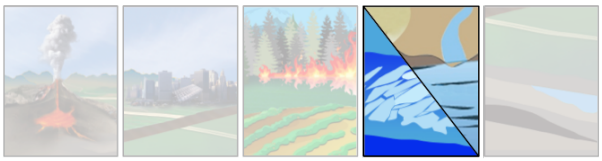
National Aeronautics and Space Administration

**NISAR: The NASA-ISRO SAR Mission**



# The Rapidly Changing Sea Ice Cover

The sea ice cover in both polar regions is undergoing rapid changes, altering the processes that impact ocean and atmospheric circulation, and impacting the human footprint, particularly in the Arctic Ocean. Twice a week, NISAR will provide new and unique information on those changes.

## Sea Ice in the Polar Oceans

Sea ice forms in the polar seas when ocean temperatures reach the freezing point. While comparatively thin (on the order of 1-5 m) compared to ice sheets and glaciers (+100s m), sea ice grows and melts in response to cooling and heating in the atmosphere and ocean over the course of a season. Because of the sensitivity of sea ice to air-sea heating and cooling, the thickness of sea ice is an indicator of changing environmental conditions. Over the last decade, the Arctic Ocean sea ice cover has been found to be rapidly thinning and decreasing in extent, compared to previous decades dating back to the 1950s. At the same time, the sea ice that forms in the Southern Ocean surrounding the Antarctic continent appears to be largely stable in extent in comparison with the Arctic, which indicates a significantly different air-sea-ice environment that needs to be further understood.

The sea ice cover is continually in motion, driven by both atmospheric and oceanic circulation. The continuous motion results in fracturing of the sea ice cover into pieces or chunks of ice (floes). In the winter, as floes break apart, the open ocean is exposed to the cooler atmosphere and new ice quickly forms (Top right). Floes also collide with each other, resulting in deformation as thinner ice is broken into blocks that pile on top of the thicker floe, producing ridges (Bottom right). NISAR has the capability of measuring ice motion and resulting changes in deformation in both polar seas.

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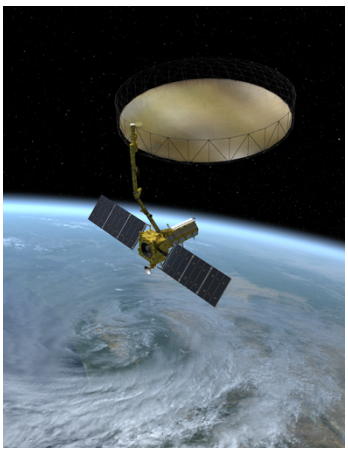
Photos: NASA/JPL-Caltech

## Impacts of the Rapidly Changing Arctic Sea Ice Cover

The thinning of the Arctic sea ice cover is resulting in a reduced sea ice extent in the summer months and a related increase in open water. Water effectively absorbs more solar radiation than ice, which leads to a warming ocean as well. The dramatic changes in the warming, summer Arctic has resulted in measurable impacts to the Arctic ecosystem and native communities and an increase in human activities in the area related to shipping and mineral resources.



## The NISAR Mission – Reliable, Consistent Observations

The NASA–ISRO Synthetic Aperture Radar (NISAR) mission, a collaboration between the National Aeronautics and Space Administration (NASA) and the Indian Space Research Organization (ISRO), will provide all-weather, day/night imaging of nearly the entire land and ice masses of the Earth repeated 4-6 times per month. NISAR's orbiting radars will image at resolutions of 5-10 meters to identify and track subtle movement of the Earth's land and its ice cover, and even provide information about what is happening below the surface. Its repeated set of high resolution images can inform resource management and be used to detect small-scale changes before they are visible to the eye. Products are expected to be available 1-2 days after observation, and within hours in response to disasters, providing actionable, timely data for many applications.

Other indications of significant Arctic change include increased buckling and breaking of the thinner ice, longer periods of summer ice melt, and an increase in wave activity. There is increased ocean productivity during the summer, the presence of multiple species normally found at lower latitudes that have migrated to more northerly, now more favorable climate, and an increase in ocean acidification. The changes in the Arctic marine ecosystems and reduction in sea ice cover has increased the environmental stress placed on populations of top-tier marine mammals, including polar bears and walrus, because the depleted ice cover in the summer months has altered their access to food. Native populations along the Arctic coasts are being impacted by the changing ice conditions and animal populations, the latter of which they rely upon as part of their cultural subsistence harvesting. The increase in wave heights during summer months are damaging coastlines and impacting the survival of coastal communities.

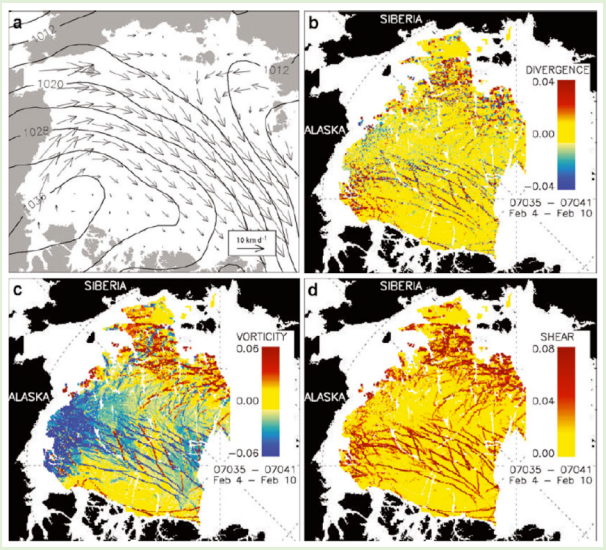
The rapidly changing Arctic sea ice cover has sparked interest in shipping as well as mineral and oil exploration. There is increased shipping along both the Northeast and Northwest Passages, significantly shortening the travel distance between the Atlantic and Pacific Oceans and thus reducing shipping costs. The exposed ocean along the northern Alaska coastline has increased the need for marine security as well as environmental monitoring by the U.S. Coast Guard and Navy, made even more difficult by the lack of suitable northern ports. Lastly, the interest in oil and mineral exploration leading to potential production has spiked, as the shallow, petroleum- and mineral-rich continental shelves throughout the Arctic have become more accessible. More shipping and mineral exploration increases the potential of oil spills, with hazard assessment and clean-up made more difficult by the sea ice cover.

As the entire Arctic ocean evolves with the changing climate, NISAR is expected to play a key role in providing detailed and extensive observations of sea ice motion and sea ice properties.

## The NISAR Mission – Sea Ice Motion

Because of the challenges of cloud cover and solar illumination at high latitudes, sea ice motion and deformation are best observed through systematic mapping using spaceborne synthetic aperture radar (SAR). In addition to observing sea ice in the Arctic Ocean, the NISAR mission will also map the extent of sea ice in the Southern Ocean on an annual basis. It will obtain an extended time series of fine-scale sea ice motion and deformation, which is key to undersnding how the sea ice thickness is changing. NISAR will image most of the sea ice areas in the polar regions twice a week, independent of cloud cover.

As shown from earlier missions, SAR-derived small-scale motion fields can show motion of individual floes, how ice floes move as cemented blocks, the opening of leads through the sea ice, and the ridging processes. With NISAR, we will be able track the details of how these processes take place. This data will provide improved understanding of the changes in sea ice motion and deformation due to decreasing thickness, including tracking the differences between the sea ice in the north and south polar regions. In addition, NISAR will provide information on the age and type of the ice, including stages of young ice growth that occurs rapidly as the ice forms on the ocean surface. This data will be particularly useful for ship navigation. Combined, these products will be valuable for use in sea-ice and ocean models, and important for climate and operational forecasting.




*Sea Ice motion derived from Radarsat-1 SAR imagery over a six-day period. a) atmospheric pressure field and dominant wind speed and direction vectors, and derived b) divergence /opening, c) vorticity rotation, d) shear or parallel motion from sequential SAR imagery. Note the dominant ice motion patterns are closely aligned with the primary wind direction and extend across most of the western Arctic.*