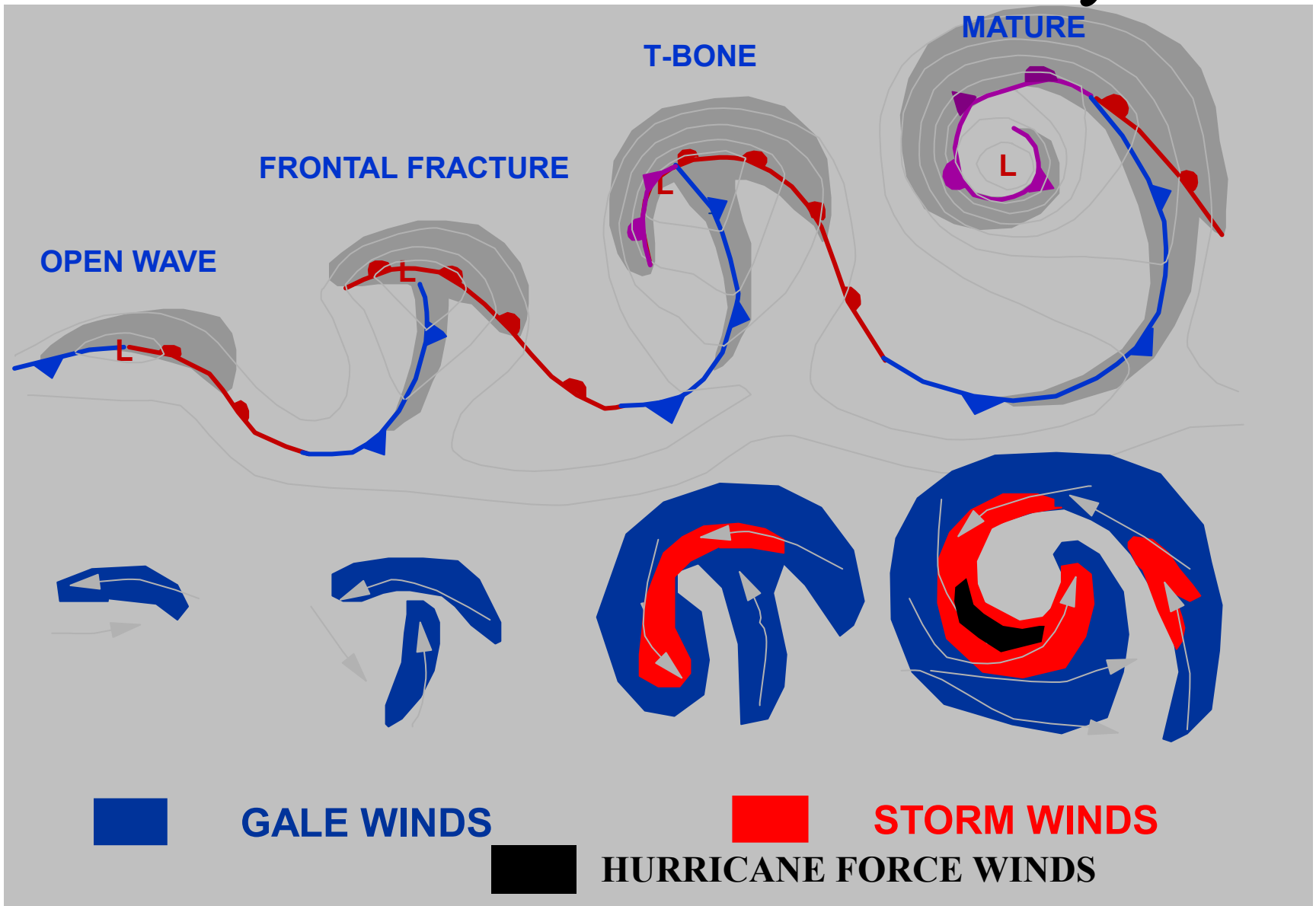
NOAA's OCEAN PREDICTION CENTER

America's Weather Warning and Forecast Service for Mariners at Sea

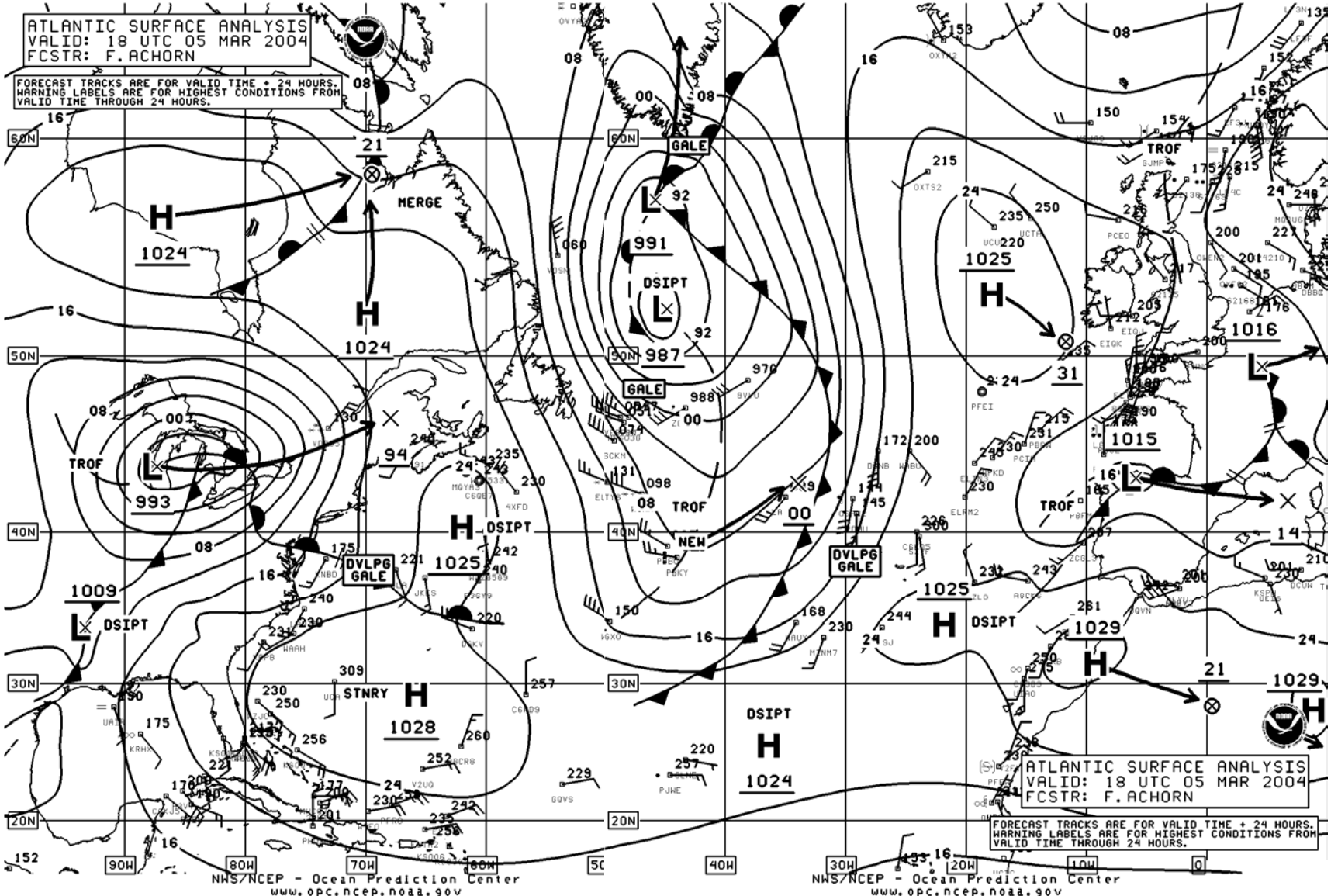
Ocean Prediction Center Website:
http://www.opc.ncep.noaa.gov

U.S. Naval Academy Presentation By
Lee.Chesneau@noaa.gov

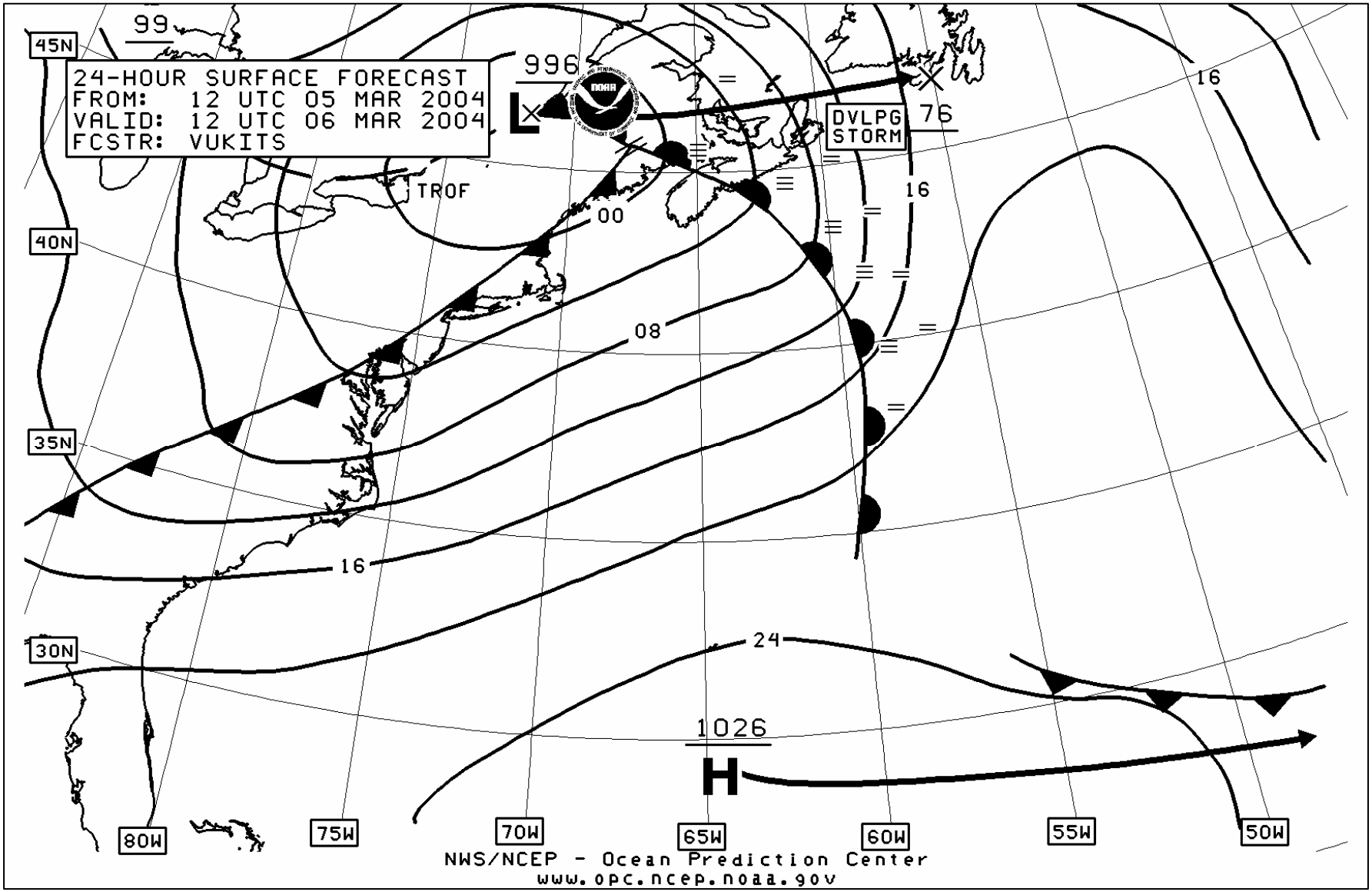
OPC issues warnings and track the weather forecasts out to 5 days…



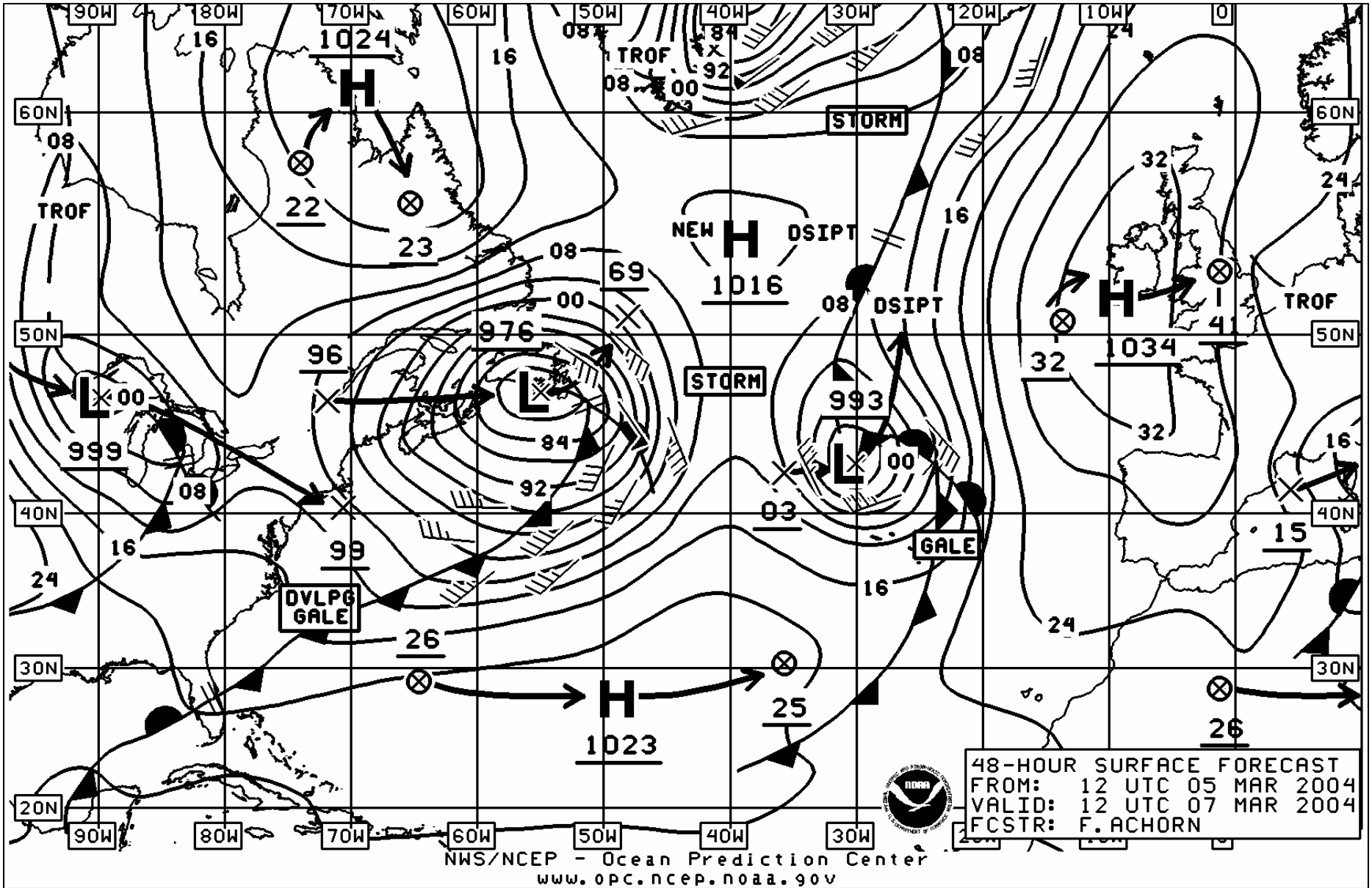
From the 4 surface analyses charts each day…00/06/12/18 UTC



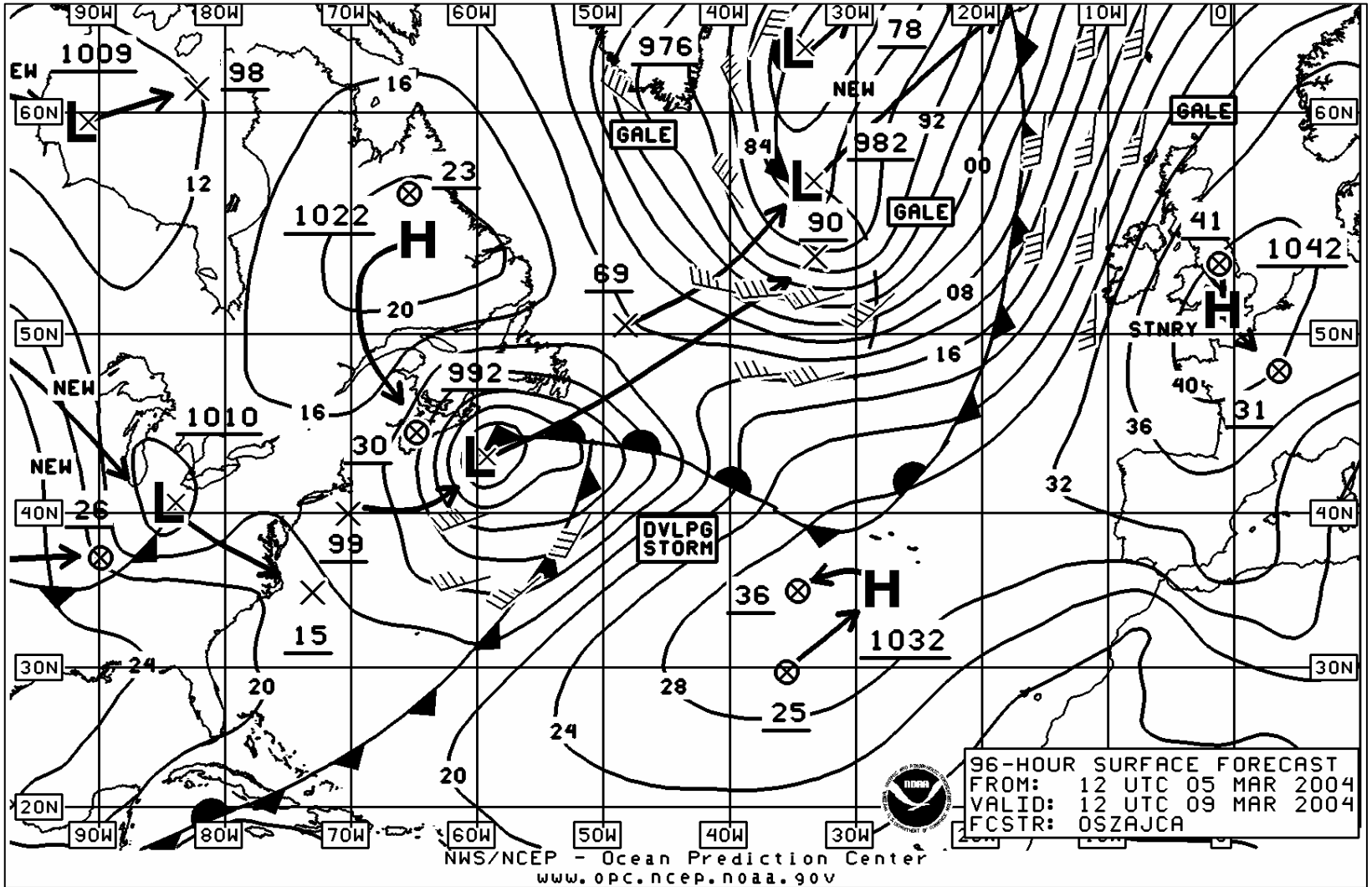
2 regional 24 hour surface pressure forecasts each day…



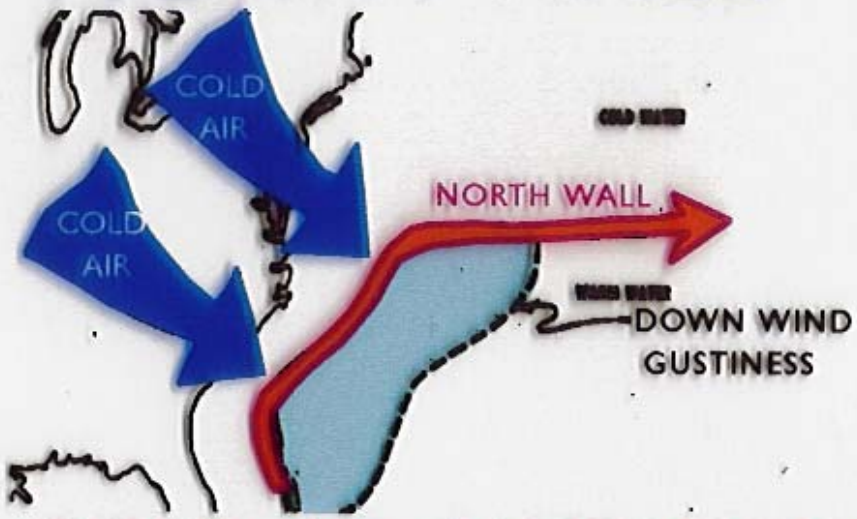
2 full ocean 48 hour surface pressure forecast each day



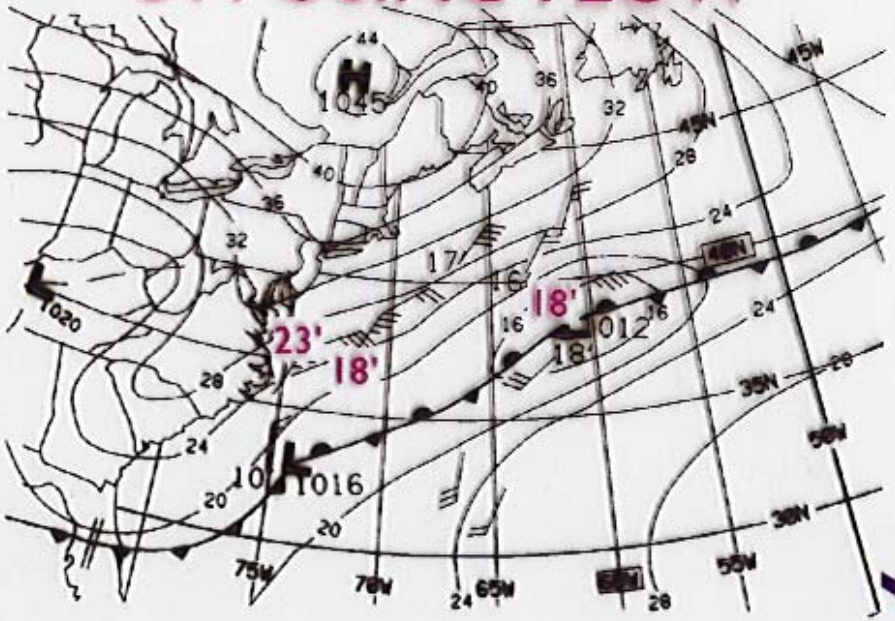
To the one lone 96 hour surface pressure forecast once a day from 1200 UTC



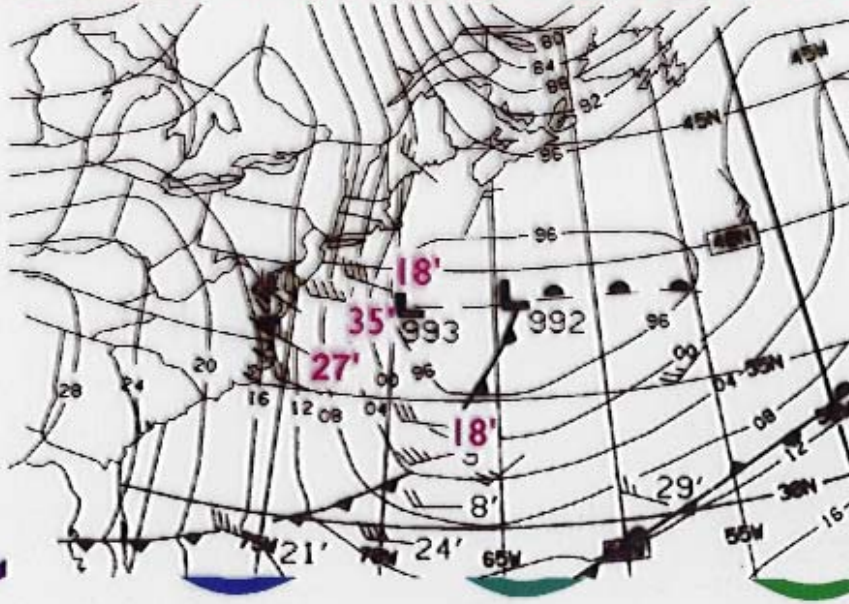
GULF STREAM - NORTH WALL



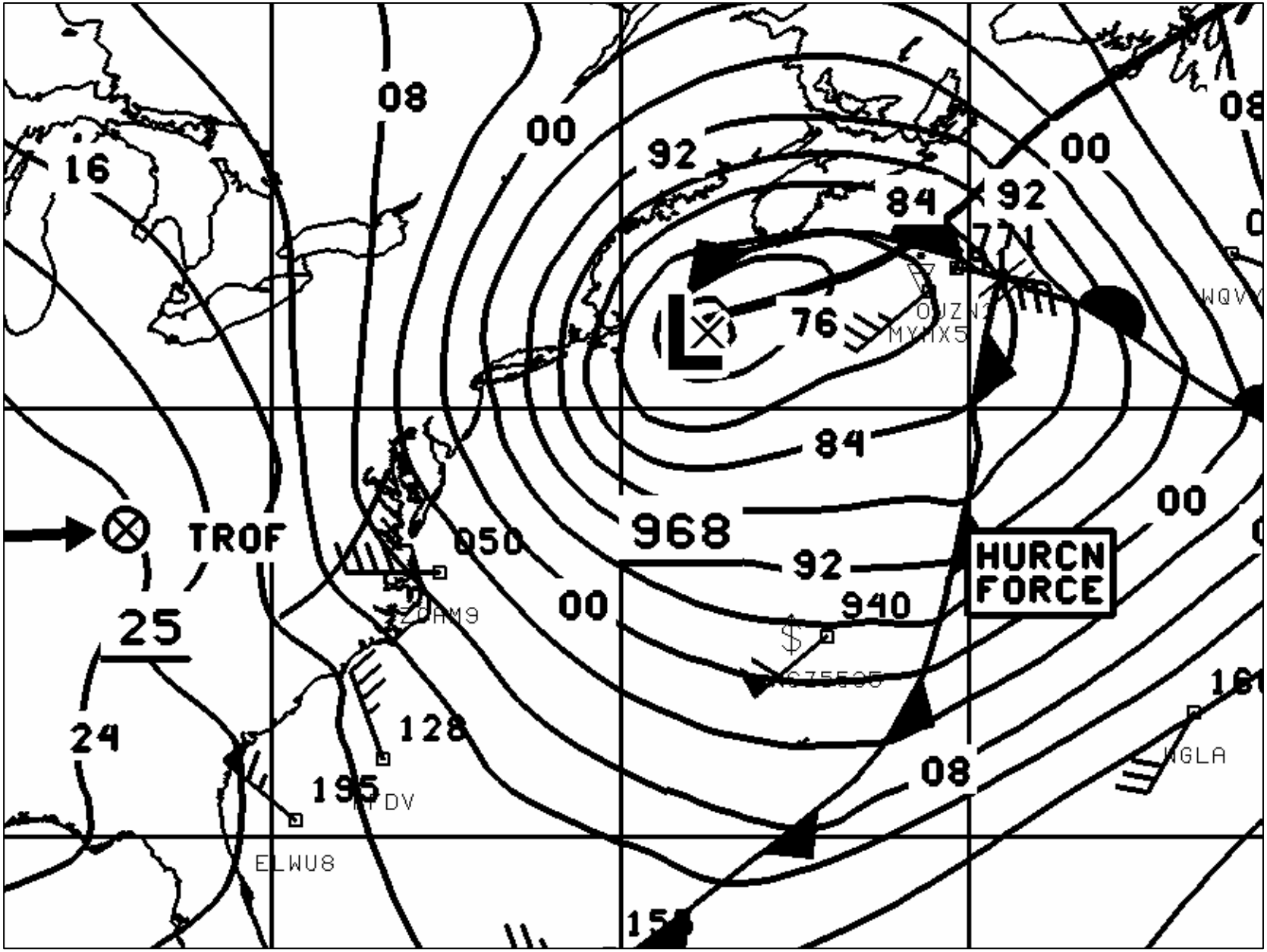
OPPOSING FLOW



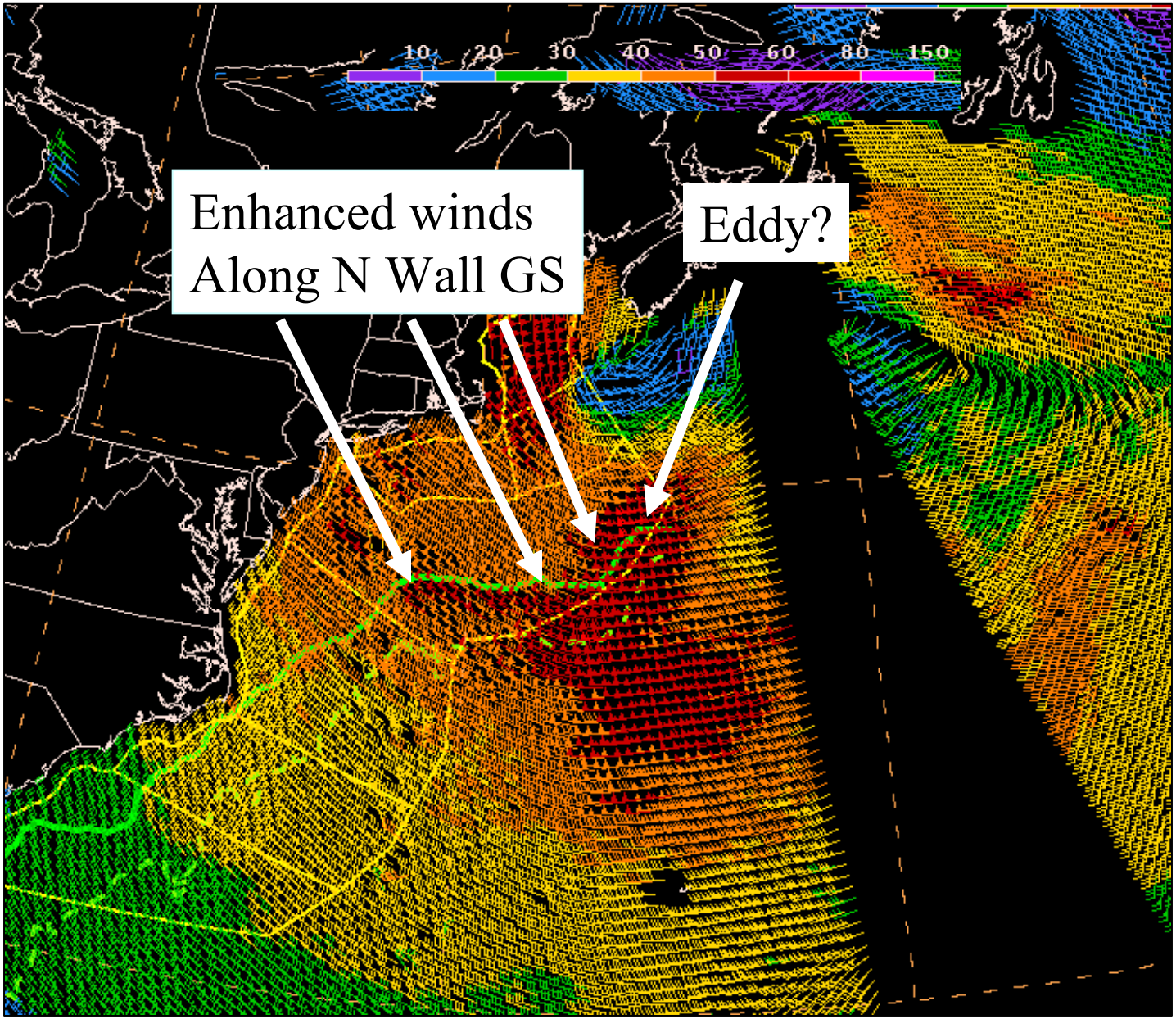
COLD AIR OUTBREAKS



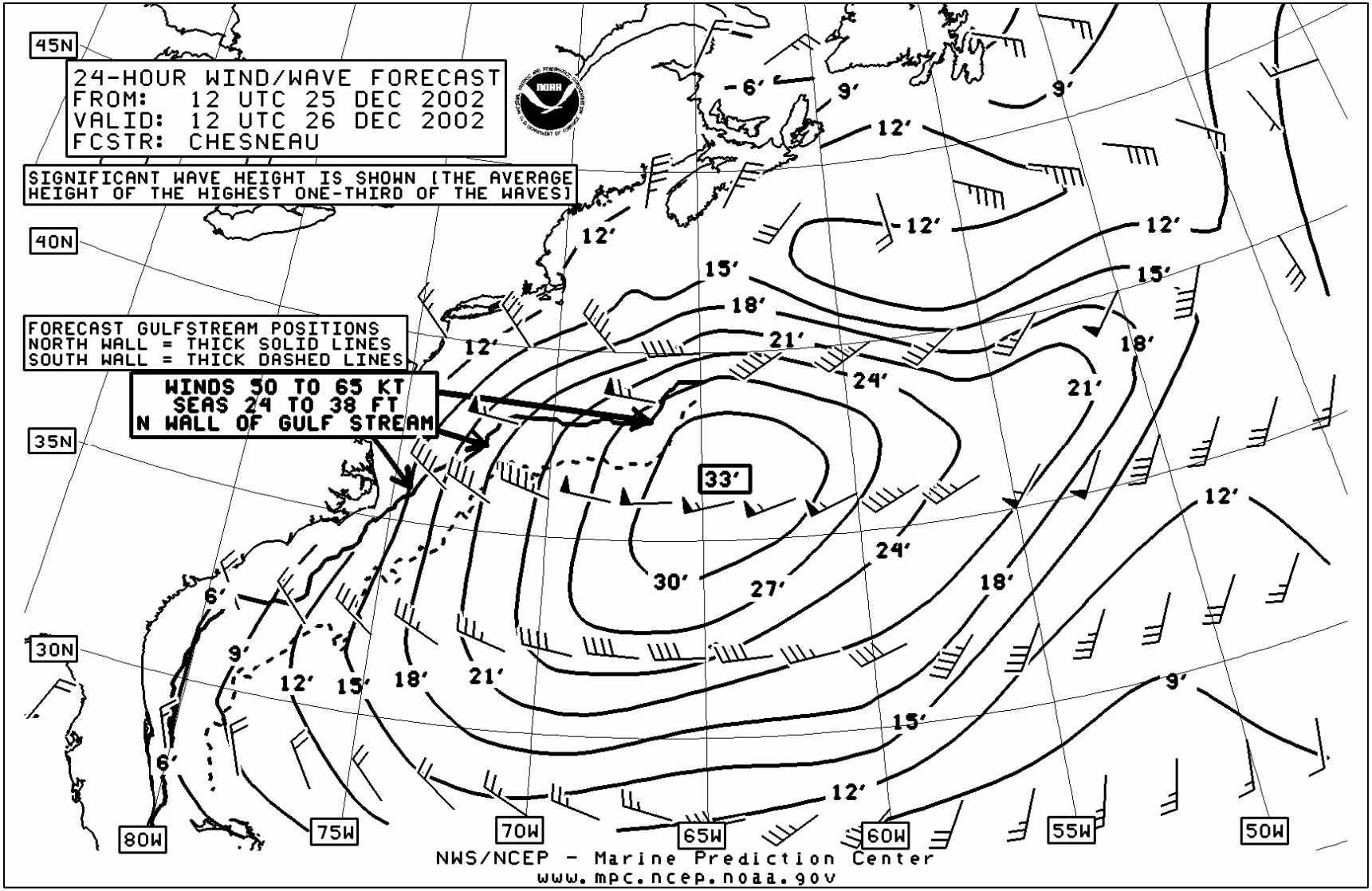
Surface Analysis VT 06Z Dec 26



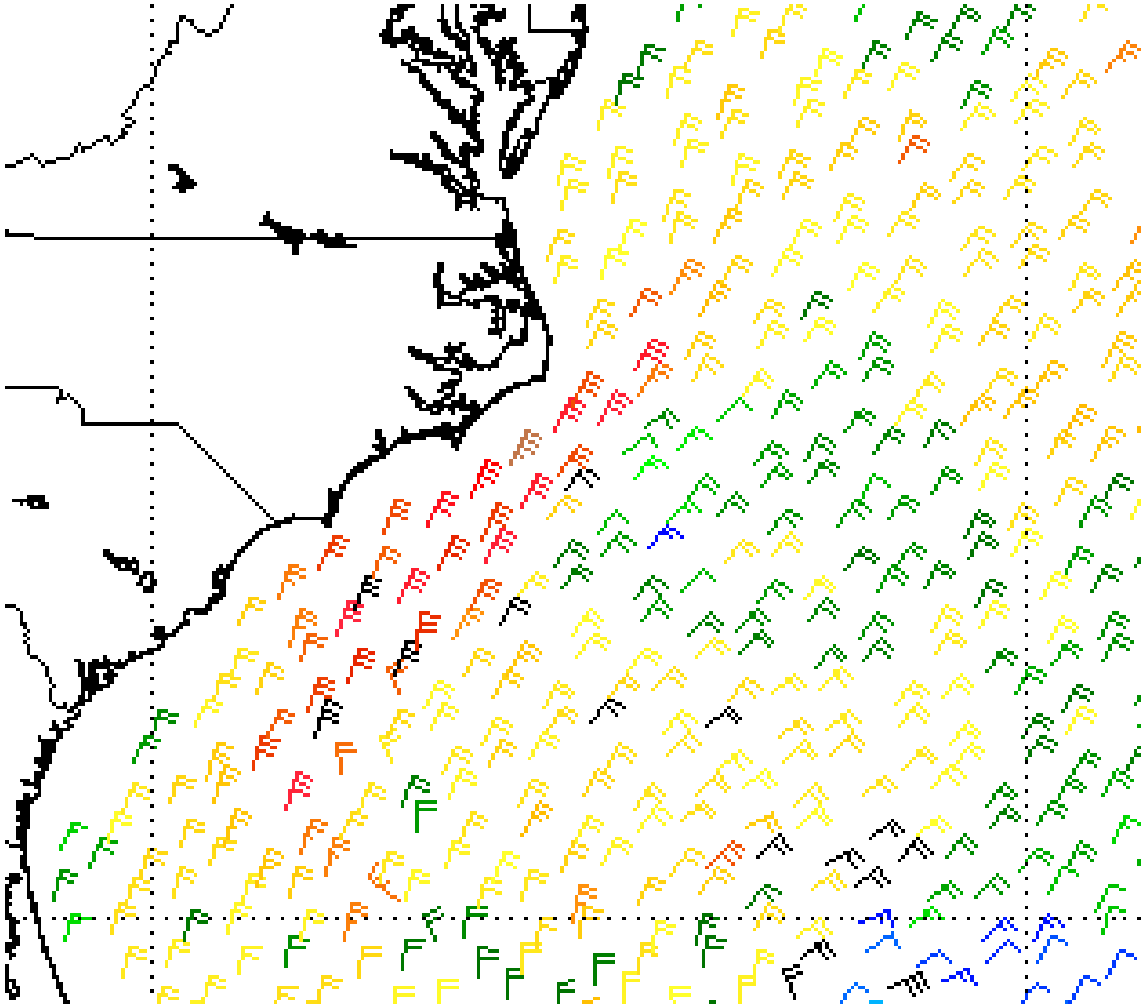
QuickSCAT Image VT 1300Z Dec 26



24 hour Wind Wave Forecast VT 12Z Dec 26

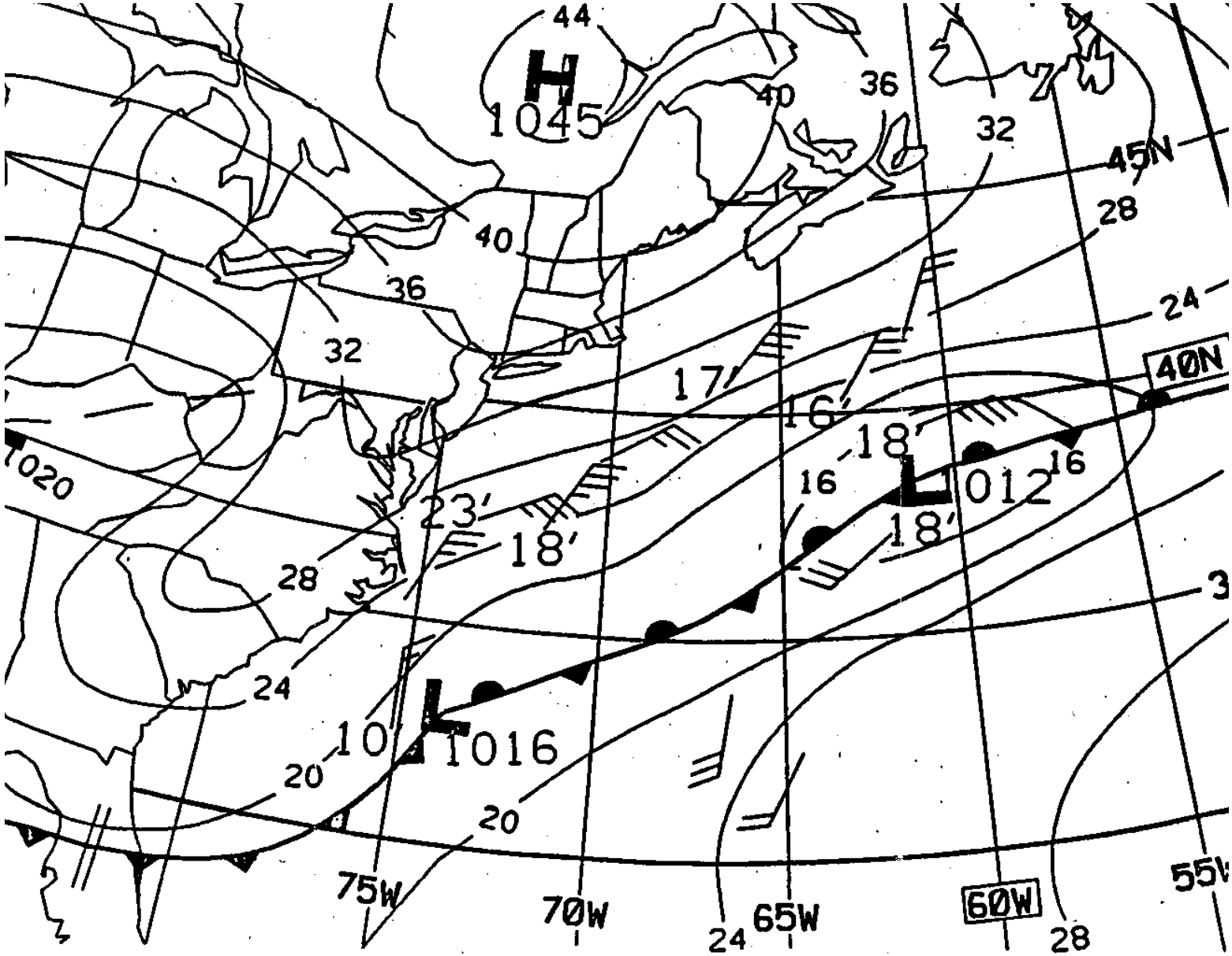


Scatterometer derived winds

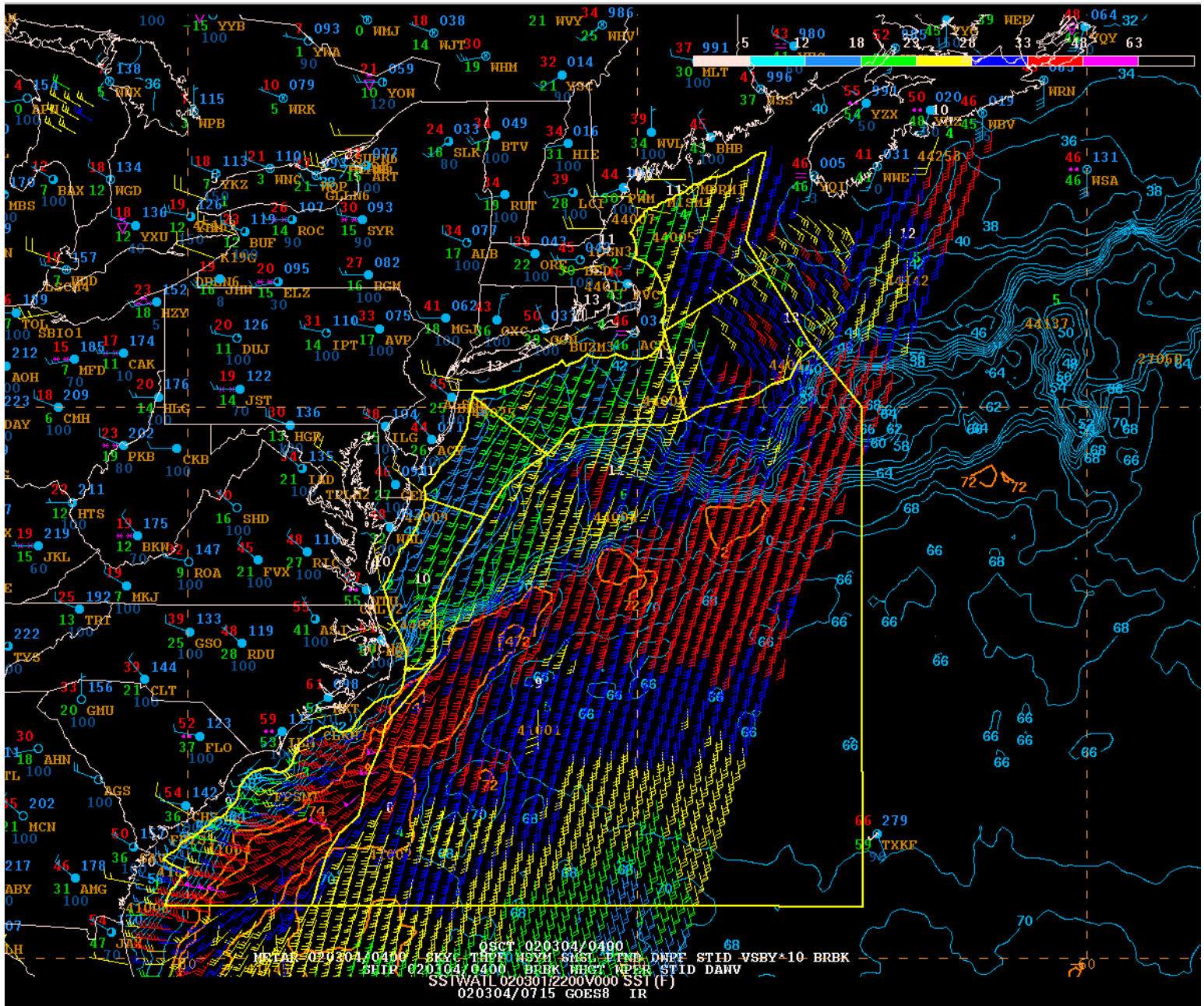


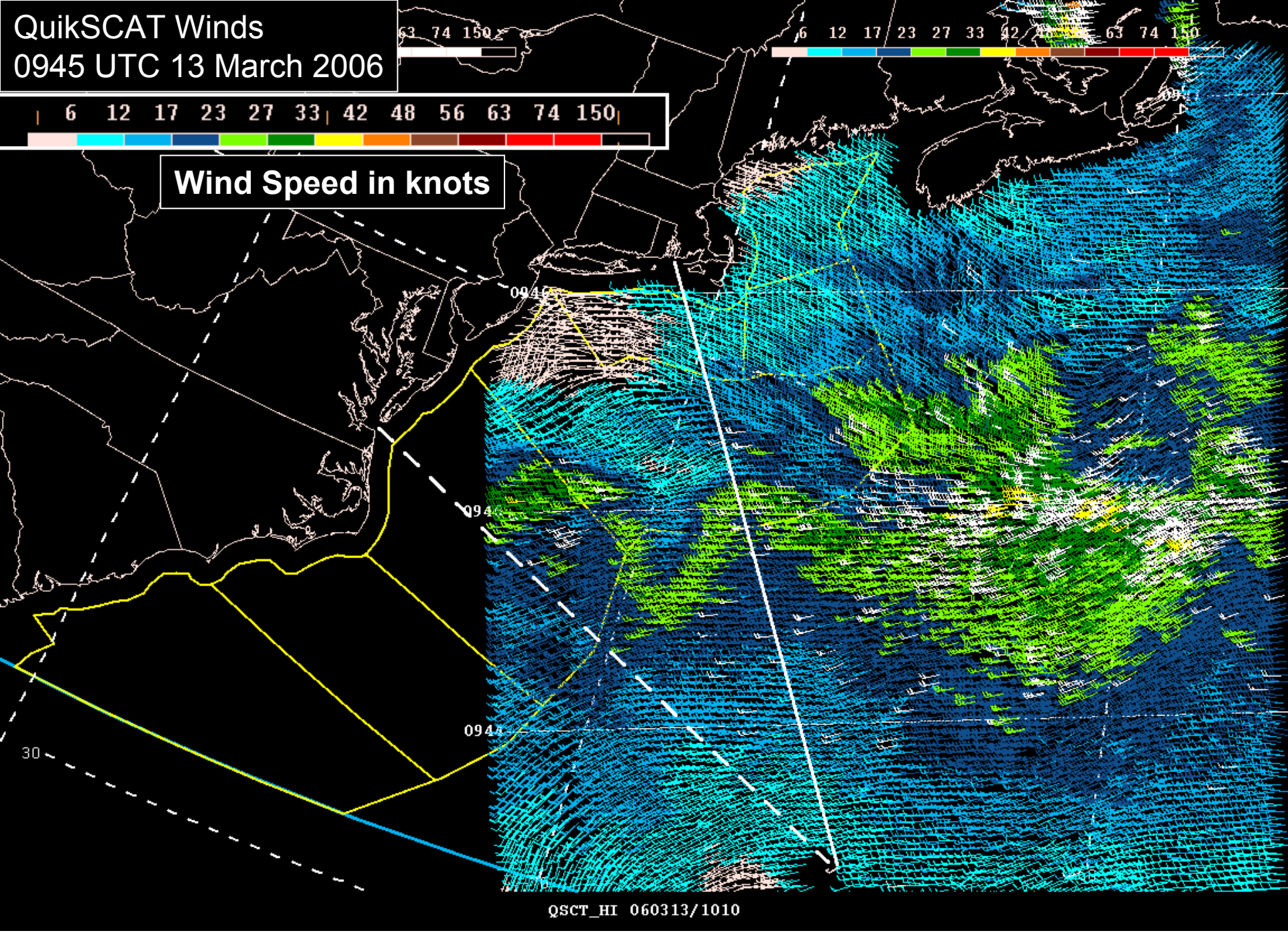
QUIKSCAT…wind speeds, directions

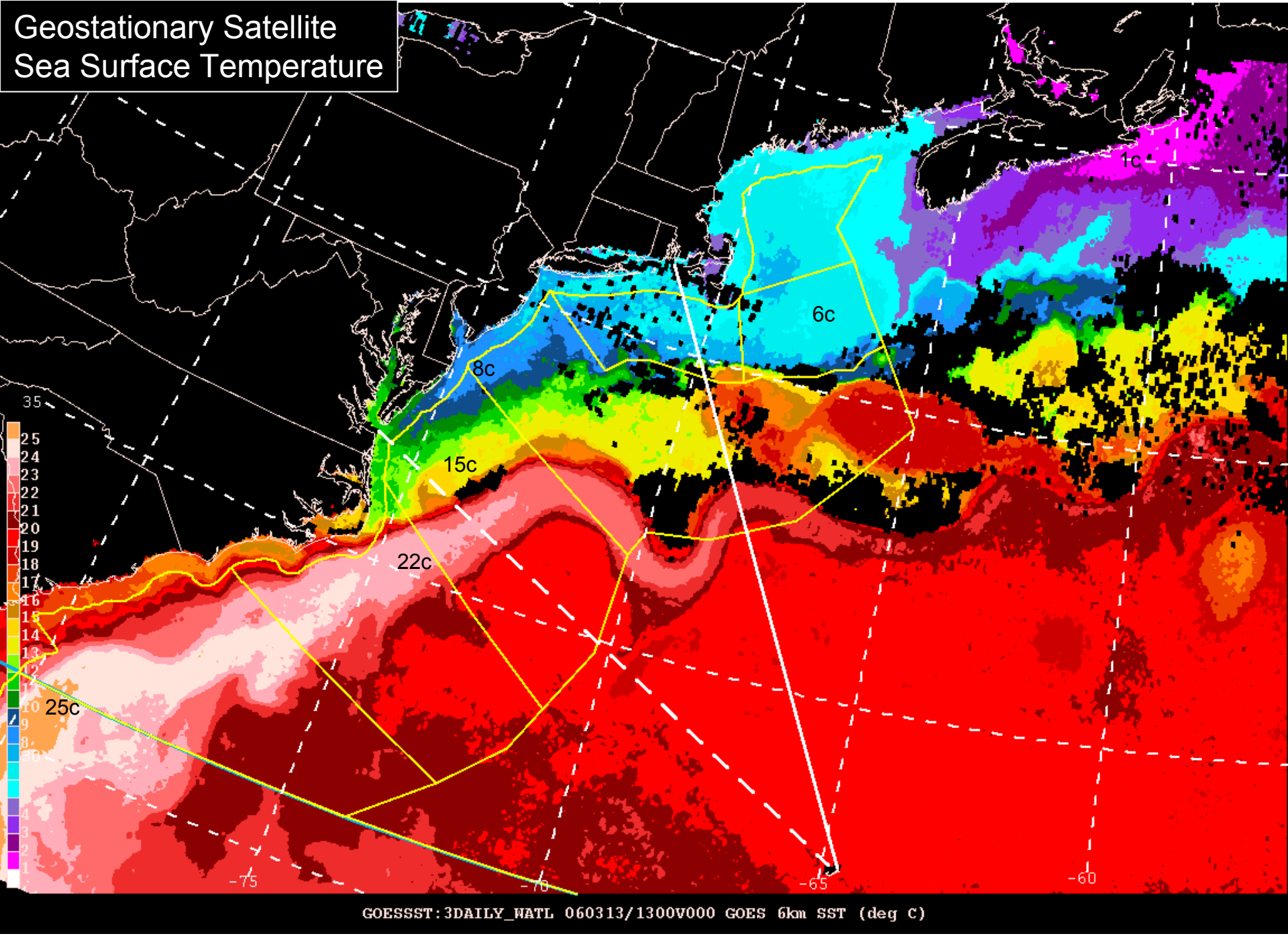
Counter Opposing Flow



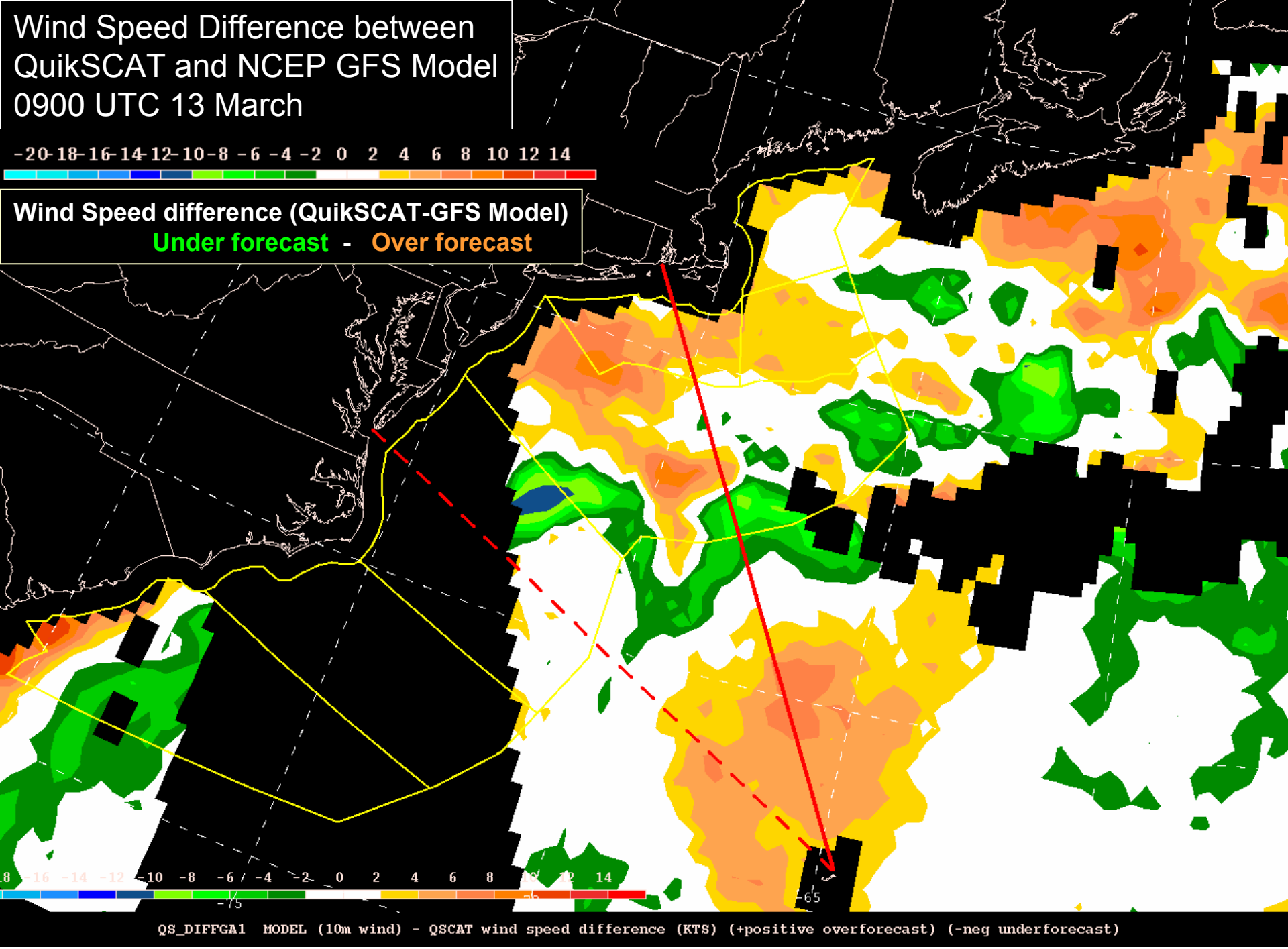
New Technology reveals increased winds in southerly flow



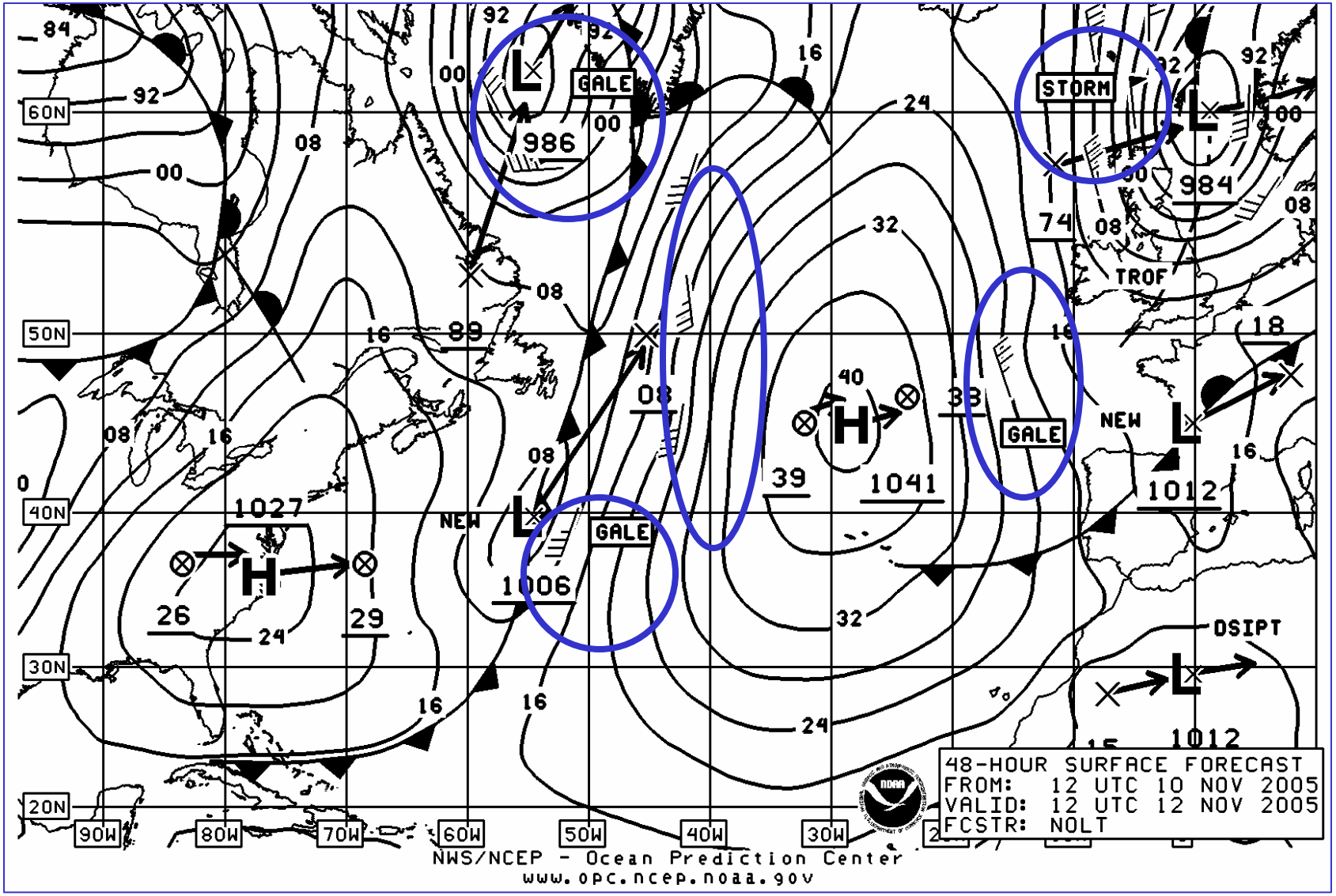

QuikSCAT Winds
0945 UTC 13 March 2006
6 12 17 23 27 33 42 48 56 63 74 150
Wind Speed in knots
0945
0944
0944
30
QSCT_HI 060313/1010


Geostationary Satellite
Sea Surface Temperature
1c
6c
8c
15c
22c
25c
35
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
-75
-70
-65
-60
GOESSST:3DAILY_WATL 060313/1300V000 GOES 6km SST (deg C)

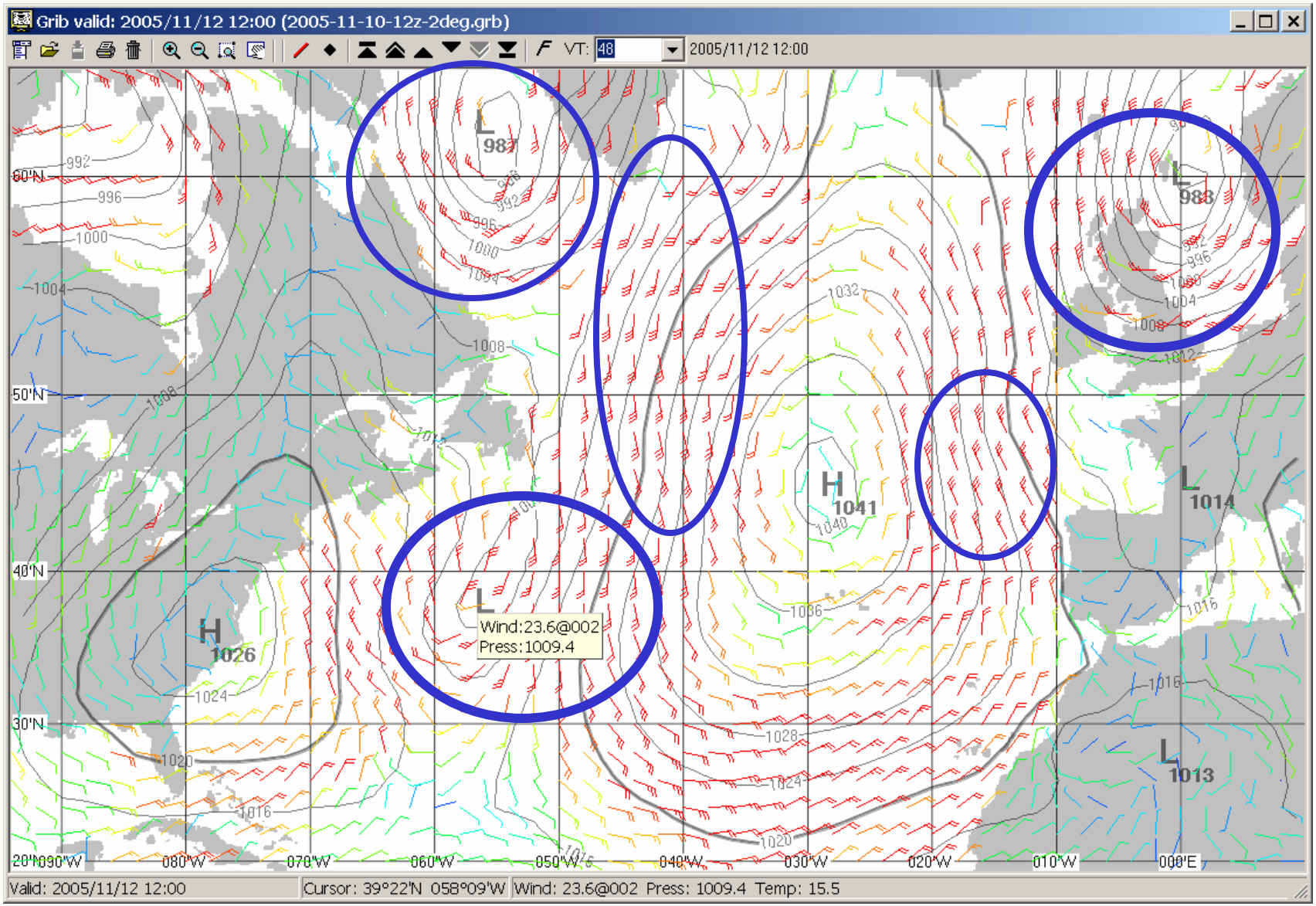
Wind Speed Difference between QuikSCAT and NCEP GFS Model 0900 UTC 13 March



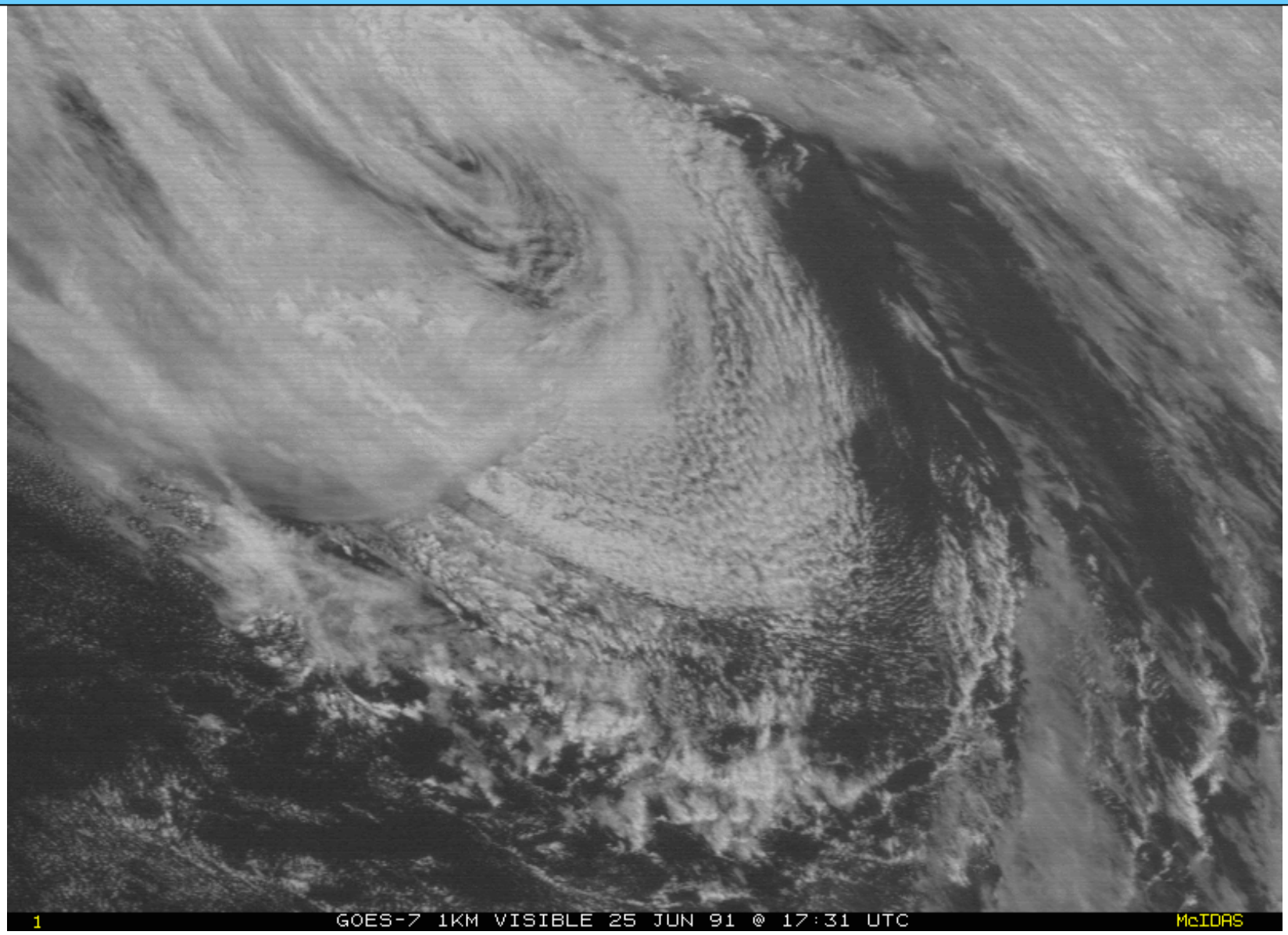
OPC Surface 48Hour FCST



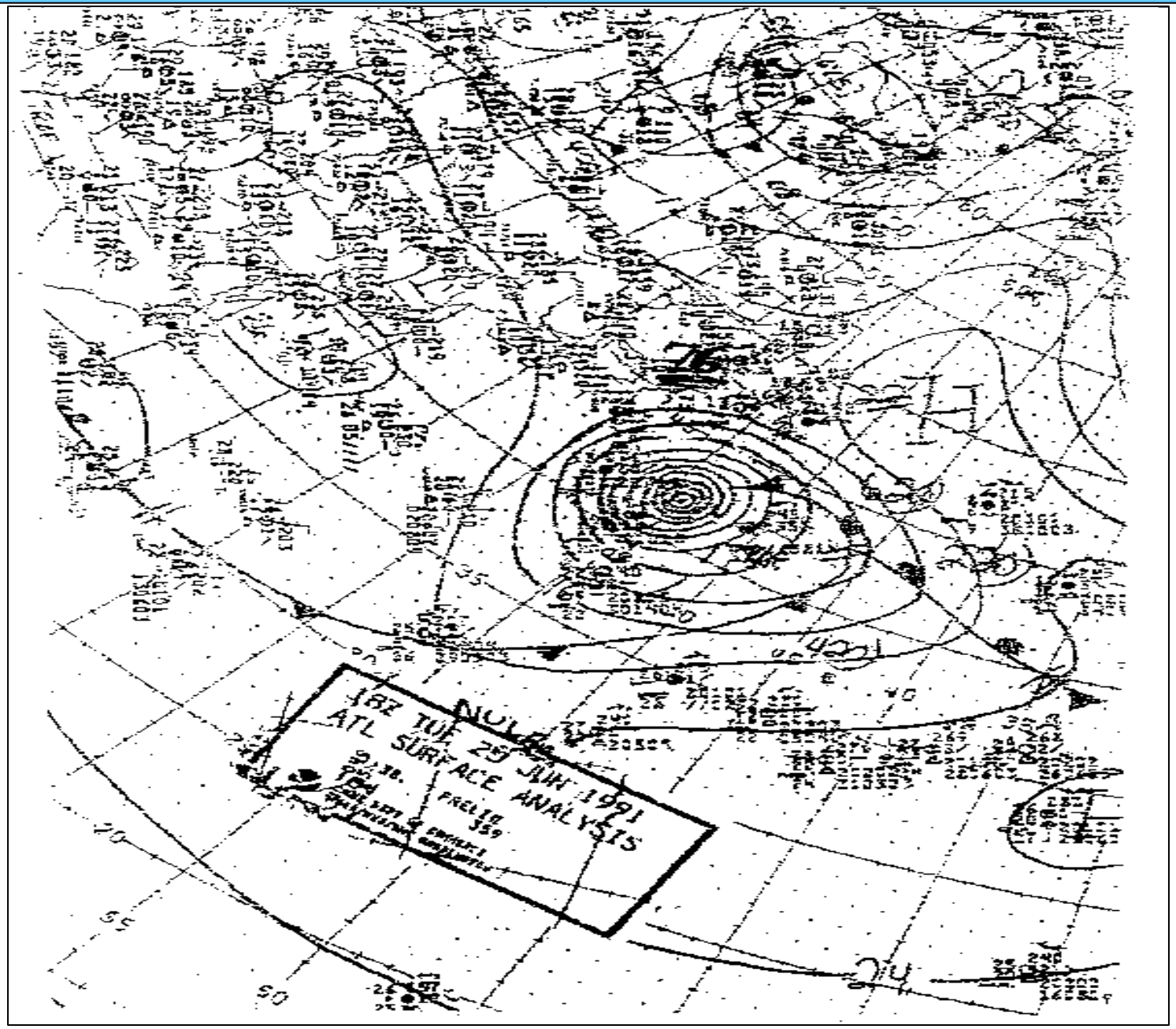
Grib +48 Hour Surface + Wind…
Does Not Match OPC Forecast



Strong Lows can develop at any time if conditions are favorable….this is a late June low with hurricane force winds…. Not a Tropical Cyclone!



1800 UTC June 25, 1991…Desert Storm Sealift/Marion-BDA Race

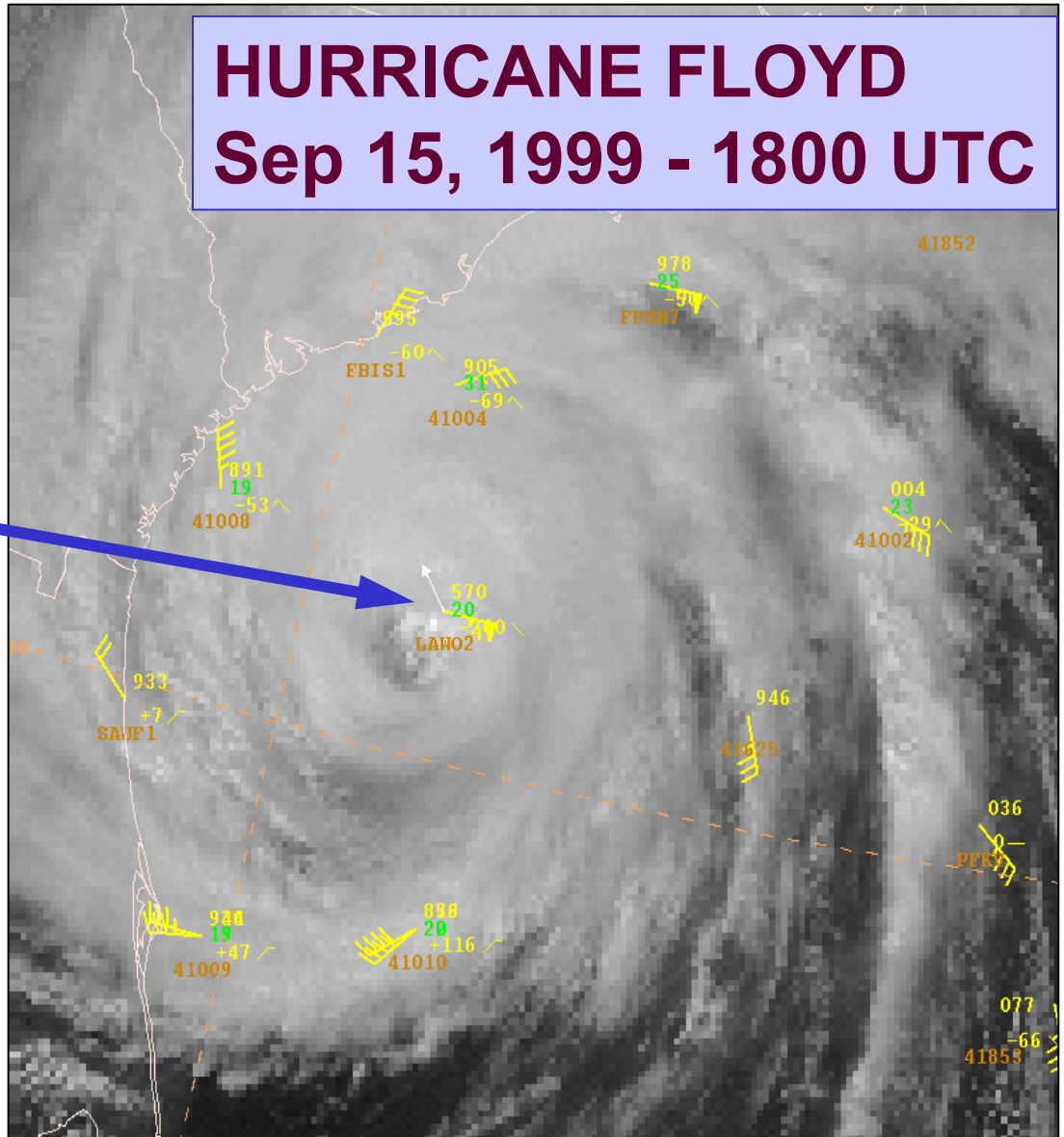


TROPICAL CYCLONES

Avoid the 34 Knot Wind Radii !!!

The Question That Need Not Be Asked

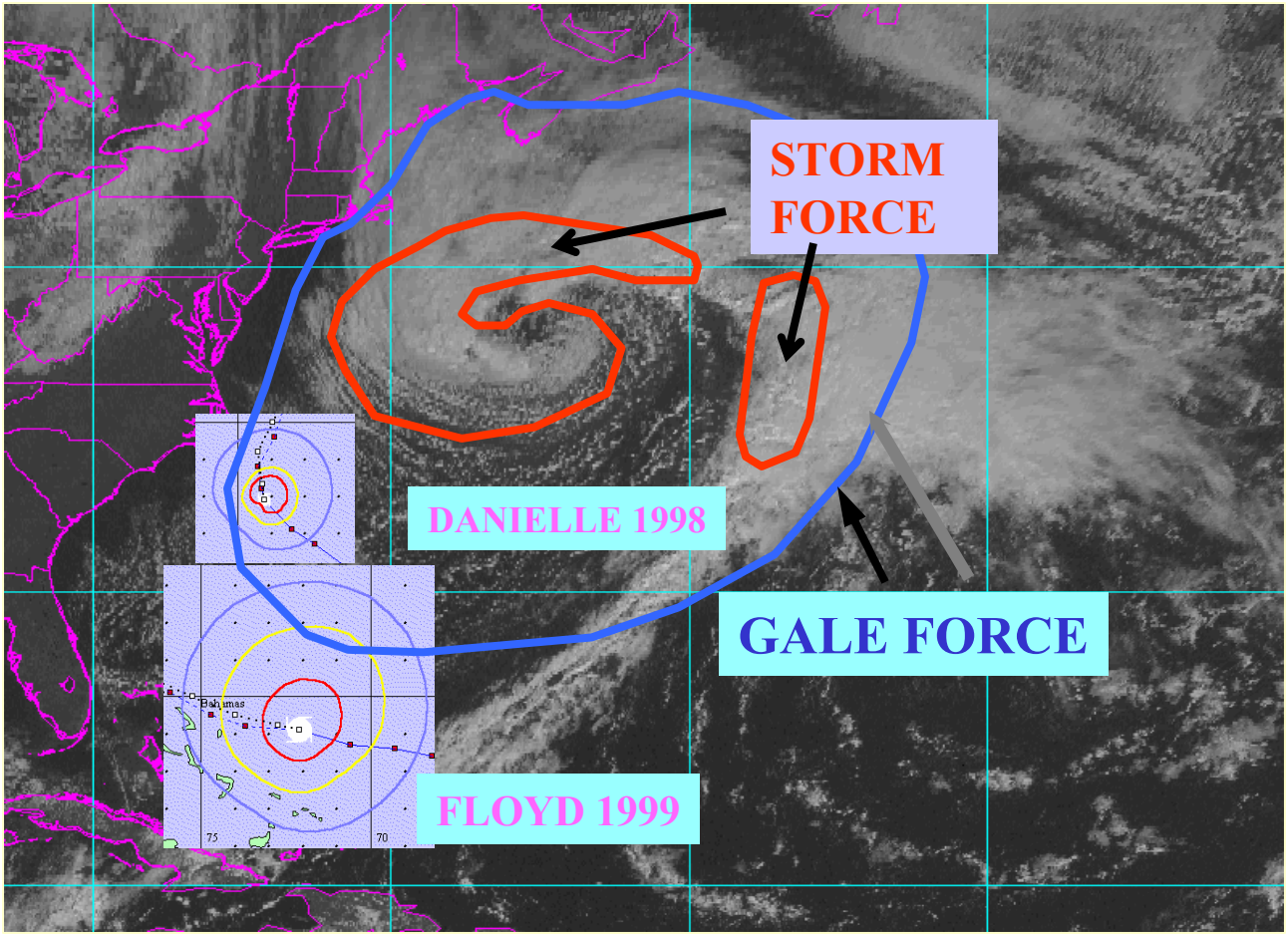
The only ship report



Is this a forecast problem?

Hurricane Isabel 18 Sep 2003

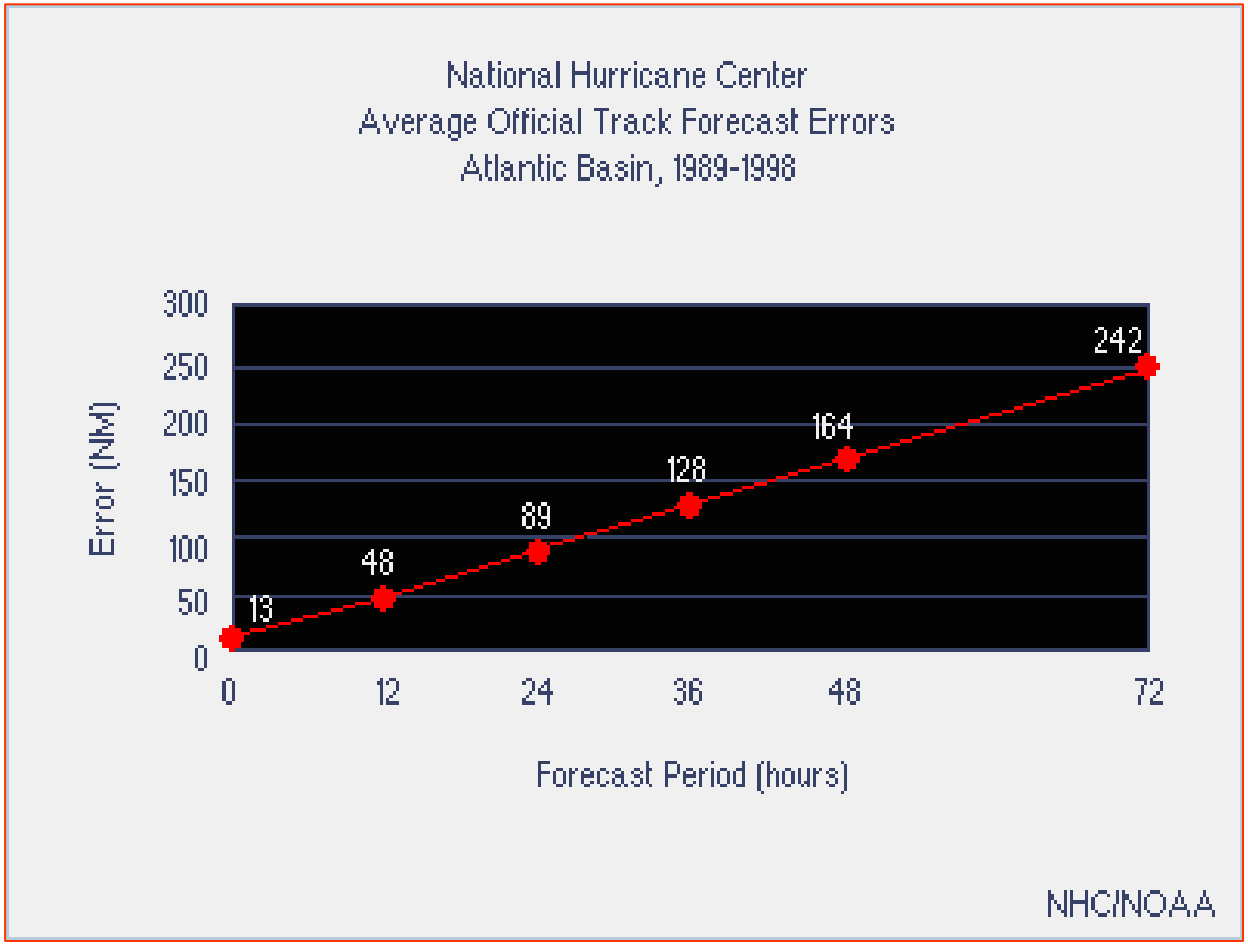
Comparing Extra-Tropical Cyclones with their Tropical Cousins



Tropical cyclones and their extra-tropical cyclone warning criteria wind & field comparisons

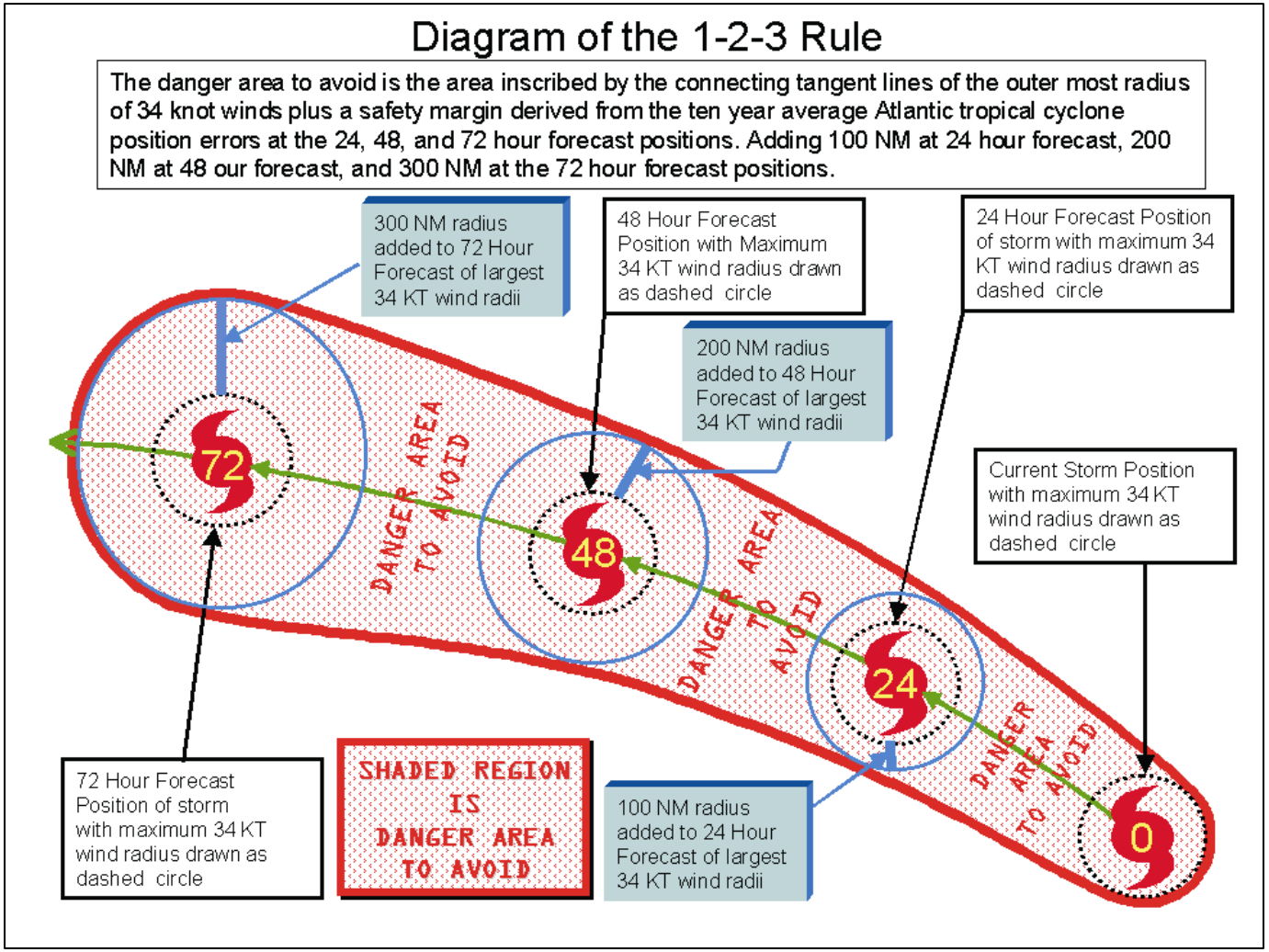
Tropical Cyclone Avoidance…

TC North Atlantic forecast track errors 1989-1998



Tropical Cyclone Avoidance…

Constructing a danger area to avoid based on statistical forecast error of uncertainty



Tropical Cyclone Message (TCM)

```
000
WTNT23 KNHC 081425
TCMAT3
HURRICANE ISABEL FORECAST/ADVISORY NUMBER  10
NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL   AL132003
1500Z MON SEP 08 2003

HURRICANE CENTER LOCATED NEAR 17.2N  42.6W AT 08/1500Z
POSITION ACCURATE WITHIN  25 NM

PRESENT MOVEMENT TOWARD THE WEST-NORTHWEST OR 290 DEGREES AT  12 KT

ESTIMATED MINIMUM CENTRAL PRESSURE  962 MB
EYE DIAMETER  25 NM
MAX SUSTAINED WINDS 100 KT WITH GUSTS TO 120 KT.
64 KT....... 30NE  30SE  30SW  30NW.
50 KT....... 50NE  50SE  50SW  50NW.
34 KT.......100NE 100SE 100SW 100NW.
12 FT SEAS..150NE 150SE 150SW 150NW.
WINDS AND SEAS VARY GREATLY IN EACH QUADRANT.  RADII IN NAUTICAL
MILES ARE THE LARGEST RADII EXPECTED ANYWHERE IN THAT QUADRANT.

REPEAT...CENTER LOCATED NEAR 17.2N  42.6W AT 08/1500Z
AT 08/1200Z CENTER WAS LOCATED NEAR 17.0N  42.0W

FORECAST VALID 09/0000Z 17.9N  44.4W
MAX WIND 115 KT...GUSTS 140 KT.
64 KT... 40NE  30SE  30SW  40NW.
50 KT... 70NE  60SE  60SW  70NW.
34 KT...120NE 100SE 100SW 120NW.

FORECAST VALID 09/1200Z 18.6N  46.8W
MAX WIND 120 KT...GUSTS 145 KT.
64 KT... 40NE  30SE  30SW  40NW.
50 KT... 80NE  70SE  70SW  80NW.
34 KT...140NE 120SE 120SW 140NW.

FORECAST VALID 10/0000Z 19.2N  49.1W
MAX WIND 120 KT...GUSTS 145 KT.
64 KT... 45NE  35SE  35SW  45NW.
50 KT... 90NE  80SE  80SW  90NW.
34 KT...150NE 130SE 130SW 150NW.

FORECAST VALID 10/1200Z 19.4N  51.1W
MAX WIND 120 KT...GUSTS 145 KT.
50 KT... 90NE  80SE  80SW  90NW.
34 KT...150NE 130SE 130SW 150NW.

FORECAST VALID 11/1200Z 19.5N  55.0W
MAX WIND 120 KT...GUSTS 145 KT.
50 KT... 90NE  80SE  80SW  90NW.
34 KT...150NE 130SE 130SW 150NW.

EXTENDED OUTLOOK. NOTE...ERRORS FOR TRACK HAVE AVERAGED NEAR 275 NM
ON DAY 4 AND 375 NM ON DAY 5...AND FOR INTENSITY NEAR 20 KT EACH DAY

OUTLOOK VALID 12/1200Z 19.5N  58.5W
MAX WIND 120 KT...GUSTS 145 KT.

OUTLOOK VALID 13/1200Z 20.0N  62.5W
MAX WIND 120 KT...GUSTS 145 KT.

REQUEST FOR 3 HOURLY SHIP REPORTS WITHIN 300 MILES OF 17.2N  42.6W

NEXT ADVISORY AT 08/2100Z

FORECASTER STEWART
```

Tropical Cyclone Advisory

```
ZCZC MIATCMAT1 ALL
TTAA00 KNHC DDHHMM
HURRICANE FRANCES FORECAST/ADVISORY NUMBER  19
NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL   AL062004
1500Z SUN AUG 29 2004
```

TCM Release Time

```
A TROPICAL STORM WATCH MAY BE REQUIRED FOR PORTIONS OF THE NORTHERN
LEEWARD ISLANDS LATER TODAY.

INTERESTS IN THE NORTHERN LESSER ANTILLES AND THE NORTHEASTERN
CARIBBEAN SEA SHOULD CLOSELY MONITOR THE PROGRESS OF FRANCES OVER
THE NEXT SEVERAL DAYS.

HURRICANE CENTER LOCATED NEAR 18.6N  54.7W AT 29/1500Z
POSITION ACCURATE WITHIN  15 NM

PRESENT MOVEMENT TOWARD THE WEST OR 280 DEGREES AT   8 KT

ESTIMATED MINIMUM CENTRAL PRESSURE  948 MB
EYE DIAMETER  10 NM
MAX SUSTAINED WINDS 115 KT WITH GUSTS TO 140 KT.
64 KT....... 30NE  30SE  30SW  30NW.
50 KT....... 60NE  60SE  60SW  60NW.
34 KT.......100NE 100SE 100SW 100NW.
12 FT SEAS..230NE 170SE 150SW 200NW.
WINDS AND SEAS VARY GREATLY IN EACH QUADRANT.  RADII IN NAUTICAL
MILES ARE THE LARGEST RADII EXPECTED ANYWHERE IN THAT QUADRANT.
```

Tropical Cyclone Advisory

```
ESTIMATED MINIMUM CENTRAL PRESSURE  948 MB
EYE DIAMETER  10 NM
MAX SUSTAINED WINDS 115 KT WITH GUSTS TO 140 KT.
64 KT....... 30NE  30SE  30SW  30NW.
50 KT....... 60NE  60SE  60SW  60NW.
34 KT.......100NE 100SE 100SW 100NW.
12 FT SEAS..230NE 170SE 150SW 200NW.
WINDS AND SEAS VARY GREATLY IN EACH QUADRANT.  RADII IN NAUTICAL
MILES ARE THE LARGEST RADII EXPECTED ANYWHERE IN THAT QUADRANT.

REPEAT...CENTER LOCATED NEAR 18.6N  54.7W AT 29/1500Z
AT 29/1200Z CENTER WAS LOCATED NEAR 18.5N  54.3W

FORECAST VALID 30/0000Z 18.8N  56.1W
MAX WIND 120 KT...GUSTS 145 KT.
64 KT... 35NE  35SE  35SW  35NW.
50 KT... 65NE  65SE  65SW  65NW.
34 KT...120NE 120SE 120SW 120NW.

FORECAST VALID 30/1200Z 19.5N  58.5W
MAX WIND 120 KT...GUSTS 145 KT.
64 KT... 40NE  40SE  40SW  40NW.
50 KT... 70NE  70SE  70SW  70NW.
34 KT...130NE 130SE 130SW 130NW.
```

Advisory PSN

Synoptic PSN

12 Hour FCST

24 Hour FCST

TCM Cont'd

36 Hour FCST

```
FORECAST VALID 31/0000Z 20.0N  61.0W
MAX WIND 120 KT...GUSTS 145 KT.
64 KT... 45NE  45SE  45SW  45NW.
50 KT... 75NE  75SE  75SW  75NW.
34 KT...140NE 140SE 140SW 140NW.
```

48 Hour FCST

```
FORECAST VALID 31/1200Z 20.5N  63.5W
MAX WIND 120 KT...GUSTS 145 KT.
50 KT... 80NE  80SE  80SW  80NW.
34 KT...150NE 140SE 140SW 150NW.
```

72 Hour FCST

```
FORECAST VALID 01/1200Z 21.8N  68.7W
MAX WIND 120 KT...GUSTS 145 KT.
50 KT... 85NE  85SE  85SW  85NW.
34 KT...160NE 150SE 150SW 160NW.

EXTENDED OUTLOOK. NOTE...ERRORS FOR TRACK HAVE AVERAGED NEAR 250 NM
ON DAY 4 AND 325 NM ON DAY 5...AND FOR INTENSITY NEAR 20 KT EACH DAY
```

96 Hour FCST

```
OUTLOOK VALID 02/1200Z 23.5N  72.6W
MAX WIND 125 KT...GUSTS 155 KT.
```

120 Hour FCST

```
OUTLOOK VALID 03/1200Z 25.5N  76.5W
MAX WIND 125 KT...GUSTS 155 KT.

REQUEST FOR 3 HOURLY SHIP REPORTS WITHIN 300 MILES OF 18.6N  54.7W
```

Getting TCMs and Graphics at Sea

- **TCMs are now available via GMDSS Safety net(C)**
- **TRS advisories through 48 hours within the HSF**
- **Radiofax Graphics**
- **WWV Boulder voice inside North of 30°N and 140°W in the Pacific and West of 35°W in the Atlantic.**
- **Internet**

TCM Cont'd

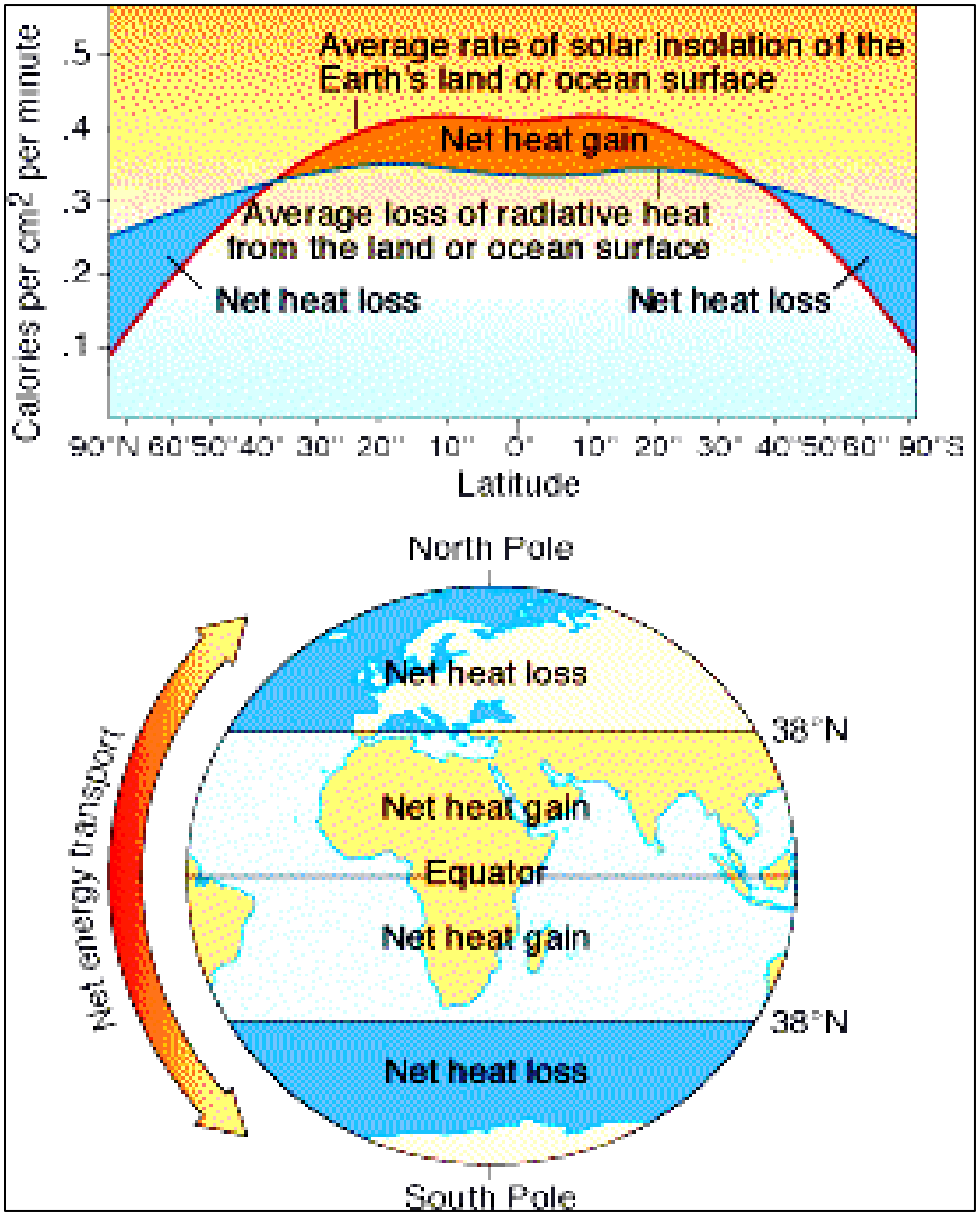
```
EXTENDED OUTLOOK. NOTE...ERRORS FOR TRACK HAVE AVERAGED NEAR 250 NM
ON DAY 4 AND 325 NM ON DAY 5...AND FOR INTENSITY NEAR 20 KT EACH DAY

OUTLOOK VALID 02/1200Z 23.5N  72.6W
MAX WIND 125 KT...GUSTS 155 KT.

OUTLOOK VALID 03/1200Z 25.5N  76.5W
MAX WIND 125 KT...GUSTS 155 KT.

REQUEST FOR 3 HOURLY SHIP REPORTS WITHIN 300 MILES OF 18.6N  54.7W

NEXT ADVISORY AT 29/2100Z

FORECASTER AVILA


$$
NNNN
```

Next Advisory Release

Where do most “lows” and “highs” come from?

The sun-primary source for solar energy

However, unequal distribution of heat across the globe and atmosphere gives mother nature the challenge of redistribution over the entire earth for a balanced heat bduget



Looking up from your boat at sea…

The Atmosphere is an "ocean of air" surrounding the earth.

…and influenced by the sun which provides solar energy in unequal distribution over planet earth…

Jet Stream

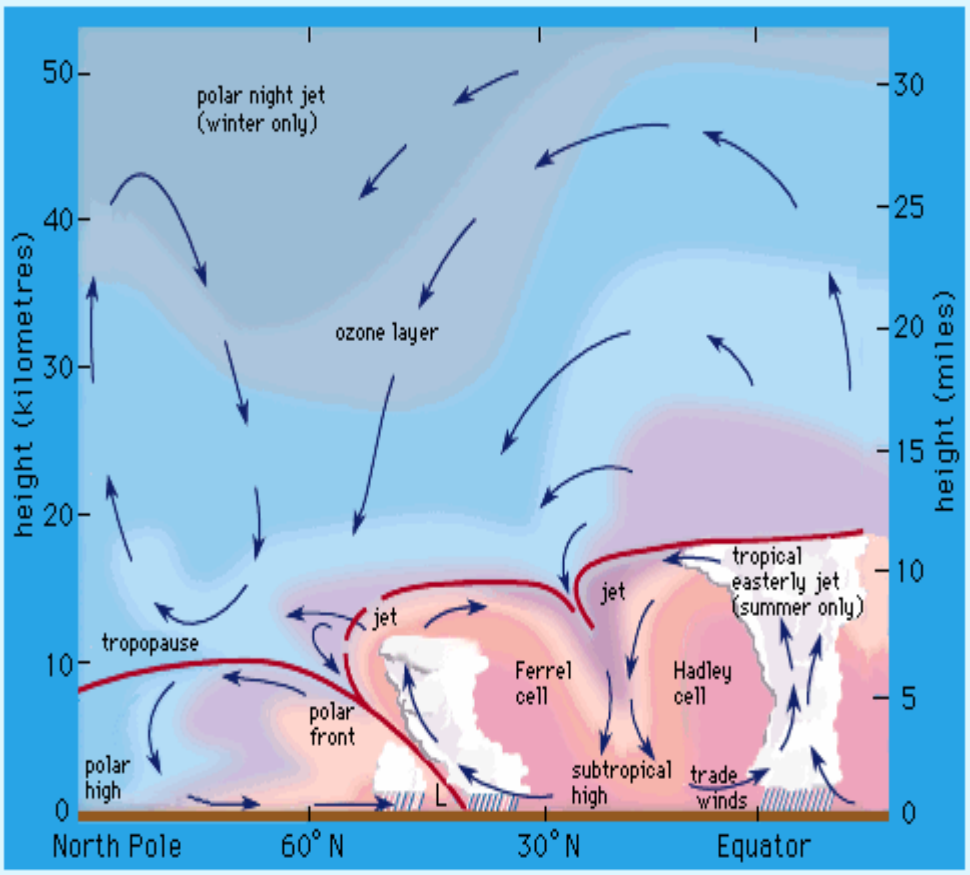
Jet Stream

current of rapidly moving air

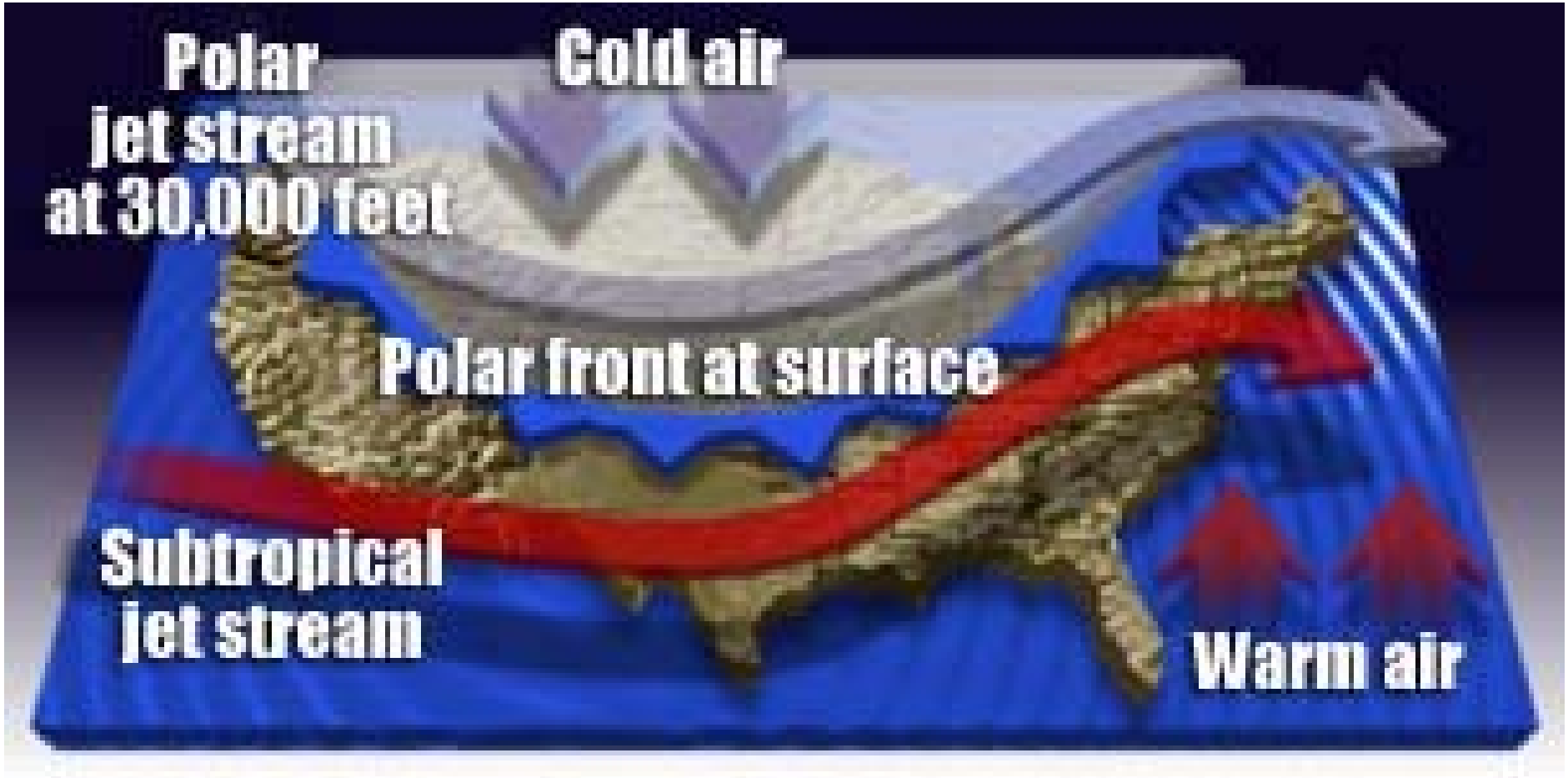
The jet stream is a current of fast moving air found in the upper levels of the atmosphere. This rapid current is typically thousands of kilometers long, a few hundred kilometers wide, and only a few kilometers thick. Jet streams are usually found somewhere between 10-15 km (6-9 miles) above the earth's surface. The position of this upper-level jet stream denotes the location of the strongest SURFACE temperature contrast (as in the diagram below).

Jet Stream Formation

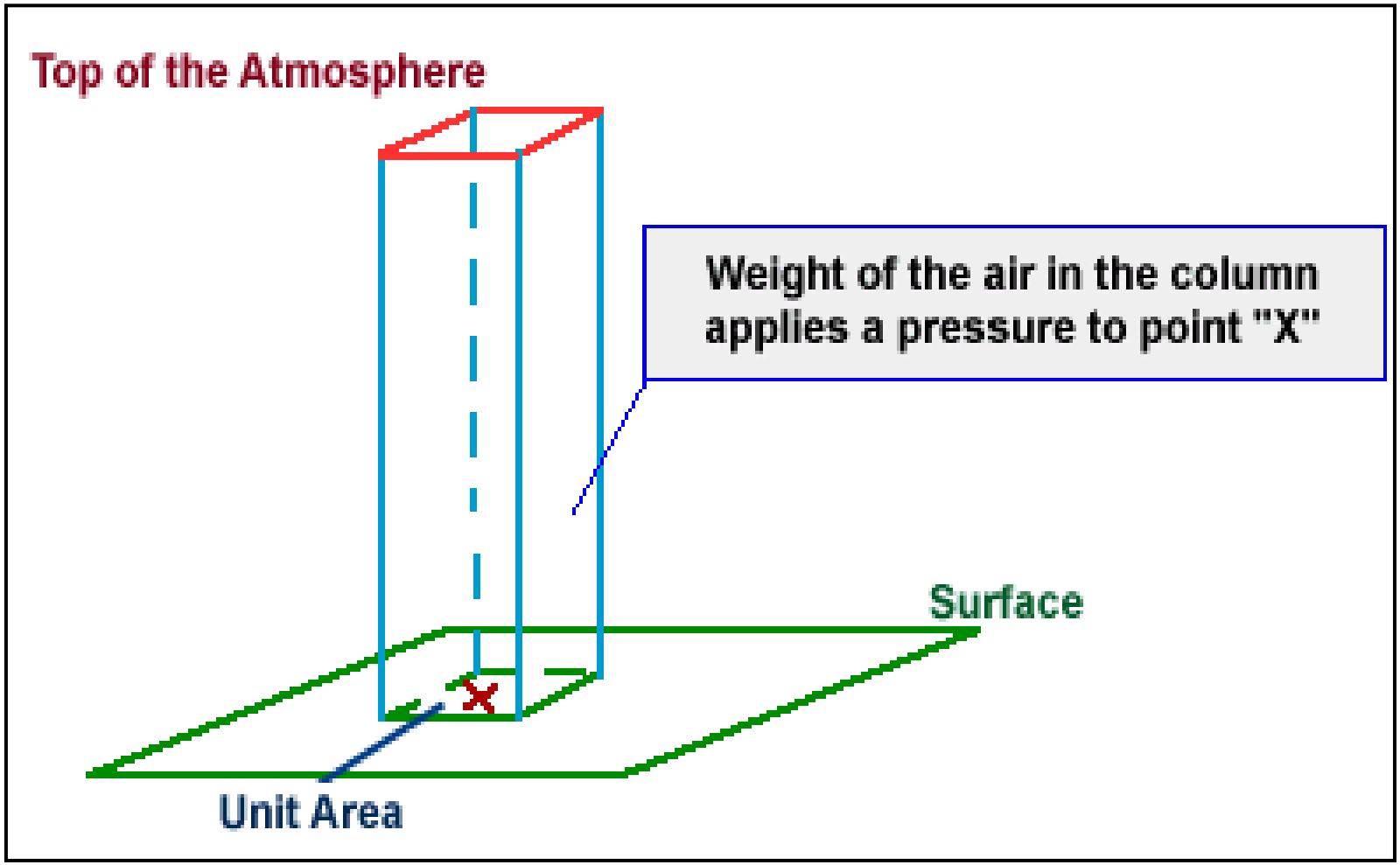
- In the areas of strong temperature gradients, the pressure gradients and the resulting wind speeds increase with more height; so long as the temperature gradients persist in the same direction. In general, they will extend into the tropopause, after which the temperature gradient reverses direction and the wind speeds diminish.



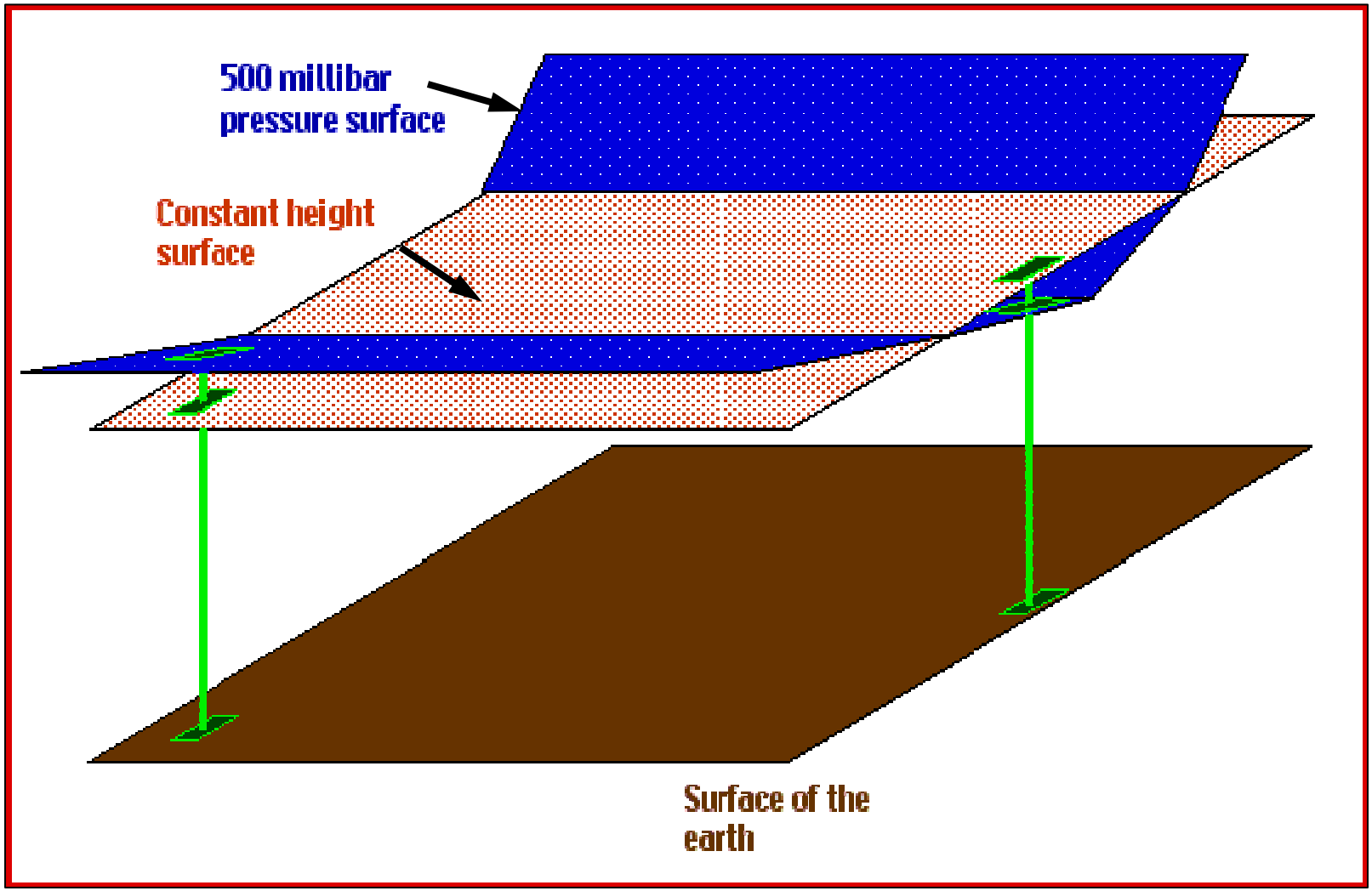
Polar & Subtropical Jet Streams



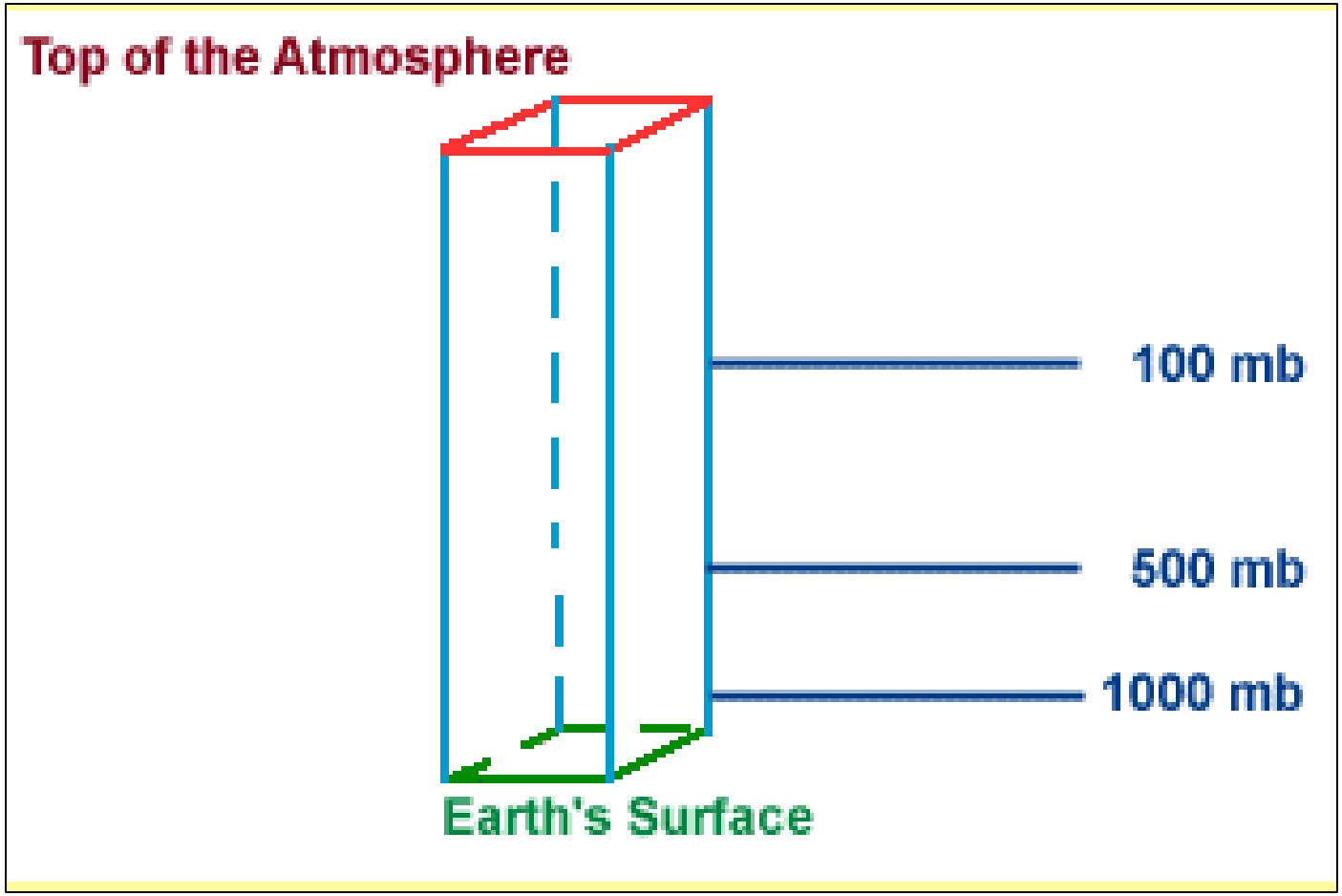
How do we describe weather above the earth's surface?



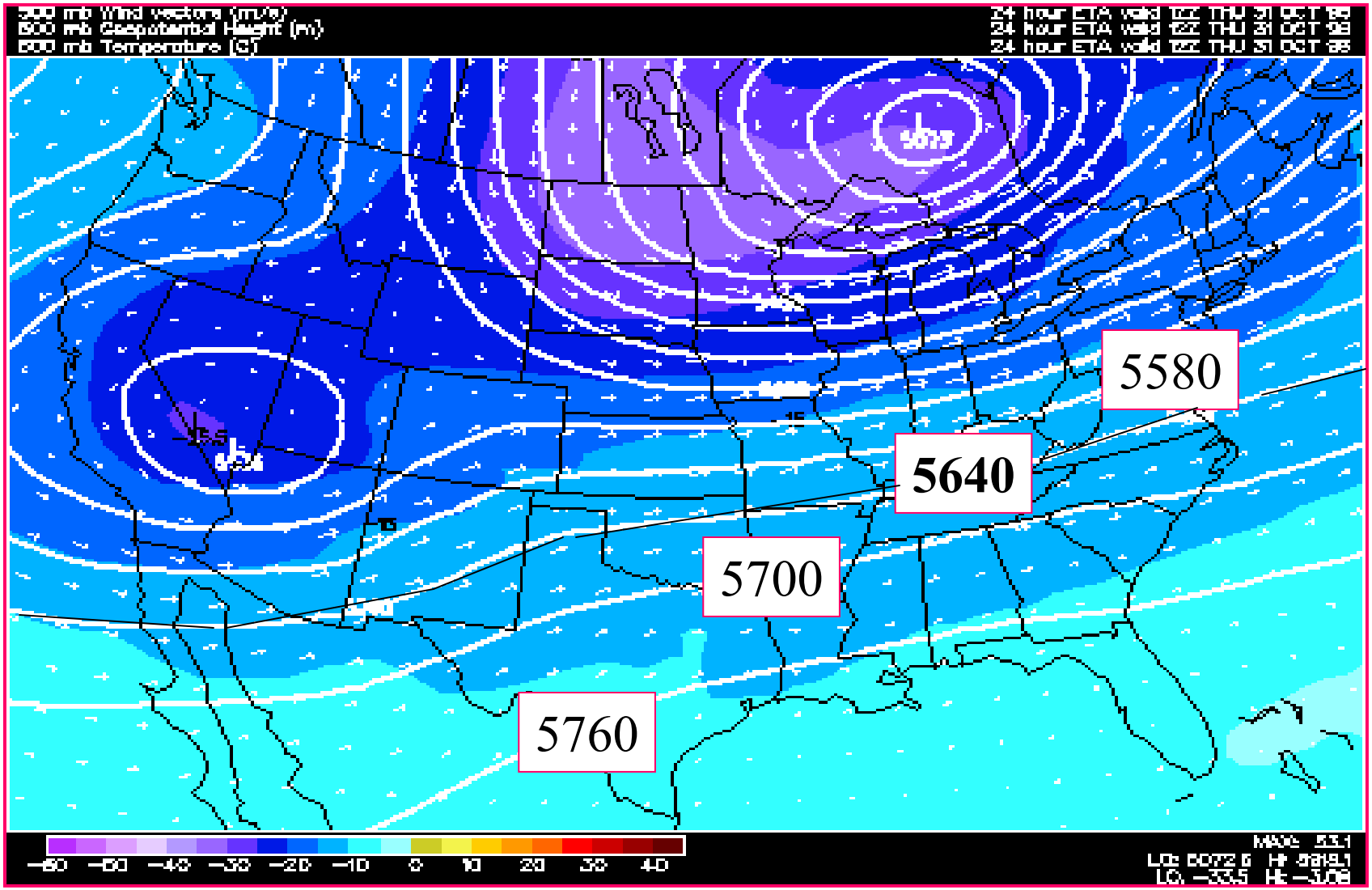
It boils down to determining whether to use constant pressure or altitude surfaces once leaving the earth's surface



Meteorological modeling and equations work best using constant pressure surfaces



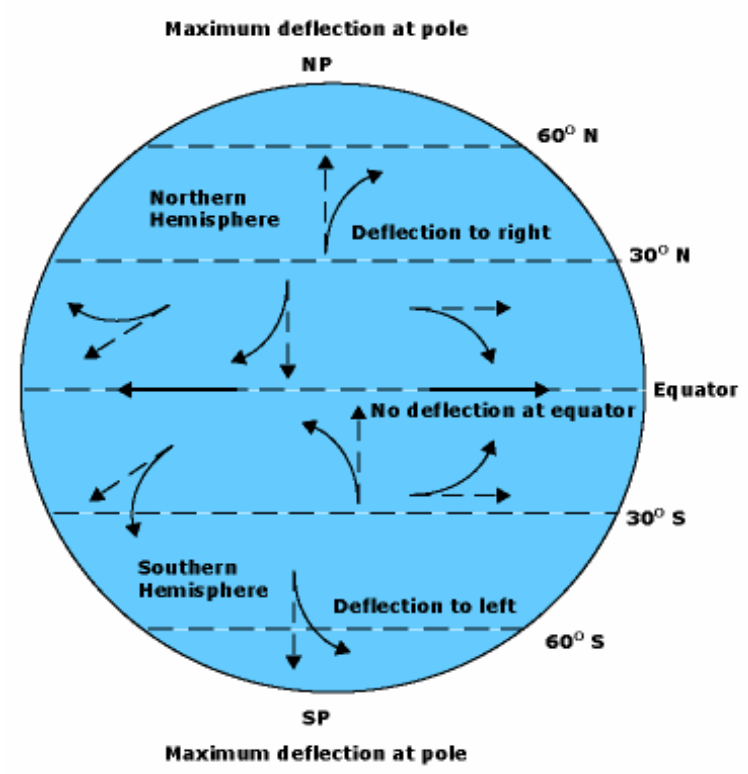
Most world wide convention countries uses 60-meter contour lines spacing at 500 Mb



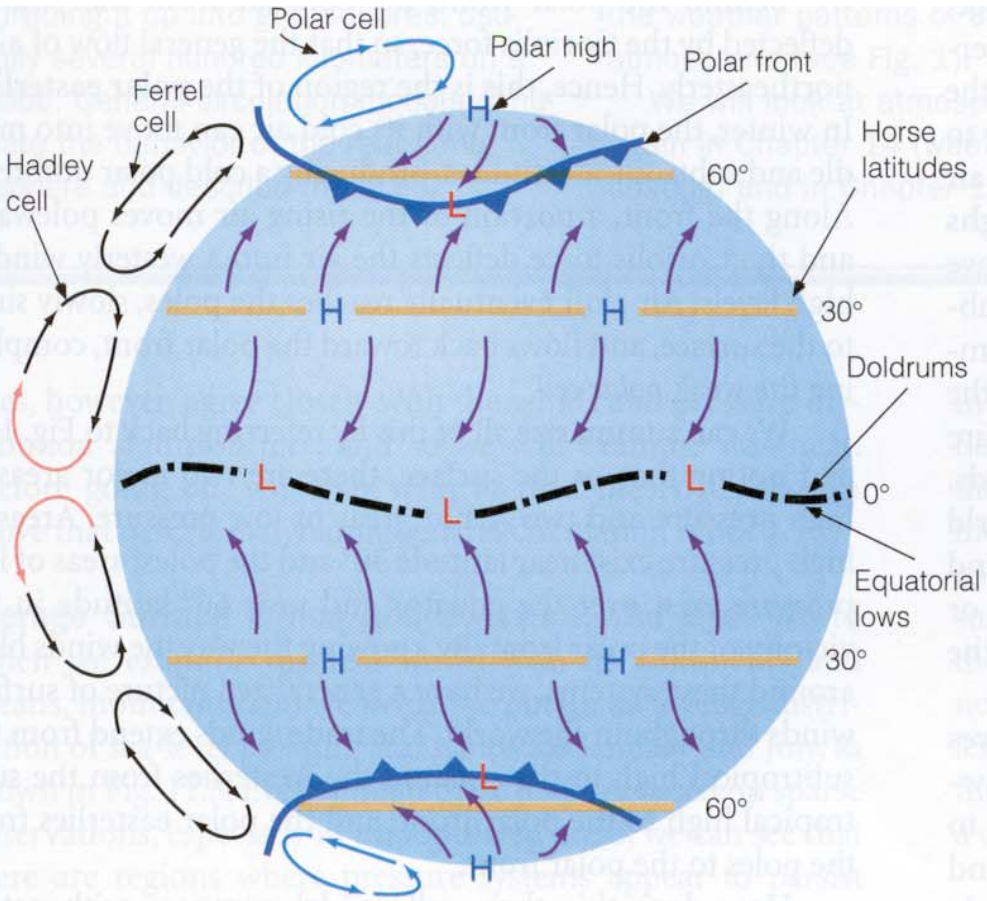
Coriolis Effect

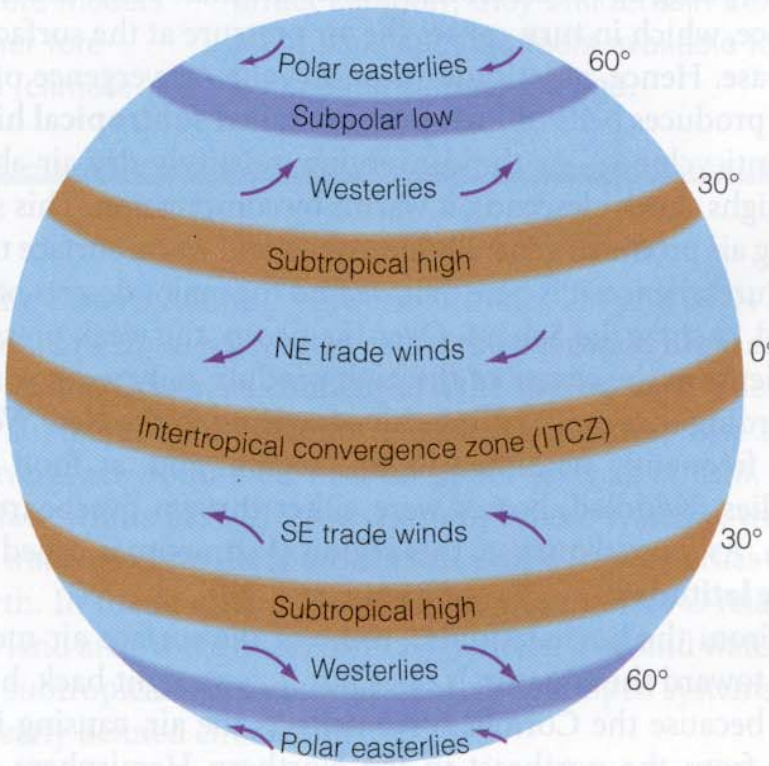
- The effect depends on initial direction of movement of the body, not compass direction.

- Deflection is minimal or non-existent at the equator.

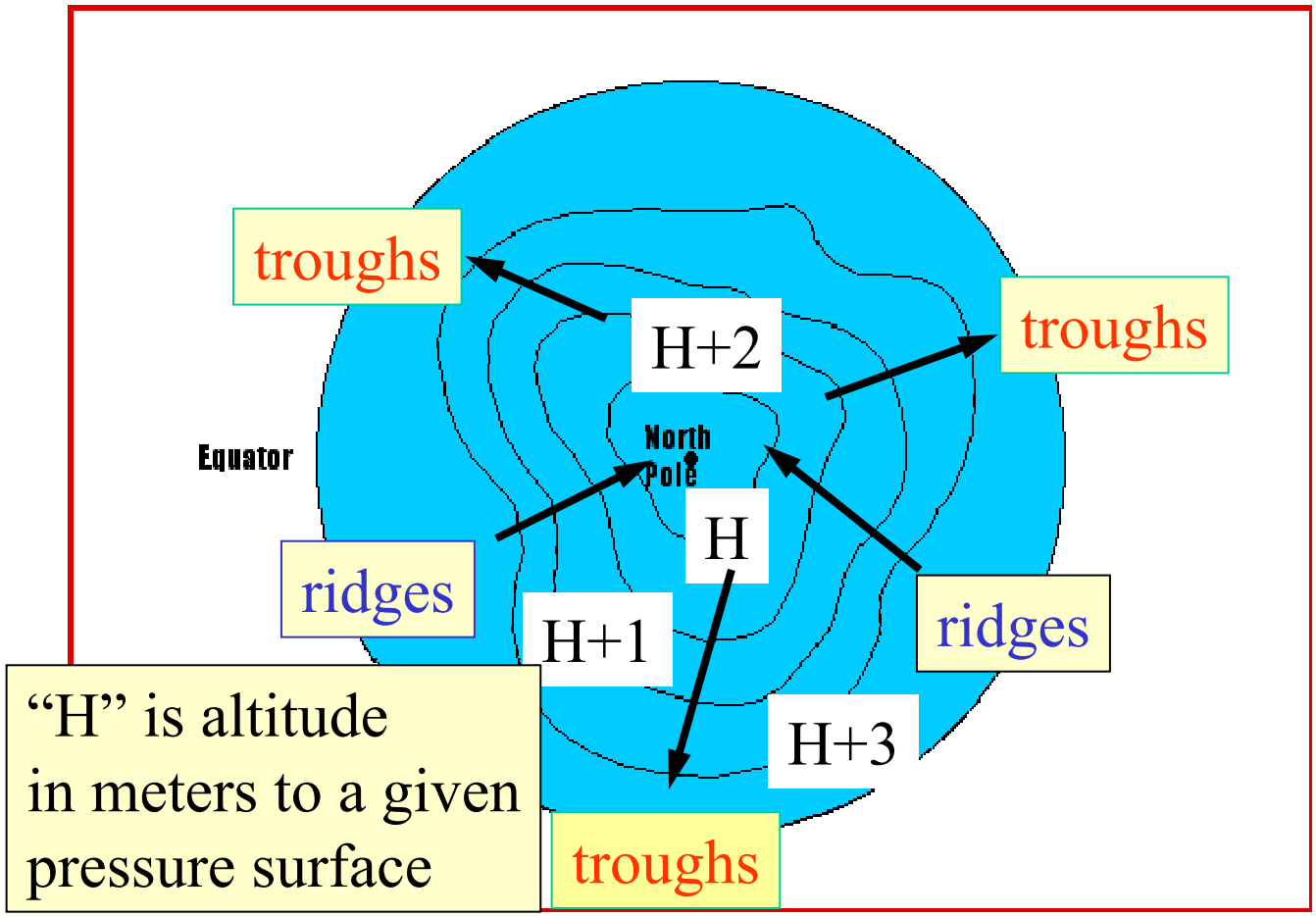


3-D look of the earth's atmosphere which depicts the conceptual model of primary circulation cells (Hadley, Farrell,and Polar) left the resultant surface patterns on the right



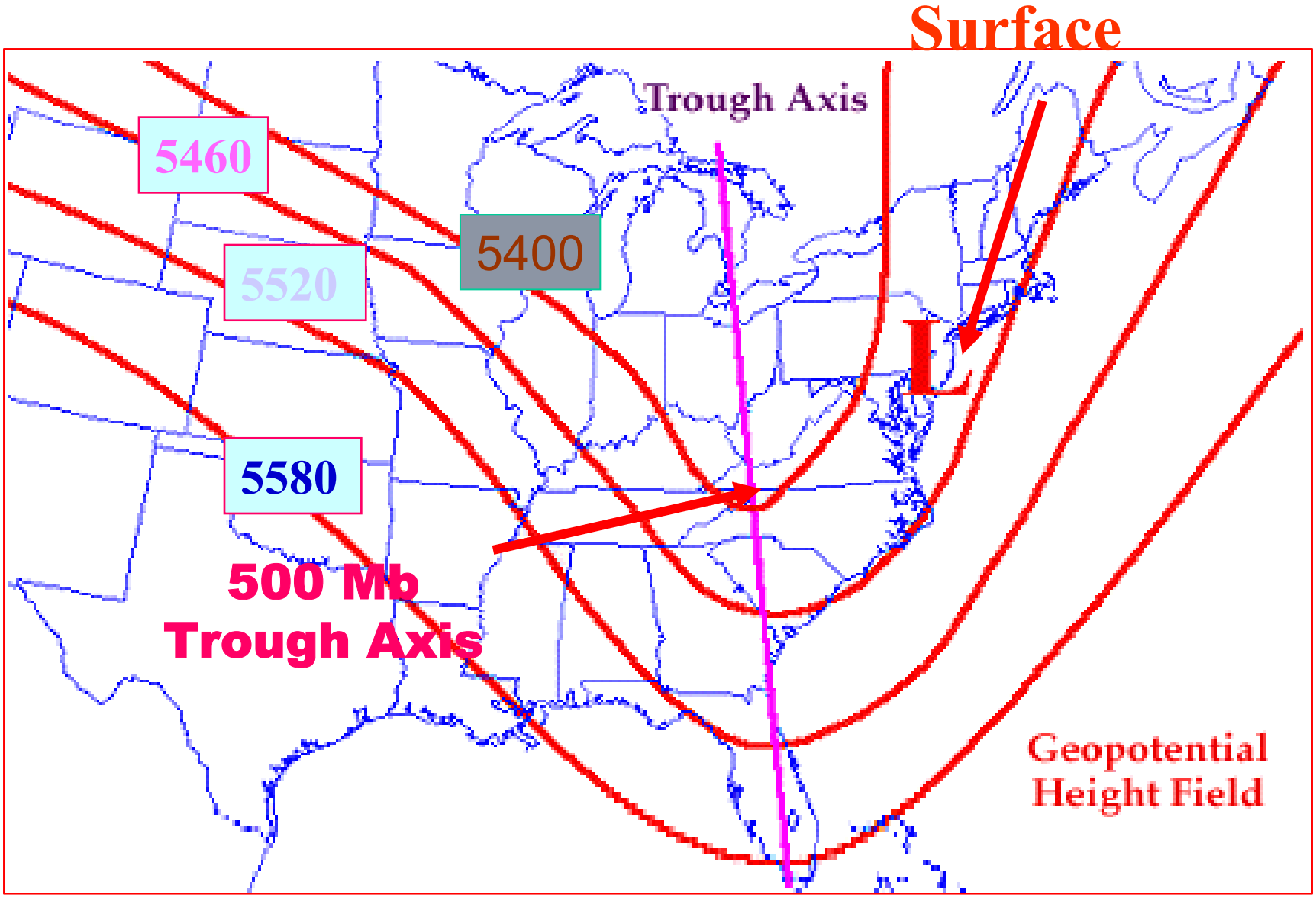


A planetary scale of height contours on a constant pressure surface, spaced at fixed intervals, on rotating earth and "coriolis force" producing longer wave troughs & ridges

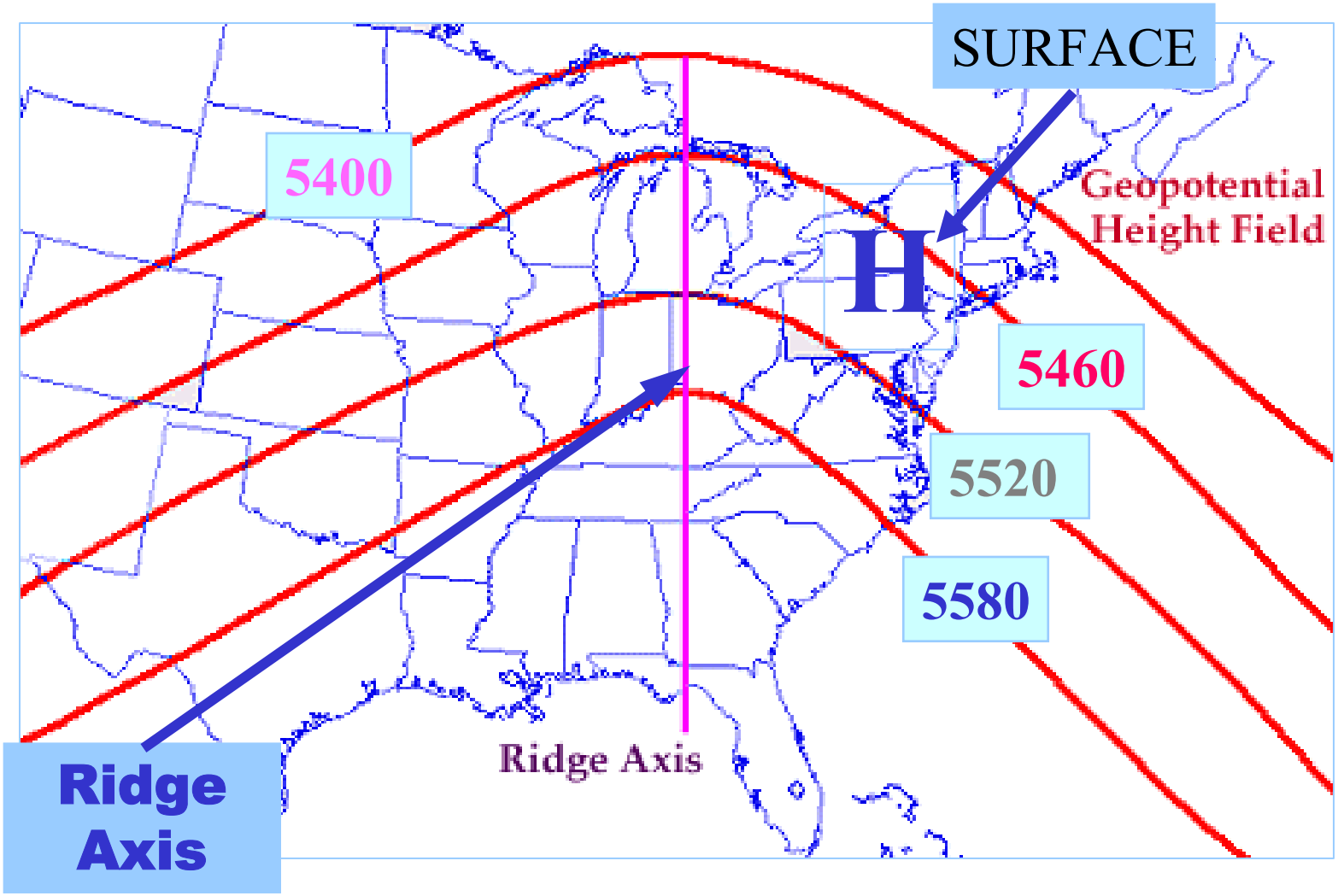


"H" is altitude in meters to a given pressure surface

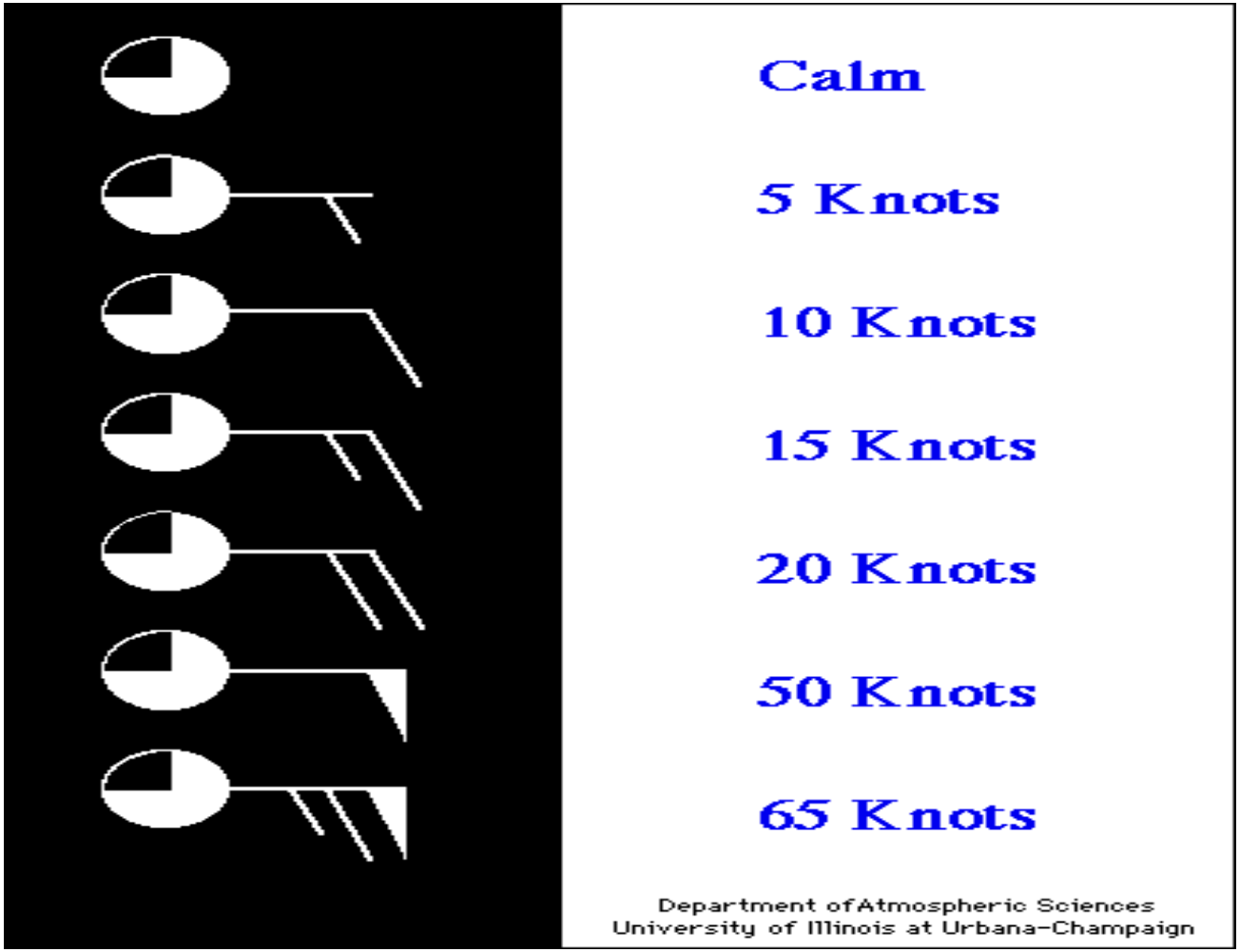
Synoptic scale features on a 500 Mb chart



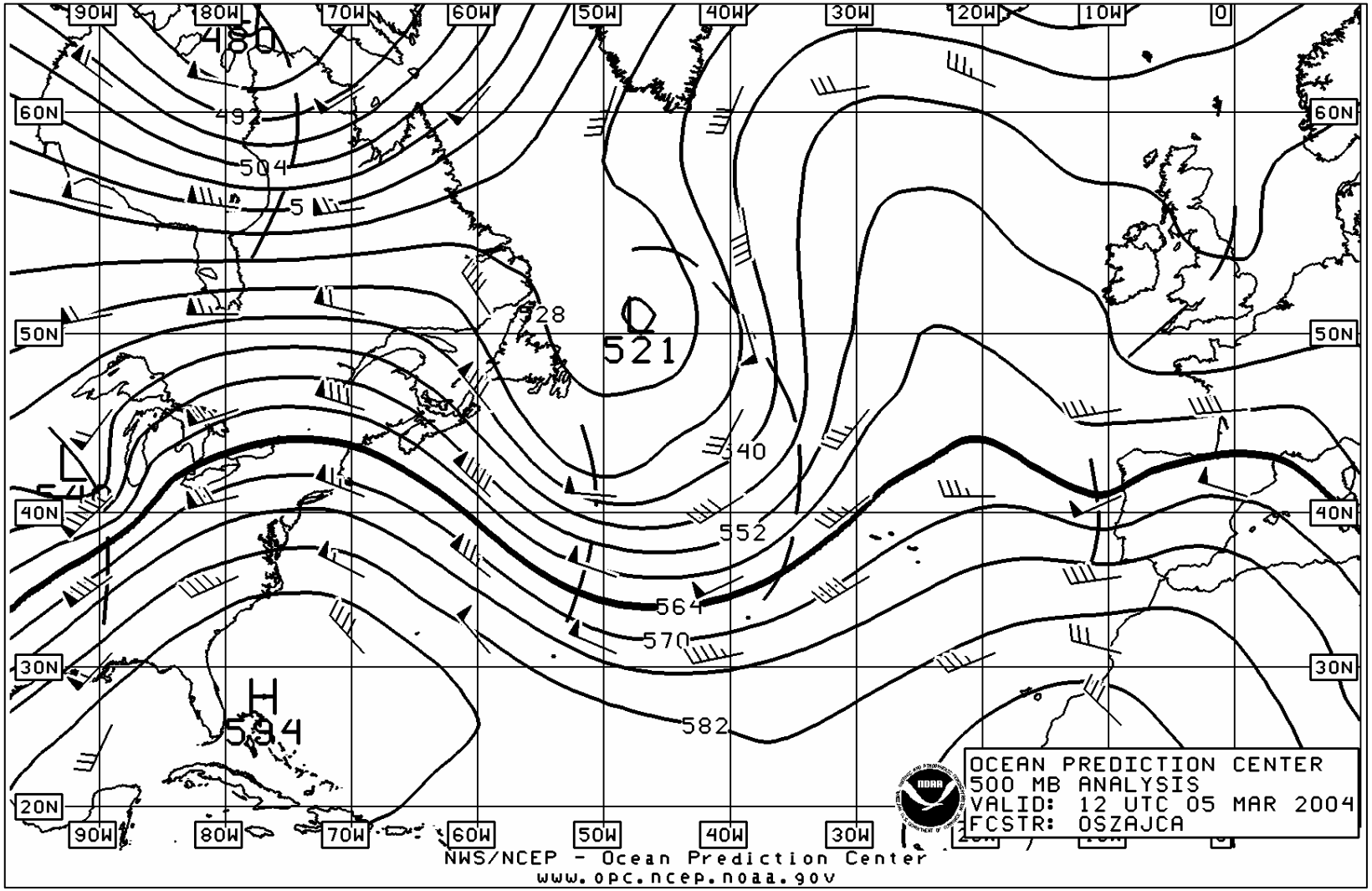
Another synoptic scale feature on a 500 Mb chart RIDGE



World wide convention also uses the following wind vectors at all levels



Put it all together and we have an OPC 500 Mb chart!



Review Rules of Thumb

- Surface lows track at 1/3 to ½ of 500 Mb wind speeds above the surface low pressure
- Surface lows will track parallel to the ISO-height contours
- Surface storm track (low pressure centers) lie between 300 and 600 nautical miles north of the **bold 5640 meter contour** (as depicted on OPC 500 Mb charts)

Review Rules of Thumb

- **Bold 5640 meter iso-height contour** represents the southern extent of surface beaufort force 6 (22-27 knots) westerlies in summer and force 7(28-33 knots) in the winter

- Up to 50 percent of the 500 Mb wind speed can be translated to the surface behind the 500 Mb trough axis (northwesterly flow), in the colder air

Mid-latitude Weather Systems

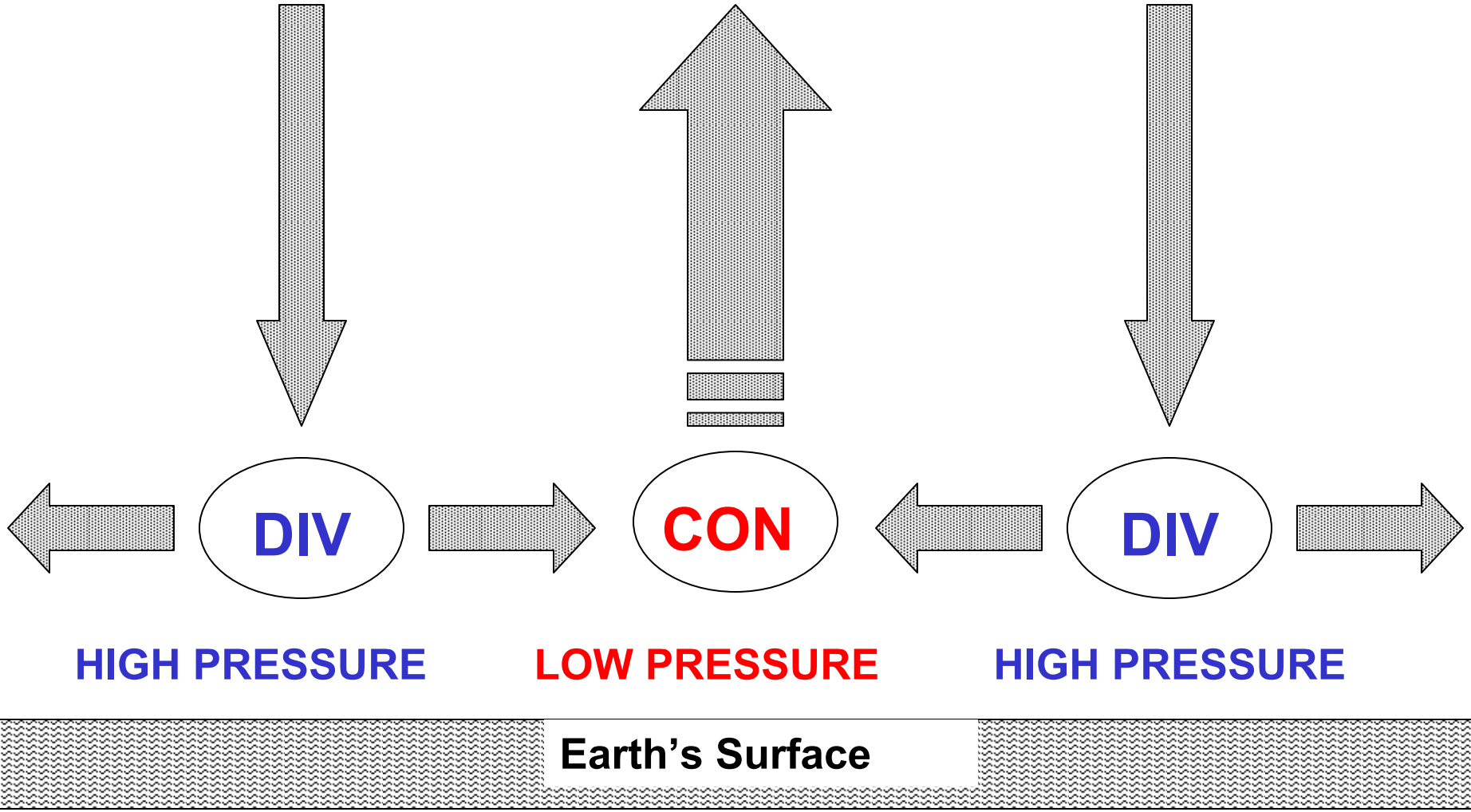
- Where does it all start?

- All weather is three dimensional (3-D)

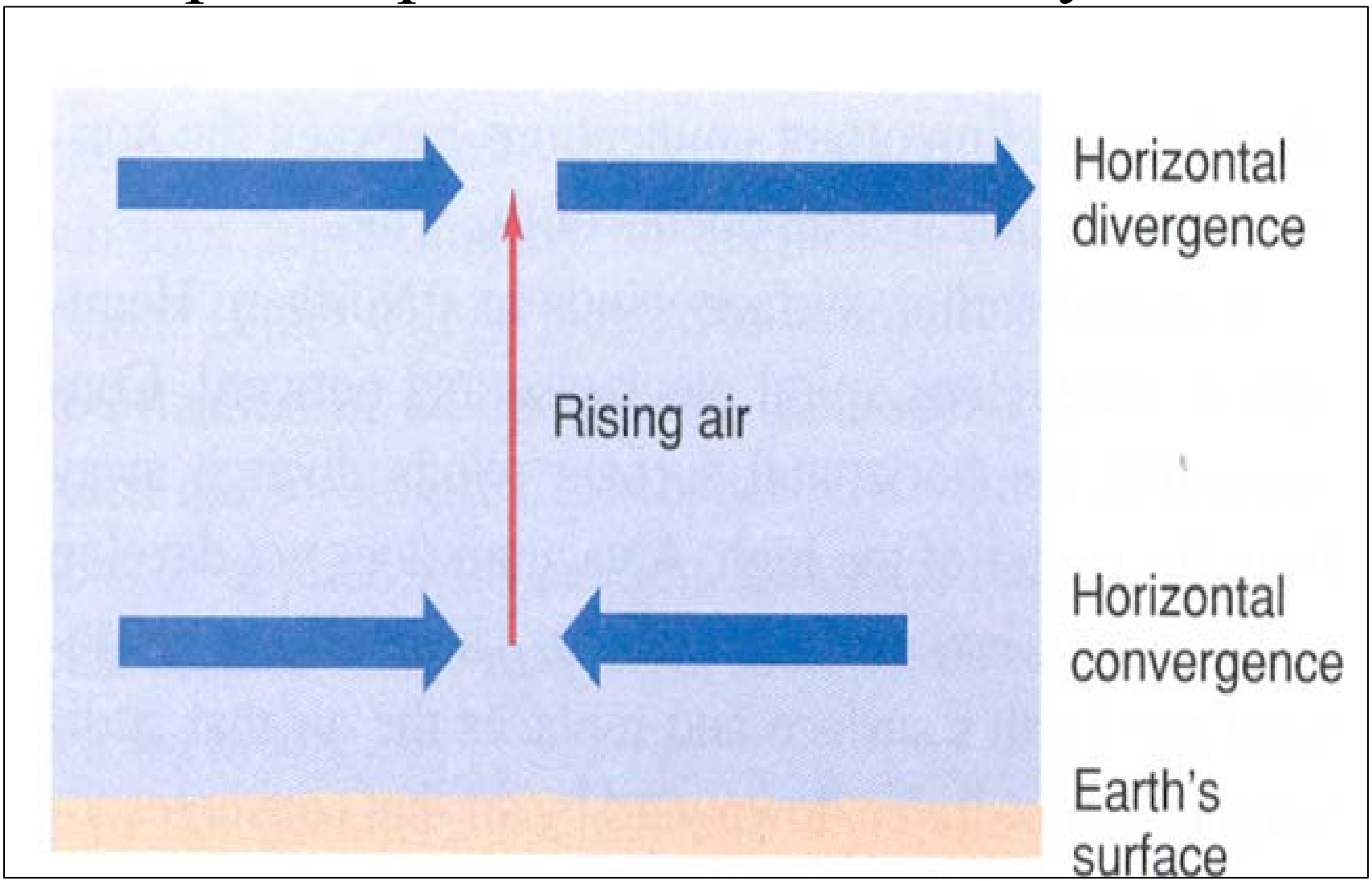
- Laws of physics as applied to the atmosphere.

- Air motion
  - Upper level are connected with surface weather systems

Rising and Sinking Air = Convergence and Divergence

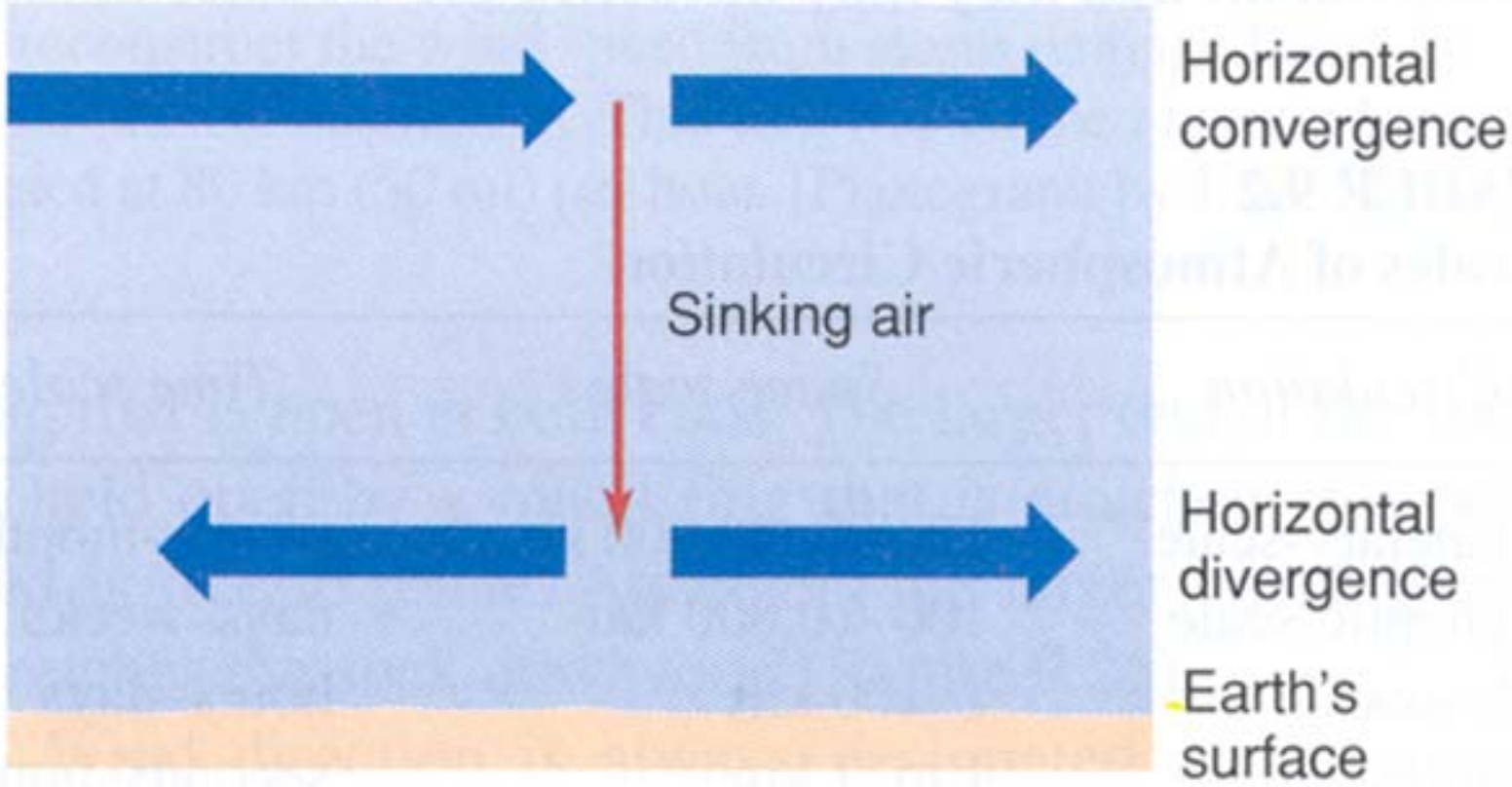


Takes place in the upper atmosphere as well producing a representation of the 3-D atmospheric processes at work…cyclones



…and Anti-cyclones

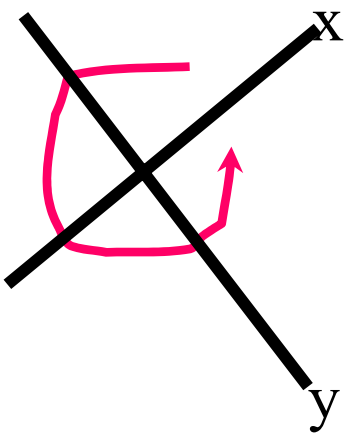
In this idealized vertical cross section of an anticyclone, air converges aloft, sinks, and diverges at the Earth's surface.



Lets Define and Examine the Importance of Vorticity as it is depicted on OPC charts

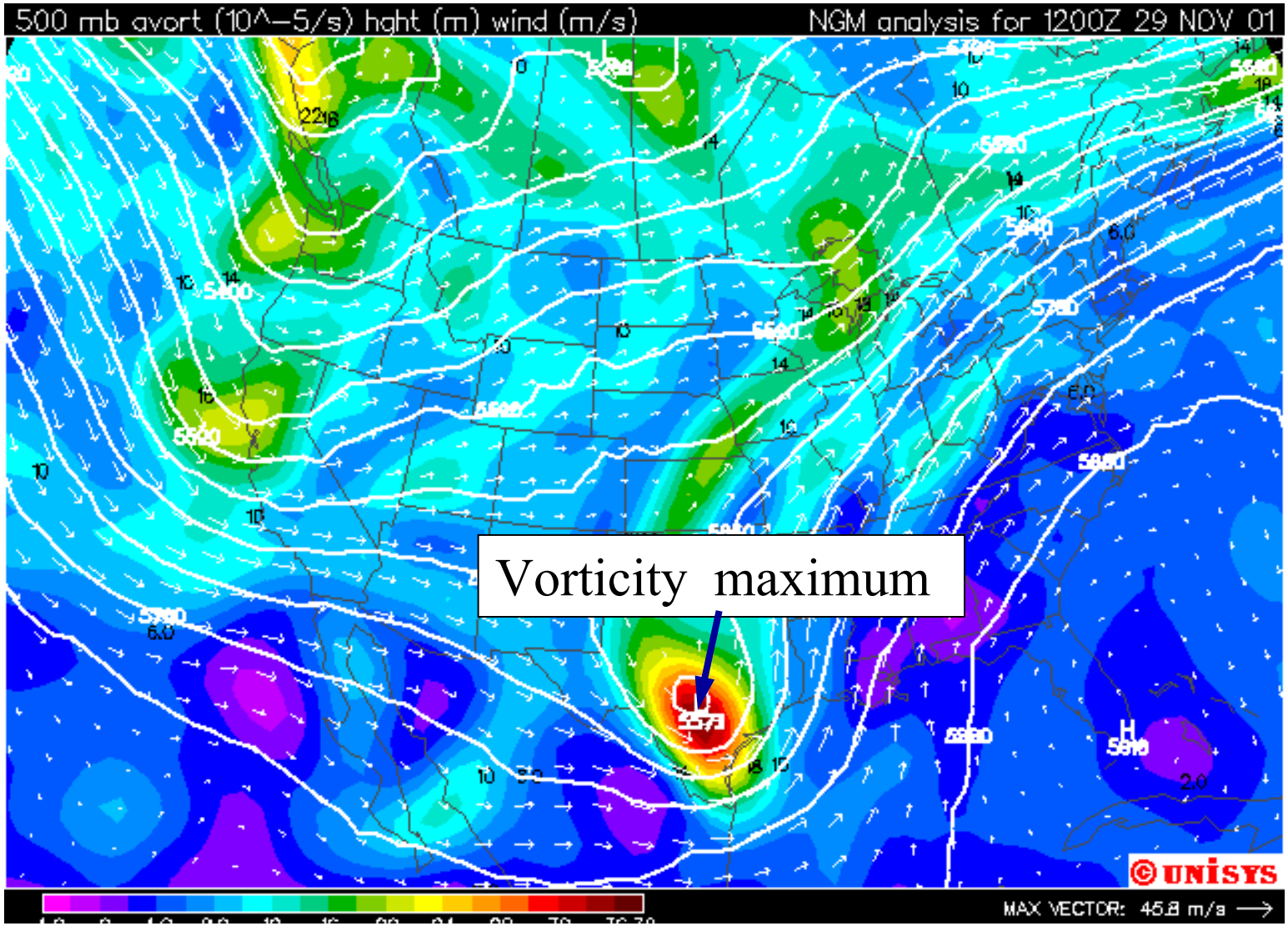
- Vorticity is the tendency for an air parcel to spin about an axis of rotation on a fixed plane
- Generally associated with short wave troughs of 50 deg longitude or less on 500 Mb surfaces
- Promotes vertical motion from below…causing surface pressures to fall.

The term Positive Vorticity Advection or "PVA" applies when values of Vorticity increases in time at a fixed location and results in the following….

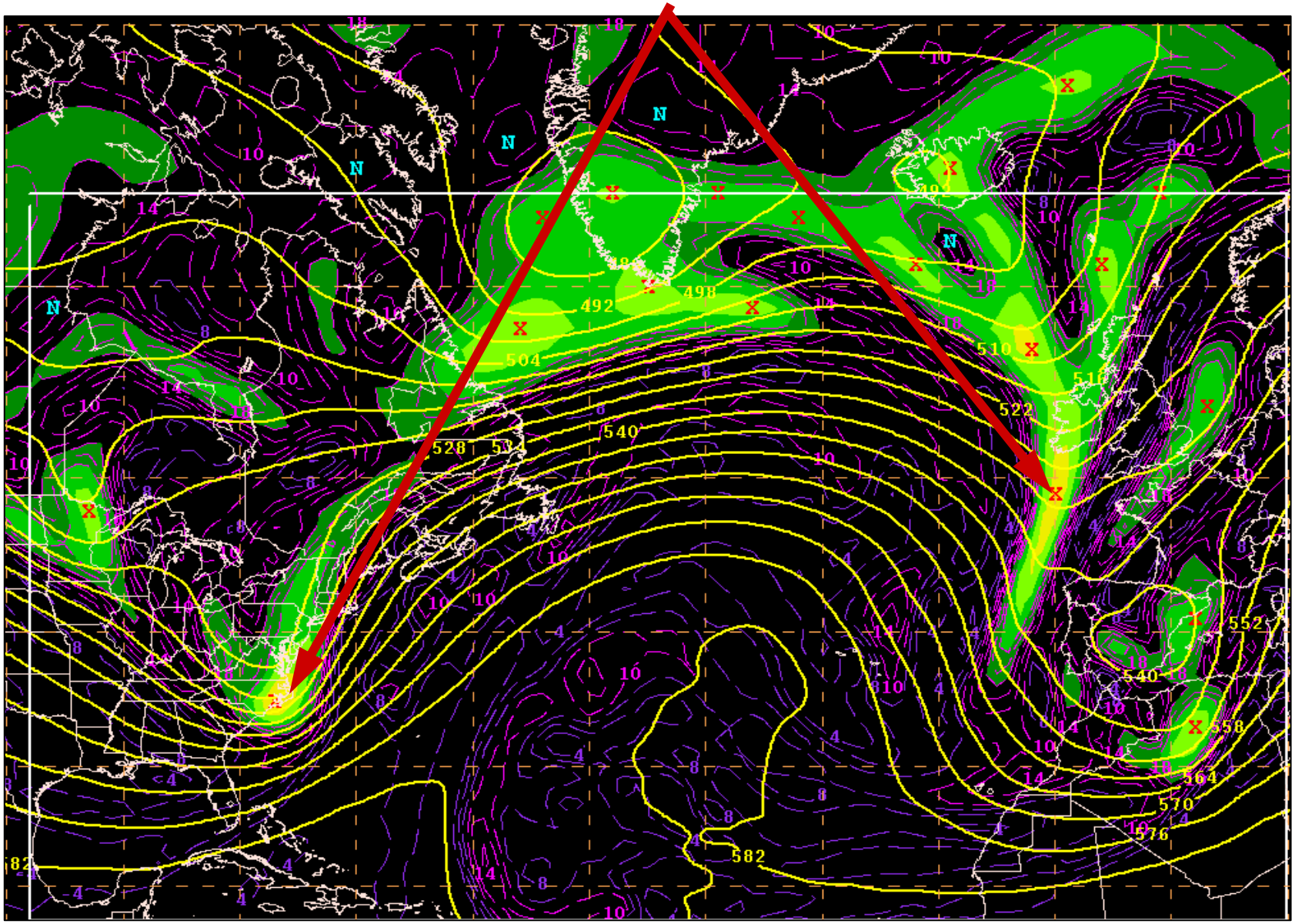


- Promotes upward vertical motion
- Leads to surface pressure falls
- Develops surface low pressure systems

Vorticity Maximum



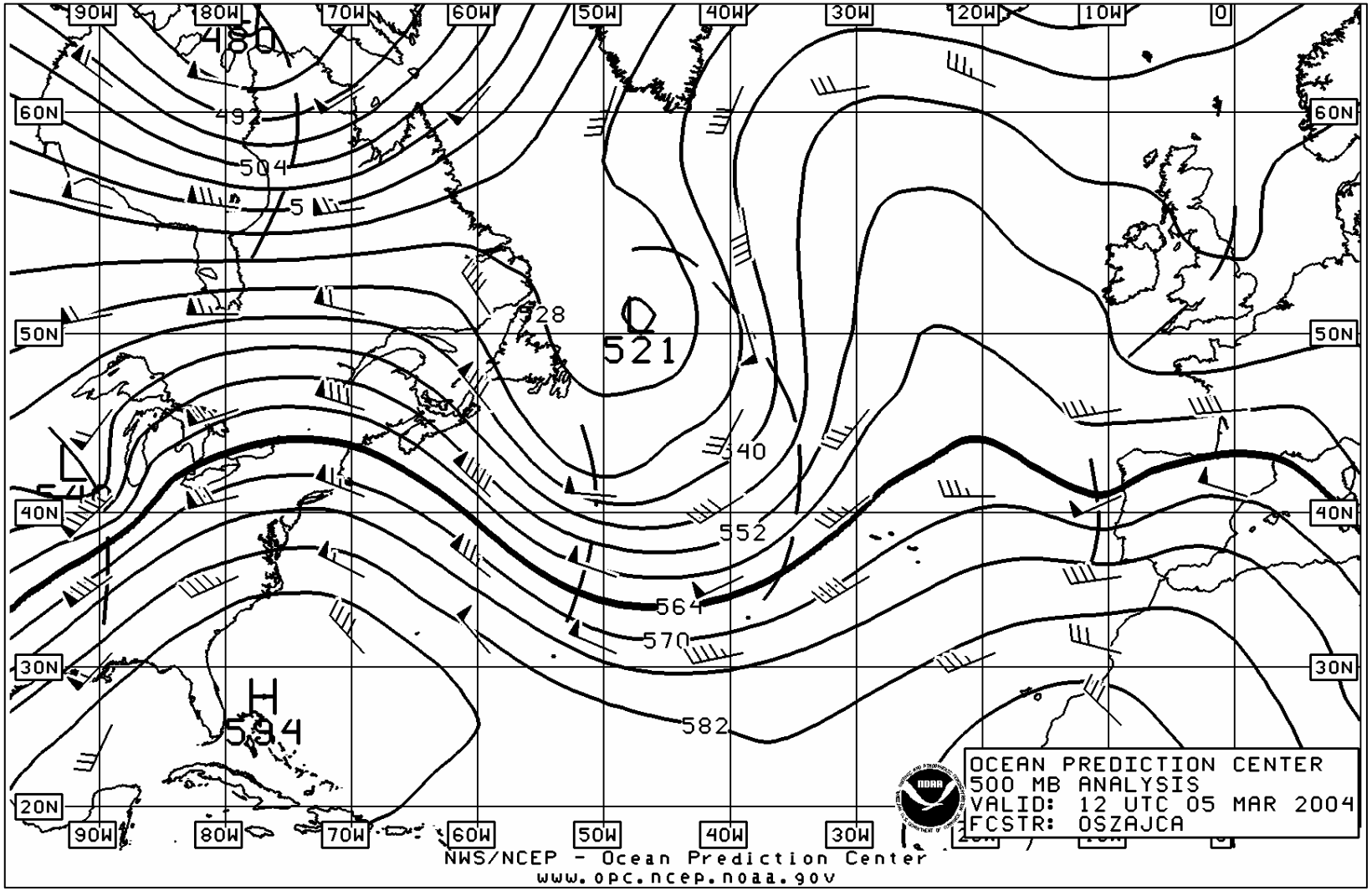
Maximum Vorticity (cont'd)



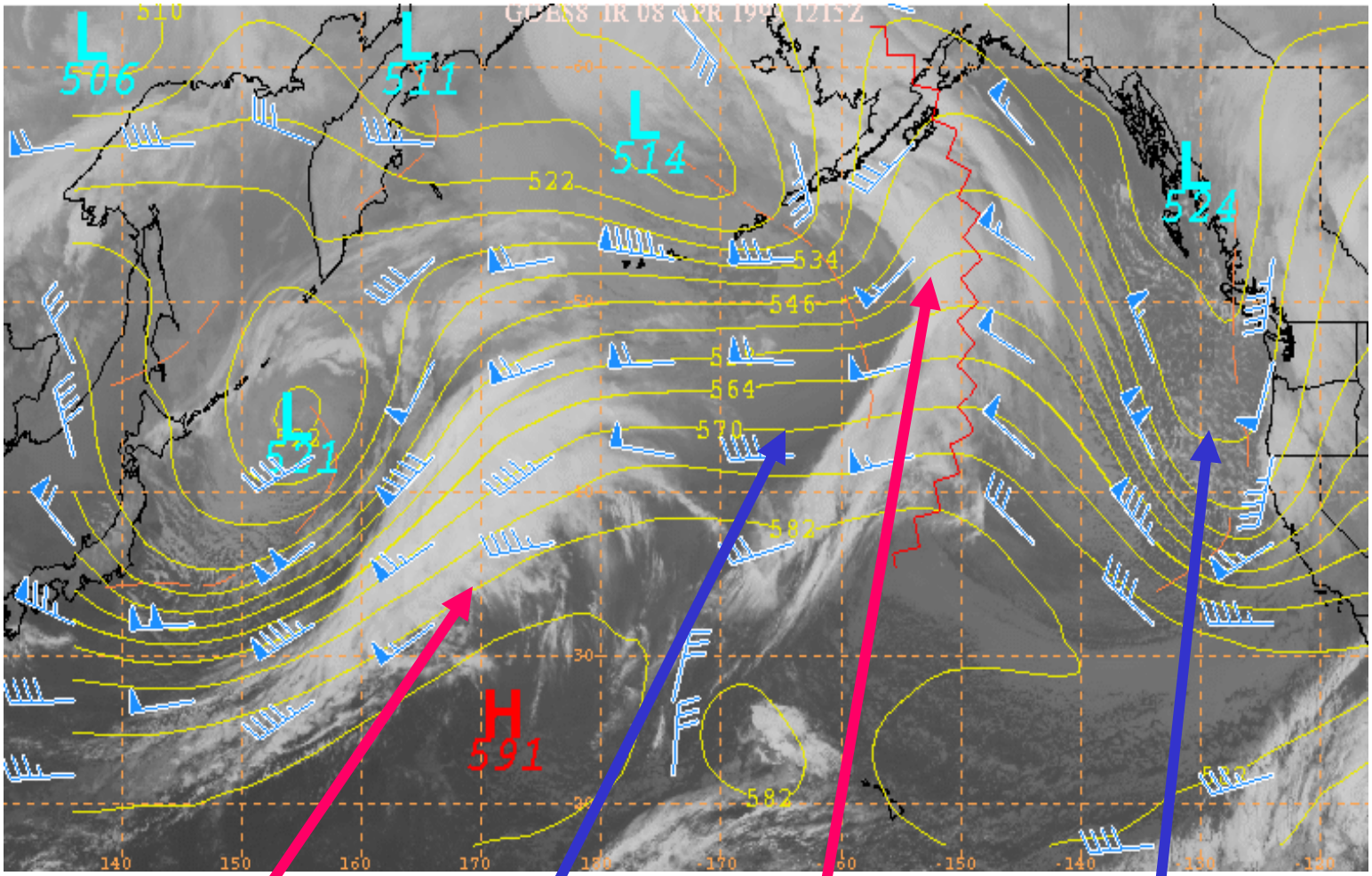
The Computed Values of Vorticity on Meteorological Maps Are…

- Depicted by a dashed line through a short wave trough on OPC 500 Mb charts.
- The dashed line does not necessarily bisects the apparent visible trough axes…remember contour curvature and wind shear (vorticity) determines where the dashed line is drawn.
- Thus "vorticity" is manifested as surface low pressure systems, fronts, or non frontal troughs of low pressure on a surface pressure chart. We see this result in Satellite images….for example…

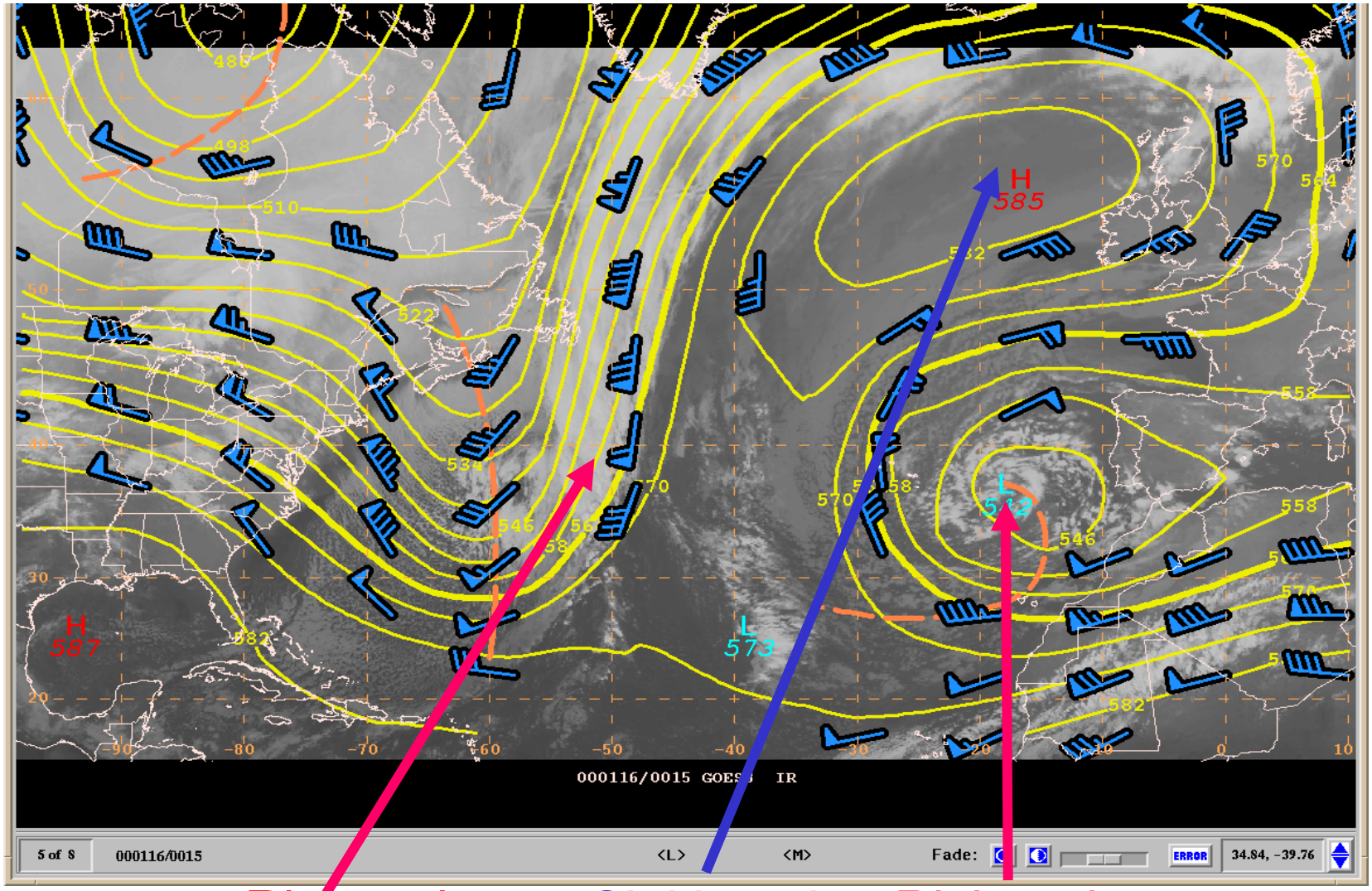
OPC 500 Mb Analysis



500 Mb when overlaid on satellite imagery reveal vertical motions…

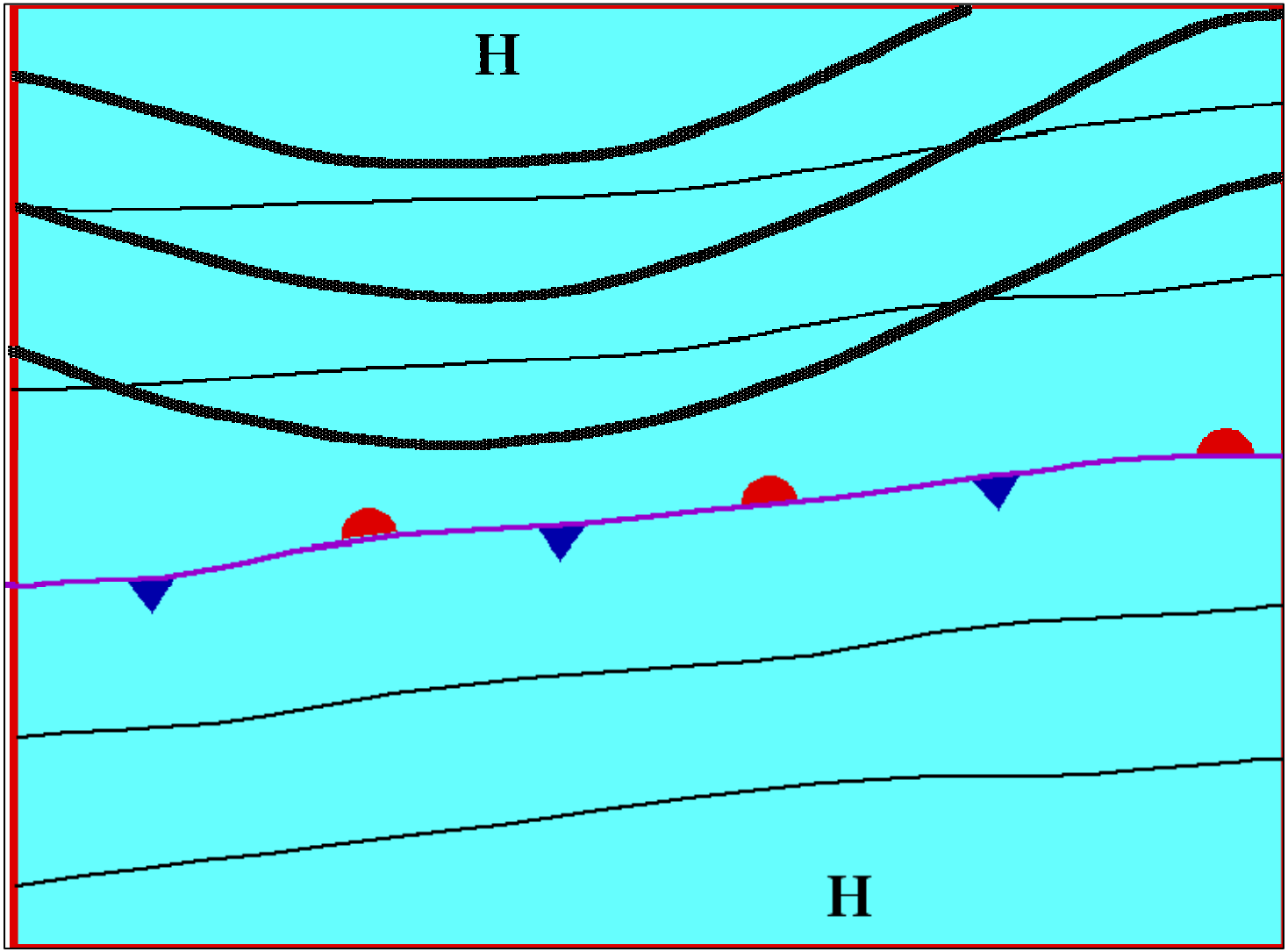


500 Mb overlaid on Satellite Imagery reveal vertical motion…

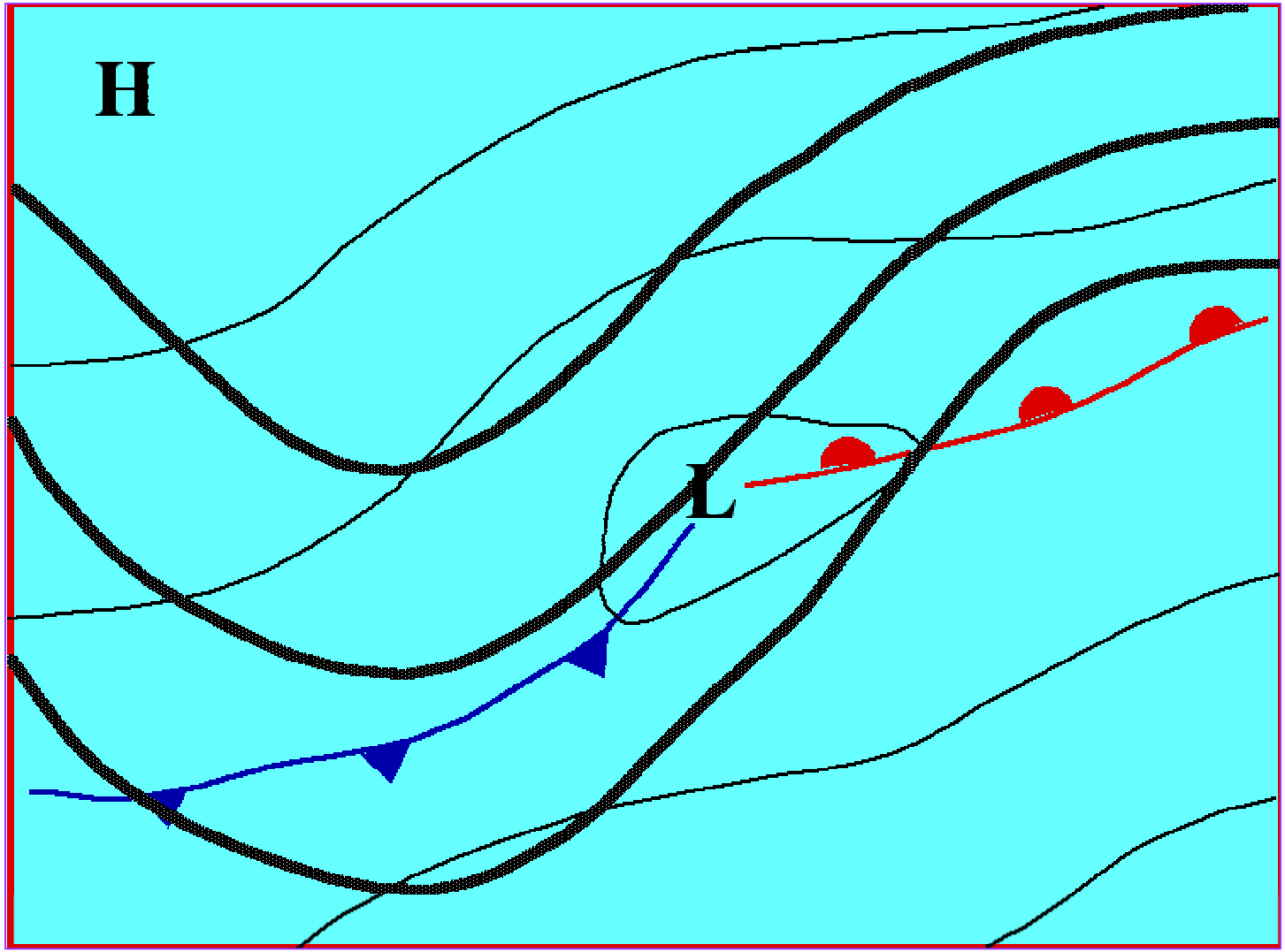


Rising air Sinking air Rising air

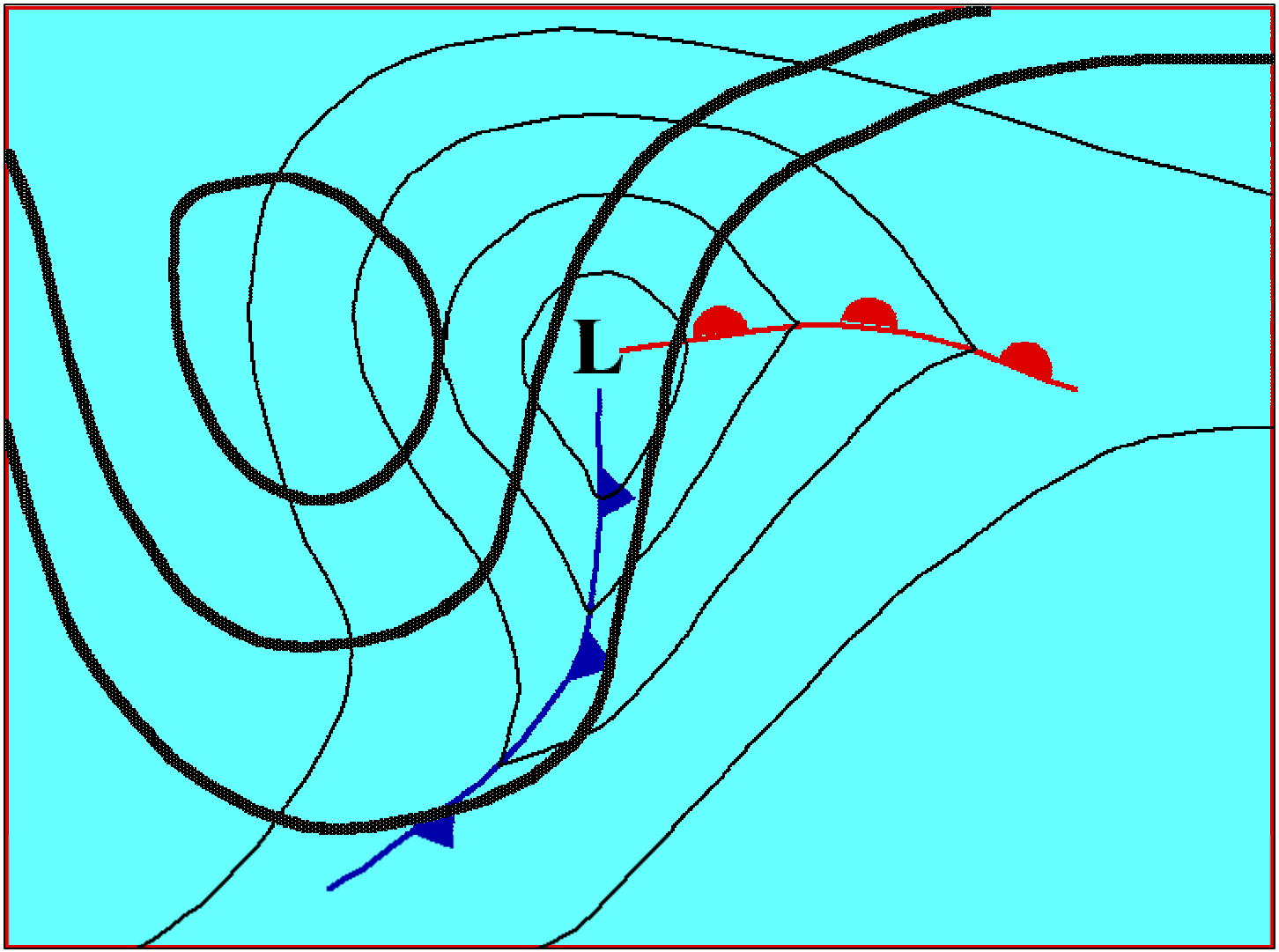
Typical 500 Mb & surface response in a 24 hour sequence : Day one



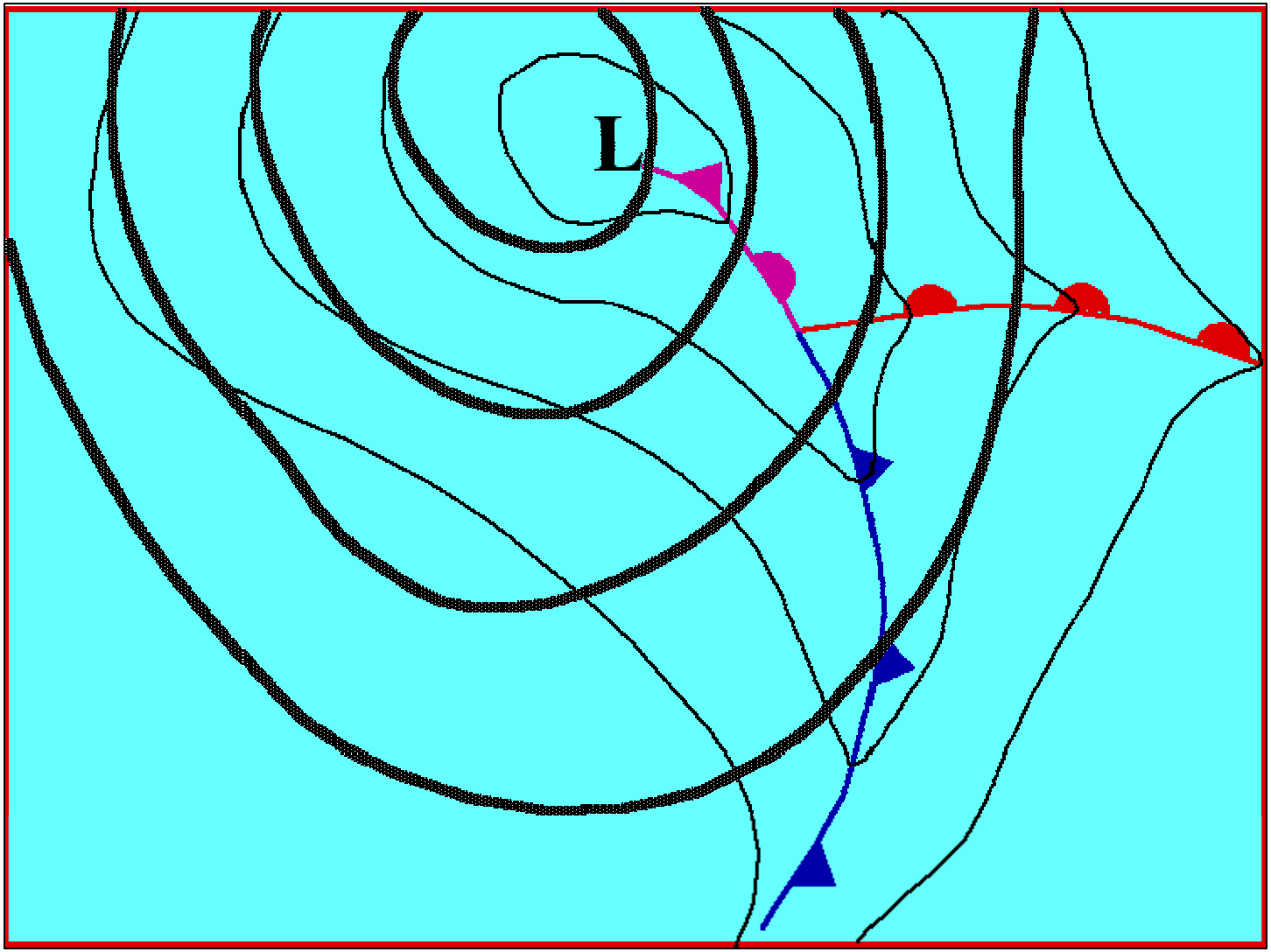
Typical 500 Mb & surface response in a 24 hour sequence: Day two



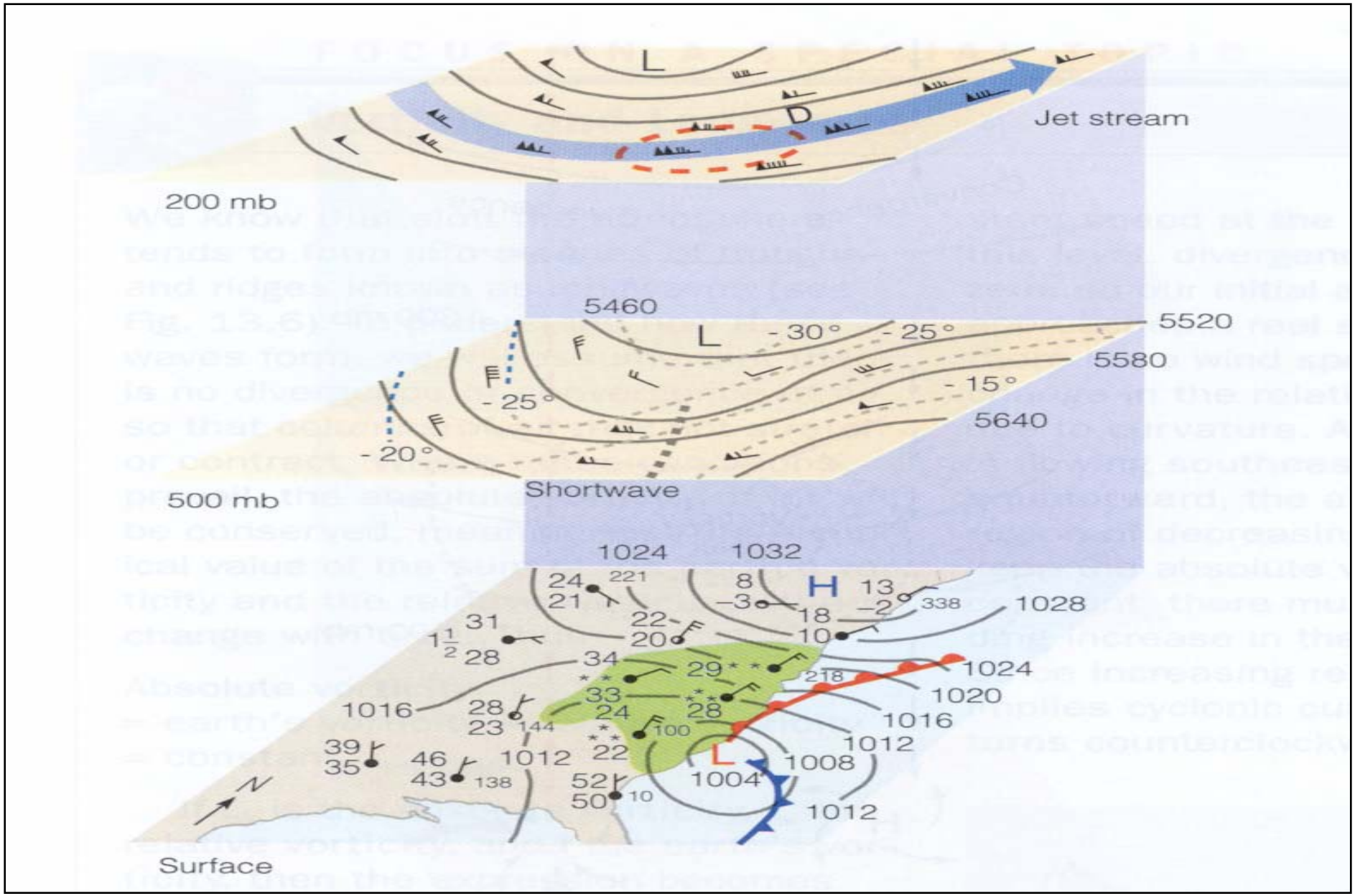
Typical 500 Mb & surface response in a 24 hour sequence:Day 3



Typical 500 Mb & surface response in a 24 hour sequence: Day 4



Schematic View of Weather in 3-D



Schematic 3-D atmospheric profile of upper level air flow, vertical motions,and synoptic scale surface low features

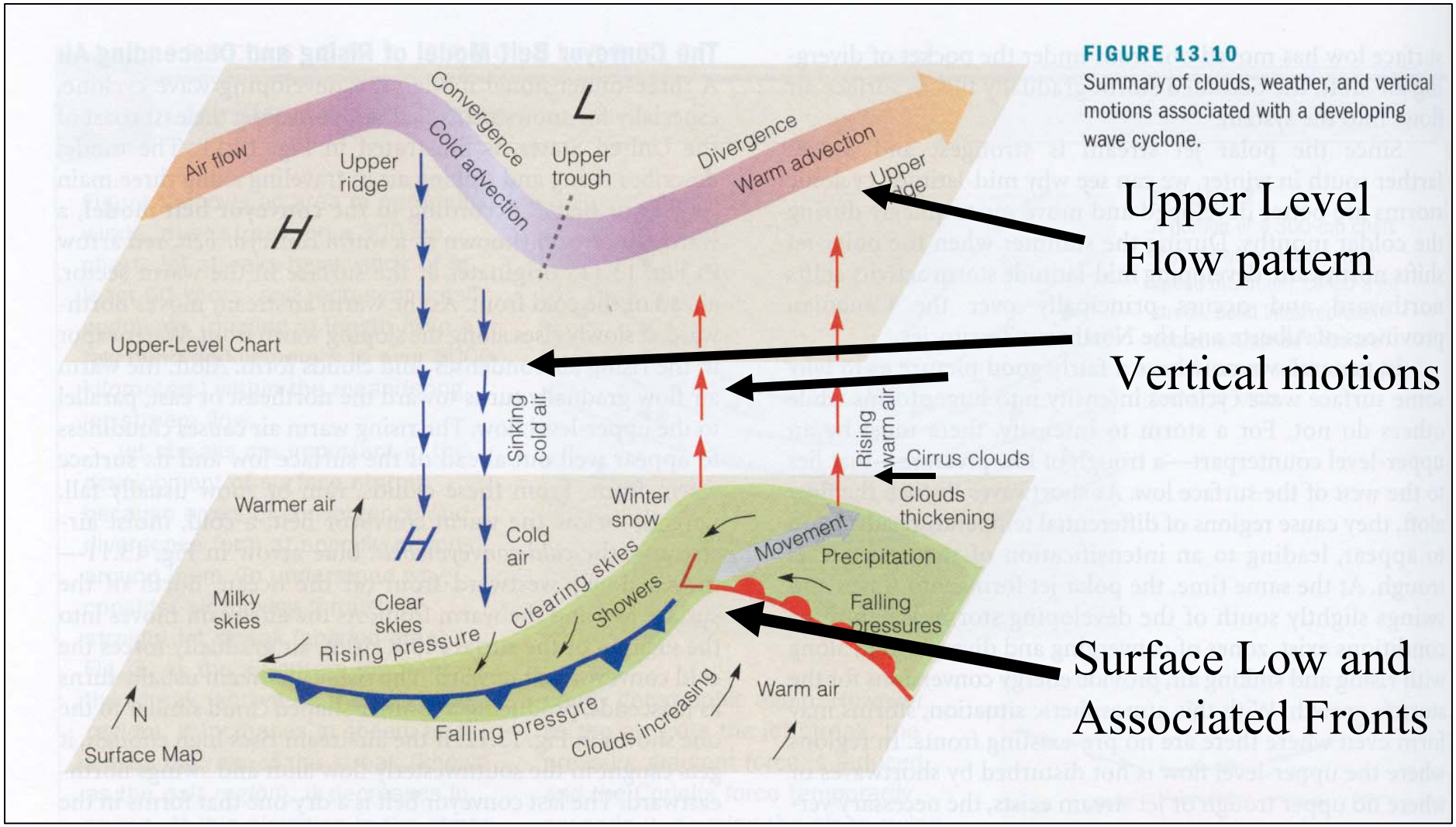
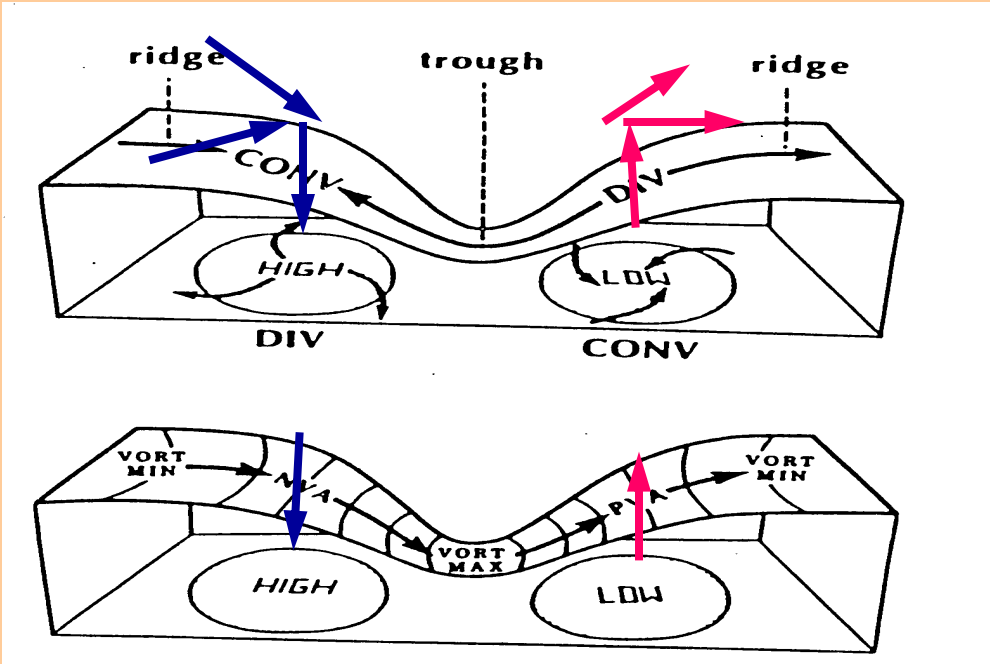


FIGURE 13.10
Summary of clouds, weather, and vertical motions associated with a developing wave cyclone.

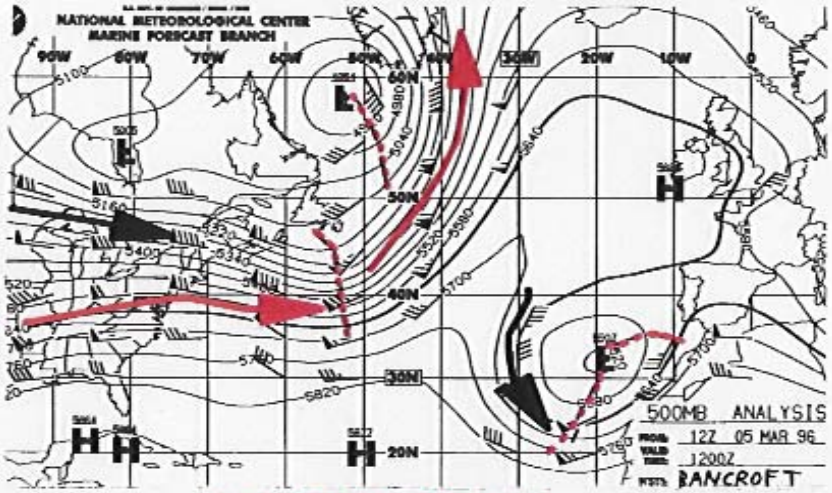
Schematic 3-D Aspect of 500 Mb and Surface Mid-latitude Cyclones

The 3-D Look 500 Mb & Surface at maturity

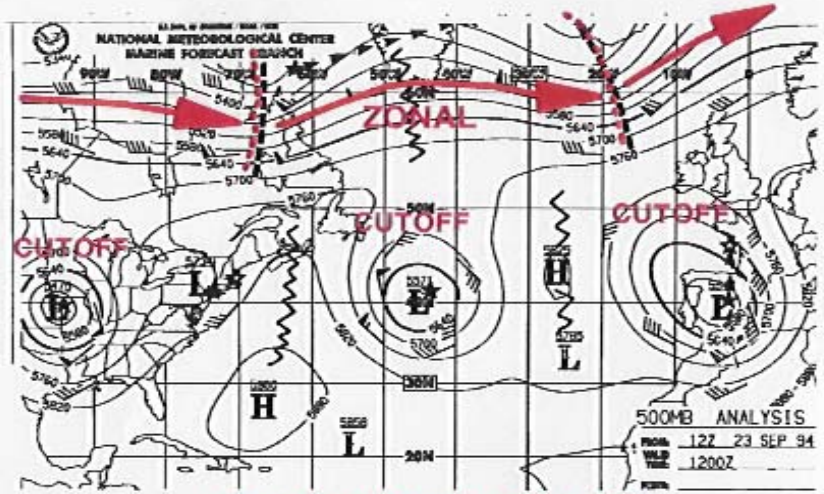


From Kocin and Uccellini AMS VOL 22 4/90 NO. 44

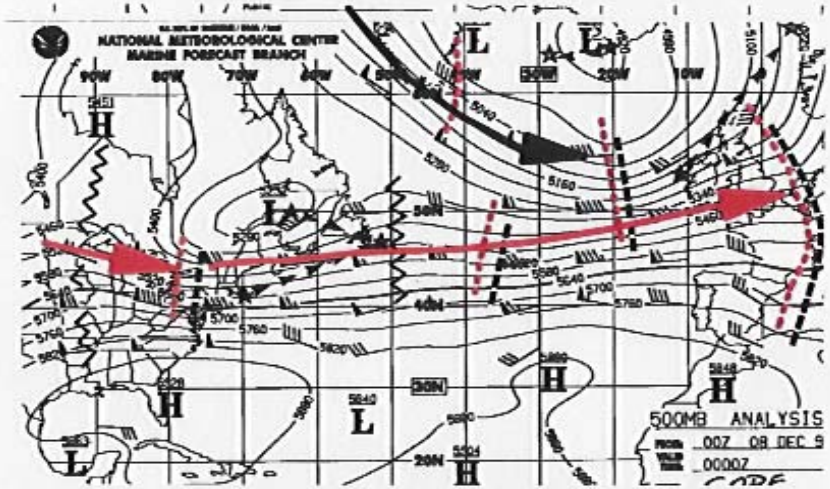
500 MB FLOW PATTERNS



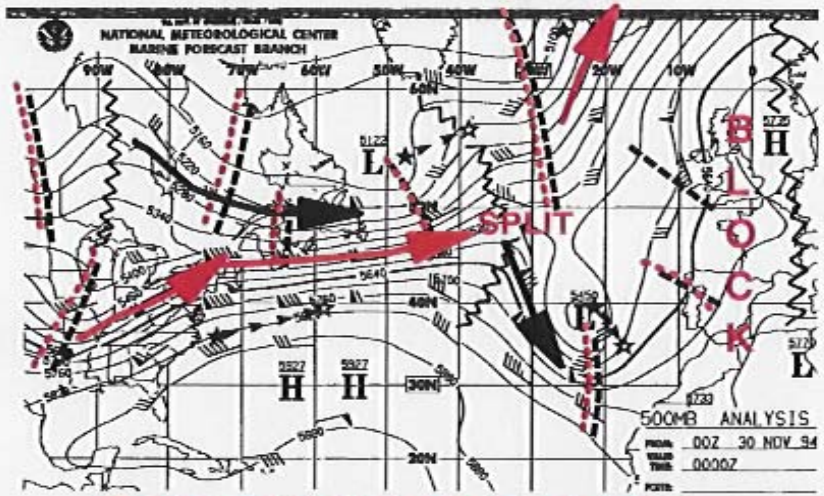
MERIDIONAL



CUTOFF LOWS



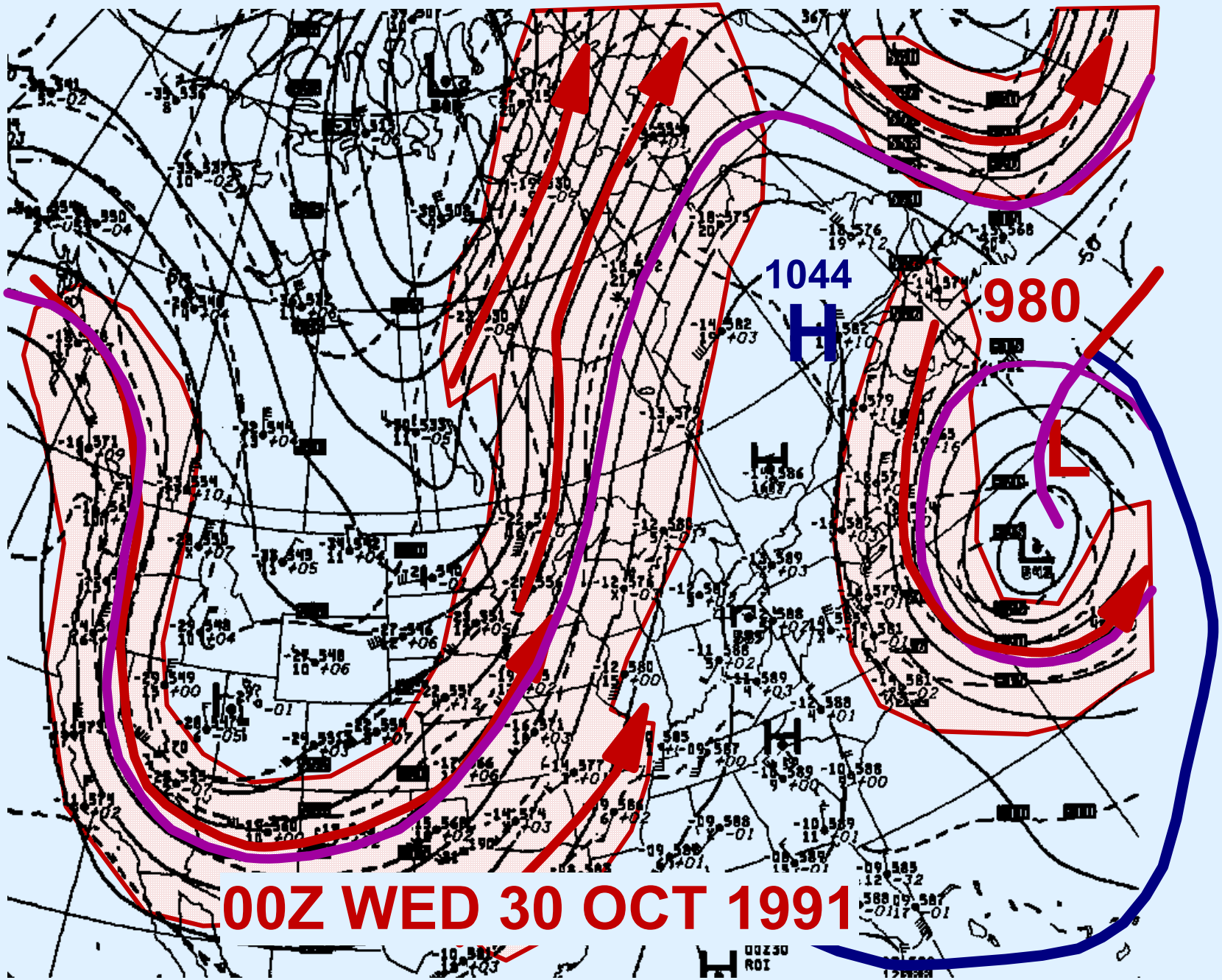
ZONAL FLOW



BLOCKING PATTERN

REMEMBER THE HALLOWEEN STORM OF 1991?

"THE PERFECT STORM"


1044
980
00Z WED 30 OCT 1991

Surface Analysis 00 UTC 30 Oct

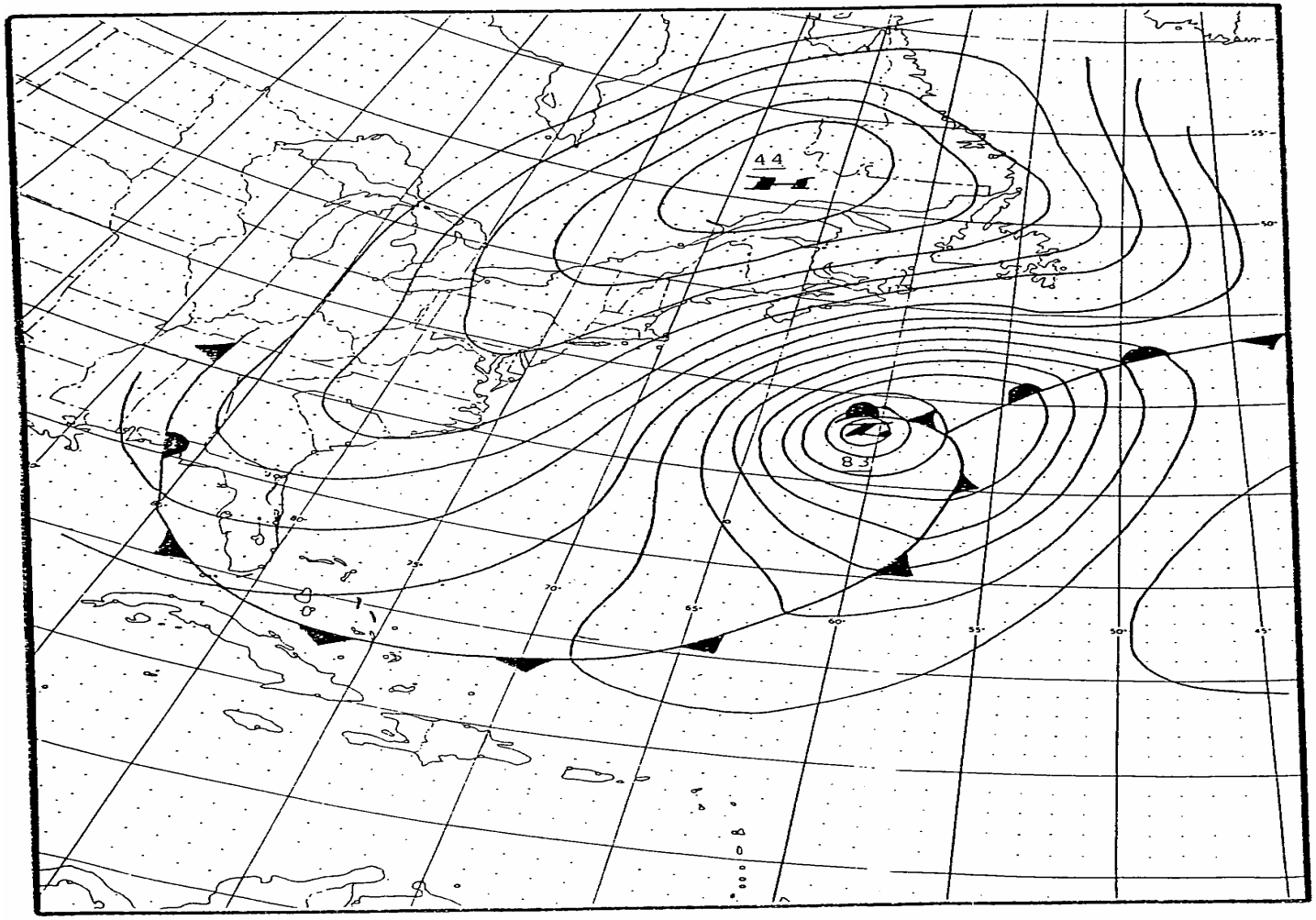


Figure 12. 0000 UTC Surface Analysis - 30 October 1991.

Surface Weather & 500 mb Level:

-SFC WX moves @ 1/3 to 1/2 speed of winds @ 500 mb level.
-SFC WX moves parallel to 500-Mb Iso-heights.
- Surface storm track lies within 300 to 600 NM poleward of the **5640 meter** Iso-height contour.
-The **5640 meter** Iso-height contour also represents equatorward extent of Beaufort Force 6 & 7 winds on the surface ("westerlies")
-50 percent winds at 500 Mb can translate down to the surface on cold side of trough(west of trough axis in the northwest flow)

Evaluation of 500 Mb charts for routing applications…

- **Examine 500 Mb low pattern and determine whether the storm track will be progressive or blocked and or and deflected.**

- **Determine the location and direction of the surface storm track and its intensity.**

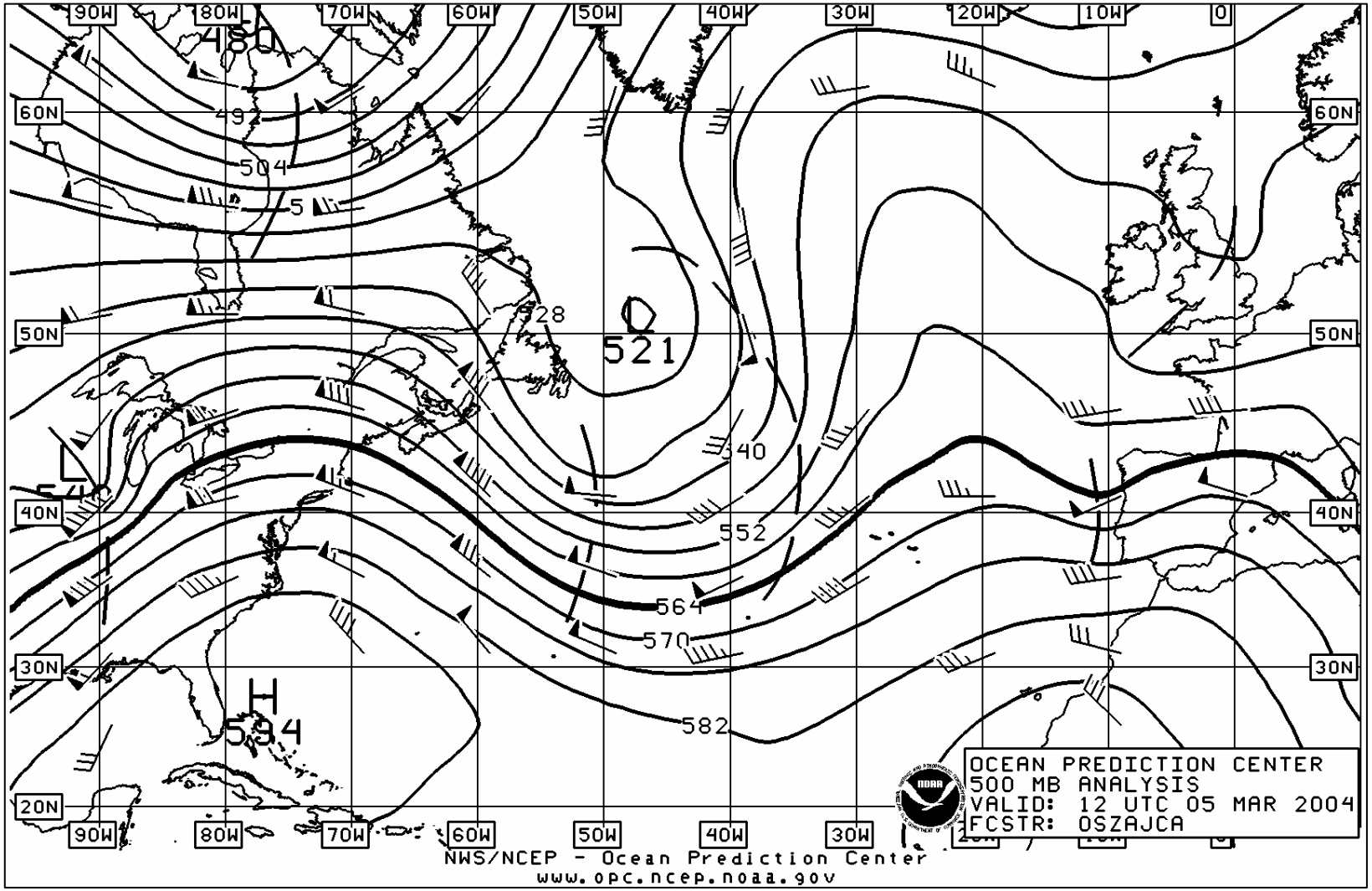
- **Determine location of southern extent of surface force 6/7 “westerlies”.**

Evaluation of 500 Mb charts for routing applications.. (cont'd)

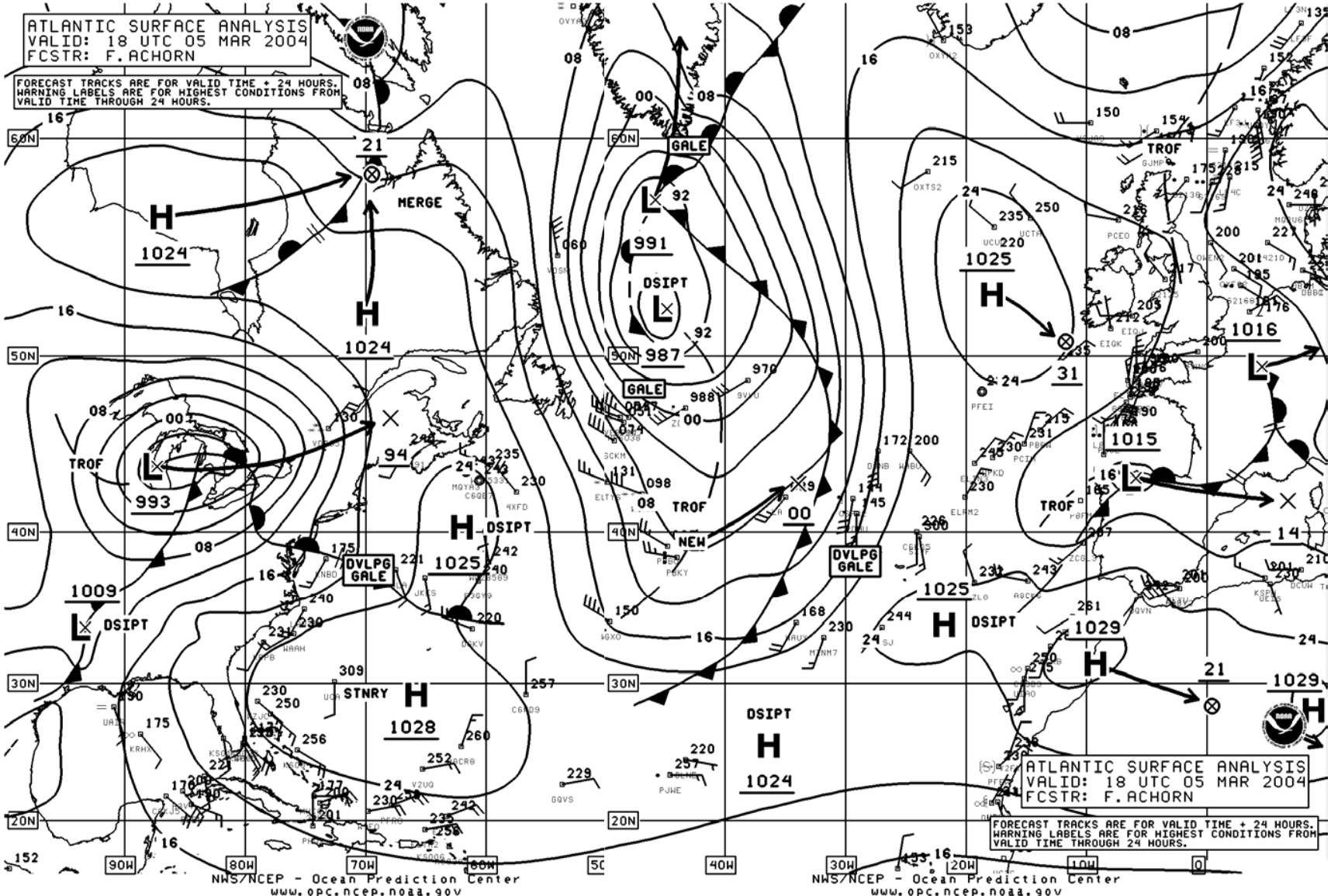
- **Assess local conditions at your vessel and evaluate the larger synoptic scale picture for weather analysis and forecast confidence building. For example:**
  - **are you north or south of the 5640 iso-height contour?**
  - **Does the manifestation of surface conditions meet your vessel performance criteria?**
- **Determine safest and optimum routing both for East and West bound voyages**

Putting Upper Air and Surface Together

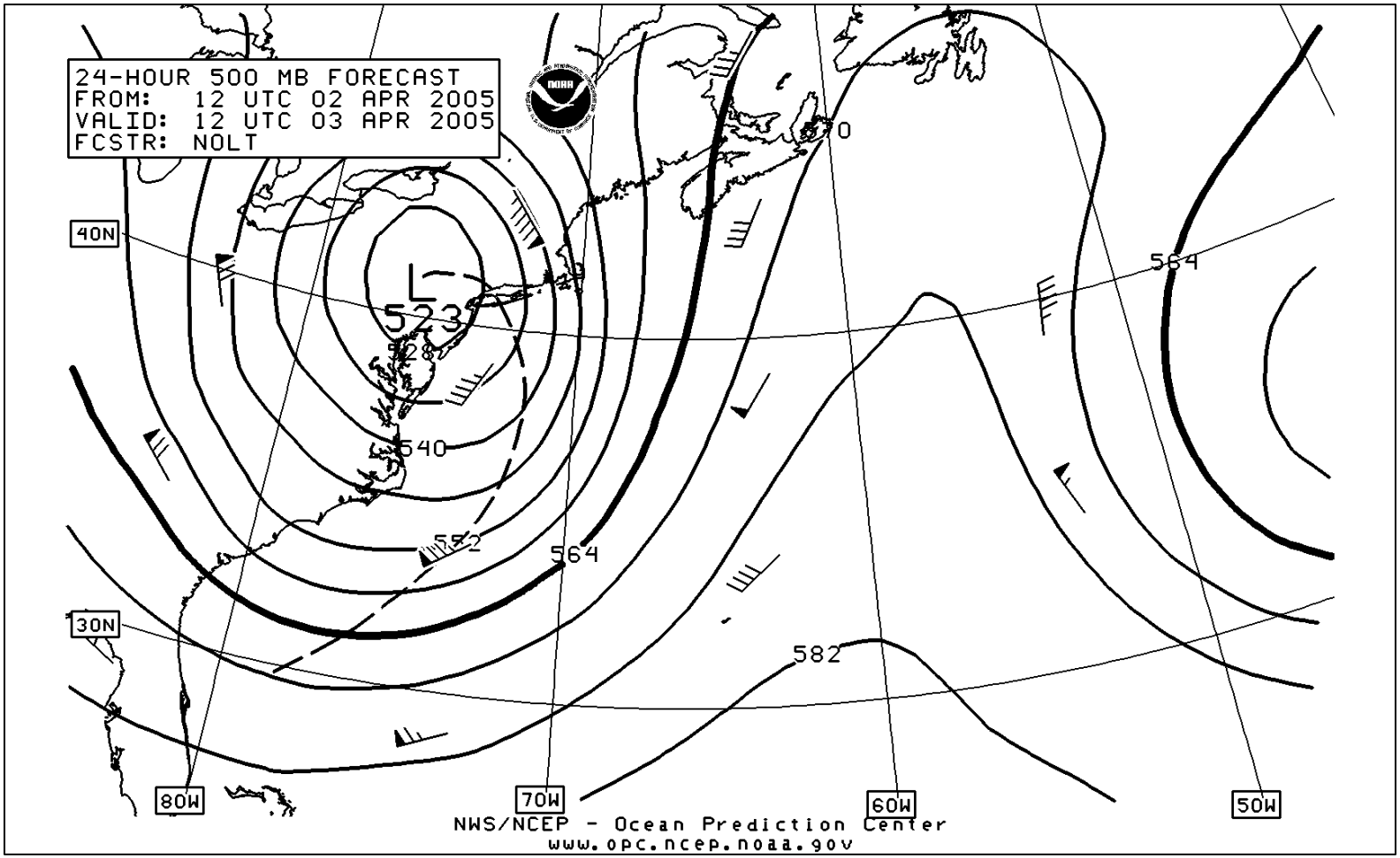
OPC 500 Mb Analysis



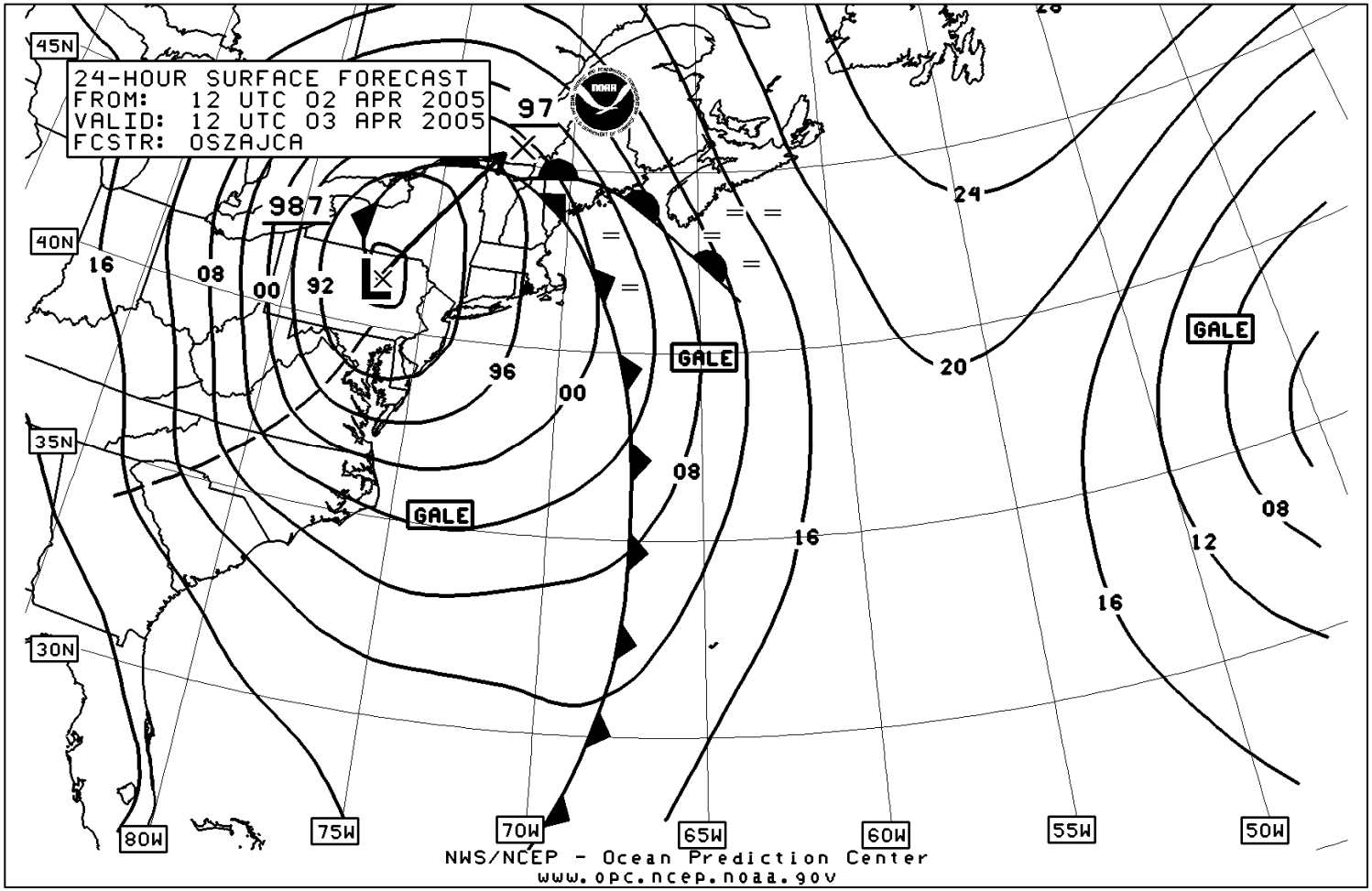
Surface Analysis Chart



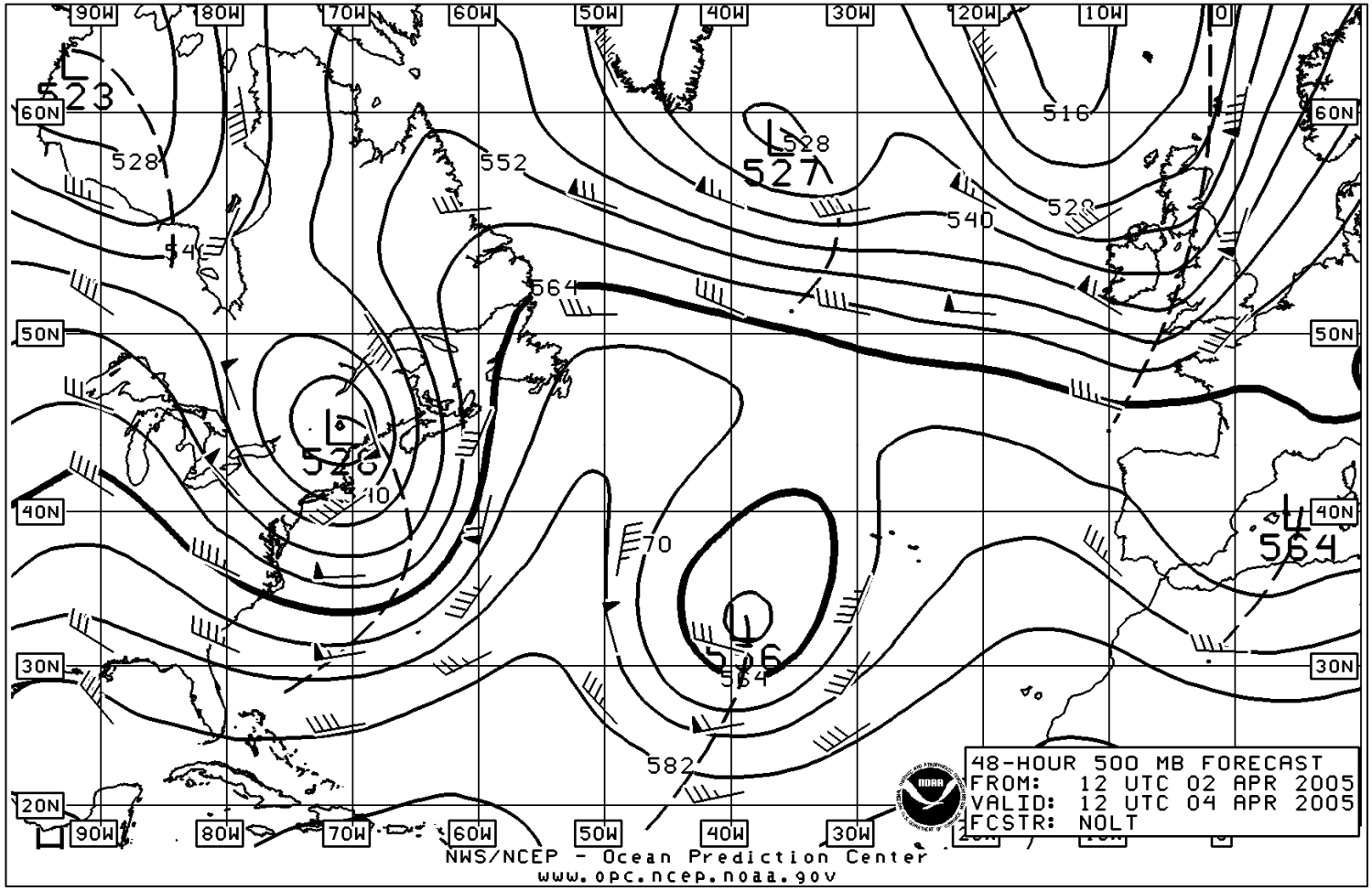
24 Hour 500 Mb Forecast



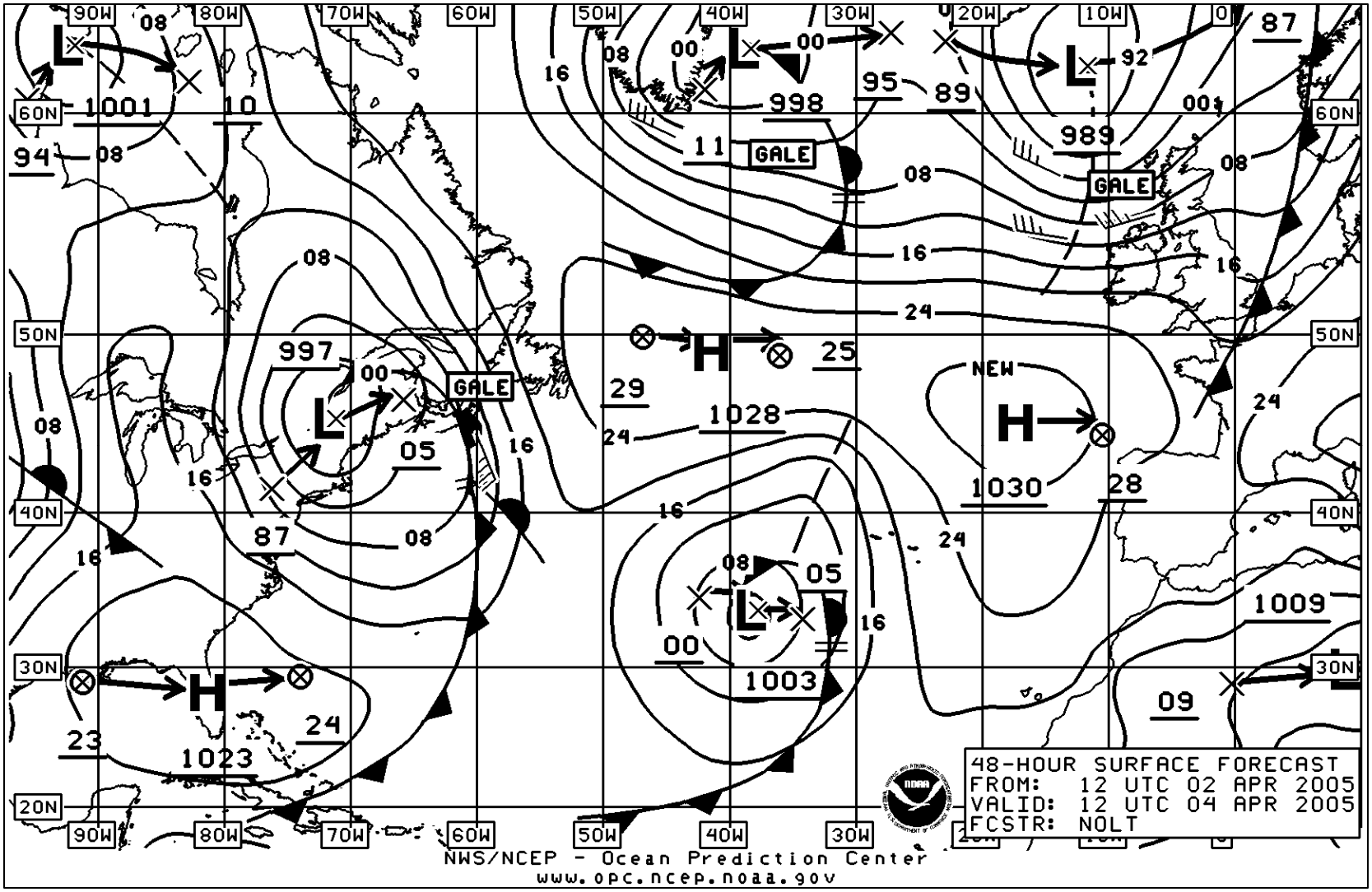
OPC regional surface pressure forecast



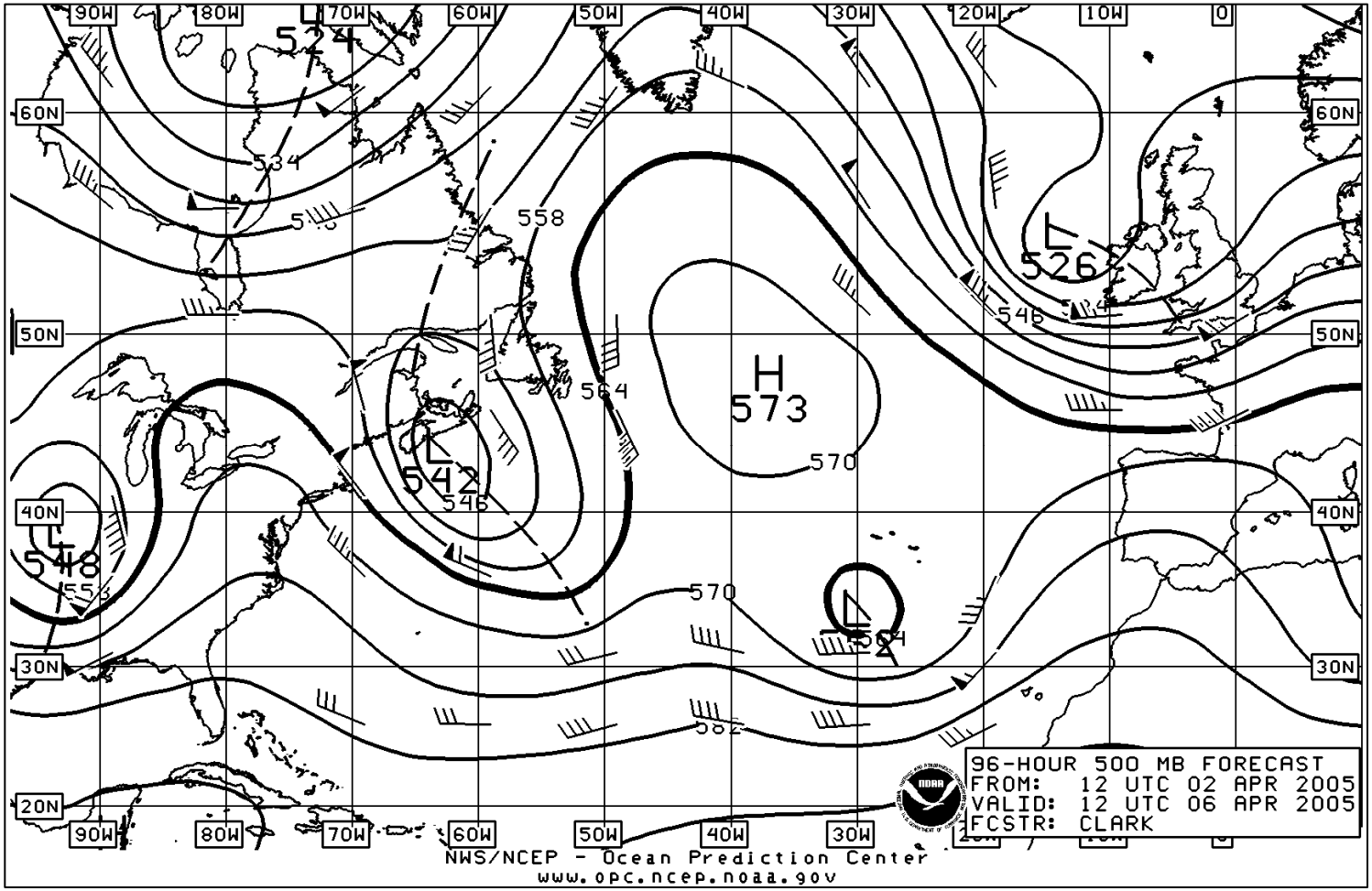
48 Hour 500 Mb Forecast



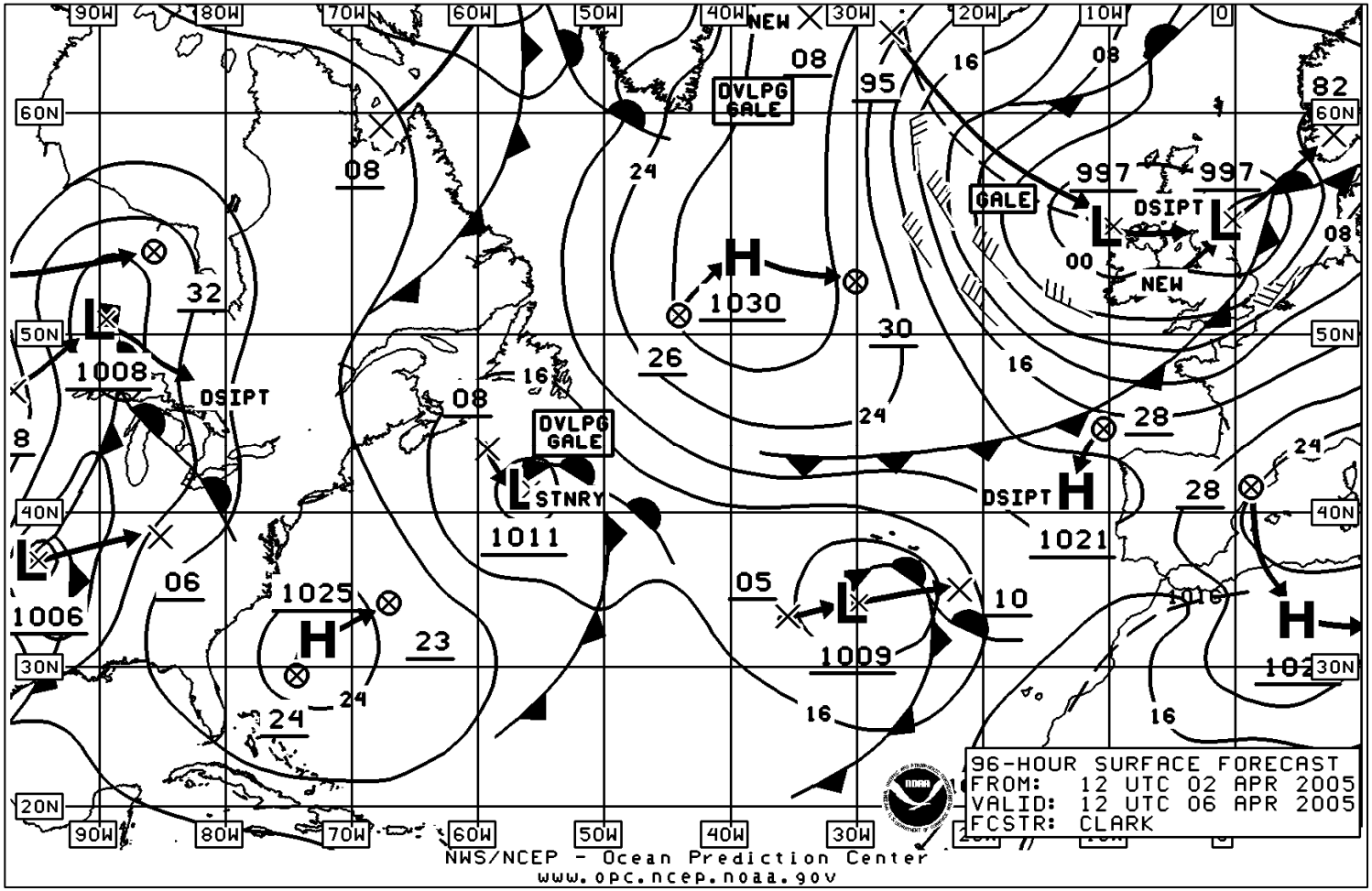
48 Hour Surface Pressure Forecast

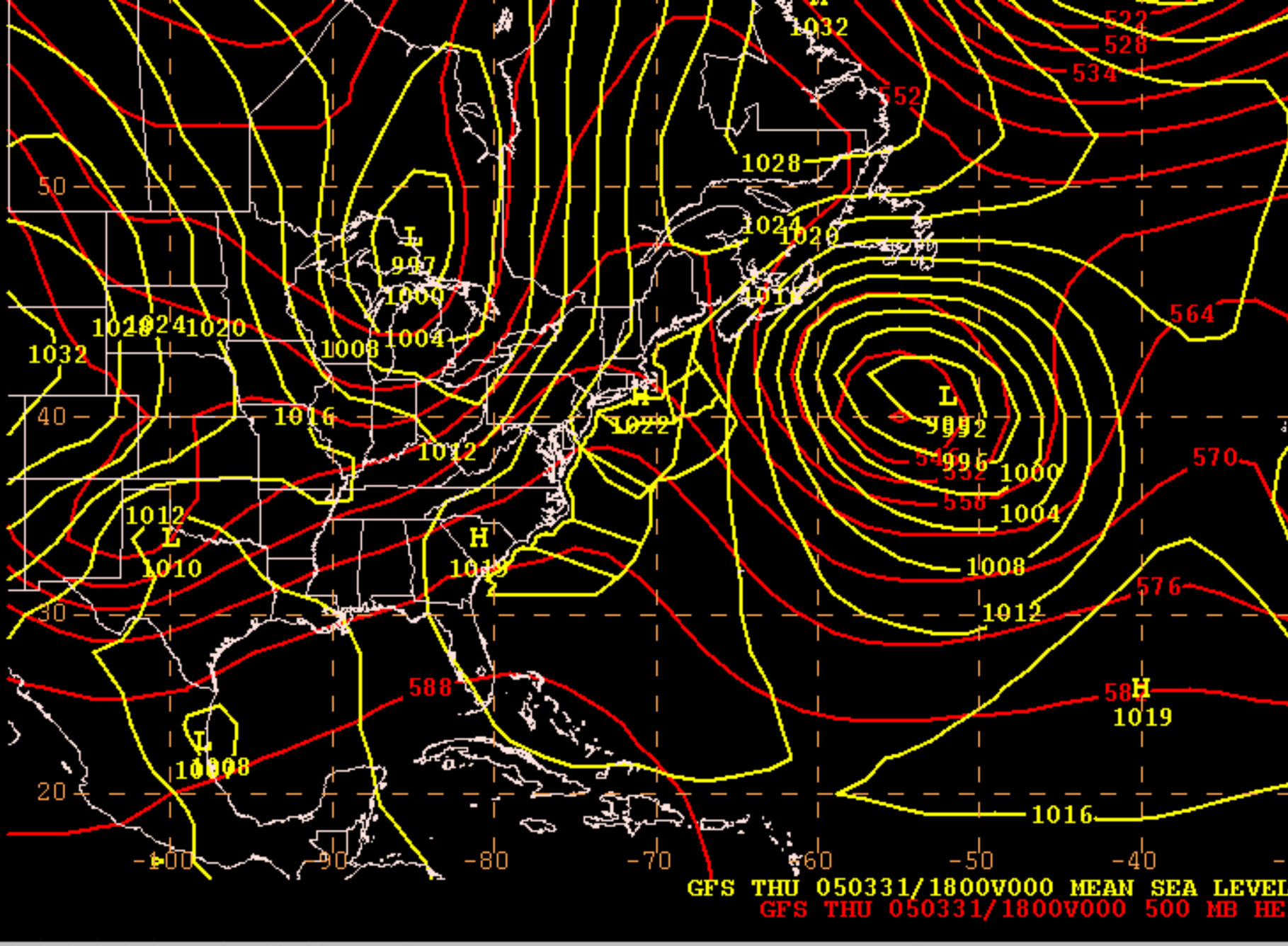


96 Hour 500 Mb Forecast



96 Hour Surface Forecast





1 of 41 THU 050331/1800V000

Terminal

File Edit View Terminal Go Help

500 MB Review of Basics

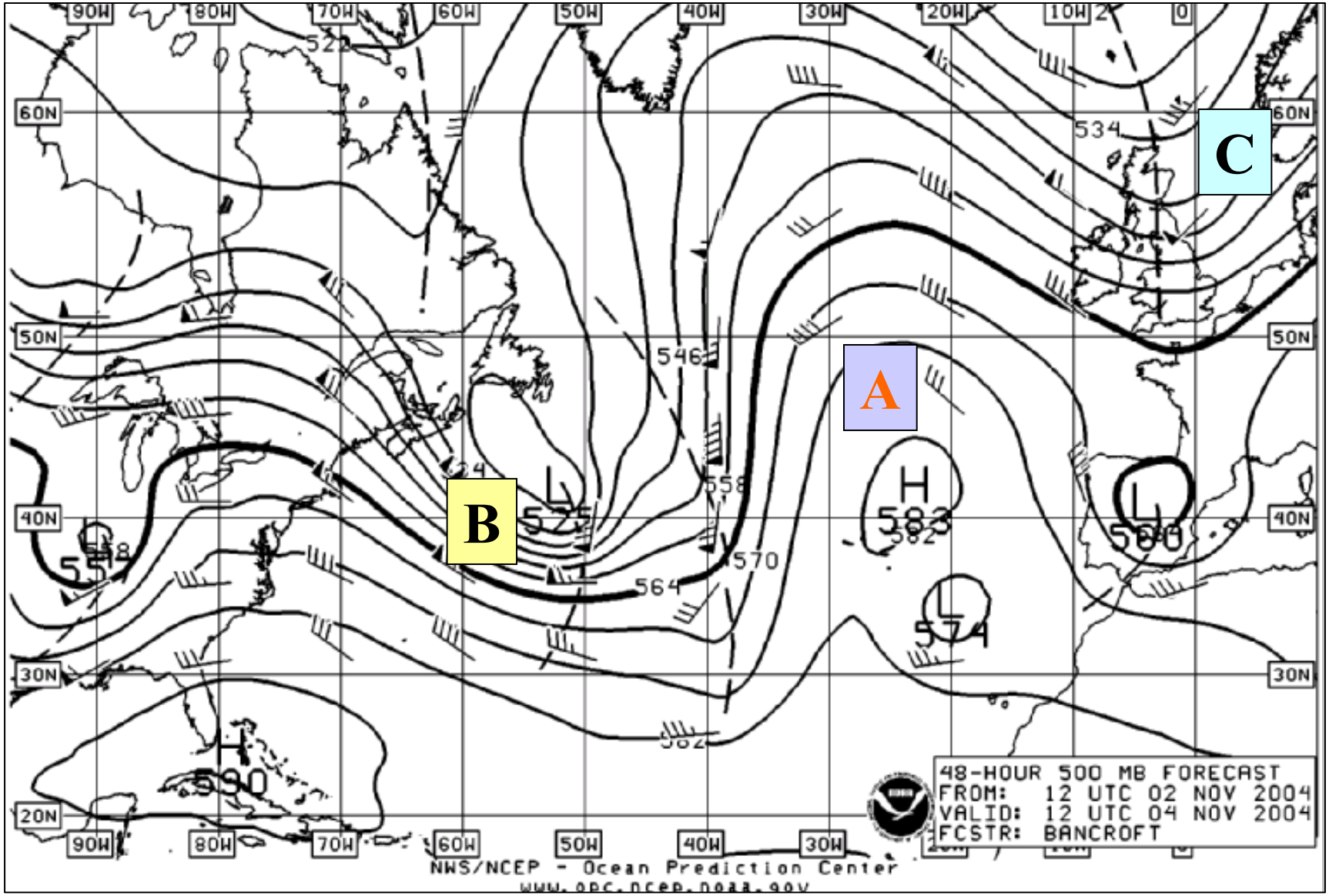
- Valid date and time (UTC)
- Determine flow patterns
- Locate wind maxima
- Locate troughs and ridges (digging or lifting)
- Locate blocks
- Locate cut off lows
- Relationship with surface features
- Tropical Systems

Summary

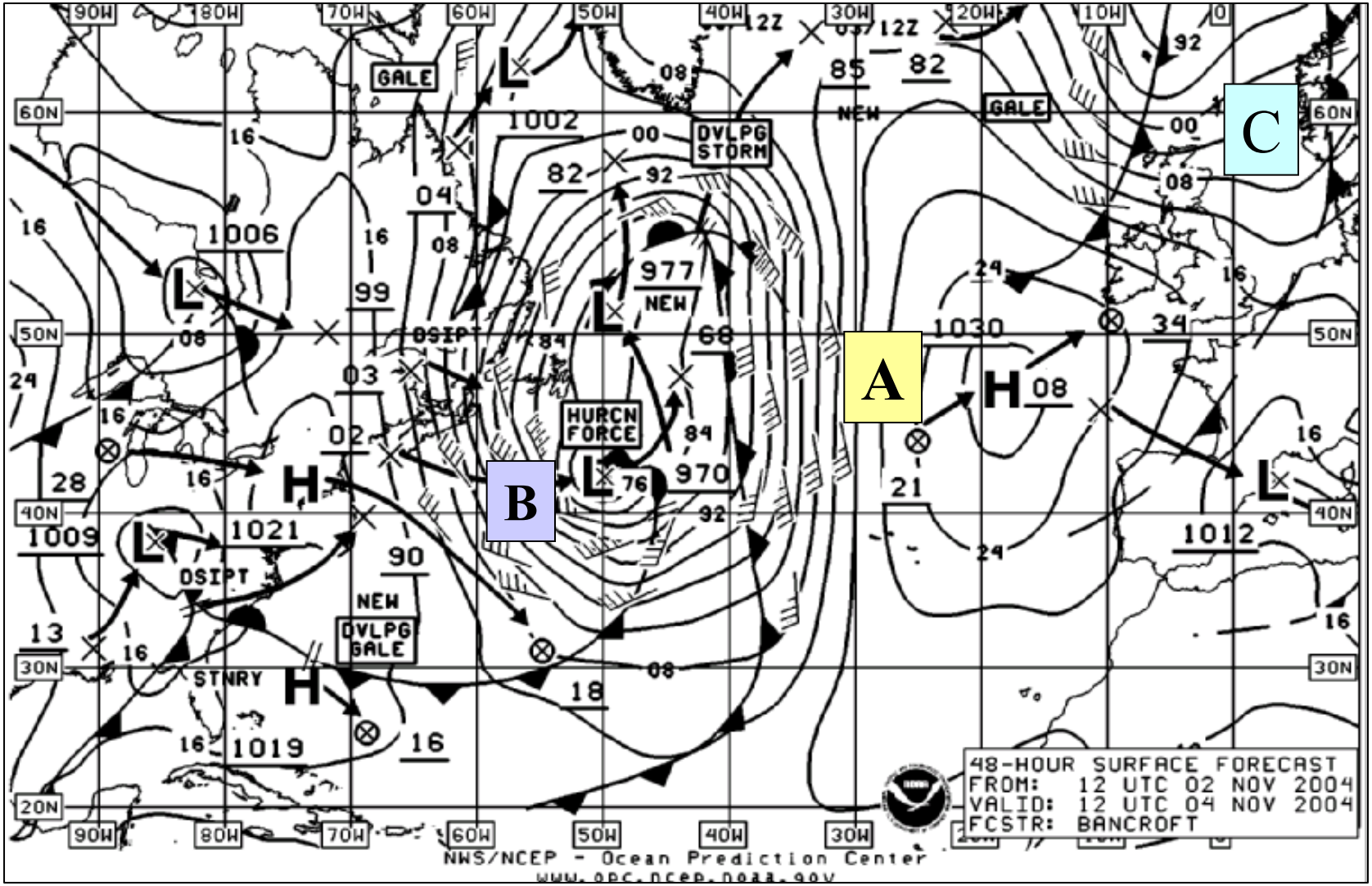
Brain Tickler….

- What is a constant pressure surface?
- What is the significance of the **bold** 5640 meter ISO-height contour
- What are the 4 major flow patterns

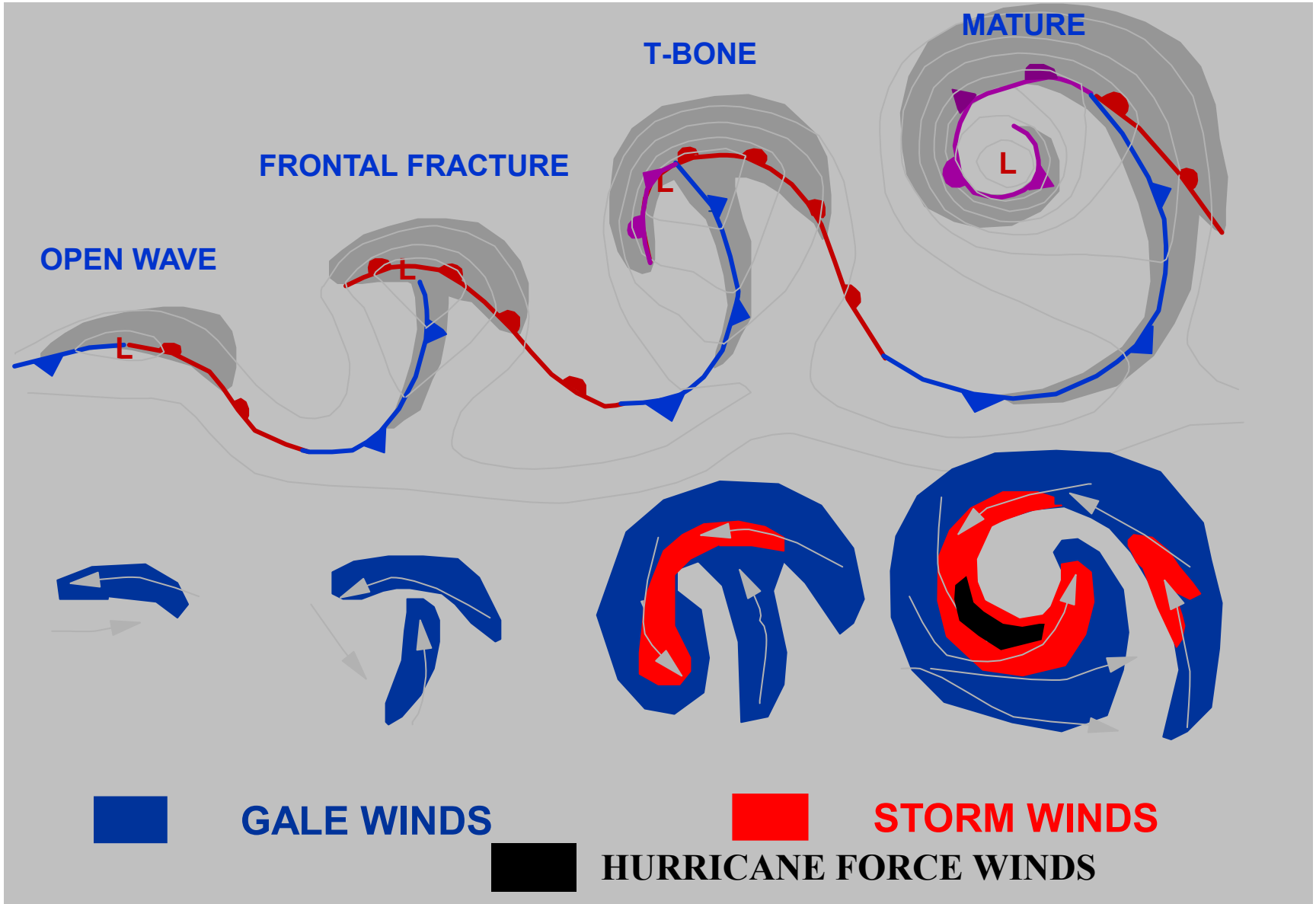
Which area(s) is(are) likely to have "Warnings"?



Which Areas Will Have Warnings?

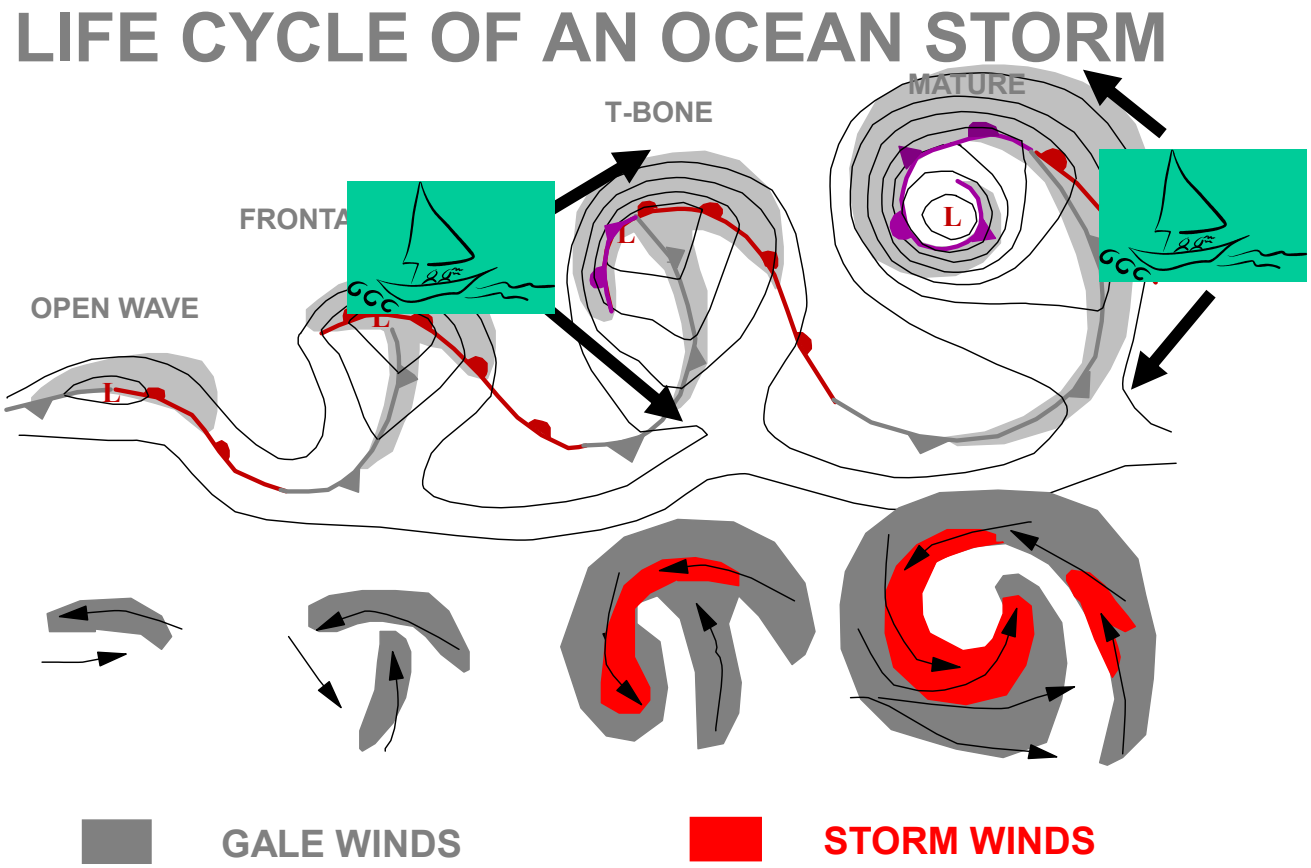


Tracking a low's forecasts out to 5 days

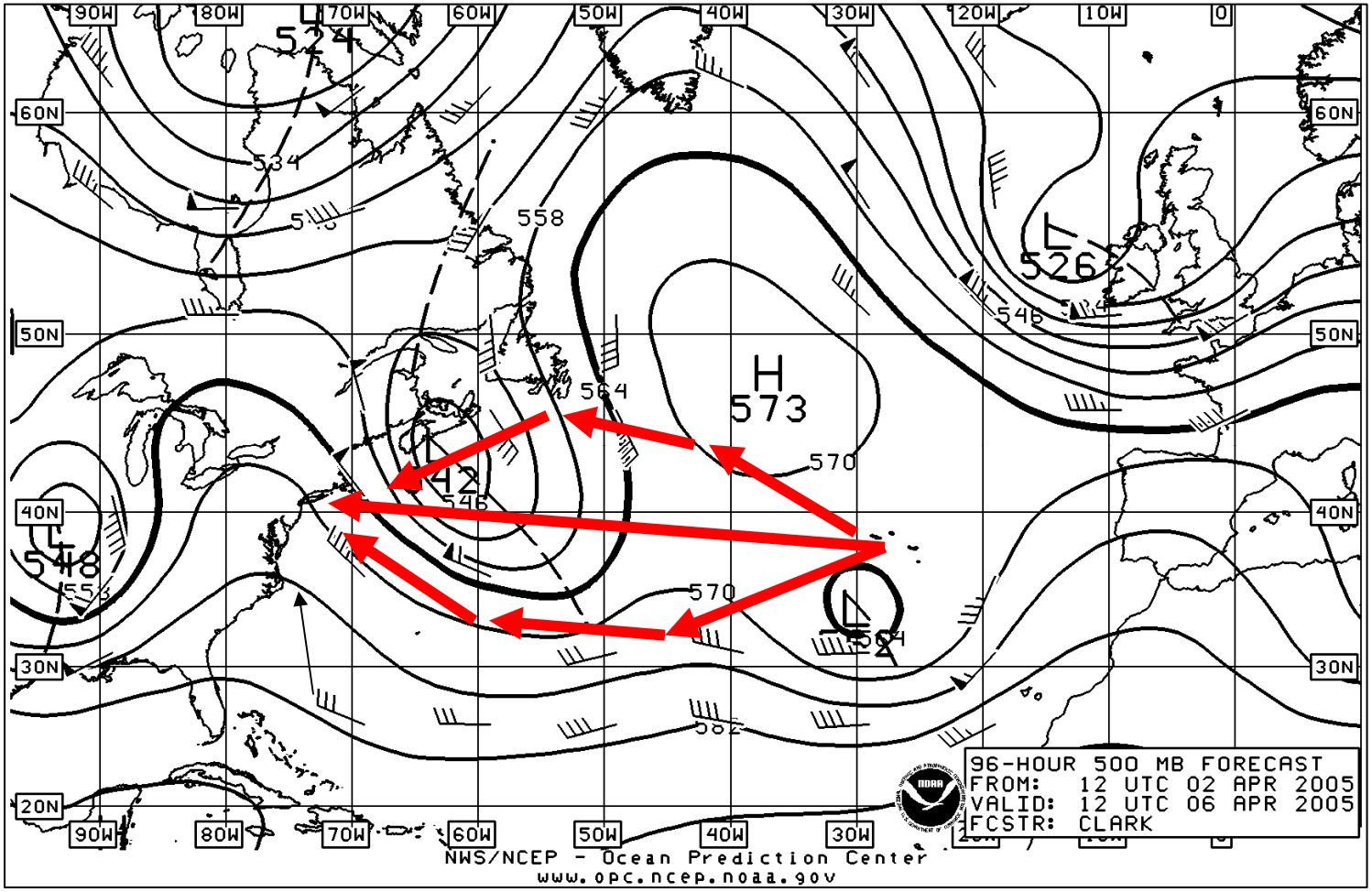


….In order to determine where should your boat be!

Determine where your boat should be day one through day four



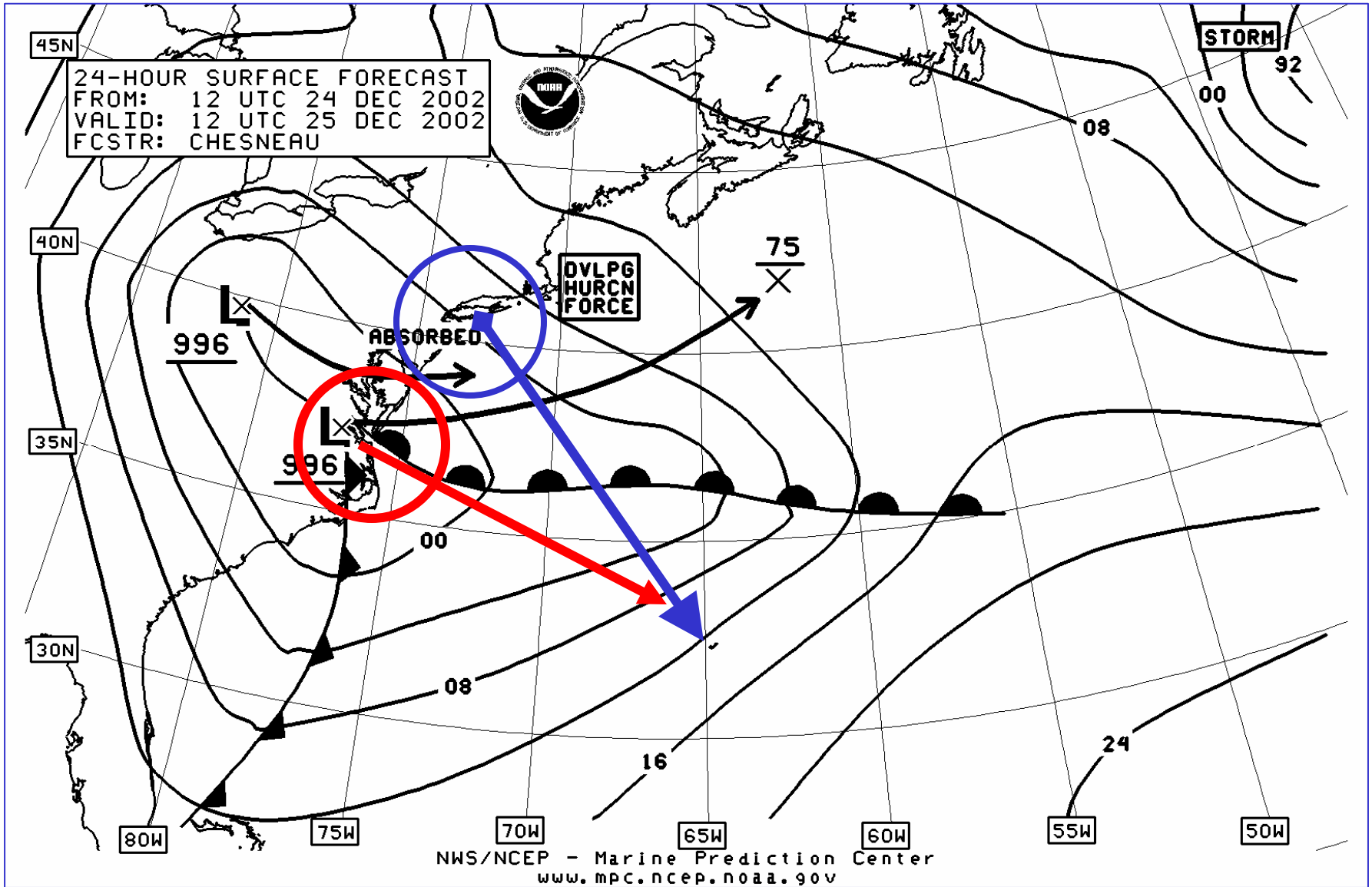
96 Hour 500 Mb Forecast



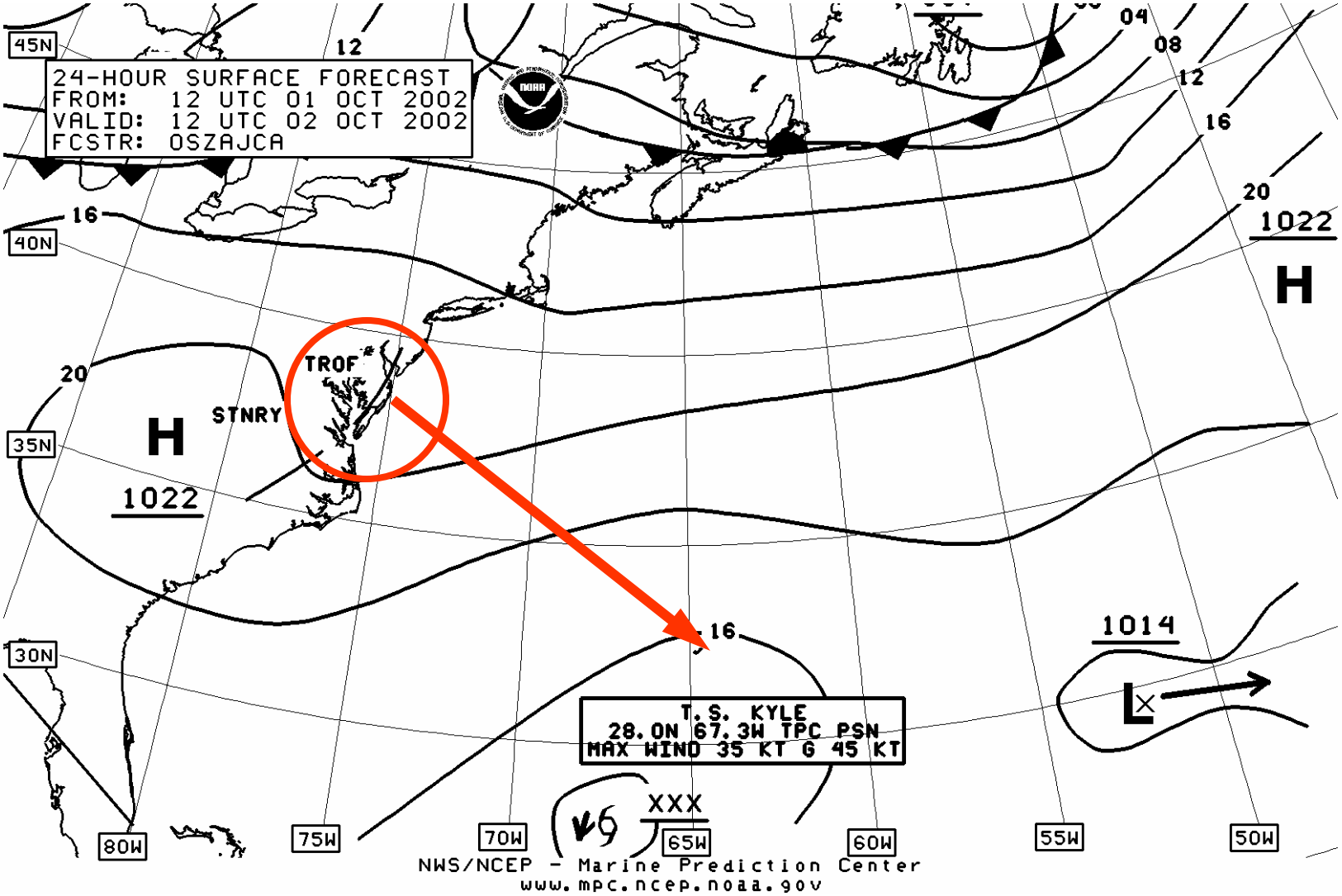
Weather Decision

If you were planning a day of sailing in Long Island perhaps en-route to Bermuda from Stanford Connecticut or even from the Chesapeake Bay, which following weather forecast would impress you the most to reconsider your plans….?

Would It Be This?



Or Would It Be This?



…Either Event Can Cause This!

For An Up Close and Personal Encounter….

Where do we go from here?

OPC Home Page Joe….take it from here!

Address http://www.opc.ncep.noaa.gov/index.shtml

www.nws.noaa.gov

National Weather Service

Ocean Prediction Center

Site Map | News | Organization | Search All NWS search Go

Search OPC
OPC search Go

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- Coastal/Offshore/High Seas Forecasts
- WorldWide HF FAX

OPC Atlantic Products
- Blank Base Maps
- Offshore/NAVTEX
- High Seas
- Morning Briefing

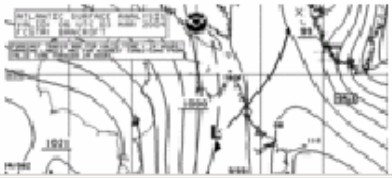
OPC Pacific Products

Top News of the Day

- **NOTICE:** There is a problem with the size of the charts being uploaded to our web site. Some of the graphics are greater than 1 mB in size. We are aware of the problem and will be implementing a fix to the problem very soon. Thanks!

- **NOAA Issues Draft Policy to Foster "Fair Weather" Partnerships**
  The National Oceanic and Atmospheric Administration (NOAA) is requesting public comment on a newly drafted policy governing NOAA's National Weather Service interactions and cooperation with the greater consortium of public, private and academic weather and climate institutions.
  -- Details

NOAA>NWS> NCEP>Ocean Prediction Center

NOTE: Automatic update every 10 minutes.

Atlantic Analysis