**WP23\_25: GEO Cold Regions Initiative (Living document)**

Submit on 14th, June ([www.geocri.org](http://www.geocri.org))

**Basic Information:**

* Full title of the Initiative: GEO Cold Regions Initiative

*Please provide the full title of the Initiative (maximum of 80 characters, including spaces) - Please note that references to 'Initiatives' in this tool should be interpreted to include GEO Flagship Initiatives, GEO Initiatives, and Pilot Initiatives*

* Short Title or Acronym: GEOCRI

*All captial letters, maximum of 20 characters*

* Current category in the 2020-2022 GWP: New activity
* Proposed category in the 2023-2025 GWP: Pilot Initiative
* Points of Contact

| **First name** | **Last/Family Name** | **Email** |
| --- | --- | --- |
| Yubao | Qiu | qiuyb@aircas.ac.cn |
| Massimo | Menenti | m.menenti@tudelft.nl  |

*Please identify the primary contact persons for the Initiative with email addresses (maximum 5)*

1. **Purpose**
* Objective

*(Please provide a sentence summarizing the main purpose of the activity)*

[Input]: Cryosphere Data Stream Services in Cold Regions through the Derived and Integrated Earth Observation Products - to facilitate the provision and standardization of satellite information products in the cryosphere-dominated cold regions to meet the needs of societies, including high elevation and high latitude cold regions.

* Please provide a short description of the Initiative

(Maximum of 300 words)

[Input]:Under a global warming scenario, the high elevation and high latitude cold regions, dominated by the cryosphere elements, are inherently fragile to the environment, where changes in the phase of water and the induced result to the environment affect billions of human lives there and the downstream area. Societal and economic development has been leading to a growing dependence on natural, ecosystem, and environmental resources. The warming reshaped the cryosphere and its embed regions, influencing the societal benefits of water availability in the downstream areas, transportation in opening Northern Sea Routes (NSR), the infrastructure and road stabilities in permafrost-rich areas, food and agriculture strategy by blooming ecosystem, climate and weather forecasting service, and challenges addressing and assessment to the sustainable development of cold regions. Timely and accurate information on the cryosphere elements, like snow, glaciers, permafrost, freshwater ice, sea ice, and even solid precipitation, is necessary to protect fragile ecosystems and the environment, facilitate sustainable exploitation of environmental resources, provide forcing data to hydrometeorological services, support the safe use of the land and ocean facilitates, and thus evaluate and foster addressing the sustainable development goals.

GEOCRI brings together the efforts of different science and industry communities’ activities currently and stakeholders in the world's cold regions. The core interest of the GEOCRI is to bring fruitful information, gathered continuously by the national and multi-national, growing infrastructures of diverse and complementary Earth observations, to users on a global scale. The contributors to the objectives of GEOCRI are currently operating observational and data infrastructures with high-performance data streaming processing capabilities with open data principles on an international platform. Likewise, data systems have been developed and are hosting rich data assets. We expect the initiative to generate continuous data streams on Essential Cold Regions Variables (ECRVs), and provide pilot services on the water availabilities in the cold mountain area, safety transportation for the land and northern sea routes, emerging cryosphere disaster mitigation, and assessment supporting the UN Sustainable Development Goals (UN SDGs), etc.

* Why is this Initiative needed?

[Input]: The world’s cold regions, where the cryosphere and its changes characterize the Earth system and human activities, have been highly influenced by global warming in the last decades and will be ongoing to global carbon neutrality. Its importance and driven force were described in the Conclusion and Recommendations from GEO Cold Regions Side Event in GEO X Plenary and Geneva Ministerial Summit (GEO, Switzerland, 2014), it recalls,

(1) More than one hundred countries around the world have cryospheric elements (various forms of frozen water). These elements are the main source of fresh water, which needs long-term monitoring and modeling, especially mass balance measurement.

(2) Cold Regions are the most ecologically and environmentally sensitive areas, and changes to these areas comprehensively affect the dynamic Earth system, impacting many aspects of society in all parts of the world.

(3) A global, comprehensive Cold Regions Information Service will strengthen synergies among the activities of the Environmental, Climate, and Cryospheric communities across poles and mountain Cold Regions. In particular, it will support the efforts of scientists, experts, and decision-makers to ensure the sustainability of these environmentally stressed areas in an increasingly complex political and economic context.

(4) With its strong link to user communities, GEO is developing a user-driven approach to Cold Regions that will complement the current science-driven effort.

* + What evidence is there to support this need?

[Input]: The changing snow and ice cultivate the local and regional climate and hydrometeorological conditions modulate the economy and societal activities. In the last decades, more and more evidence of fast-changing snow and ice interrupting the traditional ways of life and resource supplies, e.g. water availability in the low land downstream area of HMA, new challenges, and shipping activities in the Northern Arctic Sea Routes, emerging hydrometeorological and geological disaster awareness and emergency responses in HMA and Siberia cold regions, greenness in high latitude Arctic region, infrastructure and railway stability in permafrost dominated regions, and land degradation and erosion at the coast area caused by the sea ice development, and etc. The cold regions had their natural remote area, lack of the data calls for more shared and integrated EO data for addressing climate actions for the UN sustainable development Goals (UN SDGs).

* Is this Initiative open to participation by representatives of any GEO Member, Participating Organization, and GEO Associate? Yes
* Are you aware of other projects or initiatives at a global or regional scale (both in GEO and externally) that provide similar products or services? Yes
	+ Please describe.

[Input]: GEO Cold Regions Initiative (GEOCRI) was endorsed in 2016 and selected as a GEO initiative in the work program of 2017-2019, which was originally derived from the component of Water - “information services for cold regions” (WA-01-03). A rationale and consensus document has been formed at GEO X Plenary and Ministerial Summit in 2014, enhancing the UpToDate development of the information service to cold regions by different communities of international bodies. Now, several GEO initiative activities are less or more with Cryosphere elements, like Water, Mountain, and Arctic initiatives in the GEO work program. While the gaps still lie in the selected variables with data stream supplies, some of the function especially is still underdeveloped for the service practices, the activities cannot address the diverse communities in all aspects. WMO has similar activities, like the global Cryosphere watch, while it is strongly on the in-situ, and modeling for science-driven applications. Vast diverse communities and application areas by GEO are not linked and addressed. The joint essential variables have been proposed in this program discussion meeting with WMO GCW and GEO GLOWS, it will give new monuments to complement each other. New development with Arctic GEOSS, GEO NOMES, and the newly setup initiative is under development.

* + How is this Initiative unique?

[Input]:

The GEO Cold Regions Initiative (GEO CRI) has a strong legacy of understanding cold regions' environment through space observations, which is both relevant to GEO itself and accepted by users (requirement evidence on the sentinel satellite, see more about the document section of gerocri.org).

(1) The Initiative will be providing high-quality information services based on high spatial and temporal resolution products to stakeholders, relying on the fast development of the space-based data, not only for the science-driven requirement forcing data but also for societal and economic applications.

(2) The Initiative is made up of very diverse groups with experience and background covering cold regions around the globe, data providers, users, and stakeholders, its data and information stream can provide the unique standard for the global pilot service example.

(3) The Initiative has been endorsed by YOPP in 2015, and is in the process of gaining endorsements by the ISC bodies of science and GEO participant bodies, private companies of COSCO, international science programs, like the Digital Belt and Road program (DBAR), Third Pole Environment program (TPE), international research organizations, e.g., International Research Center of Big Data for Sustainable Development Goals (CBAS), and NGOs, e.g., International Polar Protection Association (IPPA).

(4) The Initiative is about the cryosphere-dominated cold regions world wildly, with a different focus than mountain areas and the Arctic regions with observational networks, creating and maintaining information services based on the synergy of in-situ and space-borne data, rather than the primary data collected by operational satellites. The complementary function will be developed with the GEO program, Arctic GEOSS, GEONOME, and other international bodies.

Additional information about the information value to the different communities can be found at [www.geocri.org](http://www.geocri.org).

* Please identify the most important actual and/or intended outputs (products, services, etc.) produced by the Initiative, along with their intended and/or actual users. This list does not need to be comprehensive but should identify the outputs which are most used and are expected to have the greatest potential impact.

| **Output** | **Status** | **Users** | **Additional info** |
| --- | --- | --- | --- |
| Snow Cover (FSC and SCA) | Algorithm has been developed, and regularly updated. | ICIMOD, Pakistan, and other countries  | Algorithm has been developed, and regularly updated. Users in the water management, agriculture, and energy area by ICIMOD, countries like Pakistan, Central Asia (CA), and others |
| Snow Water Equivalent(SWE) | Algorithm has been developed, and regularly updated. | Water Management, Agriculture, and energy (ICIMOD, Pakistan)  | Algorithm has been developed, and regularly updated. Users in the water management, agriculture, and energy area by ICIMOD, countries like Pakistan, Central Asia (CA), and others |
| Lake ice | Algorithm has been developed, and regularly updated. | Transportation and fishery | Algorithm has been developed, and regularly updated. Users in the area of transportation and fishery, and Climate Actions for SDGs (SDG13) |
| River ice | Algorithm has been developed, and regularly updated. | Transportation  | Algorithm has been developed, and regularly updated. Users in the area of transportation and fishery, and Climate Actions for SDGs(SDG13). |
| Sea Ice | Algorithm has been developed, and regularly updated. | Transportation and climate actions  | Algorithm has been developed, and regularly updated. Users in the area of transportation and fishery, and Climate Actions for SDGs(SDG13). |
| Permafrost | Algorithm has been developed, and occasionally updated. | Transportation and infrastructure | Algorithm has been developed, and occasionally updated. Users in the area of transportation and infrastructure stabilities in cold region areas, and SDG addressing (SDG11, and SDG13) |
| Frost | In development | Transportation and emerging risk management  | Users in the area of transportation and emergence reactions in the winter time.  |
| GLOF | Available but not updated periodically | Disaster, climate actions | Available but not updated periodically. User in the disaster mitigation and reactions. |
| Ice Jam Warning | In development  | Disaster | User in the transportation and disaster mitigation and reactions  |
| Snow Avalanche Warning | In development  | Disaster/ Transportation  | User in the transportation and disaster mitigation and reactions  |
| glacier surface flow velocity | Available but not updated periodically | SDG13, climate actions  | Available but not updated periodically User in the disaster mitigation and climate actions (SDG13). |
| glacier thickness change | Available but not updated periodically | SDG13, climate actions, Water Availability | Available but not updated periodically. User in the water management, climate actions(SDG13). |
| glacier extent | Available but not updated periodically | SDG13, climate actions, Water Availability | Available but not updated periodically. User in the water management, climate actions(SDG13). |
| glacier surgery warning and adaption | Available but not updated periodically | Disaster, SDG13 | Available but not updated periodically. User in the disaster management, and climate actions (SDG13). |
| Iceberg tacking | Available but not updated periodically |  |  |
| Ice Chart | Available but not updated periodically | Disaster/ Transportation  | Available but not updated periodically. Users in transportation of the arctic shipping, and shipping companies, and etc., |
| snow melt-related flooding | In development  | Disaster/ Transportation | Users in disaster and transportation, and climate actions (SDG13) |
| rain onsnow(ROS) | Planned | climate actions, SDG13 | User in climate actions (SDG13) |
| ice lens formation | Planned | climate actions, SDG13  | User in climate actions (SDG13) |
| Permafrost degradation and subsidence  | Planned | climate actions, SDG13  | User in climate actions (SDG13 |
| Iceberg tracking Calving from the marineterminated glacier (related MICI, MISI) | In development  | Water management, climate change  | Users in water management, climate actions (SDG13) |
| Derived phenology in snow and ice area  | In development  | transportation, energy, climate actions  | Users in the area of transportation, energy, climate actions  |

**Status**: Regularly updated / Occasionally updated / Available but not updated / In development / Planned

* + If needed, please provide additional comments or explanation to accompany the outputs table

[Input]: For most of these data products and streams, initial data sets have been generated for 2000 – 2022 for the Polar regions and High Mountain Asia (see Table “output” part), from the early time of 2018, several projects have been started. As regards the remaining data sets, algorithms are available and evaluated. The initiative is expected to promote the additional effort of maintaining and updating such data streams and demonstrating the services at regional to global scales.

* What kinds of decisions are the outputs of this Initiative primarily intended to support?

[Input]: Providing the assessment report on the climate actions for the SDGs (SDG13.1 and 13.3); Providing the snow, GLOF, ice mapping, and chart, etc., for the water availability, downstream ecosystem impact analysis, emerging risk management, even on a daily basis, and transportation on land and Northern Sea Route, such as water availability, and its analysis, shipping advisory, and disaster risk assessment; Providing the released as standard data products for at an open science basis, that others communities or stakeholder can be accessed and referenced. Capacity building to the stakeholders jointly with the users’ communities.

How will these decisions benefit from the outputs of this Initiative?

[Input]: The customs, authorization, or stakeholders (users) can access high-quality data products from the website with openly and freely, data analysis toolkits and reports are available for the assessment or information services.

* What kinds of impacts (for example, reduced loss of life, monetary savings, conservation of biodiversity, etc.) are anticipated as a result of the use of the outputs of this Initiative?

[Input]: Reduced loss of life and properties; energy potentially providing and assessment; Risk mitigation; Climate actions for snow and ice changes in cold regions for addressing the UN SDGs (SDG6 and SDG13).

* Has this Initiative been asked to provide specific information (for example, reports, data, services) on an ongoing basis to an international convention, organization, or other multilateral body? : Yes

 *(Required for GEO Flagships; optional for GEO Initiatives and GEO Pilot Initiatives.)*

* + Please identify the requesting organization.

[Input]: Civil disaster reduction service for the springtime frost mapping; Olympic activities support by snow mapping; Snow disaster mitigation and awareness; Shipping company or polar expedition in the Arctic Sea ice-rich time; scientist and operational unit from university or research unit;

* + Describe the nature of the request.

[Input]: information service for the emergency actions, data input for the research and decision making. An example is Remote Sensing Facilitates Snow and Ice Occurrents Management in China (see: <https://english.cas.cn/newsroom/research_news/earth/202203/t20220316_302375.shtml>)

* + Please provide supporting documentation of the request. *Required for GEO Flagships; optional for GEO Initiatives and GEO Pilot Initiatives. Multiple file selection is supported.*

[Input]: An example is Remote Sensing Facilitates Snow and Ice Occurrents Management in China (see: <https://english.cas.cn/newsroom/research_news/earth/202203/t20220316_302375.shtml>)

1. **Technical synopsis**
* Please provide a brief description of the methods used by the Initiative to produce its (actual or planned) outputs. *Please limit your input to maximum 500 words*

[Input]:

In the past years, massive Earth observation products have been produced in international and national projects, with a focus on the synergy of in-situ and space-borne data normally. This development accelerates access to large data streams freely. This makes the information service for the cold regions feasible, even operationally to some extent. The recently created databases about the cold regions and the open access to standard data products provide both the tools and historical data required for the full fruition of information services and the consolidation of the data value chain.

The data products and information produced by advanced algorithms running on the high-performance computer system have been built for more than 5 years, for example, the setup of the International Research Center of Big Data for Sustainable Development Goals (CBAS), which is affiliated by three engineering division on the data, and information producing functions. Another good tool is the online computing capacity formed by Google Earth Engine (GEE), by which several data products have been produced. Other methods and data sources are (1) multi-resources data stream by the combination of public and private data, employing the open resource Earth observations data, like Landsat, Gaofen serious, Sentinel, AMSR and MODIS, Fengyun series, and SDGSAT-1, and tools are online processing by GEE and self-developed algorithms. (2) Tools and open knowledge of the data processing tools. The method includes the physical retrieval algorithm, standard data post-processing to make the data operational and updated periodically, including snow cover, e.g., NDSI and post-process for cloud-free datasets tools, Sea Ice Concentration by ASI, NT algorithm, Sea Ice Melting ponds by MODIS algorithm (physical model), lake and river ice coverage and phenology by threshold method automatically, and etc,

As for the developed and in-development method, the continuous data stream will be operated by dedicated units that link with GEOCRI contributors, while for the planned data products, this will be continually developed by the existing projects (see below on the resource), while new group work needs to be initiated to engage new player through the open policy on the data products. At this stage, the metadata of an online database about the global cold regions has been set up, see http://115.29.142.79/group/inventury-of-database-for-earth-three-poles, the published dataset (high-level products) and open policies are the main challenges for the service, which will be discussed and developed by this initiative.

Open science is leading the way forward to create data services consistent with the new stage of the development of the EOs market, this development deserves high priority in cold regions, where data are sparse and difficult to obtain by local communities. Space-based products effectively bridge multiple information gaps.

The United Nations push the digital commons to promote the digital benefits of climate actions addressing sustainable development goals. The digital services are at the end of the data stream into sustainable practices, with traditional agencies calling for the data to be applicable and cost-free, for instance, monitoring shipping lanes to adapt to new challenges. Both the emerging policy mandate and the needs of private actors call for the provision of information services to the cold regions.

* If you would like to provide further details on the technical methods, you may upload one or more documents here.

[Input]: The developed method and publication can be accessed through an open published portal, including the dataset released, and methods used in the system.

* Are there any significant scientific or technical challenges that need to be resolved by the Initiative during the 2023-2025 period? Yes.
	+ Please describe these challenges and the steps being taken to solve them.

[Input]: The challenges are mainly about the data services pattern or mechanism, demonstration of service criteria, and standard of products when the users’ communities have not been fully developed. While it is not the technique questions, the initiative will organize the task force or meeting to produce the standard, and technique (openly) for the world stakeholder, or even from the private sectors.

* Does the Initiative expect to complete any key new outputs, improvements to existing outputs, or improvements to the methods of producing outputs, in the 2023-2025 period? Yes
	+ Please describe these new outputs or improvements.

[Input]: Build new products with the systematic methods of a data-driven regime, i.e, when new satellite data or new in-situ data input are available, a combination of EO, modeling, and AI techniques is adopted into the data stream for the services. Besides providing the new products, and standards for the services, the sets of methods of evaluation of impacts need to be considered in the new phase of development of 2023-2025.

* + Please identify the key tasks that must be implemented to ensure delivery of these changes, with target dates for completion.

**Fundamental Task:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Fundamental Task** | **Task description** | **Expected completion (month/year)** | **Members** |
| Fundamental Task1: Essential Cold Regions Variables (ECRVs) | Essential variable for service practices, SDGs reporting, societal and economic, like disaster, and shipping, which need to be work with other communities, like WMO GCW, Arctic GEOSS, to building the international group. | 6/2025 |  |
| Fundamental Task2: Collections of Repository and Data Policy | Development about the connections of the database and repositories, the aim is to make the data open operationally for the services, to be working with Arctic GEOSS (SAON), DBAR-HiMAC, and TPE members. | 6/2024 |  |
| Fundamental Task3: Data criteria for service practices | intercomparison of the data criteria for different variables, need to work with the users communities, or research unit and scientists. | 6/2024 |  |

**Pilot Services Practice:**

|  |  |  |  |
| --- | --- | --- | --- |
| Task | Task description | Expected completion (month/year) | Members |
| Pilot Service Practice 1: Interaction on addressing the SDGs in cold regions by big data | Assessment of the big data for supporting the SDG13 (13.1, 13.2, 13.3) and its SDG interactions, this work needs to be led by the HiMAC group under DBAR and its facilitated unit, CBAS. The reporting area includes the vast cold area of Eurasia (observed environment sharping changes) and Northern American or HMA regions. | 6/2025 |  |
| Pilot Service Practice 2: information service for shipping advisory in sea ice-rich areas | Providing the shipping advisory information by integrated activities with the data stream from different data sources, GFS, SIC, SIT, SID, Fog, wind and precipitation and etc., from different data sources. | 6/2025 |  |
| Pilot Service Practice 3: Water resource management in cold regions | Assess the water availability and variability in the low land area of the typical cold regions, like HMA, and other cold area, users can be ICIMOD, Pakistan, and other relevant bodies. | 6/2025 |  |
| Pilot Service Practice 4: Service to the emergency disaster mitigation and awareness in cold regions | Emergency actions, and information service on the flooding, arid and geology disaster services, or risk analysis for the coming warming years in cold regions. | 6/2025 | Jinghui Fan |

1. **Resources**
* Have all resources required to implement the Initiative's planned work in the 2023-2025 period been secured?

**☑** Gap in financial resources:

**☑** Gap in human resources:

* + What is the estimated funding gap for the 2023-2025 period?

*Numeric value / Currency*

[Input]: The seed money for the workshops and meetings has been identified for online or light face-to-face meetings, while for the operational services, and development (demonstration systems are at processing by other supports), while the resource mobilization is still needed at the development phase of the initiative.

* + What are the essential skill sets needed by the Initiative but are not currently resourced?

[Input]: Gaps exist in the system development resource, and human resources specifically in the cold region snow and ice monitoring.

* + What actions is the Initiative taking to obtain the required resources?

[Input]: Align with the existing organization and combine with the resource projects asking for more collaborations and enhancement of each other; try to engage the private sectors.

(Please: if you may write down more resources, that we may use as resources - paper, input works about Japan side)

* Please list all financial and non-financial contributions to the Initiative (other than in-kind, voluntary participation by individual contributors) having a value of more than USD 50,000.

| **Contributing Organization** | **GEO Status** | **Type of Resource** | **Value** | **Currency** |
| --- | --- | --- | --- | --- |
| Aerospace Information Research Institute, Chinese Academy of Science (AIR-CAS)  | China | National Key Research and Development Program of China DARC-SERV (Digital Arctic Shipping: New Sea Ice project) (Grant No. 2019YFE0105700) | Data, service models, and experience for shipping in Arctic Lane environment assessment | 5,870,000RMB |
| International Research Center of Big Datafor Sustainable Development Goals (CBAS) | China | CAS-Funded Project: River, Lake and Sea Ice monitoring by Big Earth Data : comparison and co-analysis. (Grant Nos XDA19070201 and XDA19070102) | Data, and method for the massive data processing on the river, lake and sea ice: sea ice melting ponds, lake ice phenology, river ice fraction, and melting ponds | More than10，000,000RMB |
| Institute for Atmospheric and Earth System Research (INAR), Finland  | Finland  | Data  | Data Center and projects (like: iCUP) |  |
| National Institute of Polar Research, Japan | Japan  | Data  | Data Center |  |
| National Environmental Satellite, Data, and Information Service (NESDIS), National Oceanic and Atmospheric Administration (NOAA)  | United States  | Data  | Data Center |  |
| CCIN/PDC | Canada | Data | Data Center |  |
| NEXTGEOSS | European Commission | Data | Data Hub |  |
| DBAR-HiMAC WG | China | Data | A network of the high mountain and cold reigons |  |
| Polar Research Institute of China  | China | Data | Polar Data Center |  |
| Nansen Environmental and Remote Sensing Center  | Norway | Data | Data |  |
| German Aerospace Center (DLR) | Germany | Data | earth obervation center (Polar and cold Regions)  |  |
| International Polar Protection Association  | Norway | Other | Users engagement  |  |
| Third Pole Program  | China | Data | Data |  |
| Northwest Institute of Eco-Environment and Resources -CAS | China | MOST-Funded Project:The Changes of Arctic Terrestrial Environment and Their Impacts | Observation, modelling, and synthesis reports on the Arctic cryosphere and vegetation | 7,210,000RMB |
| China Aero Geophysical Survey and Remote Sensing Center for Natural Resources (AGRS) | China | Financial(National Key Research and Development Program of China, Grant No. 2021YFE0116800) | Data and tools for the climate changes, water, and disaster mitigation in HMA and Arctic regions  | 3,990,000RMB |
| International Research Center of Big Datafor Sustainable Development Goals (CBAS) | China | Data | CASEarth Program data center |  |
| Institute of Remote Sensing and Digital Earth, CAS | China | Data | EO Data Center |  |
| Northwest Institute Of Eco-Environment and Resources -CAS  | China | Data | Cryospheric Data Center  |  |
| CAS Research Center for Ecology and Environment in Central Asia | China | Data | Data and projects |  |

1. **Lessons from the 2020-2022 period**
* Were all planned activities for the 2020-2022 period implemented as expected? No
	+ Please describe which activities were delayed or not implemented and how has this affected plans for 2023-2025.

[Input]: The coordination and continuing support for this work without strong endorsement led to potential risks of failure for the program, this does not much influence the period of 2023-2025.

* Were there any key challenges faced by the Initiative in the 2020-2022 period? Yes
	+ Please describe.

[Input]: Lack of labor hours for coordination, and also fewer meetings regularly, multi-partners from different countries were the biggest challenges, because of the Convid-19 breakout.

* Were there any impacts or changes to operations due to COVID-19? Yes
	+ Please describe.

[Input]: Fewer meetings and no trips get the thing worse.

* Please describe the key changes proposed for the 2023-2025 period, for example, new projects, new areas of focus, or adjustments to the activity governance.

[Input]: Covid-19 complicates the organization of the on-site meeting and the engagement of new stakeholders, while online tools and data exchange would be much better than nothing happening; online websites are a good way for the organization the exercise the data, so we started the [www.geocri.org](http://www.geocri.org) as a place for this initiative.

* Does the Initiative have outputs (products, services, etc.) available to users now, even if only on a pilot or testing basis? Yes
	+ Please provide any available information describing this usage (for example, user statistics, results of user testing) and/or feedback from users (for example, user comments, evaluations).

[Input]: HTTP://115.29.142.79/ this is a website for that, and CCIN/PDC, NEXTGEOSS, CASEarth and other repositories have been doing more.

* + Please provide supporting documentation if available.

*Multiple file selection is supported.*

* Do you have evidence of any impacts that have occurred in part as a result of using the outputs of the Initiative (for example, policy decisions taken, behaviour changes by users, risks mitigated)? Yes
	+ Please provide examples, with evidence where available.

[Input]: Shipping way advisory for private cruises the Arctic Sea, and frost and snow service for south China, like: <https://english.cas.cn/newsroom/research_news/earth/202203/t20220316_302375.shtml>

* + Please provide supporting documentation if available.

*Multiple file selection is supported.*

* Have there been any internal or external reviews or evaluations of the Initiative since 2019? No.
* Please indicate any GEO Work Programme activities with which you have ongoing collaboration.

[Input]:

ARCTIC-GEOSS - Arctic GEOSS, which was part of the GEOCRI at its 1st stage of 2017-2019, while now still be with each others, once endorsed, a meeting need to coordinate to see how much it could be enhanced the complementary role. AOGEO - Asia-Oceania Group on Earth Observations; GEOGLOWS - GEO Global Water Sustainability; GEOARC - Global Ecosystems and Environment Observation Analysis Research Cooperation; NEXT-EOS - Next Generation Earth Observation Services.

* Please indicate any additional GEO Work Programme activities with which you would like to establish new collaborations. (Check all that apply)

[Input]:

GEO-EV - GEO Essential Variables

GEO-MOUNTAINS - Global Network for Observations and Information in Mountain Environments

GEO-WETLANDS - GEO Wetlands

1. **Stakeholder engagement and capacity building**
* Are there specific countries or organizations that your Initiative would like to engage? Yes
	+ Please list these countries, regions or organizations. :

[Input]: WMO (we already have a meeting in July for exchanging the development), Pakistan, ICIMOD, and CIS are possible.

* + What are your plans to engage them?

[Input]: Remote meeting and get the data tag and open sharing.

* Does your Initiative engage users in the work of the Initiative (for example, consultation, testing, co-design)? Yes
	+ Please briefly describe the Initiative’s approach to engaging users.

[Input]: Have fewer meetings with stakeholders, and develop the potential user's engagement.

* Does the Initiative have a user engagement strategy or similar kind of document? No.
	+ Please upload it.

*Multiple file selection is supported.*

* Are there categories of users that are not represented at this time, but you would like to engage? Yes
	+ Please list these user categories or regions.

[Input]: Climate actions body, private sectors on data processing, and shipping company.

* + What are the plans for further engagement of users in the Initiative?

[Input]: Users and stakeholder meeting.

* Does the Initiative have a documented capacity development strategy? No
	+ Please describe the approach to capacity development that is being implemented by the Initiative?

[Input]: Did not plan at this moment, but while will make connections with existing summer school and other activities

* Are there any commercial sector organizations participating in this Initiative? No

*Commercial sector organizations are defined in GEO as those non-governmental organizations that operate with the expectation of financial profit.*

* Are there opportunities for commercial sector uptake of the outputs of the Initiative? Yes

*Commercial sector organizations are defined in GEO as those non-governmental organizations that operate with the expectation of financial profit.*

* + Please describe these opportunities.

[Input]: Yes, commercial companies are welcome to have a development co-design and co-produce.

* Is there already commercial uptake occurring? Yes.
	+ Please describe the nature of this uptake and the relevant commercial sector organizations.

[Input]: The private sector can provide the resource, while needs to consider helping the resource mobilization, while this needs some stratagem plan on the private development.

* Are there opportunities for further commercial sector participation in the Initiative? Yes
	+ Please describe these opportunities.

[Input]: Need to have some exchange of this initiative. The stakeholder, such as the shipping and energy company and data providing company are welcome for that.

* Does the Initiative have a plan for commercial sector engagement? No
1. **Governance**
* Please describe the roles of each of the key leadership positions, as well as any team structures involved in day-to-day management.

[Input]: Dr. Yubao Qiu is the main editor, Dr. Massimo Menenti is the co-editor, and discussion mainly with the co-lead group. Dr. Yubao Qiu operates as the day-to-day management of this initiative and will try to have in-kind post-doctor or high-level Ph.D. students for helping with the day-to-day management of this initiative.

* Is there a steering committee or other governance bodies that advise the Initiative but are not involved in day-to-day management? Yes
	+ Please describe the roles of each body. If there are multiple governance bodies, please describe the relationships among them (such as through a governance structure diagram).

[Input]: The program will start an Advisory Committee. Co-lead Team (PoC) is the Steering Committee (Coordinator) for GEOCRI, for providing the advisory functions, and lead the tasks, or providing resources to this initiative.

| **Name** | **Organzation** | **E-mail** | **Role** |
| --- | --- | --- | --- |
| Ellsworth LeDrew | F.IEEE, F.CASI, Distinguished Professor Emeritus, University of Waterloo, Canada | ells@uwaterloo.ca |  |
| Huadong Guo | Director General, International Research Center of Big Datafor Sustainable Development Goals (CBAS); ISDE | guohd@radi.ac.cn |  |
| Barbara Ryan | Director to WGIC | barbara.ryan@wgicouncil.org  |  |
| Wenjian Zhang | WMO | wzhang@wmo.int  |  |
| Hajo Eicken | International Arctic Research Center, University of Alaska Fairbanks, Fairbanks, Alaska | heicken@alaska.edu |  |
| Add…please |  |  |  |

Co-lead Team (PoC) is the Steering Committee (Coordinator) for GEOCRI, for providing the advisory functions, and lead the tasks, or providing resource to this initiative.

| **Name** | **Organization** | **E-mail** | **Role** |
| --- | --- | --- | --- |
| Xiao CHENG | Sun Yat-sen University, China | chengxiao9@mail.sysu.edu.cn | CoL |
| Hiroyuki Enomoto | NIPR/AERC, Japan | enomoto.hiroyuki@nipr.ac.jp | CoL |
| Jeff Key | NOAA/NESDIS, USA | jeff.key@noaa.gov | CoL |
| Hanna K Lappalainen | PEEX/University of Helsinki, Finland | hanna.k.lappalainen@helsink.fi | CoL |
| Xin LI | ITP-CAS, China | xinli@itpcas.ac.cn | CoL |
| Massimo Menenti | Delft University of Technology, The Netherlands | m.menenti@tudelft.nl | CoL/PoC |
| Yubao QIU | CBAS/AIR-CAS, China | qiuyb@radi.ac.cn | CoL/PoC |
| Stein Sandven | NERSC, Norway | stein.sandven@nersc.no | CoL |
| Vito Vitale | CNR, Italy | v.vitale@isac.cnr.it | CoL |

\*Stein Sandven : Advisory Board Member to EU-H2020 KEPLER; Yubao Qiu: Advisory Board Member to EU-H2020 INTAROS
\* PoCs are also the main and co-editor to the new GEOCRI WP for 2023-2025.
See: <https://www.geocri.org/team/co-lead-team> (updated accordly)

* What methods does the Initiative use to communicate with its participants? Check all that apply

☑ Email communication/e-newsletters

☑ Regular conference calls

☑ Website

☑ Regular events

☑ Others

* + Please describe.

[Input]:

Email communication/e-newsletters: regularly co-lead calls.

Regular conference calls: co-organize the meeting.

Website: www.geocri.org

Regular events: Planning:

Others: Twitter (https://twitter.com/geo\_coldregions) Linked In account

* Please describe the key risks that could delay or obstruct the completion of the planned activities and outputs of the Initiative, along with any actions taken to mitigate these risks.

| **Description of****the hazard** | **Description of the possible impacts** | **Scale of impact** | **Likelihood of occurrence** | **Mitigation measures** |
| --- | --- | --- | --- | --- |
| Human Resource shortage | Labor hours need to be secured. | Moderate | Possible |  |
| Engagement strategy | engagement with other communites  | limited | not very likely |  |

* What methods are used by the Initiative to monitor its effectiveness? Check all that apply

**☑** Informal discussions with users / beneficiaries

**☑** User or beneficiary surveys

**☑** Website statistics

**☑** Consultations or events

**☑** Evaluations

* + Would the Initiative be interested in assistance from the GEO Secretariat for developing an impact plan? Yes
	+ How are the results of the monitoring and evaluation activities shared with participants and the wider GEO community?

[Input]: no answer given -

* Are any monitoring or evaluation activities required by funders/contributors? No
1. **Participants**
* Please list the active individual participants in the Initiative

| **First name** | **Last name** | **Email address** | **Member** | **Organization** |
| --- | --- | --- | --- | --- |
| Xiao  | Cheng | chengxiao9@mail.sysu.edu.cn | China |  |
| Hiroyuki  | Enomoto | enomoto.hiroyuki@nipr.ac.jp | Japan | National Institute of Polar Research (NIPR) |
| Jeff | Key | jeff.key@noaa.gov | United States | NOAA - National Oceanic and Atmospheric Administration  |
| Hanna | Lappalainen | hanna.k.lappalainen@helsink.fi | Finland |  |
| Ellsworth  | LeDrew | ells@uwaterloo.ca | Canada |  |
| Xin  | Li | xinli@itpcas.ac.cn | China | CAS - Chinese Academy of Science  |
| Massimo  | Menenti | m.menenti@tudelft.nl | Italy | TU Delft - Delft University of Technology  |
| Yubao  | Qiu | qiuyb@aircas.ac.cn | China | International Research Center of Big Datafor Sustainable Development Goals (CBAS) |
| Stein  | Sandven | stein.sandven@nersc.no | Norway | Nansen Environmental Research Centre  |
| Vito  | Vitale | v.vitale@isac.cnr.it | Italy | JRC - Joint Research Center |
| Andreas | Dietz | andreas.dietz@dlr.de | Germany | DLR - German Aerospace Center |
| Jiancheng | Shi | shijc@radi.ac.cn | China | CAS - Chinese Academy of Science  |
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| Shiying | Liu | shiyin.liu@ynu.edu.cn | China |  |
| Masaki | Kanao | kanao@nipr.ac.jp | Japan | National Institute of Polar Research (NIPR), Japan |

1. **Other information**
* Please provide any other comments or information that was not included in the previous sections, but you would like to appear in the Implementation Plan.

[Input]: All the information is on the official website of GEOCRI: [www.geocri.org.](http://www.geocri.org.)

*Multiple file selection is supported. [****Please******upload support document files****]*

1. **Co-Editor Management**
* List of co-editors for this initiative

| **First name** | **Last name** | **Email address** |
| --- | --- | --- |
| Massimo  | Menenti | m.menenti@tudelft.nl |
|  |  |  |

no more than 5 person (<5)

**Annex: Short bio under development…. (need to be shorten)**

**Dr. Xiao CHENG**, Dean of School of Geospatial Engineering and Science, Director of Office of Scientific Research and Development and the Polar Science Center in Sun Yat-sen University. He also serves as the Secretary-General of University Polar Joint Research Center of China and National Polar Expert Committee of Ministry of Science and Technology of the People's Republic of China. Cheng Xiao has been dedicated to the research on remote sensing of the polar and ocean environment, and promoted development and system construction of China’s Polar Hawk series, which is the UAV for polar remote sensing. He has also promoted the launch and application of China’s first polar satellite Ice Pathfinder with its ground processing systems. Cheng is the winner of the National Science Fund for Distinguished Young Scholars, he has also won the Advanced Individuals in China’s Polar Expedition.

**Mr. Ding Chen**, Co-Chairman of the International Polar Protection Association, Chairman of the Polar Exploration Branch of the China Exploration Association, and President of Star Cruise International Cruise Line Co., Ltd. He has visited the Antarctic and Arctic for 20 times and has long been engaged in polar education, polar exploration and polar ecological environment protection. He has cooperated with many polar research institutions and cruise lines of UK, France, Denmark, Norway and US. His cruise line now is operating a Danish polar rescue ship and a Chinese marine survey ship.

**Dr. Andreas DIETZ,** Head of group "Polar and Cold Regions" at German Aerospace Center (DLR), German Remote Sensing Data Center (DFD), department of Land Surface Dynamics. Andreas Dietz is a research scientist and part of the team Polar and Cold Regions at the German Remote Sensing Data Center, German Aerospace Center (DLR), Wessling, Germany. At DLR since 2009, he was engaged in time series processing and analysis of remote sensing data within the projects CAWa (Central Asian Water), Timeline, and since 2015 a DFG funded project about global snow cover processing using Advanced Very High Resolution Radiometer (AVHRR) data. He conducted his PhD with the topic “Changes in Central Asian Snow Cover Characteristics between 1986 and 2012 derived from medium resolution remote sensing data“ in collaboration with the University of Würzburg, which was finished in 2013. Since then his research focused more and more on the analysis of the terrestrial cryosphere and developments of global snow cover. The Global SnowPack is a product that emerged from this research.

<http://eagle-science.org/lecturer/dietz/>

**Dr. Hiroyuki ENOMOTO** is a professor of Arctic Environment Research Center, National Institute of Polar Research (NIPR), and the Graduate University for Advanced Studies professor. Since 2014, he is the vice director-general of NIPR. He received Ph.D. at the ETH Zurich in 1989 on physical geography on sea ice and climate relationships. His research area is climatological investigations of snow and ice of ocean, land, and ice sheet in the Arctic, Antarctic, and snow cover area in the middle latitudes. He is widely scanning changing cryosphere using satellite microwave remote sensing and visiting polar snow and ice field. His first visit to the glacier was Patagonia, South America in 1981. Since then, he has worked in many cold regions. He visited Svalbard by opening a Japanese Arctic research station and Dome Fuji Antarctica to start up a new Antarctic inland station and drilling site and, installed AWS along the traverse route. He joined Japanese, Australian, and Swedish Antarctic Expeditions, and in the Arctic, he worked very often in Alaska as the collaborator of IARC/UAF and Japanese projects on the linkage of land-sea ice processes.

Since 2011, he has been working as the leading member of the Japanese Arctic research projects and working with international cryospheric and Arctic meetings. He worked as the Sub-Project Director of the Japanese Arctic Research Project: Arctic Challenge for Sustainability (ArCS), and, since 2020, He is leading the ArCS II project as the project director.

His international contributions have been stressed by working as the lead author of IPCC SROCC, steering member of IUGG/IACS, WCRP/CliC, WMO/GCOS TOPC, ISAC, and Cryospheric WG member and council member of IASC (the Vice-president of IASC since 2020). In the domestic activities in Japan, he has been working with the Japanese society of snow and ice (polar subgroup, satellite subgroup) and Japan Consortium of Arctic Environment Research, Sub-committee member of IASC, SCAR, IACS, CliC in the Science Council of Japan. He was the co-chair of the science advisory board for the 3rd Arctic Science Ministerial, held in Tokyo, 2021.
He is happy to seek a scientific frontier of the cryosphere and collaborations in international polar expeditions and community works.

[**https://researchmap.jp/read0167611/?lang=english**](https://researchmap.jp/read0167611/?lang=english)

**Dr. Jeffrey R. KEY** is the Branch Chief of the Advanced Satellite Products Branch, Center for Satellite Applications and Research (STAR), NOAA/NESDIS, located at the University of Wisconsin-Madison in the Cooperative Institute for Meteorological Satellite Studies. Jeff received the B.S. degree from Northern Michigan University in 1977, the M.S. from NMU in 1982, and the Ph.D. from the University of Colorado-Boulder in 1988. He worked as a research scientist at the University of Colorado for many years, and held faculty positions at the University of Alaska-Anchorage and Boston University before joining NOAA in 1999. He serves on a number of international panels, and is involved in activities of the World Meteorological Organization and the Group on Earth Observations. Jeff's research is in satellite meteorology and climatology of the polar regions. He has developed algorithms and models for use in the retrieval of cloud properties, radiative fluxes, snow and ice characteristics, and tropospheric winds from optical satellite data. Current research topics include the spatial and temporal variability of polar cloud, surface, and radiation properties, polar winds, and recent climate trends.

<https://stratus.ssec.wisc.edu/jkey/>

**Ms. Hanna K. LAPPALAINEN**, Dr. Docent, PanEurasian Experiment Program, Secretary General, Institute for Atmospheric and Earth System Research (INAR) at the University of Helsinki, FI

Hanna K. Lappalainen, PhD, Docent, Pan-Eurasian Experiment (PEEX) Program Secretary General at the University of Helsinki, Institute for Atmospheric and Earth System Research (INAR) (FI) and the coordinator of the of the Atmosphere and Climate Competence Center (ACCC) Impact Program. She is the lead editor of the PEEX Science Plan and has a long-term experience of coordinating large-scale research projects. She has received NASA Goddar Team Award EOS-AURA satellite OMI-Team in 2005 and an International Eurasian Academy of Sciences, IEAS, Silver medal in 2015. Lappalainen is a representative of Finland in the Sustainable SAON Data working group, a national delegate of ISAC - The International Science Initiative in the Russian Arctic (ISIRA), Co-chair of the of the Artic - GEOSS – High Mountain – Gold Regions HiMAC (2020-), Academy Member of IEAS (nomination date 02.Dec.2016), Co-Leader together with Academician M. Kulmala of the Universities of Arctic network “Arctic-boreal Hub” and a SIOS Editorial Board and the member of SIOS Data WG. She obtained her PhD. from theUniversity of Helsinki, Finland and has been engaged in analysis of the atmospheric biogenic volatile organic compounds and plant phenology. H index 15 (ISI Web of Science May 2021), 32 papers, 1002 citations Orcid ID 0000-0003-3221-2318

<https://futureearth.org/contacts/hanna-k-lappalainen/>

**Dr. Lanhai LI**, he has more than 30 years of research, teaching and consulting experience in the fields of water resources management and climate change impact assessment. He has worked in a variety of positions for institutes, universities, international organizations and private companies in China, England, Thailand, Japan and Canada .Most of his work is related to the integration of risk, reliability, simulation and optimization in water resources management. He has published about 200 papers in professional publications and peer reviewed journals. The publications have been widely referenced by academic research and engineering design, and his research and consulting work have been recognized by a number of awards for excellence in research and outreach, and invitations from Northern American, Asian and African organizations for seminars and workshops as well as hosting international conference. He currently serves as a professor in Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences. His research focuses on the Central Asia and Eastern Africa and his research fields and specializations include Snow dynamics, hydrological modeling, water resources planning and management and climate change impact assessment. He is the editorial board member of following journals: “Journal of Arid Science”, “Journal of Mountain Science”, “Arid Land Geography (Chinese version)” and “East African Journal of Science and Technology”.

Homepage: <http://people.ucas.ac.cn/~lilanhai?language=en>

**Dr. Xin LI**, currently a professor at the ITP, CAS, and is serving as director of the Research Center for Three-Pole Observation and Big Data, and director of the National Tibetan Plateau Data Center. His research interests are land data assimilation, remote sensing of hydrology and cryosphere, and integrated watershed study. His research career mainly focuses on exploring the interface between hydrology, remote sensing, and land data assimilation for advancing the fundamental understanding of ecohydrological and cryospheric processes in the cold and arid regions, particularly the endorheic river basins surrounding the Tibetan Plateau.

**Ms Bente LILJA**, Earth science expert and astrophysicist writes about Earth observation, geodesy, climate change, geohazards, water cycle and other science related topics.

**Prof.dr. Massimo MENENTI**, Professor Optical and Laser Remote Sensing, Department of Geoscience and Remote Sensing, Faculty of Civil Engineering, Delft University of Technology

Educational background: Physics (Univ. of Rome), Environmental Sciences (PhD Univ. of Wageningen). Research Interests: Land surface processes and remote sensing with emphasis on hydrology and water management. In recent years he has coordinated a EU research project Hydrological Determinants of Agricultural Production in South America: the contribution of numerical crop growth models and remote sensing. He is currently the coordinator of a EU network dealing with Climate Impact on Water and Drylands Agriculture (CLIWARDA) This is a worldwide network with participants from China, India, Argentina, Egypt and Niger besides UK, Italy and The Netherlands. Past investigations include studies of groundwater hydrology in the deserts of Libya and Egypt, the use of advanced Earth Observation sensors systems to improve the performance of atmospheric models and irrigation water management in several countries. During the same period of time he has coordinated a series of scientific studies towards the development of the Surface Processes and Ecosystem Changes Through Response Analysis (SPECTRA) Mission for the European Space Agency. He was the coordinator of the FP7 ENVironment project “A protoype observation system for water resources in South – East Asia: ground and space measurements to support hydrological and atmospheric modeling of the Qinghai – Tibet Plateau (CEOP – AEGIS)” carried out by 17 organizations in 8 countries.

[**https://www.tudelft.nl/citg/over-faculteit/afdelingen/geoscience-remote-sensing/staff/scientific-staff/profdr-massimo-menenti**](https://www.tudelft.nl/citg/over-faculteit/afdelingen/geoscience-remote-sensing/staff/scientific-staff/profdr-massimo-menenti)

**Dr. Yubao QIU**, is now a full professor at Aerospace Information Research Institute, Chinese Academy of Sciences (AIRCAS), Beijing, China. He specializes in the application of Earth Observations and data science, especially for the High Mountain Asia and polar cold regions. He achieved his Bachelor degree for Geological Engineering and master degree for Earth Probing and Information Technology in China University of Geoscience in 2000 and 2003. He finished his Ph.D degree of Cartography and Geographic Information System in Chinese Academy of Science (CAS) at 2008. He was with the Helsinki University of Technology (TKK) in 2008, and Finnish Metrological Institute (FMI) as a short-term visiting scientist for each year from 2016 to 2019. From March 2012, he began his secondment as the Scientific and Technical Officer in Secretary to Group on Earth Observations (GEO) based in Geneva, supporting the Water component-information services for cold regions, Ecosystems, and data sharing. He published more than 80 publications in the last five years, and delivered tens of open talks in international conference, and lead to several big projects in China. He is a member of National Committee of China for CODATA, and serve as professional researcher in Intl’ Research Center of Big Data (CBAS) for SDGs in CAS. From 2017, he started to co-chair the working group on High Mountain and Polar Cold Regions (HiMAC).

**Dr. Stein SANDVEN**, he has been coordinator of many Arctic research projects during the last 30 years, including 19 EU projects, 16 ESA projects and 20 projects under the Research Council of Norway. From 2011 to 2018 he was the science leader of the ESA CCI sea ice project (2012-2018).  From 2017 his main responsibility and fulltime job is to coordinate the H2020 project Arctic Integrated Observation System (INTAROS), which runs from 2016 to 2022. INTAROS has 49 partners from 20 countries and a budget of 15.5 MEURO. As coordinator of INTAROS, he works with the major organisations, programmes and projects related to Arctic observing systems in Europe, North America and Asia. From 2020 to 2022 he is coordinator of the Coordination and Support Action CAPARDUS under H2020.  Presently he is member of the advisory boards for several new Arctic projects funded by EU and the Research Council of Norway.

[**https://www.nersc.no/staff/stein-sandven**](https://www.nersc.no/staff/stein-sandven)

**Dr. Jiancheng SHI**, a senior research scientist at National Space Science Center (NSSC), Chinese Academy of Sciences (CAS), Beijing, China. Received his B.A. in Hydrogeology and Engineering Geology from the University of Lanzhou in China, and his M.A. and Ph.D. degrees in Geography from the University of California, Santa Barbara (UCSB) in 1982, 1987, and 1991, respectively. He then worked the Institute for Computational Earth System Sciences (later Earth Research Institute) at UCSB as a research professor. In 2010, he joint Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences as director and senior research scientist at the State Key Laboratory of Remote Sensing Science in Beijing, China. His research interests are microwave remote sensing of water cycle related components. He has published more than 300 journal and conference papers. He is a PI of Chinese Global Water Cycle Mission and Fellows of IEEE and SPIE.

<https://www.journals.elsevier.com/remote-sensing-of-environment/editorial-board/dr-jiancheng-shi> and <http://www.issibj.ac.cn/spotlight/interview/202112/t20211231_295490.html>

**Dr. Daqing YANG** is a Research Scientist in the Watershed Hydrology and Ecology Research Division, Environment and Climate Change Canada (ECCC). He is also Affiliate Research Professor at the International Arctic Research Center, Univ. of Alaska Fairbanks, and Adjunct Member of Graduate Program at Geography Dept, York University. Dr. Yang has extensive research experience (in China, Canada, USA, Japan, and Norway) in the areas of cold region/northern hydrology and climate. He led many NSF/NOAA/NASA/CliC/ECCC research projects of large-scale (watershed) hydrologic and climatic processes and their interactions with human impacts. He is an expert in applications/validations of remote sensing data/products, observational methods/techniques, particularly snowfall and precipitation observations and dataset development/analyses in the northern regions. He contributes to IPCC Ocean and Cryosphere Theme Report and Artic Council’s Snow, Water, Ice and Permafrost in the Arctic (SWIPA) assessment. He is the Associate Editor for Journal of Hydrology and EGU’s Atmospheric Measurement Technique, and a Guest Editor for a special issue of Polar Science. He has edited/co-edited 3 IAHS Red Books on topics of cold region hydrology and water balance analyses.

**Dr. Vito VITALE** is Research Director at the CNR Institute of Polar Sciences (ISP) in Bologna. He is an expert of radiative transfer processes into the atmosphere. His research focus is on the radiation budget and the role that atmospheric composition and surface characteristics play in modulating Shortwave (SW) and Longwave (LW) radiation components, determining their seasonal and inter-annual variability. He has been involved in polar research and management since 1986, both in Antarctica and in the Arctic. He leads the Climate Change Tower Integrated Project (CCT-IP,[www.isac.cnr.it/~radiclim/CCTower](http://www.isac.cnr.it/~radiclim/CCTower)) a large multidisciplinary project at CNR Arctic Station Dirigibile Italia, aiming to investigate arctic ABL energy budget, and the role played by different processes involving air, aerosols, clouds, snow, ice and land (permafrost and vegetation) using well integrated multidisciplinary platforms. During his long activity in polar regions, he has promoted the improvement of observation technology for harsh environments, developing also custom instrumentation. With respect to this topic, at the moment his interest is devoted to increasing the capability to perform continuous atmospheric observations over the ocean, in particular those related to radiation and aerosols

**Dr. Tonghua WU**, Associate Director of State Key Lab of Cryospheric Science, Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences. Head of the Cryosphere Research Station on the Qinghai-Tibet Plateau. He has worked for more than 20 years in the cryosphere community. He has been responsible for establishing and maintaining the integrated observation network on permafrost and climate changes among the Qinghai-Tibet Plateau, Mongolia, and Arctic. He has published more than 150 articles, conference papers and academic reports. He is serving as the Associate Editor for Arctic, Antarctic and Alpine Research.

[**https://www.researchgate.net/profile/Tonghua-Wu-2**](https://www.researchgate.net/profile/Tonghua-Wu-2)