Earth Sciences Sector

The effects of sampling resolution on the surface albedos of land cover types in the Canadian boreal region

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Abstract

Climate models commonly prescribe albedo using *in situ* observations. These observations are rarely sufficiently dense to characterize albedo at a regional scale, especially over seasonally snow-covered landscapes such as the boreal forest. The aims of this study are to (a) analyze and compare the local- and regional-scale albedo characteristics of the dominant land cover types found within the Canadian boreal region, (b) assess the the effects of snow cover on these patterns, and (c) quantify the potential bias that can result from using local-scale observations to describe surface albedos across larger geographical extents. Our study is based on local-scale *in situ* observations and regional-scale satellite (GOES) measurements that were collected as part of the Boreal Ecosystem-Atmosphere Study (BOREAS). Our results show (a) that the albedo patterns among land cover types are generally consistent at local and regional scales, (b) that snow cover not only increases the albedo of all cover types, but also their sensitivities to changes in solar zenith angle, and (c) that weekly-averaged in situ observations provide a reasonable characterization of regional-scale albedo when under snow-free conditions, but a poor characterization when snow is present. Land cover albedo characteristics are caused by canopy properties that influence within-canopy shadowing. Further studies should focus on reducing the disparity between albedo datasets over snow-covered surfaces.

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Introduction

- Land surface albedo is the fraction of incident solar radiation reflected in all directions by the land surface. It is one of the most important parameters controlling the earth's climate.
- Albedo is a key component of GCMs. The accurate parameterization of albedo in GCMs is crucial because its mis-specification can lead to large errors in modelled radiation balances.
- However, albedo is one of the largest radiative uncertainties associated with modeling. This is because GCMs often prescribe albedo by associating broad land cover classes with *in situ* albedo observations. These are rarely sufficient to characterize albedo at a regional scale.
- This is particularly a problem over landscapes whose albedos vary dramatically through both space and time.
- The seasonally snow covered landscape of the North American boreal region is one such environment. The surface albedo properties of this vast ecosystem have a huge influence on the climate of the northern hemisphere and on the carbon cycle. Hence, its spatio-temporal variations in albedo are important to understand.

Aims

The general aim of this study is to assess the ability of local-scale observations to characterize the regional scale albedo characteristics of the Canadian boreal region. Specifically, we aim to:

- Analyze and compare the local- and regional-scale albedo characteristics of the dominant land cover types found within the North American boreal region.
- Assess the the effects of snow cover on these characteristics.
- Quantify the potential bias that can result from using local-scale observations to describe surface albedos across larger geographical extents.

Data Sources

- Albedo data obtained from BOREAS project data archives.
- Local-scale (*in situ*) observations (Shewchuk, 2000) :
  - Albedo and snow data obtained from BOREAS automatic meteorological stations.
  - Towers located at grassland, Aspen, Jackpine and mixed forest sites.
  - Data collected continuously from Jan 1st 1996 to Dec 31st 1996. Provided as 15-minute averages.
- Regional-scale observations :
  - Albedo from GOES-8 satellite observations [Feb to October 1996; 4km resolution; half-hourly] (Smith et al., 2001).
  - Snow cover data from NSIDC [Jan to Dec 1996; 25km resolution; weekly] (Armstrong and Brodzik, 2002).
  - Land cover data from 1995 digital land cover map of Canada [resampled to 4km resolution] (Cihlar et al., 1999).

Results

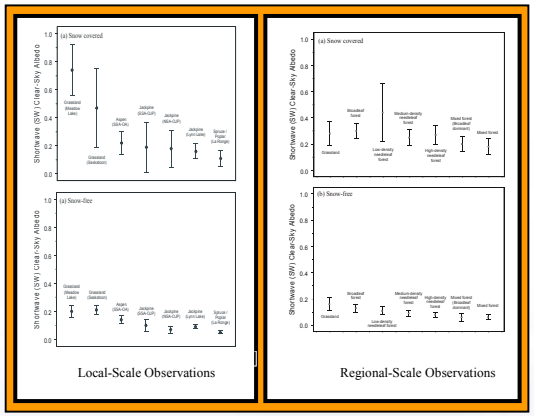
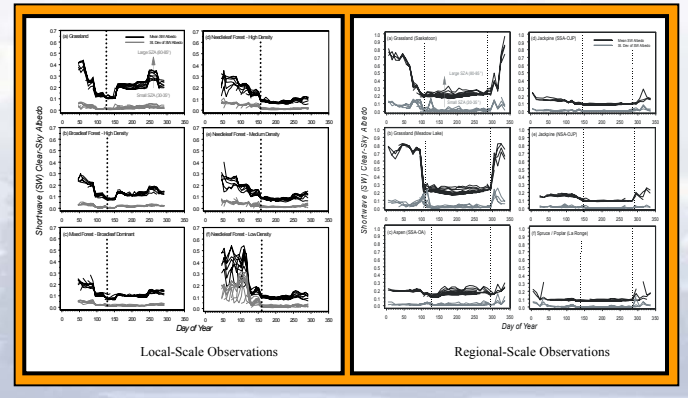


Figure 1. The relationship between land cover type and clear-sky albedo at local and regional scales. Panels show the mean albedo of each vegetation type and its standard deviation around mean.

Figure 2. The temporal relationship between clear-sky albedo and solar zenith angle for different land cover types at local and regional scales. Each black line (-) corresponds to mean albedo values for 5° SZA intervals. Each grey line (-) corresponds to the standard deviations around these mean values. Vertical dashed lines separate snow-covered and snow-free periods.



Reducing Canada's vulnerability to climate change

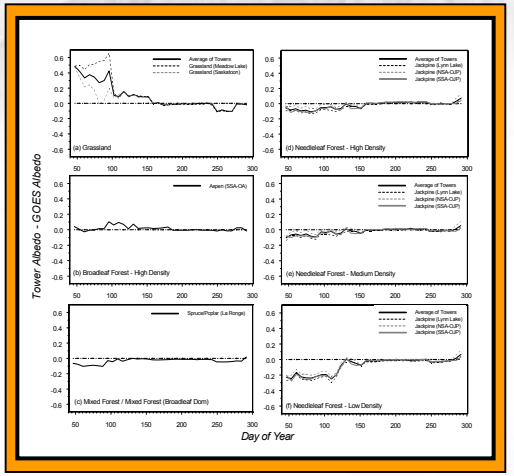


Figure 3. A comparison of tower- and GOES-based albedo observations. Panels show the absolute difference between GOES-8 observations and tower data for 7 of the land cover classes used in the regional-scale study. Albedo observations have been averaged for 7-day periods. Note that we compare observations from the three Jackpine tower sites with the three different needleleaf land cover classes.

Conclusions

- Patterns of albedo among the land cover types considered here are consistent with other studies, and are caused by various canopy properties that influence within-canopy shadowing.
- *In situ* measurements provide reasonable estimates of regional-scale surface albedo only over snow-free surfaces.
- Forest canopy density is an important factor influencing the agreement between *in situ* and regional-scale observations where snow is present, but is unimportant when snow is absent.
- Further studies should focus their attentions on reducing the disparity between data, especially over snow-covered surfaces.

References

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