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Effect of snow on diurnal variation of boreal forest albedo

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The diurnal variation of boreal forest albedo depends also on the albedo of the forest floor. In summer the effect is not drastic, because the forest floor vegetation albedo does not differ so markedly from that of the canopy. However, in winter the forest floor has a marked effect on the total albedo. Coniferous forests that in summer have an albedo of 12 % may reach an albedo exceeding 20 % in winter. The smaller the leaf area index of the canopy is, the more radical is the effect of the snow on the forest floor. The effect is larger in the red wavelength range than for the NIR wavelength range, because vegetation is strongly absorbing in the red wavelength range and strongly scattering in the NIR wavelength range. For snow the case is completely different: snow is highly scattering in both wavelength ranges and typically the reflectance is higher in the visible spectrum.
A previously developed albedo model (Manninen and Stenberg, Agricultural and Forest Meteorology 2009) based on photon recollision probability is used to analyze the diurnal variation of the albedo in snow covered conditions. Typical midwinter albedo value is used for the snow. In summer conditions the diurnal variation of the forest albedo shows the U shape as most targets. However, in winter a local maximum takes place at midday. Its magnitude depends on the leaf area index (LAI) and the sun elevation. When the leaf area index (LAI) exceeds 4, the midday black-sky albedo practically coincides with the white-sky albedo showing very little variation with the sun zenith angle, and thus the Julian day. The midday albedo (= the maximum albedo) decreases essentially exponentially with increasing LAI and the more steeply the larger the sun zenith angle is.
The ratio of the midday black-sky albedo to the white-sky albedo of the forest having snow on the forest floor varies markedly with the sun elevation, when the LAI is smaller than about 4. At the beginning of the year there appears a dip in that albedo ratio. The dip decreases with time and if there is still snow on the forest floor, eventually the albedo shows a prominence at about the same LAI value. The locations of the minimum of the dip and the maximum of the prominence depend on the day and LAI. The more north the forest is situated, the deeper the dip becomes and the smaller is the prominence. At the latitude of 45 ° the dip changes to prominence at about the Julian day of 80, at the latitude 65° that change takes place at about Julian day 120. The midday albedo of the first day of the year may be just half of its late spring value at the latitude 65°, assuming the same snow albedo value.
In conclusion the effect of LAI is more pronounced in the northern latitudes, where even small shrubs have been shown to reduce the albedo markedly.