**Integrating Activities for Advanced Communities**

# D2.9 - Repository with selected climate data from INTERACT stations integrated in INTERACT GIS

Project No.871120– INTERACT

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## Publishable Executive Summary

The development and integration of a repository for selected climate variables into INTERACT GIS was discussed among INTERACT station managers. Station managers recommended to focus on a few key variables (temperature and precipitation) and that this should preferably be built on an existing data mechanism that would allow for easy updates in the future. The system developed is based on downscaling of the Copernicus' Application Programming Interface (API) and a Python script that can collect new and updated data for existing and new INTERACT stations. Data is shown graphically for each station covering WMO climate normal from 1961-1990 and 1991-2020, on which data from individual years are shown for comparison with historic data. The update of data is made automatically and the system is thus continuously updated with new data.


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# 1. Development of the repository

## *1.1.Aims*

Research stations are critical for observing, understanding, and responding to Arctic changes. Task 2.3 of INTERACT III focuses on making station data and publications widely available to improve the services offered to the scientific community and enhance robust assessments of climate and ecosystem change. This task will contribute to the further development of INTERACT GIS, providing graphical display of selected climate data helping scientists to identify relevant stations for their research in combination with filtering functions embedded in the system.

**Aims set out in the project description:**

Task 2.3 "Making Station Data and Publications Widely Available" aims to ensure that all forms of data, both historic and near-real-time, from research stations are captured and made widely available. This task addresses objectives (i) and (iii) by contributing to INTERACT's Societal Challenges 3 and WP6.

Subtask 2.3.2 will provide open access to selected scientific data by establishing an INTERACT repository for key climate related parameters to be integrated in INTERACT GIS in cooperation with the Data Watch Guard (D2.9).

**Aims formulated by station managers:**

- Collect and store selected climate variables per station in the INTERACT GIS database.
- Utilize the WMO Climate Normal 30 years periods to illustrate climate change trends and extreme events at the stations (the periods are 1961-1990 and 1991-2020).
- Present visualizations to the users of INTERACT GIS, that gives insight in the recent four years climate at the stations and allows comparison with the WMO Climate Normal periods.

## *1.2.Development of a framework for the repository*

**Process**

The content and functionalities of the repository were discussed among INTERACT station managers at INTERACT Station Managers' Forum meetings in an iterative process allowing station managers to comment on initial development ideas. Technical solutions and visualisations were made in a collaboration between technical experts at Aarhus University and INTERACT GIS system operator Umeå University.

**Framework – recommendations from station managers**

The iterative process led to clear recommendations from the INTERACT station managers, who suggested to focus on a few key variables (temperature and precipitation) to build a robust system that potentially could be expanded with more variables in the future. Station managers also recommended that system should be built on an existing data mechanism that would allow for easy updates in the future, reducing the need for manual transfer of data. This would ensure that data from all stations would be included and


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prevent the need administrative resources for the task at the station level. Automatisation was recommended to ensure viability beyond the INTERACT project lifetime (end of 2024).

Station managers recommended that data was shown graphically for each station, reaching back as far as possible and with comparison of recent years against WMO climate normal.

# 2. System description

The INTERACT GIS database was extended with new tables to store the selected historical data – temperature and precipitation – for all INTERACT stations. Should new stations be added to the network, the system allows for easy integration of this climate variables repository element.

**Obtaining and visualising data**
Ideally data should be harvested from stations climate data repository, but it was clear early in the process that not all stations share data in a way that would allow the development of such solution. In principle it can with some manual work be possible for stations to deliver their own locally logged climate data to the database at some point but working individually with each station was deemed as too uncertain, complex and time consuming an approach in this first version.

Instead, we chose to provide default data extracted from a Copernicus global climate product: ERA5 monthly averaged data on single levels from 1940 to present. This ensures that we have unified and quality assured data available for all stations in the system. When presented to station managers, the responses have been positive and confirmed that the data is representative for recent years climate and climate change at the stations. Likewise, the calculated WMO Climate Normal averages are based on the same Copernicus ERA 5 historic data specific to the station location.

Using Copernicus' Application Programming Interface (API), a Python script was developed to easily collect new and updated data for existing and new INTERACT stations. Data updates are automated monthly to ensure an up-to-date system allowing scientists to compare recent climate data against previous years and WMO climate normal reaching back to 1961.

The visualizations and functionality on the website, can be seen in the screenshots below (Figure 1 and 2, Appendix 1). Charts are made interactive and allow users to select preferred WMO climate normal and years to be displayed on the graphical element. It is possible to expand the graphical display for a more detailed view.


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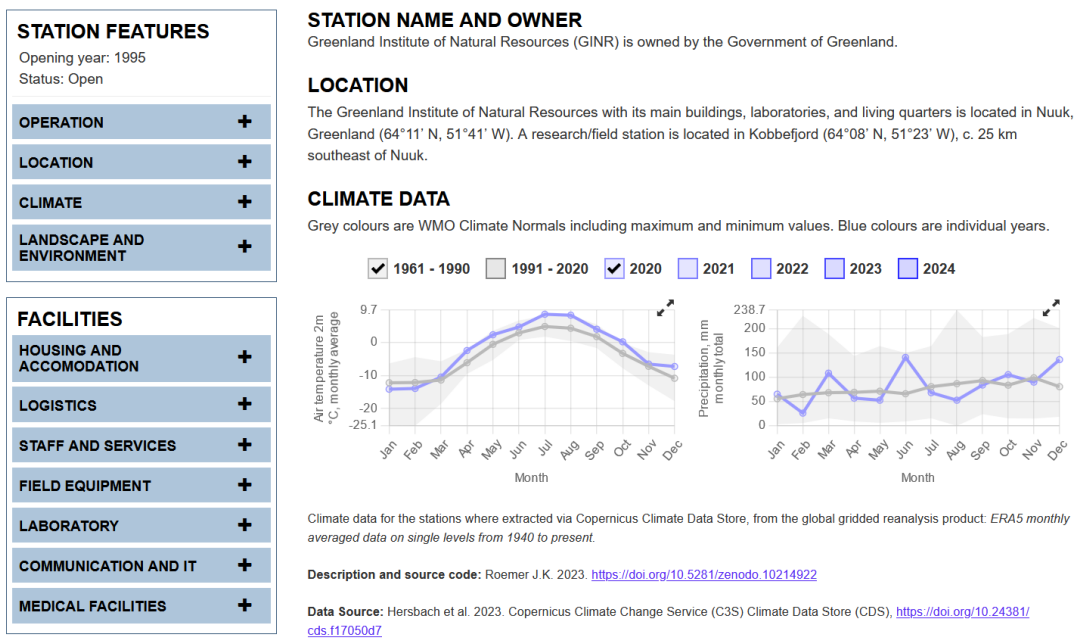


**Figure 1.** When viewing station details, in this case Greenland Institute of Natural Resources (GINR) in Nuuk, Climate Data is shown and the user can select which recent years to view and which WMO Climate Normal periods to compare to.

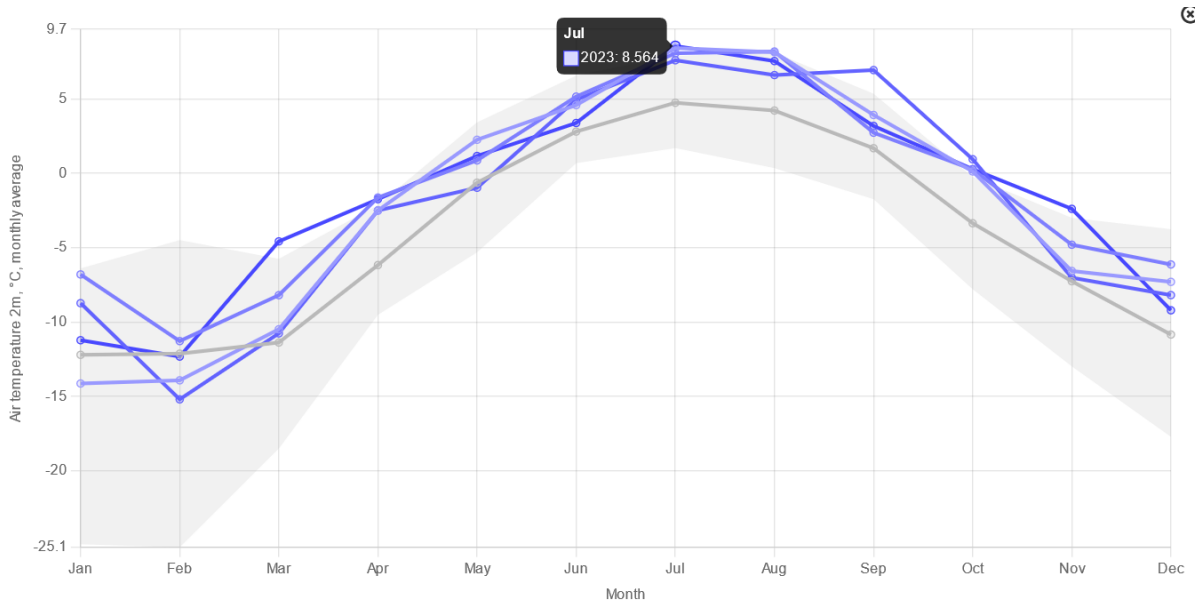


**Figure 2.** The graphs can be extended to full screen view to allow for closer inspection. In this case we see that recent years monthly average temperatures at GINR (except the short and cold winters) are several degrees above the WMO Climate Normal average for 1961-1990. Users can hover a point in the graph to get the exact value shown.


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The acquisition and processing / preparation of climate data from Copernicus is described in detail in the resources below:

Description and source code: Roemer J.K. 2023. https://doi.org/10.5281/zenodo.10214922

Data Source: Hersbach *et al*. 2023. Copernicus Climate Change Service (C3S) Climate Data Store (CDS), https://doi.org/10.24381/cds.f17050d7

See the linked github repository https://zenodo.org/doi/10.5281/zenodo.10214962 for how data was fetched from Copernicus Climate Data Store, prepared and plotted. The github repository also contains CSVs with source data for the plots.

Example of station display page can be seen here: https://interact-gis.org/Home/Station/1

**Future opportunities**

This repository represents significant progress in our ability to capture, store, and make available climate data across the diverse range of INTERACT stations, providing valuable insights into climate trends and extreme events in the Arctic region.

Continued collaboration with station managers can help refine the tool in INTERACT GIS and ensure they meet the practical needs of the research stations and visiting scientists. This could include:

- Develop harvest functionality from station repositories to allow display of ground observed data.
- Add additional variables
- Integrate local variability and increase temporal scale


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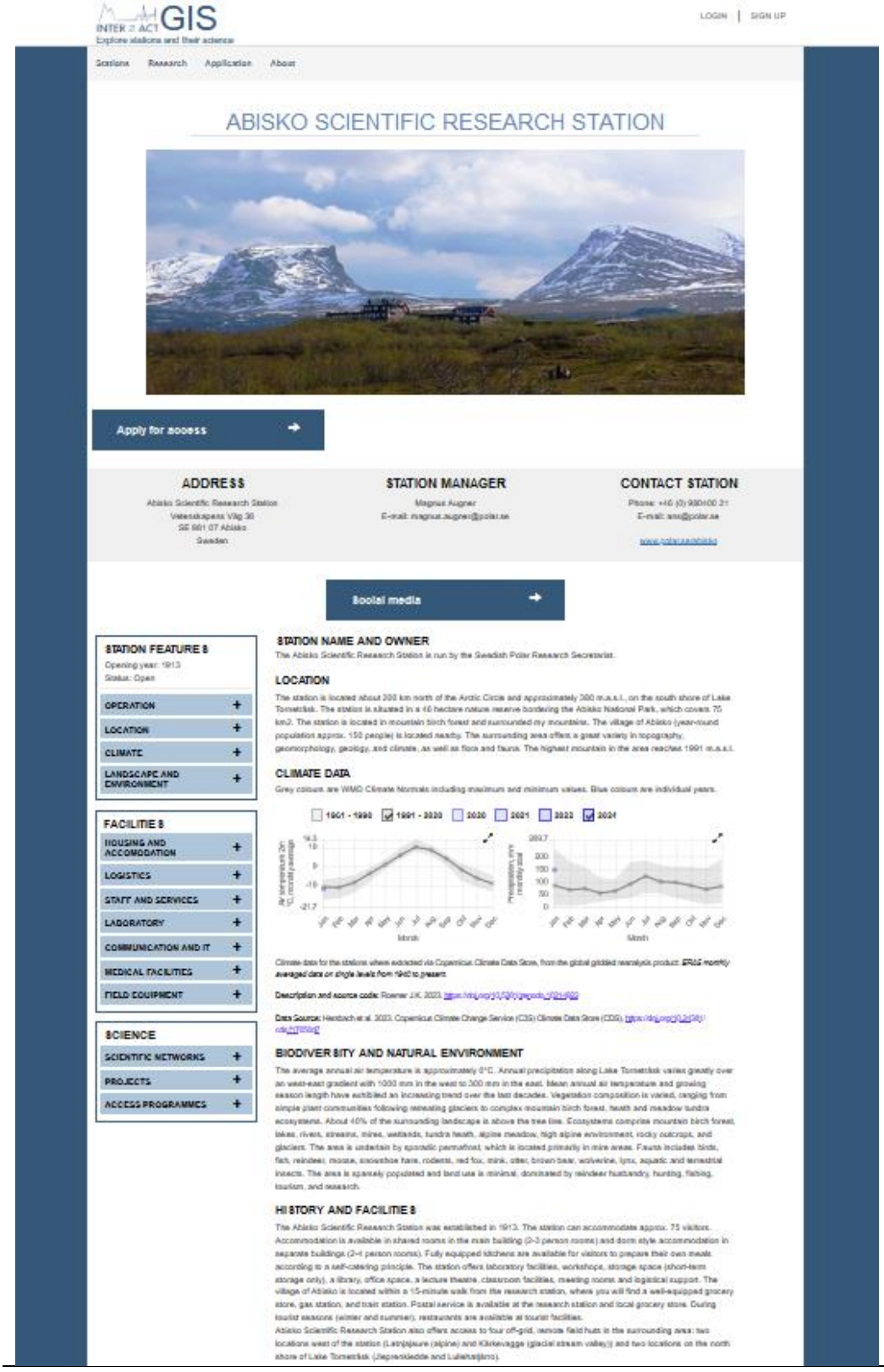
# Appendix 1. Station Display page in INTERACT GIS