SUMMARY REPORT
FROM THE

TENTH SESSION OF THE
BASELINE SURFACE RADIATION NETWORK (BSRN)

(De Bilt, The Netherlands, 7-11 July 2008)

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10TH BSRN SCIENTIFIC REVIEW AND WORKSHOP

I. OPENING SESSION

The 10th Baseline Surface Radiation Network (BSRN) Scientific Review and Workshop was hosted by Dr. Wouter Knap of the Royal Netherlands Meteorological Institute (KNMI) in De Bilt, the Netherlands, from 7–11 July 2008. Dr. Ellsworth Dutton, BSRN Project Manager, and Dr. Hein Haak, KNMI Director of Climate and Climatology, provided opening comments and introductions. The purpose of the workshop was to bring together BSRN scientists, station managers, data users, and experts in areas related to BSRN to review the status of BSRN activities, including the latest developments in instrumentation, operational procedures, data management, and quality control; to discuss some of the scientific progress achieved as a result of the availability of the BSRN and its data archive; and to consider future needs and plans for the BSRN.

Observations and Research Activities at the Cabauw Experimental Site for Atmospheric Research (CESAR) (Reinout Boers, Atmospheric Research Division, KNMI)

The Cabauw Experimental Site for Atmospheric Research (CESAR) is a national observatory run by a consortium of universities and government organizations (i.e., KNMI). It has been operational since 2001, with a data management system operational since November 2008.

The Cabauw site at an elevation of zero is representative of northwest Europe and of the Netherlands (no orography and many different air mass source regions). Aerosol observations were recently added. Instrumentation at Cabauw includes microwave radiometers, Raman lidars, scanning radars, and a rain radar in the tower (SOLIDAR 10 GHz; operational for one year) to measure clouds, water vapor, radiation, and limited trace gases. Cabauw participates in many projects, including BSRN, the Coordinated Energy and Water Cycle Observations Project (CEOP), and the Global Atmosphere Watch (GAW).

Dr. Boers also described the European Integrated Project on Aerosol Cloud Climate Air Quality Interactions (EUCAARI) which is composed of a consortium of 48 institutions from 25 countries. It has two main objectives: (1) reduce the current uncertainty of aerosol particle impact by 50 percent and quantify the relationship between anthropogenic aerosol particles and regional air quality; and (2) quantify the side effects of European air quality directives on global and regional climate and provide tools for future quantifications for different stakeholders.

Overview of GEWEX Activities and Global Data Products (Peter van Oevelen, International GEWEX Project Office)

GEWEX Phase I results and Phase II objectives were reviewed, as well as the current GEWEX organization. Also presented were GEWEX data sets and results, including those of the International Satellite Cloud Climatology Project (ISCCP), the GEWEX Cloud System Study Data Integration for Model Evaluation (DIME) web site and the recently reorganized GEWEX Regional Hydroclimate Projects.

BSRN is considered by the GEWEX community for its value not only as a provider of consistent high quality surface radiation measurements but also as an example of how to organize the scientific community to establish in-situ observational networks of the highest possible quality. However, despite the success of BSRN it is also recognized that even with the Global Climate Observing System (GCOS) adopting BSRN the existence and continuity of this network are not automatically guaranteed and the need for continued funding is still pressing at every level.

Report from the GCOS Secretariat (Richard Thigpen for David Goodrich, GCOS Secretariat)

The presentation addressed some of the recent activities of the Global Climate Observing System (GCOS) atmospheric panel related to BSRN, the preparation of the GCOS Implementation Plan (Second Edition) as requested by United Nations Framework Convention on Climate Change (UNFCC), and the development and implementation of the GCOS Reference Upper Air Network (GRUAN).

II. OBSERVATORIES – STATUS AND PROPOSALS

Status of Newly Instituted BSRN Activities in Brazil (Enio Bueno, Pereira)

Four new BSRN sites are now operational in Brazil (Rolim de Moura, Brasília, Petrolina, and São Martinho da Serra), along with the previous two sites in Florianopolis and Balbina. The Florianopolis site is being moved outside the city and there is a proposal to move Balbina (now in the Amazon) to a Large-scale Biosphere Atmosphere Experiment in Amazonia (LBA) site because its current location is too remote and hard to maintain.

Below is the status of data sent to the BSRN archive:

SONDA (months)

STATION	2004	2005	2006	2007	2008	Total
Bras’lia (BRB)			10	11		**21**
Petrolina (PTR)	6	7	10	11	2	**36**
S‹o Martinho da Serra (SMS)		12	11	12	5	**40**
Total	**6**	**19**	**31**	**34**	**7**	**97**

BSRN (months)

STATION	2004	2005	2006	2007	2008	Total
Bras’lia (BRB)			8	10		**18**
Petrolina (PTR)			1	7		**8**
Rolim de Moura (RLM)				2		**2**
S‹o Martinho da Serra (SMS)			9	12	3	**24**
Total			**18**	**31**	**3**	**52**

Proposal for the Inclusion of Eureka, Nunavut as a BSRN Station (Bruce McArthur, Environment Canada)

Eureka is located on the western side of Ellesmere Island in Canada’s high arctic, and was created as a weather station in 1947. The data are used as a World Meteorological Organization (WMO) standard for temperature and precipitation. Ozone sondes have been launched regularly there since 1957. In 1993 an Arctic research laboratory was established at Eureka by Environment Canada. Since 2005, the research activities have been coordinated by the Canadian Network for the Detection of Atmospheric Change (CANDAC). The site was used for the validation of Cloudsat and Calypso satellite data.

The primary focus of the site is atmospheric physics, whereas Alert’s research activities tend to focus on atmospheric chemistry. Access is also quite different—Eureka is reached via charter aircraft from Yellowknife or Resolute. Alert is reached via National Defense flights originating in Trenton, ON, and stopping in Thule, Greenland.

For stratospheric ozone monitoring, Eureka uses a Differential Absorption ozone Lidar (DIAL), a Brewer spectrometer, and ozone sondes plus special flights. Radiation measurements are obtained using a Kipp and Zonen CH1 pyrheliometer (direct beam measurements), a Kipp and Zonen CM21 (global and diffuse measurements), and an Eppley Precision Infrared Radiometer (PIR). Current plans are to measure reflected solar and outgoing IR measurements in 2008 or 2009.

Data is collected using BSRN standards on a CSI CR23x logger, and is transferred hourly to Bratt’s Lake (as well as stored locally on a computer).

The Radiometric Station CENER (Pamplona, Spain): Candidate for BSRN Station (Raquel Gastesi, Barasoain Public University of Navarre)

The National Renewable Energy Centre (CENER) has invested the necessary resources to set-up a high performance radiometric station, following BSRN standards for both station location and instrument selection, as well as their arrangement. Currently, the acquisition, storage, and monthly report generating processes are being defined in accordance with BSRN standards.

The main objective is to provide CENER with a baseline station for the solar radiation studies carried out in Spain that are related to solar energy thermal use. The data generated by this radiometric station will be used for:

- The validation and study of lower quality Spanish station records that CENER currently evaluates as a service to other companies within specific projects.
- The validation of satellite image treatment models that CENER is introducing as a solar radiation resource estimate.
- The validation and retesting of numerical models that CENER uses as a solar radiation resource estimate.

The inclusion of a CENER radiometric station within BSRN would vastly improve the effectiveness of these efforts and make available to the related scientific community important information on solar radiation in a currently poorly characterized geographical region.

Status of BSRN Measurements at Concordia Station (Dome C – Antarctica) (Vito Vitale, ISAC-CNR)

Concordia station offers a unique opportunity for long-term monitoring of the East-Antarctic Plateau atmosphere. In fact, the South Pole station—which is approximately 1000 km south of Concordia at a lower latitude (90°S versus 75°S) and elevation (2900 m versus 3250 m)—is largely affected by air masses of western origin and can experience significantly different weather conditions (e.g., the mean temperature is several degrees Celsius warmer, the mean wind is stronger, the mean snow accumulation is 4 times larger). During the austral summer of 2005–2006, a BASIC set of radiometers was installed at the new Italian-French station of Concordia (75°S, 123°E). All equipment was located near the first container of the Concordia Atmospheric Research Observatory (CARO), S-SW of the winter station at a distance of about 700 m from the main buildings. The equipment sits on a platform 2.8 m high that provides a perfect horizon, with only the main station representing an obstruction of 2° in zenith and approximately 5° in azimuth at about 60°NE.

In the last 2 years, recent procedures have allowed continuous operation, providing an almost complete global and down-welling irradiances time series (0.94 percent and 0.97 percent, respectively). Unfortunately a long series of failures in the tracking system (August 2007–January 2008) prevented the same performance for diffuse and direct solar components (0.66 percent of possible data). Quality check analysis results show that the data is good. Failures were found, in general, to be below 1 percent for physical possible limits (PPL) and extremely rare limits (ERL) tests. Long-wave down-welling irradiances were found to be in general below 200 Wm^{-2} with a significant percentage below the ERL minimum. This is a consequence of the particular characteristics of the site; a specific climatology is needed for this parameter. Comparison tests (global over sum, diffuse ratio, long-wave vs. temperature) exhibit failure percentages ranging from 6 percent to less than 1 percent, respectively. A test on tracking indicates that only 0.25 percent of measurements could be affected by error in pointing towards the sun.

On a daily basis data are compressed (to about 400 Kb) and sent to Italy using standard e-mail. In Italy an automatic procedure analyses the data, evaluating 1-minute averages, determining corrections for different effects, performing quality check procedures, and producing graphical products. If necessary, a procedure is implemented to graphically check the row data (1 Hz sampling).

During the year 2007 upwelling measurements were implemented, allowing the first evaluations of the albedo at Concordia. During the austral summer of 2007–2008, measurements of spectral UV radiation were obtained using a UV-RAD instrument built at the Institute of Atmospheric Sciences and Climate (ISAC) of the Italian National Research Council (CNR). A new sun-photometer with 14 channels that allows sky-brightness measurements was also installed and should be operating during the austral summer of 2008–2009.

A code for preparing data files for archival is being developed and planning is underway for data submissions to the BSRN archive, expected to be finished no later than the end of summer 2008.

Overview the BSRN Site in Tiksi, Russia (Anatoly Tsvetkov, WRDC/MGO)

A short description of a station history and its importance in coordinated research work in the Arctic region had been given. It was mentioned that the Arctic and Antarctic Research Institute (AARI) in Sankt-Petersburg, Russia (Roshydomet) and the National Oceanic and Atmospheric Administration (NOAA) have made initial joint steps towards implementing new equipment according to the BSRN site needs. Also, the Zvenigorod Research Station (the Institute of Atmospheric Physics of the Russian Academy of Sciences (IFA RAS)) and agrometeorological station Ogurtsovo near Novosibirsk (Roshydromet) are being considered as future BSRN sites.

Azores Global Atmosphere Monitoring Complex (AGAMC) and Surface Radiation Measurements in the Azores (Fernanda Carvalho, Delegacao Regional dos Acores, Instituto de Meteorologia de Portugal)

There are three monitoring sites in Azores:

1. The José Agostinho Experimental Observatory (OEJA), located in Angra do Heroísmo, has been a part of the regional station Global Atmosphere Watch (GAW) network since 1992. The first global irradiance measurements taken in Portugal using conventional instruments and methods were done in this Observatory in 1937.

2. The Serreta Experimental Observatory (OES) (38.775ºN; 27.360ºW; 100 m)

3. The PICO-NARE Experimental Observatory (OEP) (38,471ºN; 28,403ºW; 2225 m a.s.l.)

Suggestions for additional sites in Spain (Maria Lopex Bartlome and Maria Palomo)

Various sites of the Spanish National Meteorological Service were suggested as possible future BSRN sites. Discussions and evaluation of those sites is ongoing. It was suggested that Spain follow through with this suggestion and offer the continued long-term operation of one of the sites as identified by the BSRN project manager.

III. ARCHIVE ACTIVITIES

The World Radiation Monitoring Center at the Alfred Wegener Institute (Gert König-Langlo, WRMC)

After 15 years of nearly continuous operation at the Federal Institute of Technology Zurich (ETHZ), the World Radiation Monitoring Centre (WRMC) went through a transition that resulted in the archive being relocated to the Alfred Wegener Institute (AWI) in Bremerhaven, Germany, under the direction of Gert König-Langlo. As of 7 June 2008, full responsibility for the operation of WRMC is at AWI. For a limited time the WRMC at ETHZ will warehouse the archive in a frozen state.

At the end of the transition phase all original station-to-archive files submitted to ETHZ will have been copied to the new archive at AWI. Furthermore, all files submitted to the new archive have already been imported into the new archive, including the new stations from Brazil. At the moment of transition 4,032 station-months from 43 stations exist.

From now on newly submitted station-to-archive files will get accepted only at the new FTP server: ftp.bsrn.awi.de. All station managers need an individual account including written permission to download new files into their individual directories. New accounts may be obtained from Gert.Koenig-Langlo @awi.de. Only computers known in the domain name system (DNS) are allowed to login. Please consult your local system-administrator in case of problems.

The new internet address from the WRMC is http://www.bsrn.awi.de; this provides manuals, software required to use BSRN data, and links to the aforementioned FTP server, which also serves as an outgoing file server for any customers who accepted the data release guidelines. Read accounts can be obtained from Gert.Koenig-Langlo@awi.de. The customers can download the whole FTP-archive if desired, whole station directories, or just single monthly files. The public (outgoing) FTP-server has the same structure as ETHZ, containing gnuzipped station-to-archive files with UNIX end-of-line characters. In contrast to the files at ETHZ, they do not contain quality flags or derived quantities. They follow strictly the format defined in the Technical Plan for BSRN Data Management.

In addition to the FTP-service, the new archive offers data access via PANGAEA, a Publishing Network for Geoscientific and Environmental Data (http://www.pangaea.de/). PANGAEA guarantees long-term availability of its content through a commitment of the operating institutions. PANGAEA follows the "Recommendations of the Commission on Professional Self Regulation in Science for safeguarding good scientific practice." The policy of data management and archiving follows the Principles and Responsibilities of ICSU World Data Centers and the OECD Principles and Guidelines for Access to Research Data from Public Funding. Each data set is identified, shared, published and can be cited by using a Digital Object Identifier (DOI). PANGAEA metadata are searchable on Google; furthermore, PANGAEA offers a Google-like interface for searching and distributing BSRN-data via web.

Special link tables are included in the new web pages, which help in the location of BSRN data. The metadata can be accessed without login, but a login is required to access the data itself. To log in you can use the same read account used to access the FTP archive.

The incoming station-to-archive file format will stay unchanged as long as no other decision is officially announced. New incoming files should be prepared strictly according to the Technical Plan for BSRN Data Management. Files should be approved by the station scientist before they are submitted to the archive, using the f_check.c program offered at http://www.bsrn.awi.de/en/software/. It is recommended that files be produced and checked in the Unix environment, as this will guarantee that the end-of-line character of the files will automatically be correct (LF instead of CR, LF). Files prepared in a Windows environment should be changed to UNIX-format using tools like dos2unix.

All files—both in and out—on the FTP server are compressed to save space and speed up the data transfer. It is strongly recommended that users gzip all incoming files, using the free software http://www.gnu.org/software/gzip/ for Unix may be used and the free software http://7-zip.org/ for Windows.

In the past, the format for the synoptic observations has been ignored by nearly all station scientists. Thus, only a few synoptic observations are available via PANGAEA. Please recognize that many of the options for decoding synoptic observation within the GTS are not accepted within the WRMC! Please make sure that your synoptic observations are properly formatted. As an example, see:
01009 10393 42998 10093 20083 30034 40160 71000 81070 333 87458 8//// 8////

The format for AOD-measurements described in the station-to-archive format turned out to be unusable. Following the proposal of Bruce Forgan, AOD-data will be accepted in the new WRMC in the near future. Data quality management will start as soon as possible.

There are now more than 4,000 station months of data available, including:

- 43 stations — basic solar direct, diffuse and down welling long wave irradiances
- 9 stations — reflex; long wave upward
- 10 stations — UV
- 13 stations — synoptic data
- 23 stations — up air soundings
- 7 stations — total ozone
- 2 stations — ceilometer data

The Long-Term Archiving Activities at the WRDC and Current Operations Related to GAW/BSRN Data (Anatoly Tsvetkov, Voeikov Main Geophysical Observatory, World Radiation Data Center)

The archiving activity, upgrading of the WRDC web pages, and processing of data submitted by the GAW and BSRN stations were presented. Examples of long-term time series analysis were also demonstrated. In the near future, remote users will receive access to all archived and current data needed for educational and research purposes.

New Archive Advisory Panel

The Archive Advisory Panel was established at this meeting. Members include:

- Chuck Long
- Martin Wild
- Ells Dutton
- Gary Hodges
- Steve Wilcox
- Gert Konig-Langlo
- Anatoly Tsvetkov
- Lamine Boulkelia
- Fernanda Carvalho

The role of the Archive Advisory Panel will be to advise the project and archive manager on matters relating to the routine activities of the archive. An initial meeting of the group was held during the week and some suggestions were entertained for the group’s future activities. It was decided that there should be a network-wide questionnaire concerning the desire to provide additional data streams. The Project Manager will conduct that survey. Concerning synoptic formats being submitted to the archive, it was suggested that the archive manager dictate whichever format would be most beneficial to him and the network. Relations and interactions with the WRDC in Russia were also discussed briefly and it was determined that there were no outstanding issues relative to the relationship between BSRN and WRDC. The WRDC has always been an enthusiastic and capable contributor to BSRN meetings.

IV. BASIC OBSERVATIONS—ANALYSIS AND REVIEW

NREL Radiometer Calibrations and Data Quality Assessment Methods (Steve Wilcox, NREL; Liza Boyle, University of the Pacific)

The National Renewable Energy Laboratory (NREL) has developed the Broadband Outdoor Radiometer Calibration (BORCAL) method for calibrating pyranometers and pyrheliometers. The process produces several responsivities and characterizations for calibrated instruments, including a responsivity function that allows correction of cosine error in field use. A study shows that use of this function reduces errors as much or more than methods of IR offset correction. NREL has also developed methods of data quality assessment for large-scale network solar radiation measurements. These methods provide automated tools to aid in the rapid detection of systematic and other errors common to solar measurement networks.

Characterizing the Radiation Environment of the BSRN Sites (Rachel Pinker, Department of Atmospheric and Oceanic Science, University of Maryland)

It was demonstrated that observations from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument on board the Terra and Aqua polar orbiting satellites can be used to characterize the radiation climate of ground sites such as those maintained under the BSRN activity. MODIS data are available at the global scale at a resolution of 5 km and, as such, are suitable for up-scaling and studying the spatial representativeness of each site. Satellite-based estimates are available at a wide range of grid sizes.

A Proposed Working Standard for the Measurement of Diffuse Horizontal Shortwave Irradiance (Joseph J. Michalsky, Earth System Research Laboratory, NOAA)

Atmospheric radiative transfer model estimates of diffuse horizontal broadband shortwave (solar) irradiance for clear skies have historically been larger than measurements from a shaded pyranometer. A reference standard for the diffuse horizontal shortwave irradiance does not exist, and there are no known efforts to develop an absolute standard. The case for a working standard for this measurement was provided by Michalsky et al in 2007; four well-behaved pyranometers from two prior intensive observation periods (IOPs) (Michalsky et al., 2005; Michalsky et al., 2006) were chosen for this study. The instruments were characterized for spectral and angular response before the IOPs and calibrated during the IOP using a shade/unshaded technique with reference to direct irradiance from an absolute cavity radiometer. The results of the comparison and detailed analyses suggested selecting three of the four for the working standard. The 95 percent confidence uncertainty in this standard is estimated to be 2.2 percent of reading + 0.2 Wm^{-2}. In lieu of a comparison to this trio, a method for selecting pyranometers for low-uncertainty diffuse horizontal shortwave irradiance is suggested.

References:

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The Effects of the Thermal Environment on the Eppley Normal Incidence Pyrheliometer (Steve Wilcox, NREL)

The Eppley Normal Incidence Pyrheliometer (NIP) has been in use for several decades, commonly used throughout the world for the measurement of direct beam solar radiation. A study has shown that the instrument has a small (< 2%) but identifiable sensitivity to the thermal environment (temperature gradients and wind) that can change the instrument's apparent response to solar radiation. These effects manifest themselves on two general time scales: daily cycles (a smile profile) or shorter excursions that cycle up and down in a period of an hour or two. Models were developed to aid in removal of these effects but other factors, such as wind direction, may be responsible for incomplete characterization of the effects found in this study.

Responsivity of the Lindenberg BSRN Pyranometers Determined with Different Methods (Klaus Behrens, Lindenberg Meteorological Observatory, German Weather Service)

The calibration and characterization of pyranometers are important to ensure measurements of global and diffuse solar radiation with a small uncertainty. After looking for suitable methods, which allow the calibration and characterisation during routine measurements, the following methods were chosen:

1. Pseudo-Composite Method (presented by B. Forgan, Australia, during IPC VIII in 1995 at Davos, Switzerland)
2. Mix-of Sun-and-Cloud Method (presented by D. Halliwell et al. during the 9th BSRN Meeting in 2006 in Lindenberg, Germany)

For both methods, a well calibrated and maintained pyrheliometer and a pyranometer that measures diffuse solar radiation is necessary, while in the case of the Mix-of Sun-and-Cloud Method the pyranometer for the diffuse radiation has to be calibrated.

Using the Pseudo-Composite Method, one gets the responsivity of the pyranometer measuring global solar radiation for the used clear days, depending on zenith distance for every calculated minute. The Mix-of Sun-and-Cloud Method delivers only the responsivity for single zenith distances, if the calibration conditions are fulfilled. So, it is necessary to "gather" the responsivities to get a picture about the dependence on zenith distances. In general, one gets sufficient data within a month for a check of the responsivity of a pyranometer.

Both methods have the advantage that the results may be calculated afterwards without disturbing the routine measurements. A comparison of both methods showed that the results of the chosen samples were in good agreement. Both methods complement one another.

Pyranometer Calibration and Characterization: Comparing Results from Mix-of Sun-and-Cloud Calculations to ISO/ASTM Alternating and Continuous Sun-and-Shade Methods (David H. Halliwell, Environment Canada, Experimental Studies Section)

The method of determining pyranometer calibration values (responsivities) using changes in direct and global solar radiation caused by natural variations in cloud conditions, originally described at the 2006 BSRN meeting in Lindenberg, is compared to calibrations based on existing international standards (International Organization for Standardization (ISO) 9846, American Society for Testing and Materials (ASTM) G167-05). The comparison uses approximately 3 months of data collected from July–October, 2007, at the Bratt's Lake Observatory (Regina BSRN station) in Saskatchewan, Canada. Two Kipp and Zonen CM21 pyranometers were operated on a tracking system in either alternating sun and shade mode, or continuously unshaded (global) mode, allowing a combination of alternating sun and shade and continuous sun-and-shade calibrations, as well as calibration with the new analysis method. Using mean responsivities for elevation angles in the 35–55° range, the two ISO/ASTM standards agree within 0.3%. The results of the new method fall between the values determined using the two standards, confirming that the method provides an accurate estimate of the responsivity of the pyranometer. The new method also provides estimates of the responsivity as a function of elevation angle that compare well with the results from the standards.

First Analysis on Albedo Measurements at Concordia Station and Comparison with South Pole Evaluations (Christian Lanconelli, Institute of Atmospheric Sciences and Climate (ISAC))

There is great interest by the satellite community in utilizing ground-based data collected at the bi-polar network of stations for validation of retrievals. In particular, the albedo—or surface reflectivity—measured from space has been problematic, showing a low bias. Dome C (DOMC, 75°S123°E) was considered a better prospective target than the South Pole station (SPO), which is off-nadir from polar orbiting platforms and has a slightly sloped and much rougher surface. This makes SPO a less-than-ideal validation target. Polar orbiters pass nearly directly over DOMC several times a day providing an excellent target that is virtually level and almost flat due to the light winds. This makes DOMC an ideal target or validation location.

In April 2007 upwelling flux measurements started in Concordia station. An albedo rack was installed and equipped with 2 CMP22 pyranometers and a CGR4 pyrgeometer. Encouraged by the National Aeronautics and Space Administration (NASA), albedo measurements were instigated during austral summer 2007–2008 at Dome C. To verify their accuracy and representativeness, comparisons with ongoing measurements at the South Pole were undertaken. The diurnal cycle of albedo at the two sites differs markedly but can be of the same order of magnitude, ranging from <0.80 to >0.91 on a clear day during summer. It is critical to recognize that evaluations vary over time and from place to place when utilizing ground measurements for validation purposes. At DOMC, the large variation is due to the solar geometry that changes over the course of the day. Large values occur at sunrise and sunset or when the sun is low on the horizon, due to enhanced specular reflection of the sun off the bright surface. At SPO this is not the case, however, because the sun's zenith angle on any given day varies very slightly. The apparent cycles, which vary depending on the measure of shortwave up (SWU) used in the computation, depends on the surface roughness (the amplitude and orientation of the sastrugi relative to the field of view of the down-facing radiometer). The distinctive features of the daily cycle of albedo at the two sites are further demonstrated, highlighting the zenith angle effect at DOMC and azimuthal anisotropic effects of surface reflection at both sites.

Finally, to determine if there are any systematic differences in albedo at the two sites, monthly mean evaluations were compared. The results are meant to quantify the fundamental measure of reflectivity, on average, on month to seasonal time scales over the Antarctic Plateau (i.e., what portion of incoming solar radiation is reflected by the surface on average?). Ultimately, this is the variable that is important for climate change studies and is one that satellite retrievals must be able to duplicate, and models must be able to simulate

We find that the albedo, on average over the season at the two locations, is about 0.83 ± 0.03. Until similar analyses are made in the future, this is the best evaluation we can make using surface measurements. It was pointed out that calibration of all instruments in use must be precise, the leveling and tracking must be accurate, and the higher the down-facing radiometer the better for integrating effects of sastrugi. It is also obvious that there may always be effects of sastrugi that must be accounted for when interpreting satellite data.

A Proposed Improvement to the Laboratory Calibration of Pyranometers (Joop Mes, Kipp and Zonen)

As a part of improvements to the indoor calibration procedure at Kipp and Zonen, we have investigated the influence of different parameters upon the calibration of our pyranometers. The effects of the time constant of the thermopile, the type of calibration lamp used, the inhomogeneity of the light field and the pyranometer stabilization time have been investigated. The use of the measuring the dark voltages to determine the offset of the instrument is doubtful. A suggested better calibration method is presented.

V. WORKING GROUP REPORTS

Aerosol Optical Depth Working Group (Bruce Forgan, Joseph Michalsky, Christoph Wehrli, Vito Vitale, Mikhail Alexandrov, John Augustine)

1. Transmission Submission Survey
   A survey was distributed early in the year to provide information on potential submissions to the BSRN archive of transmission data. A separate report is being prepared for the July 2008 Workshop.

2. Transmission Data Submission
   The interaction with two groups on how to submit transmission data to BSRN in October 2007 provided some minor revision of the format and distribution of example data sets. This version was distributed with the survey.

   Three BSRN 'station' groups have previously 'supplied' transmission data. However, this is a bit hollow as they all get their raw signals data processed by the chair of the Aerosol Optical Depth (AOD) Working Group, who converts their in-house data into BSRN format. They are: New Zealand-Lauder, United Kingdom-Lerwick, and Australia (Alice Springs, Darwin, Cocos Is.) This conversion work has now been suspended pending the outcome of the July 2008 Workshop.

3. Transmission Code
   A source code package has been completed (MS C++) that can be used to either read or write transmission file data. Components of the code have been used to develop a program to test transmission data submissions; however, the testing has been limited and there have been no 'external-to-developer' data submissions. Work on the code has been suspended. Whether this code will need to be distributed is dependent on the outcomes of the July 2008 workshop.

   Code has been developed to do quality control of the transmission file submissions based on existing methods used within the Australian/NZ network and Global Atmosphere Watch (GAW). Its veracity with systems other than the Australian/NZ/GAW/UK radiometer systems will be dependent on data submissions.

4. Derived data formats
   Formats for the AOD+, AOD, and AOD half hourly stats have been generated from existing samples; they are essentially an extension of the transmission format and (hopefully) self explanatory. The output concatenated to the supplied transmission data files includes:

   (a) AOD plus AOD (plus cloud) for each submitted data record
   (b) AOD and Angstrom slope coefficient (i.e., filtered AOD+ using a modified Alexandrov algorithm, and hence volume is dependent on the cloud filtering)
   (c) half-hourly statistics of AOD and Angstrom exponents

   This has forced some limitations on the models used to progress from one level to another. To enable the same processing across sites, a minimum common model had to be adopted. For example, molecular extinction information had to be simplified to assume sites had no vertical radiosonde profiles, and is thus simply based on observed station level pressure. This will have impact on sites with very low AOD. More limiting factors are expected if data submission conditions are relaxed.

The half hourly AOD statistics were introduced to allow easy submission of BSRN station data to other AOD archives (i.e., the GAW Aerosol Data Archive prefers hourly statistics).

5. GAW and BSRN
   Christoph Wehrli and Bruce Forgan are in discussion on the initial algorithms for conversion from transmission to AOD plus, and AOD, with the aim to have consistency between the GAW AOD Manual and the base BSRN algorithms. Similarly, there have been discussions to enable easy conversion of the BSRN AOD product set to a set compatible with the requirements of the GAW archive. All the AOD and meta data required for the GAW Archive are available from the BSRN transmission and AOD formats.

   Development of routines to generate the file formats required for the GAW AOD archive (hourly statistics) from the BSRN format data sets had been under development but have been suspended given the lack of data submissions.

6. Algorithm development
   Cloud screening for AOD-only periods, together with calibration, remain significant issues.

   Joe Michalsky has been investigating using ancillary all sky photos to eliminate contamination of the AOD record by thin cirrus. The results are available at ftp://ftp.srrb.noaa.gov/pub/users/joeget_aer_wg_michalsky.ppt. Attempts to base selected points on Angstrom slope coefficients have not been successful to date but are still being investigated.

   At the 2006 meeting of the Atmospheric Radiation Measurement (ARM) Program .Ross Mitchell (Australia) presented a discrimination between thin cirrus and tropospheric aerosol using multiple measurements including Light Detection and Ranging (LIDAR), all sky photos, and sun photometers (http://www.arm.gov/publications/proceedings/conf16/P00067.stm). John Augustine and others in the BSRN community have released a comprehensive report on the analysis of the Surface Radiation Budget's Multi Filter Rotating Shadowband Radiometer (SURFRAD MFRSR) record from 1997–2006 (JGR, 113, DIL204, 2008) and highlights calibration and cloud screening issues.

   The well-known clear sky detection methods by Chuck Long using global and diffuse irradiance records are being compared to those used by Rickstuhl, Philipona et al (GRL, 35, LI2708, 2008) by Bruce Forgan. While there is a high correspondence between "reasonable" AOD and clear skies detected by the Long method, it tends to eliminate periods which appear to be unaffected by cirrus; the Rickstuhl and Philipona method has some potential for extended clear sun periods given that each BSRN site monitors sunshine in one form or another.

   Work on the impact of high frequency in-situ calibration methods at Australian and New Zealand sites with high frequencies of clear skies has been pursued by Bruce Forgan. There appears to be a relationship between monthly averaged calibration values and AOD even for those methods that take into account systematic changes in aerosol throughout the cal period. While the range of the changes are small (<1%) they do suggest an impact related to the vertical profile of aerosol.

   These activities all suggest that BSRN irradiance data sets and the potential spectral transmission BSRN data are well placed to assist in resolving cloud screening issues and point to the necessity of providing an optical depth data set unbiased by cloud selection algorithms (i.e., the AOD plus product). It could provide a verification tool for satellite radiance products, as well as a ground-based indicator of cirrus at non-LIDAR locations.

   The influence of the atmosphere on in-situ spectral radiometer has diminished with recent in-situ calibration methods, but it is clear that to eliminate apparent small cyclic variations in assumed top of atmosphere values, a stable spectral irradiance based reference that can be operated in the field may still be required. The recent release of low cost charge-coupled device (CCD) radiometers and silicon trap detectors are promising in this regard.

7. Associated Activities
   BSRN members (Vitale, McArthur) and associates of the BSRN community have been involved with the Polar Year activities and with a recent workshop related to AOD measurements in Polar regions. These should have a positive effect on BSRN if the submission specifics of such data is pursued, as the focus on reducing uncertainty of polar AOD products is different to those required for the majority of BSRN AOD sites.

8. Recommendations:
   If the BSRN community does not develop a BSRN spectral transmission database as part of the BSRN Archive as has been proposed and worked toward for the past several years, then:
   (a) the remaining AOD WG should be disbanded, and the non-data-base activities be shifted to the Spectral Irradiance WG;
   (b) BSRN community members who derive AOD should be encouraged to submit their data to the GAW Aerosol Data Archive.

   This determination will depend on the development and dissemination of new data submittal guidelines and formats made by the BSRN participants who are involved in AOD observations. This change became necessary due to the apparent complexity and lack of interest in the original spectral transmission submittal guidance provided by the WG.

Pyranometer Working Group (David Halliwell, Klaus Behrens, Chuck Long, Martial Haeffelin, Wouter Knap, Rakel Gastesi, Lourdes Ramirez)

Though the Pyranometer Working Group has not been active during the past 2 years, a review of related presentations made at this meeting on pyramometers shows that instrument calibration is still an issue. Organizing a calibration round-robin was suggested. Future work for the Pyranometer Working Group includes conducting a calibration comparison with BSRN stations, WMO labs/regional calibration centers, and instrument manufacturers. See iDavid Halliwell if interested in participating.

Direct Beam Working Group (Ells Dutton, Steve Wilcox, Klaus Behrens, Patrick Fishwick, Thomas Stoffel, David Haliwell, Donald Nelson)

The Direct Beam Working Group continues to investigate sources of pyrheliometer departures from absolute cavity measurements. The sources of the departures are considered to be field of view, window material and environmental effects, as well as particular instrument design features that can compound local interaction with the micro-climate. It is now generally accepted that the BSRN deployment is dependent on commercial pyrheliometers and that original BSRN specification for the routine operation of an all-weather cavity has not been realized due to persistent insurmountable issues with such deployments, although isolated cases of success were reported but not duplicated. It is now generally recognized by the group that uncertainty in the operational measurement of the direct solar beam now consists of the larges source of uncertainty in the BSRN error budget specific to downwelling irradiances.This situation was reached after considerable advances in both the downwelling IR and solar diffuse uncertainties and now stands out as requiring further actions. As a result, the Direct Beam Working Group has proposed a year-long intercomparison of all available pyrheliometric instrumentation with both all-weather and unwindowed absolute cavities. The purpose of this comparison will be to better constrain these measurements and develop error probability density functions for a variety of current pyrheliometers relative to the best available operation of cavity radiometers over a full range of environmental conditions. While this will contribute to an understanding of relative performance of pyrheliometers, it will still leave a gap between the performance of open unwindowed cavities during ideal conditions and that of the all-weather instruments when the absolute measurements cannot be made.

This comparison will be hosted by the U.S. Dept of Energy National Renewable Energy Lab in Golden Colorado between November 2008 and September 2009. All participants and their contributed instruments have been submitted and the comparisons, now known as the Variable Conditions Pyrheliometer Comparison (VCPC), will be reported on at the next meeting.

Pyrgeometer Working Group (Rolf Philipona, Joseph Michalsky, Julian Gröbner, Klaus Behrens, Tom Stoffel, Alexander Los)

Pyrgeometer calibration is presently based on the World Infrared Standard Group of Pyrgeometers (WISG). The WISG is composed of four pyrgeometers that were calibrated, installed, and are maintained by the Infrared Radiometry Section of the World Radiation Centre (WRC-IRS). The role of the WRC-IRS is to disseminate this scale to the worldwide community either by individual instrument calibrations at the Physikalisch-Meteorologisches Observatorium Davos of the World Radiation Center (PMOD/WRC), or (preferably) through the creation of pyrgeometer groups at regional calibration centers, which are traceable to the WRC-IRS.

A black-body BB1995 is used in the laboratory of WRC-IRS to characterize the pyrgeometers, that is, to determine the calibration constants C, k_1, k_2, and k_3 used in the pyrgeometer equation (Philipona et al., *Appl. Opt*., 34, 1598–1605, 1995). Measurements of the black-body and of the pyrgeometer are done at various equilibrium temperatures to simulate outdoor conditions. A new blackbody BB2007 has recently been built at PMOD/WRC to meet advanced technical demands. The sensitivities derived with the new blackbody BB2007 are within 1 percent to the ones derived with BB1995, which is within the estimated uncertainties of the characterization procedure (Gröbner, *Appl. Opt*, 2008, accepted).

The absolute calibration of the WISG is traceable to the International Pyrgeometer and Absolute Skyscanning Radiometer Comparison campaigns: IPASRC-I at the ARM Southern Great Plains (SGP) site in Oklahoma in September 1999 (Philipona et al., *JGR,* doi:2000JD000196, 2001), and IPASRC-II at the ARM North Slope of Alaska (NSA) site in Barrow, Alaska, in March 2001 (Marty et al., *JGR,* doi:2002JD002937, 2003). A second absolute IR instrument is presently being built at PMOD/WRC, which in the future will hopefully affirm the Absolute Skyscanning Radiometer (ASR) (Philipona, *Appl. Opt*., doi:10.1364/AO.40.002376, 2001) and the WISG measurements, thereby also confirming Atmosphere Emitted Radiance Interferometer (AERI) measurements and well-established model calculations that were in good agreement during the IPASRC campaigns.

Several Institutions have already established their own Regional Infrared Standard Groups of pyrgeometers (RISG) traceable to WISG (DWD Lindenberg, NREL Golden, NOAA Boulder). Specific experiments and calibration campaigns were made to further investigate pyrgeometer measurement uncertainty, including:

- J. Gröbner, and A. Los: Laboratory calibration of pyrgeometers with known spectral responsivities (*Appl. Opt.,* doi:10.1364/AO.46.007419, 2007). The responsivities retrieved using this new individual laboratory calibration agree to within 1 percent with the responsivities determined by a comparison to the WISG, which is well within the uncertainty of both methodologies and is an additional back-up of the WISG and its absolute calibration.

- I. Reda, J. Gröbner, T. Stoffel, D. Myers, and B. Forgan: Improvements in the blackbody calibration of pyrgeometers. This work improved the ARM/NREL pyrgeometer calibration (*http://www.arm.gov/publications/proceedings/conf18/index.php?sort=author#R*).

- J. Michalsky: Blackbody IR calibration via regression. This campaign shows the uncertainty resulting from different pyrgeometer formulas (*ftp://ftp.srrb.noaa.gov/pub/users/joe/joepapers/*).

Uncertainties Working Group (Bruce Forgan, Klaus Behrens, David Halliwell, Thomas Carlund, Charles Long, Laurent Vuilleumier, Thomas Stoffel)

1. Formulation on how to differentiate uncertainty sources:
   Work is progressing on specifying a process to elucidate the differentiation between the older methods utilizing “systematic” and “random” uncertainty sources with the ISO Guide to the Expression of Uncertainty in Measurement (GUM) methodology, especially when irradiances are averaged or integrated. Based on papers and reviews in recent years, this maintenance of the pre-GUM institution of a distinct difference between “random“ and “systematic“ uncertainty sources (compared to the GUM justification of treating all uncertainties identically) appears to be a major stumbling block to use of the GUM in solar and longwave radiometry. Even if two relatively simple solutions are available, namely when:

(a) Type B calibration 'constants' components are incorporated as uncertainties to the penultimate result, not the initial uncertainties, or
(b) calibration and digitization uncertainties are treated as correlated quantities when providing an intermediate uncertainty in a process to ensure that the correlated uncertainties are documented with the uncorrelated uncertainties—especially if the correlated terms can be expected to exist as a component in the final result.

Both methods produce nearly identical results. The second method is more mathematically rigorous, however, and requires more attention to detail.

The lack of use of correlated components in early BSRN dissemination of the ISO GUM, particularly in deriving calibration coefficients, has typically resulted in higher uncertainty in the calibration process (as distinct from the use of derived sensitivity coefficient) rather than reflecting the reality. This will hopefully be addressed in future reports.

2. Tests of Uncertainty Estimates

Charles Long and Liang Shi's work in developing an automated algorithm building on the original BSRN tests and the extensive BSRN and ARM data sets has been a significant step forward in providing the community with a well documented and accessible traceable methodology [http://www.bentham.org/open/toascj/openaccess2.htm — click on "view year 2008" and look for the following: Long, C. N., and Y. Shi, (2008): An Automated Quality Assessment and Control Algorithm for Surface Radiation Measurements, TOASJ, 2, 23–37]. Further improvement of these tests can be anticipated as more uncertainty analyses provide information on the significance of the various limits.

Other work has progressed on the assessment of in-situ calibration methods to estimate the typical 'environmental' factors usually used to accommodate realistic spreads of results; these factors are usually a result of unknown factors effecting uncertainty or poor measure and definition. It also impacts the relevance of the calibration process verses the use of a ('calibrated') sensitivity to derive irradiance. For example, the provision of primary (direct + diffuse) and secondary global (pyranometer only) irradiance values has always raised the dilemma of the intrinsic value of the pyranometer set with a significantly poorer uncertainty, including adjustment by the in-situ “direct + diffuse“ ratios and the provision of data to an archive without uncertainties estimates.

There are potentially interesting times ahead as the user climate community incorporates uncertainties into modeling activities.

Laurent Vuilleumier has produced a report on the comparison between the Swiss Alpine Surface Radiation Budget (ASRB) and the Center for Hazard and Risk Management (CHARM) downwelling shortwave (SWD) flux measurements, showing excellent agreement. The root mean square error (RMSE) representing the spread of the data around the regression line is below 10 Wm^{-2} since 2004 with maxima in summer and minima in winter, but at Jungfraujoch it is more challenging to maintain the stability of the measurement technique. At Payerne, the linear regression slope is significantly different from 1.0, which indicates potential calibration problems. The work also showed that the agreement between ASRB and CHARM data is less good for Long Wave Downward Radiation (LWD) measurements than for Short Wave Downward Radiation (SWD) measurements. However, once the calibration technology for LWD has changed, following the introduction of the absolute sky-scanning radiometer, (ASRB - Philipona, 2001) the differences are on the order of 2–3 Wm^{-2}. Such comparative studies are very useful in determining uncertainties for a number of measurements associated with solar and long wave measurements and statistics.

Work has been continuing using Australian network data to compare the following in-situ pyranometer calibration methodologies:

(a) component sum
(b) alternate method
(c) total diffuse comparison
(d) scattered-cloud method (Halliwell, McArthur et al., 2006)
(e) pseudo-sun-disk (IPC 1995)
(f) Fredholm solutions (using data from a, b, d or e)

and where possible, in-situ sun-shade calibrations. The results are very encouraging, showing close agreement (< 0.5%) for statistical means for discrete zenith angles. Once applied, the typical differences between the various solar components is < 8 Wm^{-2} (as represented by the station pyrheliometer) for slowly varying irradiance conditions. Whether this is a result of the model of pyranometer used or the consistency of the methods, the results will require examination of data from sites with instruments having more significant directional responses.

The pyranometer calibration results also raise the question of the submission of the two types of global irradiance to the BSRN archive. Should the pyranometer-only global irradiance submitted to the BSRN be corrected to reflect the best estimate of the pyrheliometer-diffuse combination using in-situ derived directional response (as per Long and Shi), or represent the irradiance derived using a minimal approach? The former essentially represents a high uncertainty version of the (likely) lower uncertainty pyrheliometer combination. This point was discussed during the original discussions on data submission in 1991; perhaps the discussion needs to be revised.

3. Generating Uncertainties for Missing Data
   There has been some experimentation with use of the law of propagation of distributions (LPD) as opposed to the law of propagation of uncertainties. Both are acceptable means according to the ISO GUM, but LPD is good in non-linear situations and doesn't suffer from the over-estimation of 95 percent uncertainty for rectangular distributions.

   However, it does require distributions and associated statistics generation of probability distribution functions prior to the use of Monte Carlo methods. Initial results—as applied to deriving the uncertainty of annual solar expressed as daily mean solar exposures (MJm^{-2}) with missing daily exposure values—has proven promising but suggest close examination on how monthly and annual climatological averages (and their uncertainties) are generated. It has some application in refining uncertainty estimates in the global enhancement/dimming debate and methodology that generates daily exposures when data samples are missing at maximum response times for station outages.

4. Uncertainty Propagation in Documentation
   There has been good initial collaboration between BSRN, the WMO Commission of Instruments and Methods of Observation (CIMO), and the ISO on providing consistency in either initiating documentation on uncertainty, or providing consistency in ascribing uncertainties. However, given the difference in timelines of the various procedures needed to introduce change in standards documentation, it may be several years before basic minimum common denominators can be established.

   The timelines suggest that it may be impossible to expect ready consistency between BSRN, CIMO, and ISO. This is not surprising given the different stakeholder base, but it is of concern as ISO represents a political solution for industrial traceability and has the potential to slow metrological improvements in national networks tied to WMO and CIMO, particularly is WMO progresses its activities in formalizing accreditation.

   There is significant overlap between the CIMO Expert Team (ET) responsible for solar and longwave matters and the BSRN community. Bruce Forgan is the current chair of the ET, with other members being Klaus Behrens, Bruce McArthur, and Wolfgang Finsterle (PMOD/WRC), and co-opted scientists Julian Groebner (PMOD), Ibrahim Reda (NREL), and Joe Michalsky (NOAA). There is a significant effort in the ET responsible for radiation to translate the recent advances in longwave measurement driven by the BSRN Pyrgeometer WG (lead by Rolf Philipona) into routine network operation. As indicated in the Vuilleumier report, the derivation and number of coefficients required to relate network measurements to a stable national reference need to be examined, and then the national reference will need careful consideration before specifying the level of target uncertainties.

   The recent release of the CIMO Guide (http://www.wmo.int/pages/prog/www/IMOP/IMOP-home.html) (follow the WMO No. 8 CIMO Guide link under the IMOP heading) has indicated uncertainties required for regional and national radiation centers in relation to the World Resources Report (WRR).

VI. CLOUDS AND AEROSOLS

Retrieved Cloud Properties from BSRN-Type Observations (Steve Cooper, NOAA/ESRL/GMD)

How the NOAA Earth System Research Laboratory (ESRL) SURFRAD (Surface Radiation) Network measurements could be used to obtain cloud retrieval data (direct, diffuse, and global solar).

SURFRAD stations are instrumented with Total Sky Imagers and Multi-Filter Rotating Shadowband Radiometers (MFRSR) that measure global and diffuse radiation at 415, 500, 615, 673, 870, and 940 nanometers (nm). The expected retrieval performance (optical depth) can be quantified given the inherent variability in the physics of the ground-based cloud retrieval problem. Uncertainties in ground-based MFRSR retrieved cloud optical depth are typically near 10–20 percent. These uncertainties, however, are smaller than those from similar passive satellite observations, typically 20–30 percent.

Possible SURFRAD improvements could include:

1. Quantifying impacts of adding additional measurements such as absorbing near infrared, 1.6 or 2.1 microns;
2. Seeing different part of cloud compared to satellite; and
3. Examining the effects of adding other measurements such as microwave radiometer and cloud boundary information.

Radiation Transfer in Stratus Clouds at BSRN Payerne (Laurent Vuilleumier, Federal Office of Meteorology and Climatology, MeteoSwiss)

A project for characterizing the effect of clouds on radiation was pursued at the Payerne BSRN station in Switzerland. This project included three parts. The first part was for evaluating the feasibility and accuracy of the determination of the vertical location of a cloud layer with the available data. The second part verified the correctness of the radiation transfer model used in the project for clear-sky situations. The third part determined the cloud effect on radiation for selected stratified cloud situations based on the results of the preceding parts.

Results of radiation transfer calculations with MODTRAN™ simulating real situations are presented for well-defined stratus cloud cases detected at the BSRN station in Payerne, Switzerland. These stratus situations are selected in a data set covering the years from 2000 to 2005 with a method using data widely available at BSRN stations. For 18 single layer stratus situations, the shortwave radiation fluxes calculated with MODTRAN™ are compared to surface BSRN observations at Payerne and top of atmosphere (TOA) observations from the Clouds and the Earth's Radiant Energy System (CERES) experiment. A median bias on the order of 20 Wm−2 (< 9%) was found for the differences between modeled and observed reflected solar radiation at TOA. At the surface, good agreement is obtained by adjusting the vertical extinction in the modeled cloud layer within reasonable limits for a stratus cloud: the median bias of modeled minus observed shortwave downward radiation is well within instrument precision (< 1%). The simultaneous agreement of modeled and observed radiation fluxes at the surface and TOA confirmed that radiation transfer in the atmosphere, including a single cloud layer, can be well simulated with MODTRAN™. Based on these results, the absorbance was calculated within the stratus cloud layer (cloud base to cloud top). For the 18 single stratus layer situations the median absorbance is 0.07 (minimum 0.04, maximum 0.1), the median transmittance is 0.29 (0.15 0.39), and the median cloud reflectance is 0.70 (0.63, 0.80).

Observed Cirrus Cloud Radiative Effects on Surface Level Shortwave and Longwave Irradiances (Jean-Charles Dupont, Laboratoire de Météorologie Dynamique)

The radiative effects of high altitude clouds on the surface energy budget, in both the solar and infrared spectrum, are well known but not well quantified. In fact, satellite climatologies based on passive remote sensing measurements reveal a high occurrence of cirrus clouds (13 percent average over the globe) but are not sensitive to the optically thin clouds, typically with cloud optical thickness smaller than 0.1. Long records of ground lidar measurements and recent Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) profiles, however, show that these optically thin clouds represent 50 percent or more of cirrus cloud population. Hence, the relatively small instantaneous radiative effects of these cirrus clouds can engender a significant cumulative radiative forcing.

The quantification of this cirrus cloud radiative forcing requires precise reference, typically with RMS error at less than 5 Wm^{-2}, of solar and infrared irradiance for the cloud free atmosphere determined here by a combined analysis of lidar and broadband flux measurements.

In this study, we analyzed solar and infrared irradiance measurements, cloud and aerosol lidar backscattering profiles, microwave radiometer brightness temperatures, radiosonde profiles, and sun-photometer extinctions that were gathered on five sites located in mid-latitude (SIRTA Observatory and ARM SGP Lamont), in tropical (ARM Tropical Warm Pool (TWP) Darwin and ARM TWP Nauru) and in polar regions (ARM NSA Barrow) to estimate the Cirrus Cloud Radiative Forcing (cloud base altitude above 7 km) on surface-level shortwave (CRF_{SW}) and longwave (CRF_{LW}) irradiances. The sensitivity of CRF_{SW} to Cloud Optical Thickness (noted $CRF_{SW}*$) ranges from 110 W m^{-2} to 240 W m^{-2} per unit of cloud optical thickness, depending on cloud regime. The combined influence of aerosol optical thickness and integrated water vapor on $CRF_{SW}*$ is quantified (10–20% $CRF_{SW}*$ range) for turbid and pristine atmosphere. Moreover, the sensitivity of the CRF_{LW} to both cloud emissivity and cloud temperature (noted $CRF_{LW}*$) is established and the influence of integrated water vapor on $CRF_{LW}*$ is quantified (30–50% $CRF_{LW}*$ range) for wet and dry atmosphere. The impact at global scale is studied in using CALIPSO and Atmospheric Infrared Sounder (AIRS) input data. Zonal distributions of CRF_{SW} and CRF_{LW} show a cumulative significant impact in tropic and arctic regions.

Aerosol Radiative Effects in sub-Sahel Africa: Dust and Biomass Burning (Rachel Pinker, Department of Atmospheric and Oceanic Science, University of Maryland)

Simultaneous measurements of aerosol optical properties, downward shortwave fluxes, and radiative transfer models are used for selected clear days during the dust-biomass burning season to estimate aerosol radiative effects in the sub-Sahel. Of unique value were the contributed aircraft observations made over the site during the 2006 Dust and Biomass Burning Experiment (DABEX) in the framework of the Radiative Atmospheric Divergence using ARM Mobile Facility, GERB data and AMMA Stations (RADAGAST) Project. The observations included information on the vertical structure of the aerosols and other gaseous species that indicated separation between the dust layer and aerosols from biomass burning. The importance of information on the vertical distribution of aerosol properties when using satellite observations at the Top of the Atmosphere for inferring surface fluxes was evident.

Characterization of Atmospheric Aerosols and Water Vapor using Ground-Based Sun Photometry (Mikhail Alexandrov, Columbia University and NASA Goddard Institute for Space Studies)

The Multi-Filter Rotating Shadowband Radiometer (MFRSR) measures direct and diffuse irradiances in the 415–940 nm spectral range. Our analysis algorithm for MFRSR data allows partitioning of the spectral aerosol optical depth (AOD) into fine and coarse modes, and retrieval of the fine mode effective radius. We used climatological NO_2 (based on the Scanning Imaging Absorption Spectrometer for Atmospheric CHartographY (SCIAMACHY) retrievals) and column ozone from the Total Ozone Mapping Spectrometer (TOMS). Precipitable water vapor (PWV) column amounts are retrieved from measurements in the 940 nm spectral channel. Retrievals were shown from a data set obtained by the local MFRSR network (21 instruments) at the Southern Great Plains (SGP) site operated by the U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Program. Intercomparisons between retrievals from the two MFRSRs located at the SGP's Central Facility and the correlative AErosol RObotic NETwork (AERONET) Sun-sky inversions from the CIMEL sun-photometer show remarkably good agreement. The differences in total, fine, and coarse mode AOD do not exceed the expected measurement accuracy of 0.01. We show that if only data with an AOD larger than 0.06 at 870 nm are selected, the random error in aerosol size retrievals is only about 10 percent of a typical fine mode effective radius value. Our PWV retrievals were compared with correlative standard measurements by Microwave Radiometers and GPS sensors, and with retrievals from other solar radiometers (AERONET, the Ames Airborne Tracking 6-channel Sunphotometer (AATS-6)). Some of these data are routinely available at the SGP Central Facility; however, we also used measurements from a wider instrumentation array deployed at this site during the Water Vapor Intensive Observation Period (Sept–Oct 2000).

Climatology and Interpretation of 11 Years of Aerosol Optical Depth Data from the U.S. BSRN Stations (John Augustine, NOAA R/GMDL, Earth System Research Lab)

A series of algorithms has been developed to process spectral solar measurements for aerosol optical depth (AOD) for the National Oceanic and Atmospheric Administration's (NOAA) national Surface Radiation budget network (SURFRAD). The primary components include a calibration algorithm and an AOD algorithm. The calibration procedure automatically identifies candidate points for Langley plots using the Long and Ackerman clear-sky identification method. Extrapolated calibration points are normalized to one atomic unit, grouped into one or two-month periods, statistically reduced, and averaged. The time series of quasi-monthly calibrations and associated uncertainty are fit to functions for interpolation to individual days for AOD calculations. Daily files of spectral AOD covering the visible and near infrared have been produced for 1997 through 2007 for all seven stations. Comparisons of SURFRAD daily AOD averages to NASA's AERONET product for two of the stations were generally good. An AOD climatology for each SURFRAD station was presented as an annual time series of composite monthly means that represent a typical intra-annual AOD variation. Results are similar to previous U.S. climatologies in that the highest AOD magnitude and greatest variability occurs in summer, the lowest AOD levels are in winter, and geographically, the highest magnitude AOD is in the eastern United States. Springtime Asian dust intrusions show up as a prominent secondary maximum at the western stations, which diminishes eastward. A time series of nationwide annual means shows that 500 nm AOD has decreased over the U.S. by about 0.01 AOD units over the 11-year period. However, this decline is not statistically significant, nor geographically consistent within the country. The eastern U.S. stations and western-most station at Desert Rock, Nevada show decreasing AOD, whereas the other three western stations show an increase that is attributed to an upsurge in wildfire activity in the last half of the 11-year period. When the high-frequency wildfire years are removed from those stations, the decadal tendencies go flat, thus substantiating the link to wildfire activity.

Quantification of the Direct Aerosol Effect for Cabauw, the Netherlands (Wouter Knap, Royal Netherlands Meteorological Institute)

Measurements of direct and diffuse solar irradiances in combination with radiative transfer calculations for cloudless skies were used to quantify the direct aerosol effect for the BSRN station of Cabauw, the Netherlands. The radiative transfer calculations were performed for atmospheres containing all constituents except aerosols. The direct aerosol effect was then calculated as differences between the measured and simulated solar irradiances. Cloudless situations were selected using different shortwave and longwave cloud detection algorithms. For 2006 the mean direct aerosol effect for global irradiance appeared to be -30 W/m^2. A highly linear correlation between the direct effect and the aerosol optical depth (AOD) was found with a slope of 12 W/m^2 per 0.1 unit of AOD.

Aerosol Optical Depth Measurements in the Azores (Fernanda Carvalho, Portuguese Institute of Meteorology)

A preliminary analysis of AOD results from sun-photometer measurements collected at Jose Agostinho Observatory at Angra do Heroísmo (Terceira Island, the Azores) was presented. The observational period ranges from August 2004 to December 2007, using a SP02 sun-photometer at wavelengths 412, 500, 675, and 862 nm, coupled to a 2AXP sun-tracker. The sampling interval is 5 s and data is filtered for cloud contamination in a time window of 10 minutes. Most AOD 500 nm values are below 0.3, showing a small variation during the day; frequency distribution shows a typical right skew distribution. Alpha and beta Angstrom coefficients were also computed and analyzed in the same way. Alpha values are generally positive and lower than 4, while beta values are below 1.5. AOD results from the AERONET station at Horta Observatory (Faial Island, the Azores) were also used and compared with Angra data. AOD and Angstrom coefficients were also analyzed with wind results from the automatic weather station located at both observatories. Results show different wind distributions due to different exposures; however, systematic higher AOD values are found at Horta. The proximity of the two sites indicates that these differences are more likely due to different instruments and processing methods used.

VII. NETWORK ACTIVITIES CALIBRATIONS AND SPECIAL REPORTS

Report on the GCOS Global Surface and Upper Air Networks, GSN and GUAN, Implementation Activities (Richard Thigpen, GCOS Secretariat, WMO)

Activities aimed at improving the operation of the GCOS networks, mainly the surface (GSN) and upper air (GUAN) networks, were described. Several upper air and surface stations have been renovated and workshops focused on surface and upper air measurements have led to improved quality of observations. Four technical support projects have been established in developing areas to provide direct technical support to GCOS stations. Nine Commissions for Basic Systems (CBS) Lead Centers for GCOS have been established around the world to provide better coordination with operating stations. Finally, the GCOS Cooperative Mechanism was described: this trust fund allows interested donors to make direct contributions to support GCOS activities and to target their contribution to areas of interest to them.

State of the BSRN, 2008 (Ellsworth Dutton, BSRN/NOAA)

This presentation was delivered on the morning of the third day of the meeting, later than previous years in order that the BSRN project manager could include some of the feel and pace of the organization from the current meeting. The world map was shown with current full and candidate BSRN sites along with a designation as to whether routine upper air soundings exist at the site, which had been the focus of a GCOS assessment of the network in the preceding year. In contrast, an identical map project but with only the sites that existed in 1996 was shown to demonstrate the growth of the network. Several new sites submitting data from Brazil were noted, as were the troubled sites in Nigeria and Saudi Arabia. An observation was made by Ellsworth Dutton that while BSRN is now widely recognized as the premier source on international surface radiation data, the reward has been primarily requests for more and faster information, although this can be considered to go along with the success the project has seen. The international organization structure that now endorses the BSRN was emphasized; although the WCRP connection had not changed significantly over the years, direct involvement of the GEWEX International GEWEX Project Office and GEWEX Radiation Panel, as well as a connection to GCOS through its Atmospheric Observations Panel for Climate (AOPC), was highlighted and identified as a reason for the involvement of one of its representatives, Richard Thigpen. A strong reminder of the obligation of the BSRN program and its participating sites to follow the ten GCOS monitoring principles was reiterated, as it has been at previous meetings since 2004 when BSRN first came into the GCOS realm. It was pointed out that activities beyond basic data collection had been in somewhat of a lull the past two years as BSRN management focused on the data archive transition, and also due to widespread tightened budgets. Several examples of past data analysis and observational accomplishments of the BSRN were highlighted, although few were specifically addressed recently.

Considerable work on other topics related to surface radiation and associated interests does continue both within and outside BSRN. A long list of ongoing BSRN activities and tasks was presented with brief elaboration of some of the items. While there has been a long emphasis of the open literature publication of results obtained within the BSRN project, this meeting saw a renewed request that all substantial undertakings related to the organization—and particularly its working groups—should lead to and result in such publication or results needed to insure the work receives appropriate credit and will be readily available for future generations who will pursue this work. It was pointed out that BSRN needs to consider providing a broader range of data products through its archive in order to be more responsive to its user community and to extend the utility of the information acquired as part of the effort. There should be some future guidance provided to the BSRN archive as to which products might be most useful. Site scientists and traditional and new duties and responsibilities were quickly reviewed and all were reminded of the important task that the group has and will continue to have into the future.

Calibration Activities at the World Radiation Center, PMOD/WRC in Davos, Switzerland (Julian Gröbner, PMOD/WRC)

The World Radiation Center (WRC) is currently composed of three sections: the absolute radiometry section (ARS), the infrared radiometry section (IRS), and the world optical depth research and calibration center (WORCC). The European Ultraviolet Calibration Center (EUVC) was recognized by the WMO as being the regional center for the European region with the Global Atmosphere Watch (GAW) Programme. At the WRC, pyranometers are calibrated using the composite sum method with the World Standard Group (WSG) for the direct beam and a diffuse reference CM22 pyranometer. The WSG has been compared several times to the cryogenic radiometer at the National Physical Laboratory (NPL), with differences equal or below 0.1 percent. A new cavity for pyrgeometer characterizations has been built at the Infrared Radiometry Section of the WRC. The comparison with the cavity used since 1995 at PMOD/WRC gave average differences of 0.005, 0.00026, and 0.08 for k1, k2, and k3 respectively. The pyrgeometer sensitivity retrieved with the new cavity is on average 1.0 percent higher than with the original cavity. A prototype IR Radiometer using an integrating sphere has been designed and constructed to become a future reference instrument for longwave radiation. The triad Precision Filter Radiometers (PFR) operated at WORCC for the reference for aerosol optical depth (AOD) measurements. A traveling standard PFR has been established to provide on-site quality assurance of AOD measurements.

High Quality Spectral UV Measurements Used to Calculate Optimum Sun-Exposure Times (Richard McKenzie, NIWA Lauder)

Action spectra published by the International Commission on Illumination (CIE) are used to investigate relationships between the erythemally-weighted UV radiation and vitamin D-weighted radiation. An algorithm developed using spectral measurements undertaken at Lauder, New Zealand to relate vitamin D production to the widely-used UV Index is used to calculate the behavioral patterns (exposure times and attire) required to enable the public to optimize their exposure to UV radiation. In the summer at noon, there should at mid-latitudes be sufficient UV to photosynthesize optimal vitamin D in approximately one minute for full body exposure, whereas skin damage occurs after approximately 15 minutes. Further, while it should be possible to photosynthesize vitamin D in the winter at mid latitudes, the amount of skin that must be exposed is larger than from the hands and face alone. This raises the question of whether the action spectrum for vitamin D production is correct, since studies have reported that production of vitamin D is not possible in the winter at mid-latitudes

Radiometer Calibrations and Irradiance Measurements (Tom Stoffel, National Renewable Energy Laboratory)

A review of research was given related to understanding radiometer calibrations and irradiance measurements conducted at NREL in support of the U.S. Department of Energy's Office of Science and Office of Energy Efficiency and Renewable Energy research and development programs. NREL develops renewable energy and energy efficiency technologies and practices, advances related science and engineering, and transfers knowledge and innovations to address the nation's energy and environmental goals. NREL work at the Solar Radiation Research Laboratory (SRRL), located on South Table Mountain, was presented, including an overview of two areas: (1) maintaining broadband radiometer calibrations using reference instruments traceable to the World Radiometric Reference (WRR) for solar irradiance; and (2) the World Infrared Standard Group (WISG) for infrared irradiance measurements. Both of these internationally-recognized measurement references were developed and are maintained by the Physikalisches Meteorologisches Observatorium Davos (PMOD) World Radiation Center (WRC).

An overview of the operations and maintenance of the solar and infrared measurements collected at NREL's Solar Radiation Research Laboratory (SRRL) was given. More information is available from www.nrel.gov/solar_radiation. It is noted that NREL/SRRL also provides solar and thermal irradiance calibration services to the U.S. Department of Energy Atmospheric Radiation Measurement program, which sponsors four sites contributing to BSRN.

Finally, a review was presented of some of the important features of our Measurement and Instrumentation Data Center (MIDC) designed to allow access to solar and meteorological measurements at SRRL and other locations of interest to renewable energy development. Historical and near real-time data are available from www.nrel.gov/midc.

International Workshop on Global Dimming and Brightening (Chuck Long, Pacific Northwest National Laboratory)

A brief summary was given of the International Workshop on Global Dimming and Brightening (GDB), held 10–14 February 2008 in Ein Gedi, Israel. In particular, BSRN is well positioned to address the GDB issues, and was recognized as a world leader in surface radiation measurement activities. There was general agreement at the conference that longer, better spatially distributed surface radiation measurement records are needed, especially over the oceans. In addition there was agreement that the GDB phenomenon is real and that the next step is to determine the causes.

One of the conclusions reached by the International Workshop on Global Dimming and Brightening (GDB) (Ein Gedi, Israel, February 2008) is that the next step needed is a determination of the causes of GDB. We presented an analysis of cloud and radiation parameters derived using the Radiative Flux Analysis methodology and the surface radiation measurements of eleven surface radiation sites across the continental U.S. Five of the sites are part of the US DOE ARM Program's Southern Great Plains network of sites, in the aggregate representing global climate model grid scales. The rest of the sites belong to the NOAA SURFRAD network and in the aggregate—along with the ARM site—represent the larger continental scale. Averaging all sites, we show an aggregate decadal increasing tendency in the downwelling all- and clear-sky shortwave (SW) at the rate of about 8 and 5 Wm^{-2} per decade, respectively, with a corresponding decrease in daylight cloud cover at a rate of about 2–3 percent per decade. Both the all- and clear-sky diffuse SW increase is about 4 Wm^{-2} per decade, with a corresponding increase of about 4–5 Wm^{-2} per decade for all-sky direct SW and no significant change in the clear-sky direct. But while the all-sky diffuse and direct SW and clear-sky diffuse SW is increasing for both the ARM and SURFRAD data, the clear-sky direct is increasing in the ARM data but decreasing in the SURFRAD data. For the SGP area, the greatest change in the all-sky downwelling SW and cloud cover occurs in the fall and winter months, but in the summer and fall months for the clear-sky SW. This example illustrates how the Radiative Flux Analysis, applied to BSRN-style surface radiation data, offers a powerful tool for the investigation of basic radiation and cloud parameters that lie behind GDB with respect to causes of changes in downwelling SW.

Long-term Comparisons of Collocated Ground Irradiance Flux Measurements (Laurent Vuilleumier, Federal Office of Meteorology and Climatology, MeteoSwiss)

For about a decade, instruments from two networks applying BSRN-like methodology and another network applying less stringent methodology have made collocated measurements of shortwave downward global irradiance and longwave downward irradiance at the BSRN site of Payerne and the high altitude site of Jungfraujoch, Switzerland. The networks applying the BSRN-like methodology are the Swiss Atmospheric Radiation Monitoring network (CHARM, which includes the BSRN station of Payerne) and the Alpine Surface Radiation Budget network (ASRB). In addition, measurements of shortwave downward global irradiance were also performed in the framework of the standard automated meteorological network of MeteoSwiss (designed as ANETZ). These three networks have operated independently (although comparisons have already been made). Long-term comparisons of results from these three networks allow verification of that agreement between networks applying a BSRN-like methodology compatible with the BSRN uncertainty targets, and it also allows estimating the benefit of such a technology with respect to a network applying a less rigorous methodology.

At Payerne, agreement between CHARM and ASRB is excellent. Data were compared in monthly sets as Y vs. X and linear regression fit were computed. When comparing observations of ASRB with observations of CHARM, the slope of the monthly linear regressions generally stayed within ±2% from 1. In the beginning of 2004, some adjustments were made on ASRB instruments: from this time, the agreement is even better with a slope almost always within ±1% from 1. The linear regression zero-intercept stayed stable at ~2 W/m^2. This difference comes from a relatively constant bias and is related to the thermal offset that is better compensated in the ASRB network than in the CHARM network. The root-mean square error (RMSE) around the regression fit line is below 20 W/m^2 (well below this limit since 2004). At Jungfraujoch, the ASRB versus CHARM agreement is not as good as at Payerne, but is still very satisfactory given the harsh meteorological conditions at Jungfraujoch. The linear regression fit slope is generally between 0.96 and 0.99, and the zero-intercept between 2 and 4 W/m^2 (in large part due to thermal offset). The RMSE is generally below 20 W/m^2, with a max of ~30 W/m^2. At Jungfraujoch, frequent riming episodes have become the most important cause for obtaining an agreement that is not as good as at Payerne.

The agreement between ANETZ and CHARM observations or between ANETZ and ASRB is significantly less satisfactory than the agreement between ASRB and CHARM at both Payerne and Jungfraujoch. Specifically, there are significant differences between the slopes of the monthly linear regression and their expected value of 1. Typically, the slopes have values between 0.90 and 0.95 at Payerne and between 0.8 and 1 at Jungfraujoch. These differences are most likely related to bad calibration of the ANETZ instrument. In 2007, the infrastructure and instruments (pyranometers) began the process of renewal in the standard automated meteorological network of MeteoSwiss. A large change was observed at Payerne when switching from the old system to the new one, which will require homogenization of the old data with the new.

Longwave downward irradiance was only measured by CHARM and ASRB. Comparisons revealed relatively significant differences of the linear regression fit parameters with their ideal value of 1 (slope) and 0 (zero-intercept). At Payerne, the slope is generally between 0.96 and 1, while the zero-intercepts fells between 5 and 15 W/m^2. At Jungfraujoch, the slope is between 0.95 and 1.05 most of the time, while the zero-intercepts vary between -10 and +10 W/m^2. These differences may reflect a change in calibration procedure after the introduction of the Absolute Sky-scanning Radiometer (ASR), which has been applied to ASRB but not to CHARM pyrgeometers. However, compensating effects seem to occur and the resulting general agreement is good, with bias on the order of 0 to -5 W/m^2 at Payerne (CHARM-ASRB) and -5 to +5 W/m^2 at Jungfraujoch (CHARM-ASRB with some seasonal cycle).

VIII. MODEL AND SATELLITE COMPARISONS AND ANALYSIS

Importance of Surface-based, Non-radiative-flux Parameters for Validating Satellite-derived Radiative Fluxes (Yuanchong Zhang, Columbia University at NASA GISS)

Some flux discrepancies between satellite-derived, gridded radiative fluxes, and observed fluxes from surface stations come from 'a priori' differences in non-flux factors or radiative environments that actually determine radiative fluxes for both data sets. Such differences are present in spatial resolution (grid-cell-wide mean versus point-based measurement), temporal resolution (often unmatched), and environmental physical parameters (cloud phase, amount, optical depth, particle size, atmospheric temperature/humidity profile, aerosols and other constituents, surface skin temperature, topography, albedo, emissivity, land/water, and snow/ice) as well as their different natures.

If we know and understand those relatively (radiatively) important differences among them, we may more precisely conduct our validation for satellite-derived radiative fluxes. Using non-flux parameters, cloud fraction (CF) and Aerosol Optical Depth (AOD) from the International Satellite Cloud Climatology Project (ISCCP)-FD and SOB (Surface station OBservation-based Radiative Flux Analysis product by C. Long, plus AOD produced by E. Dutton and Atmospheric Radiation Measurement (ARM) by Flynn) for high-quality-controlled stations (15 for CF and 10 for AOD) from BSRN, ARM and SURFRAD, we demonstrate their importance in improving our validation.

First, when reducing cloud fraction difference between FD and SOB from 100 percent (no restriction) to 1 percent, the mean difference (FD minus SOB) for 3-hourly Diffuse (Dif) and Direct (Dir) fluxes are reduced from 30 and -30 W/m^2 to ~7 and ~0 W/m^2, respectively, and standard deviation (Stdv) of their difference are reduced from 78 and 108 W/m^2 to 36 and 19 W/m^2, respectively; mean (Stdv) of downwelling SW (SWdn) difference are changed from ~0 (86) W/m^2 to ~6 (46) W/m^2. But about half of the flux values have no CF information in SOB, and if we only process those fluxes with available CF (which are mostly for noon ± 3 hours), mean difference is still reduced for Dif and Dir, and Stdv is reduced for all three fluxes: from 116, 100, and 144 W/m^2 to 98, 85, and 40 W/m^2, respectively. This means that some original flux discrepancies actually come from CF difference (even cell-to-point difference is still there), and the true uncertainty is smaller.

Second, when reducing FD's AOD by 50 percent to roughly bulk-match the observation-based AOD, the clear-sky counterparts of the above three SW fluxes, CSWdn, CDif and CDir, shows substantial improvements on comparison: mean (Stdv) difference between FD and SOB monthly means become -0.9 (8.7), 6.4 (11.2), and -7.3 (17.5) W/m^2 from -7.4 (11.4), 23.3 (21.0), and -30.6 (30.2) W/m^2, respectively. Further improvements are possible if we adjust AOD on an individual site basis. The method used here may be called the Meteorological Similarity Comparison Method (MSCM), which essentially makes flux comparison possible under more similar radiatively-environmental conditions, i.e., the input physical parameters for flux calculation are selected or made as close as possible to the actual observed ones so their environmental differences are narrowed. We, of course, can never completely eliminate such differences because of their different natures.

The potential of MSCM lies in more precisely physically reasoning and reducing uncertainties caused by differences in non-flux factors so as to obtain more true (usually smaller) uncertainty values for satellite-derived fluxes; it also gives feedback to improve input variables and model itself for radiative calculation, as well as to improve surface observation to meet our global climatological monitoring target (~ 10 w/m^2 for total net). All these lead to the strong need for BSRN to measure or retrieve essential, non-flux parameters and other information. The 'wish list' for parameters may be minimal—CF, cloud optical thickness (CldTau), cloud base (Pb), AOD, Ta, SASH (surface air specific humidity)—and better, plus a T/Q profile (sounding) with good spatiotemporal coverage.

Processing of the Baseline Surface Radiation Network (BSRN) Data and its Application in Validating the NASA GEWEX SRB Data (Taiping Zhang, SSAI/NASA Langley Research Center)

NASA's GEWEX Surface Radiation Network (SRB V3.0) has produced a continuous record of shortwave/longwave radiation data for the top of the atmosphere (TOA) as well as the Earth's surface at a 1° longitude by 1° latitude resolution for the time span of 23 complete years from July 1983 to June 2006. The data are given as 3- hourly, 3-hourly-monthly, daily, and monthly means. Since these data are derived from satellite-based observations, it is important to validate the data set against ground-based measurements.

The BSRN as of early 2008 has 3,941site-months of data in archive from 39 ground sites located on all continents; the earliest data go all the way back to 1992. The measurements are made at 1-minute, 2-minute, 3-minute, or 5-minute intervals. Considerable work is needed to process the BSRN data to make them comparable with the GEWEX SRB data. Additionally, the BSRN data files contain 11 quality flags for each data point. A procedure needs to be designed to appropriately use the information to exclude possibly erroneous data.

It is found that with the implementation of the quality control based on the quality flag information, the total shortwave flux from the pyranometers and from the summation of direct and diffuse fluxes are in very good agreement. And the consequent BSRN 3-hourly, 3-hourly-monthly, daily, and monthly means are also in better agreement with the GEWEX SRB.

The following are some more specific conclusions:

- Of all the 39 BSRN sites, G1 (Direct + Diffuse) has measurements for about 85 percent of the intended time; G2 (Pyranometer) has measurements for about 95 percent of the intended time;

- If we drop BSRN flag value "2", measurements for solar zenith angles (SZA) less than 45 degrees are not quite affected; measurements for SZAs larger than 45 lose about 5 percent of values; and measures for SZAs larger than 87 lose about 10 percent of values;

- If we drop BSRN flag values "2" and "5", measurements for SZAs larger than 70 can lose about 50 percent of values; measurements for SZAs larger than 87 lose practically all G1 values and 60 percent of G2 values;

- If we drop BSRN flag value "2" only, nearly all outliers are gone in G1 – G2 scatter plots;

- The Long and Shi (2008) G1 – G2 difference check can identify those outliers left over by BSRN quality check accepting "5" and "9." However, this check affects only about 0.6 percent of the data;

- The 6 sites—DAA, FLO, ILO, LIN, REG and SBO—show most outliers in G1 – G2 scatter plots of the original values. The outliers are effectively removed after the quality check. Although the data from site LIN do not show obvious outliers on the G1 – G2 scatter plot even without any quality check, the STRICT quality check, which accepts flag value "9" only, can eliminate nearly 50 percent of its data.

- The level of G1 – G2 3-hourly and daily means agreement shows dramatic improvement after quality check; and

- The change of total numbers of 3-hourly, daily, and monthly means due to quality checks as follows:
  - 3-HOURLY: 443355 - 410661 = 32694 (7.37%)
  - DAILY: 90043 - 82696 = 7347 (8.16%)
  - MONTHLY: 2575 - 2073 = 502 (19.50%)

The number of monthly means that can be computed drop appreciably after the quality check. The most affected sites are NYA (101-81=20), BAR (58-44=14), FPE (92-66=26), PAY (54-23=31), BON (93-75=18), BOU (106-90=16), E13 (81-55=26), BIL (94-56=28), GCR (54-23=31), NAU (80-68=12), FLO (12-1=11), GVN (83-47=36), and SPO (102-85=17). (The numbers in the parentheses are the numbers of monthly means computed BEFORE and AFTER quality check and their differences.)

Pyrheliometer Ventilation (Wouter Knap, KNMI)

At the Cabauw BSRN site in the Netherlands, in particularly during early spring and autumn mornings, the residual DSGL2-DSGL1 (i.e., global minus the sum of direct and diffuse irradiances) can be off zero (and positive) by several tenths of W/m^2. Pointing problems were ruled out. The reason for the difference between DSGL1 and DSGL2 was found in the presence of condensed water on the CH1 window (reducing the direct irradiance). A simple ventilation device that blows slightly heated air over the pyrheliometer window prevented the condensation process and reduced the difference between DSGL1 and DSGL2 to acceptable values.

Applications of BSRN Data to GCM Models and Comparisons (Martin Wild, ETH Zurich, Institute for Atmospheric and Climate Science)

Large uncertainties still exist in our knowledge of the Earth radiation balance and its representation in climate models. Accordingly, global mean radiation budgets simulated by climate models differ largely, particularly at the surface. BSRN data provide a unique opportunity to constrain these uncertainties. The data suggest that many models overestimate downward solar and underestimate downward longwave radiation. BSRN data also allowed the detection of widespread surface solar brightening since the early 1990s after decades of dimming. GCM simulations performed at the Swiss Federal Institute of Technology (ETH) with the global climate model ECHAM5-HAM suggest that brightening will turn back into a dimming in the coming decades, and downward longwave radiation will increase at 2–3 Wm^{-2} per decade. It will therefore be exciting to see what BSRN data will show over coming years, and whether they will support or disprove the model predictions.

MJO Detection Using Manus Surface Radiation Measurements (Chuck Long, Pacific Northwest National Laboratory)

The Madden-Julian Oscillation (MJO) is a cyclic larger scale (1000 km) increase in convection and precipitation originating over the Indian ocean and propagating eastward about the equator at 5 metres per second (m/s). The MJO has significant influence on global weather patterns and Pacific basin monsoon systems, but to date is poorly represented in global climate models in occurrence, timing, and/or strength. Previous studies have used larger scale (1 to 2.5 degree lat/long scale) satellite, and sonde data to show the occurrence and strength of the MJO. However if we are to use BSRN-type surface measurements to study the MJO phenomenon, which are by nature "point" measurements representing smaller scales, then we must prove that the MJO signals are detected in the fixed site data time series. We present an analysis of the surface radiation based Radiative Flux Analysis derived cloud fraction and shortwave cloud effect, showing we can indeed identify the MJO signal in the Manus data that well matches the temporal evolution and power spectrum analyses that use the larger-scale data. This surface-derived detection now means we can use the corresponding Manus surface site cloud radar, lidar, microwave, and other vertically pointing narrow-field-of-view and their derived cloud macro- and micro-physical properties in aggregate analyses with the aim of developing and improving parameterizations to improve the global model representation of the MJO.

Evaluation of SW and LW Based Cloud Detection Algorithms (Jean-Charles Dupont, Ecole Polytechnique - LMD/IPSL)

Results of different cloud system schemes were compared.

Clear Sky Closure Study during the Eucaari Campaign (Ping Wang, KNMI)

The DAK model (Doubling Adding KNMI) was compared with the SMARTS model (Simple Model of the Atmospheric Radiative Transfer of Sunshine). The DAK model is a line-by-line model, which has been used in KNMI for cloud, aerosol, and trace gas retrievals for about 20 years. Recently we implemented the correlated-k distribution method in the DAK model to simulate the broad band measurements (240–4600 nm). The direct, diffuse, and total irradiance were calculated with DAK and SMARTS for the cases with and without aerosols. The DAK model has good agreement with SMARTS model.

After the model comparison, the DAK model was used to simulate the BSRN direct, diffuse, and global irradiance measurements at Cabauw during the Eucaari campaign. We selected 6 clear days on 5 May and 7–11 May for comparison. The atmospheric profile from radiosonde data, the aerosol properties, and water vapor column from AERONET data were used for the DAK input. About 70 of the simulations of direct, diffuse, and global irradiances from the DAK model had excellent agreement with BSRN direct, diffuse, and global irradiances, with mean differences (DAK—BSRN) of 1.56 (+/- 3.14), 0.87 (+/-2.33), 1.76(+/-2.67) W/m^2. The DAK model is ready to be used for the clear sky and cloudy case closure study.

Comparison of Downward Radiation Observations at Tateno with Reanalyses Data (Nozomu Ohkawara, Aerological Observatory, Japan Meteorological Agency)

Surface radiation observations at the Tateno station are compared with two recent reanalyses data, ERA-40 and JRA-25. The results show that the reanalyses have the same long-term trend as Tateno observation and well represent realistic long-term trends for both shortwave and longwave radiation. It is also found that there exist differences between Tateno observations and the reanalyses. The cause may be radiation processes, including cloud parameterizations in the models and atmospheric constituents that are not taken into account such as aerosols. The long-term surface radiation observation is significantly important to assess the total quality of reanalysis products.

Climatology at the Clouds and the Earth's Radiant Energy System (CERES) Ocean Validation Experiment (COVE) (Fred Denn, Science Systems and Applications)

This talk presented some long-term (2000 through 2008) radiative data sets and trends. AERONET aerosol total optical depth data was also presented with an introduction to aerosol radiative forcing.

IX. SPECTRAL OBSERVATIONS

A First Look at an Optically Multiplexed Spectral (UVA/VIS/NIR) Radiometer (Bruce McArthur, Environment Canada)

A first look at an optically multiplexed spectral (UVA/VIS/NIR) radiometer.

Spectral Measurements Working Group Report (Joseph Michalsky[1], Bruce Forgan, Ain Kallis, Alex Manes, Bruce McArthur, Richard McKenzie, Rachel Pinker, Laurent Vuilleumier)([1]NOAA/OAR; Tartu-Toravere Meteorological Station, [3]Estonian Meteorological and Hydrological Institute; [5]Environment Canada, [6]NIWA, Lauder; [7]Dept of Atmospheric and Oceanic Science; [7]Federal Department of Home Affairs, Federal Office of Meteorology and Climatology, MeteoSwiss)

At the last BSRN meeting in Lindenburg, the Spectral Working Group was expanded to include the Ultraviolet (UV) and Photosythetically Active Radiation (PAR) working groups.

Although the inclusion of routine broadband UV-B measurements in the measurement suite of BSRN stations was adopted in Budapest in 1998, only a few site scientists have implemented them. However, the spectral working group continues to recommend the measurement of erythemally-weighted UV at all sites where possible and that instruments be calibrated as a function of solar-zenith angle and ozone column. Two recent WMO documents are available to elaborate on instrument selection and calibration for the full characterization of broadband UV instruments (WMO GAW Report No. 172, WMO GAW Strategic Plan: 2008–2015 and WMO GAW Report No. 164, Instruments to Measure Solar Ultraviolet Radiation, Part 2: Broadband Instruments Measuring Erythemally Weighted Solar Irradiance). The main reason for the reluctance of performing these measurements has been the uncertainty of the characterization and calibration of UV-B radiometers, as well as the lack of a generally recognized calibration hierarchy. The newly established European UV Calibration Centre at PMOD in Davos, Switzerland, is able to serve the above purpose (http://www.pmodwrc.ch/euvc/euvc.html). The Central Ultraviolet Calibration Facility in Boulder, Colorado has served American networks and others but its future is uncertain. However, it continues to calibrate instruments (http://www.srrb.noaa.gov/calfacil/

cucfhome.html). During the summer of 2006, COST 726 working group IV conducted a UV-B broadband comparison in Davos. Thirty-six broadband radiometers agreed to within 7 percent after calibration, although the spread was up to 50 percent with the owners' original calibrations. Calibration and characterizations of instruments at 7 laboratories were also compared. Cosine response measurements agreed to within 4 percent; however the spectral response measurements agreed less well. Details may be found in the publications section of www.cost726.org. In particular, instrument performance is reported in these publications for those interested in weighing the merits of the various commercial radiometer options. Moreover, further work by the working group is planned for deriving methods to infer erythema and vitamin D indices from these broadband UV measurements.

Richard McKenzie reported on several recent publications using NIWA's moderate resolution (0.75 nm) UV spectrometer (285–450 nm wavelength range). OMI and NIWA derived ozone were compared in one, the TUV modeled spectra and NIWA measured spectra were compared in another. Pollution's effects on the UV was the subject of a third publication. McKenzie also reported on the effects of damaging erythemal versus the positive effects of vitamin D production by UV at the de Bilt meeting. He specifically suggested that erythemal, as reported by BSRN, be corrected for ozone and solar-zenith angle.

Ain Kallis used his AvaSpec 256 UV spectrometer measurements to calculate erythemal daily doses and compared them with those derived from broadband measurements with good, but not exact, correlations for clear and cloudy skies separately. Comparisons to simultaneous 305-nm narrowband filter measurements produced similar results.

Joseph Michalsky reported on using UV Rotating Shadowband Spectroradiometer (RSS) measurements of transmission for comparisons to direct beam and diffuse horizontal models of transmission to derive single scattering albedo in the UV.

Bruce Forgan made some progress on characterizing the Middleton Absolute Scanning Radiometer; the 400–900 nm absolute 95 percent uncertainty is estimated at 1.5 percent with expected improvements on a new CCD array and temperature control. He also indicated plans to mount a NIWA spectrometer for direct beam UV measurements. Most of his work is directed toward aerosol optical depth characterization.

Rachael Pinker compared SURFRAD Photosynthetically Active Radiation (PAR) measurements with both MODIS-derived PAR and Global Modeling and Assimilation Office (GMAO) model results of downward shortwave that are multiplied by 0.45 to give estimates of PAR, with good correlations for the former and somewhat poorer results for the latter. There is a clear indication that the 0.45 conversion factor should be amended to depend on the water vapor in the atmosphere.

Regarding PAR, an intensive observation period is proposed for the Fall of 2009 for the purpose of evaluating PAR sensors against spectral measurements using the U.S. Department of Energy's Atmospheric Radiation Measurement program's visible RSS at its central facility in Oklahoma, USA. Interested parties are invited to send sensors and offer personnel for this experiment.

Use of BSRN Data for Satellite Albedo Verification (Ells Dutton for Crystal Schaaf, Center for Remote Sensing, Boston University)

A wealth of satellite-derived albedo products (CERES, MODIS, MISR, POLDER, Meteosat, MSG, MERIS, etc.) are available and all rely on BSRN data for ground-based validation. BSRN is also the source for Cal/Val for the National Polar-orbiting Operational Environmental Satellite System (NPOESS)/ Visible/Infrared Imager Radiometer Suite (VIIRS). The Committee on Earth Observation Satellites/ Working Group on Cal-Val/Land Product Validation on Surface Radiation endorses these validation efforts as well as intercomparisons between satellite products. The Global Terrestrial Observing System specifically recommends BSRN for albedo validation (Essential Climate Variable-T08).

X. WRAP-UP

New BSRN Stations

The following stations were approved as new BSRN stations:

- CENER (Pamplona, Spain)
- Eureka (Nunavut, Canada)
- A site in Suriname, South America was previously introduced by KNMI and was this tine encouraged to continue its efforts. Installation problems delayed operations by about 2 years, but data should begin later this year.

Summary of Decisions/Actions from the Working Groups Meetings Held During this Week

Oceans Working Group
Has been tasked to investigate potential new ocean stations.

Upwelling Working Group
To investigate the topics of land products and albedo validation. BSRN Site Scientists are requested to consider the addition of upwelling irradiance measurements to support various satellite measurements/retrievals.

All working groups are requested to publish results in journals with an observation/instrumentation focus. Interim reports are due in 2009 and draft publications are to be presented at the next meeting.

Direct Beam Working Group
Comparisons to be made under all-sky conditions and eventually in areas other than mid-latitudes, including:

- Distributed Comparisons: Message to BSRN soliciting data summaries of existing or future comparisons of different pyrheliometers;
- Intensive Short-Term Comparisons: Enhance NREL Pyrheliometer Comparisons (NPC) this year by including pyrheliometers; and
- Long-term Comparisons: Ells will announce a solicitation of BSRN participants who can contribute pyrheliometers for up to 12 months operation with windowed and unwindowed cavity radiometers. Steve to draft message to manufacturers asking for specimens.

Pyranometer Working Group
Mixed Sun-and-Shade methods implemented by others provide code for use of archived data. Pyranometer Calibration Round-Robin will start with a survey of participants asking for calibration facility and methods.

Albedo Working Group
Organize an intensive observing period in Oklahoma, Cabauw, or elsewhere for spectral and broadband albedo measurements. (Crystal to propose NSF? NOAA interest? Proper instrument height?) Hand-held instrumentation used for “walking survey” during changing seasons.

Spectral Working Group

- Broadband UV recommendation to come from GAW documentation
- Laurent and Julian to study conversion of Erythemal UV to Vitamin D productivity
- Joe interested in Photosynthetically Active Radiation (PAR) experiment (IOP) at SGP where RSS-1024 in continuous operation
- Calibration options: WRC-traceable facility (PMOD)

Long-Term Data Set Issues and Analyses Working Group (new)

1. Marital (see his presentation of 4 slides)
2. Decadal and regional scales for climate change studies

Tasks:

- Establish guidelines on statistical analysis tailored to surface radiation analysis
- Report of guidance, including expertise from other scientists working on historical time-series data for temperature, precipitation, etc.

- Develop analysis methods
- Define spatial and temporal scales
- Link BSRN analysis to model and satellite analyses

For the next meeting, the working group will ask for presentations by other experts on this topic (including uses of BSRN data).

Long-Term Data Set Issues and Analyses Working Group
Participants: Klaus Behrens. Rakel Gastesi, Julan Grobner, Martial Haeffelin,Chuck Kutscher, Nozou Ohkawara, Enio Pereira, Lourdes Ramirez, Vito Vitale, Martin Wild, Stephane Mevel

XI. ACTION ITEMS/DECISIONS

- Everyone needs to stay on top of getting their data into the archive in a timely manner.
- A F-Check program for test pre-archive submittal format is available.
- The issue of the synoptic observations being in different formats was raised.
- All site scientists should conduct quality analyses on their data BEFORE submitting it to the archive.
- Aerosol as a BSRN product—stay on course, but try to submit data (ask Ells Dutton if questions).
- Contacting AERONET to provide spectral transmittance data to BSRN operators.
- BSRN Manager to prepare a letter to assist (Israel) with the importance of BSRN data.
- Recommendation: Letters to WMO Committee on Basic Systems (John Nash – CIMO) and the value of BSRN activities like Ocean platforms (Bruce M.). Letter from GEWEX stronger in both cases.
- Per Wouter Knap, the CH1 Ventilator is noteworthy—specifications available.
- When BSRN sites are collocated with other radiation stations—both sites should conduct and report on comparisons of their data.
- Martin Wild's presentation of climate models and BSRN data discrepancies is a good example of the value of our work.
- Frontiers in DQ and Uncertainty is radiation in precipitation conditions. We don't know the effects of precipitation on radiometer domes/windows (frequency of events, duration of effects?).
- Photosynthetically Active Radiation (PAR) intensive observation periods (IOP) support—growing importance of PAR measurements. Help Joe (grad student opportunity). Explore with colleagues in agriculture.
- Working Groups are expected to produce publication-quality investigations and are asked to report on all published work at future meetings.
- Letters from the BSRN Managers to WMO/CBS indicating our interest in expanded oceanic surface radiation observations and to WMO/CIMO indicating the importance of the CIMO International Pyrheliometer Comparisons (IPCs) in Davos to the core BSRN activities are requested.

XII. NEXT MEETING

Approximately 8 months prior to the next meeting in 2010, the BSRN Project Manager will announce the location. BSRN station representatives from New Zealand and Brazil have offered to host the meeting.

Appendix A

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Appendix B

Tenth BSRN Scientific Review and Workshop
KNMI, De Bilt, The Netherlands
7-11 July 2008

Agenda

July 7, Monday

	<u>Opening Session</u>
08:30 – 08:35	Ellsworth Dutton and Wouter Knap – Meeting Opening and Logistics
08:35 – 08:45	Hein Haak, Director of Climate and Seismology – Welcome to KNMI
08:45 – 09:15	Reinout Boers – Observations and Research Activities at the Cabauw Experimental Site for Atmospheric Research (CESAR)
09:15 – 09:30	Peter van Oevelen – Overview of GEWEX Activities and Global Data Products
09:30 – 09:45	Dave Goodrich (presented by Richard Thigpen) – Report from the GCOS Secretariat
09:45 – 10:00	Ellsworth Dutton – Overview and Expectations for the Meeting
10:00 – 10:30	Break (poster set up)
	<u>Observatories – Status and Proposals (other status reports are in Posters)</u>
10:30 – 10:45	Enio Pereria – Status of Newly Instituted BSRN Activities in Brazil
10:45 – 11:00	Bruce McArthur– Proposal for the Inclusion of Eureka, Nunavut as a BSRN Station
11:00 – 11:15	Raquel Gastesi Barasoain – The Radiometric Station of CENER (Pamplona, Spain): Candidate to BSRN
11:15 – 11:30	Vito Vitale – Status of BSRN Measurements at Concordia Station (Dome C - Antarctica)
11:30 – 11:45	Anatoly Tsvetkov – An Overview on the Activity of Setting Up BSRN Site in Russia
11:45 – 12:00	Discussion on Newly Proposed Sites and Additional Site Needs
12:00 – 13:00	Lunch and Poster Viewing
	<u>Archive Activities</u>
13:00 – 13:20	Fernanda Carvalho – Azores Global Atmosphere Monitoring Complex (AGAMC) and Surface Radiation Measurements in the Azores
13:20 – 13:45	Gert König-Langlo – The World Radiation Monitoring Center at the Alfred Wegener Institute
14:45 – 15:10	All – Focused Discussion on BSRN Archiving Procedures and Practices
15:10 – 15:40	Break and Poster Viewing
15:40 – 16:00	Anatoly Tsvetkov – The Long Term Archiving Activities at the WRDC and Current Operation Related to GAW/BSRN data
	<u>Basic Observations – Analysis and Review</u>
16:00 – 16:20	Steve Wilcox and Liza Boyle – NREL Radiometer Calibrations and Data Quality Assessment Methods

16:20 – 16:40 Rachel Pinker and H. Wang – Characterizing the Radiation Environment of the BSRN Sites

16:40 – 17:00 Joseph Michalsky – Proposed Working Standard for the Measurement of Diffuse Shortwave Irradiance

17:00 – 17:45 Poster Viewing

8 July, Tuesday

Basic Observations – Analysis and Review (*continued*)

08:30 – 08:50 Steve Wilcox and Daryl Myers – The Effects of the Thermal Environment on the Eppley Normal Incidence Pyrheliometer (NIP)

08:50 – 09:10 Klaus Behrens – Responsivity of the Lindenberg BSRN Pyranometers Determined with Different Methods

09:10 – 09:30 David Halliwell – Pyranometer Calibration and Characterization: Comparing Results from Mix-of Sun-and-Cloud Calculations to ISO/ASTM Alternating and Continuous Sun-and-Shade Methods

09:30 – 09:50 Christian Lanconelli – First Analysis on Albedo Measurements at Concordia Station and Comparison with South Pole Evaluations.

09:50 – 10:05 Joop Mes - A Proposed Improvement to the Laboratory Calibration of Pyranometers

10:05 – 10:30 Break

Working Group Reports

10:30 – 10:45 IR WG –

10:45 – 11:00 AOD WG – Joseph Michalsky

11:00 – 11:15 Pyranometer WG

11:15 – 11:30 Direct WG

11:30 – 11:45 Pyrgeometer WG – Rolf Philipona

11:45 – 12:00 Uncertainties WG – Klaus Behrens

12:00 – 13:00 Lunch

Clouds and Aerosols

13:00 – 13:20 Steve Cooper – Retrieved Cloud Properties from BSRN-type Observations

13:20 – 13:40 Laurent Vuilleumier and D. Nowak – Radiation Transfer in Stratus Clouds at BSRN Payerne

13:40 – 14:05 Jean-Charles Dupont and Martial Haeffelin – Observed Cirrus Cloud Radiative Effects on Surface-level Shortwave and Longwave Irradiances

14:05 – 14:25 Rachel Pinker – Aerosol Radiative Effects in the Sub-Sahel Africa: Dust and Biomass Burning

14:25 – 14:45 Mikhail Alexandrov – Characterization of Atmospheric Aerosols and Water Vapor using Ground-based Sun Photometry

14:45 – 15:05 John Augustine – Climatology and Interpretation of 11-years of Aerosol Optical Depth Data from the U.S. BSRN Stations

15:05 – 15:30 Break

15:30 – 15:50 Wouter Knap – Quantification of the Direct Aerosol Effect for Cabauw, the Netherlands

15:50 – 16:20 Fernanda Carvalho – Aerosol Optical Measurements in the Azores

Network Activities, Calibrations, and Special Reports

16:20 – 16:45 Richard Thigpen – Report on the GCOS Global surface and Upper Air Networks, GSN and GUAN, Implementation Activities

16:45 – 17:45 Poster Viewing

9 July, Wednesday

Network Activities, Calibrations, and Special Reports (*continued*)

08:30 – 09:00 Ellsworth Dutton – State of BSRN

09:00 – 09:30 Julian Gröbner –Calibration Activities at the World Radiation Center, PMOD/WRC

09:30 – 09:50 Richard McKenzie – High-Quality Spectral UV Measurements used to Calculate Optimal Sun-Exposure Times

09:50 – 10:10 Thomas Stoffel – Radiometer Calibrations and Irradiance Measurements

10:10 – 10:40 Break

10:40 – 12:00 General Discussions, Action Items

12:00 – 22:00 Lunch and Local Tour

10 July, Thursday

Network Activities, Calibrations, and Special Reports (*continued*)

08:30 – 08:55 Chuck Long – Brief Report on the International Workshop on Global Dimming and Brightening

08:55 – 09:15 Laurent Vuilleumier – Long-term Comparisons of Collocated Ground Irradiance Flux Measurements

Model and Satellite Comparisons and Analysis

09:15 – 09:35 Yuanchong Zhang – Importance of Surface-Based, Nonradiative-Flux Parameters for Validating Satellite-Derived Radiative Fluxes

09:35 – 09:50 Taiping Zhang – Processing of the Baseline Surface Radiation Network (BSRN) Data and its Application in Validating the NASA GEWEX SRB Data

09:50 – 10:00 Wouter Knap and Ed Worrell – Pyranometer Condensation Problem

10:00 – 10:15 Break

10:15 – 10:35 Martin Wild – Applications of BSRN Data to GCM Models and Comparisons

10:35 – 10:50 Chuck Long –MJO Detection using Manus Surface Radiation Measurements

10:50 – 11:00 Jean-Charles Dupont – Evaluation of SW and LW based Cloud Detection Algorithms

11:00 – 11:20 Ping Wang – Clear Sky Closure Study during EUCAARI Campaign

11:20 – 11:40 Nozomu Ohkawara – Comparison of Downward Radiation Observations at Tateno with Reanalyses Data

11:40 – 12:00 Fred Denn – Climatology at the Clouds and the Earth's Radiant Energy System (CERES) Ocean Validation Experiment (COVE)

12:00 – 13:20 Lunch and Poster Viewing

Spectral Observations

13:20 – 13:40 Bruce McArthur – A First Look at an Optically Multiplexed Spectral (UVA/VIS/NIR) Radiometer

13:40 – 14:10 Joseph Michalsky –2008 Report on the Spectral Measurements Working Group

14:10 – 16:00 Break and Poster Viewing

16:00 – 17:00 Discussion – Review and Status Assessment.

17:00 – 17:45 Poster Viewing

11 July, Friday

Spectral Observations (*continued*)

08:30 – 08:50 Crystal Schaaf (presented by Ells Dutton) -Use of BSRN Data for Satellite Albedo Verification

08:50 – 09:10 Plans and Activities for Next Two Years – Charges to WGs

09:10 – 11:00 Working Group Meetings

11:00 – 12:00 Workshop Conclusions, Decisions, and Wrap Up

12:00 – 13:00 Lunch

Posters

Gé Verver – Status of the Radiation Measurements in Paramaribo, Suriname

Marion Maturilli and Gert König-Langlo – Status of the Polar BSRN Sites Ny-Ålesund and Neumayer

R. Schioppo, C. Lanconelli, M. Busetto, V. Vitale, R. Stone, A. Lupi, M. Mazzola – Use of an 2AP Tracker in a Measuring Site over the Antarctic Plateau

Julian Gröbner – The PMOD-COST 726 Calibration and Intercomparison Campaign of Erythemal Radiometers

Julian Gröbner – Intercomparison of Erythemal Broadband Radiometers Calibrated by Seven UV Calibration Facilities in Europe and the USA

David Halliwell and BruceMcArthur – Current Activities at the Alert BSRN site – a NOAA/EC Cooperative Effort

Zheng Xiagdong – Atmospheric Radiation Observations in the CMA GAW sites

Gary Hodges – Spectral Albedo at Table Mountain SURFRAD

Fred Denn and Bryan Fabbri – On Going Measurement Projects at the Clouds and the Earth's Radiant Energy System (CERES) Ocean Validation Experiment (COVE)

Nozomu Ohkawara – Status Report of Tateno Station

Laurent Vuilleumier – Status of the Payerne BSRN station

Jean-Philippe Morel – The Impact of the Clouds on UV Radiation in French Indies

Lamine Boulkelia – Status of Tamanrasset BSRN Station (Algeria)

R. Philipona (presented by L. Vuilleumier) – Aerosol and Cloud Effects on Solar Brightening and the Recent Rapid Warming in Europe

Wiel Wauben, Rob van Krimpen, Cor van Oort and Fred Bosveld – Sky Temperature / Cloud Measurements at Cabauw using the NubiScope

Paulo Fialho – Azores Observation Network (AZONET)

Appendix C

BSRN Working Group Structure (2008)

Pyranometer WG: David Halliwell (chair), Klaus Behrens, Chuck Long, Martial Haeffelin, Wouter Knap, Rakel Gastesi, Lourdes Ramirez

Pyrgeometer WG: Rolf Philopona (chair), Joseph Michalsky, Julian Gröbner, Klaus Behrens, Thomas Stoffel

Oceanic WG: TBD (chair); Gary Hodges, Robert Weller, Chuck Long, Martin Wild, Shawn Smith , Fred Denn

Direct Beam WG: Ells Dutton (Chair) Steve Wilcox, Klaus Behrens, Patrick Fishwick, Thomas Stoffel, David Haliwell, Donald Nelson

Cloud Parameters WG: Chuck Long (chair); Martial Haefflelin, Bruce Forgan, Rolf Philpona, Sylvio Mantelli

IR WG: Rolf Philipona (chair), Joseph Michalsky, Tom Stoffel, Alexander Los, Julian Gröbner

Aerosol Optical Depth WG: Bruce Forgan (chair), Joseph Michalsky, Christoph Wehrli, Vito Vitae, Mikhail Alexandrov, John Augustine

Upwelling Irradiances WG: Klaus Behrens (temporary chair), Rachel Pinker, R. Stone, Crystal Schaaf, Joseph Michalsky, Gary Hodges, Fred Denn

Spectral Measurements WG: Joseph Michalsky (chair), Rachel Pinker, Alexander Manes, Bruce Forgan, Laurent Vuilleumier, Bruce McArthur, Ain Kallis, Richard McKenzie

Uncertainties WG: Bruce Forgan (chair), Klaus Behrens, David Halliwell, Thomas Carlund, Chuck Long, Laurent Vuilleumier, Thomas Stoffel

Cold Climate Issues WG (new): Chuck Long (chair), Laurent Vuilleumier, Bruce Forgan, Vito Vitale, Dave Halliwell, Gert König-Langlo

Long Term Data Sets Issues and Analysis WG (new): Martial Haeffelin (chair), Chuck Long, Martin Wild, Julian Gröbner, Enio Pereira, Lourdes Ramirez, Taiping Zhang, Klaus Behrens, Rakel Gastesi, Nozomu Ohkawara, Vito Vitale, Stephane Mevel

Archive Advisory Panel (new) Chuck Long, Martin Wild, Ells Dutton, Gary Hodges, Steve Wilcox, Gert König-Langlo, Anatoly Tsvetkov, Lamine Boulkelia, Fernanda Carvalho

WMO CIMO WG – BSRN contact –Bruce Forgan

APPENDIX D

POSTERS

Status of the Radiation Measurements in Paramaribo, Suriname ([1]Gé Verver, [1]Wouter Knap, [2]Cor Becker) ([1]KNMI, [2]Meteorologische Dienst Suriname)

In 1999 the meteorological institutes of the Netherlands (KNMI)) and Suriname (Meteorologische Dienst Suriname (MDS)) started an atmospheric observation program in Paramaribo, Suriname (5.8ºN, 55.2ºW). A unique, tropical atmospheric observation facility was set up that fills an important gap in the international atmospheric observation network. As part of a more extensive continuous observation program, KNMI recently upgraded the radiation instruments to fulfill BSRN requirements. Although technical problems delayed the operation of the instruments, we recently started to collect data on a regular basis. We expect that the station becomes fully operational in the coming months.

Status of the Polar BSRN Sites Ny-Ålesund and Neumayer (Marion Maturilli and Gert König-Langlo, Alfred Wegener Institute)

The two polar BSRN sites Ny-Ålesund in the Arctic and Neumayer in Antarctica are operated by the Alfred Wegener Institute for Polar and Marine Research, in Bremerhaven, Germany. Both stations are equipped with identical instruments and started continuous measurements in 1992 and 1982, respectively, providing synoptic weather observations as well as daily upper air soundings and weekly ozone soundings in addition to the radiation measurements.

In Ny-Ålesund, the meteorological conditions and clouds do not only affect incoming radiation but also have an influence on outgoing radiation by albedo changes due to melting of the snow cover.

An increase of the global radiation is found at Neumayer, accompanied by a reverse trend of the downward-longwave radiation and a strong increase of the annual sunshine duration. Ceilometer data imply that the total cloud amount above Neumayer is decreasing.

The combined ozone sounding data set of the Georg Forster Station (70°46'S, 11°41'E) from 1985 to 1992 and afterwards—750 km further west at Neumayer Station (70°39'S, 8°15'W)—provides an insight of austral spring ozone depletion and its annual variation.

Currently, the Antarctic station Neumayer II is rebuilt. The new station, 'Neumayer III', is a construction that can adapt to the snow surface without getting buried and has an expected lifetime of 25 years. It is planned to be operative by March 2009, relocating the meteorological observatory and BSRN program without interruption.

Use of an 2AP Tracker in a Measuring Site over the Antarctic Plateau (R. Schioppo, [1]Christian Lanconelli, M. Busetto, [2]Vito Vitale, R. Stone, A. Lupi, M. Mazzola)([1]ISAC-CHR; [2]Italian National Research Council)

The Antarctic Plateau represents the hardest environment for mechanical as well as radiometric instrumentation. In a site like Dome C, where the Italian-French station Concordia was open as permanent station in January 2004, temperature ranges were between -70°C and -80°C during polar night, 30°C less the lowest operational limit given by Kipp & Zonen for their 2AP-GD tracker. In addition, during summer the maximum temperatures are around -20°C, so that there is no period during the whole year in which maintenance can be performed without problems arising from temperatures below 0°C. The strategies and modifications adopted are presented to allow continued operations of the 2AP-GD tracker and assure its survival in the polar night. The majority of these changes/improvements were performed during the austral 2007 campaign, when the tracker failed after 18 months of continuous work.

The PMOD-COST 726 Calibration and Intercomparison Campaign of Erythemal Radiometers (Julian Gröbner, PMOD/WRC)

The PMOD-COST 726 Calibration and Intercomparison Campaign of Erythemal Radiometers was organized at the Physikalisches Meteorologisches Observatorium Davos (PMOD) World Radiation Center (WRC) from 28 July to 23 August 2006; it is located in the Swiss Alps at 1610 meters above sea level. A total of 36 radiometers from 16 countries participated in the campaign, including one radiometer from the Central UV Calibration Facility from NOAA, U.S.A. The radiometer types represented at the campaign included:

- 9 Yankee UVB-1,
- 5 Kipp and Zonen,
- 2 Scintec,
- 11 analog,
- 8 digital Solar light V. 501,
- 1 Eldonet, and
- 1 SRMS (modified Solarlight V501).

A second spectroradiometer from the Medical University of Innsbruck, Austria, participated to provide redundant global spectral solar UV irradiance measurements; this spectroradiometer agreed with the Quality Assurance of Spectral UV Measurements in Europe (QASUME) spectroradiometer to within ±2% over the two week measurement campaign. The atmospheric conditions during the campaign varied between fully overcast to clear skies and allowed a reliable calibration for the majority of instruments. A novel calibration methodology using the spectral as well as the angular response functions measured in the laboratory provided remarkable agreement with the reference spectroradiometer, with expanded uncertainties (k=2) of 7 percent for the most stable instruments. The measurements of the broadband radiometers were analyzed both with the PMOD/WRC provided calibration as well as the prior calibration from the home institutes. The relative differences between the measurements using the prior calibration and the reference spectroradiometer varied between excellent agreement to differences larger than 50 percent for specific instruments.

Intercomparison of Erythemal Broadband Radiometers Calibrated by Seven UV Calibration Facilities in Europe and the USA (Julian Gröbner, PMOD/WRC)

An intercomparison of erythemal broadband radiometers was performed between seven UV calibration facilities. It is the first time that such a large-scale intercomparison of UV calibration facilities has been performed. The results of this study show the level of consistency that is currently achievable in the calibration of broadband UV radiometers measuring erythemally-weighted UV radiation by different laboratories. This effort fits within the declared goal of the WMO-GAW strategic plan 2008–2015 to link UV calibration services in different regions.

The characterizations of the detectors in the respective laboratories were found to be in good agreement, especially concerning the determination of the angular response, with deviations within +-4% in the calculated cosine error. The larger differences observed in the spectral response functions are due to differences in laboratory setup; however, the differences do not introduce any significant discrepancies in the resulting calibration apart from one case.

A 'blind' intercomparison of the erythemally-weighted irradiances derived from the respective institutes and PMOD/WRC showed consistent measurements to within +-2% for the majority of institutes. Only one institute showed slightly larger deviation of 10 percent. The absolute calibration of the spectroradiometers, which are used to calibrate the erythema detectors, has an uncertainty within +-5 percent. Therefore, the results of the intercomparison are very good, since nearly all instrument calibrations are well within their estimated uncertainties.

Current Activities at the Alert BSRN Site—a NOAA/EC Cooperative Effort (Bruce McArthur and David Halliwell, Environment Canada; and Ormanda J. Niebergall, Meteorological Service of Canada)

This poster highlights the current status of instrumentation and data collection at the Alert BSRN station, located in the Canadian high arctic (82°N, 63°W). The radiation measurements include the standard BSRN readings for incoming and outgoing fluxes, as well as spectral measurements at 8 wavelengths using Middleton SP2 sun photometers. Graphs of sun photometer data illustrate the diurnal cycle of V/V0, and illustrate some of the logistics (obstructions, tracker zeroing) of tracking the sun during 24-hour daylight. The site also includes measurements of meteorological parameters, and snow depth and soil temperature. Rapid collapse of the snow cover during melt is common, and the poster displays graphs and photographs of the changing surface conditions. The site is adjacent to the Global Atmosphere Watch (GAW) air chemistry laboratory at Alert, and the location and logistical support characteristics are present in photographs and text.

Atmospheric Radiation Observations in the CMA GAW Sites (Zheng Xiagdong, Chinese Academy of Meteorological Sciences)

The poster covers the status of the atmospheric radiation measurements at the Global Atmospheric Watch (GAW) sites operated by the China Meteorological Administration. The instruments were calibrated through a 1-year intercomparison with calibrated instruments, the Cavity radiometer (AHF # 30111). The AHF # 30111 was calibrated by the National Center for Meteorological Metrology (NCMM)/CMA. As different operators did the calibrations work during different periods, calibration records suggest the results have noticeable variability. This prevents us from assessing long trends of solar radiation. A standard protocol for quality assurance / quality control procedures of the data sets from the above sites should be established, especially the timely procedures for monitoring the data quality.

Spectral Albedo at Table Mountain SURFRAD (Gary Hodges, NOAA/ESRL/GMD)

A tower was installed early in 2008 at the Table Mountain SURFRAD site for the purpose of determining spectral albedo. In addition, broadband UV-B and PAR albedo are also calculated. The instruments installed are identical to their up-pointing counterparts located approximately 45 m to the south. The instruments employed are:

- Yankee Environmental Systems MFRSR measuring at six narrowband channels (nominally, 415, 500, 615, 673, 870 and 940 nm; 10 nm full width at half maximum)
- Yankee Environmental Systems UVB-1 broadband radiometer (280–320 nm)
- LI-COR LI-190 PAR (400– 700 nm)

The tower instruments are each mounted in shields: the inner surface of each shield is painted flat black, and the outer surface is gloss white. Each instrument is mounted such that the sensor is recessed slightly to avoid direct exposure to the very early or late afternoon sun. The instruments are positioned 1.5 m from the tower and 7 m above the surface. To ensure accurate albedos are calculated, the MFRSR and PAR instruments, both up- and down-pointing, are lamp calibrated every three months, while the UV-B instruments are run side-by-side.

On-Going Measurement Projects at the Clouds and the Earth's Radiant Energy System (CERES) Ocean Validation Experiment (COVE) (Fred Denn, Science Systems and Applications, Inc.; Bryan Fabbri)

Six topics were addressed in the poster: (1) Multi Filter Rotating Shadow band Radiometer (MFRSR) top of atmosphere extrapolations; (2) an automated radiometer washing system; (3) radiative closure, which describes a method of selecting data for submission to BSRN from duplicate direct, global, and diffuse shortwave radiometers; (4) an investigation of the Chesapeake Light Station on upwelling longwave radiation; (5) anomalies in paired direct, diffuse, global measurements; and (6) a discussion of downlooking radiometer placement at the Chesapeake Light Station.

Status Report of Tateno Station (Nozomu Ohkawara, Aerological Observatory/JMA)

Transition to the Global Infrared Radiation Scale Established by PMOD/WRC/IRC
Tateno station started employing the global infrared radiation scale in January 2008 retaining continuity with the past. To disseminate the global infrared radiation scale to pyrgeometers in the Asian region, the Japan Meteorological Agency (JMA) has been preparing for the start of a pyrgeometer calibration service with traceability to World Infrared Standard Group of Pyrgeometers (WISG) as a role of WMO Regional Radiation Center (RRC).

Renewal of the Data Acquisition System
The radiation data acquisition system at Tateno station was updated in March 2007. The new system has features that will help avoid missing data at a time of power failure and instrument replacement.

Start of Data Provision to CEOP of WCRP/GEWEX through the CEOP Tsukuba Reference Site
The Tateno BSRN station is one of the components of the CEOP Tsukuba reference site under the WCRP/GEWEX Monsoon Asian Hydro-Atmosphere Scientific Research and Prediction Initiative (MAHASRI). It has started providing radiation data via the BSRN data archive.

Status of the Payerne BSRN Station (Laurent Vuilleumier, Meteo Swiss)

Since November 1992, the Payerne station has been measuring the BSRN basic set of parameters. In addition, other parameters including longwave and shortwave irradiance at 10 and 30m above ground level, spectral direct irradiance, and UV erythemal irradiance are measured. Many measurements are made with redundant instruments and there are many opportunities for quality control (QC) checks. However, the multiplicity of parameters measured and possible QC checks make this procedure cumbersome. A new flexible automated QC assessment algorithm taking into account the results of the different QC checks is being developed and tested at Payerne.

Since 2004, all the UV erythemal broadband radiometers (biometers) in operation at MeteoSwiss (including at Payerne) have been undergoing yearly calibration checks by comparison to a well-calibrated reference. The estimated uncertainty for such a method is a little in excess of 5 percent for the calibration of the reference and on the order of 4 percent for inter-instrument reproducibility. This uncertainty is compatible with the observed difference between redundant measurements of UV global erythemal irradiance with several biometers. The total uncertainty of UV measurements is estimated at about 10 percent. Errors and inhomogeneities in the old data submitted to World Radiation Monitoring Center (WRMC) in the longwave, diffuse shortwave, and UV have been identified and are being analyzed. However, correction of old un-homogenized values in the WRMC database is still pending.

The Impact of the Clouds on UV Radiation in the French Indies (Jean-Philippe Morel and Jean Olivieri, Meteo-France)

A comparison between hourly irradiation measurements (in J/m² or J/cm²) obtained from a CM6B—a pyranometer that uses a classical thermopile as detector—and a SP-LITE—a low cost pyranometer that uses a photodiode BPW34 as detector—was held in "Le Raizet" from the 1st of June to the end of December 2007. The coordinates of Le Raizet, a meteorological station in the French Indies (Guadeloupe), are 16°16' N; 61°31 W.

This comparison showed the surprising impacts of clouds on UV radiation at ground level that, among others, have as a result a more or less important decrease in the hourly irradiation measurement results of the SP-LITE compared with those of the CM6B. This pyranometer is seen here as the "Reference" (better metrological quality). Decreases of 20 to about 40 percent are possible only during the rainy season (from June to October in 2007 at Le Raizet) in the middle of certain days characterised by the simultaneity of the following conditions.

1. sun elevation higher than 60 to 65 degrees,
2. presence of Cumulus (Congestus type) in the sky,
3. cloud cover about 4 to 6/8,
4. hourly sunshine duration about 30 to 50 minutes.

The last conditions clearly suggest that the solar disk is mostly unoccluded during the hourly period. The morphology of the clouds and their optical properties (particle size distributions and phase) also play an important role.

Because of the spectral response of the SP-LITE, enhancement in UV flux (up to 40 percent over clear-sky values, according to many researchers) and also decreasing in visible and near IR sun radiations, the SP-LITE pyranometer cannot measure the global radiation when the above conditions are present simultaneously. A very similar phenomenon is observed when the SP-LITE is used for measurements of the Diffuse Radiation richer in UV radiation than global radiation. The measurement results are clearly underestimated under cloudless skies in that case.

The spectra of the global and diffuse radiations simulated using good cloudless models are weighted by the spectral responses of the SP-LITE and the CM6B. The results of this operation are then integrated over all the solar spectrum. The ratios SP-LITE/CM6B obtained are almost constant for the global spectra. The mean value of these ratios is close to the calibration factor of the SP-LITE; these ratios are different for the diffuse spectra. Therefore, contrary to what is generally admitted concerning the global radiation, the SP-LITE cannot measure the diffuse radiation if an uncertainty of about 5 percent is accepted and on condition that the above conditions are not present simultaneously or cannot occur (for example, during the dry season in Le Raizet).

Status of Tamanrasset BSRN Station (Algeria) (Lamine Boulkelia, National Meteorological Office)

The National Meteorological Office (ONM) in collaboration with the World Meteorological Organization (WMO) has participated in GAW activities since 1994 with its Tamanrasset/Assekrem site, located in the desert region at about 1900 km south of Algiers (22 47'N, 05 37'E, 1377 meters above sea level (m.a.s.l.). Solar radiation (with a 3mm step) is one of the primary measurements at the Tamanrasset station.

The NOAA/Climate Monitoring and Diagnostics Laboratory (CMDL) Center for Satellite Applications and Research (STAR) group from Boulder, Colorado have sponsored the site since March 2000 and provided the shaded Eppley diffuse PSP and PIR with CR23X data logger with 1 mm step. At present, 94 months of basic measurements, including surface data and total ozone, have been archived at the WRMC, as well as UVB files generated monthly in the BSRN format since January 2008. Upper air meteorological data will be added in the near future.

Aerosol and Cloud Effects on Solar Brightening and the Recent Rapid Warming in Europe (Christian Ruckstuhl, Rolf Philipona, [1]Klaus Behrens, Martine Collaud Coen, Bruno Dürr, Alain Heimo, Christian Mätzler, [2]Stephan Nyeki, Atsumu Ohmura, [3]Laurent Vuilleumier, Michael Weller, Christoph Wehrli, and Antoine Zelenka)([1]DWD, [2]PMOD/WRC, [3]Meteo Swiss)

The rapid temperature increase of 1ºC over mainland Europe since 1980 is considerably larger than the temperature rise expected from anthropogenic greenhouse gas increases. The poster presents aerosol optical depth measurements from six specific locations and surface irradiance measurements from a large number of radiation sites in Northern Germany and Switzerland. The measurements show a decline in aerosol concentration of up to 60 percent, which have led to a statistically significant increase of solar irradiance under cloud-free skies since the 1980s. The measurements confirm solar brightening and show that the direct aerosol effect had an impact approximately five times larger on climate forcing than the indirect aerosol and other cloud effects. The overall aerosol and cloud induced surface climate forcing is ~+1 W m^{-2} dec^{-1} and has most probably strongly contributed to the recent rapid warming in Europe.

Sky Temperature/Cloud Measurements at Cabauw using the NubiScope (Wiel Wauben, Rob van Krimpen, Cor van Oort and Fred Bosveld, KNMI)

Recently KNMI purchased the NubiScope scanning pyrometer, which is sensitive in the thermal infrared (10–14mm). The instrument is installed at the BSRN site in Cabauw and performsfully automated sky temperatures measurements at 36 azimuth and 30 zenith angles every 10 minutes. From this, spatial cloud information is derived both during day- and night-time. In addition the surface temperature is measured in 2 directions.

In 2008–2009 the NubiScope will be evaluated by researchers of the climate department and meteorologists in the weather room for its suitability for operational use. Possible improvements of the NubiScope results will also be considered, for example, using synergy with other observation platforms such as a cloud ceilometer. The field test is combined with laboratory tests during which the stability and sensitivity of the pyrometer to contamination is monitored. The presentation showed some first results of the field and laboratory tests of the NubiScope.

Azores Observation Network (Paulo Fialho, AZONET)

The poster highlighted BC and iron (present on dust) aerosol concentrations monitored and sampled at Pico Mountain site with the Aethalometer (AE31). This information is compared with the carbon monoxide measurements sampled during the same period.