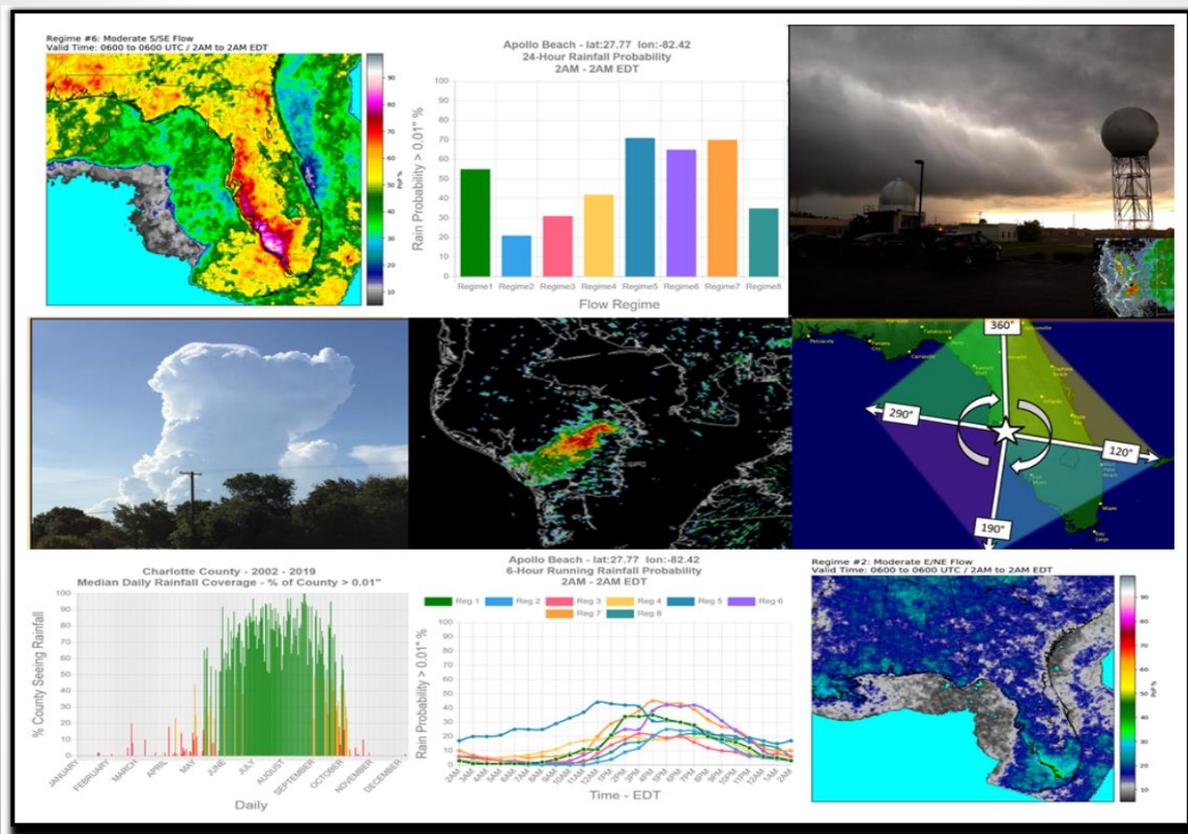# Utilizing Subtropical Ridge "Flow Regime" Convective Precipitation Climatologies within AWIPS to Enhance Warm Season Probability of Precipitation Forecasts and Related Decision Support Services Across the Southeastern United States

Bryan Mroczka
Science and Operations Officer
National Weather Service
Tampa Bay Area

Today's VLAB Forum Talk

1. Why sea breeze convective forecasting & decision support is vitally important. Plus, a little history…

2. Flow regime climatology methodology

3. Integration into the Advanced Weather Interactive Processing System (AWIPS)

4. Public/Media based website for accessing seabreeze climatology content in various forms

Why is this research important?

Florida's unique geography and favorable conditions for both land and marine activities, **combined with the daily pulse convection type of thunderstorms,** annually puts it near (or at the top) of lightning fatalities & injuries
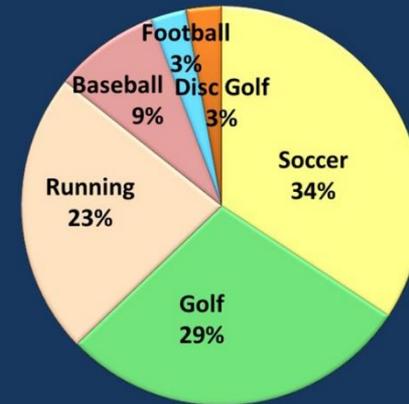

Lightning Fatalities
Water-Related Activities

- Swimming 8%
- Beach 28%
- Fishing 44%
- Boating 20%
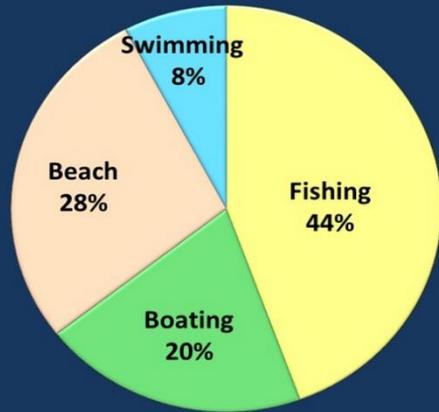
Based on 90 cases from 2006 through 2019

Compiled by John Jensenius

Lightning Fatalities
Sports-Related Activities

- Football 3%
- Baseball 9%
- Disc Golf 3%
- Soccer 34%
- Running 23%
- Golf 29%

Based on 35 cases from 2006 through 2019

Compiled by John Jensenius

LIGHTNING FATALITIES BY MONTH 1993-2003

JAN 0, FEB 1, MAR 2, APR 3, MAY 1, JUN 17, JUL 20, AUG 19, SEP 11, OCT 1, NOV 0, DEC 0
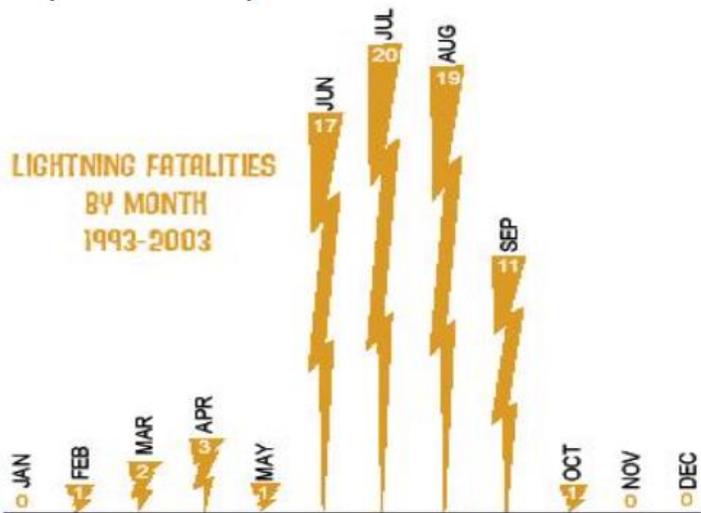
Standing on the Shoulders of Giants
A long road of research

The Sea Breeze

The sea breeze is not just simply an onshore wind forecast, but often leads to a much more inclement and dangerous weather phenomenon.

**A pleasant day at the beach or boating
can change in a big hurry…**

Refreshing Breezes…   *Wind in the sails…*

Sea Breeze Thunderstorms

The sea breeze is not just simply an onshore wind forecast, but often leads to a much more inclement and dangerous weather phenomenon.

**A pleasant day at the beach or boating
can change in a big hurry…**

Tackling the Seabreeze Thunderstorm Threat: Forecasting & Decision Support

Forecasting When and Where…

Using the "Flow Regime" Methodology

Regime #6: Moderate S/SE Flow
Valid Time: 0600 to 0600 UTC / 2AM to 2AM EDT
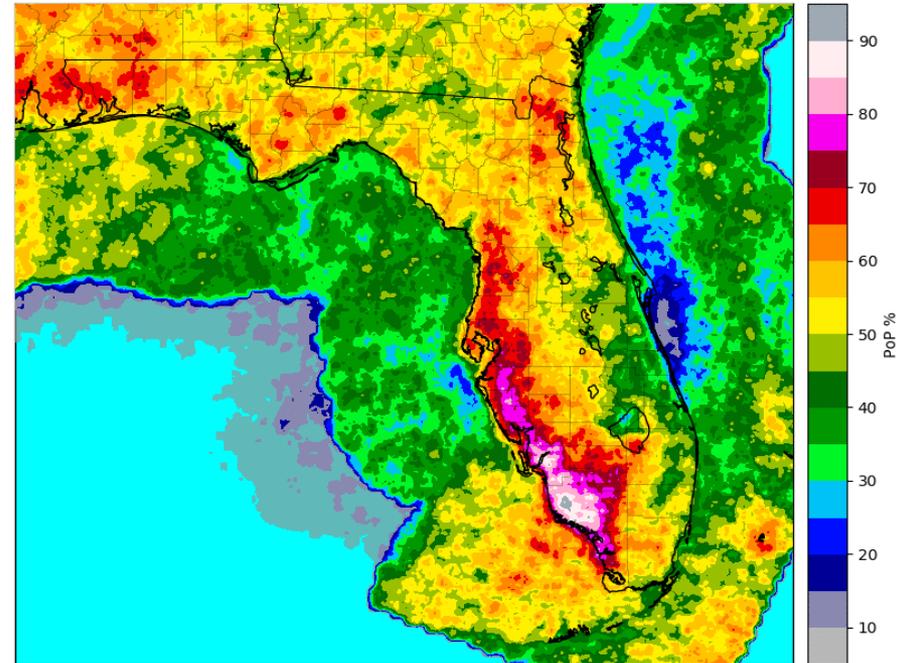
# Flow Regimes & The Subtropical Ridge

- A "Flow Regime" refers to the specific interaction between the large scale (synoptic) wind flow and the various sea breezes boundaries.

- This synoptic flow is controlled by the position and strength of the "Atlantic Subtropical Ridge".

- A region of high pressure that often exists around $30°$ north latitude over the Atlantic Ocean.
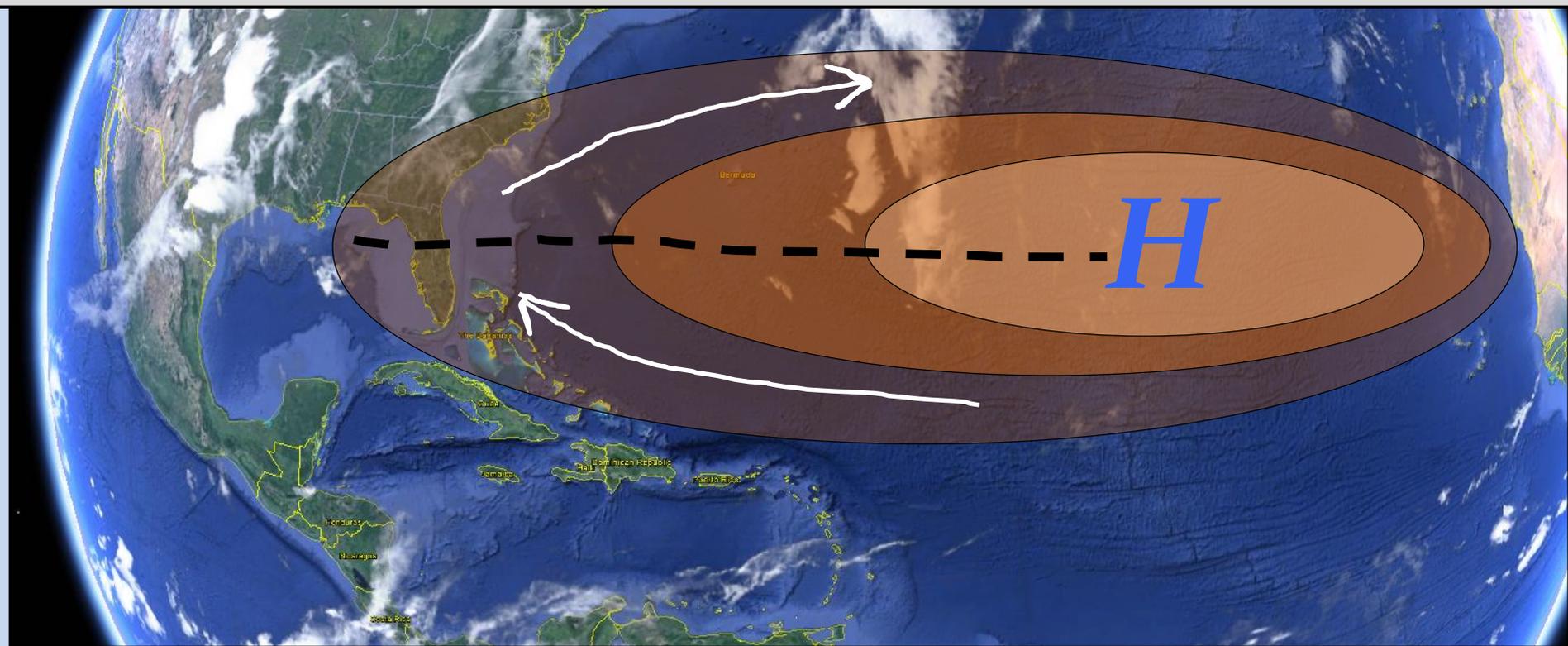
The Subtropical Ridge

- The ridge will shift to the north and south over time, and also become stronger or weaker

- The ridge's position and strength impacts on the weather across Florida and the eastern Gulf of Mexico.

- These variations in the structure of the ridge play a large role in the "where and when" for thunderstorms on a particular day.
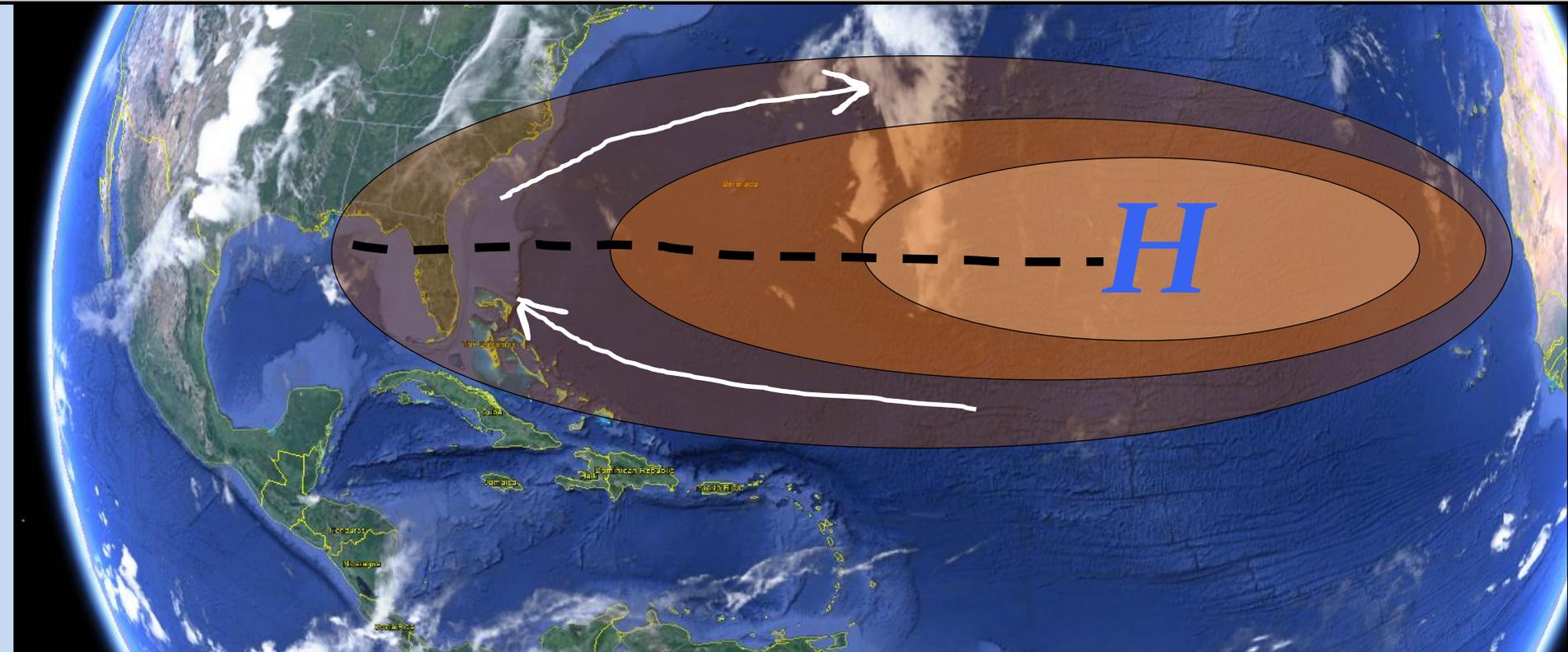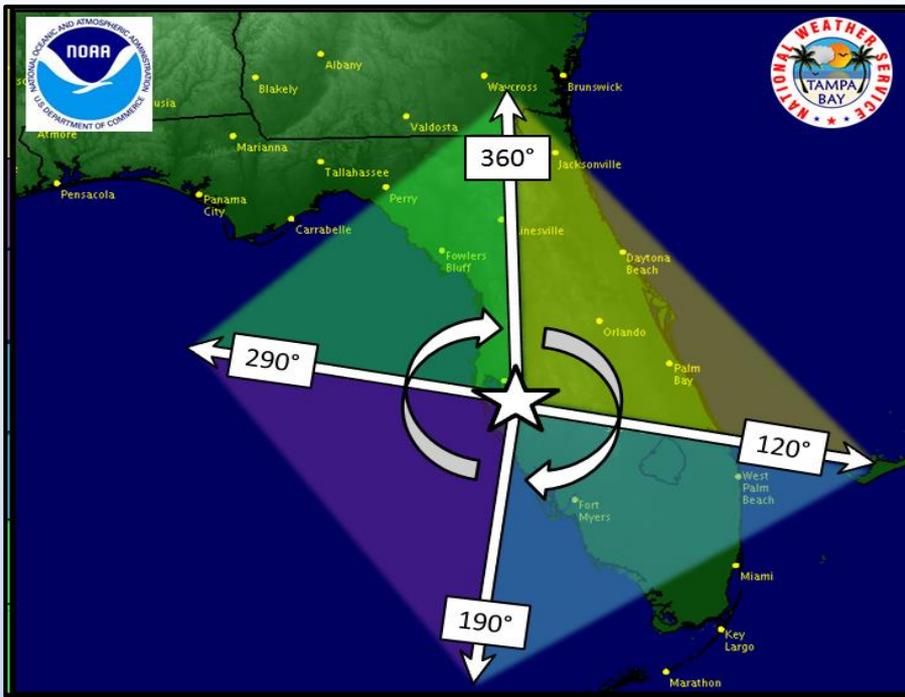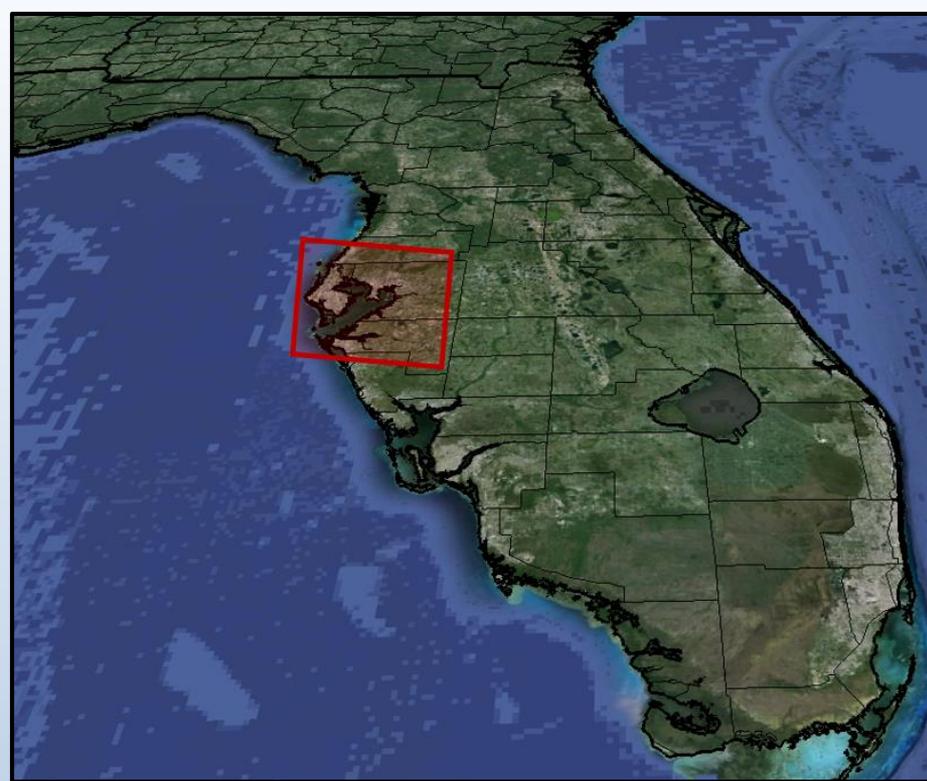
- Study days classified as ones with a subtropical regime controlled weather pattern (June 1st- Sept 15th).

- Regime was chosen by the mean 1000-700mb flow vector at 12UTC within a region around the Tampa Bay Area.

Regime #	Flow	# of Days
1	Light/Variable	98
2	E/NE 5-10kts	249
3	E/NE > 10kts	118
4	W/SW 5-10kts	428
5	W/SW > 10kts	268
6	S/SE 5-10kts	458
7	S/SE > 10kts	224
8	N/NW 5-10kts	96
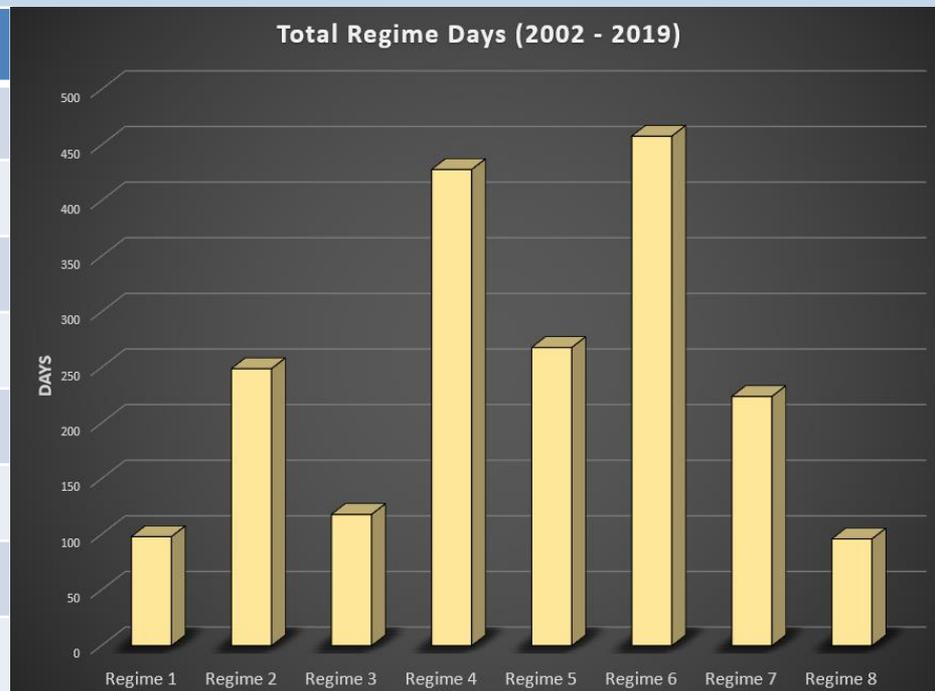
- In order to classify a day into a particular flow regime, the 1000-700mb mean vector wind at 12 UTC was calculated within a defined zone over the Florida west coast.

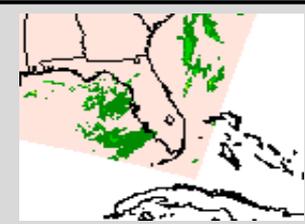- Study Period was June 1st, - Sept 15th for the years **2002 - 2019**

Wind Data

North American Regional Reanalysis (NARR) data:
- U & V Wind Components
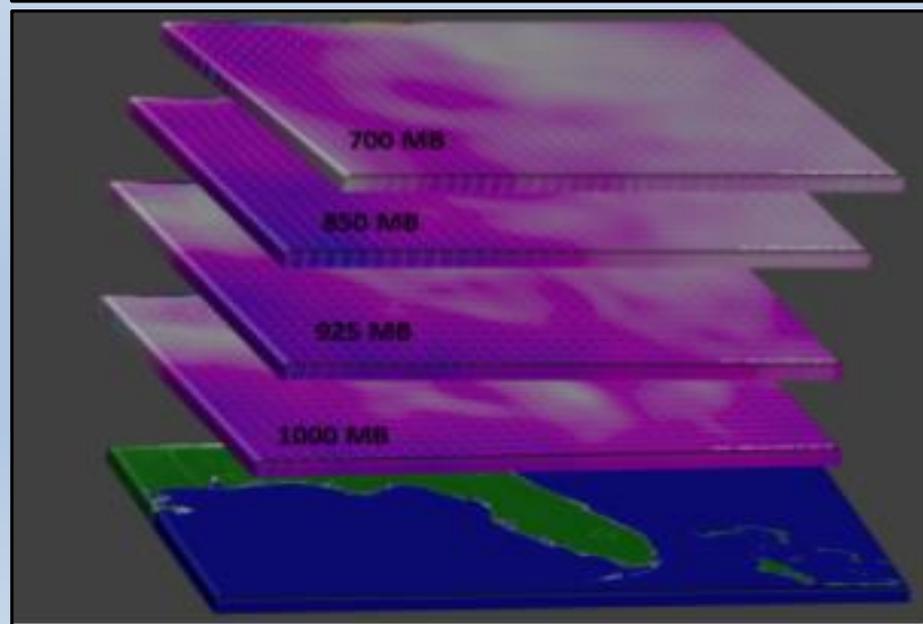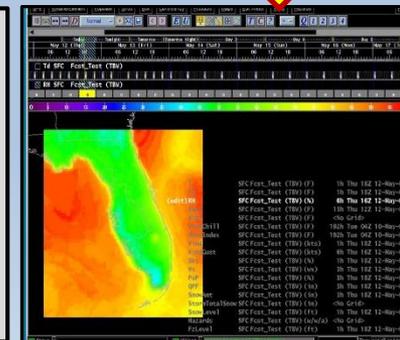   - 1000 mb , 925 mb, 850 mb, 700 mb

Precipitation Data

STAGE IV
- Hourly rainfall accumulation

Processing Engine

Graphical Forecast Editor (GFE):
- Python Based
- Precipitation & wind data combined into convective climatologies

Applying Flow Regime Research
to Forecast Operations – Part 2

1. View the 24 hour convective pattern results from each of the 8 distinct flow regimes. Probability of precipitation >= 0.01"

2. Identify the various temporal climatologies that are available through this research

3. Discover how this research is being incorporated into AWIPS for enhanced forecast and decision support

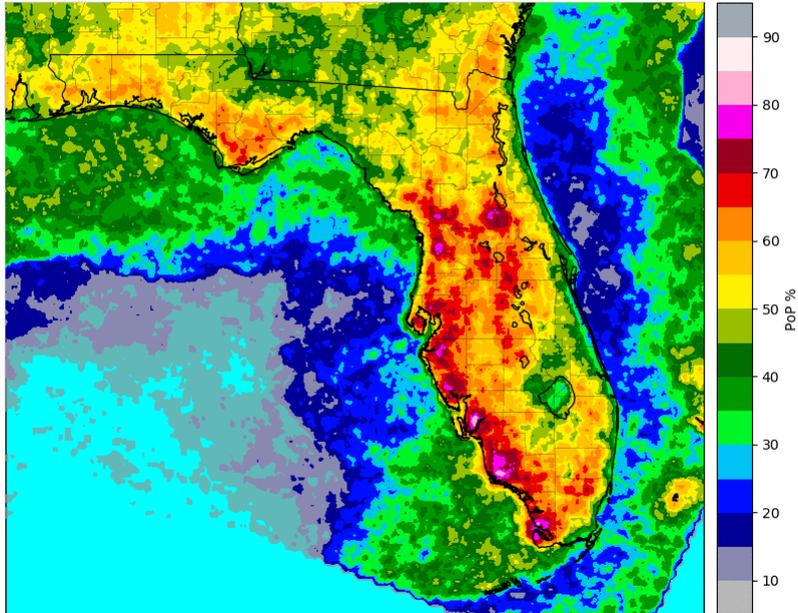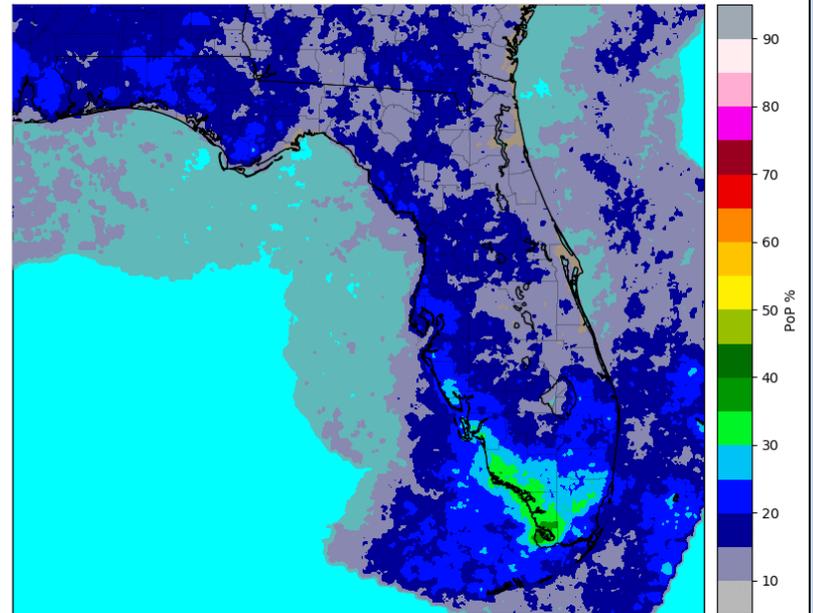4. Introduce a new Decision Support / Public Website housing all the data
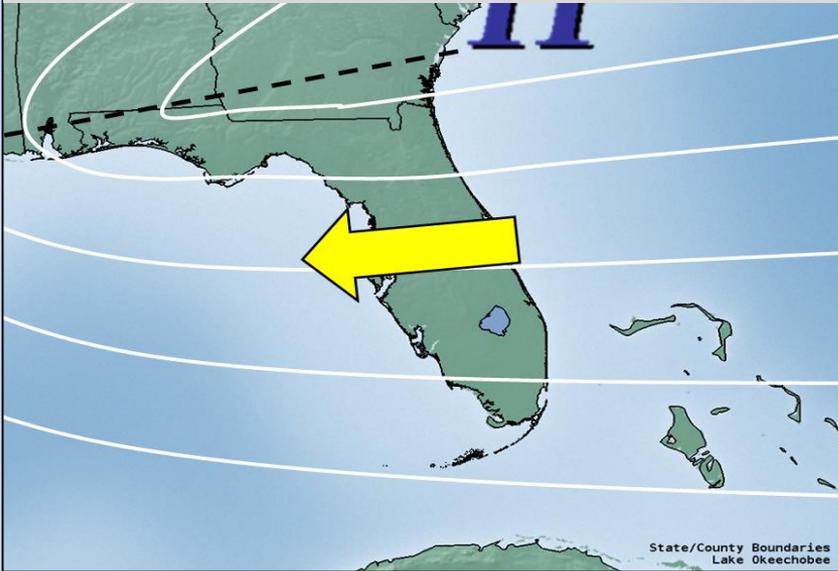
Regime #1: Light / Variable Flow

H

State/County Boundaries
Lake Okeechobee

Regime #1: Light & Variable Flow
Valid Time: 0600 to 0600 UTC / 2AM to 2AM EDT

Regime #2: E/NE 5 - 10 knots

H

State/County Boundaries
Lake Okeechobee

Regime #2: Moderate E/NE Flow
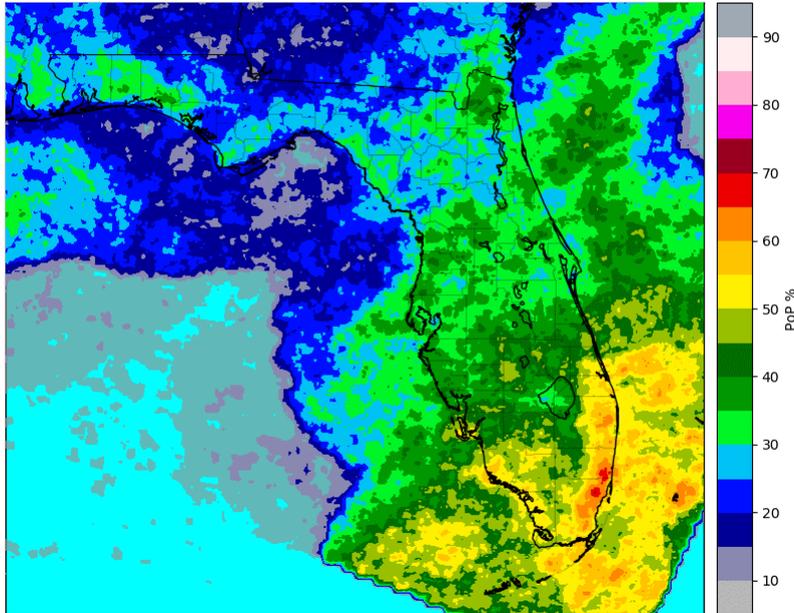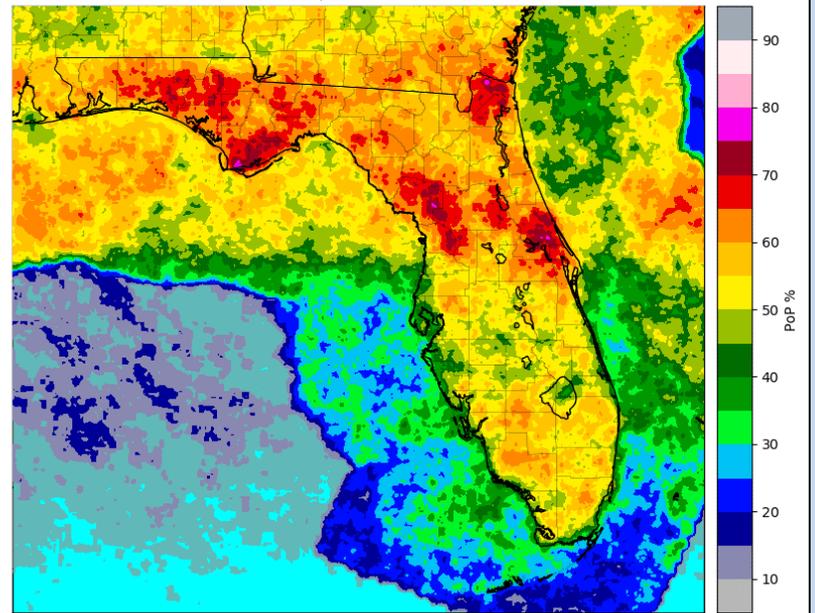Valid Time: 0600 to 0600 UTC / 2AM to 2AM EDT

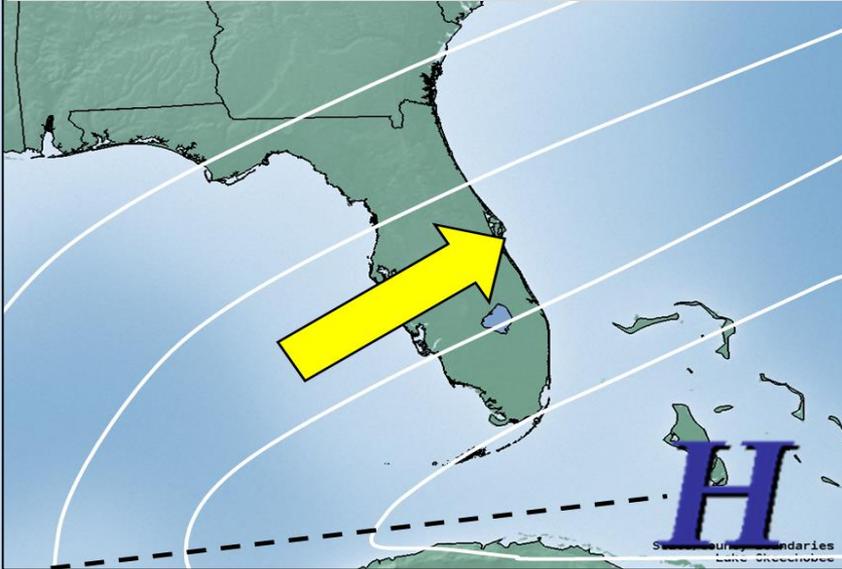**Regime #3: E/NE > 10 knots**

Regime #4: SW/W 5 - 10 knots

Regime #3: Strong E/NE Flow
Valid Time: 0600 to 0600 UTC / 2AM to 2AM EDT

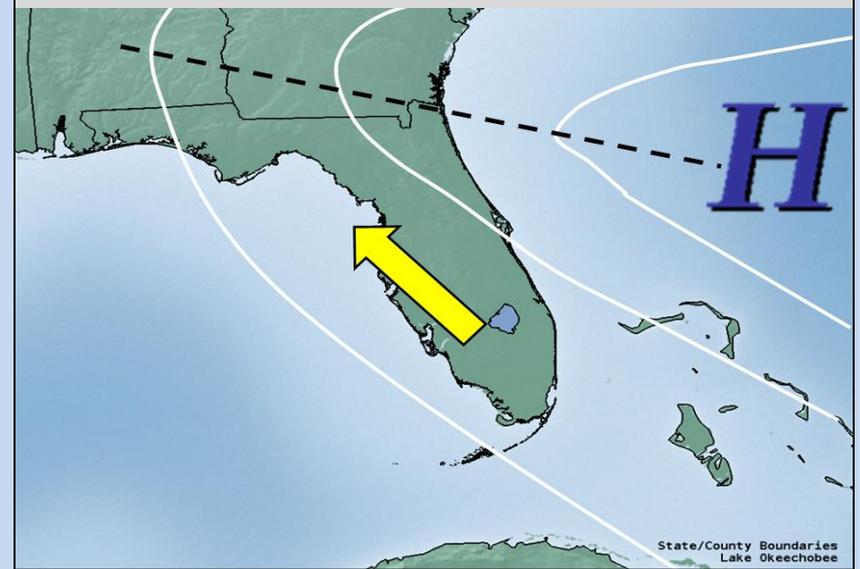Regime #4: Moderate W/SW Flow
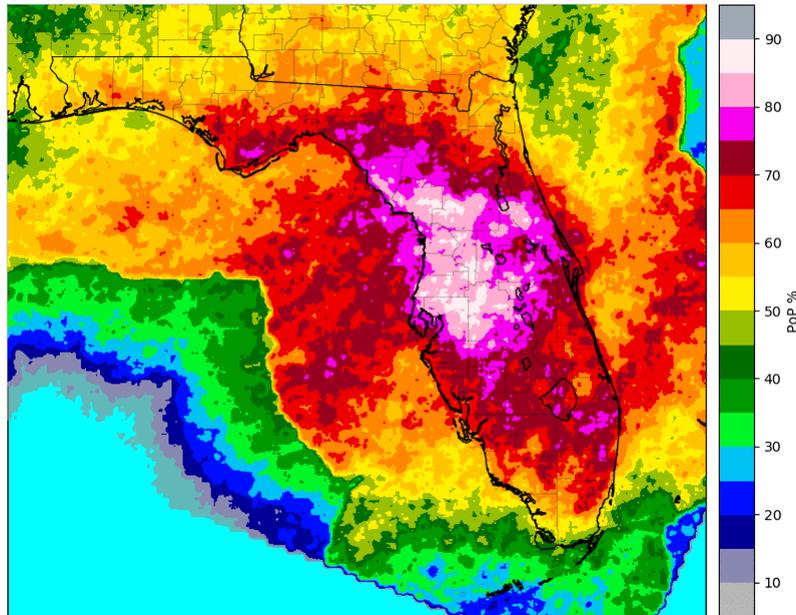Valid Time: 0600 to 0600 UTC / 2AM to 2AM EDT
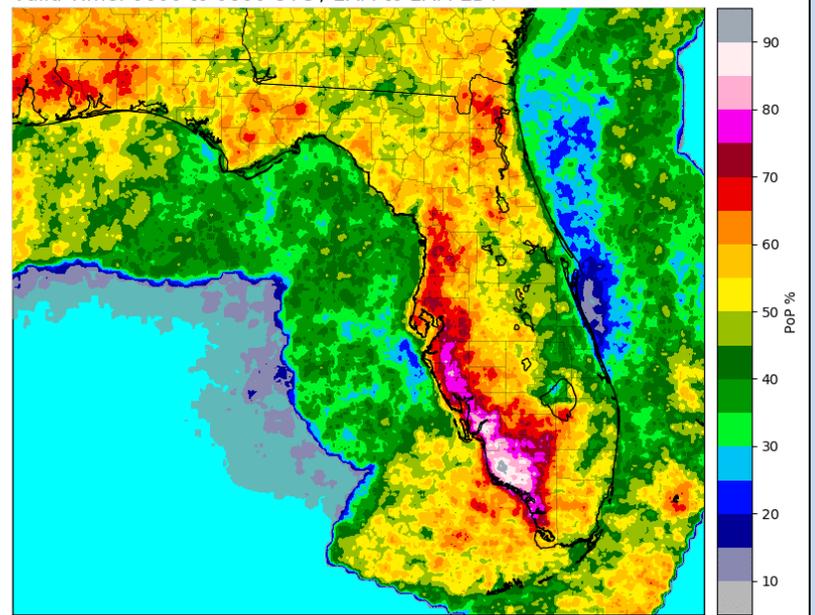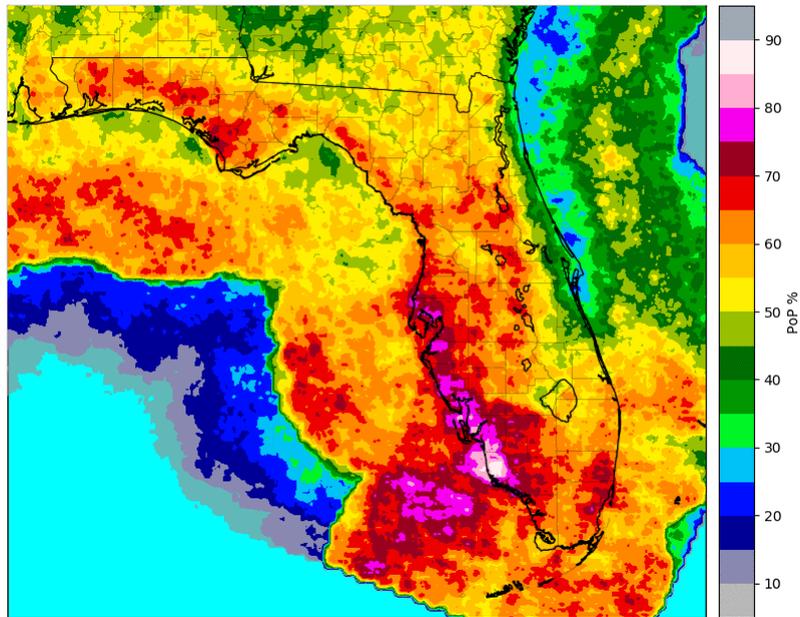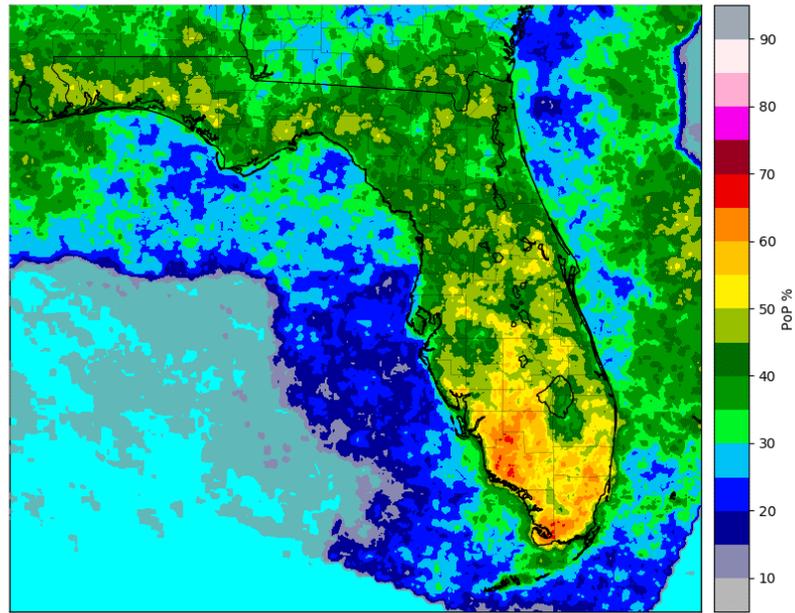
Regime #5: SW/W > 10 knots

Regime #5: Strong W/SW Flow
Valid Time: 0600 to 0600 UTC / 2AM to 2AM EDT

Regime #6: S/SE 5 - 10 knots

Regime #6: Moderate S/SE Flow
Valid Time: 0600 to 0600 UTC / 2AM to 2AM EDT

Regime #7: S/SE > 10 knots

Regime #7: Strong S/SE Flow
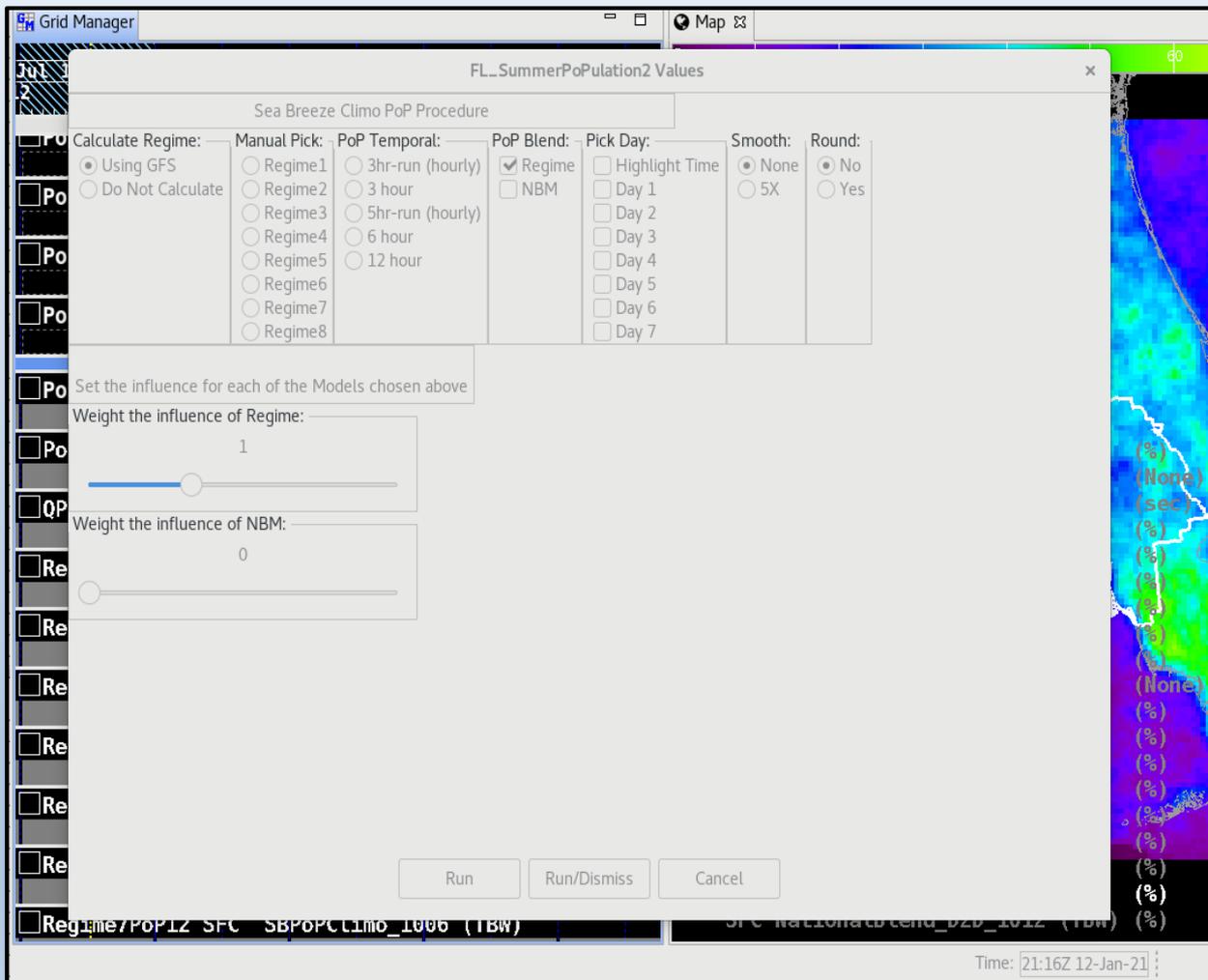Valid Time: 0600 to 0600 UTC / 2AM to 2AM EDT

Regime #8: N/NW 5 - 10 knots

Regime #8: Moderate N/NW Flow
Valid Time: 0600 to 0600 UTC / 2AM to 2AM EDT

Fast Forward (2018-2020)
National Weather Service Tampa Bay Area, FL

Graphical Forecast Editor Example:
Regime #6 - SE/S Flow 5-10 kts
12-hour Rainfall Probability / 8AM-8PM EDT

- 18 years of data (2002-2019)

- All climatologies stored via WMO/AWIPS friendly grib2

- Allows datasets to be fully integrated into AWIPS as a processed "model"

- AWIPS Data Access Framework (DAF) python system utilized to calculate the regime

- Utility of the grib2 AWIPS ingest and DAF capability allows operational expansion to all NWS offices within Florida

- Updating of datasets over time easier and more automated

Today (2021)
AWIPS / Graphical Forecast Editor Interface Procedure

- Automation to provide "first guess" at regime and population of forecast with resulting climatology

- Forecasters may choose to manually input flow regime based on analysis.

- Options include:
  - Automated or Manual
  - Temporal Period
  - Forecast Day (1 – 7)
  - Smoothing functions
  - Rounding functions

- Combined through weighted blend with National Blend of Models

Temporal Period Climatologies Available to Forecasters in AWIPS:

Synoptic Period Time Based:

24-Hour:
    0600 UTC - 0600 UTC

12-Hour:
    1200 - 0000 UTC
    0000 - 1200 UTC

6-Hour:
    0600 - 1200 UTC
    1200 - 1800 UTC
    1800 - 0000 UTC
    0000 - 0600 UTC

3-Hour:
    0600 - 0900 UTC
    0900 - 1200 UTC
    1200 - 1500 UTC
    1500 - 1800 UTC
    1800 - 2100 UTC
    2100 - 0000 UTC
    0000 - 0300 UTC
    0300 - 0600 UTC

"Running" Period Time Based:

5run-Hour:
    Running probability during a 5 hour period centered on each specific hour (1200 UTC, 1300 UTC, ...2100 UTC...)

3run-Hour:
    Running probability during a 3 hour period centered on each specific hour (1200 UTC, 1300 UTC, ...2100 UTC...)

Provides statistically significant and high resolution spatial/temporal hourly forecasts

Forecast Valid: 20Z / 4 PM EDT

18Z 19Z **20Z** 21Z 22Z

Detail Level:
Best Suited for
Days 1- 2 Forecasts
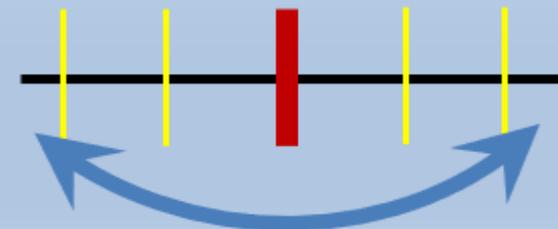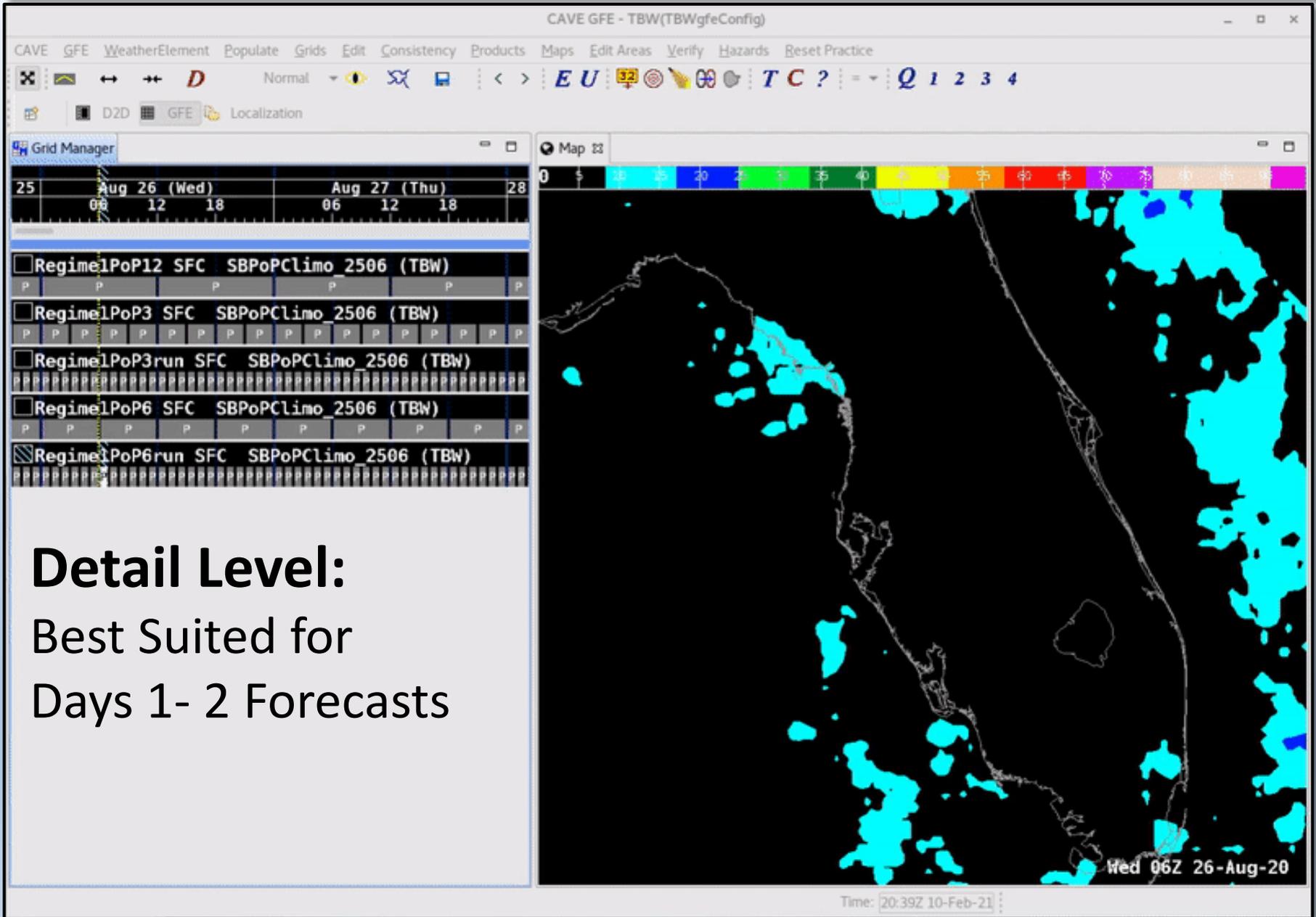
5run-Hour : Regime # 6 – SE/S Flow 5-10 kts

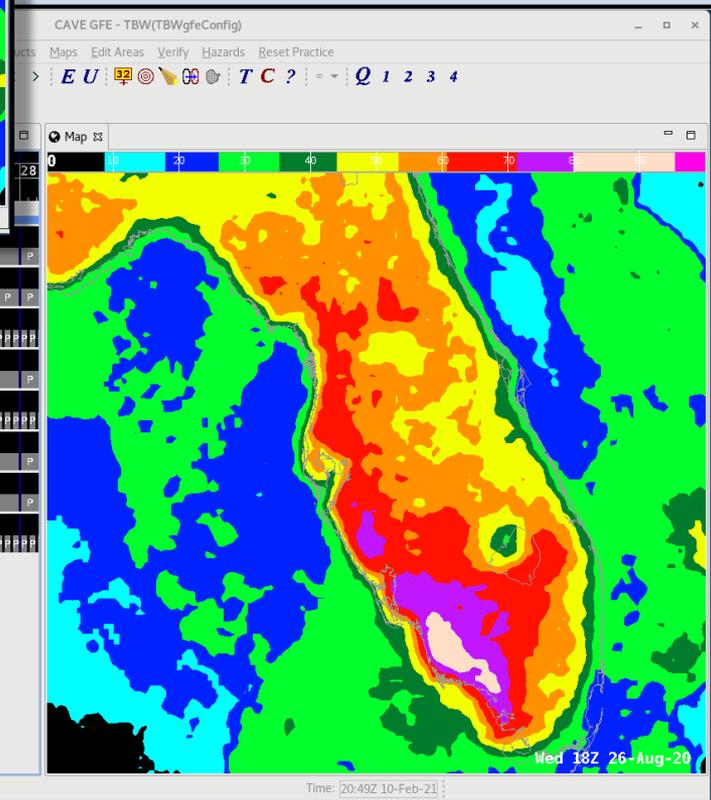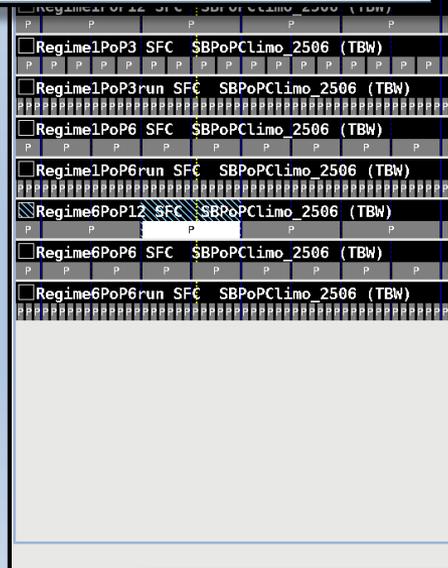**Detail Level:**
Best Suited for
Days 1 - 2 Forecasts

Detail Level:
Best Suited for
Days 2 - 4 Forecasts
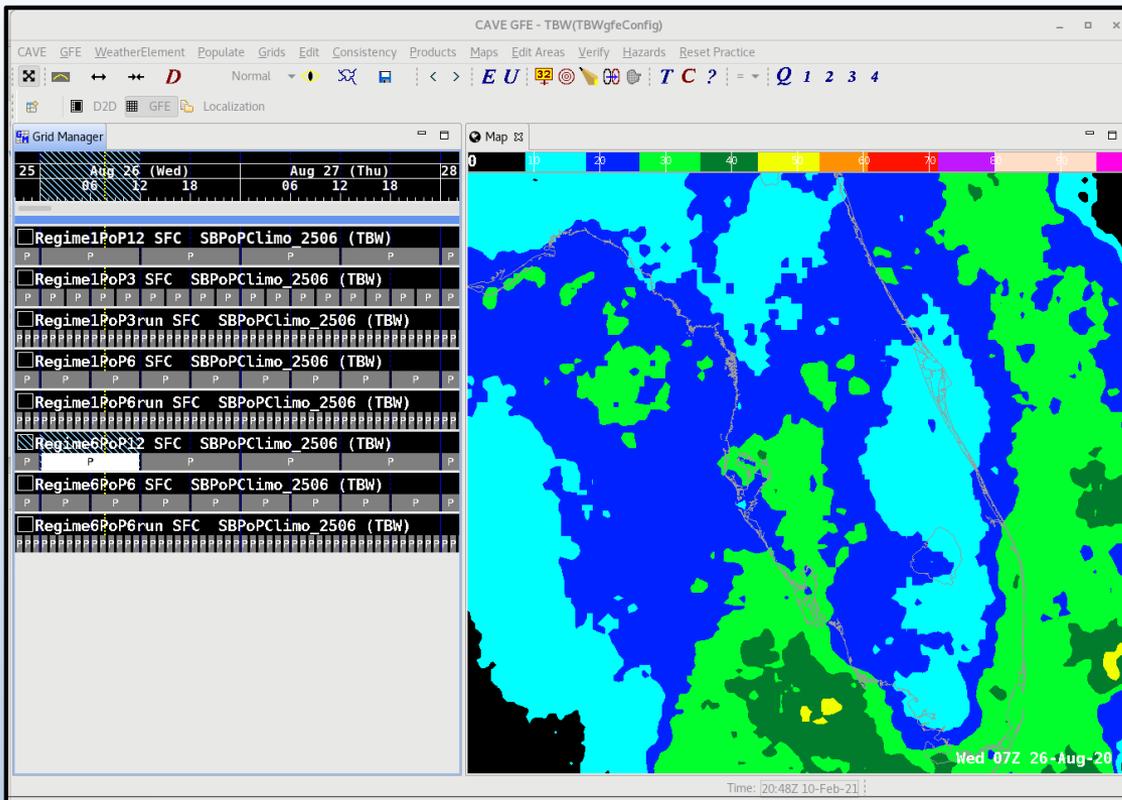
Regime # 6: 12UTC – 00UTC
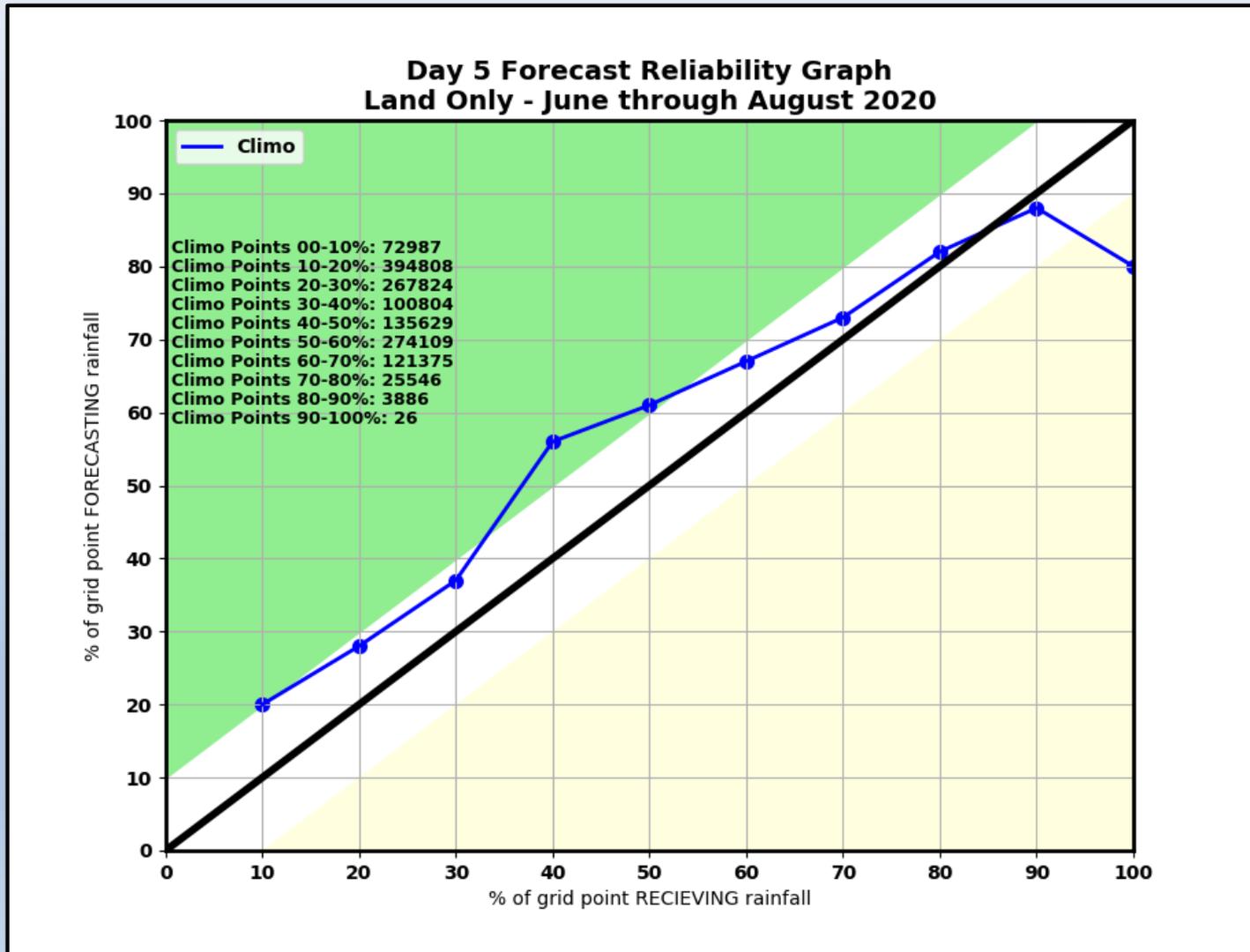800AM – 800PM

Regime # 6: 00UTC – 12UTC
800PM – 800AM

Detail Level:

Best Suited for

Days 4 - 7 Forecasts

Gridded Verification – All of Florida Reliability Chart
June – August 2020

Day 5 Forecast Reliability Graph
Land Only - June through August 2020

Climo

Climo Points 00-10%: 72987
Climo Points 10-20%: 394808
Climo Points 20-30%: 267824
Climo Points 30-40%: 100804
Climo Points 40-50%: 135629
Climo Points 50-60%: 274109
Climo Points 60-70%: 121375
Climo Points 70-80%: 25546
Climo Points 80-90%: 3886
Climo Points 90-100%: 26

% of grid point FORECASTING rainfall

% of grid point RECIEVING rainfall

Decision Support Examples

Pinellas County Florida: Regime # 1

- The unique geography of Pinellas county under weak synoptic flow allows a collision of mesoscale versions of the Gulf of Mexico seabreeze and Tampa Bay (breezes).

- The first storm of the day develops usually within 30 minutes of noon, with a high degree of forecast confidence.

- These datasets instantly provide that spatial/temporal detail, normally requiring considerable time and effort to include in the forecast
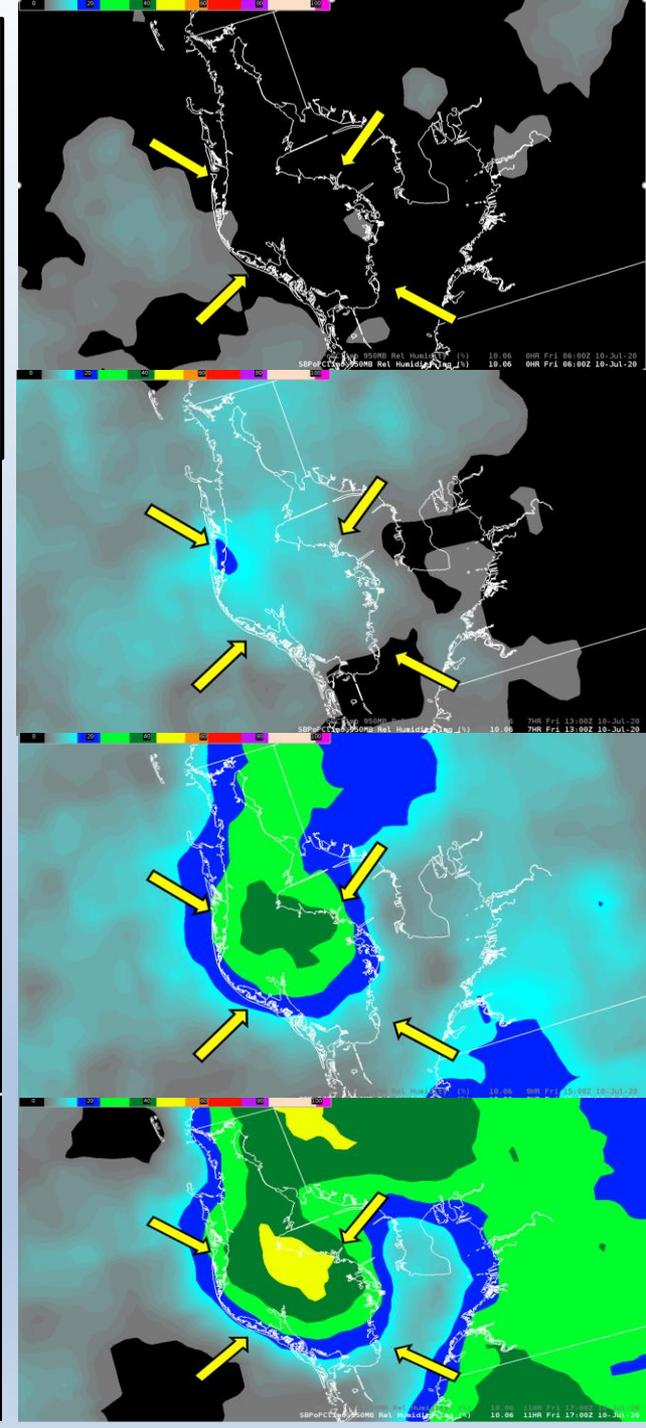
Manatee County Florida: Regime # 1 – 2000UTC / 400 PM EDT

- Beaches of Manatee/Sarasota Cnty: Rainfall potential and resulting lighting threat **less than 10%**

- Inland Manatee/Sarasota Cnty: Rainfall potential and corresponding lightning threat **approaching 60%**

- The advantages for decision support and outdoor event planning (even for "Is it safe to go to the beach?") can not be overstated.
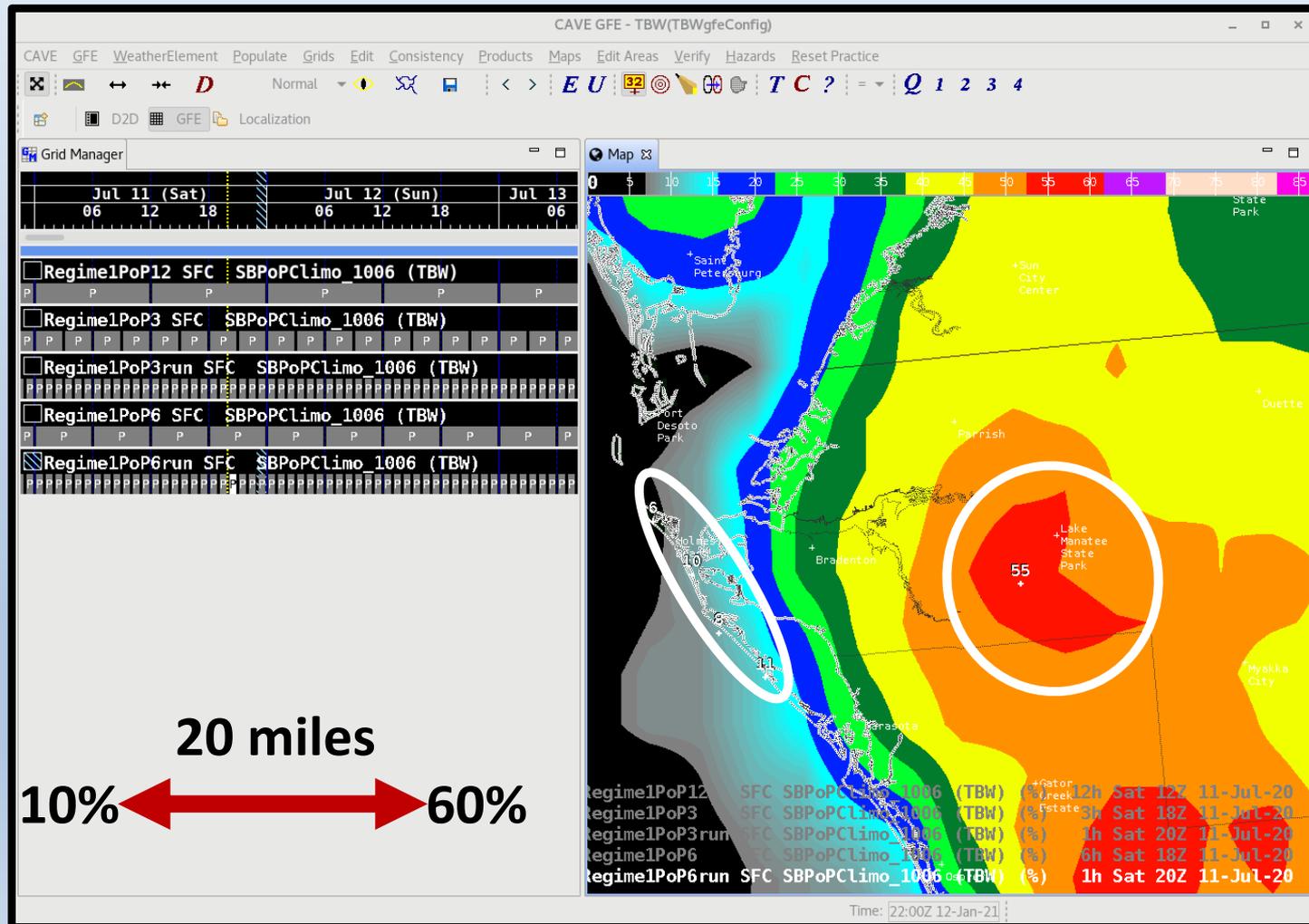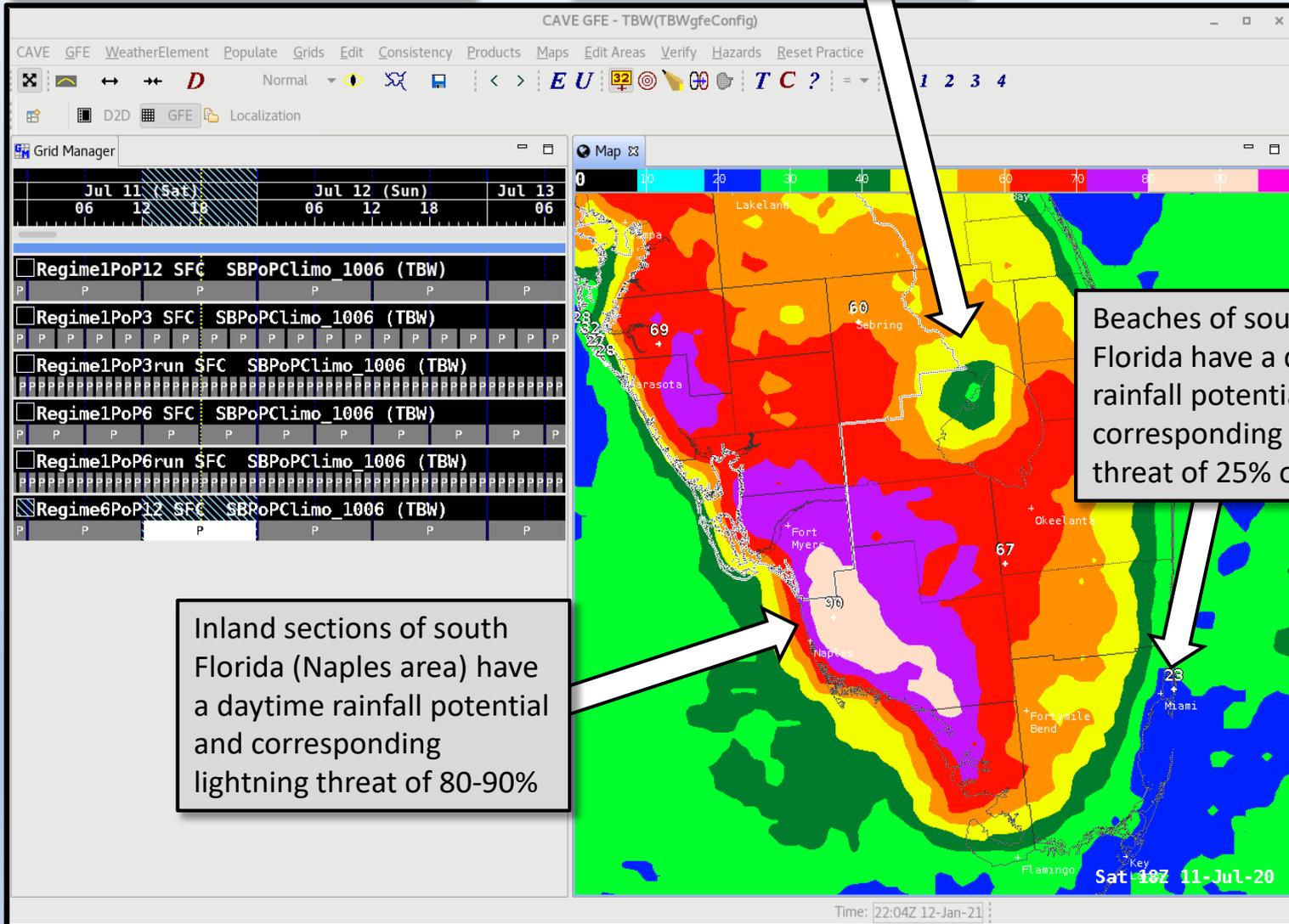
Example: Day 4 - 7 Forecast

12 hour 8AM – 8PM
Regime 6 day:

Notice Lake Okeechobee lee side rainfall shadow due to SE to NW flow

Beaches of southeast Florida have a daytime rainfall potential and corresponding lightning threat of 25% or less.

Inland sections of south Florida (Naples area) have a daytime rainfall potential and corresponding lightning threat of 80-90%
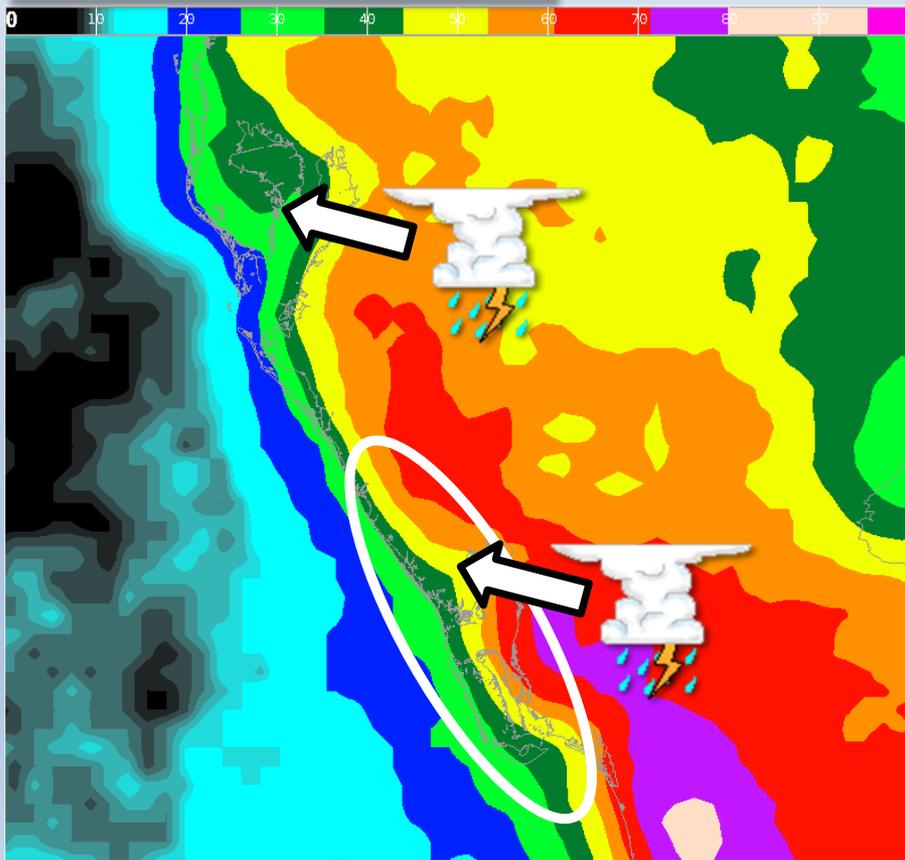
Charlotte Harbor Area
Charlotte & Lee Counties
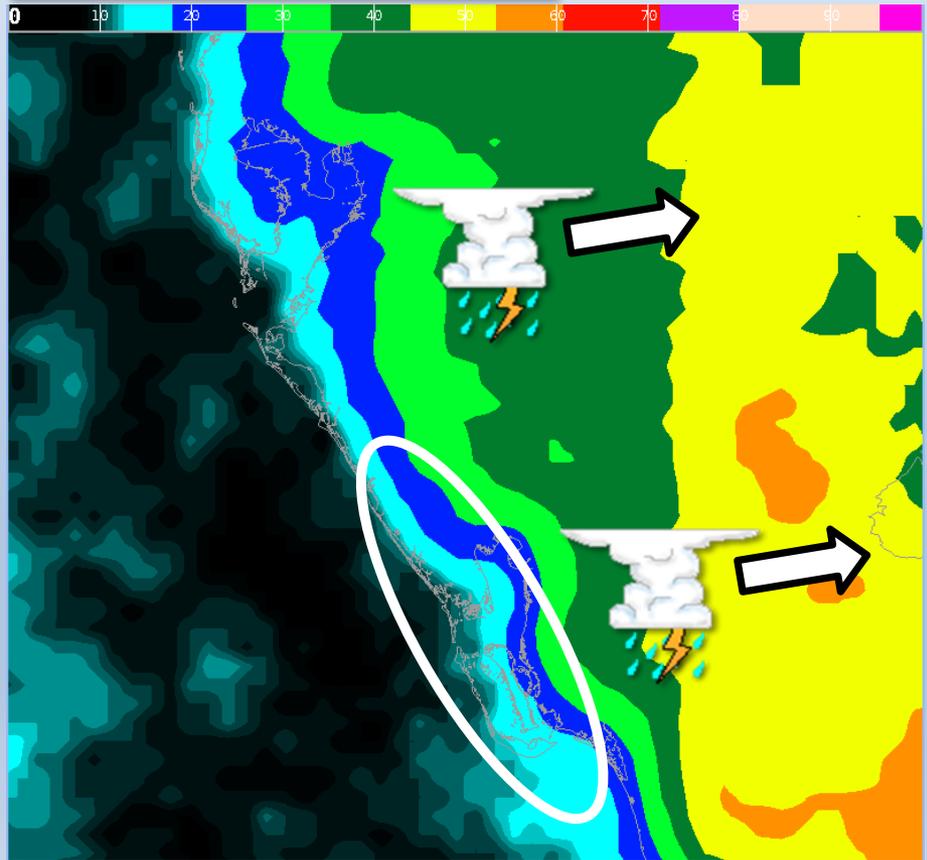
Large volumes of boating and beach activities
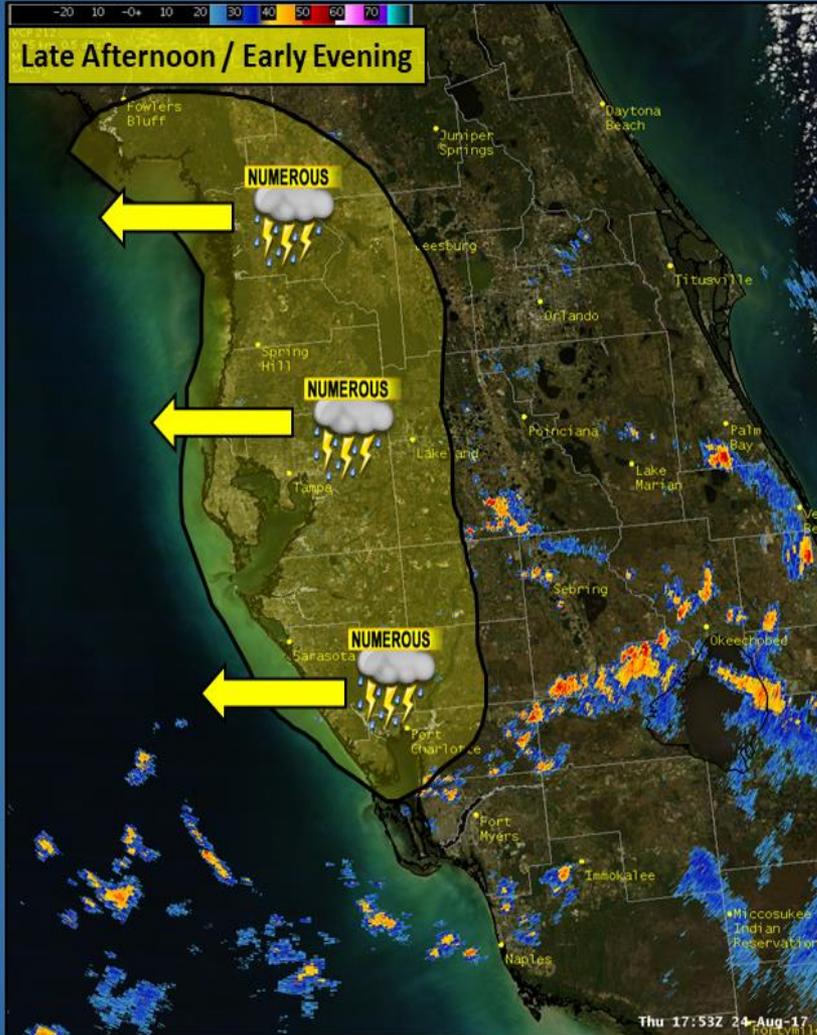
6 hour 2PM – 8PM
Regime 6 day:
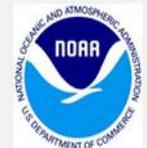S/SE 5-10 kts

6 hour 2PM – 8PM
Regime 4 day:
SW/W 5-10 kts

# Decision Support Through Social Media Utilizing Flow Regime Forecast Knowledge

Late Afternoon / Early Evening

NUMEROUS

NUMEROUS

NUMEROUS

Thu 17:53Z 24-Aug-17

2 PM EDT – Thursday August 24th, 2017

- ➤ Generally quiet conditions at 2PM expected to change during next several hours.

- ➤ Atmospheric conditions are very favorable for the development of thunderstorms later today.

- ➤ Development of numerous thunderstorms expected along I-75 corridor later this afternoon into the evening.

- ➤ Storms will move westward after development, and quickly move offshore into the Gulf.

- ➤ The quick movement offshore will pose a hazard to marine area, and boaters in Tampa Bay, Charlotte Harbor, and the coastal waters of the Gulf of Mexico should be prepared to seek safe harbor.

Will be rolled out with summer decision support seminars
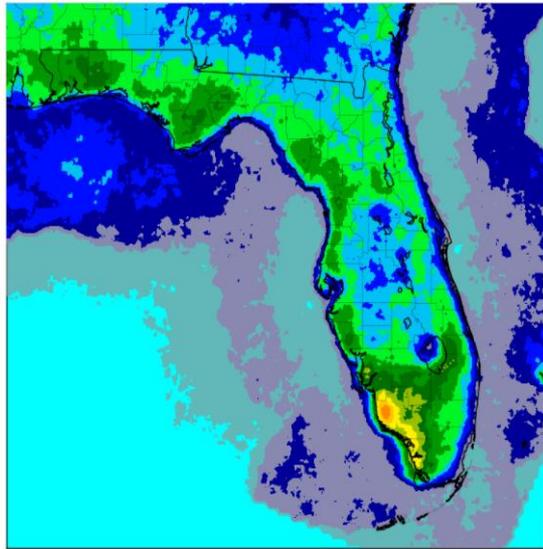*March/April 2021*
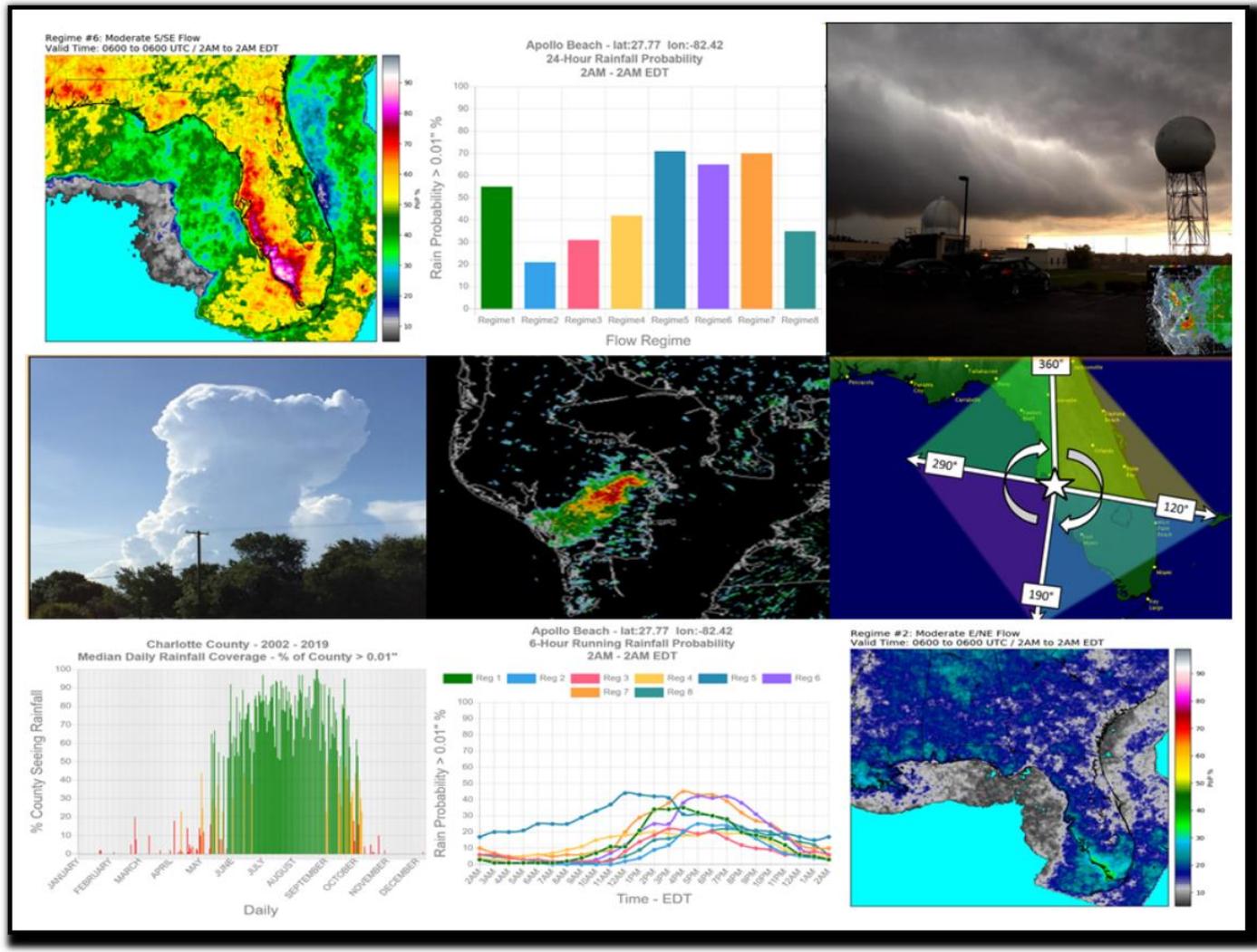
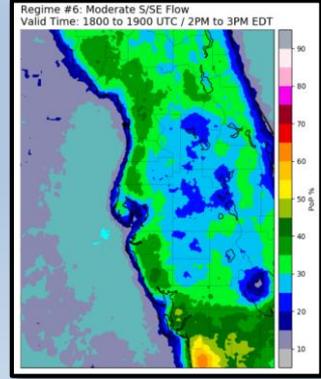# 2-D Imagery

- Choose any regimes

- Choose one of 8 viewing options ranging from Southeast United States, to Florida, to 6 varying National Weather Service county warning areas (CWAs)

- Choose any temporal period with scrolling animations available
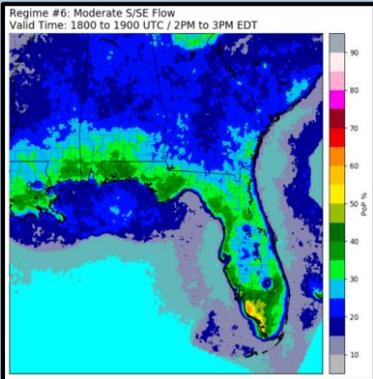
Upscale Viewing Regional to State
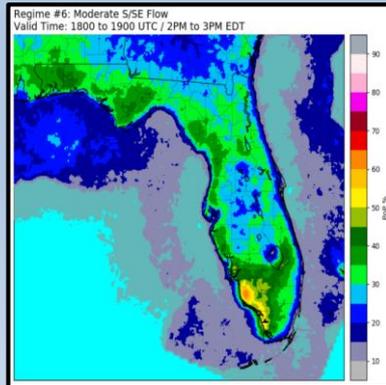
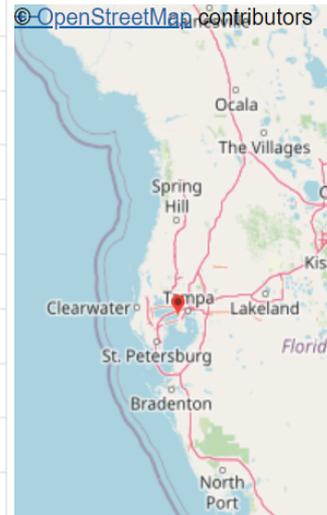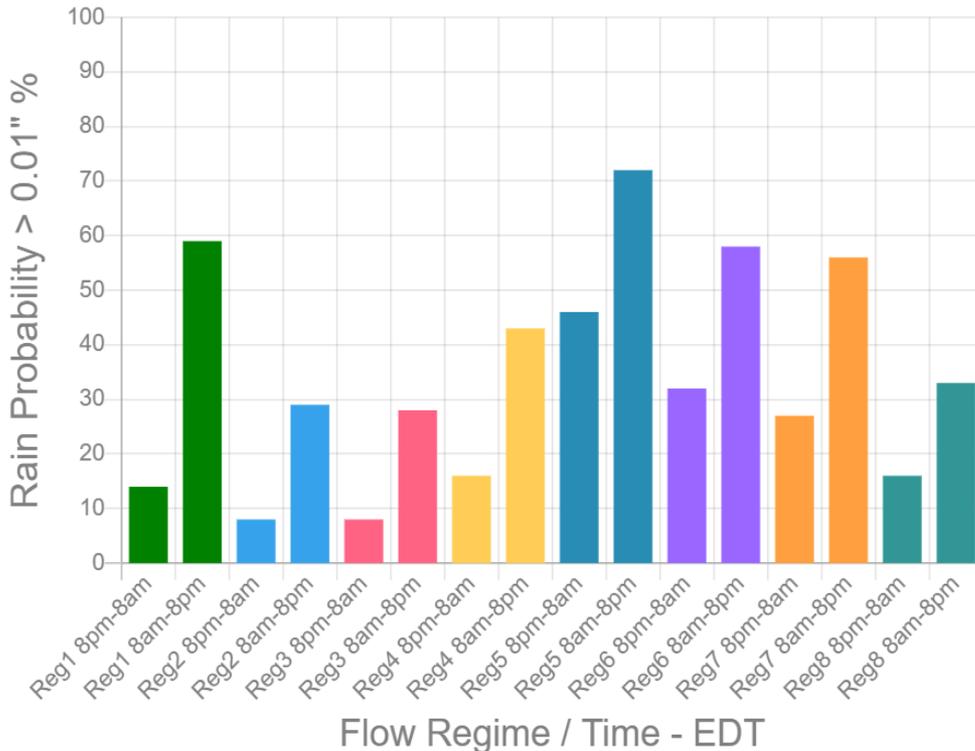Any Florida NWS County Warning Area (CWA)

Point Data Plots
12-Hour

Two bars / One color: Represents the probability of precipitation for the regime, during the two synoptic 12 hour period of a given day, at the chosen location

Tampa Intl Airport - lat:27.97 lon:-82.53
12-Hour Rainfall Probability

- Users can choose between literally hundreds of cities, town, locations across the state of Florida

- Graphs are created on the fly from pre-developed text files

- All temporal possibilities are available, and graphed in the format that best visualizes the length of data.

Point Data Plots
5run-Hour

One line color / One regime: Represents the running 5run-Hour hourly probability of precipitation for the regime, at the chosen location.

Tampa Intl Airport - lat:27.97 lon:-82.53
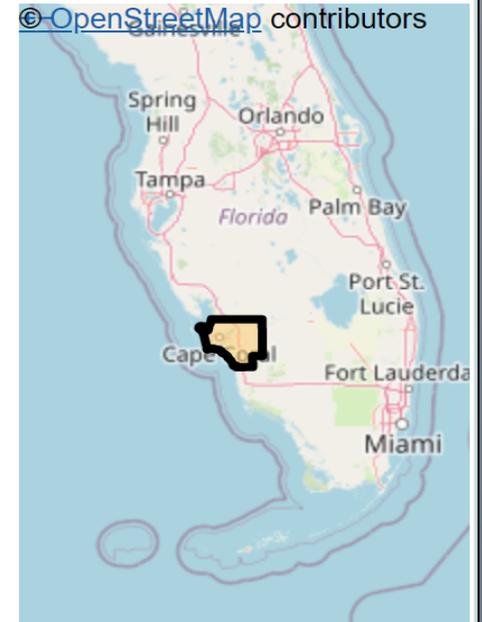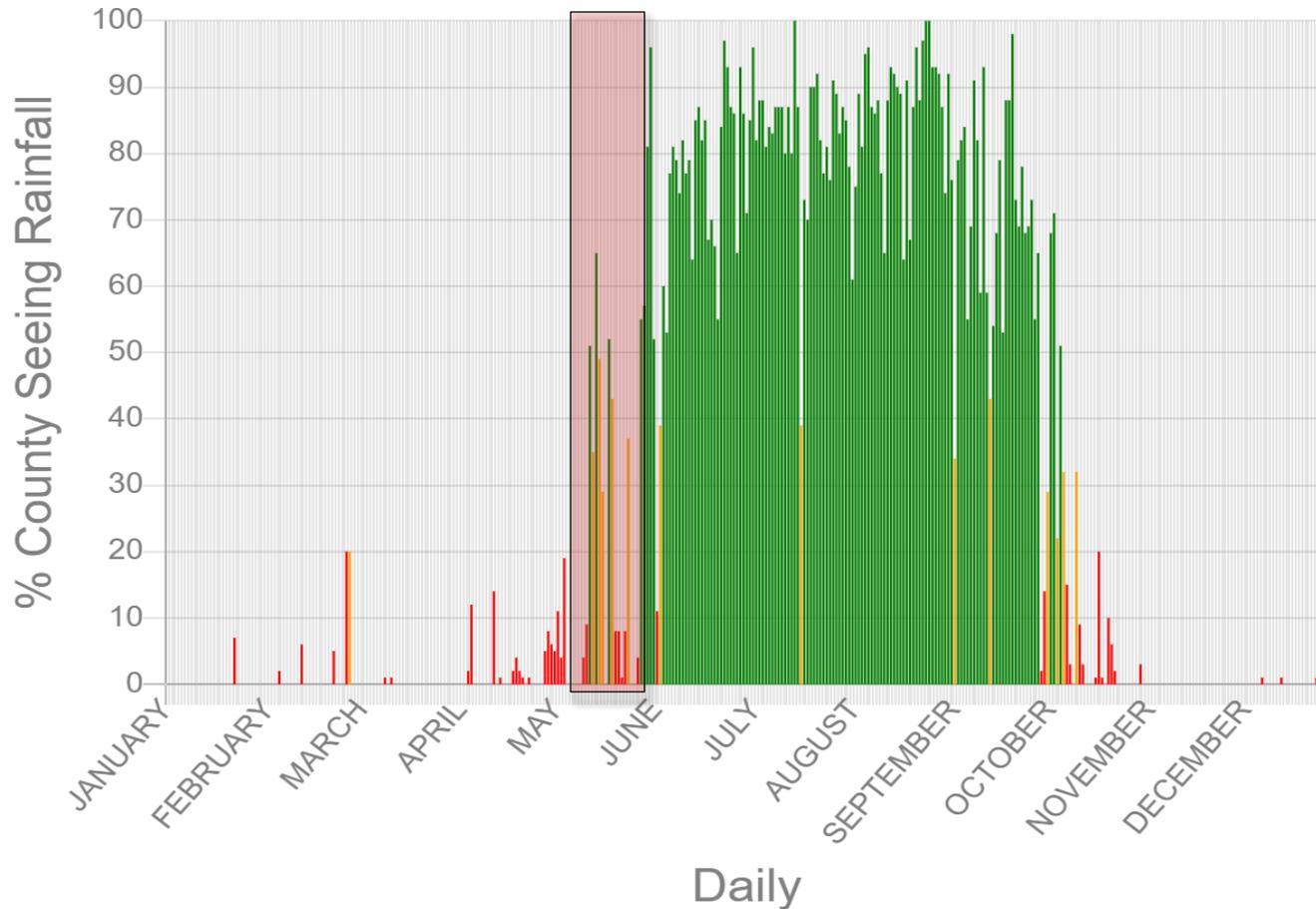5-Hour Running Rainfall Probability
2AM - 2AM EDT
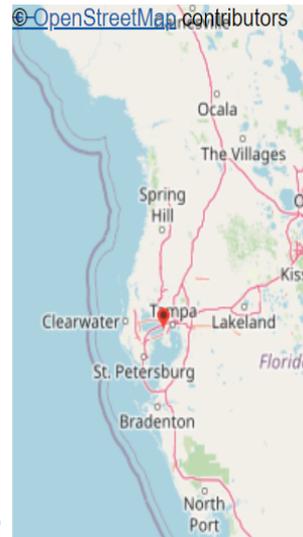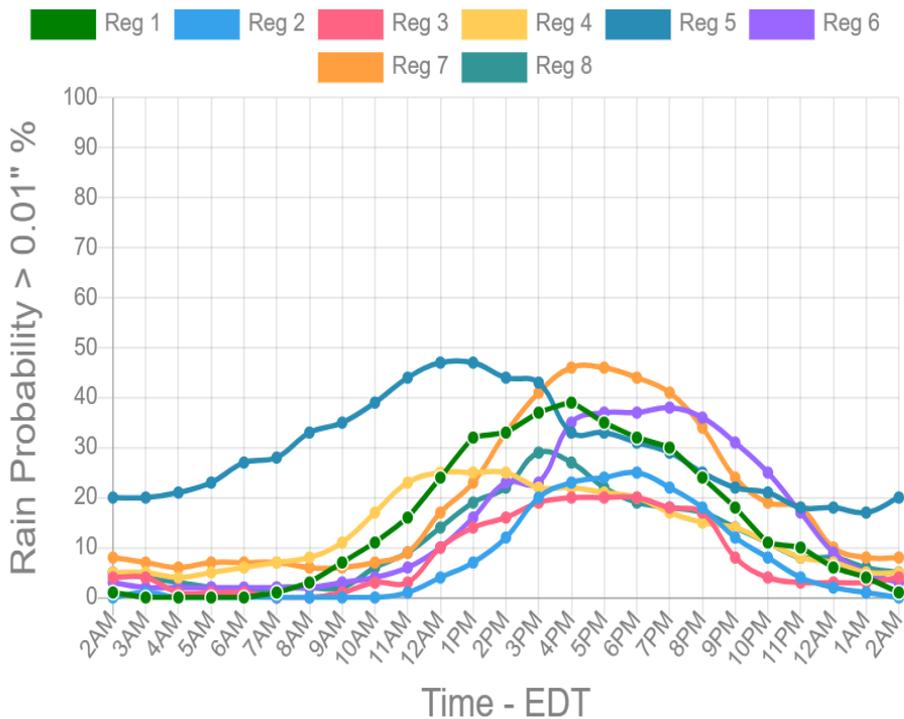
- Viewing time scales less than a temporal period of 12 hours, the graph will switch from bar to line format

- **The line format:**
  - ✓ Useful for diagnosing preferred days and times for weather sensitive.

  - ✓ Florida Power & Light has requested data access for scheduling and positioning of field crews to deal with storm related issues.

  - ✓ SW Florida Water Management District (SWFWMD) requested for their decision support purposes.
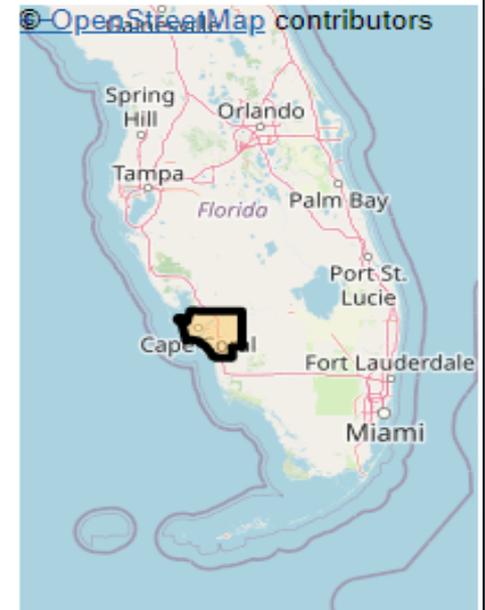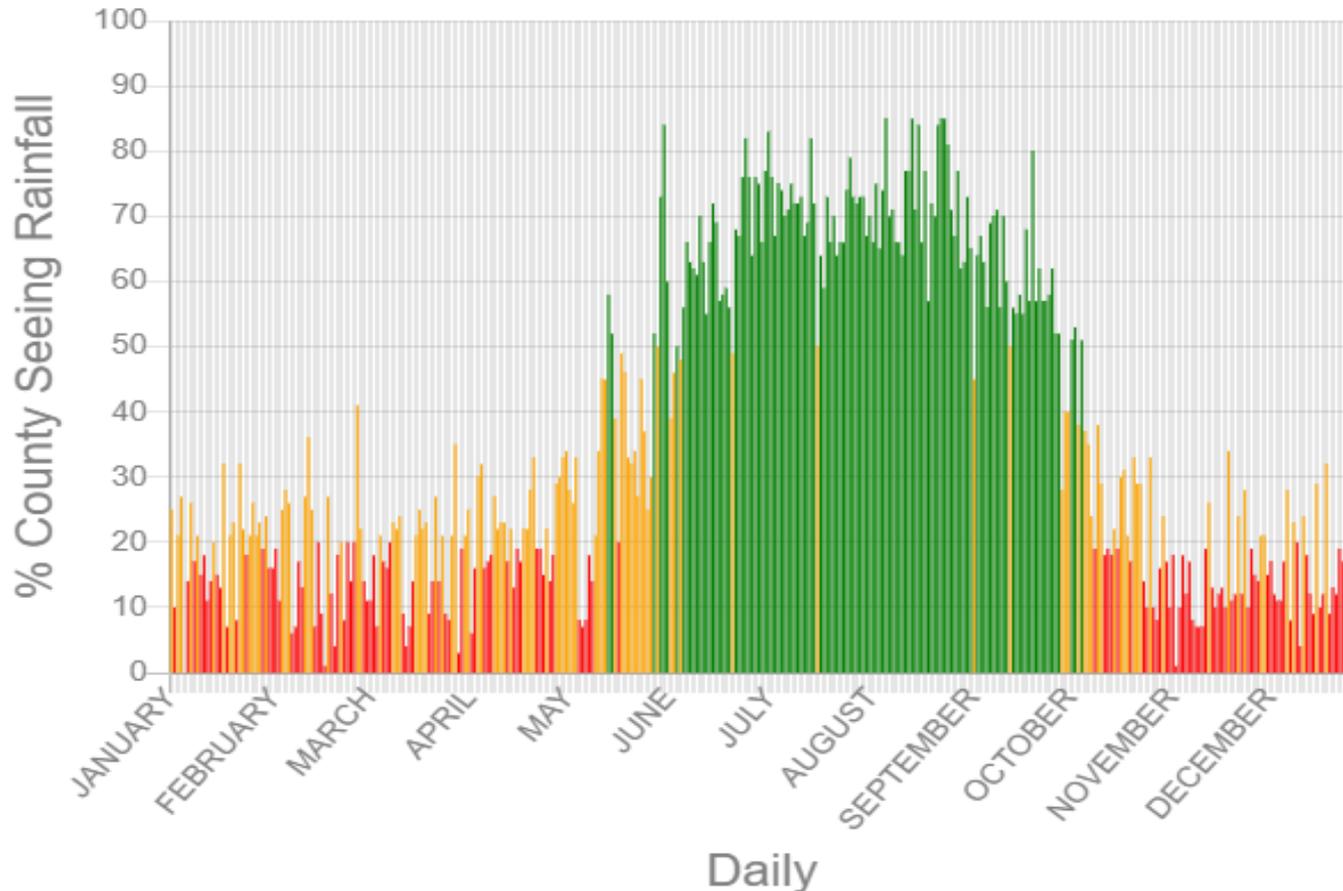
Wet Season Plots (Median) – County Based

Wet Season Plots (Mean) – County Based

Red < 20% - Orange 20% > value < 50% - Green > 50%

Lee County - 2002 - 2019
Mean Daily Rainfall Coverage - % of County > 0.01"

Wet Season Plots – Media Market Based

Orlando, FL Media Market - 2002 - 2019
Median Daily Rainfall Coverage - % of Market Area > 0.01"

Thank You For Your Time & Attention

Questions/Comments?