International Arctic Sea Ice Monitoring Program Continues Into Second Summer

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Rapid and extreme environmental changes are occurring in the Arctic. To increase the understanding of these changes, a Web-based Sea Ice Outlook program that was initiated in May 2008 has continued for a second summer in 2009 (http://www.arcus.org/search/seaiceoutlook). Here the term "outlook" refers to a procedure where investigators were asked in early June to provide projections of the mean sea ice extent for September, and to explain the rationale for their estimates.

The outlook, initiated by the Study of Environmental Arctic Change (SEARCH), was developed in response to the dramatic decrease in the areal extent of sea ice in summer 2007, when the extent dropped to a value of 39% below the average sea ice extent for 1979–1999 and 23% below the previous record minimum extent in 2005 (Figure 1). An effective response to such radical changes in sea ice extent requires enhanced, rapid communication within the Arctic science community to observe and understand Arctic processes as new information becomes available.

How the Sea Ice Outlook Works

Methods for the SEARCH Sea Ice Outlook include statistical modeling, based on spring sea ice and atmospheric conditions; heuristic approaches, such as expert opinion or use of a melt rate applied to a spatial grid of sea ice thickness distributions; or the use of a numerical sea ice/ocean model. While the outlook asks for expected values of the ice extent, researchers recognize that a quantitative projection ideally should include probabilistic estimates.

To calculate these probabilities, three participating institutions use numerical models to calculate their projections. They start with spring sea ice conditions and use a range of potential summer weather supplied from previous years (referred to as ensemble members). In this way, probabilities can be assigned as to whether a new sea ice minimum will be reached based on a historical range of summer meteorological conditions [*Zhang et al.,* 2008].

Arctic Sea Ice Outlook for 2008

The SEARCH Sea Ice Outlook synthesizes a broad range of remote sensing and field observations that were collected at the peak of the International Polar Year. Over the 2 years that this project has been operating, 25 international groups and individuals have participated in the outlook.

The effort in 2008 was a success. The median sea ice extent projection from June data was 4.4 million square kilometers, a value similar to the observed extent in September 2008 of 4.7 million square kilometers, and well below the 1979–2007 climatological average extent of 6.7 million square kilometers (Figure 1). The range of projections for September 2008 was 2.9–5.6 million square kilometers. More important, the contrast of sea ice conditions and atmospheric forcing in 2008 compared with 2007 provided clues to the future fate of Arctic sea ice.

For summer 2008, the question was whether the previous loss of multiyear sea ice and the delay in sea ice formation in autumn 2007 still would allow sufficient winter growth of sea ice thickness for the ice to last through the summer of 2008, potentially allowing for recovery from the 2007 minimum, or whether all of the first-year sea ice would melt in 2008 as occurred in 2005 and 2007, resulting in a new record minimum extent. The range of 2008 projection estimates reflected these two plausible scenarios; ultimately, neither extreme was observed.

What Is Projected for 2009?

For September 2009, the median projection of the SEARCH Sea Ice Outlook, based on June 2009 data, is 4.6 million square kilometers, with a range of 4.0–5.2 million square kilometers. The range of projections in 2009 is narrower than in 2008 and represents a projection of persistent Arctic conditions with the 2009 estimate of sea ice extent near the observed value for 2008. Outlook contributions that provide probabilistic assessments indicated a 20% chance of reaching a new record September sea ice minimum in 2009. Qualitatively, multiyear sea ice has been reduced to such low levels that the overall September sea ice extent is now tied largely to the fate of first-year sea ice, which in summer 2009 appears thin or with low concentrations away from the central Arctic.

June and July 2009 conditions were favorable for another record ice loss, but atmospheric circulation and cloudiness in August slowed ice retreat, suggesting that the 2009 outlook estimates will be too low.

The recent massive loss of multiyear sea ice makes it difficult for Arctic sea ice to return to the sea ice extents of the 1980s [*Kwok et al.,* 2009]. However, not all first-year sea ice that formed during the winter of 2008 melted during the following summer—some sea ice remained near the North Pole. Rather than a trend of further rapid sea ice loss every year, the occurrence of another year conducive to massive sea ice reduction, such as that which occurred in 2007, is necessary to cause a further rapid decline of summer Arctic sea ice in the future.

Given the multiple processes that influence sea ice and the variability of atmospheric forcing acting over the 3 months of summer, middle-of-the-range persistence sea ice projections should be favored in most years. Nonetheless, models and theory suggest that another major sea ice loss event will occur when near-perfect summerlong

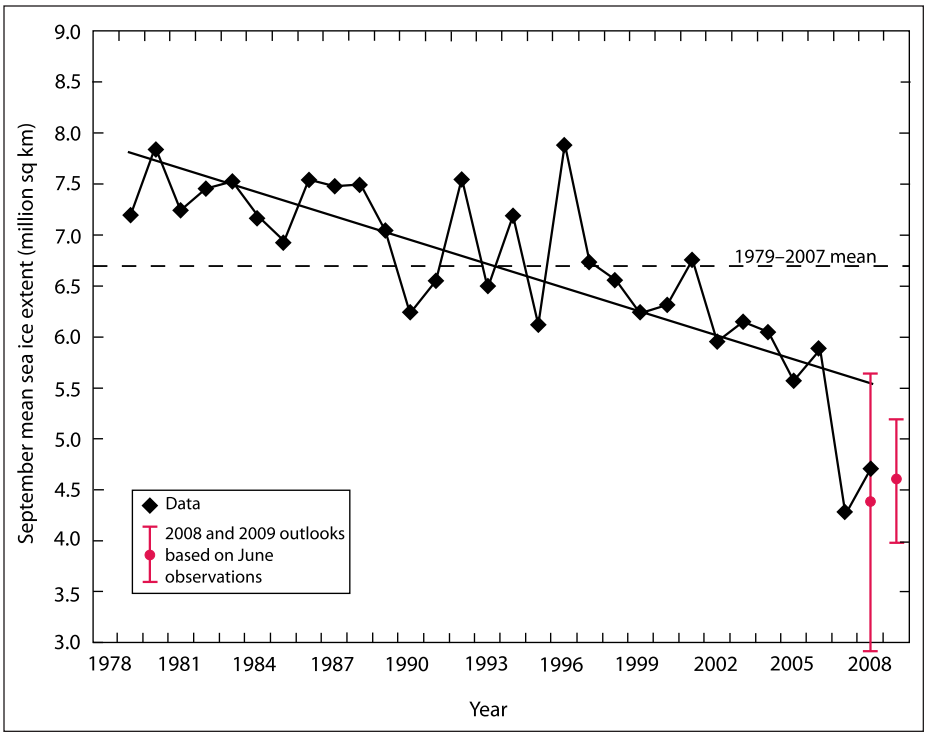

Fig. 1. Diamonds show the history of September Arctic sea ice extents from 1979 through 2008, with record low values in 2007 and 2008. Circles indicate the median value of contributed September sea ice extent outlook projections based on June data for 2008 and 2009. Error bars indicate the range of submitted values.

synchrony in physical processes aligns in favor of further sea ice loss.

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References

Kwok, R., G. F. Cunningham, M. Wensnahan, I. Rigor, H. J. Zwally, and D. Yi (2009), Thinning and volume loss of the Arctic Ocean sea ice cover: 2003–2008, *J. Geophys. Res., 114*, C07005, doi:10.1029/2009JC005312.

Zhang, J., M. Steele, R. Lindsay, A. Schweiger, and J. Morison (2008), Ensemble 1-year predictions of Arctic sea ice for the spring and summer of 2008, *Geophys. Res. Lett., 35*, L08502, doi:10.1029/2008GL033244.

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MEETING

Fostering Interdisciplinary Science to Improve Resilience to Natural Hazards

Characterization, Communication and Mitigation of Risks Arising From Multiple Hazards; Norwich, UK, 7–8 May 2009

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Despite great scientific advances and humanitarian efforts, economic and human losses from natural hazards have increased in recent decades. This is largely a result of the growth in size and vulnerability of populations. Scientists additionally face the complexities of dealing with a broad range of hazards, including the seemingly inevitable increase in the severity and frequency of hydrometeorological events. To address these issues, the U.K. Natural Environment Research Council and the Economic and Social Research Council, together with the Department for Environment, Food and Rural Affairs, sponsored a meeting to assess how the societal cost of natural disasters could be reduced through the development of new, integrated approaches to research.

The meeting brought together natural and social science experts from Europe, North America, and Asia, as well as end users of research, including representatives from the Health Protection Agency, the Environment Agency, and the reinsurance industry. The importance of interdisciplinary research in natural hazard risk reduction is widely recognized and reflected, e.g., in the Integrated Research on Disaster Risk (IRDR) initiative of the International Council for Science, the International Social Science Council, and the United Nations International Strategy for Disaster Reduction, as well as the Hyogo Declaration adopted by the World Conference on Disaster Reduction in 2005. It was noted at the workshop, however, that the effort to establish effective interdisciplinary research faces many challenges, not least of which is the tension between the disciplinary organization of the sciences and attempts to work across the boundaries between them.

If the call to support interdisciplinary research was familiar, the most striking endorsement that emerged from the meeting was for the sharing of knowledge and values among scientists, policy makers, and civil society from the beginning of a research project. Participants agreed that engaging at-risk communities with the research process is essential because greater knowledge and understanding of natural hazards encourages resilience within those communities. Such an interactive approach requires that researchers have the confidence to experiment with new ways of conducting research in these hazard contexts and even to recognize that if weighted appropriately, nonacademic knowledge can make a meaningful contribution to research and to decision making, as illustrated by multiple examples at the meeting. At the very least, such approaches will improve communications and potentially enable wiser investments and decisions through better informed policy.

It was recognized that interdisciplinary research—and increasingly, research with a high impact in terms of meeting society's needs—is nominally encouraged by funders. Nevertheless, successfully aligning basic research to shape and inform policy with the aim of increasing societal resilience may place heavy demands on researchers' time and may even be to the detriment of conventional career rewards. Ultimately, therefore, despite the motivation and commitment of many Earth scientists to contribute to the reduction of risk of vulnerable populations, participants concluded that the full potential of interdisciplinary science for loss reduction will only be fully realized after it has been sufficiently resourced and allowed to mature and grow.

For more information about the meeting, visit http://www.uea.ac.uk/env/research/meetings/hazards.

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