

STRATEGY 2022-2026

Executive summary

In the Arctic, warming is amplified and the effects on ecosystem dynamics are more pronounced and appear at a faster pace than elsewhere. Concerns about the effects of climate change on arctic ecosystems among scientists and decision makers led to the initiation of the Greenland Ecosystem Monitoring (GEM) programme in 1995. The programme should provide early observations that would act as a baseline to provide insights into the functioning of arctic ecosystems in a highly variable and changing climate.

Since the implementation at Zackenberg in North East Greenland, new long-term monitoring sites were added at Nuuk in 2009 and at Disko in 2018 to collect data along a climatic gradient from the High Arctic to the Low Arctic. GEM is now established as the only integrated long-term monitoring and research programme on ecosystem dynamics and climate change effects and feedbacks in Greenland and a leading one of its kind in the Arctic.

GEM applies internationally agreed methodological standards and provides free and open access to the data on >2000 variables monitored by the programme, including Essential Climate Variables and Focal Ecosystem Components identified by international organisations.

The GEM Strategy 2022-2026 provides a guidance and decision-making framework that will help GEM align its resources and objectives with its long-term vision. The strategy forms an overview of what GEM is striving to achieve, in order to guide GEM scientists and communicate to the broader scientific community, decision makers and other stakeholders what they can expect from GEM.

Explore GEM data on <https://data.g-e-m.dk/>

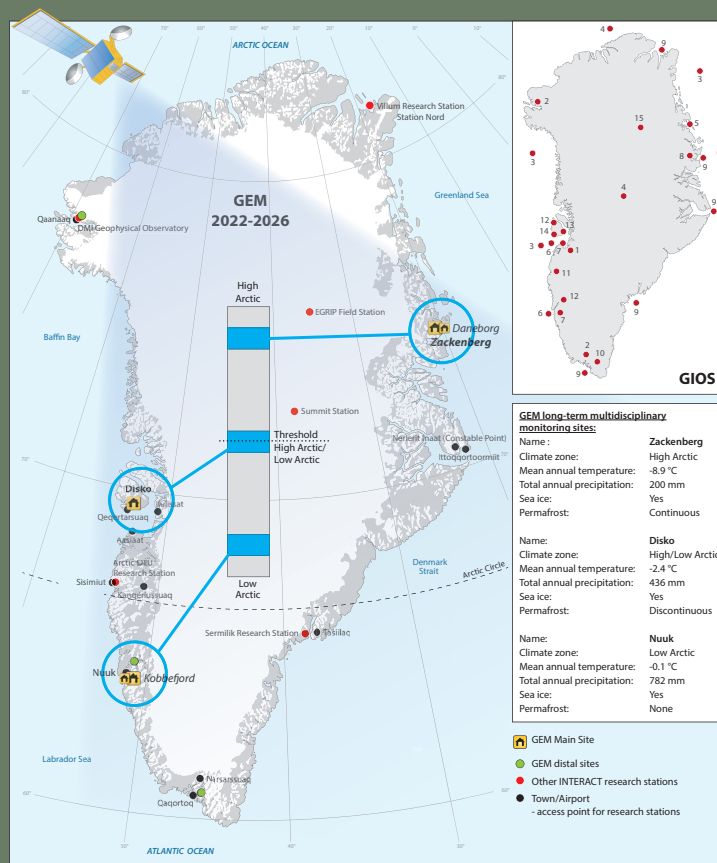


Figure 1. The location of the three GEM long-term monitoring sites along the climatic gradient from low to high Arctic.

The GEM strategy 2022-2026 is responding to national and international concerns about climate and ecosystem change by addressing science agendas and data needs of Arctic Council working groups (AMAP and CAFF) and UNs Intergovernmental Panel on Climate Change (IPCC).

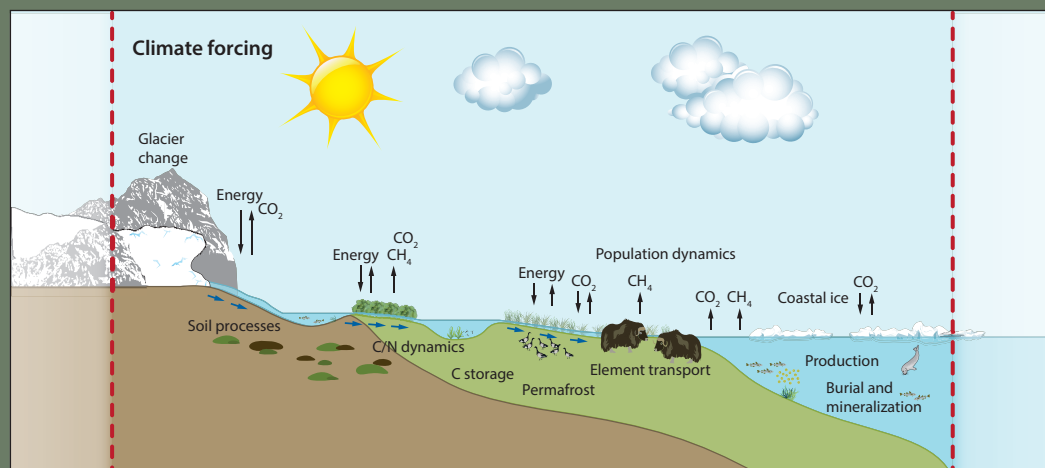


Figure 2. The GEM programme is designed to study entire arctic ecosystems to identify change and understand ecosystem processes and linkages from the land ice to the near coastal sea.

VISION

- Focusing on Greenland, GEM will contribute substantially to the basic scientific understanding of arctic ecosystems and their responses to climatic changes and variability as well as their potential local, regional, and global implications.
- GEM will consolidate and expand its position as an internationally leading integrated arctic long-term ecosystem monitoring and research programme.
- GEM will maintain the continuous update and safeguard the integrity and use of the GEM long-term data series.

MISSION

In support of mission statements of the Arctic Council Working Groups, AMAP and CAFF, the GEM 2022-2026 Strategy will continue to provide reliable science-based information on the status of and threats to arctic ecosystems and provide scientific advice to arctic governments. In particular this relates to the efforts of the governments of Denmark and Greenland to take remedial and preventive actions relating to adverse effects of climate change in the Arctic.

OBJECTIVES

Building on the GEM vision and combined with scientific agendas of international organisations, GEM will facilitate interdisciplinary initiatives answering key scientific questions at an ecosystem and Greenlandic scale. The objectives are:

- To study the state and spatiotemporal variability of essential variables of the climate, cryosphere, freshwater, land and near coastal ecosystems in Greenland.
- To provide data-based analyses revealing the connections between these key components and how their inherent spatial and temporal variability influence each other.
- To document the effects of climatic variability and long-term change on a wide range of key ecosystem components and processes in Greenland.
- To identify key indicators of change as they emerge as detectable significant trends of change from the monitoring data.

NEW THEMATIC STRUCTURE

The GEM Strategy 2022-2026 introduces a thematic structure facilitating integration within GEM and linkages to key intergovernmental organisations and scientific networks. The themes are:

1. Climate and Cryosphere

The abiotic, physical environment encompasses the 'non-living' aspects of the atmospheric, terrestrial and marine environments. The abiotic system provides the main drivers for biotic systems (Biodiversity and Populations), including the important feedbacks to the climate system (Ecosystem Feedbacks).

2. Ecosystem Feedbacks

Biotic factors are often controlled by abiotic factors, but changes in the biological system may also influence the climate – this is called a feedback mechanism. These climate ecosystem interactions have a large impact on the global climate systems, especially in the Arctic.

3. Biodiversity and Populations

Biodiversity, populations, and biological processes are influenced by abiotic factors (Climate and Cryosphere) and biotic interactions. In some instances, biological processes also feedback to impact the climate system altering radiation and carbon budgets (Ecosystem Feedbacks).

Climate and Cryosphere



Photo: Aslaq.

Ecosystem Feedbacks



Photo: Marie Frost Arndal.

Biodiversity and Populations

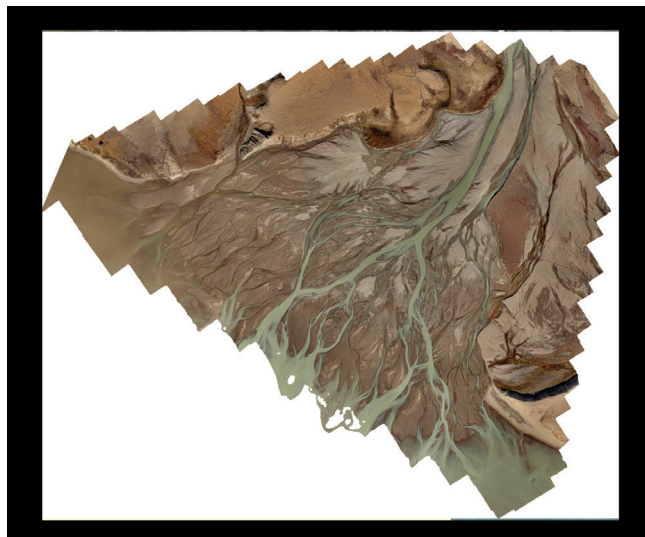


Photo: Katrine Raundrup.

NEW PROGRAMME COMPONENTS

Remote sensing component

GEM will build on experiences on how site-based insights into processes and trends can be up- and downscaled in space to implement a remote sensing component aligned with key variables within the new thematic structure. GEM will develop streamlined workflows using novel and cutting-edge techniques in photogrammetry, image processing, machine learning and online cloud processing to improve the processing capabilities and allow Greenland scale products of GEM's past and future remote sensing data.



Ecosystem modelling component

Ecosystem modelling together with remote sensing are key tools to understanding changes and making forecasts for remote and highly heterogenous arctic landscapes. GEM will therefore implement an ecosystem modelling component across the new thematic structure to improve the understanding of spatiotemporal trends and variability, uncertainties and feedbacks through the integration of long-term monitoring *in situ* data with established but novel numerical models. GEM's new focus on modelling will make use of essential variables, assess data integrity and aid the identification of extreme events, potential tipping points and likely future climate scenarios.

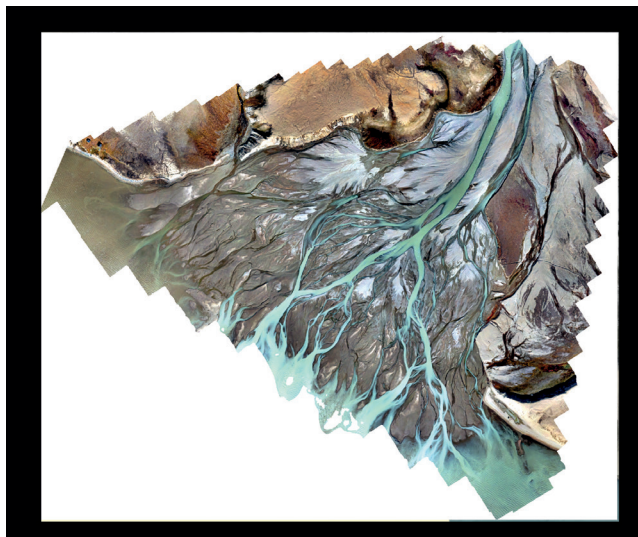


Photo: Charlotte Sigsgaard.

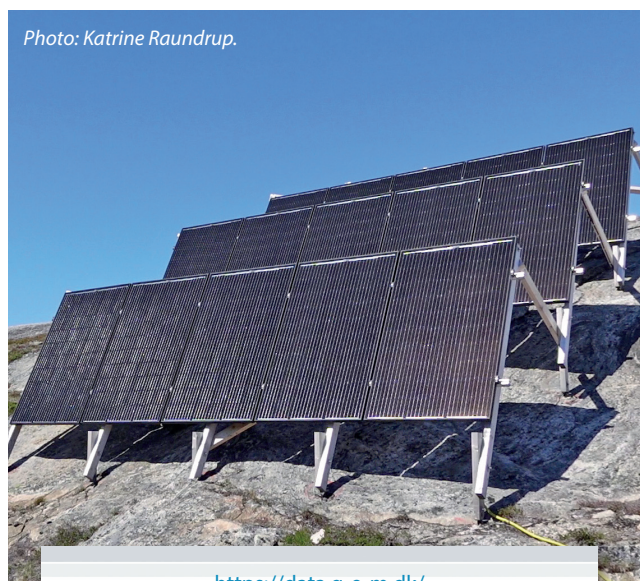


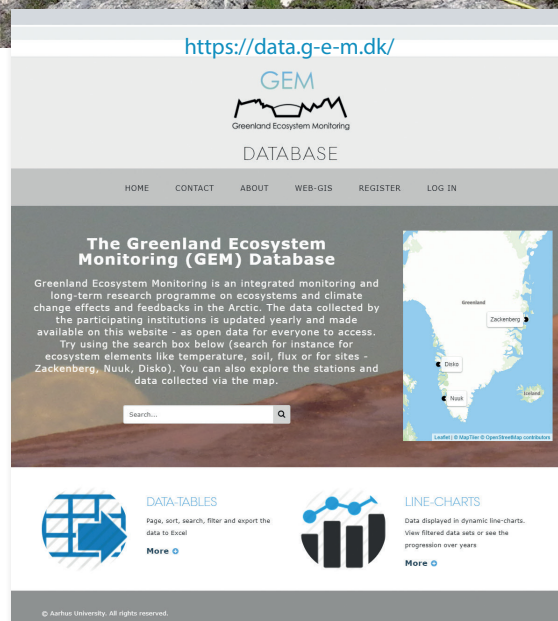
Photo: Katrine Raundrup.

INTERNAL PROGRAMME DEVELOPMENT 2022-2026

Methodological development: GEM will continue its cooperation with +30 international scientific networks and organisations to continuously develop and implement standard methodologies and technologies, including molecular techniques, new sensors, automation, mobile platforms and machine learning techniques.

Data management: GEM will provide free and open access to data following the FAIR principles. GEM will share data with recognised thematic and multidisciplinary repositories, improve usability and promote the GEM database in relevant international fora.

Green transition: GEM will implement monitoring of its carbon footprint and environmental impact and continuously seek ways of reducing these.



Read more about the GEM programme and its achievements on: www.g-e-m.dk



@GreenlandEcosystemMonitoring



@GEM_Arctic



Greenland Ecosystem Monitoring

Feel free to get in touch with the GEM Secretariat if you have questions or want to explore possibilities for collaboration at g-e-m@au.dk



Photo: Thomas Juul-Pedersen

COLLABORATION AND SOCIETAL ENGAGEMENT

International cooperation: GEM will engage actively in international projects, networks and organisations to adopt international science agendas, and promote and continuously develop the application of long-term monitoring, an integrated ecosystem approach, standardization and data sharing.

Advisory function: GEM will provide input to national, arctic and global assessments (including AMAP, CAFF/CBMP, IPCC), make up-to date information available for decision makers and respond to political requests for advice on climate and ecosystem change.

Coupling of knowledge systems and Citizen Science: GEM will explore Citizen Science as a tool to supplement the long-term monitoring activities and provide input to externally driven sustainable development projects addressing societal challenges where relevant and required.

Education: GEM will continue to use its expertise and data to develop educational materials and courses on climate change and ecosystems in Greenland for schools, high schools and the next generation of scientists at university level (through Bachelor, Master, PhD, and Post docs).

Communication and outreach: GEM will advance the knowledge on climate change and ecosystems in Greenland by continuing to produce scientific papers in peer reviewed journals and communicate significant results to decision makers and the general public through the GEM Annual Report Cards, and news and social media articles in Greenlandic, Danish and English.

