soon have latency, availability, and public impact similar to meteorological and seismic information. This requires overcoming specific technical challenges, such as improving data networks and developing faster algorithms for coping with data streams. It will also be necessary to overcome cultural challenges that inhibit the exploration of the overlap of geodesy, seismology, and cryospheric and atmospheric science. Despite these obstacles, GNSS geodesy will experience a rapid evolution as various communities critically evaluate and use these data for research purposes, leading to the development of accessible and actionable public information products. Ultimately, this evolution is essential for improving understanding of high-impact Earth system processes and for increasing public engagement.

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NEWS

Record Summer Melt in Greenland in 2010

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As Arctic temperatures increase, there is growing concern about the melting of the Greenland ice sheet, which reached a new record during the summer of 2010. Understanding the changing surface mass balance of the Greenland ice sheet requires appreciation of the close links among changes in surface air temperature, surface melting, albedo, and snow accumulation. Increased melting accelerates surface snow grain growth, leading to a decrease in surface albedo, which then fosters further melt. In turn, winter accumulation contributes to determining how much snow is required before a dark (e.g., lower albedo), bare ice surface is exposed in spring (Figure 1).

A recent analysis of surface glaciological observations, remote sensing data, and model output for 2010 points to new records for surface melt, albedo, runoff, and the number of days when bare ice was exposed [*Tedesco et al.,* 2011]. Large areas of the ablation zone in southern Greenland underwent melting for up to 50 days longer than the 1979–2009 average of 48 days of melting per year.

Warm conditions persisted through spring and summer, with the positive albedo feedback mechanism playing a major role in further enhancing melting and in leading to large negative surface mass balance anomalies. Summer snowfall was below average, maintaining the low albedo throughout the melting season. Melt during August and September was also exceptional, consistent with low surface albedos and near-surface temperature anomalies of up to +3°C, yielding a long ablation season.

The unusually warm conditions over the Greenland ice sheet in 2010 and the reduced snowfall can partially be explained by a negative North Atlantic Oscillation index phase from late spring through summer.

Monitoring the Greenland ice sheet through modeling and observational tools is crucial to understanding how recently observed increasing surface temperatures over the Arctic region are affecting surface mass balance and how this, in turn,

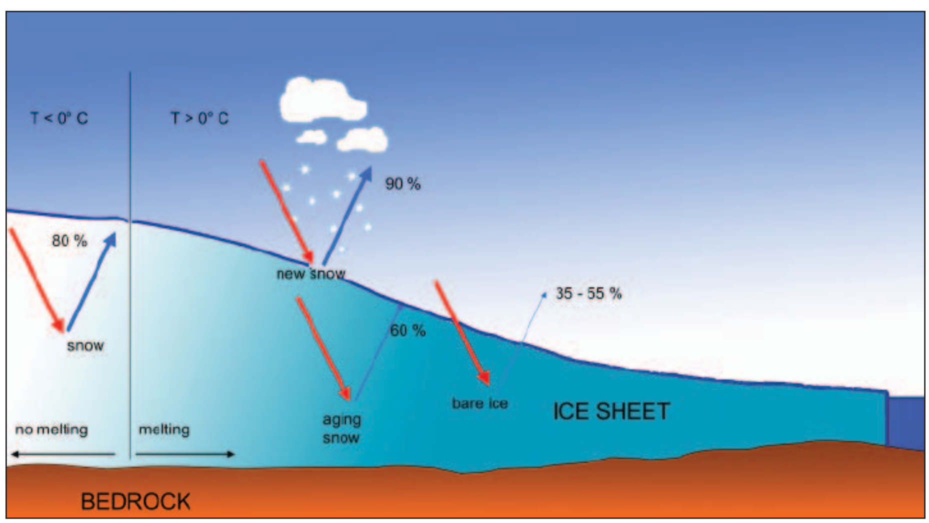

Fig. 1. Surface temperatures up to 3°C higher than average during summer 2010 generated earlier melting. When snow melts, grains tend to cluster (a process known as constructive metamorphism). This reduces the albedo, leading to increased absorbed solar radiation. New snow can increase albedo again, but accumulation was low in 2010. Bare ice, on the contrary, is much "darker" than snow, absorbing even more solar radiation and further increasing melting. Red arrows indicate incoming radiation; blue arrows indicate outgoing radiation. Percentages indicate the amount of reflected incoming solar radiation.

is affecting both surface and subglacial processes.

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European Earth Observation Program: "Positive Synergy" Between Science and Society

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Within the European Space Agency's (ESA) Earth Observation programs, a "positive synergy between science and society" comes across "very strongly," according to Stephen Briggs, head of the program planning and coordination service for ESA's Directorate of Earth Observation Programmes. Briggs offered insights into the Earth Observation programs, including missions, data policy, and cooperation with other space agencies, during a 4 April town hall meeting at the European Geosciences Union's (EGU) annual meeting in Vienna, Austria.

"One of the aspects that strikes everyone in Earth observation is the fact that when studying Earth science, it's not like looking at cosmology. We're looking at aspects of the Earth which inevitably have some consequence for society," Briggs said, pointing to recent ESA satellite imagery of natural disasters, forest cover, ice sheets, and oceans.

"When we build science missions," he said, "they certainly have practical benefits. And those missions which were designed for operation and practical environmental management in themselves generate enormous scientific interest."

Briggs gave an overview of ESA's Earth observation satellite missions, including Envisat. The agency reported on 4 April that the satellite had measured record-low levels of ozone over the European-Atlantic sector of the Northern Hemisphere during March. Briggs also discussed other spacecraft, including the European Remote Sensing 2 satellite (ERS-2); the MetOp polar-orbiting satellite; and Meteosat weather satellites. He said ESA and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) had agreed a few days earlier to cooperate on implementing a third generation of European Meteosats.

In addition, Briggs noted the importance of the agency's three Earth Explorer missions currently in orbit: the Gravity Field and Steady-State Ocean Circulation Explorer (GOCE), which ESA said on 31 March had very precisely mapped Earth's gravity; the Soil Moisture and Ocean Salinity (SMOS) mission; and the CryoSat-2 ice mission. Three Earth Explorer missions in development are the Atmospheric Dynamics Mission (ADM-Aeolus); the Swarm constellation of three satellites to measure Earth's magnetic field; and the Earth Clouds, Aerosols, and Radiation Explorer (EarthCARE) mission. Briggs said the selection of an Earth Explorer 7 mission is expected near the end of 2012.

During the EGU town hall meeting, Briggs discussed ESA's Climate Change Initiative, which supports the development of "essential climate variables," a suite of measurements defined by the Global Climate Observing System. ESA selected 11 of the variables—including cloud properties, sea level, and land cover—for the first phase of the initiative's effort to generate, preserve, and provide access to essential long-term data sets.

He also discussed the Global Monitoring for Environment and Security (GMES) program, begun in 1998, which provides a mandate to ESA to implement a suite of operational satellite systems to monitor the environment. ESA is developing five Sentinel missions—each having a two-satellite constellation to examine different aspects of the Earth system—that are planned for launch between 2012 and 2017.

Briggs said that under ESA's revised Earth observation data policy, most data are open and free of charge. "It's not useful having satellites up there unless you can get access to the data," he said. "This is something which ESA has been criticized for over the years, sometimes fairly, sometimes unfairly. But it's certainly something we have worked very hard to try to overcome in the last few years."

He noted that ESA has had "very positive and very helpful bilateral discussions" with NASA and other space agencies regarding Earth observations. "ESA and NASA have extremely strong historical links in space science, going back to the Hubble Space Telescope and beyond. In fact, all major missions which are proposed by NASA and ESA these days are proposed in conjunction with each other, simply because they are so expensive. It's a tradition that hasn't been as strong in Earth observation, and we're trying to do something about that," Briggs said.

"We can't at this stage get to the point where we can say, 'you're going to fly that mission, therefore we won't.' However, I think there's scope," Briggs said, "for improvement on the coordination in the past, which sometimes looks as if the agencies have been deliberately in competition with each other to fund exactly the same things at the same time."

—Randy Showstack, Staff Writer