AERODYNE RESEARCH, Inc.

TWST Cloud Properties Sensor

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Introduction, Background, and Motivation

- Clouds play a major role in Earth's radiation budget.
- Ground-based shortwave (SW) spectral measurements provide important observations of clouds and aerosols that provide insights into climate-related processes and help constrain climate models.

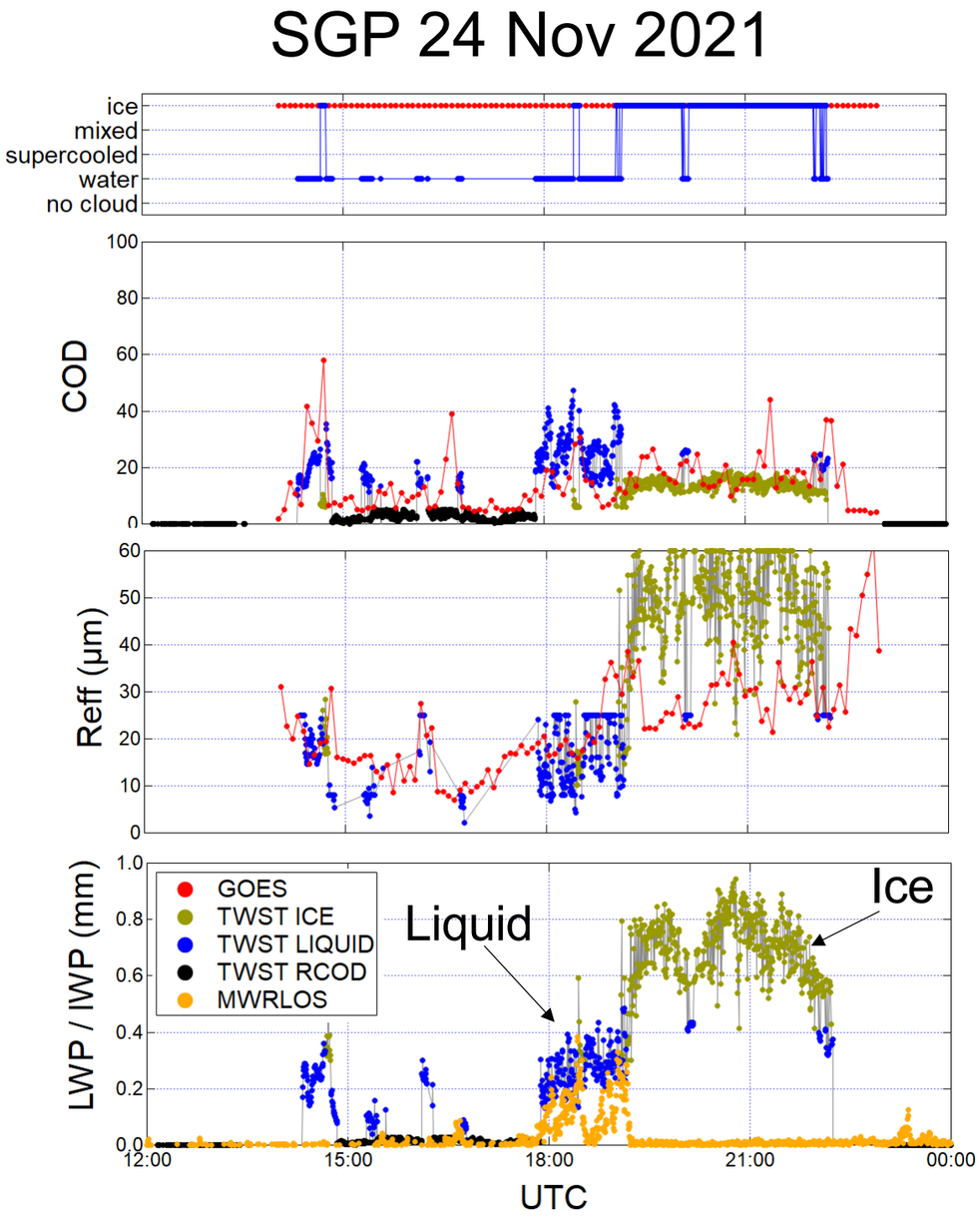
- The ***Aerodyne TWST Cloud Properties Sensor*** measures absolute spectral radiances from 440-1700 nm with a rapid time response (1 second) and a narrow field of view (1/2 degree zenith) and provides derived ***cloud optical depth*** (COD), ***droplet effective radius*** (Reff), and ***cloud thermodynamic phase***.
- TWST is being developed as a low-cost, autonomous instrument for cloud-based research, with the ability to be distributed in sub-grid networks.
- Technology Readiness Level: 7-8

Comparison with Other Sensors

- TWST is **field deployable** – i.e., sealed instrument with only computer indoors
  - 387 mm X 336 mm X 196 mm, 10 kg, 0.5 W
- TWST is **easy to use** – it has been deployed successfully many times by non-Aerodyne technicians.
- **Robust and reliable** – SAIL deployment uptime currently 99 out of 104 days - downtime due to Windows update reboot.
- TWST **inexpensive** to purchase and operate.

Instrument	Long Name	Field of View	Modality
TWST-CPS	TWST Cloud Properties Sensor	0.5º	VIS/NIR grating spectrometers
SASZe	Shortwave Array Spectroradiometer -- Zenith	1º	VIS/NIR grating spectrometers
MFRSR	Multifilter Rotating Shadowband Radiometer	Hemisphere	VIS/NIR narrowband filters
MWR	Microwave Radiometer	5.9º, 4.5º	23.8, 31.4 GHz
AERI	Atmospheric Emitted Radiance Interferometer	1.3º	3-19.2 mm
KAZR	Ka-Band ARM Zenith Radar	0.2º	35 GHz
GOES-ABI	Geostationary Operational Environmental Satellite – Advanced Baseline Imager	2-3 km footprint	VIS-LWIR filters

Cloud Properties Retrievals and Method



- Original RCOD VIS algorithm for thin cloud: 440 nm and O2 A-band equivalent width.
- Joint COD, Reff retrieval bands:
  530-610 nm, 1200-1220 nm, 1590-1610 nm
- Phase retrieval bands:
  1050 nm and 1600 nm
- Forward model inversion methods
  L-BGFS-B (bounded quasi-Newton) or
  Optimal estimation (iterative Newton, linearization of forward model, Bayesian estimation)

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Summary

Aerodyne TWST-CPS is currently being developed under a DOE SBIR Phase II project

- Reduced Stray Light with new baffle design
- Addressing calibration non-linearities and building field-deployable calibrator
- Deployed instruments at ARM SGP and SAIL locations
- Refining retrieval algorithms (i.e., ***COD, R_{eff}, Cloud Phase***)

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ASR Atmospheric System Research

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