

Fun in the Sun ? How Hot is too Hot ?

Changes in Universal Thermal Comfort Index across European beaches

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Introduction

Beach tourism is the largest tourism sector in Europe. Millions of people travel to coastal beaches for scenic views and to partake in recreational activities. Their comfort while enjoying these activities is paramount in deciding where they visit. Understanding how a person's thermal comfort will change, with projected climate change, can help the tourism and hospitality sector mitigate risk and identify opportunities to attract tourists.

In this work, a calculation for the Universal Thermal Comfort Index (UTCI) has been implemented into the xclim open-source python library. UTCI is one of the most comprehensive measures of thermal stress on the human body. UTCI is calculated for an ensemble of regional climate models participating in EURO-CORDEX. Changes between the historical period and long-term projections are compared. Four popular beach regions, in Germany, Italy, France, and Spain are presented.

Universal Thermal Comfort Index

The Universal Thermal Comfort Index is measure of thermal stress on the human body. It accounts for temperature, humidity, wind speed, as well as, radiative temperature.

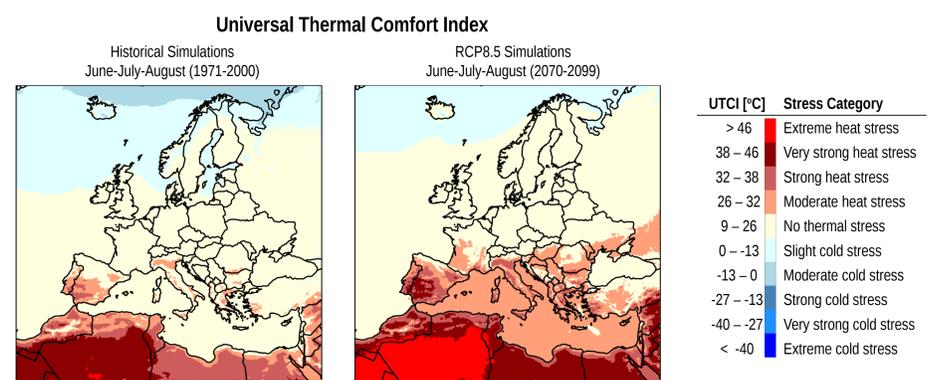


Figure 1: EUR11-CORDEX ensemble mean of UTCI of the June-July-August seasonal average over 30-years at 15 hr. (a) Historical simulations (1971-2000); (b) Long-term projection of RCP8.5 (2070-2099).

Blue Flag beaches

Beach operators are responsible for providing a safe and clean environment for patrons. Their responsibilities, and thus climate service needs, are extremely diverse. For example, they must:

- test water quality,
- manage personnel (including lifeguards),
- ensure water & electricity demands of facilities,
- ensure access to drinking water, etc.

Understanding how these responsibilities may change due to changes in thermal stresses on people is important. As people grapple with different ways to cope with thermal stress, their needs and behaviours will change. This will have a direct, yet diverse, financial impact on a municipality in terms of taxes generated by tourism, number of lifeguards needed, and electricity consumption. In addition, there will be additional demands on the natural beach environment.

European Beaches

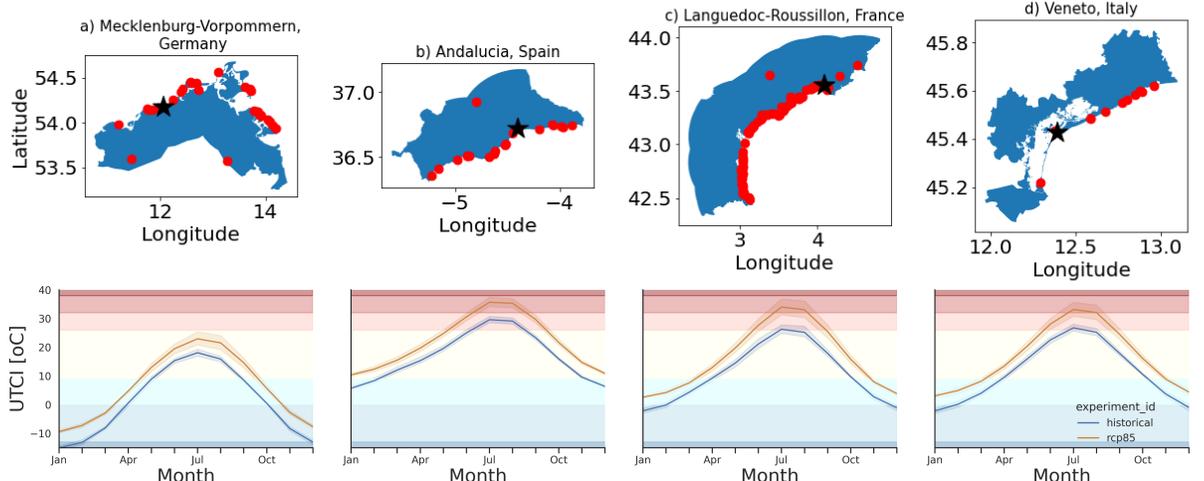


Figure 2 (Top): Four coastal regions of interest: Mecklenburg-Vorpommern, Germany; Andalusia, Spain; Languedoc-Roussillon, France; and Veneto, Italy. Blue Flag beaches are denoted by red dots, with the following beaches denoted with a black star: (a) Ostseebad Warenunede Westrand, Rostock, Germany; (b) Malagueta, Malaga, Spain; (c) Plage Echirolles, La Grande Motte, France; and (d) Lido di Venezia, Venice, Italy. (Bottom) Corresponding monthly averages of UTCI over a 30-year period. Dark lines show the ensemble mean, shaded area shows the 95% confidence interval. Background colour denotes thermal stress level.

The Euro-CORDEX ensemble shows the monthly averages of UTCI increases under RCP8.5. across all 4 regions. Conditions of 'no thermal stress' occurs earlier in spring and later in autumn. In Mecklenburg-Vorpommern, beach-goers can benefit from a longer beach season. Across the Mediterranean beach-goers will be exposed to 'strong heat stress', compared to historically 'no' or 'moderate' heat stress in July and August.

EURO-CORDEX

UTCI calculated from the following ensemble members of EUR-11 CORDEX (~12.5 km), 3hrly-frequency simulations, at 15 hr.

Global Climate Model	Realisation	Regional Climate Model
CCCma-CanESM2	r1i1p1	CLMcom-CCLM4-8-17
MIROC-MIROC5	r1i1p1	CLMcom-CCLM4-8-17
CNRM-CERFACS-CNRM-CM5	r1i1p1	CLMcom-ETH-COSMO-crCLIM-v1-1
ICHEC-EC-EARTH	r3i1p1	CLMcom-ETH-COSMO-crCLIM-v1-1
MOHC-HadGEM2-ES	r1i1p1	CLMcom-ETH-COSMO-crCLIM-v1-1
MPI-M-MPI-ESM-LR	r3i1p1	CLMcom-ETH-COSMO-crCLIM-v1-1
NCC-NorESM1-M	r1i1p1	CLMcom-ETH-COSMO-crCLIM-v1-1

Conclusions

- Universal Thermal Comfort Index: <https://doi.org/10.5281/zenodo.7055787>
- Changing 'beach seasons':
 - Monthly mean UTCI increases each month for all 4 beach regions. Conditions of 'No thermal stress' on the body is reached earlier in spring, extends later in autumn.
 - In Mecklenburg-Vorpommern, beach-goers can benefit from a longer beach season.
 - In the Mediterranean, the monthly average of UTCI in July and August reach levels of 'strong thermal stress' on the body.
- As the European continent experiences greater thermal stress in summer, there is likely increased demand for coastal tourism. Preferred locations, however, may shift northwards due to less thermal stress on the human body.