RainCube: Radar in a CubeSat

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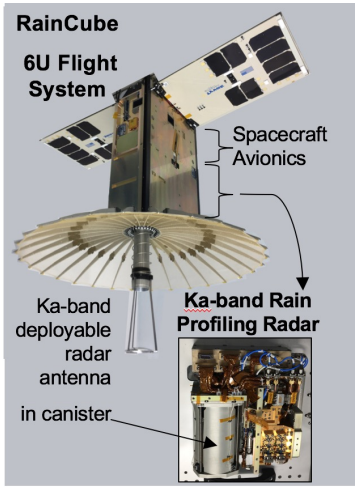
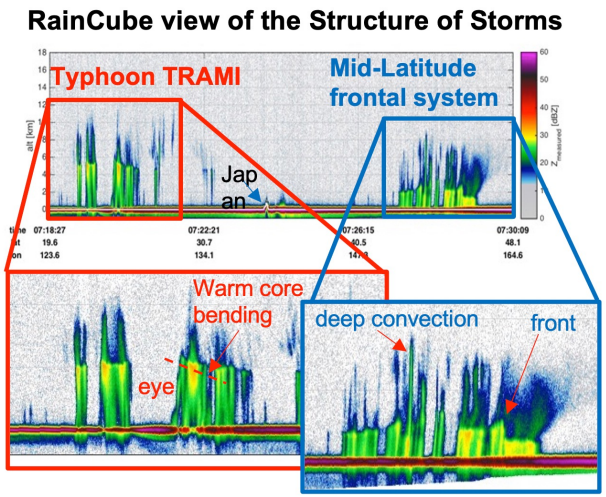
Objective

- Enable future rainfall profiling radar missions on low-cost, quick-turnaround platforms through
  - Development, launch, and operation of the first Ka-band (35.75 GHz) rain profiling radar instrument on a 6U CubeSat, and
  - Demonstration of new technologies and rainfall measurement capability of this radar. The targeted capabilities at platform altitude of 400 km include:
    - Rain detection sensitivity: 20 dBZ or better
    - Vertical resolution: 250 m
    - Horizontal resolution: 10 km or better





Accomplishments

- Designed, implemented, and successfully qualified the first-ever ultra low-sidelobe pulse compression radar in a 6U CubeSat:
  - Developed Ka-band radar electronics and deployable antenna that stows in a 4U volume
- System developed and delivered for launch within 27 months; deployed from the ISS on 7/13/18, and operated for nearly 2.5 years
- Successful demonstrated in flight a novel and low-cost radar instrument for quantitative rainfall vertical profiling measurements:
  - Successful deployment of first- ever Ka-band antenna in a CubeSat
  - First-ever demonstration of pulse compression applied to spaceborne precipitation radar
  - Demonstration of deconvolution algorithm to improve resolution of the radar measurements
  - Demonstration of radar performance, including vertical resolution of 250m; horizontal resolution of 8 km; rain detection sensitivity of +12 dBZ; and along-track sampling of 2 km (for horizontal resolution enhancement through signal deconvolution)
    - Validation of measurement performance through cross-comparison with GPM and Nexrad (US ground weather radar network)
  - Demonstration of attitude control algorithm with two reaction wheels and three torque rods that achieved sufficient nadir pointing
- Received 2 US patents, published 30 journal papers; and paved a way for NASA's new ESO's Atmospheric Observing System
- Motivated the new development of SmallSat and CubeSat constellations of weather radars by commercial sector (e.g., Tomorrow.io)

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TRL_{in} = 4 **TRL_{out} = 8**