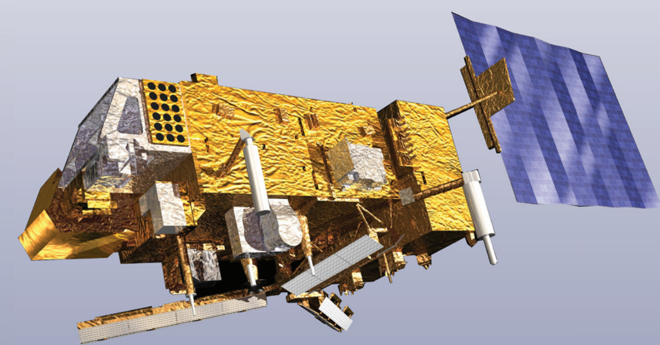
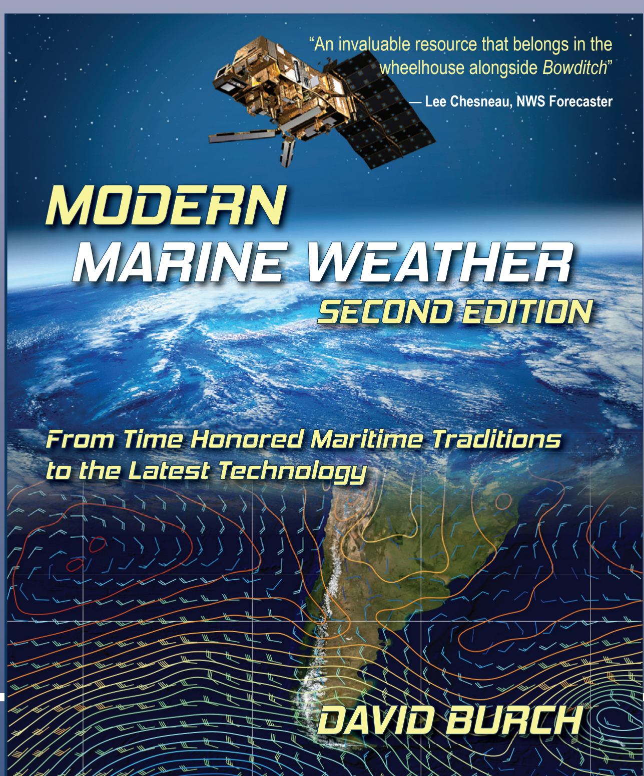
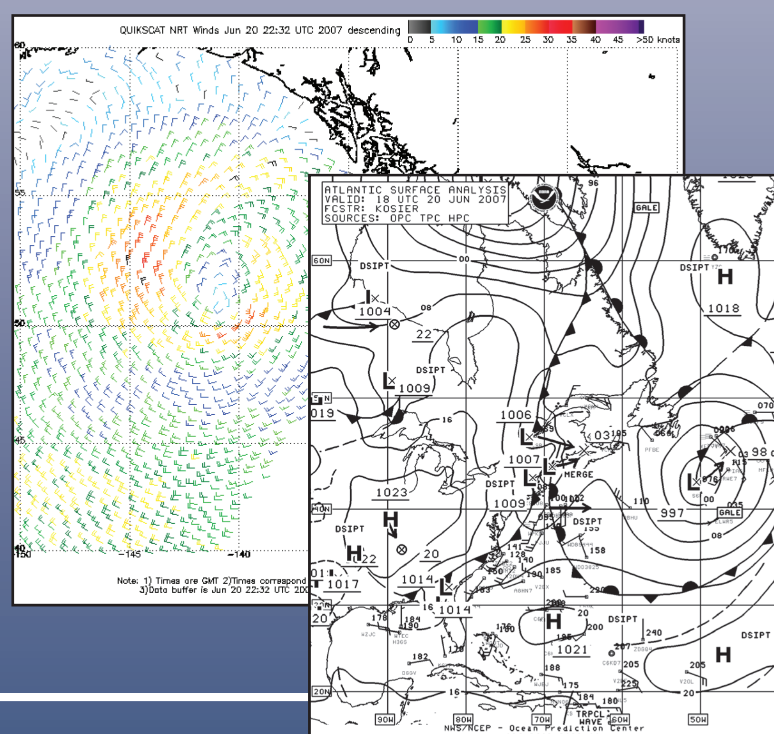
WEATHER WORKBOOK



Questions, Answers and Resources on Marine Weather





Designed to accompany
Modern Marine Weather
by David Burch

Weather Workbook

— Questions, Answers, and Resources on Marine Weather

by
David Burch

STARPATH®
Seattle, Washington

Table of Contents

Resources

Foreword

This workbook is intended to supplement the text *Modern Marine Weather* with practice questions and convenient resources. All answers are provided. The Lesson structure here matches the chapter structure in the textbook. The Points to Ponder are short essay questions. Review the background reading to formulate your understanding of these points, as if you were preparing to explain the concepts to a friend. Strive to distill your thoughts to two or three key sentences or phrases.

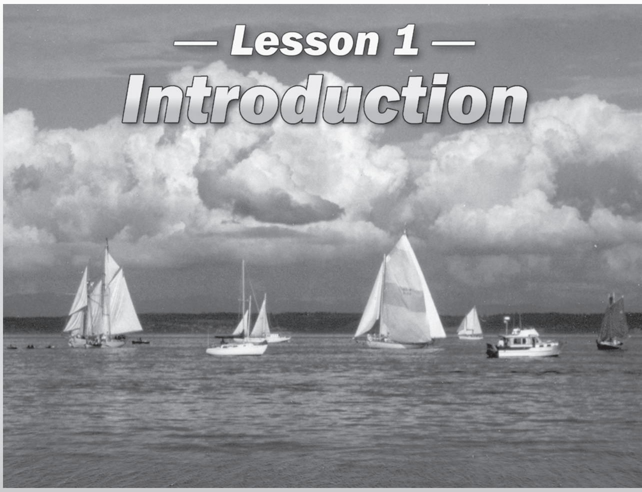
The workbook can be used in a classroom setting or for follow-up study after a classroom course is over, or it can be used for individual study if a classroom course is not available. The practice questions are intended to emphasize practical matters of the topics and to generate further discussion.

All questions assume observations within the Northern Hemisphere unless specifically marked otherwise. Questions or comments on the Workbook content or contact with the author can be made at www.starpath.com/weatherbook. We welcome your questions. We are standing by to help support your weather training program in any way we can.

Acknowledgements

Daniel Cline, Dr. Luis Soltero, Dr. Christoph Winter, and Larry Brandt provided helpful suggestions that have improved this Workbook. Thanks very much to each of you. And a special thanks to Jonathan Taylor who provided an in-depth review of the book. Tobias Burch did the text and cover graphics as well as the book design and layout. His excellent work and collaboration is, as always, very much appreciated.

October, 2012



Terms and Concepts

- Veering, backing
- Wind names, symbols
- Marine Weather Services Charts
- Ocean Prediction Center
- National Data Buoy Center
- National Hurricane Center

Lesson Goals

- Understand the role of marine weather study in our overall sailing program
- Understand the sensible elements of marine weather and how they are related
- Appreciate the role of wind forecasting and get started on wind terminology
- Make units conversions for speeds, distances, temperatures, and pressures
- Get started on using the three main Internet sources and Marine Weather Services Charts

Lesson 1 Questions

1.1 The wind is from 270 and then it shifts to 260.

- ❑ (A) The wind has veered.
- ❑ (B) The wind has clocked.
- ❑ (C) The wind has backed.
- ❑ (D) Cannot answer without knowing if we are in Northern Hemisphere or Southern Hemisphere.

1.2 A weather map shows a wind report arrow with two feathers, one long one and one short one. What wind speed does this represent?

- ❑ (A) 14 kts
- ❑ (B) 15 kts
- ❑ (C) 16 kts
- ❑ (D) Could be any of the above.

1.3 An East wind could be a sea breeze just off the coast of which state?

- ❑ (A) California
- ❑ (B) North Carolina
- ❑ (C) Could be either one
- ❑ (D) Depends on the time of day

1.4 What is the most important factor in the practical application of marine weather analysis?

- ❑ (A) Quality of shipboard instruments for verifying broadcast data
- ❑ (B) Knowing the basics of weather, so you can make a sound interpretation of the broadcast data
- ❑ (C) Ability to read as much as possible from the conditions you observe
- ❑ (D) How fast your boat is

1.5 For a sailor dependent on the wind for propulsion, knowledge of marine weather in ocean voyaging is used most often and is of most value for ?

- ❑ (A) Predicting encounters with storms underway and avoiding them if possible
- ❑ (B) Planning the best time and route to make a particular voyage
- ❑ (C) Evaluating weather patterns that do not show up in forecasts
- ❑ (D) Setting the best course underway to keep or meet favorable winds as the voyage proceeds

1.6 The publication that lists all weather sources and broadcast schedules in a particular region of US waters including the definitions of the forecast zones is called?

- ❑ (A) Coast Pilot
- ❑ (B) Pilot Chart
- ❑ (C) Marine Weather Services Chart
- ❑ (D) Sailing Directions

1.7 When the wind increases from 10 kts to 20 kts, the force of the wind increases by a factor of what?

❑ (A) 1/2 ❑ (B) 2

❑ (C) 4 ❑ (D) 16

1.8 List the names of the three components (centers) of the National Weather Service that provide the primary information about marine weather. They each have individual web sites and they each offer a unique and crucial aspect of marine weather.

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1.9 Which of the following sets of conversions has an error in it?

- ❑ (A) 984.7 mb = 29.08 inches of Mercury
- ❑ (B) 54° F = 14.5° C
- ❑ (C) 5,450 meters = 17,881 feet
- ❑ (D) 17 nautical miles per day = 0.71 knots

Lesson 1. Introduction — Points to Ponder

1. Briefly discuss why the main challenge of marine weather is usually finding more wind than avoiding too much wind.

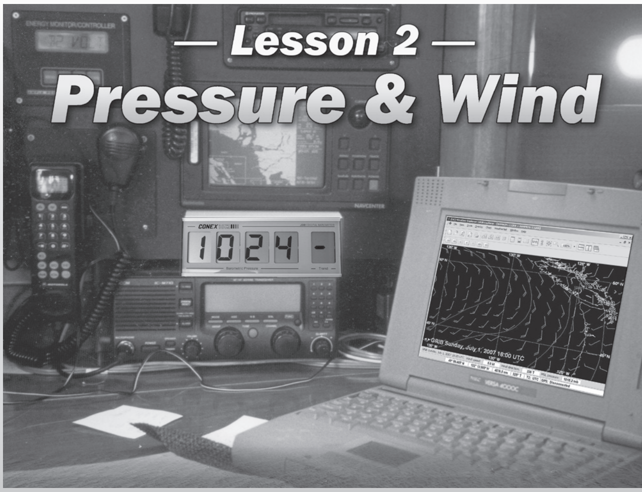
2. Briefly discuss the relationship between onboard observations of conditions around you and the forecasts you receive onboard from weather bureaus.

3. What are Marine Weather Services Charts (MSC) and where do you get them?

4. Discuss the distinctions between Synopsis, Forecast, and Observations heard on the VHF radio and other weather reports.

R1. Inches of Mercury/Millibar Conversion

Inches of Mercury to Millibar Conversion Table													
in	mb	in	mb	in	mb	in	mb	in	mb	in	mb	in	mb
28.40	961.8	28.81	975.7	29.22	989.5	29.63	1003.4	30.04	1017.3	30.45	1031.2	30.86	1045.1
28.41	962.1	28.82	976.0	29.23	989.9	29.64	1003.8	30.05	1017.7	30.46	1031.5	30.87	1045.4
28.42	962.5	28.83	976.3	29.24	990.2	29.65	1004.1	30.06	1018.0	30.47	1031.9	30.88	1045.8
28.43	962.8	28.84	976.7	29.25	990.6	29.66	1004.4	30.07	1018.3	30.48	1032.2	30.89	1046.1
28.44	963.1	28.85	977.0	29.26	990.9	29.67	1004.8	30.08	1018.7	30.49	1032.6	30.90	1046.4
28.45	963.5	28.86	977.4	29.27	991.2	29.68	1005.1	30.09	1019.0	30.50	1032.9	30.91	1046.8
28.46	963.8	28.87	977.7	29.28	991.6	29.69	1005.5	30.10	1019.3	30.51	1033.2	30.92	1047.1
28.47	964.1	28.88	978.0	29.29	991.9	29.70	1005.8	30.11	1019.7	30.52	1033.6	30.93	1047.5
28.48	964.5	28.89	978.4	29.30	992.3	29.71	1006.1	30.12	1020.0	30.53	1033.9	30.94	1047.8
28.49	964.8	28.90	978.7	29.31	992.6	29.72	1006.5	30.13	1020.4	30.54	1034.2	30.95	1048.1
28.50	965.2	28.91	979.0	29.32	992.9	29.73	1006.8	30.14	1020.7	30.55	1034.6	30.96	1048.5
28.51	965.5	28.92	979.4	29.33	993.3	29.74	1007.2	30.15	1021.0	30.56	1034.9	30.97	1048.8
28.52	965.8	28.93	979.7	29.34	993.6	29.75	1007.5	30.16	1021.4	30.57	1035.3	30.98	1049.1
28.53	966.2	28.94	980.1	29.35	993.9	29.76	1007.8	30.17	1021.7	30.58	1035.6	30.99	1049.5
28.54	966.5	28.95	980.4	29.36	994.3	29.77	1008.2	30.18	1022.1	30.59	1035.9	31.00	1049.8
28.55	966.9	28.96	980.7	29.37	994.6	29.78	1008.5	30.19	1022.4	30.60	1036.3	31.01	1050.2
28.56	967.2	28.97	981.1	29.38	995.0	29.79	1008.8	30.20	1022.7	30.61	1036.6	31.02	1050.5
28.57	967.5	28.98	981.4	29.39	995.3	29.80	1009.2	30.21	1023.1	30.62	1037.0	31.03	1050.8
28.58	967.9	28.99	981.8	29.40	995.6	29.81	1009.5	30.22	1023.4	30.63	1037.3	31.04	1051.2
28.59	968.2	29.00	982.1	29.41	996.0	29.82	1009.9	30.23	1023.7	30.64	1037.6	31.05	1051.5
28.60	968.5	29.01	982.4	29.42	996.3	29.83	1010.2	30.24	1024.1	30.65	1038.0	31.06	1051.9
28.61	968.9	29.02	982.8	29.43	996.7	29.84	1010.5	30.25	1024.4	30.66	1038.3	31.07	1052.2
28.62	969.2	29.03	983.1	29.44	997.0	29.85	1010.9	30.26	1024.8	30.67	1038.6	31.08	1052.5
28.63	969.6	29.04	983.4	29.45	997.3	29.86	1011.2	30.27	1025.1	30.68	1039.0	31.09	1052.9
28.64	969.9	29.05	983.8	29.46	997.7	29.87	1011.6	30.28	1025.4	30.69	1039.3	31.10	1053.2
28.65	970.2	29.06	984.1	29.47	998.0	29.88	1011.9	30.29	1025.8	30.70	1039.7	31.11	1053.5
28.66	970.6	29.07	984.5	29.48	998.3	29.89	1012.2	30.30	1026.1	30.71	1040.0	31.12	1053.9
28.67	970.9	29.08	984.8	29.49	998.7	29.90	1012.6	30.31	1026.5	30.72	1040.3	31.13	1054.2
28.68	971.3	29.09	985.1	29.50	999.0	29.91	1012.9	30.32	1026.8	30.73	1040.7	31.14	1054.6
28.69	971.6	29.10	985.5	29.51	999.4	29.92	1013.2	30.33	1027.1	30.74	1041.0	31.15	1054.9
28.70	971.9	29.11	985.8	29.52	999.7	29.93	1013.6	30.34	1027.5	30.75	1041.4	31.16	1055.2
28.71	972.3	29.12	986.2	29.53	1000.0	29.94	1013.9	30.35	1027.8	30.76	1041.7	31.17	1055.6
28.72	972.6	29.13	986.5	29.54	1000.4	29.95	1014.3	30.36	1028.2	30.77	1042.0	31.18	1055.9
28.73	973.0	29.14	986.8	29.55	1000.7	29.96	1014.6	30.37	1028.5	30.78	1042.4	31.19	1056.3
28.74	973.3	29.15	987.2	29.56	1001.1	29.97	1014.9	30.38	1028.8	30.79	1042.7	31.20	1056.6
28.75	973.6	29.16	987.5	29.57	1001.4	29.98	1015.3	30.39	1029.2	30.80	1043.1	31.21	1056.9
28.76	974.0	29.17	987.9	29.58	1001.7	29.99	1015.6	30.40	1029.5	30.81	1043.4	31.22	1057.3
28.77	974.3	29.18	988.2	29.59	1002.1	30.00	1016.0	30.41	1029.8	30.82	1043.7	31.23	1057.6
28.78	974.6	29.19	988.5	29.60	1002.4	30.01	1016.3	30.42	1030.2	30.83	1044.1	31.24	1058.0
28.79	975.0	29.20	988.9	29.61	1002.8	30.02	1016.6	30.43	1030.5	30.84	1044.4	31.25	1058.3
28.80	975.3	29.21	989.2	29.62	1003.1	30.03	1017.0	30.44	1030.9	30.85	1044.7	31.26	1058.6



Terms and Concepts

- Isobars and barometers
- Highs and Lows
- Ridges and troughs
- Coriolis effect
- Geostrophic and gradient winds

Lesson goals

- Understand how pressure differences cause the wind
- Predict wind speed and direction from isobars on a weather map
- Understand the differences between wind flow around Highs and Lows, ridges and troughs
- Be able to convert apparent wind to true wind
- Be able to calibrate an aneroid barometer, or accurately set an electronic barometer to the correct sea level pressure—thus understanding how pressure varies with altitude, and where to find accurate pressures online
- Read weather maps with regard to pressure distributions and related labeling practices

Lesson 2 Questions

2.1 The “standard atmosphere” pressure at sea level is equal to what?

❑ (A) 14.7 pounds per square inch

❑ (B) 29.92 inches of mercury

❑ (C) 1013.25 millibars

❑ (D) All answers are true

2.2 Pressure reports and station model displays tell us the rate of pressure change rising, falling, etc. over the past how many hours?

❑ (A) 1 ❑ (B) 3

❑ (C) 6 ❑ (D) 12

2.3 When it comes to learning what the true atmospheric pressure is from a barometer, what is the main difference between a typical aneroid barometer and a typical electronic barometer?

- ❑ (A) Electronic devices show output as a digital value whereas with an aneroid barometer we must read the pressure from a dial.
- ❑ (B) The electronic barometers use a more accurate internal mechanism to read the pressure.
- ❑ (C) Electronic barometers include a recorded history of pressures that typical aneroid devices do not — and recording barographs are not practical at sea.
- ❑ (D) Aneroid barometers usually require calibration table since the corrections are usually not the same at all pressures.

2.4 According to Buys-Ballot's law (in the Northern Hemisphere), when you put your back to the surface wind, the low pressure is ...

- ❑ (A) toward your left, and slightly back.
- ❑ (B) toward your right, and slightly back.
- ❑ (C) toward your left, and slightly forward.
- ❑ (D) toward your right, and slightly forward.

2.5 Atmospheric pressure can be expressed in several different units. Which are the best to use for marine weather applications (and think over why)?

- ❑ (A) Pounds per square inch
- ❑ (B) Millimeters of mercury
- ❑ (C) Inches of mercury
- ❑ (D) Millibars

2.6 What can be said about the role of a barometer in marine weather underway?

- ❑ (A) It is a crucial instrument and every effort should be made to use it to its fullest potential.
- ❑ (B) It is helpful in some cases but not dependable.
- ❑ (C) It was useful in the past but has less value in modern times because we now have fax maps and wireless broadcasts of weather reports.
- ❑ (D) It is only useful if we spend a great deal of effort in calibrating it.

2.7 Actual pressures in Highs and Lows are always relative to neighboring values, but as a rule, we would consider a typical pressure to be high if it is above about ...

- ❑ (A) 1000 mb
- ❑ (B) 1025 mb
- ❑ (C) 1050 mb.
- ❑ (D) 1075 mb.

2.8 Your speed is 6.5 kts, your heading is 200 T. The apparent wind is 5.0 kts at an apparent wind angle of 150 R, on starboard tack. (Part A) What is the true wind speed in kts and (Part B) what is the true wind direction ... i.e., actual wind direction not relative to the bow.

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2.9 The needle of an aneroid barometer points to 30.05 on the dial, indicating that the barometric pressure is...

- ❑ (A) 30.05 inches of mercury.
- ❑ (B) 30.05 millimeters of mercury.
- ❑ (C) 30.05 millibars.
- ❑ (D) falling.

2.10 What causes the pressure to drop on a barometer?

- ❑ (A) The Low you are in is actually deepening with time.
- ❑ (B) Your vessel is moving across the isobars toward lower pressure.
- ❑ (C) A weather system is moving across your position bringing the low pressure region closer to you.
- ❑ (D) All of the reasons listed can cause or contribute to an observed drop.

2.11 In normal sea conditions, the surface wind flows in what direction relative to the isobars?

- ❑ (A) 15° to 30° across the isobars, into the high out of the low pressures
- ❑ (B) 15° to 30° across the isobars, into the low out of the high pressures
- ❑ (C) Parallel to the isobars, clockwise around Highs, counterclockwise around Lows
- ❑ (D) Parallel to the isobars, clockwise around Lows, counterclockwise around Highs

Lesson 2. Pressure and Wind — Points to Ponder

1. Discuss why you can't judge a typical marine barometer quality from its cost.

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2. Explain how to determine wind speed and direction from the spacing and orientation of isobars on weather maps.

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3. Explain why isobar spacing (the pressure gradient) alone is not always enough to make accurate wind predictions at a given latitude at sea.

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4. Explain briefly how to check barometer quality.

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5. Why do Highs generally have clear weather and light winds while Lows have clouds, rain, and strong winds?

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6. Why is it important to be able to determine true wind speed and direction from the apparent wind speed and direction?

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R2. Winds from Isobars

Surface Wind Speed in Knots from 4-mb Isobar Spacing

		Isobar spacing in degrees of latitude													
		0.5	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**	**5**	**6**	**8**	**10**	**12**
Latitude	**10°**	288	144	96	72	58	48	41	36	32	29	24	18	14	12
	15°	193	97	64	48	39	32	28	24	21	19	16	12	10	8
	20°	146	73	49	37	29	24	21	18	16	15	12	9	7	6
	25°	118	59	39	30	24	20	17	15	13	12	10	7	6	5
	30°	100	50	33	25	20	17	14	12	11	10	8	6	5	4
	35°	87	44	29	22	17	15	12	11	10	9	7	5	4	4
	40°	78	39	26	19	16	13	11	10	9	8	6	5	4	3
	45°	71	35	24	18	14	12	10	9	8	7	6	4	4	3
	50°	65	33	22	16	13	11	9	8	7	7	5	4	3	3
	55°	61	31	20	15	12	10	9	8	7	6	5	4	3	3
	60°	58	29	19	14	12	10	8	7	6	6	5	4	3	2
	65°	55	28	18	14	11	9	8	7	6	6	5	3	3	2
	70°	53	27	18	13	11	9	8	7	6	5	4	3	3	2
	75°	52	26	17	13	10	9	7	6	6	5	4	3	3	2

Notes:
1. This table assumes the isobars are straight. For curved isobars, winds will be somewhat less around a Low and somewhat greater around a High. The effect of curvature can be up to some 30% depending on the radius of curvature. 2. The table assumes the surface wind is 65% of the geostrophic wind. 3. To find wind speed, measure 4-mb isobar spacing from a weather map in units of latitude degrees, then find wind from the table. Example: if at latitude 45° the 4-mb isobars are 120 nautical miles apart (2° on the latitude scale), then the expected surface wind is 18 knots, directed clockwise around the high pressure, pointed some 15 to 30° out of the High, or counter-clockwise around a Low and 15 to 30° into the Low.

Terms and Concepts

- Trade winds, doldrums, and Hadley cells
- Horse Latitudes and prevailing westerlies
- Air masses and stability
- Primary ocean currents

Lesson Goals

- Understand the basic composition and structure of the atmosphere and how its properties can have a direct influence on the wind and weather we observe on the surface
- Learn air mass classifications and the relationship between vertical temperature profiles and air stability
- Learn how the equatorial heating of the sun creates the doldrums and horse latitudes, and drives the trade winds and prevailing westerlies
- Understand the role of the polar front in the generation of Lows and fronts that eventually break away to cross the mid-latitudes of the globe
- Understand the origins and behavior of the winds aloft and how they contribute to the development and transport of surface systems around the globe
- Learn the distribution of ocean currents around the globe and how to predict their values in voyage planning

Lesson 3 Questions

3.1 Air masses are most often formed...

- ❑ (A) in lows
- ❑ (B) in troughs
- ❑ (C) in highs
- ❑ (D) in ridges

3.2 The Gulf Stream is often marked by which of these characteristics?

- ❑ (A) Water color
- ❑ (B) Water temperature
- ❑ (C) Wave height
- ❑ (D) All of the above can be key indicators of the presence of this current.

3.3 The typical Gulf Stream (Florida Current) off the east coast of Florida could be described as...

- ❑ (A) 0.5 to 2 kts flowing north
- ❑ (B) 0.5 to 2 kts flowing south
- ❑ (C) 2 to 4 kts flowing north
- ❑ (D) 2 to 4 kts flowing south

3.4 If the winds aloft over the Pacific or Atlantic ocean are from the SW at this moment, what might be a likely time period for them to change and be from the west?

- ❑ (A) 20 minutes to an hour
- ❑ (B) Several hours
- ❑ (C) Several days
- ❑ (D) Several weeks

3.5 Weather in the middle latitudes generally travels from ...

- ❑ (A) east to west.
- ❑ (B) north to south.
- ❑ (C) west to east.
- ❑ (D) none of these.

3.6 What type of air would you expect the trade winds over Hawaii to be?

- ❑ (A) cP
- ❑ (B) mT
- ❑ (C) mP
- ❑ (D) cT

3.7 In the Northern Hemisphere, going up from the surface...

- ❑ (A) the air temperature rises and the wind backs.
- ❑ (B) the air temperature falls and the wind veers.
- ❑ (C) the air temperature rises and the wind veers.
- ❑ (D) the air temperature falls and the wind backs.

3.8 The primary wind belt which has the greatest effect on the set, drift, and depth of the equatorial currents are the...

- ❑ (A) doldrums.
- ❑ (B) horse latitudes.
- ❑ (C) trade winds.
- ❑ (D) prevailing westerlies.

3.9 The horse latitudes are regions of...

- ❑ (A) brisk prevailing winds.
- ❑ (B) light airs and calms.
- ❑ (C) none of the above.
- ❑ (D) abundant blue sea grass vegetation.

R3. Standard Atmosphere — Pressure and Temperature vs. Altitude

Feet	Meters	Pa/Po	Pa	Po-Pa	Ta F°	Ta C°
0	0	1.0000	1013.3	0.0	59.0	15.0
5	2	0.9998	1013.1	0.2	59.0	15.0
10	3	0.9996	1012.9	0.4	59.0	15.0
20	6	0.9993	1012.5	0.7	58.9	15.0
30	9	0.9989	1012.2	1.1	58.9	14.9
40	12	0.9986	1011.8	1.5	58.9	14.9
50	15	0.9982	1011.4	1.8	58.8	14.9
75	23	0.9973	1010.5	2.7	58.7	14.9
100	30	0.9964	1009.6	3.7	58.6	14.8
150	46	0.9946	1007.8	5.5	58.5	14.7
200	61	0.9928	1005.9	7.3	58.3	14.6
250	76	0.9910	1004.1	9.1	58.1	14.5
300	91	0.9892	1002.3	10.9	57.9	14.4
350	107	0.9874	1000.5	12.8	57.8	14.3
400	122	0.9856	998.7	14.6	57.6	14.2
450	137	0.9838	996.9	16.4	57.4	14.1
500	152	0.9821	995.1	18.2	57.2	14.0
550	168	0.9803	993.3	20.0	57.0	13.9
600	183	0.9785	991.5	21.8	56.9	13.8
650	198	0.9767	989.7	23.6	56.7	13.7
700	213	0.9750	987.9	25.4	56.5	13.6
750	229	0.9732	986.1	27.2	56.3	13.5
800	244	0.9714	984.3	29.0	56.2	13.4
850	259	0.9697	982.5	30.7	56.0	13.3
900	274	0.9679	980.7	32.5	55.8	13.2
950	290	0.9661	978.9	34.3	55.6	13.1
1000	305	0.9644	977.2	36.1	55.4	13.0
1050	320	0.9626	975.4	37.9	55.3	12.9
1100	335	0.9609	973.6	39.6	55.1	12.8
1150	351	0.9591	971.8	41.4	54.9	12.7

Feet	Meters	Pa/Po	Pa	Po-Pa	Ta F°	Ta C°
1200	366	0.9574	970.1	43.2	54.7	12.6
1250	381	0.9556	968.3	44.9	54.6	12.5
1300	396	0.9539	966.5	46.7	54.4	12.4
1350	411	0.9522	964.8	48.5	54.2	12.3
1400	427	0.9504	963.0	50.2	54.0	12.2
1450	442	0.9487	961.3	52.0	53.8	12.1
1500	457	0.9470	959.5	53.7	53.7	12.0
1600	488	0.9435	956.0	57.2	53.3	11.8
1700	518	0.9401	952.5	60.7	52.9	11.6
1800	549	0.9366	949.1	64.2	52.6	11.4
1900	579	0.9332	945.6	67.7	52.2	11.2
2000	610	0.9298	942.1	71.1	51.9	11.0
3000	914	0.8962	908.1	105.1	48.3	9.1
4000	1219	0.8637	875.1	138.1	44.8	7.1
5000	1524	0.8320	843.1	170.2	41.2	5.1
6000	1829	0.8014	812.0	201.3	37.6	3.1
7000	2134	0.7716	781.9	231.4	34.1	1.1
8000	2438	0.7428	752.6	260.6	30.5	-0.8
9000	2743	0.7148	724.3	289.0	27.0	-2.8
10000	3048	0.6877	696.8	316.4	23.4	-4.8
11000	3353	0.6614	670.2	343.1	19.8	-6.8
12000	3658	0.6360	644.4	368.8	16.3	-8.8
13000	3962	0.6113	619.4	393.8	12.7	-10.7
14000	4267	0.5875	595.2	418.0	9.2	-12.7
15000	4572	0.5643	571.8	441.4	5.6	-14.7
16000	4877	0.5420	549.2	464.1	2.0	-16.7
17000	5182	0.5203	527.2	486.0	-1.5	-18.7
18000	5486	0.4994	506.0	507.3	-5.1	-20.6
19000	5791	0.4791	485.5	527.8	-8.6	-22.6
20000	6096	0.4595	465.6	547.6	-12.2	-24.6

Notes:
The standard atmosphere has a surface temperature of 59° F (15° C) and a lapse rate of minus 3.56°F/1000 ft (1.98°C/1000 ft). The standard surface pressure is 1013.25 mb and the pressure drops at a rate that can be computed from Pa = Po [1 - (6.87535*H/1,000,000)]^5.2561, where Pa is the pressure at altitude H (given in feet), and Po is the base or surface pressure, 1013.25 mb. The notation x^y means x raised to the power of y.

If you live at an elevation of 1100 feet, your pressure will read 39.6 mb lower than reported at sea level if your barometer is properly calibrated. If the barometer in your boat is 10 feet above sea level, your barometer reads 0.4 mb lower than it should if not corrected to sea level.

To record barometer offsets for calibration at some elevation (say 1,100 feet), record with the time and date of observation your barometer reading (say 953.6 mb), along with the proper sea level pressure at your location for that time obtained by interpolating Internet data (say it is 990.0 mb). Then compute the expected pressure at your elevation if the barometer were exact (Pa/Po x your reading), which in this example would be 0.9609 x 990.0 = 951.3 mb, so we see that our barometer reads too high by 953.6 - 951.3 = 2.3 mb at an instrument pressure of 953.6 mb.

Lesson 3. Global Wind and Current — Points to Ponder

Background reading is MMW chapters 3.

Review the background reading and class notes to formulate your understanding of these points, as if you were preparing to explain the concepts to a friend. Strive to distill your thoughts to two or three key sentences.

1. When sailing toward the equator, how do you know when you have entered the trade wind belt?

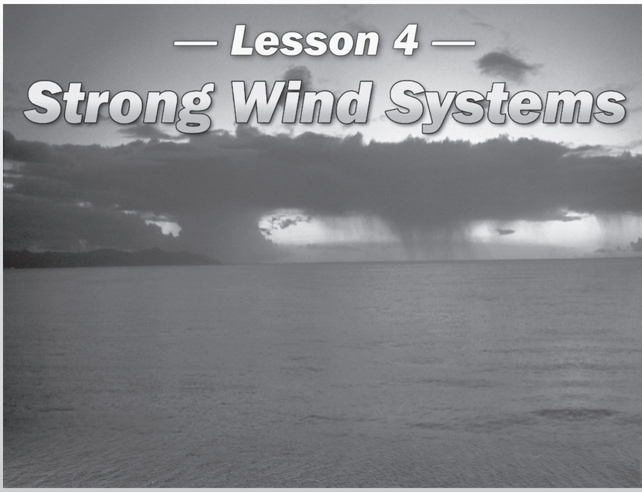
2. Why is the polar front so important to the weather in the rest of the Northern oceans?

3. What are “centers of action” and how do they affect our cruise planning?

4. How is it that storms in the North Pacific have caused so very much more destruction to mariners underway than any hurricane anywhere ever has?

5. Why don’t we have “roaring forties” and “screaming fifties” in the Northern Hemisphere?

6. What are the doldrums and what causes them?



Terms and Concepts

- Lows
- Fronts
- Squalls
- Hurricanes
- Warnings and displays
- National Hurricane Center
- QuikSCAT winds
- Wind instruments

Lesson Goals

- Learn the forecasting and warnings available for strong wind systems
- Understand distinctions between lows and fronts
- Learn the distinctions between tropical and extra-tropical storms
- Learn to predict squall behavior
- Know how to find and use QuikSCAT satellite wind measurements
- Learn typical behaviors of tropical storms and hurricanes

Lesson 4 Questions

4.1 As we scan the squall-filled horizon in warm northern waters, which squalls are those that will reach us?

❑ (A) Those that are to weather in the true wind direction.

❑ (B) Those some 30° to the left of the true wind direction.

❑ (C) Those some 30° to the right of the true wind direction.

❑ (D) Cannot be predicted without further information.

4.2 What is a good rule of thumb for the minimum water temperature needed to form a hurricane or typhoon?

❑ (A) 70° F ❑ (B) 75° F ❑ (C) 80° F ❑ (D) 85° F

4.3 What can be said about the strong winds of a squall?

❑ (A) The strongest winds come when the squall has no rain.

❑ (B) The strong winds come after the rain has finished.

❑ (C) The strong winds come before it starts to rain.

❑ (D) The strong winds come with the rain.

4.4 At sea in warm waters, you are most likely to have squalls...

- ❑ (A) at night.
- ❑ (B) in mid morning.
- ❑ (C) in late afternoon.
- ❑ (D) anytime, depends only on latitude and season.

4.5 What best describes the behavior of the wind as a warm front approaches and passes in the open ocean of the northern hemisphere?

- ❑ (A) Wind direction and speed more or less steady as the front approaches, then a sudden veer and strong increase as the front passes.
- ❑ (B) Wind veers and builds as the front approaches, then suddenly backs at the frontal surface, and then remains more or less steady as the warm sector passes
- ❑ (C) Wind backs and builds as the front approaches, then suddenly veers at the frontal surface, and then remains more or less steady as the warm sector passes
- ❑ (D) Wind speed steady until the front approaches, then brief squalls of strong winds as the front passes, then winds die off.

4.6 Cold fronts are associated with...

- ❑ (A) short heavy rain, stratus clouds, relatively small veer.
- ❑ (B) short heavy rain, cumulonimbus clouds, larger veer.
- ❑ (C) long light rain stratus clouds, relatively small veer.
- ❑ (D) long light rain, cumulonimbus clouds, relatively larger veer.

4.7 List the wind speed ranges in knots that define Gale, Storm-force, and Hurricane-force winds.

____

4.8 What is a valuable piece of information common to all types of fronts passing us in the Northern Hemisphere?

- ❑ (A) The wind will suddenly back
- ❑ (B) The wind will suddenly veer
- ❑ (C) The wind will suddenly increase
- ❑ (D) The wind will suddenly decrease

4.9 What percent of tropical disturbances develop into storms of hurricane force winds (hurricanes, cyclones, or typhoons)?

- ❑ (A) 10%
- ❑ (B) 20%
- ❑ (C) 40%
- ❑ (D) 80%

4.10 In a hurricane which has central peak winds of, say, 120 knots, how far from the center of the storm would you have to get to have winds reduced to some 40 knots or so?

- ❑ (A) 20 miles
- ❑ (B) 80 miles
- ❑ (C) 200 miles
- ❑ (D) 400 miles

4.11 In a warm sector between warm and cold fronts, the wind can be expected to be...

- ❑ (A) weak and variable.
- ❑ (B) steady in speed and direction.
- ❑ (C) strong and gusty.
- ❑ (D) It depends on the temperature.

4.12 In a tropical cyclone in the Northern Hemisphere, a vessel hove to with the wind shifting clockwise (veering) would be...

- ❑ (A) ahead of the storm center.
- ❑ (B) in the dangerous semicircle.
- ❑ (C) in the navigable semicircle.
- ❑ (D) directly in the approach path of the storm.

4.13 Generally when the barometer drops the wind increases and when the barometer rises the wind starts to diminish. Some circumstances, however, can lead to the strongest winds of a passing Low actually occurring after the barometer has bottomed out and well into a rise again. How is this situation often described?

- ❑ (A) A bent back occlusion
- ❑ (B) “Sting in the scorpion’s tail”
- ❑ (C) Any increase in pressure gradient with increasing pressure
- ❑ (D) All the above are used to describe this situation

4.14 How often do we get QuikSCAT wind measurements for our location at sea?

- ❑ (A) Every 101 minutes
- ❑ (B) Once a day
- ❑ (C) Two or maybe three times a day
- ❑ (D) Every 6 hr at 00, 06, 12, and 18z.

4.15 Which best describes a limitation of QuikSCAT wind data?

- ❑ (A) Not accurate for very low winds
- ❑ (B) Can be corrupted by heavy rain
- ❑ (C) Can underestimate very strong winds
- ❑ (D) All of the above

Lesson 4. Strong Wind Systems — Points to Ponder

1. Very briefly describe lows, troughs, and fronts, and how their distinctions make a difference underway.

___

___

___

2. Describe where and when squalls form and how they behave.

___

___

___

3. Why is a “squall line” worse than a line of squalls?

4. Describe how you would “see” or detect an approaching cold front compared to how you would detect an approaching warm front.

5. How do you put the most distance between you and an approaching tropical storm?

6. Discuss the role of your navigation radar in evaluating squall motion.

7. Discuss how the wind shifts when a frontal system approaches and then passes, and whether this varies with the type of front?

8. What distinguishes storms, gales, hurricanes, and small craft warnings?

9. Comment on the statement that “It is just as easy to choose to sail in a hurricane as it is to not sail in one.”

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This is the end of the sample.

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