nature climate change

SUPPLEMENTARY INFORMATION

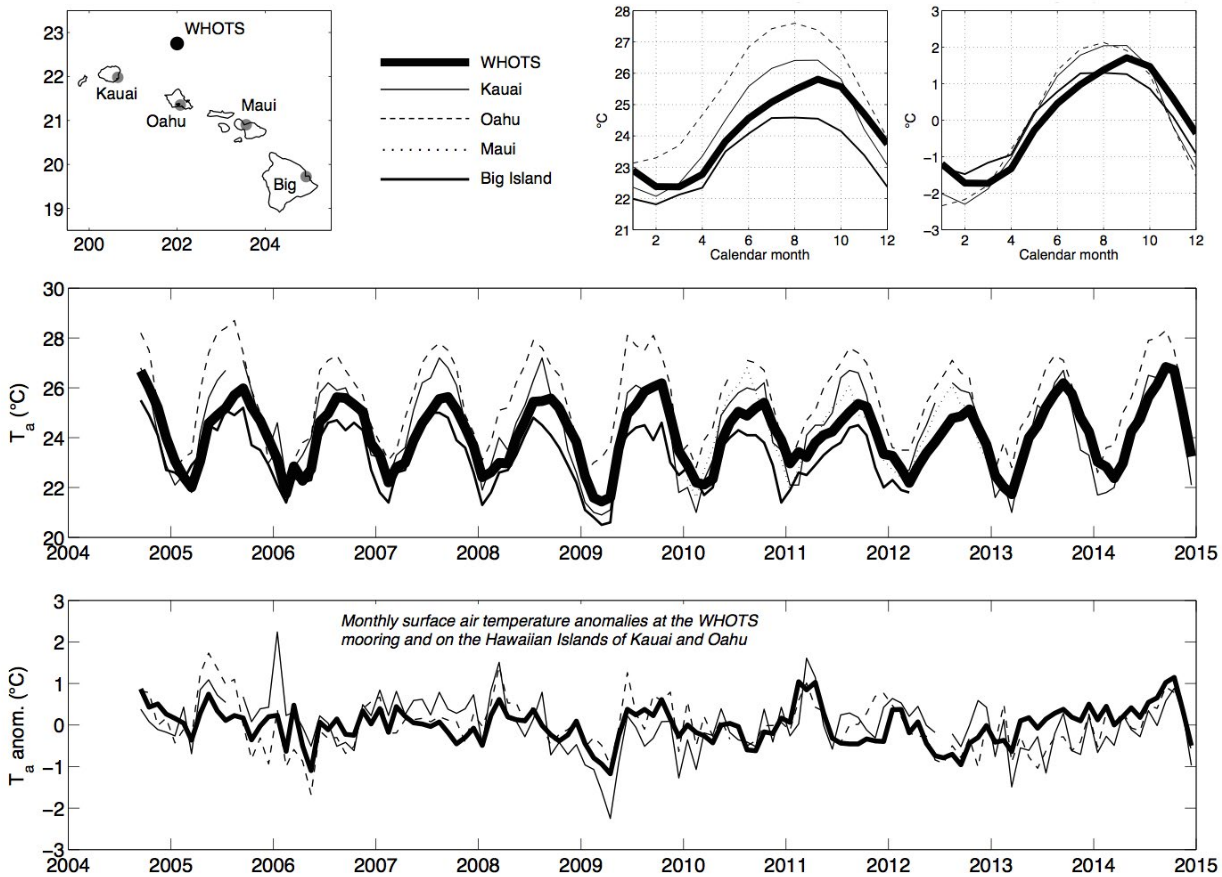
DOI: 10.1038/NCLIMATE2987

Future freshwater stress for island populations

Kristopher B. Karnauskas, Jeffrey P. Donnelly and Kevin J. Anchukaitis

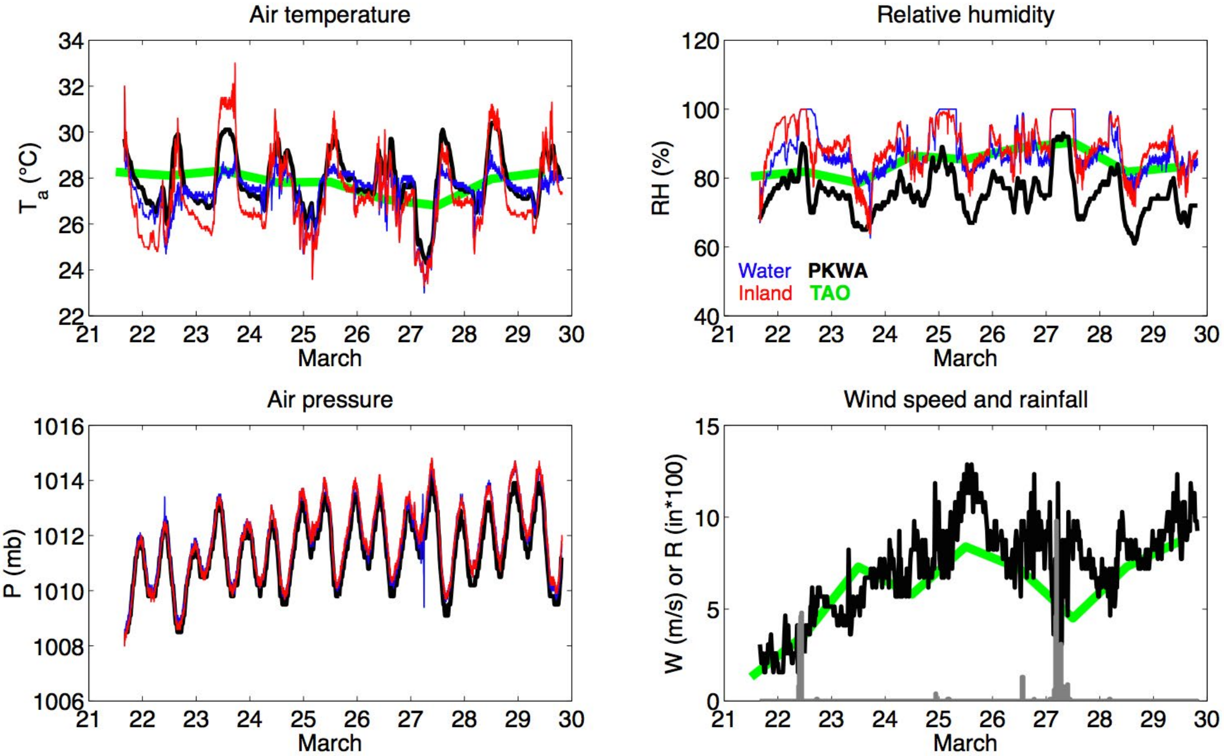
Summary: Top left: Overview map of the four island stations located in the U.S. state of Hawaii and the Woods Hole Oceanographic Institution (WHOI)–University of Hawaii Ocean Time Series (WHOTS) mooring north of Oahu (22.8°N, 158°W). The Hawaiian stations are Lihue on Kauai (22°N, 159.4°W, 45 m), Honolulu on Oahu (21.4°N, 157.9°W, 5 m), Kahului on Maui (20.9°N, 156.4°W, 20 m), and Hilo on Big Island (19.7°N, 155.1°W, 11 m). Data span 2004–2014; Kauai and Oahu have the most complete, continuous records (122 and 123 months of data, respectively), while Maui and Big Island have more substantial gaps (41 and 91 months of data, respectively). The Kauai and Oahu stations are located 160 km from the WHOTS mooring, while Maui and Big Island are located 260 and 450 km from the WHOTS mooring, respectively. Top center: Climatological mean seasonal cycles of monthly surface air temperature (°C) at Kauai, Oahu, and Big Island, and at the WHOTS mooring. Correlation coefficients are 0.98, 0.99, and 0.96 for the WHOTS mooring versus Kauai, Oahu, and Big Island, respectively, with the islands leading the mooring by one month in every case. Top right: As in left, but with the annual mean removed from each time series. Middle: Time series of monthly mean surface air temperature (°C) at the WHOTS mooring and Kauai, Oahu, Maui, and Big Island. Correlation coefficients are 0.89, 0.87, 0.85, and 0.90 for the WHOTS mooring versus Kauai, Oahu, Maui, and Big Island, respectively. Bottom: As in top, but for anomalies (i.e., mean monthly climatology removed); only Kauai and Oahu are included as those stations have the longest complete records, extending through 2014. Correlation coefficients are 0.55 and 0.64 for the WHOTS mooring versus Kauai and Oahu, respectively. Monthly mean surface air temperature observations from island stations were gathered from the U.S. National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) Global Historical Climatology Network version 3 (GHCN v3; ftp.ncdc.noaa.gov/pub/data/ghcn/v3/). Monthly mean moored air temperatures were computed from the high–frequency (1 minute) measurements by the WHOTS mooring as provided by the WHOTS project data portal (http://uop.whoi.edu/projects/WHOTS/whotsarchive.html).

DOI: 10.1038/NCLIMATE2987



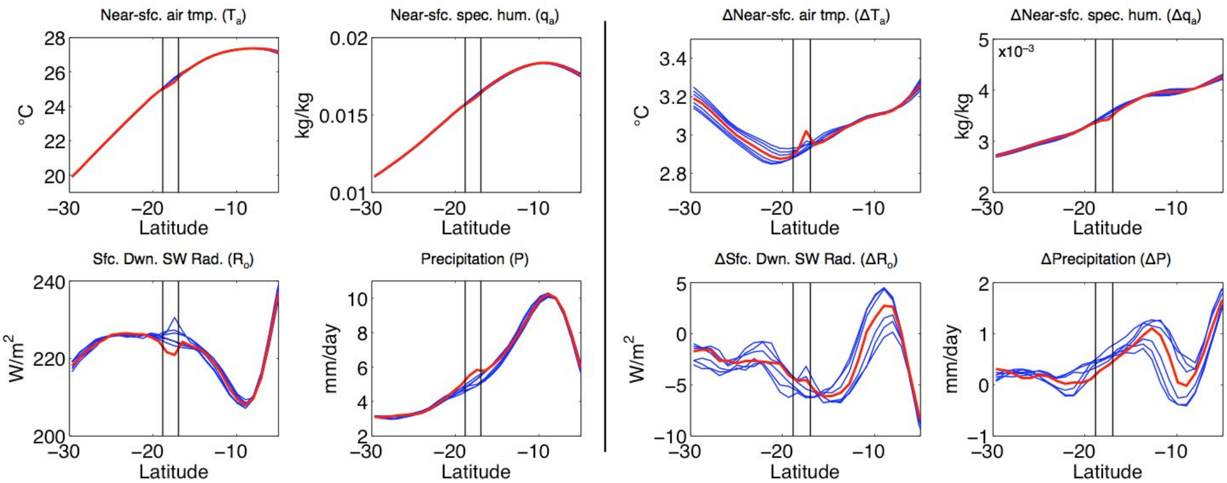
Summary: Top left: Surface air temperature (°C) from March 21–30, 2015 recorded on Kwajalein, Republic of the Marshall Islands and at the 8°N, 165°E TAO mooring (located 310 km W/SW of Kwajalein). The environmental loggers (Kestrel DROP) deployed on Kwajalein at the "water" (~2 m from water's edge) and "inland" (~120 m from water) sampled at 2-minute resolution, while the Bucholz Army Airfield weather station (PKWA; also located inland, ~830 m east of the environmental loggers) sampled at 20-minute resolution; the TAO mooring provides daily averages. Top right: As in top left, but for relative humidity (%). Bottom left: As in top-left, but for air pressure (mb; TAO data not available). Bottom right: Wind speed (m/s) recorded at station PKWA on Kwajalein and at the 8°N, 165°E TAO mooring; rainfall at PKWA also shown (grey bars).

Format: PNG
Size: 332 KB

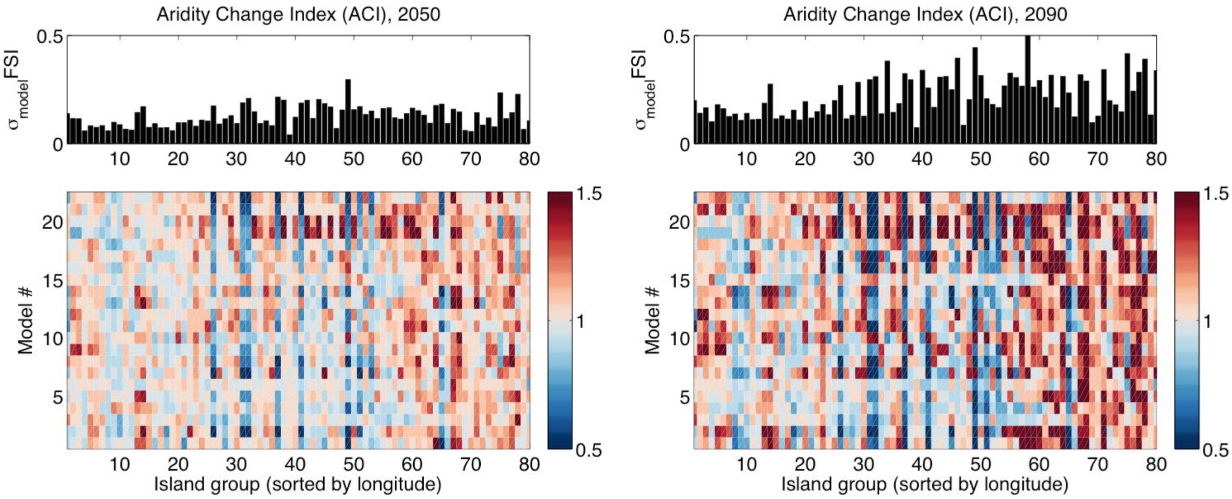


 DOI: 10.1038/NCLIMATE2987

Summary: Time–mean climatic variables (1981–1999) and their change under RCP8.5 forcing (2081–2099 relative to 1981–1999) as a function of latitude in the vicinity of Viti Levu (Fiji) as simulated by the CESM1–CAM5 model[24]. The red line in each panel is the average of the two profiles running directly through the model island, while the six blue lines in each panel are profiles immediately adjacent to the model island (three on either side). The two vertical black lines in each panel represent the full extent of the island in the model. Viti Levu is resolved in this GCM as 2 x 2 grid cells (~57,000 km^2) with elevation from 20–40 m. The actual island has a land area of 10,388 km^2 with maximum elevation of 1,394 m. Thus, this GCM represents Viti Levu as a substantially larger but flatter version of the actual island.

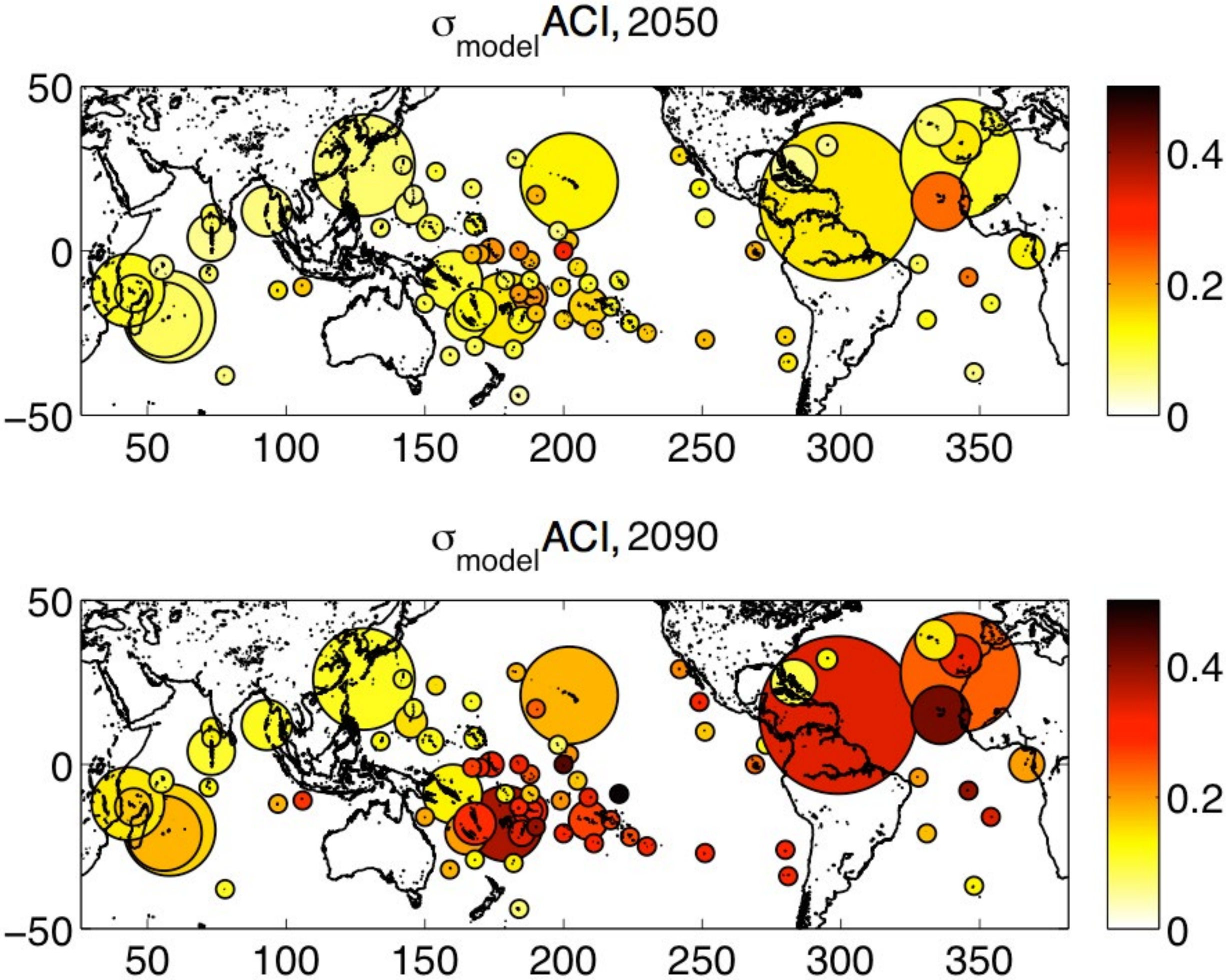


Summary: ACI at 2050 and 2090 as a function of island group (sorted by longitude) and model (in order of appearance in Supplementary Table 1) (bottom row), and the inter–model standard deviation of ACI as a function of island group at 2050 and 2090 (top row).

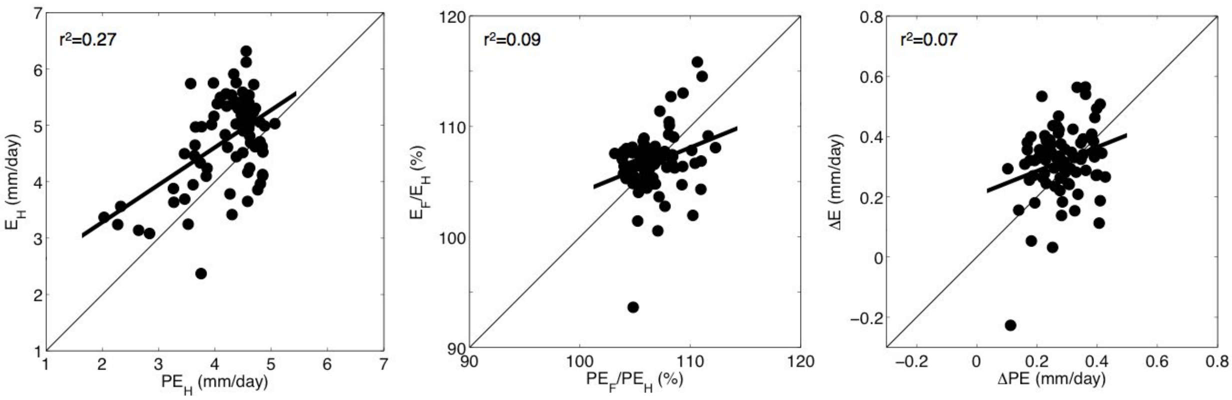


DOI: 10.1038/NCLIMATE2987

Summary: Inter–model standard deviation of ACI at 2050 (top) and 2090 (bottom).



Summary: Left: Comparison of multi-model mean, annual mean *PE* and *E* from the historical simulations at all 80 island groups considered in this study. Center: As in left but for the fractional change in PE and E between 2090 and 1990. Right: As in center but for the changes expressed as the difference (future–historical). In each panel, the thin line is the 1:1 line and the thick line is the ordinary least–squares regression line fit to the data. The r^2 value is shown in the upper–left corner of each panel.



 DOI: 10.1038/NCLIMATE2987

Summary: List of the 22 Coupled Model Intercomparison Project, Phase 5 (CMIP5)[18] global climate models (GCMs) used in this study, including model name, zonal and meridional atmospheric resolution, institution, country, and primary reference. The first run ("r1i1p1") of the historical and RCP8.5 experiments were used, except that r2i1p1 was used for the models marked with an asterisk due to one or more of the required outputs missing for r1i1p1.

Model Name (*)	x–res	y–res	Institution, Country [Reference]
ACCESS1–0	1.9	1.3	Commonwealth Scientific and Industrial Research Organisation, Bureau of Meteorology, Australia [41]
ACCESS1–3	1.9	1.3	Commonwealth Scientific and Industrial Research Organisation, Bureau of Meteorology, Australia [41]
bcc–csm1–1	2.8	2.8	Beijing Climate Center, China Meteorological Administration, China [42]
bcc–csm1–1–m	1.1	1.1	Beijing Climate Center, China Meteorological Administration, China [42]
CESM1–CAM5	1.3	0.9	National Center for Atmospheric Research, USA, [24]
CNRM–CM5 *	1.4	1.4	Centre National de Recherches Met., Centre Europeen de Recherche et Formation Advancees en Calcul Scientifique, France [43]
CSIRO–Mk3–6–0 *	1.9	1.9	Queensland Climate Change Centre of Excellence, Commonwealth Scientific and Industrial Research Organisation, Australia [6]
GFDL–CM3	2.5	2.0	NOAA Geophysical Fluid Dynamics Laboratory, USA [44]
GFDL–ESM2G	2.5	2.0	NOAA Geophysical Fluid Dynamics Laboratory, USA [45]
GFDL–ESM2M	2.5	2.0	NOAA Geophysical Fluid Dynamics Laboratory, USA [45]
GISS–E2–H	2.5	2.0	NASA Goddard Institute for Space Studies, USA [46]
GISS–E2–R	2.5	2.0	NASA Goddard Institute for Space Studies, USA [46]
HadGEM2–CC	1.9	1.3	Met Office Hadley Centre, UK [47]
HadGEM2–ES *	1.9	1.3	Met Office Hadley Centre, UK [47]
inmcm4	2.0	1.5	Russian Institute for Numerical Mathematics, Russia [48]
IPSL–CM5A–LR	3.8	1.9	Institut Pierre Simon Laplace, France [49]
IPSL–CM5A–MR	2.5	1.3	Institut Pierre Simon Laplace, France [49]
IPSL–CM5B–LR	3.8	1.9	Institut Pierre Simon Laplace, France [49]
MIROC–ESM	2.8	2.8	University of Tokyo, National Institute for Environmental Studies, Japan Agency for Marine–Earth Science and Technology, Japan [50]
MIROC–ESM–CHEM	2.8	2.8	University of Tokyo, National Institute for Environmental Studies, Japan Agency for Marine–Earth Science and Technology, Japan [50]
MIROC5	1.4	1.4	University of Tokyo, National Institute for Environmental Studies, Japan Agency for Marine–Earth Science and Technology, Japan [51]
MRI–CGCM3	1.1	1.1	Meteorological Research Institute, Japan [52]