**Chapter1**

**Introduction**

* 1. **Background and Motivation**

With the global climate change and temperature rise there’s constant effect on the polar ice sheet thus making significant change in the rise of sea level.

Greenland ice sheet mass loss has doubled in last two decades (Shephard 2012) as a result of increased ice discharge into oceans and increased melting of ice sheets. This phenomenon contributes about 0.6mm per year global sea level rise (Furst 2015).Monitoring sea level change is important for different aspects as it threatens lives in coastal areas and islands.

Huge efforts have been made to study the ice sheet conditions especially the Antarctic and Greenland ice sheet which can bring about a significant change in the sea level rise. ICESat part of NASA's Earth Observing System, is a planned satellite mission for measuring ice sheet elevation and sea ice freeboard, as well as land topography and vegetation characteristics [wiki]. Similarly Operation IceBridge uses RADARs, LIDARS and other sensors to measure ice sheet conditions. The large ice sheets of Greenland and Antarctica contains enough ice to contribute to a sea level rise of roughly 70 meters if all ice were to melt completely (Shepard & Wingham, 2007).

Several models have been proposed to explain the ice sheet conditions and are constantly being used to explain the ice conditions. Ice sheet dynamics play important role in explaining the glaciers and melting. Ice motion is affected by two main factors i.e. temperature and the strength of the bases. A lot of ice breaks due to the melting of ice sheets both superficially as well as the basal melting. The ice slides due to basal melt which is caused by high pressure from thick ice sheet. The melting point of water decreases with the increase in pressure thus thicker glacier are likely to cause basal melt as well as they also provide thermal insulation meaning higher temperature favorable for melting. Ice sheet loss is then caused due to sliding of ice sheets into the oceans.

Ice core drilling and seismic analysis have been used to understand the ice sheet conditions however it is not feasible to cover whole of the ice sheet and tend to require more time and effort so airborne ice-sounding radar is a powerful technique for understanding ice sheets and glaciers and their contiguous underlying environments with less efforts.

Ice penetrating radars have been used to locate ice surface, ice beds, detect internal layers and ultimately the thickness of ice sheet. Further studies have focused on interpreting echoes to characterize the subglacial environments of ice sheets. Specifically, echo amplitude analyses have provided images of the subglacial interface [Neal, 1979; Bentley et al., 1998] and supported the discovery of subglacial lakes [e.g., Oswald and Robin, 1973; Robin et al., 1977] as well as determined the location of ice sheet grounding lines [Uratsuka et al., 1996]. Studies using echo fading and amplitude statistics have provided estimates of small-scale roughness or the localized slope distributions of reflecting facets [Oswald, 1975; Neal, 1982].

A coherent radar system detects both the amplitude and phase of the radar signals and has a number of advantages over incoherent radar systems. For example, coherent signal integration from a moving airborne platform forms a synthetic aperture radar (SAR) that improves along-track resolution. With SAR, echoes can be resolved from the subglacial interface that otherwise are obscured by crevasse scattering (Figure 1). Furthermore, analysis of coherent radar echoes can better quantify reflection and scattering from an interface than incoherent radar analysis.

Basal melting is one of the necessary condition for basal sliding and ice surface velocity so understanding basal conditions locations is crucial for modeling ice dynamics. Bed echo reflectivity has been used to infer the basal conditions (Peter 2005, Oswald 2008) given that wet beds have higher reflectivity than frozen beds. But due to variable spatial attenuation sometimes dry beds are interpreted as wet beds. High Specularity, smooth bed and high waveform abruptness have also been used along with bed reflectivity to constrain the locations of wet beds.

This thesis studies the basal conditions of two important outlet glaciers of Greenland i.e. Jakobshavn and Petermann glacier using different attenuation models. The radar data collected by Center for Remote Sensing of Ice sheets under Operation Ice Bridge has been used to derive the basal conditions of these two glaciers.