ENSO Normals 2020

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Abstract

ENSO Normals 2020 is a new high-resolution set of climate normals for the contiguous United States that are conditioned for various phase categories of the El Niño – Southern Oscillation (ENSO): Strong La Niña, Weak La Niña, Neutral, Weak El Niño, and Strong El Niño. In addition, the optimal climate normal (OCN) – a 15-yr running average instead of the traditional 30-year normal – is utilized to better reflect the impacts of climate change. The spatial domain is a $^1/_{24}$ degree grid over the contiguous United States (CONUS). Monthly normals are provided for daily maximum temperature (tmax; °C), daily minimum temperature (tmin; °C), and liquid-equivalent precipitation (prcp; mm) and are produced for each of the five phase categories. The ENSO normals are the sum of these composites with the OCN for a given month. The result is five sets of normals, one for each phase category, which users may consult with respect to anticipated ENSO outcomes. This new product, which is based on available data through 2020, can assist stakeholders in planning for a broad array of possible ENSO impacts in a changing climate.

Arguez, A., A. Inamdar, M. A. Palecki, C. J. Schreck, and A. H. Young, 2019: ENSO Normals: A New U.S. Climate Normals Product Conditioned by ENSO Phase and Intensity and Accounting for Secular Trends. *Journal of Applied Meteorology and Climatology*, **58**, 1381-1397. https://doi.org/10.1175/JAMC-D-18-0252.1

Vose, R. S., S. Applequist, M. Squire, I. Durre, M. Menne, C. N. Willams Jr., C. Fenimore, K. Gleason, and D. Arndt, 2014: Improved Historical Temperature and Precipitation Time Series for U.S. Climate Divisions. *Journal of Applied Meteorology and Climatology*, **53**, 1232-1251. https://doi.org/10.1175/JAMC-D-13-0248.1

Input Files

The input data used to generate ENSO Normals 2020 are largely obtained from the monthly version of nClimGrid, timestamped on May 5th, 2021. The latest version of the data can be found here:

https://www.ncei.noaa.gov/thredds/catalog/data-in-development/nclimgrid/catalog.html

In addition, the ENSO time series known as the Oceanic Niño Index is obtained from NOAA's Climate Prediction Center: https://www.cpc.ncep.noaa.gov/data/indices/oni.ascii.txt

Product Files

The final product is a set of three files in NetCDF format:

tmax-enso-normals-2020-v1.0.nc: NetCDF file containing the ENSO Normals 2020 values for tmax.

tmin-enso-normals-2020-v1.0.nc: NetCDF file containing the ENSO Normals 2020 values for tmin.

prcp-enso-normals-2020-v1.0.nc: NetCDF file containing the ENSO Normals 2020 values for prcp.

Primary Variables in Each NetCDF File

strong-la-nina-normals: a variable array (dimensions: lon, lat, time) containing the Strong La Niña Normals for either tmax, tmin, or prcp (depending on the filename in question).

weak-la-nina-normals: same as above, but for Weak La Niña conditions

neutral-normals: same as above, but for Neutral conditions

weak-el-nino-normals: same as above, but for Weak El Niño conditions

strong-el-nino-normals: same as above, but for Strong El Niño conditions

quantiles: a variable array (dimensions: lon, lat, time, ecat, qnt) containing quantile values (i.e., the 10th, 25th, 75th, and 90th percentiles) for either tmax, tmin, or prcp (depending on the filename in question).

significance-test: a variable array (dimensions: lon, lat, time, ecat) indicating whether a specific composite anomaly is significantly different from zero at 90% confidence. A value of 0 means it is not significant, whereas 1 means it is. Two flags are also used: 5 if the degrees of freedom were too low to determine statistical significance, and 9 for non-CONUS values.

longitude: a variable vector (dimension: lon) containing the longitude values of the grid points

latitude: a variable vector (dimension: lat) containing the latitude values of the grid points

time: a variable vector (dimension: time) containing indices corresponding to the 12 months of the year from January (1) to December (12); also, a dimension equal to 12, indicating the number of months in the year.

qvals: a variable vector (dimension: qnt) containing the quantile levels included, namely 0.1, 0.25, 0.75, and 0.9.

lon: a dimension equal to 1385, indicating the range of gridpoint longitudes included in the product

lat: a dimension equal to 596, indicating the range of gridpoint latitudes included in the product

ecat: a dimension equal to 5, indicating the number of ENSO phase categories

qnt: a dimension equal to 4, indicating the number of quantile values included

The units of the product values are degrees Celsius for tmax and tmin and millimeters for prcp. Product values for invalid gridpoints (i.e., gridpoints over oceans or other countries) are set to the -9999.0 missing value.

Data Structure

The header information from the tmax NetCDF file is below; all files are similar in form. The output listed below was obtained by executing the following linux command:

ncdump -h enso-normals-2020-tmax.nc


```
netcdf tmax-enso-normals-2020 {
dimensions:
        lon = 1385 ;
        lat = 596 ;
        time = 12 ;
        ecat = 5 ;
        qnt = 4 ;
variables:
        float strong-la-nina-normals(time, lat, lon) ;
                string strong-la-nina-normals:long_name = "monthly normal of daily maximum air
temperature during strong la nina events" ;
                string strong-la-nina-normals:standard_name = "monthly climatology" ;
                strong-la-nina-normals:_fillvalue = -9999.f ;
                strong-la-nina-normals:valid_min = -100.f ;
                strong-la-nina-normals:valid_max = 100.f ;
                string strong-la-nina-normals:coordinates = "lon lat time" ;
                string strong-la-nina-normals:units = "degree_celsius" ;
                string strong-la-nina-normals:references = "https://doi.org/10.1175/JAMC-D-18-
0252.1" ;
```

```
        float weak-la-nina-normals(time, lat, lon) ;
                string weak-la-nina-normals:long_name = "monthly normal of daily maximum air
temperature during weak la nina events" ;
                string weak-la-nina-normals:standard_name = "monthly climatology" ;
                weak-la-nina-normals:_fillvalue = -9999.f ;
                weak-la-nina-normals:valid_min = -100.f ;
                weak-la-nina-normals:valid_max = 100.f ;
                string weak-la-nina-normals:coordinates = "lon lat time" ;
                string weak-la-nina-normals:units = "degree_celsius" ;
                string weak-la-nina-normals:references = "https://doi.org/10.1175/JAMC-D-18-
0252.1" ;
        float neutral-normals(time, lat, lon) ;
                string neutral-normals:long_name = "monthly normal of daily maximum air
temperature during neutral events" ;
                string neutral-normals:standard_name = "monthly climatology" ;
                neutral-normals:_fillvalue = -9999.f ;
                neutral-normals:valid_min = -100.f ;
                neutral-normals:valid_max = 100.f ;
                string neutral-normals:coordinates = "lon lat time" ;
                string neutral-normals:units = "degree_celsius" ;
                string neutral-normals:references = "https://doi.org/10.1175/JAMC-D-18-0252.1" ;
        float weak-el-nino-normals(time, lat, lon) ;
                string weak-el-nino-normals:long_name = "monthly normal of daily maximum air
temperature during weak el nino events" ;
                string weak-el-nino-normals:standard_name = "monthly climatology" ;
                weak-el-nino-normals:_fillvalue = -9999.f ;
                weak-el-nino-normals:valid_min = -100.f ;
                weak-el-nino-normals:valid_max = 100.f ;
                string weak-el-nino-normals:coordinates = "lon lat time" ;
                string weak-el-nino-normals:units = "degree_celsius" ;
                string weak-el-nino-normals:references = "https://doi.org/10.1175/JAMC-D-18-
0252.1" ;
        float strong-el-nino-normals(time, lat, lon) ;
                string strong-el-nino-normals:long_name = "monthly normal of daily maximum air
temperature during strong el nino events" ;
                string strong-el-nino-normals:standard_name = "monthly climatology" ;
                strong-el-nino-normals:_fillvalue = -9999.f ;
                strong-el-nino-normals:valid_min = -100.f ;
                strong-el-nino-normals:valid_max = 100.f ;
                string strong-el-nino-normals:coordinates = "lon lat time" ;
                string strong-el-nino-normals:units = "degree_celsius" ;
                string strong-el-nino-normals:references = "https://doi.org/10.1175/JAMC-D-18-
0252.1" ;
        float quantiles(qnt, ecat, time, lat, lon) ;
```

```
		string quantiles:long_name = "monthly quantile values of daily maximum air
temperature for various enso phase categories" ;
		string quantiles:standard_name = "monthly climatology" ;
		quantiles:_fillvalue = -9999.f ;
		quantiles:valid_min = -100.f ;
		quantiles:valid_max = 100.f ;
		string quantiles:coordinates = "lon lat time ecat qnt" ;
		string quantiles:units = "degree_celsius" ;
		string quantiles:references = "https://doi.org/10.1175/JAMC-D-18-0252.1" ;
	short significance-test(ecat, time, lat, lon) ;
		string significance-test:long_name = "signficance test at 90% confidence
regarding whether a specific composite anomaly is significantly different from zero" ;
		string significance-test:standard_name = "monthly climatology" ;
		significance-test:_fillvalue = 9s ;
		significance-test:valid_min = 0s ;
		significance-test:valid_max = 5s ;
		string significance-test:coordinates = "lon lat time ecat" ;
		string significance-test:units = "none" ;
		string significance-test:references = "https://doi.org/10.1175/JAMC-D-18-0252.1"
;
		string significance-test:comment = "0 means not significant, 1 means significant,
5 means the sample size was too small to determine significance, and 9 is missing" ;
	float longitude(lon) ;
		longitude:valid_max = -67.02084f ;
		string longitude:long_name = "Longitude" ;
		string longitude:bounds = "lon_bounds" ;
		string longitude:standard_name = "longitude" ;
		longitude:valid_min = -124.6875f ;
		string longitude:axis = "X" ;
		string longitude:comment = "Resolution is 1/24 degree, equivalent to 4.63 km at
the Equator, and ranging from 4.21 km at the southern boundary of 24.5625 deg. N to 3.02 km
at 49.3542 deg. N" ;
		string longitude:var_name = "lon" ;
		string longitude:units = "degrees_east" ;
	float latitude(lat) ;
		latitude:valid_max = 49.35417f ;
		string latitude:long_name = "Latitude" ;
		string latitude:bounds = "lat_bounds" ;
		string latitude:standard_name = "latitude" ;
		latitude:valid_min = 24.5625f ;
		string latitude:axis = "Y" ;
		string latitude:comment = "resolution is 1/24 degree, equivalent to 4.63 km; range
is 24.5625 to 49.3542 degrees north" ;
		string latitude:var_name = "lat" ;
```

```
                string latitude:units = "degrees_north" ;
        string time(time) ;
                string time:long_name = "time, in monthly increments" ;
                string time:standard_name = "time" ;
                string time:calendar = "gregorian" ;
                string time:units = "months" ;
                string time:axis = "t" ;
        float qvals(qnt) ;
                string qvals:long_name = "quantile levels" ;

// global attributes:
                string :date_created = "Tue Feb 15 13:17:32 EST 2022" ;
                string :date_modified = "Tue Feb 15 13:17:32 EST 2022" ;
                string :conventions = "CF-1.6, ACDD-1.3" ;
                string :ncei_template_version = "NCEI_NetCDF_Grid_Template_v2.0" ;
                string :title = "ENSO Normals 2020" ;
                string :naming_authority = "gov.noaa.ncei" ;
                string :standard_name_vocabulary = "Standard Name Table v35" ;
                string :institution = "National Centers for Environmental Information (NCEI),
NOAA, Department of Commerce" ;
                string :summary = "This product provides monthly gridded climate normals of
daily maximum temperature, daily minimum temperature, and precipitation conditioned by
ENSO phase intensity and accounting for climate change. It is produced and maintained by
NOAA\'s National Centers for Environmental Information." ;
                string :license = "no restrictitons" ;
                string :creator_name = "Point of contact: NCEI, Asheville, NC, USA" ;
                string :creator_url = "https://www.ncei.noaa.gov" ;
                string :publisher_name = "https://www.ncei.noaa.gov" ;
                string :publisher_url = "https://www.ncei.noaa.gov" ;
                :geospatial_lat_min = 24.5625f ;
                :geospatial_lat_max = 49.35417f ;
                :geospatial_lon_min = -124.6875f ;
                :geospatial_lon_max = -67.02084f ;
                string :geospatial_lat_units = "degrees_north" ;
                string :geospatial_lon_units = "degrees_east" ;
                string :geospatial_vertical_min = "surface" ;
                string :geospatial_vertical_max = "surface" ;
                string :time_coverage_resolution = "1 month" ;
                string :program = "Climate Science and Services Division" ;
                string :geospatial_lat_resolution = "0.04167 degrees" ;
                string :geospatial_lon_resolution = "0.04167 degrees" ;
                string :platform = "station" ;
}
```