

Journal of the Atmospheric Sciences

The JOURNAL OF THE ATMOSPHERIC SCIENCES (*JAS*) publishes basic research related to the physics, dynamics, and chemistry of the atmosphere of Earth and other planets, with emphasis on the quantitative and deductive aspects of the subject.

Chief Editor

ZHUO WANG

University of Illinois at Urbana-Champaign

Editors

JOHANNES DAHL

Texas Tech University

JERRY HARRINGTON

The Pennsylvania State University

ADELE IGEL

University of California, Davis

YOSHIO KAWATANI

Hokkaido University

TIFFANY SHAW

University of Chicago

DANIEL STERN

University Corporation for
Atmospheric Research

FENG XU

University of Oklahoma

PETER BARTELLO

McGill University

WILLIAM R. BOOS

University of California, Berkeley

ELIE BOU-ZEID

Princeton University

EDMUND KAR-MAN CHANG

Stony Brook University

Associate Editors

MARTA ABALOS

Universidad Complutense de Madrid, Spain

JAMES ANSTHEY

Environment and Climate Change Canada

PRAGALLVA BARPANDA

Geophysical Institute, University of Bergen,
Norway

MARC CALAF

University of Utah

SI-SI CHEN

National Center for Atmospheric Research

XIAOMIN CHEN

University of Alabama in Huntsville

YAOSHENG CHEN

Cooperative Institute for Research in
Environmental Sciences

VISHAL DIXIT

Indian Institute of Technology Bombay

JEROME FAST

Pacific Northwest National Laboratory

PETER FINOCCHIO

U.S. Naval Research Laboratory

JANNICK FISCHER

Karlsruhe Institute of Technology

MATTHEW FLOURNOY

Cooperative Institute for Mesoscale
Meteorological Studies

CHAIM I. GARFINKEL

Hebrew University of Jerusalem

VIRENDRA P. GHATE

Argonne National Laboratory

MARCO GIOMETTO

Columbia University

SUNDARARAMAN "GOPAL" GOPALAKRISHNAN

NOAA/AOML/Hurricane Research Division

JIAN-FENG GU

Nanjing University

PETER HAYNES

University of Cambridge

ERIC HENDRICKS

National Center for Atmospheric Research

AARON HILL

University of Oklahoma

SPENCER A. HILL

The City College of New York

CHRISTOPHER HOLLOWAY

University of Reading

FALKO JUDD

National Center for Atmospheric Research

CHANH KIEU

Indiana University, Bloomington

YOUNG-HA KIM

Seoul National University

KARA D. LAMB

Columbia University

ZACHARY J. LEBO

University of Oklahoma

DAN LI

Boston University

DAVID LORENZ

University of Wisconsin-Madison

JONATHAN MARTINEZ

Cooperative Institute for Research in
the Atmosphere

CHRISTINA MCCLUSKEY

National Center for Atmospheric Research

VIJAY NATRAJ

Jet Propulsion Laboratory, California
Institute of Technology

ROBERT NYSTROM

National Center for Atmospheric Research

PAUL A. O'GORMAN

Massachusetts Institute of Technology

MARIKO OUE

Stony Brook University

JOHN PETERS

The Pennsylvania State University

RIWAL PLOUGONVEN

Laboratoire de Météorologie Dynamique/IPSL,
Ecole Polytechnique, Institut Polytechnique
de Paris

ROSIMAR RIOS-BERRIOS

National Center for Atmospheric Research

ROB ROGERS

NOAA/AOML/Hurricane Research Division

LISA SCHIELICKE

University of Bonn, Germany

ADITI SHESHADRI

Stanford University

ISRAEL SILBER

Pacific Northwest National Laboratory

Y. QIANG SUN

Rice University

DANDAN TAO

University of Bergen

MARCUS VAN LIER-WALQUI

Columbia University and NASA GISS

ADAM C. VARBLE

Pacific Northwest National Laboratory

MICHAEL WAITE

University of Waterloo

SHUGUANG WANG

School of Atmospheric Sciences,
Nanjing University

RACHEL H. WHITE

University of British Columbia

LIGUANG WU

Fudan University

JUN YANG

Peking University

QIU YANG

Peking University

JUN ZHANG

University of Miami and NOAA/AOML

YANG ZHANG

Nanjing University

PABLO ZURITA-GOTOR

Universidad Complutense de Madrid
and Instituto de Geociencia

Editorial Staff

AMS Lead Technical Editor for JAS
RICHARD R. BRANDT

AMS Lead Copy Editor for JAS
RAMESH PILLAY

Peer Review Staff
ERIN GUMBEL
(Assistant to Dr. Wang)
DJ ARRUDA
CRISTINA BARLETTA

JANE FOLEY
TOM JUSTICE
ROBBIE MATLOCK

AMS Scientific and Technical Journals Staff

Director of Publications
GWENDOLYN WHITTAKER
*Associate Director—Publishing
Technology*

MICHAEL A. FRIEDMAN
Peer Review Support Manager
ANDREA HERBST

*Publications Billing and
AMS Office Manager*
CAITLIN GARRISON

Production Manager
SHEILA F. GAFVERT

Production Team Coordinator
LIZ WRIGHT

Senior Production Assistant
RAMESH PILLAY

Production Assistants
ADRIANNA CROWELL
EVELYN DOBY

Managing Technical Editor
MARK E. FERNAU

Senior Technical Editors
HOLLIS E. BAGUSKAS
RICHARD R. BRANDT

Managing Copy Editor
JESSICA A. LAPOINTE

Senior Copy Editors
KRISTIN GILBERT
RAMESH PILLAY
NICOLE E. RIETMANN
ANDREA L. SCHEIN

© Copyright 2024 American Meteorological Society (AMS). For permission to reuse any portion of this work, please contact permissions@ametsoc.org. Any use of material in this work that is determined to be “fair use” under Section 107 of the U.S. Copyright Act (17 U.S. Code § 107) or that satisfies the conditions specified in Section 108 of the U.S. Copyright Act (17 USC § 108) does not require AMS’s permission. Reproduction, systematic reproduction, posting in electronic form, such as on a website or in a searchable database, or other uses of this material, except as exempted by the above statement, require written permission or a license from AMS. All AMS journals and monograph publications are registered with the Copyright Clearance Center (<https://www.copyright.com>). Additional details are provided in the AMS Copyright Policy statement, available on the AMS website (<https://www.ametsoc.org/PUBSCopyrightPolicy>).

The JOURNAL OF THE ATMOSPHERIC SCIENCES (ISSN 0022-4928) is published monthly by the American Meteorological Society at 45 Beacon Street, Boston, MA 02108. Subscription rates for this and other AMS titles are available online at <https://www.ametsoc.org/index.cfm/ams/publications/subscription-information>. For information on becoming an AMS member and/or subscribing to the Society’s journals, visit the AMS website: <https://www.ametsoc.org/ams/>. Subscription orders, claims for missing numbers, changes of address, and other business correspondence should be sent to amsinfo@ametsoc.org (or to the American Meteorological Society, 45 Beacon Street, Boston, MA 02108-3693). Periodical postage paid at Boston, MA, and at additional mailing offices. POSTMASTER: Send address changes to the *Journal of the Atmospheric Sciences*, American Meteorological Society, 45 Beacon Street, Boston, MA 02108-3693.

INFORMATION FOR CONTRIBUTORS

Submissions Manuscripts for *Journal of the Atmospheric Sciences* should be submitted to <https://www.editorialmanager.com/amsjas/>. General questions about *Journal of the Atmospheric Sciences* should be sent to jas@ametsoc.org. Detailed information about the journal is available in the Journals section of the AMS Publications website. Authors are advised to check the AMS author information web pages for the most current information on the preparation and submission of manuscripts.

Copyright Policy The American Meteorological Society’s mission to disseminate knowledge in the atmospheric and related oceanic and hydrologic sciences is best served by promoting wide access to AMS publications while ensuring that this dissemination preserves the integrity of the originally published works. The copyrights to the materials published in AMS journals, monographs, and other publications are transferred from the authors to AMS at the time the materials are accepted for publication, allowing AMS to act as the steward for the intellectual property contained in the published works. It also allows AMS to protect the value of the materials in order to generate revenue for AMS to support the peer-review publication process so crucial to the scholarly scientific endeavor.

Use of AMS Copyrighted Materials Figures, tables, and brief excerpts from AMS primary journals (*Bulletin of the American Meteorological*

Society; Artificial Intelligence for the Earth Systems; Journal of the Atmospheric Sciences; Journal of Applied Meteorology and Climatology; Journal of Physical Oceanography; Monthly Weather Review; Journal of Atmospheric and Oceanic Technology; Weather and Forecasting; Journal of Hydrometeorology; Journal of Climate; Weather, Climate, and Society) and Meteorological Monographs may be used in scientific educational works provided the original source is acknowledged. This policy also applies to earlier issues in which the copyright notice may have stated a different policy. Restrictions on other uses of material from the abovementioned primary publications, including republication and copying of articles, are stated in the copyright notice near the front of each issue and discussed in more detail in the AMS Copyright Policy available in the Author Resources section of the AMS website. It is emphasized that the policy stated in the opening sentence above applies only to primary publications listed there. For policy on copying and other uses of materials from *Meteorological and Geostrophical Abstracts*, the *Glossary of Meteorology*, and all other AMS publications and books, please consult the copyright notice in each.

Publication Charges Authors’ institutions or sponsors are requested to pay the publication charges. Information on current publication charges is available on the AMS website.