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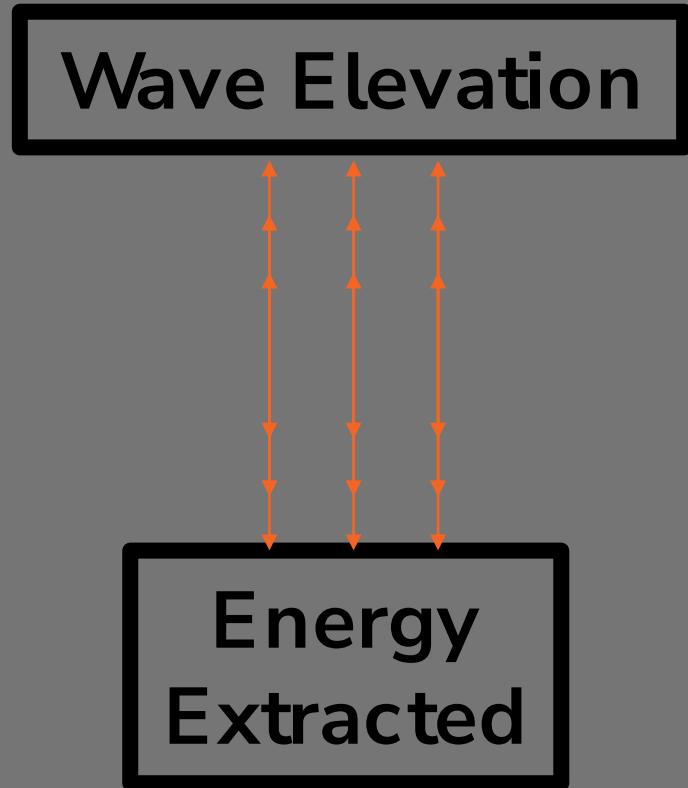
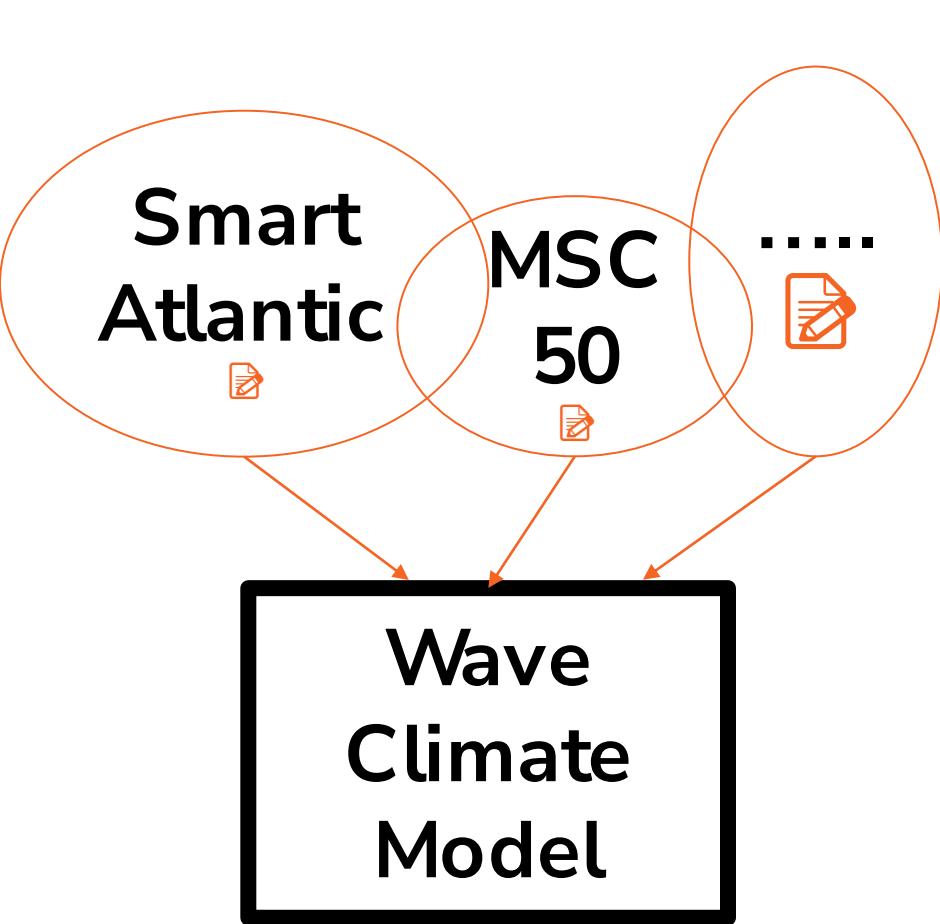
# Investigating Wave Energy and Climate Dynamics in Newfoundland

**Adithya Sudhan**  
MSc Computer Science  
Class of 2024



**Viable wave energy extraction  
requires:**

- Wave climate modelling
- Energy extraction modelling



# SWELL data for WEC arrays

SWELL: An open-access experimental dataset for arrays of wave energy conversion systems

Nicolás Faedo <sup>a,\*</sup>, Yerai Peña-Sánchez <sup>b</sup>, Edoardo Pasta <sup>a</sup>, Guglielmo Papini <sup>a</sup>,  
Facundo D. Mosquera <sup>c</sup>, Francesco Ferri <sup>d</sup>

<sup>a</sup> *Marine Offshore Renewable Energy Lab, Department of Mechanical and Aerospace Engineering, Politecnico di Torino, Turin, Italy*

<sup>b</sup> *Department of Mathematics, University of the Basque Country, Bilbao, Spain*

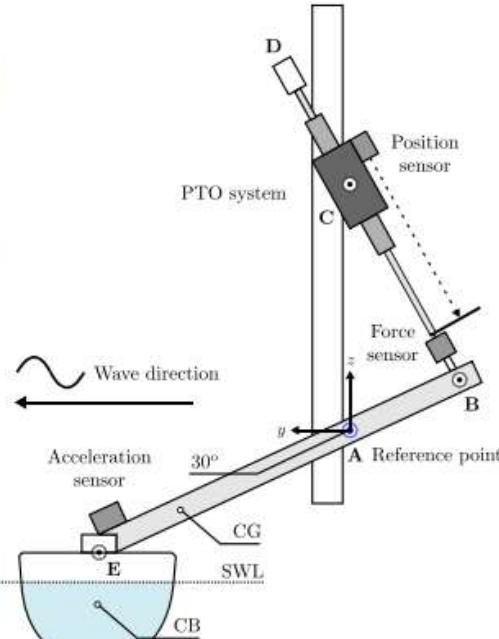
<sup>c</sup> *Instituto de Investigaciones en Electrónica, Control y Procesamiento de Señales, Universidad Nacional de La Plata, Buenos Aires, Argentina*

<sup>d</sup> *Department of the Built Environment, Aalborg University, Aalborg, Denmark*

# Lab Setup

N. Faedo et al.

Renewable Energy 212 (2023) 699–716

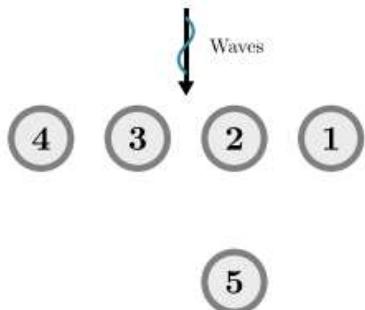


# 9 layouts

N. Faedo et al.

Renewable Energy 212 (2023) 699–716

Full layout specification



Layout 0



Layout 4



Layout 1



Layout 5



Layout 2



Layout 6



Layout 3



Layout 7



Layout 8



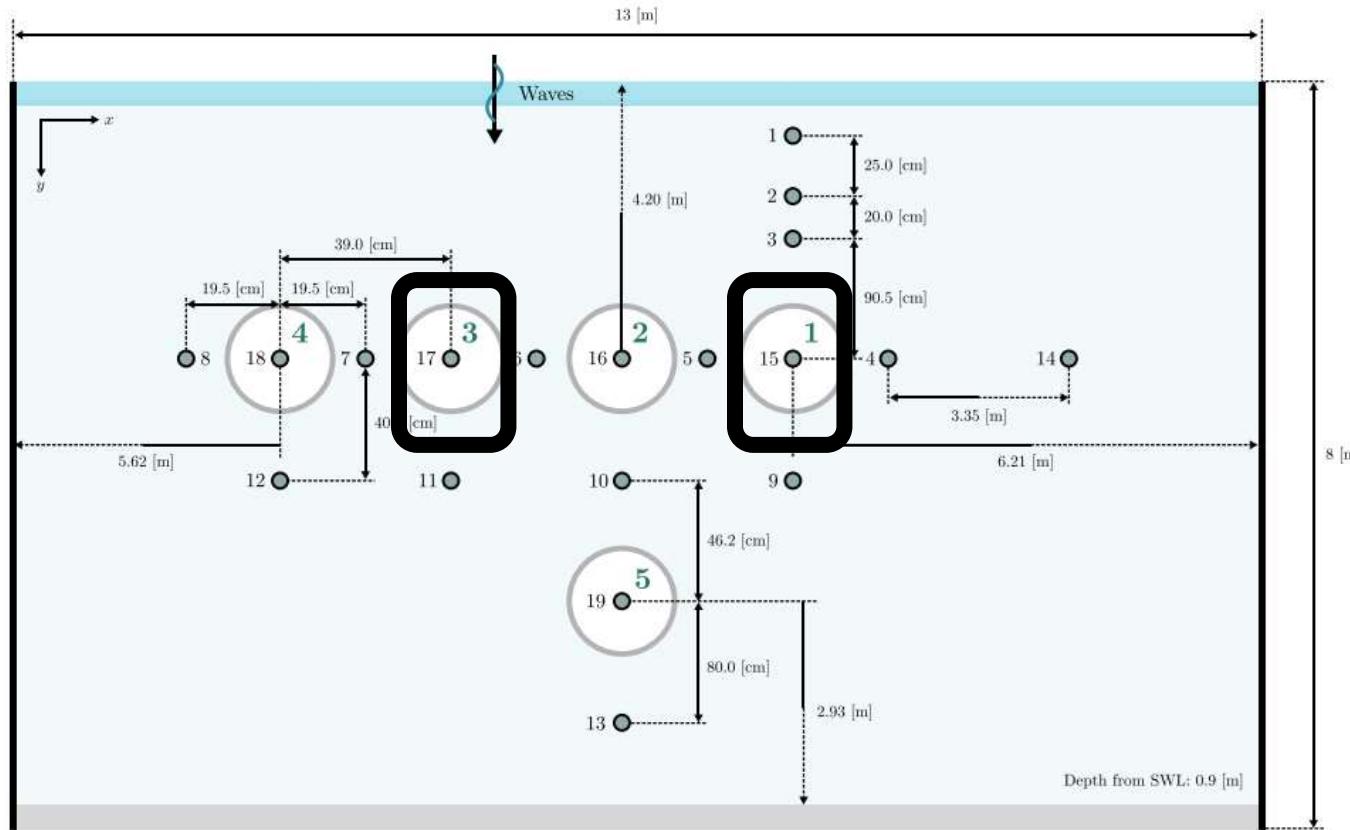
# 19 kinds of waves

Waves tested within the presented experimental campaign.

ID	Type	Period [s]	Height [m]	$\gamma$	#R	Length [s]
RSS1	Regular	0,8	0,05	-	1	60
RSS2	Regular	0,9	0,05	-	3	60
RSS3	Regular	1	0,05	-	1	60
RSS4	Regular	1,2	0,05	-	3	60
RSS5	Regular	1,5	0,05	-	1	60
BMSS	Bimodal	{0,9, 1,2}	Equal energy	-	1	60
ISS1	Irregular	1,412	0,063	3,3	2	300
ISS2	Irregular	1,836	0,104	3,3	2	300
ISS3	Irregular	0,988	0,0208	1	2	300
WNSS1	W. noise	[0,5, 10]	0,01	-	1	300
WNSS2	W. noise	[0,5, 10]	0,03	-	1	300
WNSS3	W. noise	[0,5, 10]	0,05	-	1	300

Total number of waves tested: 19

# Training model on WP 15, 17



# Wave elevation => Torque(Energy)

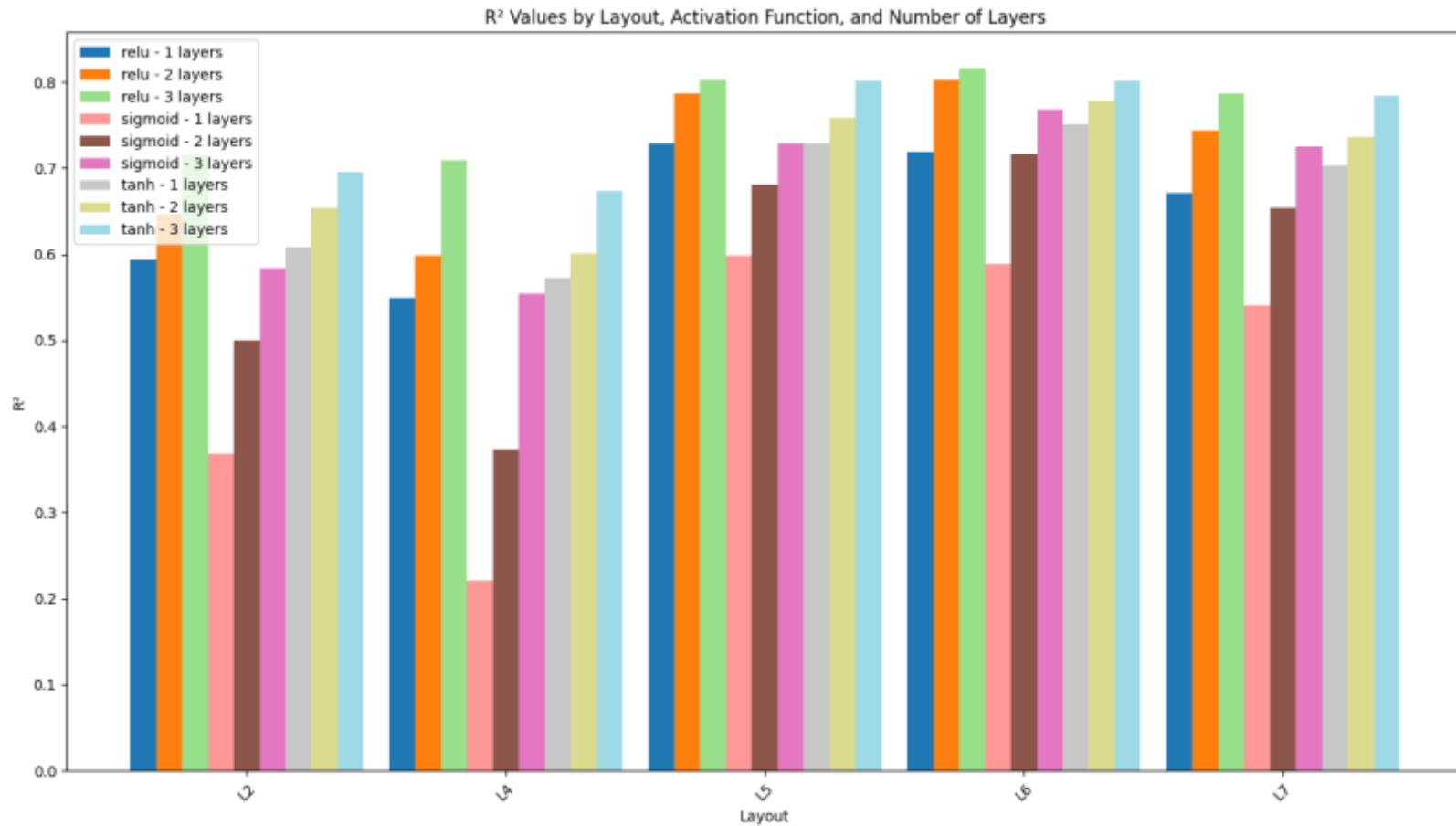
1,2,3 layer

LSTM

w/ tanh,relu,  
sigmoid

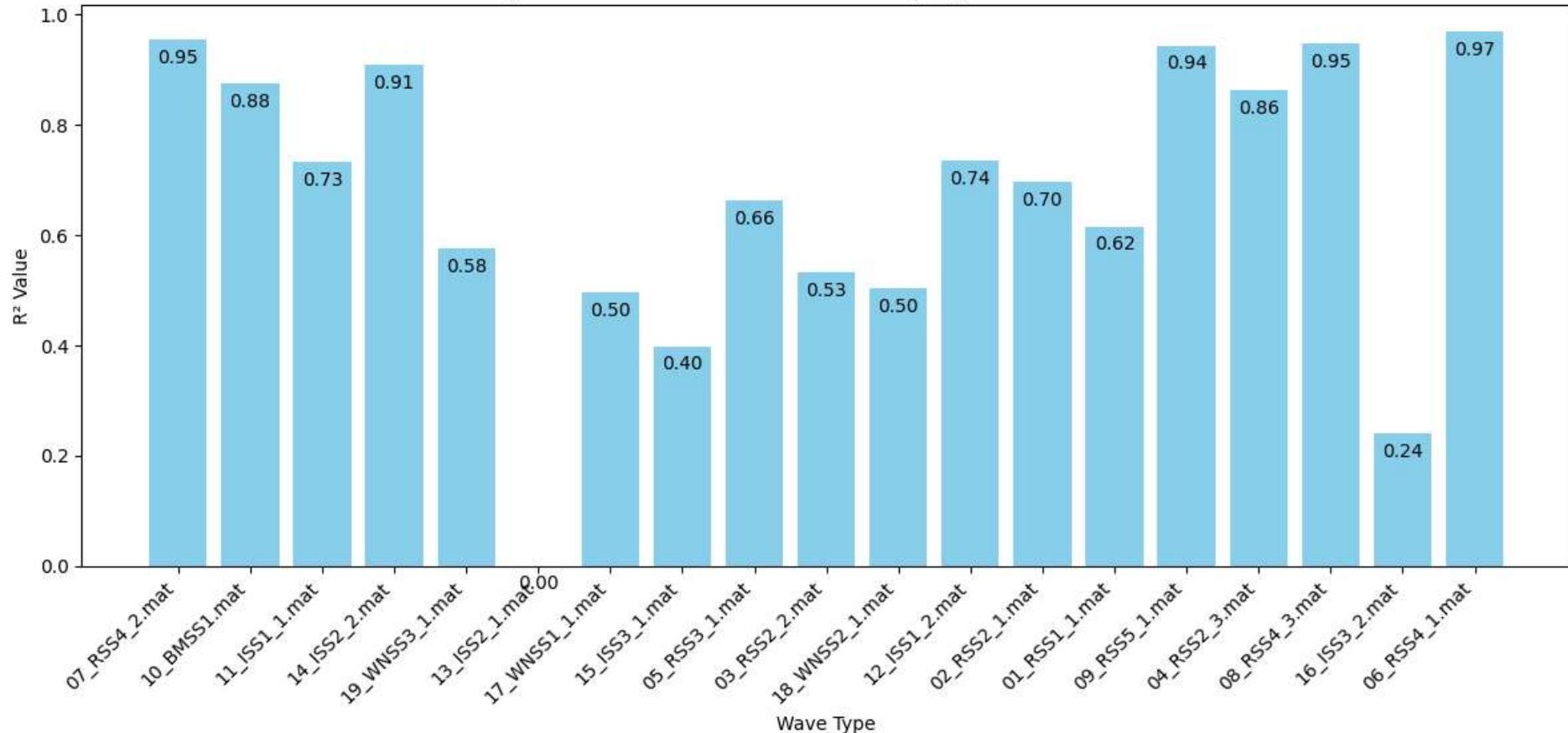


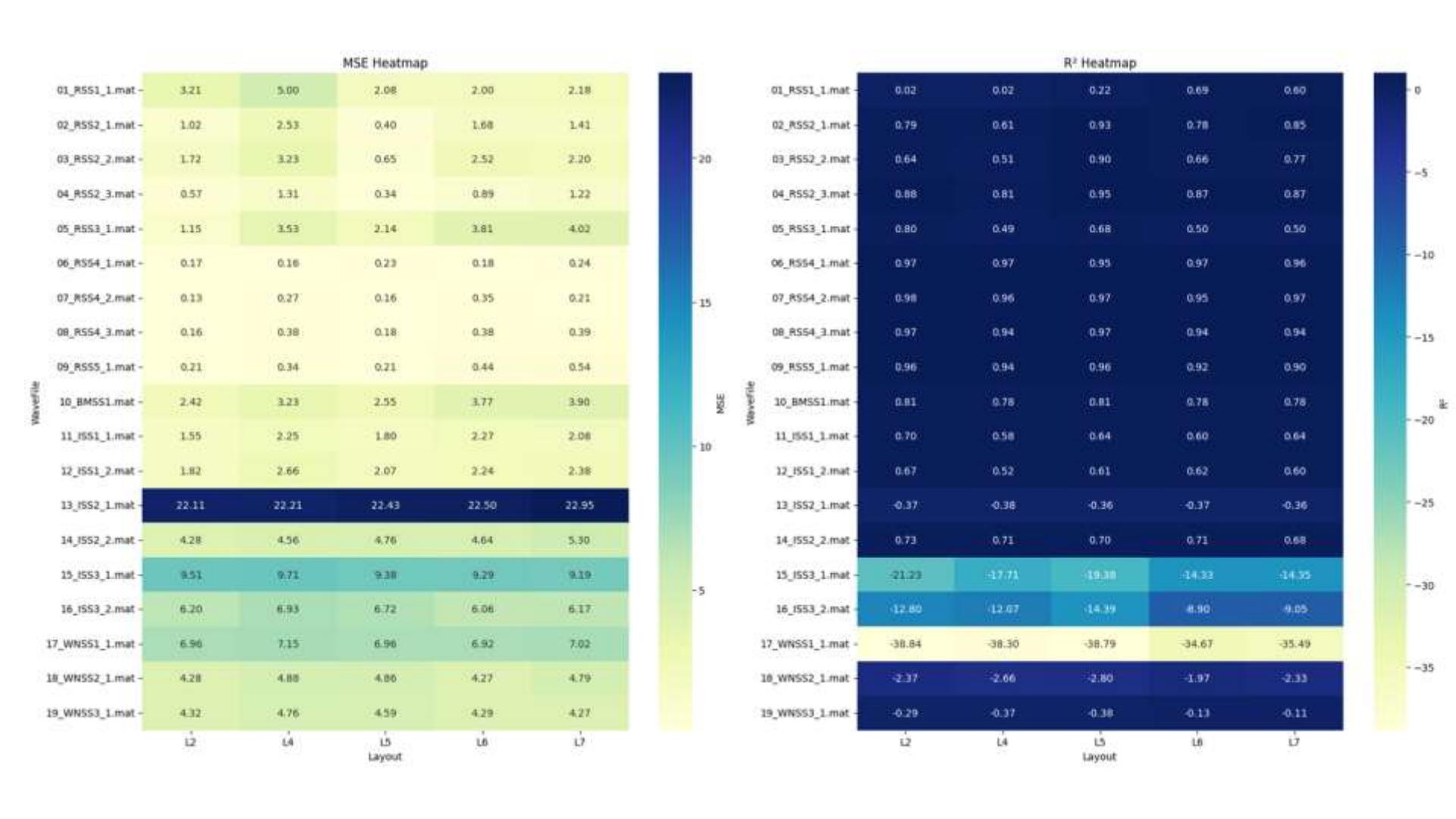
# Regular-wave-trained models pretend



# L4 model does badly on ISS waves

L4 Layout Data Trained with Random Sampling with Different Waves





Takeaway:  
Train wherever, but test on  
*irregular* waves  
for reality check

# SmartAtlantic data

The screenshot shows a web browser displaying the SmartAtlantic website at smartatlantic.ca/index.html. The page features a header with the SmartAtlantic logo and a green banner with a message about a successful pilot boarding station. Below the banner is a navigation menu with links to About Us, Notices, Newfoundland & Labrador, Nova Scotia, and New Brunswick. The main content area contains a map of the Atlantic coast with several numbered buoys (3 and 4) marked near the shore.

smartatlantic

NL: The Pilot Boarding Station (Red Island Shoal) buoy has been successful

About Us | Notices | Newfoundland & Labrador | Nova Scotia | New Brunswick

Better Information Better Decisions

3

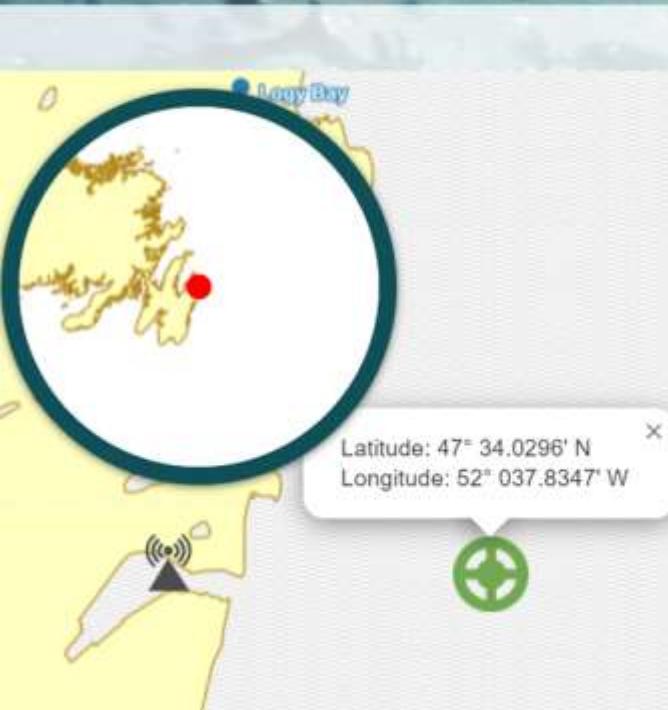
4



There's many datasets(buoys) in SmartAtlantic data

	data	graph	files	public	Fortune Bay Buoy	?	F	I	M	background	CSV
	data	graph	files	public	Fortune Bay: Dog Island - DOGIS	?	F	I	M	background	CSV
	data	graph	files	public	Fortune Bay: Pool's Cove - POOLC	?	F	I	M	background	CSV
	data	graph	files	public	Halifax (Herring Cove) Buoy	?	F	I	M	background	CSV
	data	graph	files	public	Halifax Ocean Terminals: Fairview	?	F	I	M	background	CSV
	data	graph	files	public	Halifax Ocean Terminals: Pier 31	?	F	I	M	background	CSV
	data	graph	files	public	Halifax Ocean Terminals: Pier 9C	?	F	I	M	background	CSV
	data	graph	files	public	Head of Placentia Bay Buoy	?	F	I	M	background	CSV
	data	graph	files	public	Holyrood Buoy 1	?		M		background	CSV
set	data	graph	files	public	Holyrood Buoy 1, Raw Wind Data	?	F	I	M	background	CSV
	data	graph	files	public	Holyrood Buoy 2	?	F	I	M	background	CSV
	data	graph	files	public	Holyrood Shore Station	?	F	I	M	background	CSV
	data	graph	files	public	Holyrood Wharf Weather Station	?	F	I	M	background	CSV
	data	graph	files	public	Lewisporte Tide Station	?	F	I	M	background	CSV
	data	graph	files	public	Manolis Buoy	?	F	I	M	background	CSV
	data	graph	files	public	Mouth of Placentia Bay Buoy	?	F	I	M	background	CSV
set	data	graph	files	public	MSC Datamart realtime moored buoy data	?	F	I	M	background	CSV
	data	graph	files	public	MUN Glider Deployment: Nunkaysa, Pacific, 2012-08-18	?	F	I	M	background	CSV
	data	graph	files	public	MUN Glider Deployment: Pearldiver, Gulf of St. Lawrence, 2019-08-08	?	F	I	M	background	CSV
	data	graph	files	public	MUN Glider Deployment: Pearldiver, Labrador Sea, 2019-12-04	?	F	I	M	background	CSV

# St. John's Buoy



## Current Conditions

Current Conditions

Preferences

Date/Time & Position

Time Now: 09-Aug-2024 08:44 NDT

Time of Data: 09-Aug-2024 08:30 NDT

Latitude: 47° 34.0296' N

Longitude: 52° 037.8347' W

Updated every 30 minutes

Data is Fresh



## ERDDAP

Easier access to scientific data

Brought to you by

## ERDDAP &gt; tabledap &gt; Data Access Form

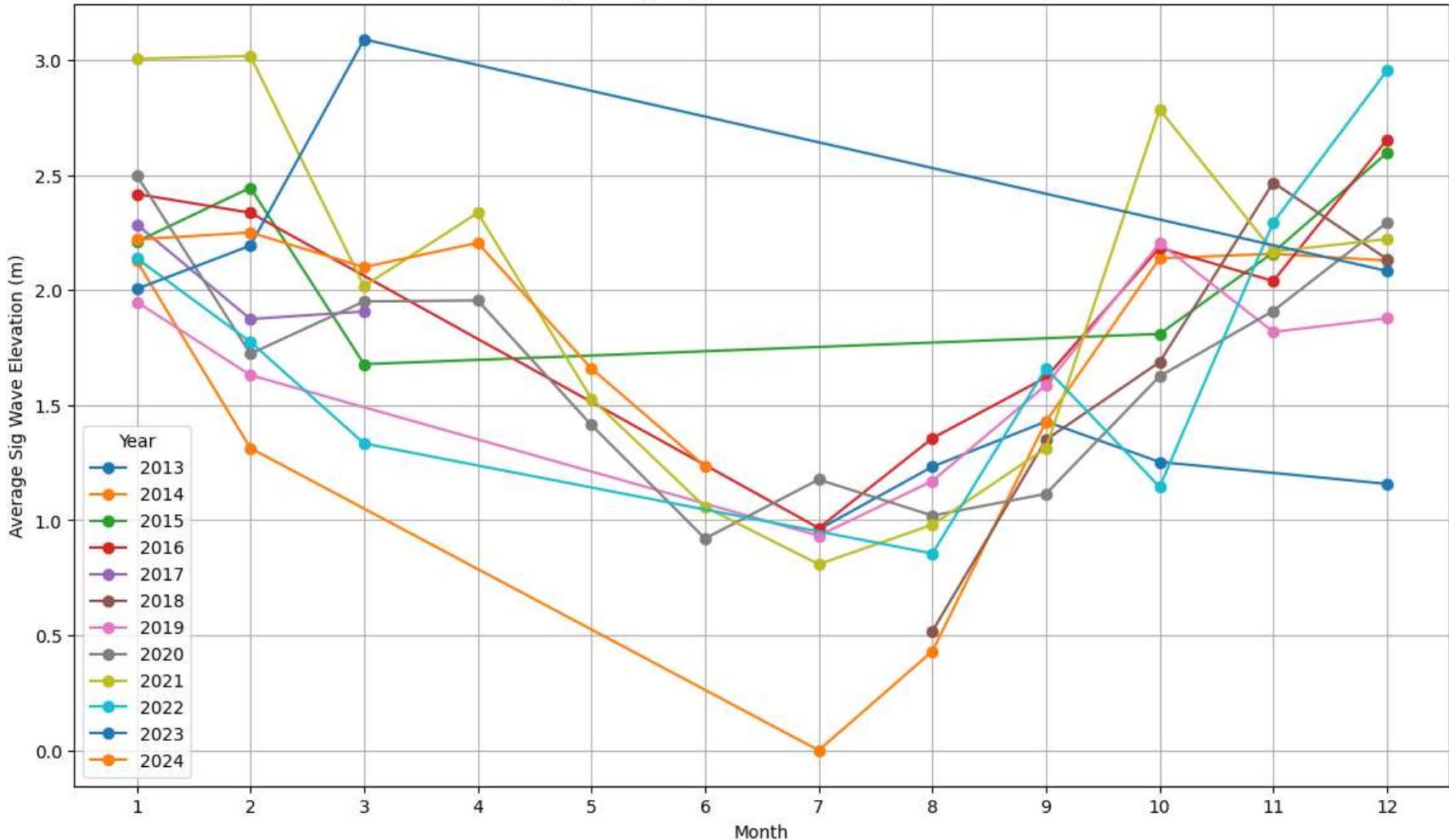
Dataset Title: **St. John's Buoy**

Institution: MI (Dataset ID: SMA\_st\_johns)

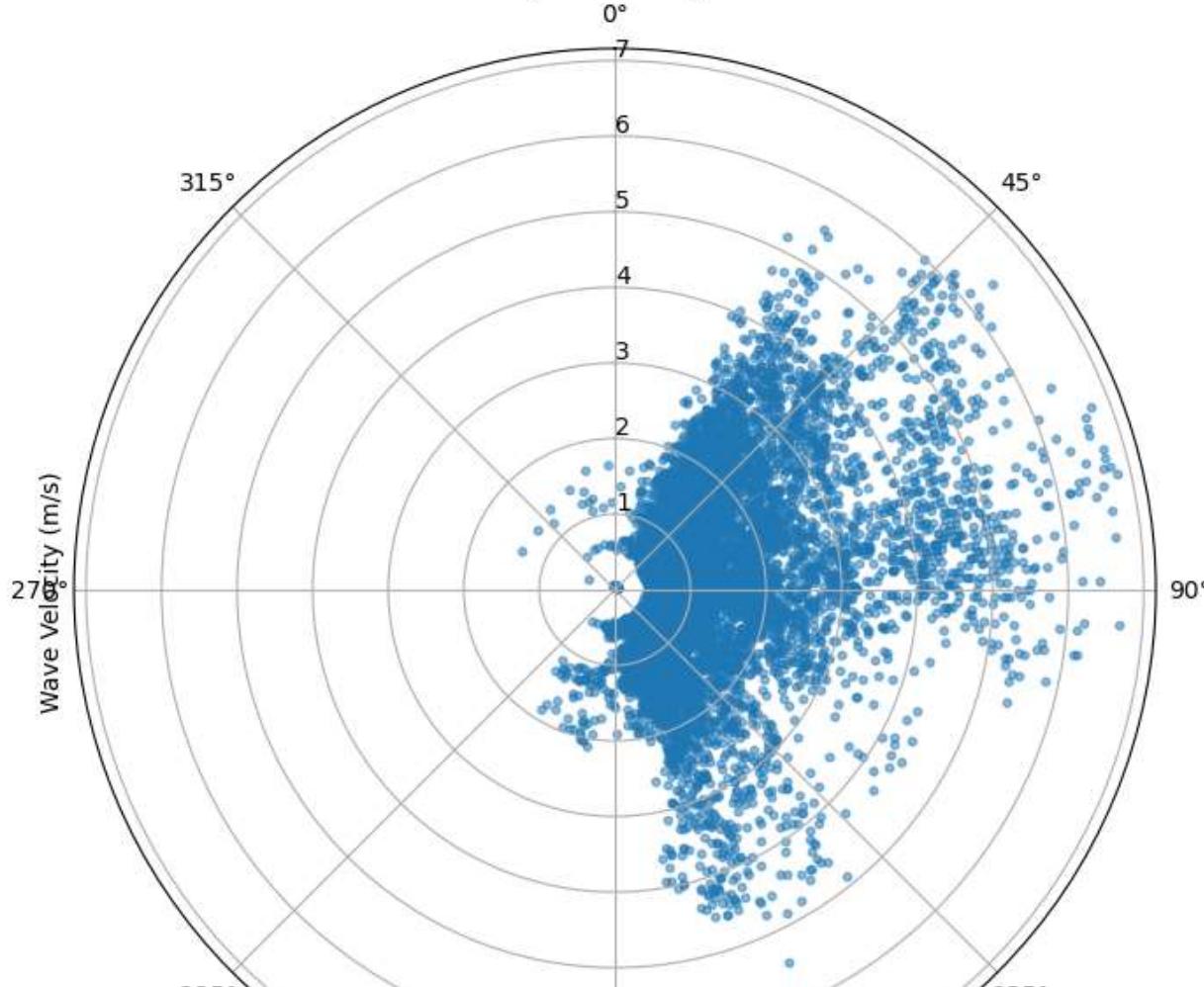
Information: [Summary](#) [License](#) [FGDC](#) [ISO 19115](#) [Metadata](#) [Background](#) [Files](#) [Make a graph](#)Variable  Check All  Uncheck All

Variable	Optional Constraint #1		Optional Constraint #2		Minimum	Maximum
<input checked="" type="checkbox"/> station_name	>=		<=		"smb_st_johns"	"smb_st_johns"
<input checked="" type="checkbox"/> time (Timestamp, UTC)	>=	2024-08-02T00:00:00Z	<=	2024-08-09T11:30:01Z	2013-07-10T17:53:01Z	2024-08-09T11:30:01Z
<input checked="" type="checkbox"/> longitude (degrees_east)	>=		<=		-52.63057833333333	-52.63057833333333
<input checked="" type="checkbox"/> latitude (degrees_north)	>=		<=		47.56716	47.56716
<input checked="" type="checkbox"/> precise_lon (Precise Longitude, degrees_east)	>=		<=		-54.86781333	-45.11410333
<input checked="" type="checkbox"/> precise_lat (Precise Latitude, degrees_north)	>=		<=		35.76485667	50.91543833
<input checked="" type="checkbox"/> wind_spd_avg (Wind Speed Average, m s-1)	>=		<=		0.2	58.0
<input checked="" type="checkbox"/> wind_spd_max (Wind Speed Max, m s-1)	>=		<=		0.5	79.5
<input checked="" type="checkbox"/> wind_dir_avg (Wind From Direction, degree)	>=		<=		0	360
<input checked="" type="checkbox"/> wind_dir90_avg (Wind Speed Average, 0 to 360)	>=		<=		0.0	407.3

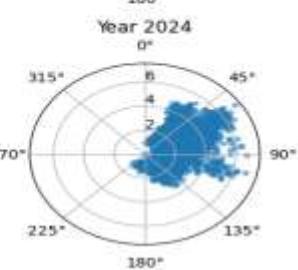
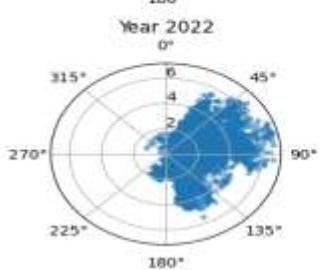
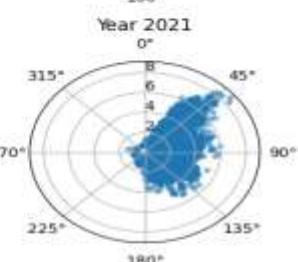
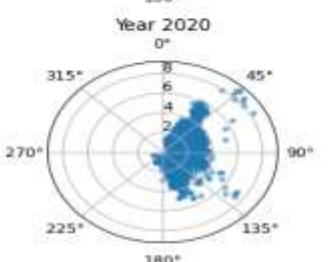
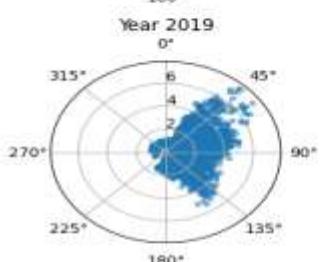
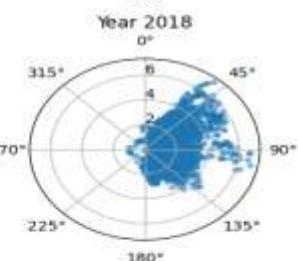
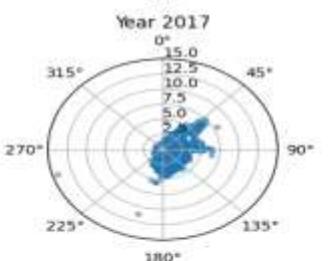
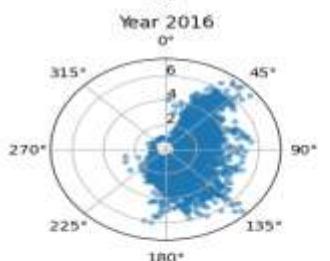
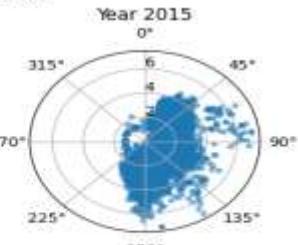
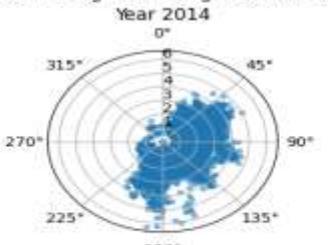
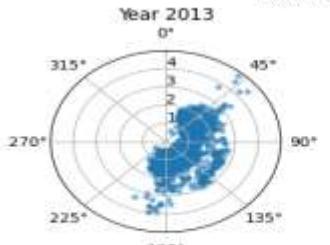
### Monthly Average Sig Wave Elevation Over the Years



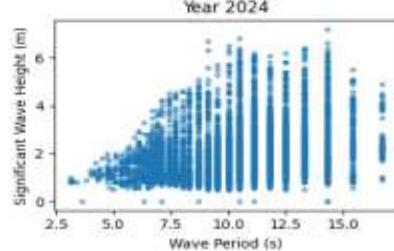
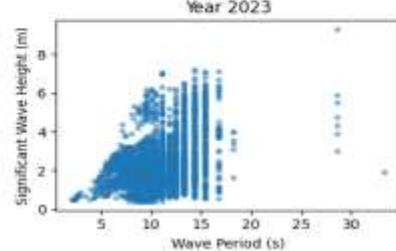
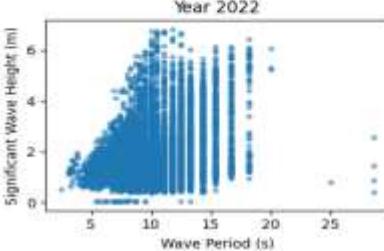
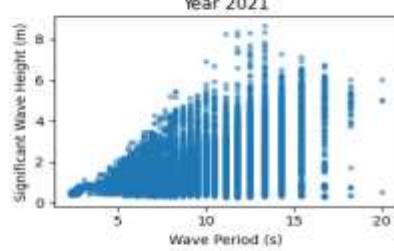
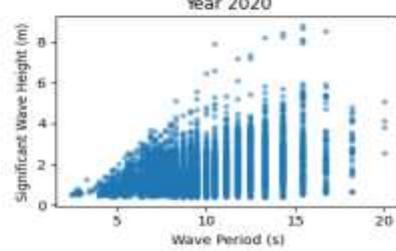
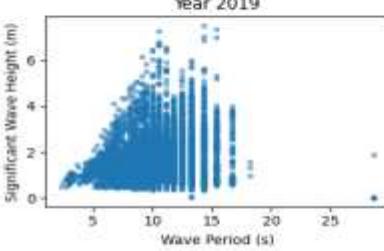
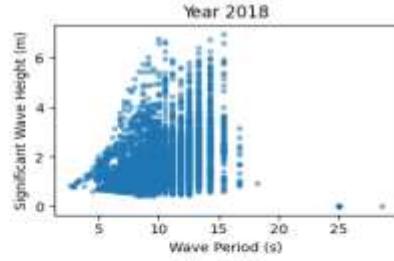
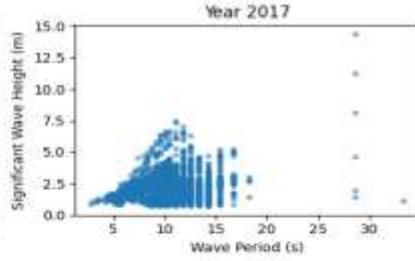
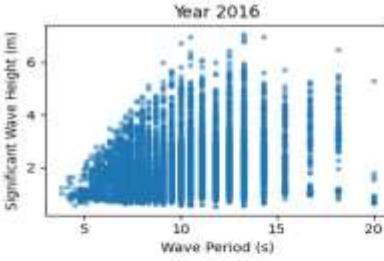
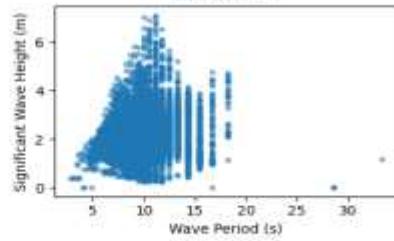
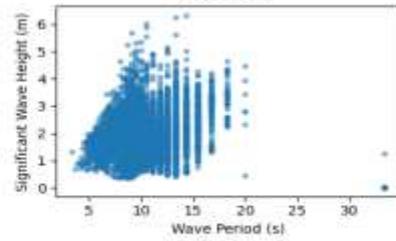
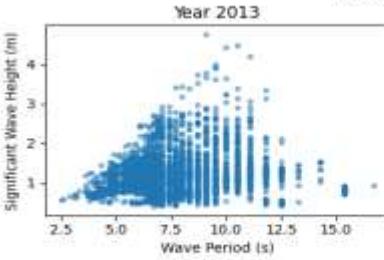
Rose Wave Scatter Plot for Sig Wave Height vs Direction for Year 2022

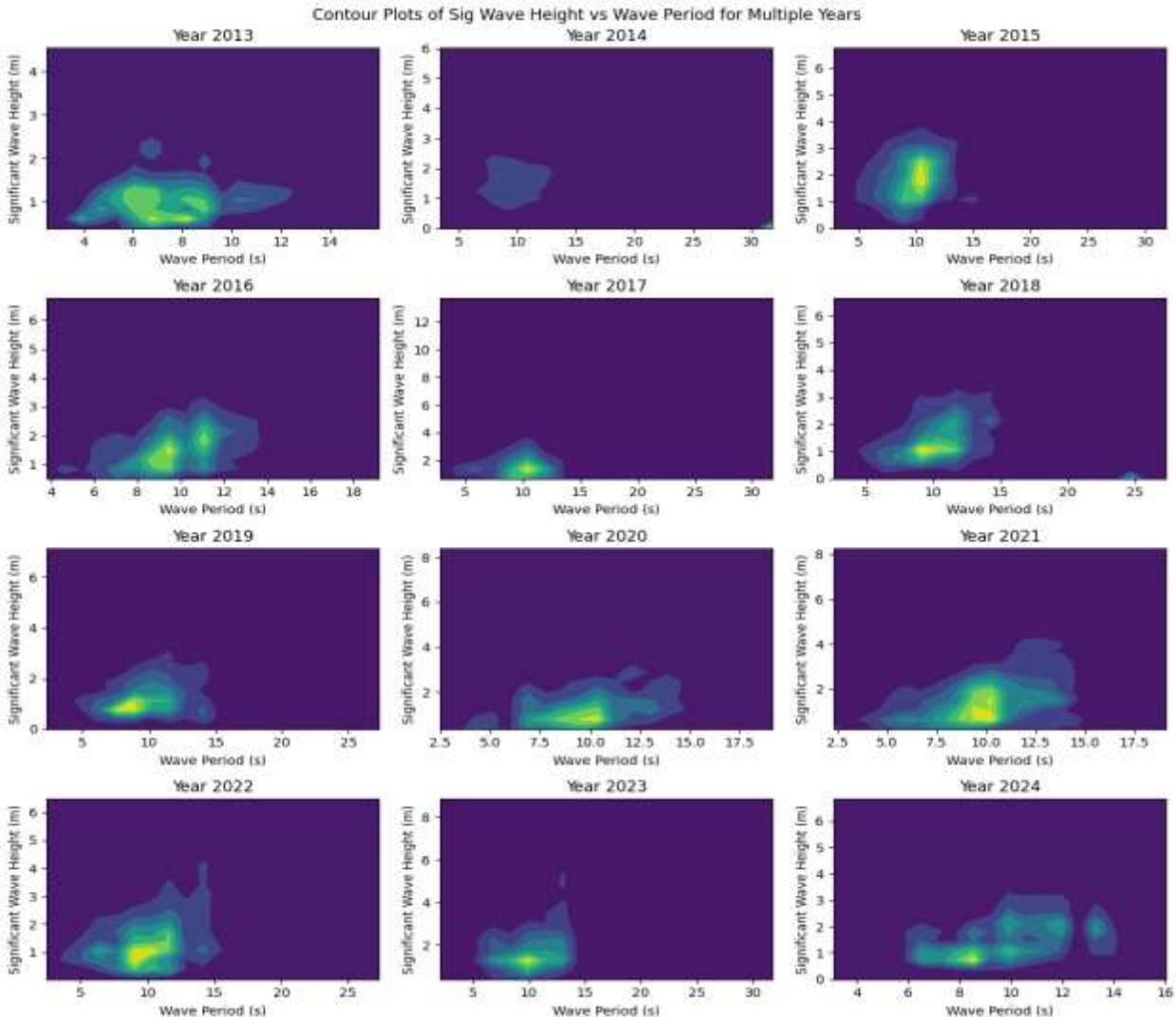


Rose Wave Scatter Plots for Sig Wave Height vs Direction for Multiple Years



## Scatter Plots of Sig Wave Height vs Wave Period for Multiple Years





# MSC 50 North Atlantic Data



Government  
of Canada

Gouvernement  
du Canada

Search Canada.ca

MENU ▾

[Canada.ca](#) › [Open Government Portal](#) › Meteorological Service of...

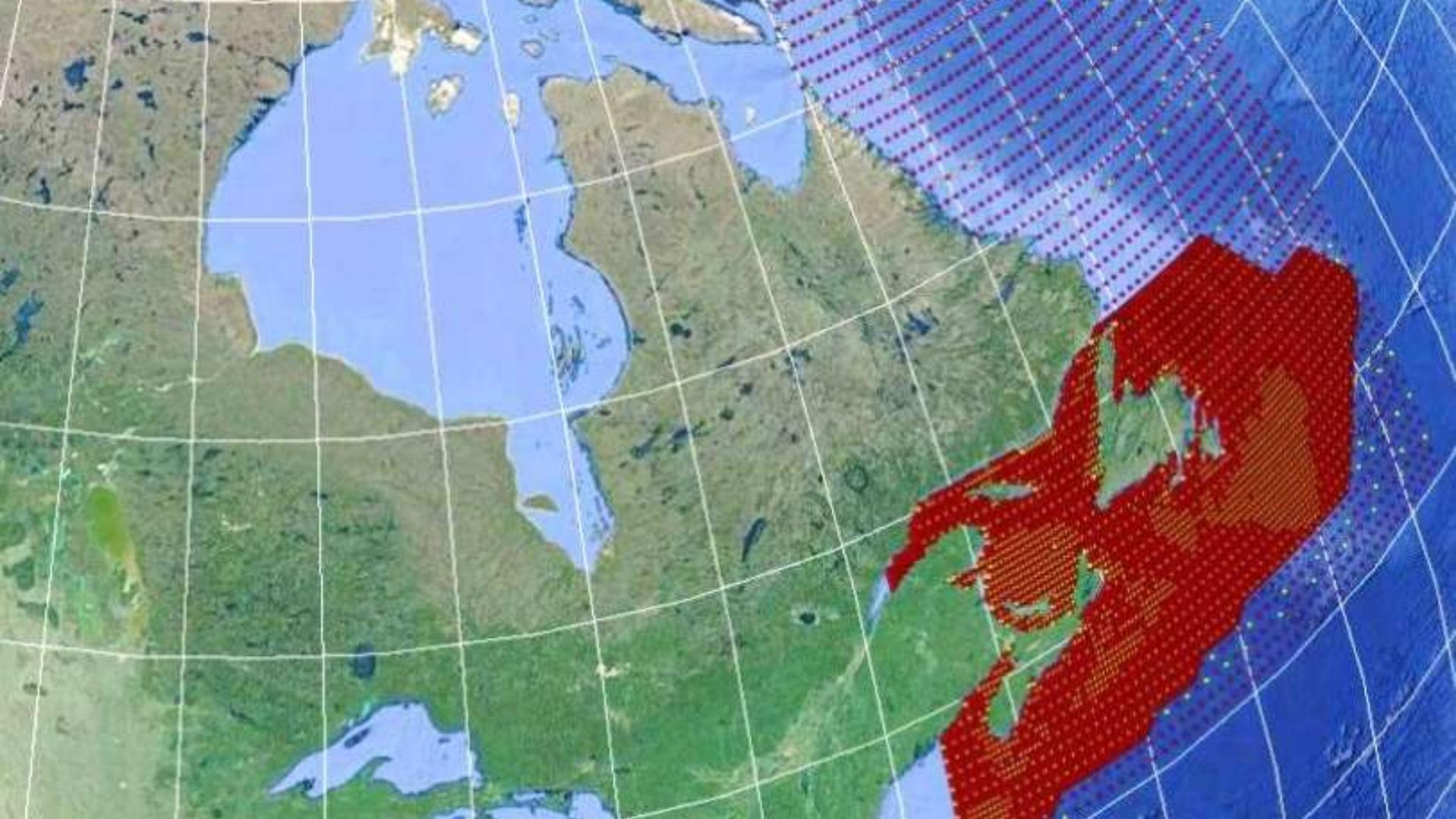
## Meteorological Service of Canada (MSC) 50 North Atlantic W Hindcast

Have your say



[Rate this dataset](#)

This dataset contains 21 statistics of wind and waves calculated from hourly re  
data of historical surface winds and ocean surface waves for the Canadian East  
the period 1954-2018 (each statistic has an annual, 4 seasonal, and 12 monthly



# Index of /public/data-donnees/msc50/atlantic-atlantique/

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[M3010247.zip](#)

[M3010248.zip](#)

[M3010249.zip](#)

[M3010250.zip](#)

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[M3010266.zip](#)

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[M3010268.zip](#)

[M3010269.zip](#)

## Raw Data for all Grid Points

08-Apr-2024 11:34	7924692
08-Apr-2024 11:34	7939699
08-Apr-2024 11:34	7963672
08-Apr-2024 11:35	7980195
08-Apr-2024 11:35	8001861
08-Apr-2024 11:35	8014518
08-Apr-2024 11:36	8037415
08-Apr-2024 11:36	8052007
08-Apr-2024 11:36	8061045
08-Apr-2024 11:37	8068941
08-Apr-2024 11:37	8081392
08-Apr-2024 11:37	8091386
08-Apr-2024 11:37	8093256
08-Apr-2024 11:38	8099566
08-Apr-2024 11:38	8111208
08-Apr-2024 11:38	8114562
08-Apr-2024 11:39	8112438
08-Apr-2024 11:39	8120694
08-Apr-2024 11:39	8121408
08-Apr-2024 11:40	8123481
08-Apr-2024 11:40	8122357
08-Apr-2024 11:40	8128914
08-Apr-2024 11:41	8125464

File Edit Format View Help

Gpt 010247, Lat 40.5000, Long -68.0000, Depth 94.2391

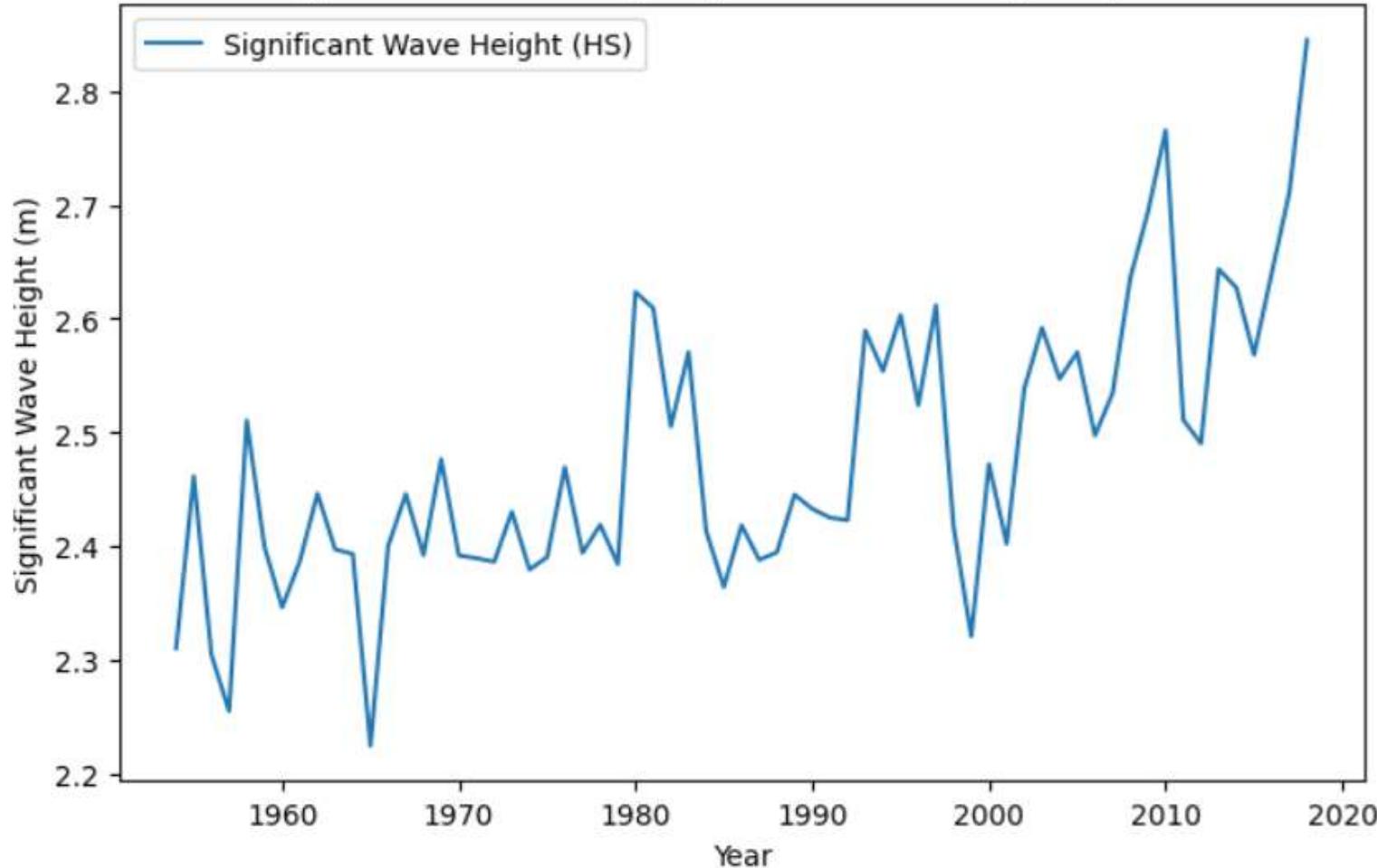
Fields in this time series:

CCYYMM - Century, Year, Month  
DDHHmm - Day, Hour, Minute (ut)  
WD - Wind Direction (deg from which)  
WS - Wind Speed (m/s)  
ETOT - Total Variance of Total Spectrum ( $m^2$ )  
TP - Peak Spectral Period of Total Spectrum (sec)  
VMD - Vector Mean Direction of Total Spectrum (deg to which)  
ETTSea - Total Variance of Primary Partition ( $m^2$ )  
TPSea - Peak Spectral Period of Primary Partition (sec)  
VMDSea - Vector Mean Direction of Primary Partition (deg to which)  
ETTSw - Total Variance of Secondary Partition ( $m^2$ )  
TPSw - Peak Spectral Period of Secondary Partition (sec)  
VMDSw - Vector Mean Direction of Secondary Partition (deg to which)  
M01 - First Spectral Moment of Total Spectrum ( $m^2/s$ )  
M02 - Second Spectral Moment of Total Spectrum ( $m^2/s^2$ )  
HS - Significant Wave Height (m)  
DMDIR - Dominant Direction (deg to which)  
ANGSPR - Angular Spreading Function  
INLINE - In-Line Variance Ratio

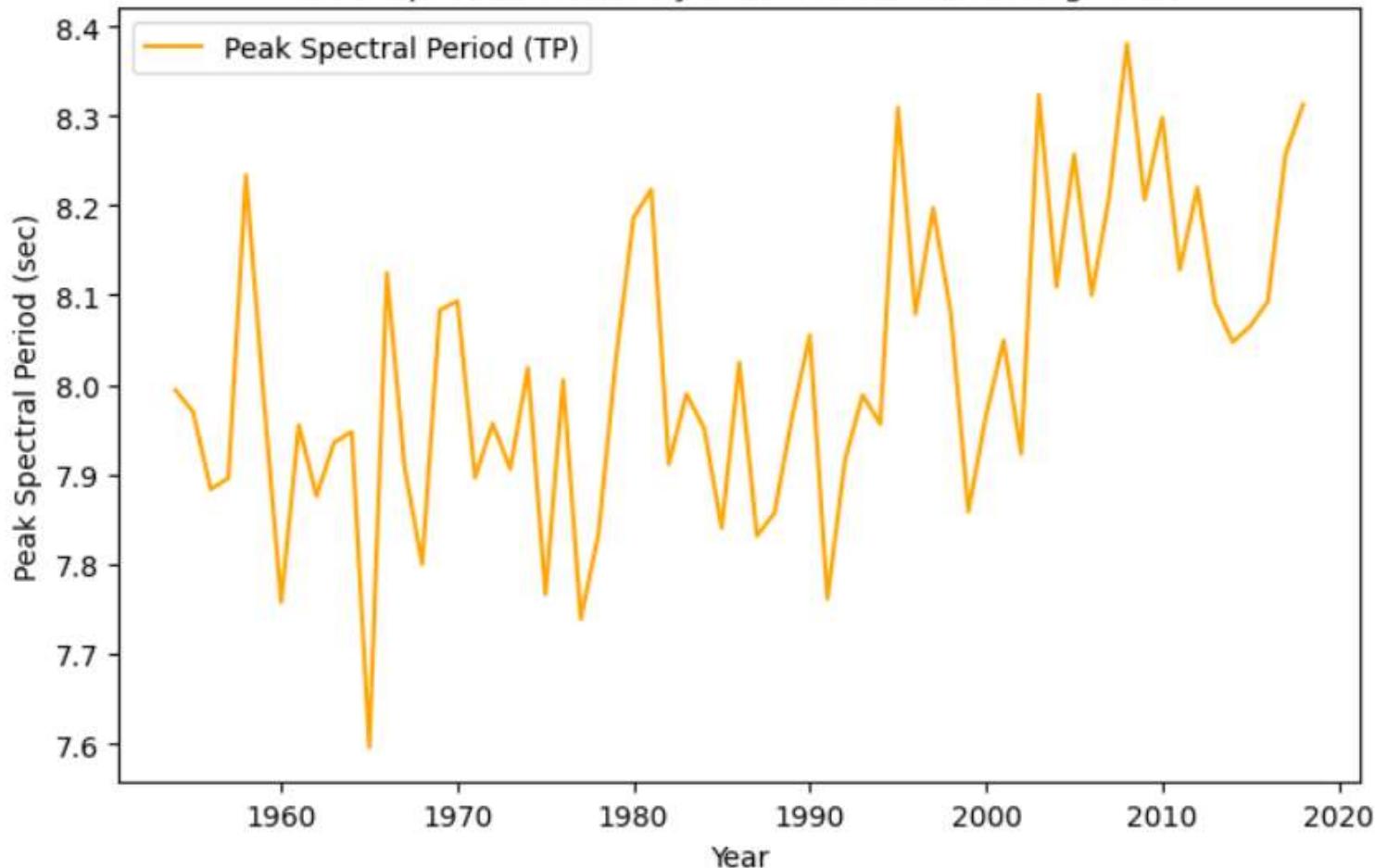
CCYYMM	DDHHmm	WD	WS	ETOT	TP	VMD	ETTSea	TPSea	VMDSea	ETTSw	TPSw	VMDSw	M01	M02	HS	DMDIR	ANGSPR
INLINE																	
195401	010000	294.4	13.58	0.601	7.560	119.2	0.580	7.663	118.5	0.021	7.228	178.6	0.632	0.741	3.101	117.2	0.8346
0.7632																	
195401	010300	304.6	15.64	0.859	8.147	118.6	0.831	8.171	118.5	0.028	8.084	126.3	0.841	0.927	3.707	116.9	0.8444
0.7671																	
195401	010600	312.3	17.71	1.225	8.853	123.6	1.176	8.813	124.4	0.048	8.902	92.2	1.120	1.160	4.427	121.4	0.8354

# Raw Data per Grid Point

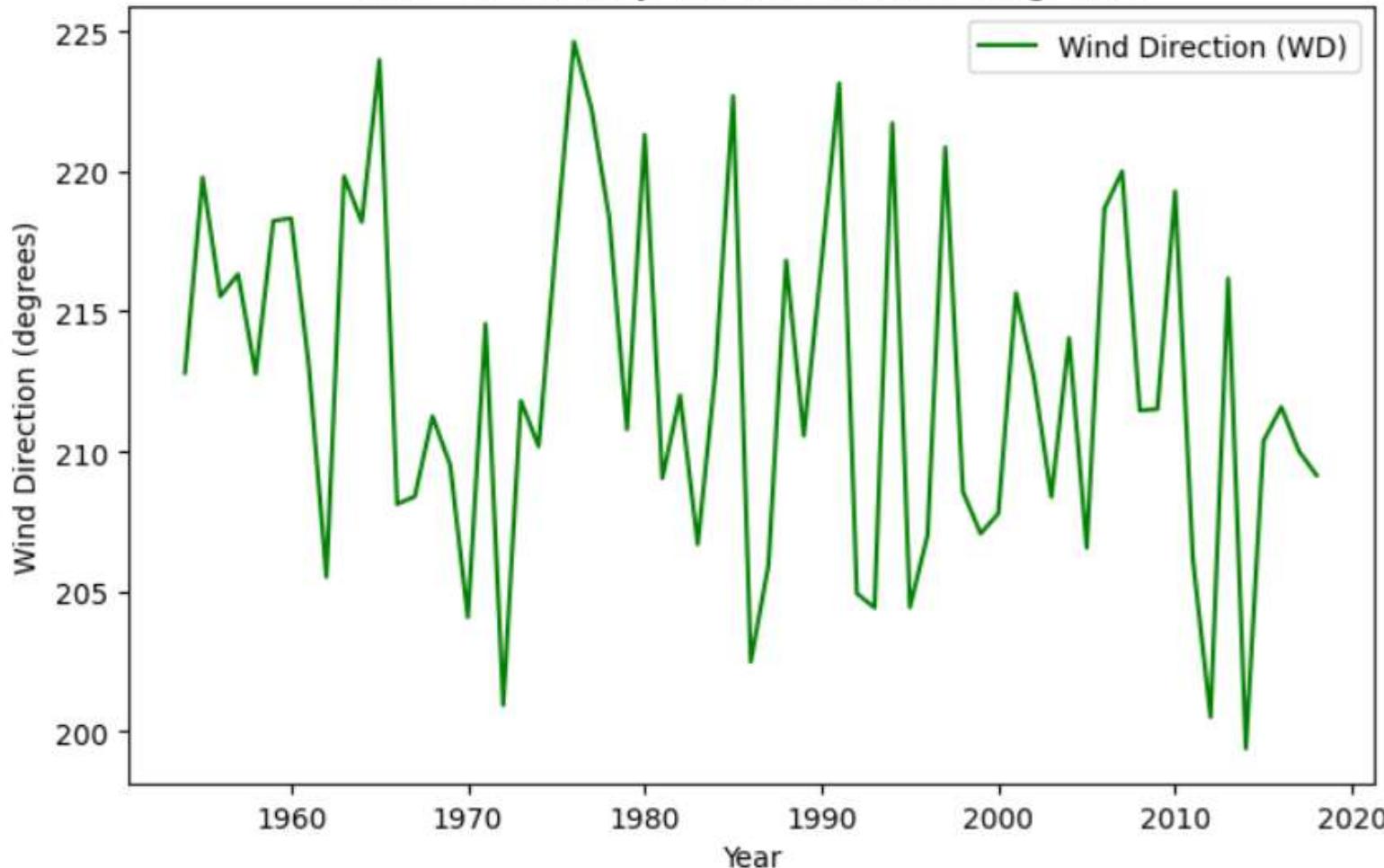
## Significant Wave Height by Year for Lat 40.5, Long -63.5



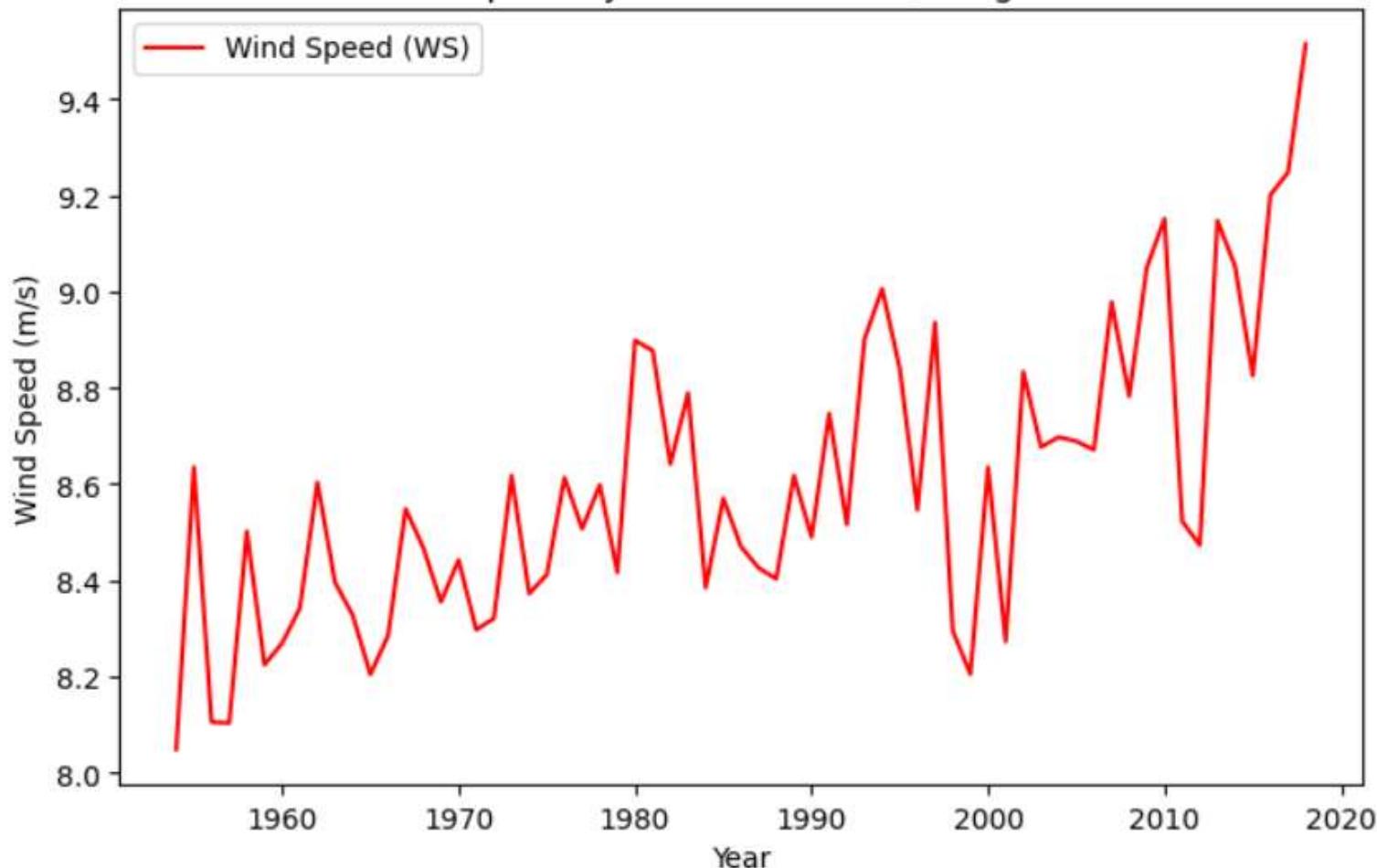
### Peak Spectral Period by Year for Lat 40.5, Long -63.5



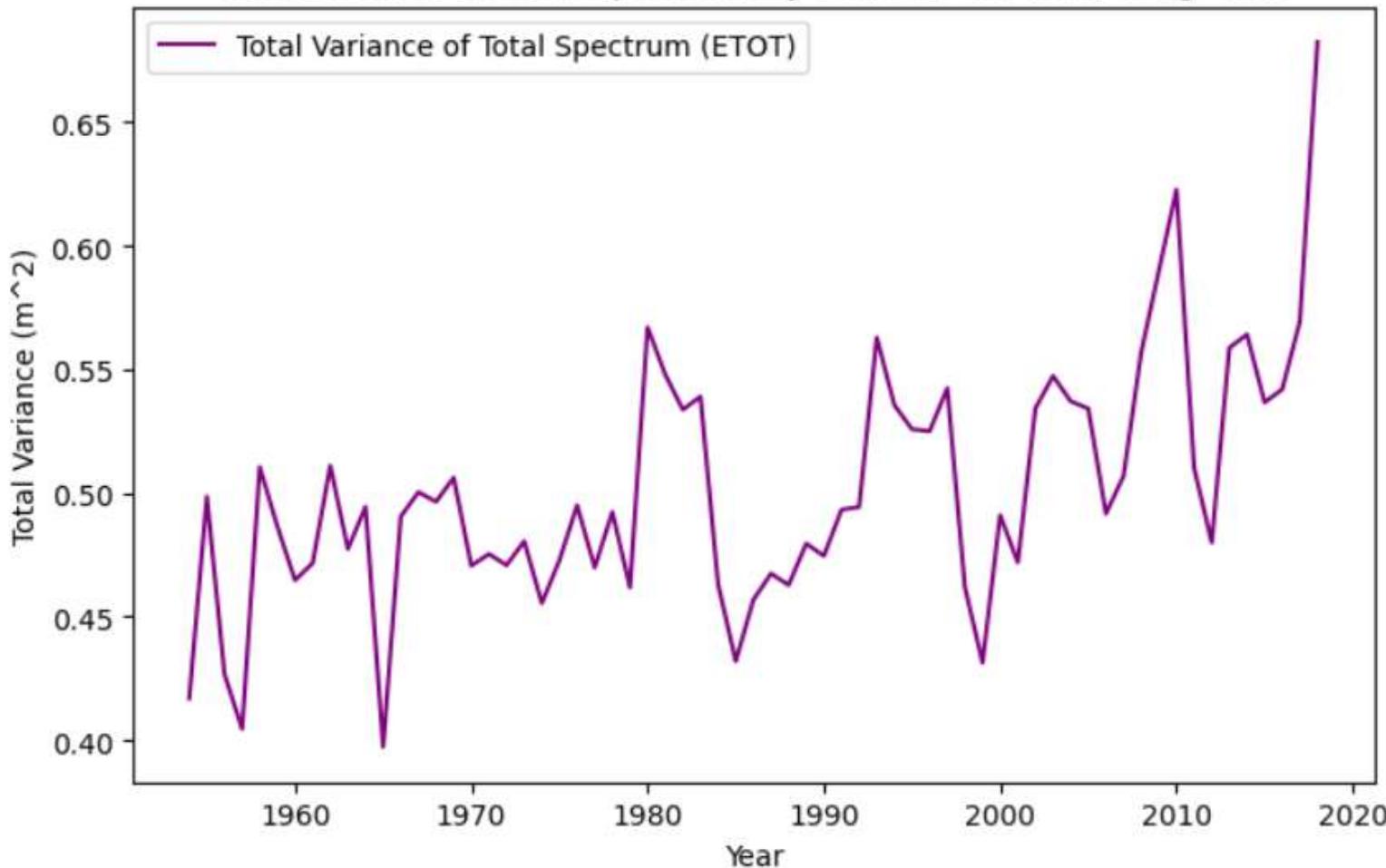
### Wind Direction by Year for Lat 40.5, Long -63.5



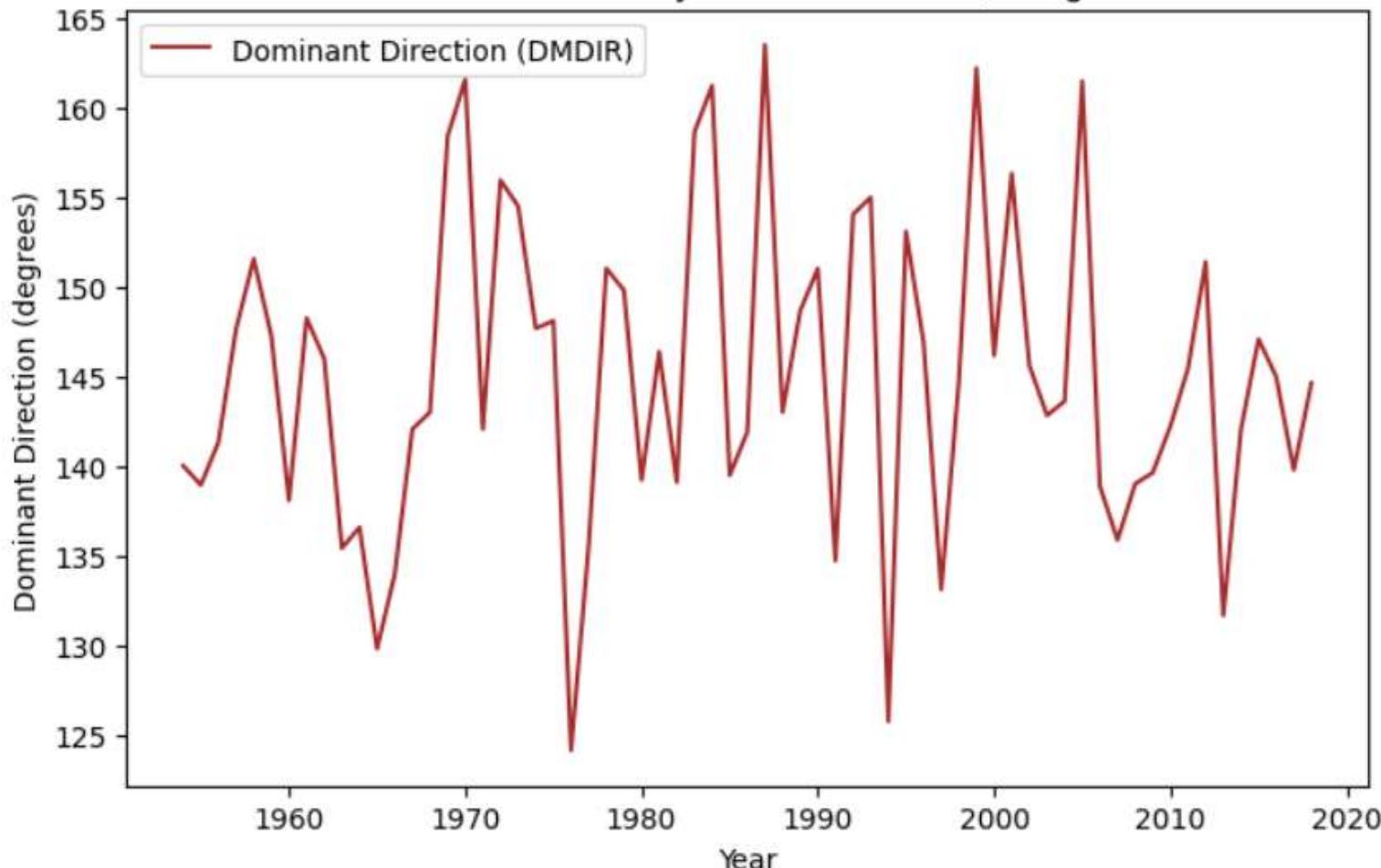
## Wind Speed by Year for Lat 40.5, Long -63.5



## Total Variance of Total Spectrum by Year for Lat 40.5, Long -63.5



Dominant Direction by Year for Lat 40.5, Long -63.5



**Takeaway:**  
**Wave energy converters should  
be able to handle 10-30%  
variability in wind speeds,  
direction, wave elevation**

Does MSC50 data say the same  
thing as SmartAtlantic data?

1 Acquire  
data

2 Prep  
data

3 Cache  
data

4 Plot  
data

# Correlate SmartAtlantic data w/ MSC

## 50 data

### Wave and Wind Data Correlator

Select SmartAtlantic Dataset

Red Island Shoal



Data from : [https://www.smartatlantic.ca/erddap/tabledap/SMA\\_red\\_island\\_shoal.csv?station\\_name%2Ctime%2Clongitude%2Clatitude%2Cprecise lon%2Cprecise lat%2Cwind spd avg%2Cwind spd max%2Cwind dir avg%2Cwind spd2 avg%2Cwind spd2 max%2Cwind dir2 avg%2Cair temp avg%2Cair pressure avg%2Cair humidity avg%2Cair dewpoint avg%2Csurface temp avg%2Cwave ht max%2Cwave ht sig%2Cwave period max%2Cwave dir avg%2Cwave spread avg%2Ccurr dir avg%2Ccurr spd avg&time%3E=2010-07-06T19%3A55%3A00Z&time%3C=2024-08-05T00%3A57%3A00Z](https://www.smartatlantic.ca/erddap/tabledap/SMA_red_island_shoal.csv?station_name%2Ctime%2Clongitude%2Clatitude%2Cprecise lon%2Cprecise lat%2Cwind spd avg%2Cwind spd max%2Cwind dir avg%2Cwind spd2 avg%2Cwind spd2 max%2Cwind dir2 avg%2Cair temp avg%2Cair pressure avg%2Cair humidity avg%2Cair dewpoint avg%2Csurface temp avg%2Cwave ht max%2Cwave ht sig%2Cwave period max%2Cwave dir avg%2Cwave spread avg%2Ccurr dir avg%2Ccurr spd avg&time%3E=2010-07-06T19%3A55%3A00Z&time%3C=2024-08-05T00%3A57%3A00Z)

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