Seven Monthly Variables: Precipitation, Tmax, Tmean, Tmin, Wind, Solar Radiation and Relative Humidity

Introduction

The most basic global variables in Climate Insights consist of temperature, precipitation, wind speed, solar radiation, and relative humidity.

Temperature

Global mean, maximum and minimum temperature datasets are the foundation. This data is created from the CRU_ts3.20 (1981-2010) dataset with a spatial resolution of 0.5° for the land area. As for the ocean area, the mean temperature data are derived from NASA reanalysis data, and the diurnal temperature range is derived from multiple GCMs, applying maximum and minimum temperatures.

Precipitation

Global land precipitation climatology is created with the Global Precipitation Climatology Centre (GPCC) monthly rainfall dataset (1981-2100), while Ocean precipitation is extracted from Xie Arkin (1981-2002), with additional data derived from the monthly precipitation of the Global Precipitation Climatology Project (GPCP; 2003-2010 at a spatial resolution of 1°).

Wind speed

To get a more accurate baseline with a global coverage, the wind speed baseline is a monthly climatology derived from three datasets, then interpolated to the standardized 0.5°x0.5° latitude and longitude grid defined by Climate Insights.

The wind data, excluding the polar area, are collected from NOAA Blended Sea Winds, which contain globally gridded, high resolution ocean surface vector winds and wind stresses on a global 0.25° grid, and multiple time resolutions of 6-hourly, daily and monthly intervals (1995-2005) . The monthly wind speed over the polar area is obtained for a 10-year period (July 1983 - June 1993) from the NASA POWER Project.

Solar radiation

The solar radiation data are collected from the NASA Langley Research Centre Atmospheric Science Data Centre. The data set contains monthly average global fields of eleven shortwave (SW) surface radiative parameters derived with the shortwave algorithm of the NASA World Climate Research Programme/ Global Energy and Water-Cycle Experiment (WCRP/GEWEX) Surface Radiation Budget (SRB) Project. The Climate Insights baseline uses all Sky Surface Downward Flux (RSDS in GCM variable name convention) monthly averages from 1984 to 2006.

Relative humidity

Relative humidity data is derived from NASA reanalysis monthly assimilated pressure data with an original resolution of 0.888888° (1981 to 2000).

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Generate and Apply Global Climate Change Patterns

The CMIP5 data for the four RCPs were retrieved from the Earth System Grid (ESG) data portal (see the GCM section in the Appendix for details). The size of whole datasets is too big to be re-distributed to a client needing specific data. Moreover, it is not economic for Climate Insights to serve that voluminous data through the internet.

In Climate Insights, these climatic data have been transformed into a global climate change pattern through a pattern-scaling method. In a word, pattern-scaling is a methodology that takes advantage of the fact that, to a reasonable approximation, local and seasonal changes in surface climate are linear in terms of the rate of warming over land and across the globe. It allows interpolation away from a limited number of available GCM simulations, enabling a time-efficient assessment of surface meteorological changes for alternative nonstandard future scenarios of changed GHG concentrations. Climate-change patterns (or "patterns") are coefficients of the regression between a real mean warming over Earth's land regions and local changes in surface climatology. They are derived by comparison against outputs from GCMs and presented as local monthly mean changes over land per degree of mean warming over land.

Patterns in Climate Insights have been created for each model using its raw data. These data have different spatial resolutions. For convenience of ensemble analyses, all resultant patterns were re-gridded to a common 720 x 360 grid (0.5°x0.5° in latitude and longitude) using a bilinear interpolation method. The patterns are produced mainly for the corresponding variables.

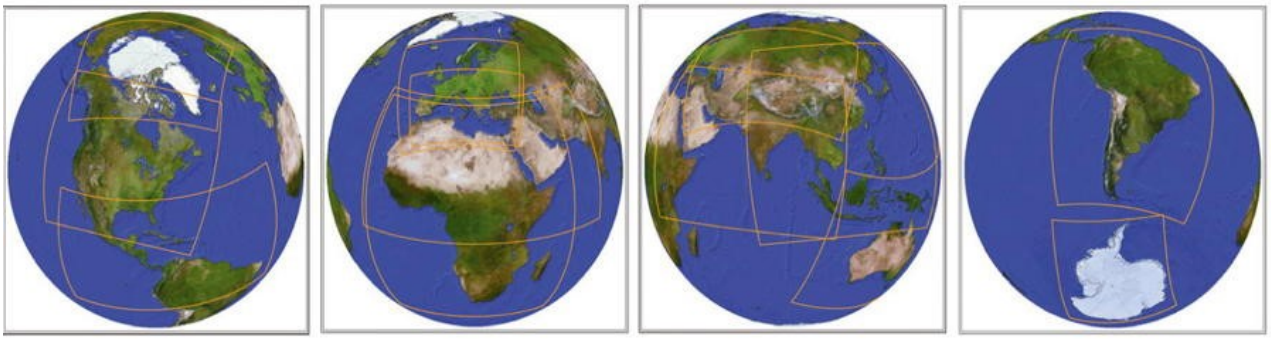
Regional Baselines

Many countries have provided their own historical climatology such as Australia, New Zealand, and the USA. In such cases, we use these data to create regional baselined for each country. Where there is no local data available for other countries, we have adopted the WorldClim (Version2) as the main data source.

WorldClim (v2) has average monthly climate data for minimum, mean, and maximum temperature, precipitation, solar radiation, wind speed, and water vapor pressure for 1970-2000. The water vapor pressure and minimum temperature were used to derive relative humidity. Moreover, the set of data has a very high spatial resolution (approximately 1 km^2) using data from between 9000 and 60 000 weather stations. Weather station data is interpolated using thin-plate splines with covariates including elevation, distance to the coast and three satellite covariates: maximum and minimum land surface temperature as well as cloud cover, obtained with the MODIS satellite platform. Interpolation has been done for 23 regions of varying size depending on station density. Satellite data improves prediction accuracy for temperature variables 5–15% (0.07–0.17°C), particularly for areas with a low station density, where prediction error remains high for all climate variables. Global cross-validation correlations were ≥ 0.99 for temperature and humidity, 0.86 for precipitation and 0.76 for wind speed.

In regions with dense meteorological observation networks, WorldClim (v2) is compatible with the data collected from local meteorological departments. However, its performance can be unsatisfactory in the areas with scarce data, even though satellite data has improved its accuracy. Additionally, the data are available over the land and not over the ocean. Therefore, WorldClim (v2) was applied to create regional baselines, rather than a global one.

Collecting data from local sources is a high priority in preparing data for Climate Insights.



Maps of the CORDEX domains

These regional projections have also been transformed into regional climate change patterns applying the same method as with GCM projections. The details of RCMs and corresponding driving GCMs are available from Climate Insights.

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Availability of GCM variables in the Climate Insights global data package

	Model	Temp	Precip	SolRad	RelHum	Wind	SLR
1	ACCESS1.3	Yes	Yes	Yes	Yes	Yes	
2	ACCESS1.0	Yes	Yes	Yes	Yes	Yes	
3	BCC-CSM1-1	Yes	Yes		Yes	Yes	Yes
4	BCC-CSM1-1-m	Yes	Yes		Yes		Yes
5	BNU-ESM	Yes	Yes				
6	CanESM2	Yes	Yes	Yes	Yes	Yes	Yes
7	CCSM4	Yes	Yes	Yes	Yes		Yes
8	CESM1-BGC	Yes	Yes	Yes	Yes		
9	CESM1-CAM5	Yes	Yes	Yes	Yes		
10	CMCC-CM	Yes	Yes	Yes		Yes	Yes
11	CMCC-CMS	Yes	Yes	Yes		Yes	Yes
12	CNRM-CM5	Yes	Yes	Yes		Yes	Yes
13	CSIRO-Mk3-6-0	Yes	Yes	Yes	Yes	Yes	Yes
14	EC-EARTH	Yes	Yes			Yes	
15	FGOALS-g2	Yes	Yes				
16	FGOALS-s2	Yes	Yes				
17	GFDL-CM3	Yes	Yes	Yes	Yes	Yes	Yes
18	GFDL-ESM2G	Yes	Yes	Yes	Yes	Yes	Yes
19	GFDL-ESM2M	Yes	Yes	Yes	Yes	Yes	Yes

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Availability of GCM variables in the Climate Insights global data package , continued

20	GISS-E2-H	Yes	Yes	Yes	Yes	Yes	
21	GISS-E2-H-CC	Yes	Yes	Yes	Yes	Yes	
22	GISS-E2-R	Yes	Yes	Yes	Yes	Yes	
23	GISS-E2-R-CC	Yes	Yes	Yes	Yes	Yes	
24	HADCM3	Yes	Yes	Yes	Yes	Yes	
25	HadGEM2-AO	Yes	Yes	Yes		Yes	
26	HadGEM2-CC	Yes	Yes	Yes	Yes	Yes	Yes
27	HadGEM2-ES	Yes	Yes	Yes	Yes	Yes	Yes
28	INMCM4	Yes	Yes	Yes	Yes	Yes	Yes
29	IPSL-CM5A-LR	Yes	Yes	Yes	Yes	Yes	
30	IPSL-CM5A-MR	Yes	Yes	Yes	Yes	Yes	
31	IPSL-CM5B-LR	Yes	Yes	Yes	Yes	Yes	
32	MIROC4H	Yes	Yes	Yes	Yes		
33	MIROC5	Yes	Yes	Yes	Yes	Yes	Yes
34	MIROC-ESM	Yes	Yes	Yes	Yes	Yes	Yes
35	MIROC-ESM-CHEM	Yes	Yes	Yes	Yes	Yes	Yes
36	MPI-ESM-LR	Yes	Yes	Yes		Yes	Yes
37	MPI-ESM-MR	Yes	Yes	Yes		Yes	Yes
38	MRI-CGCM3	Yes	Yes	Yes	Yes	Yes	Yes
39	NorESM1-M	Yes	Yes			Yes	Yes
40	NorESM1-ME	Yes	Yes				Yes