

Metody v klimatologii

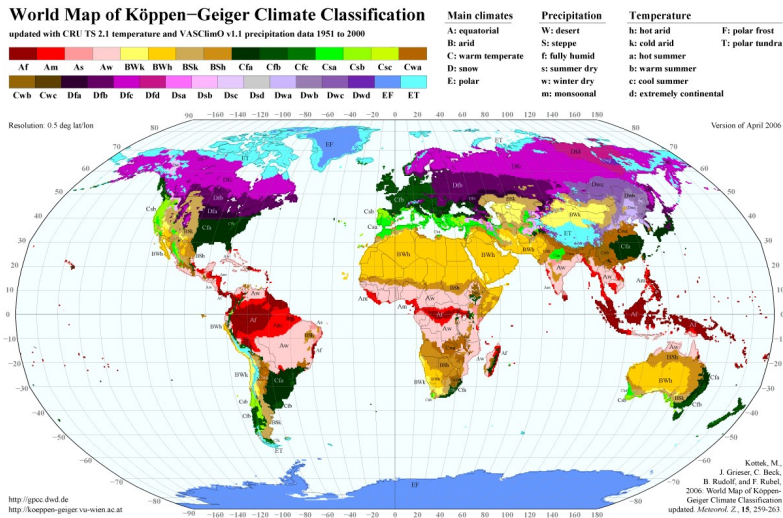
I. Úvod, zdroje dat, Climate Explorer

Obsah přednášky

1. Úvodní pojmy, analýza dat v Climate Explorer
 2. Metody prostorové analýzy dat - Empirical Orthogonal Function
 3. Metody analýzy časových řad na příkladu programu R
 4. Analýza extrémních hodnot
- Přednášky doplněny praktickým cvičením, které lze zpracovat samostatně na základě dodaných instrukcí
 - Ze cvičení se odevzdává stručný elaborát (přes IS)
 - Na konci semestru písemný test plus vypracovaná cvičení
 - V případě potřeby možno využít MS Teams či osobní konzultace (po předchozí dohodě)

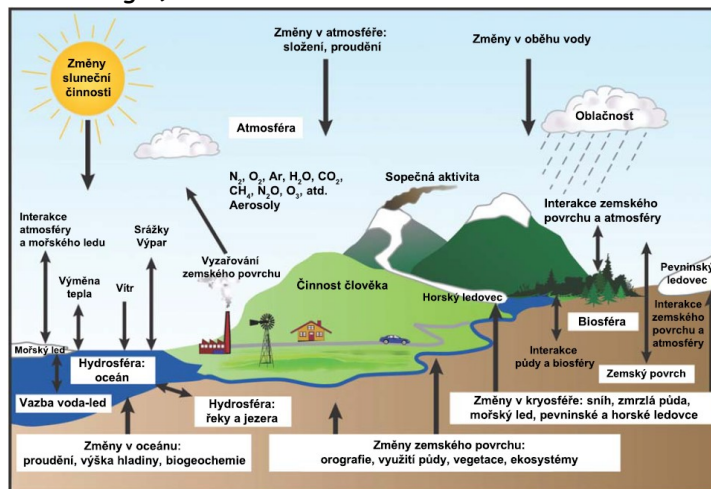
Klima a klimatologie (tradiční pohled)

- Klima = statistika počasí
- Data v klimatologii - „průměry“ meteorologických měření a pozorování
- Metody v klimatologii - popisná statistika



Současná klimatologie

Vnitřně strukturovaná na sub-disciplíny, např. s ohledem na měřítko dějů, které v **klimatickém systému** studují (mikroklimatologie, ..., regionální a globální klimatologie).



Základní součásti klimatického systému Země. Upraveno: Le Treut et al. (2007).

Současná klimatologie

Tradiční a nové sub-disciplíny klimatologie dostávají v současné globální změně nový rozměr:

- **Data assimilation, re-analysis**
 - https://epic.awi.de/id/eprint/25075/1/DA_overview.pdf
- **Atribuční analýza**
 - **World Weather Attribution - Exploring the contribution of climate change to extreme weather events**
 - <https://www.worldweatherattribution.org/>
- **Klima měst**
 - Urban Climate Change Research Network
 - <https://uccrn.ei.columbia.edu/>
- **„Open climate science“ - Climate-lab book**
 - <http://www.climate-lab-book.ac.uk/about/>
- <https://www.temperaturerecord.org/>

Současná klimatologie

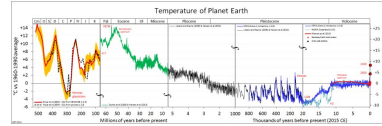
Pro současnou klimatologii je mj. typická:

- Vysoká **komplexita** studovaných jevů v čase i v prostoru
- Jejich **stochastická** povaha (všechny jevy nemají jednoznačnou příčinu, existuje vnitřní variabilita klimatu)
- Využívá vlastní **metodologie** se silným statistickým základem
- Zabývá se definováním nejistot, o řadě jevů může dát pouze **pravděpodobnostní** výpověď
- Klimatologie **není experimentální věda** (nemá k dispozici „laboratoř“). V daném čase a místě má k dispozici právě jen jednu realizaci průběhu počasí.
- Roli „laboratoře“ v klimatologii plní **numerické modely**

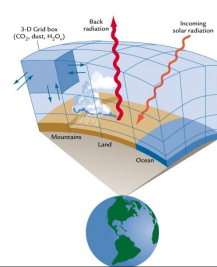
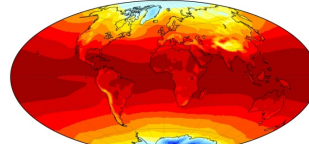
Současná klimatologie

Vytváří a analyzuje vlastní datové zdroje:

- paleoklimatologie
- družicová klimatologie
- modelování klimatu



Mean Surface Temperature (1990-1999) for EC-EARTH at ES-BSC



Datové zdroje v klimatologii

- Meteorologická měření a pozorování
 - staniční (bodová)
 - prostorová (ze systému DPZ, odvozená interpolací)
 - meteorologické prvky
 - klimatologické charakteristiky
 - indexy („climate indices“, např. NAO Index)
- Proxy rekonstrukce včetně prostorových
- Modelové výstupy (globální, regionální, místní)
- Reanalýzy
- „Hindcasts“

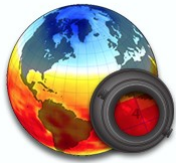
Datové zdroje v klimatologii

Datové zdroje mají ve většině případů vícerozměrný charakter a využívají speciálních datových formátů (NetCDF)

Name	Long Name	Type
800to05kyrBP_Bern3D_timeseries.nc	Bern3D-C Averaged Timeseries Output	Local File
atm_area	Area of atmosphere	—
atm_scaleheight	Scale height of atmosphere	—
atm_conc2ppm	Convert atmospheric carbon conc. [mol/m**3] to ppm	—
atmpco2	Atmospheric pCO2	ID
ATMT	Global Atmospheric Temperature	ID
ATMT_ALT	Global Atmospheric Temperature at Corresponding Altitude	ID
ATMT_Greenland	Greenland Atmospheric Temperature	ID
ATMTREQ	Tropical Atmospheric Temperature (20S - 20N mean)	ID
ATMTHI	Northern Hemisphere Atmospheric Temperature	ID
ATMTHP	North Pole Atmospheric Temperature	ID
ATMTHS	Southern Hemisphere Atmospheric Temperature	ID
ATMTHSP	South Pole Atmospheric Temperature	ID
dopta_label	Preprocessor Options (labels)	—
lat_rho	Latitude (rho grid)	ID
lat_T	Latitude (T grid)	ID
lat_U	Latitude (U grid)	ID
lon_rho	Longitude (rho grid)	ID
lon_T	Longitude (T grid)	ID
lon_U	Longitude (U grid)	ID
mask	Basin mask including Southern Ocean	Geo2D
maskf	Basin mask without Southern Ocean	Geo2D
month	Month of the year	ID
ncct_max	Maximum Global Meridional Transport	in

```

File "800to05kyrBP_Bern3D_timeseries.nc"
File type: NetCDF-3/CDM
netcdf file:/C:/data/R_data/nodf/800to05kyrBP_Bern3D_timeseries.nc
dimensions:
  lon_s = 36;
  lon_u = 37;
  lon_rho = 36;
  lat_s = 36;
  lat_u = 37;
  lat_rho = 36;
  t_T = 32;
  t_M = 33;
  yearstep_oc = 48;
  yearstep_atm = 48;
  month = 12;
  nobs = 2001;
  dopts = 24;
  time = UNLIMITED; // (801501 currently)
cd = 2;
variables:
  double lon_s(lon_s=36);
         long_name = "Longitude (T grid)";
  
```



PANOPLY

<http://www.giss.nasa.gov/tools/panoply/>

Zdroje dat - Climate Explorer

<https://climexp.knmi.nl/>

KNMI Climate Explorer

Climate Explorer European Climate Assessment & Data KNMI search in the Climate Explorer

Help News About Contact Seasonal forecast verification Climate Change Atlas

Starting point

Welcome, Petr Dobrovolny from Dept. of Geography, Masaryk Univ.

mean Nov CRU TS3.23 precipitation [mm/month] 1951:2000

60N
30N
EQ
30S
60S

180 120W 60W 0 60E 120E 180

0 24 48 72 96 120

- Select a time series
 - Daily station data
 - Daily climate indices
 - Monthly station data
 - Monthly climate indices
 - Annual climate indices
 - View, upload your time series
- Select a field
 - Daily fields
 - Monthly observations
 - Monthly reanalysis fields
 - Monthly and seasonal historical reconstructions
 - Monthly seasonal hindcasts
 - Monthly decadal hindcasts
 - Monthly RCM runs
 - Monthly CMIP5+ scenario runs
 - Monthly CMIP5 scenario runs
 - Annual CMIP5 extremes
 - EC-Earth scenario runs
 - External data (ensembles, ncep, enact, soda, ecwf, ...)
 - View, upload your field

- Climate Explorer** · rozhraní pro přístup k velkému množství dat
 · nástroj pro analýzu klimatologických dat
 · možnost analýz vlastních datových souborů

<https://climexp.knmi.nl/registerform.cgi>

Climate Explorer

Time series
monthly BRNO/TURANY GHCN v3 mean temperature
 Retrieving data from GHCN-M v2/v3 (adjusted) database ...

BRNO/TURANY (CZECH REPUBLIC), coordinates: 49.15N, 16.75E, elevation: 318m, 302m, WMO station code: 11723 BRNO/TURANY (avg Celsius) daily mean temperature (adjusted) from GHCN-M v3.3.0.20180202 (eps, pdf, raw data, netcdf)

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- EC-Earth scenario runs
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- View, upload your field

Investigate this time series

- View per month, season, half year or full year (Jan-Dec or Jul-Jun)
- View last 1, 5, 10 years
- Correlate with other time series
- Correlate with a field (correlation, regression, composite)
 - only observations
 - only reanalyses
 - only seasonal forecasts
 - only scenario runs
 - only user-defined fields
- Verify against another time series
- Spectrum, autocorrelation function
- Wavelet
- Running mean/s.d./skew/curtosis
- Trends in return times of extremes
- Plot and fit distribution

Redisplay the anomalies using the years 1981 -2010 select

Manipulate this time series

Select years: [] select

Make index: t_BRNO/TURANY Add to list

Filter adjacent months: low-pass 1st order LOESS filter
 cut-off value 12 months
 requiring at least 75 % valid data
 Filter consecutive months

Filter consecutive years: low-pass 1st order LOESS filter
 cut-off value 2 years
 requiring at least 75 % valid data
 Filter consecutive years

Scale series: Scale factor: []
 Scale

Time derivative: using 3 months
 Take time derivative
 Take anomalies and set standard deviation to one

Normalise: for each month separately
 for all months together
 Normalise

Combine: Combine with another timeseries to form a normalized index
 Mask out: Mask out based on another time series

Create a lower resolution time series

New time scale: annual (Jul-Jun)
 New variable: mean of BRNO/TURANY tavg
 Threshold: no cut Celsius
 Minimum: % valid data
 First apply: 1 -month running mean
 Missing data: ignore climatology trend persistence
 make new time series

Two annual cycles, computed with all data available (eps, pdf, raw data)

2.5%, 17%, 83%, 97.5% percentiles
 mean GHCN v3 mean temperature BRNO/TURANY

Anomalies with respect to the above annual cycle (eps, pdf, raw data, netcdf, analyse this time series)

Climate Explorer

Time series plots per season
BRNO/TURANY GHCN v3_mean temperature

The thick line is a 10-year running average (eps, pdf, raw data)

Time series plots per yr0
BRNO/TURANY_anomalies

The thick line is a 10-year running average (eps, pdf, raw data)

Jan-Dec BRNO/TURANY_anomalies (11723_19611990a)

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Climate Explorer

Existuje vztah mezi průměrnou zimní teplotou vzduchu v Brně, Tuřanech a NAO indexem?

Nejprve ověříme normalitu rozdělení teplotní řady

Make and fit a histogram
BRNO/TURANY GHCN_v3_mean_temperature (11723)

Plot

Type of plot:
 histogram with 20 bins
 quantile-quantile plot
 Gumbel plot
 logarithmic plot
 sqrt-logarithmic plot

Starting month: Dec

Season: averaging over 3 month(s)

Anomalies: subtract seasonal cycle

Years: < series <

Only for: < series <

Apply: logarithm, sqrt, square, cube, power
2/3 to series BRNO/TURANY

Detrend: detrend everything

Filters: take year-on-year differences
 subtract mean of previous years

Decorrelation scale: 0 months

Change sign: study the low extremes
 nothing Poisson Gaus Gamma Gumbel

Fit: GPD, threshold 80%
 do not constrain shape

Return time: year or value

Plot range: X: ; Y: ;

Confidence interval: 95 %

Compute

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Climate Explorer

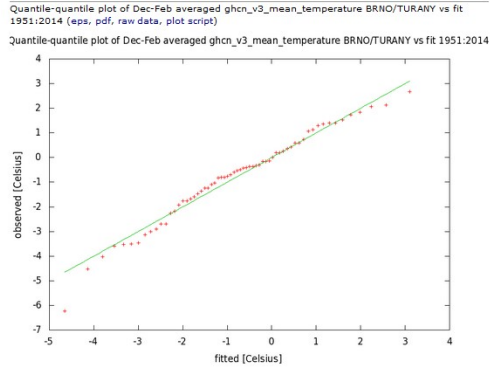
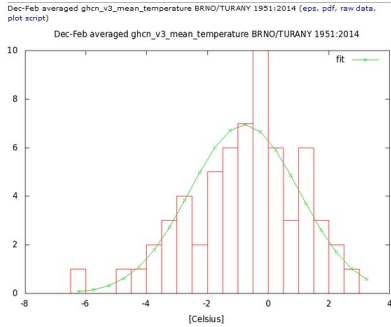
Existuje vztah mezi průměrnou zimní teplotou vzduchu v Brně, Tuřanech a NAO indexem?

CHI² test a Q-Q graf

Histogram
monthly BRNO/TURANY

The error margins were computed with a bootstrap method that assumes all points are temporally independent. The error margins were computed with a bootstrap method that assumes all points are temporally independent.

Dec-Feb averaged BRNO/TURANY avg [Celsius]	value±2σ	95% CI
N:	63	
mean:	-0.779365 ± 0.432540	-1.25317 ... -0.388095
s.d.(n):	1.80183 ± 0.318639	1.44333 ... 2.08061
s.d.(n-1):	1.816	
skew:	-0.508161 ± 0.532663	-1.00220 ... 0.451246E-01
min:	-6.233	
max:	2.667	
χ ² /df	19. / 17 = 1.14	p=0.3049



Climate Explorer

Existuje vztah mezi průměrnou zimní teplotou vzduchu v Brně, Tuřanech a NAO indexem?

Correlate with another time series
BRNO/TURANY ghcn_v3_mean_temperature

System-defined monthly timeseries
 NINO3 NINO3.4 NINO4 SO NAO CO2 GMST time

User-defined monthly timeseries

Options
 Variable: correlation coefficient, regression
 Starting month: Dec of timeseries
 Season: averaging over 3 month(s) of the timeseries same month(s)
 Anomalies: subtract seasonal cycle
 Lag: 0 months (lag positive: ghcn_v3_mean_temperature BRNO/TURANY lagging index)
 Only for: < index selected above < < ghcn_v3_mean_temperature BRNO/TURANY <
 Apply: logarithm, sqrt to ghcn_v3_mean_temperature BRNO/TURANY
 Output: rank correlation or contingency tables.
 Detrend: detrend everything
 Filters: take year-on-year differences
 subtract mean of previous years no overlap
 Running correlation: show/hide running correlation options
 Fit: straight line, parabola, cubic, straight line + a
 month time derivative, phase diagram, ...
 Plot range: X: ; Y: ;
 Decorrelation scale: 0 months
 Correlate

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Investigate this time series
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 Correlate with other time series
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Climate Explorer

Existuje vztah mezi průměrnou zimní teplotou vzduchu v Brně, Tuřanech a NAO indexem?

Time series correlations
ghcn_v3_mean_temperature BRNO/TURANY with NAO

months	lag	corr	p	no	95% CI
NAO	Dec-Feb	0.646	0.0000	63	0.52... 0.73

Fit of Dec-Feb averaged ghcn_v3_mean_temperature BRNO/TURANY (11723) vs Dec-Feb averaged NAO
 fit a+b*x 'data/1172319999.dump' using 1:2 via a,b
 result parameter values
 a = -1.08027
 b = 0.852006
 After 3 iterations the fit converged.
 final sum of squares of residuals : 119.068
 rel. change during last iteration : -8.6882e-11
 degrees of freedom (FIT_NDF) : 61
 rms of residuals (FIT_STDFIT) = sqrt(MSSR/ndf) : 1.39712
 variance of residuals (reduced chisquare) = MSSR/ndf : 1.95194
 Final set of parameters Approximate Standard Error
 a = -1.08027 +/- 0.1818 (16.83%)
 b = 0.852006 +/- 0.1288 (15.11%)
 correlation matrix of the fit parameters:
 a b
 a 1.000
 b -0.250 1.000

Tercile probabilities
 These are the probabilities that you will get a value below normal (lowest 33%), normal or above normal (top 33%) of the distribution of BRNO/TURANY ghcn_v3_mean_temperature vs NAO 1951:2014, given a certain value of the index NAO. It makes the following three assumptions

1. There is a significant correlation
2. The width and shape of the distribution around the best fit is independent of the index. For a rainfall distribution this is often not true, try selecting a sqrt or logarithm on the previous page
3. The distribution did not change over time

Therefore, use with care.
 original percentiles
 33.33 -1.30
 66.67 -0.07

Subtract influence of NAO from BRNO/TURANY ghcn_v3_mean_temperature (11723)
 Make new series

BRNO/TURANY ghcn_v3_mean_temperature vs NAO 1951:2014 (eps, pdf, month, year format, plot data, raw data)
 BRNO/TURANY ghcn v3 mean temperature vs NAO 1951:2014

Climate Explorer

Jaká je prostorová reprezentativnost
brněnské teplotní řady?

Correlate time series with an observation field
BRNO/TURANY GHCN_v3_mean_temperature

Observations

Temperature 1850-now anomalies: HadCRUT4 median, 1880-now anomalies: GISS 250km, 1200km

1880-now anomalies: NCDC v3.2.1

1850-now anomalies: HadCRUT4 filled-in by Cowtan and Way

Land 1850-2010 anomalies: CRUTEM4

1880-now anomalies: GISS 250km, 1200km

1880-now anomalies: NCDC v3.2.1

1948-now: CPC GHCM/CAMS 12m analysis (land) 0.5°, 1.0°, 2.5°

1901-2014: CRU TS3.23 (land) 0.5°, 1.0°, 2.5°, #/cell, #/value

1750-now: Berkeley 1°

0.25° 1950-now: E-OBS v12.0 Tg, 0.5° 1901-now with CRU TS (Europe)

Tmax 1901-2014: CRU TS3.23 (land) 0.5°, 1.0°, 2.5°, #/cell, #/value

1833-now: Berkeley 1°

0.25° 1950-now: E-OBS v12.0 Tx, 0.5° 1901-now with CRU TS (Europe)

Tmin 1901-2014: CRU TS3.23 (land) 0.5°, 1.0°, 2.5°, #/cell, #/value

1833-now: Berkeley 1°

0.25° 1950-now: E-OBS v12.0 Tn, 0.5° 1901-now with CRU TS (Europe)

Tmax-Tmin (DTR) 1901-2014: CRU TS3.23 (land) 0.5°, 1.0°, 2.5°, #/cell, #/value

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Select a field

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- > Annual CIMP5 extremes
- > EC-Earth scenario runs
- > External data (ensembles, ncep, enact, soda, ecmwf, ...)
- > View, upload your field

Investigate this time series

- > View per month, season, half year or full year (Jan-Dec or Jul-Jun)
- > View last 1, 5, 10 Years
- > Correlate with other time series
- > **Correlate with a field (correlation, regression, composite)**
- > only observations
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- > Plot and fit distribution

Climate Explorer

Jaká je prostorová reprezentativnost
brněnské teplotní řady v létě (JJA)?

Plot options

Variable: correlation covariance significance regression (error) reverse composite (error)

extreme dependence measures x, ybar, threshold 90 %

Demand at least: % valid points

Map type: default projection

Region: 30 °N to 70 °N, -30 °E to 40 °E in a lat-lon plot

Contours: to mask out p: 10 %

Colours: old blue-grey-red

Shading: shading and contours shading contours grid boxes

Plot options: no color bar no title on plot, no grid

label distance: 1 or no labels

Output to: browser Google Earth (km) GIS (geotiff)

Units: convert to standard units use original units

Options

Starting month: Jun of timeseries

Season: averaging over 3 month(s) of the field, same month(s) of the timeseries

Anomalies: subtract seasonal cycle

Lag: 0 months

Years: field positive: GHCN_v3_mean_temperature BRNO/TURANY lagging field

Only for: field selected above <

< GHCN_v3_mean_temperature BRNO/TURANY <

Apply: logarithm, sqrt to GHCN_v3_mean_temperature BRNO/TURANY

Output: rank correlation

Detrend: detrend everything

Filters: take year-on-year differences

subtract mean of [] previous years

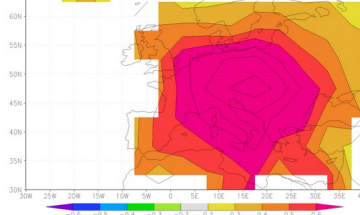
Running correlation: show/hide running correlation options

Fit: straight line, parabola,

Correlate

corr Jun-Aug averaged BRNO/TURANY ghcn_v3_mean_temperature with Jun-Aug averaged CRUTEM4.3 T2m anom 1951:2014 p<10% (exp. pdf)

corr Jun-Aug averaged BRNO/TURANY ghcn_v3_mean_temperature with Jun-Aug averaged CRUTEM4.3 T2m anom 1951:2014 p<10%



Statistically, there is almost certainly a significant connection in the map ($p_{adj} < 0.1\%$).
Details...
The fraction of the map with $p < 10.00\%$ is 92.72%. With an estimated decorrelation scale of 14.0° and (37.°) with data there are about 4 degrees of freedom in the map. This gives a field significance of 0.0% < $p_{field} < 0.1\%$.

Get the raw data as GADS control and (gipped) data files, or generate download as ascii (log).

Replot

Variable: correlation [1] rawval [1]

regression of series tag on field temperature_anomaly [Celsius/Celsius]

regression of field temperature_anomaly on series tag [Celsius/Celsius]

error on regression of series tag on field temperature_anomaly [Celsius/Celsius]

error on regression of field temperature_anomaly on series tag [Celsius/Celsius]

number of valid points [1]

relative regression [1]

error on relative regression [1]

Map type: default projection

Region: 30 °N to 70 °N, -30 °E to 40 °E in a lat-lon plot

Contours: to mask out p: 10 %

Colours: old blue-grey-red

Shading: shading and contour shading contours grid boxes

Plot options: no color bar no title on plot, no grid

label distance: 1 or no labels

Output to: browser Google Earth (km) GIS (geotiff)

Replot

Generate a new field with the influence of BRNO/TURANY subtracted linearly

Submit

Climate Explorer - datové zdroje

KNMI Climate Explorer

Climate Explorer European Climate Assessment & Data KNMI

Help News About Contact Seasonal forecast verification Climate Change Atlas

Search in the Climate Explorer

- Observations - stations, fields
 - data, indices
- Proxy reconstructions
- Reanalysis
- Hindcasts
- Model outputs
 - RCM
 - CMIP5

Select a time series

- > Daily station data
- > Daily climate indices
- > Monthly station data
- > Monthly climate indices
- > Annual climate indices
- > View, upload your time series

Select a field

- > Daily fields
- > Monthly observations
- > Monthly reanalysis fields
- > Monthly and seasonal historical reconstructions
- > Monthly seasonal hindcasts
- > Monthly decadal hindcasts
- > Monthly RCM runs
- > Monthly CMIP3+ scenario runs
- > Monthly CMIP5 scenario runs
- > Annual CMIP5 extremes
- > EC-Earth scenario runs
- > External data (ensembles, ncep, enact, soda, ecmwf, ...)
- > View, upload your field

Climate Explorer - datové zdroje

Select a daily field

Select a field by following its link (alternative)

Observations

	Tmean	Tmax	Tmin	Prcp	SLP	SST	Elev
HadGHCND 1946-2000		x	x				i
GPCP 1° 1997-now				x			i
CMORPH 0.5° 1998-now				x			i
KNMI Radar 1km 2009-now				x			i
EMULATE 1850-2003					x		i
Berkeley 1880-now 1°	x	x	x				i
E-OBS 1950-now 0.5°	x	x	x	x	x		x i
E-OBS 1950-now 0.25°	x	x	x	x	x		x i
SST OI v2 1982-now						x	i
Microwave OI 1998-now						x	i
TAO 1980-now	SST, Tair, RH, u, v, T ₅₀₀ , T _y						i

Reanalysis

	t2m	prcp	slp	u850	v850	z500	div200	u200	v200
NCEP/NCAR 1948-now	x	x	x			x			x i
ERA-interim 1979-now	x	x	x	x	x	x	x	x	x i
ERA-20C 1900-2010	x	x	x	x	x	x			i

Model

	experiment	#	tas	tmin	tmax	pr	psl	uas	vas	rsds	rlds
BCCR CM2.0	20c3m 1961-2000	1				x					i
	sresa2 2045-2065	1				x					i
	sresa2 2081-2100	1				x					i
CCCMA CGCM3.1 T63	20c3m 1961-2000	1	x			x	x	x	x		i
	sresa1b 2081-2100	1	x			x	x	x	x		i
CCCMA CGCM3.1 T47	20c3m 1961-2000	5	x	x	x	x				x	x i

Select a time series

- > Daily station data
- > Daily climate indices
- > Monthly station data
- > Monthly climate indices
- > Annual climate indices
- > View, upload your time series

Select a field

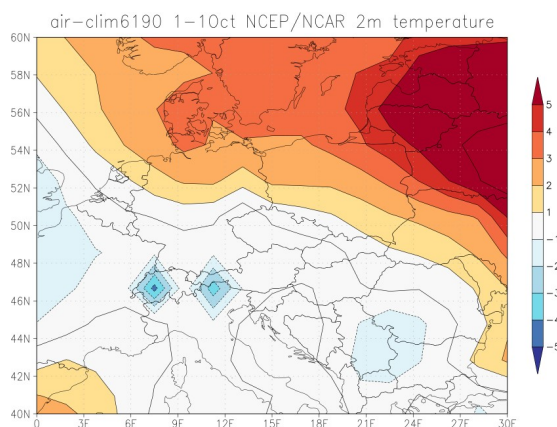
- > Daily fields
- > Monthly observations
- > Monthly reanalysis fields
- > Monthly and seasonal historical reconstructions
- > Monthly seasonal hindcasts
- > Monthly decadal hindcasts
- > Monthly RCM runs
- > Monthly CMIP3+ scenario runs
- > Monthly CMIP5 scenario runs
- > Annual CMIP5 extremes
- > EC-Earth scenario runs
- > External data (ensembles, ncep, enact, soda, ecmwf, ...)
- > View, upload your field

Datové zdroje - reanalýzy

- **Reanalýza** je objektivní analýza meteorologických dat aplikovaná zpětně na data a je označována také jako metoda fyzikálně konzistentní („správné“) interpolace.
- Propojuje meteorologická **měření** a pozorování (nerovnoměrně rozmístěná, méně četná do minulosti) s numerickým předpovědním **modelem**, který poskytuje „fyzikálně konzistentní“ stav atmosféry.
- Propojení se realizuje statisticky (např. obdoba MNČ) s využitím tzv. metody tzv. **asimilace** (spojování/propojování) dat.
- Na rozdíl od předpovědí počasí, při které se předpovědní model neustále vyvíjí, je reanalýza prováděna jednotným přístupem - použité asimilační schéma se nevyvíjí (je tzv. „frozen“). To umožňuje využití reanalýz např. při studiu změn klimatu.
- Výstupy z reanalýz mohou obsahovat i takové veličiny, pro něž nejsou za dané období k dispozici měření.
- Současné reanalýzy pokrývají celou Zemi trojrozměrně (v několika hladinách), obvykle s krokem 6 hodin
- Z časového hlediska jsou některé k dispozici pro celé 20. století, vyvíjejí se i v paleoklimatologii

Datové zdroje - reanalýzy

- Climate Explorer poskytuje jednoduché rozhraní umožňující přístup k reanalýzám v denním či měsíčním rozlišení
- Dále umožňuje jejich vizualizaci a základní zpracování



Názorné video

<https://www.youtube.com/watch?v=FAGobvUGI24>

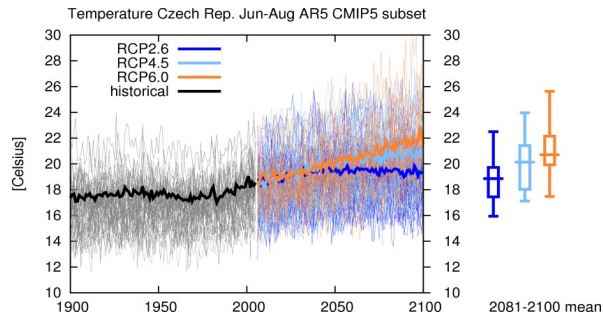
<https://reanalyses.org/>

<https://www.ecmwf.int/en/research/climate-reanalysis>

World Weather

Climate Change Atlas

Climate Change Atlas



Temperature Czech Rep. Jun-Aug AR5 CMIP5 subset. On the left, for each scenario one line per model is shown plus the multi-model mean, on the right percentiles of the whole dataset: the box extends from 25% to 75%, the whiskers from 5% to 95% and the horizontal line denotes the median (50%).

Climate Change Atlas

KNMI Climate Change Atlas

Select a region

Type: IPCC WG1 IPBES countries place box

IPCC WG1: Europe

Select a season

Season: First month Jun, length 3 months

Select a dataset and variable

Dataset: GCM: CMIP5 (IPCC AR5 Atlas subset)

Variable: precipitation

Output: absolute relative changes are shown

Map options

Scenario: Historical + RCP4.5

Measure: Difference of two periods

Reference period: 1981 - 2010

Future period: 2071 - 2100

Mean/percentiles: mean

Make map May take up to 15 minutes the first time a season / measure is shown

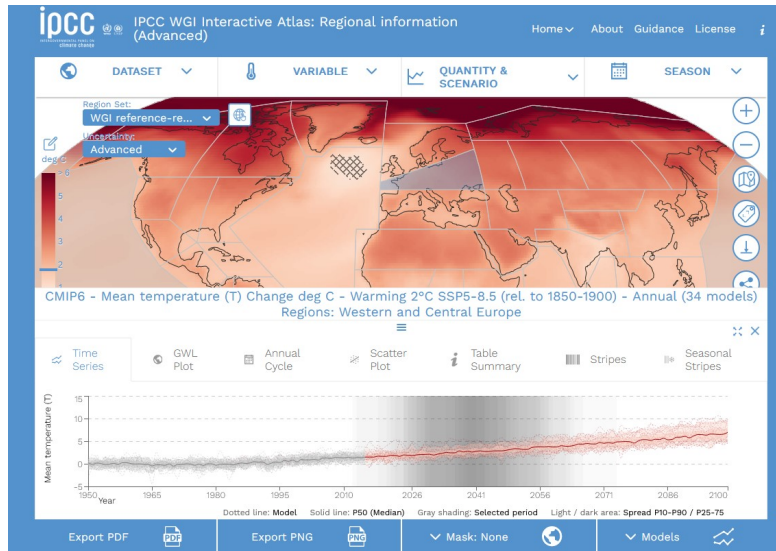
mean rcp45 precipitation 2071-2100 minus 1981-2010 Jun-Aug AR5 CMIP5 subset. The hatching represents areas where the signal is smaller than one standard deviation of natural variability (see pdf: natcov)

[mm/dy]

-2 -1 -0.5 -0.2 -0.1 0 0.1 0.2 0.5 1 2

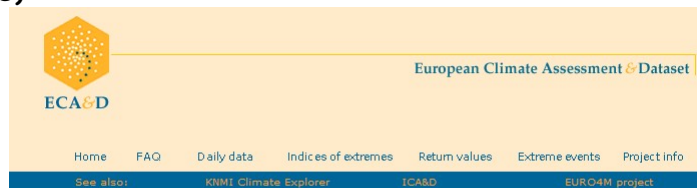
IPCC WGI Interactive Atlas

<https://interactive-atlas.ipcc.ch/>



Další zdroje dat - vybrané příklady

European Climate Assessment & Dataset project <http://www.ecad.eu/> (ECA&D)



Home

Home

Welcome to the website of the European Climate Assessment & Dataset project. Presented is information on changes in weather and climate extremes, as well as the daily dataset needed to monitor and analyse these extremes. ECA&D was initiated by the [ECSN](#) in 1998 and has received financial support from the [EUMETNET](#) and the [European Commission](#).

What's new?



The database is updated until: Dec 31, 2015.

19 February 2016 - The January 2016 update has been delayed until March 2016 due to technical problems.

December 2015 - 2015 is the joint warmest year on record. It has been very slightly warmer than in 2014, mainly due to the exceptionally warm December. See the [Climate Indicator Bulletin](#) on this year.

November 2015 - The Spanish Meteorological Service [Aemet](#) now updates its stations each month.

November 2015 - The [Czech HydroMeteorological Institute CHMI](#) has shared 65 new stations and updates these monthly.

October 2015 - [E-OBS version 12.0](#) has been released.

[All news items](#)

Další zdroje dat

Copernicus Climate Change Service <https://climate.copernicus.eu/>

Implemented by ECMWF as part of The Copernicus Programme

News Events Press Tenders Help & Support Search


European Commission | Copernicus | Climate Change Service

About Us What we do Data

European Commission | Copernicus | IMPLEMENTED BY ECMWF

Climate Change

We provide authoritative information about the past, present and future climate, as well as tools to enable climate change mitigation and adaptation strategies by policy makers and businesses.



Další zdroje dat

Copernicus Climate Change Service <https://climate.copernicus.eu/>

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Applications Data Documentation

your workspace

- No applications
- examples
- 00 Hello World**
- 01 Retrieve data
- 02 Plot map
- 03 Extract time series and plot graph
- 11 Calculate time mean and standard deviation
- 12 Calculate climatologies
- 21 Calculate regional mean and anomalies
- 31 Calculate trends
- 41 Calculate GDD
- 42 Use cdo functions
- 51 Calculate zonal means
- 52 Format maps to allow visual comparison

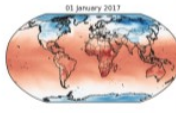
```
import edatoolbox as et

def application(title='Hello World!'):
    for output, figure:
        def application():
            ...
            HELLO WORLD!
            This is your first application using the CDS toolbox.

            Here, 3 basic tasks:
            - retrieve the 2 meter temperature from the CDS Catalogue
            - print info about the data (see it in the 'Console' tab)
            - show the data on a map.
            ...

        data = et.catalogue.retrieve(
            'reanalysis-era5-single-levels',
            {
                'variable': '2m_temperature',
                'product_type': 'reanalysis',
                'year': '2015',
                'month': '01',
                'day': '01',
                'time': '12:00',
                'area': ('12', '12'),
            }
        )
```

03 January 2017



Applications Editor Preview

Další zdroje dat

Climatic Research Unit (CRU) <http://www.cru.uea.ac.uk/>



Climatic Research Unit



Home About CRU Data Academic Programmes Research Staff and Students Information Sheets Publications Media News/Events

Home

The aim of the Climatic Research Unit (CRU) is to improve scientific understanding in

- past climate history and its impact on humanity
- the course and causes of climate change during the present century
- prospects for the future

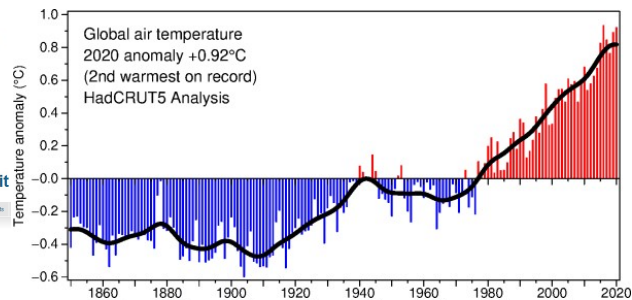


Climatic Research Unit

Home About CRU Data Academic Programmes Research Staff and Students Information Sheets

Data

- Temperature (2°x2° gridded versions)
- Precipitation (2°x2° and 2.5°x3.75° gridded versions)
- Pressure and Cloudiness Indices
- Long monthly merged total series for the UK and Ireland
- UK climate indices
- Northern climate indices
- Arctic climate data
- High resolution gridded datasets
- HadCRUT5 Stratosphere Data - November to 2014
- Time series
- Data
- Observations
- Publications
- Research indices
- Other
- Data availability
- Data and other materials associated with some specific CRU published papers



Další zdroje dat

NOAA - National Centers for Environmental Information

<https://www.ncdc.noaa.gov/>



NOAA NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



Formerly the National Climatic Data Center (NCDC)... [more about NCEI](#)

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Search

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Quick Links

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- Radar
- Model
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 - Borehole
 - Climate Forcing
 - Climate Reconstruction
 - Coral and Sclerosponge
 - Fauna
 - Fire History

Paleoclimatology Datasets

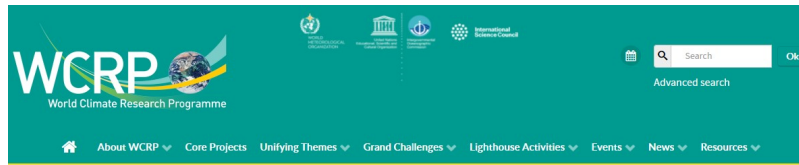


These links provide access to descriptive information and explanatory notes, maps, searches, visualizations, and more. The data cover the globe, and while most span the last few millennia, some datasets extend back

Další zdroje dat

WCRP Coupled Model Intercomparison Project

<https://www.wcrp-climate.org/wgcm-cmip>



WCRP Coupled Model Intercomparison Project (CMIP)



A Short Introduction to Climate Models - CMIP & CMIP6

WGCM

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Members
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CMIP
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CMIP Panel
Job Adverts for CMIP-IPO
WGCM Infrastructure Panel (WIP)
CMIP3
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Catalogue of MIPs
CMIP6-Endorsed MIPs
Other active MIPs
Former MIPs