Jahresbericht 2004

Physikalisch-Meteorologisches Observatorium
Davos
World Radiation Center

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Annual Report 2004

A department of the Foundation

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SFI

Schweizerisches Forschungsinstitut für Hochgebirgsklima und Medizin

DAVOS

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Zusammenfassung Jahresbericht 2004

Vorwort

Unspektakulär aber von entscheidender Bedeutung für das langfristige Bestehen des Weltstrahlungszentrums am PMOD ist die Einführung eines Qualitätssystems nach der Norm ISO/IEC 17025. Die vom Qualitätssystem betroffenen Bereiche beziehen sich auf den Unterhalt und den Betrieb der Weltstandardgruppe von Absolut-Radiometern, die den Primärstandard für die Messungen der Stärke der Sonnenbestrahlung definieren, und auf Kalibrierungen die sich auf diese Referenz beziehen, d.h. auf Kalibrierungen von Pyrheliometern und Pyranometern. Bis anhin war die Dienstleistung des PMOD als Weltstrahlungszentrum nur von der Weltmeteorologischen Organisation aber nicht offiziell durch die Organisation der metrologischen Institute anerkannt. Das PMOD/WRC ist zwar mittlerweilen in die Liste der Metrologieinstitute, die das Abkommen der gegenseitigen Anerkennung der Kalibriertätigkeiten unterzeichnet haben, aufgenommen worden, aber Grundvoraussetzung, dass die Kalibriertätigkeit des PMOD/WRC von den metrologischen Instituten offiziell anerkannt werden kann, ist ein funktionierendes und anerkanntes Qualitätssystem. Im Februar 2005 hat das PMOD/WRC sein Qualitätssystem dem Qualitätsforum der Europäischen Metrologieinstitute vorgestellt und muss nun in der praktischen Anwendung nachweisen, dass das neu eingeführte Qualitätssystem angewendet und befolgt wird.

Der Vertrag zur Finanzierung des Weltstrahlungszentrums konnte nicht rechtzeitig vor dem Auslaufen der alten Finanzperiode Ende 2003 abgeschlossen werden. Trotz fehlender Vereinbarung und fehlender rechtlichen Grundlage beim Bund und Kantons Graubünden haben alle vier Partner, der Bund, der Kanton Graubünden, die Landschaft Davos Gemeinde und die Stiftung SFI, die für 2004 vorgesehenen Beträge, die erhöht wurden, um zusätzlich auch das Infrarot Radiometer Kalibrier-zentrum am PMOD/WRC zu betreiben, termingerecht bezahlt und der Betrieb des PMOD/WRC war daher von der Verzögerung nicht betroffen. Bis Ende des Jahres 2004 waren alle rechtlichen Belange geklärt und zu Beginn des Jahres 2005 konnte der Vertrag unterzeichnet werden und rückwirkend auf 1. Januar 2004 in Kraft treten. Damit ist die finanzielle Grundlage des PMOD/WRC bis Ende 2007 gesichert.

Die Reaktivierung der Entwicklung des französischen Weltraumprojekts PICARD bedeutet nicht nur die Wiederaufnahme des Baus des dazugehörigen PMOD/WRC Filterradiometers PREMOS, sondern ermöglichte auch eine Erweiterung des schweizerischen Beitrags, da bei der französischen Wiederevaluation der Mission zusätzlich auch ein Absolut-Radiometer des PMOD/WRC in das PICARD Projekt integriert wurde. Der erweiterte Schweizer Beitrag heisst PREMOS2. Es ist geplant, dass die PICARD Mission im Jahr 2008 gestartet wird und damit wird den langjährigen Bemühungen um eine Weiterführung der Messungen der Totalen Sonneneinstrahlungen nach dem gegenwärtig laufenden VIRGO Experiment auf dem Satelliten SoHO und nach dem zukünftigen SOVIM Experiment auf der Internationalen Raumstation Erfolg beschieden.

Die Auswirkungen der variablen Sonneneinstrahlung auf die Erdatmosphäre werden am PMOD/WRC im Rahmen eines ETH-Poly-Projekts in Zusammenarbeit mit Instituten der ETH Zürich untersucht. Die erste Phase des Projekts war Ende 2004 abgeschlossen und die verschiedenen Teilresultate werden derzeit in vier Dissertationen und diversen Publikationen zusammengefasst. Das Projektziel, einen nicht-linear verstärkten Einfluss der variablen Sonnenbestrahlung auf das globale Klima mit Simulationen nachzuweisen, wurde erreicht. Die geplante Fortsetzung des Projekts bezweckt die kleine Eiszeit im 17. Jahrhundert als Folge der damals reduzierten Sonnenaktivität nachzuvollziehen. Die Fortsetzung kann jedoch nicht mehr unter PMOD/WRC Führung erfolgen, da die Regelungen der ETH Zürich für die Finanzierung von ETH-Projekten strikter geworden sind und verlangen, dass die Leitung durch ein ETH Institut erfolgt. Prof. Thomas Peter vom Institut für Atmosphären- und Klimawissenschaften hat die Leitung des Projekts übernommen und zusammen mit dem Institut für Astronomie, der EAWAG und dem PMOD/WRC wurde ein Antrag für die zweite Phase an die ETH gestellt.

Dienstleistungen, Instrumentenverkauf und Messnetze

In seiner Aufgabe als Weltstrahlungszentrum kalibrierte das PMOD/WRC im vergangenen Jahr 86 Instrumente, davon sechs Absolut-Radiometer, sechs Pyrheliometer und 38 Pyranometer an 60 wolkenfreien Messtagen. Die Zahl der kalibrierten Pyrgeometer beträgt 24 und zudem kalibrierten wir fünf Präzisions-Filterradiometer des GAW Messnetzes und sieben UV-Filterradiometer im Labor mit einer vom NIST kalibrierten Lampe.

In mehr als einem Jahr Arbeit wurde eine umfassende Dokumentation der relevanten Infrastruktur und Arbeitsvorschriften für das WRC erstellt und im Dezember 2004 erfolgte die Einführung des Qualitätssystems für alle Belange, die die Weltstandardgruppe betreffen. Ein Qualitätssystem nach der internationalen Norm ISO/IEC 17025 ist die Grundvoraussetzung für die internationale Anerkennung der Radiometrischen Referenz, die durch die Weltstandardgruppe realisiert wird, durch die metrologischen Institute.

Nach dem schwachen Absatz im Jahr 2003 war die Nachfrage nach PMO6-cc Radiometer im Jahr 2004 wiederum relativ hoch und wir konnten drei Absolut-Radiometer und eine Kontrollelektronik für eine Aufrüstung eines älteren PMO6 Radiometer verkaufen. Weiter haben wir ein Präzisions-Filterradiometer und neun Ventilations- und Heizsysteme für Pyrgeometer abgesetzt.

Das erste reguläre Betriebsjahr des Infrarot Radiometer Kalibrierzentrums am PMOD/WRC verlief entsprechend dem während der Aufbauphase ausgearbeiteten Konzept und ohne weitere Ergänzung der erstellten Infrastruktur. Eine Gruppe von vier Pyrgeometern dient als Kalibrierreferenz und wird regelmässig mit dem Absolute Sky-Scanning Radiometer auf seine Stabilität überprüft. Kundeninstrumente werden dann relativ zu dieser Gruppe kalibriert.

Das Netzwerk von acht Global Atmosphere Watch Stationen und einer schweizerischen Station, die mit PMOD/WRC Präzisions-Filter-Radiometern ausgerüstet sind, lieferte PFR Messdaten ans World Optical Depths Research and Calibration Center am PMOD/WRC wo sie überprüft und bezüglich Trübung ausgewertet werden und als Stundenmittelwerte mit Qualitätsmerkmalen versehen ans Weltdatenzentrum für Aerosole weitergegeben werden. Eine von der WMO initiierte Fachtagung mit dem Ziel die existierenden bodengebundenen Messnetze, die optische Trübung der Atmosphäre durch Aerosolbestandteile messen, zu einem globalen Verbund zu vereinigen, wurde im März 2004 durch das PMOD/WRC in

Davos organisiert. Im Rahmen dieser Tagung beurteilte die von der WMO eingesetzte Scientific Advisory Group den PMOD/WRC Beitrag als sehr wertvoll und empfahl, dass die WORCC Stationen als Eckpfeiler einer Kalibrierpyramide zwischen den verschiedenen Messnetzen eingesetzt werden.

Das langjährige Forschungsprojekt Alpine Surface Radiation Budget des PMOD/WRC liefert zuverlässig Strahlungsmesswerte, die es ermöglichen den zeitlichen Trend des Strahlungsgleichgewichts im Alpenraum zu untersuchen. An den drei ASRB Messstationen Locarno-Monti, Payerne und Davos ist ein Auswertungsalgorithmus implementiert, der es erlaubt den aktuellen Wolkenbedeckungsgrad über das Internet abzufragen.

Entwicklung und Bau von Instrumenten – Weltraumexperimente VIRGO, SOVIM, PREMOS und LYRA

Erfreulicherweise lässt sich vom PMOD/WRC Experiment VIRGO auf dem ESA/NASA-Satelliten SOHO weiterhin nur berichten, dass die Messungen ohne nennenswerte Störungen und Unterbrüche weitergehen. Die Messreihe umfasst mittlerweile über neun Jahre.

Die Instrumente des SOVIM Experiments, das für die Internationale Raumstation vorgesehen ist, wurden im vergangenen Jahr extensiv getestet und im Labor und vor Sonne charakterisiert. Nach Behebung eines Zwischenfalls, der den Ersatz eines Radiometers bedingte, wurde das Experiment zusammengebaut und als Einheit wiederum diversen Tests unterzogen. Das Experiment wird nun vor Sonne mit der Weltstandardgruppe als Referenz kalibriert und ist nächstens bereit zur Ablieferung und Integration in die Nachführeinheit, die von der italienischen Firma Alenia gebaut wird.

Die Mission PICARD, die neben dem französischen Hauptexperiment und einem Instrument von Belgien das Vier-Kanal Filterradiometer PREMOS des PMOD/WRC umfasst, war schon seit Anfang 2003 wegen finanziellen Problemen der französischen Weltraumorganisation eingefroren. Mitte Oktober 2004 wurde die Mission reaktiviert und unsere wichtigste Aktivität nach dem offiziellen Wiederbeginn war das mehrmalige Umzeichnen des Instrumentengehäuses entsprechend der verschiedenen vorgeschlagenen Varianten die Satellitenplattform um ein weiteres PMOD/WRC Instrument zu ergänzen: PREMOS-TSI, das die Totalstrahlung der Sonne messen wird. Das PMOD/WRC Experiment heisst nun PREMOS 2 und umfasst das neue PREMOS-TSI zusammen mit dem bisherigen PREMOS.

Der Bau des Filterradiometers LYRA für den ESA Technologiesatelliten PROBA-2 kam im letzten Jahr gut voran und der sehr enge Zeitplan, der fast keine Reserven enthielt, wurde wegen Problemen mit Detektoren und anderen Experimenten auf PROBA-2 leicht verzögert. Die mechanischen Teile und die Elektronik des Flugmoduls sind mittlerweilen zu einem grossen Teil fertiggestellt. Als nächstes werden die Detektoren integriert und die Ablieferung des LYRA Experiments ist Ende 2005 geplant.

ETH-Polyprojekt „Variabilität der Sonne und Globales Klima“

Das ETH Polyprojekt endete nach drei Jahren offizieller Dauer im Oktober 2004. Da die vom Projekt finanzierten Dissertationen zeitlich gestaffelt gestartet wurden, sind allerdings erst zwei von vier Dissertationen abgeschlossen. Am PMOD/WRC wurde die Entwicklung des Strahlungstransport Programms COSI zur Berechung von Sonnenspektren fertiggestellt und das Programm wurde zur Rekonstruktion der spektralen Sonneneinstrahlung von 1975 bis 2003 eingesetzt. Die Berechnungen basieren auf einer Erfassung der aktiven Gebiete auf der Sonne mit einer zeitlichen Auflösung von einem Tag, die im Rahmen einer weiteren Dissertation des Polyprojekts am Institut für Astronomie erarbeitet wurden. Die synthetischen Sonnenspektren wiederum waren Eingabedaten für Klimaberechnungen mit dem Chemistry-Climate-Model SOCOL mit denen der solare Einfluss auf das Klima in der Zeitspanne 1975 – 2000 simuliert wurde. Diese Simulationen zeigen klar, dass die Variabilität der Sonneneinstrahlung nicht-linear verstärkt wird und sie das Erdklima viel stärker beeinflusst als es einer Variation der eingestrahlten Energie entsprechen würde. Damit ist das primäre Ziel der ersten Phase des Polyprojekts erreicht, nämlich nachzuweisen, dass die variable Sonneneinstrahlung ein wesentlicher Einflussfaktor für das Erdklima sein kann.

ETH TH-Projekt – Modellierung von Atmosphärenchemie und Transportprozessen mit Ozoneinfluss

Nach etlichen Verbesserungen des Computerprogramms und dem Zusammenstellen der notwendigen Input Dateien gelingt es nun die Evolution der Ozonkonzentration für die Zeitperiode 1960 – 2000 erfolgreich bis auf einen konstanten Offset zu reproduzieren. Mit den Modellrechnungen können nun einerseits Lücken in den Beobachtungsdaten überbrückt werden und anderseits kann durch Simulationen mit veränderten chemischen Zusammensetzungen, der Einfluss bestimmter Komponenten erforscht werden, wie sich z.B. die Ozonkonzentration entwickelt hätte, wenn die CFC Emissionen gleich wie in den 60er Jahren geblieben wären.

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

Es ist geplant, die kommenden Beobachtungen mit dem LYRA/PROBA2 Weltraumexperiment als Eingabewerte in ein Klimamodell zu verwenden um damit Kurzzeitprognosen des Zustands der mittleren Atmosphäre zu berechnen. Als Vorbereitung haben wir Beobachtungen mit dem Spektrometer des SUSIM Experiments auf dem Satelliten UARS verwendet um LYRA Daten in den entsprechenden UV Wellenlängenbändern vom Januar 1992 zu extrahieren. Diese Werte wurden dem Klimamodell eingegeben und das Resultat mit der gemessenen Entwicklung der damaligen Ozonkonzentration verglichen. Die Rechnungen prognostizierten eine um rund 10 % zu hohe Ozonkonzentration, waren aber sehr erfolgreich in der Voraussage der zeitlichen Entwicklung. Damit ist die geplante Prognose aus der Sicht der notwendigen Simulationen machbar, aber die praktische Realisation der Kurzzeitprognose wird davon abhängen, ob die Beobachtungsdaten genügend schnell verfügbar sein werden.

Qualitätskontrolle: Atmosphärischer Druck, Rayleigh Streuung und der Ångström Exponent der Aerosol optischen Tiefe

Bei der Bestimmung der Aerosol Optischen Tiefe (AOD), d.h. dem Anteil der atmosphärischen Trübung durch Aerosolteilchen, muss der Streuanteil der atmosphärischen Rayleigh Streuung von der Gesamtextinktion abgezogen werden. Die Rayleigh Streuung ist zum atmosphärischen Druck proportional und daher muss der atmosphärische Druck möglichst genau bekannt sein. Die Wellenlängenabhängigkeit der AOD kann relativ gut durch Ångströms Extinktionsgesetz beschrieben werden, wobei der Exponent der Wellenlängenabhängigkeit im Wesentlichen von der Grössenverteilung der Aerosolteilchen in der Atmosphäre abhängt. Will man die Eigenschaften der dominanten Aerosolteilchen bestimmen, dann wird vor allem bei geringer atmosphärischer Trübung ein Fehler bei der Erfassung des Drucks kritisch. Simulationen des Fehlereinflusses zeigen, dass bei AOD Werten geringer als 0.05 bei 500 nm ein Fehler im Druck von 10 hPa eine zuverlässige Exponentenbestimmung verunmöglicht. Im GAW-AOD Messnetz wird eine Genauigkeit bei der Druckmessung von weniger als 3 hPa durch den in den PFR Geräten integrierten Barometer angestrebt. Diese Zielvorgabe konnte bei den drei Stationen eingehalten werden, bei denen wir die Instrumenten-Druckmessungen mit Werten der nationalen Wetterdienste überprüfen konnten.

Qualitätskontrolle: Nachführgenauigkeit der AOD Messungen

Entsprechend der WMO Richtlinien werden die PMOD/WRC Sonnenphotometer mit einem Gesichtsfeld von 2.5 Grad gebaut. Dies impliziert bei einem Sonnendurchmesser von einem halben Grad, dass die Genauigkeit der Sonnennachführung für AOD Messungen durch PFR Instrumente innerhalb von 0.45 Grad sein muss. Ein Überschreiten dieser Limite um nur 0.02 Grad führt zu signifikanten Fehlern bei der AOD Bestimmung. Nachführfehler sind bei den Instrumenten des GAW-AOD Messnetzwerkes glücklicherweise selten, kommen aber durchaus vor. Ein bei den PFR Instrumenten eingebauter optischer Sensor überwacht die Ausrichtung des Instruments auf die Sonne und Fehlausrichtungen der Instrumente werden daher erkannt und betroffene Daten können als fehlerhaft markiert werden.

Nachweis eines ansteigenden Treibhauseffekts durch Erfassung des Oberflächenstrahlungsgleichgewichts

Die Erfassung des Strahlungsgleichgewichts mit dem PMOD/WRC Forschungsprojekt ASRB (Alpine Surface Radiation Budget) zeigt einen eindeutigen Anstieg der totalen Heizung der Erdoberfläche durch die Strahlung während der Jahre 1995 bis 2003, der parallel zur Zunahme der Bodentemperatur verläuft. Die gleichzeitige Zunahme der langwelligen Himmelsstrahlung bei wolkenfreiem Himmel weisst darauf hin, dass dieser Anstieg auf eine Zunahme des Treibhauseffekts zurückgeführt werden kann.

Überprüfung der Strahlungsdaten von arktischen BSRN Stationen

Das Baseline Surface Radiation Network (BSRN) ist ein Projekt des Weltklima Forschungsprogramms. Das PMOD/WRC Forschungsprojekt, das den Treibhauseffekt in polaren Gebieten untersucht, arbeitet mit BSRN Strahlungsdaten von vier arktischen Stationen. Eine sorgfältige Überprüfung dieser Daten zeigte, dass systematische Fehler aufgrund von Instrumentenwechsel oder technischer Probleme auftreten. Da die vermutete Änderung des Treibhauseffekts ein kleiner Effekt ist, müssen diese Daten vor einer Analyse bereinigt werden.

Erforschung und Verstehen der radiometrischen Eigenschaften

Die Eigenschaften des PMO6 Absolut-Radiometers sind bei der Entwicklung sehr genau und umfassend erforscht worden. Trotzdem scheint es systematische Einflüsse auf die Messresultate zu geben, die bisher vernachlässigt wurden. Bei der Ausmessung von Nichtäquivalenzeffekten der Strahlungs- und Turbulenzverluste zwischen offenem und geschlossenem Messzustand wurde bemerkt, dass die Grösse der Fläche, die auf der Blende beschienen ist, einen Einfluss auf das Messresultat ausübt. Eine mögliche Erklärung für diesen Effekt ist, dass die Strahlung die Blende so stark erwärmt, dass die Änderung der Blendentemperatur eine genügend starke Änderung der abgestrahlten Infrarotstrahlung bewirkt, so dass diese durch die Kavität messbar wird. Dieser Effekt ist von zentraler Bedeutung bei Vergleichen der Weltstrahlungsreferenz (WRR) mit kryogenen Radiometern, weil bei solchen Vergleichen mit einem Laserstrahl gearbeitet wird, der die Blende nicht ausfüllt. Beim Vergleich der Leistungsmessungen zwischen SI-Einheiten, wie sie in metrologischen Instituten realisiert wird, und der WRR muss dieser systematische Unterschied berücksichtigt werden.

Entwicklung eines neuen Absolut-Radiometers für den Weltraum und den bodengebundenen Einsatz

Am PMOD/WRC entwickeln wir einen neuen Radiometer Typ, der auf einer phasenempfindlichen Analyse des Messsignals basieren wird. Der erfolgreiche Einsatz dieser Technik würde es erlauben verschiedene systematische Messfehler, wie unter anderem den Einfluss der sogenannten Nicht-Äquivalenz, zu eliminieren. Das erste Jahr der Doktorarbeit wurde dafür verwendet mit einem Computermodell des Instruments und des Messverlaufs alle bekannten Effekte zu simulieren um das Messverfahren und die Konstruktion eines neuen Radiometers optimieren zu können.

Internationale Zusammenarbeit

Ende Juli 2004 endete das SCOPES (Scientific Collaboration between Eastern Europe and Switzerland) Projekt *Characteristics of Low Degree Solar Oscillations from Observations in Brightness and Velocity*. Die Projektdauer war drei Jahre und im Rahmen des SCOPES Projekts sind neun Publikationen und eine Dissertation entstanden. Die Zusammenarbeit mit dem Ulugh Beg Astronomischen Institut in Taschkent, Usbekistan war sehr erfreulich und hatte dem PMOD/WRC Doktoranden Richard Wachter wertvolle wissenschaftliche und persönliche Kontakte ermöglicht.

Für das INTAS (International Association for the promotion of co-operation with scientists from the New Independent States of the former Soviet Union) Projekt begann im Mai 2004 das dritte und letzte Jahr. Die beteiligten Wissenschaftler trafen sich im Sommer 2004 in St. Petersburg um den erreichten Stand zu diskutieren und die Ziele für das letzte Jahr festzulegen.

Infrastruktur

Mit zunehmend effizienterem Zugriff auf Publikationen über das Internet verliert die eigene Bibliothek im Haus an Bedeutung. Da der Arbeitsplatz für die drei Laboranten unbefriedigend gelöst war, haben wir uns entschlossen den grossen Bibliotheksraum aufzugeben, die Bücher in einem kleineren Nebenzimmer unterzubringen und die Zeitschriften auf dem Dachboden in Archivschränken aufzubewahren. Der Seminarraum im Erdgeschoss wurde in die ehemalige Bibliothek im zweiten Stock verlegt, was ermöglichte, dass im ehemaligen Seminarraum ein Labor mit vier grosszügigen Arbeitsplätzen eingerichtet werden konnte. Wie in früheren Jahren wurden die nötigen Umbauten vom Bundesamt für Bauten und Logistik bezahlt.

Lehrverpflichtungen

In den Wintersemestern 2003/2004 und 2004/2005 hielt W. Schmutz gemeinsam mit PD Dr. H. M. Schmid die Vorlesung „Astronomie“ an der ETH Zürich. R. Philipona las in den Wintersemestern 2003/2004 und 2004/2005 an der ETH Zürich die Vorlesung „Strahlungsmessung in der Klimaforschung“.

Personelles

Seit September 2004 wird die Administration an 1½ Wochentagen mit Frau Angela Knupfer verstärkt, was eine schon lange benötigte Entlastung des Sekretariats ermöglicht. Ebenfalls seit Anfang September unterstützt uns Dr. Wolfgang Finsterle – ehemaliger PMOD/WRC-Doktorand – bei der Einführung des Qualitätssystems nach der internationalen Norm ISO/IEC 17025. Ende Mai hat der Physiklaborant Ursin Solèr das PMOD/WRC verlassen und er wurde ab Oktober durch den Laboranten Daniel Bühlmann ersetzt. Im März schloss der ETH Diplomand Christian Ruckstuhl sein Studium ab und hat ab Mitte Jahr am PMOD/WRC mit seiner Doktorarbeit begonnen. Letztes Jahr haben zwei Doktoranden ihre Doktorprüfung erfolgreich bestanden. Dr. Bruno Dürr arbeitet nun bei der MeteoSchweiz in Zürich und Dr. Richard Wachter hat eine Forschungsstelle in Stanford angenommen. Dafür ist als neuer Doktorand Uwe Schilfkowitz im Februar 2004 zu uns gestossen. Im März 2004 konnten wir das 40-jährige Dienstjubiläum von Jules Wyss feiern der seit dem 1.3.1964 am PMOD/WRC arbeitet. Wir gratulieren Jules zu diesem aussergewöhnlichen Jubiläum und danken ihm herzlich für seinen Einsatz und seine Treue zum Observatorium.

Sponsoren

Aus einer neuen Schenkung von Herrn Daniel Karbacher aus Küsnacht (ZH) konnte für den neuen Seminarraum ein Bild der in Davos wohnhaften

Künstlerin Ruth Senn angekauft werden. Frau Senn ist eine Vertreterin der konstruktiven Kunstrichtung.

Der Förderverein hat dem PMOD/WRC die zweite von vier Tranchen für die Finanzierung des im Jahr 2003 angeschafften Canon CLC 1180 Druckers und Kopierers überwiesen.

Dank

Am 1. Dezember 2004 ist der Ausschuss der Stiftung SFI und der Vorstand des Fördervereins zurückgetreten. Ich danke diesen beiden Gremien für die gute Zusammenarbeit während der fünfeinhalb Jahre meiner Zeit als Direktor und für ihre Beiträge zum Erfolg und öffentlichen Anerkennung des PMOD/WRC. Dem neuem Ausschuss danke ich für die schnelle und kompetente Übernahme der Geschäfte. Der Aufsichtskommission gebührt Dank für ihren Einsatz zugunsten der PMOD/WRC Projekte und der Pflege des guten Rufes des Observatoriums.

Die zuständigen Vertreter von Bund, Kanton Graubünden und Landschaft Davos haben ihre positive Einstellung zum Weltstrahlungszentrum bewiesen, indem sie die finanziellen Beiträge trotz fehlender Vereinbarung bezahlt haben.

Herr Daniel Karbacher verdient ein herzliches Dankeschön für seine erneute Unterstützung die es ermöglichte, eine nicht dringend benötigte Investition zu tätigen, die aber einen wichtigen Beitrag zum Wohlbefinden am Observatorium leistet.

Die grösste Anerkennung und mein besonderer Dank gehört den Mitarbeitern, die im Interesse des Observatoriums handeln und sich unaufgefordert bei Bedarf speziell einsetzen.

Davos, im März 2005 Werner Schmutz, Professor Dr. sc. nat.

Annual Report 2004

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Introduction

Werner Schmutz

We have recently introduced a quality control system, in accordance with the norm ISO/ICE 17025, for the maintenance of the World Standard Group of absolute radiometers defining the World Radiometric Reference and for the calibration of pyrheliometers and pyranometers that are based on this conventional primary reference. Although this may sound rather unremarkable, it nevertheless represented a significant step toward preserving the long term existence of the WRC at the PMOD. Prior to this action, the operational service of the WRC was officially recognized only by the World Meteorological Organization but not by the meteorological institutes. Although the PMOD/WRC had been added to the list of meteorological institutes that had signed the Mutual Recognition Agreement of calibration and measuring capabilities, official recognition required an approved operational quality system to be in place. In February 2005, the PMOD/WRC made a presentation describing its quality control system to the quality forum of the European meteorological institutes and I am pleased to say that the plan was approved, although full acceptance is conditional on a year-long operational trial of the system. This is currently under way.

I am happy to report that legal issues related to the support of the World Radiation Center (PMOD/WRC) by the Kanton Graubünden were resolved by the end of 2004, and that a new contract for financing the WRC until 2007 was signed by the four financial partners (the federal government of Switzerland, the Kanton Graubünden, the Landschaft Davos, and the foundation SFI) at the beginning of this year. It should be noted that the monetary contributions from each of the partners have been increased in order to fund the operation of the Infrared Radiometer Calibration Center.

Sometimes, as the saying goes, good things come to those who wait. As a consequence of the restart of development work on the French space mission PICARD, the manufacturing of the PREMOS filter radiometer, which represents PMOD/WRC's original contribution to the project, has resumed. Furthermore, the reevaluation of the project by the French has led to request for the construction of an additional absolute radiometer to be built by PMOD/WRC. Thus, the delay in PICARD has resulted in quite a boon for PMOD/WRC. The expanded suite of Swiss instruments is now called PREMOS2. The PICARD mission is now expected to be launched sometime in 2008. Hence, after many years of effort, continuation of the measurements of the total solar irradiance has been secured beyond 2008, past the lifetimes of the currently operational VIRGO experiment on the SOHO satellite and the future SOVIM experiment on the International Space Station.

We at PMOD/WRC have been investigating the influence of the variable solar irradiance on the terrestrial atmosphere as part of an ETH-Poly-project in collaboration with several institutes of the ETH in Zürich. The first phase of this multi-year project was completed at the end of 2004 and the various results will be presented in four PhD dissertations and several publications. The main result of the project is the demonstration that there is a non-linear amplification of the variable solar irradiance that influences the global climate. The next phase of the project will be concerned with modeling the Little Ice Age in the 17th century as a consequence of reduced solar activity. Unfortunately, the rules for ETH Poly-projects have changed and now require the principal institute to be based at the ETH. Therefore, it is now no longer possible for PMOD/WRC to continue to lead this project. Prof. Thomas Peter of the Institute for Atmospheric and Climate Science is now the principal investigator and he has submitted a proposal for the second phase together with the institute for astronomy, EAWAG, and the PMOD/WRC.

Operational Services

Statistics of Calibrations

PMOD/WRC

During 60 clear-sky days PMOD/WRC calibrated 6 absolute radiometers, 6 pyrheliometers and 38 pyranometers. These 50 instruments belong to 15 different institutions and companies. For these calibrations, the Sun was used as the source and the World Standard Group, realizing the World Radiometric Reference, was used as a reference.

As Infrared Radiometer Calibration Center the PMOD/WRC also calibrated 19 Eppley PIR and 5 Kipp & Zonen CG4 pyrgeometers for 10 different organizations. Each instrument was calibrated first against a regulated black-body radiation source and then against a reference group of infrared radiometer instruments. The latter procedure was carried out on the roof of the observatory building.

In addition, 7 UV-PFR instruments were calibrated in the laboratory. Three Precision Filter Radiometers (PFR) from the GAW network were recalibrated in sunlight by comparison to two PMOD/WRC standard PFRs, which were also calibrated in the laboratory with the trap detector. One special version of a PFR was spectrally characterized in the laboratory for a customer.

The total number of calibrations was larger than in the past years, yielding a welcome addition to the income of the PMOD/WRC.

Introduction of a Quality Management System for Calibrations of Pyrhelio- and Pyranometer

Wolfgang Finsterle and Isabelle Rüedi

There is a demand in the meteorological community for metrologically recognized irradiance measurements which are traceable to SI units. The World Standard Group (WSG) of pyrheliometers at PMOD/WRC is a primary standard that has been introduced by WMO for the use in meteorological irradiance measurements and up to now, there is no official recognition of the WSG in the metrological SI system. In order for the WSG to become a recognized primary standard within the SI the PMOD/WRC had to introduce a Quality System (QS) according to the international standard ISO/IEC 17025, covering the WSG and all calibrations of pyrhelio- and pyranometers at PMOD/WRC. A quality policy statement had to be formulated together with a comprehensive set of documentation of all relevant infrastructure and procedures. This was a major effort and it took more than a year of work. Finally, the QS was first implemented in December 2004. By conducting Internal Audits and Management Reviews PMOD/WRC will now have to demonstrate the pertinence of its QS mechanisms in everyday life during at least one year before it can be accepted by the EUROMET QS-Forum. A first presentation of the PMOD/WRC QS was given on February 14, 2005 at the EUROMET QS-Forum 12 in Bucharest (Romania). The presentation was well received and final implementation announced for 2006.

Infrared Radiometer Calibration Center

Rolf Philipona

The infrared radiometer calibration center is now officially approved and has taken up its full services and operation. The radiometric reference for longwave radiation measurements is based on the PMOD/WRC Absolute Sky-scanning Radiometer (ASR). The ASR is used on a regular basis to recalibrate the World Pyrgeometer Standard Group (WPSG), which consists of two Eppley PIR pyrgeometers and two Kipp & Zonen CG4 pyrgeometers. The four pyrgeometers of the WPSG are in continuous operation on the roof platform of PMOD since fall 2003.

Network pyrgeometers, which are going to be used in field measurements, or pyrgeometers which will be used as reference instruments in Regional Pyrgeometer Standard Groups (RPSG), are precalibrated in the PMOD/WRC blackbody calibration apparatus in the laboratory. The final calibration is made on the roof platform of the observatory, where pyrgeometers are field compared to the WPSG. A first group of four pyrgeometers, which will serve as RPSG of the Deutscher Wetterdienst at the Observatory of Lindenberg was blackbody calibrated and compared to the WPSG on the roof platform during six month.

WORCC and GAW-PFR Network

Christoph Wehrli

Eight international and one Swiss PFR stations were operational in 2004 and have delivered data to WORCC for evaluation. The PFR at Ny-Ålesund was recalibrated in Davos during the arctic night and has resumed measurements at Spitzbergen again in April. The PFR at Bratt’s Lake was taken to Mauna Loa by MSC in March for recalibration, causing a data gap of 11 weeks. The calibration coefficients have changed by less than 1% per year since initial deployment, confirming again the good stability of PFR instruments. The instrument at Hohenpeissenberg was exchanged with a newly calibrated instrument and returned to WORCC. Its recalibration at Davos has confirmed the semiannual statistical calibrations used at Hohenpeissenberg and their small drift rates very well. An informal comparison with the Japanese AOD network, co-located at Ryori, has shown agreement within GAW specifications at 2 wavelengths and a slightly larger difference in the UV channel.

The measurements from all 9 PFR stations were evaluated and, after extensive quality control and assurance, submitted to the World Data Center for Aerosols (WDCA) as hourly mean values of aerosol optical depth up to 2003.

A WMO workshop on "A global surface network for long-term observations of column aerosol optical properties" was hosted by WORCC in March 2004 at Davos. Thirty experts presented the results of their observation programs, modeling efforts and integrated applications. Strategic as well as technical aspects of a tighter collaboration between various networks were discussed in two working groups. Proceedings will be published as a GAW series report by WMO.

In a review by the SAG/Aerosol on behalf of MCH, the initial goals of WORCC were acknowledged as completely reached and their implementation considered as a major, cost-effective contribution towards a global AOD network. The SAG/Aerosol strongly recommended a transition of the PFR network from its trial phase into a fully operational mode, which will be the apex of the measurement traceability pyramid in a global AOD network.

The training course on "Aerosol Optical Depth: theory, measurements and evaluation techniques" was given again for the 12 participants of the 8th GAWTEC course at Schneefernerhaus. Selected topics of the WORCC and PFR network were presented as invited talks at 3 WMO related workshops.

The ASRB Network

Rolf Philipona, Bruno Dürr, and Christian Ruckstuhl

The Alpine Surface Radiation Budget (ASRB) network consists of 10 stations. Eight stations started measurements in 1995 and a first analysis was made with these stations over the time period 1995 to 2002. During this time period a strong temperature and absolute humidity increase at the stations is observed in conjunction with a strong increase in longwave radiation, while the shortwave radiation rather decreased.

Six ASRB stations are collocated with automatic stations ANETZ of MeteoSwiss (Locarno-Monti, Payerne, Davos, Cimetta, Weissfluhjoch and Jungfraujoch). From these stations temperature, humidity and shortwave radiation records are available since 1980. A second analysis therefore allowed investigating temperature and humidity, as well as solar global radiation trends from 1980 to 2003, and the total radiation budget was investigated with ASRB measurements from 1995 to 2003. This second investigation confirmed that solar radiation is rather decreasing and that the temperature increases due to increasing longwave radiation (see also "Greenhouse forcing outweighs decreasing solar radiation driving rapid temperature rise over land" in this annual report).

At three ASRB stations (Locarno-Monti, Payerne, Davos) the Automatic Partial Cloud Amount Detection Algorithm (APCADA) is in operation. Temperature, humidity and longwave downward radiation, which are continuously measured allow to monitor the cloud amount in real time at these stations (see http://www.pmodwrc.ch/apcada/).

Instrument Sales

PMOD/WRC

In 2004 we sold three computer controlled PMO6-cc radiometers and one new electronics unit for an older PMO6 radiometer. In the year 2004 we have only sold one filter radiometer. However, the effort to build another set of 10 PFR in 2004 was worthwhile as meanwhile orders for 8 units are being placed and an option for 4 more instruments has been announced.

We also sold nine heating and ventilation systems as an upgrade to commercial pyrgeometers to improve their performance.

With more than the double amount of the average of the past years, the financial contribution by instrument sales to the budget of the PMOD/WRC was a substantial supplement allowing extra investments.

Instrument Development

Future Space Experiment SOVIM

Claus Fröhlich, Dany Pfiffner, Hansjörg Roth, Isabelle Rüedi, Werner Schmutz, Christoph Wehrli, and Jules Wyss

The launch of the Swiss-Belgian experiment SOVIM (Solar Variability Irradiance Monitor) is still scheduled for October 2006. The year 2004 was the period of experiment verification, testing and evaluation of science software. Dependent on the weather conditions, SOVIM was tested in the thermal vacuum chamber under space conditions performing thermal vacuum test and electrical calibrations. During excellent conditions outside, the instruments were calibrated with the Sun as radiation source and the World Standard Group as reference. A time intensive task was the characterization of the radiometers using daylight and a laser in the laboratory. In January of 2005 there was a calibration of the power scale of the absolute radiometers relative to a cryogenic radiometer at NPL London. The vibration test of SOVIM was performed in February 2005 at Contraves Zürich. Delivery is currently envisaged for April 2005.

Future Space Experiment PREMOS2

Werner Schmutz, Hansjörg Roth, Daniel Pfiffner, Isabelle Rüedi, Christoph Wehrli, and Jules Wyss

PREMOS on the French micro satellite PICARD is in collaboration with the French space agency (CNES) and the Centre National de la Recherche Scientifique, Service d`Aéronomie Paris (CNRS). The PICARD project was recovered from its “on hold” status end of 2004 and before this decision there was only little activities during 2004. We have adjusted the instrument planning to the changed interface requirements of the project. Several times we had to redesign the instrument box of PREMOS according to the new requirements and space restrictions on the spacecraft and to update documentations. With the reactivation of PICARD there was an offer of opportunity from CNRS to the PMOD/WRC to include PMO6 radiometers as a second type of absolute radiometers, in addition to the SOVAP experiment from IRMB Brussels. The PMOD/WRC was awarded the necessary funds from Swiss PRODEX and accepted to build the extended experiment, now called PREMOS2, comprising the former PREMOS, three four-channel filter radiometers, and new PREMOS-TSI, a pair of PMO6 absolute radiometers. Current planning shows delivery of PREMOS2 in the year 2007 and the launch of PICARD in 2008.

Future Space Experiment LYRA

Silvio Koller, Werner Schmutz, Daniel Pfiffner, Hansjörg Roth, Isabelle Rüedi, Christoph Wehrli, and Jules Wyss

LYRA (Lyman-Alpha Radiometer) is a solar UV filter-radiometer experiment to be flown on ESA's technology mission PROBA-2. The Engineering Model (EM) and most of the Flight Model (FM) parts of LYRA have been finished. Due to manufacturing problems of the newly developed diamond detectors and because of delays of the whole satellite program LYRA progressed somewhat slower than originally scheduled. By mid of the year 2004 the EM mechanics and EM electronics were finished and could be tested. In the second half of the year LYRA FM was designed and built. The cover mechanism design, one part of the PRODEX industry contract, was performed by Contraves Space, Zurich and the manufacturing and assembly was carried out at PMOD/WRC. The LYRA cover mechanism successfully passed vibration tests at Contraves.

Our Belgian project partners provide the diamond detectors and calibration LED's. The calibration plan of 2004 included several campaigns at PTB-Bessy, NIST, the manufacturers place IMO (Institute for Materials Research of Limburgs Universitair Centrum, Belgium) and the Centre Spatiale Liège (CSL).

LYRA has a total mass of 4.8kg and a nominal power consumption during orbit nighttime of 1.5 W and during orbit daytime of 2.7 W.

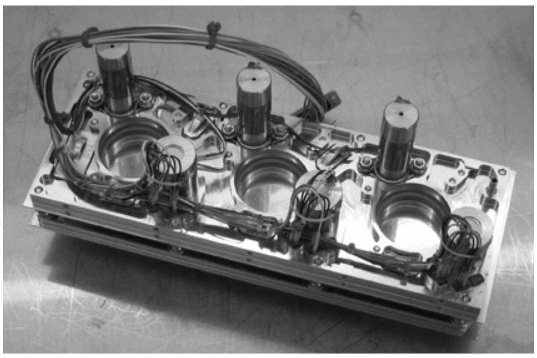

Figure 1. LYRA cover mechanism from back side.

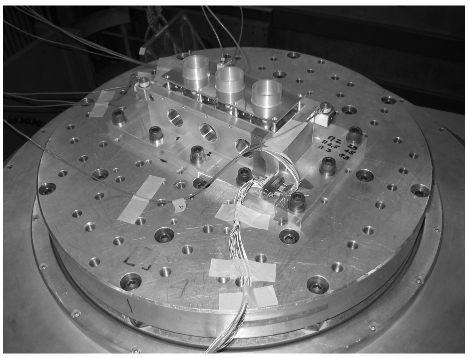

Figure 2. LYRA cover mechanism on shaker at Contraves.

The PRODEX grant for LYRA also included infrastructure for the PMOD/WRC. The new solder equipment for surface mounted devices was used for both, the EM and FM manufacturing. An ESA training of two engineers allows fulfilling of the ESA high-reliability soldering requirements.

The EGSE software (Electronic Ground Support Equipment) was development by BRUSAG as a PRODEX industry contract and was delivered in November 2004. The EGSE simulates the spacecraft interface and allows to test the LYRA EM and FM.

The ESA milestone meeting “Preliminary Design Review” was held in Belgium. Currently, the delivery for the LYRA FM is foreseen for the end of 2005. For PMOD it is planned that all environmental tests will take place in spring 2005.

TURAC – A new instrument package for radiation budget measurements and cloud detection

Christian Ruckstuhl, Marcel Spescha, and Rolf Philipona

Atmospheric radiation flux measurements and the resulting surface radiation budget are important quantities for greenhouse effect and climate change investigations. In order to decrease uncertainty on field radiation measurements, we developed an instrument, which measures downward and upward shortwave and longwave radiation with the same sensors. Two high quality instruments, a pyranometer for shortwave and a pyrgeometer for longwave measurements, are mounted on a pivotable senor head, which is rotated up and down in a ten-minute interval. To keep the instrument domes free from dew and ice and to minimize the pyranometer thermal offset, both sensors are ventilated with slightly heated air. Additionally, a ventilated temperature- and humidity sensor is integrated in the new instrument. The combination of measurements of radiation fluxes, temperature and humidity allows using the instrument for autonomous and automatic cloud amount detection. The name TURAC stands for Temperature, hUmidity, RAdiation and Clouds sensor. The TURAC sensor has been successfully tested under harsh alpine winter conditions as well as under moderate low land conditions.

Scientific Research Activities

ETH-Polyproject – Variability of the Sun and Global Climate

Overview

Eugene Rozanov, Tatiana Egorova, Margit Haberreiter, and Werner Schmutz in collaboration with IACETH and IfA-ETH

PMOD/WRC was leading the project “Variability of the Sun and Global Climate” supported by the Swiss Federal Institute of Technology and devoted to studies of the effects of the solar irradiance variability on the global chemistry and climate from the Earth's surface up to 80 km.

One aim of the project is to calculate the solar UV irradiance for times when no observations are available. In 2004, we continued the improvement of the code COSI (COde for Solar Irradiance). In particular, we carried out the updates of atomic continuum and line cross sections and the calculation of the spectral line blanketing within COSI has also been refined. We reconstructed the top of the atmosphere solar UV irradiance from 1974 to 2002 based on magnetograms of the solar disk and intensity spectra calculated with COSI. For times when observations are available, the reconstructed UV irradiance has been compared to them.

In 2004 we validated the sensitivity of our 3-D chemistry-climate model SOCOL (model tool for the evaluation of SOlar-Climate-Ozone Links) to the strength of the polar vortex against NMC observational data set. We have also compared the simulated response of the ozone and temperature to solar irradiance variability with available observational data. With our chemical-climate model SOCOL we have completed the first set of the transient simulations of the atmospheric state during 1975-2000 driven by the observed time evolution of different natural and anthropogenic forcings. We compared the solar signal extracted from the results of this run by using multiple-regression analysis with the results of the steady-state runs and observational data. We have further analyzed the response of the tropical ozone and temperature to the solar irradiance variability during 28-day solar rotation cycle on the basis of the 1-year long SOCOL ensemble run performed in 2003. These activities will contribute to the understanding of the global climate and chemistry as well as the Sun-Earth connection.

Variability of the solar UV irradiance

Margit Haberreiter, Werner Schmutz, and Eugene Rozanov

We present reconstructions of the solar UV irradiance based on the analysis of space-based and ground-based magnetograms of the solar disk going back to 1974. With COSI (COde for Solar Irradiance) we calculate solar intensity spectra for the quiet Sun and different active regions and combine them according to their fractional area on the solar disk, whereby their time-dependent contributions over the solar cycle lead to variability in radiation.

COSI calculates the continuum and line formation under conditions that are out of local thermodynamic equilibrium (non-LTE). The applied temperature and density structures include the chromosphere and transition region, which is particularly important for the UV. We reconstruct the spectral solar UV irradiance for the wavelength range from 1150 Å to 4000 Å on a daily basis. In Figure 3 on the left panel the reconstruction for Lyman α is compared with the composite compiled by Woods et al. (2000) and on the right panel it is compared with the SUSIM V21 data. Our reconstruction reproduces the SUSIM observation quite well, but underestimates the composite by Woods et al. (2000). The fact that COSI reproduces the SUSIM Data from 1994 to 2002 very well shows that the COSI reconstruction of the quiet Sun is within the uncertainty of the observations. However, the fact that we underestimate the maximum around 1992 for both data sets indicates that the temperature structures used here to represent the active regions need further improvements.

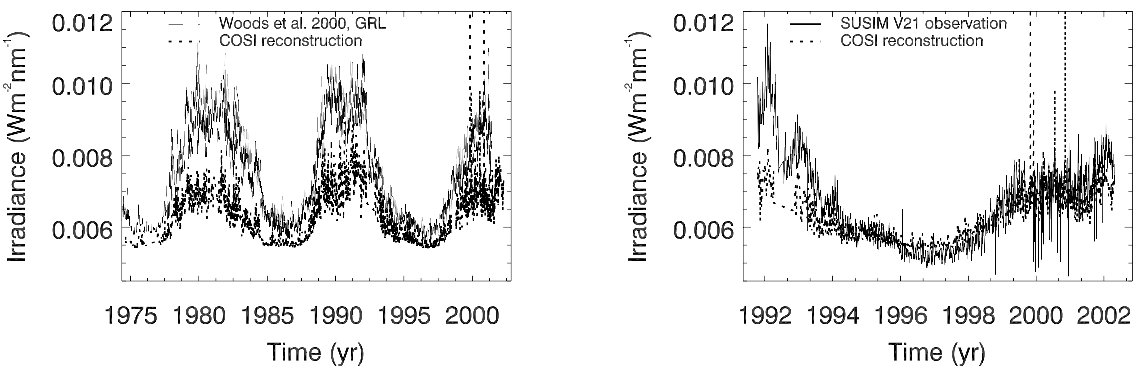

Figure 3. Comparison of our reconstruction of Lyman α (dotted line) with the composite by Woods et al. (2000) (dashed line, left panel) and its comparison with the SUSIM V21 observation (solid line, right panel).

Woods, T.N., et al., 2000, Improved solar Lyman α irradiance modeling from 1947 through 1999 based on UARS observations, Journ. Geophys. Res., 105, pp. 27195-27216.

Sensitivity of the atmosphere to the Arctic polar vortex strength

Eugene Rozanov, Tatiana Egorova, and Werner Schmutz

It is well known that the positive phase of the Atlantic oscillation is characterized by a deeper vortex and a more intensive Polar Night Jet (PNJ), which consequently leads to warmer temperatures and elevated ozone in the tropical lower stratosphere. To further validate our chemistry-climate model SOCOL we divided 25 years of simulations into two groups according to the polar vortex strength and compared the difference between these two groups against observational data processed in an identical way. The observations we used are NMC data for 1978-1998. The zonal wind difference in the composite consists of an acceleration of the PNJ by 10-15 ms^{-1} in the simulated and observed data (not shown). The simulated and observed temperature responses (Figure 4) over the northern hemisphere are similar and consist of a pronounced dipole-like structure with cooling in the middle-lower stratosphere and warming in the middle-upper stratosphere. In the tropics, the model matches the warming in the lower stratosphere. During the boreal winter the signature of a strong northern polar vortex is clearly visible in the observed and simulated data, which confirms the reliability of the model.

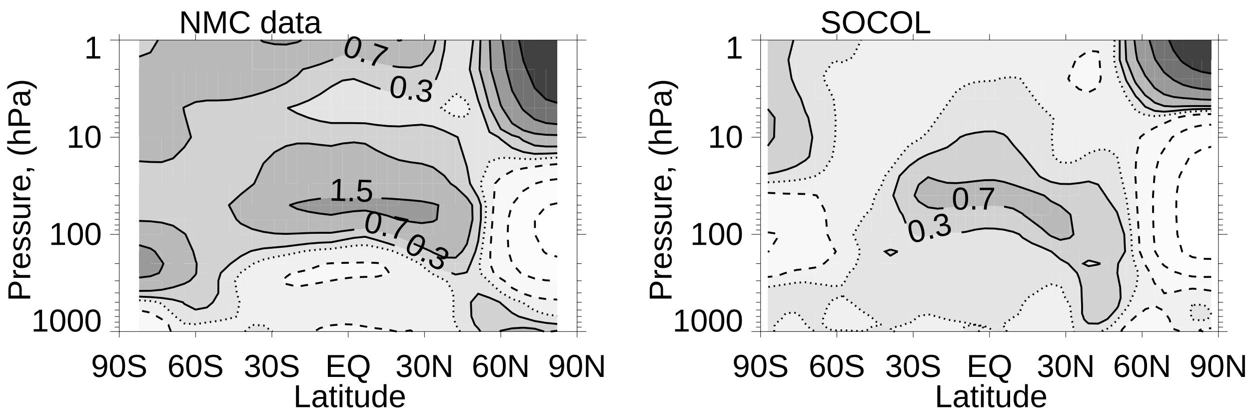

Figure 4. Pressure-latitude cross-sections of the observed (left) and simulated (right) differences between positive and negative AO phase in the temperature (isolines at -5, -2, 0.5, 0, 0.3, 0.7, 1.5, 3,5, 10 K).

Response of the atmosphere to 11-year solar variability: Simulation and observations

Tatiana Egorova, Eugene Rozanov, Margit Haberreiter, and Werner Schmutz

The response of the stratosphere to the solar irradiance variability during 11-year solar cycle, simulated with CCM SOCOL, still disagrees with the ozone response obtained from the analysis of satellite data [WMO Rep. 43, pp. 210-213, 1998]. Figure 5 illustrates substantial disagreement in the tropical middle and mid-latitude upper stratosphere. It has been argued by *Lee and Smith* [2003, *J. Geoph. Res.*, 108, 4049] that the former is the result of problems with the extraction of the solar signal from the short observational records and the problem would disappear if the quasi biannual oscillation (QBO) and volcanic effects are taken into account, therefore we conclude that our results agree reasonably well with the observations below 38 km. Figure 5 compares the SOCOL results with three observational data sets as well as with the results of *Tourpali et al.* [2003, *Geophys. Res. Lett. 30*(5), 1231]. Clearly there is a considerable scatter in the data. Notwithstanding the data scatter, SOCOL gives a reasonable description of the stratospheric and mesospheric temperature response.

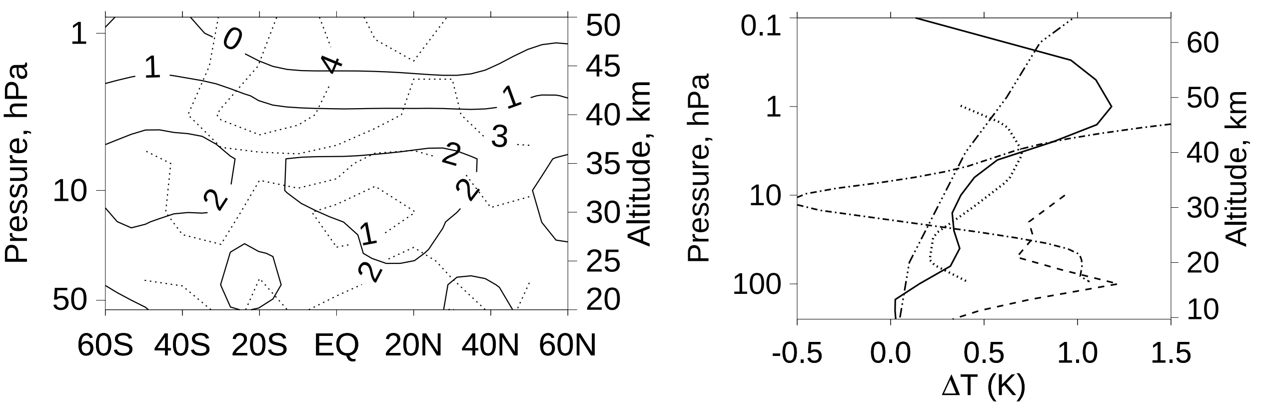

Figure 5. Annual mean zonal mean solar signal in the ozone mixing ratio (left, isolines in %) simulated (solid lines) and observed (dotted lines) and tropical temperature change in K (right): the result from SOCOL (solid) in comparison with SSU/MSU (dotted) and CPC reanalysis (dash-doted) from *Hood* [2004, Geophys. Monogr. Ser., 141, 2004], NCEP reanalysis (dashed) from *Labitzke* [2002, J. Atm. Sol. Terr. Phys. 64, 203-210], and simulations (dash-dot-dot) by *Tourpali et al.* [2003, *Geophys. Res. Lett. 30*(5), 1231].

Solar signal extracted from the transient simulation of the atmospheric state evolution during 1975-2000

Eugene Rozanov, Tatiana Egorova, Margit Haberreiter, and Werner Schmutz in collaboration with IAC ETH

We completed the transient run of our CCM SOCOL for 1975-2000 driven by the time evolving SST/SI, GHG, ODS, sulfate aerosol and solar irradiance. The results allow us to estimate the model sensitivity to the solar irradiance variability during the 11-year solar activity cycle. To extract the solar signal we applied a multiple-regression analysis. Figure 6 represents the solar signal in the zonal and annual mean ozone and temperature. The solar signal extracted from the transient simulation substantially deviates from the steady-state results (Egorova et al., 2004, Geoph. Res. Lett., 31, L06119, 2004). In the upper atmosphere the ozone response is mostly positive (~1-2%) and the negative response in the upper mesosphere is reduced. Above 30 km the maximum ozone response is more pronounced (up to 5%), occurs at higher altitudes (~40 km) and shifted toward the poles. Overall, the response obtained from the transient simulation is close to the observation data analysis. For the temperature the simulated solar signal is much closer to the results of the steady-state run by the position and magnitude of the warming spots.

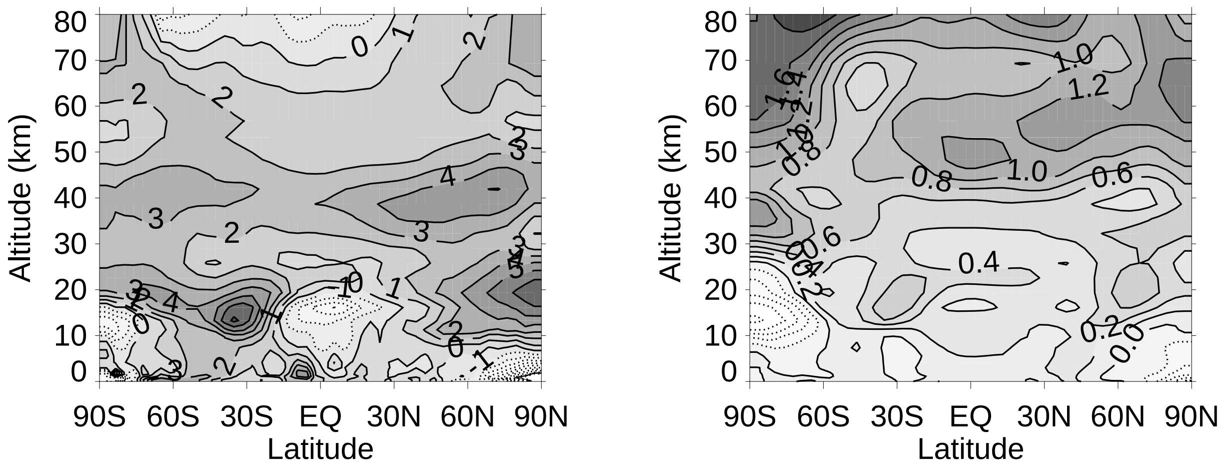

Figure 6. The changes of the zonal and annual mean ozone (left panel, isolines in percent) and temperature (right panel, isolines in K) from the solar maximum to solar minimum extracted from the transient run results using multiple-regression analysis.

Strength of the correlation between atmospheric quantities and short-term solar irradiance variability

Eugene Rozanov, Tatiana Egorova, Margit Haberreiter, and Werner Schmutz

To study the robustness of the correlation between different atmospheric quantities and short-time solar irradiance variability we have carried out nine 1-year long runs of our CCM SOCOL driven by the observed daily solar irradiance for 1992. Figure 7 illustrates the maximum correlation between hydroxyl, ozone and temperature and solar irradiance for each year of the run. The hydroxyl has robust correlations with solar irradiance in the upper stratosphere and mesosphere, because the hydroxyl concentration is defined mostly by the photolysis. The ozone and temperature correlations are more complicated because their behavior depends on non-linear dynamics and transport in the atmosphere. In the mesosphere, where the ozone life-time is short and dynamics is less important, the correlation between ozone and solar irradiance exceeds 0.5 and does not substantially change from year to year. In the upper stratosphere the correlation is still reasonable, but the dependence on the dynamical state of the atmosphere becomes noticeable. The correlation between temperature and solar irradiance is found to be significant only during some particular years. For example, during years 5 and 8 the temperature variability correlates with the solar irradiance rather well (0.4-0.5), while during the other years the typical correlation is only about 0.2.

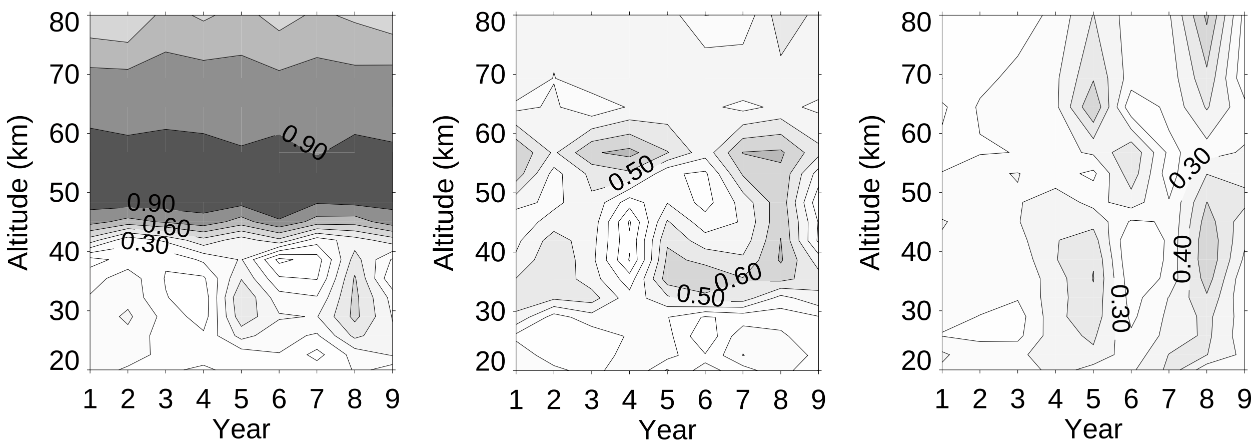

Figure 7. Maximum of the cross-correlation function between the hydroxyl (left panel), ozone (central panel), temperature (right panel) and the solar irradiance at 205 nm.

ETH-TH-Project – Modeling of ozone related atmospheric chemistry and transport processes

Christopher Hoyle, Eugene Rozanov, and Tatiana Egorova in collaboration with IACETH

During the last year, several changes have been made to MEZON, the model used in this project. The model now functions well with the ERA-40 circulation data. In preparation for the final 40 year model runs, input files have been created, containing information such as volcanic aerosol amounts in the stratosphere, or variation of photolysis rates due to the 11 year cycle in solar irradiance, for the period 1960-2000. The microphysical subroutine for the calculation of formation and growth of polar stratospheric cloud particles has been extensively reviewed, and updated. The calculation of the sedimentation of cloud particles has also been improved.

The first two model runs have recently been completed, and the analysis of the results is currently being carried out. The first of these model runs should simulate the actual evolution of the ozone layer, as it was observed. The second run is made with CFC emissions frozen at 1960's values. This should help us see exactly how much CFCs contributed to ozone loss over the last 40 years.

Figure 8 compares modeled total ozone with data from the NIWA ozone measurement data set over the time period 1965 -2000.

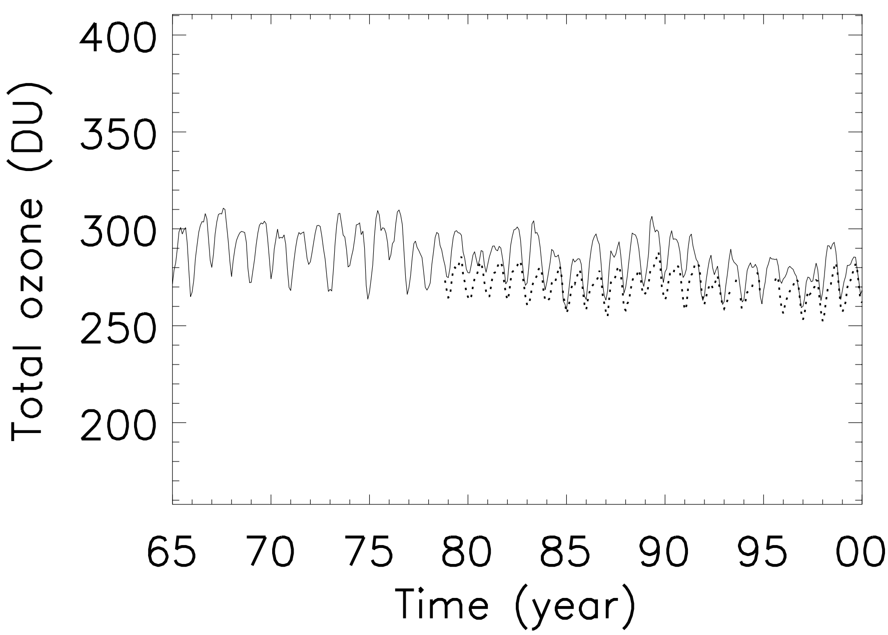

Figure 8. The variation of total ozone with time. The solid line shows modeled averaged total ozone between 34 degrees south and 34 degrees north, the dotted line shows the same, for measurements of total ozone from the NIWA ozone data set. Changes in total ozone are reproduced well by the model. Gaps in the dotted line are where measurements are either not available, or incomplete, in the NIWA data set.

COST 724 Space Weather – Nowcast and short-term forecast in the middle atmosphere based on the observed UV irradiance

Eugene Rozanov, Tatiana Egorova, Margit Haberreiter, and Werner Schmutz

We applied the chemistry-climate model SOCOL to simulate the distribution of the temperature and gas species in the upper stratosphere and mesosphere. As an input for the simulation we exploit daily spectral solar irradiance measured by SUSIM instrument onboard UARS satellite in January 1992. We have carried out an ensemble of nine 1-month long simulations using slightly different initial states of the atmosphere. We have compared the obtained time evolution of the simulated species and temperature with available satellite measurements. The obtained results allowed us to define the areas where the nowcast and short-term forecast of the atmospheric species with CCM SOCOL could be successful. The zonal mean and daily mean simulated ozone mixing ratio is presented in Figure 9 together with smoothed HALOE data. Despite of some differences all ensemble members reveal an increase of ozone mixing ratio from January 2 to January 7 and a subsequent decrease, which correlate reasonably well with the time evolution of the solar irradiance. A similar feature is also visible in HALOE data, which confirms that successful nowcast and short-term forecast of the ozone in this area is possible.

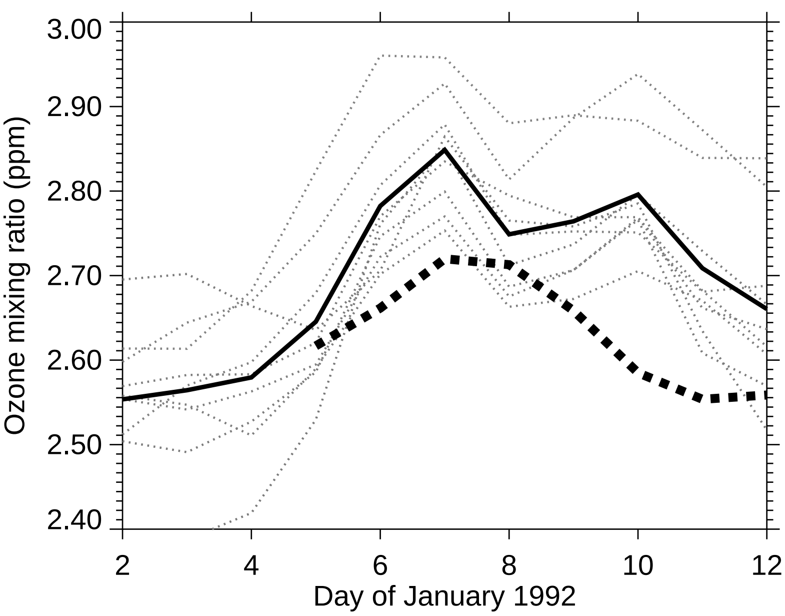

Figure 9. Zonal mean ozone volume mixing ratio (ppm) at 48 km averaged over 40°N-50°N from HALOE data (dotted thick line) and from the model results. The ensemble mean is shown by solid line, gray dotted lines represent different ensemble members.

Reanalysis of the TSI composite 1978-2004

Claus Fröhlich

A detailed analysis of the VIRGO/SoHO radiometry allowed the development of a consistent model for the sensitivity changes of the PMO6 radiometers in space. Assuming this model applies to all "classical" radiometers in space, a re-analysis of the irradiance data from HF NIMBUS and ACRIM/SMM was needed. The revised PMOD composite is shown in Figure 10 (details on the homepage www.pmodwrc.ch → Projects → Solar irradiance). The long-term trend as difference between the two minima has changed from +0.021 to -0.008 Wm^{-2}. A detailed analysis of the uncertainties involved shows, however, that even the larger trend is not significantly different from zero at the 3-σ level. The peak-to-peak amplitudes of the solar cycles 21, 22 and 23 are now 0.92 (1.01), 0.85 (0.80) and 0.86 (0.83) with the former values in brackets.

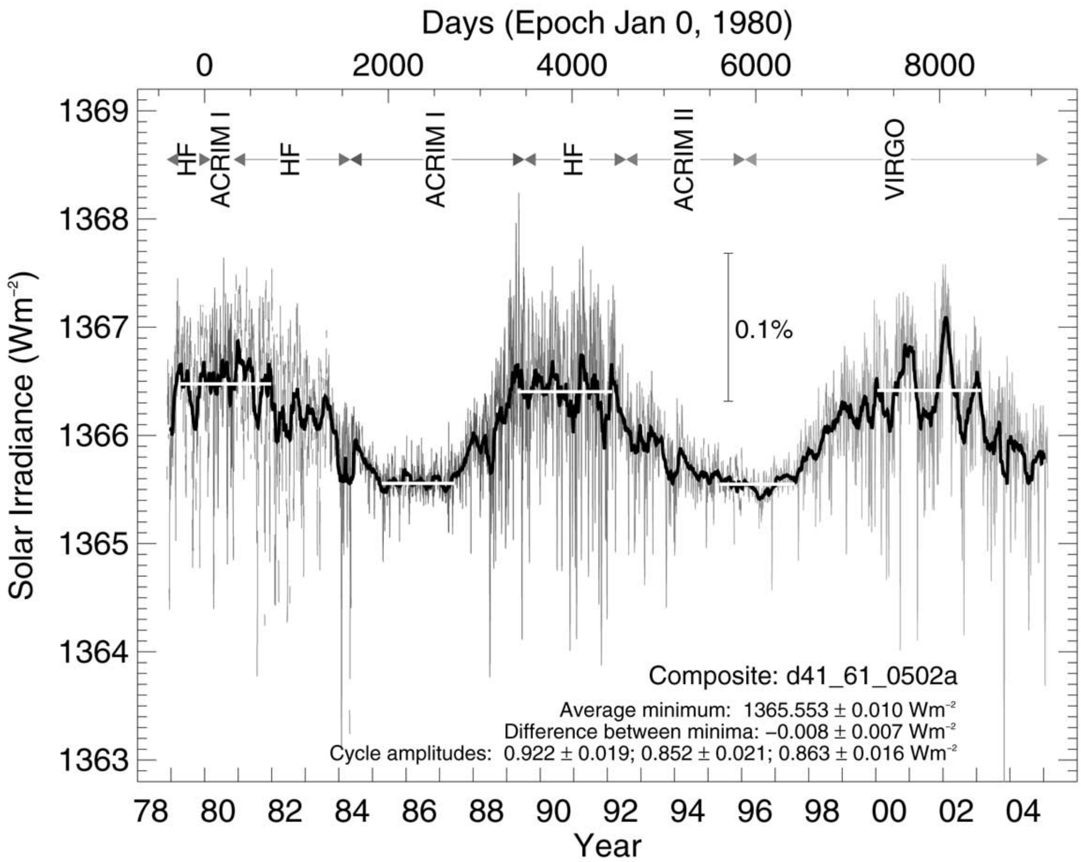

Figure 10. PMOD composite of total solar irradiance 1978-2005. The indicated uncertainties are formal statistical errors.

Quality control: Atmospheric pressure, Rayleigh scattering and the Ångström exponent of AOD

Christoph Wehrli

The α-exponent in Ångström's empirical law $\delta(\lambda) = \beta\lambda^{-\alpha}$ gives a simple estimate of the size distribution for a measured AOD spectrum $\delta(\lambda)$, allowing for a simple discrimination of dominant aerosol types. Aerosols from biomass burning or fossil fuel combustion show α greater than 2, while mineral dust or sea salt aerosols have α smaller than 1. Ångström has found a typical value for average aerosols α of 1.3±0.5.

AOD is derived as the difference of total optical depth minus Rayleigh scattering and gaseous absorption, the former being proportional to the atmospheric pressure. Pressure screening for AOD measurements leads to a selection bias of $\Delta p \approx 4\pm6$ hPa at Davos. A pressure error of 10 hPa results in a small AOD error of $\Delta\delta$ smaller than 0.005 at 368 nm and above, but will introduce a much larger error ($\Delta\alpha \approx 0.25$) in the Ångström exponent under low AOD conditions. Mean bias differences of this magnitude were indeed observed during a field comparison of AOD networks.

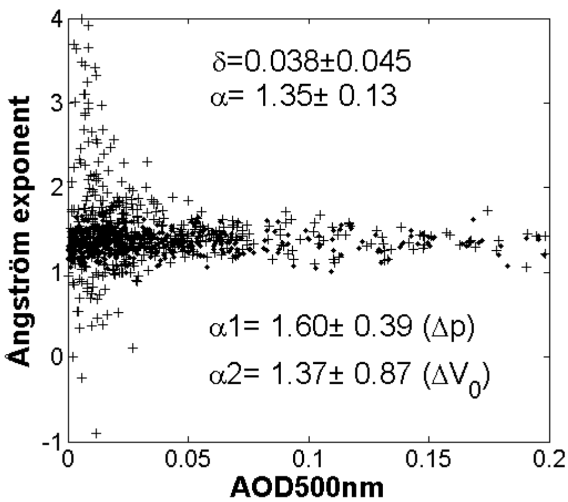

Figure 11. Simulated aerosol characteristics with pressure offset of 10 hPa result in an increased α1, while a calibration error of smaller than 1 % increases just the scatter of α2. Dots are representing idealized conditions; plus signs show random combination of pressure and calibration errors.

The PFR system uses instantaneous pressure values from an internal solid-state sensor to calculate Rayleigh scattering. A comparison of this sensor with barometric measurements obtained from the national weather services at Jungfraujoch, Bratt's Lake and Alice Springs has shown good agreement within smaller than 3 hPa. A larger offset at Mauna Loa, introduced by a previous calibration to barometric height, was readily corrected by reprocessing.

Accurate pressure values are essential for correct interpretation of AOD results from background conditions or during instrument comparisons.

Quality control: Pointing accuracy in AOD measurements.

Christoph Wehrli

The WMO specification of a slope angle smaller than 1° for Sunphotometer measurements and the solar angular diameter of approximately 0.5° lead to a requirement on the pointing accuracy for solar trackers of less than ±0.75°, a significant error of 0.02 AOD will occur if this limit is exceeded by just 0.02°. The PFR has a slope angle of 0.72° and needs to be pointed within ±0.45°.

An optical sensor in the PFR monitors its proper alignment within less than ±0.75° and QC software flags measurements where the pointing is off the solar disk. Experience with different active trackers used at GAW stations has shown (Figure 12) that these systems not always perform well. Mechanical alignment, slack or electronic hysteresis may readily let the instrument point off the Sun if the trackers are not properly maintained.

Even automatic, active Sun tracking systems may introduce errors in radiation measurements that are difficult to detect and screen in data sets; a pointing sensor in PFR permits objective quality control of trackers.

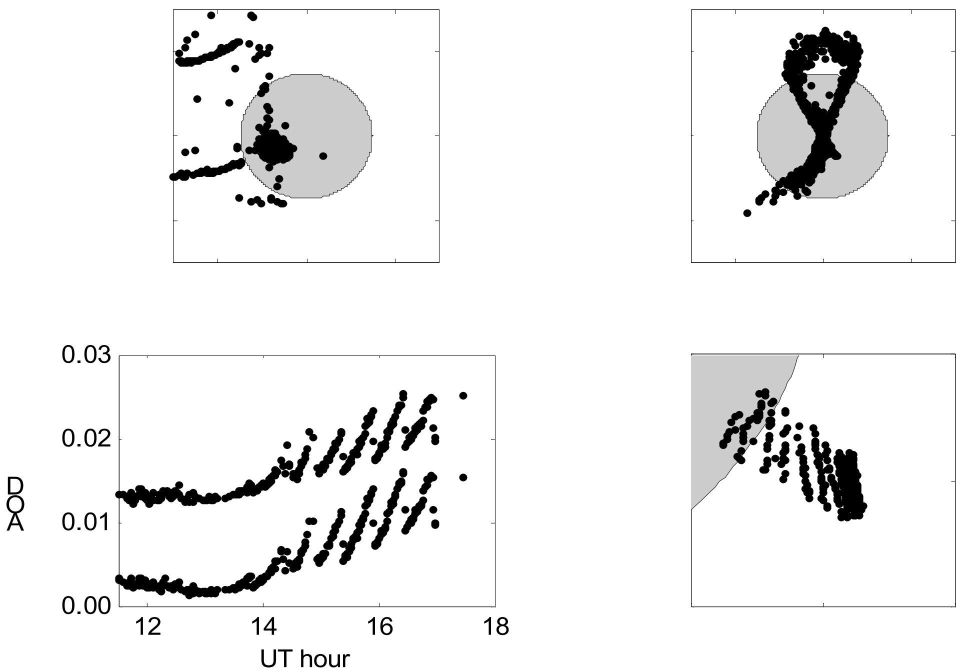

Figure 12. Top row: monthly pointing performance of two different trackers with mechanical and alignment problems. Bottom left: AOD artifacts induced by an active tracker with hysteresis problems and pointing errors as shown in the right panel.

Surface radiation budget shows rising greenhouse effect to increase temperature in Europe

Rolf Philipona and Bruno Dürr

Radiative parameters measured in central Europe over different time periods are used to pinpoint the role of individual radiative forcings in temperature increases. Interestingly, surface solar radiation (*SDR*) rather decreases. Also, on an annual basis no net radiative cooling or warming is observed under changing cloud amounts (*LCE*). However, high correlation (r_T = 0.86) to increasing temperature (*LUR*) is found with total heating radiation (*THR*) at the surface, and very high correlation (r_T = 0.98) with cloud-free longwave downward radiation (LDR_{cf}). Preponderance of longwave downward radiative forcing suggests rapidly increasing greenhouse warming, which outweighs the decreasing solar radiation measured at the surface and drives rapid temperature increases over land (see also Philipona et al., *GRL*, 2004 and Philipona and Dürr, *GRL*, 2004).

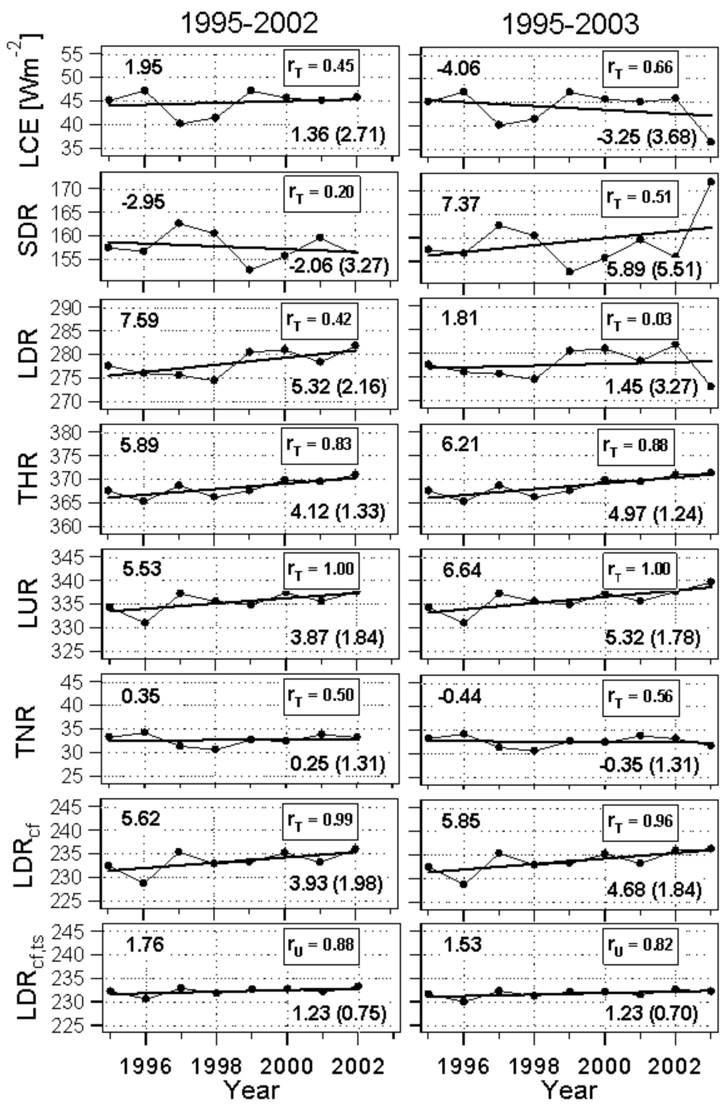

Figure 13. Annual means of individual radiative fluxes averaged over the six ASRB stations shown for the periods 1995-2002 (left) and 1995-2003 (right). Descending in the rows: longwave cloud effect (LCE), shortwave downward radiation (SDR), longwave downward radiation (LDR), total heating radiation (THR), longwave upward radiation (LUR) also corresponds to surface temperature, total net radiation (TNR), cloud-free longwave downward radiation (LDRcf), temperature subtracted cloud-free longwave downward radiation (LDRcf,ts).

Validation of Radiation Data from Arctic BSRN Stations

Marcel Sutter and Rolf Philipona

Baseline Surface Radiation Network (BSRN) is a project of the World Climate Research Program (WCRP), aimed at detecting important changes in the earth's radiation field which may cause climatic changes. Measurements started in 1992 and the network consists nowadays of about 35 stations in contrasting climatic zones all over the world. At every station, solar and atmospheric radiation (and standard meteorological parameters) are measured with instruments of the highest available accuracy and at very high frequency.

In the context of the project 'Greenhouse effect research in the Arctic', which aims at analyzing surface radiation measurements at Arctic BSRN stations and identifying possible changes in Greenhouse Effect, radiation data from 4 stations (Barrow and NyAlesund in the northern polar region, Neumayer and Southpole in the Antarctic) is analyzed. As the signal of a possible change in Greenhouse Effect is small, it is important, that the radiation data time series are free of inhomogeneities. With the help of different methods to identify cloud free and overcast situations, radiation measurements, mainly of longwave radiation, were validated and several inhomogeneities, caused by annual instrument changes, instrument modifications or presumably technical problems, were detected (see Figure 14 as an example). The longwave radiation time series were homogenized (e.g. by comparing them with MODTRAN radiation transfer model values) and are now a main part of further investigations to build a radiation climatology and to detect possible trends in longwave radiation, sky cover and Greenhouse Effect.

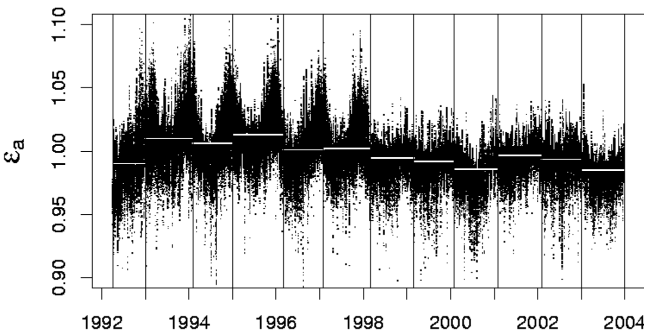

Figure 14. Apparent ground emittance under an overcast sky with times of instrument changes (vertical lines) and mean values for these periods (horizontal lines) at Neumayer. Emittance is supposed to be constant over time, but by replacing the instrument every year, artificial trends are created.

Internship – Understanding and researching radiometric absolute characterization

Sandra Moebus, Isabelle Rüedi, and Christoph Wehrli

Although the PMO6 radiometers have been absolutely characterized during their process of construction, effects were found to be important that were previously assumed to be negligible. When measuring radiation with a PMO6 radiometer, one has found out that the effect of the non-equivalence, which is the sum of the differences in radiation and air convection losses caused by non-identical heating conditions of the cavity in closed and open status, is not as stable as previously assumed. It was found that the value of the non-equivalence is a function of the size of the incident beam. During an internship, the task was to quantify the effect of the non-equivalence for several radiometers. We found that the non-equivalence as a function of the incident beam differs from instrument to instrument, thus has to be determined experimentally for each radiometer. When under-filling the precision aperture with the incident beam, the so called under-filled non-equivalence is 1 to 1.5 times higher than the non-equivalence with a normally illuminated precision aperture. A possible explanation for this effect is that the illuminated precision aperture is heated up and infrared radiation from the aperture reaches the radiometer cavity.

These measurements were made because they are important for tracing of the World Radiometric Reference (WRR) to SI units. In the end of 2004 we were preparing for the third comparison between the WRR, represented by the World Standard Group (WSG) maintained at PMOD/WRC in Davos, and the Système Internationale (SI), represented by cryogenic radiometers. The comparisons took place in January 2005 at metas (Metrologie und Akkreditierung Schweiz) in Bern and at NPL (National Physical Laboratory) in London. Two PMO6 radiometers (PMO6_09 and PMO6_11) were used as transfer instruments. To carry out the comparison, the PMO6 radiometers were used with an under-filled precision aperture as well as with an illuminated precision aperture. The gained knowledge about the behavior of the radiometer should lead to a more precise traceability of the WRR to SI units.

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

Uwe Schlifkowitz, Isabelle Rüedi, and Wolfgang Finsterle

The aim of this PhD Thesis is to develop an absolute radiometer with phase-sensitive signal detection. This technique uses frequency and phase filters to eliminate many perturbing effects, such as the so-called non-equivalence of radiative and electric heating. The main field of use is in future space experiments including observation of the sun from an out-of-ecliptic point of view. The feasibility for ground-based use of phase-sensitive radiometers is also under investigation.

We developed computer models to simulate the response of the radiometer to variable incoming radiation and to reproduce the input signal with phase-sensitive techniques. Based on these computer models the next steps will be to optimize the radiometric parameters for best performance with phase-sensitive signal detection, then building a prototype instrument, characterizing it in the laboratory, and performing tests with the sun as a source.

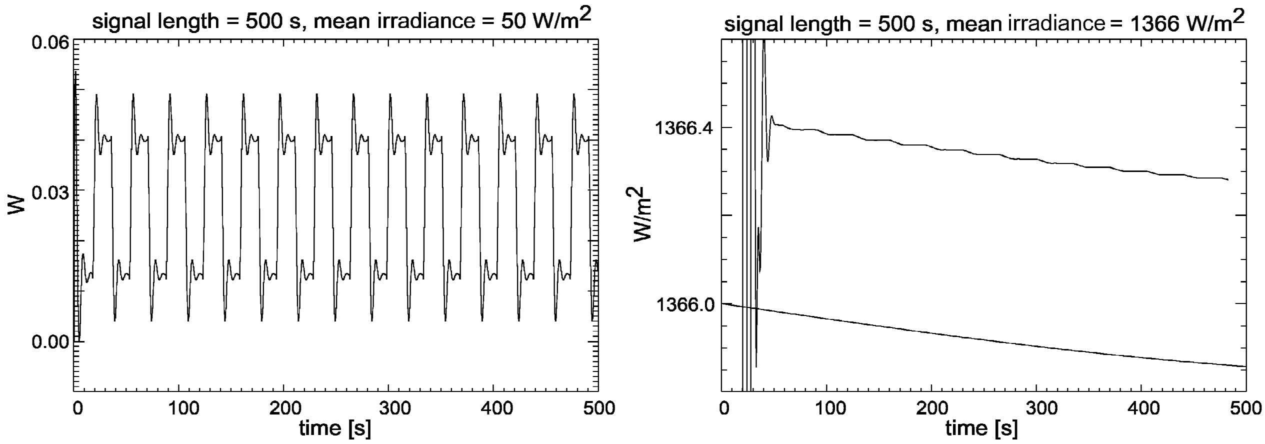

Figure 15. Results of the simulation and phase-sensitive signal detection. Left panel: Response of the electronic heating controller to a slowly decreasing input irradiance with the shutter cycle set to 36 seconds (18 s open and 18 s closed). Shown here is the electric heating power in the cavity. Right panel: Reproduced signal (upper curve) compared to input signal (lower line). The initial oscillations of the reproduced signal are an artifact caused by the phase-sensitive signal detection algorithm. Improvements to the signal detection software are currently in progress to remove the small offset of some 200 ppm between the reproduced and the input signals.

International Collaborations

INTAS

Eugene Rozanov and Werner Schmutz in collaboration with the Max-Planck-Institute for Solar system studies, Katlenburg-Lindau, Germany, the Arctic and Antarctic Research Institute, St. Petersburg, Russia, and the Main Geophysical Observatory, St.-Petersburg, Russia

PMOD/WRC coordinates the 3-year long project “Model assessment of the solar wind effects on the general circulation of the atmosphere and global ozone distribution” started in 2002 and supported by International Association for the promotion of co-operation with scientists from the New Independent States of the former Soviet Union (INTAS). The main goal of the project is to estimate the influence of Joule heating in the lower stratosphere induced by solar wind on the global ozone and climate. The collaborating institutes are Max-Planck-Institute for Solar system studies, Katlenburg-Lindau, Germany (two scientists), Arctic and Antarctic Research Institute, St. Petersburg, Russia (four scientists), and Main Geophysical Observatory, St.-Petersburg, Russia (four scientists).

In summer 2004 W. Schmutz and E. Rozanov (PMOD/WRC) visited St. Petersburg and I. Karol (MGO) visited Davos to discuss the results of the project. I. Karol held a seminar in PMOD/WRC and presented some new results obtained by his group and reviewed the main areas of scientific activity in MGO. During 2004 MGO team carried out the second numerical experiment with CCM SOCOL to simulate the response of the global ozone and climate to the additional Joule heating for the maximum solar activity case. The high frequency model output has been provided to AARI team for detailed analysis and comparison with observation data acquired from Russian meteorological stations. The aim of this study is to compare the correlations between solar wind and meteorological state of the atmosphere obtained from the model simulation and observation data.

SCOPES

Richard Wachter, Claus Fröhlich, and Werner Schmutz in collaboration with the Solar Physics department of the Ulugh Beg Astronomical Institute Tashkent, Uzbekistan

In July 2004 there was the end of the SCOPES (Scientific Collaboration between Eastern Europe and Switzerland) project *Characteristics of Low Degree Solar Oscillations from Observations in Brightness and Velocity*. The project duration was three years and it resulted in nine publications and a dissertation by the partner in Uzbekistan. The collaboration with the Ulugh Beg Astronomical Institute was fruitful for both sides and in particular, the PMOD/WRC PhD student Richard Wachter obtained precious scientific and personal contacts.

Publications

Refereed Articles

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Sutter M., Dürr B., Philipona R.: 2004, Comparison of two radiation algorithms for surface-based cloud-free sky detection, J. Geophys. Res., 109, doi: 10.1029/2004JD004582.

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Egorova T., Rozanov E., Peter T., Haberreiter M., Schmutz W.: 2004, Solar variability effects on dynamics and chemistry of the atmosphere and surface air temperature: evaluation of UV and visible radiation influence. In: Proceedings of the XX quadrennial ozone symposium, C. Zerefos (ed.), Kos, Greece, 742-743.

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Personnel

Scientific Personnel

Prof. Dr. Werner Schmutz	*Director, physicist, Sun-Earth connection, PI ETH-Polyproject, PI PREMOS, CoI LYRA, SOVIM*
PD Dr. Rolf Philipona	*Physicist, surface radiation budget, calibration of longwave instruments, IR and UV instrumentation*
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*
Christoph Wehrli	*Physicist, design and calibration of filter radiometers, atmosph. remote sensing, CoI VIRGO, SOVIM, PREMOS, LYRA*
Dr. Wolfgang Finsterle	*Physicist, quality system ISO 17025 (1.9.2004 - 31.12.2004)*
Bruno Dürr	*PhD student, ETHZ, SNSF project (left 30.6.2004)*
Dr. Tatiana Egorova	*PhD student, ETH-Polyproject*
Margit Haberreiter	*PhD student, ETH-Polyproject*
Chris Hoyle	*PhD student, ETH-TH-project*
Christian Ruckstuhl	*Diploma student ETH (until 31.3.2004); PhD student, NCCR project (since 1.7.2004)*
Uwe Schlifkowitz	*PhD student, SNSF-project (since 1.2.2004)*
Marcel Sutter	*PhD student, ETHZ, SNSF project*
Richard Wachter	*PhD student, ETHZ, SNSF project (left 31.3.2004)*
Sandra Moebus	*internship physics engineer Fachhochschule Ravensburg-Weingarten*

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 (since 11.10.2004)*
Silvio Koller	*Electronic engineer, LYRA experiment manager*
Daniel Pfiffner	*Electronic engineer SOVIM and PREMOS*
Ursin Solèr	*Physics Technician (left 31.5.2004)*
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, 3rd/4th year*
Christian Gubser	*Electronics apprentice, 2nd/3rd year*
Chasper Buchli	*Electronics apprentice, 1st year (since 1.8.2004)*

Administration

Sonja Degli Esposti	*Head administration PMOD/WRC, personnel, book keeping*
Angela Knupfer	*Administration PMOD/WRC, part time (since 1.9.2004)*
Annika Weber	*Administration apprentice, 1st/2nd year*

Caretaker

Klara Maynard	*General caretaker, cleaning*
Dostana Kostic	*part time cleaning*

Civilian Service Conscripts

Colin Müller	*20.10.2003 - 8.6.2004*
Simon Salzmann	*17.11.2003 - 12.3.2004*
Adrian Schüpbach	*29.3. - 30.7.2004*
Oliver Koller	*29.11.2004 - 22.1.2005*

Miscellaneous Activities

Participation in Meetings and Courses

Werner Schmutz

28.1. – 30.1.	COST 724 MC meeting, Athens, Greece
3.3.	COST-CH meeting, Bern
8. – 10.3.	WMO Workshop AOD2004, Davos
15.3. – 19.3.	Saas Fee course, Davos, CH
29.3.	ILWS, ESA-HQ Paris, France
6.4.	PICARD Evaluation, CNES Paris, France
24.4 – 25.4.	COST 724 MC meeting, Nice, France
6.5. – 7.5.	SANW, Bern
12.5. – 14.5.	LYRA PDR, Brussels, Belgium
27. – 28.5.	COST 724 WG1 meeting, Trieste, Italy
11.7. – 14.7.	INTAS meeting, St. Petersburg, Russia
18. – 25.7.	COSPAR-2004, Paris, France
23.9. – 25.9.	HOLIVAR workshop, Kastanienbaum
10.10. – 11.10.	COST 724 MC meeting, Trieste, Italy
12.10. – 13.10.	ISSI Study Team on Solar Magnetism and Irradiance, Bern
14.10. – 15.10.	SGAA Versoix
27.10.	GAW-CH Landesausschuss, Zürich
8.11. – 9.11.	LYRA CDR, Brussels, Belgium
29.11. – 30.11.	Space Weather workshop, ESTEC, Netherlands

Sonja Degli Esposti

ab 16.8.05	Vorbereitungslehrgang auf die Berufsprüfung Personalfachfrau/Personalfachmann mit eidg. Fachausweis, HTW Chur

Bruno Dürr

25.7. – 30.7.	BSRN Meeting, Exeter, England

Tania Egorova

16. – 17.3.	Stratospheric Ozone workshop, Zurich
30.5. – 9.6.	Ozone-2004 Symposium, Kos, Greece
18.7. – 25.7.	COSPAR-2004, Paris, France
31.7. – 9.8.	SPARC-III, Victoria, Canada

Claus Fröhlich

15.3. – 19.3.	Saas Fee Kurs, Davos
18.3.	Comité des Programmes Scientifiques, CNES, Paris
29.3. – 31.3.	SOVIM Meeting ALENIA, Torino, Italy
22.4. – 23.4.	SCAR Workshop, Villefranche, France
22.7. – 23.7.	COSPAR, Paris, France
2.9.	Comité des Programmes Scientifiques, CNES, Paris, France
4.9. – 6.9.	Solar Dynamo Workshop, Freiburg iBr, Germany
7.9. – 8.9.	Beiratssitzung Kiepenheuerinstitut, Freiburg iBr, Germany
11.10. – 14.10.	ISSI Study Team on Solar Magnetism and Irradiance, Bern
15.10.	Comité des Programmes Scientifiques, CNES, Paris, France
27.10. – 29.10.	SORCE Science Meeting, Mill Falls, NH, USA
4.11.	Stiftungsratssitzung Kiepenheuerinstitut, Freiburg iBr, Germany
13.12. – 17.12.	AGU Fall Meeting, San Francisco, CA, USA
18.12.	Besuch HEPL, Stanford University, CA, USA

Margit Haberreiter

15.3. – 20.3.	34th SAAS-FEE ADVANCED COURSE, Davos
18.7. – 25.7.	35th COSPAR Scientific Assembly Paris, France
11.10. – 15.10.	ISSI Study Team on Solar Magnetism and Irradiance, Bern

Christopher Hoyle

16.3. – 19.3.	Stratospheric Ozone Workshop & CANDIDOZ annual meeting, Zürich
31.7. – 9.8.	SPARC-III, Victoria, Canada

Rolf Philipona

12.2. – 13.2.	TUC Meeting, MeteoSwiss, Payerne
5.4.	Swiss Global Change Day, Bern
16.5. – 22.5.	AGU/CGU, Montreal, Canada
25.7. – 30.7.	BSRN Meeting, Exeter, England
21.8. – 28.8.	IRS Conference, Busan, South Korea
7.9. – 10.9.	DACH Konferenz, Karlsruhe, Germany
13.9. – 14.9.	TUC Meeting, MeteoSwiss, Payerne
4.10. – 6.10.	ETH Radiation Workshop, Zürich
10.10. – 14.10.	WGSF Meeting, Halifax, Canada
2.11. – 3.11.	GAW Expert Meeting, Tutzing, Germany

Eugene Rozanov	
16.3. – 17.3.	Stratospheric Ozone workshop, Zurich
30.5. – 9.6.	Ozone-2004 Symposium, Kos, Greece
18.7. – 25.7.	COSPAR-2004, Paris, France
31.7. – 9.8.	SPARC-III, Victoria, Canada
Christian Ruckstuhl	
7.9. – 10.9.	DACH Meteorologentagung 2004, Karlsruhe, Germany
Isabelle Rüedi	
7.10. – 8.10. & 4.11.	Conduire une équipe partenaire, Uni Lausanne
Marcel Sutter	
26.7. – 29.7.	BSRN Meeting, Exeter, England
27.9. – 1.10.	EMS Annual Meeting, Nice, France
29.8. – 3.9.	NCCR Summer School, Locarno
Christoph Wehrli	
8.3. – 10.3.	WMO Workshop AOD2004, Davos
11.3. – 12.3.	SAG/Aerosol Meeting, Davos
15.3. – 19.3.	Saas-Fee Course, Davos
7.4.	GAW-CH Landesausschuss, Zürich
29.9. – 30.9.	GAWTEC Course, Schneefernerhaus, Germany
4.10. – 06.10.	GEWEX Workshop, ETH Zürich
27.10.	GAW-CH Landesausschuss, Zürich
2.11. – 5.11.	WMO Workshop European GAW, Tutzing, Germany

Course of Lectures, Participation in Commissions

Werner Schmutz

- International Radiation Commission (IAMAS)
- Comité consultatif de photométrie et radiométrie (OICM)
- Expert Team on Meteorological Radiation and Atmospheric Composition Measurements (CIMO)
- Swiss Committee on Space Research (SANW)
- Commission for Astronomy (SANW)
- GAW-CH Working Group (MeteoSwiss)
- Swiss management committee delegate in the COST action 724
- Course of lecture Astronomie, WS 2003/2004 and WS 2004/2005 ETHZ

Claus Fröhlich

- Beirat Kiepenheuer Institut, Freiburg, Germany
- SOHO Science Working Team
- Comité de Programme Scientifique de CNES

Rolf Philipona

- Course of Lecture Strahlungsmessung in der Klimaforschung WS2003/2004 and WS2004/2005 ETHZ
- Working Group for Baseline Surface Radiation Network (WMO/WCRP)
- Atmospheric Chemistry and Physics (ACP) Commission of (SANW)
- Working Group on Surface Fluxes (WMO/WCRP/WGSF)

Isabelle Rüedi

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

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

27.2.	Anstieg des Treibhauseffektes in den Alpen	PD Dr. R. Philipona
16.3.	Wellen in der Sonnenatmosphäre, Seismologische Erforschung Der Weltraumwetter-Küche	Dr. W. Finsterle, Hawaii
17.5.	The climate and ozone anomaly 1940 - 1942 Long-term trend analysis of atmospheric ozone	Dr. S. Brönimann, Zürich Dr. J. Stähelin, Zürich
13.8.	Spektrale Strahlungsmessungen im VIS/NIR am Meteorol. Observatorium Lindenberg	Dr. M. Weller, Germany
2.9.	Ozone modeling and observations in MGO	Prof. I. Karol, Russia
6.9.	TURAC-Instrument zur Strahlungsbilanzbestimmung und Wolkenbestimmung	C. Ruckstuhl
15.11.	Solare ultraviolette Strahlungsmessungen	Dr. J. Gröbner, Italy
18.11.	Bunte Ansichten von UV Radiometern und Pyrgeometern Effekte der spektralen Selektivität auf die Messungen	Dr. A. Los, The Netherlands
26.11.	Infrarot-Grenzschichteffekte über See	Dr. E. Polnau, Germany

Guided Tours at PMOD/WRC

In 2004 the PMOD/WRC was visited by 8 groups.

Abbreviations

AOD	Aerosol Optical Depth
ACRIM	Active Cavity Radiometer for Irradiance Monitoring
ACU	Attitude Control Unit
AGU	American Geophysical Union
ARM	Atmospheric Radiation Measurement
ASRB	Alpine Surface Radiation Budget, PMOD/WRC Project
ATLAS	Shuttle Mission with solar irradiance measurements
AU	Astronomical Unit (1 AU = mean Sun-Earth Distance)
AVHRR	Advanced Very High Resolution Radiometer
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
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
EDT	Eastern daylight saving Time
EGS	European Geophysical Society
EGSE	Electrical Ground Support Equipment
EISLF	Eidgenössisches Institut für Schnee- und Lawinenforschung, Davos
ENET	supplementary meteorological network of SMA
ERBS	Earth Radiation Budget Satellite
ERS	Emergency Sun Reacquisition
ESA	European Space Agency, Paris, F
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
EUV	Extreme Ultraviolet Radiation
FDE	Fault Detection Electronics
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
HST	Hubble Space Telescope
IAC	Instituto de Astrofísica de Canarias, Tenerife, E
IACETH	Institute for Climate Research of the ETH-Z
IAD	Ion assisted deposition of thin dielectric layers
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
INTRA	Intelligent Tracker from BRUSAG
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 Calibration 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
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, 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
OCAN	Observatoire de la Côte d'Azur, Nice, F
ODS	Ozone Destroying Substances
PCB	Printed circuit board
PCSR	Planck Calibrated Sky Radiometer
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 2005)
PIR	Precision Infrared Pyrgeometer von Eppley
PMOD	Physikalisch-Meteorologisches Observatorium Davos
PMO6-V	VIRGO PMO6 type radiometer
PREMOS	Precision Monitoring of Solar Variability, PMOD experiment on PICARD
PROBA 2	ESA technology demonstration space mission
PRODEX	Program for the Development of Experiments der ESA
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig & Berlin, D
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

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
SOLERS22	Solar Electromagnetic Radiation Study for Solar Cycle 22, of STEP, ISCU
SOVA	Solar Variability Experiment on EURECA
SOVIM	Solar Variability and Irradiance Monitoring for the International Space Station Alpha by PMOD/WRC Davos, Switzerland
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
SSU	Stratospheric Sounding Unit
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
USA	United States of America
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
WMO	World Meteorological Organization, Geneva
WORCC	World Optical Depth Research and Calibration Center (since 1996 at PMOD)
WRC	World Radiation Center
WRR	World Radiometric Reference
WSG	World Standard Group
WWW	World Weather Watch, an observational program of WMO

Donations

Last year, Mr. Daniel Karbacher from Küsnacht (ZH) made a large donation to PMOD/WRC of which only a small fraction was used to purchase a painting from a local artist, Ruth Senn, who is a representative of constructive art. The association for the benefit of the SFI foundation paid the second installment in a four-year plan to reimburse the PMOD/WRC for the purchase of the institute's color printer/copy machine (a Canon CLC 1180). Also, the association supported a reception at the 34th Saas Fee Course of the Swiss Society for Astrophysics and Astronomy that was organized by PMOD/WRC in Davos.

Rechnung PMOD/WRC 2004

Allgemeiner Betrieb PMOD/WRC (exkl. Drittmittel)

Ertrag	CHF
Beitrag Bund Betrieb WRC, IRC	1'132'750.00
Beitrag Bund Betrieb WORCC	157'070.00
Beitrag Kanton Graubünden	157'185.00
Beitrag Landschaft Davos	259'927.50
Beitrag Landschaft Davos, Mieterlass	133'500.00
Beitrag Landschaft Davos, Stiftungstaxe	190'000.00
Instrumentenverkauf	149'474.10
Beitrag Bundesamt für Gesundheit	15'000.00
Diverse Einnahmen/Eichungen	92'600.88
Wertschriftenertrag/Aktivzinsen	13'809.95
	2'301'317.43

Aufwand	CHF
Gehälter	1'292'265.95
Sozialleistungen	233'936.08
Investitionen	214'342.91
Unterhalt	41'560.84
Verbrauchsmaterial	37'621.55
Verbrauch Commercial	78'588.19
Reisen, Kongresse, Kurse, IPC-X	73'319.04
Bibliothek und Literatur	18'048.67
Raumkosten	182'275.10
Nachzahlung Mehrwertsteuer	30'000.00
Verwaltungskosten	99'069.98
	2'301'028.31
Ergebnis 2004	**289.12**
	2'301'317.43

Bilanz PMOD/WRC (exkl. Drittmittel)

	31.12.2004	31.12.2003
Aktiven	CHF	CHF
Kassa	1'255.45	2'013.05
Postcheck	13'630.64	17'252.94
Bankkonten	705'405.41	476'525.76
Debitoren	89'894.45	12'168.40
Verrechnungssteuer	433.75	1'413.84
Kontokorrent Mitarbeiter	634.45	-1'728.20
Kontokorrent Stiftung	Passiv	Passiv
Kontokorrent SNF-1	2'439.70	61'787.70
Kontokorrent SNF-2	610.00	12'125.85
Kontokorrent SNF-3	53'744.95	10'346.10
Kontokorrent PREMOS	56'497.85	164.30
Kontokorrent SOVIM	342'463.35	257'112.27
Kontokorrent POLY-Projekt	1'780.15	6'347.30
Kontokorrent INTAS	1'971.40	6'553.00
Kontokorrent TH-Projekt	310.00	6'667.30
Kontokorrent LYRA-Projekt	49'515.89	65'092.50
Kontokorrent COST-724	-90'444.91	1'230.65
Kontokorrent Saas-Fee Kongress	0.00	517.50
Kontokorrent SCOUT- O3	5'448.45	-
Kontokorrent NCCR-Climate	-1'189.30	-
Transitorische Aktiven	25'370.35	38'837.85
	1'259'772.03	974'428.11
Passiven		
Kreditoren	89'559.20	73'339.05
Zahllast Mehrwertsteuer	-7'497.40	-
Kontokorrent Stiftung	238.45	13'866.50
Transitorische Passiven	542'530.55	455'199.85
Rückstellungen	458'059.30	327'639.90
Rückstellung Fehlbetrag PUBLICA	72'210.00	-
Eigenkapital	104'671.93	104'382.81
	1'259'772.03	974'428.11