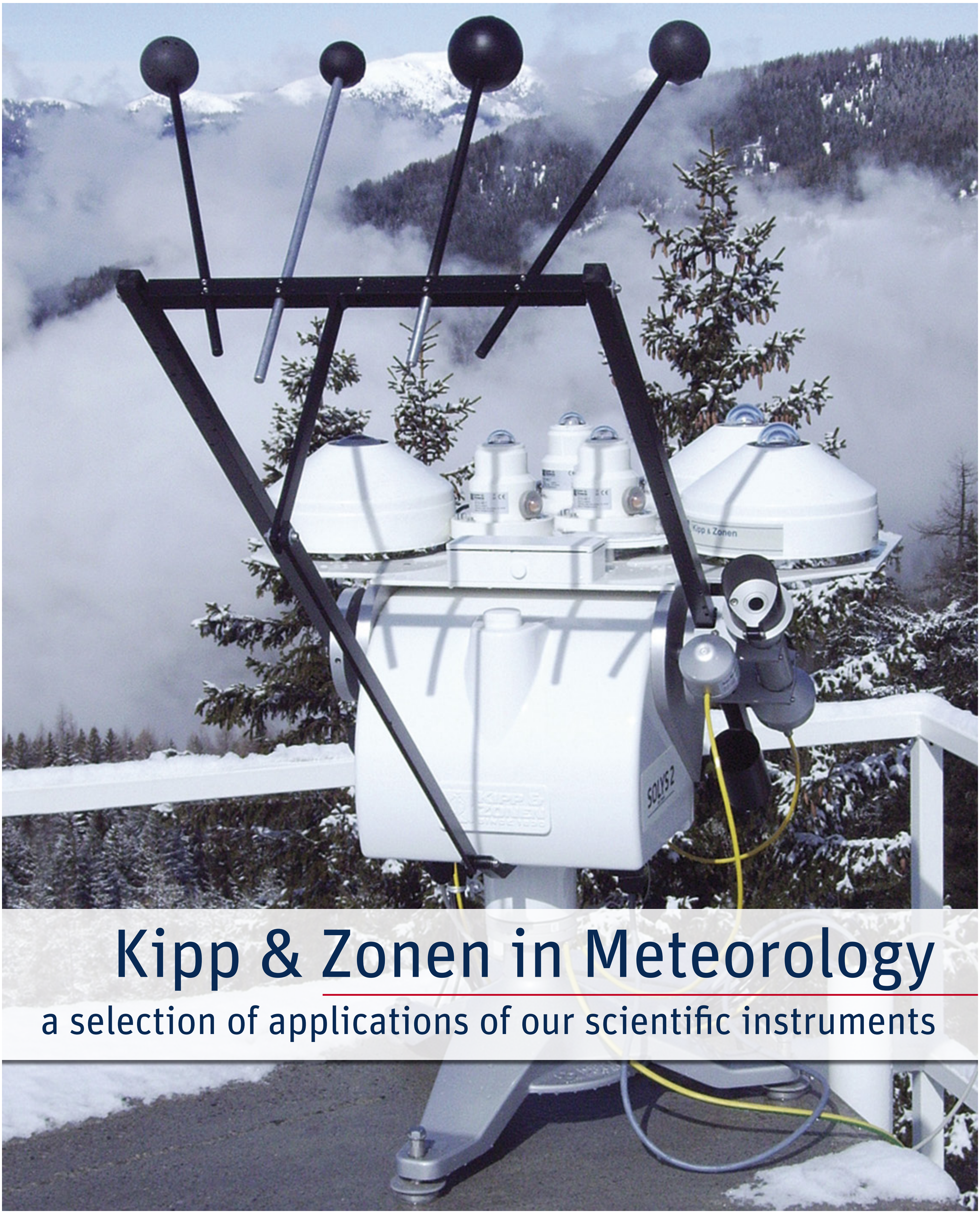

Kipp & Zonen in Meteorology

a selection of applications of our scientific instruments

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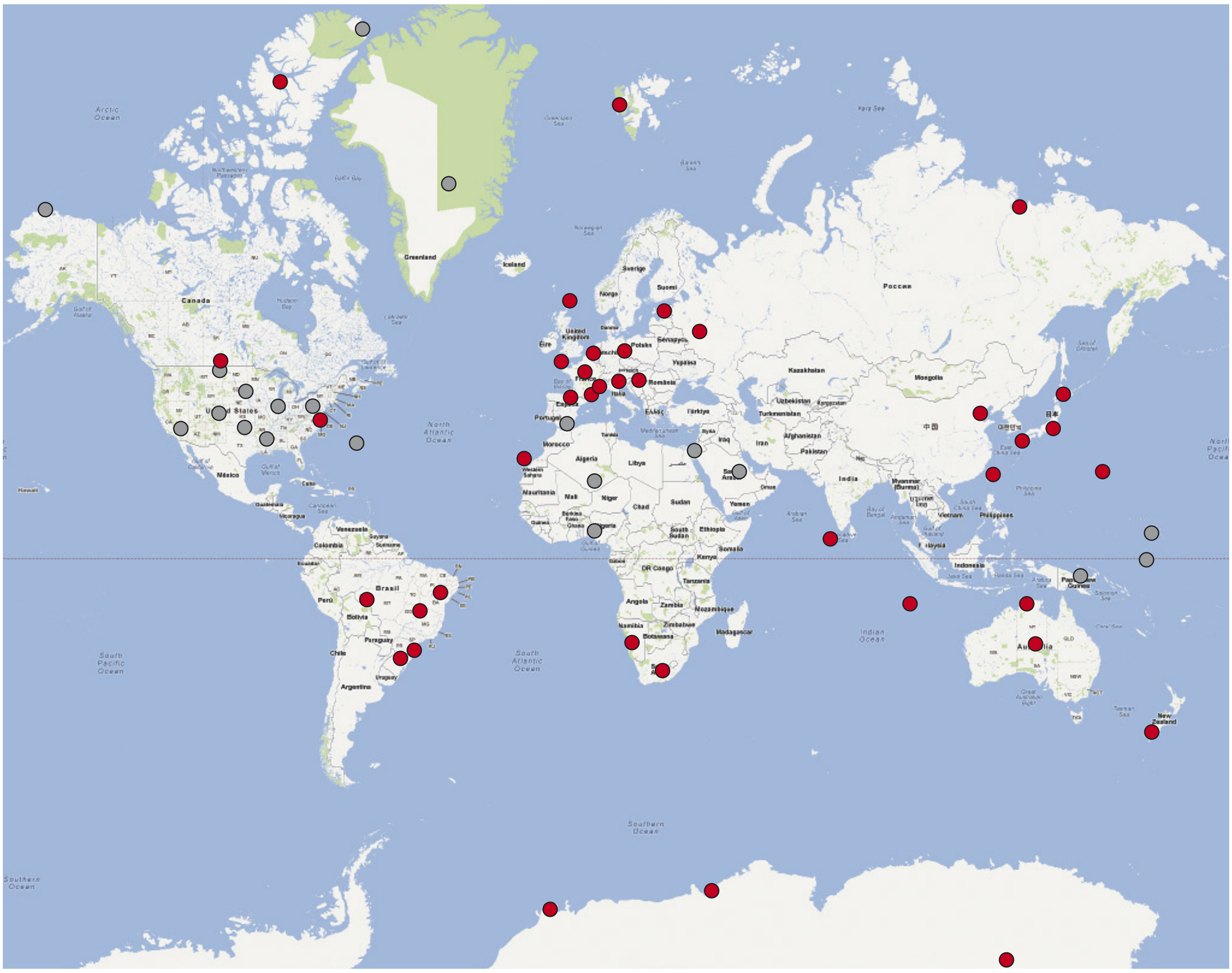
Content

Kipp & Zonen B.V. - 2014

Kipp & Zonen and the BSRN

The Baseline Surface Radiation Network (BSRN) provides the highest quality data about solar and atmospheric radiation and the energy balance at the Earth's surface. More than 60 stations around the world have been accepted by the BSRN, covering all continents and climatic zones from deserts to the Antarctic.



The BSRN global network, 'red' stations are using Kipp & Zonen equipment to measure solar radiation

The instrumentation requirements and operating practices developed by the BSRN ensure that measurements are of the highest quality. The observed data are collected, processed and reviewed by the designated site scientists and provided to the World Radiation Monitoring Centre (WRMC) at the Alfred Wagner Institute (AWI) in Bremerhaven, Germany.

The BSRN was conceived and implemented in the late 1980s as the highest level monitoring network of the World Climate Research Programme (WCRP) to contribute to climate research studies and to calibrate satellite instruments reporting radiation budget data. More recently, BSRN stations also contribute to the solar energy resource studies for the renewable energy industry. Due to the high quality reputation of the BSRN, many solar energy facilities specify a station with BSRN compatible equipment for monitoring solar radiation to the highest standards.

Kipp & Zonen has been supplying solar radiation instruments and automatic sun trackers for BSRN stations since the beginning of the network. The majority of BSRN stations now rely on our equipment for the most precise and reliable measurements. Kipp & Zonen regularly participates in meetings with BSRN scientists in order to understand their needs and to improve our products to meet the requirements of their most demanding applications.

For more information please visit our website and go to Products, select 'Atmospheric Science Instruments', click on 'Scientific Solar Monitoring Station' and then 'Read more'. Under Downloads you will find our overview of the BSRN requirements and compatible Kipp & Zonen instruments.

Find out more about the BSRN at **www.bsrn.awi.de** ■

Arctic Ice Research by SAMS for the International Polar Year

The International Polar Year (IPY) is a large scientific programme focused on the Arctic and Antarctic from March 2007 to March 2009 (to cover 2 complete annual cycles). It represents one of the most ambitious coordinated international science programmes ever attempted. Over 200 projects are designed to explore the impact of climate change and the strong links these regions have with the rest of the globe. Previous IPYs were in 1882-3, 1932-3 and 1957-8. The Scottish Association for Marine Science (SAMS) is a partner in many of the Arctic IPY projects.

The Uncertainties of the Arctic Environment

The Arctic has a major influence on global climate and is the fastest warming region of the globe. The delicately balanced eco-system is particularly vulnerable to natural and man-made impacts. In the summer of 2007 the ice shrank to the lowest area on record and in 2008 there was extensive open water less than 500 miles from the Pole at 83 degrees North.

Four Free-Drifting Stations

Every summer from 2003-2008 an international team of 24 scientists set out on a five week cruise on the Canadian Coastguard flagship, the heavy ice-breaker Louis S. St. Laurent. Their mission was to study sea ice in the Arctic Ocean, to monitor the effects of climate change and the shrinking ice cover. The major contribution of SAMS was to design and build a suite of instruments to measure the flow of heat between the sea, the ice and the atmosphere at temperatures down to -50 °C.

SAMS deployed four autonomous stations to support in-situ observations of the Arctic Synoptic Basin-wide Oceanography program. These free-drifting stations are installed on ice floes to observe key environmental parameters, including the temperature at various depths in the ice, meteorological variables and solar radiation. Measurement of the four components of the radiation balance are provided by a Kipp & Zonen CNR 1 net radiometer mounted at a height of 2 meters above the ice. Two stations feature a novel Conductivity/Temperature/Depth (CTD) package with an automatic winch developed by SAMS to make hydrographic measurements from just below the ice to the ocean floor.

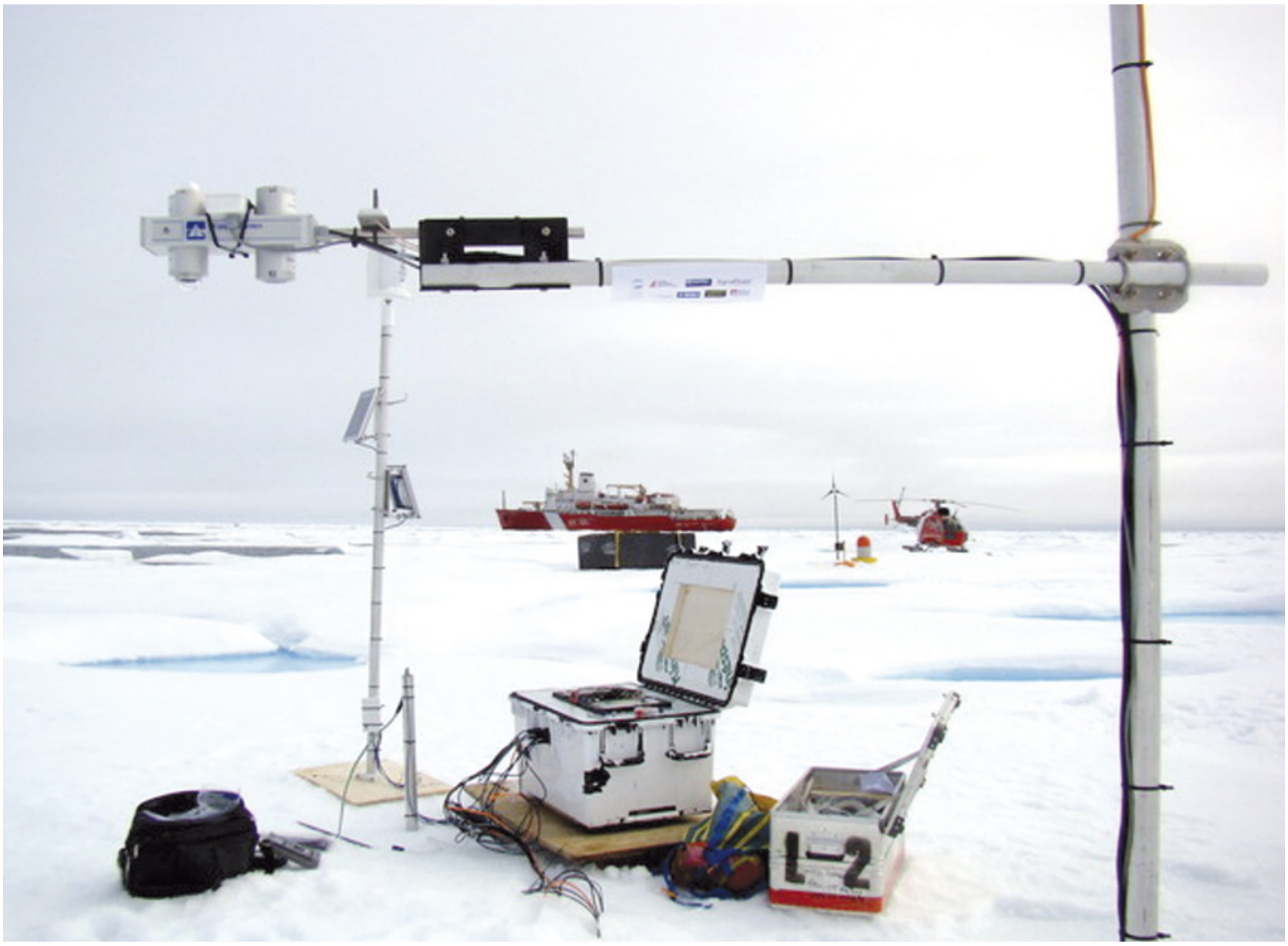
The equipment is powered for up to two years using batteries backed up by solar panels. A webcam at each site records twice-daily images of surface conditions. Data, commands, image 'thumbnails' and diagnostics are transmitted in near real time via the Iridium satellite system, with the option to request full-resolution images as required. The equipment was designed under the leadership of David Meldrum, who is a specialist in glaciology, oceanography and technology and is the only UK member of this IPY project team.

To quantify the energy balance David needed to measure incoming and reflected solar radiation, down-welling and up-welling far infrared radiation and to calculate albedo and energy fluxes. For this he required a high quality, reliable instrument with proven performance in polar conditions. Like many other scientists involved in research in Polar Regions and on glaciers, David chose the Kipp & Zonen CNR 1 net radiometer as a key component of the SAMS monitoring package.

The results of the project will be used to improve our ability to forecast the future of the sea ice and the resulting impacts on the animal and human population for whom the ice is the key to survival.

References

For more information on SAMS or the ice monitoring project go to www.sams.ac.uk or www.whoi.edu/beaufortgyre ■



Russian Solar Radiation Monitoring Network

In 2008 Kipp & Zonen provided the Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet) with solar radiation monitoring equipment to set up the first WMO Baseline Surface Radiation Network (BSRN) station in Russia. The station was installed in Orgurtsovo, Western Siberia.

This first station was just a small part of a major project to update and modernise the Roshydromet network from manual observations to automated measurements and centralised data collection.

Now Kipp & Zonen is proud to announce that we have won the international tender to supply 18 solar monitoring stations to Roshydromet for installation at key locations across Russia. The stations are based on the 2AP sun tracker with active tracking sun sensors, cold weather covers, heaters, tripod stands, height extension tubes and shading ball assemblies.

The trackers are fitted with CHP 1 pyrheliometers, CMP pyranometers and CGR 4 pyrgeometers; to measure direct, diffuse and global short-wave radiation and downwards long-wave radiation. An additional pyranometer and pyrgeometers measure reflected short-wave radiation and upwards long-wave radiation. All the pyranometers and pyrgeometers are fitted with CVF 3 ventilation units.

All four components of the radiance balance are measured and Albedo can be calculated. Six of the stations also have UVS-AB-T radiometers to monitor UVA and UVB. The order includes spare instruments and an additional 2AP station for training purposes, which will be located in Moscow.

Our instruments were extensively tested by the Main Geophysical Observatory (MGO) in St. Petersburg to ensure that they comply with Russian requirements.

The Kipp & Zonen partner in Russia for this project is the Lanit systems integration company of Moscow ■

Making Brewer 100 Ready for the Antarctic

The Brewer spectrophotometer is used to measure Ozone and Ultraviolet radiation all around the world. One very interesting location is in Antarctica. Because of the Ozone 'hole' over this continent, many Brewers are positioned there. Last year we carried out a special project for the new Belgian 'Princess Elisabeth' Antarctic Station.

The Royal Meteorological Institute of Belgium (KMI/IRM) was given a Brewer by their counterparts in the Netherlands, KNMI. Brewer Mk III, serial number 100 has been measuring Ozone and UV for many years at the KNMI headquarters in De Bilt, since 2006 alongside their more recent Brewer Mk III number 189.

Before it was shipped off to the Antarctic, Brewer 100 received an extensive factory check and service. Although 17 years old, it was still in a very good shape. In fact, the Brewer is known for its durability and many of the first Brewers built are still up and running with consistent performance; thanks to good and regular maintenance and service.

To be fully Antarctic-ready, a heater and a cold weather cover were installed. The Brewer was also put in the environmental chamber to determine its temperature coefficients, so that the data will not be affected by temperature changes.

KMI/IRM also operates Brewers 016 and 178 in Brussels. Kipp & Zonen delivered Brewer 100 and our reference Brewer 158 to Brussels, to calibrate all three Brewers at the same time. Brewer 100 was shipped to Antarctica in October 2010, when the summer measurement season started, and was installed by Alexander Mangold of KMI/RMI early in 2011. It is now making high quality Ozone and UV measurements.

Princess Elisabeth Antarctica is the first "Zero Emission" polar station, run entirely on renewable energy sources. It is located at 71°57' South and 23°20' East, on the Utsteinen Ridge, North of the Utsteinen Nunatak, Dronning Maud Land, East-Antarctica. The altitude is 1300 m and it is 190 km from the coast.

You can view Alexander's weblog at http://belatmos.blogspot.com
Visit Princess Elisabeth Antarctica at www.antarcticstation.org ■

© International Polar Foundation - René Robert

Kipp & Zonen LAS helps to improve Water Management in Australia

Formulating strategies for the efficient use of water in agriculture depends on a sound appreciation of the requirements for the optimal health and productivity of crops. This has to be balanced with the water resources available, the demands of non-agricultural water consumers and the environmental impacts.

The Murray-Darling river Basin (MDB) accounts for most of the land surface in south-eastern Australia, and provides a major part of Australia's water resources. The ongoing drought in the region, combined with climate-change expectations, has heightened and emphasised the need for improved water management at farm-regional scales. The condition of the red gum (Eucalyptus) trees along the rivers is a major political and environmental concern in the area.

Satellite remote sensing methods assist in the evaluation of water use over large areas, in terms of the contributions made by different styles of land use, evapo-transpiration rate, and the water requirements of varying types of vegetation.

Australian scientists are using the Kipp & Zonen Large Aperture Scintillometer (LAS), and other instruments, to make local measurements of the surface energy balance components, including evapo-transpiration (ET). These measurements can then be used to 'ground-truth' energy flux estimates derived from satellite data, at farm-regional scales under the unique conditions experienced in the MDB.

The project is supported by the Australian Government's 'Raising National Water Standards' (RNWS) program of the National Water Commission and the Cooperative Research Centre for Irrigation Futures, with support from the Departments of Primary Industries (DPI) and Sustainability and Environment (DSE).

Managed by Dr. Des Whitfield, Senior Systems Agronomist – Horticulture of the DPI, this project aims to provide tools, information and methods for high agricultural productivity on irrigated farms in the MDB with minimal water wastage. Another objective is to provide an approach to the evaluation of the water requirements of environmental assets in irrigated catchments of the MDB.

Comparisons are underway in a strategic range of land uses of the types encountered in the major irrigation districts of the MDB. These include lucerne, tomatoes, vines, and fallow land. Field validation and testing activities in major farming districts will facilitate the application of satellite remote sensing ET algorithms to the major irrigated crops of the region and, also benefit the red gum forests.

LAS measuring over lucerne irrigated by centre pivot sprinklers. The smoke in the background comes from the tragic Black Saturday bushfires in February 2009

Environmental Systems & Services (ES&S) in Melbourne supplies the tools for more effective environmental monitoring and management, providing DPI three LAS systems for these water resource and agriculture management projects. The projects will be further strengthened by research conducted at a number of Australian Universities also using LAS, including Charles Sturt University, Wagga Wagga and James Cook University, Townsville.

For more information on activities in Australia please contact Tim Cookes, Sales Manager, ES&S, tim.cookes@esands.com ■

Meet the Australian team. From left; Tim Cookes, Ashtika Chand, Anna Chinnery and Adam Pascale

Visit to China Meteorological Administration

After our International Sales Meeting in Penang, Malaysia Kipp & Zonen Business Managers Clive Lee and Ruud Ringoir visited the China Meteorological Administration (CMA) at their headquarters in Beijing and at their research centre and BSRN station in Xilinhot, Inner Mongolia. The visit was organized with considerable help from Joe Zhou, General Manager of our Chinese distributor Beijing Techno Solutions Ltd.

Kipp & Zonen instruments at Xilinhot, Inner Mongolia

CMA has a large quantity of Kipp & Zonen products and requested this visit to discuss calibration, specifications, international standards and instrument specific questions. On Sunday 14th of November in Beijing presentations were made about Kipp & Zonen and our products, and more specifically about individual instruments and their calibrations. Beijing had blue skies, a light dusting of snow and temperatures around freezing - a contrast to the +30 °C monsoon conditions in Penang!

The next day we traveled with Joe Zhou and three CMA people to their meteorological centre in Xilinhot, Inner Mongolia. There were a lot of discussions to inform them about installation, maintenance, data management and quality control.

The main measurement station is located 1 hour drive outside the city in flat tundra. The 360 degree clear view and uniform landscape makes it an ideal location for measuring radiation. The temperatures were between -20 °C and -25 °C with strong wind, making inspections of the instruments a chilly experience.

The short mast with a UVS-AB-T and a PAR Lite

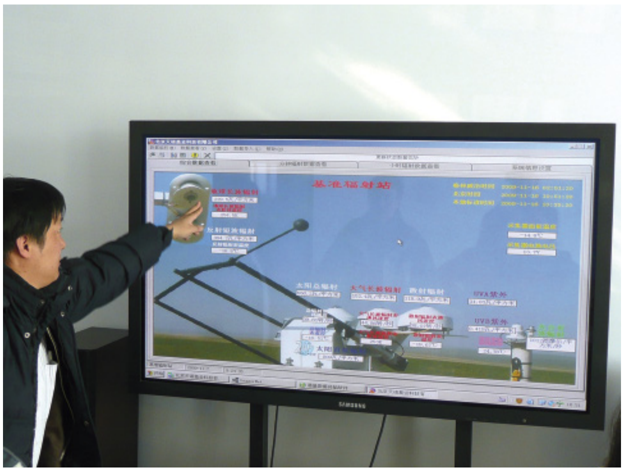
A 2AP sun tracker with shading ball assembly is fitted with a CHP 1 pyrheliometer to measure the direct radiation and ventilated CMP 21 pyranometers for global and diffuse measurement. A ventilated CGR 4 measures the downwards infrared radiation. Alongside the tracker is a short mast with a UVS-AB-T and a PAR Lite, for UVA, UVB and Photosynthetically Active Radiation.

A suitable distance away to avoid shadows is a 30 m mast with downwards facing CMP 21 and CGR 4 for reflected radiation and upwards infrared. This means that all four net radiation components are measured and albedo can be calculated. There is also a fully instrumented 200 m high meteorological tower that includes a CNR 1 net radiometer. With the addition of ventilation units to the downwards facing radiometers the site will comply with the requirements for an Extended Baseline Surface Radiation Network Station (BSRN).

The 30 m mast with downwards facing CMP 21 and CGR 4

A few hundred meters from the measurement site is a building used to collect and analyse the data.

Beijing Techno Solutions carried out the installation, provided the data loggers, and developed software to graphically display all the parameters on a large LCD screen ■



Joe Zhou explains the radiation parameter display

We would like to thank **all the China Meteorological Administration staff** in Beijing and Xilinhot for their hospitality, and **Joe Zhou** for his assistance and enthusiasm.

Operational centre at the Xilinhot station

A Special Sun Tracker Application in the Arctic

Kipp & Zonen's 2AP Sun Tracker has become an industry standard for longevity and reliability in the measurement of solar radiation. The 2AP's high power motors and precision gear drives were what ProSensing Inc. was looking for when developing a steerable remote radar system to study sea ice.

Measurement of the physical properties of snow-covered sea ice for geophysical and climate variable inversion estimation. (Photo courtesy of Dr. John Yackel, University of Calgary)

ProSensing Inc. of Amherst, Massachusetts, USA was founded in 1982. During the early 1990's the company began designing and building remote sensing instrumentation for a wide range of environmental research applications. ProSensing, with its highly qualified technical staff, has successfully deployed equipment all over the world.

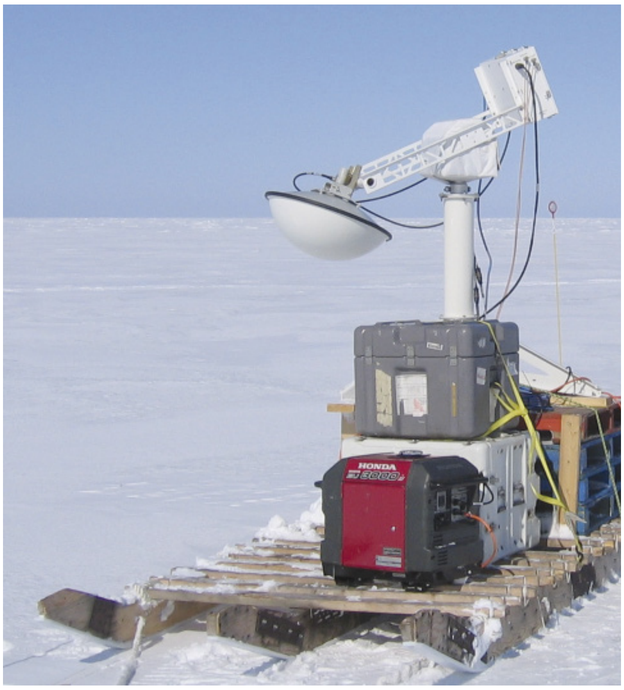
Each 2AP sun tracker is fitted with a cold weather cover, heater kit, tripod stand and height extension tube.

In 2003, ProSensing delivered three C-band Scatterometers to the University of Manitoba for studying sea ice. These solid state radars have very fine range resolution (0.3 m) and are used to investigate how changes in ice structure affect radar reflections at various polarization states. Each Scatterometer is mounted on a Kipp & Zonen 2AP Sun Tracker to accurately position the radar beam in all conditions. The data from these surface-based instruments can be used to improve satellite-based remote sensing of first year and multi-year ice in the Arctic.

During the fall of 2008, Kipp & Zonen USA delivered two additional 2AP's to ProSensing Inc. for further Scatterometers.

Whilst touring the facility, James B. Mead, President of the company, showed us many of the environmental research projects under development. One of the original Scatterometer systems had just returned for a service, after 5 years in the field, and the 2AP was found to be still in perfect condition.

For further information please contact ProSensing through www.prosensing.com



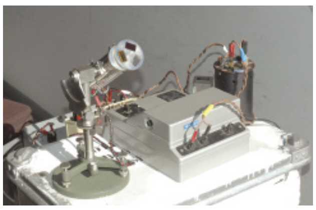
A Visit to the Rothera Station, Antarctica

by Jonathan Shanklin, British Antarctic Survey

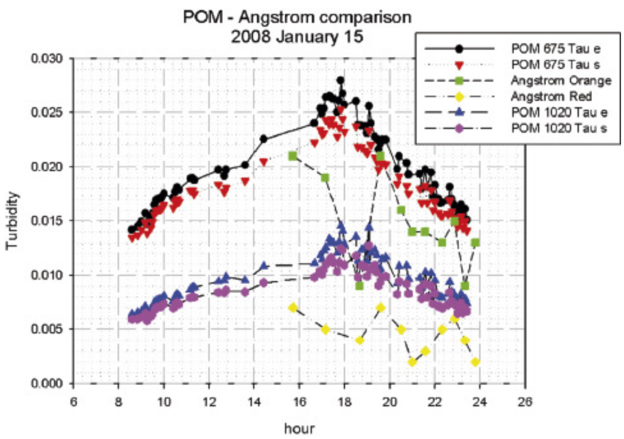
Primarily I was down in the Antarctic to commission some new instrumentation that we had installed at our Rothera Station, which is located on Adelaide Island on the Antarctic Peninsula. My arrival at the station coincided with a spell of good weather, with scarcely a cloud in the sky.

The POM-01 sky radiometer at the Rothera Station, Antarctica

These are exactly the conditions required to make observations of solar radiation, and one piece of equipment that I had to commission was a Kipp & Zonen POM-01 sky radiometer, which automatically tracks the Sun, taking observations of the solar intensity every five minutes through a series of filters.



We had purchased this to replace the old Angstrom pyrheliometer, which had not been calibrated for decades. In addition it took dedication from the observer to produce results, as a single observation needed many adjustments and the readings could take half-an-hour to complete. As a consequence observations had been made relatively infrequently at Rothera, and indeed most of them were made during my occasional visits.



Data from the instruments is used to compute atmospheric turbidity values, a critical variable when simulations of the climate are being run. It was just as well that I took the opportunity to start measurements on my arrival, as the next comparable spell of weather was shortly before my departure at the end of February ■

Solar Radiation Measurements during the 2010 Winter Olympics

By Rosie Howard, MSc. and Professor Roland Stull, University of British Columbia, Canada

In 2003 the city of Vancouver won its bid for the 2010 Winter Olympic Games to be held in British Columbia (BC), Canada. As part of 'Own the Podium 2010', a winter sports initiative designed to help Canadian athletes win more medals, a research team from the University of British Columbia (UBC) built and deployed a sophisticated weather station on the men's Olympic downhill skiing course.

The course is located in Whistler, two hours north of Vancouver in the Coastal Mountains and home to the 2010 Olympic Alpine skiing events. The Nordic skiing venue was the Callaghan Valley a few kilometers from Whistler. Cypress Mountain was the location for freestyle skiing and snowboarding, other events were hosted in Vancouver City.

Automated measurements and manual observations were taken over three winter seasons, 2008-2010. Data from the weather station served multiple purposes:

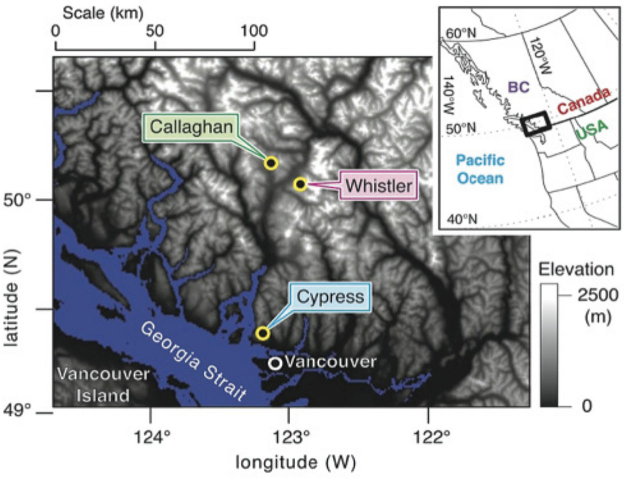


Figure 1, the locations of the 2010 Winter Olympic and Paralympic venues, including Whistler where the weather station was deployed.

1. Real-time use for Alpine Canada ski technicians, to aid them in choosing the fastest ski for current and forecast conditions;
2. Daily use for post-processing numerical weather prediction outputs from UBC models, to improve forecasts;
3. Daily use by the Vancouver Olympic Committee (VANOC) sports and operations managers, for their information and to provide a response if other Olympic teams inquired about the instrumentation, since it was for Canadian use only;
4. The creation of a large dataset (~16 GB) for research into snow surface conditions, mainly snow surface temperature.

The research aims to find relationships between the atmosphere and the snow surface by monitoring how each change with time, and by incorporating anthropogenic effects like grooming the ski run and skiing upon it. This way, ski technicians would have real-time and forecast snow surface conditions from simply knowing the current and forecast atmospheric conditions.

The Olympic downhill skiing course is in a high traffic recreational ski area that is groomed nightly. This presented a major challenge in capturing the effects of the skiers and grooming equipment, and in recording what was happening right at the snow surface, as closely and safely as possible. Therefore, most instruments were suspended directly over the ski run with the rest at the side of the run on a tower, as shown in Figure 2.

Figure 2, the suspended instrument platform above the Dave Murray downhill course and instruments on a tower to the side of the ski run

The CNR 1 net radiometer from Kipp & Zonen played a large part in this research. It was deployed on the suspended instrument carriage (Figure 3) over the snow surface to monitor the four important components of radiation, upwelling and downwelling short-wave and long-wave, with its two pyranometers and two pyrgeometers.

As expected, the surface energy budget is of utmost importance in evaluating the connection between the atmosphere and the snow surface. A preliminary look at the data confirms this, and further suggests that detailed knowledge of the radiation budget is also crucial. This requires all of the four radiation components, as measured by the CNR 1.

The instruments were removed from the site following the Olympic Games, however the study continues. A conceptual model is being created to represent the interaction between long-wave radiation emitted by the sky under different weather conditions, by the tall evergreen trees lining the Olympic course and by the snow surface itself.

This long-wave budget will be combined with solar heating of the snow, as well as other factors in the surface energy budget, to calculate snow surface temperature. Data used during the Olympics, as outlined earlier, was very well-received and feedback indicated that the information was helpful and in many cases improved team performance ■

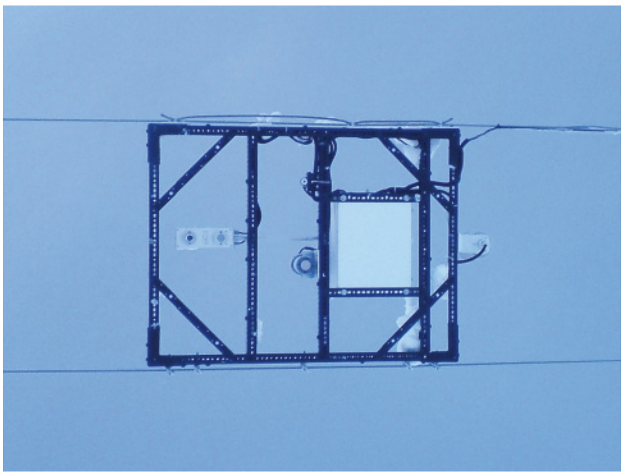


Figure 3, under-side view of the suspended platform

The Kanzelhöhe Observatory in Austria

The Kanzelhöhe Observatory for Solar and Environmental Research is located on the Gerlitzen, a mountain near Lake Ossiach and the city of Villach in Carinthia, the southernmost state of Austria. The observations take place at the western edge of the Klagenfurter Basin at 1526 m above sea level, roughly 1000 m above the valley bottom.

As knowledge about radio propagation evolved it became obvious that the earthly Ionosphere is affected by solar activity. The Observatory was founded in the early nineteen-forties to study these effects and since this time the Sun has been systematically observed every day. The full disk images of the Photosphere (Sun Spots) and the Chromosphere (Flares) are also provided to international observation networks and the internet.

From the beginning classical meteorological observations have also been carried out at the Kanzelhöhe Observatory. With the increasing scientific and public interest in climate change the fields of research were extended to cover this subject, especially with regard to solar radiation and its interaction with the atmosphere.

Kanzelhöhe Observatory is the only observatory in Austria covering these fields of interest and is affiliated to the Institute of Physics at the University of Graz; specifically the Department of Geophysics, Astrophysics and Meteorology. The observing programmes are defined by the scientific objectives of the working groups of the institute. At the Observatory the instruments and observing methods are developed, the measurements and observations are performed, and validation and archiving of data is done.

Due to its isolated location the observatory has an independent infrastructure, from an independent emergency power generating system to a well equipped workshop that enables the staff to perform all necessary mechanical, electrical, and electronic work. Today almost all of the observations and measurements are obtained and saved in digital formats, therefore it is possible to provide access to real-time data via the internet from all over the world.

In the field of atmospheric physics direct, global and diffuse solar irradiance and downwards infrared radiation are measured continuously. For this purpose Kipp & Zonen instruments are operated on a SOLYS 2 sun tracker. The sun tracker carries a pyrheliometer (CHP 1), two ventilated pyranometers (CM 22), and a ventilated pyrgeometer (CG 4). With this instrument setup it is possible to achieve the quality requirements of the Baseline Surface Radiation Network (BSRN).

As part of the Austrian UV measurement network the SOLYS 2 also carries two UVS-AB-T radiometers, for global and diffuse UVA and UVB. In addition there is a CSD 3 sunshine duration sensor.

Kanzelhöhe Observatory is also involved in projects investigating the potential of photovoltaic systems on the basis of an ideal infrastructure combined with the high quality measurement of solar radiation.

For more information about the Kanzelhöhe Observatory please visit http://www.kso.ac.at

Recomatic Electronics Handelsgesellschaft GmbH is the exclusive distributor for Kipp & Zonen in Austria and Kanzelhöhe Observatory would like to thank Recomatic for exceptional support and interest in its research requirements.

Solar Monitoring Station for Moscow Environmental Protection Department

A city can be compared to a complex living organism where it is important to keep all its organs and systems working well. The state of the urban environment is also similar to the health of a living organism and it needs continuous monitoring and diagnostics.

ATTEX engineer Aleksey Lykov on the roof of the Central Aerological Observatory in Moscow

Moscow is a huge urban ecosystem with 2500 km^2 of territory and almost 12 million inhabitants. The task of the Moscow Department for Environmental Management and Protection is to keep this system fit and healthy, using data from its 'MosEcoMonitoring' enterprise. MosEcoMonitoring continuously measures all important parameters of the ecological situation; such as the quality of air, water and soil, noise pollution and the state of urban green areas.

In July 2013 MosEcoMonitoring started to measure solar radiation with a new, state-of-the-art, Kipp & Zonen research station. The data from the station will be used to model processes of air pollution in the urban climate. One of the most important factors in cities is photochemical smog. Smog causes various health problems, including inflammation of breathing passages and lung disorders. It is formed from reactions of industrial gases such as sulfur dioxide, nitrogen dioxide and carbon monoxide with ground level ozone produced in industrial chemical processes.

From international scientific data it is known that there is a correlation between the concentration of ground level ozone and ultraviolet radiation. The researchers expect that continuous precise measurement of solar radiation in the ultraviolet, visible and far infrared wavelength ranges can provide estimates of ground ozone levels. These data will be used to verify the data obtained from open path gas analyzers used in the Moscow ecological monitoring system.

The measurement of UV is also important to determine the UV index that characterizes the harmful influence of UV radiation on human skin. This information is included in meteorological forecasts in countries with developed resort infrastructures and high solar radiation levels but it is also relevant for such regions as Moscow, especially in the summer period.

The solar radiation monitoring station of MosEcoMonitoring is installed on the roof of the Central Aerological Observatory in Dolgoprudny and consists of a SOLYS 2 sun tracker with CHP 1 pyrheliometer for DNI measurements, a CMP 21 pyranometer for GHI measurements and a shaded CMP 21 pyranometer to measure diffuse radiation (DHI). A CGR 4 pyrgeometer mounted on the tracker is used to measure downward long-wave radiation. The pyrgeometer and pyranometers are fitted with CVF 3 ventilation units to assure the cleanliness of the domes and to prevent dew, snow and ice deposition.

The system also has a CMP 21 pyranometer and a CGR 4 pyrgeometer facing downwards to measure the reflected short-wave and upward long-wave radiation to enable calculation of albedo and the complete radiation balance. Finally, a UVS-AB-T radiometer measures the incoming UVA and UVB radiation. The data from all the instruments are recorded by a COMBILOG data logger. There is a meteorological station to monitor parameters such as ambient temperature, pressure, relative humidity, wind speed and direction.

The monitoring station was supplied and installed by our distributor for Russia RPO ATTEX Ltd., of Moscow. ATTEX has a long history of working in meteorological research projects and also developed and realized the data transfer and integration of the new station into the existing systems of MosEcoMonitoring.

You can find more information about ATTEX at www.attex.net and about MosEcoMonitoring at: **www.mos.ru/en/authority/activity/ecology/index.php?id_14=22254** ■

New Insights into the Greenhouse Effect

By Dr. Rolf Philipona, Senior Scientist, MeteoSwiss, Aerological Station Payerne, Switzerland

In September 2011, a Kipp & Zonen CNR 4 net radiometer was used to make the first high quality measurements of radiative flux profiles through the atmosphere from the Earth's surface to above 30 km in the stratosphere. During two-hour balloon flights, the solar short-wave and thermal long-wave radiation was measured, both downward and upward.

Figure 1

CNR 4 mounted between two Meteolabor radiosonde packages

Solar short-wave and thermal long-wave radiation at the Earth's surface and at the top of the atmosphere is commonly measured at surface stations, from aeroplanes and from satellites. However, upper-air observations for climate have recently been given more attention with the initiation of the Global Climate Observing System (GCOS) Reference Upper Air Network (GRUAN) to provide climate-quality measurements of variables in the upper troposphere and lower stratosphere (UTLS).

The primary objectives are to monitor changes in temperature profiles and to characterise water vapour. Temperature and water vapour changes in the atmosphere alter radiative fluxes; so in-situ measurements of the fluxes through the atmosphere, and particularly the UTLS, provide valuable information.

Of greatest importance with regard to climate change are the upward and downward long-wave radiation profiles, which are directly related to radiative forcing through the atmosphere. Measurement of these profiles would provide greater understanding of radiative forcing and the Earth's greenhouse effect.

Researchers from MeteoSwiss used two Meteolabor SRS-C34 radiosondes, which measure air temperature and humidity, and are equipped with additional channels measuring the four thermopile signals and several instrument temperatures from a Kipp & Zonen CNR 4 net radiometer. The CNR 4 was mounted between the two radiosondes as shown in figure 1.

All the body and dome temperatures of the radiometers are measured with the same type of thermocouples as used for air temperature measurement in the SRS-C34. Precise body and dome temperature measurements are crucial to enable corrections for the differential thermal emissions between the radiometer domes and the thermopiles. These result from large temperature gradients caused when the instrument cools from +20 °C at the surface to -60 °C in the stratosphere.

A new technique is used to lift the equipment, consisting of two balloons with carefully adjusted lifting capacities and a GPS-controlled mechanism to automatically release the 'carrier' balloon at a pre-set altitude.

The two balloons lift the payload at a constant climb rate of about 5 m/s. After release of the carrier balloon, the payload descends at a similar rate using the 'parachute' balloon. The balloon arrangement is shown in figure 2.

Figure 2

Figure 3 shows the radiation components at ground level at the Payerne Baseline Surface Radiation Network (BSRN) station. Short-wave downward *(SDR)*, upward *(SUR)* and net *(SNR)* radiation; and the corresponding long-wave radiation, *(LDR)*, *(LUR)* and *(LNR)*. These are 1 minute averages over 24 hours on 23 September 2011.

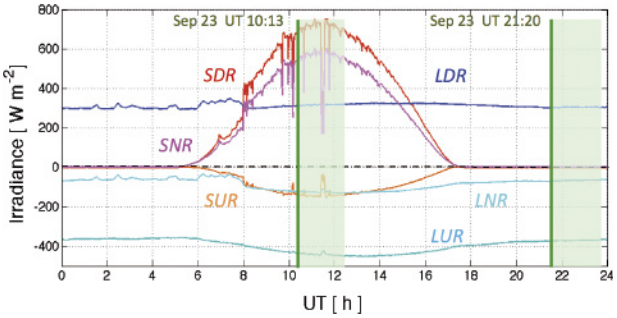


Figure 3. Surface radiation measurements at Payerne BSRN station

The daytime upper-air radiometry sounding was launched from Payerne at UT 10:13. The payload was recovered in the afternoon and launched again at UT 21:20, nighttime. Upper-air radiation profiles for the day and night flights are shown in figure 4.

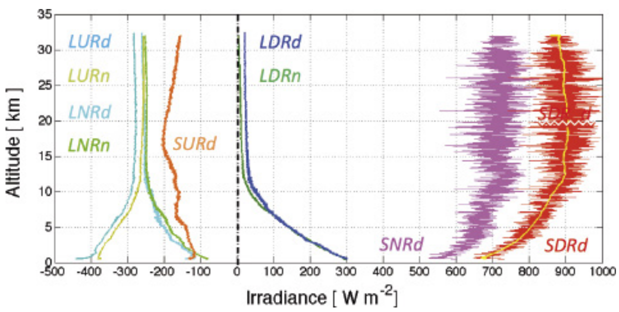


Figure 4. Day and night radiation profiles above Payerne

The daytime short-wave downward radiation *(SDRd)* shows about 680 W/m^2 at the surface and 880 W/m^2 at 32 km. This altitude was reached at UT 12:30. The solar height at the sonde's location was 40.92 degrees, resulting in a direct solar component of 1344 W/m^2. This is more than 99 % of the direct solar irradiance of 1352 W/m^2 above the atmosphere on 23 September.

The measured *SDRd* signal is rather noisy due to rotation of the payload, and to fit a smoothing curve to the dataset a locally weighted least squares regression technique is used (yellow line). The short-wave upward radiation *(SURd)* shows about -130 W/m^2 at the surface and -160 W/m^2 at 32 km. The short-wave net radiation *(SNRd)* is 550 W/m^2 at the surface and 720 W/m^2 at 32 km.

The surface-emitted long-wave upward radiation is about -445 W/m^2 during the day *(LURd)*, but only -380 W/m^2 during the night *(LURn)*. However, *LURd* shows a strong decrease during the first 1,000 m and then decreases to about -280 W/m^2 at the tropopause. *LURn* decreases similarly. Above the tropopause *LURd* and *LURn* stay fairly constant, with the night emission about 20 W/m^2 lower.

Long-wave downward radiation in the day *(LDRd)* is similar to nighttime *(LDRn)* in the lower troposphere, decreasing from about 300 W/m^2 at the surface down to about 15 W/m^2 at the tropopause. Above the tropopause, *LDRn* decreases steadily down to 4 W/m^2 at 32 km. However, *LDRd* is always about 15 W/m^2 higher even at 32 km.

This difference, which is observable above 7 km, is due to thermal long-wave radiation from the Sun. *LNRd* at the surface is about -140 W/m^2, whereas during the night *LNRn* is only about -80 W/m^2. However, the difference decreases with height and at 32 km the day and night net emissions are -270 W/m^2 and -260 W/m^2, respectively.

Consistency observed between different flights, with measurements of more than 99 % of direct solar irradiance at 32 km and long-wave downward radiation down to 4 W/m^2 at 32 km, show that upper air solar and thermal radiation can be reliably measured through the atmosphere.

The radiation profiles shown were all measured under cloud-free conditions, which is normally necessary for greenhouse effect studies. However, future measurements through clouds, aerosols or other atmospheric constituents will allow the investigation of short-wave and long-wave radiative effects, and the climate forcing at different altitudes which is directly related to the greenhouse effects ■

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Rolf Philipona, Andreas Kräuchi, and Emmanuel Brocard. 'Solar and thermal radiation profiles and radiative forcing measured through the atmosphere'. Geophys. Res. Lett., 39, L13806, doi:10.1029/2012GL052087, 2012.

Atlas Weathering Services chooses Kipp & Zonen UVS Radiometers

Kipp & Zonen is proud to announce the recent purchase of twenty-seven UVS broadband global UV-A and UV-A/B radiometers by Atlas Weathering Services Group of the USA. Atlas is a global leader in the field of material testing and advanced weathering services, with test laboratories located in New River, Arizona (DSET Laboratory) and South Florida (SFTS Miami and SFTS Everglades).

These weathering test sites utilize the latest technology in weather reporting instrumentation, such as total solar (Ultraviolet, Visible and Infrared), total UV and narrow-band UV radiometers, and pyrheliometers. The Atlas laboratory test instruments are directly traceable to national and international standards, including the World Radiometric Reference (WRR) and the National Institute of Standards and Technology (NIST).

Broadband UVS Radiometer

In the spring of 2005 Atlas made the decision to replace its ageing fleet of Total UV Radiometers and to host an independent inter-comparison amongst the leading broadband UV radiometer manufacturers to identify the best performing instruments available. Kipp & Zonen accepted the challenge with confidence and supplied a dual-band UVS-AB-T model to Atlas/DSET New River, Arizona for the inter-comparison. In addition to instrument performance, price, delivery time, and in-country support were all criteria of consideration. After a three month evaluation Atlas deemed Kipp & Zonen the victor.

As a result, Atlas purchased nineteen Kipp & Zonen UVS A-T and eight UVS-AB-T models for the Arizona and South Florida Test Facilities locations. These radiometers will be used to acquire high accuracy global UV-A and UV-B solar irradiance data, in order to assess the short and long-term durability of manufactured goods to UV radiation.

Atlas offers a range of materials testing services, including outdoors accelerated weathering testing for characterizing short and long-term UV and visible solar radiation impact on manufactured goods. The range of materials tested includes plastics, rubber products, paints, textiles, and building materials. The test data supplied by Atlas to the manufacturer is critical for determining the durability of the end product; in many cases such material testing is compulsory to ensure that the manufacturer's products meet industry standards.

Intercomparison at Atlas' test facility in Arizona

Atlas also designs and builds turn-key weathering systems that are distributed world-wide, and is buying further Kipp & Zonen UVS radiometers to integrate into these systems ■

Summary UVS Radiometers

Atlas Weathering Services Group in the USA hosted an inter-comparison of broadband UV radiometers to identify the best model available to update their weathering test facilities in Arizona and South Florida. Kipp & Zonen's UVS series was the winner and 27 instruments are now deployed at the two sites ■

Four POM Sky Radiometers for the Italian Air Force

By Marco Mariano of Eurelettronica Icas and Franco Bassetto of Vitrociset SpA

With the increasing interest in climate change and global warming research, the effects of stratospheric aerosols are being studied with greater attention. Aerosols contribute to climate forcing through different mechanisms; on one hand, they interact with the incident solar radiation by reflecting it back to space or by absorbing it. On the other hand, they also act as condensation nuclei, modifying the properties of the clouds, which also affect precipitation efficiency.

For studying the radiative forcing of aerosols, the sky-sun radiometry technique is the most accurate. Sky-sun radiometry is well established for measuring aerosol properties in the atmospheric column. It consists of measuring two variables at ground level; direct irradiance from the sun and diffuse radiance from the sky, in different spectral bands.

The Meteorological Service of the Italian Air Force, along with tasks which are strictly related to their missions of aviation and weather forecasting, is also making special observations such as ozone and solar radiation.

In 2010 the Italian Air Force issued a tender with the objective to procure systems to measure atmospheric turbidity (aerosol optical depth in the atmosphere), to complement their existing measurement network. As a result, four POM-01 Sky Radiometers (manufactured by Prede Co. Ltd. in Tokyo and distributed by Kipp & Zonen) were delivered in 2011 to Vitrociset SpA., the contractor for the procurement and installation. The systems will be installed in the near future at the Air Force sites located in:

Vigna di Valle (RESMA - Research Centre) by Lake Bracciano, north of Rome;
Monte Cimone (CAMM - Air Force Mountain Observatory), in the Appenine Mountains, south-west of Bologna;
Monte Paganella in the Dolomite Mountains; and
Messina, Sicily.

RESMA has been operating for a century with the task of studying and experimenting with meteorological instrumentation and of managing the data collected from special measurement networks; such as ozone, carbon dioxide, global solar radiation, sunshine duration and the chemical analysis of precipitation.

CAMM is established on Mount Cimone, at 2165 m altitude and has the task of carrying out environmental observations, in particular the values of background concentrations of atmospheric pollutants. Besides ordinary observations, special measurements are made of ozone, solar radiation, precipitation sampling and carbon dioxide.

POM-01 and POM-02 are used in the Asia-Pacific SKYNET network, in the European Skyrad Users Network (ESR) and for aerosol monitoring and satellite ground-truthing around the world ■

Vitrociset SpA. **www.vitrociset.it**
Contact: Franco Bassetto

Kipp & Zonen is represented in Italy by Eurelettronica Icas Srl.
www.eurelettronicaicas.com
Contact: Maria Rita Leccese

Kipp & Zonen in the Sky:
New Russian Airborne Research Laboratory

Yak-42 based airborne laboratory 'Atmosphere' on its maiden flight (photo by Sergey Lysenko)

Measuring parameters of the atmosphere over a large territory with high quality has always been a challenge for scientists around the world. Networks of ground-based stations and satellite instruments are routinely used for collecting data about different atmospheric parameters. But the limitations of these methods do not always provide the required quality of data. Ground-based stations require high spatial density and wide distribution over the territory. For such an enormous territory as Russia it is nearly impossible to have stations all over the country, especially as large parts of the country are not easily accessible. Satellite measurements on the other hand, are not always available in the right place and at the right moment and provide a limited set of data. Roshydromet decided to use another approach - a flying laboratory.

The Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet), together with the Central Aerological Observatory in Moscow, and the Main Geophysical Observatory in Saint Petersburg, developed a special instrumented airborne platform (an aircraft laboratory) which will become an effective instrument for environmental research. The new airborne laboratory is named 'Atmosphere' and will perform simultaneous measurements of various parameters of the atmosphere and the Earth's surface with high spatial and temporal resolution in a given region - even in the most remote and difficult to access areas.

The laboratory will also allow the integration of ground-based and remote sensing data in one informational picture. As an extension to its functions the aircraft will also be used for cloud modification and control by means of cloud seeding. The YAK-42D aircraft was specially modified by Myasishchev Design Bureau of Zhukovsky, Moscow Region to satisfy the research needs of Roshydromet and to carry all the necessary equipment.

The aircraft carries a set of equipment that measures gaseous and aerosol composition of the atmosphere. The data enables the identification at an early stage of various climate factors that may lead to changes on regional and global scales. Both natural fluctuations and anthropogenic influences in aerosol composition, concentration of ozone, greenhouse gases, nitrogen oxides and other gases can be detected by the system consisting of lidar, gas analysers, spectrometers and chemiluminescent instruments.

The flying laboratory will be monitoring radioactive contamination of the air and the underlying surface by measuring gamma radiation dose rate and isotopic composition. The measurements made by such an airborne laboratory will allow not only the determination of the amount of pollution but also the identification of possible sources of pollution and directions in which that pollution may spread.

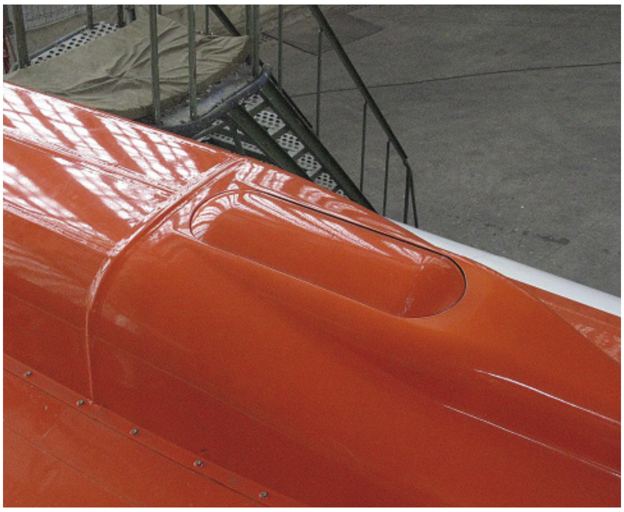
A special radar tracking system is used for research into clouds and precipitation and creating maps of different weather phenomena. Also the aircraft has onboard systems for measuring cloud microphysical parameters and cloud modification equipment.

A set of probes is used to measure electrical characteristics of the atmosphere, such as the potential of the ionosphere and its changes, and electrical charges in the troposphere associated with aerosol layers and clouds. Electrically charged cloud layers often represent a hazard for aeroplanes and the range of instruments onboard the flying laboratory will allow the study of these clouds with great detail.

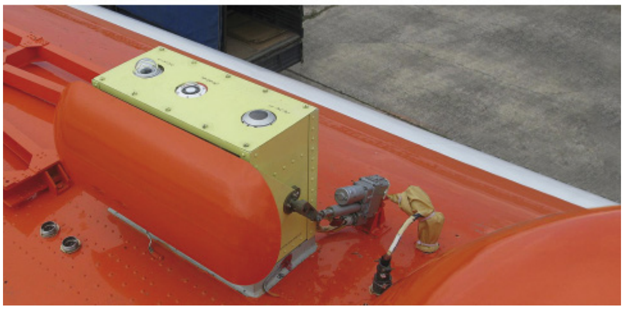
Instruments installed in special booms under the wings of the aircraft measure thermodynamic parameters of the atmosphere such as temperature, pressure, wind speed, humidity and atmospheric turbulences, which are necessary for analysing data from other measurement systems.

Radiative balance and remote sensing of clouds and the underlying surface is measured with a system that includes Kipp & Zonen radiometers. Instruments for measurements of solar, sky and terrestrial radiation were supplied via our Russian distributor RPO ATTEX. Two CMP 22 pyranometers and two CGR 4 pyrgeometers were installed on the top and the bottom of the aircraft to measure downward and upward short-wave and long wave radiation. A UVS-B-T was installed on top of the aircraft to measure the downward UVB radiation.

The instruments were mounted in a rack integrated into a specially designed fairing structure with a retractable cover to protect the instruments when no measurements are taken.



The fairing structure on top of the plane where CMP22, CRG4 and UVS-B-T radiometers are installed. (Photo: Roshydromet)



View with fairing removed: rack with radiometers and the retractable cover. (Photo: Roshydromet)

Measuring the net short-wave fluxes at the aircraft and at the surface allows determination of the absorption of solar radiation by the atmospheric layers below and above the aircraft. By measuring the long-wave thermal radiation at the same time the scientists can evaluate the influences of natural and anthropogenic aerosols and greenhouse gases on the radiative balance.

The data from high precision Kipp & Zonen radiometers are combined with high resolution spectral and brightness temperature measurements made by the scientific equipment developed in Russia by NPO Lepton of Zelenograd, Moscow Region, and the Main Geophysical Observatory.

In the summer of 2013 the new flying laboratory of Roshydromet undertook a series of test flights to test the aircraft and the instruments in various conditions; maximum and minimum height, speed and acceleration, tilts, etc. From November the laboratory started its routine monitoring flights.

You can find more information about the 'Atmosphere' airborne laboratory and other projects on the websites of Roshydromet at **www.meteorf.ru** and the Central Aerological Observatory **www.cao-rhms.ru**.

Our distributor for Russia, RPO ATTEX, can be found at **www.attex.net** ■

Solar Radiation Station Monitors Pollutants in Taiwan

Taiwan is located downwind of sources in East Asia of acid pollutants and dusts, and of Southeast Asian biomass burning emissions. Regional meteorological conditions are favourable for the airborne transport of these, and other pollutants, to Taiwan. The high-elevation Lulin Atmospheric Background Station (LABS) was constructed in 2006 to study the trans-boundary transport of air pollutants and their impact on Taiwan.

LABS is located 2,862 meters above sea level atop Mount Lulin, at the boundary of the counties of Nantou and Chiayi, in central Taiwan. Because of its high altitude, the station's readings are not affected by local pollution from factories, traffic and other domestic sources. It is positioned downwind from the Asian landmass and is therefore ideally situated to monitor long-range air pollutants originating from that source.

There are two major objectives of LABS; to investigate the atmospheric chemistry of precipitation, aerosols, trace gasses, mercury, and atmospheric radiation; and, to study the long-term variability of regional atmospheric chemistry and radiation, as well as climate changes and their impacts on Taiwan.

In November 2008 a complete Kipp & Zonen scientific solar monitoring station was added to LABS. The basis of the station is a SOLYS 2 sun tracker that mounts a set of instruments of the highest accuracy. The SOLYS 2 is fitted with a CHP 1 pyrheliometer and two CMP 21 pyranometers to measure direct, global and diffuse solar radiation. A CGR 4 pyrgeometer is added to measure downward infrared radiation from the sky.

The ideal geographic location of LABS and the local climatic conditions have attracted much international notice. The station has therefore engaged in a number of collaborative projects with organizations from abroad. LABS is operated by the Taiwan Environmental Protection Administration ■

CNR 4 on the North Slope of Alaska

By Steven F. Oberbauer, Ph.D. and Nathan C. Healey, Ph.D. of Florida International University Department of Biological Sciences, Miami

Ecological research currently being conducted on the North Slope of Alaska has been enhanced via implementation of radiation measurements made by Kipp & Zonen products. Here, we employ CNR 4 Net Radiometers at four locations: Toolik Lake (68°37'15.78" N, 149°35'47.40" W), Imnavait Creek (68°36'59.12" N, 149°18'22.69" W), Atqasuk (70°27'N, 157°24'W) and Barrow Alaska (71°18' N, 156°40' W).

This instrument is part of a suite of sensors on mobile platforms designed to examine Arctic ecological characteristics of vegetation through long-term observations within the Arctic Observation Network (AON) and the International Tundra Experiment (ITEX) established in the early 1990's.

We utilize the CNR 4 model at the North Slope locations so that we can analyze all incoming and outgoing long-wave and short-wave radiation among different vegetative communities including dry heath, moist acidic tundra, and shrub tundra, to name a few. At a fifth location, Thule Greenland (76°32' N, 68°49' W), we are using a CNR 2 in conjunction with a CMP 3 pyranometer.

Our daily scans span the Arctic growing season (May to September) enabling us to analyze phenomena occurring over seasonal, monthly, weekly, and daily time periods. These radiation measurements across the Arctic biome are critical for AON-ITEX in order to investigate both short-term and long-term energy, carbon, and water balance studies at the Earth's surface.

We don't only work in Alaska! We have also deployed a lightweight mobile sensor with a CNR 2 net radiometer and CMP 3 pyranometer system above the canopy of rainforest in Costa Rica. And two of our eddy covariance flux towers in the Everglades of Florida as well as the tower in Costa Rica use CNR 2's. And in the Florida Everglades Wetlands we're using a Kipp & Zonen Large Aperture Scintillometer (LAS) for sensible heat flux measurements.

Left: CNR 4 Net Radiometer on support cables at Toolik Lake, Alaska

Right: Steven F. Oberbauer (Principal Investigator) and Nathan C. Healey (Postdoctoral Research Associate) observing the mobile sensor system's support cables and towers

Find out more about the work of the Florida International University Department of Biological Sciences at:
www.biology.fiu.edu ■

The Sunniest Province in Canada, Saskatchewan

By V. Wittrock, Saskatchewan Research Council, Canada.

Saskatchewan is known for being the sunniest province in Canada and the ability to measure and quantify that fact is important. A Kipp & Zonen CSD 3 Sunshine Duration Sensor installed at the Saskatchewan Research Council's new Climate Reference Station at the Conservation Learning Centre, just south of Prince Albert, assists in documenting this important feature of Saskatchewan.

CSD 3 at Conservation Learning Centre

Knowledge of when the sun was shining is used by various industries and sectors; including research, construction, agriculture, tourism, insurance and the legal communities. An example of insurance and legal interest is automotive accidents, which sometimes occur when the sun is shining squarely into the eyes of the driver, resulting in an inability to see properly. Knowing if the sun was shining at that particular moment can be critical if there is an insurance claim or a legal matter to be settled.

Knowing the long-term trend of how the amount of sunshine hours is increasing or decreasing is a key parameter in tracking climate change. It has been projected that the amount of cloud cover will increase and measuring the number of sunshine hours per day, season and year objectively (without the use of models) is critical to monitoring this important climate variable.

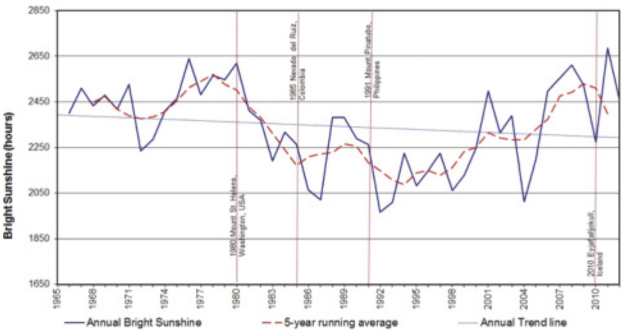
The Saskatchewan Research Council (SRC) has operated a principal Climate Reference Station (CRS) in Saskatoon, Saskatchewan since 1963 and bright sunshine has been one of twenty climate variables collected. Kipp & Zonen's CSD 1 Sunshine Duration Sensor was put into operation in January 2001 and it compared very well to the previous bright sunshine instruments utilised at the CRS.

In 2010 and 2011, SRC expanded its Climate Reference Station network to central Saskatchewan, at the Conservation Learning Centre (CLC) near Prince Albert. A Kipp & Zonen CSD 3 Sunshine Duration Sensor was installed at the new station in the spring of 2011.

‘Bright Sunshine’ is a rather loose and subjective term, largely based upon the Campbell-Stokes glass ball and paper strip instrument, where the length of the ‘burn’ on the paper caused by the focussed image of the sun is proportional to the number of ‘bright’ hours. However, this is highly dependent upon humidity (dampness of the paper), paper type and the observer’s interpretation of ‘burnt’. The instrument requires adjustment every few days to keep the sun’s image on the paper.

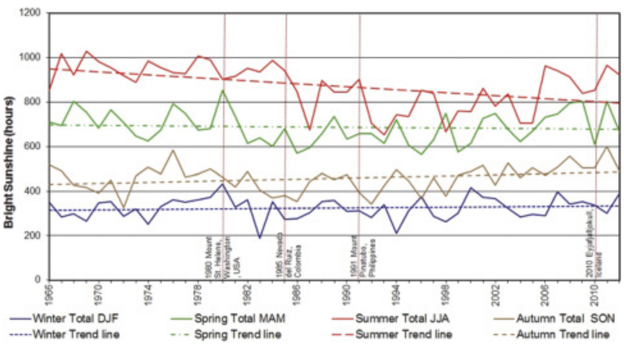
The availability of objective electronic instruments without all these drawbacks, and with real-time data available remotely, prompted the World Meteorological Organisation (WMO) to propose in 1981 that a direct solar irradiance of 120 W/m^2 best represented the threshold of historical ‘Sunny/Not Sunny’ measurements of hours of sunshine in a day. This was finally formalised in 2003 and defined as ‘Sunshine Duration’, with a required daily uncertainty in the number of sunshine hours of ± 10 %. The Kipp & Zonen CSD 1 and CSD 3 Sunshine Duration Sensors meet this requirement.

The Saskatoon Climate Reference Station began recording bright sunshine hours in 1966, and in the last 48 years has recorded some interesting variability and trends. It is possible for Saskatoon to receive up to 4490.6 hours of bright sunshine in a year, but the average was 2264 hours over the years from 1991 to 2010.



Annual sunshine hours in Saskatoon

The 1990s had the lowest number of bright sunshine hours for the period of record. The lowest year was 1992, recording 43.8 % of the actual to possible hours of bright sunshine. This drop was due to a downward trend during the summer season of June, July and August (JJA). Since the 1990s the trend has been towards more annual bright sunshine, increasing further between 2006 and 2012.



Seasonal sunshine hours in Saskatoon

Due to the northern latitude, the number of sunshine hours fluctuates markedly depending on the season. The other three seasons, while variable, do not have a strong upwards or downwards trend. The summer downward trend could have been due to various reasons, including three major volcanic eruptions around the globe, plus it is projected that the amount of cloud cover will increase with climate change ■

Together with our distributor, Campbell Scientific Canada Corp., Kipp & Zonen supports the Saskatchewan Research Council with the service and re-calibration of their CSD 1 and CSD 3 Sunshine Duration Sensors.

As a Campbell Scientific Canada representative explains; “SRC operates two Climate Reference Stations that serve important roles in climate monitoring; in Saskatoon, which celebrated its 50th anniversary in 2013, and at the Conservation Learning Centre near Prince Albert, launched in 2011. Each station has a Kipp & Zonen Sunshine Duration Sensor.

The CRS in Saskatoon is a key site for both the Province of Saskatchewan and the Meteorological Service of Canada climate monitoring network. The CLC station serves as the main meteorological data resource for the many crop development and demonstration programmes at the Centre and also as a learning tool in climate monitoring. It is a regular showcase for numerous school tours, research organisations, and the general public.”

Find out more about the Saskatchewan Research Council Climate Reference Stations at **www.src.sk.ca/industries/environment/pages/climate-reference-stations.aspx**.

Extreme Measures at Mount Sonnblick

When weather conditions are harsh, instruments need to be of the best quality and have an outstanding performance and reliability. Kipp & Zonen products are renowned for their durability and all-weather capabilities and are the equipment of choice for use in extreme conditions.

Mount Sonnblick is such a location. At 3106 m above sea level in the central range of the Austrian Alps it is a world of extremes. The lowest temperature ever recorded was -37.4 °C, the greatest snow depth 11.9 m, and the highest wind speed 242.6 km/h. A perfect location for a 2AP sun tracker that was recently delivered!

The Sonnblick Observatorium, located at the top of the mountain, has been in operation since 1886 and has a large range of instrumentation for meteorology and atmospheric science. This data is combined with satellite and other observations for climate studies. The observatory also researches radiation physics, air composition, hydrology and geophysics, as well as glaciology and pollution of the Earth's atmosphere.

Sonnblick is an ideal centre for atmospheric research because it is an unique environment for scientists. Far away from sources of pollution that affect the careful measurement of the free atmosphere above the European continent and the interaction between solar radiation and precipitation at different heights.

The Central Institute for Meteorology and Geodynamics (ZAMG) is the oldest Weather Service in the World, founded in 1851. It uses the observatory to make reliable, comprehensive observations of the chemical composition and selected physical characteristics of the atmosphere on global and regional scales.

Sonnblick Observatorium participates in the Global Atmosphere Watch (GAW) programme. GAW was established by the World Meteorological Organization amid concerns for the state of the atmosphere in the 1960's. It focuses on global networks for monitoring greenhouse gases, ozone, UV, aerosols, selected reactive gases and precipitation chemistry. The Kipp & Zonen 2AP sun tracker and complete set of radiometers will be used to ensure the highest quality solar radiation measurements, even under extreme conditions.

Recomatic Electronics Handelsgesellschaft GmbH is the exclusive distributor for Kipp & Zonen in Austria and responsible for the installation of the 2AP sun tracker at Mount Sonnblick ■

www.sonnblick.net/portal
for the Sonnblick Observatorium (German only)
www.wmo.int/pages/prog/arep/gaw/gaw_home_en.html
for Global Atmosphere Watch (GAW)

CMP 11 in Automatic Weather Stations in Mexico

By Ing. Víctor L. Hernández, Director de la División de Meteorología, Rossbach de México - Mexico is a country that possesses almost every climatic condition existing on Earth. Glaciers, tropical jungles, prairies and hot and arid deserts are all represented in its vast 2 million square kilometers! The task of the Meteorología of Servicio Meteorológico Nacional (SMN) is to monitor and analyze the meteorological parameters in this large and complex system.

Nowadays, the amount of good data necessary for analysis and prediction of climatic changes requires much more than basic data on temperature and precipitation. Solar radiation is one of the key parameters of the weather and climate which affects many processes on the Earth's surface and in the atmosphere, and it needs to be measured in modern meteorological networks.

Solar radiation is also an important factor for many biologists and agronomists, physicists and material scientists, architects and public health professionals. All of them need precise data on solar radiation to perform their work and research. For others, the special importance of solar radiation is due to growing interest in implementing renewable energy sources.

SMN has a network of Automatic Weather Stations (AWS) which are distributed over the whole of Mexican territory. Each of the 136 weather stations includes a Kipp & Zonen CMP 11 pyranometer to measure global horizontal solar irradiance. The data from the AWS are transmitted every 10 minutes via the Geostationary Operational Environmental Satellite (GOES), operated by the National Oceanic and Atmospheric Administration (NOAA) of the USA.

Map of Automatic Weather Stations in Mexico

In order to keep this network and its valuable data reliable, regular calibration of the sensors is essential. This is why the Secretaría de Energía de México (SENER) funded a project for calibration and maintenance of the pyranometers in the national network to ensure reliable surface measurements for the initial assessment of the solar energy resource of the country. These ground data are also used for the fine tuning of different radiative transfer models for analyzing the data derived from meteorological satellite images.

Calibration of the pyranometers is performed by the Solar Radiation Section (SRS) of the Instituto de Geofísica of the Universidad Nacional Autónoma de México (UNAM) near Mexico City. The Section has over 50 years of experience in the measurement of solar radiation and is one of the three Regional Radiation Centers of the World Meteorological Organization (WMO) for Region IV (North America, Central America and the Caribbean).

The specialists at SRS take care of the preventive and corrective maintenance and calibration of the CMP 11 pyranometers of the SMN AWS network. The calibration is performed according to the international standard ISO-9846:1993 Solar energy - Calibration of a pyranometer using a pyrheliometer. For this, SRS has a reference Eppley HF absolute cavity radiometer (ACR) that regularly participates in International Pyrheliometer Comparisons (IPC) at the World Radiation Center in Davos, Switzerland.

The calibration of the reference absolute cavity radiometer is transferred to a reference pyranometer using a SOLYS 2 sun tracker, according to the ISO-9846:1993 'sun-shade' method. This method requires lengthy observations and specific environmental conditions such as clear skies and a stable atmosphere, circumstances that determine the site and season of the calibration.

The reference pyranometer is used exclusively for calibrations of the field pyranometers of the SNM network and guarantees traceability of the field pyranometer calibration to the World Radiation Reference (WRR) ■

CMP 11 field pyranometers for AWS being calibrated at UNAM

CNR 4 on Top of Mount Kilimanjaro, Tanzania

By Dr. Douglas Hardy, Senior Research Fellow in the Climate System Research Center, University of Massachusetts Amherst

Kilimanjaro's shrinking glaciers have become an iconic symbol of climate change. Our climate measurements at the summit are demonstrating that variability of net radiation is the factor most closely controlling the 'health' of these glaciers. To increase the quality of our measurements, we recently added a Kipp & Zonen CNR 4 to one of the automatic weather stations (AWS).

Kilimanjaro is the highest free-standing mountain in the world with the peak at 5,895 m (19,341 ft) above sea level. The original station was installed in 2000 at an elevation of 5,775 m and includes a CM 14 albedometer and CG 1 pyrgeometer. A second station was added in 2010 and expanded with the CNR 4 and other instruments in 2012.

Together with collaborators at the University of Innsbruck (Austria), measurements and modeling are showing that Kilimanjaro glaciers are primarily sensitive to the variability of snowfall amount and timing. One obvious reason for this is because snowfall adds mass to the glaciers; more importantly, snow governs surface brightness (albedo) which controls the extent to which solar radiation is reflected rather than absorbed.

When radiation is absorbed at the glacier surface, this energy is available to drive melt and sublimation, both of which remove mass from the glaciers and are causing shrinkage. The changes in surface texture and albedo of the ice fields can be seen in the time-lapse pictures on the following page.

The principle objective of our automated stations on Kilimanjaro is characterizing the current summit climate. This knowledge is helping to interpret the long-term history of glaciers on the mountain, the ice-core records, and the larger-scale causal mechanisms driving environmental changes currently underway in east Africa. High-elevation climate in this region of the Tropics is currently not well understood, or linked to longer-term records at lower elevations.

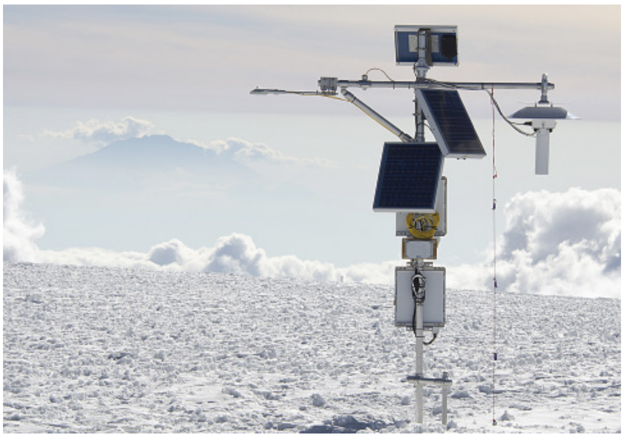
The summit glaciers on Kilimanjaro are ideally suited for radiation measurements, as low humidity combined with intense incoming solar radiation keeps instrument riming to a minimum. Time-lapse camera images demonstrate that instruments are quickly cleared of any snowfall or riming; an occasional issue, especially during the two seasonally-wet periods each year. Wind speed averages 6 m/s, which aids in the accuracy of radiation measurements without necessitating instrument ventilation.

Until our CNR 4 was installed in 2012, we measured each radiation component separately; engineering considerations required situating instruments close to the tower, which influenced measurements. Now, with the lightweight CNR 4, our measurements are being made further from the tower and better represent the four variables. During fieldwork at the site leveling adjustment consumes far less time than is required to level four different instruments.

During the first year with the CNR 4 at the site, median incoming short-wave radiation at mid-day, over all days of the year, was nearly 90 % of that at the top of the atmosphere, illustrating the intensity of radiation on Kilimanjaro. Surface albedo ranged widely, from 0.31 during the dry season to 0.90 following snowfall. Downward long-wave radiation exhibited a distinct seasonality, following the annual cycle of cloudiness and humidity. Upward long-wave radiation measurements are corroborated by surface temperature measurements made with an infrared transducer. In general, measurements reveal a close correspondence between the variability of snowfall, snow-surface age and net solar radiation.

Combined with high-accuracy air temperature and humidity measurements, the data from the CNR 4 on Mount Kilimanjaro are yielding a comprehensive new view of the summit climate. Upon retrieval of the second year of measurements in 2014, we hope to change out the instrument for calibration and make these data available.

Read the full article at: **www.kippzonen.com/kilimanjaro** ■



CNR 4 to left, temperature and humidity sensors to right
Mount Meru 70 km in the background

Northern ice field of Kilimanjaro in October 2012, January and February 2013 at 6 pm

Biography and acknowledgements

Dr. Douglas Hardy is a Senior Research Fellow in the Climate System Research Center at the University of Massachusetts Amherst. Collaborators at the University of Innsbruck include Thomas Mölg and Georg Kaser (Institute of Meteorology and Geophysics). Kilimanjaro climate research has been supported in part by the U.S. National Science Foundation (NSF).

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the NSF.

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The Highest Meteo Station in the World

By Valeria Menichini, LSI LASTEM s.r.l., Milan, Italy

Mountain regions have been designated by the General Assembly of the United Nations as primary indicators of climatic change and as sensors of the health of the Earth. Ev-K2-CNR, a department of the Italian Council for National Research, is realizing the SHARE project (Stations at High Altitude for Research on the Environment).

Specific targets are the improvement of scientific knowledge about climate variability and the impacts of climate changes, and assuring data availability over long periods. To achieve these targets a global network of mountain observatories has been created to study atmosphere composition, meteorology, glaciology, hydrology and water resources, biodiversity and health. These observatories for climatic and environmental monitoring are located across the Alps, Asia and Africa, in collaboration with UNEP, WMO, NASA, ESA and IUCN.

The Ev-K2-CNR Committee is best represented by its Pyramid Laboratory/Observatory located at an altitude of 5050 m at the base of Mount Everest in Nepal. Starting from the Pyramid the SHARE Everest project began in 2008. Since then there has been a meteorological station located on the 'South Col' at 8000 m above sea level that, in the first 3 years, supplied very useful data to the scientific community. This is the highest operational meteorological station in the world.

This year a new automatic weather station (AWS) has been added. "At this moment we have all the standard meteorological data and some are transmitted in duplicate, due to the fact that two stations are installed." says Giampietro Verza, who is responsible for the scientific equipment of the CNR Pyramid and of the whole SHARE Everest project.

"The data collected are; air temperature (more than one probe), humidity, atmospheric pressure, and wind. This is one of the most important and more stressful parameters because winds here can reach 300-350 km/h. For this reason wind is acquired with a system of double sensors and a double recording and transmission system. Moreover, we also have radiometers measuring global and UV radiation. An interesting parameter, that has been implemented, is battery condition, because it has helped to use batteries better than those available in 2008. We will improve in the future, and add additional measurements."

You can find more information about Ev-K2-CNR and the SHARE Everest project at:
www.evk2cnr.org/cms/en/evk2cnr_committee/presentation

The Everest AWS was designed and developed by LSI LASTEM s.r.l. of Milan, Italy (**www.lsi-lastem.it**) and incorporates Kipp & Zonen solar radiation instruments. A crew of the finest Italian alpinists installed the AWS at 8000 m after extensive training by LSI Lastem. LSI LASTEM s.r.l. has been a Kipp & Zonen OEM customer for over 20 years.

Eurelettronica Icas is the dedicated distributor of Kipp & Zonen products in Italy

Moldova's Solar Monitoring Station

Collecting accurate, long-term solar radiation measurements can help increase scientific understanding of the Earth's climate, and researchers in the Republic of Moldova are doing just that through their country's solar radiation monitoring station.

"All radiometric and ozone data acquired at the monitoring station are freely accessible to research centers and universities worldwide." says Dr. Alexander A. Aculinin, a senior scientist with the Atmospheric Research Group (ARG) at the Institute of Applied Physics of the Academy of Sciences of Moldova.

The ARG team is carrying out monitoring of solar radiation, aerosol optical properties and total ozone content (TOC) at the ground-based station located at the IAP in Kishinev, Moldova. The station was completed in 2003 and is situated in an urban part of Kishinev City. It was equipped using financial grants from the Civilian Research and Development Foundation (CRDF Global, USA) and the Moldovan Research and Development Association (MRDA) and under support from the AERONET project, NASA/GSFC.

The station has state-of-the-art instrumentation that consists of three principal automatically operated units; radiometric complex, Skye Instruments MiniMet automatic weather station, and a Cimel-318 sun photometer.

The radiometric complex is a key element of the whole station and it consists of the set of nine broadband radiometric sensors from Kipp & Zonen. The sensors are connected to the "brain" of the station - to the datalogger CR10X SM 4M running under remote control from PCs. Continuous measurements of direct, diffuse and total solar radiation are fulfilled within the wavelength range from UV to IR with broadband sensors such as CM 11 pyranometers, CH 1 pyrheliometer, and SP Lite, PAR Lite, UV-B and UV-A sensors. These sensors are mounted at the stationary (for total radiation) and rotating (for direct and diffuse radiation) platforms.

The monitoring station has been in operation since 2003 and is registered as a regional fixed station by the World Meteorological Organization (WMO). It is installed on the roof of the Institute of Applied Physics and is equipped with state-of-the-art radiometric instrumentation, an automatic weather station and an ozonometer.

"Since the measurement program started we have the opportunity to carry out complex researches, such as interconnection between solar radiation and optical properties of atmospheric aerosols, long-term variability of these parameters and total column ozone content, to use these measurements to validate satellite observations. We've chosen Kipp & Zonen simply because it's very reliable, of course, if it is used reasonably and efficiently."

Data centers with which the team is cooperating include the World Ozone and Ultraviolet Radiation Data Center (WOUDC) and the World Radiation Data Center (WRDC) ■

UV and Solar radiation monitoring at the ground-based station in Kishinev, Moldova

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