ITMA-04: SKiYMET Meteor Radar System at Poker Flat Research Range

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Poker Flat Meteor Radar Updates

Parameters

- 1x crossed 3-element transmit antenna
- 5x crossed 3-element receive antenna
- 30kW transmitter

2017

2018

Currently waiting for delivery…

Why ozone?

Key question from 2012 NSF Polar Research Meeting:
What is the role and impact of waves generated in the lower atmosphere on the thermal structure, composition, dynamics and **chemistry** of the polar middle and upper atmospheres?

Meteoric Chemistry

- Ozone reacts with meteor trails to reduce ionization [1]
- This only occurs when the trail has cooled sufficiently, so longer-lasting overdense meteor trails are affected more
- The result is increased decay rate for trails that last long enough to experience this chemistry

Ozone reactions with meteor trails

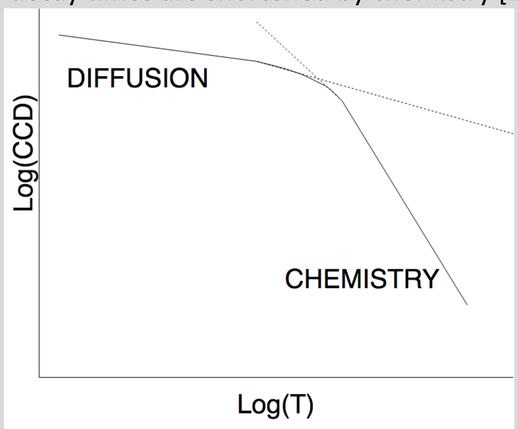
$$M^+ + O_3 \rightarrow MO^+ + O_2$$

$$MO^+ + e^- \rightarrow M + O$$

$$MO^+ + O \rightarrow M^+ + O_2$$

Estimating Ozone Density

- Plotting meteor trail decay times vs complementary cumulative distribution (CCD) of decay times illustrates effect of chemistry (figure adapted from one found in [2])
- Shorter decay times are dominated by diffusion, while longer decay times are shortened by chemistry [2]



Estimating Ozone Density Cont.

Two methods are proposed in [3] to estimate ozone density using back-scatter meteor radar:

Utilizing diurnal ozone variations

- Ozone density is higher in meteor region at night
- Differences between daytime and nighttime decay times could possibly be used to estimate ozone density

$$\exp(-t/T_{night}) = \exp(-t/T_{day}) \times \exp(-t/T_{chem})$$

- In arctic latitudes, daylight is highly variable throughout the year, another technique is needed

Utilizing ozone variations over larger time scales

- Examining decay times over a month could reveal seasonal variations in ozone density
- The slope of the "chemistry region" of the CCD plot will indicate ozone density, with steeper slopes corresponding to higher ozone densities
- Ozone densities for different months can be compared relative to each other, and a more precise relationship may exist to allow for better estimations

Coordinated Research

There is coordinated research at Poker Flat Research Range to quantify the role of wave-breaking processes in wind-driven circulation in the arctic middle atmosphere by combining wind and temperature measurements from both radar and lidar. For more information on these studies, see posters MLTL-01 and ITIT-12.

References

[1] W. Baggaley, "The de-ionization of dense meteor trains," Planetary and Space Science, vol. 26, pp. 979-981, 10 1978.
[2] W. Jones and J. Jones, "Ionic diffusion in meteor trains," Journal of Atmospheric and Terrestrial Physics, vol. 52, pp. 185-191, 3 1990.
[3] W. K. Hocking, R. E. Silber, J. M. C. Plane, W. Feng, and M. Garbanzo-Salas, "Decay times of transitionally dense specularly reflecting meteor trails and potential chemical impact on trail lifetimes," Ann. Geophys, vol. 34, pp. 1119-1144, 2016.