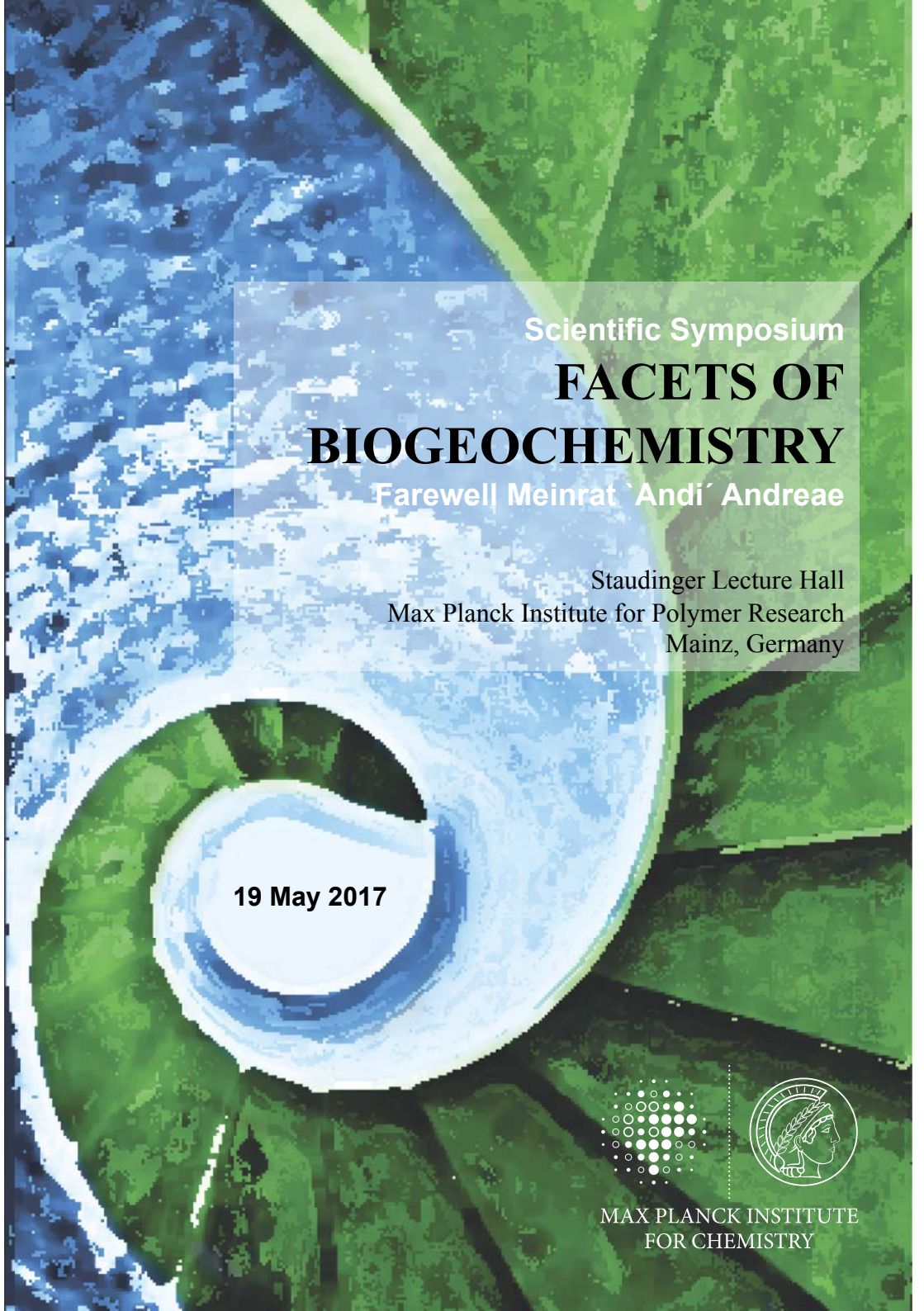

Scientific Symposium

FACETS OF BIOGEOCHEMISTRY

Farewell Meinrat `Andi´ Andreae

Staudinger Lecture Hall
Max Planck Institute for Polymer Research
Mainz, Germany

19 May 2017

MAX PLANCK INSTITUTE
FOR CHEMISTRY

CURRICULUM VITAE MEINRAT O. ANDREAE

Born: 19 May 1949, Augsburg, Germany

Education:
Vordiplom (B.S.) in Earth Sciences, 1970, University of Karlsruhe, Germany
Diplom (M.S.) in Earth Sciences, 1974, University of Göttingen, Germany. Thesis: Isotope and major element geochemistry of high grade metamorphic rocks from Southern Norway. Advisor: K.-H. Wedepohl

Ph.D. in Oceanography, 1978, Scripps Institution of Oceanography, University of California San Diego. Thesis: Distribution and speciation of arsenic in the natural environment. Advisor: E. D. Goldberg

Research Areas
Biogeochemistry, Atmospheric chemistry, Chemical oceanography, Biomass burning,
Chemistry/climate interactions, Paleoenvironments

Scholarships, Awards and Honors
- Walter Prize of the Fondation Zellidja
- Laureats de la Fondation Zellidja
- Study scholarships from the German Federal Government, 1968-1974
- Education Abroad Scholarship from the University of California, 1974-1975
- Florida State University Developing Scholar Award, 1983-1984
- World Meteorological Organization Gerbier-Mumm Award, 1988
- Fairchild Distinguished Scholar Award, California Institute of Technology, 1993
- Member, Academia Europaea, 1995
- Adjunct Professor, Faculty of Graduate Studies, York University, Ontario, Canada, 1996-
- Deutsche Bank Visiting Professorship "Science and Society", University of Frankfurt, 2001
- ISI Most Highly Cited Researchers, 2003
- Nobel Peace Prize to IPCC 2007, shared as lead author in Third Assessment Report
- Honorary Professor, Johannes Gutenberg University, Mainz, Germany, 2010
- Fellow, American Association for the Advancement of Science, 2010
- Doctor Honoris Causa, Gent University, Belgium, 2010
- Fissan-Pui Prize of the International Aerosol Research Association, with P. Artaxo, 2010
- Member, Brazilian Academy of Sciences

Memberships in Professional Societies
- European Geophysical Union
- American Chemical Society
- American Geophysical Union
- American Association for the Advancement of Science
- The Geochemical Society
- American Association for Aerosol Research

Current Professional Service
- Member, SCIENCE Board of Reviewing Editors
- Member, Advisory Board "Atmospheric Chemistry and Physics"
- Member, Scientific Steering Committee for the Large-Scale Biosphere/Atmosphere Project in Amazonia (LBA)
- Scientific Steering Committee for the German HALO Research Aircraft
- Past Chair, Core Project "Integrated Land-Ecosystem Atmospheric Processes Study (ILEAPS)" of IGBP II
- Vice-Chairman, German National Committee for Global Change Research
- Member, Advisory Board of the International Institute for Applied Systems Analysis (IIASA)

Employment
- 1974-1978 Research Assistant, Scripps Institution of Oceanography, La Jolla California
- 1978-1982 Assistant Professor of Oceanography, Florida State University, Tallahassee, Florida
- 1982-1986 Associate Professor of Oceanography, Florida State University
- 1984 Visiting Professor, Department of Chemistry, University of Antwerp, Belgium
- 1985 Visiting Scientist, National Center for At mospheric Research, Boulder, Colorado
- 1986-1987 Professor of Oceanography, Florida State University
- 1987-present Director, Max Planck Institute for Chemistry, Mainz, Germany
- 1992 Visiting Professor, University of California, Irvine
- 1993-2002 Visiting Professor, Department of Environ mental Engineering, Science, California Insti tute of Technology, Pasadena
- 2007-2009 Executive Director, Max Planck Institute for Chemistry, Mainz, Germany

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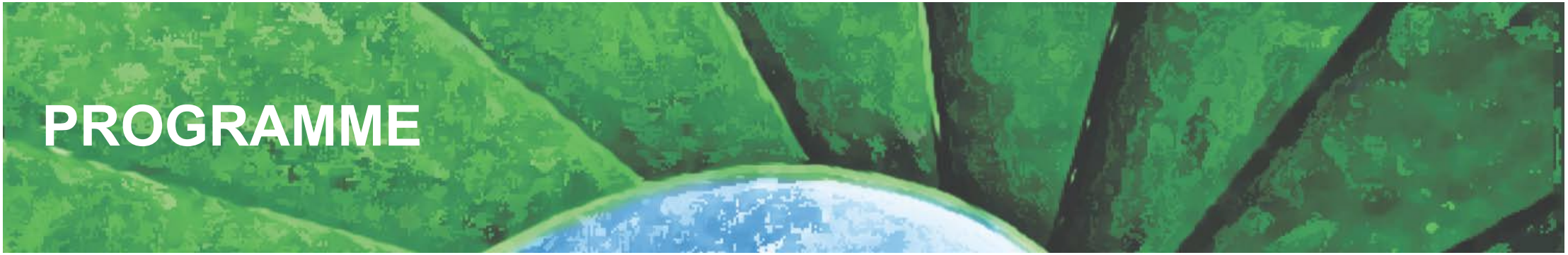
Farewell Meinrat `Andi´ Andreae

****** Programme and speaker profiles ******



PROGRAMME

09:00 - 10:00	*** Coffee & Registration ***
10:00 - 10:15	Welcome and Introduction by Ulrich Pöschl
	Session 1 *(Chairpersons: Ulrich Pöschl and Christopher Pöhlker)*
10:15 - 11:00	*The History of Research Linking Oceanic Dimethyl Sulphide Emissions by Phytoplankton to the Earth's Albedo and Climate* **Robert J. Charlson**, University of Washington, Seattle, WA, USA
11:00 - 11:45	*Reverse weathering, authigenic aluminosilicate formation, and early silica diagenesis in marine sediments - the ocean Ge/Si story of accidental discoveries* **Philip Froelich,** Duke University, NC, USA
12:00 - 13:00	*** Lunch ***
	Session 2 *(Chairpersons: Jürgen Kesselmeier and Matthias Sörgel)*
13:00 - 13:45	*Fire and Fun: Natural pollutants in the tropics* **Mary Scholes,** University of Witwatersrand, Johannesburg, South Africa
13:45 - 14:30	*From the Pioneers of Modern Geochemistry to Greenhouse Gas Emissions Verification and the Paris Climate Accords* **Ray Weiss,** Scripps Institution of Oceanography, San Diego, CA, USA
14:30 - 15:15	*IGAC's 1992 STARE (South Tropical Atlantic Regional Experiment) Mission: A Multinational Expedition that Elucidated the Global Impact of Tropical Biomass Burning* **Jack Fishman,** Saint Louis University, MO, USA
15:15 - 15:45	*** Coffee break ***
	Session 3 *(Chairpersons: Matthias Sörgel and Christopher Pöhlker)*
15:45 - 16:30	*30 years of Amazonian aerosol research: from biological functioning to dust, biomass burning and anthropogenic impacts* **Paulo Artaxo,** University of São Paulo, São Paulo, Brazil
16:30 - 17:15	*Anthropogenic aerosol cloud-mediated climate forcing: Important now more than ever and still far from saturation* **Daniel Rosenfeld,** Hebrew University, Jerusalem, Israel
17:15 - 18:00	Scientific reflections by **Meinrat „Andi" Andreae** Reception and Dinner: Max Planck Institute for Chemistry
18:00 - 18:30	*** Reception ***
18:30	*** Dinner and discussion *** *** Concluding remarks ***

The History of Research Linking Oceanic Dimethyl Sulphide Emissions by Phytoplankton to the Earth´s Albedo and Climate

Robert J. Charlson,
University of Washington, Seattle, WA, USA

The major source of cloud-condensation nuclei (CCN) over the oceans appears to be dimethylsulphide, which is produced by planktonic algae in sea water and oxidizes in the atmosphere to form a sulphate aerosol Because the reflectance (albedo) of clouds (and thus the Earth's radiation budget) is sensitive to CCN density, biological regulation of the climate is possible through the effects of temperature and sunlight on phytoplankton population and dimethylsulphide production. To counteract the warming due to doubling of atmospheric CO_2, an approximate doubling of CCN would be needed.

Robert J. Charlson

Professor Robert J. Charlson received his BS and MS degrees in chemistry from Stanford University in 1958 and 1959. From 1959-1961, he worked as a research engineer with the Boeing Company, primarily as an instrumentation engineer. He obtained his Ph.D. in the field of atmospheric sciences at the University of Washington, Seattle, in 1964. In 1964/65, he was a Fulbright Scholar to the cloud physics department at the Imperial College in London. He returned to the University of Washington in 1965 as an assistant professor in the department of civil engineering.

Here, he became a full professor in the fields of geophysics (1969-), and then moved to the Atmospheric Sciences Department (1986-), and chemistry (1995-) until he retired in 1998. Prof. Charlson has served in many committees, notably the US National Academy of Sciences Committee on Atmospheric Chemistry. Furthermore, he was a co-author of the IPCC report in 2007 and shared in the Nobel Peace Prize of that year.

Prof. Charlson's research interests are focused on the relevant integral properties of atmospheric aerosols, such as the development of methods for measurement of light scattering and absorption by atmospheric aerosols, analysis of the effects of relative humidity on light scattering, investigation of the effects of cloud condensation nuclei (CCN) on cloud albedo, as well as modelling of atmospheric sulphur compounds, especially sulphates in aerosols.

Furthermore, he works with lidar techniques on the interpretation of the column integral of backscatter as viewed from space (i.e., the integrated attenuated backscatter, IAB) as well as satellite remote sensing of albedo and related optical properties of the atmosphere. Prof. Charlson is the co-inventor of the numerous versions of the integrating nephelometer as well as co-inventor of the counterflow virtual impactor for isolating CCN from activated clouds.

Reverse weathering, authigenic aluminosilicate formation, and early silica diagenesis in marine sediments - the oceanic Ge/Si story of accidental discoveries

Philip Froelich,
Duke University, NC, USA

The early work of Goldschmidt had revealed that Ge, a trace element in the Earth's crust (~1 ppm), has the same outer electronic structure and ionic and covalent (Si-O) radii as Si, and thus substitutes for Si in tetrahedral silicate structures. He coined the phrase: "Ge behaves like a super-heavy stable isotope of Si". He documented that in igneous minerals the crustal Ge/Si ratio is about one-Ge atom per million-Si atoms (~10-6). Azam later demonstrated using radioactive 68Ge that diatoms take up and incorporate Ge into their biosiliceous opal shells with little or no fractionation. He used the 68Ge/Si system as a Si-isotopic analog to probe biochemical pathways and enzymes involved in diatom silica uptake, transfer, and opal deposition. He predicted that the ocean should display a dissolved Ge/Si ratio of 10-6. Andreae taught me the magic of hydride generation to measure dissolved Ge in natural waters at picoMolar (pM) levels (pptr). We discovered that vertical profiles of Ge in the ocean were parallel to Si at a 10-6 ratio because diatoms in surface waters take up Ge as an accidental surrogate for Si and incorporate it into their shells that then fall into the deep sea and dissolve or are buried. The observed oceanic dissolved Ge/Si ratio (0.7 pM/μM or 0.7 ppm) confirmed the predictions.

The ratio in today's diatom shells buried in siliceous oozes of the Southern Ocean (the largest sink for Si from today's ocean) is also 0.7 ppm. So diatoms faithfully record the oceanic ratio. Mass balances of fluvial and MOR hydrothermal Si and Ge fluxes to the sea suggested there must be a "missing Ge-sink" which was subsequently found to be the burial of authigenic Ge-enriched phases related to reverse weathering of Si. In addition it was discovered that the diatom Ge/Si ratio in Antarctic sediment cores varied systematically over the past 400,000 years from 0.7 ppm (interglacial) to 0.4 ppm (glacial), indicating that the ocean Ge/Si ratio was varying on 100,000 year glacial-interglacial cycles. The reasons for this are still not well understood, but probably involves glacial-interglacial variations in reverse weathering that drive fast ocean changes in both Ge and Si. High resolution pore water profiles from cores in the biosiliceous ooze belt between New Zealand and McMurdo demonstrated that during opal dissolution and diagenesis, Ge is preferentially incorporated into newly-forming authigenic clays, probably substituting into the aluminosilicate structures of these poorly-crystalline phases. Marine reverse weathering is now understood to be a globally important sink for Si and cations, which our data suggest is dependent on the supply of reactive aluminum (i.e., continental weathered debris = secondary clays) to the seabed in biosiliceous-rich sediments.

Along the way we accidentally discovered that rivers with CFPP's are greatly comtaminated (3-4 orders of magnitude) with Ge, which thus provides a tracer for CFPP-sourced As, Se and Sb. Also, we accidentally found monomethyl and dimethylgermanium (MMGe, DMGe) in the ocean, in pore waters, and in the Black Sea (anoxic basin). These are perfectly conservative, displaying concentrations comparable to inorganic-Ge, but the sources and sinks to/from the ocean of these Ge-C compounds remain unknown. Their long oceanic residence times, great stability, non-reactivity, high solubility, and non-volatility prompted Andreae to dub them "oceanic Teflon". Attempts to biomethylate or demethylate these Ge-C compounds with heat and oxidants, anaerobic bacteria, archaea and fungi were unsuccessful. The only other occurrence is in a Dow Chemical chlorosilane process which produces Si-C precursors (silanes) for commercial siloxanes – a discovery prompted by gross contamination of our lab with a sample from the Dow Carrollton (KY) plant – almost certainly a Volatile MethylSiloxane (VMS) containing trace Ge.

Philip Froelich

My primary interests are global biogeochemical cycles of nutrients, bioactive trace elements and isotopes in oceans, rivers, lakes and their sediments and pore waters, especially as these help unravel the history of past biogeochemical changes in marine productivity (carbon fluxes), climate (CO2), and continental fluvial fluxes of cations to the sea (patterns of uplift, weathering, and rainfall). We developed manganese, phosphate, silica, germanium/silicon ratio, and lithium isotope records from ocean sediment recorders, foram and diatom tracers, suboxic sediment tracers, and continental weathering intensity tracers. Side ventures have delved into:

(1) geochemical details of how paleoclimates are recorded in speleothems by monitoring modern cave air chemistry and ventilation rates, drip water chemistry and speleothem calcite in instrumented continuously monitored caves where we grow 'farmed' stalagmites; (2) how coal-fired power plant ash ponds leave long-lasting geochemical tracers of germanium and toxic arsenic, selenium and antimony in global rivers and estuaries, and (3) how equid horse teeth isotopes and trace elements have recorded Miocene climates. My most recent foray into paleogeochemical tracers is the Cenozoic record of lithium isotopes in planktonic forams, which records the continental weathering history of the planet over the past 70 Ma.

I was formerly Director of Ocean & Climates Division and Associate Director of the Lamont-Doherty Earth Observatory at Columbia University, Director and Chair of the School of Earth & Atmospheric Sciences at Georgia Tech, and most recently the Francis Eppes Endowed Chair of Oceanography at Florida State University. I am a Fellow of the AAAS.

Fire and Fun:
Natural pollutants in the tropics

Mary Scholes,
University of Witwatersrand, Johannesburg, South Africa

South Africa contributes significantly to atmospheric carbon dioxide concentrations due to the reliance on fossil fuel burning power stations for electricity. In addition, emissions from savanna fires impact ecosystem function. Sustainable development in South Africa involves a number of trade-offs between economic growth and the negative impacts on the environment and human health. Fires are viewed as having both positive and negative impacts on development.

Data will be presented on sulphur emissions from power stations and savanna fires and the associated nitrogen and sulphur deposition. Lichen distributions show a sensitivity to deposition, grasses are less sensitive than trees to additional nitrogen and sulphur applications. Water bodies and soils are not yet showing a declining trend in pH. There is a correlation between atmospheric pollution, socio-economic status and human health. A brief overview of scientific programmes conducted collaboratively in South Africa will be presented showing explicitly how capacity was developed as a result of well-planned programmes exhibiting scientific integrity.

Mary Scholes

Prof Mary Scholes, a graduate of the University of the Witwatersrand, is currently a full professor in the School of Animal, Plant and Environmental Sciences, where she holds a Research Chair in Systems Analysis. Her research activities focus on soil fertility, food security and biogeochemistry in savannas, plantation forests and croplands. Her research funds are mostly sourced from industry and the government and she is currently actively involved in monitoring the impacts, on human health and the environment, of the new power stations in the Waterberg.

Research questions addressed include: How does plant biodiversity change in savannas impacted by Sulphur and Nitrogen deposition? Is the Nitrogen cycle positively impacted in nutrient poor savannas by Nitrogen deposition? How does socio economic status and aerial pollution impact human health? Can a systems approach identify interventions that will facilitate the implementation of the Sustainable Development Goals?

She chairs the advisory boards of the Max Planck Institute for Chemistry and the International Institute of Applied Systems Analysis. She is also a member of the jury for the Volvo Environment Prize. These activities involve extensive collaborative research with a number of overseas and local institutes.

Her publication record is extensive; she has mentored over 70 postgraduate students and she teaches at postgraduate level at the University. She has been awarded the Vice-Chancellors Teaching, Research and Academic Citizen awards. She is a fellow of the Royal Society of South Africa and of the South African Academy of Science. She is the recipient of a number of national and international awards including being elected as a foreign member of the Royal Swedish Academy of Agriculture and Forestry. She has served on Senate at Wits for over 25 years and has served on Council for two terms.

She is married to Bob Scholes, a systems ecologist, and they have a 20 year old son.

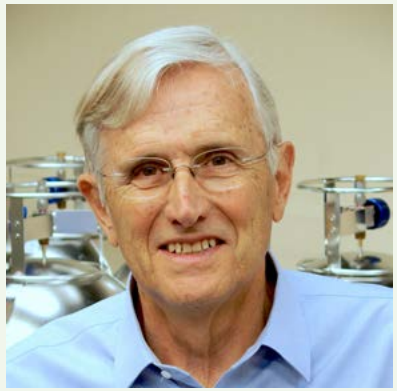
From the Pioneers of Modern Geochemistry to Greenhouse Gas Emissions Verification and the Paris Climate Accords

Ray F. Weiss,
Scripps Institution of Oceanography, San Diego, USA

Almost half a century ago, the Scripps Institution of Oceanography was an exciting place for Andi Andreae and other young geochemists to begin their research careers, studying and working with many pioneers of the field. Among these leaders were Dave Keeling and Roger Revelle, who laid the foundations of modern carbon cycle and anthropogenic climate change research and showed that there were major inconsistencies between the measured increases of carbon dioxide in the atmosphere and estimates of fossil fuel emissions and terrestrial and oceanic sources and sinks.

Our understanding of the distributions greenhouse gases (GHGs) in the atmosphere has advanced considerably in the intervening years, but even in this era of heightened concern for anthropogenic climate change there are still significant inconsistencies for many GHGs between reported emissions and the trends and distributions that are measured in the atmosphere. Taken together, "bottom-up" emissions inventories that now form the basis of legislative efforts to control emissions often do not agree with "top-down" assessments based on atmospheric measurements. And more often than not the actual emissions are greater than the reported ones, sometimes by a factor of two or more. Among the most striking examples are the emissions of very potent long-lived industrial GHGs that should be relatively easy to quantify.

Under the landmark Paris Agreement to combat and adapt to climate change, nearly all nations have agreed to a "pledge and review" approach to voluntary emissions reduction targets, or Nationally Determined Contributions (NDCs). Beginning in 2018 they will engage in a process of "stocktaking" and "facilitative review", and must strengthen these commitments if it appears that the goal of limiting global anthropogenic temperature rise to 2°C (or preferably 1.5°C) will not be met – as is almost certain to be the case. Although true emissions verification that compares nationally reported emissions with actual atmospheric observations can be politically "toxic", it is now possible to combine atmospheric GHG measurements with inverse models of atmospheric transport and mixing processes to quantify GHG emissions on regional and national scales. What is still needed is the political will to do this globally, as is already the case for monitoring compliance with nuclear disarmament agreements.



Ray F. Weiss

Ray Weiss is Distinguished Professor Emeritus and Distinguished Research Professor at the Scripps Institution of Oceanography, University of California, San Diego. He received a bachelor's degree in chemistry from the California Institute of Technology in 1964, and a doctorate in Earth sciences from Scripps in 1970. His research career has been devoted to the application of chemical and isotopic measurements to the study of natural processes in the atmosphere, oceans, and deep lakes.

Among his major contributions are: the discovery and characterization of the increase and global distribution of atmospheric nitrous oxide, a stratospheric ozone depleter and long-lived greenhouse gas; the first experimental proof of the existence of deep-sea hydrothermal vents; the practical application of dissolved atmospheric chlorofluorocarbon measurements to determine the rates of ventilation, transport and mixing processes in the oceans and in deep lakes; the first geochemical study of mixing processes in the Weddell Sea, a major source of deep water to the world oceans; and an improved calibration of the global abundance of the atmospheric hydroxyl radical, the atmosphere's primary cleansing agent.

He is a Fellow of the American Association for the Advancement of Science and of the American Geophysical Union. He has contributed to the assessments of the Intergovernmental Panel on Climate Change (IPCC) and the Scientific Assessment of Ozone Depletion, under the United Nations Environment Programme and the World Meteorological Organization. He is also the lead principal investigator for the measurement component of the Advanced Global Atmospheric Gases Experiment (AGAGE), an international consortium to measure and model the global distributions, emissions and atmospheric lifetimes of a wide range of anthropogenic and natural greenhouse gases and ozone depleting substances.

IGAC's 1992 STARE (South Tropical Atlantic Regional Experiment) Mission: A Multinational Expedition that Elucidated the Global Impact of Tropical Biomass Burning

Jack Fishman,
St. Louis University, MO, USA

The analysis and subsequent publication in 1990 of the first global distribution of pollution (ozone smog) derived from satellite measurements revealed a dominant plume that seasonally circumnavigated the entire Southern Hemisphere and appeared to have its origin over the Atlantic Ocean between 20°S and 30°S. Because of the relative lack of fossil fuel burning in this hemisphere, its origin was suspected to be from biomass burning emissions, but the fact that it did not appear to originate over either South America or southern Africa seemed to contradict this assumption.

To investigate the origin of this pollution, the International Global Atmospheric Chemistry (IGAC) Program organized STARE in 1992, an international campaign that enlisted more than 300 scientists and support personnel from 13 countries to gather and analyze measurements from seven airborne platforms in addition to an extensive suite of ground-based instruments measuring trace gases and aerosols coming from burning in southern Africa. STARE was divided into two primary components: NASA's TRACE-A (Transport of Atmospheric Chemistry near the Equator—Atlantic) field campaign that primarily used the Agency's DC-8 "Flying Laboratory" to investigate the larger scale transport of trace gases and aerosols; and SAFARI (Southern African Atmosphere-Research Initiative), which coordinated ground-based and aircraft measurements of the emissions from the widespread savannah burning throughout southern Africa during the "burning season" of August-October. Jack Fishman was TRACE-A's P.I. and Andi Andreae was the SAFARI P.I. Collectively, more than 60 peer-reviewed articles from STARE were published in a special issue of Journal of Geophysical Research in 1996.

The primary finding was that the pollution maximum observed over the South Atlantic originated from extensive biomass burning taking place concurrently over both South America and southern Africa, combined with a unique prevailing meteorology that resulted in these plumes crossing over each other at different altitudes over the ocean. Since the satellite measurements could not distinguish the height at which these plumes existed, the point at which they crossed became the well-defined maximum that was observed from space. This lecture will provide an overview of the measurements and findings from the STARE campaign, which cemented the widely held belief that biomass burning in the Tropics was a major contributor to the global cycles of a number of trace gases and aerosols.

Jack Fishman

Since 2011, Jack Fishman has been a Professor in the Department of Earth and Atmospheric Sciences and the Director of the Center of Environmental Sciences at Saint Louis University in St. Louis, MO USA. From 1979-2010, Dr. Fishman was a Senior Scientist and Branch Head in the Atmospheric Sciences Division at NASA Langley Research Center in Hampton, VA USA, where he focused on the development of a methodology for observing ozone pollution using satellites. The success of this method led to the unexpected finding of large amounts of pollution over the South Atlantic Ocean, which provided the impetus for the South Tropic Atlantic Regional Experiment, a campaign he jointly led with Andi Andreae. Prior to joining NASA, Dr. Fishman worked with Paul Crutzen at the National Center for Atmospheric Research in Boulder, CO USA; he was a visiting scientist at the Max-Planck Institute for Chemistry in 1979. His current research emphasis is on the impact of increasing tropospheric ozone concentrations on the biosphere.

30 years of Amazonian research: from ecosystem biological functioning to dust, biomass burning and anthropogenic impacts

Paulo Artaxo,
University of São Paulo, Brazil

Amazonia is a living laboratory that shows the strong links between forest biology with atmospheric chemistry and physics, climate and biogeochemical cycles. Few ecosystems show these links as strongly as Amazonia. The biogenic controls of atmospheric processes go from particles formed from VOC emissions to primary aerosol particles that can acts as CCN and are critically important for the intense hydrological cycle over Amazonia. Clouds and aerosols controls the radiation budget over the forest that is essential for the photosynthetic processes that drives the carbon allocation over the forest. The carbon cycling over the Amazon forest is globally important, and influenced by aerosols, cloud cover, ozone and climatic conditions.

The intense biology of the forest is responsible for the emissions of primary aerosol particles that can size from 20-40 nm to 20-50 micrometers. In addition, the oxidation of VOCs biogenic emissions produces particles that grown up to the accumulation mode. Naturally, regional dust as well as Sahara dust transport and sea salt also contribute to the aerosol budget over Amazonia.

Biomass burning emissions during the dry season changes the atmospheric composition, with very high concentrations over large areas for CO, ozone, aerosol particles, black carbon among other components. Long range transport of biomass burning emissions affect health of people and the hydrological cycle downwind of Amazonia. The aerosols affect the radiation balance thousands of kilometers from the sources. The effects on cloud formation and development is also important, as well as impact of aerosols from Amazonia on precipitation in the La Plata Basin. On the other side, smoke from Amazonia reach the Andes, depositing black carbon over snow, change strongly the albedo in the Andes region.

We will discuss in this presentation how we started this research 30 years ago, with very little knowledge on organic aerosols and effects on clouds and radiation balance. Today we have a quite good knowledge on how Amazonia works as an entity, but we still have a lot to learn on how humans are changing this ecosystem trough climate and land use change. How the forest will respond to a changing climate and how the occupation of Amazonia will happen is critically important for the future global carbon cycle.

Paulo Artaxo

Paulo Artaxo is professor of environmental physics at the University of São Paulo. In the 1980s, Prof. Artaxo initiated the study of tropical aerosols, emphasizing the importance of biomass burning in Amazonia as a source of climatically important aerosol particles. Since 1995, he is one of the leaders of the LBA (The Large Scale Biosphere Atmosphere Experiment in Amazonia) Experiment. He helped in the coordination of several large international experiments such as ABLE-2A and 2B, TRACE-A, SCAR-B, SMOCC, LBA-ECO, CLAIRE 98, CLAIRE2001, EUSTACH, AMAZE, EUCAARI, BUNIAACIC, SAMBBA, GMOS, GoAmazon2014-15, NGEE-Tropics, among others. He had a strong international role in fostering scientific growth in developing countries, helped IGBP, IGAC, iLEAPS, BIBEX, DEBITS, SCAR, CACGP, CYTED and other international commissions. He was a lead author of the IPCC WG1 at the AR4 and AR5 IPCC reports.

Paulo Artaxo has published more than 414 scientific papers, and presented more than 1020 scientific papers in international conferences. He is one of the most cited Brazilian scientists with more than 14,500 scientific citations, with an H-index from the ISI Web of Sciences of 68. He has more than 31,200 citations on the Google Scholar with an H-index of 89.

He was the advisor of 50 MSc and PhD students. Among his honors, Prof. Artaxo was elected member of the Brazilian Academy of Sciences in 2005 and member of TWAS in 2010. In 2004, the Brazilian Senate awarded him a special prize in recognition of his role in the contribution to the study of the effects of tropical aerosol particles on the hydrological cycle in Amazonia. In 2006, he was elected a fellow of the AAAS. In 2007, he was honored with the TWAS Earth Science Prize, for his work on Amazonia. He was the recipient of the Award Dorothy Stang of 2007. In 2009 he was awarded with the title of Doctorate of Philosophy Honoris Causa of the University of Stockholm, Sweden. In 2010 he shared with Andi Andreae the Fissan-Pui-TSI award for his work on international scientific cooperation. In 2016 received the „Prêmio Almirante Álvaro Alberto“ from MCTI, the most important Brazilian science prize.

Anthropogenic aerosol cloud-mediated climate forcing: where are we with respect to the pristine background and how far from saturation?

Daniel Rosenfeld,
Hebrew University, Jerusalem, Israel

An outstanding question, to which Prof. Andreae has devoted much attention, is how clean the pristine pre-anthropogenic atmosphere was. The importance of the level of pristine background in important because the effect of aerosols on clouds is logarithmic. This means that the relative effect becomes much larger when the reference background is cleaner. Resolving the relatively large changes of small absolute concentrations of cloud condensation nuclei (CCN) aerosols has become possible only recently with the methodology of satellite retrieval of CCN that uses the clouds as CCN chambers. The application of this methodology revealed that CCN in sparsely populated areas remain at levels typical of the Green Amazon over large distances unless encountering anthropogenic sources.

This is now evident and will be shown for Amazonia, Siberia and Australia. The opposite process of cleansing polluted continental air by cloud processing over ocean is also evident. Polluted decks of marine stratocumulus (MSC) are usually nearly fully cloudy, and they break up when sufficiently cleansed to start drizzling heavily. The cleansing has a positive feedback and jumps to a very clean state abruptly. The cleansing process up to that point takes time that is hypothesized to be nearly linear with the initial level of CCN. Therefore, the MSC remains over ocean longer time and cover larger areas when more polluted at the source of the continental air mass. A long range transport in the free troposphere can amplify this effect. Due to the logarithmic response of cloud-mediated radiative forcing, it was claimed that adding aerosols to the present already high levels would make a very small change. This would have been true if the aerosols are immediately distributed homogeneously all over the world. But the CCN observations shown here demonstrate that the nature of the atmospheric aerosol mixing is rather inhomogeneous, from the scale of the cloud turbulent eddies, and much more so for the larger scales.

The largest aerosol cloud-mediated radiative forcing occurs upon transitions between open and closed cells of marine stratocumulus. The proposed mechanism of delayed breaking of the polluted MSC decks when increasing their initial aerosol concentrations provides a mechanism for an increase of the cloud mediated aerosol forcing with the increase of aerosol emissions that is not subject to the logarithmic response of clouds to CCN concentrations. Similar considerations occur in deep convective clouds, where there appears to be a similar cleansing process that was documented over the Amazon. It is possible that once the cleansing process has advanced fully to equilibrium with the local aerosol production over pristine areas, the atmosphere is as clean as in the pre-industrial state. The time to reach this state is extended increases probably more linearly than logarithmically with the emission levels. Its quantification is becoming a new research challenge.

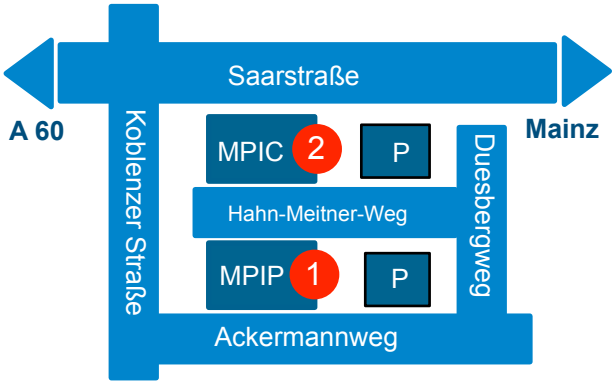
Daniel Rosenfeld

Dr. Rosenfeld received his B.Sc. in geology (1977), and M.Sc./Ph.D. (1986) in cloud physics at the Hebrew University of Jerusalem. He did postdoctoral studies at NASA/GSFC, where he started developing his unique methods for precipitation remote sensing by radars and satellites, and became a science team member of the „Tropical Rainfall Measuring Mission" satellite. In 1988, he returned to the Hebrew University for a faculty position, where he has been serving as a professor.

He focuses his research on the ways by which anthropogenic emissions of particulate air pollution affect cloud composition and precipitation forming processes. He started in the 1980's with effects of cloud seeding on convective clouds for rain enhancement, but quickly expanded it to inadvertent weather modification, which has developed to be presently known as cloud-mediated climatic impacts of aerosols.

His main research means were measurements from instrumented airplanes in clouds over many parts of the world, accompanied by remote sensing radars and satellites. Based on that, he participated in development of weather satellites and their applications. His research yielded a range of insights, including the ways by which air pollution can inhibit the formation of rain in clouds and thus decrease rainfall from shallow clouds, but invigorate storm intensity, lightning and hail from deep clouds. He showed that wind raised sea spray has the opposite effect to air pollution when it seeds the clouds - it enhance the rain and cleanses the clouds from the air pollution. This aerosol related research has been the basis for a highly productive cooperation between Drs. Andreae and Rosenfeld.

Recently Dr. Rosenfeld conceived and developed methodologies for coincident satellite retrievals of cloud drop microstructure, updrafts and the aerosol drop and ice crystal nucleating properties, which are essential for quantifying the aerosol cloud-mediated impacts on Earth's energy budge. Such measurements were unattainable until now. These emerging possibilities are likely to greatly reduce the uncertainty in anthropogenic climate forcing.



1 ***Lectures (10 am - 6 pm)***
Staudinger Lecture Hall
Max Planck Institute for Polymer Research (MPIP)
Ackermannweg 10
55128 Mainz
Germany

2 ***Reception + Dinner (starting 6 pm)***
Max Planck Institute for Chemistry (MPIC)
Hahn-Meitner-Weg 1
55128 Mainz
Germany

Phone: +49-6131-305-3000
(Susanne Benner - press office)
E-Mail: pr@mpic.de
www.mpic.de/facets-of-biogeochemistry