SWIRP: Compact Submm-Wave and LWIR Polarimeters for Cirrus Ice Properties

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Clouds are a major source of uncertainty in climate model prediction. Ice clouds, in particular, are poorly constrained and have been used as a tuning parameter in the models to balance radiation budget at the top of atmosphere and precipitation at the surface. Lack of accurate cloud ice and its microphysical property measurements has led to large uncertainty about global clouds and their processes within the atmosphere. In the 2017 NRC Earth Science Decadal Survey (DS2017), cloud feedbacks, moisture convection, convective storms and microphysical processes are highlighted as the key targets for predicting precipitation intensity and extreme weather. Liquid and ice water path, cloud and precipitation dynamics, and their variability are among the targeted observables from space. As detailed in a recent community white paper, Cloud and Precipitation Process Measurements (CaPPM), dynamics and microphysical properties are the key links between the cloud-precipitation processes and need more accurate measurements.

SWIRP (Submm-Wave and LWIR Polarimeters) is a compact conical-scan instrument, funded under NASA's Instrument Incubator Program (IIP), to measure cloud ice and its microphysical properties (particle size and shape). It makes simultaneous radiometric and polarimetric measurements from submm (220 and 680 GHz) and IR (8.6, 11, and 12 μm) bands, to cover a wide range of sensitivity for cloud ice. The conical-scan configuration preserves horizontal (H) and vertical (V) polarization information for bulk cloud particle shape retrievals. The designed submm and LWIR footprints are matched with each other to allow the joint retrieval of cloud particle size at these frequency bands. Its compact design enables to deploy SWIRP on a SmallSat system or as a hosted payload for studying fast cloud/precipitation processes.

This project will substantiate the technical feasibility of miniaturizing mm/submm polarimetric direct-detection receivers, a novel multi-channel LWIR spectro-polarimeters, and a compact Bearing and Power Transfer Assembly (BAPTA) for conical-scan observations. We will build a prototype instrument with self-calibration in a volume of 20x20x40 cm, and complete laboratory environmental and perhaps airborne/balloon tests, to raise the instrument TRL from 3 to 5 in three years.