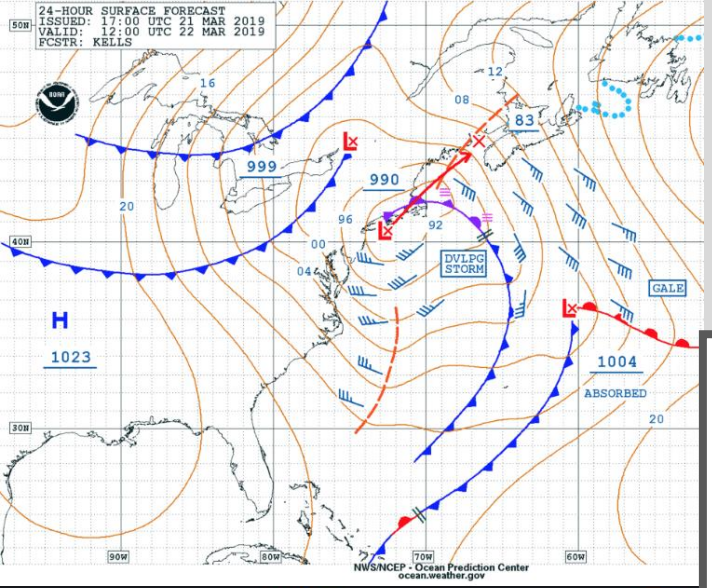
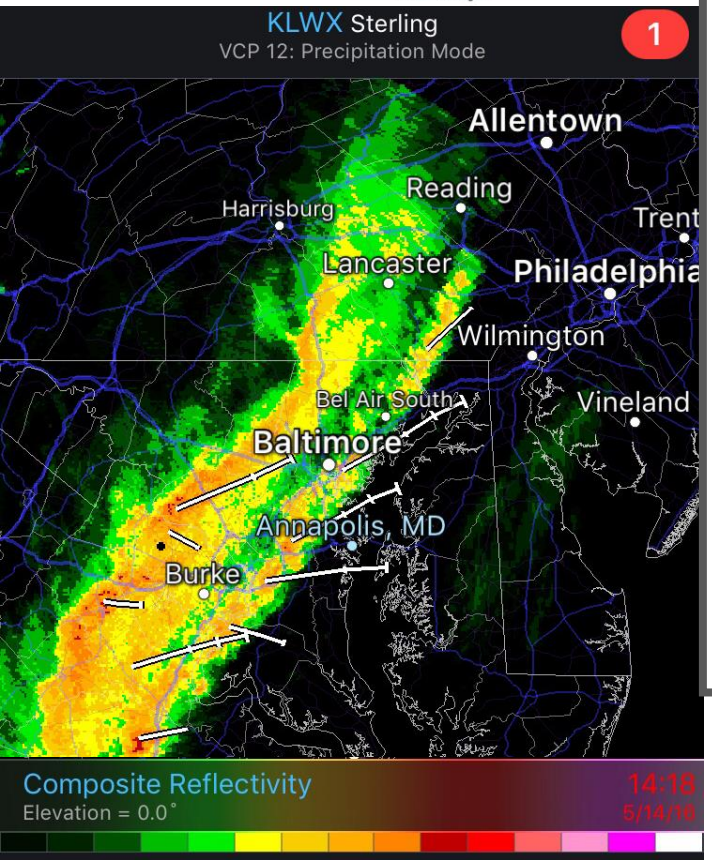




Weather Basics

Safety at Sea Seminar, 30th March 2019

Session goals:

- **Identify global wind patterns**
- **Wind flow around surface Highs & Lows**
  - **3 types of Lows to look out for**
  - **Weather on the ground?**
- **Severe weather on the Bay & in the North Atlantic**
- **Interpret main features on a surface weather chart**

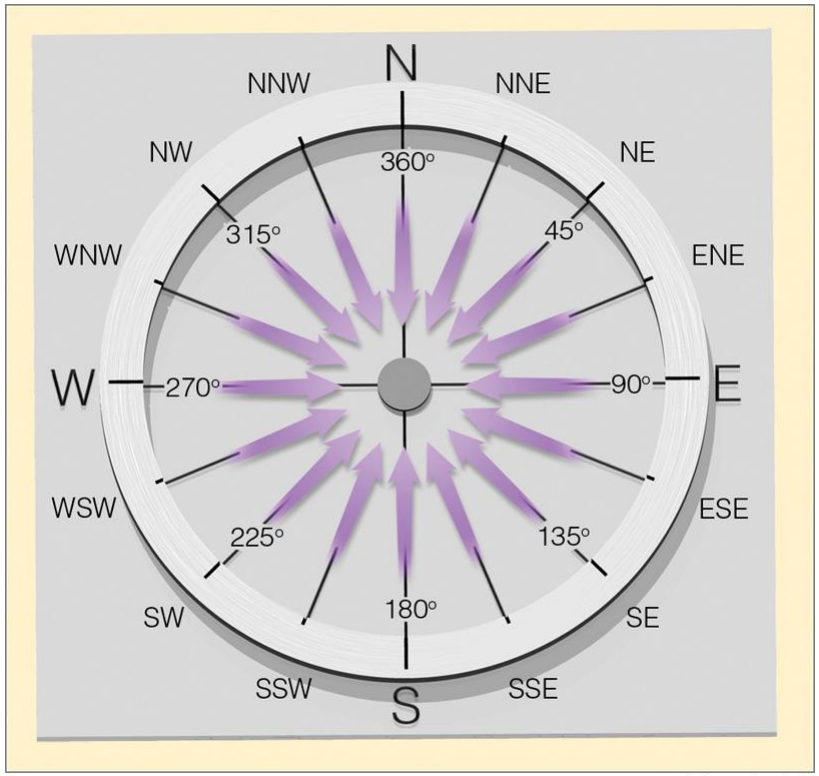
Dr. Gina Henderson
Oceanography Dept., USNA
ghenders@usna.edu

Let's take a step back to remember some basics:

- Wind → horizontal movement of air

- 'Naming' wind
  - *From source direction*

© Jan Null



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Figures courtesy of *Meteorology today, 11th edition*, Ahrens, 1th edition, 2016

Let's take a step back to remember some basics:

- 'Naming' wind
  - From source direction
- Measuring wind speed
  - Knots
  - MPH
  - Beaufort Scale

What makes air move creating wind?

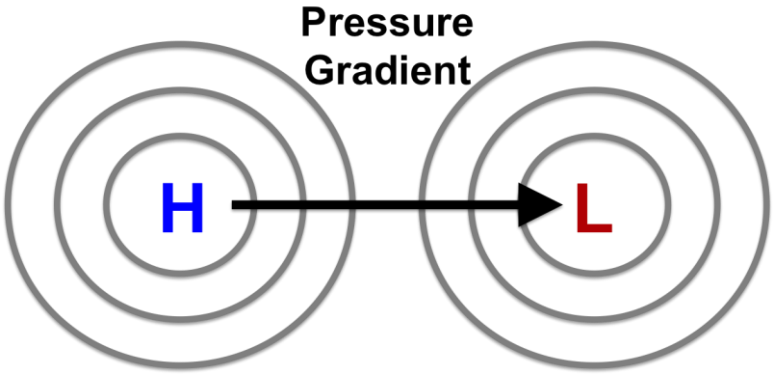
Beaufort Wind Chart – Estimating Winds Speeds

Beaufort Number	MPH Range	MPH Average	Terminology	Description
0	0	0	Calm	Calm. Smoke rises vertically.
1	1-3	2	Light air	Wind motion visible in smoke.
2	4-7	6	Light breeze	Wind felt on exposed skin. Leaves rustle.
3	8-12	11	Gentle breeze	Leaves and smaller twigs in constant motion.
4	13-18	15	Moderate breeze	Dust and loose paper is raised. Small branches begin to move.
5	19-24	22	Fresh breeze	Smaller trees sway.
6	25-31	27	Strong breeze	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult.
7	32-38	35	Near gale	Whole trees in motion. Some difficulty when walking into the wind.
8	39-46	42	Gale	Twigs broken from trees. Cars veer on road.
9	47-54	50	**Severe gale**	**Light structure damage.**
10	55-63	60	**Storm**	**Trees uprooted. Considerable structural damage.**
11	64-73	70	**Violent storm**	**Widespread structural damage.**
12	74-95	90	**Hurricane**	**Considerable and widespread damage to structures.**

Image source:
http://www.crh.noaa.gov/Image/iwx/publications/Beaufort_Wind_Chart.pdf

Let's take a step back to remember some basics:
What makes wind blow?

1. Pressure gradient force is directed from **H** to **L**



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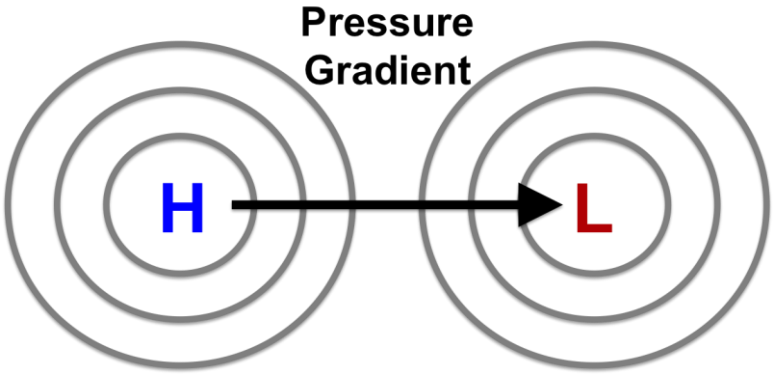
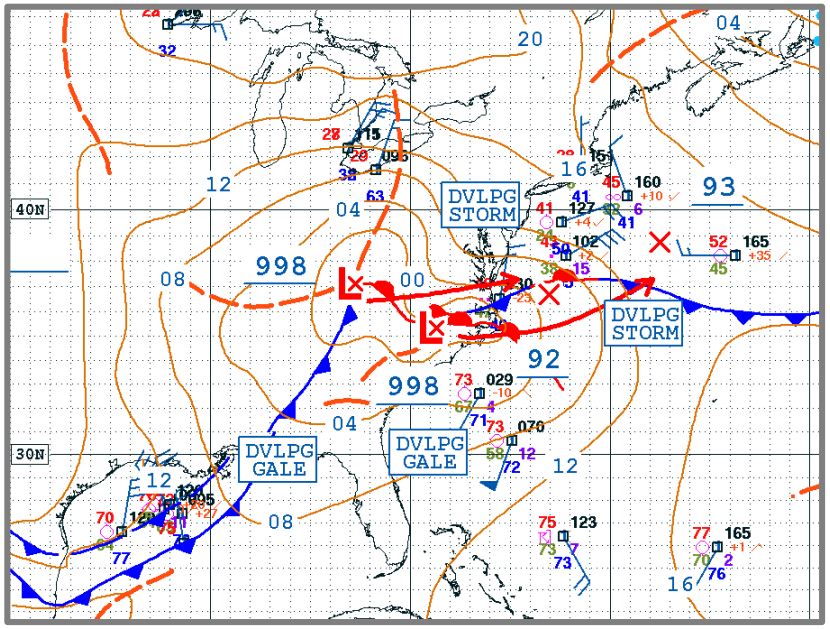


- Increased pressure gradient

➔ increased wind speed



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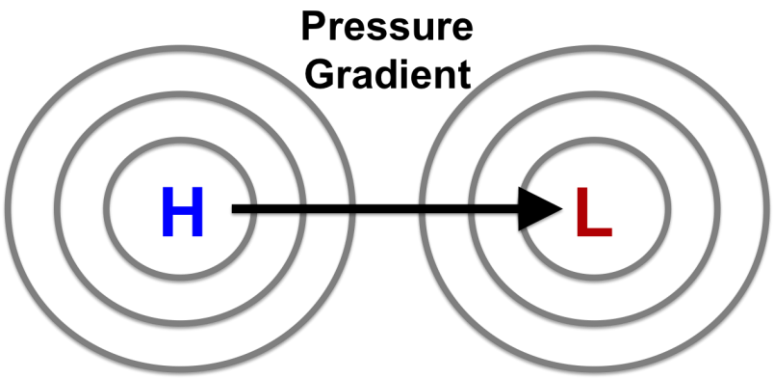
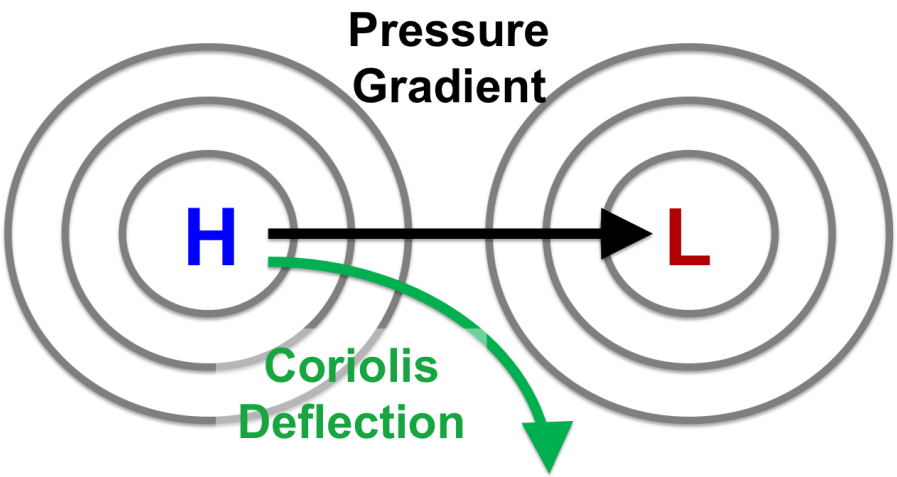


2. Coriolis force, due to Earth's rotation, deflects air to the right of its path of motion



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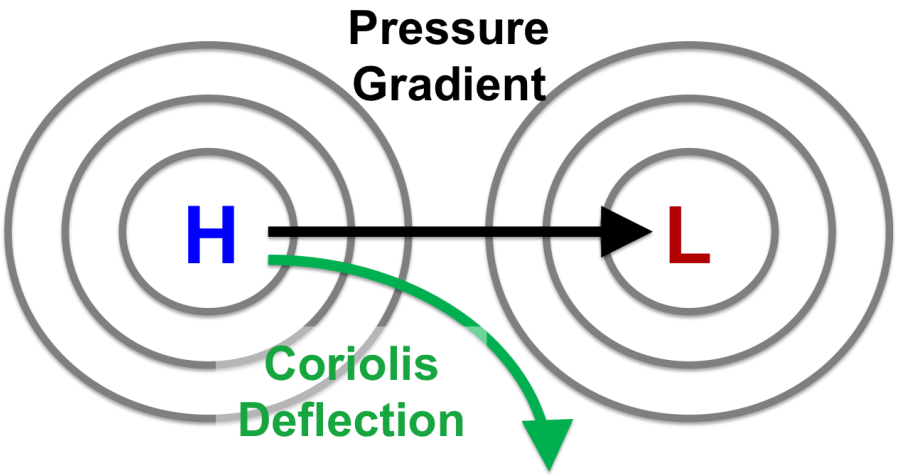
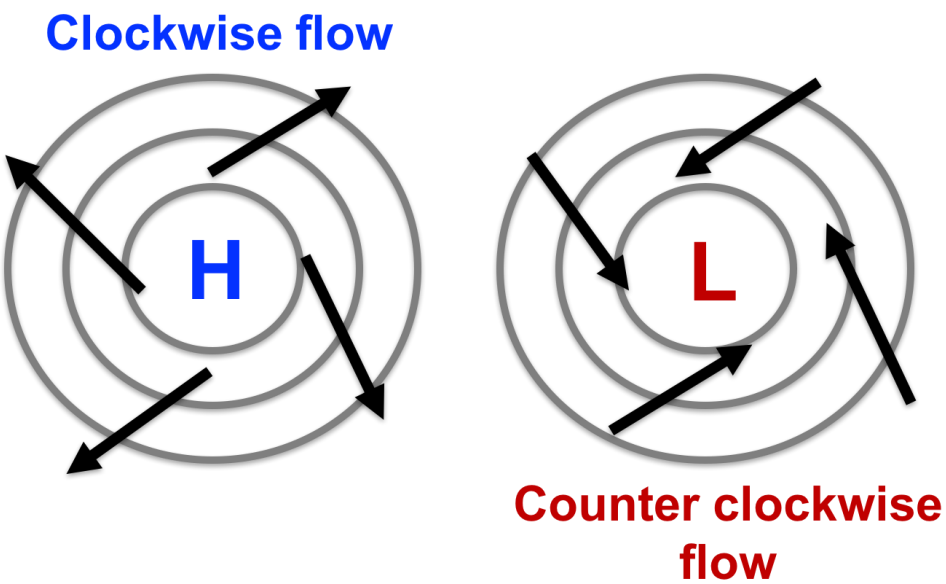


Pressure gradient + **Coriolis** = wind direction around a surface **High** & **Low** pressure



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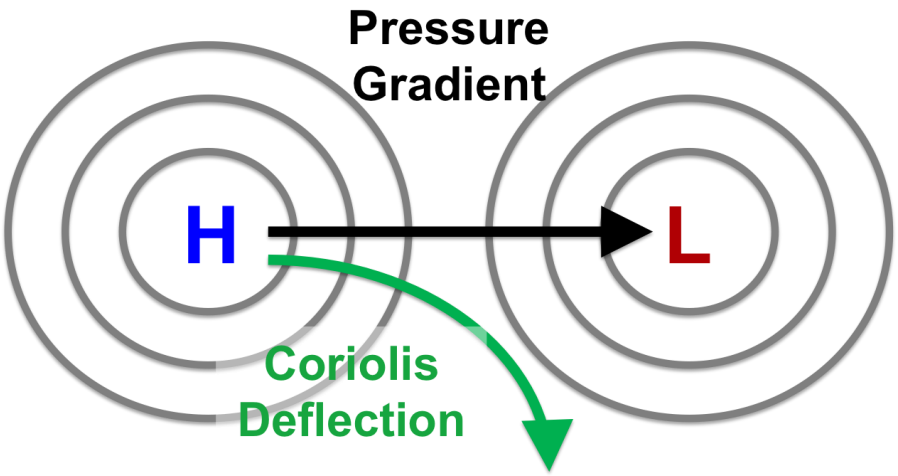
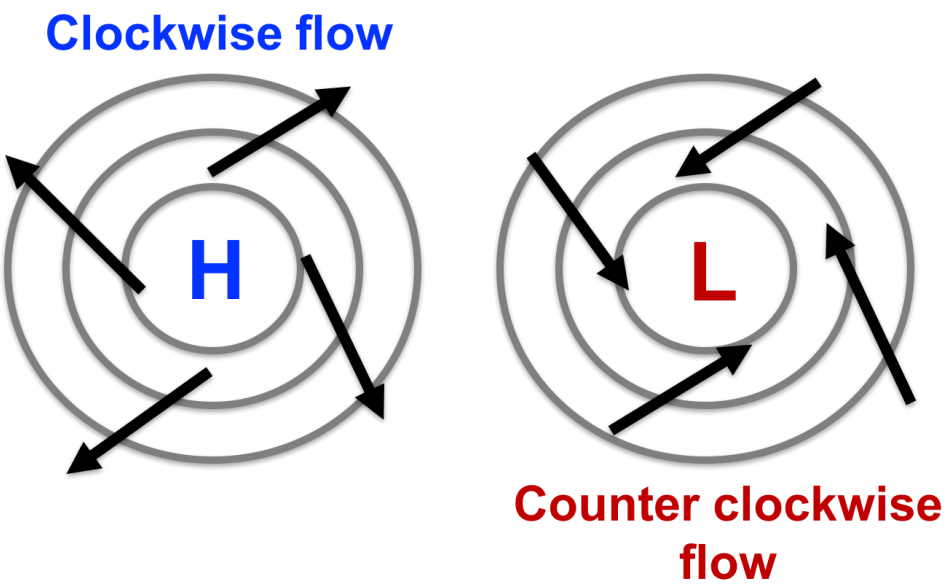


In the Northern Hemisphere:

- Cyclonic flow → counter clockwise
- Anticyclonic flow → clockwise



This even translates to global wind patterns……

Resulting in wind patterns you have all heard of:

- Trade Winds
- Westerlies
- Horse Latitudes
- Doldrums

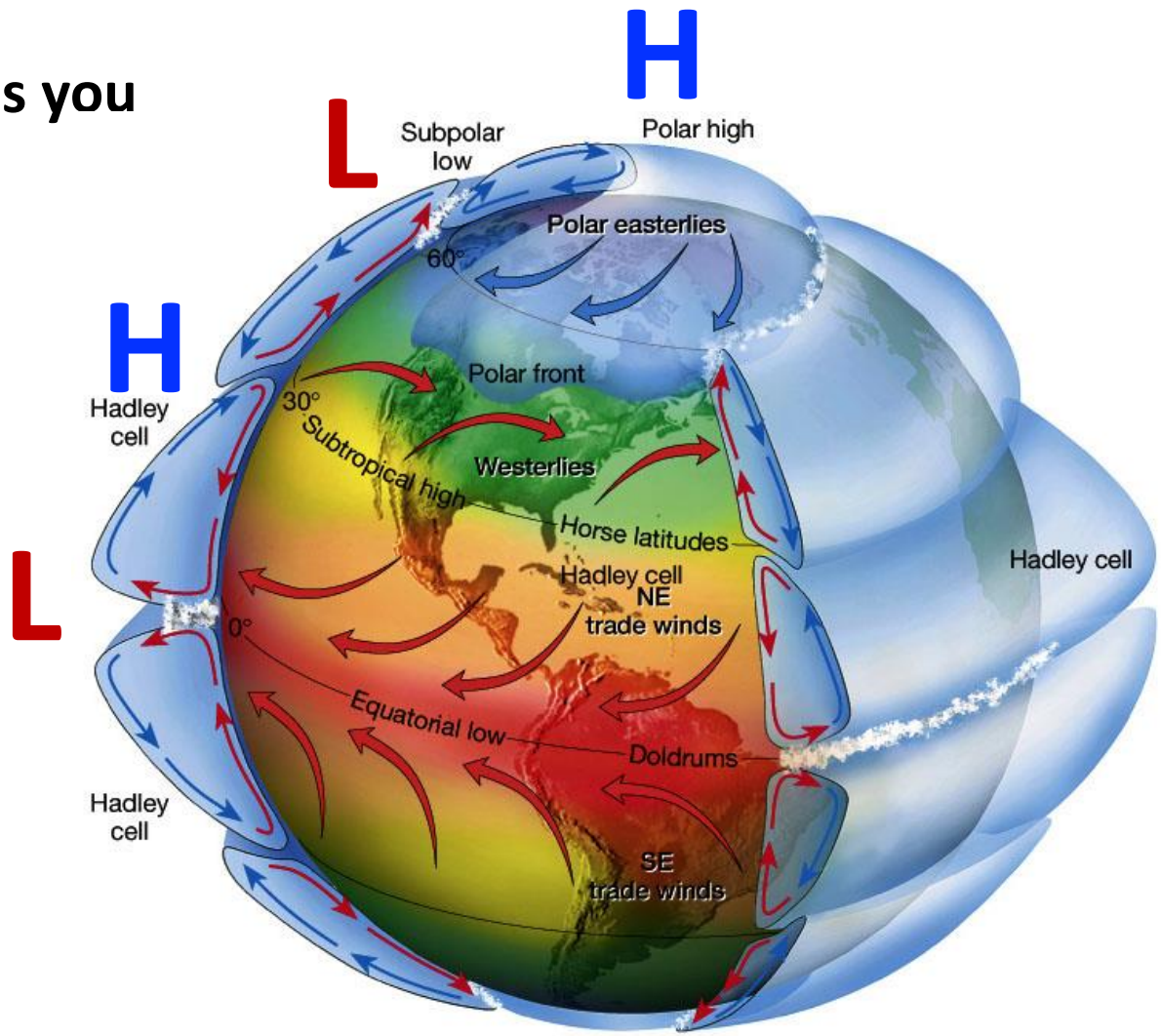


Figure courtesy of *The Atmosphere, 8th edition*, Lutgens and Tarbuck, 8th edition, 2001

This even translates to global wind patterns……

Resulting in wind patterns you have all heard of:

- Trade Winds
  Apply pressure gradient & coriolis → NE trades!
- Westerlies
- Horse Latitudes
- Doldrums

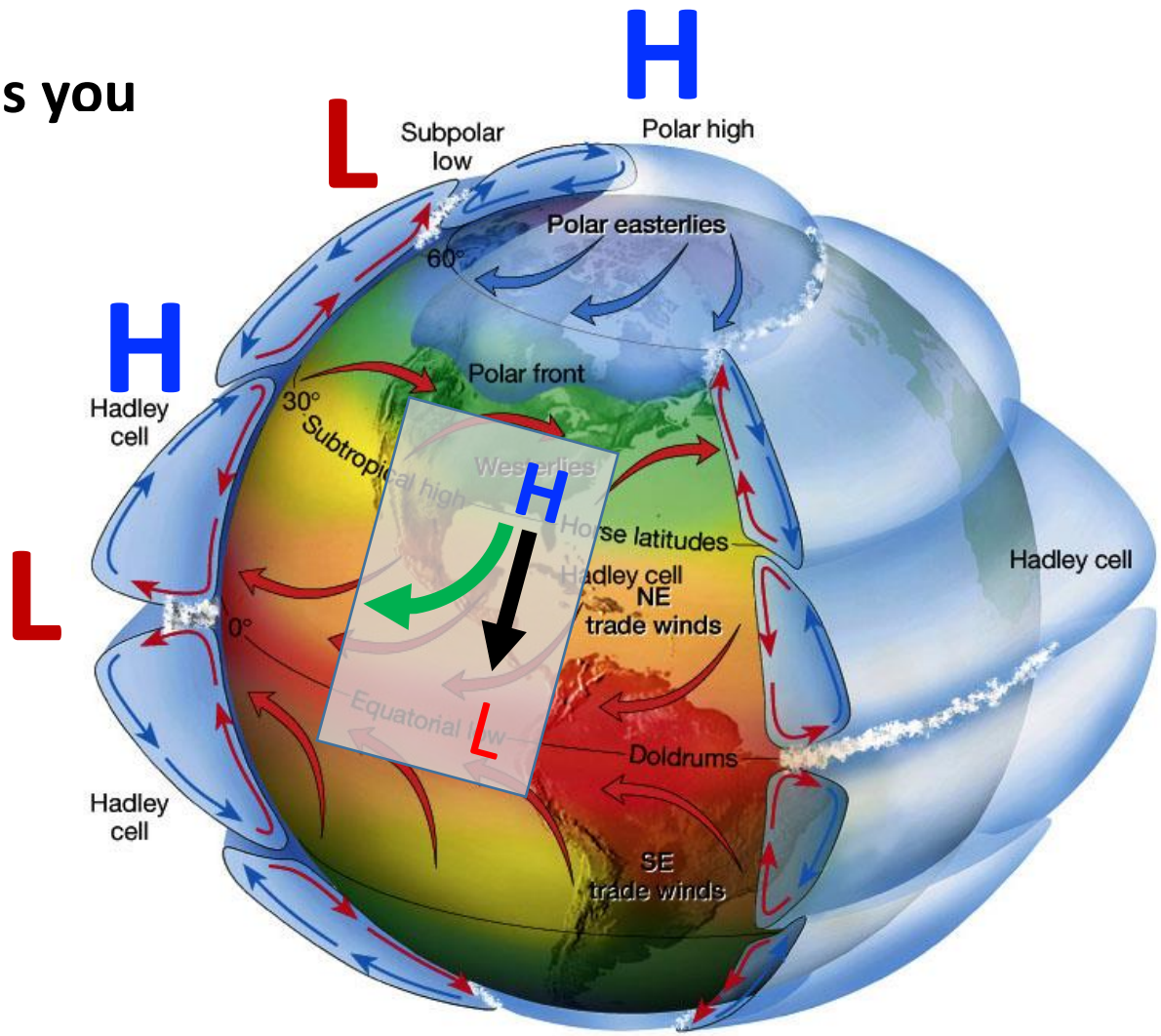
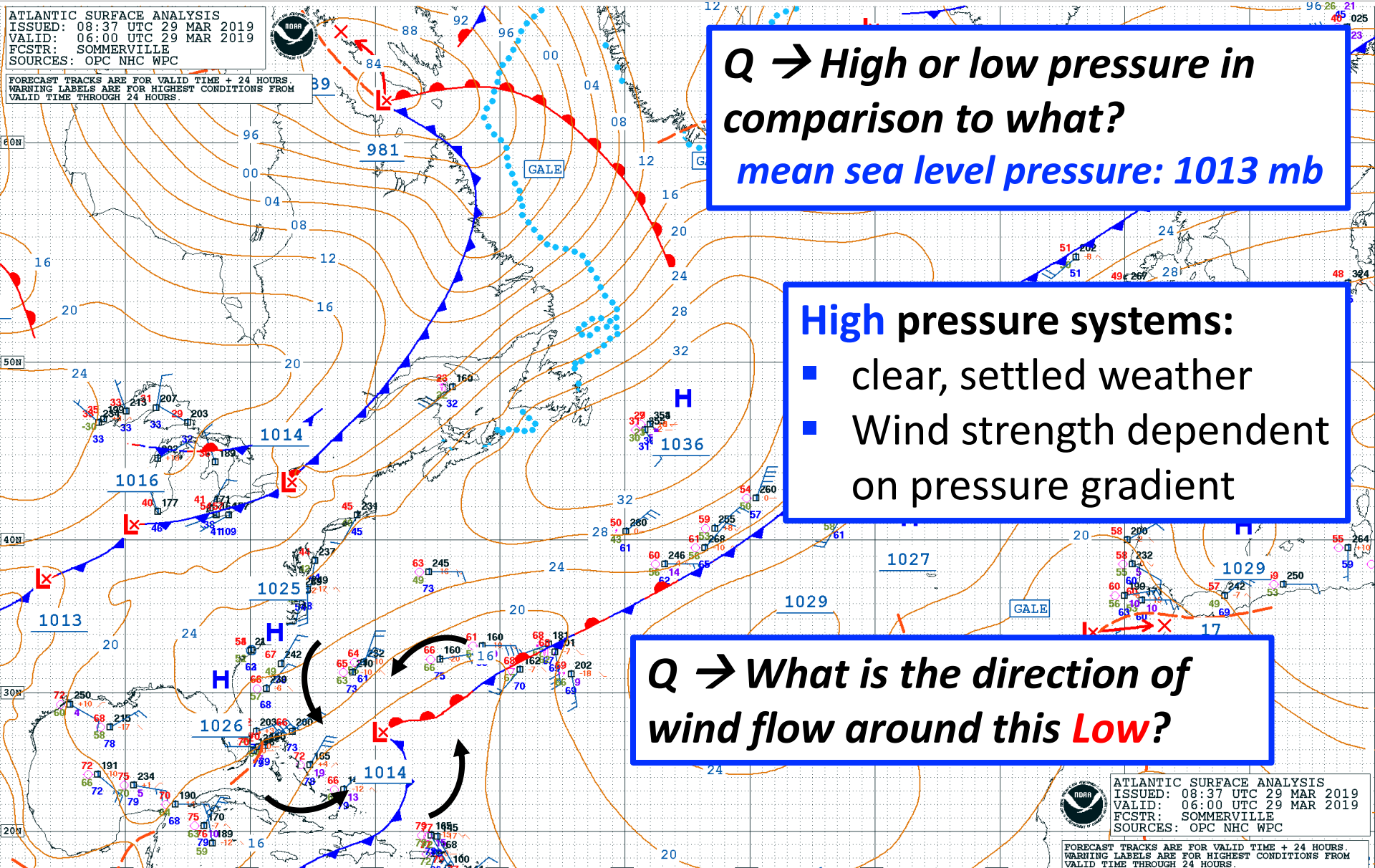


Figure courtesy of *The Atmosphere, 8th edition*, Lutgens and Tarbuck, 8th edition, 2001

Let's take a look at some Highs & Lows on a surface weather chart…..



Q → High or low pressure in comparison to what?

mean sea level pressure: 1013 mb

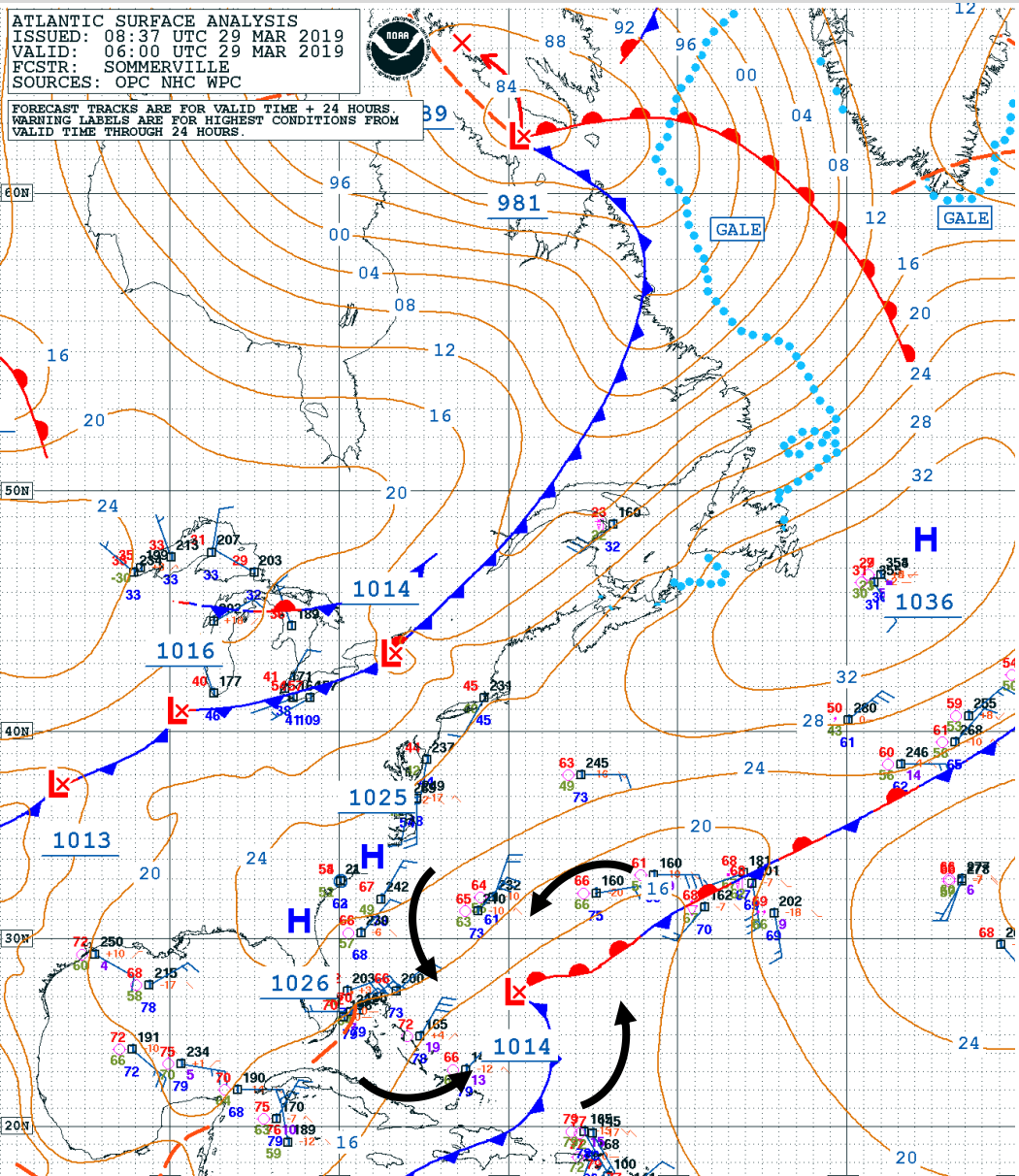
High pressure systems:

- clear, settled weather
- Wind strength dependent on pressure gradient

Q → What is the direction of wind flow around this Low?

ATLANTIC SURFACE ANALYSIS
ISSUED: 08:37 UTC 29 MAR 2019
VALID: 06:00 UTC 29 MAR 2019
FCSTR: SOMMERVILLE
SOURCES: OPC NHC WPC
FORECAST TRACKS ARE FOR VALID TIME + 24 HOURS.
WARNING LABELS ARE FOR HIGHEST CONDITIONS FROM
VALID TIME THROUGH 24 HOURS.

3 types of Low pressure systems:



1. Mid-latitude Lows:

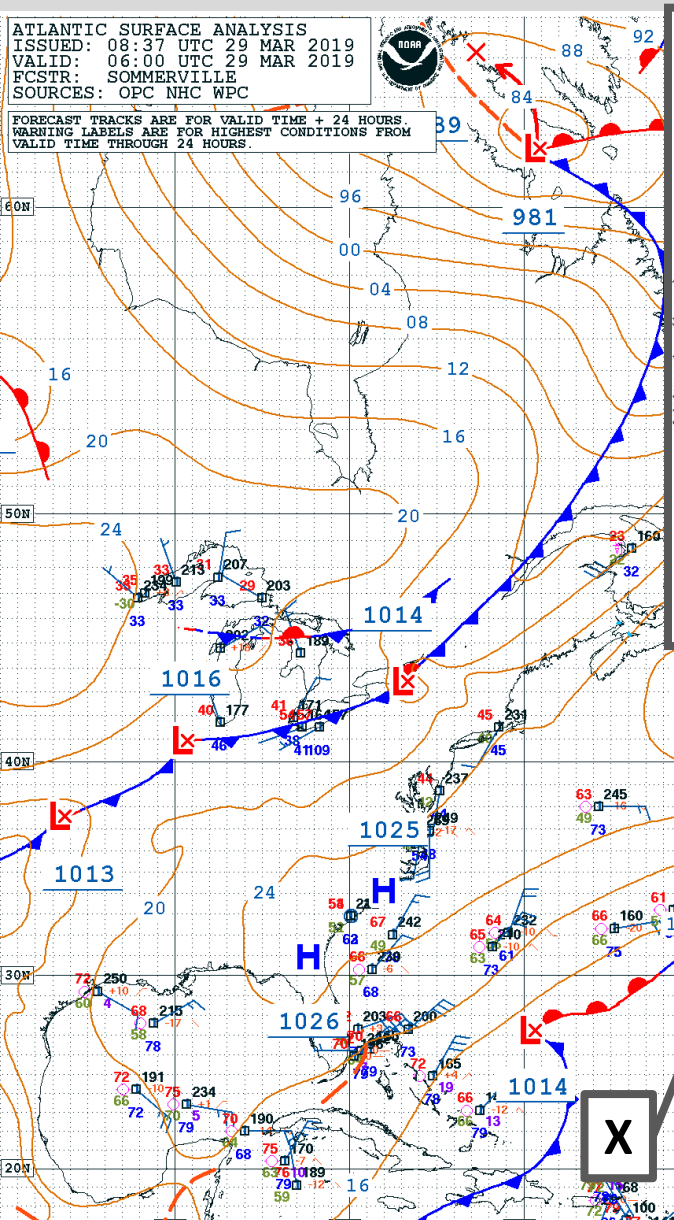
- most common between 30-60 N/S
- move (in general) from W→ E
- associated with ***fronts***
  - *boundary between air mass of different characteristics*

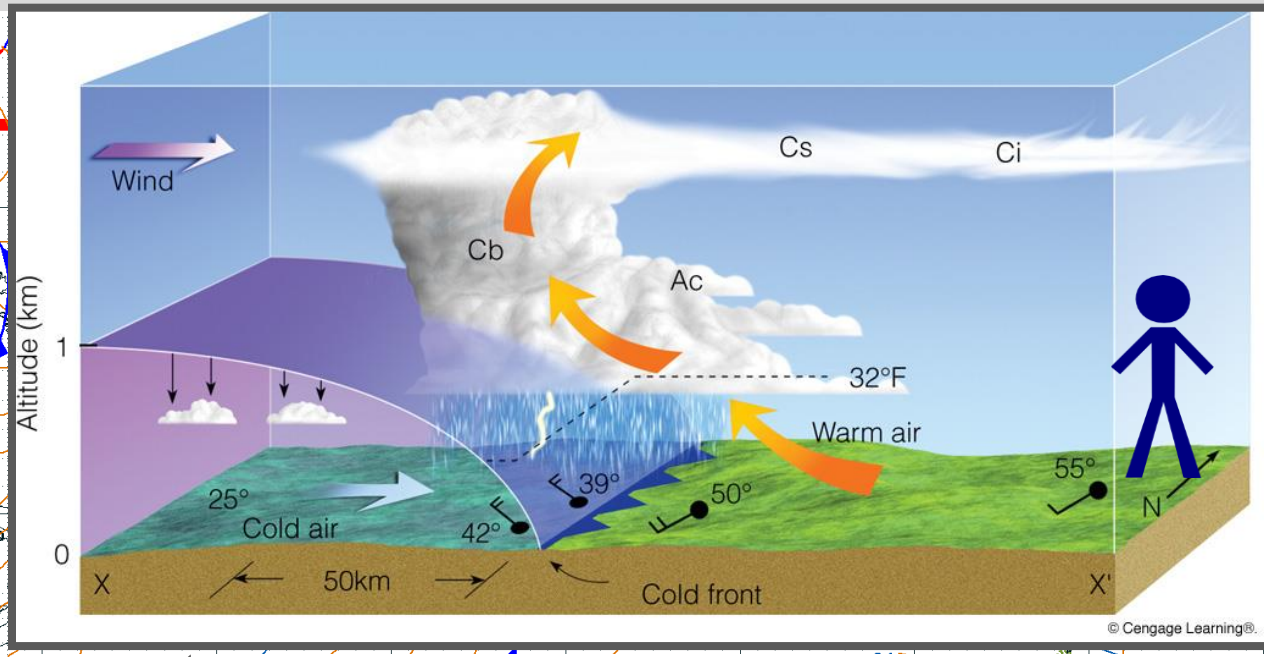
Types of fronts include:

- Cold fronts
- Warm fronts
- Stationary fronts
- Occluded fronts

3 types of Low pressure systems:

1. Mid-latitude Low – cold front passage





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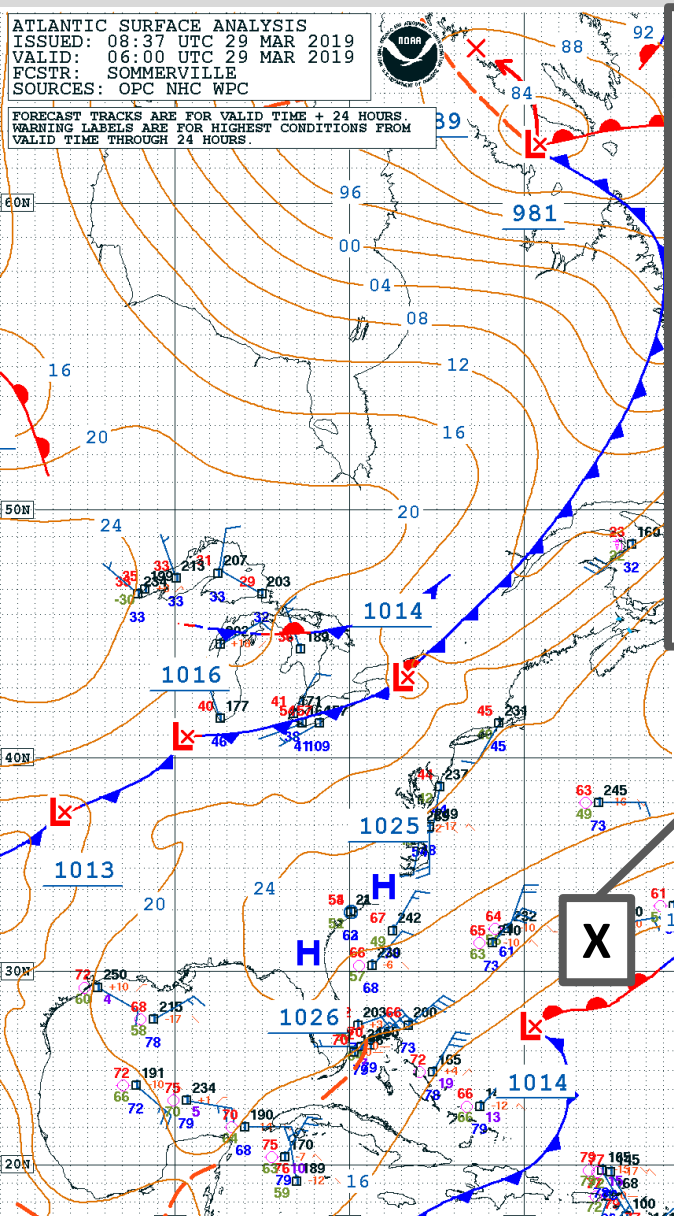
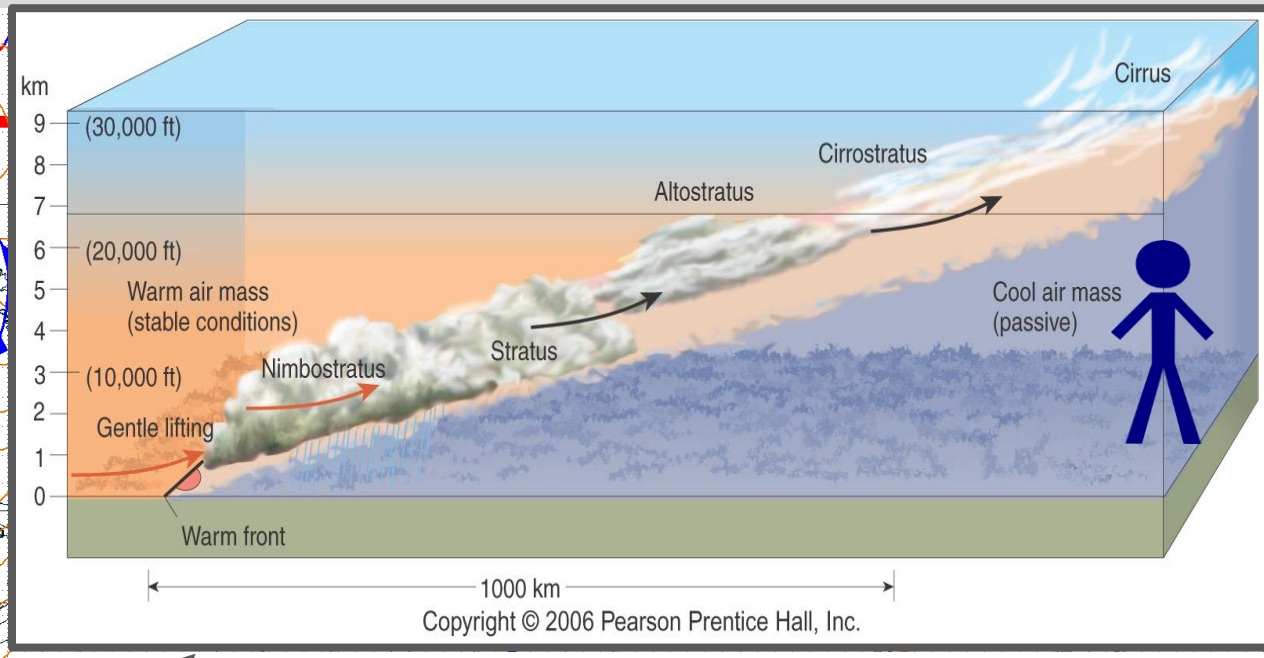
3 types of Low pressure systems:

1. Mid-latitude Low – warm front passage





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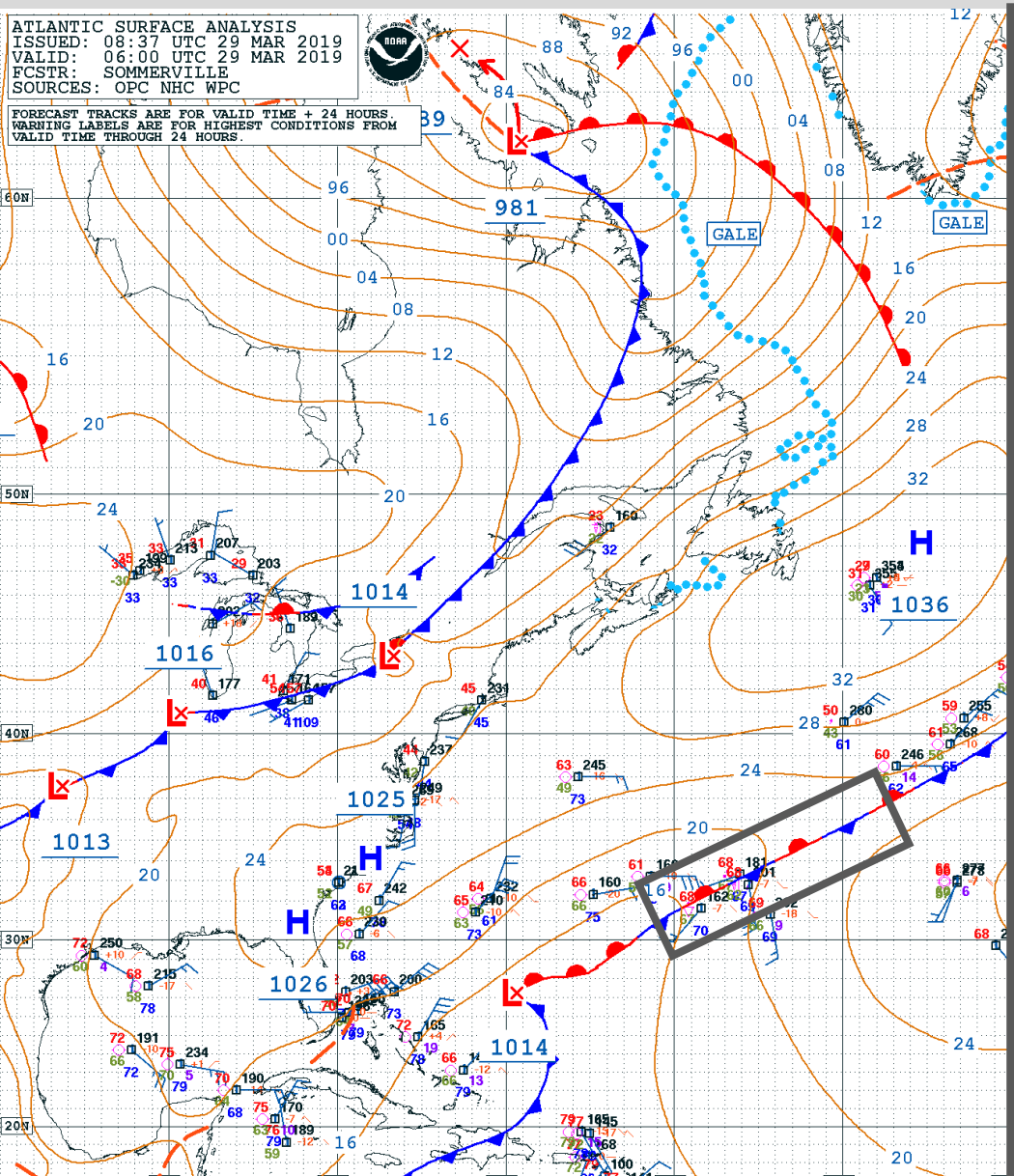
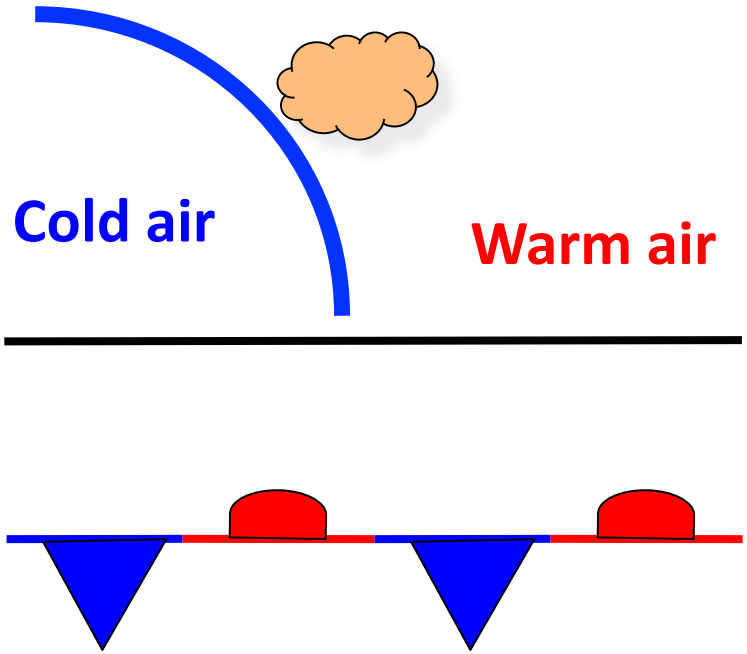
3 types of Low pressure systems:

1. Mid-latitude Low – stationary front

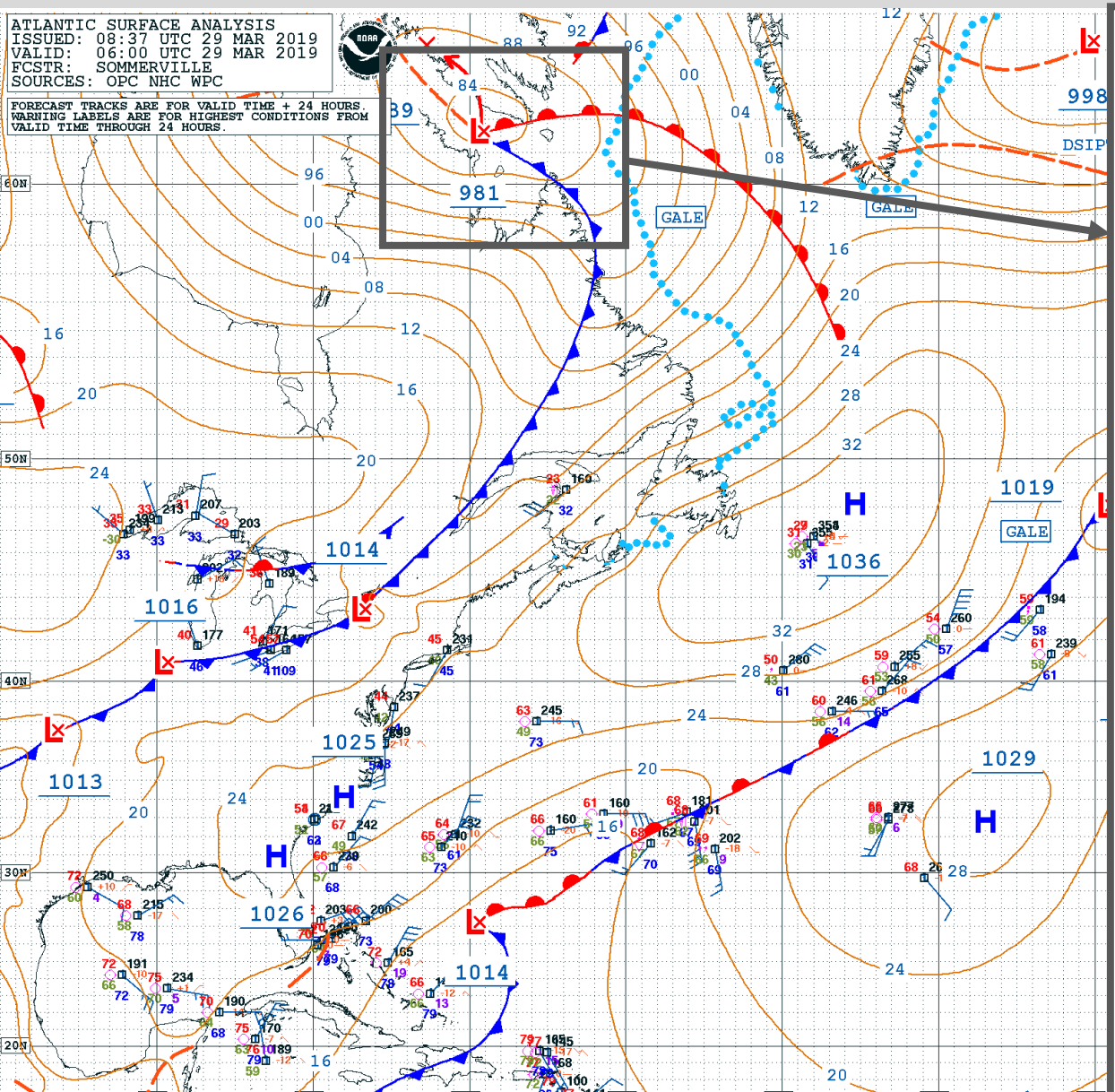


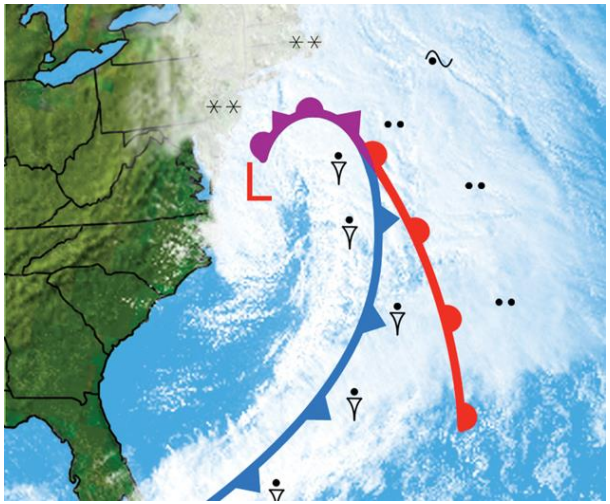


- **Clouds will vary**
- **Precipitation intensity will vary**

3 types of Low pressure systems:

1. Mid-latitude Low – occluded front





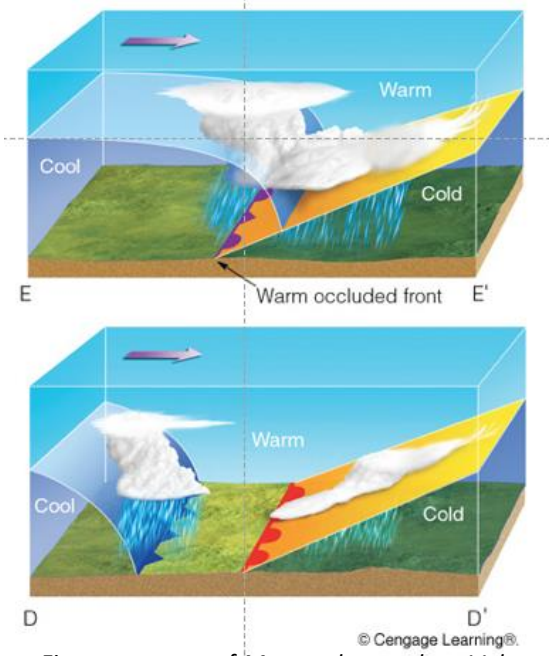


Figure courtesy of *Meteorology today, 11th*

3 types of Low pressure systems:
2. *Cut-off Lows*

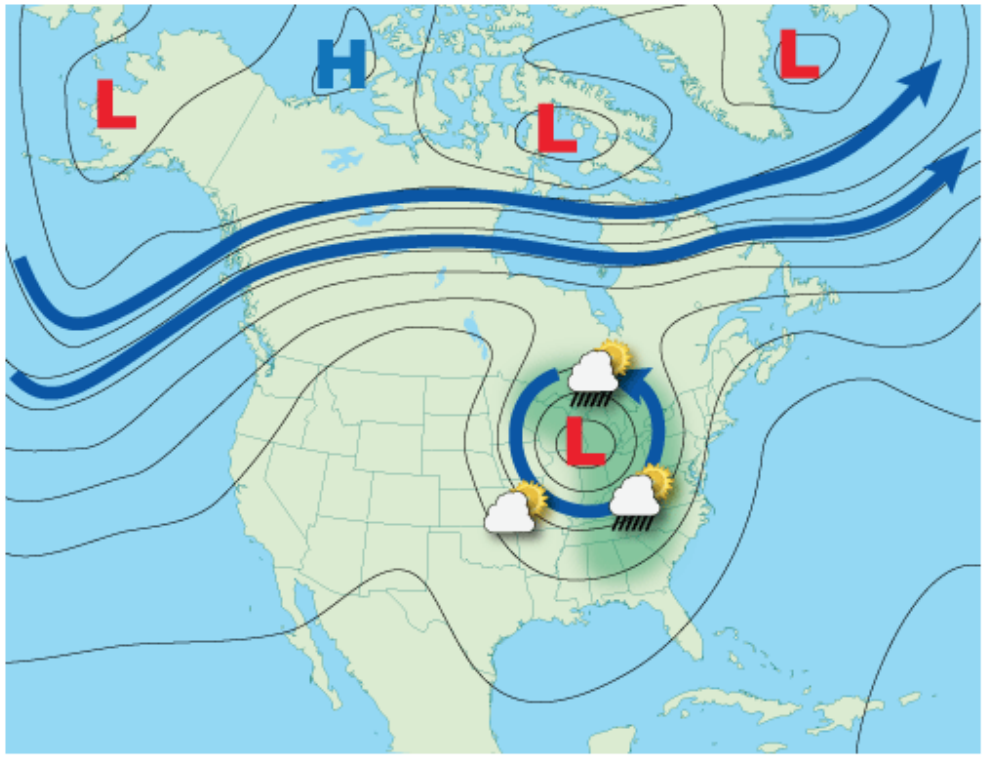


Image source: https://www.weather.gov/jetstream/basic, accessed 03/29/19

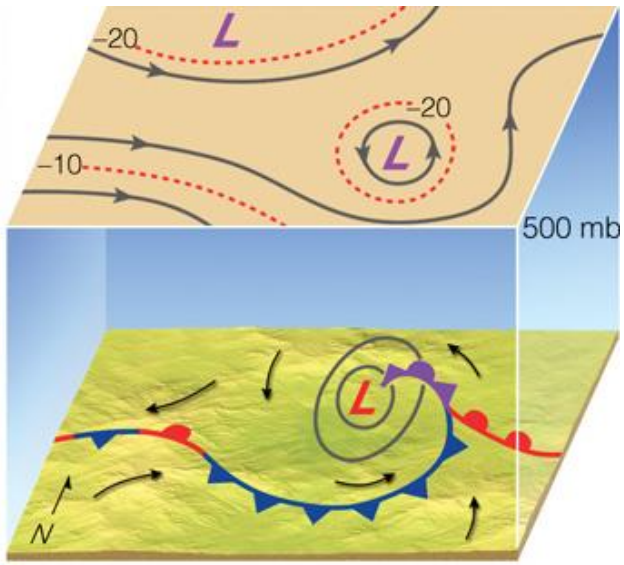
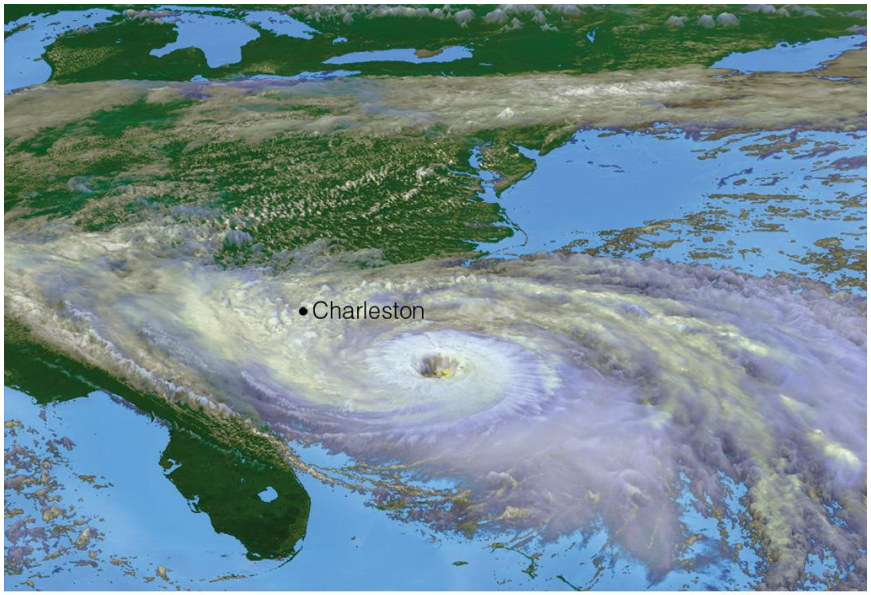


Figure courtesy of *Meteorology today, 11th edition*, Ahrens, 1th edition, 2016

- *"Cut-off low, weatherman's woe"* → move very slowly & can drift for many days
- Challenging to forecast
- Unsettled weather in east and northward quadrants of the low

3 types of Low pressure systems:
3. *Tropical Lows – cyclones/hurricanes*



NOAA/National Weather Service

- Storms fueled by warm tropical waters
- Hurricanes are really tropical cyclones
- Atlantic hurricane season is June 1st – Nov 30th

→ Tropical storm: sustained winds 34-63 knts
→ Hurricane: sustained winds > 64 knts

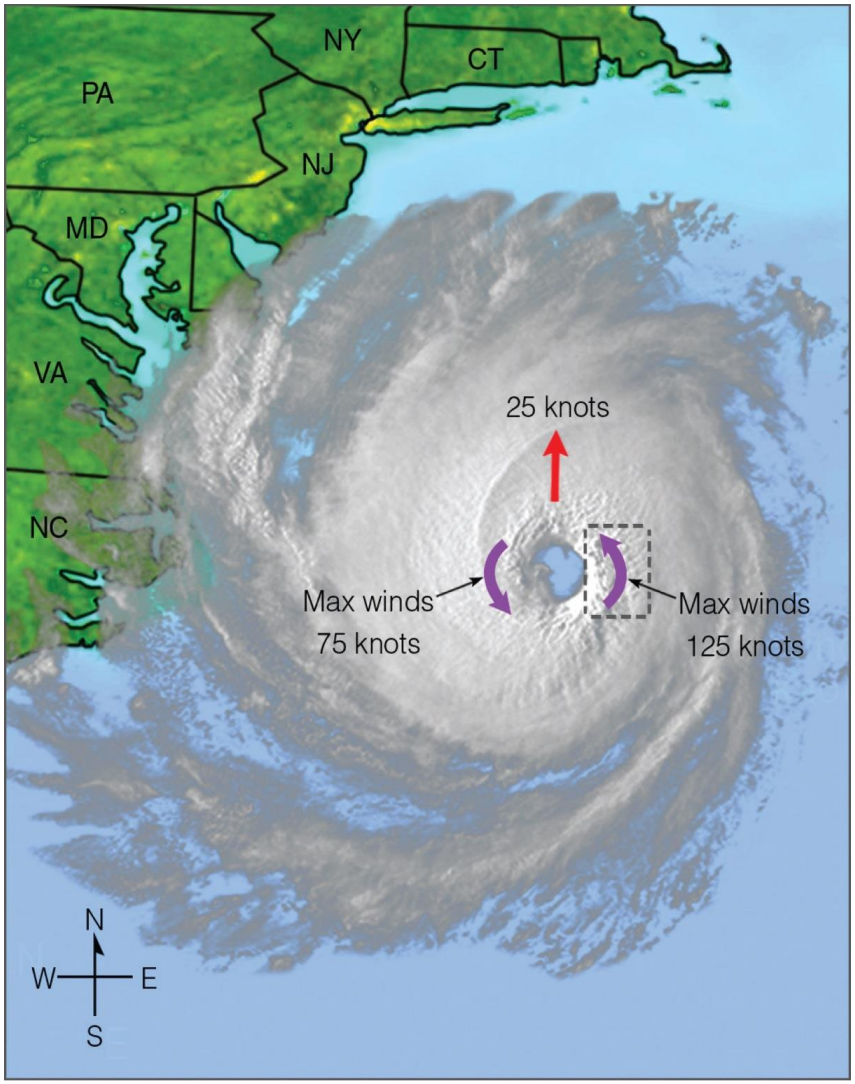
3 types of Low pressure systems:
3. *Tropical Lows – cyclones/hurricanes*

Saffir-Simpson Hurricane Wind Scale

The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous, however, and require preventative measures. In the western North Pacific, the term "super typhoon" is used for tropical cyclones with sustained winds exceeding 150 mph.

Category	Sustained Winds	Types of Damage Due to Hurricane Winds
1	74-95 mph 64-82 kt 119-153 km/h	**Very dangerous winds will produce some damage:** Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 83-95 kt 154-177 km/h	**Extremely dangerous winds will cause extensive damage:** Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129 mph 96-112 kt 178-208 km/h	**Devastating damage will occur:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156 mph 113-136 kt 209-251 km/h	**Catastrophic damage will occur:** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	157 mph or higher 137 kt or higher 252 km/h or higher	**Catastrophic damage will occur:** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

3 types of Low pressure systems:
3. *Tropical Lows – cyclones/hurricanes*



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- Hurricanes are really tropical cyclones
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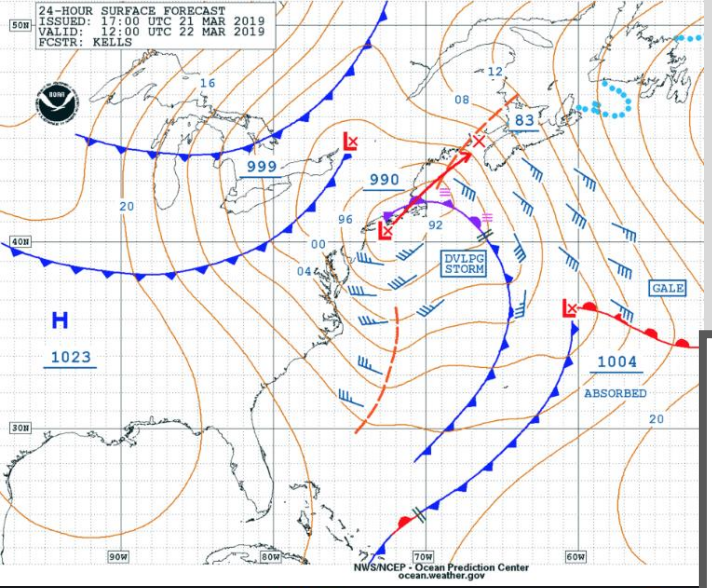
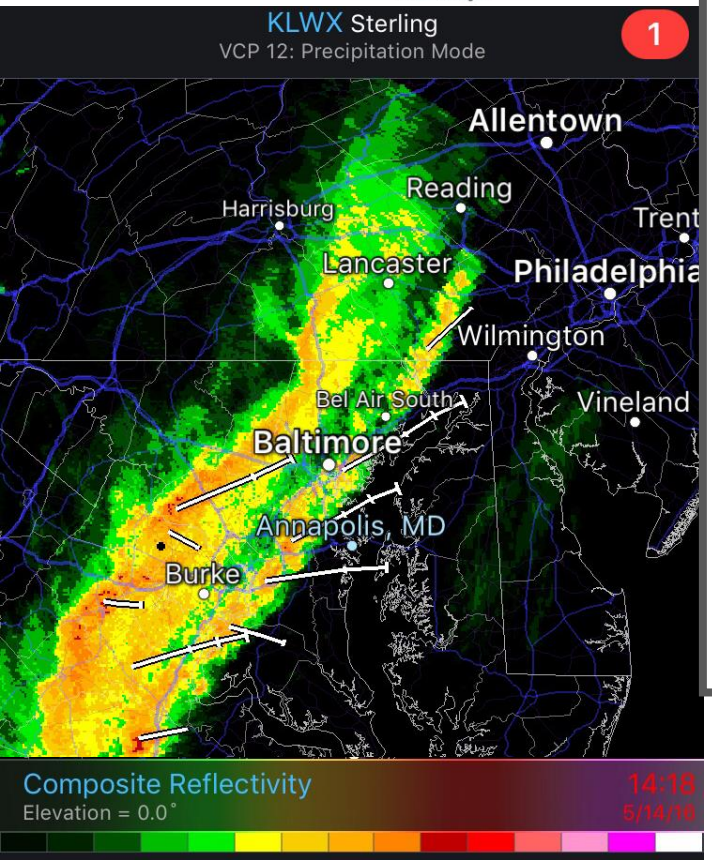
→ Tropical storm: sustained winds 34-63 knts
→ Hurricane: sustained winds > 64 knts

- Maximum wind speeds found in front right quadrant of tropical cyclone
  - sustained wind + forward movement of storm





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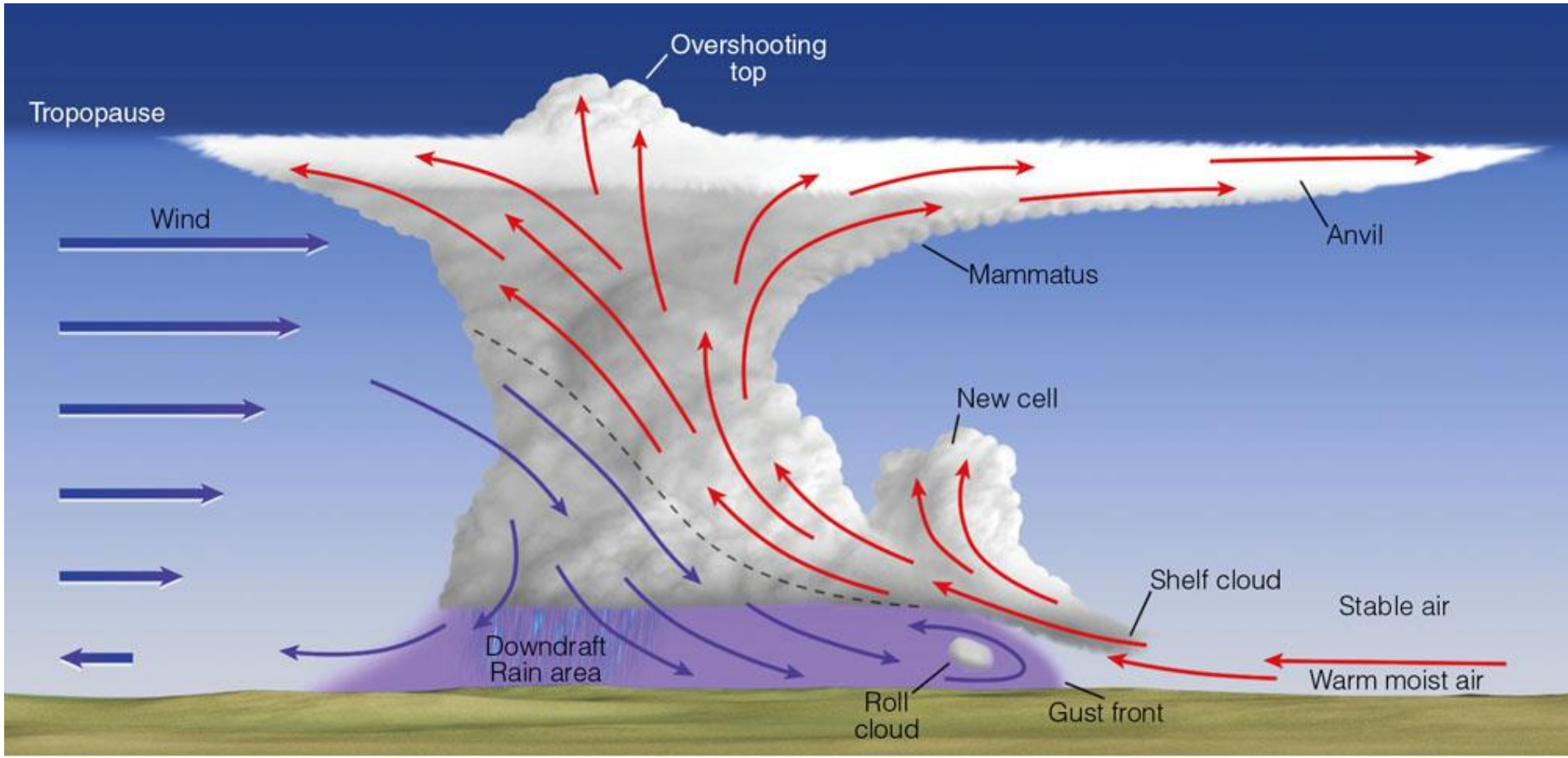
Extreme weather on the Bay

4 main types of thunderstorms

1. **Airmass** → away from frontal boundary
   - driven by intense surface heating, rarely produces hail/tornadoes
2. **Squall line** → a line of storms, often along a frontal boundary
   - Associated with heavy precipitation, winds and potentially hail/tornadoes



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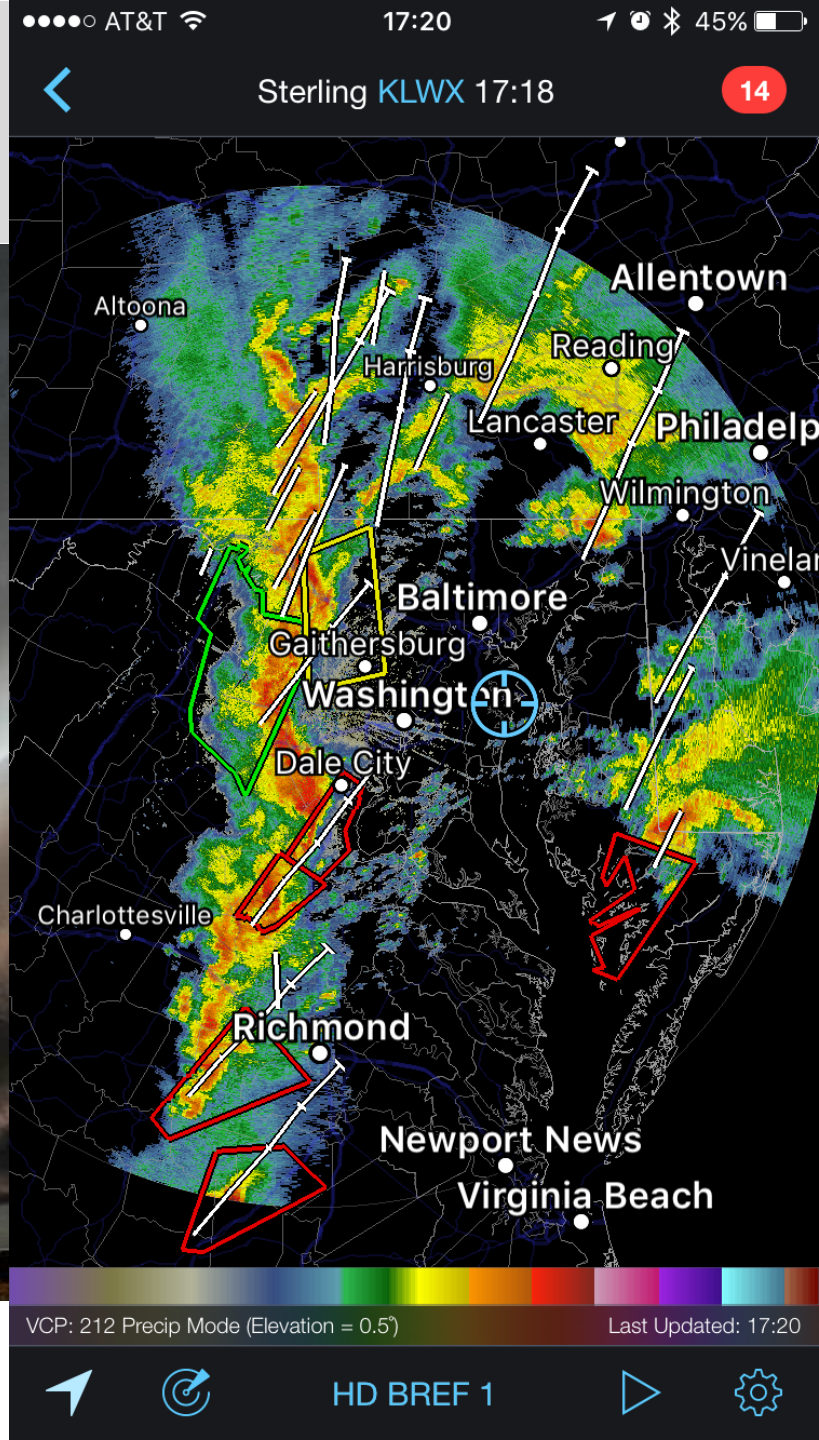
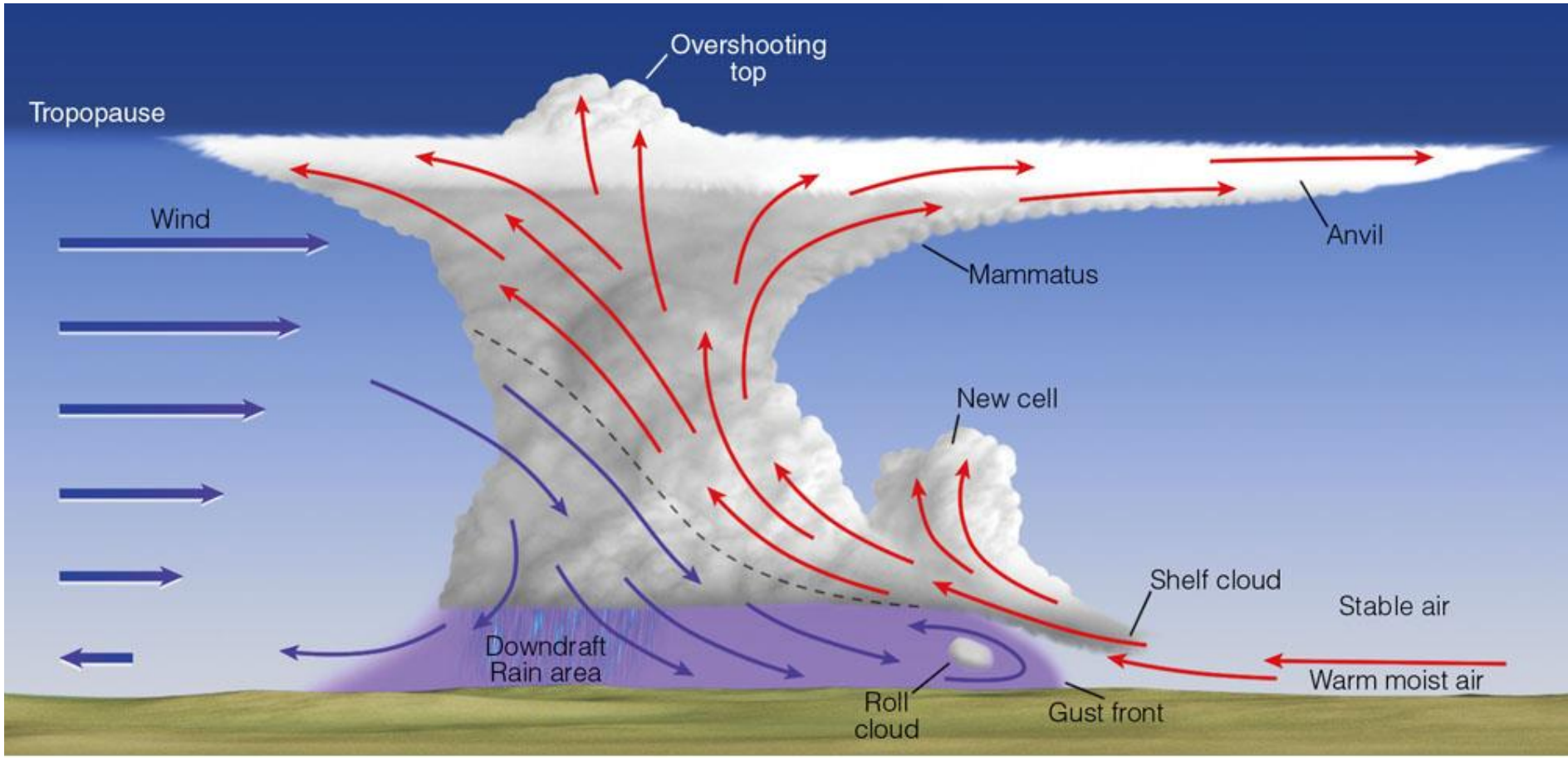
Squall Lines…
a line of thunderstorms



Extreme weather on the Bay

4 main types of thunderstorms

3. **Multi-cell** → storms occur in clusters
   - Most common in spring/summer
4. **Supercell**→ most intense and severe
   - Supercell thunderstorm updrafts **ALWAYS** rotate



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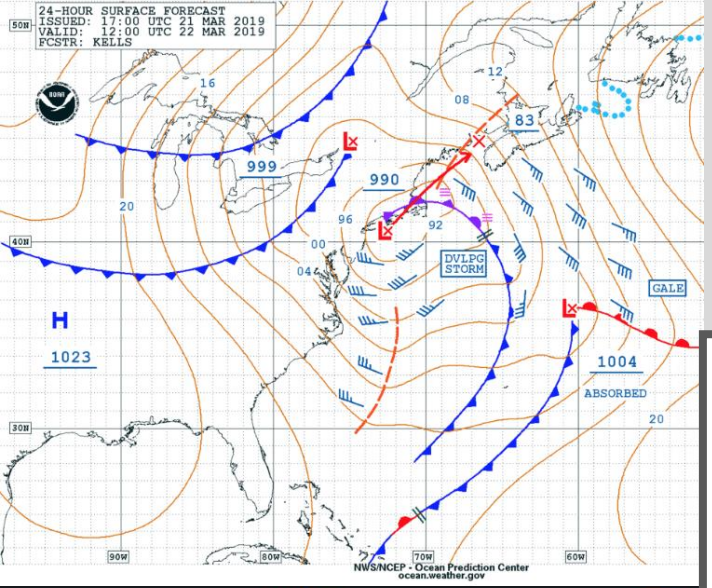
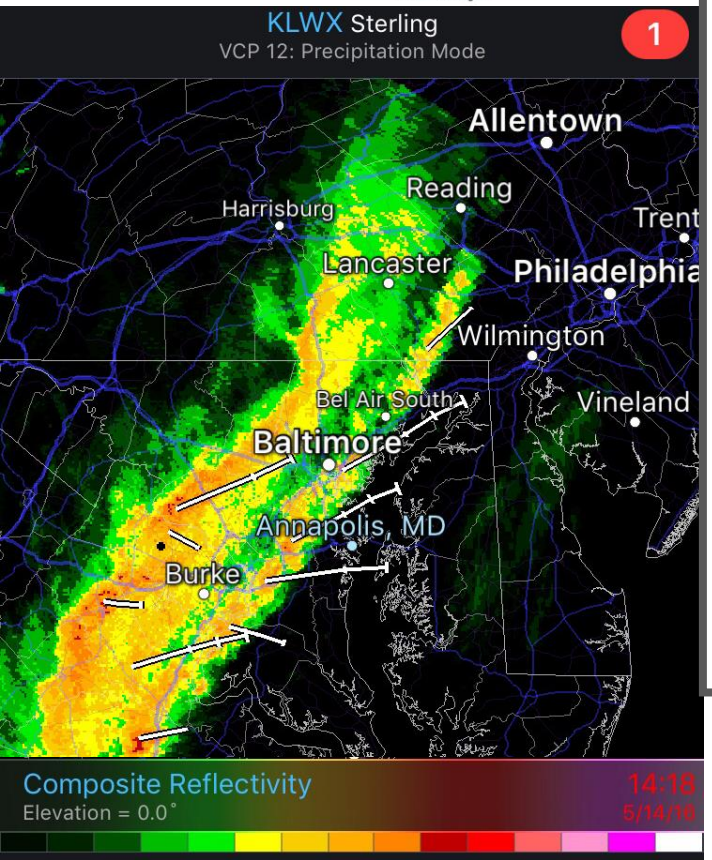
Supercell thunderstorm with anvil top





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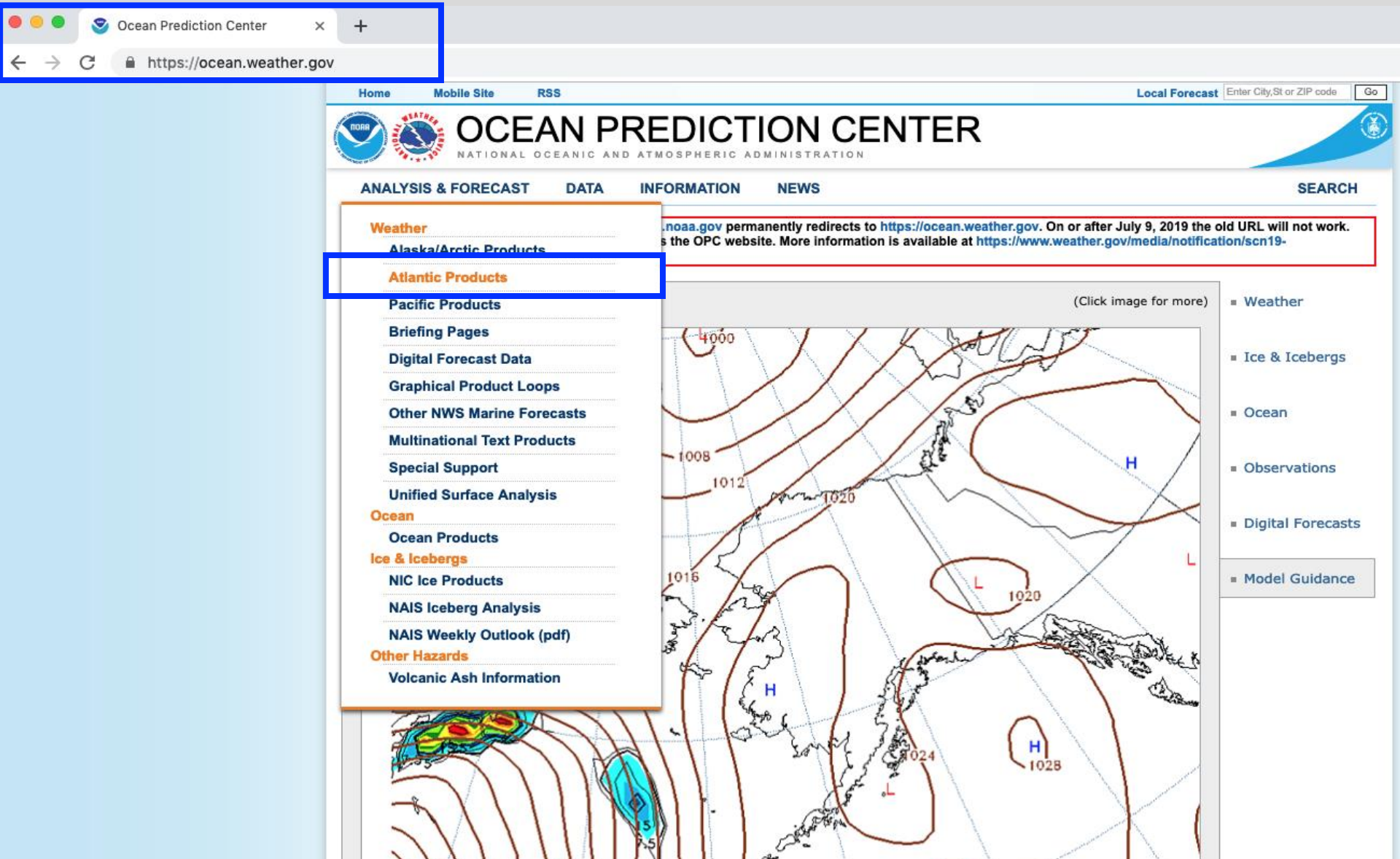
Weather products from NOAA Ocean Prediction Center (http://www.opc.ncep.noaa.gov/)



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Ocean Prediction Center - Atla

https://ocean.weather.gov/Atl_tab.shtml

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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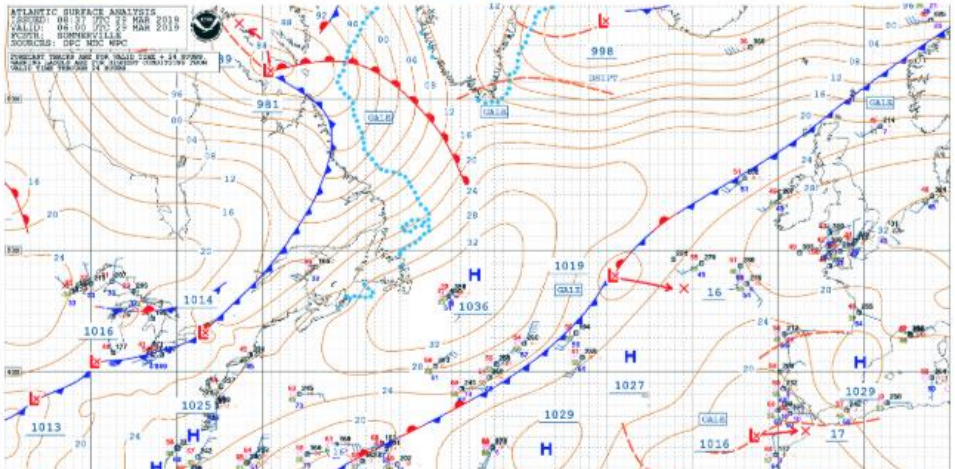
Atlantic Weather | Pacific Weather | Alaska/Arctic Weather

Analysis – Graphical Forecasts – Text Forecasts – Iceberg Analysis/Outlook – Hazards – Gridded – Other Marine

Atlantic Analysis

Click on the map below or choose from:

W Atlantic | Full Atlantic | E Atlantic



Weather products from NOAA Ocean Prediction Center (http://www.opc.ncep.noaa.gov/)

Ocean Prediction Center - Atla

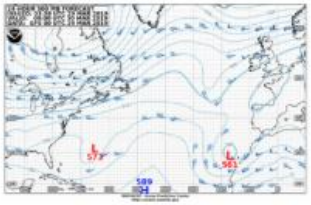
https://ocean.weather.gov/Atl_tab.shtml

Home Mobile Site RSS Local Forecast Enter City,St or ZIP code Go

OCEAN PREDICTION CENTER

SEARCH

Atlantic Graphical Forecasts

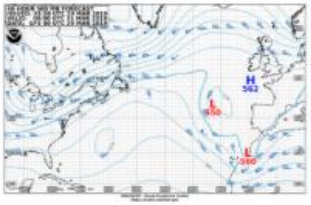


24-hour 500 mb

Loop: [3] [7] [14] Days

Updated: Fri, 29-Mar-2019 04:00:18 UTC

More 500 MB images

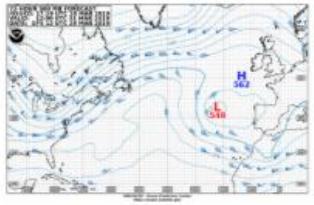


48-hour 500 mb

Loop: [3] [7] [14] Days

Updated: Fri, 29-Mar-2019 04:02:31 UTC

More 500 MB images

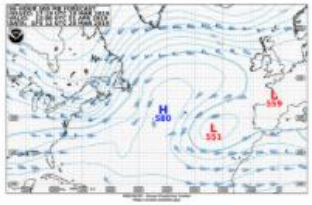


72-hour 500 mb

Loop: [3] [7] [14] Days

Updated: Thu, 28-Mar-2019 17:27:49 UTC

More 500 MB images

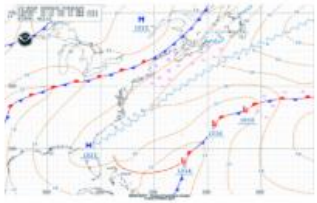


96-hour 500 mb

Loop: [3] [7] [14] Days

Updated: Thu, 28-Mar-2019 17:29:12 UTC

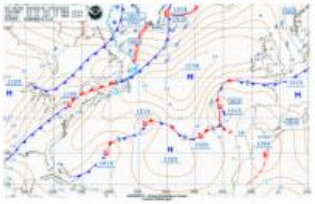
More 500 MB images



24-hour surface

Loop: [3] [7] [14] Days

Updated: Fri, 29-Mar-2019 04:14:08 UTC



48-hour surface

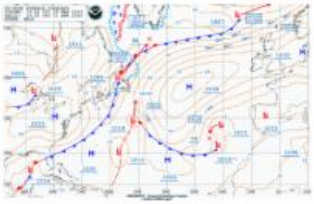
Loop: [3] [7] [14] Days

Updated: Fri, 29-Mar-2019 05:01:10 UTC

72-hour surface

Loop: [3] [7] [14] Days

Updated: Thu, 28-Mar-2019 17:31:02 UTC

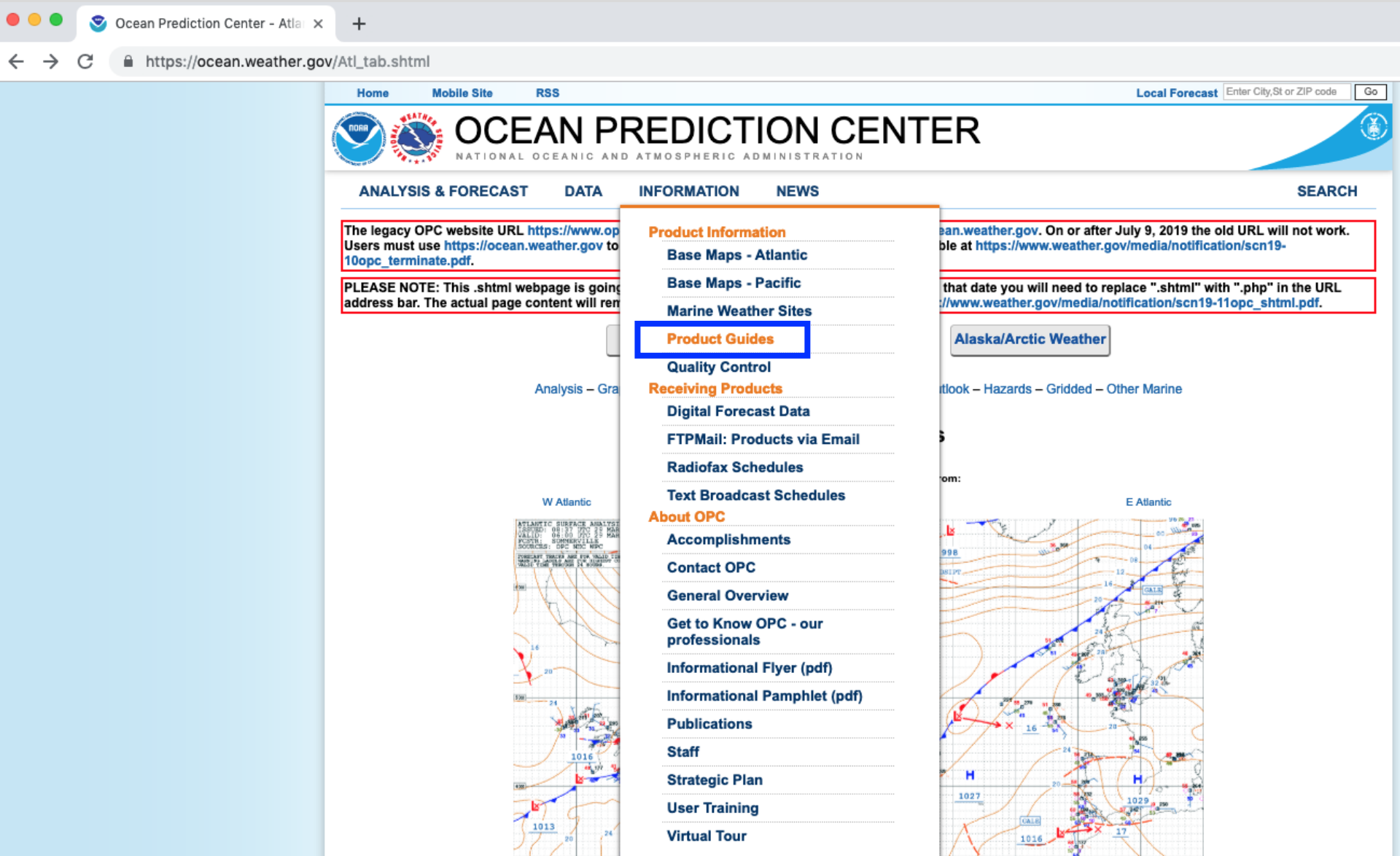


96-hour surface

Loop: [3] [7] [14] Days

Updated: Thu, 28-Mar-2019 13:25:30 UTC

How do I interpret all the symbols & notation?



How do I interpret all the symbols & notation?

Product Guides

https://ocean.weather.gov/product_guides.shtml

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Product Guides

- Archive Information
- FAQ
- Glossary
- Multi-national Text Products
- Radio Facsimile User's Guide
- Reference Publications
- Terminology & Weather Symbols Legend

More from NOAA's Voluntary Observing Ship (VOS) program:

- Marine Weather Information Guide (PDF)
- Marine Radiofax Chart FTP Email Procedures (PDF)

Page loaded: 29 Mar 2019 14:32 UTC | 29 Mar 2019 10:32 Local

CURRENT CONDITIONS	MARINE FORECASTS	MARINE RESOURCES	NEWS & INFORMATION	OPC SOCIAL MEDIA
Marine & Buoy Reports	Offshore & High Seas	Mariner's Weather Log	OPC News	Facebook
Tides Online	Tropical Marine	Voluntary Observing Ships	NWS Service Changes	Twitter
Surface Weather	Gridded Marine	National Ice Center	NWS News	YouTube

How do I interpret all the symbols & notation?

Terminology and Weather Sym

https://ocean.weather.gov/product_description/keyterm.shtml

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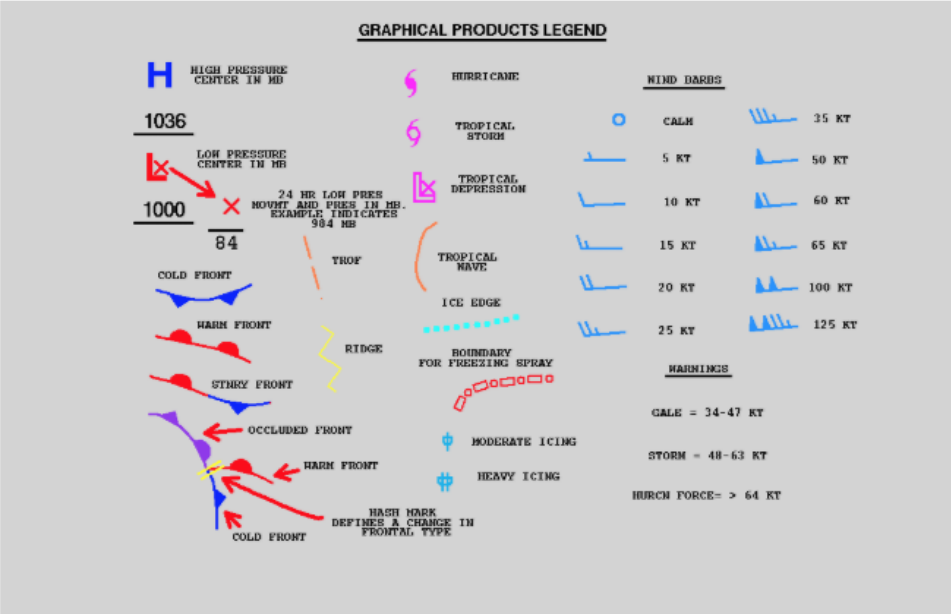
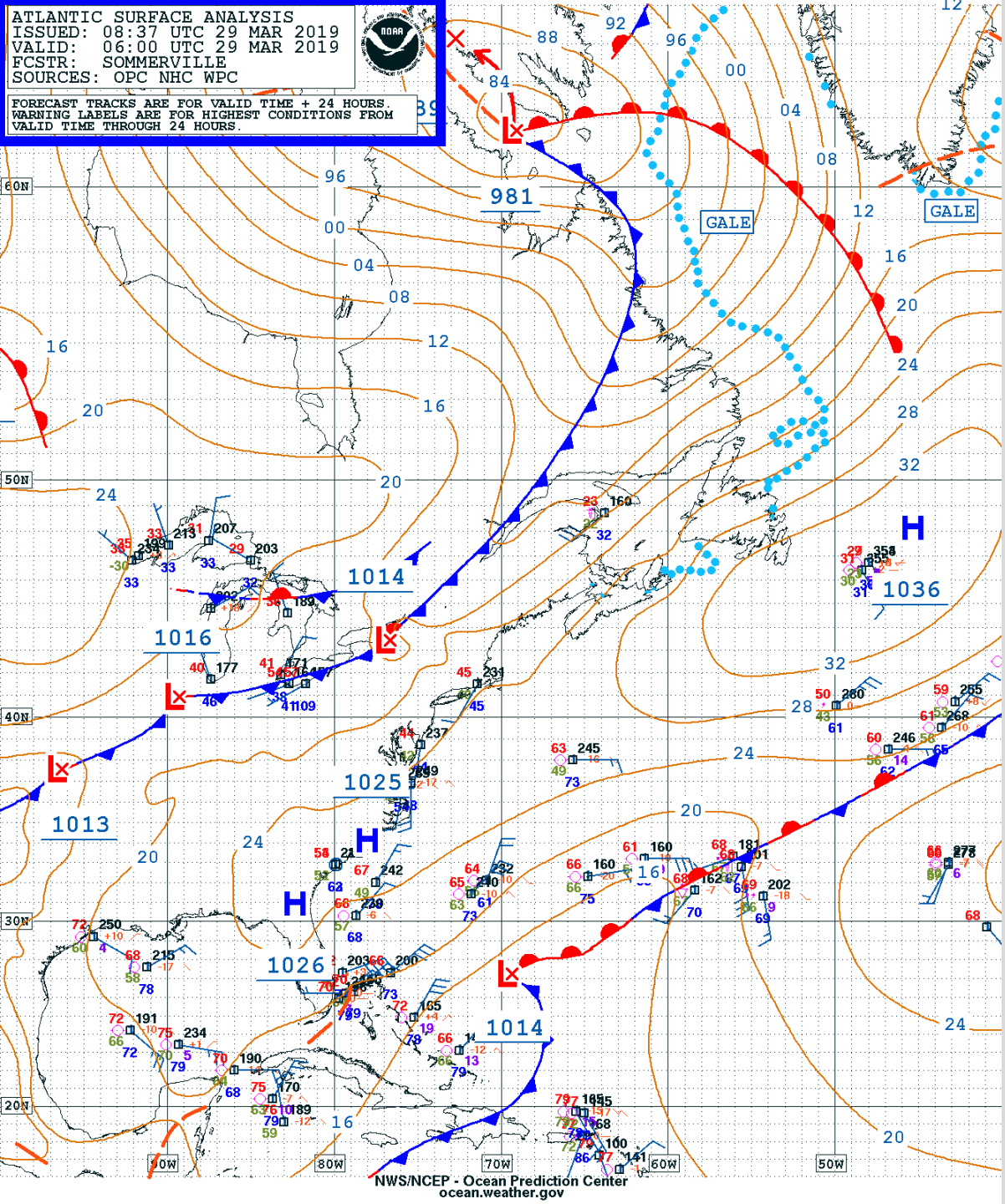
Terminology and Weather Symbols

Graphical Products Legend

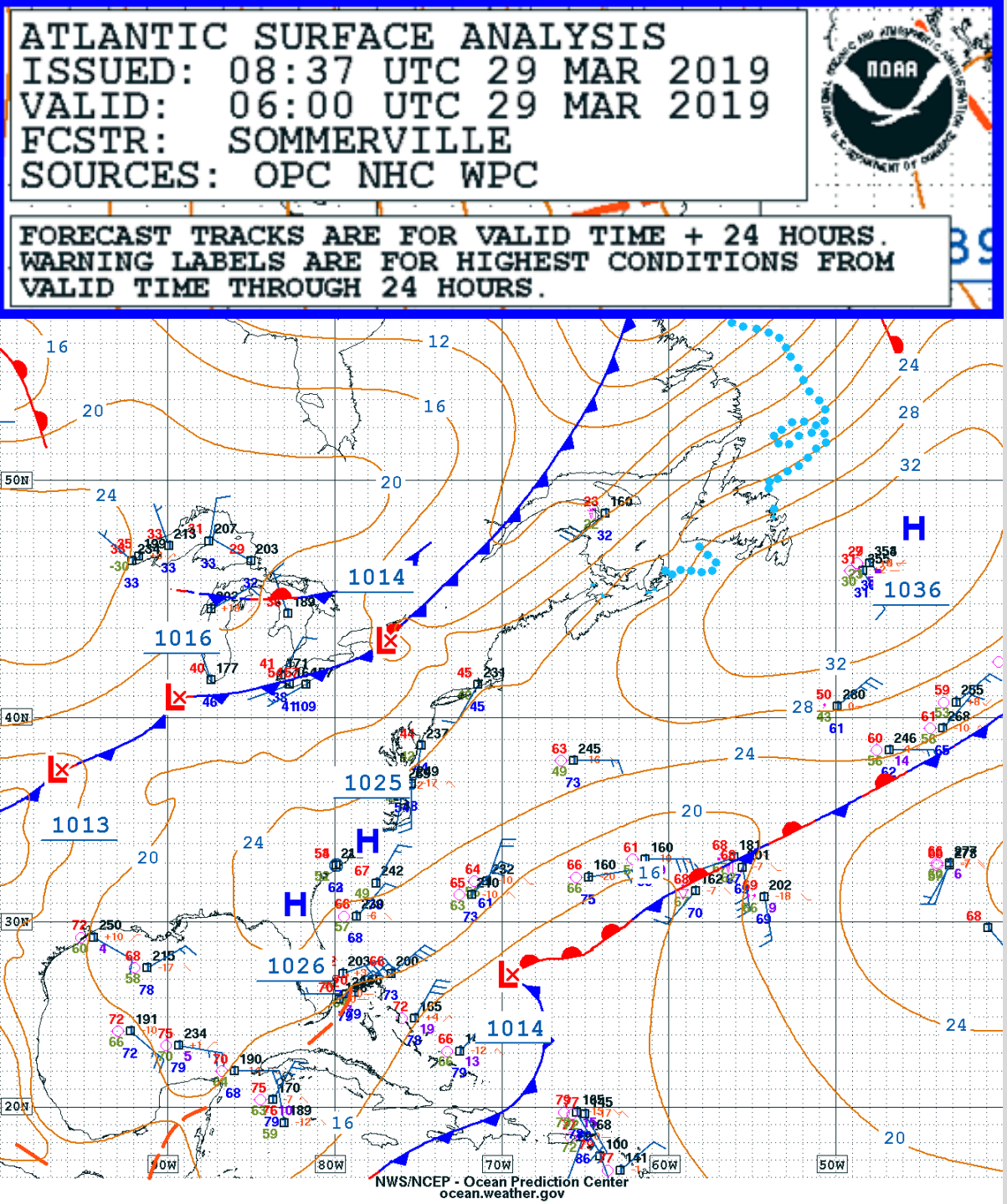




Let us identify some features on this Surface Analysis map:

Image source:

www.opc.ncep.noaa.gov

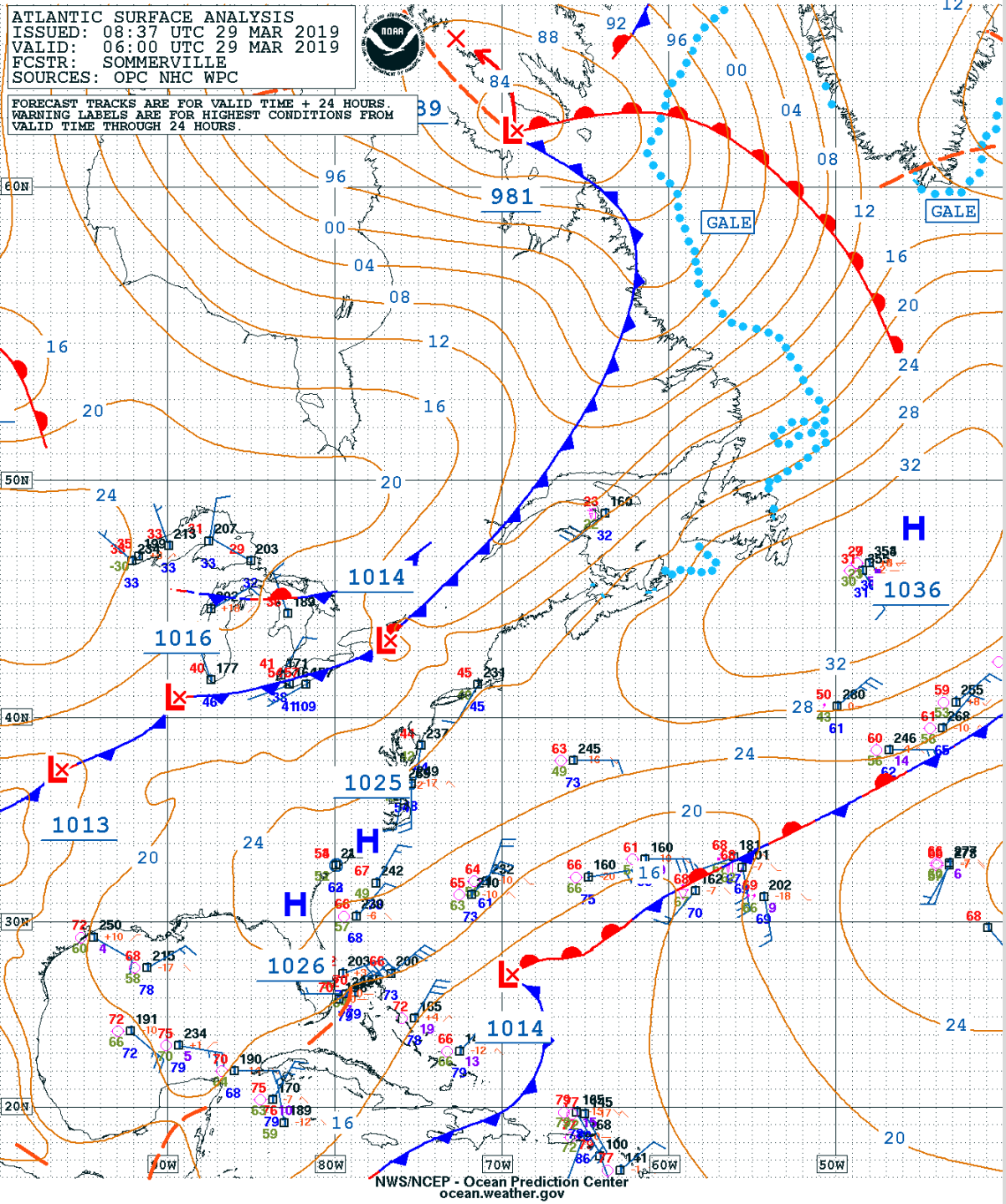


Let us identify some features on this Surface Analysis map:

- Surface map
- "ISSUED"
  - → time analysis was released
- "VALID"
  - → Time conditions apply
- UTC/GMT/Zulu time

Image source:

www.opc.ncep.noaa.gov



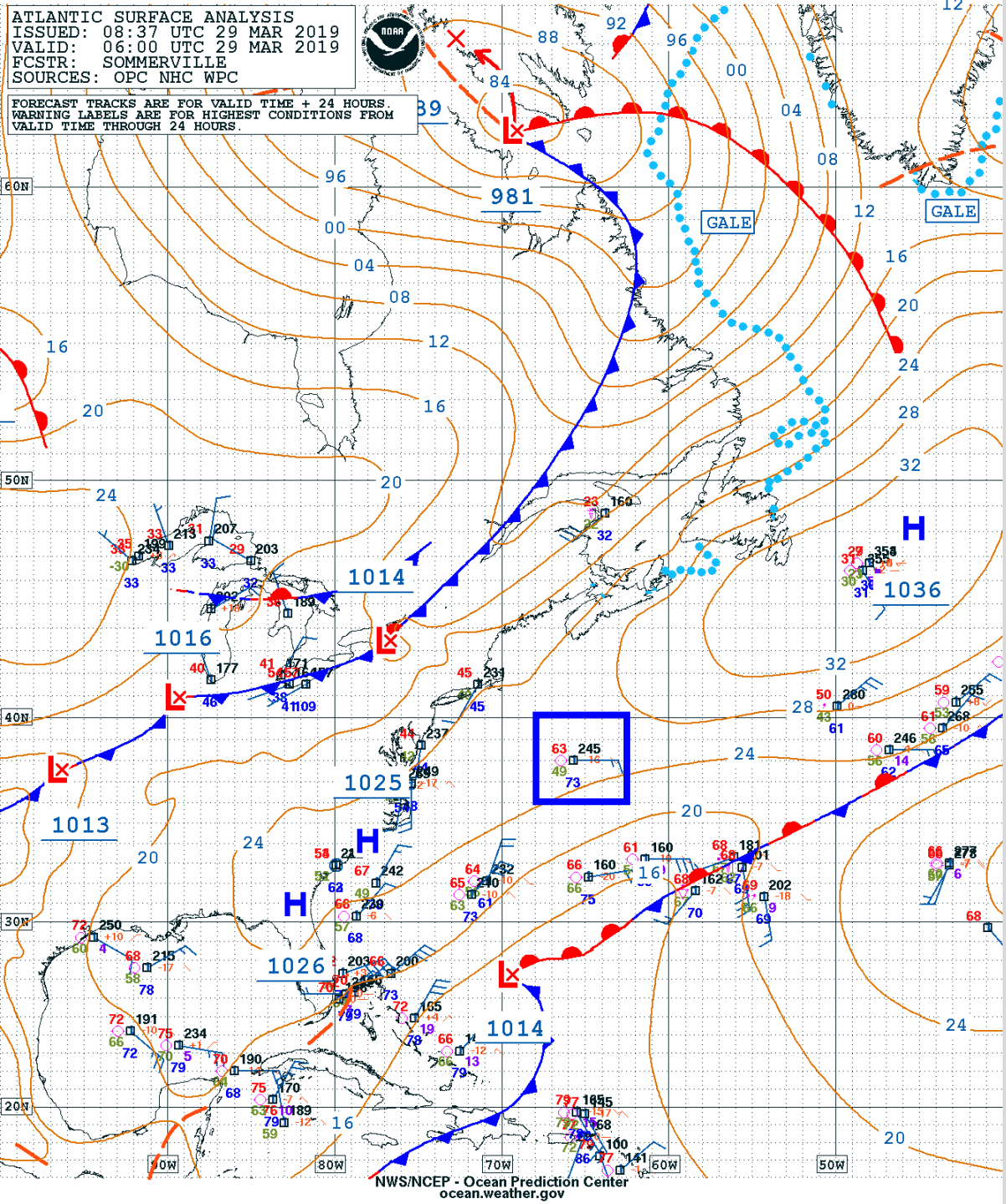
Let us identify some features on this Surface Analysis map:

- **H** vs. **L** surface pressure
- **H** vs. **L** relative to what?

Mean sea level pressure → 1013 millibars

- Pressure gradients?

Image source:
www.opc.ncep.noaa.gov



Let us identify some features on this Surface Analysis map:

- Interpreting a station model

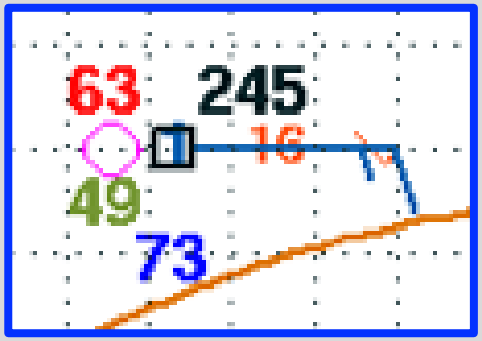
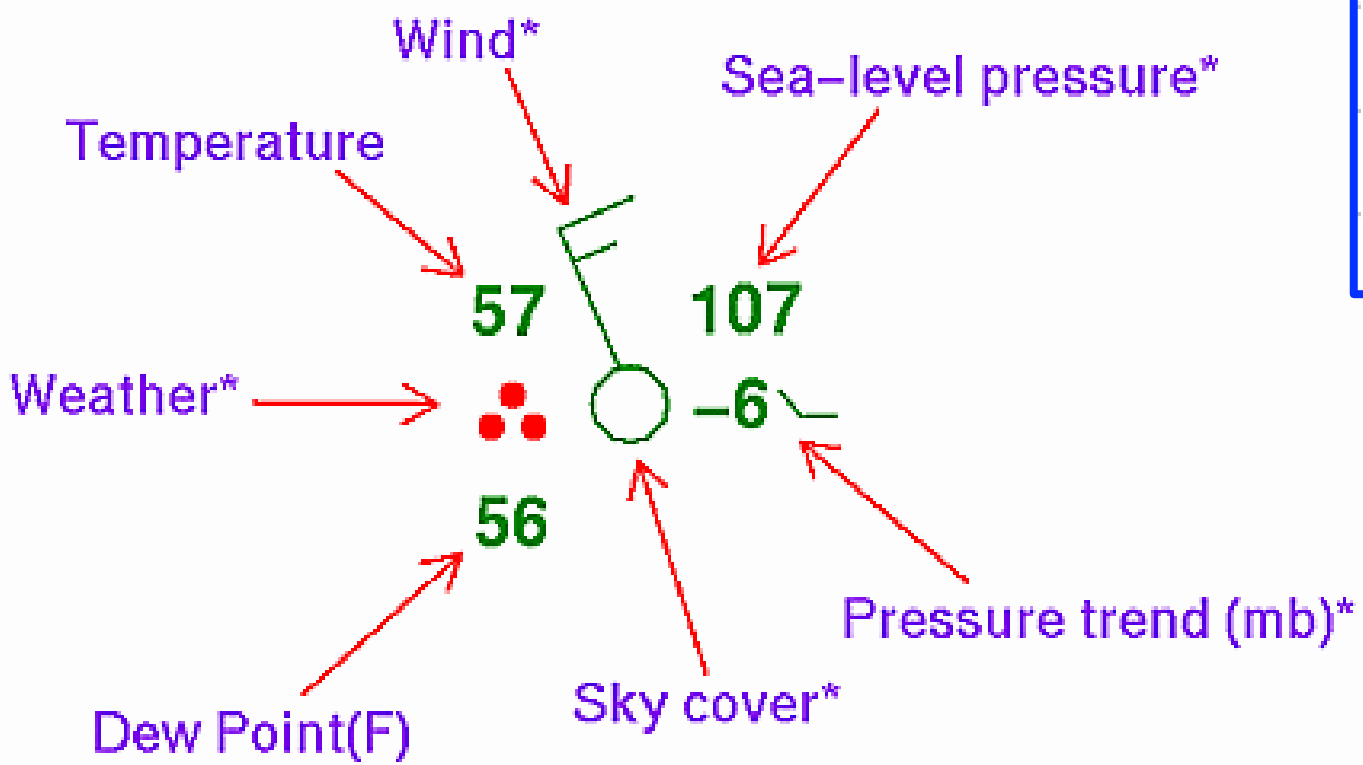


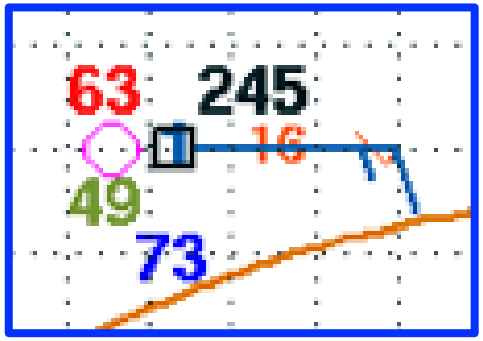
Image source:

www.opc.ncep.noaa.gov

Interpreting a station model:
What information are we given?

Image source:
http://www.wpc.ncep.noaa.gov/html/stationplot.shtml

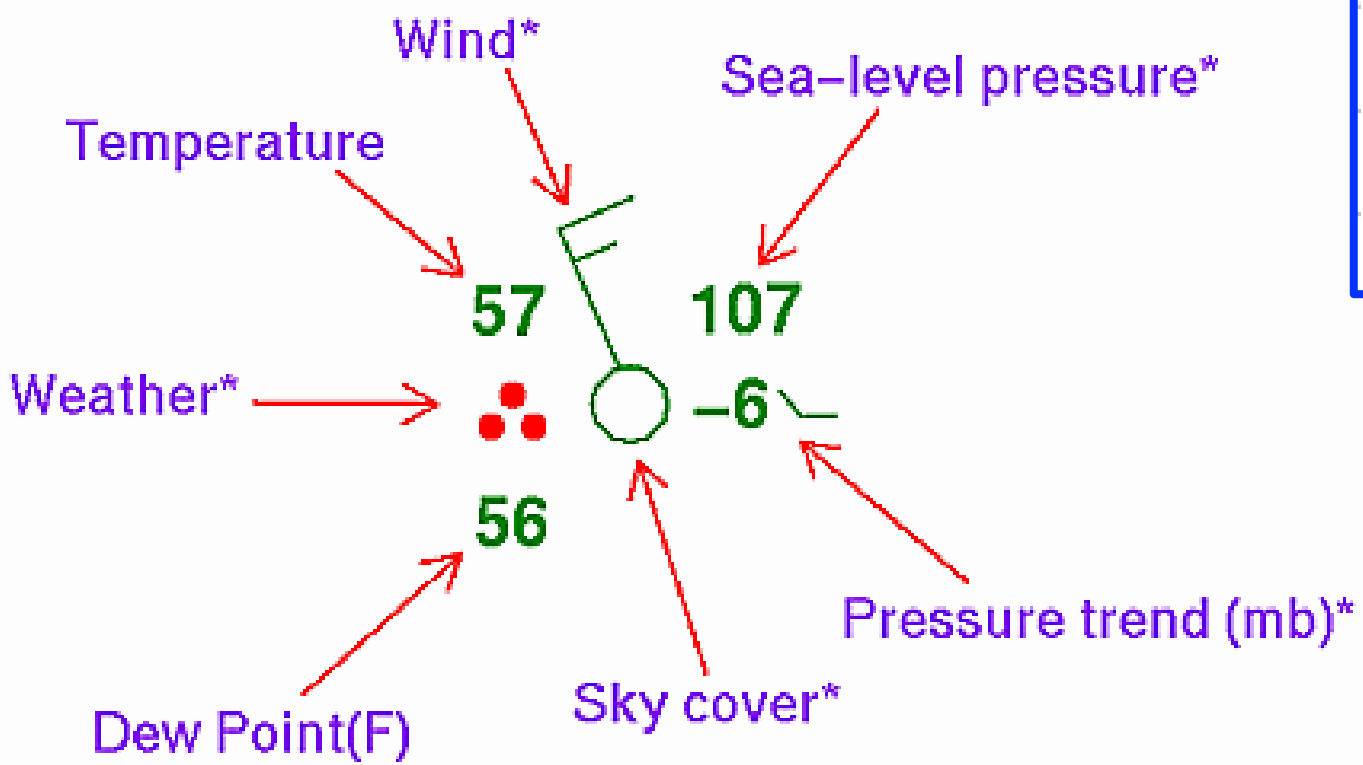


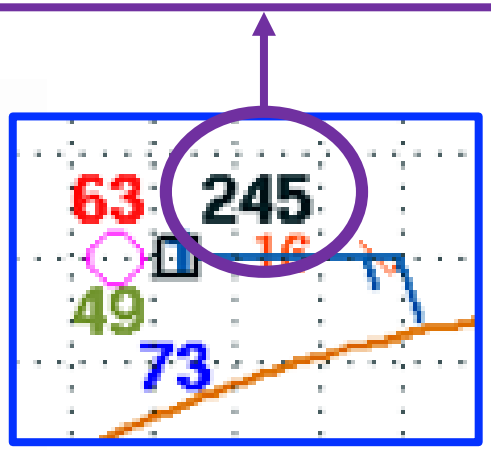


Interpreting a station model:
What information are we given?

Pressure range is 960 mb to 1060 mb…. *Add 9 or 10 to front of number*

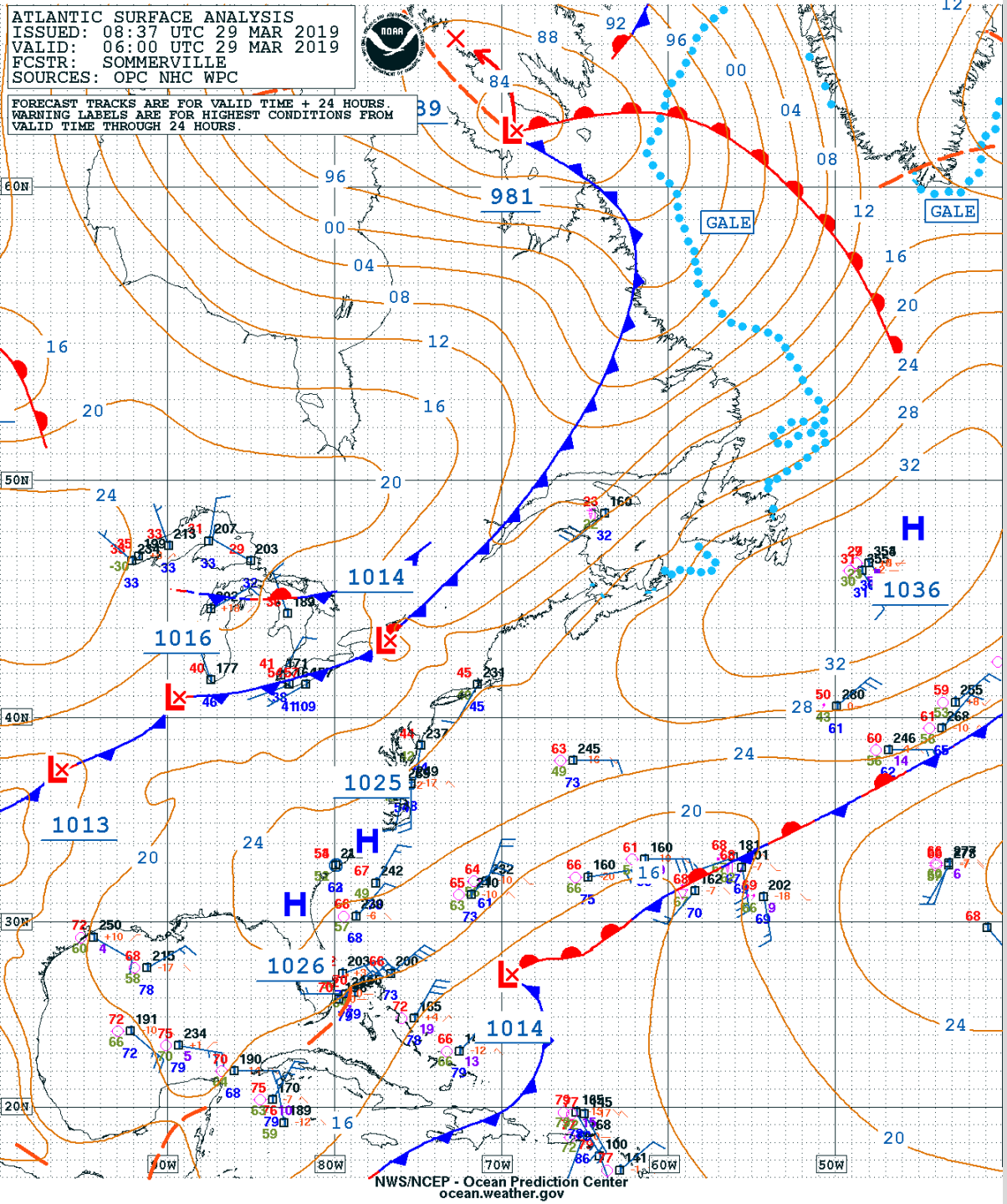
Image source:
http://www.wpc.ncep.noaa.gov/html/stationplot.shtml





How do we forecast where surface systems will move?

Look UP!



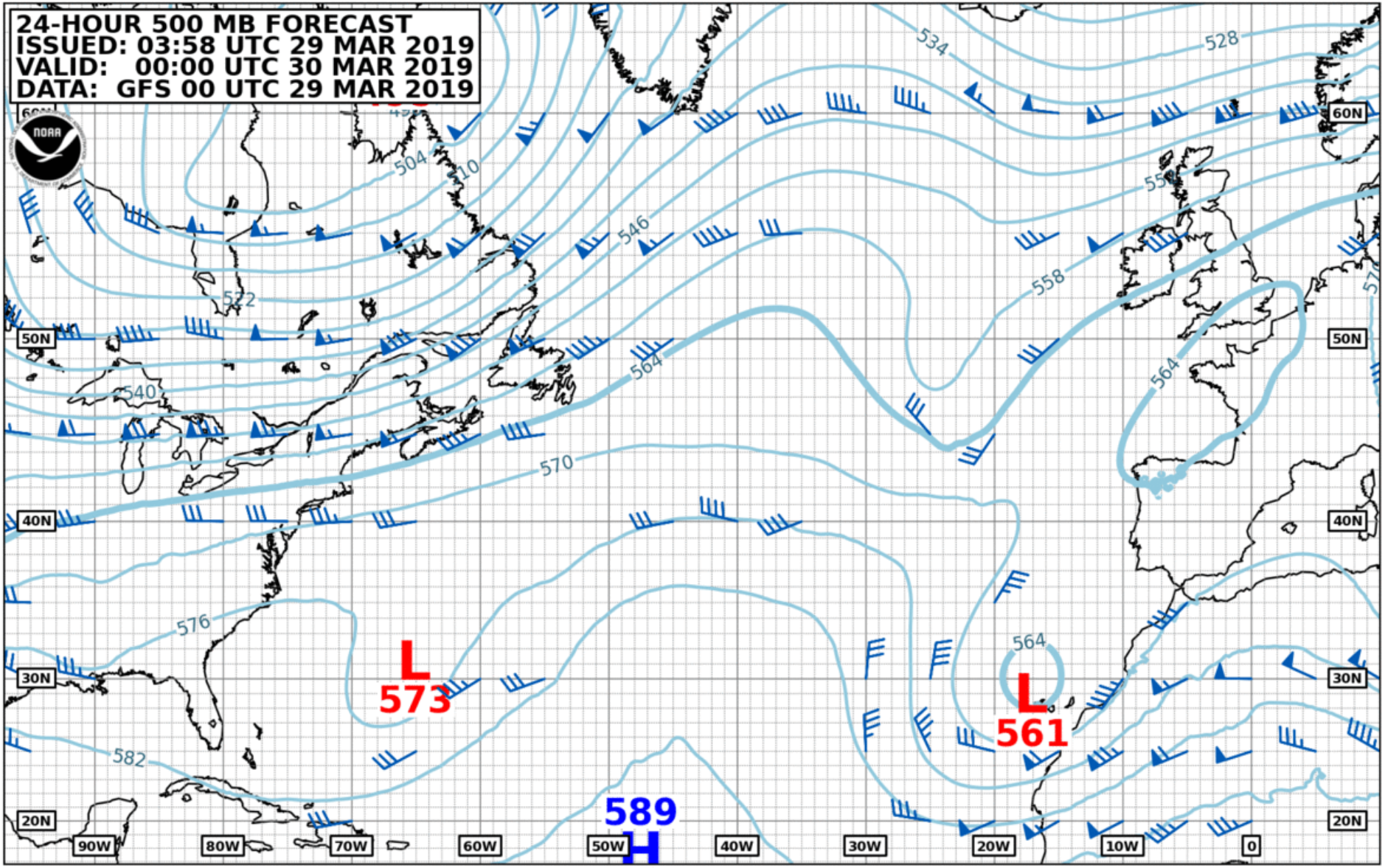
Let us identify some features on this Surface Analysis map:

- Where will our surface systems move to?
- Will they intensify or weaken?

Image source:
www.opc.ncep.noaa.gov

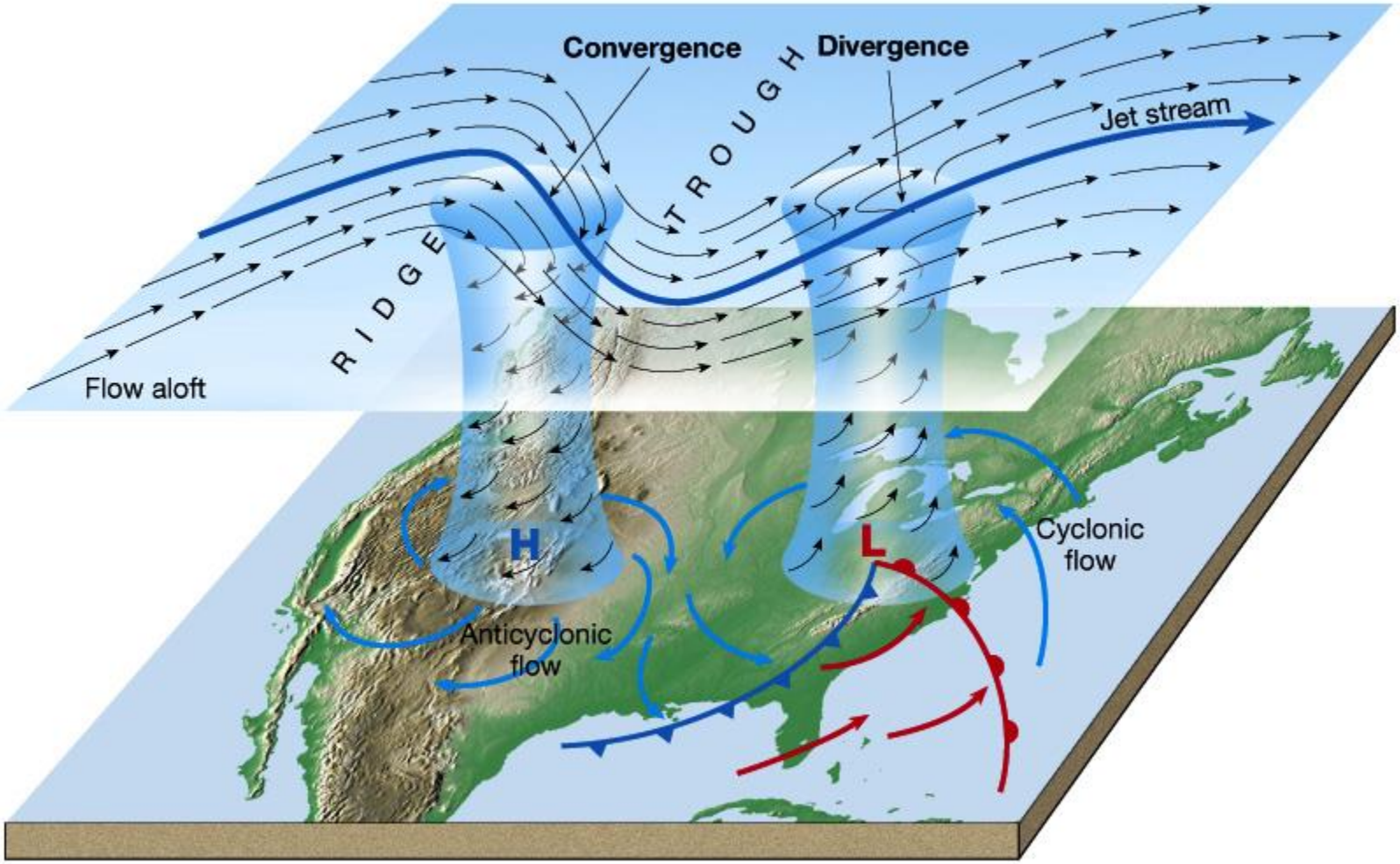
500mb Chart: forecast

-- Gives us the height where we reach 500mb of pressure



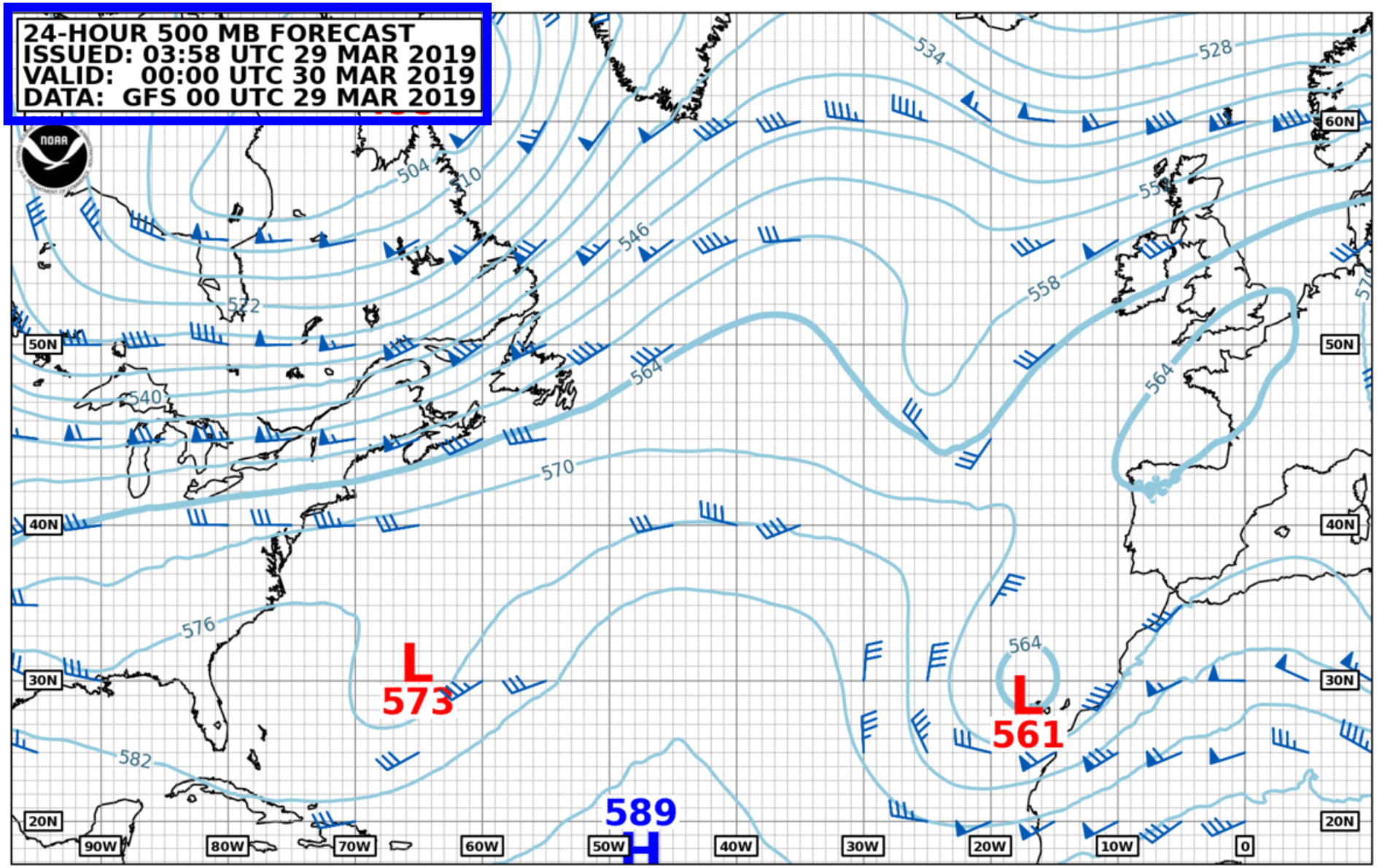
NWS/NCEP - Ocean Prediction Center
https://ocean.weather.gov

500mb Chart vs. Surface chart



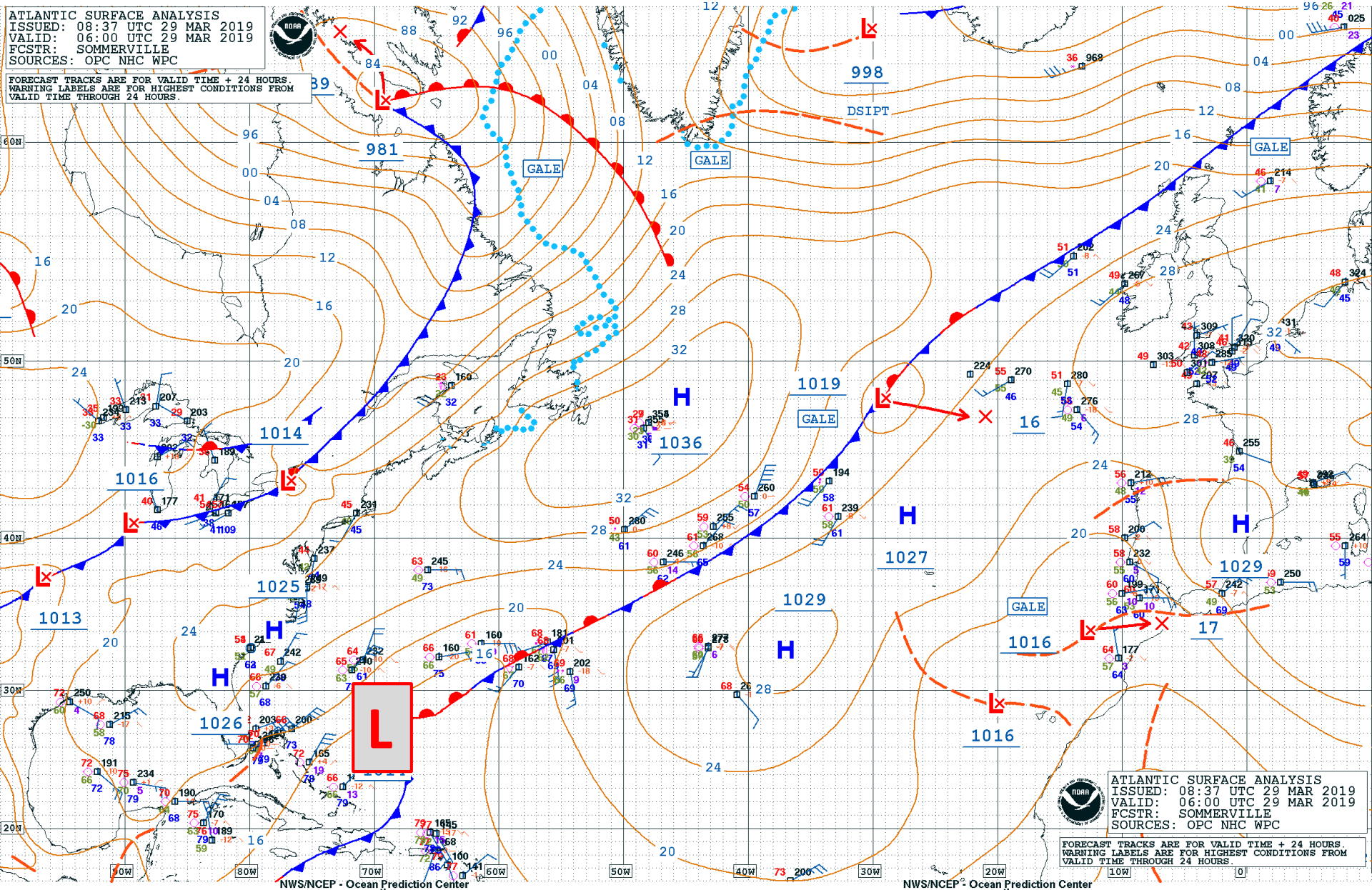
500mb Chart: forecast

-- Gives us the height where we reach 500mb of pressure



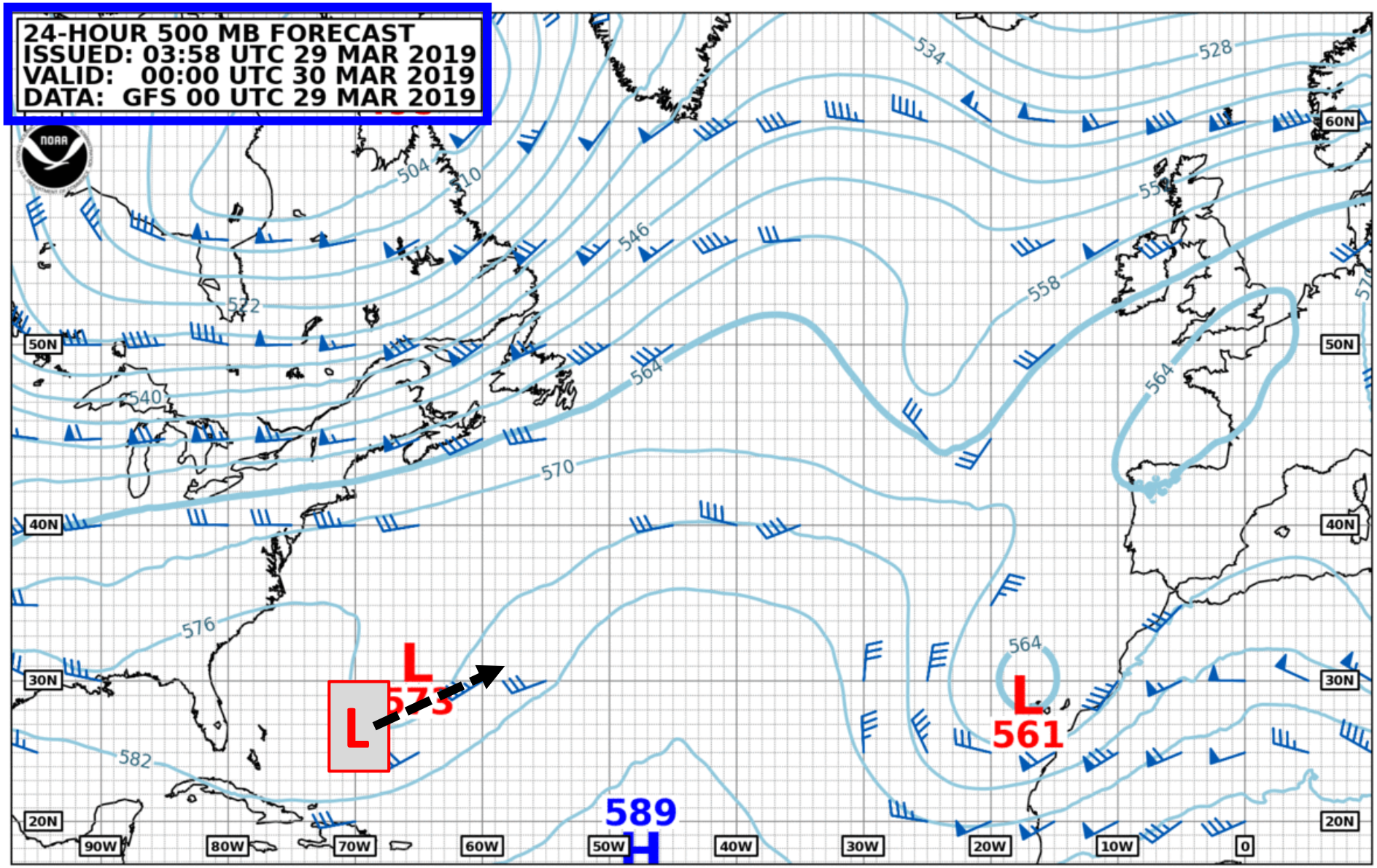
NWS/NCEP - Ocean Prediction Center
https://ocean.weather.gov

Let us track where our surface Low goes……



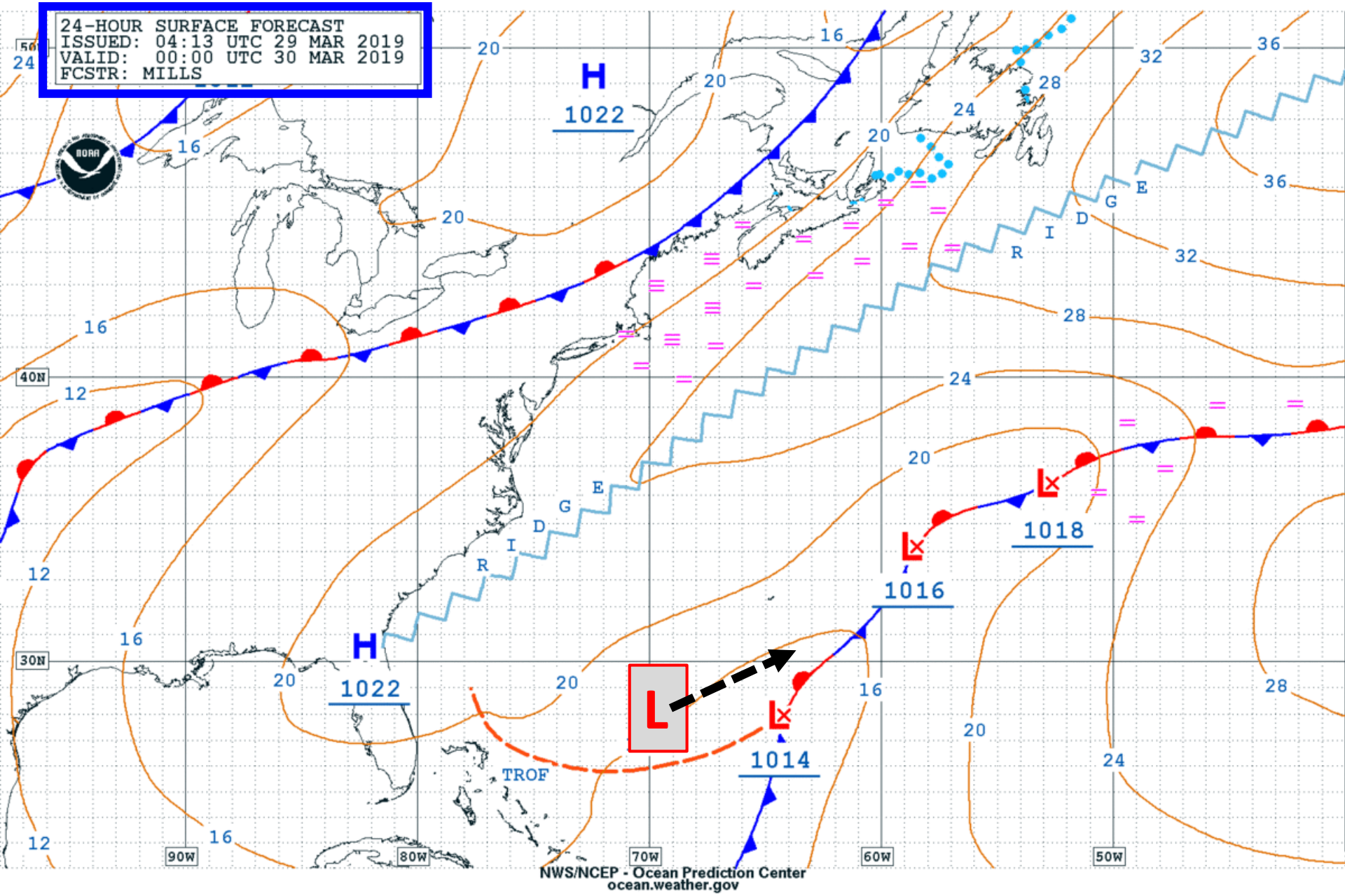
500mb Chart: forecast

-- Gives us the height where we reach 500mb of pressure

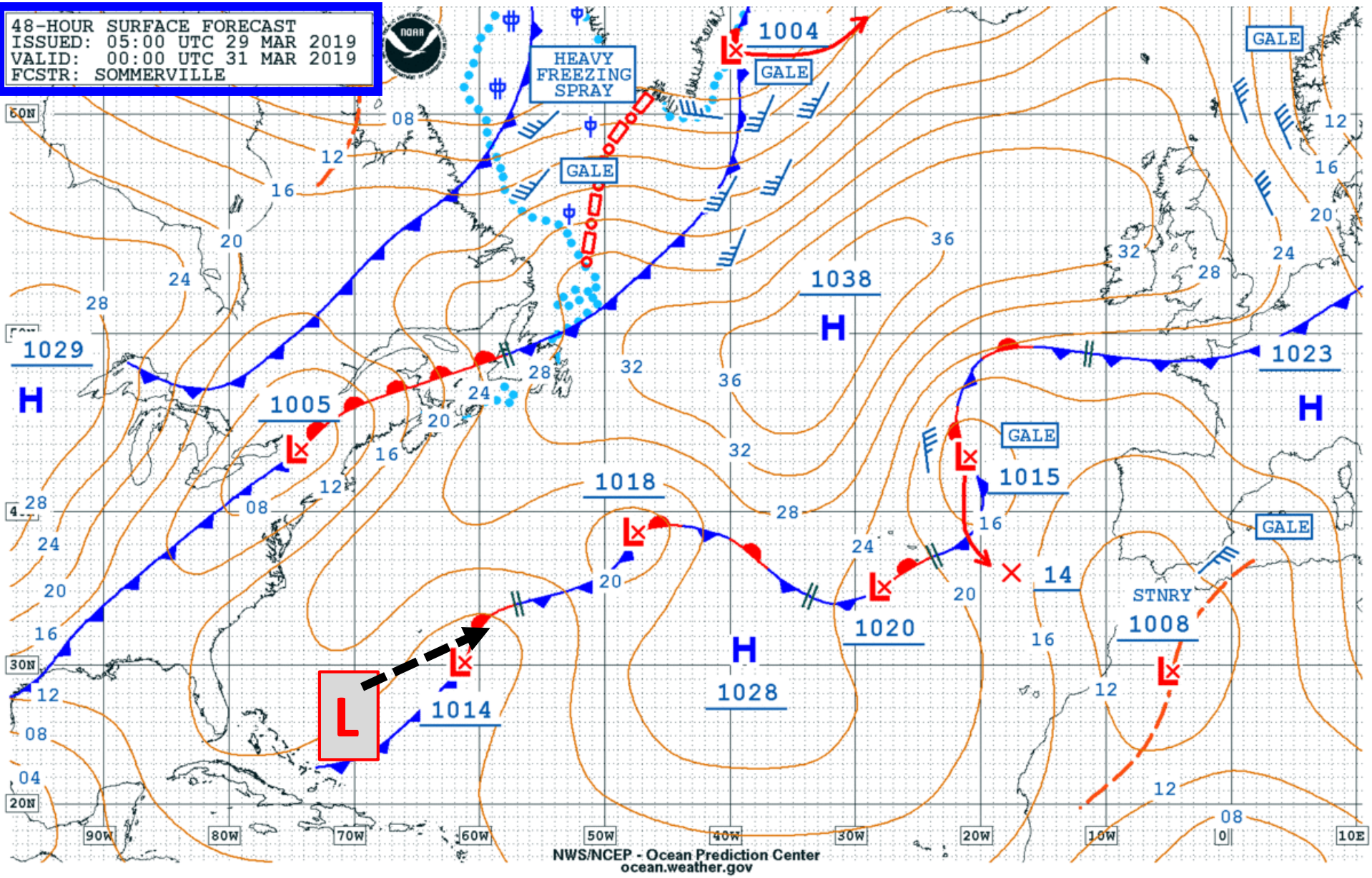


NWS/NCEP - Ocean Prediction Center
https://ocean.weather.gov

24-hour forecasted surface map

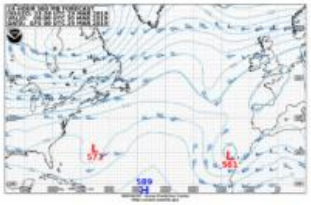


48-hour forecasted surface map



Weather products from NOAA Ocean Prediction Center (http://www.opc.ncep.noaa.gov/)

Atlantic Graphical Forecasts



24-hour 500 mb

Loop: [3] [7] [14] Days

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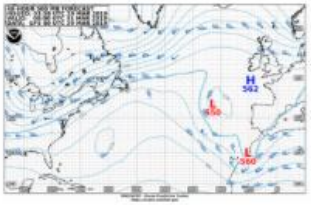
More 500 MB images



48-hour 500 mb

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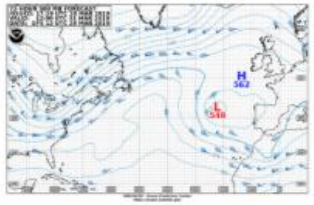

72-hour 500 mb

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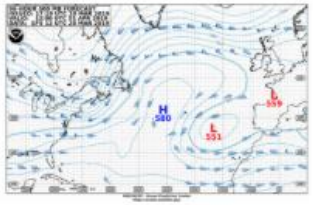
More 500 MB images



96-hour 500 mb

Loop: [3] [7] [14] Days

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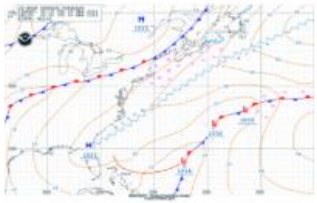
More 500 MB images



24-hour surface

Loop: [3] [7] [14] Days

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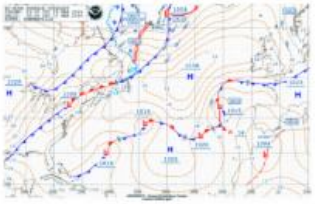


48-hour surface

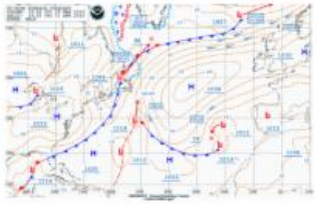
Loop: [3] [7] [14] Days

Updated: Fri, 29-Mar-2019 05:01:10 UTC

72-hour surface

Loop: [3] [7] [14] Days

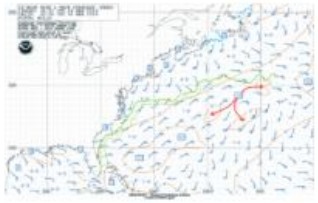
Updated: Thu, 28-Mar-2019 17:31:02 UTC



96-hour surface

Loop: [3] [7] [14] Days

Updated: Thu, 28-Mar-2019 13:25:30 UTC



24-hour wind & wave

Loop: [3] [7] [14] Days

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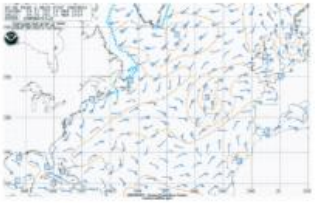
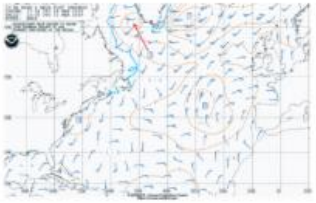


48-hour wind & wave

Loop: [3] [7] [14] Days

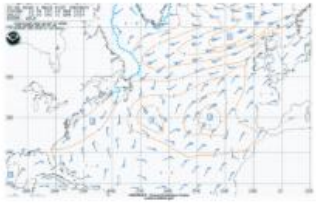
Updated: Fri, 29-Mar-2019 05:28:16 UTC



72-hour wind & wave

Loop: [3] [7] [14] Days

Updated: Thu, 28-Mar-2019 17:36:45 UTC



96-hour wind & wave

Loop: [3] [7] [14] Days

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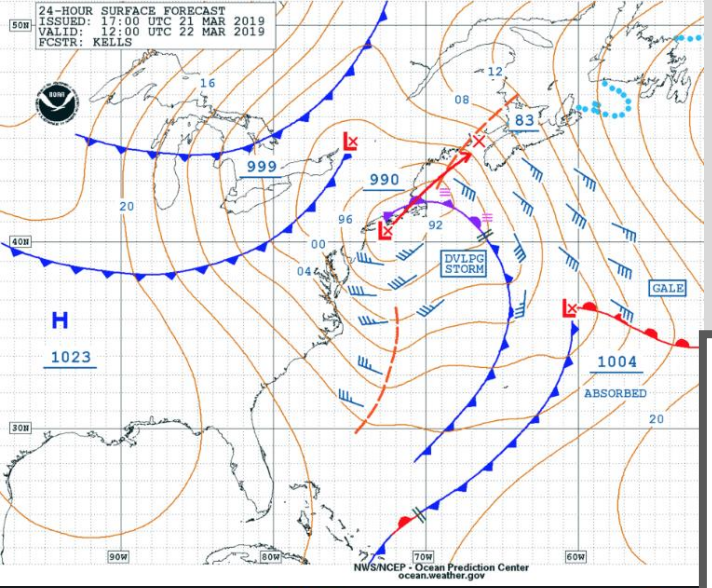

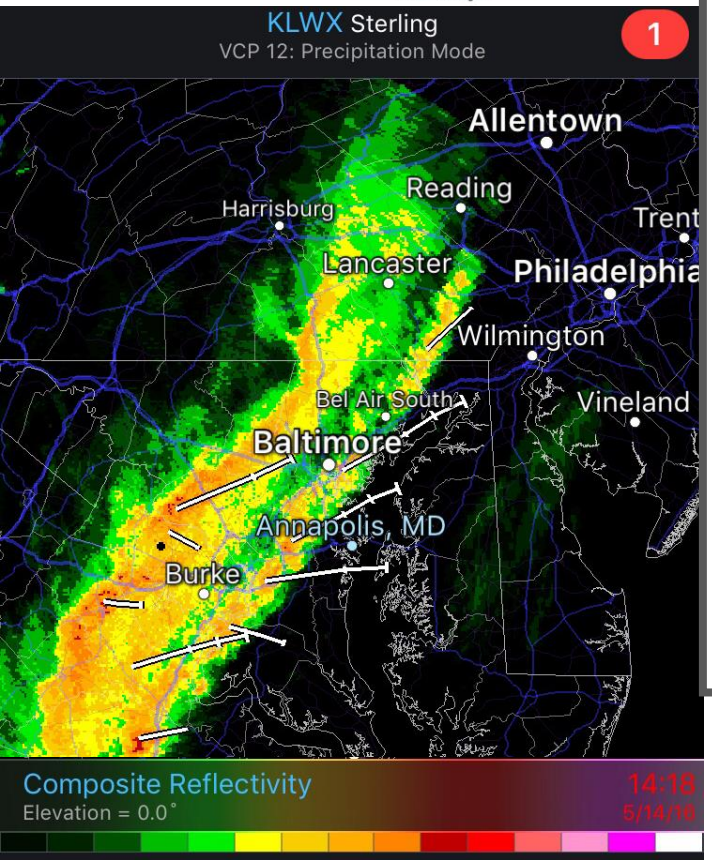

Weather Basics

Safety at Sea Seminar, 30th March 2019

Session goals:

- ✓ **Identify global wind patterns**
- ✓ **Wind flow around surface Highs & Lows**
  - **3 types of Lows to look out for**
  - **Weather on the ground?**
- ✓ **Severe weather on the Bay & in the North Atlantic**
- ✓ **Interpret main features on a surface weather chart**

Dr. Gina Henderson
Oceanography Dept., USNA
ghenders@usna.edu

Resources to learn more……

- Online "school for weather" called JetStream, that is provided by NOAA and offers lots of information if you would like to learn more
  - https://www.weather.gov/jetstream/

- For more in-depth information, the following text book is what we currently use at the Academy for teaching synoptic meteorology:
  - https://www.amazon.com/Midlatitude-Synoptic-Meteorology-Dynamics-Forecasting/dp/1878220101