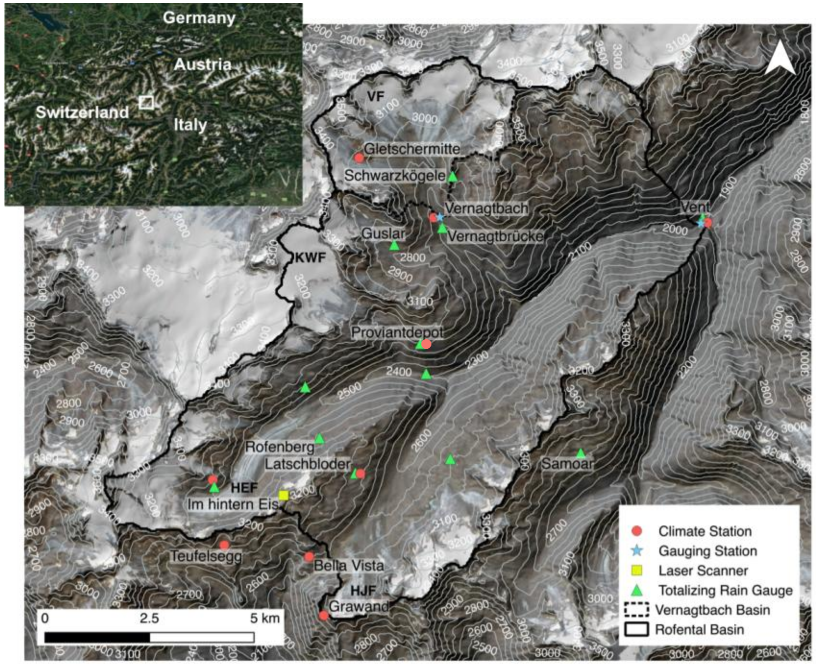
From measurements in the field to physically based modelling: the Rofental

University of Innsbruck

Research Basin Rofental

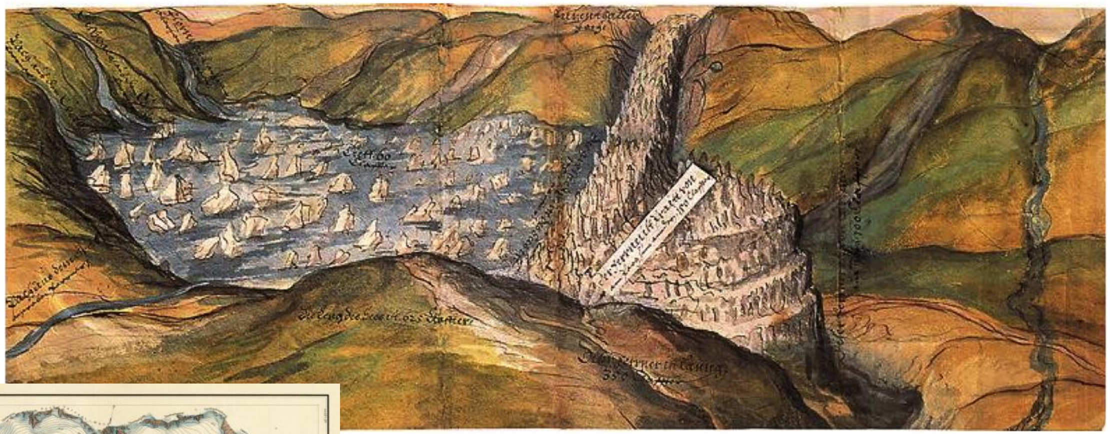
- Ötztal Alps, 1.890 to 3.770 m a.s.l., 98.1 km^2
- Joint effort of several institutions and many people, monitoring since 1884
- Data collection available from the GFZ Data Services repository: https://doi.org/10.5880/fidgeo.2023.037

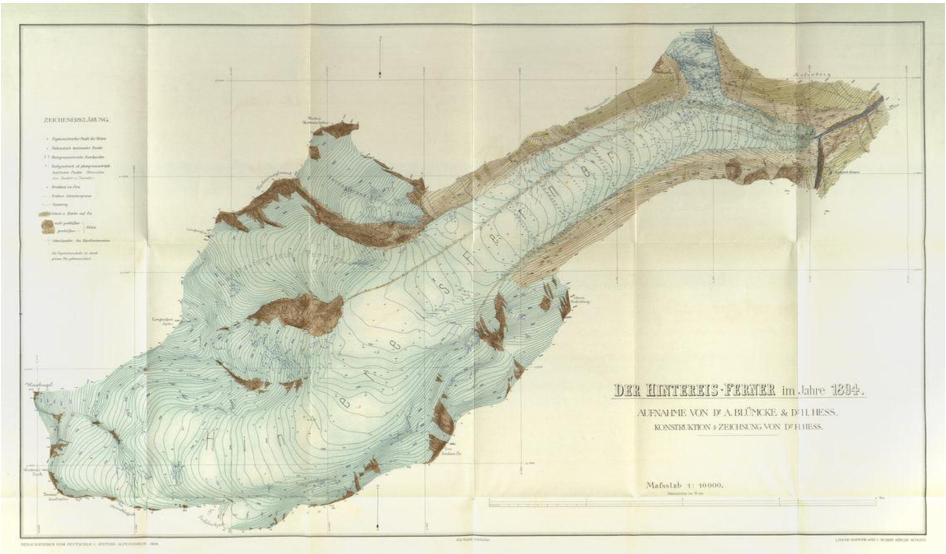


Part of international research initiatives:

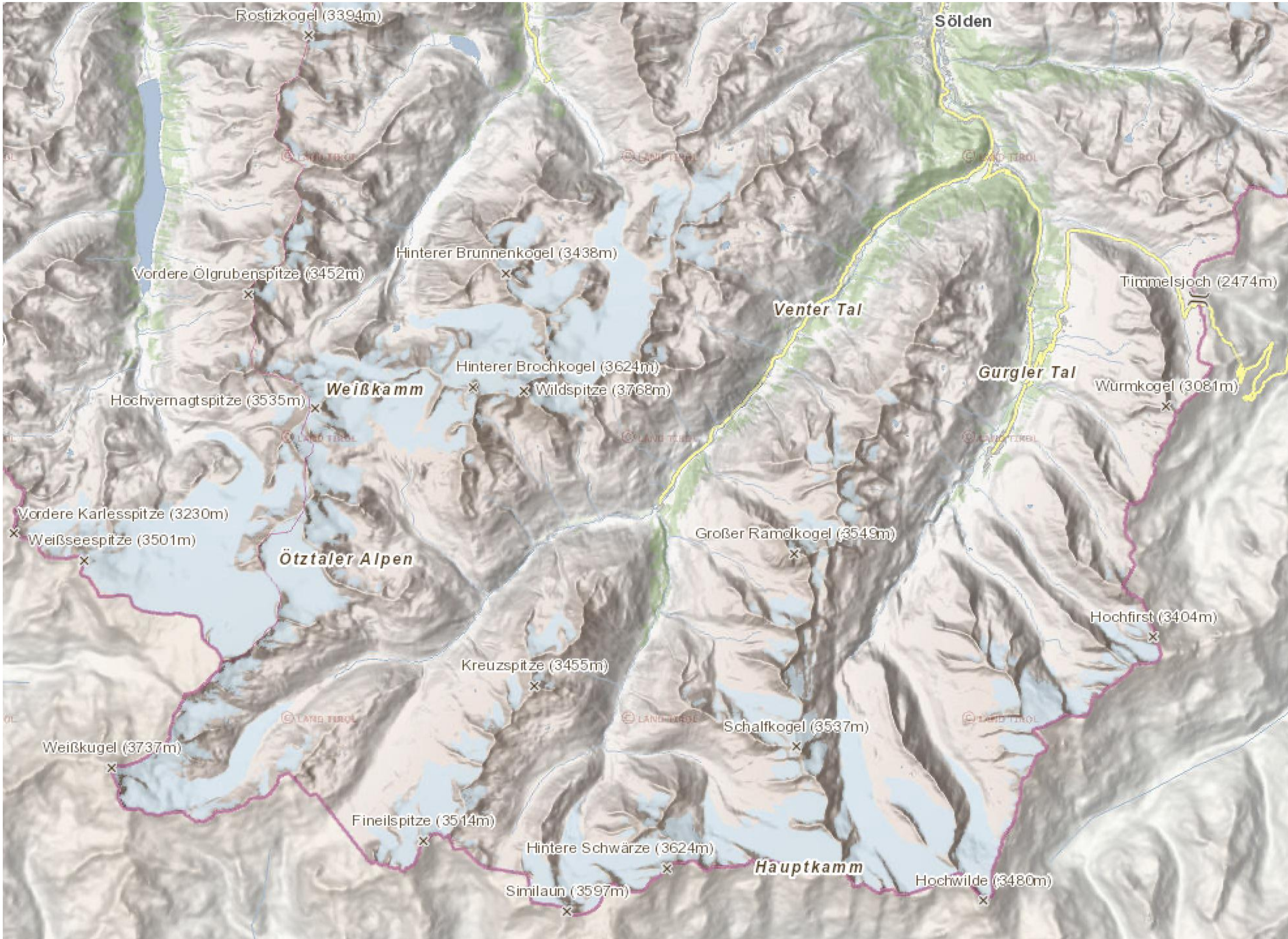
- GEWEX INARCH https://www.usask.ca/inarch/
- LTSER platform Tyrolean Alps within LTER Austria, LTER Europe and ILTER http://lter-austria.at/ta-tyrolean-alps
- ERB Euro-Mediterranean Network of Experimental and Representative Basins http://erb-network.simdif.com
- EU Horizon 2020 INTERACT research stations https://eu-interact.org/field-sites/station-hintereis/
- UNESCO IHP http://en.unesco.org/themes/water-security/hydrology

Research Basin Rofental





Hinterer Brochkogel (3624m)
Weißkamm
Wildspitze (3768m)
Hochvernagtspitze (3535m)
Großer Vernagtferner
Vent
Ötztaler Alpen
Gepatschferner
Kesselwandferner
Rofental
Kreuzspitze (3455m)
Weißkugel (3737m)
Hintereisferner
Hochjochferner
Fineilspitze (3514m)
Hintere Schwärze (3624m)
© LAND TIROL


Rostizkogel (3394m)
Sölden
Hinterer Brunnenkogel (3438m)
Vordere Ölgrubenspitze (3452m)
Timmelsjoch (2474m)
Venter Tal
Hinterer Brochkogel (3624m)
Gurgler Tal
Weißkamm
Wildspitze (3768m)
Würmkogel (3081m)
Hochvernagtspitze (3535m)
Vordere Karlesspitze (3230m)
Weißseespitze (3501m)
Großer Ramolkogel (3549m)
Ötztaler Alpen
Hochfirst (3404m)
Kreuzspitze (3455m)
Schalfkogel (3537m)
Weißkugel (3737m)
Fineilspitze (3514m)
Hintere Schwärze (3624m)
Hauptkamm
Hochwilde (3480m)
Similaun (3597m)

Rofental cooperation: Academy of Sciences, Munich

BAdW | BAYERISCHE AKADEMIE DER WISSENSCHAFTEN

Geodesy and Glaciology

- The project
- Research
- Work areas
- **Vernagtferner Digital**
  - Webcam
  - Weather data
  - Mass balance
  - Maps
  - Photo Gallery
- Young scientists
- History
- Advisory board
- Project committee
- Research staff
- Publications
- Medienspiegel

Vernagtferner Digital

Vernagtferner in September 2014

Geography

Country	Austria
State	Tyrol
Geographic coordinates	10°49' East, 46° 52' North

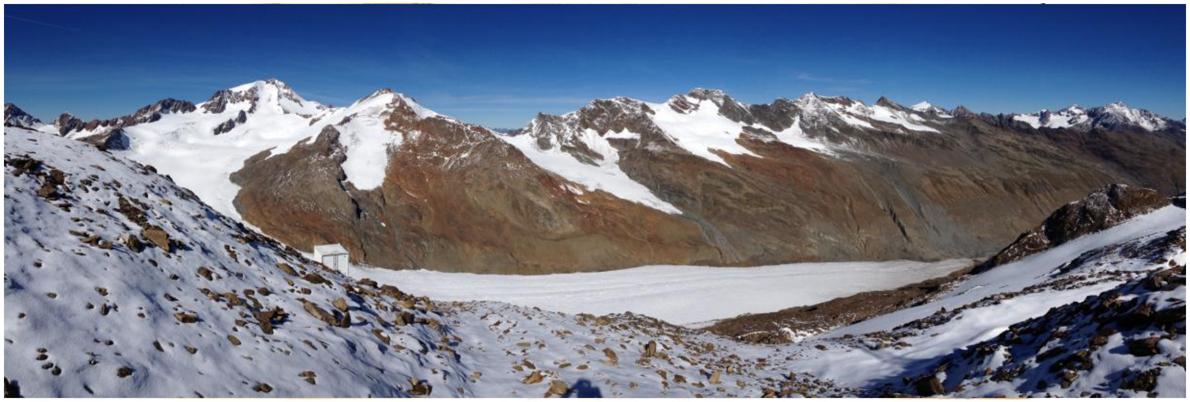
Rofental cooperation: ACINN, University of Innsbruck

EN Staff login Search Quicklinks

Studies Research Connect About us

Department of Atmospheric and Cryospheric Sciences (ACINN)

Hintereisferner – an Open Air Laboratory

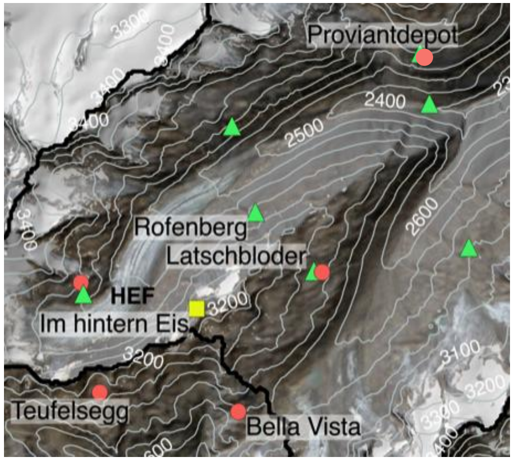


Hintereisferner (HEF) is a valley glacier located in the inner Ötztal Alps, Austria. It is the key research site for glaciological studies carried out at the Institute of Atmospheric and Cryospheric Sciences of the University of Innsbruck (ACINN) since many decades. In historical documents, the glacier is mentioned in 1601 for the first time, which is in the context of the formation of an ice dammed lake in front of the glacier (Figure 1).

Similar references date from 1678, 1774, 1770, and 1816. More systematic observations, mainly referring to length changes, began in 1847 and the first regional maps were produced in 1870 and 1888. The first detailed map of HEF dates from 1894, followed by a long series of maps from terrestrial surveys (Figure 2) and since 2001 upgraded by one or two airborne LIDAR surveys per year for geodetic determination of ice volume changes (Figure 3).

- ACINN
- News and Events
- Research
  - Atmospheric Dynamics
  - Atmos. Physics and Chemistry
  - Ice and Climate
  - Atmospheric Turbulence
- Studies
- People
- Graduate Seminar
- Papers and Books
- Theses
- Open Research Data

Rofental cooperation: Geography, University of Innsbruck



Meteorological data:

Temperature, humidity, wind speed and direction, air pressure, precipitation, radiative fluxes (short- and longwave, up and down)

Snow data:

- Bella Vista (2805 m a.s.l.)

  Pair of snow pillow/scale with ultrasonic snow depth, snow temperature profile, acoustic snow drift

- Latschbloder (2919 m a.s.l.)

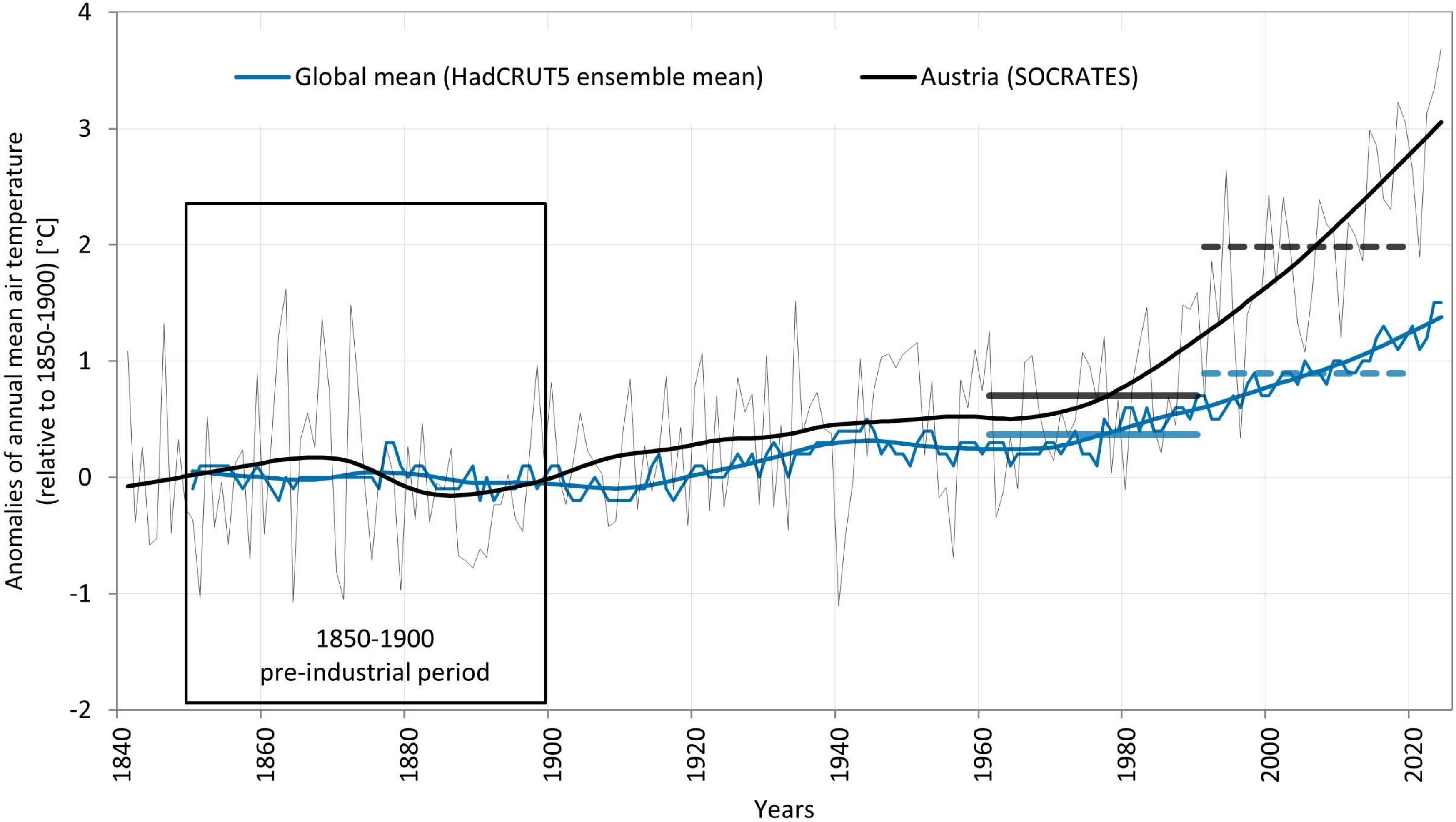
  Ultrasonic snow depth, snow temperature profile

- Proviantdepot (2737 m a.s.l.)

  Surface temperature, snow depth, snow water equivalent, layered density and liquid water content (snow pack analyzer), snow temperature profile

Rofental cooperation: Hydrographic Service of Tyrol

Entwicklung der mittleren Jahrestemperatur weltweit 1850–2024 (blau) und in Österreich 1841–2024 (schwarz). Dargestellt sind jährliche Abweichungen vom Mittel der Jahre 1850-1900 (dünne Linien) und deren geglättete Trends (42Jahre LOESS-Filter) (Formayer et al., 2025, Morice u.a. 2021).



https://klimaportal.geosphere.at/informationsportal-klimawandel/neoklim_lufttemperatur.html

Research Basin Rofental

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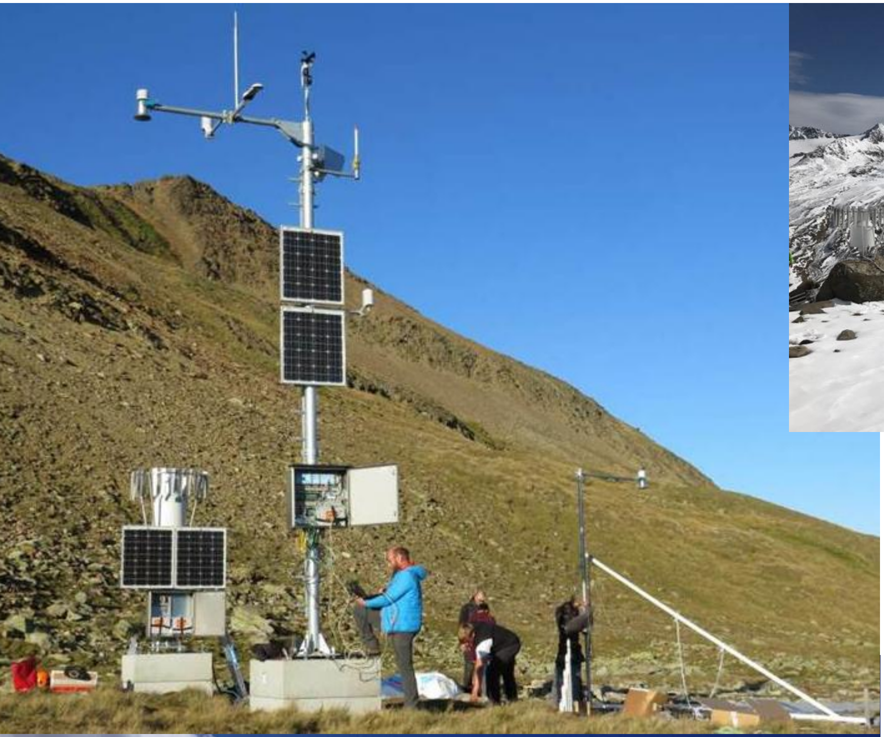


Earth Syst. Sci. Data, 10, 151–171, 2018
https://doi.org/10.5194/essd-10-151-2018

Open Access Earth System Science Data

The Rofental: a high Alpine research basin (1890–3770 m a.s.l.) in the Ötztal Alps (Austria) with over 150 years of hydrometeorological and glaciological observations

Ulrich Strasser[1], Thomas Marke[1], Ludwig Braun[3], Heidi Escher-Vetter[3], Irmgard Juen[2], Michael Kuhn[2], Fabien Maussion[2], Christoph Mayer[3], Lindsey Nicholson[2], Klaus Niedertscheider[4], Rudolf Sailer[1], Johann Stötter[1], Markus Weber[5], and Georg Kaser[2]

[1]Department of Geography, University of Innsbruck, Innsbruck, 6020, Austria
[2]Department of Atmospheric and Cryospheric Sciences, University of Innsbruck, Innsbruck, 6020, Austria
[3]Geodesy and Glaciology, Bavarian Academy of Sciences and Humanities, Munich, 80539, Germany
[4]Hydrographic Service of Tyrol, Innsbruck, 6020, Austria
[5]Photogrammetry and Remote Sensing, Technical University of Munich, Munich, 80333, Germany

Correspondence: Ulrich Strasser (ulrich.strasser@uibk.ac.at)

Received: 3 August 2017 – Discussion started: 21 August 2017
Revised: 26 November 2017 – Accepted: 18 December 2017 – Published: 24 January 2018

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Earth Syst. Sci. Data, 16, 3579–3599, 2024
https://doi.org/10.5194/essd-16-3579-2024

Open Access Earth System Science Data

Operational and experimental snow observation systems in the upper Rofental: data from 2017 to 2023

Michael Warscher, Thomas Marke, Erwin Rottler, and Ulrich Strasser

Department of Geography, University of Innsbruck, 6020 Innsbruck, Austria

Correspondence: Michael Warscher (michael.warscher@uibk.ac.at)

Received: 5 February 2024 – Discussion started: 20 February 2024
Revised: 13 June 2024 – Accepted: 26 June 2024 – Published: 12 August 2024

Abstract. This publication presents a comprehensive hydrometeorological data set for three research sites in the upper Rofental (1891–3772 m a.s.l., Ötztal Alps, Austria) and is a companion publication to a data collection published in 2018. The time series presented here comprise data from 2017 to 2023 and originate from three meteorological and snow hydrological stations at 2737, 2805, and 2919 m a.s.l. The fully equipped automatic weather stations include a specific set of sensors to continuously record snow cover properties. These are automatic measurements of snow depth, snow water equivalent, volumetric solid and liquid water contents, snow density, layered snow temperature profiles, and snow surface temperature. One station is extended by a particular arrangement of two snow depth and water equivalent recording devices to observe and quantify wind-driven snow transport. These devices are installed at nearby wind-exposed and sheltered locations and are complemented by an acoustic-based snow drift sensor. We present data for temperature, precipitation, humidity, wind speed, and radiation fluxes and explore the continuous snow measurements by combined analyses of meteorological and snow data to show typical seasonal snow cover characteristics. The potential of the snow drift observations is demonstrated with examples of measured wind speeds, snow drift rates, and redistributed snow amounts during several blowing snow events. The data complement the scientific monitoring infrastructure in the research catchment and represent a unique time series of high-altitude mountain weather and snow observations. They enable comprehensive insights into the dynamics of high-altitude meteorological and snow processes and are collected to support the scientific community, local stakeholders, and the interested public, as well as operational warning and forecasting services. The data are publicly available from the GFZ Data Services repository: https://doi.org/10.5880/fidgeo.2023.037 (Department of Geography, University of Innsbruck, 2024).

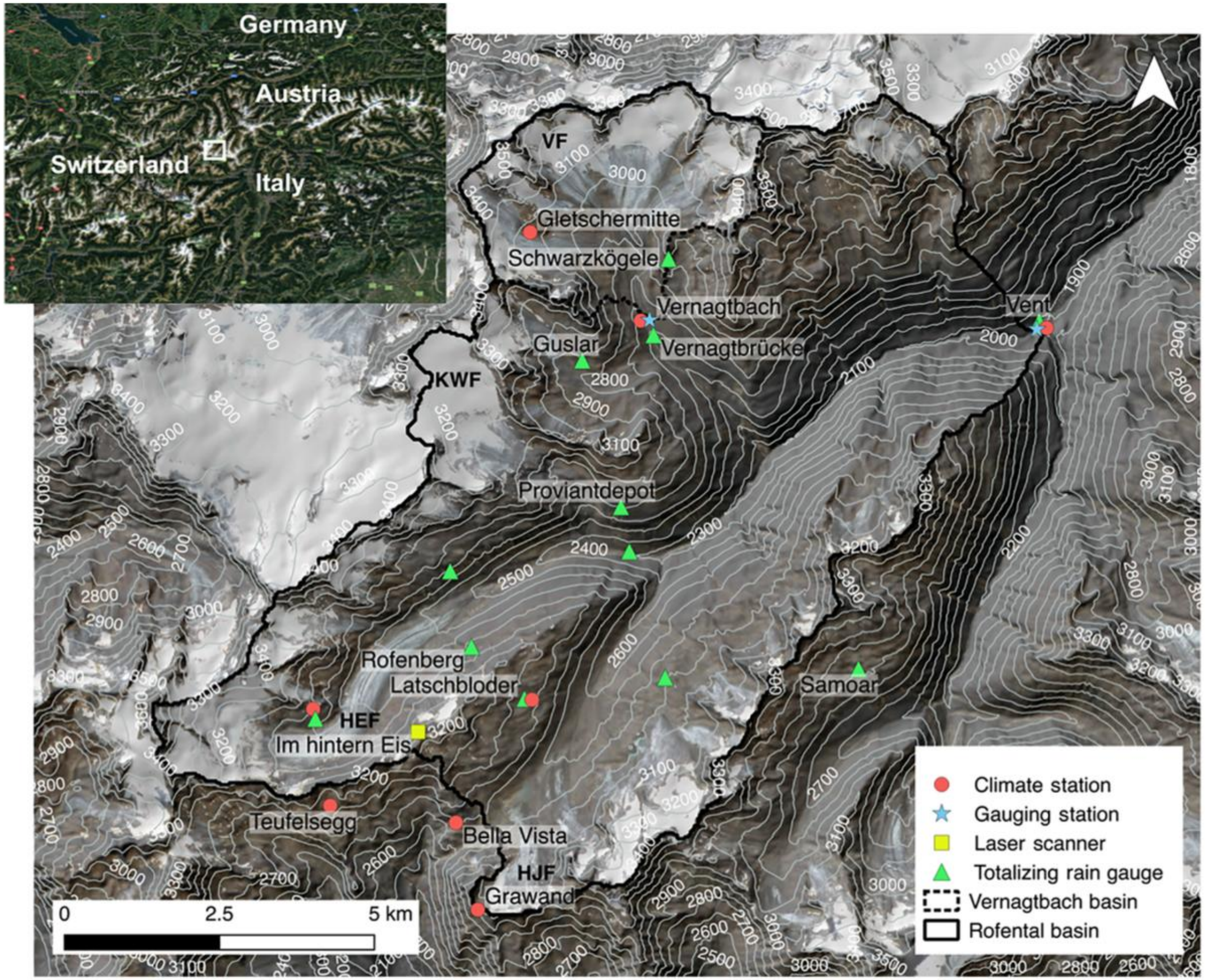

Figure 4. The Rofenache (98.1 km^2) and Vernagtbach (11.44 km^2) catchments with permanent meteorological stations and the runoff gauges. Background satellite image of the top left inset from maps.google.com, copyrights by Google (2009) and TerraMetrics (2017).

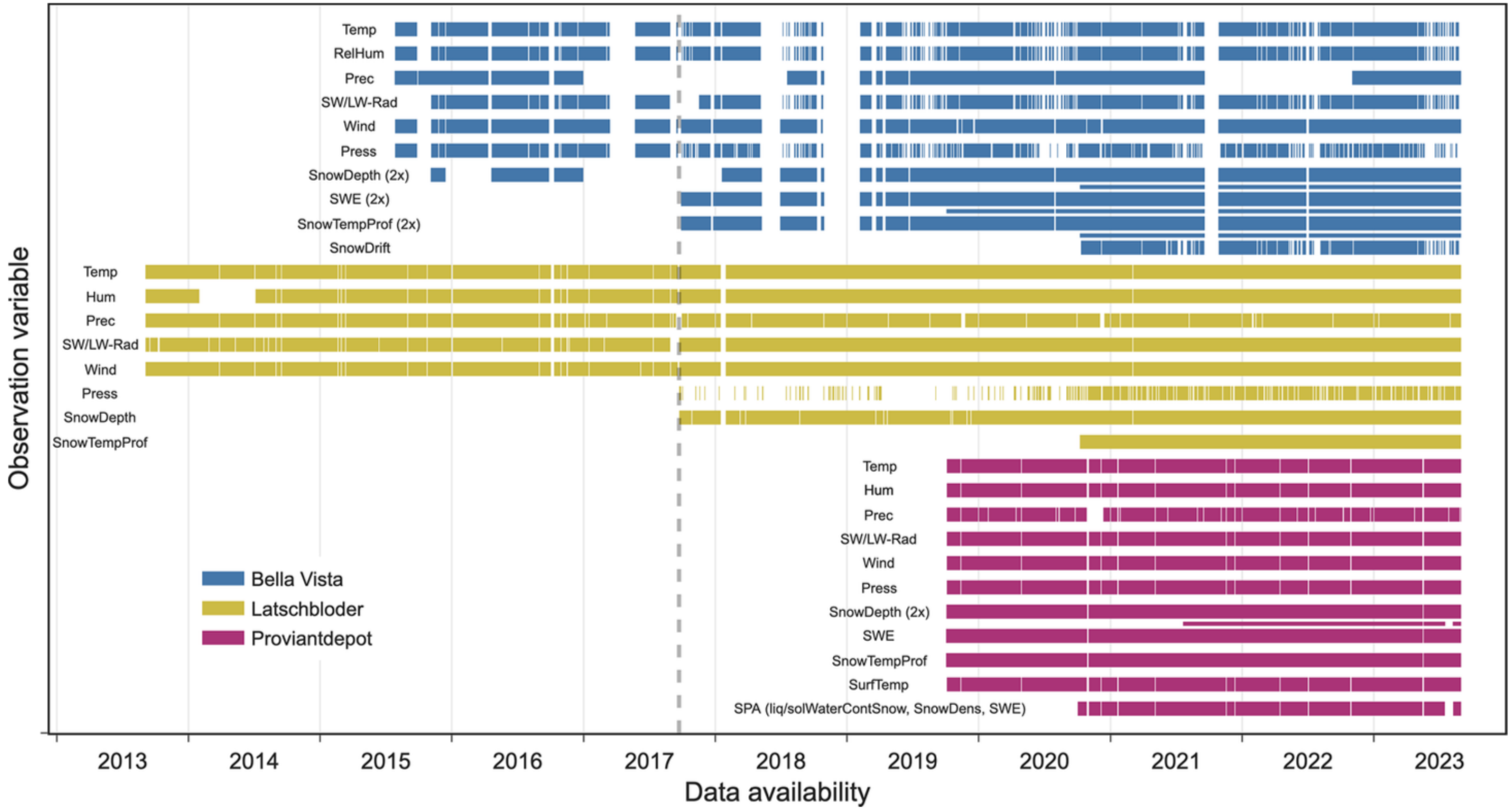

Figure 4. Data availability for the three AWSSs at Bella Vista, Latschbloder, and Proviantdepot for all measured variables from 2013 to 2023. Some variables are recorded with two different sensors at the same location. These are indicated by "(2×)", and the narrow bars show the data availability for the second sensor. The dashed vertical line highlights the beginning of the data period presented here (September 2017). The plot is based on daily aggregations of the data. If one 10 min value is missing on a specific day, the entire day is classified as missing data in this figure. The frequent short gaps in atmospheric pressure readings at the Bella Vista and Latschbloder sites are caused by frequent single 10 min data points missing (unidentified malfunction of the logger). The large data gaps at the Bella Vista station were caused by recurring lightning damage.

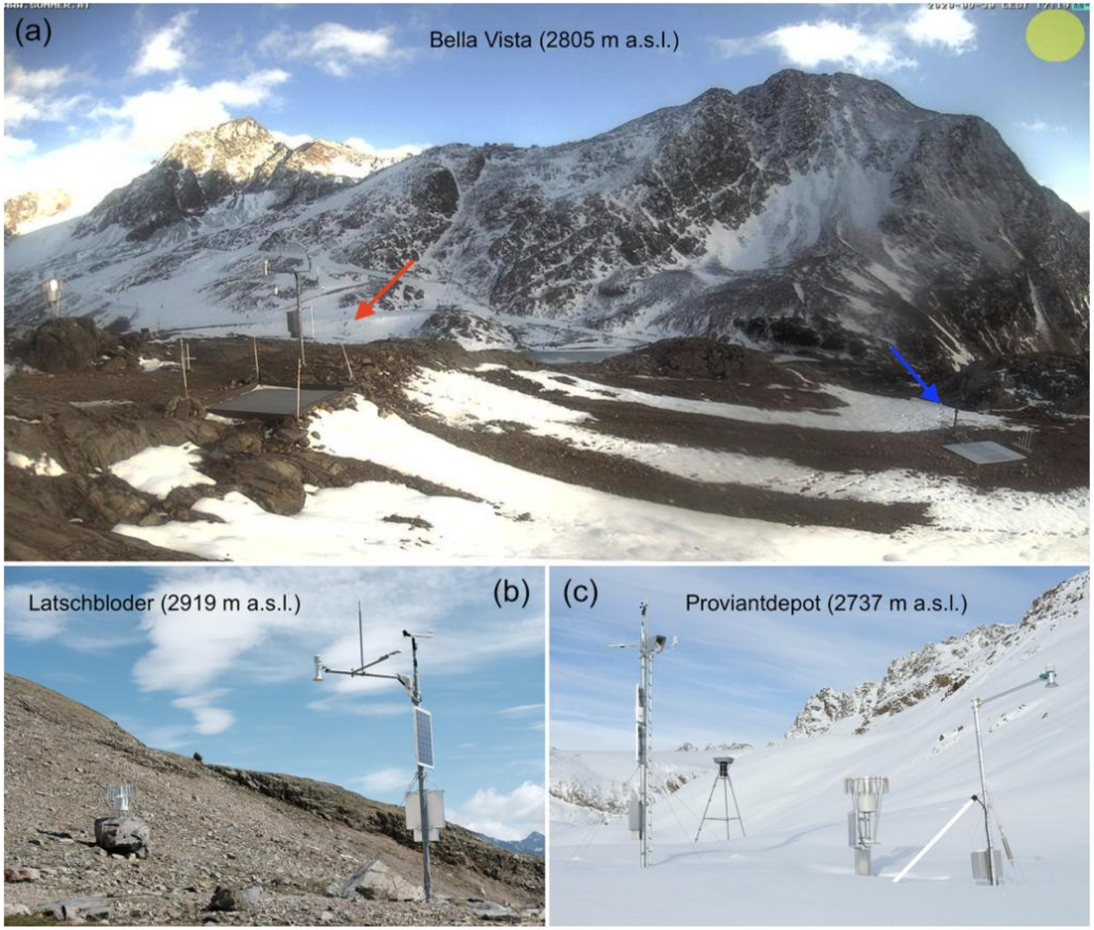

Figure 2. **(a)** Webcam image from the Bella Vista station (2805 m a.s.l.). The red arrow marks the main "exposed" AWSS. The blue arrow marks the additional snow measurements (HS, SWE, and snow temperatures) in the slight depression ("sheltered" location). **(b)** The Latschbloder AWSS (2919 m a.s.l.) with an OTT pluviometer on the left. **(c)** The Proviantdepot AWSS (2737 m a.s.l.). The ultrasonic snow depth sensor on the right instrument is part of the snowpack analyzer (SPA). The snow scale is buried right in front of the photographer beside the SPA. There is a second snow depth sensor at the main mast (not visible from this angle). Behind the main mast the old totalizing rain gauge can be seen, and in the background the Kesselwandferner can be seen (left, behind the main mast).

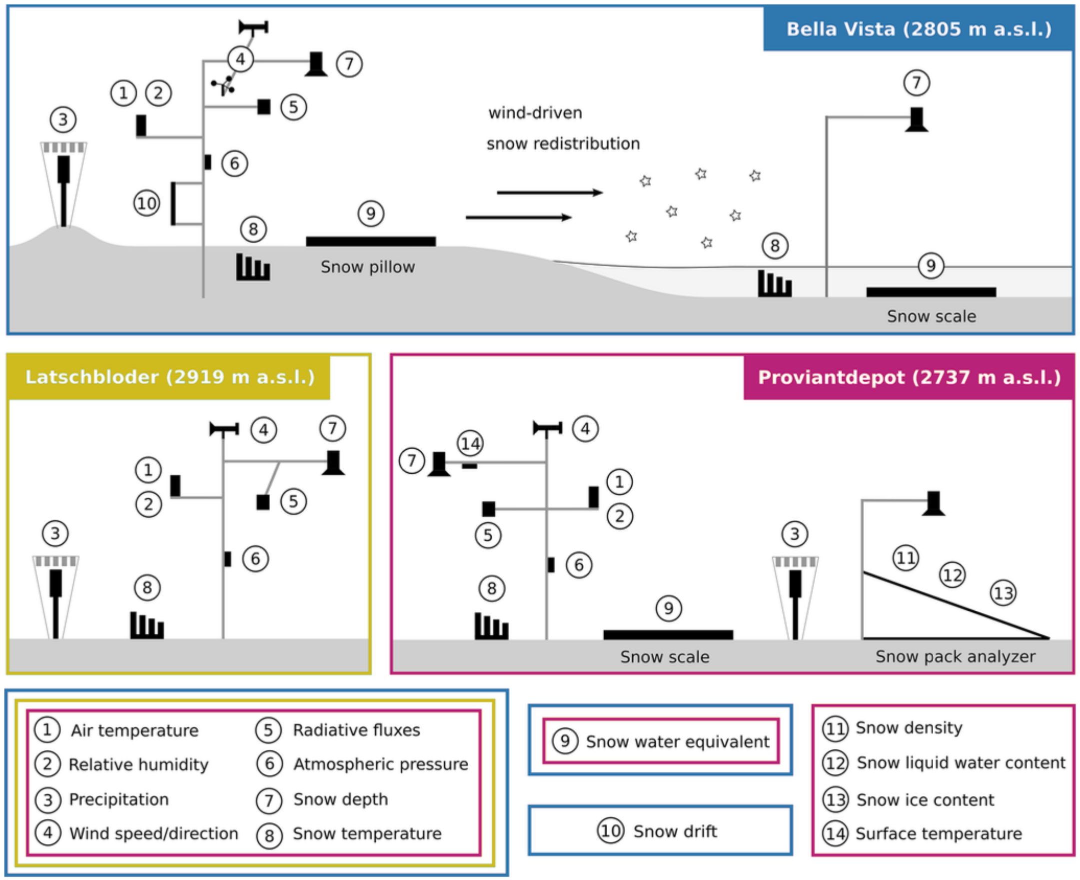

Figure 3. Schematic overview of the three AWSSs at Bella Vista, Latschbloder, and Proviantdepot. The color-coded boxes around the numbered variables show the respective equipment installed at each station. The relative arrangement between the instruments in the scheme does not correspond exactly to reality for display reasons.

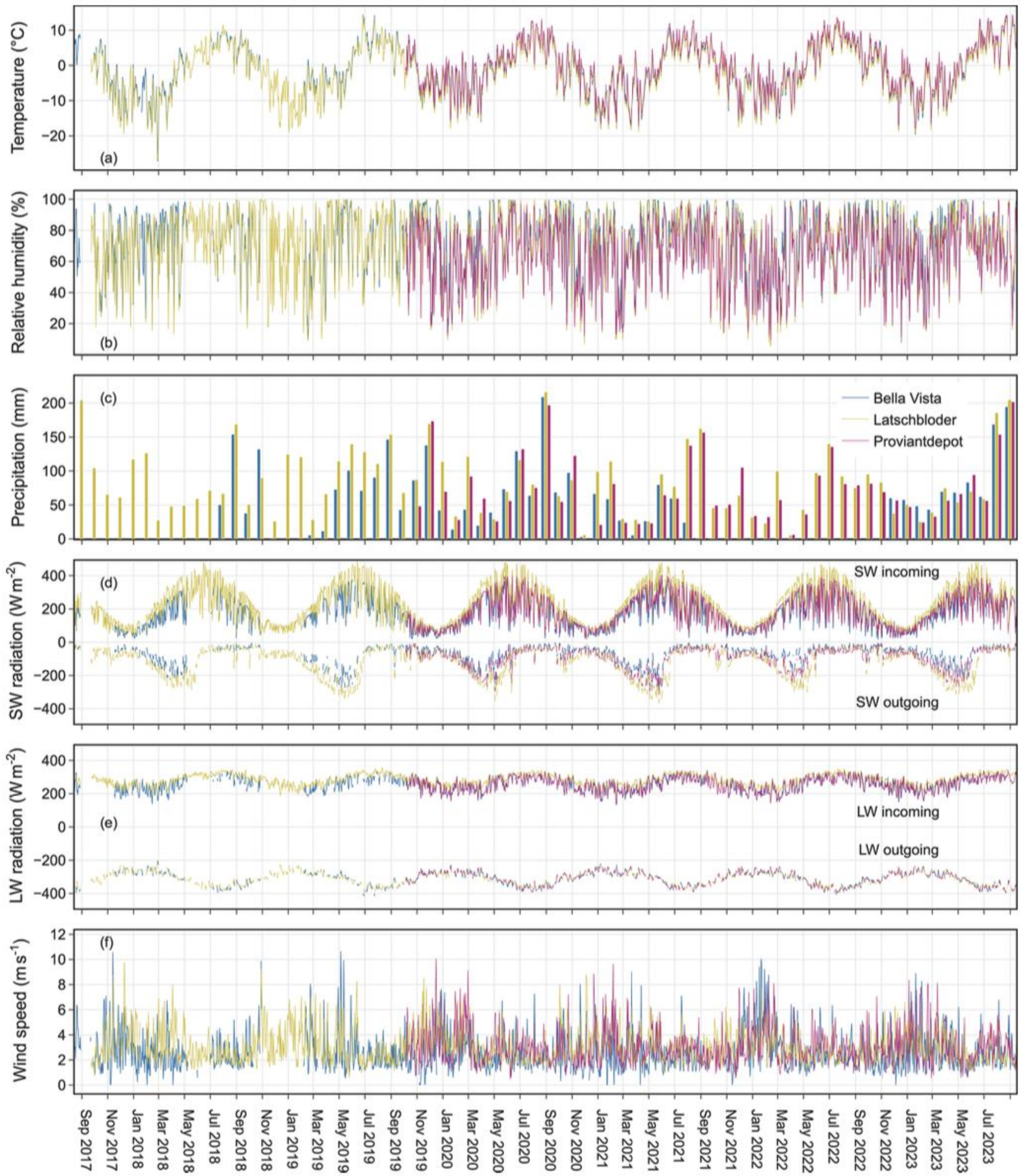

Figure 5. Main meteorological variables (daily averages) at the three stations of Bella Vista, Latschbloder, and Proviantdepot (September 2017 to August 2023). Air temperature **(a)**, relative humidity **(b)**, precipitation **(c)** (monthly totals), shortwave radiation **(d)**, longwave radiation **(e)**, and wind speed **(f)**.

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Geosci. Model Dev., 17, 6775–6797, 2024
https://doi.org/10.5194/gmd-17-6775-2024

Geoscientific Model Development
Open Access

Model description paper

openAMUNDSEN v1.0: an open-source snow-hydrological model for mountain regions

Ulrich Strasser[1], **Michael Warscher**[1], **Erwin Rottler**[1], **and Florian Hanzer**[1,2]

[1]Department of Geography, University of Innsbruck, Innrain 52, 6020 Innsbruck, Austria
[2]lumiosys GmbH, Innrain 52, 6020 Innsbruck, Austria

Correspondence: Ulrich Strasser (ulrich.strasser@uibk.ac.at)

Received: 21 January 2024 – Discussion started: 13 March 2024
Revised: 17 June 2024 – Accepted: 20 July 2024 – Published: 12 September 2024

Abstract. openAMUNDSEN (the open source version of the Alpine MUltiscale Numerical Distributed Simulation ENgine) is a fully distributed snow-hydrological model, designed primarily for calculating the seasonal evolution of snow cover and melt rates in mountain regions. It resolves

1 Introduction

The seasonal evolution of the mountain snow cover has a significant impact on the water regime, the microclimate,

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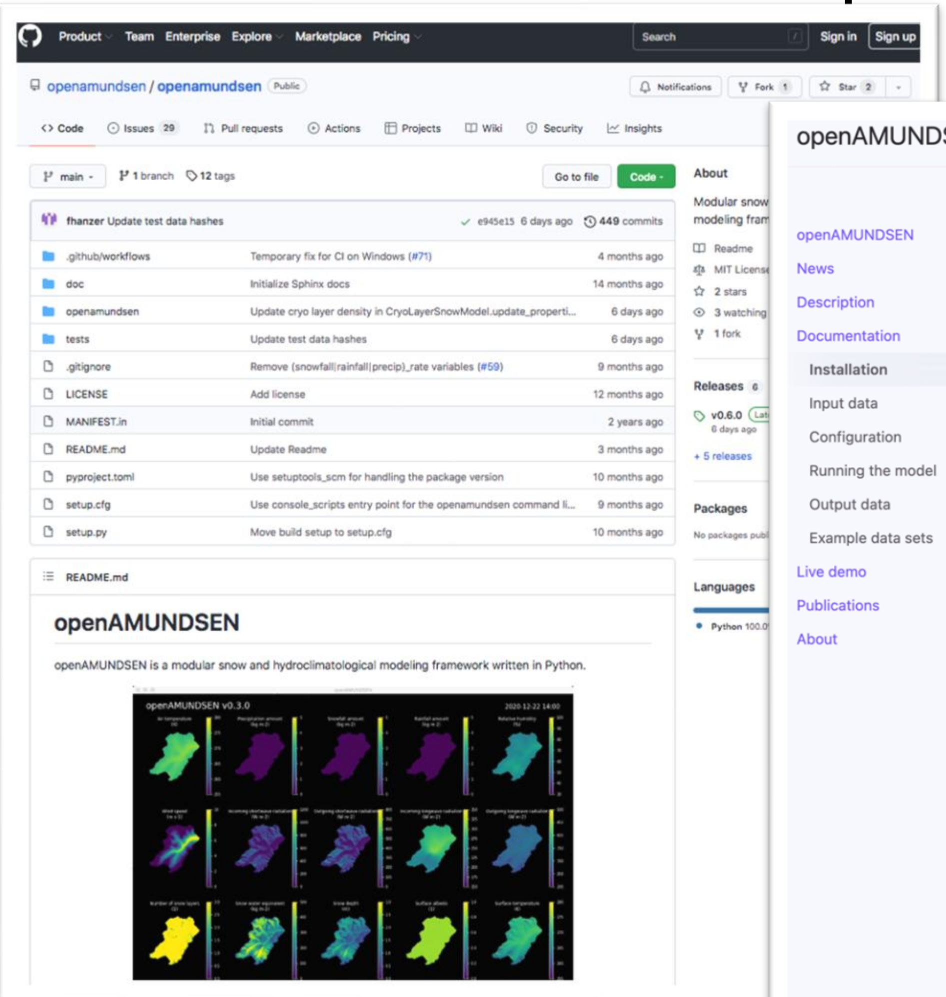
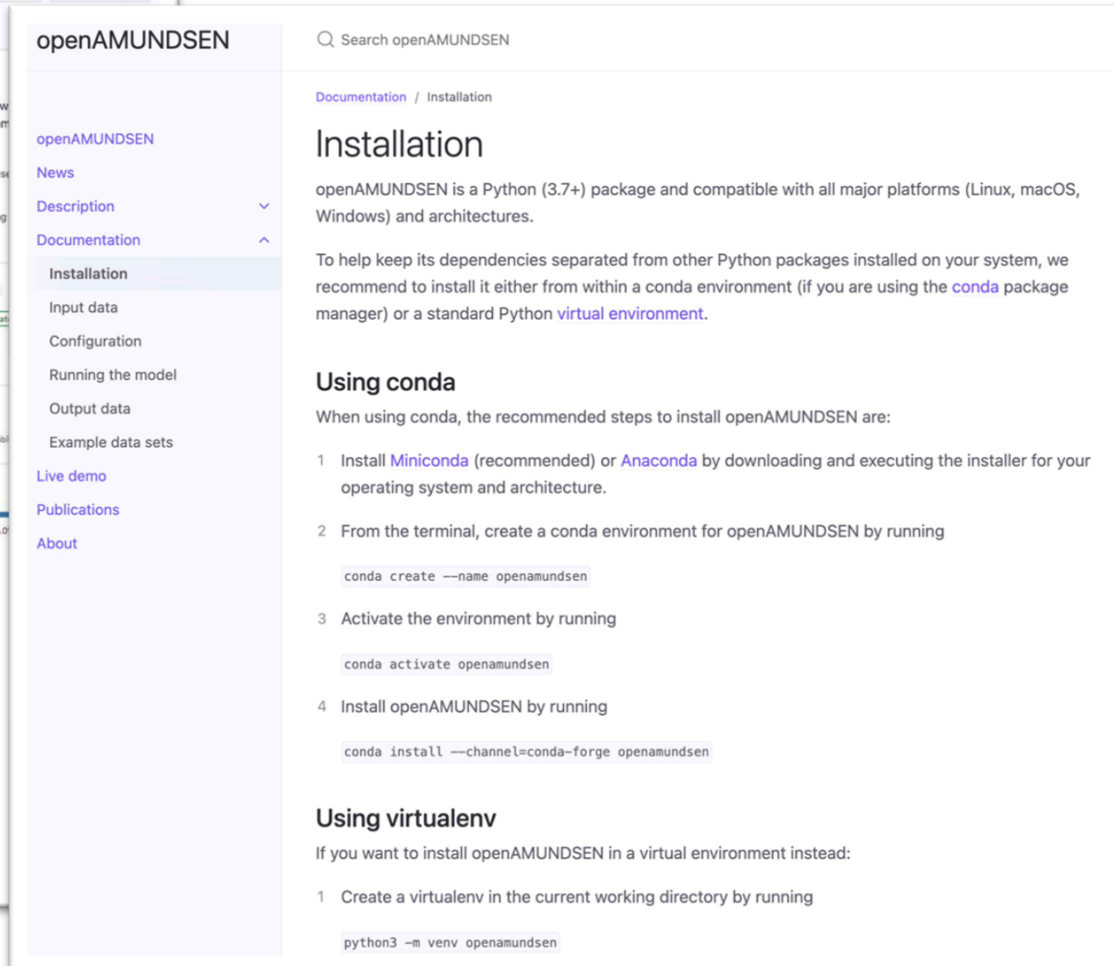
Model: openAMUNDSEN





https://github.com/openamundsen/

https://doc.openamundsen.org/

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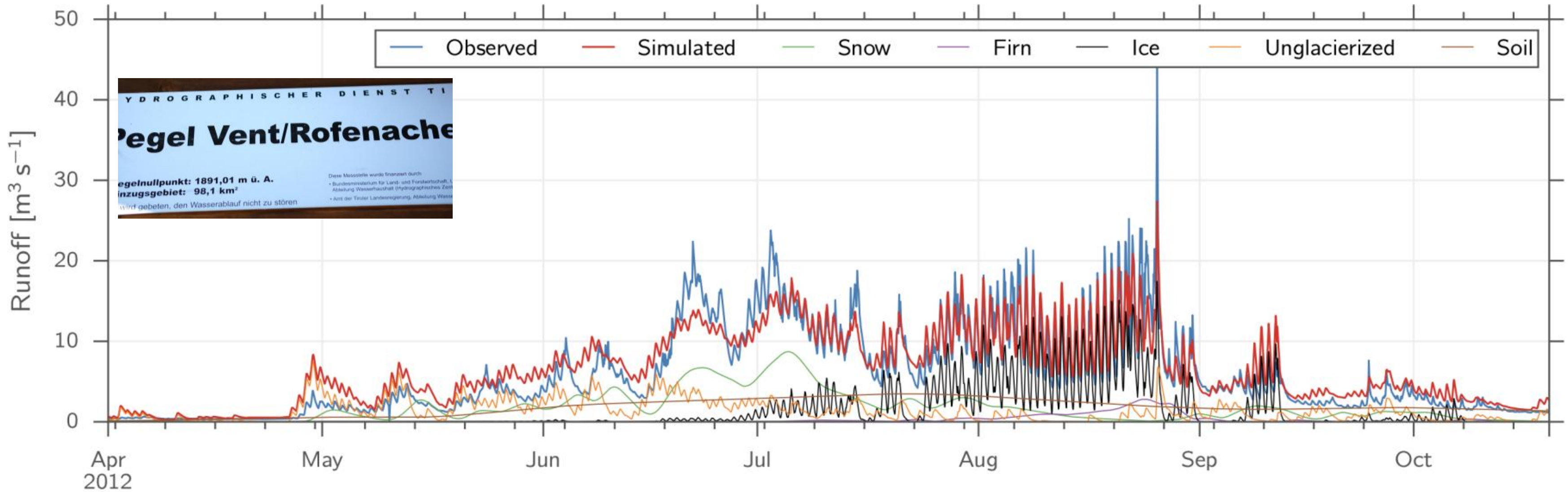
Model: openAMUNDSEN



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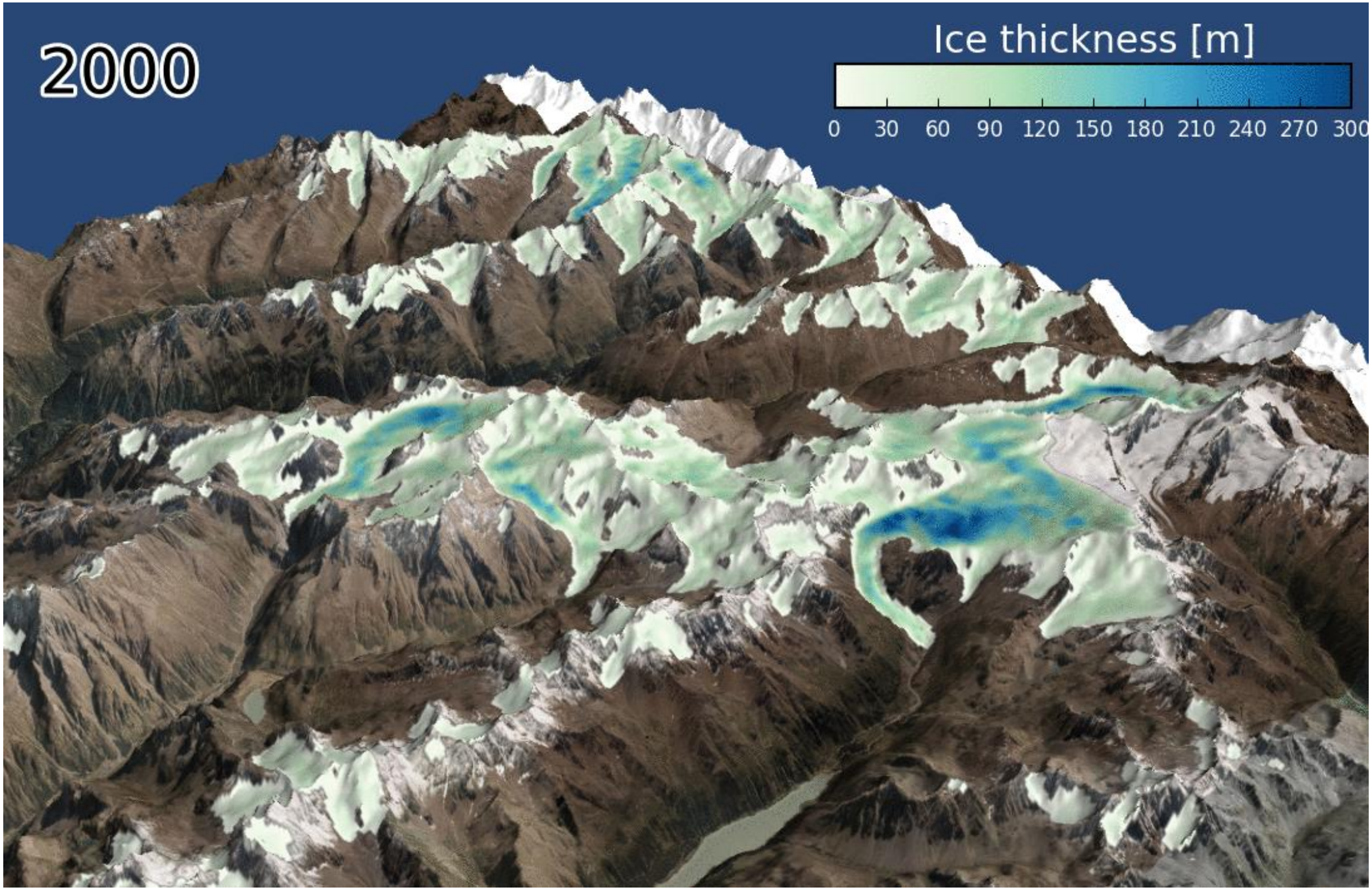

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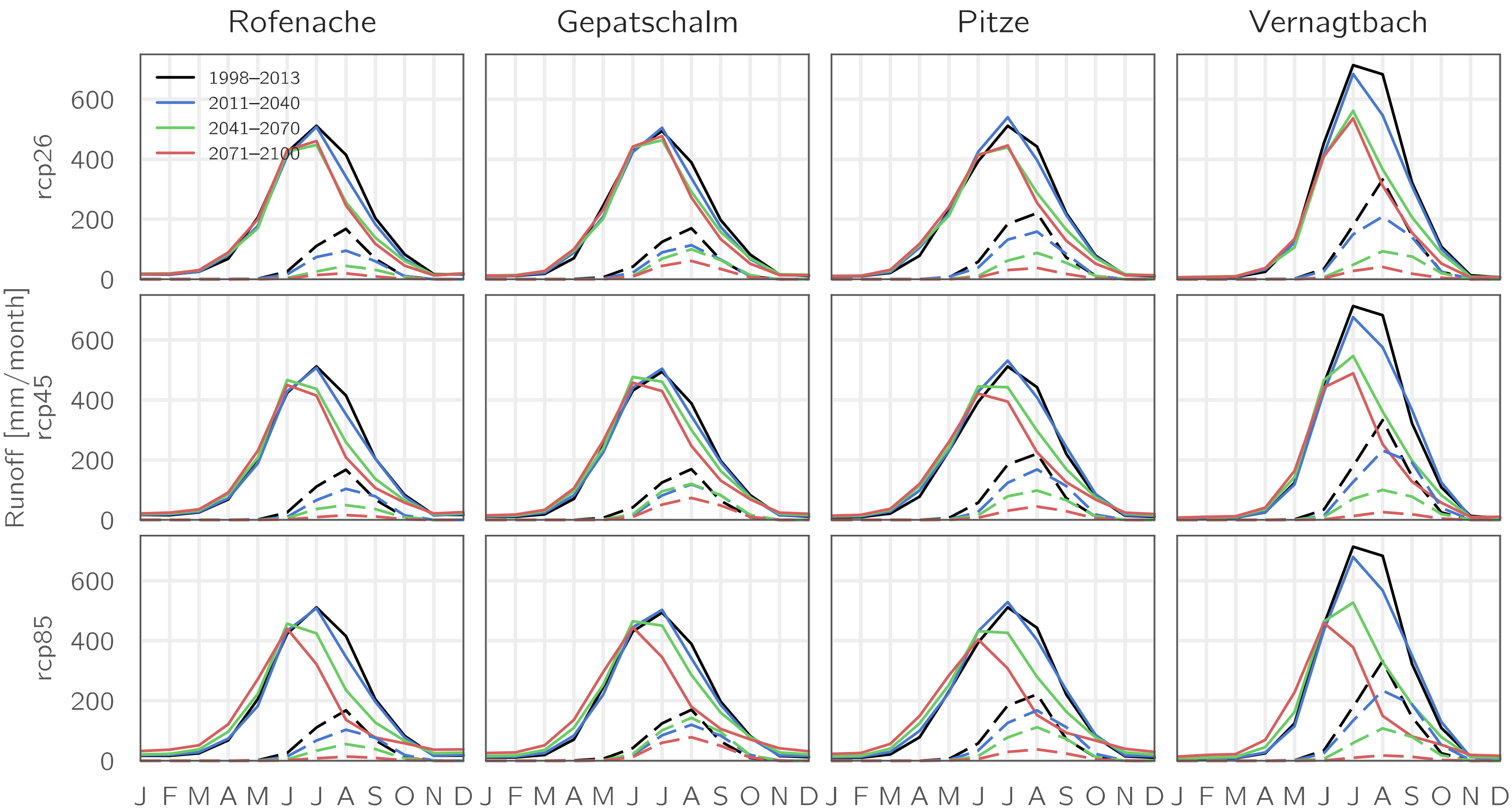
Hydrol. Earth Syst. Sci., 22, 1593–1614, 2018
https://doi.org/10.5194/hess-22-1593-2018

Hydrology and Earth System Sciences
Open Access
EGU

Projected cryospheric and hydrological impacts of 21st century climate change in the Ötztal Alps (Austria) simulated using a physically based approach

Florian Hanzer[1,2], Kristian Förster[1,3], Johanna Nemec[4], and Ulrich Strasser[1]
[1]Department of Geography, University of Innsbruck, Innsbruck, Austria
[2]Wegener Center for Climate and Global Change, University of Graz, Graz, Austria
[3]Institute of Hydrology and Water Resources Management, Leibniz Universität Hannover, Hannover, Germany
[4]ENVEO IT GmbH, Innsbruck, Austria



Average monthly runoff (multi-model mean ±1 SD indicated as shaded bands) as simulated for the early, middle, and late 21st century for four catchments/gauges and the three emission scenarios. Dashed lines indicate bare ice melt runoff. From Hanzer et al. (2018).

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2024 | Revised: 16 August 2024 | Accepted: 23 August 2024
15279

WILEY

H ARTICLE

o-temporal wet snow dynamics from model simulations remote sensing: A case study from the Rofental, Austria

in Rottler | Michael Warscher | Florian Hanzer | Ulrich Strasser

epartment of Geography, University of nsbruck, Innsbruck, Austria

Correspondence
Erwin Rottler, Department of Geography, University of Innsbruck, Innrain 52f, Innsbruck, Austria.
Email: erwin.rottler@uibk.ac.at

Funding information
ESA EXPRO+ AlpSnow - Alps Regional Initiative project, ESA Contract No. 4000132770/20/I-NB

Abstract
The formation and concentration of liquid water (LW) in the snowpack constitute processes linking snow and runoff. Hence, the LW content of the snowpack sents a crucial target variable to investigate for snowmelt-induced runoff pre y, we capture the wet snow dynamics at higher than hectome water catchment Rofental, Tyrol, Austria (98.1 km d remote sensing data for the 5 ye ducted using the int

Hydrol. Earth Syst. Sci., 22, 1593–1614, 2018
https://doi.org/10.5194/hess-22-1593-2018

Hydrolo Earth S Sci

Projected cryospheric and hydrological impacts of 21st century climate change in the Ötztal Alps (Austria) simulated using a physically based approach

Florian Hanzer[1,2], Kristian Förster[1,3], Johanna Nemec[4], and Ulrich Strasser[1]
[1]Department of Geography, University of Innsbruck, Innsbruck, Austria
[2]Wegener Center for Climate and Global Change, University
[3]Institute of Hydrology and Water Resourc
[4]ENVEO IT GmbH, Innsb
az, Austria
ersität Hannover, Hannover, Germa

h 2018

enario, whereas runoff volumes dec
l) and 47 % (summer) towards the
–2100), accompanied by a shift in
ards June.

The Cryosphere, 10, 1859–1881, 2016
www.the-cryosphere.net/10/1859/2016/
doi:10.5194/tc-10-1859-2016

The Cryosphere Open Access EGU

Multilevel spatiotemporal validation of snow/ice mass balance and runoff modeling in glacierized catchments

Florian Hanzer[1,2], Kay Helfricht[3], Thomas Marke[2], and Ulrich Strasser[2]

[1]alpS – Centre for Climate Change Adaptation, Innsbruck, Austria
[2]Institute of Geography, University of Innsbruck, Innsbruck, Austria
[3]Institute for Interdisciplinary Mountain Research, Austrian Academy of Sciences, Innsbruck, Austria

Correspondence to: Florian Hanzer (florian.hanzer@uibk.ac.at)

Received: 2 March 2016 – Published in The Cryosphere Discuss.: 5 April 2016
Revised: 13 July 2016 – Accepted: 7 August 2016 – Published: 25 August 2016

Abstract. In this study, the fully distributed, physically based

1 Introduction

Research Basin Rofental – new projects

Sub-seasonal and seasonal prediction of snow cover dynamics in complex mountain terrain: integrating snow simulations with weather forecasts and satellite-based snow data
(*Fram3S*)

TABLE OF CONTENTS

UNIVERSITY OF SASKATCHEWAN
Global Water Futures
GWF.USASK.CA

GWF

National Hydrology Research Centre
11 Innovation Boulevard
Saskatoon SK S7N 3H5 Canada
Tel: (306) 966-1427
Email: gwf.project@usask.ca

21 May 2024

Austrian Science Fund FWF

RE: Letter of Cooperation for the project "Sub-seasonal to seasonal prediction of snow cover dynamics in complex mountain terrain: integrating snow simulations with weather forecas' and satellite-based snow data (Fram3S)", submitted to the Austrian Science Fund FWF by consortium of researchers from the University of Innsbruck (Tyrol, Austria), the Europe Research Academy EURAC (South Tyrol, Italy) and the University of Trento (Trentino the EUREGIO Science Fund.

Dear FWF Evaluation Committee,

I confirm the interest of The International Network for Alpine Research Catchr (INARCH), a cross-cut project of the GEWEX Hydroclimatology Panel (World Programme), in the project Fram3S submitted to FWF by Professor Ulrich Innsbruck, Austria) as PI of the above listed consortium. INARCH is supr Water Futures programme – a research consortium of Canadian univ investigators. Fram3S proposes to develop an integrated modelling dynamics of the snow cover for the mountainous region of the E Trentino. Therefore, state-of-the-art statistical, physical and da approaches will be combined, applied and evaluated, and the res assessed for different lead times and spatial resolutions. The main res long in advance a spatially distributed snow model can predict the dynamic snow cover – this being of high scientific interest and well fitting into the INARC program.

ÖAW ÖSTERREICHISCHE AKADEMIE DER WISSENSCHAFTEN

INTERNATIONALE BEZIEHUNGEN & NACHWUCHS- UND FORSCHU
FORSCHUNGSFÖRDERUNG – NATIONALE UND INTERNATIONALE

FUNDING APPLICATION FOR A RESEARCH PROJECT WITHIN THE AUSTRIAN ACADEM SCIENCES "EARTH SYSTEM SCIENCES PROGRAM" - CALL 2024 CHANGING ALPS – MULTIPLE CONFLICTS BETWEEN PRODUCTION, PROTECTION, AND RESTORATION

PROJECT TITLE:
WATER AVAILABILITY AND USE IN A DEGLACIATED ÖTZTAL: A CO-CREATIVE DEVELOPMENT OF A COMMON VISION FOR THE FUTURE

RUNNING TITLE/ACRONYM:
COWAVIS

PRINCIPLE INVESTIGATORS – PI – MAXIMUM OF THREE PERSONS

1. **RESPONSIBLE PI (NAME, INSTITUTION, ORCID, AREA OF EXPERTISE, EMAIL)**
   DR. JUTTA KISTER, UNIVERSITY OF INNSBRUCK, HTTPS://ORCID.ORG/0000-0001-9022-9092, SOCIAL-ECOLOGICAL TRANSFORMATIONS
2. **PI (NAME, INSTITUTION, ORCID, AREA OF EXPERTISE)**
   DR. ERWIN ROTTLER, UNIVERSITY OF INNSBRUCK, HTTPS://ORCID.ORG/0000-0003-3072-2189, ALPINE HYDROCLIMATOLOGY

thank you!

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Hohe Mut (2670 m)