Climate Change and Offshore Wind in New York State

Jeff Freedman
Atmospheric Sciences Research Center
University at Albany, State University of New York

Photo simulation Jones Beach NY - courtesy UL - AWS Truepower

Advanced Energy Conference, New York City 28 March 2018

The Climate System And Atmospheric Variability

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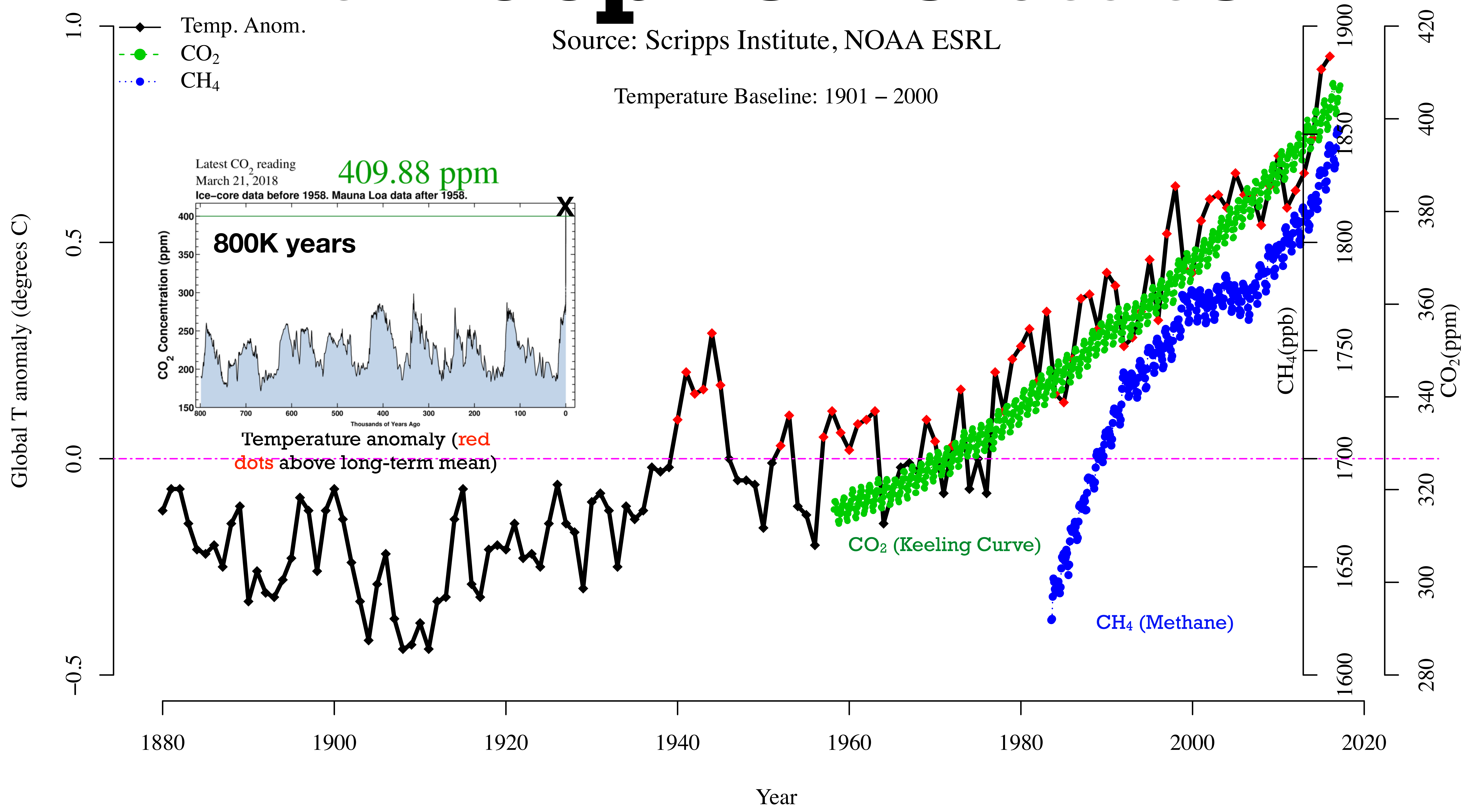
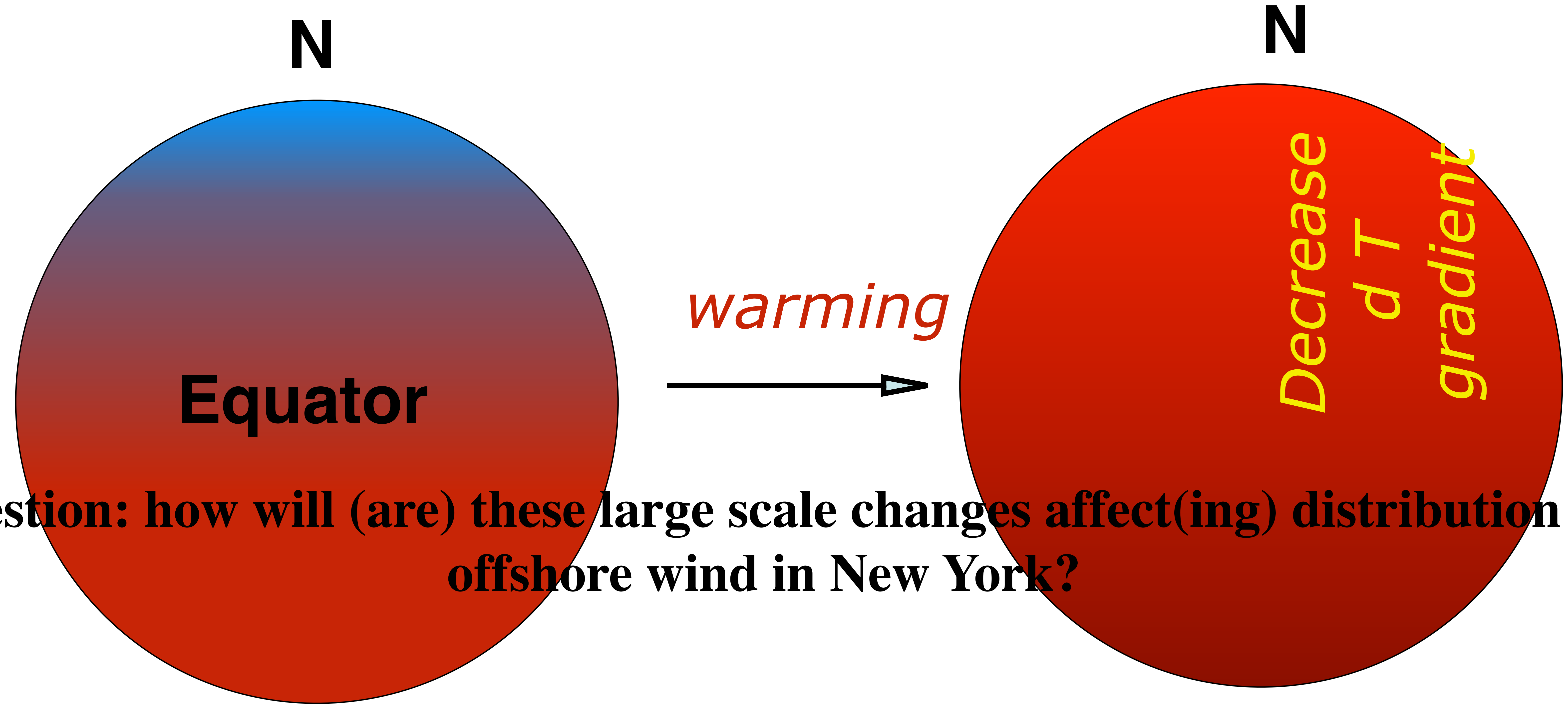
BIG QUESTION: How does atmospheric variability in all its flavors affect our characterization of the wind resource over the longer term?

Atmospheric State



Global Warming and Wind

Hypothesis: leads to a reduction in the meridional thermal gradient (since higher latitudes experience greater warming) and hence the pressure gradient which drives the wind.



Question: how will (are) these large scale changes affect(ing) distribution of offshore wind in New York?

A few years ago…

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 114, D14105, doi:10.1029/2008JD011416, 2009

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Wind speed trends over the contiguous United States

S. C. Pryor,[1] R. J. Barthelmie,[1] D. T. Young,[1] E. S. Takle,[2] R. W. Arritt,[2] D. Flory,[2]
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Received 4 November 2008; revised 15 April 2009; accepted 15 May 2009; published 23 July 2009.

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Not so windy: Research suggests winds dying down

June 10, 2009

WASHINGTON – The wind, a favorite power source of the green energy movement, seems to be dying down across the United States. And the cause, ironically, may be global warming – the very problem wind power seeks to address…..“It’s a very large effect,” said study co-author Eugene Takle, a professor of atmospheric science at Iowa State University. In some places in the Midwest, the trend shows a 10 percent drop or more over a decade. That adds up when the average wind speed in the region is about 10 to 12 miles per hour….”There’s been a jump in the number of low or no wind days in the Midwest”, said the study’s lead author, Sara Pryor, an atmospheric scientist at Indiana University….Jeff Freedman, an atmospheric scientist with AWS Truewind, an Albany, N.Y., renewable energy consulting firm, has studied the same topic….He said his research has found no definitive trend of reduced surface wind speed….One of the problems Pryor acknowledges with her study is that over many years, changing conditions near wind-measuring devices can skew data. If trees grow or buildings are erected near wind gauges, that could reduce speed measurements.

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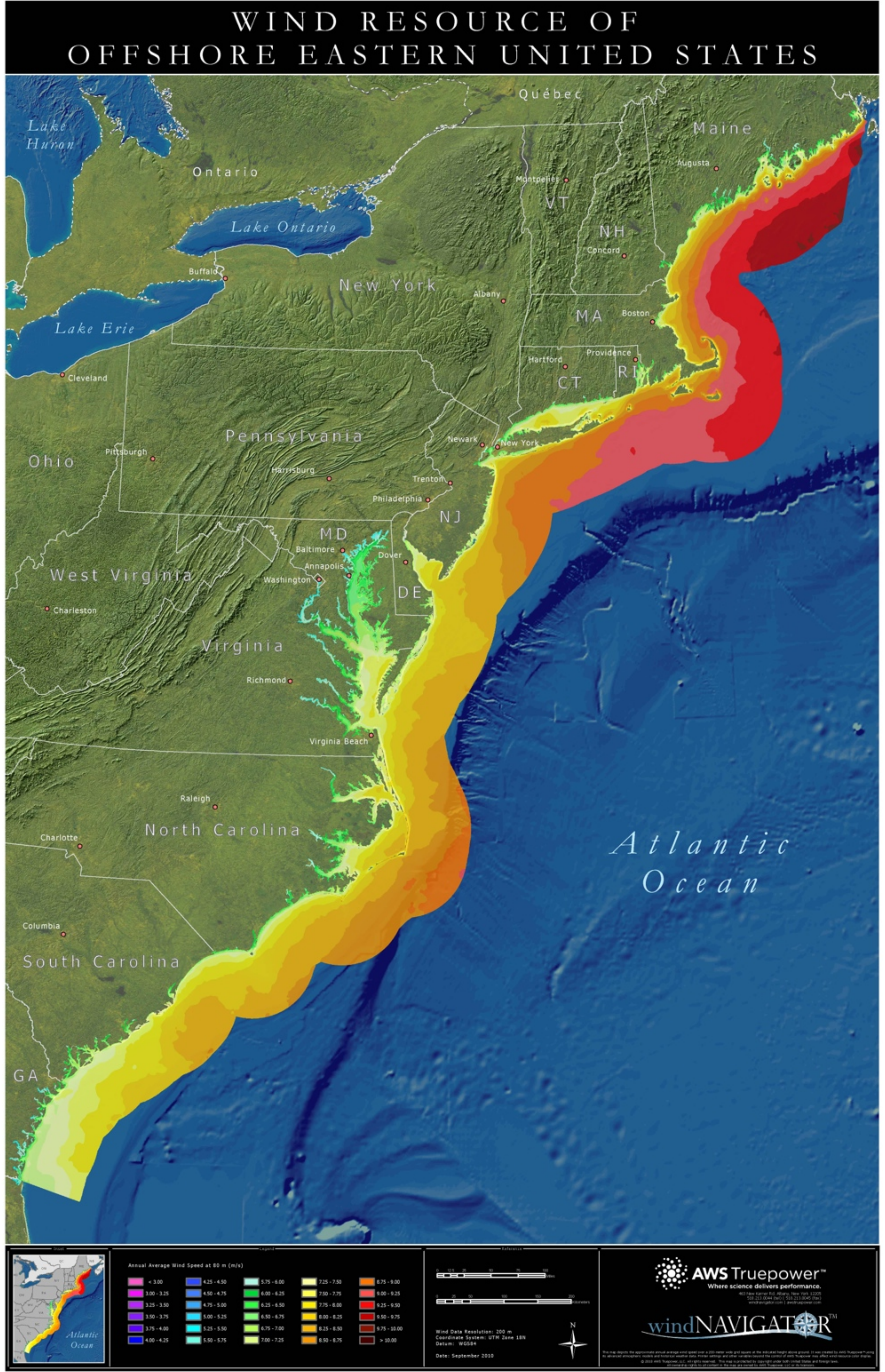
My 2¢

Gotta read beyond the headlines

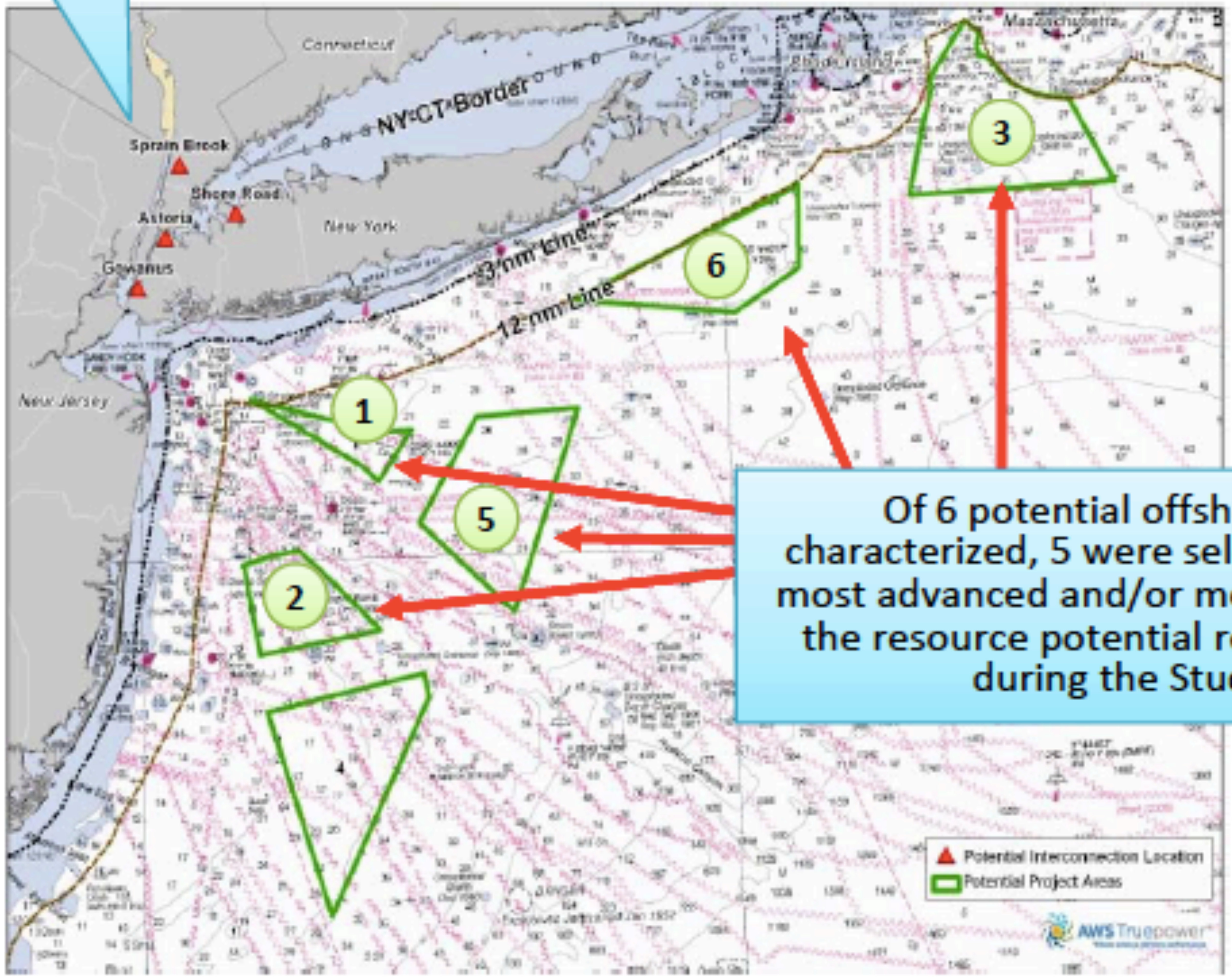


Offshore Wind Resource

Courtesy UL-AWST

Potential Offshore Wind (OSW) Sites in NY

Interconnection Points



Offshore Site	Area (km²)	Build-Out Potential (MW)	MW Assumed Available before 2030 (MW)
1	285	855	791
2	663	1,989	1295
3	1,521	4,563	2594
5	1,372	4,116	2402
		3,081	1869

Of 6 potential offshore wind areas characterized, 5 were selected as the closest, most advanced and/or most representative of the resource potential reasonably available during the Study period.

Figure A.8

NEW YORK STATE OF OPPORTUNITY.

From NYSERDA Clean Energy Cost Study (May 2016)

Potential Offshore Wind (OSW) Sites in NY

Interconnection Points

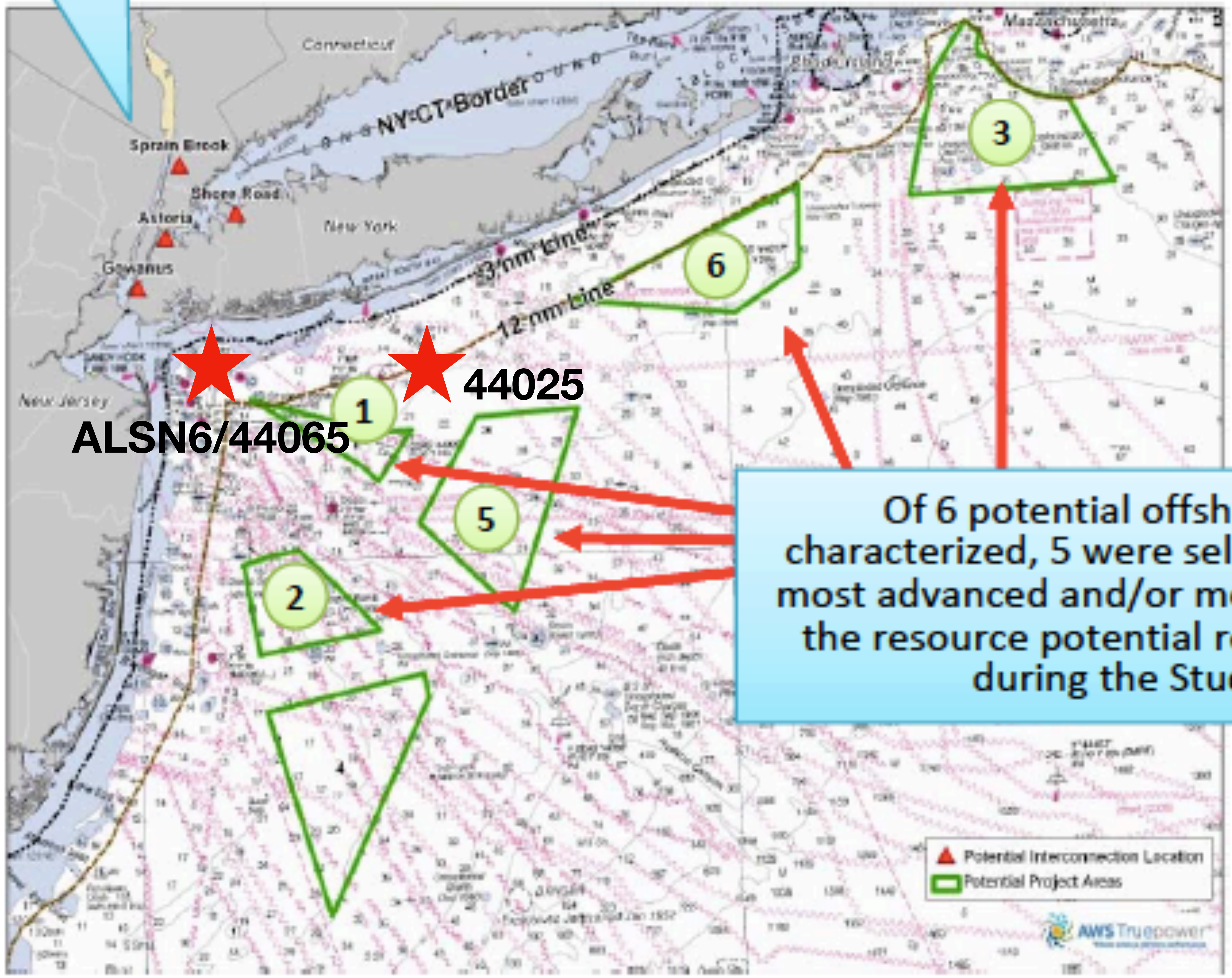


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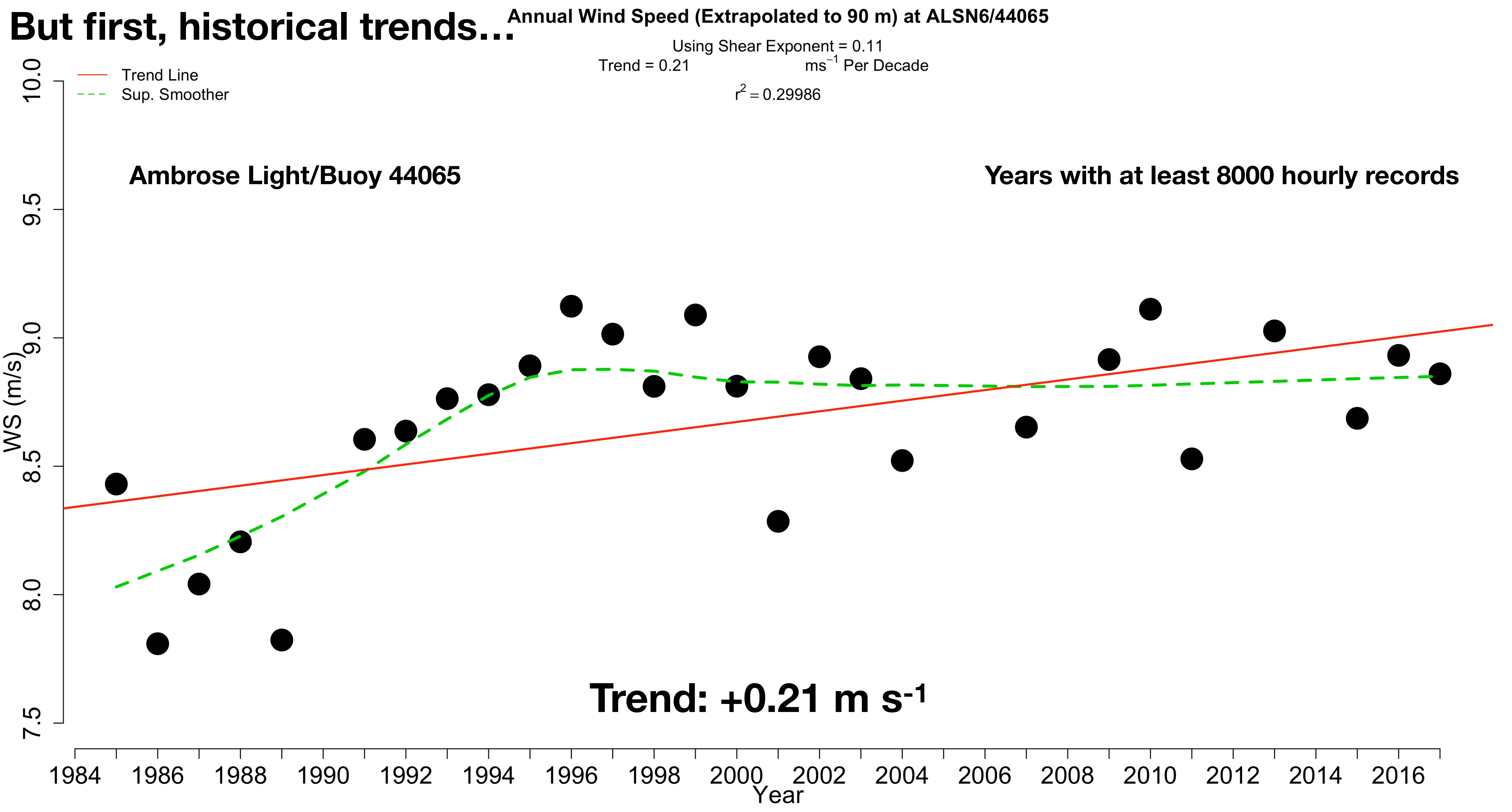
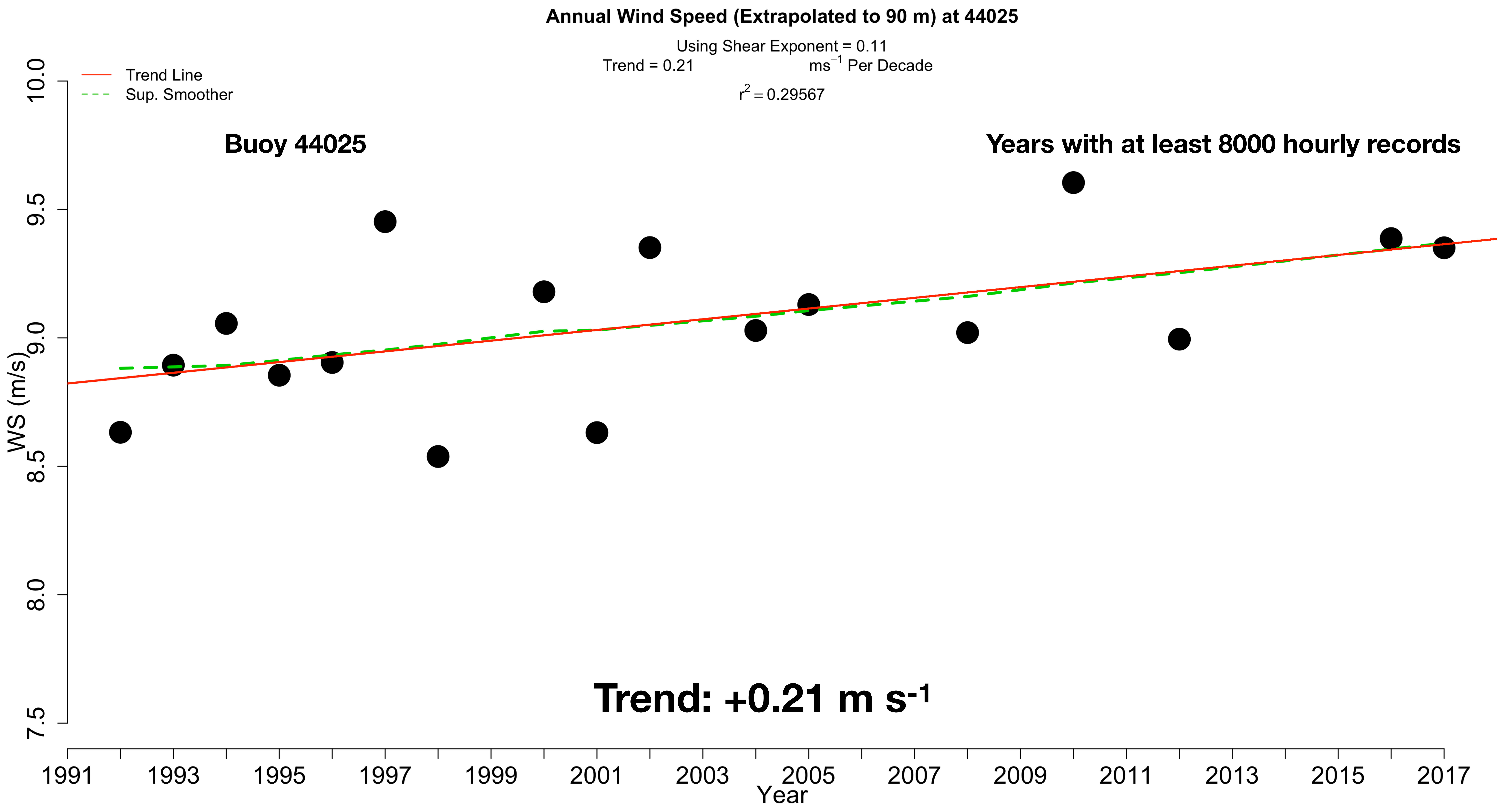
Figure A.8

74

From NYSERDA Clean Energy Cost Study (May 2016)

But first, historical trends…





Annual Wind Speed (Extrapolated to 90 m) at 44025
Using Shear Exponent = 0.11
Trend = 0.21 ms^{-1} Per Decade
$r^2 = 0.29567$
Trend Line
Sup. Smoother
Buoy 44025
Years with at least 8000 hourly records
WS (m/s)
10.0
9.5
9.0
8.5
8.0
7.5
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Year
Trend: +0.21 m s^{-1}

UNIVERSITY AT ALBANY
State University of New York

“Effects of Climate Change on Renewable Energy Distribution in New York State”

ATMOSPHERIC SCIENCES RESEARCH CENTER • 1961 •

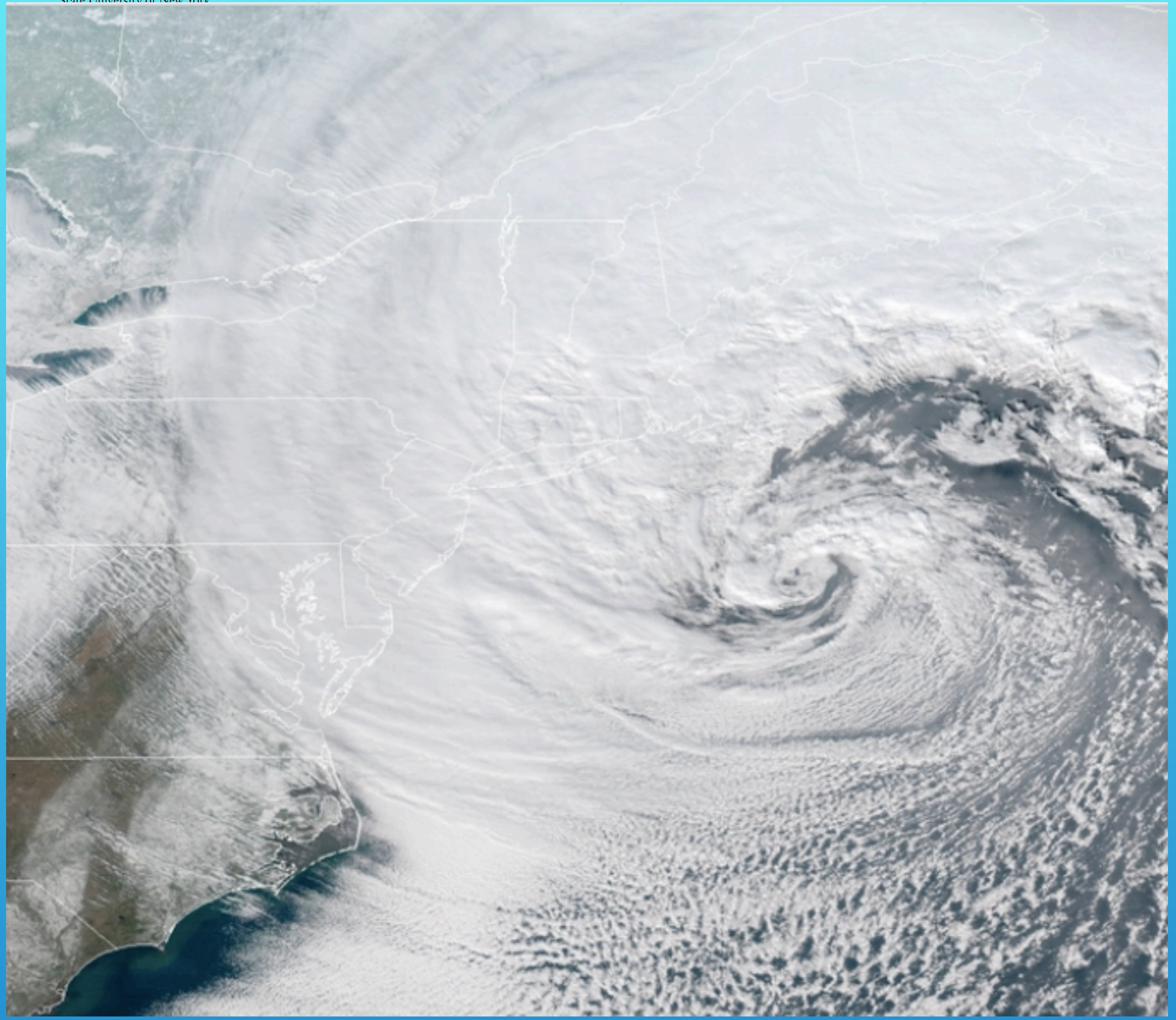
Sponsored by the New York State Energy Research and Development Authority
Agreement #105161

UAlbany ASRC and DAES, UL-AWST, and MNI, Inc.

To meet the REV goals, solar and wind energy production will need to increase ten-fold

Thus, *it is crucial that a high-resolution assessment of the potential influence of climate change on NY’s integrated renewable energy resource is available for planning, policy, and development purposes*

Fewer? More intense?

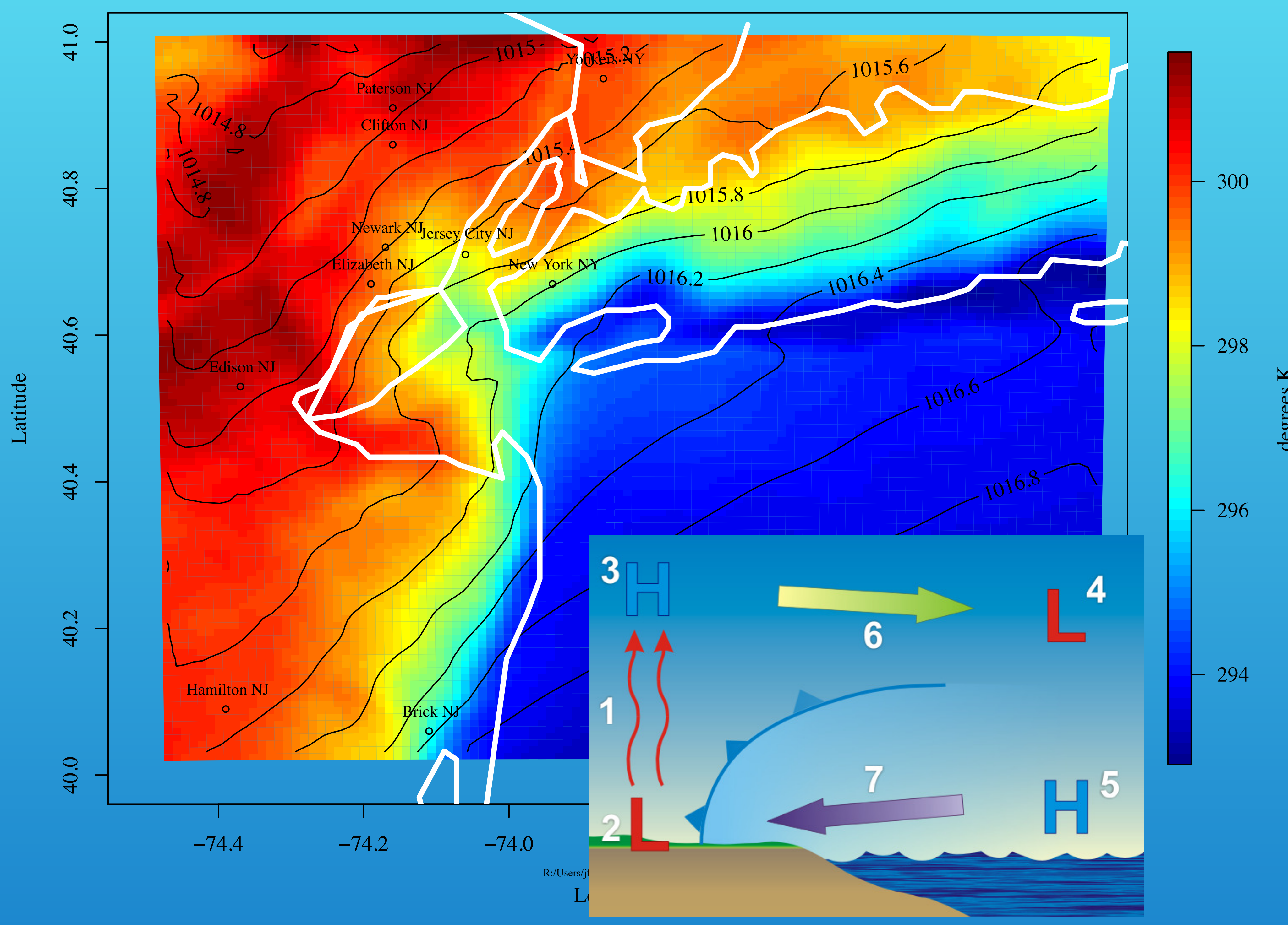


4 January 2018 Nor’easter GOES-16 Image
(0.5 km res)   1812 UTC

Meteorological and climatological influences (mesoscale): strengthen/weaken sea breezes; offshore low-level jet synoptic scale: frequency of frontal passages, low/high pressure systems, intensity/persistence of surface pressure gradients (do we have more/fewer storms, more intense/ weaker storms?)

Land - sea surface temperature gradient increase/decrease?

2 m Temperature And SLP For Composite Hour = 2000 GMT



High Resolution Climate Modeling

Perform **dynamic downscaling** of the selected CMIP5 models in WRF for 3 periods:

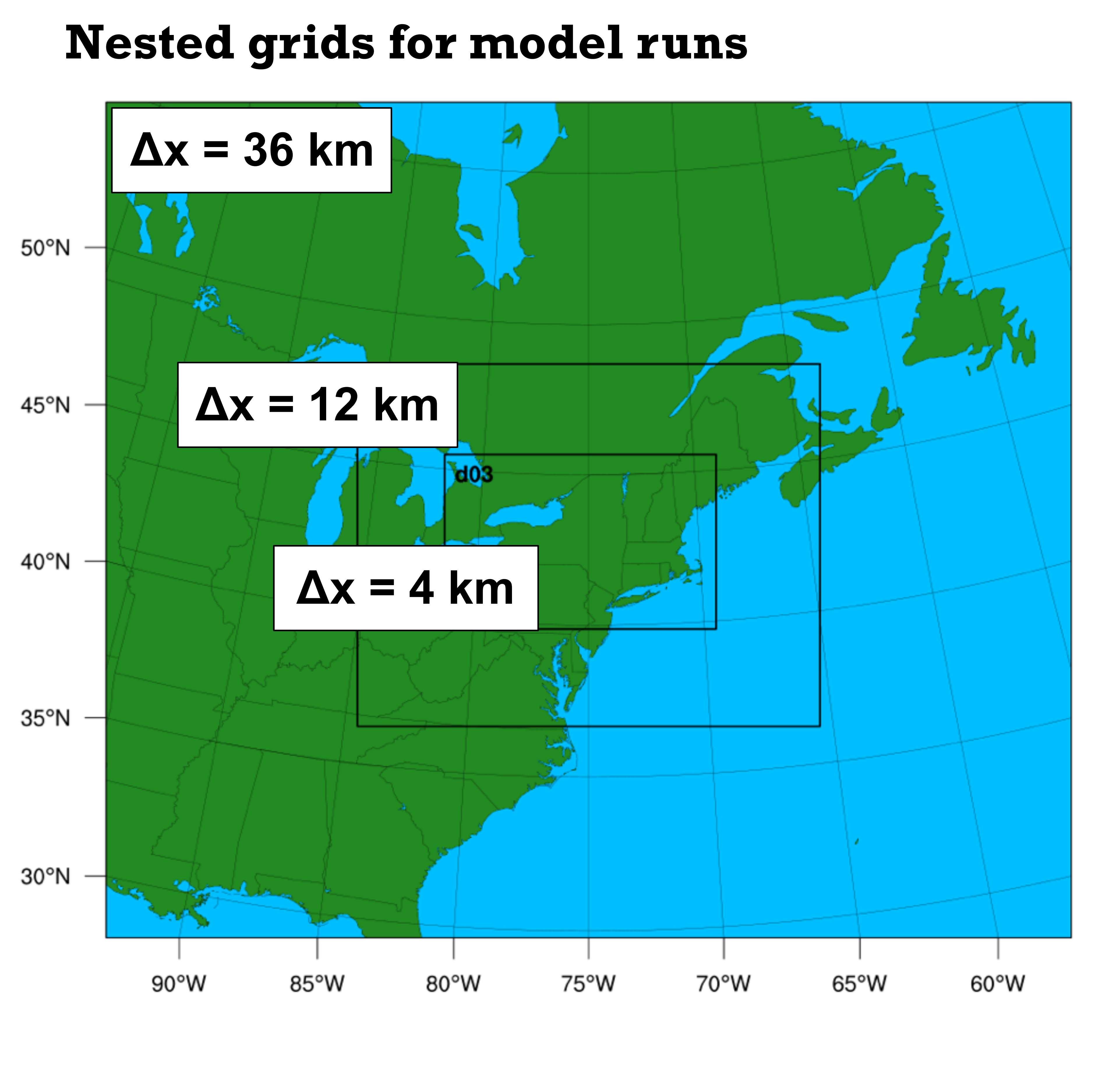
1. historical (1998 -2017)
2. near-future (2018 - 2035)
3. mid-future (2036 - 2055)

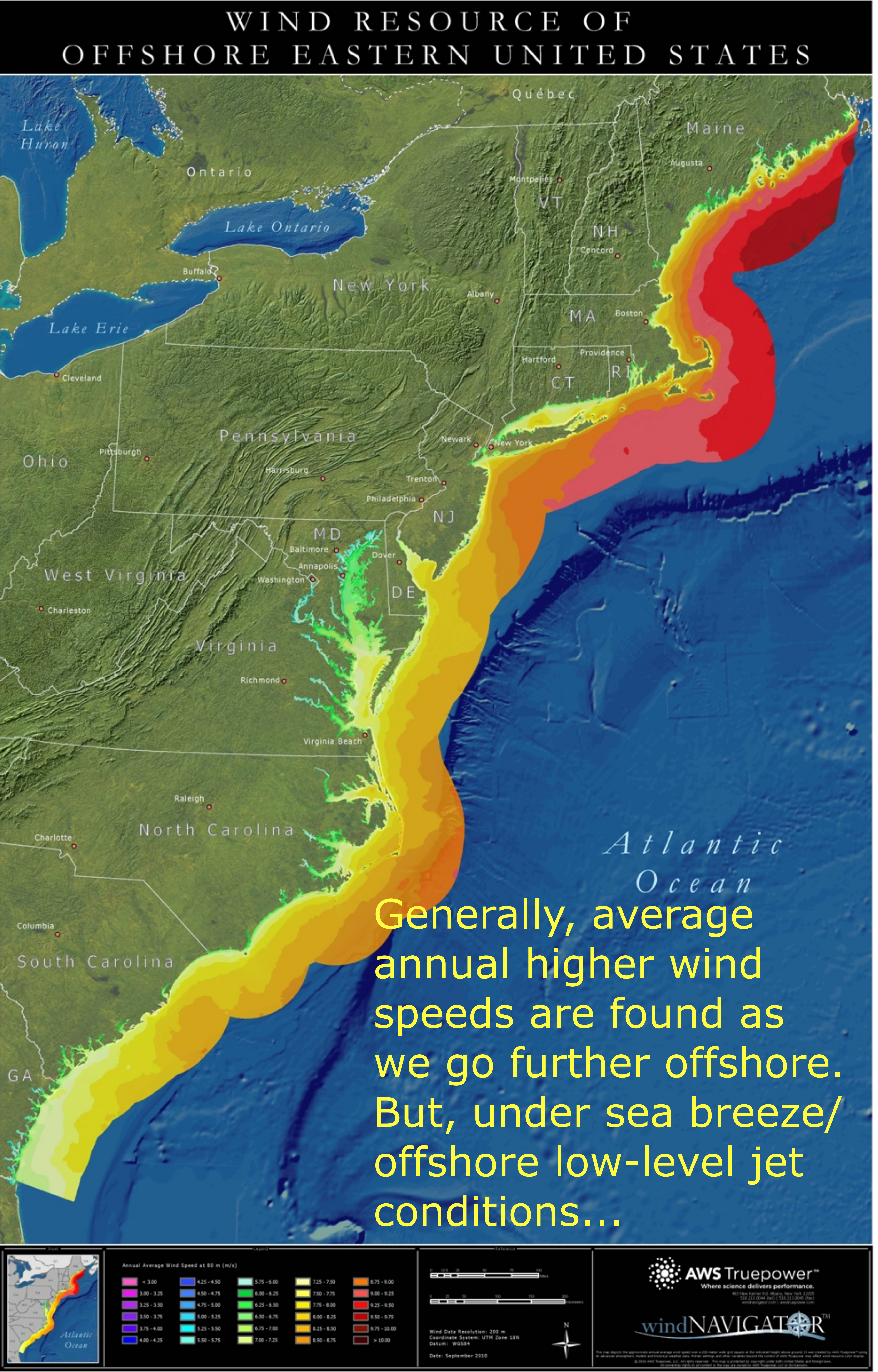
Variables of interest:

Surface (10 m) and **hub height (80m, 100 m, and 120 m) wind speed and direction**

surface irradiance

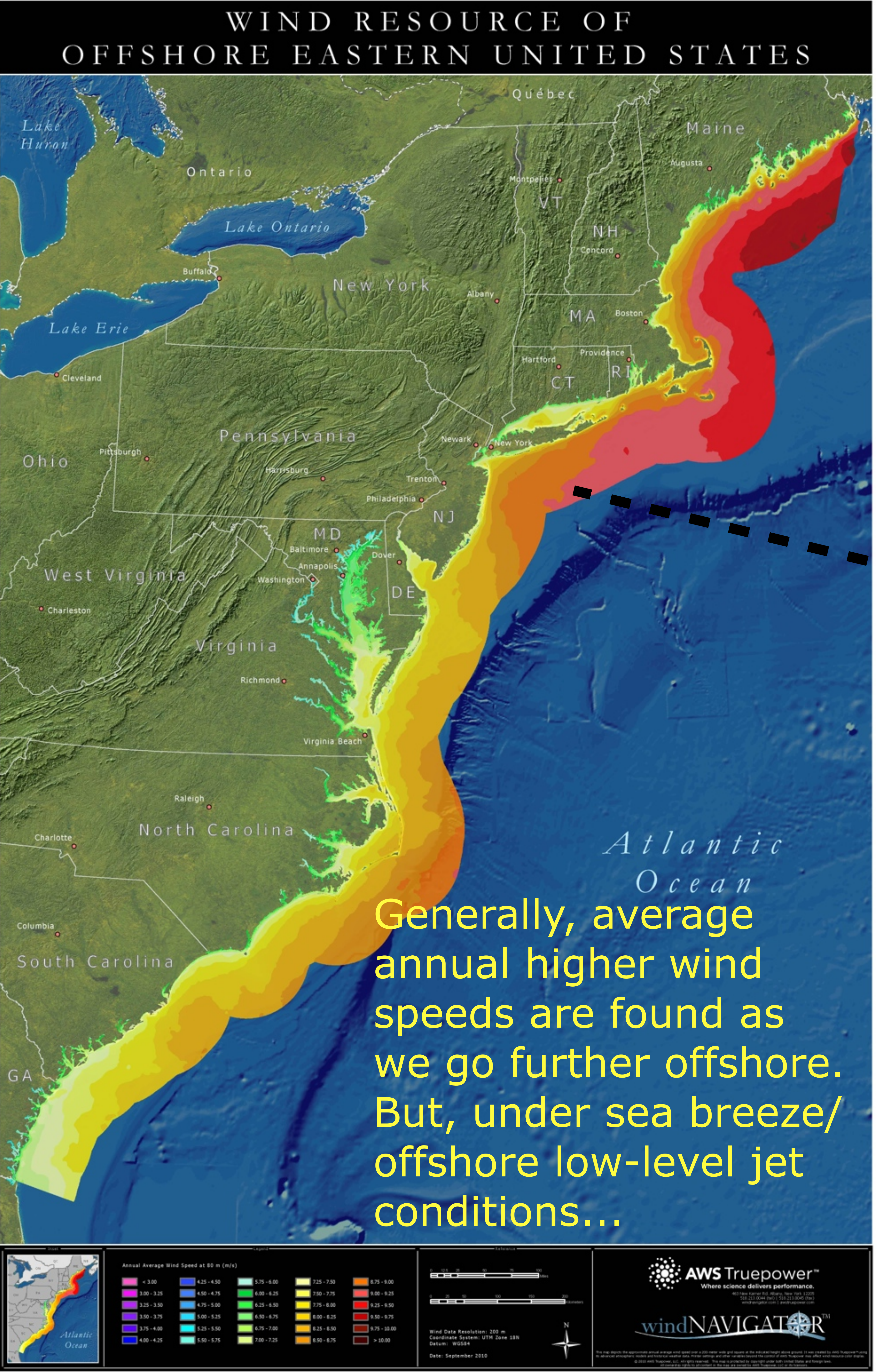
precipitation

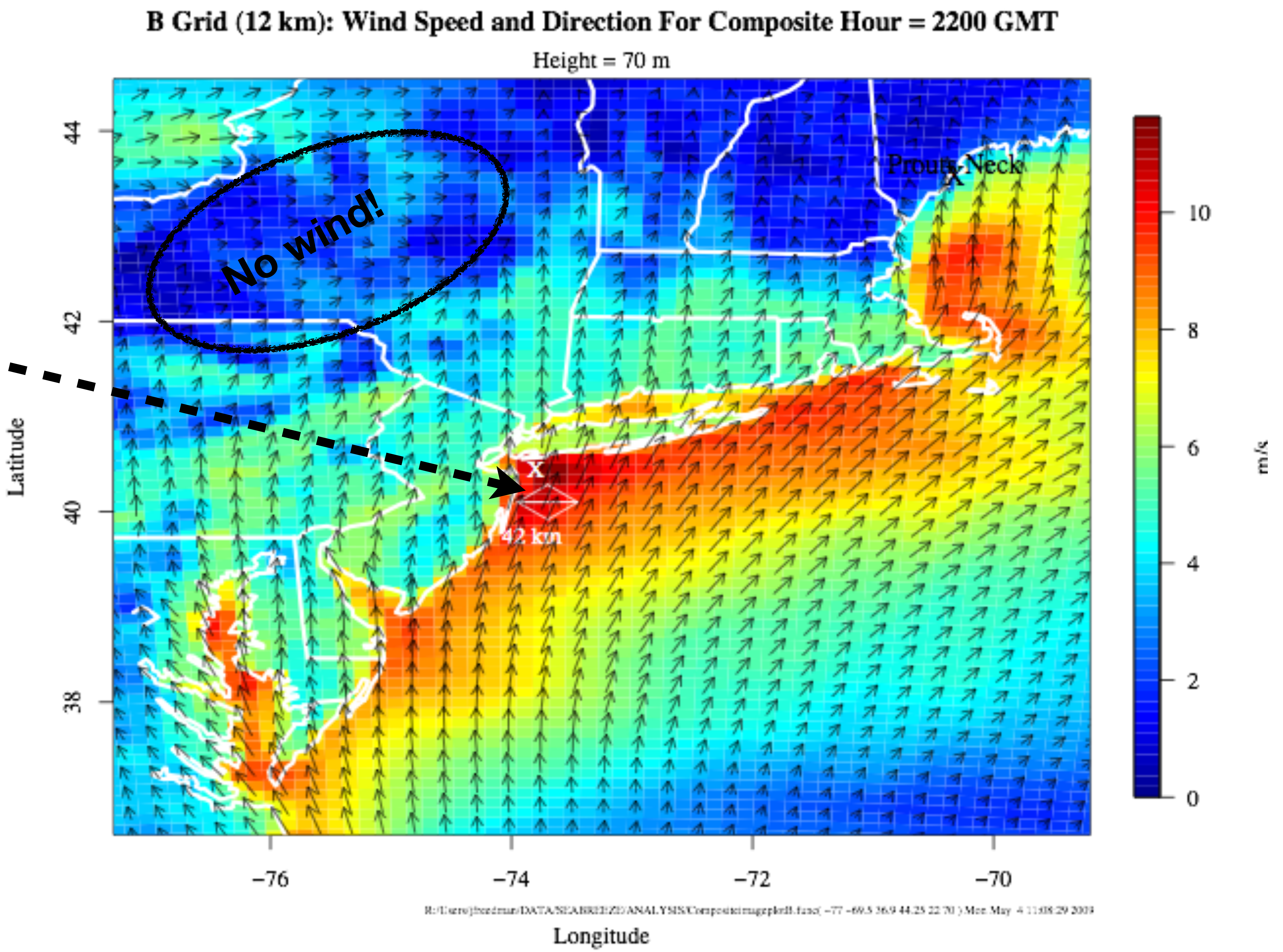




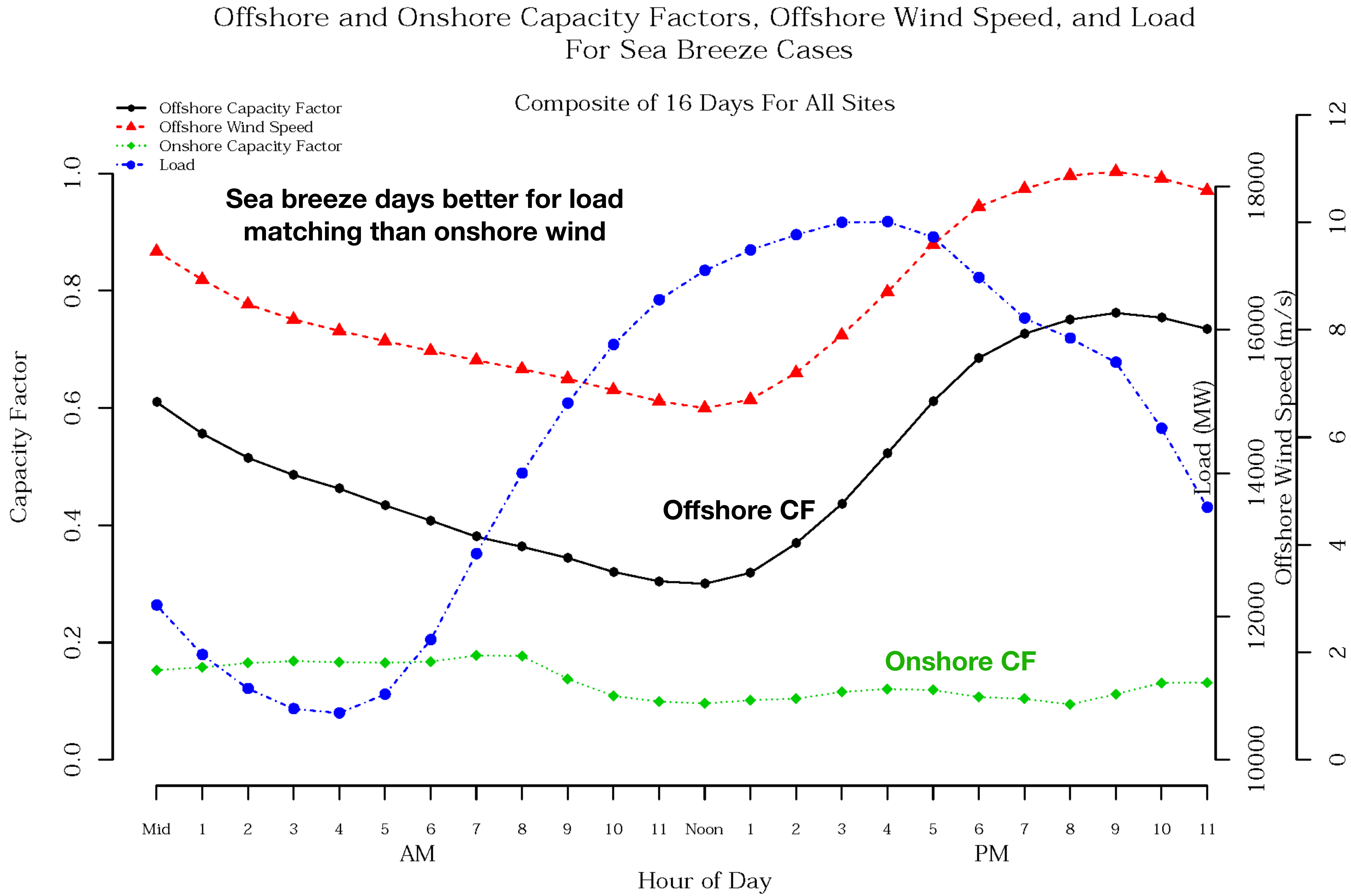
Generally, average annual higher wind speeds are found as we go further offshore. But, under sea breeze/ offshore low-level jet conditions...

About the sea breeze…



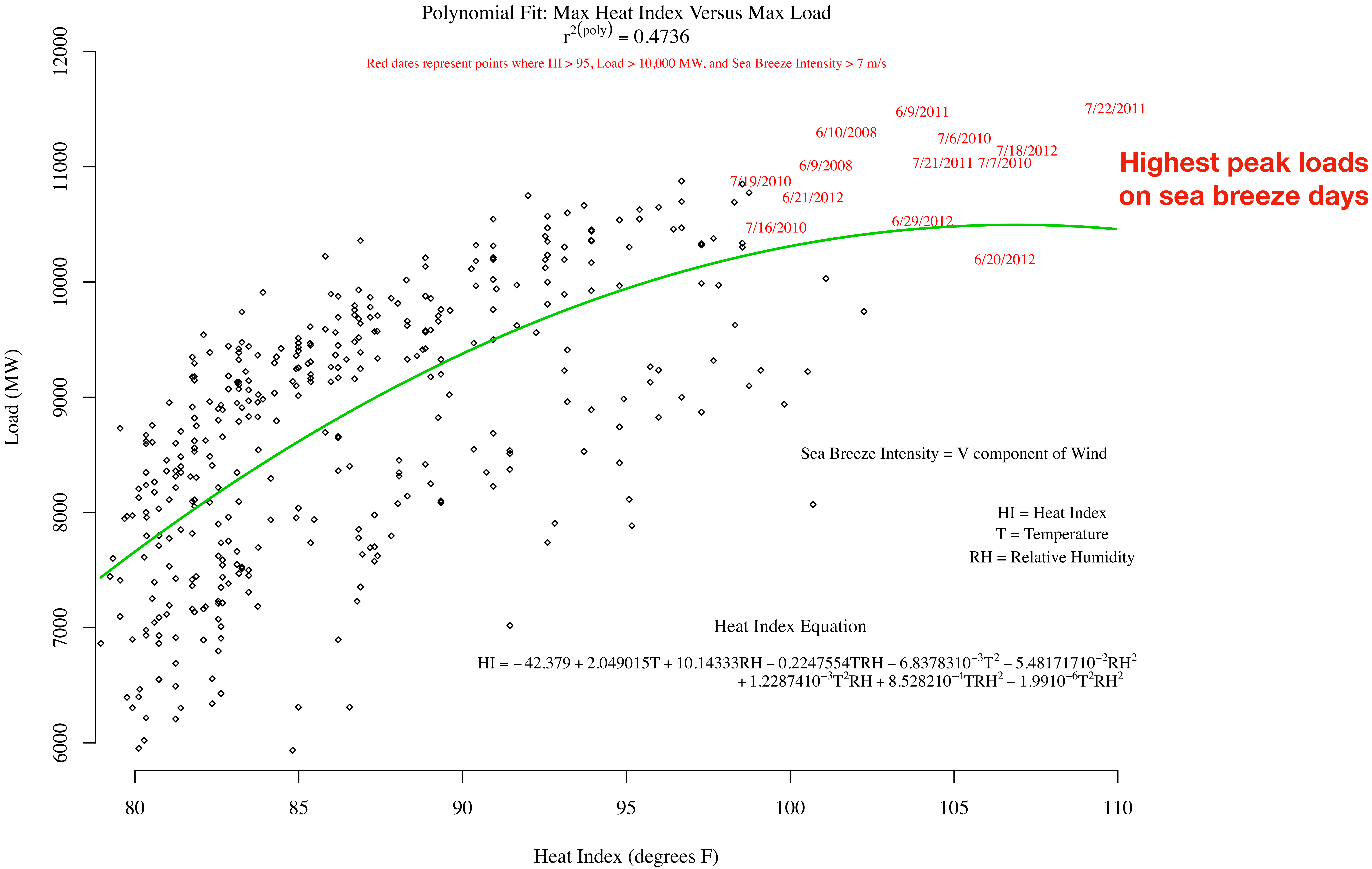


speed/direction arrows every 24 km



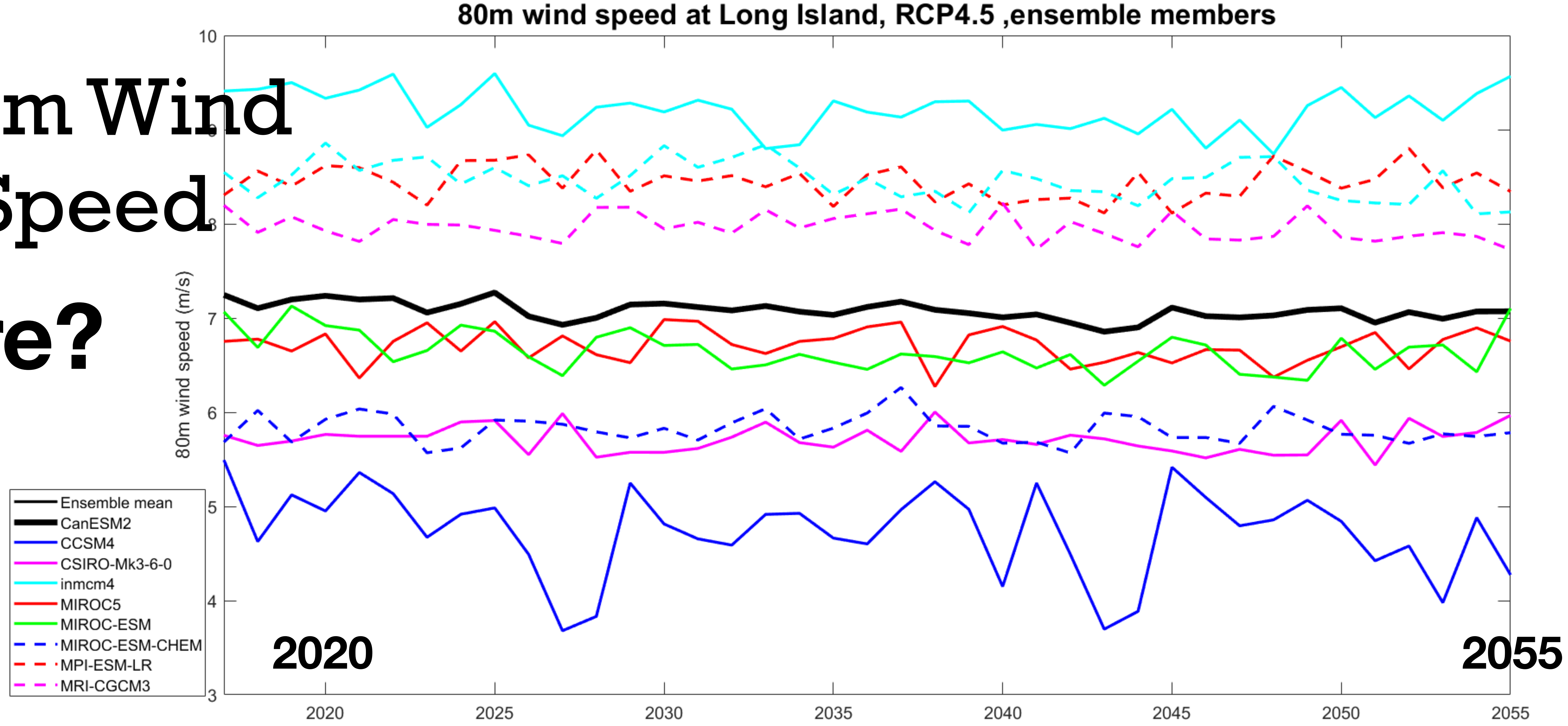
Offshore and Onshore Capacity Factors, Offshore Wind Speed, and Load
For Sea Breeze Cases
Composite of 16 Days For All Sites
Offshore Capacity Factor
Offshore Wind Speed
Onshore Capacity Factor
Load
Sea breeze days better for load matching than onshore wind
Offshore CF
Onshore CF
Capacity Factor
0.0
0.2
0.4
0.6
0.8
1.0
Load (MW)
10000
12000
14000
16000
18000
Offshore Wind Speed (m/s)
0
2
4
6
8
10
12
Mid 1 2 3 4 5 6 7 8 9 10 11 Noon 1 2 3 4 5 6 7 8 9 10 11
AM
PM
Hour of Day

Heat Index versus Peak Load, NYC (2008 – 2012)

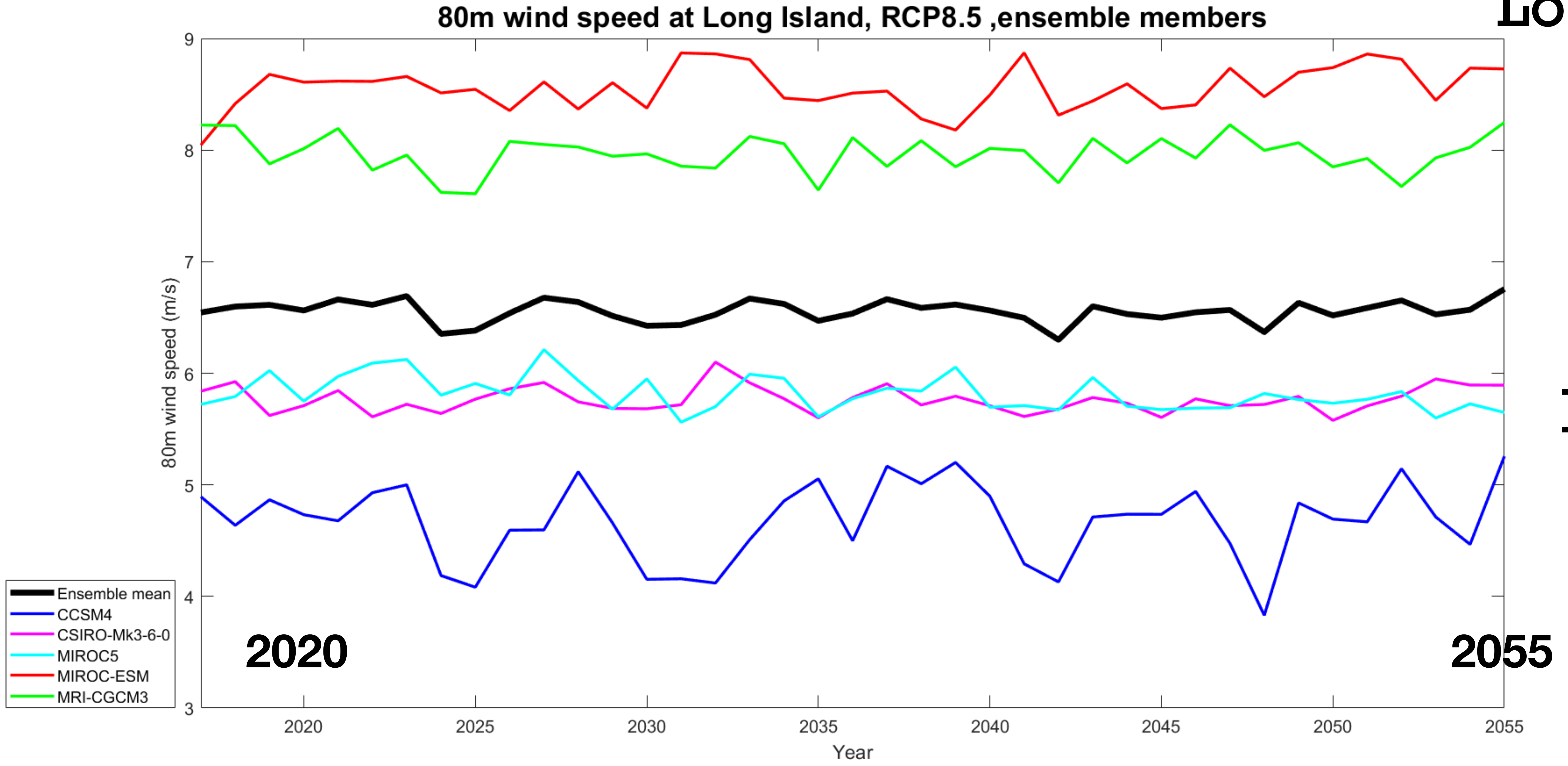


80 m Wind Speed

The Future?



RCP4.5



RCP8.5

Long Island

RCP: Representative Concentration Pathways

80 m Wind Speed

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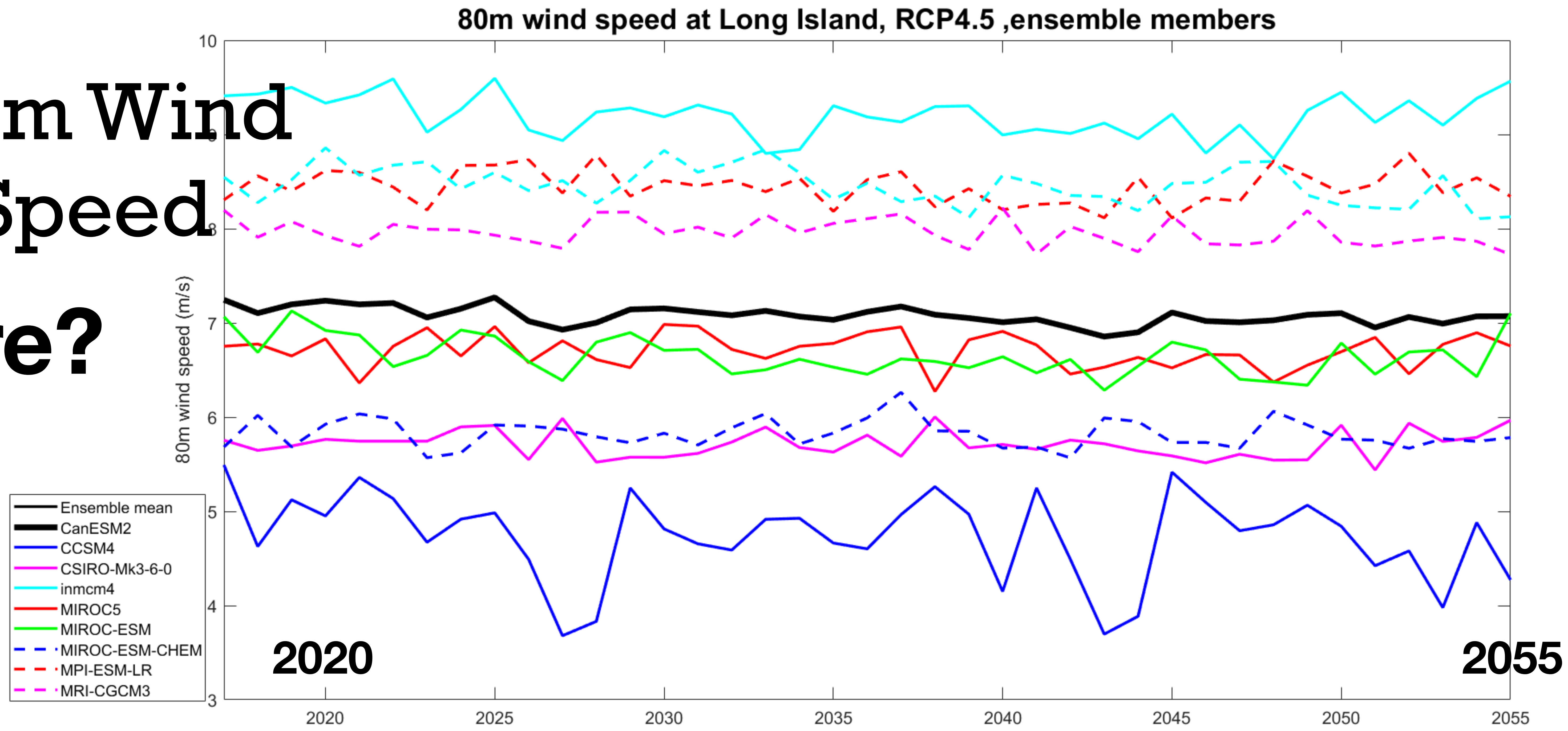
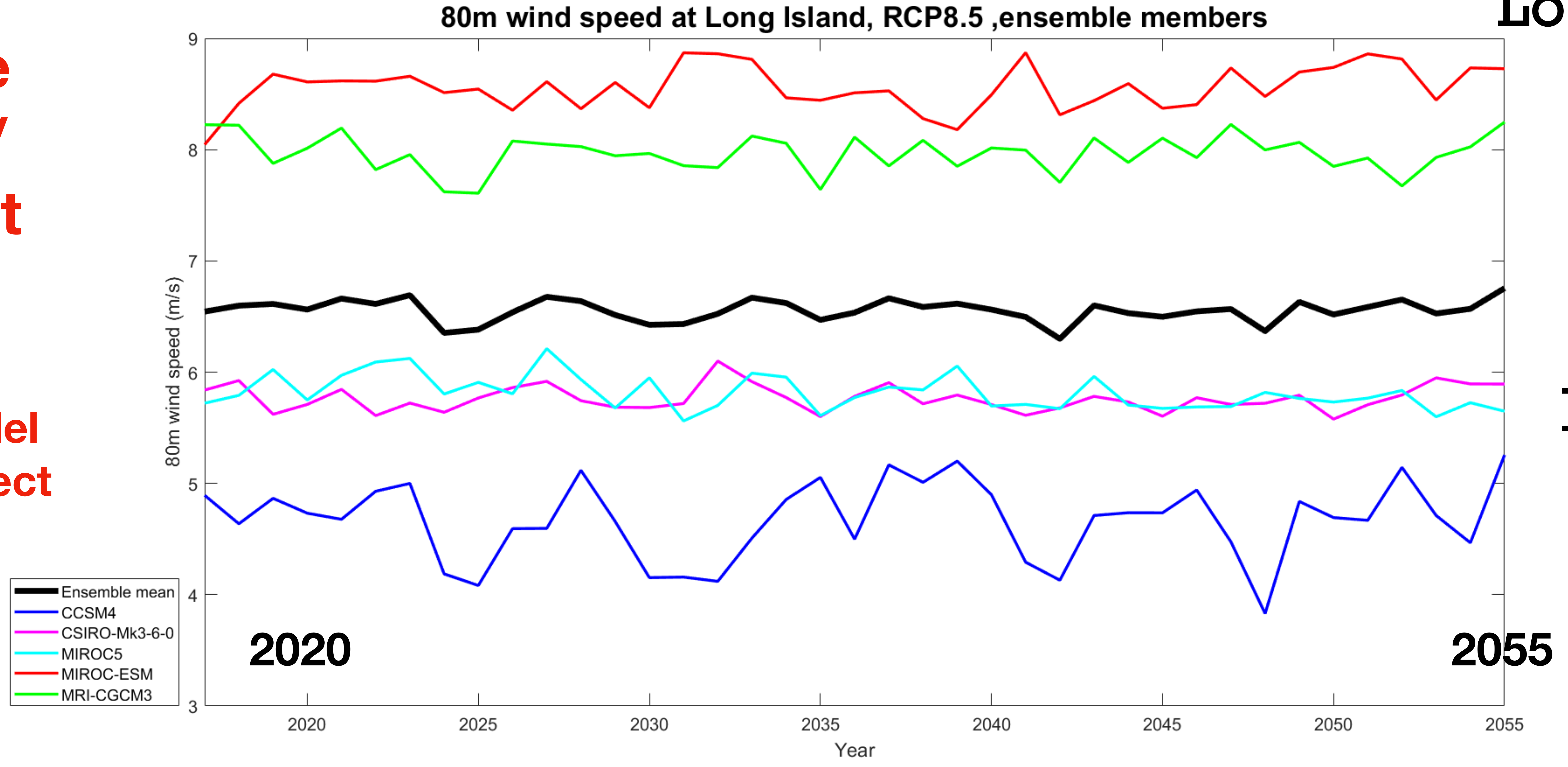


Long Island

This is just the CMIP5 Model/ Ensemble—not downscaled!

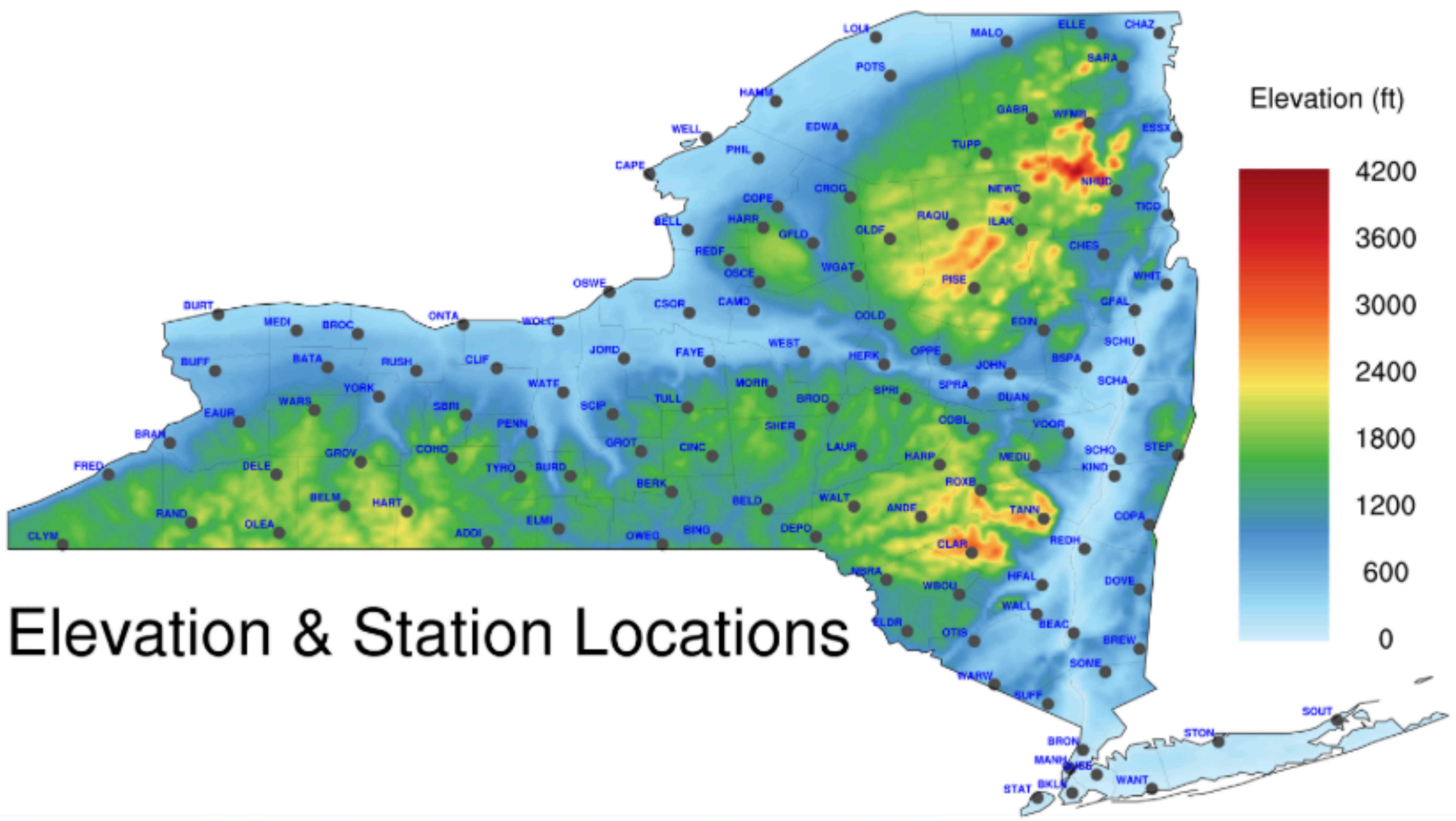
CMIP5: Coupled Model Intercomparison Project [Phase 5])

RCP8.5



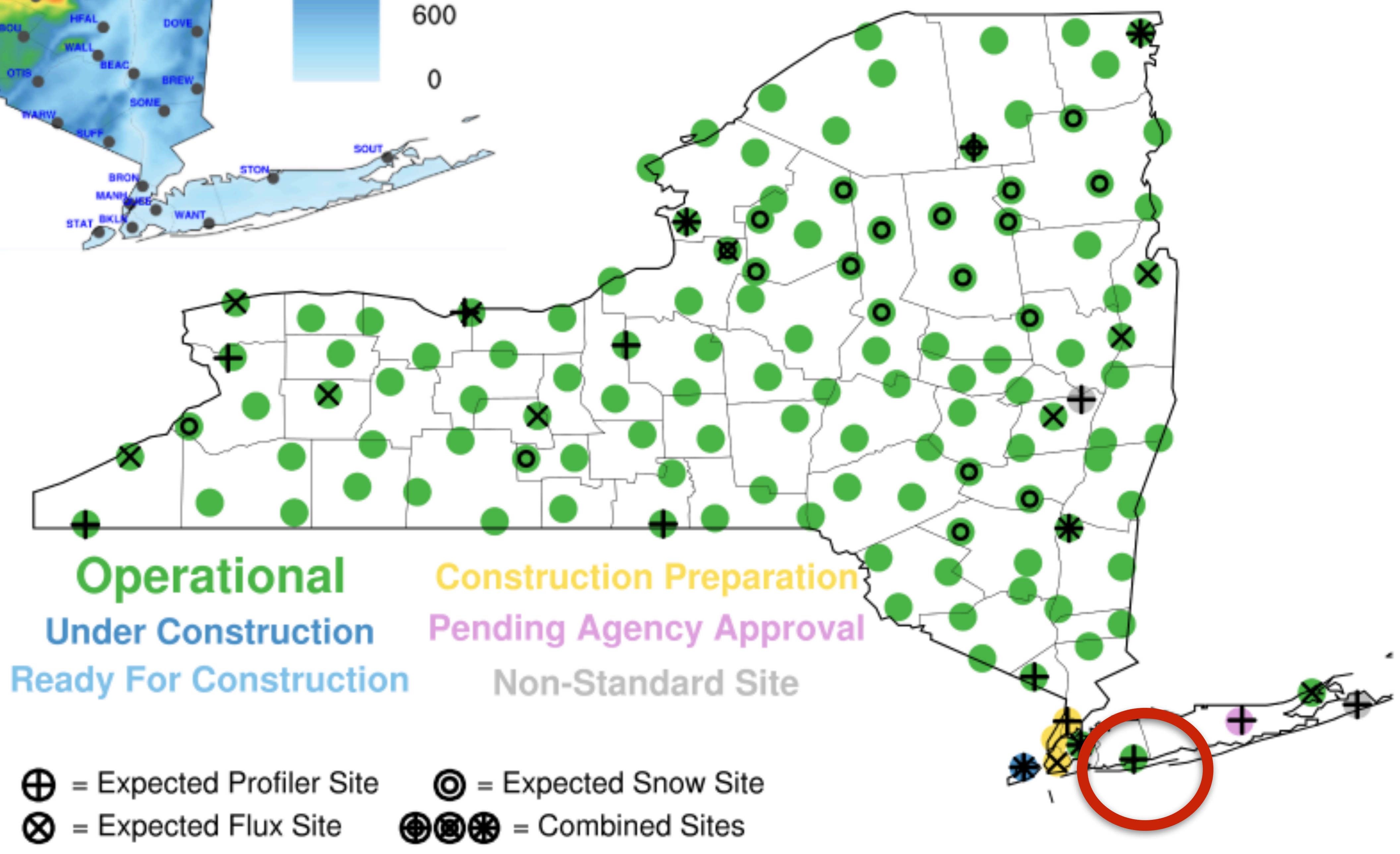
http://www.nysmesonet.org

New York Topography (ft) With Station IDs



Elevation & Station Locations

Nick Bassill NYSM



Wantagh

New York State Mesonet
126 surface stations (standard)
17 Profiler (LiDAR, Radiometer)
17 Flux (H, LE, CO_2, Rn)
20 Snow depth

Wantagh, NY Seabreeze (10 April 2017)

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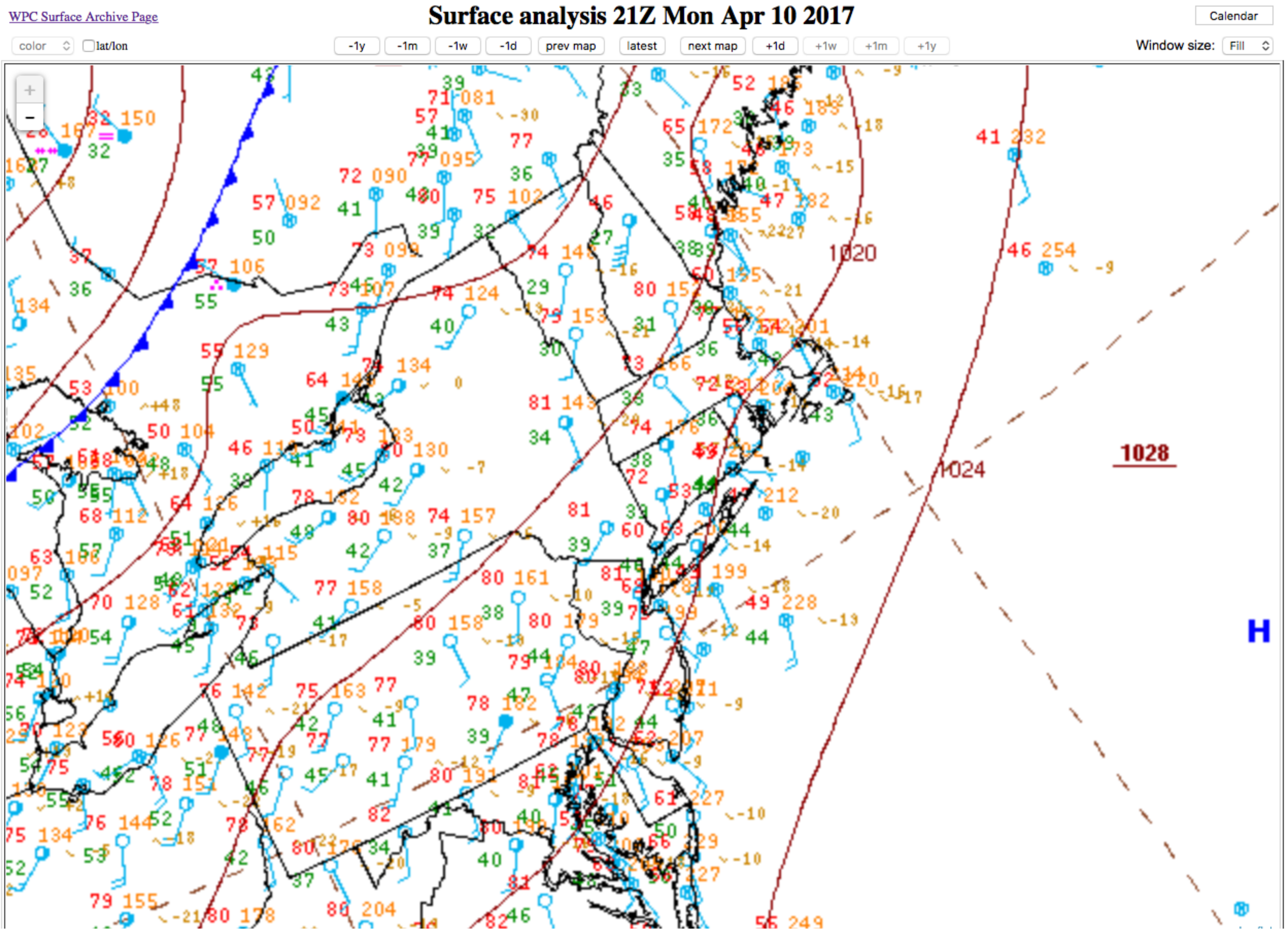
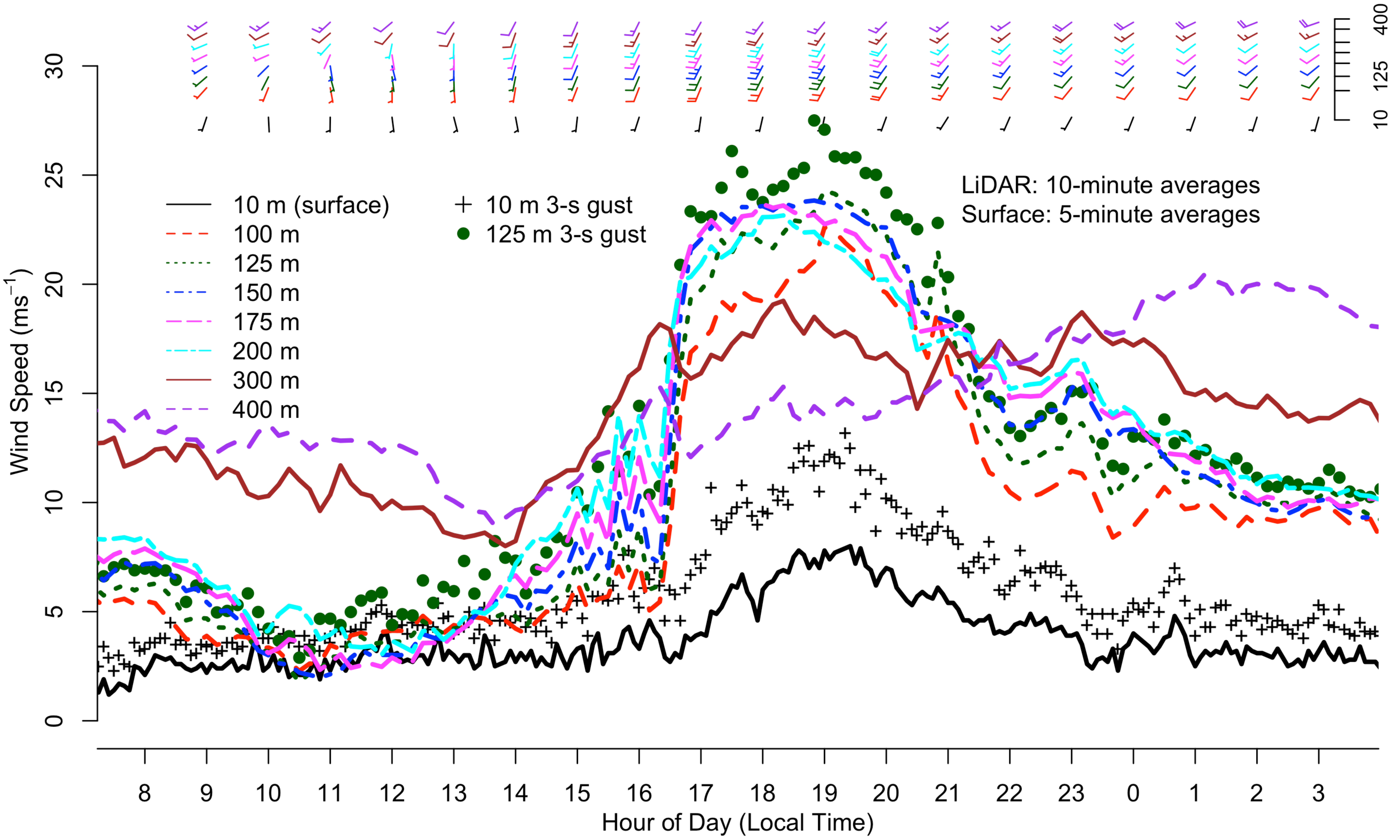


Wantagh, NY Seabreeze (10 April 2017)



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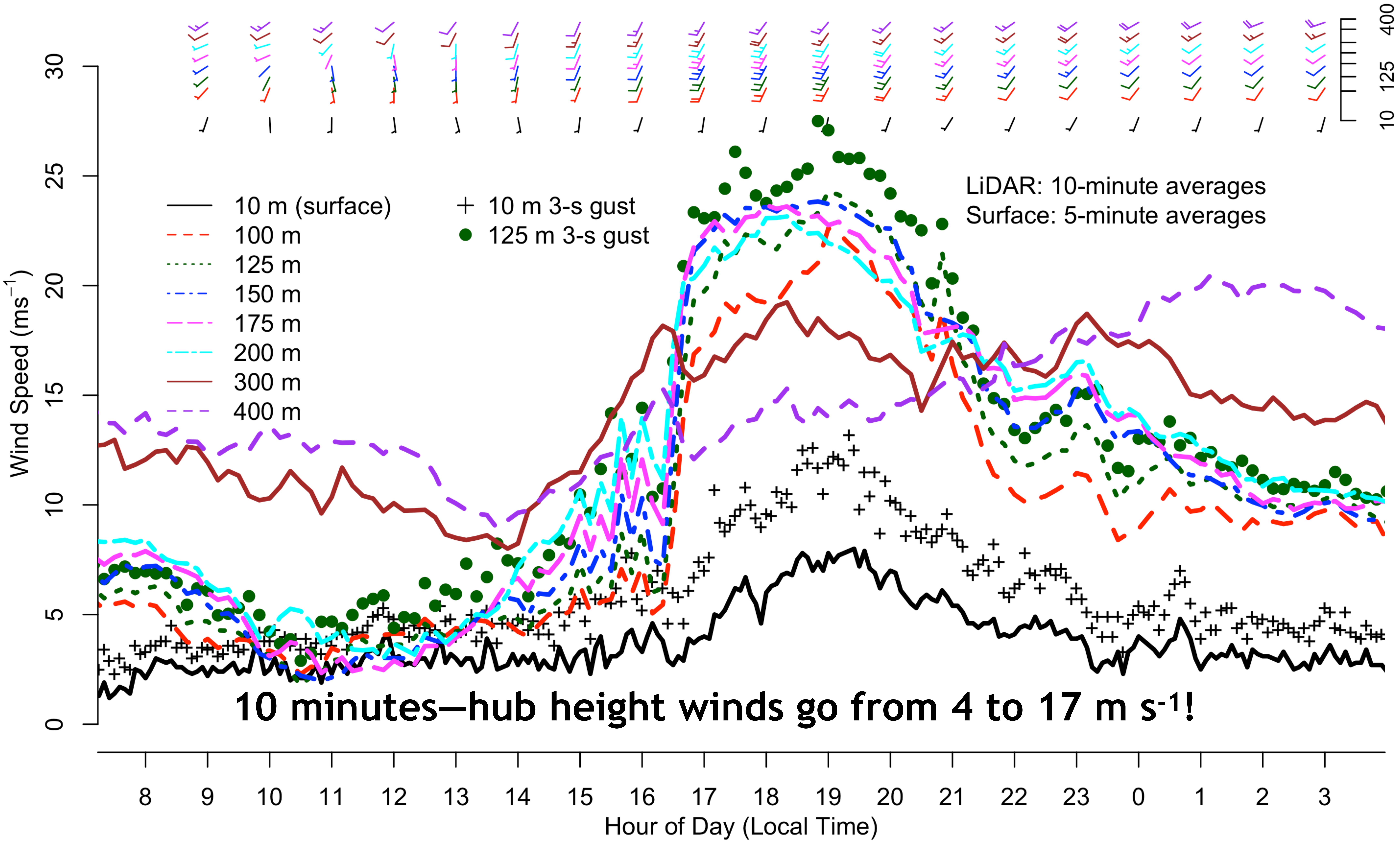

10 minutes—hub height winds go from 4 to 17 m s^{-1}!

Thank You!

jfreedman@albany.edu