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Physikalisch-Meteorologisches Observatorium Davos World Radiation Center

Annual Report 2005

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SFI

Schweizerisches Forschungsinstitut für Hochgebirgsklima und Medizin

DAVOS

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Zusammenfassung Jahresbericht 2005

Vorwort

Alle fünf Jahre ist die Durchführung der Internationalen Pyrheliometer Vergleiche die Hauptaufgabe des PMOD/WRC. Letztes Jahr fanden die zehnten Vergleiche (IPC-X) statt und im Gegensatz zu den schwierigen Wetterverhältnissen vor fünf Jahren, waren die Bedingungen für die Messungen der Sonneneinstrahlung optimal. Dies erlaubte nicht nur die erforderlichen Messungen durchzuführen, sondern sorgte auch für gute Stimmung unter den IPC Teilnehmern. Parallel zu den IPC-X wurde auch der zweite internationale Vergleich von Filterradiometern durchgeführt. Anschliessend an die drei Wochen der IPC-X fanden in Davos zwei Konferenzen statt, NEWRAD und UVNet, für die das Observatorium Davos die lokale Organisation übernommen hatte.

Passend zu den operativen Erfolgen ist der Fortschritt in der internationalen Anerkennung der Kalibriertätigkeit des WRC. Das Qualitätssystem nach der Norm ISO/ICE 17025, das vor etwas mehr als einem Jahr eingeführt wurde, ist im Januar 2006 durch das Qualitätsforum von EUROMET, der Vereinigung der Metrologischen Institute, gutgeheissen worden. Für eine vollständige Anerkennung müssen nun noch die beantragten spezifischen Kalibrier- und Messfähigkeiten des WRC formell durch das EUROMET und anschliessend durch die zuständige Kommission des Internationalen Büros für Masse und Gewichte anerkennt werden.

Mit dem nahenden Start des Experiments LYRA im Jahr 2007 laufen parallel die Vorbereitungen zur Auswertung der künftigen Messdaten, die als Eingabewerte für Chemistry-Climate-Model Rechnungen zur Beurteilung des Ist-Zustandes der mittleren Erdatmosphären eingesetzt werden sollen. Das nun seit 2001 laufende Polyprojekt in Zusammenarbeit mit Instituten der ETH Zürich und neu auch mit der EAWAG, wird für eine zweite Drei-Jahres Phase von der ETHZ mit der Finanzierung von vier Doktorandenstellen unterstützt, wobei ein Doktorand ab Februar 2006 in Davos arbeitet. Das Polyprojekt, ein weiteres durch den SNF finanziertes Projekt sowie eine internationale Forschungszusammenarbeit im Rahmen eines SCOPES Projektes sind gemeinsam der Untersuchung des Einflusses der variablen Sonnenbestrahlung auf das Erdklima gewidmet und bilden zusammen mit Forschungsprojekten, die Strahlungsmessungen am Boden miteinbeziehen, die theoretische Basis und Motivation für den Bau der Weltraumexperimente.

Ein langjähriges Forschungsprojekt, das ASRB, das vom ehemaligen Direktor Claus Fröhlich initiiert wurde, hat zehn Jahre lang ein Messnetz von Strahlungsmessungen in den Alpen betrieben. Dieses Forschungsmessnetz wird seit dem letzten Jahr ins SwissMetNet integriert und soll nach einer zweijährigen Übergangsphase in Zukunft von der MeteoSchweiz operationell weitergeführt werden.

Neu betreibt das PMOD/WRC seit Mitte 2005 ein Zentrum für die Kalibrierung von UV Radiometern (UVC). Das UVC ist nicht ein Teil des Weltstrahlungszentrums, da die neue Aufgabe durch einen Schweizerischen Beitrag an die COST Aktion 726 finanziert ist. Für Aussenstehende ist das UVC jedoch eine attraktive Ergänzung des WRC, da es sowohl in seiner Aufgabenstellung bestens zum WRC passt, als auch eine bald 100-jährige Tradition des Observatoriums wieder aufgreift – war doch der PMOD Gründer Carl Dorno ein Pionier der UV Forschung.

Seit 1996 betreiben wir auch das WORCC, das Zentrum für die Untersuchung der atmosphärischen Trübung. Bis anhin wurde diese Aktivität durch Drittmittel finanziert. Da das WORCC von der internationalen Gemeinschaft sehr geschätzt und beachtet ist und die zuständige WMO Beratergruppe eine Weiterführung des WORCC auf solider Basis empfohlen hat, soll versucht werden, das WORCC bei der kommenden Erneuerung des Vertrags zur Finanzierung des Weltstrahlungszentrums operationell dem WRC anzugliedern. Damit würde unsere Position als Kompetenzzentrum für die Kalibrierung von Strahlungsmessgeräten ausgebaut und gestärkt.

Internationale Vergleiche von Pyrheliometern und Filterradiometern (IPC-X und FRC-II)

Im Jahr 2005 fanden vom 26. September bis 14. Oktober 2005 die 10. Internationalen Pyrheliometer Vergleiche statt, die alle fünf Jahre abgehalten werden. Es nahmen 77 Teilnehmer aus 42 Ländern mit 101 Instrumenten teil und es konnte an elf klaren Tagen gemessen werden. Die provisorische Auswertung der Messungen zeigt, dass einerseits die

Radiometrische Weltreferenz (World Radiometric Reference, WRR), die durch die Weltstandardgruppe realisiert ist, innerhalb der von der Meteorologischen Weltorganisation vorgeschrieben 0.2 % stabil geblieben ist, und anderseits, dass die Kalibrierung in der geforderten Genauigkeit auf die Teilnehmerinstrumente übertragen werden konnte. Dank einer ausserordentlich grossen Anzahl von Vergleichsmessungen, kann das Verhalten der Instrumente auch auf einem höheren Genauigkeitsniveau analysiert werden. So wird u.a. untersucht, ob ein 0.05 %iger Unterschied in der zeitlichen Stabilität zwischen der WRR und dem Mittel der Teilnehmerinstrumente signifikant sei.

Zum zweiten Mal (nach 2000) beteiligten sich IPC-Teilnehmer an einer gleichzeitigen Kampagne zur Untersuchung von Messmethoden der atmosphärischen Trübung. Vierzehn Instrumente von neun Instituten, die vier verschiedene Typen umfassten, nahmen an diesem Vergleich teil. Bei den ersten Vergleichen im Jahr 2000 war das Schwergewicht auf den Vergleich der Instrumentenmesswerte gelegt. Bei den zweiten Vergleichen untersuchte man vor allem die Auswertealgorithmen und die Auswirkungen verschiedener Kalibriermethoden. Es stellte sich heraus, dass die verschiedenen Auswertemethoden systematische Unterschiede in der berechneten atmosphärischen Trübung bewirken, die von der gleichen Grössenordnung sind wie der Beitrag der Unsicherheit der Messdaten. Das bedeutet, dass mit der Evaluation und allgemeinen Anwendung der besten Auswertemethode die Genauigkeit der Messungen der atmosphärischen Trübung verbessert werden könnte.

Parallel zu beiden Instrumentenvergleichen wurden bei schlechter Witterung zu beiden Themen sowohl Schulungs- wie auch Forschungsseminare abgehalten, die den wertvollen Austausch von Erfahrungen zwischen den Wissenschaftlern erlaubte.

Dienstleistungen und Messnetze

Zusätzlich zu den Pyrheliometern und Filterradiometern, die an den IPC-X und FRC-II teilnahmen, konnten an 75 klaren Tagen 31 Pyranometer, 5 Actinometer und 1 Pyrheliometer kalibriert werden. Im Rahmen des zweiten Betriebsjahres des Infrarot Radiometer Zentrums (IRC) wurden 25

Pyrgeometer kalibriert. Die Abteilung für die Berechnung der atmosphärischen Trübung (WORCC) kalibrierte 12 Filterradiometer.

Im zweiten Betriebsjahr des Infrarot Radiometer Kalibrierzentrums (IRC) als offizieller Teil des Weltstrahlungszentrums zeigte sich die internationale Akzeptanz des IRC in der wachsenden Zahl der Kundenanfragen. Letztes Jahr waren es vierzehn Institute aus vier Kontinenten die Pyrgeometer zur Kalibrierung geschickt hatten um die IR Strahlungsmessungen der jeweiligen Landesmessnetze auf die Referenz am PMOD/WRC zurückführen zu können. Die Kalibriereinrichtungen im Labor wurden verbessert und auf dem Dach des Institutsgebäudes sind weitere Kalibrierplätze geschaffen worden. Die Anwesenheit von einigen Strahlungsexperten mit fundierten Kenntnissen im IR Bereich während den IPC-X wurde für informelle Diskussionen und Erfahrungsaustausch über Kalibrierungsprobleme genutzt und es resultierten aus diesen Kontakten wertvolle Kollaborationsabsprachen.

Im Verlauf des letzten Jahres wurde das Referenzzentrum für UV Strahlungsmessung vom Joint Research Center der Europäischen Kommission in Ispra ans PMOD/WRC übertragen. Nach dem Transfer der Ausrüstung im Juli 2005 wurde das Instrumentarium installiert, so dass ab dem Jahr 2006 das UV Radiometer Zentrum offiziell den Betrieb aufnehmen konnte.

Der Betrieb des GAW Messnetzes mit PMOD/WRC Präzisions-Filter-Radiometern (PFR) läuft weiterhin erfolgreich und zufriedenstellend, wobei immer noch nicht die gewünschte Anzahl Messstationen mit PFR Instrumenten ausgerüstet ist. Dies obwohl die Geräte schon lange gefertigt wurden und bereit zur Installation wären. Leider fehlen an den vorgesehenen Stationen noch immer die notwendigen Sonnennachführungen. Zur Qualitätssicherung der Standardinstrumente des Messnetzes wurde deren Langzeitverhalten mit einem Instrument verglichen, das von der Station auf Mauna Loa zurückkam. Ein Instrument an dieser Station kann durch die guten Wetterbedingungen und dank der Höhe der Station laufend mit der Langley Methode kalibriert werden. Die dadurch in den letzten Jahren entstandene ausführliche Kalibriergeschichte dieses Instrumentes macht es auch zu einem Vergleichsstandard. Der Vergleich der designierten Standardinstrumente mit dem Instrument, das von Mauna Loa zurückkam zeigt, dass alle Instrumente während fünf Jahren, innerhalb der vom Betrieb erforderlichen 1 %, stabil geblieben sind.

Das ASRB Messnetz des PMOD/WRC und der MeteoSchweiz, das nun seit einem Jahrzehnt die IR-Strahlung im Alpenraum misst, wird weiterhin bis Ende 2007 sorgfältig betreut und unterhalten. Parallel erweitert die MeteoSchweiz innerhalb ihres neuen SwissMetNet die Strahlungsmessungen im IR Bereich, so dass nach einer zweijährigen Beobachtung der gleichen Messgrösse durch beide Messnetze eine zuverlässige Fortsetzung der IR Messreihe durch das SwissMetNet allein möglich sein wird. Eine kontinuierliche IR Messreihe wird eine wichtige Grundlage sein um die Änderung des Klimas der Schweiz fundiert beurteilen zu können.

Entwicklung und Bau von Instrumenten – ein neues Absolut-Radiometer und die Weltraumexperimente SOVIM, PREMOS und LYRA

Im Rahmen eines Nationalfonds Projekts wird ein neuer Typ Absolut-Radiometer entwickelt, der auf einer phasenempfindlichen Analyse des Messsignals basiert. Im ersten Projektjahr wurde vor allem ein Computermodell des Instrumentes entwickelt, um ein theoretisches Verständnis für das Messprinzip zu bekommen. Im vergangenen zweiten Projektjahr wurde ein Prototyp gebaut und die Messdaten mit dem Computermodell verglichen. Es zeigte sich, dass Modell und Prototyp befriedigend übereinstimmen, so dass im nächsten Schritt das Labor verlassen werden kann und Messungen vor Sonne durchgeführt werden.

Im vergangenen Jahr befanden sich am PMOD/WRC gleichzeitig drei Weltraumexperimente im Bau. Diese zeitliche Überlappung hat die technische Abteilung stark belastet aber in Zukunft sollte sich die Situation etwas entspannen, da zwei Experimente, SOVIM und LYRA, praktisch fertig hergestellt sind. Somit können wir uns nun auf den Bau des Experiments PREMOS konzentrieren.

Solarer Einfluss auf die Temperaturen um die Stratopause, in der unteren Stratosphäre und der unteren Troposphäre

Drei Modellrechnungen für die Zeitspanne 1975 – 2000 mit dem CCM *SOCOL,* die erste mit einem der Beobachtungen entsprechenden Anstieg der Treibhausgase, die zweite mit zusätzlich dem Verlauf der Konzentration der Ozon zerstörenden Substanzen und die dritte wiederum zusätzlich mit der beobachteten zeitlichen Variation der Sonneneinstrahlung, wurden mit einer Simulation verglichen, bei der diese Grössen konstant gelassen wurden. Die Beobachtung zeigt, dass die Temperatur um die Stratopause in diesem Zeitraum stetig abnimmt. Die Simulationen mit den beiden anthropogenen Einflüssen, aber ohne die Variation der Sonneneinstrahlung, ergeben beide eine starke Abnahme der Temperatur in dieser Höhe, wobei die Abnahme aber wesentlich stärker berechnet wird als beobachtet ist. Es braucht den Einfluss der variablen Sonneneinstrahlung, die während dem Maximum des solaren Aktivitäts-Zyklus in den Jahren 1979, 1990 und 2001 die Stratosphäre erwärmte. Die Sonneneinwirkung verlangsamt den anthropogen verursachten Abkühlungstrend und somit stimmt die Modellrechnung besser mit der Beobachtung überein.

Die oben erwähnten Modellrechnungen wurden auch mit der von Satelliten beobachteten Temperaturverteilung in der unteren Troposphäre und der unteren Stratosphäre verglichen. Wenn alle drei Effekte miteinbezogen werden, stimmen die Rechnungen im Wesentlichen mit den Beobachtungen überein, indem die richtige geographische Verteilung der Gebiete mit Temperaturabnahme und Temperaturzunahme aus den Simulationen resultiert. Eine genaue Analyse zeigt jedoch, dass gewisse Stellen nicht ganz richtig berechnet werden, so dass man daraus schliessen muss, dass das Modell zwar ausserordentlich erfolgreich ist, aber offenbar noch nicht sämtliche in Realität vorkommenden Effekte korrekt berücksichtigt.

Einer der vermuteten fehlenden Effekte könnte der Einfluss des Einfalls von energetischen Elektronen auf die Erdatmosphäre sein (Energetic Electron Precipitations, EEP). Eine Untersuchung dieses Effektes zeigt, dass die Konzentration von NO_X in der mittleren Stratosphäre über den tropischen Breiten durch die EEP beeinflusst wird, was wiederum die Ozonkonzentration beeinflusst. Diese wiederum bewirkt Änderungen der Temperaturen in der Stratosphäre. EEP scheint in der Wirkung mit der solaren UV Strahlung vergleichbar zu sein. Die beiden Effekte wirken verstärkend ausserhalb der polaren Regionen, aber über den Polen ist die kombinierte Wirkung geringer, weil sich die Effekte gegenseitig kompensieren.

Anthropogener Treibhauseffekt und starke Wasserdampfrück-koppelung bewirken eine Erwärmung in Europa

Die Temperaturen in Europa steigen wesentlich rascher an als das Mittel der Nordhemisphäre. Strahlungsmessungen in den Alpen deuten auf eine verstärkte Einstrahlung hin. Ein verstärkter Treibhauseffekt könnte durch eine erhöhte Himmelsstrahlung vor allem im infraroten Strahlungsanteil zu Stande kommen, die wiederum durch eine Rückkoppelung durch den Anstieg des Wasserdampfes bewirkt werden könnte. Der Effekt scheint vor allem in Zentral- und Nordosteuropa stark zu sein, wo genügend Wasser für eine verstärkte Verdunstung zur Verfügung steht.

Strahlungsklimatologie und Trends von BSRN Stationen in polaren Breiten

Zehn Jahre Beobachtungsdaten der vier Stationen des Baseline Surface Radiation Network (BSRN) in polaren Breiten wurden aufgrund der vermuteten Änderung des Treibhauseffekts im Rahmen einer ETH-Doktorarbeit auf Trends untersucht. Der beobachtete Anstieg der Erwärmung ist gut mit der Änderung der Oberflächenfeuchtigkeit und der Himmelsstrahlung im Infraroten bei klarem Himmel korreliert, was die Bedeutung der Wasserdampf-Rückkopplung bei der globalen Erwärmung unterstreicht. Der auch festgestellte Trend in der Albedo und der Wolkeneffekt auf die Strahlung scheinen jedoch weniger direkt mit der Erwärmung gekoppelt zu sein. Der abnehmende Bedeckungsgrad in gewissen Monaten spiegelt sich jedoch in der Zunahme der direkten solaren Einstrahlung.

Monatliche Klimatologie der Trübungswerte

Für die meisten der mit PMOD/WRC Präzisions-Filter-Radiometern ausgerüsteten Stationen des Global Atmosphere Watch Messnetzes bestehen Datenreihen von fünf oder mehr Jahren. Mit diesen Daten kann nun eine Klimatologie der monatlichen Trübungswerte zusammengestellt werden. Die Datenreihen sind noch zu kurz, um einen signifikanten Trend feststellen zu können, bzw. umgekehrt gesagt, innerhalb der Unsicherheiten sind die Trübungswerte konstant. Die Daten bilden nun eine solide Basis für die weltweite Trübungsüberwachung gegen die man einen zukünftigen Trend durch die Klimaänderung wird feststellen können.

Das PMOD-Komposit der Totalen Solaren Einstrahlung 1975-2005

Das PMOD/WRC Weltraumexperiment SoHO/VIRGO konnte im Dezember 2005 das zehnjährige Jubiläum seiner Beobachtungsreihe feiern. Dank der langjährigen Erfahrung mit den Empfindlichkeitsänderungen der PMO6V Absolutradiometer konnten auch systematische Änderungen früherer Experimente entdeckt und korrigiert werden. Durch den Miteinbezug von Messungen von der Erdoberfläche für die Jahre von 1977 und 1978 konnte nun eine verbesserte Zusammenstellung und Homogenisierung aller bisherigen Messungen der Variation der sogenannten Solarkonstante erstellt werden. Die Zeitreihe der zusammengesetzten TSI-Beobachtungen umfasst nun drei Maxima und bald drei vollständige solare Aktivitätszyklen von rund elf Jahren.

ETH-Polyprojekt – Iteration einer Opazitätsverteilfunktion

Im Rahmen der ersten Drei-Jahres-Phase des ETH Polyprojekts Variabilität der Sonne und Globales Klima wurde die Dissertation *Modeling Variations of the Solar UV Spectrum with COSI* abgeschlossen. Ein wesentliches Ergebnis dieser Arbeit war die Erweiterung einer bekannten Methode für die Behandlung der Opazitäts-Wirkung von Millionen von Spektrallinien, die sogenannte Opazitätsverteilfunktion (ODF) für Sternatmosphären im lokalen thermo-dynamischen Gleichgewicht (LTE), in dem man nun neu Abweichungen von LTE mitberücksichtigt. Die Verallgemeinerung gelang mittels Iteration der ODFs, wobei gezeigt werden konnte, dass die Iteration in lediglich drei Schritten konvergiert.

COST-724 Weltraumwetter – Jetzt- und Kurzzeitprognosen der mittleren Atmosphäre basierend auf beobachteter UV Einstrahlung

Die Messungen der Sonnenbestrahlung der Erdatmosphäre mit dem Weltraumexperiment LYRA auf dem Satelliten Proba2, der im Verlauf von 2007 gestartet wird, sollen in speziell ausgewählten Wellenlängenbändern, die für den Zustand der mittleren Atmosphäre von Bedeutung sind, als Eingabewerte in ein Klimamodell verwendet werden, um damit Kurzzeitprognosen des Zustands der mittleren Atmosphäre zu berechnen. Im ersten Jahr des Projekts wurde die Machbarkeit eines „Nowcastings" studiert. Im vergangenen zweiten Projektjahr war das Ziel die Optimierung des verwendeten Modells. Es wurde dafür ein Programm-Modul für das bestehende CCM SOCOL entwickelt und getestet, das zusätzlich die Jonenchemie der jonosphärischen D-Region mit einbezieht.

Internationale Zusammenarbeit

Ein Jahr nach dem Ende des SCOPES (Scientific Collaboration between Eastern Europe and Switzerland) Projekts des PMOD/WRC mit Usbekistan hat das Observatorium eine neue SCOPES Partnerschaft mit dem Main Geophysical Observatory in St. Petersburg Russland starten können. Das Ziel des Projektes ist die Simulierung der zeitlichen Entwicklung des zukünftigen Klimas und insbesondere der Ozonkonzentration in der Stratosphäre bis in die Mitte dieses Jahrtausends. Sowohl in St. Peterburg als auch bei uns wurden Rechnungen mit dem CCM Modell SOCOL, das im Rahmen des Polyprojekts entwickelt wurde und nun auch von weiteren Gruppen national und international eingesetzt wird, durchgeführt. Die ersten Resultate sind ausserordentlich interessant: Wenn die Erwartungen über die Reduktion der Ozon zerstörenden Substanzen zutreffen, dann wird sich die Ozonkonzentration in der Stratosphäre bis ca. im Jahr 2030 auf die früheren Werte erholen, aber durch die Wirkung der weiterhin ansteigenden Konzentration der Treibhausgase wird die Konzentration bis 2050 höhere Werte als vor dem Rückgang um 1975 erreichen.

Lehrverpflichtungen

In den Wintersemestern 2004/2005 und 2005/2006 hielt W. Schmutz gemeinsam mit PD Dr. H. M. Schmid die Vorlesung „Astronomie" an der ETH Zürich. R. Philipona las in den Wintersemestern 2004/2005 und 2005/2006 an der ETH Zürich die Vorlesung „Strahlungsmessung in der Klimaforschung" sowie die gleiche Vorlesung im WS 2005/2006 an der Universität Bern.

Personelles

Anfangs des Jahres 2005 verliess die Leiterin der Abteilung für Solar-Radiometrie, Dr. Isabelle Rüedi, das Observatorium um an der WMO ihre Berufslaufbahn fortzusetzen. Ihr Nachfolger wurde Dr. Wolfgang Finsterle der vor seiner Umbesetzung schon für die Einführung eines Qualitätssystems für diese Abteilung im Haus arbeitete und daher schon bestens mit seiner neuen Aufgabe vertraut war. Auf Anfang April wurde PD Dr. Rolf Philipona als Leiter des Infrarot Radiometer Zentrums durch Dr. Julian Gröbner ersetzt, der vorher am Joint Research Center der Europäischen Kommission in Ispra (I) als Leiter des Europäischen UV Zentrums angestellt war. Dr. Rolf Philipona wurde mit der Übertragung des Forschungsmessnetzes ASRB ins SwissMetNet beauftragt. Sein Arbeitsplatz befindet sich neu bei der MeteoSchweiz in Payerne.

Im Juni hat Sandra Möbus, Studentin der Fachhochschule Ravensburg, ihre Diplomarbeit als Physikingenieur erfolgreich abgeschlossen und ab Oktober als Laborantin gearbeitet. Wie im Vorjahr haben auch im Jahr 2005 zwei Doktoranden ihre Doktorprüfung abgelegt. Dr. Chris Hoyle hat eine Postdoc Stelle in Norwegen gefunden und Dr. Margit Haberreiter wurde im Rahmen eines Nationalfonds Projekts als Postdoc für Helioseismologie angestellt. Ich gratuliere den drei Personen herzlich zu den gelungenen Abschlüssen.

Im Oktober 2005 hat Sonja Degli Esposti die berufsbegleitende Ausbildung zur eidgenössischen Personalfachfrau erfolgreich bestanden. Ich freue mich sehr über ihre Leistung und gratuliere auch ihr ganz herzlich zu diesem schönen Erfolg.

Sponsoren

Im Jahr 2005 hat das PMOD/WRC ein Radiometer für die Bestimmung der atmosphärischen Trübung und spektrale Messungen der Globalstrahlung von Yankee Environment Systems (YES) bestellt um die Anzahl der verschiedenen Typen von Instrumenten zur Trübungsbestimmung zu erhöhen, die am World Optical Depth Research and Calibration Center (WORCC) betrieben und verglichen werden können. Der Kauf wurde durch Herrn Daniel Karbacher aus Küsnacht, Zürich ermöglicht, der wiederum das Observatorium mit einer grosszügigen Schenkung bedacht hat. Leider hat sich die Lieferung des Instrumentes erheblich verzögert, so dass der gespendete Betrag erst in der Rechnung des Jahres 2006 berücksichtigt werden wird.

Der Förderverein hat die dritte von vier Tranchen für die Finanzierung des im Jahr 2003 gekauften Canon CLC 1180 Druckers und Kopierers überwiesen.

Dank

Während der drei Wochen der IPC-X und FRC-II, den zwei Tagungen in der darauffolgenden Woche und den wochenlangen aufwendigen Vorbereitungsarbeiten waren meine Mitarbeiter zusätzlich stark gefordert. Es freut mich ausserordentlich, dass ich berichten kann, dass ohne Ausnahme alle mit ihrem Engagement zur reibungslosen und erfolgreichen Durchführung dieser Veranstaltungen beigetragen haben. Das ganze Jahr war geprägt von hoher Einsatzbereitschaft und guter Arbeitsatmosphäre am Institut.

Den Mitgliedern des Ausschusses SFI und der Aufsichtskommission danke ich für die stets positive und fördernde Begleitung und die vorausschauende Planung für eine erfolgreiche Zukunft des Observatoriums Davos. Dem Bund, dem Kanton Graubünden und der Landschaft Davos Gemeinde verdanke ich die Finanzierung des Weltstrahlungszentrums, die nicht nur die Erfüllung des Dienstleistungsauftrags erlaubt, sondern auch durch die vorhandene Infrastruktur, eine solide Grundlage für zusätzliche Drittmittelprojekte bildet, die von PRODEX, SNF und ETH Zürich unterstützt werden.

Davos, im April 2006 Werner Schmutz, Prof. Dr. sc. nat.

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Introduction

Werner Schmutz

Every five years the PMOD/WRC focuses on organizing and hosting the International Pyrheliometer Comparisons. The 10th comparisons (IPC-X) were held in Fall 2005 and in contrast to the weather conditions of five years before, skies were beautifully clear, yielding a bounty of required calibration data as well as lifting the spirits of all participants. Upon the recommendation of the Commission for Instruments and Methods of Observation of the World Meteorological Organization (WMO), and following the example first established at IPC-IX, comparisons of filter radiometers for aerosol optical depth determinations were carried out simultaneously with those of the pyrheliometers. After the comparisons, the PMOD/WRC acted as the local organizer for the NEWRAD conference and a UVNet workshop, both of which were held in Davos. Hence, the staff was fully occupied with organizational duties for more than a month. I am very proud to report that their efforts resulted in the smooth and successful completion of all three events. I would like to take this opportunity to express my deepest appreciation to everyone on the PMOD/WRC staff for their hard work and dedication.

As a complement to the operational success of the comparisons it is also fitting to report that the formal acceptance of the operational service as World Radiation Center made progress in that the quality control system at PMOD/WRC, in accordance with the ISO/ICE 17025 norm, was approved by the quality forum of the European metrological institutes (Euromet). The next steps for the PMOD/WRC to become a fully recognized metrological institute are a formal approval of the WRC's Calibration and Measurement Capability, which has been submitted to Euromet for acceptance, and finally, the approval by the Consultative Committee for Photometry and Radiometry of the International Bureau of Weights and Measures.

With the resumption of the PICARD mission in 2004, there are currently three space experiments in various stages of manufacturing at the PMOD/WRC. Work is progressing well. The first instrument, SOVIM, is essentially finished, while for the second, LYRA, the hardware is nearly complete and we are preparing for the test and verification phase. The third instrument, PREMOS, is in the middle of the development phase.

In parallel with these construction efforts, we are also laying the theoretical and analytical foundations for the interpretation of the solar irradiance data that will be collected by the aforementioned instruments. The ETH-Poly-project, which represents a collaboration between the PMOD/WRC and several institutes of the ETH in Zürich, was approved for a second three-year phase in 2005. The PhD students have been selected and the project will officially re-commence in February 2006. Additional research projects financed by the SNSF and the Swiss COST, and an international collaboration in the frame of SCOPES, are designed to investigate the influence of the variable solar irradiance on the terrestrial atmosphere. These projects, together with those involving ground based radiation measurements, provide the theoretical background and motivation for the hardware construction activities of the observatory.

The Alpine Surface Radiation Budget project, a long-term SNSF research project carried out in collaboration with the IACETH and which was started by the former director of the PMOD/WRC, Claus Fröhlich, has maintained a network of radiation measurements in the Alps for ten years. The operation of this network is in the process of being transferred from PMOD/WRC to MeteoSwiss and integrated into the SwissMetNet. The ASRB observations will continue until the transfer is complete. The PMOD/WRC is working with MeteoSwiss during the transfer to ensure that measurements with instruments of the SwissMetNet do not introduce any discontinuities in the data.

Since 1996 the PMOD/WRC has operated the World Optical Depth Research and Calibration Center (WORCC). This service is currently financed through a Swiss contribution to the Global Atmosphere Watch project of the WMO. We intend to formally integrate the operation of the WORCC into the chartered tasks of the World Radiation Center (WRC). The addition of the WORCC to the WRC complements its established components, the calibration centers for pyrheliometers and infrared radiometers, and thus strengthens the position of the PMOD/WRC as a center for the calibration of all types of radiometers.

Comparisons

International Pyrheliometer Comparisons (IPC-X)

Wolfgang Finsterle

The 10th International and Regional Pyrheliometer Comparisons (IPC-X, RPCs) were held at PMOD/WRC from 26. September – 14. October 2005. The weather conditions were very favorable, allowing measurements to be taken on 11 days, resulting in over 1000 data points for PMO2. The record number of 77 participants from 42 countries operated a total of 101 instruments. IPC's are organized by PMOD/WRC every five years. The main goals of the comparisons are the dissemination of the World Radiometric Reference (WRR) and to monitor the long-term stability of the World Standard Group (WSG) that realizes the WRR. Preliminary results confirm that the WSG has been stable over the past five years within the required limits (0.2% according to the WMO/CIMO guide). The long-term variations of the WRR-to-WSG ratios (WRR reduction factors) are plotted in Figure 1 for each WSG instrument. While PMO5, CROM2L and TMI67814 virtually did not change the remaining three instruments (PMO2, HF18748, PAC3) showed small drifts of less than ±0.02% per year since IPC-IX (2000). Therefore, all six WSG instruments fulfill the stability criterion and thus remain members of the WSG (based on preliminary results available at the time of writing).

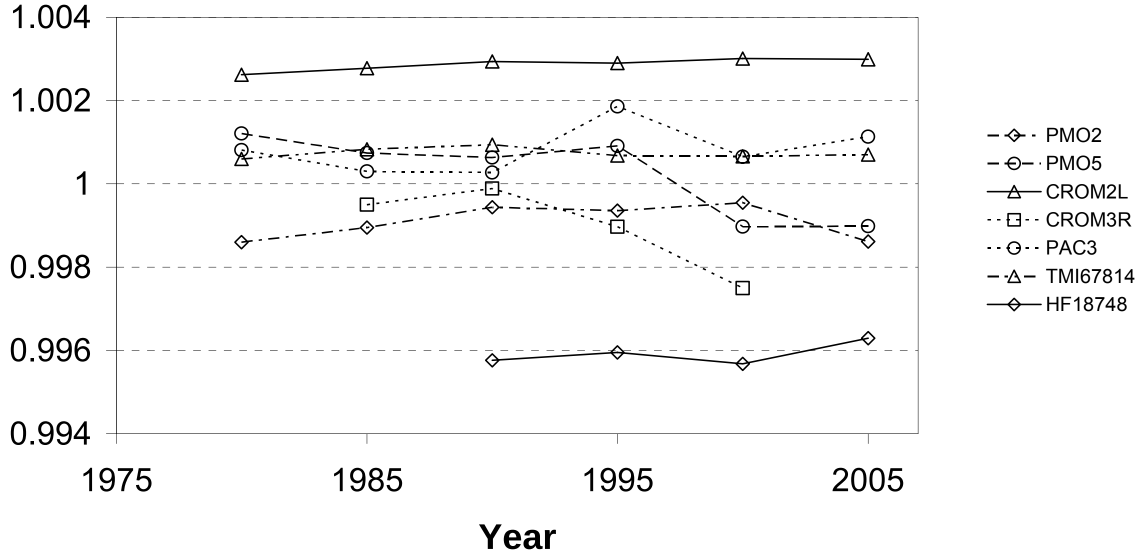

Figure 1. The WRR-to-WSG ratios (WRR reduction factors) of the WSG instruments over the past 25 years.

With respect to the other participating instruments the WSG might have drifted by some 0.01% per year on average. The significance of such a small drift is still under investigation.

As all WSG instruments are more than 25 years old any of them might cease to function in the not too far future. To replace the possible loss of a WSG instrument three candidate instruments are operated in parallel with the WSG. If they perform in accordance with the stability requirement they might be added to the WSG during the next IPC (IPC-XI, 2010).

During overcast or rainy (snowy!) days a symposium was held. Radiation experts from PMOD/WRC as well as other IPC-X participants presented their work and/or radiation infrastructure in order to share and build knowledge. Three training workshops were addressing the *Design of Pyrheliometers*, *The Expression of Uncertainty in Measurement*, and *Excel Pivot Tables*. Guest speaker Atsumu Ohmura of ETH Zurich emphasized the need for accurately calibrated radiation instruments in his talk on *A Special Position of Radiation in the Climate System.*

Filter Radiometer Comparisons, FRC-II

Christoph Wehrli

At the first FRC-I in year 2000, measurements were evaluated by uniform software in order to discriminate instrument specific effects and to avoid algorithmic differences. Although weather conditions were far from perfect and the number of measurements limited good agreement within 0.015 optical depths was found for radiometers corresponding to WMO specifications.

Concurrent with IPC-X, the second Filter Radiometer Comparison of 15 instruments from 9 countries was held at Davos. This comparison was based on aerosol optical depth (AOD) results that were derived from measurements by different algorithms used in normal operation of the radiometers. During 10 days with excellent weather conditions more than 3000 clear Sun readings at one minute interval were collected with daily mean AOD500 between 0.025 and 0.110. Thus the recommendations for filter radiometer comparisons formulated during the WMO workshop at Davos in 2004 were over accomplished by far.

All participating filter radiometers were of direct pointed type, e.g. classic sunphotometers, including two sky-scanning - radiometers, but no hemispherical radiometers. Nine radiometers were calibrated prior to FRC-II, the other 5 instruments were calibrated during FRC-II by Langley methods or cross calibration, and one radiometer was post-calibrated at Mauna Loa.

Excellent agreement within better than ±0.01 optical depths at the common wavelengths of 870±5nm and 500±3nm was found for all instruments, indicating that this level of uncertainty found in previous comparisons is routinely achieved by operational observation programs. An example of AOD values and differences between instruments on a typical day is shown in Figure 2.

In order to estimate the uncertainties in AOD due to algorithmic methods, the measurements of September 30, 2005 from a PFR instrument were processed simultaneously by three experts, using in-situ calibrations at its GAW network site (Bratt's Lake) in 2005, Langley calibration at Mauna Loa in March 2004, and by the General Method (Forgan, B.W., Applied Optics 33, 4841-4850, 1994) based on its 500 nm channel data of the same day.

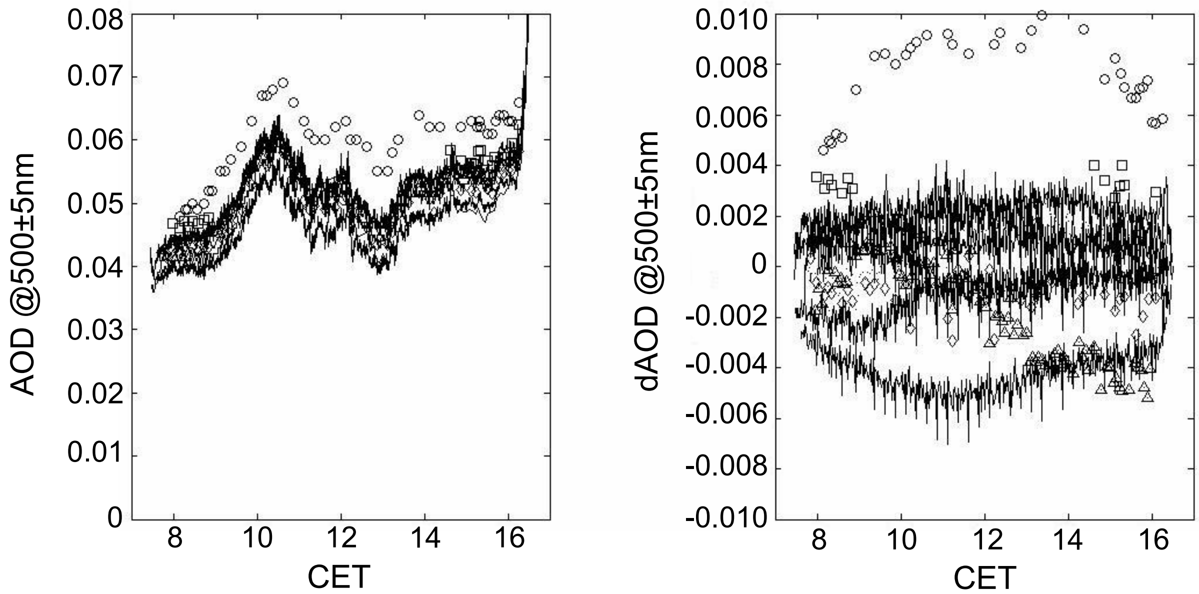

Figure 2. AOD at 500nm determined from 12 filter radiometers at Davos on 13. October 2005. Left panel: Daily variations around a mean of ≈0.05, typical for conditions during FRC-II; Right panel: Differences of individual measurements to sample means are within ±0.005 for 11 of 12 instruments.

Results of the AERONET version 1 and 2 processing of the measurements by a CIMEL instrument for the same day are also compared, and related to the PFR results. Table 1 lists the average AOD values obtained from identical datasets by different algorithms.

For the PFR results, the spread of variant methods is below 0.005 at all four wavelengths. Calibration site and epoch seems to have negligible effect on results, indicating high stability of the instrument with time and transport.

For the CIMEL radiometer, the difference between processing versions is similar at 500nm, but significantly larger at 380nm and 870nm. The difference to PFR results is smaller than 0.005 with version 2 algorithm, with a notable reduction at 380nm. The calibration of the 870nm channel was apparently off by more than 1%, corresponding data would be corrected or eliminated after promotion to Level 2 quality assured results.

Table 1. Daily averages of AOD on 30. September 2005 derived from a single PFR radiometer by 3 different algorithms (CW, BF and DH) and 3 different calibrations, and results of a single CIMEL radiometer using AERONET Level 1.5 data in old and new versions of the direct Sun algorithm.

	PFR	**862**	**500**	**412**	**368**	**CIMEL**	**870**	**500**	**380**
1	CW, MLO2004	0.0109	0.0238	0.0316	0.0368	V1L1.5	-0.005	0.031	0.055
2	BF, MLO2004	0.0102	0.0233	0.0329	0.0397	V2L1.5	0.005	0.028	0.037
3	DH, MLO2004	0.0129	0.0234	0.0295	0.0358				
4	CW, BLO2005	0.0111	0.0225	0.0313	0.0370				
5	CW, DAV-GM	0.0102	0.0239	0.0328	0.0385				
	Range	**0.0027**	**0.0014**	**0.0034**	**0.0039**		**0.010**	**0.003**	**0.018**

This exercise shows that uncertainties due to algorithms are of the same order as those associated with calibration or instrument type. Unification of processing algorithms could eventually bring the uncertainty in AOD below 0.01 if a corresponding uncertainty in calibration and operation (cleaning routine, pointing accuracy) can be achieved and maintained.

Operational Services

Statistics of calibrations

PMOD/WRC

In 2005 the World Standard Group (WSG) has been operated on 75 days with clear skys. During these days the PMOD/WRC has calibrated 31 pyranometers, 5 actinometers, and 1 pyrheliometer.

As Infrared Radiometer Center the PMOD/WRC also calibrated 16 Eppley PIR and 9 Kipp&Zonen CG4 pyrgeometers from 14 different organizations. Each instrument was first characterized with a black-body source; the final calibration was obtained by direct outdoor comparison of downwelling far infrared irradiance against the World Infrared Standard Group (WISG) of pyrgeometers.

Twelve Precision Filter Radiometers (PFR) were calibrated in sunlight by comparison to WORCC standard instruments. Four of them were recalibrations for the operation of the GAW network and the others have been original calibrations of newly manufactured instruments for sale. Seven PFRs were also calibrated in the laboratory in order to maintain and control the standard instruments and for quality assurance of GAW network instruments. The standard lamps in the optical laboratory of PMOD/WRC were also used to calibrate two spectroradiometers of a customer.

The total number of calibrations performed at PMOD/WRC increased again compared to previous years.

Quality Management System for calibrations of Pyrheliometers and Pyranometers

Silvio Koller

The Quality Management System (QMS) according to the international standard EN ISO/IEC 17025 is operational at PMOD/WRC since December 2004 for all calibrations of pyrheliometer and pyranometer. The QMS has been proven as very beneficial for the quality of the operational service at PMOD/WRC and has led to better-documented and standardized processes for the individual calibration request.

The system has been validated by one internal audit and a management review at the end of the year 2005. The goal of the internal audit was aimed at receiving feedback after the first phase of experience regarding user friendliness of the calibration procedures and to optimize the definitions of the processes.

Traceability of the World Standard Group is achieved by the International Pyrheliometer Comparisons but also by comparisons of the WSG instruments to two transfer instruments which at the beginning of 2005 have been compared to cryogenic radiometers at NPL and METAS.

In February 2006 the final implementation report of the PMOD/WRC QMS has been presented to the technical committee *Quality* of EUROMET. Two Calibration and Measurement Capabilities (CMC), which are termed *responsivity for direct solar irradiance* and *responsivity for global solar irradiance*, have been proposed via METAS to EUROMET and to BIPM for approval.

Infrared Radiometer Center

Julian Gröbner

In its second year of operation the calibration services of the IRC have been in frequent use, showing it is by now well accepted by the international community. Pyrgeometers were sent by 14 Institutions from 4 continents for calibration to PMOD/WRC in order to become traceable to the IRC reference. The standard calibration procedure comprises a black-body characterization followed by an outdoor comparison to the World Infrared Standard Group of Pyrgeometers (WISG). The WISG is composed of four pyrgeometers, 2 Eppley PIR and 2 Kipp&Zonen CG4, which are themselves traceable to the Absolute sky-scanning Radiometer (ASR) developed at the PMOD/WRC.

The laboratory facilities for the black-body characterization were upgraded in spring 2005 and new diagnostic tools were implemented. The black-body is now flushed with nitrogen during routine pyrgeometer characterizations to improve the calibration reproducibility and guarantee well defined measurement conditions.

The outdoor calibration platform capabilities on the roof of PMOD/WRC were increased by 3 additional pyrgeometer locations which now allow the simultaneous calibration of up to 9 pyrgeometers, of which 4 are mounted on sun trackers with individual shading disks.

An internal review was undertaken at the IRC, with the goal of implementing the procedures of the ISO/IEC 17025 standard. An initial step was achieved by devising and applying a standard calibration procedure for the data acquisition system of the IRC which is now traceable to the Swiss Federal Office of Metrology and Accreditation (metas).

An opportunity for informal discussions on pyrgeometer related topics was used with participants of the tenth international pyrheliometer comparison (IPC-X); collaborations were initiated between the IRC and the Australian bureau of Meteorology and the National Renewable Energy Laboratory of the U.S.

Ultraviolet Radiometer Center

Julian Gröbner

A collaboration agreement between the PMOD/WRC and the European Reference Center for ultraviolet radiation measurements (ECUV), located at the Joint Research Center of the European Commission in Ispra, Italy was successfully initiated in 2005. The first objective, transfer of laboratory instrumentation for UV filter radiometer calibrations as well as the transportable reference spectroradiometer QASUME from the JRC to PMOD/WRC was accomplished in July 2005. Since July 2005, all operational activities of the former ECUV are under the responsibility of the PMOD/WRC. The Ultraviolet radiometer calibration Center (UVC) of the PMOD/WRC will host and operate the UV instrumentation under the responsibility of Julian Gröbner, the former head of ECUV.

The first activity of the UVC was the participation at the first GAW Regional Brewer Calibration Center-Europe (RBBC-E) intercomparison campaign with the transportable reference spectroradiometer QASUME as UV reference. The intercomparison was held at the “El Arenosillo” Atmospheric Sounding Station, INTA, near Huelva, Spain from 10 to 19 September 2005. The measurements obtained during the intercomparison were used to calibrate seven Brewer Spectrophotometers for global spectral UV irradiance relative to the QASUME reference.

Julian Gröbner is leading the working group on Quality control of the COST Action 726, *Long term changes and climatology of UV radiation over Europe*. The goal of the working group is to homogenize UV measurements in Europe through the application of common quality control and quality assurance procedures to the participating national and regional UV networks. A key event will be the intercomparison of selected broadband filter radiometers at PMOD/WRC in the summer of 2006.

WORCC and GAW-PFR network

Christoph Wehrli

Operations of the PFR stations were continued in the 7th year since the network was started. The PFR at Ny-Ålesund was again recalibrated at Davos and the instruments at Alice Springs, Mace Head, and Mauna Loa were swapped with newly calibrated radiometers. The PFR at Bratt's Lake was taken to Davos for the second Filter Radiometer Comparisons. Despite of the measurement gap caused by this activity, the site still complies with the GAW requirements for long-term monitoring.

Measurements from four PFR stations were evaluated and submitted to the WDCA as hourly means up to the end of 2004. Final quality control and assurance for the remaining five stations is still pending and will be included in the submission of 2005 data to WDCA.

According to recommendations made by SAG/Aerosol in 2004, a substantial number of interference filters and a commercial radiometer as used in Aeronet were purchased, using funds provided from PMOD/WRC budget and profiting from the sale of PFR instruments. The filters will be used as maintenance parts for existing PFRs and in manufacturing of another series of instruments to be offered for sale in the 3rd quarter of 2006. With the installation of a CIMEL radiometer in September, Davos has become a site in the Aeronet network. Thanks to funds from a private donation, another spectral radiometer MFRSR-7, that is widely used in different AOD networks, could be ordered and will be installed in 2006.

The activities and services of the Swiss GAW program, during the past ten years were reviewed most favorably by a panel of three international experts, who recommended the continuation of the Swiss GAW program, including WORCC.

The proceedings of the column aerosol optical properties workshop at Davos in 2004 were published as GAW report Nr. 162 by WMO.

The training course on AOD observations was held again for the participants of the 10th GAWTEC course at Schneefernerhaus. Presentations of the WORCC and PFR-network were given at three international workshops.

Quality Assurance: Maintenance of standard filter radiometer calibration for AOD determination

Christoph Wehrli

The Precision Filter Radiometers at GAW sites, where *in-situ* calibration by the Langley method is not feasible, are re-calibrated by comparison with two reference instruments at Davos. One of them was calibrated on a stratospheric balloon in 1998, the other by Langley method at Mauna Loa in 2000, and the radiometric response of both instruments is monitored by laboratory calibrations, which indicate stability within ±0.5% over six years.

Since 2003, the relation between both reference PFRs was routinely determined by simultaneous solar measurements in order to detect relative changes in any of the 2*4 channels. Various approaches of direct comparison, ratio Langley technique and Forgan’s general method gave slightly different relations between reference channels that were all within about 0.5% to 1%. Neither of these relational calibrations would however exclude a simultaneous drift of these identical reference instruments.

Routine Langley extrapolations at Davos provide another means to monitor the calibration of the reference radiometers. No statistically significant changes larger than 1% could be detected.

In anticipation of the FRC-II, the PFR at Mauna Loa was swapped out and returned to Davos. The Mauna Loa instrument has a long history of Langley calibrations and well known drift rates of typically less than 0.25% per year. It could thus be used to verify the calibration of the reference instruments at Davos. A simultaneous change of -1% was thus found at 412nm for both, and a -1% change at 500nm in one of the reference instruments. All other channels changed less than 0.7% over 5 and 7 years.

From all points above we conclude that the reference calibrations were maintained and transferred to field instruments in the GAW network within ±1% over the last 5 years.

The ASRB network integrated in new SwissMetNet

Rolf Philipona

The Alpine Surface Radiation Budget (ASRB) network was built in collaboration between PMOD/WRC and MeteoSwiss. State of the art radiation instruments were installed at ten previously existing ANETZ or ENET meteorological stations of MeteoSwiss between 1994 and 1996. For more than one decade individual shortwave and longwave surface radiation fluxes have since been accurately measured at altitudes ranging from 390 meter (Locarno-Monti) up to 3580 meter (Jungfraujoch) above sea level. Extensive analyses of these measurements have let to a number of scientific publications and gave important insights on the altitude dependence of the surface radiation budget, on cloud radiative effects, and on radiative forcings and their impact on climate change. Rapid temperature increases in Europe from 1995 to 2002 were shown to be related to longwave downward radiative forcing and unexpected high water vapor feedback greenhouse warming (Philipona et al., GRL, 2005).

MeteoSwiss is presently reorganizing and unifying their individual networks and the respective data flows and completely rebuilding all surface measuring sites. In this process it was decided to integrate the ASRB network in the new SwissMetNet. In order to prepare for this integration the ASRB data acquisition was transferred from Davos to Payerne. Maintenance of the ten ASRB stations is now made by MeteoSwiss and all previously recorded data is stored on a data server of MeteoSwiss at Payerne.

In the new SwissMetNet six ASRB stations (Cimetta, Eggishorn, Gornergrat, Jungfraujoch, Männlichen and Weissfluhjoch) will be newly equipped with shortwave and longwave radiation instruments measuring downward fluxes at high altitudes. Additional nine Baseline Surface Radiation Budget (BSRB) stations, equally distributed over Switzerland, will measure downward and upward radiation fluxes at low altitudes. To guarantee continuity of ASRB measurements old and new instruments will measure in parallel at the stations at least until the end of 2007.

Instrument sales

PMOD/WRC

Compared to 2004, retail sales of PFR instruments increased substantially in 2005: six instruments plus three control units were sold last year. In addition, shortly before end of the year, we delivered another set of two PFR instruments to Norway; these will be included in the report for fiscal year 2006. Unfortunately, the inverse situation holds for the sale of PMO6-CC absolute radiometers: despite numerous sales in 2004, none were sold during 2005.

During 2005, orders were placed for ten units of the PMOD/WRC ventilation-heating system (VHS), which improves the performance of commercially-available pyranometers and pyrgeometers. At the end of last year we began the manufacturing of a new series of thirty VHS units.

The PMOD/WRC has also been asked to install additional thermistors in six Precision Infrared Radiometers (PIR). The additional thermistors will allow more accurate determinations of the thermal distributions of the detectors and domes.

Instrument development

Development of a new absolute radiometer for space and ground-based use

Uwe Schlifkowitz and Wolfgang Finsterle

In the first year, a computer model of an existing PMO6 radiometer was developed in order to show that it is possible to operate such instruments with a phase-sensitive signal analysis (PMOD/WRC annual report 2004). This model has turned out to work quite well, so a measurement campaign was started during summer.

Although the radiometer which was used for the measurements was not fully characterized, the results were quite satisfying regarding the signal-to-noise ratio and the number of data points per time span, compared to data obtained with the traditional operating mode. Thus, it could be shown that the computer model as well as the phase-sensitive analysis with real data are working very well.

The next step was to replace the analog heater control system in an existing radiometer by a digitally controlled, pulsed heater. While the analog system controls the electrical power delivered to the cavity by adjusting the voltage across the heating resistor, the digital heating system sends electrical pulses of constant height but variable widths to the cavity to achieve the intended temperature inside the cavity. The benefits of this approach are mainly that the TSI is directly connected to the heater's on/off ratio, which eliminates the source of error regarding the reading of the voltage and current values.

The next steps include tests of the new phase-sensitive data analysis in conjunction with a pulse-width modulated radiometer in front of the sun. If these tests turn out successfully as expected, a new prototype will be built and the data transfer, with on-board data reduction, has to be optimized.

Space experiment SOVIM

PMOD/WRC

The final environmental and vibration tests of the SOVIM experiment took place last year at Contraves Space in Oerlikon (CSZ). Otherwise, the bulk of the PMOD/WRC effort for this experiment was focused on the preparation of the documentation and paperwork required for instrument acceptance by ESA. In one of the most important milestones of the year for the PMOD/WRC, the SOVIM instrument acceptance review (IAR) took place in June in Davos. With the exception of a few requests that have been fulfilled in the meantime, and the replacement of the mirrors on the front shield (still pending), the instrument has been provisionally accepted. In addition SOVIM had to pass two interface tests, a software interface test in Turin at Alcatel Alenia Space (AAS) and, as part of the experiment package SOLAR, a mechanical fit test a week later in Bremen at EADS Space. Both tests were passed successfully.

Space experiment PREMOS

PMOD/WRC

The PREMOS experiment, to be launched on the French micro satellite PICARD, is a collaborative project with the French space agency (CNES) and the Centre National de la Recherche Scientifique, Service d`Aéronomie Paris (CNRS).

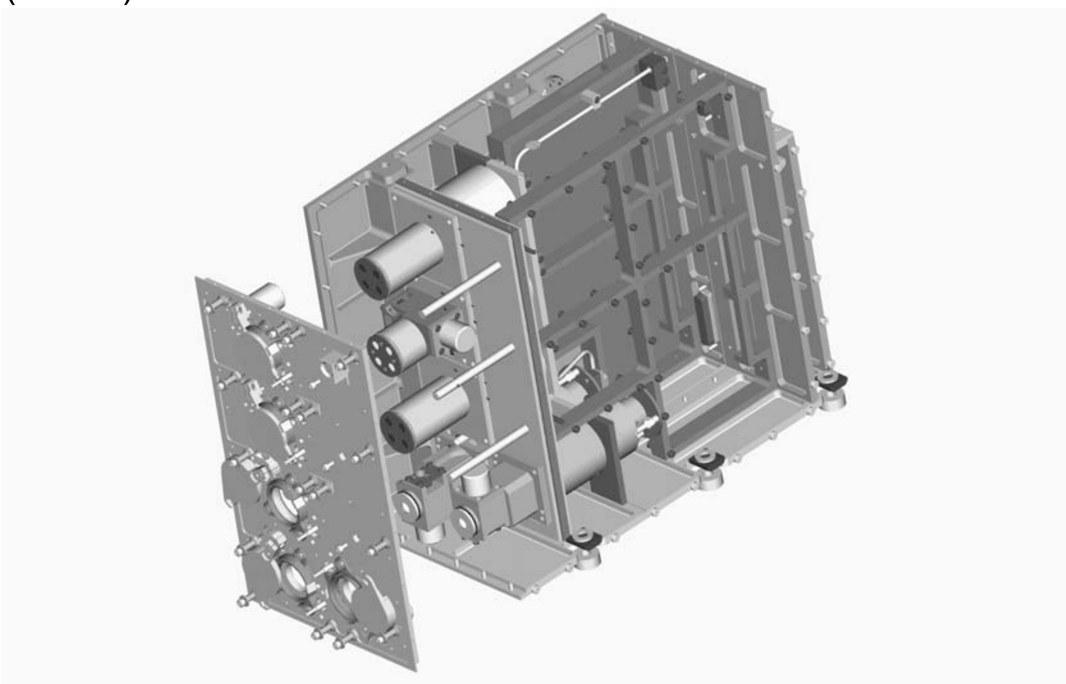

Figure 3. Drawing of the PREMOS package with covers, instruments, and frames for the electronic prints.

Preliminary design planning of PREMOS took place in 2005. We confirmed the possibility of integrating two additional TSI radiometers together with the three Filter Radiometers and the electronics within the very restricted volume and mass limits of the instrument. The design phase ended successfully with the preliminary design review (PDR) at CNES Toulouse at the end of November. After the PDR, we began the detailed definition of internal and spacecraft interfaces. The design phase for instrument electronics and data acquisition has started and will end with the completion of prototypes in spring 2006.

With the current schedule, the delivery of PREMOS is anticipated at the end of July 2007 and the launch of PICARD will occur in 2009.

Space experiment LYRA

PMOD/WRC

The LYRA (Lyman-Alpha Radiometer) experiment will be integrated on the *Project for On-Board Autonomy* (PROBA 2) satellite, which is a technology demonstration sponsored by the European Space Agency. The LYRA experiment was developed in collaboration with the Royal Meteorological Observatory of Belgium, the Centre Spatial de Liège (Belgium), IMEC (a division of IMOMEC, Belgium) and the Max-Planck-Institut für Sonnensystemforschung (Germany). It consists of three identical UV instruments, each of which measures the solar irradiance in four different wavelength ranges (channels) simultaneously. The channels have been chosen for their relevance to Aeronomy, Space Weather and Solar Physics: Ch1: Lyman-alpha (121.6 nm), Ch2: 200-220 nm range, Ch3: Al filter (17-70 nm) and Ch4: Zr filter (1-20 nm).

Last year functional tests with the LYRA engineering model and the satellite interface as well as the external power supply were carried out. The LYRA Flight Model (FM) was also fully assembled. The FM was calibrated in a first calibration campaign at the Berlin Synchrotron facility (BESSY). This was the first time that the entire measurement chain, including optical filters, detectors, and data acquisition of the system could be tested and absolutely calibrated with a known input UV source.

Thermal balance tests of LYRA were carried out at Contraves Space, Zurich, in order to validate their thermal model of the instrument. The PMOD/WRC infrastructure, an actively controlled heliostat that allows the instrument to be exposed to sunlight in a cleanroom environment, was used for several thermal and functional tests, and to verify solar-blindness of LYRA in the visible range. The resulting signal was verified against the predicted sensitivity to visual light calculated from the radiometric model.

Due to problems during the development phase of the BOLD (Blind to Optical Light Detector) component, the LYRA project schedule had to be shifted and became very tight at the end of the experiment assembly phase. The LYRA FM will now be delivered to the satellite manufacturer by the end of March 2006. Before delivery, vibration and thermal vacuum tests will have to be performed. A final calibration campaign will then take place again at the Berlin synchrotron “BESSY”. The PROBA-2 launch is expected in spring 2007.

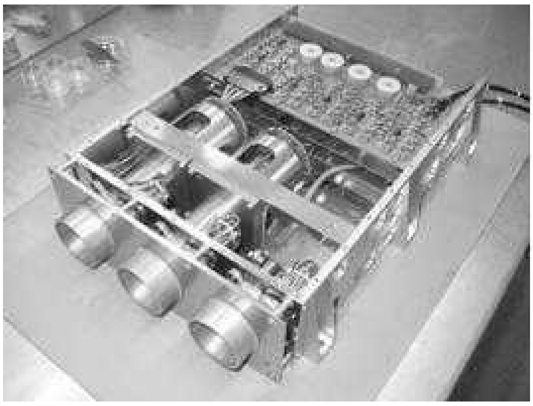

Figure 4. LYRA FM (one detector removed)

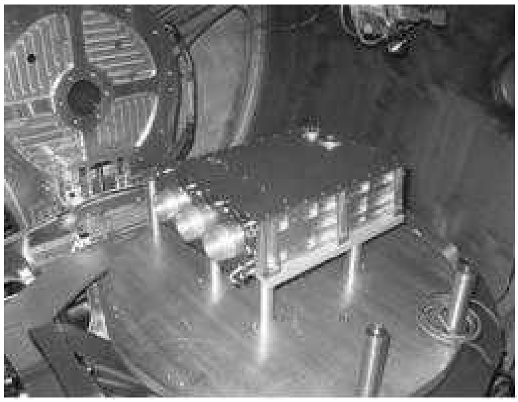

Figure 5. LYRA FM in BESSY vacuum chamber

Scientific Research Activities

Solar influence on temperature trends near the stratopause

Eugene Rozanov, Tatiana Egorova, and Werner Schmutz in collaboration with IACETH, Zurich

It was pointed out by Randel (SPARC, 2004) that the global cooling near the stratopause is substantially smaller during 1995-2000 than in the previous time. To elucidate the causes of this behavior we analyzed the global stratopause temperature evolution simulated with the CCM SOCOL for 1975-2000, driven by external forcing. Figure 6 illustrates global and annual mean anomalies of the temperature at an altitude of 50 km as calculated by three model runs. The first run ("SG") is driven by the observed time evolution of the sea surface temperature/sea ice and greenhouse gases, for the second run ("SGO") the time evolution of the Ozone Destroying Substances had been added, and the third run ("SGOSI") takes into account the observed spectral solar irradiance variability. The cooling of the stratopause is rather persistent for the "SG" and "SGO" runs reflecting steady increase of the greenhouse gases and ozone depletion due to increase of the chlorine loading. The variability of the solar irradiance included in the run "SGOSI" leads to the warming during the years when the solar activity was at maximum (1979, 1990 and 2001) and therefore, causes the flattening of the temperature trend after 1995 in agreement with observations.

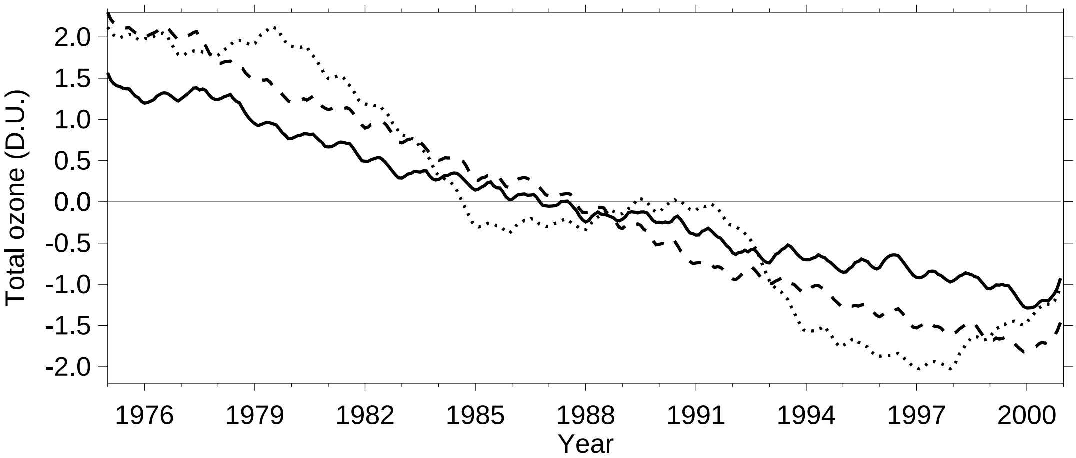

Figure 6. Global and annual mean temperature anomalies at the stratopause from three model runs (SG – solid line, SGO – dashed line, SGOSI – dotted line; see text)

Temperature trends simulated with CCM SOCOL

Eugene Rozanov, Tatiana Egorova, and Werner Schmutz in collaboration with IACETH, Zurich

To study the influence of the solar variability on the atmosphere we have carried out a number of transient simulations with our CCM SOCOL. These simulations where driven by the observed time evolution of the sea surface temperature/sea ice distributions, greenhouse gases and ozone destroying substances, stratospheric volcanic aerosol, and spectral solar irradiance taken in different combinations to elucidate the effects of any particular forcing. The validation of the simulated time evolution of the temperature and ozone in the stratosphere for 1978-1993 was published by Rozanov et al. (Adv. Space. Res., 2005). This year we continue the validation of the model against satellite data for the period 1978-2000. In Figure 7 we present the simulated linear trend of the temperature in the lower troposphere and lower stratosphere which can be compared with the same quantity obtained from satellite measurements (MSU instrument, Santer et al., JGR, D21104, 2004). The comparison with the satellite data (not shown) reveals that in the lower troposphere the model successfully simulates overall warming. However, the simulated cooling spots in the Northern hemisphere are slightly displaced compared to the MSU data. In the lower stratosphere the model simulates well the overall cooling, the dipole (warming-cooling) pattern over the southern high latitudes, as well as the warming over the western USA. Not visible in the satellite data is the predicted warming over eastern Russia.

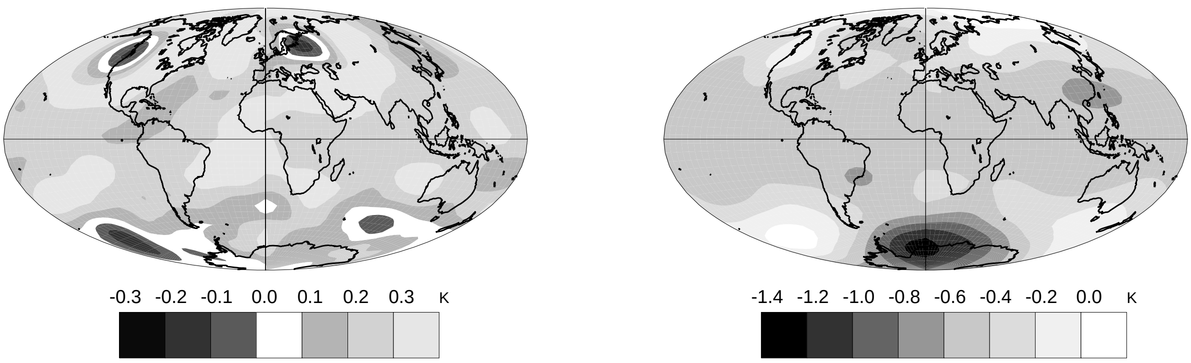

Figure 7. Predicted linear temperature trend (K/decade) for the MSU T2 channel (centered at ~700 hPa, left) and for the MSU T4 channel (centered at 70 hPa, right) from transient CCM SOCOL simulations covering the years 1975-2000.

Simulation of the atmospheric response to nitrogen oxides source due to energetic electron precipitation

Eugene Rozanov

In order to study the effects of the energetic electron precipitations (EEP) on the atmosphere we have introduced additional source of nitrogen oxides due to EEP into the UIUC Chemistry-Climate model (Rozanov et al. 2005, Geophys. Res. Lett. 32, L14811). We have performed two model runs with and without additional source. The comparison of the results reveals NO_x increase by about 1.5 ppbv in the middle stratosphere over the tropical and middle latitudes. In the upper stratosphere over the polar winter regions the simulated NO_x enhancement reaches 10 ppbv. Figure 8 shows that it results in the decreases of the ozone mixing ratio in the stratosphere by up to 5% over middle latitudes and up to 20% over southern high-latitudes, which leads in turn to the cooling in the middle stratosphere over the tropics by 0.5 K and up to 2 K over southern high-latitudes. Detectable changes have also been found in the surface air temperatures. These results imply that the magnitude of the atmospheric response to EEP events can potentially exceed the effects from solar UV fluxes. The two mechanisms work in phase outside polar latitudes, but can compensate each other within polar latitudes.

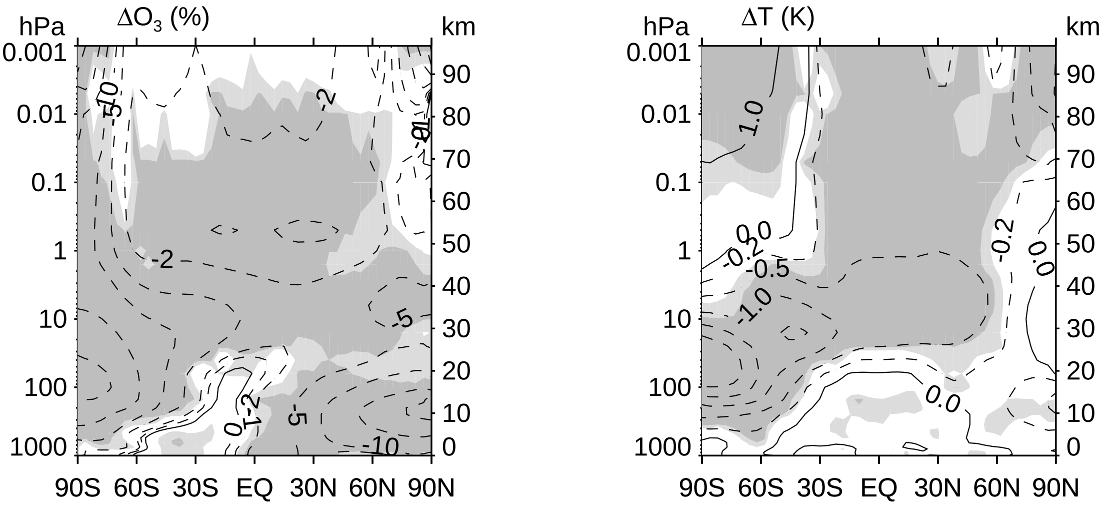

Figure 8. Annual-mean changes of zonal mean O_3 (%) and temperature (K) due to EEP. The light (heavy) shading shows the regions where the changes are statistically significant at or better than the 20% (5%) level.

Anthropogenic greenhouse forcing and strong water vapor feedback increase temperature in Europe

Rolf Philipona

Europe’s temperature increases considerably faster than the northern hemisphere average. Recent investigations indicate that the vast majority of the rapid temperature increase recently observed in Europe is likely due to an unexpected high water vapor feedback greenhouse warming.

Temperature and humidity changes were thoroughly analyzed over Europe after measures around the Alps jumped two times over the levels predicted by general circulation models in the past two decades. Surface radiation measurements from 1995 to 2002 over the Alps show strongly increasing total surface absorbed radiation, concurrent with rapidly increasing temperature. The analysis provides evidence that large-scale weather patterns in Europe uniformly, but weakly, influence annual average temperatures and suggest that the observations combine to indicate that the region is experiencing an increasing greenhouse effect, and that the dominant part of the rising surface absorbed radiation is longwave downward radiation, mainly due to water vapor increase.

After examining increased cloud amounts to the north of the Alps and decreased amounts in the southern portion, it was found that both sides experienced clear warming over the time period. Such findings correspond with previous cloud investigations showing that for midlatitudes, annual mean cloud cooling by reflection of solar shortwave radiation is roughly canceled by cloud warming caused by absorbed and reemitted heat through longwave radiation.

The strong increase of longwave downward radiation is shown to be due to increasing cloudiness, rising temperature, rising water vapor and due to the driving cause: the long-lived anthropogenic greenhouse gases. The radiation measurements in the Alps show for the first time that the different forcings can be separated and that anthropogenic greenhouse forcing is measurable at Earth’s surface. Above all however, the measurements demonstrate strong water vapor feedback that rapidly warms Central and Northeastern Europe, where sufficient surface water is available for evaporation (Philipona et al., GRL, 2005).

Radiation climatology and trends at high latitude BSRN sites

Marcel Sutter

About 10 years of data from the Baseline Surface Radiation Network (BSRN) sites Barrow (BAR) and Ny Alesund (NYA) in the Arctic and Neumayer (GVN) and Southpole (SPO) in the Antarctic were analyzed. After quality control and homogenization, a climatology of the four high latitudes BSRN sites over the observed period (1993 - 2003) was built and the annual cycle of seasonal and monthly trends of the measured radiation time series and derived parameters like radiation from the cloud free sky were determined (Sutter M., Ph.D. Thesis ETH No. 16502, 2006). Analysis revealed increasing trends in the direct solar irradiance (SDR_{dir}) and mostly decreasing trends in cloud cover at all four sites. Figure 9 displays the annual cycle of the monthly trends of APCADA (Automatic Partial Cloud Amount Detection Algorithm) calculated cloud amount and SDR_{dir} over the observed period at the site NYA.

In view of the increased warming rates of the lower atmosphere in arctic regions during the cold seasons, correlated trends were searched in radiation and meteorological parameters. The annual cycle of the temperature changes, observed at the four BSRN sites, seems to be best correlated with changes in surface humidity measurements, respectively cloud free longwave downward radiation, which indicates the importance of water vapor feedback in conjunction with increased warming rates. Observed trends in albedo and radiative cloud effect or other radiation parameters are only partially correlated with trends in temperature.

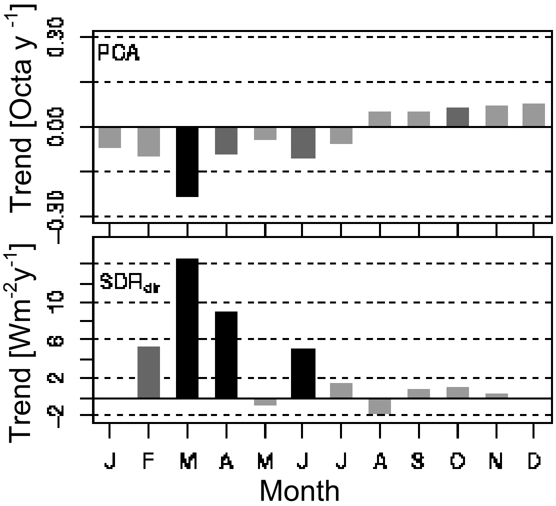

Figure 9. Annual cycle of trends per year of APCADA calculated cloud amount (PCA) and direct solar irradiance (SDR_{dir}), measured at NYA. The colors of the histogram (3 shades of gray) provide information about the significance of the trends, derived from a linear regression. Significance is increasing with darker color.

The PMOD TSI composite 1977-2005

Claus Fröhlich

The successful analyses of the different sources of degradation of the radiometers of SoHO/VIRGO improved the understanding of the processes responsible for sensitivity changes and allowed a thorough re-analysis of the PMOD composite which now covers almost three complete solar cycles.

Figure 10 shows the PMOD TSI composite and its mode. The mode is the value of the maximum of the distribution. As the variance of TSI is asymmetric because of the dimming by dark sunspots on one side and the brightening by faculae on the other, the mode represents the value of TSI, which would be seen without the direct effects of sunspots or faculae. During maxima the mode is higher than the mean by 0.24, 0.10 and 0.12 Wm^{-2}, respectively, which means that the influence of sunspots is always larger than the one of faculae, but varies strongly between cycles. During minima both are about the same, with a slight difference of 0.02 Wm^{-2} in the opposite direction during the second minimum, indicating a larger contribution of faculae during periods of low sunspot numbers. Note also the periods without any sunspots during the maximum of cycle 23, which make the mean and mode coincide.

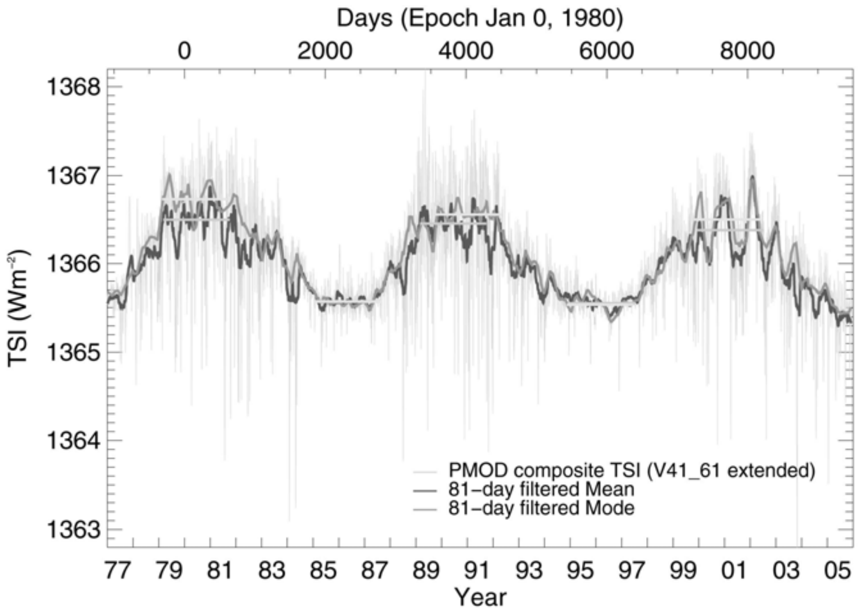

Figure 10. Composite of measurements of the Total Solar Irradiance by space experiments of the last 25 years plus TSI values reconstructed from ground based magnetograms and white light images of the Sun for 1977 and 1978. Plotted in light green are the daily values of the extended PMOD composite for the last 3 solar cycles 21, 22 and 23. Also shown are 81-day running means (red line) and modes (blue line) together with the corresponding maxima and minima.

Monthly climatology of Aerosol Optical Depth

Christoph Wehrli

A few stations of the GAWPFR network have been operating for more than 5 years, and thus qualify as long-term monitoring sites according to the definition given during the AOD experts meeting in Davos in 2004. It becomes now possible to establish an initial monthly climatology for these stations that may serve as reference values against which aerosol events like boreal fire smoke, desert dust storms or volcanic eruptions can be detected, but the time series are still too short to allow for a trend analysis. Likewise, no change in aerosol spectra, as indicated by the Ångström exponent α, can be concluded from these measurements.

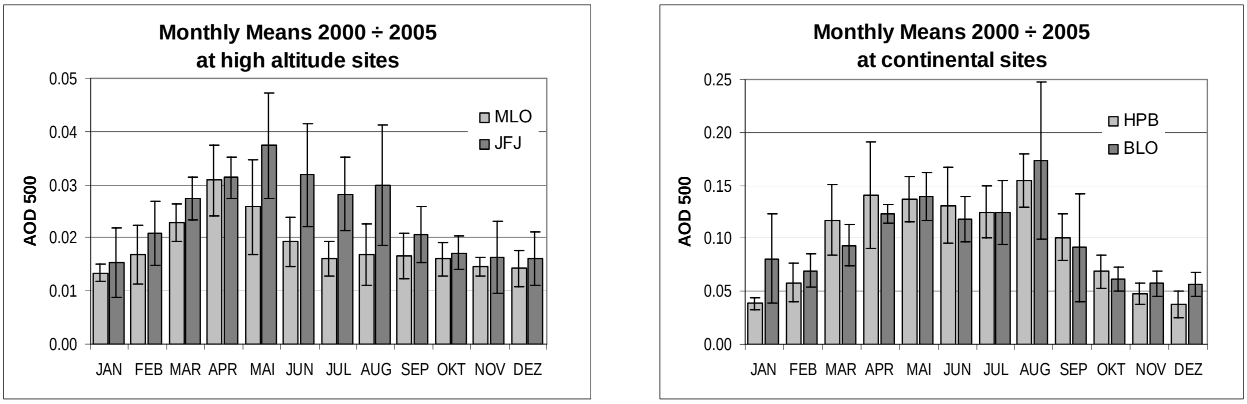

Figure 11. Monthly means and standard deviations of aerosol optical depth at 500 nm. Left panel: AOD at Mauna Loa (MLO) remains below 0.02 OD, except for March to May, whereas at Jungfraujoch (JFJ) this value is exceeded from February to September. Annual means are 0.015 OD for MLO and 0.025 OD for JFJ. Right panel: Annual variation of AOD at Hohenpeissenberg, Germany (HPB) and Bratt's Lake, Canada (BLO) are startling similar with both annual means at slightly less than 0.10 OD.

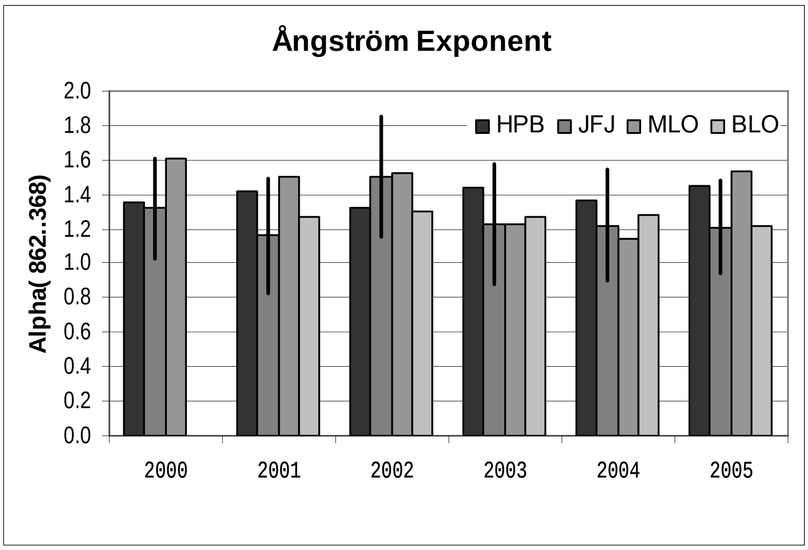

Figure 12. Annual means of the wavelength exponent observed at above PFR stations are within 1.34±0.13, corresponding neatly to the classic finding of A. Ångström. A potential downward trend of -0.12 OD/y, suggested by MLO results of the first 5 years, is not confirmed if data from 2005 are included.

ETH-Polyproject – Iterated opacity distribution functions

Margit Haberreiter and Werner Schmutz

We calculate solar spectra with the radiative transport model COSI (Code for Solar Irradiance) for different activity regions on the solar disk taking into account the departure from conditions of local thermodynamic equilibrium (non-LTE) in the solar atmosphere. For the realistic calculation of the spectrum it is important to include *all* line transitions in the non-LTE calculation. We account for the millions of lines not directly, but indirectly by means of Opacity Distribution Functions (ODFs). The line opacities within a certain wavelength range are sorted according to their strength and then the ODF can be described by a relatively small number of frequency points. The ODFs are iterated until the population numbers of the atomic levels are practically unchanged.

In Figure 13 we show the effect of including ODFs on the emergent continuum spectrum in the wavelength range 1000 to 5000 Å and 2000 to 20000 Å. There is a strong effect of line blocking in the UV from 1000 to 2000 Å, which is due to the high number of spectral lines in that wavelength region, forming a *quasi-continuum* (dotted line), which is lower than the continuum calculated without ODFs (solid line). As the number of spectral lines decreases towards longer wavelengths, this effect is less important in the visible and IR (panel b). We emphasize that the synthetic spectra match the observation only if the line opacities are taken into account in the atmosphere calculation.

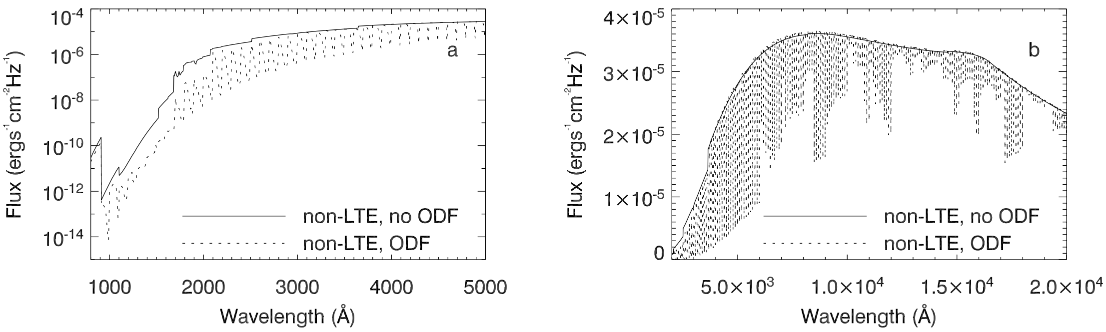

Figure 13. Continuum spectra shown (a) on a logarithmic scale and (b) on a linear scale. The spectra are calculated with (dotted line) and without (solid line) ODFs for different wavelength ranges. The high number of spectral lines in the UV leads to a decrease of the emergent flux due to the effect of line-blocking.

COST 724 Space Weather – Ionospheric module for nowcasting the ionic and neutral state of the mesosphere

Tatiana Egorova, Eugene Rozanov, and Werner Schmutz

The irradiance of the solar Lyman-alpha emission has a direct impact on the upper terrestrial atmosphere because it is a source of ionization of the D-region, the major contributor to the dissociation of water vapor and some other neutral constituents, as well as a direct input of heat in the mesosphere. The LYRA experiment, developed by PMOD/WRC in collaboration with the Royal Meteorological Observatory of Belgium, which will be launched on the ESA satellite PROBA2 in 2007, will monitor the solar irradiance at the Lyman-alpha (121.6 nm) and the Herzberg band 200-220 nm wavelength range. Based on the LYRA data, we will calculate in near real time, i.e. "nowcasting", the neutral and ionic state of the of the upper atmosphere. We aim at publishing these results on a web site as part of a public European space weather information in the frame of the COST action 724.

To fulfill this task we are developing an ion-chemistry module that will be inserted to the coupled 3-D chemistry-ionosphere-climate model (CICM), which is an extension of the CCM *SOCOL* that has been developed at PMOD/WRC as part of the ETH-Polyproject " Variability of the Sun and Global Climate" (Egorova et al., 2005). We are restricting the computations to the ionospheric *D*-region between 50 and 80 km. Modeling of the *D*-region differs from that of the upper *E*- and *F*-regions in that its rather complicated ion composition is determined by the ion chemistry. As ionization sources we take into account ionization by direct solar radiation above 65 km and by galactic cosmic rays below 65 km. We have defined and implemented the list of chemical reactions and their rates for the *D*-region. The current version of the ionospheric chemistry scheme includes electrons, 51 positive and negative ions and their clusters, and 186 reactions integrated to the neutral chemistry scheme. Presently, we are thoroughly testing this scheme for neutral and ion chemistry with a 1-D model, before we implement it to 3-D chemistry-ionosphere-climate model.

International Collaborations – SCOPES

Evolution of the ozone and temperature in the future simulated with the CCM SOCOL

Eugene Rozanov, Tatiana Egorova, and Werner Schmutz in collaboration with the Main Geophysical Observatory, St. Petersburg, Russia

The PMOD/WRC is the Swiss partner in the SCOPES (Scientific Co-Operation between Eastern Europe and Switzerland) Joint Research Project titled *Modeling of the global ozone and climate evolution in the first half of the XXI century*. The main goal of the project is to simulate the time evolution of the global climate and ozone using the Chemistry-Climate Model SOCOL (which was developed at the PMOD/WRC) and published scenarios of anthropogenic activity. During 2005 we carried out two simulations (one by the PMOD/WRC and one by the Main Geophysical Observatory in St. Petersburg) spanning the first 50 years of the 21st century. This time period is expected to be characterized by a steady increase in greenhouse gases and a decrease in chlorine and bromine loading due to an (assumed) reduction in the use of halocarbons. Such an evolution may result in further warming in the troposphere, slower cooling of the stratosphere, and recovery of the ozone layer to its condition before the appearance of the "ozone hole". The time evolution of the calculated global mean and annual mean total ozone is shown in Figure 14. The results for this particular simulation suggest a recovery of the global mean total ozone to pre-1975 levels by 2032. The persistent cooling of the stratosphere due to the steady increase in greenhouse gases slows the ozone destruction in the stratosphere and leads to further increases in the total ozone beyond 2032.

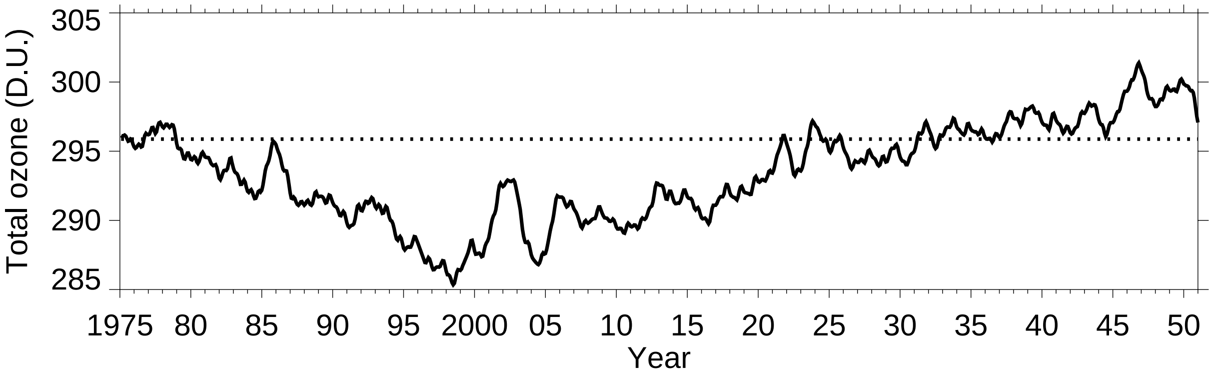

Figure 14. Time evolution of the global and annual mean total ozone (DU) from 1975 to 2050 simulated with CCM SOCOL.

Publications

Refereed Articles

Benmoussa A., Hochedez J.-F., Schmutz W.K., Schühle U., Nesládek M., Stockman Y., Kroth U., Richter M., Theissen A., Remes Z., Haenen K., Mortet V., Koller S., Halain J.P., Petersen R., Dominique M., D'olieslaeger M.: 2005, Solar-Blind Diamond Detectors for Lyra, the Solar VUV Radiometer on Board Proba II, Exp. Astronomy 16, 141-148, doi:10.1007/s10686-003-0035-3.

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Haberreiter M., Krivova N.A., Schmutz W., Wenzler T.: 2005, Reconstruction of the solar UV irradiance back to 1974, Advances in Space Research 35, 365-369, doi: 10.1016/j.asr.2005.04.039.

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Other Publications

The Sun, solar analogs and the climate. Saas-Fee Advanced Course 34, 2005, held March 15-20, 2004 in Davos, Switzerland, Swiss Society for Astrophysics and Astronomy (SSAA). Edited by Rüedi I., Güdel M., and Schmutz W., Berlin: Springer, ISBN 3-540-23856-5.

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Holzer-Popp T., De Leeuw G., Schoemaker R., Schaug J., Wehrli C.: 2005, European aerosol optical depth measurements from ground and space. In: EMEP CCC-report 5/2005, Measurements of Particulate Matter: Status Report 2005; Karl E. Yttri (ed.), NILU, Norway.

Katsiyannis A.C., Berghmans D., Hochedez J.-F., Nicula B., Lawrence G., Defise J.-M., Ben-Moussa A., Delouille V., Dominique M., Lecat J.-H., Schmutz W., Theissen A., Slemzin V.: 2005, SWAP: an EUV imager for solar monitoring on board of PROBA 2. In: Optics for EUV, X-Ray, and Gamma-Ray Astronomy II, O. Citterio and S.L. O'Dell (eds.), Proc. SPIE 5901, p. 236-243, doi: 10.1117/12.616803.

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Personnel

Scientific Personnel

Prof. Dr. Werner Schmutz	Director, physicist, Sun-Earth connection, CoI ETH-Polyproject, PI PREMOS, CoI LYRA, SOVIM
PD Dr. Rolf Philipona	Physicist, head of IR Radiometer Center (until 31.3.2005), ASRB scientist (since 1.4.2005, place of work: MeteoSwiss Payerne)
Dr. Julian Gröbner	Physicist, head of IR and UV Radiometer Centers, CoI PREMOS (since 1.2.2005)
Dr. Eugene Rozanov	Physicist, project manager ETH-Polyproject, GCM and CTM calculations
Dr. Isabelle Rüedi	Physicist, absolute radiometry, solar physics, calibration of shortwave instruments, CoI VIRGO, SOVIM, PREMOS, LYRA (left 31.1.2005)
Dr. Wolfgang Finsterle	Physicist, absolute radiometry, solar physics, calibration of shortwave instruments, CoI VIRGO, SOVIM, PREMOS, LYRA
Christoph Wehrli	Physicist, design and calibration of filter radiometers, atmosph. remote sensing, CoI VIRGO, SOVIM, PREMOS, LYRA
Dr. Tatiana Egorova	Postdoc, meteorologist, COST-724, SNSF project
Margit Haberreiter	PhD student ETHZ, ETH-Polyproject
Chris Hoyle	PhD student ETHZ, ETH-TH-project (left 30.9.2005)
Christian Ruckstuhl	PhD student ETHZ, NCCR project (left 31.3.2005)
Uwe Schlifkowitz	PhD student, ETHZ, SNSF project
Marcel Sutter	PhD student, ETHZ, SNSF project
Sandra Moebus	diploma student (until June 2005), physicist engineer, IRC, WRR-SI (since 1.10.2005)
Urs Graf	internship, student ETHZ (18.7.–12.8.2005)
Pascal Hobi	internship, student ETHZ (18.7.–12.8.2005)

Expert Advisor

Dr. Claus Fröhlich	Physicist, solar variability, helioseismology, radiation budget, PI VIRGO, PI SOVIM, CoI GOLF, MDI

Technical Personnel

Hansjörg Roth	Deputy director, head technical support department, electronic engineer, experiment manager VIRGO, SOVIM, PREMOS
Daniel Bühlmann	Laboratory technician
Silvio Koller	Electronic engineer, LYRA experiment manager, quality system manager
Daniel Pfiffner	Electronic engineer SOVIM and PREMOS

Marcel Spescha	Laboratory technician
Christian Thomann	Laboratory technician
Jules U. Wyss	Mechanic, general mechanics, 3D design and manufacturing of mechanical parts
Marcel Knupfer	Electronics apprentice, 4th year (left 31.7.2005)
Christian Gubser	Electronics apprentice, 3rd/4th year
Chasper Buchli	Electronics apprentice, 1st/2nd year

Administration

Sonja Degli Esposti	Head administration PMOD/WRC, personnel, book keeping
Angela Knupfer	Secretary, part time
Annika Weber	Administration apprentice, 2nd/3rd year

Caretaker

Klara Maynard	General caretaker, cleaning
Dostana Kostic	part time cleaning (left 20.4.2005)
Silvia Messmer	part time cleaning (13.6.–14.12.2005)

Civilian Service Conscripts

Oliver Koller	29.11.2004 – 22.1.2005
Felix Michel	3.1.– 4.3.2005
Christ Andri Hassler	31.1.–29.4.2005
Christian Walther	4.4.–12.8.2005
Markus Suter	15.8.–28.10.2005
Adrian Süss	29.8.–27.11.2005
Stefan Moser	31.10.2005 – 16.3.2006

Miscellaneous Activities

Participation in Meetings and Courses

Werner Schmutz

9.1.–11.1.	PICARD meeting, Paris, France
19.1.	COST-CH meeting, Bern
20.– 22.2.	PICARD meeting, Cannes, France
13.3.–16.3.	GAW workshop at WMO, Geneva
20.4.	GAW-CH review, Zürich
23– 25.4.	COST 724 MC meeting, Vienna, Austria
12.–13.5.	SANW, Bern
29.– 31.5.	PICARD meeting, Paris, France
26.6.–2.7.	Solar Variability and Earth’s Climate, Monte Porzio, Cantone, Italy
3.–5.7.	ISSI workshop, Bern
4.8.–11.8.	IAMAS 2005, Beijing, China

23.9.	Meeting of the SSAA, Basel
26.9.–14.10..	10th International Pyrheliometer Comparisons IPC-X, Davos
5.10.	ESA Cosmic Vision, Bern
14.10.	Commission for Astronomy, Bern
17.–19.10.	NEWRAD meeting, Davos
20.–21.10.	UVNet Workshop, Davos
24.–27.10.	Meeting of the CCPR at BIPM, Paris, France
27.10.	GAW-CH meeting, Zürich
5.11.–3.12.	Visit at the Max Planck Institute for Solar System Research, Lindau, Germany
Sonja Degli Esposti	
16.8.04 – 25.10.05	Vorbereitung auf die Berufsprüfung Personalfachfrau, HTW Chur
6. + 7.9.	Abschlussprüfung schriftlich, Personalfachfrau mit eidg. Fachausweis
26.10.	Abschlussprüfung mündlich, Personalfachfrrau mit eidg. Fachausweis
Tatiana Egorova	
7.–10.3	SCOUT-O3 annual meeting, Zürich
24.–29.4.	EGU Assembly, Vienna, Austria
26.6.–1.7.	SEC, Solar variability and Earth's Climate, Frascati, Italy
2.–11.8.	IAMAS 2005, Beijing, China
9.12.	Invited Seminar in Bern University, IAP, Bern
Wolfgang Finsterle	
14.–16.2.	QS-Forum, Bucharest, Romania
3.–7.5.	TECO 2005, METEOREX 2005, Bucharest, Romania
30.5.–2.6.	17th ESA/PAC Symposium, Sandefjord, Norway
26.9.–14.10.	10th International Pyrheliometer Comparisons IPC-X, Davos
17.–19.10.	NEWRAD meeting, Davos
31.10.–4.11.	Phoebus Group at ISSI meeting, Bern
Claus Fröhlich	
15.3.–19.3.	Comité des Programmes Scientifiques, CNES, Paris, France
25.–29.4.	European Geophysical Union, Wien, Austria
6.–10.6.	Workshop "Solar Variability and Planetary Climates", ISSI, Bern
27.6.–2.7.	Solar Variability and Earth's Climate, Monte Porzio, Cantone, Italy
4.–7.7.	2nd Research Team meeting; ISSI, Bern
18.–21.7.	NASA-NIST TSI Workshop, NIST, Gaithersburg, MD, USA
17.–19.10.	NEWRAD meeting, Davos
21.–22.10.	Stiftungsrat Jungfraujoch/Gornergrat, Interlaken
31.10.–4.11.	1st Research Team meeting, ISSI, Bern
5.–9.12.	AGU Fall Meeting, San Francisco, CA, USA
Julian Gröbner	
3.–4.3.	QASUME project meeting, Innsbruck, Austria
22.3.	Visit Payerne
18.–19.4.	COST 726 MC Meeting, Špindleruv Mlýn, Czech Republik
28.–30.6.	PREMOS-2 Meeting, CNES, Paris, France
10.–19.9.	RBCC-E UV & Ozone Intercomparison campaign, Mazagon, Spain
17.–19.10.	NEWRAD meeting, Davos
20.–21.10.	UVNet Workshop, Davos
21.–22.10.	COST 726, WG4 meeting, PMOD/WRC, Davos
7.– 8.11.	PICARD meeting, CNES, Toulouse, France

15.–16.11.	Visit Observatory Izaña, Tenerife, Spain
Margit Haberreiter	
27.6.–1.7.	Solar Variability and Earth Climate, Monte Porzio Catone, Italy
3.–6.7.	ISSI Team, Relationship between Solar Magnetism and Irradiance, Bern
Silvio Koller	
14.–16.2.	QS-Forum, Bucarest, Romania
Sandra Möbus	
10.1.–21.1.	Kryogenvergleiche, METAS Bern und NPL London, UK
22.–23.6.	Abgabe Diplomarbeit, Fachhochschule Ravensburg, Germany
Rolf Philipona	
7.4.	6th Swiss global change Day, Bern
24–29.4.	EGU General Assembly 2005, Wien, Austria
7.7.	Forum zum Hitzesommer 2003, Bern
2.–11.8.	IAMAS-2005 conference, Beijing, China
5.–9.12.	AGU Fall Meeting 2005, San Francisco, USA
Eugene Rozanov	
7.–10.3.	SCOUT-O3 annual meeting, Zürich
25.–29.4.	EGU Assembly, Vienna, Austria
27.6.–1.7.	SEC, Solar variability and Earth climate, Frascati, Italy
2.–11.8.	IAMAS 2005, Beijing, China
27.–28.10.	Main Geophysical Observatory, St. Petersburg, Russia
14.–18.11.	ESWW-II, ESA-Estec Nordwijk, Netherlands
Isabelle Rüedi	
10.1.–21.1.	Kryogenvergleiche, METAS Bern und NPL London, UK
14.–16.2.	QS-Forum, Bucharest, Romania
Marcel Sutter	
28.8.–2..	NCCR Summer School, Grindelwald
Christoph Wehrli	
14.3.–16.3.	GAW2005 workshop, WMO Genf
20.–22.4.	GAW-CH review, MCH Zürich
7.7.	PROCLIM Forum zum Hitzesommer 2003, Bern
26.9.–14.10.	IPC-X und FRC-II, Davos
17.–19.10.	NEWRAD meeting, Davos
27.10.	GAW-CH Landesausschuss, Zürich
9.–11.11.	GAWTEC course, Schneefernerhaus, Germany
18.–19.11.	GAW/SAG Aerosol meeting, Leipzig, Germany

Course of Lectures, Participation in Commissions

Werner Schmutz

- International Radiation Commission (IRS, IAMAS)
- Comité consultatif de photométrie et radiométrie (CCPR, OICM BIPM)
- Expert Team on Meteorological Radiation and Atmospheric Composition Measurements (CIMO, WMO)
- Swiss Committee on Space Research (scnat)
- Commission for Astronomy (scnat)
- GAW-CH Working group (MeteoSwiss)
- Swiss management committee delegate to the COST action 724

- Course of lecture Astronomie, WS 2004/2005 and WS 2005/2006 ETHZ
- Examination expert: Ph.D. of Margit Haberreiter, Maura Vonmoos, and Thomas Wenzler, ETHZ

Wolfgang Finsterle

- Expert Team on Meteorological Radiation and Atmospheric Composition Measurements (CIMO, WMO)

Julian Gröbner

- GAW-CH Working group (MeteoSwiss)
- Swiss management committee delegate to the COST action 726
- Working group leader of COST action 726

Rolf Philipona

- Course of lecture Strahlungsmessung in der Klimaforschung WS 2004/2005 and WS 2005/2006 ETHZ
- Course of lecture Strahlungsmessung in der Klimaforschung WS 2005/2006 University of Berne
- Working group for Baseline Surface Radiation Network (WMO/WCRP)
- Atmospheric Chemistry and Physics (ACP) Commission of SCNAT
- Working group on Surface Fluxes (WMO/WCRP/WGSF)

Christoph Wehrli

- GAW-CH Working Group (SMA)
- WMO/GAW Aerosol SAG
- Working group for Baseline Surface Radiation Network (WMO/WCRP)
- Course of lecture Aerosol Optical Depth at the GAWTEC course

Public Seminars at PMOD/WRC

7.1	Phasensensitive Analyse der TSI	U. Schlifkowitz
25.1.	Modeling the effects of short- and long-term solar variability on ozone and climate”	Dr. T. Egorova
31.3.	Wie und warum die Temperatur ansteigt in Europa	PD Dr. R. Philipona
17.6.	Kunst – konkret – konstruktiv	Ch. Schmutz
22.9.	Reconstruction of the solar UV irradiance	M. Haberreiter
26.9.-14.10	Seminars of IPC-X and FRC-II	
17.–19.10.	NEWRAD meeting, congress center Davos	
20.–21.10.	UVNet Workshop, congress center Davos	
30.9.	Three dimensional chemical transport model study of Ozone and Related Gases, 1960 - 2000	C. Hoyle,
18.11.	On the effect of the inhomogeneous subsurface flows on the high degree solar p-modes	B. Sheregashvili, Belgien
8.12.	Modeling variations of the Solar UV spectrum with COSI	M. Haberreiter

Guided Tours at PMOD/WRC

In 2005 the PMOD/WRC was visited by 12 groups.

Participants IPC-X

Ihab	*Abboud*	*Canada*
Lihwu E.	*Akeh*	*Nigeria*
BŸlent	*Aksoy*	*Turkey*
Don	*Anderson*	*Australia*
Anne	*Andersson*	*Sweden*
Alexander	*Baskis*	*Israel*
Klaus	*Behrens*	*Germany*
Barbara	*Bogdanska*	*Poland*
Luis	*Ca*	*Guinea-Bissau*
Thomas	*Carlund*	*Sweden*
Fernanda	*Carvalho*	*Portugal*
Fred	*Denn*	*U.S.A.*
Peiru	*Dong*	*China*
Leonardo	*Fajardo Sierra*	*Columbia*
Wei	*Fang*	*China*
Patrick	*Fishwick*	*England*
Bruce	*Forgan*	*Australia*
Fernando	*Gimenez*	*Argentinia*
Serge	*Ginion*	*Belgium*
Arman	*Griarte*	*Philippines*
Mahesh K.	*Gupta*	*India*
Dave	*Halliwell*	*Canada*
John	*Hickey*	*U.S.A.*
Kohei	*Honda*	*Japan*
Viera	*Horecka*	*Slovakia*
Serm	*Janjai*	*Thailand*
Stefan	*KŠllberg*	*Sweden*
Ain	*Kallis*	*Estonia*
Wouter	*Knap*	*The Netherlands*
Mohamed H.	*Korany*	*Egypt*
Alexander	*Los*	*The Netherlands*
Meena D.	*Lysko*	*South Africa*
Duncan	*Maciver*	*U.S.A.*
Martin	*Mair*	*Austria*
Darius	*Mikalajunas*	*Lithuania*
Dave	*Moore*	*England*
Jean-Philippe	*Morel*	*France*
Svetlana	*Morozova*	*Russia*
Pedro A.	*Mostraj Aguilera*	*Chile*
Dr. Augustin	*Muhlia*	*Mexico*
Harald	*MŸllejans*	*Italy*
Salimon K.	*Muyiolu*	*Nigeria*
Zoltan	*Nagy*	*Hungary*
Erik	*Naranen*	*U.S.A.*
Donald	*Nelson*	*U.S.A.*
Ormanda	*Niebergall*	*Canada*
Ifeanyi D.	*Nnodu*	*Nigeria*
Sam	*Ochoto*	*Uganda*
Cristian	*Oprea*	*Romania*
Bouziane	*Ouchene*	*Algeria*
Prasan	*Pankaew*	*Thailand*
Alexandre	*Pavlov*	*Russische Fšderation*
Maria	*Pavlovich*	*Russia*
Vladimir	*Pavlovich*	*Russia*
Juan C.	*Peleaz*	*Cuba*
Jiri	*Pokorny*	*Czech Republc*
Krunoslav	*Premec*	*Croatia*
Sutham	*Rachupimol*	*Thailand*
Oscar A.	*Ramirez*	*El Salvador*
Ibrahim	*Reda*	*U.S.A.*
Yongyuth	*Sawatdisawanee*	*Thailand*
Ahmed	*Shibaika*	*Sudan*
Noureddine	*Sidki*	*Morocco*
Thomas	*Stoffel*	*U.S.A.*
Watcharapol	*Subwat*	*Thailand*
Korntip	*Tohsing*	*Thailand*
Martin	*Veenstra*	*The Netherlands*
Esequiel	*Villegas*	*Peru*
Yupeng	*Wang*	*China*
Craig	*Webb*	*U.S.A.*
Ed	*Worrell*	*The Netherlands*
Yun	*Yang*	*China*
Willem J.	*Zaaiman*	*Italy*

Participants FRC-II

Bureau of Meteorology, Melbourne, Australia

Deutscher Wetterdienst, Lindenberg, Germany

Earth System Research Laboratory, NOAA, USA

Joint Research Centre, Ispra, EU

Meteorological Office, East Hampstead, United Kingdom

Meteorological Service of Canada, Downsview, Canada

PMOD/WRC, Davos, Switzerland

Swedish Meteorological and Hydrological Institute, Norrköping, Sweden

University of Colima, Mexico

Participating instrument types:

8 WORCC PFR 4 channels

4 Carter-Scott SP02 4 channels

2 CIMEL CE318 8 channels

1 Carter-Scott ASR hyperspectral radiometer

Abbreviations

AOD	Aerosol Optical Depth
ACRIM	Active Cavity Radiometer for Irradiance Monitoring
AGU	American Geophysical Union
ARM	Atmospheric Radiation Measurement
ASRB	Alpine Surface Radiation Budget
ATLAS	Shuttle Mission with solar irradiance measurements
AU	Astronomical Unit (1 AU = mean Sun-Earth Distance)
BAG	Bundesamt für Gesundheitswesen
BBW	Bundesamt für Bildung und Wissenschaft, Bern
BESSY	Berliner Elektronen Speicher Synchrotron
BiSON	Birmingham Solar Oscillation Network
BOLD	Blind to optical light detector
BSRN	Baseline Surface Radiation Network of the WCRP
BUWAL	Bundesamt für Umwelt, Wald und Landschaft, Bern
CART	Cloud and Radiation Testbed
CCM	Chemistry-Climate Model
CAS	Commission for Atmospheric Sciences, commission of WMO
CHARM	Swiss (CH) Atmospheric Radiation Monitoring, CH contribution to GAW
CIE	Commission Internationale de l'Eclairage
CIMO	Commission for Instruments and Methods of Observation of WMO, Geneva
CIR	Compagnie Industrielle Radioélectrique, Gals
CMDL	Climate Monitoring and Diagnostic Laboratory
CNES	Centre National d'Etudes Spatiales, Paris, F
CNRS	Centre National de la Recherche Scientifique, Service d`Aéronomie Paris
CoI	Co-Investigator of an Experiment/Instrument/Project
COSPAR	Commission of Space Application and Research of ICSU, Paris, F
COST	Co-operation in the field of Scientific and Technical Research, an intergovernmental framework program of the ESF
CPC	Climate Prediction Center, USA
CPD	Course Pointing Device
CSEM	Centre Suisse de l'Electro-Mécanique, Neuenburg
CTM	Chemical Transport Model
CUVRA	Characteristics of the UV radiation field in the Alps
DIARAD	Dual Irradiance Absolute Radiometer of IRMB
DLR	Deutsche Luft und Raumfahrt
EGS	European Geophysical Society
EGSE	Electrical Ground Support Equipment
ERBS	Earth Radiation Budget Satellite
ERS	Emergency Sun Reacquisition
ESA	European Space Agency, Paris, F
ESF	European Science Foundation
ESO	European Southern Observatory
ESOC	European Space Operations and Control Center, Darmstadt, D
ESTEC	European Space Research and Technology Center, Noordwijk, NL
ETH	Eidgenössische Technische Hochschule (Z: Zürich, L: Lausanne)
EURECA	European Retrievable Carrier, flown August 1992 - June 1993 with SOVA experiment of PMOD/WRC

EUV	Extreme Ultraviolet Radiation
FWHM	Full width half maximum (e.g. filter transmission)
GAW	Global Atmosphere Watch, an observational program of WMO
GAWTEX	GAW Training & Education Center
GCM	General Circulation Model
GEWEX	Global Energy and Water Cycle Experiment of WCRP
GHG	Greenhouse Gases
GOLF	Global Oscillations at Low Frequencies= experiment on SOHO
GONG	Global Oscillations Network Group
GSFC	Goddard Space Flight Center, Maryland, USA
HALOE	Halogen Occultation Experiment on board UARS
HECaR	High sensitivity Electrically Calibrated Radiometer
HF	Hickey-Frieden Radiometer manufactured by Eppley, Newport, R.I., USA
IACETH	Institute for Climate Research of the ETH-Z
IAMAS	International Association of Meteorology and Atmospheric Sciences of IUGG
IAS	Institut d'Astrophysique Spatiale, Verrières-le-Buisson, F
IASB	Institut d'Aéronomie Spatiale de Belgique, Bruxelles, B
IAU	International Astronomical Union of ICSU, Paris, F
IFU	Institut für Umweltwissenschaften, Garmisch-Partenkirchen
ICSU	International Council of Scientific Unions, Paris, F
IDL	Interactive Data-analysis Language
IKI	Institute for Space Research, Moscow, Russia
INTAS	International Association for the promotion of co-operation with scientists from the New Independent States of the former Soviet Union, EU grant
IPASRC	International Pyrgeometer and Absolute Sky-scanning Radiometer Comparison
IPC	International Pyrheliometer Comparisons
IPHIR	Inter Planetary Helioseismology by Irradiance Measurements
IR	Infrared
IRC	Infrared Radiometer Center
IRMB	Institut Royal Météorologique de Belgique, Brussel, B
IRS	International Radiation Symposium of the Radiation Commission of IAMAS
ISA	Initial Sun Acquisition
ISS	International Space Station
ISSA	International Space Station Alpha (NASA, ESA, Russia, Japan)
IUGG	International Union of Geodesy and Geophysics of ISCU
JPL	Jet Propulsion Laboratory, Pasadena, California, USA
JRC	Joint Research Center of the European Commission in Ispra, Italy
KIS	Kiepenheuer-Institut für Sonnenphysik, Freiburg i.Br.
KrAO	Crimean Astrophysical Observatory, Ukraine
LASCO	Large Angle and Spectrometric Coronagraph
LOI	Luminosity Oscillation Imager, Instrument in VIRGO
LYRA	Lyman-alpha Radiometer, ROB & PMOD/WRC experiment on PROBA 2
MCH	MeteoSwiss, Zürich
MDI	see SOI/MDI
metas	Swiss Federal Office of Metrology and Accreditation
MODTRAN	Moderate Resolution Transmission Code (in Fortran)
MSC	Meteorological Service of Canada, Toronto
MSU	Microwave Sounding Unit

NASA	National Aeronautics and Space Administration, Washington, USA
NCEP	National Center for Environmental Prediction, NOAA, USA
NIMBUS7	NOAA Research Satellite, launched Nov.78
NIP	Normal Incidence Pyrheliometer
NMC	National Meteorological Center, USA
NOAA	National Oceanographic and Atmospheric Administration, Washington, USA
NPL	National Physical Laboratory, Teddington, UK
NRL	Naval Research Laboratory, Washington, USA
NREL	National Renewable Energy Lab
ODS	Ozone Destroying Substances
PCB	Printed circuit board
PDR	Preliminary Design Review
PFR	Precision Filter Radiometer
PHOBOS	Russian Space Mission to the Martian Satellite Phobos
PI	Principle Investigator, Leader of an Experiment/Instrument/Project
PICARD	French space experiment to measure the solar diameter (launch 2009)
PIR	Precision Infrared Pyrgeometer von Eppley
PMOD	Physikalisch-Meteorologisches Observatorium Davos
PMO6-V	VIRGO PMO6 type radiometer
PREMOS	Precision Monitoring of Solar Variability, PMOD/WRC experiment on PICARD
PROBA 2	ESA technology demonstration space mission (launch 2007)
PRODEX	Program for the Development of Experiments der ESA
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig & Berlin, D
QASUME	Quality Assurance of Spectral Ultraviolet Measurements in Europe
RA	Regional Association of WMO
RASTA	Radiometer für die Automatische Station der SMA
ROB	Royal Belgian Observatory
RS422	Serial communication interface
SAG	Scientific Advisory Group of the GAW program
SANW	Schweizerische Akademie der Naturwissenschaften, Bern
SARR	Space Absolute Radiometer Reference
SCOPES	Scientific Collaboration between Eastern Europe and Switzerland, grant of the SNSF
SLF	Schnee und Lawinenforschungsinstitut, Davos
SFI	Schweiz. Forschungsinstitut für Hochgebirgsklima und Medizin, Davos
SIAF	Schweiz. Institut für Allergie- und Asthma-Forschung, Davos
SIMBA	Solar Irradiance Monitoring from Balloons
SMD	Surface Mounted Devices
SMM	Solar Maximum Mission, Satellite of NASA
SNF	Schweizer. Nationalfonds zur Förderung der wissenschaftlichen Forschung
SNSF	Swiss National Science Foundation
SOCOL	Combined GCM and CTM computer model, developed at PMOD/WRC
SOHO	Solar and Heliospheric Observatory, Space Mission of ESA/NASA
SOI/MDI	Solar Oscillation Imager/Michelson Doppler Imager, Experiment on SOHO
SOJA	Solar Oscillation Experiment for the Russian Mars-96 Mission
SOL-ACES	Solar Auto-Calibrating EUV/UV Spectrometer for the International Space Station Alpha by IPM, Freiburg i.Br., Germany
SOVA	Solar Variability Experiment on EURECA
SOVIM	Solar Variability and Irradiance Monitoring, PMOD/WRC experiment for the International

	Space Station Alpha
SPC	Science Programme Committee, ESA
SPM	Sun photometer
SSD	Space Science Department of ESA at ESTEC, Noordwijk, NL
SST/SI	Sea Surface Temperature and Sea Ice
STEP	Solar Terrestrial Energy Program of SCOSTEP/ICSU
SUSIM	Solar Ultraviolet Spectral Irradiance Monitor on board UARS
SW	Short Wave
SWT	Science Working Team
TSI	Total Solar Irradiance
UARS	Upper Atmosphere Research Satellite of NASA
UTC	Universal Time Coordinated
UV	Ultraviolet radiation
VIRGO	Variability of solar Irradiance and Gravity Oscillations, Experiment on SOHO
WCRP	World Climate Research Program
WDCA	World Data Center for Aerosols, Ispra
WISG	World Infrared Standard Group of pyrgeometer, maintained by WRC
WMO	World Meteorological Organization, a United Nations Specialized Agency, Geneva
WORCC	World Optical Depth Research and Calibration Center (since 1996 at PMOD/WRC)
WRC	World Radiation Center, Davos
WRDC	World Radiation Data Center, St. Petersburg
WRR	World Radiometric Reference
WSG	World Standard Group, realizing the WRR, maintained by WRC
WWW	World Weather Watch, an observational program of WMO

Donations

In 2005 the PMOD/WRC ordered a MFRSR radiometer for optical depth and spectral global radiation measurements from Yankee Environment Systems (YES), in order to increase the number of different instruments that are based at the World Optical Depth Research and Calibration Center (WORCC) operated by the PMOD/WRC on its premises. The purchase of this radiometer was made possible thanks to a generous donation from Mr. Daniel Karbacher (from Küsnacht, ZH). The instrument has not yet been delivered and therefore its procurement will be included in the 2006 year-end financial report.

As it has done for the last two years, the association for the benefit of the SFI foundation paid an annual installment that reimburses the PMOD/WRC for the purchase of the institute's color printer/copy machine.

Rechnung PMOD/WRC 2005

Allgemeiner Betrieb PMOD/WRC (exkl. Drittmittel)

Ertrag	CHF
Beitrag Bund Betrieb WRC, IRC	1'076'448.00
Beitrag Bund Betrieb WORCC	159'270.00
Beitrag Kanton Graubünden	173'285.00
Beitrag Landschaft Davos	259'927.50
Beitrag Landschaft Davos, Mieterlass	133'500.00
Beitrag Landschaft Davos, Stiftungstaxe	190'000.00
Beitrag MeteoSchweiz, Kyoto Beitrag	56'250.00
Instrumentenverkauf	124'062.05
Diverse Einnahmen/Eichungen	111'652.75
Wertschriftenertrag/Aktivzinsen	49'108.75
	2'333'504.05

Aufwand	CHF
Gehälter	1'284'242.20
Sozialleistungen	227'677.60
Investitionen	226'511.70
Unterhalt	39'405.75
Verbrauchsmaterial	32'776.80
Verbrauch Commercial	42'345.35
Reisen, Kongresse, Kurse, IPC-X	79'169.73
Bibliothek und Literatur	17'795.60
Raumkosten	133'500.00
100-Jahr Feier	50'000.00
Verwaltungskosten	139'525.59
	2'272'950.32
Ergebnis 2005	**60'553.73**
	2'333'504.05

Bilanz PMOD/WRC (exkl. Drittmittel)

	31.12.2005	31.12.2004
Aktiven	CHF	CHF
Kassa	2'087.30	1'255.45
Postcheck	8'186.44	13'630.64
Bankkonten	637'180.20	705'405.41
Debitoren	44'288.45	89'894.45
Verrechnungssteuer	488.10	433.75
Kontokorrent Mitarbeiter	-561.95	634.45
Kontokorrent Stiftung	Passiv	Passiv
Kontokorrent SNF-1, 200020-101848	2'130.22	2'439.70
Kontokorrent SNF-2, 200021-102040	43'757.30	610.00
Kontokorrent SNF-3, 21-68171.02	516.25	53'744.95
Kontokorrent SNF 200020-109420	11'584.10	0.00
Kontokorrent PREMOS-2	207'977.95	56'497.85
Kontokorrent SOVIM	107'713.65	342'463.35
Kontokorrent POLY-Projekt	0.00	1'780.15
Kontokorrent INTAS	1'971.40	1'971.40
Kontokorrent TH-Projekt	0.00	310.00
Kontokorrent LYRA-Projekt	192'318.74	49'515.89
Kontokorrent COST-724	-42'332.81	-90'444.91
Kontokorrent COST-726	-122.40	0.00
Kontokorrent SCOUT-03	5'836.95	5'448.45
Kontokorrent NCCR-Climate	0.00	-1'189.30
Kontokorrent SCOPES	437.50	0.00
Kontokorrent NEWRAD	189.70	0.00
Transitorische Aktiven	12'795.35	25'370.35
	1'236'442.44	1'259'772.03

	31.12.2005	31.12.2004
Passiven		
Kreditoren	69'939.60	89'559.20
Zahllast Mehrwertsteuer	-2'845.72	-7'497.40
Kontokorrent Stiftung	15'375.50	238.45
Transitorische Passiven	575'710.00	542'530.55
Rückstellungen	413'037.40	458'059.30
Rückstellung Fehlbetrag PUBLICA	0.00	72'210.00
Eigenkapital	165'225.66	104'671.93
	1'236'442.44	1'259'772.03