Using Dropsonde Descending Speed to Determine Vertical Air Velocity in a Hurricane

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The objective of this project is to derive the vertical air currents in hurricanes using a physics-based model to describe the dropsonde fall speed in still air. By assuming that the dropsonde falls at terminal velocity and in a vertical disposition in still air, a physics model can be constructed to calculate the still air fall speed. The vertical air velocity is the difference between the actual fall speed of the dropsonde and its fall speed in still air. The drag coefficient for calculating terminal velocity was determined empirically by searching for the best-fit fall speed in an altitude range that can be approximated as still air. For this entire project, I wrote MATLAB codes for model calculation, data analyses, and graphics. All data was taken from publicly available online sources (i.e. NOAA) or was provided by the Naval Research Lab in Monterey. A total of 291 dropsonde measurements of Hurricane Joaquin were analyzed. The terminal velocity model fit 260 of them, or about 89%. The resultant drag coefficients from each sounding were used to derive the vertical air velocity from each sounding. Two factors affecting the accuracy of the derived vertical velocity were also examined -- the range of altitudes used to optimize the drag coefficient to simulate the drop speed in still air and the tilting and tumbling of the dropsonde that change the vertical cross-section area. It was found that large errors may be associated with cases with extreme winds in the hurricane, while the majority of the cases show consistent drag coefficients throughout the measurement depth. Soundings in close proximity to each other also show consistent features of updraft and downdraft, indicating that the derived vertical velocity is physically consistent.

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Second Award of $2,000