# METR01: New Meteor Radar at Poker Flat Research Range: First Observations and Analysis

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## Introduction

In November 2018, a new meteor radar system was installed at Poker Flat Research Range (65.13N, 147.49W). The primary goal is to extend the scope of studies in the Arctic by combining radar and lidar wind, temperature, and density measurements. This poster presents some “first light” results from the radar, along with some preliminary analysis of simultaneous radar and lidar measurements.

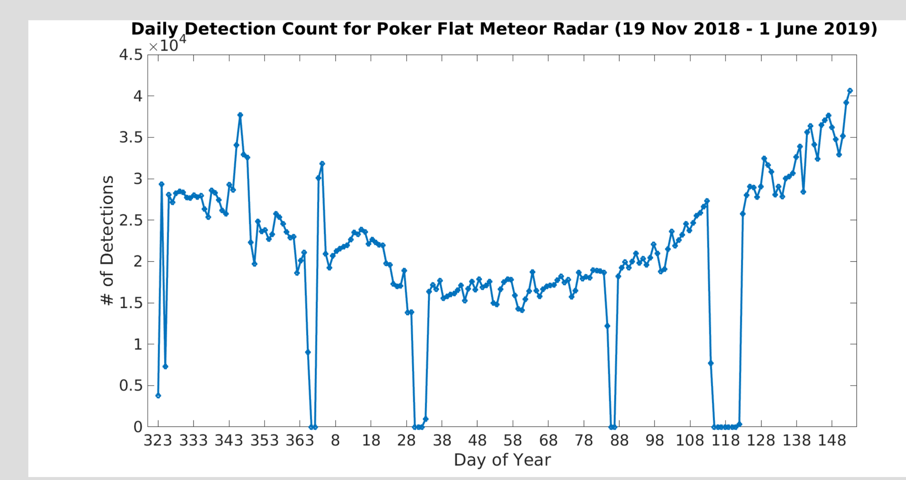
## Radar Specifications

The meteor radar system at PFRR is a standard SKiYMET installation with the following specifications:

- 32.55 MHz
- 625 PRF / 1.6 ms IPP
- 7-bit Barker sequence
- 30 kW transmit power

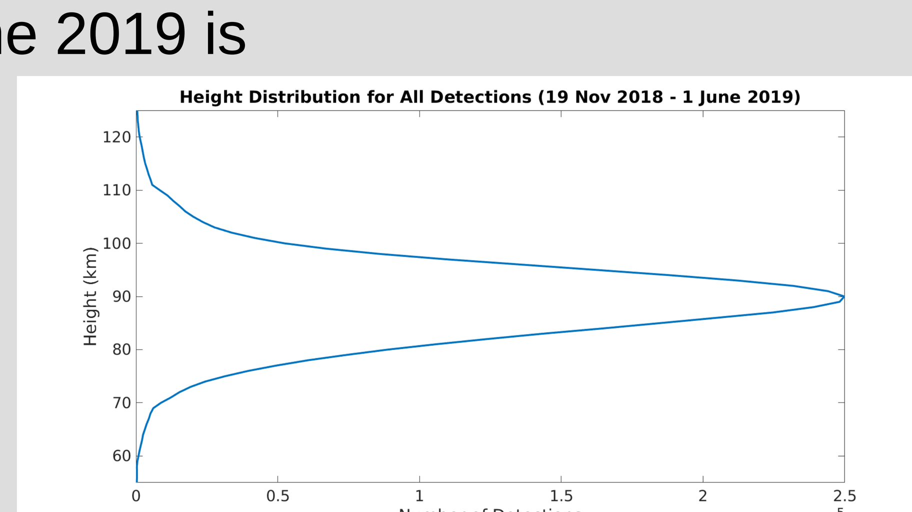
## Daily Detection Rates

The number of objects detected by the radar for each day is shown to the right. Outside of meteor showers, a seasonal variation can be seen. Days with near-zero counts correspond to the radar being off-line for maintenance.



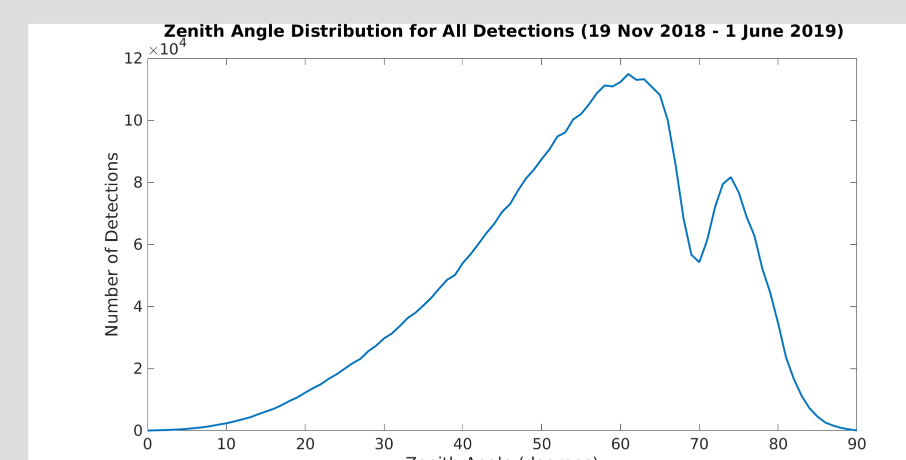

## Height Distribution

The height distribution for all detections between 19 Nov 2018 and 1 June 2019 is shown. All of the meteor detections are sorted into 1 km height bins. The peak of meteor detections is at 90 km.



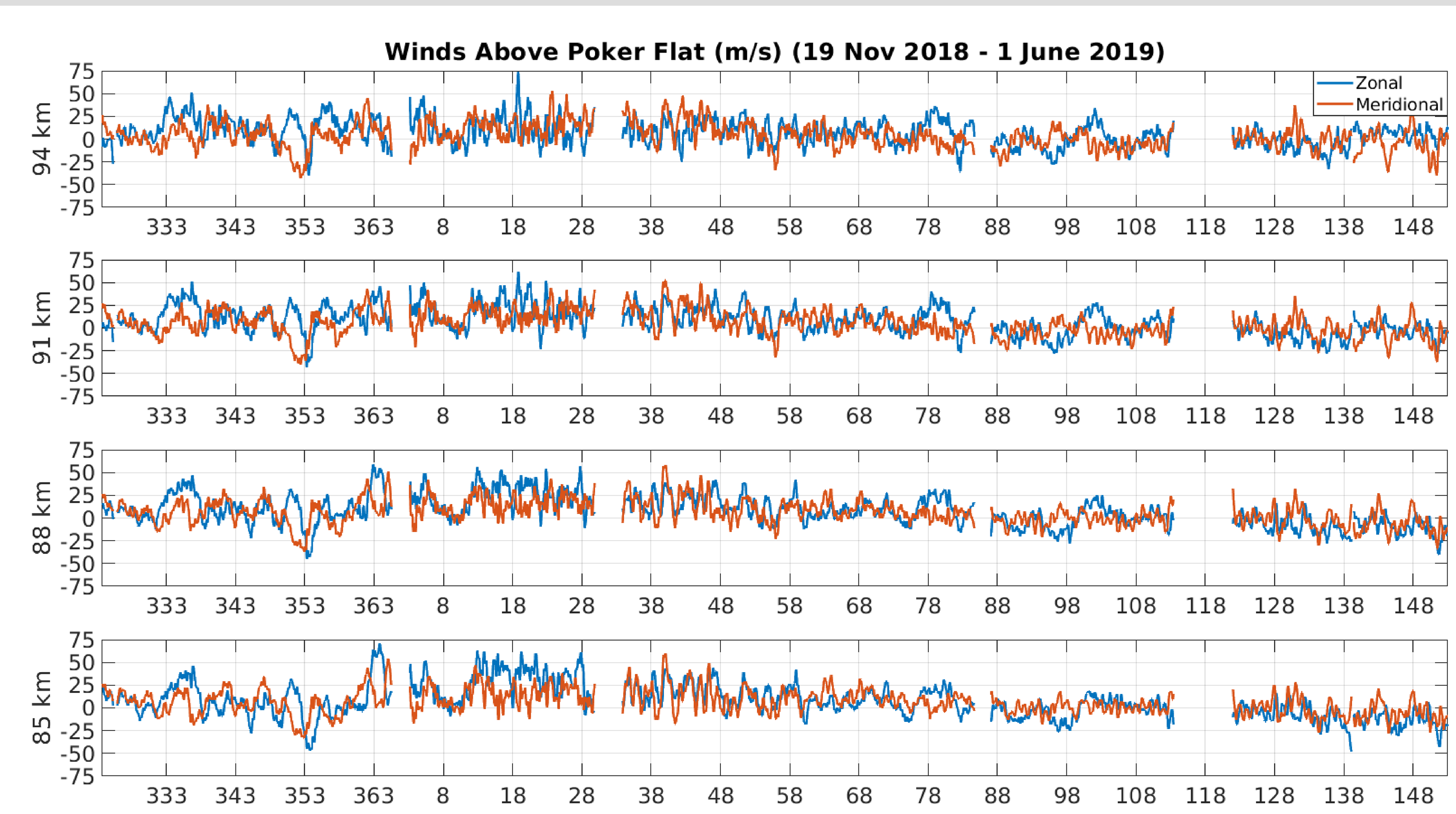

## Zenith Angle Distribution

The zenith angle distribution for all detections from 19 Nov 2018 to 1 June 2019 is shown. All of the meteor detections are sorted into 1 degree zenith angle bins. There is a drop off in detections around 70 degrees due to the PRF that is used by the radar. Most meteors are detected between 50 and 70 degrees.




## Hourly Winds

Hourly winds are calculated using the position and radial velocity of meteors. Zonal and meridional components of winds at 4 altitudes in the meteor region are shown. Winds for each height were calculated using a 3 km bin centered at the height shown on the figure.




## Simultaneous Radar and Lidar Observations

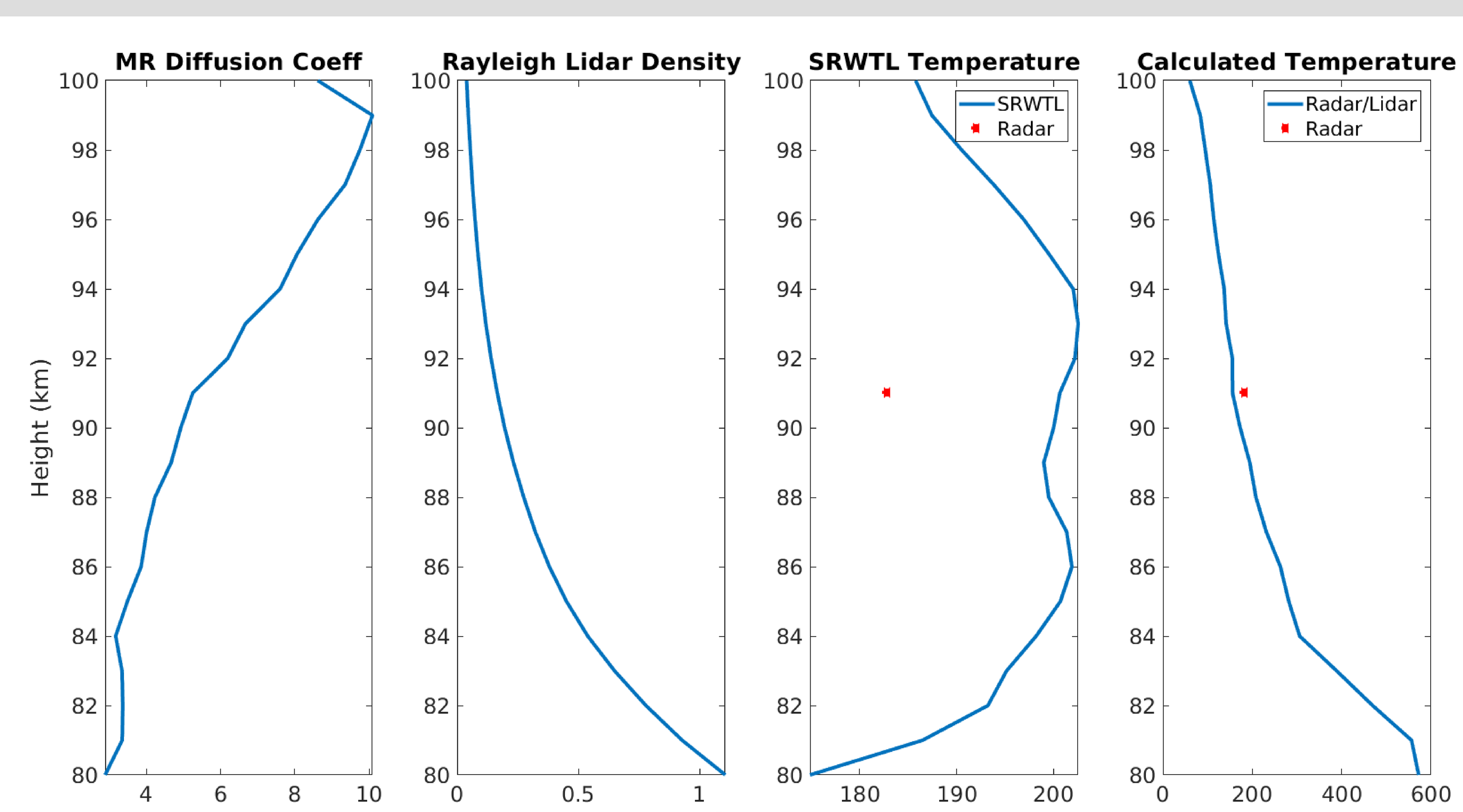
There is a model relationship between diffusion coefficient [D], density [ρ], and temperature [T] that allows for one of these parameters to be calculated when the other two are known. Measurements from a meteor radar, a Rayleigh lidar, and a sodium resonance wind temperature lidar (SRWTL) located at PFRR are used to test the self-consistency of this model relationship. Two versions of this relationship are given in [1] and [2], and are presented in that order below.

$$D = 2.23\times10^{-4} K_0 T/\rho \qquad D = (3.5m/4\rho A)(kT/\pi\mu)^{1/2}$$

$K_0$ = Ionic mobility

m = Mass of atmospheric particle
A = Collision cross section
μ = Mass of diffusing particle

The MR diffusion coefficient, calculated using the decay time of underdense meteors, and the Rayleigh lidar density are used to calculate temperature using the expression given in [1]. An average temperature estimate from only the radar decay times is calculated using the method in [3], and is shown as a red dot for comparison. The calculated temperature varies greatly over a range of 500 K, much more than what is expected, or observed in the SRWTL temperature. There is no scalar value that will reconcile the estimates. Future work includes a better understanding of the observations and detailed modeling of meteor trails in the Arctic.




## References

[1] Younger, J. P., Reid, I. M., Vincent, R. A., & Murphy, D. J. (2015). A method for estimating the height of a mesospheric density level using meteor radar. Geophysical Research Letters.
[2] Greenhow, J. S., & Hall, J. E. (1960). Diurnal variations of density and scale height in the upper atmosphere. Journal of Atmospheric and Terrestrial Physics.
[3] Hocking, W. K. (1999). Temperatures using radar-meteor decay times. Geophysical Research Letters.