Surface Energy Budget Process Relationships as a Means for Evaluating Model Performance in Central Greenland

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The Greenland Ice Sheet (GIS) plays important roles in the global climate system, impacting sea-level rise, northern hemisphere circulation patterns, and potentially the ocean thermohaline circulation. Variability in the GIS mass budget is of utmost importance and is the result of numerous processes including surface melt, runoff, and precipitation. Within the context of a warming Arctic, surface melt is increasing dramatically. It is therefore essential to understand the key processes that control variability in the surface temperature and ultimately surface melt. The surface energy budget, comprised of radiative, turbulent, and conductive heat fluxes, represents the balance of energy at the surface and largely determines the surface temperature variability. To represent the surface energy budget and melt in current and future climates, numerical models must be able to accurately represent variability in the surface energy budget, including the partitioning of energy into individual terms and the key atmospheric drivers. This presentation draws upon a comprehensive set of surface and atmosphere measurements made at Summit, Greenland to examine the key terms of the surface energy budget. Variability in surface radiation is found to be largely driven by the solar cycle and by the presence of clouds. Changes in surface radiation elicit responses in the surface temperature, turbulent sensible and latent heat fluxes, and conductive heat flux. Relationships are developed that relate the radiative forcing terms and responding terms as they manifest over a full annual cycle. These relationships are then used to evaluate how surface energy budget processes are represented in model and reanalysis products, including ERA-Interim, CFSv2, and the new CESM.

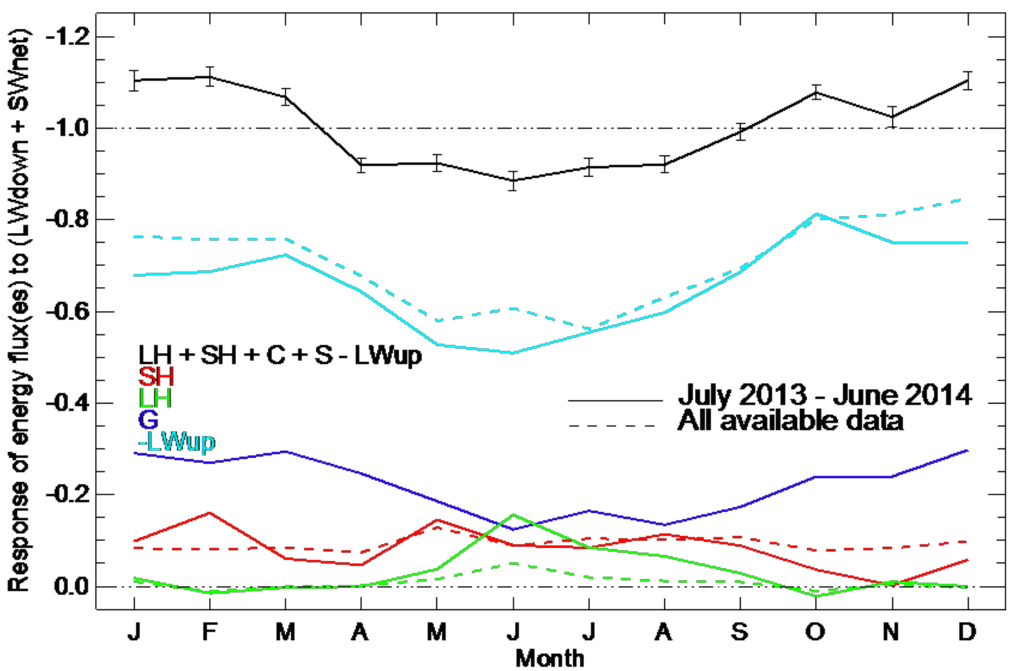

Figure 1. Monthly "slopes" showing the responses of individual energy budget terms to radiative forcing. Here the "forcing" terms are the net shortwave (SWnet) and downwelling longwave (LWdown) fluxes. The "responding" terms are the latent heat (LH), sensible heat (SH), ground heat (G), and upwelling longwave radiation (LWup), which is a proxy for surface temperature.