April 13, 2023

Senator Jeanne Shaheen
Chair; Subcommittee on Commerce, Justice, Science, and Related Agencies
Committee on Appropriations
United States Senate
Room S-128, The Capitol
Washington, D.C. 20510

Senator Jerry Moran
Ranking Member; Subcommittee on Commerce, Justice, Science, and Related Agencies
Committee on Appropriations
United States Senate
Room S-128, The Capitol
Washington, D.C. 20510

Representative Hal Rogers
Chair; Subcommittee on Commerce, Justice, Science, and Related Agencies
Committee on Appropriations
United States House of Representatives
H-310, The Capitol
Washington, D.C. 20515

Representative Matt Cartwright
Ranking Member; Subcommittee on Commerce, Justice, Science, and Related Agencies
Committee on Appropriations
United States House of Representatives
H-310, The Capitol
Washington, D.C. 20515

SUBJ: Need for Increased Funding of Research to Inform Sea Level Rise Projections

Dear Chairs Shaheen and Rogers and Ranking Members Moran and Cartwright:

We are writing to strongly encourage you to significantly increase funding for scientific research related to the impacts of a warming climate on glaciers and ice sheets in the Arctic and Antarctica to improve projections of future sea level rise.

Better understanding of changes in the cryosphere is essential to improving estimates of the rate of sea level rise in the coming decades. Rising sea levels along the coast of the United States pose a risk to millions of Americans and will inundate homes and other property valued at trillions of dollars with uneven and inequitable impacts across demographic groups. Ecosystems and critical infrastructure are also at risk. Improved estimates of the rate of sea level rise will help make strategies to reduce the impacts of rising sea level timelier and more cost-effective. Smarter adaptation to rising seas will dramatically reduce risks to human health, property, and the environment and costs to society.

We urge you to take the following steps to address the critical need for expanded funding to support research that will result in the best possible projections of ice loss and rising sea levels to support local, state, and federal decisionmakers responsible for planning responses to coastal storm flooding and inundation from rising seas.

- Include consideration of funding needs related to ice sheet and glacier research in Subcommittee hearings on the FY 2024 budget, including appropriate testimony;
- Based on hearings, identify needed increases for NSF and NASA that provide significant additional funding in FY 2024 (e.g., a 50 percent increase in research funding);
- Include in appropriations legislation language encouraging NSF, NOAA, the Global Change Research Program, and other federal agencies to provide an ongoing forum for discussion of glacier and ice sheet research needs and priorities, including development of periodic cross-agency research plans; and
- Encourage agencies to design a research program that is scaled to the significant risks that rising sea level poses to the U.S. coast and express a willingness to consider expanded funding in FY 2025 and subsequent years.

This letter provides:

- a summary of impacts of rising sea level on the United States' coasts;
- a summary of sea level rise knowledge gaps;
- an overview of declining funding for critical research on glaciers and ice sheets; and
- discussion of needed future funding in this area, including the need for expanded coordination of research planning.

Impacts of Rising Seas

The National Oceanic and Atmospheric Administration (NOAA) recently issued new estimates of future sea level rise concluding that the rate of sea level rise along American coasts is accelerating and is likely to rise as much over the next 30 years (i.e., about 1.3 feet by 2050 in the "Intermediate" scenario) as it has over the last 100 years. Sea level rise averaging as high as 1.7 feet around the coastline is possible over this period and could reach as high as 2.2 feet in some places (e.g., in the Western Gulf of Mexico).

By the year 2100, NOAA projects sea level rise along the American coasts to average about 4 feet (in the "Intermediate" scenario) while an average increase of over 7.2 feet is possible. Sea level rise in some regions will be higher than this average. By 2150, NOAA forecasts average sea level rise of over 7 feet in the "Intermediate" scenario with the possibility of average increases as high as 12.8 feet with increases reaching 14.7 feet in the Western Gulf of Mexico.

NOAA explains in its new report that the rate of sea level rise depends on increases in global air temperature driven by the release of greenhouse gases. Importantly, these projections do not include the possible rapid deterioration of ice sheets in Antarctica and Greenland which would

result in higher projected increases occurring sooner than previously expected. This point was emphasized by the latest IPCC report and could account for an additional 3 feet of sea level rise by 2100. Finally, sea level will continue to rise for centuries after 2150.

Rising sea level, in conjunction with more severe and frequent coastal storms, will bring economic, environmental, and social disruption to coastal communities on an unprecedented scale. In the short term, coastal communities can expect more "sunny day flooding" during high tides and larger surges and greater flooding during storms. In the longer-term, all or parts of hundreds of coastal communities will face far more extensive flooding than they currently experience. As sea levels rise, sunny day flooding will increase and gradually lead to permanent inundation. Specific impacts include coastal erosion and land loss, failed water and sewer systems, saltwater inundation of freshwater resources, and forced infrastructure abandonment. The combination of more severe storms and rising seas is projected to result in potential losses of coastal property running into trillions of dollars. These loss estimates, however, are based on the existing population along the coast and are likely to rise as population increases spur new development in risky coastal locations.

Rising sea levels are also a risk to coastal ecosystems, including beaches and wetlands, and critical infrastructure. A recent study found that 97 percent of U.S. coastal wetlands could be lost to rising seas by the year 2100 in a worst case scenario. Several studies have projected beach loss for specific coastal regions. For example, the U.S. Geological Survey estimates loss of 31-67 precent of California beaches by 2100. In North Carolina, 14 of 17 beaches are expected to have eroded all the way to the road by 2080. The State of Florida reported that "critically eroded" beaches increased from 217 miles in 1989 to 419 miles in 2019 but made no projection of future beach loss.

As the combined risks of coastal storm surge flooding and ever rising sea levels are better recognized, local, state, and federal governments are developing response plans and making investments, sometimes in the billions of dollars, to reduce property loss and increase public safety. For example, implementing coastal resilience plans for New York City alone could cost over $50 billion, of which 65 percent will be federal appropriations. In addition, there is evidence that some of these plans are based on unreasonably low expectations of future sea level with a recent study finding "Over half of U.S. communities included in our analysis underestimate the high end of future sea level rise…". Investing now in the research needed to support the best possible estimates of the timing of future sea level rise will help assure that plans to address coastal flood risk draw on the best possible sea level rise projections and identify the most appropriate design solutions.

Sea Level Rise Science Knowledge Gaps

Given the serious impacts that rising seas will have on the United States coasts, governments and private parties need to develop strategies to minimize impacts. These strategies require reliable information on the rate and extent of future coastal inundation risks. Sea level rise projections developed by the Interagency Sea Level Rise and Coastal Flood Hazard and Tools

Interagency Task Force indicate a wide range of possible future sea level rise based on different scenarios of air temperature warming. For example, the Intermediate scenario for sea level rise along the United States coast by 2050 is 0.40 meters with a range of 0.31 to 0.49.

In addition, the Interagency Sea Level Rise Scenarios report explains that today's projections of sea level rise may be a significant underestimate. The report notes:

> "However, these projections include only physical processes in which there is at least medium confidence in the current scientific understanding…the largest potential contributions to long-term GMSL [Global Mean Sea Level] rise come from ice-sheet processes in which there is currently low confidence. Projections that include the magnitudes, rates, and thresholds associated with these ice-sheet processes, particularly under higher emissions futures, could give rise to GMSL rise values well above the likely range. Pathways to such unknown-likelihood, high-impact outcomes—"potential surprises" …include:
>
> • earlier-than-projected ice-shelf disintegration in Antarctica,
> • abrupt, widespread onset of marine ice-sheet instability and/or marine ice-cliff instability in Antarctica, and
> • faster-than-projected changes in surface-mass balance on Greenland, potentially associated with changes in atmospheric circulation, cloud processes, or albedo changes." (page 21)

The concern that gaps in scientific knowledge are an obstacle to reliable estimates of future sea level rise and thus to effective development of response strategies is shared by a significant number of scientists working in this field. In May of 2022, a group of over thirty scientists published a statement in *Eos*, the journal of the American Geophysical Union, noting:

> "Our ability to accurately and actionably project ice loss and its contributions to sea level rise requires glaciological knowledge and research coordination, as well as effective knowledge dissemination to decisionmakers, that are still unrealized. Current ad hoc efforts to meet these needs are inadequate, delaying the benefits of scientific research for many communities already grappling with increased coastal flooding and other impacts."

The *Eos* statement described the most significant gaps in current understanding of sea level rise science questions:

> "…major gaps in glaciological understanding, observational data, and technical capacity persist and impede efforts to produce actionable predictions of ice loss directly linked to societal consequences…For example, we have only sparse observations from ice sheet boundaries, including the edges of marine-terminating glaciers and ice sheets where ocean currents influence ice loss. We lack a basic understanding of what happens between glacier ice and the underlying land, where topography, sediments, and

> subglacial water influence ice motion. We also lack sufficient long-term monitoring of climate conditions that are forcing ice sheet change, including ocean heat content, which was recently recognized as critically important to both the Greenland and Antarctic ice sheets."

The IPCC Sixth Assessment Report noted that feedbacks between the ice sheets, oceans, atmosphere, and solid Earth are crucial aspects of modeling ice sheet contributions to sea level rise. Model improvements are needed to understand the role of climate feedbacks on ice sheet stability. The monitoring efforts identified in the *Eos* statement would help inform modeling.

Declining Funding for Research on Glaciers and Ice Sheets

Funding for research of glaciers and ice sheets is primarily through the National Science Foundation (NSF) Office of Polar Programs (OPP) with some additional funding from the National Aeronautics and Space Administration (NASA) Sea Level Rise Change Team and several additional programs.

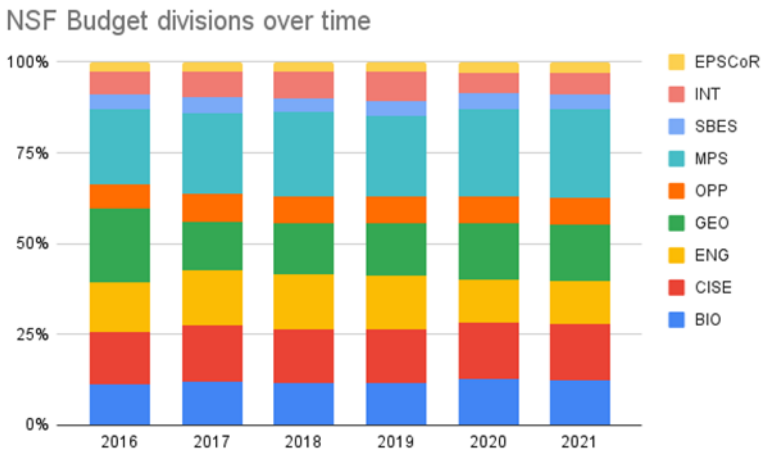
Based on a review of recent funding for research of glaciers and ice sheets, the authors of the Eos statement concluded:

> "Despite the serious implications of coastal inundation and other ice loss impacts, research on Earth's glaciers and ice sheets remains a low funding priority in the U.S. scientific enterprise."

More specifically, authors of the *Eos* statement conclude:

> "In the past 5 years, funding for OPP has dipped to less than 6% (<$500 million) of the total NSF research budget…and only one third of the OPP budget goes to research because of the high costs of supporting polar logistics. This limited amount is then spread across all 10 disciplines working in the polar regions. Assuming an equal split across all 10, the maximum annual amount that glaciology could receive is approximately $10 million…Available funding data from NASA are more limited, yet there has been a proportional decrease there as well: Funding for Earth science research, which includes cryosphere studies, dropped from nearly 10% of the total NASA budget in 2017 to 8.5% in 2021."

The chart below shows changes in funding for National Science Foundation divisions over time.



The FY 2024 Budget submitted to Congress by the President calls for total funding of OPP of $556.6 million, a slight 3.7 percent increase from the $545 estimated for FY 2023 and $544 approved for 2022. The majority of this FY 2024 funding (i.e., $454.85) is for the high costs of maintaining infrastructure in polar environments. Unfortunately, funding for the critical research elements of the program (i.e., $106.8) is down 7.6 percent from the FY 2023 estimated level of $115.6 and is less valuable after accounting for inflation.

Future Funding for Glacier and Ice Sheet Research: Level and Priorities

The *Eos* statement calls for reversing the "low prioritization of funding for glaciology in the United States" and increasing funding "scaled to match the high stakes of rising sea levels".

Other statements from the cryosphere research community support the need for expanded funding. A recent study concluded:

> "The past 2 decades have shown that ice sheets react to climate far more rapidly than previously thought (Rignot and Kanagaratnam, 2006; Joughin et al., 2014). The study of glaciers and ice sheets has moved from a fringe scientific exercise to a central question of major global economic significance. In response to COVID-19, USD 18 billion flowed from the US government to fund vaccine development (Tozzi et al., 2020). Appropriate resourcing is possible. While the emergent threat of sea level rise is less abrupt than that from COVID-19, a similarly serious effort is required to reduce uncertainties in sea level projections."

Although significant funding for additional research of glaciers and ice sheets is essential, there is interest within this research community to improve coordination among federal agencies and academic researchers and develop practices that identify high priority research needs and translate identified needs into funded research. The *Eos* statement notes:

> "Given the current funding landscape, we propose holding regular, open discussions to facilitate deeper reflection on the critical research needed. Within these meetings,

glaciologists must debate, decide on, and then disseminate near- and long-term research priorities for funding that focus on vital observational, knowledge, and modeling gaps."

Conclusion

Your action to support increased funding for research of glaciers and ice sheets, including the steps recommended on page 2 of this letter, will support more timely and cost-effective action to adapt to the risks posed by rising seas.

The *Coastal Flood Resilience Project* is a coalition of organizations and individuals working for stronger programs to prepare the United States for more severe coastal storms and rising sea level resulting from a changing climate. Please note that the views expressed in this letter are those of the contributors listed below. Contributors' affiliations are identified for informational purposes and this identification does not represent endorsement by their organization.

We are happy to answer any questions or provide clarifying comments. We look forward to working with you on this critical matter.

Sincerely,

- Andy Aschwanden; University of Alaska Fairbanks
- Ginny Catania; University of Texas at Austin
- Stephen Eisenman; Anthropocene Alliance
- John Englander; Rising Seas Institute
- Harriet Festing; Anthropocene Alliance
- Rich Innes; Senior Policy Director, Association of National Estuary Programs
- Bethany Kraft; Audubon Society
- Dr. Twila Moon; National Snow and Ice Data Center, University of Colorado Boulder
- Jeffrey Peterson; author of *A New Coast: Strategies for Responding to Devastating Storms and Rising Seas*
- Susan Ruffo; United Nations Foundation and former Associate Director for Climate Preparedness and Resilience, White House Council on Environmental Quality
- Mark Rupp; Georgetown Climate Center
- Dr. Shaina Sadai; Union of Concerned Scientists
- Jason Scorse; Middlebury Center for the Blue Economy
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