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MOISTURE INITIALIZATION IN THE MESO ETA MODEL

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Introduction

Moisture content in the atmosphere is an important factor due to its unique properties. In addition to the impact on the model processes such as latent heat release (e.g. during convection), and varied radiational reflectivities (e.g. cooling due to low-level stratus), the spatial and temporal distributions of moisture directly affect the precipitation forecast. Therefore, how a model initializes and modifies moisture fields is an important part of assessing the accuracy of the model's representation of the atmosphere.

During the summer months, moisture surges from the Gulf of California and the eastern Pacific Ocean present a forecast problem. These surges of moisture are associated with the development of convective activity which produce the primary source of monsoon precipitation over the Southwest. During several of these surges in the summer of 1995, soundings from the initial analysis of Meso Eta model and actual soundings were compared at five stations throughout the western United States: Tucson, Arizona; Desert Rock, Nevada; Salt Lake City, Utah; Reno, Nevada; and Great Falls, Montana.

Methodology

Several moisture surges from the eastern Pacific and Gulf of California occurred during the evaluation period. The soundings were studied, beginning before the moisture moved over the stations and ending when the moisture moved out of the region. Radiosonde observations and the initialization time step of the Meso Eta soundings are compared during these moisture surges. The stations for the Meso Eta soundings were chosen for a specific gridpoint rather than the station identifier to help alleviate error introduced by interpolation.

Moisture Initialization of the Meso Eta Model

The Meso Eta model uses an Optimal Interpolation (OI) scheme, called the mesoscale Eta Data Assimilation System (EDAS), to initialize moisture. The first guess for EDAS is provided by the Global Data Assimilation System (GDAS). GDAS relies primarily on radiosonde and SSM/I polar orbiting sounder data. EDAS incorporates new data every three hours within the Meso Eta domain (29km/50 levels). GDAS gives a global scale representation of the moisture and EDAS fills in the holes on the finer scale and updates the data every three hours.

Cases of Moisture Surges

Approximately 150 soundings were compared for four surge cases. Two cases were selected which illustrate how the Meso Eta typically modelled moisture surge events.

July 9-13, 1995

On July 9, mid-level moisture from the Gulf of California began to progress northward just west of Tucson. By July 13, the surge had moved as far north as Great Falls, Montana. The observed sounding on July 11 at 0000 UTC in Tucson (Fig. 1a) shows a shallow layer of moisture at the 500 mb level. The Meso Eta sounding for Tucson at 0300 UTC on the same day (Fig. 1b) did not capture the moisture at that level. However, the temperature profile was quite accurate. For example, the 500 mb temperature at Tucson is about -10 degrees C in both soundings. At the same time, the Salt Lake City sounding (not shown) showed a layer of moisture between 550 mb and 500 mb and the atmosphere above that layer being relatively dry. The Meso Eta sounding, however, did not show the moist layer near 500 mb, but made a very moist layer between 400 mb and 200 mb. On July 12 at 0000 UTC, the observed sounding for Great Falls (Fig. 2a) showed a moist layer between 550 mb and 450 mb along with a fairly moist layer between 375 mb and 250 mb. The Meso Eta sounding for 0300 UTC (Fig. 2b) did not contain enough moisture in either of those layers. In Tucson, the sounding (not shown) at 0000 UTC shows a moist layer which was not indicated on the Meso Eta sounding.

August 6-11, 1995

Moisture from the remnants of a tropical depression in the Pacific, off the end of Baja California, is provided with a path into the central west as a shortwave moves through the northwest. As the moisture pushed into Utah, the lower part migrated eastward over Arizona.

The sounding for Tucson on August 11 at 1200 UTC (Fig. 3a) indicates a very moist layer just above 600 mb and a dry layer between 400 mb and 300 mb. The Meso Eta sounding (Fig. 3b) hints at the moist and dry layers but the magnitude of these layers is not nearly as pronounced.

Cases of Dry Soundings

Although the main purpose of this study was to examine the Meso Eta sounding versus the radiosonde for moist cases, dry cases were also examined. In the dry cases, the radiosondes and the Meso Eta soundings were much more alike.

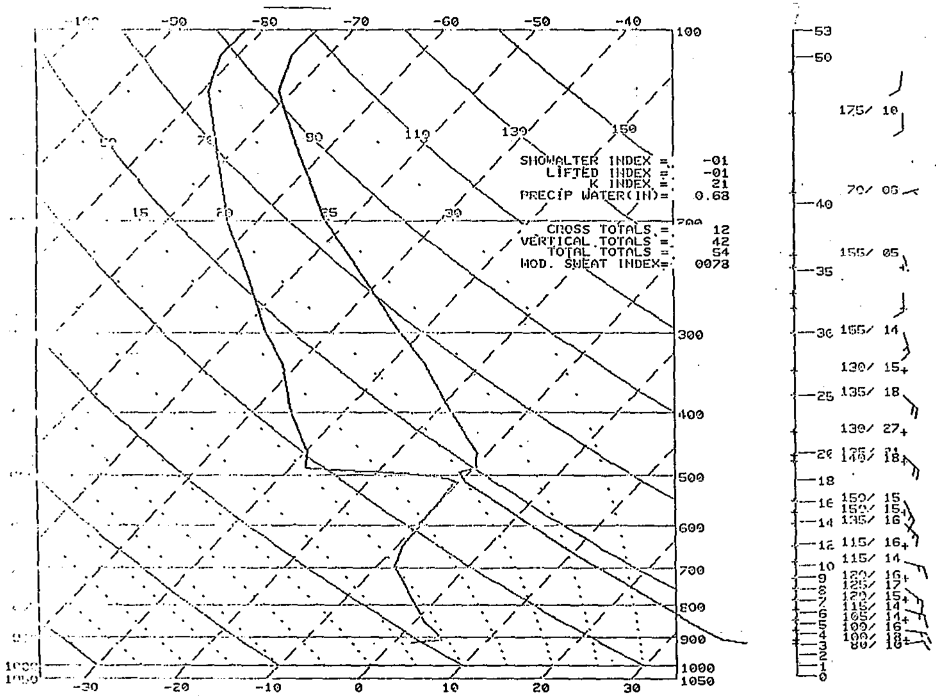
Discussion and Conclusions

There are well-known problems associated with the moisture initialization process currently used at the National Meteorology Center (NMC). Radiosonde data used in the data assimilation are sparse, even over the continent. When these soundings are interpolated, the vertical and horizontal structure of the sub-synoptic moisture field is poorly represented, especially over the mountainous Southwest. The problem is further compounded by the lack of adequate sounding data over the eastern Pacific. Moisture data in this region is derived from satellite sounder data, which lacks good vertical resolution and cannot be used when a cloud layer is present.

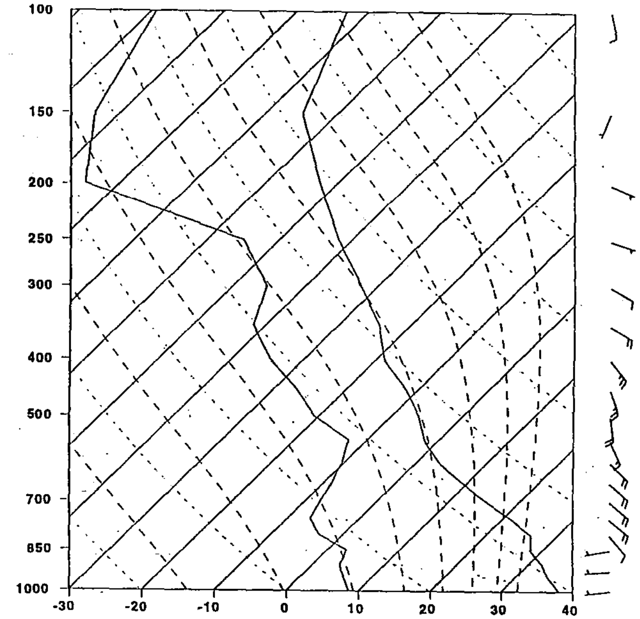
This study points out the critical need to improve the moisture initialization, as part of the larger goal of improving model QPF. Each NMC model is initialized differently; therefore, forecasters should carefully compare each model's initial moisture analysis with water vapor imagery and radiosonde observations.

Some future implementations may provide improvement in the initialization of the moisture field. Future improvements to EDAS include using GOES-8 and GOES-9 sounder data, which are more accurate than GOES-7, the assimilation of precipitation, a variational scheme (which will better assimilate surface observations and other sub-synoptic data sources), and the initialization of clouds. These improvements will take time. In the meantime, this study points out the need for forecasters to examine the vertical structure of the moisture fields, initial analyses, and forecast model soundings. The model may have a good handle on the temperature and wind fields, but the model QPF can be significantly impacted by a poor moisture analysis.

1a



1b



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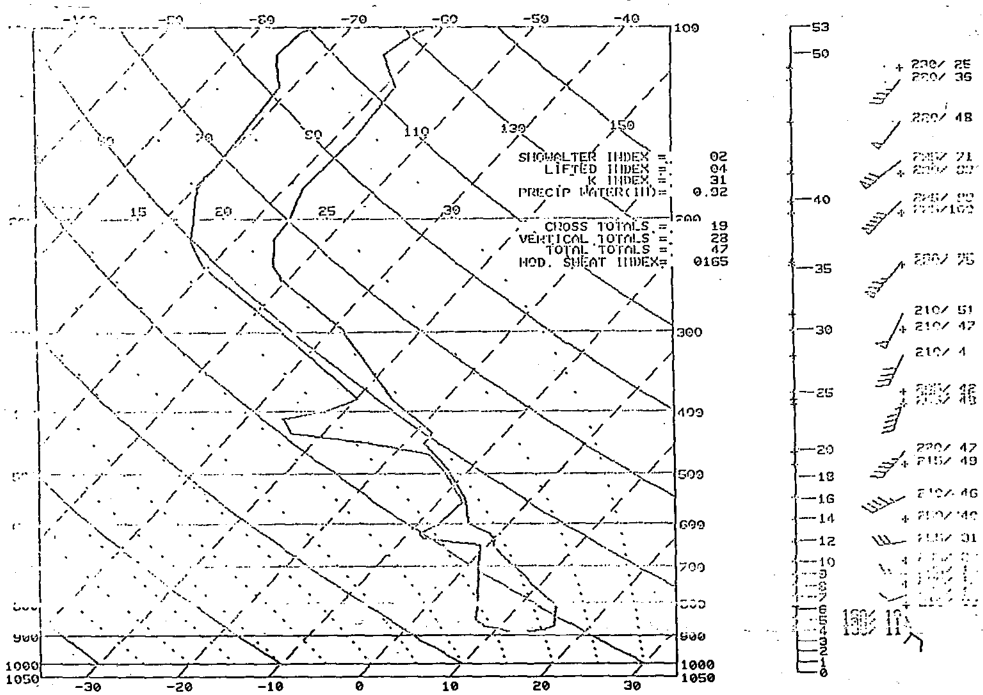

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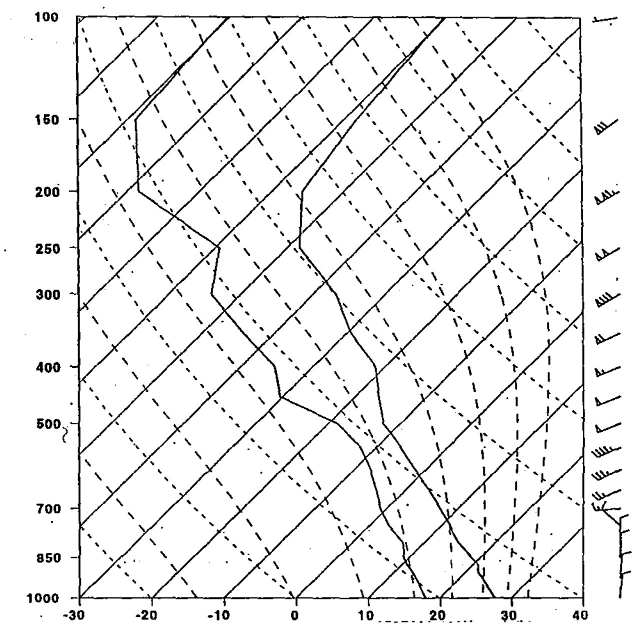
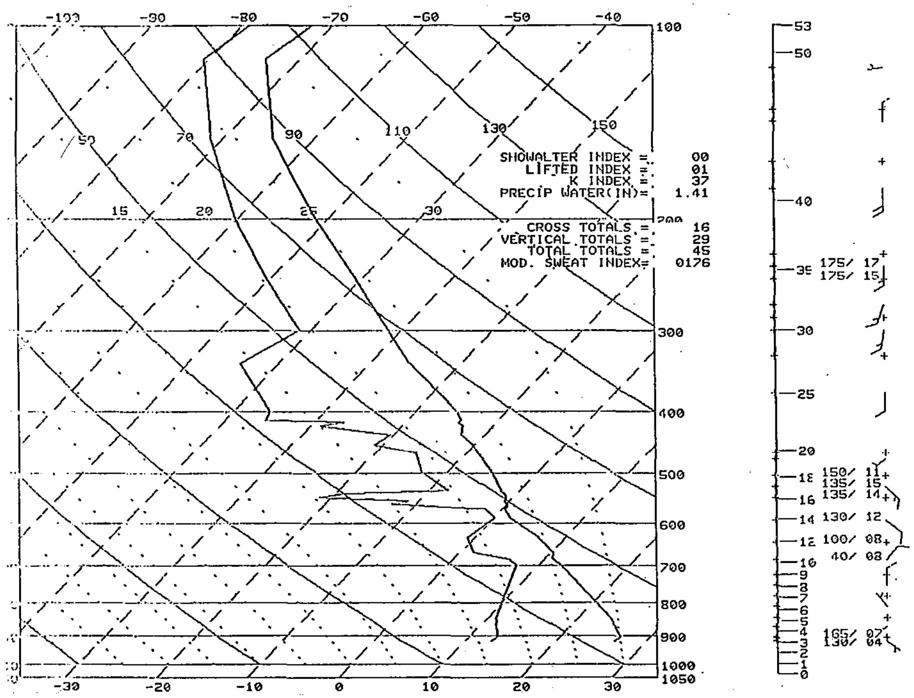


Fig. 1a Tuscon,AZ July 11,1995 Radiosonde 00z, Fig. 1b Tuscon,AZ July 11,1995 Meso Eta Sounding 03z, Fig. 2a Great Falls,MT July 12,1995 Radiosonde 00z, Fig. 2b Great Falls,MT July 12,1995 Meso Eta Sounding 03z.

3a



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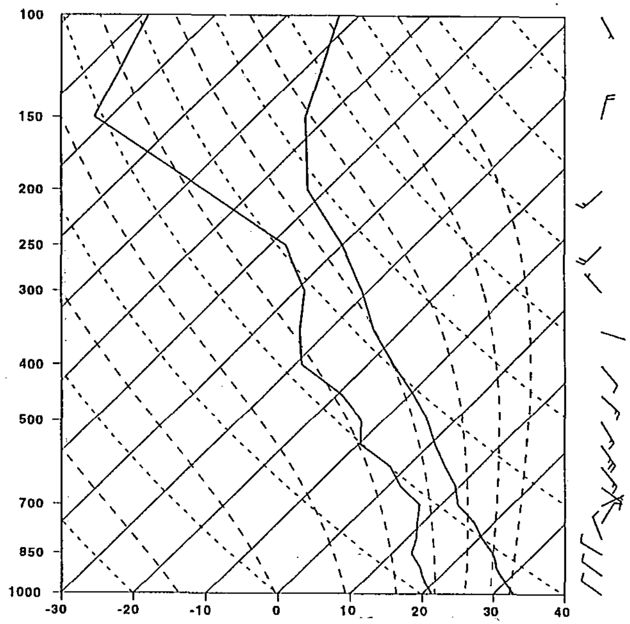

Fig 3a Tuscon,AZ August 11,1995 Radiosonde 12z, Fig. 3b Tuscon,AZ August 11,1995 Meso Eta Sounding 15z