Using NCAR Reanalysis Data to Create a Climatology of Altimeter Error

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1. Introduction
Non-standard temperatures affect the accuracy of pressure-altimeter readings, which can pose a threat for general aviation, especially near elevated terrain during colder-than-standard temperatures. During colder temperatures, these aircraft are flying at lower altitudes than indicated by their altimeters. To quantify this risk, we are using archived model reanalysis data from the National Center for Atmospheric Research (NCAR) to create a 30-year climatology of Corrected D-values for the winter months for October through March. Air transport pilots currently use a parameter called D-value, which provides the estimated error between the true altitude and the pressure altitude due to non-standard temperatures (and humidity). Since general aviation pilots typically operate below Class A airspace, the D-values should be “corrected” for the non-standard surface pressure values to isolate the impact of non-standard temperature. Comparisons will also be made with a simpler rule of thumb based solely on temperature at flight altitude.

2. Research Objective
The goal is to help quantify the degree of altimeter error due to non-standard temperature in an effort to improve general aviation pilot education and awareness.

3. Methods
NCAR has archived model reanalysis data for easy download. For this project, mean sea level pressure, temperature, latitude, and longitude, at the 875 mb, 750mb, and 650mb levels were downloaded and converted into a netCDF format. These levels were chosen to represent pressure altitudes at 4k, 8k, and 12k feet. The formulas from Figure 2 were applied to every day during a single month then averaged over the month and then finally averaged over the 30 year period from 1981-2010. Advanced statistics were computed using NCL and include mean, variance, standard deviation, median, root mean squared difference and the difference between the Rule of Thumb (ROT) and the Corrected D-Value (Dc) terms. These statistics were computed and plotted on a side by side comparison to visually analyze the difference between the two methods.

\[ H_{IA} = \frac{T_0}{L} \left( \frac{P - RL/C}{P_0} - \left( \frac{P_{MISA} - RL/C}{P_0} \right) \right) \]  

\[ ROT = 0.004 \times (T_A - T_{STD}) \times h_{IA} \]

Figure 1: Thirty year mean for the month of January. The left-hand column represents the Corrected D-Value while the right-hand column represents the Rule of Thumb

Figure 2: Equation (a) is the Corrected D-Value term that accounts for non-standard surface pressure. Equation (b) is the Rule of Thumb Equation (a) is compared to. It is another general aviation altimeter correction equation.

4. Results

Figure 3: Thirty year median for the month of January. The left-hand side is the Corrected D-Value and the right-hand side is the ROT

Figure 4: Left-hand side shows the difference (Dc minus ROT) for January. The right-hand side shows RMSD for January.

Figure 5: Thirty year Standard Deviation for the month of January. The left-hand side is the Corrected D-Value and the right hand side is the ROT.

5. Conclusions and Future Work

• The ROT method underestimates when compared to the Corrected D-Value method which is assumed to be more accurate.
• In January 200ft difference or greater for most of US
• Largest difference in months of January and February at higher latitudes.
• Both equations very similar at the 4,000ft level, but differences become larger with altitude.
• Used to educate pilots with quantifiable error information.
• Analyze CFIT accidents and see if altimeter error was a cause.

6. References

Figure 1, 3, 4, 5: National Centers for Environmental Prediction/National Weather Service/NOAA/U.S. Department of Commerce. 1994, updated monthly. NCEP/NCAR Global Reanalysis Products, 1948-continuing.
