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UAV applications for thermodynamic profiling: Emphasis on ice fog research

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Ice fog occurs often over the Arctic, cold climatic, and mountainous regions for about 30% of time where temperature (T) can go down to -10ºC or below. Ice Nucleation (IN) and cooling processes play an important role by the controlling the intensity of ice fog conditions that affect aviation application, transportation, and local climate. Ice fog can also occur at T above -10ºC but close to 0ºC it occurs due to freezing of supercooled droplets that include an IN. To better document ice fog conditions, observations from the ice fog events of the Indirect and Semi-Direct Aerosol effects on Climate (ISDAC) project, Barrow, Alaska, Fog Remote Sensing And Modeling (FRAM) project Yellowknife, Northwest Territories, and the Mountain Terrain Atmospheric Modeling and Observations (MATERHORN) project, Heber City, Utah, were analyzed.. Measurements difficulties of small ice fog particles at cold temperatures and low-level flying restrictions prevent observations from aircraft within the surface boundary layer. However, unmanned Aerial Vehicles (UAVs) can be operated safely to measure IN number concentration, Relative Humidity with respect to ice (RHi), T, horizontal wind speed (Uh) and direction, and ice crystal spectra less than about 500 micron. Thermodynamic profiling by a Radiometrics Profiling Microwave Radiometer (PMWR) and Vaisala CL51 ceilometer was used to describe ice fog conditions in the vertical and its time development. In this presentation, ice fog characteristics and its thermodynamic environment will be presented using both ground-based and airborne platforms such as a UAV with new sensors. Some examples of measurements from the UAV for future research, and challenges related to both ice fog measurements and visibility parameterization will also be presented.