Climate, Energy, and Urbanization

Initiatives

GEO Cold Regions Initiative (GEOCRI)

Focus Area(s):

- **Climate, Energy, and Urbanization**
- **Water and Land Sustainability**
- **Weather, Hazard, and Disaster Resilience**

Challenge

Climate change is rapidly transforming the world's cold regions, exacerbating the vulnerability of ecosystems and altering the societal operations and governance within affected communities. Global warming has reshaped the Cryosphere and its surrounding and downstream areas, affecting key Societal Benefits Areas (SBAs) such as water availability in downstream regions, transportation through Northern Sea Routes (NSR) and harsh regions, infrastructure stability in permafrost areas, water- and Cryosphere-induced disasters, and lowland agriculture due to ecosystem changes. Additionally, insufficient observations and agile monitoring of the Cryospheric elements, lack of adequate data and tools, and limited or neglected information services required by local populations present major challenges to sustainable development in these regions. Timely and effective Cryospheric and environmental monitoring, along with comprehensive value-added data for decision-making, is urgently needed to address these issues.

Solution

Digital sciences and technologies, including Earth system science, environmental sciences, Earth observations (EO), Artificial Intelligence (AI), Big Data, and Data Governance with policies, provide comprehensive solutions for operations and sustainable development, delivering valued information services for cold regions. These Earth Intelligence and emerging innovations provide trusted, transparent, and undifferentiated approaches to data and knowledge, fostering groundbreaking scientific discoveries and reinvigorating the confidence of various stakeholders in societal activities at the policy level, such as the COP, global SDG policies, and national policies. By leveraging these EO and data technologies, it becomes affordable for the world to enhance monitoring capabilities, improve data accuracy, and optimize decision-making processes. Integrated Data Solutions will offer a pathway for transforming sustainable monitoring in cold regions from digitization to Earth-intelligent systems.

Intended Socioeconomic and Environmental Impact

This initiative aims to enhance operations and accelerate sustainable development in cold regions by improving the Cryosphere observations, monitoring and predicting, and disaster response and mitigation. It will reduce the risks of induced disasters, such as flooding and infrastructure instability. The integration of Earth Observations, data and AI, and data-driven decision-making provides the Deeping information for, e.g., transportation planning and advisory, ensuring the stability of transport networks, protecting vital ecosystems, mitigating disasters, and projecting future cryosphere changes. Enhanced disaster early warning systems and response solutions, and

optimized operations in cold regions, together with the development of robust AI techniques able to identify hidden patterns in multisystem and multimodal big datasets, will lead to the detailed characterization of cascading effects of climate change-induced transformation in the cold regions (e.g., impact of landslides and snow avalanches on road, electricity, and water networks), resulting in reduced economic losses, energy savings, lower pollution, decreased carbon emissions, and improved resilience to climate change, which contributes to the achievement of the UN Sustainable Development Goals (SDGs).

Objectives for 2025–2030

From 2025 to 2030, the GEOCRI initiative aims to significantly enhance the understanding, management, and operations of cold regions through the integration of high-quality Earth observation data, advanced AI-driven analytics, and improved high-quality information services. The initiative will focus on several key objectives:

- **Expansion of Data Streams and Data Products**: GEOCRI will continue to expand and improve the continuous data and product streams on Essential Cold Regions Variables (ECRVs), providing real-time, high-resolution products that cover critical aspects such as water availability in cold mountain areas, the safety of transportation on land and sea routes, cryosphere-included disaster mitigation, and sustainable development in cold regions' operations. This will include new data products, such as high-resolution snow cover products; river, lake, and sea ice monitoring data; soil thaw and refreezing; water expansion and loss; and vegetation and carbon dynamics. These data will support resource management, flood prediction, and climate change impact assessment in cold regions.
- **AI-Driven Computing and Processing**: GEOCRI will integrate AI algorithms for data flow processing, predictive modeling, and decision support models. AI will be used to enhance spatiotemporal coverage by filling data gaps in seamless spatial and temporal scale, and provide more accurate predictions, particularly in remote areas where data continuity has historically been challenging. Existing products will be upgraded with higher spatial and temporal resolutions to provide more accurate, reliable, and timely information.
- **Improved Information Services**: The platform will offer enhanced data and information services, with more accessible online tools for visualizing and analyzing snow, ice, and other essential relevant data products. These services will support decision-making for stakeholders in government, research, and industry, particularly in cold region activities operations, for example, water management, disaster mitigation and awareness, infrastructure weakness assessment, transportation (shipping and land road feasibility), climate risk assessment and adaptation, and UN SDGs.
- **User Expansion and Engagement**: By the end of 2030, GEOCRI plans to significantly expand its user base and foster greater collaboration among international bodies, such as global agreements, organizations, and bodies; policy bodies, such as the agreement of fishery in the Polar regions; and international science programs, such as the UN Science Decades for SDGs and Cryosphere Decades led by UNESCO; private companies, such as COSCO; and international standard information buyers.

How We Work

GEOCRI unites cold regions activities through current science efforts, industry involvement, and engagement with stakeholder communities, including users, public awareness, and policymakers. It operates under a distributed cooperation model, co-led by a team of lead experts from different countries and international organizations. The governance of GEOCRI also includes a Science Committee that comprises policymakers, users, and scientific experts. As the standard data product system for Cold Regions, an interoperable data portal, specific working groups, and a Secretariat will be formally set up to support operations and coordination. GEOCRI emphasizes communication and collaboration among organizations, utilizing online and in-person meetings, seminars, and workshops, such as the HiMAC Workshop, to discuss observational progress, EO data products, and services, and advance environmental change science discoveries under the global warming threat. The initiative has forged strong national and regional partnerships, integrating research efforts from across the globe.

The co-lead group will be expanded in the GEOCRI work program. The Science Committee and the Secretariat will be set up once the Initiative receives endorsement.

Donors

China	Aerospace Information Research Institute, Chinese Academy of Science (AIR-CAS)
	China Aero Geophysical Survey and Remote Sensing Center for Natural Resources (AGRS)
	Institute of Tibetan Plateau Research, Chinese Academy of Sciences (ITP-CAS)
	National Marine Environmental Forecasting Center (NMEFC)
	National Space Science Center, Chinese Academy of Sciences (NSSC-CAS)
	Northwest Institute of Eco-Environment and Resources, Chinese Academy of Science (NIEER-CAS)
	Polar Research Institute of China
	Sun Yat-Sen University
	Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences (XIEG-CAS)
Finland	Institute for Atmospheric and Earth System Research (INAR), University of Helsinki
Germany	German Aerospace Center (DLR)
High Mountain and Cold Region Working Group (HiMAC WG), Digital Belt and Road Program (DBAR)	
International Research Center of Big Data for Sustainable Development Goals (CBAS)	
Japan	National Institute of Polar Research (NIPR)
Netherlands	Delft University of Technology
Norway	The Arctic University of Norway (UiT)

Partners

GEO Participating Organizations
International Research Center of Big Data for Sustainable Development Goals (CBAS)
International Society for Digital Earth (ISDE)
Non-affiliated
Digital Belt and Road Program (DBAR)
Pan-Eurasian Experiment (PEEX)

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