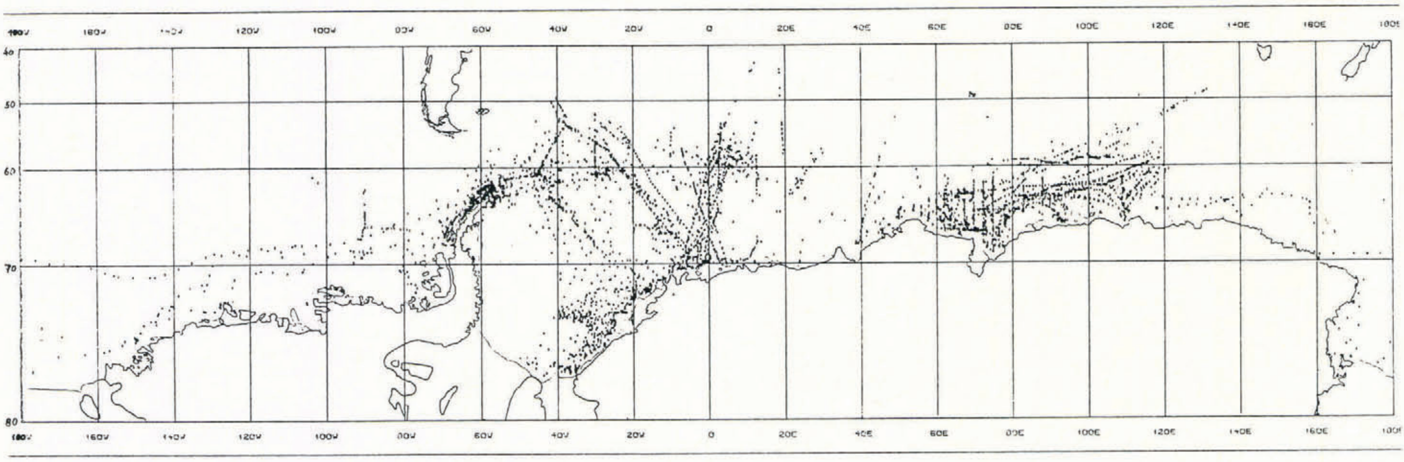

Location of iceberg observations under the programme initiated in 1981. Main ship tracks are clearly reflected. The average observation represents 14 icebergs.

icebergs >1000 m. These account for most of the iceberg mass (see Table I).

Consideration of iceberg-distribution patterns and the observed area of the Southern Ocean, and of duplicate observations, indicates more than 300 000 icebergs south of the Antarctic Convergence, with a total ice mass of about 10^{16} kg. Consideration of mean residence times indicates an annual iceberg production from the continent of $2–3 \times 10^{15}$ kg, which is considerably higher than most other recent estimates. This also suggests that the Antarctic ice sheet is in balance.

The data indicate large regional differences in iceberg sizes, the most noticeable being between the two sides of the Antarctic Peninsula, and between the Amery Ice Shelf/ Prydz Bay area and the remainder of East Antarctica. These differences are probably mainly related to different calving sites.

About one-third of the observed icebergs are over the continental shelf of Antarctica. The total under-water area of these icebergs is two orders of magnitude less than the under-water area of the Antarctic ice shelves. The annual total iceberg melting and its effect on the water masses over the continental shelf has been calculated from ocean-water temperature variations at 200 m depth and estimated melt rates. This turns out to be an order of magnitude less than the annual effect of melting sea ice. The iceberg data considered here are probably under-represented with respect to the smallest sizes, and they do not include icebergs that have become <10 m. Inclusion of these ice bodies would increase the total melt.

EFFECT OF SURFACE ROUGHNESS ON REMOTE SENSING OF SNOW ALBEDO

(Abstract)

by

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ABSTRACT

Narrow field-of-view sensors on satellites monitoring solar radiation measure the reflected radiance in a particular direction. For climatic studies of the Earth's radiation budget, the albedo is needed, which is the integral of the upward radiance over all angles divided by the downward irradiance. In order to infer the albedo from a radiance measurement at only one angle, it is necessary to know *a priori* the distribution of reflected radiation with angle, i.e. the bi-directional reflectance-distribution function (BRDF). The BRDF is a function of four angles: solar zenith and azimuth, and satellite zenith and azimuth. For areal or temporal averages on many natural surfaces, only three angles are needed to describe the function, because only the difference between the two azimuths is important, not their individual values. This assumption was made when developing empirical BRDFs from Nimbus-satellite data for use in the Earth Radiation Budget Experiment (ERBE). However, in large areas of the polar regions, all four angles are needed, because the sastrugi are oriented parallel to a prevailing wind direction. The BRDF shows a forward peak when the solar beam is along the direction of the sastrugi, and an enhanced backward peak when it is perpendicular. Averaging over all solar azimuths (relative to the sastrugi azimuth) causes back-scattering to be averaged together with forward-scattering. The conclusion of the ERBE analysis, that snow is the most nearly isotropic of all Earth surfaces, is therefore at least partly a spurious result of this averaging.

Measurements of the BRDF were carried out from a 23 m tower at the South Pole during January and February at 900 nm wavelength for varying azimuths between the Sun and the sastrugi fabric. The wavelength was selected near the midpoint of the solar-energy spectrum but where scattered sky radiation is negligible. Measurements were made with 10° field of view at 15° intervals in viewing zenith and azimuth angles throughout the day, at intervals of 1 h (15° of solar azimuth). For BRDF normalized such that its angular average is unity, the principal features of the results include a forward-scattering peak with a value of about five together with a side- and back-scattering lobe of 1.1 to 1.3. Variations in solar azimuth produced a skewness in BRDF which was approximately consistent with enhanced scattering at the specular angle with respect to the

solar azimuth and the orientation of the principal fabric of the sastrugi pattern. The angularly averaged pattern was remarkably similar to the results of Taylor and Stowe even though their values were integrated over wavelength and were made through the atmosphere. Our studies thus suggest that, for mid- to late summer, the Taylor and Stowe results require only small corrections for sastrugi effects. This is not, however, expected to be true from sunrise through late November.

Spectral albedos showed values at visible wavelengths of 0.97 to 0.99 which agree very well with the model calculations of Wiscombe and Warren using our observed mean snow grain-sizes. Albedos for wavelengths above 1400 nm were higher than model predictions, indicating that the depth dependence of grain-size must be included in the analysis.

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