An Active Sonde for Local Remote Sensing of Cloud and Precipitation Dynamics

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Accurate forecasting of hurricane track and intensity and severe tornadic weather has the potential to save billions of dollars and thousands of lives. Collecting the in-situ data needed to understand hurricane and convective mesoscale dynamics by aircraft missions is expensive. Balloon sondes and dropsondes provide a key means of obtaining vertical profile information in either hurricanes via densely-spaced sounding curtains, or tornado-producing supercells. Existing sondes sample wind, temperature and atmospheric pressure data in order to track storm conditions. However, the extremely small cost, size, weight and power (C-SWAP) envelope of a disposable sonde places technological demands on the sensor suite that have heretofore precluded measurements of cloud and precipitation density and hydrometeor phase. Data such as reflectivity (Z), liquid and water mass density *M*, and mean droplet/particle size <*D*> in the region immediately around the sonde trajectory would be useful for studying cloud and precipitation dynamics, while derived data such as the radiative heating flux from hydrometeor phase and water vapor pressure over saturation, and ice-water content (IWC) in clouds are important to quantify heating rate profiles and study cloud heating dynamics.

The goal of this study is to illustrate the feasibility of integrating a low cost, readily available single-chip radar to measure phase of hydrometeors and precipitation density in addition to the derived quantities such as heating rate and IWC. In addition, the project will also incorporate an inexpensive optical cloud lidar that will provide *M*/<*D*> measurements in clouds, thereby enhancing the overall signal-to-noise ratio (SNR) and sensitivity of the instrument for large hydrometeors. The retrieval of derived quantities such as IWC could potentially provide a traceable means of observation independent of radiometry for validating IWC retrievals from radiometric means such as the future MetOp Second Generation Ice Cloud Imager (ICI) instrument. The low C-SWAP of the sonde configuration studied improves the data collected in hazardous conditions such as hurricanes, and reduces the need for manned flight into such conditions.