Schweizerische Eidgenossenschaft
Confédération suisse
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Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss

GAW-CH Conference 2011

18-19 January 2011, ETH Zurich

Summary and recommendations

In 1994, the Swiss GAW programme (GAW-CH) was launched as a national contribution to the international GAW programme. GAW-CH is coordinated by the Federal Office of Meteorology and Climatology MeteoSwiss. Within GAW-CH, a strong collaboration has been established between national research institutions and federal offices involved in atmospheric observations and analyses. The Swiss GAW programme includes monitoring of various physical and chemical atmospheric variables, research activities and advanced services, so as to deliver reliable information to the scientific community and to policymakers.

The GAW-CH Conference 2011 was organized in Zurich, Switzerland, 18-19 January, 2011. It started with an introduction followed by five sessions:

- Gaseous species
- Water vapor and clouds
- Ozone
- Aerosols
- Radiation

A summary discussion closed the Conference.

The present document gives a summary and proposes recommendations as a result of the presentations and discussions.

INTRODUCTION (Dominique Ruffieux)

In his welcome address, Gerhard Müller defined the national and international framework of the GAW activities. Liisa Jalkanen presented the GAW international activities within WMO. Oystein Hov presented the WMO-GAW Programme and its role in atmospheric research and environmental prediction. Finally, Dominique Ruffieux pointed out the close collaboration between the operational monitoring and research communities within GAW-CH and its importance.

Session GASEOUS SPECIES (Chair: Brigitte Buchmann)

Conclusions

- Long-term column data at Jungfraujoch provide a unique data record (combined and harmonized from different instruments) for the trend analysis of greenhouse gases column data over central Europe.
- The comprehensive in-situ measurement programme at Jungfraujoch fully supports the GAW- and GCOS programme as well as international treaties.
- The long-term in-situ time series demonstrate the changes in the troposphere and the sophisticated instrumentations allow an early detection of new compounds (e.g. substitutes of the compounds banned in the Montreal Protocol).
- Audit results by the Swiss GAW World Calibration Centre (WCC-Empa) show that significant improvements were made worldwide for CH_4 and CO_2 measurements (global sites). New measurement techniques for N_2O and CO will follow (QCL, CRDS) and an improvement of the data quality of these compounds is anticipated.
- Model results clearly support the understanding of the distribution of pollutants and greenhouse gases but still have deficits in simulating long-term trends (e.g. of reactive ozone precursors).
- Assimilation of data records is promising in order to improve trend simulations but requires regionally and temporally representative measurements and a reliable data stream of these observations.

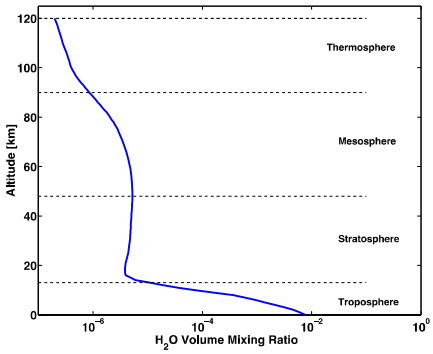
Recommendations

- The excellent position of the Swiss GAW Programme should be maintained by continuing long-term observations of the chemical composition and selected physical parameters.
- New relevant parameters should be included to serve the early warning task of GAW (e.g. substitutes for regulated or forbidden compounds) or to better understand the changes of the troposphere (e.g. continuous isotope measurements).
- To achieve the GAW goals, more emphasis should be given to quality assurance and quality control, especially harmonizing long-term records (first priority of global GAW sites).
- To improve the benefit and visibility of these observations integrated products and services should be developed and made available.
- To understand changes of reactive gases (e.g. tropospheric ozone), models have to be improved. This requires consistent networks, as well as essential metadata (characterization of sites, traceability, filtering methods, etc.). In addition, the spatial coverage of key compounds (e. g. PAN or other recommended VOC) which are essential for the model validation needs to be expanded.

Session WATER VAPOR AND CLOUDS (Chair: Niklaus Kämpfer)

Importance of water in the atmosphere and how to measure it

Water in its different phases (vapor, liquid, ice) is crucial for radiative, chemical and dynamical processes. Water vapor is an essential climate variable and contributes with 60% to the natural greenhouse effect. The altitude distribution of water vapor extends over more than four orders of magnitude with most of it residing in the lowest part of the atmosphere.



This huge change of the amount of water vapor as a function of altitude calls for different measuring techniques. A large number of different in situ and remote sensing techniques is available in Switzerland.

Various techniques can be used to measure water vapor

- Column density (integrated water vapor)
  - GPS network AGNES
  - Microwave radiometry at Payerne (MeteoSwiss) and Zimmerwald (IAP)
  - FTIR on Jungfraujoch (Uni Liège)
- Tropospheric profiles
  - Radiosondes
    - SRS-C34 digital replaces SRS-400 analog (MeteoSwiss)
    - Snowwhite sondes regularly launched at Payerne (MeteoSwiss)
    - COBALD sondes (*IAC*ETH)
  - Lidar up to 4km during day and up to 10 km during the night
  - Microwave radiometry at Payerne (MeteoSwiss) and Zimmerwald (IAP)
- Upper troposphere lower stratosphere (UTLS)
  - Some sondes
- Stratosphere / Mesosphere
  - Few sondes give reliable data, max altitude approx. 30 km
  - Microwave radiometry at Zimmerwald (IAP) gives profiles up to 75 km

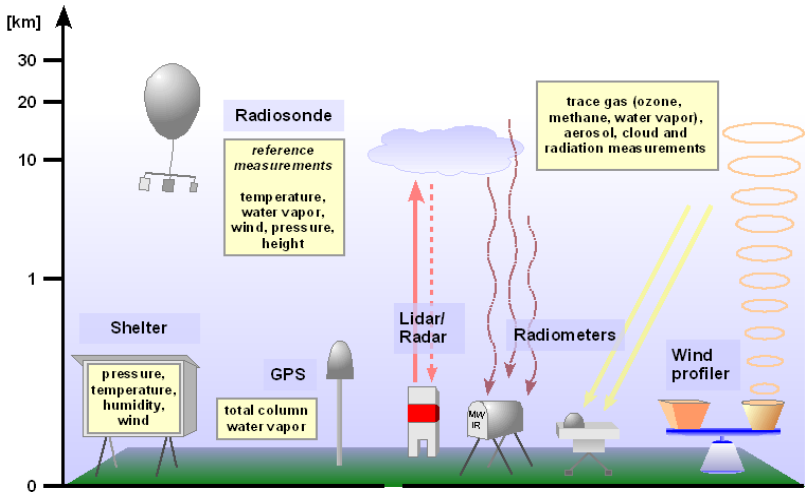
Depending on altitude, data about the water distribution are used for a multitude of purposes.

The main applications of such datasets are the following:

- Numerical weather prediction
- Trend studies (climate change aspects)
- Case studies (super-saturation, sudden stratospheric warmings, atmospheric waves and tides etc.)
- Surveillance of atmospheric change e.g. Network for the Detection of Atmospheric Composition Change (NDACC)

Conclusions

In Switzerland a unique infrastructure to measure the distribution of water vapor over the whole altitude range is available. This has mainly been achieved through the excellent collaboration between MeteoSwiss and research institutes, particularly within the GAW Programme. For long-term upper air data records with high quality a focus on *reference observations* is needed. This is the aim of the GCOS Reference Upper Air Network: GRUAN**,** see www.GRUAN.org . GRUAN is a reference network for long term observations of upper air essential climate variables. A focus is presently on water vapor and temperature to start with. A key issue in this context is the traceability to standards, uncertainty analyses, validated products and the inclusion of meta data.



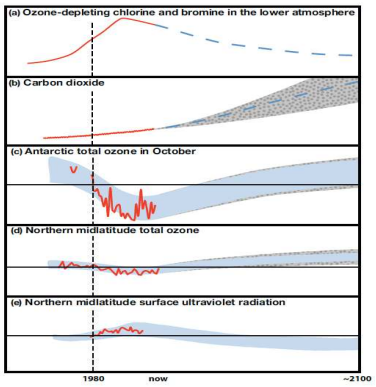
Concept of a GRUAN station (graphics from H.Vömel, DWD-Lindenberg)

The GRUAN MeteoSwiss station at Payerne together with infrastructure from IAP, University of Bern, would make possible in the near future the build up of an entire reference column for water vapor, from ground to up to the mesosphere.

Session OZONE (Chair: Johannes Staehlin)

Long-term evolution of the ozone layer and expected future changes

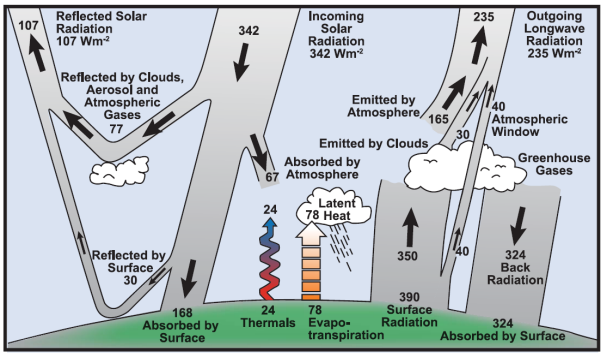
The Figure below shows the long-term evolution of stratospheric ozone. After a strong increase in anthropogenic emissions of Ozone Depleting Substances (ODS) (particularly large during the 1970s and the first part of the 1980s) they strongly decreased by the successful implementation of the Montreal Protocol and therefore chemical ozone depletion by manmade chemicals also will slowly decrease (see panel a); in the second part of this century the ozone hole is expected to disappear (see panel c). The thickness of the ozone layer at mid-latitudes is expected to recover, and numerical simulations predict a larger thickness of the mid-latitudinal ozone layer in future than prior to the time when ODS reached the stratosphere (see panel d). This “super recovery” is attributed to the effect of the ongoing climate change (see panel b) which is expected to lead (among other effects) to an enhancement of the Brewer Dobson circulation. Simultaneously ozone mixing ratios at the tropopause altitude might increase, and ozone at these altitudes is a strong greenhouse gas enhancing greenhouse gas warming.

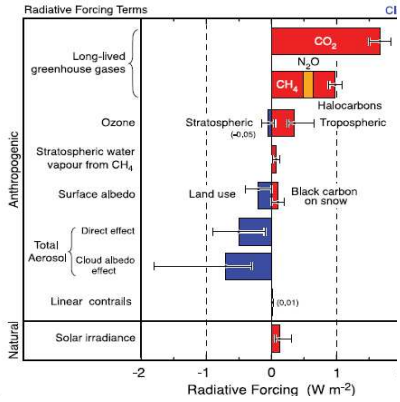


Recommendations

- Long-term high quality measurements of total ozone and its vertical distributions from ground are very important (despite of the decrease in stratospheric ODS concentrations) and should be continued because:
    - Ozone is an important GCOS variable
    - Documentation of the recovery of the ozone layer from ODS
    - Study of the increasingly important effects of climate change on the ozone layer (e.g. enhancements of Brewer Dobson circulation and related feedbacks (e.g. change in ozone mixing ratios at the tropopause level)
    - Validation and quality control of satellite ozone measurements
- The valuable collaboration between different groups involved in Swiss stratospheric ozone research should be continued.

Session AEROSOLS (Chair: Urs Baltensperger)





Conclusions

- Quantifying the anthropogenic impact on Earth's energy balance: Mission impossible?
- The large uncertainty of the aerosol forcing results in a large uncertainly of the total anthropogenic radiative forcing. Reducing uncertainty of aerosol forcing will better constrain climate sensitivity (temperature change for CO2 doubling) and the climate sensitivity is a key uncertainty for mitigation scenarios.
- 1 W/m2, which makes a big difference, corresponds however to AOD of 0.03; satellites do no (yet) reach this accuracy
- The aerosol direct effect is better constrained today than in the past
- We have learned a lot about aerosol sources, transport, abundance, properties, etc. The aerosol measurements are important to determine the actual value of the radiative forcing including spatial and seasonal variation, the actual reasons such as the contribution of each source and the long-term trends. The aerosol measurements can be applied to validate models and satellite data, to make process studies
- The indirect effect and there especially the glaciation effect remaining the ‚piece of resistance'. The aerosol-cloud interaction, data on the structure of mixed-phase clouds, ice formation and chemical composition of ice nuclei are all important points to be studied in order to understand the cloud formation and the aerosol indirect effect.

Conclusions

A strong effort has been devoted to monitoring and analyzing the radiation balance because of its importance for climate change related research. This revealed that modulating effects by many atmospheric constituents and the extraterrestrial solar irradiance affect the general signal that is expected from the increase of greenhouse gas concentration. In order to understand these modulating effects, longer time series of high accuracy and stable measurements of irradiance in different wavelength bands are required. Such measurements should be conducted at locations where other measurements characterizing the atmospheric composition are conducted. This emphasizes the importance of station such as Jungfraujoch or Payerne where very large arrays of parameters are measured. In the case of radiation, it is particularly important to co-locate high accuracy radiation measurements with observations characterizing the aerosols, clouds and water vapor. In addition, increased synergies should be found for enhancing the value of monitoring for climate purpose. This could increase the societal benefit of such programs. For example, such monitoring activities can be used as reference measurements for applications in favor of public health (UV) or renewable energy (solar radiation).

FINAL DISCUSSION (Chair: Urs Baltensperger)

Open Issues

- Near Real Time access to the data
- Uniform access to data, with all needed metadata (world data centres, GAWSIS)
- Information grid (WIS, GEOSS)
- Communication platforms (SAGs, assessments)

We have learned a lot (sources, transport, abundance and properties, interaction with clouds, etc.). But the uncertainty has not decreased: for example, the aerosol uncertainty in IPCC 2007 was not the true uncertainty but rather the variability of models (which all are constrained by external factors).

Conclusions and recommendations

It was acknowledged that we have come a long way in understanding the atmospheric composition and Earth's energy balance, but our picture is still incomplete and the system is constantly changing. In the future, we need more measurements and better models, and an enhanced integration of observations and models. New compounds are being emitted that may become important and therefore need to be monitored right from the beginning. Redundancy of observations, consistent calibration and better traceability (extended metadata) over a long term (longer than the lifetime of one generation of instruments) are needed for robust, defensible long-term time series. Long-term data records from a variety of platforms and the integration of these observations are needed for better uncertainty and trend estimates of atmospheric variables and to develop integrated products/services that amplify the value of individual long-term time series. Improved models will help integrate observations, and more observations are needed to validate the models.

Specifically considering the GAW-CH program, it was recognized as having produced very relevant results of single stations, but enhanced collaboration was deemed needed. The strong interaction of MeteoSwiss with the research community through the GAW-CH programme was considered essential and must be maintained and even extended to an international scale.

Further comments were also made specifically regarding GAW-CH:

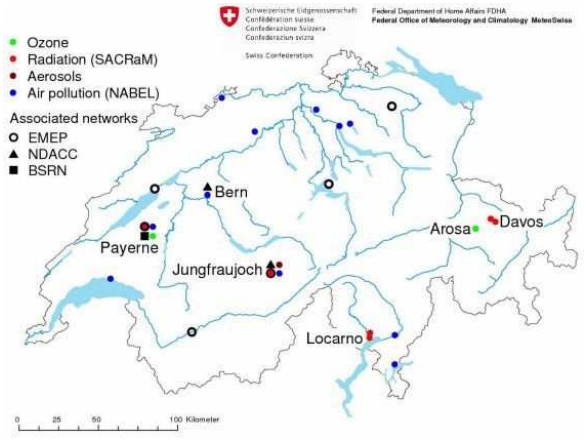
- **Long-term commitments are necessary to achieve required precision, accuracy and continuous development of instrumentation**
- **Fifteen years of high quality data for Switzerland: excellent achievement, but increased exchange with others (different topics & international) is needed**
- **Combine monitoring with science (good balance) (e.g. strengthen link GAW to water cycle, new synthetic compounds link to radiative forcing)**
- **Twinning is important (Switzerland is already very active)**
- **Long-term measurements allow to asses special events (e.g. volcanic eruption)**
- **New compounds, substitutes for banned, have to be taken in consideration**
- **Meta data is very important**
- **Harmonized datasets with good documentation are required (GAW network)**

- **Good data traceability is a prerequisite**
- **Vertical profiling often missing and must be developed**
- **Need to combine in-situ with satellite measurements**
- **Assessments require better models to reduce uncertainties**
- **Data access should be improved (including campaign data for model evaluation/ improvement)**
- **Combine in-situ with open path measurement techniques**
- **Success of 15 years of time series for Switzerland only possibly through continuous funding and perfect combination of MeteoSwiss and GAW monitoring**

Finally, a few conclusive points were mentioned and discussed:

- **Do we need a near real time climate service?**
- **Need for data products for each compound**
- **Routinely delivered products (NRT or as regular products, monthly means or forecasts)**
- **Visibility of the GAW-CH programme has to be increased (important for funding)**
- **Characterization of glaciated clouds is an important topic**

Main GAW-CH Stations and associated networks



Dominique Ruffieux and Jörg Klausen, 24 November, 2011