

ON THE TOP

HIGH ALTITUDE RESEARCH STATION
JUNGFRAUJOCH





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INTERNATIONAL

Research at Jungfrauoch has always been open to scientists from all around the world. Since its beginnings in 1930, institutions from Austria, Belgium, Germany, Great Britain and Switzerland have been members of the International Foundation High Altitude Research Station Jungfrauoch. About 50 years ago, the foundation expanded to include a smaller station on the Gornergrat. Today, HFSJG operates the research stations on behalf of its members, who co-finance the foundation with their contributions. The foreign partners are represented by scientific organizations. Swiss membership is represented by the Academy of Sciences, the University of Bern, which hosts the foundation, plus the municipality of Zermatt, and the Gornergrat and Jungfrau railway companies. The participation of the Jungfrau Railways has an additional historical reason. In 1894 the Swiss Federal Council made support of the research station a condition for the concession to the company to build a railway in the pristine alpine world.

Inauguration ceremony for the research station on July 4, 1931.





RESEARCH LABORATORIES IN PERPETUAL ICE

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Research was conducted at Jungfrauoch long before the construction of the High Altitude Research Station. But when the Jungfrau Railways commenced operations in 1912, daring research expeditions came to an end. Geophysicist Alfred de Quervain was the driving force behind the idea of building a research station with laboratories and permanently installed monitoring devices. He convinced the Swiss Natural Research Society of his idea and formed the Jungfrauoch Commission in 1922. Researchers from Switzerland and from abroad – especially from the medical and astronomical communities – were enthusiastic. When opened in 1931, the station even had a stall for high altitude experiments with animals. A few years later, an observatory especially for meteorologists and cosmic ray researchers was built on the Sphinx rock, which today is still the symbol of the Jungfrauoch. The High Altitude Research Station stands at 3,454 metres above sea level – the highest in Europe. It’s also the world’s only high altitude research station that can be reached by rail.

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The history of the High Altitude Research Station is closely connected to that of the Jungfrau Railways. The station owes its success greatly to the fact that throughout the year there is efficient transport available for researchers and their sophisticated measuring instruments.

MEASURING, OBSERVING AND COOKING

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The times when scientists in the Jungfrau region had to sleep in icy caves are long gone. Still, hardly anyone sleeps well here during the first night at the research station. Moreover, researchers often have to cope with harsh weather conditions and the effects of the altitude. Life in the research station is a bit like time travel: on the one hand it has the charm of a research station with historical character elegantly integrated into the natural landscape, and at the same time it has state-of-the-art research infrastructure – including data transfer with a broadband internet connection. The physicists, physicians, glaciologists and many other researchers spend more than 1,000 working days a year at Jungfraujoch. Two alternating custodian couples look after the researchers as well as the instruments – but the scientists have to cook for themselves. Any researcher whose work involves high-altitude measurements and observations can apply for a working place in the High Altitude Research Station.

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Depending on the project, the researchers spend anywhere from a few days to several weeks at the station. For this reason, they appreciate both the first-class research infrastructure as well as the cosy dining and recreation room.





ESSENTIAL DATA BASIS

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Meteorological measurements and observations were the first fields of research at Jungfrauoch. In fact in 1925 a meteorological pavilion was built on the glacier. Automated data recording and transmission began in 1980 using standardized measuring instruments. The weather station, one of the highest in Europe, is permanently manned, mainly because visual weather observations are just as important for meteorologists as the instrumental measurements. Therefore, the custodians record their observations of visibility and cloud type and height, forwarding them to Meteo Swiss several times a day. But the data from the Jungfrauoch aren't just important for good weather forecasts. Gathered over a long period of time, temperature and wind measurements also provide a basis for environmental and climate research, which is playing an increasingly important role at the research station. The identified trends are of great importance since the consequences of climate change are particularly pronounced in alpine areas.

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In spite of being one of the first automated stations in Switzerland, the maintenance of the instruments must still be provided by qualified personnel on site.

HEALTH AT HIGH ALTITUDE

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Researchers have long been interested in the effects of a high-altitude stay on the human body. This issue was one of the first to be investigated at the High Altitude Research Station. With its location at about 3,500 metres above sea level, it is ideal for such medical studies. Thanks to the Jungfrau Railways, the station is easily accessible for participants in medical experiments – and especially for those who otherwise are not accustomed to high altitude. Lately, several research groups have looked into how people with various health problems cope with high altitude. Researchers at Bern's Inselspital for example wanted to know how heart patients handle an altitude above 3,000 metres. Scientists from the University of Zurich studied how the cardiovascular systems of eight subjects adapted during 28 days spent at the research station. And physicians from the Ludwig Maximilian University in Munich sought correlations between blood gas values and symptoms of acute altitude sickness.

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The Jungfrauoch offers unique conditions for medical experiments, such as tests to show how the cardiovascular system adapts to high altitude during an extended stay.





SCIENCE IN SNOW AND ICE

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The Great Aletsch Glacier originates at Jungfrauoch and is the longest glacier in the Alps. The High Altitude Research Station therefore offers an ideal environment for scientific work in snow and ice. Thanks to the excellent infrastructure and the easy access, the Great Aletsch Glacier is one of the most extensively investigated glaciers in the world. ETH Zurich's long-term measurements of changes in length, mass balance and volume of the glacier have, among other aspects, documented advancing climate change. The exploration of permafrost is also playing an increasingly important role at Jungfrauoch. These activities are summarized by the Swiss Monitoring network PERMOS, which measures the temperature on the surface and within the steep cliffs. The Institute for Snow and Avalanche Research (SLF) is investigating the role of the snow cover on the heat balance and the stability of rock faces. It collaborates with partners such as the University of Bonn.

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Observations of the Great Aletsch Glacier are made with modern remote sensing technology as well as direct field measurements.

DOCUMENTING CLIMATE CHANGE

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As Jungfrauoch is far above most air pollution, the High Altitude Research Station is particularly suitable for measuring the composition of the atmosphere. Of particular interest is the concentration of the greenhouse gas carbon dioxide (CO_2). The University of Heidelberg, for example, has been measuring radiocarbon in atmospheric CO_2 continuously since 1986. These reference measurements serve to determine how much CO_2 is released into the atmosphere through the burning of fossil fuels. The Oeschger Centre for Climate Change Research at the University of Bern is constantly monitoring the concentrations of CO_2 and O_2 (oxygen). The researchers use these high-precision measurements in their efforts to determine how man-made CO_2 is distributed to the atmosphere, the biosphere and the ocean. Along with the values for about 100 gases that the research institution Empa began measuring in 1972, this new information makes it possible to gain more knowledge on air quality, sources of air pollutants and climate change.

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The Jungfrauoch is one of the stations in the National Air Pollution Monitoring Network (NABEL). It's operated by Empa and the Federal Office for the Environment (FOEN). This picture shows the air inlet system of the measuring station.





MONITORING THE ATMOSPHERE

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The very dry alpine air at Jungfrauoch is especially suited for various atmospheric studies. For example, the University of Liège (Belgium) specializes in working with infrared spectrometers. Unlike in-situ measurements, these make it possible to determine the so-called column integrated concentrations or vertical profiles. This yields information about the composition of the atmosphere above the Jungfrauoch. Among other things, scientists can track the development of more than 20 atmospheric gases connected with ozone depletion or the greenhouse effect. These measurements are of key importance as a means of monitoring the Montreal and Kyoto protocols. These international agreements protect the ozone layer and limit the emission of greenhouse gases.

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The scientific orientation of the High Altitude Research Station has changed over the decades. Initially, astronomy and radiation research were the focus; today it's environmental and climate research. Among other things, information about the state of the atmosphere is in demand.

UNDERSTANDING CLOUD FORMATION

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At Jungfraujoch, aerosol measurements have been recorded continuously for more than 20 years. The Paul Scherrer Institute (PSI) and Empa want to gain a better understanding of how fine suspended particles in the air affect the climate. Along with 30 other observation sites, the High Altitude Research Station is part of the global monitoring network Global Atmosphere Watch, which is under the auspices of the World Meteorological Organization (WMO). Because Jungfraujoch is in the clouds from time to time, it is also an ideal place to investigate the interaction between aerosols and clouds. Through the Cloud and Aerosol Characterization Experiment (CLACE), large-scale international research projects are organized that examine how aerosol particles, depending on their physical and chemical properties, change the clouds. These measurements are supplemented by remote sensing methods. MeteoSwiss has examined the vertical distribution of aerosols, and ETH Zurich has explored the role of aerosols in the formation of ice in high-altitude cirrus clouds.

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The data measured at Jungfraujoch are usually sent directly to the home institutions of the researchers. In around 50 projects, more than 100 variables are being measured.





20/21

Research: Biology

UNIQUE CONDITIONS FOR EXPERIMENTS

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Jungfrauoch also provides biologists with special conditions for experiments and observations with its high altitude and the exposed location on the Alpine arc, where even Sahara dust can accumulate. In a joint project, the University of Bern and the Freie Universität Berlin wanted to find out if microorganisms were transported along with the desert dust. They also investigated how well these tiny organisms, which live in the desert soil and rocks, survived the trip to the high Alps. In another area, researchers at the Universities of Zurich and Fribourg studied the connection between memory disorders and reduced oxygen at high altitude. They observed the behaviour of two groups of Long-Evans rats: one in normal laboratory conditions and the other in cages with an especially stimulating environment. All experiments done on humans and animals are subject to the licensing requirements of the National Advisory Commission on Biomedical Ethics.

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From the very beginning there has been research with animals at Jungfrauoch. There even used to be a stall at the research station. Today, researchers look into topics such as how rats deal with memory disorders at high altitude.

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Hochalpine Forschungsstationen
Jungfrauoch & Gornergrat

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