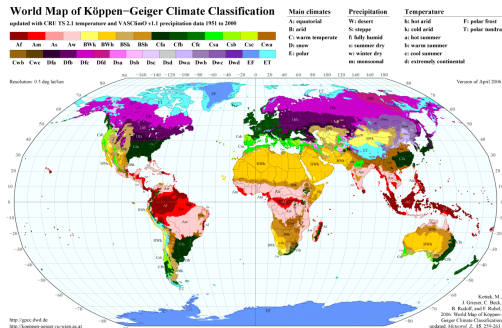


Methods in climatology

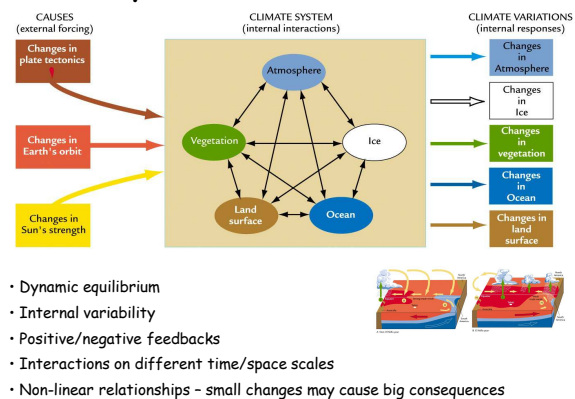
I. Introduction, data sources

Climate and climatology

- Climate = weather statistics
- Climatology data - „average“ of meteorological data
- Methods in climatology - descriptive statistics

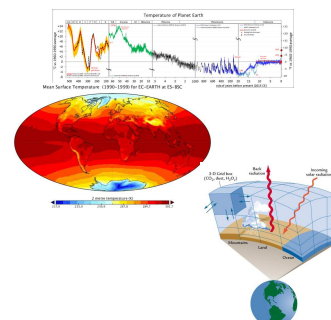


Climate system



Contemporary climatology

- High complexity
- Stochastic nature of climate
- Dealing with uncertainty
- New data sources:
 - palaeoclimatology
 - satellite climatology
 - climate modelling



Rozměr klimatického systému, časová a prostorová proměnlivost klimatu

Složitost úplného klimatického systému i jeho subsystémů se odráží v značné časové a prostorové proměnlivosti hodnot meteorologických prvků a jejich klimatologických charakteristik

V praktických aplikacích se zabýváme částmi úplného klimatického systému. Popisujeme ho typickými hodnotami meteorologických prvků resp. jejich klimatologických charakteristik (rozměr globální, regionální, mezo, topo, mikro, rozměr hraničních vrstev).

Kategorie časové proměnlivosti klimatu

- sekulární
- interannuální
- sezónní
- interdiurní
- jiná (geologických dob, ...i řád minut)

Kategorie prostorové proměnlivosti klimatu

- globální
- regionální
- topická až chorická
- jiná

Climatology data sources

- Observations
 - stations (points)
 - fields (interpolated, remotely sensed)
 - meteorological variables
 - climate indices (e.g. NAO Index)
- Proxy reconstructions (also spatial)
- Reanalyses
- Hindcasts
- Model outputs (global, regional)

Data sources - some examples

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

Další zdroje dat

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

Další zdroje dat

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

Další zdroje dat

IRI/LDEO Climate Data Library <http://iridl.ldeo.columbia.edu/>

Další zdroje dat

BADC - The British Atmospheric Data Centre <http://badc.nerc.ac.uk/home/index.html>

Další zdroje dat

NOAA - National Centers for Environmental Information

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

Další zdroje dat

CMIP5 - Coupled Model Intercomparison Project Phase 5
<http://cmip-pcmdi.llnl.gov/cmip5/>

Climate Explorer

- rozhraní pro přístup k velkému množství dat
- nástroj pro analýzu klimatických dat
- možnost analýz vlastních datových souborů

Climate Explorer

Výběr řady průměrných měsíčních teplot vzduchu z Brna, Tuřan

Climate Explorer

Climate Explorer

Climate Explorer

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

Nejprve ověříme normalitu rozdělení teplotní řady

Climate Explorer

Analyza polí meteorologických prvků / klimatologických charakteristik

The screenshot shows the 'Field' and 'Plot field' sections. The 'Field' section includes options for 'New variable' and 'New variable with lower time resolution'. The 'Plot field' section includes options for 'Time', 'Region', 'Map type', 'Anomalies', 'Contours', 'Colours', 'Shading', and 'Plot options'. A red circle highlights the 'New variable' section, and a red arrow points to the 'Plot' button.

Climate Explorer

Analyza polí meteorologických prvků / klimatologických charakteristik

The screenshot shows a world map and a time-space diagram. The world map displays a color-coded field of data. The time-space diagram shows a vertical axis representing time (from 1950 to 2010) and a horizontal axis representing latitude (from 90N to 90S). A color bar at the bottom indicates the values of the field.

Hovmöller (time-space) diagram

Climate Explorer - datové zdroje

The screenshot shows the 'Data sources' section of the Climate Explorer interface. It lists various data sources and their corresponding variables. A red arrow points to the 'Observations - stations, fields' section.

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

Climate Explorer - datové zdroje

The screenshot shows the 'Data sources' table in the Climate Explorer interface. The table lists various data sources and their corresponding variables. A red circle highlights the 'Observations' section.

Observations	Tmax	Tmin	Prcp	SLP	SST	Elev
NO2000recon v141-2000						
GPCP 1° 1997-now			x	x		
CMORH 0.5° 1998-now				x		
KNMI Radar 1km 2009-now				x		
SMILT4E 1850-2005					x	
Berkeley 1880-now 1°	x	x	x			
E-OBS 1950-now 0.5°	x	x	x	x	x	x
E-OBS 1950-now 0.25°	x	x	x	x	x	x
SST OI v2 1982-now					x	
Microwave OI 1998-now					x	
T20 1980-now						SST, Tair, RH, u, v, tp, fy
Reanalysis	t2m	prcp	slp	u10	v10	s500
NCER/NCAR 1948-now	x	x	x			x
ERA-Interim 1979-now	x	x	x	x	x	x
ERA-20C 1900-2010	x	x	x	x	x	x
Model	experiment	#	tair	tmin	tmax	pr
BCCR CM2.0	20c3m 1961-2000	1	x	x	x	x
	area2 2043-2065	1			x	
	area2 2081-2100	1			x	
CCMA CGCM3.1 T63	20c3m 1961-2000	1	x	x	x	x
	area2b 2081-2100	1	x		x	x
CCMA CGCM3.1 T47	20c3m 1961-2000	5	x	x	x	x

Data sources - reanalyses

- Reanalysis is a scientific method for developing a comprehensive record of how weather and climate are changing over time.
- Observations and a numerical model that simulates one or more aspects of the Earth system are combined objectively to generate a synthesized estimate of the state of the system.
- Reanalyses are created via an unchanging ("frozen") data assimilation scheme and model(s) which ingest all available observations every 6-12 hours over the period being analyzed.
- This unchanging framework provides a dynamically consistent estimate of the climate state at each time step.
- A reanalysis typically extends over several decades or longer, and covers the entire globe from the Earth's surface to well above the stratosphere.

- NCEP/NCAR Reanalysis
- ECMWF re-analysis (ERA-40, ERA-Interim)

<https://reanalyses.org/>

<https://reanalyses.org/atmosphere/comparison-table>

Data sources - hindcasts (backtesting)

- testing a predictive model using existing historic data
- a statistical calculation determining probable past conditions
- hindcasting usually refers to a numerical model integration of a historical period where **no observations have been assimilated**. This distinguishes a hindcast run from a reanalysis.

<http://www.oceanweather.com/research/HindcastApproach.html>

Data sources - Model simulations

- CMIP5 - Coupled Model Intercomparison Project
- RCM - ENSEMBLES

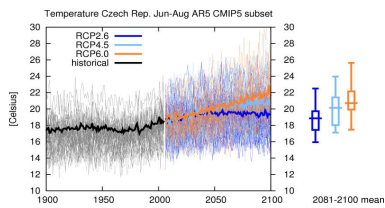
Climate Change Atlas

The screenshot shows the KNMI Climate Explorer interface. The main navigation bar includes 'Climate Explorer', 'European Climate Assessment & Data', and 'KNMI'. A search bar is located in the top right. Below the navigation bar, the 'KNMI Climate Change Atlas' section is active. The interface is divided into several filter sections:

- Select a region:** Type (IPCC WG1, SPES, countries, place, box), IPCC WG1 (World), and a search box.
- Select a season:** First month (Jan), length (12), and months.
- Select a dataset and variable:** Dataset (GCM: CMIP5 (IPCC AR5 Atlas subset)), Variable (near-surface temperature), and Output (map, time series).
- Map options:** Scenario (Historical + RCP4.5), Measure (Difference of two periods), Reference period (1986-2005), Future period (2081-2100), and Mean/percentiles (mean).

 A 'Make map' button is at the bottom, with a note: 'May take up to 15 minutes the first time a season / measure is selected'. On the right side, there are links for 'Further information' and 'Funding'.

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

This screenshot shows the same KNMI Climate Explorer interface as above, but with different search parameters. The 'Region' is set to 'Europe', 'Season' is 'Jun', and 'Variable' is 'precipitation'. The 'Map options' section shows 'Scenario: Historical + RCP4.5' and 'Measure: Difference of two periods'. The 'Reference period' is '1986-2005' and the 'Future period' is '2071-2100'. The 'Mean/percentiles' is set to 'mean'. The 'Make map' button is present. Below the interface, a map of Europe is displayed, showing precipitation changes. A color scale at the bottom indicates the change in mm/day, ranging from -2 (dark blue) to 2 (dark red). The map shows a significant increase in precipitation (red/orange) over the Czech Republic and surrounding areas, with a decrease (blue) in other regions.