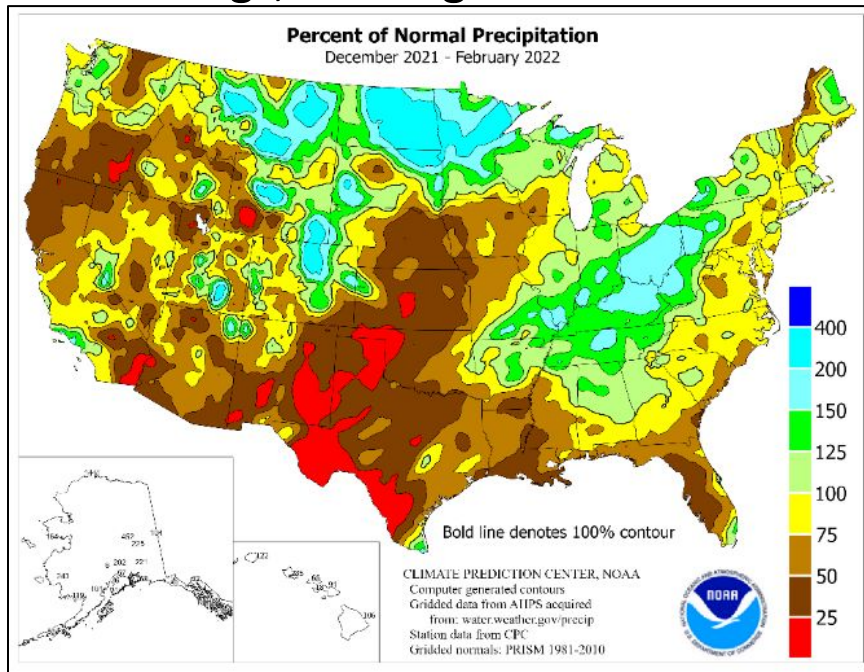
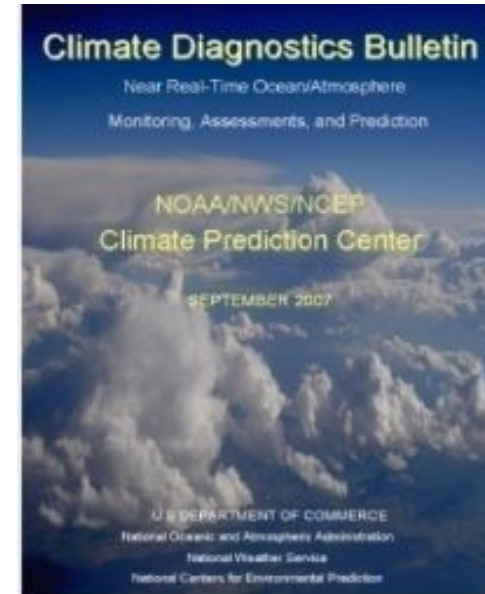
Thereby promoting effective management of climate risk and a climate-resilient society

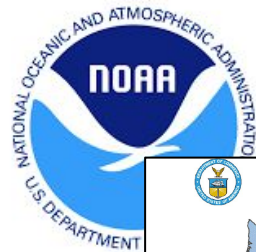
<https://www.cpc.ncep.noaa.gov/>

Both domestic and international presence

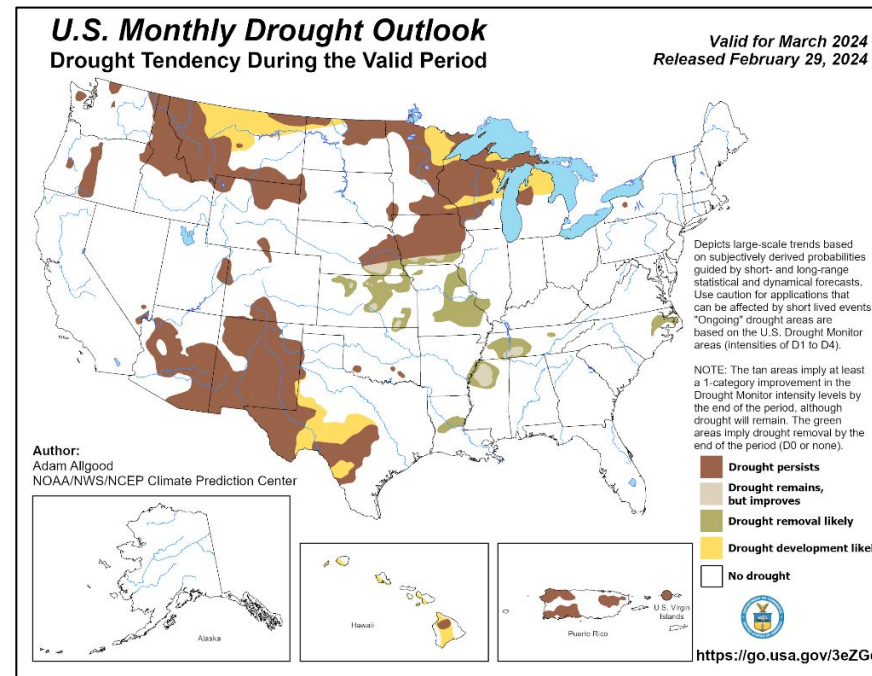
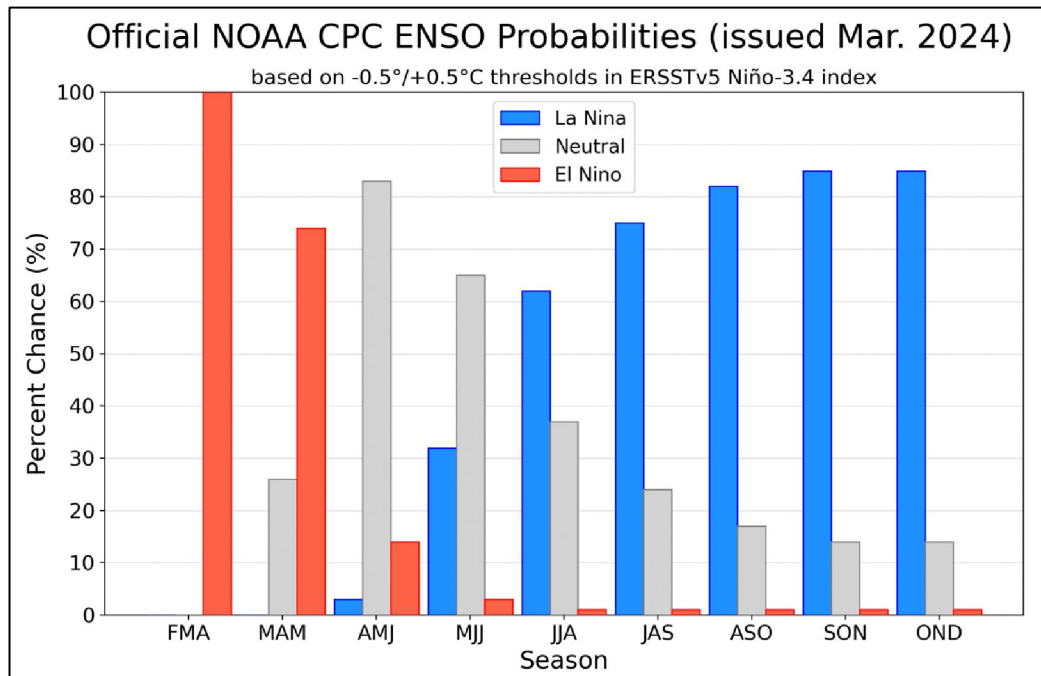
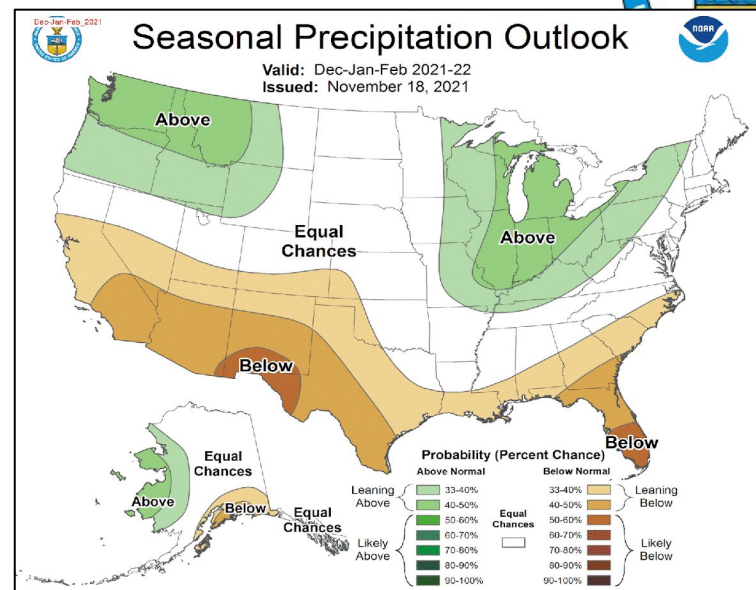
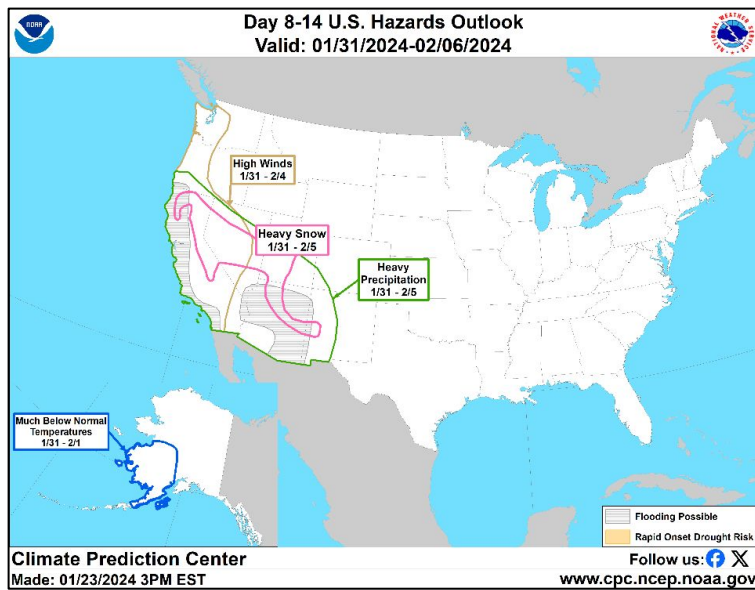
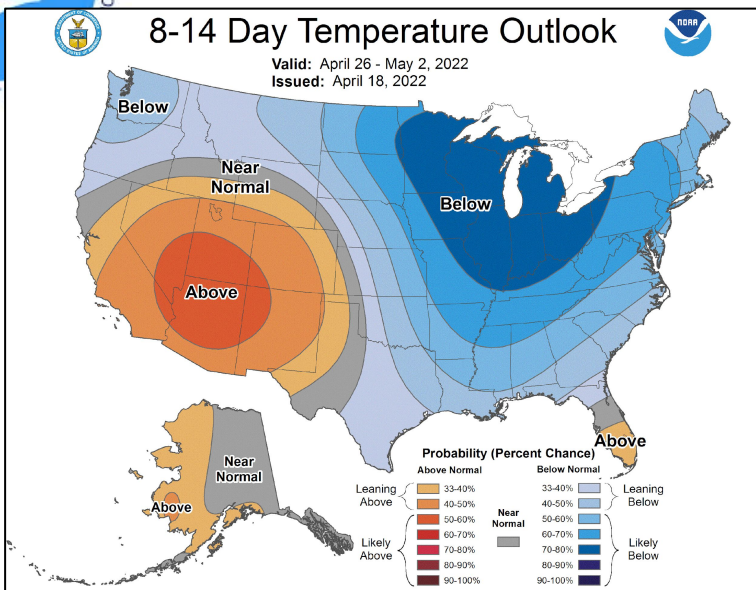
CPC Mission – Monitoring Services

- U.S. Drought Monitor
 - ✓ Co-produced with other agencies including USDA
- Satellite and Gauge Precipitation
- Surface Temperature
- Atmospheric and Ocean reanalysis
- Monitor common types of Climate Variability:
 - ✓ ENSO, MJO, NAO, AO, PNA, stratosphere
- ENSO Diagnostic Discussion
- Briefings, training for NWS field and partners, stakeholders





CPC Mission – Forecast Products and Services

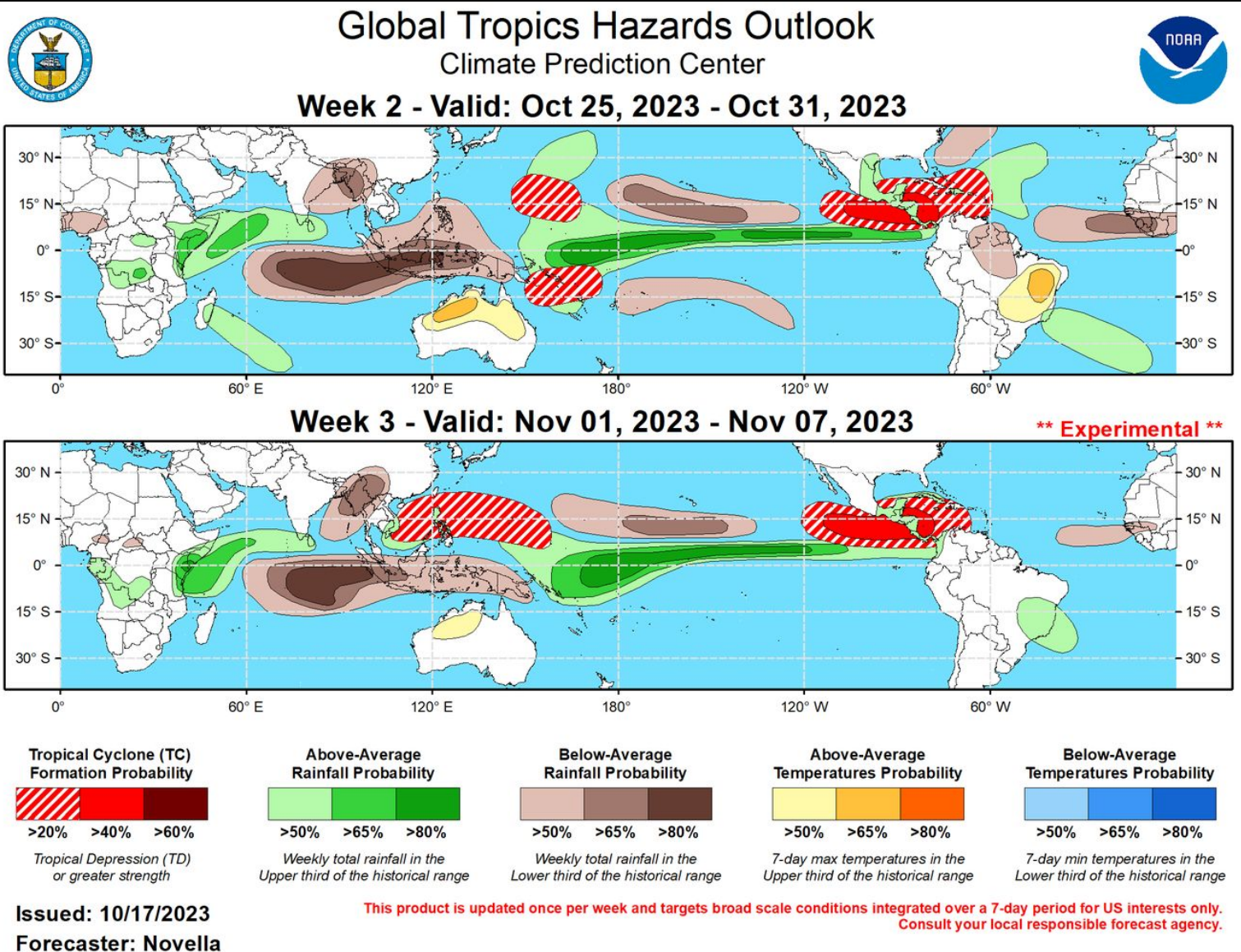




Global Tropics Hazards Outlook



<https://www.cpc.ncep.noaa.gov/products/precip/CWlink/ghaz/index.php>



- ✓ **Forecast elements include:**
 - Hazardous weekly precipitation
 - Hazardous extreme heat/cold
 - Favored TC genesis regions
- ✓ **Forecast Format:**
 - Targets Weeks 2-3
 - Probabilistic

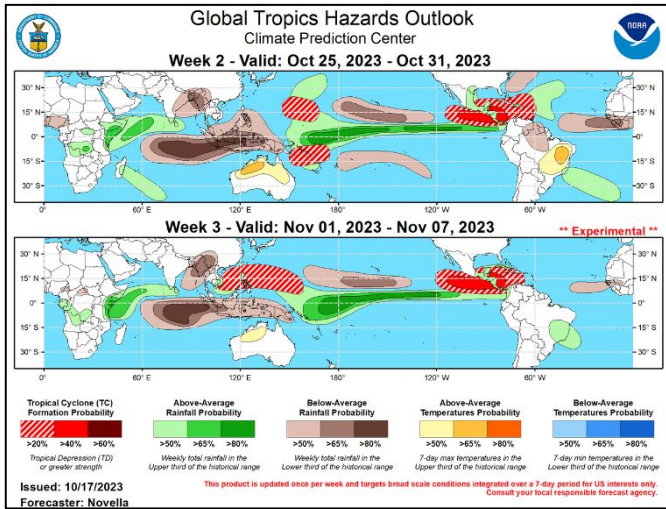


Global Tropics Hazards (GTH) Outlook



- ✓ **Goal:**
 - ✓ Monitor and assess changes in anomalous tropical rainfall, winds, other extremes and communicate this information to NWS and other forecasters
 - ✓ Provide situational awareness, early watch for potential tropical related hazards such TCs, subseasonal rainfall departures, monsoon impacts, etc.
 - ✓ Support sectors of the U.S. economy (finance, emergency management, energy, agriculture, WRM) that have both domestic and foreign interests

- ✓ **Stakeholders:**
 - ✓ NWS, NOAA, Federal, state and local government, aid organizations, emergency management entities



GTH Outlook Discussion

Last Updated - 03/19/24

Valid - 03/27/24 - 04/09/24

A robust MJO event continues to unfold, with the enhanced convective phase now crossing the Western Pacific. During the past week or so, widespread enhanced convection overspread the eastern Indian Ocean and western Maritime Continent, which is a departure from the weakening ENSO base state. Dynamical models are in good agreement with tight ensemble clustering that strong MJO activity continues to propagate eastward from the Western Pacific and into Western Hemisphere over the next two weeks, though it should be noted that the forecasted phase speed is on the fast end of the MJO frequency range. As the suppressed phase of the MJO is moving into the Maritime Continent, this tends to suppress tropical cyclone (TC) activity in the Australia and South Pacific regions, which have been active recently.

One TC formed over the last week. On March 15 TC Megan formed in the Gulf of Carpentaria. It intensified quickly, reaching category 1 strength, and came ashore into northern Australia on March 18. The Joint Typhoon Warning Center (JTWC) expects Megan to dissipate in the next day or so, but indicate that the system will be closely monitored for signs of regeneration.

Consensus among the model ensembles depicts the MJO in phases 8 and 1 during week-2, which would slightly favor TC genesis in the southwest Indian Ocean. This is also supported by the ECMWF extended range TC genesis forecast, so a slight risk (>20% probability) for TC genesis is posted east of Madagascar. The MJO in phase 8 or 1 tends to suppress TC activity for the Australia and South Pacific regions, which have been quite active lately. Model solutions diverge by week-3 but generally still indicate eastward propagation of the MJO signal into the Indian Ocean, which would once again begin to favor TC genesis off the northwest coast of Australia for week-3.

GIS Ready Formats

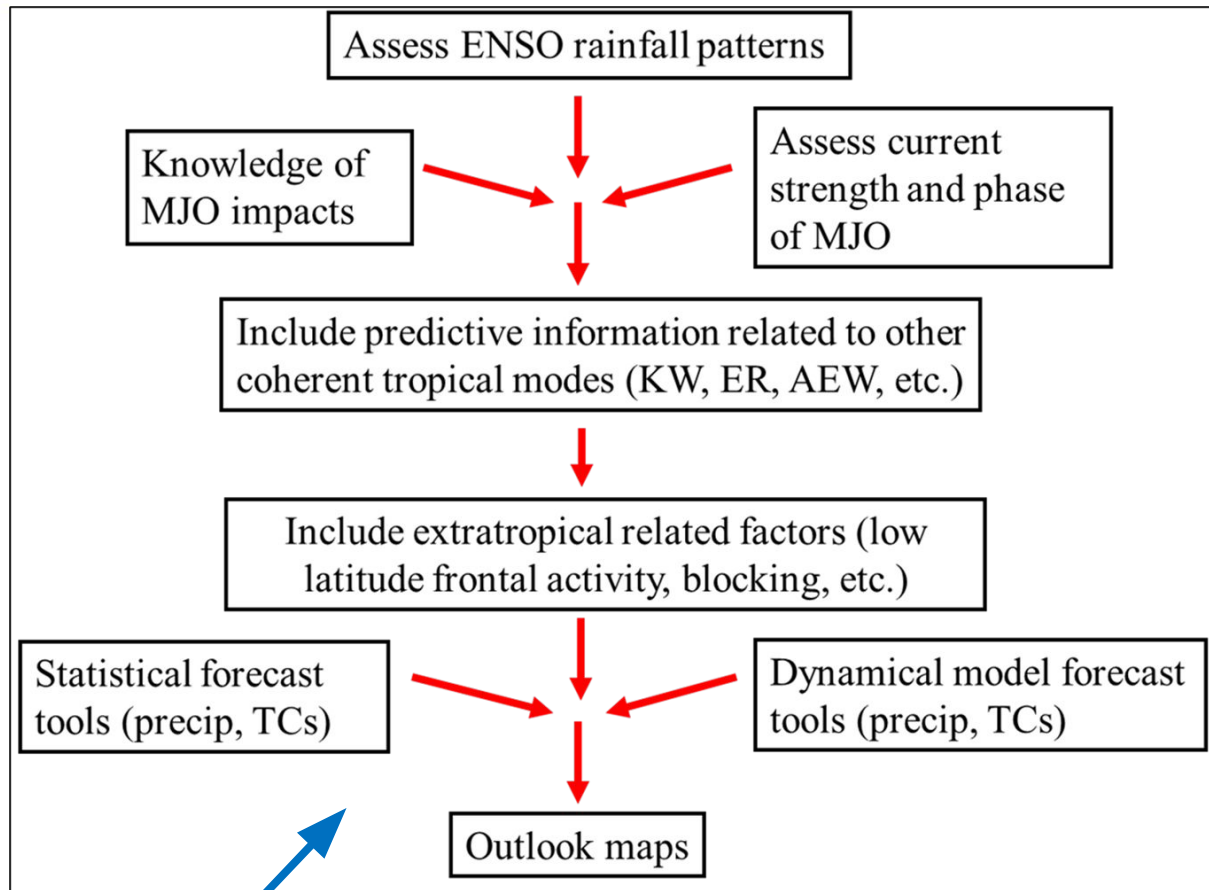
Hazard	Week-2	Week-3
Tropical Cyclone Formation Probability	KMZ KML SHP	KMZ KML SHP
Enhanced Precipitation Probability	KMZ KML SHP	KMZ KML SHP
Suppressed Precipitation Probability	KMZ KML SHP	KMZ KML SHP
Above Average Temperatures Probability	KMZ KML SHP	KMZ KML SHP
Below Average Temperatures Probability	KMZ KML SHP	KMZ KML SHP

- [Tropical Cyclone Only GTH Map](#)
- [Precipitation Only GTH Map](#)
- [Temperature Only GTH Map](#)
- [Lines Only GTH Map](#)

- [Latest Product \(PDF Format\)](#)
- [Latest Briefing \(PDF Format\)](#)
- [GTH Archive](#)



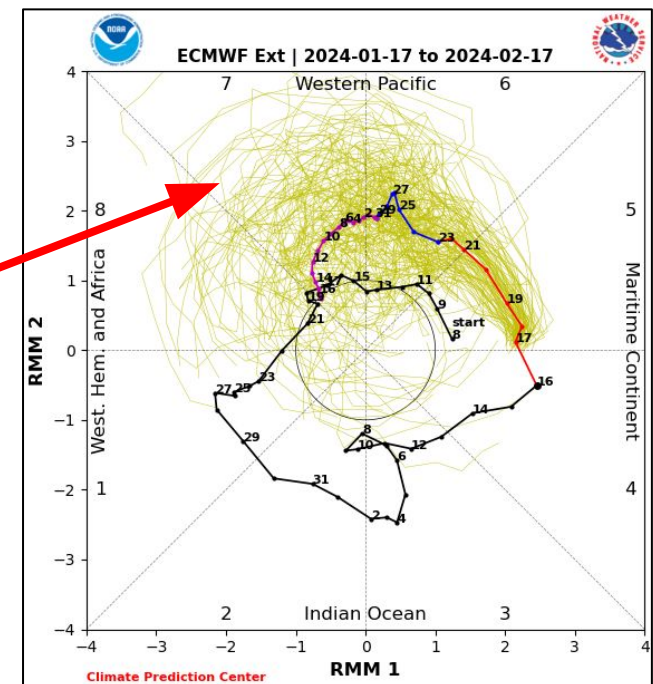
Global Tropics Hazards (GTH) Outlook



Factors considered and utilized as part of the outlook process

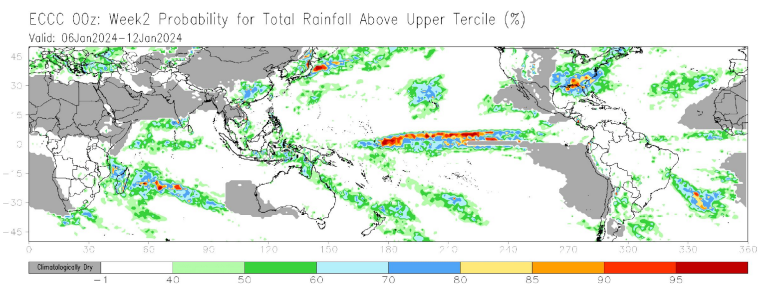
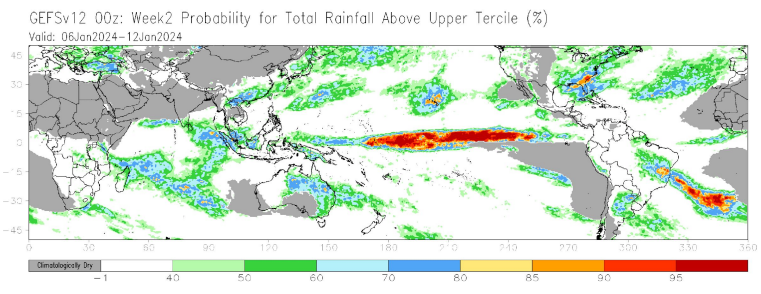
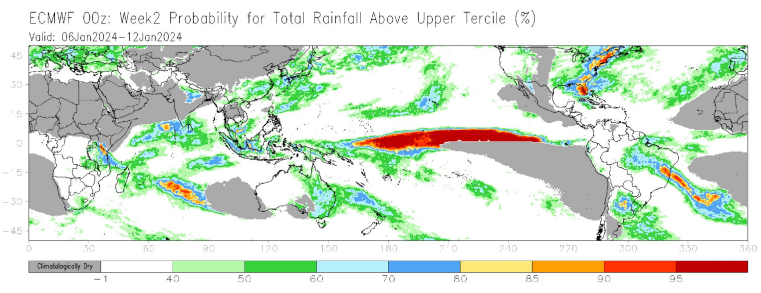
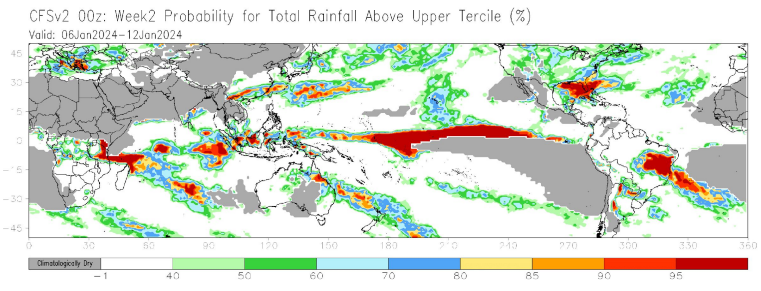
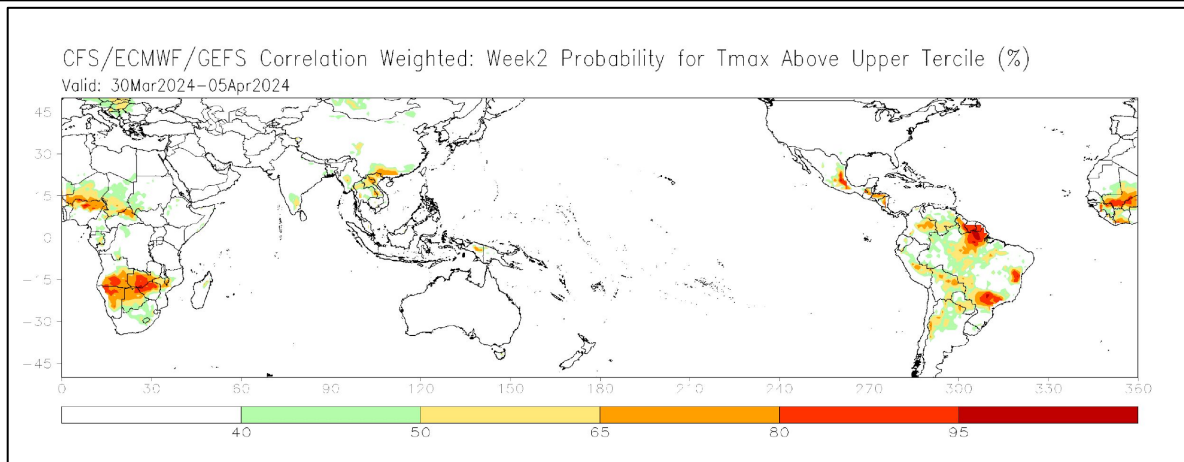
MJO index forecast from ECMWF for the next 1-4 weeks

- ✓ Forecasters use a variety of climate monitoring and forecast guidance products -- both dynamical model and statistical methods
- ✓ ENSO, Madden-Julian Oscillation (MJO) and other subseasonal tropical variability are physical drivers



Global Tropics Hazards (GTH) Outlook

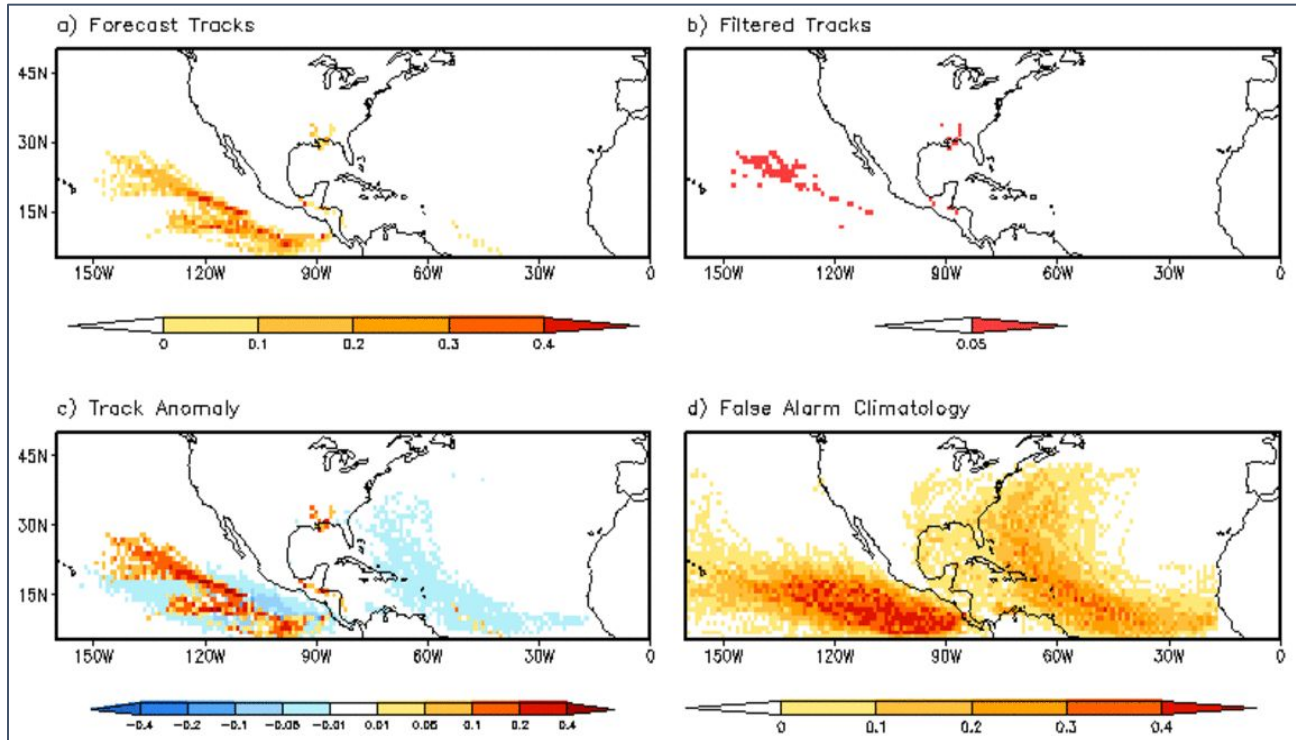
- ✓ Dynamical model guidance from several operational ensemble model systems
- ✓ Post processed (bias-corrected, calibrated)
- ✓ Forecast systems utilized:
 - NCEP Climate Forecast System (CFS)
 - NCEP Global Ensemble Forecast System (GEFS)
 - ECMWF Ensemble Prediction System (EPS)
 - Environment Climate Change Canada (ECCC) Global Ensemble Prediction System (GEPS)



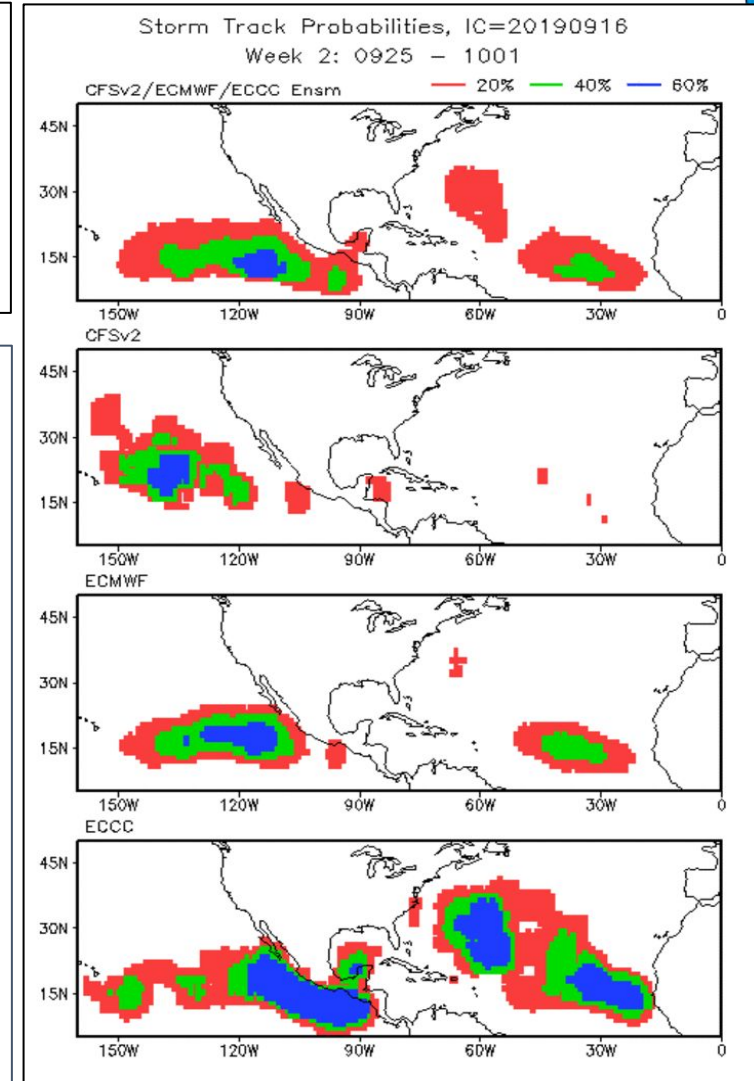
Global Tropics Hazards (GTH) Outlook

Tropical Cyclone Detection / Tracking

- Method based on Camargo and Zebiak (2002)
- Detection thresholds model based on reforecasts
- Verification: HURDAT2 and JTWC Best Track Data



Forecast tracks



Probabilities (Each model, multi-model)



Global Tropics Hazards (GTH) Outlook

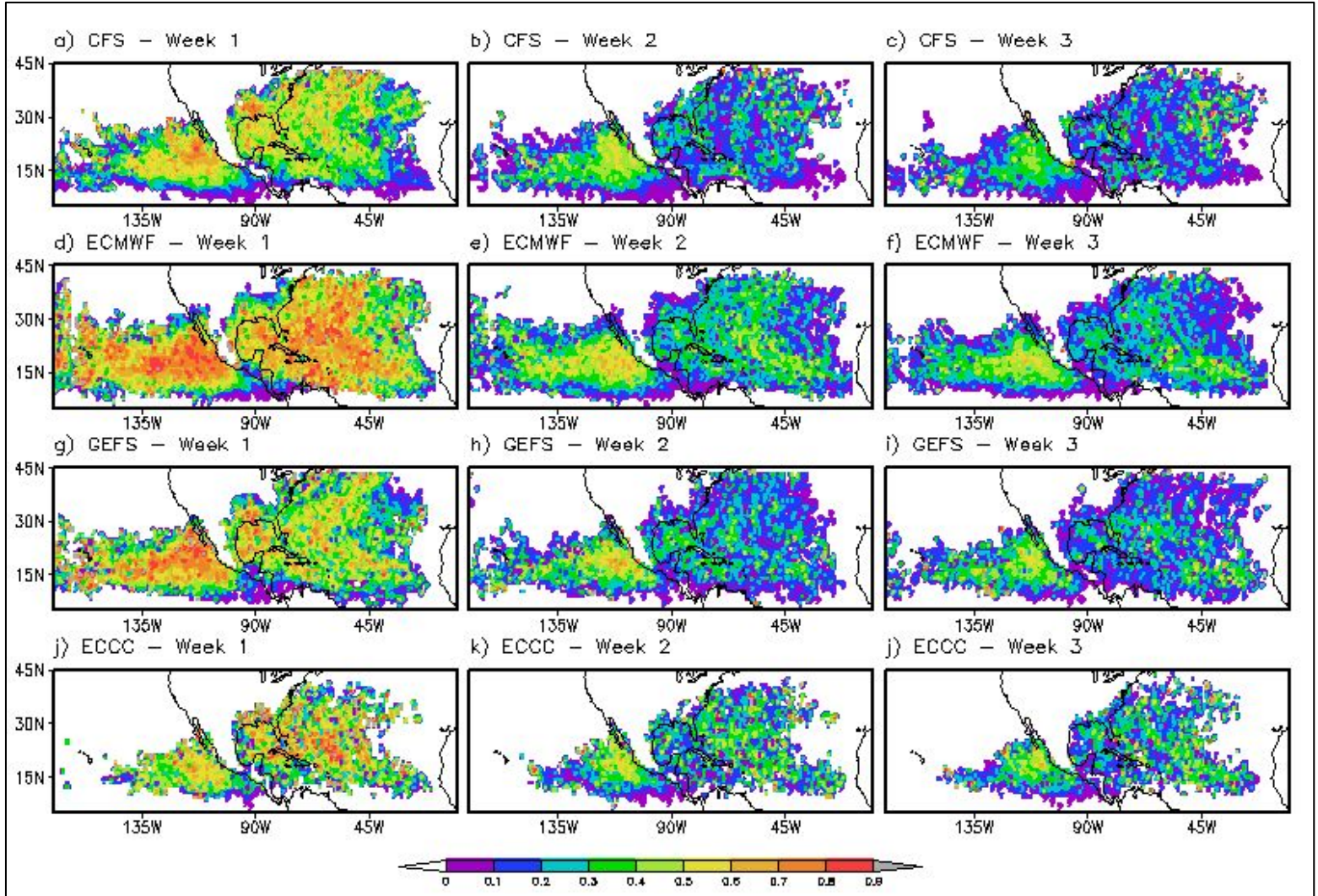


Week 1

Week 2

Week 3

- ✓ Critical Success Index (CSI):
 $CSI = a / (a+b+c)$
a = Hits
b = False Alarms
c = Misses
- ✓ Reforecast overlap period:
2000-2012
- ✓ ECMWF, GEFSv12 perform the best in this sample
- ✓ EPAC shows higher forecast skill than NATL
- ✓ Some skill remains during Week 3





Global Tropics Hazards (GTH) Outlook

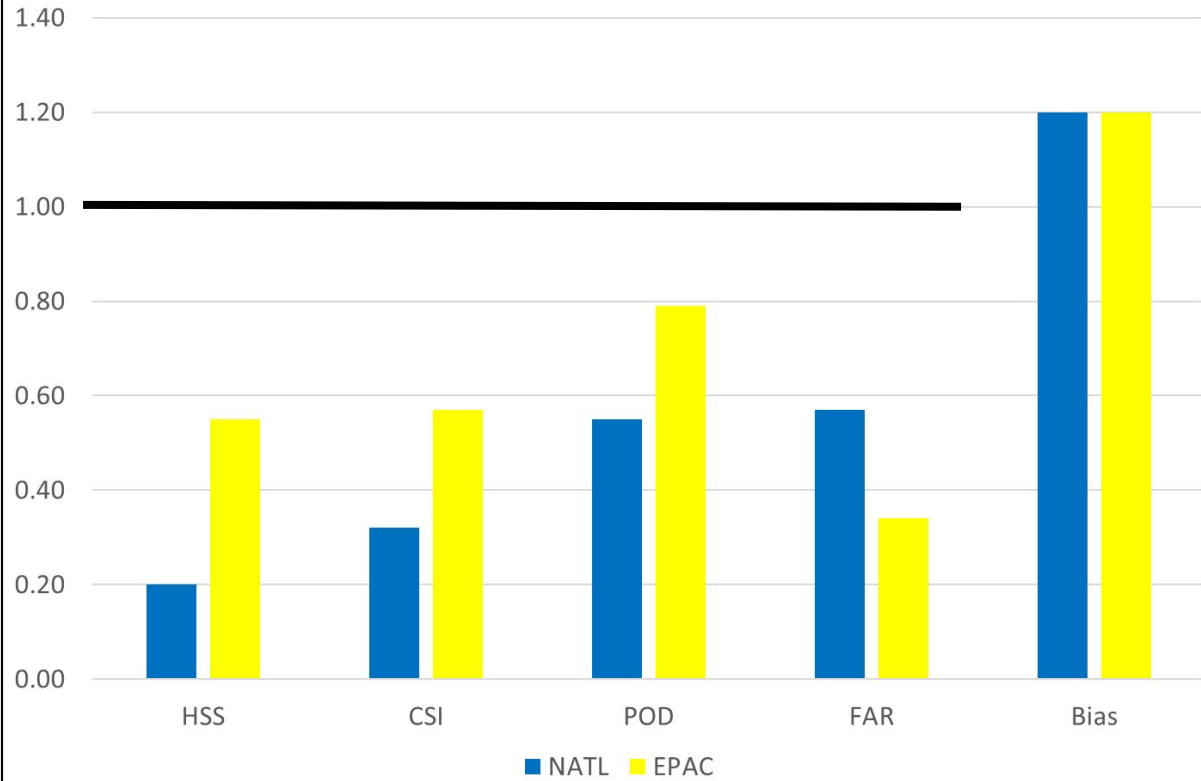


CPC Week 2-3 GTH Official Outlook to Date

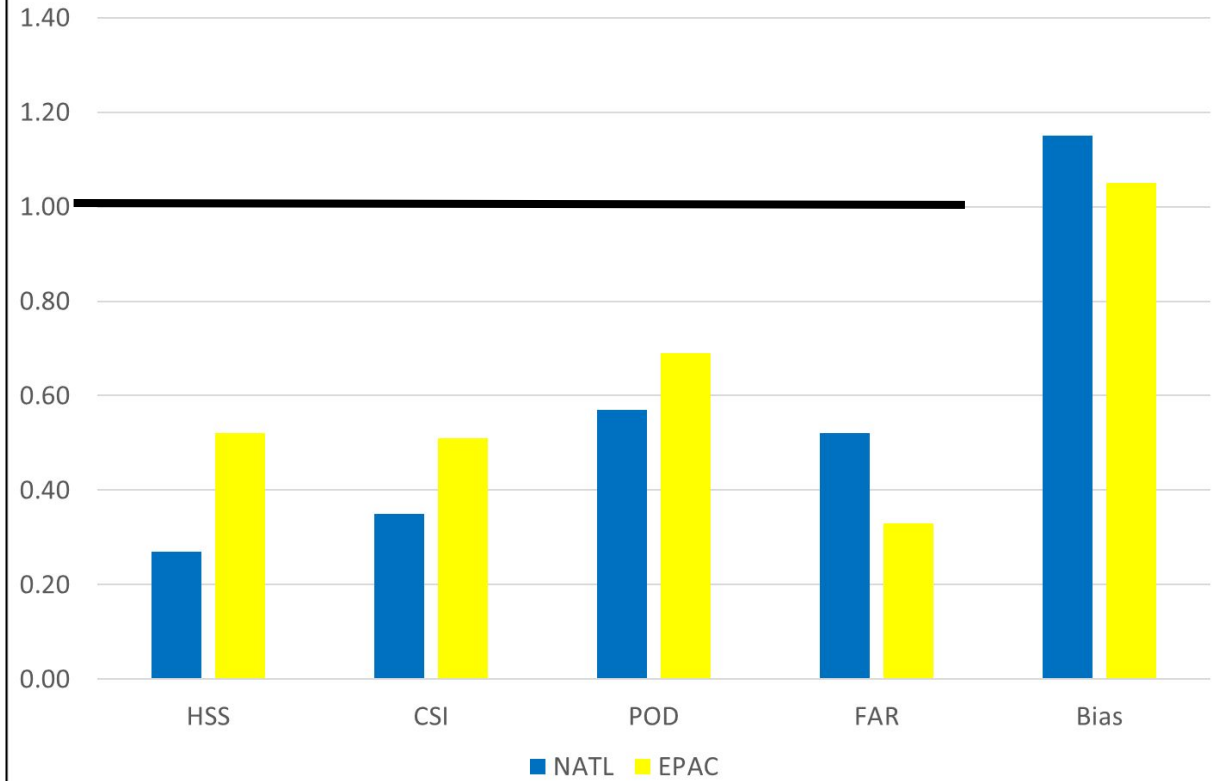
- Heidke Skill Score = $(a + d) - E / (n - E)$
- Critical Success Index = $a / (a + b + c)$
- Probability Of Detection = $a / (a + c)$
- Accuracy = $(a + d) / n$
- False Alarm Rate = $b / (a + b)$
- Bias = $(a + b) / (a + c)$

		Observed	
		YES	NO
Forecast	YES	A	B
	NO	C	D

Week 2 -- 9/2022-11/2023



Week 3 -- 9/2022-11/2023





Summary



- ✓ CPC produces many domestic and global monitoring products as well as outlook products that span from Week 2 out to approximately 1 year
- ✓ The CPC Week 2-3 probabilistic GTH outlook was first released on September 13, 2022 with Week 3 currently experimental in nature
- ✓ The GTH outlook attempts to target “forecasts of opportunity” that can be identified to provide above-normal lead time, confidence for potential high impact events related to tropical cyclones
- ✓ Increased lead time and confidence can play an important role in situational awareness, early decision making and possible mitigation of weather/climate risk



Thank you for your time and attention
Jon.Gottschalck@noaa.gov

Global Tropics Hazards (GTH) Outlook

Some applications and product uses of the GTH outlook and live briefing from stakeholders

Stakeholder Feedback



Focusing on stakeholder benefits and feedback from FEMA, DoD and state/city emergency management offices are below:

From FEMA: "NWS staff use the GTH extensively in the WPAC and SPAC to drive confidence/uncertainty messaging to FEMA leadership regarding prepositioning of assistance teams and resources, and advance travel planning. Typically, FEMA leadership will begin pulling triggers during HIGH or MEDIUM chances in your outlooks or TCFA's, especially if in phase with high probabilities in the GTH"

Domestic use includes usage by city management offices (as noted by the New Orleans Director of Homeland Security and Emergency Preparedness in 2019). "We review and utilize the product for advance planning and situational awareness purposes such as with festivals (> 150 per year). Have discussions with organizers and can ask for more detailed emergency plans and contingencies from them, can help us determine what level of support we are going to provide as far as incident command, and what requests of support we ask from our local WFO."



Operational use of the CPC Global Tropical Hazards Outlook in the Emergency Management Community: Comments from the Director of the Office of Homeland Security and Emergency Preparedness of the City of New Orleans

CPC Stakeholders Workshop
College Park, MD September 2019

Victor Murphy



A Conversation with Collin Arnold, Director of New Orleans GOHSEP

- "It also allows us to determine what level of support to provide we need to provide with regard to incident command and needing additional support from the local WFO."
- "A week 3/week 4 outlook would be another tool at our disposal. I've found the GTHO to be pretty accurate and I'm glad to be on the call each week."



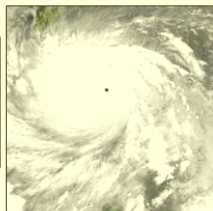
Stakeholder Feedback

Maritime interests: "The GTH gives OTSR a 1 to 2 week heads-up on potential TC formation areas, to aid planning ahead with possible ship routing concerns generating a running list of ships transiting through tropical development areas to watch and can result in diversions or advisories."

"The GTH also is used as a long-range planning tool often for Trans Pacific aircraft flights. One of the many real world examples was during Super Typhoon Trami in 2018 when we were able to afford our commanders adequate lead time for planning asset relocation and base safety measures for equipment and personnel."

"The precipitation and temperature outlooks are used for humanitarian aid purposes and in a contingency planning in these scenarios similar to USAID and the Red Cross."

GTH outlook used for guidance, situational awareness information for recovery efforts (i.e., after a high impact event is just as important)



Typhoon Haiyan 2013



Stakeholder Feedback



**Spaceflight Meteorology Group
June 2012, sent by SMG Chief, Frank Brody**



“Recent outlooks highlighting the Gulf of Mexico for tropical cyclone development were very accurate. This gave SMG valuable early insight into what may unfold in the Gulf and Caribbean. Following one of these GTM briefings, I used the global outlook chart to brief NASA Johnson Space Center that tropical cyclone potential would be increasing the following week ...”

Linda Spuler, the NASA/JSC Emergency Preparedness Manager, made this comment:

“As Emergency Preparedness Manager for the Johnson Space Center, I greatly appreciate the long range tropical outlook. The information is extremely valuable to me. I use it to brief Center management on potential activity in the gulf, and it allows me to help JSC proactively prepare for potential events instead of just reacting to events as they occur. Kudos to the NWS for providing a tool that concisely shows a lay person areas of interest to focus upon.



Organization Feedback

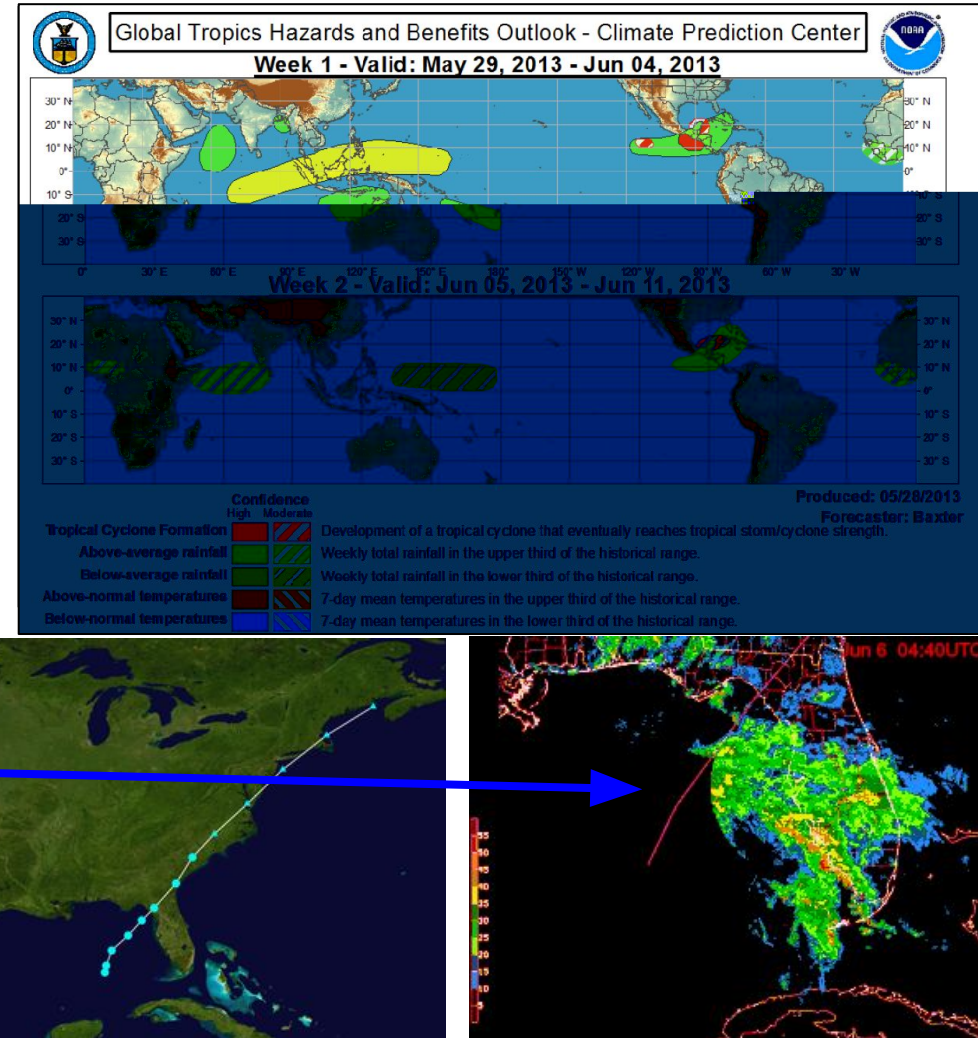


NWS HQ Leadership Team – GOES Satellite Operations Decision
June 7, 2013 communication with then NWS Director Louis Uccellini
Regarding Tropical storm Andrea – briefing late May 2013

All,

During the morning NWS leadership briefing, Louis took time to comment on how much he and the staff there appreciated **the lead time provided by our GTH outlook 2 weeks in advance for tropical cyclogenesis in the NW Caribbean and southern Gulf of Mexico for Tropical storm Andrea, along with the likely flooding rains across Florida.** At the time he pushed the product up the chain to NOAA leadership and it actually **resulted in an adjustment to the GOES-13 to GOES-14 transfer of operations schedule** (i.e., they wanted to make sure they had reliable satellite coverage for operational entities in the southeast U.S.).

He personally congratulated CPC on this outlook and communication and just wanted folks to know this.





NATIONAL
WEATHER
SERVICE

Community-Based Model Development at NCEP/EMC for Operational Weather Prediction

Avichal Mehra¹

¹Chief, Coupled Modeling Division at NOAA/NWS/EMC, College Park, MD

2024 National Hurricane Conference
March 25-28 2024, Orlando, FL



- **Acknowledgements**

- All of the outstanding scientists and engineers at the Environmental Modeling Center, and Collaborators within NOAA, at other Federal agencies, Academia, and the Private Sector

- **Reference**

- [EMC 5-Year Implementation Plan](#)



Evolution of NCEP Modeling Suite into UFS Apps

NPS Modeling System	Current Version	FY2022 - FY2027	UFS-based Version	UFS Application
Global Weather, Waves & Global Analysis	GFS/ GDASv16.2	<p>Unified Forecast System (UFS)</p>	GFS/ GEFS/SFS	UFS Medium Range & Sub-Seasonal
Global Weather and Wave Ensembles, Aerosols	GEFSv12			UFS Marine & Cryosphere
Short-Range Regional Ensembles	SREFv7			UFS Seasonal
Global Ocean & Sea-Ice	RTOFSv2		HAFS	UFS Hurricane
Global Ocean Analysis	GODASv2			RRFS/WoF
Seasonal Climate	CDAS/ CFSv2			
Regional Hurricane 1	HWRfv13			
Regional Hurricane 2	HMONv3			
Regional High Resolution CAM 1	HiRes Window v8			
Regional High Resolution CAM 2	NAM nests/ Fire Wxv4			
Regional High Resolution CAM 3	RAPv5/ HRRRv4			
Regional HiRes CAM Ensemble	HREFv3			
Regional Mesoscale Weather	NAMv4			
Regional Air Quality	AQMV6			
Regional Surface Weather Analysis	RTMA/ URMA v2.8		3DRTMA/ URMA	
Atmospheric Transport & Dispersion	HySPLITv7		HySPLIT	UFS Air Quality & Dispersion
Coastal & Regional Waves	NWPSv1.3		RWPS	UFS Coastal Waves
Great Lakes	GLWUv1.0.3		GLWU	UFS Lakes
Regional Hydrology	NWMv2.1		NWM	UFS Hydrology
Space Weather 1	WAM/IPEv1		WAM/IPE	UFS Space Weather
Space Weather 2	ENLILv1			

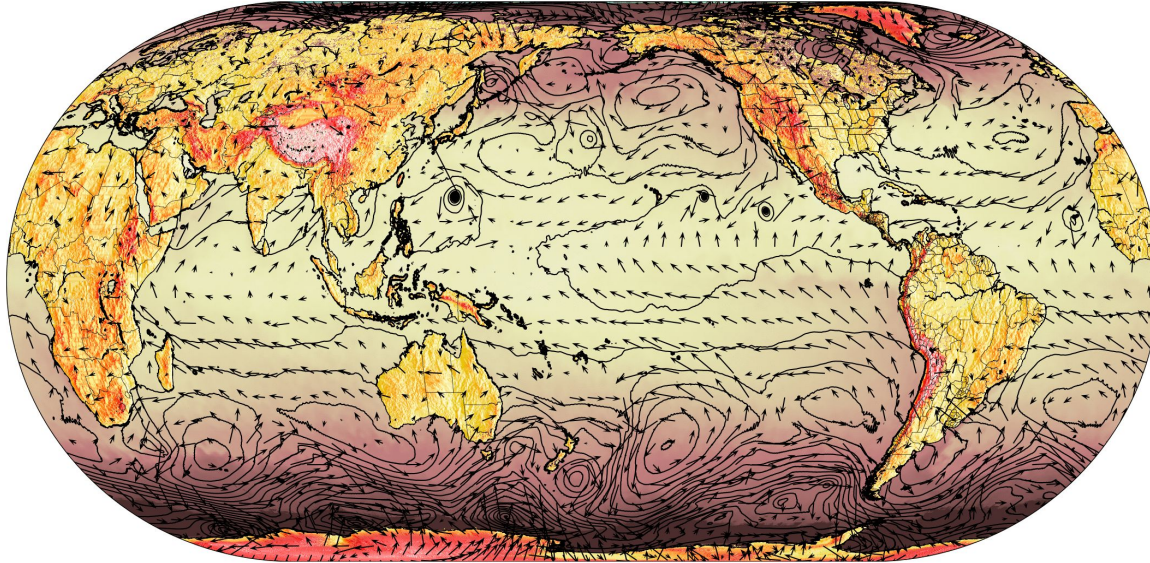


Global Coupled Prediction Systems



MRW/S2S: Building a Six-Way Global Coupled Unified Forecast System For future GFS, GEFS and SFS

Warm shade: Surface Temp, Contour: MSLP, Cool shade: Convective Cloud Cover, Arrows: 10m Wind
C3072L127 2018090100 f000



UFS Earth System Model Components:

- FV3 (Atmosphere)
- MOM6 (Ocean)
- CICE6 (Sea Ice)
- WW3 (Waves)
- NOAH-MP (Land)
- GOCART (Aerosols)

A fully coupled UFS serves as a foundation for future operational global forecast systems at NOAA/NWS/NCEP ranging from weather to subseasonal to seasonal scales.

GFSv17 Development Priorities

- **Coupled forecast model (atm, land, ocn, ice, wav)**
- **Improved DA with marine JEDI**
- **Physics improvements including Noah-MP land model and Thompson Microphysics**
- **Unstructured Wave grids w/2-way coupling**
- **Higher resolution (9-km target)**
- **Improve on known issues in GFSv16**
- **Consolidation of NCEP production suite**
 - GODAS combined in Coupled GDAS
 - Retirement of NAM and RAP

GEFSv13 Development Priorities

- Have the same model configuration as of GFSv17 (Latest UFS coupled forecast model)
- Include interactive aerosols in all ensemble members
- Early cycle EnKF analysis for ensemble initial perturbations
- Advanced model stochastics for all component models
- Reanalysis/reforecast
- **30 years reforecast to support forecast calibration (and training)**
- Extend forecast length to 48 days
- Improve on known issues in GEFSv12
- Consolidation of NCEP production suite
 - Retirement of SREF

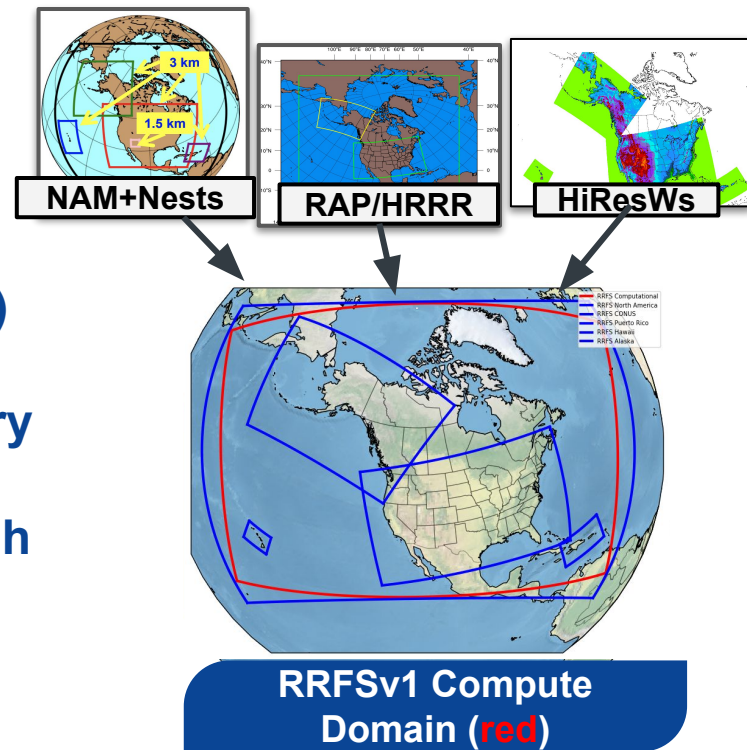
Regional Prediction System



Rapid Refresh Forecast System (RRFS)

A UFS Application

- FV3 dynamical core Limited Area Model
- Hourly updated
- 3 km grid spacing over North America
- 65 vertical layers
- Hybrid 3D EnVar assimilation (30 members)
- Includes Smoke & Dust
- Deterministic forecasts to *at least* 18h every hour
- Deterministic & Ensemble forecasts to 48+h every 6 hours



Hurricane Analysis and Forecast System

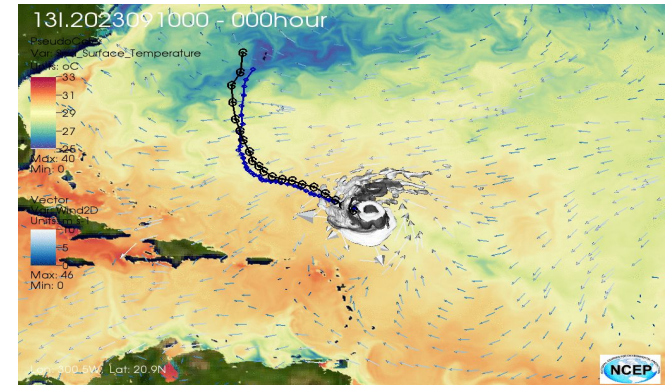


Hurricane Analysis and Forecast System (HAFS v1)

- HAFS is NOAA's new hurricane modeling system within the Unified Forecast System (UFS) framework which was **implemented operationally in June 2023**
- HAFS is a results of multi-year R2O collaboration between NWS's Environmental Modeling Center and OAR's AOML/Hurricane Research Division and other UFS partners
- HAFS has atmosphere-ocean-wave coupling, improved data analysis and physics, and provides detailed outputs following the storm

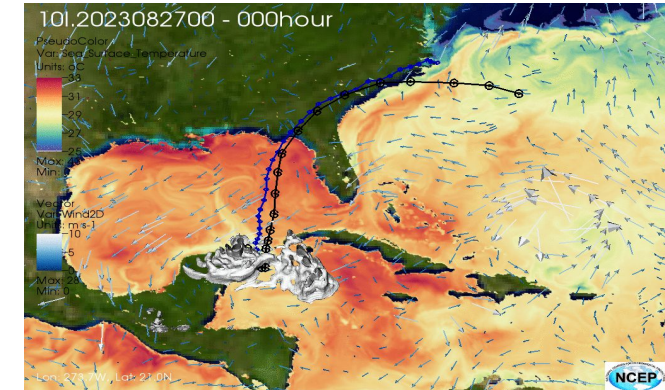
HFS A

Hurricane Lee, 13L, 20230910 00Z



HFS B

Hurricane Idalia, 10L, 20230827 00Z



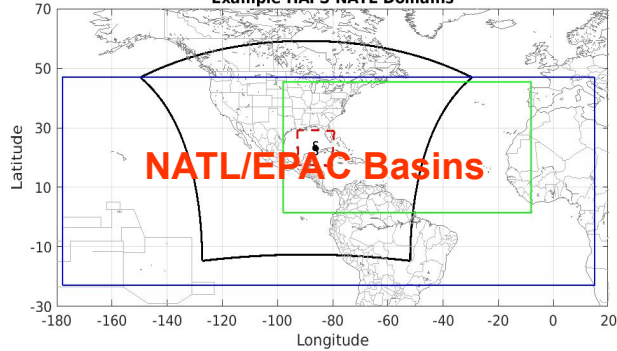
NCEP's Operational Hurricane Modeling Systems

	HWRF Operational since 2007	HMON Operational since 2017	HAFS-A Operational Since 2023	HAFS-B Operational Since 2023
System and Infrastructure	NMM E-grid NCEP coupler 13.5/4.5/1.5 km L75	NMM B-grid NCEP Coupler 18/6/2 km L71	FV3 dyn-core CMEPS 5.4/1.8 km L81	FV3 dyn-core CMEPS 6/2 km L81
Data Assimilation	3DEnVar Self-cycled DA for priority TC	No DA	4DEnVar	4DEnVar
Vortex Initialization	Vmax > 25 kt warm-cycled VI	Vmax > 25 kt warm-cycled VI	Vmax > 40 kt warm-cycled VI	Vmax > 40 kt warm-cycled VI
Ocean/Wave Coupling	POM/WW3 RTOFS	HYCOM RTOFS	MOM6/WW3 RTOFSv2	HYCOM RTOFSv2
CONOPS	Global Basins Maximum slots: 3	NHC Basins Maximum slots: 3	Global Basins Maximum slots: 7	NHC basins Maximum Slots: 5

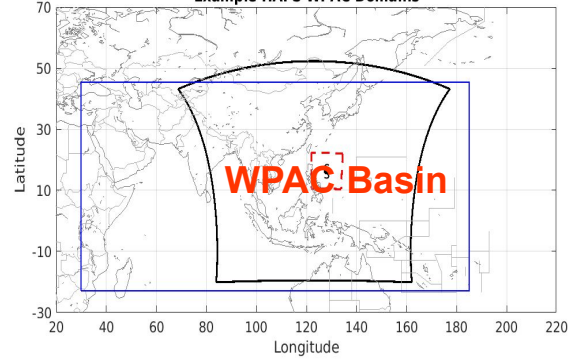


Configurations: HAFS vA runs in all Global Basins

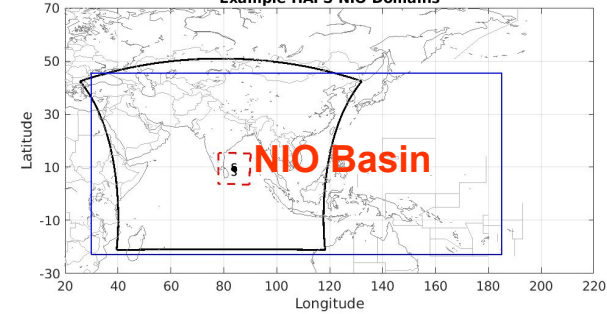
Example HAFS NATL Domains



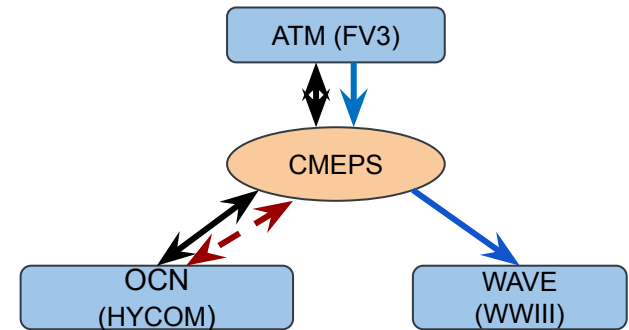
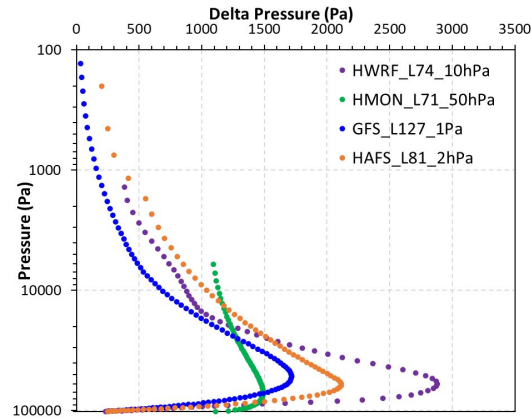
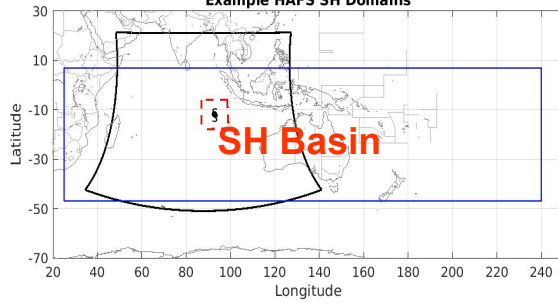
Example HAFS WPAC Domains



Example HAFS NIO Domains



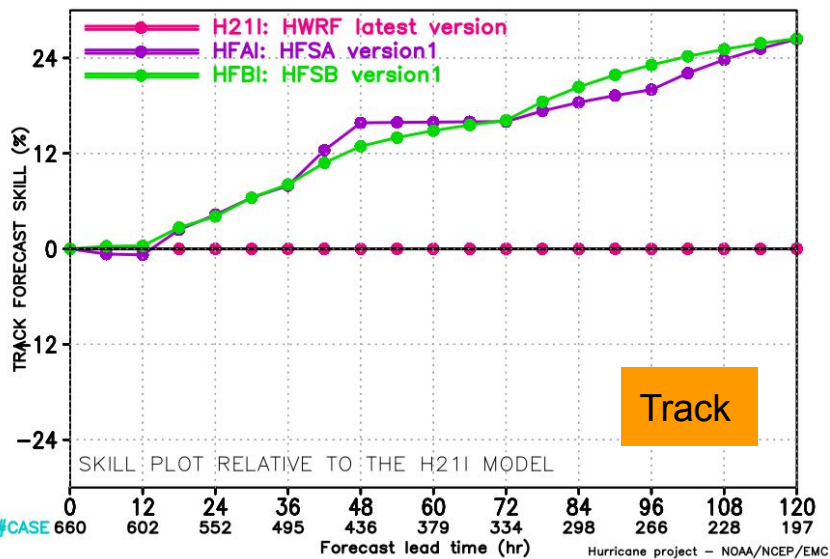
Example HAFS SH Domains



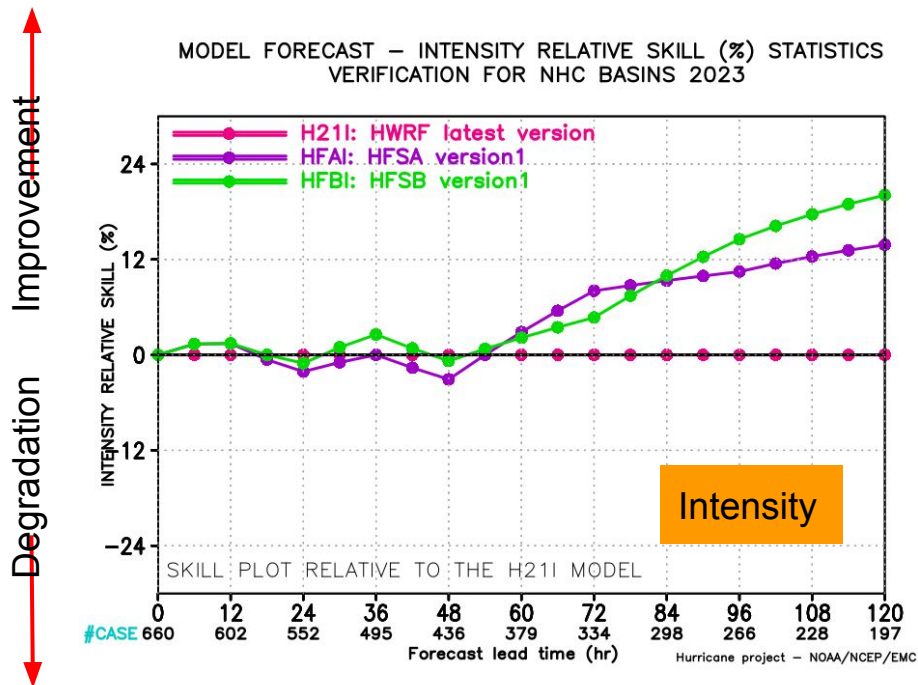
NOAA's New Generation Hurricane Model HAFS Forecast Skills Relative to Legacy HWRP

All 2023 Storms in NHC Basins

MODEL FORECAST – TRACK FORECAST SKILL (%) STATISTICS
VERIFICATION FOR NHC BASINS 2023



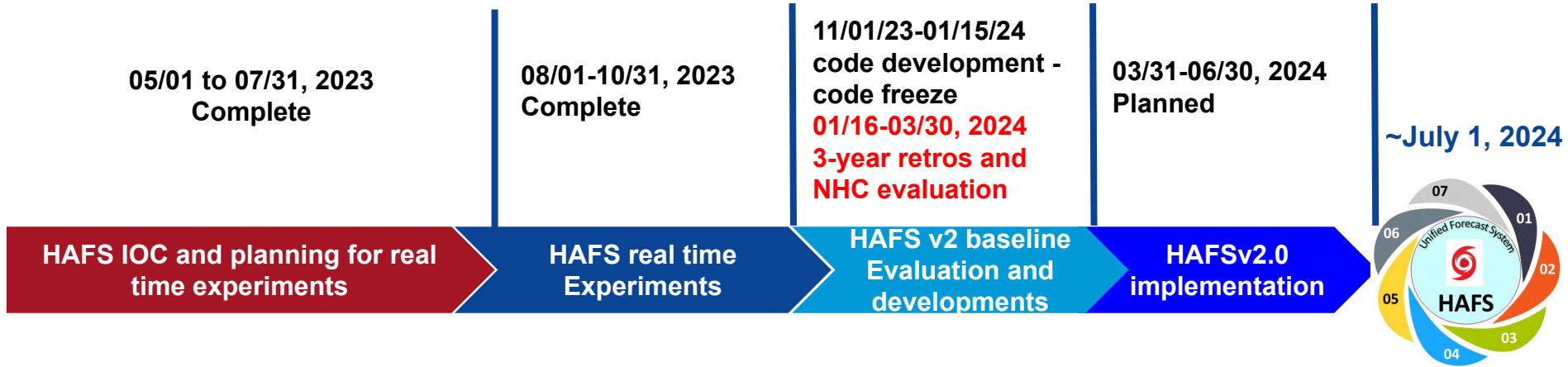
MODEL FORECAST – INTENSITY RELATIVE SKILL (%) STATISTICS
VERIFICATION FOR NHC BASINS 2023



Improvement ↑
Degradation ↓



Timeline for HAFS v2 Transition to Operations



Testing two configurations:

- High resolution domains
- Improving model physics
- Improved Vortex initialization and Inner-core data assimilation
- T&E to select optimal configurations

Highlights HAFS v2.0

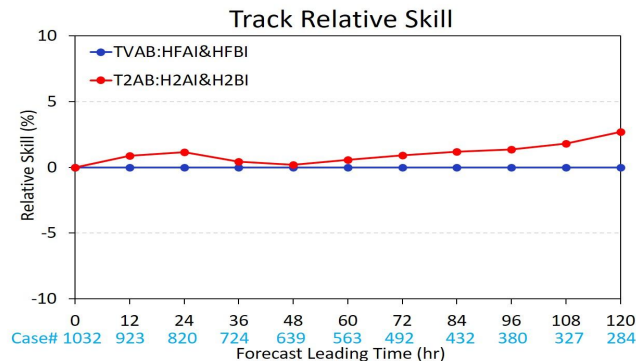
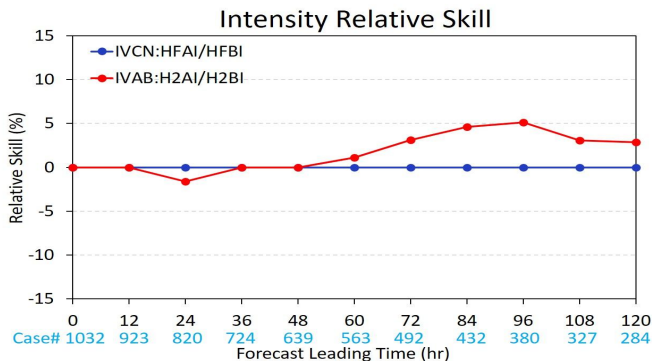
- Higher resolution for HAFSA
- MOM6 coupling for HAFSA
- High-density meso AMVs DA
- Improved vortex relocation
- Improved physics
- Code modernization and optimization
- Model efficiency and stability

NCO implementation

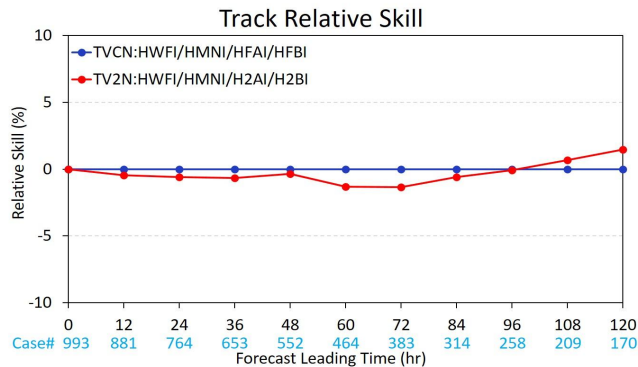
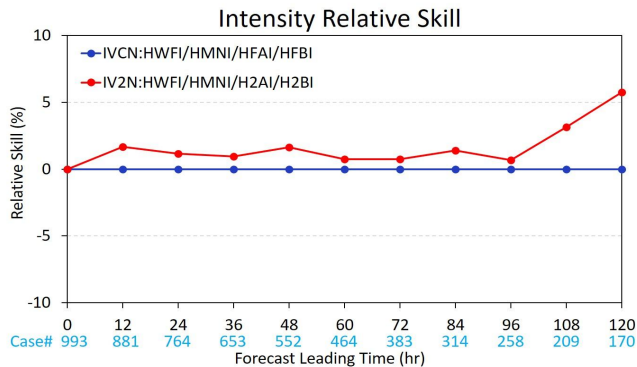


Consensus Skill: HAFSv2 vs HAFSv1

NATL
BASIN



EPAC
BASIN



Intensity: DSHP, LGEM, HWRF, HMON, HAFSA, HAFSB, CTCI

Track: AVNO, EGRR, HWRF, HMON, HAFSA, HFSAB, EMXI, CTCI



NATIONAL WEATHER SERVICE

Development Roadmap for Hurricane Modeling Systems

Target Annual Upgrades

HAFSv2

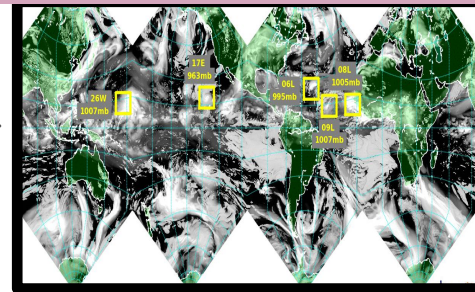
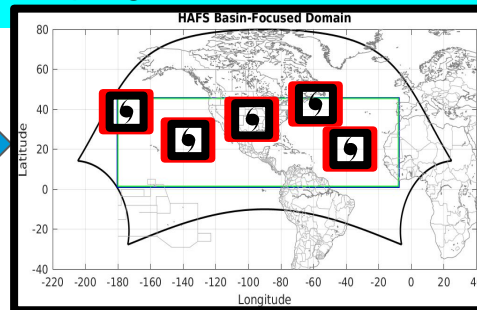
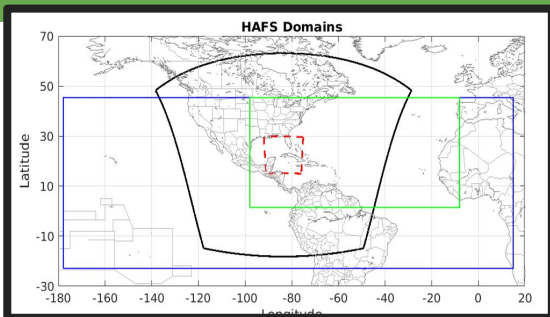
- Storm-centric with one moving nest
- Improved vortex initialization
- Flight-level obs. for priority storms
- 4DEnVar using GDAS ensemble
- TC-calibrated Physics based on UFS physics suites
- Atm/Ocn Coupled System, one-way Wave

Near future plans

- Multiple moving nests in a basin-centric domain
- Sophisticated VI, GSI and/or AI and/or dynamics-based VI
- High-frequency, self-cycled 4DEnVar, weakly coupled Atmos/Ocean DA, All-sky, explore JEDI-based DA
- Scale-aware model Physics suitable for high res. model
- Three-way HAFS/MOM6/WW3 coupling

Long term plans

- Multiple moving nests with cloud-resolving resolutions in a global model framework
- Multi-scale, coupled DA
- High temporal and spatial resolution of in-situ atms/ocn obs
- AI-based sub-kilometer model physics
- Hurricane Ens. Prediction System
- High res. products, tornadoes, inundation and flooding



Application of AI/ML for Operational NWP



Current/Planned AI/ML Activities at NCEP/EMC

Observations	Data Assimilation	Forecast	Post/Product
Radiosonde processing	Physics emulation	AC Accelerated Transport	Wave Systems
Satellite Thinning	Improved Background	Atmospheric Chemistry Emulator	Air Quality Bias Correction
AMV super-observations and error estimation	Background Error Covariances	Physics Suite Emulation	Sub-Seasonal/ Seasonal forecast products
Conventional / Aircraft quality control	CRTM emissivity modeling	Radiation Parameterizations	
Observation Anomaly Detection	High-resolution background downscaling and emulation	Ensemble Forecasting / Forecast Model Emulation	
	Radiance bias correction	Fire emissions for sub-seasonal to seasonal predictions	



Real Time forecasts using Google deepmind Graphcast ML model emulator

Evaluation results of GraphCast, a high-resolution model presented by *Lam et al., 2023* (0.25 degree resolution, 37 pressure levels), trained on ERA5 data from 1979 to 2017.

Status:

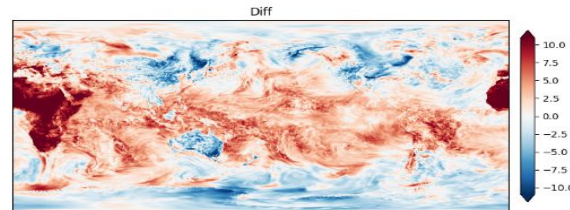
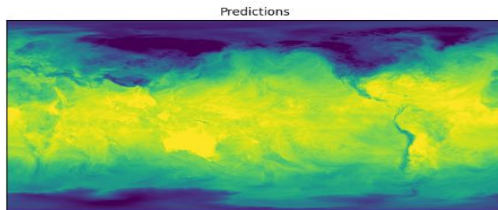
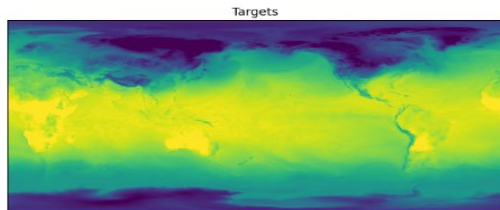
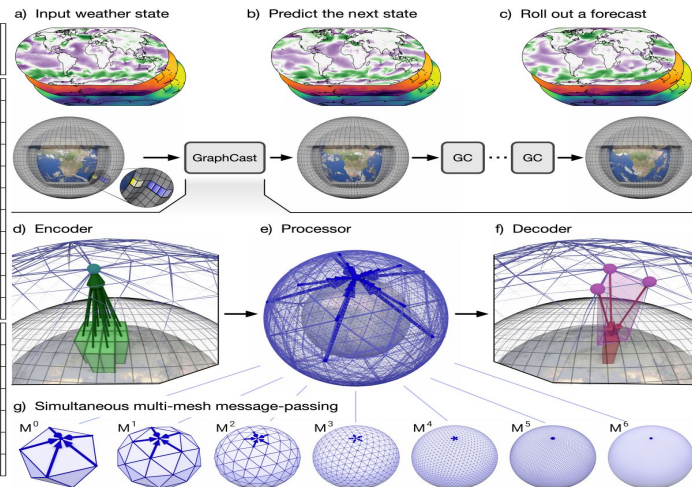
- Able to run GraphCast with ERA5 data on NOAA cloud

EMC's Plan:

- Run GraphCast in real time with GDAS analysis
- Train GraphCast with GEFSv12 reanalysis and run ensemble forecast.

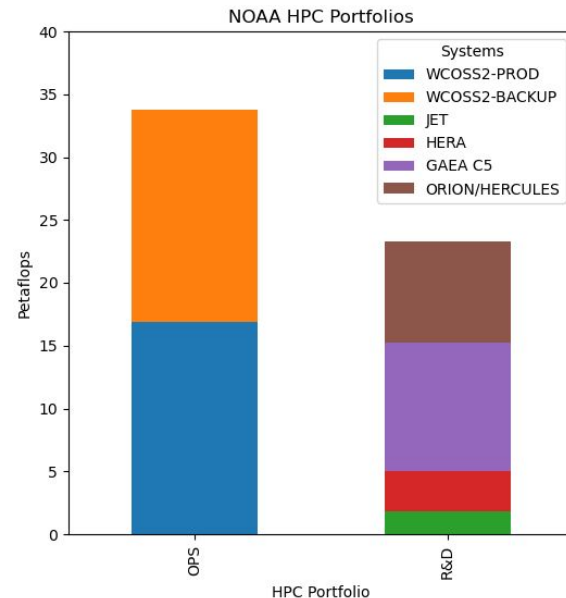
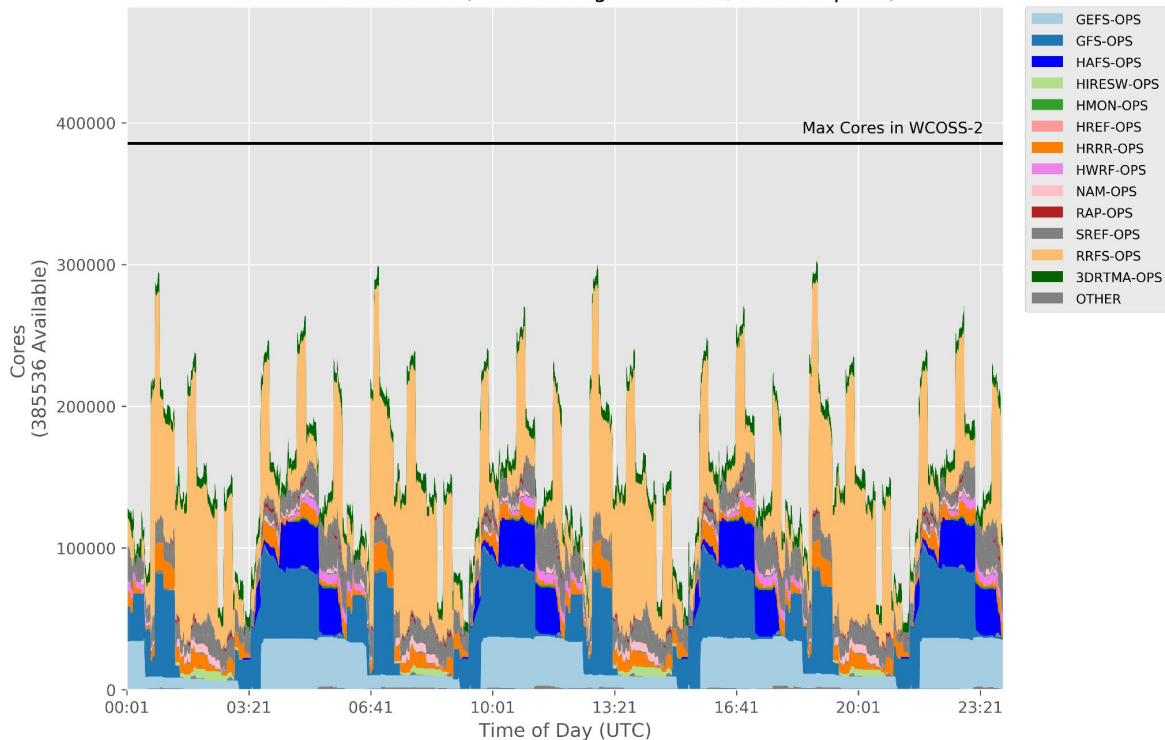
Variable name	Role (accumulation period, if applicable)
Geopotential	Input/Predicted
Specific humidity	Input/Predicted
Temperature	Input/Predicted
U component of wind	Input/Predicted
V component of wind	Input/Predicted
Vertical velocity	Input/Predicted
2 metre temperature	Input/Predicted
10 metre u wind component	Input/Predicted
10 metre v wind component	Input/Predicted
Mean sea level pressure	Input/Predicted
Total precipitation	Input/Predicted (6h)
TOA incident solar radiation	Input (1h)
Geopotential at surface	Input
Land-sea mask	Input
Latitude	Input
Longitude	Input
Local time of day	Input
Elapsed year progress	Input

2m_temperature, 6:00:00



Challenges: HPC Resources

WCOSS2 Prod HWM (40.47% avg utilization, 78.66% peak)



** Significant increase in R&D HPC is anticipated from DRSA, BIL, and IRA; still may be insufficient for R20



Imagine a World

*

- **Operational Production Suite backbone of continuously assimilating comprehensive coupled Earth System Model**
 - **“Digital Twin” - constant update of global state and innovation of training data**
- **Regular prediction systems (e.g., 2/day global, hourly CAM) and ad hoc (hurricane, fire, dispersion, etc)**
- **Variety of approaches - deterministic, ensemble-based, surrogate systems trained on reanalysis and backbone**
- **Cloud-based systems to accommodate HPC requirements as-needed**

**

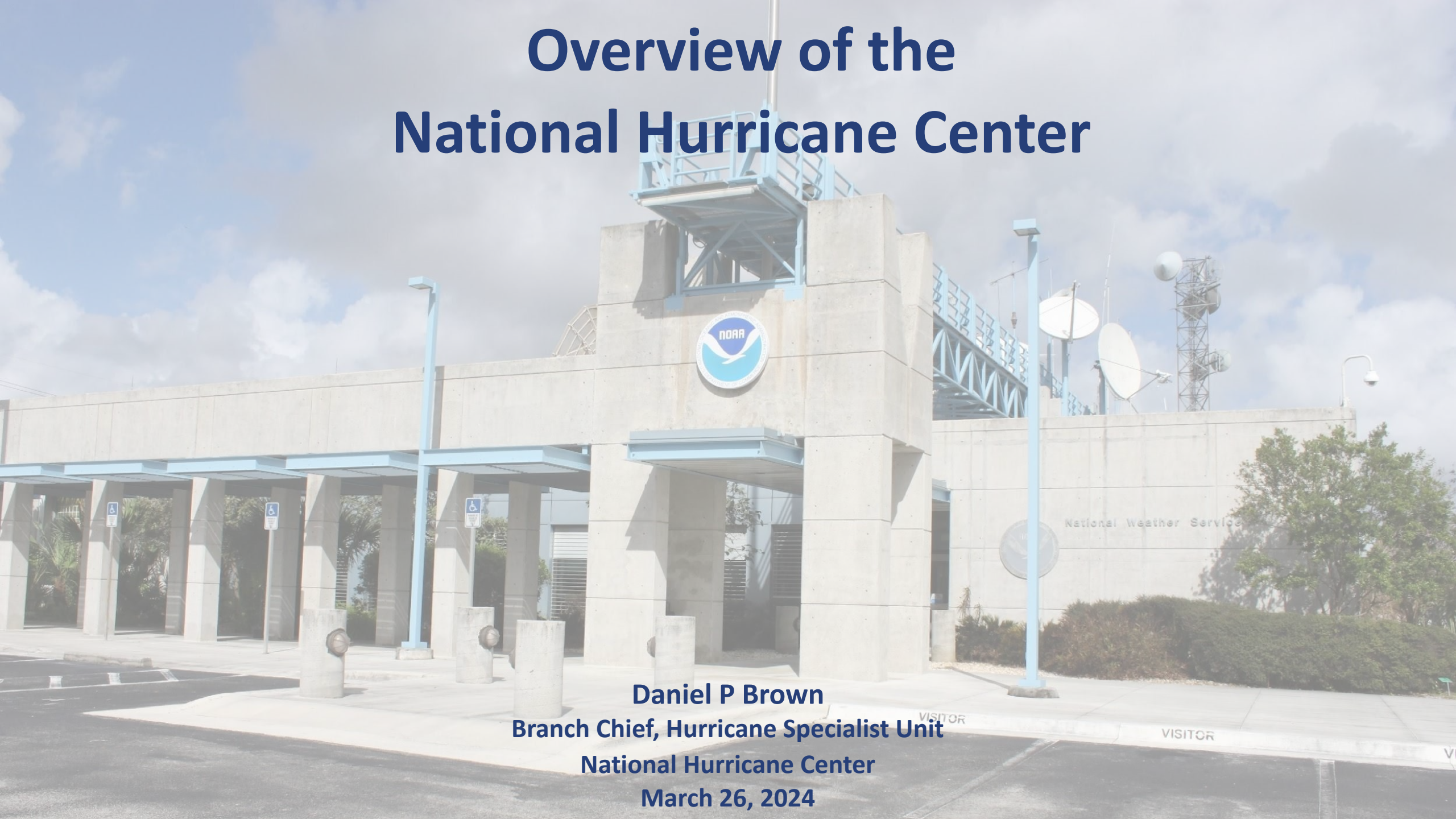


Thank you!

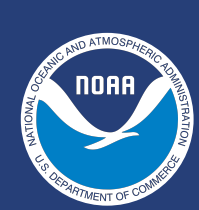


NATIONAL WEATHER SERVICE

Overview of the National Hurricane Center



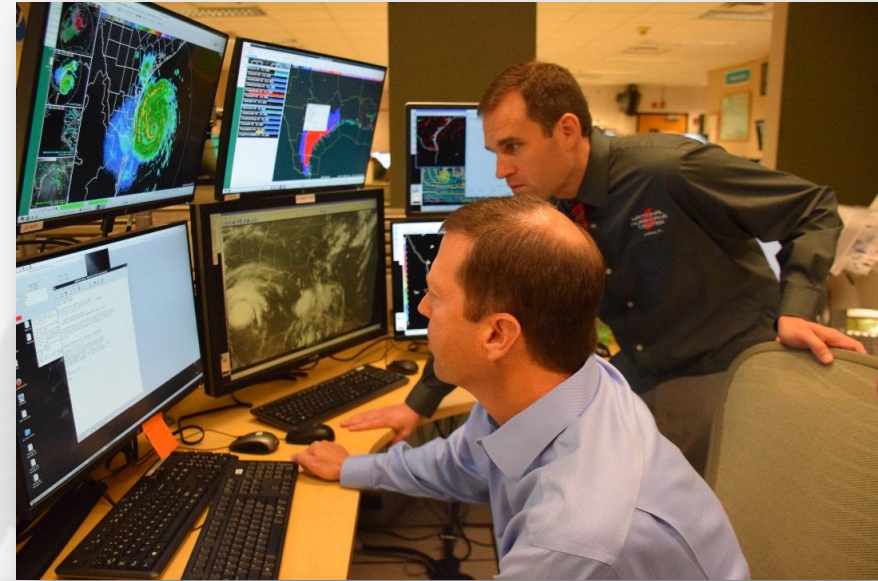
Daniel P Brown
Branch Chief, Hurricane Specialist Unit
National Hurricane Center
March 26, 2024



The Mission

Mission:

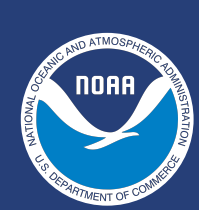
Save lives, mitigate property loss, and improve economic efficiency by issuing the best watches, warnings, and forecasts of hazardous tropical weather and by increasing understanding of these hazards.



Vision:

To be America's calm, clear and trusted voice in the eye of the storm, and with our partners, enable communities to be safe from tropical weather threats

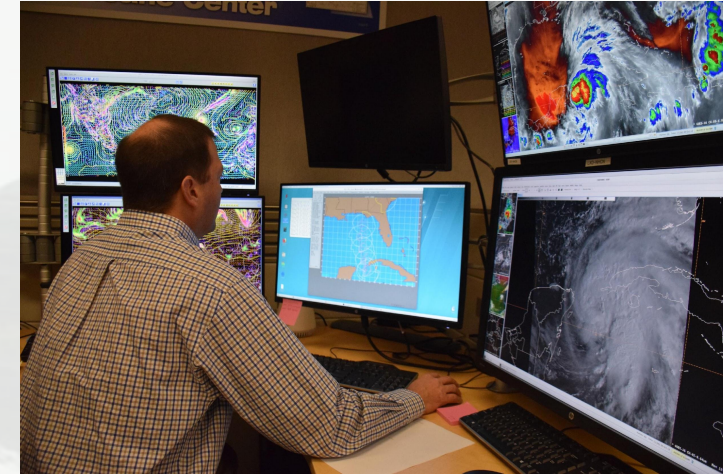




The People



- ~46 NHC government positions across four work units
- Around 15 contractors
- Also host to:
 - U.S. Air Force Reserves outpost (coordinating hurricane aircraft reconnaissance)
 - Federal Emergency Management Agency (FEMA) Hurricane Liaison Team
 - NOAA Corps Officer
 - Navy hurricane forecaster
 - Occasional visiting scientists and students



The Operating Units

Hurricane Specialist Unit (HSU) - 11 forecasters

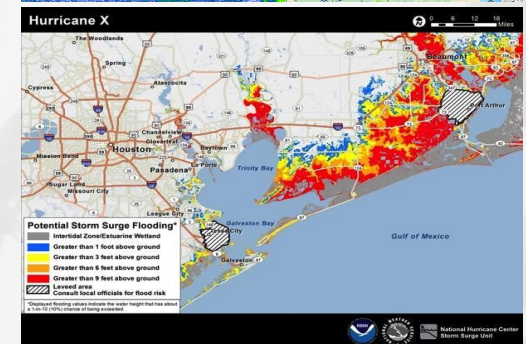
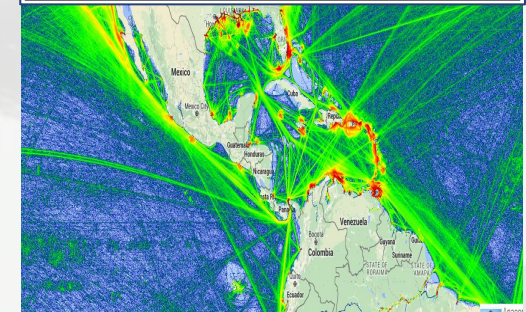
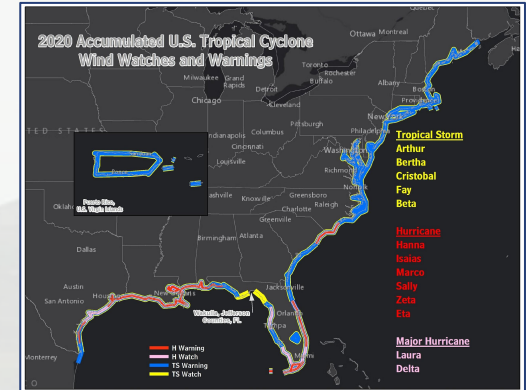
- Develop, coordinate (domestically and abroad) and issue tropical cyclone forecasts and warnings
- Enhance response through a public awareness program and training for emergency managers, meteorologists and the media

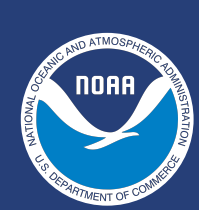
Tropical Analysis and Forecast Branch (TAFB) - 18 forecasters

- Produce and issue gridded, text and graphical marine analyses, forecasts and warnings for the tropical Atlantic and northern East Pacific
- Provide satellite analyses and support to the HSU

Technology and Science Branch (TSB) – 10 meteorologists

- NHC Storm Surge Unit
- Help maintain NHC's operational information technology systems
- Advance the Center's forecast skill and scientific credibility

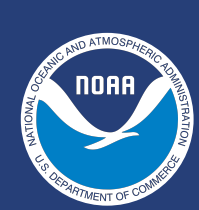




The Facility

- Opened in 1995
- 25,000 square ft
- Design team included Herb Saffir
- Rest five feet above flood plain
- 10-inch thick walls made from 3000 cubic yards of concrete, reinforced with 45 miles of steel reinforcing rods
- More than 50 miles of electrical and communications wiring
- Also houses the NWS Miami Weather Forecast Office





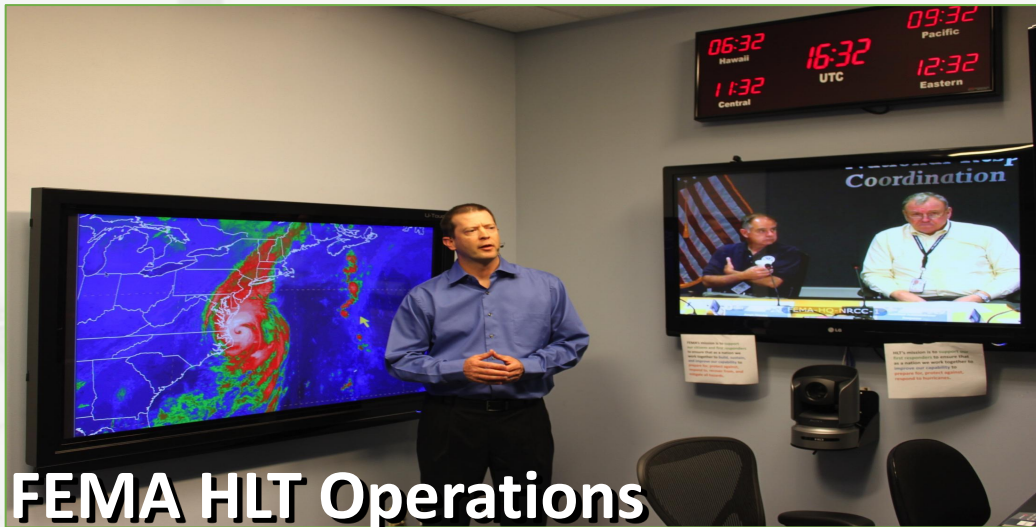
A Look at Operations



NHC Operations



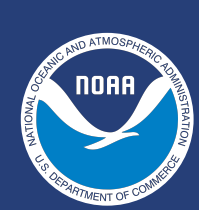
TAFB Operations



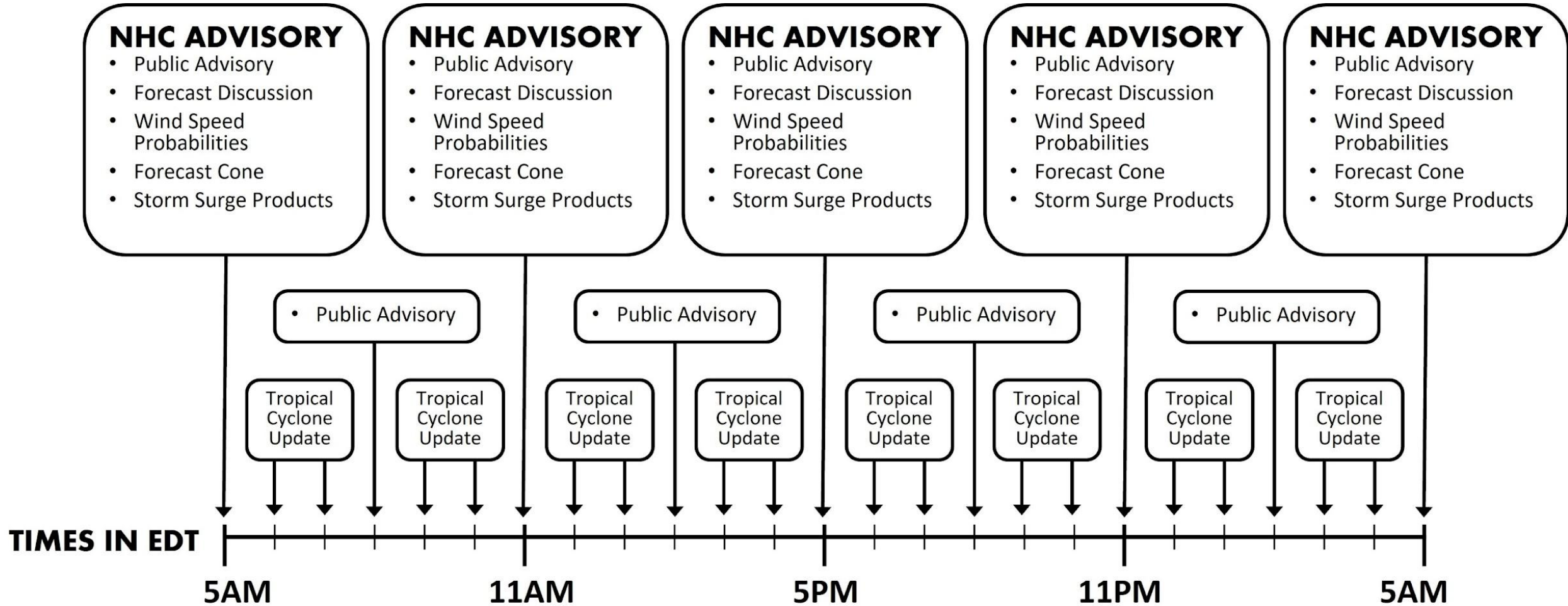
FEMA HLT Operations

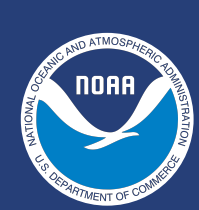


CARCAH Operations

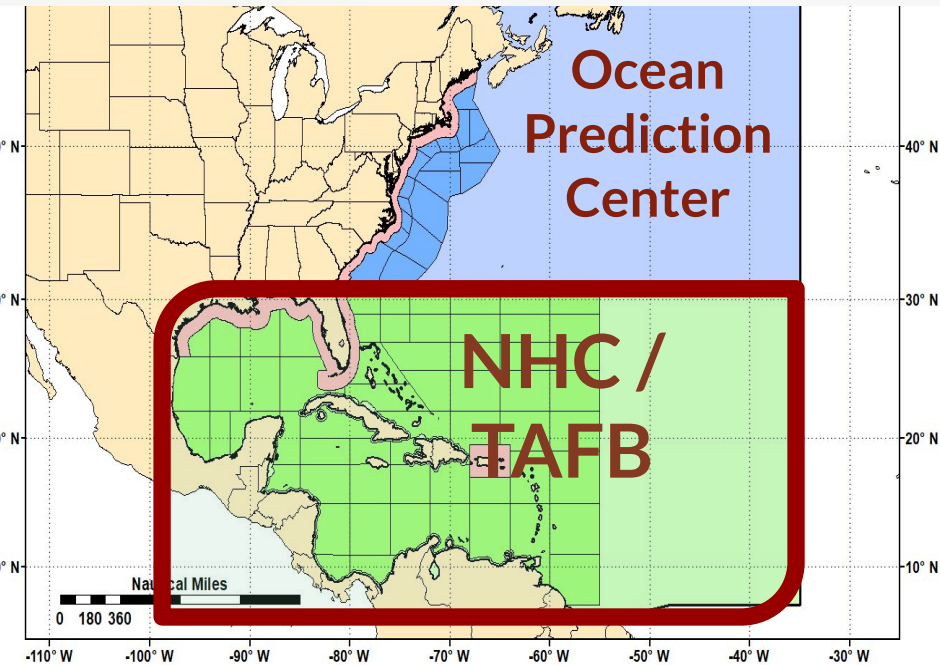
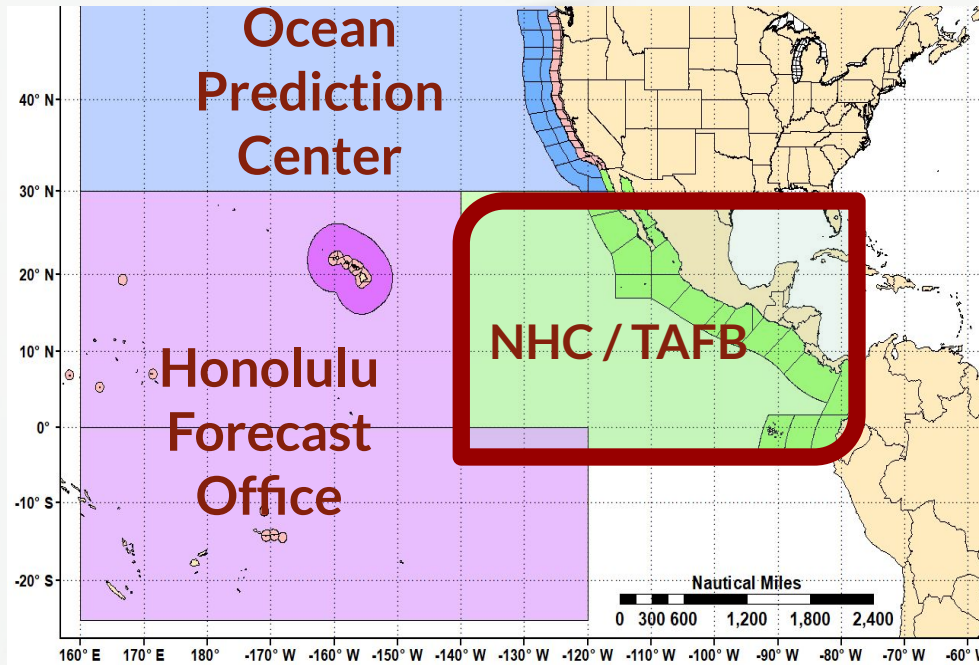


Hurricane Specialist Unit Pace of Information Flow

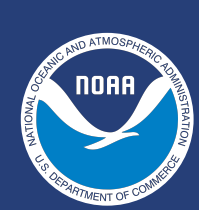




Tropical Analysis and Forecast Branch Providing Life-Saving Marine Forecasts



- 80% of all traded goods globally are carried by sea
- In 2018, the American Blue Economy contributed \$373 billion to the nation's Gross Domestic Product (GDP), supporting 2.3 million jobs
- Maritime commerce is expected to triple by 2030



TAFB Products and Operations



- 24/7/365 Operations – about 100 graphical, text, and gridded products issued each day
 - Surface analysis, Tropical Weather Discussions, Wind/Wave Forecasts, High Seas and Offshore Waters Forecasts
- Routinely provide "spot" forecasts and decision-support briefings to the U.S. Coast Guard
 - TAFB provided 157 spot forecasts & more than two dozen live briefings in 2023
- Also perform Dvorak "classifications" and assist HSU with international collaboration

HIGH SEAS FORECAST
NWS NATIONAL HURRICANE CENTER
1030 UTC FRI OCT 02 2015

SUPERSEDED BY NEXT ISSUANCE IN 6 HOURS

SEAS GIVEN AS SIGNIFICANT WAVE HEIGHT...WHICH IS THE AVERAGE HEIGHT OF THE HIGHEST 1/3 OF THE WAVES. INDIVIDUAL WAVES MAY BE MORE THAN TWICE THE SIGNIFICANT WAVE HEIGHT.

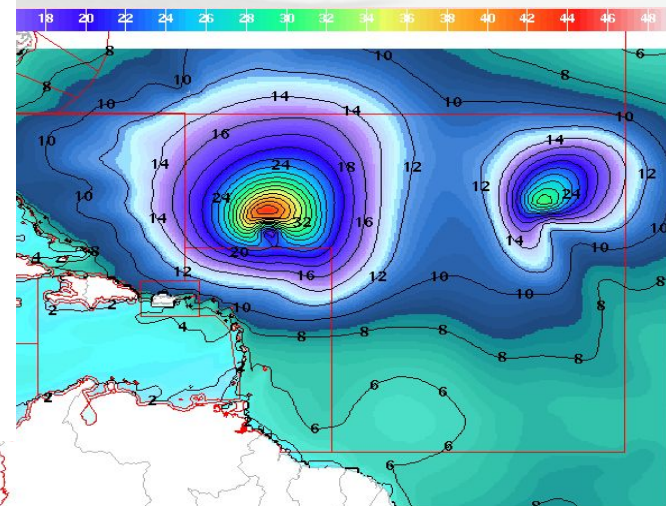
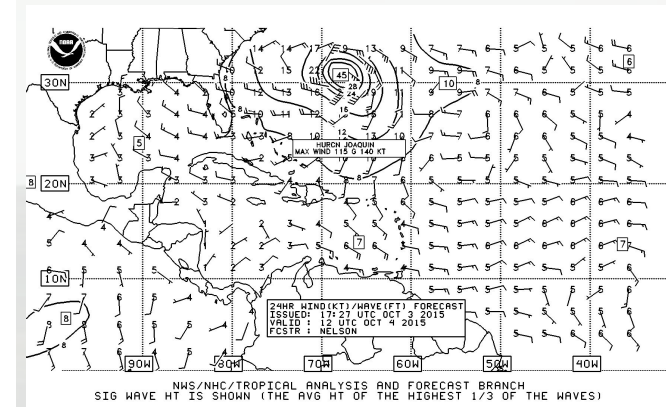
PAN PAN

ATLANTIC FROM 07N TO 31N W OF 35W INCLUDING CARIBBEAN SEA AND GULF OF MEXICO.

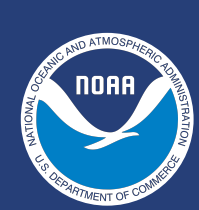
SYNOPSIS VALID 0600 UTC FRI OCT 02.
24 HOUR FORECAST VALID 0600 UTC SAT OCT 03.
48 HOUR FORECAST VALID 0600 UTC SUN OCT 04.

.WARNINGS.

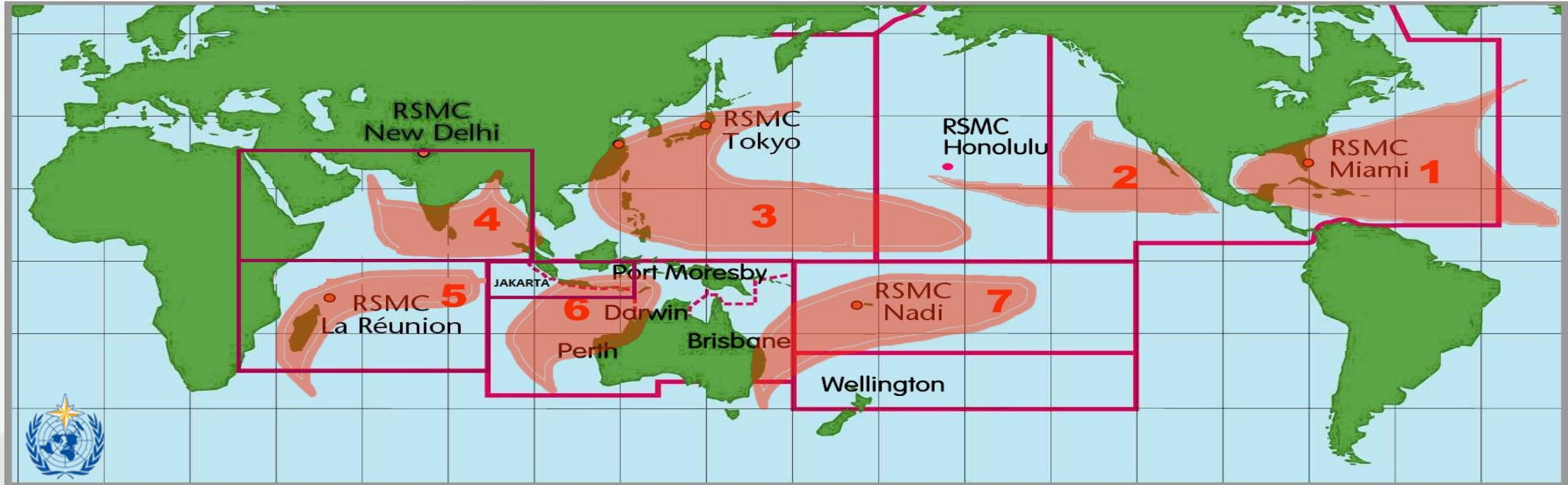
...HURRICANE WARNING...
.HURRICANE JOAQUIN NEAR 23.3N 74.7W 935 MB AT 0900 UTC OCT 02 MOVING NW OR 315 DEG AT 3 KT. MAXIMUM SUSTAINED WINDS 115 KT GUSTS 140 KT. TROPICAL STORM FORCE WINDS WITHIN 160 NM W SEMICIRCLE...140 NM NE QUADRANT AND 180 NM SE QUADRANT. SEAS 12 FT OR GREATER WITHIN 400 NM NE QUADRANT...150 NM SE QUADRANT...120 NM SW QUADRANT...AND 300 NM NW QUADRANT WITH SEAS TO 39 FT. ELSEWHERE S OF 28N BETWEEN 70W AND 78W WINDS 20 TO 33 KT. SEAS 9 TO 12 FT. N OF 28N BETWEEN 70W AND 75W WINDS 20 TO 25 KT SEAS 8 TO 10 FT. REMAINDER OF AREA N OF 21N BETWEEN 65W AND 78W AND OUTSIDE OF THE BAHAMAS WINDS 20 KT OR LESS. SEAS 8 TO 11 FT IN MIXED SWELL.



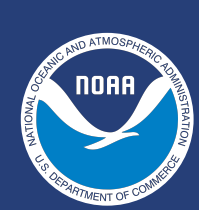
Significant Wave Height (ft) Valid 17 Sep 2010 0000 GMT



International Collaboration World Meteorological Organization



NHC is one of 7 Regional Specialized Meteorological Centers (RSMC) that produce and coordinate tropical cyclone forecasts for various ocean basins.



International Collaboration Highlights



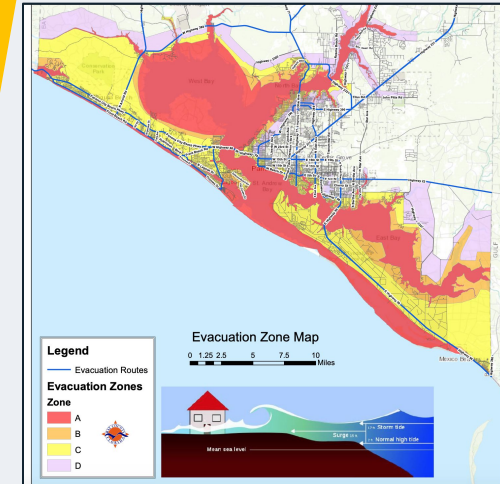
- NHC provides forecasts and guidance on watches and warnings to 28 WMO member nations
- NHC hosts and teaches two-week workshop on tropical cyclones for international government meteorologists
- NHC Director serves as Chairman of the WMO RA-IV Hurricane Committee. Annual meeting updates the Region's "Hurricane Operational Plan"
- U.S. conducts annual Caribbean Hurricane Awareness Tour
- Storm surge projects



NHC Supporting the Nation's Emergency Managers

Timeline – Years Before

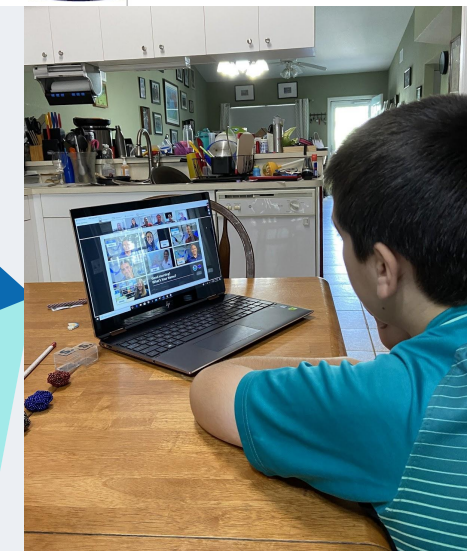
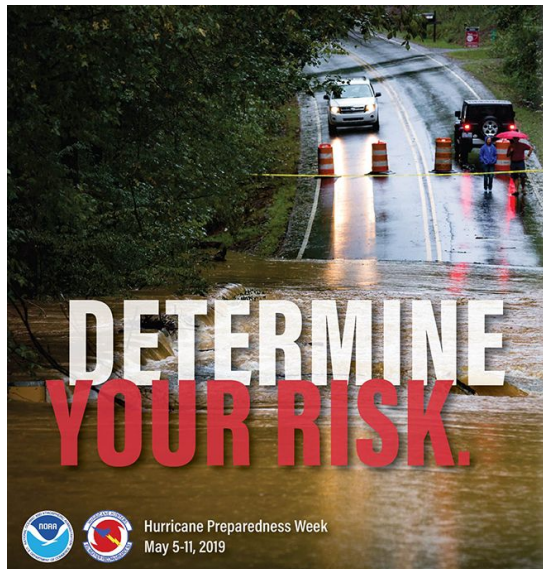
- ▶ Storm Surge Vulnerability Mapping
 - ▶ Work conducted by NHC's Storm Surge Unit and funded by FEMA
 - ▶ Drives the Nation's evacuation zones
- ▶ Evacuation Studies
 - ▶ Work conducted by U.S. Army Corps of Engineers
 - ▶ Results in "Clearance Times" – how long will it take to evacuate population
- ▶ Training
 - ▶ Hurricane preparedness classes for state and local emergency managers



NHC Supporting the Nation's Emergency Managers

Timeline – Months Before

- ▶ Battle is won during the off season
 - ▶ Encourage readiness & personal preparedness
 - ▶ Exercises (Federal/State Partners)
 - ▶ State/local hurricane conferences
 - ▶ Hurricane Awareness Tour
 - ▶ National Hurricane Preparedness Week



NHC Supporting the Nation's Emergency Managers

Timeline – Days Before

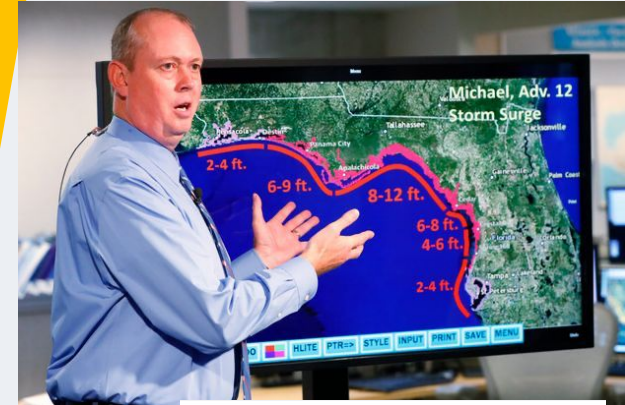
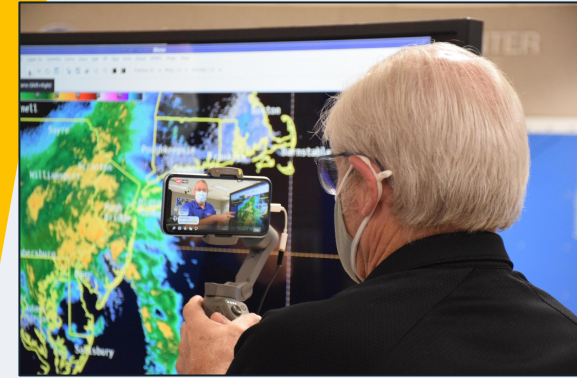
- ▶ NHC supports all levels of governmental emergency managers
- ▶ **FEMA Activates the Hurricane Liaison Team**
 - ▶ Supports response operations through rapid exchange of critical information
 - ▶ NHC supports video teleconferences with FEMA and other Federal Agencies
 - ▶ VTCs with state emergency operations center
 - ▶ Responding to emergency management questions and concerns from all levels
- ▶ **Operational Support for U.S. Coast Guard**
 - ▶ TAFB provides live briefings with Districts 7 and 8



NHC Supporting the Nation's Emergency Managers

Timeline – Hours to Days Before

- ▶ **NHC Media Pool**
 - ▶ Activated whenever a U.S. hurricane watch or warning is in effect
 - ▶ Conduct interviews with local and national media
- ▶ **Social Media**
 - ▶ NHC provides Key Messages
 - ▶ Warning and hazard-based information and safety messaging
 - ▶ Facebook Live to highlight threats
- ▶ **Collaborate Watches/Warnings**
 - ▶ NWS Weather Forecast Offices
 - ▶ International Meteorological Services





Questions/Comments

Contact: daniel.p.brown@noaa.gov

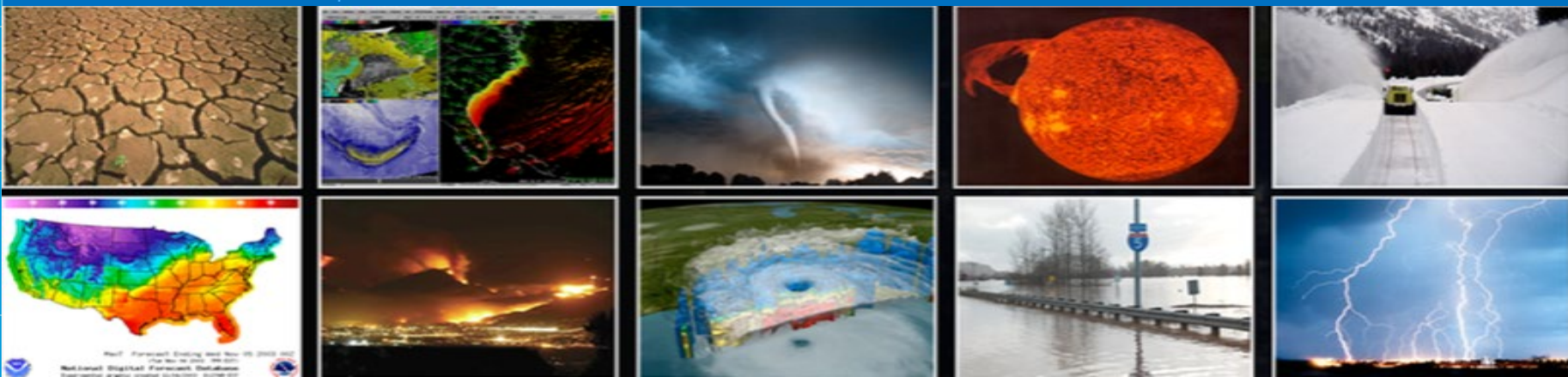


NOAA
National
Weather
Service

Ocean Prediction Center

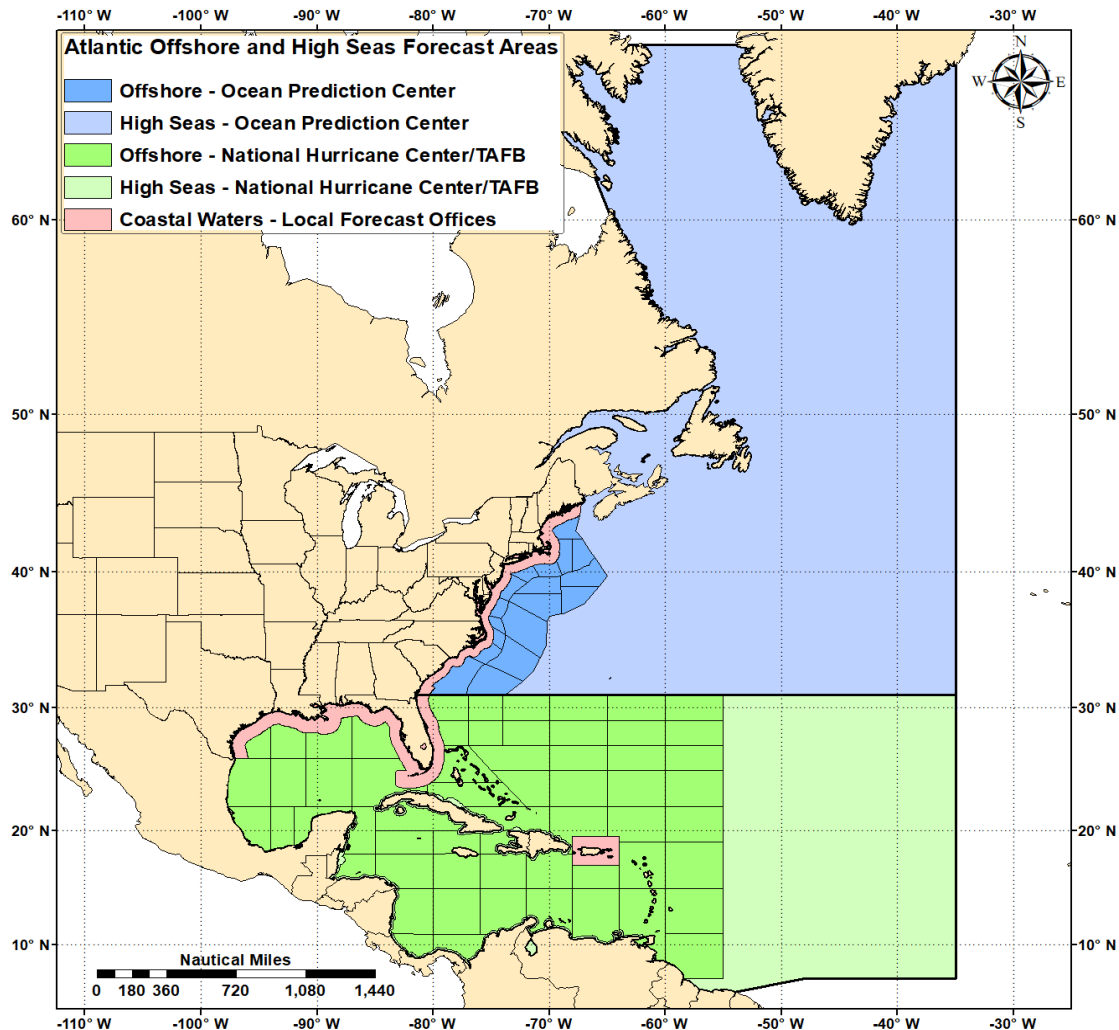
Michael Folmer, PhD
 Warning Coordination Meteorologist

Special Thank You:
 Casey Joseph, Forecaster/Outreach Focal Point
 Darin Figungskey, Operations Forecast Branch Chief
 LTJG Thomas Cervone-Richards, NOAA Corps



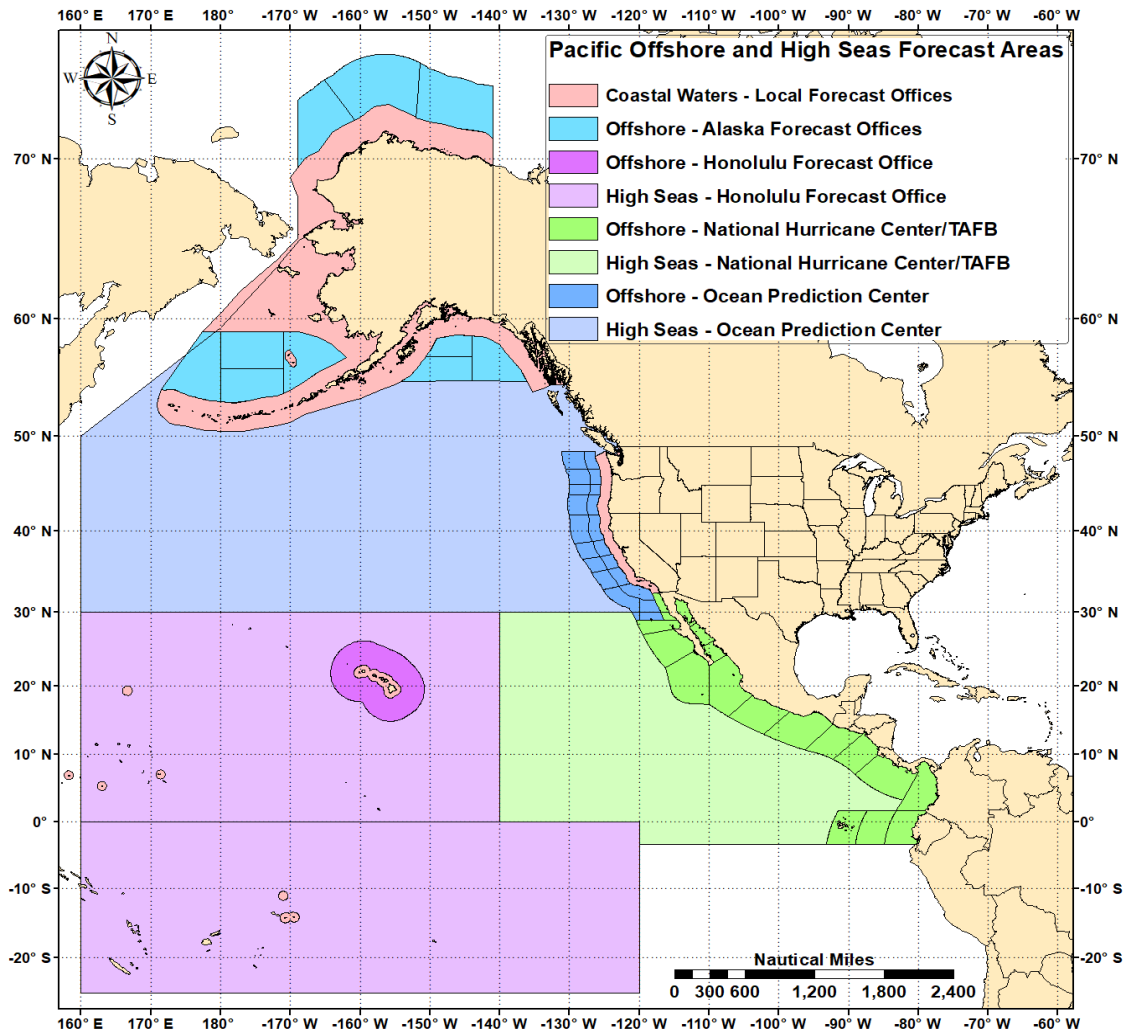
Atlantic Forecast Area

Offshore and High Seas
(radiifax charts to Europe and
Africa)



Pacific Forecast Area

Offshore and High Seas
(radiofax charts to Asia)





Why?

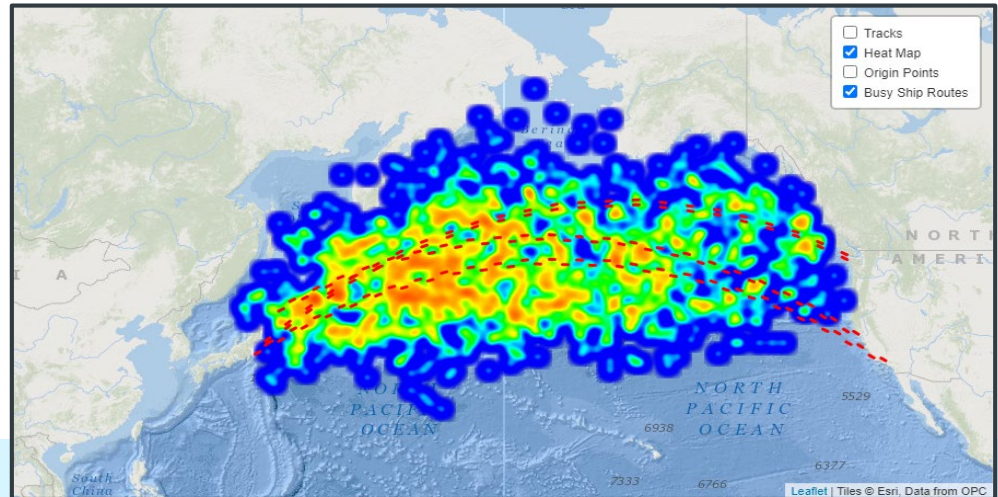
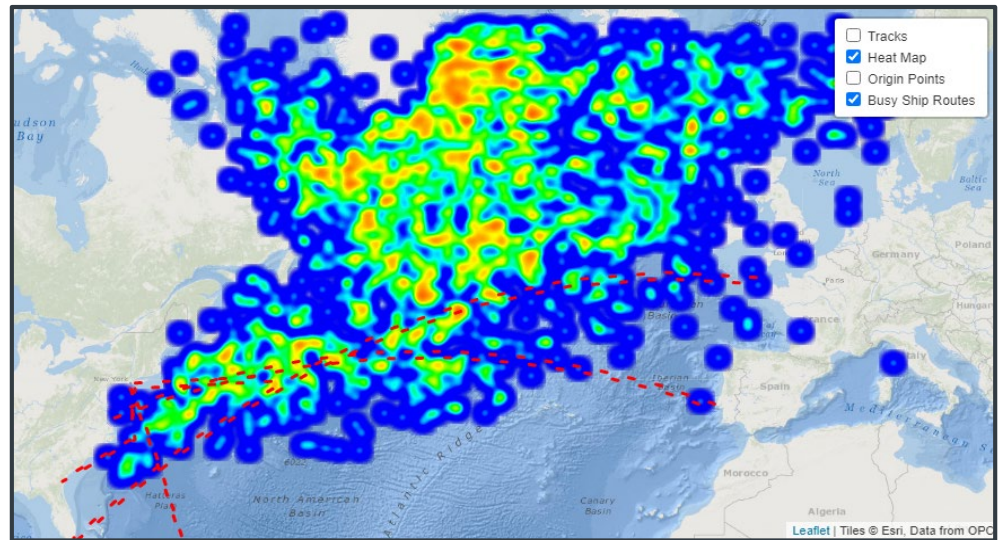


Heat Maps of extratropical hurricane-force lows in the Atlantic and Pacific since 2005.



Atlantic average, 45

Pacific average, 38



Climatology

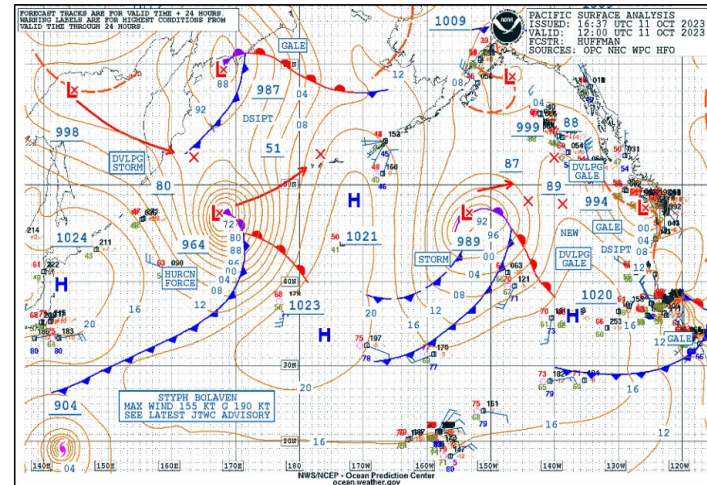
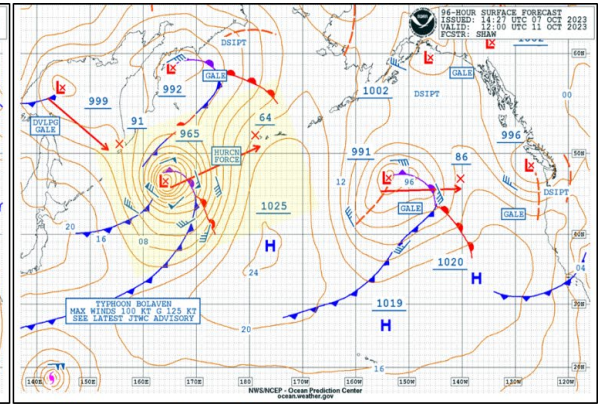
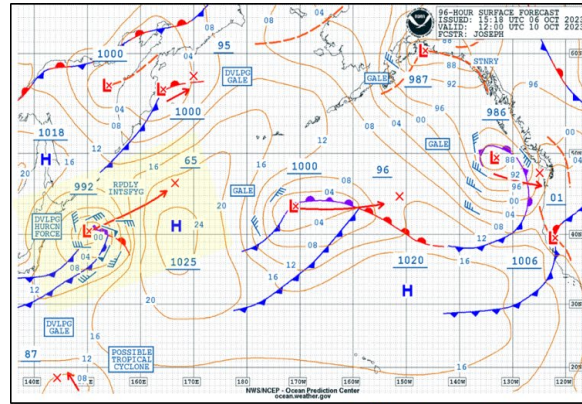
	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	SEASON TOTALS
2005-2006	0	0	3	2	2	3	3	5	9	6	0	0	33
2006-2007	1	0	0	3	4	6	8	13	20	7	1	3	66
2007-2008	0	0	1	0	6	5	10	9	6	4	1	0	42
2008-2009	0	0	1	3	7	3	13	11	4	6	2	1	51
2009-2010	0	0	0	0	6	2	7	6	8	1	0	0	30
2010-2011	0	0	0	1	4	4	1	3	13	4	1	1	32
2011-2012	0	0	0	2	4	5	11	7	3	7	1	0	40
2012-2013	0	0	0	0	5	5	5	13	7	4	3	0	42
2013-2014	0	0	0	0	2	5	14	9	10	5	1	0	46
2014-2015	0	0	1	2	2	6	9	14	8	11	4	0	57
2015-2016	1	1	0	0	4	1	11	11	11	7	2	1	50
2016-2017	0	1	0	1	4	1	12	10	10	9	2	0	50
2017-2018	0	0	1	1	4	4	9	9	7	8	3	1	47
2018-2019	0	0	0	2	4	7	7	8	9	4	3	1	45
2019-2020	0	0	0	3	3	4	9	9	6	3	4	1	42
2020-2021	0	0	0	3	3	8	4	6	8	7	2	1	42
2021-2022	0	0	0	3	3	3	11	13	11	10	1	1	56
	0.1	0.1	0.4	1.5	3.9	4.2	8.5	9.2	8.8	6.1	1.8	0.6	45.4

Monthly totals of unique hurricane force lows in the Pacific



Avoidance

October 11, 2023





Avoidance



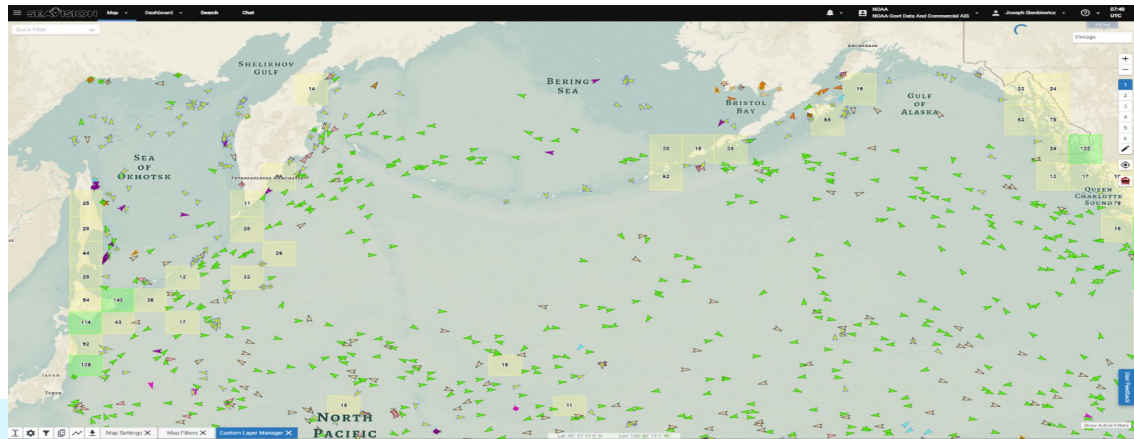
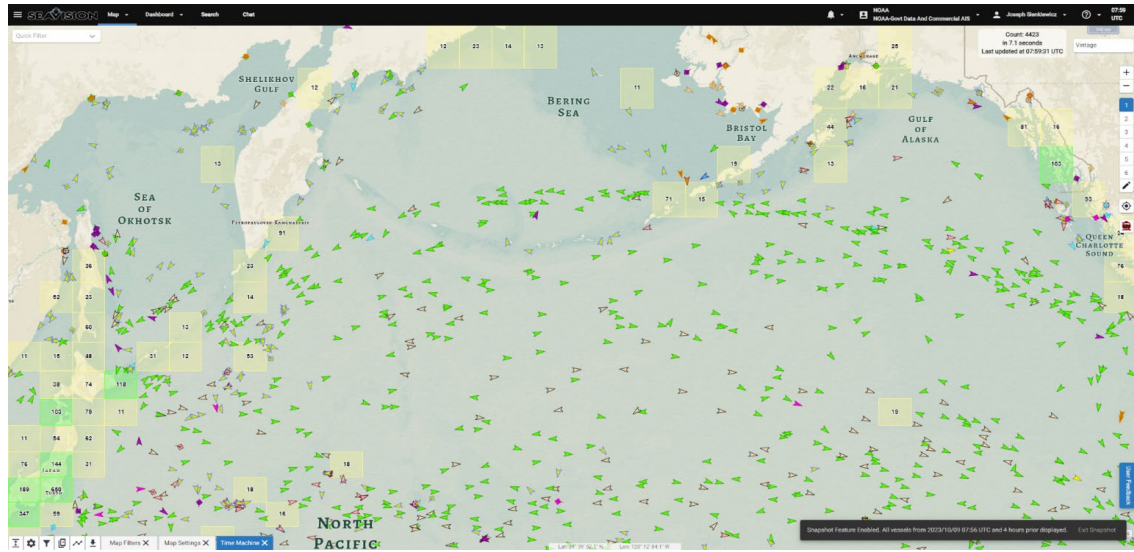
October 9,
2023 (top)



October 11,
2023 (bottom)



graphics courtesy SeaVision





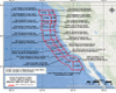











What We Do

Over 150 products each day

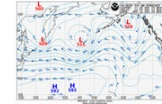
<https://ocean.weather.gov>



Pacific Text Forecasts

<p>Offshore Waters Forecasts <i>description</i></p>	 <p>Live Map</p>	<p>Washington and Oregon waters </p> <p>Updated: Wed, 09-Nov-2022 15:30:31 UTC</p> <p>California waters </p> <p>Updated: Wed, 09-Nov-2022 15:31:04 UTC</p>
<p>NAVTEX Coastal & Offshore Waters Forecasts <i>description</i></p>	 <p>Live Map</p>	<p>Astoria, OR: Canadian Border to Pt Saint George, CA </p> <p>Updated: Wed, 09-Nov-2022 17:34:10 UTC</p> <p>San Francisco, CA: Pt Saint George, CA to Pt Piedras Blancas, CA </p> <p>Updated: Wed, 09-Nov-2022 17:31:58 UTC</p> <p>Cambria, CA: Pt Piedras Blancas, CA to Mexican Border </p> <p>Updated: Wed, 09-Nov-2022 17:31:47 UTC</p>
<p>High Frequency Voice Broadcast for Offshore Waters (VOBRA) <i>description</i></p>	 <p>Live Map</p>	<p>Washington and Oregon Waters </p> <p>Updated: Wed, 09-Nov-2022 15:32:30 UTC</p> <p>California waters </p> <p>Updated: Wed, 09-Nov-2022 15:32:47 UTC</p>
<p>High Seas Forecasts <i>description</i></p>		<p>North Pacific Ocean </p> <p>Updated: Wed, 09-Nov-2022 16:12:30 UTC</p> <p>East and Central North Pacific Ocean (Metarea XII) </p> <p>Updated: Wed, 09-Nov-2022 17:28:13 UTC</p>

Pacific Graphical Forecasts

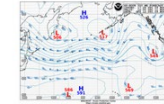


24-hour 500 mb

Loop: [3] [7] [14] Days

Updated: Wed, 09-Nov-2022 17:29:21 UTC

[More 500 MB images](#)

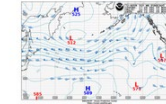


48-hour 500 mb

Loop: [3] [7] [14] Days

Updated: Wed, 09-Nov-2022 17:30:42 UTC

[More 500 MB images](#)

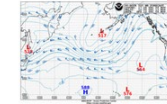


72-hour 500 mb

Loop: [3] [7] [14] Days

Updated: Wed, 09-Nov-2022 17:32:03 UTC

[More 500 MB images](#)

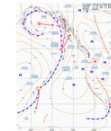


96-hour 500 mb

Loop: [3] [7] [14] Days

Updated: Wed, 09-Nov-2022 17:33:21 UTC

[More 500 MB images](#)



24-hour surface

Loop: [3] [7] [14] Days

Updated: Wed, 09-Nov-2022 17:04:43 UTC



48-hour surface

Loop: [3] [7] [14] Days

Updated: Wed, 09-Nov-2022 17:08:14 UTC



72-hour surface

Loop: [3] [7] [14] Days

Updated: Wed, 09-Nov-2022 17:59:17 UTC



96-hour surface

Loop: [3] [7] [14] Days

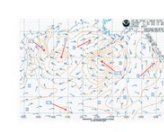
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24-hour wind & wave

Loop: [3] [7] [14] Days

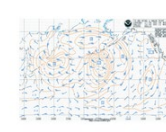
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48-hour wind & wave

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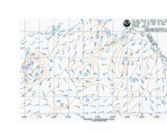
Updated: Wed, 09-Nov-2022 17:49:26 UTC



72-hour wind & wave

Loop: [3] [7] [14] Days

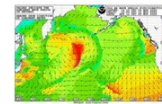
Updated: Tue, 08-Nov-2022 17:59:04 UTC



96-hour wind & wave

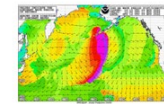
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Updated: Wed, 09-Nov-2022 14:57:06 UTC



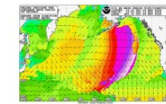
24-hour wave period & direction

Loop: [3] [7] [14] Days



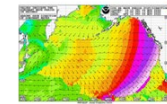
48-hour wave period & direction

Loop: [3] [7] [14] Days



72-hour wave period & direction

Loop: [3] [7] [14] Days



96-hour wave period & direction

Loop: [3] [7] [14] Days



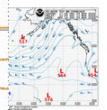
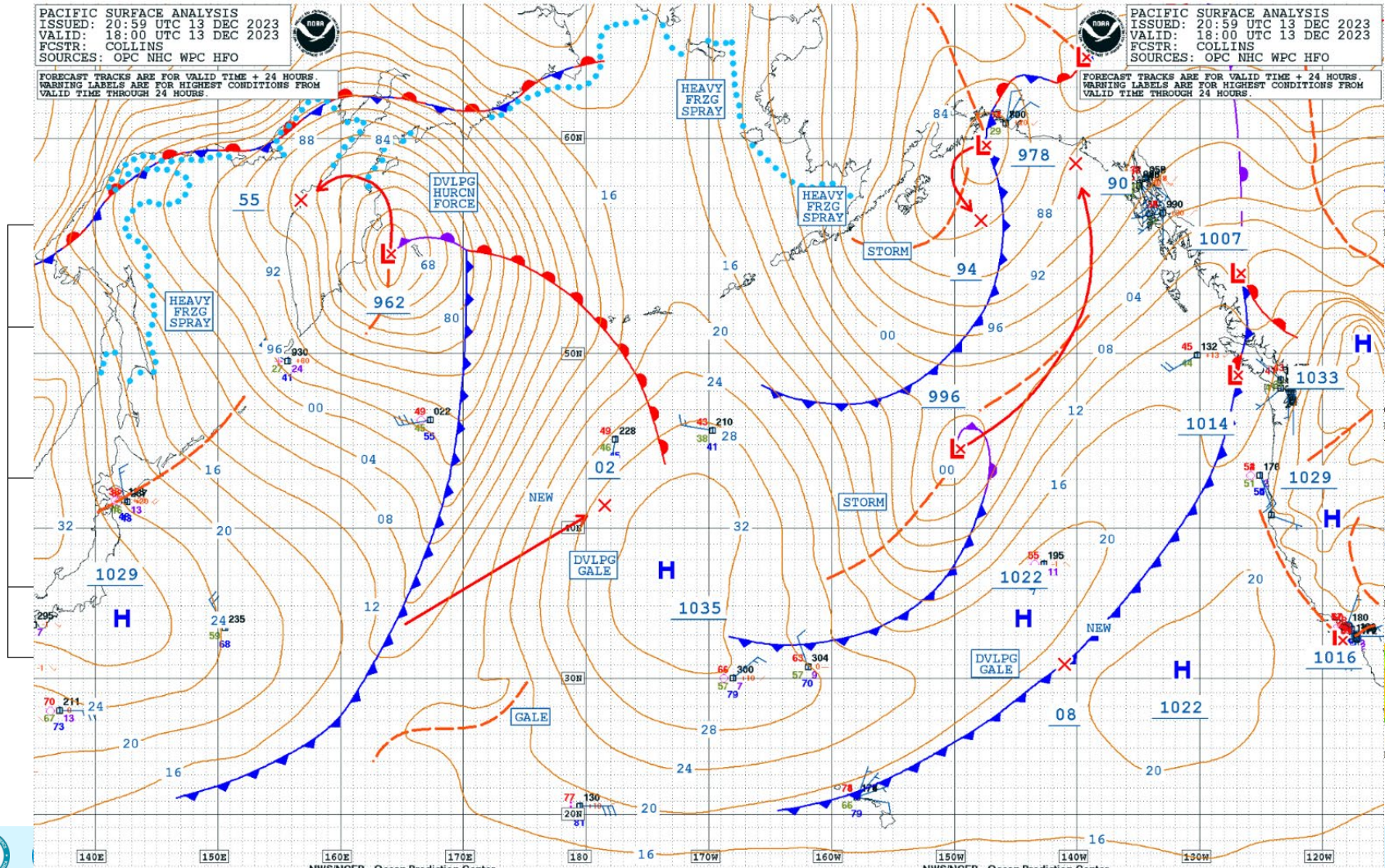
PACIFIC SURFACE ANALYSIS
 ISSUED: 20:59 UTC 13 DEC 2023
 VALID: 18:00 UTC 13 DEC 2023
 FCSTR: COLLINS
 SOURCES: OPC NHC WPC HFO



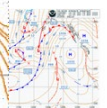
FORECAST TRACKS ARE FOR VALID TIME + 24 HOURS
 WARNING LABELS ARE FOR HIGHEST CONDITIONS FROM
 VALID TIME THROUGH 24 HOURS.

PACIFIC SURFACE ANALYSIS
 ISSUED: 20:59 UTC 13 DEC 2023
 VALID: 18:00 UTC 13 DEC 2023
 FCSTR: COLLINS
 SOURCES: OPC NHC WPC HFO

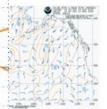
FORECAST TRACKS ARE FOR VALID TIME + 24 HOURS
 WARNING LABELS ARE FOR HIGHEST CONDITIONS FROM
 VALID TIME THROUGH 24 HOURS.



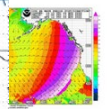
ur 500 mb
 [] [14] Days
 Nov-2022 17:33:21 UTC
 0 MB images



ur surface
 [] [14] Days
 Nov-2022 14:27:11 UTC



wind & wave
 [] [14] Days
 Nov-2022 14:57:06 UTC



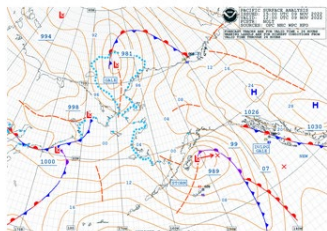
period & direction
 [] [14] Days



What We Do

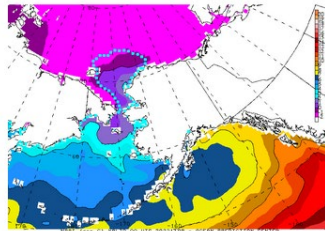


Alaska/Arctic Analysis



Latest Surface Analysis

Updated: Wed, 09-Nov-2022 15:10:18 UTC



Latest SST/Ice Edge Analysis

Updated: Tue, 08-Nov-2022 23:10:39 UTC



Alaska/Arctic Graphical Forecasts



24-hour surface

Loop: [3] [7] [14] Days

Updated: Wed, 09-Nov-2022 07:24:56 UTC



48-hour surface

Loop: [3] [7] [14] Days

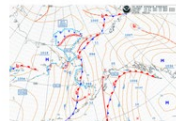
Updated: Wed, 09-Nov-2022 06:10:57 UTC



72-hour surface

Loop: [3] [7] [14] Days

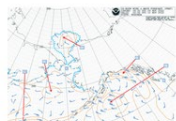
Updated: Tue, 08-Nov-2022 17:27:03 UTC



96-hour surface

Loop: [3] [7] [14] Days

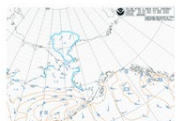
Updated: Wed, 09-Nov-2022 14:27:49 UTC



Loop: [3] [7] [14] Days

24-hour wind & wave

Updated: Wed, 09-Nov-2022 06:33:35 UTC



Loop: [3] [7] [14] Days

48-hour wind & wave

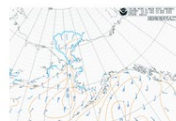
Updated: Wed, 09-Nov-2022 06:39:59 UTC



Loop: [3] [7] [14] Days

72-hour wind & wave

Updated: Tue, 08-Nov-2022 17:59:03 UTC



Loop: [3] [7] [14] Days

96-hour wind & wave

Updated: Wed, 09-Nov-2022 14:57:45 UTC



U.S. National Ice Center
NOAA component = OPC Ice
Services Branch

<https://usicecenter.gov>



U.S. NATIONAL ICE CENTER

ABOUT PRODUCTS RESOURCES NEWS CONTACT US

United States

ARCTIC ICE MINIMUM
FOR 2020

Greenland



U.S. National Ice Center

Mission and Organizational Alignment

The U.S. National Ice Center provides global to tactical scale ice and snow products, ice forecasting, and related environmental intelligence services for the United States government.

Tri-agency organization composed of:

NOAA component:

NWS Ocean Prediction Center Ice Services Branch

Navy component:

Fleet Weather Center Norfolk, Naval Ice Center

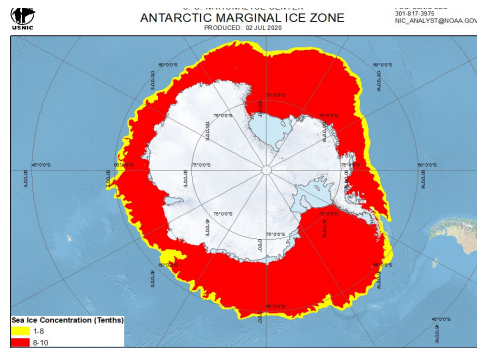
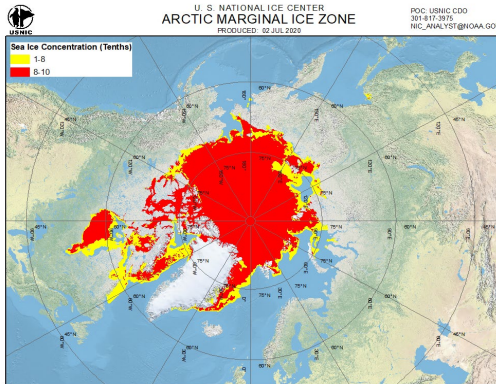
USCG component:

Office of Waterways and Ocean Policy, Mobility and Ice Operations Division

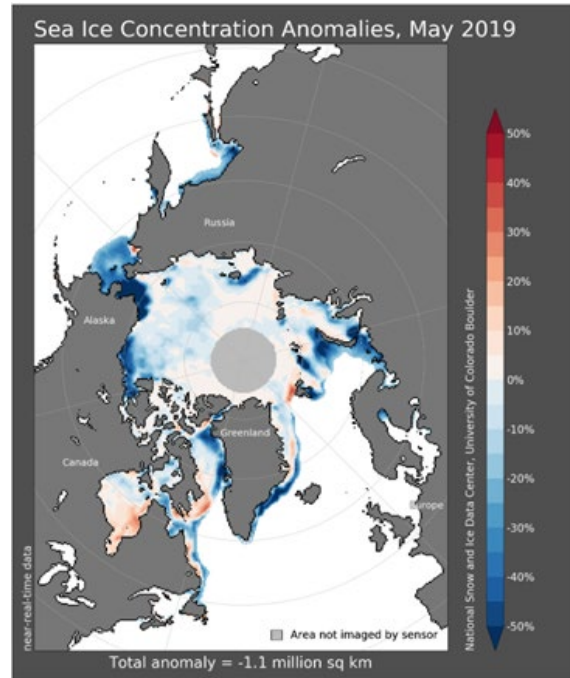


Ice Services

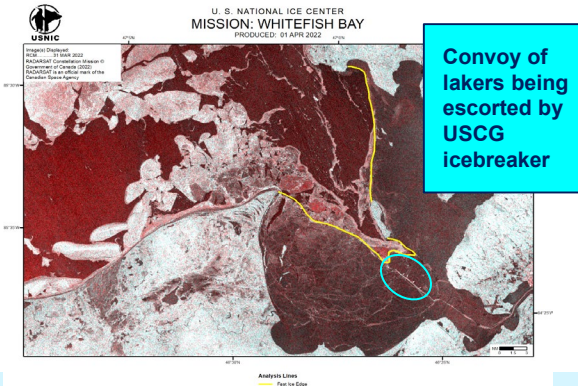
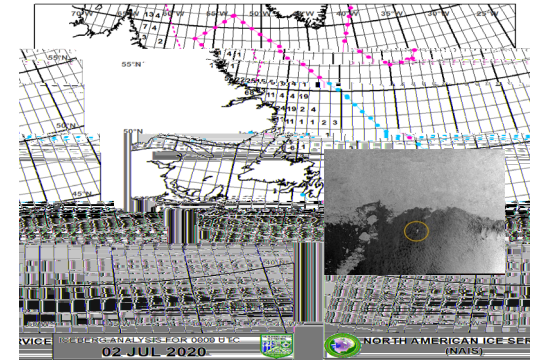
Ice Extent and Change



Ice Concentration and Thickness

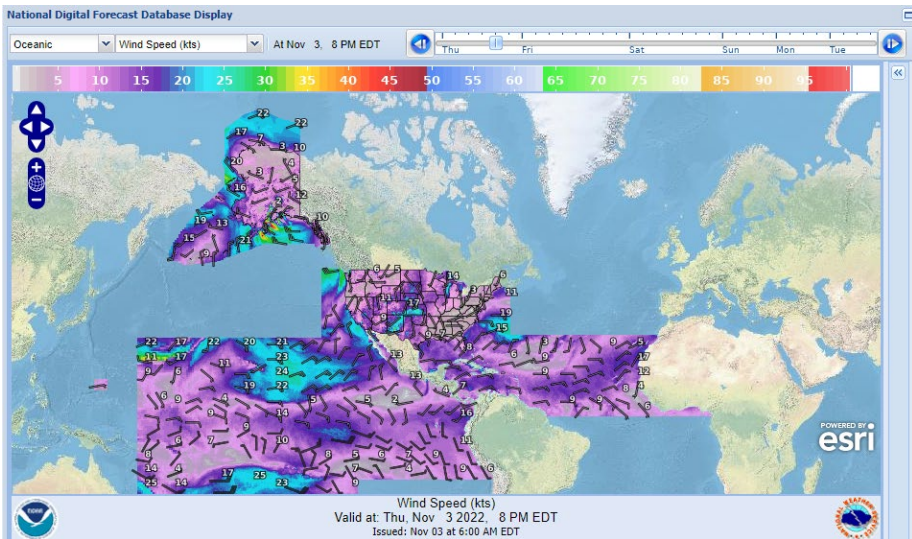


Icebergs and Ice Routing





What We Do



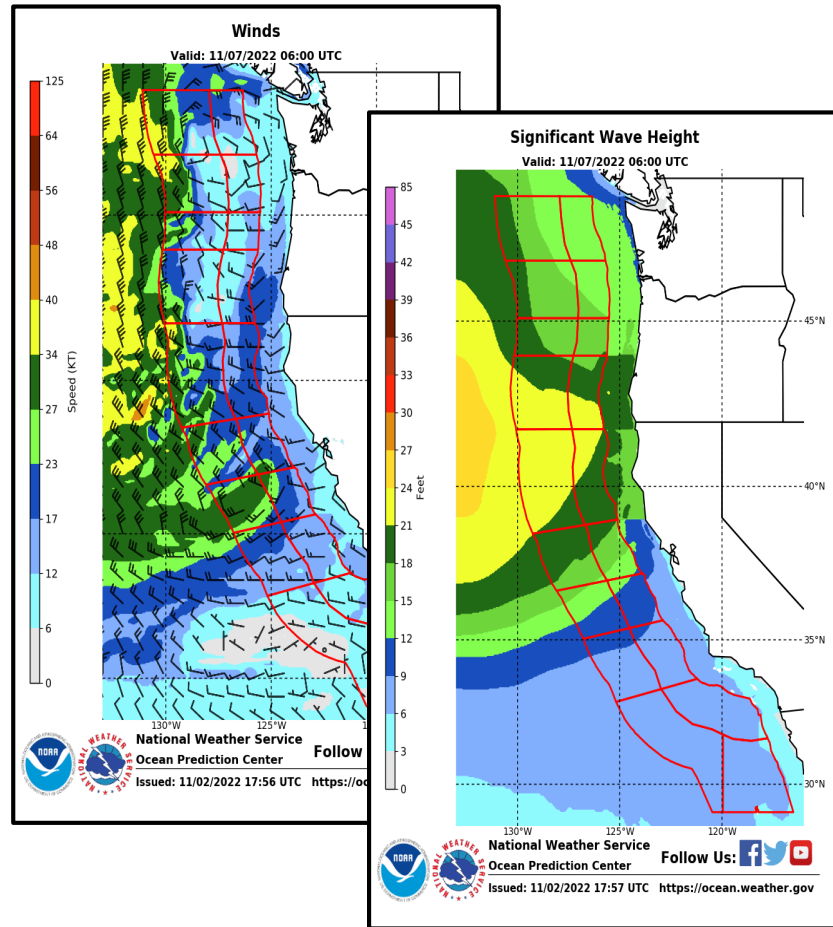
National Digital Forecast Database (NDFD)

https://www.weather.gov/mdl/ndfd_info

<https://digital.weather.gov/>

Top: oceanic domain of the NDFD, forecast, November 4, 2022, 0000 UTC

Upper Right: wind and wave forecasts, November 7, 2022, 0600 UTC





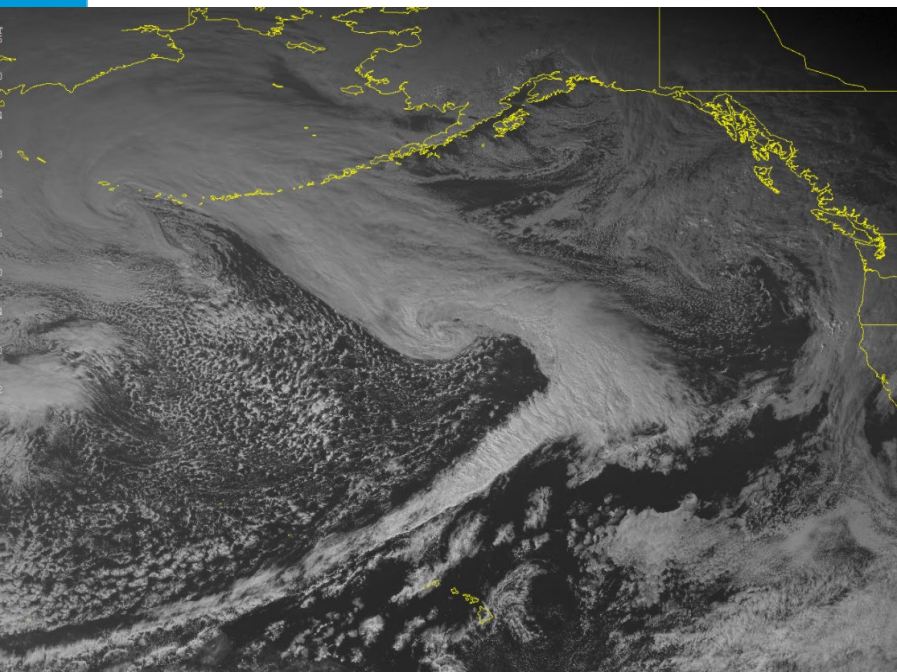
How We Do It



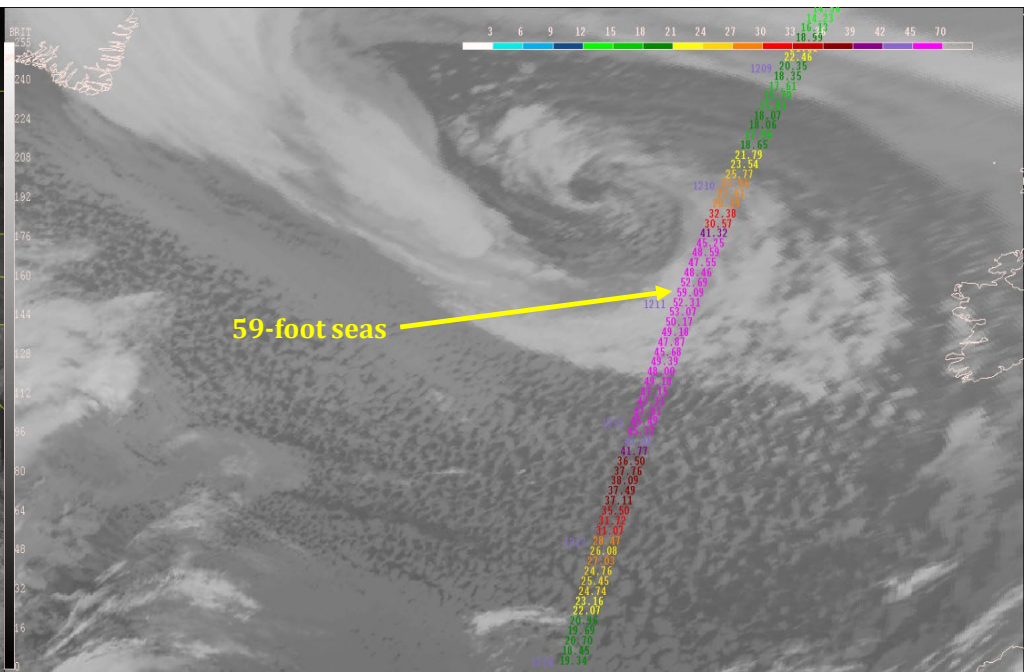
Satellite imagery

L: visible image, Pacific, January 24, 2020, 00 UTC

R: infrared image + altimeter, Atlantic, October 27, 2020, 12 UTC



200124/0000 GOES17 CH02 VIS_0.64



SRHB_201027/1200
201027/1200 GOES16 CH13 IR_10.4



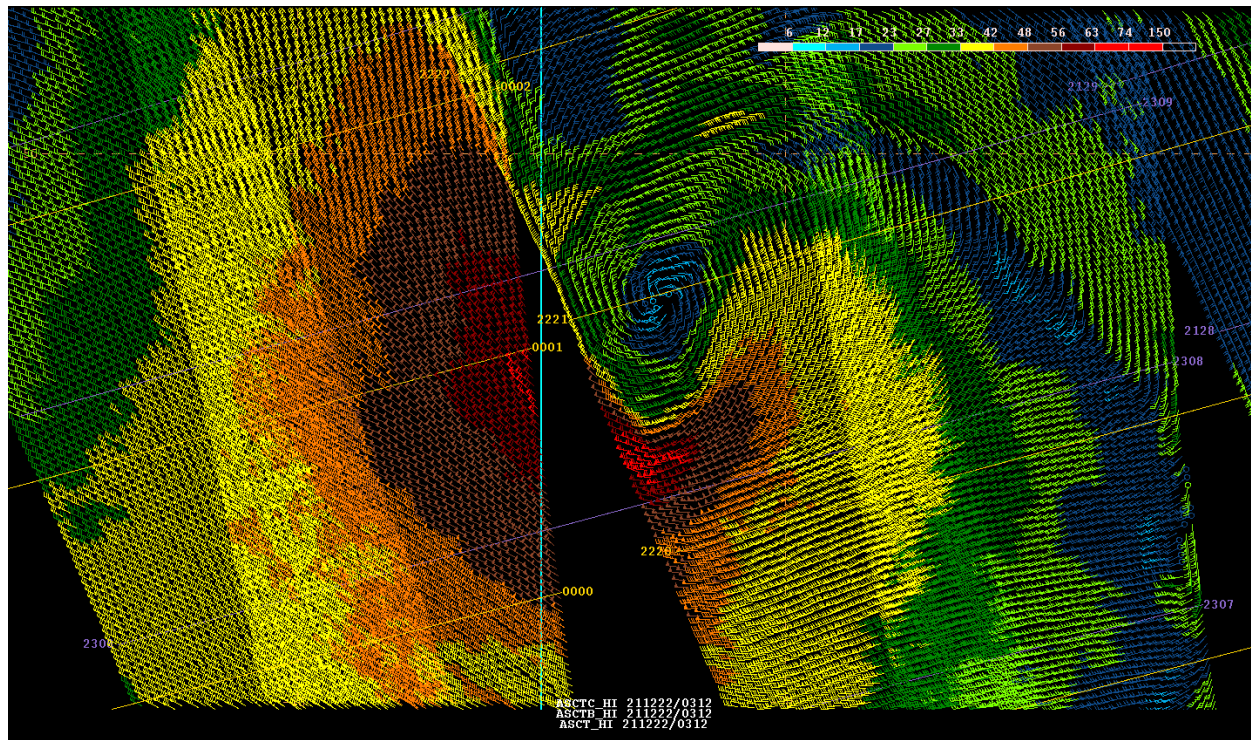


How We Do It



Satellite imagery

*Scatterometer data,
December 22, 2021, from
~0000 UTC*



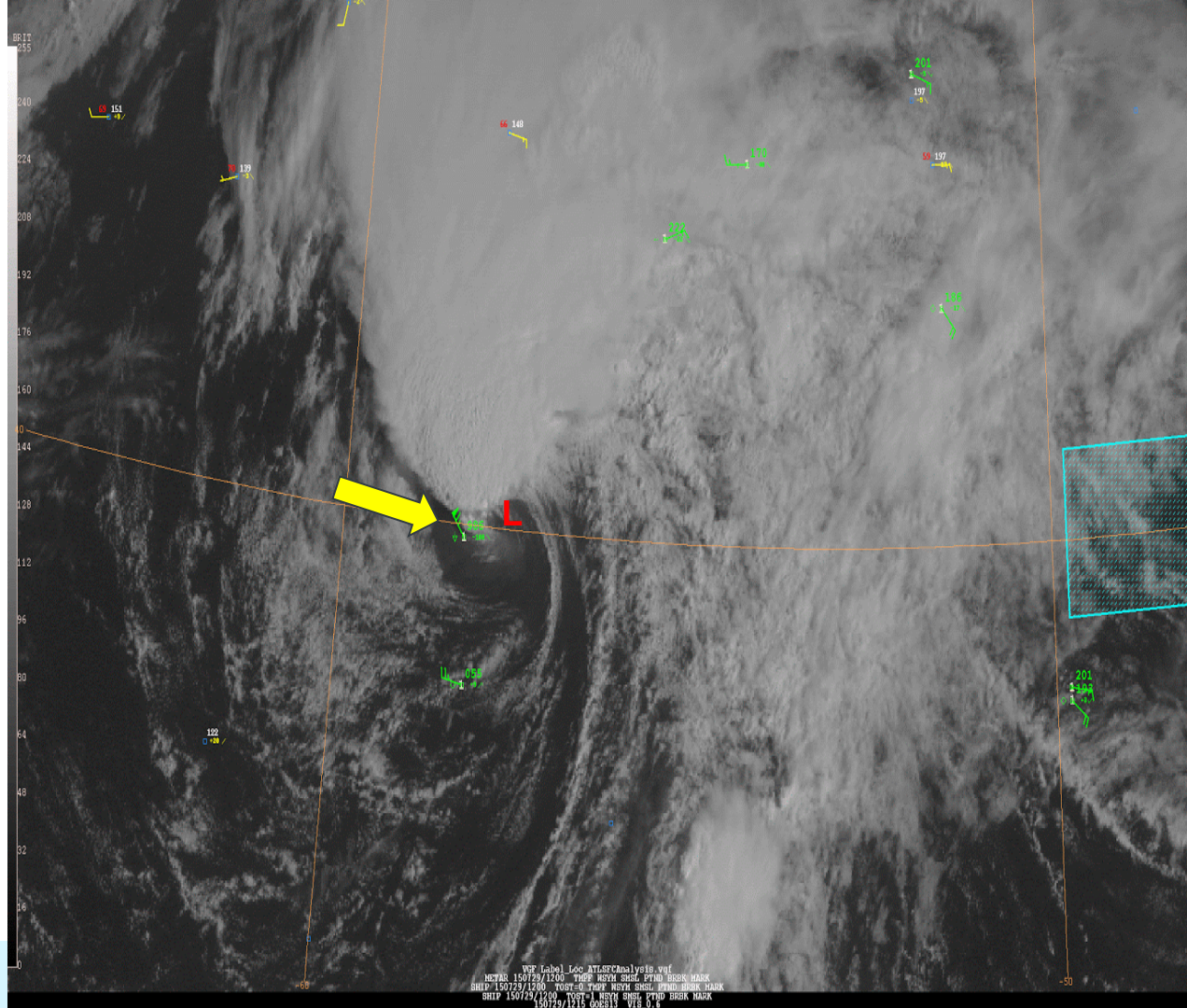


Observations



Satellite imagery

Visible image, July 29, 2015,
12 UTC



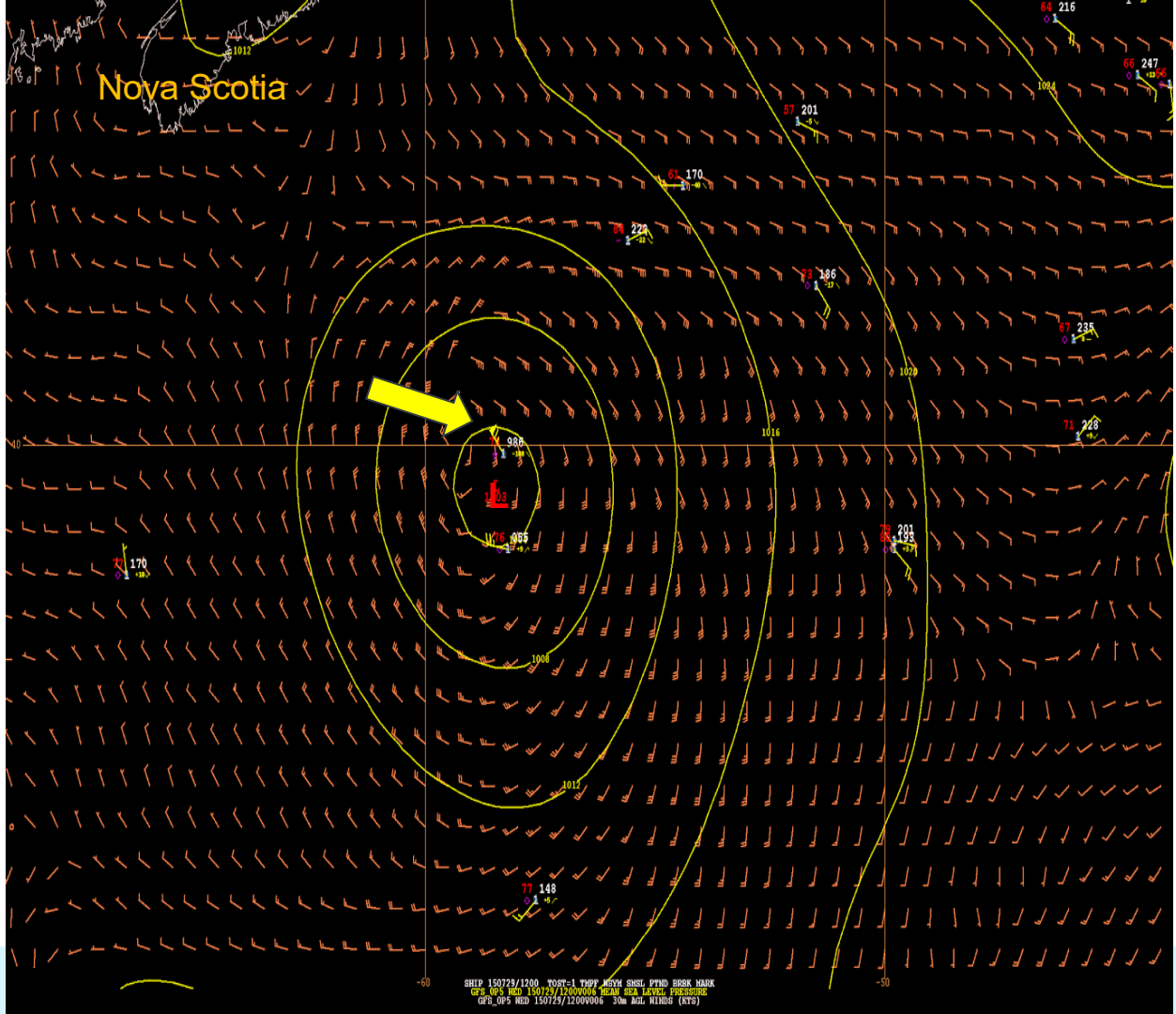


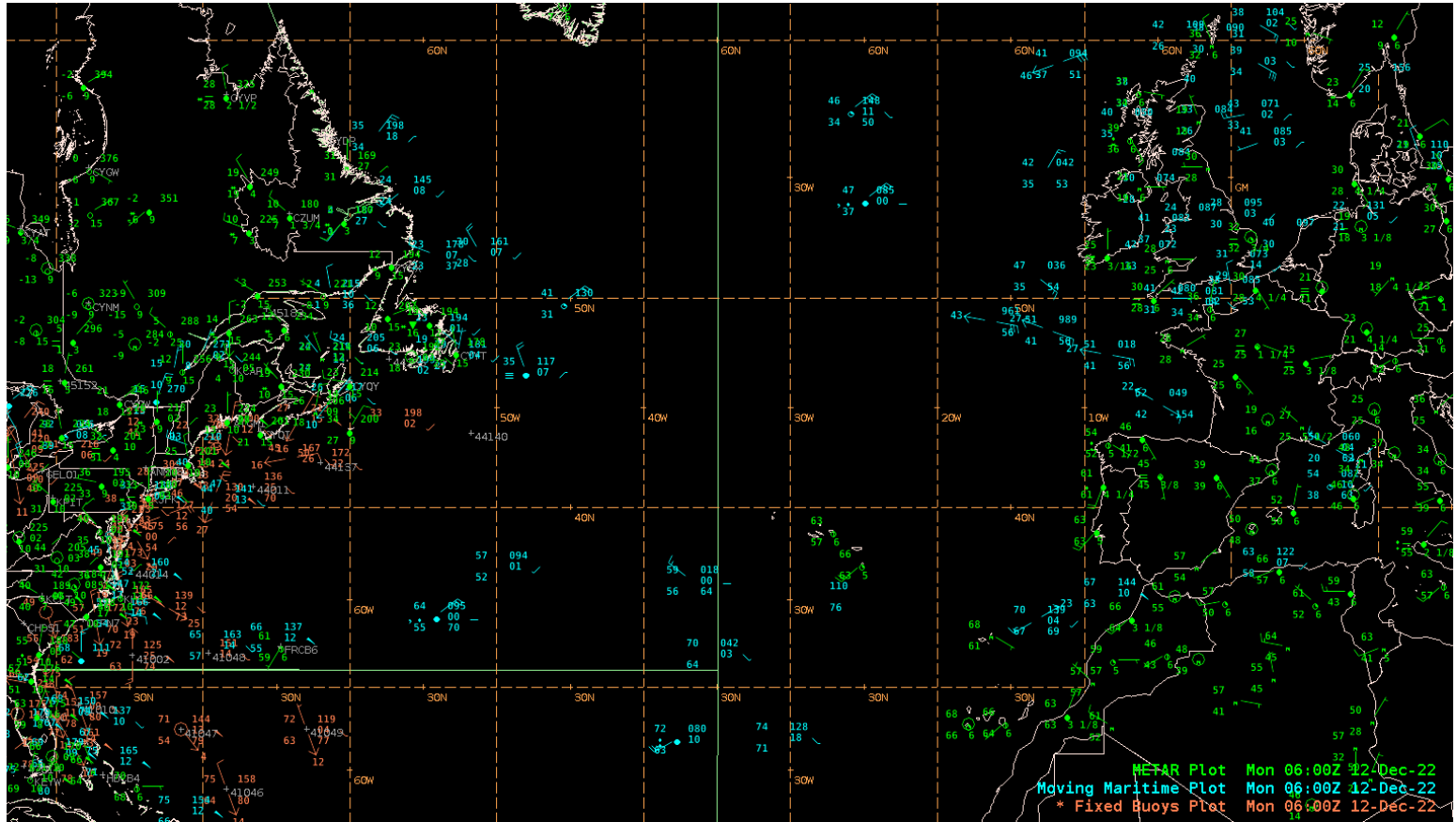
Observations



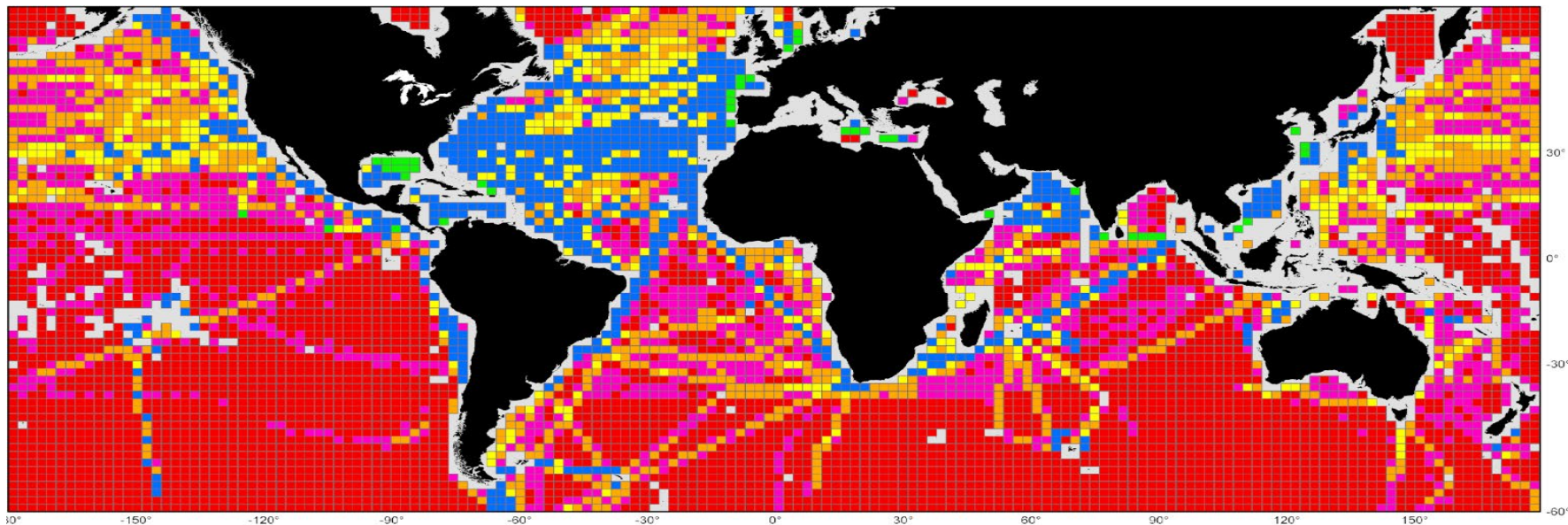
Global Forecast System (GFS)


*Six-hour forecast, July 29,
2015, 12 UTC*






Observations - We Need Them!



 No or insufficient amount of VOS data

 Minimum to good amount of VOS data

December 2022
Voluntary Observing Ships (VOS)
Data Source: GTS/Meteo-France

20



Decision Support Services

 NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Storm Warning

Today (12/11)

KEY MESSAGES:

CALL TO ACTION: Vessels planning to be in the area should execute avoidance plans.

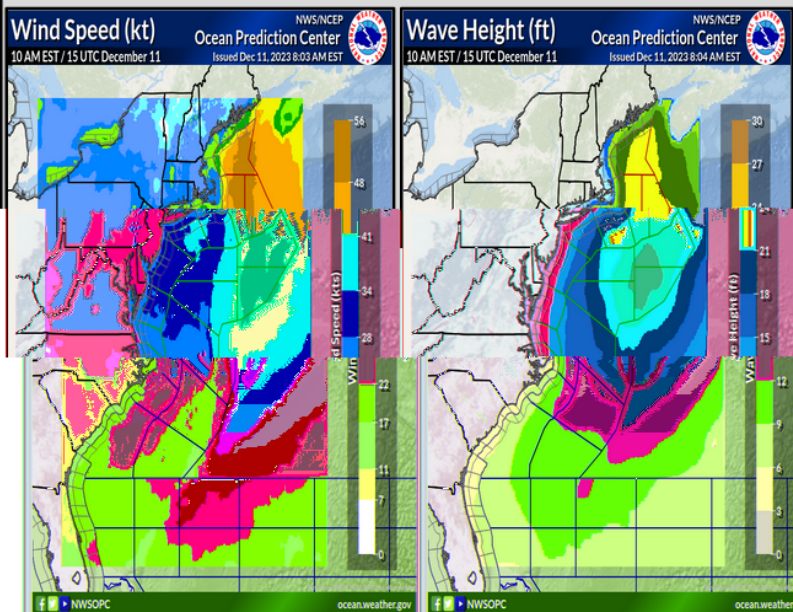
- A strong cold front will continue to push east farther offshore of the East Coast today, trailing low pressure moving northeast from New England into southeast Canada.
- By late morning, storm-force conditions will occur from about 36.5N to 44N east of 69W. Hurricane-force wind gusts will also occur, especially in vicinity of the Gulf Stream. ...
- Storm-force conditions will move well east into the north Atlantic late this afternoon into this evening.
- Widespread seas over 20 feet will be in place late this morning north of 36N and east of about 71.5W. Maximum seas will approach 30 feet especially in and near the Gulf Stream from about 37N to 40N between 66W and 70W. These very high seas will also shift east into the north Atlantic this evening.
- Winds and seas will be higher in and near any thunderstorms, mostly concentrated along and ahead of the strong cold front.



ISSUED: 14 UTC December 11, 2023



Outlook for the Western Atlantic East Coast N of 31N to 65W



Wind Forecast (L, kt) and Wave Forecast (R, ft) Valid 10 AM / 15 UTC Monday, December 11, 2023





Decision Support Services

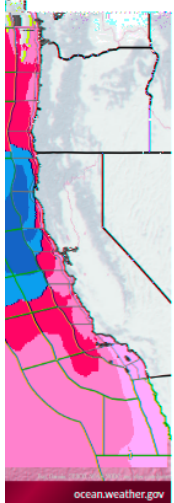


NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Gale Warning

Thursday (11/23) through Friday (11/24)

KEY MESSAGES:



CALL TO ACTION: Vessels in the area should use caution or make avoidance plans depending on your vessel type and cargo.

- Behind a front, and also between lower pressure near the coast and inland and higher pressure offshore centered off the Pacific Northwest, an area of sustained gale-force winds will occur late tonight through Friday.
- The gales should be off of the northern California and far southern Oregon coasts, mainly from about Point Reyes north to between Point St. George and Cape Blanco. The chances for gales diminish Friday night.
- Areas of 12-foot seas off of the Pacific Northwest today will shift south tonight, increasing to 15 to 20 feet off of the northern California coast Thursday.
- 12-foot seas will build south offshore of much of the California coast Thursday night, with 12-foot seas also building back north off of the Pacific Northwest late Friday and Friday night.

10 AM PST / 18 UTC



ISSUED: 16 UTC November 22, 2023

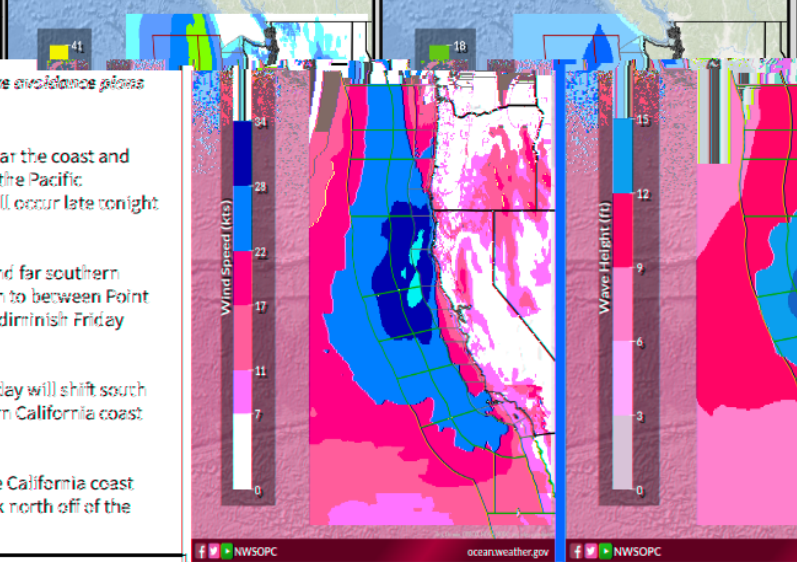
@NWSOPC
 @NHC_Pacific

Outlook for the Pacific Ocean

From 30N to 50N E of 133W

Wind Speed (kt) Ocean Prediction Center
10 AM PST / 18 UTC Thurs Nov 23 Issued Nov 22, 2023 9:40 AM EST

Wave Height (ft) Ocean Prediction Center
10 AM PST / 18 UTC November 23 Issued Nov 22, 2023 9:42 AM EST

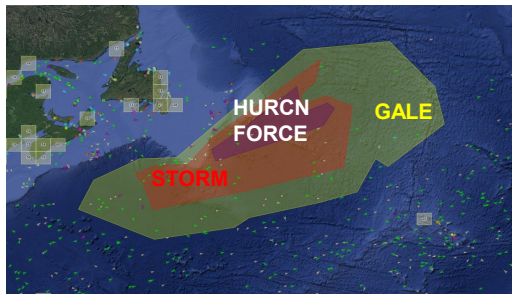
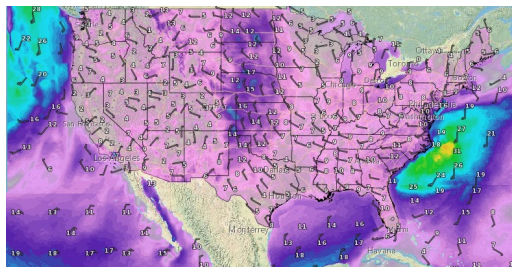


Wind Speed Forecast (I, knots) and Wave Height Forecast (R, feet) Valid 10 Thursday, November 23.





Future of High Seas Forecasts?



HIGH SEAS FORECAST FOR METAREA XII
NWS OCEAN PREDICTION CENTER WASHINGTON DC
1145 UTC THU NOV 03 2022

CCODE/1:31:12:01:00/AOW+POR/NWS/CCODE
SUPERSEDED BY NEXT ISSUANCE IN 6 HOURS

SEAS GIVEN AS SIGNIFICANT WAVE HEIGHT...WHICH IS THE AVERAGE HEIGHT OF THE HIGHEST 1/3 OF THE WAVES. INDIVIDUAL WAVES MAY BE MORE THAN TWICE THE SIGNIFICANT WAVE HEIGHT.

ONLY YOU KNOW THE WEATHER AT YOUR POSITION. REPORT IT TO THE NATIONAL WEATHER SERVICE. EMAIL US AT VOSOPS@NOAA.GOV(LOWERCASE).

SECURITE

PACIFIC N OF 30N AND S OF 67N E OF A LINE FROM BERING STRAIT TO 50N 160E

ALL FORECASTS VALID OVER ICE FREE FORECAST WATERS

SYNOPSIS VALID 0600 UTC NOV 03.
24 HOUR FORECAST VALID 0600 UTC NOV 04.
48 HOUR FORECAST VALID 0600 UTC NOV 05.

.WARNINGS.

...STORM WARNING...

.LOW 61N146W 985 MB MOVING S 05 KT. FROM 56N TO 60N E OF 163W...ALSO FROM 50N TO 57N BETWEEN 131W AND 136W WINDS 25 TO 40 KT. SEAS 10 TO 19 FT.

.24 HOUR FORECAST LOW 59N145W 993 MB. FROM 52N TO 59N BETWEEN 148W AND 162W WINDS 30 TO 45 KT. SEAS 9 TO 18 FT.

.48 HOUR FORECAST LOW 56N136W 992 MB. WITHIN 660 NM W AND 420 NM S QUADRANTS WINDS 35 TO 50 KT. SEAS 14 TO 26 FT. ELSEWHERE E OF A LINE FROM 59N160W TO 53N160W TO 50N150W TO 42N124W WINDS 25 TO 40 KT. SEAS 8 TO 16 FT.

...STORM WARNING...

.M OF A LINE FROM 52N163E TO 46N160E WINDS TO 25 KT. SEAS TO 9 FT.

.24 HOUR FORECAST LOW 53N160E 996 MB. FRONT WILL EXTEND FROM LOW TO 50N161E TO 40N153E. WITHIN 120 NM E OF FRONT WINDS 35 TO 50 KT. SEAS 12 TO 21 FT. ELSEWHERE WITHIN 300 NM E OF FRONT WINDS 25 TO 40 KT. SEAS 8 TO 13 FT.

.48 HOUR FORECAST LOW 50N167E 1003 MB. FRONT WILL EXTEND FROM 59N170E TO LOW CENTER TO 42N163E TO 36N156E. WITHIN 120 NM E OF FRONT N OF 47N WINDS 35 TO 50 KT. SEAS 14 TO 23 FT. ELSEWHERE WITHIN 300 NM E OF FRONT WINDS 25 TO 40 KT. SEAS 8 TO 16 FT.

...STORM WARNING...

.LOW 38N178E 995 MB MOVING E 10 KT. WITHIN 180 NM NW QUADRANT WINDS 35 TO 50 KT. SEAS 16 TO 25 FT. ELSEWHERE WITHIN 480 NM N AND 300 NM W QUADRANTS WINDS 25 TO 40 KT. SEAS 10 TO 18 FT. ALSO FROM 31N TO 48N BETWEEN 175W AND 169E WINDS 20 TO 30 KT. SEAS 8 TO 14 FT.

.24 HOUR FORECAST LOW 39N179W 997 MB. WITHIN 240 NM N AND 180 NM W QUADRANTS WINDS 35 TO 50 KT. SEAS 17 TO 27 FT. ELSEWHERE WITHIN 300 NM N AND NW OF A LINE FROM 44N165W TO 40N179W...ALSO WITHIN 360 NM NW...300 NM SW AND 120 NM SE QUADRANTS WINDS 25 TO 40 KT. SEAS 10 TO 18 FT.

.48 HOUR FORECAST LOW 37N179W 1001 MB. FROM 40N TO 45N BETWEEN 175W AND 176E...AND FROM 33N TO 44N BETWEEN 175E AND 179W WINDS 25 TO 40 KT. SEAS 12 TO 21 FT.

...GALE WARNING...

Storm (Low, Front, Area, Line) -- TAFB (Gap Winds), OPC

Event Level Parts	Example
eventHeader	WARNING 2020-00012: STORM
issueTime	ISSUED 1745 UTC TUE JUL 14 2020
initialDetails	.WITHIN 47N55W 46N51W 44N45W 47N55W WINDS 40 TO 50 KT.
forecastDetails	.24 HOUR FORECAST WITHIN 47N55W 46N42W 45N52W 44N44W 47N55W. WINDS 40 TO 50 KT. .48 HOUR FORECAST WITHIN 48N56W 46N41W 46N52W 45N45W 48N56W. WINDS 40 TO 50 KT.

Gale (Low, Front, Area, Line) -- TAFB (Gap Winds), OPC

Event Level Parts	Example
eventHeader	WARNING 2020-00012: GALE
issueTime	ISSUED 1745 UTC TUE JUL 14 2020
initialDetails	.WITHIN 47N55W 46N51W 44N45W 47N55W WINDS 30 TO 40 KT.
forecastDetails	.24 HOUR FORECAST WITHIN 48N56W 46N41W 46N53W 46N47W 48N47W 53N49W 56N52W 48N56W. WINDS 30 TO 40 KT. 48 HOUR FORECAST WITHIN 49N57W 47N42W 47N54W 47N48W 49N48W 54N50W 57N53W 49N57W. WINDS 30 TO 45 KT.

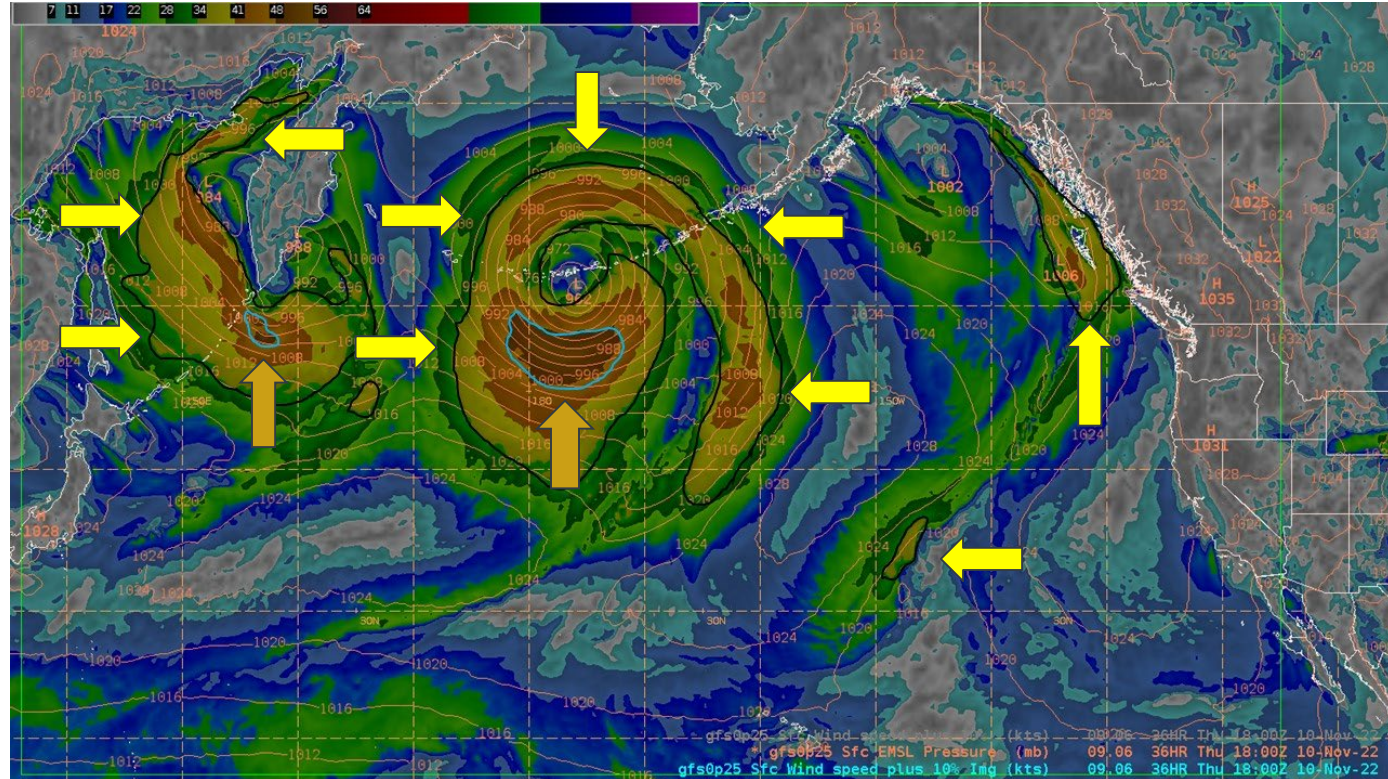




Need to Serve Mariners with 21st Century Information



*GFS 36-hour
forecast, valid
November 10,
2022, 18 UTC*



Save the Date!

- A great opportunity for forecasters and researchers that specialize in marine weather and associated hazards to interact and learn from industry partners and customers in-person and virtually.



MARINERS' WEATHER HAZARDS WORKSHOP
16-18 APRIL, 2024

nwsmarinersworkshop@noaa.gov
5830 University Research Court
College Park, Maryland 20740-3818

TOPICS TO BE COVERED

- SEA ICE & FREEZING SPRAY**
 - Freezing Spray impacts
 - Sea ice forecasting
 - Speakers from US Coast Guard
- EXTRATROPICAL CYCLONES**
 - Climatology
 - Impacts to Port Operations
 - Forecaster approach to high impact storms
- MARINE FORECASTING**
 - NWS Products and Services
 - High Seas Forecast
 - Guest speaker from the National Ocean Service

ABOUT OUR WORKSHOP

In an effort to provide the world's best marine weather forecasts the Ocean Prediction Center invites you to participate in a three day hybrid Mariner's Weather Hazards Workshop Spring 2024!

The workshop is geared toward a wide spectrum of marine users from crabbers to cruise ships from the tropics to the arctic. Operational meteorologists hope to gain a deeper understanding for the maritime community so that we may continue to work towards protecting life and property at sea.



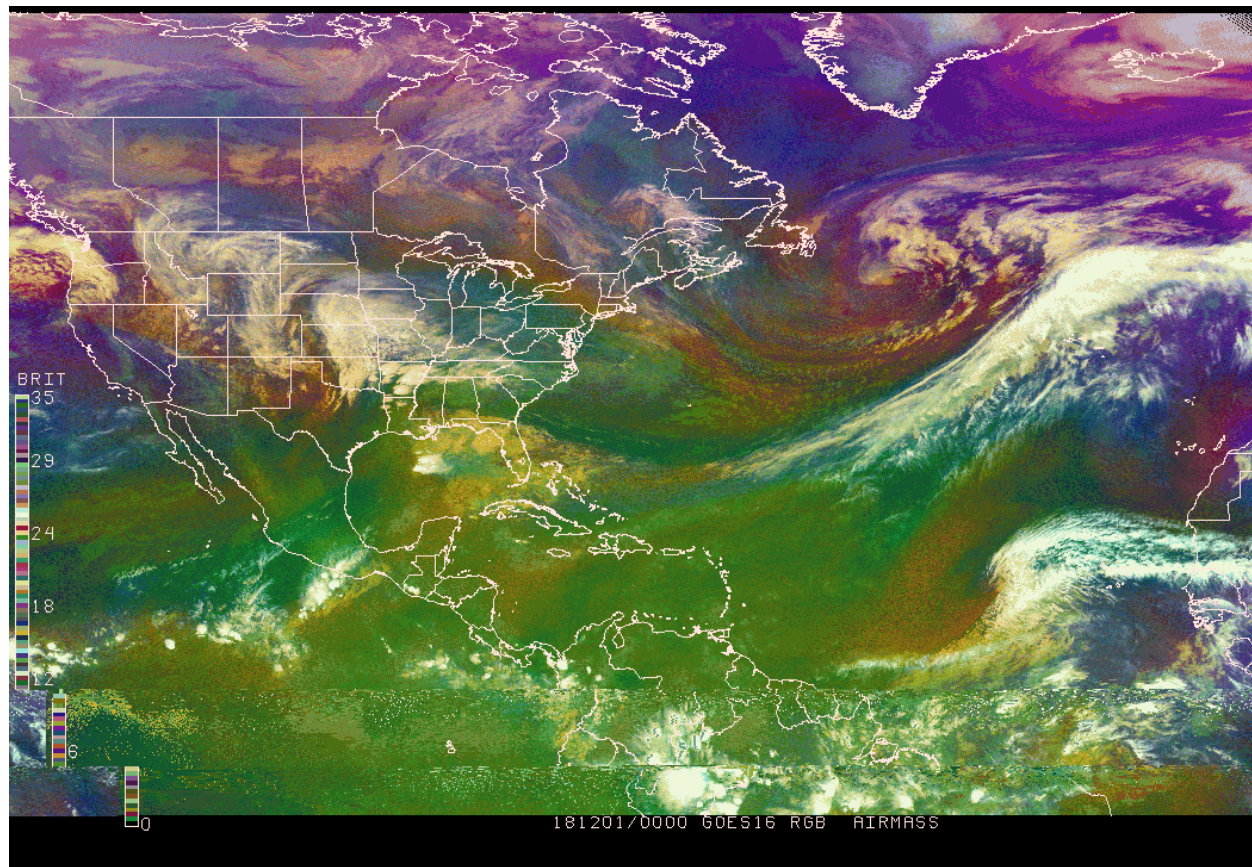


Thank you!



Michael Folmer

michael.folmer@noaa.gov



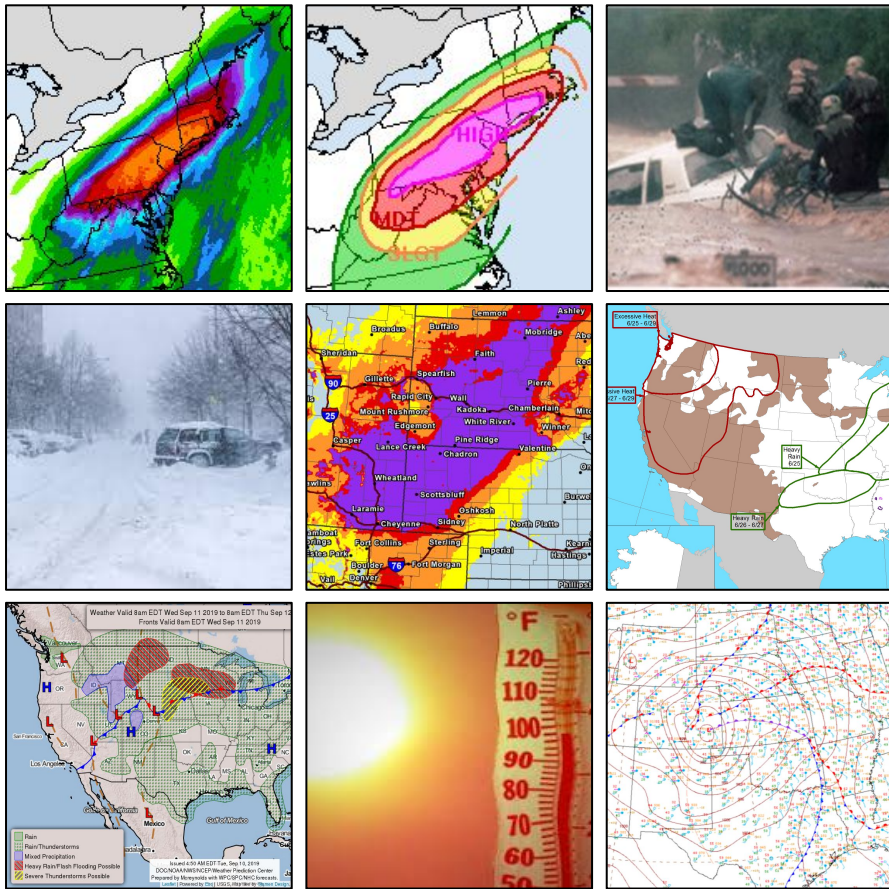
Overview of the Weather Prediction Center

Alex Lamers, Warning Coordination Meteorologist
NOAA/NWS Weather Prediction Center

2024 National Hurricane Conference

March 26, 2024 | Orlando, FL

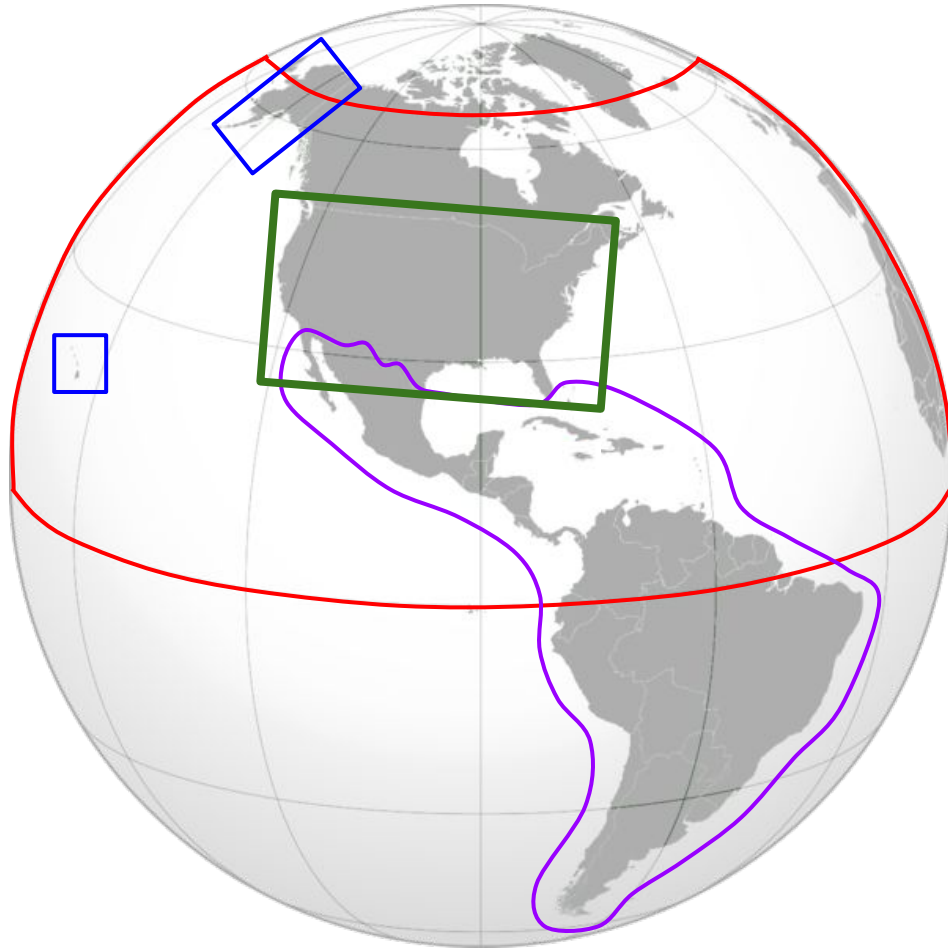




What do we do?

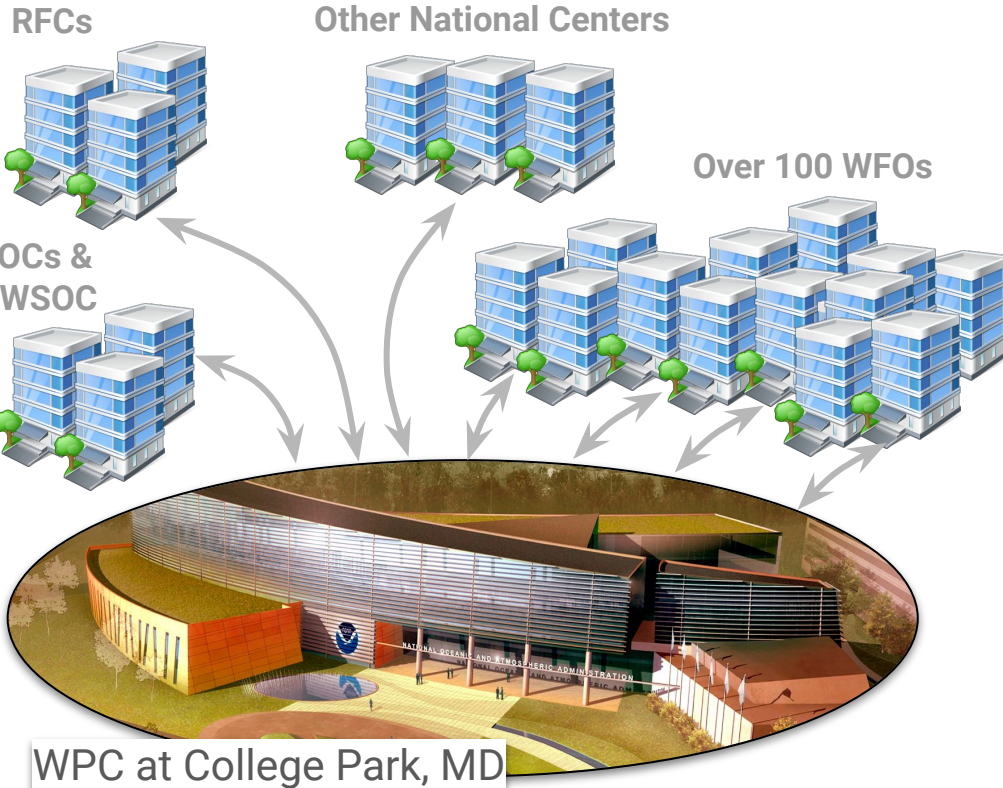
- Short answer: a lot!
- Precipitation¹ forecasting expertise including rainfall and snow/ice
- Growing role in extreme² temperatures, from heat to cold
- Foundation of the national weather story³
- Continuing the 150+ year legacy of surface weather map analysis
- Backup for Nat'l Hurricane Center

Where do we do it?



- CONUS: multitude of forecasts
- OCONUS: Alaska medium range and Hawaii forecast discussion
- Tropical cyclone rainfall statements with NHC and CPHC
- International Desk trains forecasters from Central and South America and the Caribbean

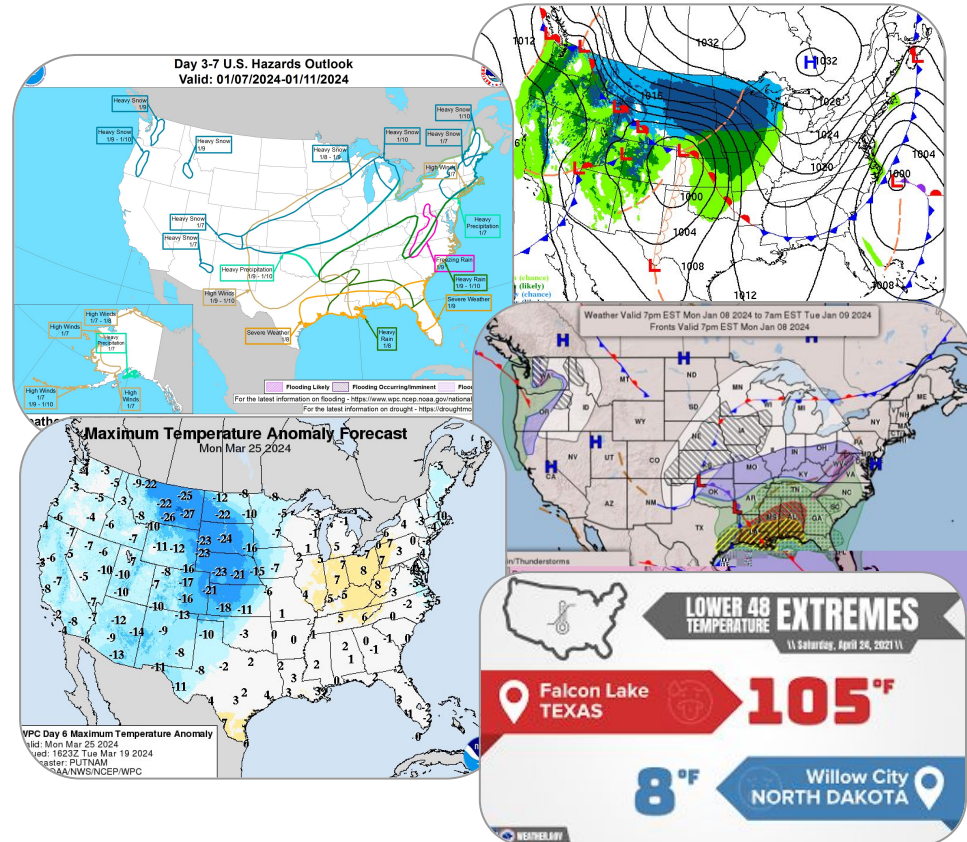
Nerve Center for National Weather Coordination



- On any given day we are in communication with just about every field office around the country
- In particular, collaboration focused on precipitation
- Fundamentally, there are inputs from all levels of the agency in the products you see on our website
- Co-located with OPC, NWS Ops Center, and NWS Senior Duty Meteorologist

Foundation of the National Weather Story

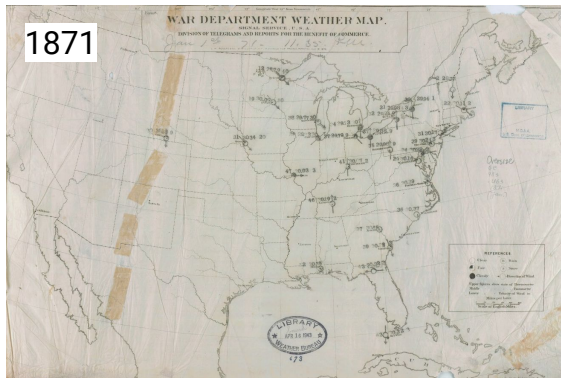
- Basic weather maps and forecast charts that show the expected weather and major fronts and pressure systems
- Hazardous weather outlooks that synthesize official forecast information from other NWS centers and sources
- Contextual information such as potential temperature records and anomalies
- National extremes and summaries of major weather events



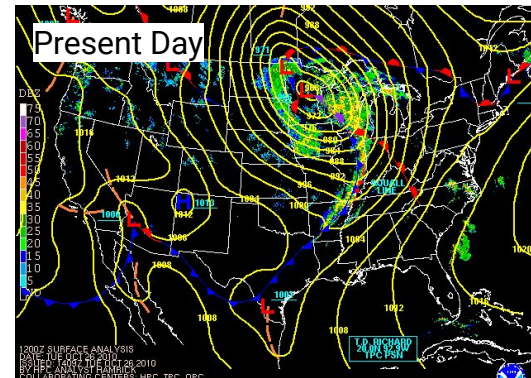
Deep Roots Mapping the Nation's Weather



HOW IT STARTED



HOW IT'S GOING



Signal Service Office in
D.C. (1872)



It's **IN OUR DNA** to bring together many bits of information into a **coherent national weather story**. You can trace this practice back over 150 years to the U.S. Army Signal Service and an early Smithsonian observing network that got its start in the 1840s.

Motivation and Mission

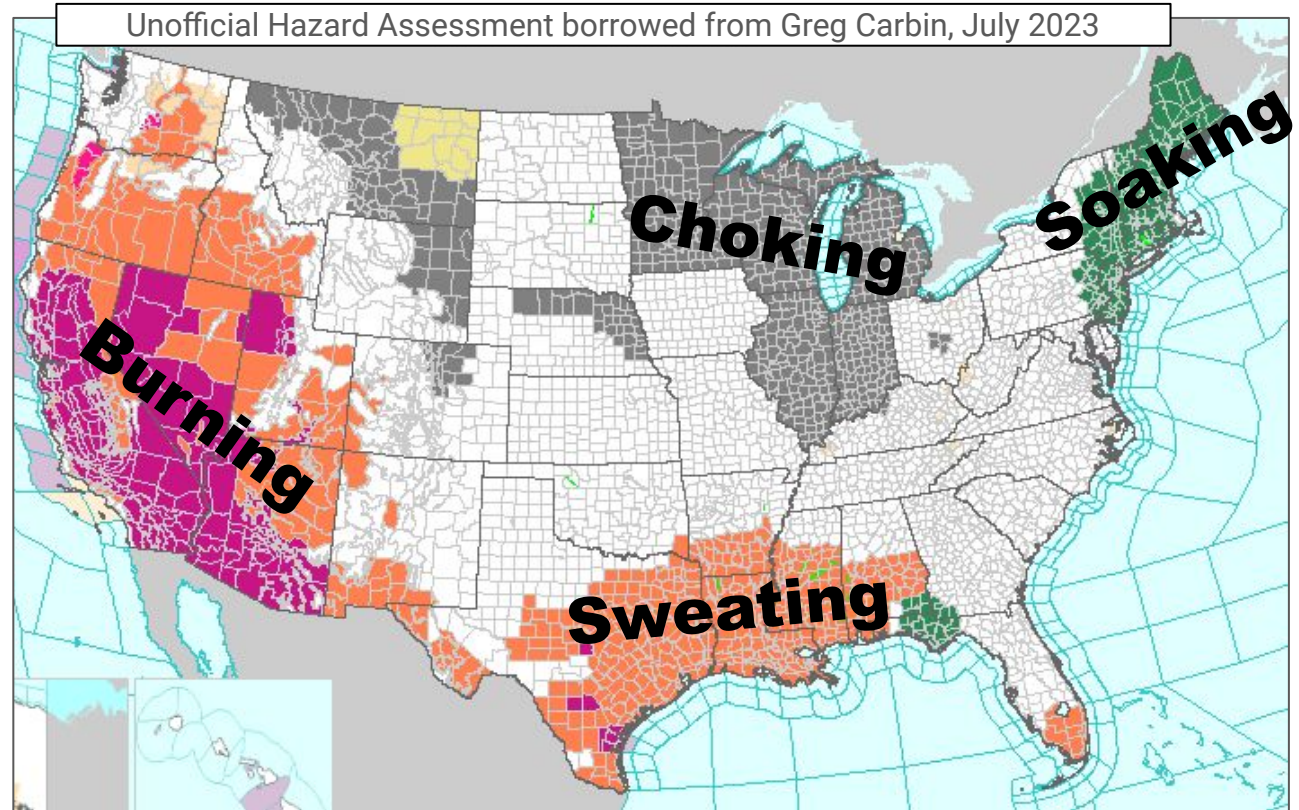
U.S. Leading Cause of
Weather-Related Fatalities
*(NWS and CDC stats agree, although not
exact numbers)*

Extreme Temps

Next Highest Cause of
Weather Fatalities (NWS)

Flooding

From new WPC roadmap:
we “champion the
prediction of **rain storms,**
winter storms, and
extreme temperature
events for the protection
of life and property”

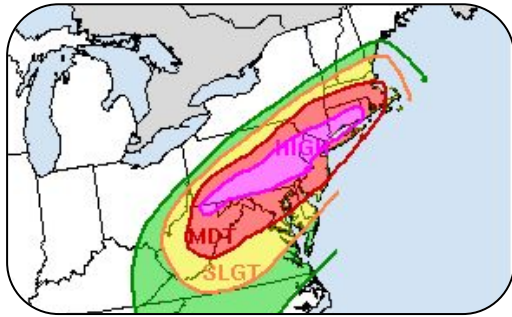


Helping You Find The Problem Spots

This is just the tip of the iceberg! We have more products that are focused on extreme precipitation and temperatures.



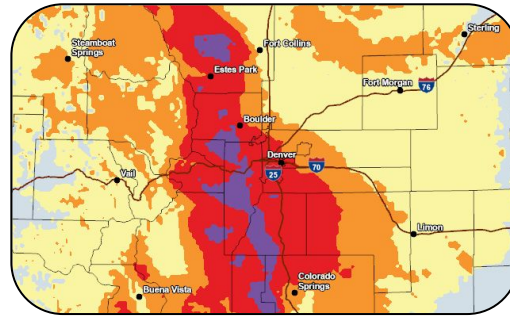
Excessive Rainfall Outlook



Translating rainfall forecast into a likelihood of flash flooding, based on factors like rainfall rate, preceding rain, historical context.



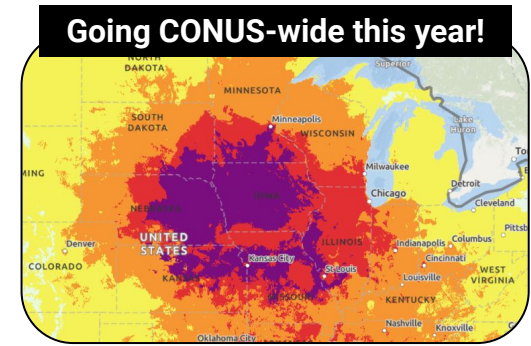
Winter Storm Severity Index



Translating the official NWS forecast of snow, ice, wind, etc. into a potential societal impact – in other words, how disruptive?



HeatRisk



Translating the official NWS temperature forecast into how unusual this level of heat is. Correlated with health impacts.

Advancing Probabilistic Forecasting



Probabilistic Precipitation Portal

PROTOTYPE: Page under development. Not for operational use.

CONUS: Contiguous US

About

Quantitative Precipitation Forecast

Includes rainfall, plus the liquid equivalent of any frozen precipitation

Snowfall Forecast

Includes sleet accumulation, but excludes ice

SCENARIOS

Expected Amount

Official National Weather Service forecast

High End Amount

1 in 10 chance (10%) of higher amounts

Low End Amount

9 in 10 chance (90%) of higher amounts

EXCEEDANCE PROBABILITIES

At least 0.1 inches

At least 1 inch

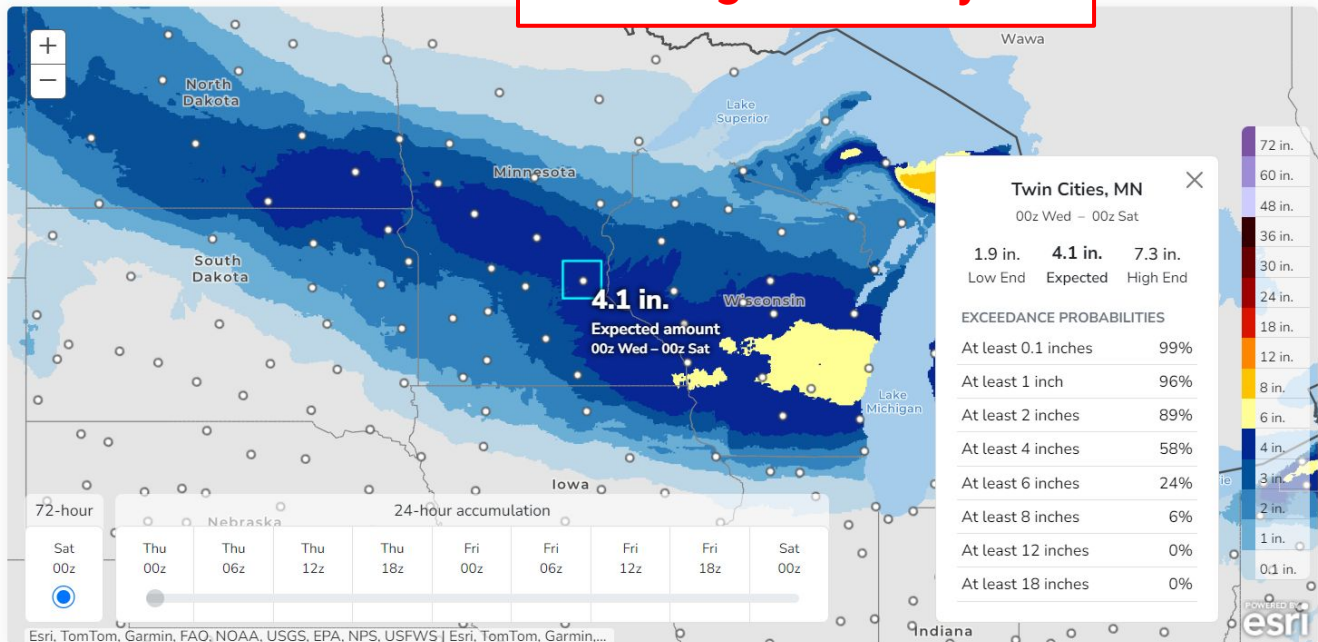
At least 2 inches

At least 4 inches

Expected Amount of Snowfall

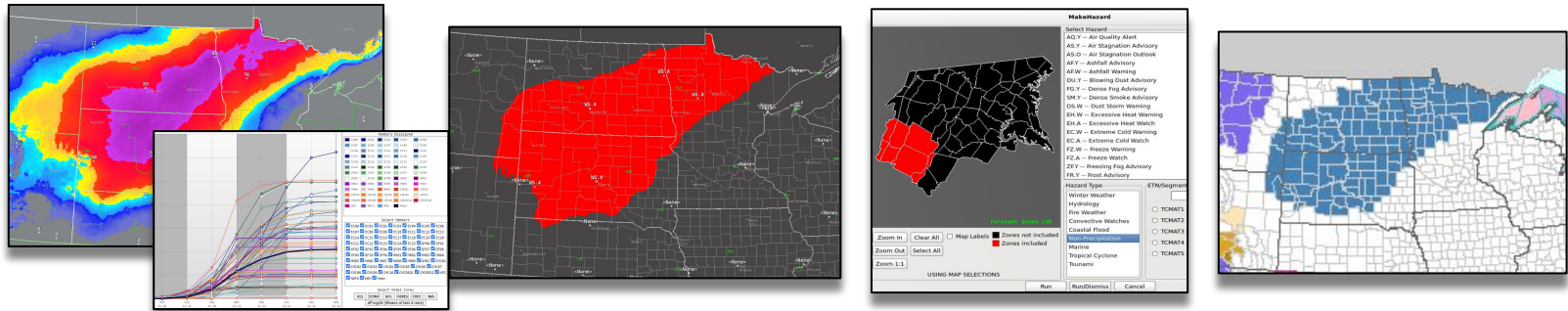
72-hour accumulation: 00z Wed, Mar 20 to 00z Sat, Mar 23

Debuting later this year!



Probabilistic Approaches to Hazard Decisions

Collaborative Winter Storm Watch Experiment testing a methodology for Watch area recommendation from WPC to local NWS forecast offices...



WPC leverages ensemble info...

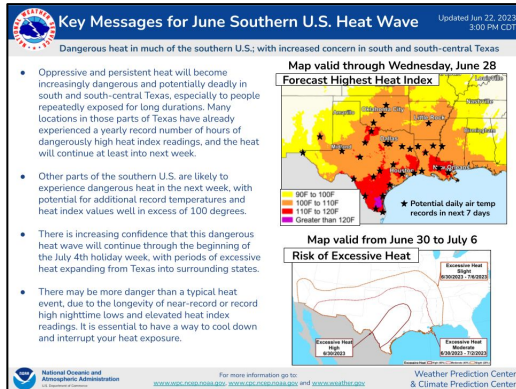
...to produce a first guess area.

WFOs use it for collaboration and decisions...

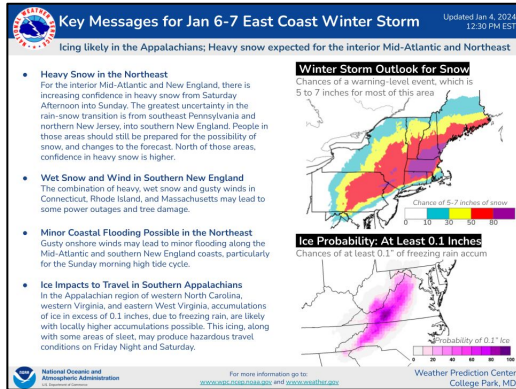
...resulting in consistent final common picture

The goal is to leverage the strengths of ensemble systems and WPC winter expertise and pair it with local decision-making and understanding at a critical juncture pre-event

Key Messages Graphics



- Available now for winter storms, cold snaps, heat waves
- Heat graphics integrated into Heat.gov
- Collaboration across time scales with the Climate Prediction Center for longer lead time
- Aiming for regional-scale, warning-level events

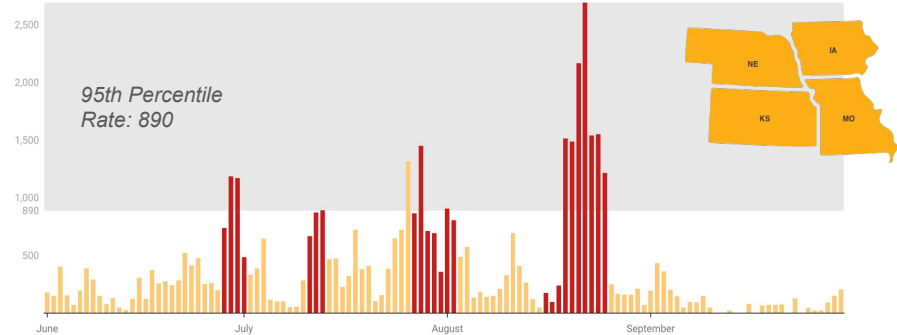


Impact verification:
we DID see major spikes in heat emergency department visits when we had Key Messages in effect.

Example for HHS Region 7 to right.

Heat-Related Emergency Department Visit Rates (per 100,000) in 2023 in HHS Region 7

HHS Region 7: Iowa, Kansas, Missouri, Nebraska



Stay Engaged! How to Get In Touch...

- We want to hear from you!
- What works and what doesn't?
- Ongoing social science study of our web page and precipitation products to improve user experience
- Do our synthesis products tell you what you need to know about the national weather story?
- What do you need to be ready for extreme temperatures and precipitation?
- What lead times do you need for major preparedness actions for those types of events? Studies for hurricane evacuations, but more opaque to us for other situations.

QR Code: Digital Business Card with my Contact Info



Alex Lamers
alex.lamers@noaa.gov

Operations at the National Water Center

Jason Elliott

*Service Coordination Hydrologist, Water Prediction Operations Division
Office of Water Prediction | National Water Center*

Office of Water Prediction / National Water Center

- The Office of Water Prediction (OWP) operationally supports and delivers science-based, integrated, consistent, timely, reliable and accurate operational water resources monitoring, prediction and diagnostic information to the Nation.

Key Functions

- National Water Model
- Visualization Services
- Validation and Development
- Emerging Services & Training
- Operations and Decision Support Services
- ...and more!



NWC Operations

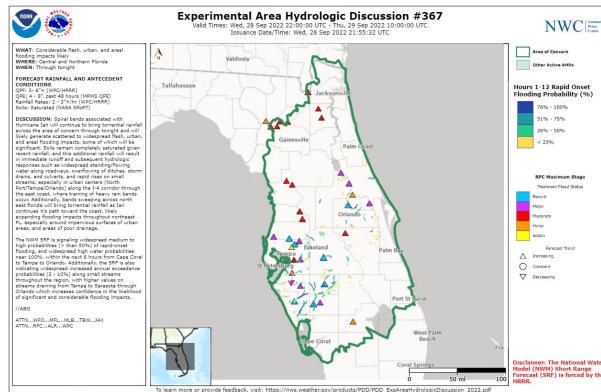
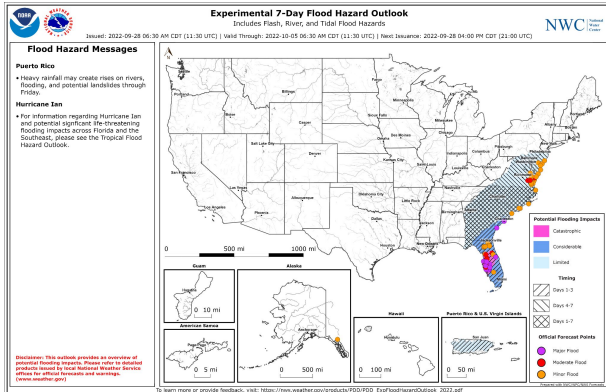
- The role of the Operations Division within the National Water Center is to determine, coordinate, and deliver the National-level hydrologic picture
 - We do this through products and services, mostly still experimental
- Current operating hours:
5:00 AM CT → 8:30 PM CT (can extend)
- Current staffing (about $\frac{2}{3}$ of 'full' staffing):
 - 2 Senior Hydrologists
 - 4 Lead Hydrologists
 - 7 Hydrologists
 - 2 Winter/Remote Sensing Scientists
 - 3 GIS Specialists
 - 2 Technical Support Staff
 - 4 Managers



NWC Public Products (currently experimental)

<https://www.weather.gov/owp/operations>

Flood Hazard Outlook FHO	Area Hydrologic Discussion AHD	Nat'l Hydrologic Discussion NHD
National overview of potential flood impacts in the next seven days	Localized overview of areas with rapid onset flood potential in the next 0-18 hours	Descriptive narrative of current and forecast hydrologic conditions during the next ten days



National Hydrologic Discussion - EXPERIMENTAL
NWS National Water Center - Tuscaloosa AL
1015 AM CDT WED SEP 28 2022

Synopsis...
Hurricane Ian likely to produce widespread considerable flooding impacts across the Florida Peninsula, southern Georgia, and coastal South Carolina, and limited impacts across portions of the Southeast and southern Mid-Atlantic. Localized flooding impacts possible in Puerto Rico...

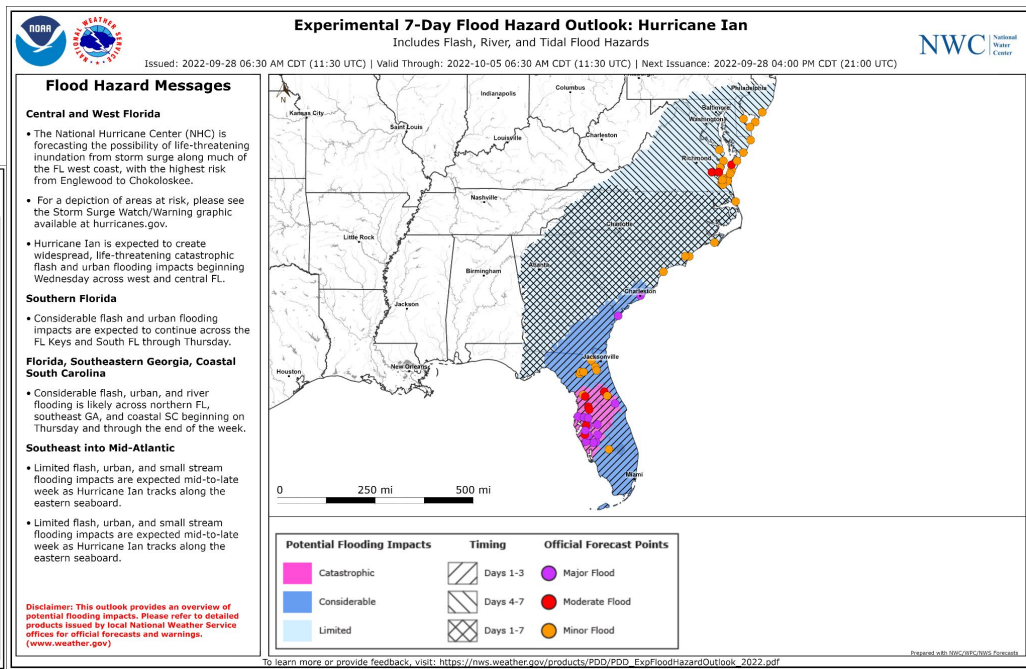
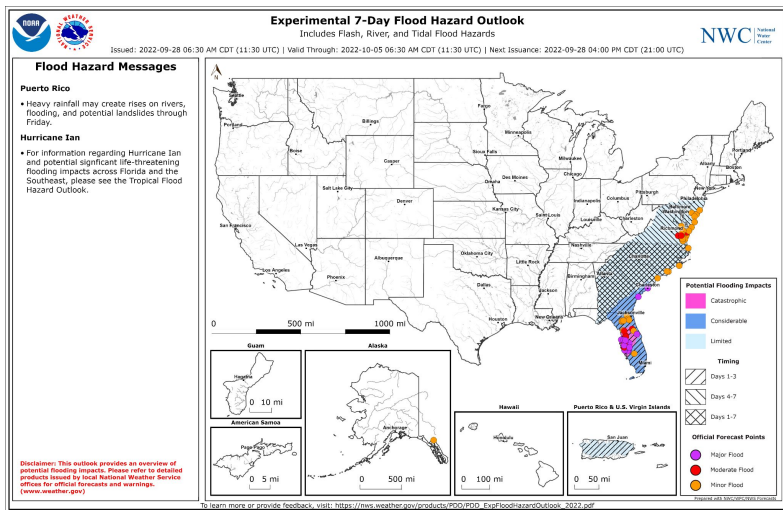
Discussion...

Hurricane Ian...
Hurricane Ian will continue impacting much of central and southern FL today and will generate moderate to major river flooding, including record major flood forecasts across portions of the Southeast later this week based on the latest forecast from the NHC. Despite some remaining uncertainty in Ian's forecast track, confidence is high for catastrophic life-threatening flooding impacts for portions of central FL, considerable flooding impacts for the rest of the FL Peninsula, southern GA, and coastal SC, and limited flooding impacts across much of the Southeast and southern Mid-Atlantic. The latest OFF from WPC indicates rainfall associated with Ian will continue over the Florida Keys, South FL and throughout much of the Peninsula through day 2 (Thu) and spread further into the Southeast and southern Mid-Atlantic late on day 2-5 (Thu-Sun). Rainfall amounts continue to be better agreed ahead of Ian's pending landfall; current forecast rainfall amounts from WPC include 12-18" with local amounts up to 24" for central and northeast FL, 6-8" for the FL Keys and south FL, and 4-8" for eastern GA and coastal SC. With two feet of rainfall possible in the central portion of FL, any municipality's storm sewer system will be challenged and hydrologic impacts will likely be felt in urban, suburban, and exurban environments outside of floodplains.

The National Hurricane Center is also forecasting the possibility of life-threatening inundation from storm surge along much of the FL west coast, with the highest risk from Marco Island to Tampa Bay. For a depiction of areas at risk, please see the Storm Surge Watch/Warning graphic available at hurricanes.gov.

Flood Hazard Outlook (Experimental)

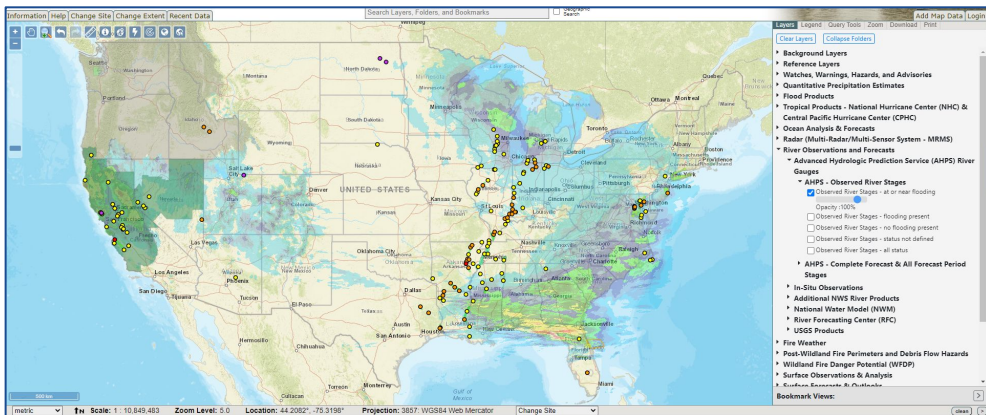
- Issued (soon to be) twice daily – at 4 PM / 7 AM CDT; 3 PM / 7 AM CST
- During tropical operations, a specially-zoomed visualization of the outlook, with further detailed Flood Hazard Messages, is also produced at the same times



Experimental Services (Publicly available)

NWS GIS Viewer

<https://www.weather.gov/owp/operations>



- Both the suite of NWC Visualization Services and the publicly-available inundation mapping services are available through the NWS GIS Viewer

<https://viewer.weather.noaa.gov/water>






National Water Center Products and Services

Operational and Experimental
[Weather.gov > Office of Water Prediction > National Water Center Products and Services](#)

Office of Water Prediction
National Program

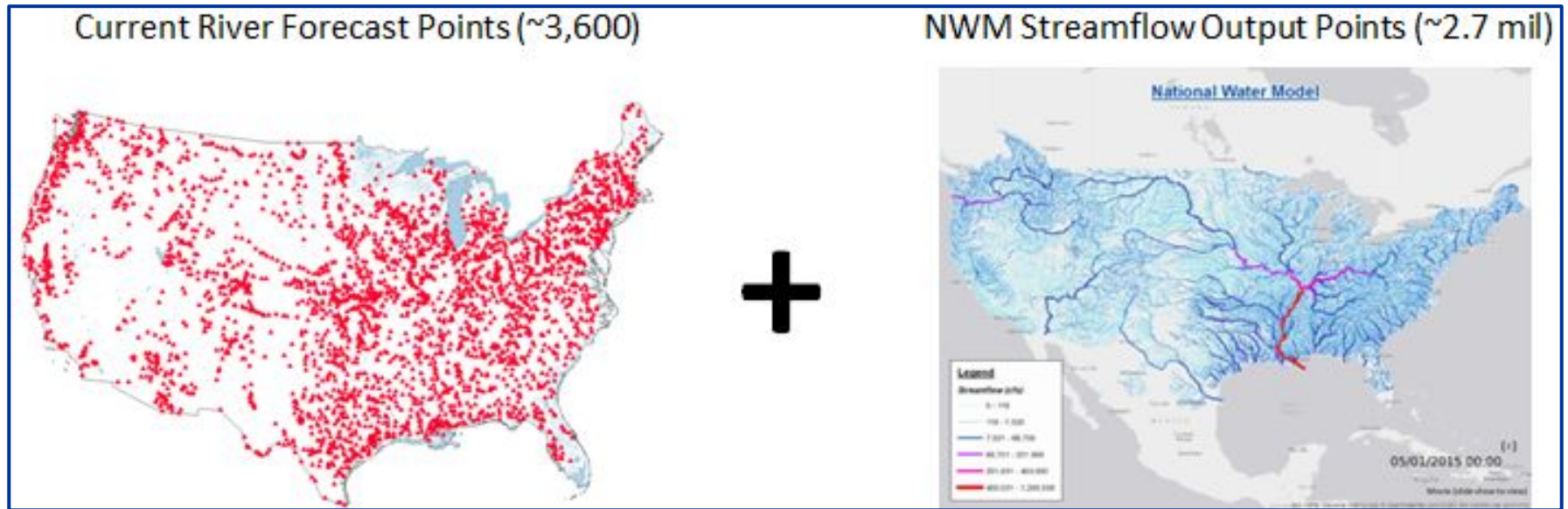
NWC

2023 National Hydrologic Assessment

-  **Area Hydrologic Discussion**
Experimental short range, episodic, discussion and graphic which highlights locations across the nation that may be impacted by rapid-onset flooding, using National Water Model and other guidance.
AHD Product Description Document
Provide Feedback on AHD
AHD One-Pager
-  **Flood Hazard Outlook**
High level graphical depiction and key messages highlighting the potential threat of inland flood hazards (flash, urban, small stream and riverine) and their associated impacts (catastrophic, considerable, and limited) for the next seven days.
FHO Product Description Document
Provide Feedback on FHO
FHO One-Pager
-  **National Hydrologic Discussion**
Experimental discussion of the current and forecast hydrologic conditions across the nation, including a variety of short and medium range (Days 1-10) observed and modeled hydrologic guidance.
NHD Product Description Document
Provide Feedback on NHD
NHD One-Pager
-  **Significant River Flood Outlook**
Operational flood outlook intended to provide a general outlook for significant (moderate and above) river flooding. It is not intended to depict all areas of minor flooding or small-scale events such as localized flooding and/or flash flooding.
-  **NWC Visualization Services**
Experimental geospatial services depicting forecasts from the River Forecast Centers and the National Water Model. Services available via the prototype NWS National Map Viewer, or directly via URLs hosted on the Hydrologic Visualization and Inundation Services (HydroVIS) cloud resource. Refer to the [HydroVIS Product Description Document](#) for details.
NWC Visualization Services River Forecast Center Product Description Document
-  **NEW! - Flood Inundation Mapping (FIM) Services - NEW!**
Experimental services depicting the extent of predicted inundation, as derived from River Forecast Center forecasts and National Water Model analyses and forecasts. Services are available via the [Viewer](#) or directly via URLs hosted on the Hydrologic Visualization and Inundation Services (HydroVIS) cloud system. These services are currently only available for an area that includes 10% of the U.S.

National Water Model

- NWM is a hydrologic model that simulates observed and forecast **streamflow**
- *Complements* official NWS river forecasts provided at approximately 3,600 locations across the CONUS with a very fine spatial and temporal scale and a large spatial coverage (3.2 million river reaches/3.6 million river miles)



National Water Model Operational Cycles

- Visit <https://water.noaa.gov/about/nwm>



Lookback Range 3-28 hrs

*Including open loop
(non-DA) members*



18 Hour Forecast

~10 Day Ens Forecast

*Including open loop
(non-DA) member*

30 Day Ensemble Forecast

**Hawaii* /
Puerto Rico USVI***
**3 Hour Lookback
48 Hour Forecast**
HIRES ARW/NAM-NEST/MRMS

Alaska
**3 Hour Lookback
48/240 Hr Forecasts**
HRRR, GFS, NBM, MRMS

***Coastal Total Water Level**

Map Legend

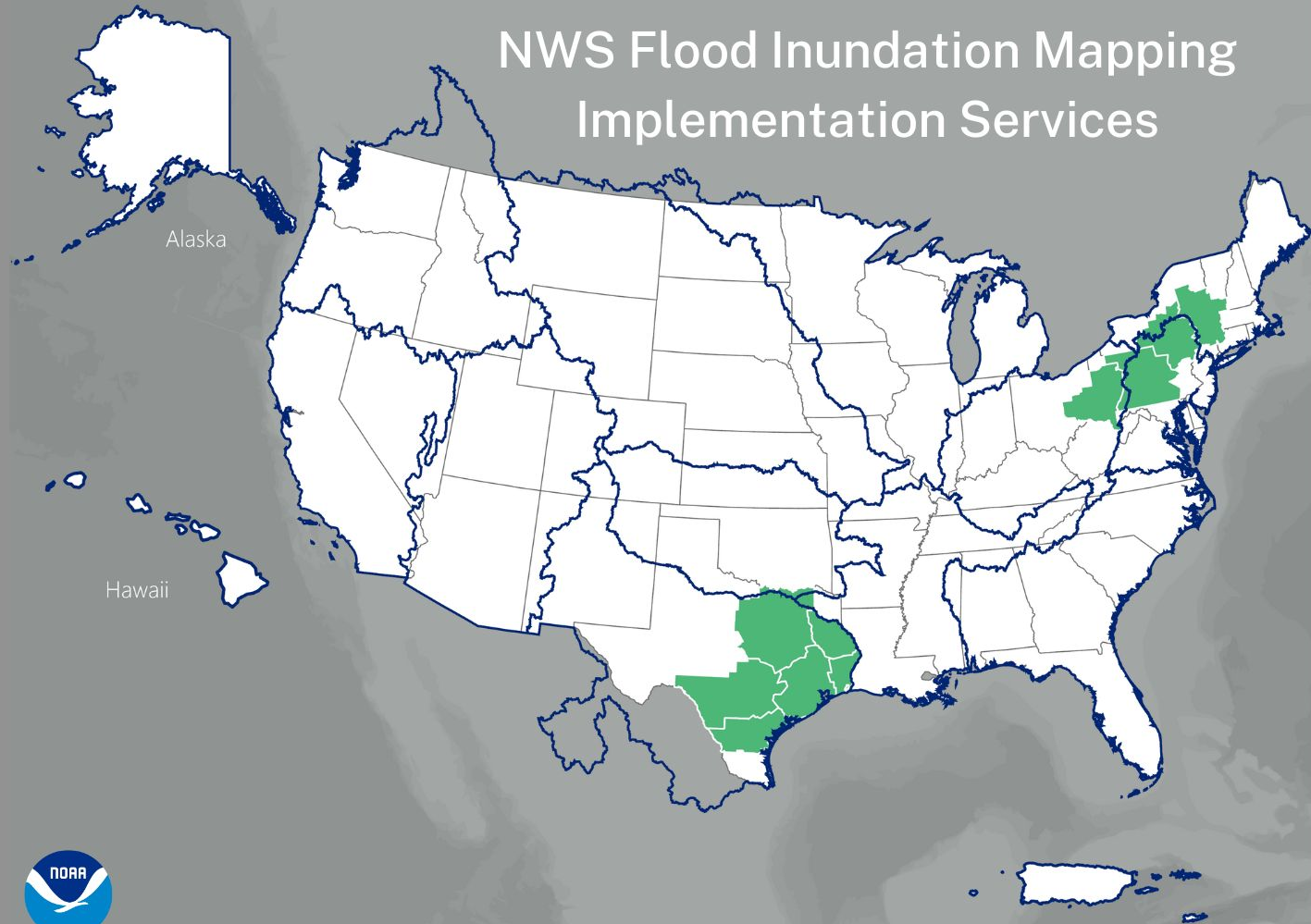
10%

Population served by
October 2023.

NWS County Warning
Areas

NWS River Forecast
Center Boundaries

NWS Flood Inundation Mapping Implementation Services

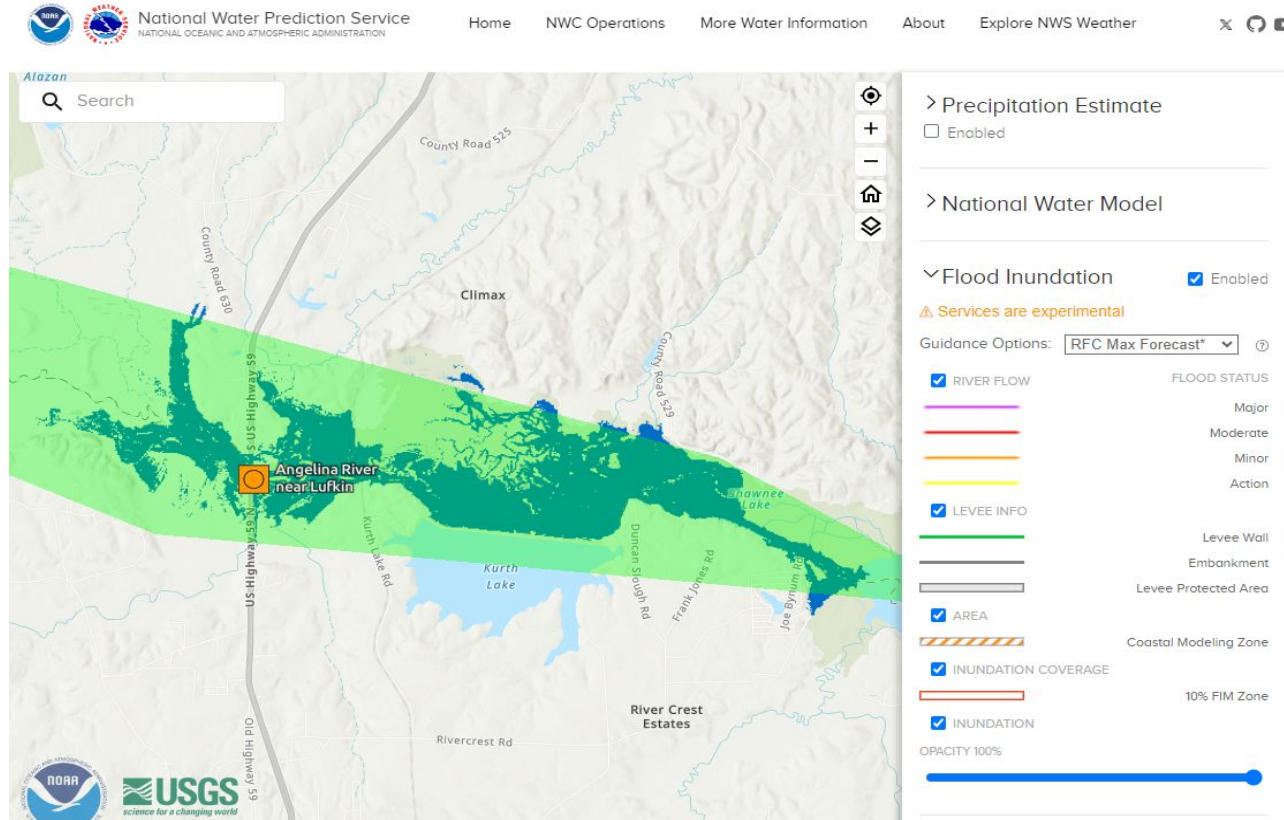


Over the next 3 years, the **National Weather Service's National Water Center** will work in coordination with **NWS River Forecast Centers, Weather Forecast Offices,** and other Federal partners to release forecast flood inundation mapping services to the Nation.



National Water Prediction Service

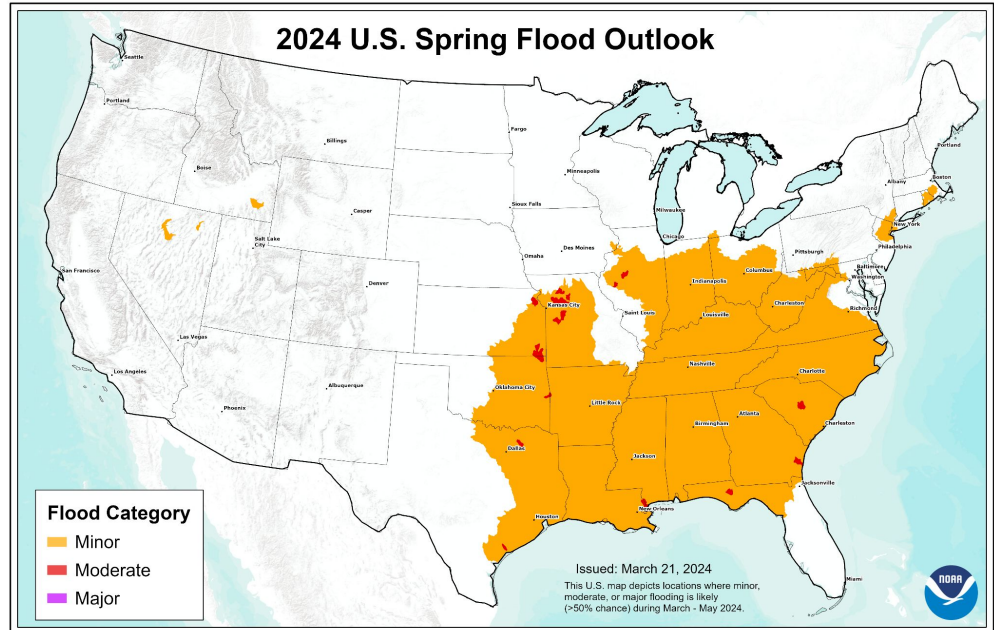
- Coming tomorrow!
- New, modernized viewing platform for all NWS hydrologic information
- Will include the experimental FIM services currently on the NWS GIS Viewer
- *Join us tomorrow for additional info*



Other NWC Operations Functions

- Include, but are not limited to:
 - The annual NOAA National Hydrologic Assessment
 - Service Status Monitoring
 - Review of Flood Inundation Mapping for intel
- Coordination with other federal agencies in the water space
- Interaction with the remainder of the NWS (field & National centers)

- New initiatives under development include longer-range products and water resources operations and products



We are on NWSChat, powered by Slack!

- **Search for national-water-center**
- **Channel is open to all to join**
- **Products post here routinely, along with occasional other items**
- **Local needs are best served by your local NWS office; we are available for larger scale needs**

national-water-center Public channel for OWP's National Water Center for external collaboration and product moni...

559 🔒 Canvas

Yesterday

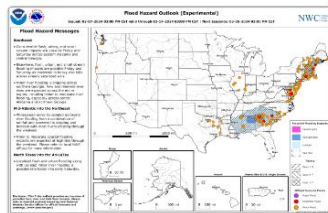
WxBot APP 9:27 AM
National Weather Service Issues Hydrometeorological Discussion

Untitled

```
1 AGUS74 KNCO 071526
2 HHDNHC
3
4 National Hydrologic Discussion - EXPERIMENTAL
5 NWS National Water Center - Tuscaloosa AL
```

NWC-Products WORKFLOW 2:37 PM
National Water Center Issues: National Flood Hazard Outlook (experimental)
https://www.weather.gov/images/owp/FHO/National/Archive/National_FHO_2024-03-07T14:35:06.png (edited)

(3 MB)



Today

NWC-Products WORKFLOW 6:15 AM
National Water Center Issues: Area Hydrologic Discussion 0054 (experimental)
https://www.weather.gov/images/owp/AHD/Archive/AHD_2024-03-08T06:12:11.png (edited)

(548 kB)



Product-only channel also available (no chats): **[national-water-center-datafeed](#)**



OWP | OFFICE OF
WATER
PREDICTION



Thank You!



Jason Elliott



jason.elliott@noaa.gov



<https://water.noaa.gov>

***TC TORNADO BASICS and
SPC GUIDANCE
Roger Edwards and Matt Elliott***

***Storm
Prediction
Center***

Norman, Oklahoma

***National Hurricane Conference
26 March 2024***



TC TORNADO FACTS & CLIMATOLOGY

- **MOST COMMON: Outside 50-kt wind radius**
- **NNW-NE-SE of center (deep-shear-related)**
- **Most common and damaging from mini-supercells**
- **Occasionally reported from non-supercell radar features (weak – EF0-EF1)**
- **Sharp decrease >500 km from coasts**
- **Clear diurnal preference, but still occur at night**
- **Occur over water and can move ashore**
- **In every stage of classification (MH, H, TS, TD, low)**
- **Detailed discussion in Edwards (2012), EJSSM
Still valid w/some new research since**

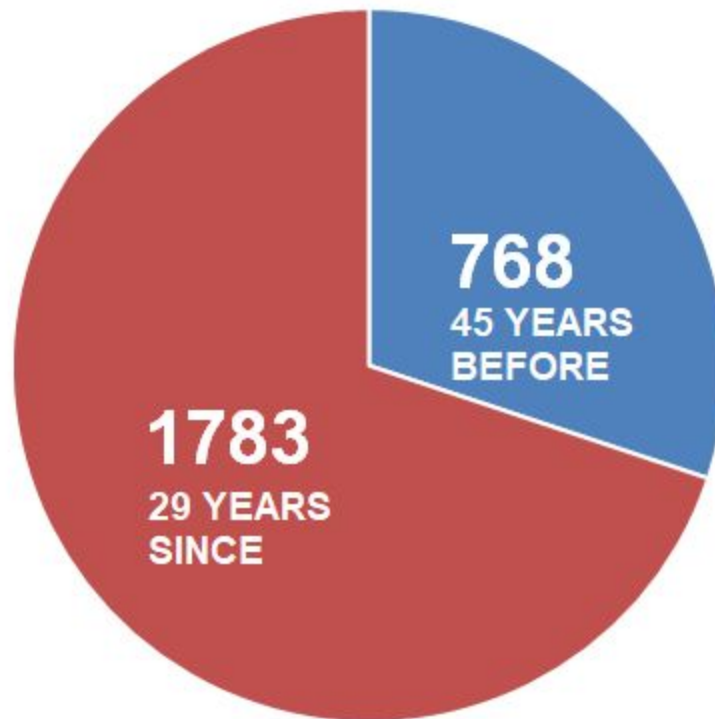
TC TORNADO FACTS & CLIMATOLOGY

WSR-88D and
SPC TCTOR era:
1995 onward

Many more weak TC
tornado reports,

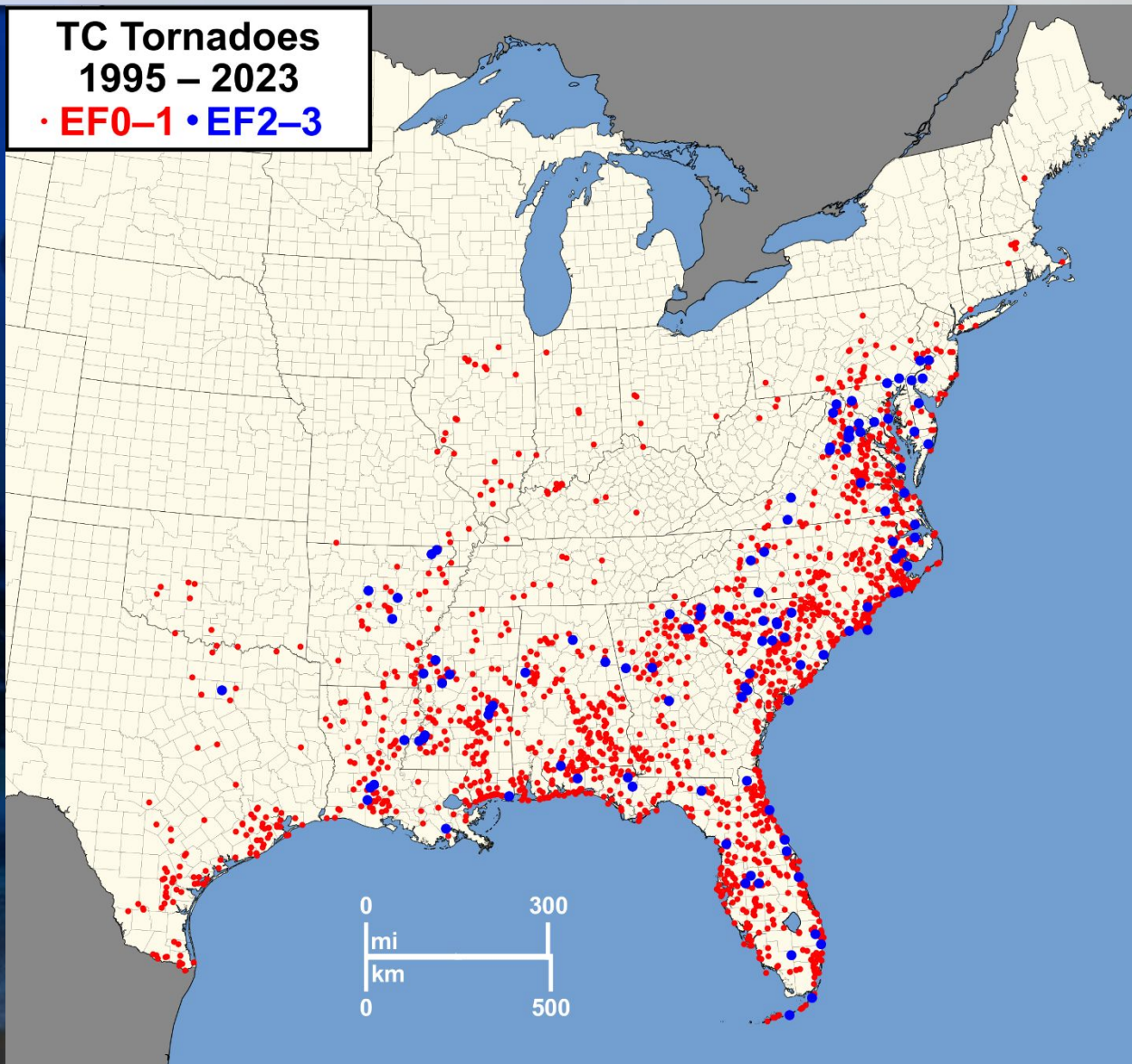
Many more TC tornado
reports TOTAL

**TC Tornado Record:
before/since WSR-88D**



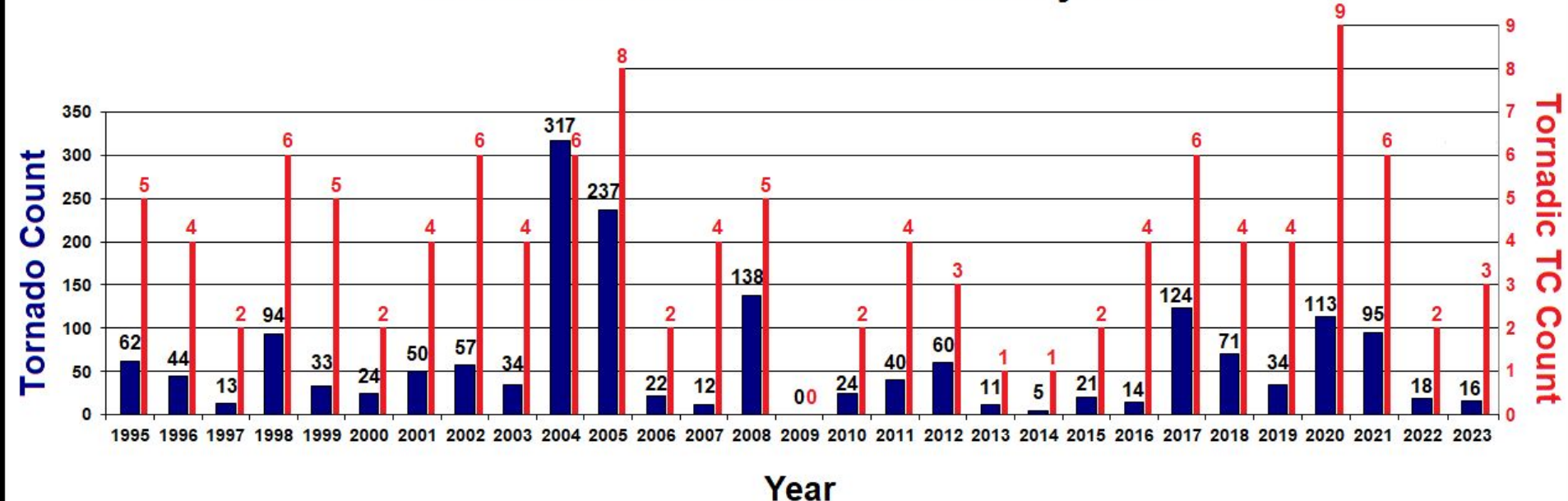
Pre-88D data from Schultz and Cecil
(2009)

TC TORNADO FACTS & CLIMATOLOGY



TC TORNADO FACTS & CLIMATOLOGY

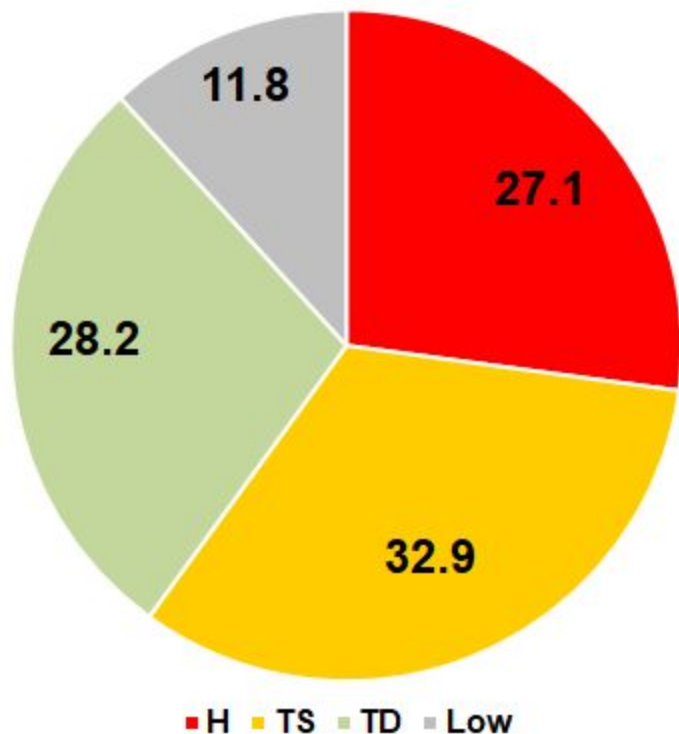
TC Tornadoes and Tornadoic TCs by Year



Highly variable year-to-year in WSR-88D era

TC TORNADO FACTS & CLIMATOLOGY

**TC Tornadoes by
Classification at Tornado
Time: 1995–2023 Percent**



***TCTOR DATA:
TC strength at
tornado time
(from HURDAT)***

TC TORNADO FACTS & CLIMATOLOGY

TROPICAL CYCLONE	YEAR	TORNADO REPORTS
H Ivan	2004	118
H Beulah	1967	115
H Frances	2004	103
H Rita	2005	98
H Katrina	2005	59
H Andrew	1992	56
H Harvey	2017	52
TS Fay	2008	50
H Gustav	2008	49
H Georges, TS Cindy	1998, 2005	48

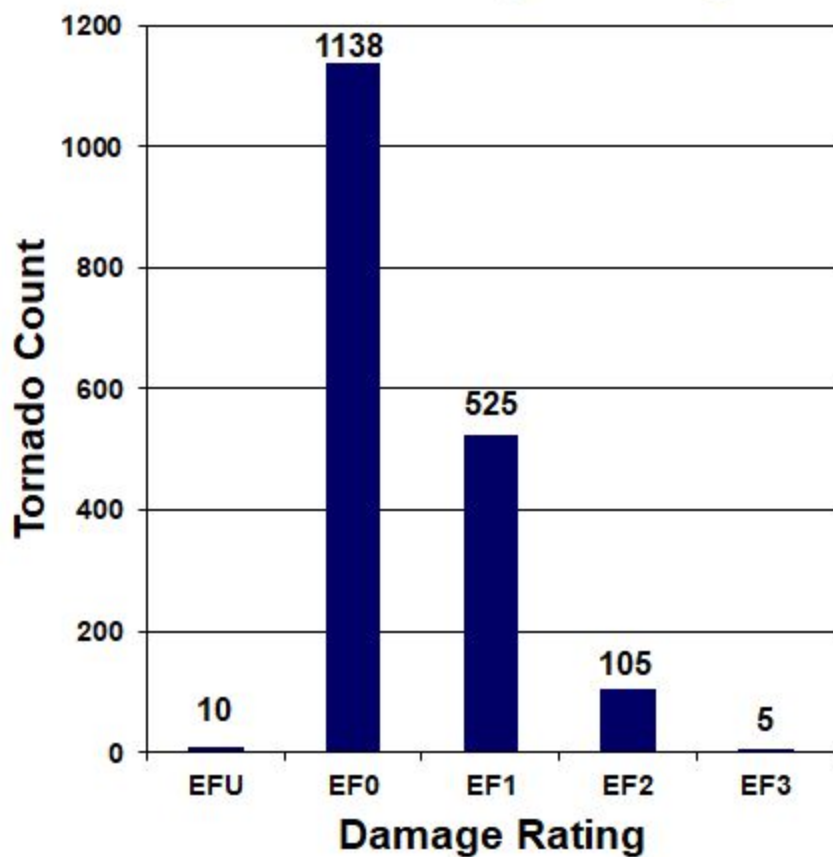
TOP-10 LIST

**From TCTOR
and pre-1995
formal
references**

**Peak
classification**

TC TORNADO FACTS & CLIMATOLOGY

**TC Tornadoes
1995–2023 by Rating**

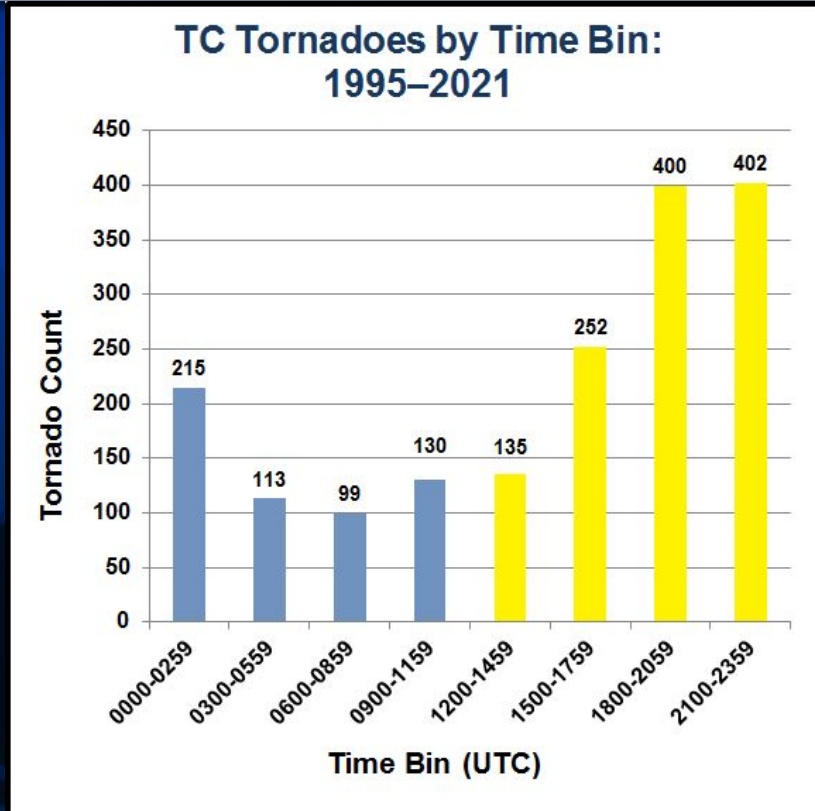


(E)F-scale rating

**NOT “TORNADO
INTENSITY”**

(Edwards et al. 2013
damage-rating
paper, BAMS)

CLIMATOLOGICAL APPLICATION TO FORECASTING CONCEPTS



DAYTIME
FAVORED

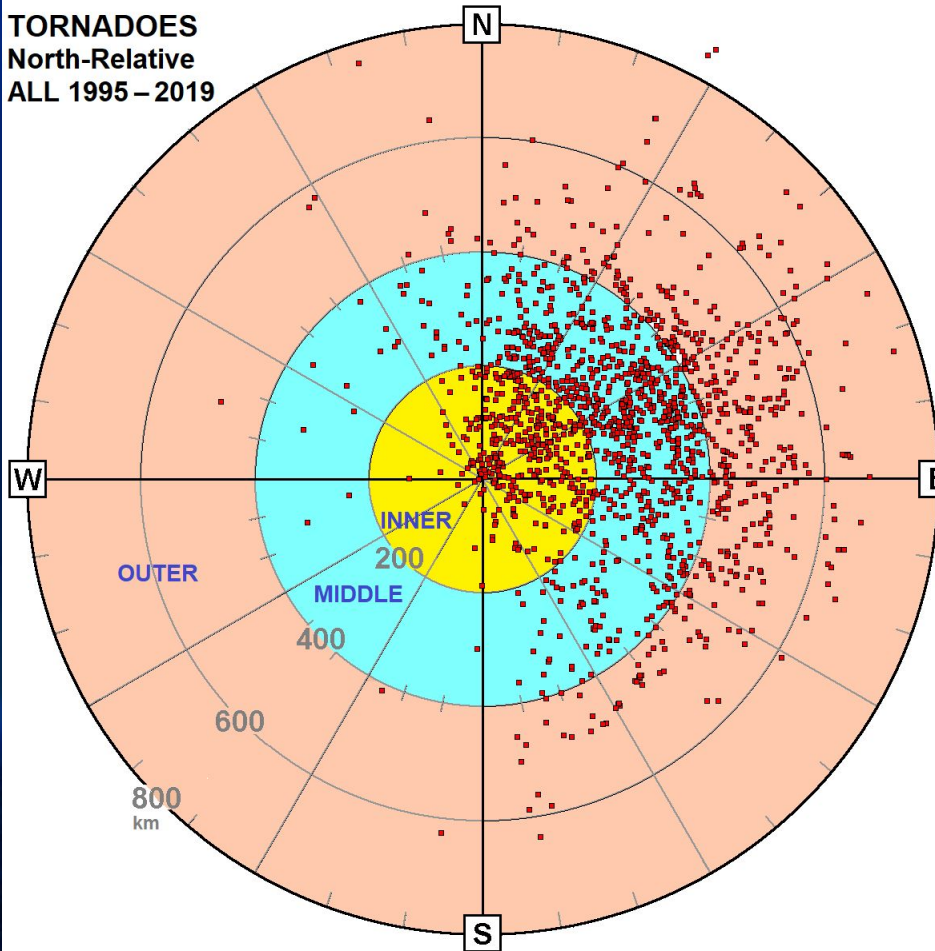
PHYSICAL BASIS BEHIND CLIMATOLOGY:

In deep moist environment, subtle warming under cloud cover or in clear slots greatly increases CAPE.

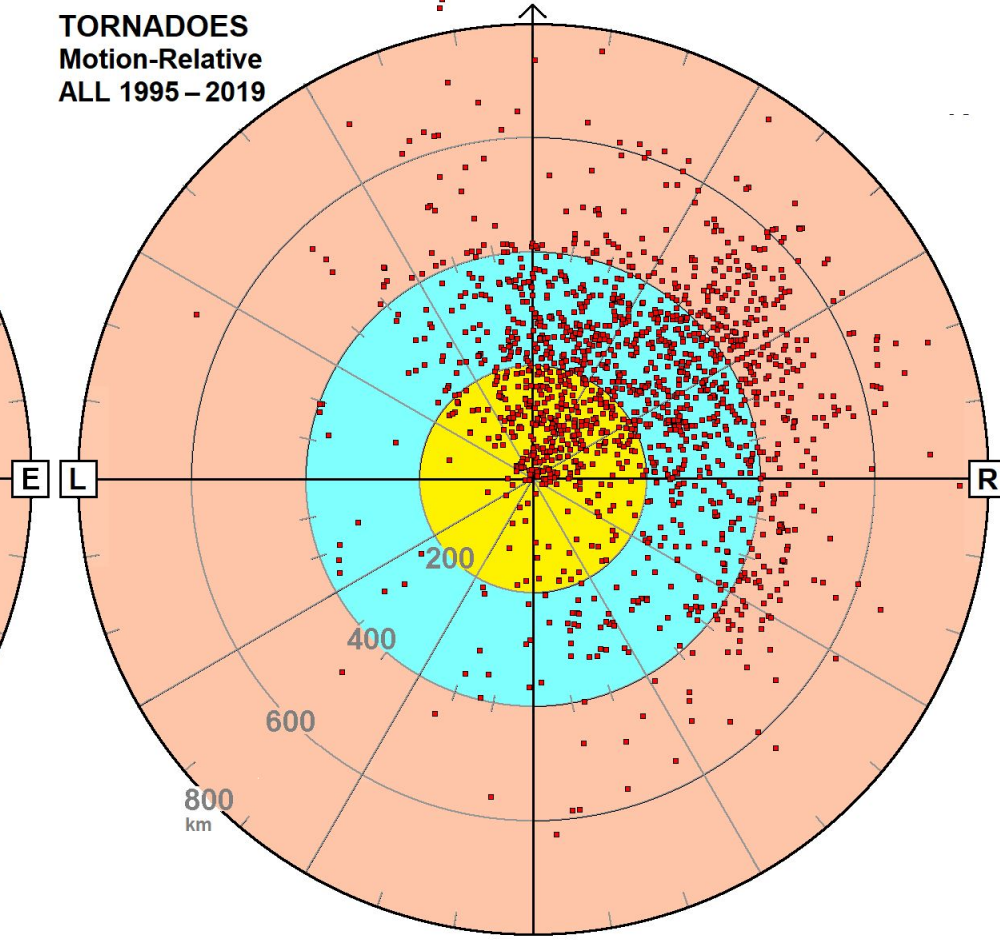
CLIMATOLOGICAL APPLICATION TO FORECASTING CONCEPTS

AZRAN of TCTOR events from center

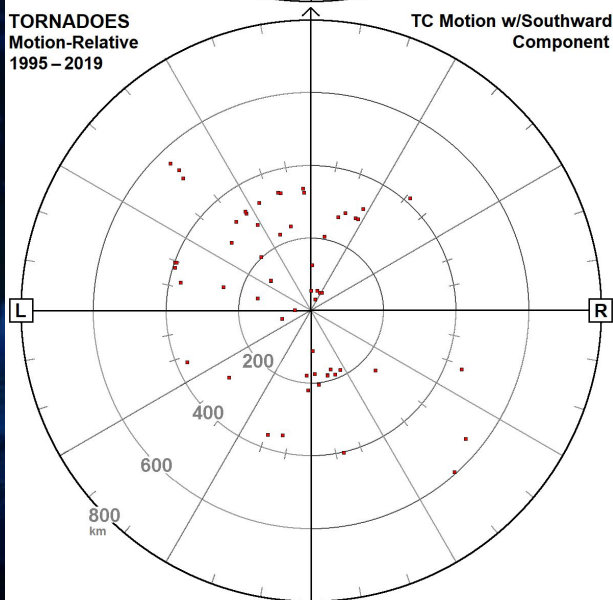
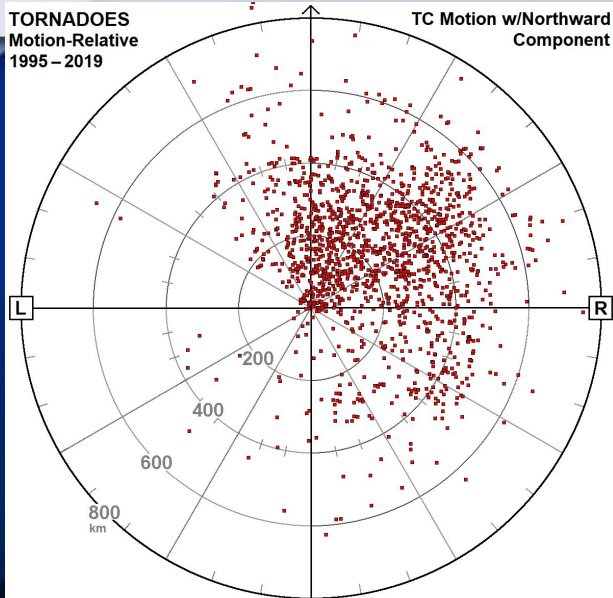
TORNADOES
North-Relative
ALL 1995 – 2019



TORNADOES
Motion-Relative
ALL 1995 – 2019



CLIMATOLOGICAL APPLICATION TO FORECASTING CONCEPTS

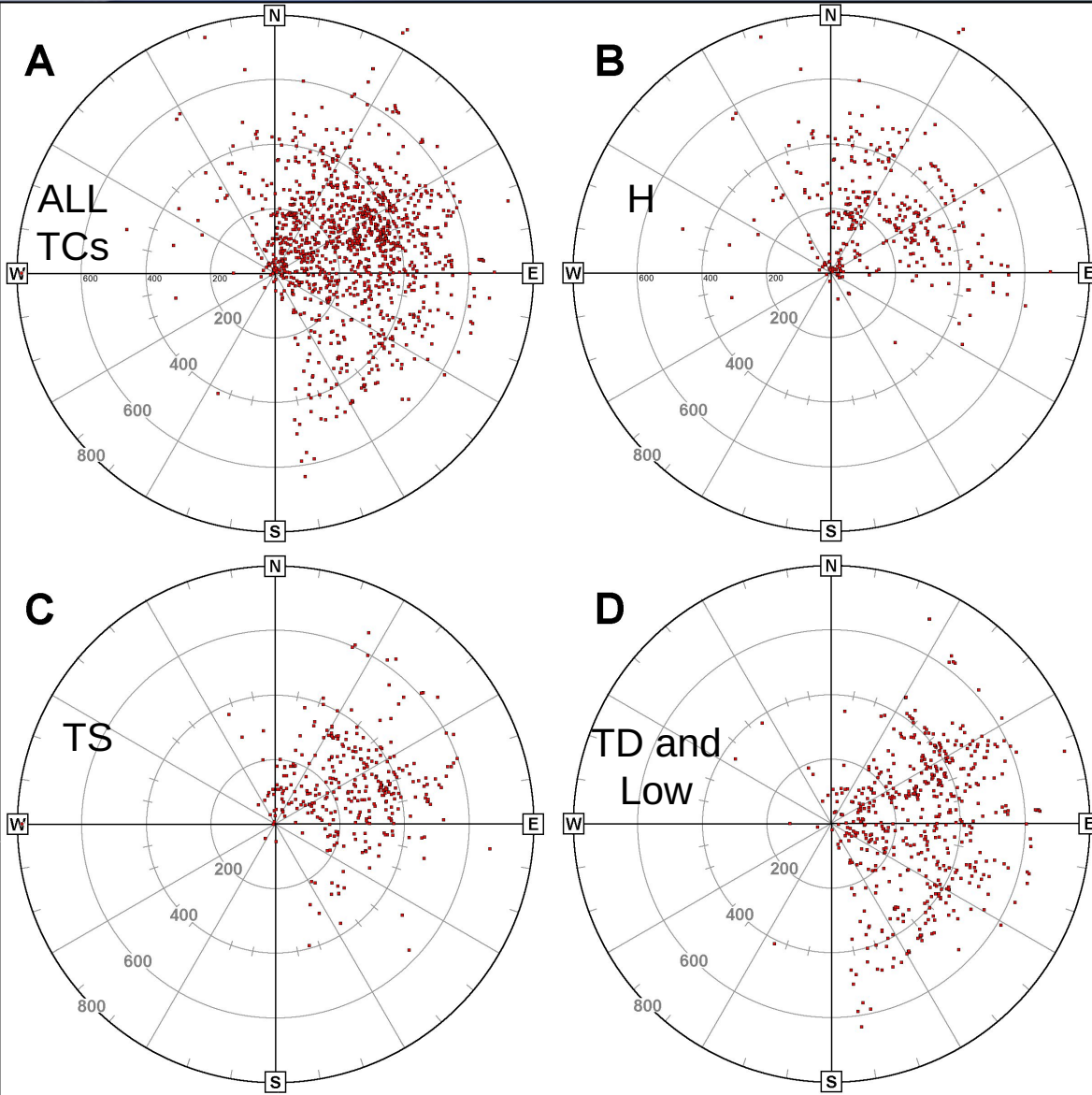


Motion-relative AZRAN of TCTOR events from center:
Northward translation component

**HOW
MOTION-RELATIVE
FAILS**

Motion-relative AZRAN of TCTOR events from center:
Southward translation component

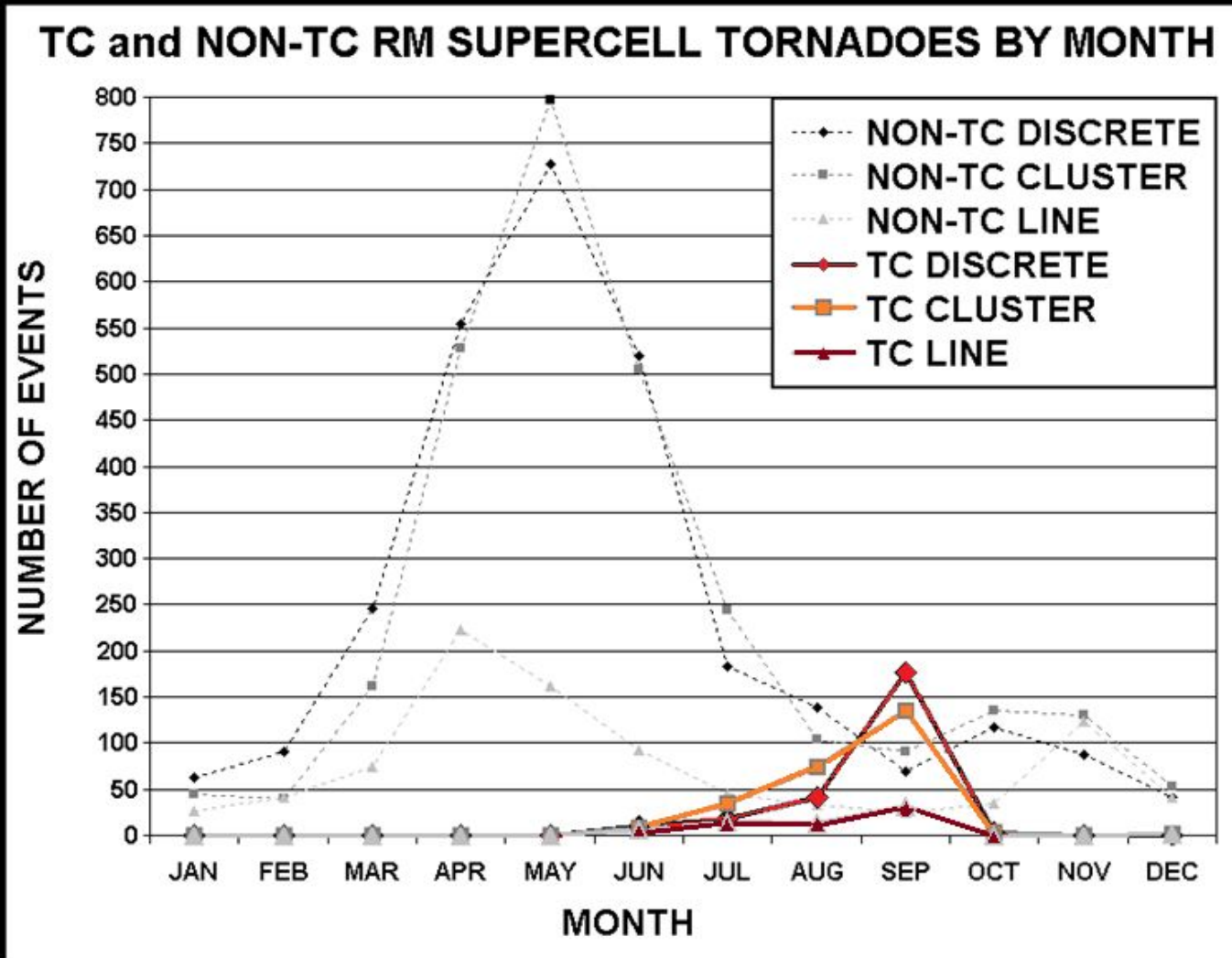
CLIMATOLOGICAL APPLICATION TO FORECASTING CONCEPTS



Tornadoes more common in SE sectors as TCs weaken...WHY?

...greatly due to that sector's being over water when most are mature hurricanes!

CLIMATOLOGICAL APPLICATION TO FORECASTING CONCEPTS



data from Edwards et al. (2012)

REVIEW ARTICLE for MORE DETAILS

Edwards, R., 2012: Tropical cyclone tornadoes: A review of knowledge in research and prediction. *Electronic J. Severe Storms Meteor.*, 7 (6), 1–61.

Electronic Journal of
SEVERE STORMS METEOROLOGY

Tropical Cyclone Tornadoes: A Review of Knowledge in Research and Prediction

ROGER EDWARDS

NWS Storm Prediction Center, Norman, Oklahoma

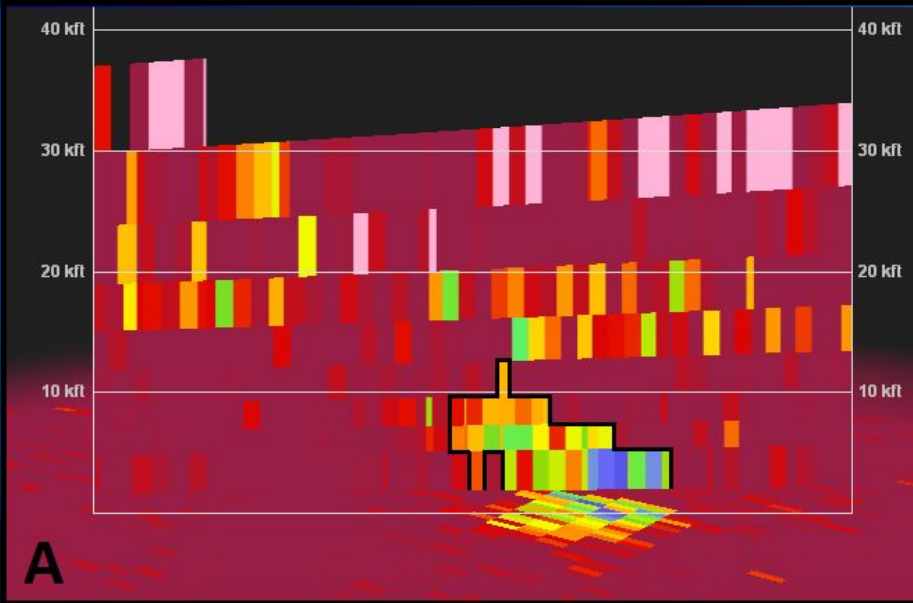
(Submitted 18 August 2011; in final form 7 September 2012)

ABSTRACT

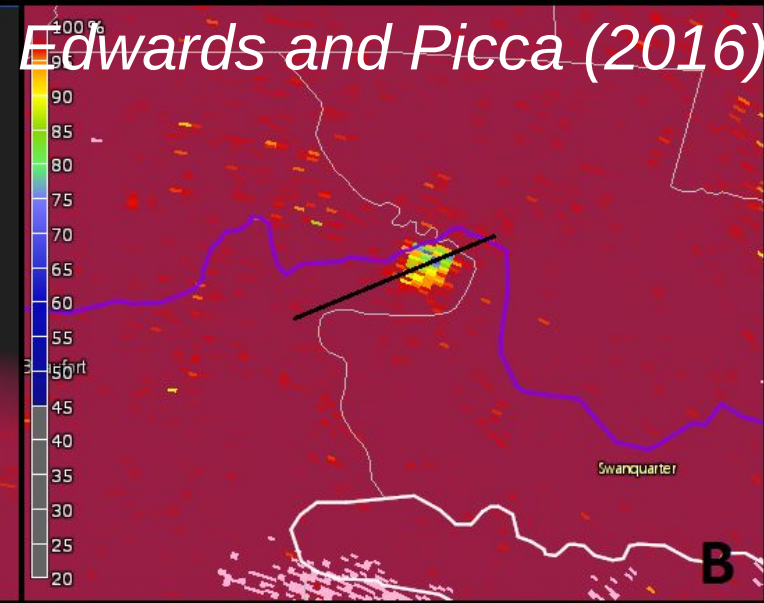
The scientific documentation and investigation of tropical cyclone (TC) tornadoes has spanned portions of ten decades, but has been missing a documentary overview of topical knowledge accumulated to any given point in that time span. This review article summarizes the evolution of TC tornado-related literature from the perspectives of crucial historic tornadoes, climatology, distribution patterns, applied research into their environments, remote and environmental observations, forecasting practices, and numerical simulations at various scales. Discussion of the future of TC tornado research and prediction includes several testable hypotheses, along with potentially beneficial tools soon to be available to operational forecasters.

Available at EJSSM, SPC Publications web site
and (internal access) SPC Formal Science Library

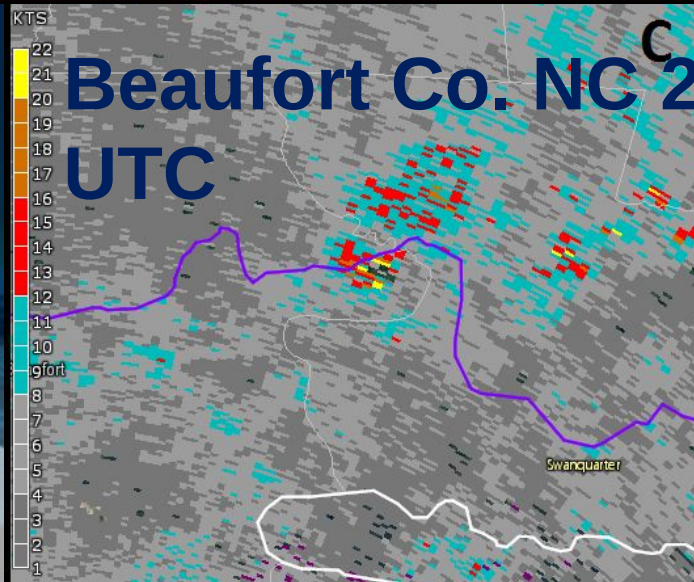
KEY RESEARCH SINCE 2012 REVIEW



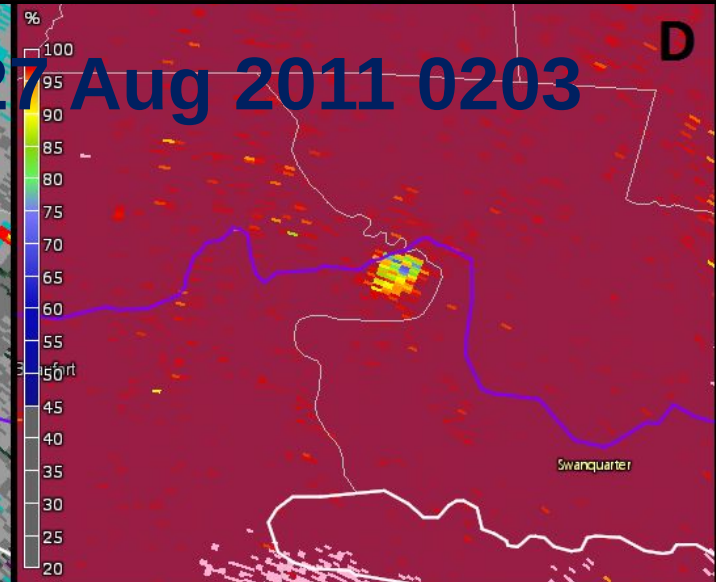
A



B



C

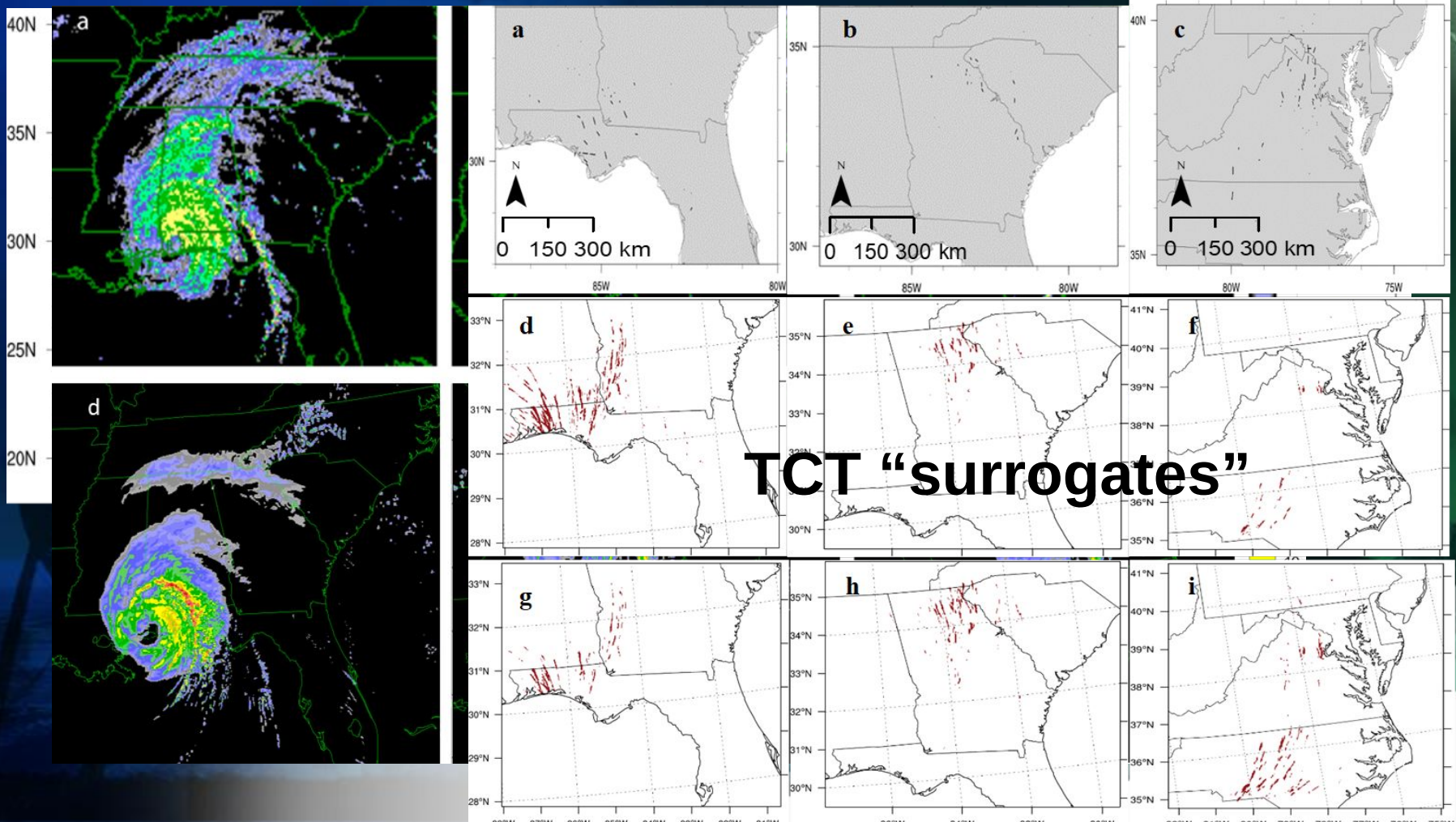


D

Warning & damage-survey uses

KEY RESEARCH SINCE 2012 REVIEW

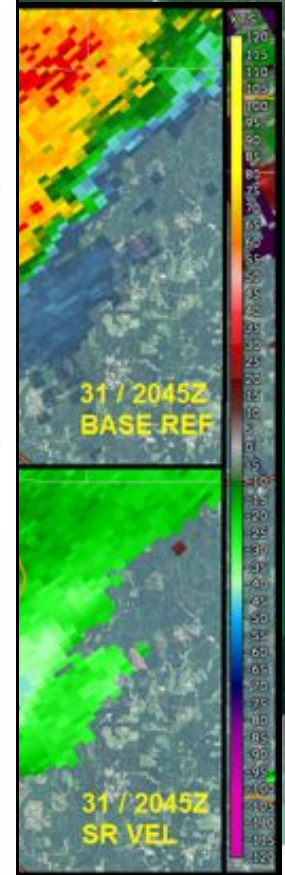
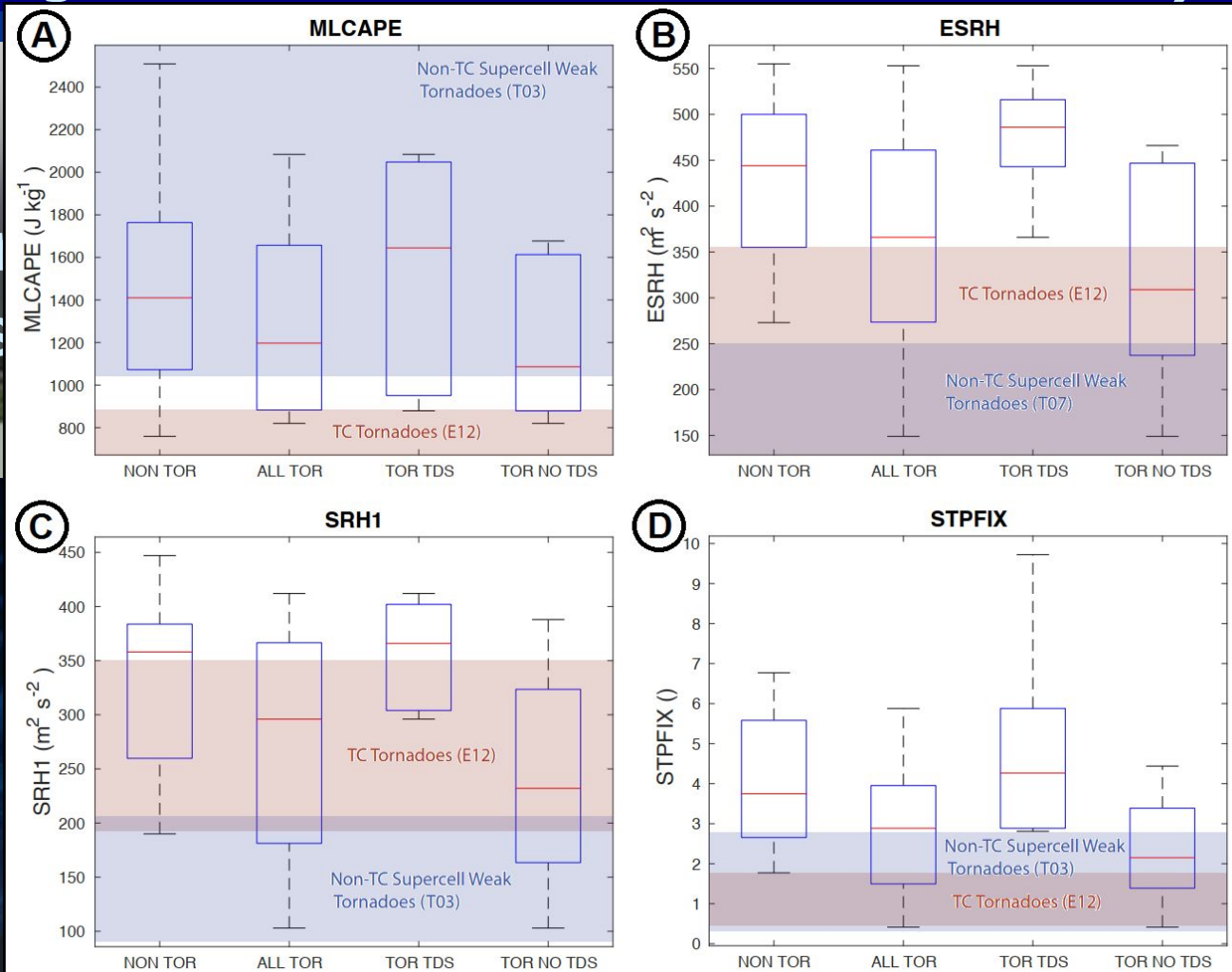
Promising app. of hi-res CAM NWP (Carroll-Smith et al. (2019, EJSSM): Successful WRF simulation of Ivan (2004)



KEY RESEARCH SINCE 2012 REVIEW

Ongoing applications of Harvey findings (Nowotarski et al., including several SR-WFO collaborators and me)

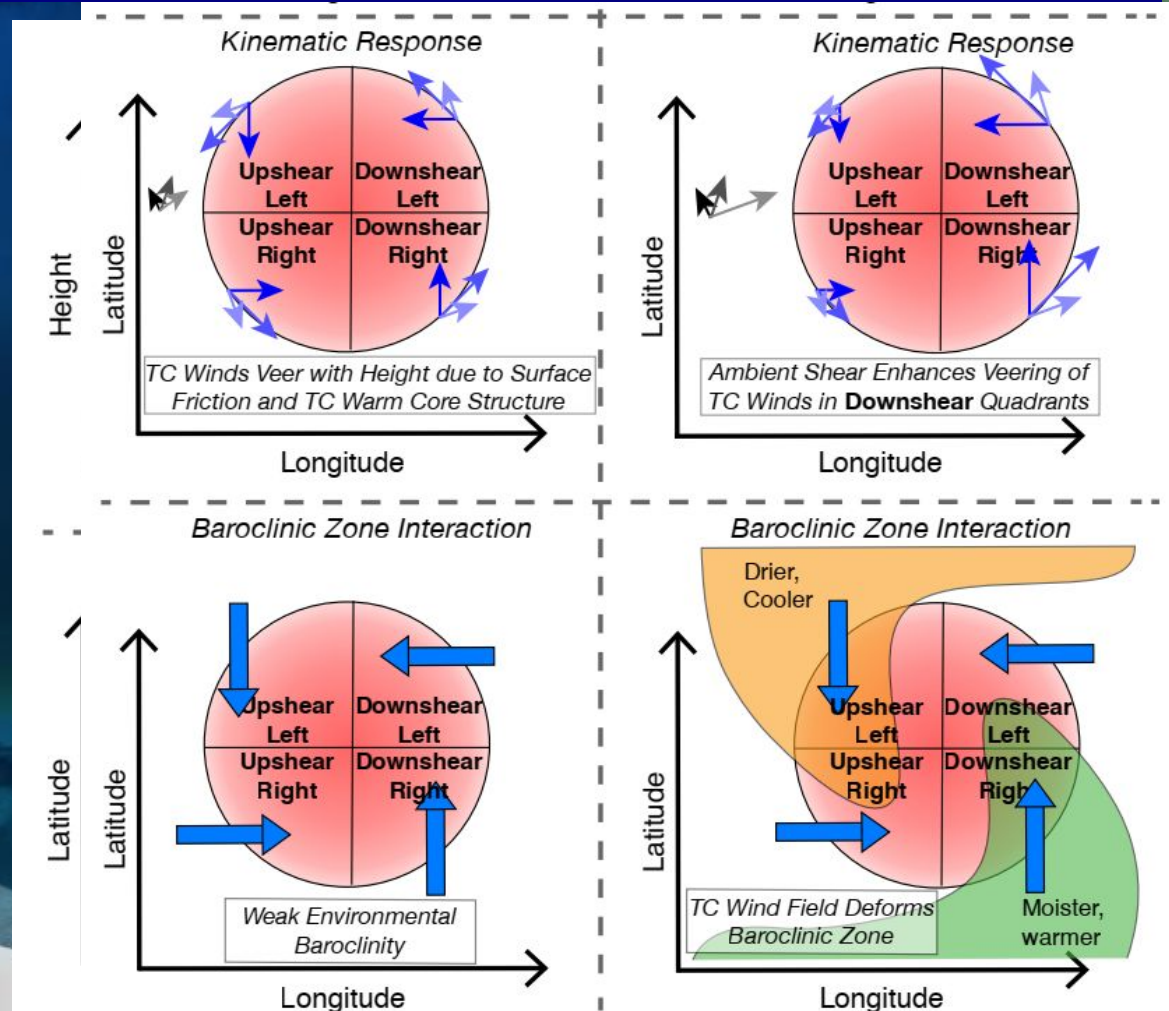
SE TX
respon
issues



KEY RESEARCH SINCE 2012 REVIEW

Stronger-sheared TCs lead to more tornadoes and explain why they occur downshear right (usually NE quad).

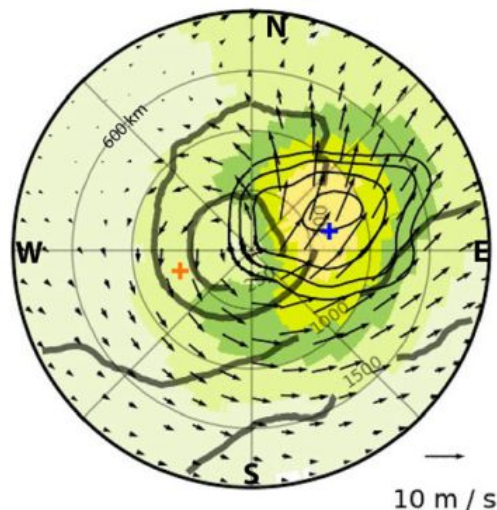
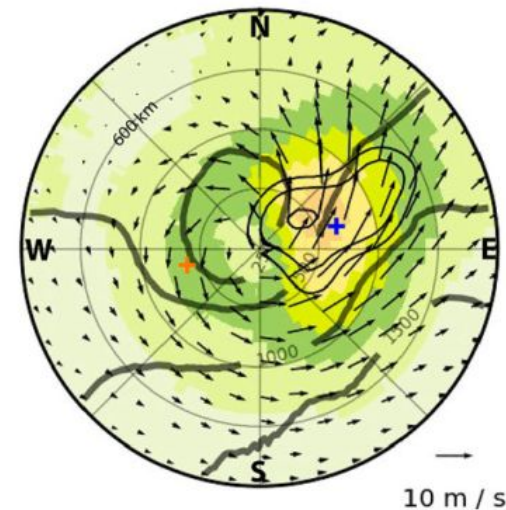
(Schenkel et al. 2020)



10-m to 700-hPa Bulk Shear Magnitude/Vectors and MLCAPE in Ground Relative Coordinate (72 cases)

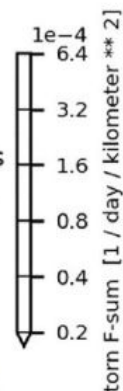
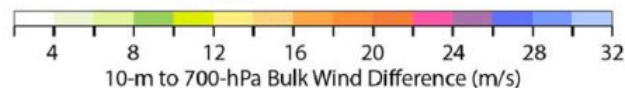
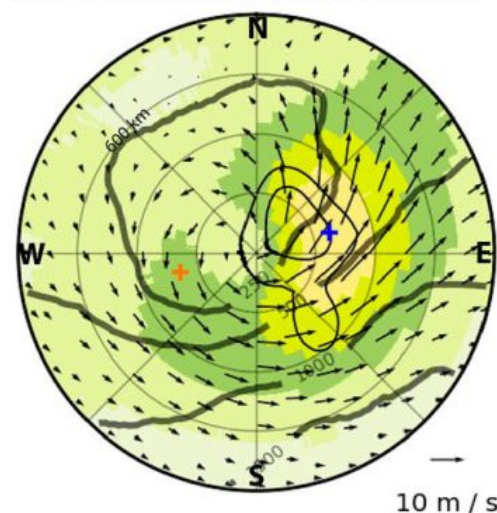
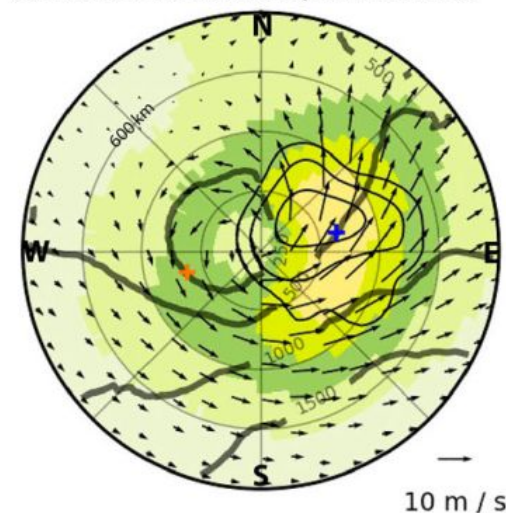
(a) 1200-1500 UTC NARR Composite of All Cases

(b) 1800-2100 UTC NARR Composite of All Cases



(c) 0000-0300 UTC NARR Composite of All Cases

(d) 0600-0900 UTC NARR Composite of All Cases



TCTOR density vs. CAPE & sfc-700-mb BWD (Trier et al. 2023)

TCTORs max out at all hours where sfc-700-mb "shear" intersects CAPE gradient. That's NE-SE of center!

FIG. 8. Diurnal cycle of 10-m-700-hPa BWD magnitude (color shading) and vectors, MLCAPE (250, 500, 1000, and 1500 J kg^{-1} contours in bold gray), and the F-sum tornado density field (thin black contours with values indicated at right) for $n = 72$ ALL-CASES composite in ground-relative coordinates. The color-coded cross symbols indicate the locations of the composite soundings, and time series presented in Figs. 9 and 10, respectively.

TC TORNADO FORECASTING CONCEPTS

Shifting from climatology-based and
empirical to

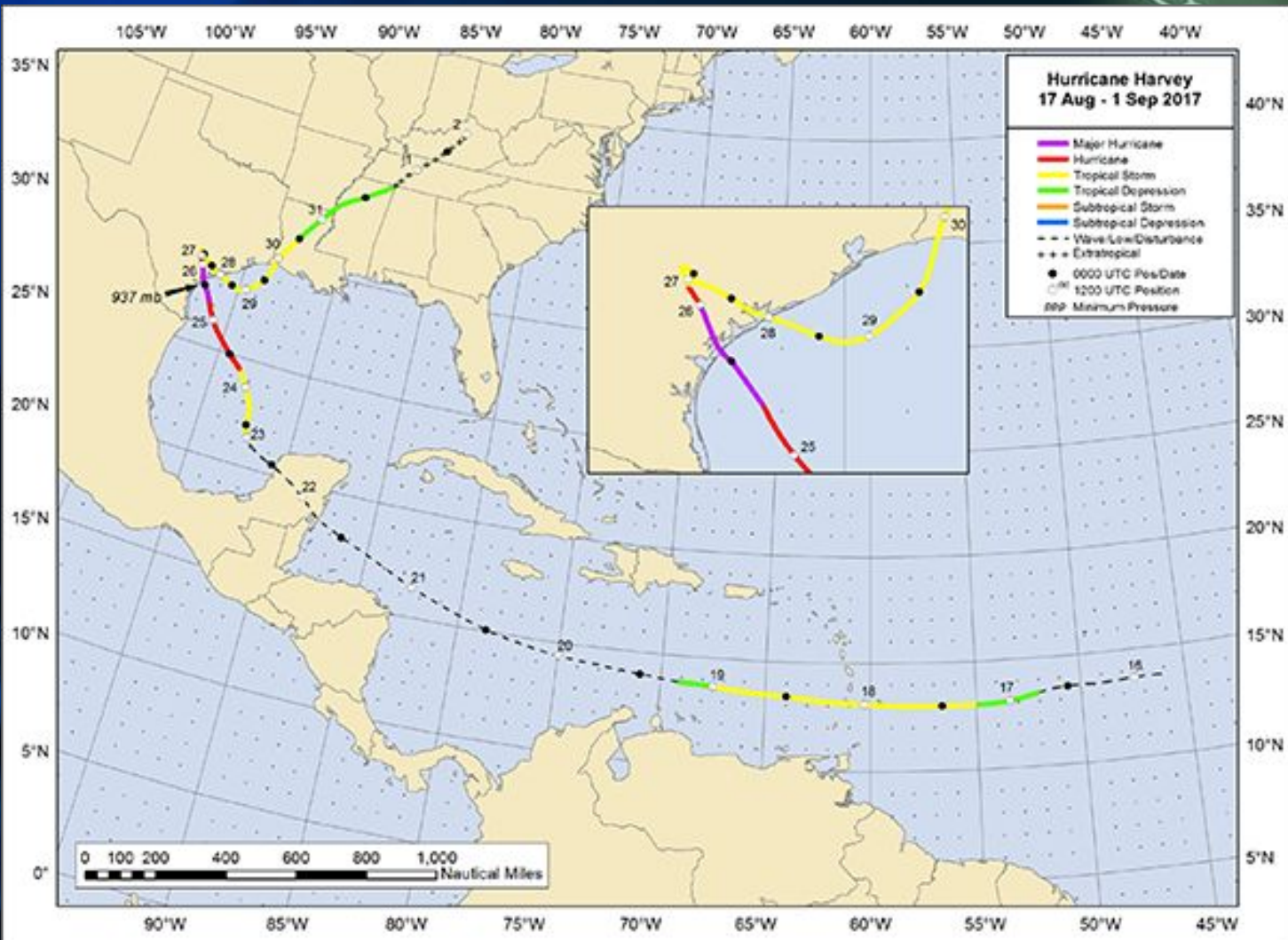
INGREDIENTS-BASED THINKING

For supercells in midlatitude systems and tropical cyclones!

- ◆ **MOISTURE:** usually no problem
- ◆ **INSTABILITY:** helps to have diurnal heating with large antecedent BL theta-e to offset weak lapse rates aloft
- ◆ **(source for) LIFT:** Spiral bands, embedded boundaries concentrate threat on mesoscale and smaller – **MINDFUL HAND ANALYSIS is CRUCIAL!**
- ◆ **VERTICAL SHEAR:** Peak hodographs in climatologically favored N-NE-SSE sector (thanks, ambient shear!)

SPC OUTLOOK-SEQUENCE CASE

HARVEY-17

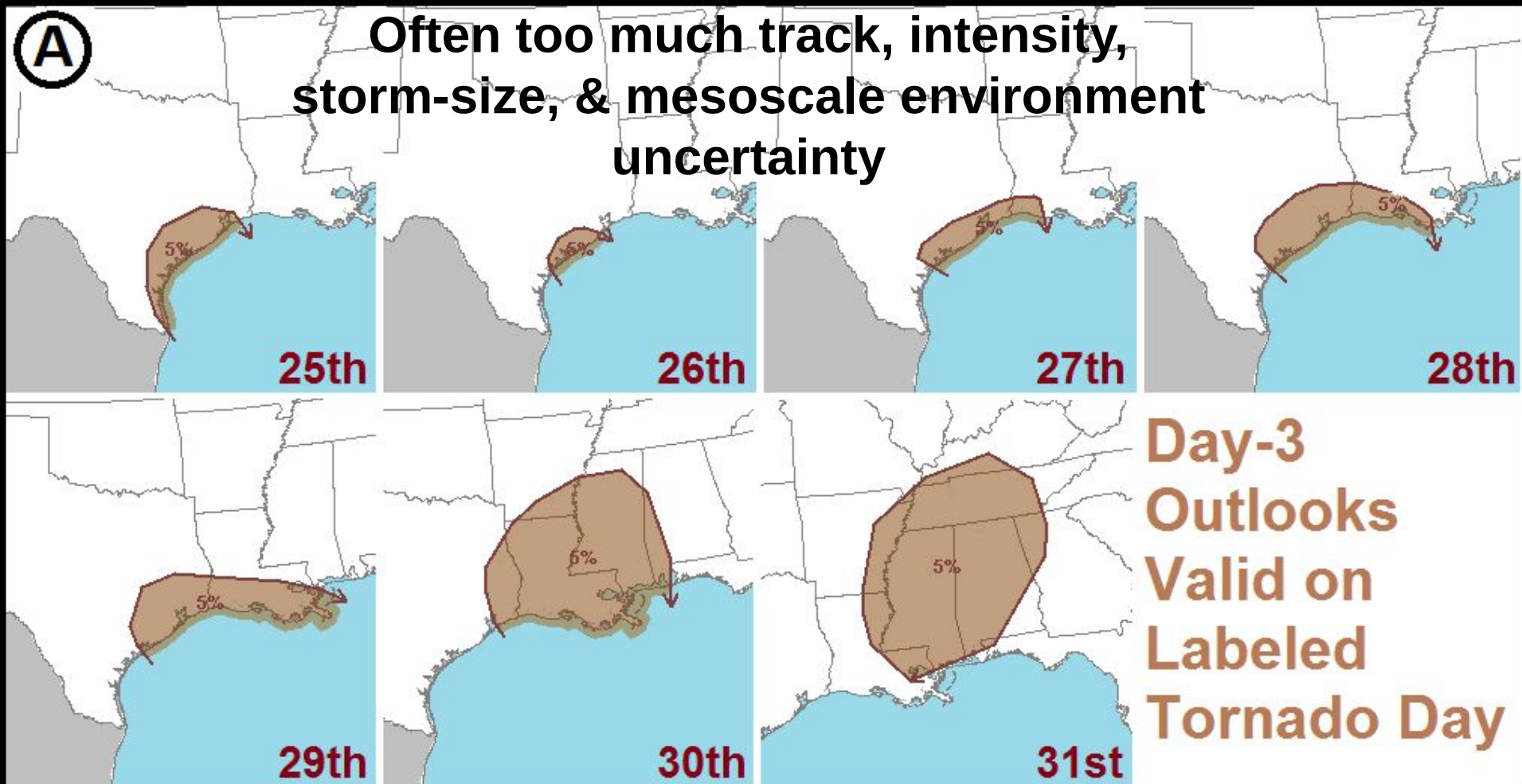


SPC OUTLOOK EXAMPLES FOR TCs

OUTLOOKS (Day-3 examples for HARVEY-17)

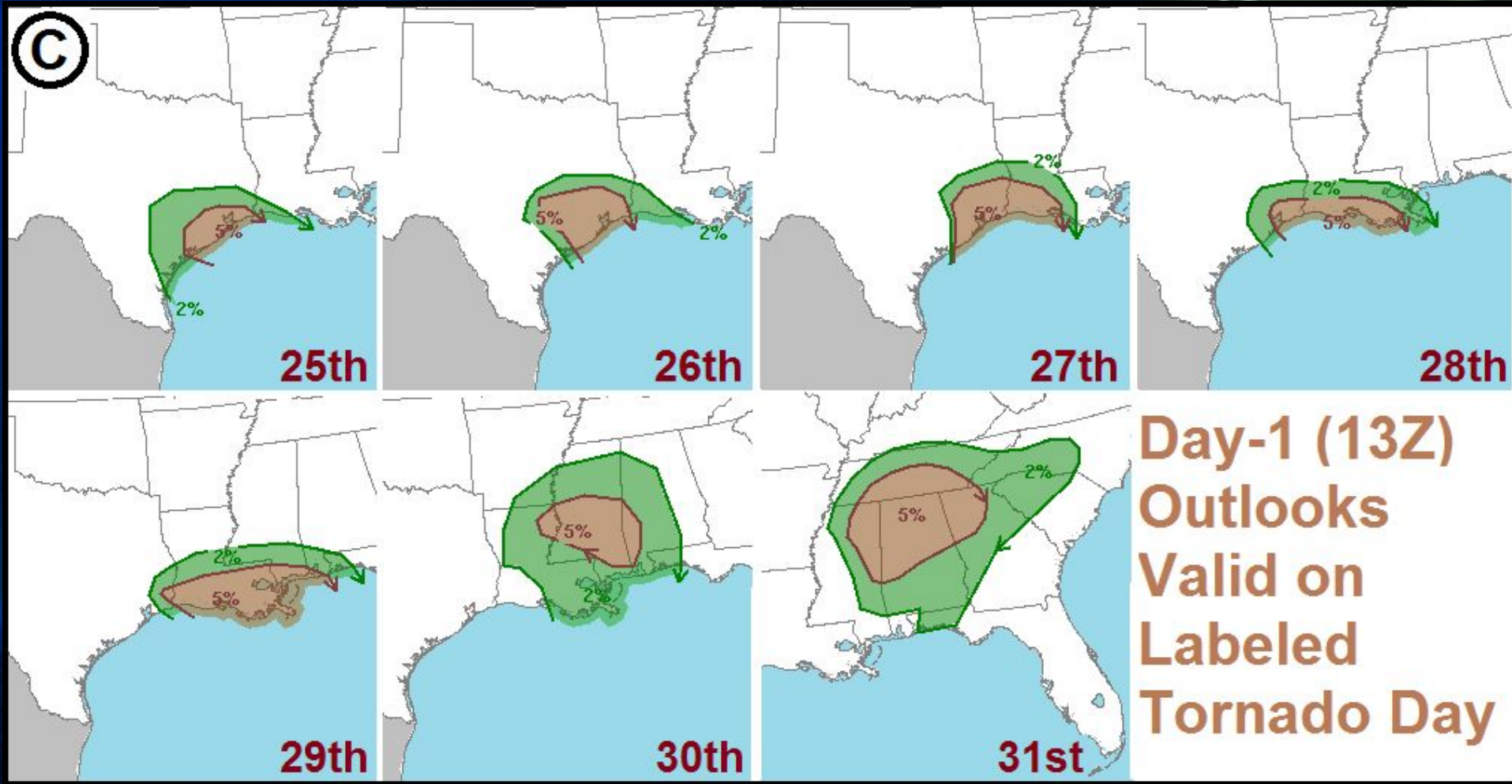
(A)

Often too much track, intensity, storm-size, & mesoscale environment uncertainty



SPC OUTLOOK EXAMPLES FOR TCs

OUTLOOKS (Day-1 examples for HARVEY-17)



SPC OUTLOOK-SEQUENCE CASE

HARVEY-17

ZCZC MIATCPAT4 ALL
TTAA00 KNHC DDHMM

BULLETIN

Hurricane Harvey Advisory Number 22
NWS National Hurricane Center Miami FL AL092017
400 PM CDT Fri Aug 25 2017

...MAJOR HURRICANE HARVEY BEARING DOWN ON THE TEXAS COAST...
...CATASTROPHIC FLOODING EXPECTED DUE TO HEAVY RAINFALL AND STORM SURGE...

SUMMARY OF 400 PM CDT...2100 UTC...INFORMATION

LOCATION...27.5N 96.5W
ABOUT 60 MI...95 KM ESE OF CORPUS CHRISTI TEXAS
ABOUT 60 MI...100 KM S OF PORT OCONNOR TEXAS
MAXIMUM SUSTAINED WINDS...125 MPH...205 KM/H
PRESENT MOVEMENT...NW OR 325 DEGREES AT 10 MPH...17 KM/H
MINIMUM CENTRAL PRESSURE...941 MB...27.79 INCHES

WATCHES AND WARNINGS

CHANGES WITH THIS ADVISORY:

The Tropical Storm Warning has been discontinued south of Port Mansfield, Texas.

The Storm Surge Watch has been discontinued south of Port Mansfield, Texas.

The government of Mexico has discontinued the Tropical Storm Watch north of Boca de Catan.

SUMMARY OF WATCHES AND WARNINGS IN EFFECT:

A Storm Surge Warning is in effect for...
* Port Mansfield to High Island Texas

A Hurricane Warning is in effect for...
* Port Mansfield to Sargent Texas

A Tropical Storm Warning is in effect for...
* North of Sargent to High Island Texas

A Storm Surge Warning means there is a danger of life-threatening inundation from rising water moving inland from the coastline in the indicated locations. For a depiction of areas at risk, please see the National Weather Service Storm Surge watch/warning Graphic, available at hurricanes.gov. This is a life-threatening situation.

A Hurricane Warning means that hurricane conditions are expected somewhere within the warning area, in this case within the next few hours. Preparations to protect life and property should already be complete.

Interests in southern Louisiana should continue to monitor the

HAZARDS AFFECTING LAND

RAINFALL: Harvey is expected to produce total rain accumulations of 15 to 30 inches and isolated maximum amounts of 40 inches over the middle and upper Texas coast through next Wednesday. During the same time period Harvey is expected to produce total rain accumulations of 5 to 15 inches in far south Texas and the Texas Hill Country over through southwest and central Louisiana. Rainfall of this magnitude will cause catastrophic and life-threatening flooding.

STORM SURGE: The combination of a dangerous storm surge and the tide will cause normally dry areas near the coast to be flooded by rising waters moving inland from the shoreline. The water is expected to reach the following heights above ground if the peak surge occurs at the time of high tide...

N Entrance Padre Island Natl Seashore to Sargent...6 to 12 ft
Sargent to Jamaica Beach...5 to 8 ft
Port Mansfield to N Entrance Padre Island Natl Seashore...3 to 5 ft
Jamaica Beach to High Island...2 to 4 ft
Mouth of the Rio Grande to Port Mansfield...1 to 3 ft
High Island to Morgan City...1 to 3 ft

The deepest water will occur along the immediate coast near and to the northeast of the landfall location, where the surge will be accompanied by large and destructive waves. Surge-related flooding depends on the relative timing of the surge and the tidal cycle, and can vary greatly over short distances. For information specific to your area, please see products issued by your local National Weather Service forecast office.

WIND: Tropical storm conditions are occurring in portions of the hurricane and tropical storm warning areas, and hurricane conditions are expected to begin within the hurricane warning area in the next few hours. Tropical storm conditions are likely to persist along portions of the coast through at least Sunday.

SURF: Swells generated by Harvey are affecting the Texas, Louisiana, and northeast Mexico coasts. These swells are likely to cause life-threatening surf and rip current conditions. Please consult products from your local weather office.

TORNADOES: A few tornadoes are possible through Saturday near the middle and upper Texas coast into far southwestern Louisiana.

NEXT ADVISORY

Next intermediate advisory at 700 PM CDT.
Next complete advisory at 1000 PM CDT.

\$\$
Forecaster Berg

NNNN

Tornado Statement provided by the
SPC

SPC OUTLOOK-SEQUENCE CASE

HARVEY-17

25 August 2017

SPC Convective

Category 4 Hurricane

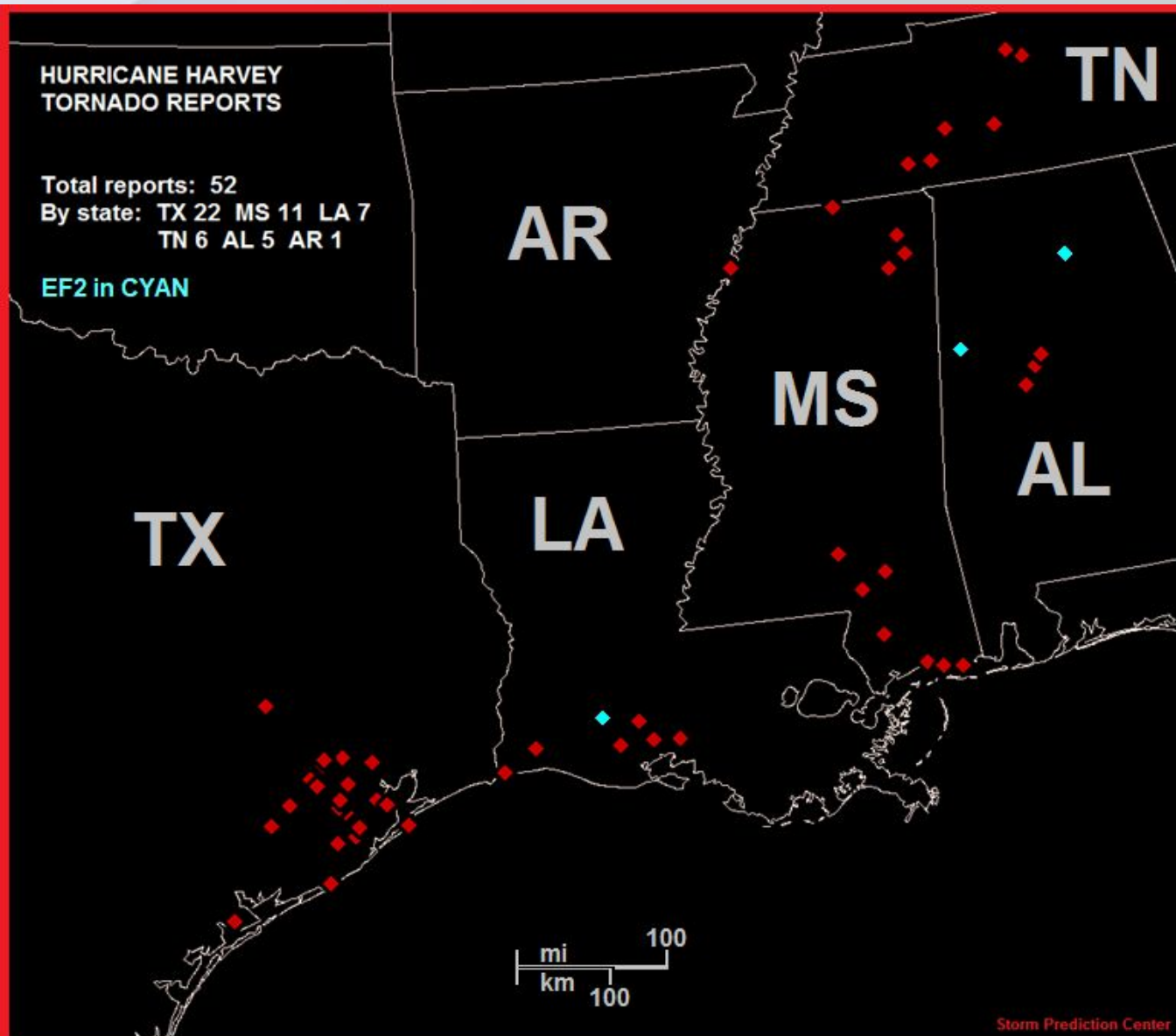
Social Media

“Just a Slight Risk (Level 2 of 5) with a Category 4 Hurricane?”



Reminder: The SPC is forecasting the severe weather risk from tornadoes, wind, or hail from embedded thunderstorms

IMPACT EXAMPLE (ATMOSPHERE)



HARVEY-17

**RECORD
DURATION:**

**7 DAYS
COMBINED**

SPC WEBSITE INFO FOR TCs



Storm Prediction Center

NOAA / National Weather Service


Local Forecast by ZIP


HOME | NEWS | SPC PRODUCTS | WEATHER INFO | FORECAST TOOLS | RESEARCH | OUTREACH | NWS/NCEP

Search SPC... 

A Slight Risk of Severe Thunderstorms is Forecast Today and/or Tonight

A few tornadoes and locally damaging winds are possible tonight with stronger cells mainly north through northeast of the center of Hurricane Harvey. Additionally, the line of storms moving through southeast South Dakota and northern/northeast Nebraska will continue southeastward, offering locally damaging winds and/or hail throughout the evening.

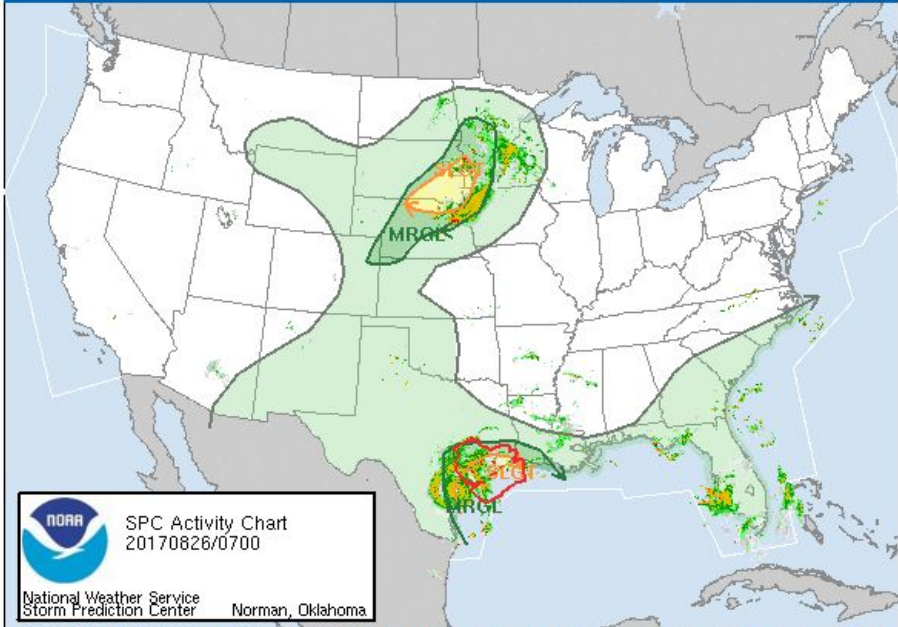
 For additional details, see the latest [Day 1 Convective Outlook](#).

HURRICANE HARVEY Related Information: 

[National Hurricane Center](#)
Tornado Watch: 0465

TC Related Information

[Overview](#) | [Conv. Outlook](#) | [Watches](#) | [MDs](#) | [Storm Reports](#) | [Mesoanalysis](#) | [Fire](#) | [Hazards](#)



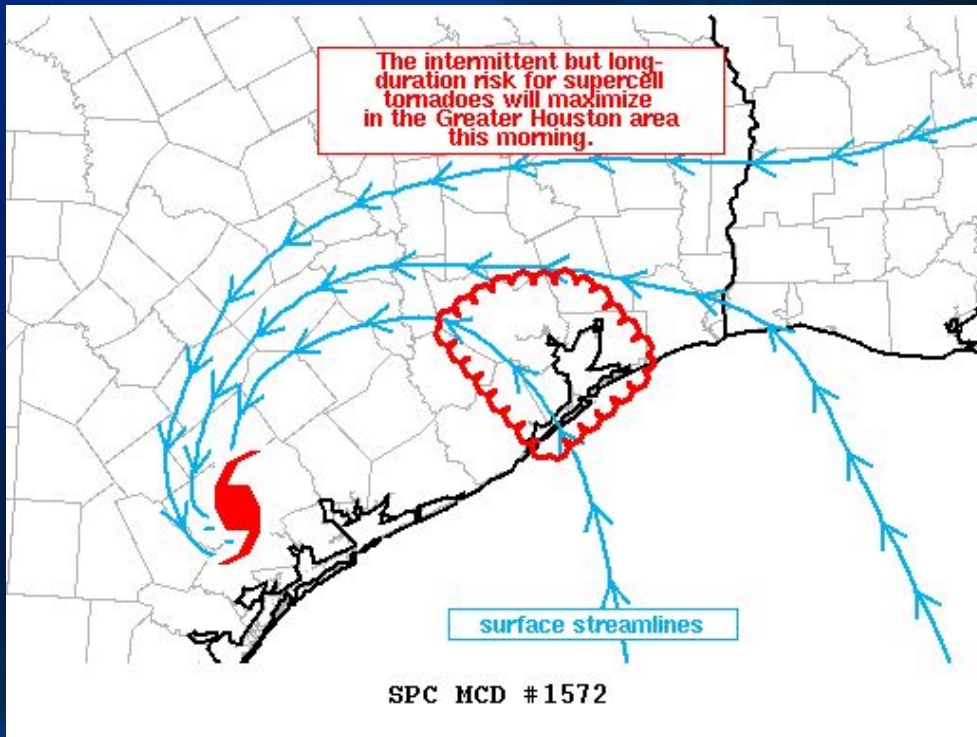
Hazard	Fri (08/25)	Sat (08/26)	Sun (08/27)	Mon (08/28)	Tue (08/29)	Wed (08/30)	Thu (08/31)	Fri (09/01)
Severe	Slight	Slight	Marginal	No Area	No Area	No Area	No Area	No Area
Fire	Elevated	No Critical	No Area	No Area	No Area	No Area	No Area	No Area

www.spc.noaa.gov
OV



MESOSCALE DISCUSSION EXAMPLE for TCs

HARVEY-17



Mesoscale Discussion 1572
NWS Storm Prediction Center Norman OK
0649 AM CDT Sat Aug 26 2017

Areas affected...the Galveston Bay/Greater Houston area

Concerning...Tornado Watch 467...

Valid 261149Z - 261345Z

The severe weather threat for Tornado Watch 467 continues.

SUMMARY...The intermittent but long-duration risk for short-lived supercell tornadoes will maximize in the Galveston Bay/Greater Houston area this morning.

DISCUSSION...The latest subjective surface streamline analysis implies low-level convergence is focused across the Galveston Bay vicinity. Surface observations also show temperatures in the lower 80s degrees F from Brazoria County to Houston Hobby and east-northeast to Beaumont. Dewpoints are ranging from the upper 70s to around 80 at the coast. As a result, buoyancy is maximized in the discussion area compared to areas farther inland and closer to the center of Harvey. Time trends in the KHGX VAD suggest a decrease in hodograph size has occurred during the past few hours with 0-1 km SRH less than 50 m²/s² according to observed storm motions. Nonetheless, the moist-tropical airmass will support intermittent low-level rotation with the strongest updrafts embedded within convective bands and clusters for the next several hours.

..Smith.. 08/26/2017

...Please see www.spc.noaa.gov for graphic product...

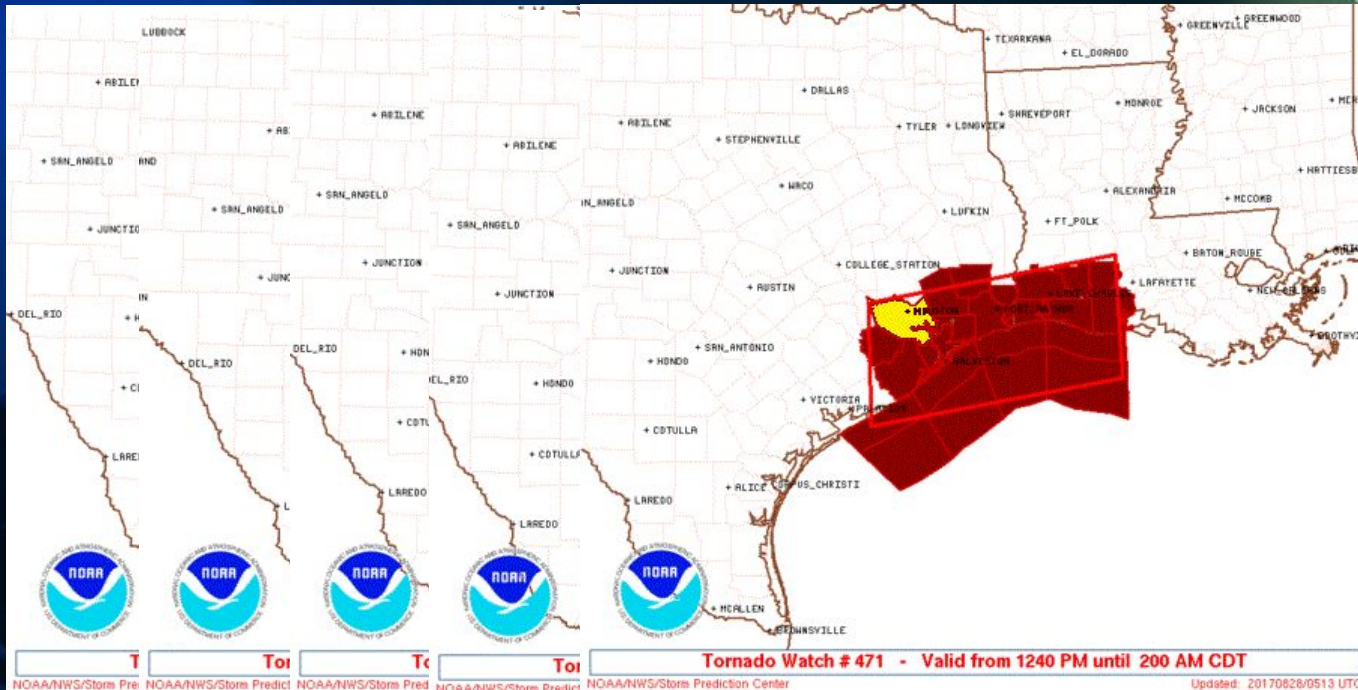
ATTN...WFO...LCH...HGX...

LAT...LON 29799582 30059540 30099479 29579430 29019506 29799582

**PRECEDES and/or
UPDATES
TORNADO WATCH**

TORNADO WATCH EXAMPLES for TCs

HARVEY-17 – EXTREME DURATION



CITY of HOUSTON: 60 HOURS in TORNADO WATCHES
WFO WARNING AREA: 96 HOURS
WHILE IN RECORD RAIN & FLOODING

A circular frame containing a storm scene. The background is a dark, stormy sky with a bright green lightning bolt striking down on the right side. In the foreground, several palm trees are silhouetted against the dark sky, their fronds blowing in the wind. The overall color palette is dominated by dark blues, greens, and blacks, with a bright green highlight from the lightning.

Contacts:

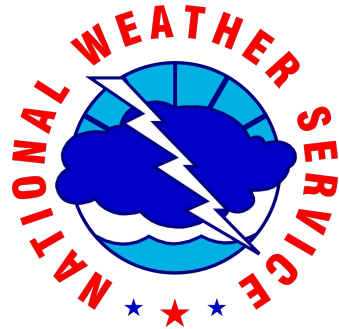
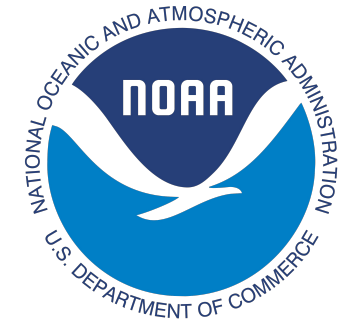
Roger.Edwards@NOAA.gov
(former NHC meteorologist)

Matthew.Elliott@NOAA.gov
(SPC WCM)

Aviation Weather Center Operations

Kansas City, MO

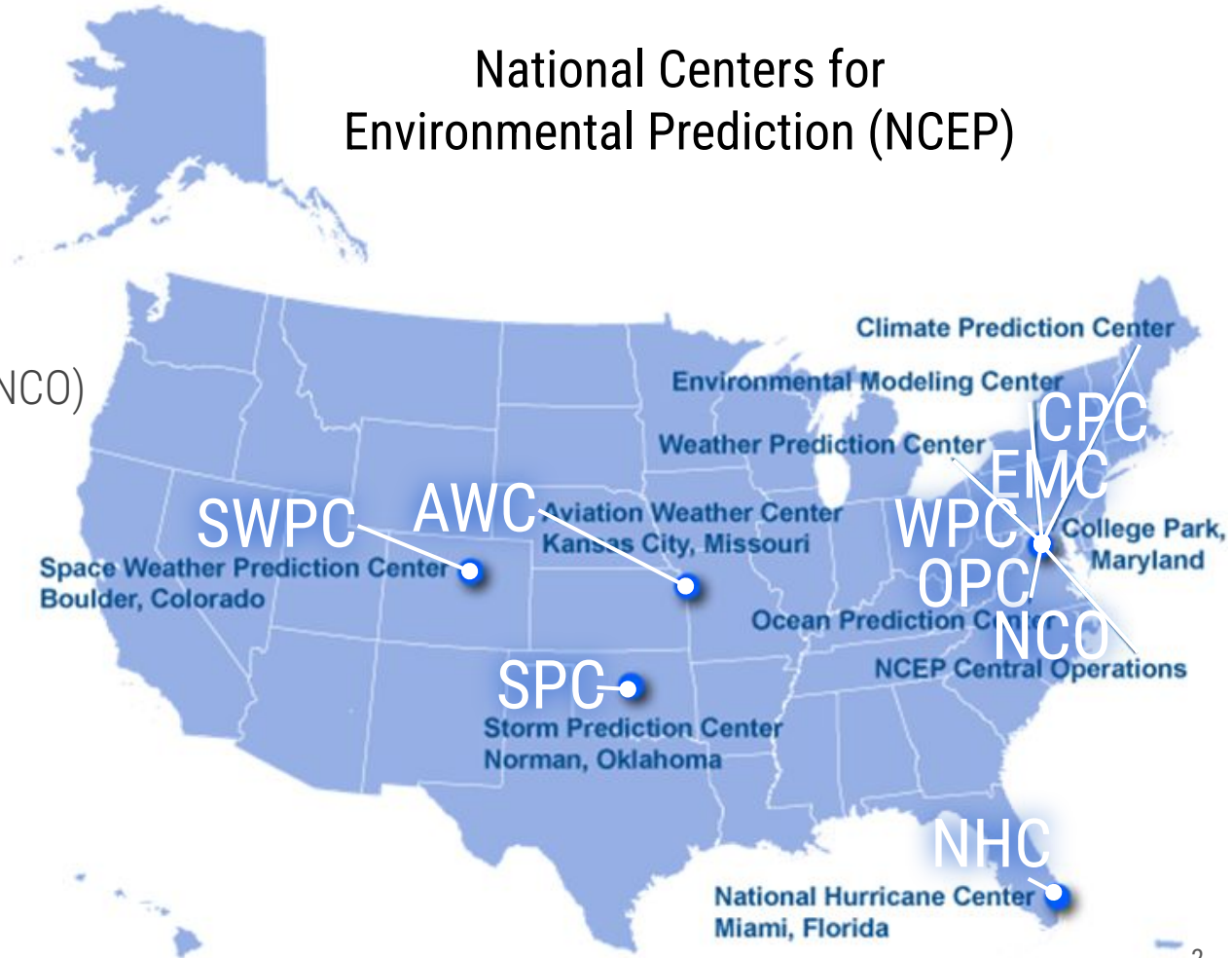
Amanda Martin - Acting Warning Coordination Meteorologist



National Centers for Environmental Prediction (NCEP)

9 Specialized Centers

- Aviation (AWC)
- Climate (CPC)
- Modeling (EMC)
- Supercomputing & data flow (NCO)
- Hurricanes (NHC)
- Oceans (OPC)
- Severe storms (SPC)
- Space weather (SWPC)
- Hydrometeorology (WPC)





Aviation Weather Center

www.aviationweather.gov



OUR MISSION STATEMENT

The Aviation Weather Center delivers consistent, timely and accurate weather information for the world airspace system.

We are a team of highly skilled people dedicated to working with customers and partners to enhance safe and efficient flight.

OUR VISION

To be the trusted authority and leading innovator for aviation weather information.

A Brief History of Aviation Weather Forecasting

1961

USAF Air Weather Service issues the **first official forecast of clear air turbulence**

1977

Crash of Southern Airlines 242 in New Hope, GA kills 72. NTSB recommends “procedures for the timely dissemination of all available severe weather information by controllers”

1978

Convective SIGMET unit established within the National Severe Storms Forecast Center. NWS meteorologists stationed in **13 ARTCCs**

1981

NWS meteorologists now stationed in **all 21 ARTCCs**. That partnership continues today

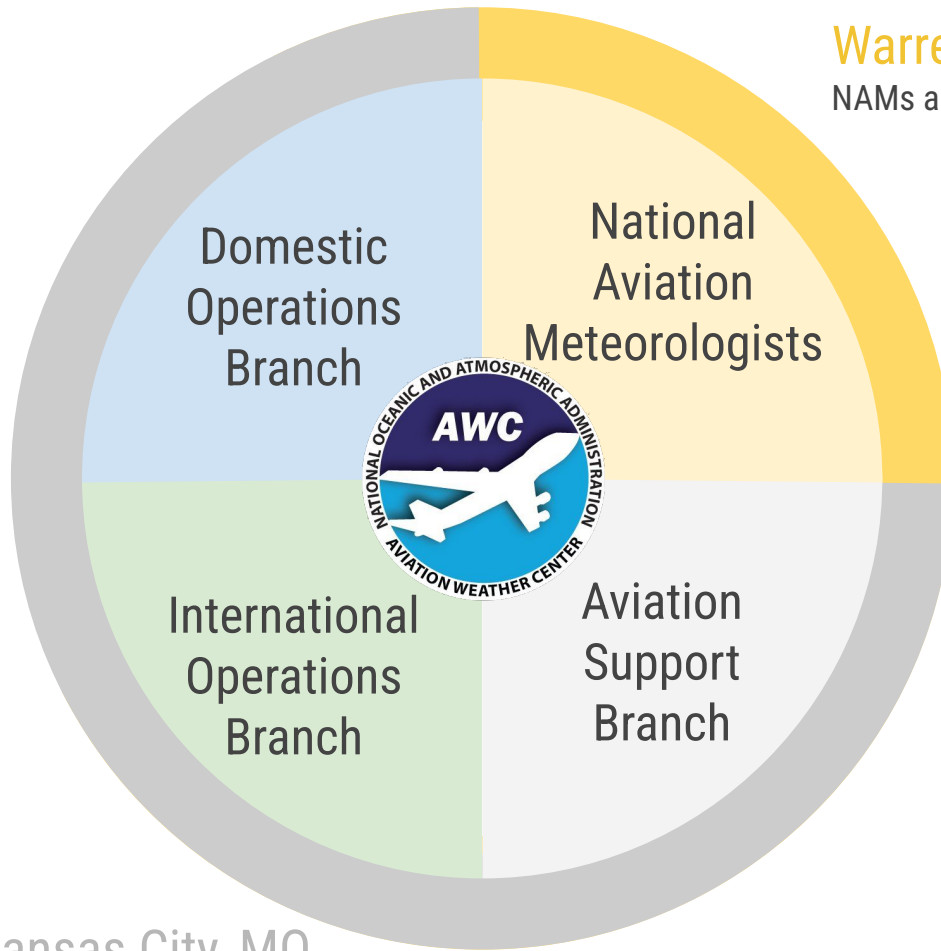
1982

National Aviation Weather Advisory Unit (NAWAU) is formed. Renamed to **AWC** in 1995

Structure of AWC

Warrenton, VA

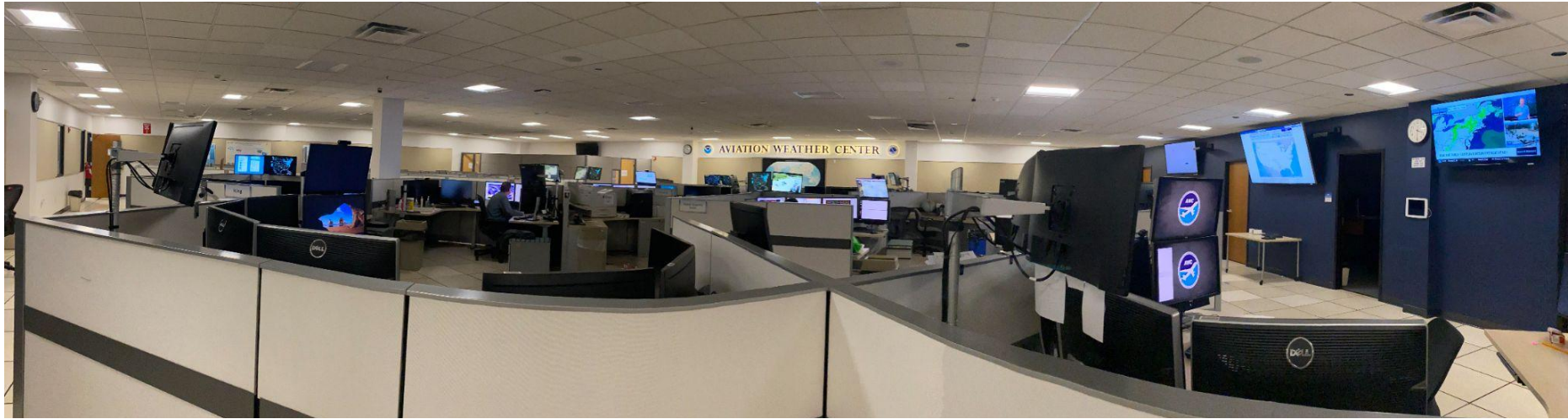
NAMs are embedded with the FAA at the ATCSCC



- 4 branches
- 2 locations
- ~80 people
 - Forecasters
 - Researchers/developers
 - IT staff
 - Administrative support staff
 - Managers & supervisors
 - NOAA Corps Officer

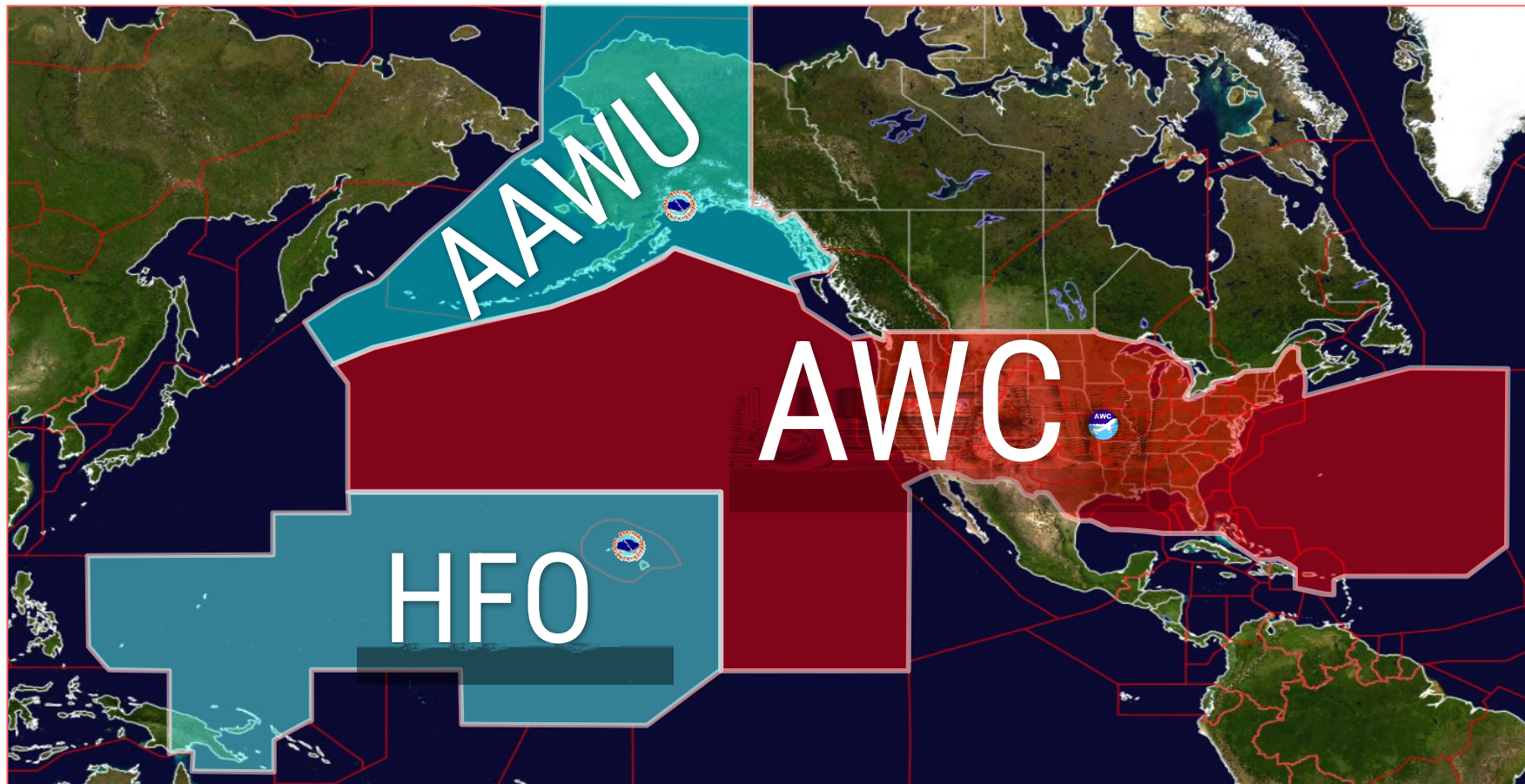
Kansas City, MO

Most AWC staff are based here



Kansas City, MO





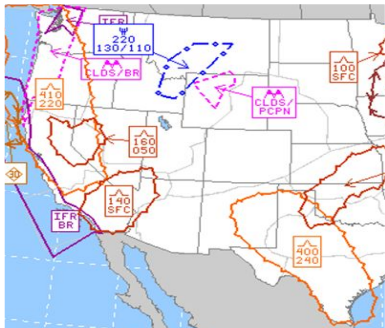
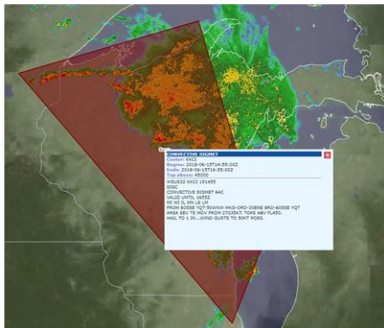
AAWU

AWC

HFO

Aviation Weather Center Operations

Domestic Operations



AVIATION WARNINGS

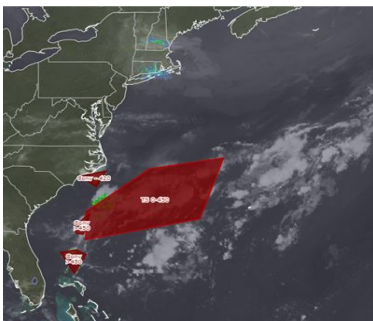
AVIATION FORECASTS

COLLABORATION

DESKS

International Operations

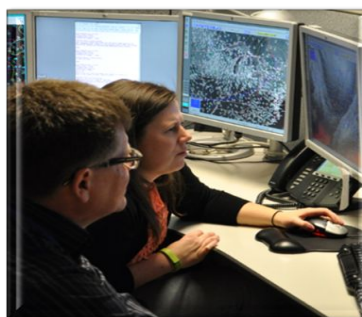
Atlantic · Pacific
Gulf of Mexico & Caribbean



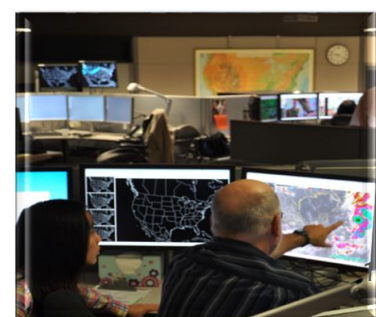
Global Significant Weather (SIGWX)
· Area Forecasts for Gulf of Mexico & Caribbean



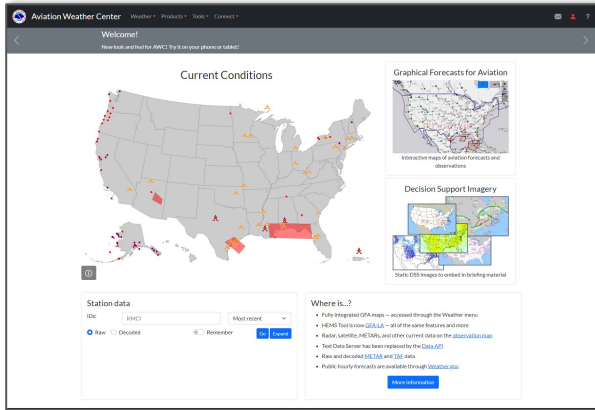
International meteorological services



Tropical · SIGWX North · SIGWX South



Aviation Weather Center Support Branch



PRODUCTS & SERVICES

Graphical Forecasts for Aviation (GFA)
• WAFS Internet File Service (WIFS)
• Computer models · Operational shift fill-in

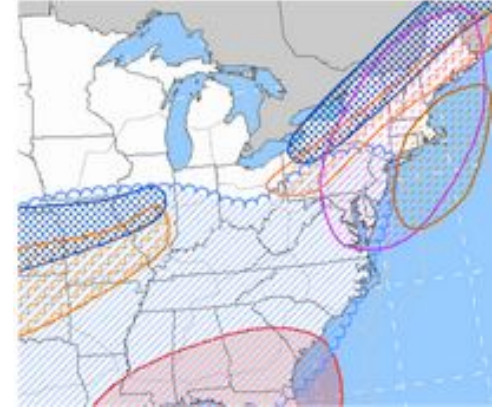
DATA, TECHNOLOGY, & INFRASTRUCTURE

IT architecture & security · Production systems · Data management · Support for remote forecast operations

SCIENCE & TECHNOLOGY

Aviation Weather Testbed (AWT)
• Aviation Weather Research Program · Research initiatives

National Aviation Meteorologists (NAMs)



DECISION SUPPORT

Embedded with FAA decision makers · Balance air traffic demand with capacity · Fully integrated & coordinated weather decision support

NAS ASSESSMENT

Conduct post-event reviews · Debriefings · Improve safety, efficiency, and decision making for the National Air Space (NAS)

PERTI ACTIVITIES

NAMs are involved in the FAA's broader strategic efforts to Plan, Execute, Review, Train, Improve

AviationWeather.gov



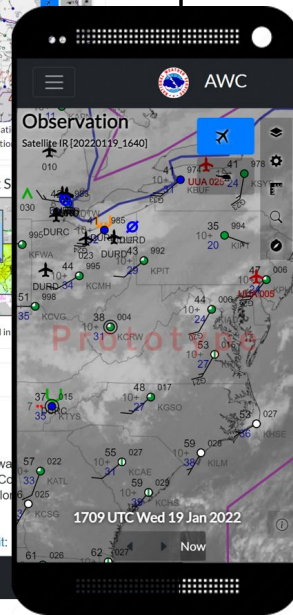
New look and feel for aviationweather.gov

- Mobile-first design
- Consistent navigation across all pages
- Focus on in-house aviation products
- Updated Graphical Forecasts for Aviation (GFA)

The screenshot displays the Aviation Weather Center (AWC) website interface. At the top, the navigation bar includes the AWC logo, "Weather", "Products", "Tools", and "Connect". Below the navigation is a "What's new?" section with a sub-header "New look and feel for AWC! Try it on your phone or tablet!". The main content area is divided into several sections:

- Current Conditions:** A large map of the United States showing various weather symbols (triangles, circles, squares) indicating current conditions across different regions.
- Graphical Forecasts for Aviation:** A smaller map showing forecasted conditions for aviation.
- Decision Support System:** A section with interactive maps and static images for embedding.
- Get station data:** A form with "ID:" set to "KMCI" and "past 6 hours" selected. It includes radio buttons for "Raw" and "Decoded" data, and a "Go" button. Below the form is a list of station data entries, such as "KMCI 181853Z 310146Z21KT 18SH FEW200 08/109 A3046 RPK AO2 PK MND 28026/1836 SLP".
- Tweets:** A section titled "Tweets by @NWSAWC" showing a tweet from @NOAASatellites about the new #GOEST satellite launch.

At the bottom of the page, there is a footer with the USA 50th Anniversary logo, "Privacy Policy", "Freedom of Information Act", "NWS Glossary", "Information Quality", and "Disclaimer".



Messages/news
(scrolling)

Quick view of
aviation weather
conditions (click
to go to GFA)

Quick access
to station data

The screenshot shows the Aviation Weather Center (AWC) website. At the top is a navigation bar with the AWC logo and menu items: Weather, Products, Tools, and Connect. Below the navigation bar is a dark grey header with a 'Welcome!' message and a note about a new look and feel for mobile devices. The main content area is divided into several sections:

- Current Conditions:** A large map of the United States with various weather symbols (clouds, rain, snow, etc.) overlaid on it.
- Graphical Forecasts for Aviation (GFA):** A smaller map titled 'Graphical Forecasts for Aviation' with the text 'Interactive maps of aviation forecasts and observations' below it.
- Decision Support Imagery (DSI):** A section titled 'Decision Support Imagery' with the text 'Static DSS images to embed in briefing material' below it, showing several smaller weather maps.
- Station data:** A form with a text input field containing 'KMCI', a dropdown menu set to 'Most recent', radio buttons for 'Raw' (selected) and 'Decoded', a 'Remember' toggle, and 'Go' and 'Expand' buttons.
- Where is...?:** A list of links and information:
 - Fully integrated GFA maps – accessed through the Weather menu
 - HEMS Tool is now [GFA-LA](#) – all of the same features and more
 - Radar, satellite, METARs, and other current data on the [observation map](#)
 - Text Data Server has been replaced by the [Data API](#)
 - Raw and decoded [METAR](#) and [TAE](#) data
 - Public hourly forecasts are available through [Weather.gov](#)

Navigation bar

Link to GFA

Link to dedicated
DSS imagery

Help area

Youtube Tutorials

☰ YouTube

- 🏠 Home
- 📺 Shorts
- 📄 Subscriptions
- 📖 Library
- 🕒 History

Sign in to like videos, comment, and subscribe.

👤 Sign in

Explore

- 🔥 Trending
- 🛒 Shopping
- 🎵 Music
- 🎬 Movies & TV
- 📺 Live
- 🎮 Gaming
- 📰 News
- 🏆 Sports
- 💡 Learning
- 💄 Fashion & Beauty
- 🎧 Podcasts

➕ Browse channels

More from YouTube

Search



👤 Sign in



NWSAWC

@nwsawc207 143 subscribers 18 videos

NOAA NWS Aviation Weather Center >

Subscribe

HOME VIDEOS PLAYLISTS COMMUNITY CHANNELS ABOUT 🔍

Latest Popular Oldest



AWC Archive View
80 views • 1 month ago



FAA Pre-Flight Briefing using Aviationweather.gov
460 views • 3 months ago



WRN FLYERS: Turbulence and Low-Level Wind Shear: A Pilot's...
133 views • 4 months ago



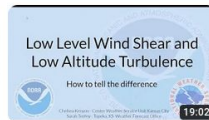
WRN FLYERS: Low-Level Wind Shear and Low Altitude Turbulence: How...
102 views • 4 months ago



WRN FLYERS: NOAA Aviation: Operational Turbulence
28 views • 7 months ago



WRN FLYERS: Turbulence and Low Level Wind Shear: A Pilot's...
91 views • 7 months ago



WRN FLYERS: Low Level Wind Shear and Low Altitude Turbulence: How...
124 views • 7 months ago



WRN FLYERS: High Turbulence Mechanisms and Satellite...
25 views • 7 months ago

Connect ▾

📘 About AWC

🐦 Twitter

📘 Facebook

📺 YouTube

🧪 Aviation Weather Testbed

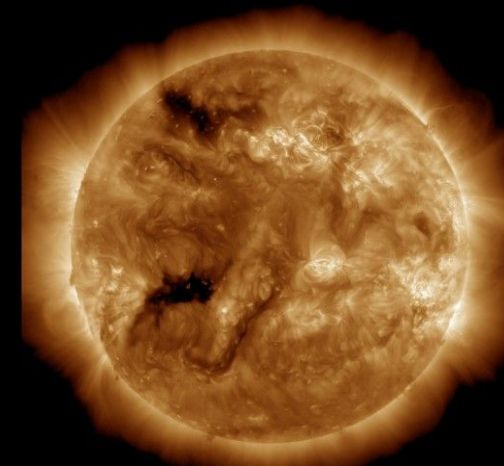
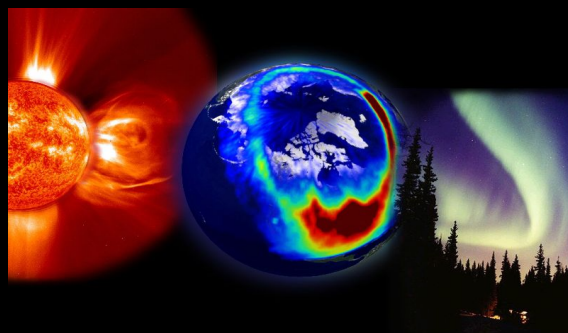
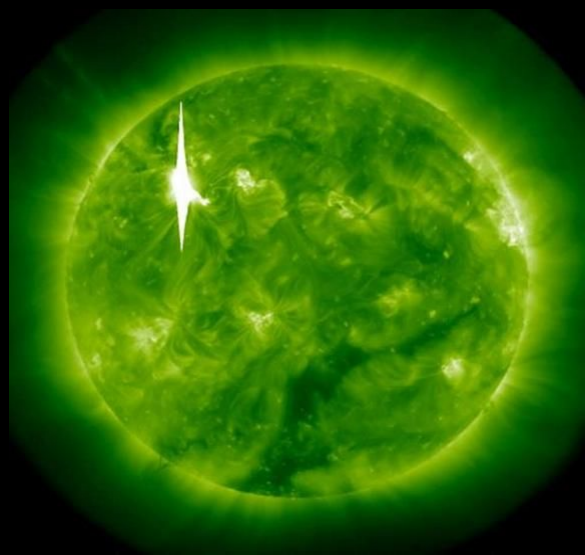


Thank you!

Questions?

Amanda.Martin@noaa.gov
aviationweather.gov

Space Weather Prediction Center (SWPC) Support for Communications



SWPC: "Safeguarding Society with Actionable Space Weather Information"

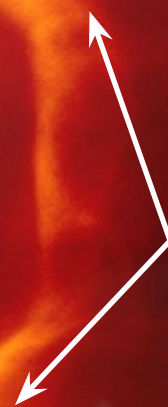


What is Space Weather?

Space weather refers to the variable conditions on the Sun and in space that can influence performance and reliability of space and ground-based technological systems, and endanger life or health.



Coronal
Mass
Ejection



Two white arrows pointing from the text to a bright, glowing cloud of plasma being ejected from the Sun's corona.

Various emissions from the Sun affect Earth

93 Million Miles from Sun to Earth



A long white arrow at the bottom of the slide, spanning the distance from the Sun to Earth.

Ionosphere



A white arrow pointing from the text to the upper layer of Earth's atmosphere, depicted as a blue, glowing ring.

Magnetosphere



A white arrow pointing from the text to the region of space around Earth, depicted as a blue, glowing, teardrop-shaped field.

SWPC Forecast Operations (SWFO)

Operations, systems & data monitoring, forecasting, watches/warnings & Alerts, IDSS, etc.



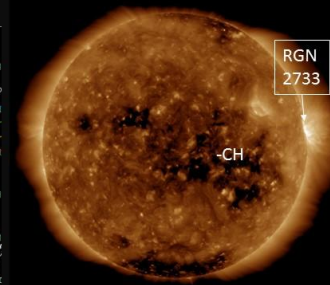
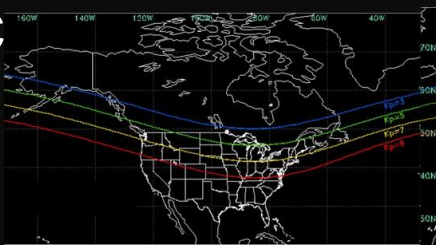
Staffed 24 hours 7 days a week – just like any NWS forecast office

Core partnerships with USAF, NASA, FEMA, NERC

G1

Minor geomagnetic storm watch in effect: 31 January and 1 February, 2019

Most likely area of Aurora Extent: to the vicinity of the green line (Kp=5)



590/AA, 193 2019-01-30 12:59:04 UT

For updating aurora visibility information go to the SWPC aurora (OVATION-Prime) model: <http://www.swpc.noaa.gov/products/aurora-30-minute-forecast>

SPACE WEATHER PREDICTION CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Monday, July 15, 2019 13:10:50 UTC

HOME ABOUT SPACE WEATHER PRODUCTS AND DATA DASHBOARDS MEDIA AND RESOURCES SUBSCRIBE ANNUAL MEETING FEEDBACK

SEARCH

SPACE WEATHER CONDITIONS on NOAA Scales

24-Hour Observed Maximums: R S G (none, none, none)

Latest Observed: R S G (none, none, none)

Predicted 2019-07-15 UTC: R1-R2 1% (S1 or greater), R3-R5 1% (G)

Solar Wind Speed: 479 km/sec Solar Wind Magnetic Fields: Bt 6 nT, Bz -3 nT Noon 10.7cm Radio Flux: 67 sfu

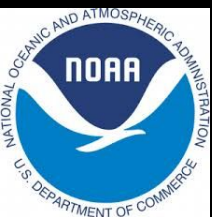
WSA-Enlil v2.0 now operational
published: Thursday, June 13, 2019 19:53 UTC
SWPC is pleased to announce the successful implementation of the upgraded WSA-Enlil heliospheric model v2.0 (the first upgrade since the initial im.

NWS Summer 2019 Safety Campaign
published: Tuesday, June 11, 2019 04:06 UTC
Get ready for summer weather hazards by visiting our Summer Safety website at <https://www.weather.gov>

Solar Cycle 25 Preliminary Forecast
published: Tuesday, June 11, 2019 04:03 UTC
The NOAA/NASA co-chaired international panel to forecast Solar Cycle 25 released a preliminary forecast for Solar Cycle 25 on April 5, 2019.

Save the Date - June 26, 2019 - Space Weather Enterprise Forum
published: Tuesday, June 11, 2019 04:02 UTC
The 2019 Space Weather Enterprise Forum will be held June 26, 2019

SERVING ESSENTIAL SPACE WEATHER COMMUNITIES





Focus areas

(3 primary activity types SWPC forecasts)

Impacts & Phenomena Based Forecasts

Solar Radiation Storms (S-scale) : related to Solar Proton Events

Solar Radiation Storm Warnings and Alerts

HF Radio Blackouts (R-scale): as related to Solar Flares

Solar Flare Alerts

Geomagnetic Storms (G-scale): as related to origin source
Coronal Mass Ejection (CME), Coronal Hole (CH)

Geomagnetic Storm Watches, Warnings, and Alerts

S 1 R 1 G 1	Minor
-------------------	-------

S 2 R 2 G 2	Moderate
-------------------	----------

S 3 R 3 G 3	Strong
-------------------	--------

S 4 R 4 G 4	Severe
-------------------	--------

S 5 R 5 G 5	Extreme
-------------------	---------

Sunspots & Solar Cycle

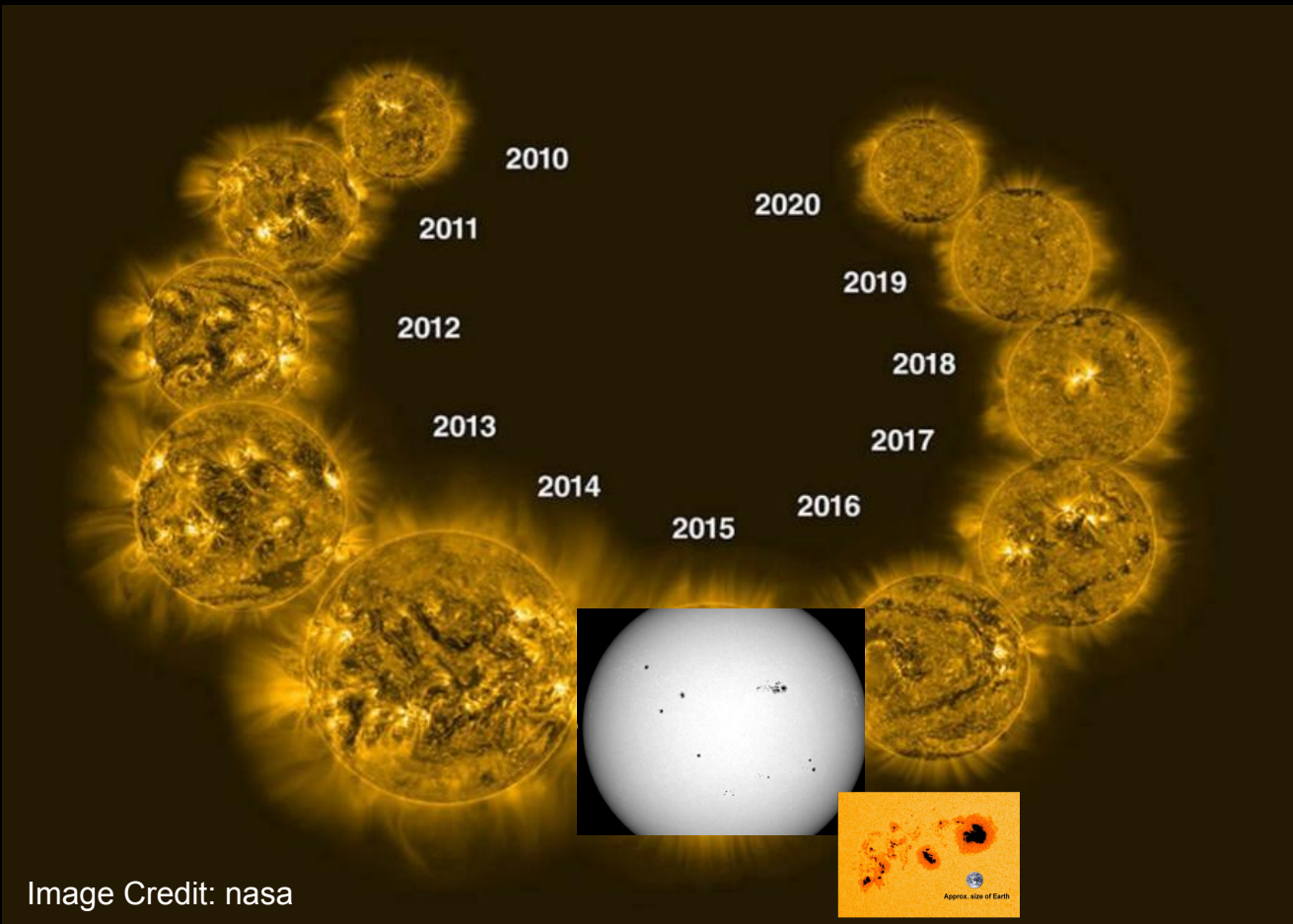
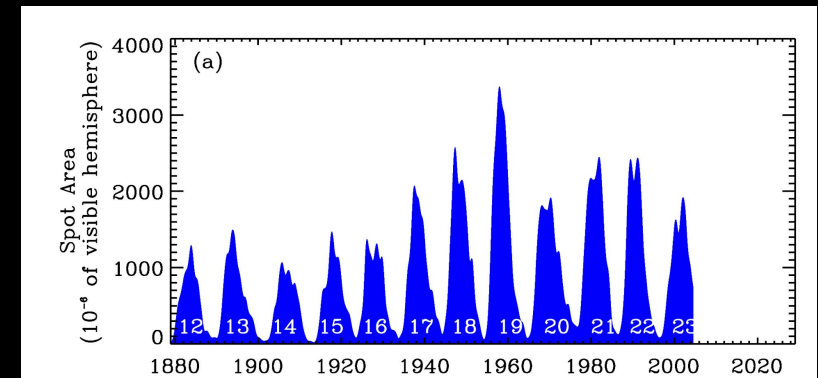
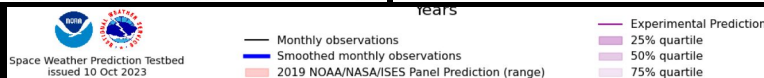
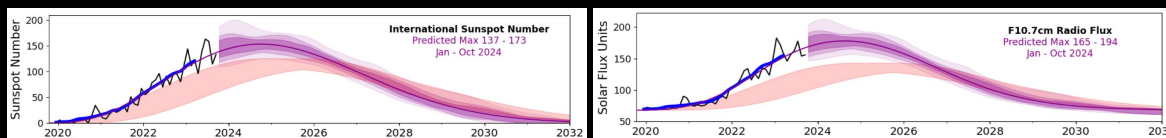


Image Credit: nasa

The highest sunspot numbers (most sunspots) are correlated with solar maximum. This is part of the 11-year solar cycle. Solar maximum is when we have increased chance of Severe & Extreme events



Solar Flares

Dec 31st

Location of a flare on the Earth-facing disk does not matter. The affect on Earth's **sunlit** side ionosphere is immediate.



Their strength is measure in **X-ray** energy from a space weather package on the GOES satellites and the strength relates to geographic area of impact to our ionosphere.



When Significant Space Weather and Catastrophic Terrestrial Weather come together – Sep 2017

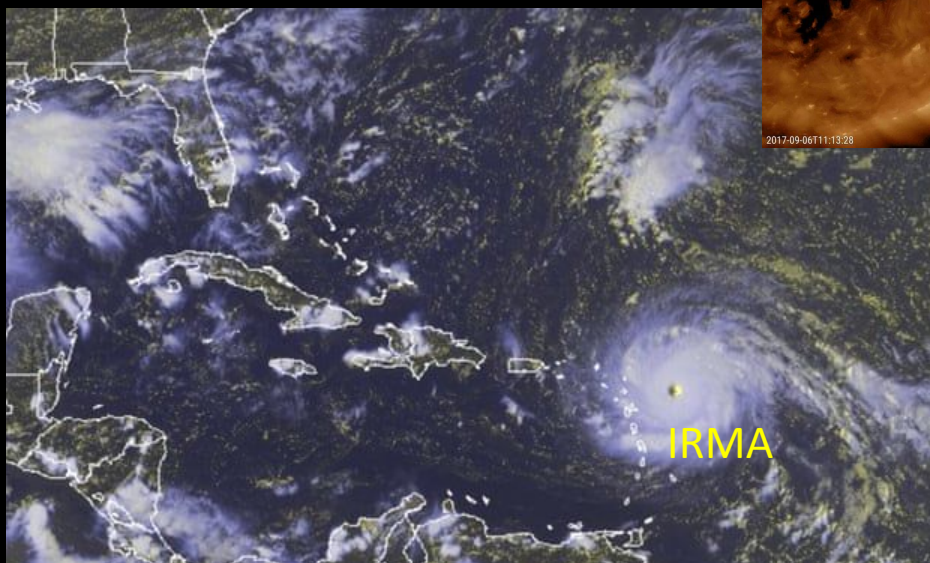
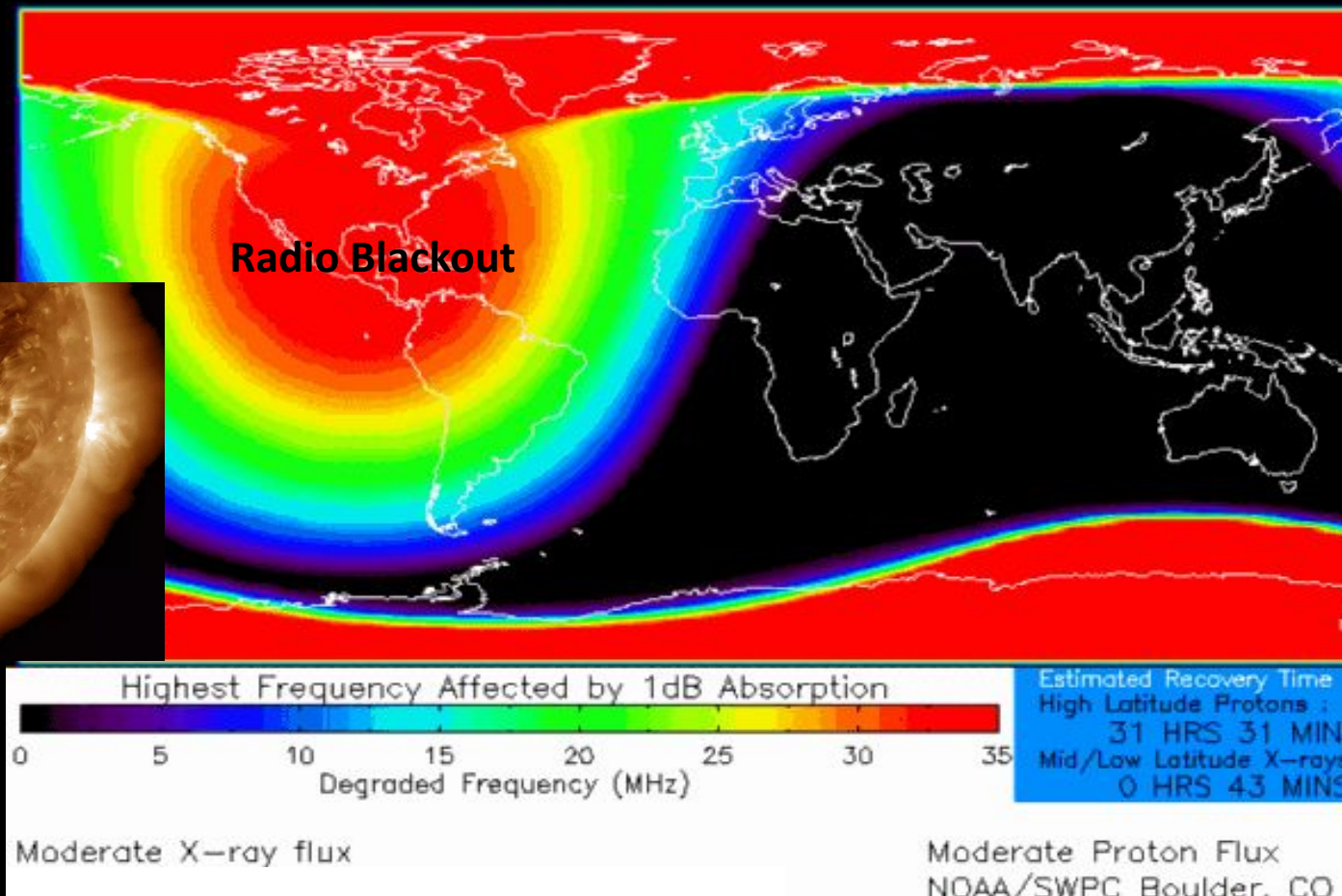
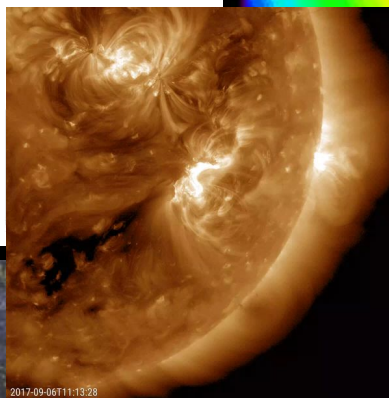


EOS NEWS NEWS FROM AGU JOURNALS TOPICS & DISCIPLINES OPINIONS BLOGS AGU'S CENTENNIAL

SPACE SCIENCE & SPACE PHYSICS Scientific Press Releases

Solar Flares Disrupted Radio During 2017 Hurricane Irma

On 6 September 2017, as Category 5 Hurricane Irma hit the Caribbean's Leeward Islands, and Tropical Storm Jose hovered in the wings, another storm erupted on the Sun.



HF Radio Comm from the Caribbean Islands (Ham Radio in particular) was nearly impossible during the hurricane disasters & crisis response for several hours. Hurricane Watch Net & Aviation Communication notably impacted.





Frequency (Radio) Bursts



Strongest Solar Flare of this Solar Cycle

Updated
2023 Dec 14
1900 EST

WHAT: Multiple Aviation Communication Impacts Associated with this Event

Dec 14th

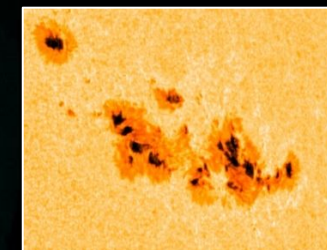
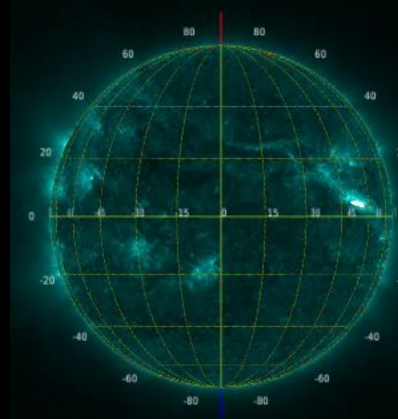
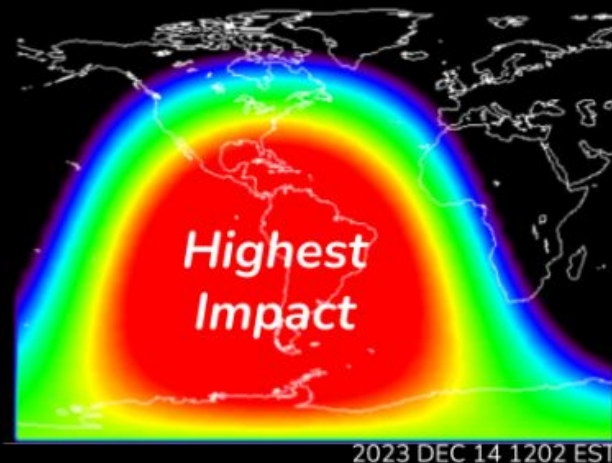
Amazing Event - likely one of the largest solar radio events ever recorded

Radio communication impacts between approximately 1200 - 1400 EST Thu

CWSUs report degraded communications across Nation

- ZKC, ZMP, ZAU, ZNY, ZOB
- "... Never seen anything like this..." - ZOB

Possible Earth-directed Coronal Mass Ejection (CME) being analyzed

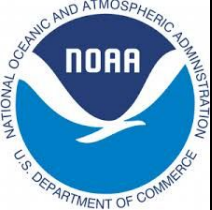


Safeguarding Society with Actionable Space Weather Information

Space Weather Prediction Center;
Boulder, CO

Can make radio communication difficult or unclear on frequencies other than HF bands. Additional Air Traffic Control (ATC) bands impacted dramatically on higher communication bands over U.S. - problem on 14 Dec! Could also be issue for urban environment communication repeater systems. Also, concern for military assets and interests.





Solar Radiation Storms



Feb 9-13th

We talk with NASA every day about threat of these events

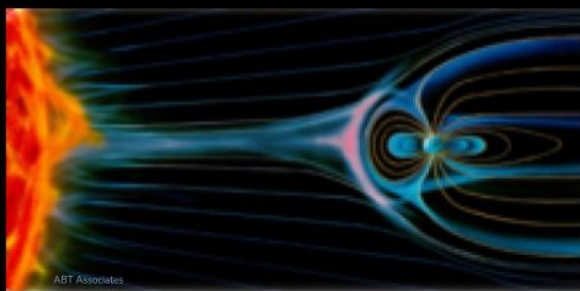


Solar Radiation Storm Event

S1 S2

Updated
2024 Feb 09
1435 EST

WHAT: A Solar Energetic Particle Event is in Progress



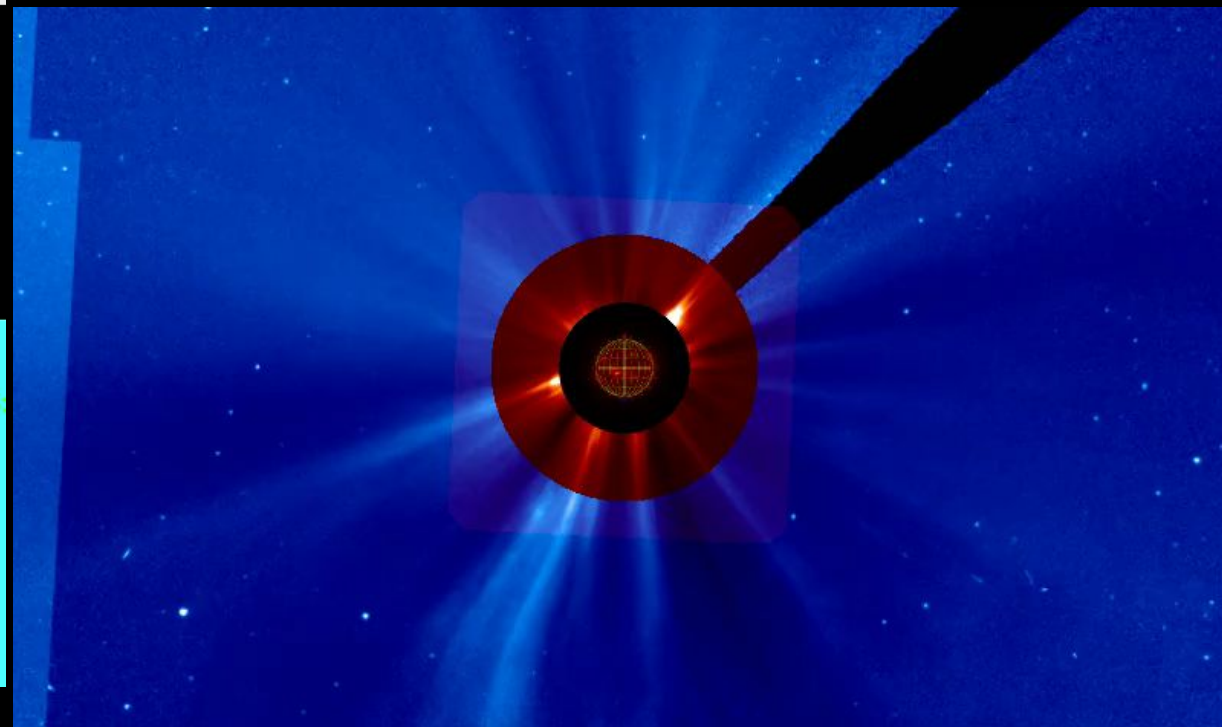
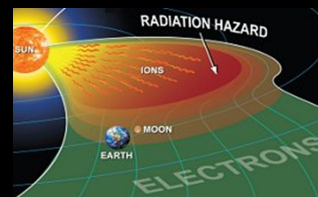
EVENT:
A solar radiation storm occurs when charged particles are accelerated by processes at or near the Sun and arrive in enough quantity at Earth. S2 levels are less common, while S1 storms are not uncommon

TIMING:
The S1 event first began at 09/1530 EST and is expected to last to at least 10/0100

GOES Proton Flux (5-minute data)

10/0100

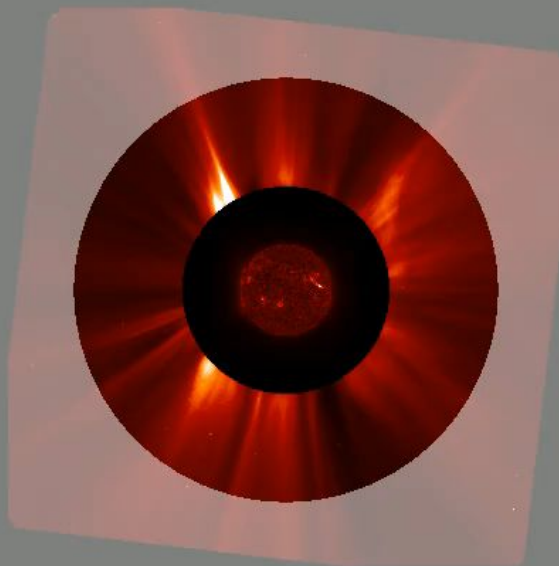
EFFECTS



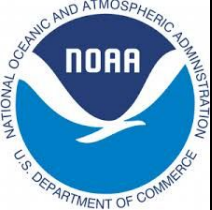
Can adversely affect aviation – increased radiation exposure risk to astronauts and perhaps aircrews at high altitudes near polar regions; relates to long HF communication outages extending from polar regions; can delay space launch and cause increased risk of anomalies to satellites

Coronal Mass Ejections (CME)

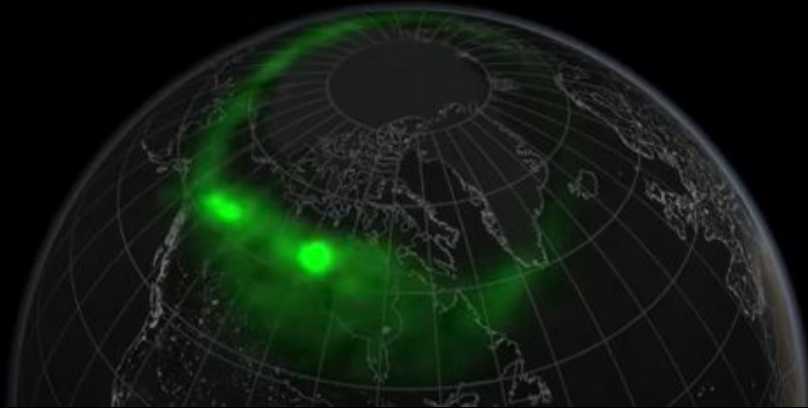
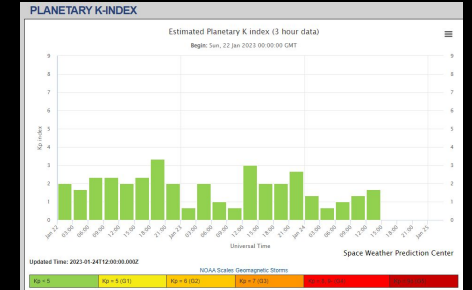
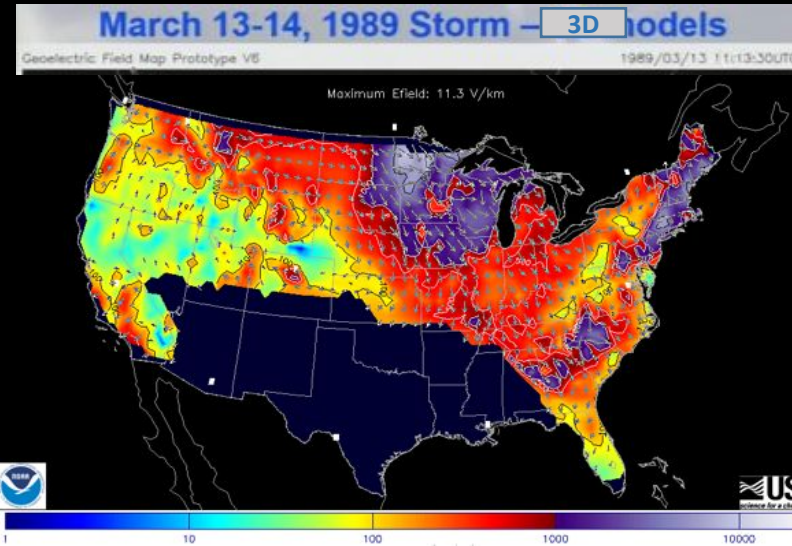
Tremendous expulsions of solar and embedded magnetic fields. Their impact to our magnetosphere can cause major changes resulting in **Geomagnetic Storms**



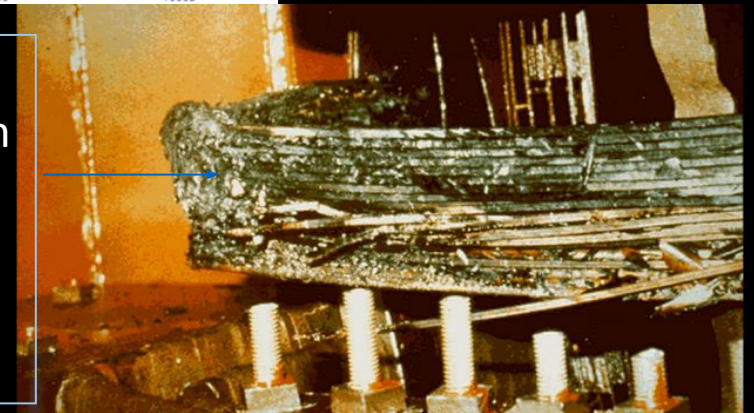
Fastest Earth-directed CMEs can get here in 15 hours. Usually, they are slower and take 2 to 4 days.



Geomagnetic Storms

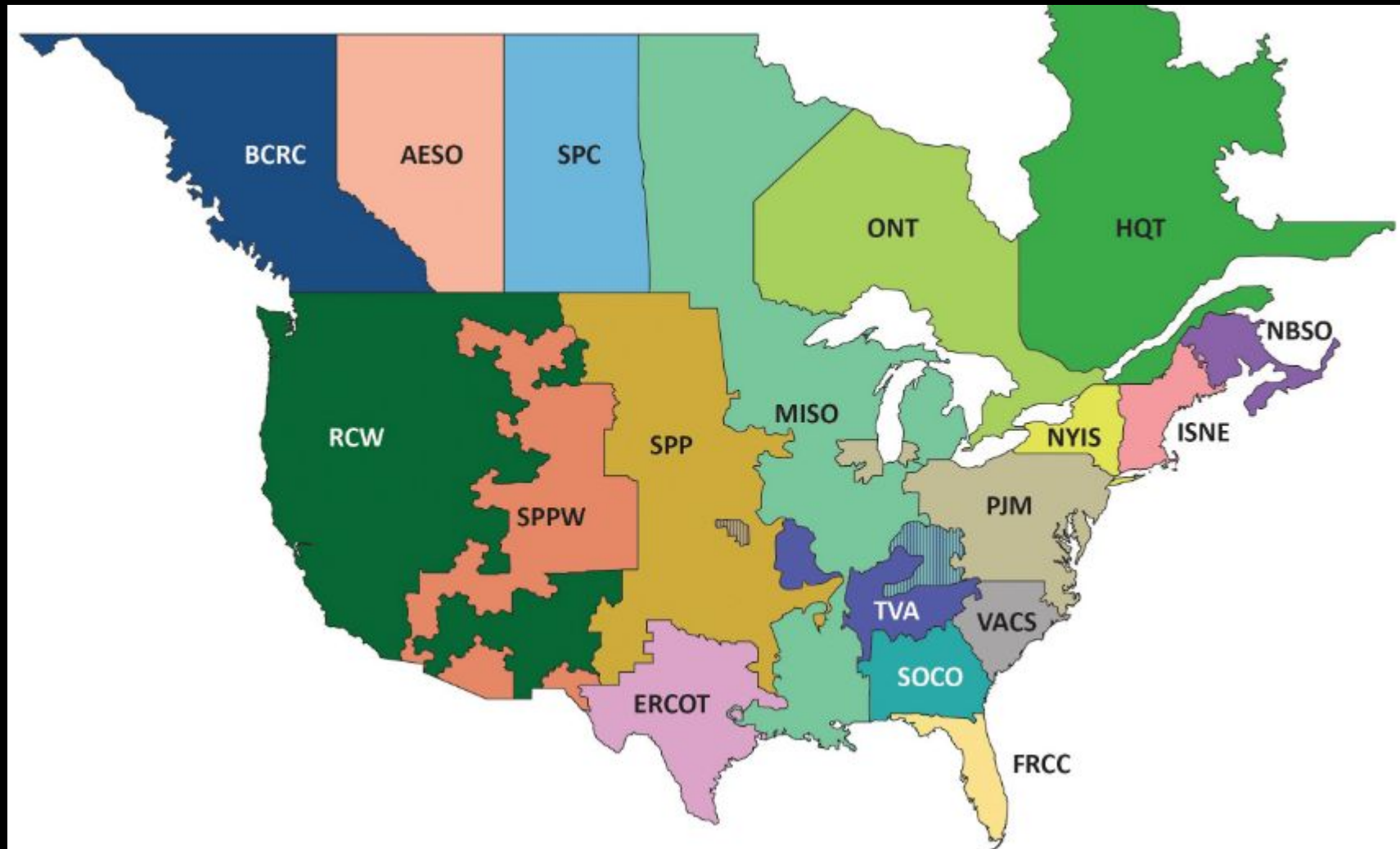


Severely
damaged Salem
New Jersey
Nuclear Plant
GSU
Transformer



Can produce problematic geomagnetic induced currents on the power grid systems...
and can lead to ionosphere storms that can cause scintillation, electron density
changes that may impact SATCOM, GNSS, HF MUF depressions, satellite drag, and
more... even well after the Geomagnetic Storm is done

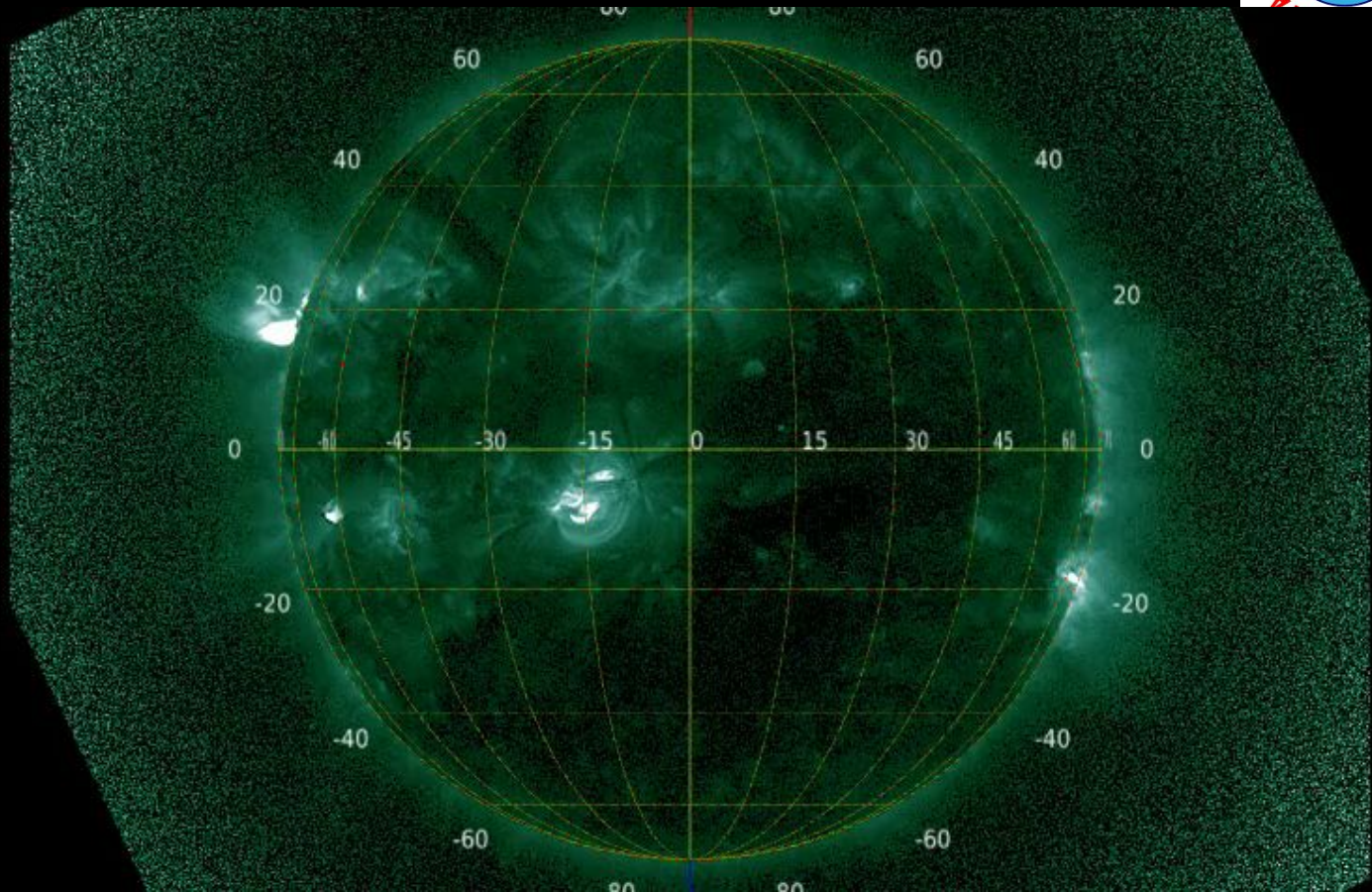
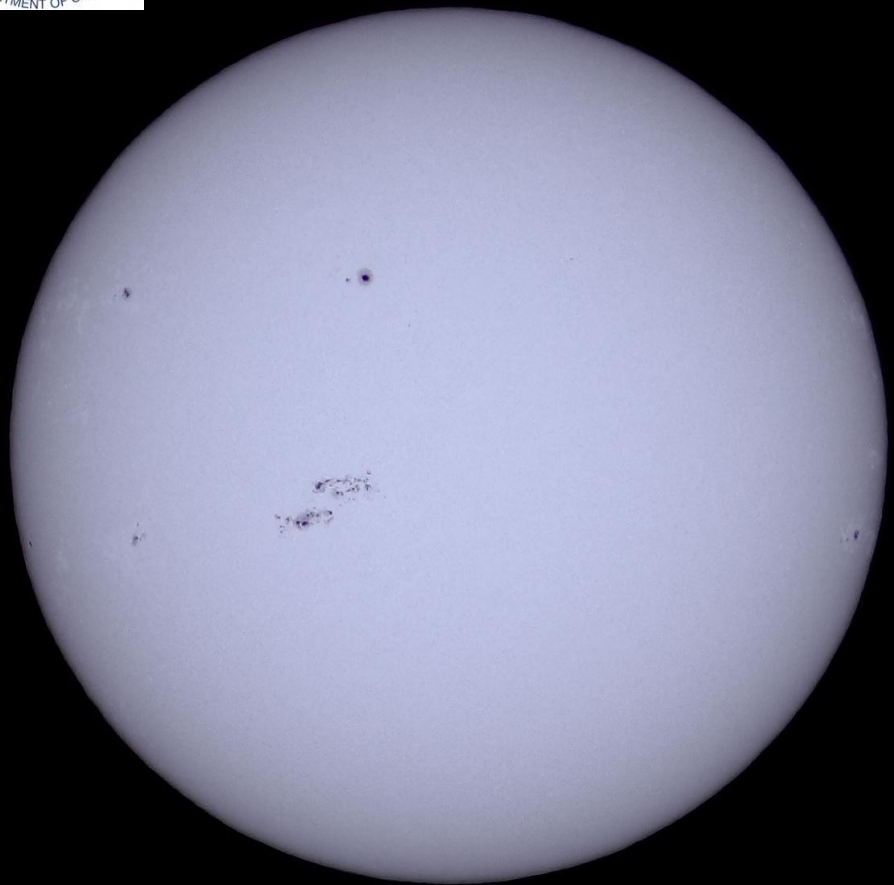
Reliability Coordinators (RC) throughout the two major and three minor Interconnections



Mitigating Power Outage Potential to our Interconnected Power Grid:
NERC Hotline Call

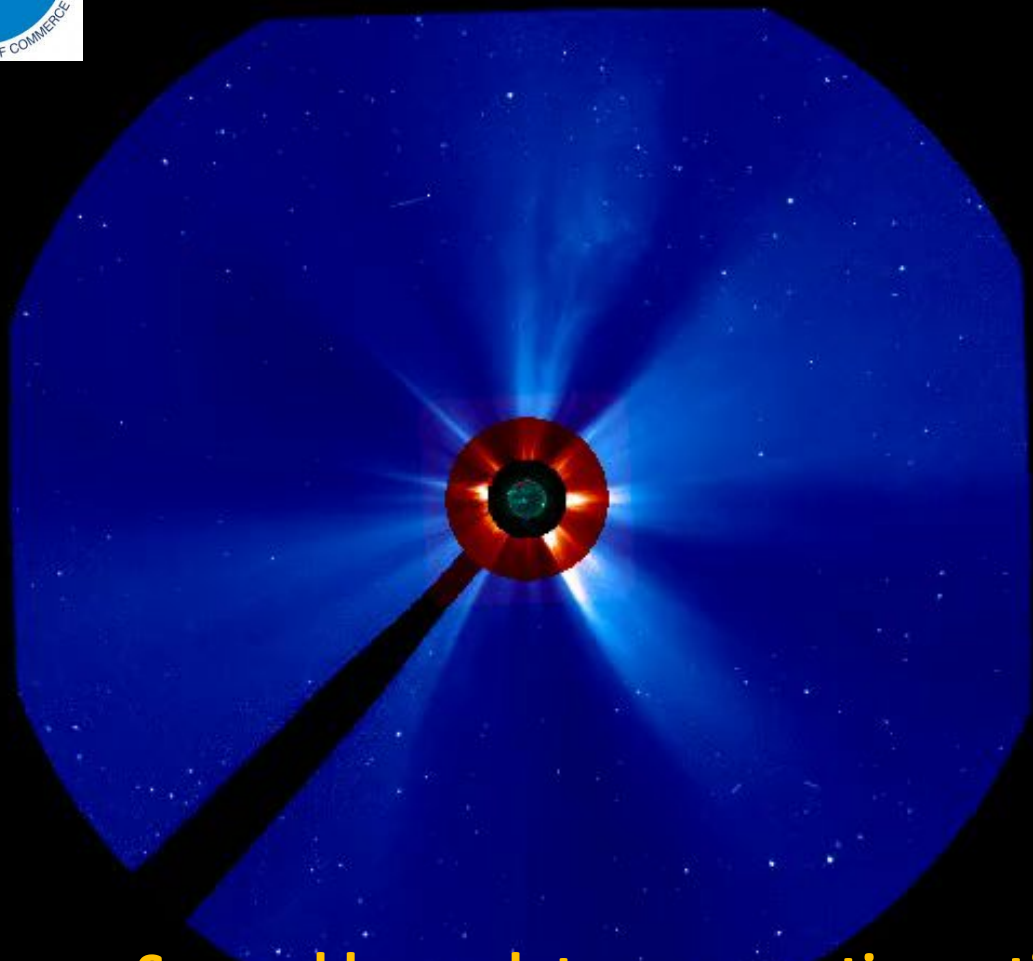
All RC's are on the NERC hotline call when we initiate the NERC hotline call beginning at G3

22 March 2024 – Sunspots/Flares



Massive and magnetically complex active region sunspot group to the south and a much smaller and moderately complex active region sunspot group to the north. The northern spot group erupted with an X1 (R3) long duration flare (few hours). The southern group also flared shortly afterwards. SWPC forecasters made calls to NASA and Oakland ATC when flare activity reached M5 (R2).

22-23 March 2024 – CME/Radiation Storm



MODERATE Solar Radiation Storm Event **S2**

WHAT: A Solar Energetic Particle Event is in Progress

EVENT:

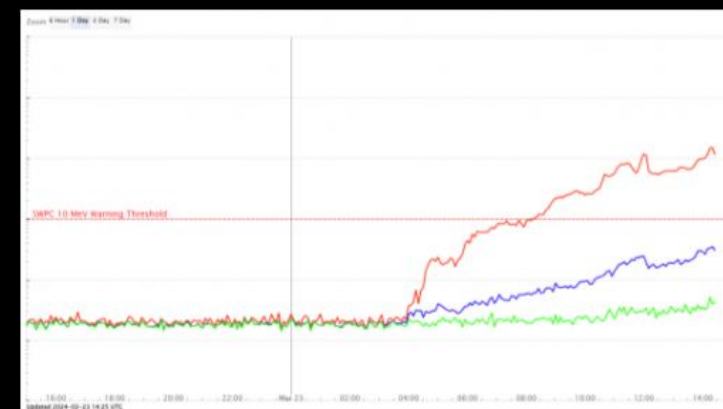
The greater than 10 MeV proton flux became enhanced following an X1.1 flare at 23/0133 UTC. Solar radiation storms at S1-S2 (Minor-Moderate) levels have been observed.

TIMING:

S1 (Minor) levels were observed beginning at 23/0815 UTC, and S2 (Moderate) levels began at 23/1405 UTC.

EFFECTS:

Degradation to HF communications in the polar regions; possible risk to space launch and satellites; high flying interests along polar routes should monitor the situation for updates. The general public need not be concerned.



Several hours later, energetic particles (protons) arrive at GOES-16/18. SWPC forecasters call NASA/SRAG among others. About 6 hours later, imagery from the NASA coronagraph at L1 (1 million miles from Earth) captures the associated CME departing the Sun. It is a full halo and SWPC forecasters begin analyzing and modelling the CME for anticipated Earth arrival timing and intensity. Speed over 1000 km/s (fast)

24 Mar - Geomagnetic Storms



Geomagnetic Storm Levels Continue



Updated
2024 Mar 24
4:15pm EDT

WHAT: CME progression continues and the effects are anticipated to linger into 25 March



EVENT:

A coronal mass ejection (CME) that departed the Sun Friday evening, 22 March, reached Earth this morning and continues its progression and geomagnetic storm levels to at least G3 are expected through Sunday evening, 24 March.

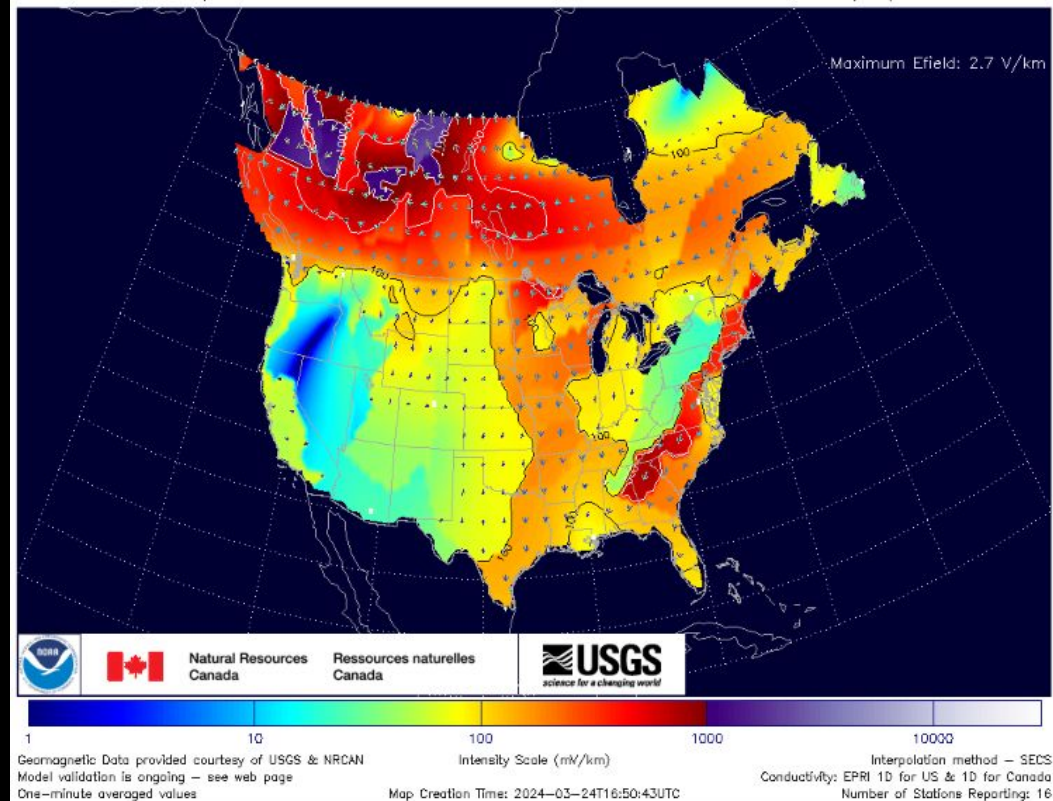
TIMING:

Changes in the strength of the geomagnetic storm levels will occur due to variations in solar wind as the CME continues to pass over Earth.

EFFECTS:

G1 through G4 levels have been reached so far with this CME related activity and should G4 levels be reached tonight, the aurora may become visible over much of the northern half of the country, and maybe as far south as Alabama to northern California.

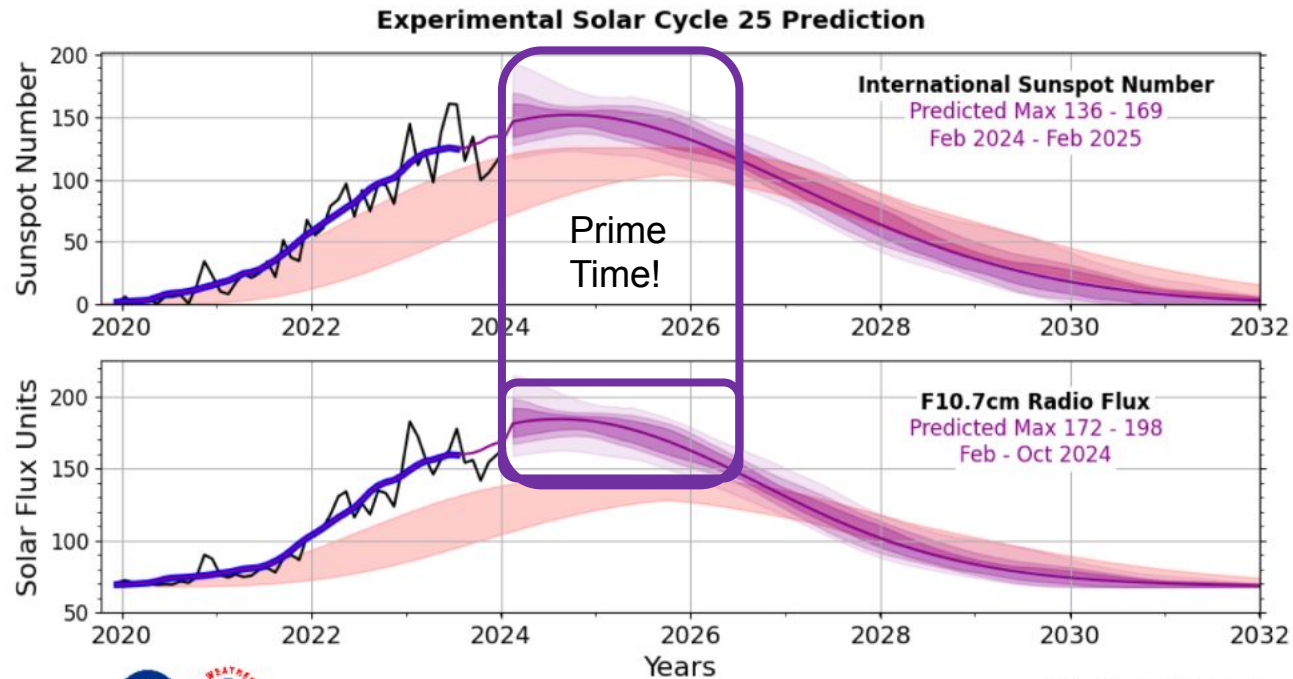
Geoelectric Field Map US-Canada-1D 2024/03/24 16:39:30UTC



CME shock arrives at L1 as observed by DSCOVR/ACE spacecraft. SWPC forecasters issue Sudden Impulse warning for benefit of the power grid. Decent SI observed less than 30 minutes later. Geomagnetic responses rapidly escalate and SWPC forecasters begin calling specific transmission operation centers, Oakland ATC, NASA/SRAG, NWS SOC. At G3 (NERC Hotline Call), at G4 – FEMA WOC and Denver MOC contacted.

Current Solar Cycle 25 is ramping up; currently above the original forecast margin of error

Solar Cycle Progression Updated Prediction (Experimental)




Space Weather Prediction Testbed
issued 2 Feb 2024

— Monthly observations
— Smoothed monthly observations
— 2019 NOAA/NASA/ISES Panel Prediction (range)

— Experimental Prediction
— 25% quartile
— 50% quartile
— 75% quartile



How to STAY Informed

NOAA Space Weather @NWSSWPC · 21h
 G3 storm levels were reached at 03/2359 UTC due to anticipated CME arrival. The G2 Watch and appropriate warnings continue for 04 Nov as CME passage continues. Visit swpc.noaa.gov for the latest information and updates.

Kp=7 Strong Geomagnetic Storm ALERT

G3

G3

SPACE WEATHER PREDICTION CENTER
 NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Wednesday, January 19, 2022 19:35:19 UTC

WEATHER PRODUCTS AND DATA DASHBOARDS MEDIA AND RESOURCES SUBSCRIBE ANNUAL MEETING

Search

ONS on NOAA Scales

Observed Maximums	Latest Observed	Predicted 2022-01-19 UTC
R1-R2 none	R none	R1-R2 20%
S none	S none	S1 or greater 1%
G2 moderate	G none	R3-R5 5%

Solar Wind Speed: **584** km/sec Solar Wind Magnetic Fields: Bt **4** nT, Bz **-1** nT Noon 10.7cm Radio Flux: **115** sfu

S1 minor

MINOR Solar Radiation Storm
 Began 28 March at 1325 UTC

S1 minor

NOAA Space Weather @NWSSWPC · Nov 2

G1 Watches posted for 3-4 Nov. Several CMEs occurred 1-2 Nov, to include a full halo CME related to an M1 flare (R1 - Minor Radio Blackout) from RGN 2891 at 02/0301 UTC. Analysis & model results suggest Earth-directed components possible. swpc.noaa.gov for more info

G1

MINOR Geomagnetic Storm WATCH:
 03-04 Nov, 2021 UTC-days

Analysis suggests likely Earth-directed component from several CMEs. Visit www.noaa.gov for continuing updates and forecasts.

What is a Coronal Mass Ejection (CME)?
 published: Thursday, December 09, 2021 17:13 UTC
 Coronal Mass Ejections (CMEs) are large expulsions of plasma and magnetic field from the Sun's corona.

Space Weather
 published: Thursday, November 11, 2021 14:00 UTC
 Just like we experience weather in space!

GOES-17 goes live
 published: Friday, September 18, 2021 14:00 UTC
 GOES-17 operations on August 17, 2021.

The WAM-IPE is
 operational!

3 May

R3 Strong

X1 (R3) STRONG Solar Flare
 3 May at 1325 UTC

3 May

R3 Strong

PRIMARY AREA of IMPACTS
 Large portions of sunlit side of Earth

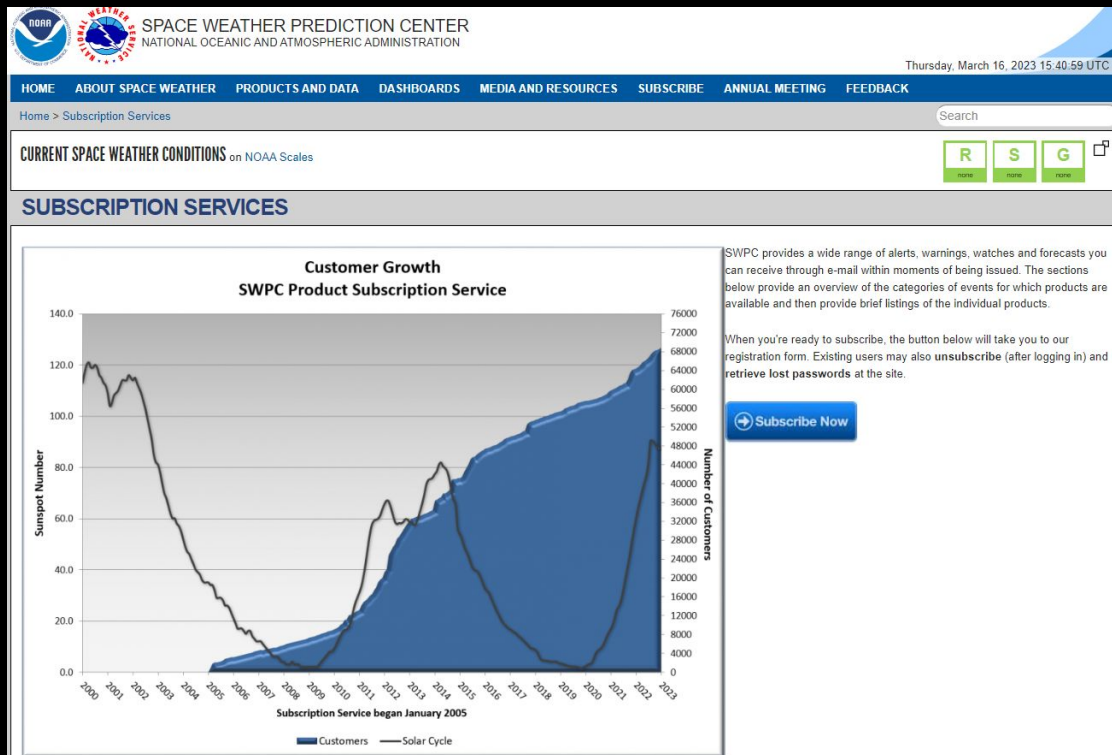
POSSIBLE EFFECTS
 HF Radio: Significant area of blackouts; loss of contact for up to an hour over sunlit side of Earth.
 Navigation: Low frequency communication degraded for about an hour.



Webpage: swpc.noaa.gov



How to GET Informed



iNWS - Interactive NWS
National Weather Service Mobile Decision Support Services (MDSS)

iNWS MOBILE ALERTING

Receive customized text message and e-mail alerts for National Weather Service products that you care about.

Welcome

InteractiveNWS (iNWS) is the home of new mobile and desktop innovations of the National Weather Service. This application suite allows NWS partners to receive National Weather Service products in new and innovative ways, such as text messaging and mobile-enabled webpages. iNWS strives to fulfill our mission of protecting life and property by using technology to reach out to our customers.

Note: If you are receiving alerts, but never signed up for them, they may be coming from a new FEMA public system called the Wireless Emergency Alerts (WEA). More information can be found at [Wireless Emergency Alerts Consumer Guide](#)

iNWS is an experimental service intended for NWS core partners: emergency managers, community leaders, other government agencies and the electronic media.

DOC | NOAA | National Weather Service - iNWS Version 6.7.7
 Privacy Policy | [Terms of Use](#) | FOIA | Information Quality | Disclaimer | Glossary | Texting While Driving

- SWPC PSS for direct emails of many various products and WWA
- *NWS INWS for direct text messages and/or emails of primary WA
- *experimental service intended only for NWS core partners, EMs, and other government agencies

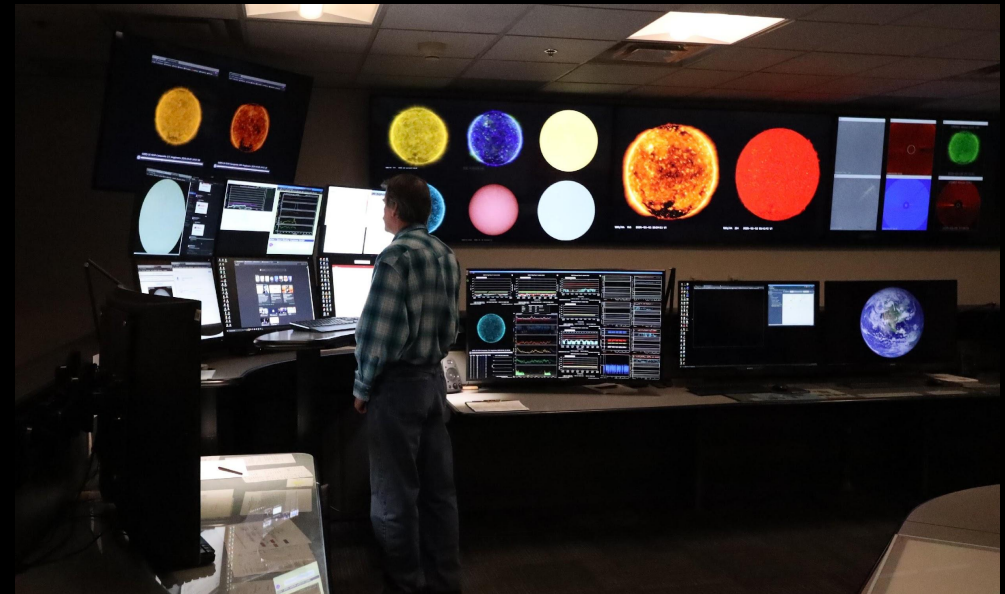
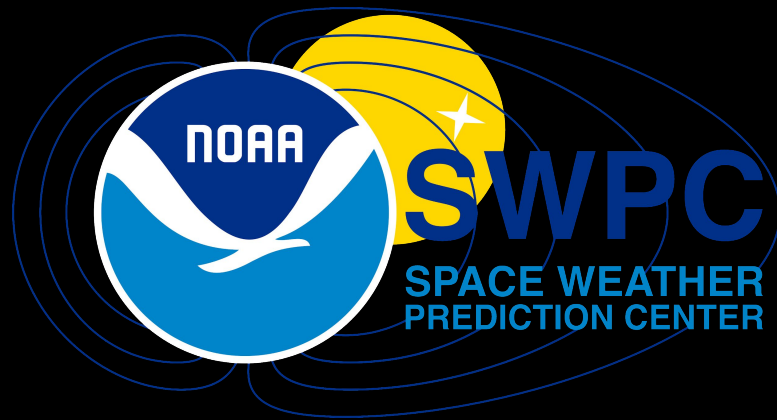
Thank You!

POC for your questions or needs

- Use your NWS WFO WCMs when possible for basic, general information; but for more specific needs or expertise, contact SWPC

Shawn Dahl – SWPC Service Coordinator

shawn.dahl@noaa.gov



“Safeguarding Society with Actionable Space Weather Information”

