



Greenland_Ice_Sheet_cci+
Antarctica_Ice_Sheet_cci+
User Workshop Report (UWR)

Reference : DTU-NU-ESA-GIS-AISCCI+-UWR-001
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ESA Climate Change Initiative (CCI+) Essential Climate Variable (ECV)

Greenland_Ice_Sheet_cci+ (GIS_cci+) Antarctica_Ice_Sheet_cci+ (AIS_cci+)

User Workshop Report (UWR)

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Change Log

Issue	Author	Affected Section	Reason	Status
0.5	D. Fantin	All	Document Creation	
1.0	C. Hvidberg, D. Floricioiu	All	Document consolidation	Released to ESA



Acronyms

Acronyms	Explanation
C3S	Copernicus Climate Change Service
CCI	Climate Change Initiative
CFL	Calving Front Location
CS2	CryoSat-2
DEM	Digital Elevation Model
DMI	Danish Meteorological Institute
DTU-N	DTU Microwaves and Remote Sensing Group
DTU-S	DTU Geodynamics Group
ECV	Essential Climate Variable
ENVEO	ENVIRONMENTAL Earth Observation IT GmbH
EO	Earth Observation
ESA	European Space Agency
GCOS	Global Climate Observation System
GEUS	Geological Survey of Denmark and Greenland
GFZ	Deutsche GeoForschungsZentrum
GIS	Greenland Ice Sheet
GLL	Grounding Line Location
GMB	Gravimetry Mass Balance
IMBIE	Ice Sheet Mass Balance Inter-Comparison Exercise
InSAR	Interferometric Synthetic Aperture Radar
IV	Ice Velocity
MEaSURES	Making Earth System Data Records for Use in Research Environments (NASA)
MFID	Mass Flux and Ice Discharge
NBI	Niels Bohr Institute, University of Copenhagen
NEGIS	North East Greenland Ice Stream
OptIV	Optical IV
OT	Offset Tracking
PROMICE	Danish Program for Monitoring of the Greenland Ice Sheet
RA	Radar Altimetry
S&T	Science and Technology AS
S2	Sentinel-2
SAR	Synthetic Aperture Radar
SEC	Surface Elevation Change
SMB	Surface Mass Balance
SoW	Statement of Work
TPROP	Technical Proposal
TUDr	Technische Universität Dresden
UL	University of Leeds
URD	User Requirement Document

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1 Introduction

This document is the User Workshop Report (UWR) prepared for Phase 2 of the Greenland_Ice_Sheet_cci+ GIS_cci+ and Antarctica_Ice_Sheet_cci+ AIS_cci+ projects in accordance with the Contracts [AD1 and AD3] and the Statements of Work (SoW) [AD2 and AD4] with the Annex B.

The UWR is prepared jointly between the GIS_cci+ and AIC_cci+ projects.

The UWR document is part of the WP500 Product Assessment in the GIS_cci+, with the task “Use the user workshop to collect feedback from users on user requirements”, and with deliverable id: D5.3.

The UWR document is also part of the task 1 Requirements Analysis in the AIS_cci+ as WP130 User Consultation Workshop and with deliverable id D1.3.

1.1 Purpose and Scope

It is an important and necessary task to ensure that the user requirements for the GIS_cci+ and AIS_cci+ are continuously revisited and updated, to document the relevant user needs for climate science and services for the ECV's to be produced.

In addition to our own review of user needs and input from GCOS, CRG and CMUG, documented in the URDs ([RD1] and [RD2]), we have arranged a user workshop in order to engage directly with the users and obtain feedback from users on existing and planned data products.



The user workshop was held as a side event to the 2024 European Polar Science Week, 3-6 September 2024 in Copenhagen, Denmark.

The purpose of this document is to describe and report on these user workshop activities, and to provide recommendations to the GIS_cci+ and AIS_cci+ on further product developments based on the input and feedback from users obtained as part of the user workshop.

1.2 Document Structure

This document is structured as follows:

- Chapter 1 describes the purpose and structure of the document.
- Chapter 2 provides an overview of the user workshop and the activities.
- Chapter 3 analyses data from the online user survey.
- Chapter 4 summarizes the recommendations and concludes the document.

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1.3 Applicable and Reference Documents



Table 1.1: List of Applicable Documents

No	Doc. Id	Doc. Title	Date	Issue/ Revision/ Version
AD1	ESA/Contract No. 4000126523/19/I-NB - Greenland_Ice-Sheets_CCI+ and its Appendix 1 (incl CCN3)	CCI+ Phase 1 New R&D pm CCI ECVs for Greenland_Ice Sheet_cci (incl CCN3)	Cont: 2019.03.06 CCN3: 2022.12.05	-
AD2	ESA-EOP-SC-AMT-2021-53	Climate Change Initiative Extension (CCI+) Phase 2 - New R&D on CCI Essential Climate Variables -SoW (incl Annexes)	2022.06.10	Issue 1 Revision 2
AD3	ESA/Contract No. 4000143397/23/I-NB CCI+ PHASE 2 - AIS	CCI+ PHASE 2 - NEW R&D ON CCI ECVS for AIS CCI	13.02.2024	NA
AD4	ESA-EOP-SC-AMT-2023-12 and its appendix 2	STATEMENT OF WORK, ESA EXPRESS PROCUREMENT – EXPRO CCI+ Phase 2 – Theme II – Antarctic Ice Sheet (AIS)	14.07.2023	1.2

Table 1.2: List of Reference Documents

No	Doc. Id	Doc. Title	Date	Issue/ Revision/ Version
RD1	ST-DTU-ESA-GISCCI+-URD-001	<u>User Requirement Document (URD), for the Greenland Ice Sheet_cci+ project of ESA's Climate Change Initiative</u>	2023.05.17	3.1
RD2	NU-ESA-AISCCI+-URD-001	<u>User Requirements Document (URD) for the Antarctic Ice Sheet_cci+ project of ESA's Climate Change Initiative</u>	2024.06.14	2.0

Note: If not provided, the reference applies to the latest released Issue/Revision/Version

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2 The user workshop

2.1 Purpose of a user workshop

An important part of each phase of the CCI projects is to continuously update user requirements to ensure that the ECV produced by the projects are timely and relevant for climate research and climate services. This is done by reviews of user needs, user surveys and input from the GCOS, CRG and CMUG, and is documented in the URDs [RD1] [RD2].

In order to obtain direct feedback from the users, we have arranged a user workshop jointly between the GIS_cci+ and the AIC_cci+ projects. The workshop served several purposes:

- 1) to advertise and promote the data products produced by the GIS_cci+ and AIS_cci+, and demonstrate the added value from these products.
- 2) to obtain direct feedback from users on their experience of working with the data products.
- 3) to collect input from users on new products, both on experimental products that are under development, and on future products and opportunities.

The timing of a user workshop in relation to the phase 2 projects is important for the outcome and application of the results. Originally, the plan was to arrange a workshop in the first year of the phase 2 projects, with the user workshop mainly considered to provide input to the user requirements analysis. However, it was later agreed to postpone the workshop to the second year of the phase 2 projects, as this would allow us to present the new product release from the GIS_cci+ phase 2. The focus of the user workshop would then be to collect input from users on their experience using the data, taking advantage of more data being released after the first year of the projects, and providing input to the climate assessment of the ECVs produced by the projects. The users could also be asked for input on new and future products to be developed.



2.2 Location and format of the user workshop

The user workshop was held in relation to the 2024 European Polar Science Week, 3-6 September 2024 in Copenhagen, Denmark. The timing of this conference was excellent in relation to the GIS_cci+ and AIS_cci+, and very timely for providing input to the Climate Assessment Reports (CARs). Furthermore, the participants of this conference were exactly the audience that we would like to address in our user workshop.

The 2024 European Polar Science Week is an important joint event between the European Commission and the European Space Agency. The overall objective of the conference is to bring together the European polar science community and promote European cooperation for polar science. Among the more specific goals of this conference are to share the latest scientific results with a focus on Earth observation, to identify major scientific challenges and observation gaps, and finally to formulate recommendations for a polar science agenda for ESA and the Horizon Europe Programme. The Conference included international keynote speakers, researchers, monitoring projects, climate services, political stakeholders, industrial partners, and representatives from the EC and ESA, and was visited by hundreds of international participants.

The user workshop consisted of three main activities:

- An ESA CCI data user consultation was held jointly between the six ESA CCI cryosphere projects.
- Presentation of a poster with the title: “ESA’s Climate Change Initiative - Monitoring the Earth’s Cryosphere” was presented at the 2024 European Polar Science Week, 3-6 September 2024 in Copenhagen, Denmark.
- An online user survey to obtain user feedback on existing and planned products. The user survey was advertised at the 2024 European Science Week and at relevant email listservers.

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2.3 User consultation

The main activity at the 2024 Polar Science Week was to host a special session, organized as a side event on Friday morning of the conference, 6 September 9:30-10:30: “ESA CCI Data User Consultation: Collecting user requirements for tracking and understanding Earth’s shrinking cryosphere”.

The session was organized and chaired by the GIS_cci+ and AIS_cci+ projects and included the six ESA CCI cryosphere projects. The session was successfully completed with approximately 25 participants.

The main outcome of the session was to advertise and promote knowledge of the ECV products and to show the quality of the records and inspire new applications. Another outcome was to get in direct contact with the users in the discussion and question session and to promote the online user survey, see below.

The agenda for the meeting is shown here:

Agenda:

Chairs: Dana Floricioiu (DLR) (AIS_cci+), Alex Messerli (ASIAQ) (GIS_cci+)

- Welcome by session chairs
- Overview of ECVs by the six ESA CCI cryosphere projects:
 - Antarctic Ice Sheet CCI by Andrew Shepherd, UNN, UK
 - Greenland Ice Sheet CCI by Louise Sandberg Sørensen, DTU, DK
 - Glaciers CCI by Frank Paul, UZH, CH (presenting online)
 - Snow CCI by Thomas Nagler, ENVEO, AU
 - Sea Ice CCI by Thomas Lavergne, METNO, NO
 - Permafrost CCI by Annett Bartsch, B.GEOS, AU
- Discussion and questions

2.4 Poster



Another important activity at the 2024 Polar Science Week was the presentation of a poster with the title: “ESA’s Climate Change Initiative - Monitoring the Earth’s Cryosphere”.

The poster was displayed every day in the poster session presented by Christine Hvidberg (UCPH) (GIS_cci+) and Dana Floricioiu (DLR) (AIS_cci+). In addition, a small print of the poster was posted on a News board outside the main Auditorium.

The purpose of the poster was to advertise the user consultation session at the conference and the online user survey (QR code on the poster, see below), as well as to engage directly with users throughout the conference. A poster session can offer opportunities to discuss directly with users.

Throughout the week, the poster was rather sparsely visited, perhaps due to the location of the poster board. Nevertheless, we managed to enter discussions with several very engaged users on their use of data products and feedback for further development of ECVs. We have included this feedback in section 2.6 below.

The poster is shown below in Figure 1.

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ESA's Climate Change Initiative

Monitoring the Earth's Cryosphere

<https://climate.esa.int/en/about-us-new/climate-change-initiative/>





cci

ESA's Climate Change Initiative (CCI) is a major research and development effort that generates global, decades-long satellite data records to track and understand key aspects of the Earth climate system, and known as Essential Climate Variables.

These data records support the United Nations Framework Convention on Climate Change and the International Panel on Climate Change to monitor, assess and address changes to Earth's climate system.

ESA CCI comprises six research projects with a specific focus on the Earth's Cryosphere.

Are you interested and want to know more about the ESA CCI cryosphere projects?


Earth's Cryosphere is shrinking:
The ESA Climate Change Initiative (CCI) provides key satellite observations to track and understand the changes.

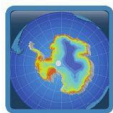
CCI Data User Consultation: FRIDAY MORNING (9:30 - 10:30)
in ROOM HOLBERG (The Black Diamond, Floor 1)

Antarctic and Greenland Ice Sheets CCI:

Participate in a user survey and help improve and develop the products.

Scan the QR code to access the survey (~5min)





Antarctic Ice Sheet CCI



Snow CCI



Greenland Ice Sheet CCI



Sea Ice CCI



Glaciers CCI





Permafrost CCI

Presented by: Dana Floridiolu (DLR/AIS CCI), Christine Hvidberg (UCPH/GIS CCI), and the AIS CCI and GIS CCI teams. For further information, contact: Dana Floridiolu dana.floridiolu@dlr.de, Christine Hvidberg ch@nhu.ku.dk

Figure 1. Poster presented at the 2024 Polar Science Week, 3-6 September 2024, Copenhagen, Denmark.

2.5 Online user survey

The third, and most important component of our user workshop activities was to perform an online user survey to obtain feedback from users on existing and planned products. With this survey, we wished to engage with a wider group of scientific users and stakeholders. The user survey was developed and timed in order to be advertised at the 2024 Polar Science Week, both in the user consultation session and on the

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poster (with a QR code to the survey link). In addition, and perhaps most importantly, it was announced on the Cryolist email list, reaching out to hundreds of users worldwide, and to project teams in relevant Horizon Europe projects OCEAN:ICE, PROTECT and PolarRES.

The survey was designed to assess both the current ECVs produced by the GIS_cci+ and the AIS_cci+ and to provide input to new products under development and future products in general.

The survey was successfully completed by 36 users.

We monitored the replies and found that the majority of replies were received following the announcement in online fora, not during the 2024 Polar Science Week. This is expected, as conference participants are more likely to engage in person than online. However, we believe that the activities during the conference contributed to improving the general knowledge of the CCI products, and also allowed us to discuss directly with the users.

2.6 Interviews with users

We conducted a few ad hoc interviews with four selected users during the 2024 Polar Science Week. These users were experienced researchers in geophysical surveys on ice sheets and ice flow modelling, respectively, and represented both Antarctic and Greenland research. All are engaged in ongoing large-scale international projects to monitor the ice sheets, collect in-situ data or provide input into ice sheet modelling assessments. They are experienced users of satellite-based products, from CCI projects and elsewhere.

When asked about major polar scientific challenges, observation gaps and research needs for the coming years, they mentioned the following points:

- The ice thickness of the Greenland and Antarctic ice sheets is not well-constrained everywhere. In particular, some areas of Antarctica are sparsely covered. This gap will limit our ability to determine the stability of these ice sheets.
- The internal structure of the large ice sheets has been mapped, but there are large gaps, in particular in Antarctica. The internal structure is a rich dataset that can be interpreted to provide critical knowledge of key parameters for understanding ice sheet evolution, such as past snow accumulation, and the geothermal heat flux and basal melting.
- The interior temperature of the ice sheets is not well-constrained. Ice temperature is a property that depends on a complex interplay between the past climate history, geothermal heat flux and internal advection within the ice, and can only rarely be observed in boreholes. The ice temperature has a direct influence on the ice flow and response to climate change.
- Meltwater hydrology and the links to ice velocity are not well known. Meltwater is produced at the surface, where it forms supraglacial lakes, drains to the base or refreezes in the top firn layers. Understanding the meltwater hydrology is essential to predict the ice sheet's sensitivity to warming temperatures.
- As an EO data user (not expert) it can be challenging to navigate the large portfolio of data available and to know what is the right one to use. For instance, some ECVs are available through both CCI and C3S. It would be good with some guidelines.

Overall, there is an increasing interest in using satellite-based data products in climate assessments, as validation of models, or to develop new parameterizations in the climate models, where satellite data are used to constrain climate system processes, for example in relation to basal sliding of ice sheets or ice calving processes. Many conversations at the conference addressed these applications and mentioned the need for long records that are publicly available, praising the goal of the ESA CCI programme.

3 Online user survey

3.1 Introduction

The goal of the user survey was to collect quantitative input from users at the user workshop to investigate their view of existing data products and obtain input on their priorities for further data production and ECV developments.

The survey was designed to poll the information of the type of data required by the users and also to allow for further feedback with free comments fields. The feedback can be used for the climate assessment work and to guide future developments.

3.2 The Questionnaire

The questionnaire was designed and then tested by the project partners. The survey was launched during the 2024 Polar Science Week and subsequently advertised to a wider user community through email lists, see section 2.

The questionnaire consisted of a total of 16 questions, of which 9 were multiple choice questions, and 7 were text boxes, with options to add further comments. In addition, there were 4 optional questions about the respondent. The questionnaire was designed to be short and simple, in order to gain as many respondents as possible. However, we only partly managed to make the survey appear simple and easy to fill, mainly because the projects do cover a wide range of applications and data that can not be investigated with few questions. In the end, the questionnaire was well attended with 36 respondents.

The questionnaire and responses, including interactive versions of figures in this section, are found here: https://docs.google.com/forms/d/1gOHeAb4l8ePcOyxtumpw2H5IXrNIaUzF1_qXqnuLZI/edit#responses.

3.3 The respondents

The questionnaire asked a number of questions to gauge the background and experience of the respondents. Respondents were asked to identify the number of years of experience, and as shown in Figure 2, almost 50% of the respondents have >10 years of experience, suggesting that the survey is based on knowledge built over a long period of time. We believe that this increases the quality of the survey and that it can provide a solid basis for directing the future research focus of the AIS_cci+ and GIS_cci+ projects.

Please identify the number of years of experience you have working in this field.

34 responses

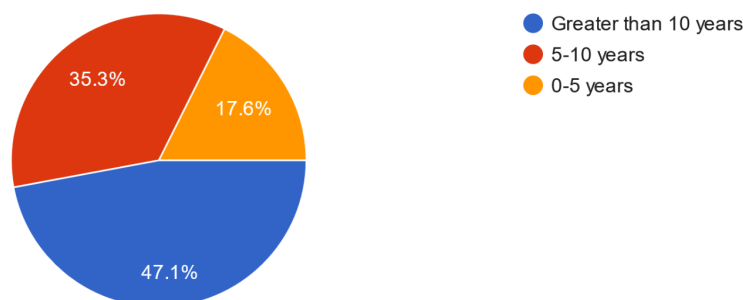


Figure 2. Respondent's year of experience in this scientific field.

What are your own primary activities in relation to ice sheets? (choose multiple if appropriate)

36 responses

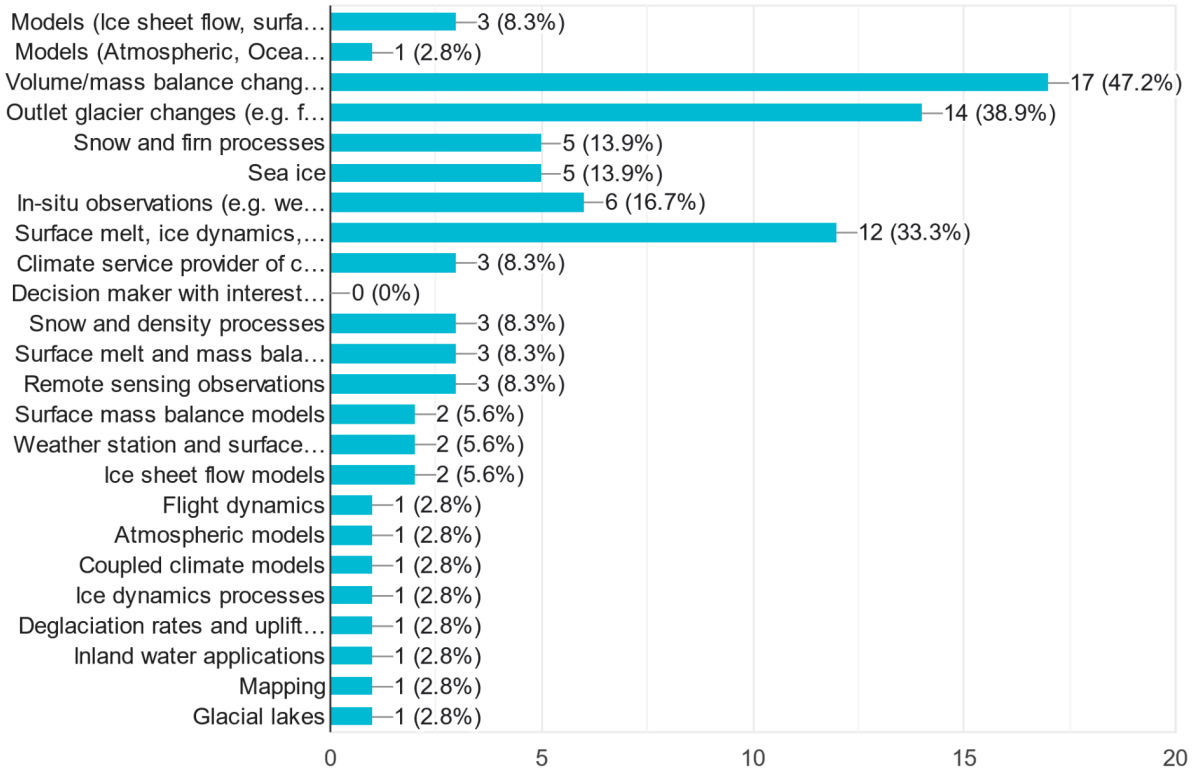


Figure 3. Respondent's primary activity in relation to ice sheets.

What is the primary geographical focus of your activities? (choose multiple if appropriate)

35 responses

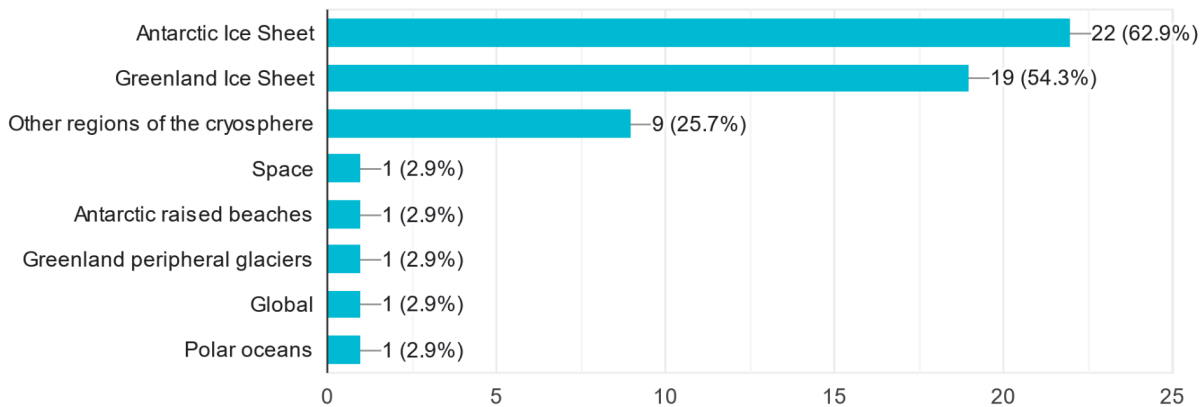


Figure 4. The primary geographical focus of the respondents.

The respondent's primary activity in relation to ice sheets covers a wide range of disciplines, including volume/mass balance changes (47%), Outlet glacier changes (39%), surface melt and ice dynamics (33%), see Figure 3. The primary geographical focus of the respondents was distributed mainly on the Antarctic Ice Sheet (63%) and the Greenland Ice Sheet (54%), see Figure 4.

The respondents were asked whether they had already used any of the ice sheets CCI products, and 50% of the respondents answered positively, see Figure 5.

Have you already accessed Greenland or Antarctic Ice Sheets CCI products in the past?

36 responses

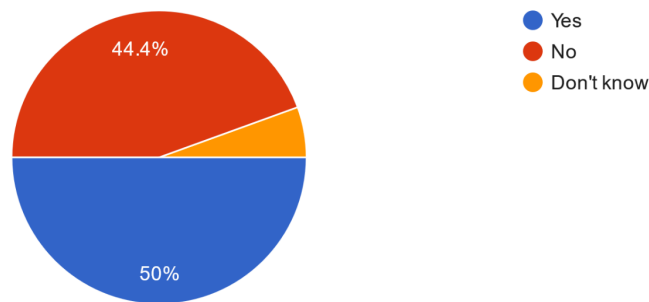


Figure 5. The experience with CCI data by the respondents.

3.4 Plans for future applications

The respondents were then asked about what would be their recommendations for the regions of future interest. The majority of the respondents answered ice sheet margins/coastal regions (69%) or ice shelves (50%), see Figure 6.

What are the regions of interest for your future applications? (choose multiple if appropriate)

36 responses

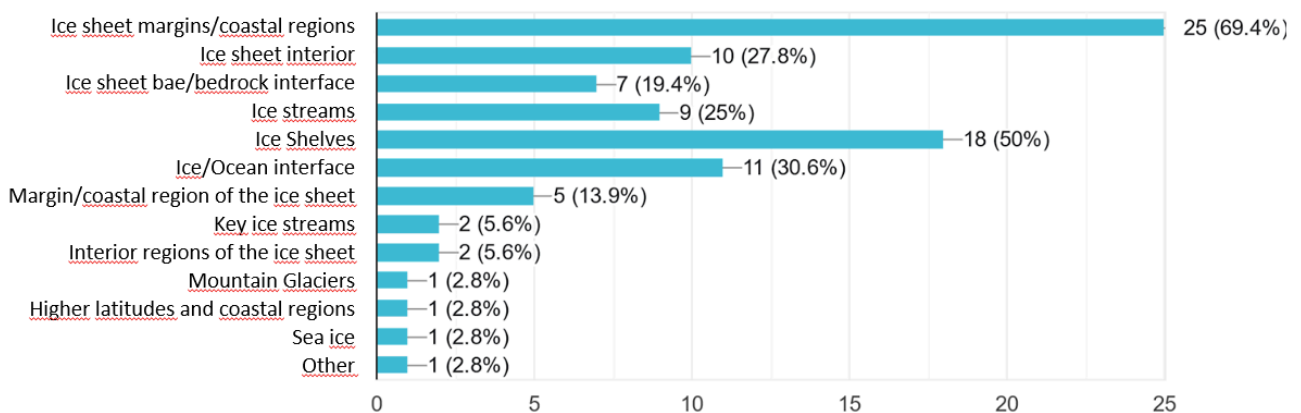


Figure 6. The future regions of interest of the respondents.

The respondents were asked about what resolution would be needed to detect climatic changes for a list of different parameters. For parameters related to ice dynamics, surface elevation change and ice velocity, monthly resolution is sufficient for most respondents, while for surface melt-related parameters, like supraglacial lakes and surface melt extent, weekly resolution is needed, See Figure 7.

The respondents had many additional comments to this question, mainly to underline the importance of high temporal resolution to detect changes related to surface melting, but also to add additional critical parameters that require high temporal resolution:

- “For early warning of ice shelf collapse or significant accelerations in ice loss, weekly is best.”
- “Surface melt extent is needed at high temporal resolution to understand firn corrections for altimeter products.”
- “For fast outlet glaciers, velocity and surface water features can evolve even daily. So the more frequent the data the better. For lower level applications seasonal datasets can be helpful.”
- “Influence of liquid water on surface mass and energy balances, interactions between liquid water and firn structure.”
- “Grounding Line tidal motion; weekly/daily melt extent.”
- “Lakes as they can change rapidly.”

How frequently should the following parameters be surveyed to detect climatic changes? Tick multiple boxes if you wish to specify a range

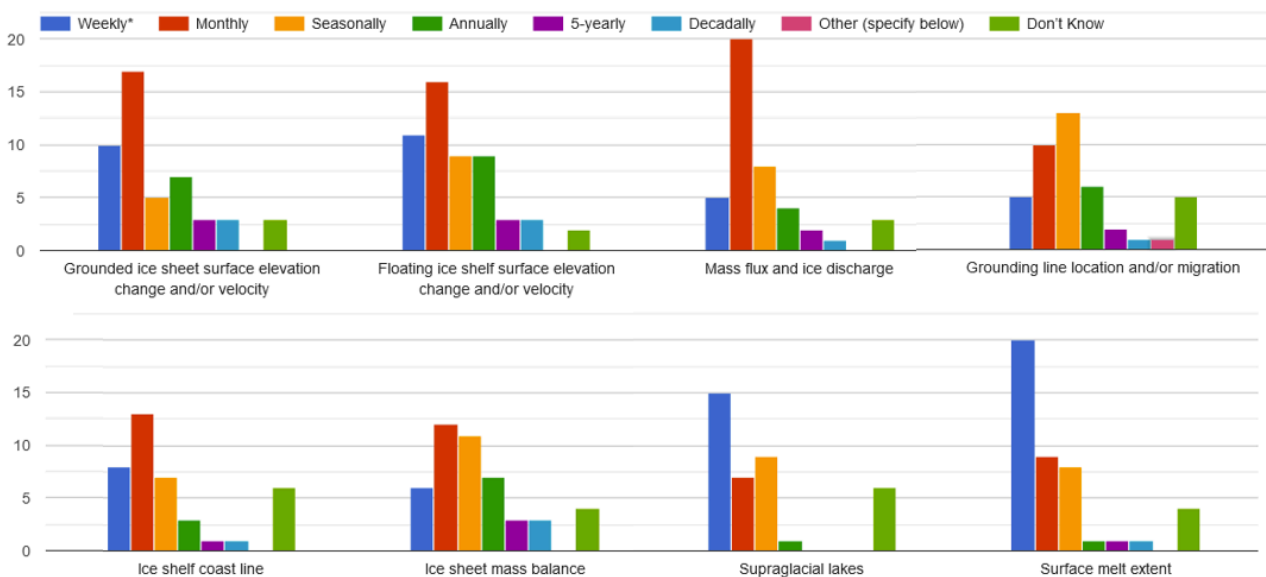


Figure 7. Respondent’s view of how frequently selected parameters should be surveyed to detect climatic changes.

3.5 Demand for existing and new CCI products

The respondents were then asked questions about the importance of existing or potential new CCI products. Of these, three products stand out with the highest priority: Surface elevation change (17), Ice velocity (13), and Ice sheet mass balance (10). See the full list in Figure 8.

The respondents were also allowed to provide other products of high priority, not included in the list. The answers pointed to the following categories:

- sea ice products
- surface albedo of both ice sheets
- water storage changes
- all products with the highest temporal resolution

We would like to assess the relative importance of existing and/or potential new CCI products. Please indicate your highest priorities (1 = highest priority and 6 = lowest priority).

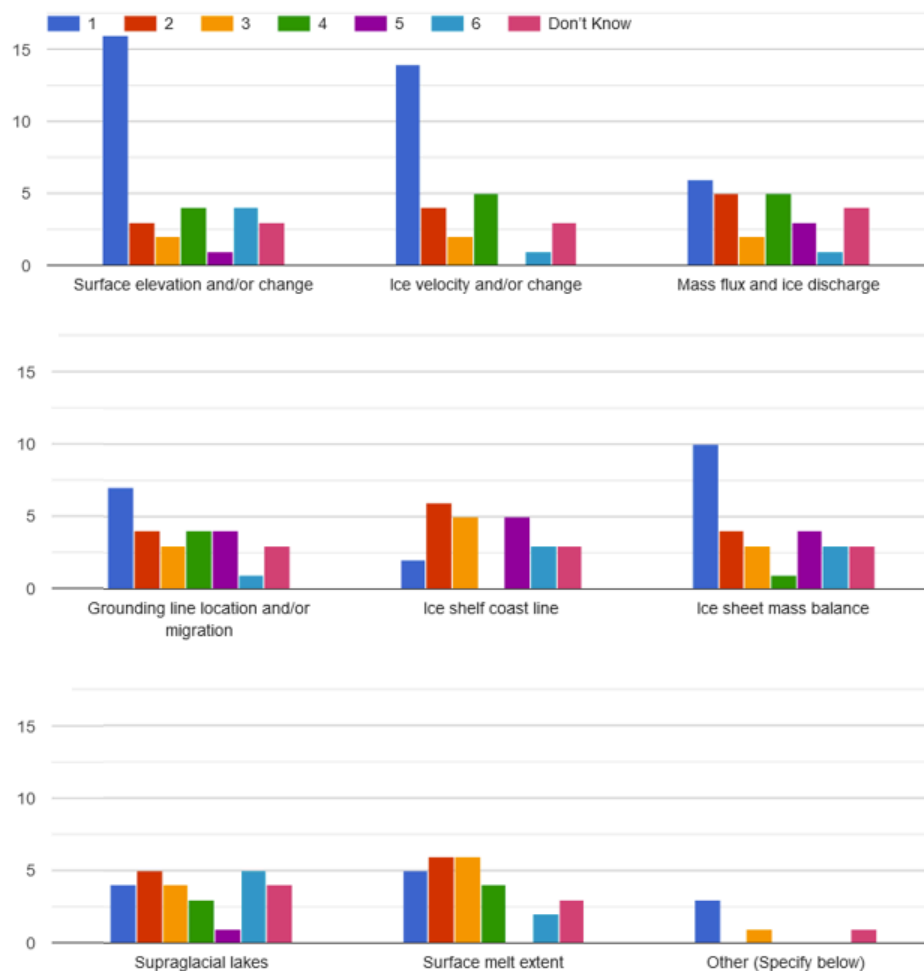


Figure 8. The respondent’s opinion on the relative importance of existing and potential new CCI products.

The respondents were asked about the demand for existing CCI products. In general, all products were interesting and in high demand, with the highest demand on Surface elevation change (28), Ice velocity (26), and Ice sheet mass balance (27), see Figure 8.

In the comments field, two responses were given:

- “Calving front location would be useful (again)”

- “Temporal resolution should be maximal, variables should be as close as possible to what is being measured (with derived variables such as temporal changes also provided), and retrieval should make use of all the best satellite observations, even if they are not from ESA. The last point is crucial for users to rely on the CCI products in the long term.”

Calving front locations were previously produced in GIS_cci+, but are currently not produced within CCI. For AIS_cci+, it is also not included in the baseline project, but an optional activity (as CCN1) called Ice Shelf Coastlines (ISCL) started in August 2024 and is led by the consortium partner S&T.

The other comment about combining several datasets addresses several important issues that should be considered in future developments. Users are looking for the best products, and do not constrain themselves to one provider.

We would like to assess the demand for existing CCI products. Please indicate whether you might use CCI estimates of the following parameters.

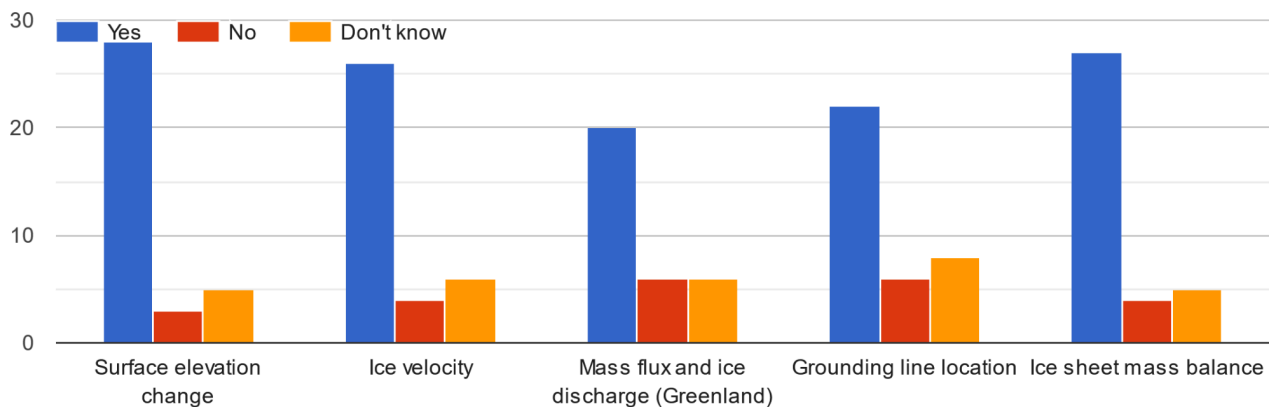


Figure 9. The interest in CCI products by the respondents.

The respondents were also asked about their demand for potential new CCI products, see Figure 10. The most demanded parameters are Ice velocity change (25), Grounding line migration (23), Ice sheet mass balance partitioned into surface mass balance change and ice dynamics change (24).

The comments included three further suggestions:

- Sea ice products
- Surface albedo for machine learning applications as well as for the development of new parameterisations.
- Ice shelf thinning rates

We would also like to assess the demand for potential new CCI products. Please indicate whether you might use CCI estimates of the following parameters.

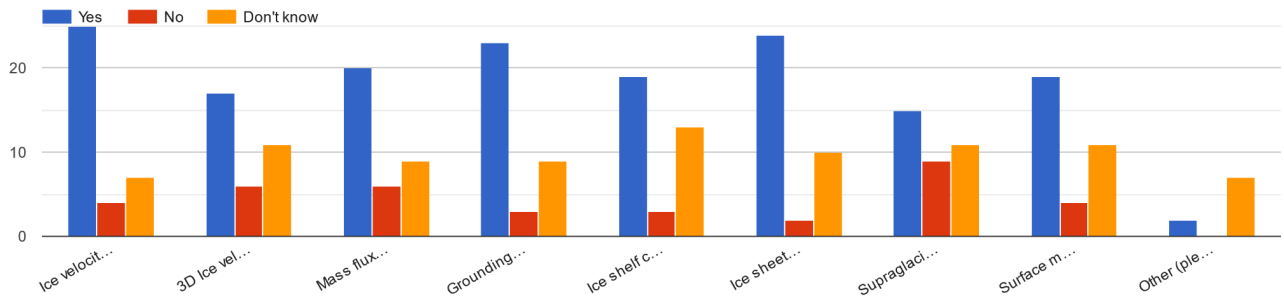


Figure 10. The demand for potential new CCI products.

3.6 Areas of priority

Respondents were asked about which geographical areas should be prioritized. The majority prioritized areas with the greatest mass imbalance (35%), with the second and third priority being ice shelves (21%) and outlet glaciers (21%). See Figure 11.



We would like to gauge opinion on which sites to prioritise for product generation. Please indicate which of the following areas of interest you think are of greatest importance for each parameter. 34 responses



Figure 11. Areas of highest priority.

3.7 Recommendations



The respondents were asked to provide any additional comments or recommendations for the GIS_cci+ and AIS_cci+ projects, respectively.

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A few comments were provided. The comments show that potential users cover a wide range of applications, from beginners to experienced users, interested in uncertainties. The comment about uncertainties was given similarly for both AIS and GIS.

List of comments:

- “Dealing with datasets with significant numbers of NaNs is a problem - guidance for how to deal with those, or even better a product without NaNs would be great.” (AIS)
- “Really useful data to use as a student.” (AIS)
- “For velocity products, better metadata information would be very useful, for example, layers showing - on a per-pixel basis - the precise methodology used to obtain velocity measurements (e.g. incoherent tracking-, coherent tracking-, or InSAR LOS-derived, or a combination). At present no such information exists, making e.g. uncertainty quantification difficult.” (AIS and GIS)
- “Very useful products! Thanks for all the work that goes into them!” (GIS)

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4. Summary and recommendations

The AIS_cci+ and GIS_cci+ user workshop was held during the 2024 Polar Science Week, 3-6 September 2024 in Copenhagen, Denmark. The user workshop was held during year 2 of the GIS_cci+ phase 2 project with the purpose of promoting the CCI products to the users and obtaining direct feedback on existing and future CCI products. This will inform the climate assessment of the CCI products and future development of CCI products. For AIS_cci+, the user workshop was held in year 1 and is part of the user requirements analysis.

The user workshop activities included a range of activities: a user consultation session, held jointly with the six ESA CCI cryosphere projects, a poster presentation, and an online user survey.

The user workshop received qualified input from many users at different levels of experience through these activities. About half of the respondents to the online survey were very experienced users with more than 10 years of experience.

Overall, the CCI data are very positively received by the users. The users are engaged in developing the portfolio of CCI data products, and there are several suggestions for new ideas and products.

Based on the user survey and discussions and interviews with conference participants, we have composed a list of summary statements and recommendations:

- The highest priority should be given to observing areas with the greatest mass imbalance, including ice shelves and outlet glaciers.
- The demand for the existing CCI data products continues to be high, in particular for surface elevation change, Ice velocity, and Ice sheet mass balance.
- Several new CCI products would be in high demand, in particular Ice velocity change, Grounding line migration, Ice sheet mass balance partitioned into surface mass balance change and ice dynamics change.
- The demand for CCI products in high temporal resolution is increasing. In particular, products related to surface melting, hydrology and processes near the grounding line would be useful in high resolution, preferably weekly.

From discussions during the user workshop, a wish list of observational data gaps has emerged:

- ice-sheet-wide maps of ice thicknesses. Current maps have gaps.
- ice-sheet-wide maps of the internal layering and structure, in particular for Antarctica. Current datasets are sparse and large areas are not covered.
- Internal Ice temperature. This data does not exist today.
- Meltwater hydrology on, in and under the ice. Any Earth Observation that can provide better spatial and temporal coverage of meltwater hydrology, including for example seasonal evolution of surface lakes and drainage networks.