Appendix A

Matching Day Analysis

Exceptional Events Demonstration Addressing the 2015 8-Hour Ozone (O_3) National Ambient Air Quality Standard (NAAQS)

Lake and Porter Counties, Indiana

Air Quality Forecast Verification Report

Episode Overview

Episode Dates: May 22-23, 2023

Region: Northwest Indiana

Pollutants: Ozone (O_3) and Fine Particulate Matter ($PM_{2.5}$)

May 22, 2023 (Monday)

Overview:

A broad surface high pressure stretched from Canada through the Ohio Valley into the southern Plains. This created sunny skies, low humidity (30% range), and light northeast winds shifting later in the day. Temperatures were near 80°F.

Upper-level flow was northwesterly/northerly across the Great Lakes with strong 500 mb ridging over the Central U.S.

Ozone:

Conditions were favorable for ozone formation due to:

Dry air and clear skies.

Light winds and lake breeze development.

Temperatures near 80°F (slightly less than ideal but supportive).

The GA Tech model indicated ozone beginning to develop over Lake Michigan, with potential for moderate AQI levels by late afternoon.

PM2.5 / Smoke:

No major smoke intrusion noted for this day; prior weekend smoke had cleared quickly. Elevated smoke aloft may have caused slight light extinction, reducing ozone chemistry marginally.

AQAD Issuance:

No indication of an AQAD for this day, but conditions were trending toward moderate ozone.

May 23, 2023 (Tuesday)

Overall Pattern:

Sunny skies continued with highs near 83°F. Winds were light east in the morning, shifting south before a lake breeze developed after 18Z.

The same high-pressure system dominated, with low humidity and a dry column.

Ozone:

Conditions were even more favorable for ozone formation:

Lake breeze circulation enhancing stagnation near the shoreline.

Temperatures slightly warmer than Monday.

GA Tech model projected increasing ozone over Lake Michigan, supported by HRRR runs.

NOAA 06Z BC suggested an ozone AQI near 84 (Moderate), though typically adjusted downward. **Ozone exceedances were observed across IL, IN and MI this day.**

PM2.5 / Smoke:

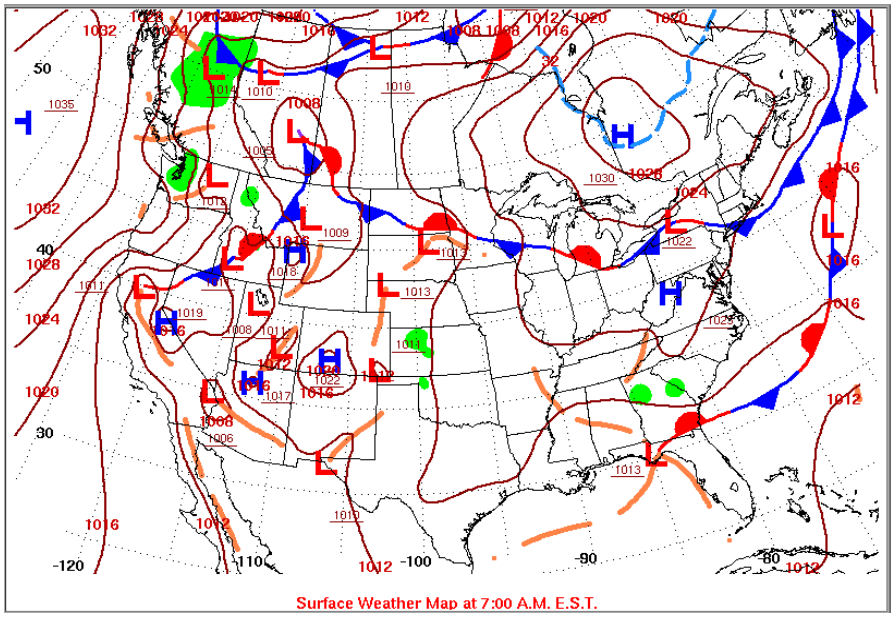
No significant surface smoke impacts yet, but RAP-SMOKE indicated elevated smoke layers aloft, which could slightly suppress ozone chemistry due to light extinction at the surface but if any of the plumes are mixed down it could enhance ozone production regardless due to VOC/SVOC loads in the plume.

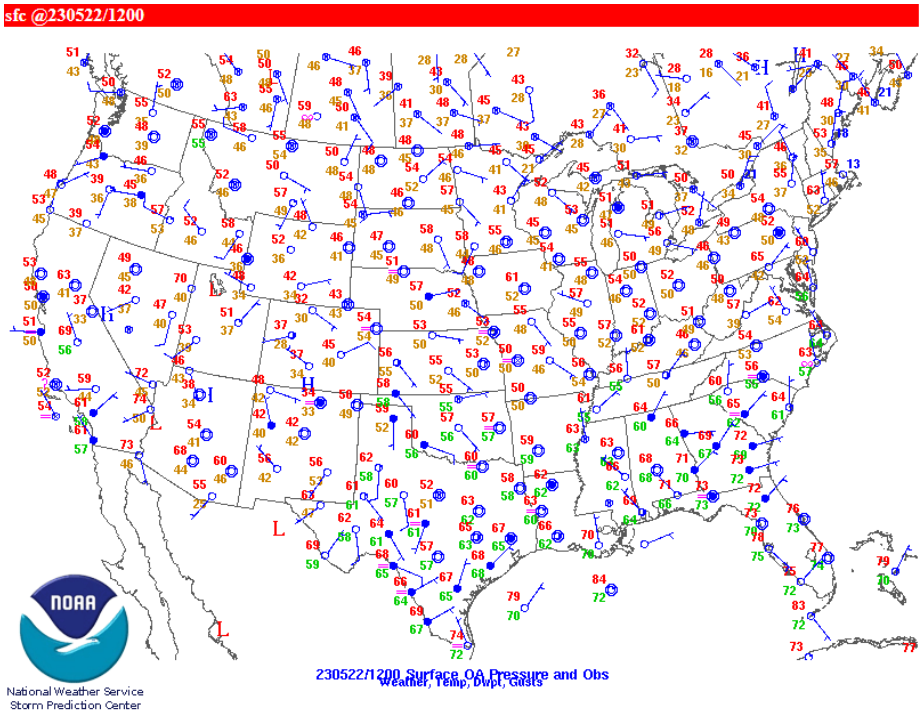
RAP-SMOKE guidance correctly predicted timing/location of smoke transport but underestimated concentrations during the weekend event.

Elevated smoke layers persisted aloft during May 22–23.

Surface, 850 and 500 mb plots from 12Z on May 22, 2023

MONDAY MAY 22, 2023





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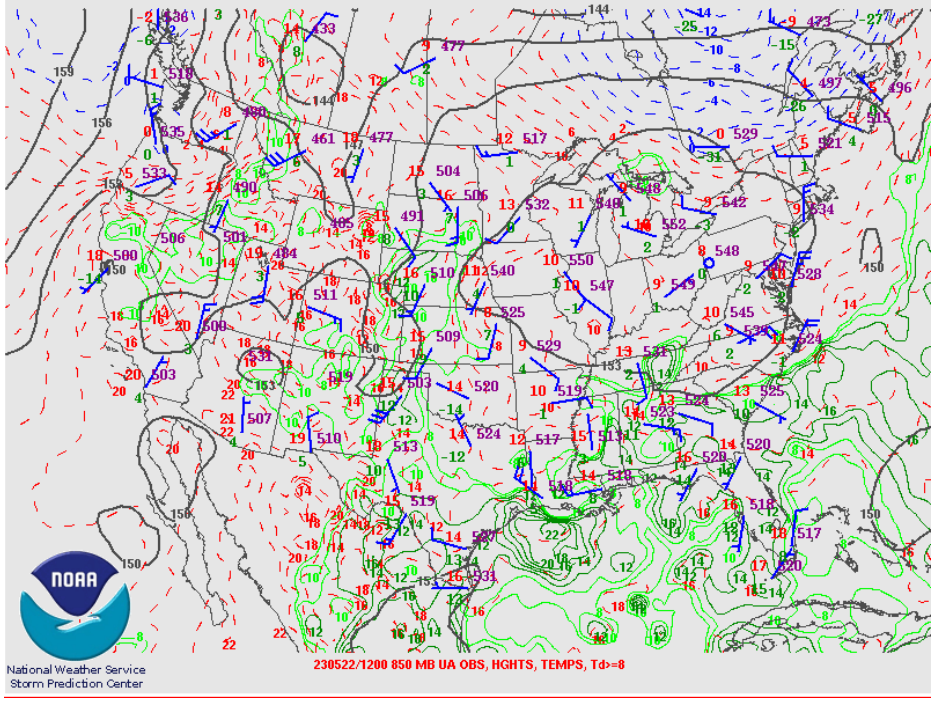

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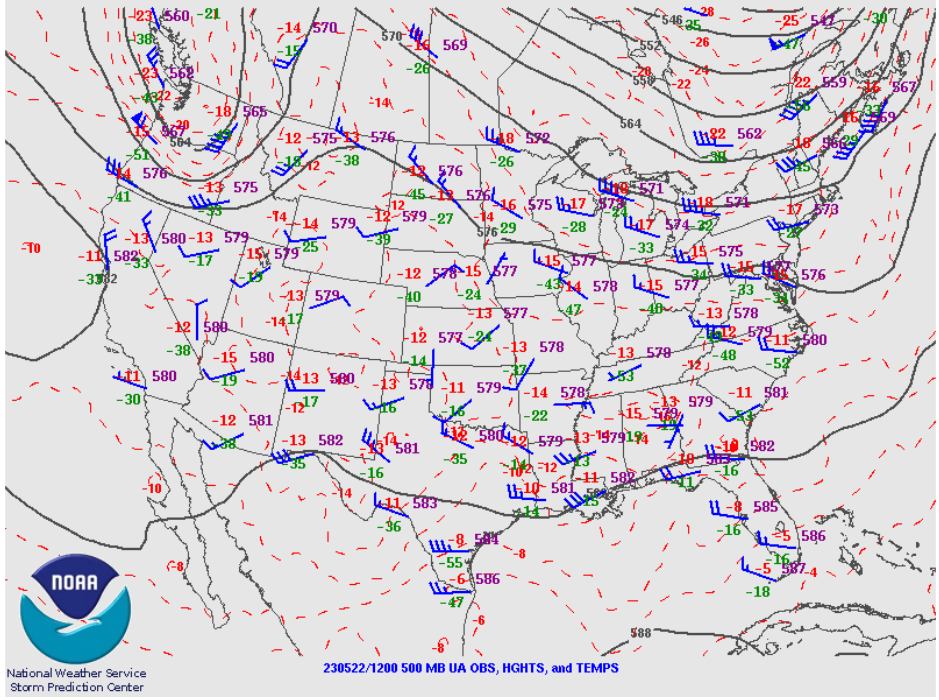
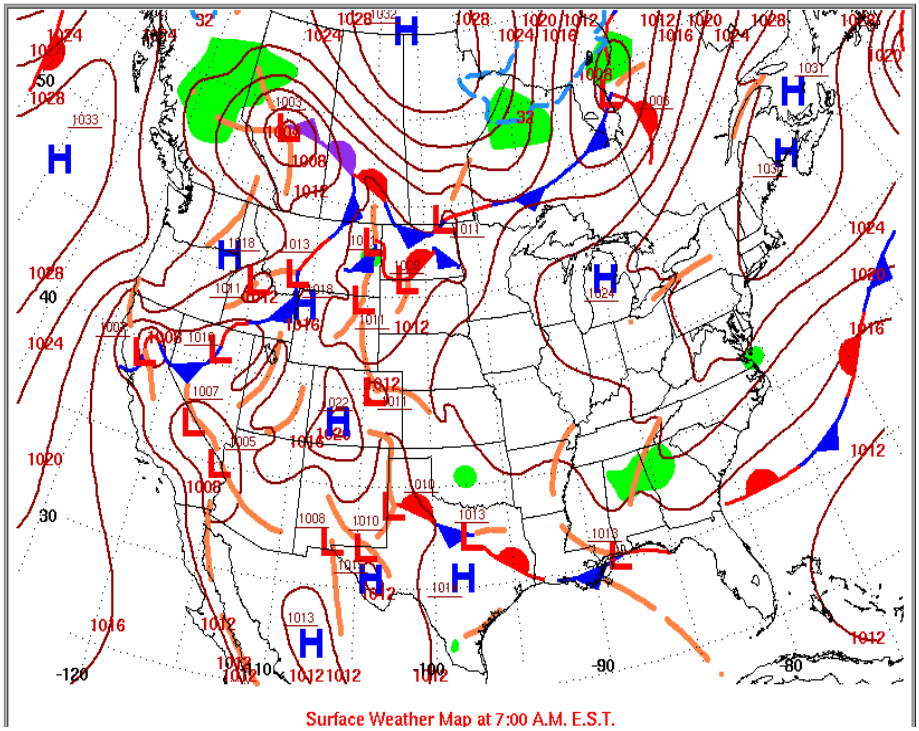
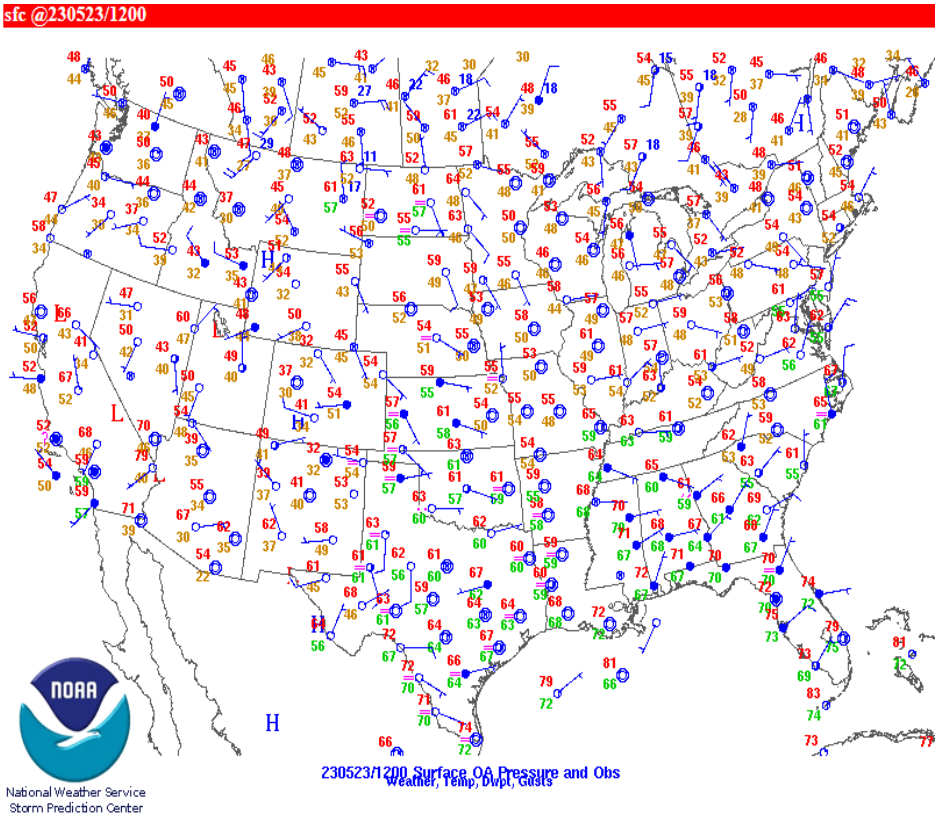


Surface, 850 and 500 mb plots from 12Z on May 23, 2023





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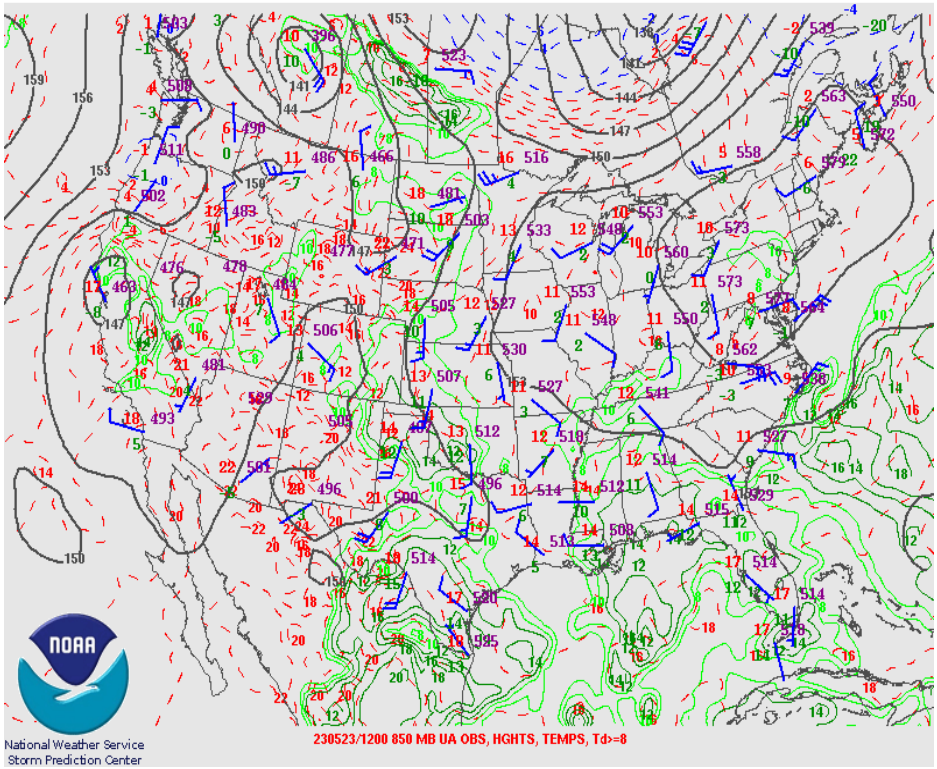

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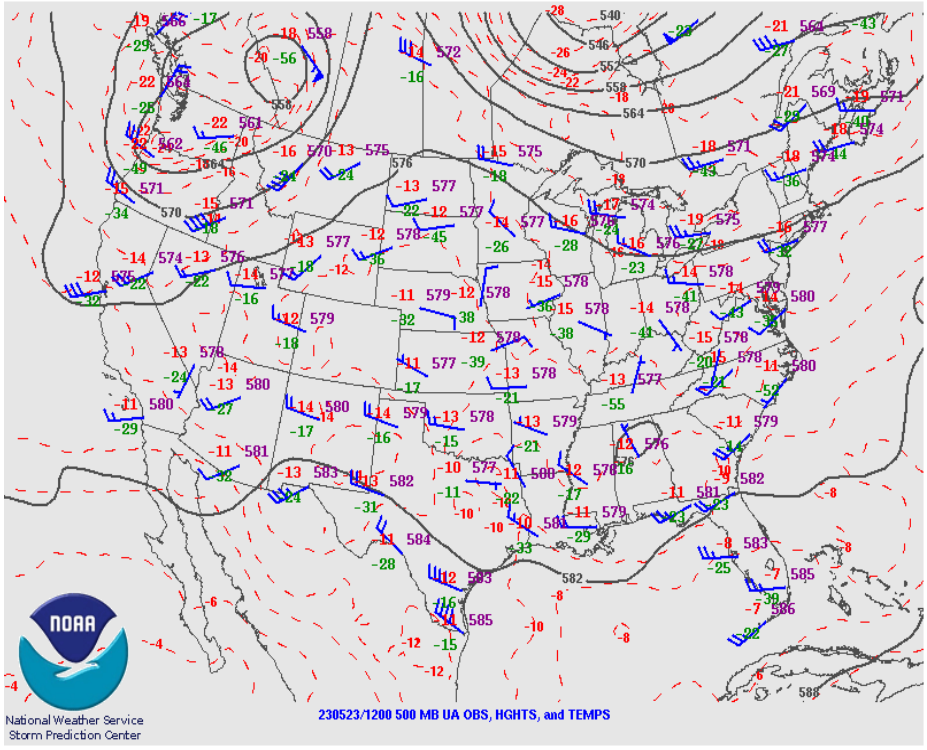


Air Quality Forecast Verification Report

Episode Overview

Episode Dates: May 29–June 3, 2023

Region: Northwest Indiana

Pollutants: Ozone (O_3) and Fine Particulate Matter ($PM_{2.5}$)

Overview

This period marked a multi-day ozone episode across parts of Indiana driven by persistent high pressure, strong solar radiation, and stagnant conditions. The episode culminated in Air Quality Action Days (AQADs) for ozone on June 2 and June 3 across all seven forecast regions. Smoke from Canadian wildfires (Nova Scotia) also contributed to elevated $PM_{2.5}$ levels later in the period.

Synoptic Pattern:

A strong, high-amplitude ridge dominated the north-central U.S. and extended into Canada.

Surface high pressure retrograded westward, reinforcing easterly low-level flow and creating a stagnant air mass.

Northern jet stream displaced well into Canada, leaving Indiana under subsidence and dry conditions.

Surface Conditions:

Inland highs: upper 80s to lower 90s°F; lakeshore areas: 10–15°F cooler due to onshore flow.

Afternoon relative humidity: 25–40% inland.

Dew points: upper 40s to lower 50s.

Winds: light easterly to northeast, occasionally gusting to 15 mph.

Upper-Air:

850 mb temperatures: 15–17°C, supporting strong heating and ozone chemistry.

Ridge remained nearly stationary through June 3, limiting ventilation.

3. Day-by-Day Conditions

May 29 (Monday)

Weather: Mostly sunny, highs near 90°F inland, cooler lakeshore.

Ozone: Conditions favorable for ozone buildup; models indicated Moderate to USG potential.

$PM_{2.5}$ / Smoke: RAP-SMOKE showed vertically integrated smoke aloft; surface impacts minimal.

May 30 (Tuesday)

Weather: Continued warm and dry pattern; highs near 90°F inland.

Ozone: Persistent stagnant air mass supported rising ozone; Moderate AQI likely.

$PM_{2.5}$ / Smoke: Elevated smoke layers persisted; fine particulate remained Good to Moderate.

May 31 (Wednesday)

Weather: Similar pattern; highs upper 80s°F; ridge remained dominant.

Ozone: Continued ozone buildup; Moderate AQI widespread.

$PM_{2.5}$ / Smoke: Smoke aloft continued; minimal surface impact.

June 1 (Thursday)

Weather: Mostly sunny, highs near 90°F inland; stagnant conditions persisted.

Ozone: NOAA and GA Tech models indicated USG potential; forecasters noted rising risk.

$PM_{2.5}$ / Smoke: RAP-SMOKE suggested vertically integrated smoke and some surface impacts possible.

June 2 (Friday)

Weather: Sunny, highs near 89°F inland; easterly flow, low humidity.

Ozone: Conditions highly favorable for rapid ozone development:

Persistent stagnant air mass.

Strong solar radiation.

Retrograding high pressure.

NOAA and GA Tech models forecast USG ozone; NOAA noted recent underprediction trend.

$PM_{2.5}$ / Smoke: Smoke from Nova Scotia fires transported into region; minor surface impacts.

June 3 (Saturday)

Weather: Sunny, highs near 88°F; backdoor cold front approached late, but air mass remained stagnant.

Ozone: USG ozone risk persisted; GA Tech model forecast high ozone; NOAA projected high moderate but forecasters maintained USG forecast due to persistent conditions.

$PM_{2.5}$ / Smoke: RAP-SMOKE indicated surface and vertically integrated smoke over western Indiana and south into Kentucky/Tennessee; $PM_{2.5}$ forecasted as Moderate.

AQAD: Issued for ozone statewide (all 7 regions).

Source: Fires in Nova Scotia contributed to smoke transport into Indiana during the episode.

Impact:

Elevated smoke layers persisted aloft throughout the period, causing light extinction and slightly reducing ozone chemistry.

Surface smoke impacts increased by June 3, particularly in western Indiana.

Model Performance: RAP-SMOKE captured timing/location but underestimated concentration during prior events.

Summary

Overall Pattern: Persistent high-pressure ridge and stagnant conditions drove a prolonged ozone episode from May 29–June 3.

Ozone:

Moderate AQI observed early in the week; USG ozone forecast and AQADs issued June 2–3. **USG level Ozone observed across IL/IN/MI and WI on June 2 and IN/IL/WI on June 3.**

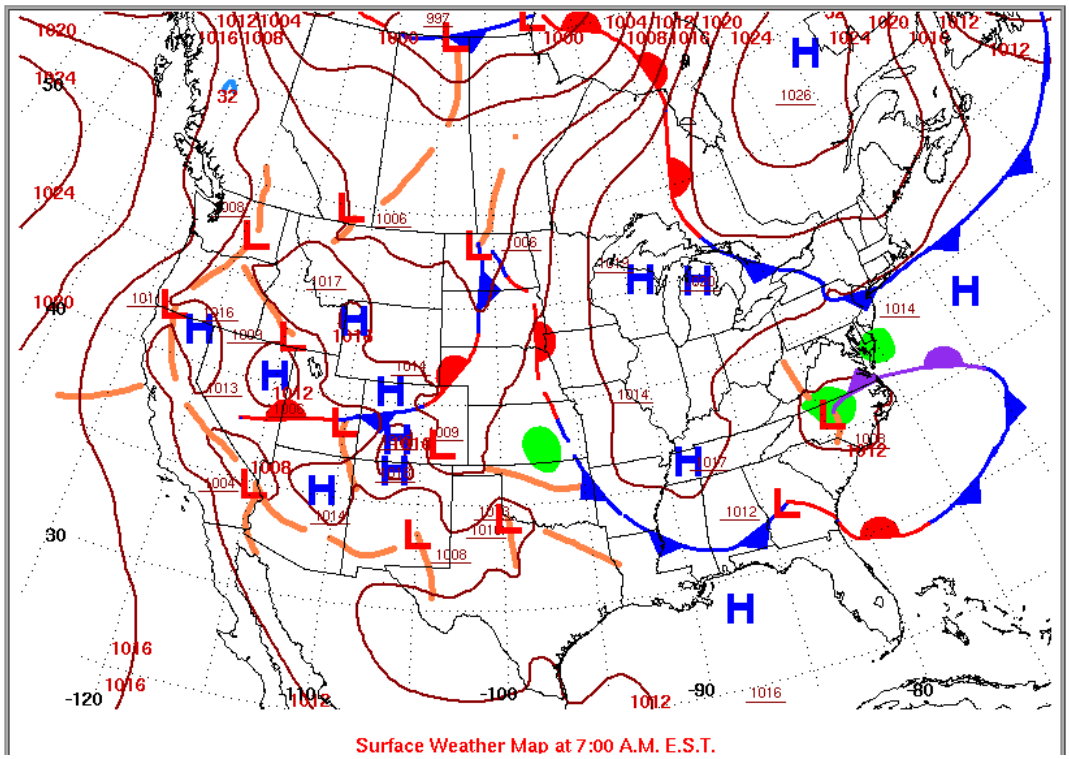
$PM_{2.5}$:

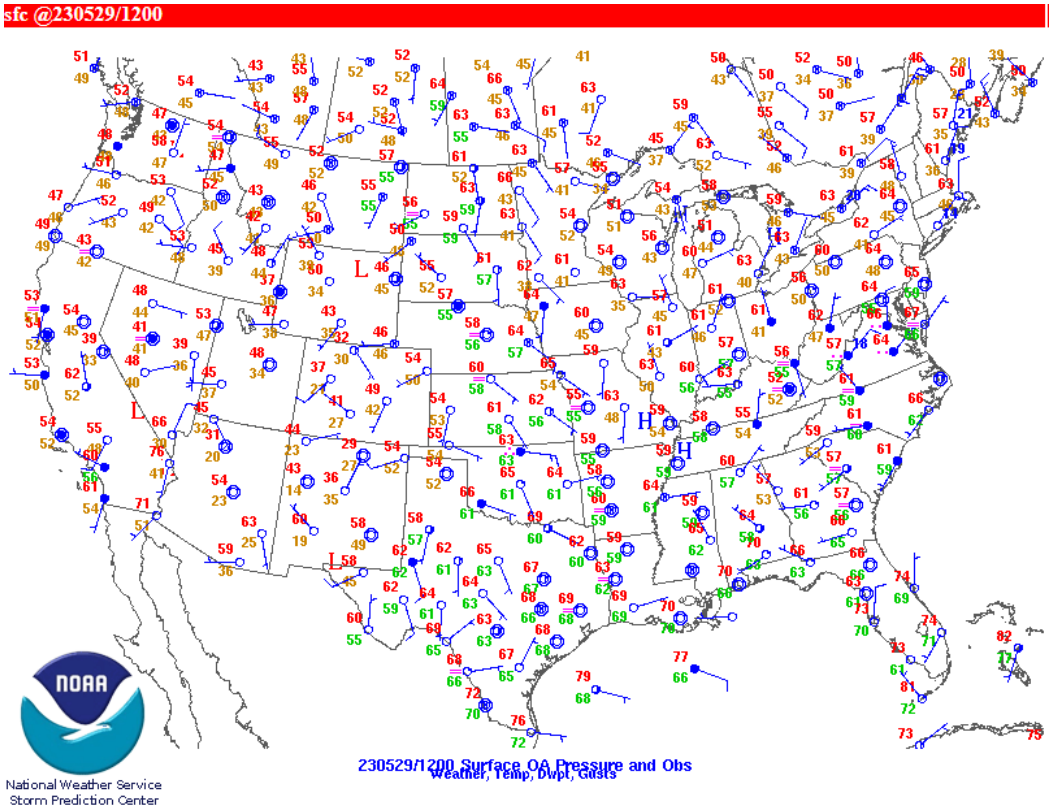
Good early in the week; Moderate by June 3 due to smoke transport.

Smoke:

Elevated layers aloft throughout; surface impacts increased late in the episode.

Surface, 850 and 500 mb plots from 12Z on May 29, 2023





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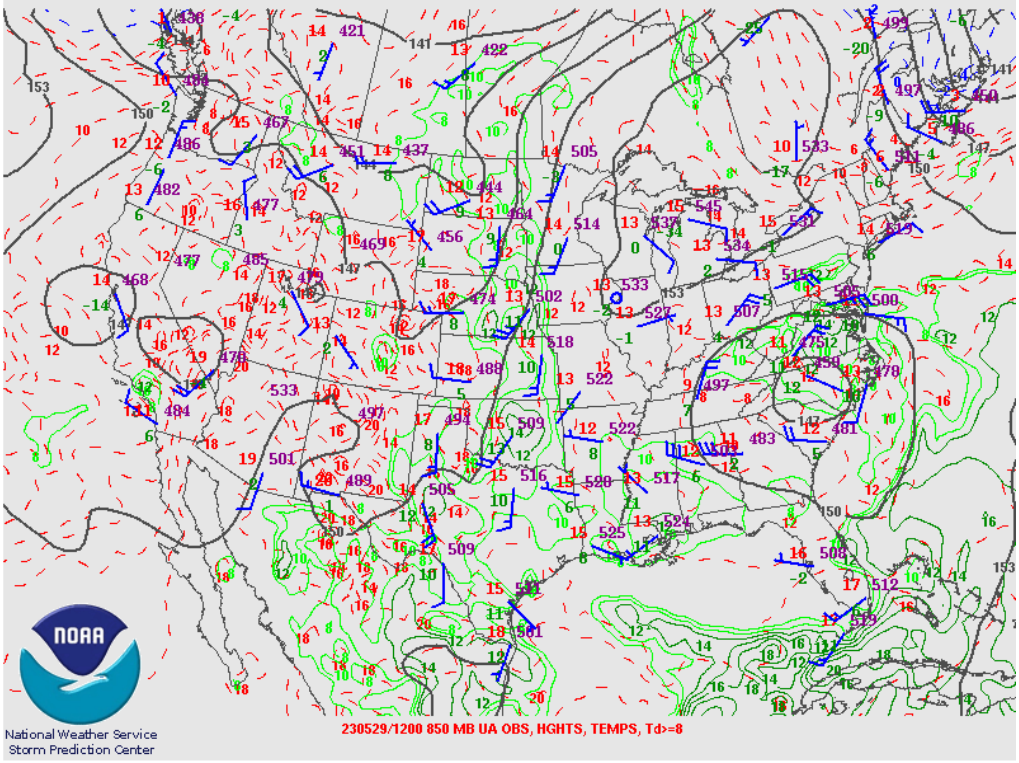

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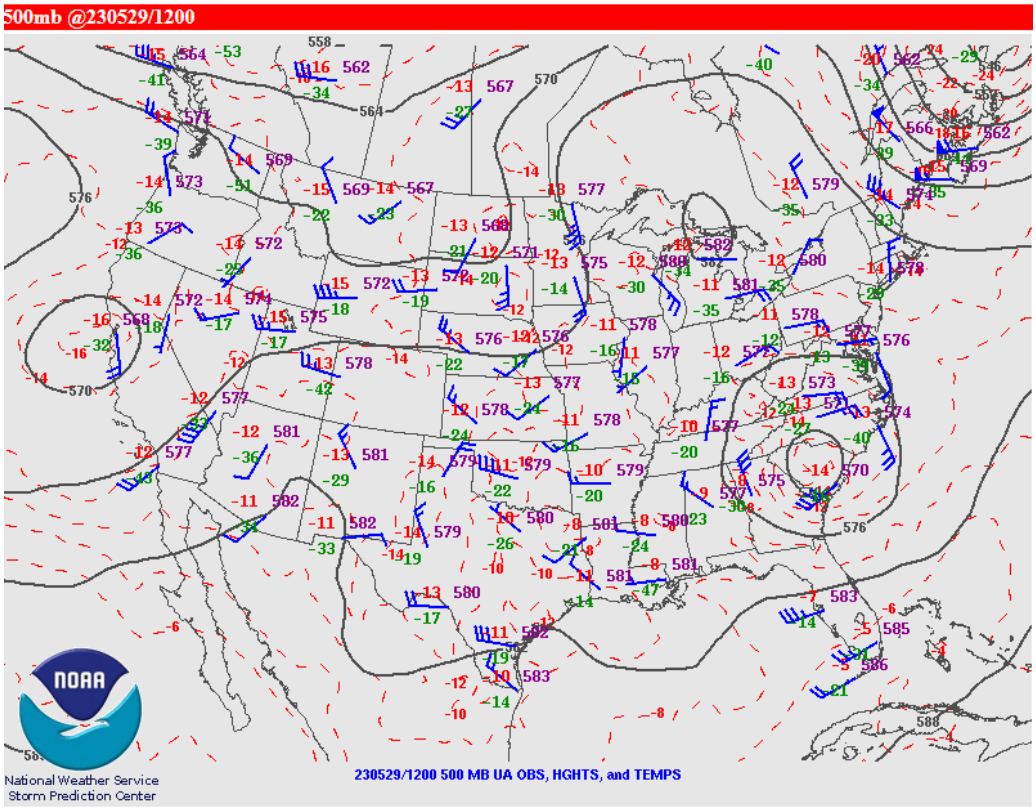
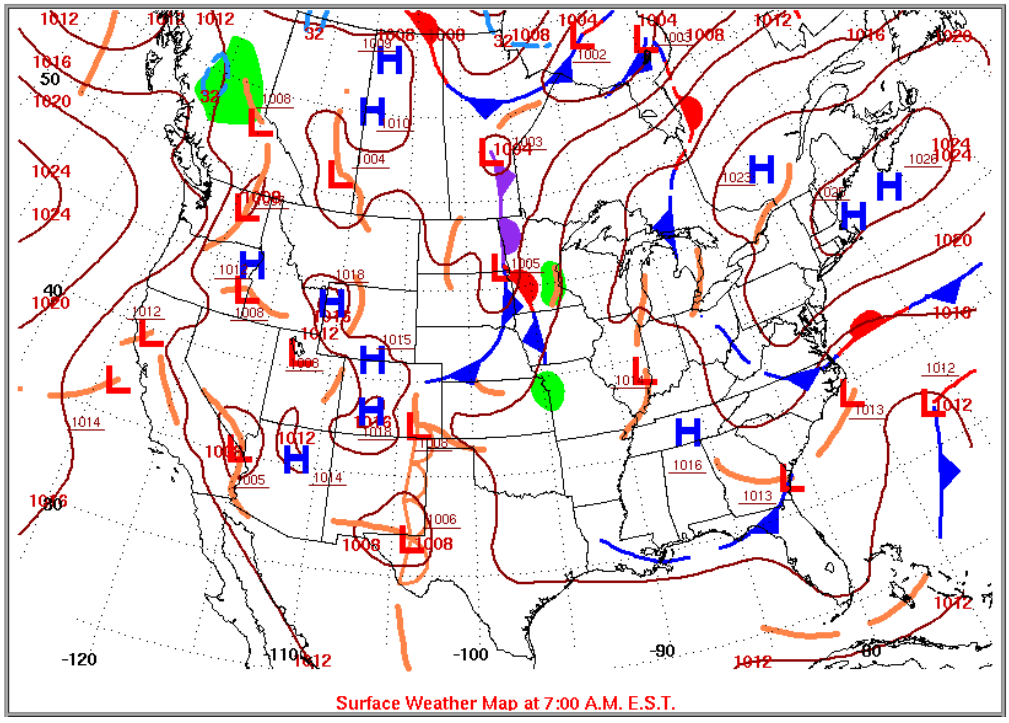
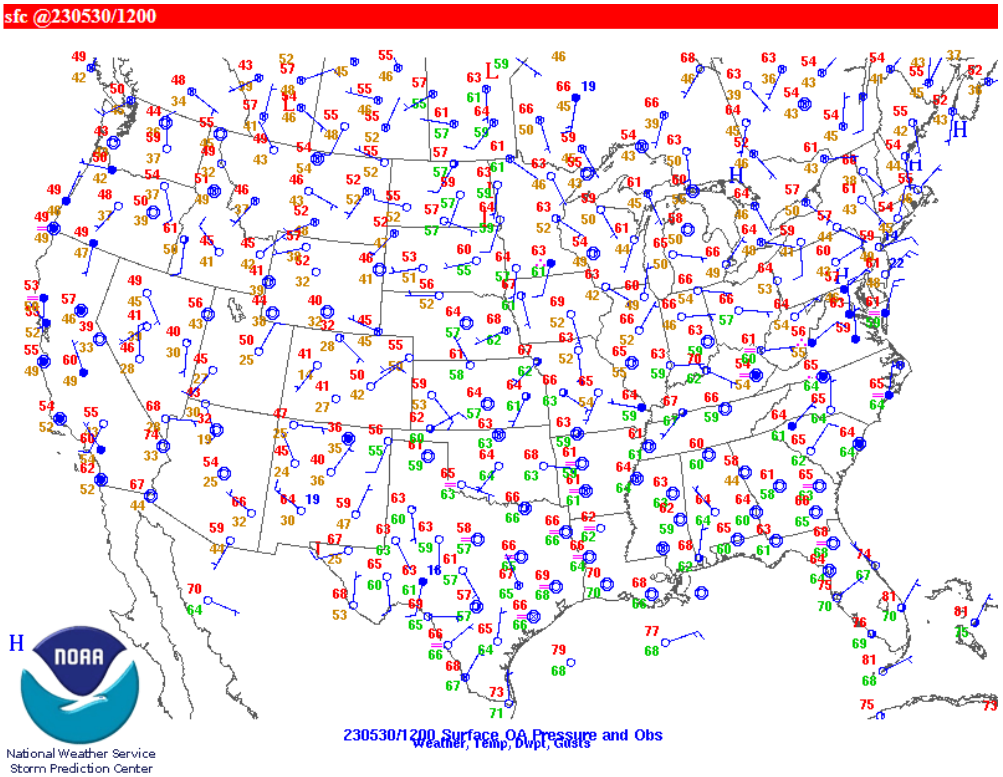


Surface, 850 and 500 mb plots from 12Z on May 30, 2023





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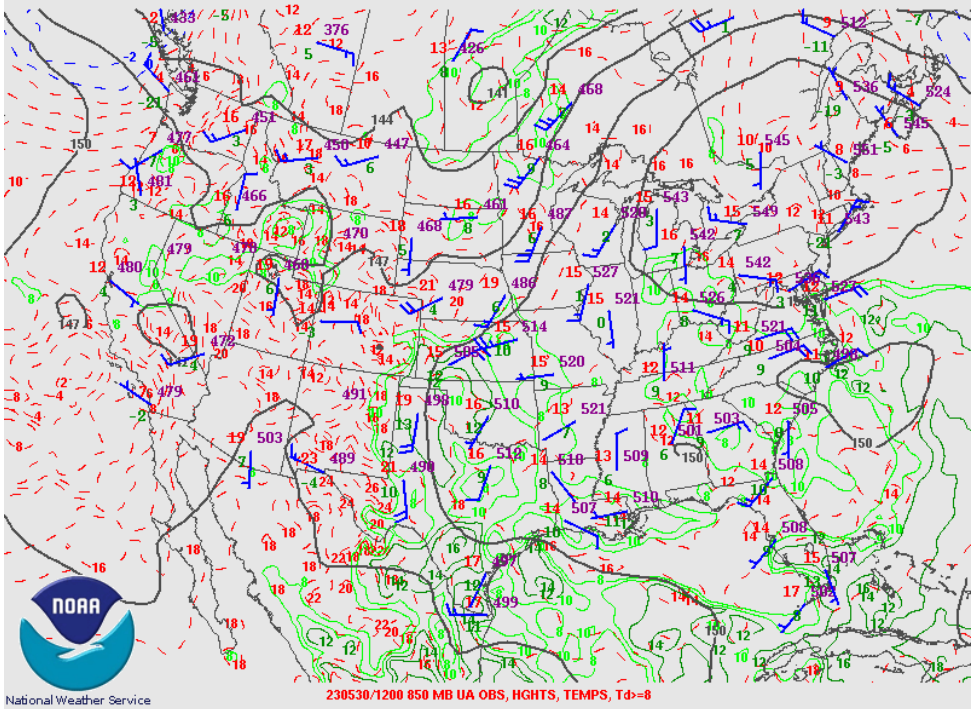

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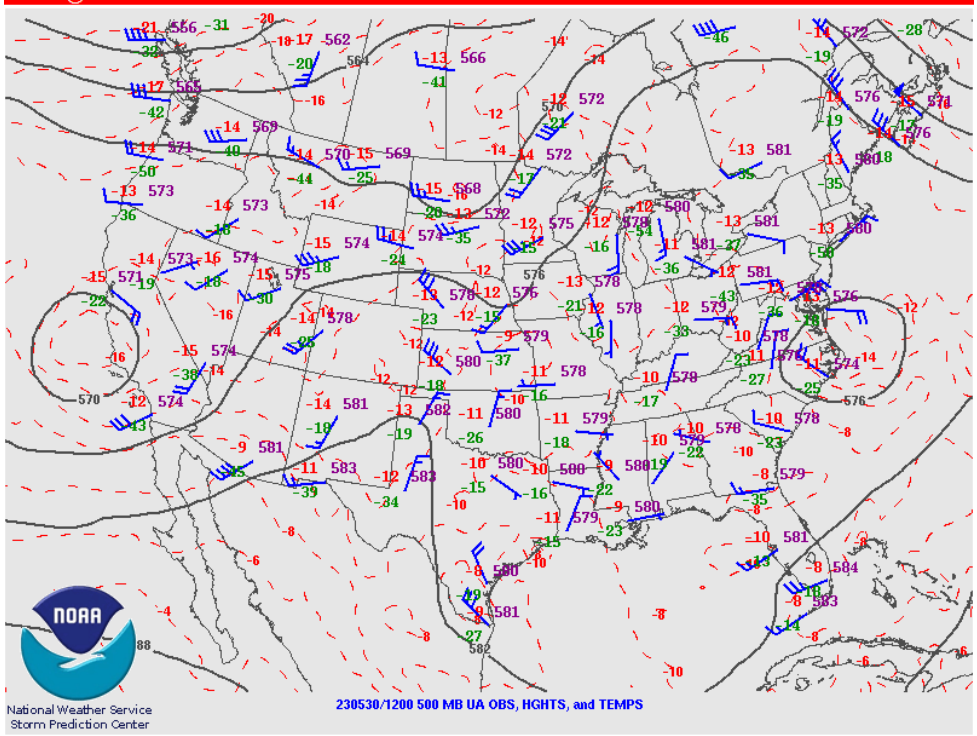

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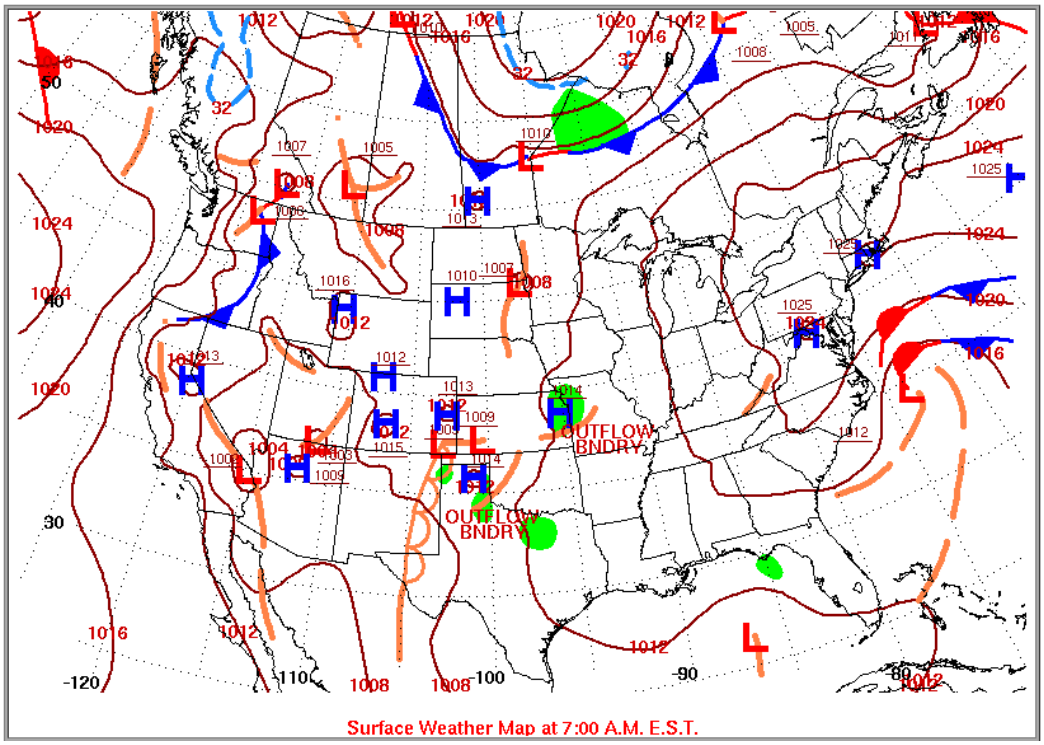

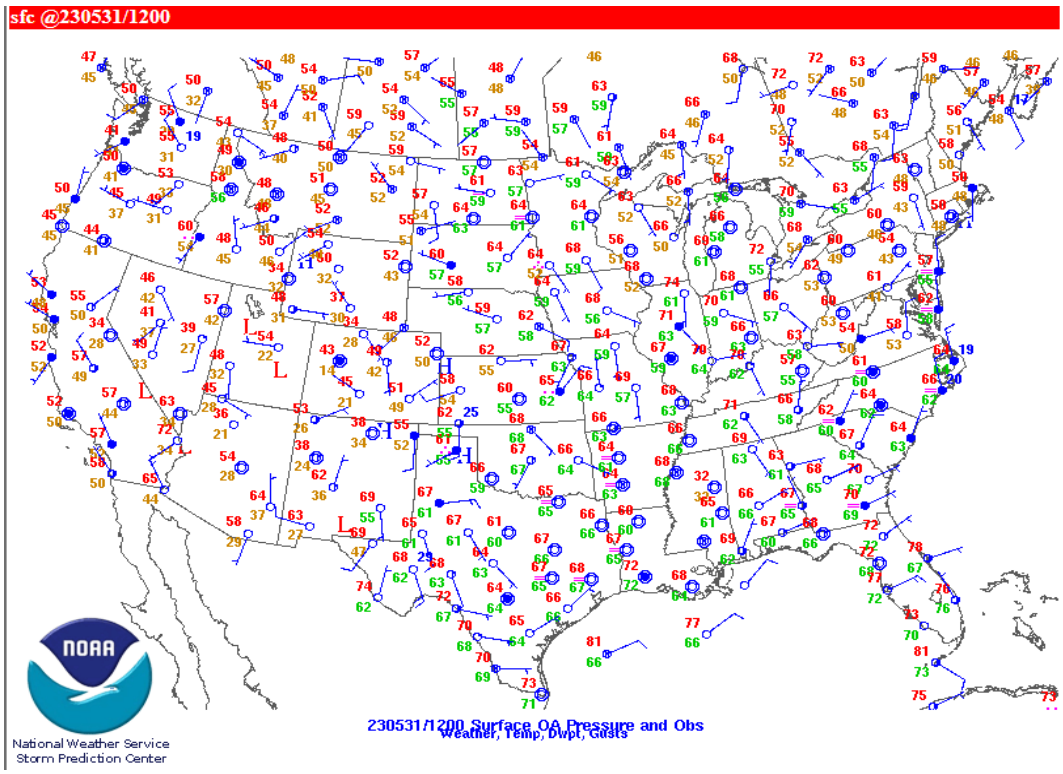

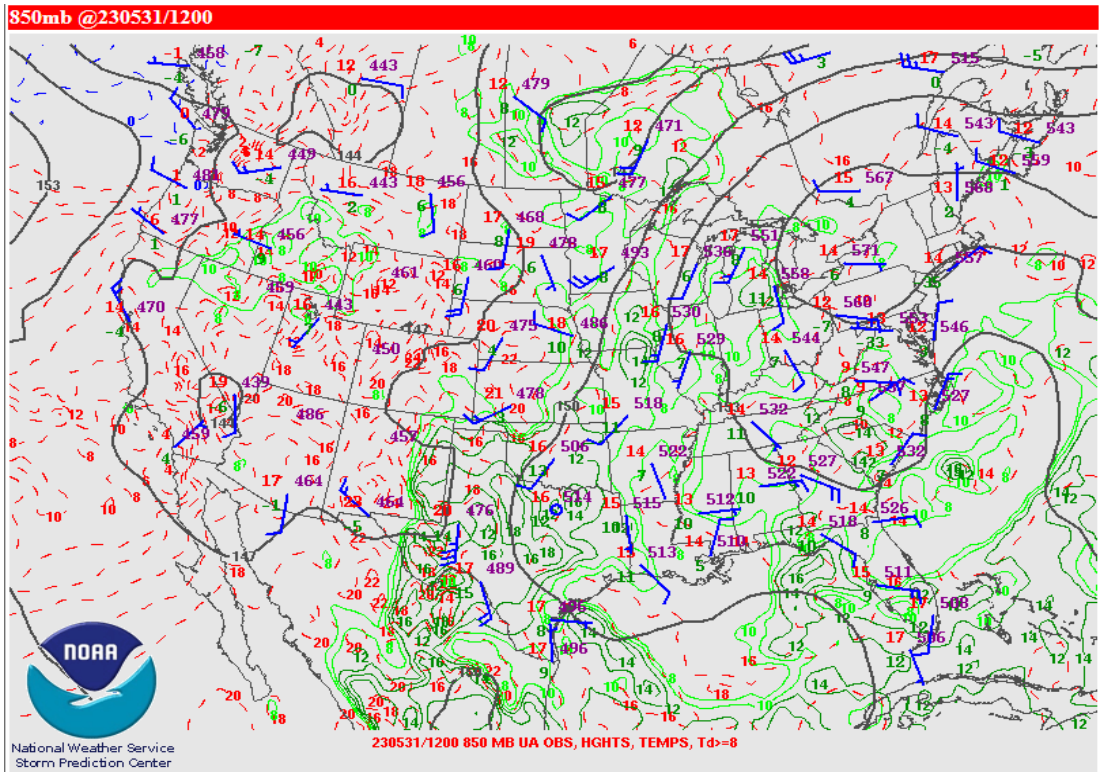
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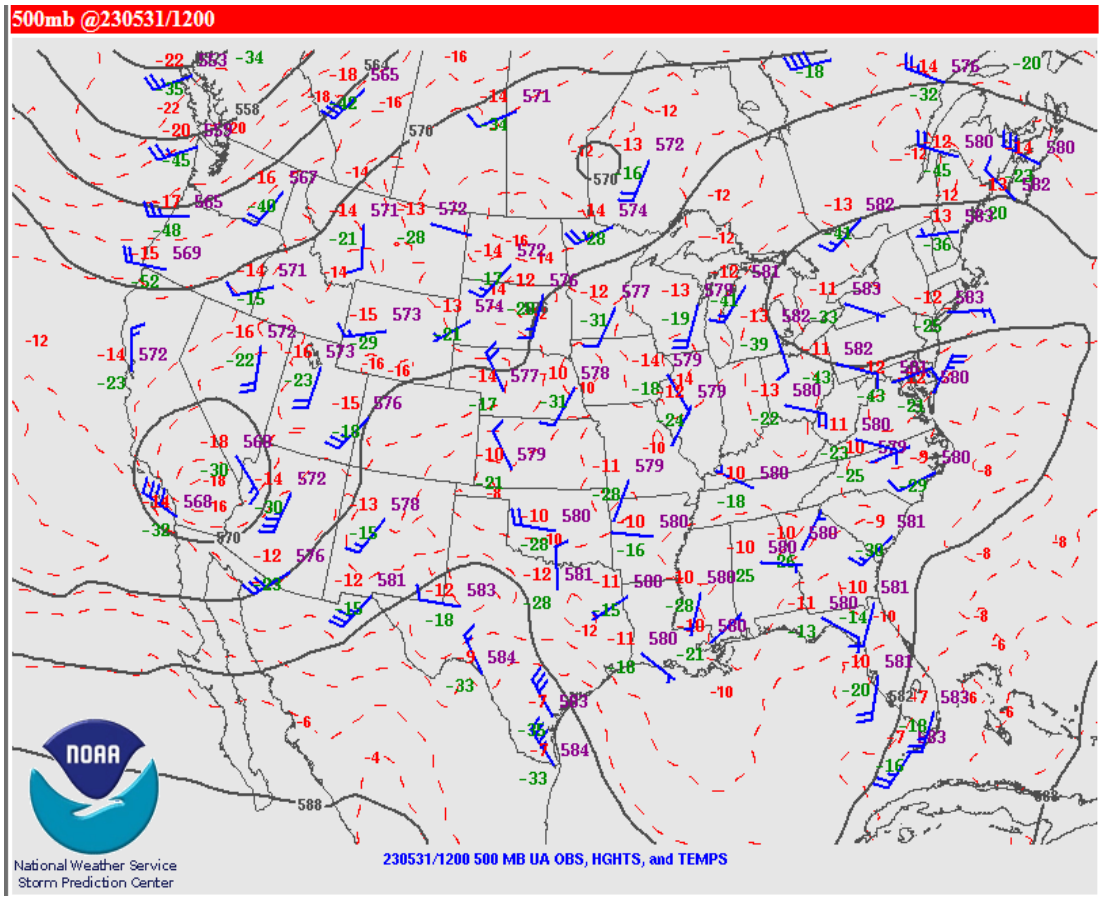
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National Weather Service
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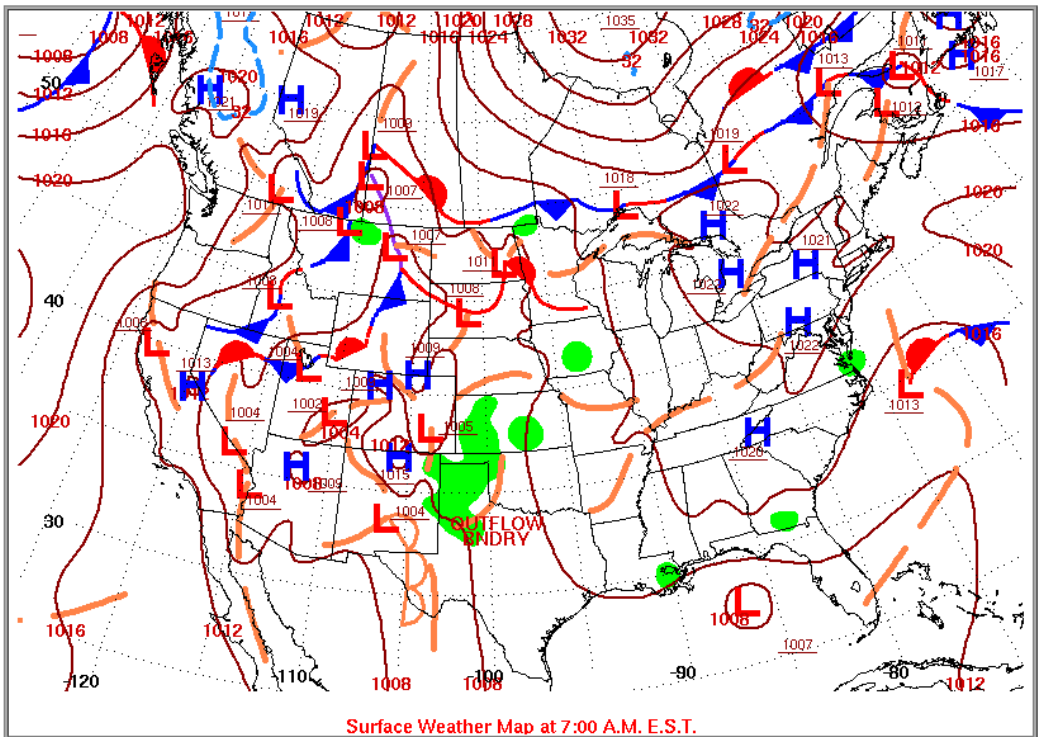
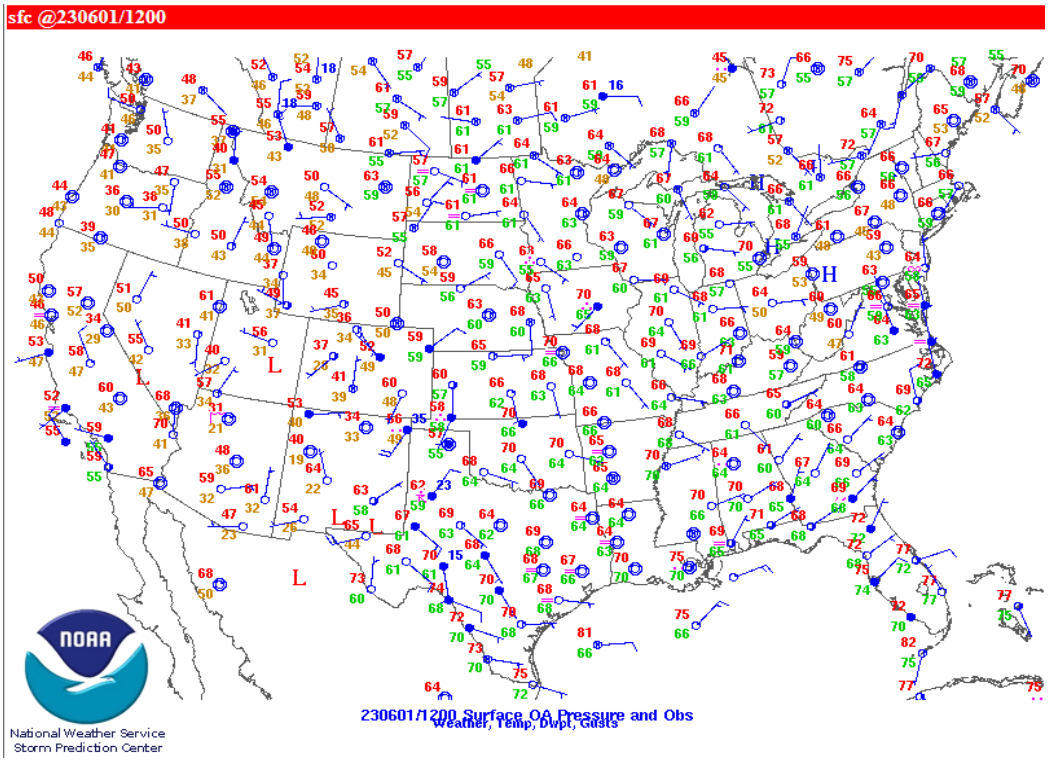
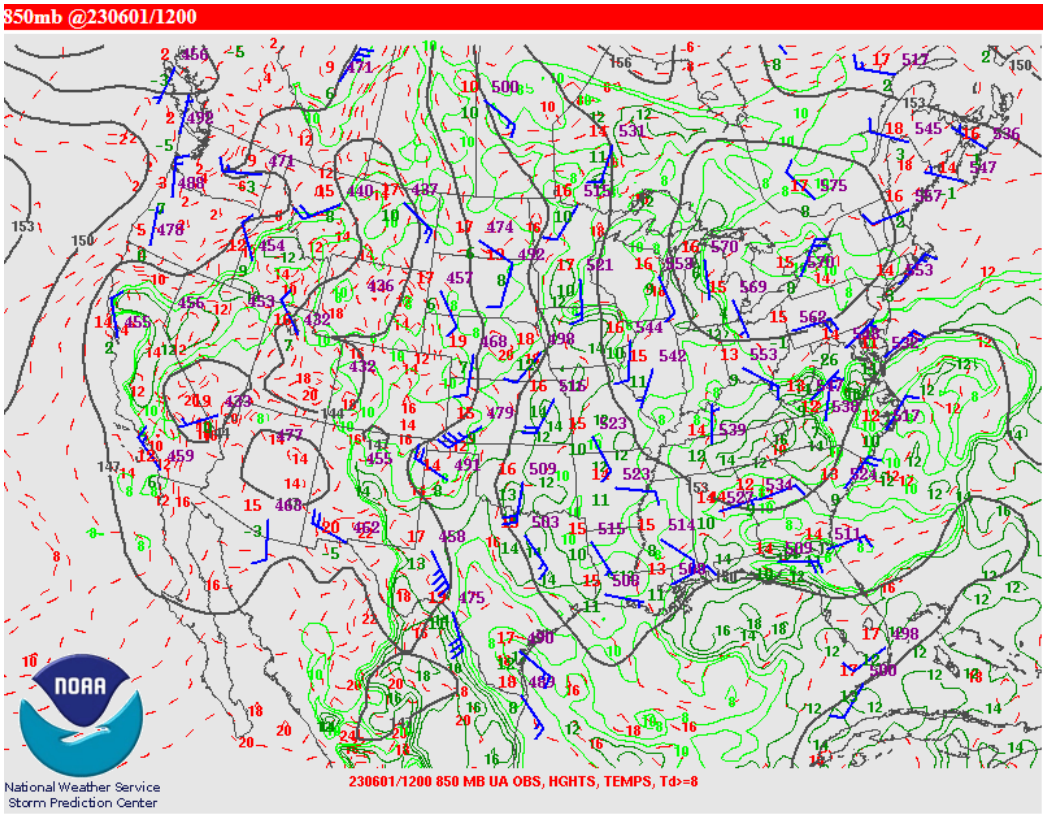
Surface, 850 and 500 mb plots from 12Z on June 1, 2023

THURSDAY JUNE 1, 2023



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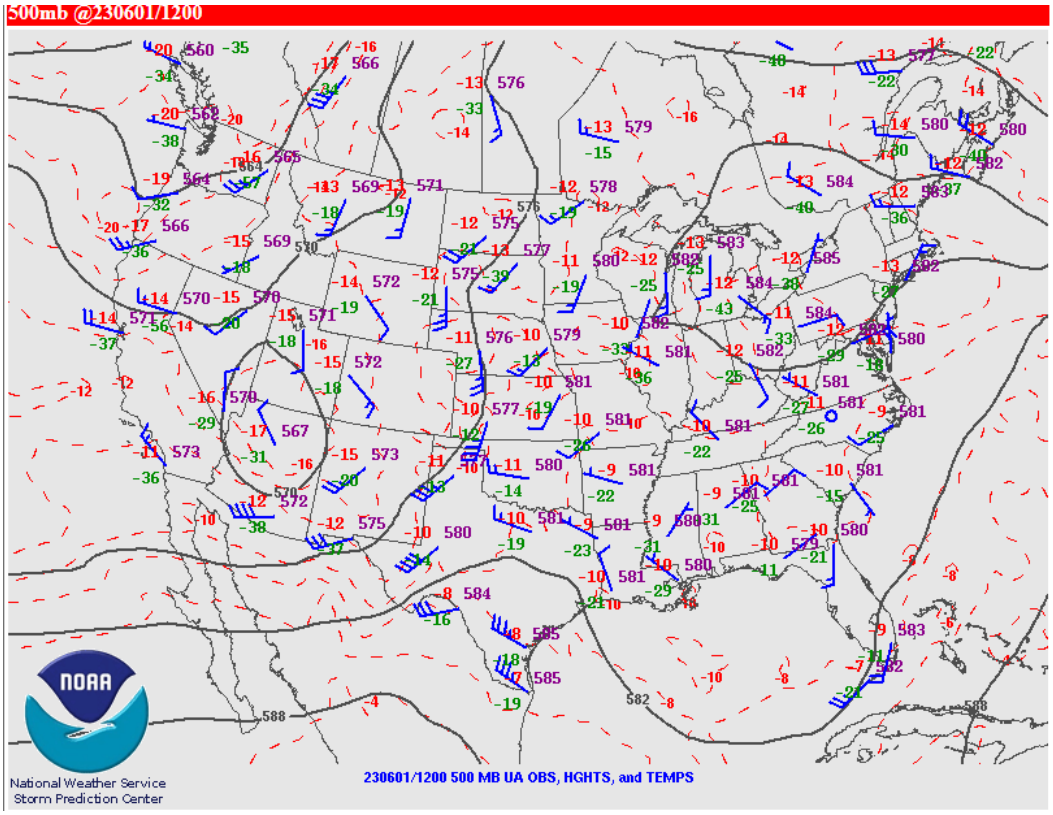
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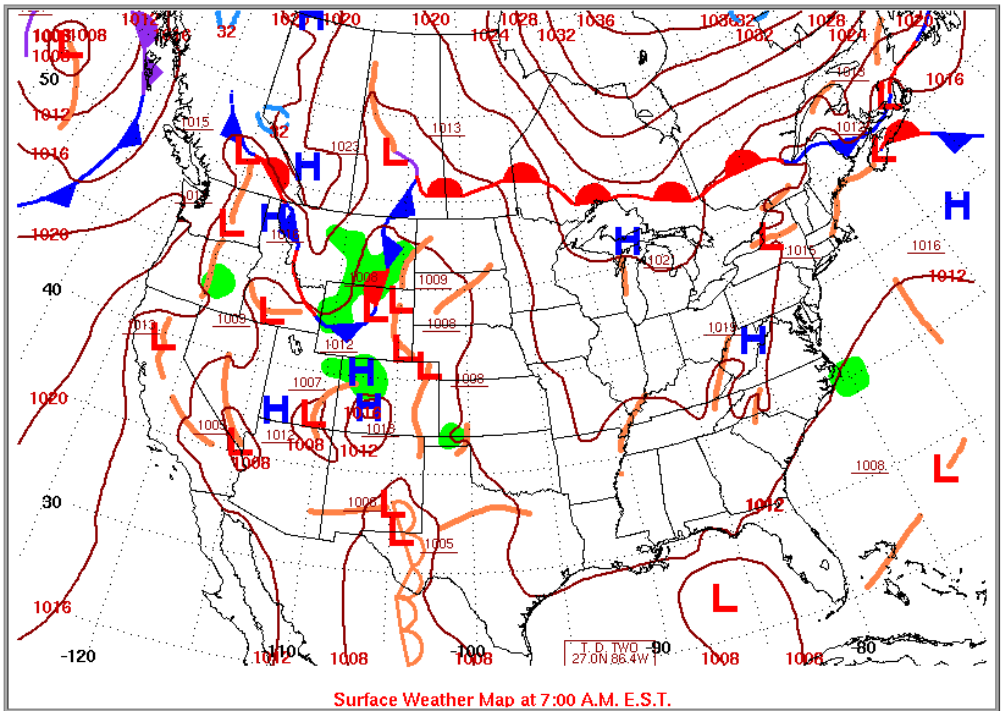
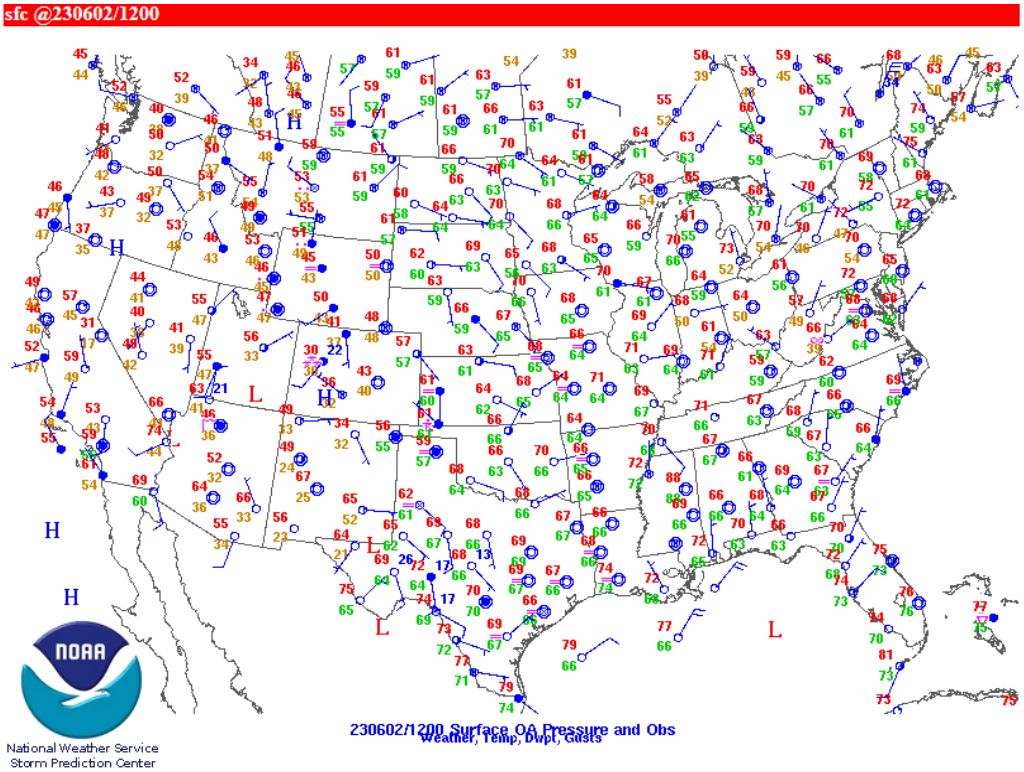
Surface, 850 and 500 mb plots from 12Z on June 2, 2023





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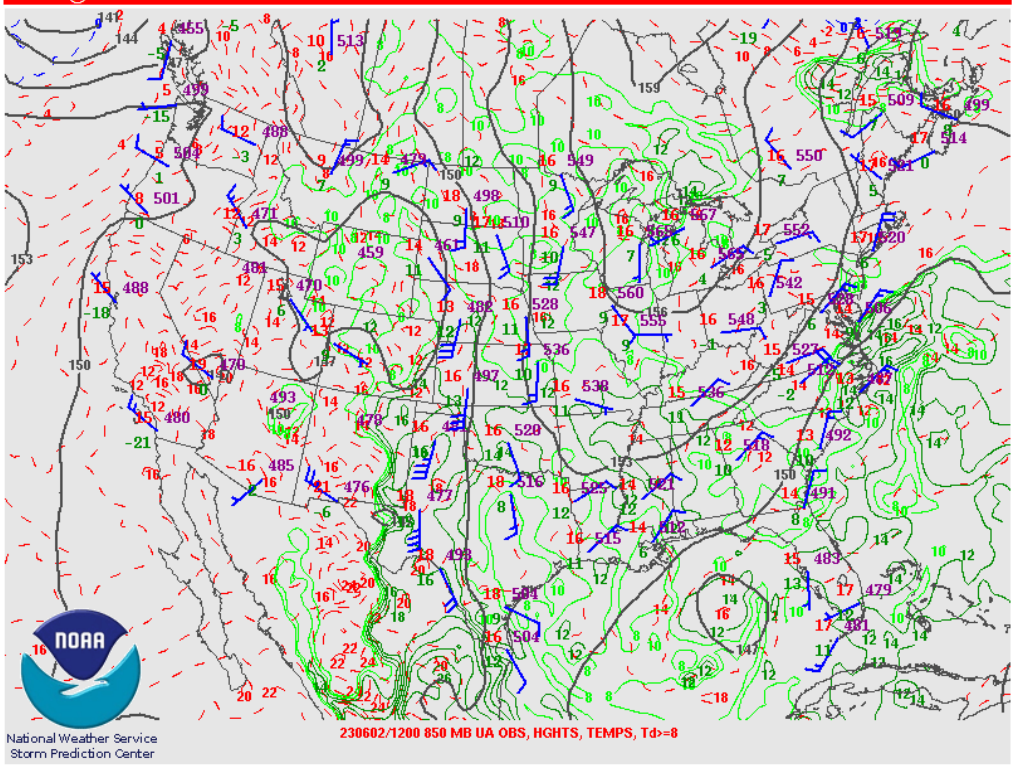

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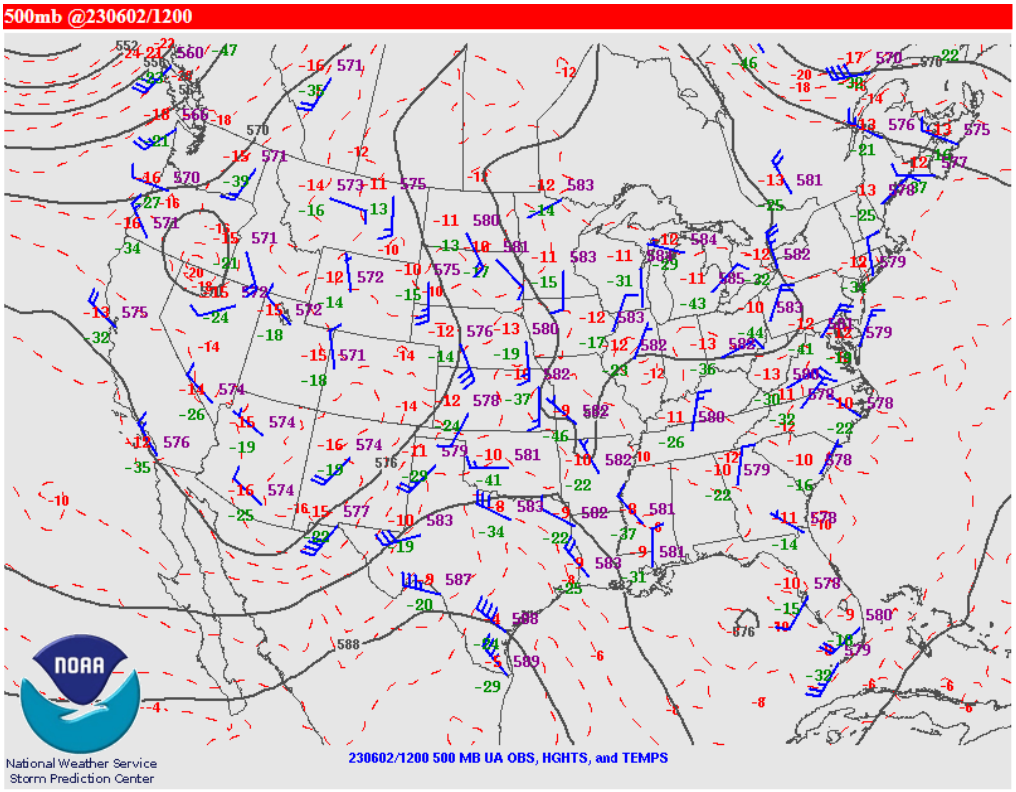
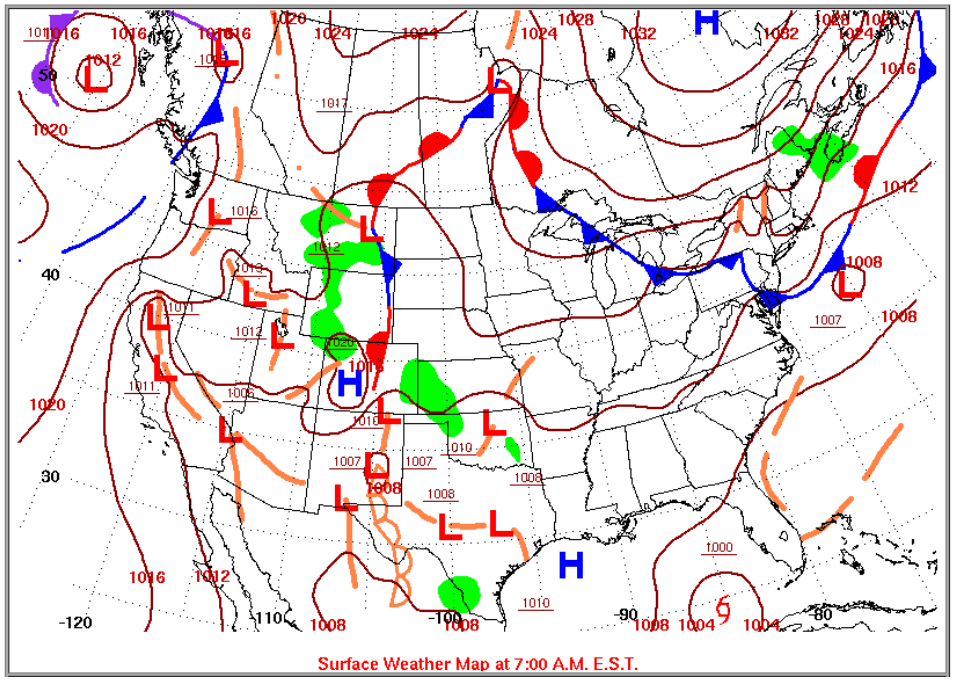
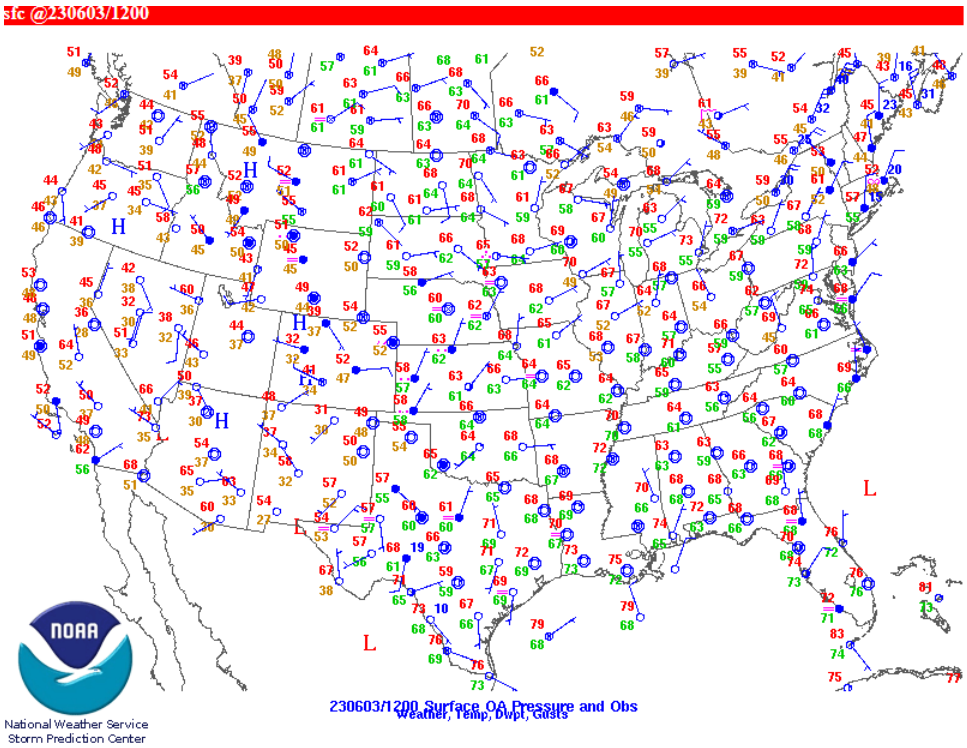
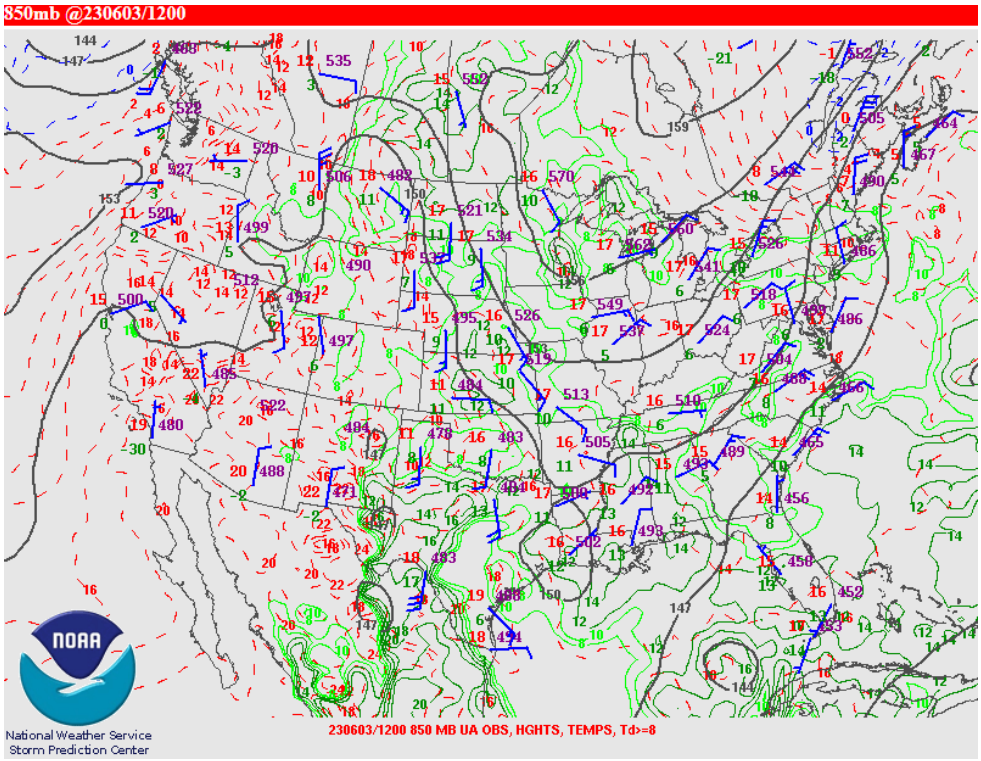


Surface, 850 and 500 mb plots from 12Z on June 3, 2023

SATURDAY JUNE 3, 2023



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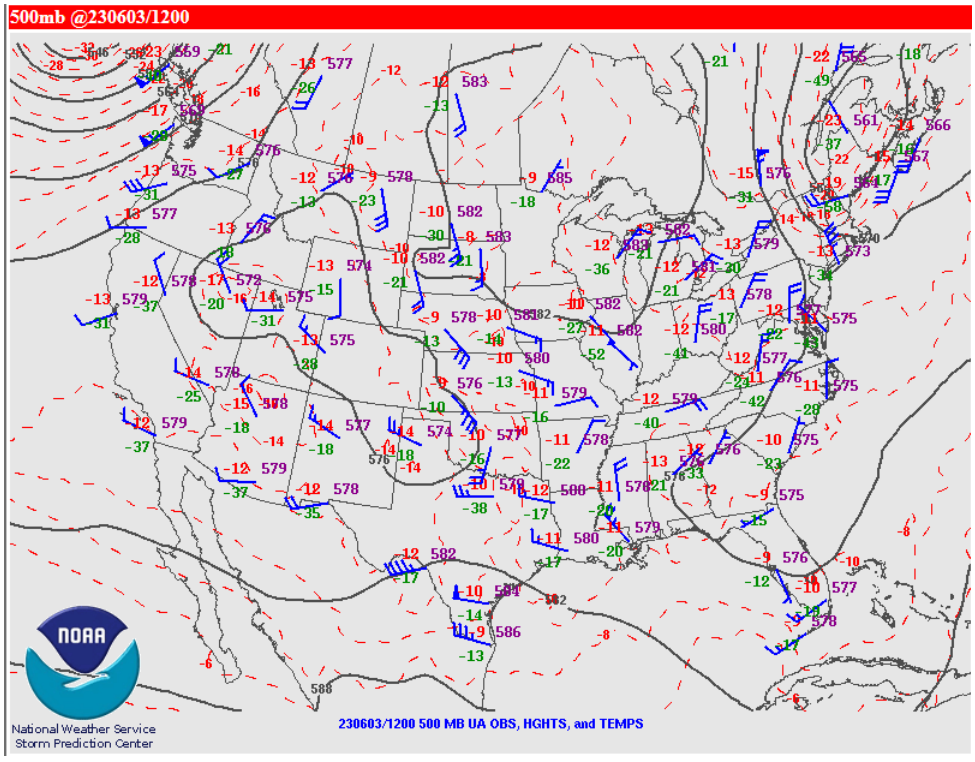
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Air Quality Forecast Verification Report

Episode Overview

Episode Dates: June 9–10, 2023

Region: Northwest Indiana

Pollutants: Ozone (O_3) and Fine Particulate Matter ($PM_{2.5}$)

Overview

This short-duration event was characterized by persistent wildfire smoke impacts and a transition from cool, hazy conditions under high pressure to warmer, more unstable conditions ahead of an approaching low-pressure system. Ozone remained mostly in the Good to Moderate range, while $PM_{2.5}$ reached Moderate levels at all sites on June 9 due to smoke transport.

Meteorological Synopsis

June 9:

Surface high pressure overhead early, shifting south into Illinois by afternoon.

Winds: northerly 5–10 mph, gusting to 15 mph; hazy skies due to smoke aloft.

Temperatures: 70s°F; stable air mass limited ozone formation initially.

June 10:

High pressure sliding east, bringing return of southwesterly flow and warm air advection.

Temperatures: rising into the 80s°F; 850 mb temps near 13°C.

Increasing cloud cover ahead of approaching low and cold front reduced ozone potential.

Pattern Evolution:

Saturday night: cold front pushing south from Canada; low pressure approaching from the west.

Sunday (June 11): convergence of front and low expected to bring windy, wet conditions and significant ventilation.

Day-by-Day Conditions

June 9 (Friday)

Weather:

Cool, hazy skies; highs in the 70s°F; northerly winds under surface high pressure.

Ozone:

Good at all monitors; stable air and limited solar radiation prevented significant ozone buildup.

$PM_{2.5}$ / Smoke:

Moderate at all sites due to wildfire smoke transport; impacts primarily aloft but enough mixing to elevate surface concentrations.

Weather:

Warmer with highs in the 80s°F; southwesterly flow returned; increasing clouds ahead of low-pressure system.

Ozone:

GA Tech and NOAA models forecast Moderate ozone, but cloud cover and lack of lake breeze limited risk for USG but smoke at the surface negated those conditions.

$PM_{2.5}$ / Smoke:

RAP-SMOKE and HRRR guidance suggested smoke aloft with as southerly flow increased.

NOAA and GA Tech models forecast Moderate $PM_{2.5}$ along lakeshore; Good elsewhere.

Smoke Discussion

Source: Canadian wildfire smoke continued to affect the region.

Impact:

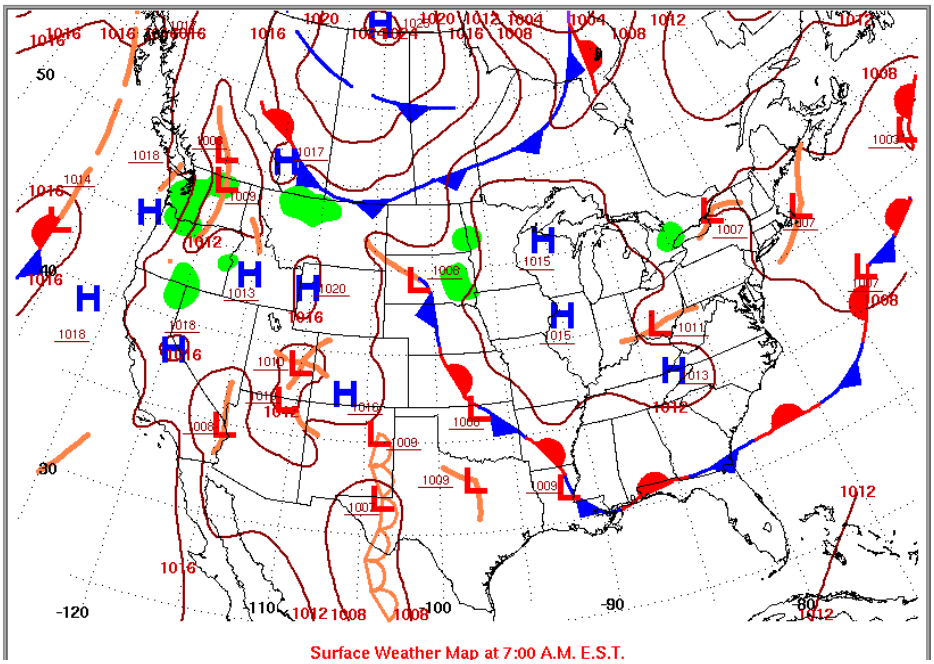
June 9: Significant haze and Moderate $PM_{2.5}$ at all sites.

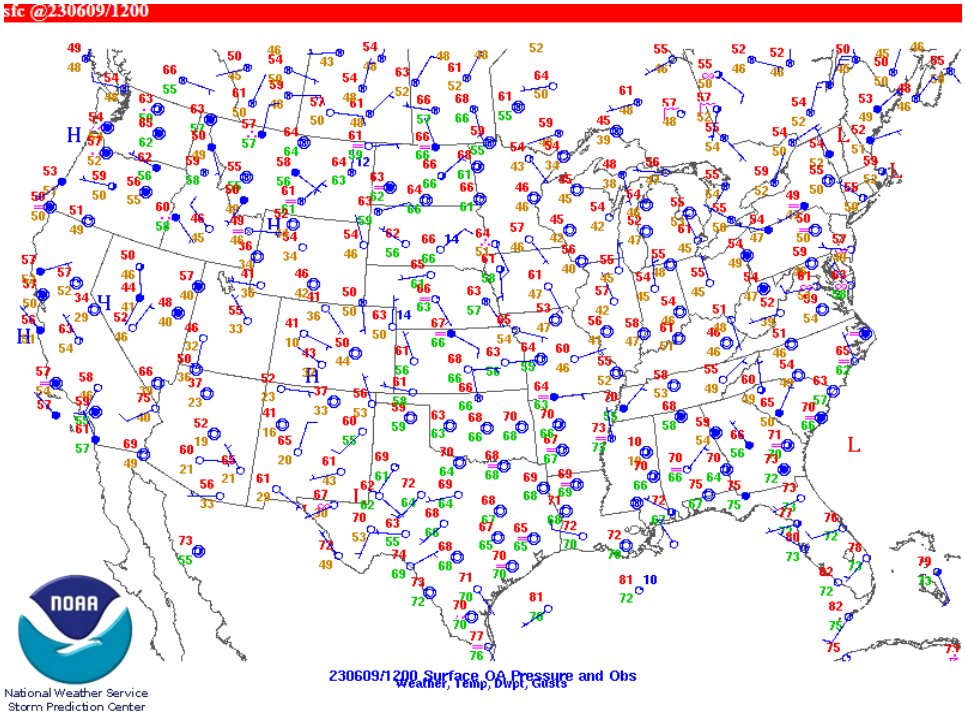
June 10: Surface smoke impacts improved with southerly flow, though elevated layers persisted aloft. **Ozone exceeded at multiple sites around southern Lake Michigan from WI, IL, IN and MI on this day.**

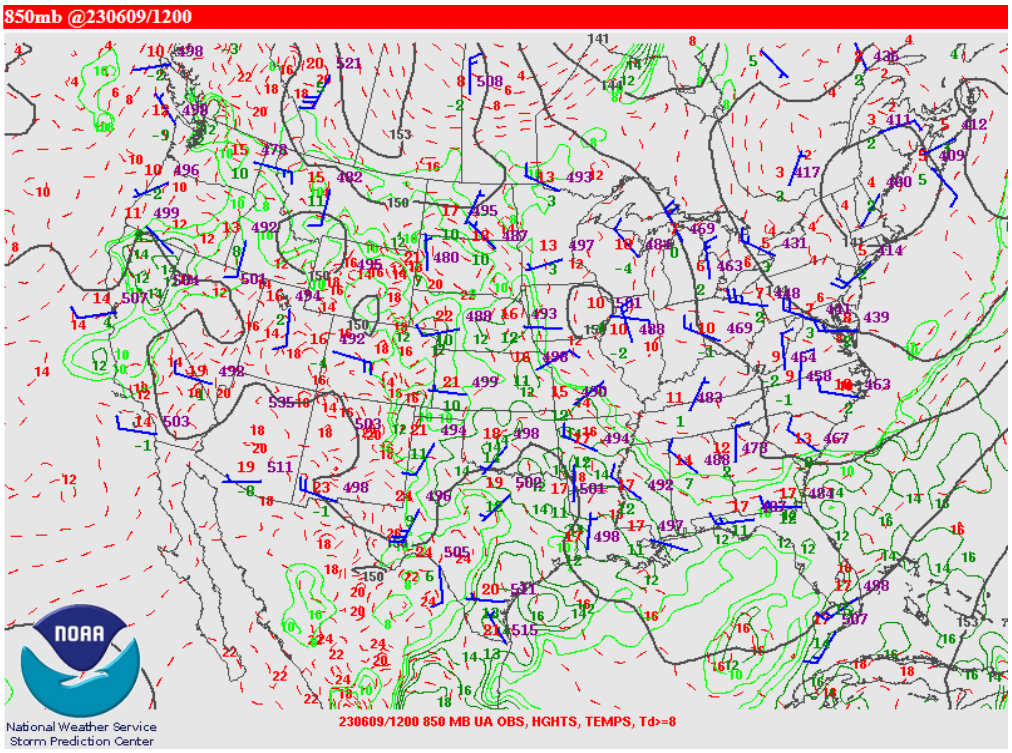
Model Performance: RAP-SMOKE and HRRR were not fully updated for the weekend; forecasters noted need for real-time adjustments.

Surface, 850 and 500 mb plots from 12Z on June 9, 2023

FRIDAY JUNE 9, 2023



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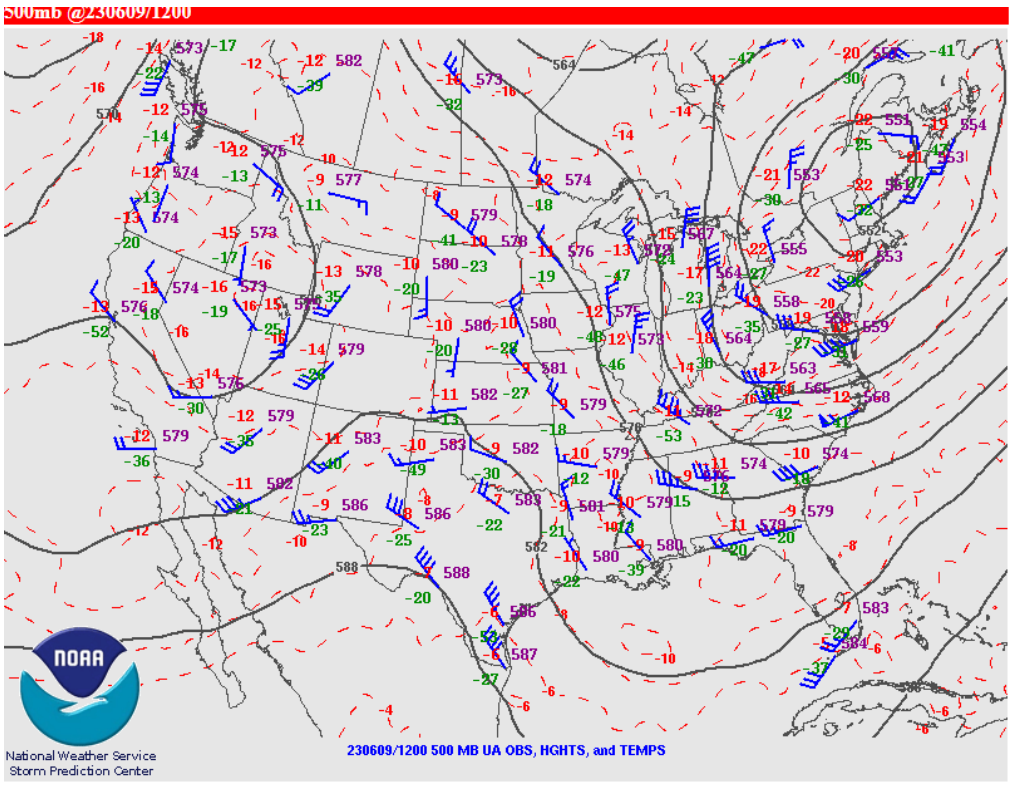
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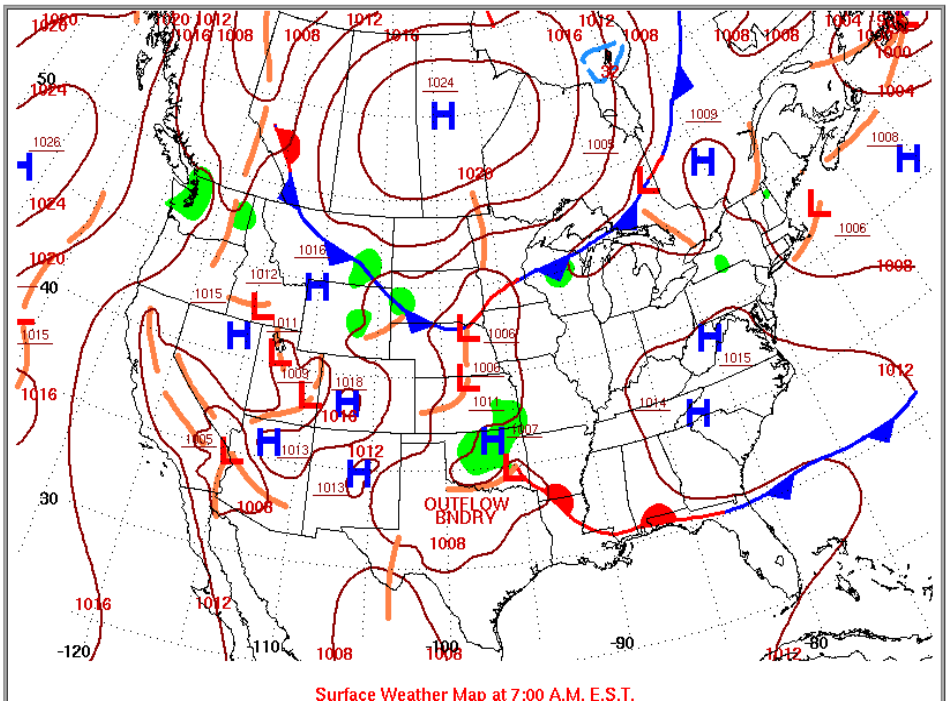
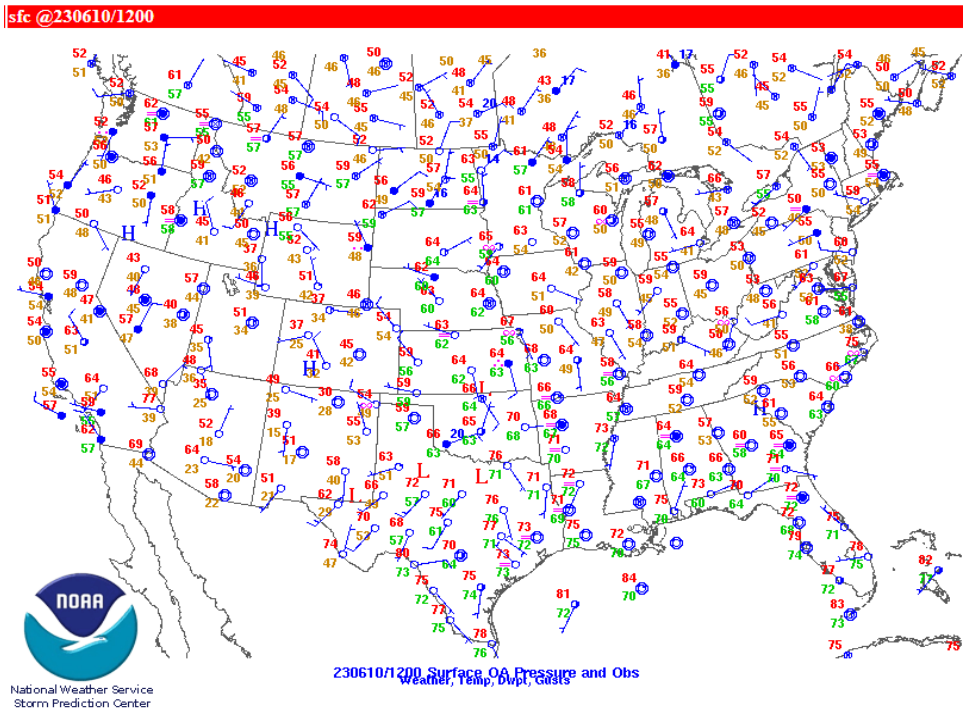
Surface, 850 and 500 mb plots from 12Z on June 10, 2023

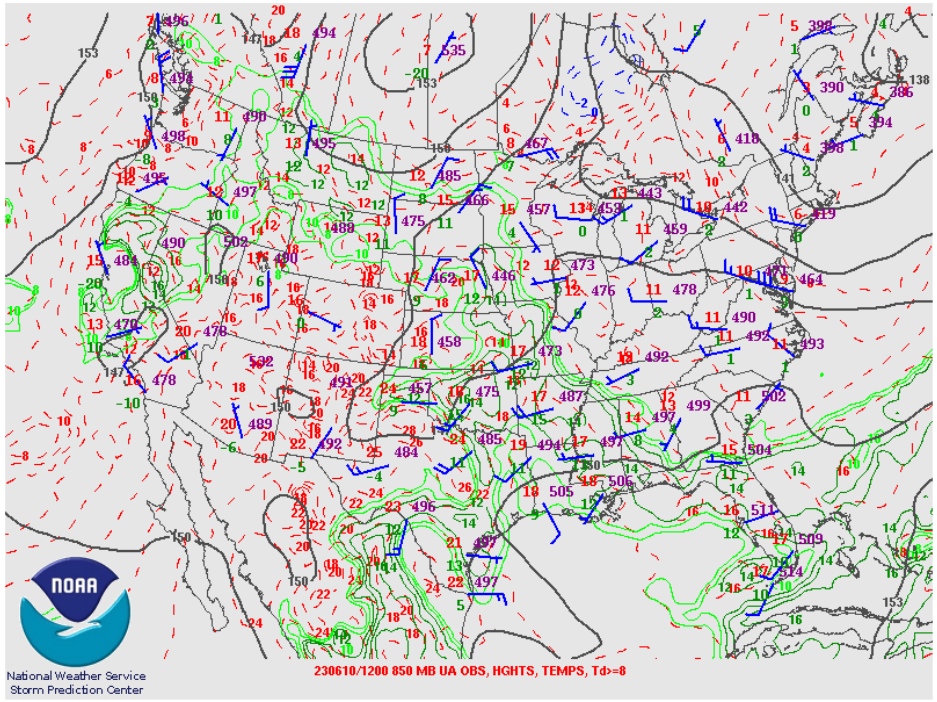
SATURDAY JUNE 10, 2023



Surface Weather Map at 7:00 A.M. E.S.T.



850mb @230610/1200



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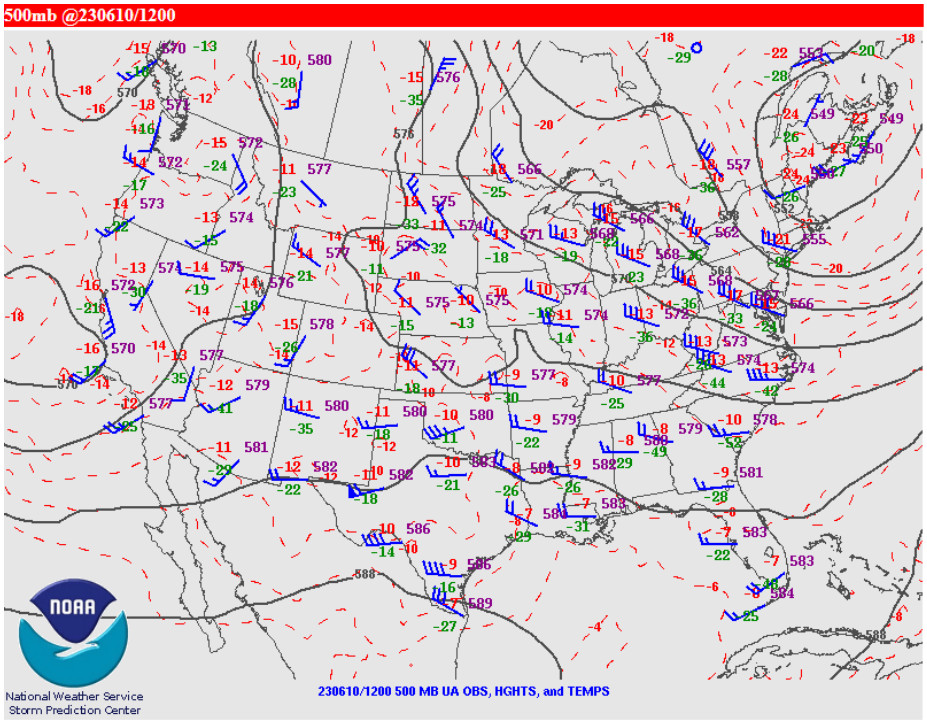


Air Quality Forecast Verification Report

Episode Overview

Episode Dates: June 17–21, 2023

Region: Northwest Indiana

Pollutants: Ozone (O_3) and Fine Particulate Matter ($PM_{2.5}$)

Overview

This period featured persistent high pressure and Rex Block conditions, creating stagnant air and repeated smoke intrusions from Canadian wildfires. The combination of warm temperatures, strong solar radiation, and limited ventilation led to multiple Air Quality Action Days (AQADs) for ozone and fine particulates. Ozone levels escalated from Good early in the week to USG by June 21, while $PM_{2.5}$ remained in the Moderate range throughout due to smoke transport.

Meteorological Synopsis

Pattern:

Rex Block locked high pressure over northern Michigan, maintaining warm, dry air and northerly/easterly flow.

Upper-level low over the Tennessee Valley slowly drifted northeast, eventually increasing mixing and shower chances late in the period.

Surface Conditions:

June 17: High near 77°F, northerly winds 5–10 mph.

June 18–19: Highs mid-80s°F, winds shifting south-southeast, then east-southeast; RH <50%.

June 20–21: Highs upper 80s to near 90°F; east winds gusting to 20 mph.

Upper-Air:

850 mb temps: 10–11°C on June 17, rising to 14–15°C by June 21.

Persistent subsidence and clear skies favored ozone formation despite atypical wind directions.

Day-by-Day Conditions

June 17 (Saturday)

Weather: Sunny, high near 77°F; northerly winds.

Ozone: Rising toward Moderate; GA Tech and NOAA models indicated Good to Moderate.

$PM_{2.5}$ / Smoke: Moderate due to lingering smoke aloft; surface impacts limited but present.

AQAD: Issued for Ozone and $PM_{2.5}$ across multiple Indiana regions.

June 18 (Sunday)

Weather: Mostly sunny, high near 86°F; south-southeast winds; chance of late showers.

Ozone: Moderate risk; NOAA forecast Moderate, GA Tech similar.

$PM_{2.5}$ / Smoke: Continued Moderate; smoke transport persisted under easterly flow.

AQAD: Issued for Ozone in several regions (West Central, Central, East Central, Southwest, Southeast Indiana).

June 19 (Monday)

Weather: Mostly sunny, high near 85°F; east-southeast winds gusting to 15 mph.

Ozone: Moderate to USG potential; NOAA and GA Tech indicated rising levels.

$PM_{2.5}$ / Smoke: Moderate; RAP-SMOKE showed plume shifting south and east.

AQAD: Issued for Ozone in Northwest, North Central, Northeast, and Northern Indiana.

June 20 (Tuesday)

Weather: Mostly sunny, highs upper 80s°F; persistent Rex Block pattern.

Ozone: Elevated; conditions conducive for USG near Lake Michigan.

$PM_{2.5}$ / Smoke: Moderate; smoke impacts continued at surface and aloft.

June 21 (Wednesday)

Weather: Mostly sunny, highs near 90°F; east winds gusting to 20 mph.

Ozone: USG observed across Northwest Indiana; NOAA forecast Moderate but underestimated.

$PM_{2.5}$ / Smoke: Moderate; smoke plume recirculation noted in HRRR guidance.

AQAD: Conditions warranted AQAD; ozone exceedances confirmed.

Smoke Discussion

Source: Canadian wildfires continued to inject smoke into the Great Lakes region.

Impact:

Persistent elevated smoke layers throughout the episode; surface impacts increased during northerly flow periods.

RAP-SMOKE and HRRR guidance captured plume location but required real-time adjustments.

Effect on Chemistry:

Light extinction from smoke aloft occasionally reduced ozone formation efficiency, but precursor transport and stagnant conditions outweighed this effect.

Summary

Overall Pattern: Rex Block and persistent high pressure created stagnant conditions, favoring ozone buildup and smoke transport.

Ozone:

Good early in the week; Moderate by June 17 then USG across several southern Lake Michigan states on the 18, 19th with moderate on the 20th then USG again on the 21st for IN/IL and WI.

AQADs issued June 17–19 for multiple regions.

$PM_{2.5}$:

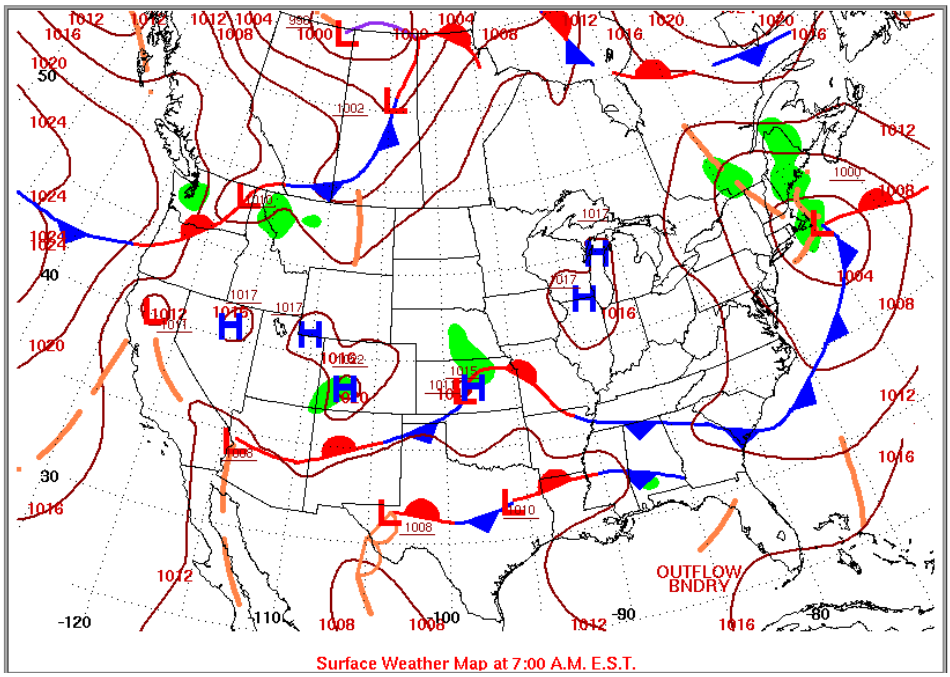
Moderate throughout due to wildfire smoke; surface impacts varied but significant.

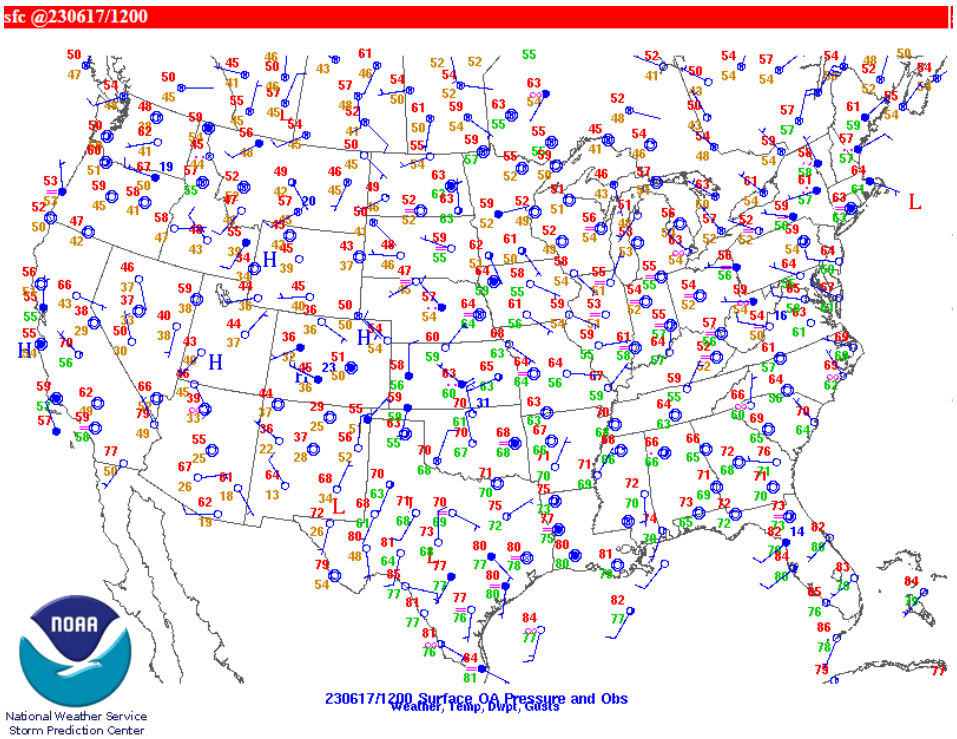
Smoke:

Continuous influence from Canadian fires; RAP-SMOKE guidance useful but underestimated concentrations.

Surface, 850 and 500 mb plots from 12Z on June 17, 2023

SATURDAY JUNE 17, 2023





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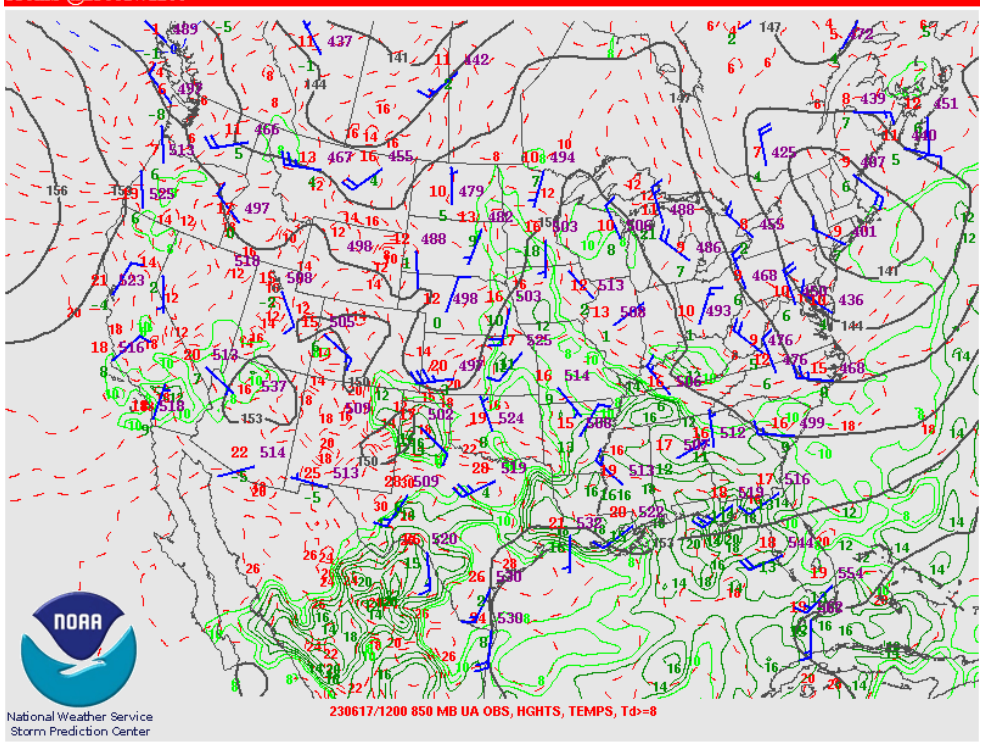

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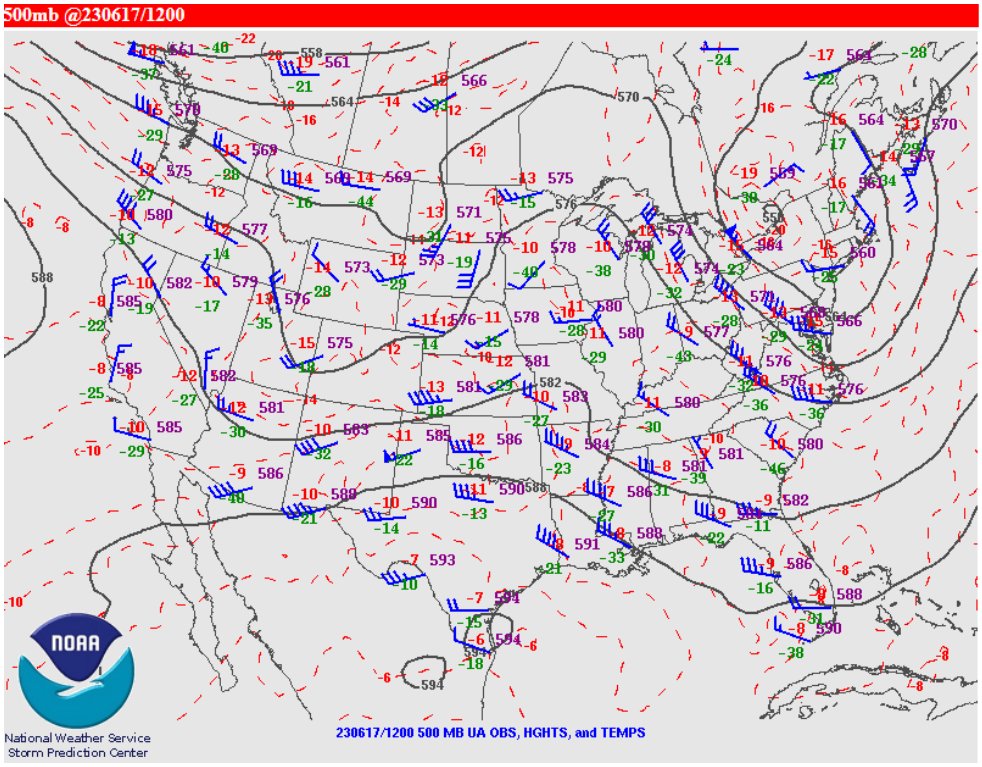
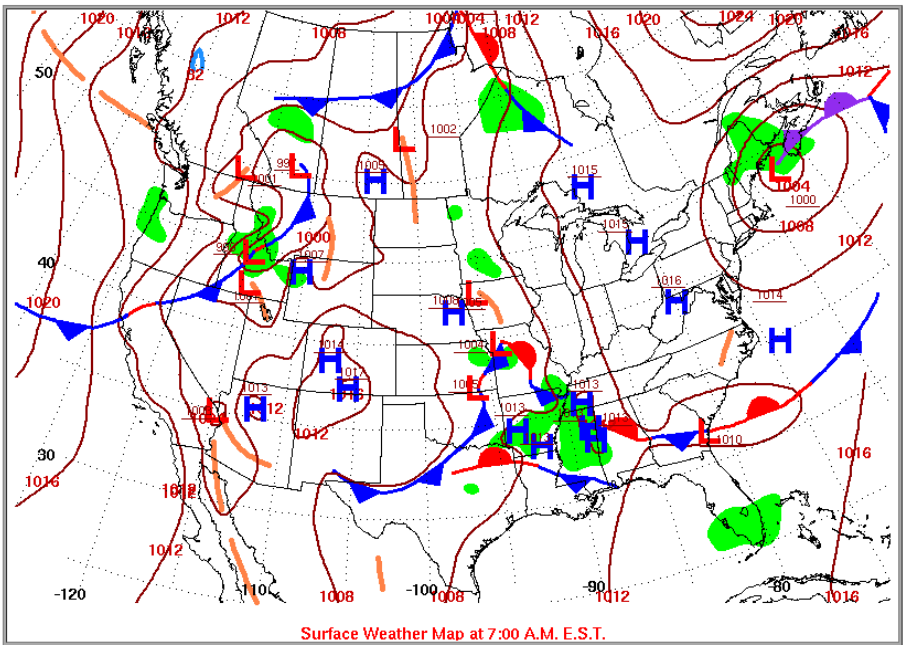
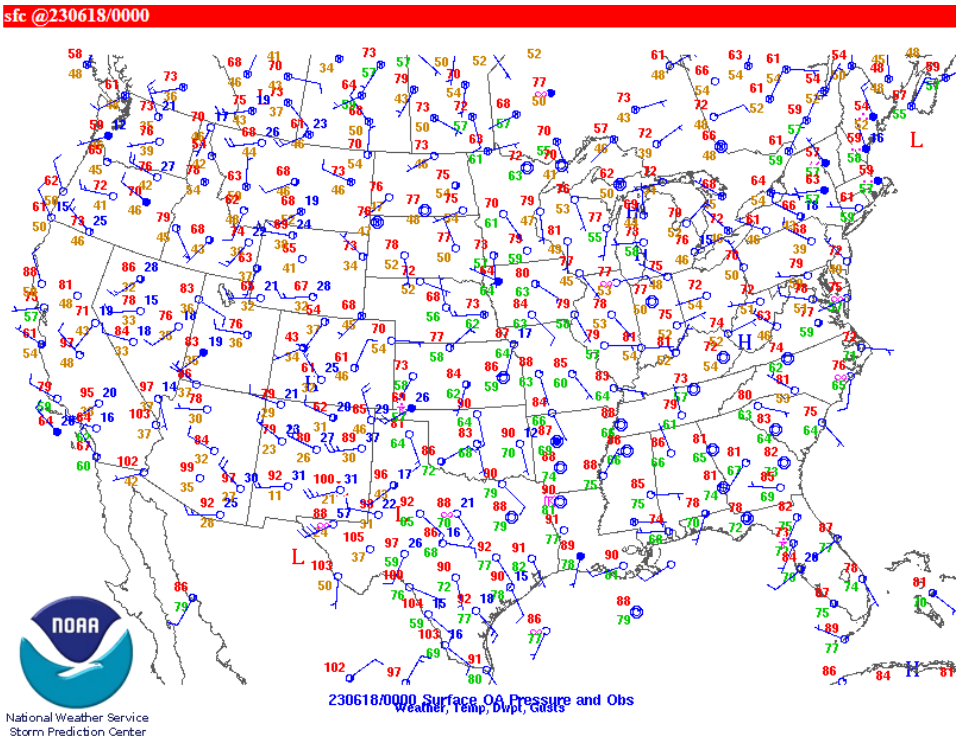


Surface, 850 and 500 mb plots from 12Z on June 18, 2023

SUNDAY JUNE 18, 2023





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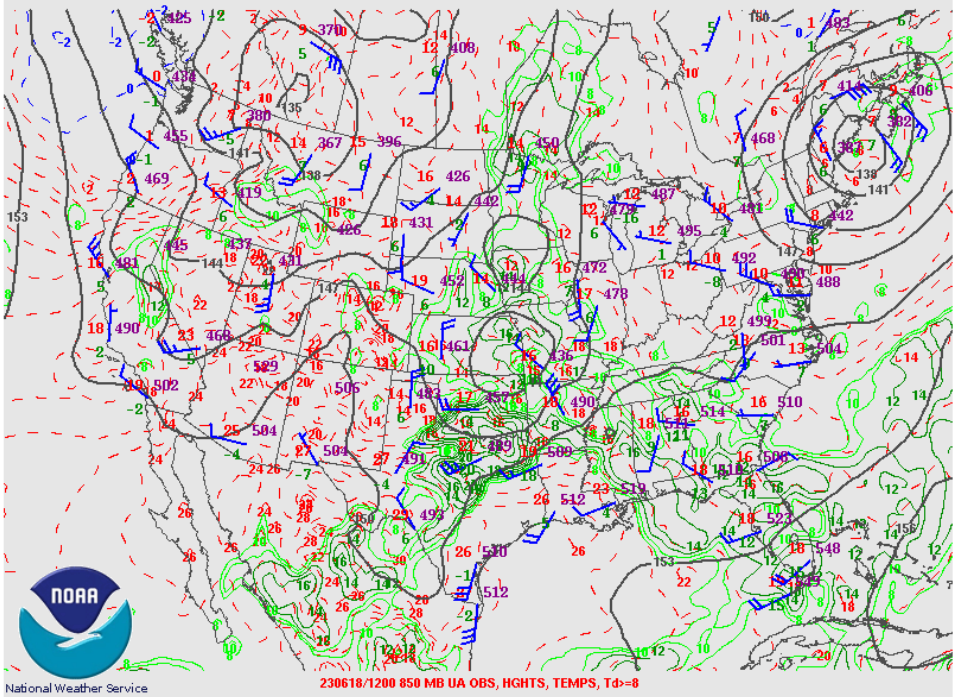

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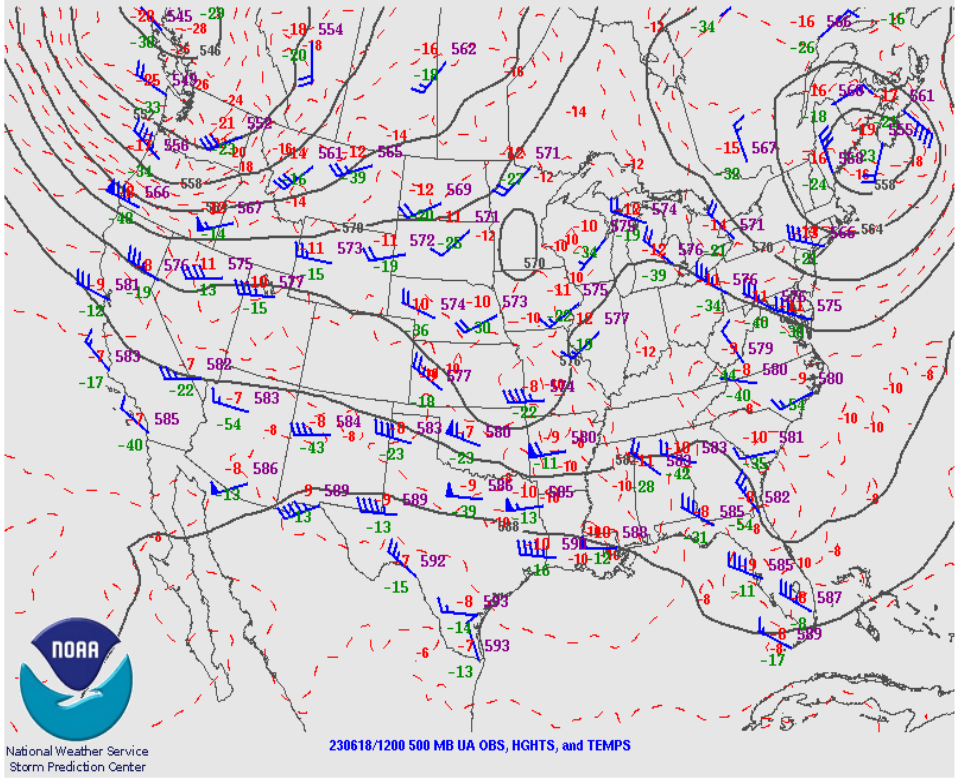
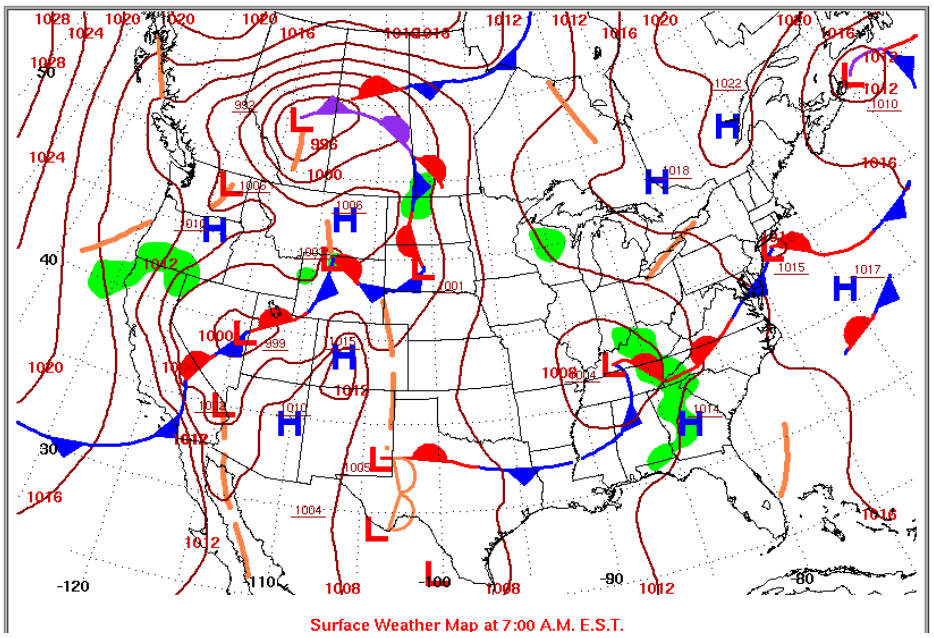
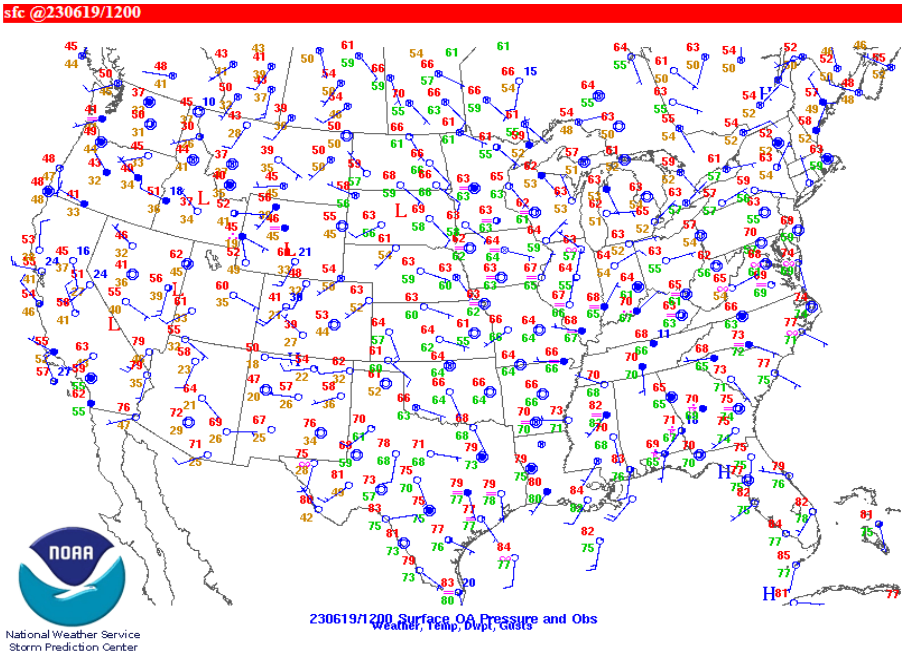


Surface, 850 and 500 mb plots from 12Z on June 19, 2023





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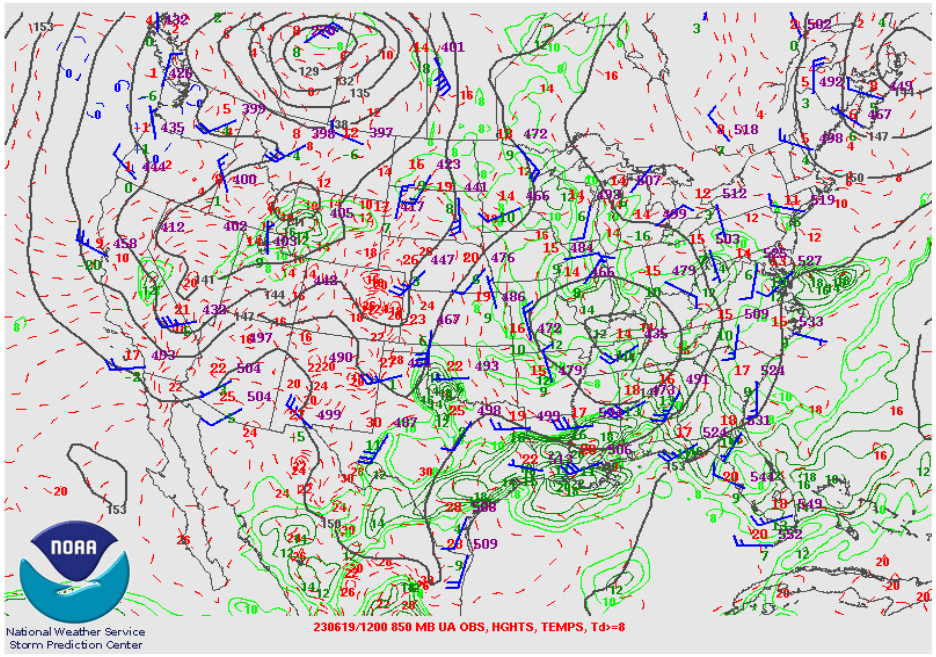

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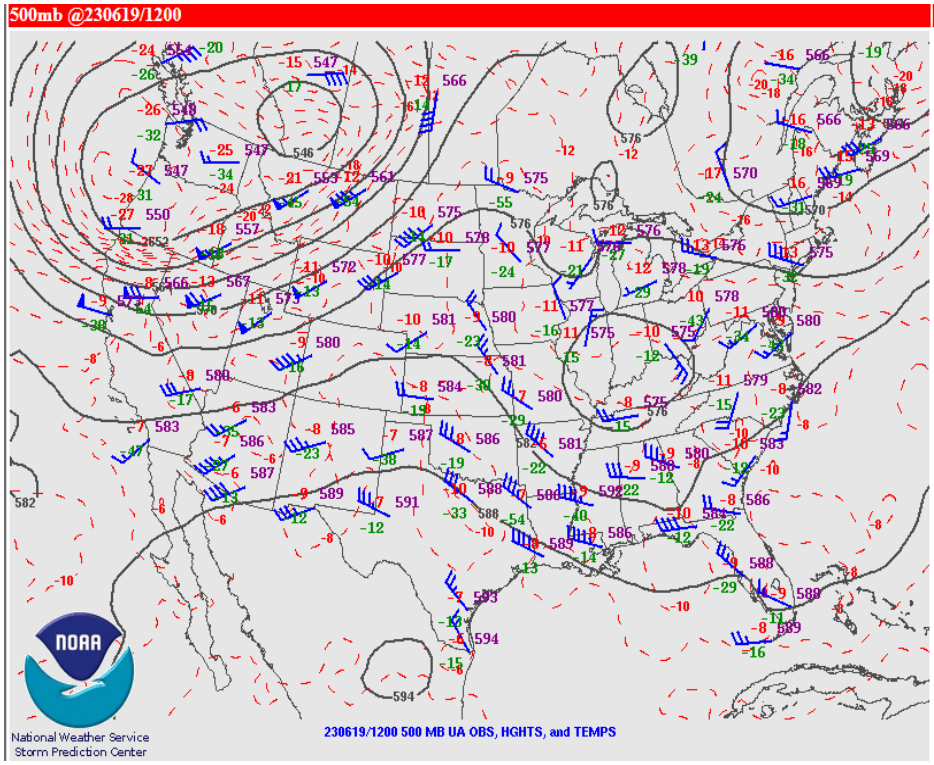
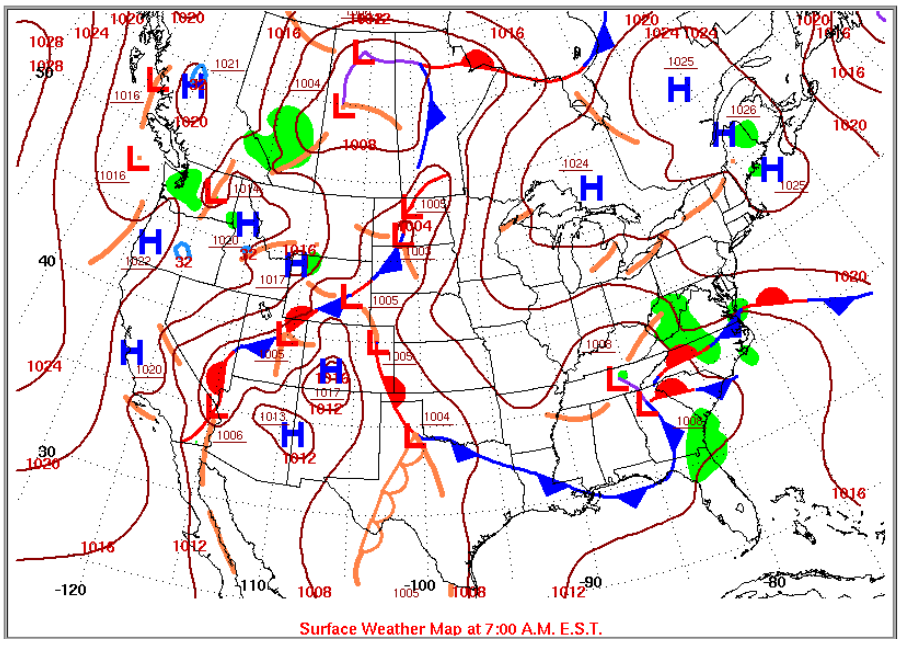
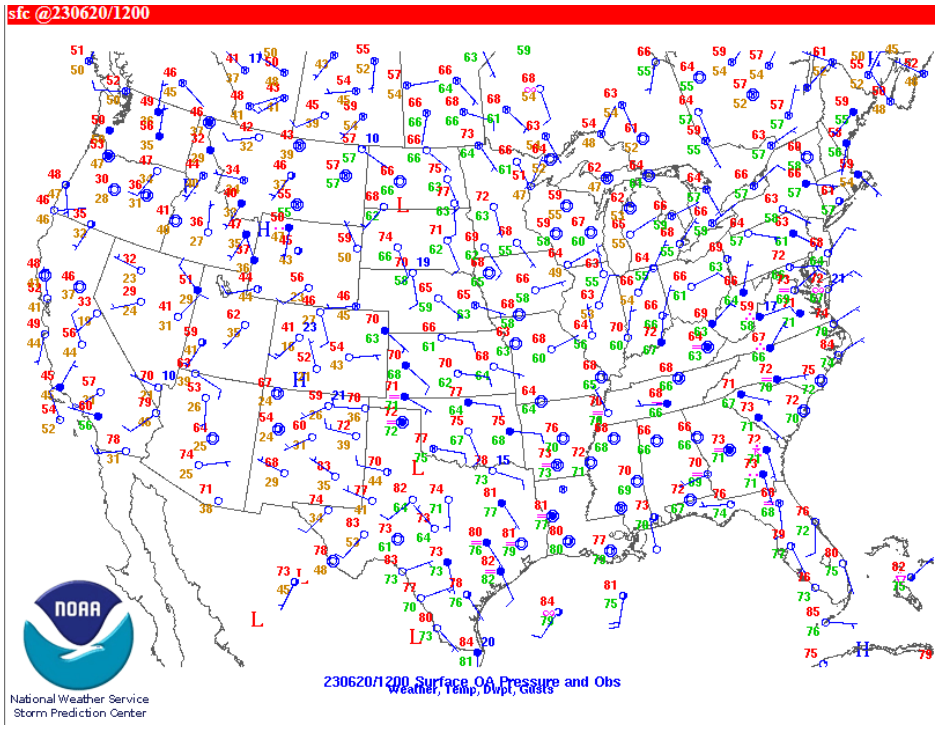


Surface, 850 and 500 mb plots from 12Z on June 20, 2023





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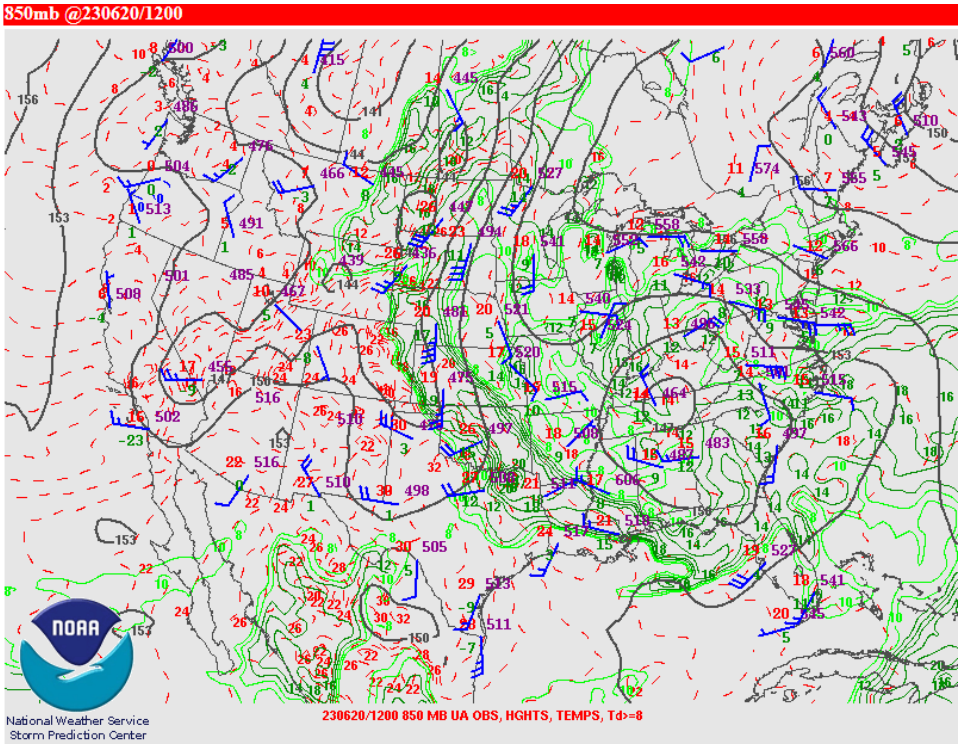

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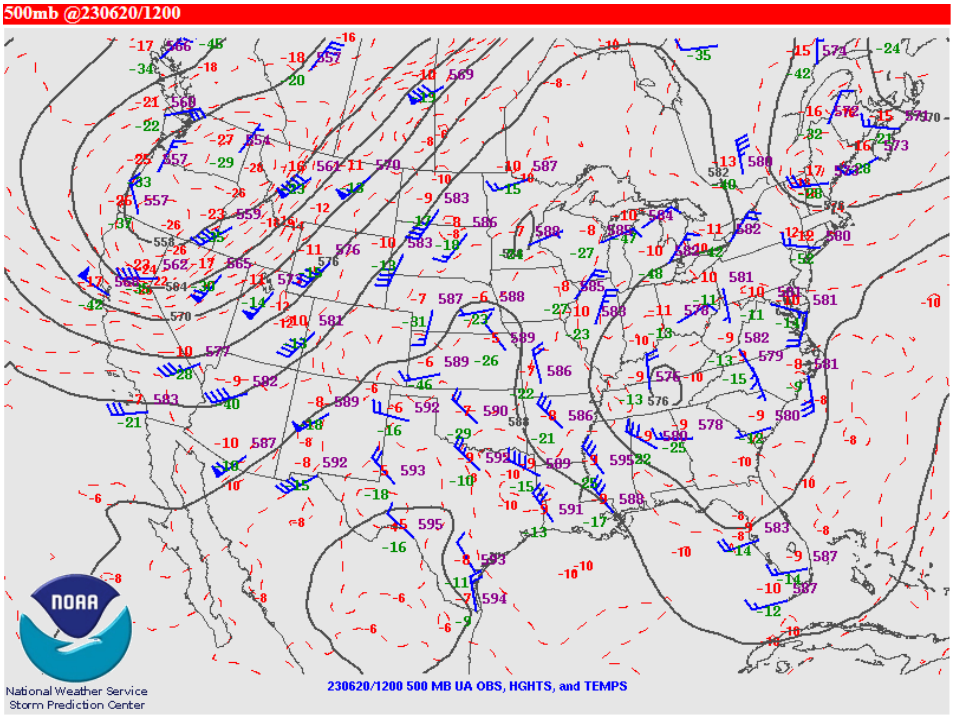
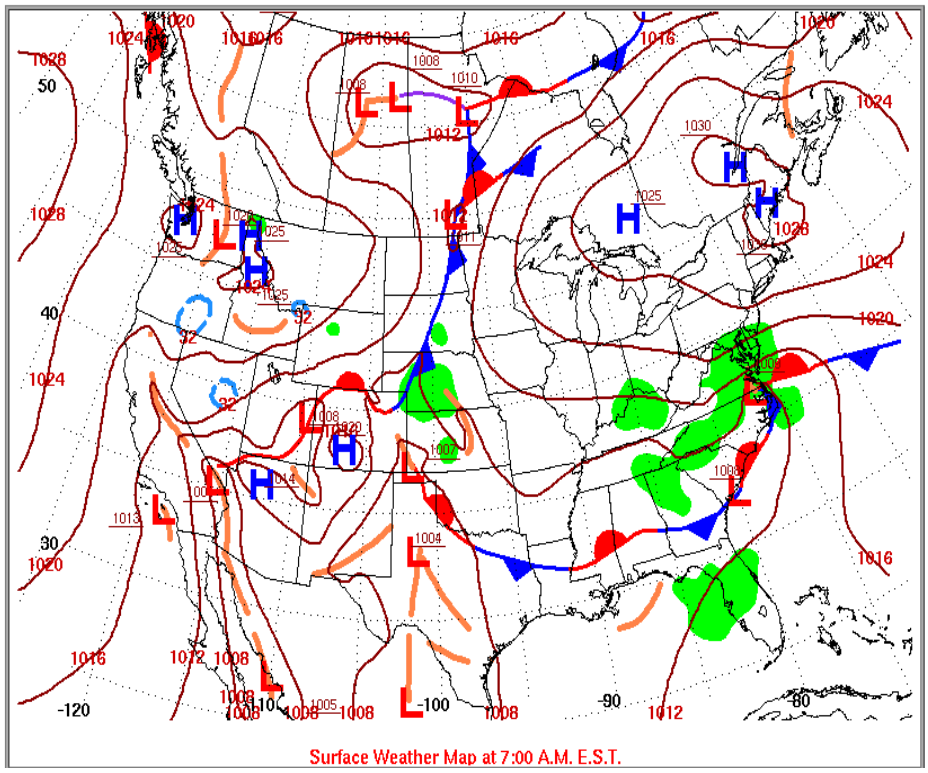
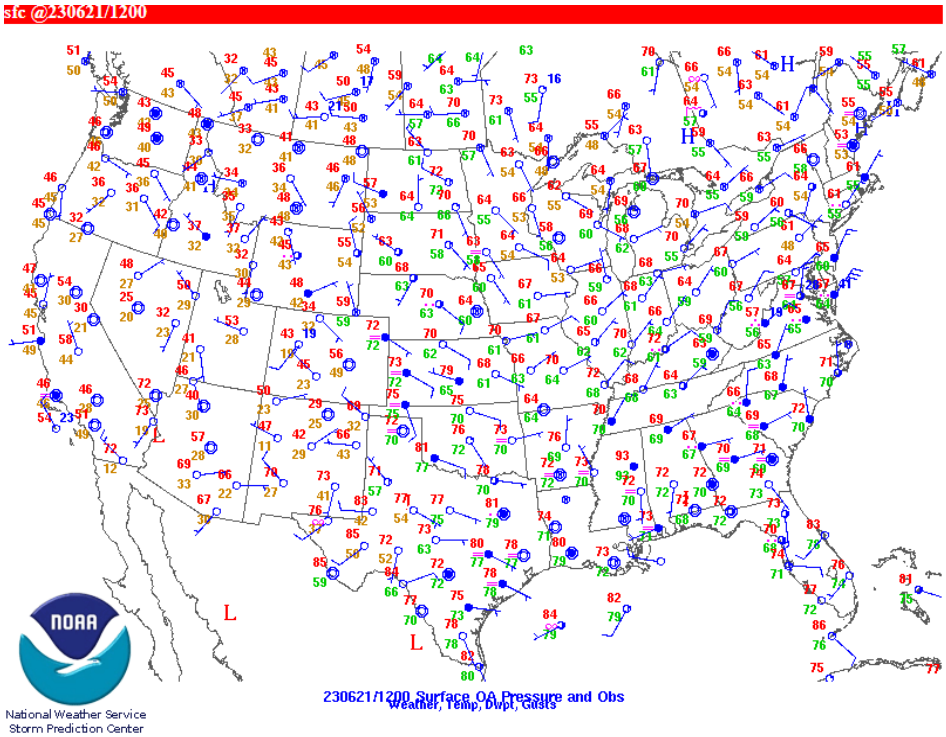


Surface, 850 and 500 mb plots from 12Z on June 21, 2023

WEDNESDAY JUNE 21, 2023





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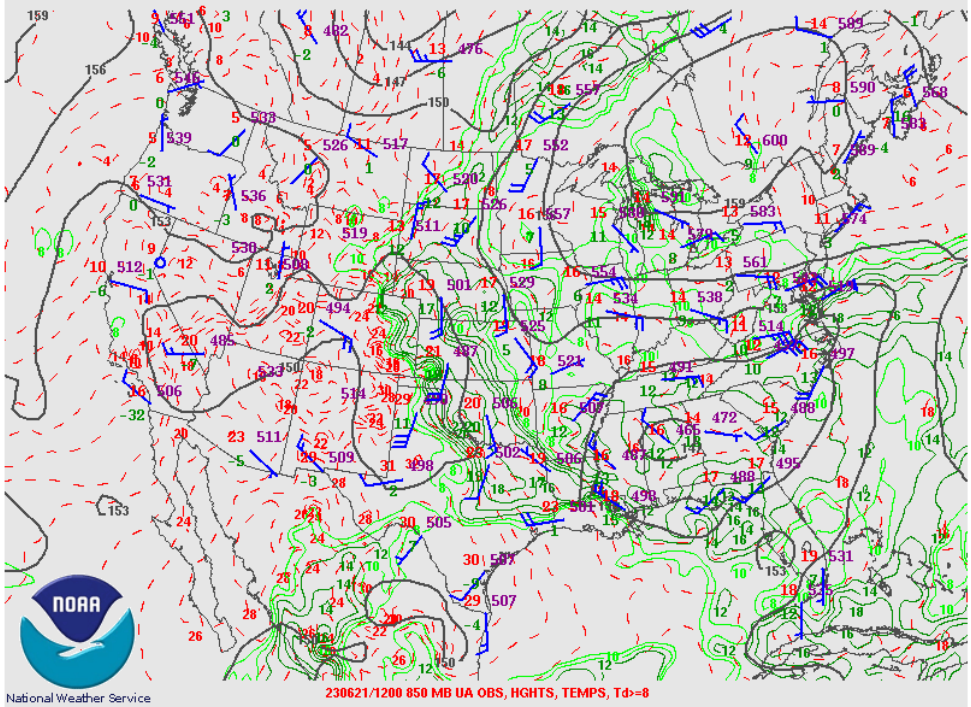

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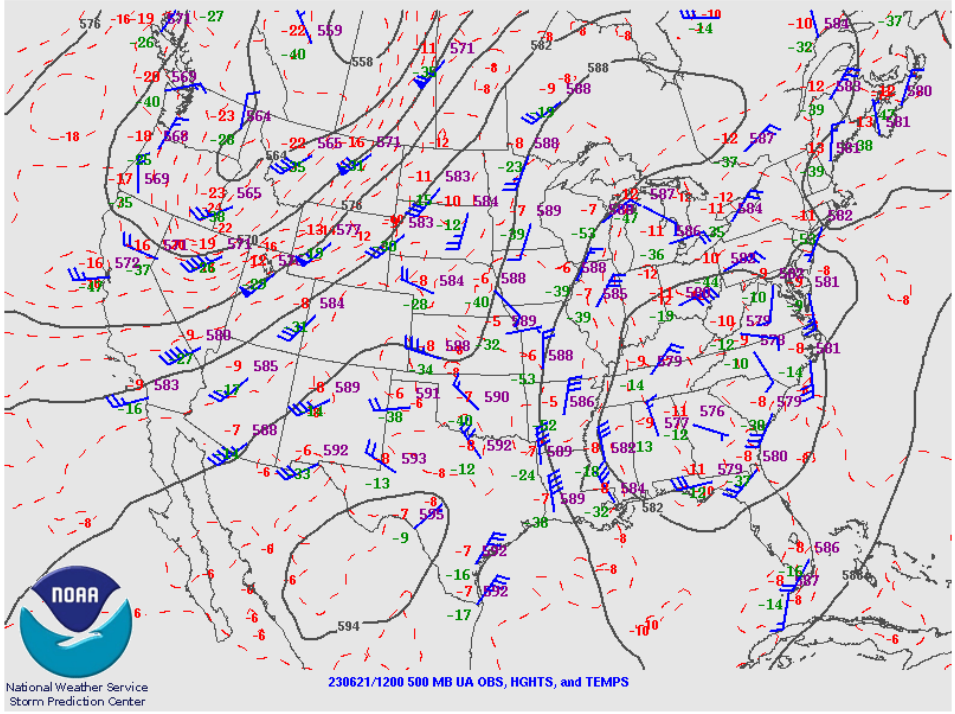


Air Quality Forecast Verification Report

Episode Overview

Episode Dates: July 3–4, 2023

Region: Northern Indiana

Pollutants: Ozone (O_3) and Fine Particulate Matter ($PM_{2.5}$)

Overview

This short episode occurred under a transitioning weather pattern with moderate ozone potential and lingering $PM_{2.5}$ concerns. While smoke impacts were minimal compared to June episodes, moderate $PM_{2.5}$ persisted due to stagnant conditions and slow wind speeds. Ozone remained mostly in the Moderate range, supported by rising temperatures and sunny skies.

Meteorological Synopsis

Pattern:

July 3: Partly cloudy skies, highs in low 80s°F, dewpoints in the 60s, RH near 60%, northwest winds near 10 kts.

July 4: Mostly clear skies, highs in upper 80s°F, RH above 40%, southwest winds near 5 kts.

July 5 (outlook): Continued warm conditions, highs upper 80s°F, south winds near 10 kts.

Ventilation:

Light winds and slow air mass turnover favored pollutant accumulation.

Scattered rain chances remained low until later in the week.

Day-by-Day Conditions

July 3 (Monday)

Weather: Partly cloudy, highs low 80s°F, northwest winds near 10 kts.

Ozone: Models indicated Moderate ozone potential; conditions supported buildup under sunny breaks and light winds.

$PM_{2.5}$ / Smoke: Moderate $PM_{2.5}$ possible; smoke impacts minimal per Canadian model and weekend observations.

July 4 (Tuesday)

Weather: Mostly clear, highs upper 80s°F, southwest winds near 5 kts; RH above 40%.

Ozone: Increased risk for Moderate ozone due to higher temperatures and sunny skies; GA Tech and NOAA models aligned on Moderate forecast. **One USG in northwest Indiana on July 4th for PM2.5 and multiple sites went USG for Ozone in both IL/IN.**

$PM_{2.5}$ / Smoke: Moderate $PM_{2.5}$ continued possible; minimal smoke intrusion expected.

Smoke Discussion

Source: Canadian wildfire smoke impacts were minimal during this period.

Impact:

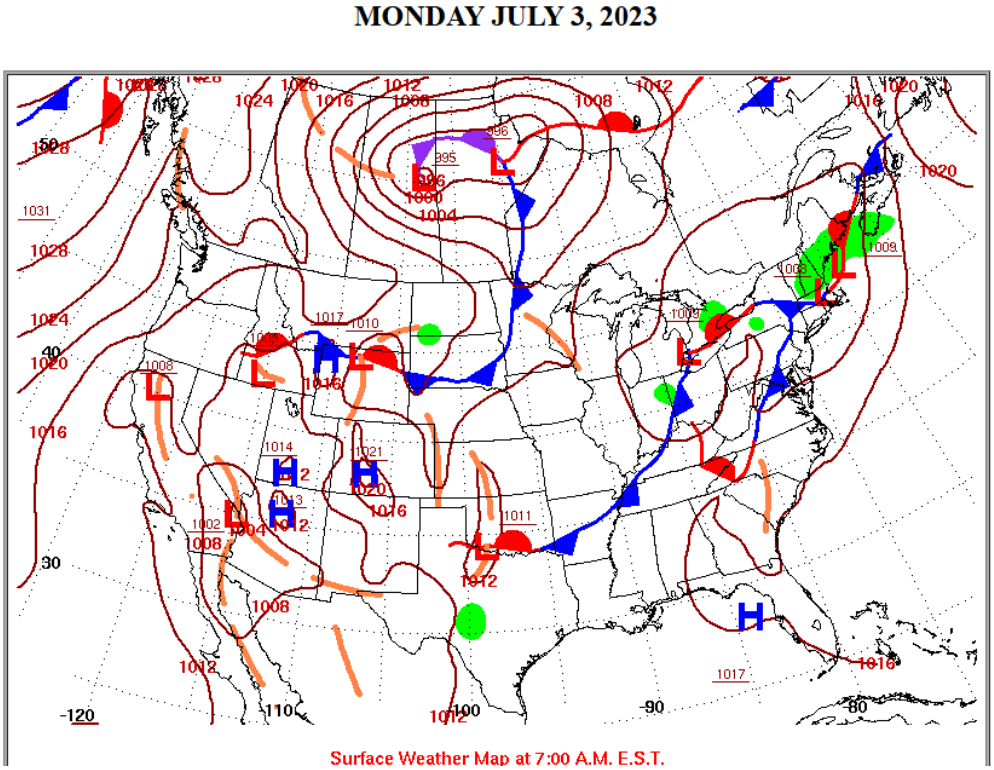
No significant surface smoke intrusion; haze was negligible compared to June episodes.

RAP-SMOKE and Canadian model guidance confirmed limited smoke transport.

Effect on Chemistry:

With minimal smoke, ozone chemistry proceeded normally under sunny conditions with some enhancements.

Surface, 850 and 500 mb plots from 12Z on July 3, 2023



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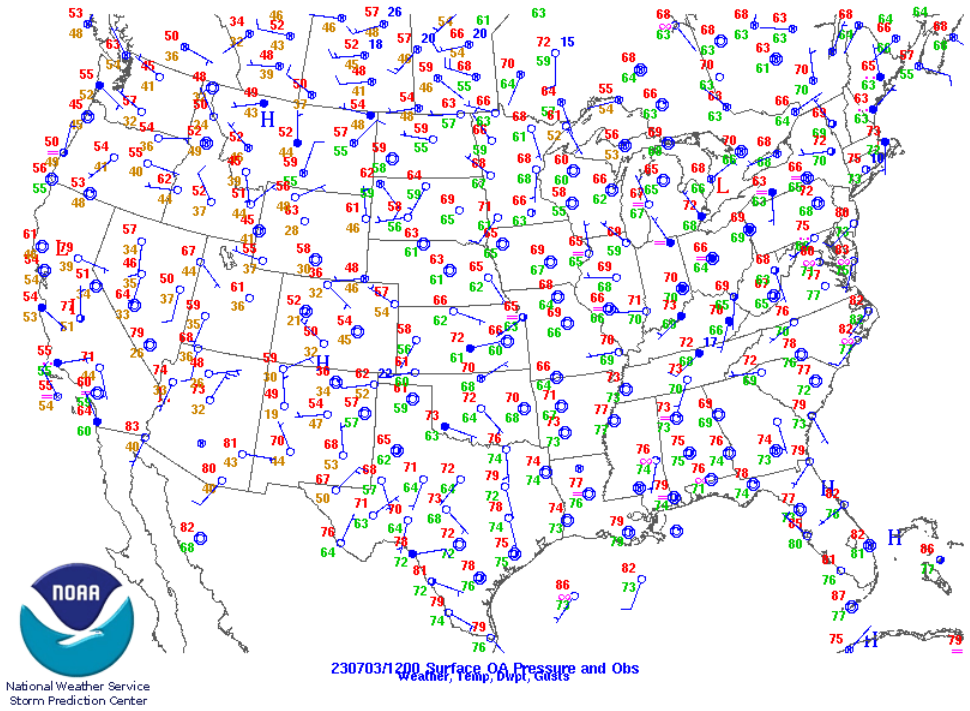

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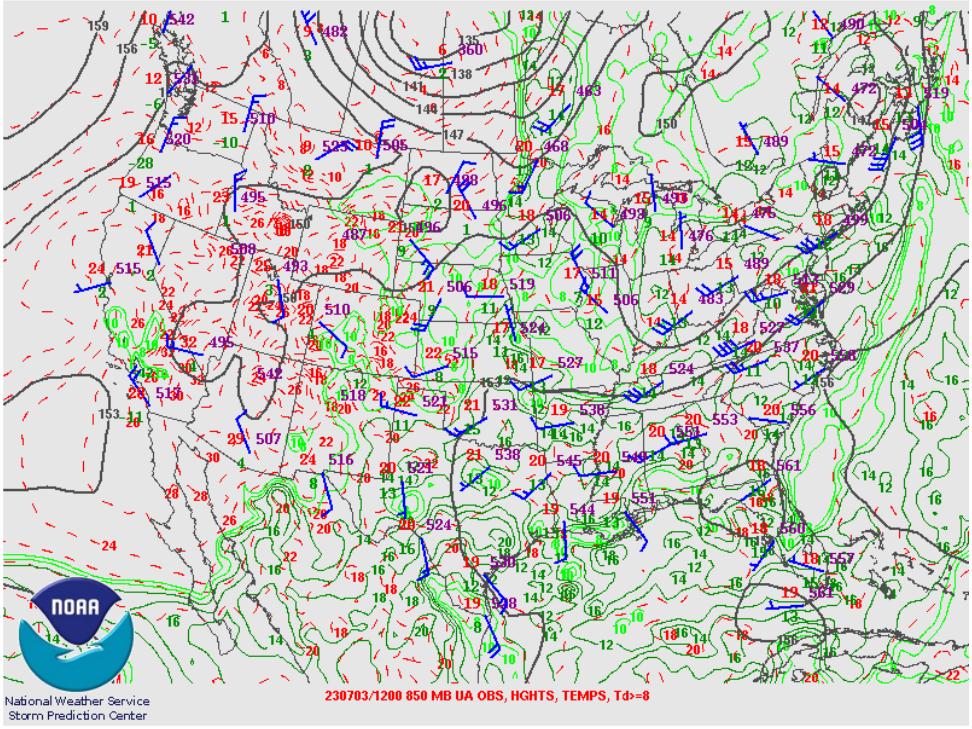
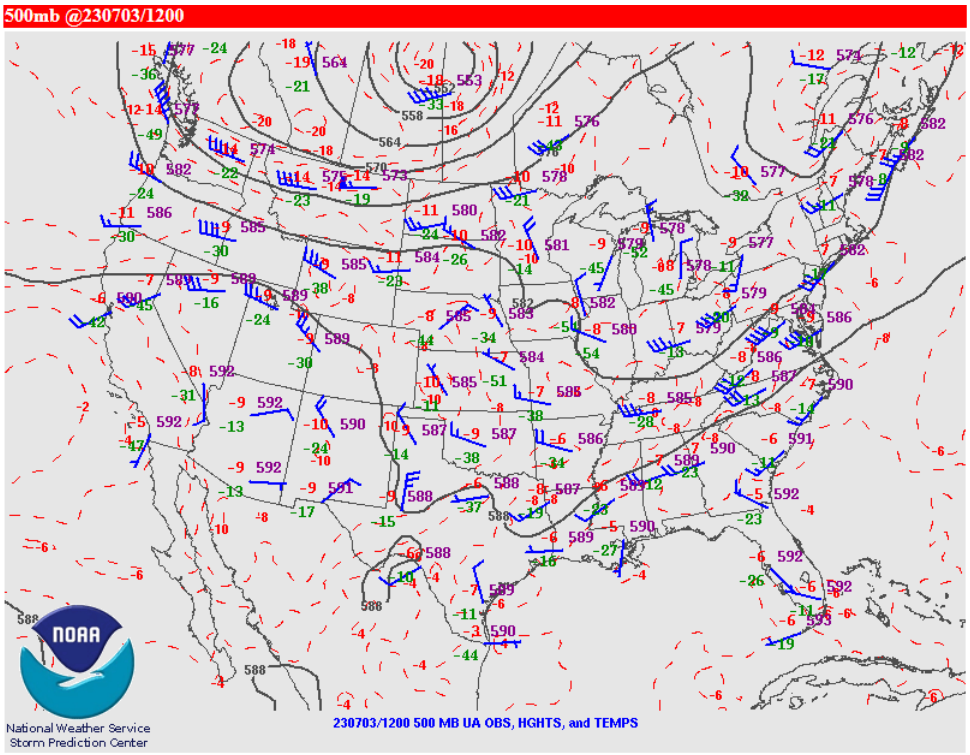
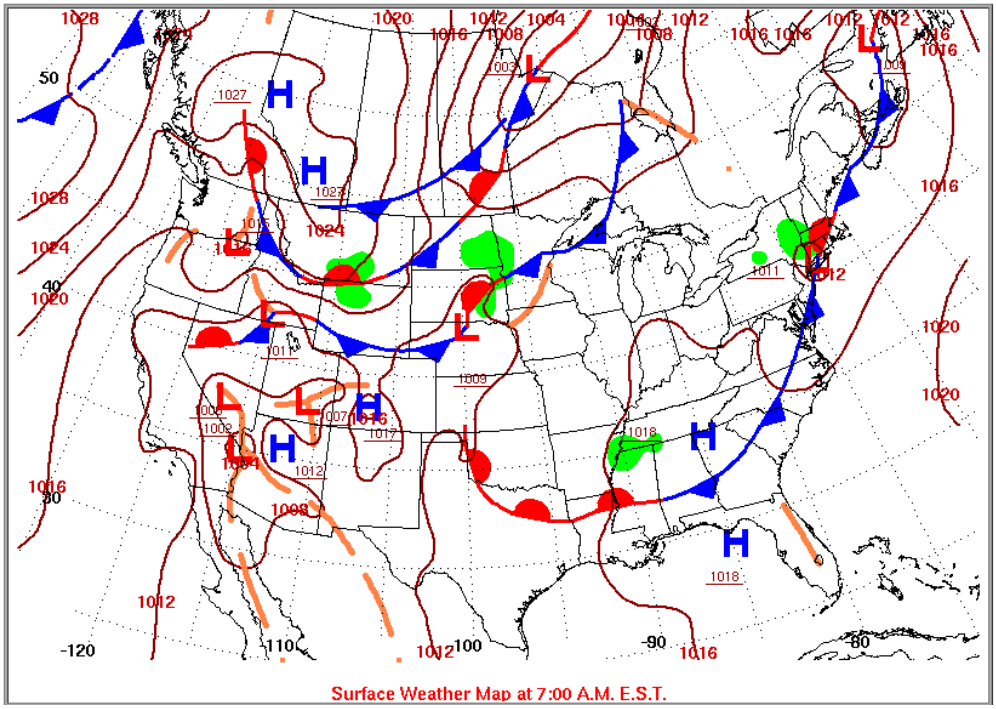




Surface, 850 and 500 mb plots from 12Z on July 4, 2023

TUESDAY JULY 4, 2023



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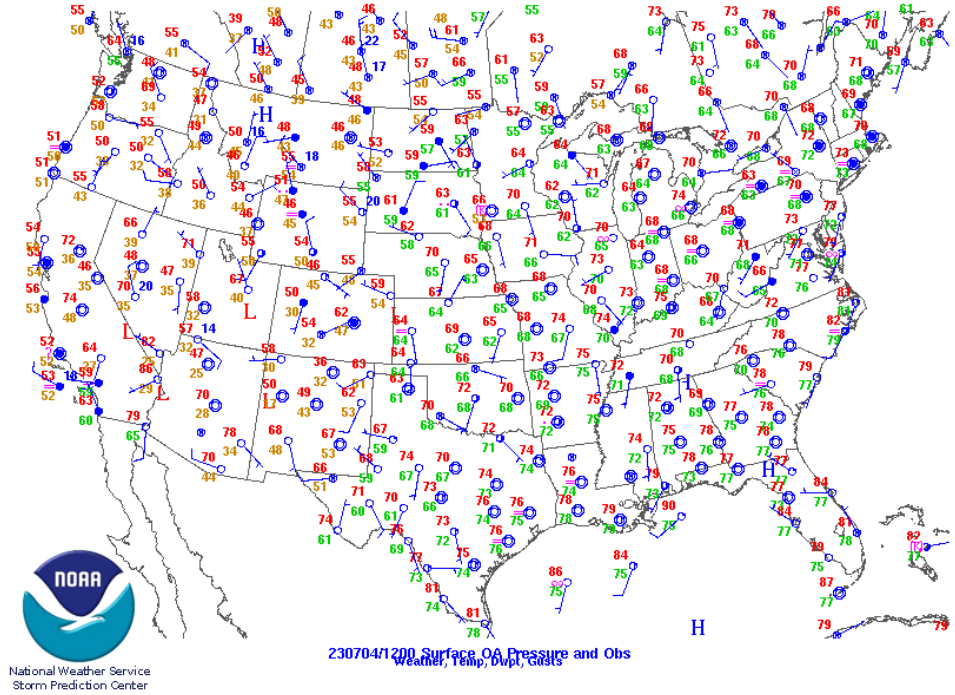

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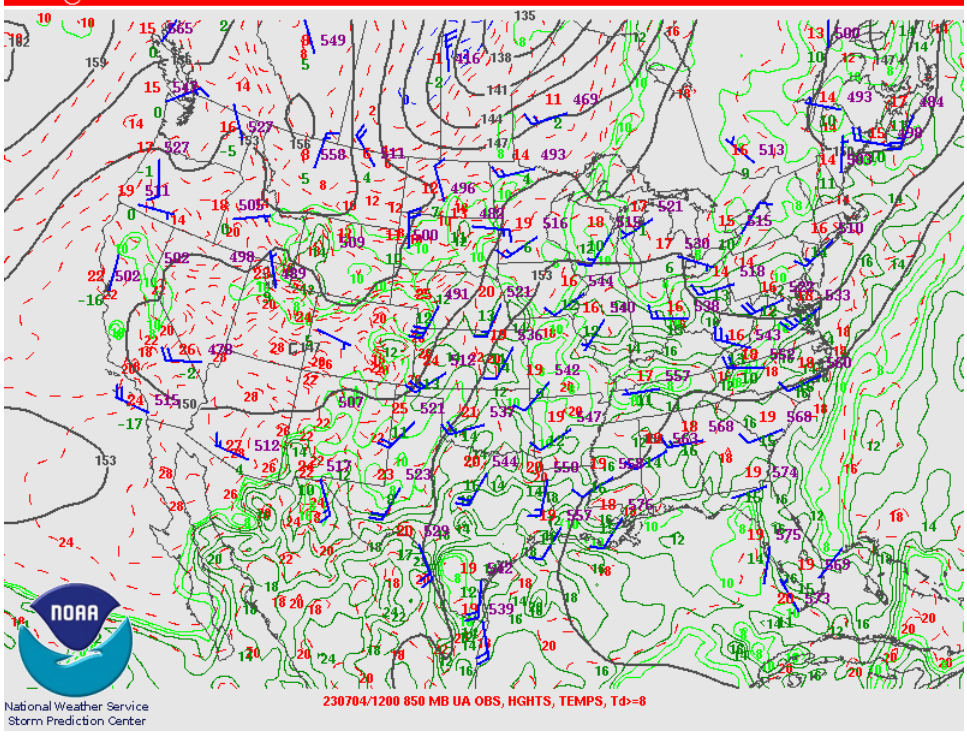
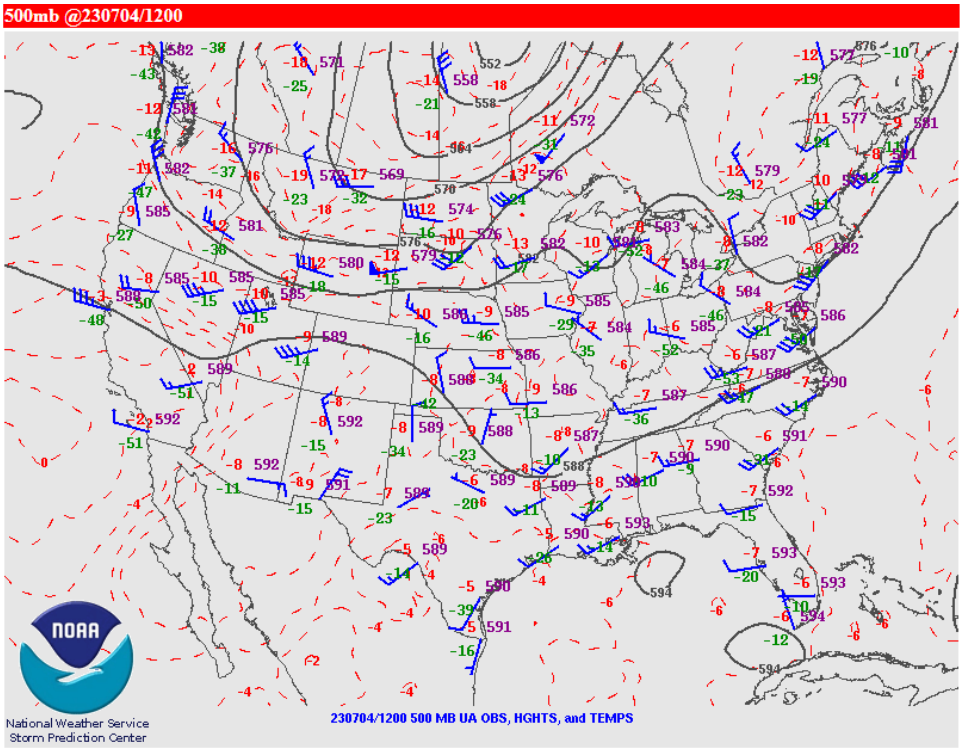




Air Quality Forecast Verification Report

Episode Overview

Episode Dates: July 22–25, 2023

Region: Northwest

Pollutants: Ozone (O_3) and Fine Particulate Matter ($PM_{2.5}$)

Overview

This period marked a transition from cooler, post-frontal conditions to a hot, stagnant pattern under building upper-level ridging, which favored ozone formation and smoke intrusion. Ozone levels escalated from Moderate on July 22 to USG on July 23, with continued elevated risk through July 24–25. $PM_{2.5}$ remained mostly Moderate, with short-lived spikes due to wildfire smoke transport.

Meteorological Synopsis

Pattern:

Early period (July 22): Influence of longwave trough and surface ridge; cooler temps, northerly winds.

Mid-period (July 23–24): Heights rising, warm air advection, and lake breeze development; upper-level ridge expanding eastward from the Southwest.

Late period (July 25): Ridge dominance, highs near 90°F inland, southeasterly gradient favoring lake breeze; very low precipitation chances.

Surface Conditions:

July 22: High near 82°F, light west winds; RH ~50%.

July 23: High near 83°F, southwest winds; chance of storms.

July 24: High near 85°F, light winds; RH ~45%; lake breeze after 19Z.

July 25: High near 89°F, south winds; dew points mid-60s°F.

Upper-Air:

850 mb temps: 13°C on July 22; rising to 15°C July 24; surging to 17–20°C by July 25.

Day-by-Day Conditions

July 22 (Saturday)

Weather: Partly sunny, highs mid-70s°F; northerly winds 10–15 mph.

Ozone: Moderate forecast; NOAA and GA Tech models aligned.

$PM_{2.5}$ / Smoke: Good to Moderate; minimal smoke intrusion.

July 23 (Sunday)

Weather: Mostly sunny, high near 83°F; southwest winds; chance of storms late.

Ozone: USG observed in some areas; GA Tech indicated ozone buildup near Lake Michigan.

$PM_{2.5}$ / Smoke: Moderate; FireWork model suggested smoke plume approaching late.

AQAD: Elevated ozone warranted AQAD for sensitive groups

July 24 (Monday)

Weather: Sunny, high near 85°F; light winds; lake breeze after 19Z.

Ozone: Moderate to USG potential; GA Tech showed ramp-up; NOAA remained conservative.

$PM_{2.5}$ / Smoke: Moderate; smoke concentrations 5–20 µg/m³ possible; clearing later in day.

AQAD: Issued for ozone in Northwest Indiana.

July 25 (Tuesday)

Weather: Sunny, high near 89°F; south winds; strong lake breeze expected.

Ozone: USG risk continued; GA Tech forecasted widespread elevated ozone; NOAA model likely underestimating.

$PM_{2.5}$ / Smoke: Smoke impacts diminishing; AQI trending Moderate.

Smoke Discussion

Source: Canadian wildfire smoke transported into Indiana intermittently.

Impact:

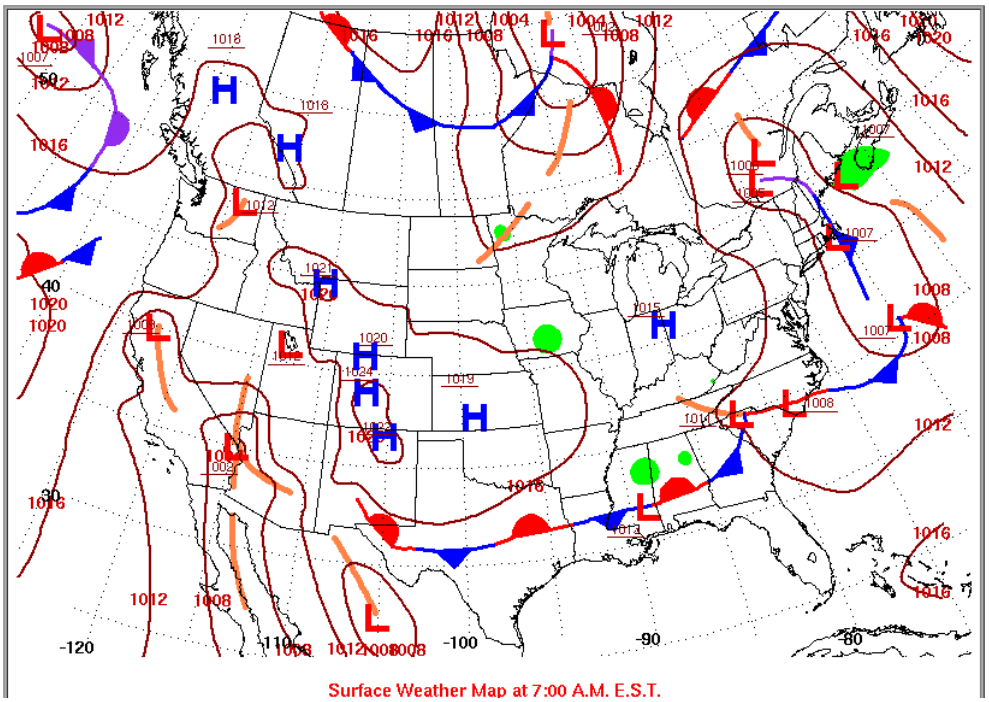
July 22: Minimal smoke intrusion.

July 23–24: Surface smoke impacts increased; concentrations up to 20 µg/m³ before clearing late July 25. **USG ozone on July 23 and 25th**

Model Performance: FireWork and HRRR captured plume timing; NOAA BC overestimated $PM_{2.5}$ AQI early but corrected later.

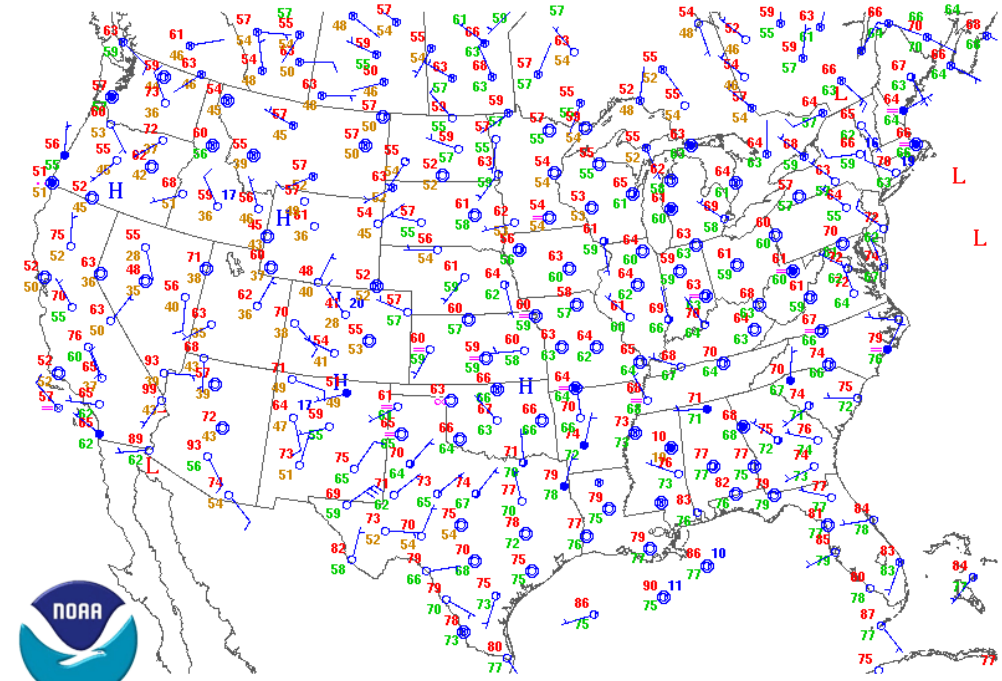
Surface, 850 and 500 mb plots from 12Z on July 22, 2023

SATURDAY JULY 22, 2023



Surface Weather Map at 7:00 A.M. E.S.T.

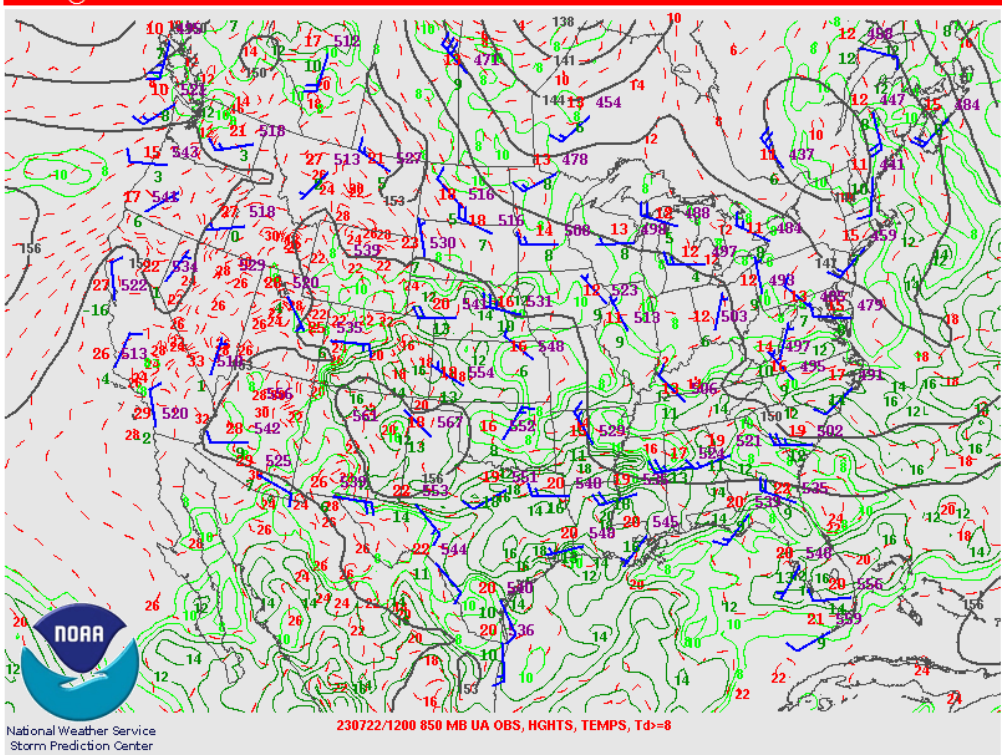
sfc @230722/1200



National Weather Service
Storm Prediction Center

230722/1200 Surface OA Pressure and Obs
Weather, Temp, Dwpt, Gusts

850mb @230722/1200



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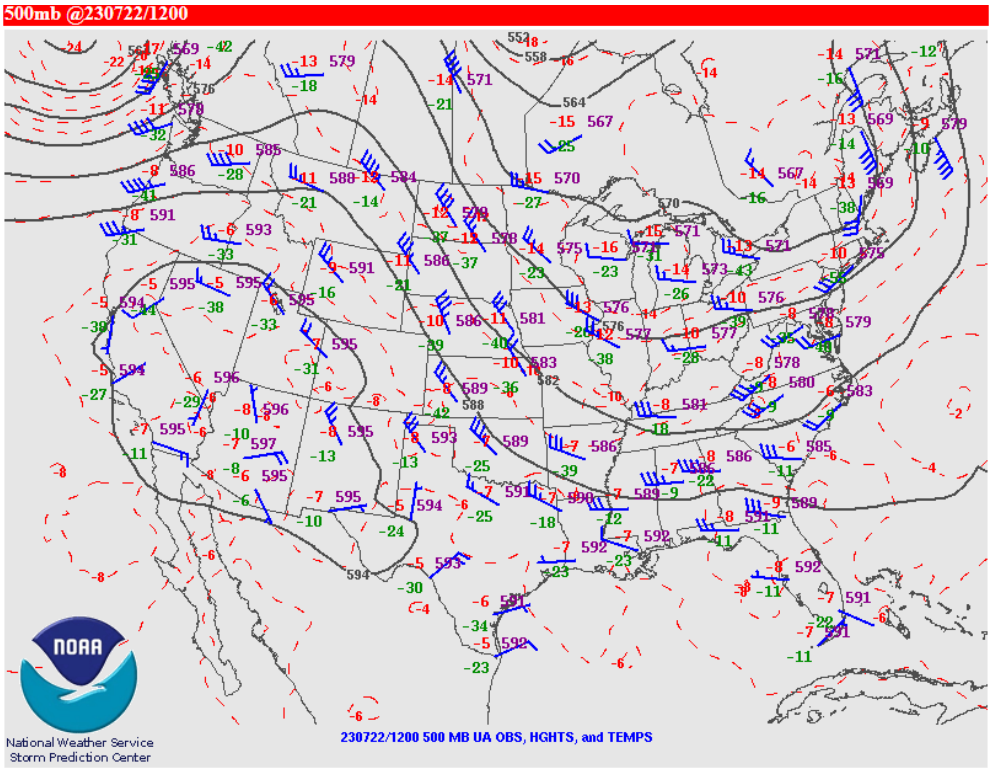
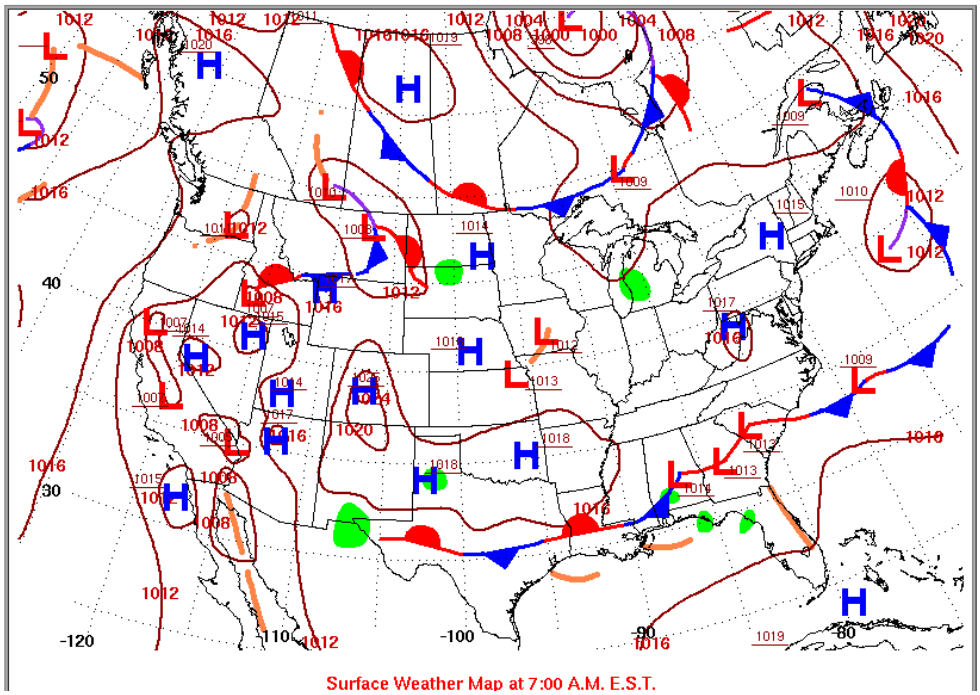
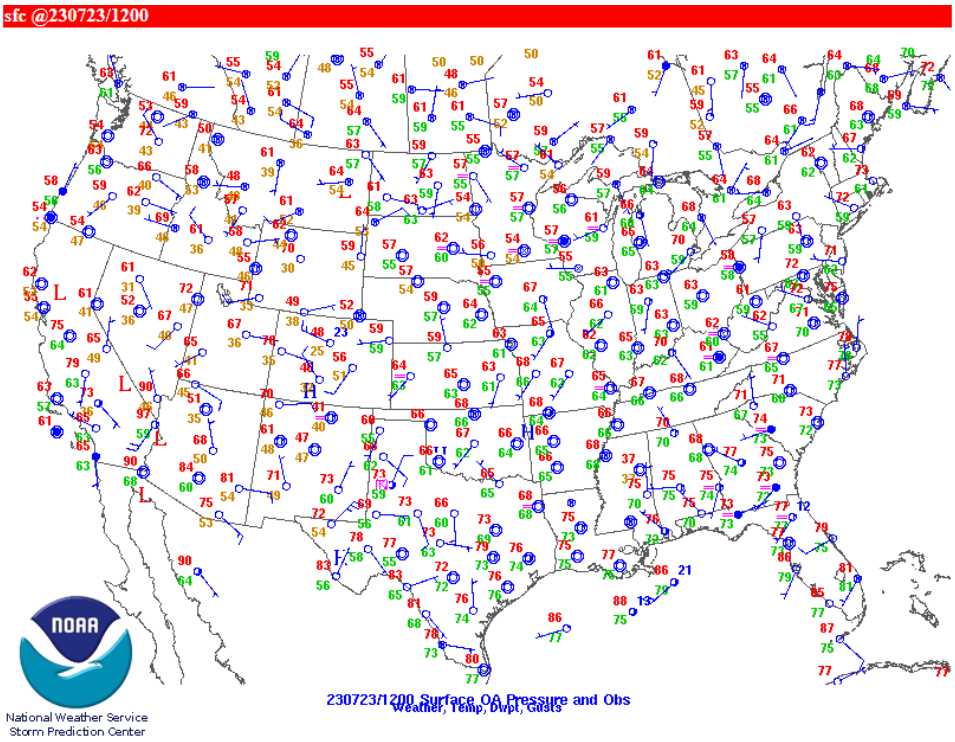


Surface, 850 and 500 mb plots from 12Z on July 23, 2023

SUNDAY JULY 23, 2023



Surface Weather Map at 7:00 A.M. E.S.T.



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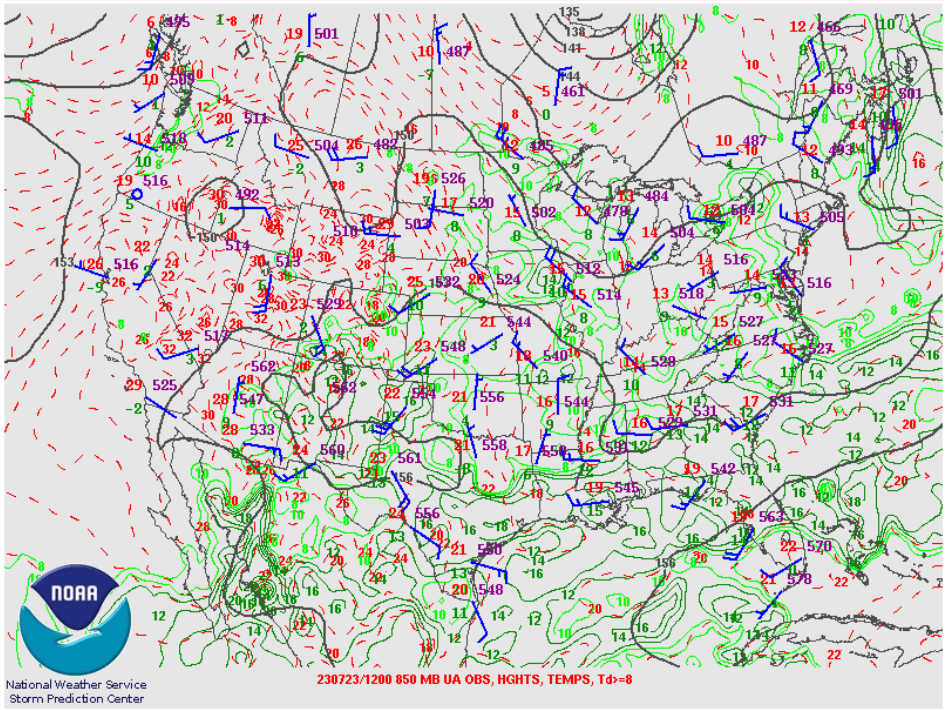

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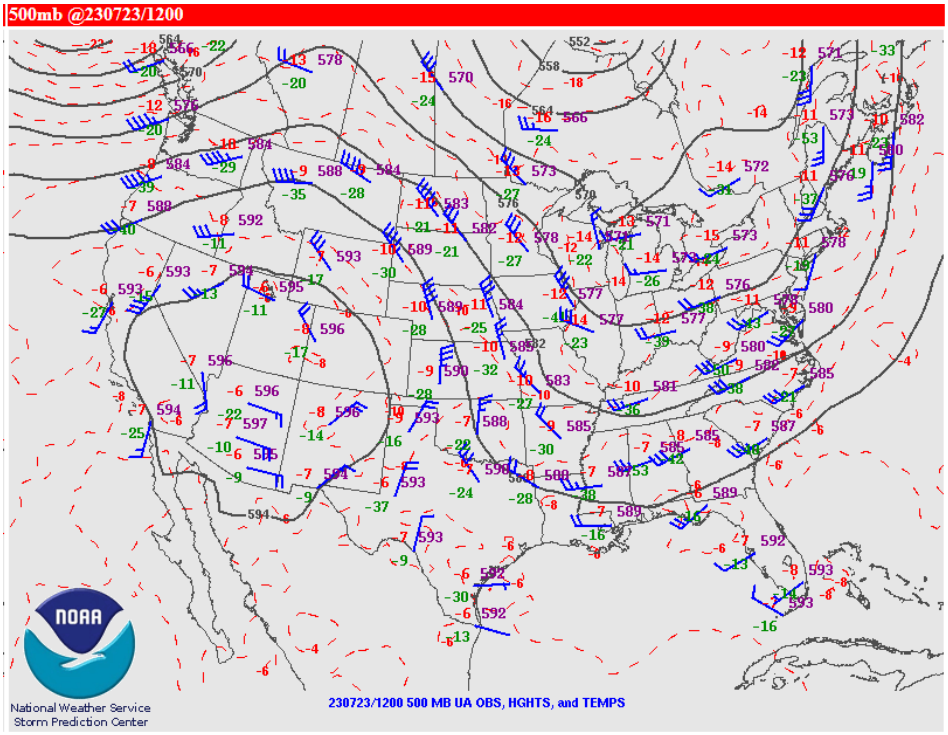
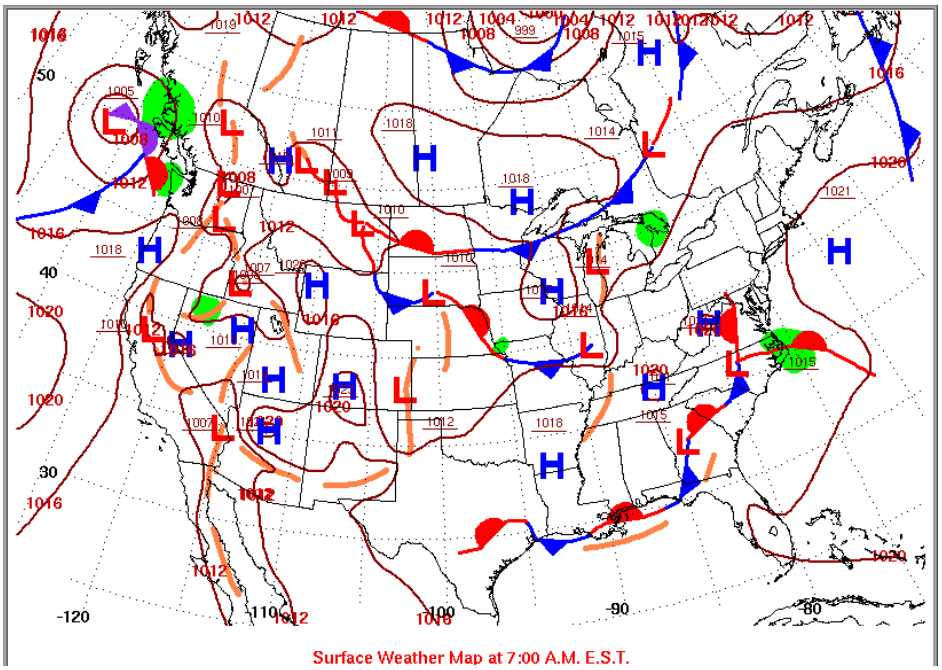
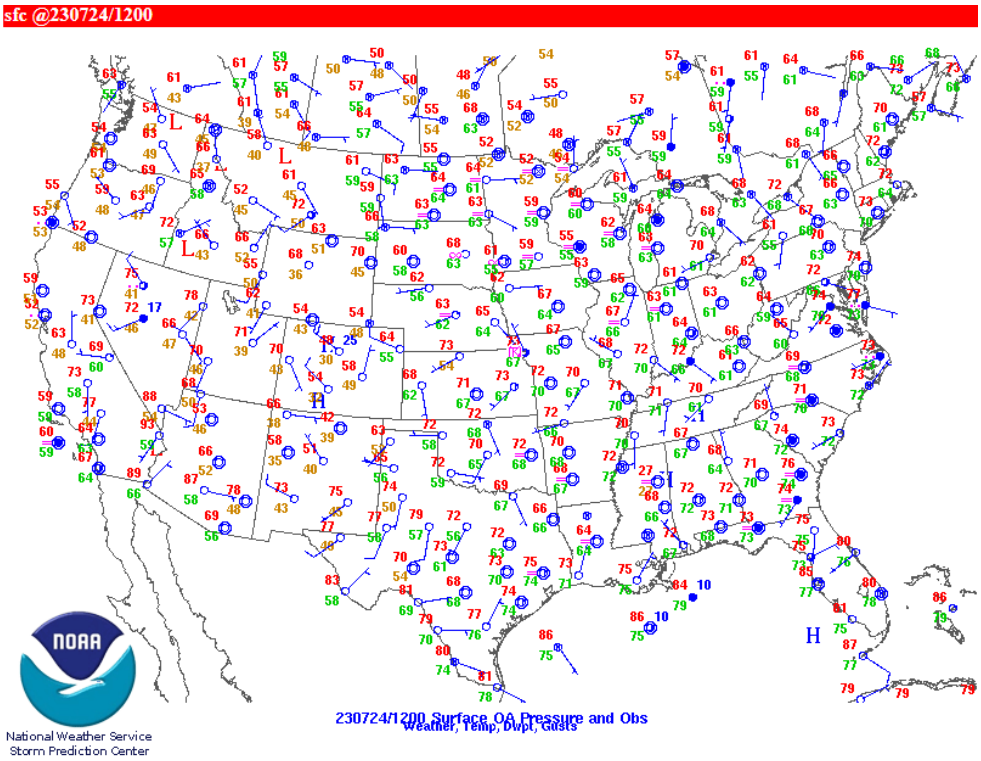


Surface, 850 and 500 mb plots from 12Z on July 24, 2023





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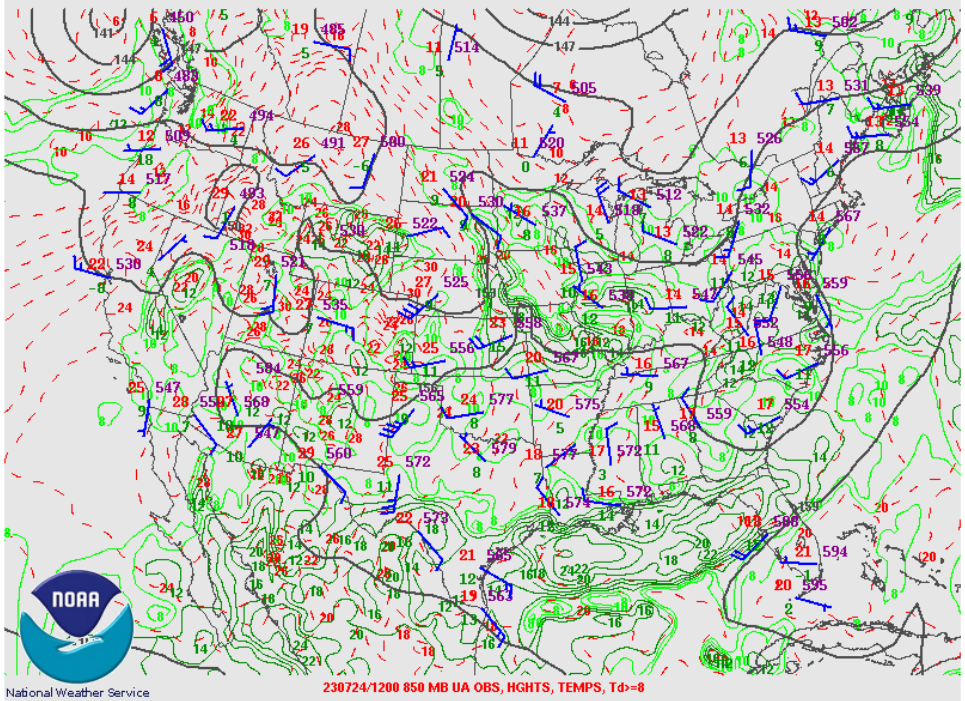

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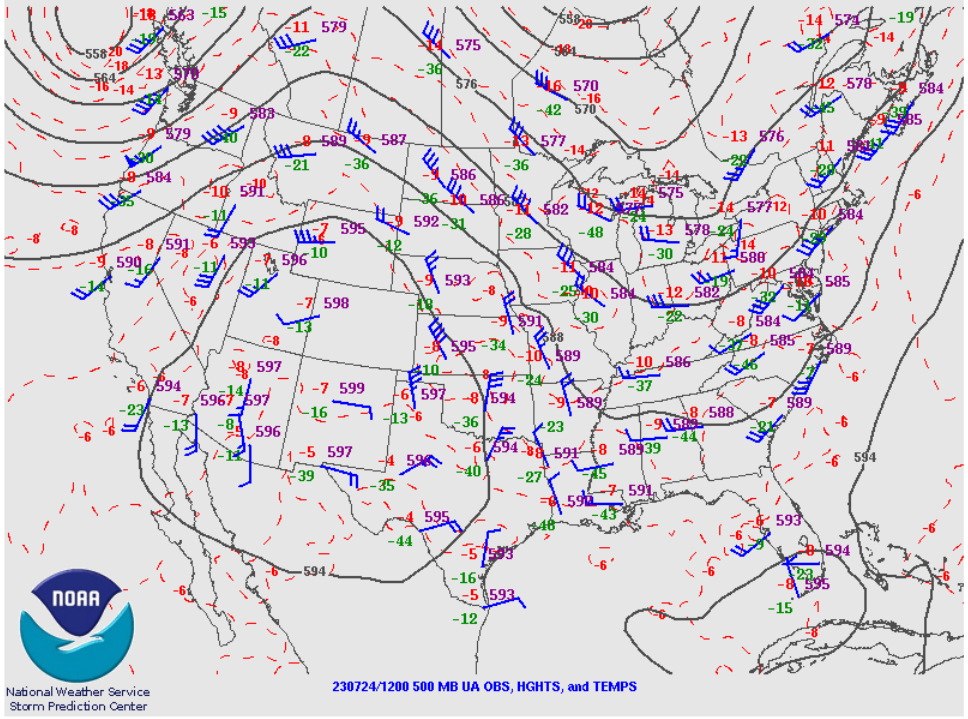
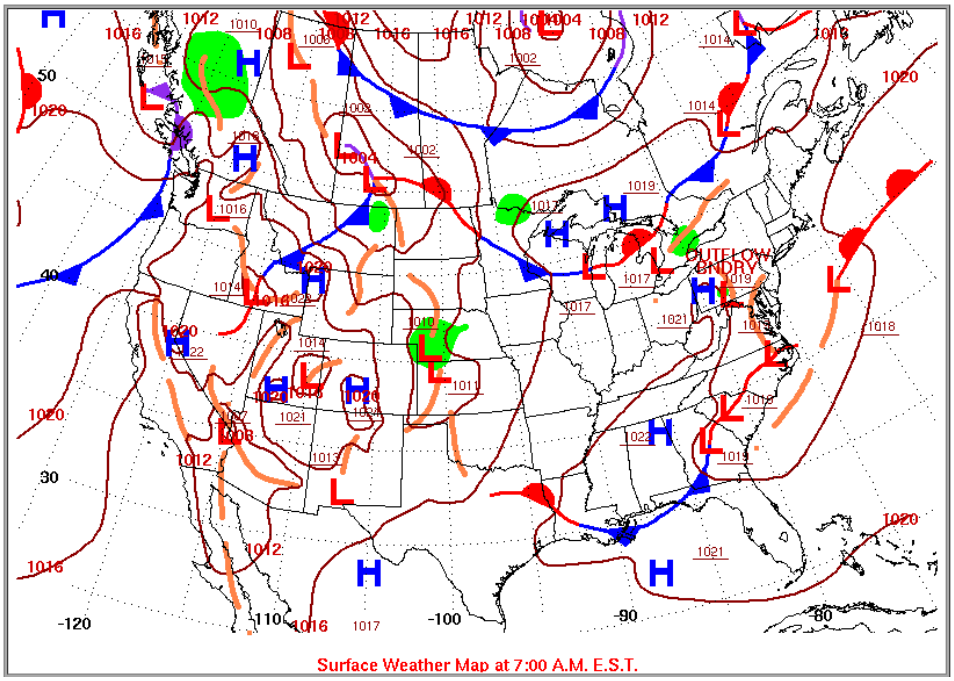
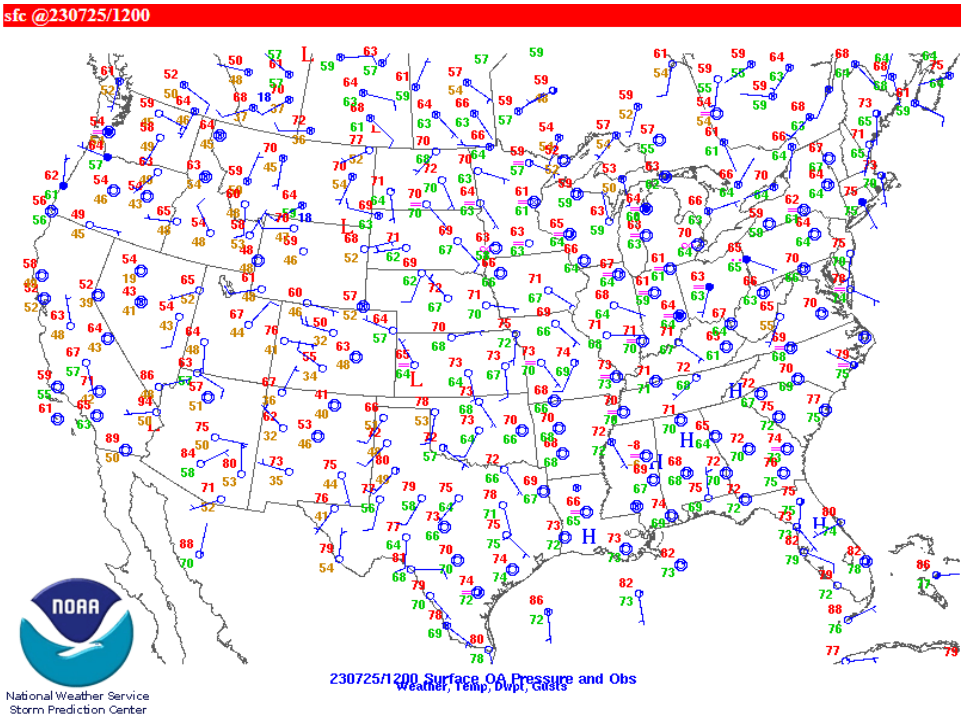


Surface, 850 and 500 mb plots from 12Z on July 25, 2023

TUESDAY JULY 25, 2023





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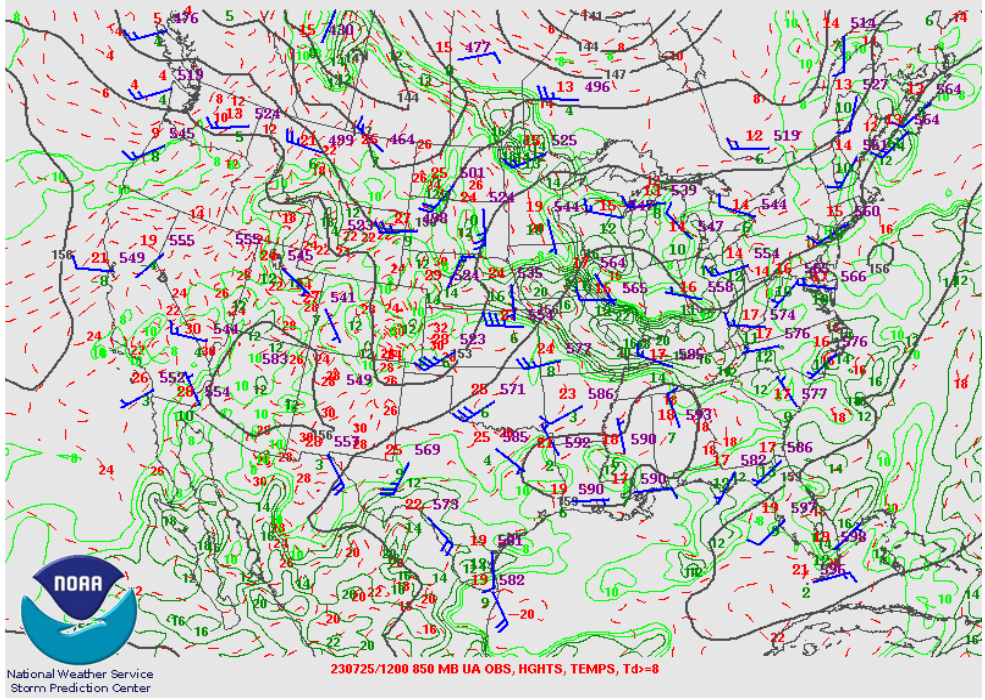

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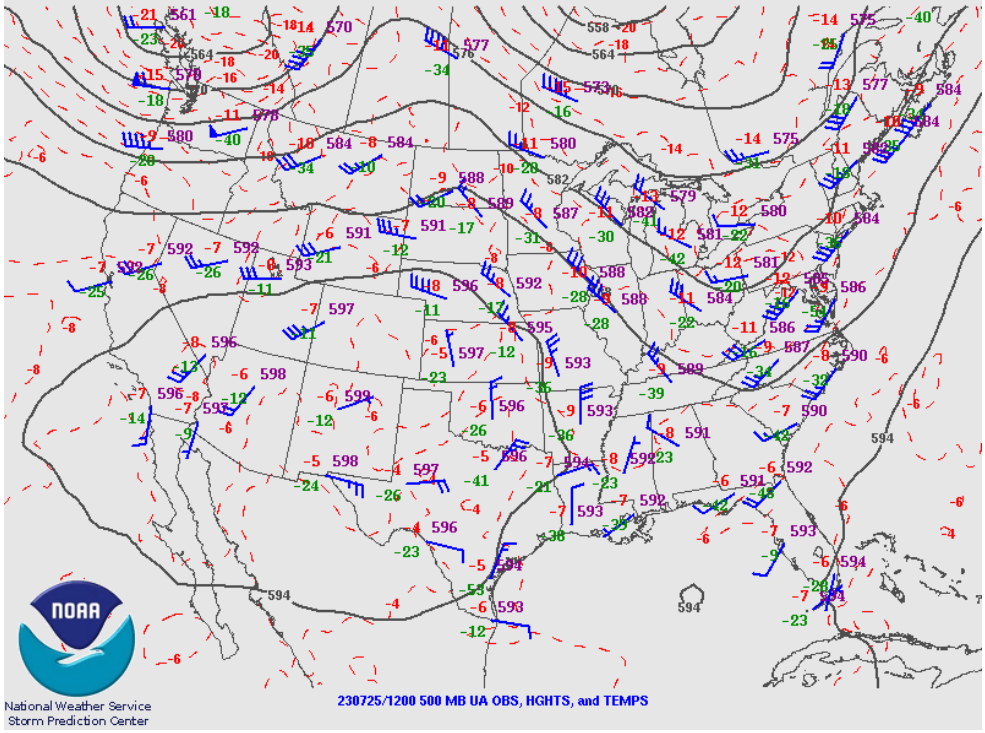


Air Quality Forecast Verification Report

Episode Overview

Episode Dates: August 2–3, 2023

Region: Northwest Indiana

Pollutants: Ozone (O_3) and Fine Particulate Matter ($PM_{2.5}$)

Overview

This short-duration episode occurred under a stagnant upper-level pattern with northwesterly flow aloft and weak surface features, creating conditions favorable for ozone buildup and intermittent smoke impacts. Ozone escalated from Moderate on August 2 to USG on August 3, while $PM_{2.5}$ remained Moderate to Good, with localized increases due to wildfire smoke transport.

Meteorological Synopsis

Pattern:

Upper-level ridge stalled over the Central Plains; Indiana remained under northwesterly flow aloft.

Surface high pressure over the northeastern U.S. provided light winds and stable conditions.

Cold front sagged south into northern Illinois late August 3, followed by a secondary front on August 4 bringing northerly flow and cooler air.

Surface Conditions:

August 2: High near 83°F; east winds shifting south; RH >50%; dew point near 68°F.

August 3: High near 82°F; north-northeast winds 5–15 mph; gusts near 20 mph late; dew points falling with frontal passage.

Upper-Air:

850 mb temps: ~15°C both days; typical for mid-summer but supportive of ozone chemistry under sunny skies.

Prior Air Quality

July 31: Ozone Good; $PM_{2.5}$ Good/Moderate.

August 1: Ozone Good; $PM_{2.5}$ Good.

August 2: Ozone Moderate; $PM_{2.5}$ Moderate/Good.

August 3: Ozone USG; $PM_{2.5}$ Moderate/Good.

4. Day-by-Day Conditions

August 2 (Wednesday)

Weather: Partly sunny; highs low 80s°F; light east winds becoming south; RH >50%.

Ozone: Moderate observed; GA Tech and NOAA models indicated potential for elevated ozone near Lake Michigan.

$PM_{2.5}$ / Smoke: Moderate to Good; RAP-SMOKE suggested minor smoke intrusion (5–10 µg/m³) across north-central Indiana.

August 3 (Thursday)

Weather: Mostly sunny; highs low 80s°F; north-northeast winds increasing to 15 mph with gusts near 20 mph late; frontal passage.

Ozone: **USG observed;** GA Tech forecasted USG near southern Lake Michigan; NOAA model underestimated (90 AQI). Lake breeze and stagnant pre-frontal conditions enhanced ozone buildup.

$PM_{2.5}$ / Smoke: Moderate; FireWork model kept main smoke plume north, but RAP-SMOKE indicated localized impacts (5–10 µg/m³).

AQAD: Issued for ozone in Northwest Indiana.

Smoke Discussion

Source: Canadian wildfire smoke remained north of Indiana, but minor plumes reached northern Indiana on August 2–3.

Impact:

Surface concentrations generally low (5–10 µg/m³), but enough to contribute to Moderate $PM_{2.5}$ AQI.

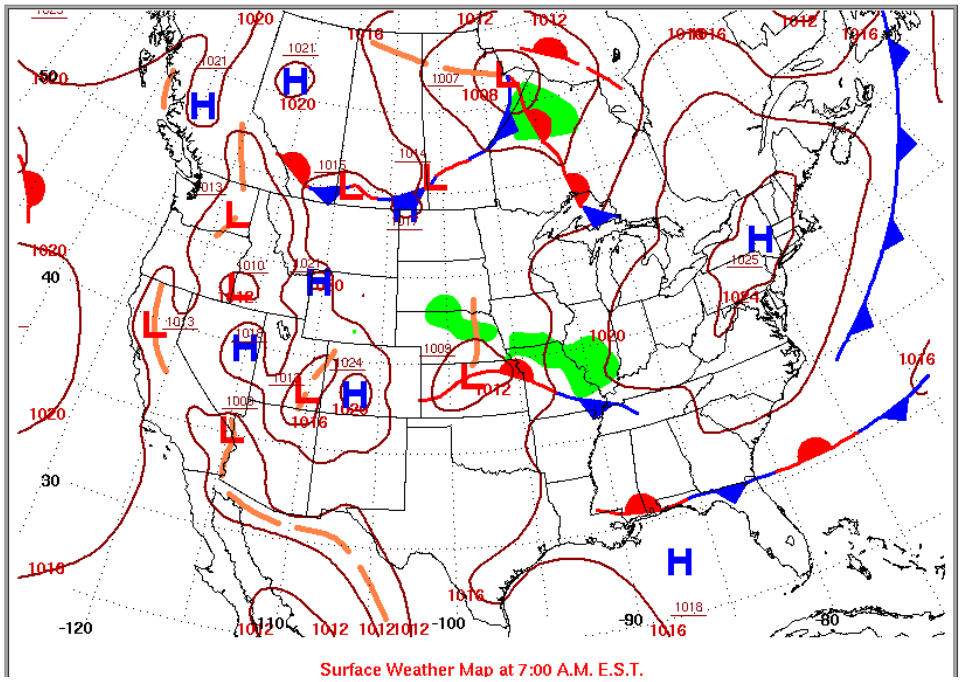
RAP-SMOKE guidance captured timing; FireWork kept heavier smoke north of the region.

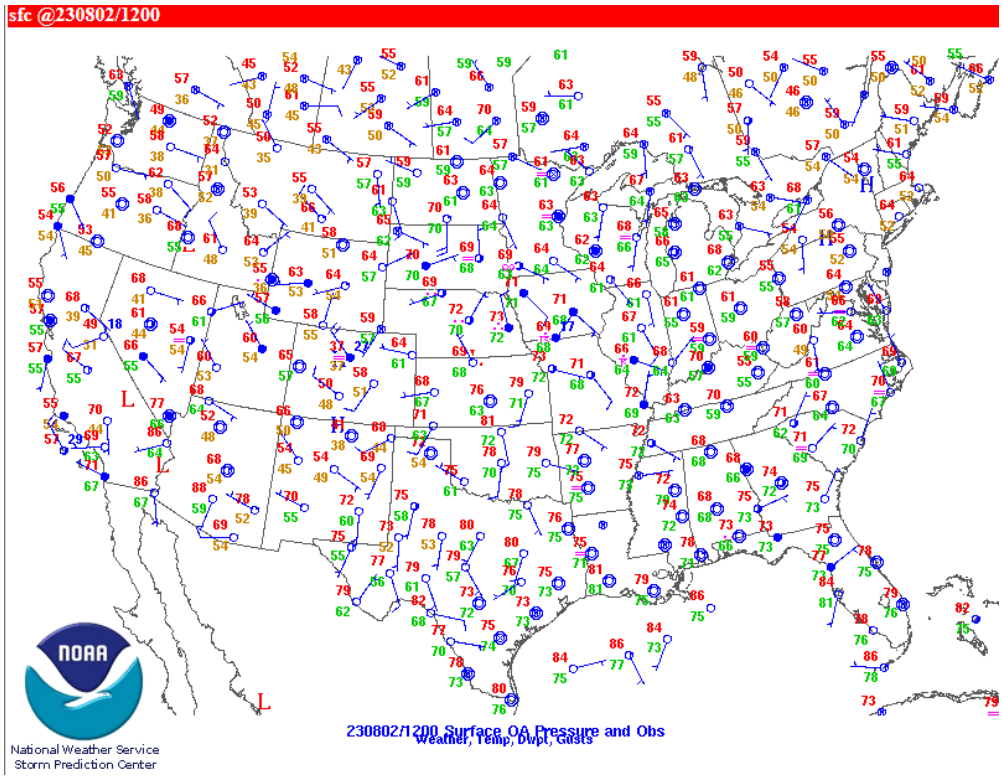
Effect on Chemistry:

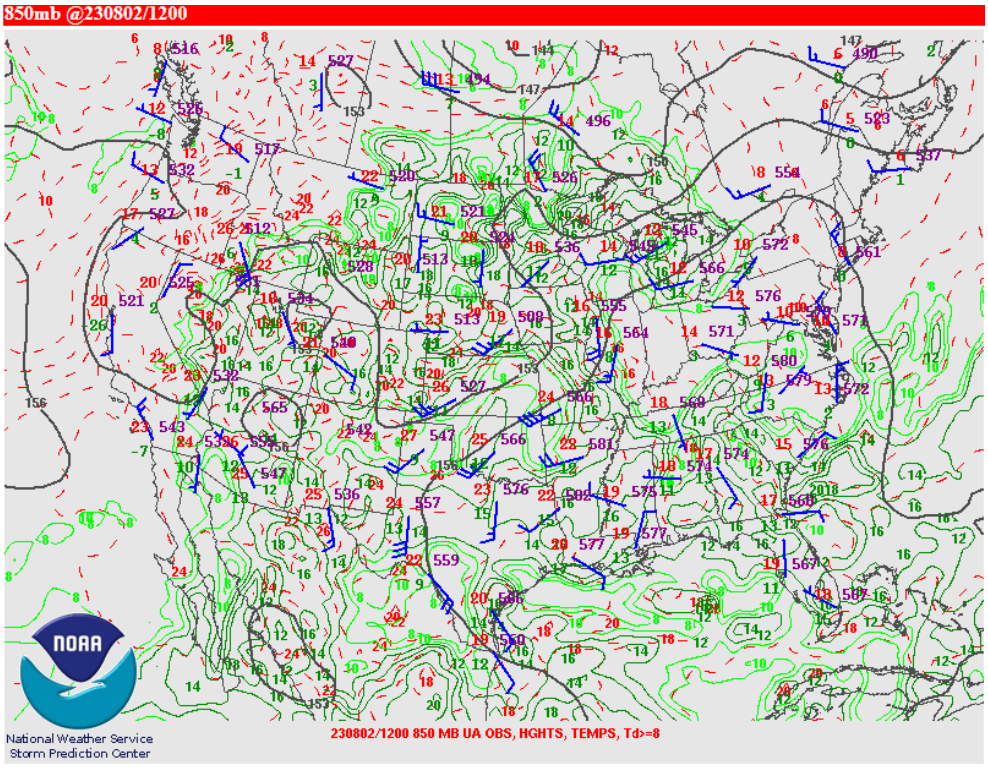
Limited smoke intrusion may have slightly enhanced ozone formation through precursor transport.

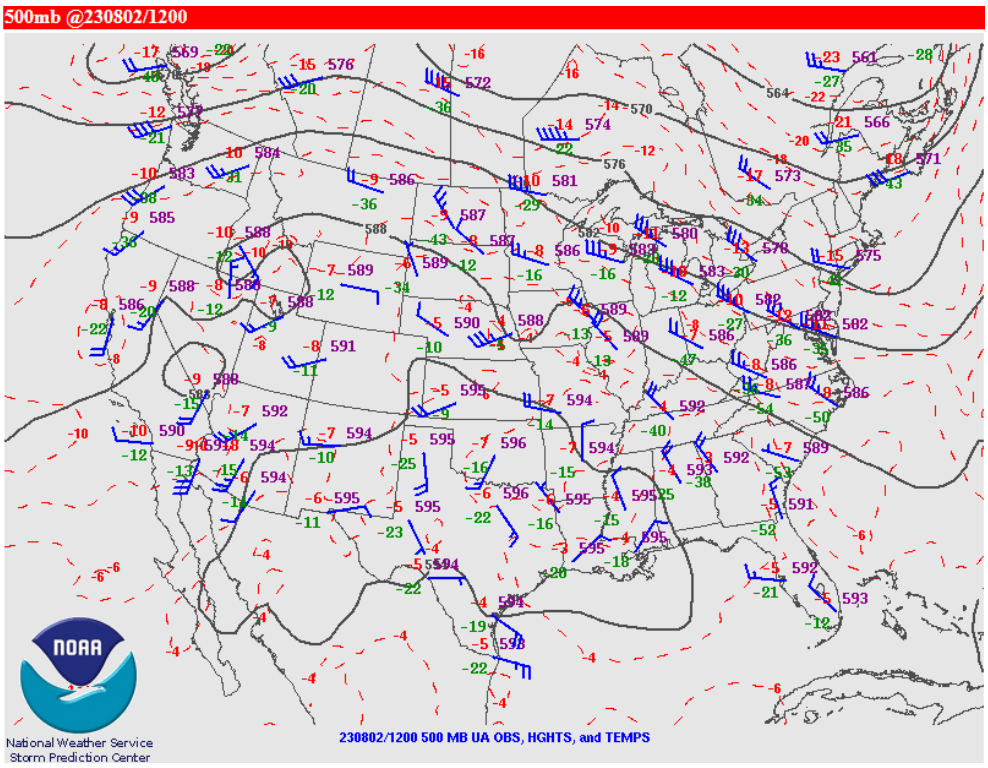
Surface, 850 and 500 mb plots from 12Z on August 2, 2023

WEDNESDAY AUGUST 2, 2023



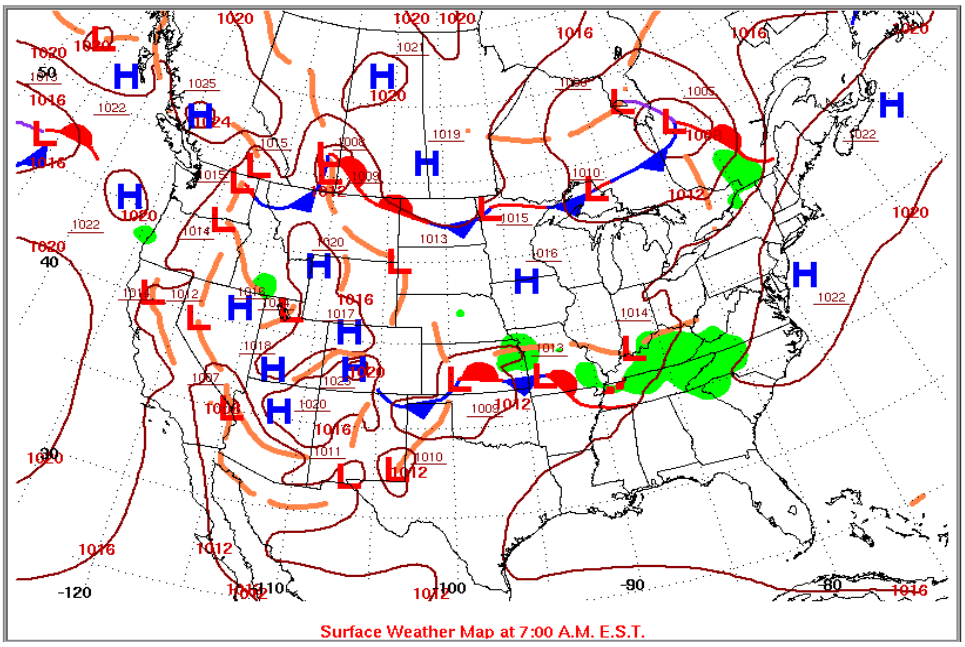






Surface, 850 and 500 mb plots from 12Z on August 3, 2023

THURSDAY AUGUST 3, 2023



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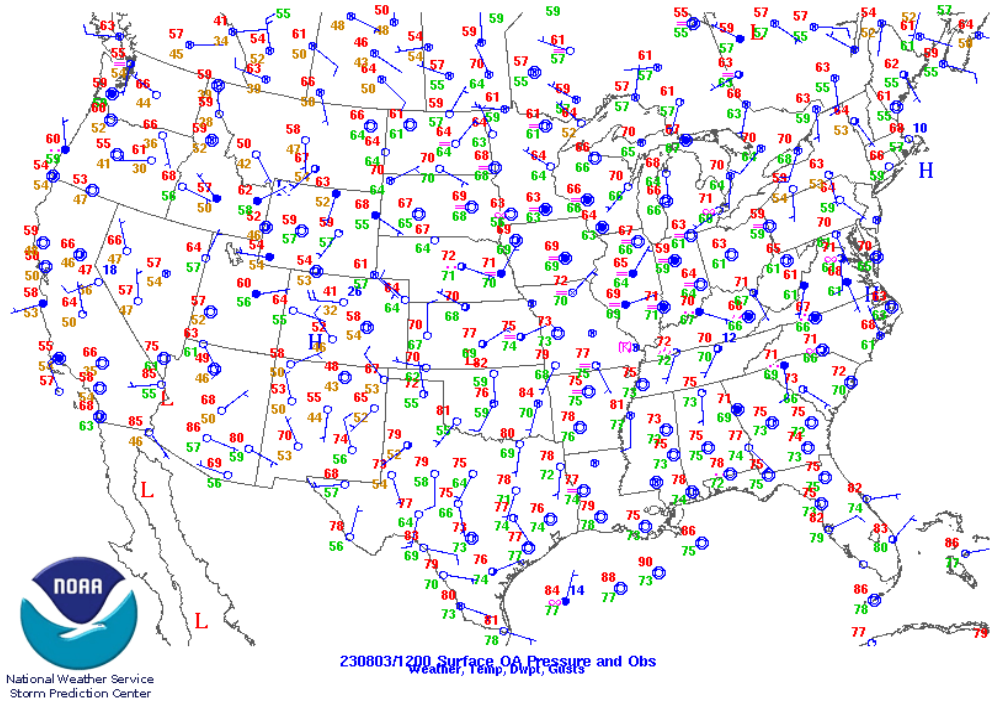
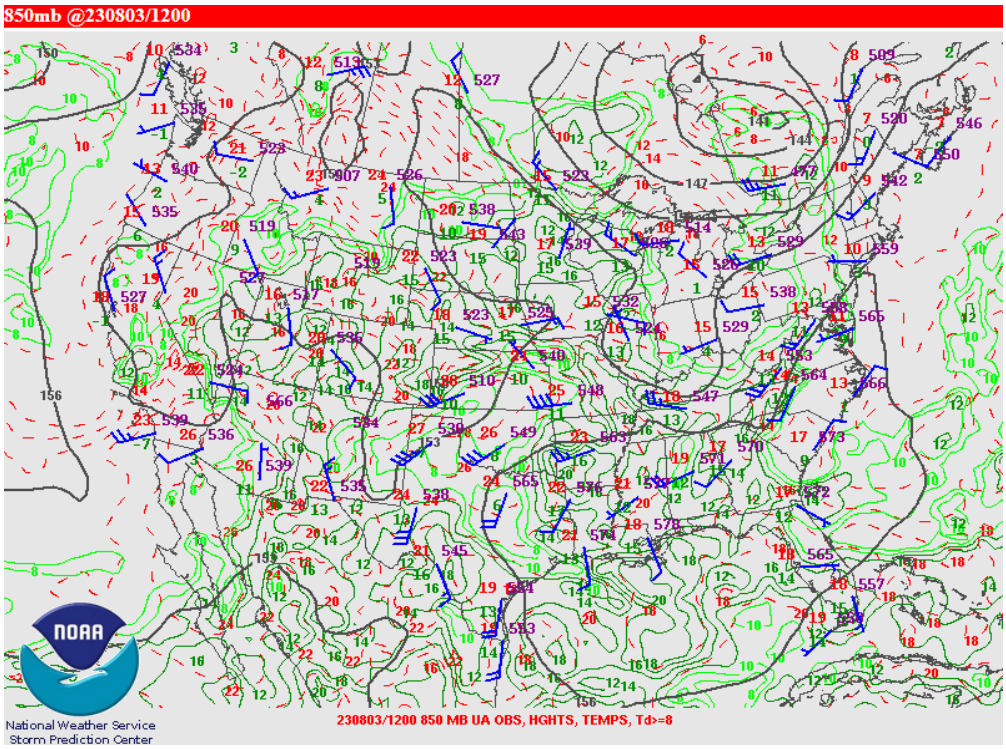
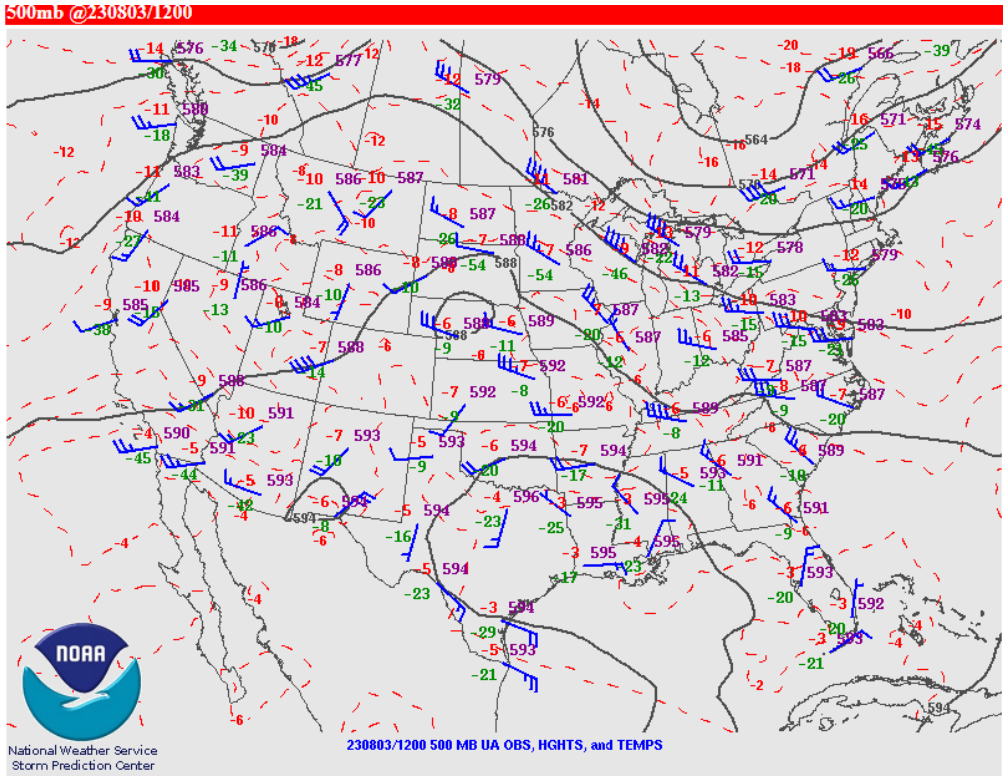



850mb @230803/1200
National Weather Service
Storm Prediction Center
230803/1200 850 MB UA OBS, HGHTS, TEMPS, Td>=8


500mb @230803/1200
National Weather Service
Storm Prediction Center
230803/1200 500 MB UA OBS, HGHTS, and TEMPS

Air Quality Forecast Verification Report

Episode Overview

Episode Dates: June 10–12, 2025

Regions: Statewide overview with focus on Northwest

Pollutants: Ozone (O_3) and Fine Particulate Matter ($PM_{2.5}$)

Prepared from forecasts issued: June 9–12, 2025

Overview

Between June 10 and June 12, 2025, Indiana remained under northwest flow aloft with cool, dry air and recurring elevated Canadian wildfire smoke aloft. The period started with good ozone and moderate $PM_{2.5}$ in the northern forecast region on June 10. As the upper trough drifted east and surface high pressure shifted southeast, sunny skies, warming temperatures, and lower mixing heights promoted ozone build-up, warranting:

AQAD for Ozone on Wednesday, June 11 — Southeast Indiana

AQAD for Ozone on Thursday, June 12 — Central/East Central Indiana

$PM_{2.5}$ remained Moderate at times, supported by light wildfire smoke and relatively light winds, especially into June 12.

Meteorological Synopsis (Statewide)

June 10 (Tuesday)

Aloft: Northwest flow; 500 mb trough axis centered over the Great Lakes/Ohio Valley slowly drifting east.

Thermodynamics: 850 mb temperatures 7–13°C; mixing heights near 6000 ft.

Surface: High pressure dominating; west–southwest winds; dewpoints in the 50s.

Sky/Smoke: Scattered cumulus; elevated wildfire smoke leading to hazier-than-normal skies; highs mid–upper 70s.

June 11 (Wednesday)

Aloft: Continued northwest flow, slight warming as trough departs; ridge strengthening to the west pushes into the region.

Thermodynamics: 850 mb 10–13°C; abundant sunshine; dewpoints 50s.

Surface: High pressure and ridge extension across the Midwest; winds veering southwest (~9 mph).

Sky/Smoke: Elevated smoke persists with vertically integrated smoke near/over 50 mg/m^2; surface smoke 10–20 $\mu g/m^3$ in parts of Indiana.

Temps: Warming trend; highs rising further through midweek.

June 12 (Thursday)

Aloft: Split flow persists; ridge weakens as an upper low approaches from the southwest; northern boundary remains near the IN/MI border, parallel to the jet and slow-moving.

Thermodynamics: 850 mb near 15°C; mid 80s at the surface; dewpoints in the 60s.

Surface: High pressure to the south; stationary boundary to the north; increasing cloud cover ahead of the southern-stream system.

Sky/Smoke: Near-surface smoke ~20 $\mu g/m^3$ recurring; lingering elevated smoke trapped beneath weak gradients and stable overnights.

Ozone

June 10:

Meteorology: Mid 70s, clear skies, dewpoints ~50°F, 850 mb near 10°C, mixing heights ~6000 ft; winds west.

Model Guidance: Canadian & NOAA 06Z BC: Moderate ozone likely tomorrow (Jun 11), Good today.

Observed/Expectation: Good ozone today; build-up expected next day with warming and sunshine.

June 11:

Meteorology: Highs mid–upper 80s; southwest winds; 850 mb >15°C; mixing heights ~4000 ft (lower).

Model Guidance: NOAA 06Z BC Moderate (some USG over the lake); Canadian slightly higher.

Decision: With clear skies, warming, and smoke precursors, Moderate ozone likely (USG risk near Lake Michigan not directly impacting inland due to SW flow).

AQAD Issuance: Ozone AQAD for Southeast Indiana (regional sensitivity and synoptics supportive).

June 12:

Meteorology: Slightly cooler northwest portions; mostly cloudy, dewpoints 60s; 850 mb ~15°C; mixing heights ~5000 ft.

Model Guidance: NOAA & Canadian Moderate ozone; continued smoke influence.

Decision: Moderate ozone likely across northern regions; AQAD for Ozone issued for Central/East Central Indiana.

$PM_{2.5}$ (Fine Particulate)

June 10:

Winds: West, >10 mph; gusts near 20 mph; mostly clear.

Models: NOAA 06Z BC Moderate $PM_{2.5}$; Canadian slightly lower. HRRR smoke higher than both.

Decision: Moderate $PM_{2.5}$ possible, driven by continued light wildfire smoke.

June 11:

Winds: Southwest, >15 mph; gusts >20 mph; sunny.

Models: NOAA/Canadian Moderate $PM_{2.5}$; persistent light smoke aloft; HRRR showing 10–20 µg/m³ near-surface impacts.

Decision: Moderate $PM_{2.5}$ remains likely.

June 12:

Winds: Southwest with speeds <10 mph later; mostly cloudy; frontal boundary still north.

Models: NOAA/Canadian Moderate $PM_{2.5}$; lingering smoke trapped by weaker winds and stalled boundary.

Decision: Moderate $PM_{2.5}$ likely; potential localized increases under stable overnight conditions (especially urban valleys).

Day-by-Day Conditions (June 10–12)

June 10 (Tue)

Weather: Clear to mostly sunny; mid 70s; dewpoints ~50°F; WSW winds; mixing heights ~6000 ft.

Ozone: Good (building expected next day).

$PM_{2.5}$ / Smoke: Moderate at times due to light Canadian smoke; HRRR shows 10–20 µg/m³ bands brushing northern Indiana.

June 11 (Wed)

Weather: Mostly sunny; highs mid–upper 80s; SW winds; 850 mb >15°C; mixing heights ~4000 ft.

Ozone: Moderate likely in NW/NC/NE; AQAD for Ozone — Southeast Indiana. USG over lake not expected to translate inland with SW flow.

$PM_{2.5}$ / Smoke: Moderate; light-to-moderate smoke aloft with near-surface 10–20 µg/m³ in parts of the state.

June 12 (Thursday)

Weather: Increasing clouds; highs mid 80s (cooler NW); dewpoints 60s; 850 mb ~15°C; boundary stalled north.

Ozone: Moderate likely; AQAD for Ozone — Central/East Central Indiana.

$PM_{2.5}$ / Smoke: Moderate continues; smoke lingering due to weaker winds and persistent boundary.

During the Period:

June 10–11: Elevated smoke aloft (vertically integrated ~50 mg/m^2) with near-surface bands of 10–20 µg/m³ impacting parts of Indiana, particularly in the northern half and around the periphery of surface high pressure. **USG Ozone on the 11th and 12th in IN/IL.**

June 12: Light to moderate smoke persisted statewide; stalled boundaries near the northern border and relatively light winds aided trapping and mix-down during overnight stable periods (e.g., in Indianapolis).

Model Notes: HRRR-NCEP consistently showed higher near-surface smoke than Canadian/NOAA smoke guidance; Canadian model slightly underpredicted $PM_{2.5}$ compared to observations. NOAA 06Z BC $PM_{2.5}$ guidance matched recent measurements more closely.

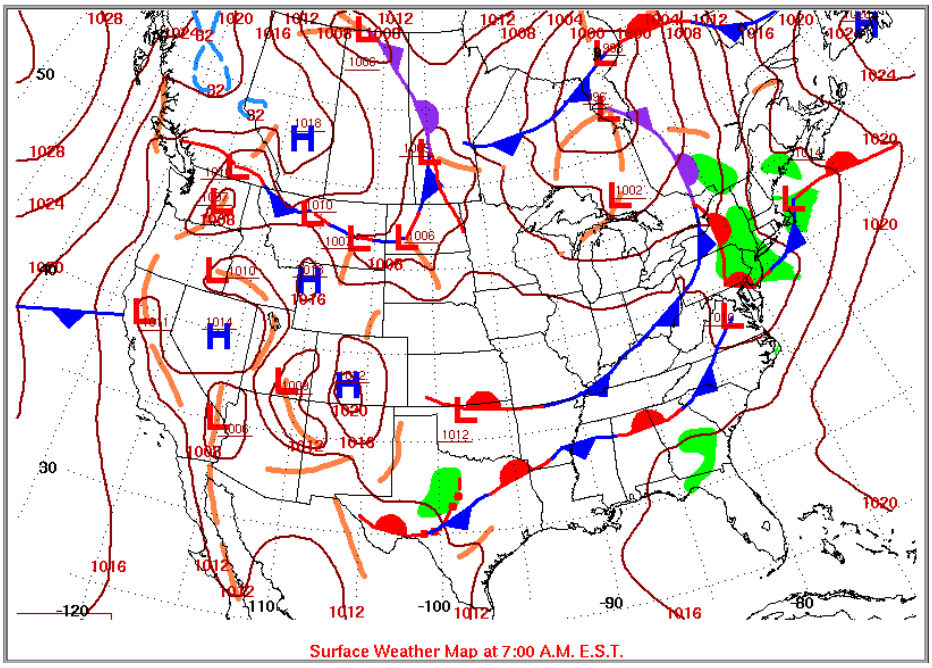
Effect on Chemistry: Smoke precursors (NOx/VOCs) and light extinction can have opposing effects; however, under clear to mostly sunny conditions with warm advection and lower mixing heights, the net effect during June 11–12 favored ozone buildup while sustaining Moderate $PM_{2.5}$.

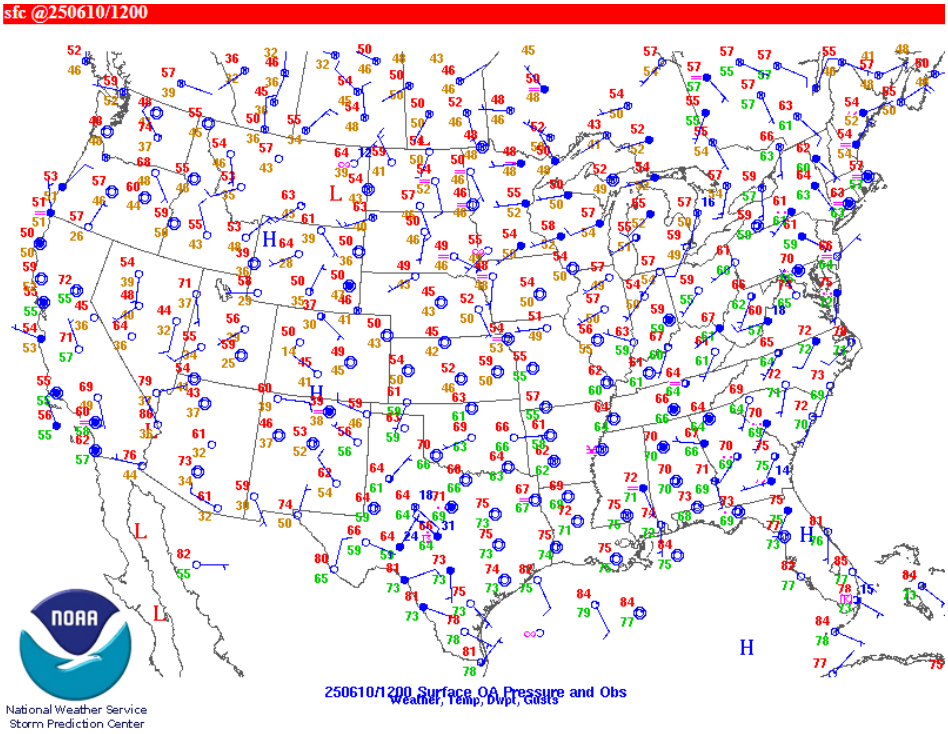
$PM_{2.5}$: Moderate throughout much of the episode, supported by light-to-moderate smoke and intermittent light winds, especially on June 12.

Smoke: Recurring elevated smoke with near-surface bands (10–20 µg/m³) contributed to haze and sustained $PM_{2.5}$.

Surface, 850 and 500 mb plots from 12Z on June 10, 2025

TUESDAY JUNE 10, 2025





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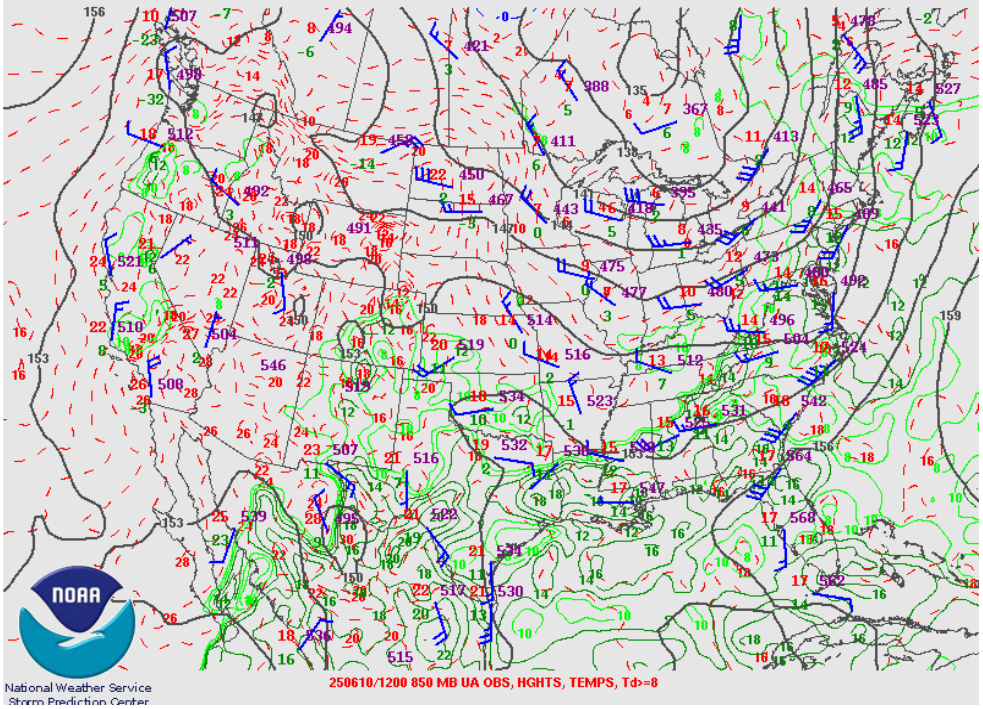

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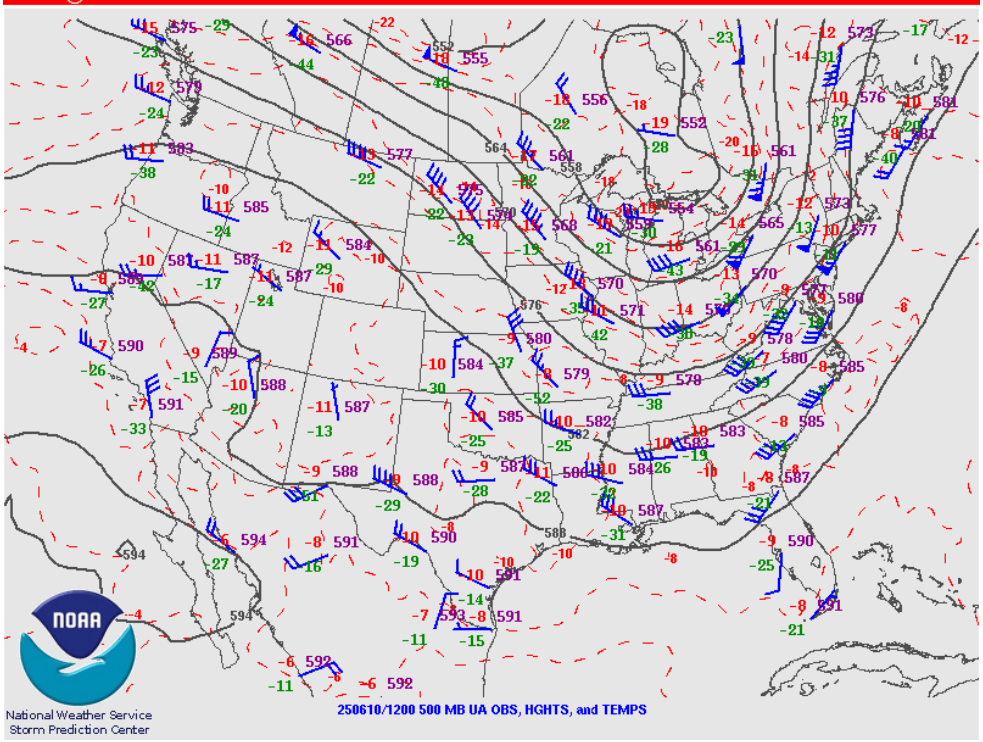
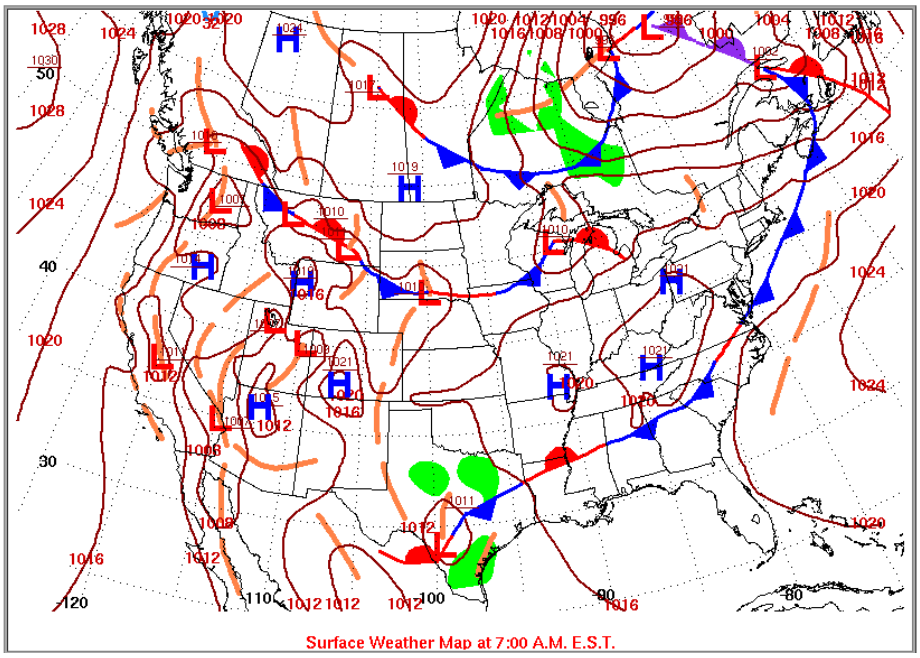
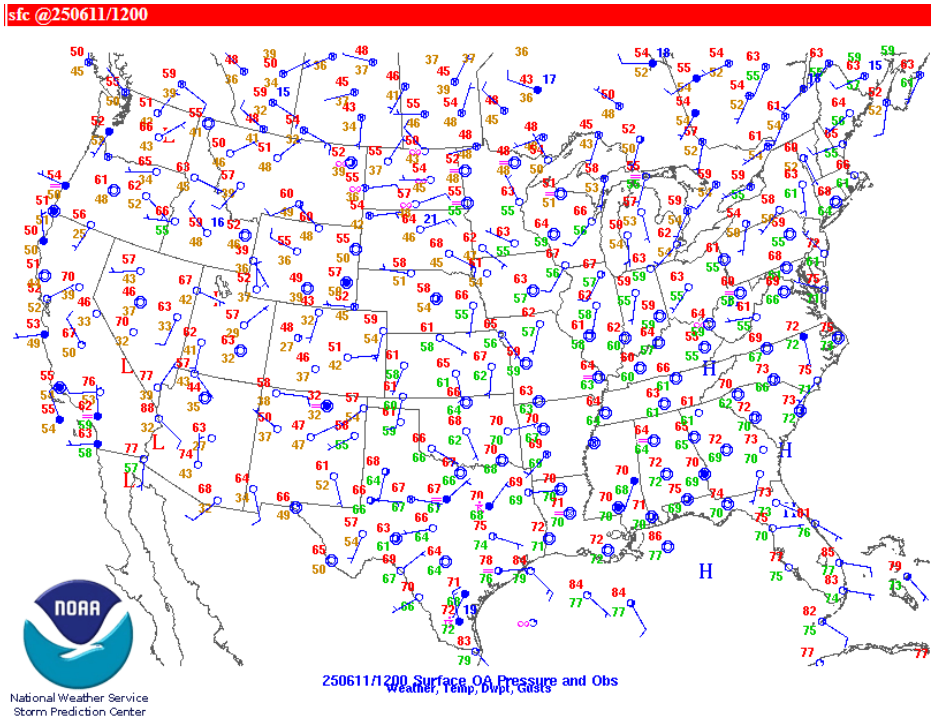


Surface, 850 and 500 mb plots from 12Z on June 11, 2025

WEDNESDAY JUNE 11, 2025





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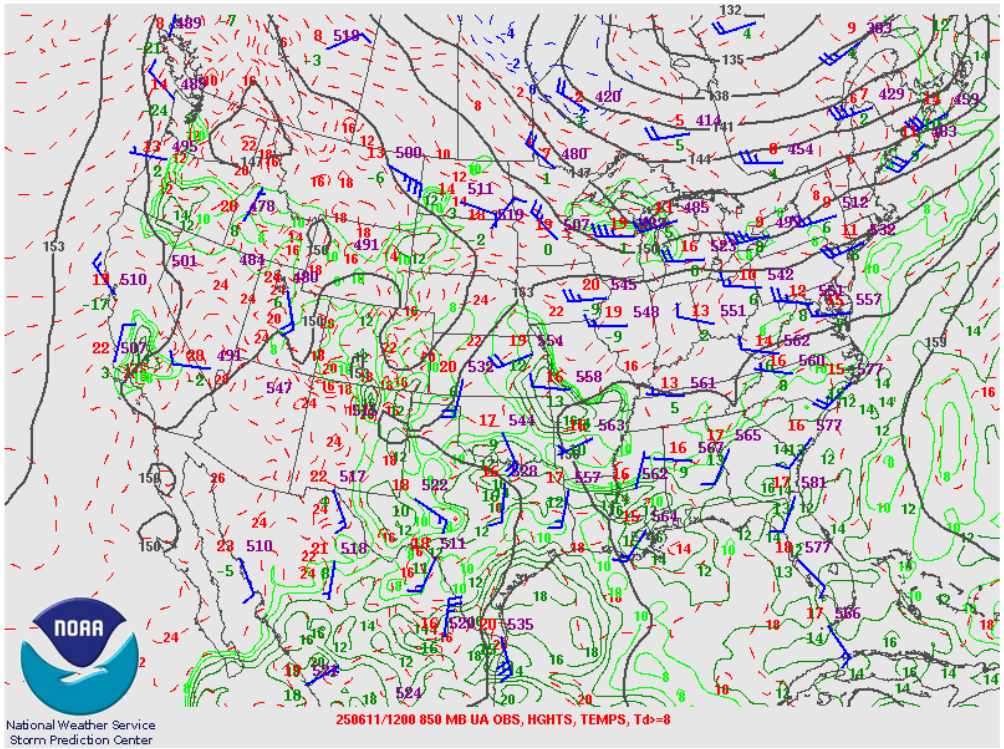

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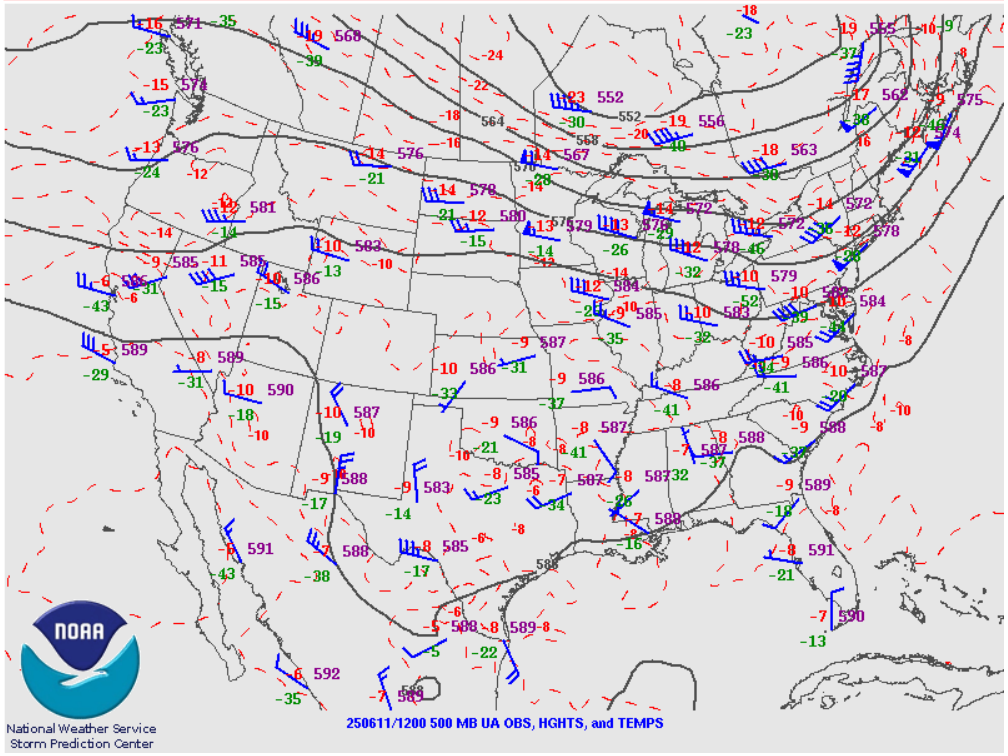
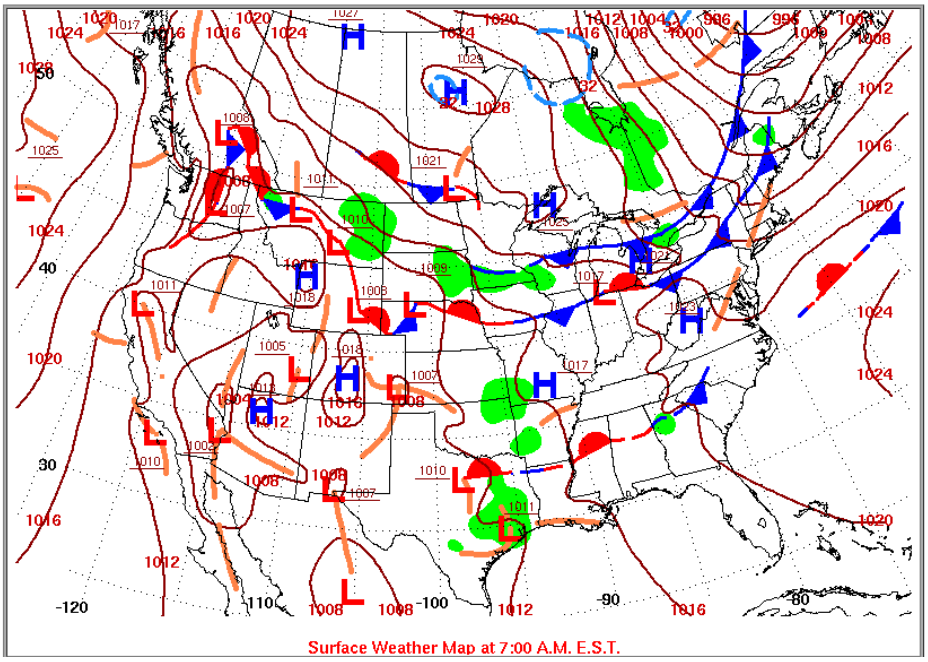


Surface, 850 and 500 mb plots from 12Z on June 12, 2025

THURSDAY JUNE 12, 2025



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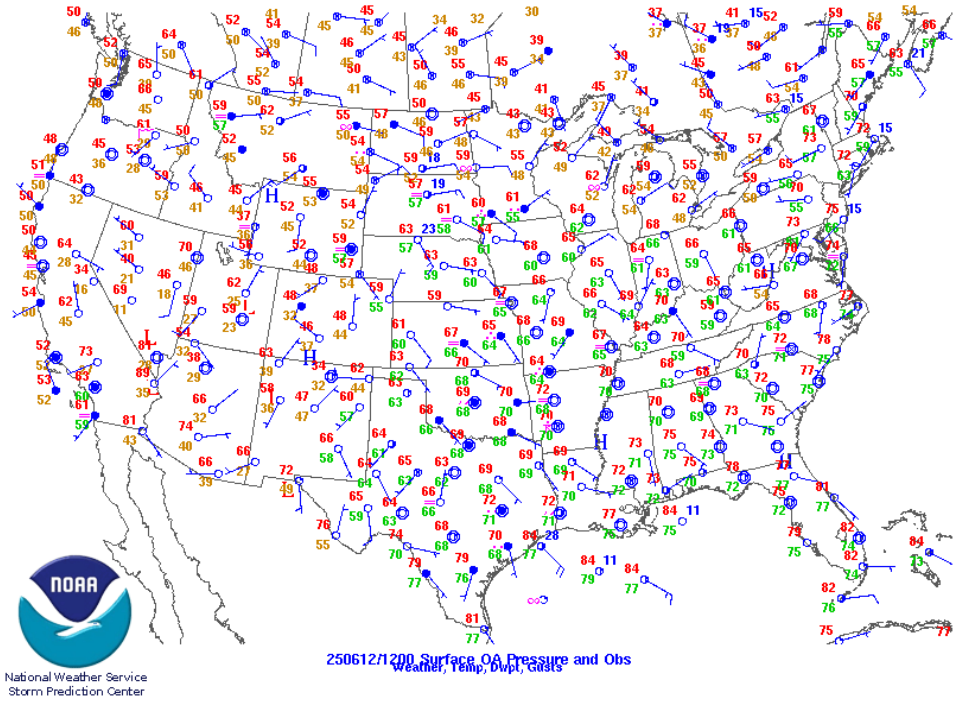

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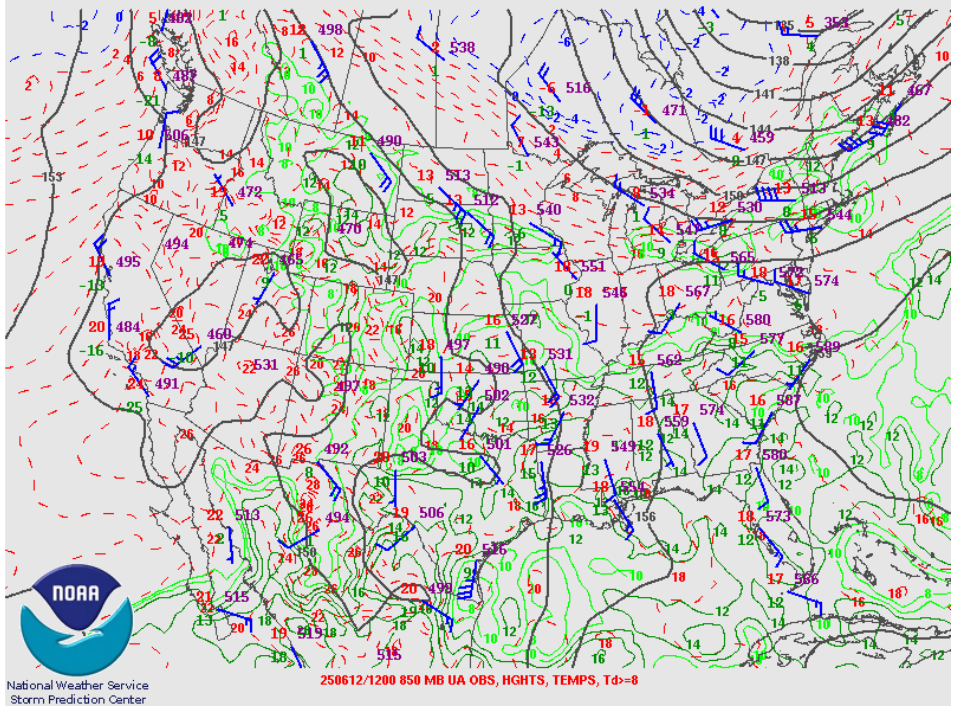

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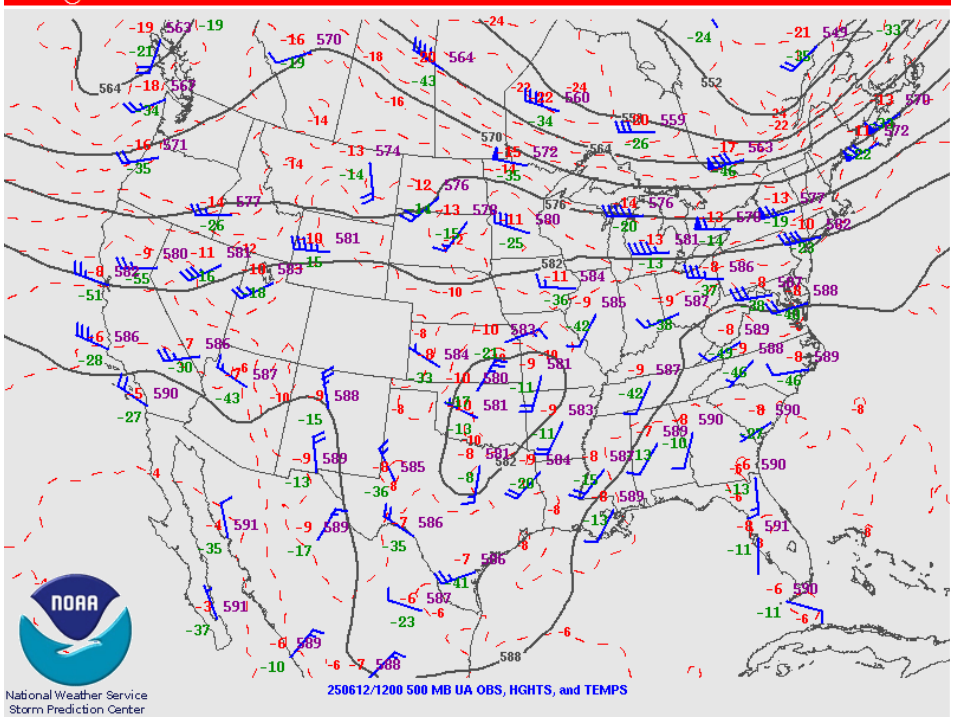


Air Quality Forecast Verification Report

Episode Overview

Episode Dates: July 1–2, 2025

Region: Northwest

Pollutants: Ozone (O_3) and Fine Particulate Matter ($PM_{2.5}$)

Prepared from forecasts issued: July 1–2, 2025

Overview

The period July 1–2, 2025 featured post-frontal moderation under northwest flow aloft, gradual warming, and high pressure building from the west. This setup yielded mostly clear skies, dewpoints in the 60s, and light winds, conditions that supported background-to-moderate ozone potential in Northwest Indiana, while $PM_{2.5}$ buildups remained unlikely outside of isolated, light smoke intrusions.

Ozone: Predominantly Good, with Moderate possible in NW Indiana due to light winds, warming, and lake breeze effects.

$PM_{2.5}$: Mostly Good; models suggested minimal smoke impacts and low risk of accumulation.

Prior Air Quality (Context)

Northwest / North Central / Northeast — June 30, 2025

Ozone (highest AQI category): NW Moderate; NC Good; NE Good

$PM_{2.5}$ (highest AQI category): Good across all three regions

Meteorological Synopsis (Statewide)

July 1 (Tuesday)

Aloft/Pattern: An upper-level trough shifted east along the U.S.–Canadian border; cold front moved south of the Ohio River.

Surface: High pressure building from the west; partial clearing statewide; northwest surface flow.

Thermodynamics: 850 mb temperatures ~15°C north / 17°C south under continued northwest flow; dewpoints falling via modest cold advection.

Sky/Temps: Partly cloudy north; more cloud cover south near the boundary; highs low 80s (north) to mid–upper 80s (south).

Smoke: HRRR-NCEP indicated minor visibility impacts (surface 1–4 µg/m³) with slightly higher aloft; Canadian smoke model hinted at 20–30 µg/m³ over parts of NW Indiana tomorrow but noted high bias in recent runs.

July 2 (Wednesday)

Aloft/Pattern: Surface high centered over Missouri; weak west–northwest flow; developing 500 mb ridge to the west with a weak trough over the Great Lakes.

Surface: High pressure taking hold; light W–NW winds; dewpoints in the 60s; highs in the 80s.

Shortwave: Subtle disturbance near the northern boundary could increase cloud cover late (very low QPF <0.1").

Smoke: AirNow/HRRR/NOAA guidance showed very light smoke aloft; synoptic pattern kept heaviest smoke well north.

Regional Forecast Decisions (NW/NC/NE Indiana)

Ozone

July 1:

Meteorology: Near 80°F (north), mostly clear by afternoon; dewpoints 60s; 850 mb ~15°C; mixing heights >5000 ft; scattered morning showers possible.

Model Guidance:

NOAA 06Z BC: Good ozone statewide; Moderate over Lake Michigan.

Canadian model: Some Moderate risk today, Good tomorrow; more aligned with recent observations.

Decision: Moderate ozone possible in NW Indiana (light winds + warming + potential lake breeze). Otherwise Good.

July 2:

Meteorology: Mid–upper 80s, mostly clear; dewpoints 60s; 850 mb ~15°C; mixing heights ~6000 ft; winds <10 mph (W–NW).

Model Guidance: NOAA & Canadian both mostly Good ozone.

Decision: Continued Good ozone with low risk of Moderate (localized NW shorelines if lake breeze strengthens).

AQADs: None for northern regions.

$PM_{2.5}$ (Fine Particulate)

Model Guidance:

NOAA 06Z BC: Good $PM_{2.5}$ today/tomorrow.

Canadian $PM_{2.5}$: Good today, slight increase tomorrow.

Smoke: Canadian model shows a line of light smoke late on July 2; NOAA/HRRR show no significant surface impacts.

Decision: $PM_{2.5}$ buildup unlikely.

July 2:

Winds: West, below 10 mph; low chances of isolated showers; scattered cloud cover.

Model Guidance: Good $PM_{2.5}$ both days; HRRR and NOAA no notable smoke impacts (aloft only).

Decision: $PM_{2.5}$ remains Good with minimal smoke-related influence.

Day-by-Day Conditions (July 1–2)

July 1 (Tue)

Weather: Partly cloudy north; moderating temperatures; low 80s (north) to mid–upper 80s (south); dewpoints falling; surface high building; NW winds.

Ozone: Good, with Moderate possible in NW Indiana due to light winds and lake breeze potential.

$PM_{2.5}$ / Smoke: Good; light smoke aloft; minimal surface impact (HRRR 1–4 µg/m³).

July 2 (Wed)

Weather: Mostly clear; mid–upper 80s; light W–NW winds; subtle shortwave may increase clouds late (very low QPF).

Ozone: Mostly Good (NOAA & Canadian aligned); low risk of Moderate in NW shoreline zones.

$PM_{2.5}$ / Smoke: Good; Canadian model's band of smoke late likely overpredicted; NOAA/HRRR show no significant impacts.

Smoke Discussion

Source/Transport: Light Canadian wildfire smoke drifted southward under NW flow, with heavier plumes remaining well north of Indiana during July 1–2.

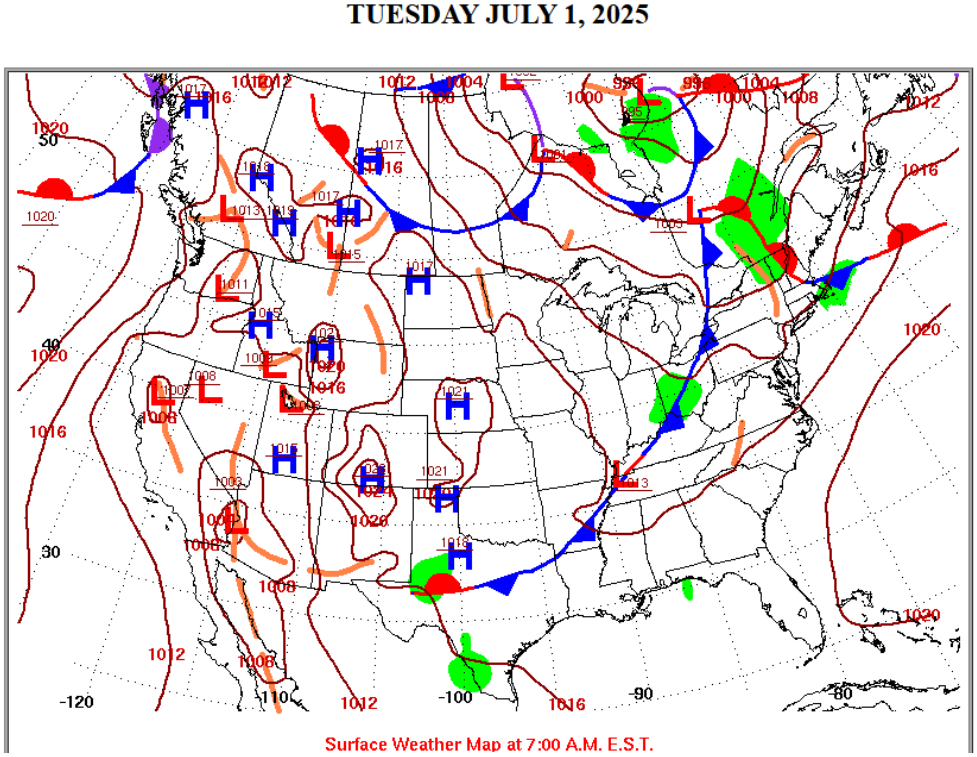
Observed/Modeled:

July 1: HRRR-NCEP indicated minor visibility impacts (surface 1–4 µg/m³) and slightly higher aloft.

July 2: AirNow Fire and Smoke, NOAA Column Integrated Smoke, and HRRR Vertically Integrated Smoke showed very light smoke aloft with limited mixing to the surface**. USG Ozone in IN/IL.**

Canadian $PM_{2.5}$ forecast attempted 20–30 µg/m³ in NW Indiana but noted a recent high bias—not supported by NOAA/HRRR.

Surface, 850 and 500 mb plots from 12Z on July 1, 2025



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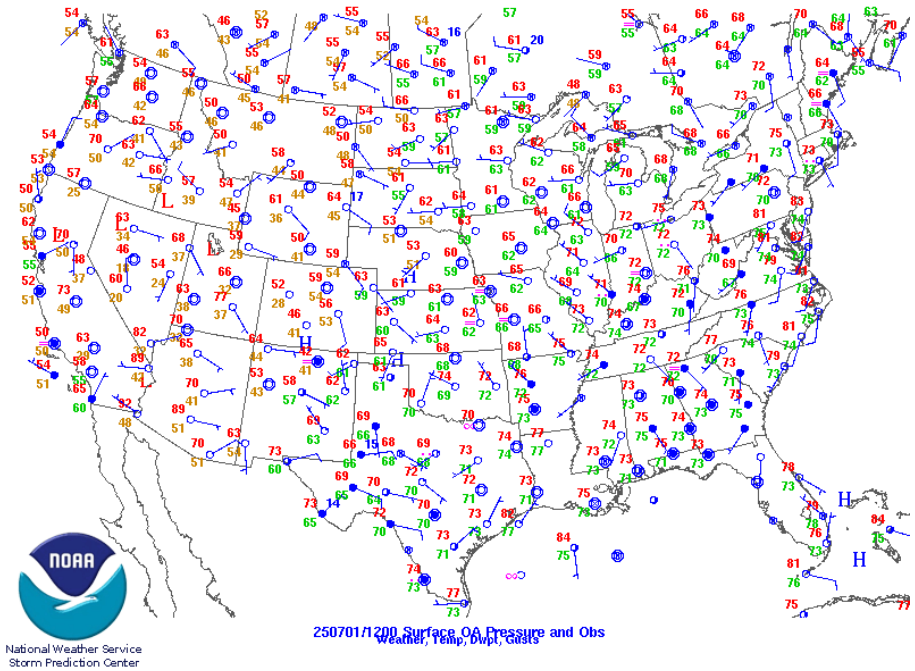
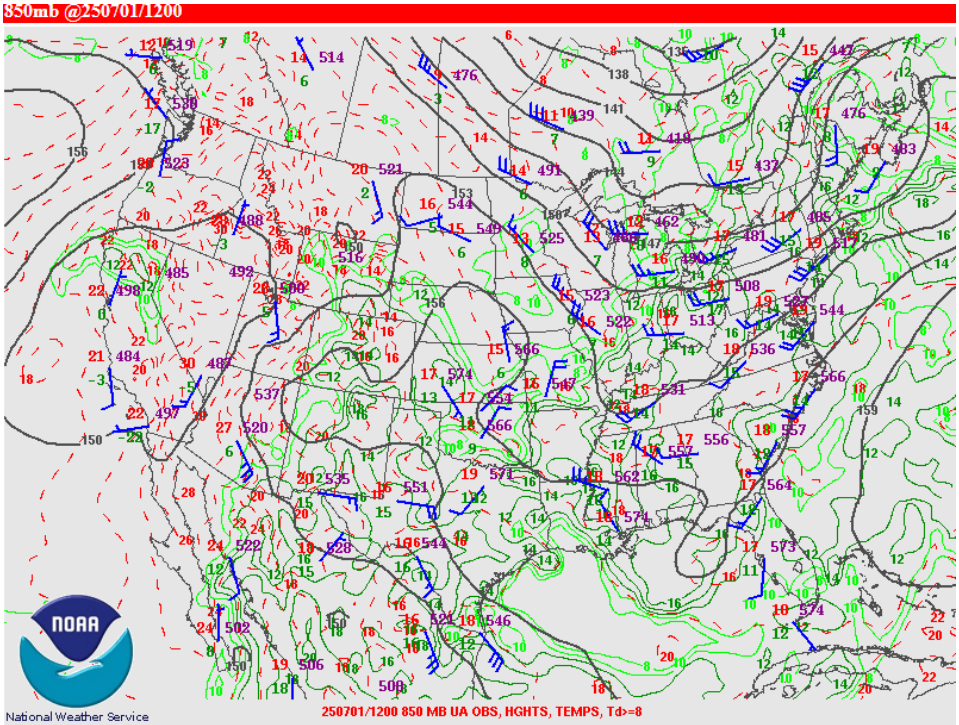
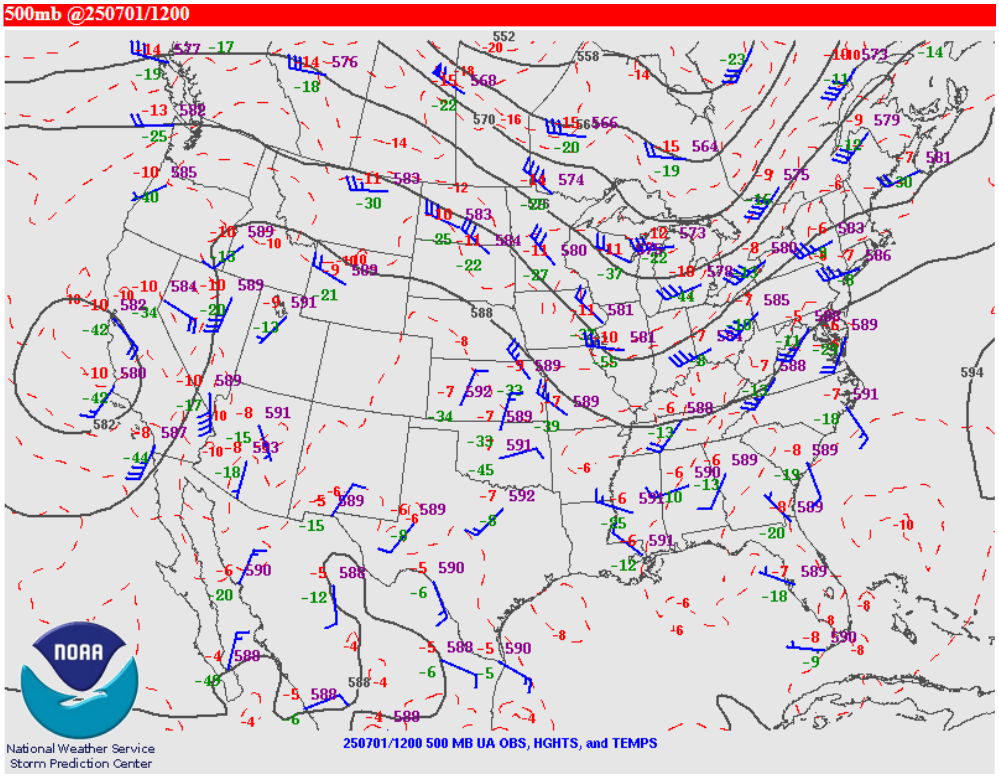


National Weather Service
Storm Prediction Center

850mb @250701/1200

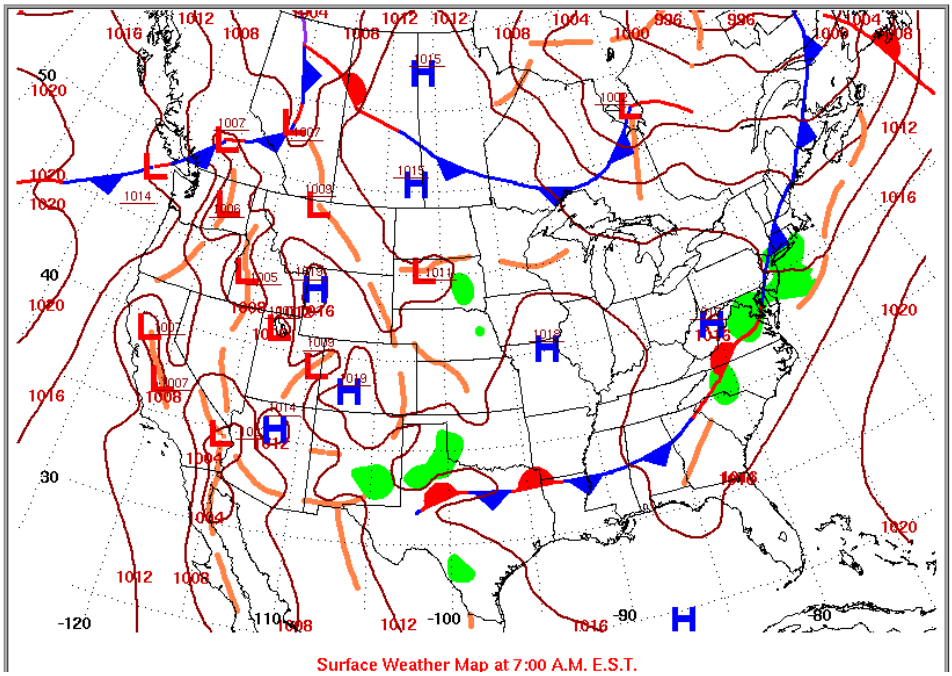


National Weather Service
Storm Prediction Center



Surface, 850 and 500 mb plots from 12Z on July 2, 2025

WEDNESDAY JULY 2, 2025



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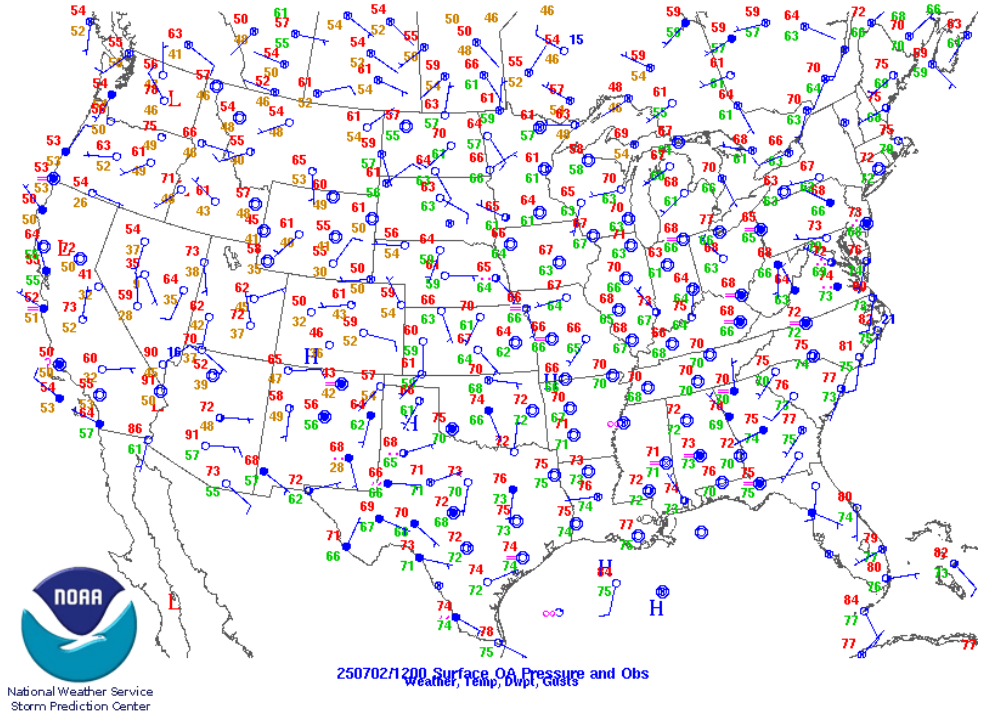

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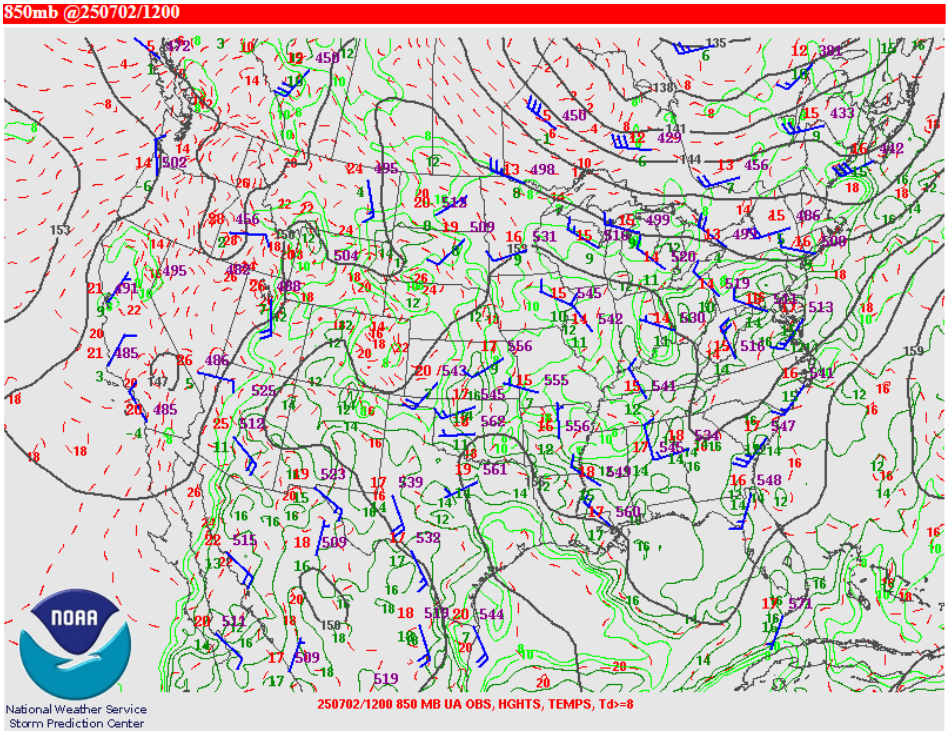
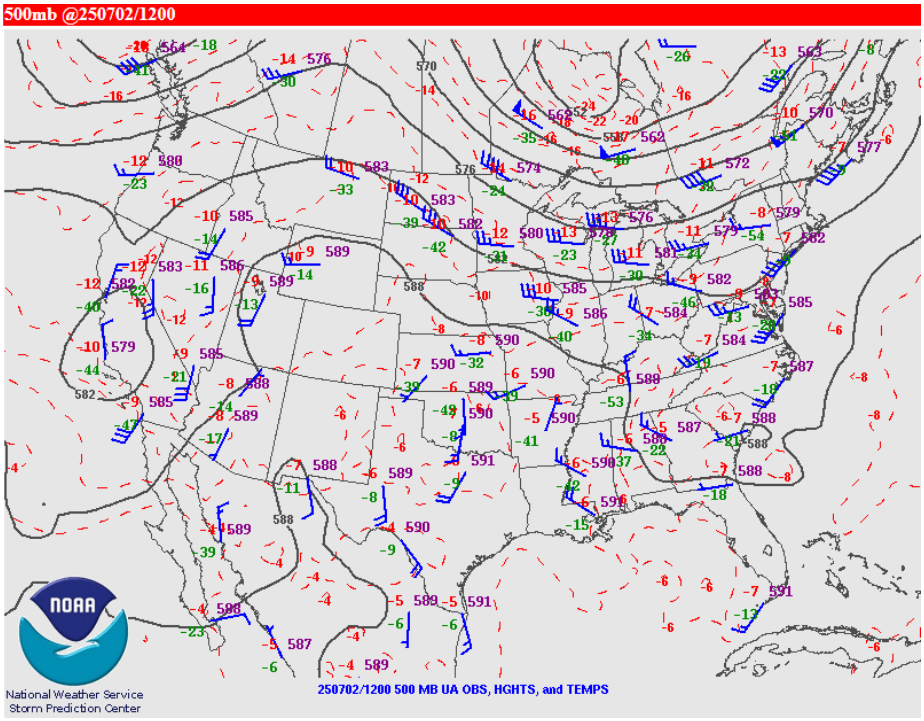




Air Quality Forecast Verification Report

Episode Dates: July 13–14, 2025

Region: Northwest

Pollutants: Ozone (O_3) and Fine Particulate Matter ($PM_{2.5}$)

Episode Overview

This verification covers conditions following the July 11 forecast for July 13–14, 2025. The period featured a transition from a warm, humid regime under southwest flow to a stalled frontal boundary and light winds, creating conditions conducive to ozone buildup near Lake Michigan and sustained $PM_{2.5}$ impacts from Canadian wildfire smoke.

Meteorological Synopsis

July 13:

High pressure dominated northern Indiana; mostly clear skies; highs near 80°F; dewpoints in the 60s.
850 mb temperatures ~15°C; mixing heights ~5000 ft; light winds (≤5 mph).
Smoke models indicated light Canadian smoke intrusion; HRRR suggested near-surface concentrations ~10 µg/m³.

July 14:

Stationary front across southern Indiana; light winds statewide; high mid-80s north, upper 80s south.
Dewpoints rose to near 70°F; 850 mb temps 17–19°C; mixing heights ~6000 ft early, falling later.
Persistent light smoke aloft; HRRR and NOAA models showed lingering near-surface smoke in NW Indiana

Forecast Summary

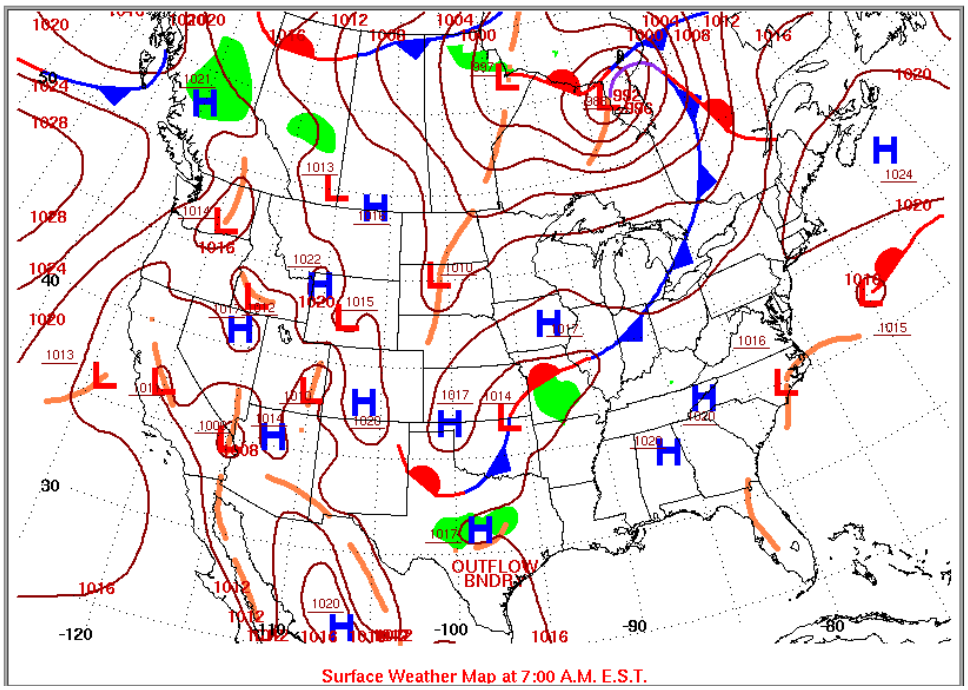
Ozone:

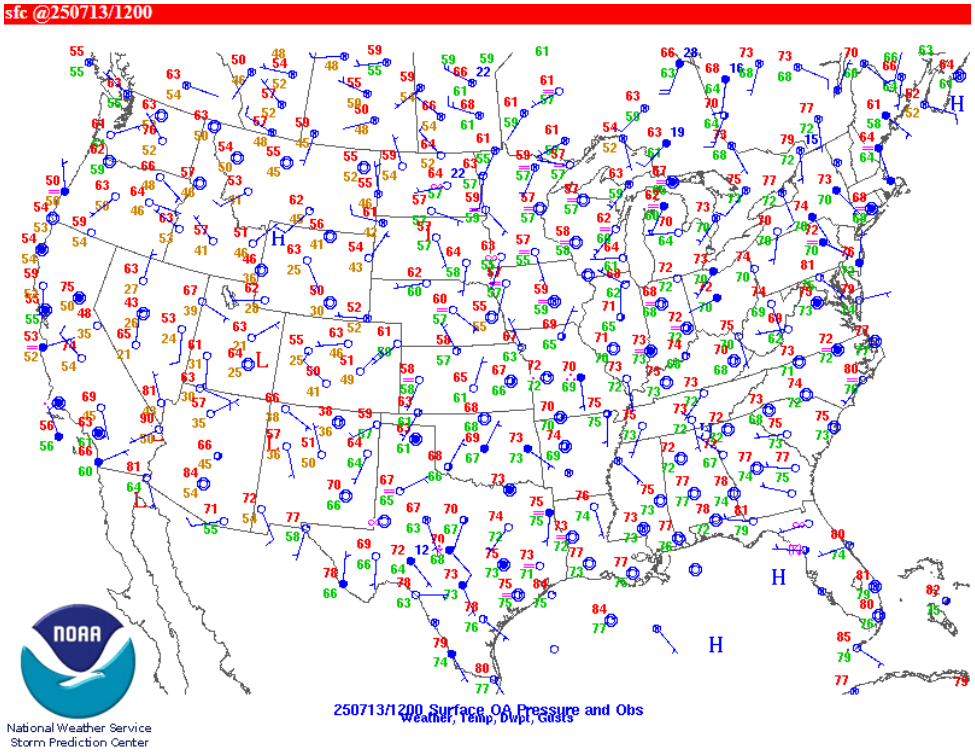
July 13: Mostly Good statewide; low risk of Moderate near Lake Michigan.
July 14: Mostly Moderate; potential USG near lakeshore flagged in later updates. **USG at several sites in IN/IL.**

$PM_{2.5}$:

Moderate likely both days due to light smoke; NOAA model leaned higher than Canadian guidance.

Surface, 850 and 500 mb plots from 12Z on July 13, 2025





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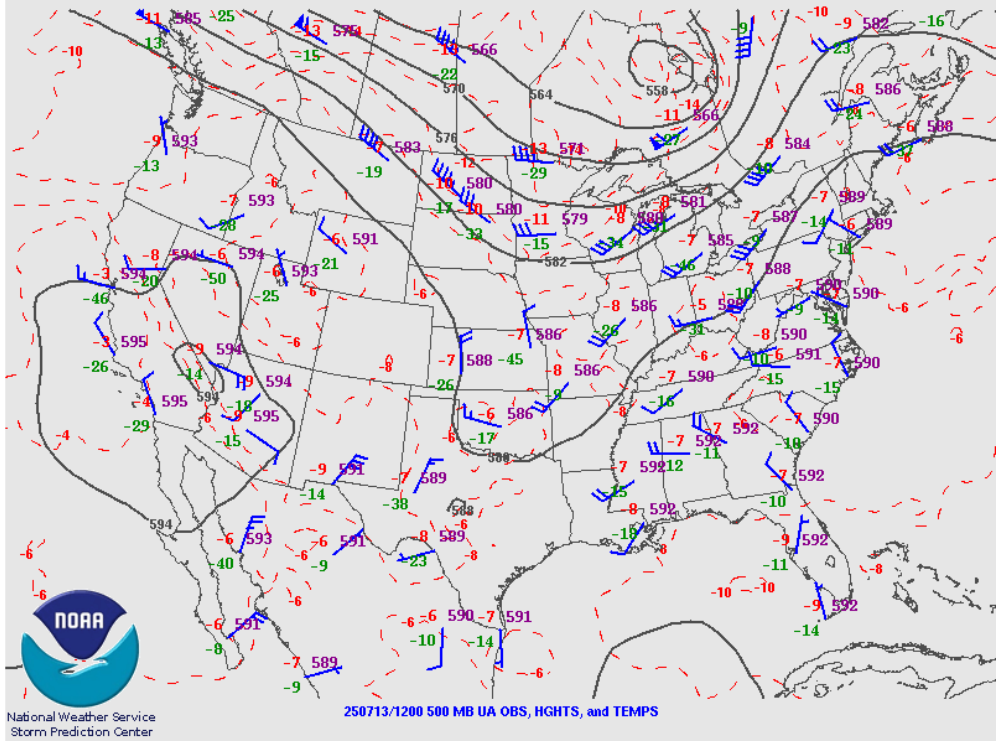

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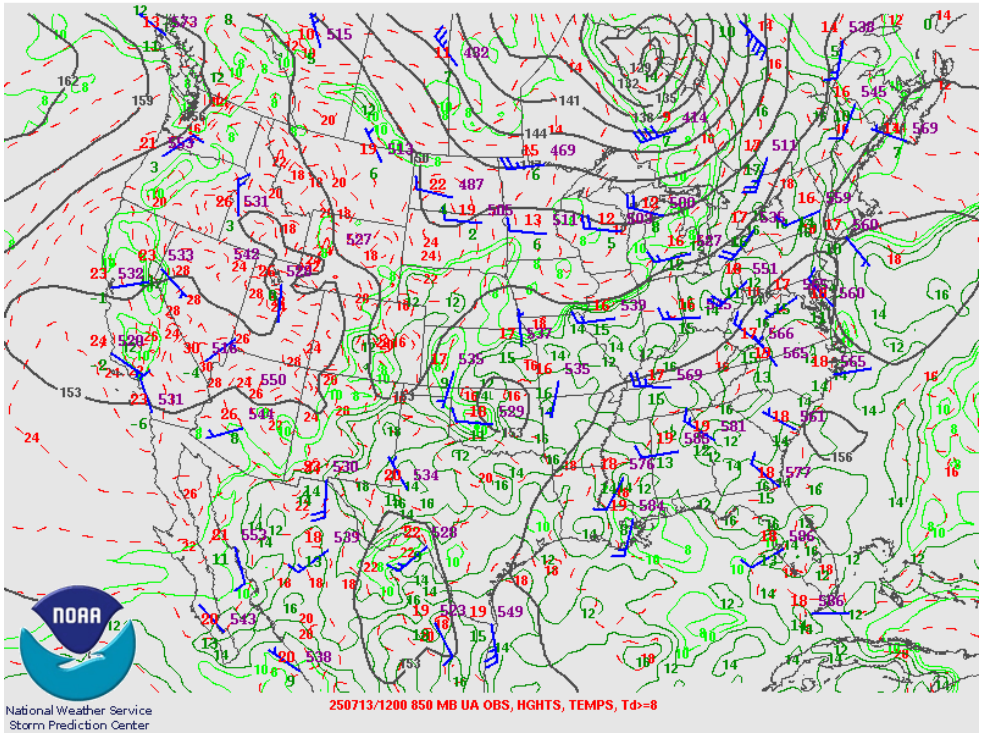
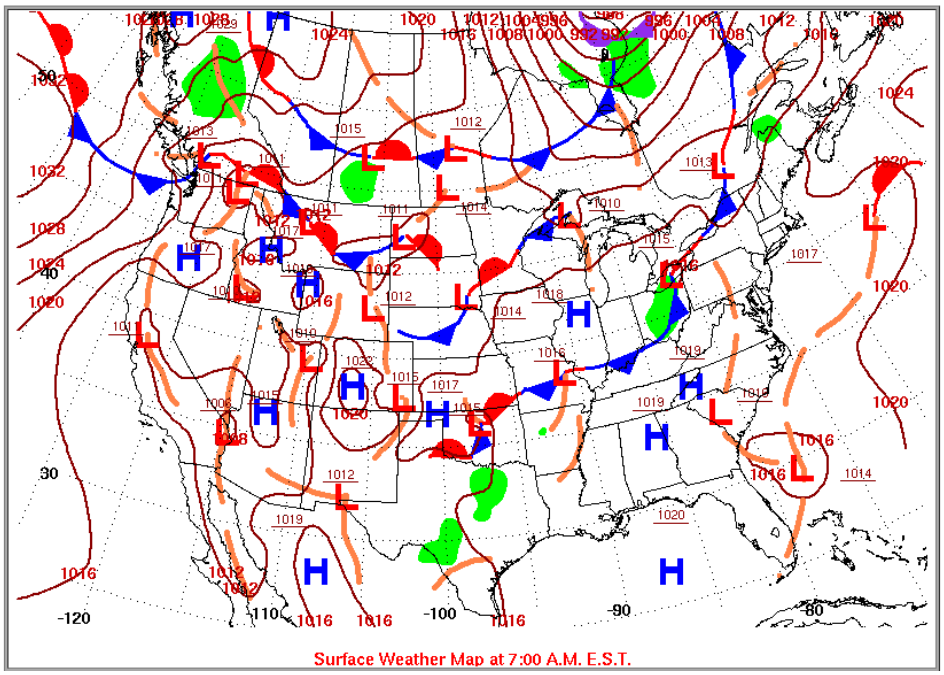
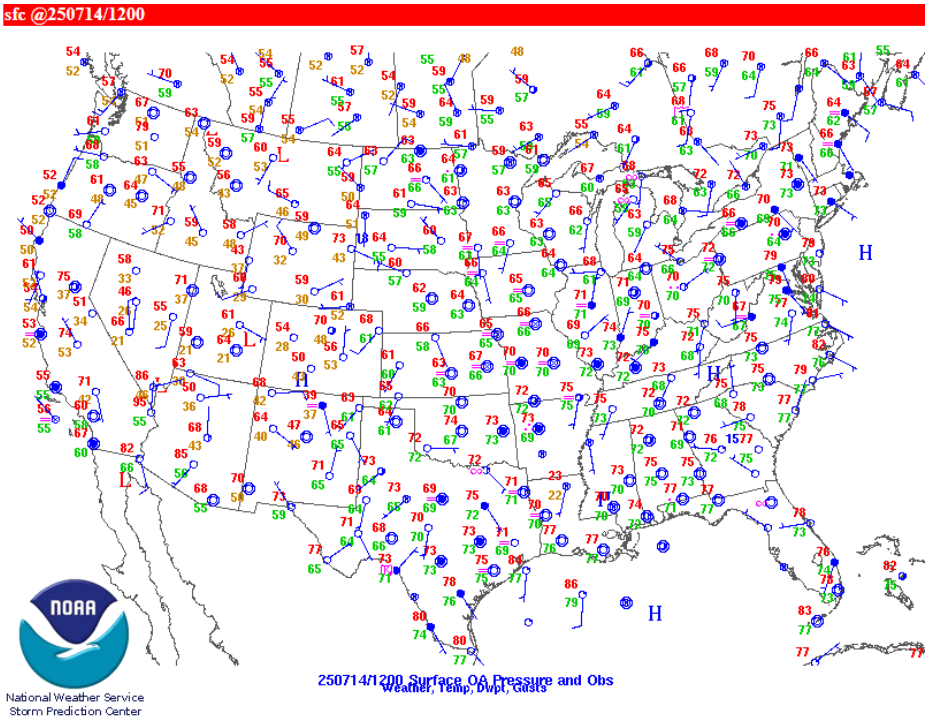


Surface, 850 and 500 mb plots from 12Z on July 14, 2025

MONDAY JULY 14, 2025





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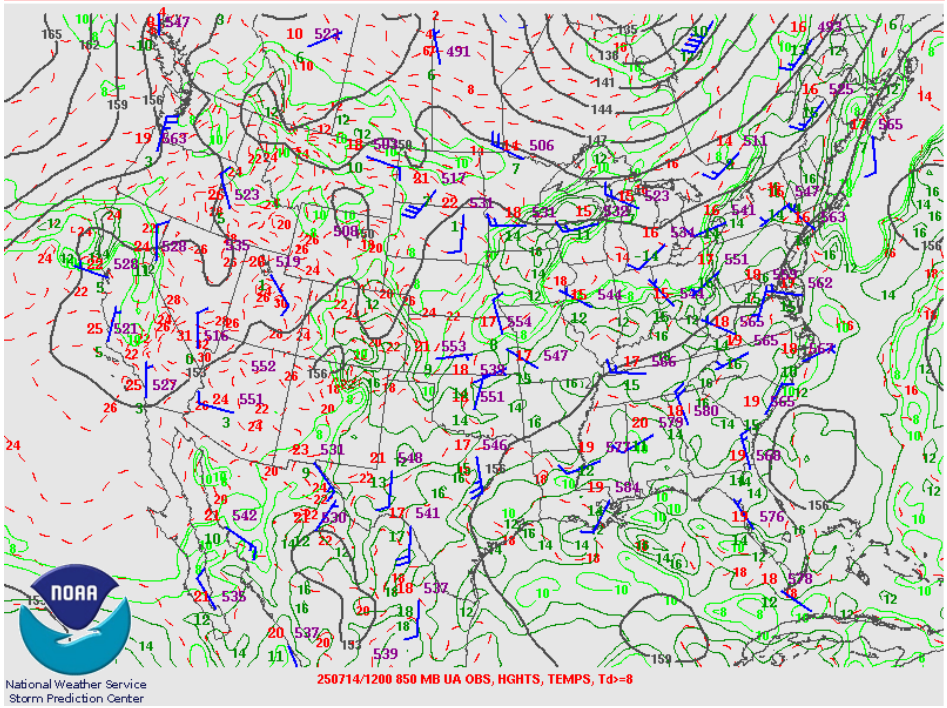

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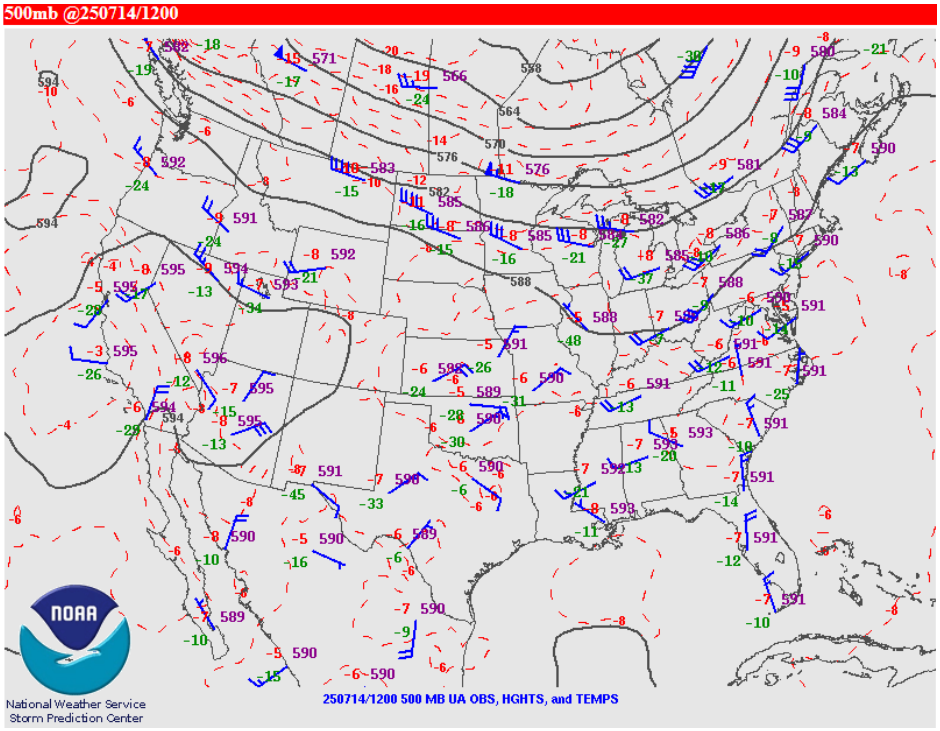


Air Quality Forecast Verification Report

Episode Overview

Episode Dates: August 5–6, 2025

Region: Northwest

Pollutants: Fine Particulate Matter ($PM_{2.5}$) and Ozone (O_3)

Overview

This episode was driven by Canadian wildfire smoke intrusion combined with light winds and high pressure, resulting in elevated $PM_{2.5}$ concentrations and moderate ozone levels.

AQAD: Issued for Fine Particulates on August 5 for Northwest, North Central, and Northeast Indiana.

$PM_{2.5}$: Moderate to USG on August 5; decreasing to Moderate on August 6 as smoke plume lifted north.

Ozone: Mostly Moderate both days; no AQAD for ozone.

Prior Air Quality Context

August 1: $PM_{2.5}$ USG; Ozone Good

August 2–3: $PM_{2.5}$ Moderate; Ozone Good

August 4: $PM_{2.5}$ Moderate; Ozone Mostly Good

Meteorological Synopsis

August 5 (Tuesday)

Pattern: High pressure over Mid-Atlantic; weak trough over Ohio Valley; easterly return flow.

Surface: Highs near 80°F; dewpoints near 60°F; scattered clouds; light east winds (~5 mph).

Upper-Air: 850 mb temps near 15°C; mixing heights ~6000 ft.

Smoke: HRRR and NOAA models indicated lingering smoke with near-surface concentrations up to 20 µg/m³; aging plume persisted across northern Indiana.

August 6 (Wednesday)

Pattern: High pressure remains east; weak ridge builds from west; warm front north of Indiana.

Surface: Highs low 80s°F; dewpoints rising to upper 60s°F; light southeast winds (~5 mph).

Upper-Air: 850 mb temps slightly above 15°C; mixing heights near 5000 ft.

Smoke: Canadian and HRRR models showed smoke lifting north; NOAA indicated residual light concentrations but trending downward.

Forecast Decisions

Ozone

August 5:

Models: NOAA and Canadian showed mostly Moderate ozone; consistent with recent measurements.

Decision: Moderate ozone likely due to warm temps, scattered clouds, and smoke precursors.

August 6:

Models: Continued Moderate ozone forecast; no AQAD warranted.

Decision: Moderate ozone risk persists.

$PM_{2.5}$

August 5:

Models: NOAA 6Z BC showed Moderate with hourly USG potential; Canadian similar but slightly lower; HRRR indicated smoke plume lingering.

Decision: AQAD issued for Fine Particulates; USG $PM_{2.5}$ possible due to smoke and light winds.

August 6:

Models: NOAA kept Moderate; Canadian showed improvement to Good; HRRR indicated smoke lifting north.

Decision: $PM_{2.5}$ decreasing but Moderate still possible; AQAD not extended.

Day-by-Day Conditions

August 5

Weather: High near 80°F; dewpoints ~60°F; scattered clouds; light east winds (~5 mph).

Ozone: Moderate across NW/NC/NE Indiana.

$PM_{2.5}$: Moderate to USG; AQAD in effect for Fine Particulates.

Smoke: Lingering plume; HRRR and NOAA indicated near-surface concentrations up to 20 µg/m³.

AQAD: Yes (Fine Particulates).

August 6

Weather: High near 82°F; dewpoints upper 60s°F; scattered clouds; light southeast winds (~5 mph).

Ozone: Moderate; no AQAD.

$PM_{2.5}$: Moderate; improving as smoke lifted north.

Smoke: Residual light concentrations; trend toward clearing.

Smoke Discussion

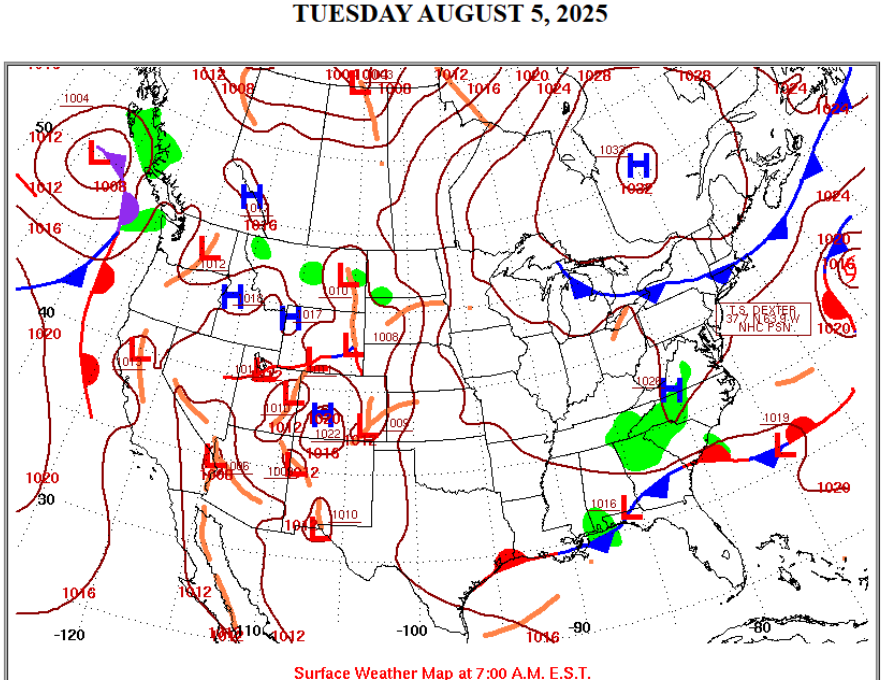
Source: Canadian wildfires (Saskatchewan, Manitoba) continued to inject smoke into the Great Lakes region.

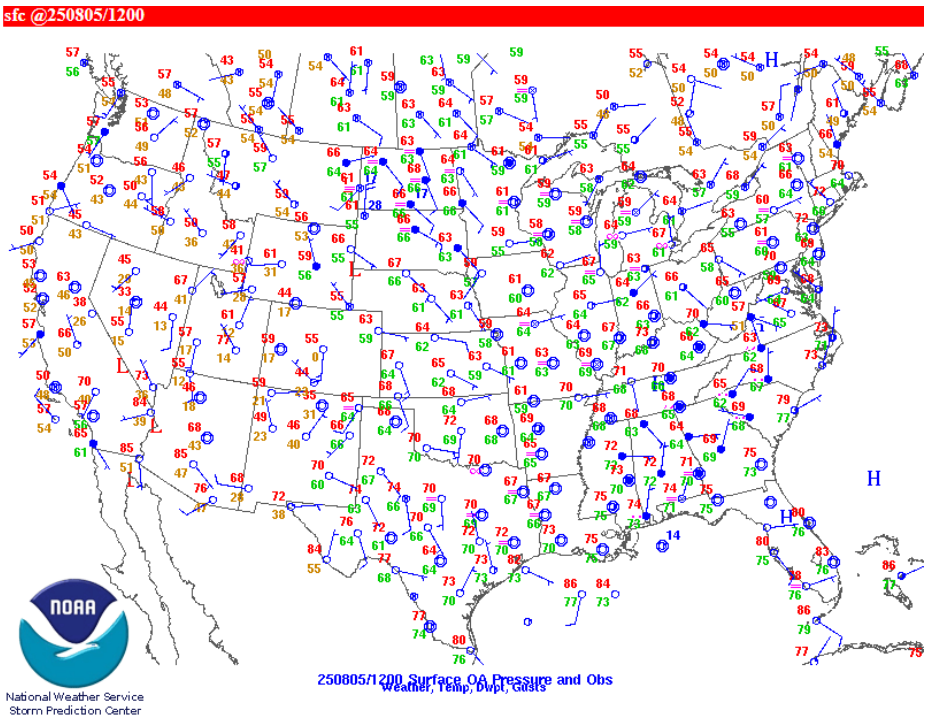
Impact:

August 6: Significant haze; $PM_{2.5}$ reached USG at some sites; NOAA and HRRR captured plume well.

Model Performance: NOAA $PM_{2.5}$ guidance aligned with observations; Canadian model underpredicted persistence; HRRR provided best near-surface timing.

Surface, 850 and 500 mb plots from 12Z on August 5, 2025





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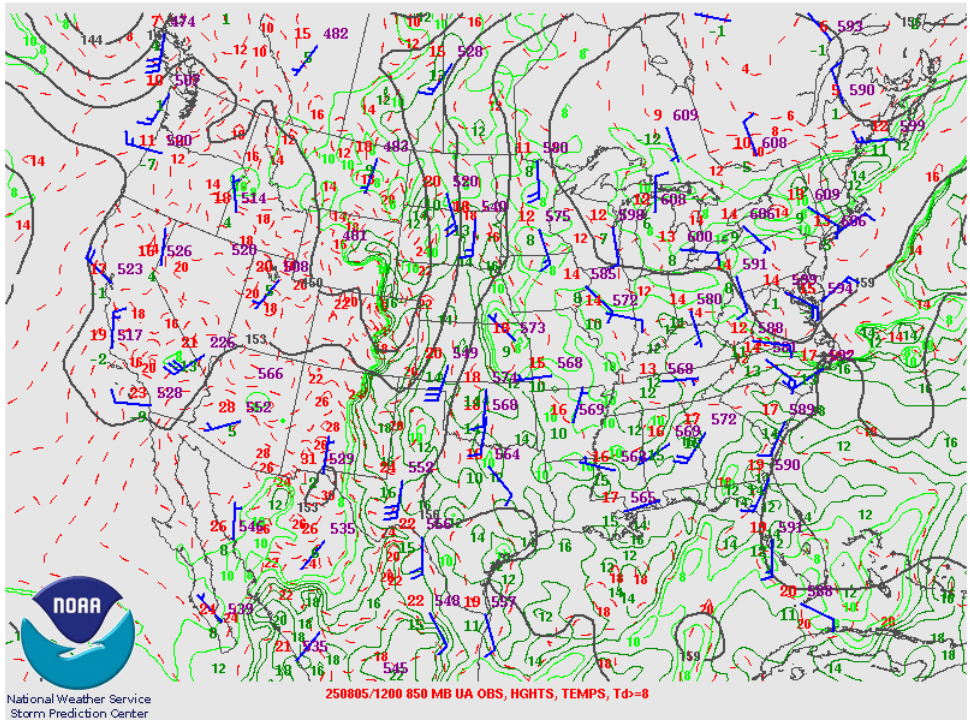

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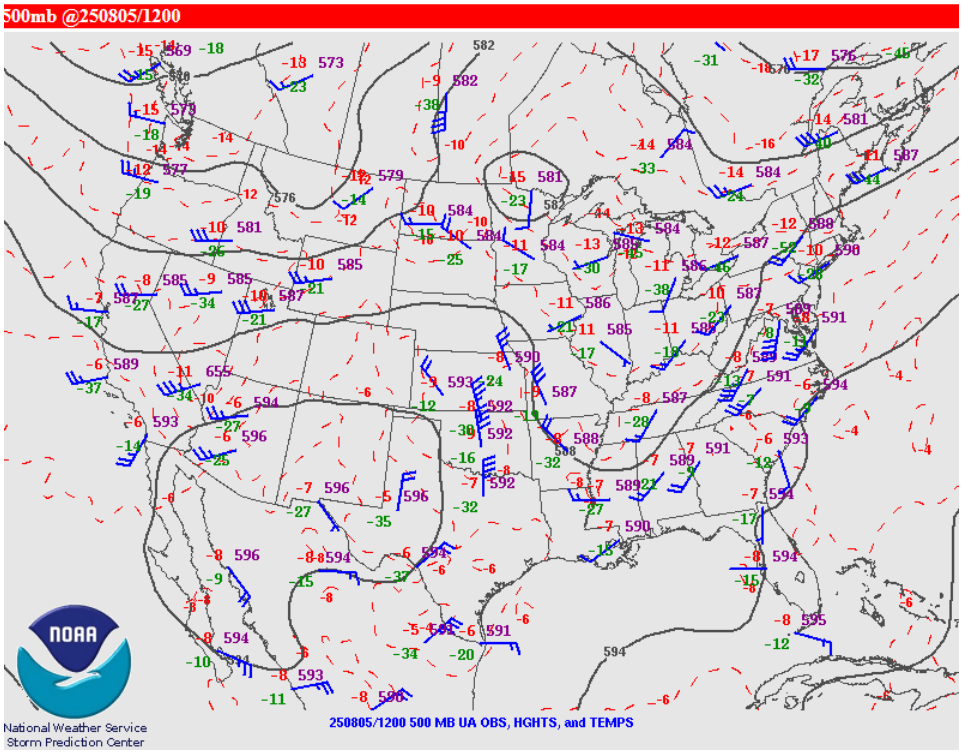
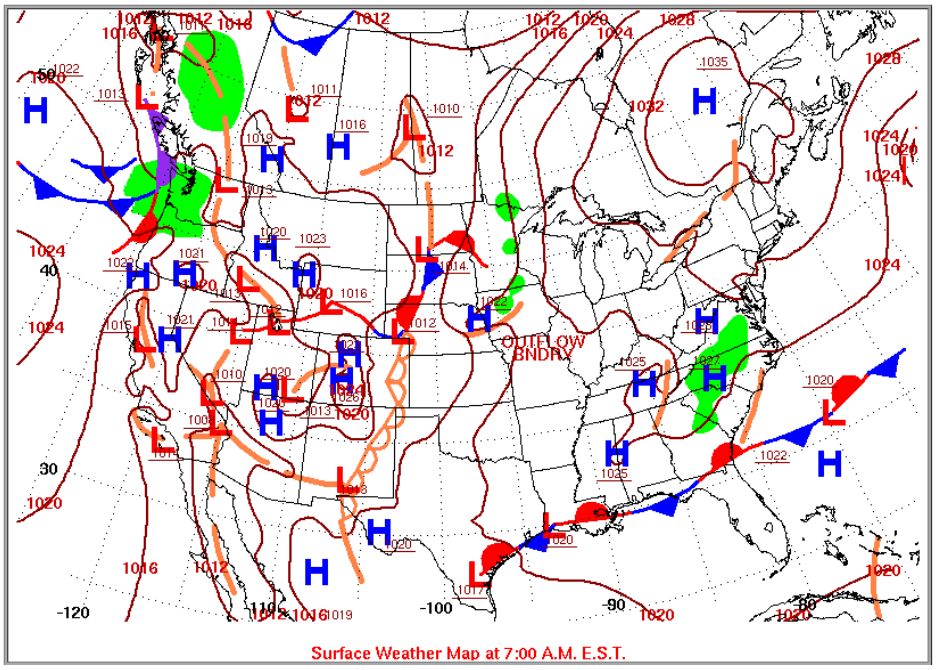
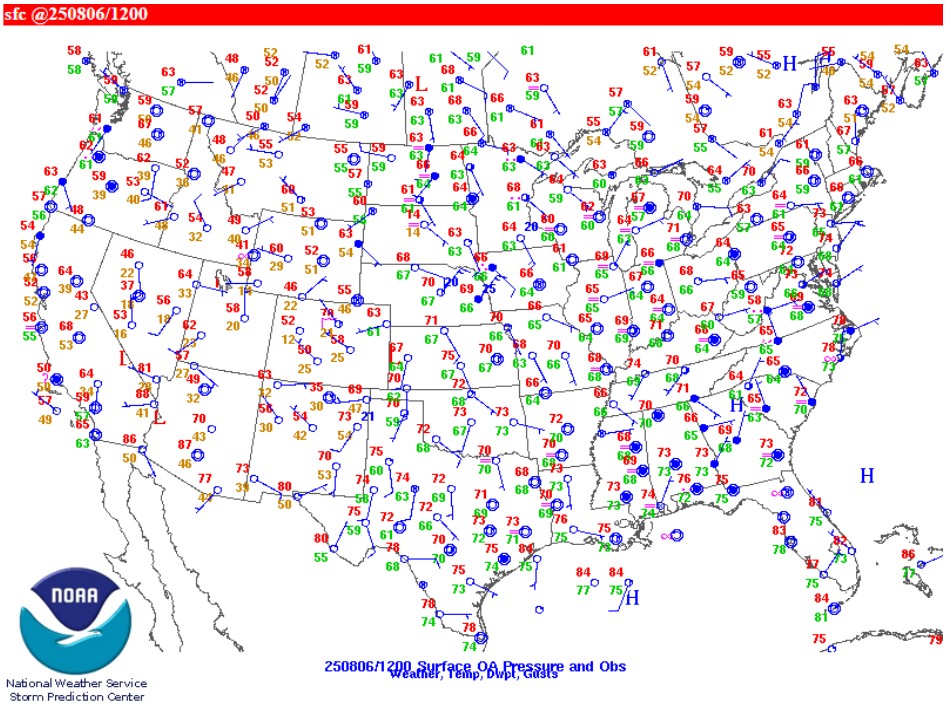
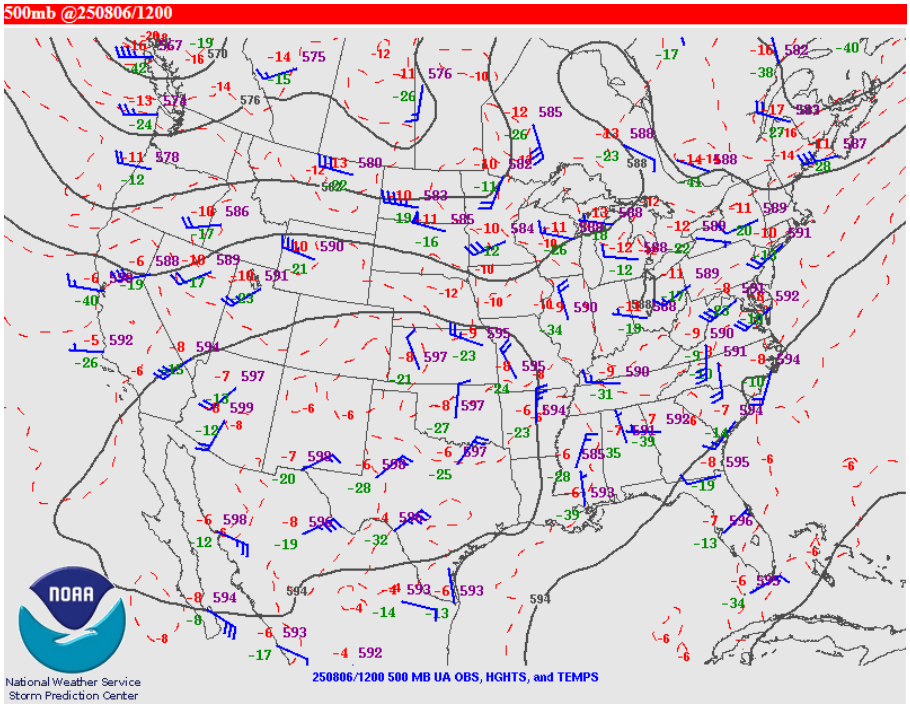
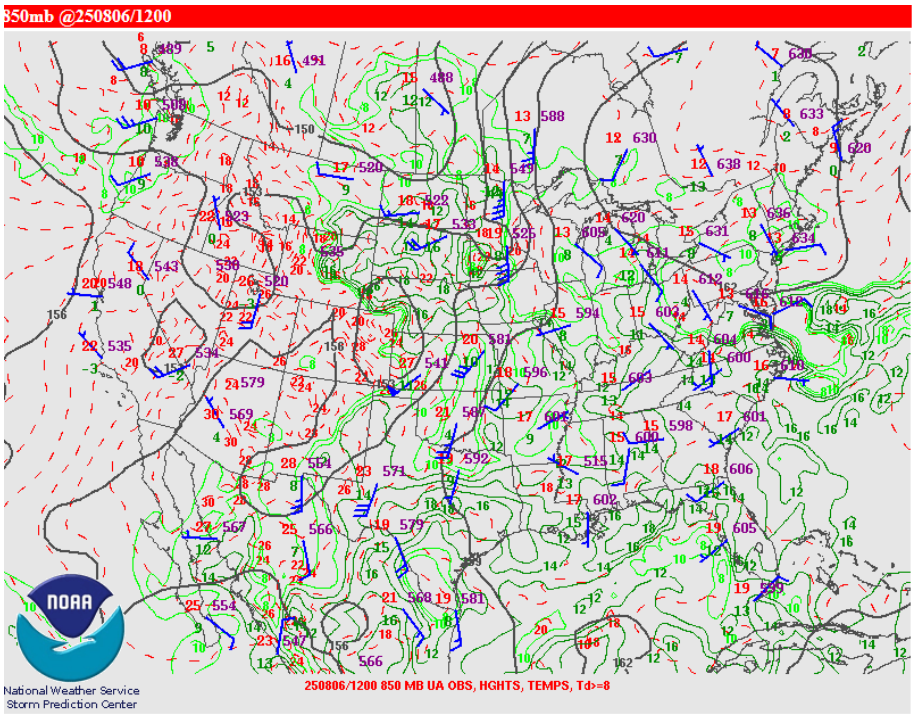


Surface, 850 and 500 mb plots from 12Z on August 6, 2025









Sources:

IDEM Forecast emails from 2023 and 2025

Surface Map with fronts: Daily Weather Map

Surface and Upper Air Maps: Storm Prediction Center Forecast Tools