Feb 2nd, 9:30 AM - 3:30 PM

Research poster: An Overview of progress in NSF EPSCoR project entitled, “Reducing cloud uncertainties in climate models”

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An Overview of Progress in NSF EPSCoR Project entitled, “Reducing Cloud Uncertainties In Climate Models”

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Motivation/Objective

**Problem:**
Climate change prediction by the use of Global Climate Models (GCMs) is highly sensitive to cloud feedbacks, which introduce the largest uncertainties in the prediction of climate sensitivity (S). It was found that 70% of the ensemble variance in the global feedback parameter (λ), where λ = 1/S, was due to two leading factors, the entrainment coefficient and the ice fall velocity.

Hence, characterization of Vf in clouds is critical for accurately estimating climate sensitivity and the earth’s radiation budget in general.

General Approach

Better characterization of clouds and accurate representation of Vf in regional and global climate models is possible by:
1. Analysis of new measurements to produce characterizations of the ice particle size distribution (PSD) to parameterize Vf more accurately, based on recent field studies.
2. Using a remote sensing retrieval for better phase discrimination (ice vs. liquid) in clouds.
3. Performing long and short range simulations using WRF (Weather Research Forecasting Model).

Short simulations with WRF will determine the direct effect of changes in the cloud microphysics on radiative forcing whereas longer simulations will show the impact of climate feedback effects relative to the standard formulations.

Future Goals

- Work with Dr. Mitchell to resolve problems in the current Arctic PSD scheme to obtain a robust Arctic cloud PSD.
- Work with Dr. Arnott to complete the paper based on FTIR measurements.
- Work with Dr. Mitchell on satellite remote sensing as an alternative to the ground based remote sensing in order to determine the % liquid water in cold (-15 to -35°C) clouds.
- Incorporate results from improved cloud PsDs to parameterize Vf more accurately in climate models like WRF.
- Perform simulations using WRF to determine the effects of cloud microphysical changes on radiative effects.

Acknowledgements

This research was sponsored by NSF EPSCoR grant EPS-0814372 and the Office of Science (BER), U.S. Dept. of Energy, Grant No. DE-FG02-06ER64201. We also acknowledge the ARM community for data provided for this research.

Preliminary Results Using MPACE Data

**Figure 1.** Wavelength dependence of tunneling

The emissivity difference between 12 µm and 11 µm channels enables phase discrimination in clouds and forms the basis of the remote sensing retrieval technique. Based on the emissivity ratio between these channels, the % liquid water content (LWC) in the cloud can be determined.

**Figure 2(a).** Arctic cloud as a function of temperature indicates that the cloud emissivity is greatest in the cold temperatures. **Figure 2(b).** Large scale cirrus clouds as a function of temperature indicates that the cloud emissivity is greatest in the cold temperatures.

**Figure 3(a) and (b).** Show agreement between parameterized curves and observational data. However, small differences were encountered in two temperature regimes (-40°C to -45°C) and (-15°C to -20°C) which can be resolved with higher order curve fits.

**Figure 4.** Shows retrieved cloud liquid and ice water path in an Arctic cloud using two methods: radar and passive infrared radiation. Whereas longer simulations will show the impact of climate feedback effects relative to the standard formulations.

**Figure 5(a) and (b).** Show agreement between parameterized curves and observational data. However, small differences were encountered in two temperature regimes (-40°C to -45°C) and (-15°C to -20°C) which can be resolved with higher order curve fits.

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