Weather for Safety at Sea

Stu Friedman



Follow Along Today... at <u>www.colyc.org/weather</u>

<u>Or email:</u> Stufriedman1@gmail.com

Always monitor and heed official warnings by the US Weather Service, Environment Canada and other governmental meteorological services





- Terminology and Dynamics
- Sources of Information
- Your Weather Strategy





Terminology and Dynamics



What Causes Wind - Pressure Gradients





Tighter Gradient = More Wind







Wind Around Fronts







If a person stands with their back to the wind, the air pressure to the left is lower than the pressure to the right.

Stu's amendment – The center of low pressure is over your left shoulder.







Wind Around Fronts Revisited





2018 Mac - Friday







2018 Mac - Saturday







2019 Mac - Saturday







"Bomb Cylone" Dennis



Representing Wind on a Map





"Bomb Cylone" Dennis Winds



ic

SAILING







entire period (hr). must be >25kts



The Beaufort Scale



Force	Speed (mph) (knots)		Description	Specification (sea)	(land)
0	0-1	0-1	Calm	Sea like a mirror	Smoke rises vertically
1	1-3	1-3	Light Air	Ripples, no crests	Smoke drift, but wind vanes do not move
2	4-7	4-6	Light Breeze	Small, short wavelets, Crests do not break, have glassy appearance	Leaves rustle, felt on face, vanes move
3	8-12	7-10	Gentle Breeze	Large wavelets, crests begin to break.	Leaves and small twigs in constant motion.
4	13-18	11-16	Moderate Breeze	Small waves, becoming larger. Frequent white caps.	Dust and loose paper moved, small branches moved.
5	19-24	17-21	Fresh Breeze	Moderate waves, many whitecaps.	Small trees in leaf begin to sway.
6	25-31	22-27	Strong Breeze	Large waves begin to form, extensive white foam crests.	Large branches in motion. Difficulty using umbrellas.
7	32-38	28-33	Near Gale	Sea heaps up and white foam from breaking waves blown in streaks.	Whole trees in motion. Inconvenience felt while walking.
8	39-46	34-40	Gale	Moderately high waves of greater length.	Twigs broken off trees.
9	47-54	41-47	Severe Gale	High waves. Crests of waves begin to topple, tumble, roll over. Spray may affect visibility.	Slight structural damage may occur. Roofing tiles blown off. Ground littered with many small twigs/broken branches.
10	55-63	48-55	Storm	Very high waves with long overhanging crests. Sea surface takes on white appearance.	Small live trees uprooted, structural and vegetative damage.
11	64-72	56-63	Violent Storm	Exceptionally high waves. Small and medium sized ships might be for a time lost to view behind waves.	Large live trees uprooted. Widespread structural damage.
12	72-83	64-71	Hurricane	Air filled with foam and spray. Sea completely white with driving spray.	Severe and extensive damage. Windows broken. Roofs peeled off. Mobile homes overturned.



"Wind Rose" KORD July





	MODELER	DATE
und Speed (m/z)	Sara West	10/25/2002
> 11.D5	DIBPLAY	UNIT
8.49 - 11.06	Wind Speed	m/s
5.40-8.49	AVO. WIND SPEED	CALMININDS
334-5.40	3.93 m/s	5.44%
120-334	O RIENTATIO N	PLOTYEAR-DATE-TIME
051-120	Direction (blowing from)	1961 Jul 1 - Jul 31 Michight - 11 PM

WORK DC Along 1.5 for Colory Contracted of Solarian Lange Solarian contracted and the rest



Cycle of Prevailing Winds in Chicago

- Prevailing S/SW/W
 - Low pressure approaching
 - Often warm and sunny
 - Often brisk and build as low/front approaches.
 - Warm/moist air conducive to storms
- Post frontal northerlies
 - Often start brisk N/NW after front passes
 - Veer NE/E and wane, depending on how fast front moves
 - Dry, stable air prevents storms
- High pressure brings sea breezes.
 - Once low moves off, high pressure and light easterlies set in.
 - Sea breeze builds during the day thru sunset.
 - Occasional "lake breeze convection"

KCGX (Meigs) Winds During July



[CGX] CHICAGO/MEIGS Windrose Plot [Time Domain: Jul,] Period of Record: 01 Jul 2000 - 01 Aug 2011





Sea Breezes



- Caused by differential heating of land mass (low pressure) vs. cooler large body of water (high pressure).
- Conditions favoring sea breezes:
 - Temperature difference > 6 degrees F
 - Weak gradient wind
- Happen most in Chicago in spring/early summer before lake has fully warmed but can and do happen all summer
- Clouds along the shoreline and moving inland on otherwise clear day are good indicators a sea breeze has formed.
- "Zone of convergence" can occur when sea breeze meets (light) gradient
- Can cause "sea breeze fronts" inland which can actually spawn thunderstorms.
- Converging fronts can occur on peninsulas (Florida, Long Island)
- Land breezes can form at night.



Prevailing Winds Elsewhere

Hadley Cells, Bermuda/Pacific Highs and Trade Winds



- Rising air at equator thunderstorms, doldrums
- Air cools and sinks at 30 degrees high pressure zones (Bermuda)
- Coriolis effects bends sinking air into easterly trades.
- Trans-Pac = downwind in easterlies.
- Atlantic crossings route north when going to Europe, south when going to Carib.

Measuring Waves







3 Requirements for Convection



Element	Impact	How to Anticipate
Surface Lifting	Causes air parcels to rise and possibly condense into clouds.	Everything from fronts, geography, outflow from storms, etc.
Moisture	Moist air is lighter and more buoyant than dry air. Moisture enables evaporation and clouds	Warm and humid surface conditions.
Instability	Cold air aloft makes rising parcels more buoyant and cloud tops higher.	CAPE – Convective Available Potential Energy.



CAPE (J/kg)



Magnitude of 0-6km shear vector (kt)

	<20	20 to 35-40	>35-40
<1000	Ordinary	Ordinary or Multicell	Ordinary or Supercell
1000-2500	Ordinary with some Pulse Severe	Multicell	Supercell
>2500	Ordinary with some Pulse Severe	Multicell	Supercell



Single Cell (Pulse) Storms – "Pop Ups"



- Most common during summer
- Sometimes seem "random" or "pop up" – not part of organized front or system
- Typically last 30-60 mins
- Minimal severe threat, except in "pulse storms" when instability is very high but shear is low.
- KEY: Hard to track on radar!





Supercells

- Can last for many hours
- Threats include:
 - tornadoes
 - large hail
- damaging winds
- Often manifest a mesocyclone hook echo.
- KEY: Not hard to track; produce gust front in advance





Squall Lines

- Long line of thunderstorms
- Can be broken or unbroken
- "Bowing" of line often indicates strongest part of squall line damaging straight-line winds
- Gust front leading the line of storms on radar
- Greatest danger for solid line is straight-line wind
- Greatest danger for broken line is tornados





Downdrafts and Macro/Microbursts

- Macro and microbursts caused by severe downdrafts associated with deep, moist, convection.
- Microburst < 4km area; macroburst 4km – 10km
- Not visible on standard doppler – need stormrelative velocity radar (RadarScope app).
- Cause wind in excess of 60 knots.
- Best predictor "DCAPE"





Outflow Boundaries

- Caused by downdraft hitting surface and dispersing out from storm center.
- Can race well out ahead of storms.
- Can cause temporary and dramatic shift in wind and temperature.
- Can cause convection in their own right.
- Often a sign of impending storm.





2019 COLORS Outflow Boundary



Day/Time (UTC/Z)	Speed/Gust	Direction		
4 2019 152 1658 -99.0	1.4 1.7	062 -99.0		
4 2019 152 1700 -99.0	1.7 1.9	051 -99.0		
4 2019 152 1702 -99.0	1.7 1.9	038 -99.0		
4 2019 152 1704 -99.0	2.0 2.5	025 -99.0		
4 2019 152 1706 -99.0	5.2 9.2	005 -99.0		
4 2019 152 1708 -99.0	11.7 14.4	004 -99.0		
4 2019 152 1710 -99.0	10.0 13.6	015 -99.0		
4 2019 152 1712 -99.0	5.8 6.5	031 -99.0		
4 2019 152 1714 -99.0	7.7 9.1	021 -99.0		
4 2019 152 1716 -99.0	13.2 15.6	005 -99.0		
4 2019 152 1718 -99.0	9.0 12.5	013 -99.0		

• Thunderstorm cluster arrived roughly 22Z.





Sources of Information



My Daily Forecasting Approach

- Check current conditions
- Check Skilling or your favorite forecaster see general direction of things.
- Check NOAA 48 hour marine forecast and/or 5 day offshore forecast.
- Read NOAA Area Forecast Discussion.
- Check hazards.
- Assess underlying big picture data



Current Local Observations

NWS Great Lakes Portal

- Hazards, waves, winds, weather



GLERL

- Buoy observations
- Special research products (e.g., Straits of Mackinac currents)



NOAA - Great Lakes Environmental Research Laboratory



Local TV / Radio

- Choose wisely
- Focus on big picture trends major changes in weather, fronts, convection.
- Don't believe the tombstones considerably decreased confidence after each day forward.
- POP chance that any point in the forecast area will receive at least .01 inches of liquid precipitation.
 - Doesn't indicate amount
 - Doesn't necessarily indicate likelihood your location will receive precipitation.







NOAA Marine Forecasts



- Deliberately go out only 48 hours.
- Offshore forecasts go out 5 days.
- Fairly accurate. Reflect local factors such as sea breezes.
- Do not reflect possibility or effect of convection, outflows, downbursts.

LMZ740>742-232215-Winthrop Harbor to Wilmette Harbor-Wilmette Harbor to Northerly Island-Northerly Island to Calumet Harbor-**932 AM CST Sat Feb 23 2019**

GALE WARNING IN EFFECT FROM LATE TONIGHT THROUGH LATE SUNDAY NIGHT

REST OF TODAY

East winds 10 to 20 kt. Patchy fog. Numerous showers and slight chance of thunderstorms. Waves 2 to 4 ft.

TONIGHT

Southeast winds 20 to 25 kt becoming southwest gales to 35 kt after midnight. Patchy fog in the evening. Periods of showers and slight chance of thunderstorms in the evening, then scattered showers after midnight. Waves 3 to 5 ft.

SUNDAY

West gales to 45 kt. A few storm force gusts to 50 kt possible. Scattered rain and snow showers in the morning. Waves 4 to 7 ft occasionally to 9 ft.

SUNDAY NIGHT

West gales to 45 kt diminishing to 30 kt. Partly cloudy. Waves 4 to 7 ft occasionally to 9 ft subsiding to 3 to 5 ft after midnight.



NOAA Area Forecast Discussion

- Google it!
- Updated several times daily. More often during unsettled weather periods.
- Indicates confidence level models in agreement?
- Indicates favored/unfavored locations.
- Lots of jargon and shorthand but still valuable to beginner.

Area Forecast Discussion

Issued by NWS Chicago, IL

<u>Home</u> | **Current Version** | <u>Previous Version</u> | <u>Text Only</u> Versions: **1** <u>2</u> <u>3</u> <u>4</u> <u>5</u> <u>6</u> <u>7</u> <u>8</u> <u>9</u> <u>10</u> <u>11</u> <u>12</u> <u>13</u> <u>14</u> <u>15</u> <u>16</u> <u>17</u> <u>18</u> <u>40</u> <u>41</u> <u>42</u> <u>43</u> <u>44</u> <u>45</u> <u>46</u> <u>47</u> <u>48</u> <u>49</u> <u>50</u>

Precip/snow: As noted before, the precip shield should affect mainly the NW half of the <u>CWA</u> through this morning. Meanwhile, broad <u>WAA</u> will support pockets of light rain across the SE half of the <u>CWA</u>. An arc of significant low-level <u>moisture</u> transport will shift NE across the <u>CWA</u> late this afternoon through this evening. This will support a round of widespread showers, potentially heavy at times across the entire <u>CWA</u>. As the surface low passes NW of the <u>CWA</u> late tonight and a mid-level <u>dry slot</u> crosses all but the NW portion of the <u>CWA</u>,



Local Hazards



NWS Hazardous Weather Outlook

E FORECAST	PAST WEATHER	SAFETY	INFORMATION	EDUCATION	NEWS	SEARCH	ABOUT
forecast by St" or ZIP code location Go ion Help	News Headlines • Winter and February 2011 • February 28 Tornadoes (1 • NWS Chicago Doppler R: 2017 Spotter Training Ca	7 Climate Summa Updated March 3) adar Out of Servic	ry: T)p 5 Warmest	February in Chicago	and Rockford		
RECAST o O'Hare tional Airport IL	Toxt Broducts	Products					Chicago Weather Forecast
Cu	rrent Hazards Cur	ren.	dar Forecaste	Pivers and Lakes	Climate and Past	Weather I	ocal Programs
Cloudy Cloudy C C C C C C C C C C C C C C C C C C C	Ea Forecast Discuss izardous Weather Or ne Forecast Issued: nois Hourly Weather iana Hourly Weather Lake Michigan Water Tomp Beach Forecast Chicago Metro Forecast	ion Iss 04/201 03/04/2 103/0 sued: 03 Sur Issued: 0 red: 03/04/2017 Issued: 03/04/2017	17 05:03:59 AM CS 2017 03:03:54 AM AM CST v04/2017 10:03:56 3/04/2017 09:03:3 08:03:39 AM CST 017 09:03:51 AM 0 03/04/2017 09:03:	ST CST AM CST 4 AM CST CST 26 AM CST			
Cloudy H*F	Tomado Warning Issued: C Severe Thunderstorm Warr Flood Warning Issued: C3M Flash Flood Warning Flash Flood Statement Severe Weather Statement Special Marine Warning Is Marine Weather Statement Local Storm Report Issued	12/28/2017 06:02: ing Issued: 03/0 11/2017 12:03:52 Issued: 03/01/2(Issued: 03/01/2(Issued: 03/02/2) Issued: 03/01/2(Issued: 03/	52 PM CST 11/2017 12:03:15 A 2 AM CST 017 12:03:40 AM C 017 08:03:41 AM C 10:02:59 PM CST 017 12:03:29 AM C 03:07 AM CST	M CST ST ST			
change location	Other Watch/	Warning	Advisory	1			
	Non-Precipitation Headlines Winter Weather Headlines	2					

OHare Daily Climate Summary Issued: 03/04/2017 12:03:29 AM CST Rockford Daily Climate Summary Issued: 03/04/2017 12:03:29 AM CST Aurora Daily Climate Summary Issued: 03/04/2017 12:03:25 AM CST DuPage Arport Climate Summary Issued: 03/04/2017 12:03:28 AM CST Chciago Executive Airport Climate Summary Issued: 03/04/2017 12:03:35 AM CST Valoaraiso Climate Summary Issued: 03/04/2017 12:03:35 AM CST

NWS Storm Prediction Center



SPC MCD #1319



A Note on Paid Weather Sources

- Various forms
 - "Pro" versions of websites and apps
 - Race weather routers
 - Passage-making routers
- All data based on core government models. Some interpolate or extrapolate withing time periods
- Race-routers can be valuable, particularly if you don't run expedition or get real time data.
- Passage-making routers essential for longer offshore voyages out of radio range.
- With all pay attention to big picture. Don't obsess over minute details of forecast.



So many models....

- Global dynamic models (GFS, ECMWF, IKON, UKMET)
- "Mesoscale" models (NAM, HRRR)
- Lots of other models and they often don't agree.

So what's a sailor to do?

- Trust NOAA more than raw data! They know model biases and local factors
- Focus on model agreement When models agree, they're probably right. When they disagree....
- Focus on evolution. If forecast for Saturday changes from Wednesday's to Thursday's run, have less confidence in either.
- Ensemble models are valuable but by definition, "average".



Safety at Sea Weather Presentation

Using a Sat Phone

- Nearly complete coverage on Lakes.
- •Low bandwidth; expensive data plans
- Require some practice.
- Learn model update schedule
- Iridium Go Wifi hotspot, interfaces with tablet wind apps.







NOAA Weather Radio

- Great source of forecasts and hazards.
- Available everywhere on the Lake
- Know your zones
- Know your channels
- Know how to operate your radio

NOAA We	ather Radio Frequencies				
162.400 MHz	(WX2)				
162.425 MHz	(WX4)				
162.450 MHz	(WX5)				
162.475 MHz	(WX3)				
162.500 MHz	(WX6)				
162.525 MHz	(WX7)				
162.550 MHz	(WX1)				
Channel numbers, e.g. (WX1, WX2) etc. have no special significance but are often designated this way in consumer equipment. Other channel numbering schemes are also prevalent.					

NWR Coverage

Station Listing County Coverage Listing Back to US Map

Upper Michigan WZ2513 Copper Harb Ontario WXK73 WZ2515 Houghtor Grand Marai Michigan KIG74 WNG576 KZZ78 KIG 66 WZ2514_ Newbern Ashland Munising Marguette KJY76 WNG683 Crystal Fall WNG684 KZZ35 WNG 572 KIG83 Wisconsin Alpena -WNG 553 Wausaukee WXN69 Sister Bay WWF70 **KXI33** Gavlord West Branch KIH22 kzz33_ -KIH29 raverse City Mount Pleasant Flint Legend Oceans, Lakes and Rivers Coverage Area Not Covered Canada







Sirius XM Weather

- Satellite based complete coverage on Great Lakes
- Good big picture, simulated radar
- Interfaces to MFD
- Expensive
- Hardware
- Service







Your Boat's Radar

- Limited in range
- Adjust gain
- Adjust rain and sea clutter
- MARPA poor man's AIS (if a poor man could afford radar)







Your Weather Strategy



Keeping a Weather Log



	B	Boat Wind		Pressure		Cloud	Sea			
Time	Speed	Course	Dir	Speed	Gust	Reading	Tendency	Cover	State	Remarks

- Log your observations every 4 hours or whenever there are apparent changes to conditions
- Great for tracking changes in wind speed and direction, particularly between watches
- Keep an eye on pressure tendency and cloud cover



Learning More

Online Learning

- Penn State Certificate Program
- UCAR Met Ed
- Theweatherprediction.com

Books

<u>The Weather Book – USA</u> <u>Today</u>

- Simple, easy intro

<u>Ahearns, Meteorology Today</u> - Good intro college level text

<u>Burch, Modern Marine Weather</u> - Best comprehensive text for sailors





This presentation is available for download and at <u>www.colyc.org/weather</u>

<u>Or email:</u> <u>Stufriedman1@gmail.com</u>

Always monitor and heed official warnings by the US Weather Service, Environment Canada and other governmental meteorological services





Supplemental Materials



Distance Race/Passage-making Routine





Fronts





Cold Front

- Cold air approaching
- Wind shift to W/NW and eventually N/NE
- Source of lift, can lead to severe storms



Warm Front

- Cold air retreating
- Wind shift to SW
- Often cloudy, wet



Stationary Front

- Neither air mass moving
- Light wind
- Fog? Stratus precipitation?

•

Occluded Front

- Cold front caught up to warm front
- Signals beginning of end of the Low
- Heavy precipitation



Last Months's 200+ Knot Jet Stream









Factor	Impact
Wind	Causes disturbances on the surface.
Fetch	The longer distance the wind blows out of the same direction, the higher the waves can build.
Time	The longer time the wind blows out of the same direction, the higher the waves can build.
Depth	Depth at which breakers will form / safe water depth = 2.5 x (maximum forecast swell + wind-wave height)



Multicell Storm

- Most common spring through early autumn
- Can last hours to more than a day
- Appear often as lines but not as consistent as squall lines (and more sporadic).





Great Weather Geek Sources

- NWS Weather Prediction Center surface forecasts
- Pivotalweather.com/Tropicaltidbits.com Model data
- Penn State E-Wall Everything!
- NCEP Model Analysis and Guidance



- Almost all based on some model output choose your preferred app based on interface.
- Good indicator of storm speed and direction.
- Base vs. Composite reflectivity.
- Doesn't always reflect storm formation.
- Can also be used to assess wind speed and direction
- Accuracy decreases over time.
- Geek it out with RadarScope.

