IASC Proposal Template

IASC Working Groups (WGs) encourage and support science-led international programs by offering opportunities for planning and coordination, and by facilitating communication and access to facilities. Crosscutting projects encourage the IASC Working Groups (WGs) to explore activities which straddle disciplinary lines and are of interest to two or more WGs. IASC wishes to promote cross-discipline thematic activities and encourage interaction between the WGs, in particular between natural and social sciences WGs.

Any proposals submitted to IASC should have been discussed with WG leadership and/or membership before submission.

Evaluation Criteria:

- Does the activity have scientific merit? Does it address research priorities identified within the ICARP III process & IASC Working Group Work Plans?
- How many disciplines/WGs are meaningfully involved in the proposed activity? Does it bridge social and natural sciences?
- Does the activity promote interdisciplinary involvement not only in the implementation but also the planning of the activity?
- Circumarctic and/or polar activities are encouraged.
- Each activity shall involve early career scientists[1]. Does the activity intend to promote the involvement of early career scientists not only in the implementation but also the planning of the activity?
- Does the activity have support or endorsement from organizations other than IASC?

All funded activities must follow IASC requirements.

Title: Glacier - atmosphere interactions in a rapidly warming Arctic environment

Relevant IASC Working Groups:

X Atmosphere X Cryosphere □Marine □Social & Human □Terrestrial

Requested amount (€):

(Maximum € 15,000 for Workshop)

Total: € 10,000

[e.g. CWG: € 6500; AWG: € 3500]

[1] Please note that early career scientists receiving support can only receive support from IASC for one activity every 18 months.

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How does the proposed activity assist IASC in fulfilling its mission?
(Maximum 200 words)

The proposed activity aims to bring together experts within glaciology and atmospheric sciences, thereby fostering multi-disciplinary and international research in the Arctic. It aims to study the physical environments and their two-way coupling. The proposed activity feeds into the recommendations given about "Arctic Research Priorities for the Next Decade" as outlined in the ICARP III final report, to further exploration of physical linkages of the atmosphere-ice system. The proposed activity follows up on recent cross-cutting activities (2018-2020) involving the Cryosphere and Marine WGs, with a focus on glacier-ocean interactions. Collectively, the proposed and recent cross-cutting activities contribute to the research priority to "enhance our understanding of a fully coupled physical climate system (atmosphere-ocean-ice) on diverse space and time scales" (ICARP III).

The proposed activity strives to engage and promote early-career scientists (ECS) during planning, conduction and reporting of the activity. This will help them in building international and cross-disciplinary research networks. The Association of Early Polar Career Scientists (APECS) will manage applications for ECS travel funds.

How does the proposed activity align with the foci of the relevant IASC Working Groups?
(Maximum 200 words)

The proposed activity involves two of the IASC working groups: the Cryosphere Working Group (CWG)/ Network on Arctic Glaciology (NAG) and the Atmosphere Working Group (AWG).

The proposed activity contributes to all three research foci of the CWG: 1) Atmosphere-glacier-ocean interactions: implications on the pan-Arctic glacier mass budget; 2) extreme cryospheric events (e.g. heavy snowfall / rain-on-snow events, extreme glacier summer melt); and 3) cutting barriers in snow knowledge (e.g. snow albedo, snow drift, precipitation downscaling). NAG has a strong focus on the mass balance and dynamics of Arctic glaciers and their response to climate change, which most closely connects to research focus 1) above.

The proposal contributes to all research foci of the AWG: 1) Cloud, water vapour, aerosols, fluxes; 2) Arctic Air Pollution; 3) Coupled Arctic climate system; 4) Arctic weather extremes; 5) Linkages: Role of the Arctic in the global climate system. Strongest contributions are anticipated to foci 3) and 5).

Description of the proposed activity:
(Maximum 1000 words)

The proposed cross-cutting activity will be implemented in the next annual meeting of the IASC Network on Arctic Glaciology (NAG) in Szczyrk, Poland, 26-28 January 2021, in the form of presentation and discussion sessions.

The Arctic climate system has between 1971 and 2017 warmed at more than twice the average rate observed in the Northern Hemisphere (AMAP, 2019) due to Arctic Amplification. Recent warming has led to an acceleration of Arctic land-ice mass loss, which during 1992-2017 accounted for 30% of total sea level rise.

Glaciers exist and evolve through a long-term balance between mass gain (snow accumulation and moisture deposition) and mass loss (melt water runoff, sublimation and frontal ablation). The role of the atmosphere is twofold for glaciers. Firstly, near-surface atmospheric conditions determine the energy balance of a glacier surface, which in turn determines melt rates. Atmospheric warming induces an increase of melt rates, but a detailed quantification of changes in melt requires a coupled treatment of atmospheric boundary layer conditions, the state of the surface and the underlying snow, firn (old-snow) or ice. Secondly, the main mass source for glaciers is snow accumulation. Changes in sea ice cover and atmospheric flow patterns result in changes to both the amount and phase of precipitation (snow vs. rain) and thus changes in snow accumulation. This latter process can either delay or enhance mass loss of glaciers in case of summer snowfall or winter rainfall, respectively, and the associated albedo feedback. Increased surface melt may partly be retained within the extensive firn areas of Arctic ice caps. However, increased melt causes changes in the firn stratigraphy due to percolation and refreezing, with impact on runoff-hydrology.

Glaciers are a product of the climate system, but also feedback on the climate system itself. Linking studies across the atmosphere and cryosphere ultimately contributes to an improved understanding of the role of the Arctic in the climate system, both at a regional and global scale (ICARP III). This would help to assess the impact of future climate dynamics, with projected shifts in large-scale circulation patterns inducing persistent changes in precipitation and temperature patterns, on the mass budget of Arctic glaciers and the Greenland Ice Sheet. Atmospheric circulation patterns, and systematic changes thereof in a future climate, may induce strongly contrasting patterns of glacier mass balance across the Arctic. Such contrasts were for example observed in 2012, when the Greenland Ice Sheet experienced record melt, while glacier mass loss in Svalbard was comparably moderate. Understanding atmosphere-glacier interactions across the Arctic and their variability in space and time requires cross-disciplinary approaches and the integration of field observations, satellite remote sensing, and numerical modelling to further our understanding of the two-way coupling between the glacier surface and the atmosphere.

We have identified three themes that address topics of mutual interest for the Atmosphere and Cryosphere WGs:

1) **Atmospheric circulation patterns and the impact on the Arctic land-ice mass budget**

   Research questions:
   a) What are projected trends in atmospheric circulation patterns and how will they affect seasonal temperatures and precipitation on Arctic glaciers and the Greenland Ice Sheet?
   b) How significant are long-term changes in atmospheric circulation for estimates of the glacier mass budget at a regional scale?
   c) How do changes in large-scale atmospheric circulation patterns translate into changes of the glacier's microclimate, i.e. within the atmospheric boundary layer over a glacier surface?
   d) What is the impact of changes in atmospheric circulation on Arctic air mass trajectories? How does this affect deposition rates of pollutants, such as black carbon, on glacier surfaces? What would be the impact on surface albedo?

2) **Precipitation and snowfall in the Arctic – observations & modelling**

   Research questions:
   a) How to best observe precipitation and snow accumulation on Arctic glaciers and the Greenland Ice Sheet?

b) What methods can be used to downscale precipitation from coarse-resolution climate models or reanalysis products to finer grids used for glacier and ice sheet simulations?
c) Will the frequency of rain-on-snow events change in a future climate and what is impact on glacier mass balance and snow/firn conditions? This connects also to Research question 1a.
d) How important is wind-driven snow redistribution for surface mass balance modelling?
e) Can we make more extensive use of remote sensing to observe snow parameters from space, including snow depth, wetness and albedo? What is the impact of atmospheric conditions (e.g. clouds and moisture) on the accuracy of the retrieved parameters?

3) **Coupling of glaciers and atmosphere in general circulation models (GCMs), regional climate models (RCMs) and earth system models (ESMs)**

Research questions:

a) How are glaciers and ice sheets represented in GCMs, RCMs and ESMs? What are the key (two-way) ice – atmosphere coupling processes that should at least be included in large-scale models?
b) What future climate predictions exist for the Arctic, how reliable are they and how do they account for transient cryosphere – atmosphere interactions? For example, how is the changing geometry of Arctic glaciers and the Greenland Ice Sheet incorporated in large-scale models?

Expected short-term results and long-term (5-year) legacy:
(Maximum 200 words)

The proposed activity follows up on previous cross-cutting activities in 2018, 2019 and 2020, involving the Cryosphere WG / Network on Arctic Glaciology and the Marine WG. With the current proposed activity, involving the Atmosphere WG we now shift our focus to atmosphere-glacier interactions and we believe the cross-cutting activity will provide an excellent interdisciplinary forum for glaciologists and atmosphere scientists to present and discuss their work and to stimulate future collaborations. Such cross-disciplinary research is required in order to predict future climate dynamics and its connection with land-ice mass changes, thereby providing important insights in the vulnerability and resilience of Arctic environments and societies.

Through the proposed workshop we will help early-career scientists in building international, cross-disciplinary research networks. This will increase their visibility and recognition by the scientific community and help them establish networks needed for future projects and project proposals.

During the activity we will discuss the idea for a jointly written paper reviewing recent research on observing and modelling pan-arctic glacier-atmosphere interactions, involving an equal share of researchers from both WGs.

Dissemination of results:

(Maximum 200 words)

- A workshop summary report will be submitted to the IASC office and distributed among AWG and CWG members (February 2021).
- The "Book of abstracts", including workshop agenda, abstracts, as well as minutes from open discussion and open forum meeting will be published on the IASC and IASC-NAG website (https://nag.iasc.info/publications) and distributed among the communities.
- The activity is expected to foster ideas for scientific papers in international scientific journals with a focus on atmosphere-glacier interactions. During the activity we will discuss the idea for a jointly written review paper (see previous section).
- The activity is expected to initiate and strengthen collaboration between the glaciology and atmosphere communities, thereby fostering joined research proposals in the coming years.

Detailed Budget Specification:

- *Travel costs: specify number of participants and indicate early career scientists*
- *Logistic support: provide detailed cost listing*

	own contribution	requested from IASC	contribution from other sponsors	total
Travel costs *		7000		7000
Logistics*		3000		3000
etc.				

Travel support: Partial travel support is requested for ca. 10 participants of the NAG annual meeting (average support 700 € per person; mainly early career, but also a

few senior scientists/invited keynote speakers, if requested). We will strive to include group representatives from all of the involved IASC working groups and a broad international representation. As in the past years, we will seek assistance from the Association of Polar Early Career Scientists (APECS) in order to review applications and distribute ECS travel funds.

Logistic support: Workshop facilities/equipment, i.e. conference room rental: ca. 500 EUR (3 days); name tags: ca. 200 EUR; coffee/tea/refreshments: ca. 2300 EUR (16 EUR per person and day; e.g. 50 participants x 3 days).

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