The International Network for Alpine Research Catchment Hydrology (INARCH) and its Common Observing Period Experiment (COPE), 2022–2024

https://inarch.usask.ca/

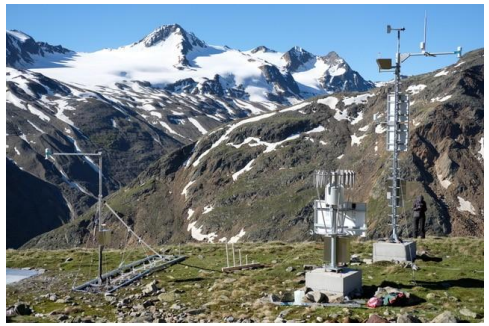
Chris DeBeer

GLOBAL WATER FUTURES OBSERVATORIES





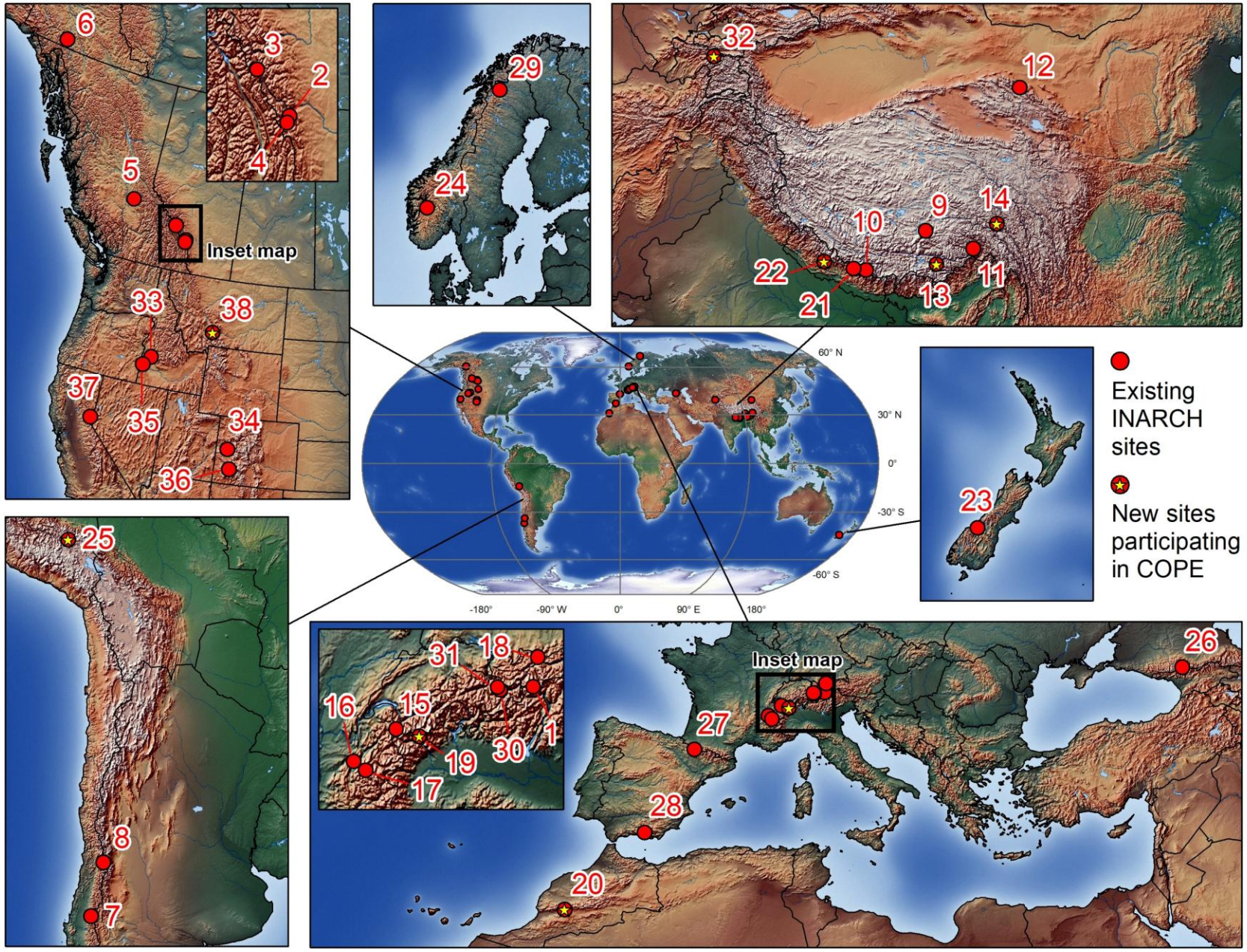




INARCH Basins

Austria **1.** Rofental Open Air Laboratory (OpAL);
Canada **2.** Marmot Creek Research Basin; **3.** Peyto Glacier; **4.** Fortress Mountain Snow Observatory; **5.** Quesnel River Research Basin; **6.** Wolf Creek Research Basin;
Chile **7.** Valle Hermoso, Upper Diguillín River Basin; **8.** Estero Las Bayas, Upper Maipo River Basin;
China **9.** Nam Co Monitoring and Research Station for Multisphere Interactions; **10.** Qomolangma Atmospheric and Environmental Observation and Research Station; **11.** Southeast Tibet Observation and Research Station for the Alpine Environment; **12.** Upper Heihe River Basin; **13.** Yala Shampo Cryosphere Hydro-Ecological Station*; **14.** Changdu Ecological Monitoring Station*;
France **15.** Arve Catchement; **16.** Col de Porte Experimental Site; **17.** Col du Lac Blanc Experimental Site;
Germany **18.** Schneefernerhaus and Research Catchment;
Italy **19.** Torgnon Ecosystem Station*;
Morocco **20.** Rheraya Catchment, High Atlas Mountains*;
Nepal **21.** Langtang Catchment; **22.** Hidden Valley, Himalayas*
New Zealand **23.** Brewster Glacier;
Norway **24.** Finse Alpine Research Centre;
Peru **25.** Salcca-Sibinacocha Catchment*;
Russia **26.** Djankuat Research Basin;
Spain **27.** Izas Research Basin; **28.** Guadalfeo Monitoring Network;
Sweden **29**. Tarfala Research Catchment;
Switzerland **30.** Dischma Research Catchment; **31.** Weissfluhjoch Snow Study Site;
Tajikistan **32.** Kyzylsu Glacier and Monitoring Sites*;
United States of America **33.** Dry Creek Experimental Watershed; **34.** Grand Mesa Study Site; **35.** Reynolds Creek Experimental Watershed; **36.** Senator Beck Basin Study Area; **37.** Sagehen Creek, Sierra Nevada; **38.** Bridger Range*.

*new sites participating in the Common Observing Period Experiment (COPE)



https://inarch.usask.ca/science-basins/research-basins.php

Other/new basins reported in COPE

- Grand Mesa, Colorado, USA
- Fuglebekken Catchment, Svalbard, Norway
- Mount Lebanon
- East River Basin, Colorado, USA
- Tuolumne River Basin, California, USA
- Tenderfoot Creek Experimental Forest (TCEF); Bozeman Creek Watershed (BCW), Montana, USA
- Tombstone Waters Observatory, Yukon, Canada
- Atwater Study Plot / Little Cottonwood Canyon, USA
- Senator Beck Basin, USA
- Sangvor, Tajikistan
- Snowy Mountains, Australia

Common Observing Period Experiment (COPE)
2022–2024

- INARCH held field observation phase of COPE
- focusing on obtaining high-quality measurements,
- ensure all sensors are working,
- enhance observations at our mountain research basins,
- fly supplementary UAV acquisitions,
- run high resolution models and
- work together for comparison of processes, data sharing, and model testing in challenging environments
- https://inarch.usask.ca/science-basins/cope.php

COPE modelling activities

- we plan to take a variety of different models and apply them in different basins to
  - see how they work,
  - make sure we have the proper forcing information,
  - try different forcing, at different scales,
  - see what corrections are needed for those forcings,
  - calculate snow and ice dynamics and hydrological dynamics at the surface, and
  - look at these diagnostically with available measurements from ice and snow changes, to soil moisture, streamflow, and turbulent fluxes, as available.
- This has not been done globally in alpine regions and could be potentially very powerful.

Common Observing Period Experiment (COPE)
2022–2024

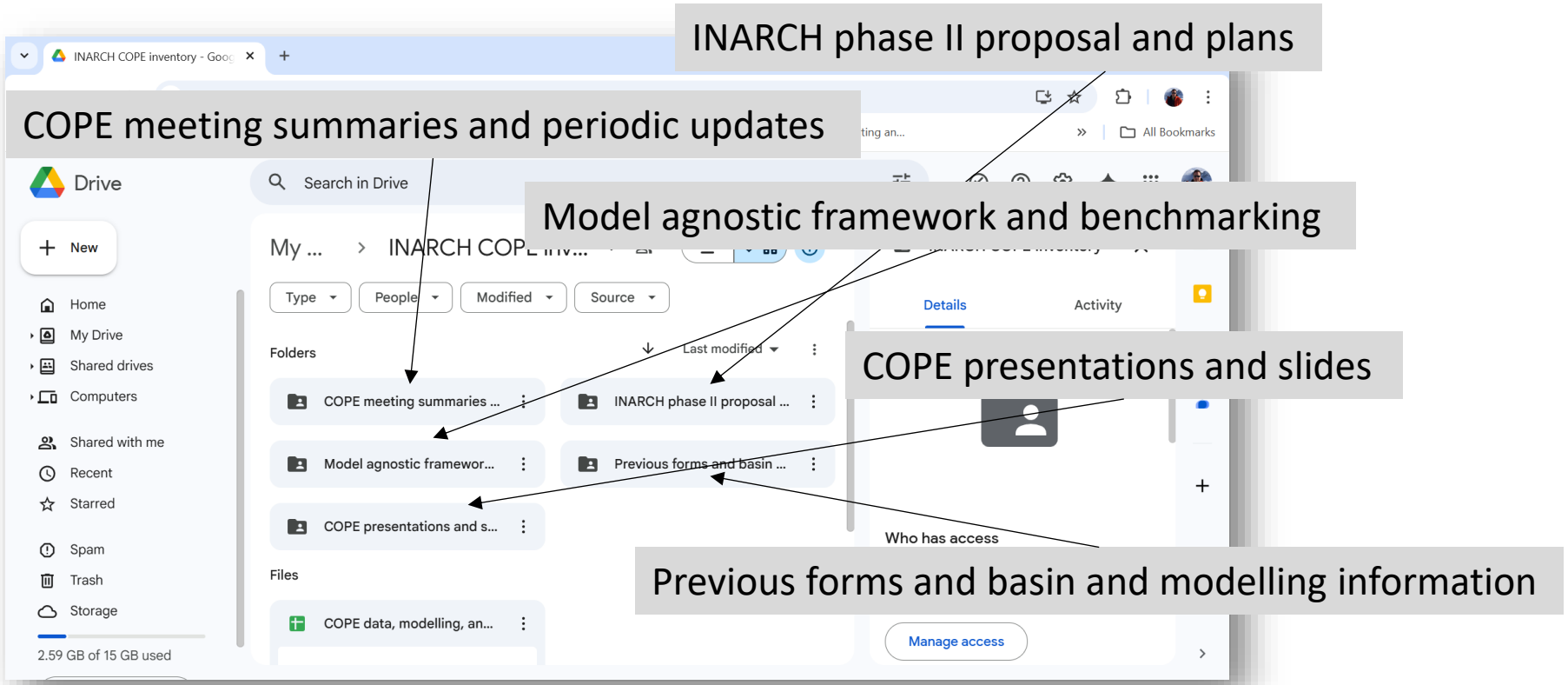
Hydrological, Meteorological, Glaciological Models

1. CRHM
2. openAMUNDSEN
3. OGGM (open global glacier model)
4. Cosipy
5. WRF\NoaaMP\CLM\LES models
6. FSM2
7. Thethys-Chloris
8. SPHY
9. AMelt
10. SNOWPACK/Alpine3D
11. Canadian Hydrological Model (CHM)
12. SnowModel
13. AWSM/iSnobal
14. FSM-OSHD
15. S3M
16. TopoPyScale
17. SURFEX-Crocus
18. SnowMet

- Details of these models are available at https://inarch.usask.ca/science-basins/cope.php
- Application of these models in as many places as possible to look at differences in results seen with elevation, vegetation structures, climate, etc.

INARCH COPE inventory – Google Drive

- https://drive.google.com/drive/folders/1PRZpNKhGwrdvs08Pgj_nWlcyiBsolJZK?usp=sharing



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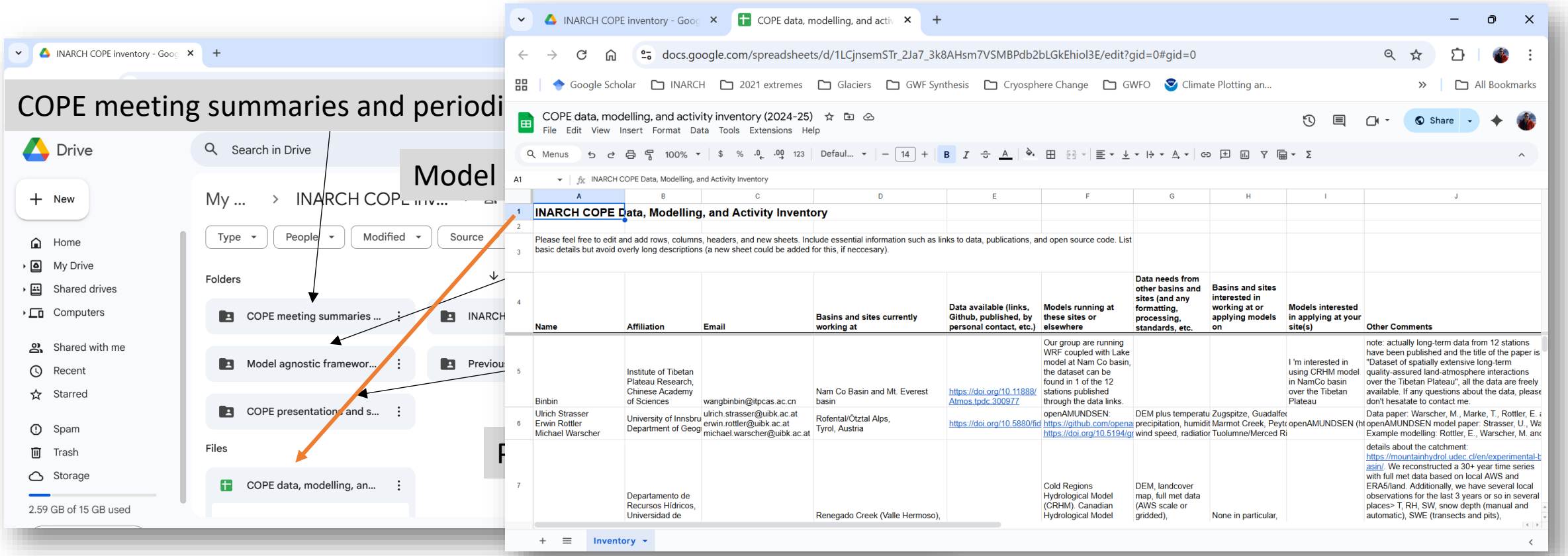

COPE data

Common Observing Period Exp

sk.ca/science-basins/cope.php#DataObservationalProductsCOPEoutputs

2021 extremes | Glaciers | GWF Synthesis | Cryosphere Change | GWFO | Climate Plotting an...

Data, Observational Products, COPE outputs

COPE datasets are being compiled, quality assured and controlled, and released. Those currently available (covering all or part of the COPE period) are listed below, while a more comprehensive listing of INARCH data is **available here**.

- Tibetan Plateau
  - Ma, Y., Xie, Z., Chen, Y., Liu, S., Che, T., Xu, Z., Shang, L., He, X., Meng, X., Ma, W., Xu, B., Zhao, H., Wang, J., Wu, G., Li, X. (2023). Spatially extensive long-term quality-assured land-atmosphere interactions dataset over the Tibetan Plateau. National Tibetan Plateau / Third Pole Environment Data Center. **https://doi.org/10.11888/Atmos.tpdc.300977**.
- Rofental, Ötztal Alps, Austria
  - Department of Geography, University of Innsbruck (2024): Continuous meteorological and snow hydrological measurements for 2013-2023 from three automatic weather stations (AWS) ...stria. GFZ Data Services. ...3.037.

...ebster, C., Mazzotti, G. (2024). A high-resolution snow and ...Dischma region in ...i.org/10.16904/envidat.568.

...basins ...oducts, **https://sgascoin.github.io/INARCH/**

...025). OGGM standard projections aggregated for 10 ...rds/17018026

Impressum

GFZ DATA SERVICES
GEOSCIENCES DATA PUBLISHER

Dataset

Continuous meteorological and snow hydrological measurements for 2013-2023 from three automatic weather stations (AWS) in the upper Rofental, Ötztal Alps, Austria

Released

Cite as:

Copy citation to clipboard

Department of Geography, University of Innsbruck (2024): Continuous meteorological and snow hydrological measurements for 2013-2023 from three automatic weather stations (AWS) in the upper Rofental, Ötztal Alps, Austria. GFZ Data Services. https://doi.org/10.5880/fidgeo.2023.037

A high-resolution snow and hydrometeorological dataset for the Dischma region in Switzerland

Jan Magnusson | Tobias Jonas | Yves Bühler | Clare Webster | Giulia Mazzotti

Jan Magnusson | 10.16904/envidat.568 | 19 Dec

INARCH

Sentinel-2 snow products

Data

Level 2B products (L2B)

Sentinel-2 level 2B snow products have a 5-day revisit and a spatial resolution of 20 m.

`LIS_S2-SNOW-FSC*.tif` provides the fractional snow cover:

- 0: No-snow

zenodo

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universität innsbruck

Department of Atmospheric and Cryospheric Sciences (ACINN), University of Innsbruck

Published September 1, 2025 | Version v1

Dataset | Open

OGGM standard projections aggregated for 10 INARCH basins

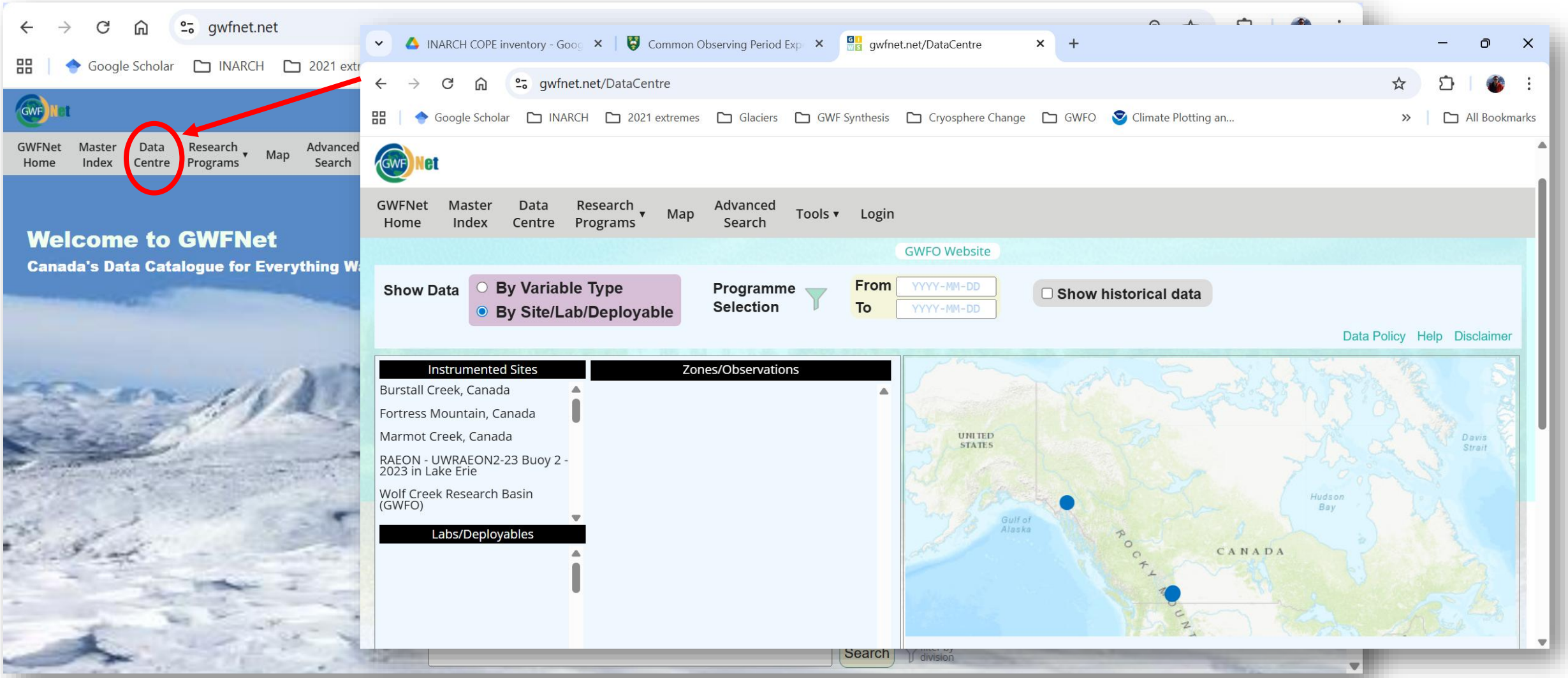
Schmitt, Patrick[1]; Nicholson, Lindsey[1]; Prinz, Rainer[1]

Show affiliations

This dataset provides glacier projections from the Open Global Glacier Model (OGGM) v1.6.1 standard projections, aggregated for 10 glacierized basins defined by the INARCH network.

The data include annual glacier volume and area, as well as melt, precipitation, and total runoff (annual and monthly). Melt and

Data management system - GWFNet



INARCH Phase II Science Questions

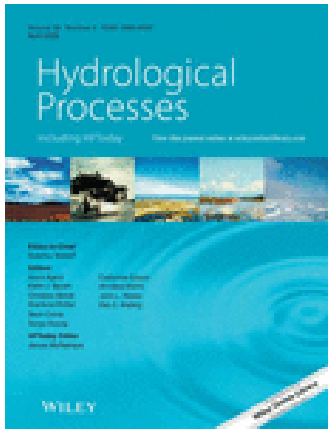
1. How different are the observation and measurement approaches amongst INARCH basins and do we expect distinctive differences in our understanding of basin response and hydrological predictability because of the sampling schemes, and data quality and quantity?
2. How do the predictability, uncertainty and sensitivity of energy and water exchanges vary with changing atmospheric thermodynamics, ecosystem structure and water management in various high mountain regions of the Earth?
3. What improvements to high mountain energy and water exchange predictability are possible through improved physics in, coupling of, and downscaling of models in complex terrain, and improved and expanded approaches to data collection and assimilation?
4. To what extent do existing model routines have global validity, are transferable, and meaningful in different mountain environments for providing service to society?
5. Can mountain systems be predicted and managed to find solutions to help achieve water sustainability in river basins under climate change?

Eventually contribute to answering - How have mountain atmospheric-cryospheric-hydrological-ecosystem-human systems co-evolved to their current states and how will they respond to climate change over the next century?

Common Observing Period Experiment (COPE)
2022–2024

Next steps

- Publish data in ***Earth System Sciences Data*** **special issue**, "Hydrometeorological data from mountain and alpine research catchments," https://essd.copernicus.org/articles/special_issue871.html
- Call for papers in ***Hydrological Processes*** **special issue**, "Improving Measurement, Understanding, and Prediction of Alpine Cold Regions Hydrological Processes and Their Sensitivities to Global Change," https://onlinelibrary.wiley.com/page/journal/10991085/homepage/call-for-papers/si-2024-001778

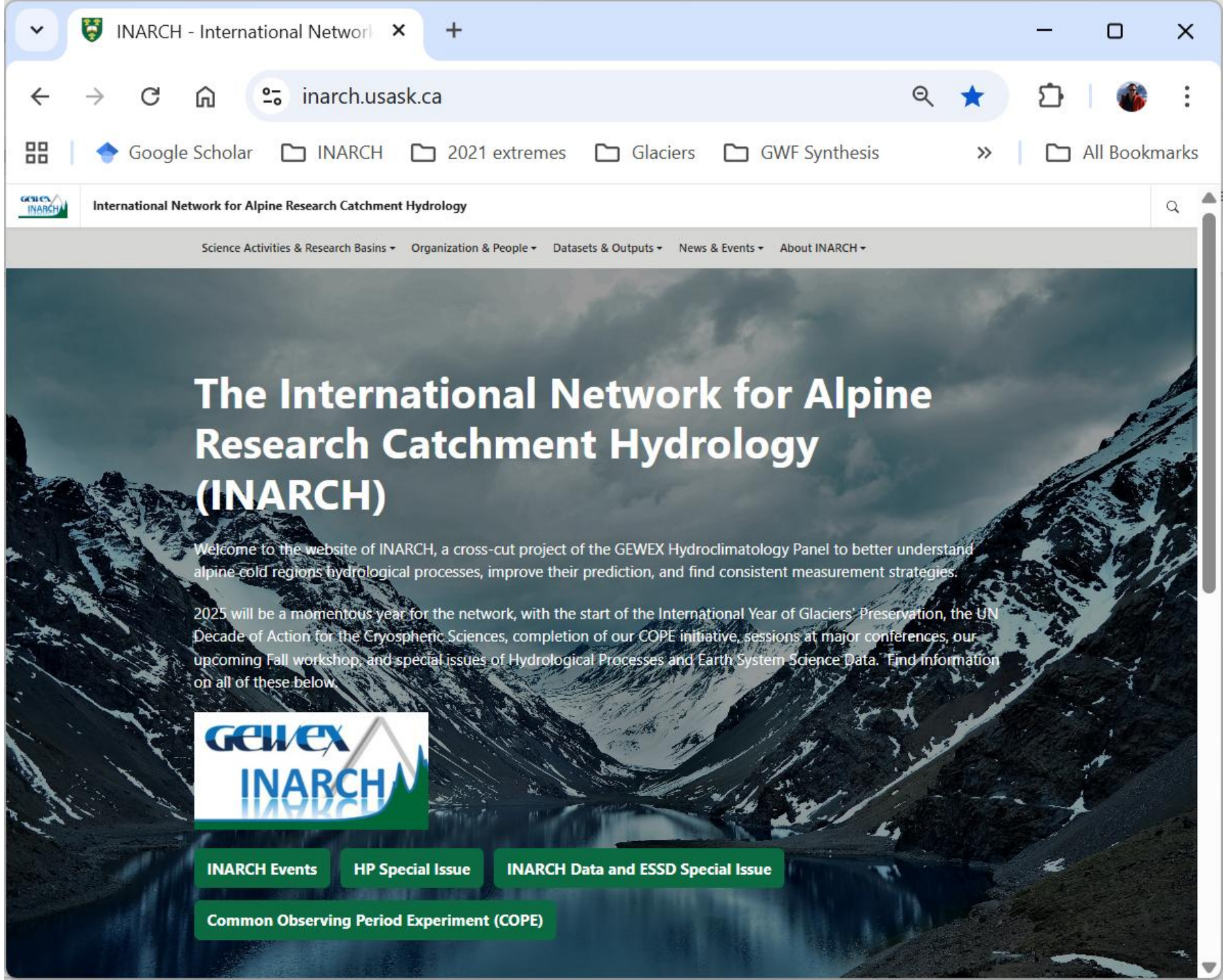


- **International Mountain Conference 2025:** INARCH will convene a focus session, FS 3.116 *High mountain hydrology and cryosphere: observations, modelling, prospects* at IMC 2025, September 15, 2025.
  - 17 talks, 16 posters

IMC Innsbruck 2025
International Mountain Conference

Website

- Please look at the website and let me know of changes, additions, more materials, etc.



In summary

- What COPE data already available/published?
  - Not much, need more, need to make it easily available across INARCH; perhaps eventually an overarching data publication with all COPE data in ESSD
  - We have GWFNet and the data portal. This can be an easy, central access point for metadata and to download data
- For all COPE activities, records, meeting notes, materials, lists and inventories there is a Google drive
  - The link can be shared with you. Please go there to access any materials you need and add/edit the inventory or other things
- Send Chris any other updates on publications or activities for the website and for our reporting to GEWEX