INVESTIGATING THE SURFACE ENERGY AND MASS BUDGETS OF ARCTIC SEA ICE: FIELD TRIP TO RESOLUTE, NUNAVUT

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The Arctic Ocean is covered by perennial or seasonal ice cover over most of its surface. Since subfreezing temperatures persist throughout most of the year in the Arctic, precipitation generally falls in the form of snow, blanketing the ice pack with a protective cover. Due to its high albedo and insulating capacity, snow over sea ice remains a critical component of the global climate system. Few quality datasets of snow over sea ice and of ambient environmental conditions exist given the harsh climatic conditions that prevail over the Arctic Ocean. To improve our knowledge of Arctic conditions and processes, some field studies have recently been initiated. In particular, the Collaborative Interdisciplinary Cryosphere Experiment (C-ICE; Mundy et al. 2001) is a unique field program held each spring on McDougall Sound, near Resolute, Nunavut. It has led to the collection of precise measurements of the atmosphere, sea ice and the underlying waters over the past 7 years. This proposal requests funding to participate in the next C-ICE field program in 2003 to make detailed snow measurements over a period of 10 days. With an excellent infrastructure already in place, we intend to perform detailed measurements of the snow-pack (including the spatial distribution of snow thickness, density and heat content), in addition to blowing snow during high wind events. These measurements will allow us to validate a model recently developed by Dery and Tremblay (2002) for the simulation of snow on ice covered oceans.

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1. ABSTRACT

2. BACKGROUND

Given its ubiquitous presence throughout the year, snow remains an essential element of the Arctic climate system. With its higher albedo and lower thermal conductivity (when compared to sea ice), snow reflects a large amount of incoming solar radiation that would otherwise heat the surface and insulates well the underlying sea ice from the cold air above. Furthermore, snow over sea ice may differ substantially in its characteristics (e.g., density, thermal conductivity, and heat content), and in its physical processes (e.g., snow redistribution by wind) when compared to snow over land.

Another particular characteristic of snow-covered sea ice is that it typically has a low surface roughness such that lower wind speeds are required to produce blowing snow events over this surface compared to most land areas. In fact, a climatology of these events shows that blowing snow occurs up to 100 days per year over the Arctic Ocean (Dery and Yau 1999). Three main features of this process remain especially significant in controlling surface-atmosphere heat and mass fluxes. First, blowing snow sublimation perturbs considerably surface sensible and latent heat fluxes (Dery et al. 1998). This results in the cooling and moistening of the atmosphere while inducing a net loss of mass from the snowpack (Dery and Yau 2002). A preliminary analysis (by Tremblay and Dery) of snow data from the Surface Heat Budget of the Arctic Ocean (SHEBA) experiment demonstrates that 30% of the annual snowfall over sea ice is eroded through blowing snow sublimation. Second, a significant sink of mass exists if leads are present within the pack ice (Dery and Tremblay 2002). This occurs when strong winds carry blowing snow into open waters. Third, microrelief over sea ice associated with phenomena such as snowdrifts and sastrugi induce a non-uniform pattern in snow depth over sea ice (Iacozza and Barber 1999). This heterogeneity, together with compaction effects, modulates ocean-atmosphere heat transfer.

To study snowpack evolution and several aspects of snow redistribution by wind over sea ice, Dery and Tremblay (2002) have developed a snow/ice model that includes blowing snow effects. This model is able to resolve the transport of blowing snow into leads and