EARTH NETWORKS*



2021 ATLANTIC HURRICANE OUTLOOK

PRESENTED BY: ANTHONY SAGLIANI AND ALYSSA ROBINETTE MAY 13, 2021

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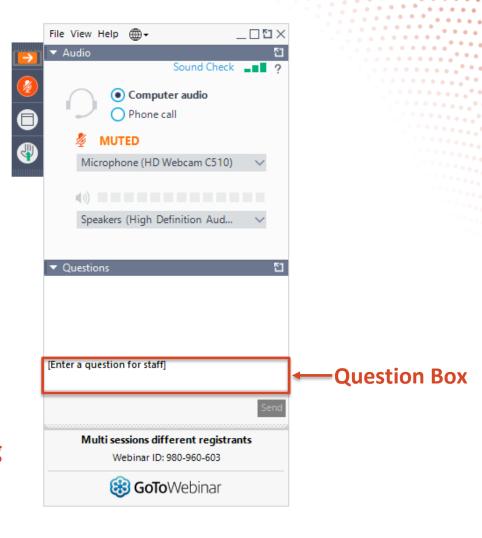
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2021 HURRICANE OUTLOOK METEOROLOGICAL TEAM

ALYSSA ROBINETTE

Meteorologist



ANTHONY SAGLIANI Meteorologist



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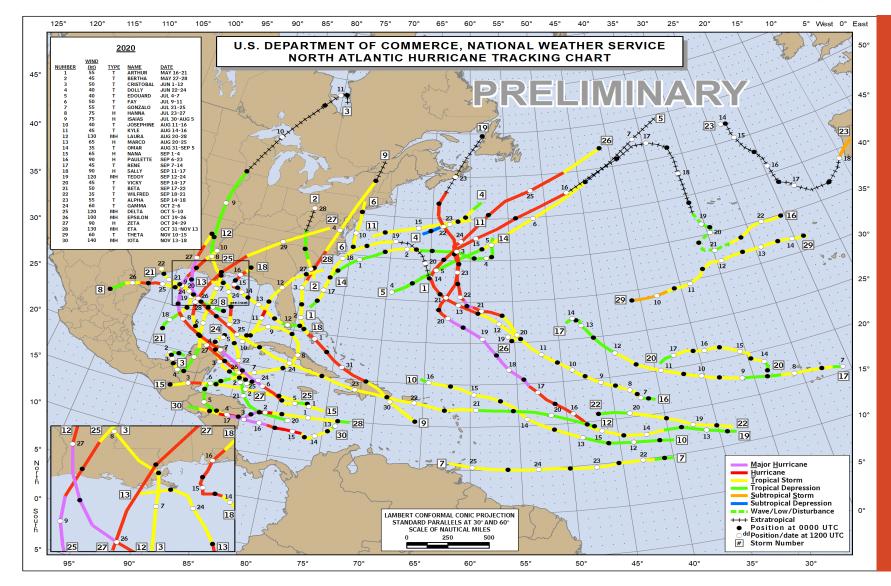




JOHN BENEDICT Meteorologist



REVIEW OF 2020 HURRICANE SEASON

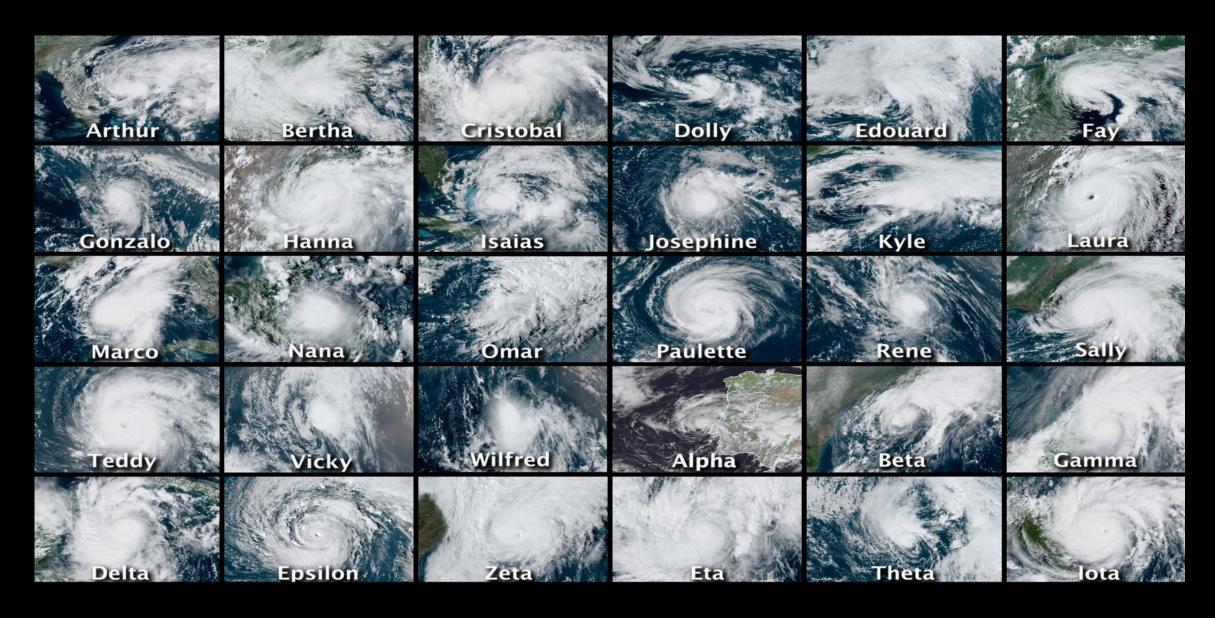


2020 TOTALS

- 30 Tropical Storms (R)
- 14 Hurricanes
- 7 Major Hurricanes (Tie R)



THE 2020 ATLANTIC HURRICANE SEASON



REVIEW OF 2020 HURRICANE SEASON



Tropical watches and warnings issued in every coastal county except Wakulla and Jefferson in Florida

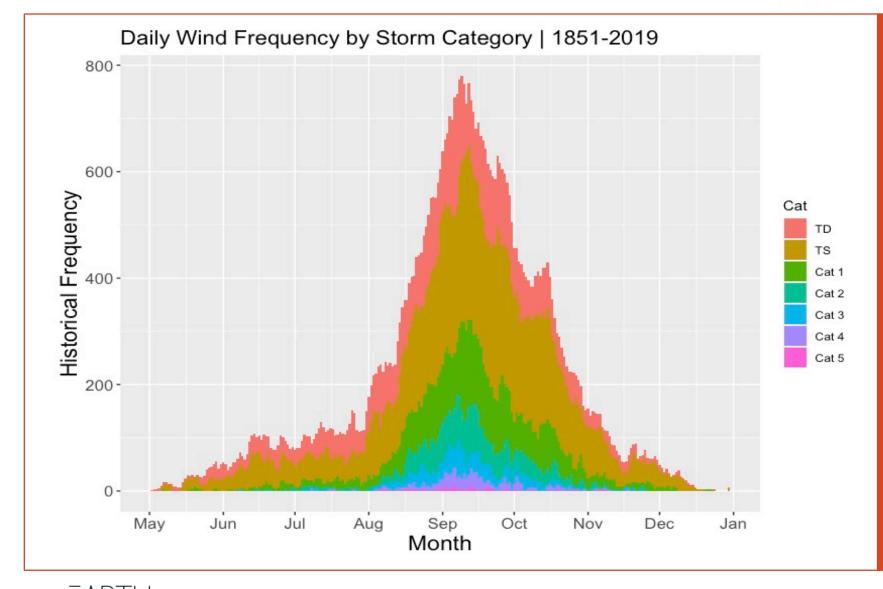


VERIFICATION OF 2020 HURRICANE OUTLOOK

	May Forecast	July Update	2020 Actual
ACE	150	175	180
Named Storms	16	22	30
Hurricanes	9	11	14
Major Hurricanes	4	5	7



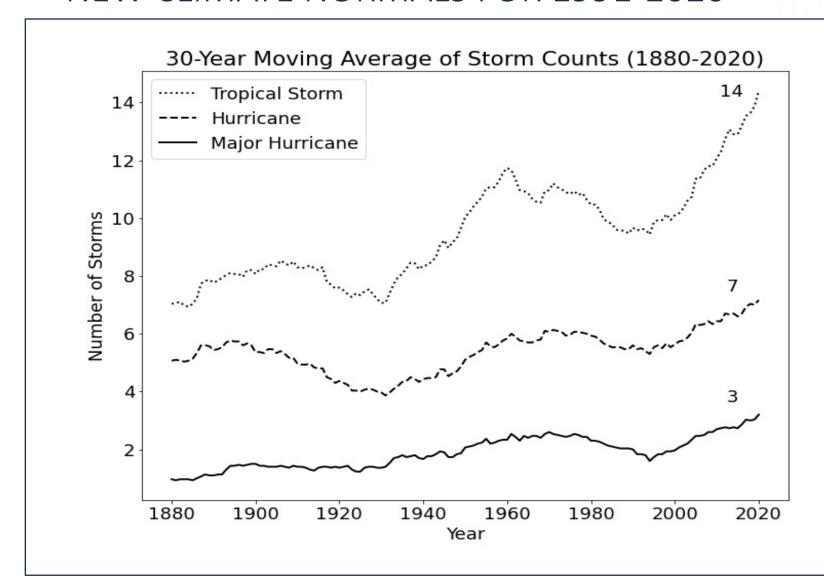
CLIMATOLOGY OF ATLANTIC TROPICAL CYCLONES



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



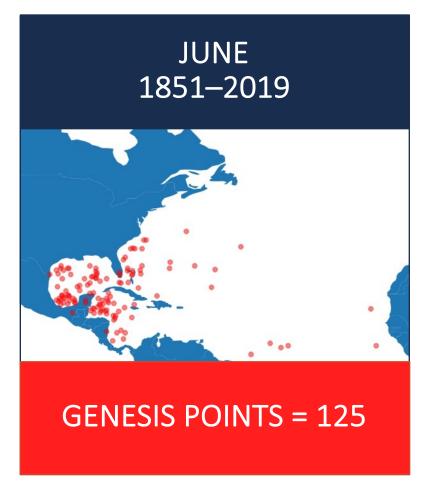
NEW CLIMATE NORMALS FOR 1991-2020

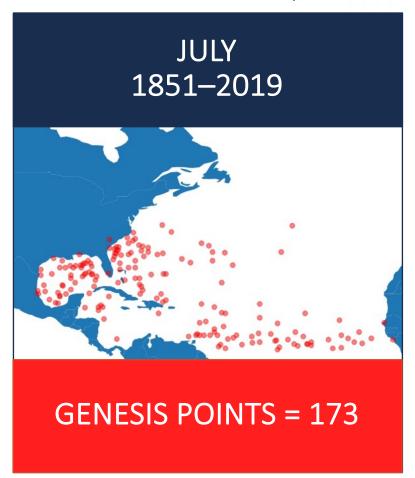


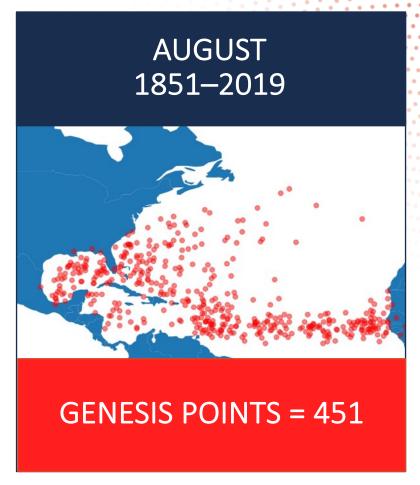
- 14 named storms,7 hurricanes,3 major hurricanes
- This only includes active era of Atlantic storms that began in 1990s
- We will use 1950-2020
 for climate normals to
 get a better scope of
 the range of possible
 seasonal activity



TYPICAL TROPICAL CYCLONE FORMATION, JUNE – AUGUST

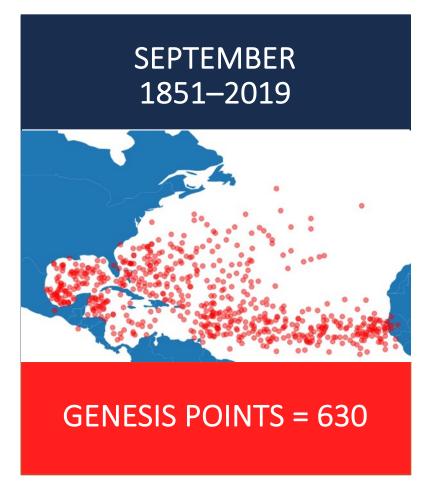


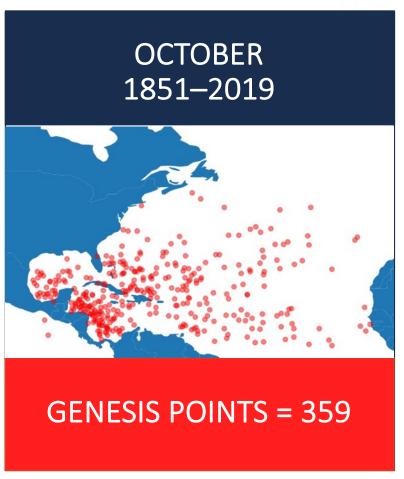


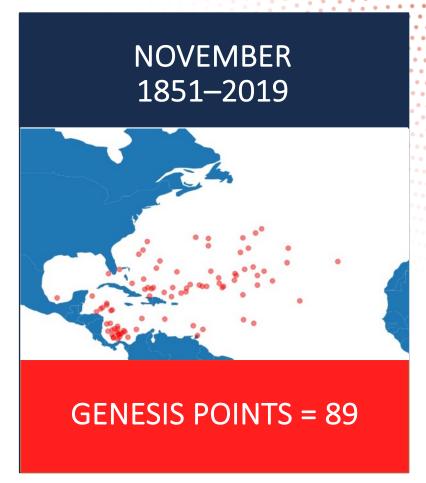




TYPICAL TROPICAL CYCLONE FORMATION, SEPTEMBER – NOVEMBER

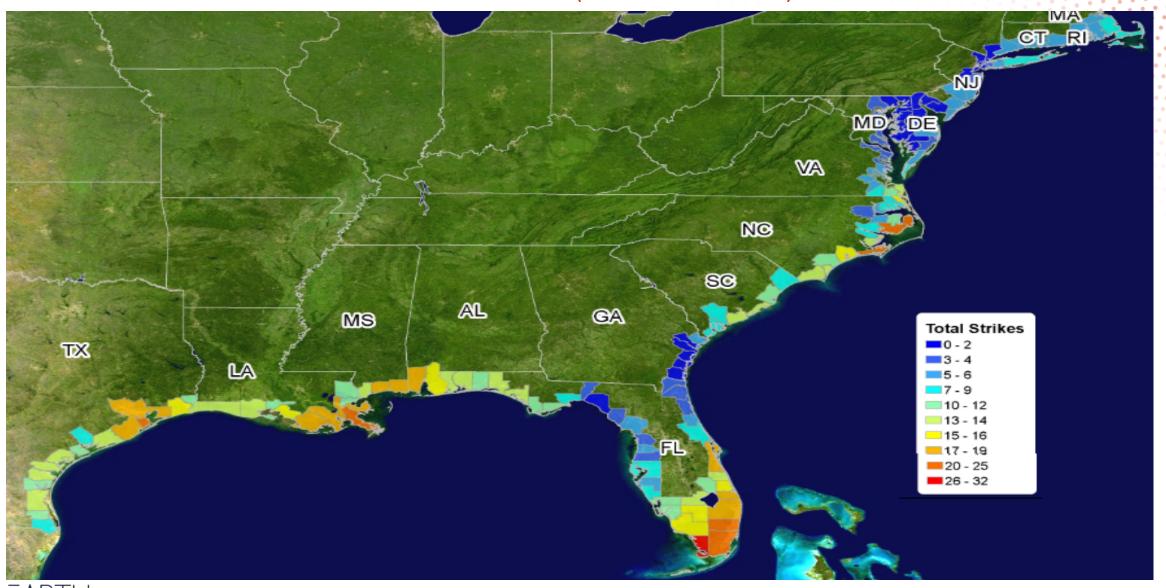








TOTAL U.S. HURRICANE LANDFALLS (1900 – 2010)





ELEMENTS OF THE 2021 ATLANTIC HURRICANE OUTLOOK

KEY PREDICTORS

• El Niño / La Niña (ENSO)

Atlantic Multi-decadal Oscillation (AMO)



ENSO – A PERIODIC CYCLICAL WARMING AND COOLING OF THE EQUATORIAL PACIFIC OCEAN

Typical circulation patterns during El Niño/La Niña

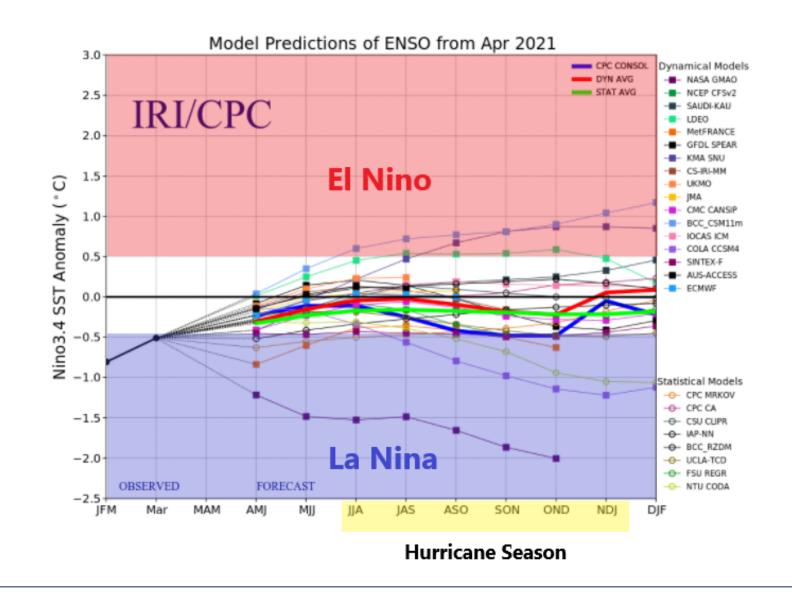
(Source: WMO, El Niño/Southern Oscillation)

EL NINO/LA NINA BACKGROUND convection convection Equator Equator upwelling Thermocline Thermocline 120°E 120°E 60°W El Niño La Niña



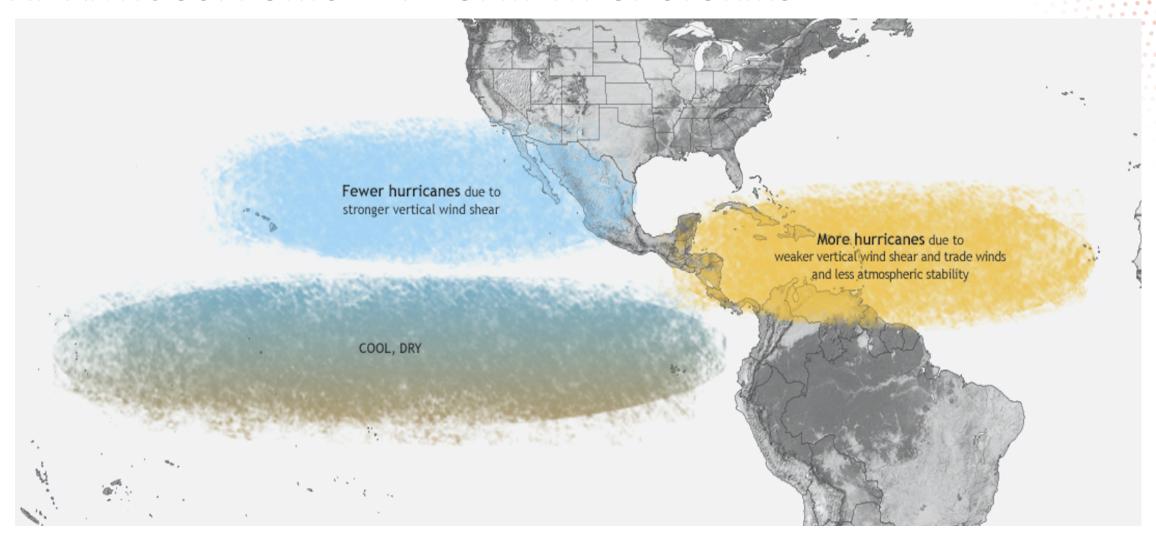
LATEST ENSO MODEL FORECASTS

Most models forecast Neutral ENSO for the 2021 Hurricane Season. Some get close to La Niña conditions. Overall large spread and range of possibilities.



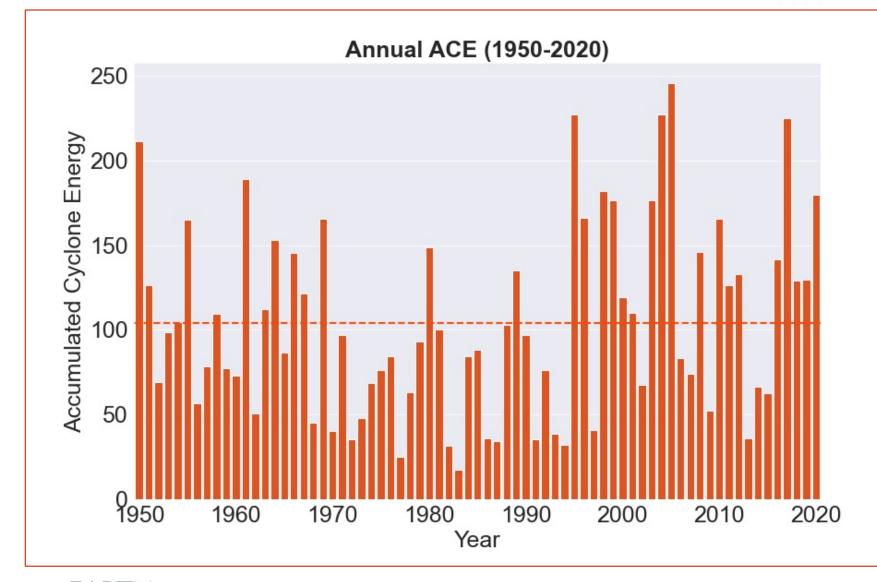


TYPICAL IMPACT OF LA NINA – LOWER WIND SHEAR IN THE ATLANTIC SUPPORTS DEVELOPMENT OF STORMS





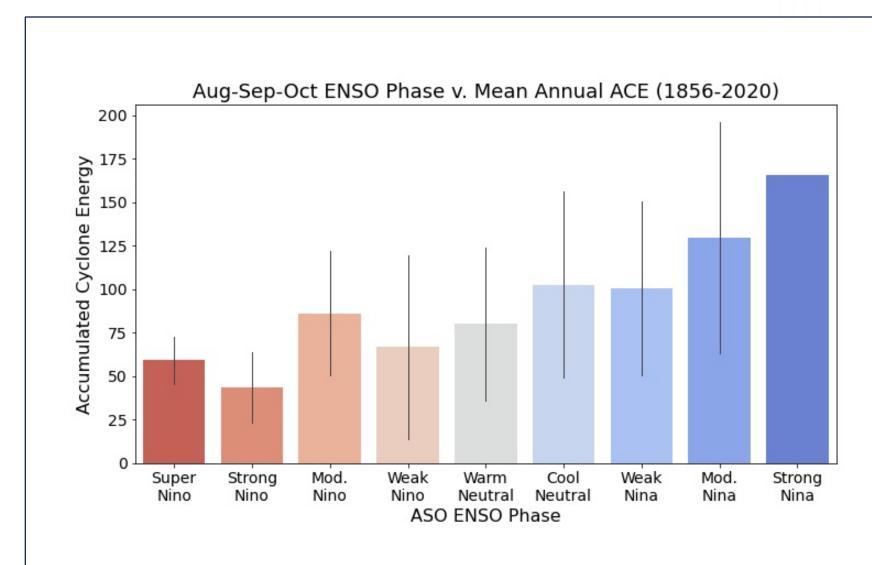
ACCUMULATED CYCLONE ENERGY INDEX (ACE)



- ACE measures total overall seasonal activity.
- Factors in both intensity and duration of named storms.
- Mean ACE from 1950-2020 is 104.
- 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.

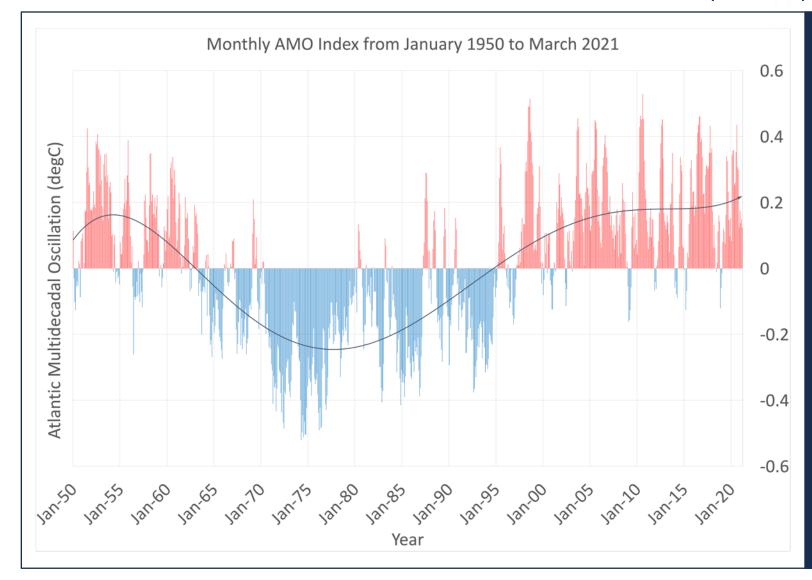


When considering just ENSO, La Niña events favor higher ACE (more active seasons) than El Niño.

Note that "Neutral" does not mean "not important." It is a spectrum from Niña to Niño.



ATLANTIC MULTIDECADAL OSCILLATION (AMO)



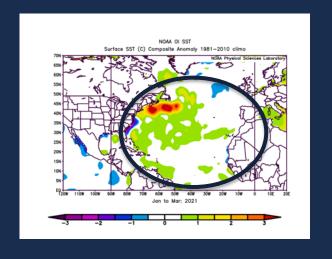
- AMO cycles typically last 20-30 years.
- Since 1995, AMO has been mainly positive (warm SST).

2021 AMO VALUES:

Jan. = 0.14,

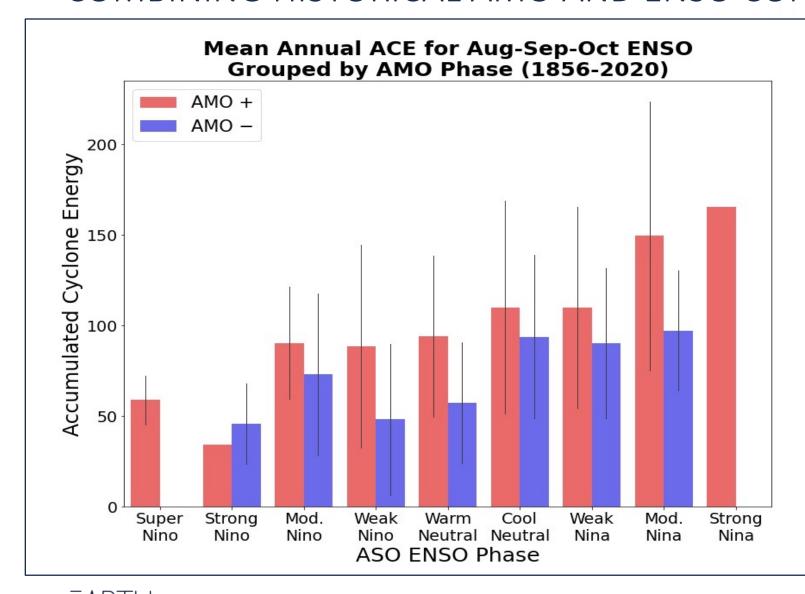
Feb. = 0.15

Mar. = 0.12





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.



EARTH NETWORKS 2021 FORECAST METHODOLOGY

IN-HOUSE STATISTICAL MODELS

- Neural Network model is used to forecast 2021 ACE.
- Model based on 41 years of data spanning 1980 to 2020.
- Utilizes several global atmospheric and oceanic predictors (e.g. ENSO, AMO, others).
- Poisson regression equations to forecast number of named storms, hurricanes, major hurricanes.

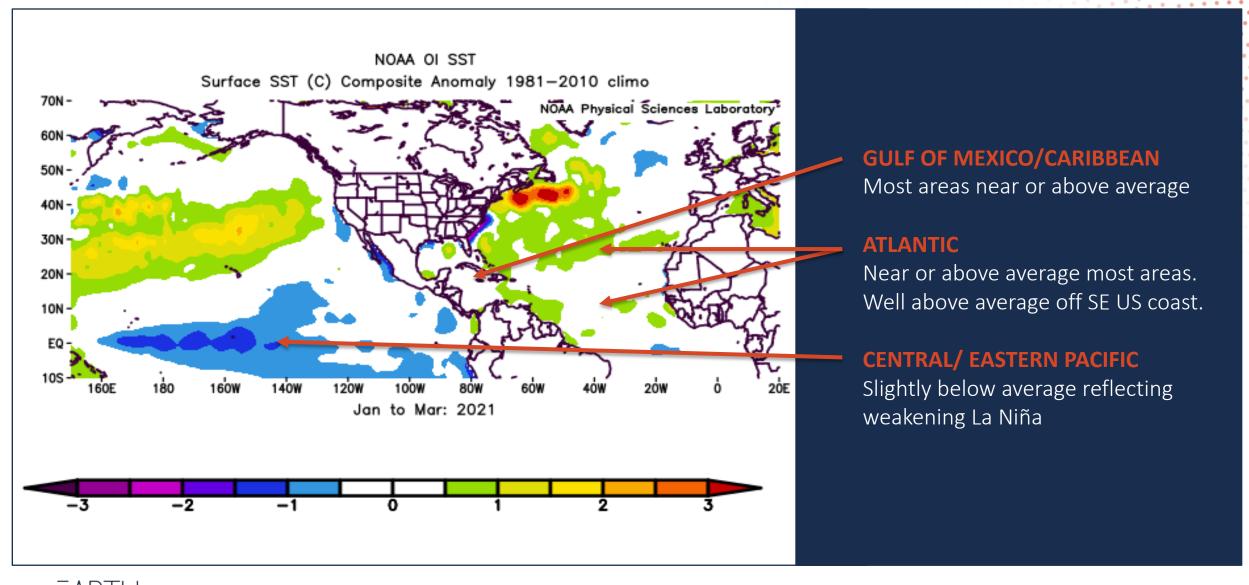
ANALOGS

- Analogs are chosen by the forecast team.
- Each member chooses 5 or more years where 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.

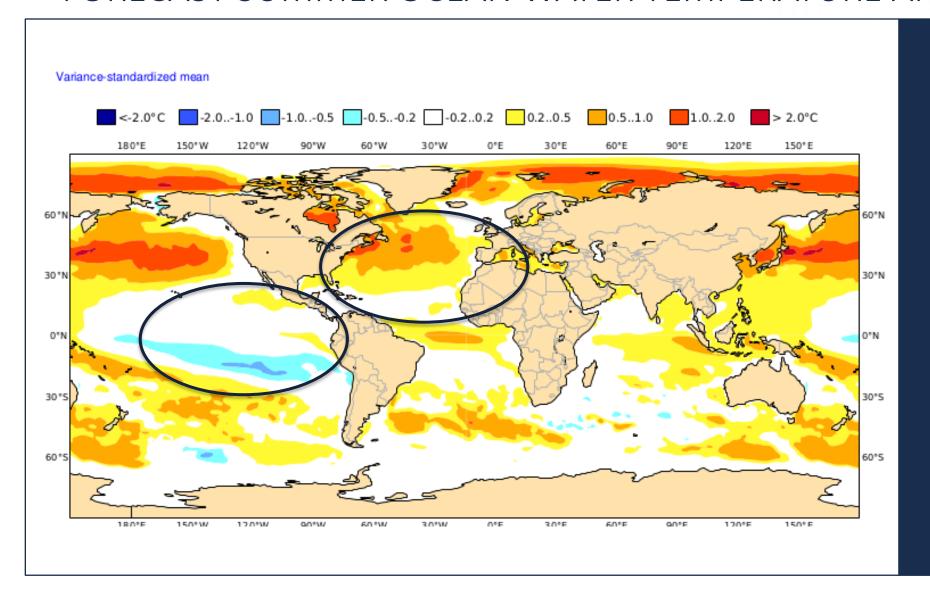


LATEST OCEAN WATER TEMPERATURE ANOMALIES





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 2021

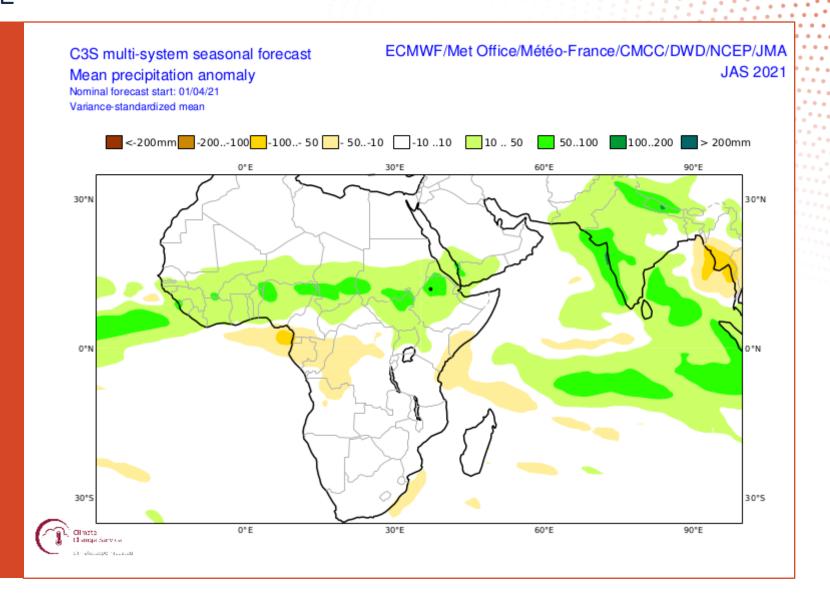


WEST AFRICAN RAINFALL

Above average rainfall predicted across Sahel region of Africa July through September.

This likely reflects consistent and numerous African Easterly Waves.

African Easterly Waves can develop into tropical storms and hurricanes once they travel into the open Atlantic Ocean.





ANALOG YEARS — YEARS WITH SIMILAR PREDICTOR PATTERNS TO 2021

Year	ACE	Named Storms	Hurricanes	Major Hurricanes
1989	135.1	11	7	2
1996	166.2	13	9	6
2001	110.1	15	9	4
2006	83.3	10	5	2
2008	145.7	16	8	5
2011	126.3	19	7	4
2012	132.6	19	10	2
2013	36.1	14	2	0
2018	129.0	15	8	2
Mean of Analog Years	118.3	14.7	7.2	3.0
Normal Tropical Season (1950-2020)	104	12	6	3

Years where Cool Neutral ENSO through the Summer and Fall

A 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	133	118	125.5
Named Storms	16	15	15.5
Hurricanes	8	7	7.5
Major Hurricanes	3	3	3.0



EARTH NETWORKS – 2021 ATLANTIC HURRICANE OUTLOOK:

Above Normal: 55% chance

Normal: 30% chance

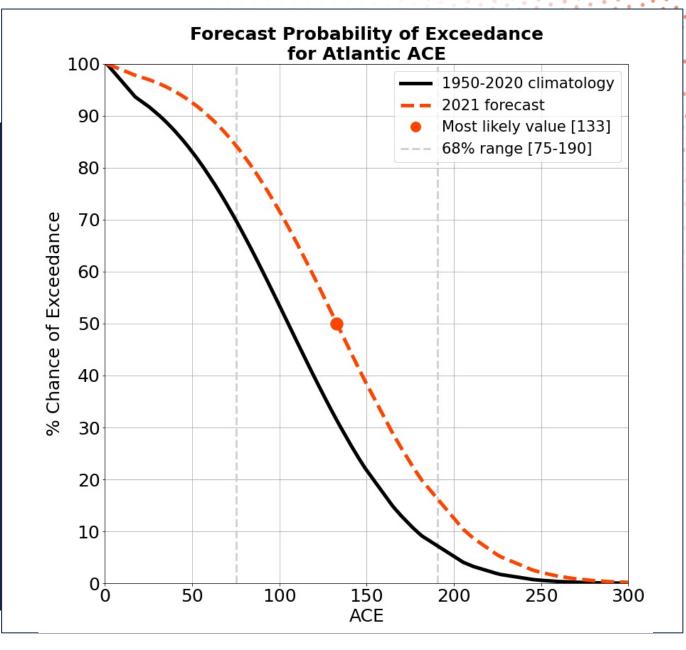
Below Normal: 15% chance

CATEGORY	NORMAL (1950-2020)	FINAL FORECAST
ACE	74 to 126	133 (+/- 58)
Named Storms	10-14	16 (+/- 4)
Hurricanes	5-7	8 (+/- 3)
Major Hurricanes	2-3	3 (+/- 1)



2021 PROBABILITY OF EXCEEDANCE FOR ACE

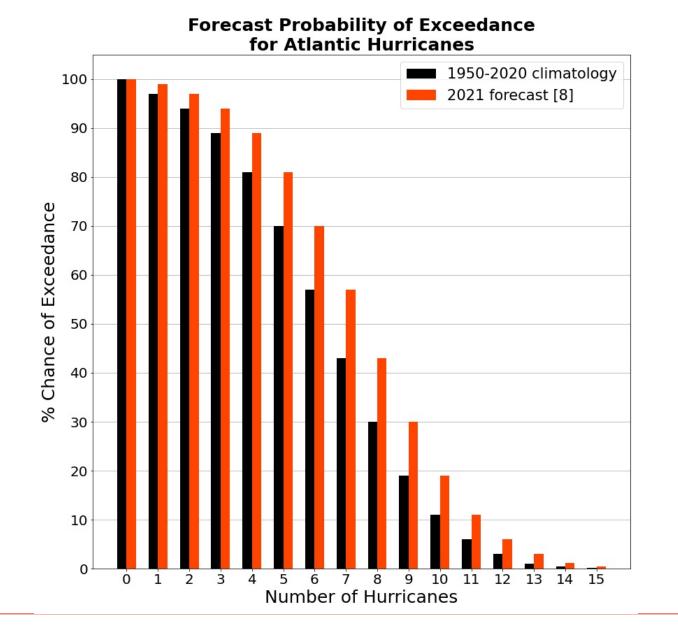
- In order to better convey uncertainty in the forecast, Probability of Exceedance charts have been included to enable users to more accurately assess risk.
- The black line is the probability of a given ACE number being achieved based on 1950-2020 climatology.
- The orange dashed line displays the probability of ACE exceeding a given value based on a forecast of 133.





2021 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 black bar is the probability of a given hurricane count being achieved based on 1950-2020 climatology.
- The orange bar shows the probability of a hurricane count being exceeded a given forecast value of 8.





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).

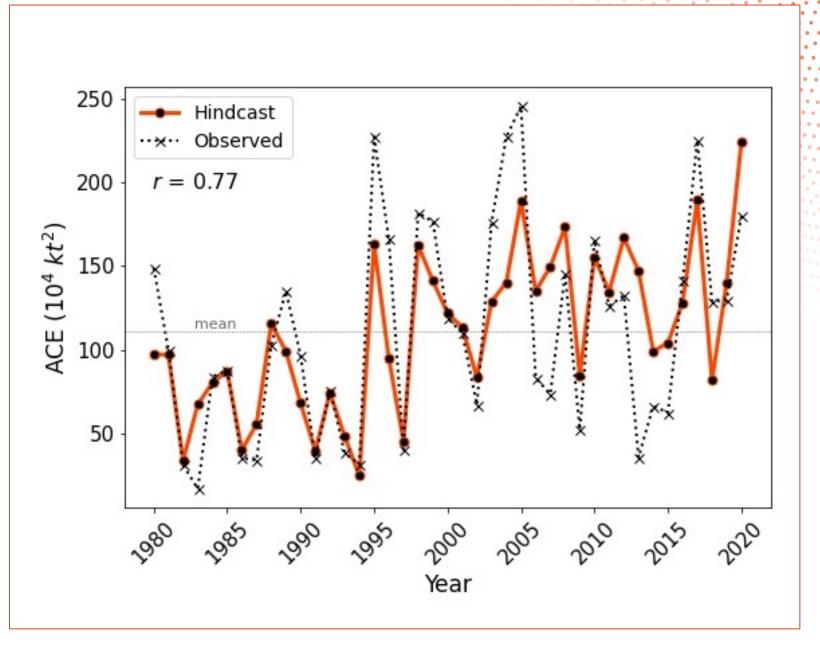
COMMENTARY ON OUR NEURAL NETWORK MODEL

- 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

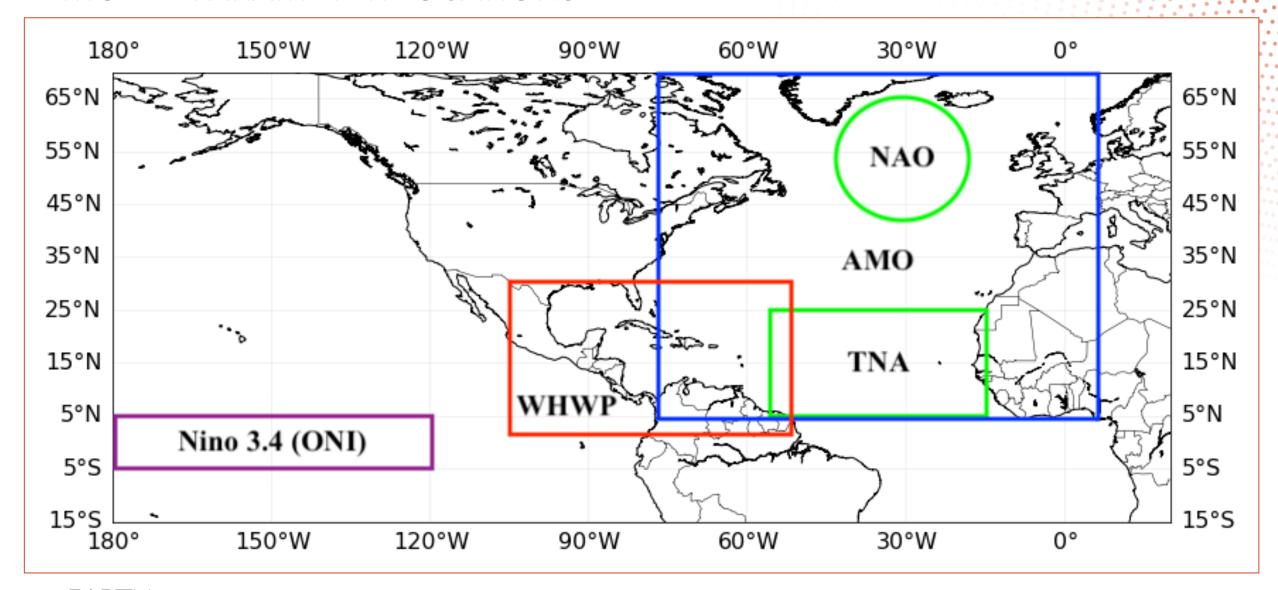
- Final forecast probability is determined by the likelihood ACE will fall into a given tercile.
- Tercile groupings correspond to 1/3 (33.3%) of observed seasonal values in 1950 to 2020 climatology.
- Above normal seasonal ACE is therefore the highest 1/3 of recorded values, or >126.
- Normal seasonal ACE values are the middle 1/3 which are between 74 and 126.
- Below normal seasonal ACE values are <74.

APRIL CROSS-VALIDATED HINDCAST ACE (1980-2020)



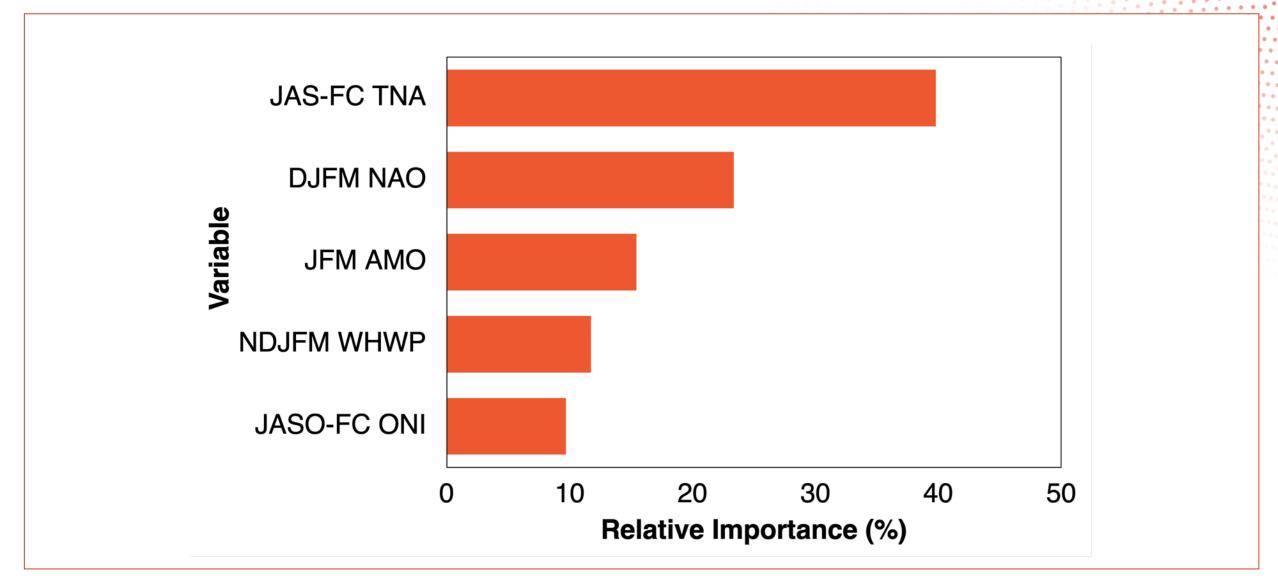


MODEL PARAMETER LOCATIONS

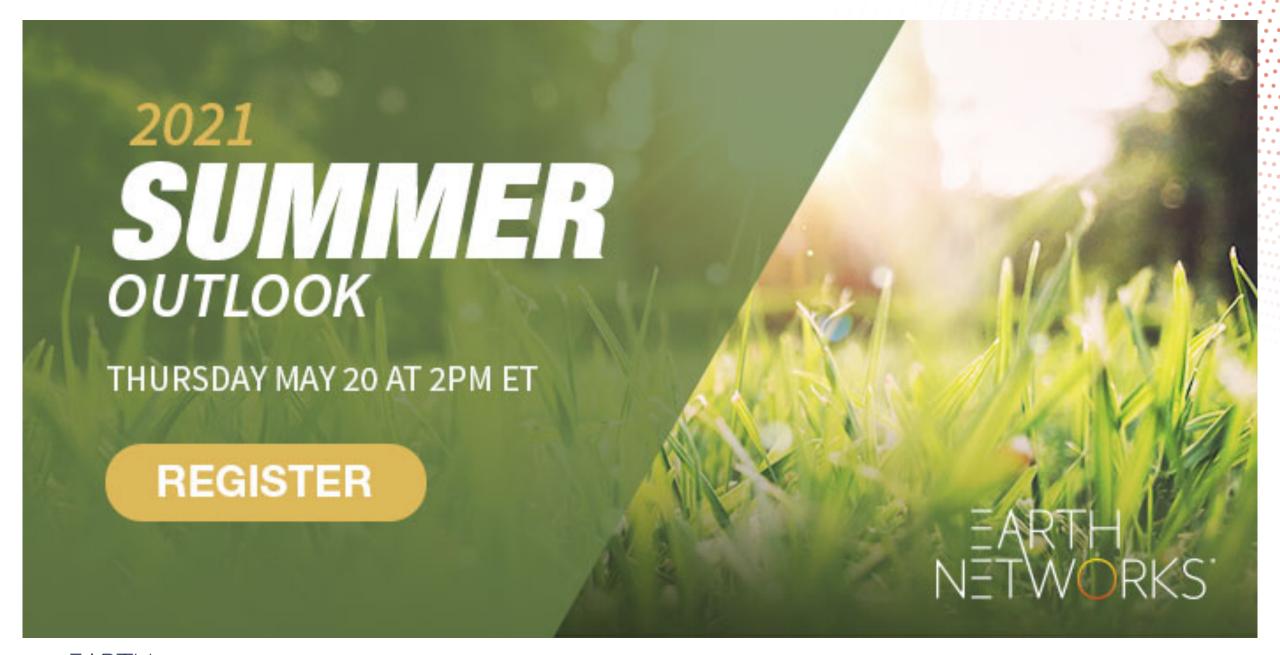




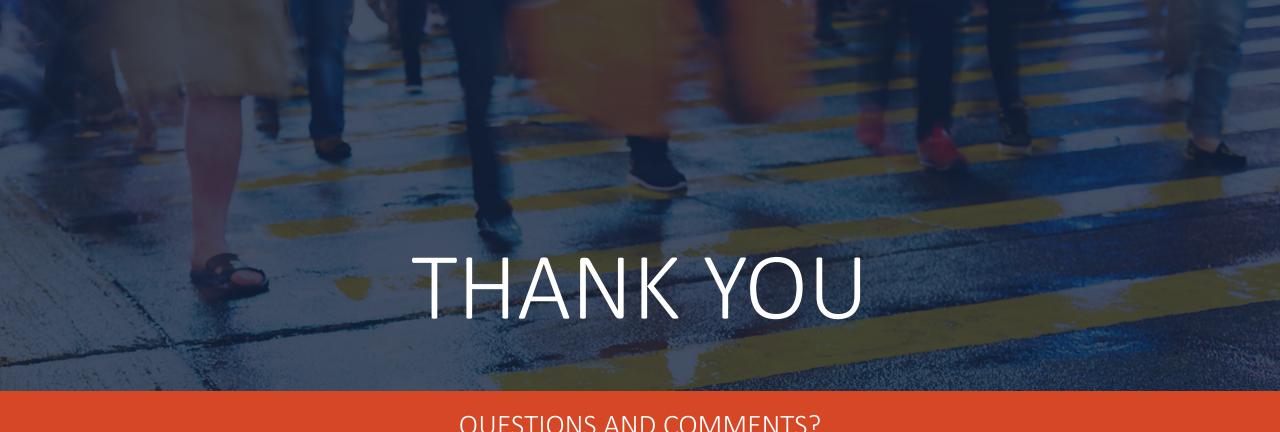
RANKED IMPORTANCE OF FORECAST VARIABLES











QUESTIONS AND COMMENTS?

