SUPPLEMENT

# EXPLAINING EXTREME EVENTS OF 2015 FROM A CLIMATE PERSPECTIVE

**Editors**
Stephanie C. Herring, Andrew Hoell, Martin P. Hoerling, James P. Kossin,
Carl J. Schreck III, and Peter A. Stott

**Special Supplement to the**
*Bulletin of the American Meteorological Society*
Vol. 97, No. 12, December 2016

Cover credits:
Front: ©Photo by Joe Raedle/Getty Images—A vehicle drives through flooded streets The flood was caused by a combination of the lunar orbit which caused seasonal high tides and what many believe is the rising sea levels due to climate change. (on September 30, 2015, in Fort Lauderdale, Florida) South Florida is projected to continue to feel the effects of climate change, and many of the cities have begun programs such as installing pumps or building up sea walls to combat the rising oceans.

AMERICAN METEOROLOGICAL SOCIETY

# S11. THE ROLE OF ANTHROPOGENIC WARMING IN 2015 CENTRAL EUROPEAN HEAT WAVES

Sebastian Sippel, Friederike E. L. Otto, Milan Flach, and Geert Jan van Oldenborgh

This document is a supplement to "The Role of Anthropogenic Warming in 2015 Central European Heat Waves" by Sebastian Sippel, Friederike E. L. Otto, Milan Flach, and Geert Jan van Oldenborgh (*Bull. Amer. Meteor. Soc.*, **97 (12)**, S51–S56) • ©2016 American Meteorological Society • DOI:10.1175/BAMS-D-16-0150.2

See figures on following pages.

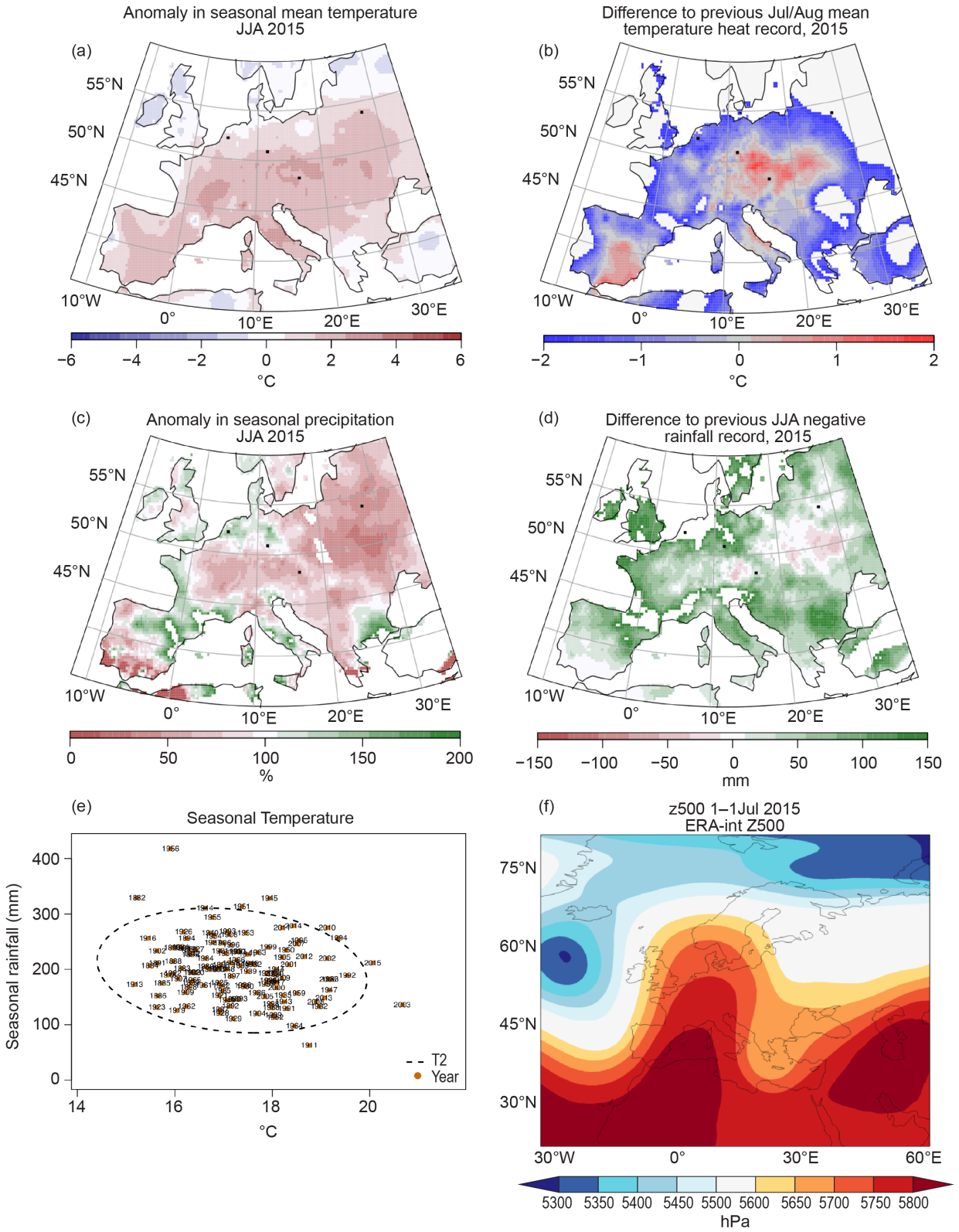


**Fig. S11.1. (a), (c) Anomalies in European summer 2015 seasonal mean temperature (°C) and precipitation (%), respectively. (b),(d) Differences to previous Jul/Aug records in mean temperature (°C) and low rainfall (mm), respectively, relative to 1950–2014 as in the main text. (e) Seasonal temperature (°C) versus seasonal rainfall (mm) in Vienna, Austria. The ellipse denotes a quantile of 5% multivariate extremes computed by Hotelling's T^2 control chart (Santos-Fernández 2012) using robust mean and covariance estimates (Rousseeuw and Hubert 2011). (f) 500-hPa geopotential heights over Europe on 1 Jul 2015.**

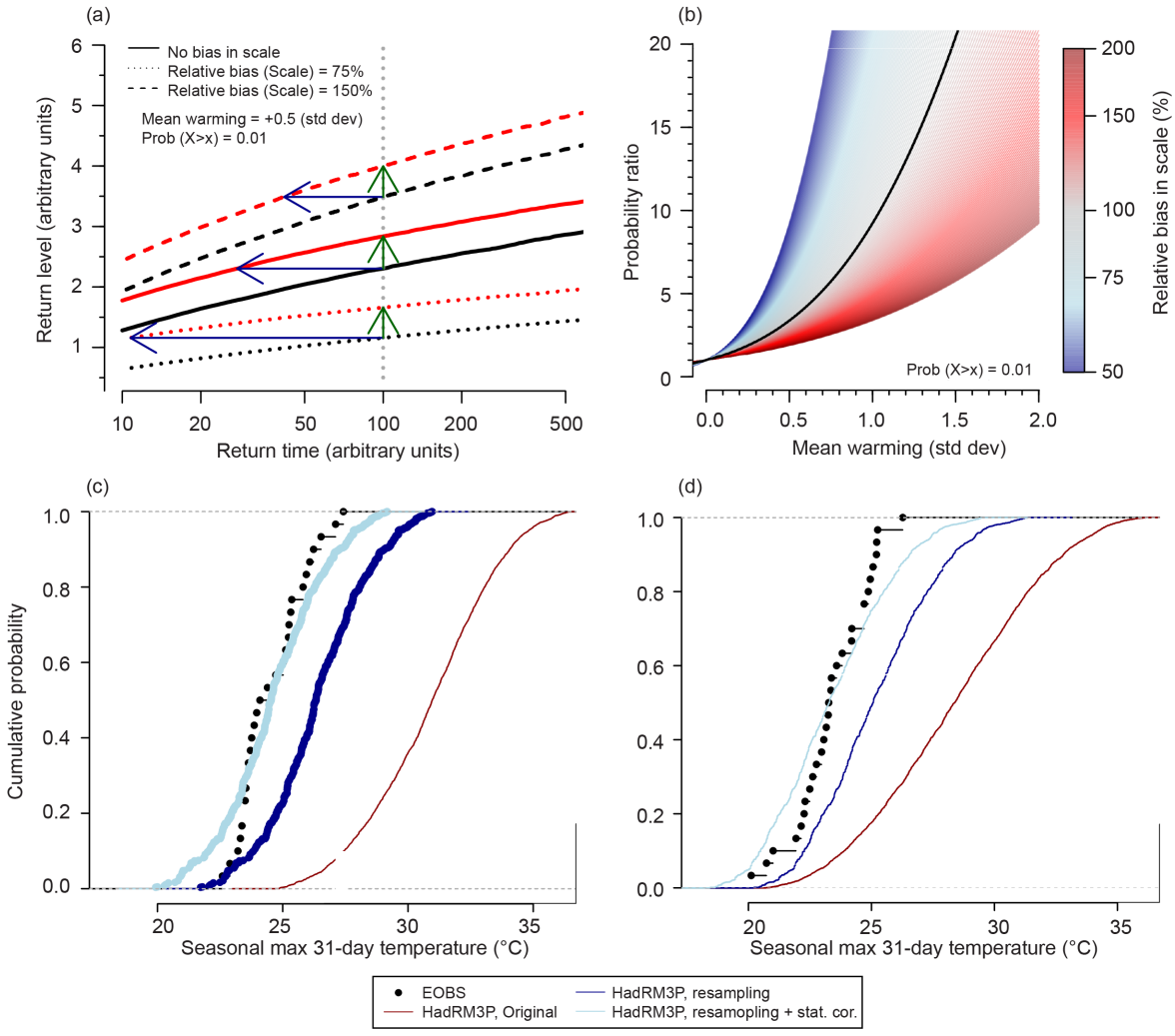


**Fig. S11.2. (a) Return time plots for Gaussian distributed random variables that differ only in their standard deviation. A mean shift of 0.5 std dev results in an equal change in return levels, but leads to substantially different changes in return times across the three sets. (b) Probability ratio for different levels of mean warming and biases in std dev. Cumulative distribution function of Tair3d,max in (c) Vienna and (d) Jena in the "original," "resampled," and "resampled+mean-adjustment" simulations; temperature in °C.**

## REFERENCES

Rousseeuw, P. J., and M. Hubert, 2011: Robust statistics for outlier detection. *Wiley Interdiscip. Rev.: Data Mining Knowl. Discov.*, **1**, 73–79, doi:10.1002/widm.2.

Santos-Fernández, E., 2012: *Multivariate Statistical Quality Control Using R*. Springer, 134 pp., doi:10.1007/978-1-4614-5453-3.