



Weather

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MIT Bluewater Skippers

Aim of this session

Over the next two hours we hope to give you an overview of weather from a primarily practical standpoint. After this session you should:

- Understand what the near-term weather will be from looking at the clouds
- Know where to look for detailed weather forecasts, both on land and on the boat
- Know the range of applications that will integrate weather predictions for use on a boat

Of necessity we will not go into any topic in detail; there are plenty of sites on the web for further exploration.

Agenda

- Weather Basics
 - Where does the weather come from?
 - Fronts and air masses
 - Cloud types
 - Wind, waves, and warnings
- Practical forecasting
 - What can you tell from looking at the skies and barometer? (pictures, stories)
 - Wave heights (wind and fetches) (there's a standard chart for this)
- Forecasting products
 - The wide range and uses of forecasting products (NOAA surface and 500 mb, weather radar on your phone, grib, ???)
 - What is available ashore, and how to get them (lots of demos here?)
 - What is available onboard (some digging required?)

The Causes of Weather

- Atmospheric pressure
- The global wind pattern
- Wind and weather
- Air masses
- Atmospheric pressure
- Isobars
- Dew point (determines bottom of cloud formations, fog, and rain)

The Causes of Weather

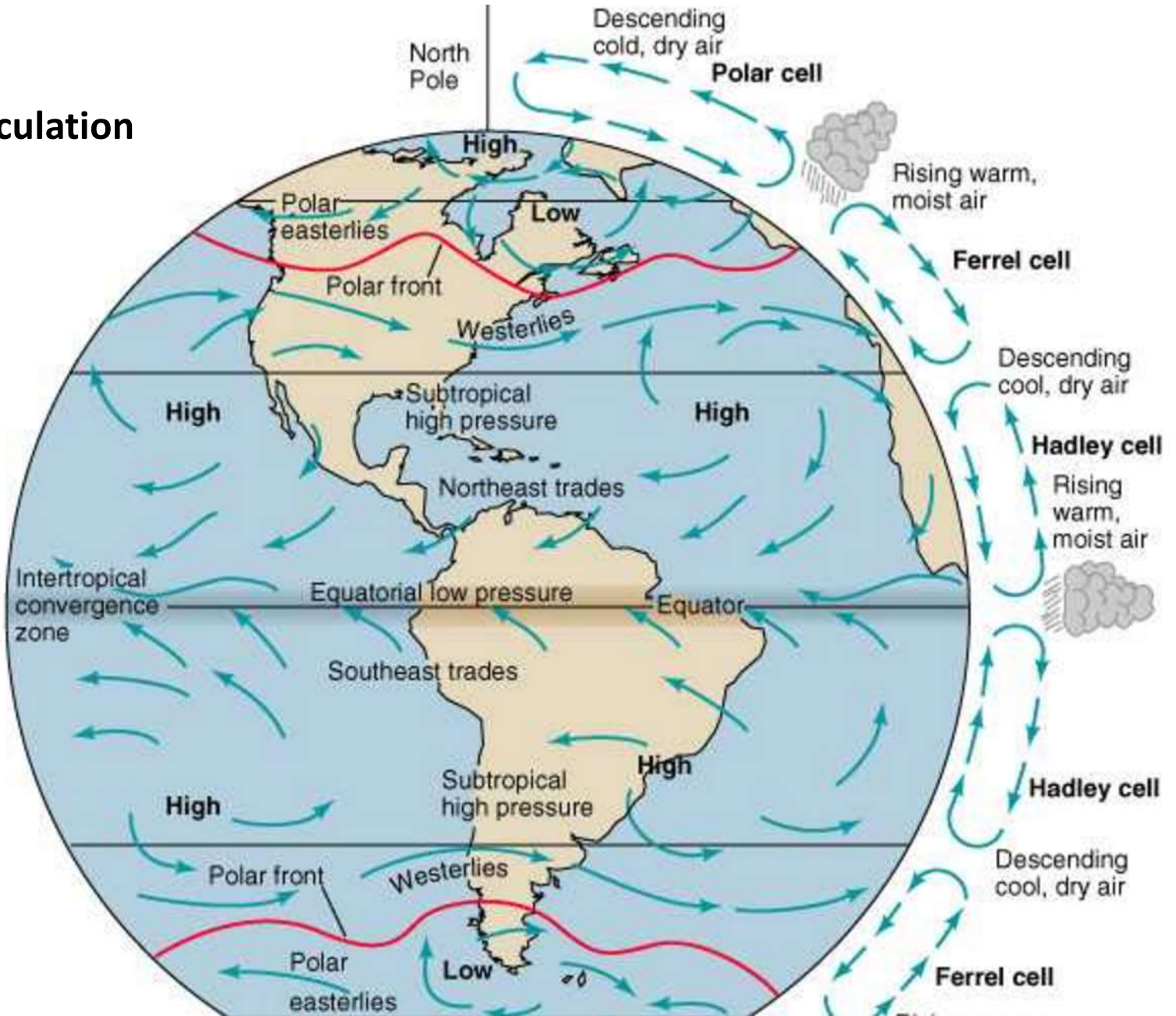
Weather is caused by the interactions of air masses that are not in equilibrium – different pressures, temperatures, and moisture content.

Air masses are vast expanses of air that have similar densities, temperatures and moisture and arise from different geographical regions; they move as part of the prevailing winds.

When two dissimilar air masses meet, their boundary is a ‘front’, which is what gives rise to much of the interesting weather.

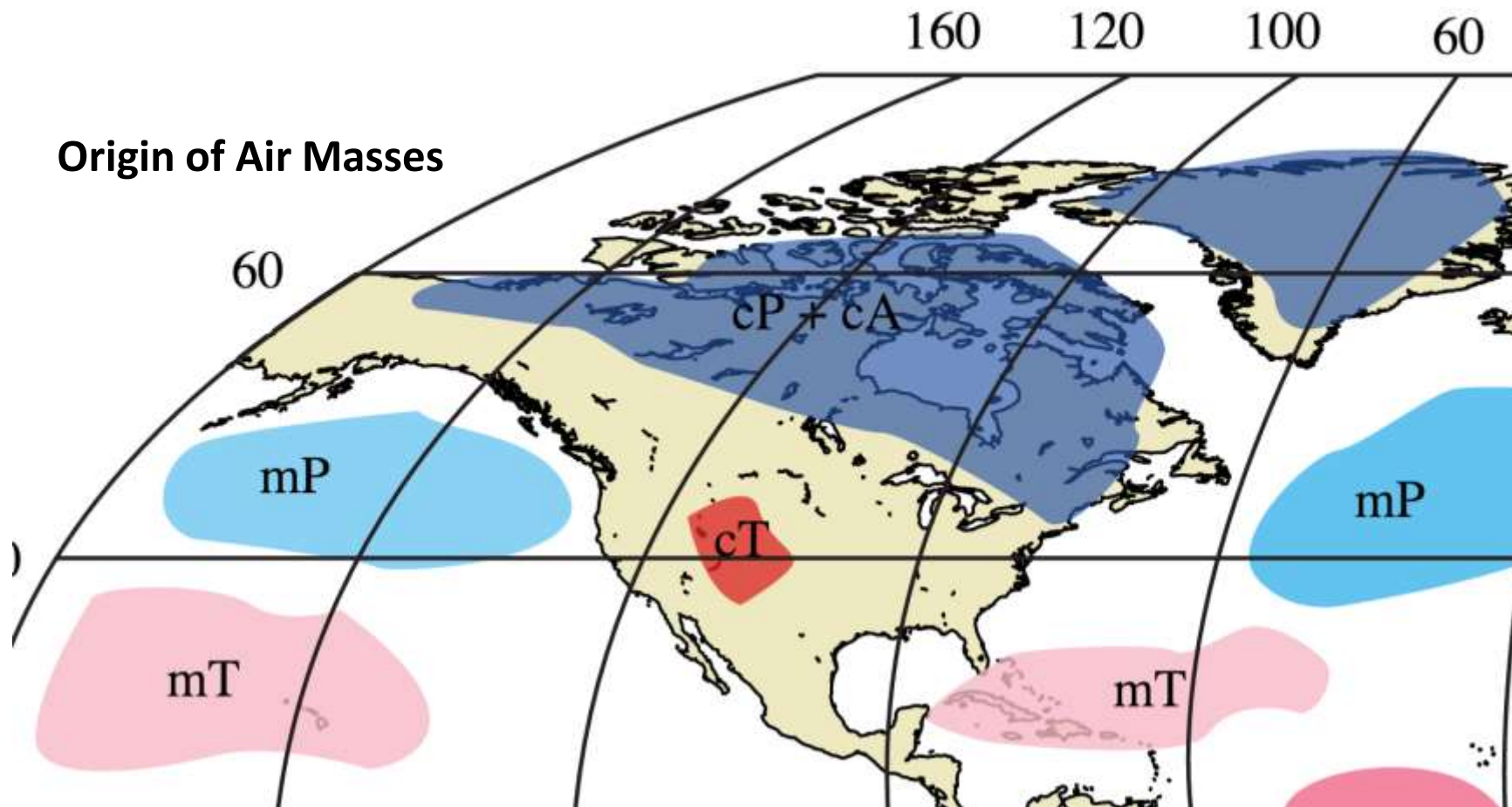
The Causes of Weather

Global Circulation

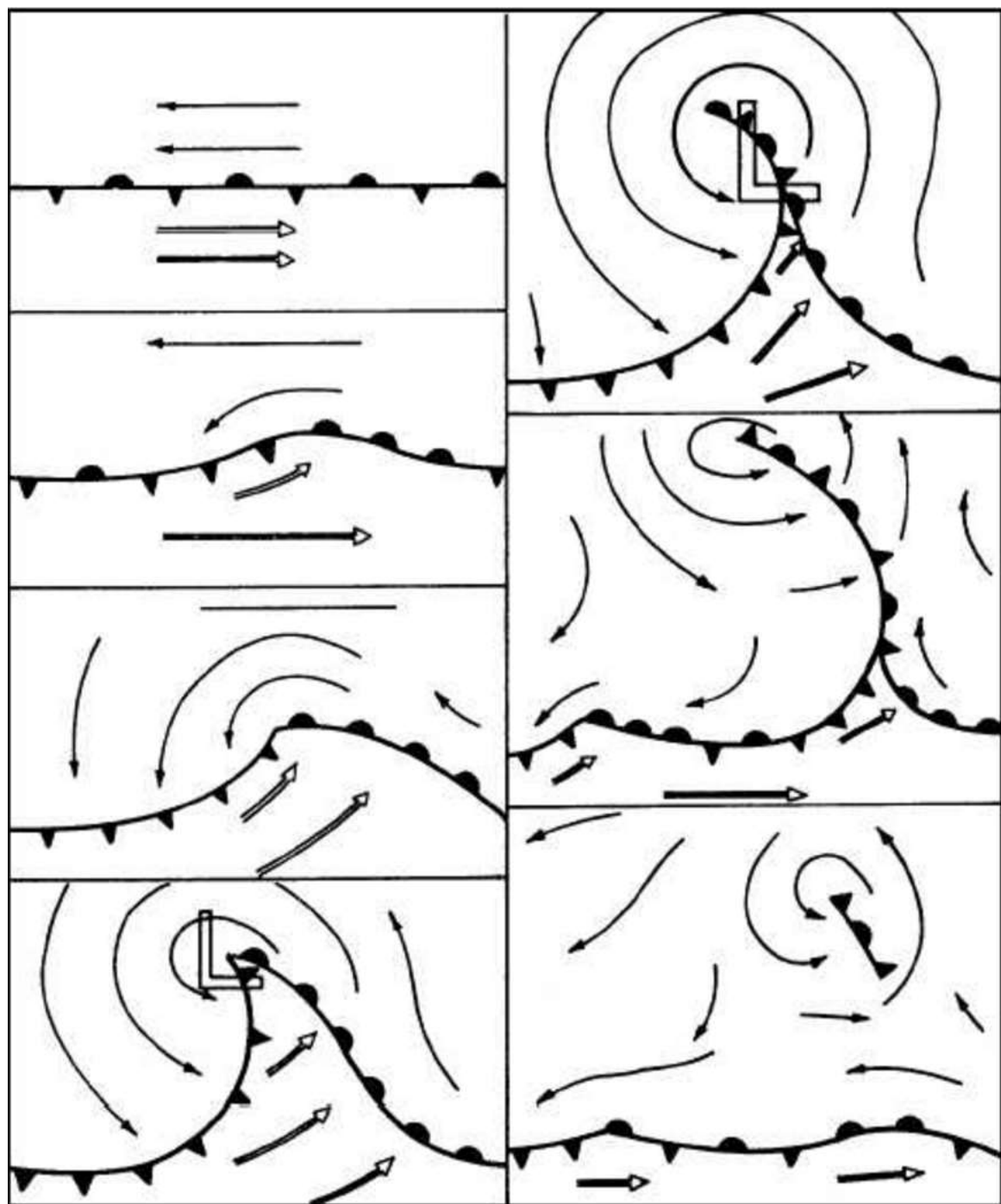


The Causes of Weather

Origin of Air Masses



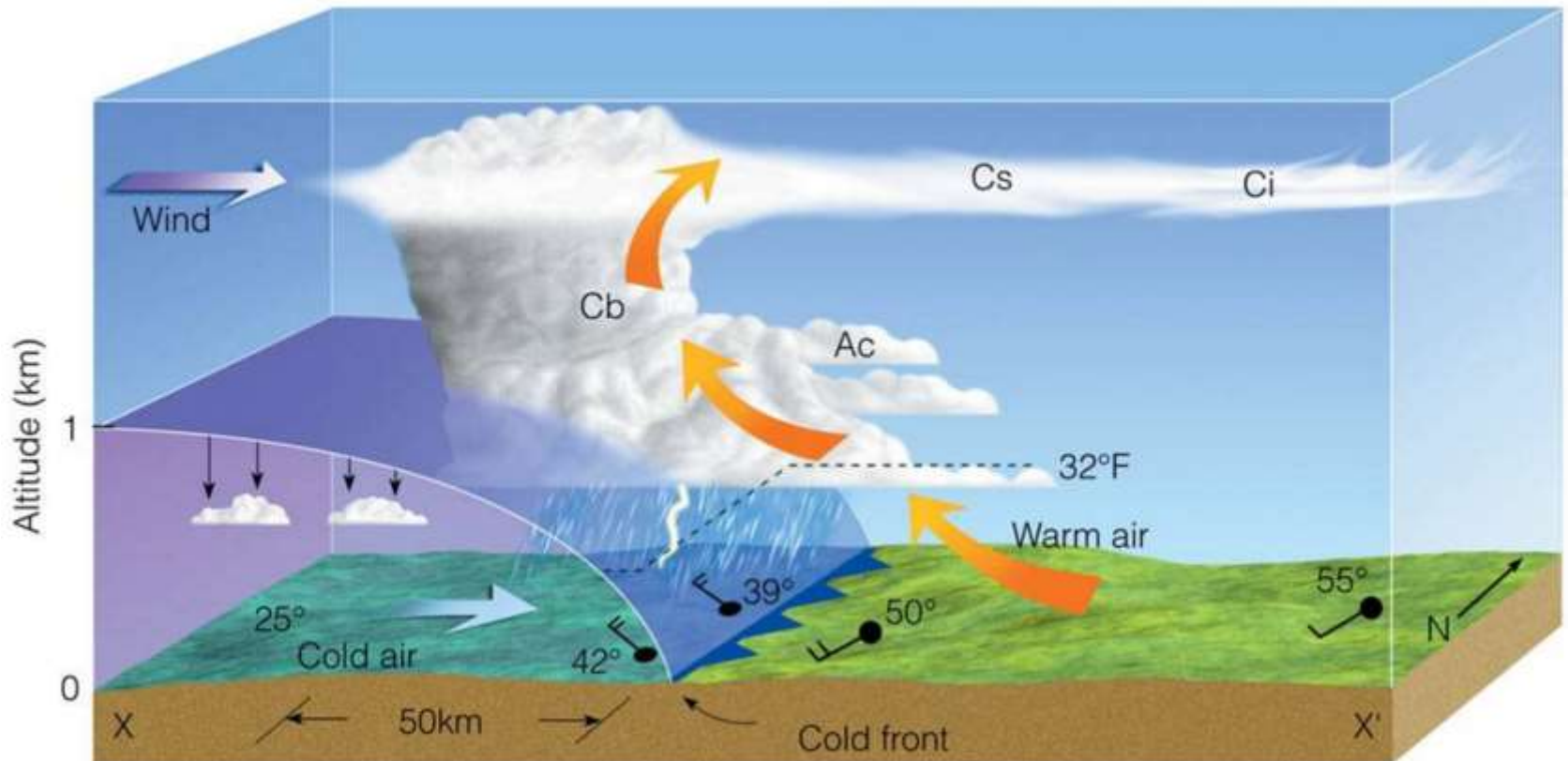
Fronts and Weather Systems



Fronts and Weather Systems

In a **Cold Front** the Cold Air pushes underneath warm air and causes the air to rise violently and rapidly

- Cold fronts move fast 20- 35 kts
- Generally move E-SE
- Weather deteriorates rapidly
- Approaching clouds seen 50- 150 miles ahead of cold front



Fronts and Weather Systems

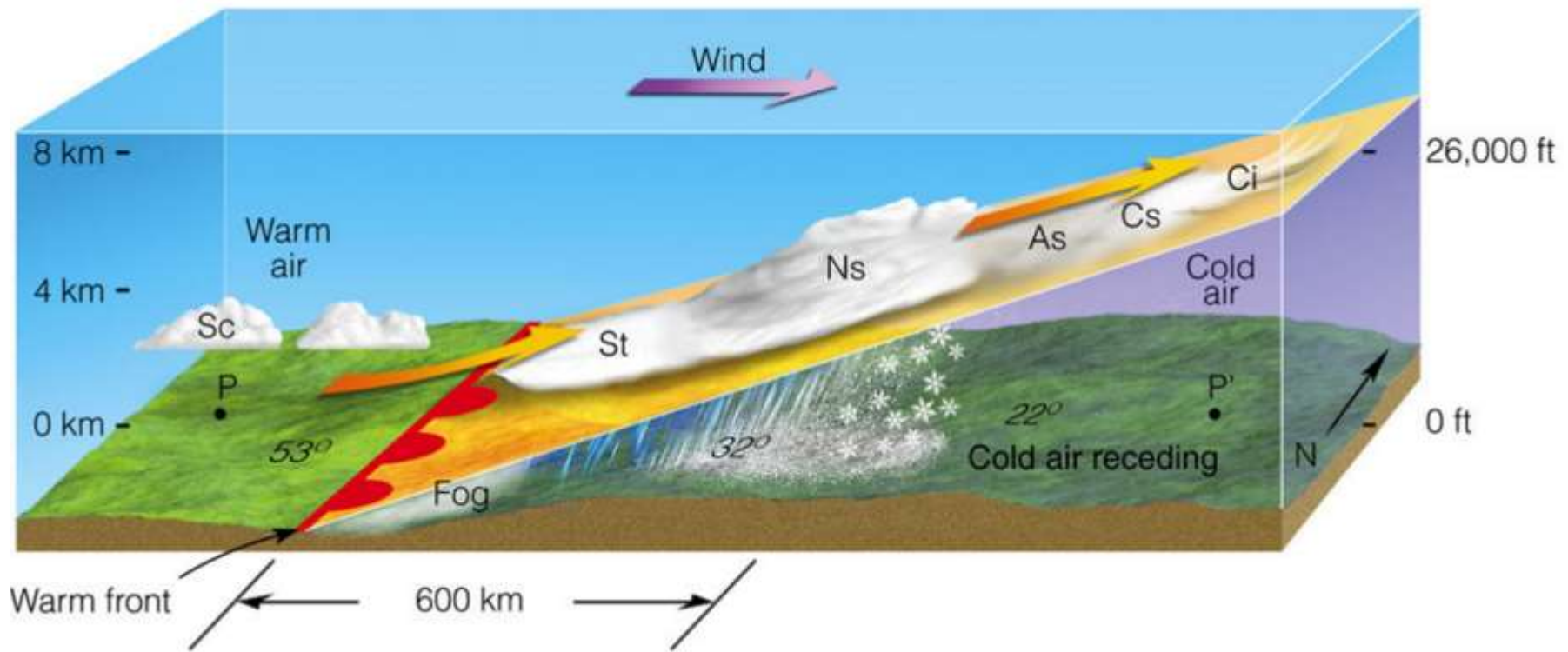
In a **Warm Front** warm air slides over cold air

Moves slowly 10-15kts

Weather deteriorates gradually

Approaching clouds seen from 1000+ miles

Symbol marking the front is a line with red half circles (warm air is behind the line)



Fronts and Weather Systems

Cloud Types

The basic categorization: shape

- Cumulus clouds are puffy
- Stratus clouds are flat layers
- Cirrus – detached or semi-detached filaments

‘Nimbus’ clouds are associated with precipitation.



Bluewater Weather

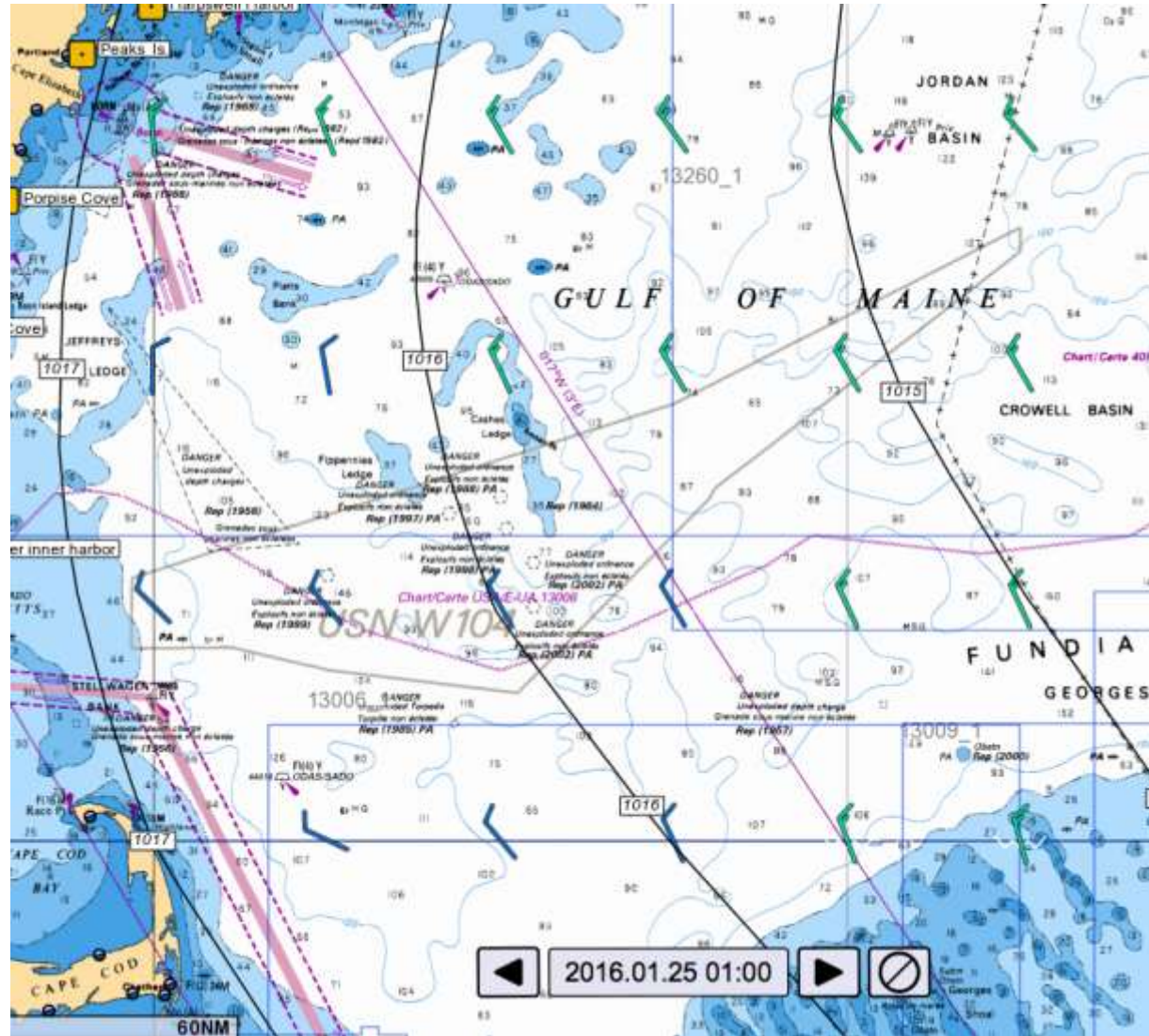
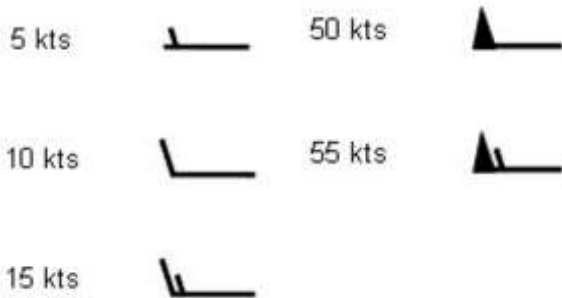


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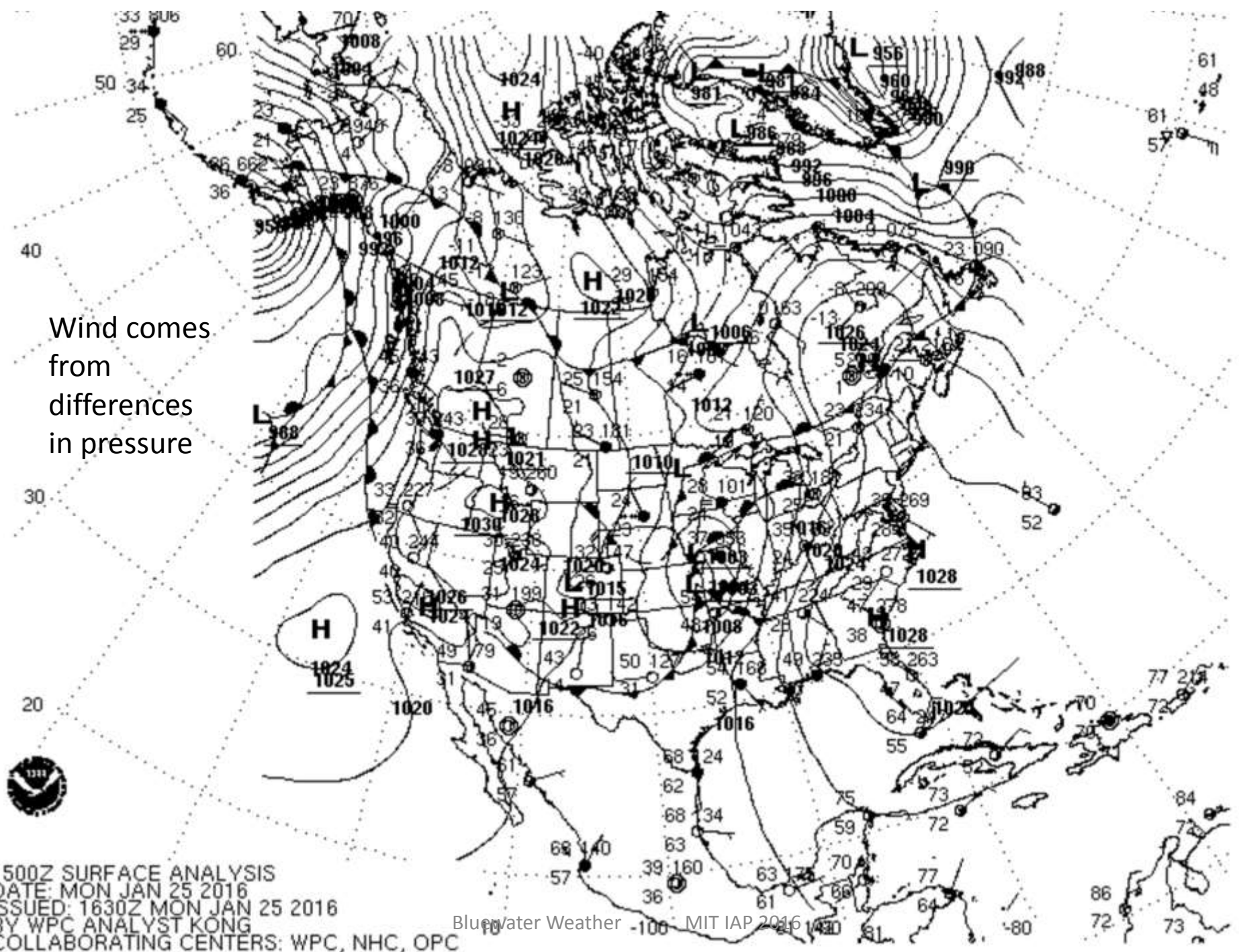
Wind, Waves and Warnings

Wind comes from differences in pressure, and at the surface flows almost along the pressure isobars (due to the Coriolis force).

Direction and speed is represented on charts via a **wind barb**; the barb 'points' in the direction the wind is going.



Wind comes from differences in pressure



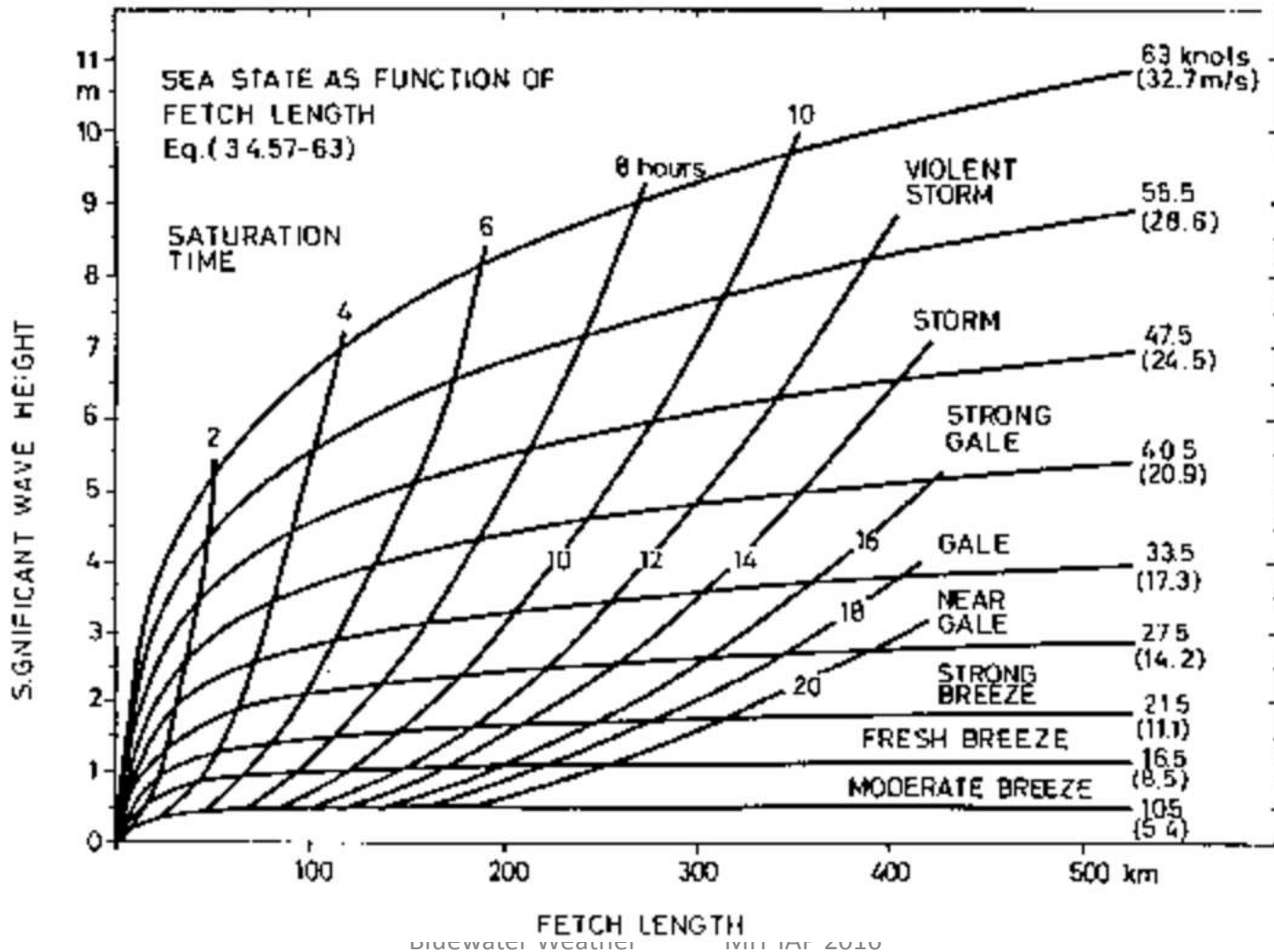
Winds, Waves and Warnings

Beaufort scale – 1-12; ~ 5 kts of wind per number.



Winds, Waves and Warnings

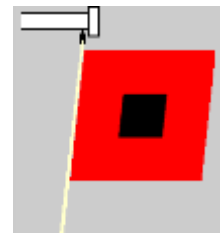
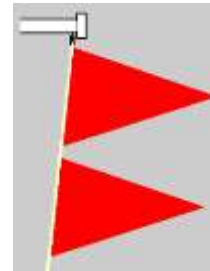
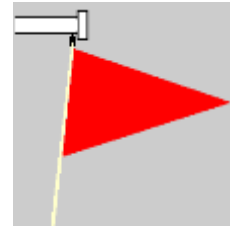
The greater the wind and the fetch, the higher the wave:



Winds, Waves and Warnings

Warnings

- Small craft advisory: forecast winds of 25 kts to 33 kts (no guidance on what a 'small craft' is)
- Gale warning: forecast winds of 34 kts to 47 kts
- Storm warning: forecast winds of 48 kts to 63 kts



What can you tell from looking at the skies and barometer?

PRACTICAL FORECASTING

Reading the Weather

- Building cumulus clouds signal wind and storm

Clouds

- Stratus: Layered clouds, stable air
 - Nimbostratus, Stratocumulus, Altostratus, Cirrostratus, Cirrus (progressively higher altitudes)
- Cumulus: Puffy clouds, unstable air
 - Cumulonimbus: Thick, tall, puffy clouds (winds)



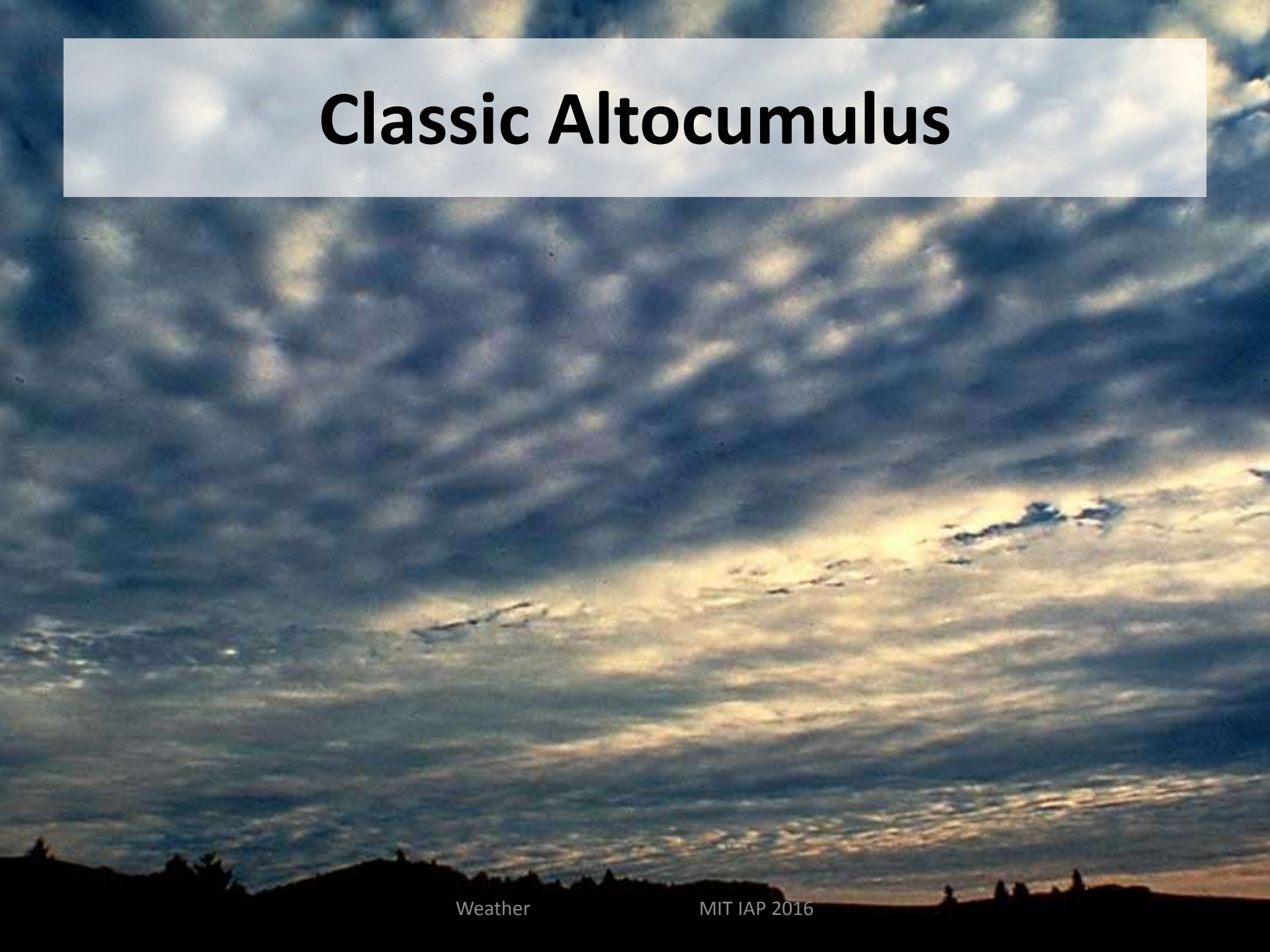
Stratus



An aerial photograph of a coastline. On the left, a sandy beach curves along a green, forested cliffside. The ocean is dark blue with white surf breaking along the shore. In the distance, the coastline continues with more cliffs and a small bay. The sky is filled with soft, grey, low-hanging clouds that partially obscure the view, creating a misty atmosphere. The overall scene is serene and atmospheric.


Low-hanging stratus wisps

Classic Altocumulus



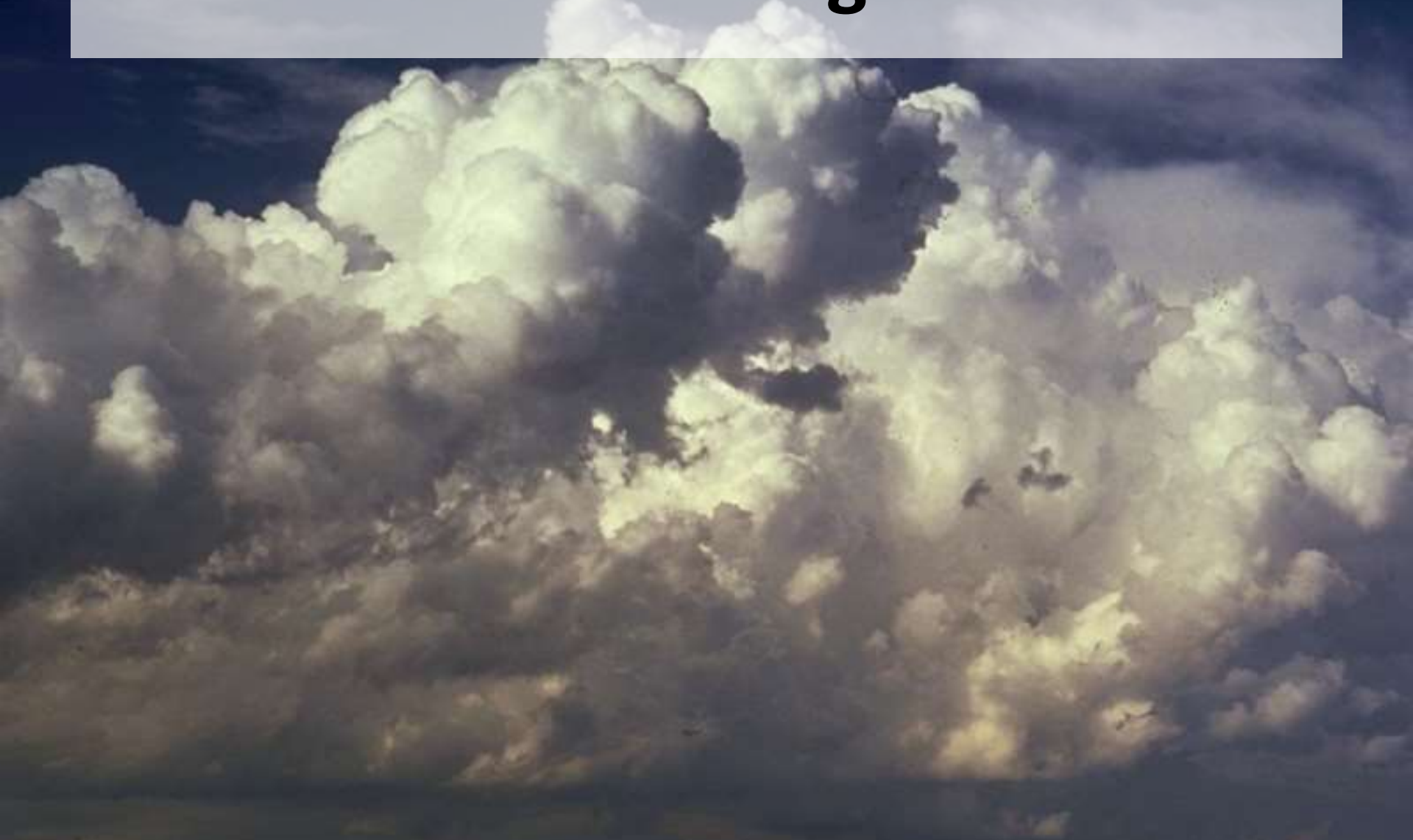
A photograph of a beach scene. The foreground shows a sandy beach with gentle waves washing onto it. The middle ground features a line of white-capped waves breaking against the shore. The background is a vast, deep blue ocean meeting a sky filled with numerous wispy, white cirrus clouds. The overall lighting is bright, suggesting a clear day.

Jet Stream Cirrus



Cumulus of Fair Weather

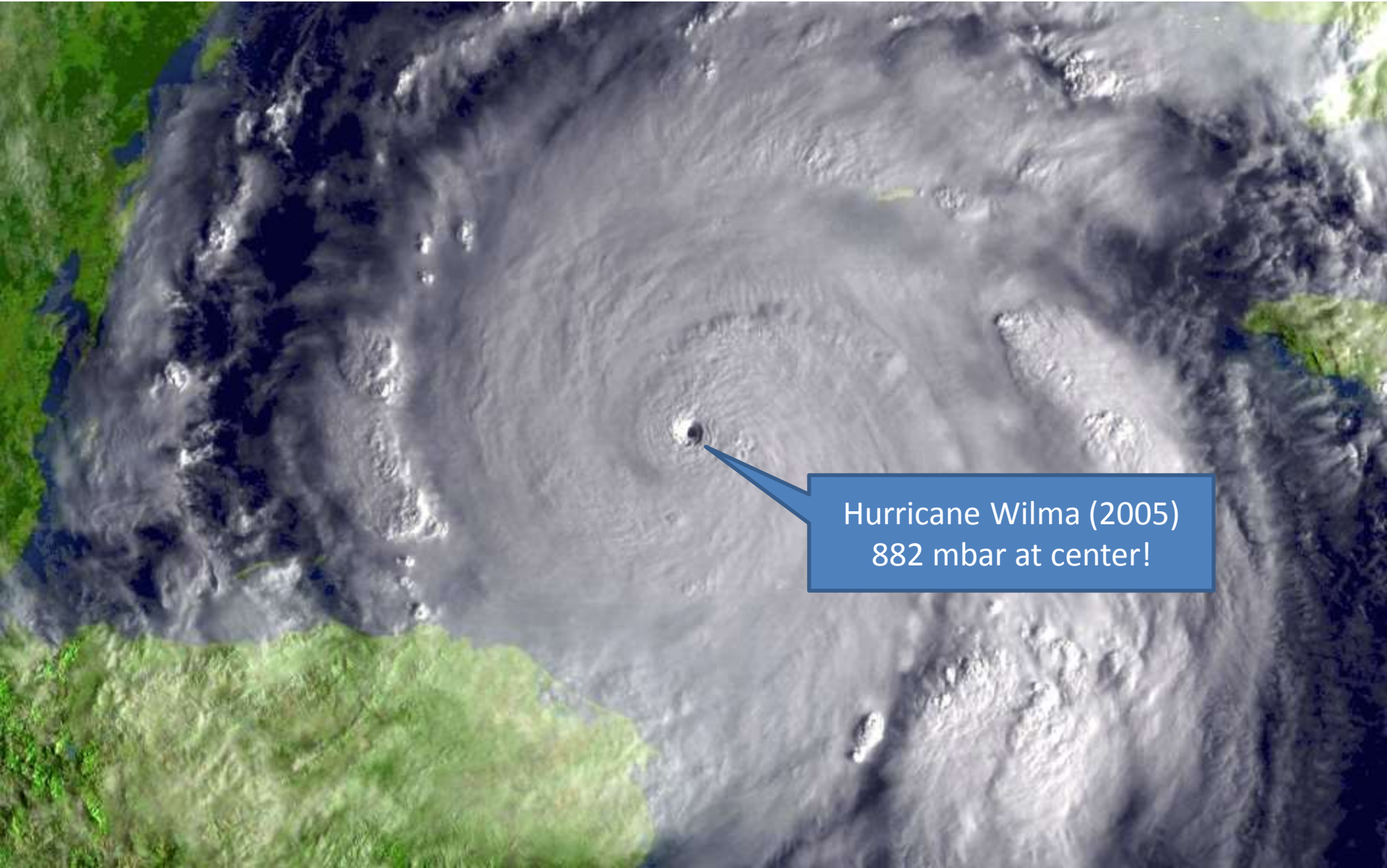
Cumulus Congestus



Reading the Weather

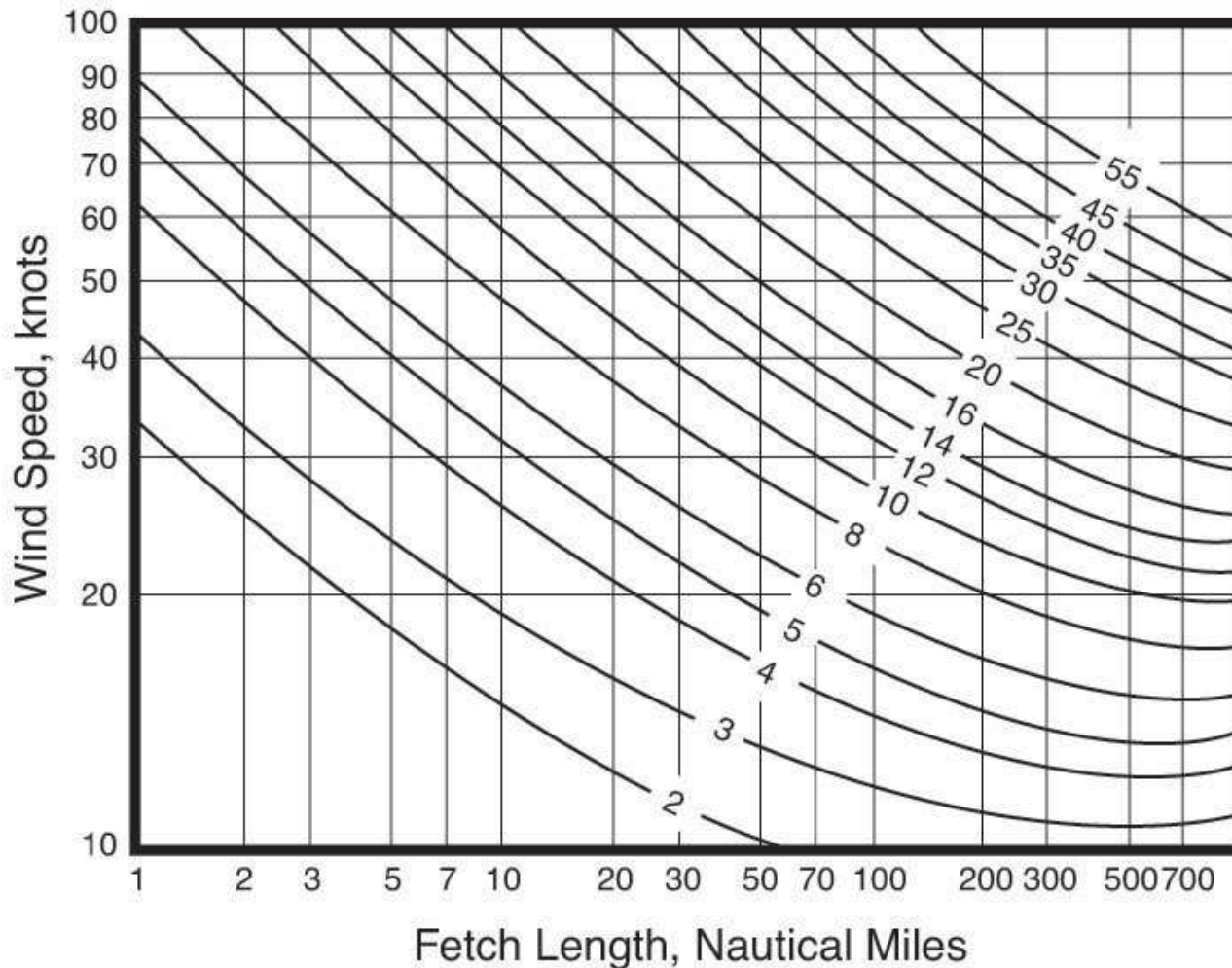
- Building cumulus clouds signal wind and storm
- Falling barometer
 - Millibars (mb or mbars) typically 1013.25 mbar
 - Falling 4 mb in 3 hours, expect winds 20+ knts
 - Falling 6 mb in 3 hours, expect gale-force winds!

Falling barometer = a Low is coming



Hurricane Wilma (2005)
882 mbar at center!

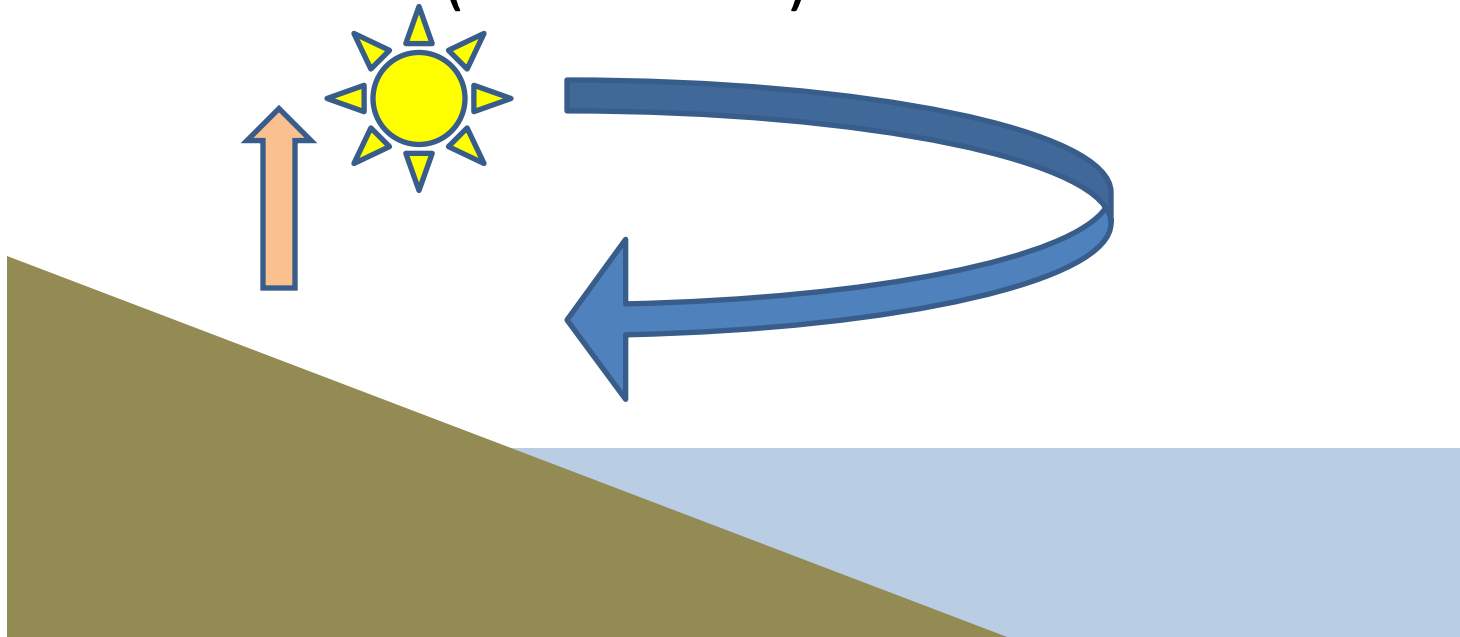
The Wind Drives the Waves



The Effects of Land

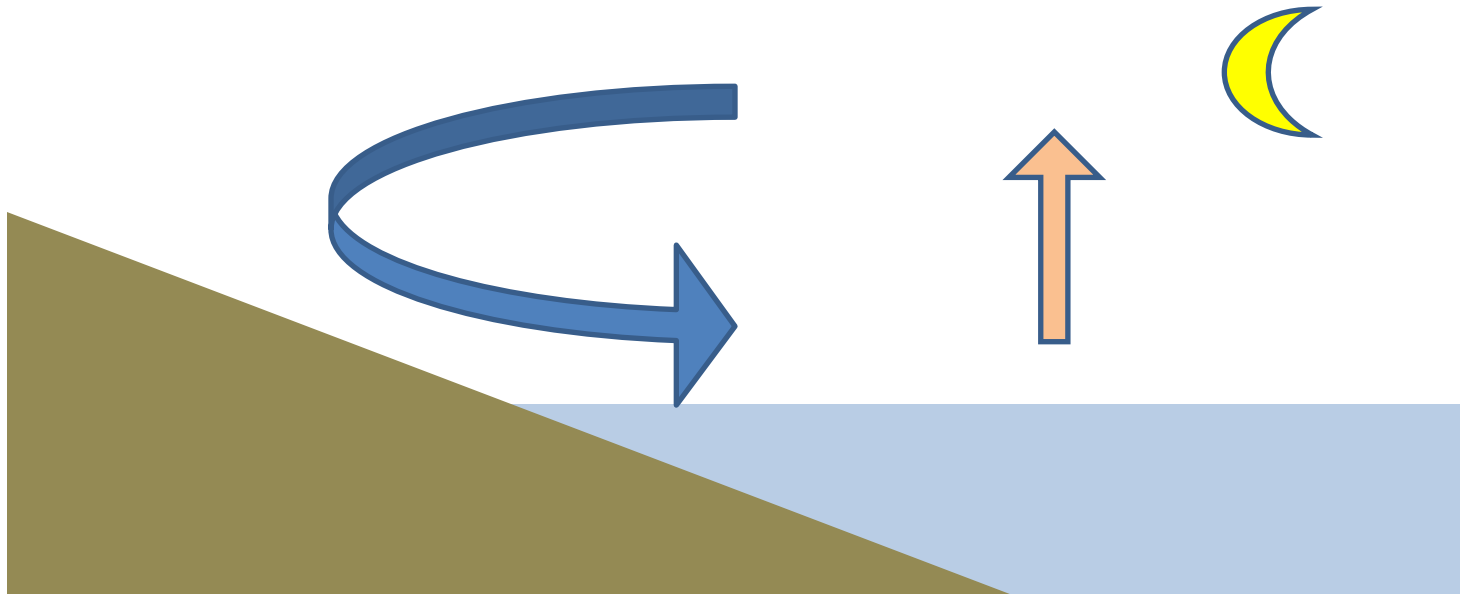
Morning to Afternoon

- Land heats up, air rises, cools, sinks again, wind picks up
- Warm air rises over land, cool air from the sea moves inland (sea breeze)



The Effects of Land Evening to Night

- Land cools, convection stops, winds die down
- Warm air rises from the water, cool air flows down coastal slopes (land breeze)



What forecasts are available and how to make use of them?

FORECASTING PRODUCTS

Predicting the Weather

- Use multiple sources
 - Triangulate
- Are forecasts in disagreement or changing over time?
 - Suggests uncertainty in the model. Be cautious.

Day sailing - off your mooring and back

- Look at forecast charts
 - Is there a front coming with a major change in wind and weather?
 - or are things stable and so shift attention to detail?
- Listen to (or read) the marine weather forecast
- Consider your knowledge of the local wind effects
 - Sea breezes, effects of islands, straits, and channels

NWS Marine Forecast

ANZ200-251300- 717 PM EST SUN JAN 24 2016

.SYNOPSIS FOR MASSACHUSETTS AND RHODE ISLAND COASTAL WATERS... HIGH PRES WILL BUILD OVER THE NATION/S EAST TONIGHT...THEN MOVE OFFSHORE OF THE MID ATLANTIC COAST MON. A WEAK COLD FRONT WILL SLOWLY APPROACH THE FROM THE WEST...PASSING ACROSS THE WATERS WED MORNING. HIGH PRES RETURNS TO NEW ENGLAND WED NIGHT AND THU THEN SHIFTS NE TOWARD THE CANADIAN MARITIMES THU NIGHT. ON ITS HEELS WILL BE AN OCEAN STORM PASSING WELL SE OF NANTUCKET FRI.

ANZ230-251300- BOSTON HARBOR- 717 PM EST
SUN JAN 24 2016 TONIGHT NW WINDS 5 TO 10 KT. WAVES 1 FOOT OR LESS... EXCEPT 3 TO 5 FT AT THE OUTER HARBOR ENTRANCE.

MON NW WINDS 5 TO 10 KT...BECOMING W IN THE AFTERNOON. WAVES 1 FOOT OR LESS...EXCEPT 2 TO 4 FT AT THE OUTER HARBOR ENTRANCE.

MON NIGHT S WINDS 5 TO 10 KT. WAVES 1 FOOT OR LESS.

TUE SW WINDS 10 TO 15 KT...INCREASING TO 15 TO 20 KT IN THE AFTERNOON. GUSTS UP TO 30 KT. WAVES AROUND 2 FT.

TUE NIGHT SW WINDS 15 TO 20 KT WITH GUSTS UP TO 30 KT... DIMINISHING TO 10 TO 15 KT WITH GUSTS UP TO 20 KT AFTER MIDNIGHT. WAVES AROUND 2 FT.

WED W WINDS 5 TO 10 KT. WAVES 1 FOOT OR LESS.

WED NIGHT W WINDS 5 TO 10 KT...BECOMING NW AFTER MIDNIGHT. WAVES 1 FOOT OR LESS.

THU E WINDS AROUND 5 KT. WAVES 1 FOOT OR LESS.

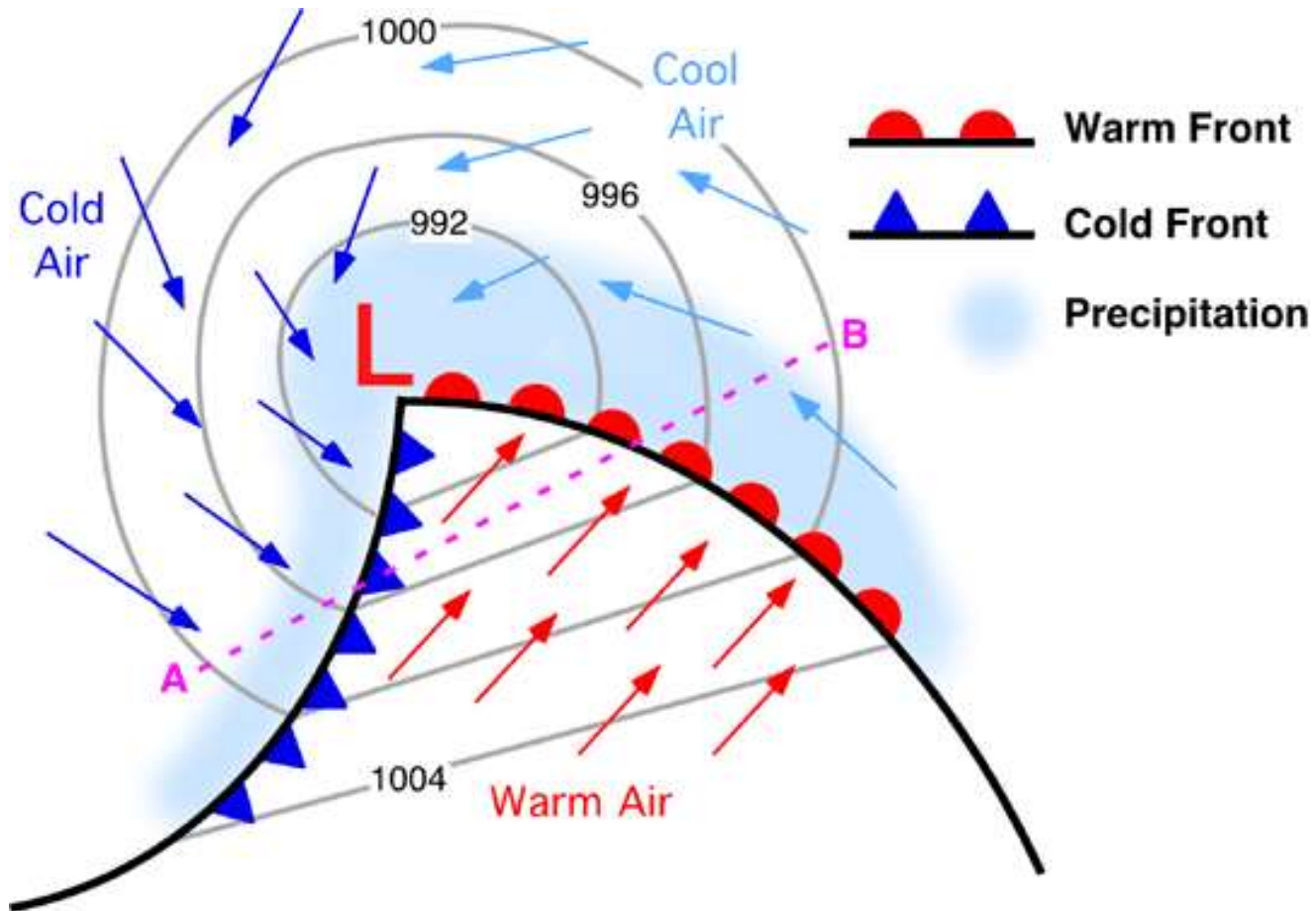
THU NIGHT E WINDS 5 TO 10 KT. WAVES 1 FOOT OR LESS. A CHANCE OF SNOW. VSBY 1 TO 3 NM.

FRI N WINDS 5 TO 10 KT. WAVES 1 FOOT OR LESS. A CHANCE OF SNOW AND RAIN. VSBY 1 TO 3 NM.

FRI NIGHT NW WINDS 5 TO 10 KT. WAVES 1 FOOT OR LESS...EXCEPT 2 TO 4 FT AT THE OUTER HARBOR ENTRANCE.

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Read the local paper



Coastal sailing for a few days

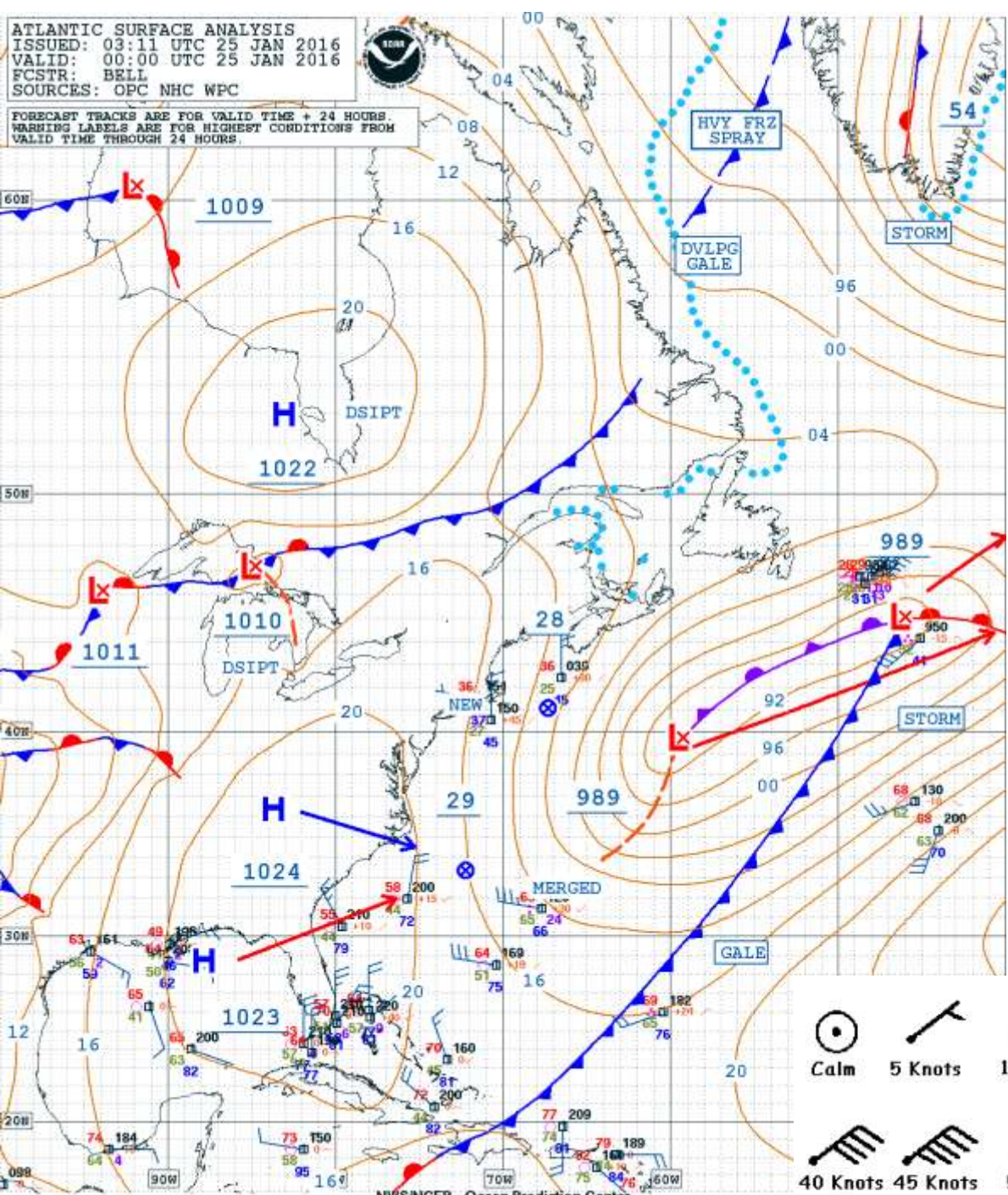
- Hope for the best; plan for the worst
- Is it safe now, and is the window opening or closing?
- What's the down side look like?
 - If the wind shifts, will you be beating all the way home?
 - What's "Plan B"?

Sources of Weather Forecasts

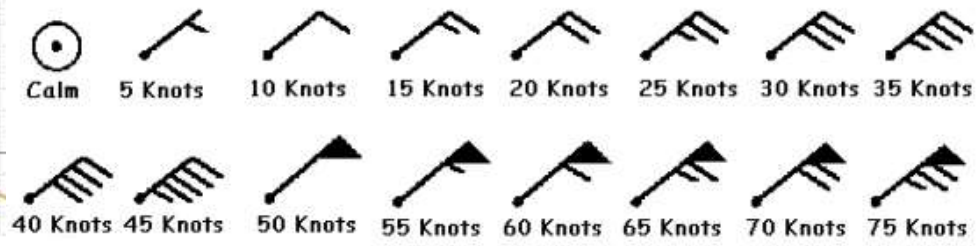
- National Weather Service Marine Forecast
 - www.weather.gov/marine
 - Also available for mobile devices mobile.weather.gov
 - A long list of government sources for weather
- NOAA Weather Radio
 - WX on your VHF radio
- NOAA Weather Fax
- Commercial Products
 - Examples: SailFlow, Buoyweather, Predict Wind, mobileGrib

ATLANTIC SURFACE ANALYSIS
ISSUED: 03:11 UTC 25 JAN 2016
VALID: 00:00 UTC 25 JAN 2016
FCSTR: BELL
SOURCES: OPC NHC WPC

FORECAST TRACKS ARE FOR VALID TIME + 24 HOURS.
WARNING LABELS ARE FOR HIGHEST CONDITIONS FROM
VALID TIME THROUGH 24 HOURS.



NOAA Weather Fax Surface Charts



NOAA Weather Fax – Wind/Wave

24-HOUR WIND & WAVE FORECAST (FEET)

ISSUED: 06:06 UTC 24 JAN 2016

VALID: 00:00 UTC 25 JAN 2016

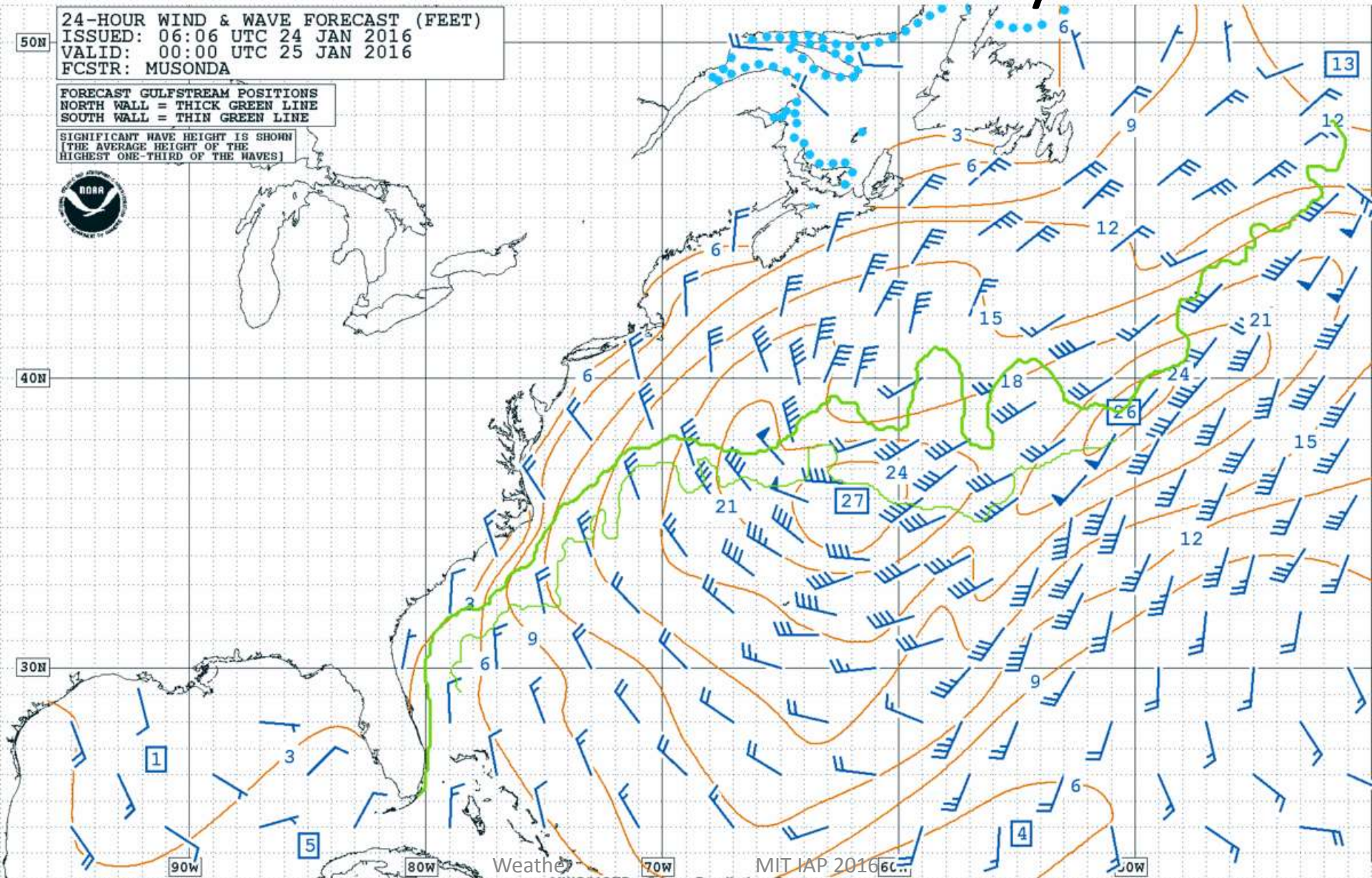
FCSTR: MUSONDA

FORECAST GULFSTREAM POSITIONS

NORTH WALL = THICK GREEN LINE

SOUTH WALL = THIN GREEN LINE

SIGNIFICANT WAVE HEIGHT IS SHOWN
(THE AVERAGE HEIGHT OF THE
HIGHEST ONE-THIRD OF THE WAVES)



Weather

70W

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60W

50W

SailFlow

<http://www.sailflow.com/>

Forecast Tables

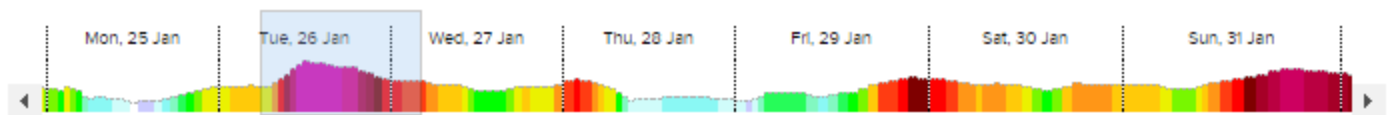
Quicklook/Plus Forecast

Daily 7 Day

Basic Detailed

Tue, 26 Jan

Hour	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12
Wind (mph)	11	10	10	11	12	13	14	15	17	18	21	23	22	22	22	21	21	20	19	18	17	17	1
Gust	19	19	19	19	18	17	22	26	31	35	40	44	43	41	40	39	38	37	34	31	28	26	2
Sky	☀	☀	☀	☀	☀	☁	☁	☁	☁	☁	☁	☁	☀	☀	☀	☀	☀	☁	☀	☀	☀	☀	☀
°F	32	32	32	33	34	35	37	39	41	42	43	45	45	44	44	43	43	42	41	40	39	39	3
Wave Ht(ft)	2	2	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	
Per(s)	10	10	10	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	7	5	3	3	



Demos

Fair Winds and Following Seas!

