

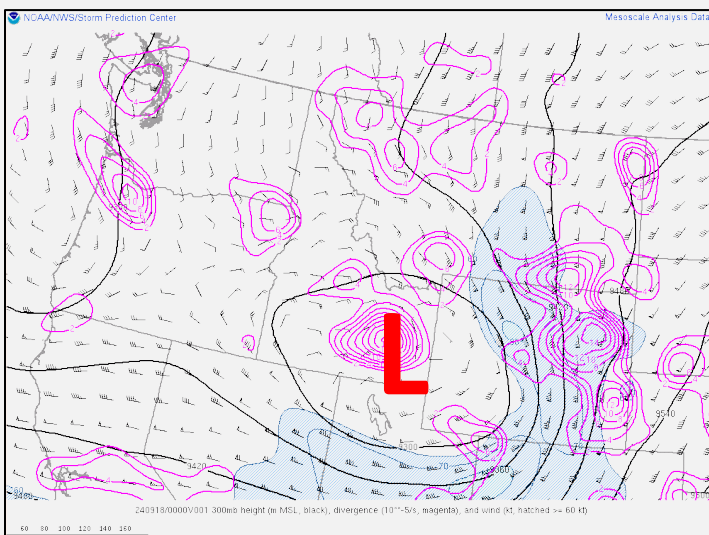
# Heavy Rain & Strong Winds

September 17-18, 2024

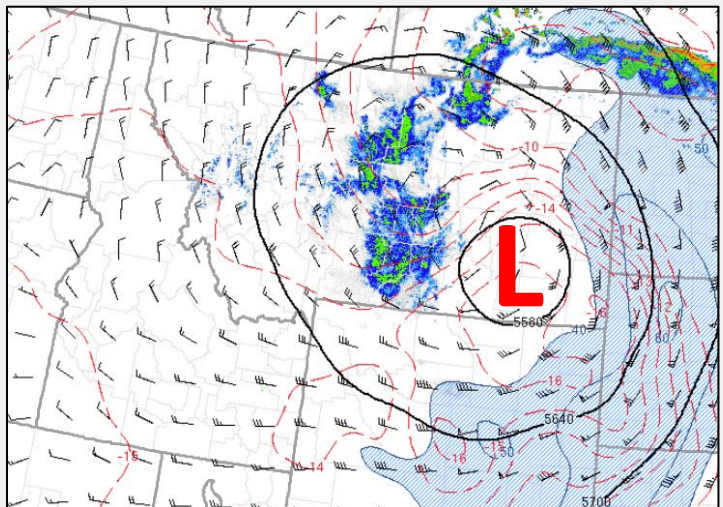
National Weather Service – Billings, MT

**OVERVIEW:** A dynamic weather system brought heavy rain and strong winds to our region on the 17<sup>th</sup> and 18<sup>th</sup> of September. The system began with showers and embedded thunderstorms on the evening of the 17<sup>th</sup>, then evolved into widespread rain and strong west winds by daybreak on the 18<sup>th</sup>. Rain and strong winds continued for much of the day, eventually diminishing by evening. This event was not record-setting, but the combination of rain and wind made it significant. The precipitation was very beneficial regarding wildfire season. Also, though it wasn't a cold system for the time of year, it did produce heavy snowfall for high elevations in the Beartooth Mountains. It is estimated that over a foot of snow fell at elevations above 10,000 feet, north of Cooke City and west of Red Lodge.

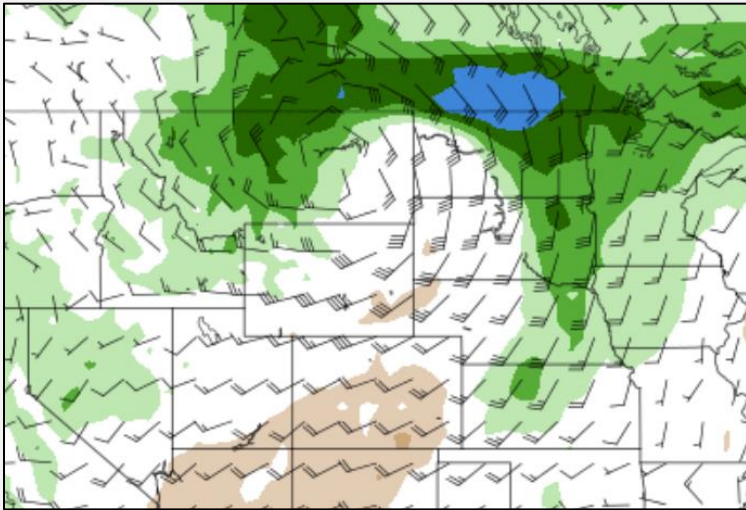
**METEOROLOGY:** We could see the potential for Montana to be impacted by a strong weather system several days in advance. It was originally thought that western Montana would see the greatest impacts, but over time the system evolved to be deeper and further east, thus taking a more favorable track to affect south central and southeast Montana. Several conditions came together to produce the heavy rain and strong winds. First was a strong low-pressure system lifting out of the great basin providing strong ascent (figure 1), which was necessary to produce showers and thunderstorms in the initial stages of this event. Next, the specific track of the low resulted in a period of deep upslope winds at its onset, followed by strong ascent within the trowal (trough of warm air aloft) region (figure 2). This track also resulted in "dry-slotting" for several hours in southeast Montana late Tuesday night into Wednesday morning. Third, there was anomalously high moisture due to favorable winds bringing moisture northward from the central plains (figure 3). This is a common feature for many strong/wet systems in the fall and spring – and sometimes they produce snow! Finally, the deep low-pressure system and strong pressure gradient on the east side of the mountains resulted in the strong westerly winds (figure 4) on Wednesday. The slow movement of the low allowed the strong winds to persist for most of the day. See the following images for a brief description of these factors.



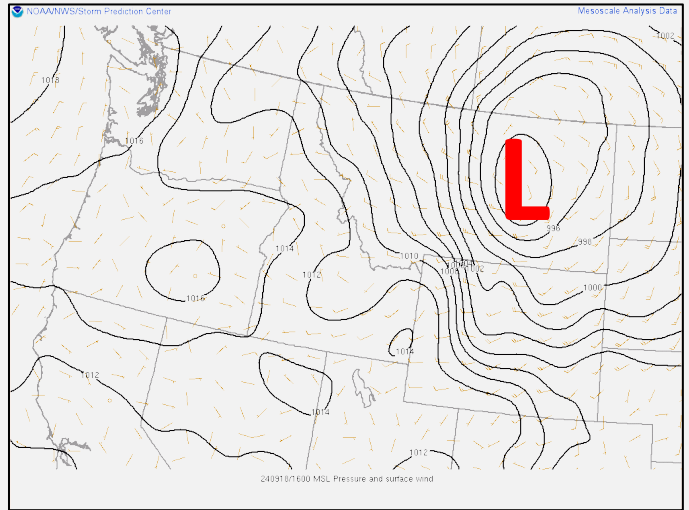
**Figure 1:** (9/17 @ 6pm) 300mb (upper-level) low over southeast ID and western WY providing very diffluent south-southeasterly flow aloft, and thus strong ascent for showers and embedded thunderstorms.



**Figure 2:** (9/18 @ 5am) 500mb (mid-level) analysis shows precipitation associated with trowal (trough of warm air aloft) wrapping from southern Alberta southward through central MT.



**Figure 3:** (9/18 @ 6am) Precipitable water anomalies show atmospheric moisture values of 2 to 4 standard deviations above normal across central MT. Note the trajectory of moisture lifting through the central plains and wrapping around the low over eastern MT.



**Figure 4:** (9/18 @ 10am) Surface pressure analysis shows deep low pressure over east central MT and a strong gradient along the east side of the mountains, resulting in strong westerly winds.

**PRECIPITATION:** Due to the track of the low, heaviest rain occurred over the west half of our forecast area, but some precipitation reached southeast Montana as well. Unfortunately, very little rain fell east of the Bighorn Mountains in the Sheridan area. Rainfall totals in excess of an inch were common, and some locations saw over 2 inches. Livingston tied its daily record on the 17<sup>th</sup> with 0.89 inches (and 0.62 inches fell on the 18<sup>th</sup>). The Billings airport recorded 1.23” of rain on the 18<sup>th</sup>, making it the 5<sup>th</sup> wettest September day on record (dating back to 1934). The table at right shows several of the highest reports we received, as well as what was observed at our main airport stations.

**MOUNTAIN SNOW:** Due to the dynamic nature of this system, snow levels fell enough to produce wet snow as low as Cooke City (elevation 7600 feet) Tuesday night. A Snotel (Snow Telemetry) station north of Cooke City at 9100 feet reported a depth as high as 8 inches Wednesday morning. No doubt that elevations above 10,000 feet in the Beartooths saw over a foot of snow, and possibly near two feet.

SITE	PEAK WIND
Busby 7 N	63 mph
Livingston	59 mph
Home Creek Divide	59 mph
Badger Peak Raws	58 mph
Hardin 9 N	56 mph
Billings	55 mph
Hardin 2 WNW	55 mph
Billings 6 SE	54 mph
Big Timber	53 mph
Birney 9 N	52 mph
Little Bighorn Raws	51 mph
Wyola	50 mph

**WIND:** While the widespread heavy rain was appreciated, and the high elevation snow was noteworthy, the greatest impact from this storm system was likely the strong winds. Though not extreme, many locations observed several hours of 50 to 60 mph gusts. In fact, the average wind speed for the entire day at the Billings airport was 24.6 mph, making the 18<sup>th</sup> the windiest September day on record (dating back to 1950). A few of the peak wind gusts observed are shown in the table at left.

SITE	PRECIPITATION
Steamboat Raws	3.75”
Crazy Raws	3.29”
Bighorn Mountain Raws	3.18”
Roundup 8.5 NNE	2.75”
Wicked Creek Raws	2.42”
Horse Thief Raws	2.41”
Roundup 4.3 SSE	2.23”
Soda Butte Raws	2.21”
Roundup	2.17”
Livingston 12 S	2.13”
Wild Horse Raws	2.04”
Melville 10 ENE	2.10”
Kilo	1.98”
Mystic Lake	1.96”
Pompey’s Pillar 1 ESE	1.84”
Livingston	1.51”
Billings	1.30”
Baker	0.29”
Miles City	0.27”
Sheridan	0.20”