Comparison of Surface and TOA Cloud Forcings Computed Using Several Cirrus Cloud Property Retrievals

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Satellite-derived fluxes provided by Pat Minnis and Surface Radiation Analysis provided by Chuck Long

ABSTRACT: Several algorithms have been proposed for the retrieval of cirrus microphysical properties using combinations of active and passive remote sensors. Objectively evaluating the strengths and weaknesses of these algorithms under various conditions is difficult because a statistically significant sample of aircraft validation data has not been compiled. However, as the goal of data collected at the ARM central facilities is to better understand the role of clouds in the radiation budget, we use the more tractable approach of radiative closure to make an objective evaluation of the retrievals. To this end, a validation experiment is here performed by the application of several retrieval algorithms to a number of cirrus events from the ARM Southern Great Plains site.

DATA AND METHODS

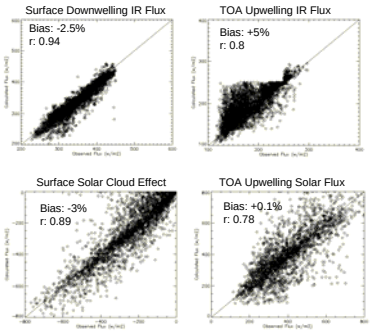
Approach: use the software infrastructure developed for the CRF study described in Mace et al (2006) to conduct comparisons to observed TOA and surface fluxes.

- Several specific cirrus cases at ARM SGP Central Facility chosen throughout the year 2000.
- For each case, developers provided IWC and Dge (Fu, 1996) retrievals in input files.
- Retrieved Microphysics used to calculate cirrus radiative properties.
- Radiative properties then used to calculate solar and IR fluxes using sounding data from the ARM site, for comparison with observations

A WORD ON THE SEVERAL RETRIEVALS AND ON THE RADIATION MODEL

Source	Description	Name Used in Plots
G. Mace	VZ, extinction constrained by Raman lidar	Mace Bimodal
Mace et al, 2006	Combination of retrieval algorithms, parameterizations, and empirical equations	Ciret4
Yuying Zhang	Retrieval based on reflectivity and radiance	Zhang ZR
Roger Marchand	Retrievals base on reflectivity and Doppler velocity, parameterized for several different ice crystal habits	Marchand ZV aggregates
		Marchand ZV bullets4
		Marchand ZV bullets6
		Marchand ZV hollowcolumns
		Marchand ZV plates
		Marchand ZV solidcolumns
Matrosov	Empirical Z-IWC relationship	MatrosovShupe Emp
Matrosov et al, 2002	Retrieval based on reflectivity and Doppler velocity	MatrosovShupe VZ
Matrosov, 1999	Retrieval based on reflectivity and radiance	MatrosovShupe ZR
Sally McFarlane	Retrievals based on reflectivity and lidar absorption (Donovan et al), for two different crystal habits	McFarlane hexcolumns
		McFarlane rosettes
Min Deng (2006)	Based on 3 Doppler Moments	Mdeng

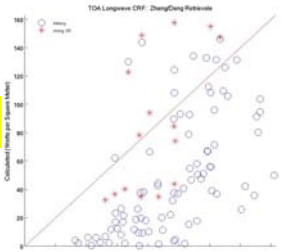
REASONABLE AGREEMENT BETWEEN MODEL CALCULATIONS AND OBSERVATIONS WHEN THE SKY IS CLEAR

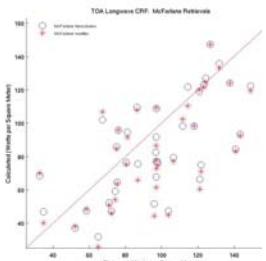


FIRST RESULTS

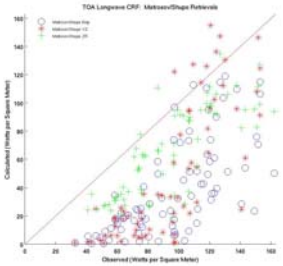
- Able to ingest, run, and evaluate candidate algorithms and compare to fluxes (See Case Studies)
- **All algorithms appear to diagnose too little forcing in cases where the forcing is small**.
- Better agreement is found in situations where the forcing is large.
- Scatter Plots of LW TOA CRF given here for various groups of retrievals.

Zhang/Deng Retrievals

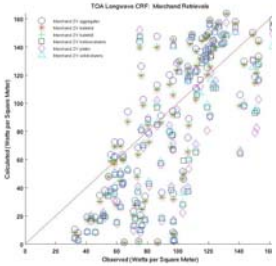




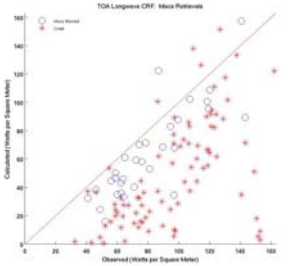
McFarlane Retrievals



Matrosov/Shupe Retrievals



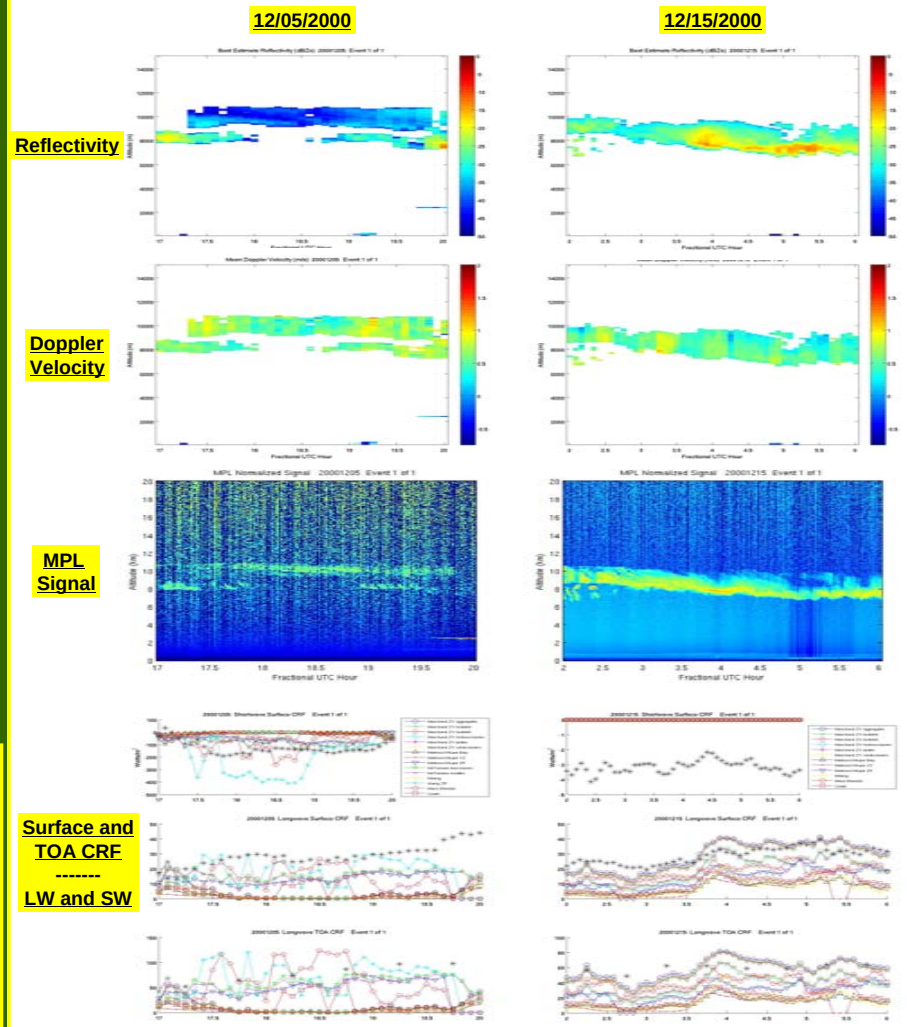
Marchand Retrievals



Mace Retrievals

CASE STUDIES

(Observations Are Shown With A Black Asterisk)



SUMMARY AND FUTURE WORK

- **Interalgorithm differences and agreements bear further examination**
- **There seems to be a general bias in the forcing at small values of forcing**
- **NEXT STEPS**
  - **Extend the data set**
  - **Focus on representative case studies and understand differences and similarities**
  - **Examine instances of general disagreement between retrievals and observations**

REFERENCES

Fu, Q. (1996), "An Accurate Parameterization of the Solar Radiative Properties of Cirrus Clouds for Climate Models", J. Clim., 9, 2058-82.

Mace et al (2006), "Cloud Radiative Forcing at the Atmospheric Radiation Measurement Program Climate Research Facility: 1. Technique, Validation, and Comparison to Satellite-Derived Diagnostic Quantities", J. Geophys. Res., 111, in proof.

Matrosov, S. (1999), 'Retrievals of Vertical Profiles of Ice Cloud Microphysics from Radar and IR Measurements Using Tuned Regressions Between Reflectivity and Cloud Parameters", J. Geophys. Res., 104, 16741-53.

Matrosov et al (2002), "Profiling Cloud Ice Mass and Particle Characteristic Size from Doppler Radar Measurements", J. Atmos. Ocean. Tech., 19, 7, 1003-18.