

# Atmospheric Chemistry and Physics

An Interactive Open Access Journal of the European Geosciences Union

[www.atmospheric-chemistry-and-physics.net](http://www.atmospheric-chemistry-and-physics.net)

## Advisory Board Members

### Paul J. Crutzen (Chairman)

Max Planck Institute for Chemistry,  
Mainz, Germany  
[crutzen@mpch-mainz.mpg.de](mailto:crutzen@mpch-mainz.mpg.de)

### Meinrat O. Andreae

Max Planck Institute for Chemistry,  
Mainz, Germany  
[m.andreae@mpic.de](mailto:m.andreae@mpic.de)

### Guy P. Brasseur

National Center for Atmospheric Research,  
Boulder, USA  
[brasseur@ucar.edu](mailto:brasseur@ucar.edu)

### Daniel McKenna

National Center for Atmospheric Research,  
Boulder, USA  
[danny@acd.ucar.edu](mailto:danny@acd.ucar.edu)

### Stuart A. Penkett

University of East Anglia, Norwich, UK  
[m.penkett@uea.ac.uk](mailto:m.penkett@uea.ac.uk)

### Veerabhadran Ramanathan

Scripps Inst. of Oceanography, La Jolla, USA  
[vramanathan@ucsd.edu](mailto:vramanathan@ucsd.edu)

## Executive Editors

### Ulrich Pöschl (Chief-Executive Editor)

Max Planck Institute for Chemistry,  
Mainz, Germany  
[u.poschl@mpic.de](mailto:u.poschl@mpic.de)

### Ken Carslaw

University of Leeds, UK  
[k.s.carslaw@leeds.ac.uk](mailto:k.s.carslaw@leeds.ac.uk)

### Thomas Koop

Bielefeld University, Germany  
[thomas.koop@uni-bielefeld.de](mailto:thomas.koop@uni-bielefeld.de)

### Rolf Sander

Max Planck Institute for Chemistry,  
Mainz, Germany  
[rolf.sander@mpic.de](mailto:rolf.sander@mpic.de)

### William Thomas Sturges

University of East Anglia, Norwich, UK  
[w.sturges@uea.ac.uk](mailto:w.sturges@uea.ac.uk)

## Co-Editors

### Ilse Aben

SRON Netherlands Institute for Space  
Research, Utrecht, The Netherlands  
[i.aben@sron.nl](mailto:i.aben@sron.nl)

### Markus Ammann

Paul Scherrer Institute, Villigen, Switzerland  
[markus.ammann@psi.ch](mailto:markus.ammann@psi.ch)

### Yves Balkanski

Laboratoire CEA-CNRS-UVSQ, LSCE/IPSL,  
Gif-sur-Yvette, France  
[yves.balkanski@lsce.ipsl.fr](mailto:yves.balkanski@lsce.ipsl.fr)

### Urs Baltensperger

Paul Scherrer Institute, Villigen, Switzerland  
[urs.baltensperger@psi.ch](mailto:urs.baltensperger@psi.ch)

### Carlo Barbante

University of Venice, Italy

### Thorsten Bartels-Rausch

Paul Scherrer Institut, Villigen, Switzerland

### Allan Bertram

University of British Columbia, Canada

### Timothy Bertram

University of California, San Diego, USA  
[tbertram@ucsd.edu](mailto:tbertram@ucsd.edu)

### Wolfram Birmili

Leibniz Institute for Tropospheric Research,  
Leipzig, Germany  
[birmili@tropos.de](mailto:birmili@tropos.de)

### Jan W. Bottenheim

Environment Canada, Toronto, Canada  
[jwbottenheim@gmail.com](mailto:jwbottenheim@gmail.com)

### Jørgen Brandt

National Environmental Research Institute,  
Roskilde, Denmark  
[jbr@dmu.dk](mailto:jbr@dmu.dk)

### Stefan Buehler

Lulea University of Technology, Kiruna,  
Sweden  
[sbuehler@ltu.se](mailto:sbuehler@ltu.se)

### James B. Burkholder

NOAA Earth System Research Laboratory,  
Boulder, USA  
[james.b.burkholder@noaa.gov](mailto:james.b.burkholder@noaa.gov)

### Tim Butler

Institute for Advanced Sustainability  
Studies, Germany

### Chak K. Chan

Hong Kong University of Science and  
Technology, Hong Kong  
[keckchan@ust.hk](mailto:keckchan@ust.hk)

### Yafang Cheng

Max Planck Institute for Chemistry,  
Mainz, Germany  
[yafang.cheng@mpic.de](mailto:yafang.cheng@mpic.de)

### Patrick Chuang

University of California, Santa Cruz, USA

### Ronald Cohen

University of California, Berkeley, USA  
[rccohen@berkeley.edu](mailto:rccohen@berkeley.edu)

### John N. Crowley

Max Planck Institute for Chemistry,  
Mainz, Germany  
[john.crowley@mpic.de](mailto:john.crowley@mpic.de)

### Joachim Curtius

Johann Wolfgang Goethe-University,  
Frankfurt am Main, Germany  
[curtius@iau.uni-frankfurt.de](mailto:curtius@iau.uni-frankfurt.de)

### Daniel J. Cziczo

Pacific Northwest National Laboratory,  
Richland, USA  
[djcziczo@mit.edu](mailto:djcziczo@mit.edu)

### Martin Dameris

DLR Oberpfaffenhofen, Germany  
[martin.dameris@dlr.de](mailto:martin.dameris@dlr.de)

### Ashu Dastoor

Science and Technology Branch,  
Air Quality Research Division, Canada

### Frank Dentener

European Commission, Ispra, Italy  
[frank.dentener@jrc.ec.europa.eu](mailto:frank.dentener@jrc.ec.europa.eu)

### Neil M. Donahue

Carnegie Mellon University, Pittsburgh, USA  
[nmd@andrew.cmu.edu](mailto:nmd@andrew.cmu.edu)

### Manvendra K. Dubey

Los Alamos National Laboratory, USA  
[dubey@lanl.gov](mailto:dubey@lanl.gov)

### Bryan N. Duncan

NASA Goddard Space Flight Center,  
Greenbelt, USA  
[bryan.n.duncan@nasa.gov](mailto:bryan.n.duncan@nasa.gov)

### Timothy J. Dunkerton

NorthWest Research Associates,  
Redmond, USA

### Ralf Ebinghaus

Institute for Coastal Research,  
Geesthacht, Germany  
[ralf.ebinghaus@gkss.de](mailto:ralf.ebinghaus@gkss.de)

### Andreas Engel

Goethe University, Frankfurt, Germany

### Quentin Errera

Belgium Institute for Space Aeronomy,  
Belgium  
[quentin@aeronomie.be](mailto:quentin@aeronomie.be)



**Barbara Ervens**

University of Colorado, Boulder, USA  
barbara.ervens@noaa.gov

**Maria Cristina Facchini**

National Research Council (CNR),  
Bologna, Italy

**Graham Feingold**

NOAA Earth System Research Laboratory,  
Boulder, USA  
graham.feingold@noaa.gov

**Federico Fierli**

National Research Council, Rome, Italy  
f.fierli@isac.cnr.it

**Qiang Fu**

University of Washington, Seattle, USA  
qfu@atmos.washington.edu

**Stefano Galmarini**

Joint Research Centre, Ispra, Italy  
stefano.galmarini@jrc.it

**Laurens Ganzeveld**

Wageningen University, Netherlands

**Timothy Garrett**

University of Utah, Salt Lake City, USA  
tim.garrett@utah.edu

**Alan Geer**

European Centre for Medium-Range  
Weather Forecasts, Reading, UK  
alan.geer@ecmwf.int

**Evangelos Gerasopoulos**

National Observatory of Athens, Greece  
egera@noa.gr

**Christoph Gerbig**

Max Planck Institute for Biogeochemistry,  
Jena, Germany

**Stefania Gilardoni**

Institute of Atmospheric Sciences  
and Climate, Italy

**Alex B. Guenther**

National Center for Atmospheric Research,  
Boulder, USA  
guenther@ucar.edu

**Martin Gysel**

Paul Scherrer Institut, Villigen, Switzerland  
martin.gysel@psi.ch

**Robert Harley**

University of California, Berkeley, USA  
harley@ce.berkeley.edu

**Neil Harris**

University of Cambridge, UK  
neil.harris@ozone-sec.ch.cam.ac.uk

**Peter Haynes**

University of Cambridge, UK  
phh@damtp.cam.ac.uk

**Martin Heimann**

Max Planck Institute for Biogeochemistry,  
Jena, Germany  
martin.heimann@bgc-jena.mpg.de

**Ellie Highwood**

University of Reading, UK

**Andreas Hofzumahaus**

Forschungszentrum Jülich, Germany  
a.hofzumahaus@fz-juelich.de

**Rupert Holzinger**

Institute for Marine and Atmospheric  
Research, Utrecht, The Netherlands  
r.holzinger@uu.nl

**Corinna Hoose**

Karlsruhe Institute of Technology, Germany  
corinna.hoose@kit.edu

**Patrick Jöckel**

DLR Oberpfaffenhofen, Germany  
patrick.joekel@dlr.de

**Jan Kaiser**

University of East Anglia, Norwich, UK  
j.kaiser@uea.ac.uk

**Maria Kanakidou**

University of Crete, Heraklion, Greece  
mariak@chemistry.uoc.gr

**Thomas Karl**

National Center for Atmospheric Research,  
Boulder, USA  
tomkarl@ucar.edu

**Veli-Matti Kerminen**

Finnish Meteorological Institute,  
Helsinki, Finland  
veli-matti.kerminen@fmi.fi

**Frank Keutsch**

University of Wisconsin, Madison, USA  
keutsch@wisc.edu

**Astrid Kiendler-Scharr**

Forschungszentrum Jülich, Germany  
a.kiendler-scharr@fz-juelich.de

**Thomas Kirchstetter**

Lawrence Berkeley National Laboratory,  
Berkeley, USA  
twkirchstetter@lbl.gov

**Silvia Kloster**

Max Planck Institute for Meteorology,  
Hamburg, Germany

**Daniel Knopf**

Stony Brook University, USA  
daniel.knopf@stonybrook.edu

**Monika Kopacz**

NOAA Climate Program Office,  
Silver Spring, USA  
monika.kopacz@noaa.gov

**Radovan Krejci**

Stockholm University, Sweden  
radek@itm.su.se

**Martina Krämer**

Research Center Jülich, Germany  
m.kraemer@fz-juelich.de

**Markku Kulmala**

University of Helsinki, Finland  
kulmala@cc.helsinki.fi

**Ari Laaksonen**

University of Eastern Finland,  
Kuopio, Finland  
ari.laaksonen@uef.fi

**William Lahoz**

Norwegian Institute for Air Research,  
Kjeller, Norway  
wal@nilu.no

**Kari Lehtinen**

Finnish Meteorological Institute and  
University of Kuopio, Finland  
kari.lehtinen@uef.fi

**John Liggi**

Environment Canada, Toronto, Canada  
john.liggi@ec.gc.ca

**Xiaohong Liu**

Pacific Northwest National Laboratory,  
Richland, USA  
xiaohong.liu@pnnl.gov

**Franz-Josef Lübken**

Leibniz Institute of Atmospheric Physics,  
Kühlungsborn, Germany  
luebken@iap-kborn.de

**Jianzhong Ma**

Chinese Academy of Meteorological  
Sciences, Beijing, China  
mjz@cma.cma.gov.cn

**Rob MacKenzie**

University of Birmingham, UK

**Bernhard Mayer**

Ludwig-Maximilians-University,  
Munich, Germany  
bernhard.mayer@lmu.de

**Gordon McFiggans**

University of Manchester, UK  
g.mcfiggans@manchester.ac.uk

**Robert McLaren**

York University, Toronto, Canada

**Craig McNeil**

University of Washington, Seattle, USA  
cmcneil@apl.washington.edu

**V. Faye McNeill**

Columbia University, New York, USA  
vfmcneill@columbia.edu

**Nikolaos Mihalopoulos**

University of Crete, Heraklion, Greece  
mihalo@chemistry.uoc.gr

**Paul Monks**

University of Leicester, UK  
p.s.monks@leicester.ac.uk

**Jennifer G. Murphy**

University of Toronto, Canada  
jmurphy@chem.utoronto.ca

**Ottmar Möhler**

Forschungszentrum Karlsruhe,  
Eggenstein-Leopoldshafen, Germany  
ottmar.moehler@kit.edu

**Athanasios Nenes**

Georgia Institute of Technology, Atlanta, USA  
nenes@eas.gatech.edu

**Mathias Palm**

University of Bremen, Germany  
mathias@iup.physik.uni-bremen.de

**Markus Petters**  
North Carolina State University,  
Raleigh, USA  
[markus\\_petters@ncsu.edu](mailto:markus_petters@ncsu.edu)

**Andreas Petzold**  
Forschungszentrum Jülich, Germany  
[a.petzold@fz-juelich.de](mailto:a.petzold@fz-juelich.de)

**Tuukka Petäjä**  
University of Helsinki, Finland

**Andrea Pozzer**  
Max Planck Institute for Chemistry,  
Mainz, Germany  
[andrea.pozzer@mpic.de](mailto:andrea.pozzer@mpic.de)

**Andre S. H. Prevot**  
Paul Scherrer Institute, Villigen, Switzerland  
[andre.prevot@psi.ch](mailto:andre.prevot@psi.ch)

**Alexander Pszenny**  
University of New Hampshire, Durham, USA  
[alex.pszenny@unh.edu](mailto:alex.pszenny@unh.edu)

**Johannes Quaas**  
University of Leipzig, Germany  
[johannes.quaas@uni-leipzig.de](mailto:johannes.quaas@uni-leipzig.de)

**Xavier Querol**  
Institute of Environmental Assessment and  
Water Research, Barcelona, Spain  
[xavier.querol@idaea.csic.es](mailto:xavier.querol@idaea.csic.es)

**Patricia Quinn**  
NOAA, Seattle, USA  
[patricia.k.quinn@noaa.gov](mailto:patricia.k.quinn@noaa.gov)

**Claire Reeves**  
University of East Anglia, Norwich, UK  
[c.reeves@uea.ac.uk](mailto:c.reeves@uea.ac.uk)

**Andreas Richter**  
University of Bremen, Germany  
[andreas.richter@iup.physik.uni-bremen.de](mailto:andreas.richter@iup.physik.uni-bremen.de)

**Nicole Riemer**  
University of Illinois at  
Urbana-Champaign, USA  
[nriemer@illinois.edu](mailto:nriemer@illinois.edu)

**Ilona Riipinen**  
University of Helsinki, Finland

**Janne Rinne**  
University of Helsinki, Finland  
[janne.rinne@helsinki.fi](mailto:janne.rinne@helsinki.fi)

**Greg Roberts**  
Scripps Institution of Oceanography,  
La Jolla, USA  
[roberts.gregc@gmail.com](mailto:roberts.gregc@gmail.com)

**Yinon Rudich**  
Weizmann Institute, Rehovot, Israel  
[yinon.rudich@weizmann.ac.il](mailto:yinon.rudich@weizmann.ac.il)

**Lynn M. Russell**  
UCSD, Scripps Institution of Oceanography,  
La Jolla, USA

**Thomas Röckmann**  
Utrecht University, The Netherlands  
[t.roeckmann@uu.nl](mailto:t.roeckmann@uu.nl)

**Harald Saathoff**  
Karlsruhe Institute of Technology,  
Eggenstein-Leopoldshafen, Germany  
[harald.saathoff@kit.edu](mailto:harald.saathoff@kit.edu)

**Michael Schulz**  
Norwegian Meteorological Institute,  
Oslo, Norway

**John H. Seinfeld**  
California Institute of Technology,  
Pasadena, USA  
[seinfeld@caltech.edu](mailto:seinfeld@caltech.edu)

**Drew Shindell**  
NASA Goddard Institute for Space Studies,  
New York, USA  
[dshindell@giss.nasa.gov](mailto:dshindell@giss.nasa.gov)

**Chul Han Song**  
Gwangju Institute of Science and  
Technology, Republic of Korea  
[chsong@gist.ac.kr](mailto:chsong@gist.ac.kr)

**Dominick Spracklen**  
Institute for Atmospheric Science, Leeds, UK

**Bjorn Stevens**  
Max-Planck-Institut für Meteorologie,  
Hamburg, Germany  
[bjorn.stevens@zmaw.de](mailto:bjorn.stevens@zmaw.de)

**Philip Stier**  
University of Oxford, UK  
[philip.stier@physics.ox.ac.uk](mailto:philip.stier@physics.ox.ac.uk)

**Gabriele Stiller**  
Karlsruhe Institute of Technology, Germany  
[gabriele.stiller@kit.edu](mailto:gabriele.stiller@kit.edu)

**Andreas Stohl**  
Norwegian Institute for Air Research,  
Kjeller, Norway  
[ast@nilu.no](mailto:ast@nilu.no)

**Hang Su**  
Max Planck Institute for Chemistry,  
Mainz, Germany  
[h.su@mpic.de](mailto:h.su@mpic.de)

**Joel Thornton**  
University of Washington, Seattle, USA  
[thornton@atmos.washington.edu](mailto:thornton@atmos.washington.edu)

**David Topping**  
University of Manchester, UK  
[david.topping@manchester.ac.uk](mailto:david.topping@manchester.ac.uk)

**Holger Tost**  
Johannes Gutenberg University,  
Mainz, Germany  
[tosth@uni-mainz.de](mailto:tosth@uni-mainz.de)

**Ivonne Trebs**  
Max Planck Institute for Chemistry,  
Mainz, Germany  
[i.trebs@mpic.de](mailto:i.trebs@mpic.de)

**Kostas Tsigaridis**  
Columbia University and NASA GISS,  
New York, USA  
[kostas.tsigaridis@columbia.edu](mailto:kostas.tsigaridis@columbia.edu)

**Michel Van Roozendael**  
Belgian Institute for Space Aeronomy,  
Brussels, Belgium  
[michelv@oma.be](mailto:michelv@oma.be)

**Geraint Vaughan**  
University of Manchester, UK  
[geraint.vaughan@manchester.ac.uk](mailto:geraint.vaughan@manchester.ac.uk)

**Elisabetta Vignati**  
Joint Research Centre – European  
Commission, Ispra, Italy

**Annele Virtanen**  
University of Eastern Finland, Finland

**Bernhard Vogel**  
Karlsruhe Institute of Technology,  
Eggenstein-Leopoldshafen, Germany  
[bernhard.vogel@kit.edu](mailto:bernhard.vogel@kit.edu)

**Christiane Voigt**  
Deutsches Zentrum für Luft- und Raumfahrt  
(DLR), Wessling, Germany  
[christiane.voigt@dlr.de](mailto:christiane.voigt@dlr.de)

**Rainer Volkamer**  
University of Colorado, Boulder, USA  
[rainer.volkamer@colorado.edu](mailto:rainer.volkamer@colorado.edu)

**Thomas von Clarmann**  
Karlsruhe Institute of Technology, Germany  
[thomas.clarmann@kit.edu](mailto:thomas.clarmann@kit.edu)

**Thomas Wagner**  
Max Planck Institute for Chemistry,  
Mainz, Germany  
[thomas.wagner@mpic.de](mailto:thomas.wagner@mpic.de)

**William Ward**  
University of New Brunswick,  
Fredericton, Canada  
[wward@unb.ca](mailto:wward@unb.ca)

**Ernest Weingartner**  
Paul Scherrer Institute, Villigen, Switzerland  
[ernest.weingartner@psi.ch](mailto:ernest.weingartner@psi.ch)

**Paul O. Wennberg**  
California Institute of Technology,  
Pasadena, USA

**Heini Wernli**  
ETH Zurich, Switzerland  
[heini.wernli@env.ethz.ch](mailto:heini.wernli@env.ethz.ch)

**Jason West**  
University of North Carolina,  
Chapel Hill, USA  
[jjwest@email.unc.edu](mailto:jjwest@email.unc.edu)

**Jonathan Williams**  
Max Planck Institute for Chemistry,  
Mainz, Germany  
[jonathan.williams@mpic.de](mailto:jonathan.williams@mpic.de)

**Fangqun Yu**  
State University of New York at Albany, USA  
[fangqun.yu@asrc.albany.edu](mailto:fangqun.yu@asrc.albany.edu)



## Editorial Support

**Natascha Töpfer**  
Phone: +49-551-900339-40  
[editorial@copernicus.org](mailto:editorial@copernicus.org)

## Publication Production

**Nadine Deisel**  
Phone: +49-551-900339-50  
[production@copernicus.org](mailto:production@copernicus.org)