EuChemS Historical Landmarks Award 2021

«Chemistry of the Atmosphere»

University of Bern, Department for Chemistry, Chemical Biology and Pharmaceutical Sciences

February 16, 2023, 09.30-17.00

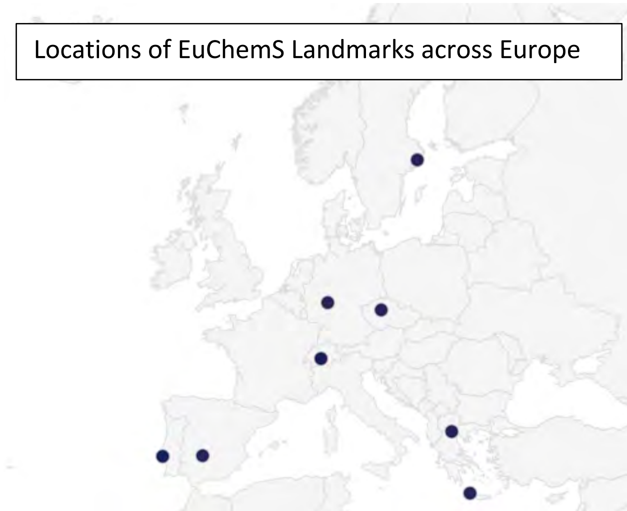
SCS
Swiss Chemical Society

EuChemS
European Chemical Society

EuChemS Historical Landmarks

The European Chemical Society (EuChemS) is an overarching association representing more than 120,000 chemists from 50 member organisations and 34 countries. Our mission is to nurture a platform for scientific discussion, and provide an unbiased, European voice on key policy issues in chemistry and related fields. We work on connecting and sharing our message with scientists, policymakers, and citizens.

Our initiative, the EuChemS Historical Landmark Awards, identifies chemical sites that have played a vital role in defining the cultural makeup and history of Europe, in order to recognise the importance of Chemistry in European history and cultural heritage. Such sites are awarded a plaque with which visitors can learn about the discoveries and breakthroughs from the past. In addition, the award links all EuChemS Landmarks, thus creating a network of historically significant chemical sites all over Europe. This network grants exposure to the geographical scope and the diversity of the European scientific landscape, and promotes it within the chemical community and beyond. It honours the discoveries and breakthroughs that strengthen the sense of belonging of European chemists, and reminds them that as far as the history of chemistry goes, people and ideas alike have circulated, been shared and shaped through meetings and communication across national boundaries.


Locations of EuChemS Landmarks across Europe

Jungfraujoch High Altitude Research Station is an outstanding example. Since the 1931 inauguration of the research station, international cooperation was given high priority. The Kaiser-Wilhelm-Gesellschaft from Germany and the Austrian Academy of Sciences, among others, were founding members of the international foundation, the result of which was the establishment of the station. Later on, Jungfraujoch Station hosted a strategic alliance between Belgian and Swiss researchers, which developed into an impactful and significant operation, and it continues to attract international researchers to this day to study and to understand the central role of atmospheric chemistry, amongst other relevant and important scientific topics. Indeed, the scientific significance of the station is undoubtable. The original fundamental measurements and early identification of harmful atmospheric constituents, such as anthropogenic greenhouse gases, and evidence of how their presence in our atmosphere has changed over the last 70 years was discovered at this alpine location.

The award ceremony on 16-17 February, 2023 will be an event that signifies how Jungfraujoch High Altitude Research Station connects scientific communities from all across Europe. This two-day event will consist of high profile guests, representing international research and academic institutions, discussing the importance of the research undertaken at Jungfraujoch. Following this, an international delegation will visit the High Altitude Research Station, where the plaque will be inaugurated, and the scenic station will be shown to the attendees.

Prof. Floris Rutjes, Radboud University, the Netherlands
EuChems President

Prof. Angela Agostiano, University of Bari Aldo Moro, Italy
EuChemS President-Elect

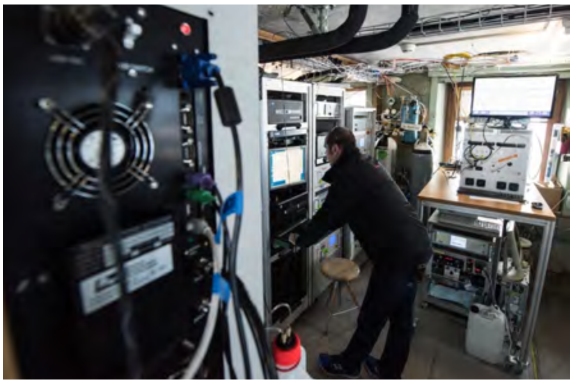
Dr. Brigitte Van Tiggelen,
Chair of the EuChemS Historical Landmark Selection Committee
Chair of the EuChemS Working Party on the History of Chemistry

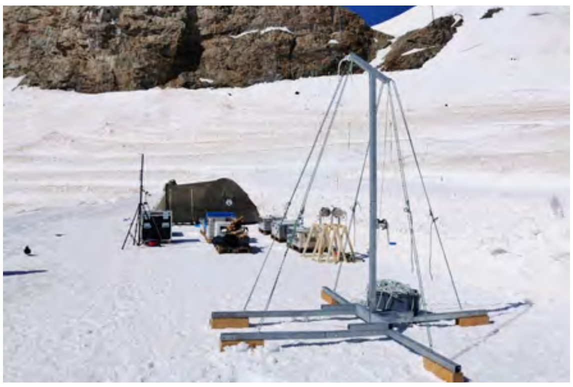
Dr. Nineta Hrastelj FRSC
EuChemS Secretary General

Program Symposium 2023

Thursday, 16th February 2023	
09.30	Welcome Coffee and Networking
10.00	Welcome Messages by *Prof. Silvio Decurtins*, President Foundation HFSJG, *Prof. Floris Rutjes*, President EuChemS and *Prof. Anne-Sophie Nyssen*, President F.R.S.-FNRS/Rectrice University of Liège
10.15	***Prof. Justus Notholt***, University of Bremen, DEU «How does remote sensing work, and what do we learn from the historical observations at the Jungfraujoch?»
10.45	***Dr. Emmanuel Mahieu***, University of Liege, BEL «Remote-sensing of the atmospheric composition at the Jungfraujoch station: an iconic program initiated in the early 1950s»
11.15	***Prof. Bertrand Calpini***, MeteoSwiss, CHE «MeteoSwiss on the Jungfraujoch observation site: a world reference for the monitoring of climate change»
11.45	Lunch Break
13.15	***Prof. Stefan Brönnimann***, University of Bern, CHE «The history of atmospheric ozone measurements and the role of swiss observatories»
13.45	***Dr. Stephan Henne,*** Empa, CHE «Long-term observations of halogenated trace gases at Jungfraujoch for estimating global and regional emission trends»
14.15	***Prof. Urs Baltensperger***, PSI/ETHZ, CHE «Chemistry, a detective tool in atmospheric aerosol science»
14.45	Coffee Break
15.15	***Prof. Margit Schwikowski***, PSI/University of Bern, CHE «The international ICE MEMORY initiative»
15.45	***Prof. Hans-Werner Jacobi***, University of Grenoble, FRA «Interaction between snow and the atmosphere in high latitudes and altitudes: Interplay of physical and chemical processes»
16.15	***Dr. Franziska Scholder-Aemisegger***, EHTZ, CHE « Multi-platform observations of stable water isotopes in the North Atlantic trades as tracers for the atmospheric circulation at different scales »
16.45	"Small" Ceremony: Messages by Dr. Ir. Véronique Halloin, Secretary-General F.R.S.-FNRS Dr. Ginette Roland, University of Liège and Award Presentation
17.00	Aperitif

Impressions form the Jungfraujoch and the Research Station





Abstracts for the EuChemS Symposium, February 16, 2023

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Dr. Emmanuel Mahieu, University Liege, Belgium:

Remote-sensing of the atmospheric composition at the Jungfraujoch station: an iconic program initiated in the early 1950s

It is in 1950 that researchers from the University of Liège have recorded the first atmospheric infrared solar spectra at the Jungfraujoch scientific station, in the Swiss Alps, at a time when climate change was not a matter of worry. These pioneering observations have first allowed to confirm that methane and carbon monoxide were ubiquitous constituents of the Earth's atmosphere, even at this unpolluted and remote place. After a period devoted to the characterization of the solar photosphere, the recording of atmospheric spectra resumed in the mid-1970s, stimulated by rising concerns related to possible stratospheric ozone depletion. Since then, this monitoring activity has been conducted at that site without interruption, allowing to gather high-quality data crucial for the characterization of the Earth's atmosphere and of the changes affecting it, resulting from anthropogenic activities or natural causes. Nowadays, more than thirty atmospheric constituents are monitored, allowing to extend on a daily basis precious multi-decadal time series that are unique worldwide.

In this paper, we first remind about the successive steps which led to establishing the observational program of the Liège team at the Jungfraujoch and we highlight some important historical findings. Then we present recent results relevant to the Montreal and Kyoto Protocols, or related to the monitoring of air quality.

Prof. Dr. Justus Notholt, University Bremen, Germany

How does remote sensing work, and what do we learn from the historical observations at the Jungfraujoch?

Remote sensing has been established as a powerful tool in studying the composition of the Earth atmosphere. One observation geometry is by using the sun as external light source, and measuring at the ground the spectra, which contain absorption features of the atmosphere. An analysis gives the concentrations of up to 30 trace gases in the atmosphere, including ozone, CO_2, methane, carbon monoxide, CFCs. The observations at the Jungfraujoch serve as an important historical data set, with first spectra recorded in the early 1950s. These spectra are the oldest existing spectral data set. During the talk the basics of remote sensing will be discussed. Furthermore, the observations at Jungfraujoch with regard to studying the composition of the Earth atmosphere and its long-term evolution will be discussed.

Prof. Dr. Bertrand Calpini, MeteoSwiss, Switzerland

MeteoSwiss on the Jungfraujoch observation site:
a world reference for the monitoring of climate change

The Jungfraujoch station is iconic because of its location for observing stars, the earth's atmosphere, the glaciers and mountains that surround it, and has a prominent place on the bucket list of many a tourist. At MetoSwiss we are the proud custodians of weather measurements made over the past 100 years. With the support of the GAW programme, our Office has engaged in a game changer, and this as early as 1994. The observation of the atmospheric column, as continuously carried out and improved by our Belgian colleagues since 1950, is a treasure. With the combination of in situ and remote sensing meteorological and atmospheric observations, with our national and international partners, the Jungfraujoch today forms a world reference point for the monitoring of climate change. The specific example of water vapour and its evolution in this alpine environment, extracted from high-precision solar radiation measurements and time series of temperature measurements at the Jungfraujoch, represents an essential complement for the FTIR observations. Switzerland is pleased to be the direct partner of University of Liège in Belgium in our common challenge to provide sustainable and high quality observations for the benefit of understanding the global climate. The presentation will address some of the contributions of physical meteorology in support of interpreting the atmospheric composition observations.

Prof. Dr. Stefan Brönnimann, University Bern, Switzerland

The History of Atmospheric Ozone Measurements
and the Role of Swiss Observatories

Research on atmospheric ozone has a long and interesting history. Spectroscopic measurements of the ozone column started around a century ago and were related to fundamental questions of the vertical structure of the atmosphere. Soon the relation to atmospheric dynamics was discovered, notably the close negative relation to tropopause height. Total column ozone became a meteorological quantity that could possibly benefit weather forecast. Since 1926, total column ozone has been measured in Arosa (since 2020 Davos), making this the longest record in the world. Other questions concerned ozone in the troposphere. In fact, ozone measurements were performed by Daniel Challonge at Jungfraujoch and Lauterbrunnen in the early 1930s to establish the vertical gradient of ozone in the troposphere. At the same time, Chapman put forth the main reaction cycle behind the formation of the stratospheric ozone layer. However, this could not explain the seasonal and latitudinal distribution of ozone, which led to the discovery of a slow, meridional circulation of the stratosphere. In the context of the International Geophysical Year 1957/8, a global total column ozone network was established, and a clever set-up with measurements at short time intervals around sunset or sunrise allowed the retrieval of ozone profiles. Ozone sondes were flown on weather balloons since the 1960s, and Payerne became an important ozone sounding station. Satellites began the measure ozone in the 1970s. The discovery of the ozone hole in the 1980s provided a new incentive to monitor total column ozone - the Arosa series proved useful as the only long reference series -, while increased near-surface ozone started to cause health problems. The radiative effect of both stratopheric and tropospheric ozone became relevant as a climate forcing.

Today the ozone layer is monitored to detect the expected ozone recovery (and to improve weather forecasts, as envisaged a century ago), while tropospheric ozone continues to exceed air quality standards. Swiss observatories play an important role for both, tropospheric and stratospheric ozone. This brief history shows how the interest in ozone changed several times – ozone was a meteorological quantity, then a geophysical quantity, a chemical quantity, and a radiative quantity – evidencing the many geophysical relations it has with the atmosphere. This is due to the chemical and radiative properties of the ozone molecule, combined with the sharp vertical gradient. For precisely these reasons, historical ozone data are interesting today as a window to the past radiative, dynamical and chemical state of the atmosphere.

Dr. Stephan Henne, Empa, Switzerland

Long-term observations of halogenated trace gases at Jungfraujoch for estimating global and regional emission trends

Since the 1930s, halogenated gases have been used in a wide spectrum of anthropogenic applications, from foam blowing over fire retardant to refrigerant. Different generations of halogenated gases have contributed to environmental problems (stratospheric ozone depletion, global warming) and, as such, their emissive production and use has been targeted by various international treaties (Montreal Proto-col and its amendments, Kyoto Protocol, Paris Agreement). Long-term atmospheric observations and atmospheric models are the core validation tools for confirming/checking compliance with agreed-upon phase-out and phase-down scenarios.

Since 2000, Empa carries out continuous, in-situ measurements of more than 50 halogenated trace gases at Jungfraujoch as part of the global AGAGE network (Advanced Global Atmospheric Gases Ex-periment). Combining these observations with global scale transport and chemistry models, it is possi-ble to derive global emission trends of most of these long-lived compounds. For most of the ozone depleting substances (chlorofluorocarbons, hydrochlorofluorocarbons, halons) estimated emissions trends confirm compliance with the Montreal protocol. However, discrepancies for others serve as a warning system and point to where additional efforts for emission reductions are needed. Similarly, global trends of compounds targeted solely for their large global warming potential (hydrofluorocar-bons), show first indications of the more recent regulation efforts.

In addition to global scale studies and because the site is frequently impacted by regional pollution events, Jungfraujoch observations can be used to estimate spatially resolved emissions from Switzer-land and across Europe. Swiss national total emissions are routinely estimated by a tracer-ratio method and provided as part of the national inventory report to UNFCCC. At the regional scale, atmospheric transport models are applied to provide the link between observations and emissions. In the last two decades, these transport models have evolved from a relatively coarse grid resolution, barely suitable for representing high-Alpine observations, to a kilometer-scale resolution, allowing emission estimates on increasingly finer scales.

Prof. Dr. Urs Baltensperger and Dr. Nora Kristina Nowak, PSI/ETHZ, Switzerland

Chemistry, a detective tool in atmospheric aerosol science

Chemistry is an important discipline in all geoscience domains, including the atmosphere. This presentation will focus on atmospheric aerosol science and will show how chemistry has been used as a detective tool in this field. As an example, the aerosol chemical composition helps to identify the contributions of the various aerosol sources, especially the discrimination of anthropogenic and natural sources, as well as their evolutions with time. The chemical composition is also decisive in determining the aerosol impact on health. Comparison of the chemical composition at the Jungfraujoch with observations at lower altitude helps in determining chemical aging processes during transport from the point of emission to a remote site. Next, the chemical composition together with physical properties such as size governs the interaction of aerosol particles with radiation as well as with clouds, and is therefore important in defining the impact of aerosols on climate. Highly time resolved chemistry measurements are also important to elucidate physical processes. The latter include for example vertical transport processes, important for mixing of air from the planetary boundary layer to the free troposphere, or the formation of new particles from gaseous precursors.

Prof. Dr. Margit Schwikowski, PSI/University Bern, Switzerland

The international ICE MEMORY initiative

Mountain glaciers worldwide have retreated dramatically and thinned in recent times and are in danger of disappearing rapidly in the coming decades as global temperatures rise. Not only the glacier termini are affected, but also the accumulation zones in the upper parts of the glaciers, where ice cores for paleo studies are collected. This is a major challenge the scientific community is facing, since glacial-archived information forming one of the best libraries of past climatic and environmental changes is under threat of being lost forever. As an international initiative, ICE MEMORY aims at collecting heritage ice cores from the world's key endangered glaciers. By creating an international ice core repository in Antarctica, the heritage cores will be stored under safe conditions and under international governance, to provide high-quality samples for ice core science to be conducted by future generations of scientists throughout the world.

Prof. Dr. Hans-Werner Jacobi, University Grenoble, France

Interaction between snow and the atmosphere in high latitudes and altitudes: Interplay of physical and chemical processes

Snow is an important element of the cryosphere impacting physical and chemical processes at the Earth surface in high altitudes as well as in high latitudes. Due to such processes snow can play a crucial role for example in regional or local climate due to its albedo, in atmospheric chemistry due to its role as photochemical reactor, or in biogeochemistry as a temporal reservoir of impurities. Nevertheless, the role of chemical processes in snow is regularly overlooked and related processes are often not well understood. Some examples of such processes will be discussed by presenting results from studies in the Himalayas and over the Arctic Ocean. Processes will concern for example the snow albedo and how it is impacted by different impurities or the role of snow for the destruction of tropospheric ozone in the Arctic. I will finally discuss potential reasons which have caused the existing knowledge gaps concerning chemical snow processes and what methods and tools may have the potential to contribute closing such gaps.

Dr. Franziska Scholder-Aemisegger, ETHZ, Switzerland

Multi-platform observations of stable water isotopes in the North Atlantic trades as tracers for the atmospheric circulation at different scales

Low clouds over the tropical oceans are at the heart of current uncertainties in future climate projections. These boundary layer clouds form due to a subtle interplay between the large-scale atmospheric circulation and small-scale physical processes embedded in the flow. In this presentation, I show how stable water isotopes can be used as measurable tracers of this interplay and thus serve as a tool to link different flow regimes in the North Atlantic trades with low-level cloudiness. To do so, I take advantage of a combination of multi-platform isotope observations with high-resolution numerical model simulations. In the first part of my presentation, I show how the Saharan heat low dynamics in summer moistens the eastern subtropical North Atlantic. Ground- and satellite-based remote sensing observations (FTIR and IASI) over the Canary Islands highlight large synoptic timescale variability of stable water isotope signals. This observed variability in the heavy isotope content of the free troposphere can be linked with different atmospheric transport pathways and water vapour sources using air parcel trajectories and numerical tracers in a regional model simulation. Despite the strong free tropospheric moistening by the Saharan air layer, low-level cloudiness is anomalously low in this flow regime. In the second part of my presentation, I use in-situ measurements of stable water isotopes in the downstream North Atlantic trades from the Barbados Cloud Observatory and from the French research aircraft ATR. With these observations, I illustrate how water isotope signals in the lower troposphere are linked to different mesoscale cloud organisation patterns and their associated cloud-relative overturning circulation.

Organizing Committee

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