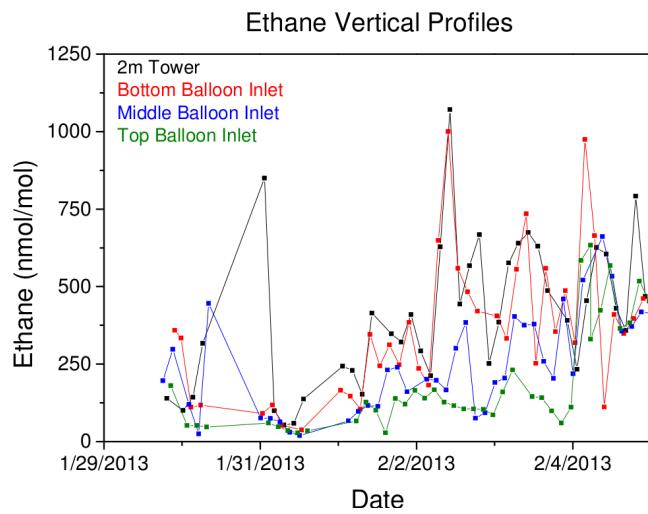


# Non-Methane Hydrocarbons During Winter Ozone Production Events in the Uintah Basin

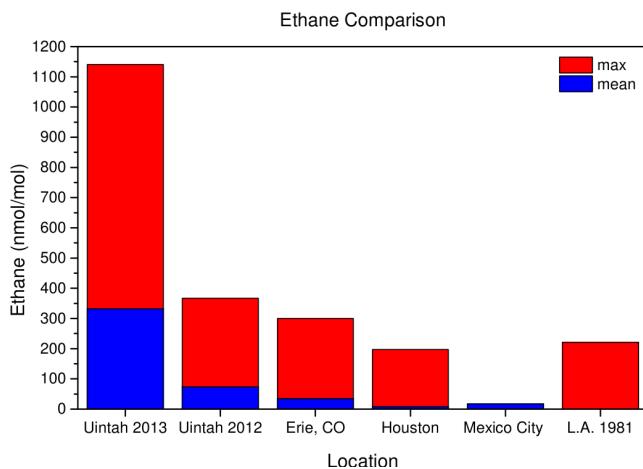
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Emissions of Non-Methane HydroCarbons (NMHC) are primarily linked to anthropogenic fossil fuel activities, such as oil and natural gas extraction and distribution, and are important tropospheric ozone precursors. The Uintah Basin, Utah, is a region of heavy oil and natural gas development where high winter-time ozone production events have been observed during strong inversions when there is snow cover present. In the winters of 2012 and 2013, we conducted measurements of methane and NMHC during the Uintah Basin Winter Ozone Study. NMHC were monitored along a vertical gradient up to 150 m using a flux tower and tethered balloon. In 2013, measurements of NMHC were also conducted from within the snowpack. In 2012, no high ozone events were observed. In contrast, during the 2013 study, several periods of high ozone occurred concurrently with strong increases in ambient NMHC. Here, we present vertical profile measurements of C<sub>2</sub>-C<sub>5</sub> alkanes, benzene and toluene comparing 2012 and 2013. Data from 2013 show strong vertical gradients with build-up of NMHC near the surface during inversion events leading to high ozone. The NOAA/INSTAAR global flask network provides a useful comparison for expected regional background values of NMHC, and we find up to a 570-fold enhancement in Uintah, providing evidence for the importance of local emissions sources. Additionally, we report evidence of in-snowpack chlorine chemistry from analysis of butane and pentane isomer ratios, indicating that the snow serves as a reactive chlorine reservoir that may enhance ozone production chemistry.



**Figure 1.** Observations of ethane from the surface (2 m) and from three inlets on a tethered balloon up to 150 m.



**Figure 2.** Comparison of mean and maximum ethane mole fractions measured in the Uintah Basin in 2012 and 2013, with reported values from other locations (Grosjean et al., 1984; Velasco et al., 2007; Duan et al., 2008; Gilman et al., 2009, 2013).