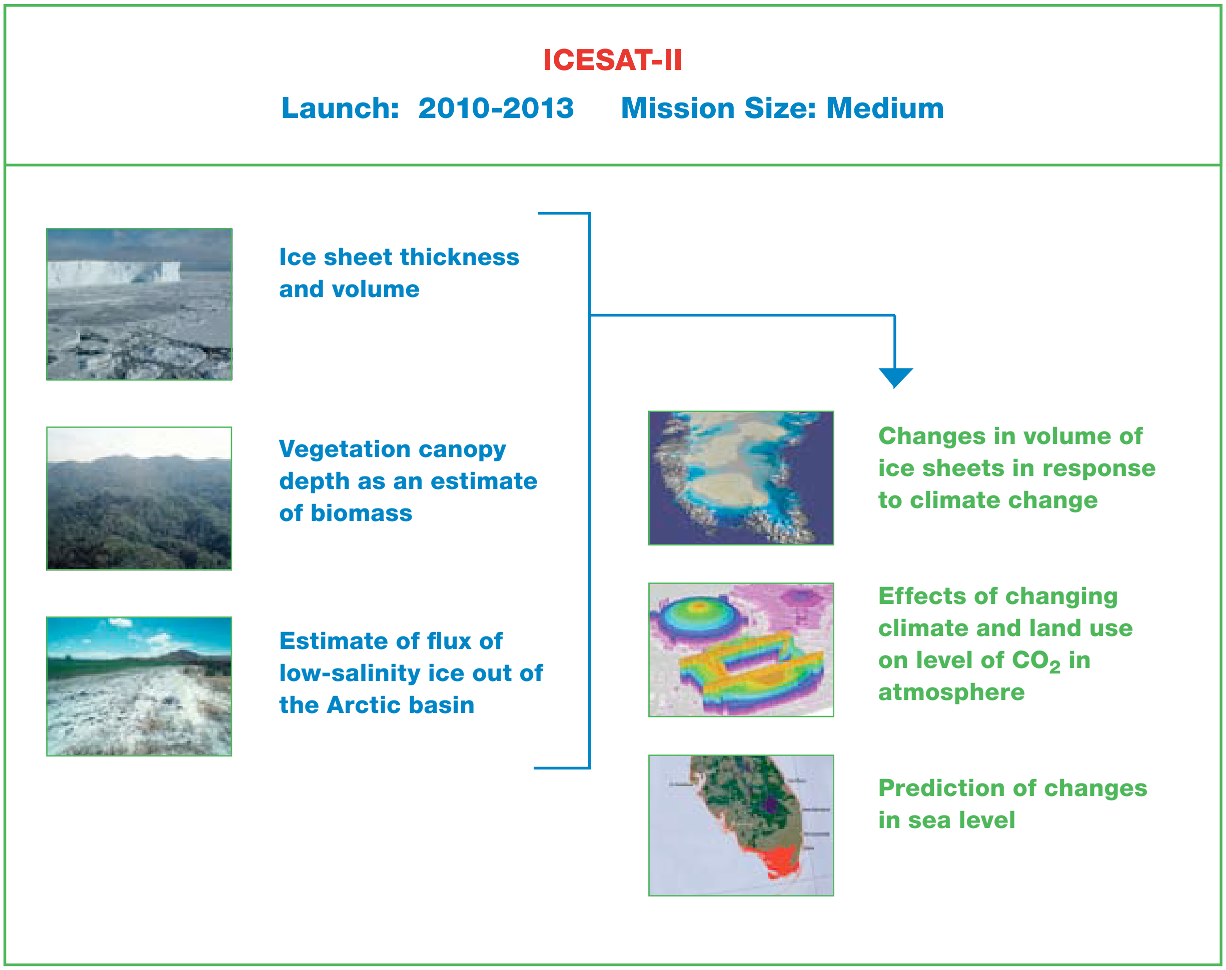

ICESat-II MISSION

Sea-level rise is governed by three factors: melting of permanent snow cover and mountain glaciers, the thermal expansion component of sea level, and decreases in the size of permanent ice sheets, the last of which is the least well constrained. The measurements proposed for ICESat-II directly address the contribution of changing terrestrial ice cover to global sea level. Thus, they are key to projecting the effects of sea-level change on growing populations and infrastructure along almost all coastal regions.

Canopy-depth measurements made from ICESat-II will address changes in terrestrial biomass, which stores a substantial amount of carbon. Many factors influence the character of the vegetation, including climate, land-use, and fertilization by increased CO_2. Measurement of the vegetation-canopy depth will contribute to the ability to assess those influences and therefore better understand the carbon balance and future climate change.

Background: Space-borne lidar is a demonstrated technology for obtaining highly accurate topographic measurements of glaciers, ice sheets, and sea ice. Repeated observations of the polar ice caps by NASA's

ICESat system are documenting decreases in ice sheet volume. Data acquired over sea ice is proving sufficiently accurate to allow making the first basinwide estimates of sea ice thickness. The technology as demonstrated so far on aircraft also can be used to measure vegetation canopy depth, which can be used as an estimator of biomass. ICESat-II is designed as a follow-on to the successful ICESat mission and would carry a highly accurate lidar instrument for repeat topographic mapping.

Science Objectives: The mass balance of Earth's great ice sheets and their contributions to sea level are key issues in climate variability and change. The relationships between sea level and climate have been identified as critical subjects of study in the Intergovernmental Panel on Climate Change assessments, the Climate Change Science Program strategy, and the U.S. International Earth Observing System. Because much of the behavior of ice sheets is manifested in their shape, accurate observations of ice elevation changes are essential for understanding ice sheets' current and likely contributions to sea-level rise. ICESat-II, with high altimetric fidelity, will provide high-quality topographic measurements that allow estimates of ice sheet volume change. High-accuracy altimetry will also prove valuable for making long-sought repeat estimates of sea ice freeboard and hence sea ice thickness change, which is used to estimate the flux of low-salinity ice out of the Arctic basin and into the marginal seas. Altimetry is the best (and perhaps only) technique for making this measurement on basin scales and with seasonal repeats. That is particularly important for climate-change studies because sea ice areas and extents have been well observed from space since the 1970s and significant trends have been shown, but there is no such record for sea ice thicknesses. As climate change proceeds, continuous measurements of both land-ice and sea-ice volume will be needed to observe trends, update assessments, and test climate models. The altimetric measurement made with the proposed lidar, along with a higher-precision gravity measurement (such as on GRACE-II), would optimally characterize changes in ice sheet volume and mass and directly enhance understanding of the ice sheet contribution to sea-level rise. Coupled with the interferometric synthetic aperture radar in the DESDynI mission, the instrumentation would provide a comprehensive data set for predicting changes in Earth's ice sheets and sea ice.

In addition to studies of ice, the proposed instrument could be used to study changes in the large pool of carbon stored in terrestrial biomass. In particular, the proposed lidar could be used to measure canopy depth and thus estimate land carbon storage to aid in understanding the responses of biomass to changing climate and land management.

Mission and Payload: The proposed ICESat-II mission would deploy an ICESat follow-on satellite to continue the assessment of polar ice changes and to complement studies of vegetation canopy. The satellite would fly in a low-Earth, non-Sun-synchronous orbit. The payload would include a single-channel lidar with GPS navigation and pointing capabilities sufficient for acquiring high-accuracy repeat elevation data over ice and vegetation. The proposed ICESat-II mission would address technical issues uncovered during the ICESat mission. Limitations of the lasers on ICESat are understood and will be readily corrected for ICESat-II.

Cost: About $300 million.

Schedule: NASA's successful demonstration of space-borne lidar technology for ice applications suggests that it is feasible to deploy a new lidar instrument by 2010 and within the timeframe of planned studies after the International Polar Year.

Further Discussion: See in Chapter 9 the section "Ice Sheet and Sea Ice Volume," and in Chapter 11 the section "Sea Ice Thickness, Glacier Surface Elevation, and Glacier Velocity."

Related Response to Committee's RFI: 111.