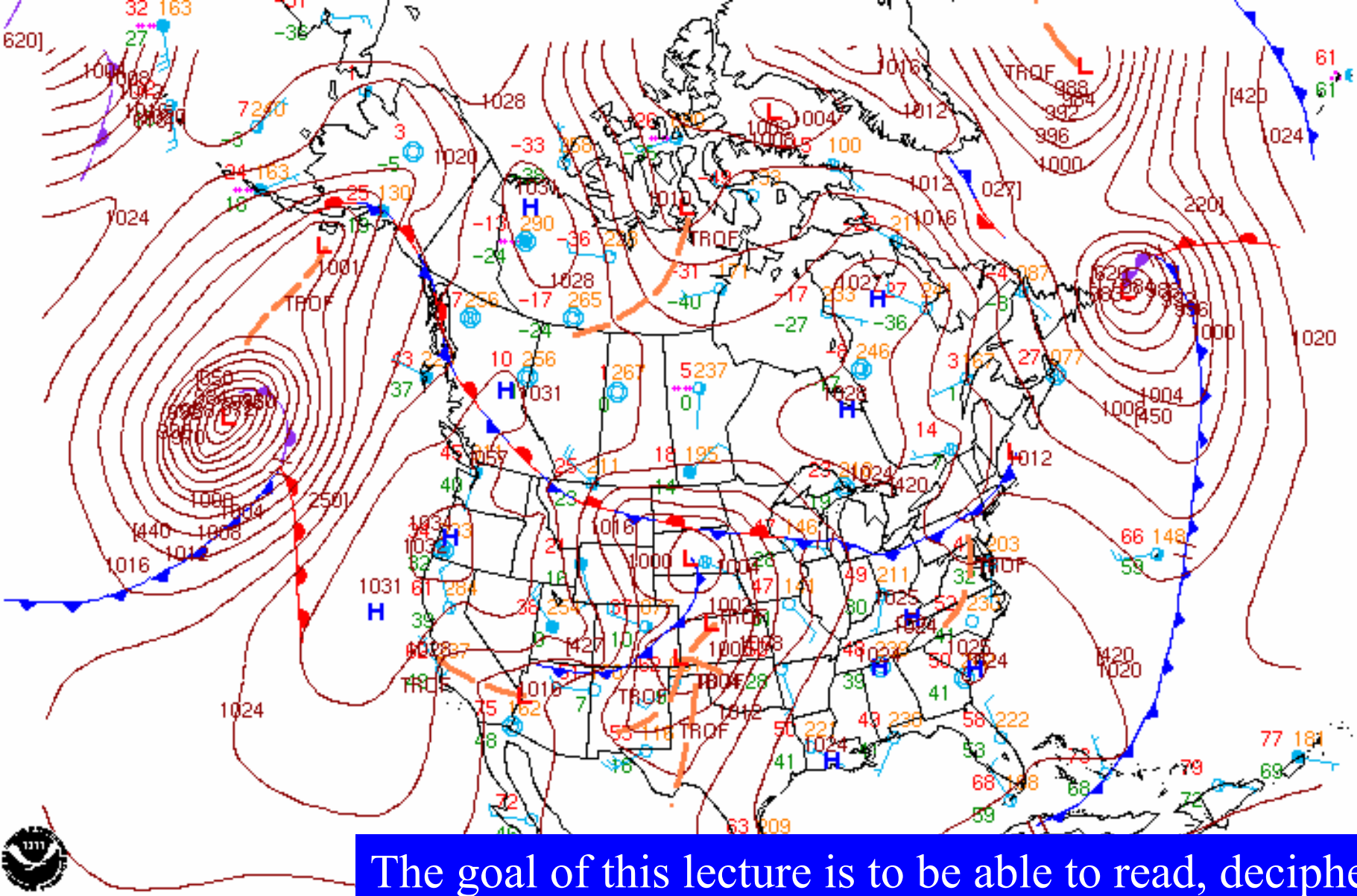




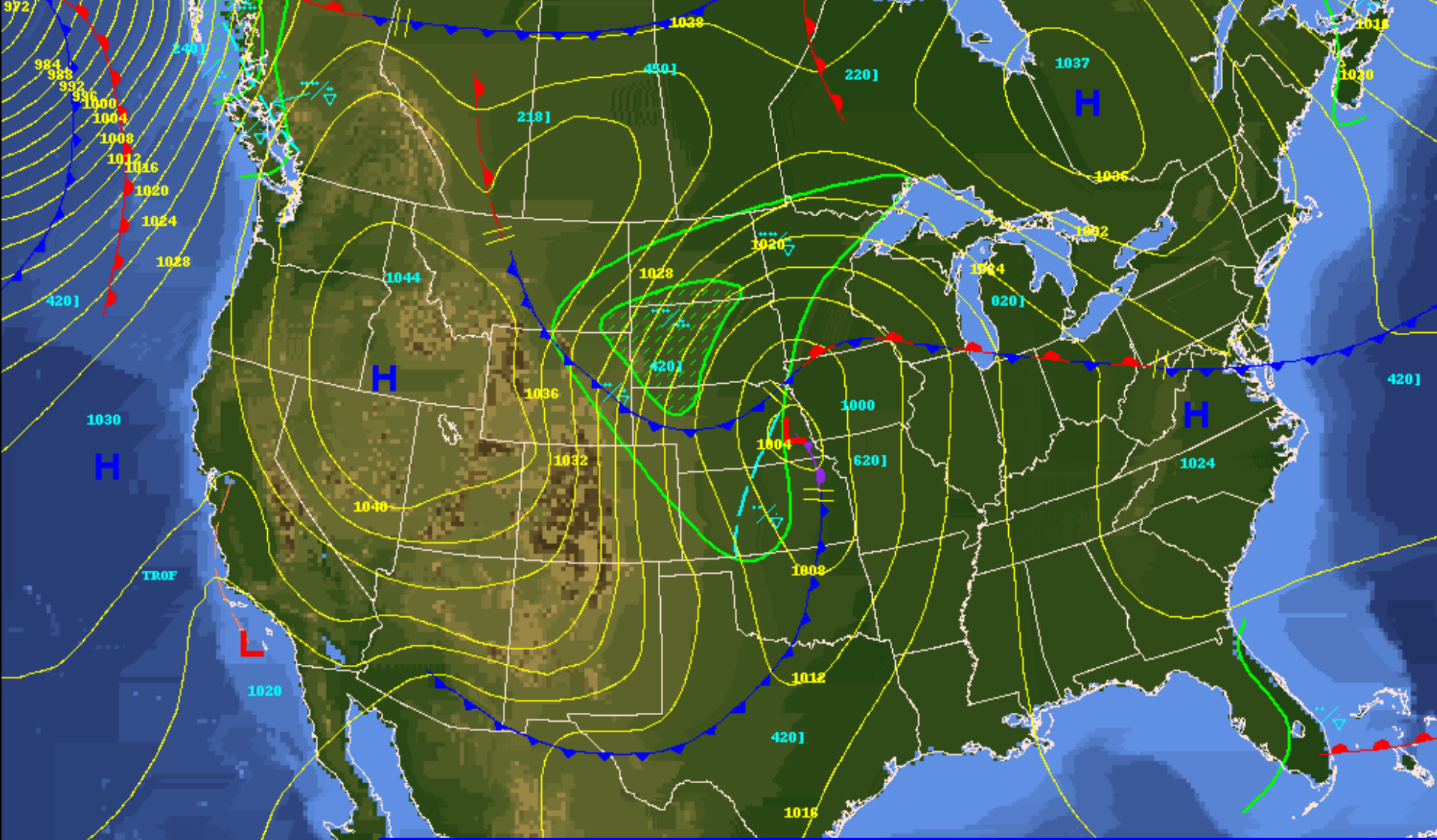
Weather for the Mariner

CDR Donna Sengelaub



The goal of this lecture is to be able to read, decipher and understand a surface weather chart and.....

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...and to be able to forecast weather for your position using the information on a prognostic (forecast) chart .

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Weather Generalizations

- Weather generally moves from west to the east.
- Always be aware that your boat is moving relative to moving weather systems.
- Generally, if one did not move relative to the weather, one would observe weather to move in sequence, i.e. high pressure would eventually be replaced by low pressure and low pressure would eventually replace high pressure
- Pay attention to changes in cloud formation and the direction from which clouds approach.
- Clouds are the mariner's best visual indicator of changing weather.



Weather Generalizations

- Observe the sea surface condition in relation to weather conditions. Gradually increasing ripples on the water are first indication of increasing wind.
- Long parallel streaks in the water where foam and flotsam/jetsam line up (called Langmuir Circulation) runs parallel with the wind and is a good indicator of true wind direction.
- Generally, warm, moist air fuels low pressure. So warm currents such as the Gulf Stream can cause dying low pressure systems to redevelop and deepen.
- Low Pressure systems are associated with storms and high pressure systems serve to block these storms.



Weather Generalizations

- Changes in air pressure, wind direction, humidity and temperature are excellent indicators of changing weather.
- If wind barbs indicate that temperature and dew point differ by 5 degrees expect fog. If temperature and dew point differ by 3 degrees or less expect rain.
- Use Buys Ballot's law to locate general location of high and low pressure centers.



Weather vs Climate

- Climate is what you expect.
- Weather is what you get.



Air Masses

- Air masses are vast bodies of air with uniform temperature and moisture
- Air is modified by its source region or in other words, the area over which the air originates.
- Therefore, air masses are modified to be a combination of:
 - Cold or warm
 - Continental (dry air) or Maritime (moist air)
- The next slide shows six regions in North America where air masses are formed and modified.



1
2
Very cold, dry

3
Cool, moist

4
Cold, dry

5
Cool, moist

6
Hot, dry

Warm, moist



Air Masses

• The types of air masses are called:

1. Maritime polar
cool and moist
2. Arctic
very cold and dry
3. Continental polar
cold and dry
4. Maritime Polar
Cool and moist
5. Continental tropical
Hot and dry
6. Equatorial/Maritime tropical
(always warm and moist)





Air Pressure and Pressure Trends

- Air Masses cause changes in the barometric pressure of the air
- Barometric pressure is a very important indicator of impending weather
- Rapid pressure changes
 - Over 6 mb fall (or rise) in 3 hours
- Moderate pressure changes
 - 3-6 mb fall (or rise) in 3 hours
- Slow pressure changes
 - 3 mb fall (or rise) in 3 hours

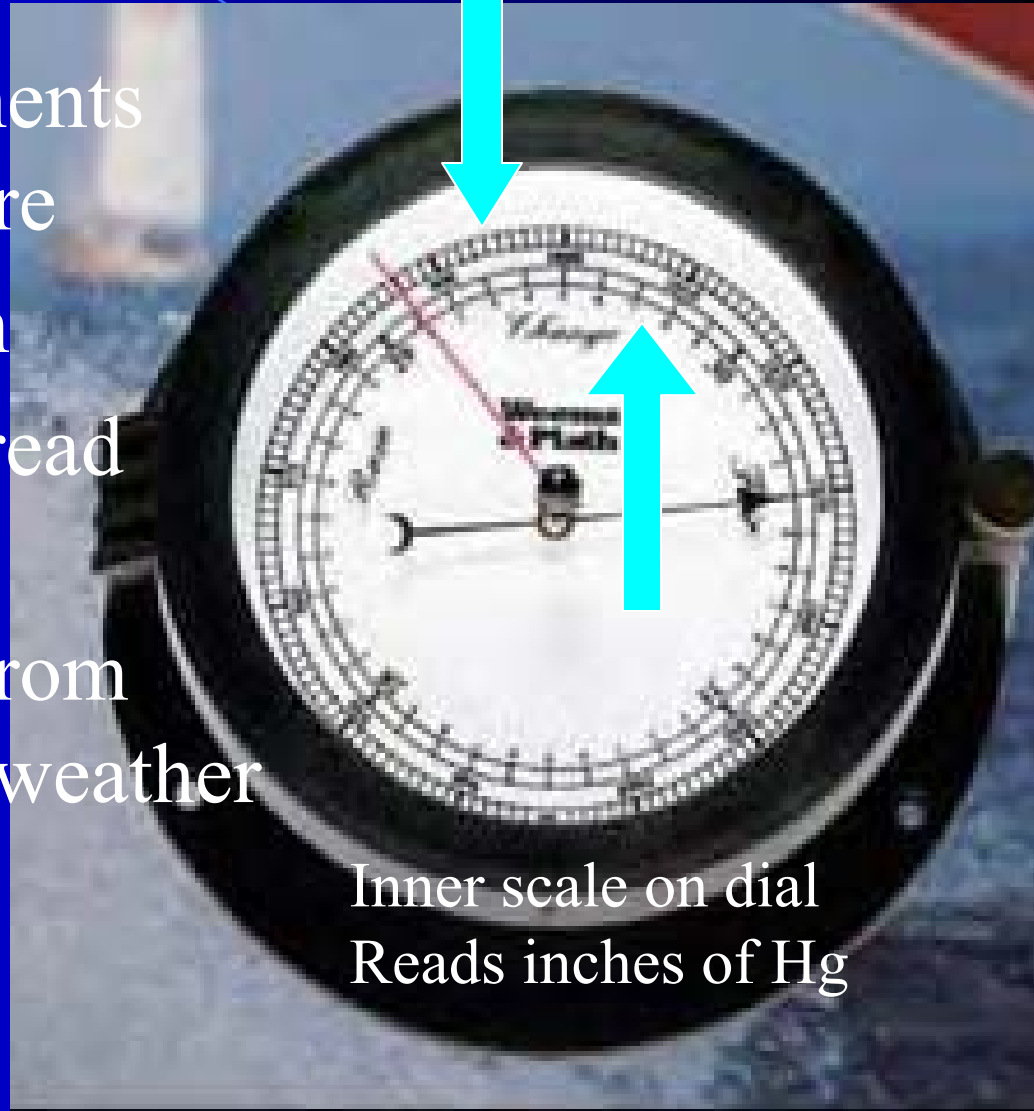


- Barometric pressure is a very important indicator of impending weather
- Barometric pressure should be logged every hour





Outer scale on dial
reads millibars



Inner scale on dial
Reads inches of Hg

- Barometers are instruments that measure air pressure
- Pressure is measured in
 - inches of mercury (read from inside dial)
 - millibars mb (read from outside dial used on weather charts)



Pressure Trends

- It is important to log barometric pressure every hour and keep track of pressure trends—
- When you do this, look to see how the barometric pressure changes within a 3 hour period.
- Rapid pressure changes
 - Over 6 mb fall (or rise) in 3 hours
- Moderate pressure changes
 - 3-6 mb fall (or rise) in 3 hours
- Slow pressure changes
 - 3 mb fall (or rise) in 3 hours



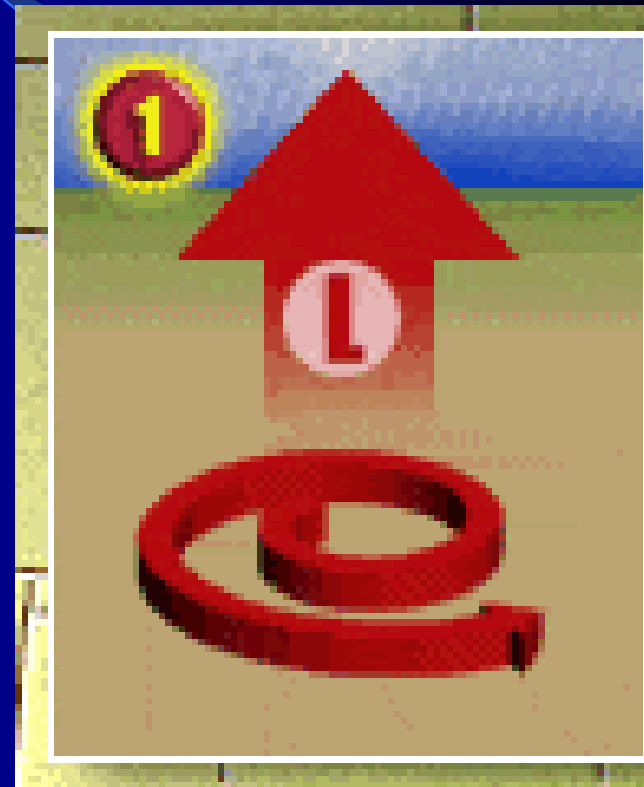
Air Masses and Pressure

- Two types of air pressure:
- High pressure
 - Think of high pressure as a mound or hill of air
- Low pressure
 - Think of low pressure as a depression of air

Low Pressure



- Air rises at the center of low pressure
- Air circulates around low pressure centers counter clockwise and pulls the surrounding air inward like a vacuum
- Low pressure centers are the anchoring points for fronts.
 - 950 mb is a very deep low pressure system (results in an intense storm)
 - 988 mb is a moderately deep low pressure system
- Associate low pressure with storms or deteriorating weather





High Pressure

- Air sinks at the center of high pressure
- Air circulates around high pressure centers clockwise and deflects the air outward.
- High pressure tends to block or deflect approaching bad weather
- High pressure indicates fair and dry weather
 - 1035 mb is a very strong high pressure center
 - 1012 is a moderately strong high pressure center





Wind and Pressure

- Wind is the result of high and low pressure differences and the atmosphere's attempt to equalize the two
 - Air tends to flow from high pressure (mound of air) and toward low pressure (depression of air)



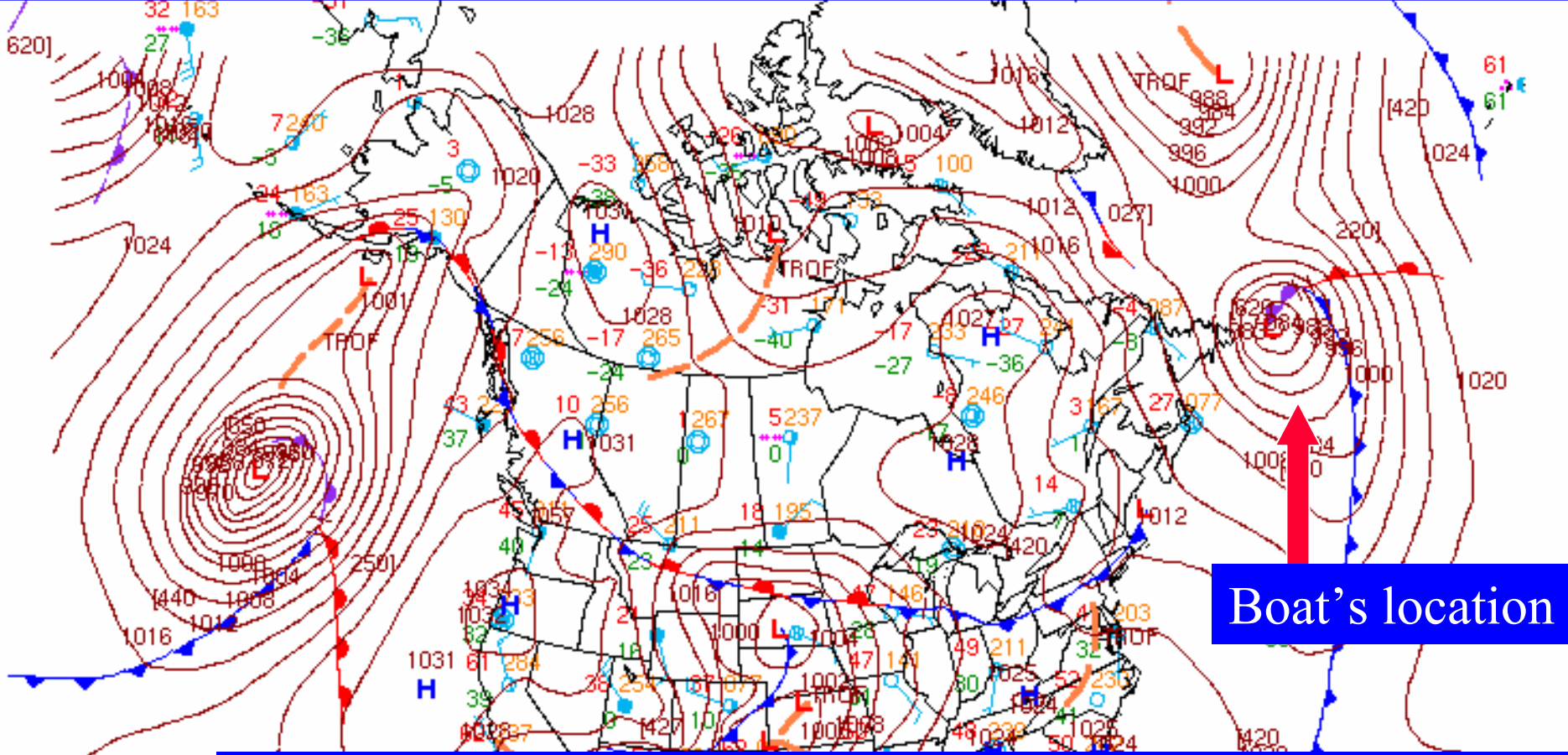
Wind and Pressure

- The greater the pressure difference between high and low pressure, the greater the wind speed
- Wind direction is always indicated *from* the direction the wind is blowing
 - For example, NE wind blows from the NE
 - A southerly wind blows from the south



Wind and Pressure

- Isobars on a weather chart are contours of pressure around a high or low pressure center
 - Isobars are indicated in millibars (mb)
 - Barometric Pressure is lowest at the center of a low
 - Barometric Pressure is highest at the center of a high
- Tightly packed isobars on a weather chart indicate a strong gradient or wind.



Boat's location

Where on this chart are the winds the strongest?

The point of the red arrow indicates your boat's location. Knowing what you know about the direction of winds around a low, what direction would the wind be coming from?

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Buys Ballot Law

- Its important to know where the low pressure center is located.
- This is thumb rule to use to locate the low pressure system relative to your location.
 - Stand with the wind at your back
 - Turn 15 deg to your right
 - Low pressure will be to your left and high pressure will be to your right




Sea Breeze

- Sea Breeze can be felt as far as 40 miles offshore. A sea breeze occurs almost daily and blows from the ocean toward land.
- It is caused by the differential heating between land and water. Land heats up and cools faster than water. As land heats up during the day, a thermal low pressure forms over land. Water is relatively cooler than the land and therefore has relatively higher pressure than the land.
- Since wind always blows from higher to lower pressure, air moves from the water to land and a sea breeze results.
- Sea Breezes normally occur close to sunset and can last up to 12 hours. The hotter the land and cooler the water relative to the land, the stronger the sea breeze.
- So if the weather is hot and you are becalmed during the day, the winds will pick up after sunset.



Land Breeze

- Land Breeze is the reverse of a sea breeze. It also can be felt as far as 40 miles offshore. A land breeze occurs almost daily and blows from the land toward the ocean.
- It is caused by the differential heating between land and water. Land cools down faster than water. As land cools down at night, high pressure forms over land. Water is now relatively warmer than the land and therefore has relatively lower pressure than the land.
- Since wind always blows from higher to lower pressure, air moves from the land to the water and a land breeze results.
- Land Breezes normally occur after sunrise and can last up to 12 hours. The colder the land and warmer the water relative to the land, the stronger the land breeze.



Air Masses and Frontal Systems

- When two different air masses collide, the boundary of the collision is called a front.
- Four Types of fronts:
 - Cold front
 - Warm front
 - Occluded front
 - Stationary front





Cold Front

- 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





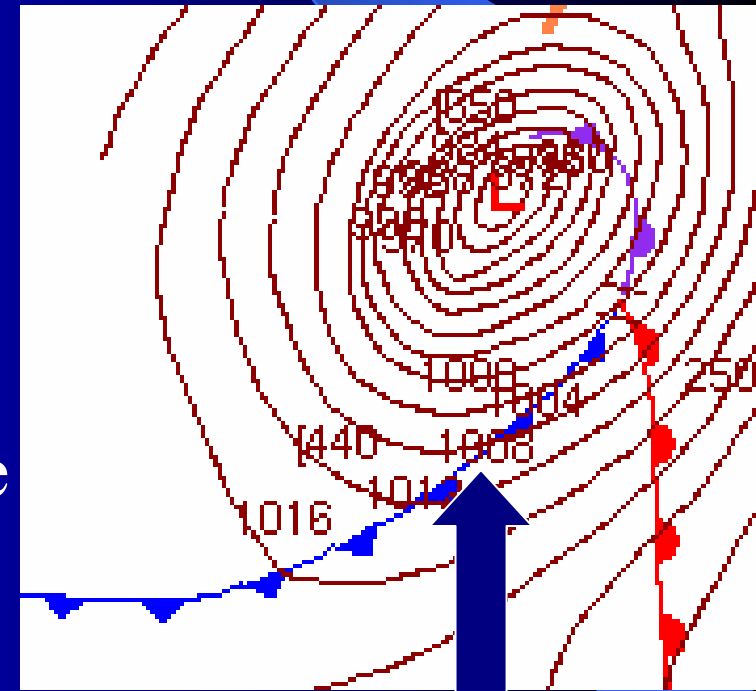
Cold Front Weather

- Heavy rain
- Thunder and lightning
- Tornados
- Hail

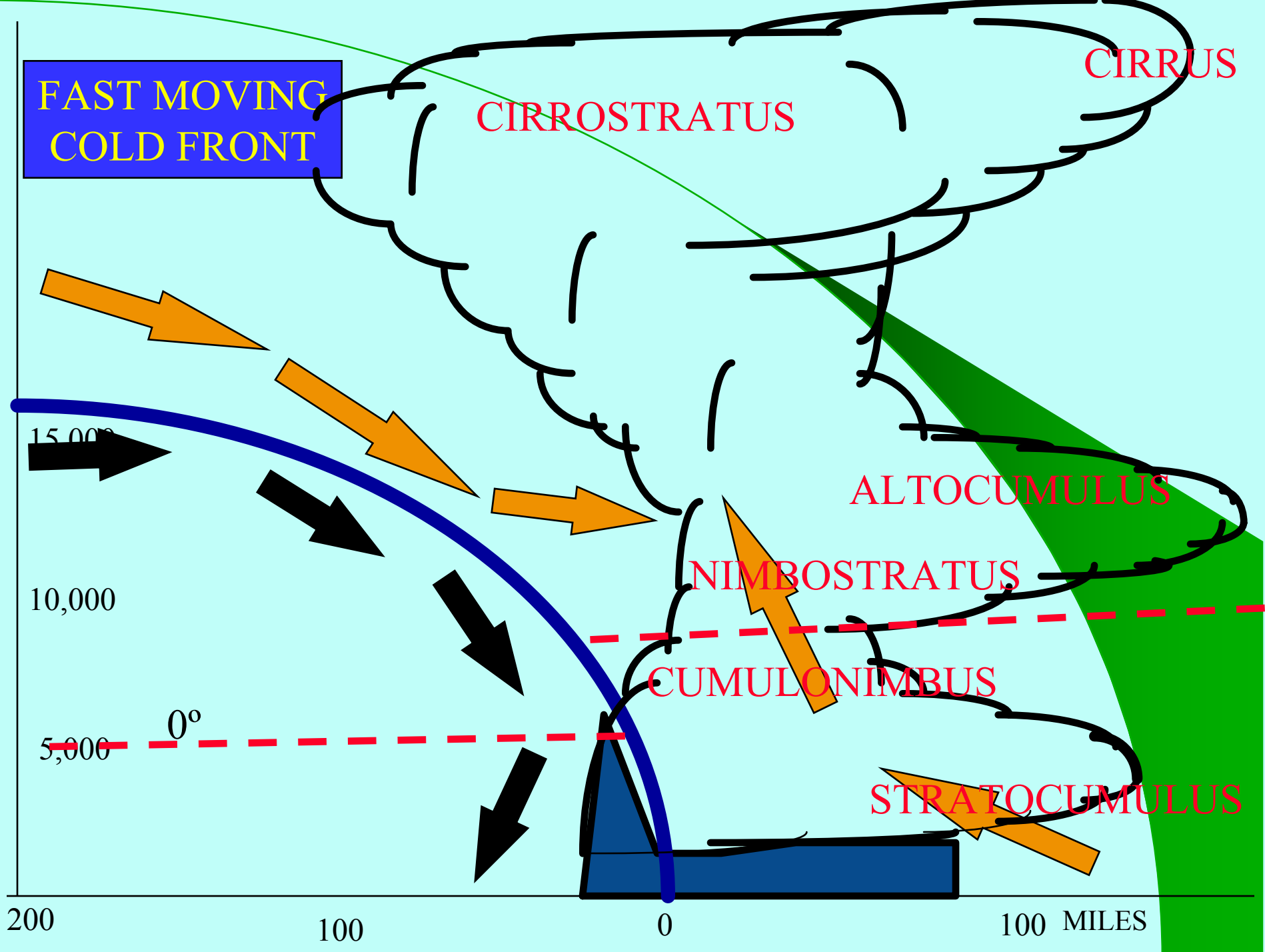


Cold Front Weather Sequence

- Winds steady from SW
- Altocumulus (**Ac**) clouds (mid-level puffy clouds) on W or NW horizon
- Barometer pressure falls
- Clouds progressively lower and thicken
- Cumulonimbus (**Cb**) clouds or Thunderheads form
- Symbol to mark the boundary of the front is a line with blue triangles (cold air is behind the line)



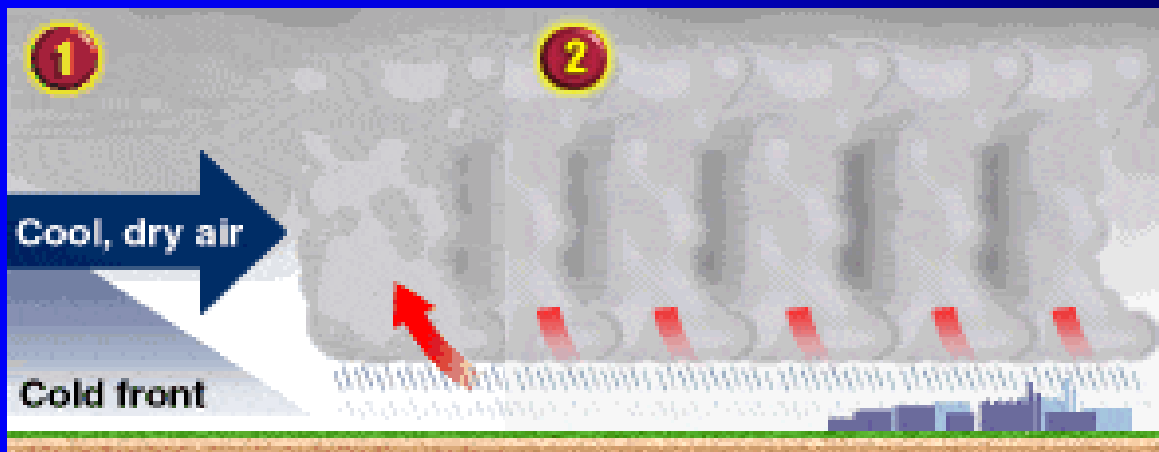
Cold front symbol





Cold Front Weather Sequence

- Squalls: precede front by 5-6 hours
 - Intense black clouds
 - Violent gusty winds
 - Cold blast of wind several miles ahead of front





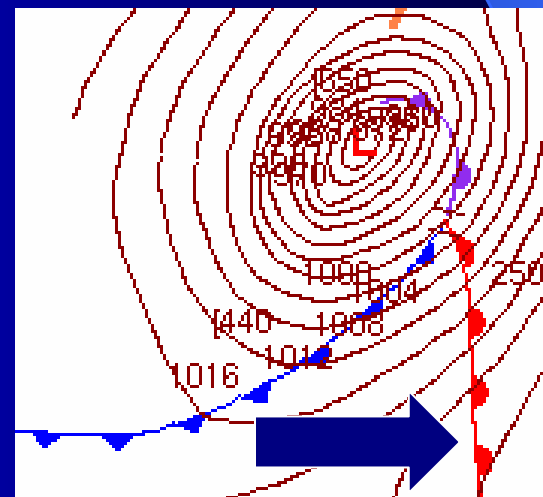
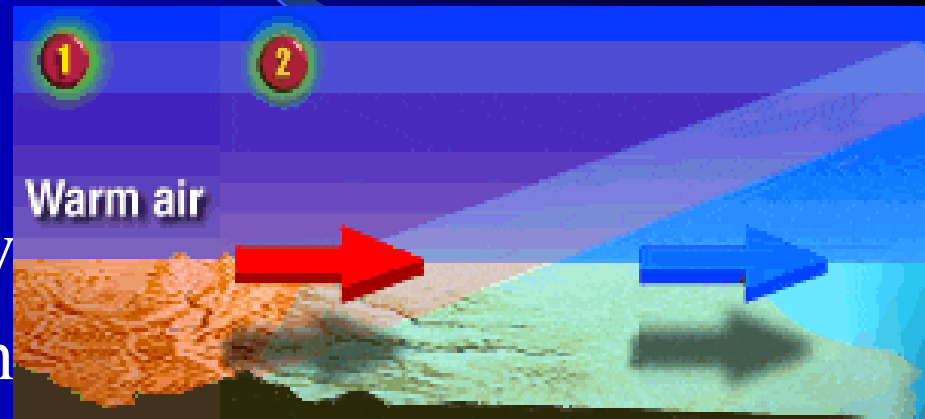
Cold Front Weather Sequence

- As front passes, weather is as follows:
 - Wind veers (moves clockwise) from SW to W-NW
 - Barometer pressure at lowest
 - Rain or squall
 - Thunder and lightning
 - Rapid clearing of sky
 - Strong gusty winds from W-NW
 - Air temperatures become colder



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)



Warm front symbol



Warm Front Weather

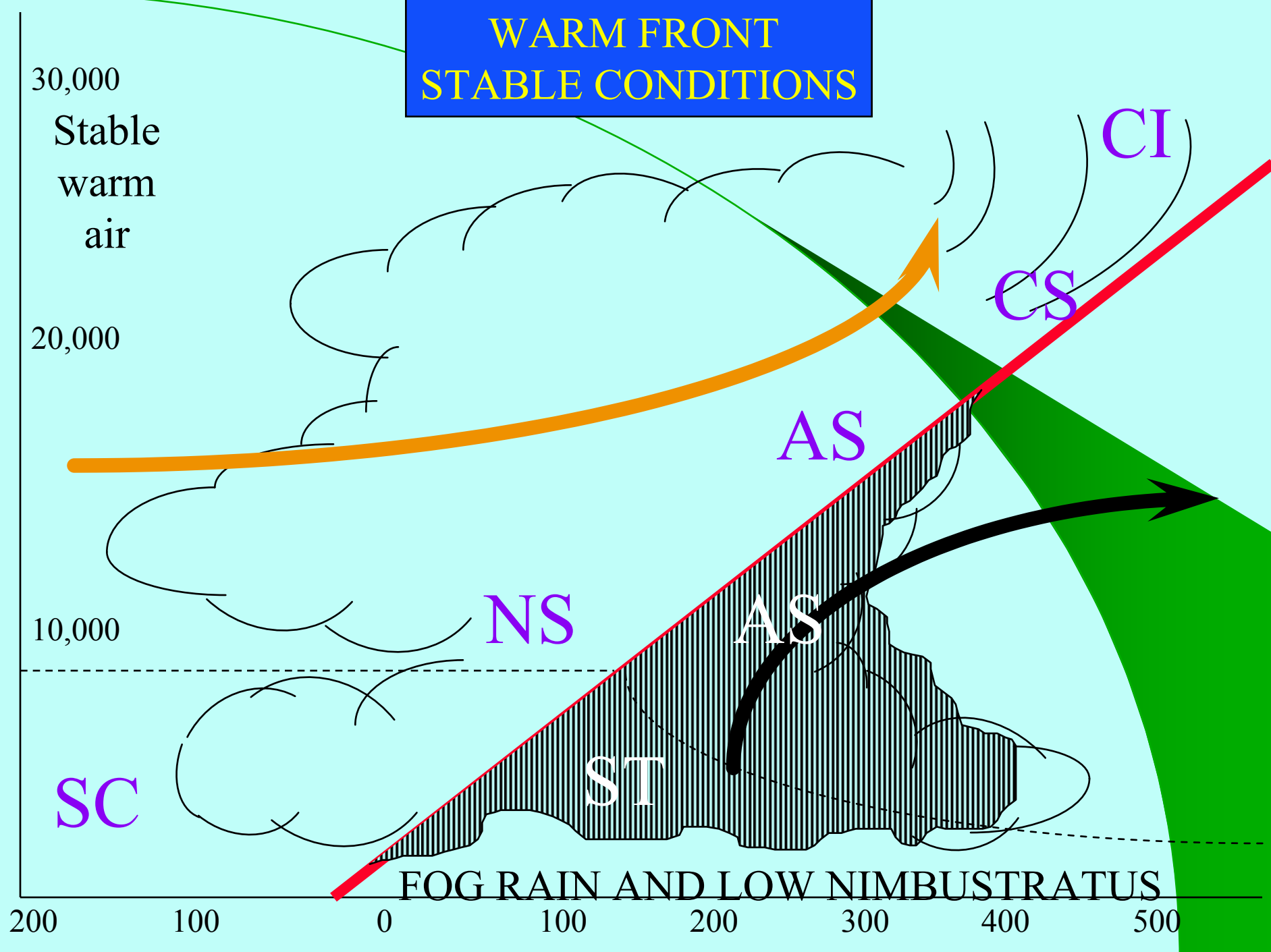
- Cirrus clouds (**Ci**) (high clouds) thicken to Cirrostratus (**Cs**) then Altostratus (mid-level) clouds, then Ns (low dark rain clouds)
- Steady light rain
- Persistent fog
- Barometer pressure falls



Warm Front Weather Sequence

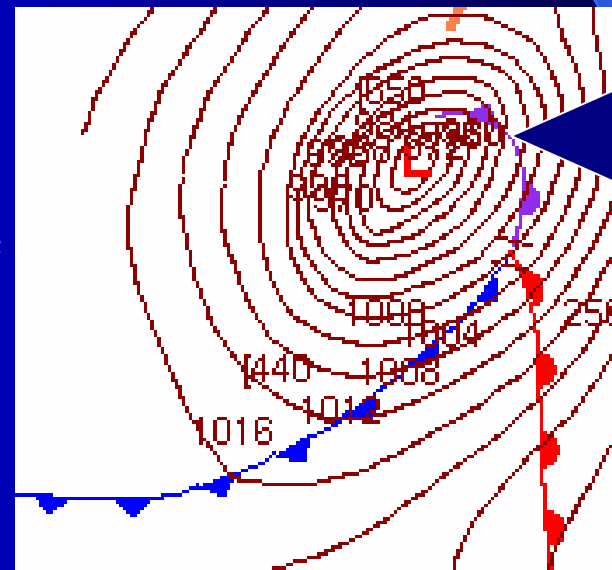
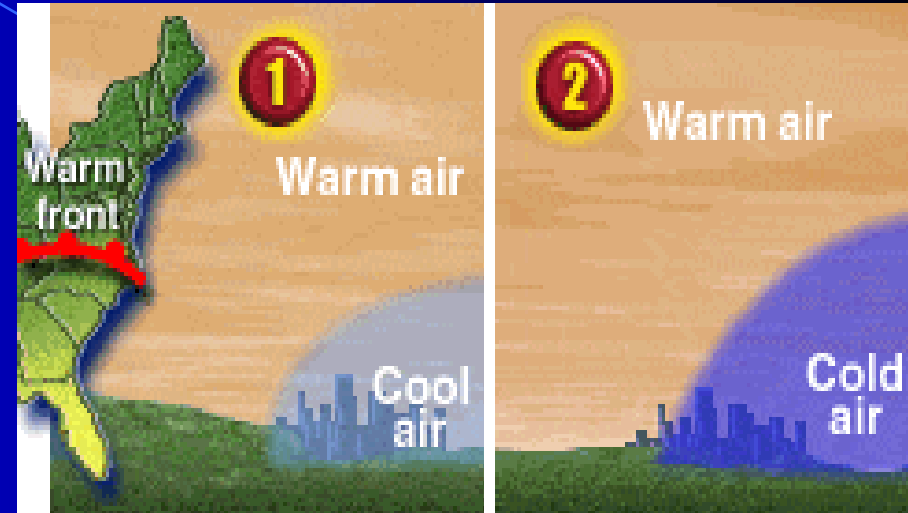
- Front passes gradually, less intense than cold front
- Wind veers (rotates clockwise) from S-SE to SW
- Drizzle and fog may persist
- Rain and thick clouds diminish
- Air temperatures become warmer

**WARM FRONT
STABLE CONDITIONS**



Occluded Front

- Occurs when cold front overtakes the warm front
- Weather is a combination of cold steady, misty rain and drizzle
- Notice the symbol to mark the occluded front is a purple combination of a cold and warm front symbol

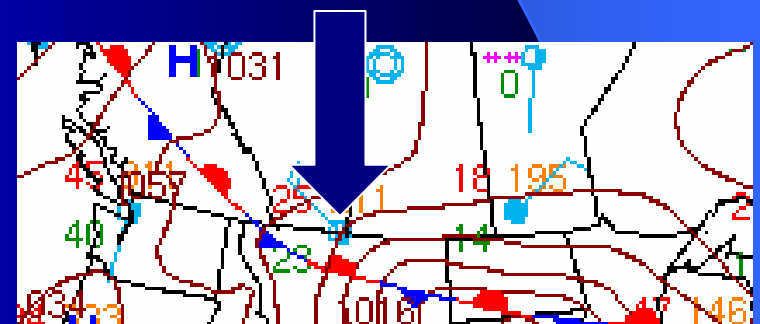
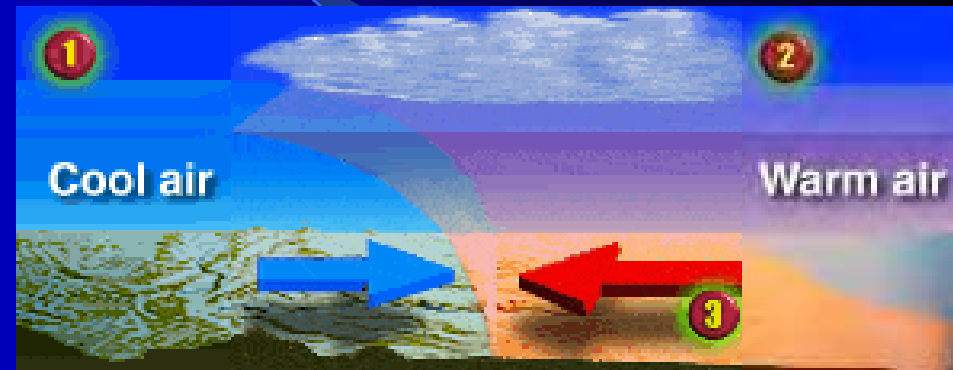


Occluded
Front
symbol



Stationary Front

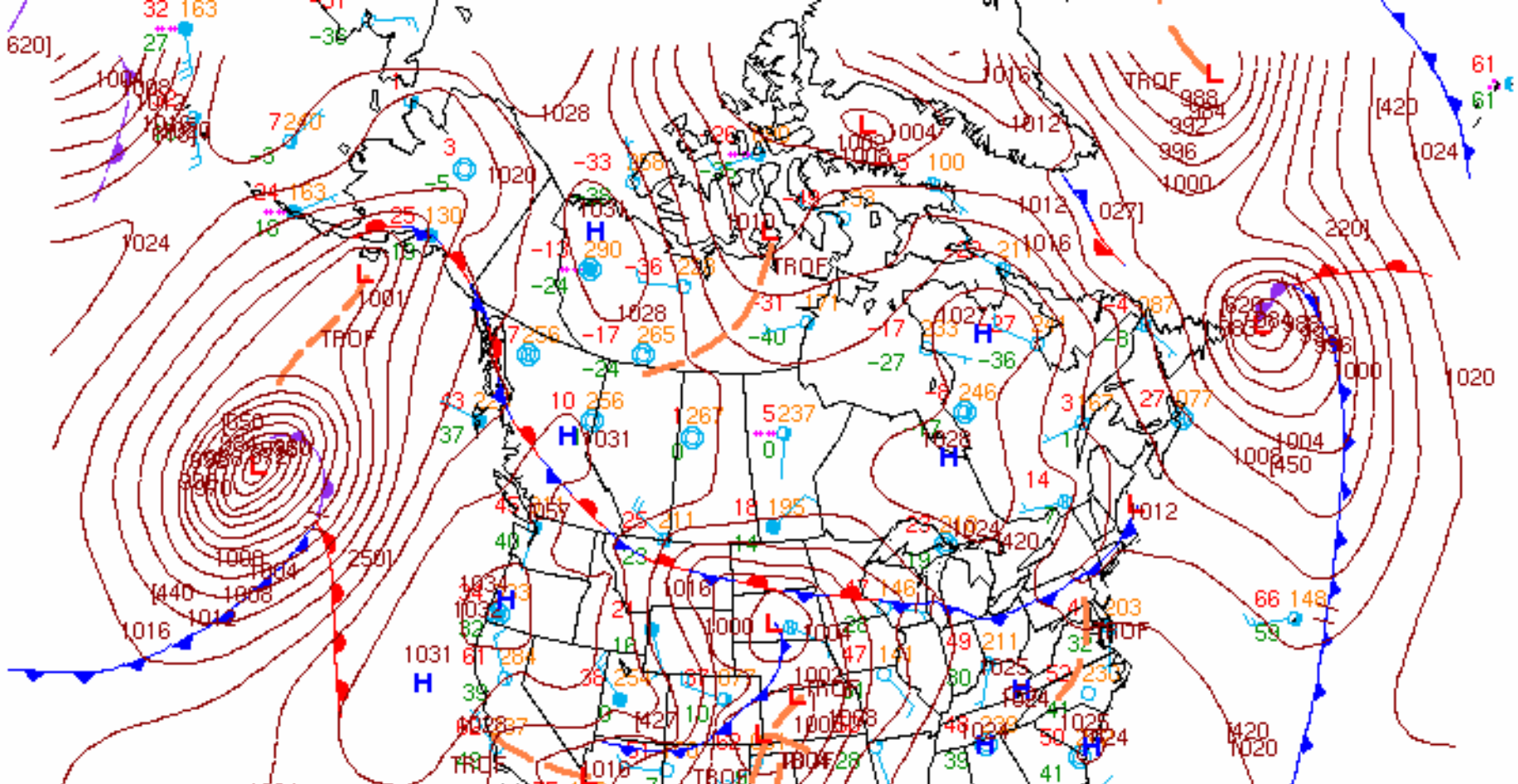
- Occurs when the frontal boundary either moves very slowly or does not move
- Notice that the symbol marking the stationary front is alternating red half circle on the warm air side and blue triangles on the cold air side



Stationary front symbol



The Jet Stream is the upper air current that moves low pressure centers. Lows act as vacuums and pull and rotate surrounding air masses toward its center. As these air masses rotate about the low, they collide and form fronts. Lows are analogous to the spiraling water you see when you drain water from your bathtub.



Can you pick out the warm fronts, cold fronts, occluded fronts and stationary fronts on this chart?

What kind of weather is associated with each?

How does the wind shift with each type of frontal passage?

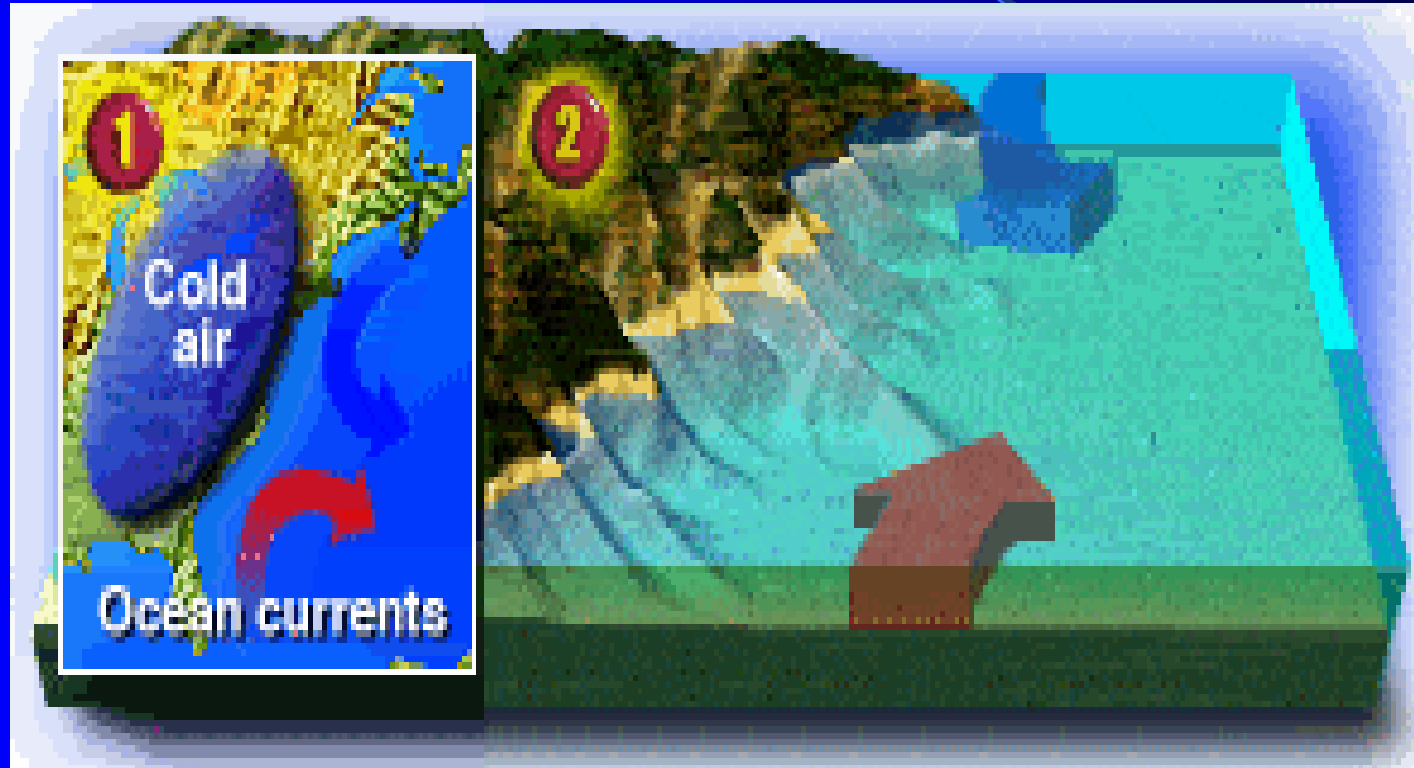


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Cape Hatteras

Conditions for the “Perfect Storm”?



Warm moist air adds fuel to low pressure systems. Therefore, the warm sector of the Gulf Stream can cause a Dying low pressure system moving offcoast to redevelop.



Clouds and Nautical Weather Sayings

- Red sky at night, sailor's delight. Red sky in the morning, sailor take warning.
- Mackerel skies and mare's tails make tall ships carry low sails.
- First rise after very low indicates a stronger blow.
- But what do they mean?!!



Clouds

- To understand the nautical sayings, we first need to talk a bit about clouds.
- Clouds are the mariner's most important visual indicator of changing weather.



Cloud Classifications

Clouds are classified by height :

low (stratus), mid level (alto) and high (cirrus) and

...texture:

heap (cumulus) or flat (stratus)

Latin	Translation	Example
cumulus	heap	fair weather cumulus
stratus	layer	altostratus
cirrus	curl of hair	cirrus
alto	height, upper air	altocumulus
nimbus	rain	cumulonimbus or nimbostratus



CDR Sengelaub's Cloud Watching Rule

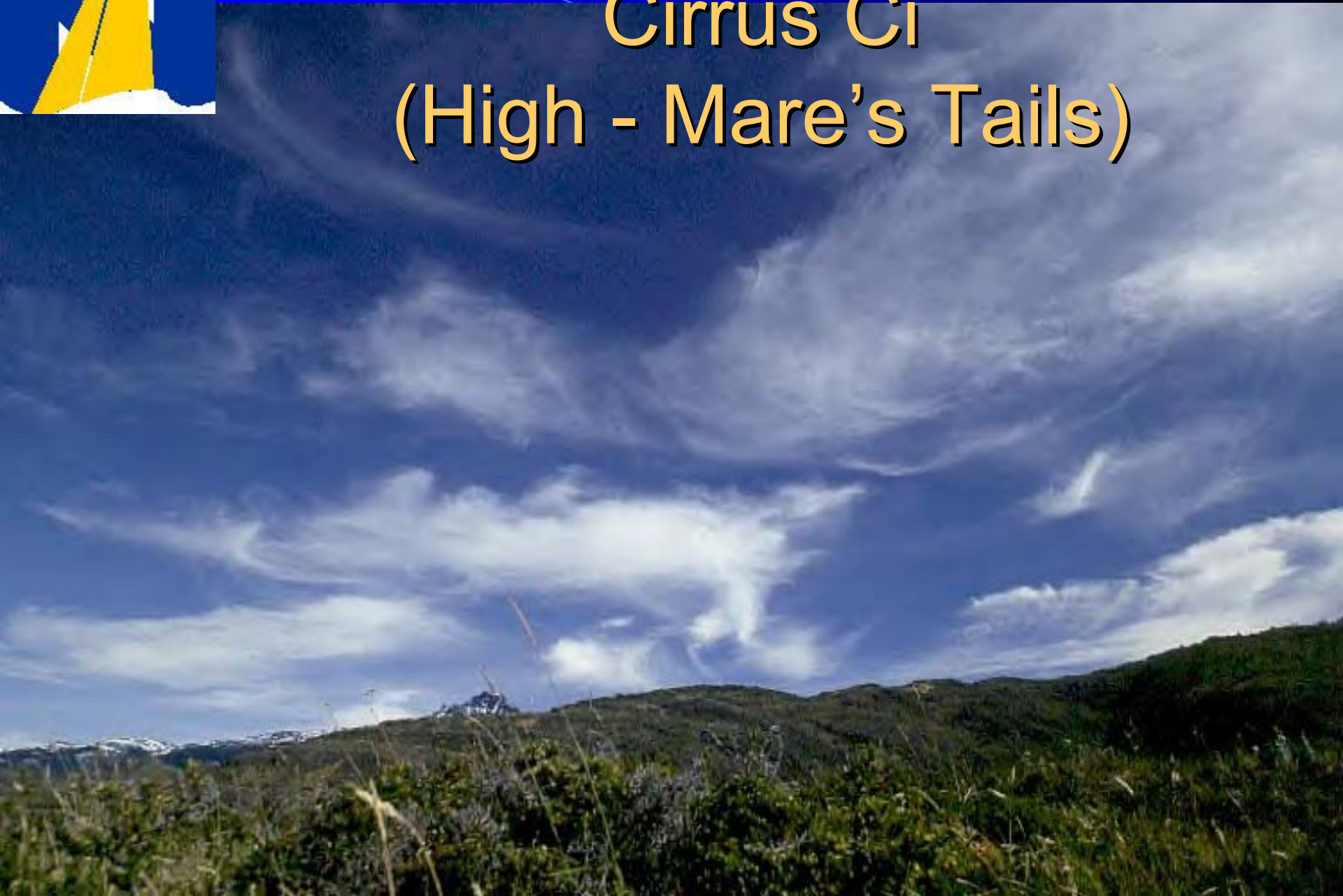
- If high clouds appear from the west, southwest or northwest and then progressively thicken (cumuloform clouds) and lower, a cold front is approaching.
- If high clouds appear from the west or south and then flatten out and lower (strataform clouds), a warm front is approaching.



Clouds

Cirrus Ci

(High - Mare's Tails)





Clouds

Alto cumulus Ac
midlevel clouds
(mackerel skies)



Clouds Stratus (low flat)




Clouds

cumulus Cu (heap/ midlevel)

fair weather cumulus



A small icon in the top left corner showing a yellow sailboat on a white wave against a blue background.

Cumulonimbus Cb (Thunderheads)
extreme vertical extent from surface to
~ 20,000 - 35,000 ft
anvil top indicates strong wind shear





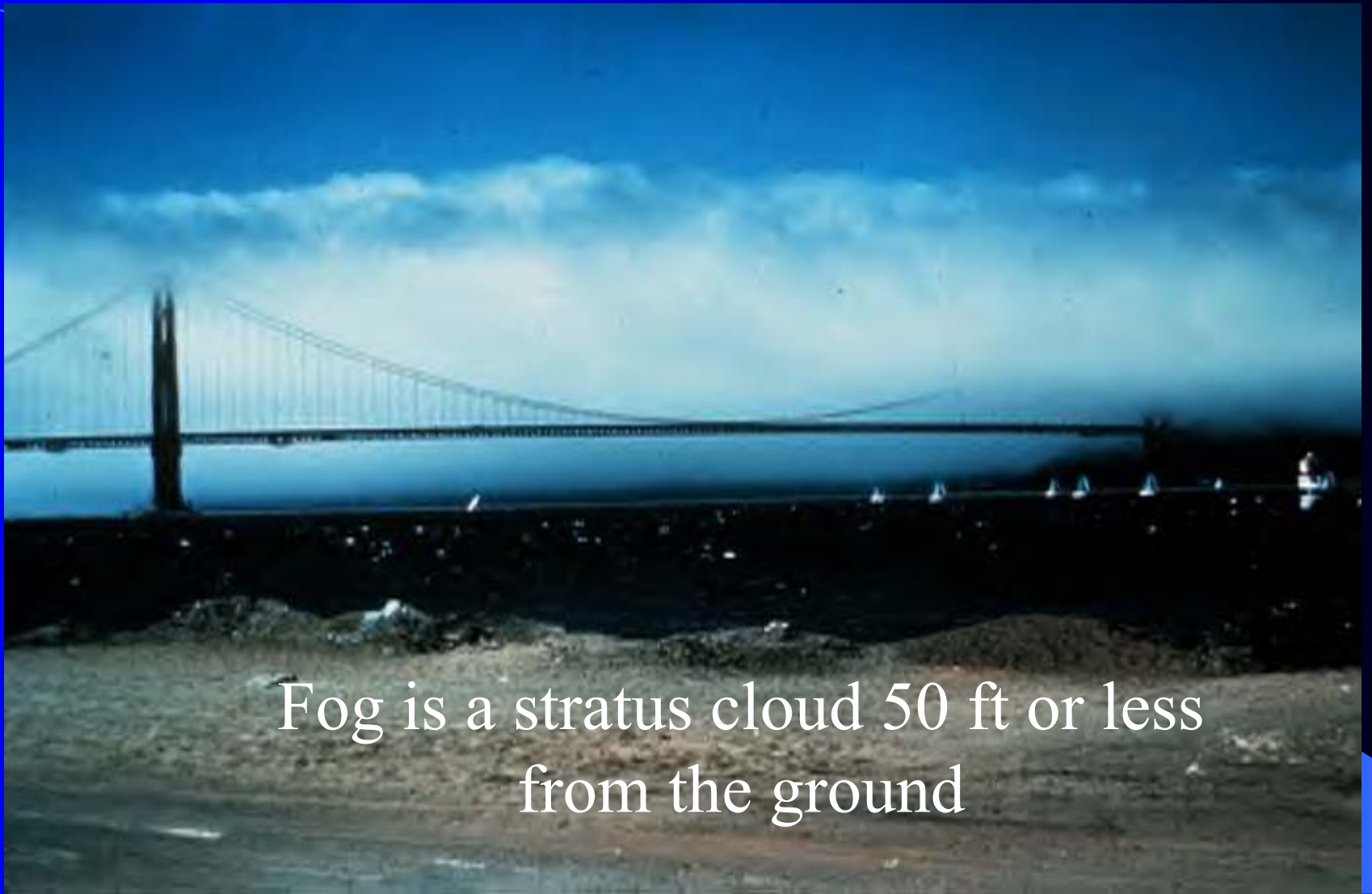
Clouds

Cumulonimbus Cb





Clouds Fog



Fog is a stratus cloud 50 ft or less
from the ground

A stylized icon of a sailboat with a yellow sail and a dark hull, set against a white background with blue waves.

Clouds

Red Sky at Night Sailor's Delight

As the sun sets and moves lower in the sky, the colors observed are those in the longer wavelengths of the spectrum (orange and red). At night the sun is in the western sky. A red sky indicates clear weather in west. Since weather generally moves from west to east, a red sky indicates that the west is clear and there are no approaching weather making systems.



Clouds

Red Sky in the Morning...

Sailor Take Warning

In the morning, the sun rises above the eastern horizon, and the red colors observed are those in the longer wavelengths of the spectrum. A red sky in the morning therefore indicates clear weather in east. However, since weather generally moves from west to east, a red sky indicates that the east is clear and therefore deteriorating weather is approaching from the west.






Mackerel Skies and Mare's Tails Make Tall Ships Carry Low Sails

Mackerel Skies (Altostratus or cirrostratus Clouds) and Mare's Tails (Cirrus Clouds) indicate an approaching cold front as warm air is rapidly pushed up in advance of the front.





First Rise After a Very Low Indicates a Stronger Blow

- This saying refers to the rise in barometric pressure following a period of low pressure.
- Wind is caused by the difference between high and low pressure and the atmosphere's attempt to equalize the two. The greater the pressure differences, the stronger the wind.



Weather Resource Information

- Local Area Broadcast –VHF channels 1-6
- Weather Charts obtained via HF weather facsimile
- Phone call to duty forecaster at any Naval Meteorology and Oceanography Center or Detachment (Patuxent River, MD; Norfolk; San Diego; Jacksonville, FL; Brunswick, ME)
- Internet: NOAA weather charts obtained from internet prior to sailing
 - www.noaa.gov
 - www.nlmoc.navy.mil
- Weather observations passed from other boats
- Buoy reports (obtained from weather facsimile chart)



Local Area Weather Broadcast

- Local area broadcasts are prerecorded messages provided by NOAA and provide current weather conditions and forecasts for specific areas.
- NOAA provides local area weather updates on VHF channels 1-8. VHF radios have a Wx button with which to quickly access these broadcasts.
- Broadcasts are also located on HF frequencies (Check Reeds for specific HF frequencies and times of broadcast)
- Caution: Weather information is perishable information and local area broadcasts are good only for a SPECIFIC area at a SPECIFIC time.

Additional Weather Resources for Official Navy Use (CSNTS)

- Naval Atlantic Meteorology and Oceanography Center
NLMOC (Norfolk, VA)
 - (757) 444-7750
- Naval Atlantic Meteorology and Oceanography Detachment
(Patuxent River, MD)
 - (301) 342-3174
- Naval Atlantic Meteorology and Oceanography Detachment
(Brunswick, ME)
 - (207) 921-2356
- For Gulf Stream or Hurricane information
www.nlmoc.navy.mil



Weather Charts

- Weather Charts can be accessed via HF facsimile
- Various weather charts are disseminated on a set schedule by NOAA
- Reeds provides the schedule and HF frequencies via which these charts can be accessed.
- One can pre-program the Furuno Weather Facsimile machine to automatically access the HF signal at the time that these charts are broadcast.



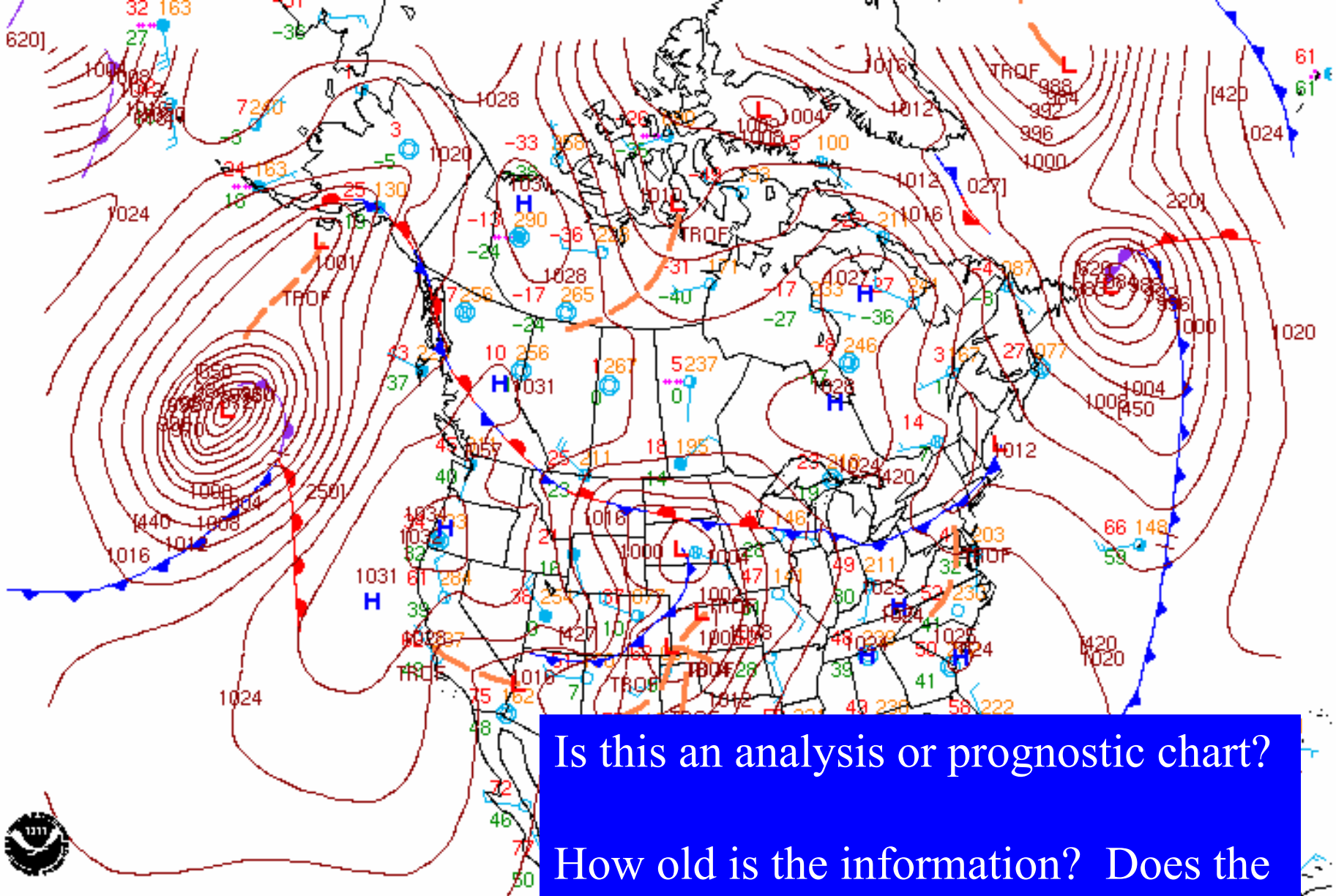
Weather Charts

- Weather Charts can be divided into two types:
 - Analysis Charts (charts that tell you what the weather did)
 - Prognostic (Forecasting) Charts (charts that try to predict what the weather will do)



Weather Charts

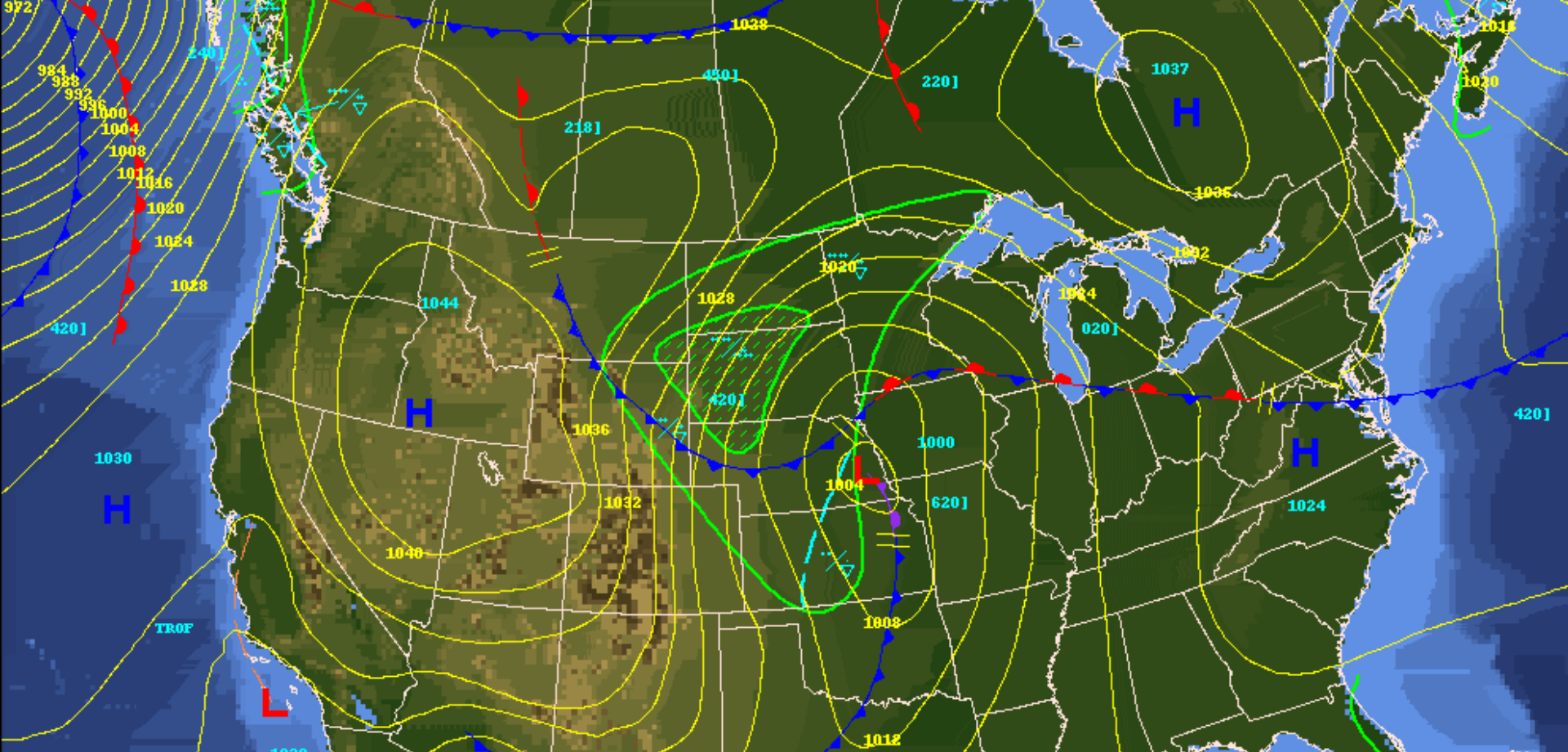
- When reading a weather chart it is important to first check:
 - Is it an analysis or prognostic (forecast) chart?
 - If it is an analysis chart, how old is the analysis?
 - If it is a prognostic chart, at what time is the forecast valid?



Is this an analysis or prognostic chart?
How old is the information? Does the information pertain to the area in which you are located?

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Is this an analysis or prognostic chart?
At what time is this information valid?
Does the information pertain to the area
are located?

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Weather Charts

- When reading a weather chart it is also important to determine if that analysis or prognostic chart gives you the surface weather information or if it gives you the upper level weather information
- For the mariner the surface analysis or the surface prognostic chart provides the most useful information
- For forecasters (or aviators), the upper level charts provide additional useful information as to how the surface weather will move



Weather Charts

- Upper level charts are indicated by atmospheric level
- For example 700mb, 500 mb, 400mb etc.



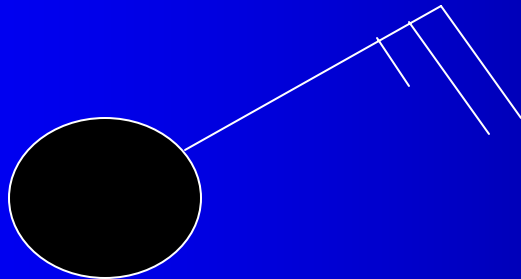
Weather Charts

- Surface charts will be entitled surface and can give you information regarding different parameters
- For example: surface pressure, surface wind direction



Weather Charts and Symbols

- Surface weather charts will show cold, warm, occluded and stationary frontal boundaries
- Wind barbs, which indicate wind direction and speed are sometimes shown and look like





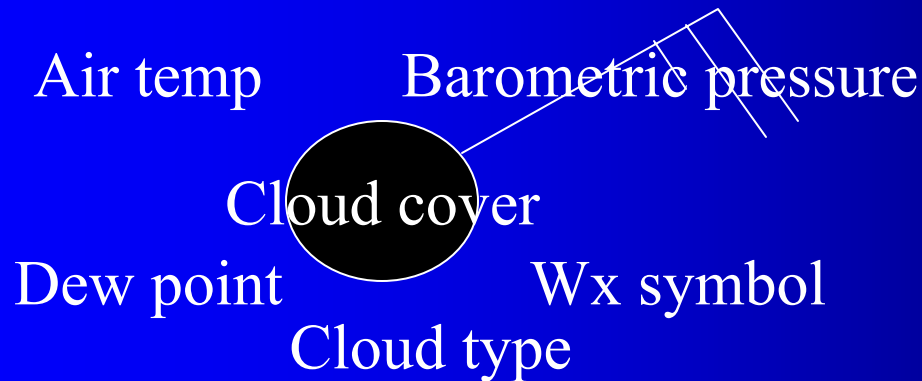
Deciphering Wind Barbs

- Wind barbs give information regarding
 - cloud cover
 - wind direction
 - wind speed
 - Barometric pressure
 - Air temperature
 - Dew point



Deciphering Wind Barbs

Wind direction and speed
(each long barb 10 kts; short barb 5kts)
Wind is from NE in this example



For Barometric Pressure:

0153 means 1015.3 mb

803 means 980.3 mb

(if 1st digit is 0 put a 1
before it)

(if 1st digit is 5,6,7, 8 or
9, put a 9 before it)



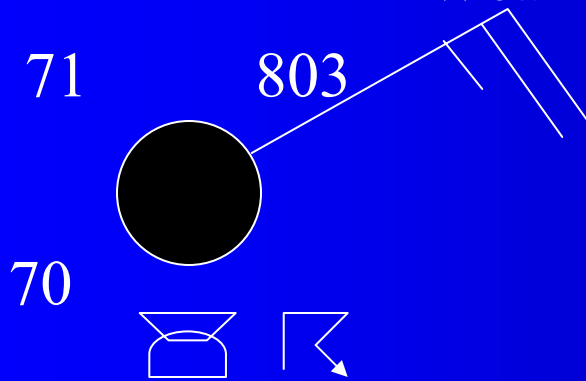
Deciphering Wind Barbs

Example: Wind direction is from the NE, wind speed is 25 kts. Air pressure is 980.3 mb Air temperature is 71 deg, dew point is 70 degrees.

● denotes sky is overcast.

Cloud symbol  denotes cumulonimbus.

Weather symbol  denotes thunder/lightning.



Notice that air temp and dew point temp difference is less than 3 deg, expect precipitation

For Barometric Pressure:

0153 means 1015.3 mb

803 means 980.3 mb

(if 1st digit is 0 put a 1 before it)

(if 1st digit is 5,6,7, 8 or 9, put a 9 before it)



Weather charts and wind

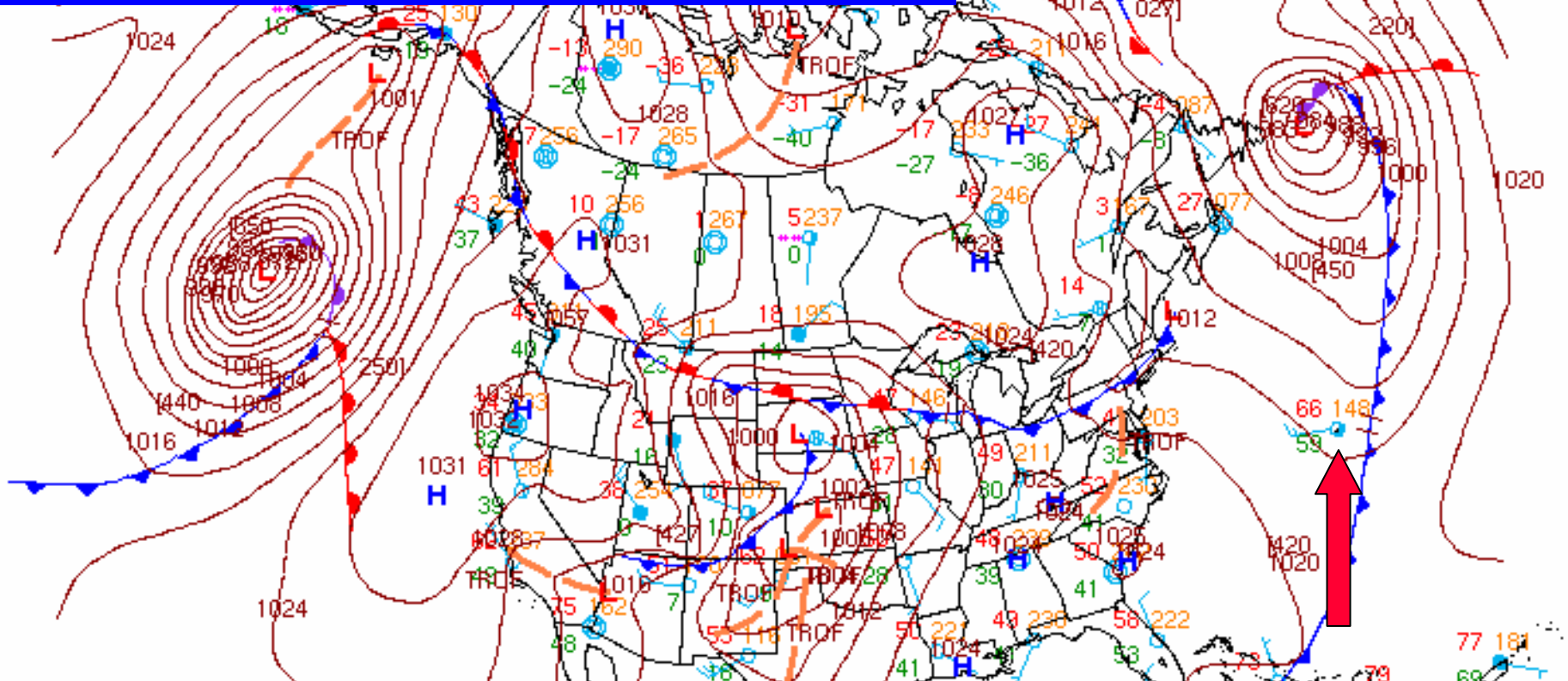
- Some weather charts may not show wind barbs.
- Wind can also be determined by looking at the isobars (the lines of constant pressure) surrounding the low or high pressure
 - The tighter the spacing between isobars, the stronger the wind



Weather Charts and Wind

- Around a low pressure center, wind blows parallel, but slightly crosses the isobars in toward low pressure
 - Slightly inward and counterclockwise around a low
- Around a high pressure center, wind blows parallel, but slightly crosses the isobars outward from high pressure clockwise
 - Slightly outward and clockwise around a high

Where are the strongest winds on the chart?
Without wind barbs can you determine
wind direction and strength?



The red arrow denotes your boat's location and a nearby weather observation. From the wind barb, can you determine the wind direction, sky cover, air temp and dew point and barometric pressure?

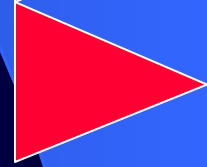
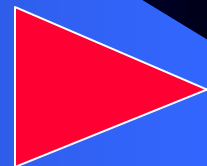
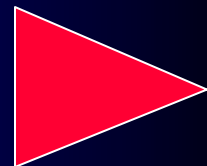


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Wind Warnings

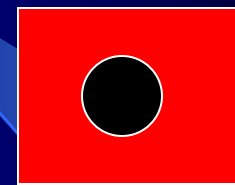
- **Small Craft Warnings: 18 - 33 kts**
 - A *Small Craft Advisory* is issued to alert operators of small craft whenever sustained winds of 18 to 33 knots inclusive, and/or seas of 7 feet or greater, are either ongoing or forecasted to develop within the next 12 hours.
- **Gale Warnings: 34 - 47 kts**
 - A *Gale Warning* is issued to alert all mariners whenever sustained winds of 34 to 47 knots, associated with a non-tropical system, are either ongoing or forecasted to develop within the next 12 hours.





Wind Warnings

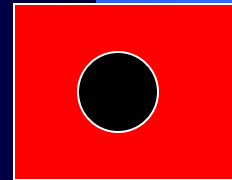
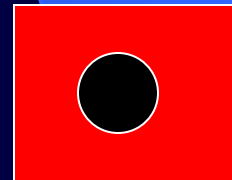
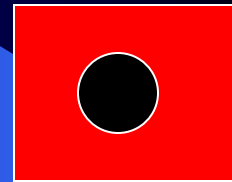
- Storm Warnings: 48 + kts
 - Sustained winds above 48 knots of non-tropical (extratropical) origin. Does not have closed cyclonic rotation. Such storms are infrequent within the Chesapeake, however when they do occur, happen in fall or early spring.





Wind Warnings

- Tropical Depression >34 kts
 - Definite Closed Cyclonic (CCW) Rotation
- Tropical Storm Warning 34-63 kts
 - Winds in this range associated with a system developing from a tropical depression would be covered under a *Tropical Storm Warning* (34 to 63 knots). Differs from a midlatitudes or extratropical storm in that it has a closed cyclonic (CCW) rotation
- Hurricane Warnings: 64 + kts
 - Atlantic Hurricane season lasts from June- Nov
 - Peak time frame for Atlantic August - October

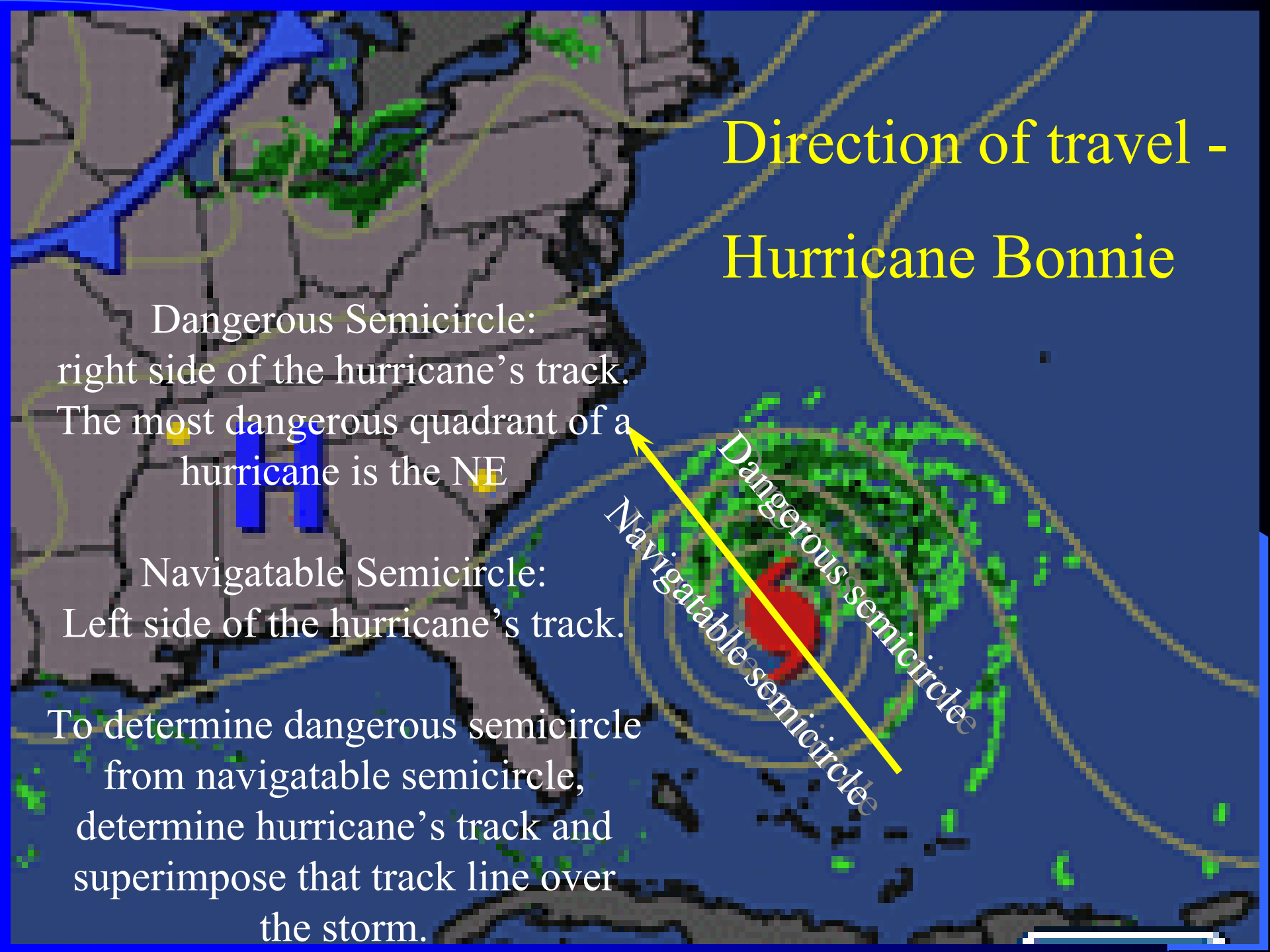


Direction of travel - Hurricane Bonnie

Dangerous Semicircle:
right side of the hurricane's track.
The most dangerous quadrant of a
hurricane is the NE

Navigatable Semicircle:
Left side of the hurricane's track.

To determine dangerous semicircle
from navigatable semicircle,
determine hurricane's track and
superimpose that track line over
the storm.



The diagram shows a satellite-style map of the Atlantic Ocean with a hurricane track. A red arrow indicates the direction of travel from the bottom right towards the top left. Two semicircles are drawn relative to the track: an inner one labeled 'Dangerous semicircle' and an outer one labeled 'Navigatable semicircle'. A yellow arrow points from the hurricane's center towards the top left, following the track. The hurricane's eye is marked with a red circle. The storm's structure is shown in green and white, with a red center. The background is a dark blue ocean with a grey landmass on the left.

Questions???



H.C.

The first naval meteorologist