

Monthly Weather Review

MONTHLY WEATHER REVIEW (*MWR*) publishes research relevant to the analysis and prediction of observed atmospheric circulations and physics, including technique development, data assimilation, model validation, and relevant case studies. This research includes numerical and data assimilation techniques that apply to the atmosphere and/or ocean environments. *MWR* also addresses phenomena having seasonal and subseasonal time scales.

Chief Editor

RON McTAGGART-COWAN
Environment and Climate Change Canada

Associate Chief Editor

KRISTEN L. CORBOSIERO
University of Albany, State University of New York

Editors

JEFFREY ANDERSON
National Center for Atmospheric Research
TOMMASO BENACCHIO
Danish Meteorological Institute
MARK BUEHNER
Environment and Climate Change Canada
CLARK EVANS
NOAA/OAR/Global Systems Laboratory
TOM GALARNEAU
National Severe Storms Laboratory
JIDONG GAO
NOAA/NCEP Severe Storms Laboratory

JOSHUA P. HACKER
National Center for Atmospheric Research
DARYL KLEIST
NOAA/NWS/NCEP/Environmental Modeling Center
MATTHEW R. KUMJIAN
The Pennsylvania State University
JUSTIN McLAY
Naval Research Laboratory
ZHIYONG MENG
Peking University
JUSTIN MINDER
University of Albany, State University of New York

DEREK POSSELT
Jet Propulsion Laboratory, California Institute of Technology
JULIAN QUINTING
Karlsruher Institut für Technologie
ROSAMAR RIOS-BERRIOS
National Center for Atmospheric Research
PAUL ROUNDY
University of Albany, State University of New York
ANGELA ROWE
University of Wisconsin–Madison

RUSS S. SCHUMACHER
Colorado State University
JASON SIPPEL
NOAA/Atlantic Oceanographic and Meteorological Laboratory/Hurricane Research Division
STAN TRIER
National Center for Atmospheric Research
CHRISTOPHER WEISS
Texas Tech University
ANDREW WINTERS
University of Colorado Boulder

Associate Editors

BECKY ADAMS-SELIN
Atmospheric and Environmental Research
ALTUĞ AKSOY
University of Miami and NOAA/AOML
JAVIER AMEZCUA
Tecnológico de Monterrey and University of Reading
KARINA APODACA-MARTINEZ
Spire Global, Inc., Weather and Earth Intelligence
THOMAS BENDALL
Met Office
DAVID BODINE
University of Oklahoma
JOSEPH BOOMGARD-ZAGRODNIK
Verisk Weather Solutions
MICHAEL J. BRENNAN
NOAA/NWS/NCEP National Hurricane Center
KRISTEN CALHOUN
NOAA/National Severe Storms Laboratory
JEAN-FRANÇOIS CARON
Environment and Climate Change Canada
STEVEN CAVALLO
University of Oklahoma
TING-YU CHA
National Center for Atmospheric Research
MANDA CHASTEEN
National Center for Atmospheric Research
BUO-FU CHEN
Center for Weather and Climate Disaster Research, National Taiwan University
RAY CHEW
Goethe University Frankfurt
HRISTO G. CHIPILSKI
Florida State University
BRUCE COFFER
North Carolina State University
MICHAEL CONIGLIO
NOAA/National Severe Storms Laboratory
ALEX CRAWFORD
Centre for Earth Observation Science, Clayton Riddell Faculty of Environment Earth and Resources, University of Manitoba
DANIEL T. DAWSON II
Purdue University
JENNIFER DEHART
Colorado State University
CHARLOTTE DEMOTT
Colorado State University
LEIF DENBY
Danish Meteorological Institute
SARAH D. DITCHEK
CIMAS, University of Miami and NOAA/AOML/Hurricane Research Division

ANDREAS DÖRNBRACK
German Aerospace Center Oberpfaffenhofen
YU DU
Sun Yat-sen University
JEFF DUDA
CIRES, University of Colorado Boulder, and NOAA/Global Systems Laboratory
PATRICK DURAN
NASA Marshall Space Flight Center
PETER FINOCCHIO
U.S. Naval Research Laboratory
MICHAEL FISCHER
NOAA/AOML/Hurricane Research Division
MATTHEW FLOURNOY
NOAA/NWS/NCEP Storm Prediction Center
MICHAEL M. FRENCH
Stony Brook University
STEPHANE GAUDREAU
Environment and Climate Change Canada
GUOQING GE
CIRES, University of Colorado Boulder, and NOAA/Earth System Research Laboratory
JEREMY A. GIBBS
NOAA/National Severe Storms Laboratory
ERIC GILLELAND
National Center for Atmospheric Research
STEVEN J. GREYBUSH
The Pennsylvania State University
OKSANA GUBA
Sandia National Laboratories
SOYOUNG HA
National Center for Atmospheric Research
ANDREA N. HAHMANN
DTU Wind, Technical University of Denmark
WEI HAN
Earth System Modeling and Prediction Centre, China Meteorological Administration
ANDREW HAZELTON
CIMAS, University of Miami and NOAA/AOML/Hurricane Research Division
THUS HEUS
Cleveland State University
AARON HILL
University of Oklahoma
JANA HOUSER
Ohio University
YONGJIE HUANG
University of Oklahoma
DOMINIK JACQUES
Environment and Climate Change Canada
AARON JOHNSON
University of Oklahoma
WILLIAM A. KOMAROMI
NOAA/NWS/OSTI-Modeling and IMSG

JAMES M. KURDZO
MIT Lincoln Laboratory
MARCIN KUROWSKI
Jet Propulsion Laboratory
ANDREA L. LANG
University of Wisconsin–Madison
LILI LEI
Nanjing University
YU-CHIENG LIU
National Central University, Taiwan
ANTHONY LYZA
NOAA/OAR/National Severe Storms Laboratory
JIM MARQUIS
Pacific Northwest National Laboratory
JONATHAN MARTINEZ
Cooperative Institute for Research in the Atmosphere
ANNARELI MORALES
Weld County Department of Public and Environmental Health, Greeley, Colorado
JAKE MULHOLLAND
University of North Dakota
SHAWN MURDZEK
CIRES, University of Colorado Boulder, and NOAA/Global Systems Laboratory
JASON E. NACHAMKIN
Naval Research Laboratory
CHRISTOPHER NOWOTARSKI
Texas A&M University
KELLY M. NÚÑEZ OCASIO
Texas A&M University
JOHN PETERS
The Pennsylvania State University
JUSTIN PFLUG
University of Maryland Earth System Science Interdisciplinary Center and NASA Goddard Hydrological Sciences Laboratory
JONATHAN POTERJOY
University of Maryland
JACOPO RIBOLDI
ETH Zurich
MICHAEL RIEMER
Johannes Gutenberg-Universität Mainz
JAMES RUPPERT
University of Oklahoma
BEN SCHENKEL
University of Oklahoma and the National Severe Storms Laboratory
CARL SCHRECK III
North Carolina State University
ALEX SCHUETH
Texas Tech University
CRAIG SCHWARTZ
National Center for Atmospheric Research

KEITH D. SHERBURN
NOAA/National Weather Service
PATRICK SKINNER
CIMMS, University of Oklahoma, and NOAA/OAR/National Severe Storms Laboratory
LAURA SLIVINSKI
CIRES, University of Colorado Boulder, and NOAA/Physical Sciences Laboratory
RYAN SOBASH
National Center for Atmospheric Research
CHRISTOPHER SUBICH
Environment and Climate Change Canada
W. JAMES STEENBURGH
University of Utah
MAXIME TAILLARDAT
Météo-France and National Centre for Meteorological Research
DANA TOBIN
CIRES, University of Colorado Boulder, and NOAA/Weather Prediction Center
RYAN D. TORN
University of Albany, State University of New York
BENJAMIN TRABING
NOAA/NWS/National Hurricane Center and UCAR
STEFAN TULICH
CIRES, University of Colorado Boulder, and NOAA/Earth System Research Laboratory/Physical Sciences Division
MARCUS VAN LIER-WALQUI
Columbia University, and NASA Goddard Institute for Space Studies
ADAM VARBLE
Pacific Northwest National Laboratory
ROBERT ADAM WARREN
Bureau of Meteorology, Australia
BRANDON WOLDING
CIRES, University of Colorado Boulder, and NOAA/Earth System Research Laboratory/Physical Sciences Laboratory
MAY WONG
National Center for Atmospheric Research
KIMBERLEY WOOD
University of Arizona
ROCHELLE WORSNOP
CIRES, University of Colorado Boulder, and NOAA/Physical Sciences Laboratory
GEORGE YOUNG
The Pennsylvania State University
YUNJI ZHANG
The Pennsylvania State University
BOWEN ZHOU
Nanjing University
ANDREA ZONATO
University of Trento, Italy

AMS Scientific and Technical Journals Staff

Director of Publications
GWENDOLYN WHITTAKER

Managing Production Editors
HOLLIS E. BAGUSKAS
JESSICA LAPOINTE

Senior Peer Review Support Assistants
DJ ARRUDA
ROBBIE MATLOCK

Production Team Coordinator
LIZ WRIGHT

Associate Director—Publishing Technology
MICHAEL A. FRIEDMAN

Peer Review Support Manager
ANDREA HERBST

Peer Review Support Assistants
JANE FOLEY
COLLEEN GAFFNEY
TOM JUSTICE

Senior Production Assistant
RAMESH PILLAY

Publications Billing and AMS Office Manager
CAITLIN GARRISON

Senior Peer Review Support Associates
CRISTINA BARLETTA
HAYLEY CHARNEY
ERIN GUMBEL

Production Manager
SHEILA F. GAFFERT

Production Assistants
ADRIANNA CROWELL
EVELYN DOBY

© 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.C. § 107) or that satisfies the conditions specified in Section 108 of the U.S. Copyright Act (17 U.S.C. § 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 MONTHLY WEATHER REVIEW (ISSN 0027-0644) 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>. 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 *Monthly Weather Review*, American Meteorological Society, 45 Beacon Street, Boston, MA 02108-3693.