Anticipating Winds on Port Townsend Bay

PTSA March 13, 2024



Wind Speed versus Wind Force

 $\mathbf{F} = \frac{1}{2} \rho C S \mathbf{V}^2$

- F = Wind Force
- V = Wind Speed
- S = area of sail, hull, rig
- C = aerodynamic coefficient
- ρ = air density

10 kt +/- 2.5 kt

- At 7.5 kt, V² = 56.3
- At 12.5 kt, V² = 156.3



Current is "named" for the direction the water is flowing to



(Master) - Point Wilson, 2.7 mi NE of (depth 20 ft), Admiralty Inlet, Washington Current 138° 1.8 kts

(Master) - Point Wilson, 2.7 mi NE of (depth 56 ft), Admiralty Inlet, Washington Current 137° 1.8 kts

(Master) - Point Wilson, 2.7 mi NE of (depth 118 ft), Admiralty Inlet, Washington Current 135° 1.6 kts

18ft

Weather Observations

Conditions at PTWW1 as of (4:30 pm PST on 02/01/2024) 0030 GMT on 02/02/2024:

Unit of Measure: Imperial 🗸

Time Zone: Station Local Time

Select

×

Click on the graph icon in the table below to see a time series plot of the last five days of that observation.

Wind Direction (WDIR):

Wind Speed (WSPD):

Wind Gust (GST):

Atmospheric Pressure (PRES):

🖄 Air Temperature (ATMP):

🖄 Water Temperature (WTMP):

Wind Speed at 10 meters (WSPD10M):

Wind Speed at 20 meters (WSPD20M):

Combined plot of Wind Speed, Gust, and Air Pressure
Water Level

ESE (110 deg true) 15.9 <mark>k</mark>ts

19.0 kts

Wind data from PTWW1 is subject to obstruction by ferries docking at the pier during the daytime hours.

15.5 kts

17.5 kts



Port Townsend Ferry dock

https://www.ndbc.noaa.gov/station page.php?station=ptww1

Weather Observations

Port Townsend Uptown

Current conditions at CW1035 Port Townsend (C1035)

Lat: 48.12516°N Lon: 122.76153°W Elev: 232.0ft.

№ **47°F** 8°C

Humidity 84% Wind Speed SE 11 MPH Barometer 29.86 in (1011.18 mb) Dewpoint 42°F (6°C) Visibility NA Wind Chill 42°F (6°C) Last update 18 Feb 03:07 PM PST

https://forecast.weather.gov/MapClick.php?CityName=Port+Townsend&state= WA&site=SEW&textField1=48.1172&textField2=-122.759&e=0#.U5N-LyjySCc



Weather Observations

Point Wilson Coast Guard Light Station

Port Townsend, WA Weather





https://www.localconditions.com/weather-port-townsendwashington/98368/

Wind Observations

Consider

- Site exposure
- Instrument
 - Installation
 - Calibration
- Representation of your location
- Units: 1 kt = 1.15 mph = 0.51 m/s
- Standardized to 10 meters



NOAA Tides and Currents

Tides

- Predicted based on astronomy
- Observed includes weather affects

NOAA/NOS/CO-OPS Observed Water Levels at 9444900, Port Townsend WA From 2024/02/17 00:00 GMT to 2024/02/18 23:59 GMT



PTWW1

Weather Forecasts – NWS Marine Zone Forecast

Marine Zone Forecast

...GALE WARNING IN EFFECT THROUGH THIS EVENING... ... SMALL CRAFT ADVISORY IN EFFECT THIS EVENING...

Today S wind 25 to 35 kt. Wind waves 4 to 6 ft.

- SW wind 20 to 30 kt becoming SE 5 to 15 kt after midnight. Wind waves 3 to 5 ft subsiding to 2 ft or less after Tonight midnight.
 - S wind 5 to 15 kt rising to 15 to 25 kt in the afternoon. Wind waves 2 ft or less building to 2 to 4 ft in the afternoon. Thu
- S wind 15 to 25 kt rising to 20 to 30 kt after midnight. Wind waves 3 to 5 ft. Thu Night
 - Fri S wind 20 to 30 kt. Wind waves 3 to 5 ft.
- S wind 15 to 25 kt becoming SE to 10 kt after midnight. Wind waves 2 to 4 ft subsiding to 1 ft or less after midnight. Fri Niaht

PZZ173: Waters From

James Island to Point Grenville 10 To 60 NM

47N

- Sat SE wind 10 to 20 kt becoming S to 10 kt. Wind waves 1 to 3 ft subsiding to 1 ft or less.
- S wind to 10 kt. Wind waves 1 ft or less. Sun





https://www.weather.gov/marine/sewmz

Weather Forecasts – Weather Models

What is GRIB? **GRI**dded **B**inary, a file format used to convey data on weather, waves, and currents,



Global Models

Table 7.5-1. Selected Global Model Datasets						
Model	Resolution			Updates every 6h. h0 valid at HH		
	km	nmi	deg	then forecasts every		
GFS	28	15	0.3	1h to h120, 3h to h240, 12h to h384		
GDPS	25	13	0.2	3h to h48, 6h to h96, 12h to h240		
NAVGEM	32	60	1	3h to h48, 6h to h96, 12h to h144		

- GFS U.S. Global Forecast system
- GDPS Canadian Global Deterministic Prediction System
- NAVGEM U.S. Navy Global Environmental Model

U.S. Global Forecast System (GFS)

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0.0

0

Calgar

Phoeni

08

GFS and other Global Scale Models

Advantages

- Freely available
- Covers all waters of the world
- Many parameters (grib2)
- Multiple levels
- Forecast range to 16 days
- Models can be compared
- Supports optimal routing

Disadvantages

- Misrepresents coastal winds
- Underestimates tropical disturbances
- Delay time 6.5 hr from observation
- No human forecaster involved!
- No Highs, Lows, Fronts

Regional Models



		Table	7.5-3.	Select	ed Regional	Datasets		
	Source	R	esolut	ion	Danaa	01	Up-	
		km	nmi deg		Range	Steps	dates	
	HRRR	3	1.6	0.03	18h 36h at HH	1h	1h	
	NAM (conus)	3	1.6	0.03	60h	1h	6h	
	NAM (na)	12	6.5	0.11	84h	1h	6h	
	RAP	11	6.0	0.10	21h	1h	1h	
₹	NBM (conus+)	2.5	1.4	0.02	264h	1h to h36, 3h to h192, 6h to h264	1h	
	NBM (oceanic+)	10	5.4	0.09	264h	3h to h192, 6h to h264	4h	
K	NDFD (conus)	2.5	1.4	0.02	168h	1h to h18, 3h to h48, 6h to h96, 12h to h168	30m	
	NDFD (oceanic)	10	5.4	0.09	120h	3h to h48, 6h to h120	6h	
	HRDPS (upper na)	2.5	1.4	0.02	48h	3h	6h	

GRIB data on grid points



Regional and High Resolution Models

Advantages

- Model grid greatly reduced
- Forecast increments reduced
- Ingests radar, satellite, and other data
- Can be run more frequently

Disadvantages

- Forecast range reduced
- Limited to specific areas
- Delay "initialized" by global models
- File sizes increase quickly

GRIB Viewer Interpolates between Grid Points

On Grid Points



Interpolated



GRIBs vs. Apps

Weather apps

- Easier to use
- More attractive
- Fixed viewing area
- Meteograms
- Target forecast area may be vague
- Weather model may not be obvious
- May not be a marine forecast

GRIBs

- Interpolates between grid points
- Import to nav program
- Overlay on nav chart
- Meteograms
- Simulation
- Routing
- Model comparison (overlays)
- Save GRIBs on your computer
- Control file size (costs)

Weather App vs. GRIB viewer

Windy app

GRIB viewer in nav program





- NDFD Annotated Model
- NWS Seattle input
- 1.3 nm spatial resolution
- 3 hr forecast blocks
- 7 day forecast range
- Multiple variable
- Marine version

"MapClick"

Weather Elements	Weather/Precipitation	Marine Weather			
Temperature (°F)	Rain	Swell Period			
Dewpoint (°F)	Thunder	Swell Hgt/Dir			
Wind Chill (°F)	Snow	Swell 2 Period			
	Freezing Rain	Swell 2 Hgt/Dir			
Surface Wind kt	Sleet	Wind Wave Height			
Sky Cover (%)	Freezing Spray	🗹 Significant Wave Height			
Precipitation Potential (%)	☐ Fog	Freezing Spray			
Relative Humidity (%)					



https://forecast.weather.gov/MapClick.php?CityName=Port+Townsend&state= WA&site=SEW&textField1=48.1172&textField2=-122.759&e=0#.U5N-LyjySCc

Validating Forecasts: NWS Zone & Models

- NWS Marine Zone:
- Observations on-board, ships, buoys, ASCAT
- Models: GRIB data is machine output only!
- Choose the right model scale: spatial and temporal
- Validate model forecast by comparing with
 - Observations on-board, ships, buoys, ASCAT
 - Other models
 - NWS forecasts maps and text

Compare GRIB to Observations

HRRR

Observation

15:00

Wednesday, Jan 31, 18:00 GMT

Gusting to 7.58kn.

Winds:6.41kn. from ESE (109°)

18:00

21:00





Compare GRIB to Observations



Observation

Point Wilson Coast Guard Light Station, WA Weather

Current Weather for Mon Mar 11 2024





Predicting Current

- Only at Current Stations
- 19 yr rolling average

Point Wilson, 1.6 mi. NE of (PUG1624) Depth: 21 feet

LAT/LON: 48.1569° N 122.7260° W

Note: Depth is measured below chart datum.





tidesandcurrents.noaa.gov/map/index.html

Predicting Current

- OFS Salish Sea and Columbia R.
- Surface current
- GRIB format
- Beta not operationally guaranteed
- 0.3 nm spatial resolution
- 1 hr temporal resolution
- Daily update
- Forecast to 48 hr
- Coupled with NAM



When do forecast typically fail?

- Near smaller scale (< few nm) land features
- When pressure gradients are small
- Near cumulus type clouds
- Estimating wind gust *direction*

Weather concepts can help

- Thermally driven winds
- Surface friction and blocking effects of land features
- Cloud circulation
- Atmospheric stability

Temperature Driven Winds

- Land warms and cools faster than water Air is heated and cooled from below
- Warmer air rises, cooler air sinks
- Temperature effects are more clear in light wind May not be forecast

Sea Breeze

Most common land influence on wind

Land warms more rapidly than water

- Air above land rises
 - Cumulus clouds inland
- Cooler air over water flows onshore

Direction veers as wind speed increases

Extends several miles offshore



Anabatic = Upslope

- Land warms with daytime southern exposure
- Land warms air, warm air rises
- Wind builds and veers through afternoon
- Inland Cumulus clouds
- **Enhances Sea Breeze**

Anabatic Winds

31

85

74

85

arsely wooded

Atmospheric Pressure Driven Winds

- High & Low pressure pattern causes wind
- Earth's surface is rough and creates friction
- Friction slows and backs the wind
- Land has more friction than Water, so Wind is slowed and backed over land Wind speeds up and is veered over water

Edge Effect

- Wind veers over water / backs over land
- Veering increases with wind speed
- Port tack lifted near windward shore
- Wind speed over water roughly twice as fast as over land
- **FW** = marine forecast wind



Corner Effect

- Wind backed, slowed over land
- <u>Convergence</u> over water
- Wind maximum downwind of "corner"
- Clouds likely over max wind area



Channeled Winds

Formed by

- steep coastal lands
- single headland
- island passes

Channel determines wind S/D

Maximum speed at channel outlet

40

301



Channeled Winds



Channeled Winds





Channeling + Edge + Corner Effects



Channelingwind max at outlet

╋

Edge Effectwind increases and veers over water





Coastal Cliffs - Onshore



May allow limited near shore calm or light winds Lee shore is a concern

Ripples & Waves are good indicator

Coastal Cliffs – Onshore winds with steep bluff

Coastal Cliffs – Onshore winds with steep bluff lift off the water



Coastal Cliffs - Offshore



Near shore reversal Wind minimum in downdraft Maximum further offshore Ripples & Waves indicate pattern



Wind Shadows & Dirty Air



Steep vs. Flat Shorelines



Anticipating Wind Gusts – Speed, Direction



Anticipating gusts with virtual sounding



m®ion=nwus&pkg=mslp_wind&runtime=2024030618&fh=36

Reading Sea State from Wind & Current

- Waves formed by wind speed, fetch, duration
- Wave speed increases with wind speed
- Waves steepen quickly against current
- Waves decrease slowly with current

Effect of current on wave steepness



Estimating Race Day Weather

- Day 7: GFS, Tide, Current
- Day 5: NWS Marine Zone Forecast
- Day 2: High Resolution Models, Current Model

Race Day:

- NWS Marine Zone Forecast
- High Resolution Models and compare to observations
- Current Model
- GFS Virtual Sounding
- Sky check for convective clouds
- Estimate local terrain effects



Corner Effect - max

Offshore - min

Channeling - max

Channeling

Corner Effect - min

Pain Sino

Onshore - min

Wind Response to Land Affects Worksheet

Day/ Tir Date PS	Time	Forecast	Reach	Land Affect	Wind Response				Your Reach Forecast	
	PST	Wind D/S/G			Wind Speed		Wind Direction		Wind D/S/G	
		-,-,-			More	Less	Veer	Back		
Land Affects Key										
Thermal Affects: land heats / cools faster than water; air flows to warmer surface					Friction Affect: Slows and Backs the Wind					
Sea Breeze (SB)						Edge (E)				
Anabatic (SB+A)					Corner – Port / Starboard (Cp / Cs)					
Land Breeze (LB)					Channeling (Ch)					
Drainage (LB+D)					Coastal Cliffs – Onshore / Offshore (CCOn / CCOff)					
Fall Wind or Cold Air Outflow (CAO)					Dirty Air (DA)					