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'Missing volatile organic compounds' and their atmospheric impacts in the changing Arctic

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University Grant Program Report
UGP 2018: 'Missing volatile organic compounds' and their atmospheric impacts in the changing Arctic

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Background

The Arctic is warming faster than the rest of the world due to climate change. One of its consequences is the anticipated increasing concentrations of ambient volatile organic compounds (VOCs) emitted by plants, resulting from ongoing ecosystem transition ('greening' or vegetation shifts). This project aimed to measure those changes in VOCs in the Alaskan Arctic with UM's state-of-the-science mass spectrometer. The collected data will be used to answer overall questions on the implications for atmospheric chemistry in the Arctic:

a) to what degree are there significant biogenic VOCs present in the Arctic atmosphere due to warming climate and vegetation shifts?
b) what is the importance of biogenic VOCs in controlling other air pollutant levels such as ozone, formaldehyde, particulate matter in the Arctic?

Project progress

The project primarily supported a graduate student for preparation for the field campaign, and deployment of the Proton Transfer Reaction Time of Flight Mass Spectrometer to the Toolik Field Station in Alaska (68° 38' N, 149° 36' W). The field campaign took place between May 17 and June 28 for 6 weeks. We were not able to obtain a waiver of the Toolik Field Station user-day fees for the student's lodging and food from the National Science Foundation. Besides, the shipping cost for transporting the PTR-ToF-MS to and from Fairbanks, AK exceeded the budget due to the large dimension of the instrument which required special handling. Nevertheless, the user-day for the UM student and the shipping cost were absorbed by the existing NSF grant (E-Prop # 2017-164), and we were able to complete the field campaign.

Figure 1*. Left: Photo of the Toolik Field Station in the north slope of Alaska. Right:Photo of UM graduate student Catie Wielgasz replacing sampling inlet filter during the field campaign at the Toolik Field Station.*

We collected about 5 weeks of field data for atmospheric VOC concentration at the Toolik Field Station. The field deployment of PTR-ToT-MS was led by UM graduate student Catie Wielgasz (See Figure 1). The PTR-ToF-MS was used to collected the full mass spectrum (*m/z* 10-400) every 2 minutes. The instrument was calibrated every other day and instrument background was checked every few hours. We also collected data at 10 Hz for about one week; this data will be used as a test of our instrument's capability for eddy covariance measurements for VOCs fluxes.

We are currently processing the whole data set. This includes instrument inter-comparison with co-located Gas chromatography–mass spectrometry (GC-MS) measurements provided by the CU-Boulder collaborators. Figure 2 shows the preliminary data for ambient isoprene and methanol mixing ratios observed at Toolik. Major sources of both VOCs are from biogenic emissions. Isoprene mixing ratio reached to 1 part-per-billion by volume (ppbv) at the end of June. Again, we are still working on quality control of the data. One ppbv concentration of isoprene in the Arctic would certainly have implications for our understanding on the fates of tropospheric ozone in the remote area. In addition to biogenic VOCs, we also measured species hazardous air toxics (e.g., terpenes, aldehydes, alcohols, ketone, organic acids, aromatics) as well as previously unstudied VOCs.

This project so far has already led to several external proposal submissions (*e.g.*, E-Prop # 2018-574, 2018-628, 2019-290, 2019-619), including one proposal submitted to the EPA on topic of "missing volatile organic compounds" in fire smoke. As we process and further analyze the field observations, we anticipate manuscripts and more external proposal submissions will be forthcoming.

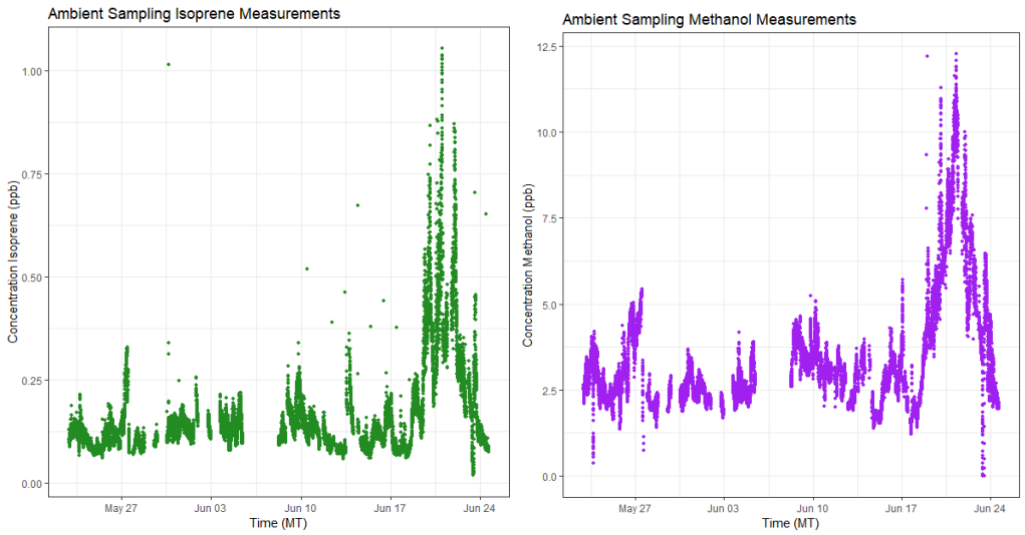

Figure 2*. Preliminary results of ambient isoprene and methanol mixing ratios observed at the Toolik Field Station in May – June, 2019.*