Big Data Analysis Approach for Elliptical Pattern Identification

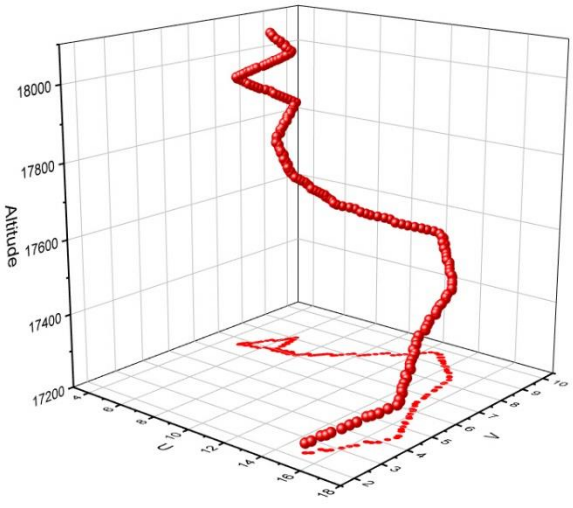
Background

The University of Idaho (UI) has been involved in a multi-institutional effort to quantify atmospheric gravity waves (AGWs) in the stratosphere. AGWs are a wave-based transfer of momentum and pressure through the atmosphere that can be caused by topography, weather patterns, and solar eclipse events. To detect AGWs, the UI team launches radiosonde instrumentation via high altitude balloons. Radiosondes transmit atmospheric conditions to a ground station throughout the duration of the balloon flight, including GPS data that is used to determine the wind speed and direction. When a radiosonde interacts with an AGW, the wave motion causes the radiosonde to travel in an elliptical pattern over a fixed altitude rise. This is an important distinguishing feature, as the Hodograph analysis approach is centered upon identifying these elliptical patterns in individual flight profiles. The ellipses are then fit mathematically, and parameters of the waves can be extracted from the fit. While this approach is simplistic, it is very labor intensive. For example, the UI team and their collaborators collected profiles from 100 flights in Chile in December 2020, during a total solar eclipse and the individual flight profile analysis is still on-going. UI is also actively planning for a nationwide citizen science data collection effort during solar eclipse events in 2023 and 2024 (>700 data sets for each event).

Objective

Develop a python programming approach for automating the identification of elliptical structures from collected radiosonde flight profiles. The program must be capable of analyzing multiple large data sets given the number of flights planned. The algorithm can be validated with analysis results from the 100 Chilean flights, and the long-term project goal is to apply this algorithm nationwide during the 2023 and 2024 campaigns.

Example: This single flight profile contains >7600 data points. It was visually inspected to identify 11 AGW candidates. This 173 data point subset represents the lowest altitude candidate. Note the enclosed pattern in the xy-projection, which is the identification target.



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