Surface Pressure Analyses...Clearing the Confusion In the Presence of Differing Solutions

A brief essay and training exercise on the various types of sea level reduction of pressure in models and analyses

Revised April, 2001

Case Study #1 and Case Study #2 are available for further study. Questions to be answered after completion of this module can be downloaded here.

Sea Level Pressure (SLP) is likely one of the most analyzed parameters in weather forecasting. Its use and value is multi-faceted. As such, it is important that we understand how SLP is calculated. With AWIPS, NWS forecasters are presented with a number of different 'versions' (or methods of reduction) of sea level pressure which can lead to a number of different sea level pressure solutions, especially for regions of high terrain. It is the purpose of this document to aid in the understanding of the differences and similarities between the SLP analyses we're presented with. But why is this important? I can think of several reasons:

- Horizontal pressure gradients are critical in the evaluation and forecast of surface wind direction.
- Knowing the magnitude and tendency of surface pressure can give a good assessment of the strength of a particular system.
- Correctly evaluating the location of surface low pressure can be critical in weather forecasting.
- Sea Level Pressure can serve as important information in the verification of a particular model solution.

Objectives

Upon completion of this material, the reader will be able to:

- Discuss the different reduction methods employed by the various models in the AWIPS operational sea level pressure analyses.
- Understand the most critical parameters in the reduction of sea level pressure.
- Understand the sensitivity of sea level pressure analyses to changes or errors in the temperature profile.
- Apply the information herein in day-to-day forecasting.

Introduction

In order to analyze and visualize the 'surface' horizontal pressure fields, the observed (or forecast) surface pressure must be 'reduced' to a common reference level. If the surface pressure (unreduced pressures) is plotted, one will simply see a reflection of the surface topography, because pressure varies greatly in the vertical (~1 mb per 10 meters), but only slightly in the horizontal (~1 mb per 100,000 meters). An example is shown here. For most applications, the common reference level is sea level, and hence the name of the reference pressure...**S**ea **L**evel **P**ressure (**SLP**). In order to 'reduce' surface pressure to sea level, one must integrate the hydrostatic equation from the station pressure level (**Pst**) to sea level (**Psl**) to account for all that fictitious 'air' below the ground:

ln (Psl) = ln (Pst) + (g / (RTm)) Zst

A critical parameter in this reduction is **Tm** (the mean temperature of the layer from sea level to the station level **Zst**), because the 'weight' of the air is heavily dependant on its' temperature. Tm may be calculated from some surface value (or surface estimate), and the standard atmosphere (or some given lapse rate) below. The value of Tm is important because the temperature of the layer between the surface and sea level will have a significant impact on the calculated SLP, especially at higher elevations (where your integrating through a larger layer).

One can quantify the sensitivity of the SLP to changes/errors in the Tm values. If we simply take the differential of **ln(Psl)** in Equation 1 above, one gets:

***d*Psl = [(-g(Psl)(Zst)) / ((R)(Tm)**2)] *d*Tm**

By plugging in the appropriate values, it can be demonstrated that in typical cold winter conditions, at altitides of around 5,000 ft MSL, a difference of 5 C in the mean temperature will lead to differences of about 7.5 mb! With warmer temperatures, the difference is somewhat less. **A practical rule of thumb is that the *maximum expected error in SLP (mb) will be 1.0 to 1.5 times the anticipated 'error' in the mean temperature (in Celcius) at elevations of 3000-5000 ft.***.

In summary...various methods of reducing station pressure to a common 'sea level' pressure exist. All these methods start by using the same measurement of the station pressure, then calculate the mean temperature of the layer between the station height and sea level. The calculation of T is the most significant parameter in the estimation of SLP. The derivation of T accounts for much of the difference between the SLP reduction methods addressed below. One fact which needs to be immediately made clear is that the *true* horizontal pressure gradient at the surface cannot be ascertained (Doswell 1988: *Mon. Wea. Rev,* pp. 1251–1252). **The various techniques of pressure reduction all produce *estimates* of the horizontal pressure field, each with it's own inherent weaknesses. There is no single true, correct solution of Sea Level Pressure...only estimates.**

"Standard" Surface Pressure Reduction For Surface Observations (MSLP)
[Surface -> Station Plot**]** on AWIPS[Surface -> Station Plot**]** on AWIPS

The best way to begin this study on deriving Sea Level Pressure is to describe how the NWS surface (ASOS) pressure observations are reduced to sea level. The most commonly used sea level pressure is **M**ean **S**ea **L**evel **P**ressure - that reduction which is performed by ASOS. The steps which are taken to produce MSLP from ASOS observation are summarized below:

1) Actual (unreduced) surface pressure (station pressure) is measured.

2) The mean of the **surface** temperature at the observation time and 12 hours earlier is determined (to reduce any diurnal effects).

3) The mean temperature from the surface to sea level is calculated using the 12 hour averaged surface temperature, and an assumed lapse rate of 6.5 K / 1000m. The pressure is then 'reduced' to mean sea level using this value in the equation above. In practice, this step is performed through the use of an "R" value, which is essentially the pressure reduction ratio based upon the station pressure and average temperature for a given station.

4) An additional "plateau" correction is used to minimize the variations of annual mean SLP values.

Very interesting and misleading MSLP readings will often be output by ASOS at high altitude stations as a result of this methodology. One weakness is the effect of using the surface temperature in the calculation of the mean temperature of the below ground profile. For example, imagine if a very cold, but very shallow airmass moved across the high plains of eastern Colorado (elevation ~5000 ft). Observed MSLP may rise 6 mb with the passage of this cold air mass. Note, however, that much of this pressure rise will be the result of the integration of the cold temperatures *below the ground* to sea level, not the added pressure from the weight of the cold shallow airmass. If this same airmass moved over a surface station near sea level (with the same ambient conditions), the rise in observed MSLP with the passage of this air mass will be significantly *less*; but the change in station pressure should be the *same*! Can you think of why?

Local Awips MOS Program (LAMP) SLP Analysis:
[Surface -> LAMP -> MSL Pressure**]** on AWIPS[Surface -> LAMP -> MSL Pressure**]** on AWIPS

The LAMP MSLP analyses are an objective analyses of the ASOS MSLP values. As such, the LAMP MSLP analyses will be similar to hand analyses you may perform on the surface data, but subject to the smoothing inherent in an objective analysis.

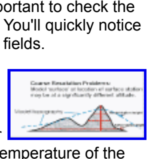
Local Area Prediction System (LAPS) SLP Analysis:
[Surface -> LAPS -> MSL Pressure**]** on AWIPS[Surface -> LAPS -> MSL Pressure**]** on AWIPS

The LAPS MSLP analysis is similar to the LAMP analyses in that they are both objective analyses of the observed surface station MSLP values. However, the LAPS MSLP analyses may integrate a greater number of surface stations for the analyses (when fully implemented), and are **interpolated to a much higher resolution grid (10km)**. Therefore, the LAPS MSLP analyses have the potential to preserve much of the detail and variation in the observed MSLP fields. These analyses are performed over a small domain (typically not much larger than the CWA of the local NWS office), and as such, until a relatively high density of surface observations are integrated into the analyses (which is not the case for the UNR CWA), the analyses are of limited additional value.

NGM / AVN Model SLP Analyses:
[Volume -> Browser -> NGM or AVN MSL Pressure**]** on AWIPS[Volume -> Browser -> NGM or AVN MSL Pressure**]** on AWIPS

The NGM and AVN models use the **'Shuell'** method to calculate SLP, which roughly tries to duplicate the standard MSLP reduction described above. However, no time averaging of the surface temperature is employed. **In order to calculate the mean temperature, the model "surface" temperature, and the standard atmosphere lapse rate (6.5 C / 1000m) are used**. However, there are restrictions imposed on maximum temperatures allowed in the analyses (special averaging is employed if the temp at ground level or 1000mb are above 17.5 C). Essentially, the Shuell method differs from the standard (ASOS) MSLP reduction method in three respects: **1)** the Shuell method uses a "ground" temperature which is really a layer somewhat above the model surface; **2)** it imposes restrictions on the temperature increase used for the reduction; and **3)** it does not do any time averaging of the temperature fields.

Because this method uses the near surface model temperatures for it's reduction of SLP, it is very important to check the surface temperatures and surface temperature gradients when analyzing NGM / AVN SLP pressures. You'll quickly notice that when significant errors do occur, the cause can easily be explained by a poor model temperature fields.



One additional aspect to keep in mind about the AVN and NGM models which use the Shuell method. These AVN and NGM are the coarsest models we regularly peruse, and as such have specific limitation on their estimates of SLP. One such limitation is that the topography will be significantly smoothed in these models, and therefore stations which are near large mountains (such as Denver or Reno) will typically not have pressure analyzed well by these models for two reasons: 1) the surface temperature of the model is at a much higher surface than the 'real' surface; 2) there is a greater distance to extrapolate the surface temperature to the surface. The diagram on the right gives an example.

RUC Model SLP Analyses:
[Volume -> Browser -> RUC MSL Pressure**]** on AWIPS[Volume -> Browser -> RUC MSL Pressure**]** on AWIPS

The RUC SLP reductions are performed significantly different from the ASOS MSLP or Sheull reductions. In order to minimize unrepresentative local variations caused by local surface temperature variations or shallow airmasses, **the 700 mb temperature is used to estimate an "effective" surface temperature**, rather than the actual station temperatures. In practice, the standard lapse rate is used from 700 mb to the station elevation to determine the "effective" surface temperature. which, along with the observed station altimeter values, are then 'reduced' to produce sea level pressure using the standard lapse rate. This reduction method has been shown to be effective in preserving geostrophic continuity with reality more than the other methods. See Benjamin and Miller, MWF 1990, for further details on this method.

Note that if the atmospheric lapse rate between 700 mb and the surface station height is the same as the standard atmosphere, this reduction will be very similar to that of the MSLP reduction without the temporal temperature averaging.

Because 700 mb temps are used, there will not be a significant diurnal signal on the SLP values. Therefore, you may notice some variation between the RUC and other methods (such as the Shuell) where a diurnal signal may be present).

Note that if there is a significant inversion present (perhaps from a shallow cold air mass) the RUC (or MSAS) SLP estimate will likely be lower than that of the 'standard' MSLP calculation, because the RUC estimate of surface temperature will be higher.

MSAS SLP Analyses:
[Surface -> MSAS (MAPS) -> MSL Pressure**]** on AWIPS[Surface -> MSAS (MAPS) -> MSL Pressure**]** on AWIPS

The MAPS Surface Analysis System (MSAS) SLP reductions are performed similarly to the RUC method. With the MSAS analyses, **the ETA 700 mb temperatures are used to determine an 'effective' surface temperature**. Also, the station altimeter settings are used in the analyses, rather than the observed station pressure values. Since more altimeter observations are available than stations with observed pressure, it allows for more data to be ingested into the analysis.

Like the RUC SLP analyses, if there is an inversion present, the MSAS SLP will be lower than most of the other methods. Alternatively, if there is a deep, dry mixed layer to the surface, the RUC and MSAS SLP analyses will likely be higher than the other methods.

With the advent of AWIPS Build 5, we now have a Shuell-like reduction available for MSAS. This reduction uses the near-surface model temperatures like the reductions of the AVN and NGM.

ETA Model SLP Analyses:
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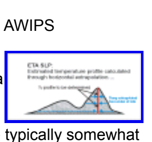


The ETA MSLP (EMSL) reduction to sea level is unique for it is actually a ***horizontal*** reduction method. As described in Mesinger and Treadon (MWF 1995), the *virtual* temperature profile beneath a given station is estimated by extrapolating the *virtual* temperature horizontally from surrounding data at a similar elevation. In most cases, this will mean relatively short extrapolations at the top of the profile, but potentially very large extrapolations at the bottom of the profile. The ETA SLP analyses are typically somewhat smoother than most of the other SLP analyses. Take a look at the graphic on the right for an explanation of this reduction methodology.

With the advent of AWIPS Build 5, we now have a Shuell-like reduction available for the AWIPS "MesoETA". This reduction uses the near-surface model temperatures like the reductions of the AVN and NGM.

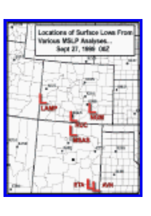
Analysis / Model	Temperature Estimation	Pertinent Characteristics, Biases, Inherent Errors
ASOS	Observed surface station temperature	Can show very large fluctuations at high elevations due to cold, shallow air masses or very warm temperatures. Temporal mean of temperature helps remove diurnal signal.
LAMP	Observed surface station temperature	LAMP analyses are analyses of the observed MSLP, and subject to the errors/biases above.
LAPS	Observed surface station temperature	Same as above, but performed on a high-resolution (10km) grid. May utilize a greater number of surface stations than LAMP.
NGM / AVN	Shuell Method (ASOS-like): Surface temperature (and below ground profile) estimated from near-surface model layer	Dependant on accuracy of model near-surface temperature fields. Calculated pressure will be slightly higher than ASOS MSLP at night and lower during the day (if surface fields representative) due to diurnal signal. Course model resolution will create anomalous values in regions of significant topography.
RUC	Temperature profile estimated from 700 mb temperature	Perhaps the best analysis method for preserving the geostrophic wind and pressure gradients. Generally a smooth analysis. Will exhibit relatively lower SLP values when strong shallow inversion present, and higher SLP values when deep, dry adiabatic lapse rates extend to the surface.
MSAS (MAPS Reduction)	Temperature profile estimated from NGM 700 mb temperatures	Perhaps the best analysis method for preserving the geostrophic wind and pressure gradients. Generally a smooth analysis. Will exhibit relatively lower SLP values when strong shallow inversion present, and higher SLP values when deep, dry adiabatic lapse rates extend to the surface.
MSAS (Shuell Reduction)	Shuell Method (ASOS-like): Surface temperature (and below ground profile) estimated from near-surface model layer.	Dependant on accuracy of model near-surface temperature fields. Calculated pressure will be slightly higher than ASOS MSLP at night and lower during the day (if surface fields representative) due to diurnal signal. SLP fields will have large gradients in areas of significant topography due to elevation-induced model surface temperature gradients.
ETA (ETA Reduction)	*Horizontal* reduction or virtual temperature - not as sensitive to surface temp.	Smooth, perhaps most consistent reduction technique.
ETA (Shuell Reduction)	Shuell Method (ASOS-like): Surface temperature (and below ground profile) estimated from near-surface model layer.	Dependant on accuracy of model near-surface temperature fields. Calculated pressure will be slightly higher than ASOS MSLP at night and lower during the day (if surface fields representative) due to diurnal signal. SLP fields will have large gradients in areas of significant topography due to elevation-induced model surface temperature gradients.

AWIPS Field Names...

Because of the confusion with the new SLP fields that we now have with AWIPS Build 5, the field names, displayed names, and reduction methodologies have been summarized in the table below. Note that several of the fields have changed! Thanks to Tom Salem for supplying this information...

Model / Analysis	**Name In Menu**	**Displayed Name**	**Reduction Scheme**	**Change from AWIPS 4.3?**
MSAS	MSL Press	MSAS NWS MSLP	Shuell	YES
MSAS	MSL Press (2)	MSAS MSAS MSLP	MAPS	YES
LAMP	MSL Press	LAMP MSLP	Analysis of ASOS Obs	NO
ETA	MSL Press	ETA ETA Model MSLP	ETA	NO
Meso-ETA	MSL Press	MesoETA MSL Pressure	Shuell	YES
Meso-ETA	MSL Press (2)	MesoETA ETA Model MSLP	ETA	YES
NGM	MSL Press	NGM MSL Pressure	Shuell	NO
MRF/AVN	MSL Press	MRF/AVN MSL Pressure	Shuell	NO

Implications and Considerations



The basic implication of the different methods of calculating MSLP is obvious...there will be significant differences in the calculated MSLP between the observations and various analyses, especially over higher terrain. **Note that one cannot assume that an alternate MSLP analysis is 'bad' simply because it does not agree with the surface observations, it may simply be a different interpretation of similar information.** For instance, look at the graphic to the right.

Notice how there are many different interpretations of where the surface low pressure has been analyzed. What is a forecaster to do in light of all these differing solutions? What systematic method should be used to analyze for the best solution?

Here's some guidance if there are significant differences in the estimated SLP values...

1) First check out how well the various analyses reflect the direction and magnitude of the observed surface winds. Which analysis appears most consistent with the observations?

2) Look at the thermal fields from which the analyses are estimating Tv to see if they are representative. For the NGM/AVN and (other Shuell reductions), look at the surface temperatures. For the RUC, look at the 700 mb temps, for the MSAS, look at the NGM 700 mb temps. Are these temperatures realistic?

3) Look at the upper levels. Since the station pressure will be a reflection of the state of the atmosphere, look at the thermal and kinematic features in the model, and compare them to the satellite imagery (or other remote sensing you may have; profilers, 88D, etc). Are the upper level features consistent with reality?

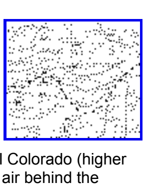
4) Understand the effect of the model topography. Models may give widely varying solutions based simply on how they're interpreting the topography.

5)The 'surface', or boundary layer winds in the models act *independent* of the model-derived SLP values. As such, they may serve as a better indication of the actual 'surface' pressure features.

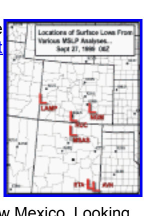
6)Constant height analyses near the surface may give valuable extra information on the true nature of pressure (height) gradients near the surface. Such analyses can be compared between various model solutions to assess model differences near the surface not affected by the derivation of SLP.

Case Study #1

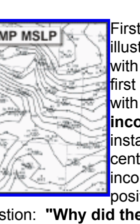
Click on the thumbnails to view graphics mentioned in the text.



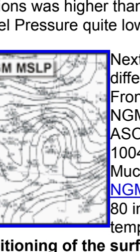
Late on September 26 (00Z, Sept 27) a cold front was slowly moving southward across the Central Plains. Temperatures ahead (south) of the front were generally in the 80s, with upper 40s to mid 60s behind the front. At 00Z on the 27th, the front was partially 'hung-up' on the high mountains of Colorado, with the eastern plains of CO mostly in the 50s and mid 60s in the cooler airmass, and warmer temperatures in western CO, and further to the south. These features are shown on the analyzed surface map at 00Z (see Figure at right). From the observed winds, one can imagine how the surface pressure fields *should* appear. The west winds over western Colorado and eastern Utah suggest a surface pressure gradient must exist with some east-west gradient over western and central Colorado (higher pressure to the west, lower pressure to the east). Higher pressure should exist below the dense, cold air behind the surface front, with a gradient that would support northeast winds over the eastern Plains of Colorado.

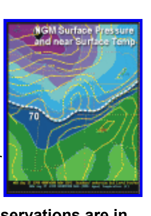


A strong thermal gradient will generally bring about a wide range of interpretations of SLP between the various models (especially over elevated terrain)...and this case was no different. A variety of different positions were analyzed at 00Z Sept. 27 for the low SLP analyzed in the area. Which is the 'right' solution? Is there a 'bad' solution here? Or are all of these 'correct' in some way? Which one will help you make the best forecast? This graphic illustrates why it is important to know what information is used to determine SLP in the different models. Let's take a moment to examine the differences in the different Sea Level Pressure analyses, and how they were derived.

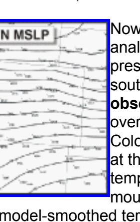


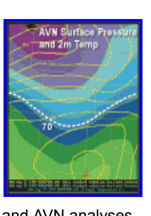
First, let's address the LAMP analysis (or the ASOS MSLP). This analysis illustrates a region of low pressure centered over western Colorado (1003 mb), with a trough extending to the south-southeast to a 999 mb low over southeast New Mexico. Looking first at the observed pressure values, one can see that the analyses agrees rather well (as it should) with the observed ASOS MSLP values. **The observed surface winds, however, illustrate several inconsistencies between the LAMP pressure gradient and the observed winds at this time**. For instance, the winds at Grand Junction (GJT), Eagle (EGE), and Alamosa (ALS) (and several other central Colorado locations) are not consistent with the gradient of the pressure field. Though these inconsistencies may partially be from topographical influence, it appears that a surface low or trough positioned further to the east may be more consistent with the observations. Which brings up a good question: **"Why did the ASOS observations indicate a surface low pressure center over western Colorado??"** The reason for the placement of the lowest pressure near Grand Junction is likely due to the **relatively high temperatures at GJT, MTJ, FMN, combined with the high elevation of these sites**. The virtual temperatue which was assigned these stations was higher than surrounding locations, and integrated through a larger depth, thus making the derived local Sea Level Pressure quite low.



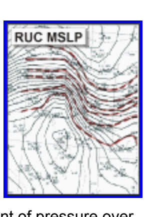


Next, lets look at the NGM SLP solution. This analysis illustrates a significantly different solution than the LAMP analysis, with a low center (1005 mb) along the Front Range of Colorado, just to the south of Colorado Springs. In general, the NGM analyzed pressures in southern Colorado are quite a bit higher than the ASOS / LAMP values, especially over western Colorado. Where ASOS had a 1004 mb low near Grand Junction, the NGM had sea level pressures of 1009 mb. Much of the differences observed in the pressure can be explained by looking the NGM near surface temperature fields. While the observed temperatures were near 80 in western Colorado, the NGM had temperatures only around 60! The temperatures on the front range were more representative. **Notice that with the positioning of the surface low further to the east (than the LAMP analysis), the surface wind observations are in agreement with the pressure fields over Colorado.** As such, the pressure analysis appears to be relatively 'good', but perhaps for the wrong reason...we know that the NGM analyzed pressures over western Colorado are too high, therefore the gradient across Colorado must be somewhat in error. Keep in mind, however, that the elevation of the model terrain will be quite different from the observation station elevations...if the model terrain is higher than reality, one would expect the model analysis temperatures to be higher if the model and actual temperatures were similar. As with all relatively course models, one must be suspect of the representativeness of the terrain in this area.

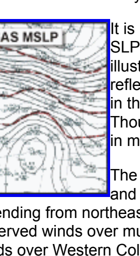




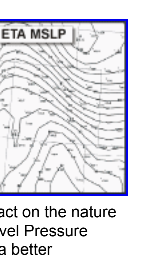
Now, on to the AVN analysis. This solution is very different from the preceding analyses in several respects. First, there is no hint of a secondary surface low pressure area in Colorado; but rather only a primary low center (1001 mb) in southeast New Mexico. **As such, this analysis is not as representative of the observed surface winds**. The AVN pressure field would support northeast winds over most of Colorado, while most of the observed winds over central and western Colorado are west or northwest. Why is this analysis unrepresentative? Looking at the surface temperature fields, it can be seen that the AVN surface temperatures, like the NGM temperatures, were not representative over the mountainous terrain - the model simply advected the cooler temperatures across the model-smoothed terrain much more efficiently than reality. Note the differences between the NGM and AVN analyses over southeast Colorado - the AVN did not catch on to the warmer temperatures over southeast Colorado (upper 60s) as well as the NGM did. Thus, the AVN did not analyze the local low surface pressure in eastern Colorado that was present in the NGM analysis. Note, that the pressure difference between the two models in this area was on the order of 2-3 mb, which is consistent to what you'd expect for temperature differences of about 4C (as was observed between the NGM and the AVN surface) according to the discussion in the first part of this document. In summary, one can explain much of the difference between the NGM and the AVN graphics from the differences in the temperature analyses, and the model topography. This brings to mind an important analysis point...**one must be careful when comparing thermodynamic surface fields from different resolution models...because of the analysis of the topography...they can be considerably different!**



The RUC analysis initially appears to be somewhat of a positional compromise between the LAMP (ASOS) and the NGM surface pressure analyses, but actually has several significant departures from those analyses. First, the primary (deepest) surface low pressure (996 mb) is located over south central Colorado, with only a shallower low pressure area to the south and east. As opposed to the NGM which illustrated higher pressures over western Colorado than ASOS, the RUC exhibited significantly lower pressures in this area, making the difference between these analyses 10 mb over southwest and southern Colorado! The lower RUC pressure over southen Colorado, combined with high pressure over northern Colorado, also created a very strong north-south pressure gradient across the state at this time. To find the source of these differences, we must look at the 700 mb temps (contoured in red on the figure), from which the Tv profile was determined in the RUC. In general, the surface pressure field mimicks the orientation of the 700 mb isotherms - the strong gradient of pressure over the northern part of the state is similar in nature to the gradient of temperature, and the the position of the low pressure trough is similar to the position of a 700 mb thermal ridge. However, the magnitude of the SLP low is difficult to explain. In comparison to the other SLP analysis, the RUC analysis appears to be very good. The pressure fields reflect the position of the cold front along the Front Range of Colorado, but the surface low over southern Colorado should, perhaps, be located further to the east, and the inverted trough could be deeper and extend further to the north to support the west winds over southern Wyoming.



It is interesting to compare the RUC and the MSAS SLP analyses, for both use the same method of SLP reduction, but the origin of the 700 mb temperature fields is different. The MSAS SLP analysis illustrates a pressure gradient which is more zonal (east-west) than that of the RUC, which is likely a reflection of the NGM temperatures which were used in the analysis. The position of the surface low in the MSAS analysis appears to be a bit too far south, given the strong westerly winds at Alamosa. Though one can not necessarily throw away an analysis from one observation, it is something to keep in mind.



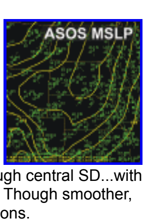
The ETA SLP solution appears to be somewhat of a compromise between the AVN and RUC solutions, with a very smooth appearance, and an inverted trough extending from northeastern New Mexico through central Wyoming. This analysis does not fit the observed winds over much of central and western Colorado - the analysis would support easterly winds over Western Colorado, while the observed winds were westerly! Though we do not have the ETA surface data available to estimate how the ETA came up with this analysis, it is entirely possible that the cold air over the Plains, which would interpolated to represent the 'reduced' airmass below the ground of the higher elevation Colorado areas, thus increasing the derived pressure in this area in not producing the desired trough over the central part of the state.

As can be seen in the analyses above, the method used in determining the MSLP can have a great impact on the nature of the derived MSLP field. The accuracy of other model fields will determine the accuracy of the Sea Level Pressure analyses. Differences in the MSLP can often be explained by examinations of models fields, leading to a better understanding of how representative the model is.

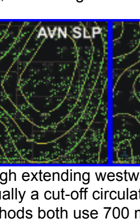
Case Study #2

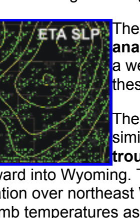
Click on the thumbnails to view graphics mentioned in the text.

This case study emphasizes some of the differences of calculated Sea Level Pressure that can be observed over the Plains (at lower altitude), and some unique sensitivities of the SLP reduction methods at night.

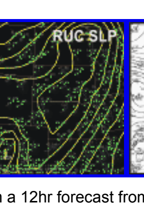


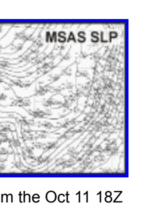
During the night of 11-12 October, a shallow cold front was moving southeastward across South Dakota. The ASOS MSLP analysis illustrated a 1011 mb trough through central SD, with high pressure building behind the slow moving front. A secondary trough axis extended westward into Wyoming where the surface winds indicated a possible circulation. The observed surface winds were generally in agreement with the MSLP analysis, illustrating an appropriate windshift along the trough axis, and stronger winds in the regions of tighter gradients.



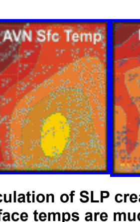


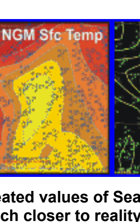
The AVN and ETA SLP analyses were **similar to the ASOS analysis**. Both demonstrated a similarly deep trough axis through central SD...with a weaker secondary trough axis to the west through Wyoming. Though smoother, these analyses both agree favorably with the surface observations.

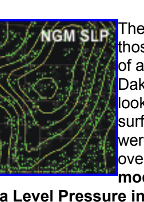




The MSAS and RUC SLP analyses, though similar, **demonstrated somewhat deeper troughs over the Dakotas**, with a deeper trough extending westward into Wyoming. The MSAS analysis, in fact, had virtually a cut-off circulation over northeast Wyoming. Remember that these two methods both use 700 mb temperatures as the basis for Tv, and as such **will likely have a *higher* value of Tv** used in the calculation of SLP (as the estimated surface Tv will be interpolated to through any existing shallow inversion). This will, in turn, could explain the lower SLP values observed in this case. [Note that the MSAS analysis is contoured at a higher resolution, and that the RUC analysis is from a 12hr forecast from the Oct 11 18Z run].







The NGM SLP analysis at this time is the most unique among those shown. The NGM analysis had the deepest low pressure of all the analyses, 1008 mb, within the trough over South Dakota. To find the reason for this anomalous low pressure, we look to the field from which this SLP estimate was derived...the surface temperatures. The NGM near-surface temperatures were very much in error, with temperatures in excess of 70F over much of western and central South Dakota. **The warm model surface temperatures which were used in the calculation of SLP created values of Sea Level Pressure in the NGM which were too low**. Note that **the AVN model surface temps are much closer to reality, and as such, result in a much better SLP reduction**.

Back to Weather Science

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