CLIMATE RESEARCH FACILITY

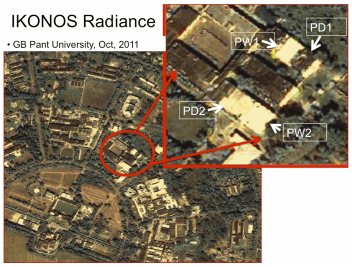
Measured Radiative Cooling from Reflective Roofs in India

Research Highlight

Reflective surfaces can help mitigate climate forcing by reducing the electrical energy needed for ventilation and cooling, and also by reducing the total net radiation absorbed by the Earth system. Estimating the reduction of net radiation absorbed due to the deployment of reflective roofs or other surface materials is not trivial, especially in regions with high aerosol loading. Previous estimates of the radiative benefits of reflective surfaces had, until recently, been based on models.

Now, experimental evidence has been brought to bear on the problem. During the ARM Facility's Ganges Valley Aerosol Experiment field campaign, DOE's Office of Science and Office of Energy Efficiency and Renewable Energy collaborated to quantify the radiative benefit of reflective roofs obtained above urban and rural atmospheres in India. As reported by Salamanca et al., (2012), sections of roof surfaces at both rural and urban sites in northern India were painted white and compared with adjacent unpainted control surfaces. Both painted and control surfaces were instrumented with shortwave and longwave net radiometers and thermometry. Radiometric imagery from the IKONOS satellite (see Figure 1) was periodically targeted to quantify the amount of radiation returned to space by each roof surface. Outgoing radiation measurements were then also compared with estimates from a radiative transfer model (RRTMG).

On average, the equivalent increase in outgoing radiation at the top of the atmosphere was approximately 250 W m-2 (shortwave and near infrared) for a transition from a relatively black (emissivity = 0.9) to whitened (emissivity = 0.4) surface reflectance beneath a relatively clean rural atmosphere (aerosol optical depth [AOD] near 0.1). However, the benefit was nearly a factor of two lower for the more polluted urban atmospheres with AOD $>$ 0.5. Comparison of the IKONOS observations with results from RRTMG confirmed that an accurate model representation of radiative benefit is possible but sensitive to aerosol loading. Extending this work to evaluate the radiative benefit of reflective surfaces over full seasonal cycles and in major Indian cities is expected to provide a policy relevant analysis useful for developing air quality and building construction standards.



True color image of light (PW1, PW2) and unpainted tar (PD1), and concrete (PD2) roofs at the Pantnagar, India site taken on October 21, 2011. We note that the concrete roof is considerably more reflective than the tar roof but less reflective than the painted surfaces.

Reference(s)

Salamanca F, S Tonse, S Menon, V Garg, KP Singh, M Naja, and ML Fischer. 2012. "Top-of-atmosphere radiative cooling with white roofs: Experimental verification and model-based evaluation." Environmental Research Letters, 7(4), 044007, doi:10.1088/1748-9326/7/4/044007.

Contributors

Marc L. Fischer, *Lawrence Berkeley National Laboratory*

Working Group(s)

Aerosol Life Cycle, Cloud Life Cycle, Cloud-Aerosol-Precipitation Interactions

Office of Science
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