Evaluating the use of HYSPLIT Back-Trajectories for Particulate Matter Sources

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Abstract

As air quality in major metropolitan areas continues to be further investigated and monitored, it is highly likely that graduates from environmental and earth science courses will find employment opportunities in the field of air pollution and air quality monitoring.

With this in mind, our project has the aim of identifying, implementing, and evaluating the basic principles of HYSPLIT back trajectories for a known event.

The period of peak PM_{10} values at the Vancouver International airport (YVR) during 2015 was identified, and the source of this pollution traced using HYSPLIT back trajectories. Synoptic maps and large scale weather patterns were analyzed to identify which heights and features are best evaluated when confirming the reliability of the HYSPLIT output.

With a large scale high pressure feature in place over the period in question, it become clear that the HYSPLIT back-trajectories were very accurate in identifying the source of the PM_{10} concentrations. The best representation in synoptic weather charts that correlates to the trajectories seen was found to be in the 700mb region. Satellite imagery allowed us to confirm that a large scale wildfire event in the Pemberton region was responsible for these pollution values.

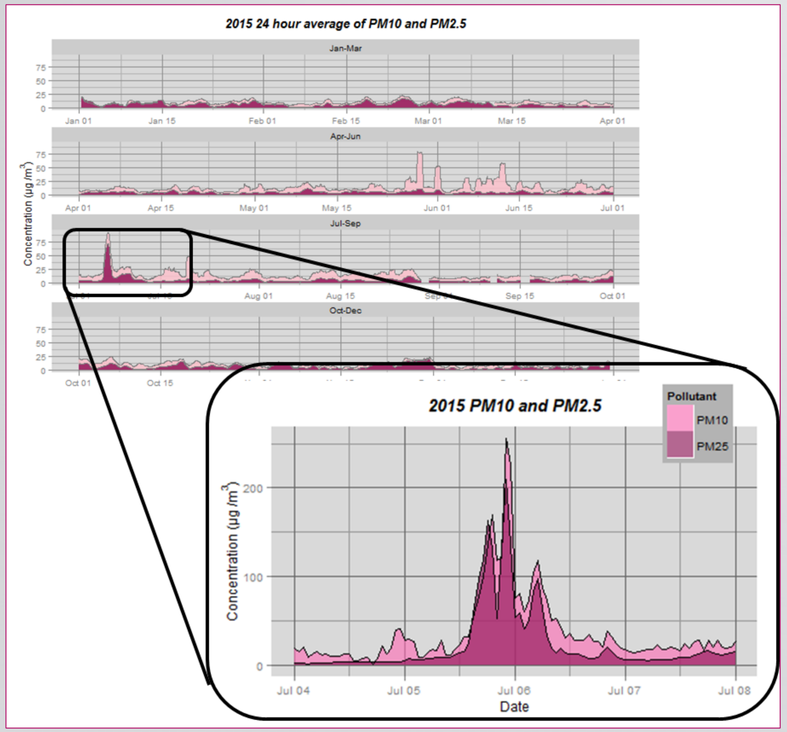

Figure 1. Particulate Matter concentrations at Vancouver International Airport, 2015

Methods and Materials

A 24 hour running mean of both PM_{10} and $PM_{2.5}$ was plotted for 2015 to identify periods of peak concentration.
Using the National Oceanic and Atmospheric Administration's (NOAA) online trajectory modelling tool 'HYSPLIT', the source region of the PM_{10} and $PM_{2.5}$ was identified using 'back trajectory' modelling runs.
The back trajectory plots were then compared against a range of synoptic products from both the Plymouth State University weather center, and from the NOAA Earth System Research Laboratory.
Finally, satellite imagery was obtained from the NASA MODIS spectrometer aboard the TERRA polar orbiting satellite.

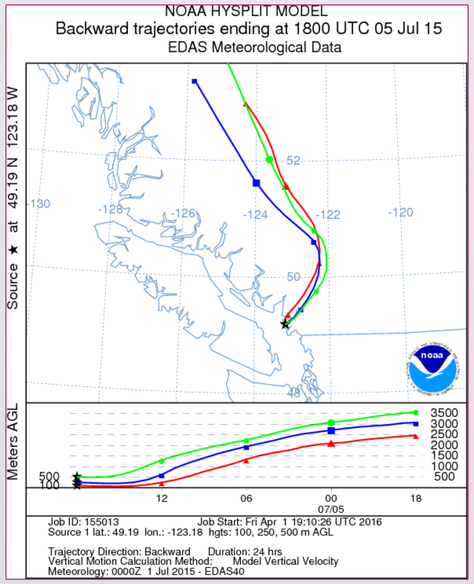

Figure 2. HYSPLIT Back Trajectory .

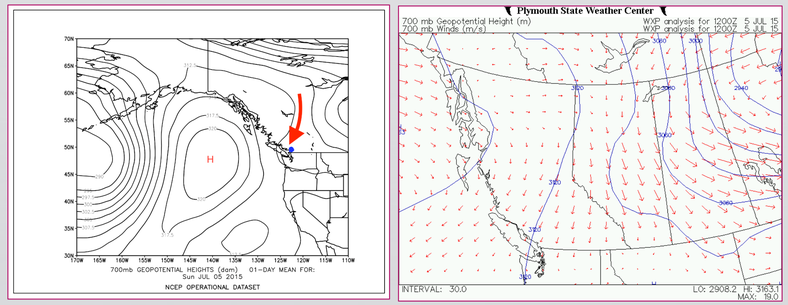

Figure 3. Synoptic Products from NOAA (left) and Plymouth State (right) for July 5th, 2015

Results & Discussion

It is visible from the 700mb synoptic maps that the winds during July 5th were north northeasterly at YVR.

The back trajectory products from HYSPLIT correlate with these wind profiles which confirms that users can utilize HYSPLIT's ability to identify possible pollutant source locations.

The satellite image in Figure 4 shows the prevailing wind's influence on wildfire smoke movement, heading towards the lower mainland from the Pemberton area. Pooling in the valleys and low lying areas is also evident, and this is supported by the high pressure system seen in the synoptic products.

Using the synoptic maps and satellite images to focus on a period of elevated particulate matter verifies how HYSPLIT can be of use in detecting the flow of pollutants to an area.

Hot Spots

The Nasa Modis satellite viewer is able to detect Thermal anomalies, which usually detect controlled burns, volcanos and wild fires. Using this feature with our other knowledge of $PM_{2.5}$ is useful for detecting areas that may be under wildfire conditions.

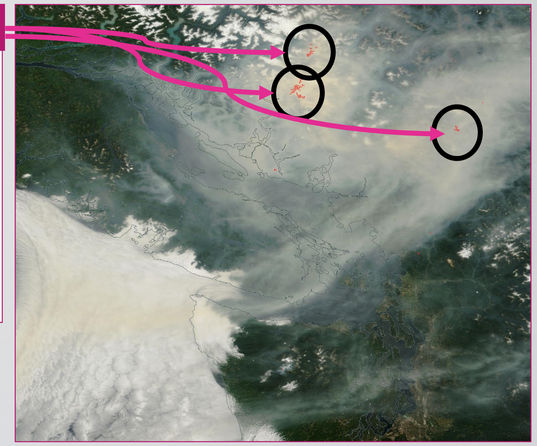

Figure 4. Visible Satellite July 5th , 2015

Conclusions

In this project we have confirmed the ability for HYSPLIT back trajectories to adequately identify sources regions of air pollutants, given the knowledge of approximate heights that should be investigated. This has been confirmed by analysis of synoptic scale weather features.

We have identified that $PM_{2.5}$ & PM_{10} concentrations from sources such as wildfires are influenced by synoptic scale motions around 700mb. This has been confirmed by the use of geopotential height maps and plotted wind vectors.

This contributes to the evidence that both students and professionals alike can utilize HYPLIT to accurately model pollutant source locations, and potential areas of high pollutant concentrations for a known period. The use of HYSPLIT greatly reduces the analysis required in determining these trajectories.

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