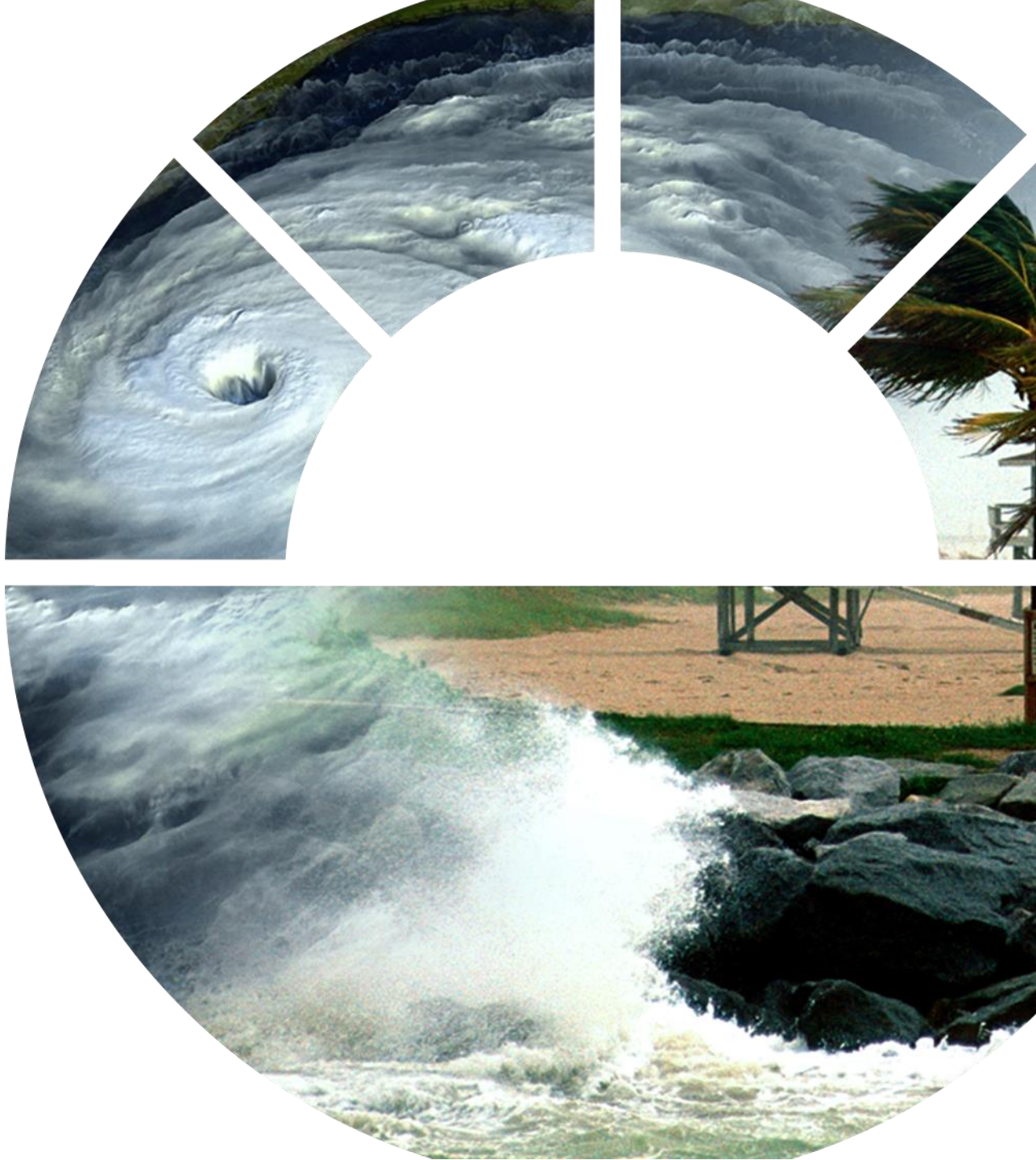
FREE WEBINAR

WEDNESDAY, MAY 11 | 11 AM EST

2022 Atlantic Hurricane Outlook



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Before we get started….

- This webinar is being recorded. The recording will be available following the webinar.
- By default, all attendees are in listen-only mode and your microphone is muted.
- Have questions? Enter them in the questions chat box for Q&A at the end of our session.
- Feel free to contact us after the presentation at info@aem.eco.

2022 Hurricane Outlook Meteorological Team

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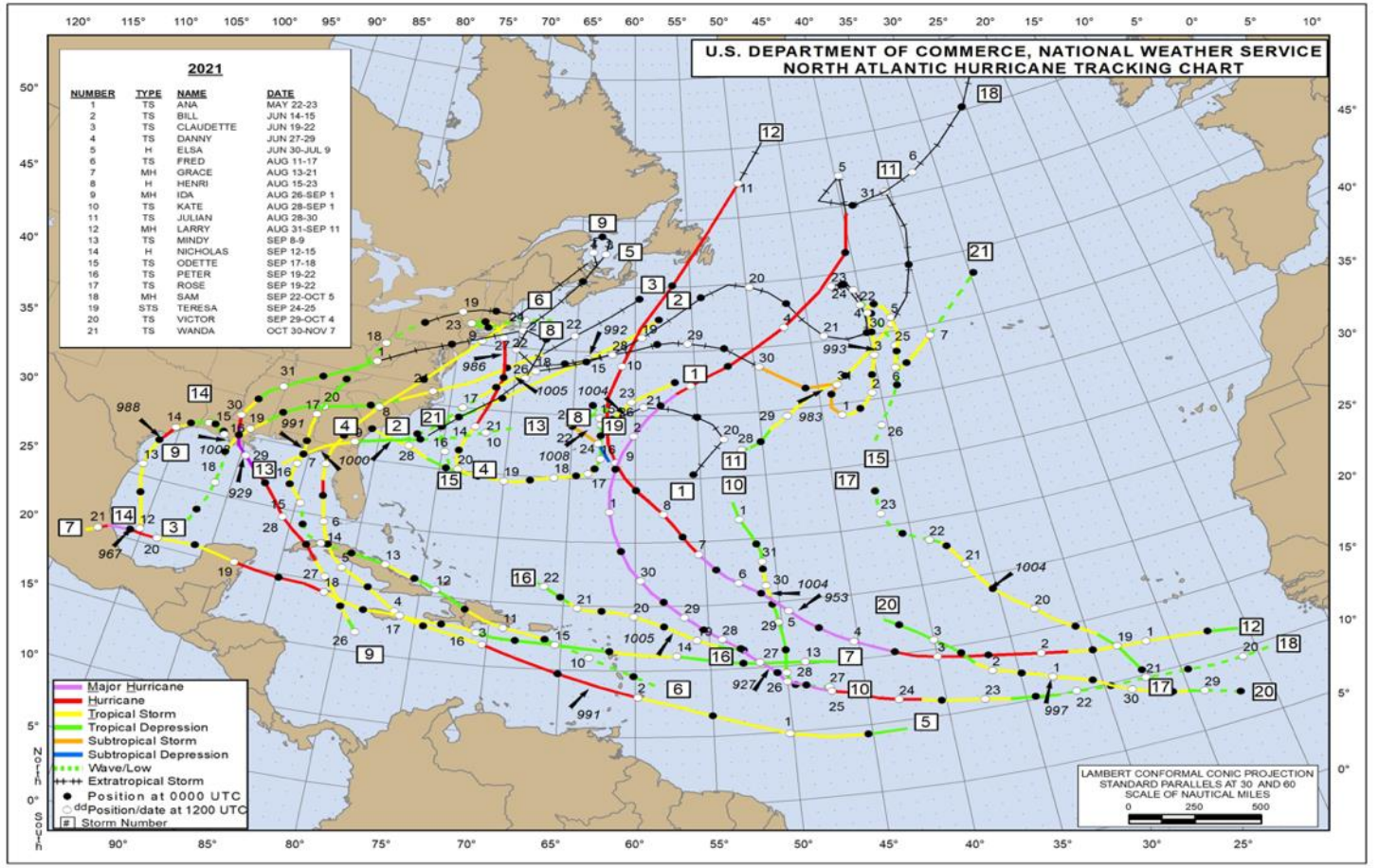
Agenda

1. Reviewing the 2021 Atlantic Hurricane Season
2. Tropical Cyclone Climatology and How Climate Factors Influence the Forecast
3. The 2022 Atlantic Hurricane Forecast

Review of 2021 hurricane season

2021 Totals

- 21 Tropical Storms
- 7 Hurricanes
- 4 Major Hurricanes



2021 Atlantic hurricane season

2021 Atlantic hurricane season

By the numbers:

21
Named storms
Average is fourteen

Ana
Bill
Claudette
Danny
Elsa
Fred
Grace
Henri
Ida
Kate
Julian
Larry
Mindy
Nicholas
Odette
Peter
Rose
Sam
Teresa
Victor
Wanda

7
Hurricanes
Average is seven

4
Major hurricanes
Average is three

5
Rapidly intensifying storms
Elsa, Grace, Ida, Larry, Sam

8
Storms hitting the U.S. coastline

7th
Consecutive year with a named storm forming before June 1st

NOAA Hurricane Hunters

58
Hurricane eyewall passages

462.2
Flight hours

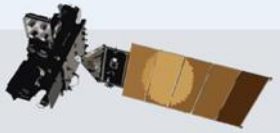
1,310
Dropsondes deployed
to gather vital atmospheric data

NOAA underwater hurricane gliders

66
Glider deployments

2,309
Glider days

78,328
Temperature and salinity profiles
These help improve forecasts for current storms



15
NOAA weather satellites in operation

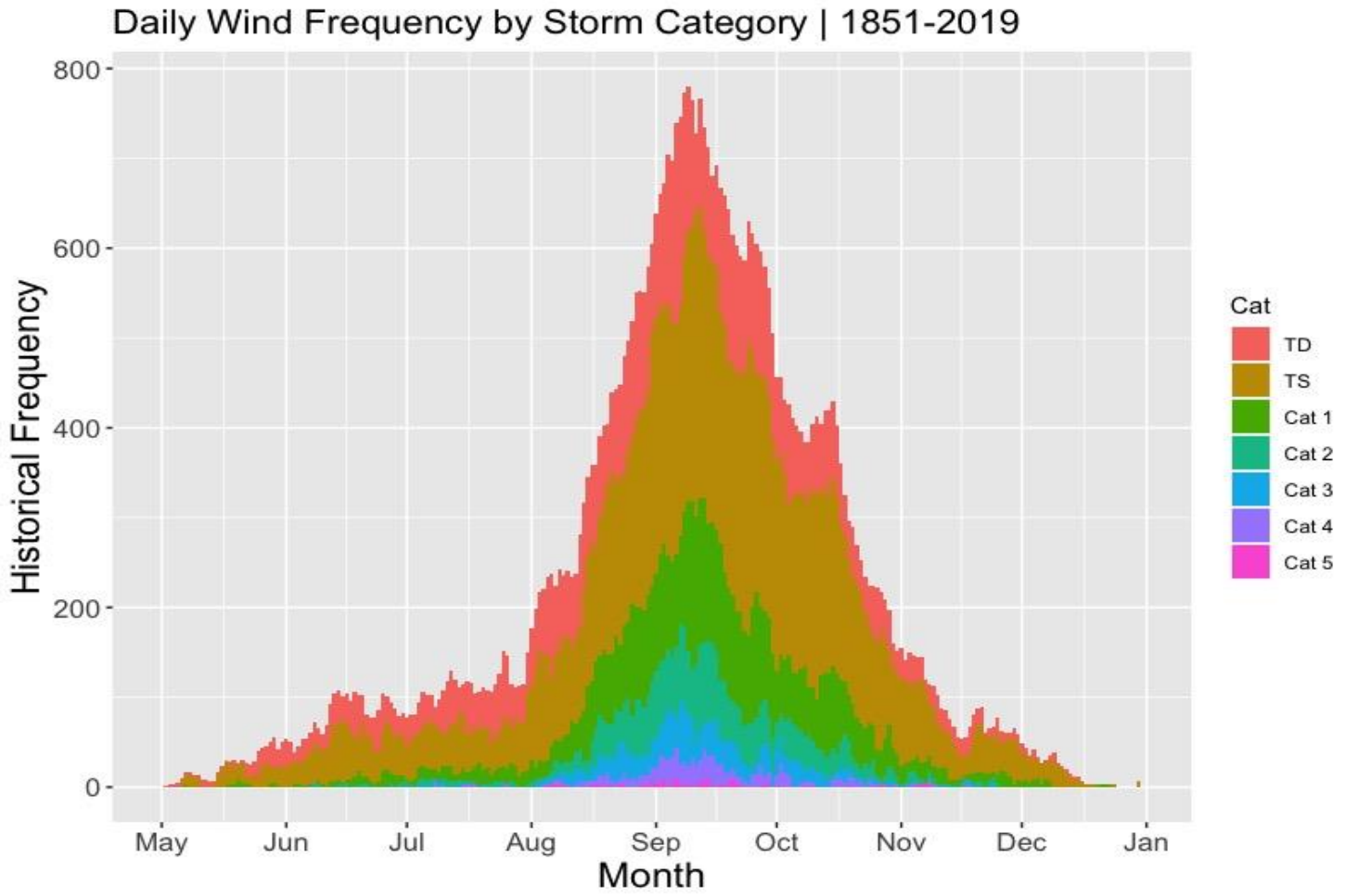
6th
consecutive above-normal season
Previous record: 4 from 1998 to 2001

59
Facebook Live broadcasts
from Ithe National Hurricane Center

2021 Hurricane Outlook: How did we do

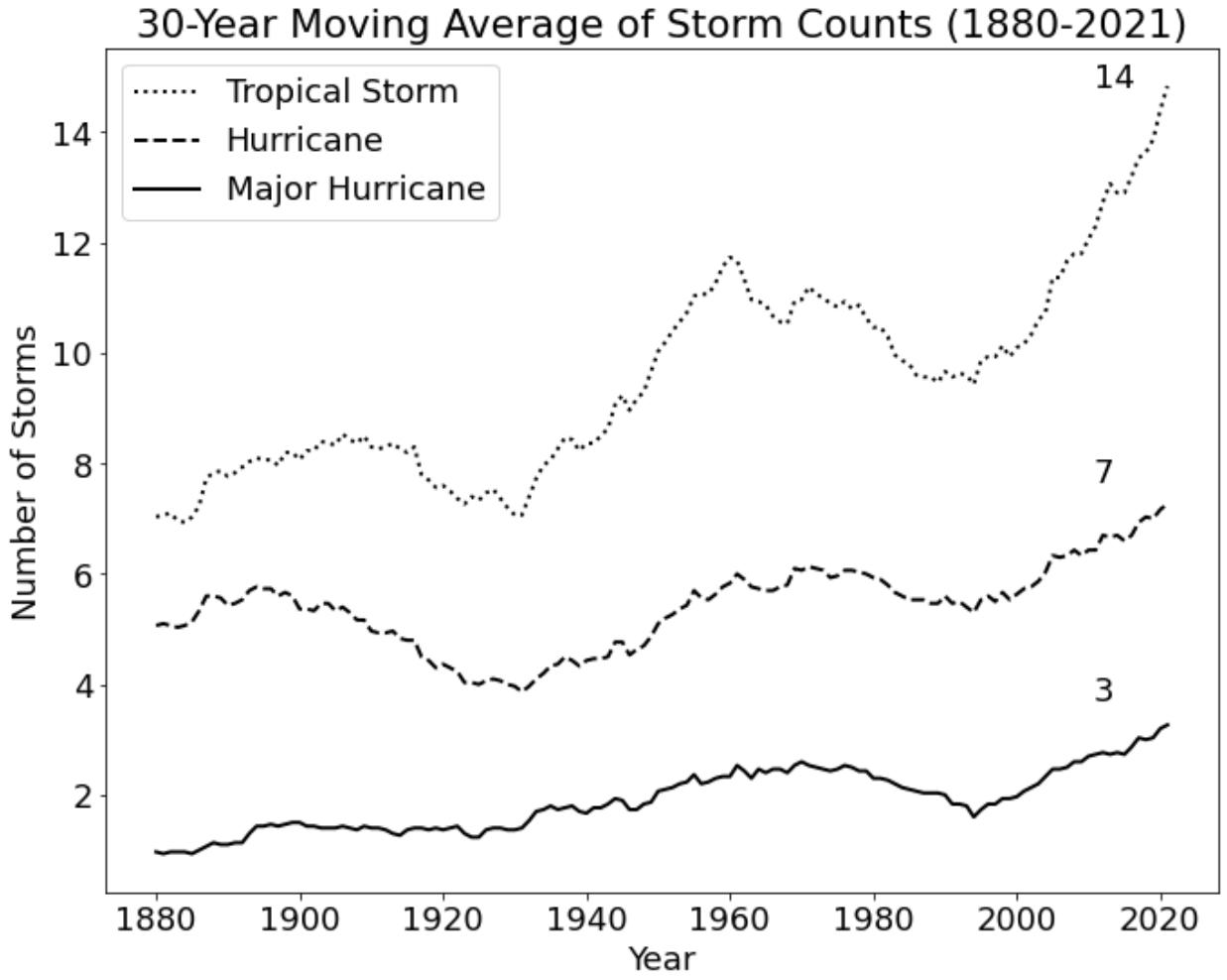
	May Forecast	2021 Actual
ACE	**133**	**146**
Named Storms	**16**	**21**
Hurricanes	**8**	**7**
Major Hurricanes	**3**	**4**

Climatology of Atlantic tropical cyclones



- Occasional storms develop early (before June 1)
- Peak activity in early September; secondary October peak
- August-October primary time for major hurricanes

Climate normals for 1991 - 2020



- 14 named storms, 7 hurricanes, 3 major hurricanes
- This only includes active era of Atlantic storms that began in 1990s
- We will use 1950-2020 for climate normals to get a better scope of the range of possible seasonal activity

Typical tropical cyclone formation, June – August

June
1851–2019

Genesis Points = 125

July
1851–2019

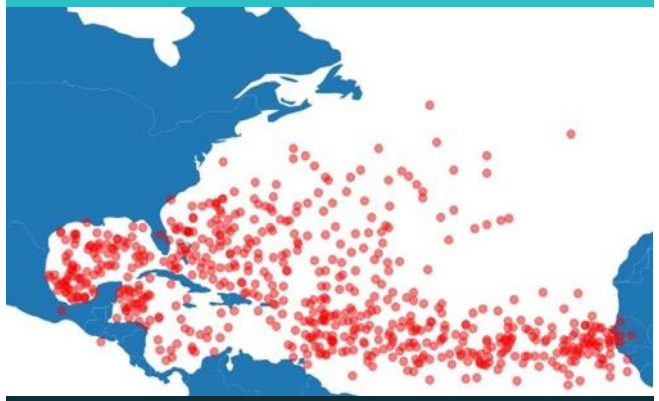
Genesis Points = 173

August
1851–2019

Genesis Points = 451

Typical tropical cyclone formation, Sept.–Nov.

September
1851–2019



Genesis Points = 630

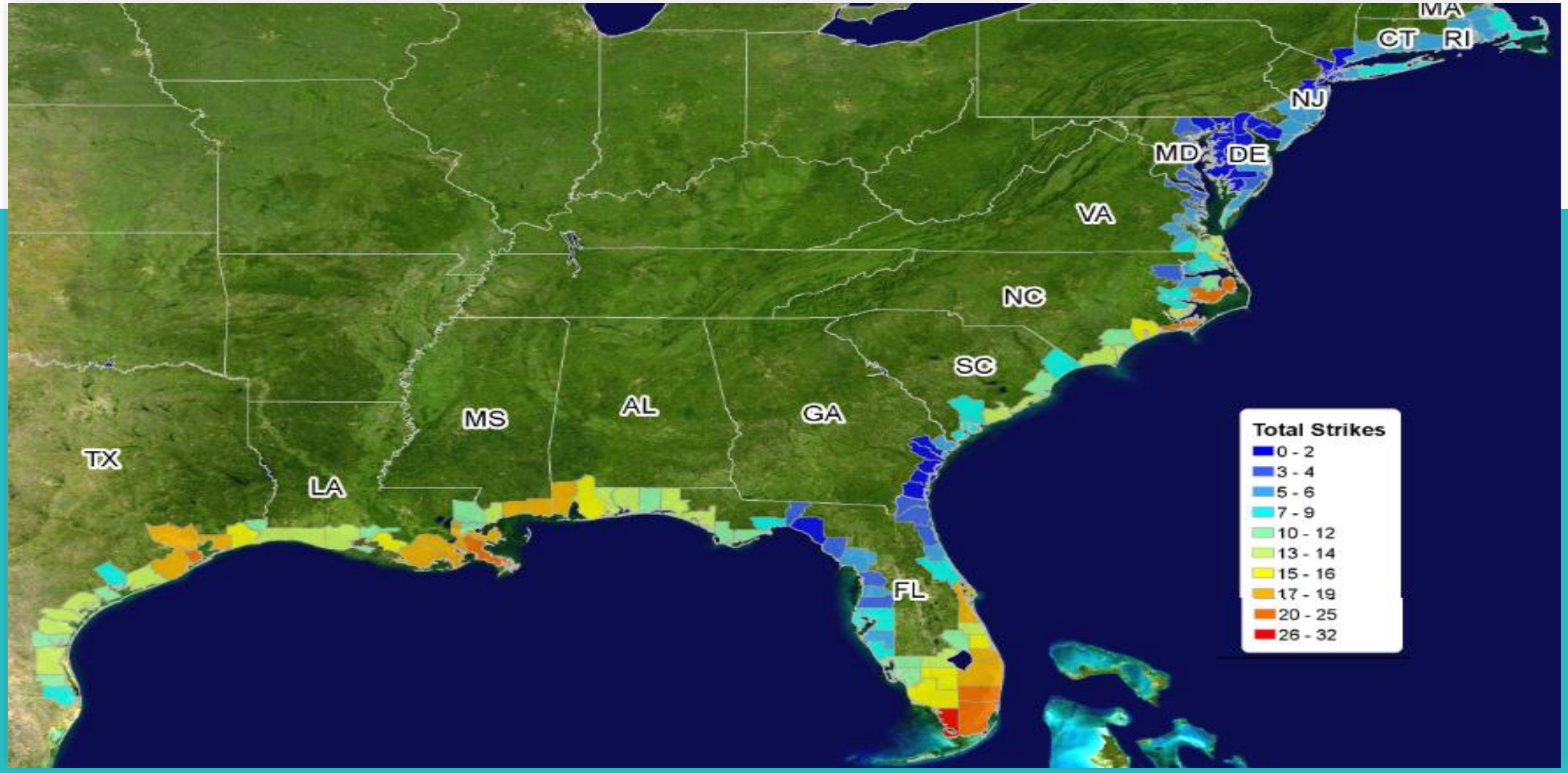
October
1851–2019

Genesis Points = 359

November
1851–2019

Genesis Points = 89

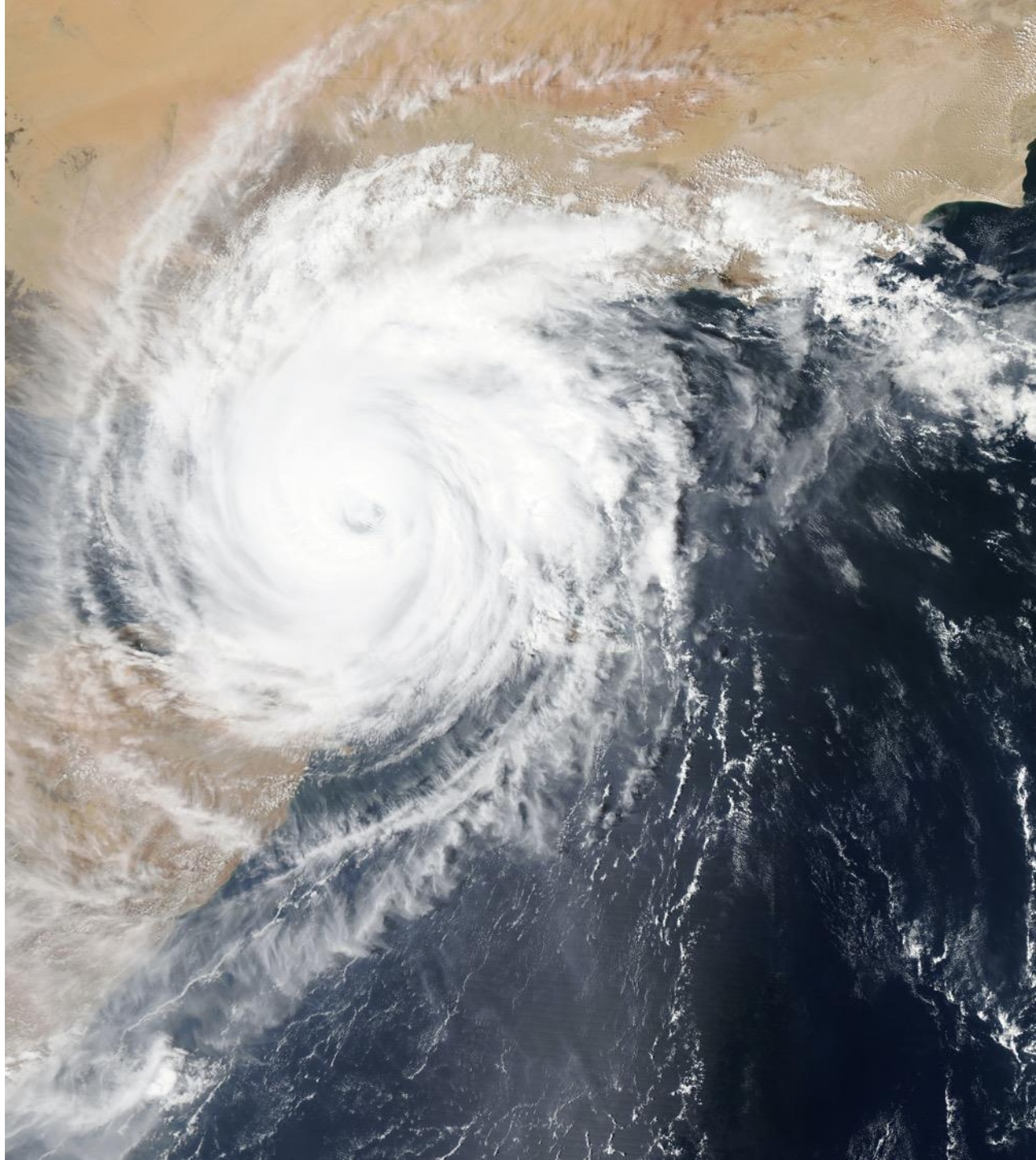
Total U.S. hurricane landfalls (1900 – 2010)



Elements of the 2022 Atlantic Hurricane Outlook

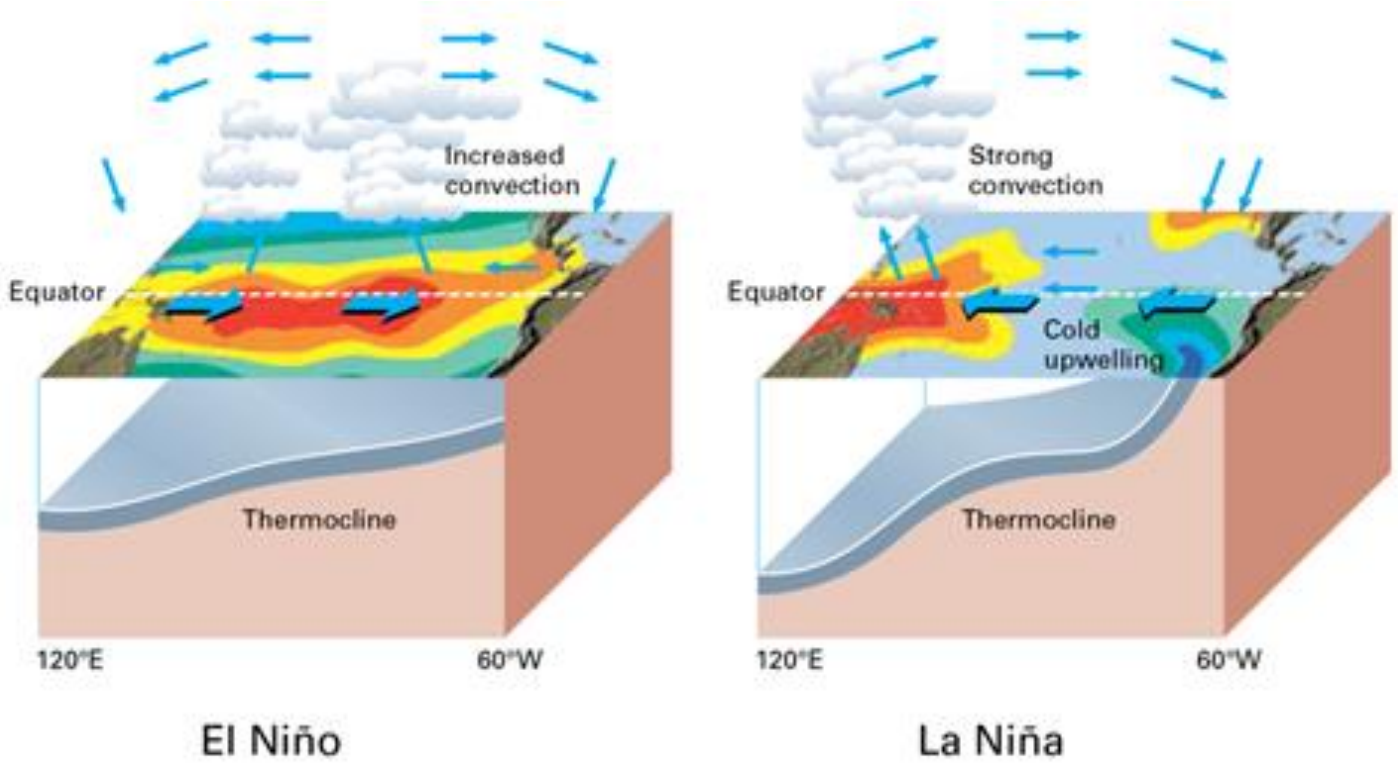
KEY PREDICTORS

- El Niño / La Niña (ENSO)
- AMO (Atlantic Multidecadal Oscillation)
- Western Hemisphere Warm Pool



ENSO – A periodic cyclical warming and cooling of the equatorial pacific ocean

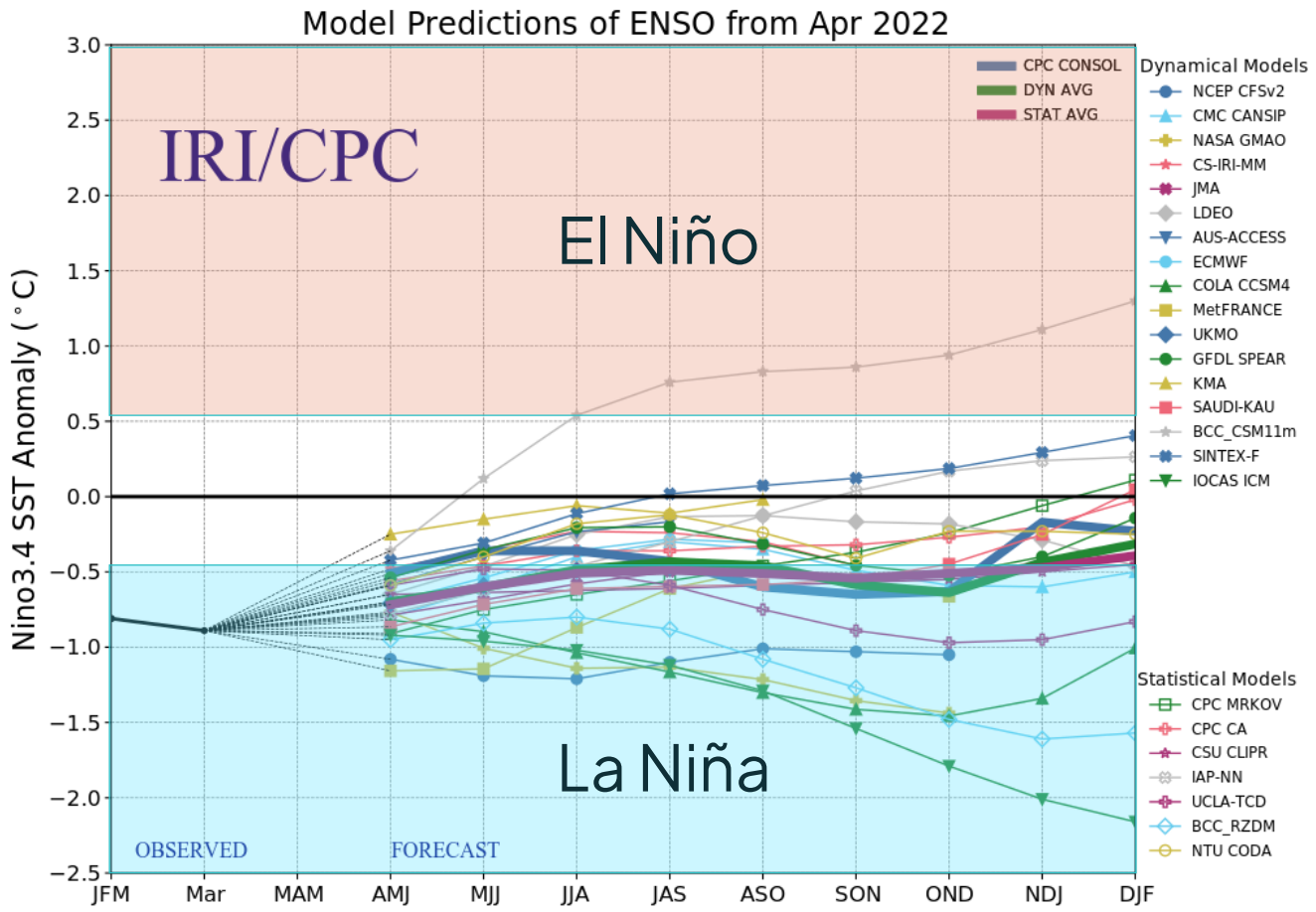
EL NIÑO/LA NIÑA BACKGROUND



- Typical circulation patterns during El Niño/La Niña

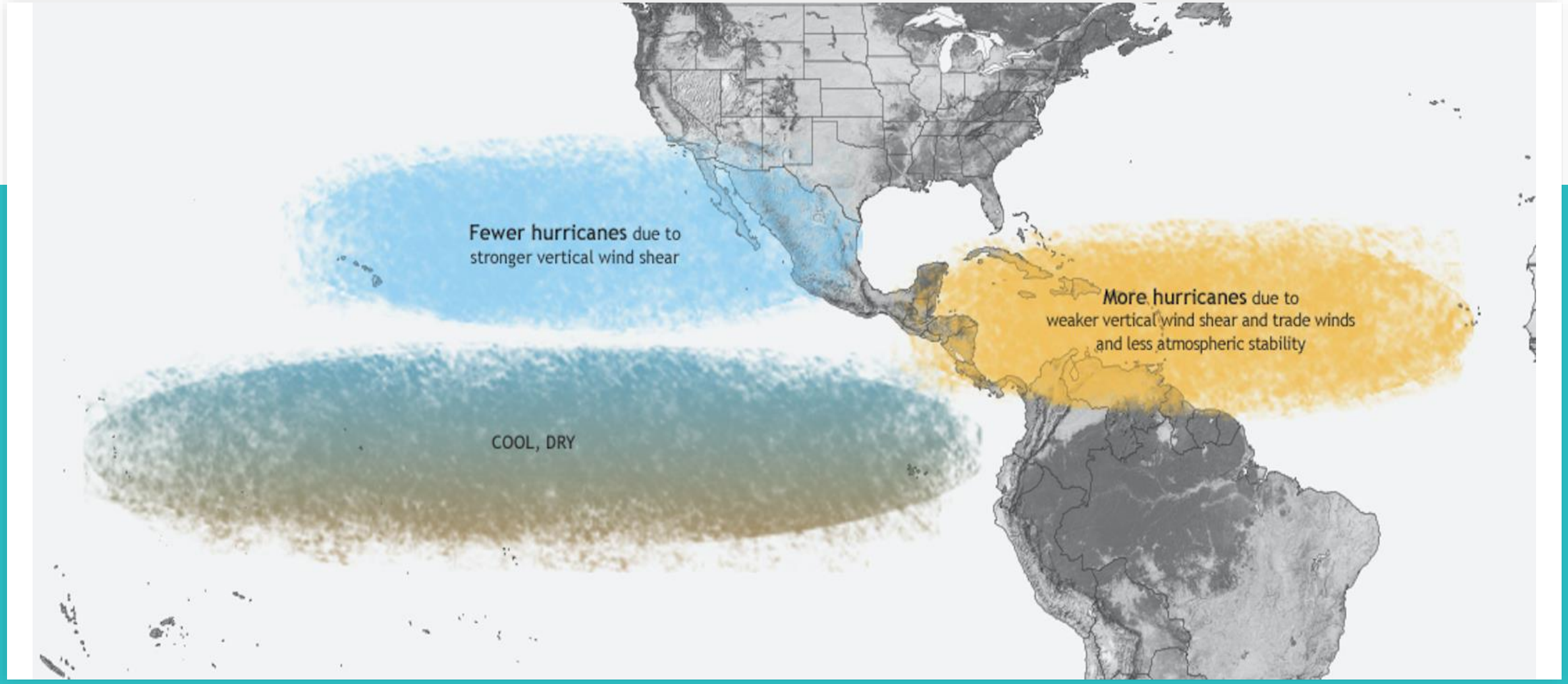
Source: WMO, El Niño/Southern Oscillation)

Latest ENSO model forecasts

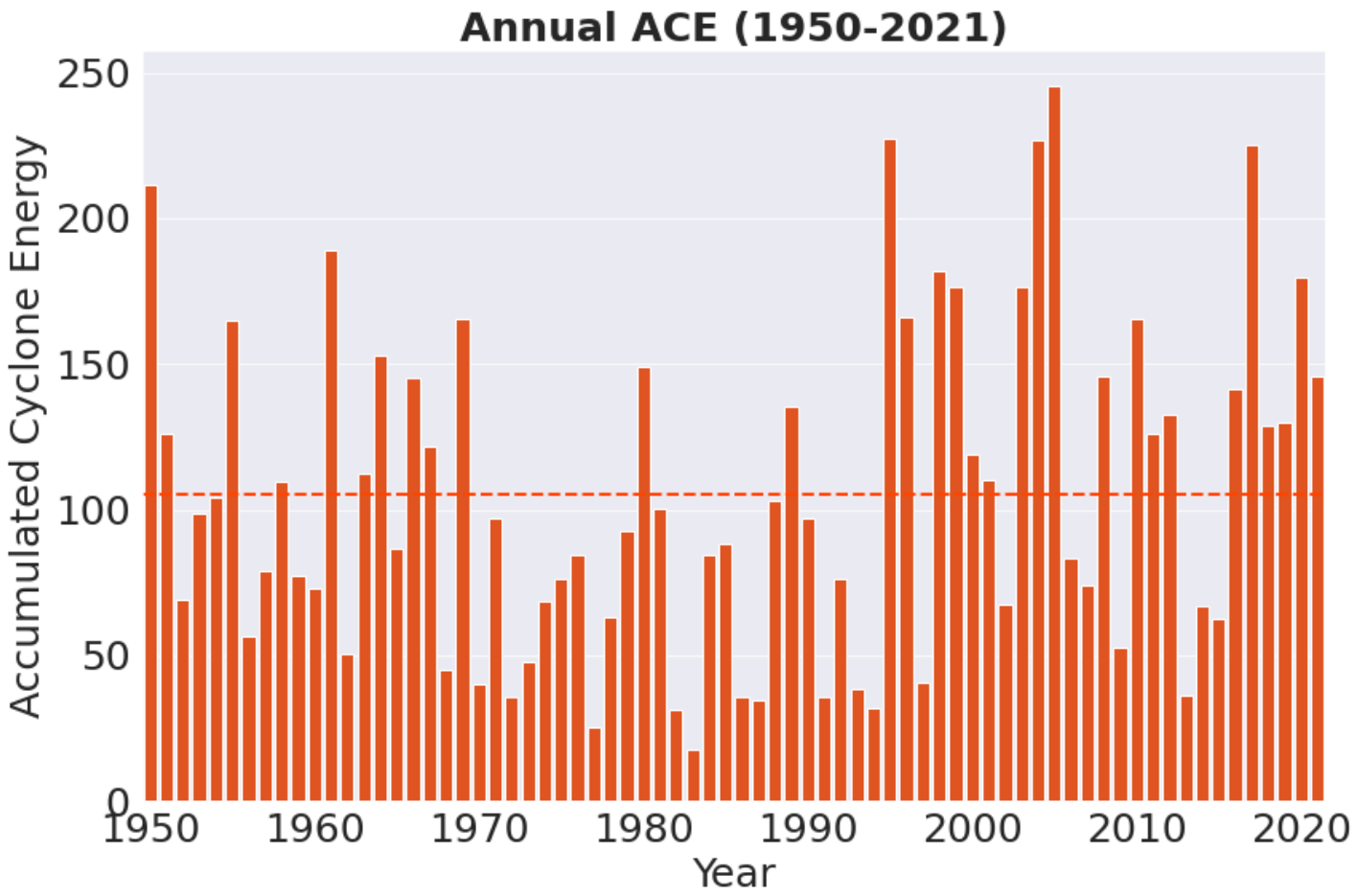


- Nearly all models show weak La Niña or ENSO-neutral conditions during the summer and into the fall.

Typical impact of La Niña: Lower wind shear in the Atlantic supports development of storms

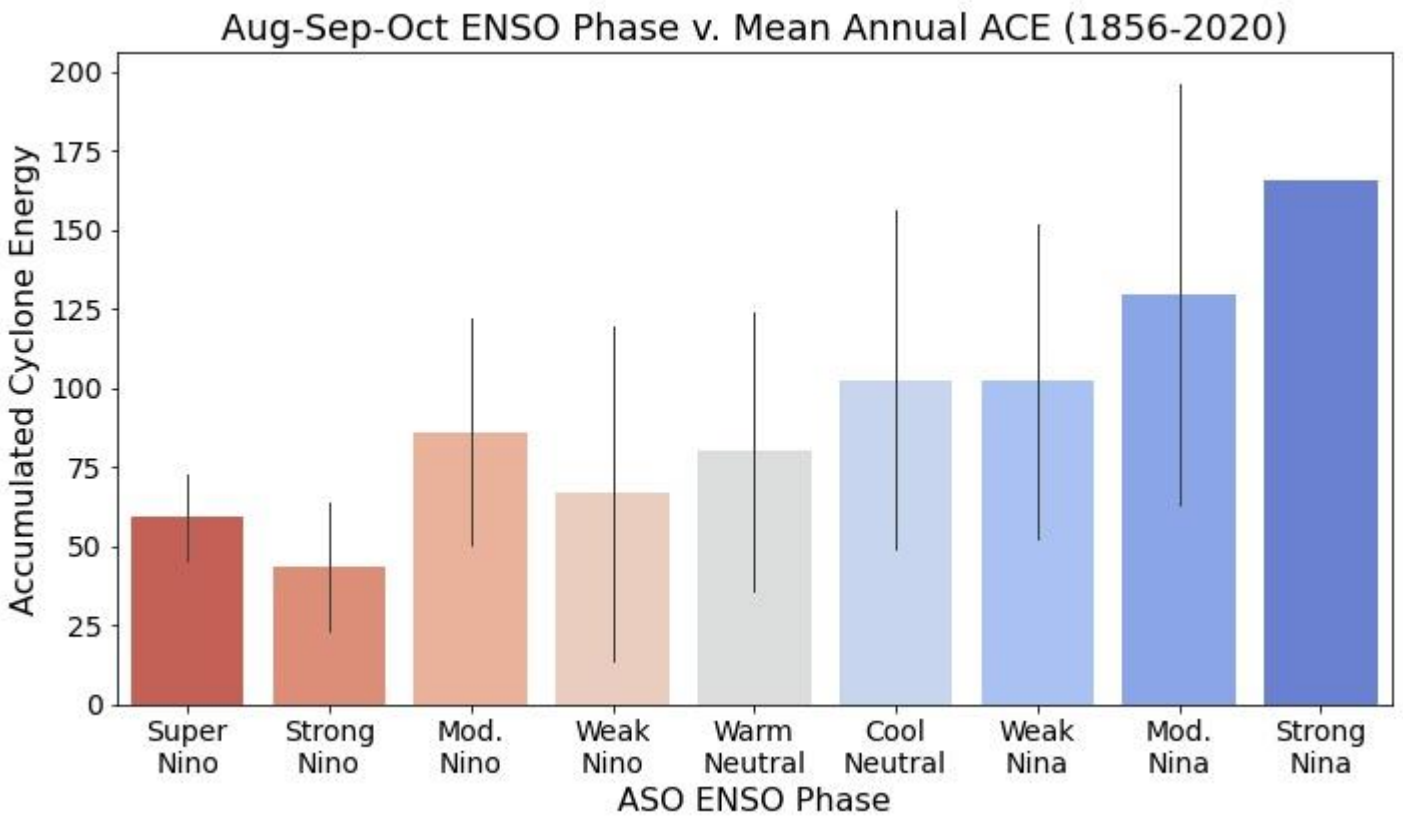


Accumulated Cyclone Energy Index (ACE)



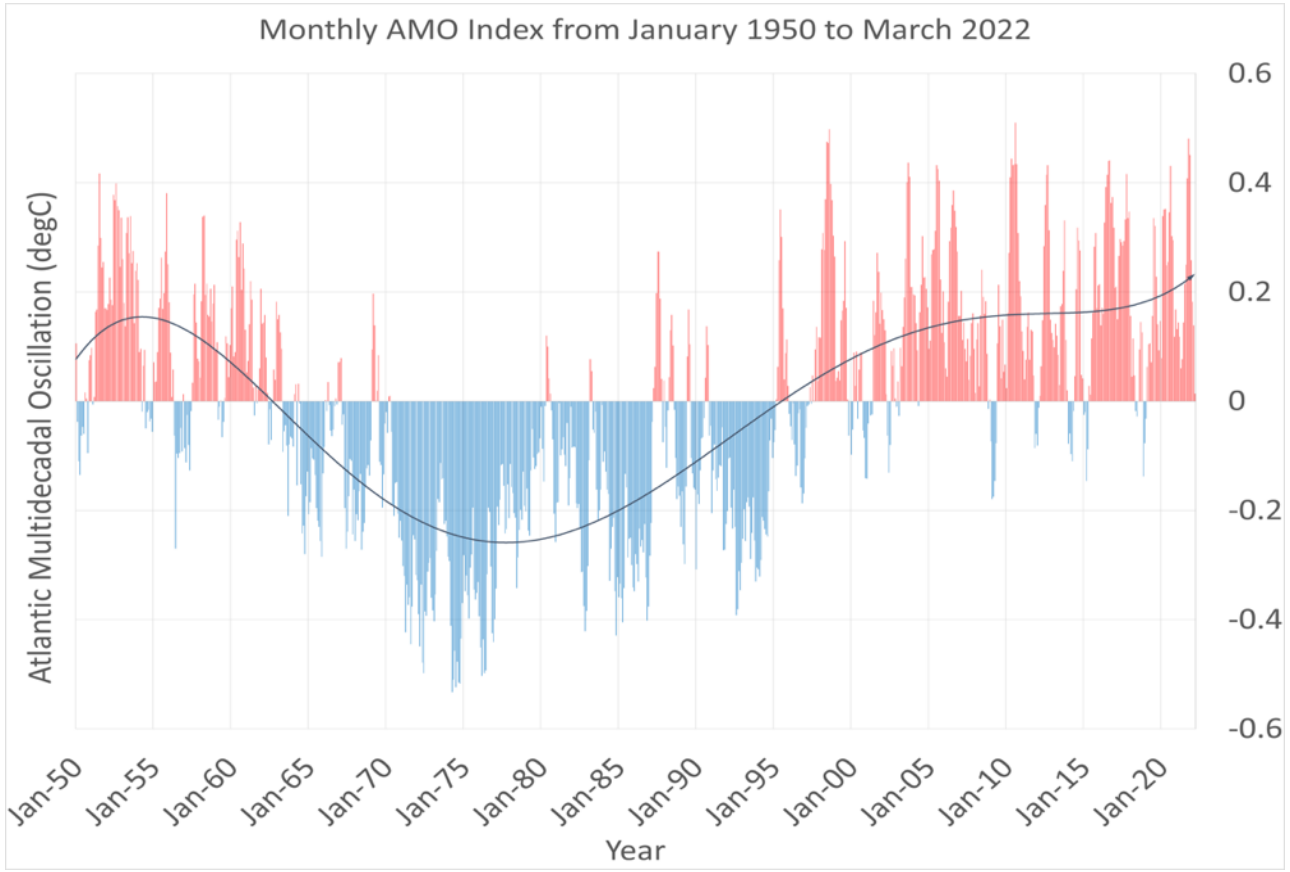
- ACE measures total overall seasonal activity.
- Factors in both intensity and duration of named storms.
- Mean ACE from 1950-202 is 105.
- 2005 and 2017 most recent years with >200 ACE.
- 2013, 2014 and 2015 most recent years with less than 100 ACE.

Historic Atlantic activity during different ENSO conditions



- When considering just ENSO, La Niña events favor higher ACE (more active seasons) than El Niño.
- Note that “Neutral” does not mean “not important.” It is a spectrum from Niña to Niño.

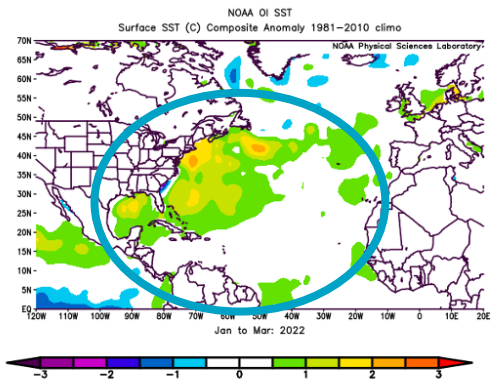
Atlantic Multidecadal Oscillation (AMO)



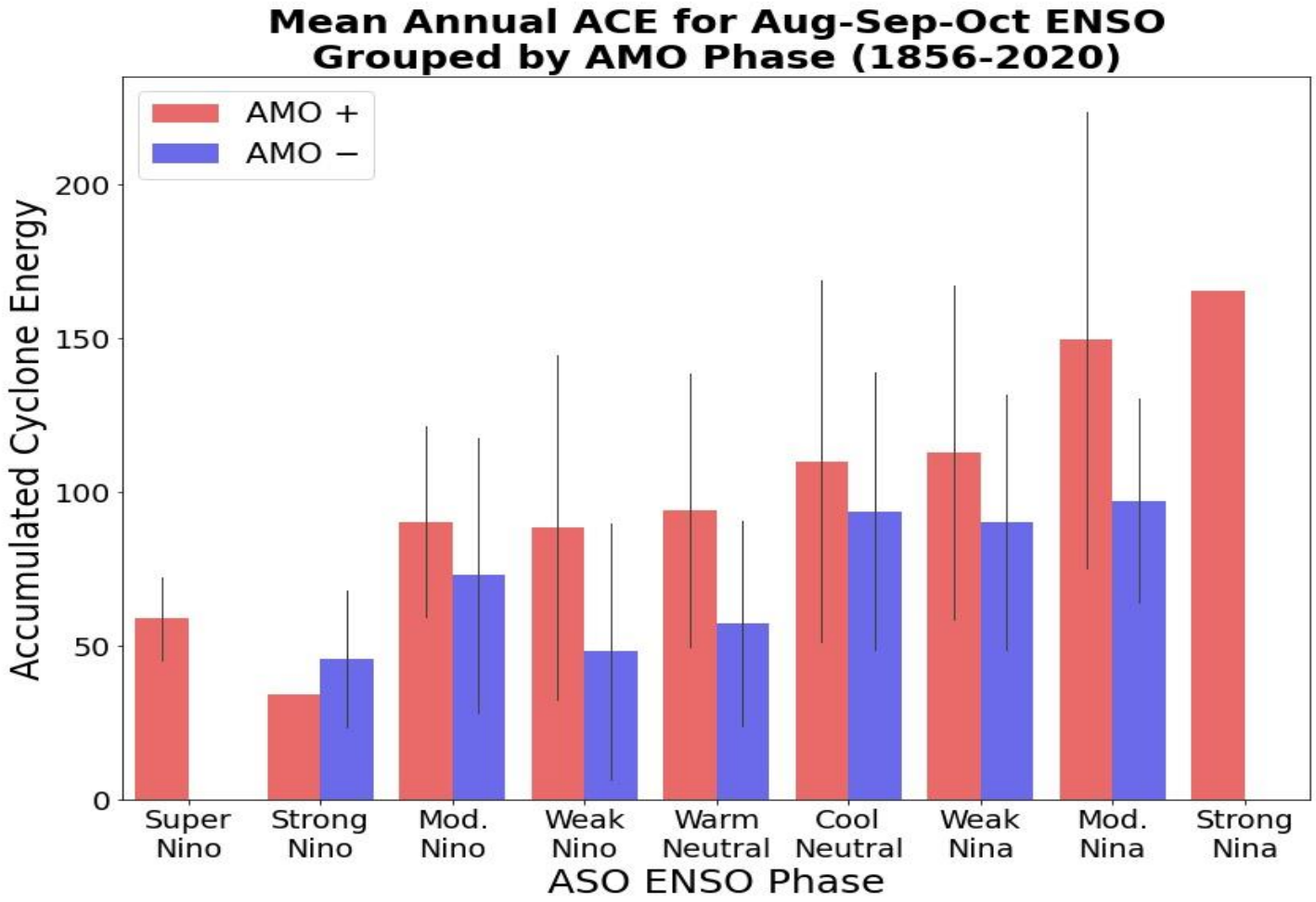
- AMO cycles typically last 20-30 years
- Since 1995, AMO has been mainly positive (warm SST)

2022 AMO Values:

Jan. = +0.18
Feb. = +0.14
Mar. = +0.01

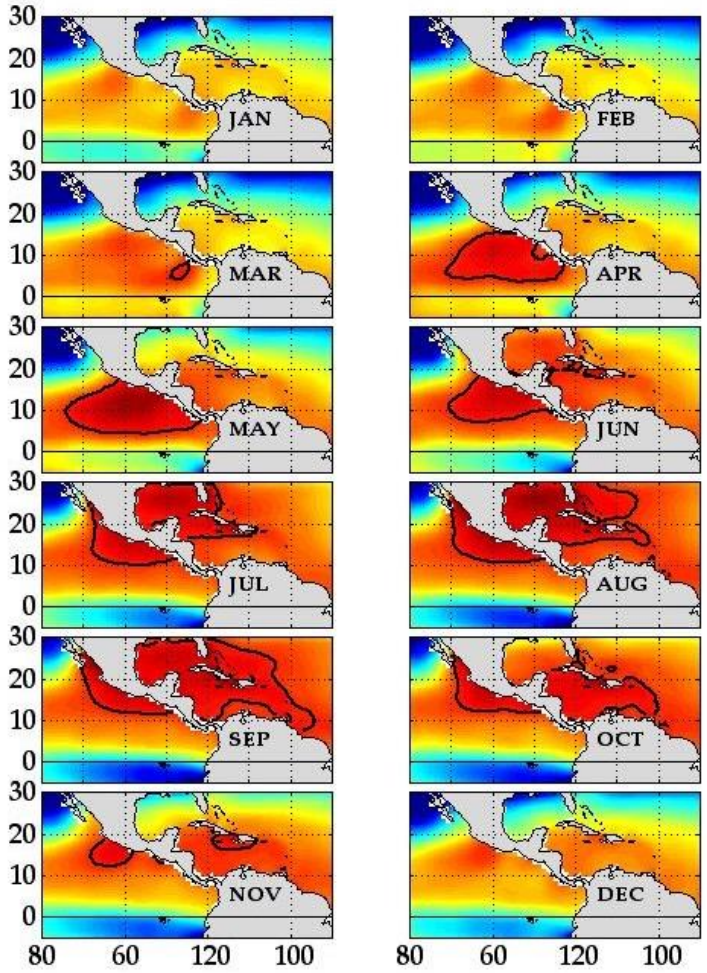


Combining Historical AMO and ENSO conditions



- Both AMO and ENSO modulate Atlantic tropical activity
- When ENSO phase is combined with AMO phase, a clear pattern emerges
- Stronger La Niñas and positive AMOs favor more active hurricane seasons
- Stronger El Niños and negative AMOs favor more inactive hurricane seasons

Western Hemisphere Warm Pool



- Area of sea surface temperatures warmer than 28.5 °C that develops west of Central America in the spring, then expands to the tropical waters to the east in the summer.
- WHWP is significantly correlated with Atlantic hurricane activity.
- Large WHWP reduces vertical wind shear and increases instability in the Atlantic main development region.
- Small WHWP increases vertical wind shear and reduces instability.

AEM 2022 forecast methodology

MACHINE LEARNING MODEL

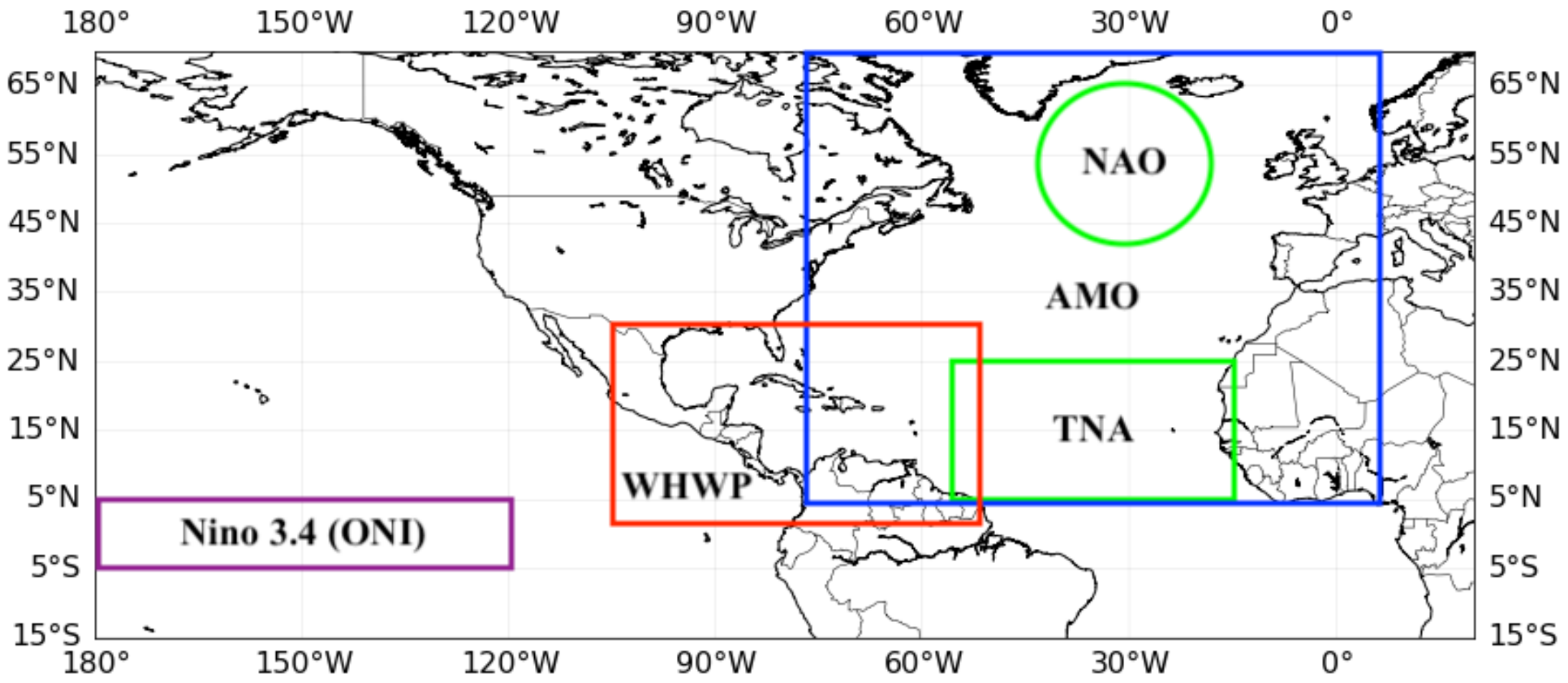
- Neural Network model is used to forecast ACE, the number of named storms, the number of hurricanes, and the number of major hurricanes.
- Model based on 41 years of data spanning 1980 to 2021.
- Utilizes several global atmospheric and oceanic predictors (e.g. ENSO, AMO, others).

ANALOGS

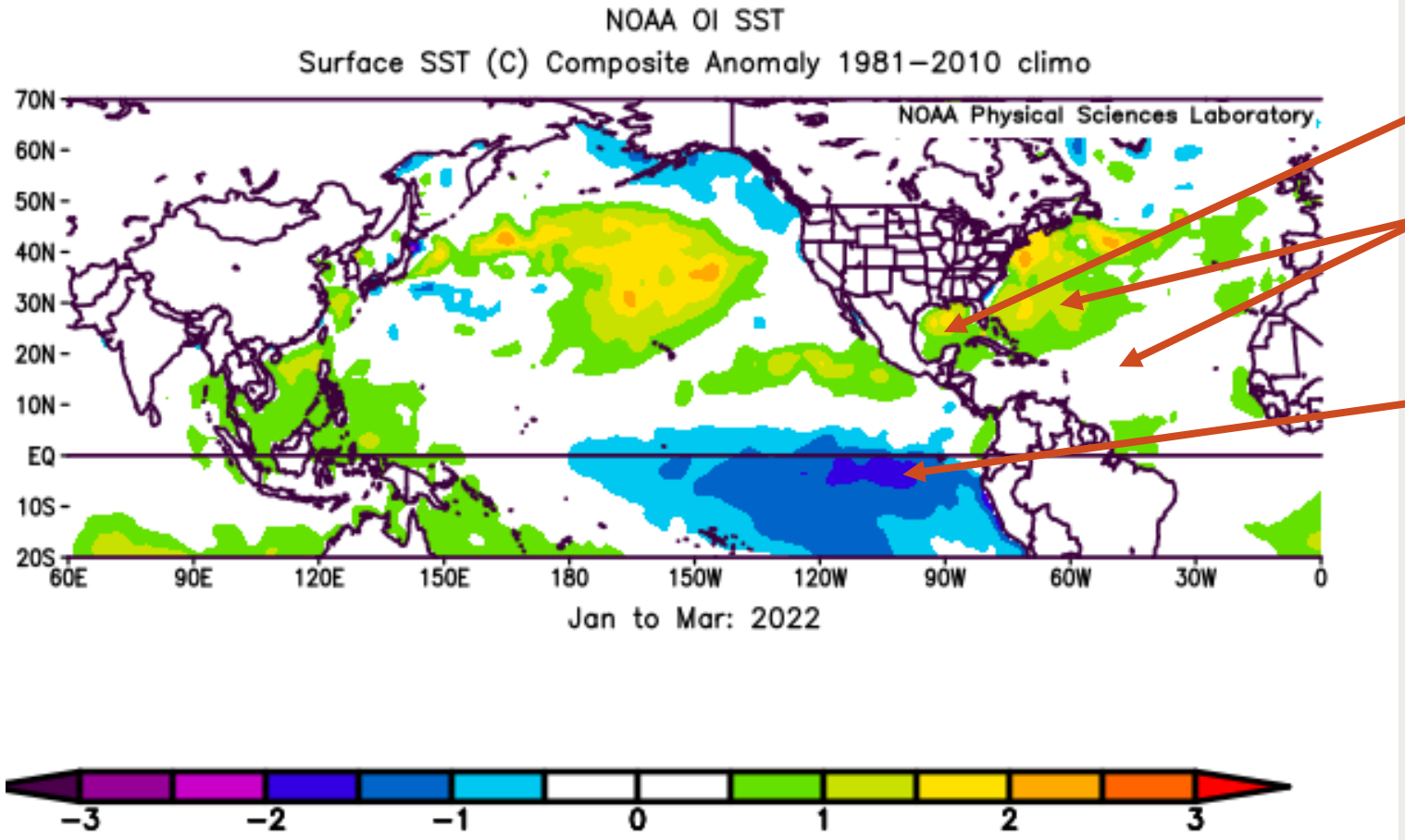
- Analogs are chosen by the forecast team.
- Five or more years are chosen when similar expected atmospheric and oceanic conditions from June to November occurred.
- Compute the average of ACE, number of named storms, hurricanes and major hurricanes.

KEY FINAL STEP: Consider statistical model forecasts with analog averages and make final adjusted prediction as needed.

Model parameter locations



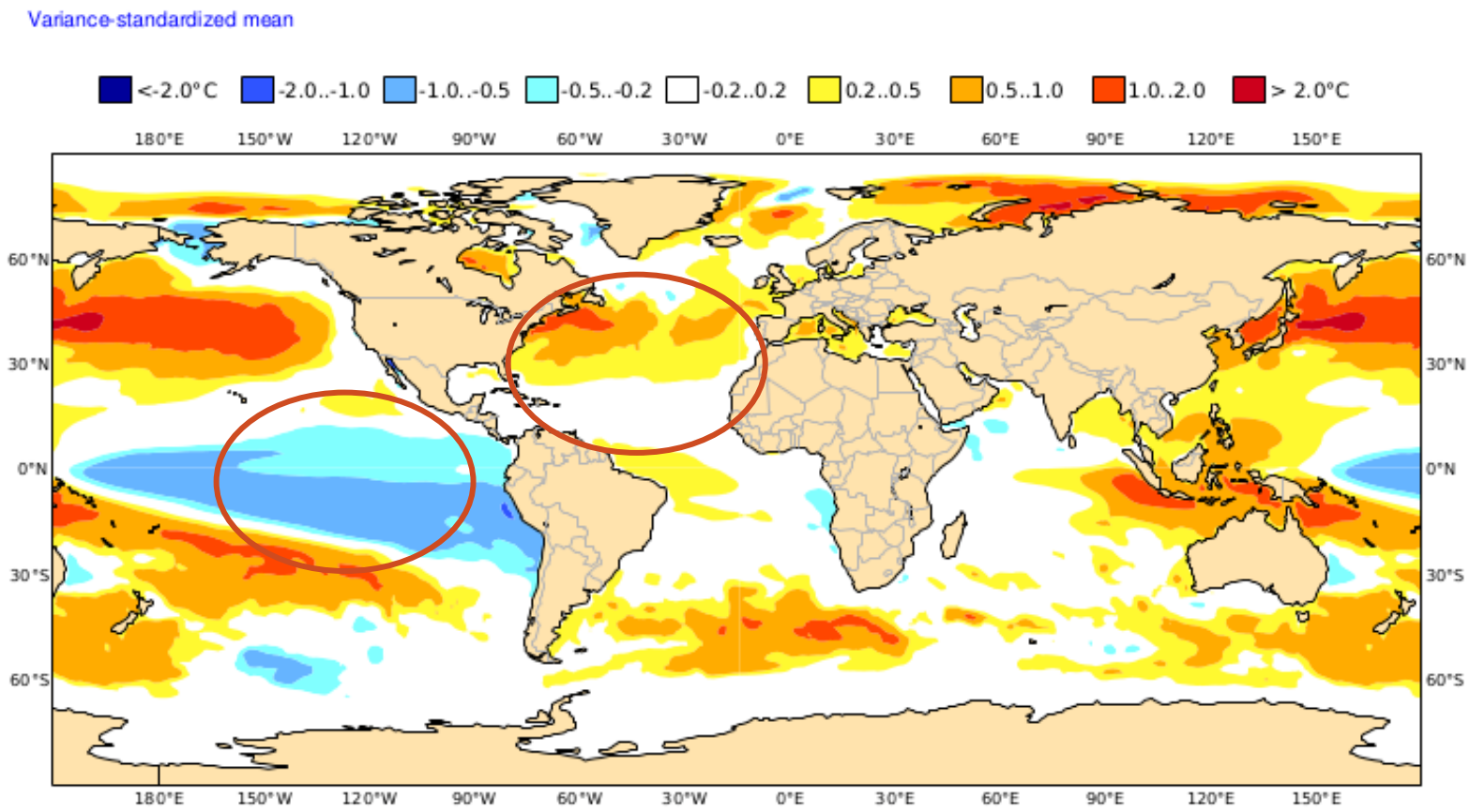
Latest ocean water temperature anomalies



GULF OF MEXICO/CARIBBEAN

- Most areas near or above average
- Well above average off Southeastern US coast
- Below average reflecting a weak La Niña

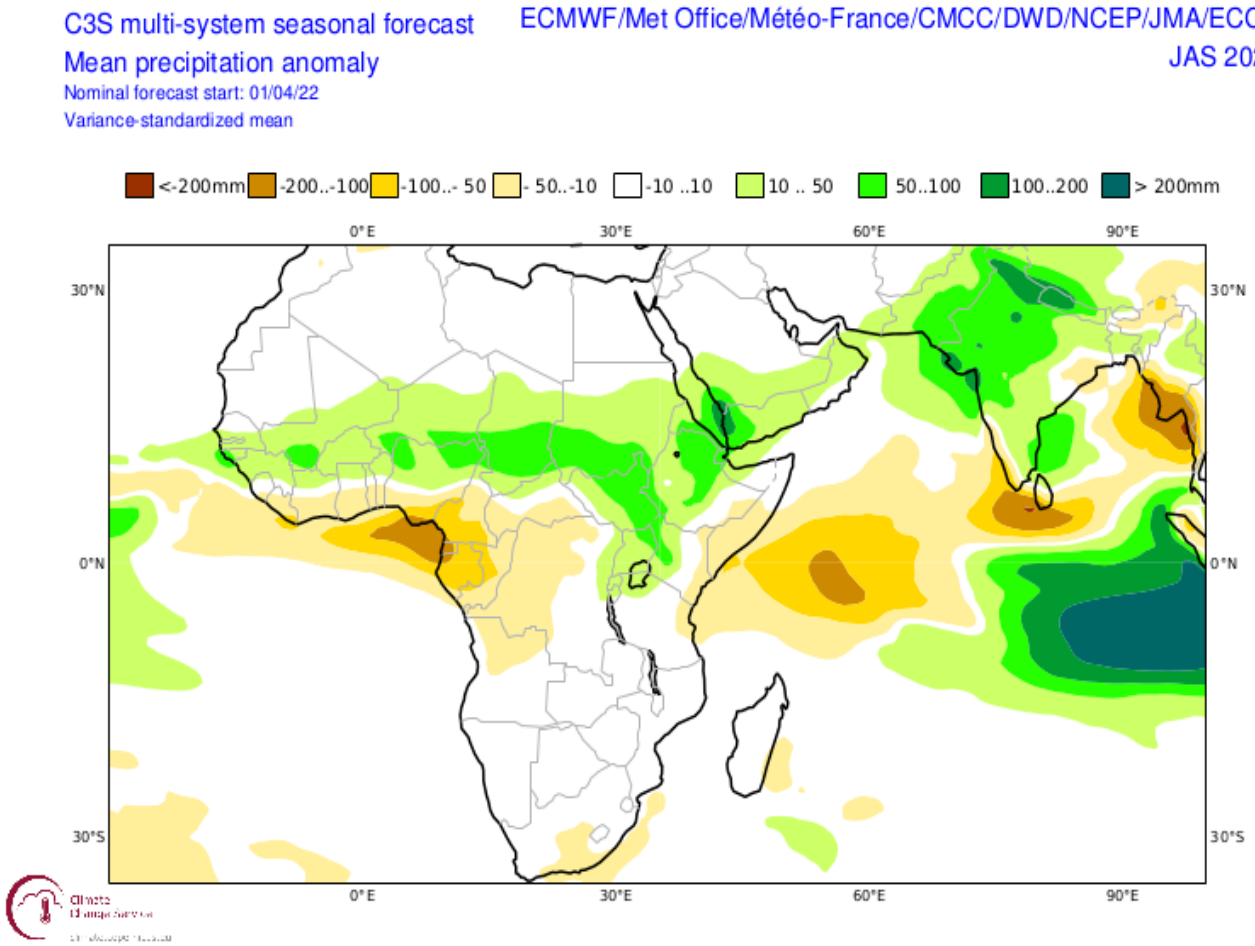
Forecast summer ocean water temperature anomalies



- C3S multi-system seasonal forecast Mean forecast SST anomaly
-
- ECMWF/Met Office/Meteo-France/CMCC/DWD/ NCEP July-August-September 2022

West African rainfall

- Near to slightly above average rainfall forecast across Sahel region of Africa July through September.
- This likely reflects persistent, frequent African Easterly Waves
- African Easterly Waves can intensify into tropical storms and hurricanes once they reach the eastern tropical Atlantic Ocean near the Cape Verde Islands



Analog years - years with similar predictor patterns to 2022

Year	ACE	Named Storms	Hurricanes	Major Hurricanes
1996	166.2	13	9	6
2000	119.1	15	8	3
2001	110.1	15	9	4
2008	145.7	16	8	5
2012	132.6	19	10	2
2021	145.6	21	7	4
Mean of Analog Years	136.6	16.5	8.5	4.0
Normal Tropical Season (1991-2020)	122	14	7	3

Years where La Nina or Neutral ENSO occur Summer and Fall

A large and warm WHWP and positive AMO

Analog years point to ABOVE NORMAL tropical activity for the upcoming season.

Combining analogs with statistical model forecast

CATEGORY	STATISTICAL MODEL FORECASTS	MEAN OF ANALOGS	MEAN OF MODEL AND ANALOGS
ACE	153	137	145
Named Storms	18	17	17.5
Hurricanes	8	9	8.5
Major Hurricanes	4	4	4.0

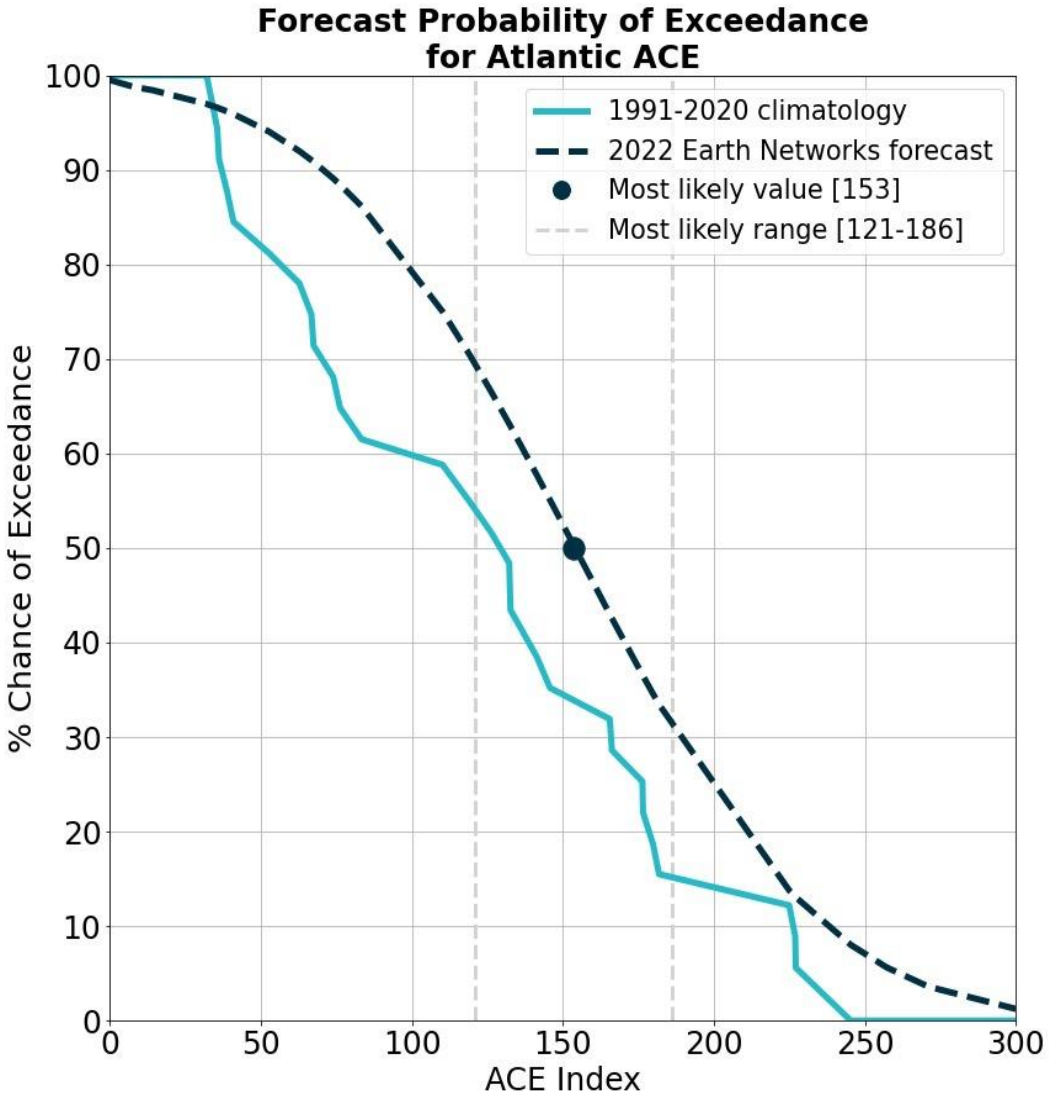
AEM 2022 Atlantic Hurricane Outlook:

Above Normal: 49% chance	Normal: 39% chance	Below Normal: 12% chance

CATEGORY	NORMAL(1991-2020)	FINAL FORECAST
ACE	75 to 155	153 (121-186)
Named Storms	12-16	18 (16-21)
Hurricanes	5-9	8 (6-10)
Major Hurricanes	2-4	4 (3-5)

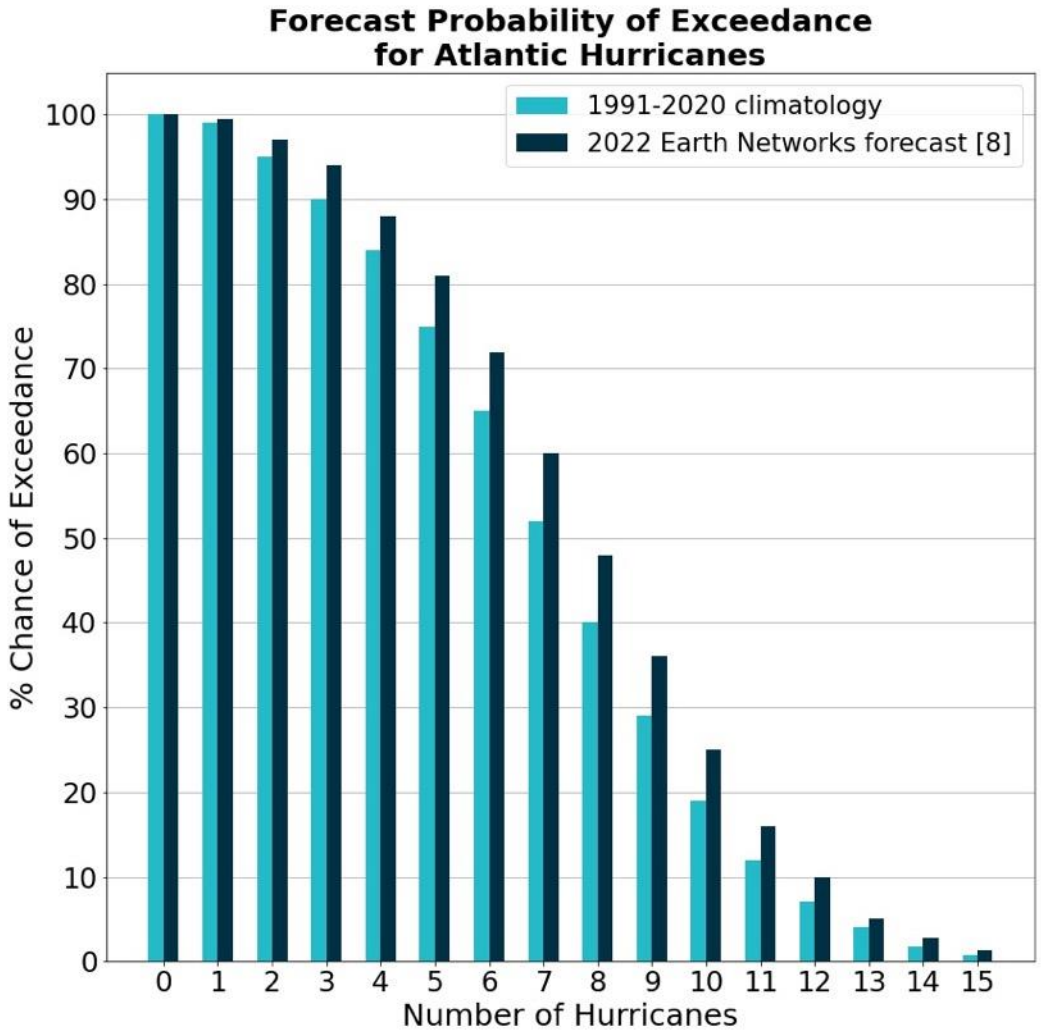
2022 probability of exceedance for ACE

- In order to better convey uncertainty in the forecast, Probability of Exceedance charts have been included to enable users to more accurately assess risk.
- The light blue line is the probability of a given ACE number being achieved based on 1991-2020 climatology.
- The dark blue dashed line displays the probability of ACE exceeding a given value based on our forecast of 153.



2022 probability of exceedance for hurricanes

- In order to better convey uncertainty in the forecast, Probability of Exceedance charts have been included to enable users to more accurately assess risk.
- The light blue bar is the probability of a given hurricane count being achieved based on 1991-2020 climatology.
- The dark blue bar shows the probability of a hurricane count being exceeded a given forecast value of 8.



Questions?

For more information, let's talk at:
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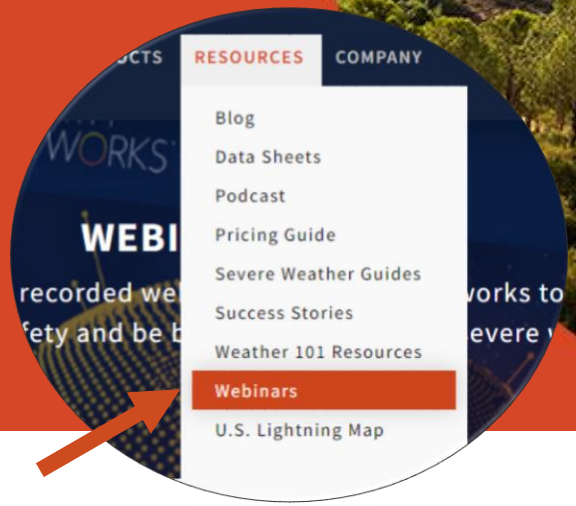

Addendum

For more information, let's talk at:
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Technical Definitions and Terminology Explanations

KEY DEFINITIONS

- **Accumulated Cyclone Energy (ACE):** Sum of the Squares of 6-hourly Maximum Sustained Wind Speeds (in units of knots) for all Systems while they are at least Tropical Storm intensity.
- **Named Tropical Storm:** 1 Minute Sustained Winds > 33 kt (39 mph).
- **Hurricane:** 1 Minute Sustained Wind > 63 kt (74 mph).
- **Major Hurricane:** 1 Minute Sustained Wind > 95 kt (110 mph).

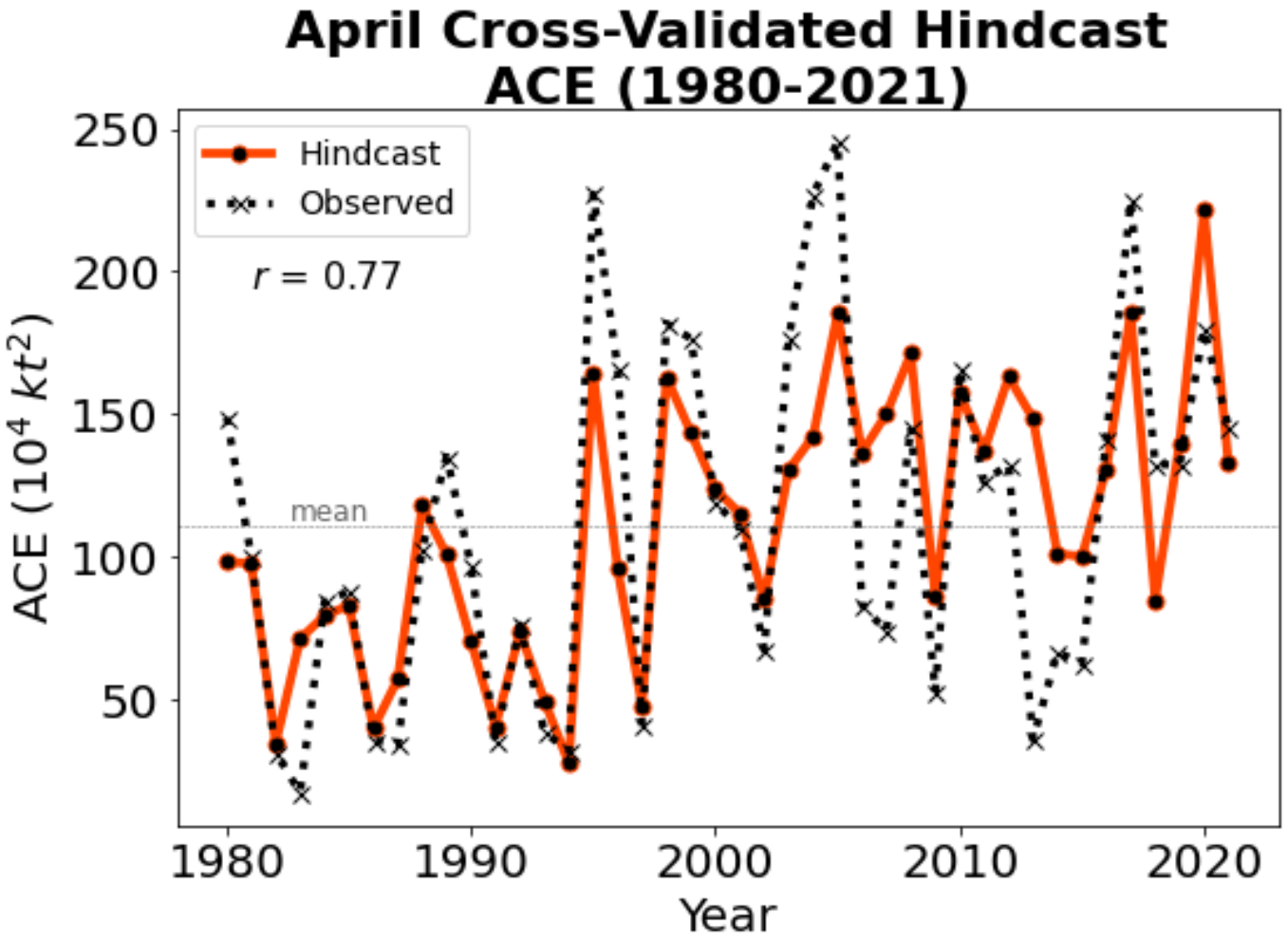
COMMENTARY ON OUR NEURAL NETWORK MODEL

- Our statistical prediction forecast is based a neural network incorporating several predictors in the Atlantic ocean basin that have shown skill in seasonal ACE forecasting.
- Model is designed to run in April.
- Correlation coefficient, r, was calculated to be 0.77 for the 1980-2020 ACE hindcast period the model was developed on, demonstrating strong forecast skill.

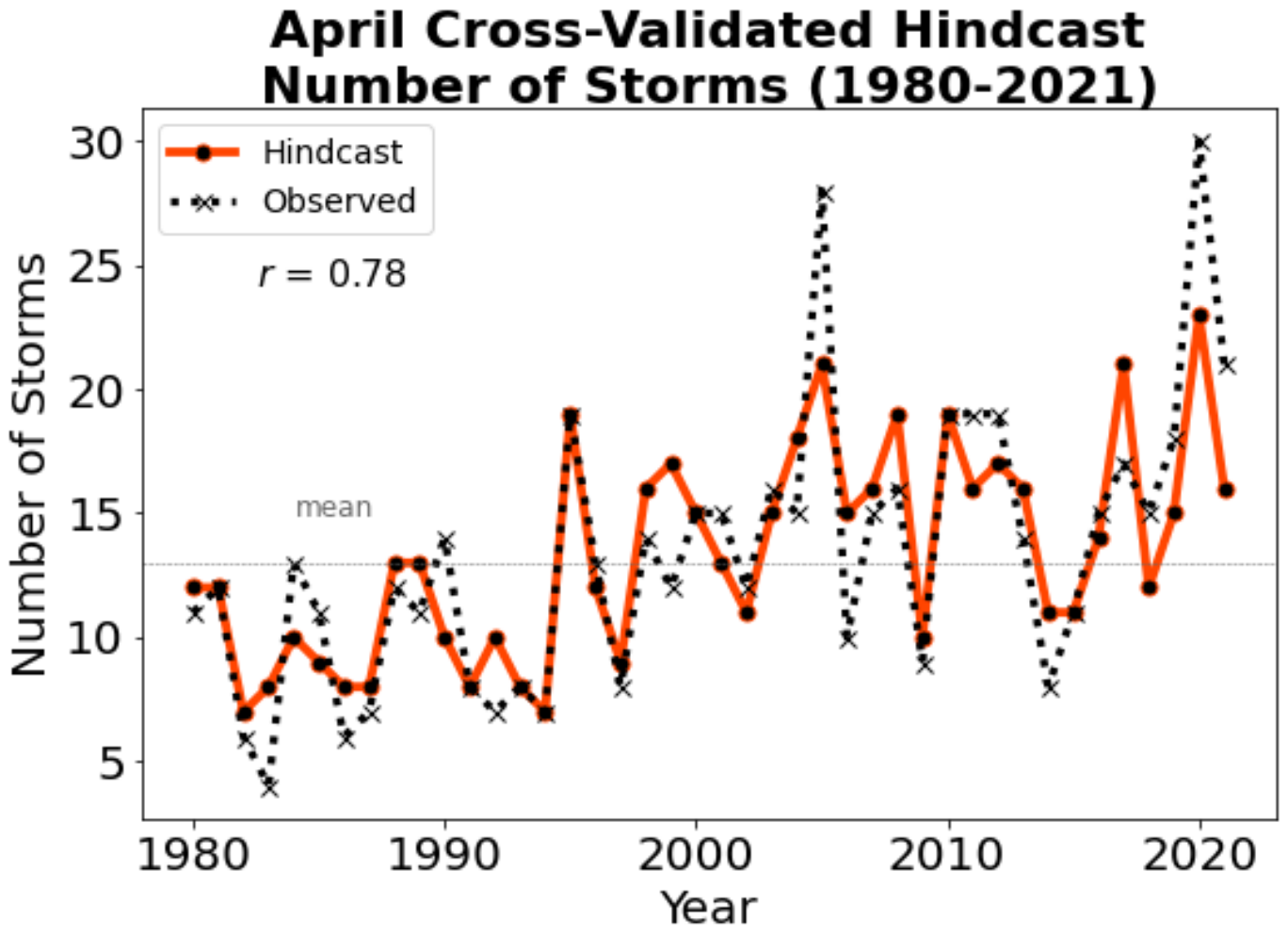
FORECAST PROBABILITY

- Final forecast probability is determined by the likelihood ACE will fall into a given tercile.
- Tercile groupings correspond to 1/3 (33.3%) of observed seasonal values in 1991 to 2020 climatology.
- Above normal seasonal ACE is therefore the highest 1/3 of recorded values, or >155.
- Normal seasonal ACE values are the middle 1/3 which are between 74 and 155.
- Below normal seasonal ACE values are <75.

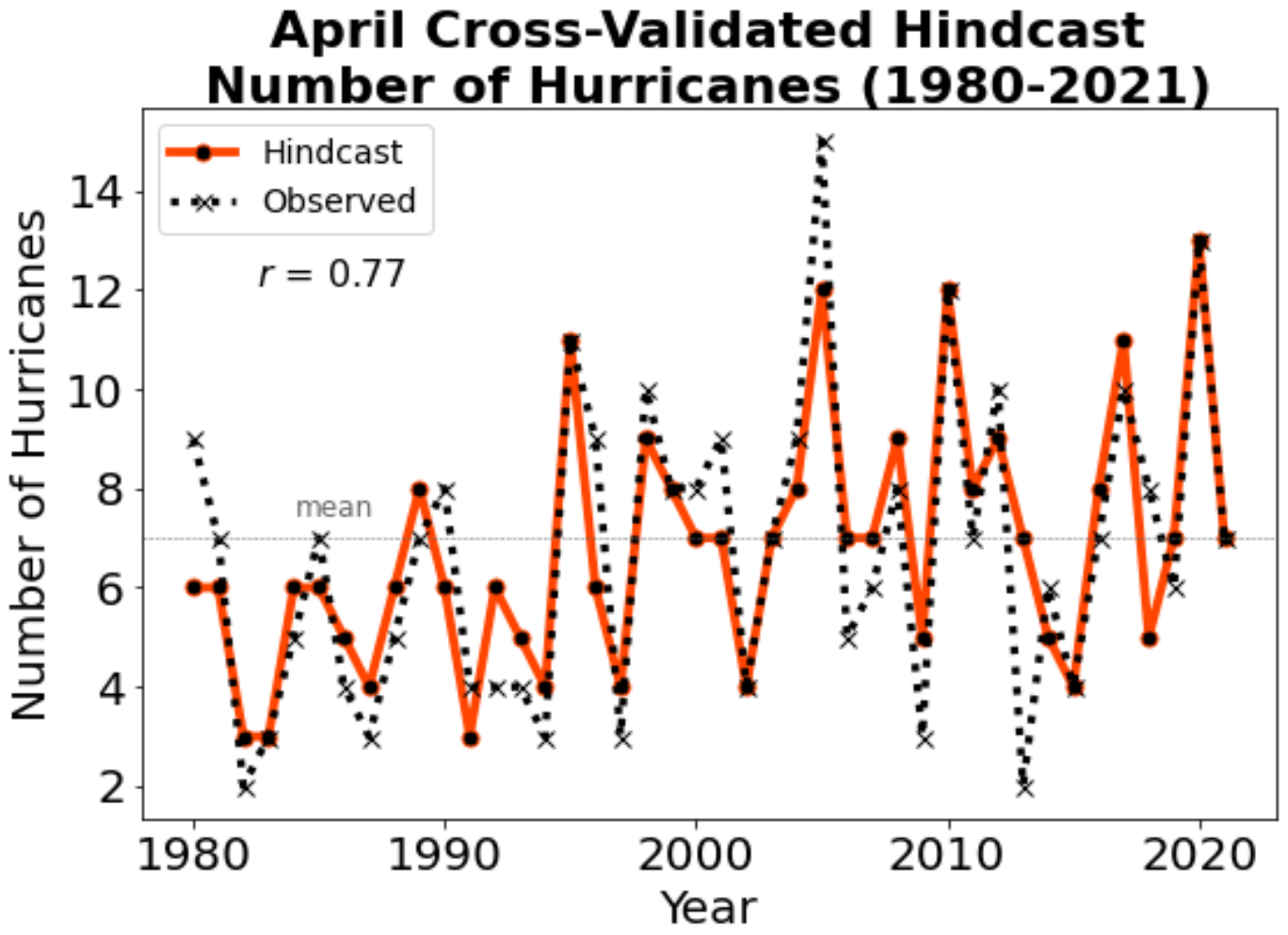
April cross-validated hindcast ACE (1980-2021)



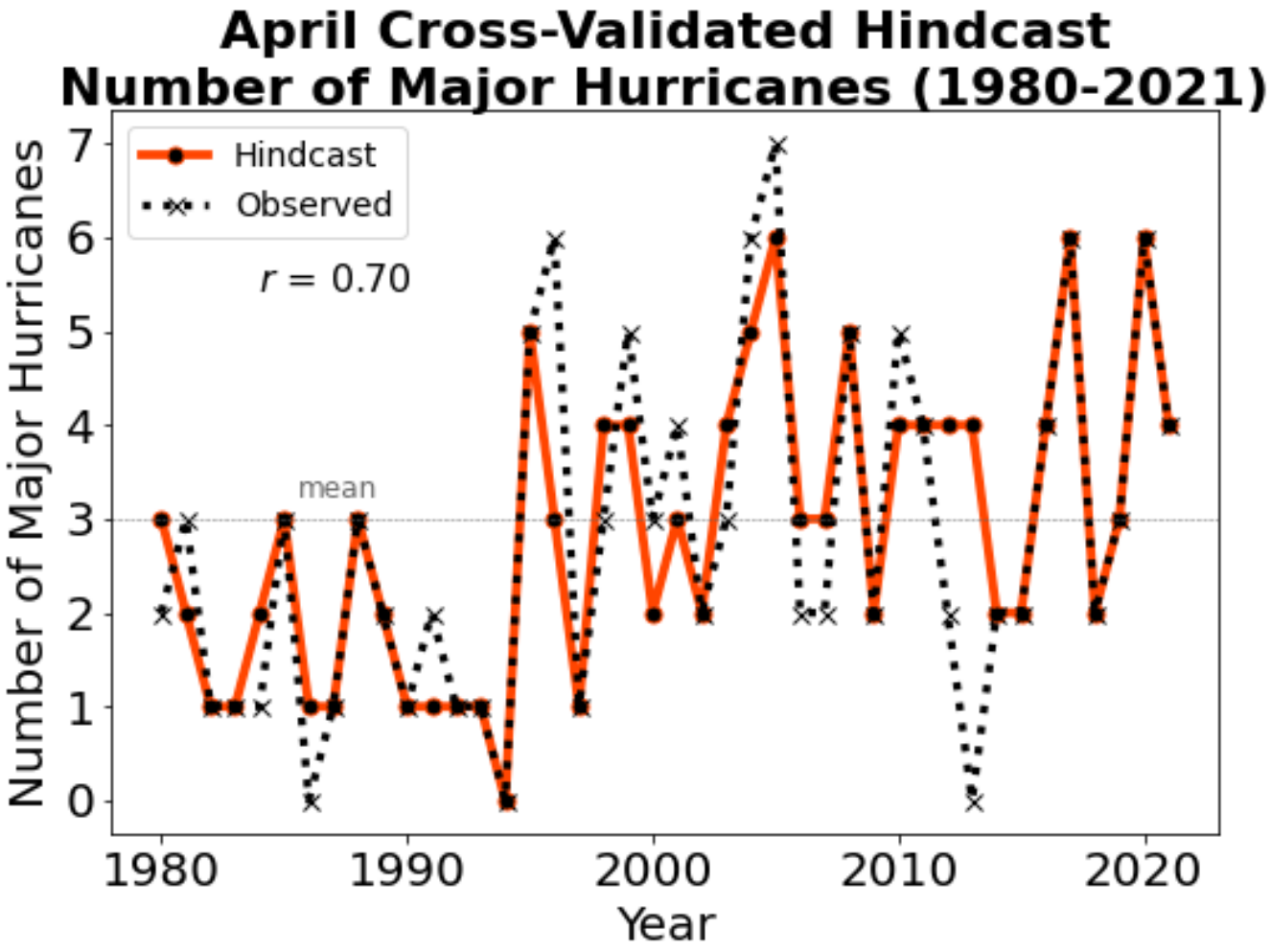
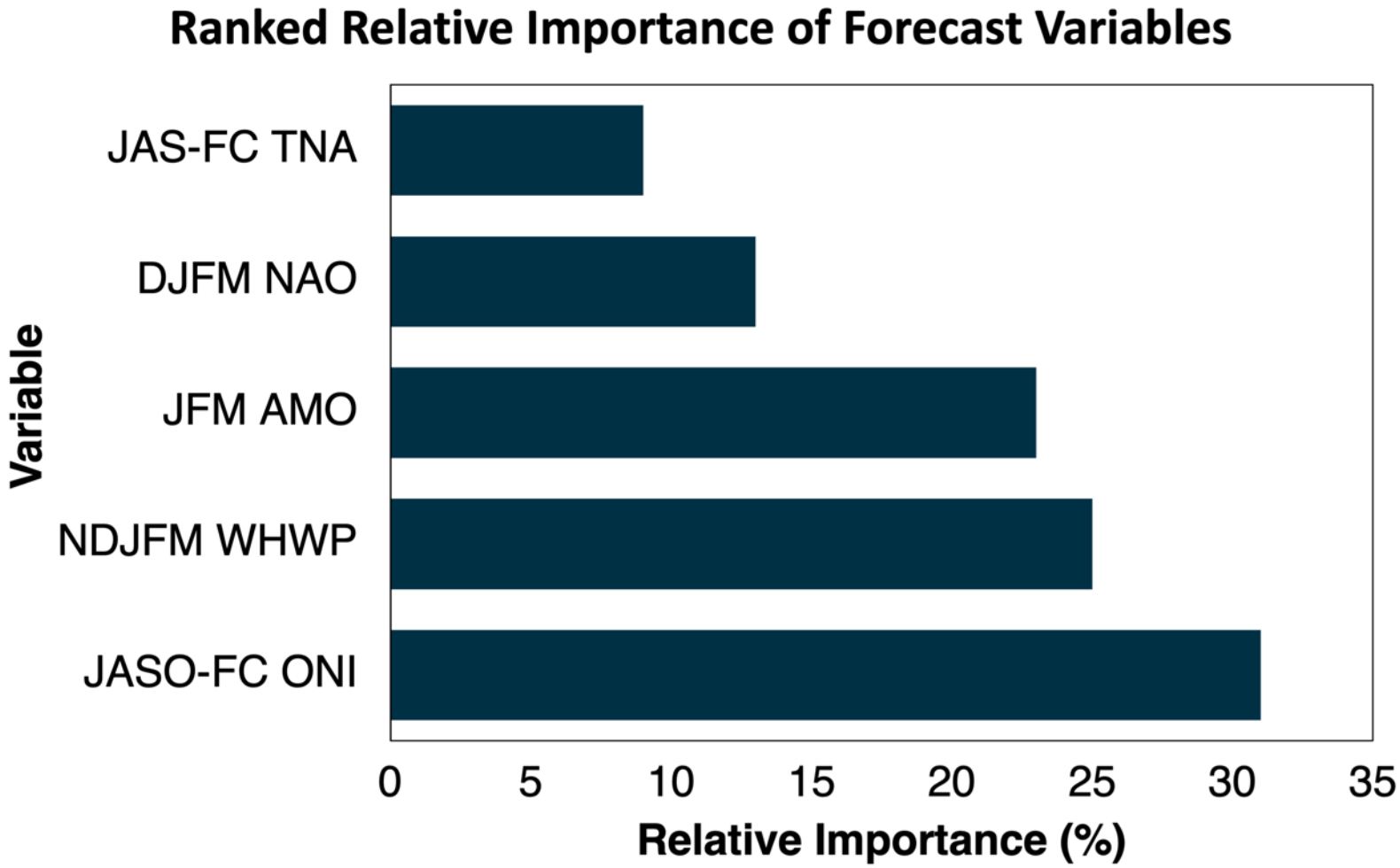
April cross-validated hindcast named storms (1980-2021)



April cross-validated hindcast hurricanes (1980-2021)



April cross-validated hindcast major hurricanes (1980-2021)



Ranked importance of forecast variables