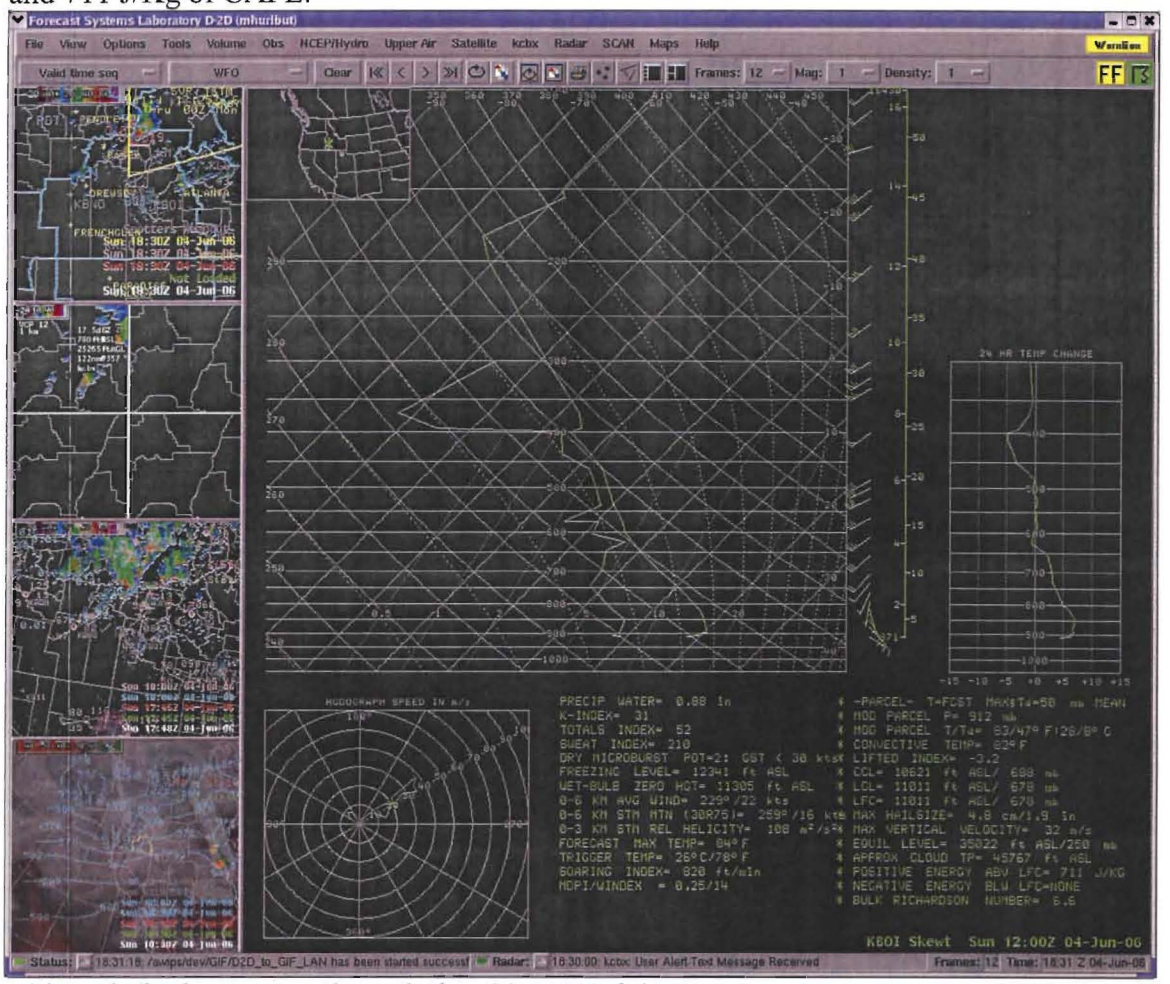
Post Mortem for June 4, 2006 F2 Tornado and Microburst

Composed by: Melissa Hurlbut

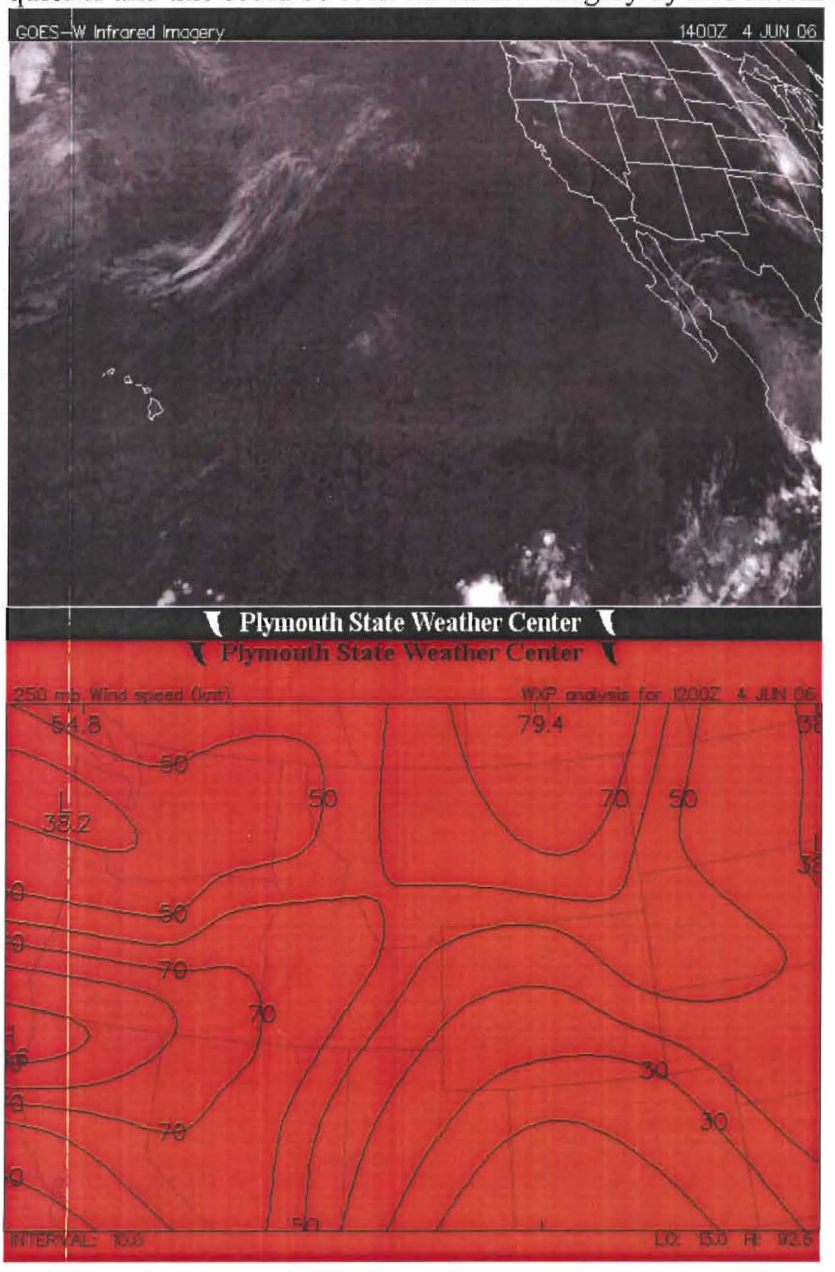
Staff for event: George Skari, Jay Breidenbach, Chuck Redman, Melissa Hurlbut, Dawn Fishler

Pre-Storm Environment: A negatively tilted short wave trough was moving across central Washington and Oregon. This system was tapping into a plume of pacific moisture and the BOI 12Z Sounding showed 0.88 inches of precipitable water. The sounding also showed 0-3km 108 m2/s2 helicity with a strong veering profile, a -3.2 LI, and 711 J/Kg of CAPE.



Although the lapse rates through the -30 to -10 C layer were not very steep yet, daytime heating in combination with the rapid cooling aloft associated with the passing of the cold front would create very steep lapse rates later in the day. The profile would then become considerably more favorable for hail formation and significant wind, while the strong shear indicated the possibility of mesocyclone formation. Model data showed significant instability across the CWA with forecast CAPE values of up to 2000 J/Kg and 0-6 km bulk shear of up to 65 kts in the 16-20Z time frame. With the short wave passing to the North, it was apparent to the forecasters that the best moisture in combination with this instability would be across our northern zones. A jet streak was observed on WV/IR to be

moving northeast quickly across southern Oregon, which would also place the northern zones in the favorable left exit region of the jet. Model data supported this observation. Surface dew points were in the mid 40s to mid 50s at 14Z while temperatures were warming quickly. Pockets of clearing were allowing some locations to destabilize even quicker and this could be seen on visible imagery by mid morning.

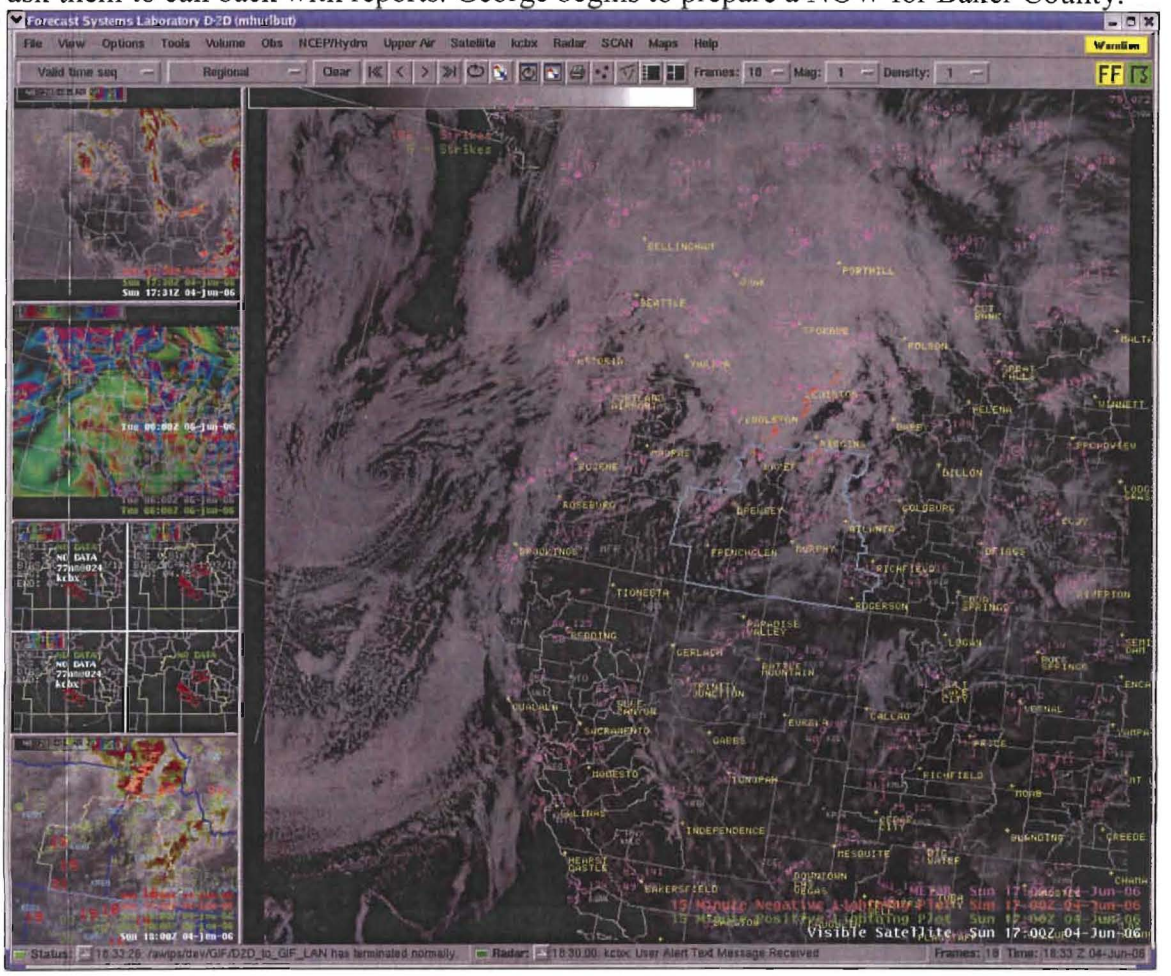


Timeline of Events:

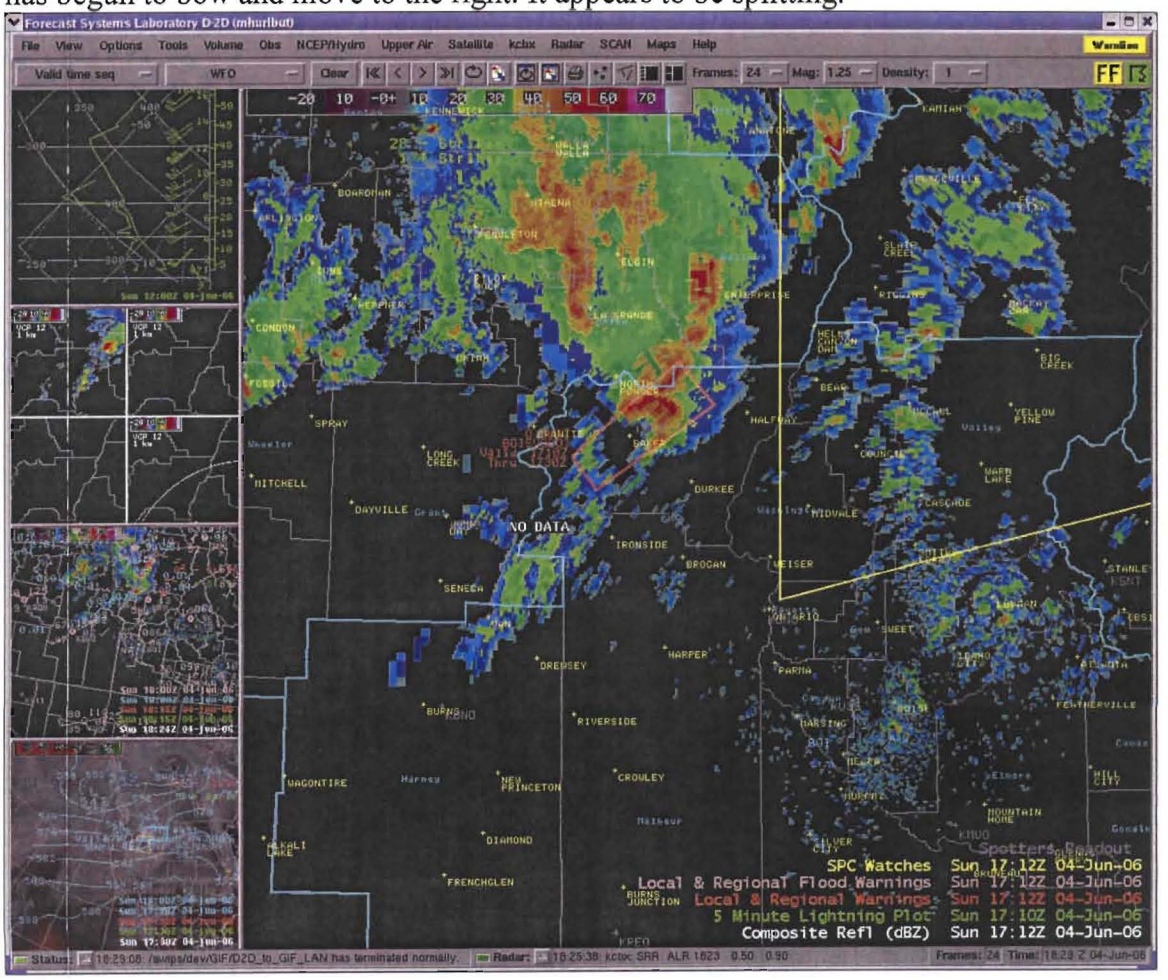
1300Z - Jay Breidenbach arrives to work the aviation shift for the day and receives briefing from Ken Parker and Dave Groenert.

1330Z – Jay and I begin to look through more data and realize that the situation has the potential for more severe storms than originally thought. We begin to discuss enhanced

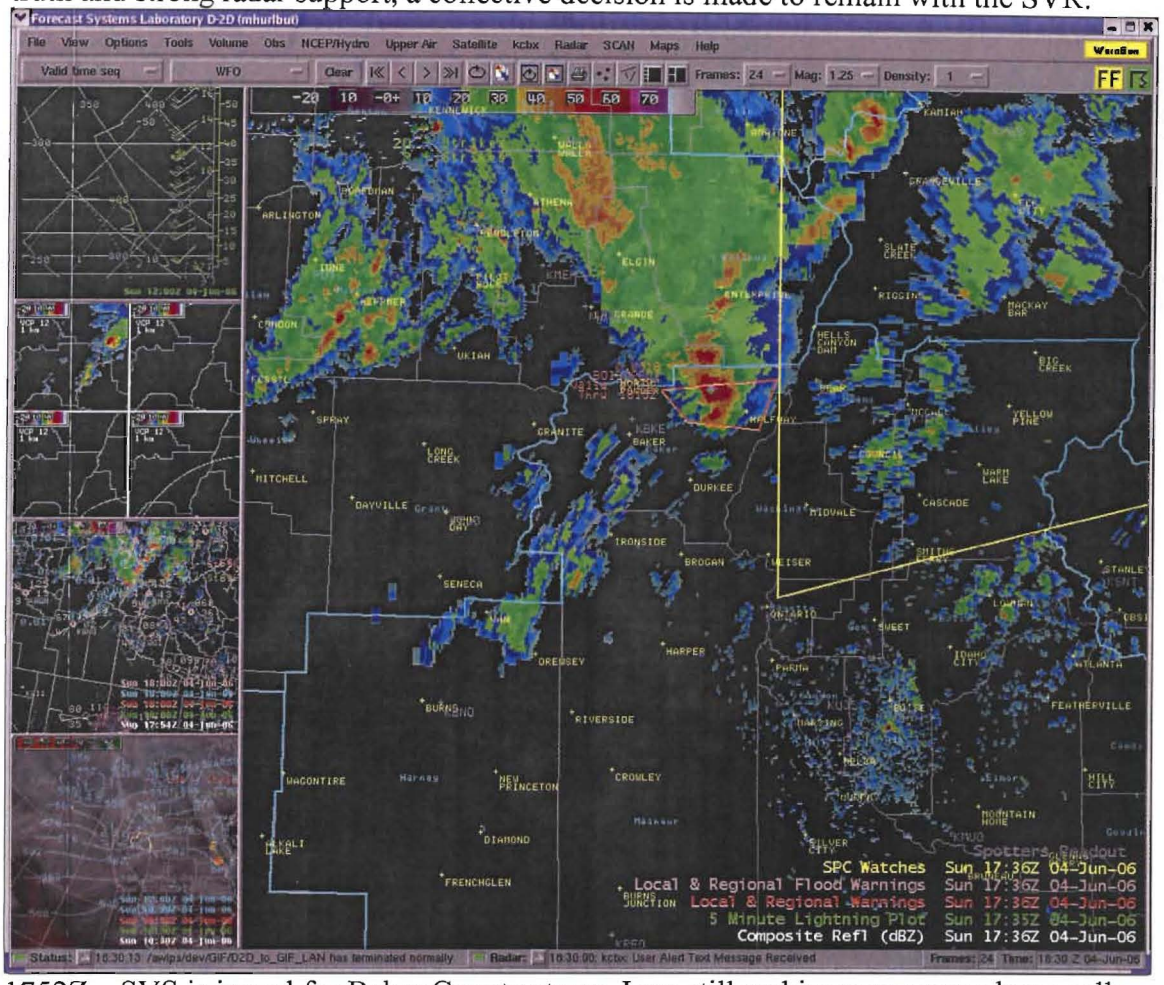
wording in the forecast and the possibility that SPC could later issue a watch over a portion of our CWA.
1350Z – George Skari arrives to work the public shift for the day. Jay makes the decision to immediately brief George on the convective potential instead of waiting until 1430Z to brief him and the fire weather forecaster for the day. Extra staffing is discussed but it is decided that 4 forecasters should be adequate to cover the situation. George makes note of who is available to call should we need more help.
1400Z – A strong storm is observed on radar mosaic in PDT's CWA. Forecasters note how it is bowing and how it already appears to be displaying severe structures. PDT issues a warning for this storm at 1405Z, shortly after we discussed it.
1420Z – Chuck Redman arrives to work fire weather. He is informed of the situation. George delegates duties and each person begins to monitor radar and satellite data while issuing daily products as quickly as possible before the storms reach the western portion of our CWA.
1620Z – A collective decision is made that storms may be more severe than radar and satellite data are showing, based on the distance from the radar and some beam blockage due to the mountainous terrain. A clearly defined front (image is from 17Z) now appears to be forming a squall line. PDT has also been sharing LSRs over 12 planet with BOI and MSO. I call two spotters in Baker County ahead of the storm, tell them the situation and ask them to call back with reports. George begins to prepare a NOW for Baker County.



1630Z – The first spotter calls back and estimates wind speeds of 60 mph.
1634Z – George issues NOW for cell moving over Baker County.
1635Z – Second spotter calls back and reports dime sized hail with some stones larger than dime, 35 kt winds, and heavy rain.
1640Z – George decides that although radar isn't indicating anything severe, ground truth from spotter reports may be enough evidence. He begins to prepare a SVR.
1646Z – SVR for Baker County for a severe thunderstorm capable of producing damaging winds in excess of 60 mph. George mentions Baker City specifically in call to action.
1650Z – SVR is transmitted on NAWAS and spotters are called ahead of the storm
1709Z – SVS issued for Baker County storm
1713Z – WCL arrives from SPC
1715Z – SPC coordination call begins. A collective decision is made within the office that the southern counties should be excluded as dry air was quickly moving in. George takes the conference call and talks them out of including the Boise metro area but SPC prefers to keep Payette, Gem and Boise Counties in.
1720Z – WW #431 is issued with aerial outline.
1729Z – A 2nd SVR is issued for Baker County and is transmitted on NAWAS. The storm has begun to bow and move to the right. It appears to be splitting.



1730Z – A spotter calls from Baker City and reports damage. A house is partially collapsed, trees and power lines are down and roofs have been blown off houses.
1736Z – Storm begins to show signs of a possible mid level rotation. The northern vortex of the bow is strengthening while the southern end appears to be dying out. Forecasters are discussing whether to issue a TOR or to stick with the SVR. Due to lack of ground truth and strong radar support, a collective decision is made to remain with the SVR.

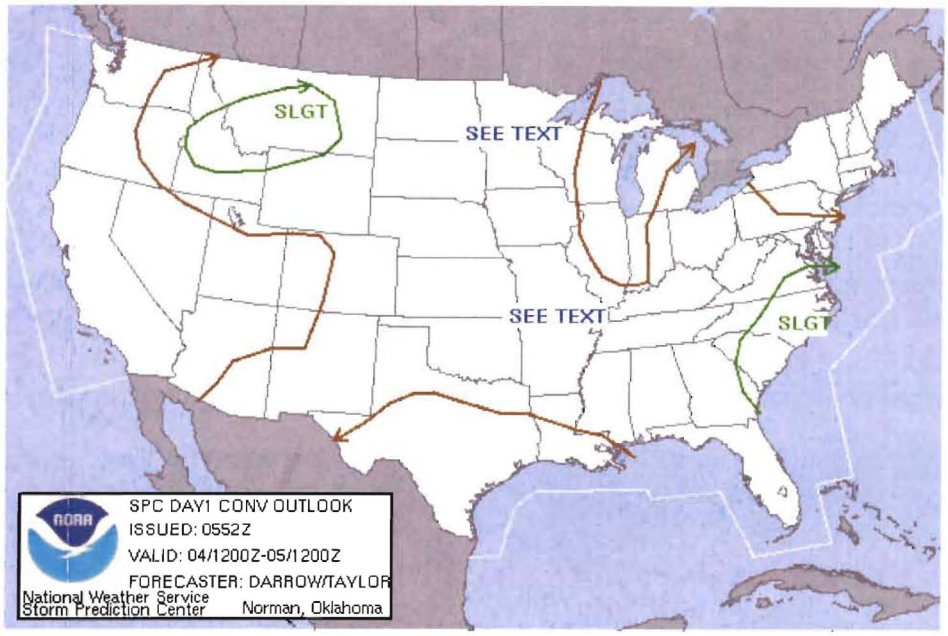


1752Z – SVS is issued for Baker County storm. I am still making numerous phone calls to spotters downstream of storm.
1753Z – George assigns Dawn Fishler to aviation duties and Jay takes over radar. Each person is continuing to monitor radar as well and there is continuous discussion of storms. Chuck and I continue to use 12 planet to inform PDT and MSO of incoming LSRs while I also log LSRs into our own database.
1755Z – I begin to save images to the S drive when time permits.
1758Z – Jay issues a SVR for Adams county and it is sent over on NAWAS. Storm has tracked through Baker County and now has a mod/stg meso signature, which is also displayed on SCAN. WarnGen has formatted the warning with the mention of a possible tornado.
1800Z – Flagstaff Hill RAWS reports a gust of 80 mph.
1830Z - I call spotters ahead of storm to alert them and ask if they can return the phone call when the storm has passed.

1835Z – SVS is issued for Adams county.
1840Z – First spotter calls from Cuprum, Idaho. He reports that quarter sized hail fell for 5 minutes and it is now covering the ground.
1845Z – Spotter calls from Bear, Idaho. She and her husband are trapped inside of their house. Trees are broken down everywhere and roofs have been peeled off. There is a possible injury.
1854Z – Jay ends the Adams county warning with an SVS. Watch #431 continues.
1900Z – George calls Paul Flatt and notifies him of the damage reports. He is coming to the office.
1945Z – Paul arrives. George makes a few schedule changes to cover the evening balloon release so that Dawn can go on storm survey to Baker City with Paul.
2000Z – John Jannuzzi is notified of storm event
2045Z – WCN Watch box is cancelled for the rest of BOI CWFA counties as drier air has moved into the CWFA. Threat of storms has diminished over BOI and has now moved into MSO's CWFA.

Performance of Staff: The 5 forecasters on shift that day communicated extremely well with each other throughout the event. George made the decision early on before threat escalated to split duties and delegated what he wanted done. Each forecaster was monitoring data while contributing to both warning operations and daily duties. Communication between neighboring offices was also excellent and LSRs were often sent over chat before they were even logged into the database. These reports were crucial to narrowing down the magnitude of the threat. Spotter reports were also crucial to operations. A warning may not have been issued as soon for Baker County had we not utilized them. The spotters in Adams County should also be commended for their performance and their dedication. Spotters in Bear returned the phone call minutes after a tree fell in front of their house, trapping them inside. Lead times on warnings were sufficient enough to allow people to make preparations for the storm and to take cover.

MSO had sent a chat to SPC early on asking for their thoughts on convective potential. Boise and West Central mountains were under a slight risk, but in the convective checklist and in our forecast we acknowledged that the threat could start further west over Baker County. We had expected the possibility of a watch box, but sooner than it was actually issued. By the time a watch was issued for our area we were in the middle of warning operations. The process of setting up a watch over a portion of our CWFA was a bit of a distraction at a critical time. From talking with SPC employees and from viewing these events happen, I suggest we make it a practice to call SPC early before any activity begins to discuss the possibility of a watch if we believe it is necessary and we haven't been contacted.

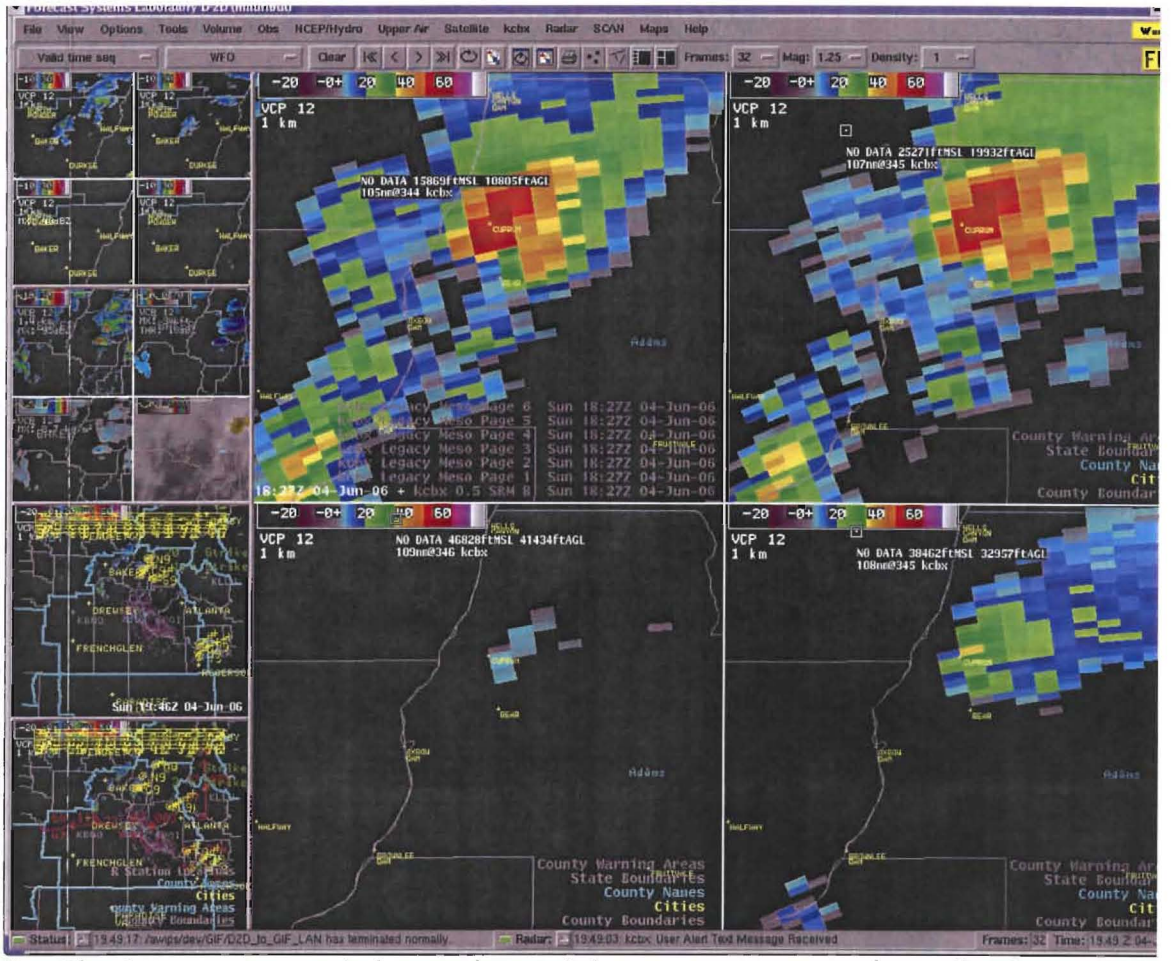


Severe Thunderstorm Watch # 431 - Valid from 1125 AM until 600 PM MDT

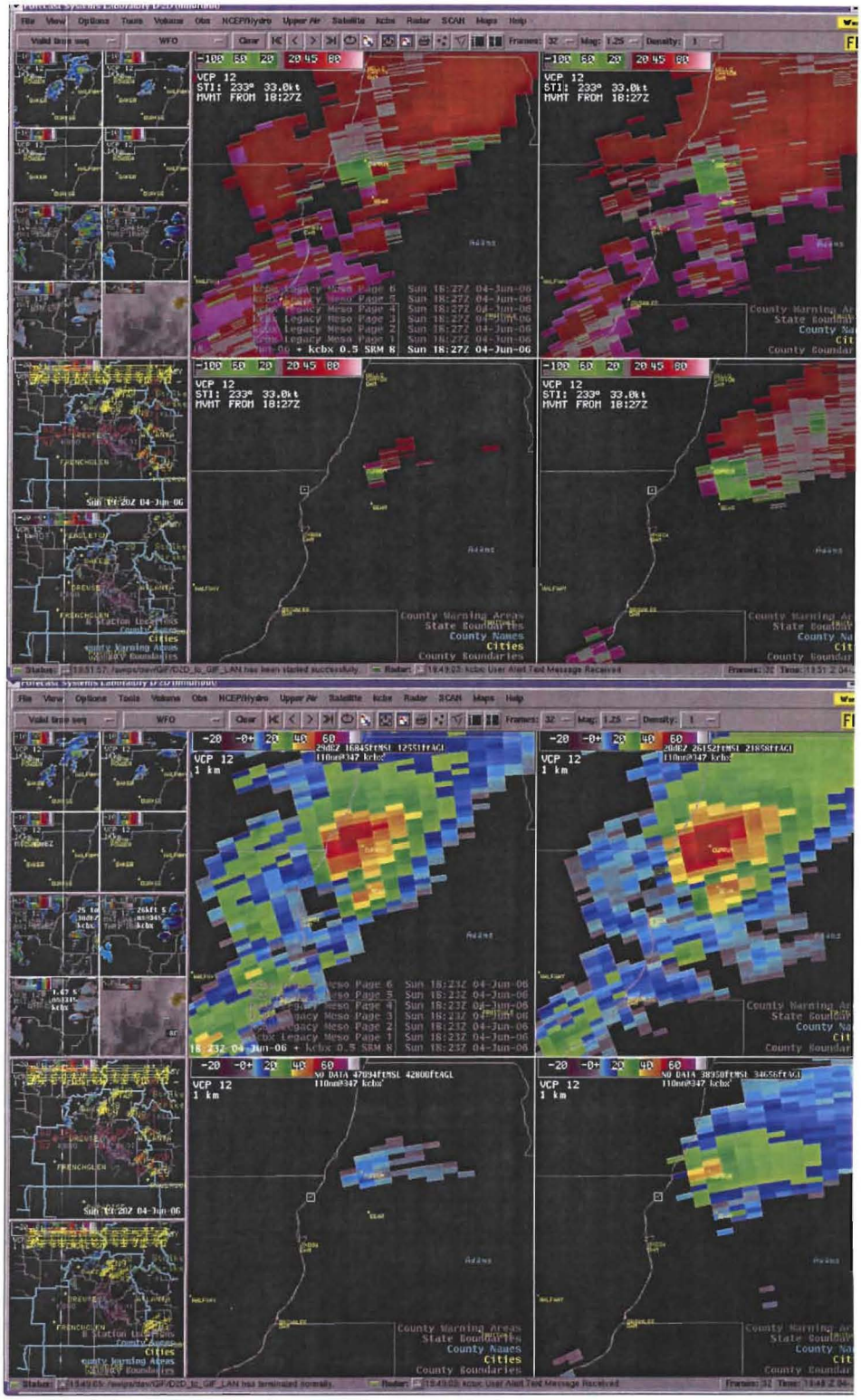
NOAA/NWS/Storm Prediction Center — Updated: 20060604/1726 UTC

NWS personnel were onsite within one day to asses damage and make assessments of damage. In Bear, Idaho, the storm survey revealed that the damage was caused by a tornado with a rating of F1, although in a second assessment after more data was received it was revealed that the tornado was a strong F2. For verification purposes we missed a

tornado warning. While we monitored this storm, there was continuous discussion among forecasters as to whether a SVR or a TOR should be issued. Because of the distance of the storm and the mountainous terrain, the lowest slice, or 0.5 degree tilt, was viewing the storm at 15,000 ft so there was no way to tell what was happening below this elevation in the storm.



Satellite data was not overly impressive, and there were no spotters immediately available ahead of this storm that could have offered ground truth. The storm did have indications of a mesocyclone, though again the lowest height of the meso below 15,000 ft could not be observed. There were indications of a weak echo region. The storm was located on the favorable south end of the squall line, giving it better access to shear. In addition, while other portions of the squall line fell apart over complex terrain, this southern cell tracked over the valley nearly its entire life cycle.

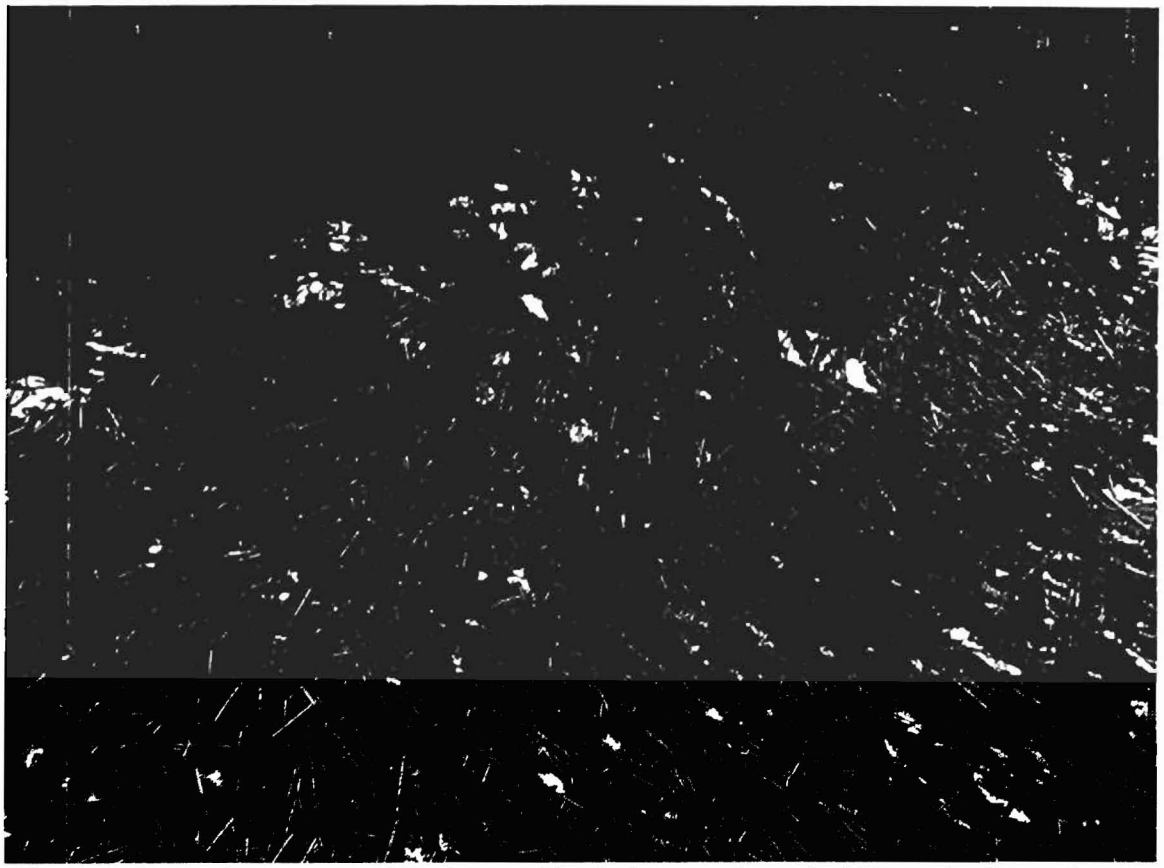


The environmental analysis done earlier indicated an environment that favored right moving supercells. After considering all these facts and the climatology of tornadoes in Idaho, ie the rarity, a decision was made to issue a strongly worded SVR including the threat of golf ball sized hail and damaging winds in excess of 70 mph. In addition to this,

a statement was added to indicate that there was possible rotation and a tornado may develop. I believe given the distance of the storm from the radar, the rugged terrain, and climatology, that the choice to go with a strongly worded SVR was appropriate. It would be hard to fault a warning forecaster for not issuing a TOR given the data.

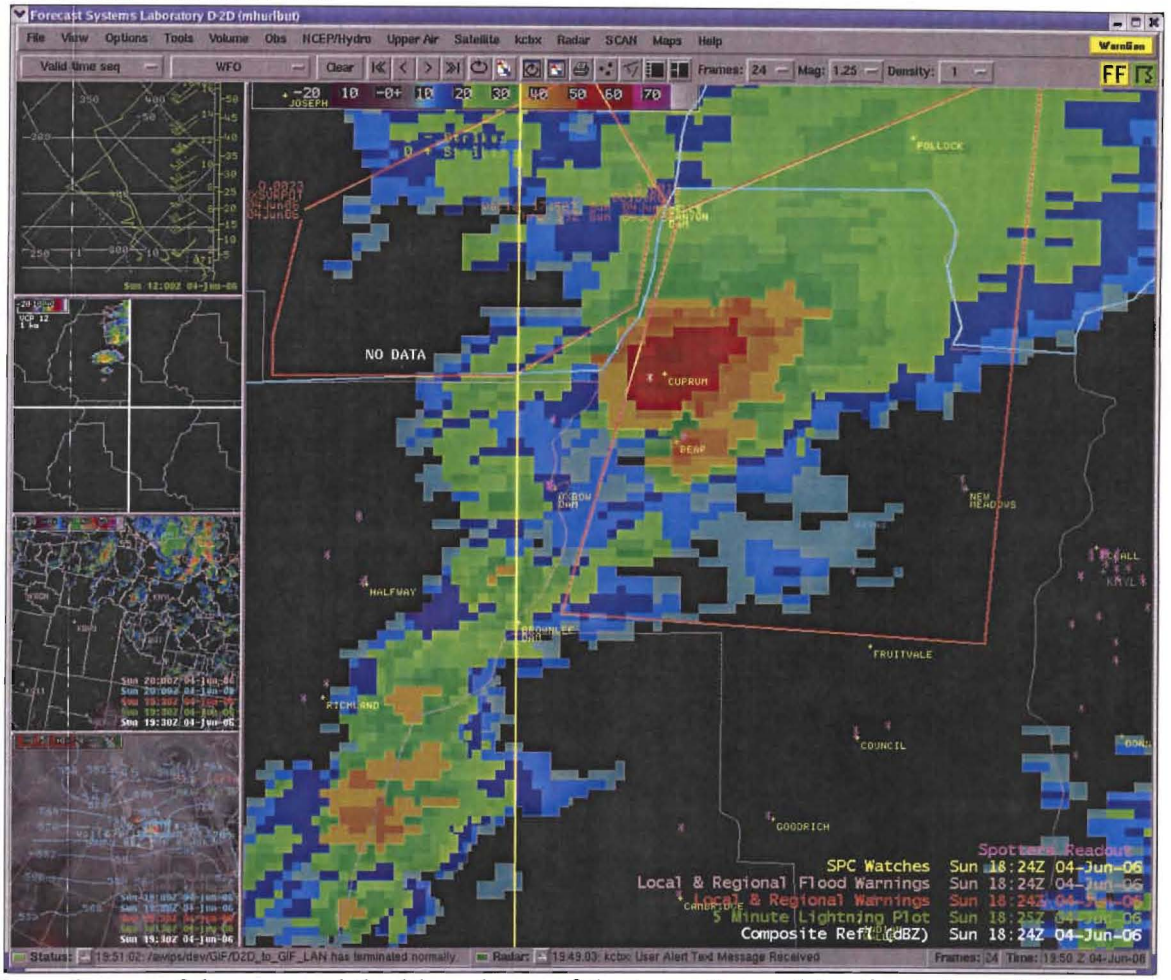
Storm Surveys: Paul Flatt and Dawn Fishler drove to Baker City the day of the event after we received numerous reports of widespread damage. These reports were slightly misleading as to the extent of the damage. Paul and Dawn documented large branches down and minor roof damage. Wind damage verified the warning in Baker County, but no substantial or widespread damage was observed. This damage was further northeast as the storm aquired supercell traits.

Jay Breidenbach and I drove to Bear, Idaho the following day. Upon first driving into Bear, the damage appeared to be mostly due to straight line winds. However, as we progressed down the road, it was evident that there was rotational damage as well. The storm had a forward motion northeast at 45 mph so with the rotation the most significant damage was seen on the right side of the storm. Acres of trees (initial estimate from USFS is 5000 acres) were uprooted and/or snapped and thrown to the ground. A path was visible. An aerial photo taken by the USFS revealed an estimated path of 12 miles and a width of ¼ to ½ of a mile.



Sheds and greenhouses were lifted up and hurled approximately 100 yards. Several residents gave eye witness accounts of rotation in the storm, debris being lifted into the air, and described the sound as something like a freight train or thunder that didn't stop.

Residents also gave estimated time of the tornado between 12:15pm and 12:45pm, which coincides with radar data.

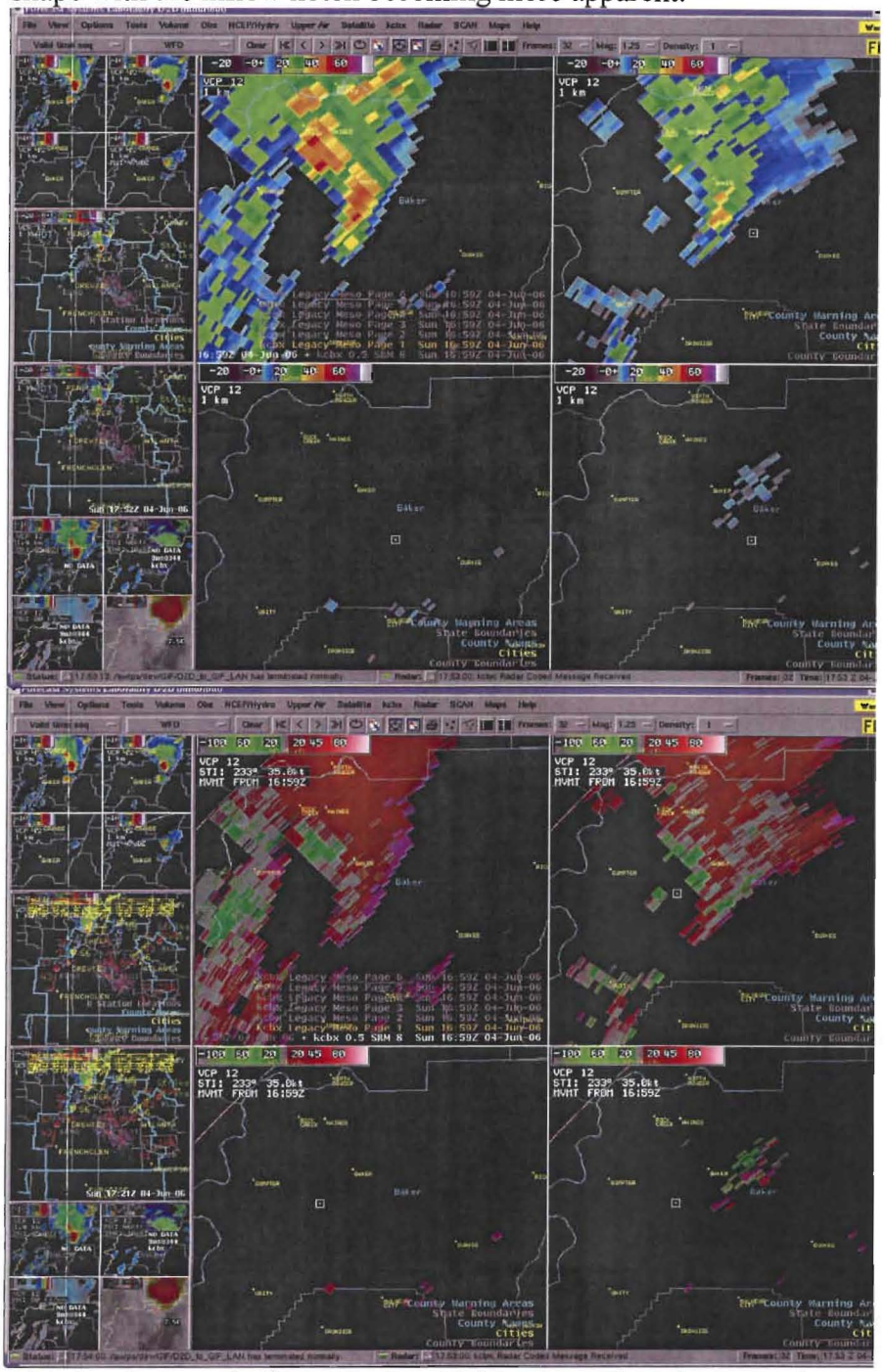


Based on roof damage and the blow down of the trees, Jay and I estimated an F1 tornado. Our storm survey was conducted in the location of first touchdown, and may have been one of the weakest parts of its lifetime. Following our initial assessment, two NOAA employees with more expertise in storm surveys were contacted. Their assessment was that the extensive blow down of pine trees and the width of the swath indicated a strong F2 with the possibility that it reached a weak F3 in some locations.

Despite widespread damage, there were no fatalities and only one injury was reported. This injury occurred at a camp site. A family was in their tent that is composed of metal structuring and is somewhat of a cross between a cabin and a tent. This structure included beds, and a small furnace. They heard the wind coming and attempted to take shelter. Several large trees were blown down crushing the tent with the family remaining mostly unharmed inside. These trees landed on the small furnace which then fell over on their 12 yr old boy giving him 3rd degree burns and a broken collarbone. It is speculated that the furnace saved the family from further harm, as the trees were leaning against it.

Preliminary Post Analysis: After examining radar data and viewing the damage, we have started to make our first reanalysis of how the storm progressed. The cell that

initially began on the southern portion of the squall line gradually began to intensify. It was not severe as it entered Baker County. As the storm intensified it began to take a bow shape with the inflow notch becoming more apparent.



This is where we believe that in a highly sheared environment it created bookend vortices. The counterclockwise rotation of the northern end was favored while the clockwise rotation in the southern end died out. It is here we believe that it first began to strengthen the mesocyclone. At this time the jet would have moved to the north enough that the storm was now placed in the left exit region. Shortly after the storm bowed out and the southern vortex weakened, the storm began to deviate to the right. Heating ahead

of the storm at the surface while cooling aloft associated with the front provided even better buoyancy as it progressed further to the East. The updraft was strong enough for the storm to sustain itself while it tracked along rugged terrain. A weak echo region began to form with indications that there was strengthening midlevel rotation. The storm continued to track across eastern Oregon into Western Idaho with reports continuing to indicate damaging winds and large hail. Just before the storm reached Bear and Cuprum, Idaho an interaction with terrain possibly acted to strengthen the severity of the storm. Bear is located in a narrow valley that is oriented southwest to northeast, or the same orientation as the storm inflow. It is possible that channeling of this flow could create a sort of "venturi effect", increasing the speed of the inflow into the storm. At this point a moderate to strong midlevel rotation was being detected on the radar and meso alerts were received at the workstations. Damage reports given in Cuprum and Bear support that this storm was not the more common "gustnado", but that it was formed from a mesocyclone. The largest hail was recorded in Cuprum beneath the highest reflectivities, while the tornado reported in Bear lines up with the weak echo region and midlevel rotation. It appears that the storm situated itself in the valley with unimpeded inflow and the tornado formed along the rear flank downdraft. It is most likely that the end of this cell came as it encountered a much more rugged terrain, cutting off the inflow that had sustained it for so long.