Interpolation Function

The interpolation function is used to figure out wind speed and direction for a given specific Altitude, Longitude and latitude. The interpolation function uses inputted data, and interpolates it with the given data set from NOAA.

The given NOAA data is very specific. The data consists of 12 altitudes, each with wind speed and direction data for specific longitudes and latitudes.

Pictured below is the wind direction at 20mb (27476.30194 meters above sea-level):

399	lon	lat	WDIR 20 mb
400	239.25	40	309.168
401	239.5	40	311.668
402	239.75	40	311.788
403	240	40	309.478
404	240.25	40	309.788
405	240.5	40	311.778
406	240.75	40	312.778
407	241	40	312.178
408	241.25	40	310.748
409	241.5	40	309.378
410	241.75	40	309.808
411	242	40	308.888
412	242.25	40	309.718
413	242.5	40	308.568
414	242.75	40	306.478
415	243	40	306.168
416	243.25	40	305.688
417	243.5	40	303.908
418	239.25	40.25	310.028
419	239.5	40.25	313.858
420	239.75	40.25	314.118
421	240	40.25	310.018
422	240.25	40.25	309.388
423	240.5	40.25	310.348
424	240.75	40.25	311.008
425	241	40.25	311.028
426	241.25	40.25	310.748
427	241.5	40.25	309.448
428	241.75	40.25	309.268
429	242	40.25	308.888
430	242.25	40.25	310.298
431	242.5	40.25	310.348
432	242.75	40.25	307.848
433	243	40.25	307.088
434	243.25	40.25	307.878
435	243.5	40.25	307.638
436	239.25	40.5	310.448

Longitude continues to increase by 0.25, until Latitude is increased by 0.25. The pattern continues until the last longitude (239.5) at 42.5 Latitude, then repeats for the next altitude.

The Interpolation function outputs the wind direction and velocity for very specific altitudes by estimating what it would be using the given data. For example, if given an input of (Altitude, Latitude, Longitude) = (27,476.30194, 40, 239.25), then the output for wind direction would simply be 309.169. However, if given an input of (20,000, 40.30, 241.08), the code must interpolate the data in order to output an accurate direction (the same goes for velocity).

Because the process for wind velocity is the same as wind direction, the focus will be just dealing with direction from now on.

When given the input (20,000, 41.03, 241.08), the code first looks for the two altitudes it falls between. 20,000 falls between 21,062 (50mb) and 18,706 (70mb) in the given data set. Both given altitudes contain 198 rows for wind direction. The function goes to the set of data within the altitude, and figures out which latitudes the inputted latitude falls within. In the example set (Altitude, Latitude, Longitude) = (20,000, 40.30, 241.08), the two are values 40 and 40.25. The function then goes through the longitudes corresponding to latitudes of 40 and 40.25, and checks which two values are closest to the inputted longitude. In this example case with the inputted longitude of 241.08, the two closest are 241 and 241.25 for the specific altitude. The directions corresponding to the longitudes 241 and 241.25 in the latitude 40 are 312.178 and 310.748. The directions corresponding to the longitudes 241 and 241.25 in the latitude 40.25 are 320.178 and 323.748. (The determined values above were only for the lower altitude, the same must be done for the upper altitude). The interpolation now begins, starting with these values.

Explained Simply, Take these theoretical values, for an input of

(Altitude, Latitude, Longitude) = (1000, 10, 150)

And theoretical values shown below that correspond to the NOAA data, as explained above.

$$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$$

Lower Alt = 500

STEP 1

Lower Lon (x_1): 100, Lower Lat (x): 5 = 20 (y_1)

→ Interpolated wind direction at our desired Lon: 150, Lat: 5 = 21 (y)

Upper Lon (x_2): 200, Lower Lat (x): 5 = 22 (y_2)

Upper Lon (x_1): 200, Upper Lat (x): 15 = 14 (y_1)

→ Interpolated wind direction at our desired Lon: 150, Lat: 15 = 18 (y)

Lower Lon (x_2), Upper Lat (x): 15= 23 (y_2)

STEP 2

We now have interpolated wind directions at two of the same longitudes, but now the values must be interpolated for our desired latitude, 10.

Lon (x): 150, Lower Lat (x_1): 5 = 21 (y_1)

→ Desired Lon 150, Desired Lat 10, Wind Direction = 19.5

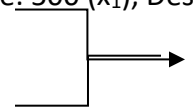
Lon (x): 150, Lower Lat (x_2): 15 = 18 (y_2)

Step 3

We now have a Wind Direction for our desired longitude and latitude, but at the specific altitude of 500. We want it for our desired altitude.

The same 2 step process above also occurred for the altitude of 1500, and the values from these two altitudes are interpolated to get our final answer.

Altitude: 500 (x_1), Desired Altitude: 1000(x), Wind Direction: 19.5 (y_1)



Wind Direction at Desired Altitude, Longitude, and Latitude = 21 (y)

Altitude: 1500 (x_2), Desired Altitude: 1000 (x), Wind Direction: 23.4 (y_2)

The Matlab functions that do everything stated above:

```
function [y2] = Interpolate(x1,x2,x3,y1,y3)
%Interpolate Interpolates for y2 using points (x1,y1) and (x3,y3)
y2 = (x2-x1)*(y3-y1)/(x3-x1) + y1;
end
```

```
%% Interpolate Data
% Upper Bound Direction
lowerBoundLatDirU = Interpolate(lonRange(1), lon, lonRange(2), upperBoundDirM(dataLatLonLoc(1), 3), upperBoundDirM(dataLatLonLoc(2), 3));
upperBoundLatDirU = Interpolate(lonRange(1), lon, lonRange(2), upperBoundDirM(dataLatLonLoc(3), 3), upperBoundDirM(dataLatLonLoc(4), 3));

upperBoundDir = Interpolate(latRange(1), lat, latRange(2), lowerBoundLatDirU, upperBoundLatDirU)

% Lower Bound Direction
lowerBoundLatDirL = Interpolate(lonRange(1), lon, lonRange(2), lowerBoundDirM(dataLatLonLoc(1), 3), lowerBoundDirM(dataLatLonLoc(2), 3));
upperBoundLatDirL = Interpolate(lonRange(1), lon, lonRange(2), lowerBoundDirM(dataLatLonLoc(3), 3), lowerBoundDirM(dataLatLonLoc(4), 3));

lowerBoundDir = Interpolate(latRange(1), lat, latRange(2), lowerBoundLatDirL, upperBoundLatDirL)

% Upper Bound Speed
lowerBoundLatSpdU = Interpolate(lonRange(1), lon, lonRange(2), upperBoundSpdM(dataLatLonLoc(1), 3), upperBoundSpdM(dataLatLonLoc(2), 3))
upperBoundLatSpdU = Interpolate(lonRange(1), lon, lonRange(2), upperBoundSpdM(dataLatLonLoc(3), 3), upperBoundSpdM(dataLatLonLoc(4), 3))

upperBoundSpd = Interpolate(latRange(1), lat, latRange(2), lowerBoundLatSpdU, upperBoundLatSpdU)

% Lower Bound Speed
lowerBoundLatSpdL = Interpolate(lonRange(1), lon, lonRange(2), lowerBoundSpdM(dataLatLonLoc(1), 3), lowerBoundSpdM(dataLatLonLoc(2), 3))
upperBoundLatSpdL = Interpolate(lonRange(1), lon, lonRange(2), lowerBoundSpdM(dataLatLonLoc(3), 3), lowerBoundSpdM(dataLatLonLoc(4), 3))

lowerBoundSpd = Interpolate(latRange(1), lat, latRange(2), lowerBoundLatSpdL, upperBoundLatSpdL)

% Final Values
windSpeed = Interpolate(altRange(1), alt, altRange(2), lowerBoundSpd, upperBoundSpd);
windDir = Interpolate(altRange(1), alt, altRange(2), lowerBoundDir, upperBoundDir);
```