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Update Report for the WCRP Joint Scientific Committee

Climate and Cryosphere (CliC)

WORLD METEOROLOGICAL ORGANIZATION

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Foreword to CliC's 2025 Annual Report

The highlight of the last year for CliC was undoubtedly our in person Open Science Conference, held in Wellington, New Zealand, in February 2026, which was widely agreed to have been an excellent and inspiring event. The OSC had 423 participants from 32 countries; some 100 registrants were students, while another 70 identified as Early Career Researchers, so this represented a broad and diverse community. One of the reasons why the OSC was so successful was that it represented all the cryosphere (not just polar) and its interactions with the climate system. There was real invigorating energy and excitement, and a panoply of excellent presentations and discussions, at the OSC. Now we need to capitalise on this clear enthusiasm and interest in all things climate- and cryosphere-related. The CliC leadership gratefully thanks the local organisers/hosts and all the sponsoring bodies, the invited speakers and everyone else involved, without whom we could not have had an OSC!

Beyond the OSC, CliC has been spinning up its new, cross-cutting Impacts of Changes in the Mountain Cryosphere (IC-MONTC) activity group that links nicely with WCRP GEWEX, ANDEX, MRI and other WCRP and external project activities. We are also looking into a possible new permafrost working group, which would be based around the theme of people, structures and adaptation, to complement the existing Permafrost Carbon Network that we already co-sponsor. Existing groups such as POLAR Cordex, GlacierMIP, ISMIP (ice sheet projections) and sea ice groups have continued their valuable work, which will in part be pivotal for supporting next-generation climate model projections that will underpin the Intergovernmental Panel on Climate Change's next major AR7 report scheduled for 2029. We are closely involved in planning activities for both the International Polar Year (IPY5, 2032/33) and the UNESCO-led International Decade of Action for Cryosphere Sciences, 2025-2034. Furthermore, we have been working closely with our parent organisations at WCRP and WMO to help produce a commissioned Policy Brief on global sea level rise, which represents a first of its kind document for WCRP. Following on from this, we are keen to help lead or advise a new cross-cutting WMO/WCRP sea-level activity that can build on work of our recently sunset ISMASS (Ice Sheet Mass Balance & Sea-level Expert Group).

There have been some inevitable recent challenges around funding, particularly since our international Project Office is based in the US (UMass Amherst) but also due to the recent global cuts in WCRP budgets. However, we have been forward planning scenarios to help ensure the future stability of the IPO and the continuation of the excellent science and impact

work that CliC galvanises across the cryospheric and climate realm. We look forward to further exciting milestones and developments for CliC and its communities during 2026 and beyond.

Best wishes,

Edward Hanna, Chair of CliC's Scientific Steering Group

CliC Chair E. Hanna standing in front of Khardung Glacier during field excursion of the first Leh Indian Glaciology Summer School, 25 June 2025.

High-level publications

- Feb 7, 2025: The Polar Special Issue of Science, co-coordinated by CliC, including 2 CliC-led papers on Arctic and Antarctic change: Antarctica in 2025: Drivers of deep uncertainty in projected ice loss and Disappearing landscapes: The Arctic at +2.7°C global warming

- May 29, 2025: GlacierMIP working group published the 3rd phase of GlacierMIP that focused on the long-term stabilization of glaciers under a range of climatic conditions in Science: Glacier preservation doubled by limiting warming to 1.5°C versus 2.7°C. This paper led to interviews for the New York Times, The Guardian, CNN, Agence France Presse, CBC, VRT NWS & VRT radio 1, NOS & NOS radio 1, NOS Nieuwsuur, Nieuwsblad, Algemeen Dagblad, Le Soir, La Libre, Mongabay, Glacier Media, Science Daily, GlacierHub, and Today's Science.
- Chapters within the NOAA Arctic Report Card:
    - Sea Ice (Co-authored by several members of the CliC Arctic Sea Ice Working Group)
    - Surface Air Temperature (Co-authored by E. Hanna, CliC SSG Chair)
- Sea Ice section of The Arctic in the Bulletin of the American Meteorological Society (BAMS) State of the Climate in 2024 reports, published in August 2025.
- Hanna et al. (2025) "Current understanding of global sea-level rise". WMO WCRP CliC.
- Future Sea-level Rise Is Certain, but the Amount and Speed Are Uncertain By Tim Naish, Edward Hanna and Amy Lovecroft on behalf of the World Climate Research Programme and its Climate and Cryosphere Project

Capacity Building/Education and Training Highlights

- CliC held an Open Science Conference (423 attendees representing 32 countries) in Wellington, New Zealand in February 2026. Full details can be found at clic2026.com. 100 registrants were students, and another 70 also identified as Early Career Researchers.
- BEPSII ECR Steering Committee members Laura Dalman and Emelia Chamberlain are organizing a BEPSII ECR Grant-Writing Workshop for early 2026, designed to support ECRs in developing fellowship and grant applications.

- In 2025, SORP quarterly seminar series, PROS4SORP continued, with the purpose of building a more coherent community and raising awareness of SORP activities. Three presentations were held in 2025:
    - 25 January 2025: “Antarctic change and cascading impacts.” by Dr Petra Heil. Link: https://youtu.be/sntsmyVsJVQ
    - 8 May 2025: “ODYSEA and the Southern Ocean: Research Opportunities with Satellite Winds and Surface Currents“ by Dr Sarah Gille. Link: https://youtu.be/892xfz1kRqA
    - 11 August 2025: “Modelling fine-scale melt patterns below ice shelves” by Franka Jesse. Link: https://youtu.be/5mCF4-zOWlk

Linkages with other Core Projects, Lighthouse Activities, Academy, etc.

- CliC is spinning up a new, cross-cutting Impacts of Changes in the Mountain Cryosphere (IC-MontC) activity group that links nicely with GEWEX, ANDEX, MRI and other project activities.

Partnerships with entities outside of WCRP

- BEPSII played an active role in supporting and amplifying the “SOS from the Cryosphere” Open Letter to World Leaders ahead of COP30. This effort was closely aligned with BEPSII’s broader engagement on cryosphere governance, including the paper Governing the Cryosphere beyond political timeframes, which provides a conceptual framework for long-term, science-informed decision-making beyond short political cycles. The Open Letter received widespread regional and international media attention, including coverage by Reuters at the opening of COP, and led to an invitation to contribute an extensive opinion piece on cryospheric tipping points for “Land and

Climate Review". An after-COP30 analysis is available here: https://www.youtube.com/watch?v=1hnIU-gQGuw

- CliC held its 2025 SSG meeting alongside the CliC Open Science Conference in Wellington, New Zealand and used this opportunity to strengthen cooperation with SCAR and its working groups. Representatives of several partner organizations participated in the meeting, including: IACS (Sandra Barreira), IGS (Allen Pope), SCAR-INSTANT (Tim Naish), Shawn Marshall (IASC and Global Cryosphere Watch GCW), and WMO-PHORS (Thamban Meloth).

- We have appointees to the 4 subgroups of the IPY planning taskforce.

- CliC organized an IC-MontC virtual side event at the launch event for the International Year of Glaciers' Preservation at WMO in January, 2025. More information and recordings are available here.

- CliC (led by L. Vargo and the IPO) continues to engage with SCAR's AntClimNow (Near-term Variability and Prediction of the Antarctic Climate System) to help develop their Antarctic Indicators Working Group.

- IPO Director K. Alverson participated in the 15th Session of the Arctic Climate Forum (ACF-15), hosted by Environment and Climate Change Canada, virtually May 27-28, 2025 from 15:00 to 18:00 UTC and the 16th Session of the Arctic Climate Forum (ACF-16), hosted by Rosshydromet, Russia, virtually November 5-6, 2025.

- CliC SSG Members Thamban Meloth and Yao Tandong participated as members in meetings of the WMO EC-Phors in February, 2026 in Wellington, New Zealand alongside the CliC OSC.

- CliC serves as stakeholder for The Glacier Mass Balance Intercomparison Exercise (GlaMBIE), which is a European Space Agency project, building on existing activities and the network of the International Association of Cryospheric Sciences (IACS) working group on Regional Assessments of Glacier Mass Change (RAGMAC).

- Many partner organizations partnered with the Climate and Cryosphere Open Science Conference, including: New Zealand, Australia, SCAR-INSTANT, Victoria University of Wellington Antarctic Research Centre, Korea Polar Research Institute (KOPRI),

International Association of Meteorology and Atmospheric Sciences (IAMAS) International Commission on Climate (ICCL), Securing Antarctica's Environmental Future (SAEF), International Association of Cryospheric Sciences (IACS), and International Glaciological Society (IGS).

- The Scientific Committee on Antarctic Research's (SCAR) INStabilities and Thresholds in ANTarctica (INSTANT) Research Programme convened for a 1 Day Symposium with more than 60 participants, alongside the CliC OSC. The symposium had a series of invited talks and panel discussions in plenary to progress the agenda of the INSTANT Programme and its priorities.
- SSG members Amy Lovecraft, Miriam Jackson and Yao Tandong took part in the Paris technical launch of the UNESCO led, International Decade for Action on Cryosphere Research, in March 2026, to showcase CliC scientific leadership for the decade and strengthen linkages with UNESCO and its International Oceanographic Commission.

Future Science Directions for JSC Consideration

The CliC SSG met on February 8th, 2026 in Wellington New Zealand and decided on a number of actions and identified future priorities including:

- Sea Level Rise to be implemented through participation in the broader WCRP task team
- Engagement with both the Decade of Action for Cryospheric Science and IPY-5
- High mountain cryosphere

The full report of the SSG meeting is available on our website.

New Activities

- ASIWG is involved in the production of the annual Sea Ice Outlook (SIO) initiative, as part of the Sea Ice Prediction Network. This report provides an open process for those interested in Arctic sea ice to share ideas about the September minimum sea ice extent.

SIO produces reports in June, July, and August containing a variety of perspectives on Arctic sea ice — from observations of current conditions, to advanced numerical models, to qualitative perspectives from citizen scientists. The ASIWG is actively seeking to establish linkages with other working groups to optimize the usefulness of the SIO activity: https://www.arcus.org/sipn/sea-ice-outlook

- Through the EU-funded PolarRES project led by Priscilla Mooney, and involving Andrew Orr, members our PolarCORDEX activity have downscaled two CMIP6 GCMs over the Arctic CORDEX and two CMIP6 GCMs over the Antarctic CORDEX domains using multiple regional climate models. The two CMIP6 GCMs for each polar region were chosen to represent a 'storyline' approach, based on physically consistent future changes in atmospheric and ocean circulation. Results from PolarCORDEX are also being used for ISMIP7 (Ice Sheet Model Intercomparison Project for CMIP7). Plans to contribute to the downscaling of CMIP7 are under consideration.

- GlacierMIP aims to develop new community-based global-scale future projections and ensure they are published in time for inclusion in the AR7 main report. For this, they are currently in close communication with other community efforts (e.g., CMIP7, ISMIP7, ISIMIP) to ensure a consistent setup that will allow, among others, for output to be compared and combined (e.g., forcing with same climate forcing).

- IC-MontC held a workshop at the International Mountain Conference in Innsbruck for community discussion around improving high-resolution climate modeling in mountainous regions, with 25 participants. Workshop organizers have submitted a workshop report to BAMS entitled Advances in High-Resolution Climate modelling and Cryosphere systems over Mountainous Regions.

- ISMIP7 is a MIP of CMIP7 which will target the IPCC 7th Assessment report, and will also be preparing datasets (atmosphere, ocean, and ice shelf fracture) for driving the ice sheet models using CMIP6 Earth System Models for the component of ISMIP7 that uses CMIP6 dataset. Ice sheet models will be asked to run a number of CMIP6 derived projections to explore the uncertainty in sea level projections.

- SORP member and incoming co-chair Channing Prend is one of the lead organizers for an InSync workshop in February 2026 prior to the Ocean Sciences Meeting in Glasgow. The workshop, "Observing the physics and biogeochemistry of a changing Antarctic sea

ice zone“, will focus on coordinating ocean and sea-ice observations in advance of Antarctica InSync and the International Polar Year (IPY).

- A special issue of *Advances in Atmospheric Sciences* on climate and cryosphere is in preparation based on contributions presented at the 2026 CliC Open Science Conference, but also open to all interested contributors.

- SSG Member Chris Burn is working towards developing a new working group along the lines of ‘Permafrost in the built environment’, seeking to engage RIFS, IPA or other relevant groups as a possible co-sponsors and ensuring complementarity and lack of overlap with the Permafrost Carbon Network.

General

- CliC’s new Strategic Plan has been revised following earlier feedback and will be submitted to the JSC-47 meeting for approval.

Communications

CliC saw a massive spike in website traffic over the course of 2025. Please find specific metrics below, followed by the percentage of increase compared to the previous calendar year.

- **Total users**: 22,259 (+480%)
- **Total sessions**: 28,306 (+446%)
- **Total views**: 37k (+111%)
- **Total events**: 115k (+122%)

We also launched a new website in 2025 for the CliC Open Science Conference in February 2026: clic2026.com. This secondary site received another 31k active users, 85k views, and 239k events. If we combine the tally of views and events across both sites, CliC had 122k website views and 354k events (or user interactions) in 2025.

Our communication channels also include a newsletter and several social media accounts. These platforms all saw growth in 2025, with the exception of Twitter/X. Please see the table below for further analytics data.

Platform	Link	2026 Followers	Notes
CliC Newsletter	Join Now	2460 (+760 from 2025)	**Publications in 2025**: 1 **Recipients**: 1.7k **Open Rate**: 36.6% **Click Rate**: 12%
Twitter/X	Link	3626 (-331 since Aug 2024)	Twitter/X has steadily fallen out of favor (especially with the scientific community) over the past several years and saw a dramatic spike in abandoned and deleted accounts around the end of 2024. Many of our followers moved to Bluesky or Threads.
Bluesky	Link	259	This was our first full year of using BlueSky (account opened in late 2024). Our follower count suggests we recovered around 78% of the followers we lost on Twitter.
Facebook	Link	3.6k (+249 in 2025, 207.4% increase compared to 2024)	Engagements: 819 (+19.7% from previous 365 days)
LinkedIn	Profile and Group	489 members (+67 since Aug 2024)	92 active group members (+47 since Aug 2024)
Instagram	Link	109	Our Instagram hasn't been active since losing our communications intern, but our followers have continued to grow despite the lack of new content.

Other Working Group Publications

BEPSII:

- Castellani, G., Tedesco, L., Steiner, N. and Vancoppenolle, M. (2025). Numerical models of sea ice biogeochemistry. In Sea Ice, D.N. Thomas (Ed.). https://doi.org/10.1002/9781394213764.ch20.

- Castellani, G., Granskog, M.A., Elias Chereque, A., Chan, A.C.Y., Perez, I., Flores, H., Katlein, C. and Peeken, I. (2025) Arctic sea-ice ridges: a major contributor to algal habitable space in spring. Front. Mar. Sci. 12:1653882. doi: 10.3389/fmars.2025.1653882.

- Corkill, M., Takenobu Toyota, Daiki Nomura, Klaus M. Meiners, Pat Wongpan, Ryota Akino, Nana Samori, Masaki Yoshimura, Ashley T. Townsend, Trevor Corkill, Delphine Lannuzel; A novel probe to sample dissolved and particulate matter in sea ice at high vertical resolution. Elementa: Science of the Anthropocene 3 January 2025; 13 (1): 00053. doi: https://doi.org/10.1525/elementa.2024.00053.

- Dalman, L. A., Meiners, K. M., Thomas, D. N., Deman, F., Bestley, S., Moreau, S., et al. (2025). Observation-based estimate of net community production in Antarctic sea ice. Geophysical Research Letters, 52, e2024GL113717. https://doi.org/10.1029/2024GL113717.

- Haddon, A., Adam H. Monahan, Tessa Sou, Nadja Steiner; Simulated increases of future Arctic dimethylsulfide ocean concentrations, emissions and high-flux events. Elementa: Science of the Anthropocene 3 January 2025; 13 (1): 00090. https://doi.org/10.1525/elementa.2024.00090

- Hayward, A., Wright, S.W., Carroll, D. et al. Antarctic phytoplankton communities restructure under shifting sea-ice regimes. Nat. Clim. Chang. 15, 889–896 (2025). https://doi.org/10.1038/s41558-025-02379-x.

- Meiners, K.M., Lannuzel, D., Leu, E. and Brown, K.A. (2025). Nutrients and organic matter dynamics in sea ice. In Sea Ice, D.N. Thomas (Ed.). https://doi.org/10.1002/9781394213764.ch16

- Tedesco, L., Steiner, N., Pekeen, I., 2025. Sea-Ice Ecosystems, in Comprehensive Cryospheric Sciences and Environmental Change. Ed. Claire Earys, Elsevier, doi:10.1016/B978-0-323- 85242-5.00043-9.

- Tedesco, L., Castellani, G., Duarte, P., Jin, M., Moreau, S., Mortenson, E., Saenz, B. T., Steiner, N., and Vancoppenolle, M., 2025 (Accepted in The Cryosphere). Brief communication: Intercomparison study reveals pathways for improving the

representation of sea-ice biogeochemistry in models, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2025-1107, 2025.

- Tedesco, L., Rapp, J. Z., Heil, P., Arnold, S. R., Creamean, J., Law, K., Stefels, J., Lahteenmaki Uutela, A., 2025 (In Review at Nature Communications). Governing the Cryosphere beyond political timeframes, EarthArXiv [preprint], doi:10.31223/X5BJ35.

GlacierMIP:

- Zekollari*, H., Schuster*, L., Maussion, F., Hock, R., Marzeion, B., Rounce, D.R., Compagno, L., Fujita, K., Huss, M., James, M., Kraaijenbrink, P.D.A., Lipscomb, W.H., Minallah, S., Oberrauch, M., Van Tricht, L., Champollion, N., Edwards, T., Farinotti, D., Immerzeel, W., Leguy, G., Sakai, A. (2025), Glacier preservation doubled by limiting warming to 1.5°C versus 2.7°C, Science 388, 979-983, doi: 10.1126/science.adu4675
  [* equal contribution]

LINKAGES:

- A stretched Polar Vortex and North American and Eastern Asian Cold-Air Events during January/February 2025. Overland J, Chandra V, Kim BM, Wang M, Ku H, et al. (2025) A stretched Polar Vortex and North American and Eastern Asian Cold-Air Events during January/February 2025. PLOS Climate 4(8): e0000679.
  https://doi.org/10.1371/journal.pclm.0000679

SORP:

- Theo Spira, Ivy Frenger, Carolina Dufour, et al. No longer polar opposites? Similarities in recent Arctic and Antarctic sea ice change. AGU Advances, under review. ESS Open Archive [preprint], 2025, doi:10.22541/essoar.176229943.38616843/v1

- SOFIA manuscripts under review:

- Muilwijk, M., Hattermann, T., Beadling, R. L., Swart, N. C., Nummelin, A., Guo, C., Chandler, D. M., Langebroek, P., Zhou, S., Dutrieux, P., Chen, J.-J., Danek, C., England, M. H., Griffies, S. M., Haumann, F. A., Jüling, A., Jouet, O., Li, Q., Martin, T., Marshall, J., Pauling, A. G., Purich, A., Song, Z., Smith, I. J., Thomas, M., Trombini, I., van der Linden, E., and Xu, X.: Large Regional Differences in Antarctic Ice Shelf Mass Loss from Southern Ocean Warming and Meltwater Feedbacks, The Cryosphere, under review, EGUsphere [preprint], 2025, https://doi.org/10.5194/egusphere-2025-3747, 2025.
- Xiyue Zhang, Ariaan Purich, Clara Deser, et al. Robust yet Diverse Tropical Responses to Antarctic Meltwater Across Models. Geophysical Research Letters, under review. ESS Open Archive [preprint], 2025, doi:10.22541/essoar.176227269.95062412/v1

- SOFIA articles published:
  - Kaufman, Z., Wilson, E., Purich, A., Beadling, R., & Li, Y. (2025). The impact of underestimated Southern Ocean freshening on simulated historical sea surface temperature trends. Geophysical Research Letters, 52, e2024GL112639. https://doi.org/10.1029/2024GL112639
  - Xu, X., Martin, T., Beadling, R. L., Liu, J., Bischof, S., Hattermann, T., et al. (2025). Robustness and mechanisms of the atmospheric response over the Southern Ocean to idealized freshwater input around Antarctica. Geophysical Research Letters, 52, e2024GL113734. https://doi.org/10.1029/2024GL113734

PolarCORDEX:

- Akperov, M., W. Zhang, T. Koenigk, A. Eliseev, V. A. Semenov, I. I. Mokhov, Projected changes in near-surface wind speed in the Arctic by a regional climate model, Polar Science, Volume 43, 2025, https://doi.org/10.1016/j.polar.2024.101162.
- Dahlke, S., Rinke, A., Shupe, M.D. and Cox, C.J., 2025: The Two Arctic Wintertime Boundary Layer States: Disentangling the Role of Cloud and Wind Regimes in

Reanalysis and Observations During MOSAiC, Atmos. Sci. Lett., https://doi.org/10.1002/asl.1298

- Deb, P., D. Bromwich, A. Orr, A. Sena, and K. R. Clem (2025), Recent surge in surface melting of West Antarctic ice shelves linked to Interdecadal Pacific Oscillation, Commun. Earth Environ., 6, 99, https://doi.org/10.1038/s43247-025-02077-8.

- Gilbert, E., D. Pishniak, J. A. Torres, A. Orr, M. Maclennan, N. Wever, and K. Verro (2025), Extreme precipitation associated with atmospheric rivers over West Antarctic ice shelves: insights from kilometre-scale regional climate modelling, The Cryosphere, 19, 597– 618, https://doi.org/10.5194/tc-19-597-2025.

- Heinemann, G., 2025: A case study of a wintertime low-level jet associated with a downslope wind event at the Tiksi observatory (Laptev Sea, Siberia). Meteorology 4(1), 7. https://doi.org/10.3390/meteorology4010007.

- Heinemann, G., Drüe, C., Makshtas, A., 2025: Simulations of low-level jets at the Tiksi observatory (Laptev Sea, Siberia) using the regional climate model CCLM and evaluation using SODAR observations for the winter 2014/15. Journal of the European Meteorological Society 3 100027. https://doi.org/10.1016/j.jemets.2025.100027.

- Kohnemann, S., Heinemann, G., 2025: Gap flows in Nares Strait: Multi-scale numerical model simulations in comparison to aircraft measurements. Earth and Space Science 12, e2024EA003912. https://doi.org/10.1029/2024EA003912.

- Landwehrs, J., S. Murto, F. Gebhardt, E. Gilbert, A. Rinke, 2025: Topographic effects of Svalbard on warm and moist air intrusions into the central Arctic, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2025-4535

- Swetha Chitella, S. P., A. Orr, and P. Deb (2025), Radiosonde measurements and Polar WRF simulations of low-level wind jets in the Amundsen Sea Embayment, West Antarctica, Adv. Atmos. Sci., DOI: 10.1007/s00376-025-4398-5.

- Teske, V., Timmermann, R., Nissen, C., Zentek, R., Semmler, T., Heinemann, G., 2025: Simulated density reorganization on the Weddell Sea continental shelf sensitive to atmospheric forcing. Ocean Sci., 21, 1205–1221. https://doi.org/10.5194/os-21-1205-2025.

- Tiedeck, S., and A. Rinke, 2025: Extending the Surface Energy Budget View on Arctic Atmospheric Rivers: Climatological Classifications and Dependence on the Flavor, Geophys. Res. Lett., https://doi.org/10.1029/2025GL118799