Near-future climate data for Odesa, Ukraine as a first step towards creating an adaptation plan for a city

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Introduction

Urban communities and infrastructure around the globe are under increasing stressors related to climate change. There are three kinds of effects of the environmental impact of extreme weather and climate events. Primary effects are changing physical systems and processes, biological systems, structure and function of ecosystems, and social, economic and other development factors. Secondary effects are leading to the destruction of agriculture and infrastructure, and the contamination of the environment. Tertiary effects are responsible for the proliferation of diseases.

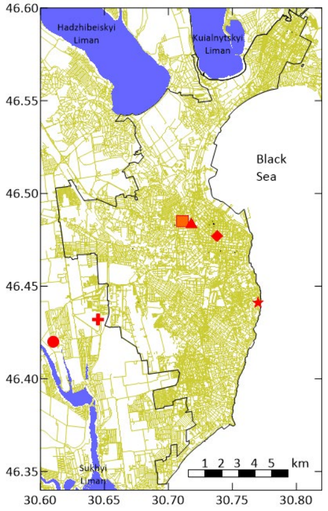
The aim is to create a set of climate data and indices which is locally, spatially and timely oriented towards Odesa, Ukraine, and will be then used in climate change adaptation planning (we named the dataset CP_OdU – Climate Projections for Odesa, Ukraine; https://doi.org/10.5281/zenodo.7481942). This dataset must meet the following requirements:

- should contain meteorological variables and indices that describe typical local weather conditions and extreme events for Odesa;
- should be the outcome of modelling that considers the spatial location of Odesa and has the necessary spatial resolution horizontally;
- should have a time scale that allows tracking the development of weather conditions, taking into account the uncertainties of the future climate.

The EURO-CORDEX dataset contains many output variables that fully describe weather conditions and can be used to calculate indices defining the state of the climate and its change. The spatial resolution of the horizontal grids in the regional climate models (RCM) of the dataset is ~0.11° or ~12 km allowing us to consider the features of the underlying surface in urban areas, at least on the city scale. The output variables are on the daily basis for the period up to 2100, and the total number of simulations exceeds 100, which allows for accounting for the uncertainties of the future climate.

Data

The CP_OdU dataset includes output variables from 26 and 76 simulations by RCP4.5 and RCP8.5, respectively. The RCP4.5 scenario is a stabilization scenario, which means the radiative forcing level stabilizes at 4.5 W/m^2 before 2100 by employing technologies and strategies for reducing greenhouse gas emissions. On the other hand, in the RCP8.5 scenario, the radiative forcing level reaches 8.5 W/m^2 due to increasing greenhouse gas emissions over time, i.e., leading to high greenhouse gas concentration levels.



Map of Odesa with location of HMC BAS and grid points by different simulations of RCMs

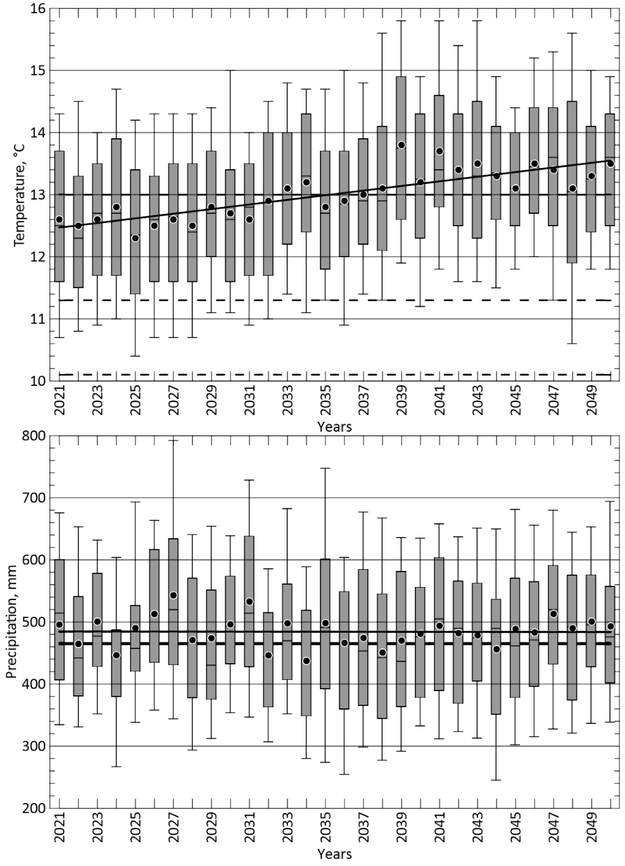
Meteorological variables used in this study

Name	Description	Units
CC	daily cloud cover	oktas
DD	daily value of wind direction	°
FG	daily mean wind strength	m s^{-1}
FX	daily maximum wind gust	m s^{-1}
RH	daily relative humidity	%
RR	daily precipitation amount	mm
SD	daily snow depth	cm
SS	daily sunshine duration	hours
TG	daily mean temperature	°C
TN	daily minimum temperature	°C
TX	daily maximum temperature	°C

The indices used in this study are proposed in ECA&D. The calculation procedure of these indices is quite simple and involves, in most cases, the calculation of the mean, minimum and maximum values of a certain meteorological variable in a certain period or the number of days where this value was above or below a certain threshold in this period of time. The indices relate to the cloudiness, temperature, precipitation, humidity, snow, sunshine, and wind. Also, the compound indices were calculated..

Results

Figure displays two commonly used climatic parameters – mean temperature and precipitation sum – for Odesa by the RCP8.5 scenario. A significant trend towards an increase in the average annual temperature will continue, and the temperature will also increase for all months. There exists only little probability of a negative average monthly temperature and only in January. Although the average annual precipitation sum will increase slightly (~ 20 mm), it will decrease significantly in summer and increase in spring and at the end of the year. In general, it seems that the climate of Odesa is moving towards the Mediterranean climate – warm to hot, dry summers and mild, moderately wet winters.



Annual mean temperature and precipitation sum in 2021–2050 for scenario RCP 8.5 in Odesa, Ukraine by model ensemble. The box plots visualize 10/90-percentile (whiskers), 25/75-percentile (box), median and average (dots), linear trend (solid line). The dashed lines are 30-year mean values for 1961–1990 at 10.1 °C, for 1991–2020 at 11.3 °C and for 2021–2050 at 13.0 °C for temperature and for 1961–1990 at 464 mm, for 1991–2020 at 466 mm and for 2021–2050 at 484 mm for precipitation

Borovska and Khokhlov (2023) Climate data for Odesa, Ukraine in 2021–2050 based on EURO-CORDEX simulations. Geosci. Data J., in press, DOI: 10.1002/gdj3.197