Unusual Heavy Wet Snowstorm

October 4, 1987

Jonathan Finch *National Weather Service, Dodge City, KS*

Presented by :

Hayden Frank *National Weather Service, Taunton, MA*

Storm Details

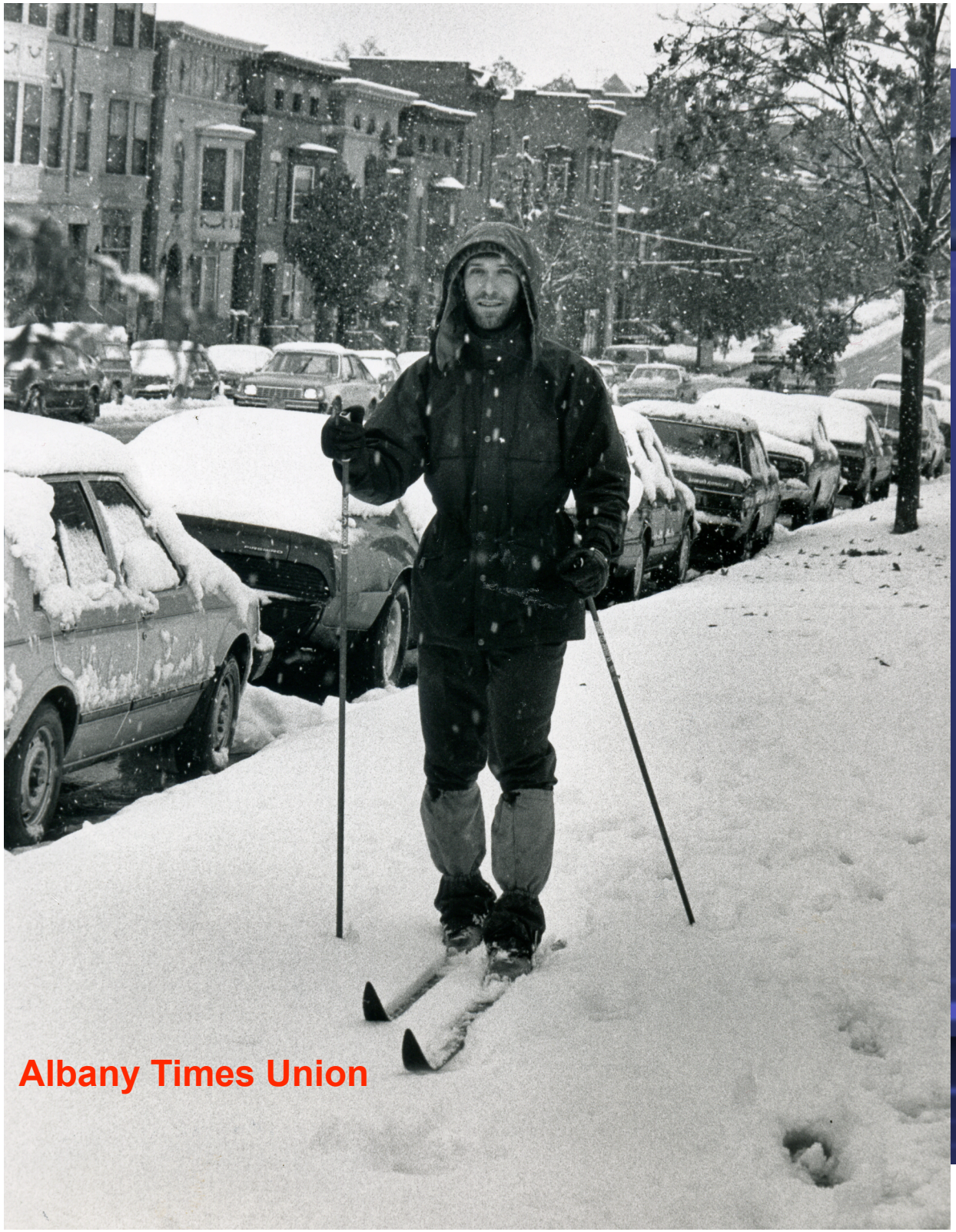
- This storm occurred when trees were fully leaved and near peak color.
- Downed limbs and trees caused widespread power outages.
- Many residents said that the breaking limbs sounded like rifle shots.
- Several hundred thousand people were without power, some for weeks.
- There were 20 storm related deaths and 300 injuries. A few of these deaths were from falling trees.

North Salem, NY
Westchester County

Brunswick, NY
Rensselaer County

Brunswick, NY
Rensselaer County

Brunswick, NY
Rensselaer County



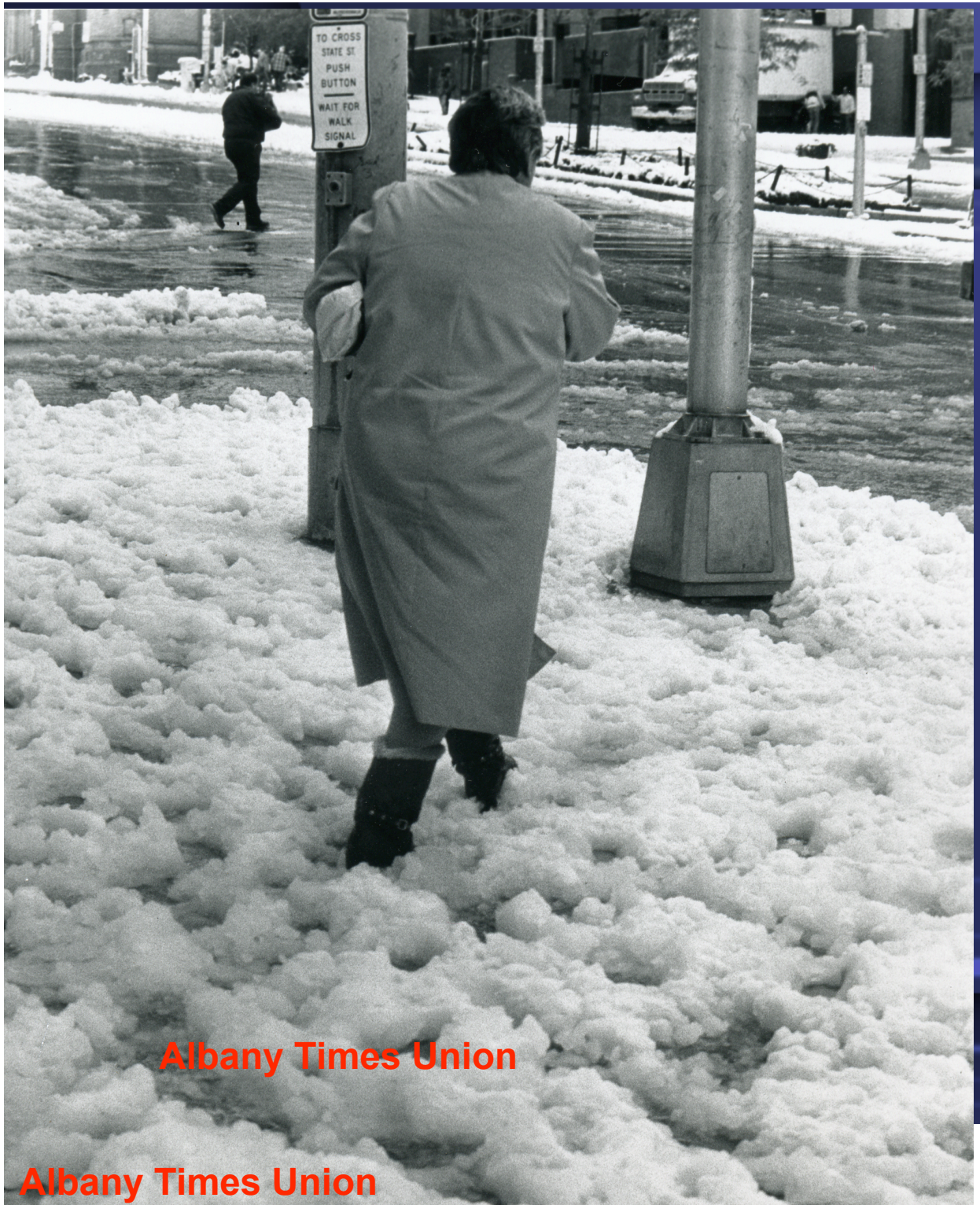
Albany Times Union

Albany, NY

Albany, NY

Albany Times Union

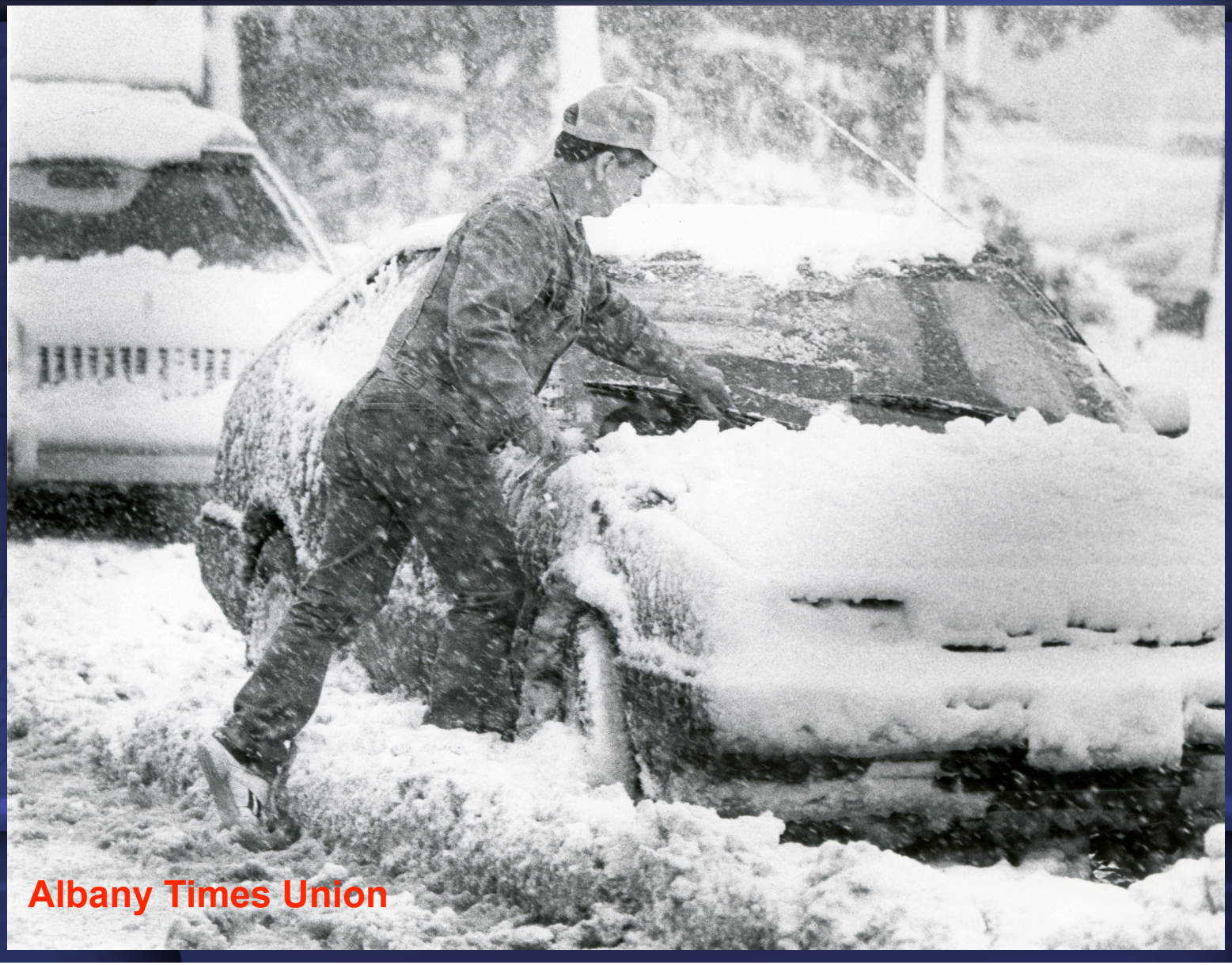
Albany, NY



Albany Times Union

Albany Times Union

Albany, NY



Albany Times Union

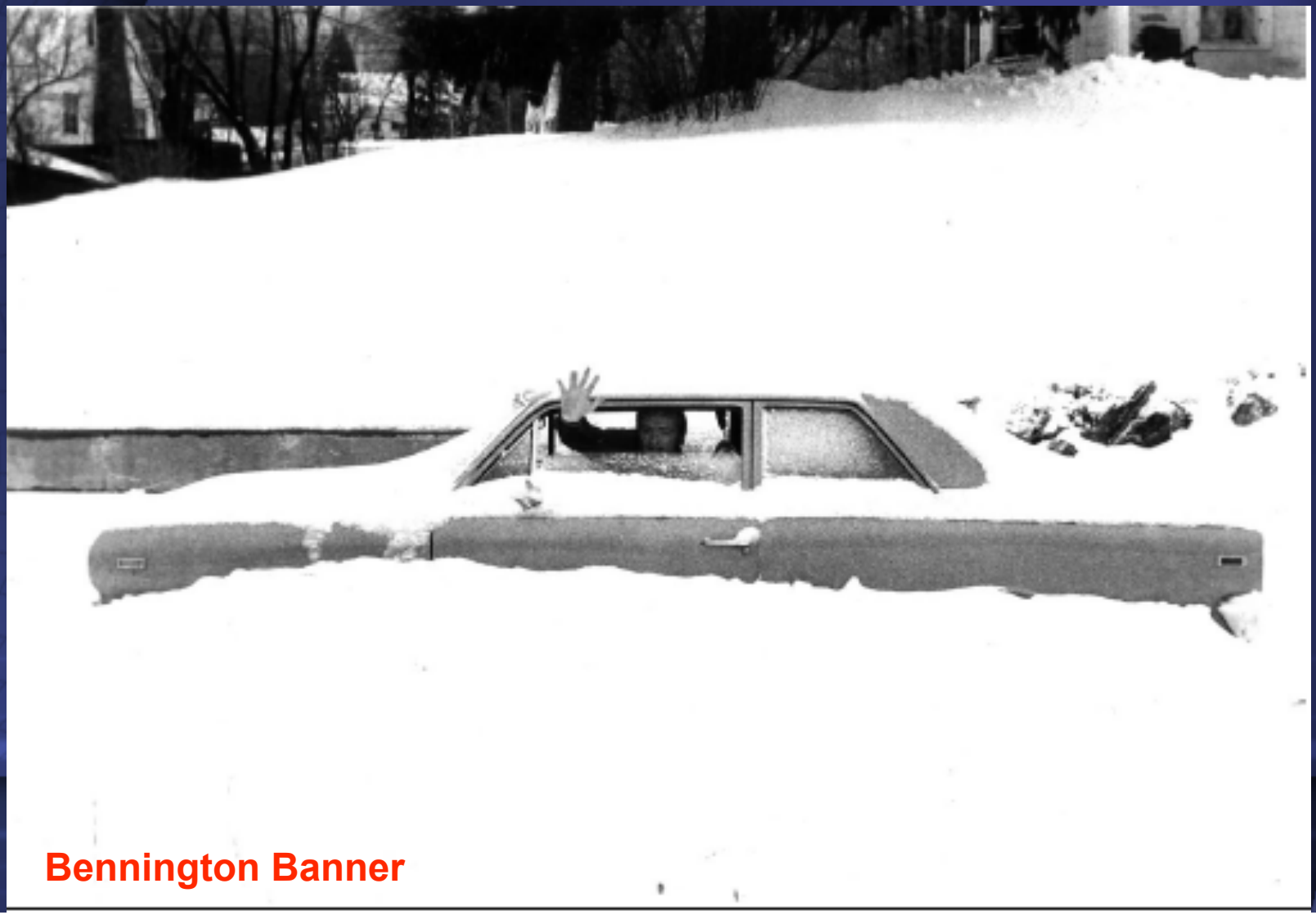
Bennington, VT

Bennington Banner

Bennington, VT

Bennington Banner

Bennington, VT



Bennington Banner

Bennington, VT

Bennington Banner

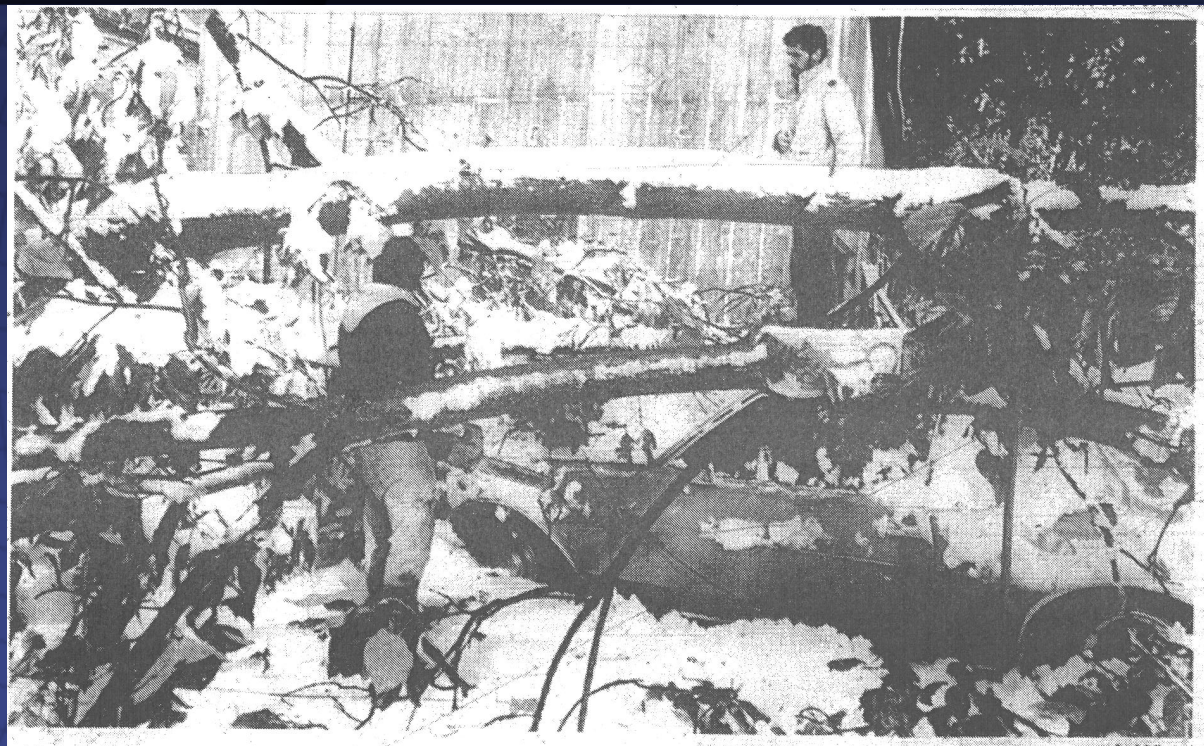
Bennington, VT

Bennington Banner

Bennington, VT

Pittsfield, MA

Berkshire Eagle



Joel Librizzi

LOOKING THINGS OVER are John Klein, standing on the roof of his Chevy, which amazingly suffered no serious damage, and Steven Van Bramer, who is about to free the car, parked off First Street.

'It just smashed the trees to pieces, it didn't matter if they were oak or birch or maple or whatever'

In the orchard: apples picked, trees broken

By Kimberly Donovan

RICHMOND — Francis Bartlett, owner of Bartlett's Orchard, escaped serious crop loss in yesterday's storm because his crew had finished picking the apples on Friday — but the trees in his orchard were damaged.

"We were lucky," he said, "if the trees had apples on them it would have been a disaster."

But he still has reason to worry. There is considerable damage to the orchard and Bartlett has yet to assess its extent. Large limbs have broken off many of the trees and every so often the cracking sound of a limb snapping shot through the orchard.

"There goes another one," said Bartlett sadly. Standing in over a foot of snow and surveying the sagging apple trees, he shakes his head and laughs.

"This is so bad you've got to laugh about it because there's nothing else you can do," he said.

Because the crop has been harvested, Bartlett's immediate concern is how the slender, young trees will withstand the weight of the snow.

"With young trees, you never know how they'll fare." His other worry is the power outage. The harvested apples are kept in a heavily insulated storage chamber that controls humidity and has a constant temperature of 33 degrees. If the power, which has been off in Richmond since early yesterday morning, is not restored by nightfall, the apples may begin to sweat, which could cause them to decay. Extended power loss is a problem Bartlett has never encountered before.

As a result of September's rain, Bartlett lost an estimated 6,000 bushels of apples that are now on the ground. When the snow melts, he hopes to salvage them for cider.

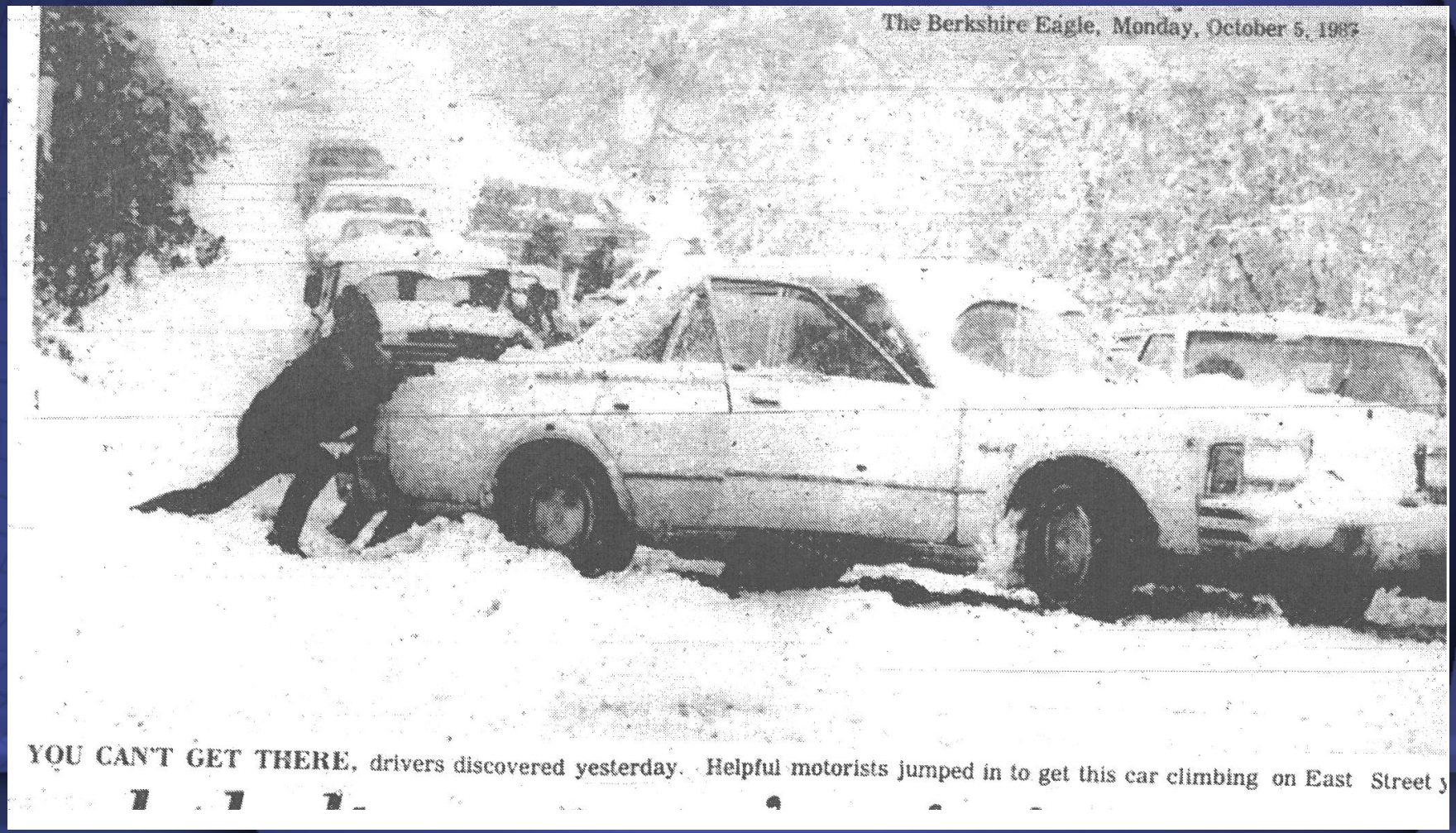
The seven Jamaican migrant workers Bartlett hired to pick apples this year were huddled in their trailer trying to get warm after a morning of playing and sledding in the snow. They had never seen snow before and thought it was a great surprise. But Bartlett, who has seen plenty of it, was even more surprised. "I've never seen anything like this before. Never."

The phone was ringing off the hook with people asking if the store was open. Bartlett's response?

"Have you looked outside? Stay home."

Pittsfield, MA

Berkshire Eagle



The Berkshire Eagle, Monday, October 5, 1987

YOU CAN'T GET THERE, drivers discovered yesterday. Helpful motorists jumped in to get this car climbing on East Street y

East of Broome, NY (elev. 1500 ft)
Schoharie county

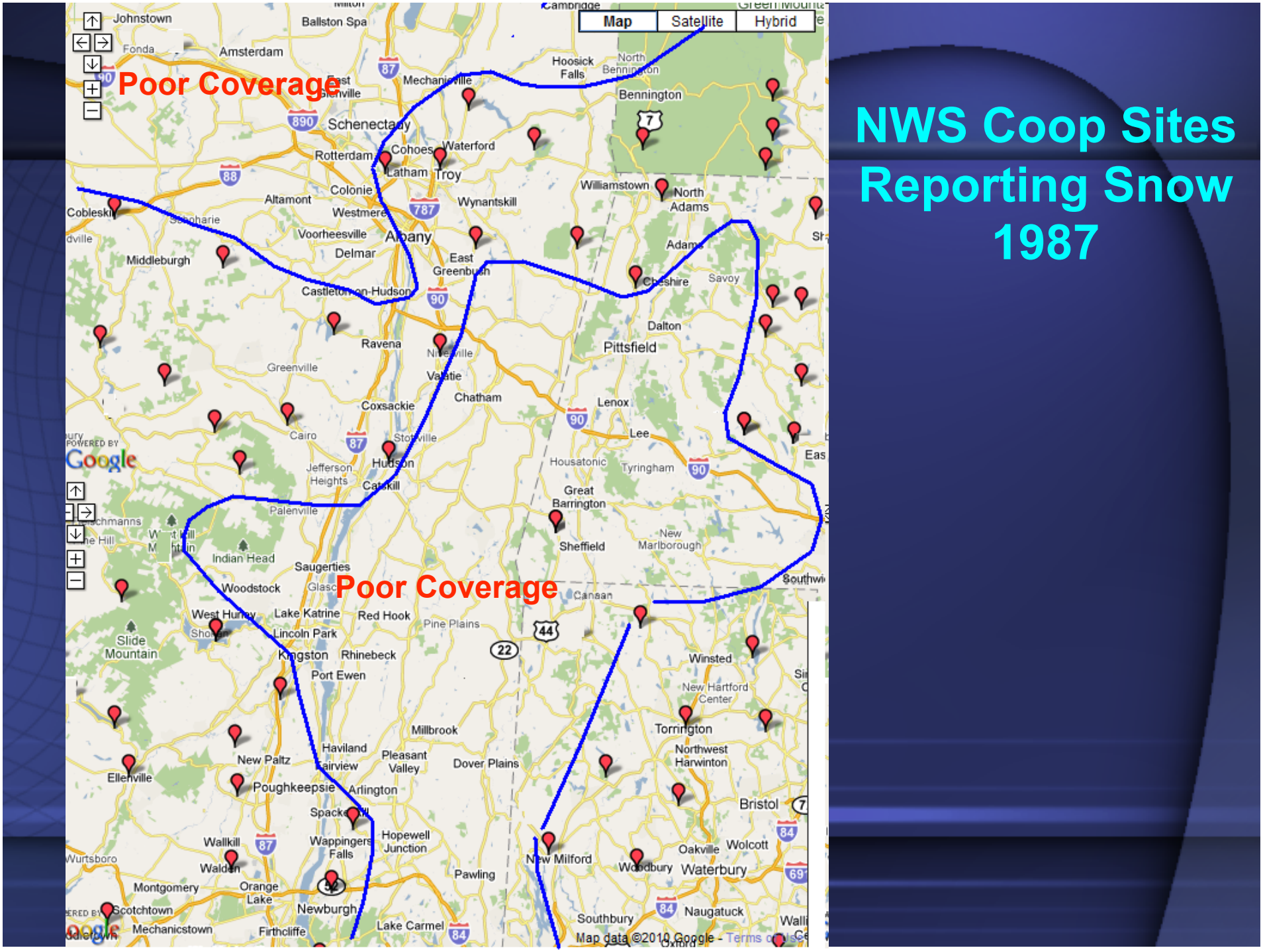
Betty Chichester

East of Broome, NY (elev. 1500 ft)
Schoharie county

Betty Chichester

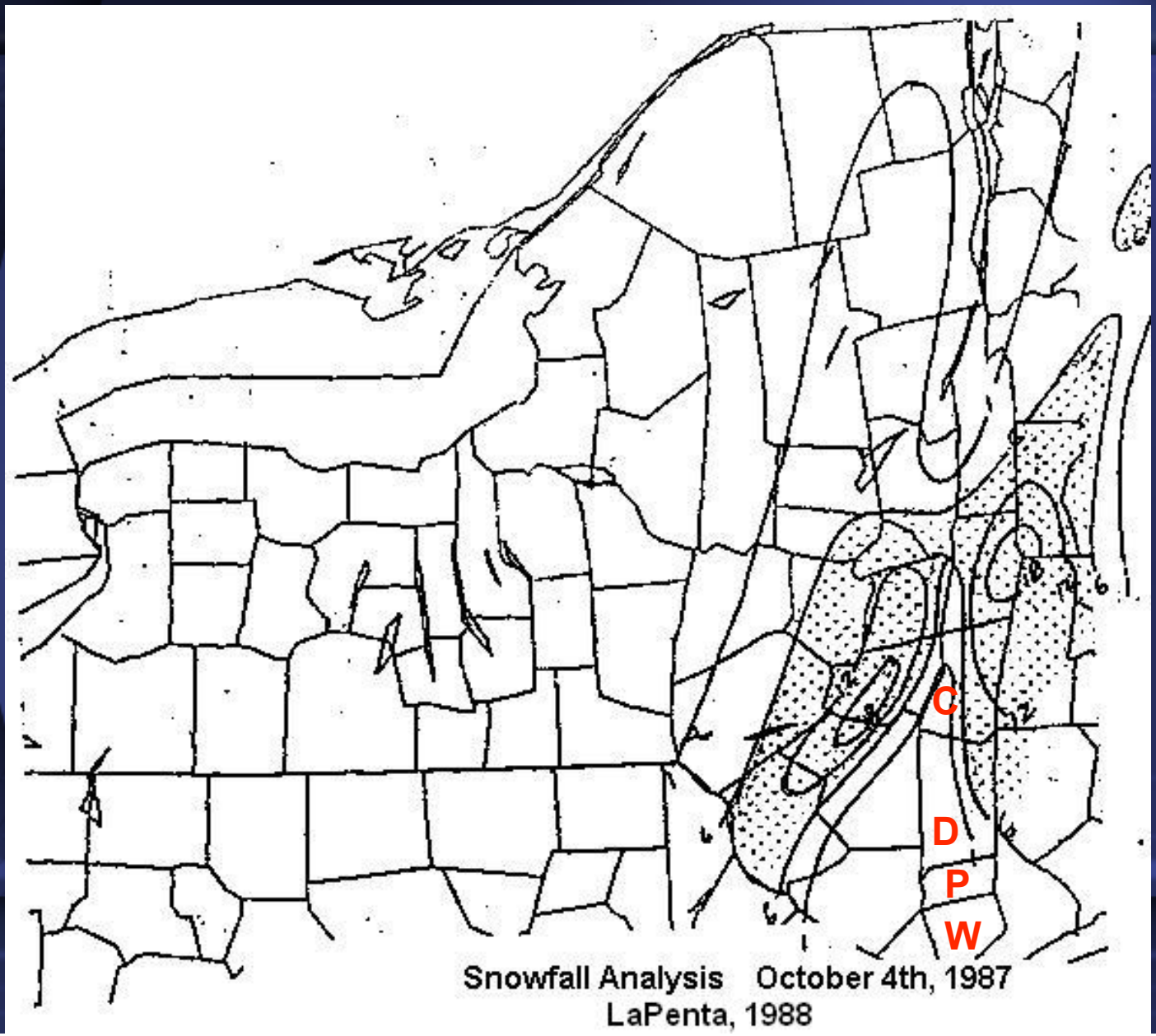
East of Broome, NY (elev. 1500 ft)
Schoharie county

Previous Snowfall Documentation



NWS Coop Sites Reporting Snow 1987

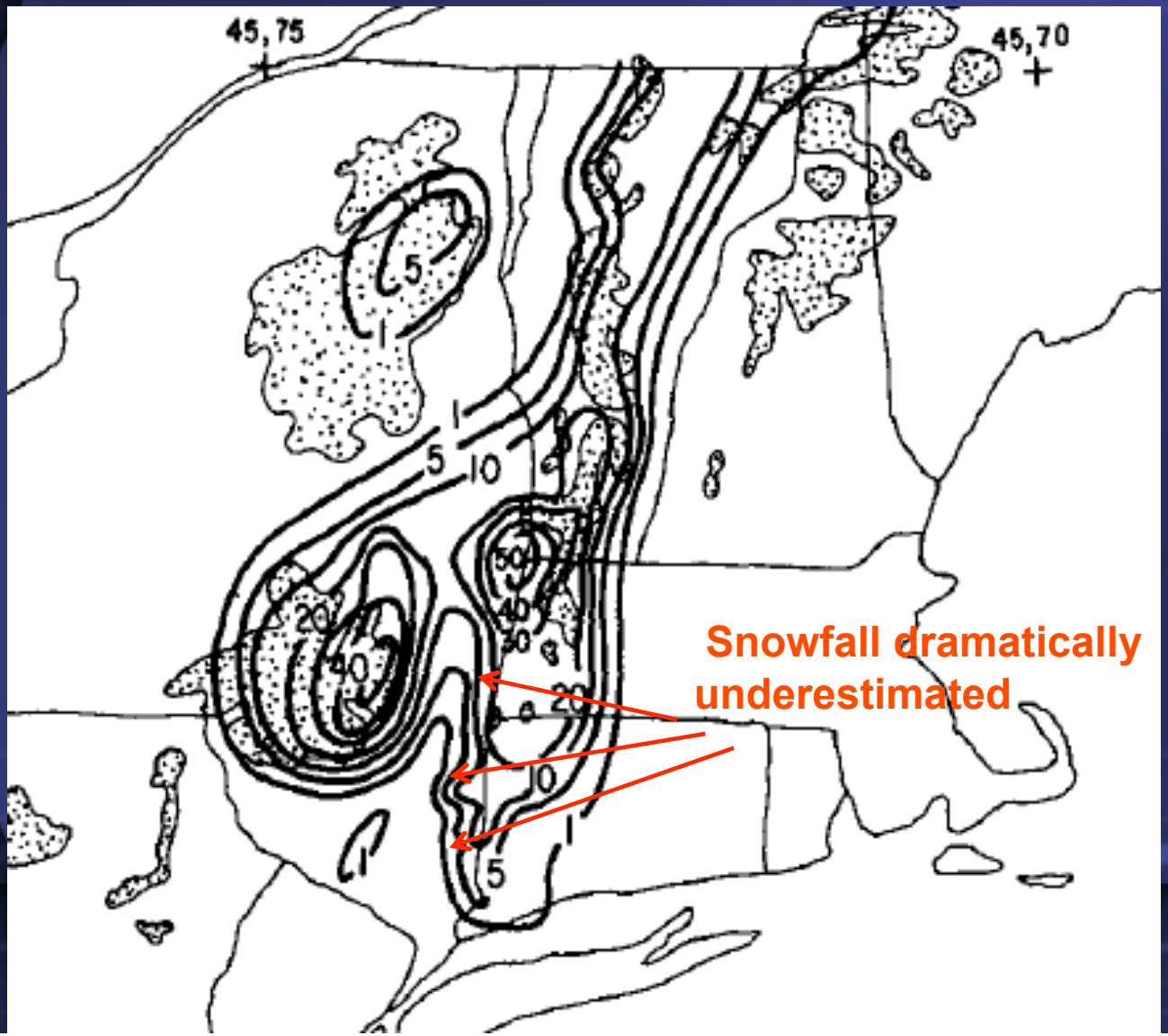
Snowfall Analysis (La Penta 1988)



Snowfall Analysis (La Penta 1988)…

- Adequate for area with good cooperative observer coverage.
- Inadequate for areas with little or no cooperative observers, especially from southern Rensselaer county southward into northern Westchester county.
- Claimed that snow-water ratios were as low as 3.5 to 1.

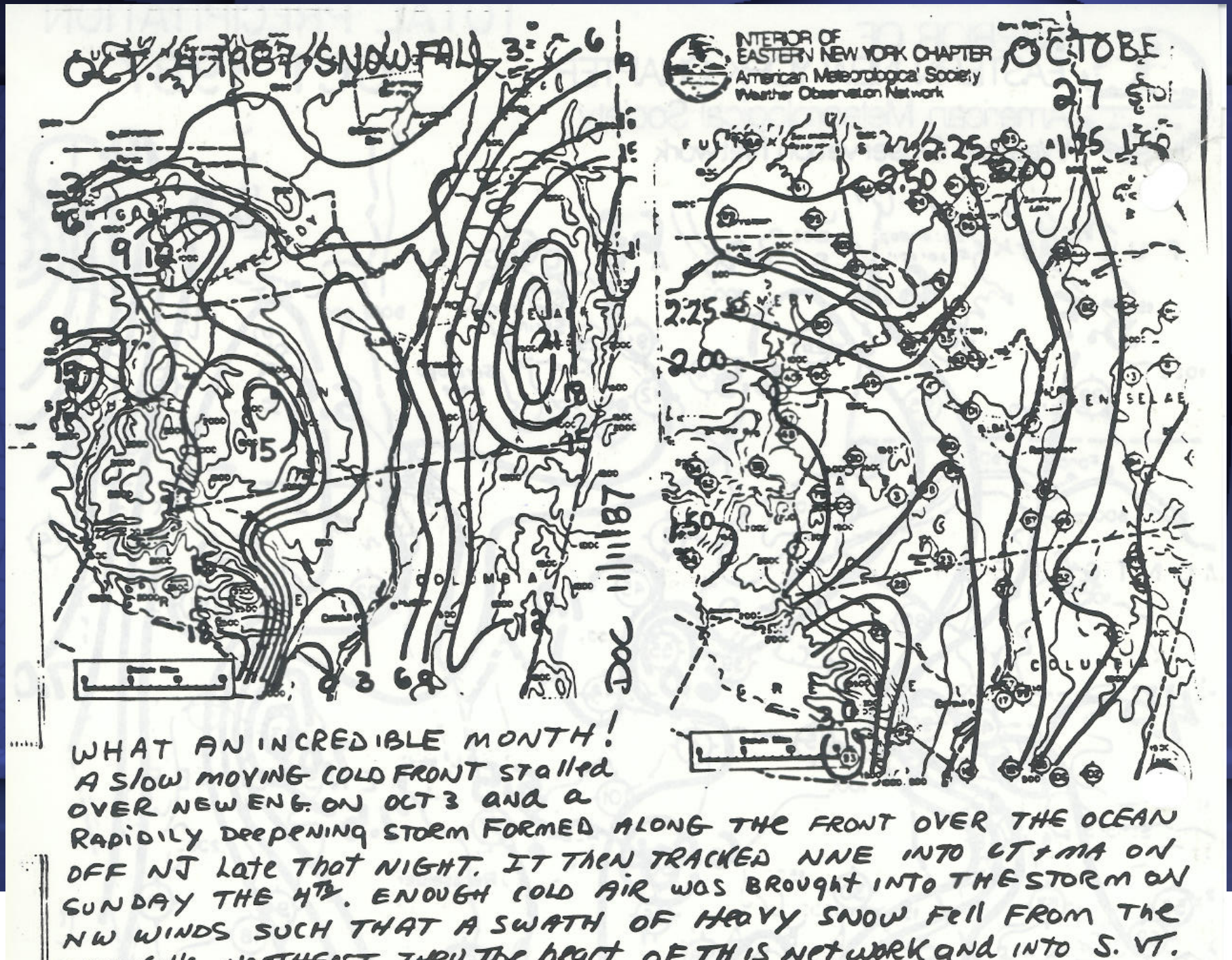
Snowfall Analysis (Bosart & Sanders 1991)



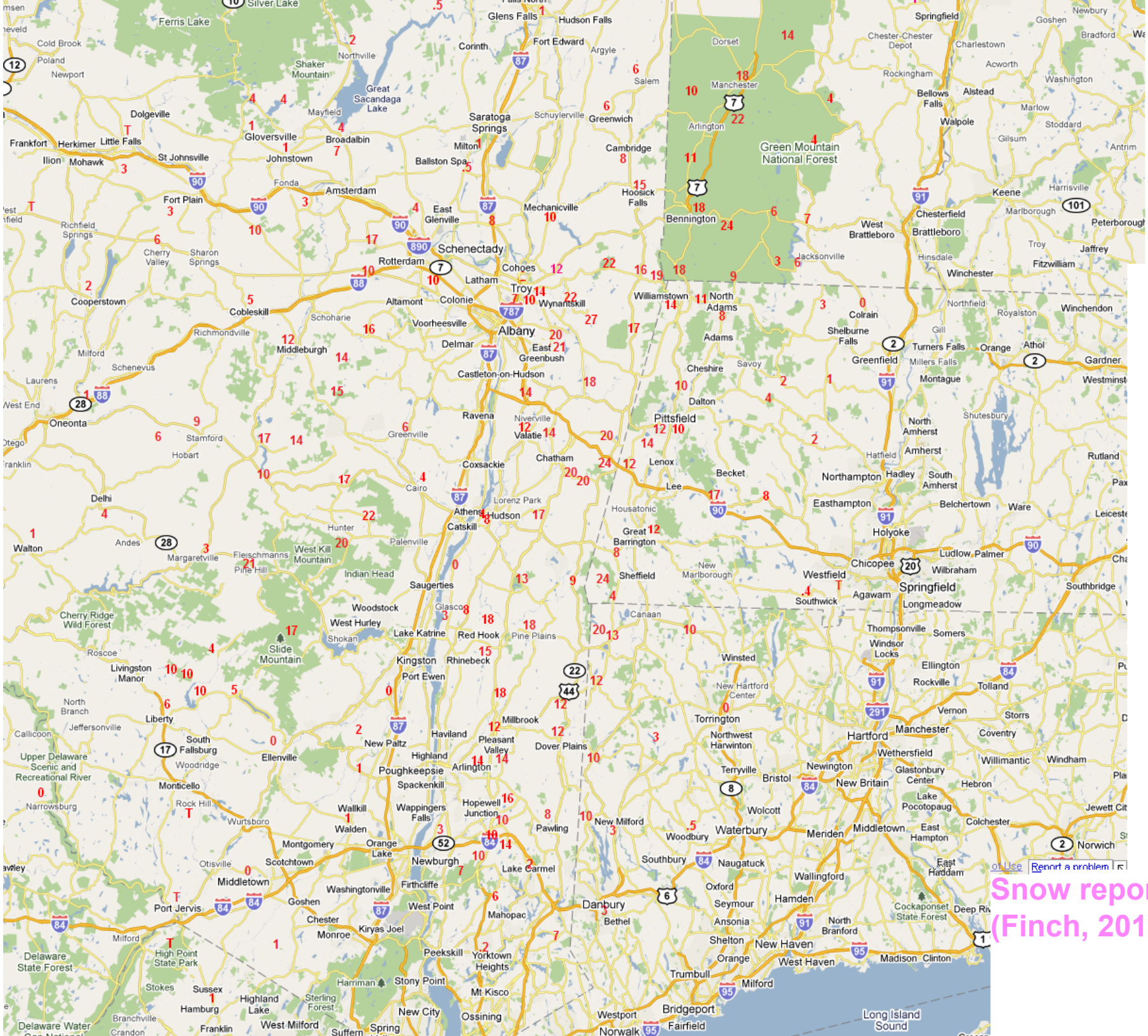
Combined Snow Documentation
(Finch, 2010)

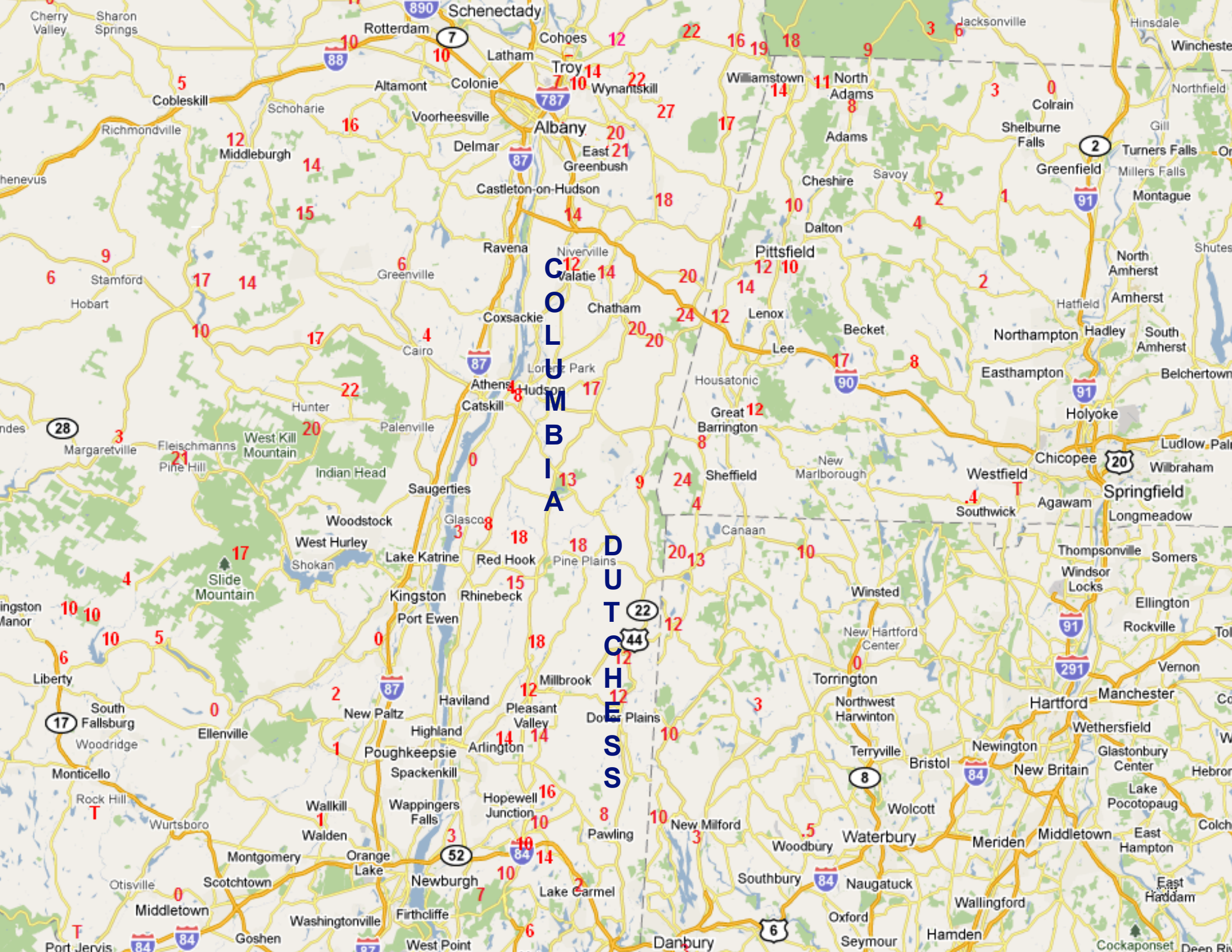
- Interior Eastern NY Weather Observation Network
- Local Historians
- Local Newspapers
- Weather Hobbyists

Interior Eastern NY Weather Observation Network

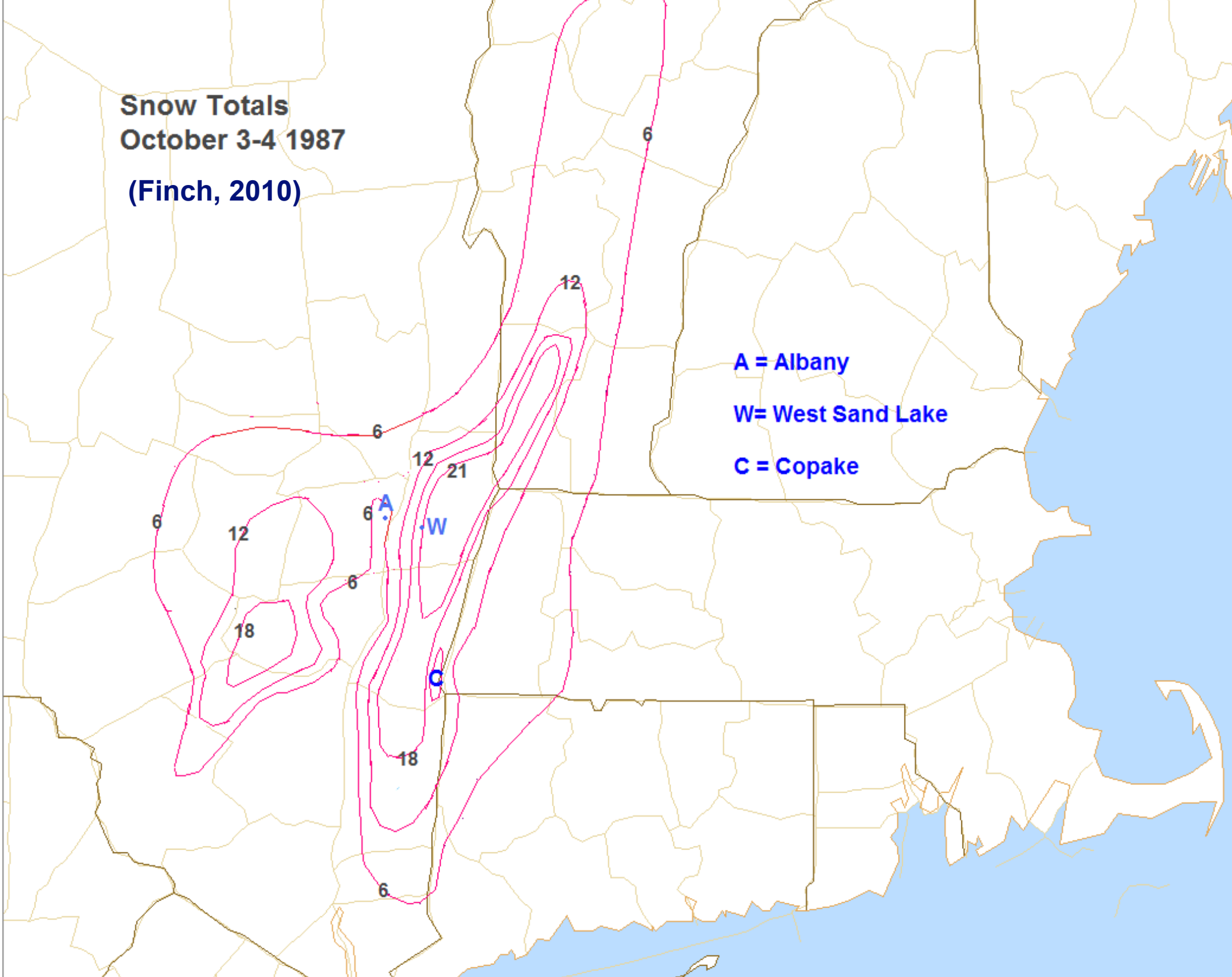


WHAT AN INCREDIBLE MONTH! A SLOW MOVING COLD FRONT STALLED OVER NEW ENG. ON OCT 3 AND A RAPIDLY DEEPENING STORM FORMED ALONG THE FRONT OVER THE OCEAN OFF NJ LATE THAT NIGHT. IT THEN TRACKED NNE INTO CT & MA ON SUNDAY THE 4TH. ENOUGH COLD AIR WAS BROUGHT INTO THE STORM ON NW WINDS SUCH THAT A SWATH OF HEAVY SNOW FELL FROM THE [illegible] NORTHEAST THRU THE HEART OF THIS NETWORK AND INTO S. VT.


Snow reports
(Finch, 2010)


COLUMBIA
DUTCHESS
Schenectady
Troy
Albany
Rotterdam
Cohoes
Latham
Colonie
Altamont
Voorheesville
Delmar
Cobleskill
Schoharie
Richmondville
Middleburgh
Castleton-on-Hudson
Ravena
Niverville
Valatie
Greenville
Stamford
Hobart
Coxsackie
Chatham
Cairo
Athens
Hudson
Catskill
Lonely Park
Hunter
Palenville
West Kill Mountain
Fleischmanns
Pine Hill
Margaretville
Indian Head
Saugerties
Woodstock
West Hurley
Shokan
Slide Mountain
Lake Katrine
Red Hook
Glasco
Kingston
Rhinebeck
Port Ewen
Pine Plains
Millbrook
Dover Plains
Pleasant Valley
Haviland
New Paltz
Ellenville
Highland
Poughkeepsie
Arlington
Spackenkill
Wallkill
Walden
Wappingers Falls
Hopewell Junction
Pawling
Montgomery
Orange Lake
Newburgh
Lake Carmel
Otisville
Scotchtown
Middletown
Washingtonville
Firthcliffe
West Point
Goshen
Port Jervis
Monticello
Rock Hill
Wurtsboro
Liberty
South Fallsburg
Woodridge
Williamstown
North Adams
Adams
Cheshire
Dalton
Pittsfield
Lenox
Becket
Lee
Housatonic
Great Barrington
Sheffield
New Marlborough
Canaan
Colrain
Shelburne Falls
Greenfield
Savoy
Millers Falls
Montague
Turners Falls
Gill
Northfield
Jacksonville
Hinsdale
Winchester
North Amherst
Amherst
Hatfield
Northampton
Hadley
South Amherst
Easthampton
Belchertown
Holyoke
Chicopee
Ludlow
Wilbraham
Springfield
Agawam
Longmeadow
Westfield
Southwick
Thompsonville
Somers
Windsor Locks
Ellington
Rockville
Vernon
Winsted
New Hartford Center
Torrington
Northwest Harwinton
Hartford
Manchester
Wethersfield
Newington
Bristol
New Britain
Glastonbury Center
Terryville
Lake Pocotopaug
Wolcott
Waterbury
Meriden
Middletown
East Hampton
Woodbury
New Milford
Southbury
Naugatuck
Wallingford
Oxford
Seymour
Hamden
Danbury
Cockaponset
East Haddam
Deep River


PUTNAM
Westchester
Athens
Hudson
Catskill
Hunter
Palenville
Margaretville
Fleischmanns
Pine Hill
West Kill Mountain
Indian Head
Saugerties
Woodstock
Glasco
West Hurley
Shokan
Lake Katrine
Red Hook
Pine Plains
Slide Mountain
Kingston
Rhinebeck
Port Ewen
Livingston Manor
Liberty
South Fallsburg
Woodridge
Ellenville
New Paltz
Haviland
Highland
Millbrook
Pleasant Valley
Dover Plains
Arlington
Poughkeepsie
Spackenkill
Monticello
Rock Hill
Wurtsboro
Wallkill
Walden
Wappingers Falls
Hopewell Junction
Pawling
New Milford
Montgomery
Orange Lake
Newburgh
Otisville
Scotchtown
Middletown
Lake Carmel
Washingtonville
Firthcliffe
Port Jervis
Goshen
West Point
Mahopac
Danbury
Bethel
Chester
Monroe
Kiryas Joel
Peekskill
Yorktown Heights
High Point State Park
Harriman
Stony Point
Mt Kisco
Stokes
Sussex
Hamburg
Highland Lake
Sterling Forest
New City
Ossining
Franklin
West Milford
Suffern
Spring Valley
Nanuet
Newton
Wanaque
Ramsey
Pearl River
Stamford
Oakland
Wyckoff
Hillsdale
White Plains
Greenwich
Lake Mohawk
Ridgewood
Eastchester
Harrison
Hopatcong
Wayne
Paramus
Yonkers
New Rochelle
Boonton
Paterson
Teaneck
Hackensack
Dover
Clifton
Glen Cove
Housatonic
Great Barrington
Sheffield
New Marlborough
Canaan
Easthampton
Holyoke
Chicopee
Westfield
Springfield
Agawam
Southwick
Longmeadow
Ludlow
Wilbraham
Thompsonville
Somers
Windsor Locks
Winsted
Ellington
Rockville
New Hartford Center
Torrington
Vernon
Manchester
Hartford
Northwest Harwinton
Wethersfield
Terryville
Bristol
Newington
New Britain
Glastonbury Center
Wolcott
Lake Pocotopaug
Woodbury
Waterbury
Meriden
Middletown
East Hampton
Southbury
Naugatuck
East Haddam
Wallingford
Oxford
Hamden
Seymour
Cockaponset State Forest
Ansonia
North Branford
Shelton
New Haven
Orange
West Haven
Madison
Clinton
Trumbull
Milford
Bridgeport
Westport
Fairfield
Norwalk
Darien
Long Island Sound
Southold
Mattituck
Miller Place
Riverhead
Northport
East Northport
Terryville
Ridge
Tuckahoe
Huntington Station
Commack
Coram
Manorville
Hampton


Snow Totals
October 3-4 1987
(Finch, 2010)
A = Albany
W= West Sand Lake
C = Copake
6
12
6
12
21
6
A
W
6
12
6
18
C
18
6

Daily Temperatures

Milbrook, NY (Dutchess county)

	HI	LO	AVG
10-Sep	82	57	69
11-Sep	67	52	59
12-Sep	66	57	61
13-Sep	66	59	62
14-Sep	75	59	67
15-Sep	69	57	63
16-Sep	71	51	61
17-Sep	70	62	66
18-Sep	64	50	57
19-Sep	64	59	64
20-Sep	61	59	60
21-Sep	70	50	60
22-Sep	70	52	61
23-Sep	68	57	62
24-Sep	67	59	63
25-Sep	64	39	51
26-Sep	59	31	45
27-Sep	70	30	50
28-Sep	70	50	60
29-Sep	69	49	59
30-Sep	68	57	62
1-Oct	60	50	55
2-Oct	60	39	50
3-Oct	58	40	49

MF 1-10A
(5-83)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

SURFACE WEATHER OBSERVATIONS

STATION **ALBANY, N.Y. (COUNTY AIRPORT)**

DATE **OCT 0 4 1987**

TO CONVERT LST TO GMT ADD 5 hrs. SUBTRACT ____ hrs.

TYPE (1)	TIME (LST) (2)	SKY AND CEILING (Hundreds of Feet) (3)	VISIBILITY (Miles) SURFACE (4)	VISIBILITY (Miles) TOWER (4a)	WEATHER AND OBSTRUCTIONS TO VISION (5)	SEA LEVEL PRESS. (Mbs.) (6)	TEMP. (°F) (7)	DEW PT. (°F) (8)	WIND DIRECTION (00-36) (9)	WIND SPEED (Kts.) (10)	WIND CHARACTER (11)	ALTIM. SETTING (Ins.) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (13)	OBSERVER'S INITIALS (15)
SA	0050	7 SCT M14 OVC	7		R-	116	38	37	35	13		988	8343 1 172 / 60	HPT
/	725	18 11361 83573 10033 20028		30010	40116	58	034	600	81				76166 84724	/
/		333 10156 20033 70216	90	573 =										HPT
RS	0150	M7 OVC	3		R-IP-F	100	35	34	32	16		983	IPB49	HPT
SA	0250	M7 OVC	3		R-IP-S-									/
/					F	093	35	34	32	12		981	SB06 98000	HPT
RS	0350	E6 OVC	2		R-S-F	085	34	33	32	10		979	IPE43 63043 17//	HPT
SA	0450	E6 OVC	2		R-S-F	079	34	33	32	16		977		HPT
SP	0547	W5X	3/4		S-F				32	16		975	*WET SNW *RIGHT60	RM
SA	0550	W5X	3/4		S-F	075	33	33	32	16		975	RIGHT60 WET SNW RE45	RM
SA	0610	W5X	3/4		S-F	075	33	33	33	14		975	~~RIGHT60~~ WET SNW	RM
/									61430		ONE		20190 90401 33	/
/	725	8 11/12 93314 10006 20006	3	99/66	40725	56	014		60331		7717		7 333 10156 20006	/
/							4/00		3 70483			90	103 90783 =	/
SP	0735	W2X	1/2		SF				31	13		975	WET SNW	RM
SP	0739	W2X	1/2		TSF				32	12		975	TB37	RM
RS	0753	W2X	1/2		SF	075	33	33	31	13		975	TB37E52 SNOINCR 1/1/2	RM
/													TSTMS W AT SCH	/
SA	0850	W2X	1/2		S-F	078	33	33	31	15		976	WET SNW SNOINCR 1/2/3	RM
RS	0956	W5X	1/2		S-F	084	33	33	31	15		977	WET SNW SNOINCR 1/3/4	RM
/													30797 90404	/
SA	1050	W5X	1/2		S-F	092	33	32	32	18		979	WET SNW	RM
SA	1150	W5X	1/2		S-F	095	33	33	31	18		980	WET SNW	RM
SP	1226	E 8 OVC	2 1/2		S-F				31	20		980		RM
RS	1250	E 10 OVC	3		S-F	095	36	32	31	18		980	11243 ONE 19// 33	RM
/													90222 90405	/

Bosart & Sanders, 1991 Commentary on Albany Observations

"The official reports of light snow, aside from the 13 UTC observations of heavy snow, are misleading given the observed precipitation intensity and the local whiteout conditions."

Snow to Liquid Ratios

- Snow ratios were problematic since:

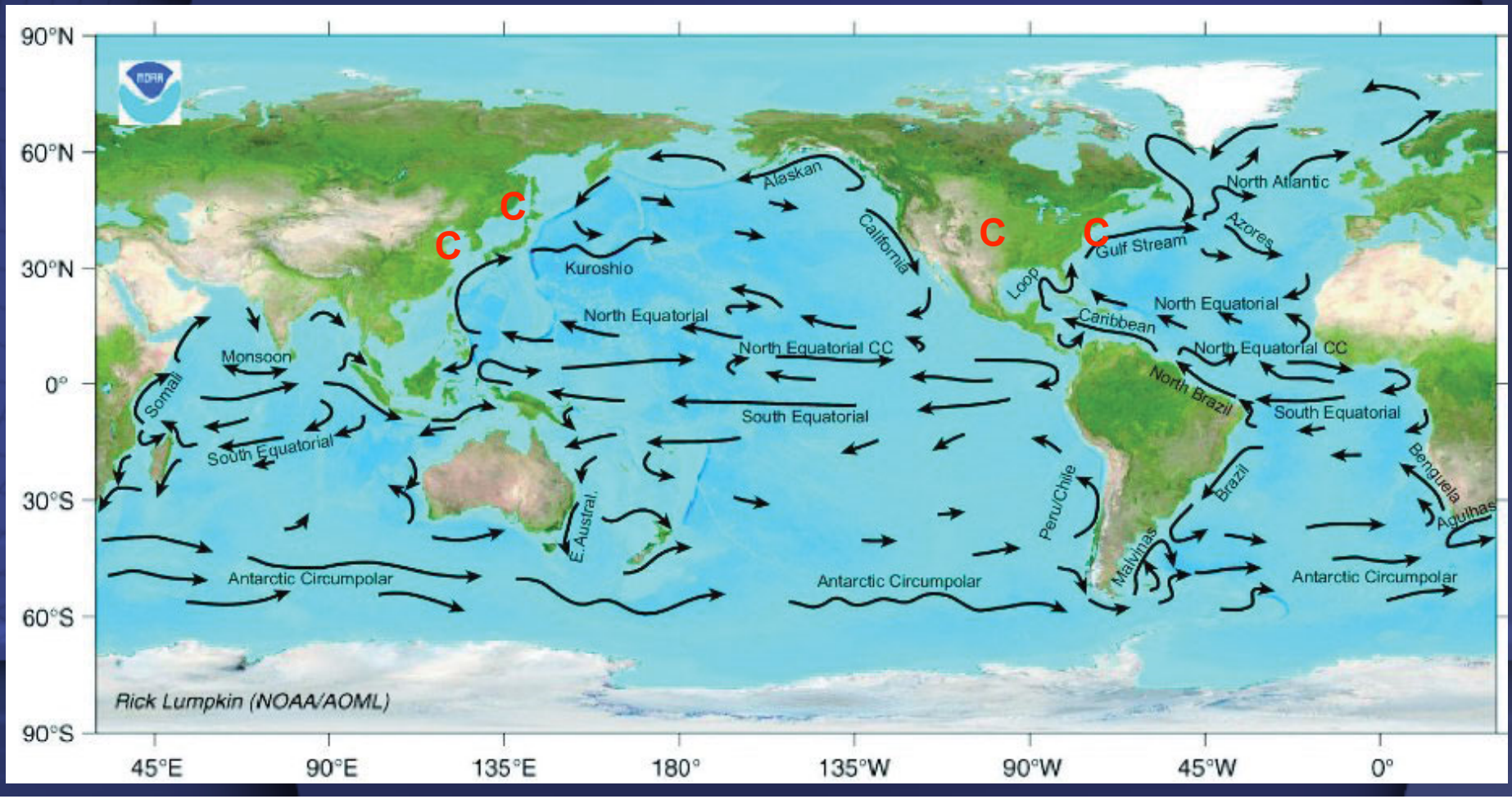
1. A large portion of the total system QPF was liquid
2. Previous heavy rains resulted in soaked ground with ponding of water
3. The ground was warm in early October resulting in strong melting as the snow fell
4. A slush layer developed at the bottom of the snow pack

- Snow ratios of 6 or 7 to 1 are believable but not 3.5 to 1 as some have claimed.

A look at Cyclogenesis

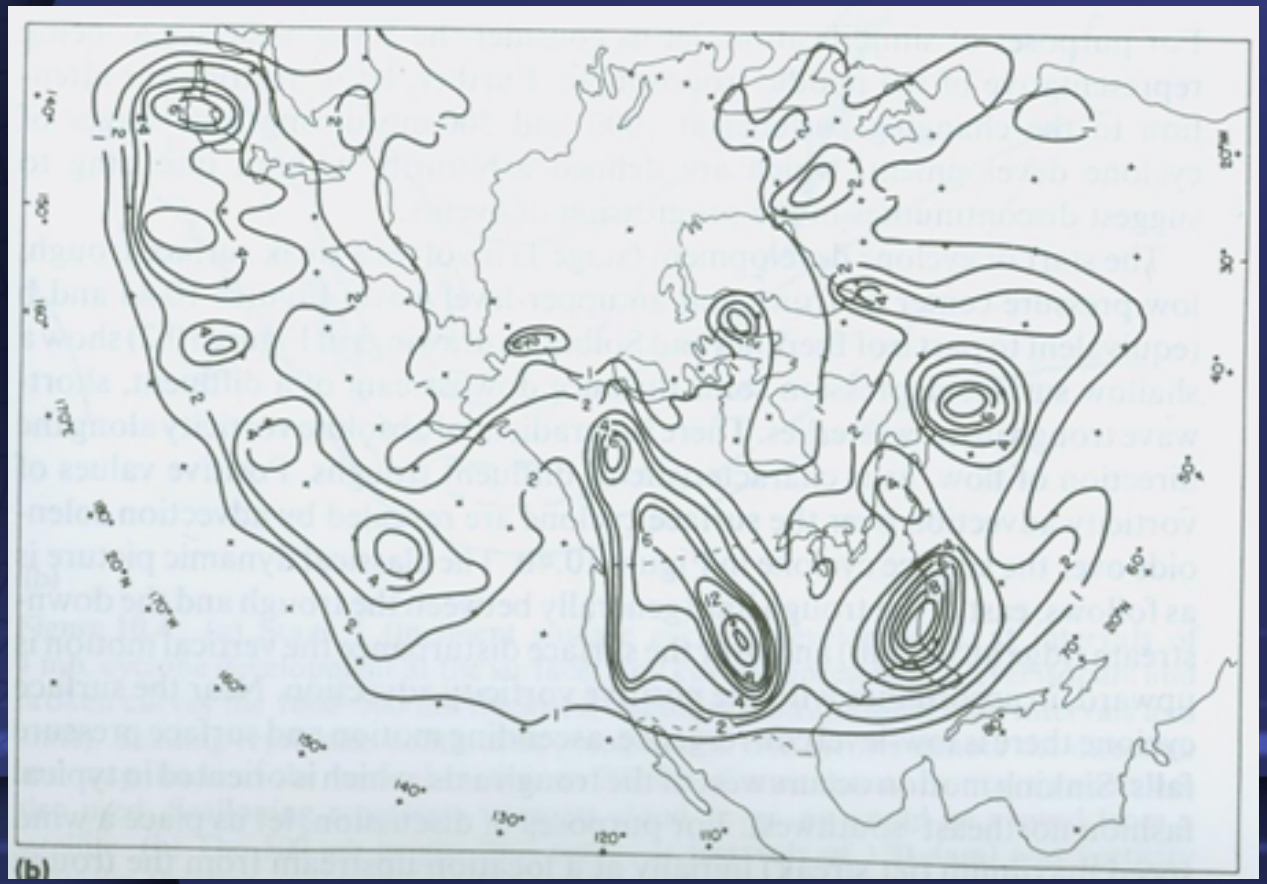
Land Sea Distribution & Ocean Currents NOAA/AOML

Prefered Locations for Cyclogenesis



Locations of Cyclogenesis 1978 to 1982

(Roebber, 1984)



Favored Areas for Cyclogenesis

"Mid-Latitude Weather Systems" by Toby Carlson

- Downstream of a mountain chain (Rockies)
- Downstream of an elevated Plateau where dry static stability is already low (high lapse rates)
- Off or near the eastern coast of major continents at mid-latitudes

1. There is a pre-existent area of surface vorticity.
2. There is a pre-existent, low level baroclinic zone between land and sea which can be augmented by warm ocean currents.
3. Moist static stability is low.

Divergence (Development) Term

"*Mid-Latitude Weather Systems*" by Toby Carlson

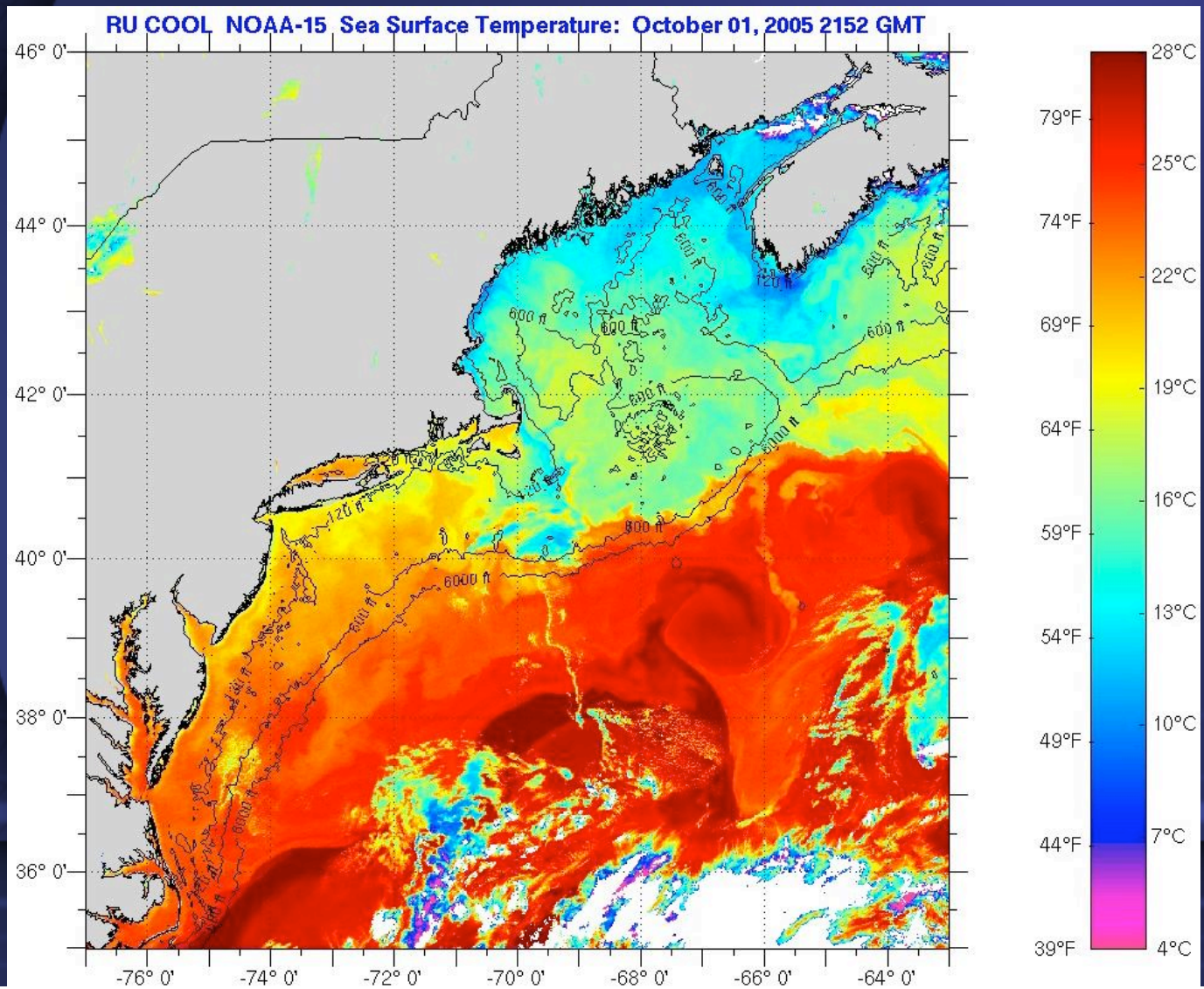
- **Development occurs more rapidly when there is a pre-existent source of positive absolute vorticity such as what frequently occurs just off the eastern seaboard.**

Divergence term in Vorticity Equation = $-(\zeta + f)(dv/dx + du/dy)_p$

- **Pressure falls occur preferentially along a front and near the surface vorticity maximum where the development term is maximized.**

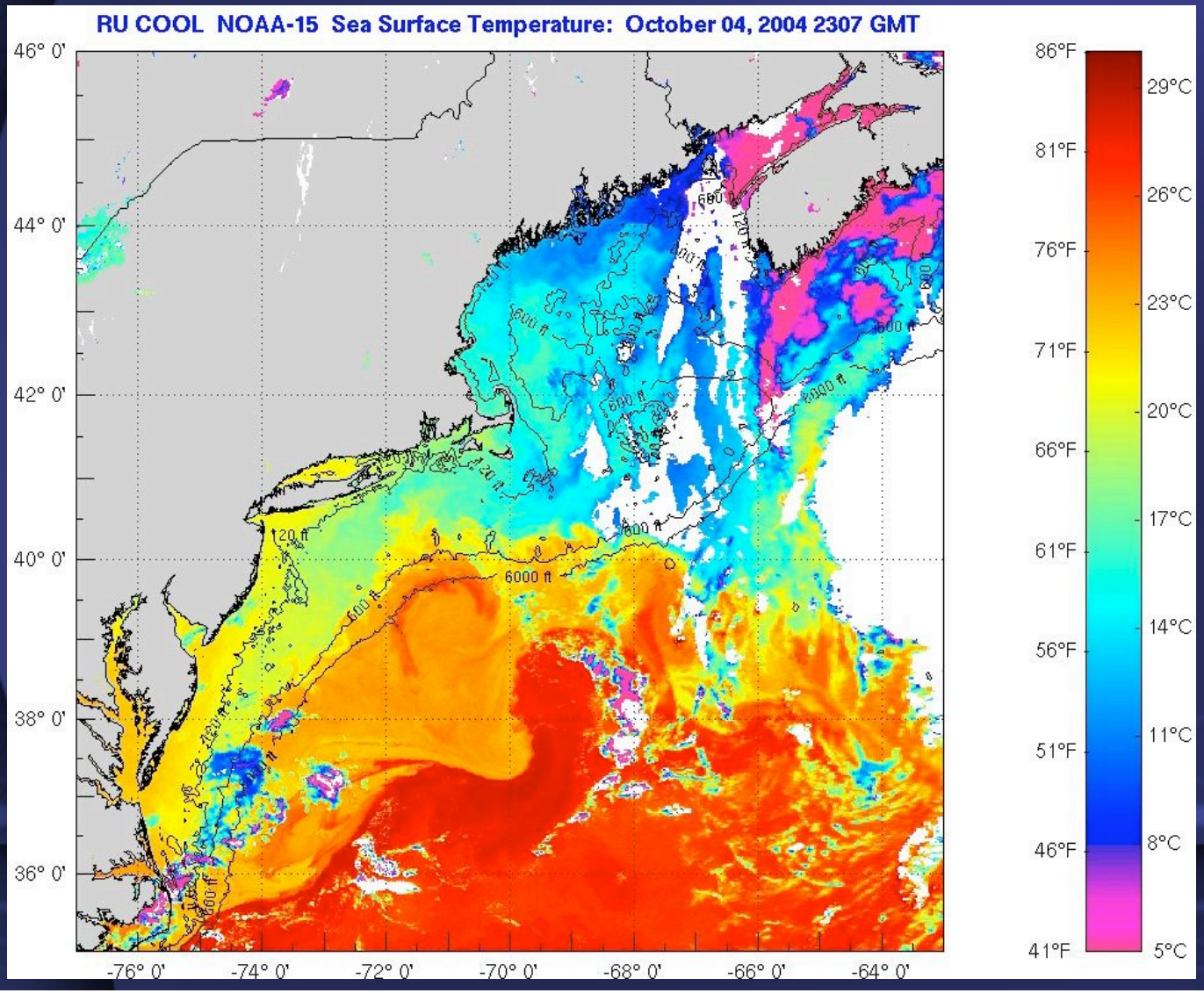
Rutgers - Coastal Ocean Observations Lab

October 1, 2005 SST



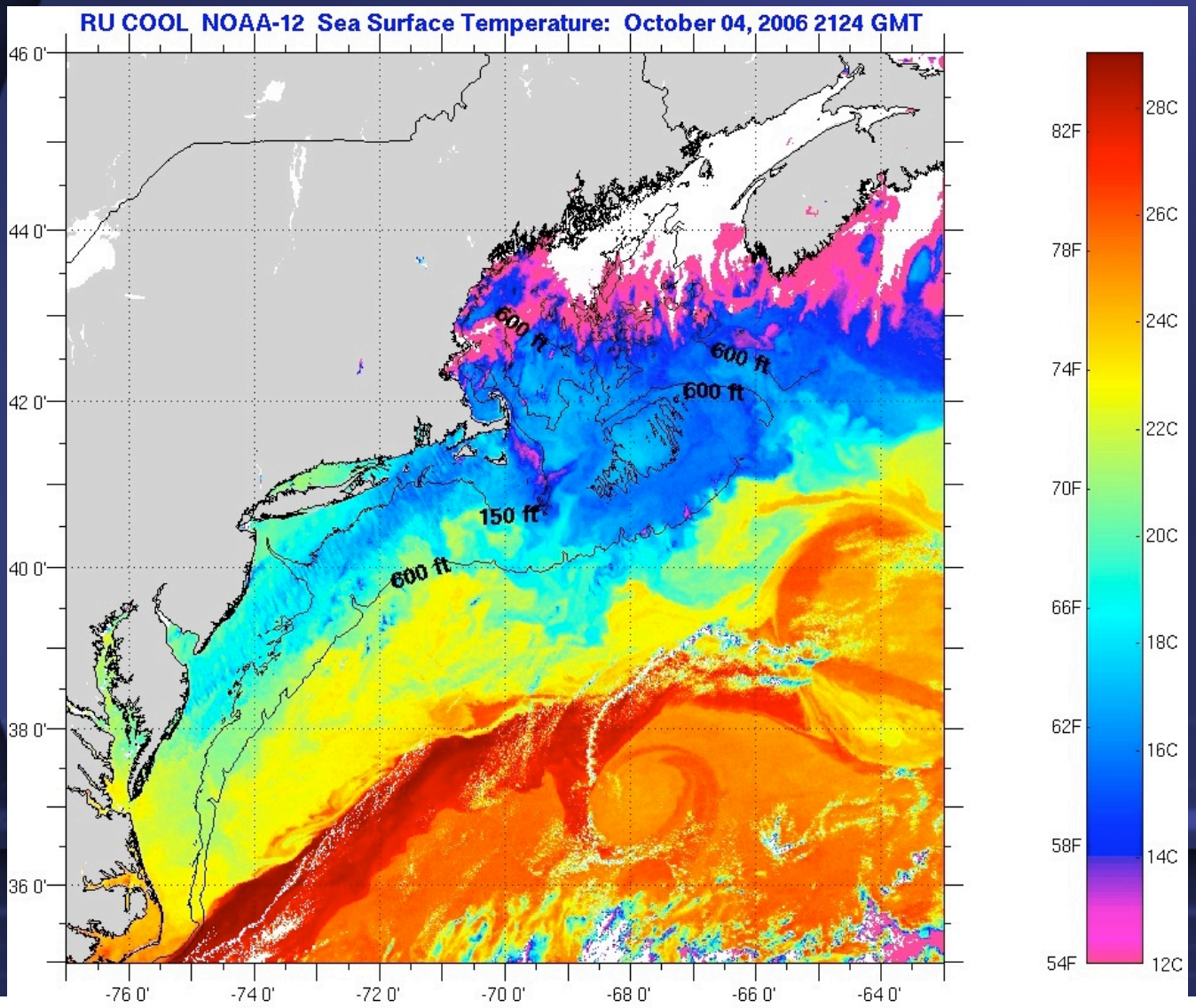
Rutgers - Coastal Ocean Observations Lab

October 4, 2004 SST



Rutgers - Coastal Ocean Observations Lab

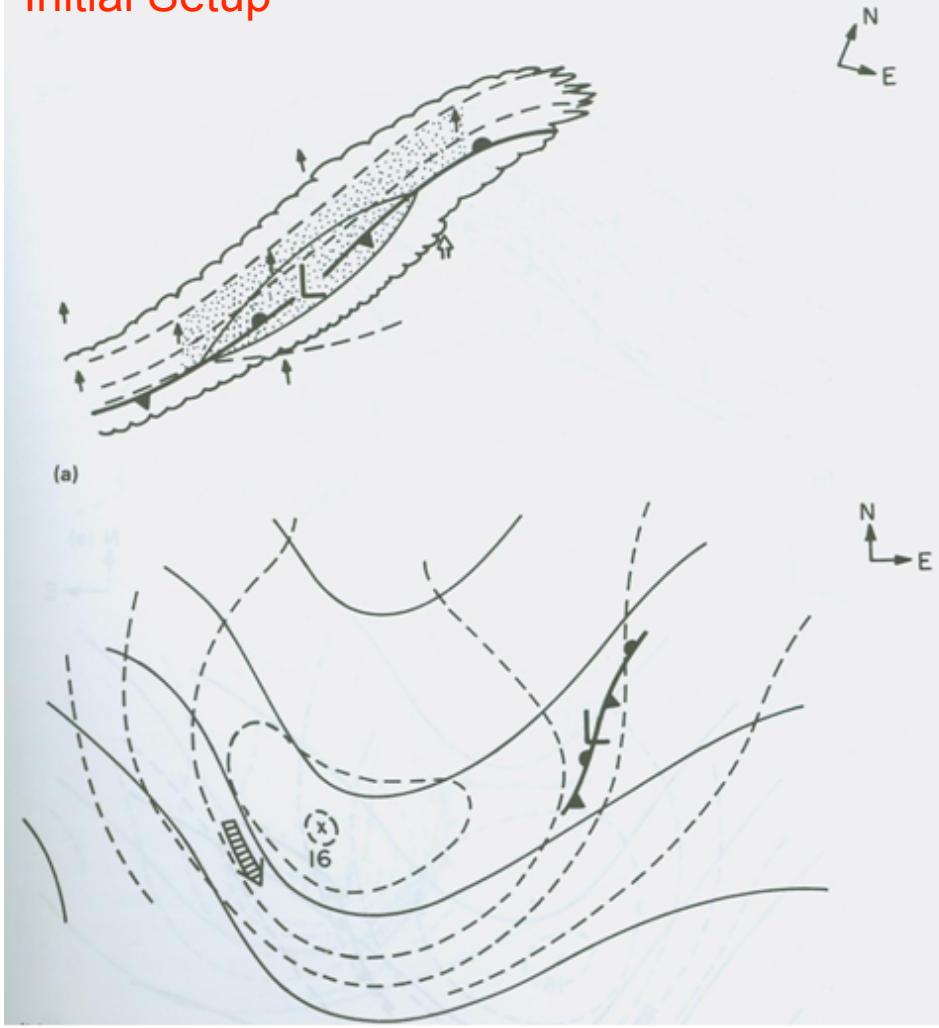
October 4, 2006 SST



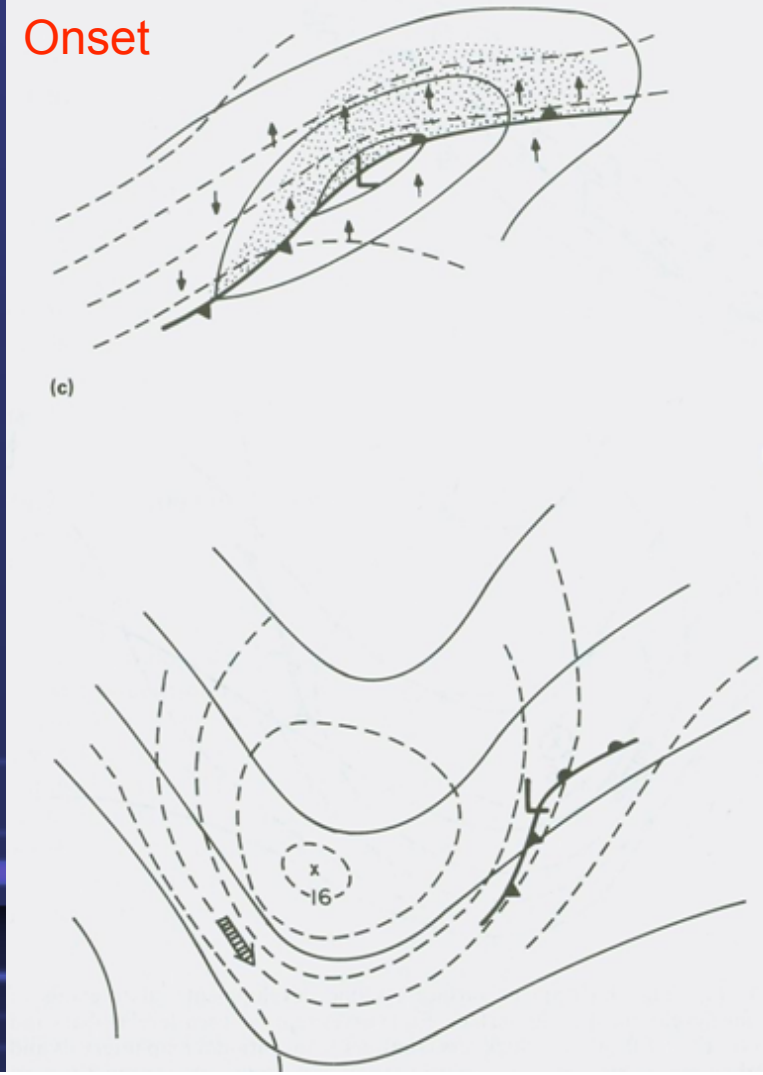
Stages of Cyclogenesis

"Mid-Latitude Weather Systems" by Toby Carlson

Initial Setup



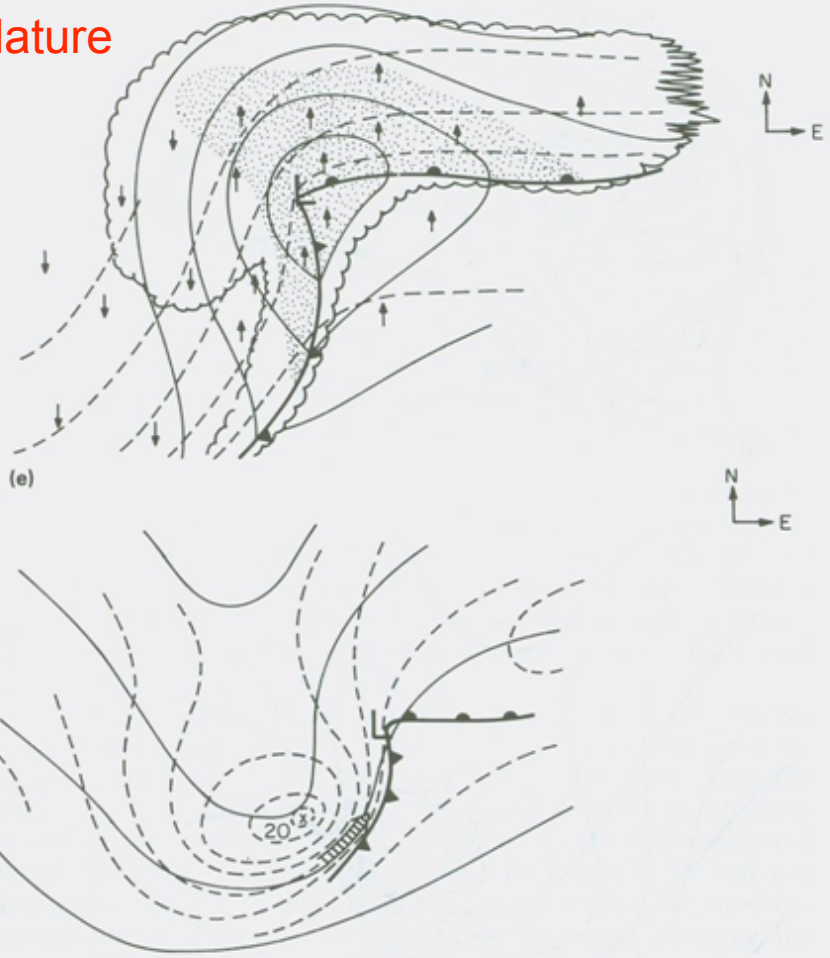
Onset



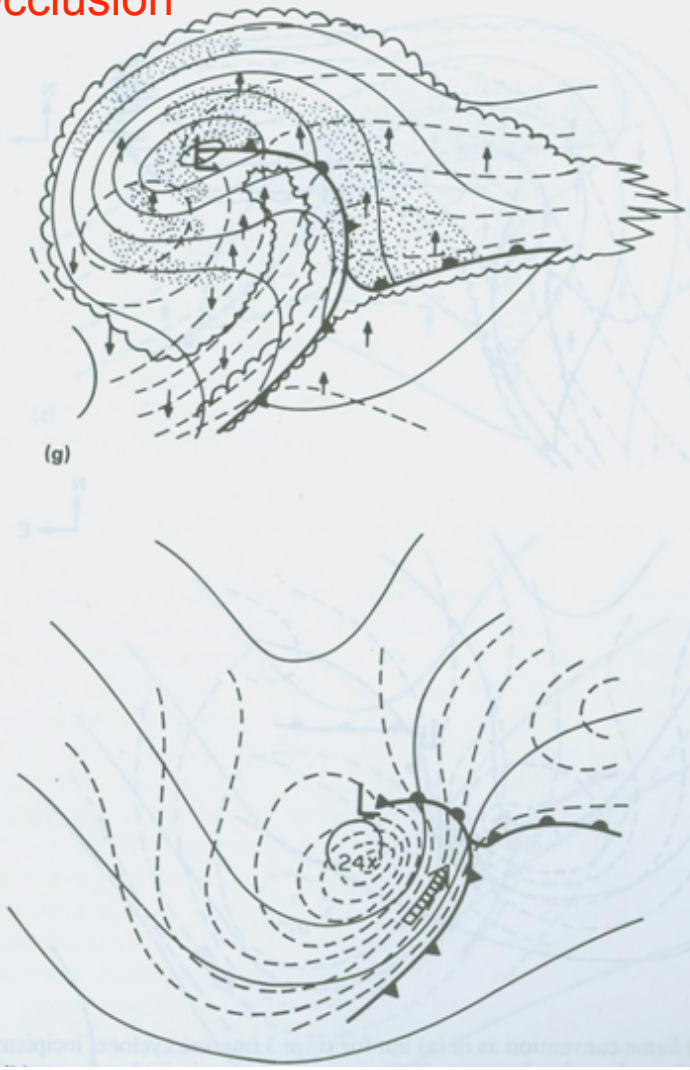
Stages of Cyclogenesis

"Mid-Latitude Weather Systems" by Toby Carlson

Mature

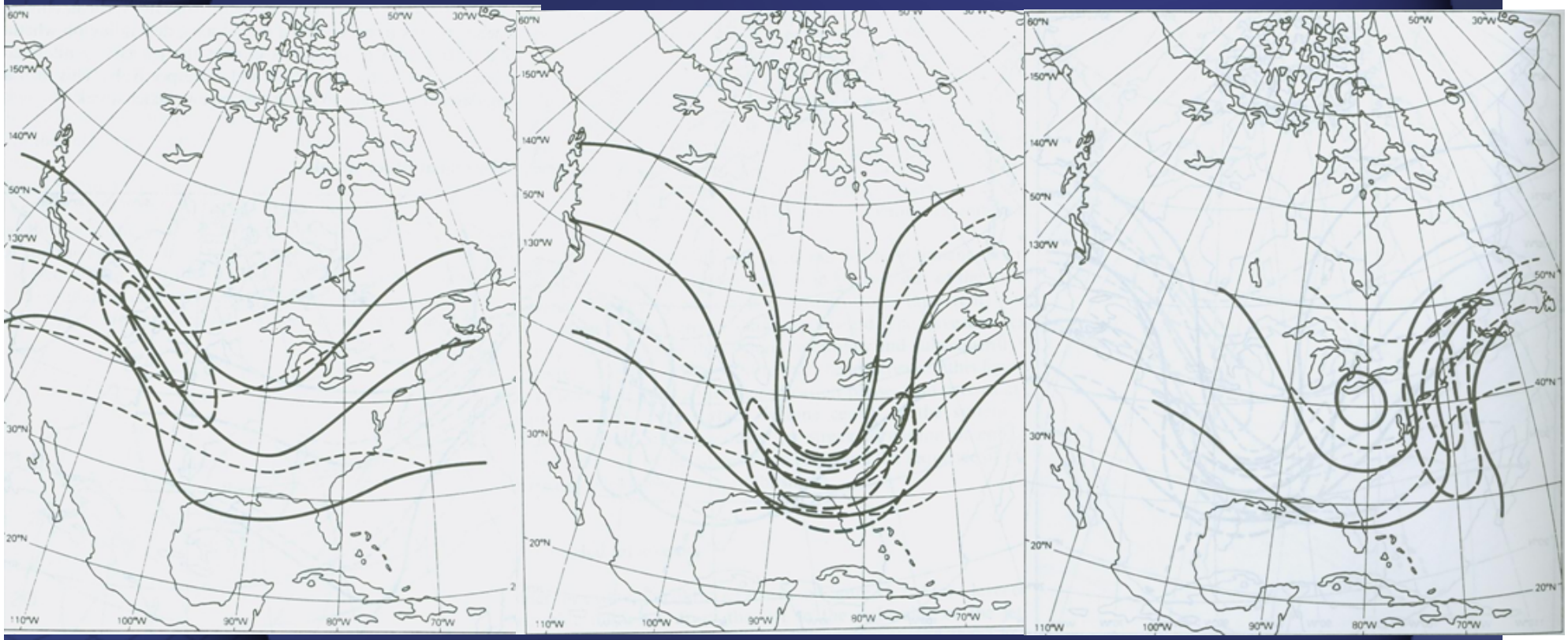


Occlusion



Schematic Evolution of 500mb Height/Thickness & Jet During Cyclogenesis

"Mid-Latitude Weather Systems" by Toby Carlson



Bosart & Sanders, 1991

Q-G forcing for October 4, 1987 storm

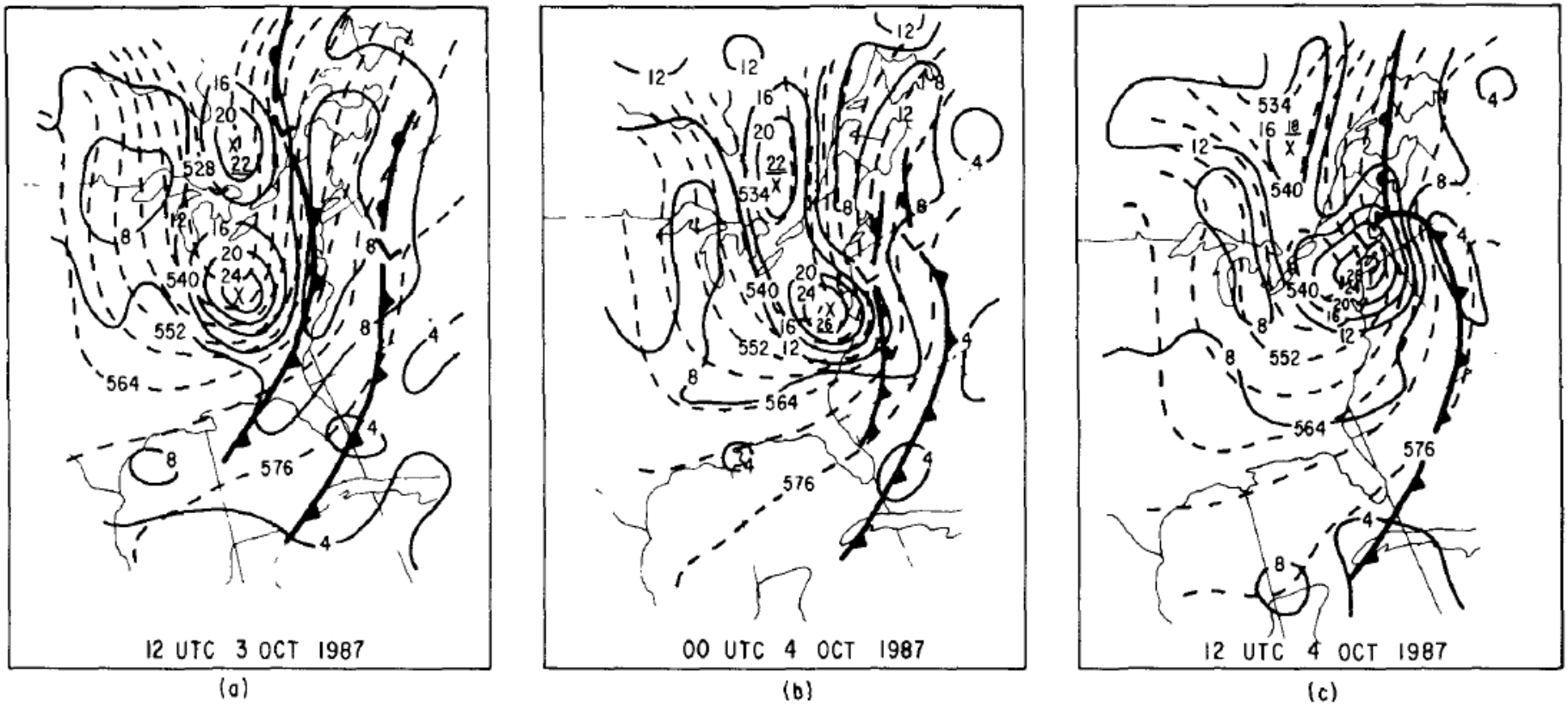
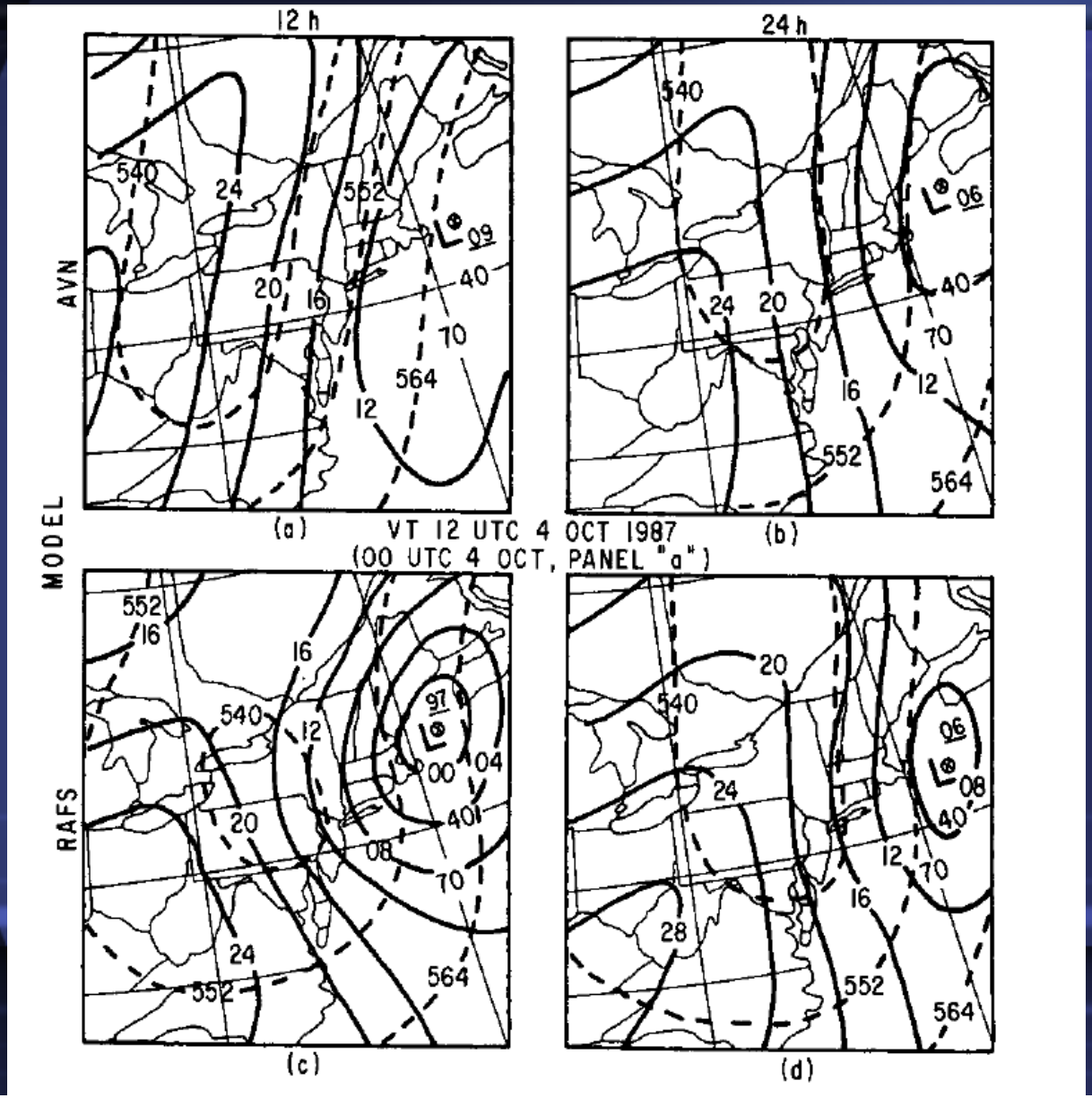


FIG. 6. Absolute vorticity (solid) every 4×10^{-5} s^{-1} at 500 mb and 1000–500-mb thickness (dashed) every 6 dam for: (a) 1200 UTC 3 October 1987, (b) 0000 UTC 4 October 1987, and (c) 1200 UTC 4 October 1987.

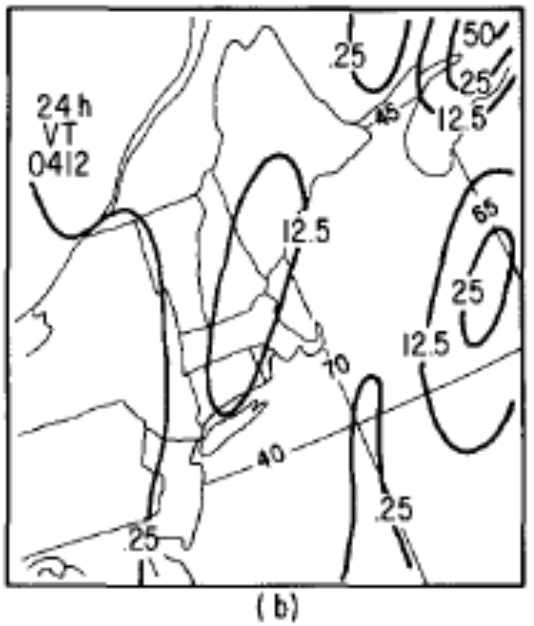
Bosart & Sanders 1991

Model Forecasts for October 4, 1987 storm

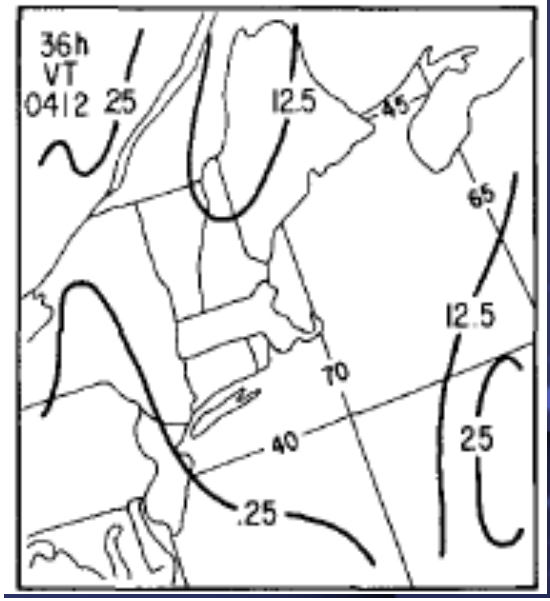


Bosart & Sanders 1991

Model Precipitation for October 4, 1987 storm



(b)



24 hr fcst valid 12 UTC 4th

36 hr fcst valid 12 UTC 4th

Bosart & Sanders 1991

Relationship between Low Temperatures & Elevation

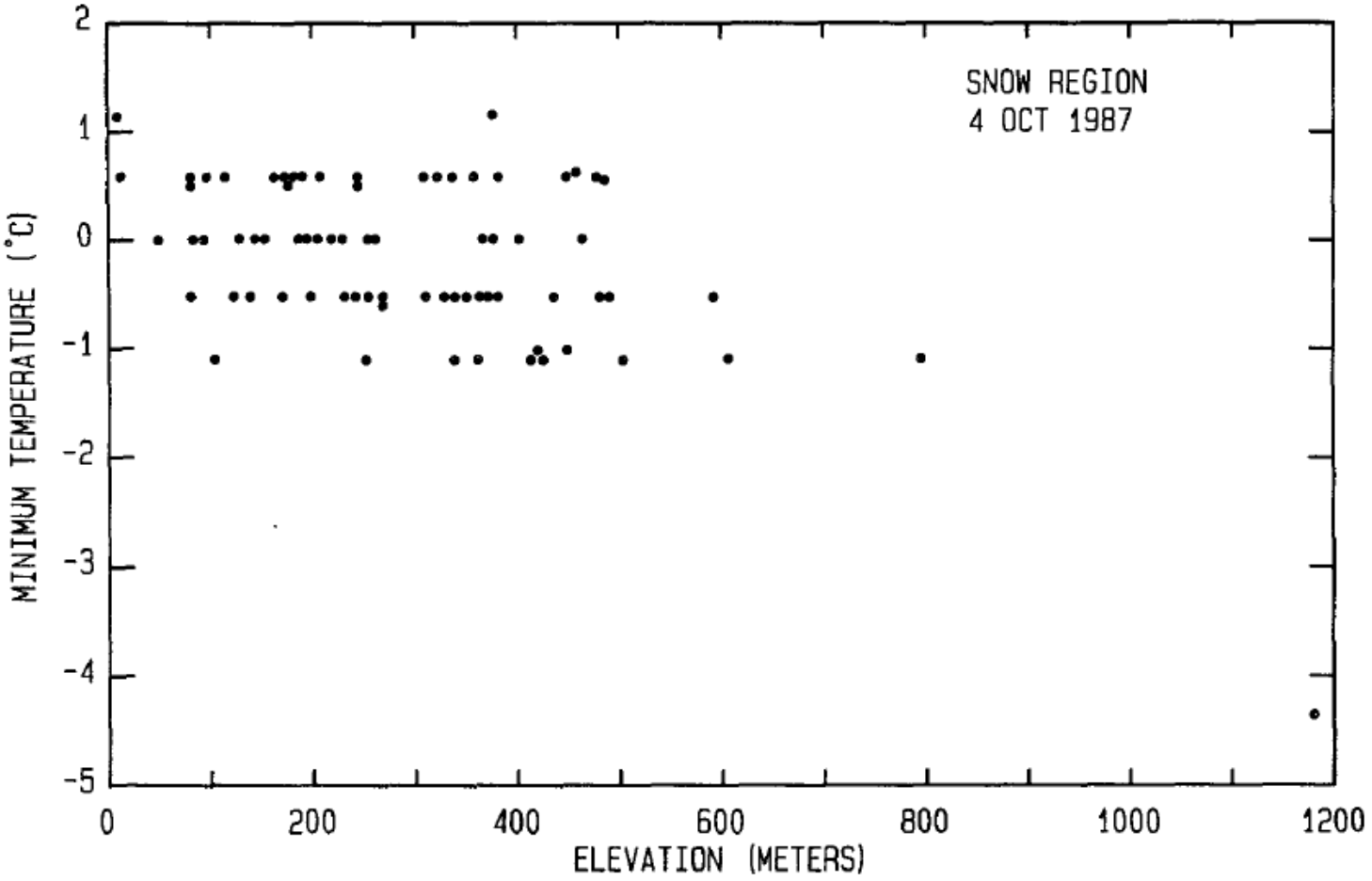


FIG. 10. Minimum temperature (°C) versus elevation (m) within the snow region on 4 October 1987.

Bosart & Sanders 1991

Findings for October 4, 1987 storm

- After cold advection and lift cooled the column, additional cooling from melting snow aided in the creation of the cold dome.

- Deepest echoes/clouds occurred close to rain-snow line and appeared to mark the signature of a mesoscale circulation driven by melting snow.

Bosart & Sanders 1991

Findings for October 4, 1987 storm

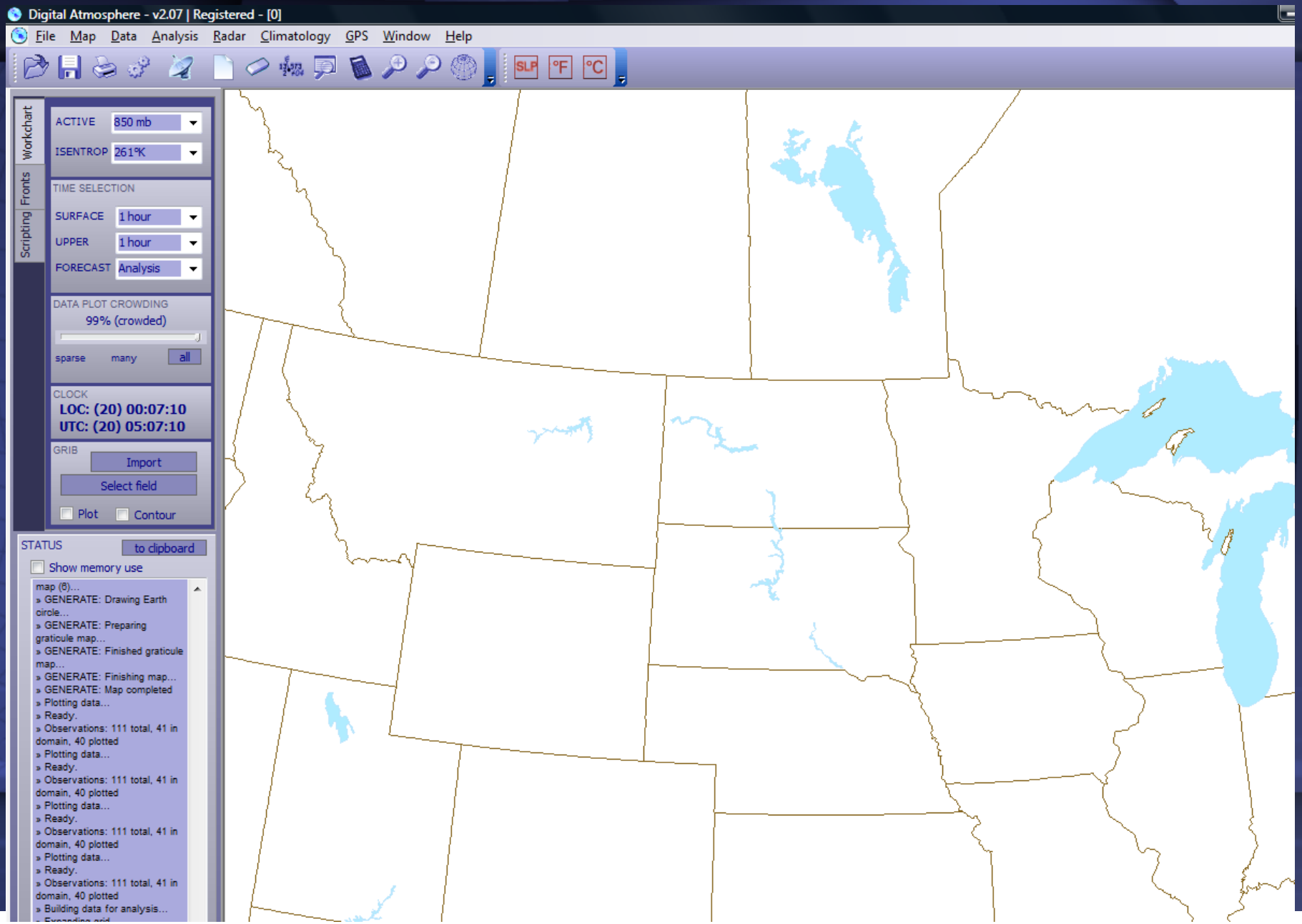
- Cyclone development was in accordance with quasi-geostrophic principles with cyclogenesis occurring as vorticity advection overspread the low-level circulation center.

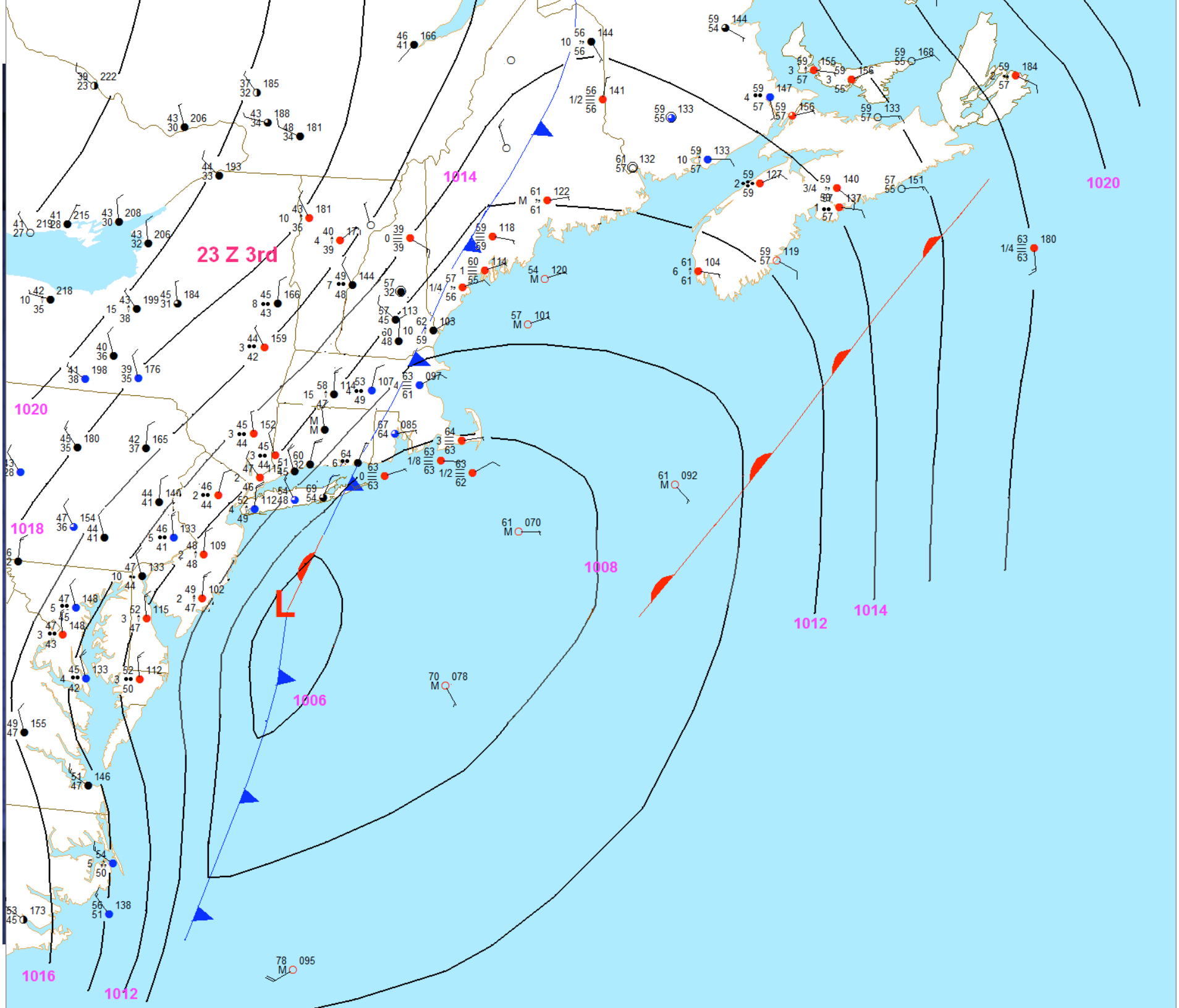
- Nevertheless, the NMC models failed to predict cyclogenesis with the RAFS suffering from poor initialization at low levels off the coast.

Meteorological Analysis Methodology

- Imported surface and upper air data into “Digital Atmosphere” to plot the data
- Exported images out of “Digital Atmosphere” as .png files
- Imported images into Microsoft Paint and hand analyzed

Digital Atmosphere & Historical Data

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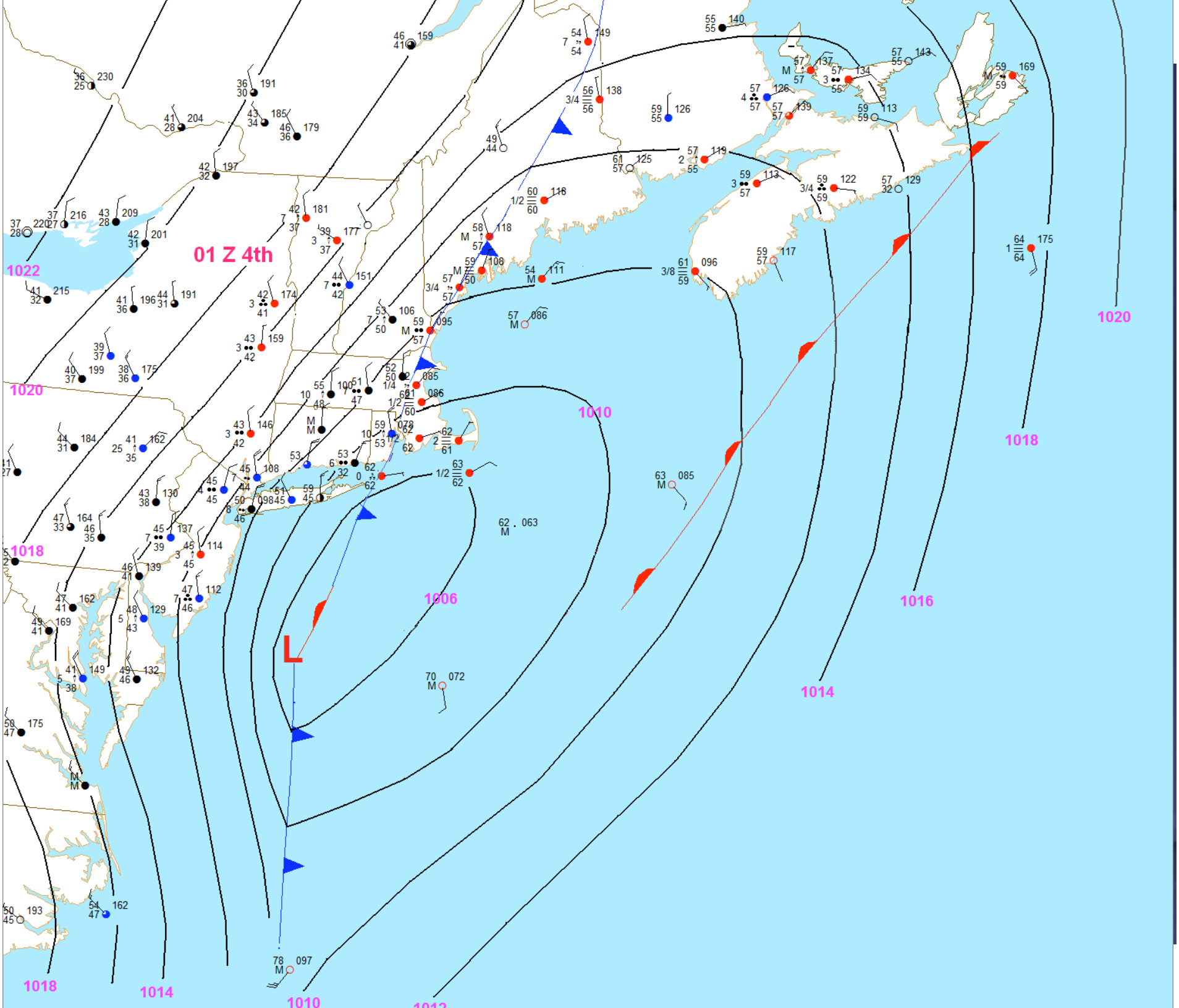
1020
1018
1016
1014
1012
1008
1006
L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1016
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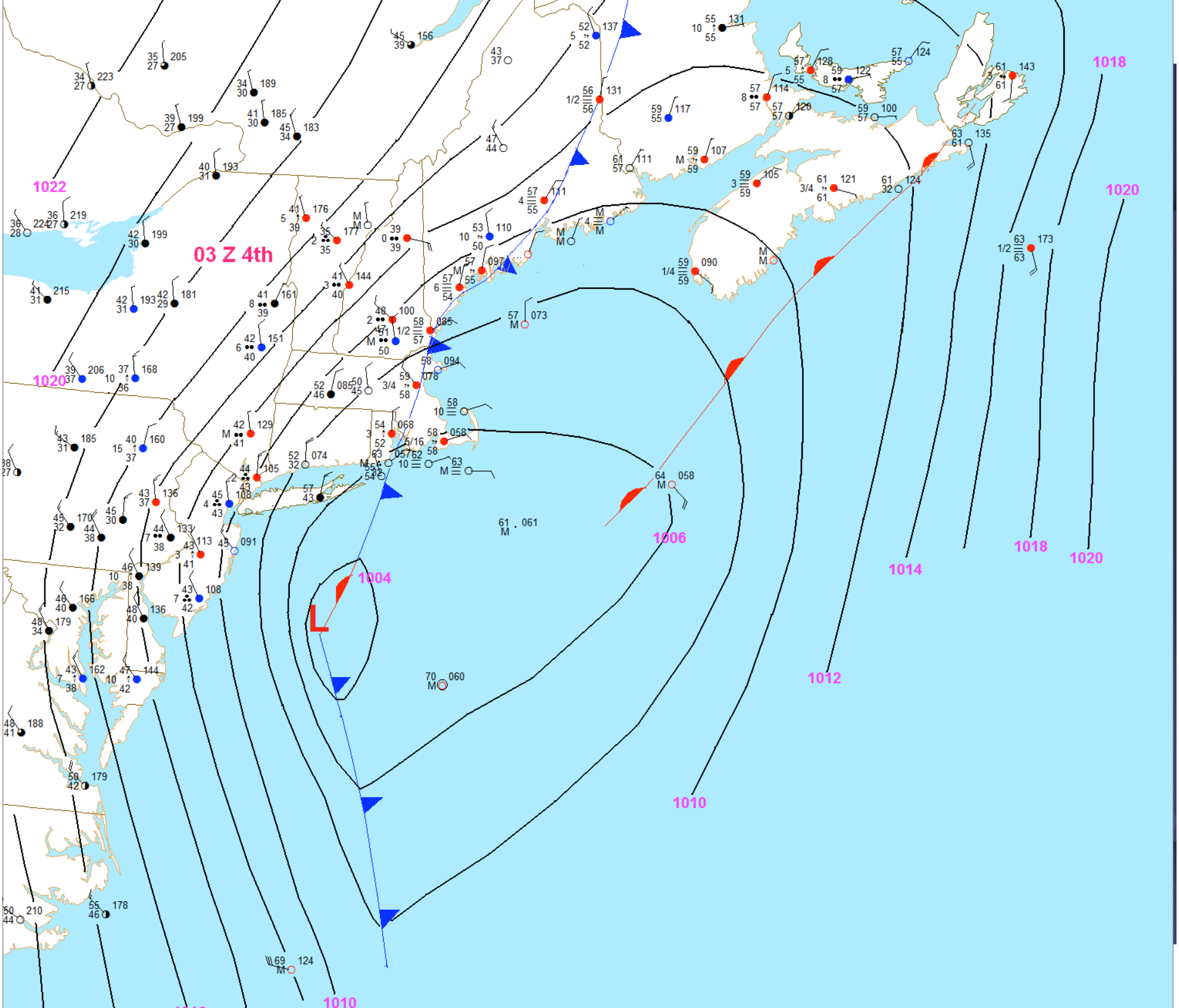
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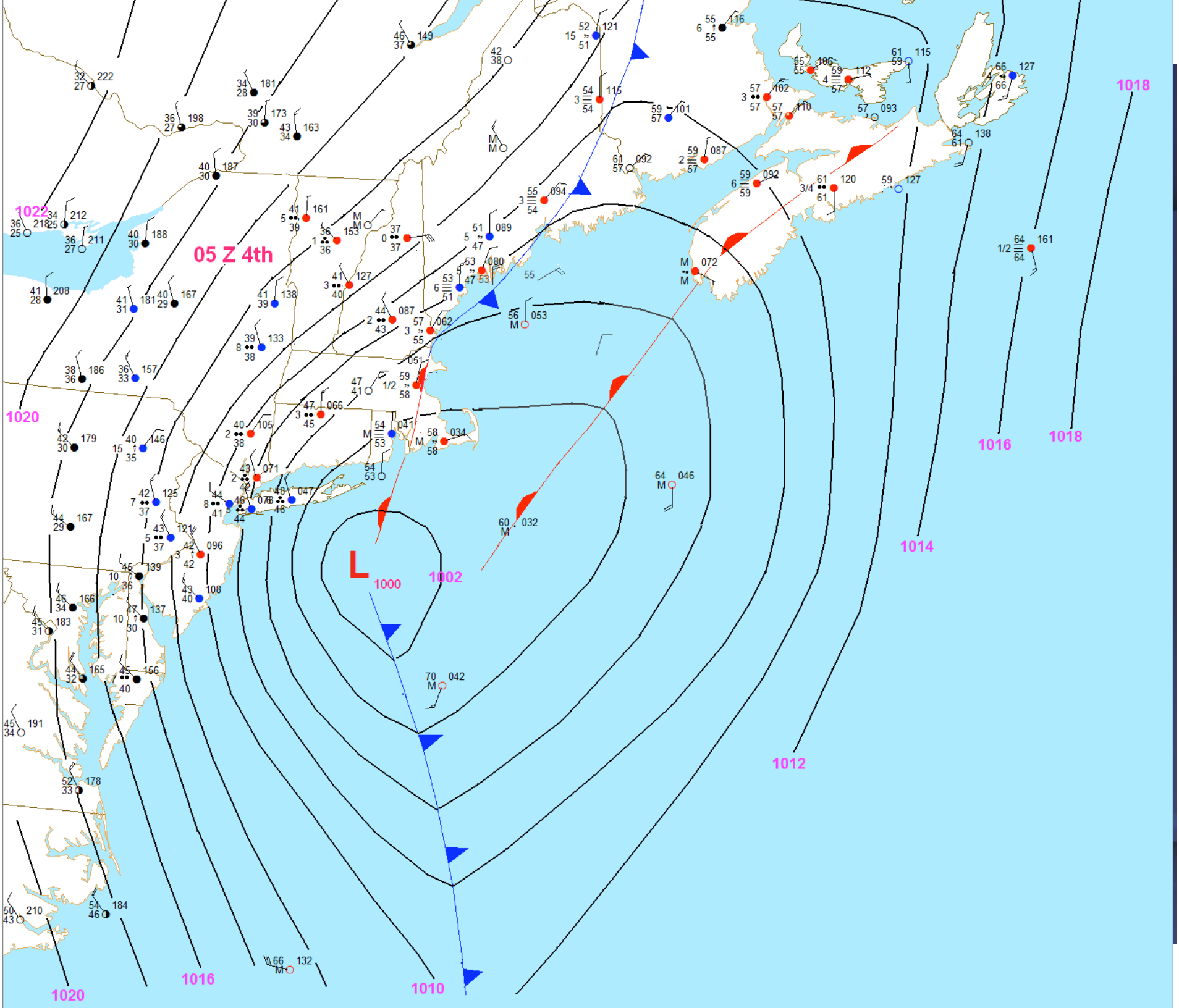
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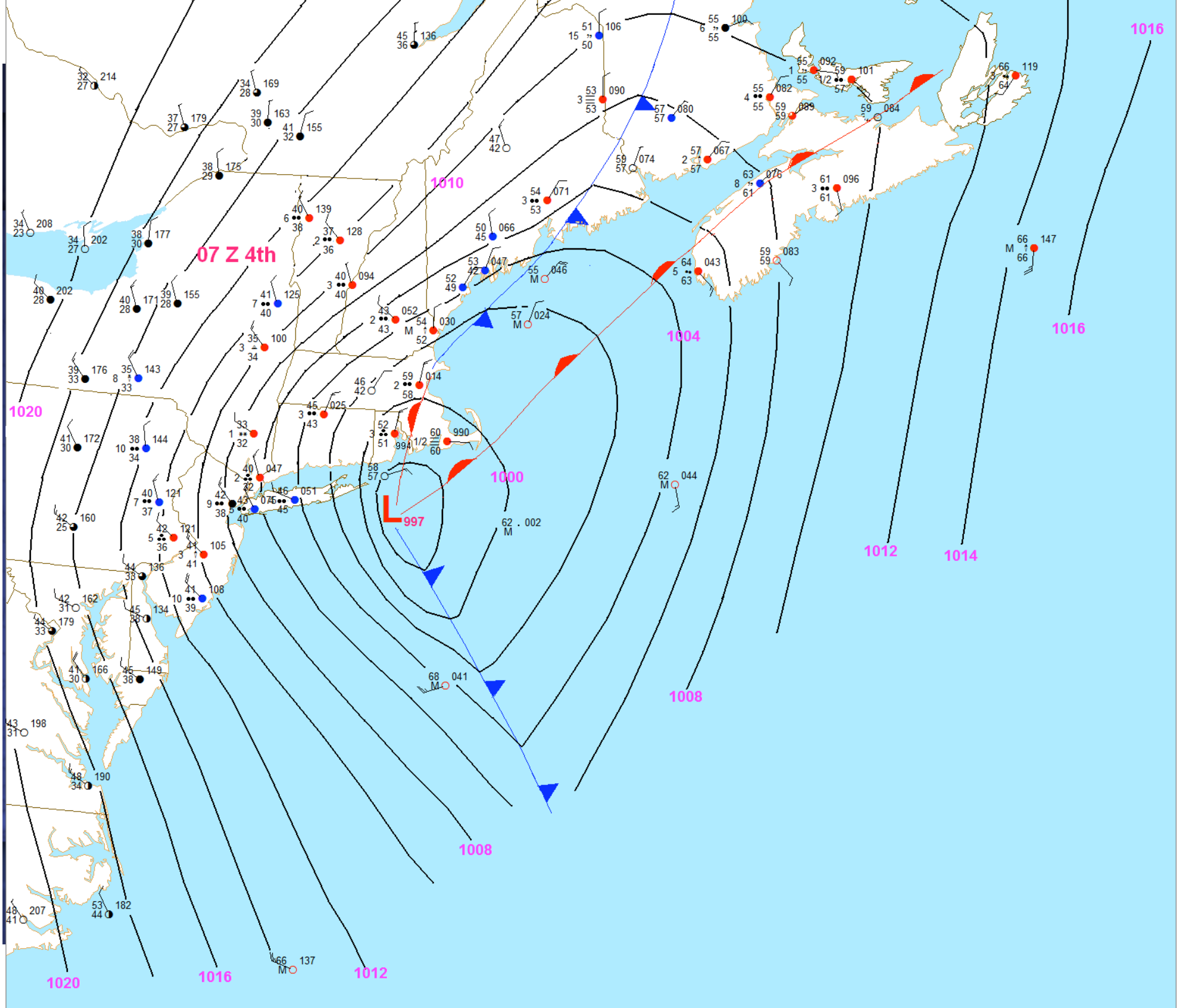
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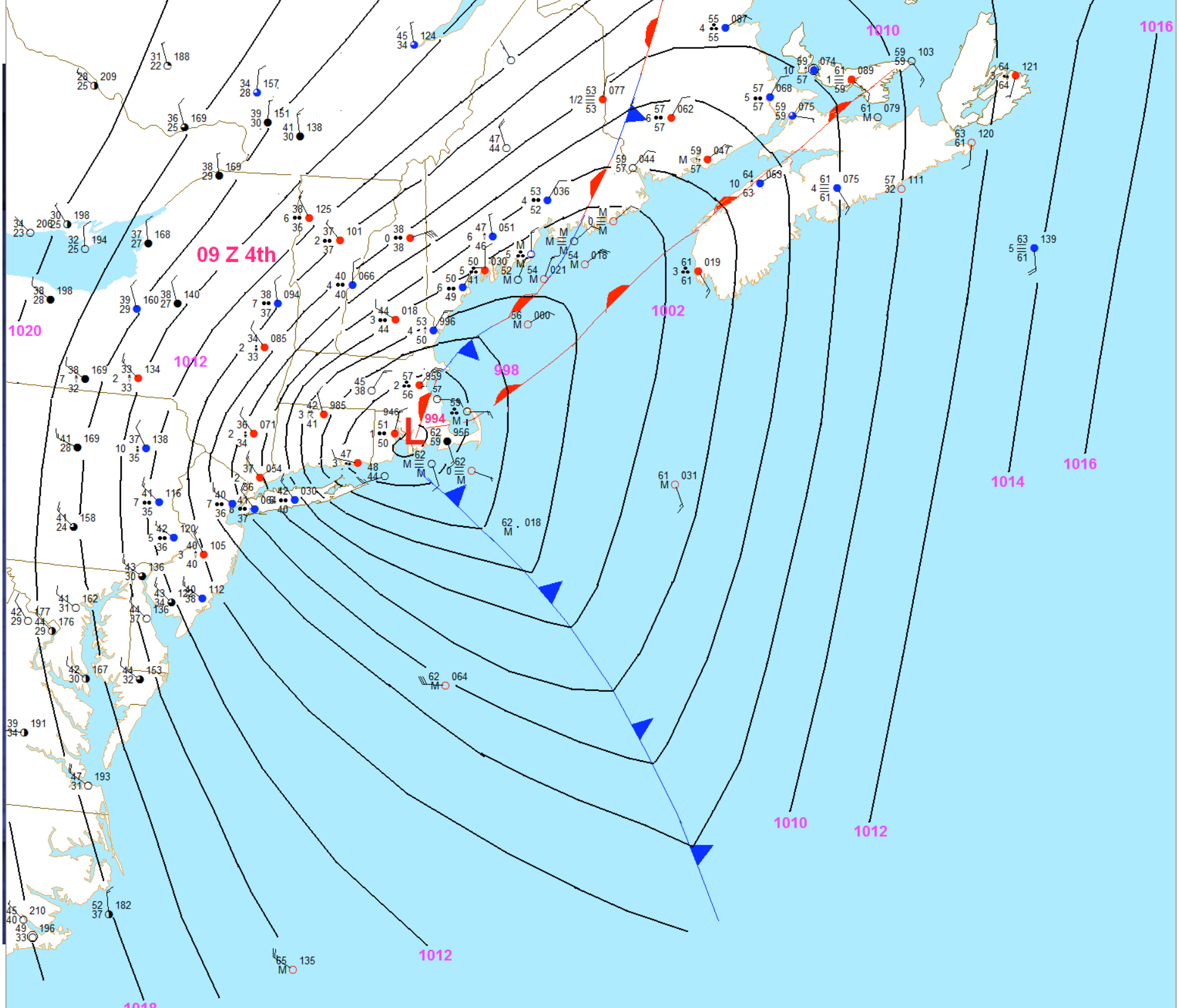
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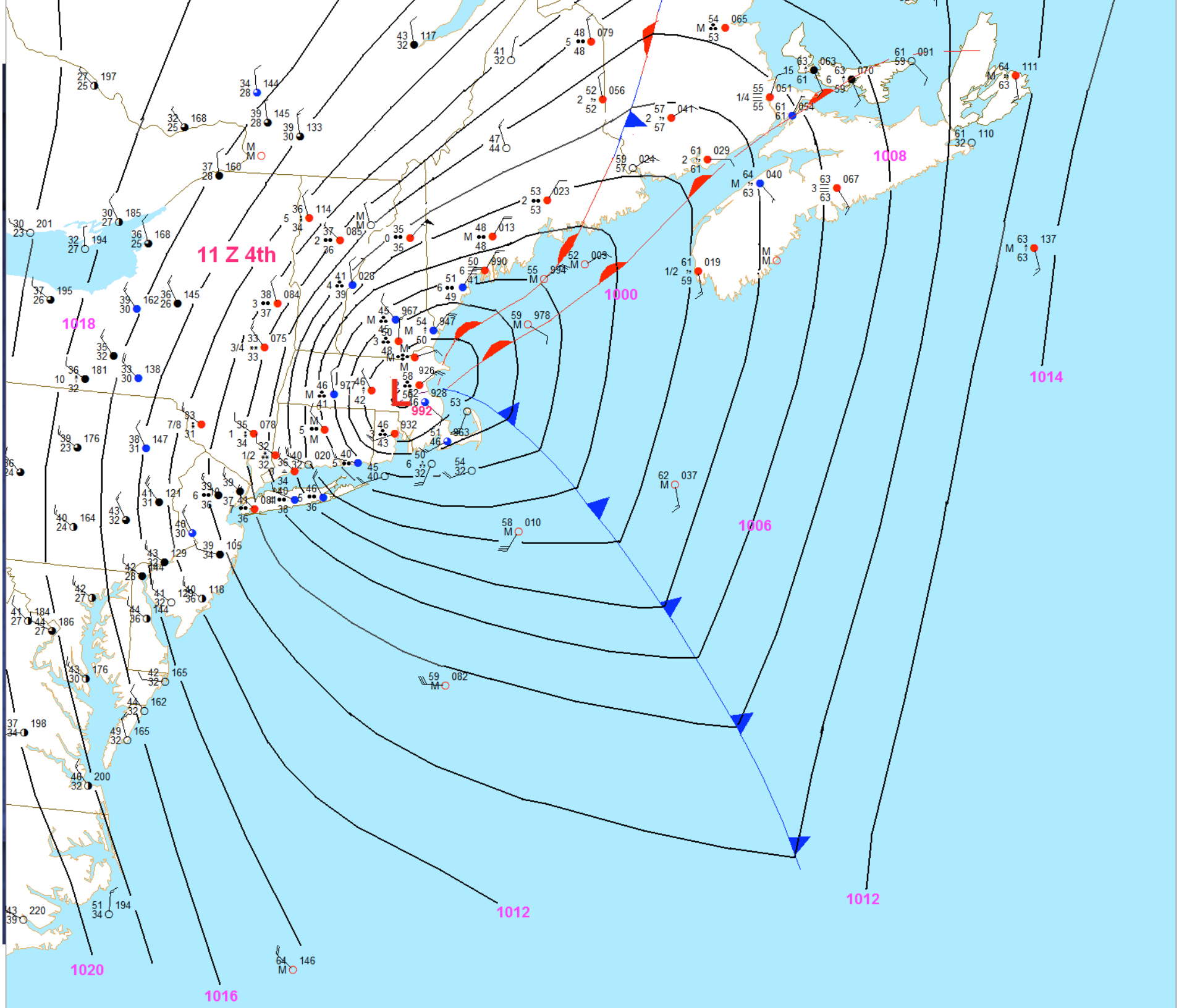
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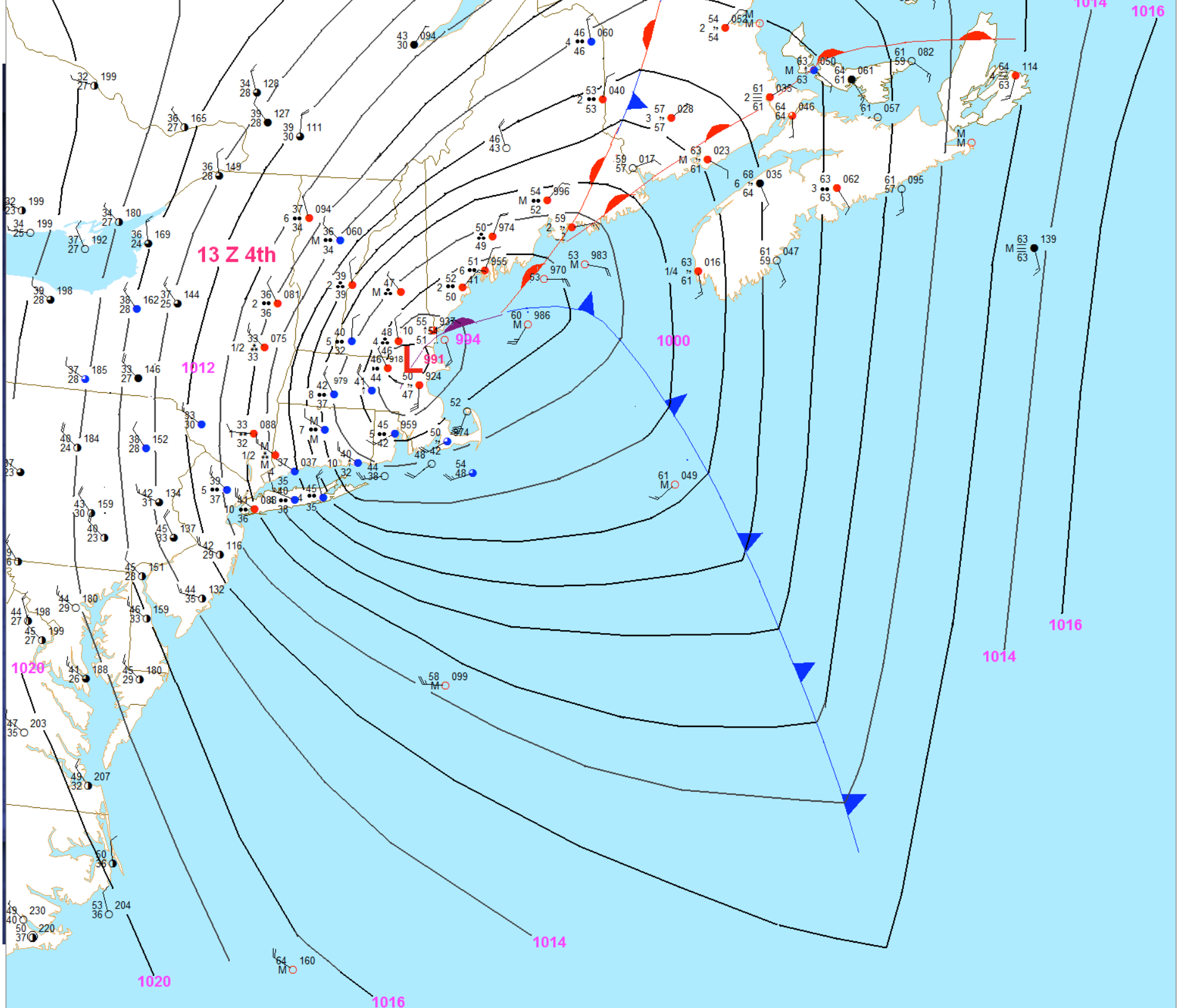
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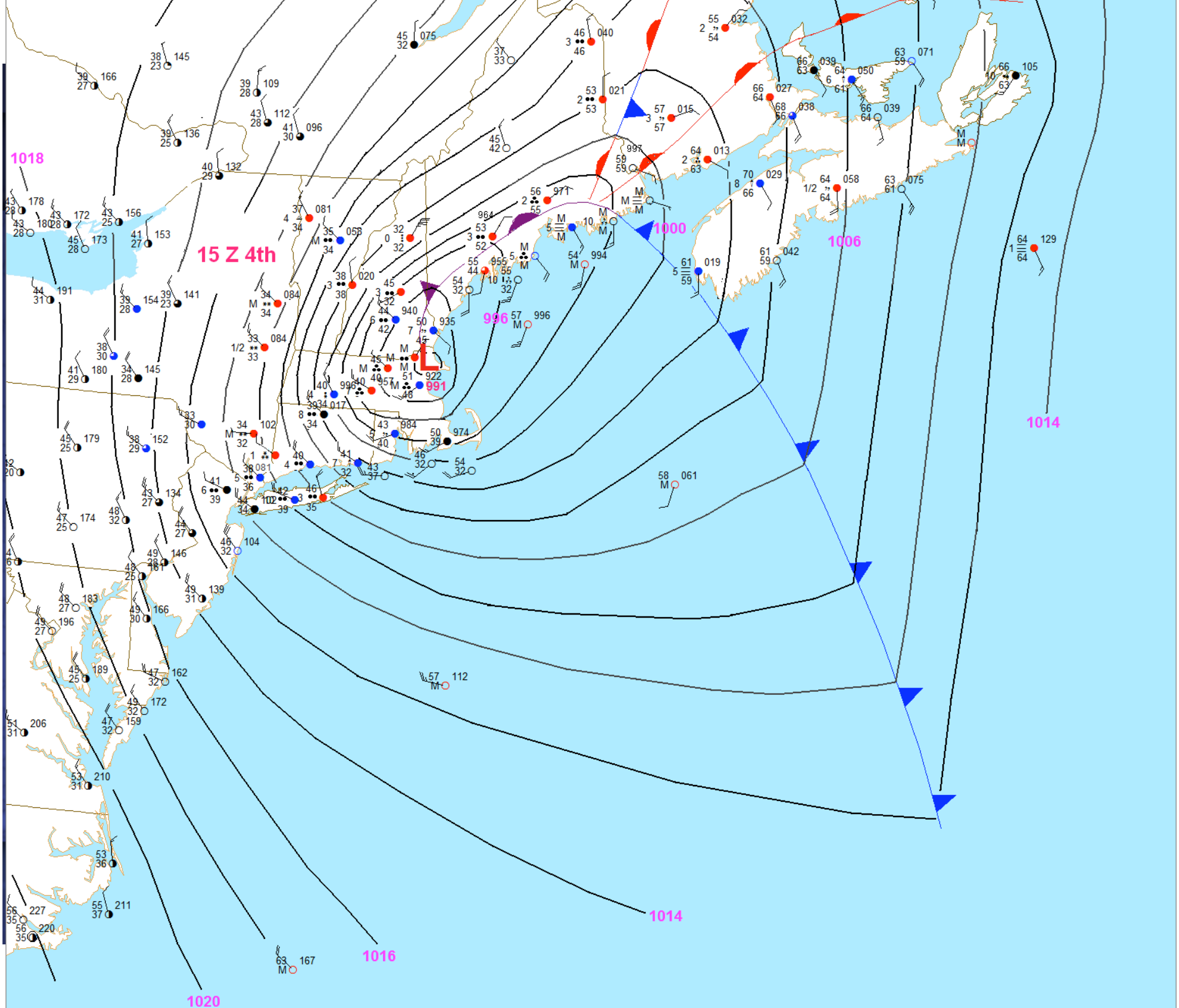
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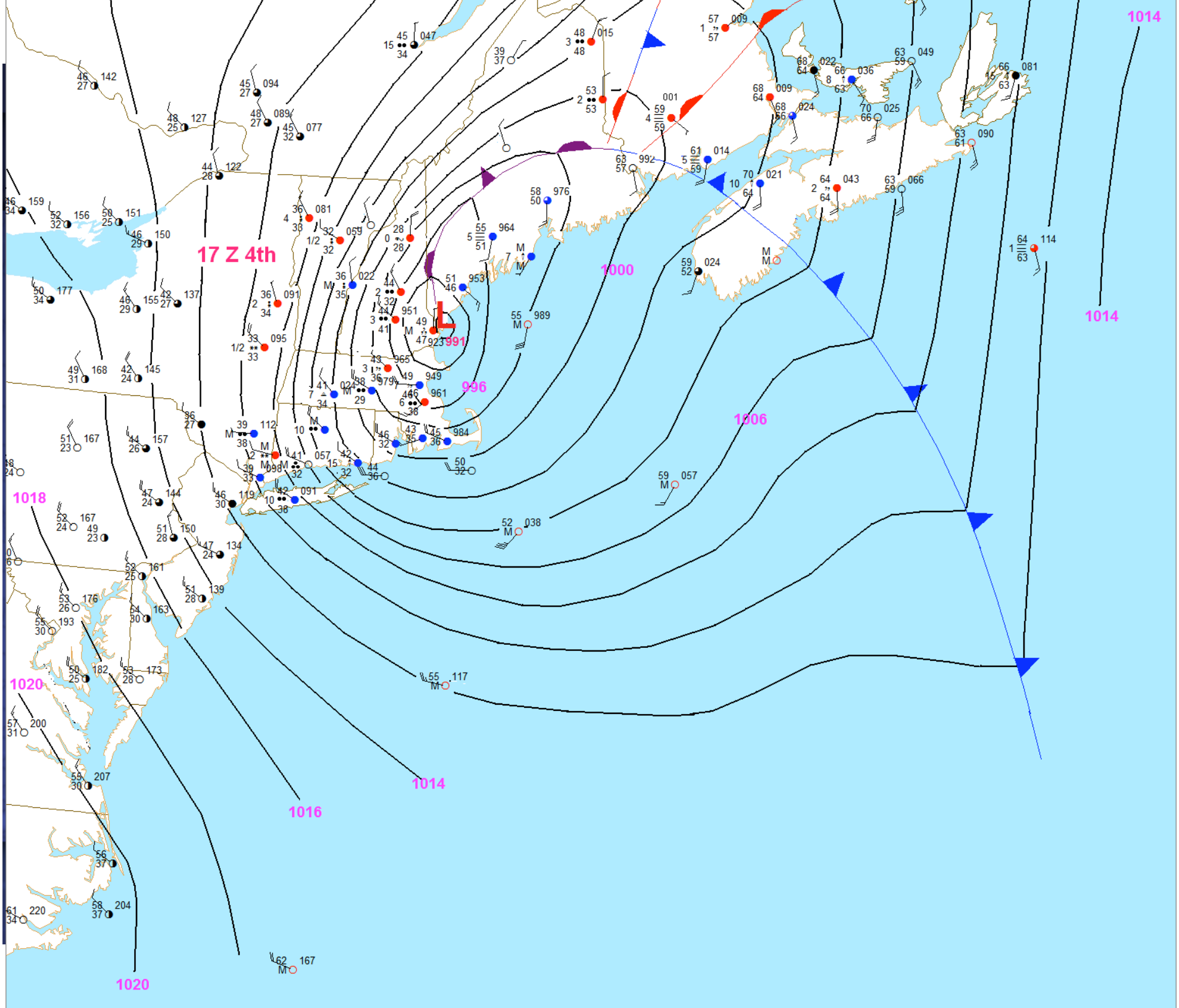
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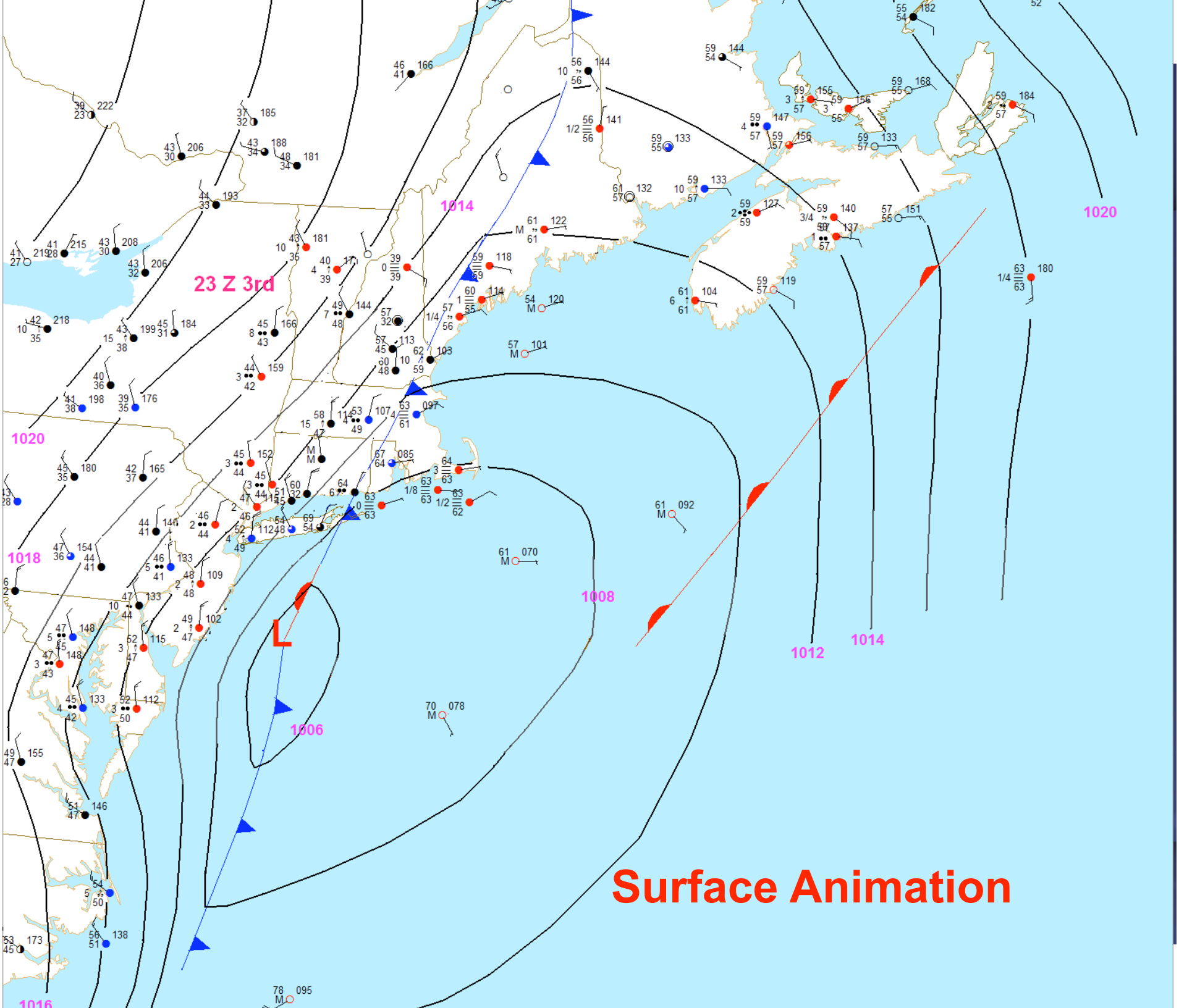
23 Z 3rd
1014
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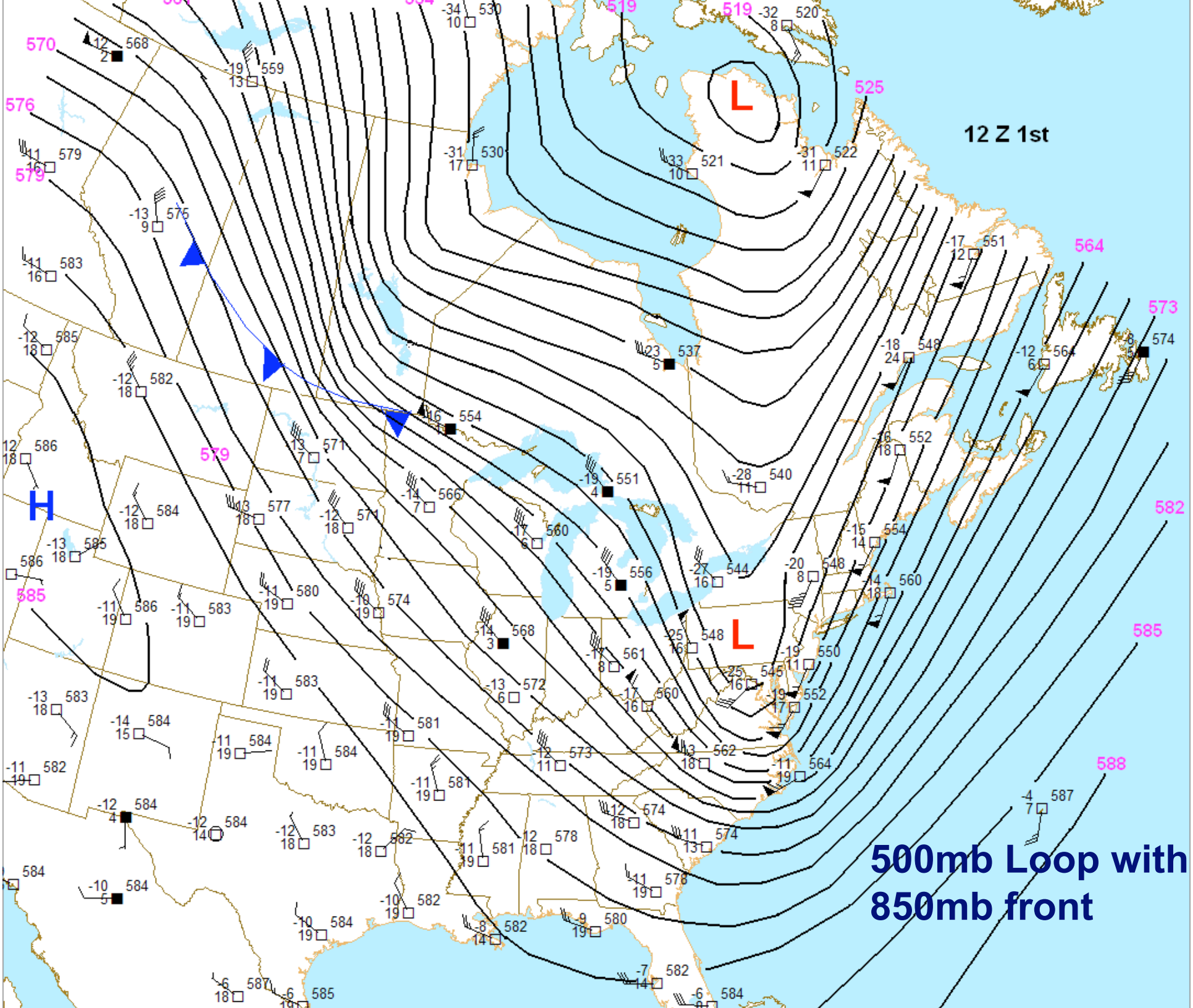
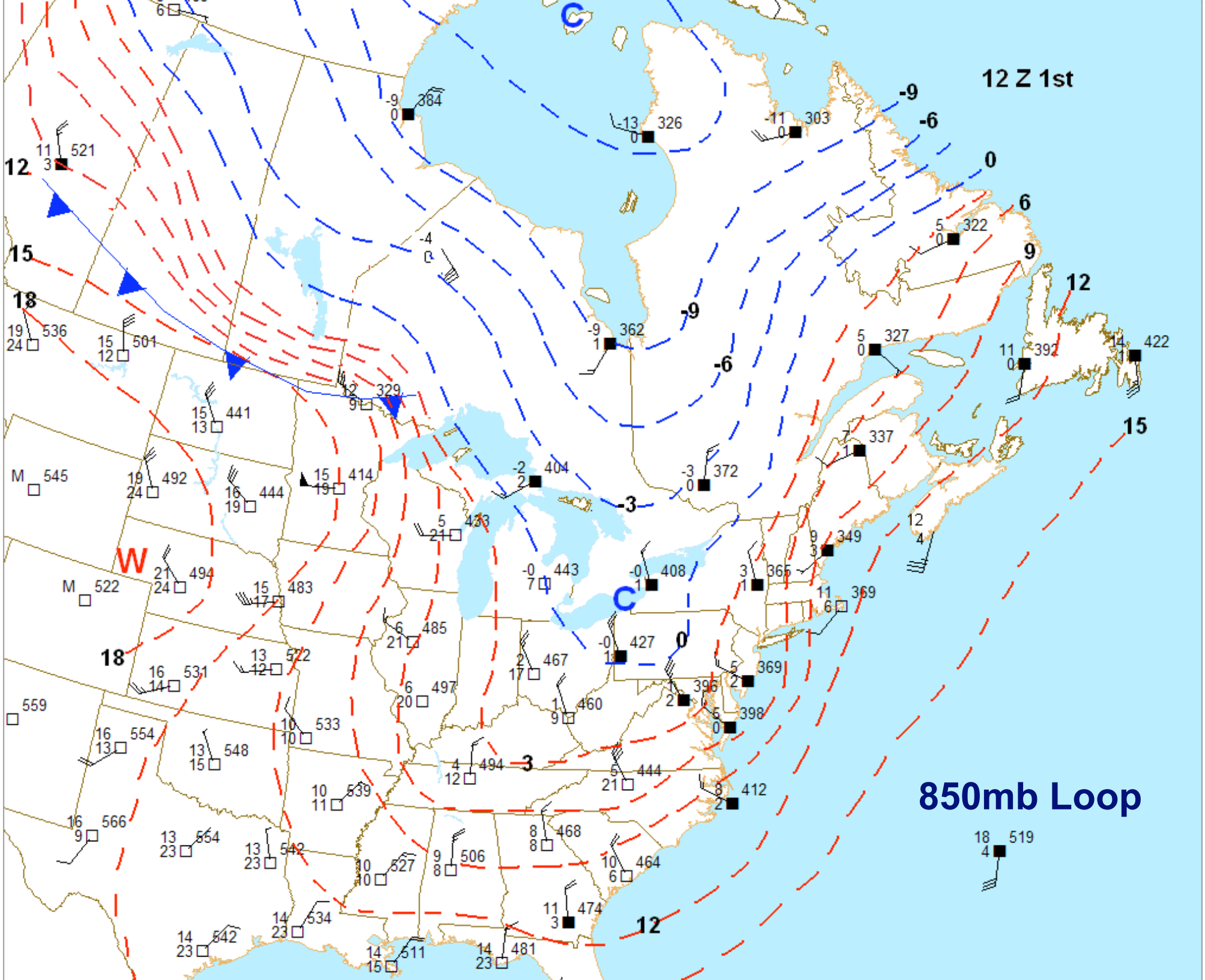
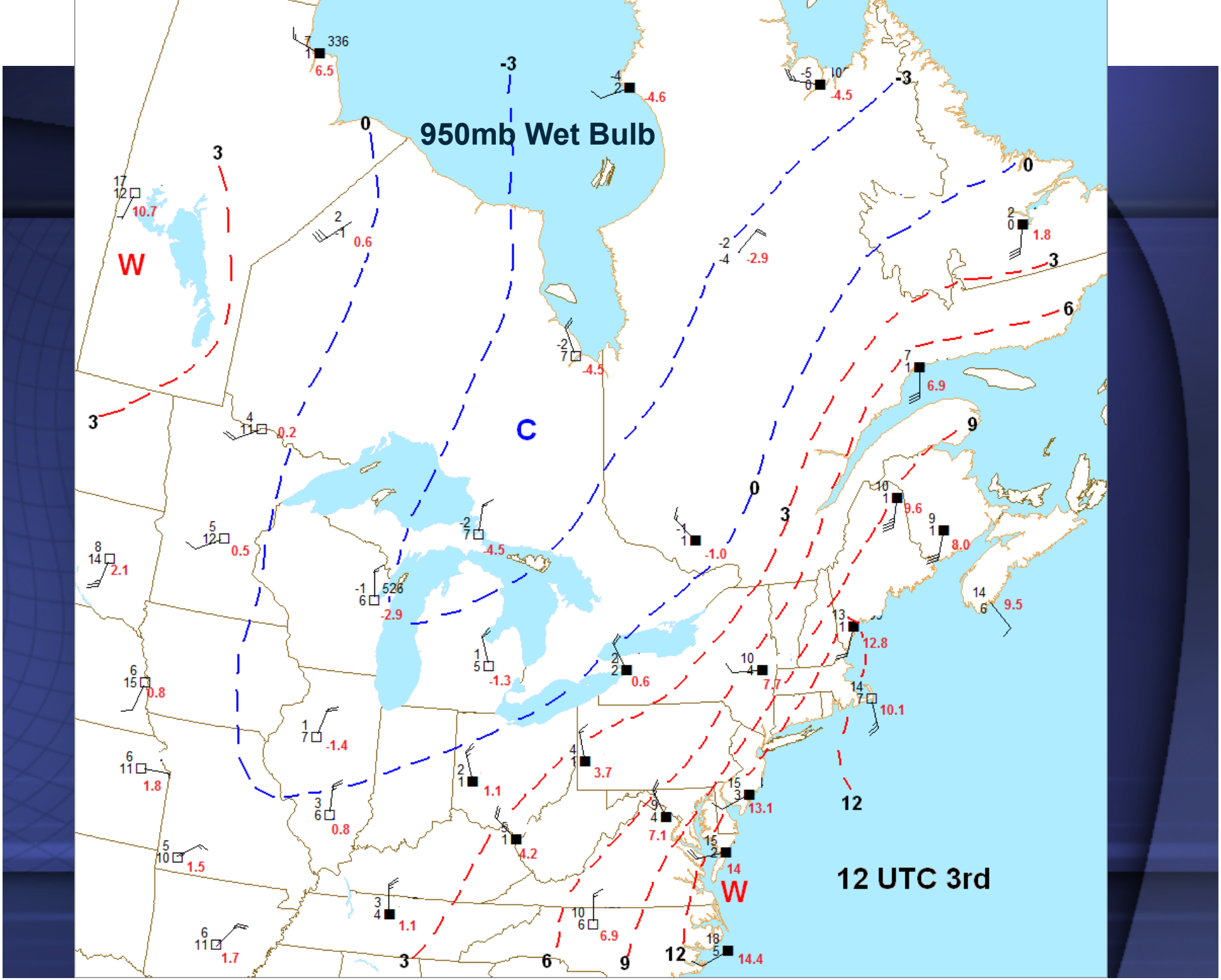
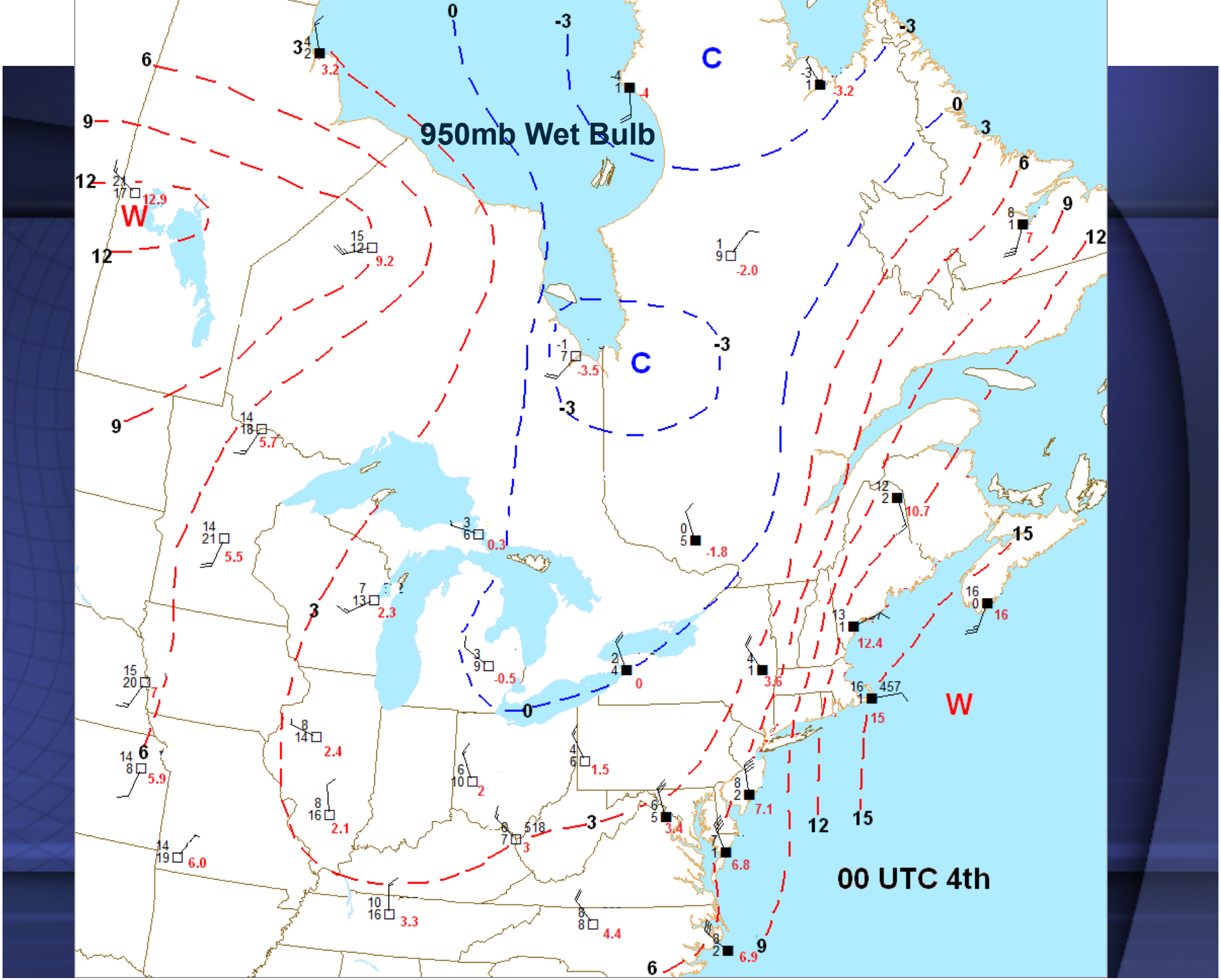
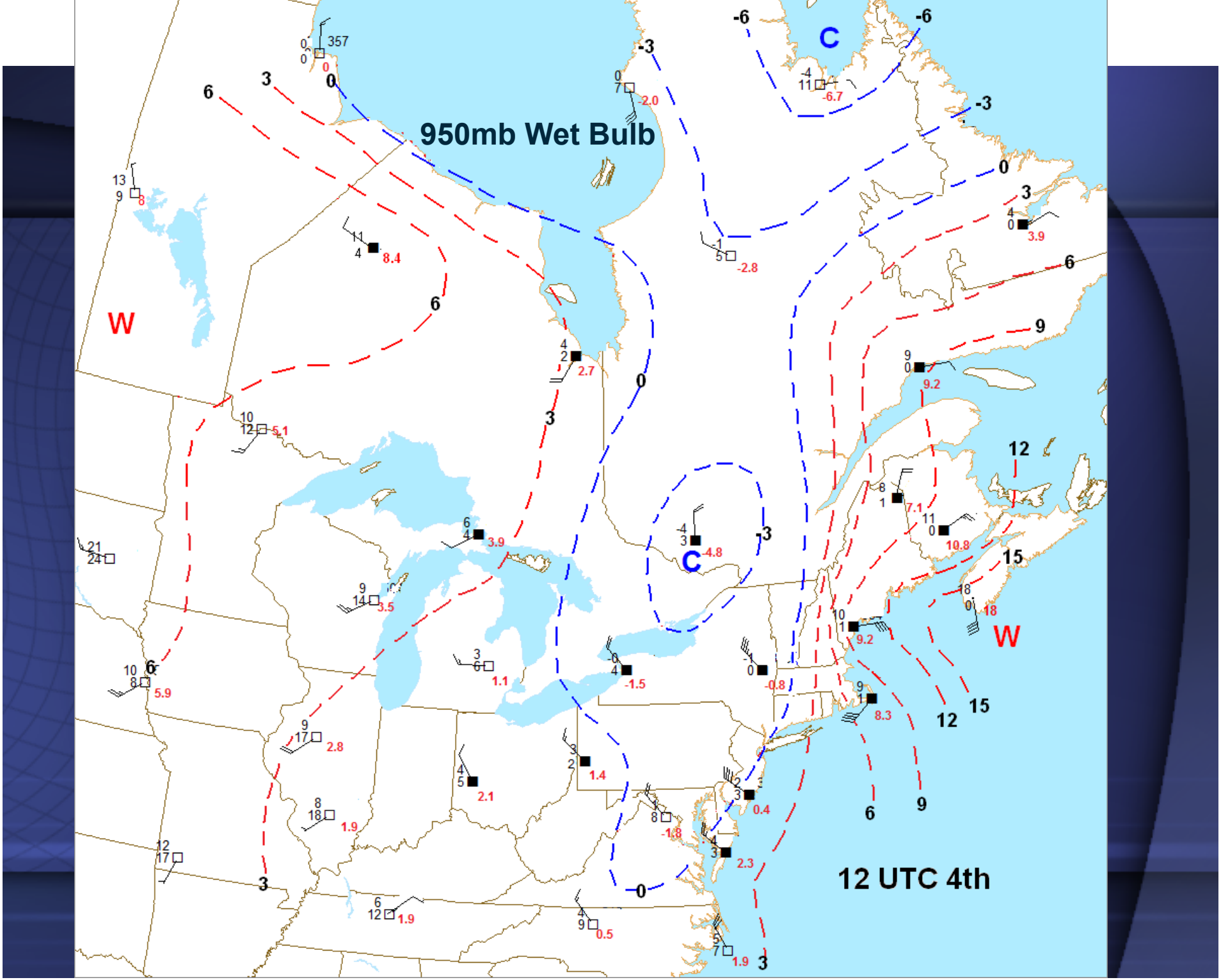
L
Surface Animation


12 Z 1st
500mb Loop with
850mb front

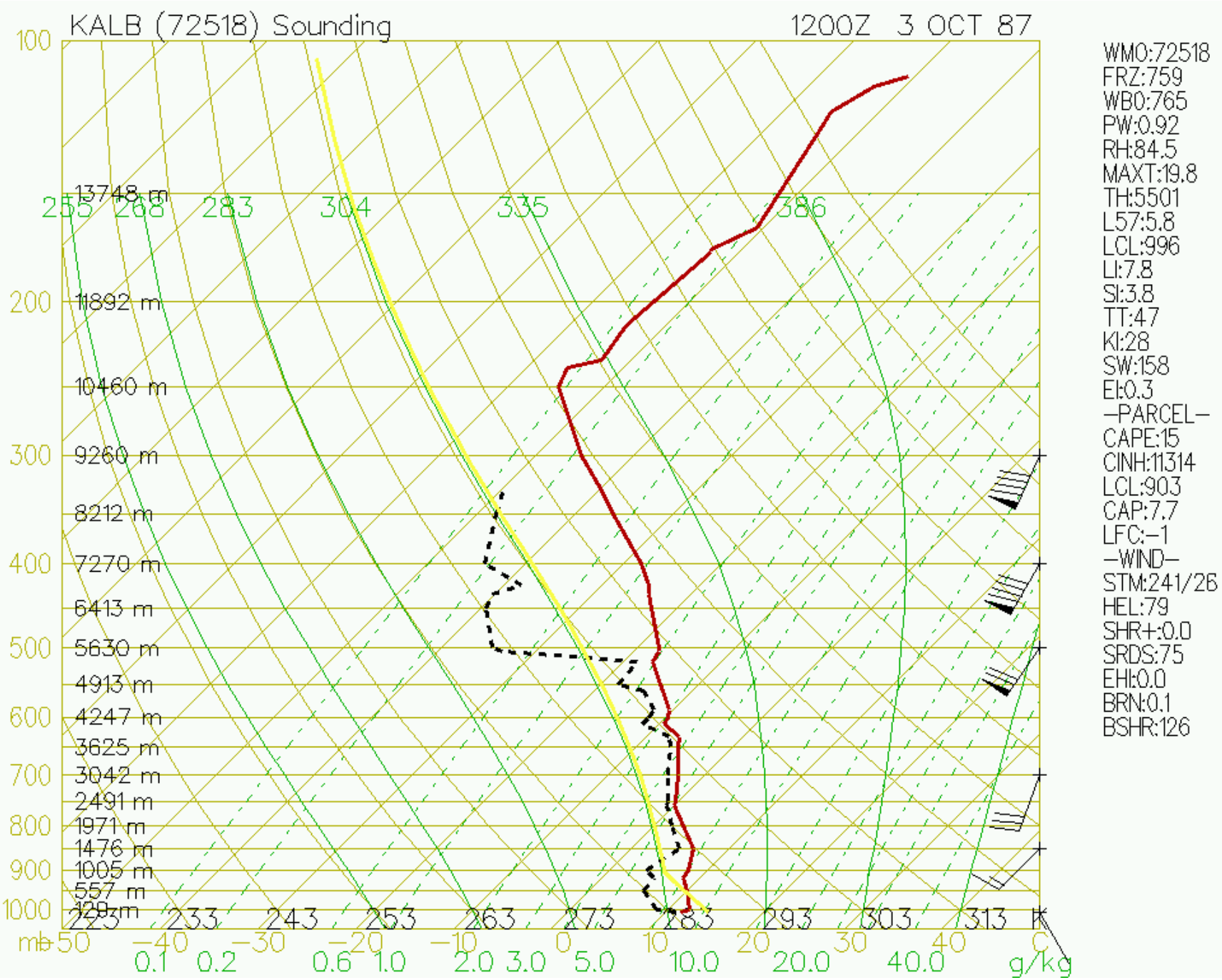

12 Z 1st
850mb Loop

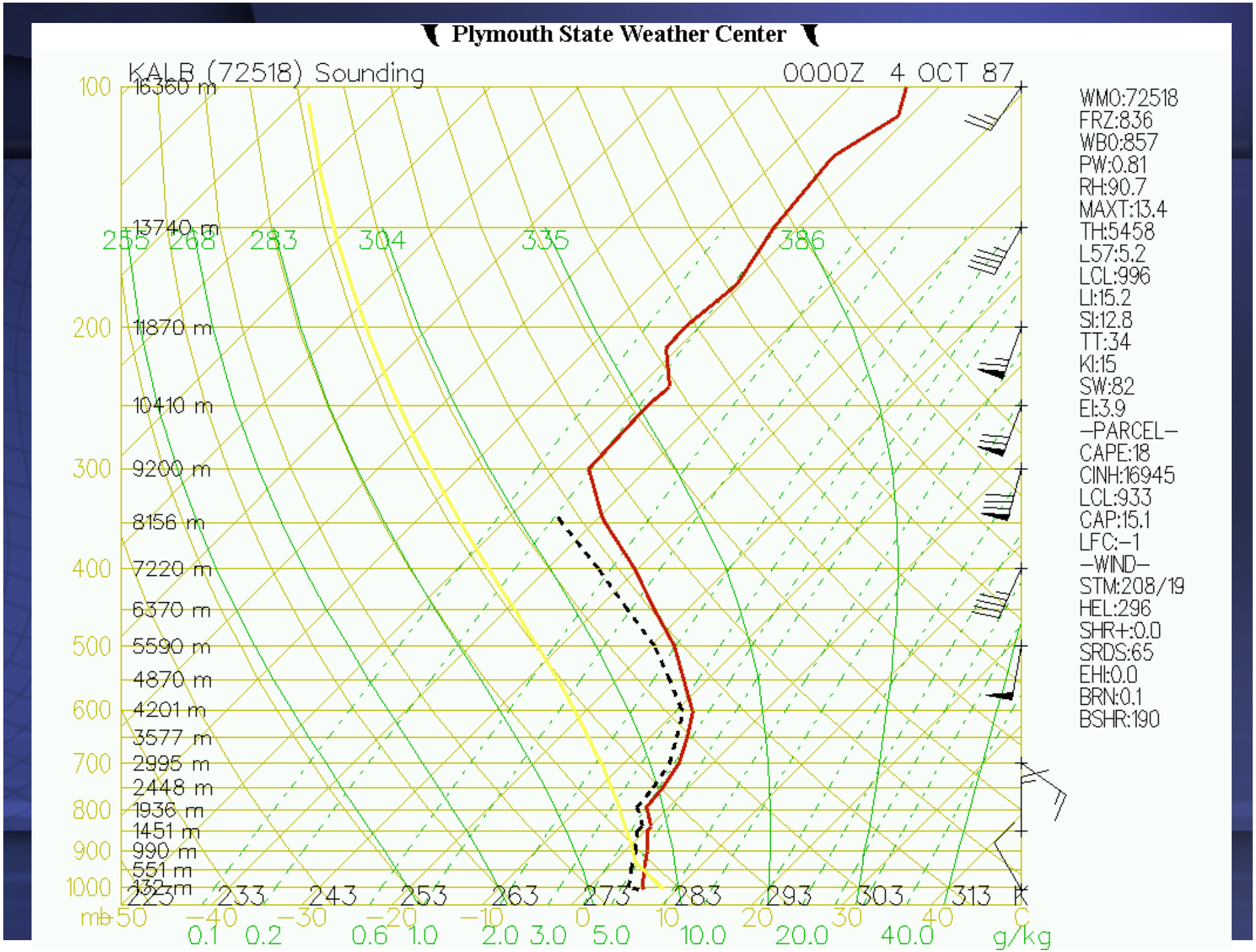

950mb Wet Bulb
W
C
W
12 UTC 3rd


950mb Wet Bulb
00 UTC 4th
W
C


950mb Wet Bulb
12 UTC 4th
W
C
W
C

Plymouth State Weather Center




Plymouth State Weather Center
KALB (72518) Sounding
0000Z 4 OCT 87
16360 m
13740 m
11870 m
10410 m
9200 m
8156 m
7220 m
6370 m
5590 m
4870 m
4201 m
3577 m
2995 m
2448 m
1936 m
1451 m
990 m
551 m
132 m
100
200
300
400
500
600
700
800
900
1000
mb
255 268 283 304 335 386
223 233 243 253 263 273 283 293 303 313 K
-50 -40 -30 -20 -10 0 10 20 30 40 C
0.1 0.2 0.6 1.0 2.0 3.0 5.0 10.0 20.0 40.0 g/kg
WMO:72518
FRZ:836
WB0:857
PW:0.81
RH:90.7
MAXT:13.4
TH:5458
L57:5.2
LCL:996
LI:15.2
SI:12.8
TT:34
KI:15
SW:82
EI:3.9
-PARCEL-
CAPE:18
CINH:16945
LCL:933
CAP:15.1
LFC:-1
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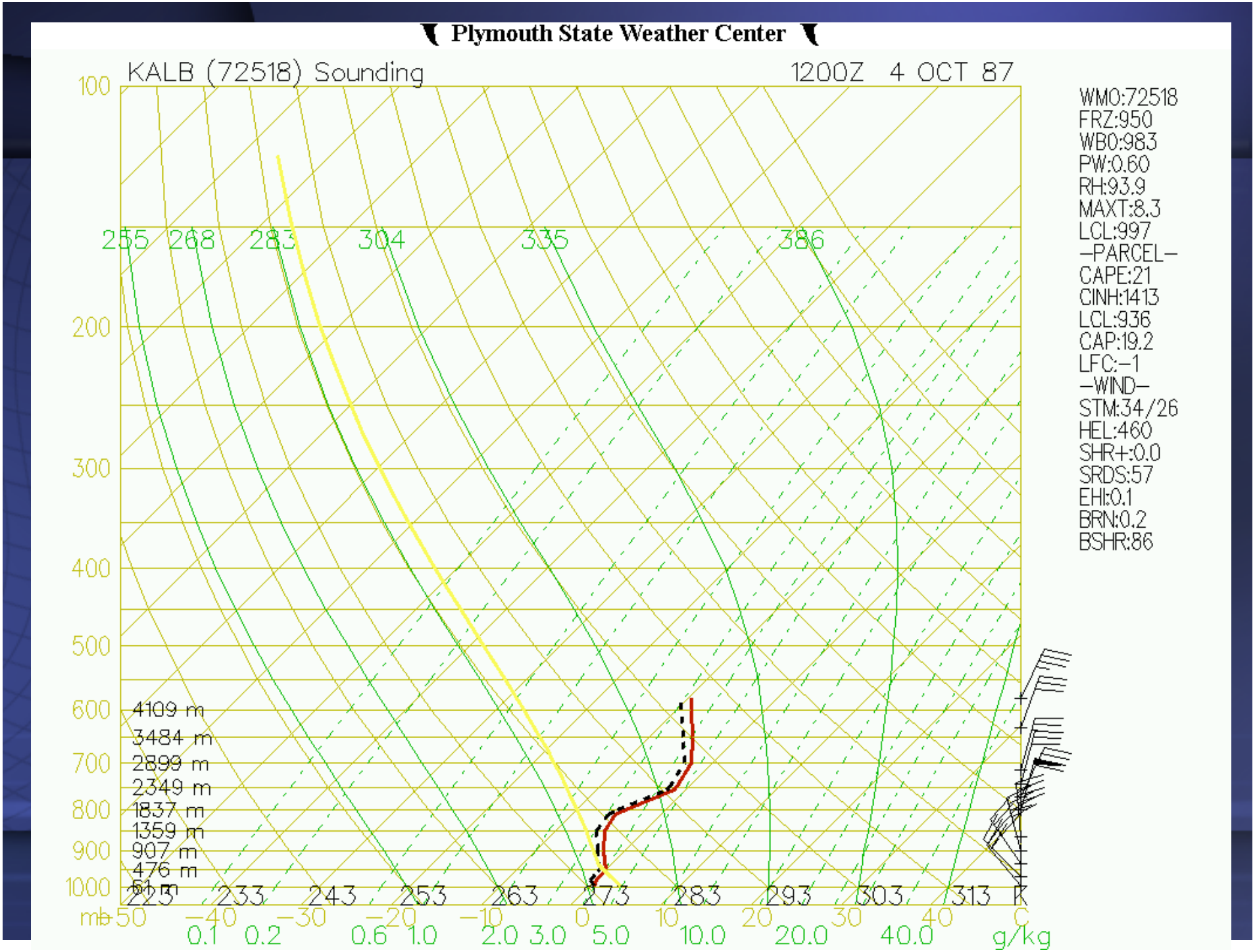
SHR+:0.0
SRDS:65
EHI:0.0
BRN:0.1
BSHR:190


Plymouth State Weather Center
KALB (72518) Sounding
1200Z 4 OCT 87
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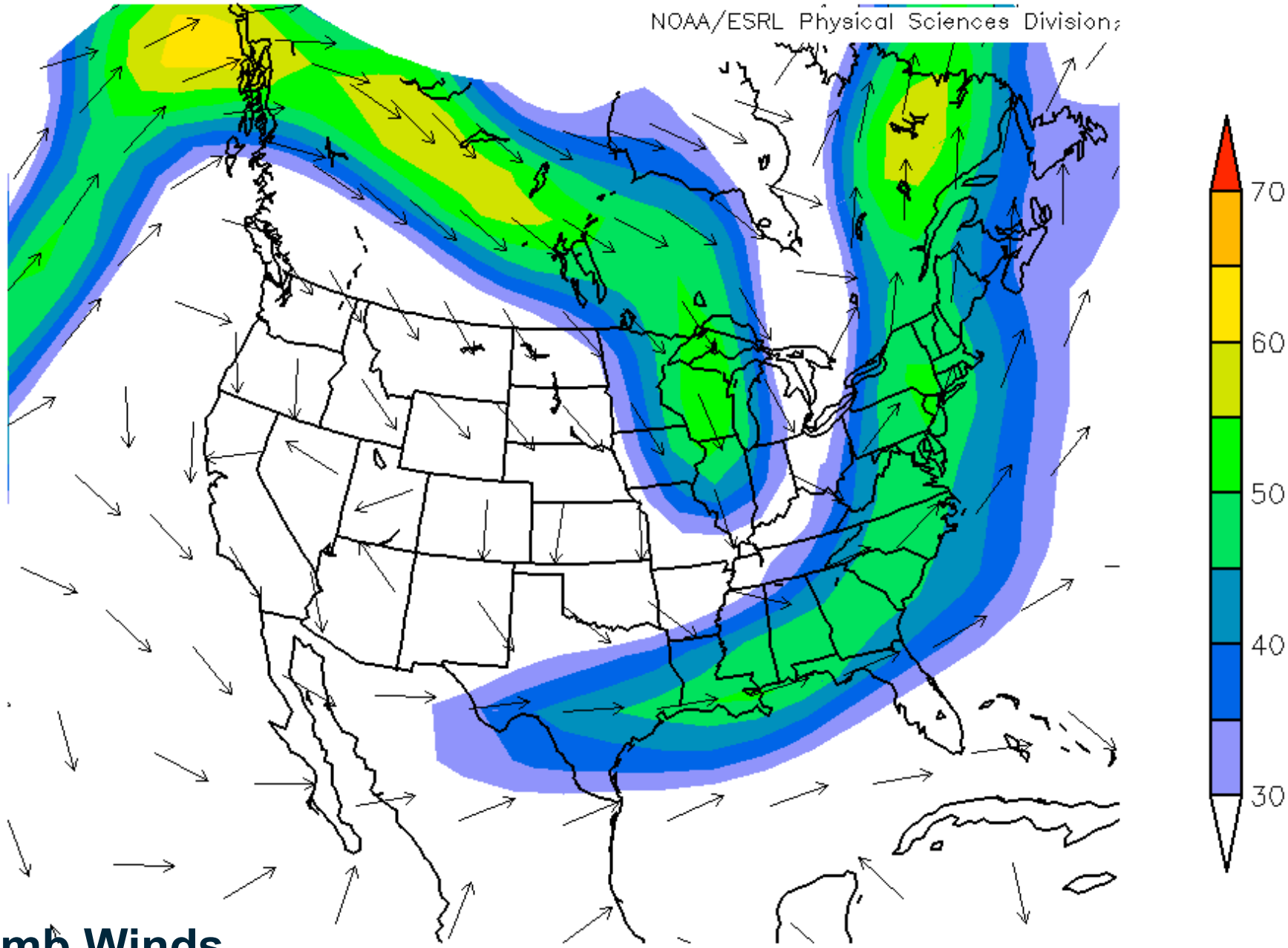
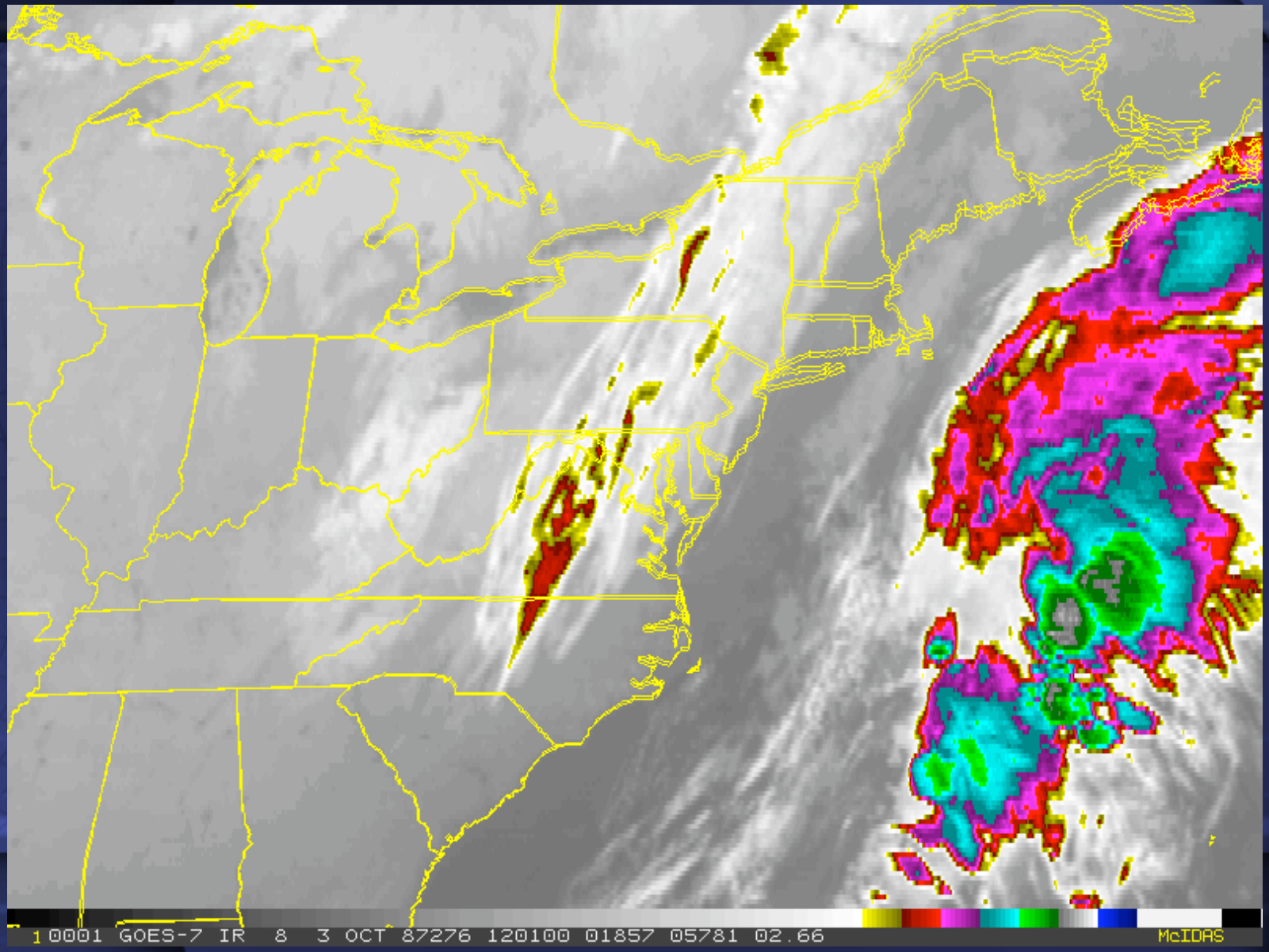
FRZ:950
WB0:983
PW:0.60
RH:93.9
MAXT:8.3
LCL:997
–PARCEL–
CAPE:21
CINH:1413
LCL:936
CAP:19.2
LFC:–1
–WIND–
STM:34/26
HEL:460
SHR+:0.0
SRDS:57
EHI:0.1
BRN:0.2
BSHR:86
100
200
300
400
500
600
700
800
900
1000
255 268 283 304 335 386
4109 m
3484 m
2899 m
2349 m
1837 m
1359 m
907 m
476 m
61 m
223 233 243 253 263 273 283 293 303 313 K
mb 50 –40 –30 –20 –10 0 10 20 30 40 C
0.1 0.2 0.6 1.0 2.0 3.0 5.0 10.0 20.0 40.0 g/kg

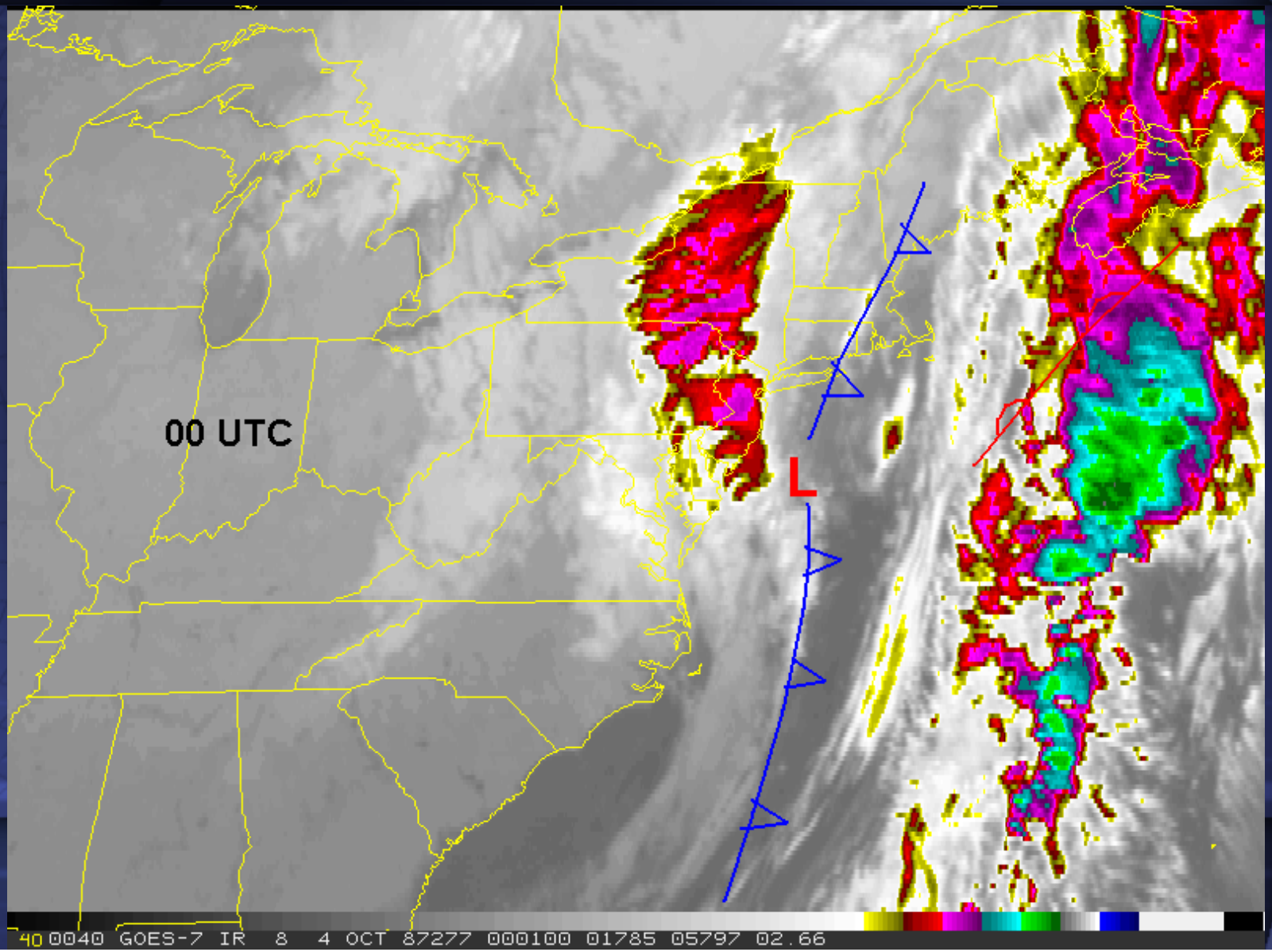

NOAA/ESRL Physical Sciences Division
70
60
50
40
30
250mb Winds (m/s) Composite Mean
10/1/87 0z
NCEP/NCAR Reanalysis

250 mb Winds

IR Loop



IR with Surface Fronts



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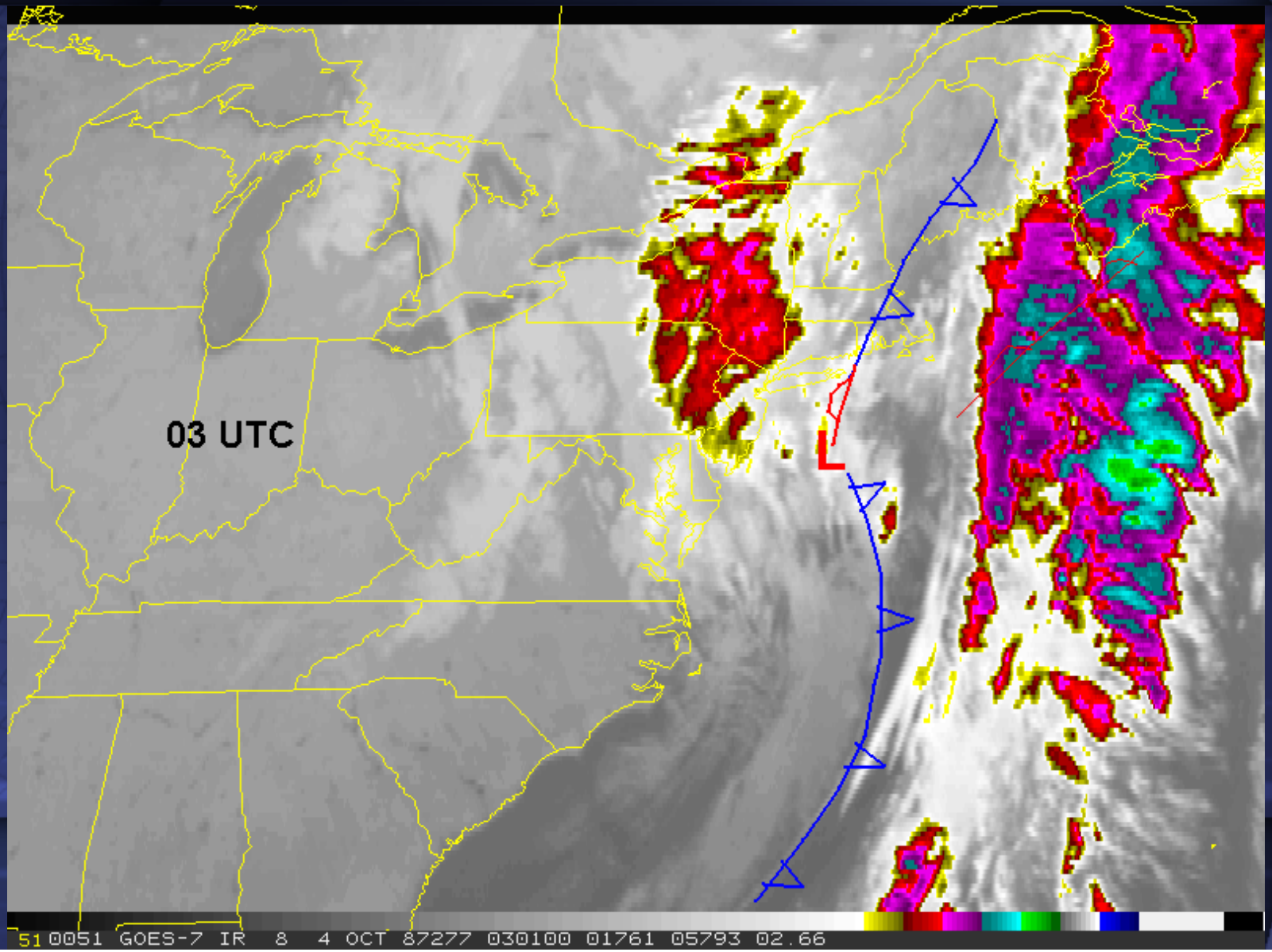
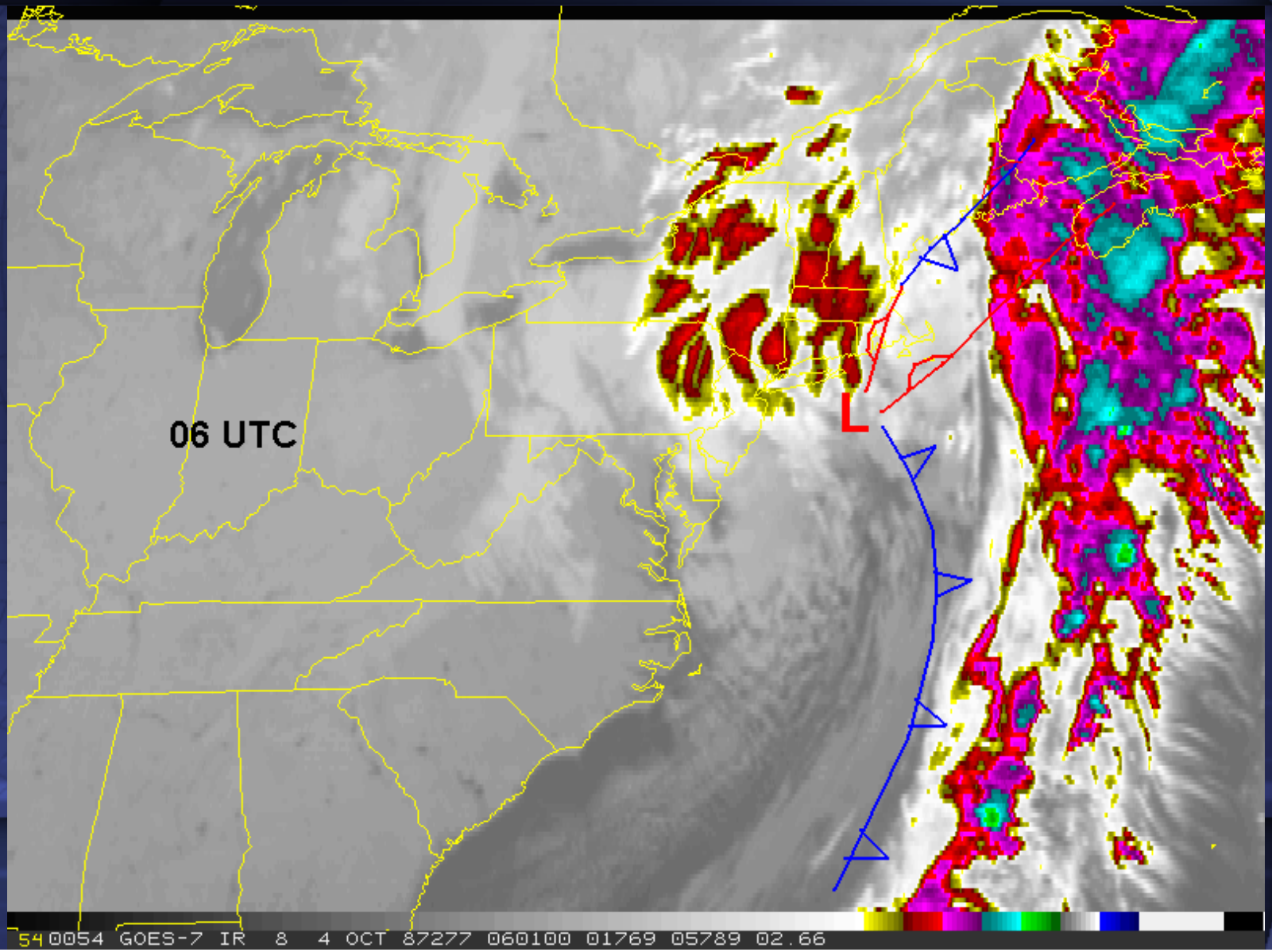


IR with Surface Fronts



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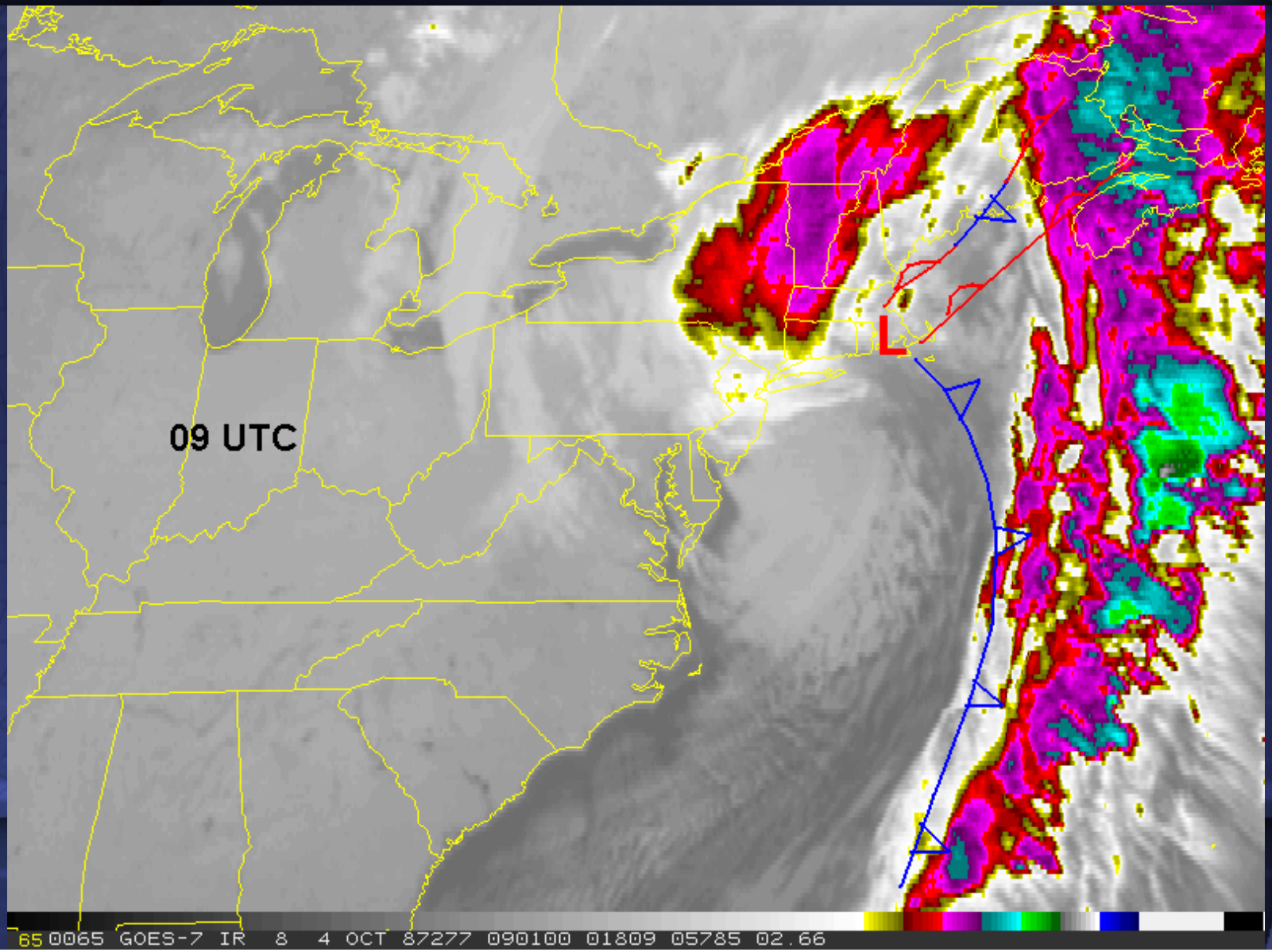

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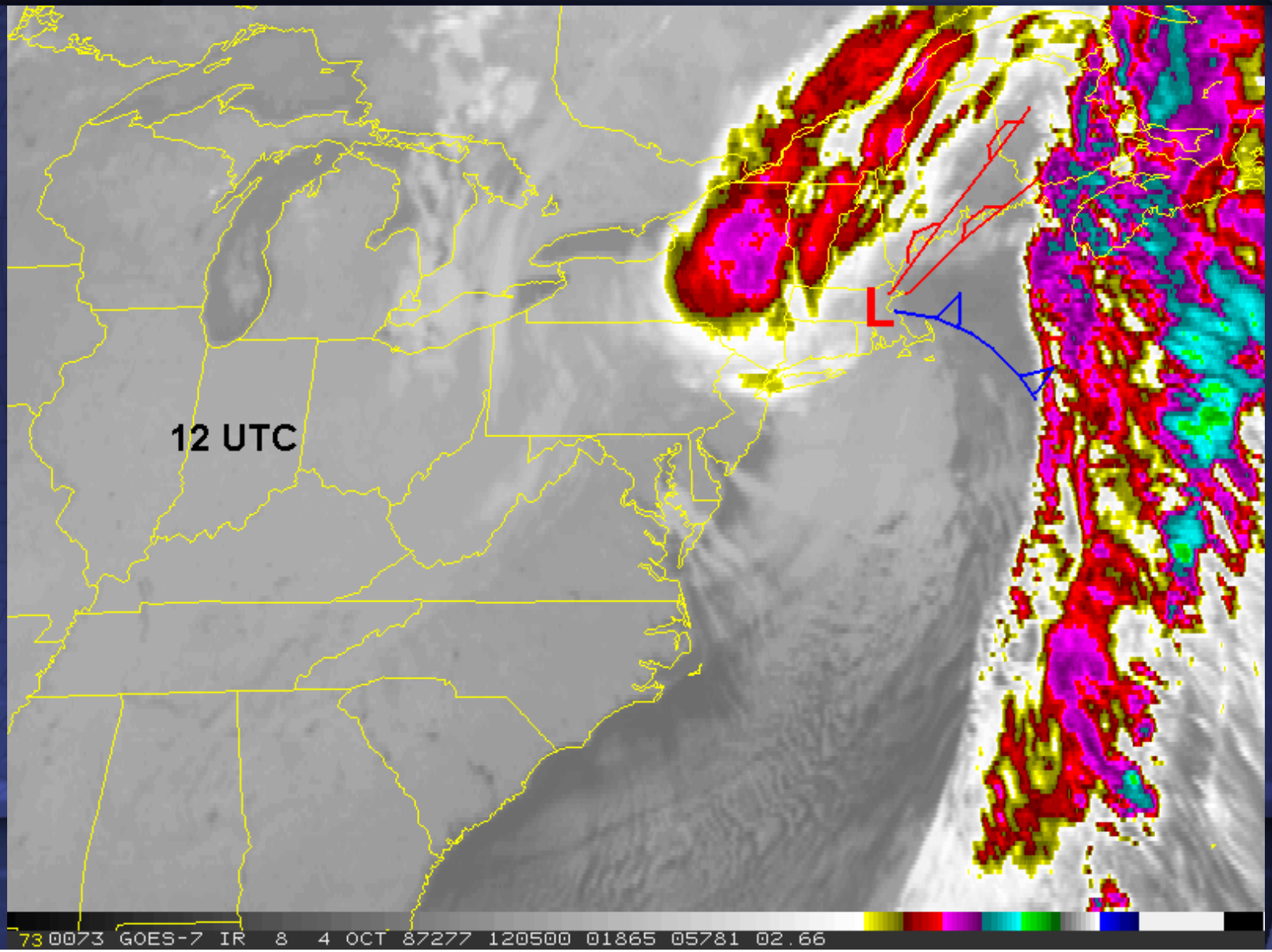
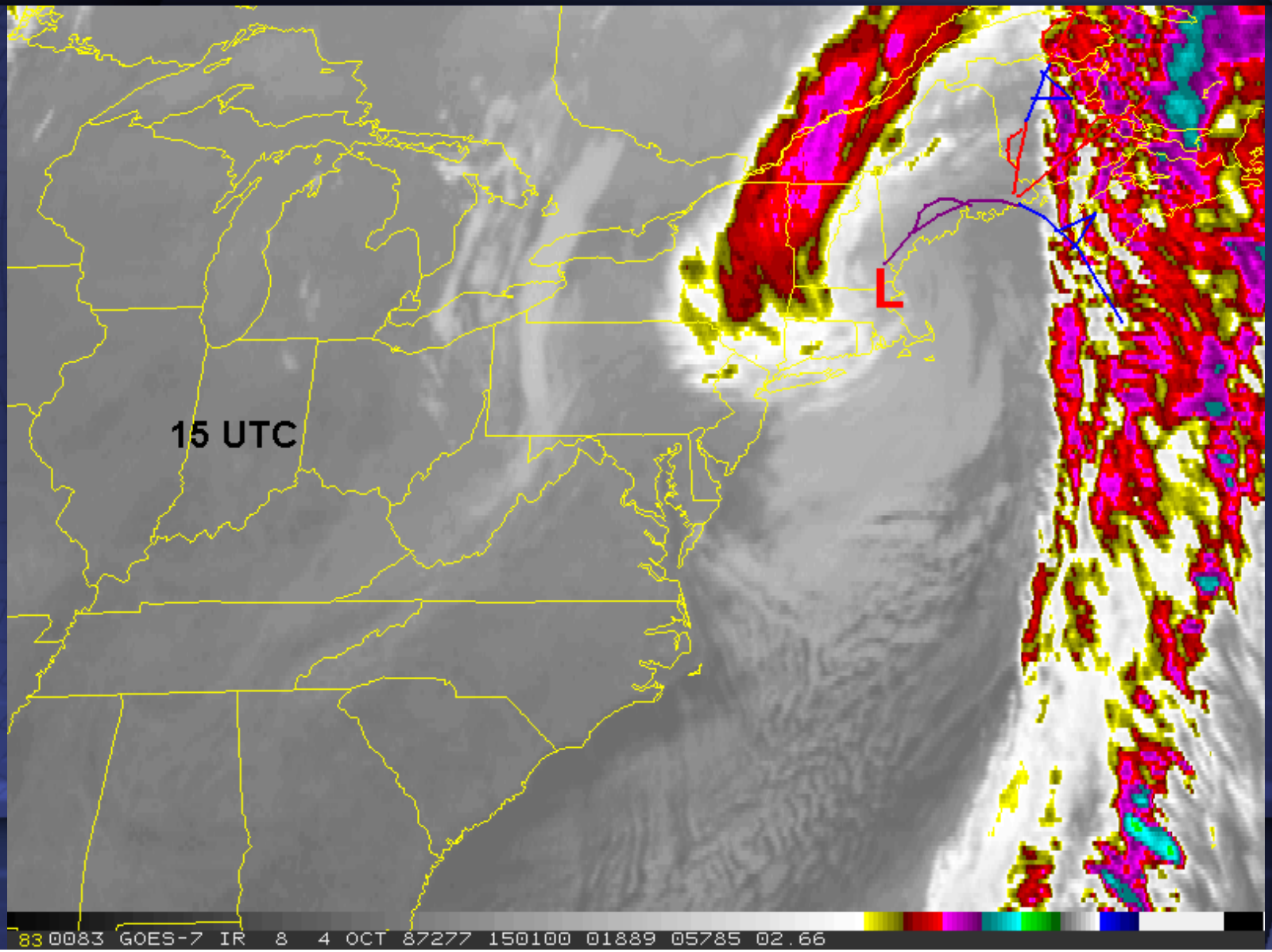
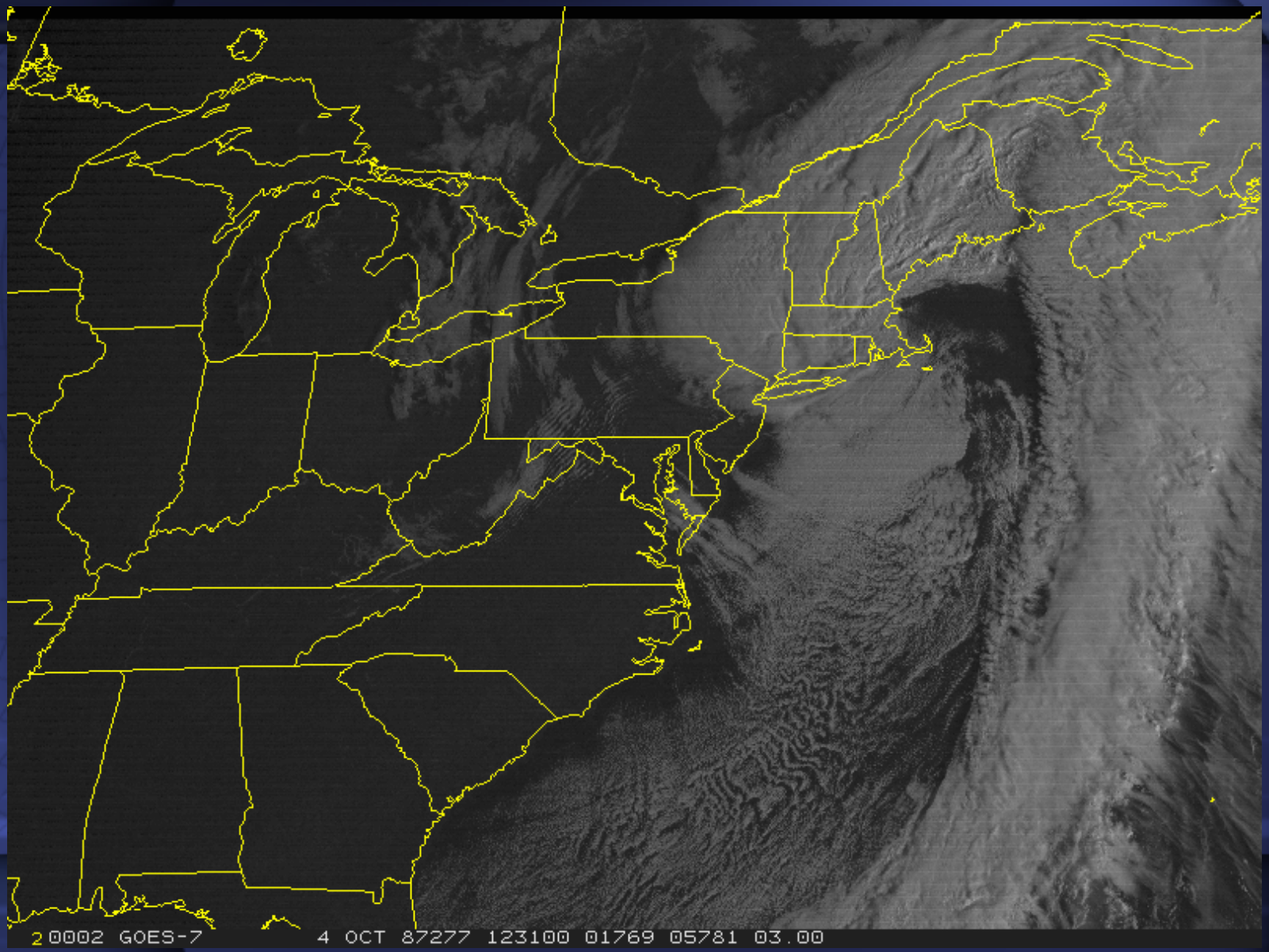


IR with Surface Fronts



Visible Image 1230 UTC 4th



Questions?