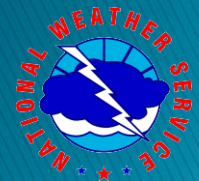


The Labor Day 2014 Northern Michigan Tornado Event

WFO Gaylord, MI

Matt Gillen
Michael Boguth
Bruce Smith

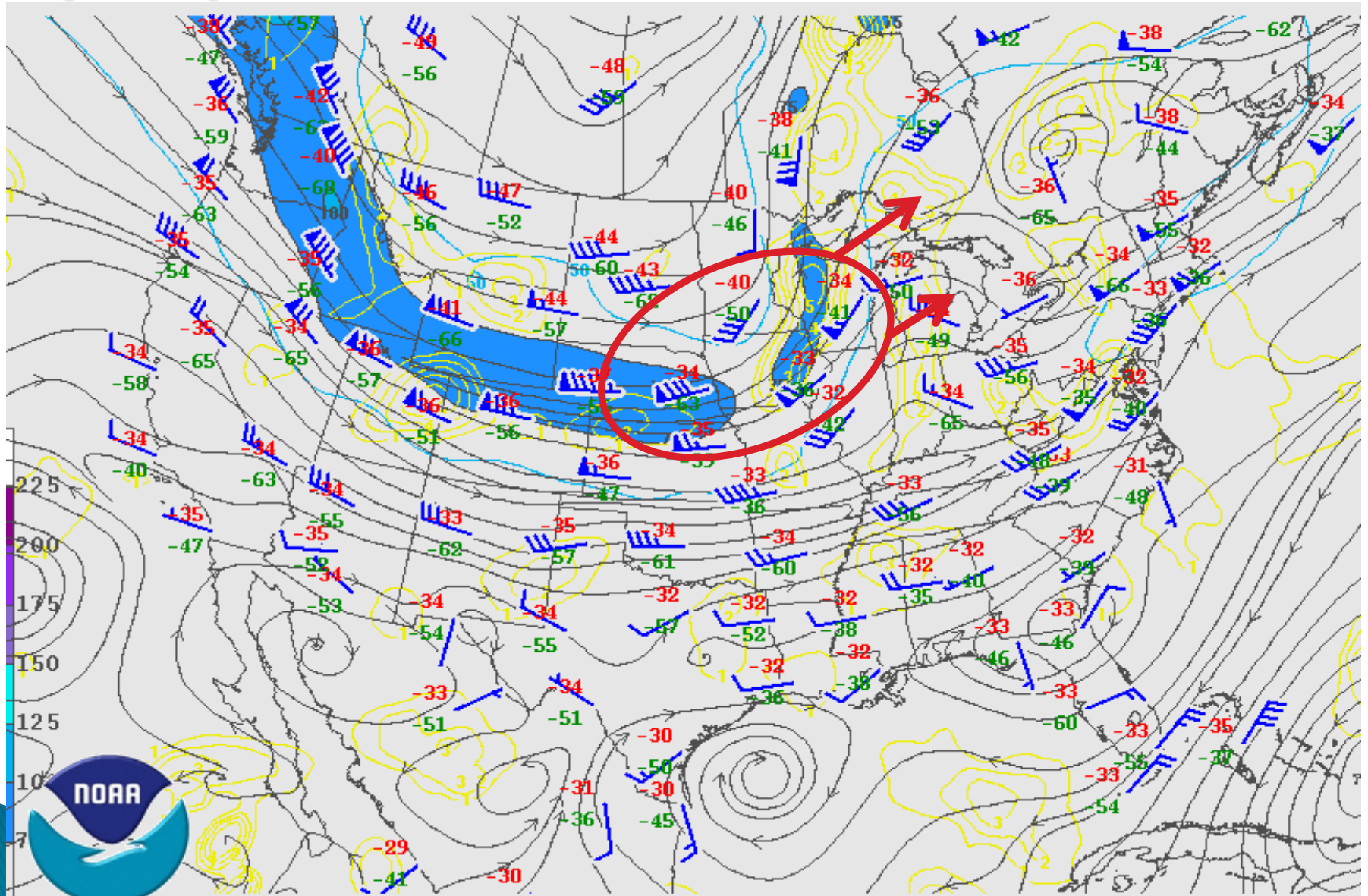


Agenda

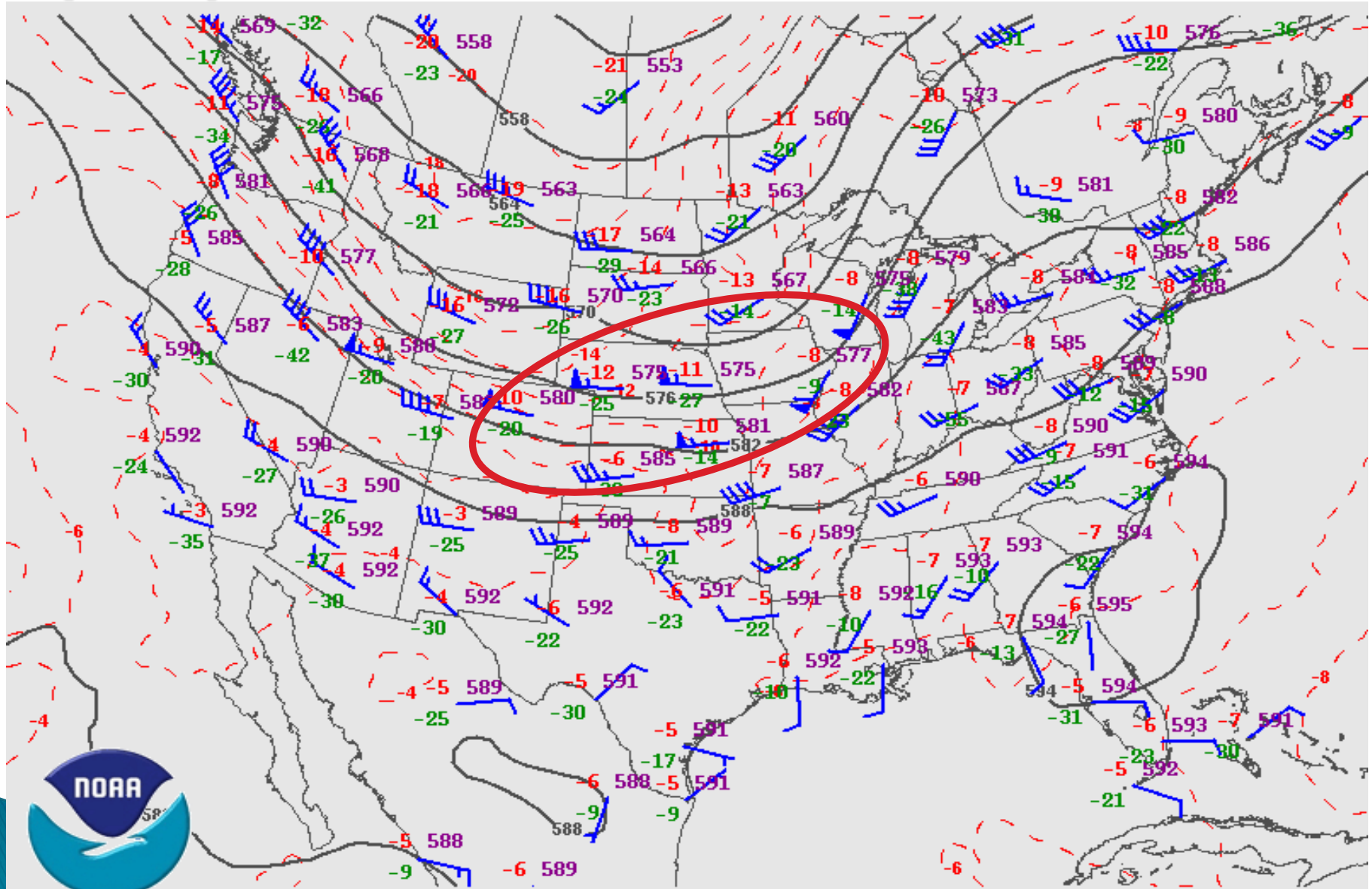
- ▶ Quick synoptic overview
- ▶ Forecast expectations
 - WFO Gaylord
 - SPC
- ▶ What happened?
- ▶ Related DSS
- ▶ Takeaways & future work



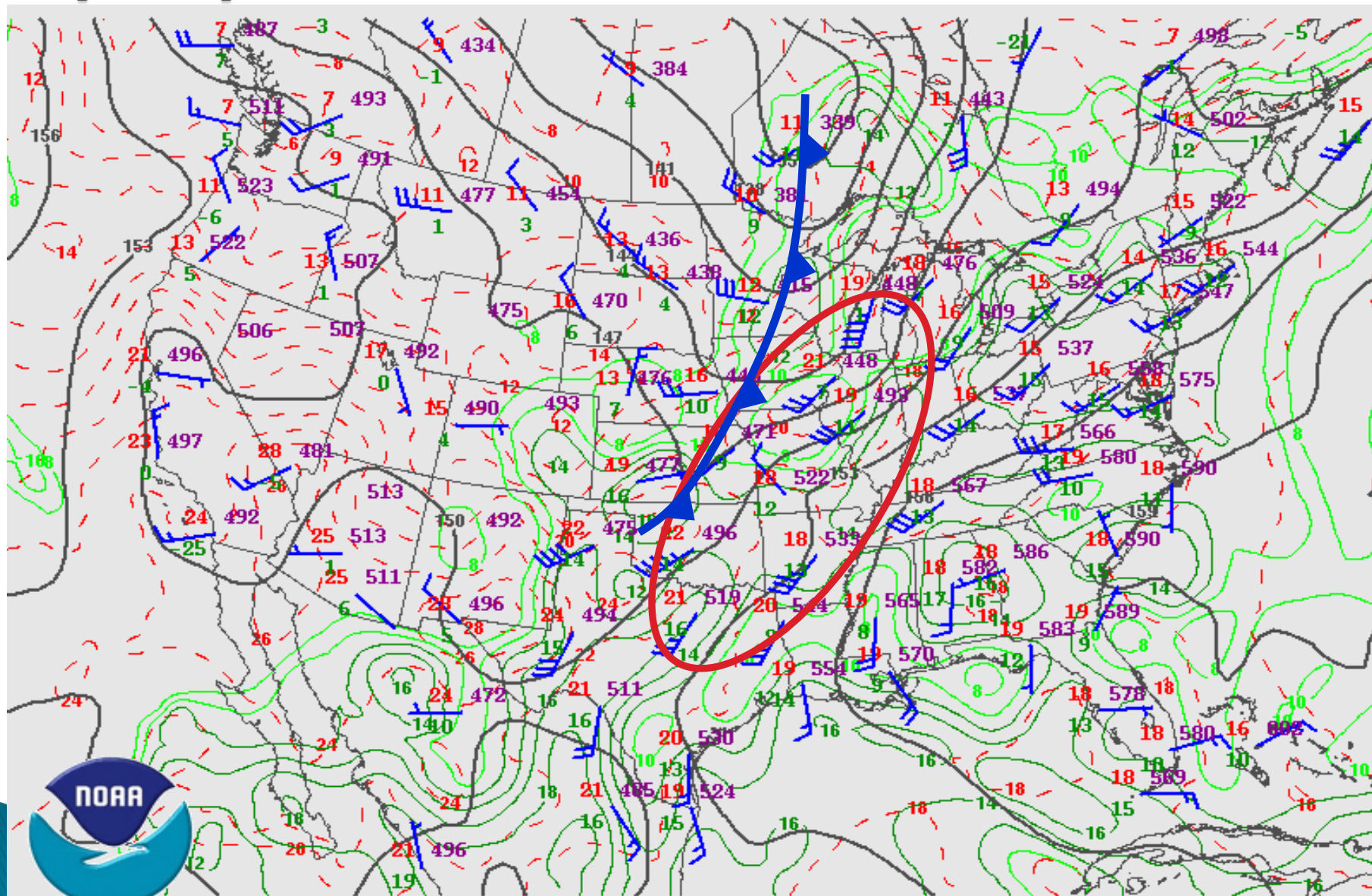
Synoptic Overview



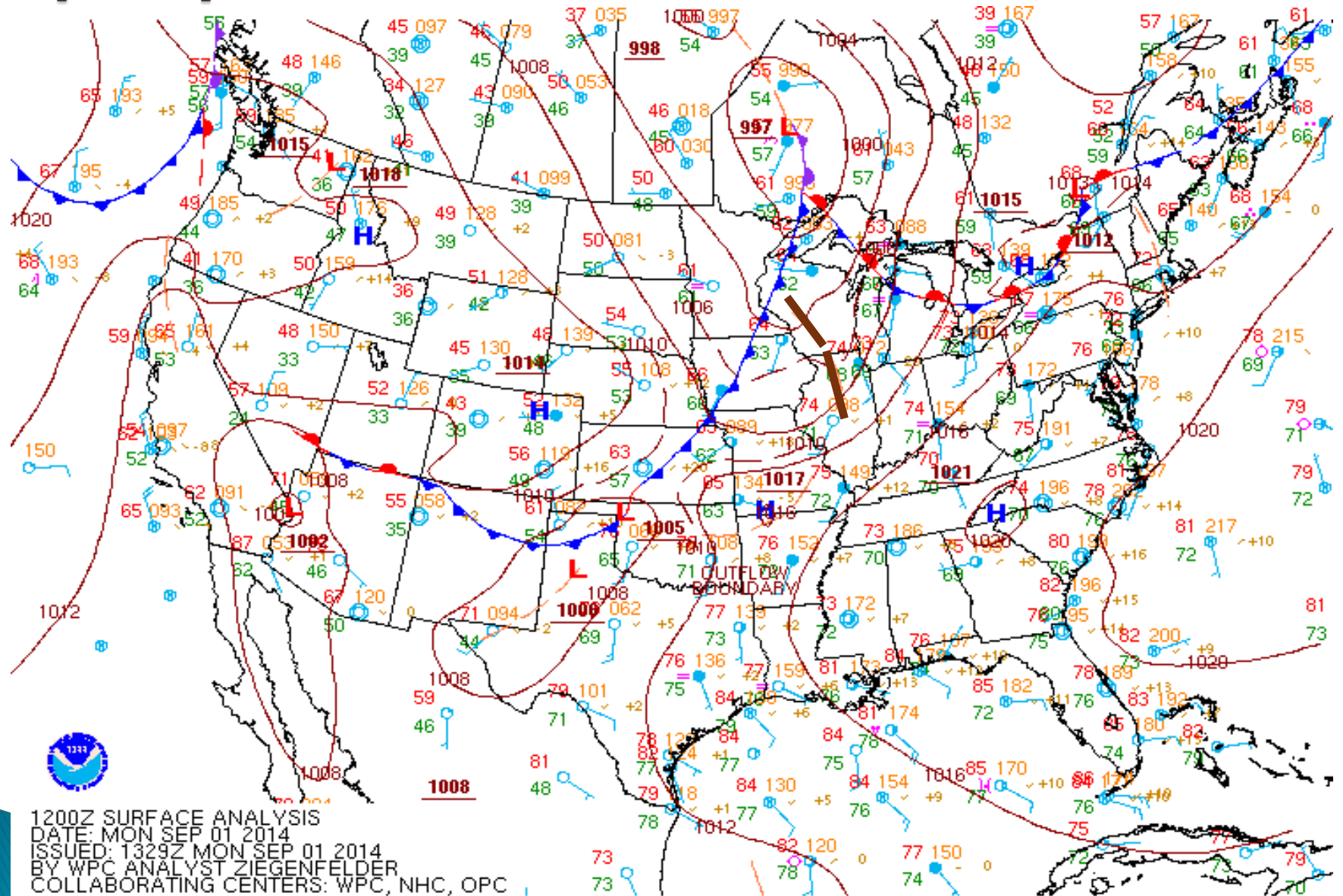
Synoptic Overview



Synoptic Overview



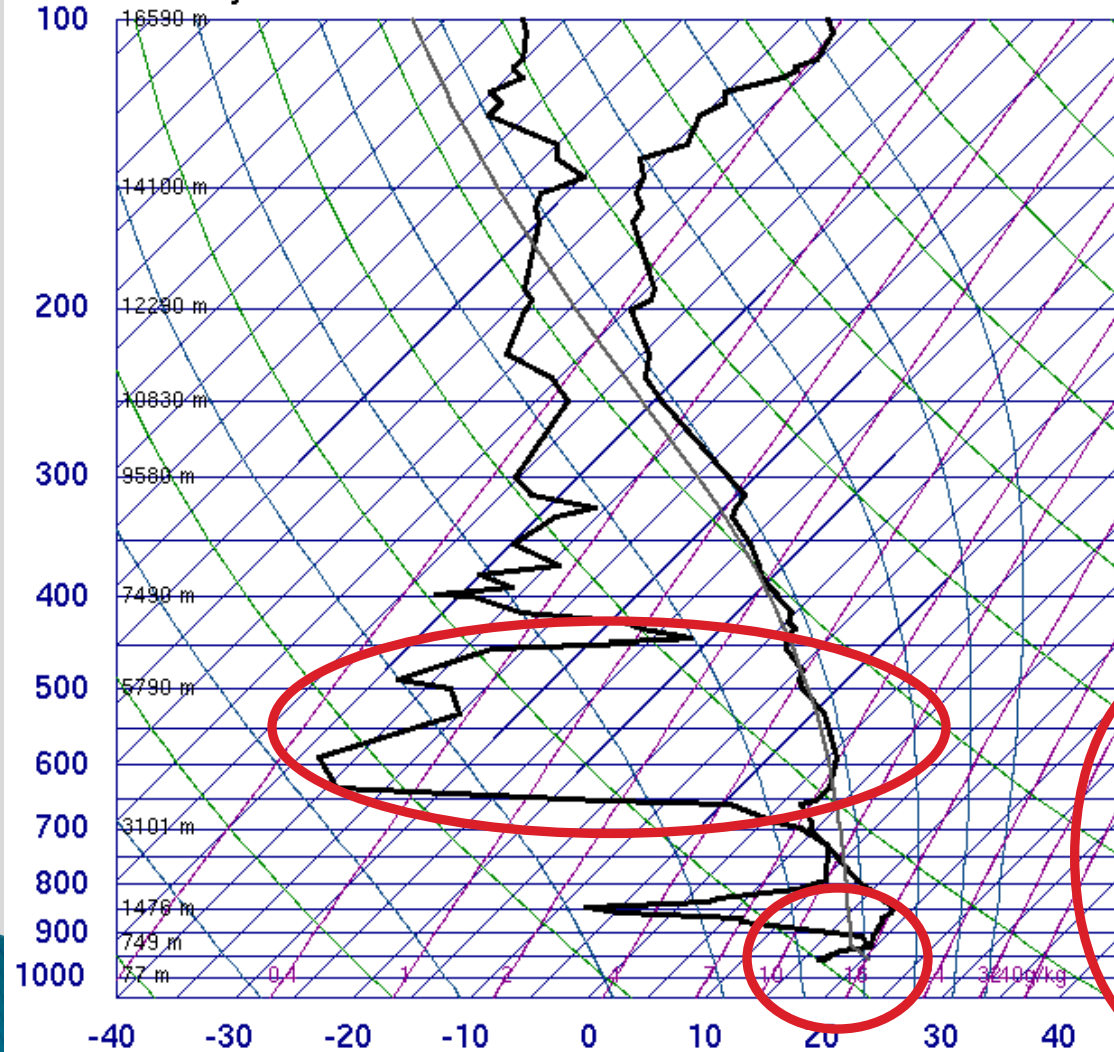
Synoptic Overview



1200Z SURFACE ANALYSIS
DATE: MON SEP 01 2014
ISSUED: 1329Z MON SEP 01 2014
BY WPC ANALYST ZIEGENFELDER
COLLABORATING CENTERS: WPC, NHC, OPC

Synoptic Overview

72634 APX Gaylord



PARCEL	CAPE	CINH	LCL	LI	LFC	EL
SURFACE	0	0	65m	3	M	212'
MIXED LAYER	20	-165	1090m	1	2602m	10966'
FCST SURFACE	397	0	1914m	-2	10384m	35776'
MU (925 mb)	1158	-4	342m	-4	1254m	38846'

PW = 1.11 in	3CAPE = 11 J/kg	WBZ = 9899'	WNDG = 0.0
K = 19	DCAPE = 1044 J/kg	FZL = 13697'	ESP = 0.0
MidRH = 47%	DownT = 55 F	ConvT = 84F	MMP = 0.07
LowRH = 49%	MeanW = 10.9 g/kg	MaxT = 86F	NCAPE = 0.11
SigSevere = 320 m3/s3			
Sfc-3km Agl Lapse Rate = 5.2 C/km			
3-6km Agl Lapse Rate = 5.1 C/km			
850-500mb Lapse Rate = 6.2 C/km			
700-500mb Lapse Rate = 5.1 C/km			

Supercell = 0.0
Left Supercell = -0.0
STP (eff layer) = 0.0
STP (fix layer) = 0.0
Sig Hail = 0.0

	SRH(m2/s2)	Shear(kt)	MnWind	SRW
SFC - 1 km	102	24	224/23	209/14
SFC - 3 km	65	10	215/17	183/10
Eff Inflow Layer	13	3	225/29	214/20
SFC - 6 km		31	211/21	187/14
SFC - 8 km		27	216/21	194/14
Eff Shear (EBWD)		7	212/22	190/15
BRN Shear = 1 m ² /s ²				
4-6km SR Wind =		198/26 kt		
..... Storm Motion Vectors.....				
Bunkers Right =		245/10 kt		
Bunkers Left =		209/36 kt		
Corfidi Downshear =		217/25 kt		
Corfidi Upshear =		174/2 kt		

1km & 6km AGL Wind Barbs

12Z 01 Sep 2014

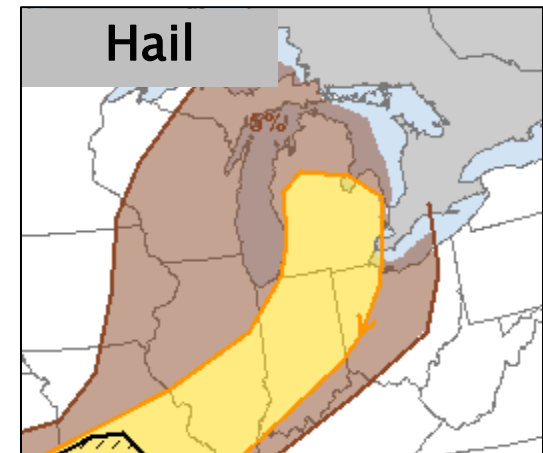
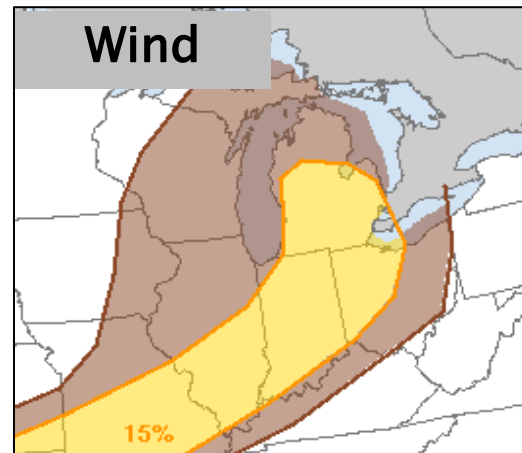
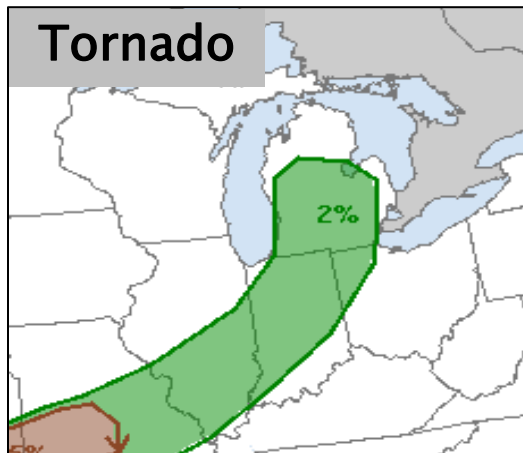
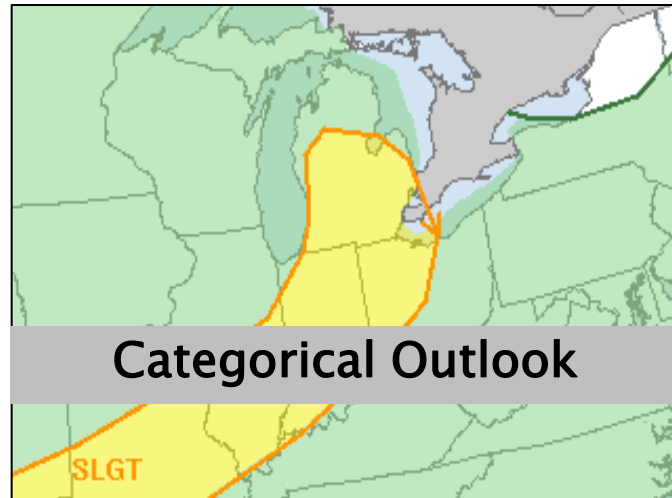
University of Wyoming

WFO Gaylord Expectations

- ▶ Convection along pre-frontal trough arriving early afternoon (coincident with 55 kt mid level jet)
- ▶ Forecast threats:
 - Marginal damaging wind threat (mid-level dry air)
 - Minimal tornado threat (with quasi-unidirectional flow)
- ▶ Potential forecast issues: Early morning stratus and its impact on destabilization



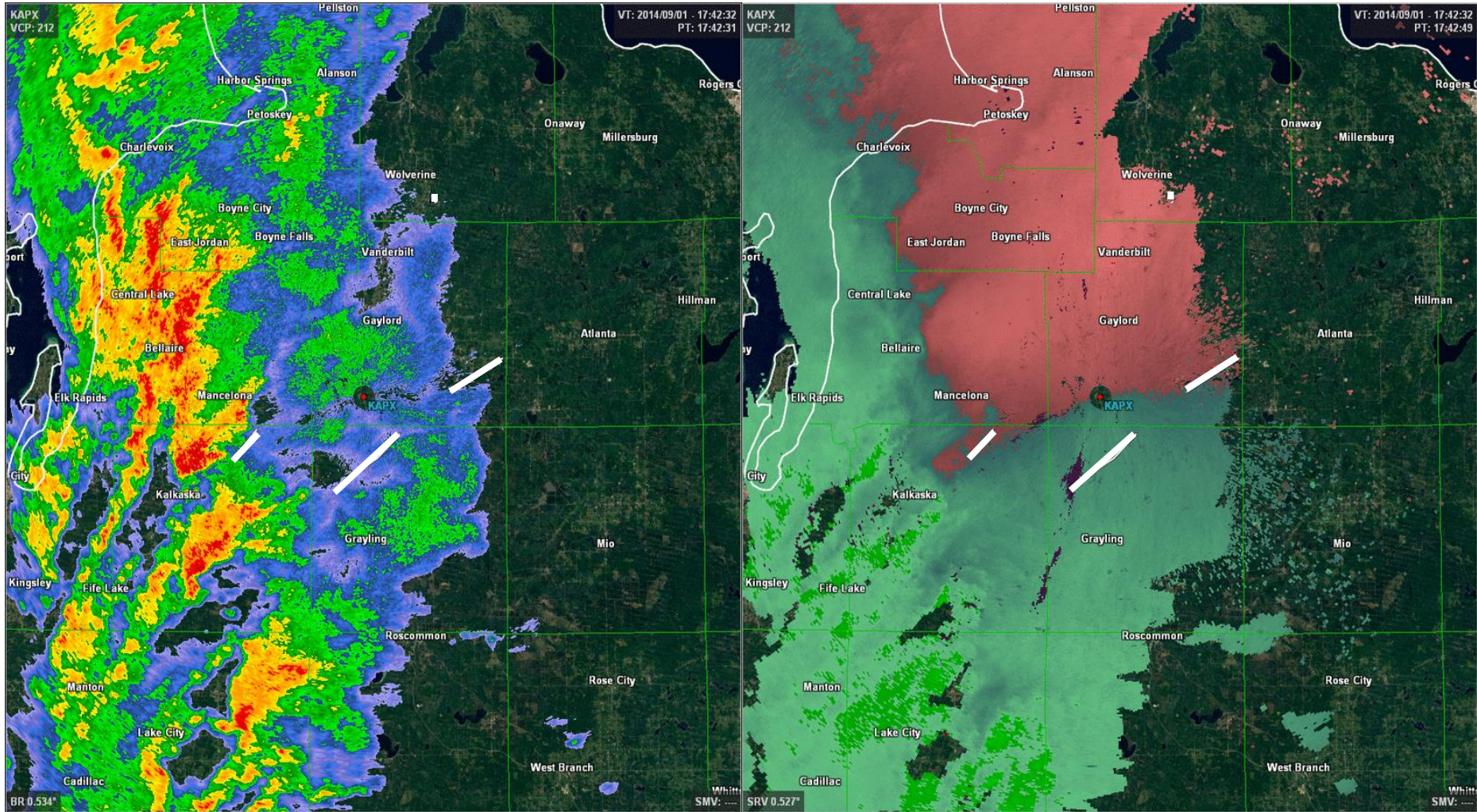
SPC – Sept 1st 1300z Day 1 Outlook



“A broken band of pre-frontal convection will be possible this afternoon from northern Indiana into lower Michigan...A few damaging gusts will be possible with MLCAPE around 2000 j/kg and enhanced deep-layer vertical shear.”



What Happened

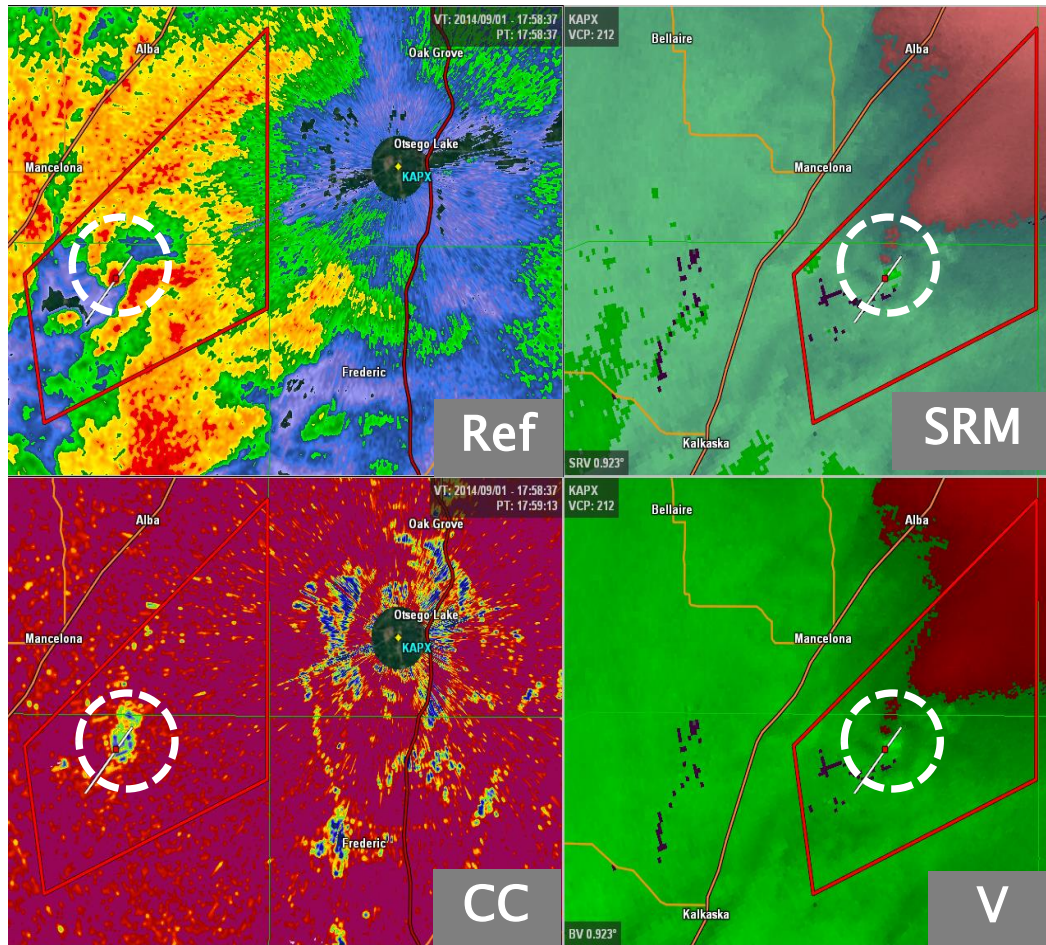


What Happened

- ▶ Broken line of convection arrived early afternoon (as expected).
- ▶ Embedded low-topped supercells (not expected)
- ▶ Four confirmed tornadoes between 1:53pm – 2:52pm
 - One EF-0 & three EF-1
 - Crawford County tornado details:
 - Rating: EF-1
 - Max wind: 100 mph
 - Path length: 9.10 miles
 - Time on ground: 13 minutes
- ▶ Two separate reports of damaging wind.



What Happened



Kalkaska County, MI EF-1 Tornado

▶ The role of Dual-Pol:

- TDS allowed for “Radar Confirmed” tornado wording to be used.
- Able to quickly & more confidently issue ‘Tornado’ LSRs.
- Dual-pol products from this event confirmed that all four tornadoes in fact had a collocated TDS.

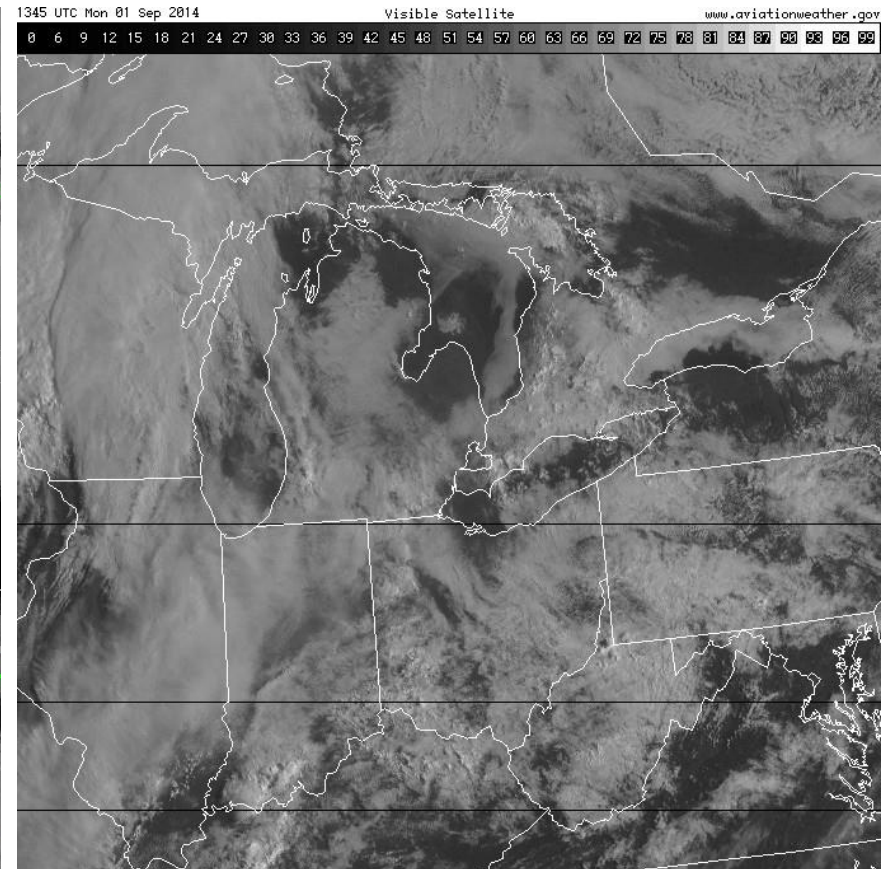
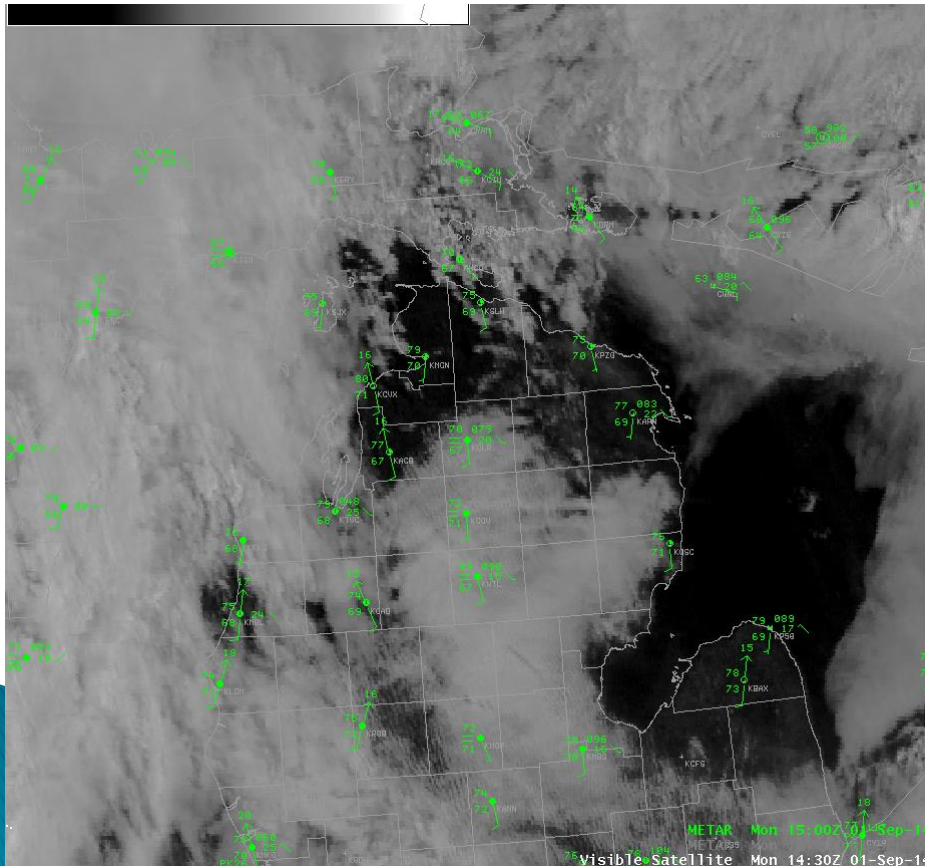


What Happened



What Changed From Morning Expectations?

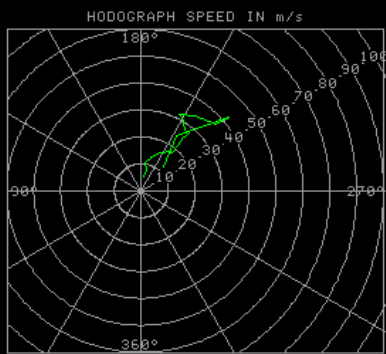
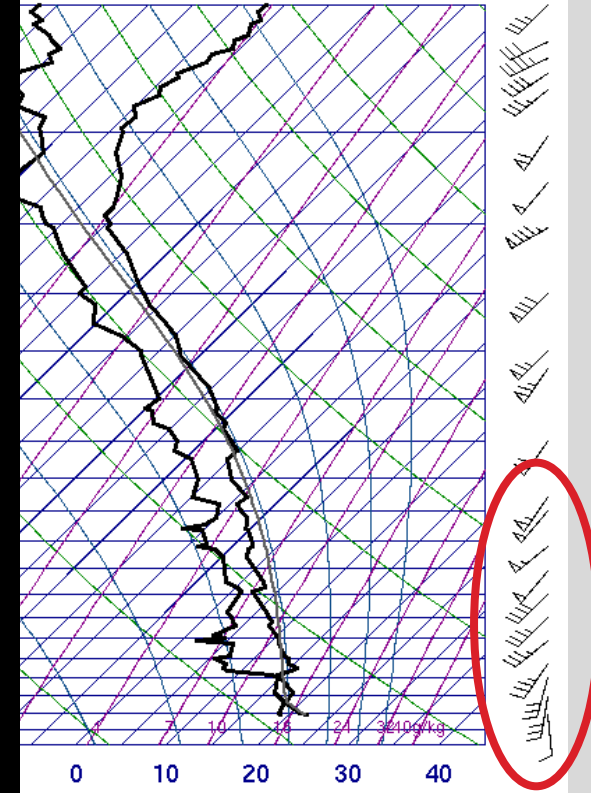
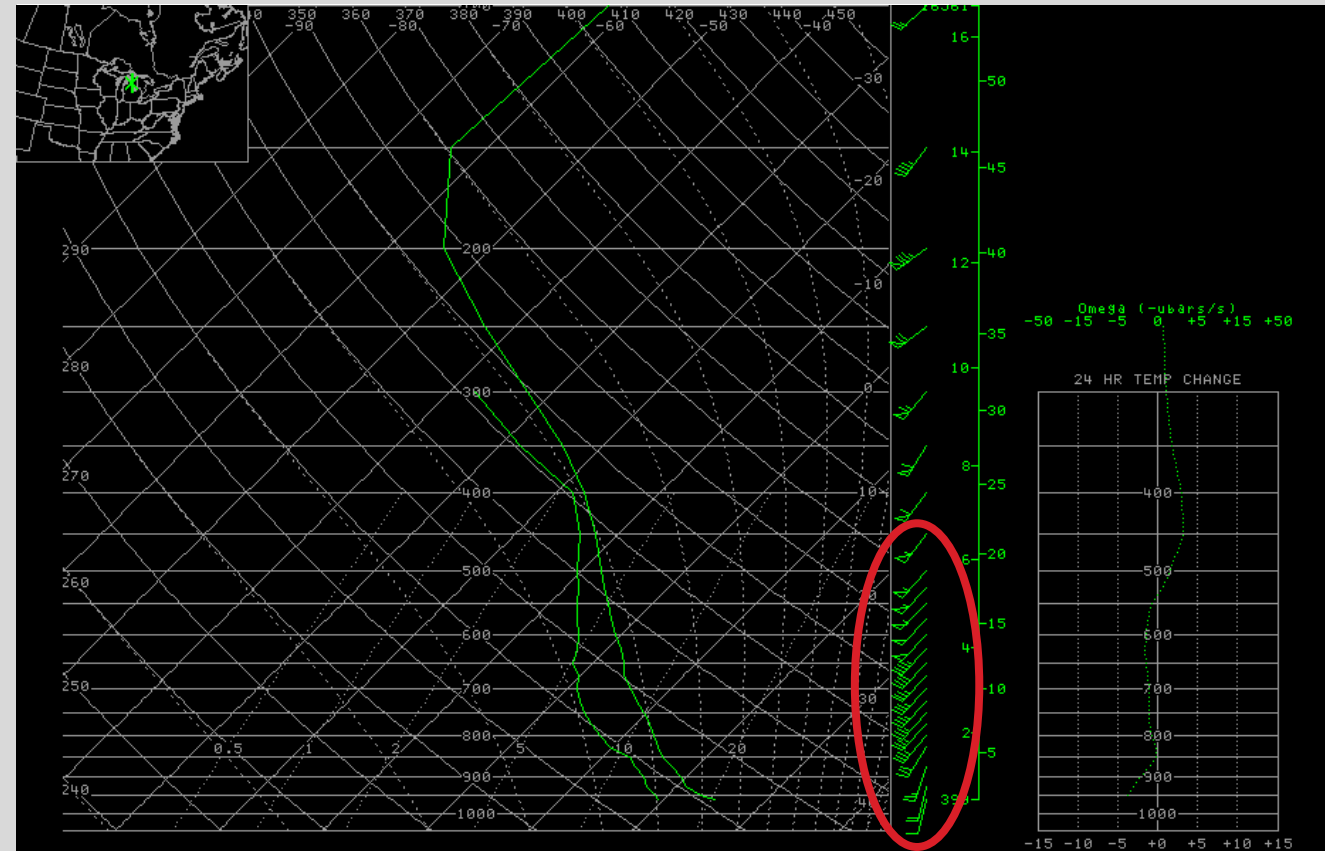
- ▶ Stratus across northern Michigan eroded just prior to arrival of convection
 - Enhanced instability
 - However, near surface winds remained slightly backed – even after the clouds eroded – which resulted in enhanced low level helicity



What Changed From Morning Expectations?

1200 UTC

1800 UTC



PRECIP WATER= 1.55 in
 K-INDEX= 31
 TOTALS INDEX= 45
 SWEAT INDEX= 320
 DRY MICROBURST POT=2; GST < 30 kt_dIFTED INDEX= -4.0
 FREEZING LEVEL= 13798 ft ASL
 WET-BULB ZERO HGT= 12617 ft ASL
 0-6 KM AVG WIND= 214°/37 kts
 0-6 KM STM MTN (30R75)= 244°/27 kt
 0-3 KM STM REL HELICITY= 167 m²/s²
 FORECAST MAX TEMP=NA
 TRIGGER TEMP= 25°C/78°F
 SOARING INDEX=NA
 MDPI/WINDEX = 0.54/37

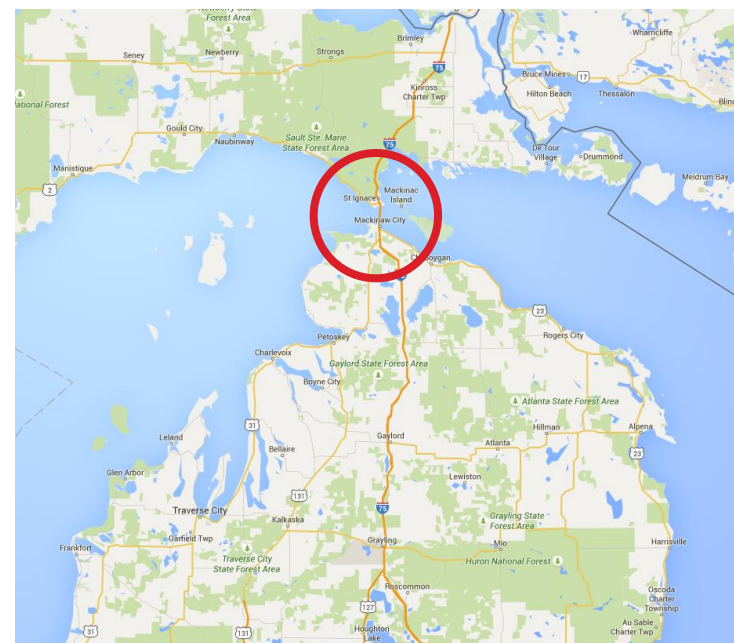
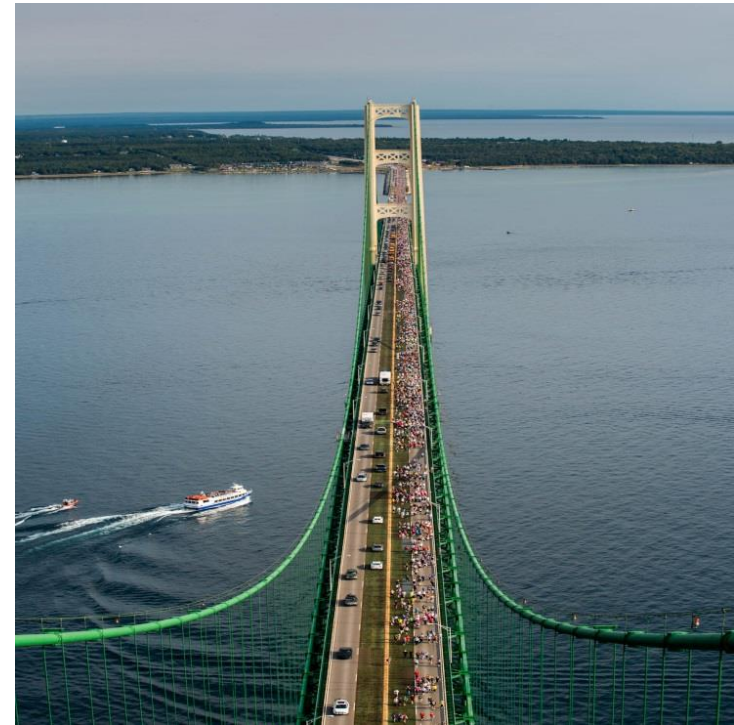
-PARCEL- T=SFC;Td=SFC
 INIT PARCEL P= 958 76 66 ° mb
 INIT PARCEL T/Td= 76/66° F/24/19° C
 CONVECTIVE TEMP= 77°F
 LFC= 3854 ft ASL/ 876 mb
 CCL= 3731 ft ASL/ 880 mb
 LCL= 3649 ft ASL/ 882 mb
 MAX HAILSIZE= 106.7 cm/42.0 in
 MAX VERTICAL VELOCITY= 150 m/s
 EQUIL LEVEL= 40272 ft ASL/199 mb
 APPROX CLOUD TP=NA
 POSITIVE ENERGY ABV LFC= 1137 J/KG
 NEGATIVE ENERGY BLW LFC=NONE
 BULK RICHARDSON NUMBER= 17.4

LFC	EL	SRH(m ² /s ²)	Shear(kt)	MnWind	SRW
1353m	35371'	SFC - 1 km	180	21	189/24 98/29
8926m	29882'	SFC - 3 km	213	31	209/28 103/19
1055m	39887'	Eff Inflow Layer	188	22	189/25 99/29
1353m	35371'	SFC - 6 km		50	216/35 122/14
		SFC - 8 km		57	216/37 132/15
		LCL - EL (Cloud Layer)		63	218/42 152/15
		Eff Shear (EBWD)		47	216/34 119/15
		BRN Shear = 57 m/s ²			
		4-6km SR Wind = 194/20 kt			
	Storm Motion Vectors.....			
		Bunkers Right = 238/38 kt			
		Bunkers Left = 194/40 kt			
		Corfidi Downshear = 228/72 kt			
		Corfidi Upshear = 244/26 kt			



Decision Support

- ▶ Mackinac Bridge
 - Connects Michigan's Upper and Lower Peninsulas
 - Five miles long
 - Fifth largest suspension bridge in the world
 - At it's highest point, the bridge surface is ~200 feet above the Straits of Mackinac
- ▶ Annual Labor Day Bridge Walk
 - Averages 40,000–65,000 participants
 - 7:00 am to 2:30 pm



Decision Support



Decision Support

- ▶ DSS Weather Impact Notification sent to local EMs one and two days prior to event (August 30 and 31)
 - “Window of dry weather for the early morning hours”
 - “Increasing threat of showers and thunderstorms from late morning into the afternoon”
- ▶ Also communicated with local EMs morning of event – to fine tune timing, impacts, etc.



Takeaways & Future Work

- ▶ Event reminds us that tornadoes in the Great Lakes region (and elsewhere) can occur even when traditional thermodynamic & kinematic parameters initially appear marginal
- ▶ Importance of high SA
- ▶ Future research may look into effect of stratus and its potential influence on reflectivity tags/gravity waves and the low level shear environment



Questions?

Matt Gillen
Matthew.Gillen@noaa.gov

Michael Boguth
Michael.Boguth@noaa.gov

Bruce Smith
Bruce.Smith@noaa.gov

23rd Annual Great Lakes Operational
Meteorology Workshop
August 25–27, 2015

