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Degradation of the North American Radiosonde Network

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Over the last five years the National Oceanic and Atmospheric Administration (NOAA) has instituted significant changes in the North American radiosonde network. These changes, prompted by needs to modernize the National Weather Service (NWS) in an environment of fiscal austerity, have contributed to the degradation of the network and may have an adverse impact on operations and scientific research. The principal changes may be summarized as follows:

1) Introduction of an automatic radiotheodolite radiosonde system (ARTS)
2) Introduction of a second sounding system with different error characteristics into the domestic network.
3) The relocation of radiosonde stations as part of a NWS effort to consolidate forecast offices.
4) The loss of the 0000 UTC Mexican soundings due to curtailment of NOAA support for the program.

The original ARTS sounders proved to be extremely sensitive to nearby lightning strikes as noted by Schwartz (1990). It was not unusual to have as many as ten stations out of operation at a given time (some were out for two months) during the summer of 1986. An inadequate supply of spare parts contributed to the downtime at several locations. The situation was most severe in the western United States where forecasters on occasion could not resolve important subsynoptic scale features in the radiosonde network. Likewise, case study analyses were less attractive for researchers because of the resulting significant gaps in the upper-air data coverage.

The ARTS sounders continue to be plagued with problems. As a very recent example, Fig. 1 shows the transmitted sounding for Dayton, Ohio (72429) at 0000 UTC 15 June 1990, the evening before the devastating flood in Shady Side, Ohio. This faulty ARTS sounding (the temptation to use the obvious acronym is resisted) was partially rejected by the National Meteorological Center (NMC) with all heights and temperatures deleted at and above 500 mb as noted on the 0235 UTC 15 June 1990 operationally transmitted radar chart and confirmed from inspection of the 0000 UTC 15 June 1990 constant pressure maps. The problems, however, began at the ground with a transmitted (observed) surface temperature and dew point temperature of 27.2°C (22.8°C) and 25.2°C (21.1°C), respectively. (Ambient 0000 UTC temperatures/dew point temperatures in Ohio ranged from 22–27°C/20–22°C under clear skies to thunderstorm conditions). The geopotential height and temperature errors at 72429 expressed as a departure from ambient conditions at the standard pressure levels were as follows: 850 mb (+23 m, +3°C), 700 mb (+44 m, +3°C), 500 mb (+120 m, +13°C), 300 mb (+370 m, +22°C), 250 mb (+510 m, +30°C) and 200 mb (+720 m, +36°C). Daily problems with the ARTS sounders persist, suggesting that important instrumental design and/or quality control issues remain to be resolved.

On 1 March 1989 the NWS began using a new type of radiosonde at selected upper air stations in western North America. In preliminary testing the second sonde exhibited warm biases of 0.3°C (10 meters) in the middle and upper troposphere ranging upward to 0.8°C (40 meters) in the lower stratosphere both day and night. This introduction of a second sonde into the upper-air network with different systematic and random error characteristics could conceivably have an adverse impact on the model analysis and initialization cycle at the NMC.

Over the last several years there have been a number of radiosonde site relocations (Oklahoma City, Oklahoma to Norman, Oklahoma; Boothville, Louisiana to Slidell, Louisiana; Salem, Illinois to Paducah, Kentucky; and Victoria, Texas to Corpus Christi, Texas) with more to come. These relocations, forced by ongoing budgetary cuts, NWS reorganization and local site problems, are further reducing the homogeneity of upper air station coverage across the United States, especially in portions of the Midwest and Texas. There was also serious discussion (not approved) of relocating such stations as Wallops Island, Virginia; Cape Hatteras, North Carolina; Del Rio, Texas; and International Falls, Minnesota farther inland or away from international borders. Is it desirable to decrease upper-air data coverage along the rapidly growing coastal margins of the country? Is it a smart policy to increase
the NMC model analysis and initialization uncertainty in coastal regions by moving radiosonde stations inland when operational experience and scientific research shows the importance of sampling coastal baroclinic zones properly for the prediction of coastal frontogenesis and cyclogenesis? Is it wise to consider relocating a station site such as Del Rio, Texas, that is so ideally placed to sample the return flow of Gulf of Mexico moisture up the Rio Grande Valley prior to severe weather outbreaks? Given the intense scientific interest in the climate problem, shouldn’t benchmark upper-air observations be maintained over many years from fixed locations?

The most recent problem has been the loss of the 0000 UTC Mexican radiosonde observations. NOAA was forced to curtail support for twice-daily Mexican soundings under budgetary duress. Conceivably, however, the elimination of the Mexican soundings may have an adverse impact on operations. The 0000 UTC analysis and forecast cycle is the basis for the 10-day integration of the medium-range forecast model (MRF) used in support of NMC’s extended forecast responsibilities. An important question is to what extent the MRF forecast quality—as well as the shorter range regional analysis and forecast system (RAFS) might suffer from the absence of Mexican upper-air observations. The problem might be particularly important in winter when a deep trough is located over western North America with a jet streak in the base of the trough over northern Mexico. If the wind and temperature fields are not analyzed and initialized properly in a dynamically active region then how confident can forecasters be of MRF or RA$FS$ cyclogenesis prognoses over the southern United States in response to the eastward ejection of the Mexican trough? Would an inadequate analysis of the upper-level jet streak over Mexico have an adverse impact on the prediction of the low-level jet associated with the return flow of moist air from the Gulf of Mexico?

A similar problem would apply to the frequent cutoff 500-mb cyclones over the southwestern United States and northern Mexico. A crucial forecast issue is the prediction of the timing, location, and intensity of potential severe weather outbreaks east of the Rockies, especially in the late winter and early spring. The loss of the 0000 UTC Mexican radiosonde observations may conceivably degrade the analysis and initialization of the hot, dry air plume that forms over the Mexican Plateau and plays such a crucial role in severe weather outbreaks. Similarly, poorly analyzed tropospheric mass- and wind fields over Mexico might adversely impact the operational model prediction of the return moist flow from the Gulf of Mexico as the trough moves eastward. The problem is not restricted to the cool season. A proper analysis of the thermal, moisture and wind fields over Mexico is required for the successful prediction of important warm season phenomena such as flash flooding over the southwestern United States in the wake of landfalling Mexican hurricanes or from squall lines associated with the interaction of transient upper-air disturbances across northern Mexico, Arizona, and New Mexico in the presence of complex topography.

A fundamental point that has prompted this comment is that the operational data deployment decision-making process appears to be flawed. For example, the author was unaware of the impending loss of the 0000 UTC Mexican radiosonde observations until they stopped appearing on the routinely transmitted facsimile charts. Numerous phone calls were made to colleagues in other universities and at NMC to see if they had any advance word of the termination of the soundings but to no avail. This writer is left to conclude that the cutback decision was an administrative one made under budgetary duress at high levels by people forced to choose the least unattractive option. The current situation is unfortunate. Budgetary considerations alone should not be allowed to dictate the configuration of operational data networks independent of the needs of the user community. The existing radiosonde network is the cornerstone of the operational analysis and prediction system at NMC. The unprocessed soundings and gridded NMC analysis products derived from the sounding data are used extensively by the scientific community for a wide variety of theoretical, modeling, climate, and weather related investigations. High priority should be given to the reversal of some of these decisions or the consideration of new alternatives. It is imperative, however, that the user community be included in the decision making process in a more meaningful way than appears to be practiced at the present time.

REFERENCE