Atmospheric Formaldehyde (HCHO) Concentrations

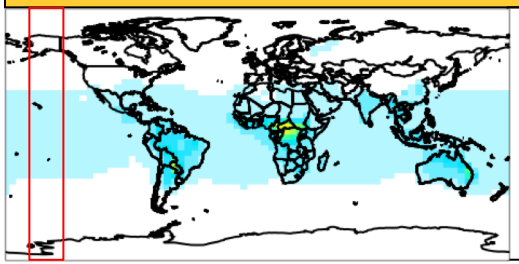
Mikhail Schee
Undergraduate Research Opportunities Program Spring 2018

1. Introduction

Volatile Organic Compounds (VOC's) in the atmosphere pose risks to health in countries experiencing industrialization. India has no systems in place to make ground based VOC measurements. Formaldehyde (HCHO) is a high-yield product of VOC oxidation and can be measured by satellites. Such measurements of HCHO can be used as proxy measurements for reactive VOC emissions.

The goal of this project is to establish any underlying trend in atmospheric HCHO over the remote Pacific, far from anthropogenic sources. These trends will act as a baseline in further research of the HCHO trends over India.

2. The Remote Pacific



For the purposes of this project, the remote Pacific refers to the region between 140 and 160 degrees west stretching trough all latitudes. This area is marked by the red box on the map. It should be noted that this region includes Hawaii and portions of Alaska.

3. GEOS-Chem & MERRA2

GEOS-Chem is a global chemical transport model driven by NASA's Goddard Earth Observing System (GEOS).

The Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA2) was used to provide input data to the GEOS-Chem model for this project.

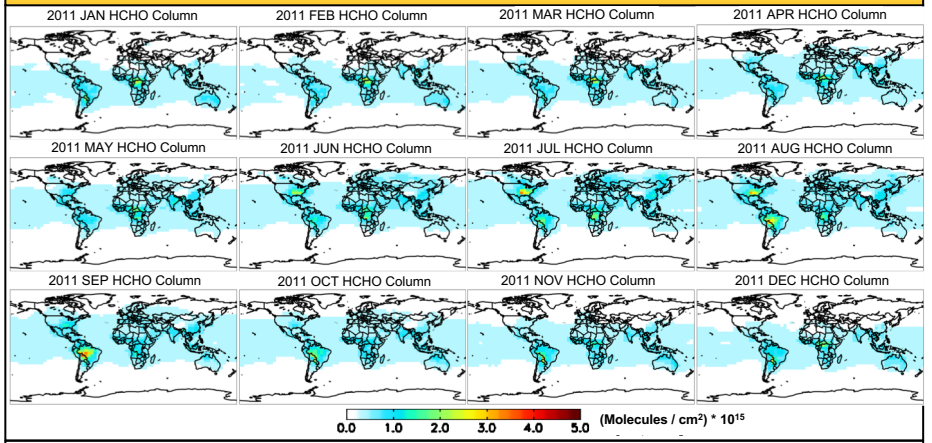
4. Formaldehyde Formation

The majority of biogenic HCHO in the atmosphere is formed by the following reaction:

$$VOC + OH \rightarrow HCHO + products$$

The presence of HCHO in the remote atmosphere is heavily linked to the presence of methane (CH_4). Over the remote pacific, where CH_4 is the only important HCHO source, it is expected that the trend in HCHO concentrations should closely follow the trend in CH_4 concentrations.

5. HCHO Distribution Across the World

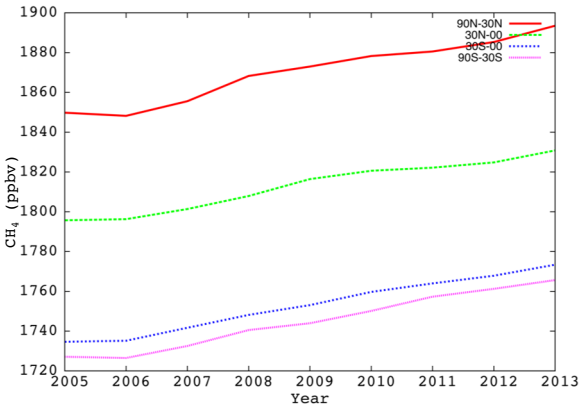


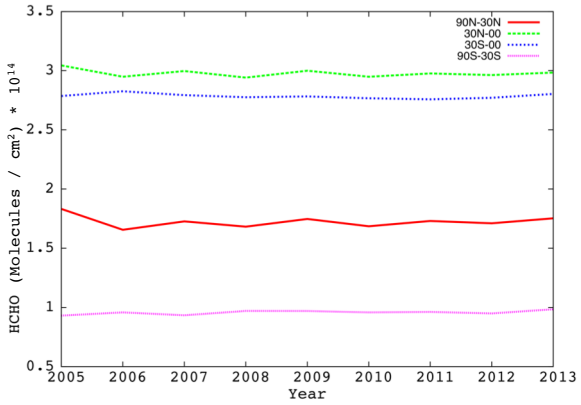
Above are plots of HCHO in the atmosphere averaged monthly over a characteristic year. Higher magnitudes are usually found over land and during the northern hemisphere's summer. This is because of anthropogenic sources such as fossil fuel burning and also biogenic sources like forests. Note that column values are also higher in the mid-latitudes and tropical regions.

6. Results

The top graph on the right shows the atmospheric concentrations of CH_4 averaged over 4 different latitude bands during the period from January 2005 to January 2013. The unit of ppbv means parts per billion by volume. All four bands have a clear increasing trend and the magnitude of the concentrations in the bands increases going northward.

The bottom graph on the right shows the concentrations of HCHO over the same latitude bands and time period, however the longitude range has been restricted to the remote Pacific. The unit of molecules / cm^2 refers to the number of molecules contained in a cm^2 column stretching from the planets surface up through the atmosphere. In this graph there is no discernable trend with time and the bands closer to the equatorial region have higher magnitudes.





Acknowledgements

I would like to thank professor Dylan Millet and Sreelekha Chaliyakunnel for their help and support in completing this project.