

**Proposal title: A Study of Arctic Radiation Budget using CERES/MODIS Satellite and
ARM NSA Surface Observations and NASA GISS Model**

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1. Scientific goals

We plan to use DOE ARM surface observations, the NASA CERES on *Terra* and *Aqua* flux measurements and coincident MODIS cloud and aerosol products, cloud and radiation flux products from GOES-10 to fill in gaps at the ARM Northern Slope Alaska (NSA, 71° 19' N, 156° 37' W) site during 2000-2006 period. Based on 6-yr dataset, we propose to develop a long-term merged aerosol-cloud-radiation vertical distribution product. In particular, we will develop the vertical profiles using two differently subsetted EOS datasets and a pseudo-EOS dataset based on GOES data. NASA CERES SW and LW fluxes and MODIS cloud and aerosol properties will be averaged in a 1° box centered on the ARM NSA site. Also, data from all CERES FOVs that include the site will be averaged for a given overpass. The GOES data are currently being analyzed at NASA LaRC and will be converted to CERES-like data using site specific narrowband-broadband conversion functions. A radiative transfer model will be used as input, the vertical distributions of cloud properties determined from the ARM ground-based radar-lidar-radiometer data, surface fluxes, and temperature and humidity profiles to compute the vertical distribution of radiative divergence. The satellite flux, cloud, and aerosol measurements will be used to constrain the calculations. Since large uncertainties are possible in the cloud and aerosol properties, they will be adjusted to ensure consistency between the TOA and surface fluxes. We will then study the seasonal and diurnal variations of surface, TOA and atmosphere SW and LW radiation budgets using the 6 years of surface-satellite data. Finally we will investigate the impacts of clouds on the surface/TOA/atmosphere radiation budgets in duration and strength and study the relationships between the radiation budget and the cloud vertical distributions for both multi-layered and single-layered cloud systems.

2. Presentations

The following presentations are partially supported by NASA NEWS project during the period of 09/2008-09/2009:

1. Dong, X., B. Xi, A. Kennedy, Z. Feng, J. Entin, P. Houser, B. Schiffer, W.B. Rossow, W. Olson, T. L'Ecuyer, T. Liu, K-L Hsu, and B. Lin: Studying the Role of Water and Energy Cycle in Extreme Events using An Integrative Analysis of Observations. 1st Global Change and the Environment in Asia and Pacific (GCEAP): Global and local Energy and Water Cycles variability. Hong Kong, Sept. 24-26, 2008.
2. Xiquan Dong: Impact of Clouds and Radiation on Climate changes and extreme weather. Seminar at ZhongShan University, GuangZhou, Guangdong, PRC. Sept. 23, 2008.
3. Crosby, K. X. Dong, B. Xi. C. Long, and R. Stone: A 10-yr Climatology of Arctic Cloud and Surface Radiation Budget Derived From Ground Based Observations at the ARM NSA site and NOAA Barrow Observatory. NASA NEWS STM. Baltimore, MD, Nov. 3-5, 2008.
4. Feng, Z. X. Dong, and B. Xi: Investigation of Extreme Precipitation Events during the Summer 2007 at the ARM SGP and Oklahoma. NASA NEWS STM. Baltimore, MD, Nov. 3-5, 2008.
5. Dong, X., B. Xi, A. Kennedy, Z. Feng, J. Entin, P. Houser, B. Schiffer, W.B. Rossow, W. Olson, T. L'Ecuyer, T. Liu, K-L Hsu, and B. Lin: Investigation of water and energy extremes during the 2006-2007 drought and flood events at SGP using an integrative analysis of observations. NASA NEWS STM. Baltimore, MD, Nov. 3-5, 2008.
6. Crosby, K., X. Dong, and B. Xi: An Investigation of Arctic Surface, TOA, and Atmospheric Radiation Budgets using collocated Surface and Satellite Observations over Barrow, AK. AMS 10th Conference on Polar Meteorology and Oceanography. Madison, WI, May 17-21, 2009.
7. Dong, X., B. Xi, K. Crosby, C. Long, and R. Stone: A 10-yr Climatology of Arctic cloud fraction and their impact on Surface Radiation Budget at Barrow, Alaska. AMS 10th Conference on Polar Meteorology and Oceanography. Madison, WI, May 17-21, 2009.
8. Feng, Z., X. Dong, B. Xi, D. Del Genio, and P. Minnis: Evaluation of NASA GISS SCM simulated Deep Convective Clouds using the integrated surface and satellite observations at the ARM SGP site. AGU joint Assembly, Toronto, Canada, May 24-27, 2009.

9. Dong, X., B. Xi, K. Crosby, C. Long, and R. Stone: A 10-yr Climatology of Arctic cloud fraction and their impact on Surface Radiation Budget at Barrow, Alaska. AGU joint Assembly, Toronto, Canada, May 24-27, 2009.
10. Feng, Z., X. Dong, B. Xi, D. Del Genio, and P. Minnis: Evaluation of NASA GISS SCM simulated Deep Convective Clouds using the integrated surface and satellite observations at the ARM SGP site. Gordon Research Conference (radiation and climate), New London, NH, July 5-10, 2009.
11. Dong, X., B. Xi, A. Kennedy, Z. Feng, J. Entin, P. Houser, B. Schiffer, W.B. Rossow, W. Olson, T. L'Ecuyer, T. Liu, K-L Hsu, and B. Lin: Investigation the 2006 Drought and 2007 Flood Extreme Events at the SGP using an Integrative Analysis of Observations. International Symposium on Atmospheric Light Scattering and Remote Sensing. Xi'an, China, July 13-17, 2009.

3. Accomplishments and Summary of Research

Publications:

The following papers are primarily supported by this funded project, and the NEWS grant has been listed in the acknowledgements.

1. Feng, Z., X. Dong, and B. Xi, 2009: A Method to Merge WSR-88D Data with ARM SGP Millimeter Cloud Radar Data by Studying Deep Convective Systems. *J. Atmos. Oceanic. Technol.* 26, 958-971.
2. Dong, X., B. Xi, K. Crosby, C. Long, and R. Stone: A 10-yr Climatology of Arctic cloud fraction and their impact on Surface Radiation Budget at Barrow, Alaska. Submitted to JGR.
3. Dong, X., B. Xi, A. Kennedy, Z. Feng, J. Entin, P. Houser, B. Schiffer, W. Olson, T. L'Ecuyer, T. Liu, K-L Hsu, and B. Lin, 2009: Investigation the 2006 Drought and 2007 Flood Extreme Events at the SGP using an Integrative Analysis of Observations. Submitted to J. Clim.

Thesis:

The following theses are primarily supported by this funded project, and the NEWS grant has been listed in the acknowledgements.

Graduated students:

1. HongChun Jin, 2008: Arctic Mixed-phase Cloud Microphysical Properties Deduced from ARM Surface and Aircraft in situ Measurements during M-PACE. Master's thesis, University of North Dakota, 84pp.
2. Kathryn Crosby, 2009: An Investigation of Arctic Surface, TOA, and Atmospheric Radiation Budgets using collocated Surface and Satellite Observations over Barrow, AK. Master's thesis, University of North Dakota, 70pp.

Current graduate students:

3. Zhe Feng, Ph. D student: Evaluation of the model-simulated midlatitude convective systems using the long-term merged surface and satellite dataset (2007-2011).
4. Di Wu, M.S. Student: Studying the 2007 summer Extreme Precipitation Events at the SGP using an integrative analysis of WRF and data (2008-2010).
5. Behn Zib, M.S. student: An investigation of the min Arctic ice coverage during the summer 2007 using an integrated dataset (2009-2011).