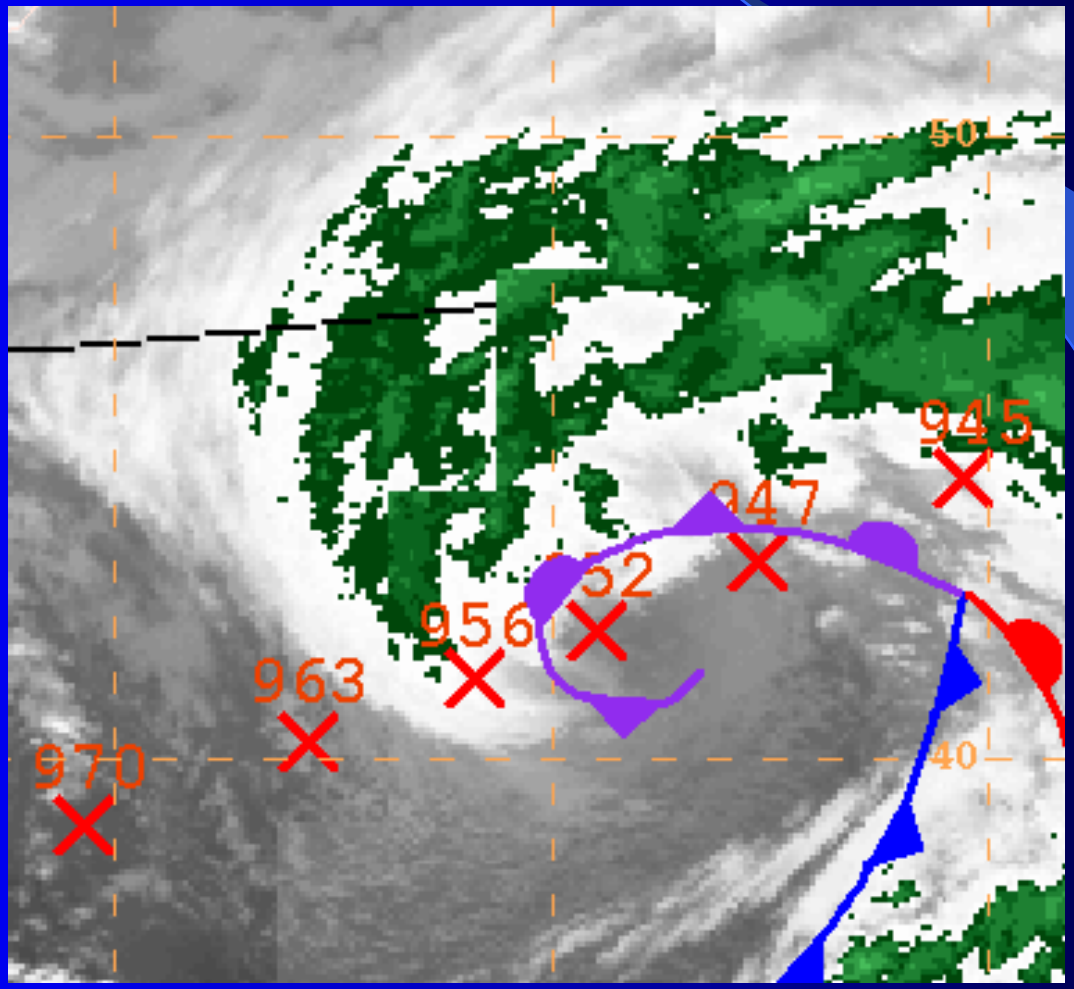
# Smigelski – Mogil – Burt Technique for Estimating Central Pressure of Extratropical Cyclones

**OPC – SOO Training #4**



**The SMB Technique was designed as an extratropical version of the Dvorak technique. The goal is to provide a way of systemically estimating the central pressure of extratropical cyclones based on changes in structure in 12 hourly satellite imagery. This was done initially for the North Atlantic and then the Pacific. The Pacific paper was never published but I (somewhere) have a copy. Frank Smigelski did the bulk of the work in the late 80's and early 90's. The work was funded by the Office of Naval Research..**

**The key to the technique is to follow the progress of the tail of the comma of mid and low cloud as the system evolves. It involves looking back at earlier images (in 6 hour time steps) and comparing the evolution. The more it wraps up (or inward) the deeper the cyclone…seems like common sense. Since Frank looked at a lot of cyclones in both basins he was able to find differences. For instance…Pacific cyclones tended to not get as deep as the Atlantic cyclones. Also, the depth of Pacific systems were dependent on the flow regime (meridional – more intense; zonal – more sheared, weaker).**

**One strength of this system is that it may help us (in our analyses) maintain persistent deepening rates. In the past we have tended to deepen cyclones when data is present and be more conservative when there is a lack of data. That is why I have chosen to add this to the list of "papers" for your professional collection. Unfortunately, I only have two copies of the original paper thus the Powerpoint version of distribution.**

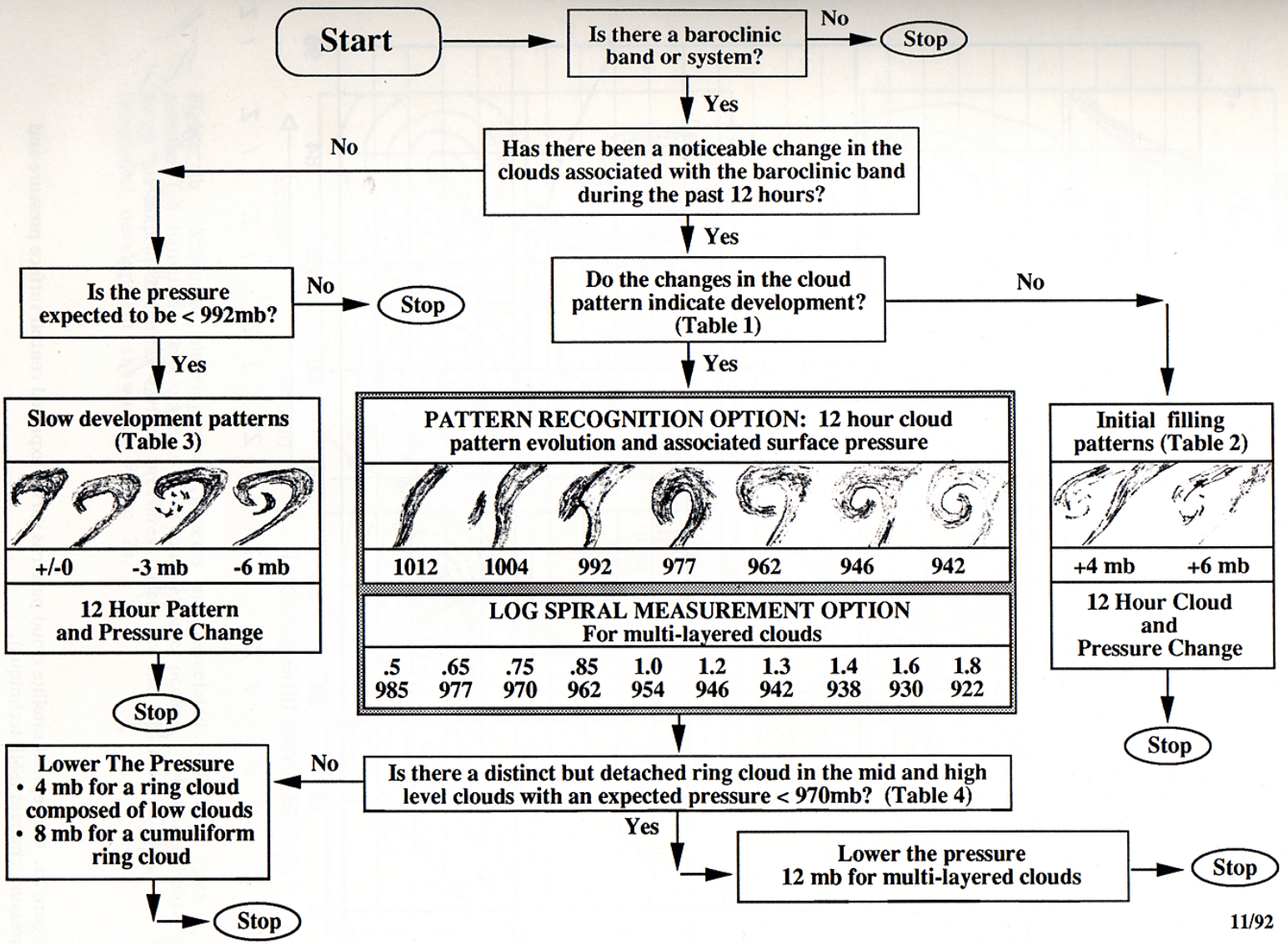



**Figure 1. Flow chart (SMB technique) for estimating central pressures of mid-latitude North Atlantic Ocean cyclones from cloud patterns and their changes**

The worksheet and graph can be photocopied and used for the life cycle of any storm (initial development through and including initial filling). Since all storms we have studied so far developed and reached maturity in 84 hours or less, the amount of space allotted each storm should be sufficient.

## Cloud Pattern Curvature and Its Relationship to Central Pressure

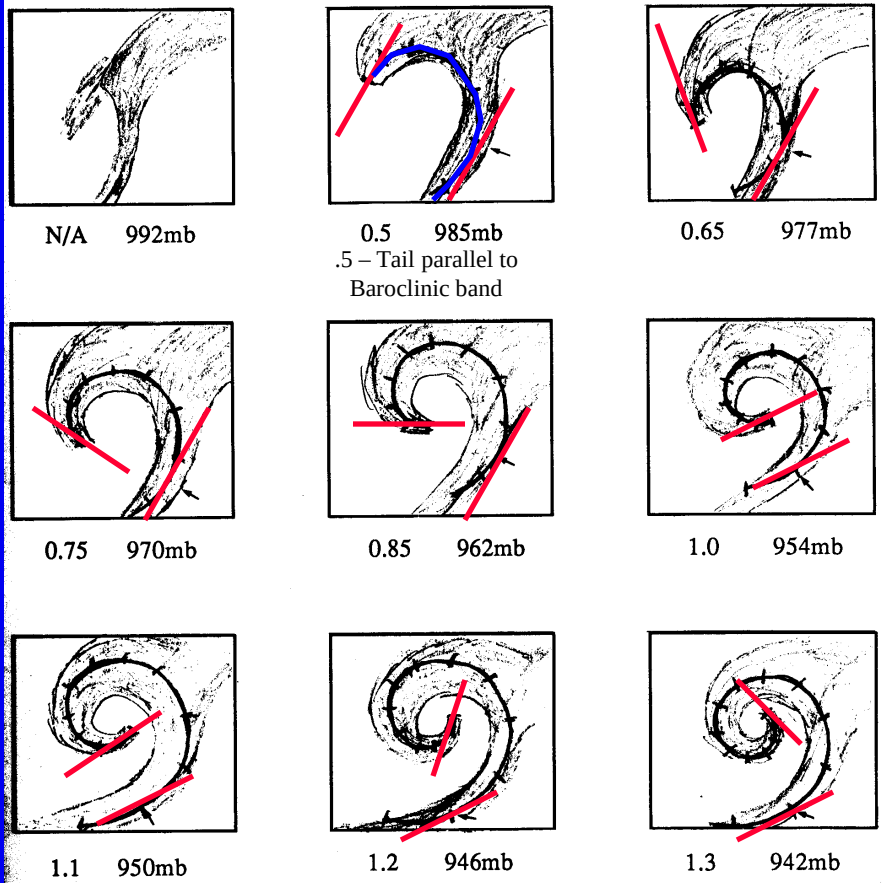



**Figure 7.** Cloud measurement in tenths of a ten degree log spiral (tick marks) and associated central pressures. Shading indicates middle and high clouds only.

# Determining Central Pressures for Cyclones with Ring Cloud Features

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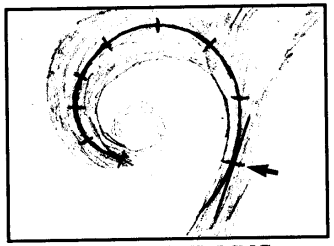
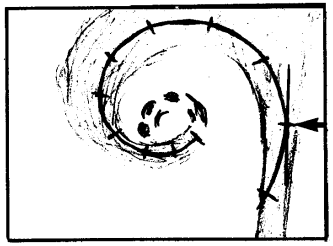


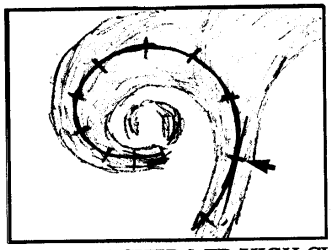
LOW CLOUD RING
Cloud Spiral: 0.8 = 966mb
Adjust pressure -4mb
Final pressure 962mb

b



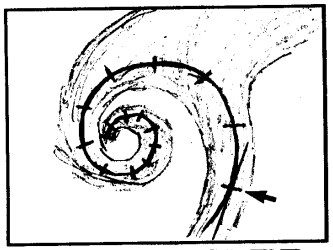
ENHANCED CUMULUS RING
Cloud Spiral: 0.9 = 960mb
Adjust pressure -8mb
Final pressure 952mb

c



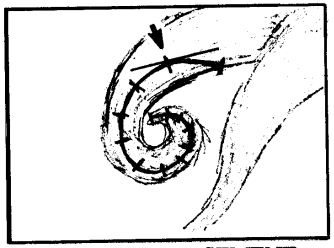
DISTINCT AND DETACHED MID/HIGH CLOUD RING
Cloud Spiral: 0.9 = 960mb
Adjust pressure -12mb
Final pressure 948mb

d



NO RING ADJUSTMENT
Cloud Spiral: 1.5 = 934mb
Final pressure 934mb

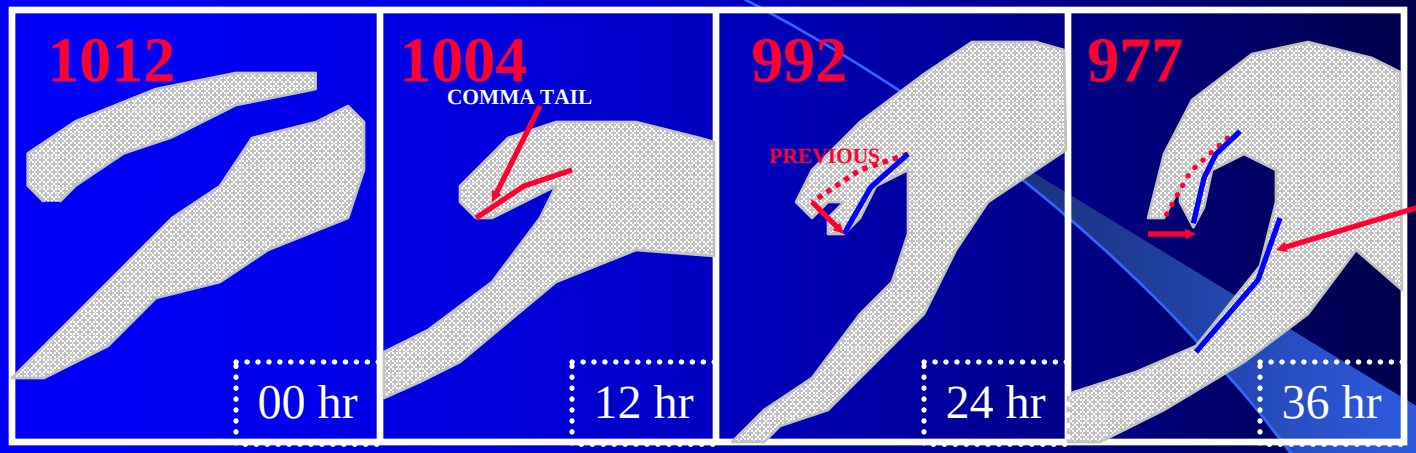
e



NO RING ADJUSTMENT
Cloud Spiral: 1.1 = 950mb
Final pressure 950mb

Figures 9a - e. Schematics showing examples of central pressure estimates for cyclones with ring cloud features. For bottom two examples (d and e), ring cloud adjustment was not applied because the ring cloud is attached to the main spiral band. For e, spiral measurement is for comma head portion only due to the presence of a cloud-free wedge.

# Atlantic Example – 12 hour interval

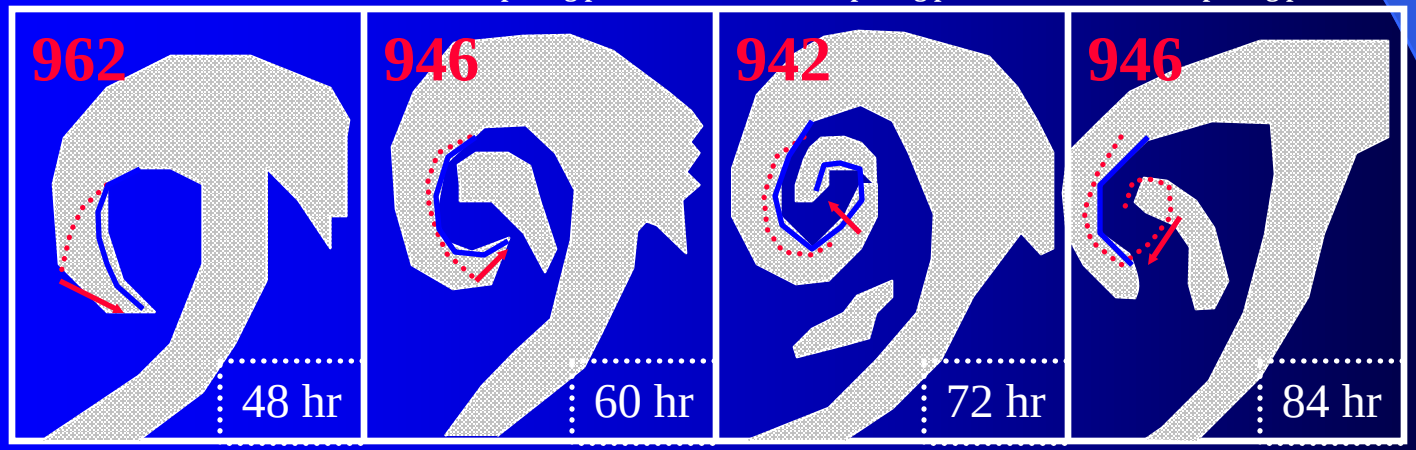



Baroclinic leaf with upstream Vorticity lobe – 1012 mb

Cusp of comma either emerges or forms as vorticity lobe approaches. 8 mb deepening past 12 hrs.

Tail of comma cusp begins to wrap up and push toward back edge of baroclinic band. 12 mb deepening past 12 hrs.

Comma tail continues to push toward the back edge of the baroclinic band. 15 mb deepening past 12 hrs.



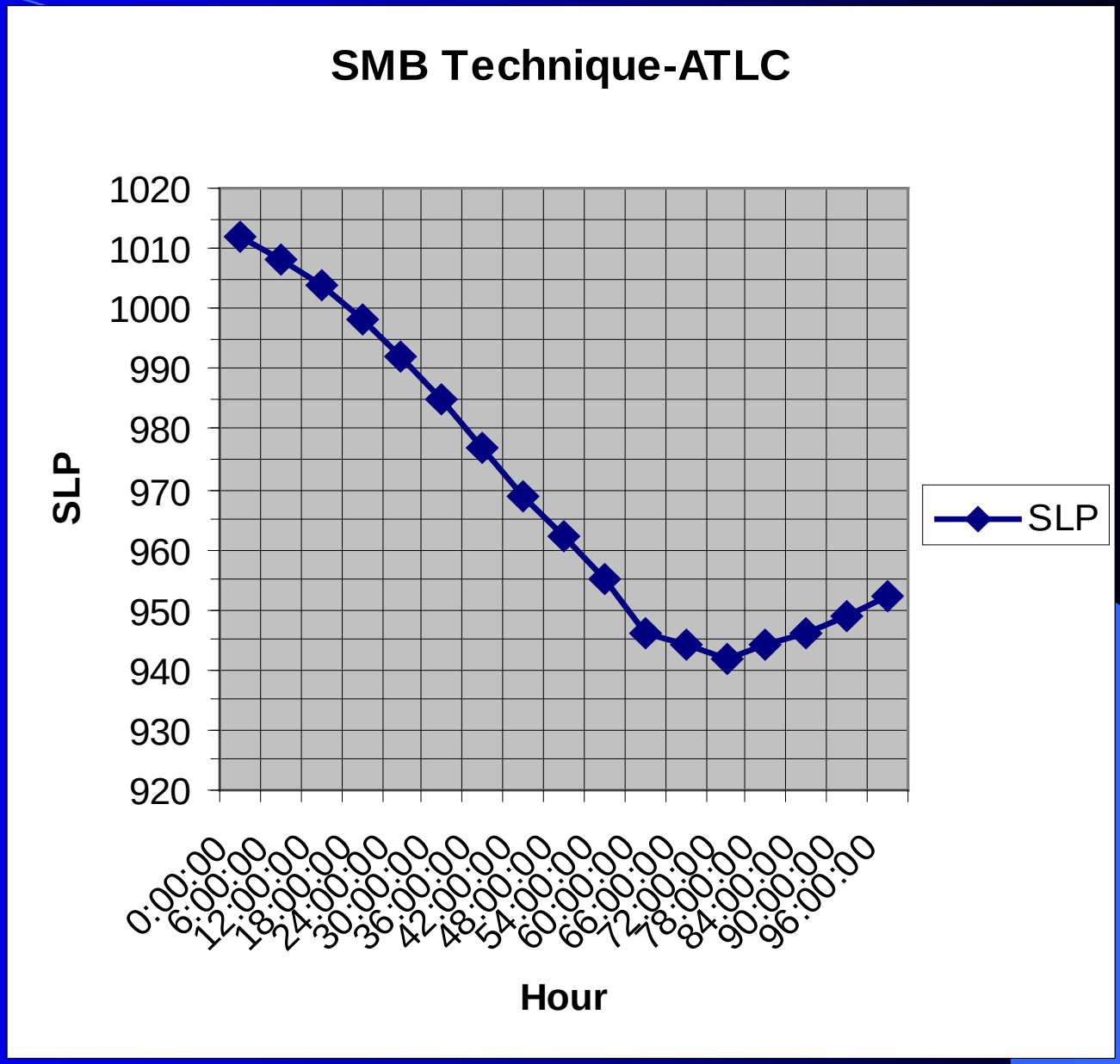

Continued intensification. 15 mb deepening past 12 hrs.

Convection has broken out near center. 16 mb deepening past 12 hrs.

Convection has merged with comma tail. 4 mb deepening past 12 hrs. Cyclone max intenisty.

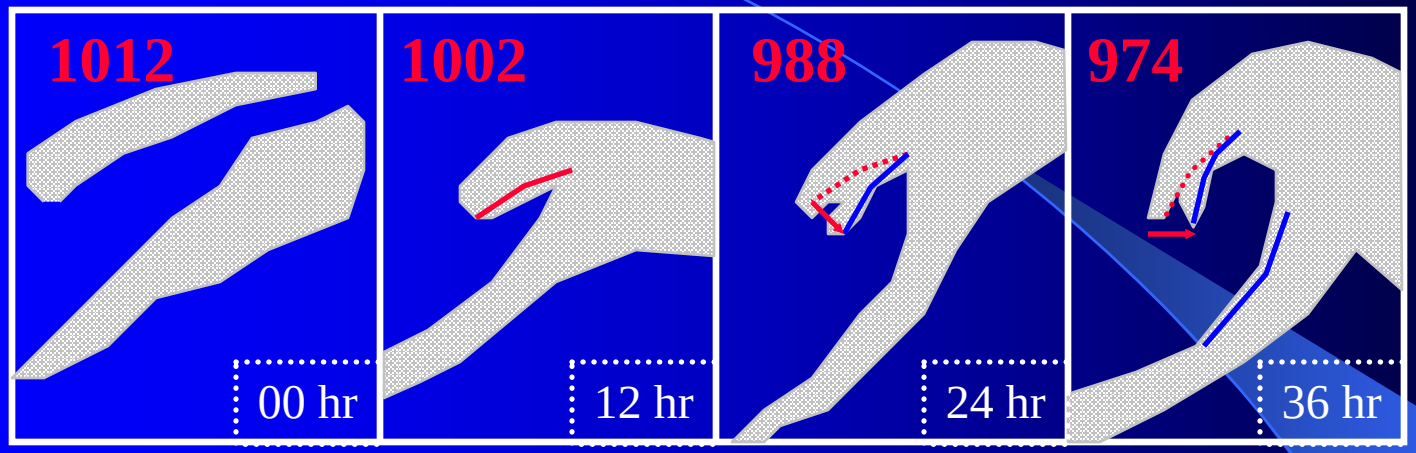
System begins to shear. 4 mb filling past 12 hrs.

| Hour | SLP | delta-SLP |
|---|---|---|
| 0:00:00 | 1012 | |
| 6:00:00 | 1008 | -4 |
| 12:00:00 | 1004 | -4 |
| 18:00:00 | 998 | -6 |
| 24:00:00 | 992 | -6 |
| 30:00:00 | 985 | -7 |
| 36:00:00 | 977 | -8 |
| 42:00:00 | 969 | -7 |
| 48:00:00 | 962 | -7 |
| 54:00:00 | 955 | -7 |
| 60:00:00 | 946 | -9 |
| 66:00:00 | 944 | -2 |
| 72:00:00 | 942 | -2 |
| 78:00:00 | 944 | 2 |
| 84:00:00 | 946 | 2 |
| 90:00:00 | 949 | 3 |
| 96:00:00 | 952 | 3 |



# Pacific Meridional Example – 12 hour interval

Similar to Atlantic example…initially deepens faster but then does not get as deep.



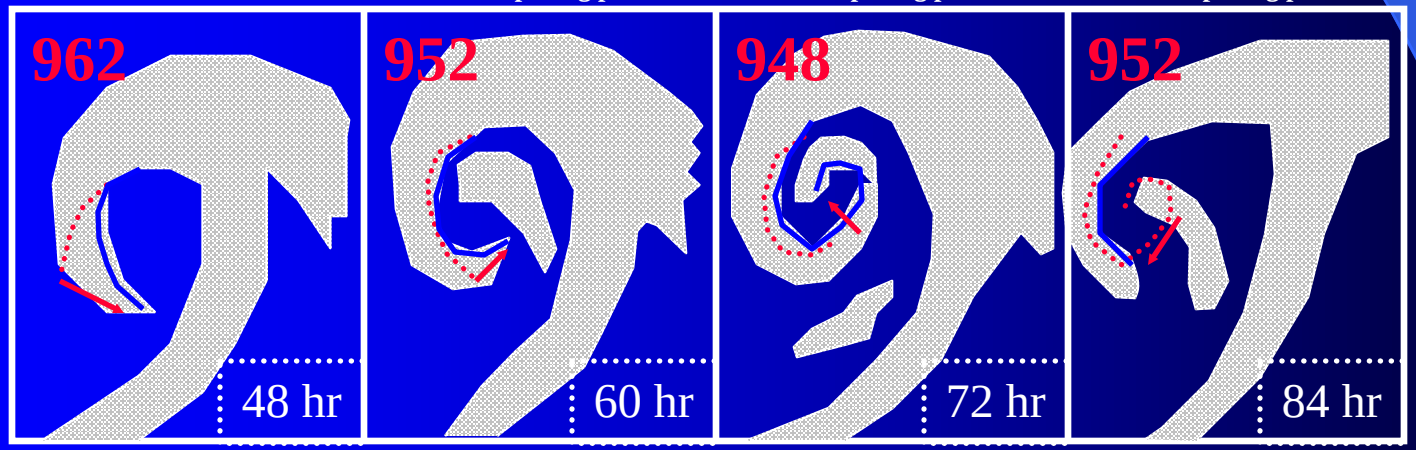

Trailing edge
Of
Baroclininc band

**Baroclinic leaf with upstream Vorticity lobe – 1012 mb**

**Cusp of comma either emerges or forms as vorticity lobe approaches. 10 mb deepening past 12 hrs.**

**Tail of comma cusp begins to wrap up and push toward back edge of baroclinic band. 14 mb deepening past 12 hrs.**

**Comma tail continues to push toward the back edge of the baroclinic band. 14 mb deepening past 12 hrs.**



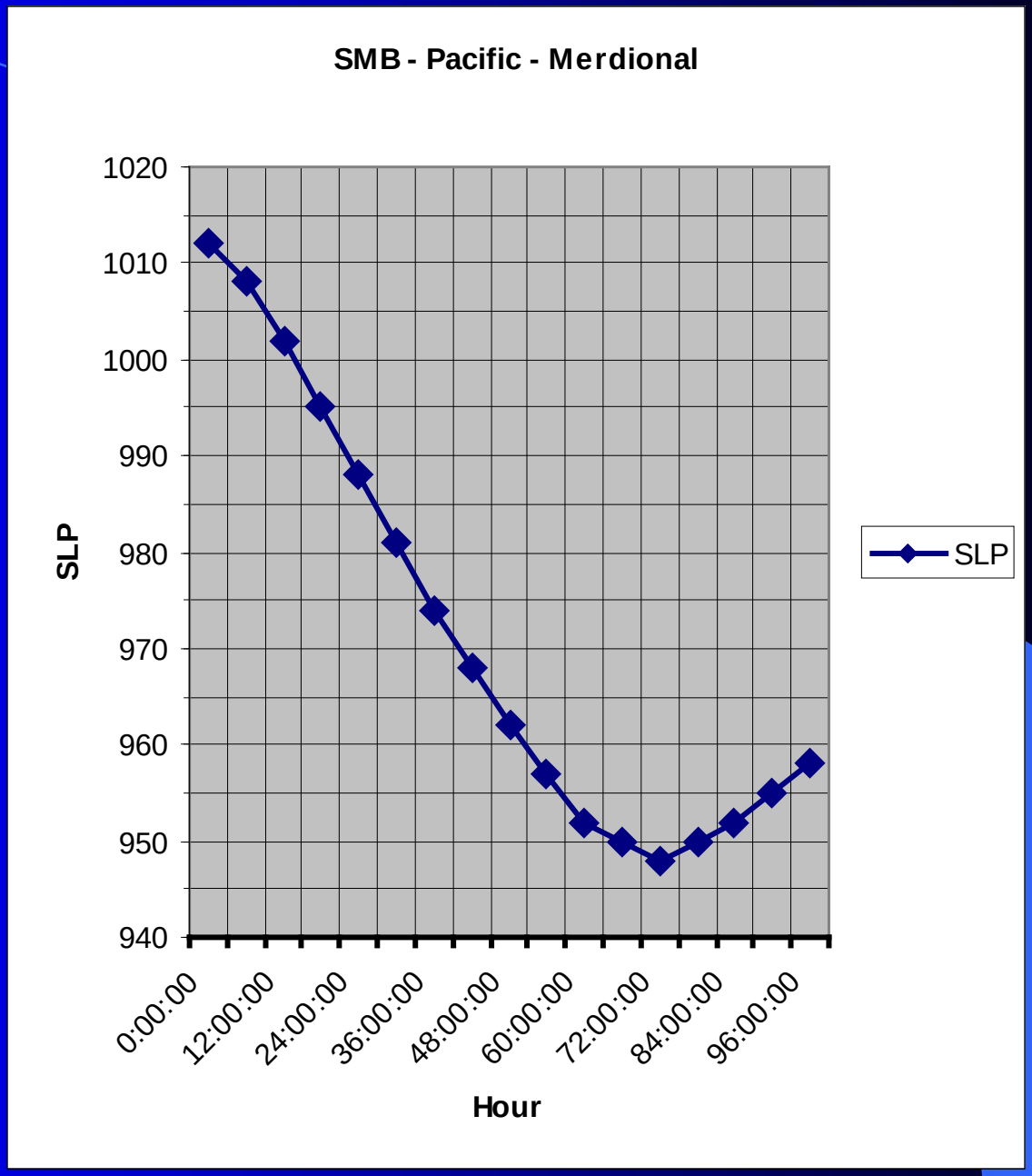

**Continued intensification. 12 mb deepening past 12 hrs.**

**Convection has broken out near center. 10 mb deepening past 12 hrs.**

**Convection has merged with comma tail. 4 mb deepening past 12 hrs.**
**Cyclone max intenisty.**

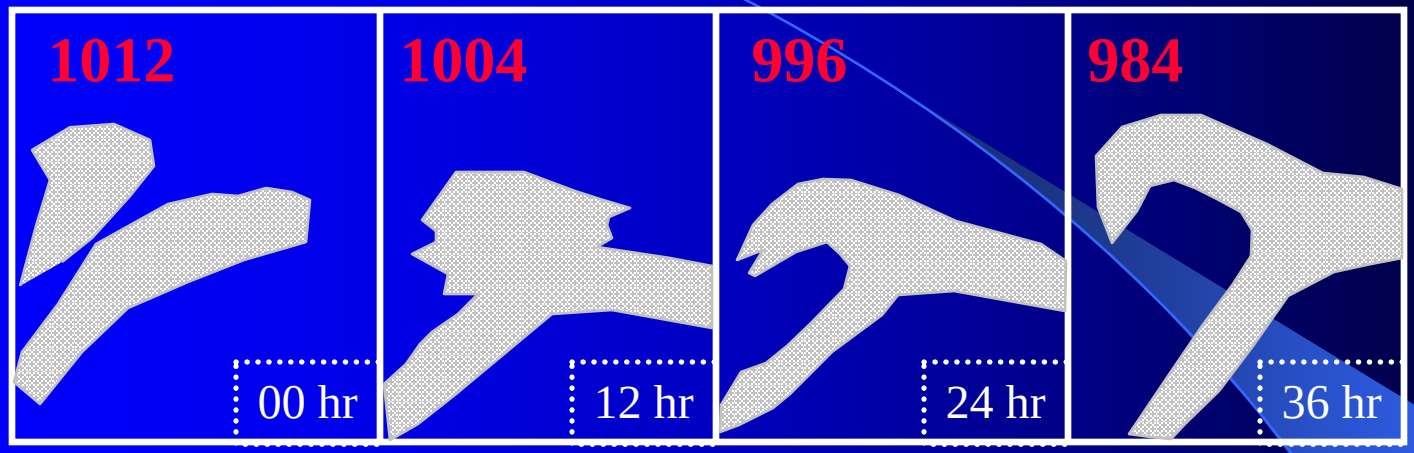
**System begins to shear. 4 mb filling past 12 hrs.**

| Hour | SLP | delta-SLP |
|---|---|---|
| 0:00:00 | 1012 | |
| 6:00:00 | 1008 | -4 |
| 12:00:00 | 1002 | -6 |
| 18:00:00 | 995 | -7 |
| 24:00:00 | 988 | -7 |
| 30:00:00 | 981 | -7 |
| 36:00:00 | 974 | -8 |
| 42:00:00 | 968 | -6 |
| 48:00:00 | 962 | -6 |
| 54:00:00 | 957 | -5 |
| 60:00:00 | 952 | -5 |
| 66:00:00 | 950 | -2 |
| 72:00:00 | 948 | -2 |
| 78:00:00 | 950 | 2 |
| 84:00:00 | 952 | 2 |
| 90:00:00 | 955 | 3 |
| 96:00:00 | 958 | 3 |



# Pacific Zonal Example – 12 hour interval

Weakest evolution of three categories…SMB called it ZONAL flow but in essence the cyclone is in predominantly confluent flow and shears.

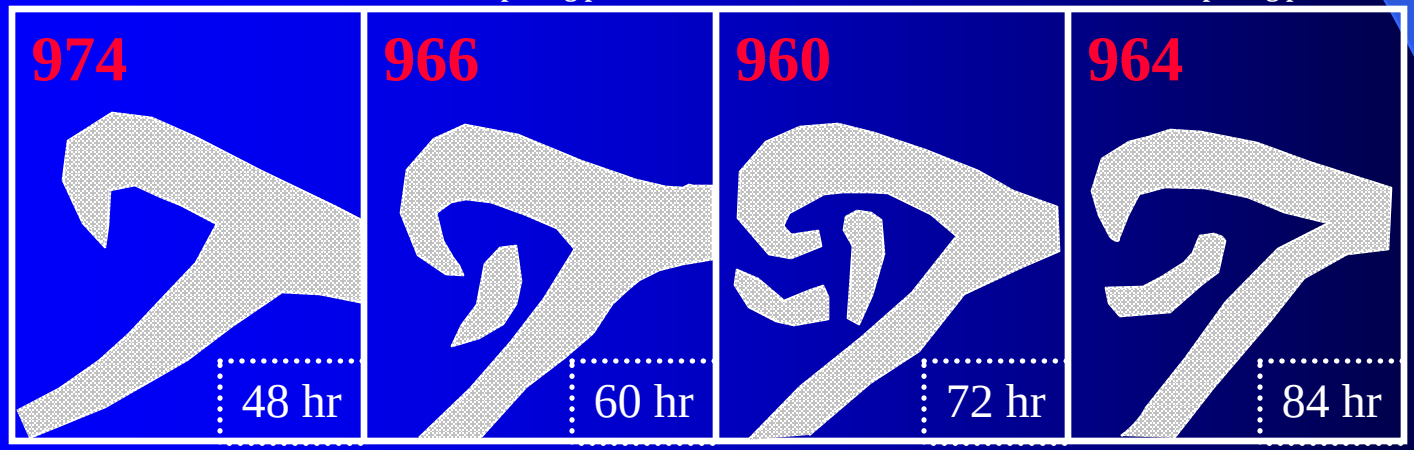



**Baroclinic leaf with upstream Vorticity lobe – 1012 mb**

**Cusp of comma begins to emerges as vorticity lobe approaches.**
**8 mb deepening past 12 hrs.**

**Tail of comma cusp becomes better defined.**
**8 mb deepening past 12 hrs.**

**Comma tail begins to push toward the back edge of the baroclinic band.**
**12 mb deepening past 12 hrs.**




**Comma tail continues to wrap toward the baroclnic band.**
**continued intensification.**
**10 mb deepening past 12 hrs.**

**Convection has broken out near center.**
**8 mb deepening past 12 hrs.**

**More convection. Triple point shears eastward. .**
**6 mb deepening past 12 hrs.**
**Cyclone max intenisty.**

**System continues to shear.**
**4 mb filling past 12 hrs.**

| Hour | SLP | delta-SLP |
|---|---|---|
| 0:00:00 | 1012 | |
| 6:00:00 | 1008 | -4 |
| 12:00:00 | 1004 | -4 |
| 18:00:00 | 1000 | -4 |
| 24:00:00 | 996 | -4 |
| 30:00:00 | 990 | -6 |
| 36:00:00 | 984 | -6 |
| 42:00:00 | 979 | -5 |
| 48:00:00 | 974 | -5 |
| 54:00:00 | 970 | -4 |
| 60:00:00 | 966 | -4 |
| 66:00:00 | 963 | -3 |
| 72:00:00 | 960 | -3 |
| 78:00:00 | 962 | 2 |
| 84:00:00 | 964 | 2 |
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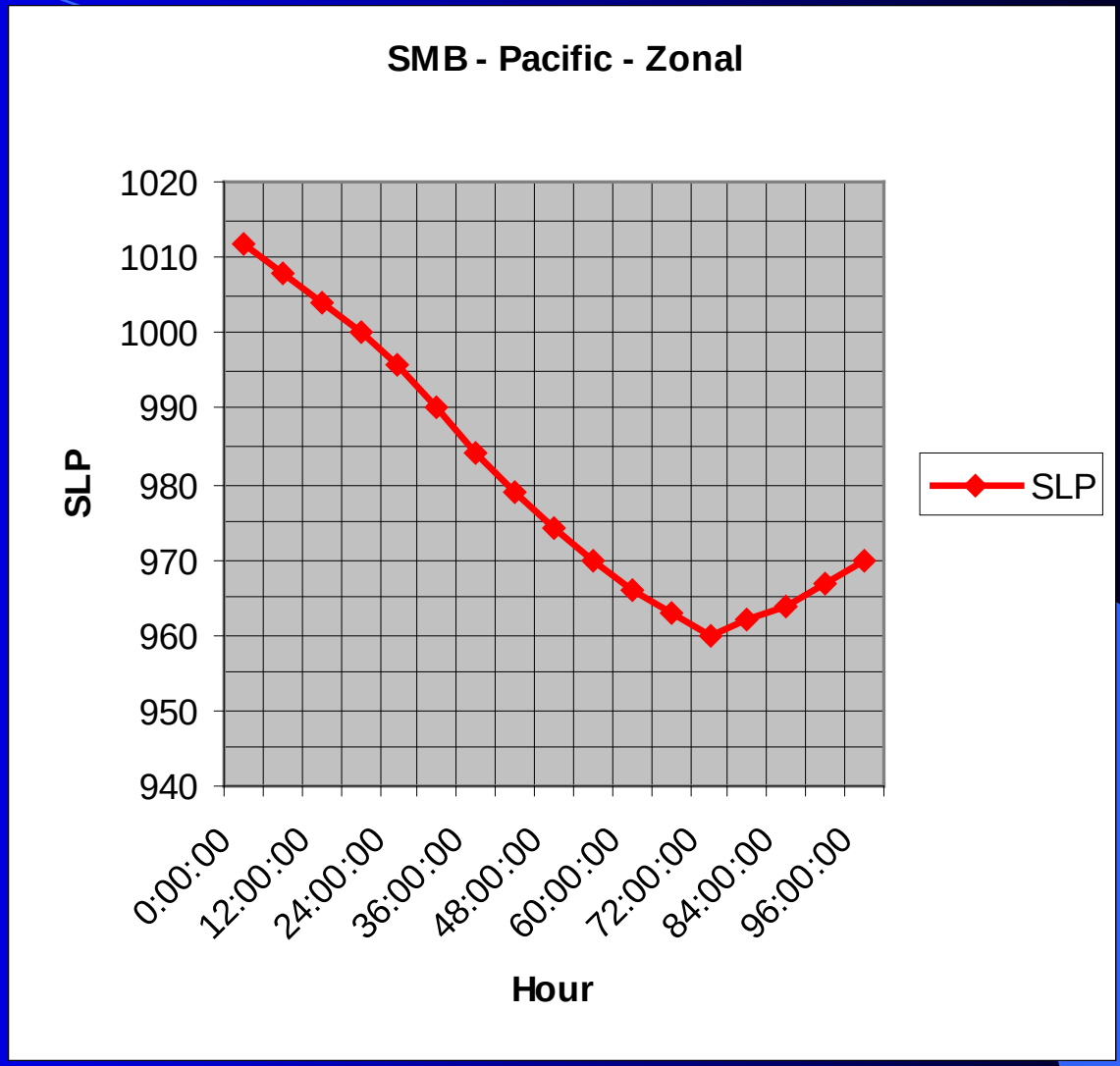
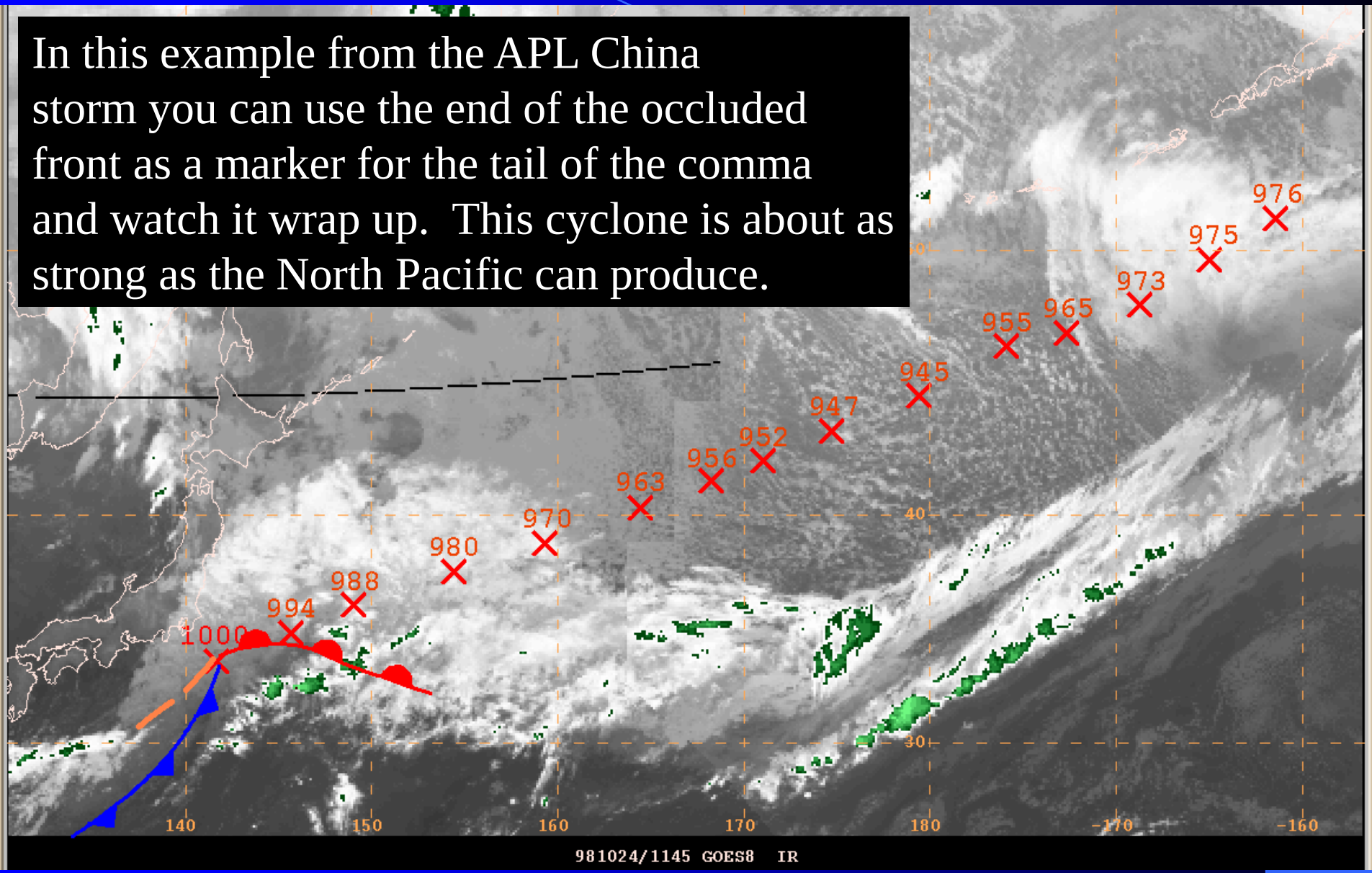
| 96:00:00 | 970 | 3 |



# 10/24/98 12Z

In this example from the APL China storm you can use the end of the occluded front as a marker for the tail of the comma and watch it wrap up. This cyclone is about as strong as the North Pacific can produce.



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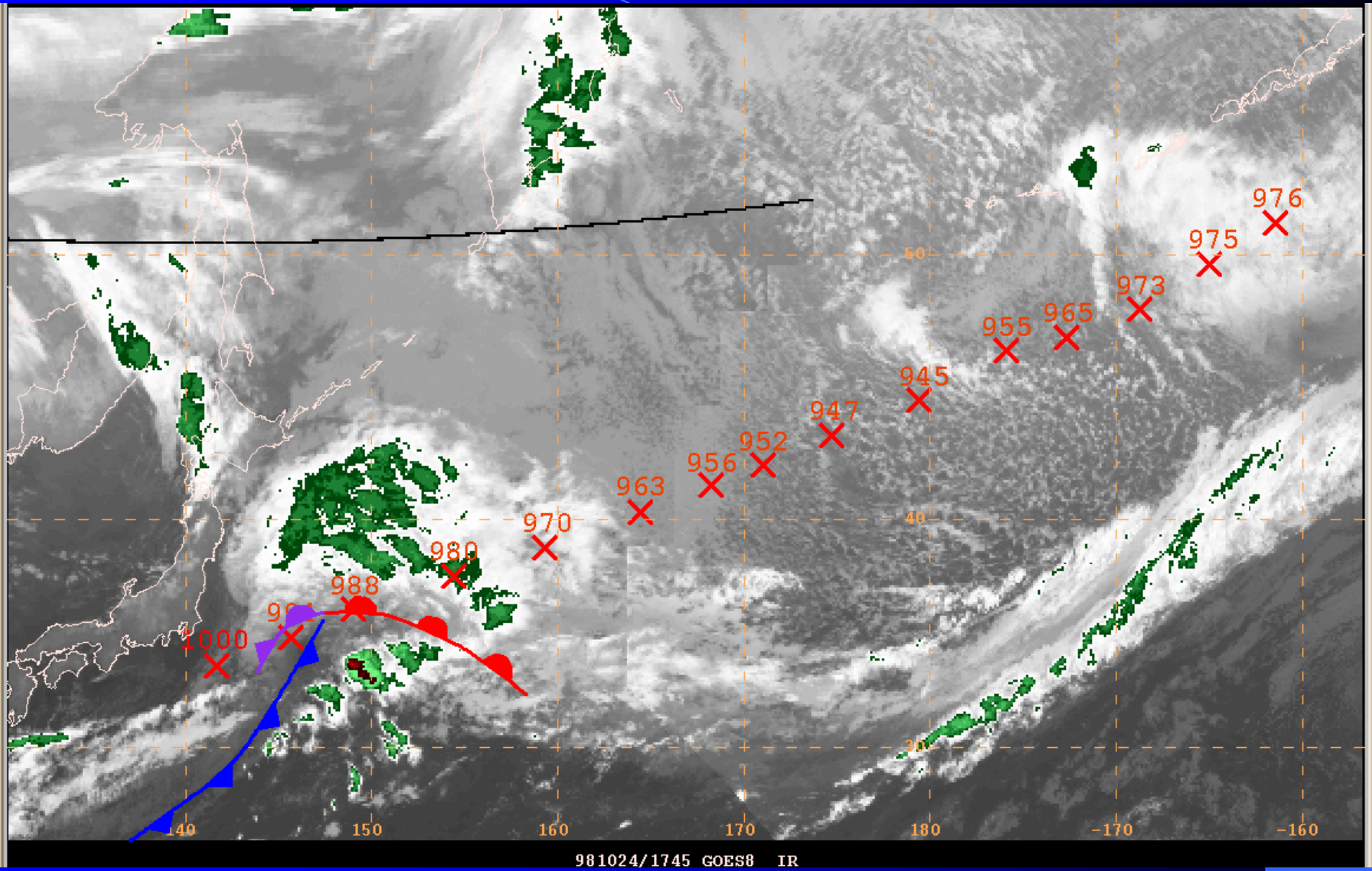
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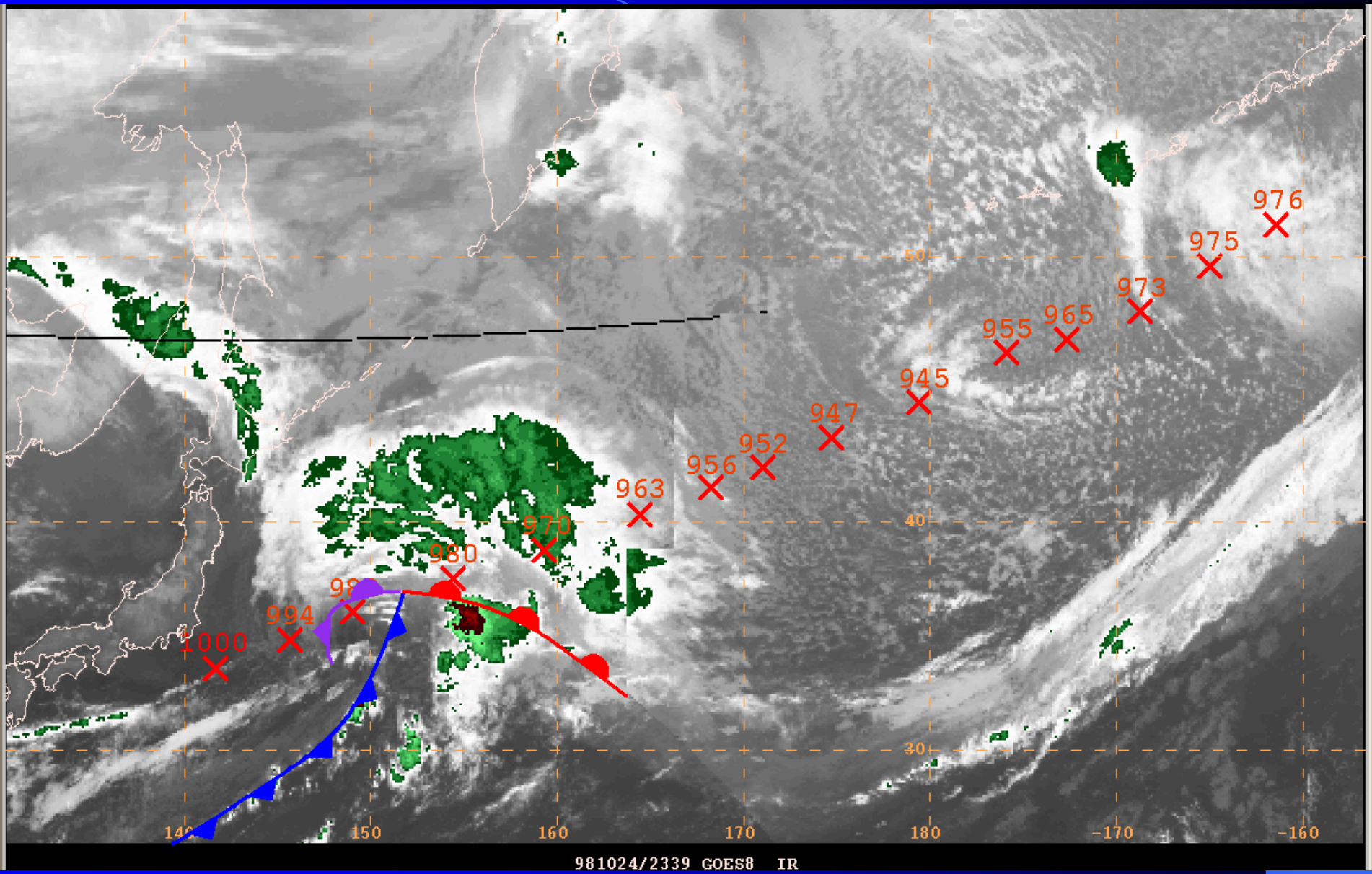
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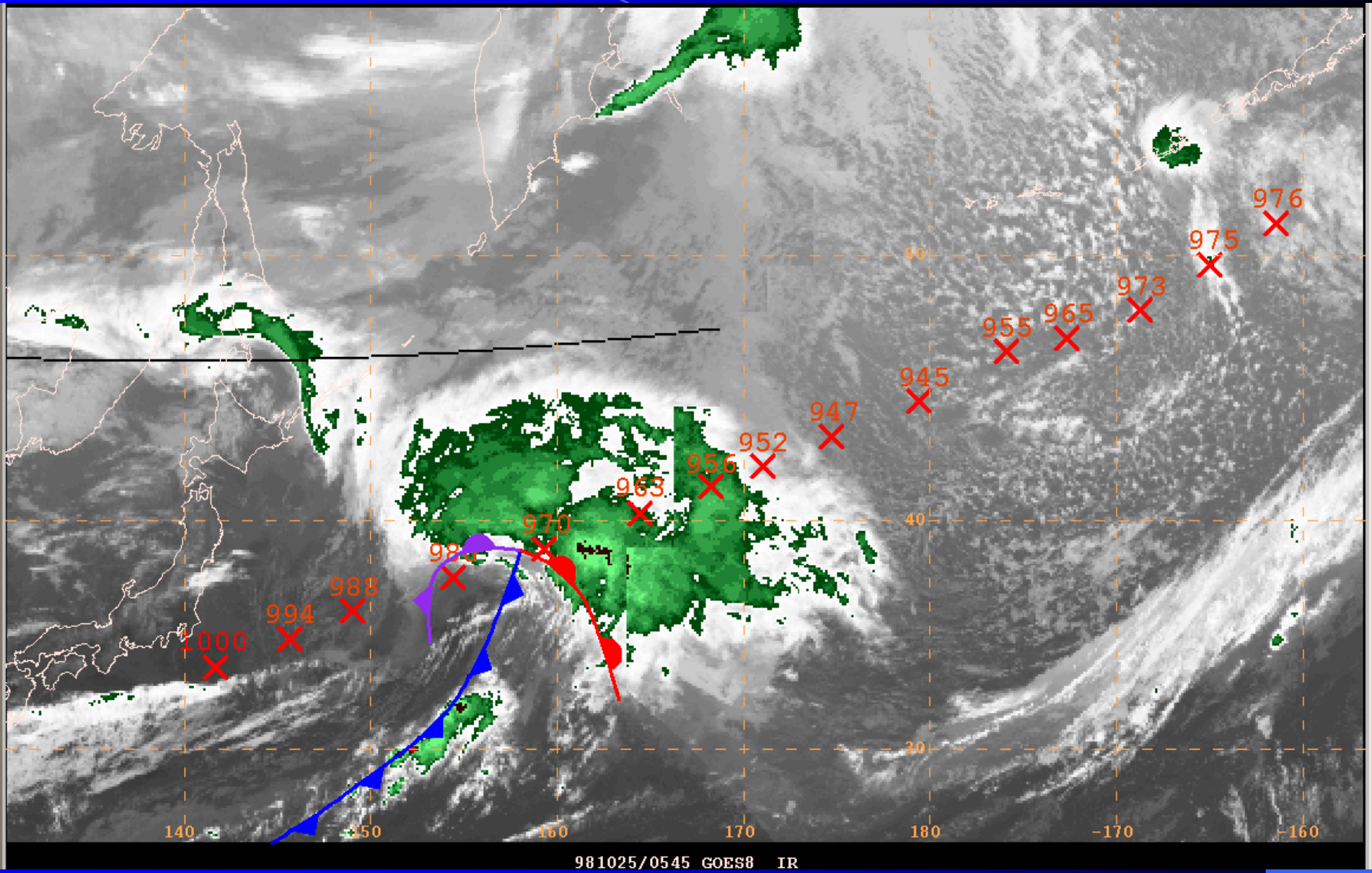
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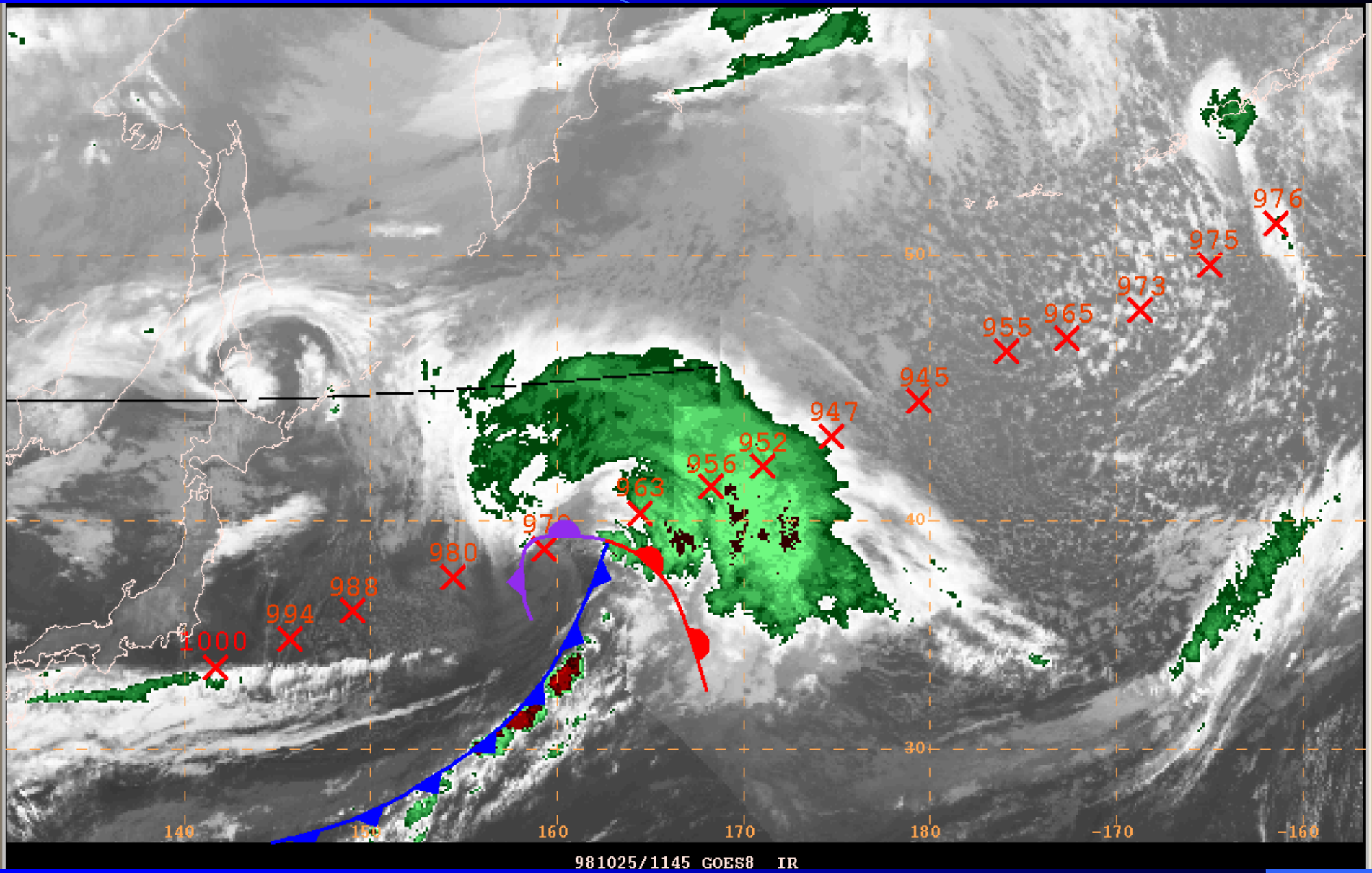
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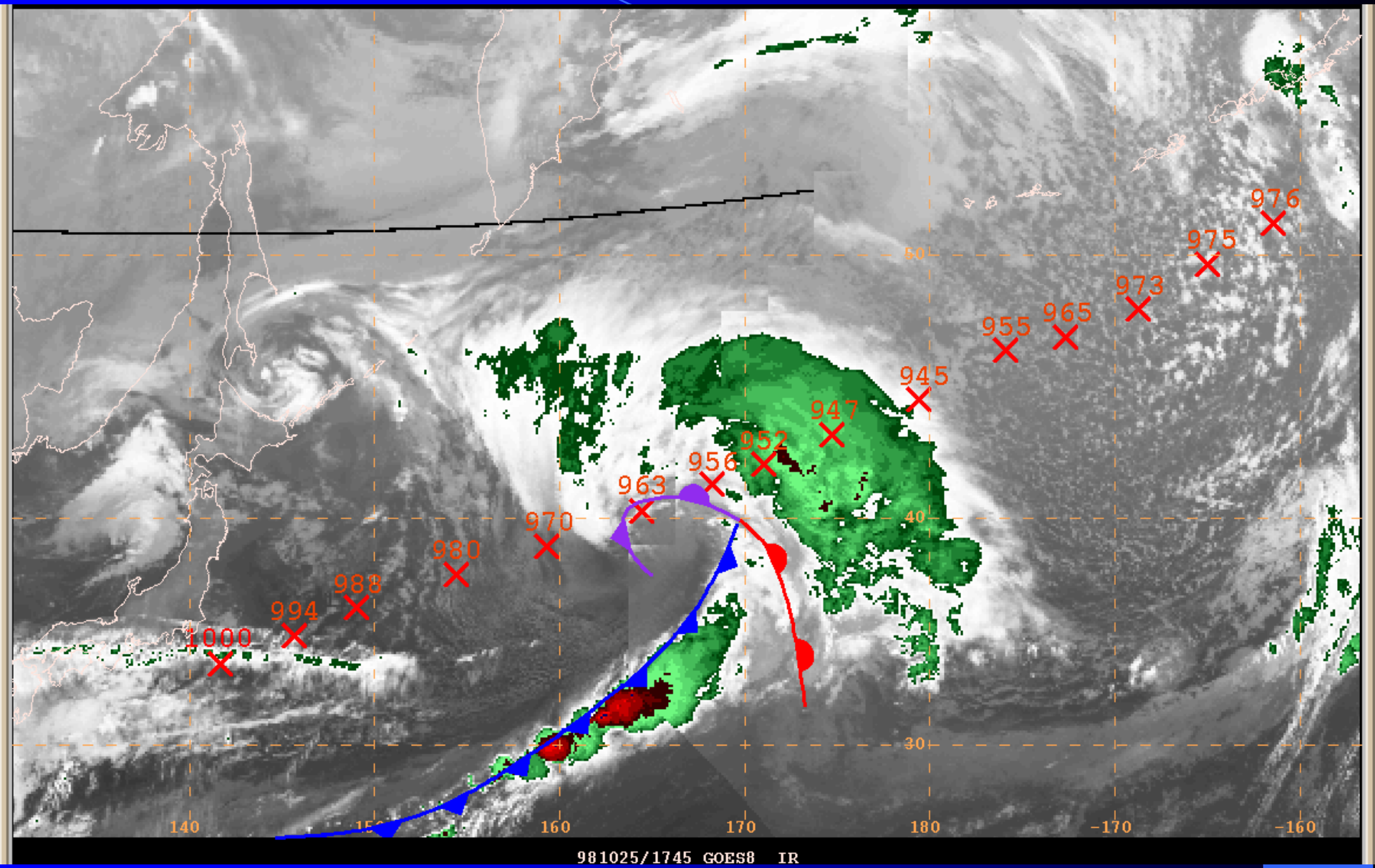
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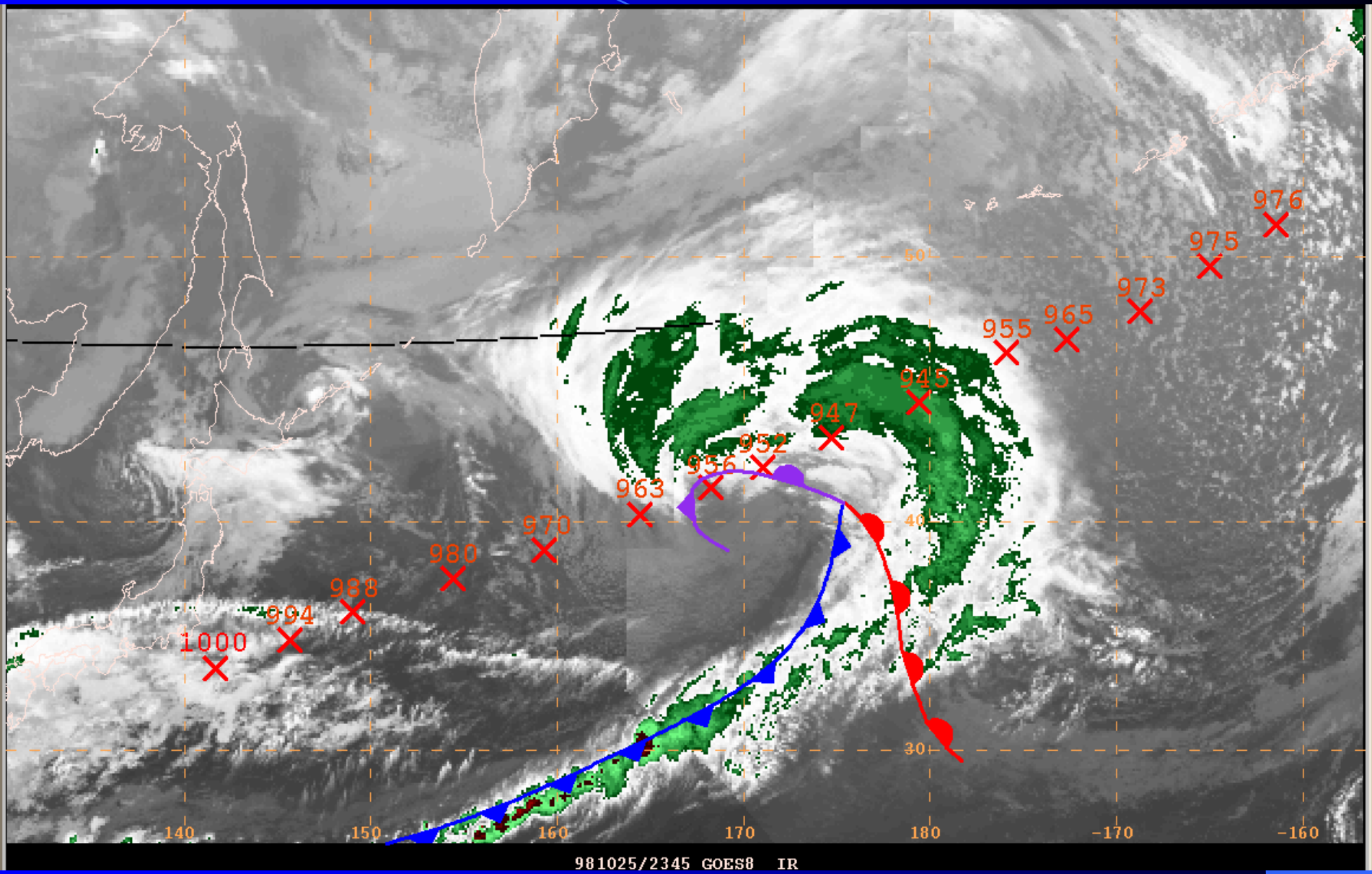
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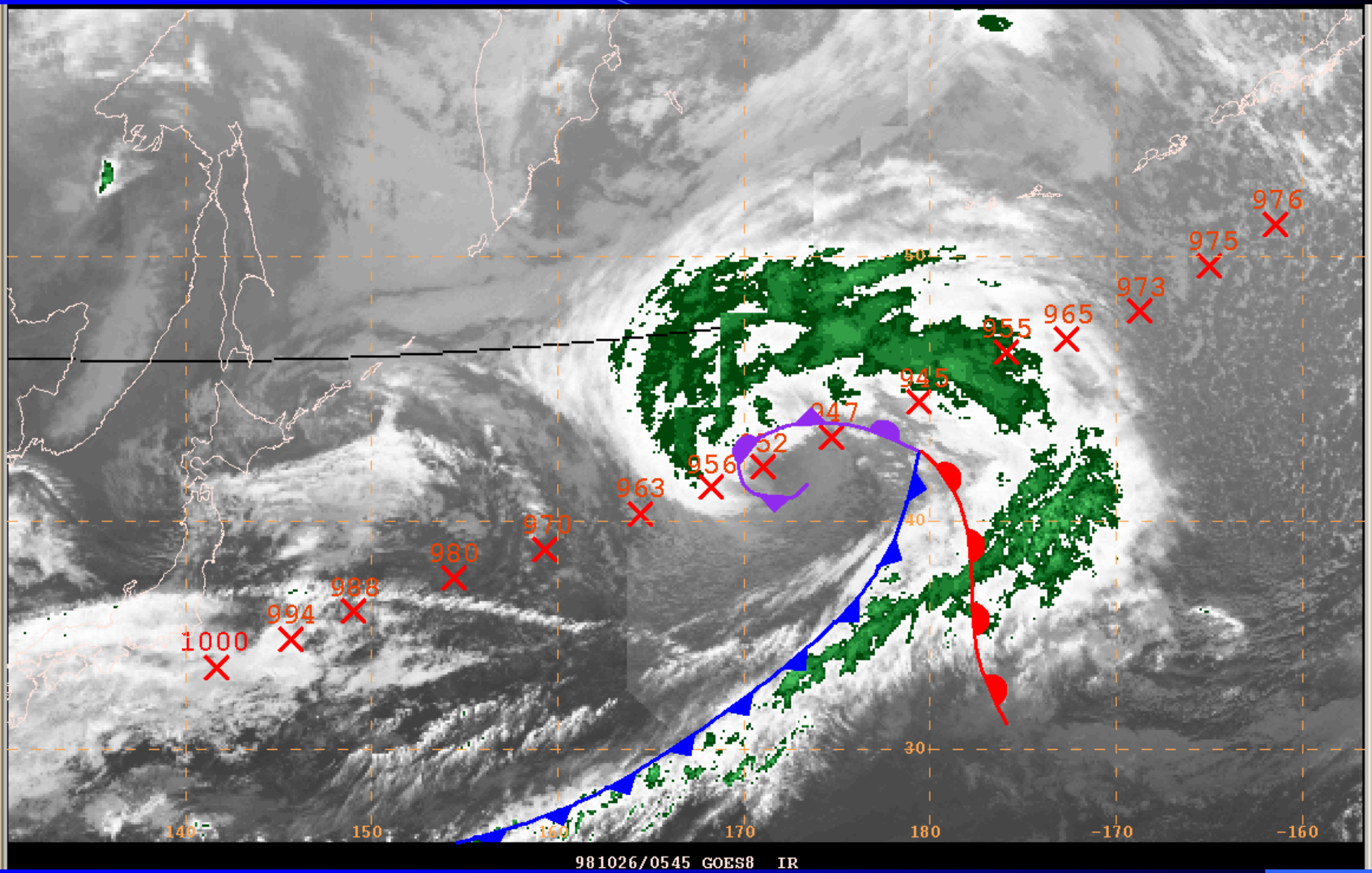
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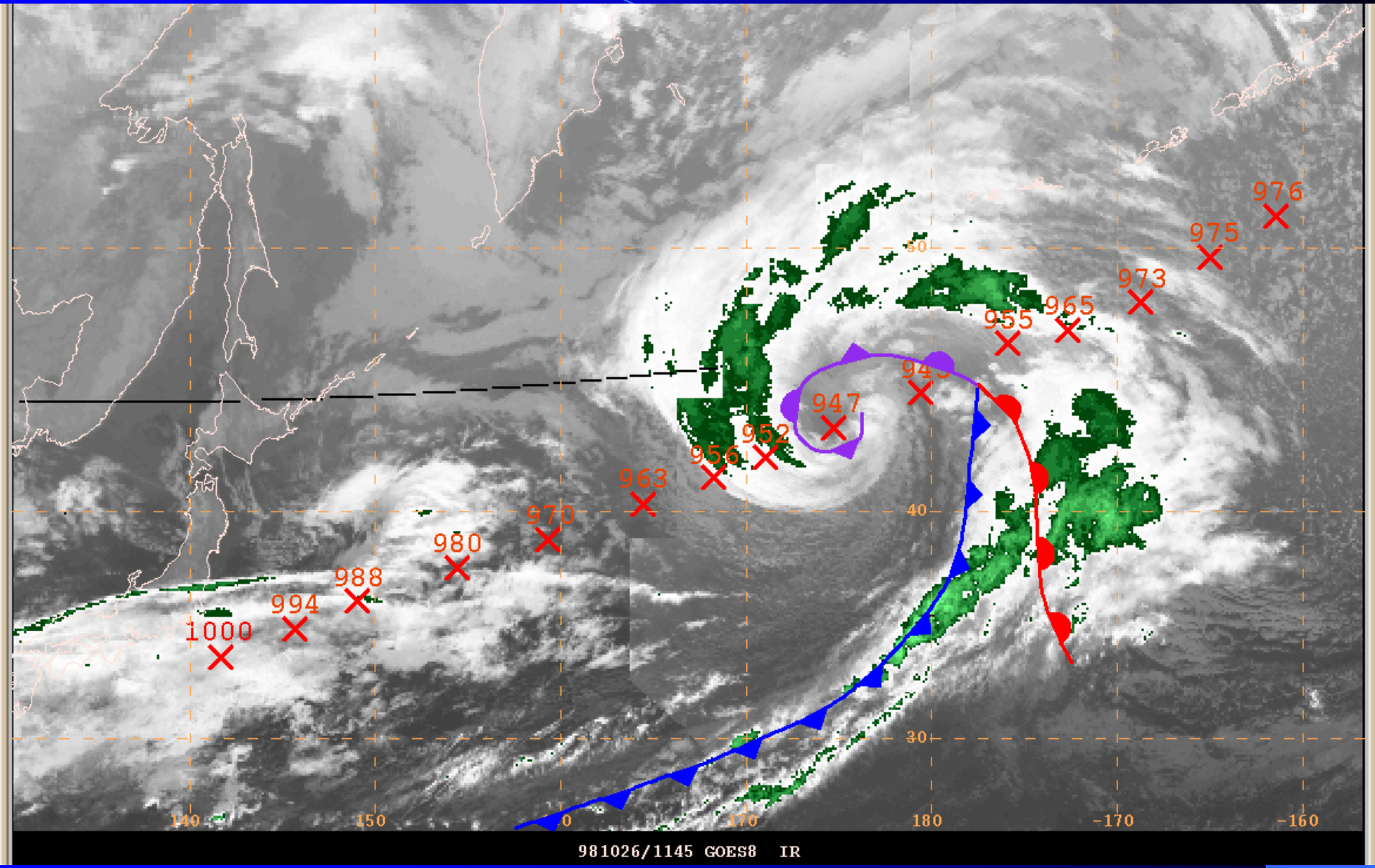
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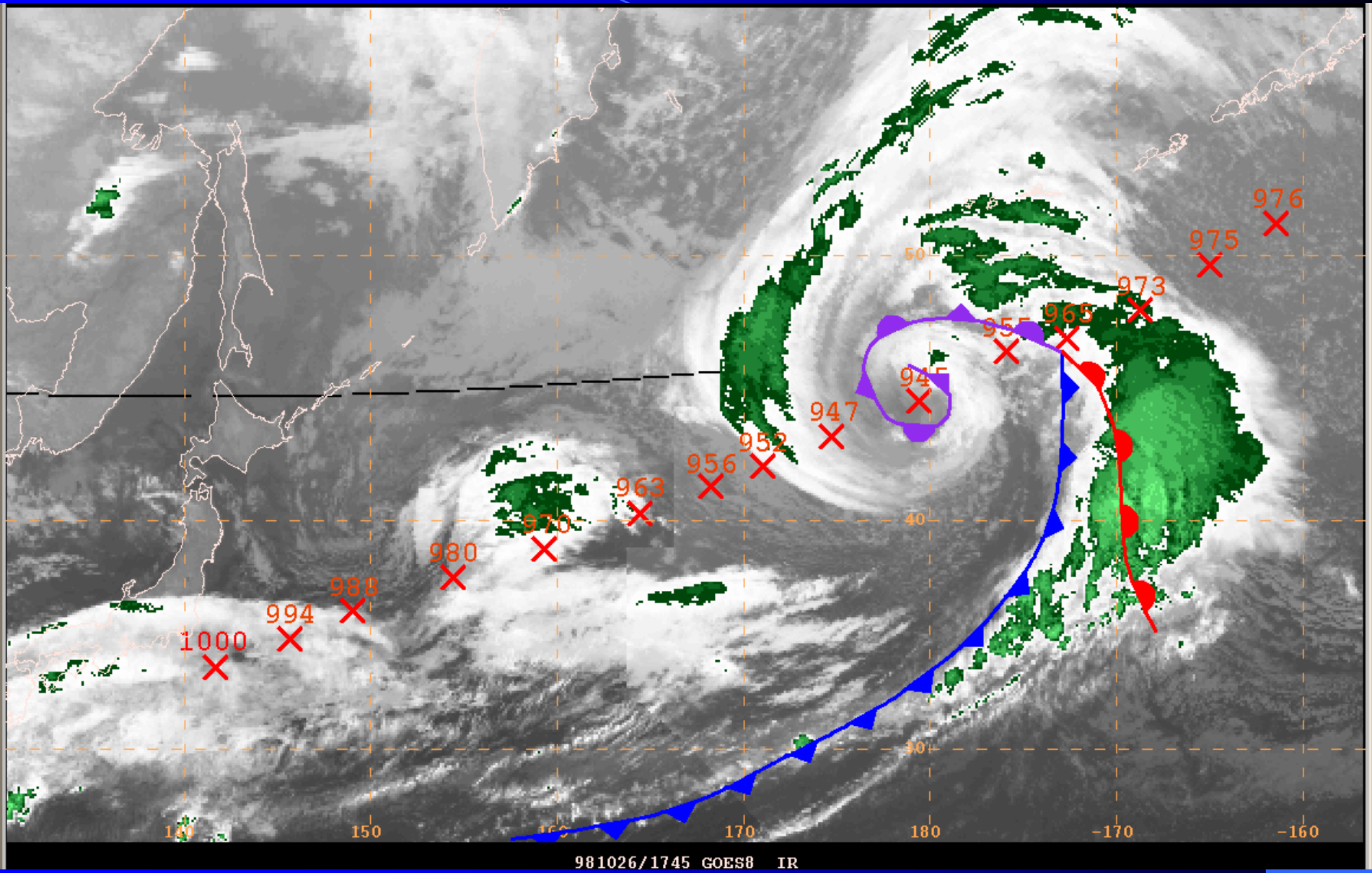
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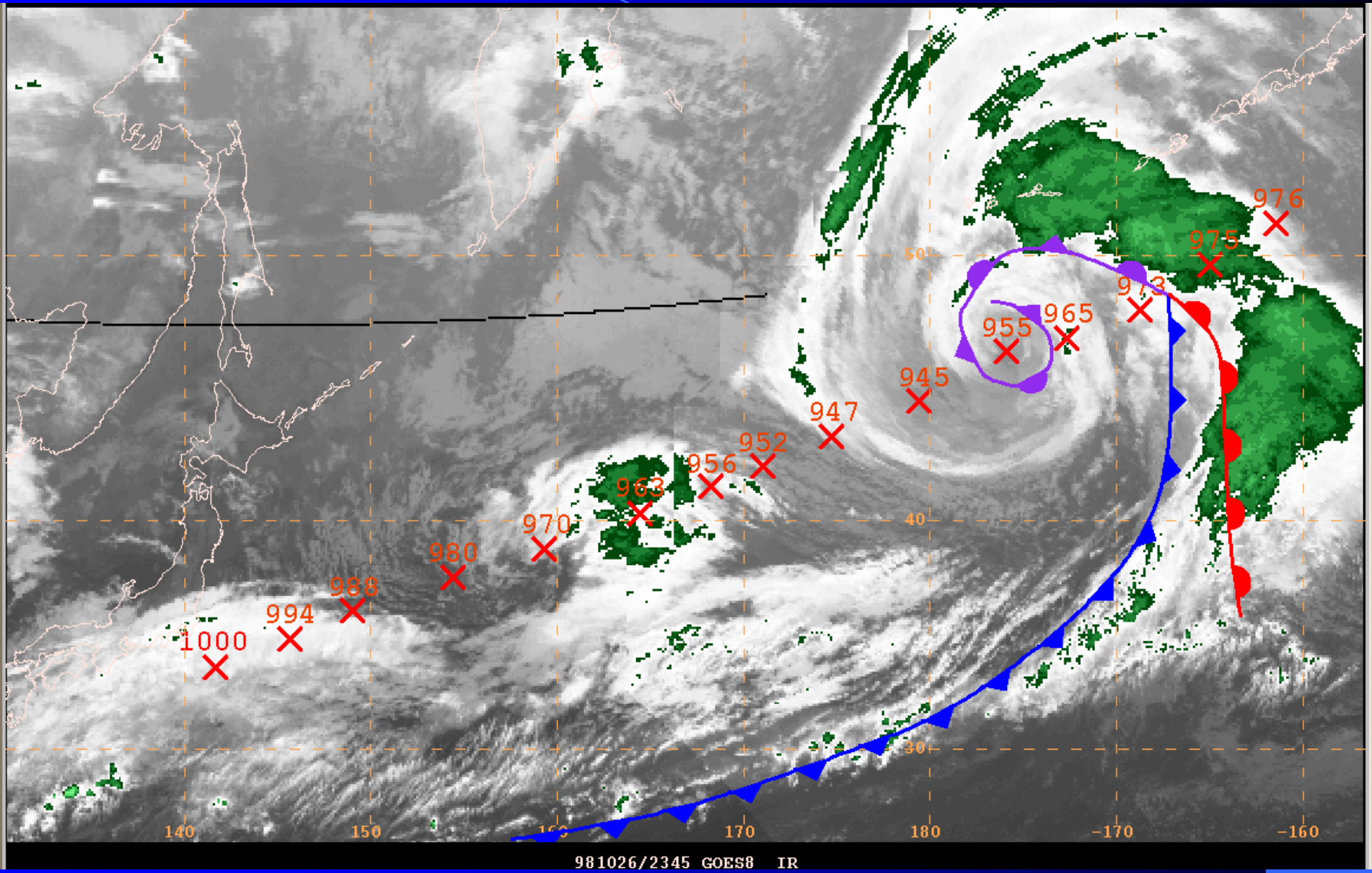
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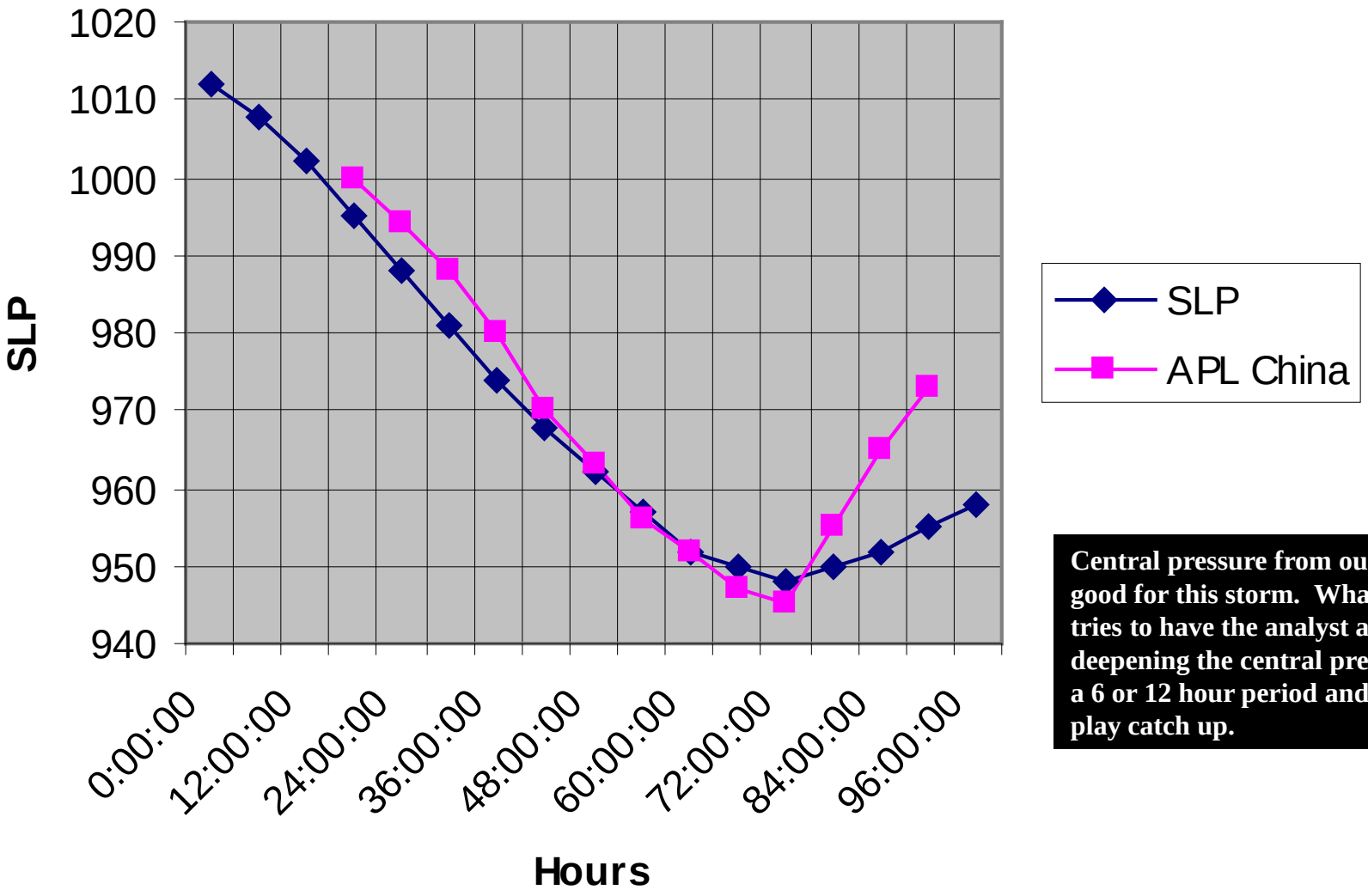
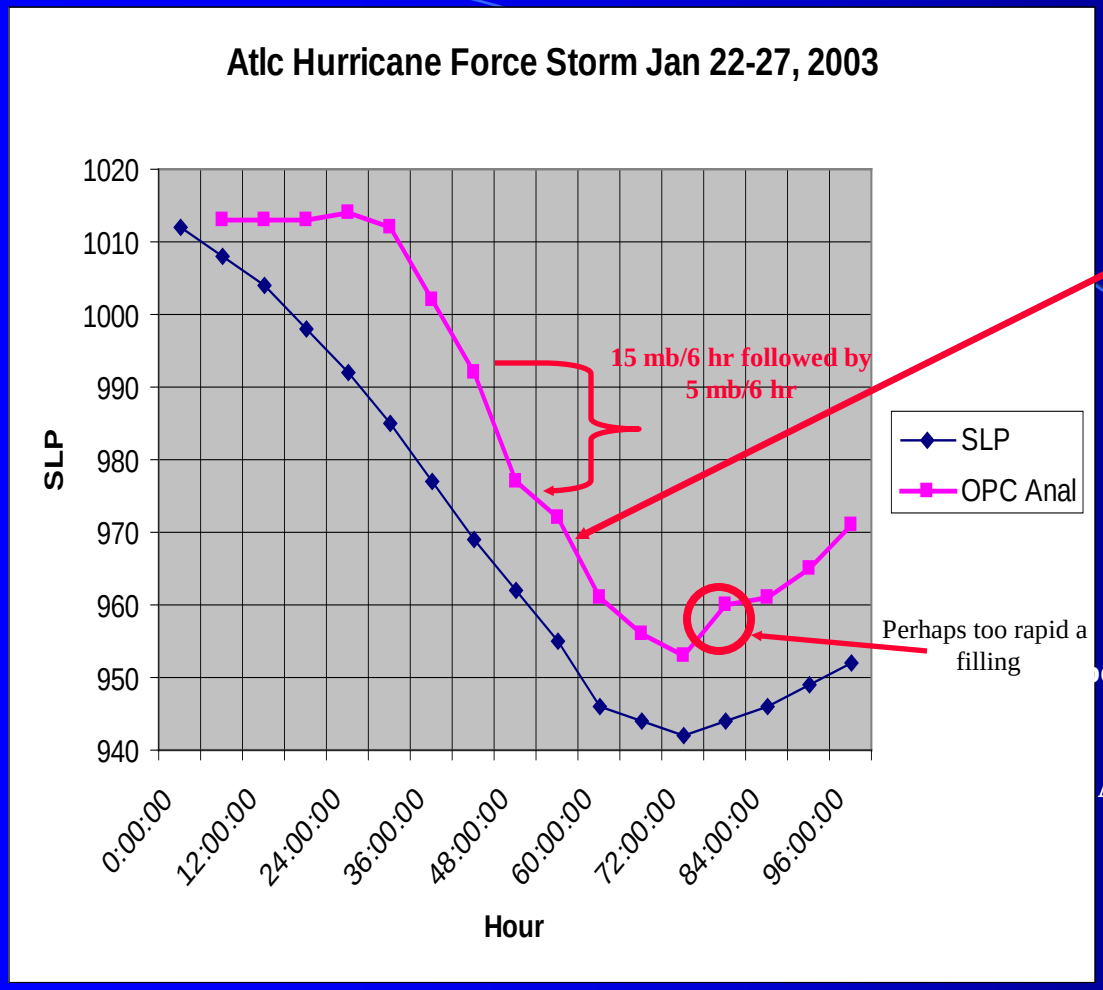
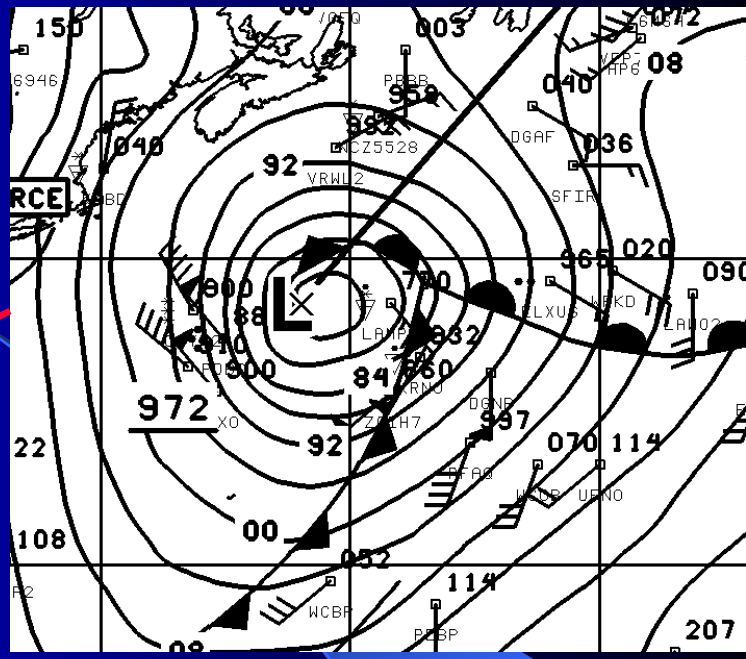
# APL China Storm - SMB Technique



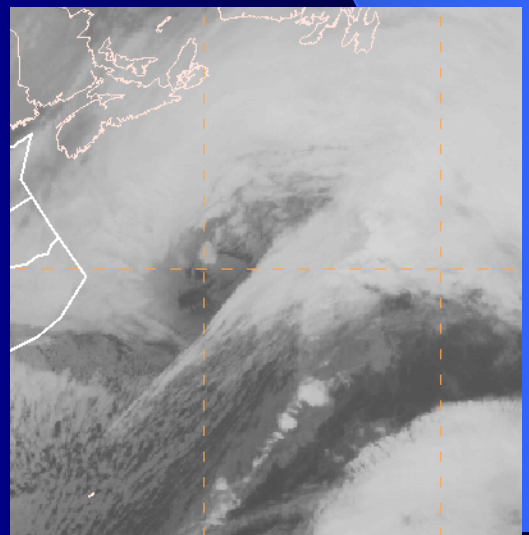

**Central pressure from our analyses looks good for this storm. What this technique tries to have the analyst avoid is not deepening the central pressure for a 6 or 12 hour period and then play catch up.**



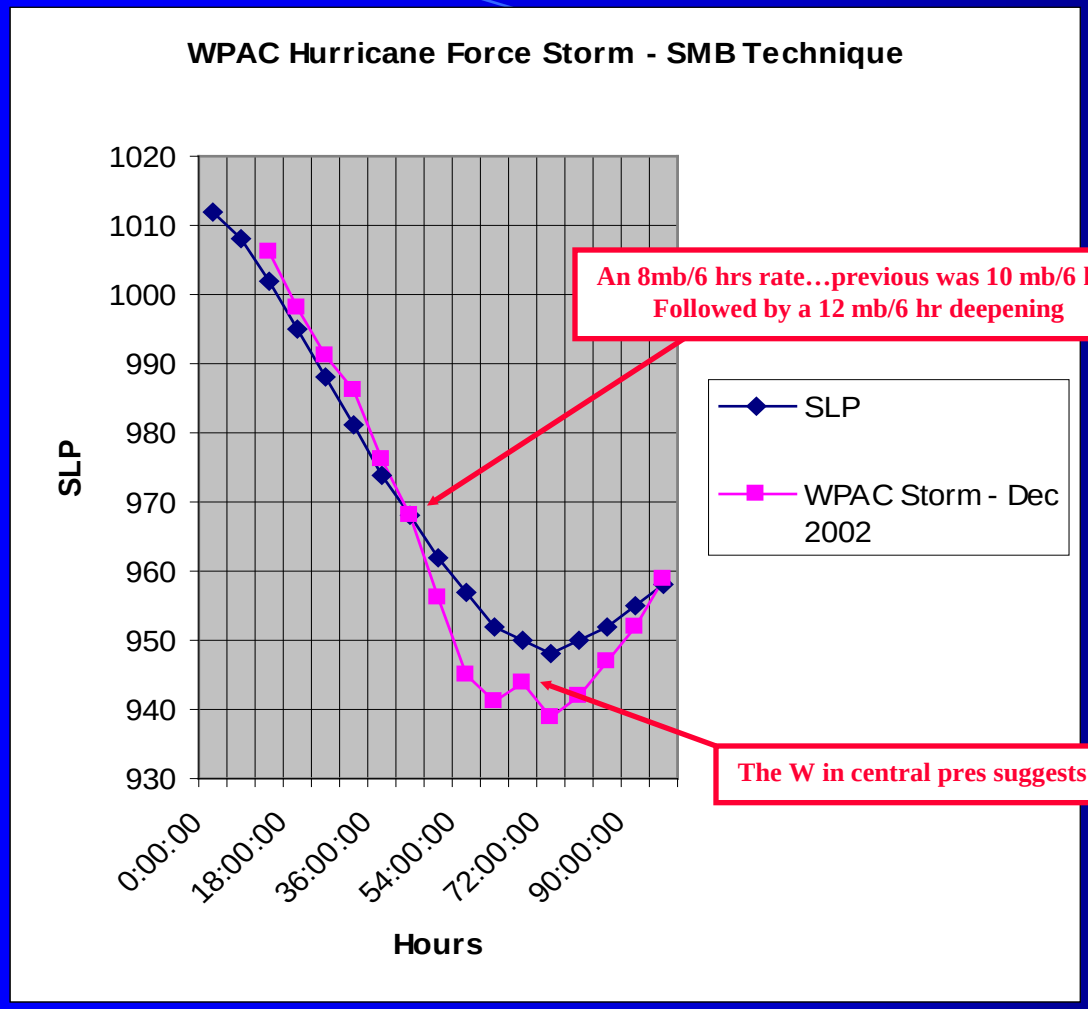



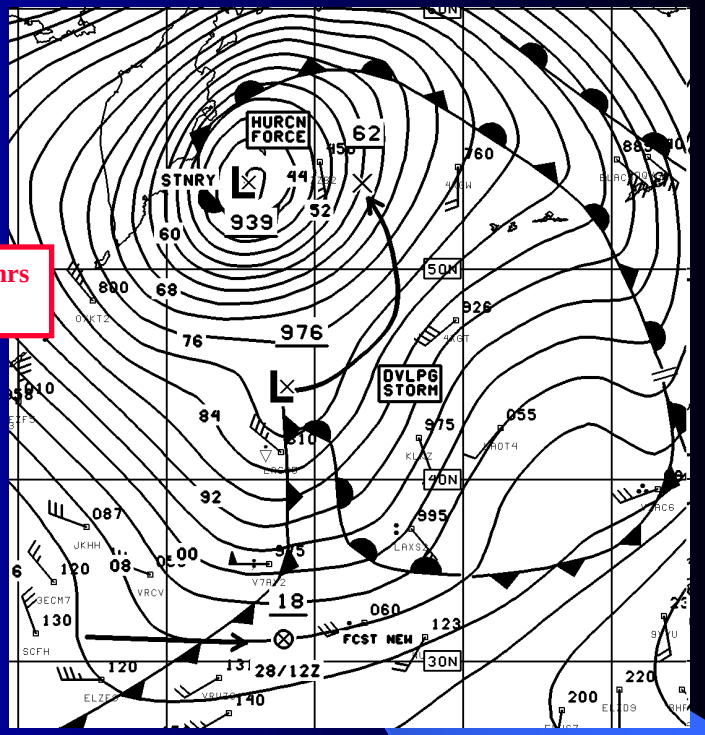

**Plotting the deepening rate suggests that perhaps a lower central pres (e.g., 969) would have been more consistent with the earlier deepening rate.**

**A 977 observation to the east suggest a lower pressure.**

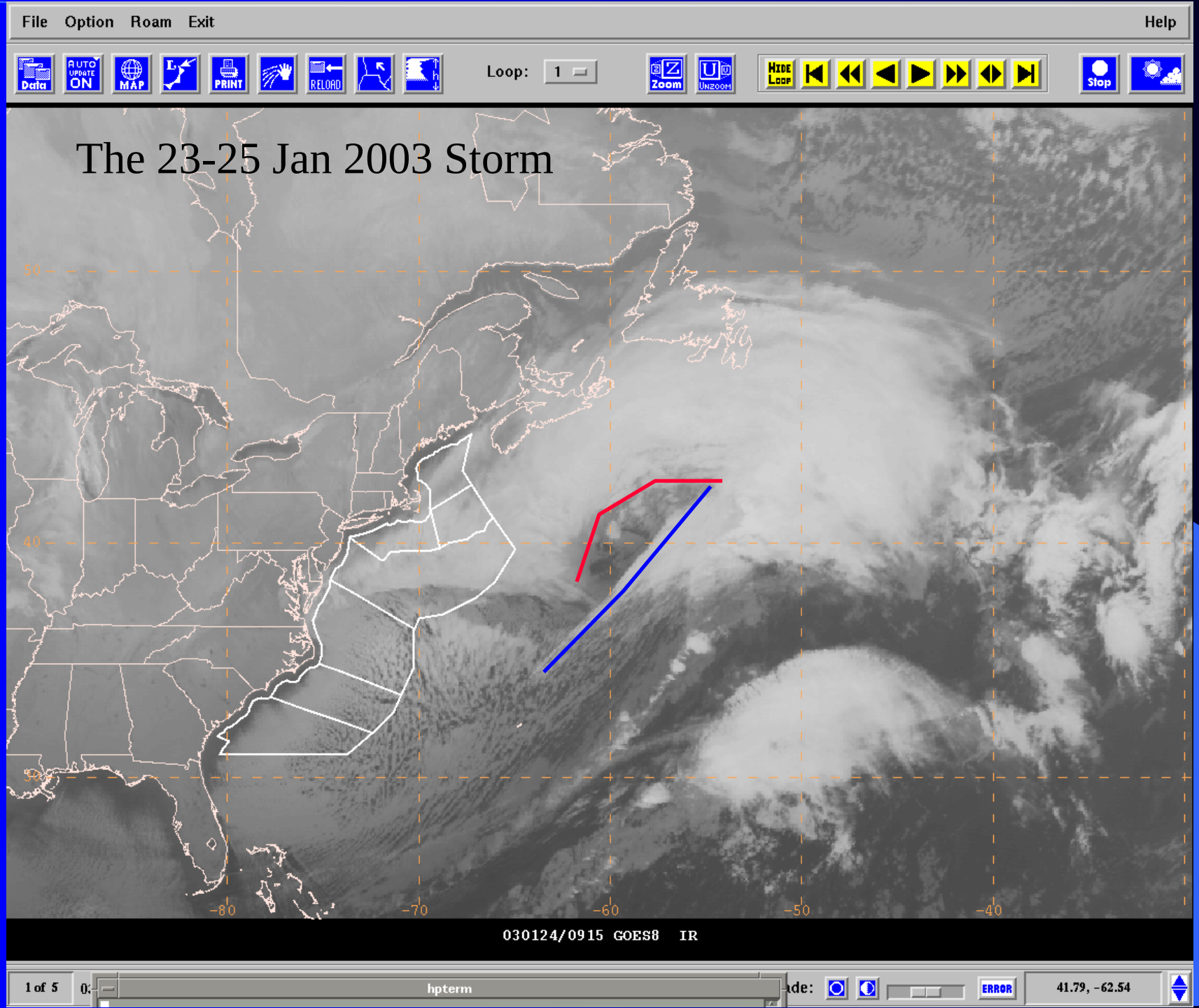


# Atlc Hurricane Force Storm




# Pac Hurricane Force Storm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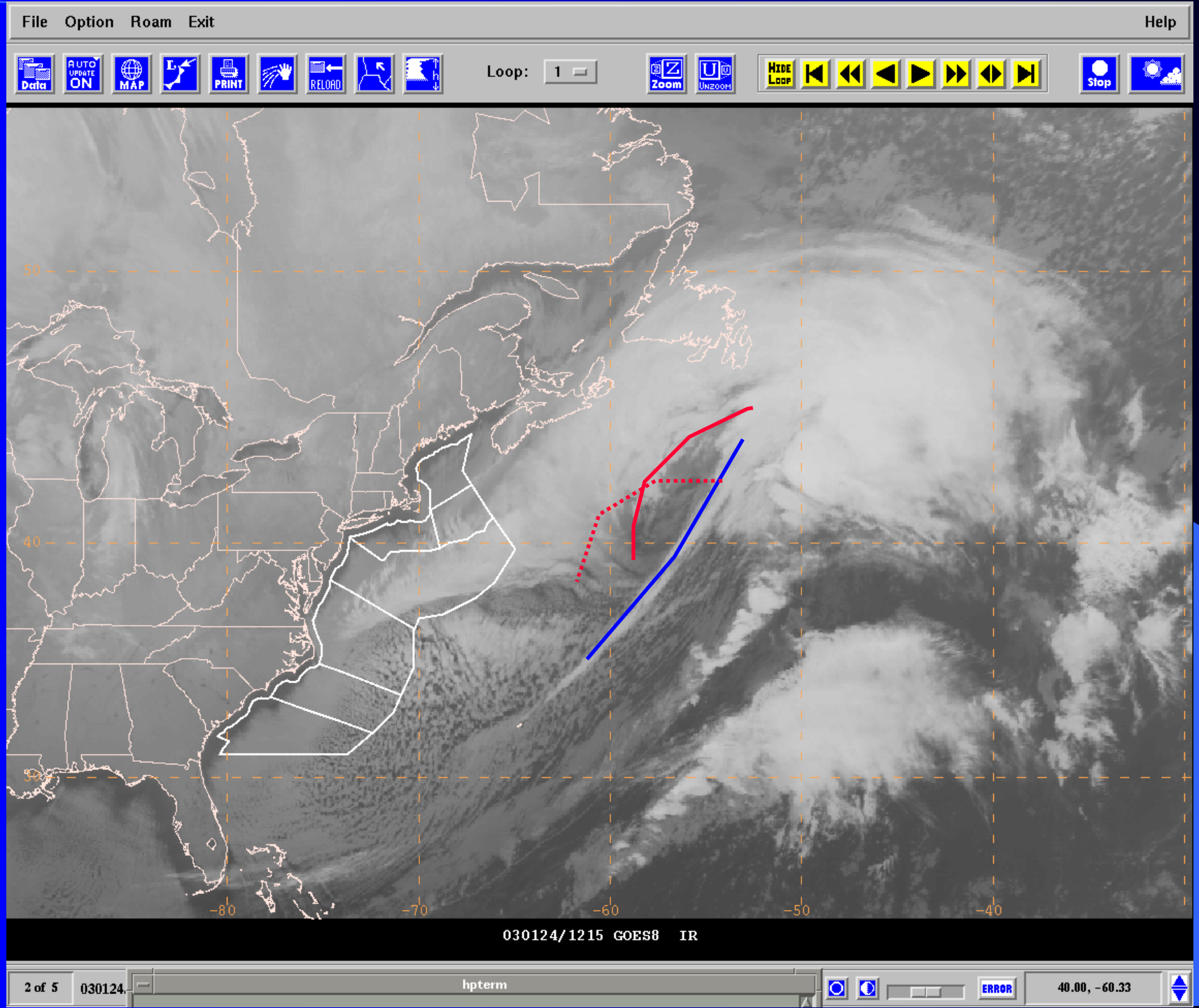
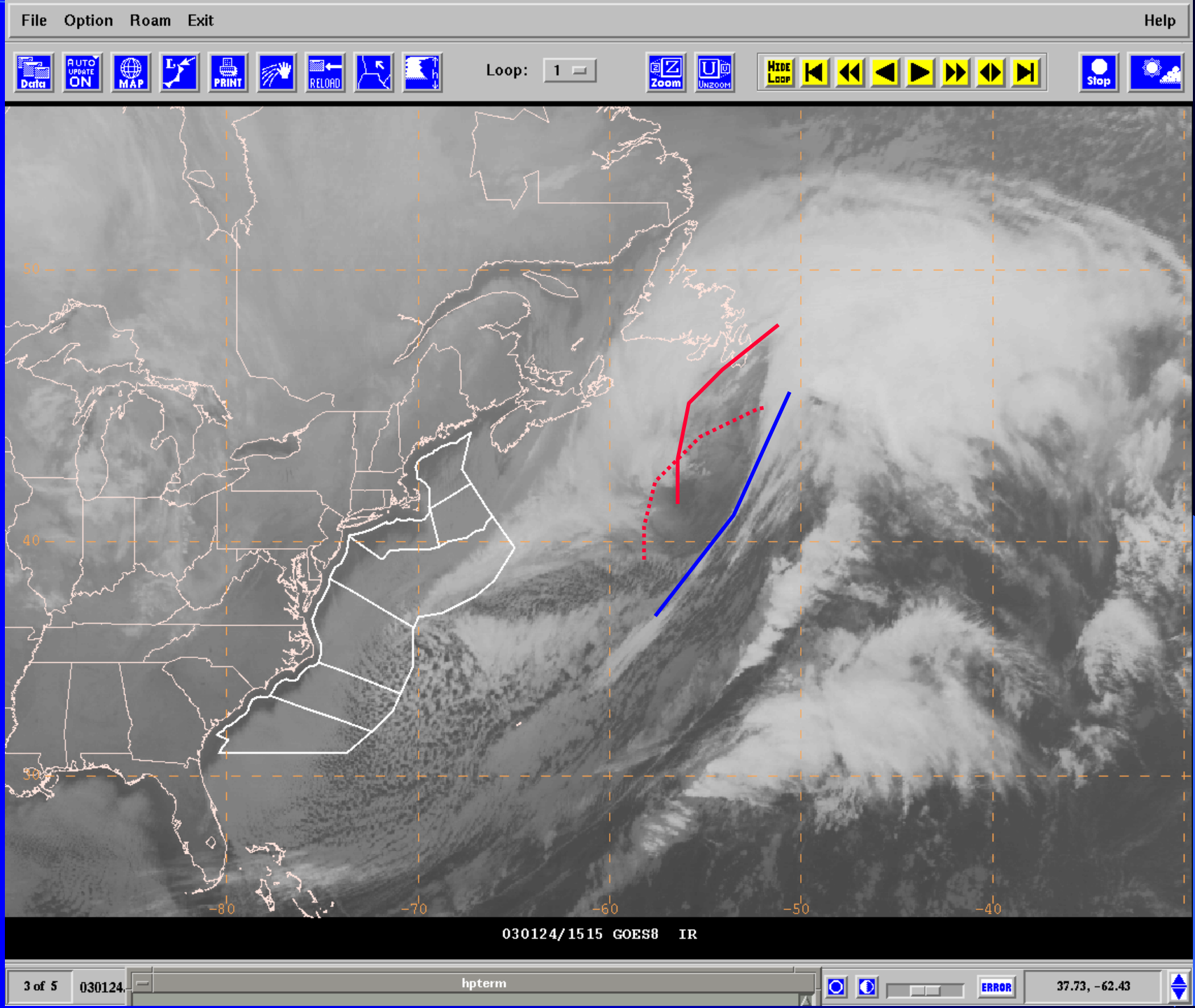
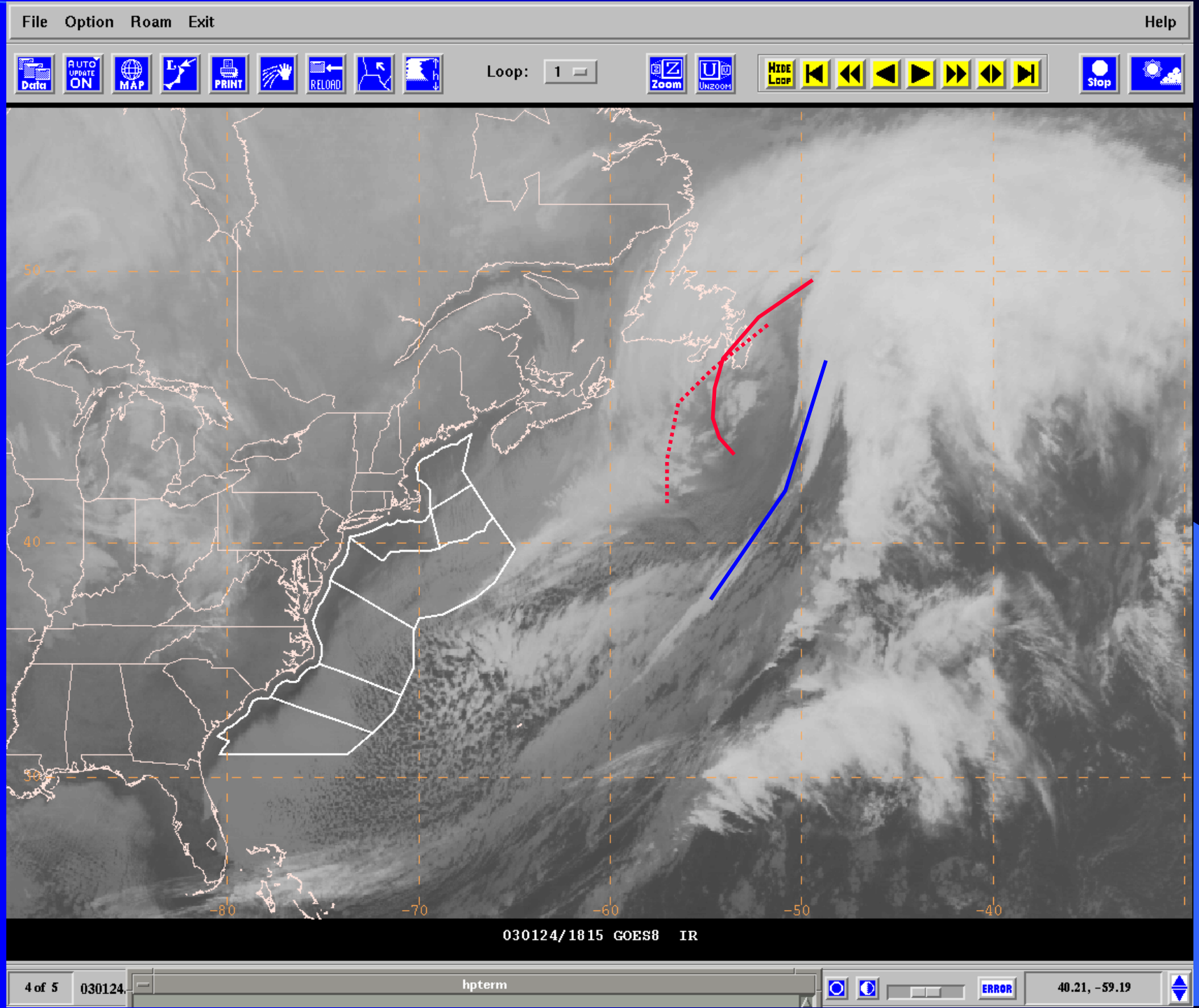
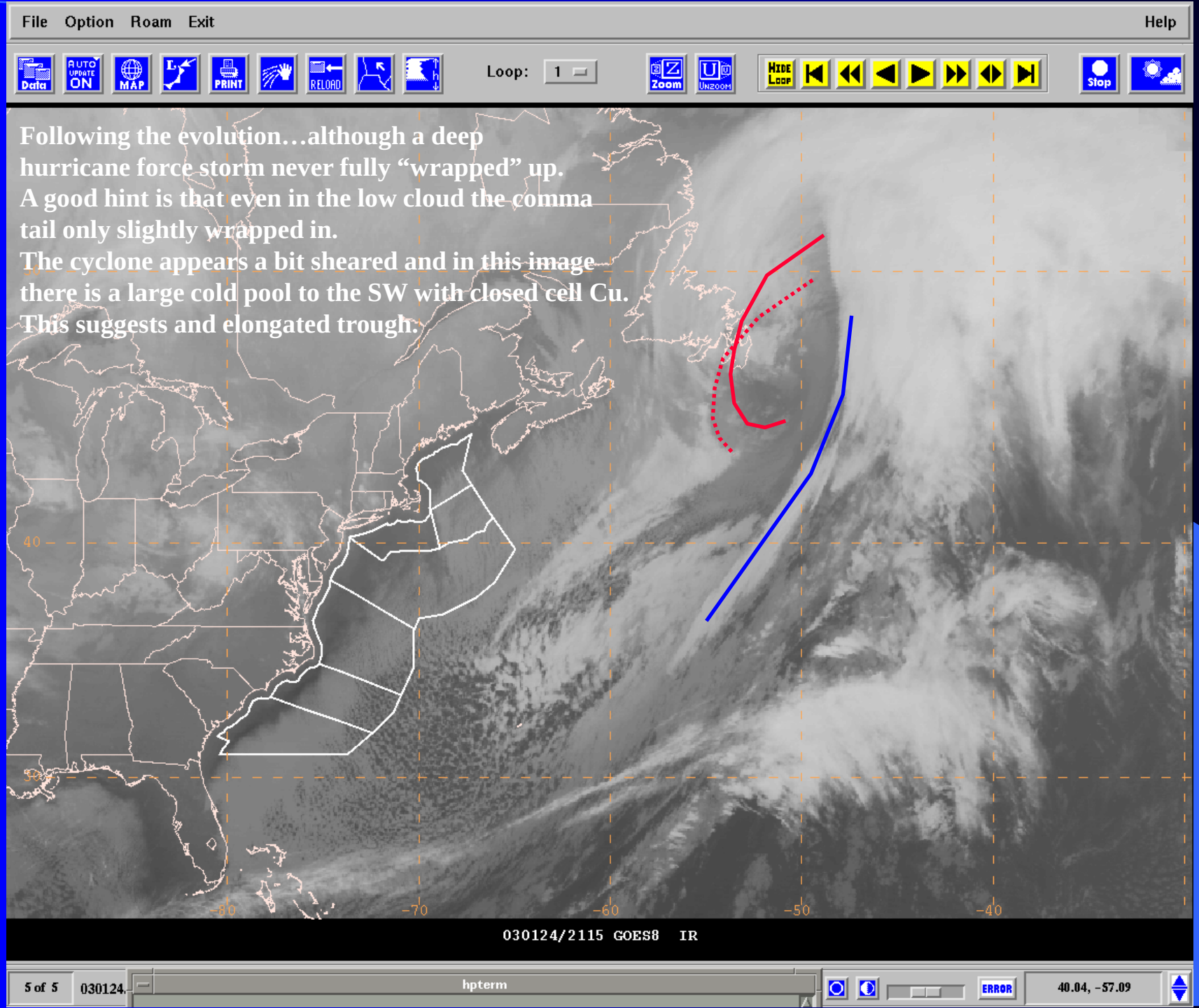
ERROR
41.79, -62.54


File
Option
Roam
Exit
Help
Data
AUTO UPDATE ON
MAP
PRINT
RELOAD
Loop:
1
Zoom
Unzoom
HIDE Loop
Stop
50
40
30
-80
-70
-60
-50
-40
030124/1215 GOES8 IR
2 of 5
030124.
hpterm
ERROR
40.00, -60.33


File
Option
Roam
Exit
Help
Data
AUTO UPDATE ON
MAP
PRINT
RELOAD
Loop:
1
Zoom
UnZoom
HIDE LOOP
Stop
50
40
30
-80
-70
-60
-50
-40
030124/1515 GOES8 IR
3 of 5
030124
hpterm
ERROR
37.73, -62.43

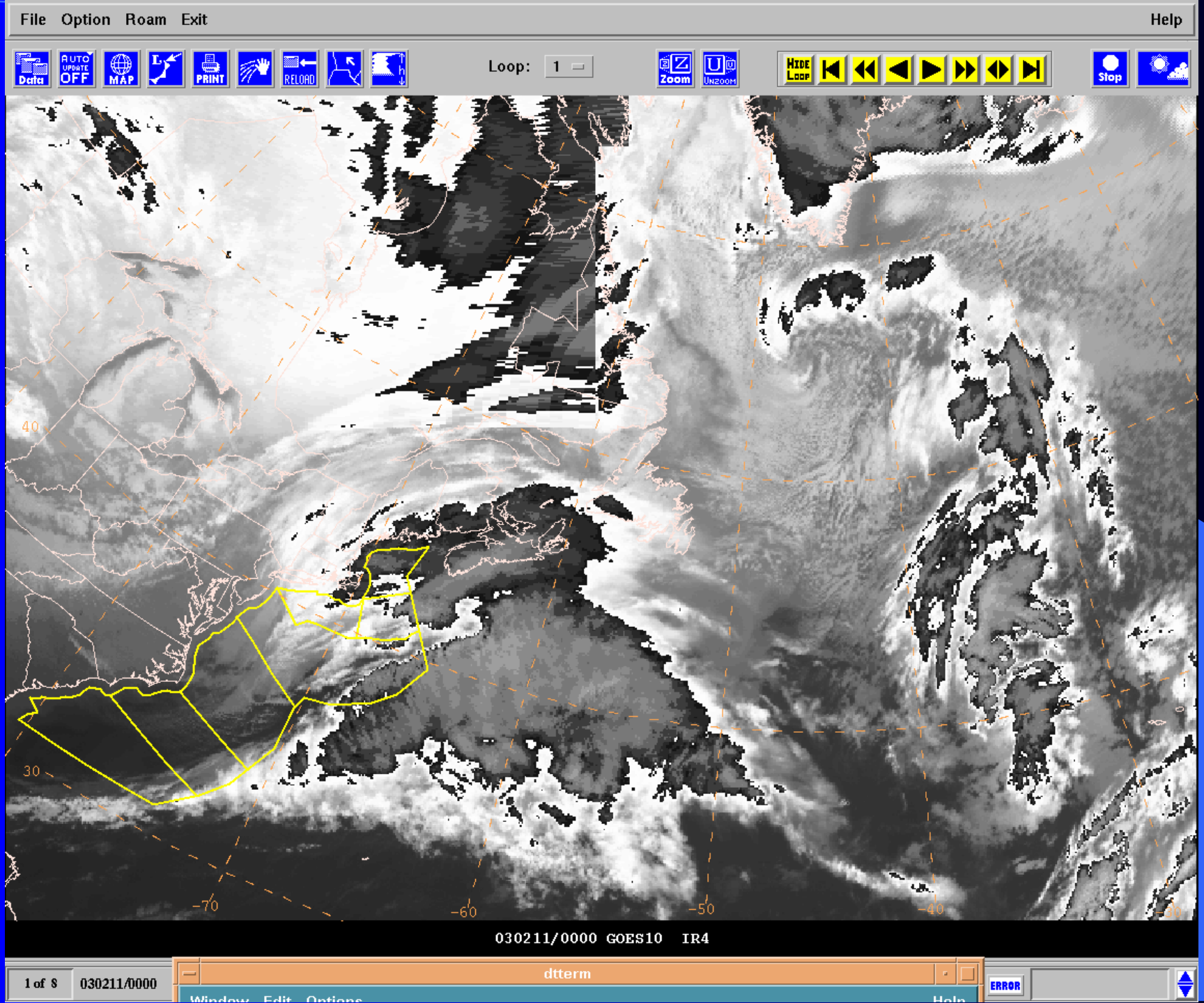

File
Option
Roam
Exit
Help
Data
AUTO UPDATE ON
MAP
PRINT
RELOAD
Loop:
1
Zoom
Unzoom
HIDE Loop
Stop
50
40
30
-80
-70
-60
-50
-40
030124/1815 GOES8 IR
4 of 5
030124.
hpterm
ERROR
40.21, -59.19

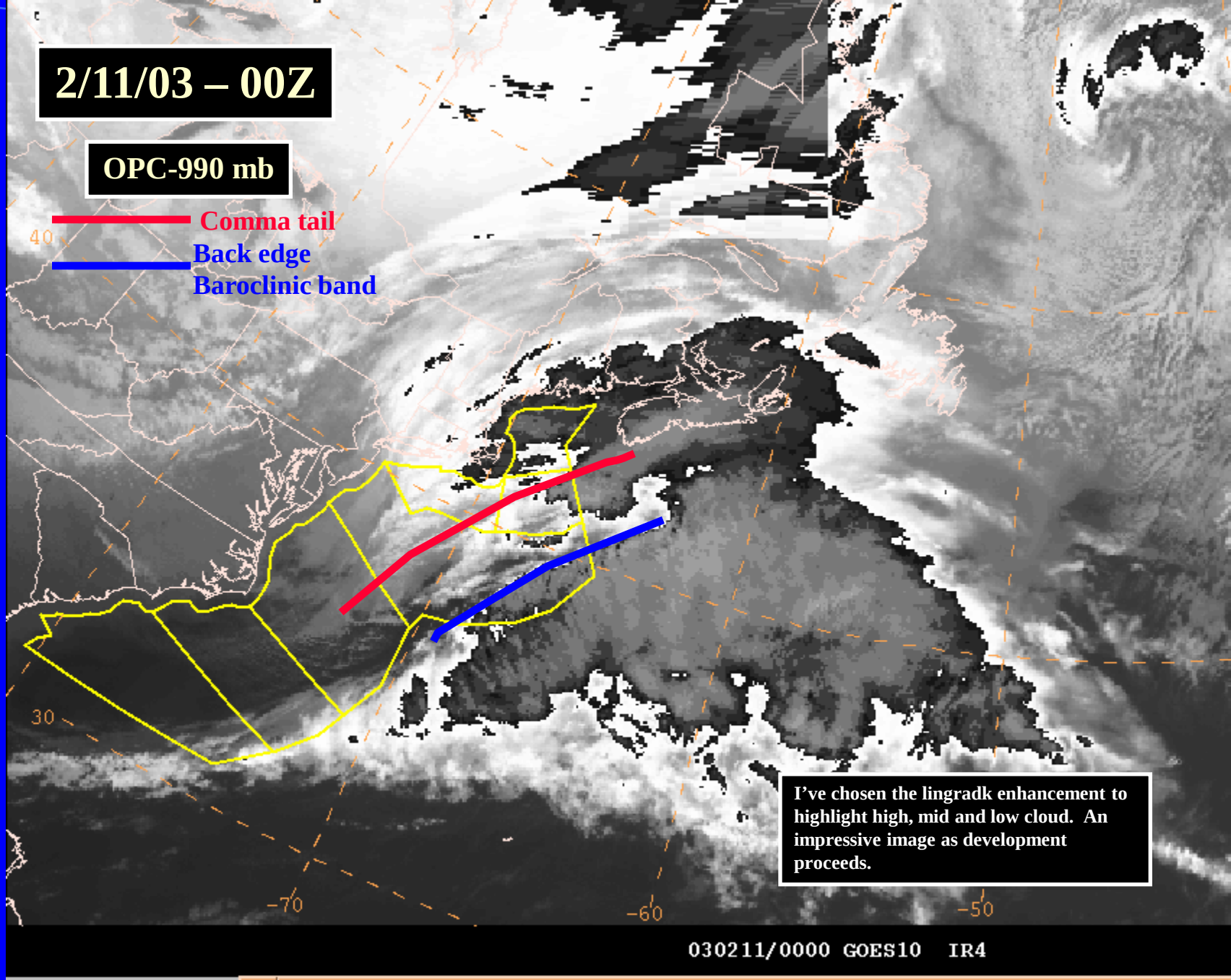

File Option Roam Exit
Help
Data
AUTO UPDATE ON
MAP
PRINT
RELOAD
Loop: 1
Zoom
Unzoom
HIDE Loop
Stop
Following the evolution…although a deep hurricane force storm never fully "wrapped" up.
A good hint is that even in the low cloud the comma tail only slightly wrapped in.
The cyclone appears a bit sheared and in this image there is a large cold pool to the SW with closed cell Cu.
This suggests and elongated trough.
40
30
-80
-70
-60
-50
-40
030124/2115 GOES8 IR
5 of 5
030124.
hpterm
ERROR
40.04, -57.09

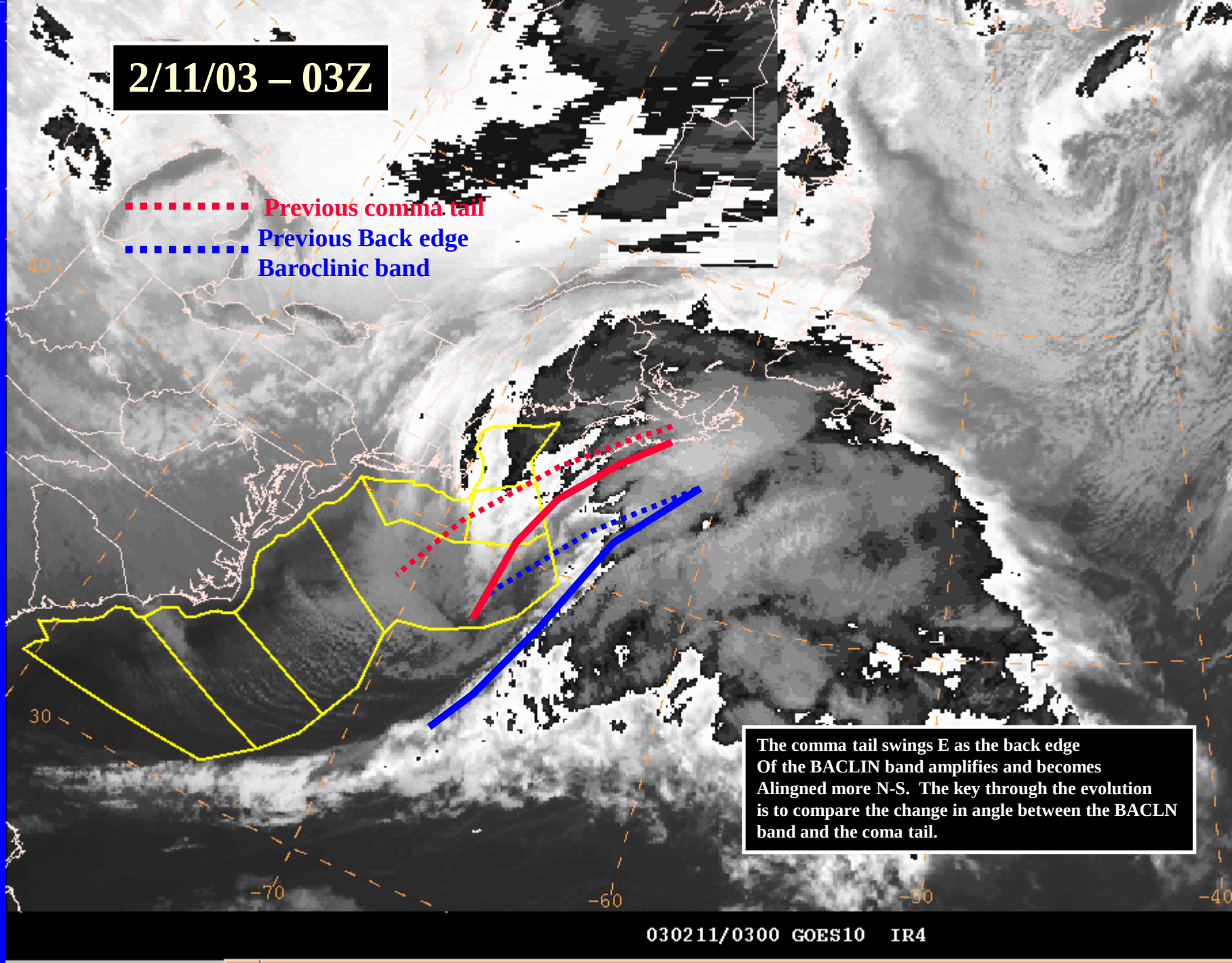
Now lets look at a case where all is going right with the atmosphere!!

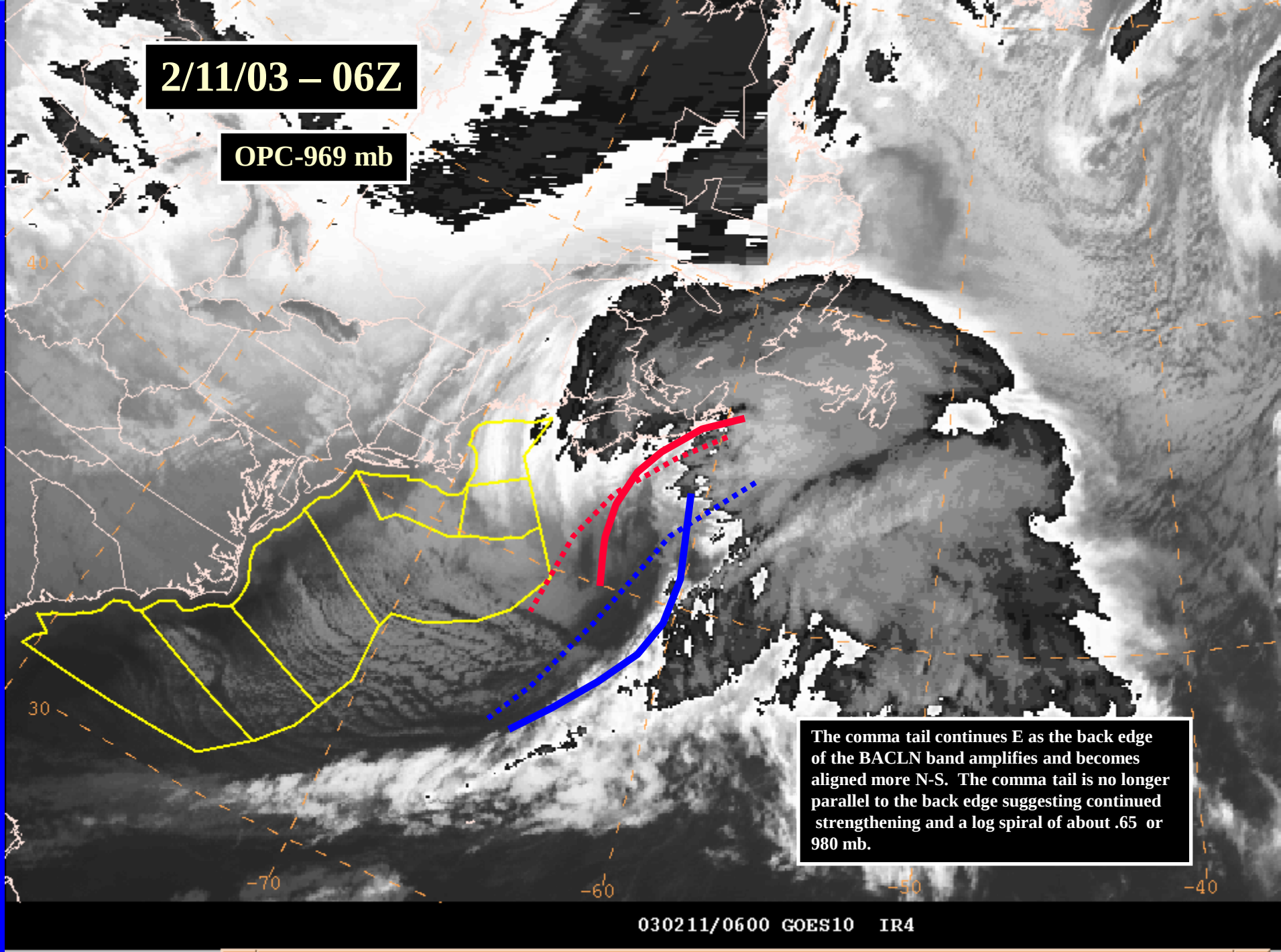
# Feb 10-12, 2003

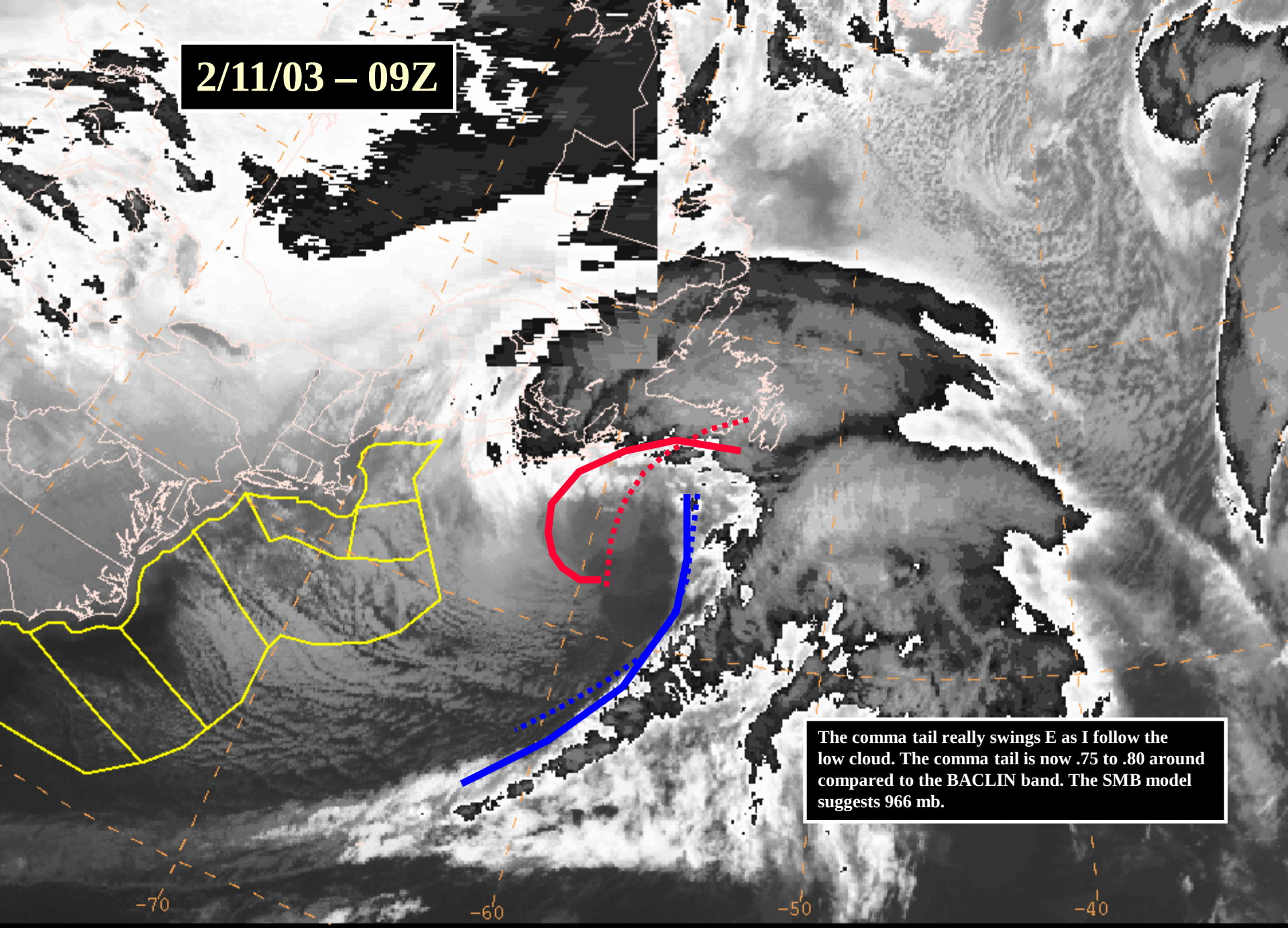
**First a loop of the evolution…**
**Then we'll step through the 3 hourly images.**

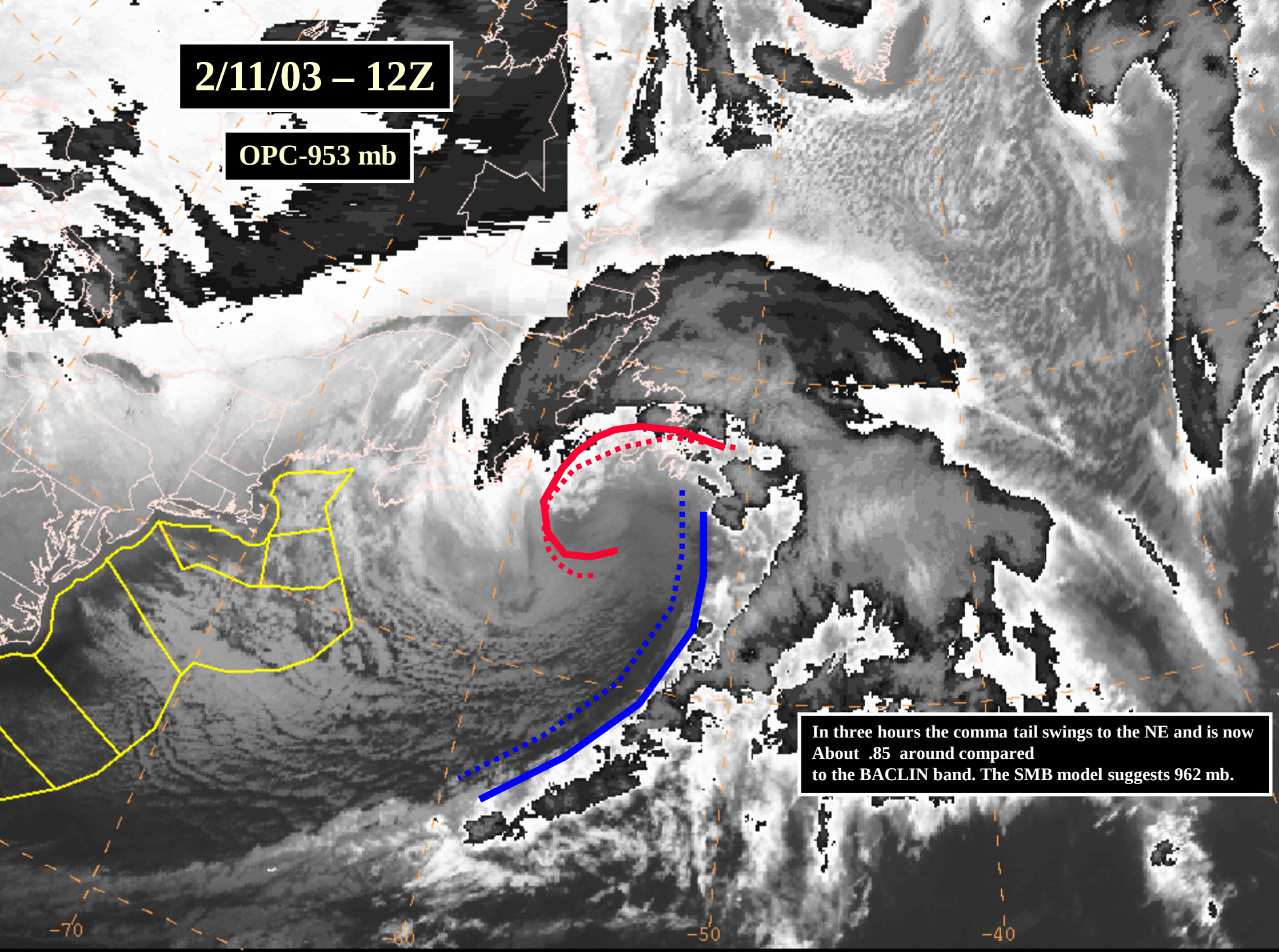

File Option Roam Exit
Help
Data
AUTO UPDATE OFF
MAP
PRINT
RELOAD
Loop: 1
Zoom
UnZoom
Hide Loop
Stop
40
30
-70
-60
-50
-40
030211/0000 GOES10 IR4
1 of 8
030211/0000
dtterm
Window Edit Options
Help
ERROR

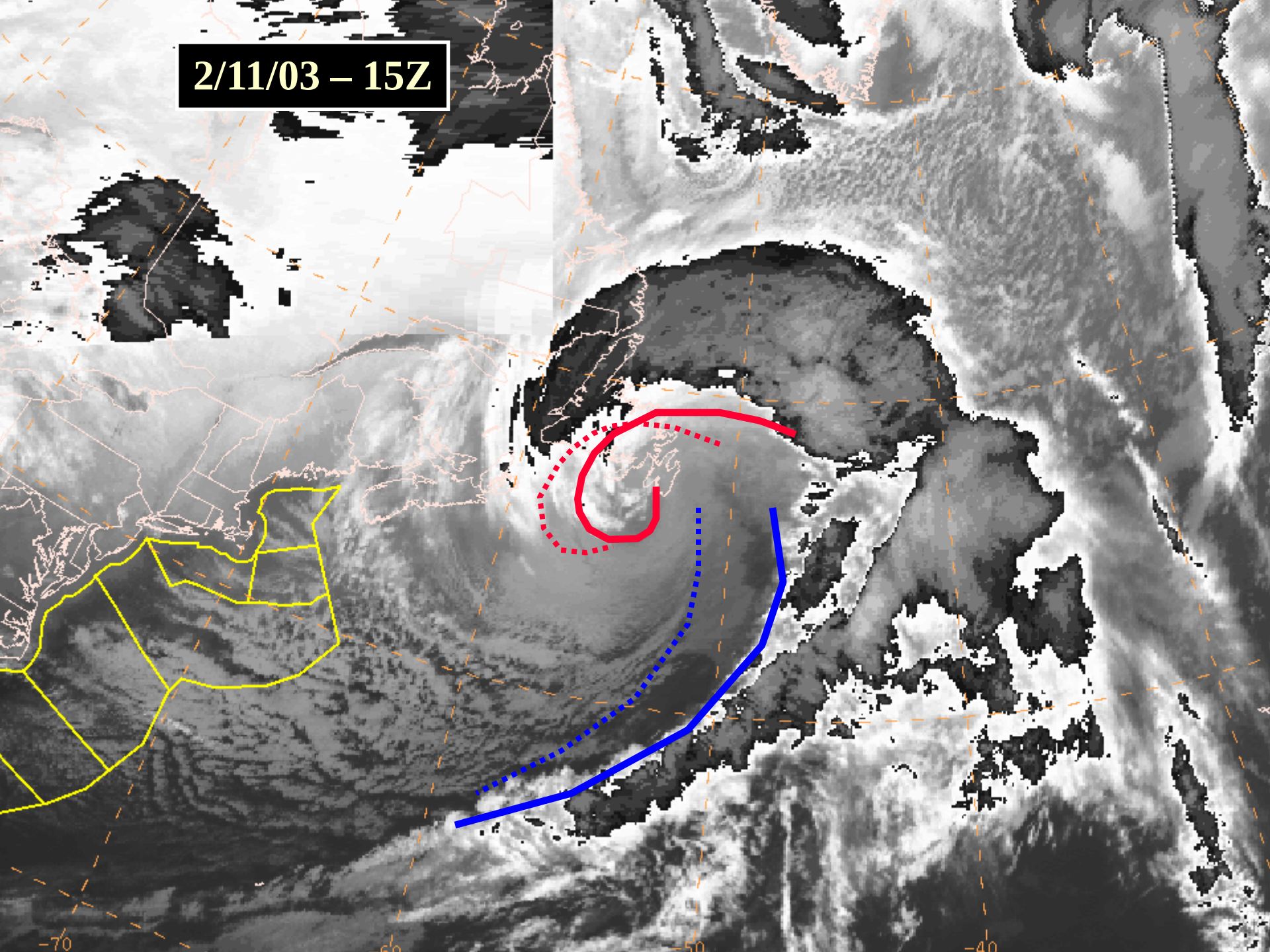

2/11/03 – 00Z
OPC-990 mb
Comma tail
Back edge
Baroclinic band
40
30
-70
-60
-50
I’ve chosen the lingradk enhancement to highlight high, mid and low cloud. An impressive image as development proceeds.
030211/0000 GOES10 IR4
1 of 8
030211/0000
dtterm

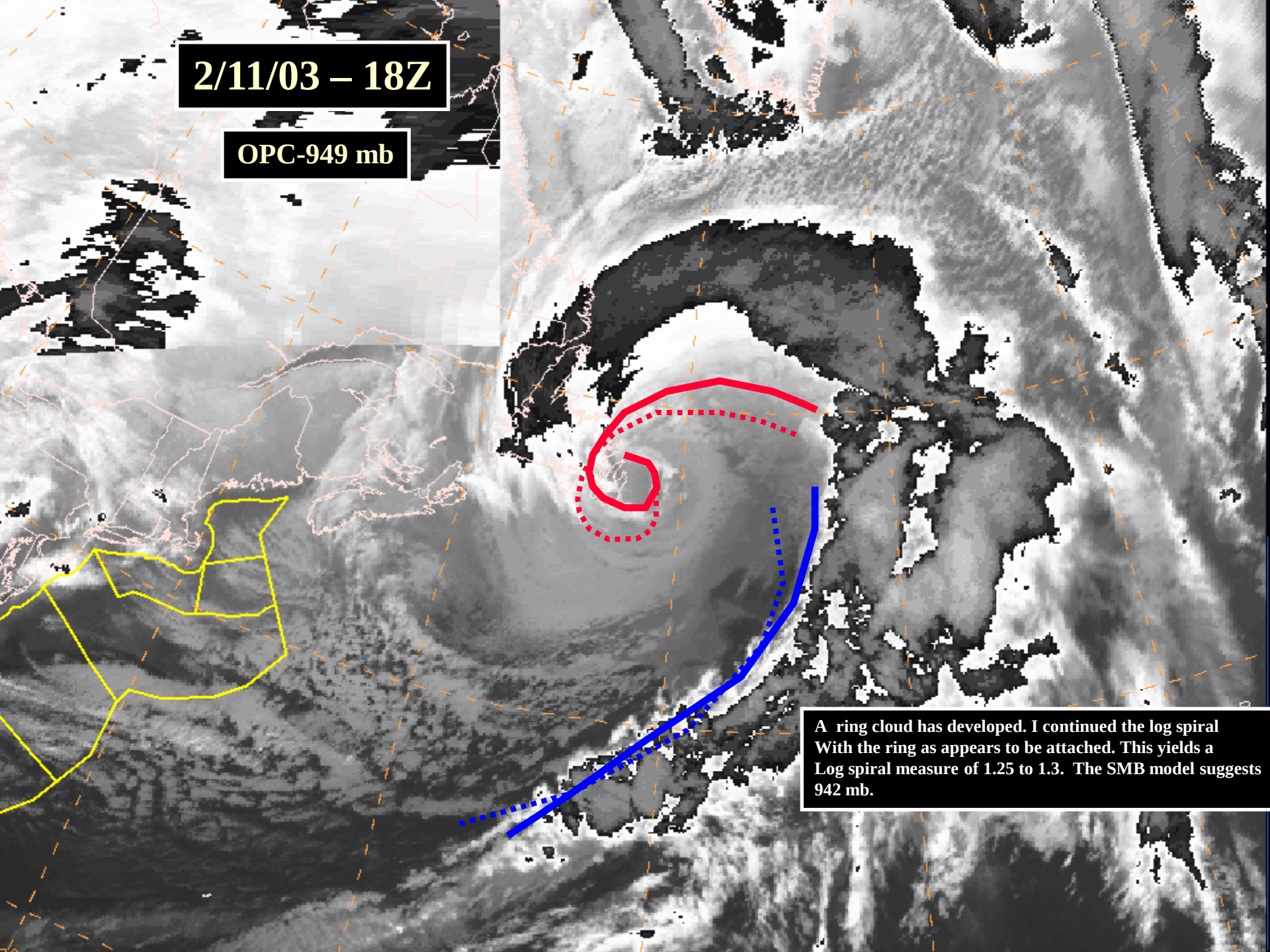

2/11/03 – 03Z
Previous comma tail
Previous Back edge
Baroclinic band
The comma tail swings E as the back edge
Of the BACLIN band amplifies and becomes
Alingned more N-S. The key through the evolution
is to compare the change in angle between the BACLN
band and the coma tail.
030211/0300 GOES10 IR4

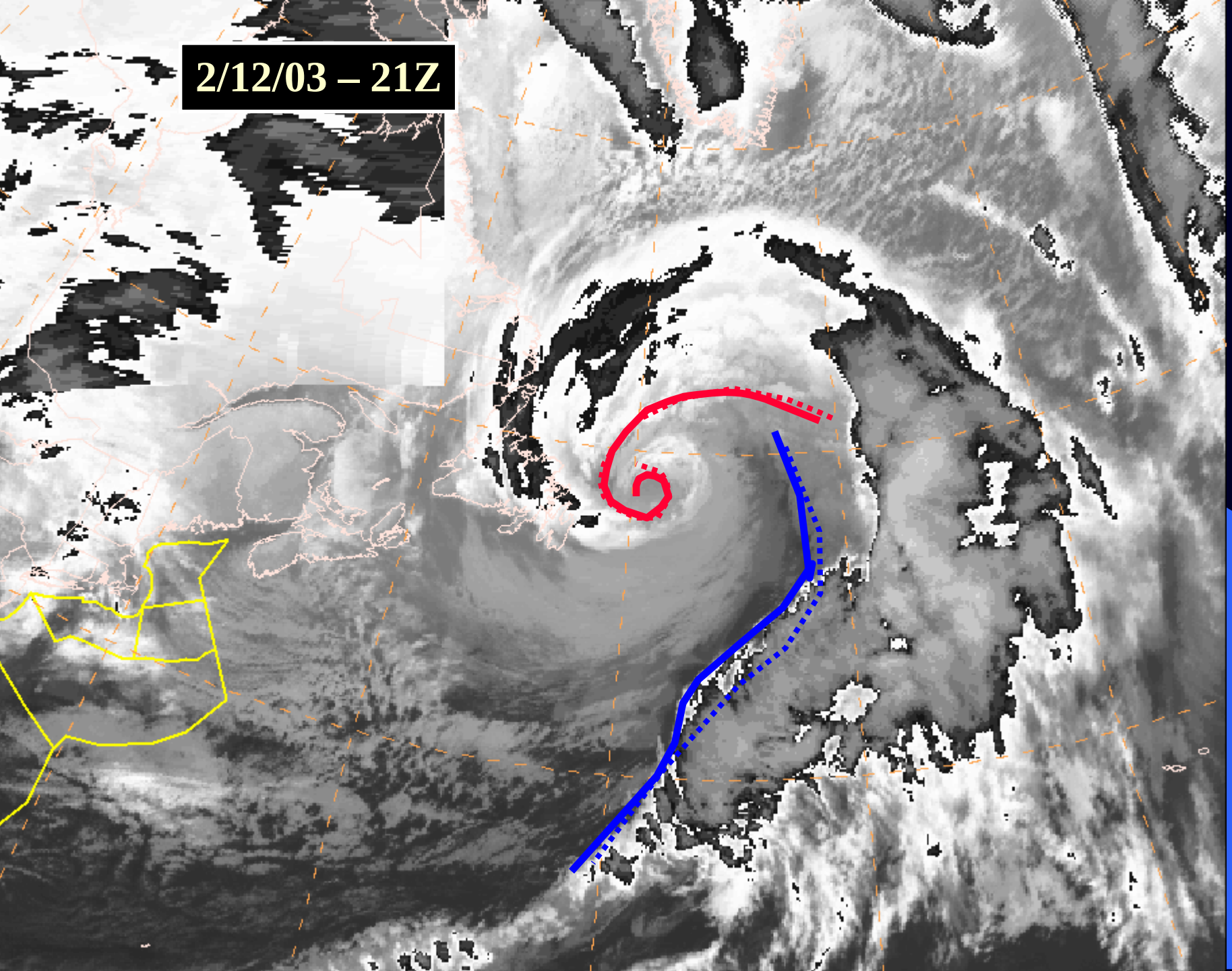

2/11/03 – 06Z
OPC-969 mb
40
30
-70
-60
-50
-40
The comma tail continues E as the back edge of the BACLN band amplifies and becomes aligned more N-S. The comma tail is no longer parallel to the back edge suggesting continued strengthening and a log spiral of about .65 or 980 mb.
030211/0600 GOES10 IR4

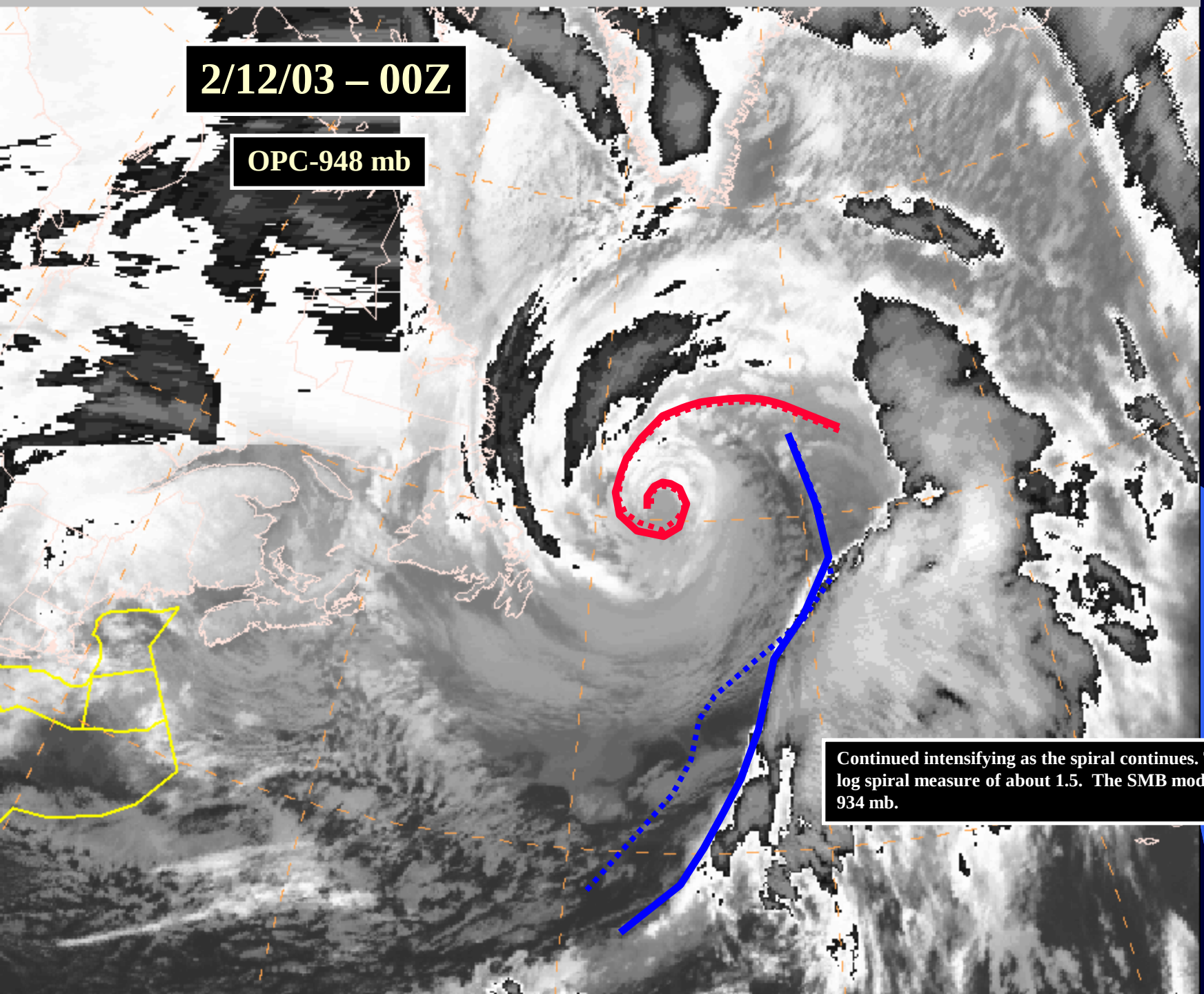

2/11/03 – 09Z
The comma tail really swings E as I follow the low cloud. The comma tail is now .75 to .80 around compared to the BACLIN band. The SMB model suggests 966 mb.
-70
-60
-50
-40
030211/0900 GOES10 IR4

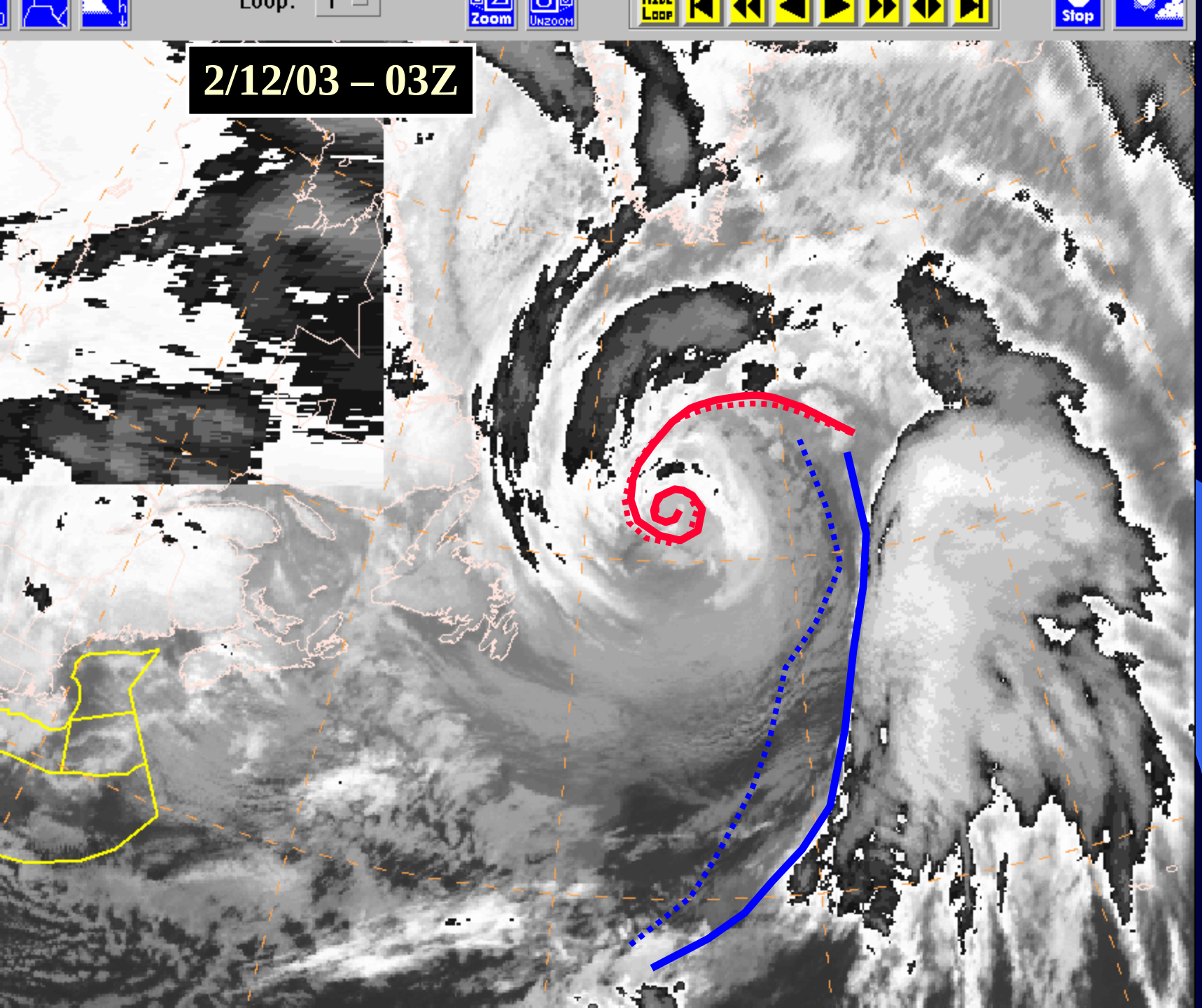

2/11/03 – 12Z
OPC-953 mb
In three hours the comma tail swings to the NE and is now
About .85 around compared
to the BACLIN band. The SMB model suggests 962 mb.
-70
-60
-50
-40

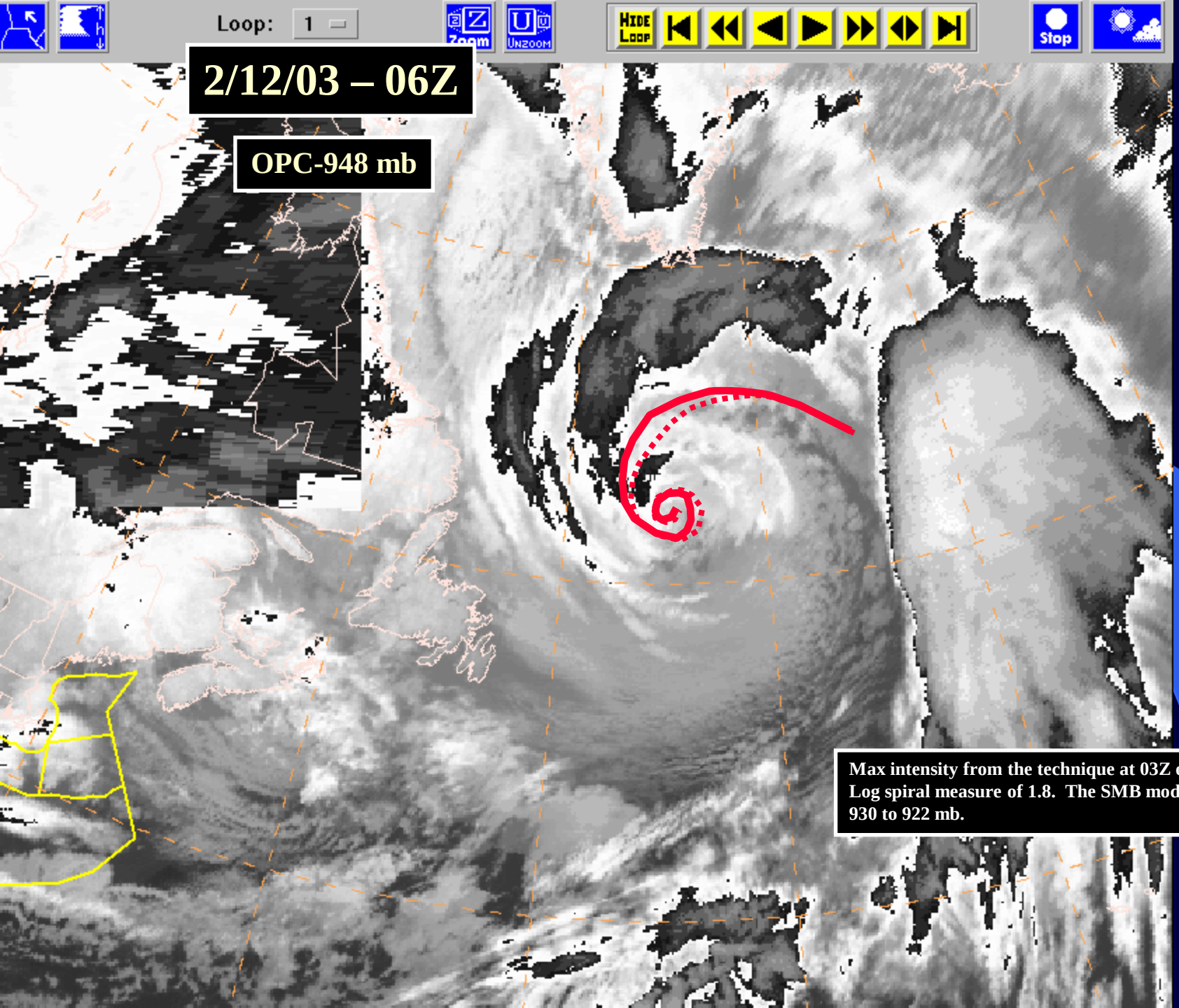

2/11/03 – 15Z

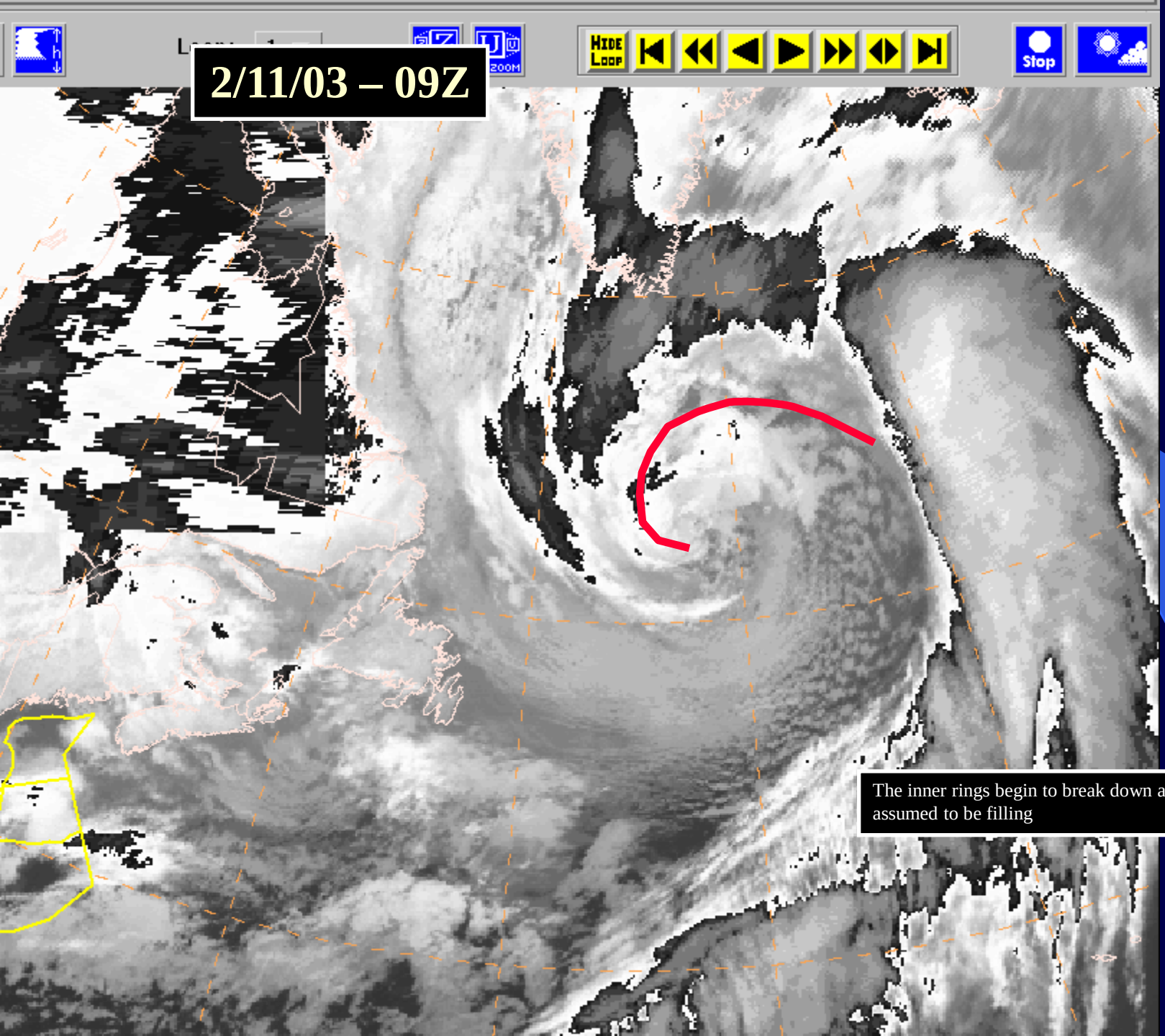

2/11/03 – 18Z
OPC-949 mb
A ring cloud has developed. I continued the log spiral
With the ring as appears to be attached. This yields a
Log spiral measure of 1.25 to 1.3. The SMB model suggests
942 mb.

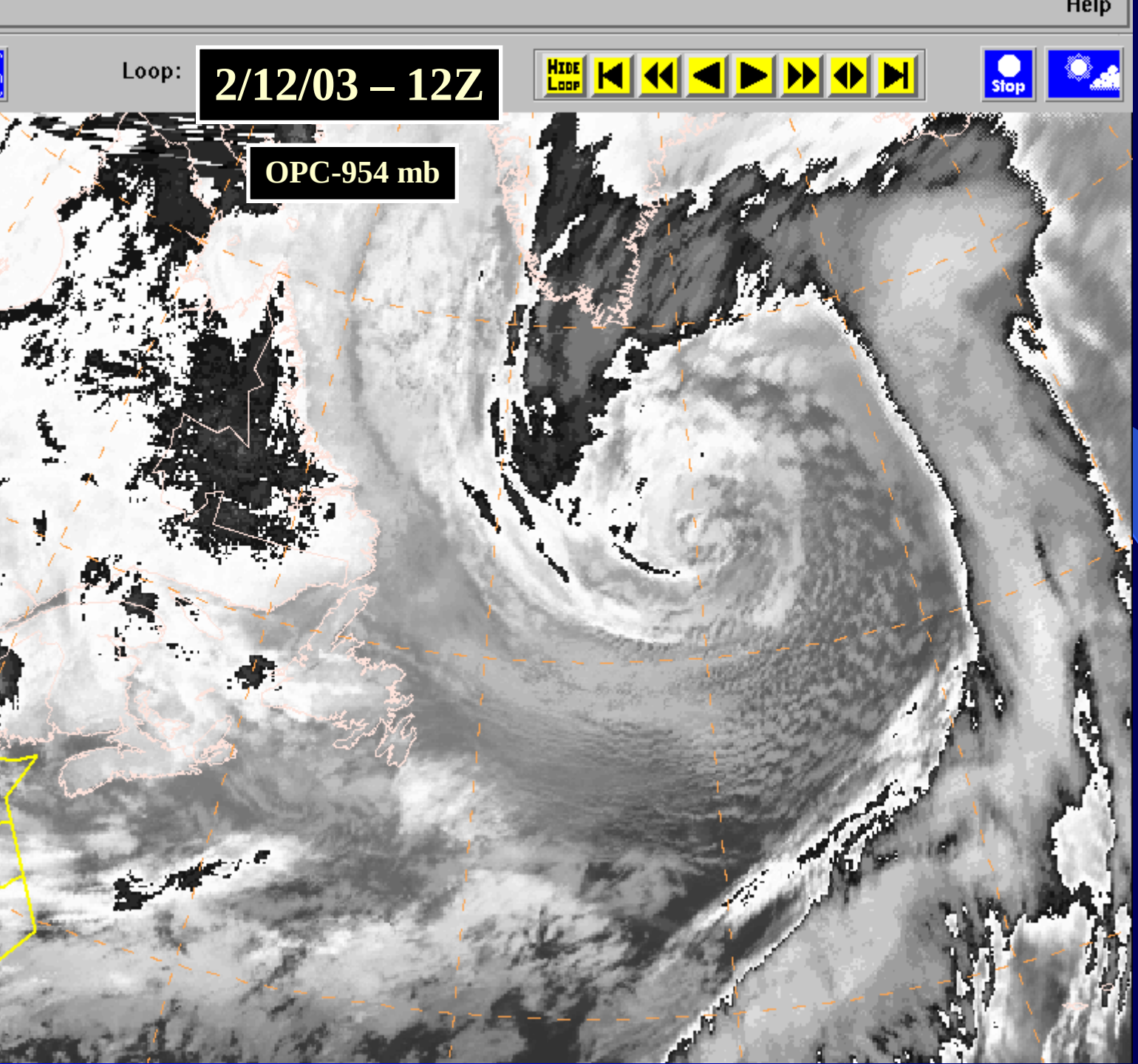

2/12/03 – 21Z

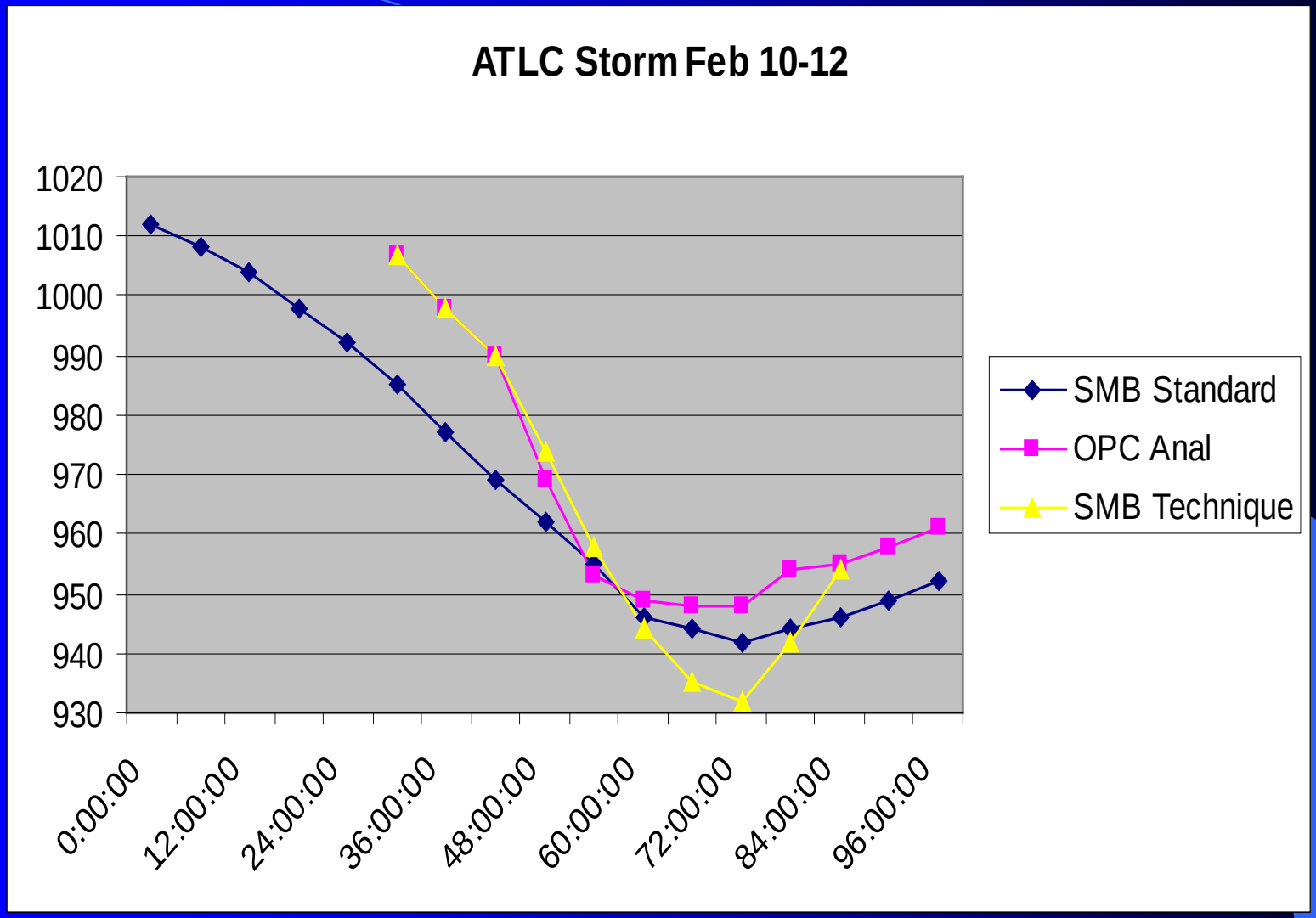

2/12/03 – 00Z
OPC-948 mb
Continued intensifying as the spiral continues. This yields a log spiral measure of about 1.5. The SMB model suggests 934 mb.


2/12/03 – 03Z


Loop: 1
Zoom
Unzoom
Hide Loop
Stop
2/12/03 – 06Z
OPC-948 mb
Max intensity from the technique at 03Z or 06Z. Log spiral measure of 1.8. The SMB model suggests 930 to 922 mb.


2/11/03 – 09Z
The inner rings begin to break down and the cyclone is assumed to be filling


Help
Loop:
2/12/03 – 12Z
Hide Loop
Stop
OPC-954 mb




I have applied the SMB technique a bit conservatively. I did look at the data used in the analyses and the storm passed near a drifting buoy near the time of maximum depth that only reached into the 950's. We did see south of NFLD an incredible pres gradient with 34 mb/3 hr pres rise. Does the technique work… for the most part but is not perfect. Obvious you must weigh the data that you have.

## Is there some use for us?

I think so…but not necessarily adopting the whole technique.

The lesson here is to look at the evolution and make a judgment about deepening or filling then TO BE AWARE OF THE PREVIOUS DEEPENING RATE(S) and apply a reasonable value. Again the goal is to avoid inconsistent deepening/filling rates.