Extending the Temporal Range for Aviation Wind Guidance

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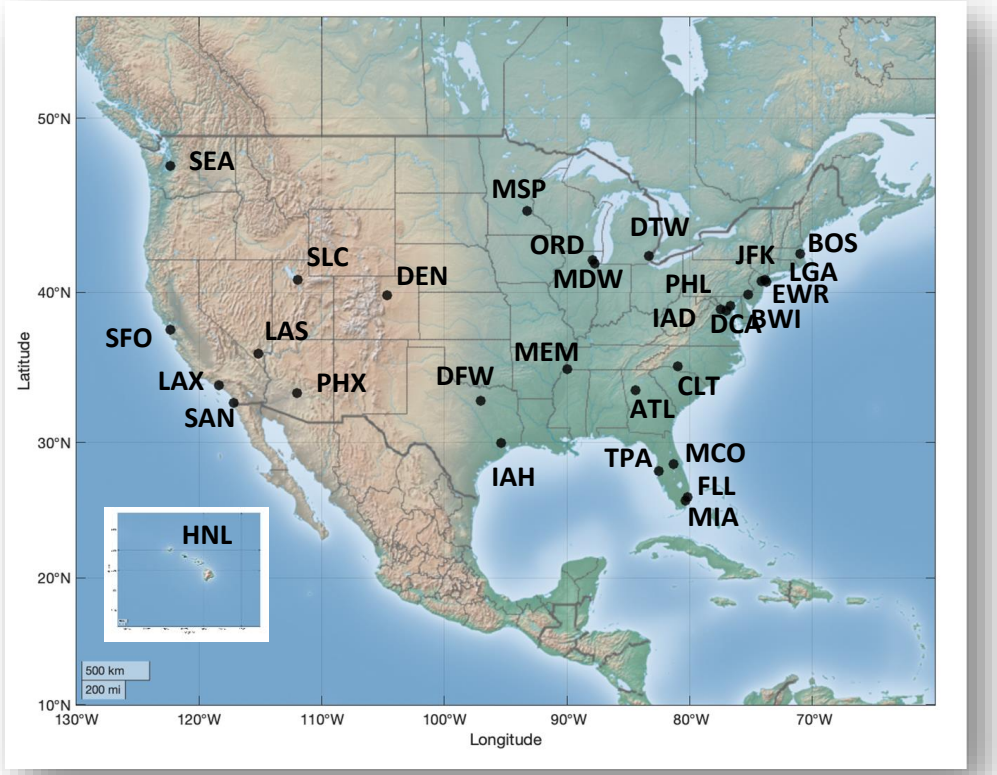
Project Background

- Wind information can be key for FAA in planning ahead of high traffic days around seasonal holidays and other national events.
- Current long range forecast products at FAA are more qualitative
  - Terminal Aerodome Forecasts (TAFs) go out to 36 hrs
  - National Aviation Meteorologists (NAMs) brief out to 7 days
- Airport authorities can utilize wind forecasts for economical and optimal scheduling of runway and aircraft maintenance
  - Currently climatology is used

30 Core Airports



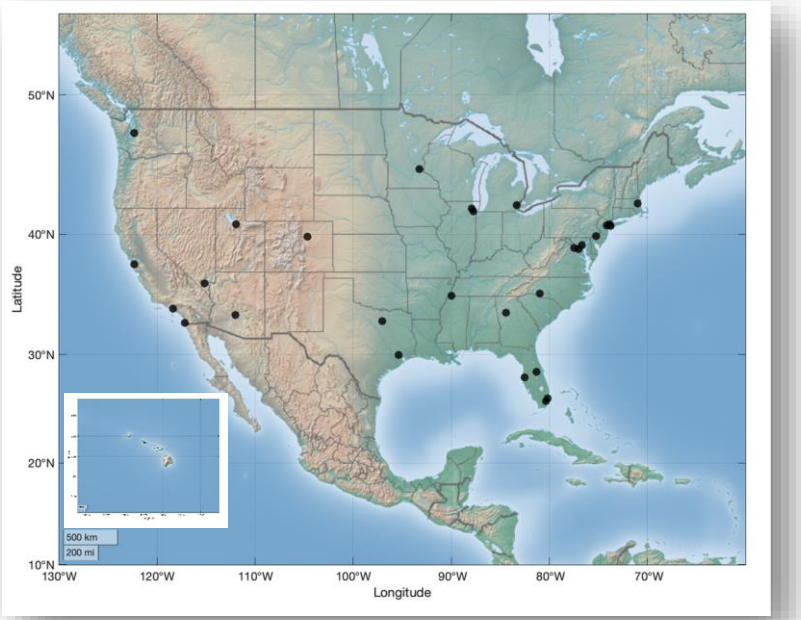
ATL - Hartsfield-Jackson Atlanta Intl
BOS - Boston Logan Intl
BWI - Baltimore/Washington Intl
CLT - Charlotte Douglas Intl
DCA - Ronald Reagan Washington National
DEN - Denver Intl
DFW - Dallas/Fort Worth Intl
DTW - Detroit Metropolitan
EWR - Newark Liberty Intl
FLL - Fort Lauderdale/Hollywood Intl
HNL - Honolulu Intl
IAD - Washington Dulles Intl
IAH - Houston Intercontinental
JFK - New York John F. Kennedy Intl
LAS - Las Vegas McCarran Intl
LAX - Los Angeles Intl
LGA - New York LaGuardia
MCO - Orlando Intl
MDW - Chicago Midway
MEM - Memphis Intl
MIA - Miami Intl
MSP - Minneapolis/St. Paul Intl
ORD - Chicago O`Hare Intl
PHL - Philadelphia Intl
PHX - Phoenix Sky Harbor Intl
SAN - San Diego Intl
SEA - Seattle/Tacoma Intl
SFO - San Francisco Intl
SLC - Salt Lake City Intl
TPA - Tampa Intl

Project Background

- **Objective**: Explore and develop a wind outlook product tailored to the 30 core airports

- **Project Goals**
  - Evaluate the skill of wind forecasts on S2S time scales, specifically related to the National Airspace System reliability (Focus on 30-core airports after consult with NAMs)
  - If skill is sufficient, test multiple calibration methods
  - Deliver a calibrated product on CPC timescales

- **Key questions investigated in this initial evaluation**
  - What is surface wind speed forecast skill for days 6 to 16 for core 30 US airports?
  - Is there seasonality in skill? skill of maximum winds from mean winds?
  - Any benefit in aggregating over days? E.g., Is day-6 skill higher than days 6-7 or 6-9 ?



Model and Data

- **Model: GEFSv12 reforecasts**
  - 2000-2019
  - Daily 00z initialized
  - Daily mean from 6 hourly instantaneous
  - Spatial resolution: 1x1 degree
  - Ensembles - 11 (10+control)
  - Forecast length – 15 days

- **Verification: GHCN daily**
  - NOAA National Climatic Data Center
  - Daily mean (AWND) from daily summary files

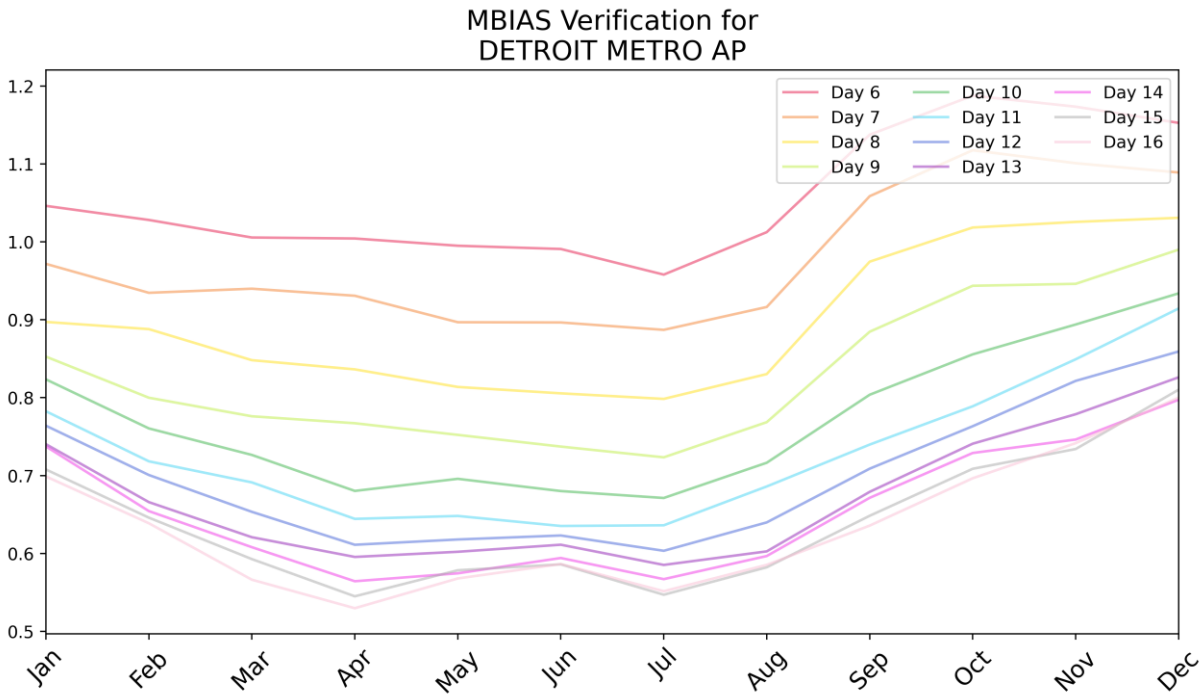
Methodology

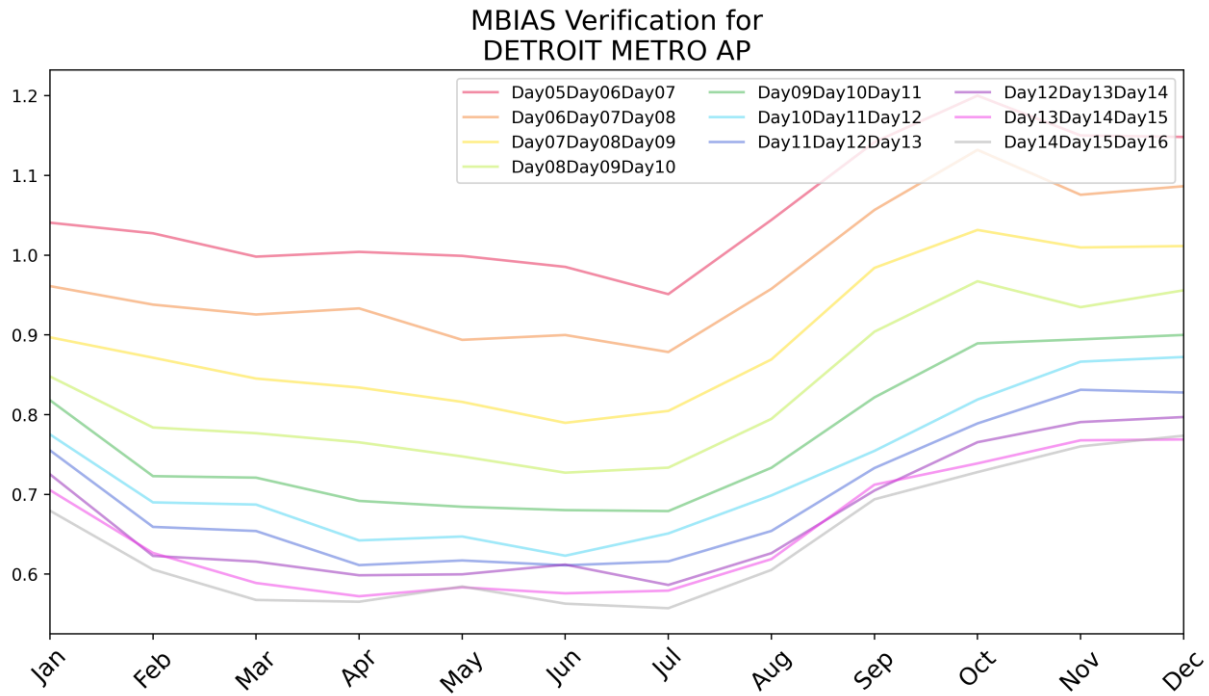
- **Method**
  - Assessing model biases and relative frequency (distribution) matching
  - Apply appropriate calibration methods based on bias and distribution types
    - Quantile mapping based on Gamma Distributions
      - In conjunction with National Blend of Models (NBM) team
    - 1/4th Root Transform and Linear Regression
    - Censor Shifted Gamma Distribution (CSGD)
  - Rescore after calibration
  - Generate products that meet user requests
    - Text based product
    - Map based product for days (website)

Results

- **Binning days (2,3-days together)**
  - Didn't really see much benefit: Eliminated specificity and minimal difference

- Multiplicative Bias (MBIAS) is the ratio of the means of the forecast and observation

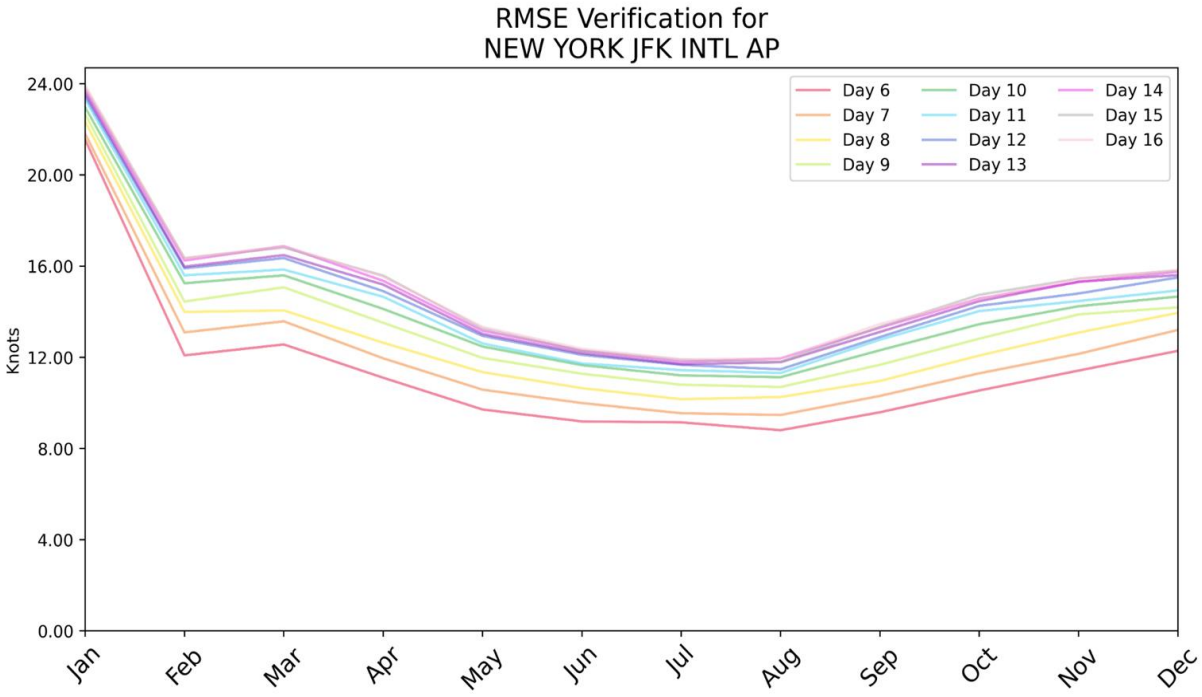


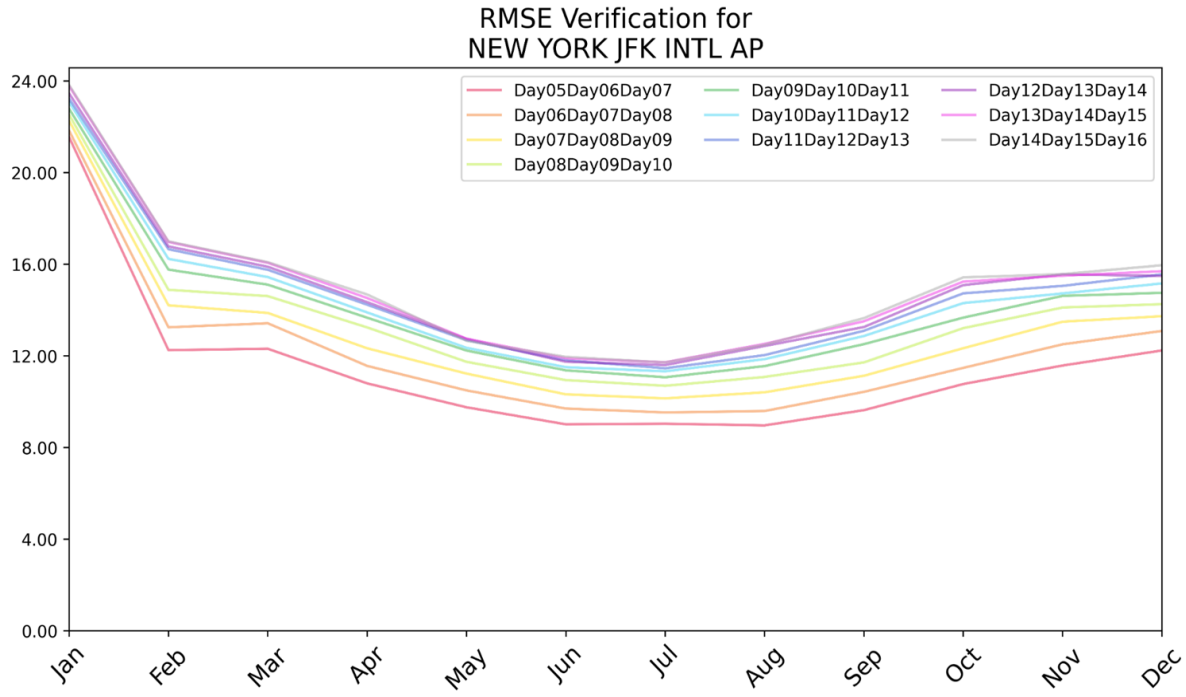


Results

- **Binning days (2,3-days together)**
  - Didn’t really see much benefit: Eliminated specificity and minimal difference

- Root Mean Square Error (RMSE)



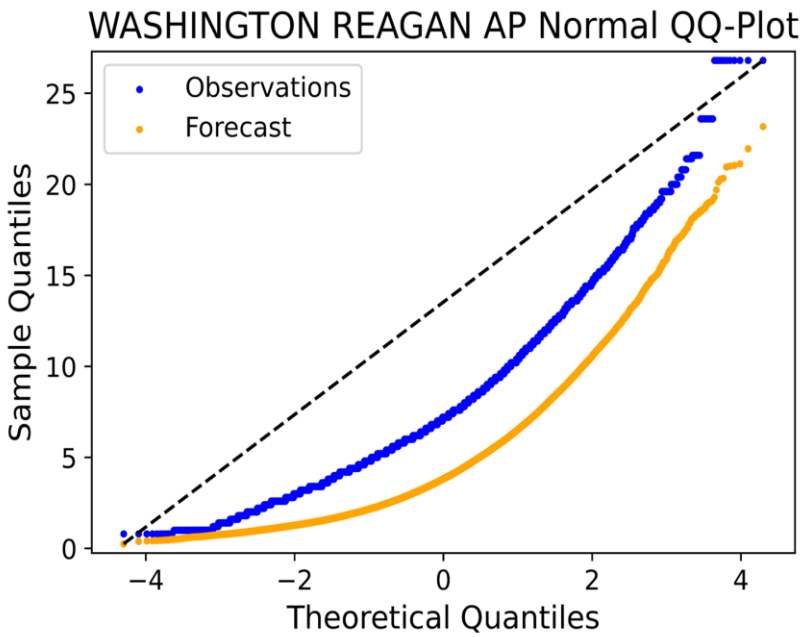


Results

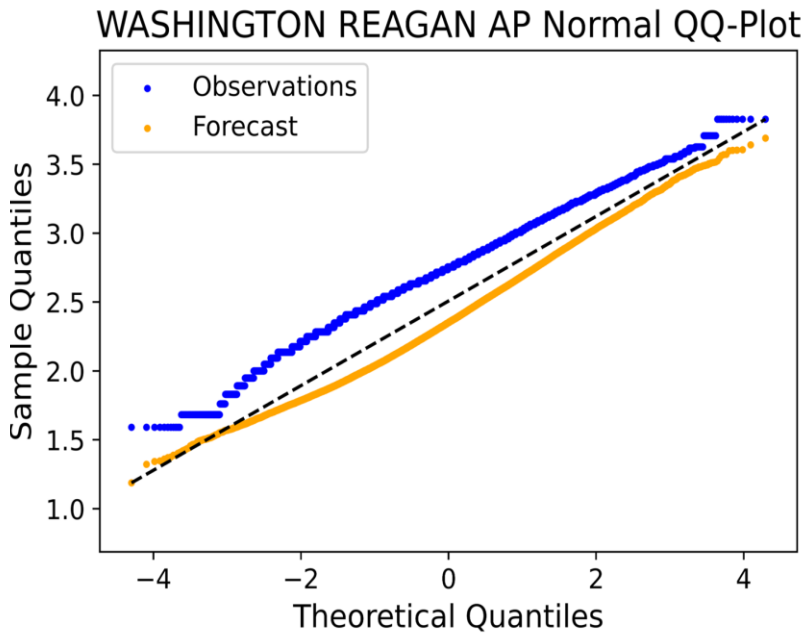
- **Determining distributions and biases**
  - Analyzed distributions for observation and model data

- Neither distribution fits perfectly but one fits observations and one fits model

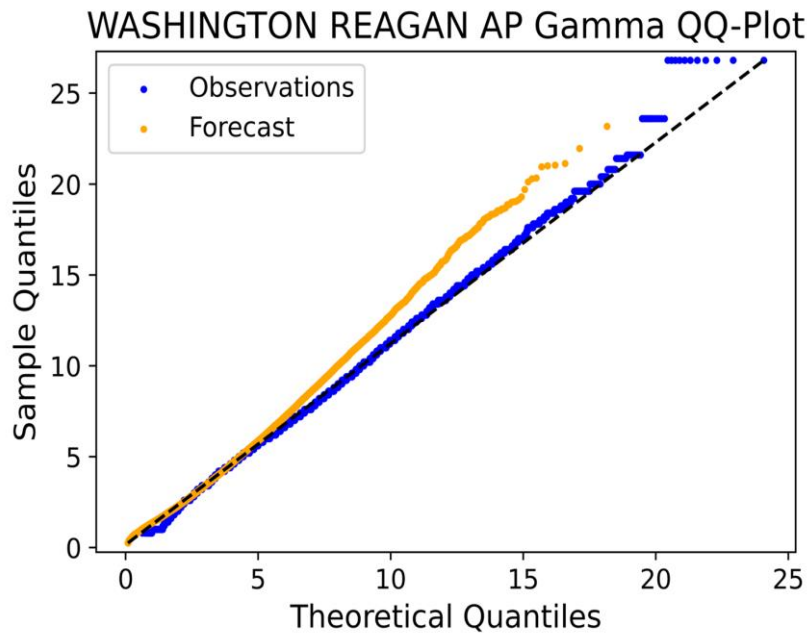
Normal Distribution (Raw Data)



Normal Distribution (After 4th Root Transform)



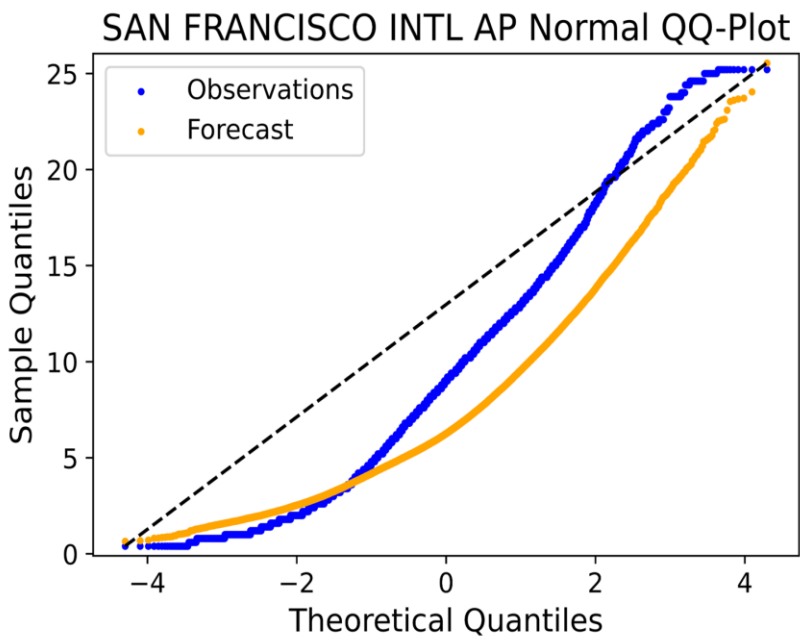
Gamma Distribution (Raw Data)



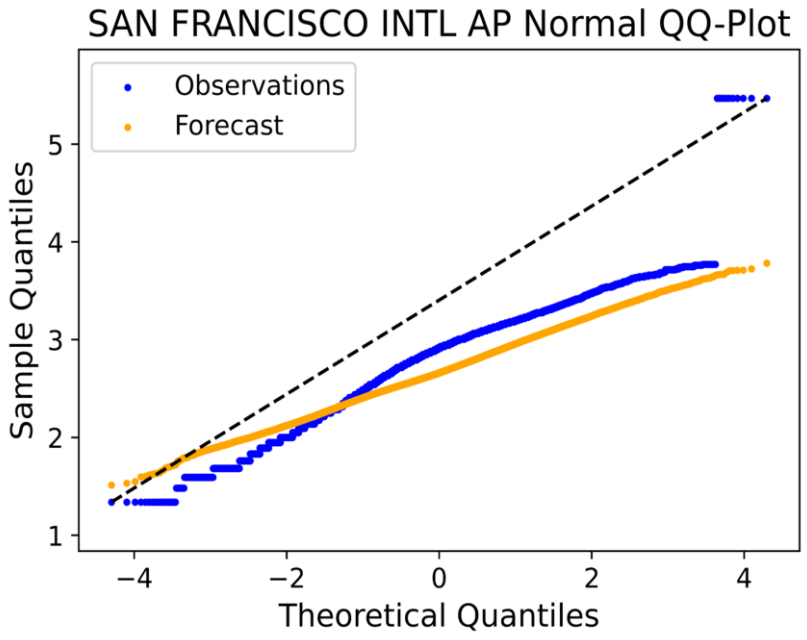
Results

- **Determining distributions and biases**
  - Analyzed distributions for observation and model data
- Neither distribution fits (gamma still fits forecast)

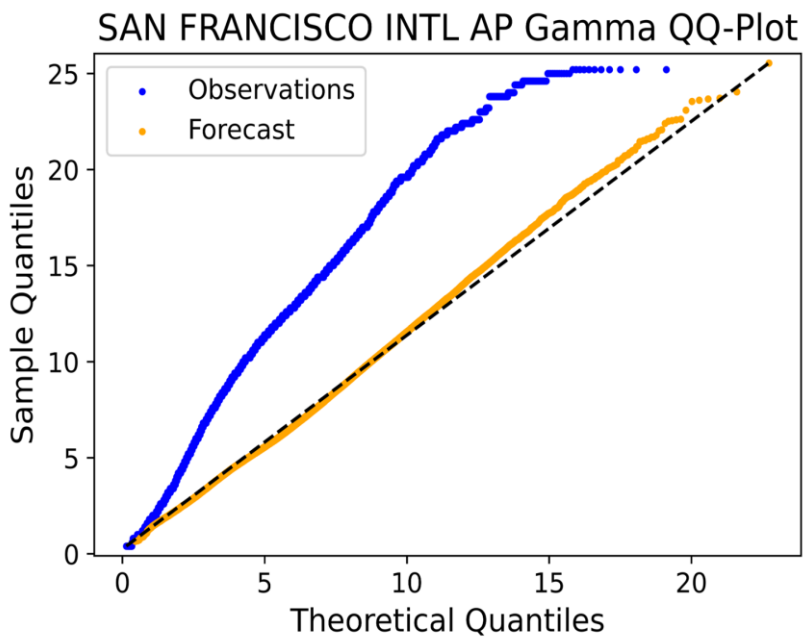
Normal Distribution (Raw Data)



Normal Distribution (After 4th Root Transform)

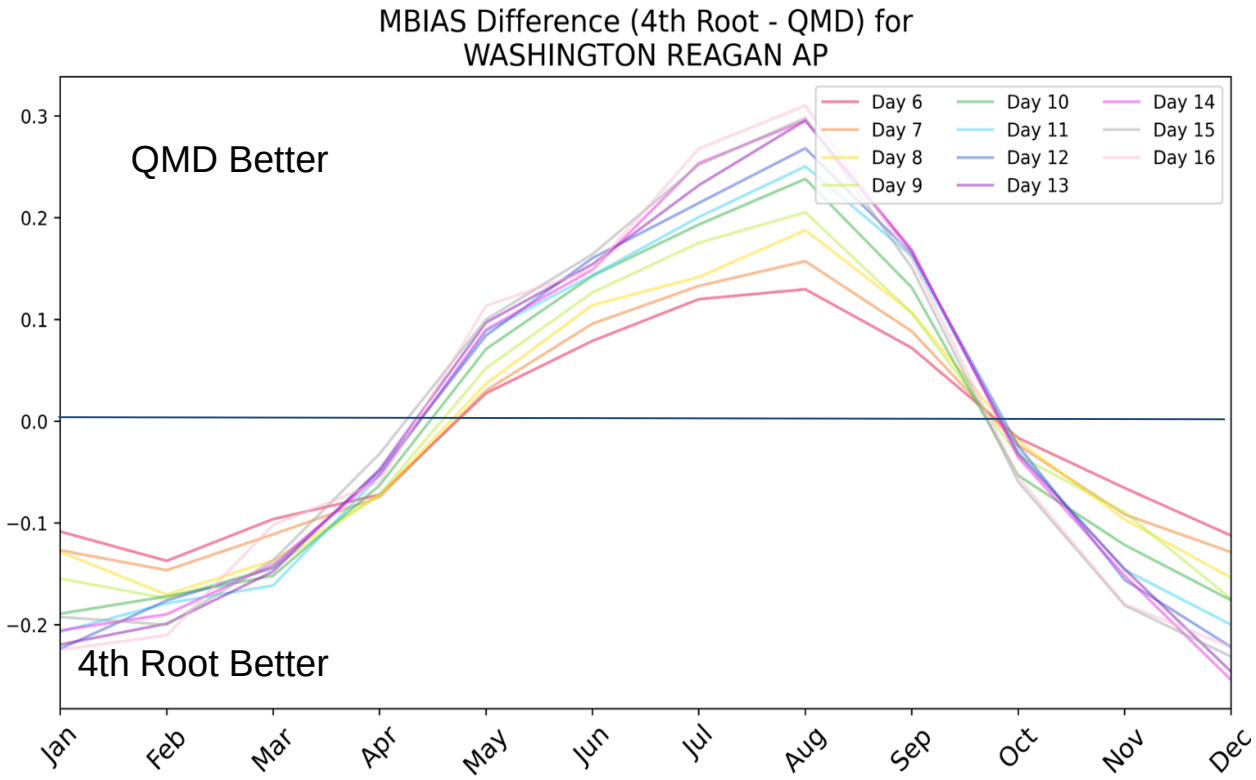


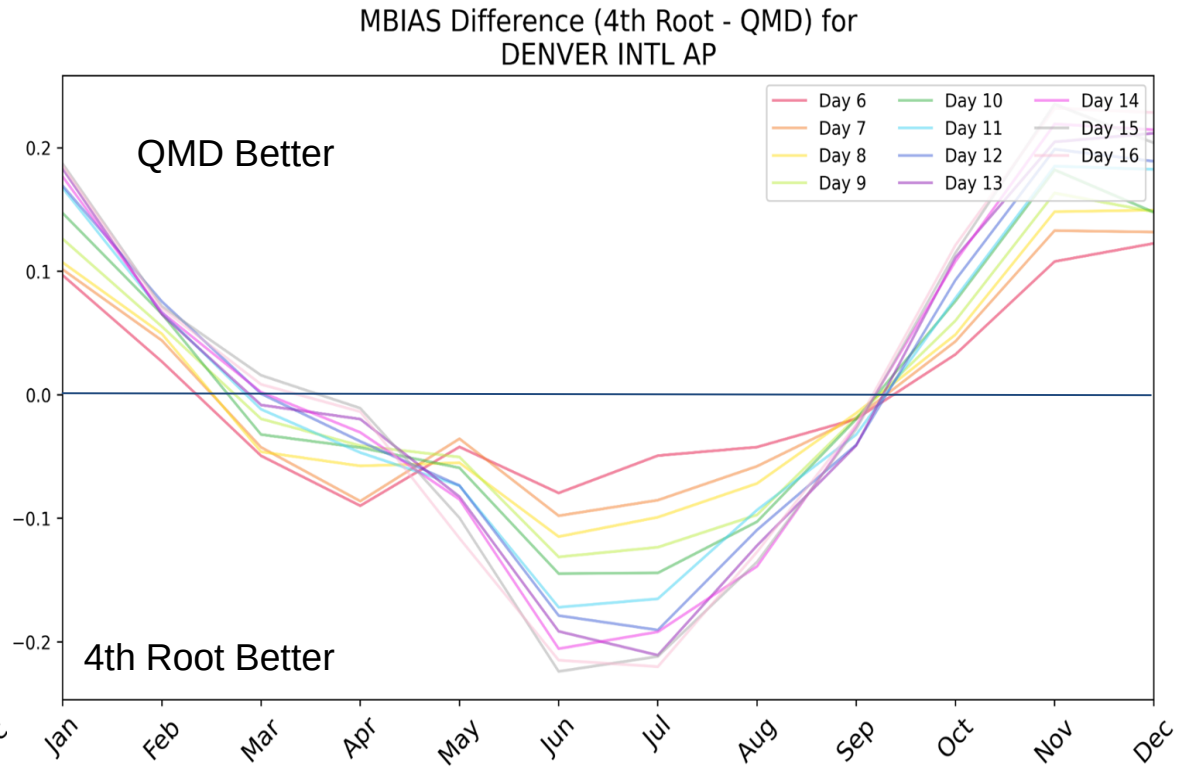
Gamma Distribution (Raw Data)



Results

- **Calibration Methods**
  - Quantile mapping using gamma distributions (borrowed from NBM)
  - Linear Regressions after normalization (¼ root transform)





Outputs

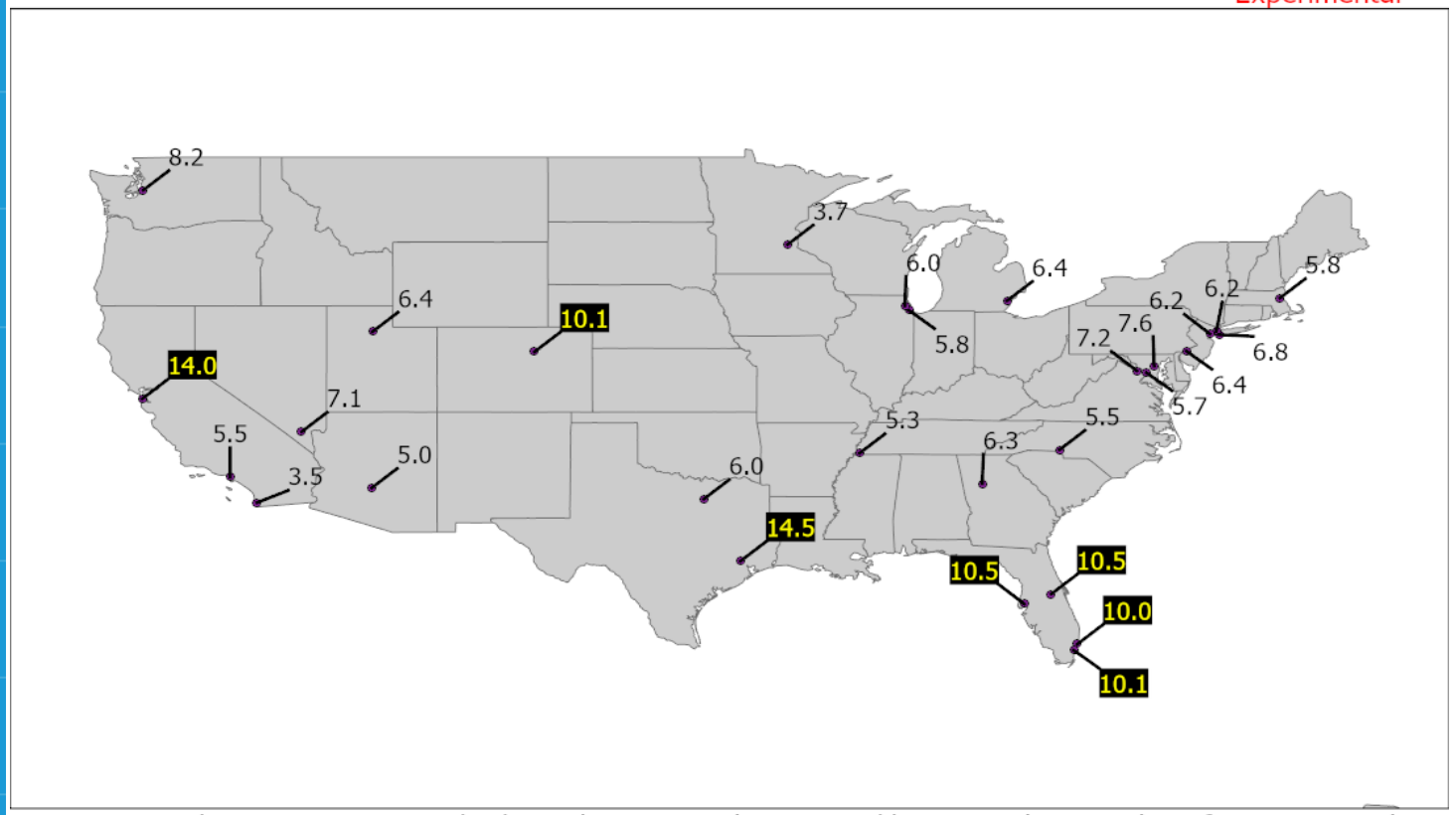
- Experimental maps are found at: https://www.cpc.ncep.noaa.gov/products/predictions/short_range/aviation/index.shtml

- Proposed strategy
  - To a single URL on a CPC FTP (https://ftp.cpc.ncep.noaa.gov/aviation/)
  - Keep 7 days (https://ftp.cpc.ncep.noaa.gov/aviation/) Aviation_Daily_0.txt → Aviation_Daily_7.txt

Corrected Daily Average Wind Speed for GEFS-v12
Init: 2021-12-27 Units: knots

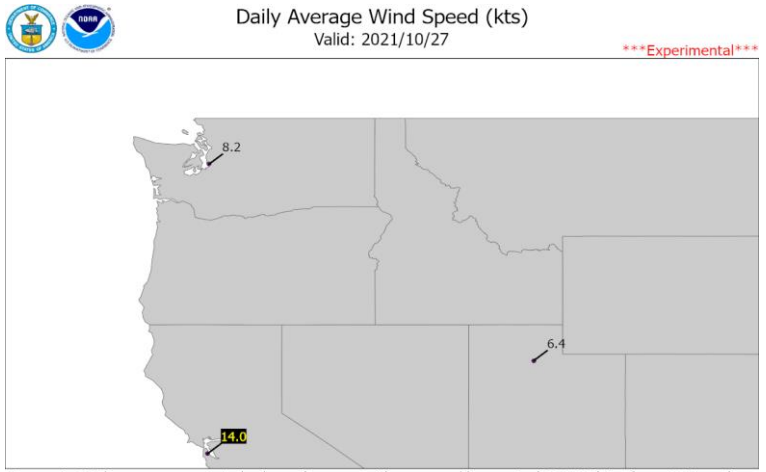
	Lat	Lon	1/1/2022	1/2/2022	1/3/2022	1/4/2022	1/5/2022	1/6/2022	1/7/2022	1/8/2022	1/9/2022	1/10/2022	1/11/2022
ATLANTA HARTSFIELD INTL	33.63	-84.44	6.7	7.4	4.9	5.7	5.7	6	5.8	6	6.2	6.3	6.4
BALTIMORE WASH INTL AP	39.16	-76.68	6.5	7.2	7.6	7.4	7.9	7.3	7.6	7.3	7.6	7.4	7.4
BOSTON LOGAN INTL AP	42.36	-71.01	8.7	8.9	7.2	5.6	6.1	6.7	6.7	6.6	6.5	6.6	6.6
CHARLOTTE DOUGLAS AP	35.22	-80.95	8.2	8.4	7	6.1	6.3	6.4	5.9	6.2	6.4	6.4	6.4
CHICAGO MIDWAY AP	41.78	-87.75	7.3	8.7	6.6	5.3	6.7	6.4	6.6	6.5	6.5	6.5	6.5
CHICAGO OHARE INTL AP	41.99	-87.93	5.2	6	5.4	5.8	6.7	7	7.3	7.1	7	7	7.2

Outputs



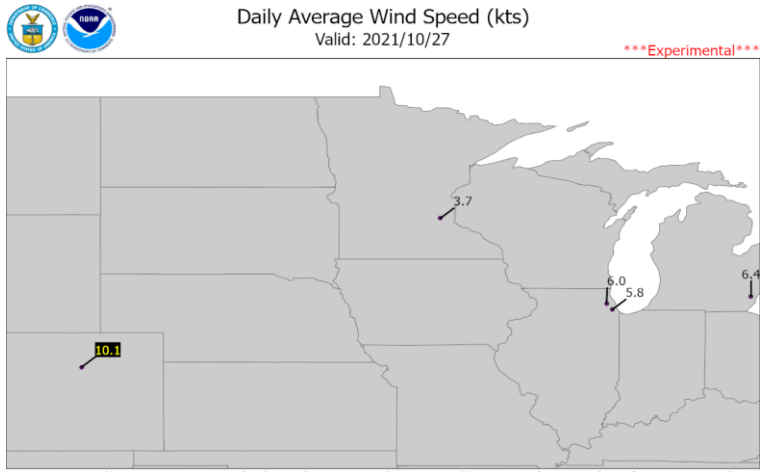
- 1 CONUS map and 7 regional maps
  - South West, South Central, South East, North East, North Central, North West, Hawaii
- Blocked numbers with yellow text signify the 8 kts threshold was surpassed
  - 2 more thresholds may be added for the 20 and 35 kts

Outputs



Forecast, 24-hour average winds, based on quantile mapped/corrected GEFS data from 00Z cycle.

Created: 2021/10/20 Climate Prediction Center



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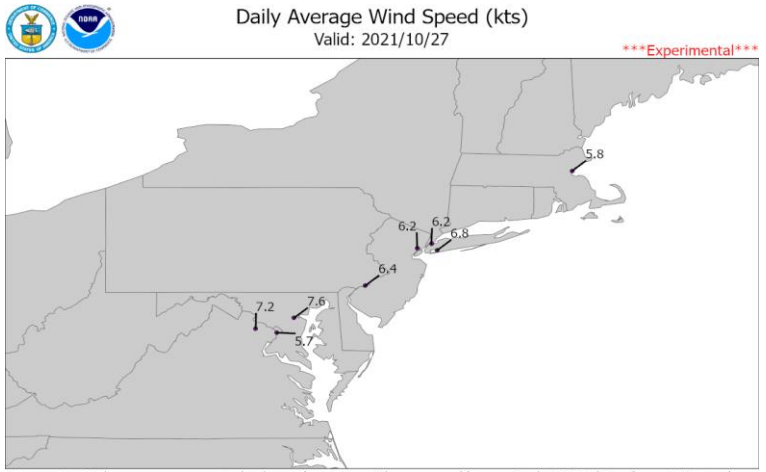

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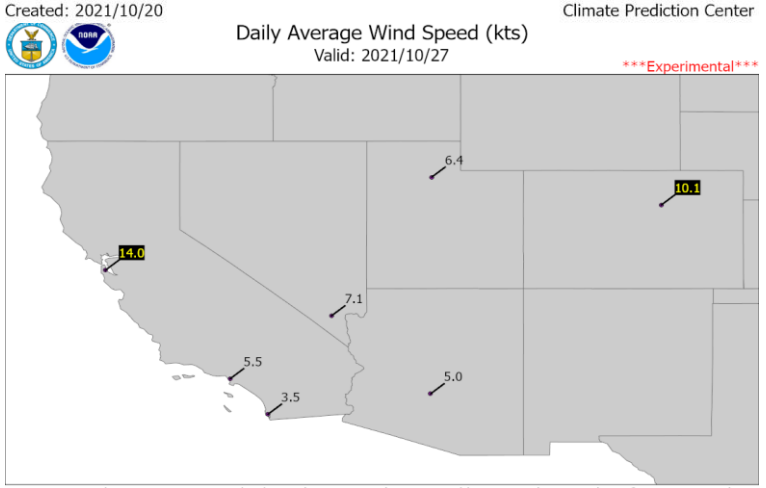

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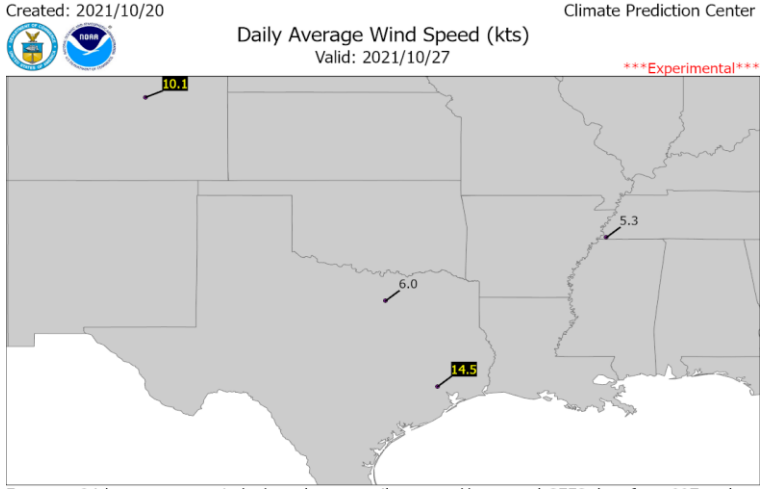

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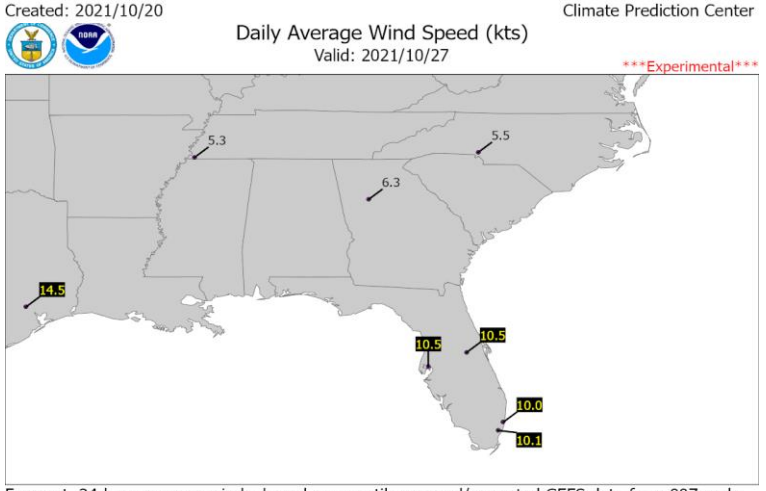

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Next Steps/Lessons

- **Potential further work**
  - Getting out into Week 3-4
    - Calibrations and longer ranges can be worked - not sure of benefit
  - Other calibration methods
    - NWS - NBM reported issues with winds along west coast
    - PSL work to use cubic splines instead of pre-determined PDFs

- **Lessons Learned**
  - To get any skill with max winds - wind need to be treated like Tmin/Tmax in any hindcast or real-time output
  - Current hindcast data readily available don't really support the data needed to answer the questions asked by NAM and FAA partners