The vast continent of Antarctica has been, except for the most recent decades, a minor focus of scientific exploration. Yet what is already known about Antarctica conclusively demonstrates that, despite its remote location, it plays a hugely significant role in the global system. Assessing Antarctica's role in global climate change and glaciological research, offers a major scientific challenge because of the vastness of the continent and variable climatic conditions (sea ice, snow accumulation rate, atmospheric circulation). The emphasis should be research on near-surface snow and firn, floating glacier ice (ice shelves), glaciers, ice streams and continental and marine ice sheets. These species of ice facilitate studies on glacier energy and mass balance, surface glaciology, snow and firn microstructure and related transport properties, GPR studies of internal stratigraphy, paleo-climatology (deduced from ice core), numerical modeling, and remote sensing.

Area of Interest to SASE

Validation of surface energy and mass balance of snow covered areas vis-à-vis blue ice areas of the Antarctic continent based on climatic-meteorological data, GPS studies and satellite remote sensing

To the human eye, the vast Antarctic ice sheet gives the impression of homogeneity. However, large seasonal fluctuations in surface climate at these high latitudes create substantial changes in surface energy balance. Long term fluctuations in the energy balance of Antarctic ice sheet are of considerable interest because of significant contribution to mass balance and its fluctuations resulting from greenhouse induced warming, sublimation and melting. Only with a thorough understanding of the atmospheric boundary layer and the energy and mass-exchange processes can the response of the Antarctic ice sheet to changing climatic conditions be simulated by thermodynamic ice-sheet models. A major difficulty lies in the fact that due to sparse observatory network over the Antarctic continent, area averaged values for energy balance components in different snow-ice medium are still not precisely known or can at best be summed over a sketchy. The blue-ice areas in Antarctica are of particular interest because though they make up only a small part of the Antarctic continent, they are one of the few areas on the continent where ablation exceeds accumulation and can be used as an indicator for climate change. Keeping this in view we should focus our attention on energy and mass balance of blue ice regions along the coastal areas of Antarctica vis-a-vis surrounding snow covered areas. The research for the validation of glacier surface melting, surface movement and mass balance could possibly include:
Meteorological data collection network in the blue ice and surrounding snow regions can yield a unique data set documenting the meteorological and glaciological processes during summer and winter with a high temporal and spatial resolution. Based on data from these stations the surface energy exchange and amount of energy available for melting can be computed.

Blue ice and snow cover properties can be monitored using satellite data in optical as well as microwave region. Properties of the snow cover reflect local meteorological conditions. Therefore in order to detect climate variability on the basis of the seasonal dynamics of the snow, satellite images that show variations due to changes in the snow cover can be utilized. Simultaneous field measurements (snow pit observations, spectral radiometer data) can be used to validate the findings in the satellite images with observed meteorological conditions. The energy balance as derived for the locations of and areas with a completely frozen snow cover. The same separation can be achieved from the evaluation of satellite imagery. Space-based microwave sensors can also record the occurrence of liquid water or refrozen ice layers in the near surface.

Surface Glaciology: Measurements of the surface movement of ice using global positioning systems (GPS) will provide information about how the ice sheet flows and changes over time.

The systematic research in the above areas will help us to address the following scientific questions:

1. What is the current rate of change in mass balance of blue ice areas in Antarctica?
2. What is the influence of major atmospheric circulation systems on the moisture flux over coastal areas in Antarctica?
3. How does climate vary over the blue ice areas of west Antarctica on seasonal and interannual scales?
4. Obtain a good estimate of the mass balance of the blue ice regions and its spatial variability.
5. Measure the surface energy budget during summer over the blue ice regions and snow covered regions.
6. Obtain a data set for the validation of surface parameters determined from satellite data.
7. Construct a calibrated energy balance model for the Antarctic region.
8. Determine the sensitivity of the blue ice region’s mass balance to climate change.

**Study of snow and firn microstructure and transport properties**

Fresh snow gets accumulated on the top of the old snow and firn and the weight of the snow and young firn on the underlying old firn causes acceleration in compaction process more and more, eventually leading to formation of ice.
Snow and firn are highly layered because of differences in the way that snow accumulates and because of aging. The microstructure of snow and firm near and at the surface control many of the optical and transport properties; e.g., how heat and vapor exchanges take place between air and snow and polar firn. As the microstructure also affects the interaction of solar radiation in different parts of the electromagnetic spectrum, field measurements of near surface microstructure can provide a valuable ground truth “check” for complementary efforts using remote sensing to map the spatial variations of snow, firm and ice properties. Another aspect of this study could be that chemical analysis of the snow and ice in depth could reflect on the atmospheric composition back in the time when those ice crystals were snow and firm in the top layers and to determine whether changes in the near-surface snow and firm properties could cause changes in the processes in the snow and firm.

This study would involve field and lab work to characterize snow and firm properties over the continental shelf and ice cap. The near surface snow and firm properties would include: surface roughness, depth-density profile, grain size, porosity, specific surface area, tortuosity and permeability. Depending on the availability of the drilling machine we can also drill large snow/firm/ice cores up to 20 meter and analyze their properties and microstructure. Based on these measurements we will also try to develop a model to predict the way that snow changes over time as it is buried, a process called firnification.