Cryosphere interface

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The cryosphere encompasses sea, lake and river ice, snow-coverage, glaciers, ice-capse, ice-sheets, frozen ground, and permafrost, called sub-systems hereafter. The changes herein are critical for the earth-system as the cryosphere's sub-systems and atmosphere interact at various scales, and affect the energy, water and trace gas cycles. In this interaction, the various cryospheric sub-systems may have their own time scales and/or may affect the atmosphere at different times and differently. Examples of such interactions and what parameters, quantities and fluxes need to be measured/determined to understand/improve modeling these interactions are discussed. This discussion includes a review of accuracy and resolution needed for these purposes.

Field campaigns were suitable to gain insight and develop models for understanding sub-system processes. Routine monitoring data provided hints at possibly "missing" cryosphere processes. The new climate/earth system approach puts forward new challenges for data collection. Data must be available in space and time for long time at sufficient resolution globally, i.e. even in logistically hard/expensive to reach places. Methods have to be established to integrate existing time series into datasets suitable for earth system research.

A threefold strategy is presented to address these challenges. (1) Intelligent data processing procedures must be developed to use data for purposes other than they were collected for originally. Gridding of data from networks with long time series, for instance, allows understanding climatic behavior/distribution, and identifying changes. Combination of multiple datasets may be another example of tools to gain new insight, because some observed changes in a system might only be explainable by changes occurring in other systems. (2) Intelligent observational strategies that serve multiple disciplines have to be developed and implemented. In enhancing data collected for different purposes and/or planning future measurements for use by various disciplines, for instance, it has to be considered that network design and density play a role for capturing regional climatologies/changes correctly. (3) Both the state quantities and fluxes have to be measured to close the energy balance.