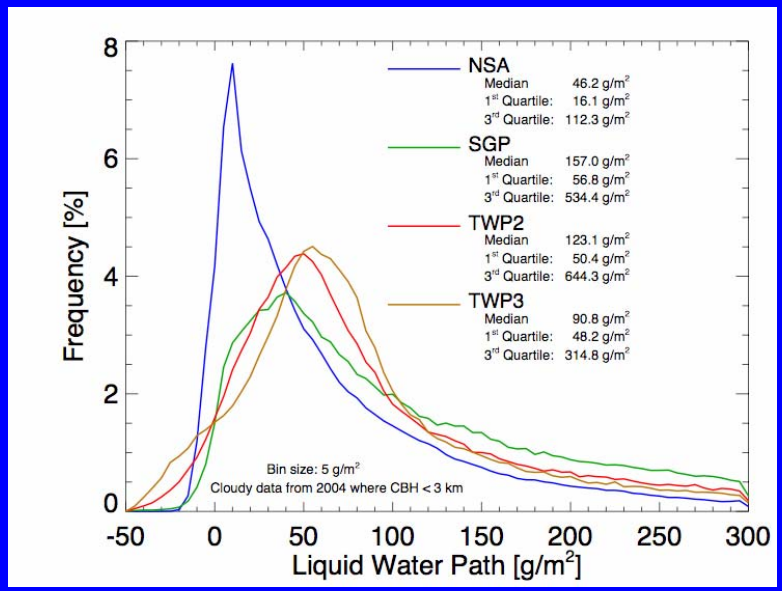
CLOWD Overview: Past, Present & Future

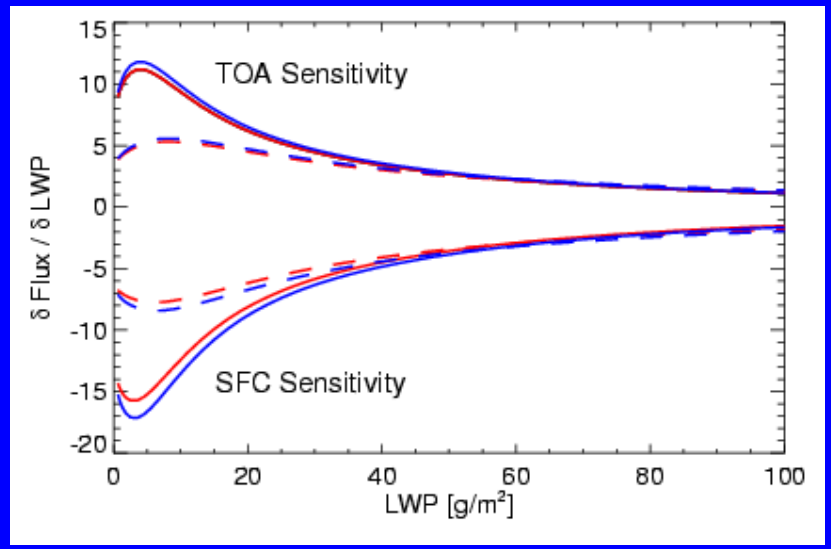
Andy Vogelmann
Brookhaven National Laboratory
Dave Turner
University of Wisconsin-Madison
Jennifer Comstock
Pacific Northwest National Laboratory

& Lots of Contributors

Radiative Importance of "Thin" Liquid Water Clouds



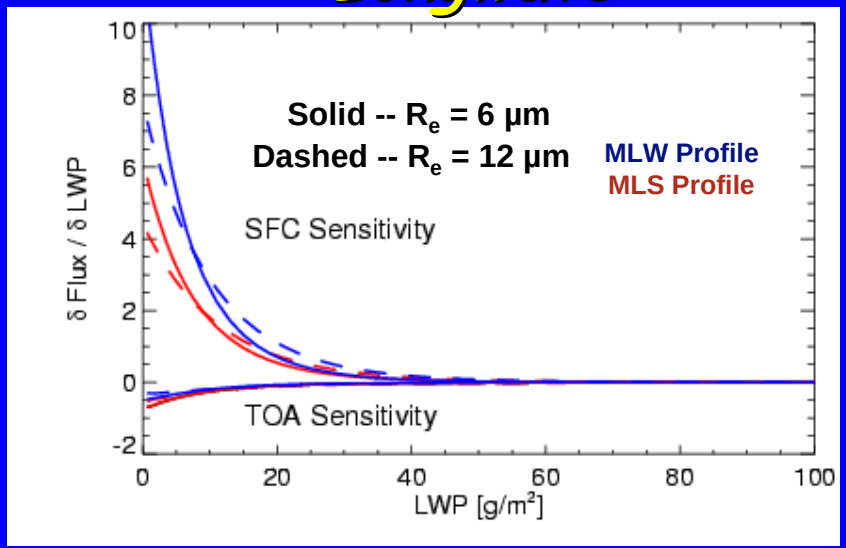
Shortwave



- Thin clouds occur very frequently in Arctic, mid-latitudes, and tropics
- Radiative fluxes very sensitive to small changes in liquid water path (LWP) when LWP <100 g/m²

Turner et al., BAMS, 2006 (accepted), Sengupta et al., J Climate, 2003

Longwave



CLOWD Strategy

Goal:

Determine the best strategy for measuring properties of clouds with low optical depths and low liquid water paths (LWP) at ARM locales 24/7 (develop VAP).

Cloud situations:

Single-layered, Broken clouds (pronounced 3D variability), Mixed-phase, Multi-layered systems

1) Evaluate & characterize retrieval methods

A) Examine results to:

i) Identify and correct errors

ii) Evaluate and compare performances (w/in applicable regimes)

B) Based on results:

i) Identify algorithm gaps

ii) Recommend instrument improvements and additions

iii) Determine additional study periods

CLOWD Strategy, cont.

2) Begin synthesis of multiple methods in single, best-estimate product (e.g., SGP)

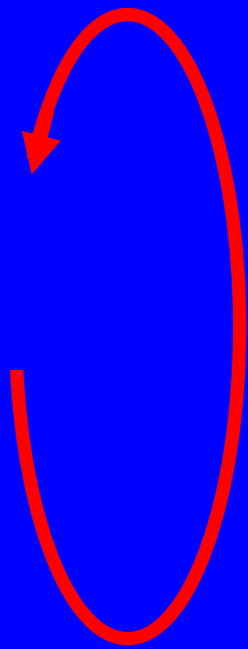
- Design and conduct IOP to truth the resulting algorithms

3) Complete best estimate (set of) algorithm(s) for single site (SGP site).

→ Entrain cloud modelers

4) Validate SGP algorithm in operational mode

5) Repeat for NSA and TWP



A CLOWD-Centric Timeline of Events

2003

Fall	CLOWD Working Group proposed & formed (Turner)

2004

Jan	Initiated First CLOWD intercomparison
Mar	Initial intercomparison results reviewed at ARM STM
Fall	Recommend AERIs be rapid sample

2005

Spr.	GVR data starts at NSA
	Pt Reyes AMF deployment (incl. 2-NFOV radiometer)
Sum.	W-Band (95 GHz) ARM Cloud Radar installed at SGP
	MFRSR cloud optical depth (diffuse) VAP released
	Intensive attempts with MWR offsets (Turner, Clough)

cont.

CLOWD-Centric Timeline, cont.

2005

Fall Raman lidar LWC/P & temp. channels added (Turner)

CLOWD session IRF/CP Working Group Meeting

7 presentations on state-of-the-art methods

Recommendations

Purchase of 90/150 GHz MWRs

More routine radiosondes at NSA (2x daily)

2006

Spr. ASD Shortwave Spectrometer at SGP (Pommier)

COPS-CLOWD IOP proposed at STM

Endorsed by CP/IRF WGs

Sum. COPS-CLOWD IOP submitted

BAMS motivation & Intercomparison article accepted

1.6 μm detectors arrive for MFRSR &/or NFOV

Fall First 90/150 GHz MWR (will be) delivered

MPL cloud optical depth VAP released

MWR physical retrieval VAP released

CLOWD-esque Retrieval Developments

1996	MWR	Std. ARM (monthly coefs) prod. (Liljegren and Lesht)
	MFRSR	MFRSR-derived τ (Min and Harrison)
1998	MWR	MWR auto-calibration software installed (Liljegren)
2001	MWR	SHEBA results (Westwater et al.)
	MWR	Physical-iterative method (Lin et al.)
	MWR	Variable coefficient (surf. met) (Liljegren et al.)
2003	MWR	Physical-iterative method w/ opt. est. (Marchand et al.)
	MWR	90 GHz performance (Crewell & Lohnert)
	AERI	AERI 8-13 μm band feasibility & demonstration (Turner)

cont.

Retrieval Developments, cont.

2004	SW BB	τ from SW broadband measurements (Barnard & Long)
	NFOV	Broken cloud optical depth (Marshak et al.)
2005	AERI	8-13 μm band (Turner)
	AERI	8-13 and 3-5 μm band (Turner & Holz)
	WAIL	WAIL at the SGP (Polonsky et al.)
	MFRSR	Scanning MFRSR theory (Min)
2006	NFOV	Zenith and flux broken cloud retrievals (Chiu et al.)
	MWR	183-GHz MWR in the Arctic (Cadeddu et al.)
	BAMS	CLOWD Motivation & Intercomparison (Turner et al.)
	Combo	AERI + MWR retrieval (Turner)

Current & Future CLOWD Topics

Single-layered clouds

- Merged AERI-MWR-MFRSR retr. (Turner)
- Proposed 90/150 Deployment at COPS
  → MWR uncertainties
- Proposed Thin Cloud-RSR
- Resolve scale babble (& cloud frac. effects)

Move to more complicated CLOWD Cases

- Broken clouds (NFOV)
- Mixed phase
- Multi-layered systems