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FACT SHEET: United States Hosts First-Ever Arctic Science Ministerial to Advance International Research Efforts

Science Ministers from 25 governments and the European Union gathered at the White House to discuss Arctic research priorities and sign a Joint Statement on increased international collaboration on Arctic science and inclusion of Indigenous peoples in understanding and responding to changes in the Arctic

The Arctic environment is changing at an unprecedented pace, posing threats to livelihoods and ecosystems. One year after President Obama's visit to Alaska, and building on his unwavering commitment to advance understanding of changes occurring in the Arctic and their global consequences, today the White House hosted the first-ever Arctic Science Ministerial (ASM).

Science Ministers, or their representatives, from 25 governments—Canada, the People's Republic of China, the Kingdom of Denmark, the Faroe Islands, Finland, France, Germany, Greenland, Iceland, India, Italy, Japan, the Republic of Korea, the Netherlands, New Zealand, Norway, Poland, the Russian Federation, Singapore, Spain, Sweden, Switzerland, the United Kingdom, and the United States of America—and the European Union and representatives from Arctic Indigenous peoples' organizations gathered to discuss collective efforts to increase the pace of international scientific collaboration in the Arctic.

A capstone of the ASM was the signing and release of a **Joint Statement** by the delegations gathered today. The Joint Statement recognizes that international collaboration and the inclusion of Arctic Indigenous peoples in science and decision-making are essential to advancing research in the Arctic. The Joint Statement and the ASM help chart a new collective approach in Arctic science that will inform national policies concerning climate-change mitigation and resilience, Arctic development, stewardship, and the needs of the region's Indigenous peoples.

The Ministers used the occasion of the ASM to highlight several new initiatives. They include:

- Today, the **United States** released the first ever Arctic-wide digital elevation model (DEM). The result of a collaboration between the National Geospatial Intelligence Agency and the National Science Foundation, this digital representation of the Arctic land surface has an unprecedented high resolution of 8 m. A 2 m resolution Arctic DEM is to be created during the next 12 months and will be an important baseline for assessing future land surface changes.

- The **European Union** will initiate a new 5-year project (2016-2021) coordinated by Norway to develop an Integrated Arctic Observing System (INTAROS). The project, with a €15.5 million budget, will involve scientists in 14 European countries (Belgium, Denmark, Finland, France, Germany, Greenland, Ireland, Italy, Norway, Poland, Portugal, Spain, Sweden, and the United Kingdom), as well as in a number of countries elsewhere in the world (Canada, the Peoples' Republic of China, the Russian Federation, and the United States, with other countries expected to join).
The United States is among the countries that will work with the INTAROS scientists. In 2017, the **U.S. Office of Naval Research** will initiate a 5-year project—Arctic Mobile Observing System (AMOS)—that will develop new sensors, platforms, and techniques for mobile-observing systems that drift with the moving sea-ice cover, or operate autonomously in the ocean below the ice.
- The **European Union** will also initiate two new projects to understand the impact of the changing Arctic on the weather and climate of the Northern Hemisphere. The projects APPLICATE (Advanced Prediction in Polar regions and beyond: modelling, observing system design and LInkages associated with a Changing Arctic climate) (2016-2020, €8 million budget) and Blue-Action (2016-2021, €7.5 million budget) will involve scientists in 13 European countries (Belgium, Denmark, the Faroe Islands, Finland, France, Germany, Iceland, Italy, Norway, Poland, Portugal, Spain, and the United Kingdom), as well as in a number of countries elsewhere in the world (Canada, the Peoples' Republic of China, the Republic of Korea, the Russian Federation, and the United States).
- In 2017, the **United Kingdom** will begin fieldwork for the "Changing Arctic Ocean Programme", a five-year research effort to explore the effects of changes to the physical environment (ice and ocean) on the marine ecosystem and the associated biogeochemical functioning of the Arctic Ocean.
- The United States will support "EyesNorth," a **U.S. National Science Foundation** research-coordination network of community-based observing initiatives in the Arctic and beyond. Involving scientists and northern residents in Finland, Greenland, Iceland, Norway, the Russian Federation, Sweden, the United States, and elsewhere, EyesNorth will expand the science of community-based observing, including the use of Indigenous knowledge and local place-based knowledge, and provide a critical connection between observing environmental change and community preparedness and response. "EyesNorth" will contribute to the work of SAON—Sustaining Arctic Observing Networks—a joint effort of

the Arctic Council (through its Arctic Monitoring and Assessment Programme) and the International Arctic Science Committee.

- In a further contribution to SAON, the **U.S. National Oceanic and Atmospheric Administration (NOAA)** will open a U.S. SAON Office. It will foster interagency and international collaboration in the development of Arctic observing and data systems, as well as the delivery of higher-level data and information to the scientific community and policymakers.

- The **U.S. Environmental Protection Agency (EPA)** will advance STEM education and empower citizens through Arctic STEM cooperative partnerships with the Local Environmental Observer (LEO) Network—a network of local environmental observers and topic experts who apply traditional knowledge, science and technology to document significant, unusual environmental events in Alaska.
- The **U.S. Department of Energy** will develop a design-support tool for remote off-grid microgrids in the Arctic; and the **Office of Naval Research** will support the Alaska Network of Energy Education and Employment (ANEEE).
- In 2017, the **U.S. National Science Foundation** will announce new awards for projects that promote public participation in Arctic research.
- With the assistance of the indigenous community of Pond Inlet, the **Smithsonian Institution** will open a new exhibition, *Narwhal: Revealing an Arctic Legend*, in August 2017 at the National Museum of Natural History in Washington, DC. The exhibition will feature the biology, ecology, and cultural relations of the narwhal and the effects of climate change on its population and range.
- **Finland and the United States** will collaborate to organize an international Arctic STEM Education Summit during the Finnish Chairmanship of the Arctic Council (2017–2019). The summit will bring together senior government officials, students, educators, researchers, technologists, and other experts to share best practices and develop new educational partnerships that enhance STEM education. It will facilitate information and resource sharing, foster new education networks, and promote a legacy of formal and informal STEM education and lifelong learning both inside and outside the Arctic.

The ASM seeks to deepen international collaborations that enable nations to address large-scale research questions and increase the pace of discovery. Existing national and international observing and research efforts are impressive, but they are not able to meet the demand for comprehensive and

integrated information in the Arctic. People in the Arctic are already experiencing significant impacts from climate change. The scale and pace of research must increase to move beyond documenting changes to increasing knowledge and understanding, developing predictive capabilities that inform decision and policy making, and increasing the resilience of Arctic communities and ecosystems.

The White House organized the ASM around four themes that reach across national boundaries and provide opportunities to advance understanding of and ability to respond to rapid environmental change in the Arctic.

The four themes of the Ministerial and the Joint Statement are:

1. Arctic-Science Challenges and Their Regional and Global Implications
2. Strengthening and Integrating Arctic Observations and Data-Sharing
3. Applying Expanded Scientific Understanding of the Arctic to Build Regional Resilience and to Shape Global Responses
4. Empowering Citizens through Science Technology, Engineering, and Mathematics (STEM) Education Leveraging Arctic Science

Today's Arctic Science Ministerial will facilitate progress on each of these themes, described in more detail below. A broad call for deliverables that support the four themes realized more than 150 contributions describing some of the many Arctic science activities of foreign governments and U.S. departments and agencies. Many contributions, described below by theme, are continuing investments that support research efforts critical to long-term and sustained measurements essential to understanding the Arctic. Other contributions, highlighted today at the ASM and summarized above, are new efforts that build on existing work, and address gaps in information critical to advancing new understanding of the Arctic.

Theme I: Arctic Science Challenges and Their Regional and Global Consequences

The annual average air temperature in the Arctic is rising at more than twice the rate of the annual average global air temperature. This rapid transition in the atmosphere is reflected in rapid transitions on land and in the ocean. The dramatic changes are having a profound impact on Arctic cultures, communities, and ecosystems, and they also have global consequences.

Some of the most dramatic changes are occurring in the cryosphere: sea ice,

freshwater ice, snow cover, land ice sheets, glaciers, and permafrost. Permafrost is warming and thawing, changing landscape, drainage patterns, and habitats, and increasing the potential for the release of potent greenhouse gases that will amplify Arctic and global warming. Glaciers,

untain ice caps, and the Greenland ice sheet are shrinking and ontributing to worldwide sea-level rise. Sea-ice extent, thickness, and ume are decreasing, resulting in larger ocean surface waves and greater coastal erosion, compounding the challenges of Indigenous communities t hunt ice-dependent marine mammals. There is also growing evidence that the diminishing sea ice is contributing to changing atmospheric circulation patterns that are affecting weather—including some kinds of extremes—in lower-latitude regions.

There is therefore an urgent need for increased monitoring and research to better understand the causes and consequences of the rapidly changing Arctic environmental system. There is also a need for increased effort to incorporate the growing data and knowledge base into improved computer models for enhanced forecasting of weather, water, and ice on hourly to weekly time scales, as well as improved projections of the state of the Arctic System and global climate over yearly to decadal time scales.

In recognition of these needs, the tempo of research sponsored by Arctic and non-Arctic countries has already been increasing for some time, with impetus from the eight-nation Arctic Council, the International Arctic Science Committee, the World Meteorological Organization, and a growing number of national centers for polar research. The existing national research efforts and collaborations among them will be the building blocks for expanded international cooperation going forward, facilitated by the information exchanges and networking at the Ministerial and future such meetings expected to follow. Among the existing efforts highlighted at the Ministerial under the “Arctic Science Challenges” theme were:

- The U.S. National Aeronautics and Space Administration (NASA) is working with scientists in Canada, and with the U.S. Department of Energy (DOE), to carry out a large, multi-year combined fieldwork and remote-sensing campaign to investigate ecosystem vulnerability and greenhouse gas emissions from boreal forests and tundra in the Arctic region.
- Italy and the Netherlands are using advanced synthetic aperture radar remote sensing techniques to measure land-surface elevation changes occurring in response to permafrost degradation.

- Iceland, India, the Netherlands, Norway, Poland, Spain, and Switzerland are each studying different aspects of how Arctic glaciers, ice caps, and the Greenland ice sheet are losing mass to the ocean and contributing to sea-level rise.

- The "Ice sheet Mass Balance Inter-comparison Exercise 2 (IMBIE-2)," a collaboration between scientists supported by the European Space Agency (ESA) and NASA, provides a framework for assessing recent changes in the mass balance of the Greenland ice sheet, and has an explicit aim to widen participation to enable the entire scientific community to become involved.
- The U.S. Office of Naval Research "Stratified Ocean Dynamics of the Arctic" is a 5-year (2016-2021) project that supports scientists in the United States, Republic of Korea, and the United Kingdom to study changes in ocean circulation, stratification, and the flow of heat and their collective impact on sea ice in the Pacific sector of the Arctic Ocean.

Theme II: Strengthening and Integrating Arctic Observations and Data-Sharing

On September 10, Arctic sea-ice reached its annual minimum extent, which tied with 2007 as the second-lowest in the period of satellite observations that began in 1979. All ten of the lowest minimum sea-ice extent values in that period have occurred during the last ten summers (2007–2016) exemplifying the dramatic changes that are occurring throughout the Arctic environmental system.

Observations and observation platforms, systems, and networks confirm that the sea ice and other components of the Arctic environmental system —permafrost; snow cover; glaciers, ice caps, and the Greenland ice sheet; terrestrial and marine ecosystems—are all changing at unprecedented rates. Nonetheless, the Arctic remains under-observed and data-sparse. The current observing capabilities need to be sustained and new capabilities need to be added to deliver a comprehensive view of the Arctic environmental system. To maximize the benefits of enhanced Arctic-observing capabilities there needs to be full and open access to data and the value-added information and products derived from the data. Data sharing is essential.

Observations are vital for the research described in Theme I. They are also needed for improving weather, water, and sea-ice forecasting, and for

projecting how changes in the Arctic will affect conditions around the world and how the Arctic will evolve under different global-emissions scenarios. The current inadequacy of Arctic observing is one of the main reasons for the uncertainties in sea-ice and climate predictions and in projections of climate-change impacts on people, communities, and ecosystems.

Since the last International Polar Year began in 2007 there has been a growing awareness of the urgent need to improve Arctic observing capabilities and develop data policies that promote sharing through full and open access. This recognition is reflected in a number of ongoing projects and collaborations that were reviewed at the meeting, including:

- Canada, the Peoples' Republic of China, the Republic of Korea, Japan, and the United States, working together through the Pacific Arctic Group of the International Arctic Science Committee (IASC), share responsibility for the Distributed Biological Observatory (DBO), a biophysical change detection array in the northernmost Bering Sea and the Chukchi and Beaufort seas.
- Germany is working with multiple countries to carry out the Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAiC) between October 2019 and October 2020. The centerpiece of MOSAiC is the icebreaker "Polarstern", operated by the Alfred Wegener Institute in Germany, which will support year-round observations of the physics of the atmosphere, sea ice, and ocean and the biogeochemistry of the ice and ocean as the ship drifts with the moving sea ice.
- The Russian Federation is developing and improving methods, models, and technologies for hydrometeorological prediction.
- The World Meteorological Organization has launched the Year of Polar Prediction (YOPP), which is actually a two-year project running from mid-2017 to mid-2019, aimed at achieving a significant improvement in environmental-prediction capabilities for the polar region and beyond. The Alfred Wegener Institute in Germany hosts the YOPP international coordination office.
- As contributions to YOPP, Canada is developing a high-resolution coupled environmental prediction system that will enhance the accuracy of high-impact weather event predictions in the North, and the European Space Agency Arctic Earth Observation Impact Assessment is addressing the combination of Earth Observation data streams with a numerical model of the Arctic Ocean sea-ice system using advanced data-assimilation techniques to construct a highly flexible system for

Arctic Mission Benefit Analysis (ArcMBA).

- With support from Norway, the Sustaining Arctic Observing Networks (SAON) initiative promotes the vision of well-defined, long-lived observing networks that provide users with full and open access to high-quality data that can realize pan-Arctic and global value-added services and societal benefits.
  As a contribution to SAON, Norway is establishing SIOS (Svalbard Integrated Arctic Earth Observing System), a research infrastructure coordination organization of 26 partners from Europe and Asia. SIOS promotes more openness, better access, data sharing and knowledge management for the international research community.
- Canada and the United States continue to collaborate in mapping the seafloor of the Arctic Ocean.
- The U.S. Environmental Protection Agency, Department of the Interior, Department of State, Department of Health and Human Services, Centers for Disease Control and Prevention, and the U.S. Geological Survey are working with Canada and Finland to expand the Local Environmental Observer (LEO) Network into a pan-Arctic network.

Theme III: Applying Expanded Scientific Understanding of the Arctic to Build Regional Resilience and to Shape Global Responses

Arctic peoples and communities face long-standing challenges that are compounded by environmental, social, and economic changes that are occurring in the Arctic, driven above all by global climate change and its accentuation in the Arctic region. These changes are testing the resilience and sustainability of people and communities.

Rapid environmental change, such as degrading permafrost and increasing coastal erosion, is affecting critical infrastructure—buildings; roads, railways and bridges; airports, harbors and ports; and energy-supply chains—and the health and well-being of Arctic residents. It is also exposing the shortcomings of existing capabilities to forecast environmental conditions that affect economic activities and the daily lives of Arctic residents —maritime and air transportation, energy and mines, fisheries, and tourism. In some cases, growing economic activity is challenging the traditional ways of life of Indigenous society. It will be essential to apply the improved scientific understanding and forecasting capabilities sought under Themes 1 and 2 to the development of integrated strategies to meet the basic needs of Arctic people and increase regional resilience and adaptation capacity.

At the same time, improved understanding of how the effects of rapid climate change in the Arctic are affecting both the pace of global climate change and its impacts, including weather patterns and extremes across the Northern Hemisphere, will be important both to motivating increased bition around climate-change mitigation and to shaping resilience rategies in countries around the globe.

orts reviewed at the Ministerial under Theme 3 include:

- Canada will address the topic of coping with a changing environment at local and regional levels by examining case studies of capacity building and partnership development with "Big Science".
- Nordforsk—an intergovernmental organization under the Nordic Council of Ministers—supports a Nordic Centre of Excellence that is investigating climate-change effects on the epidemiology of infectious diseases and impacts on northern societies. NordForsk also supports three additional Nordic Centres of Excellence to collectively focus research on resilience, adaptation, and sustainability as they relate to communities, reindeer husbandry, and resource extraction.
- In 2015, Japan initiated the 5-year "Arctic Challenges for Sustainability (ArCS)" project. The Netherlands and the Russian Federation are also investing in Arctic sustainable development research.
- The U.S. Geological Survey is assessing historical shoreline change and Arctic coastal vulnerability, and mapping coastal flooding to develop a database of historical and future wave and storm-surge conditions across the Arctic Ocean for use in development and mitigation planning of infrastructure, communities, and natural-resource management.
- The Russian Federation is undertaking a comprehensive assessment of the sustainability of its Arctic coastal systems and infrastructure for spatial planning of maritime activities and socio-economic development.
- Norway is studying climate change and its impacts on the Arctic environment and human activities in order to improve the existing integrated management of northern waters.
- The U.S. Department of Transportation is conducting climate-change vulnerability-assessments and developing adaptation options for Alaska transportation infrastructure.
- Japan is investigating the predictability of Arctic weather and sea ice in consultation with forecast users such as shipping companies.
- India is studying the role of the Arctic in modulating the Indian Monsoon over seasonal to millennial time scales.

- The Republic of Korea is investigating the relationship between Arctic warming and sub-Arctic winter weather in order to enhance prediction capability;
- Singapore is interested in identifying sensitivities and feedbacks between Arctic change and vulnerable regions of southeast Asia, and is assessing the viability of trans-Arctic shipping routes and analyzing their impact on maritime transportation.
- Spain is improving process understanding of the large-scale atmospheric response to changing sea ice and assessing the impact of the rapidly changing Arctic on non-Arctic countries, and conducting research into the sustainability of fisheries in the Barents Sea region.
- China is studying Arctic amplification of warming and the global consequences of sea-ice retreat.
- Canada, Denmark, the United States and other countries are collaborating to refine, develop and implement the World Meteorological Organization Arctic Polar Regional Climate Center (PRCC) Network concept. It will develop and deliver improved climate products and services in response to the defined needs of Arctic clients and stakeholders for climate information in support of decision-making.

Theme IV: Empowering Citizens through Science Technology, Engineering, and Mathematics (STEM) Education Leveraging Arctic Science

STEM education is essential for sustainable development in the Arctic and vital for preparing young people in the Arctic to face challenges arising from continuing environmental, social, and economic change. Engagement with Arctic science, combined with Arctic Indigenous and local knowledge, will enhance the delivery of education to students in the region, and inclusion of more Arctic science in STEM education in the region will inspire a new generation of locally educated experts to solve Arctic and global-science challenges and empower the citizens of the Arctic to enjoy full participation in decision-making that improves the quality of their lives.

Arctic science can also be a catalyst for enhancing STEM education outside of the Arctic. The Arctic can serve as a real-world laboratory to train the next generation of scientists and engineers in a variety of Arctic-relevant disciplines. Activities such as virtual participation in field projects, development of high-impact multimedia educational web content, and student engagement in competitions and summer schools in Arctic locations are all known to be effective tools for education and learning.

Activities undertaken as part of the International Polar Year demonstrated that student and public engagement in science can strengthen learning through observations and research about the changing Arctic and how it affects the rest of the world.

orts reviewed at the Ministerial under this theme include:

Norway is supporting the development of a "One Stop Shop for Arctic Knowledge" by the University of the Arctic (UArctic). It unites more than 170 research-focused universities, colleges, and institutes around the circumpolar North of the eight Arctic states, as well as Arctic Council observer states. UARctic will create four new "mini MOOCs" (Massive Open Online Courses) that will provide a basic introduction to the Arctic for a broad audience, and a catalogue of Arctic courses and study programs, and research infrastructure. UArctic will also use web-based, big-data analytics to create an online directory of Arctic-wide research institutions, researchers and research projects, publications, and research trends and gaps to foster international research and education collaboration.

- The European Union EDU-ARCTIC project supports researchers and educators in the Faroe Islands, France, Iceland, Norway, and Poland to develop an innovative educational program to attract young people to natural sciences and polar research.
- The Arctic Warrior project in Spain uses educational transmedia and game-design elements to promote Arctic environmental protection.
- Singapore is working to increase awareness in the Tropics of the changes in the Arctic by convening seminars and conferences.
- The "Japan-Russia Expert Education Project" will continue to nurture professionals to play leading roles in creating a sustainable future in the Russian Far East and the Arctic.
- The U.S. Department of the Interior will continue its support for the Alaska Native Science and Engineering Program (ANSEP) at the University of Alaska Anchorage, which is effecting systemic change in STEM education and capacity-building among Alaska Native students.

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