EXHAUSTION

The **EXHAUSTION** project

[Exposure to heat and air pollution in Europe – cardiopulmonary impacts and benefits of mitigation and adaptation]

ENBEL workshop
18 February, 2022 (online)

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The impact pathway from climate change to changes in exposure and health damage related to heat stress and air pollution in Europe

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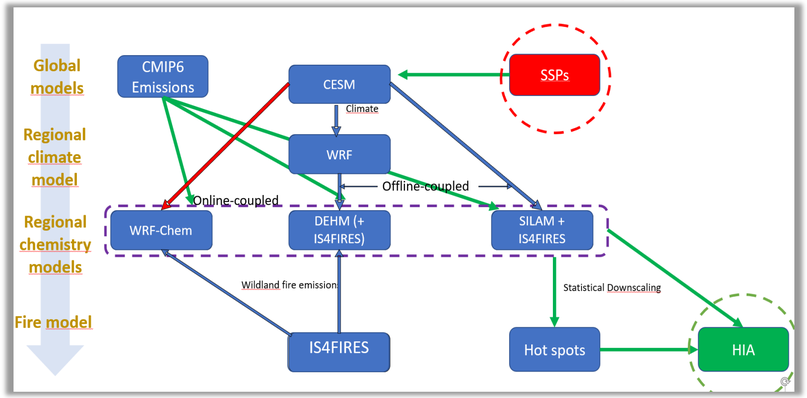
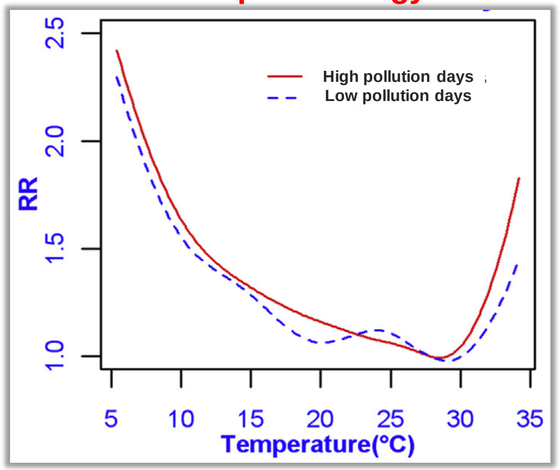
Cross-disciplinary collaboration

- *Objective:* “Quantify the changes in cardiopulmonary mortality and morbidity due to extreme heat and air pollution (including from wildfires) under selected climate scenarios, while accounting for adaptation, calculate the associated costs, and identify effective strategies for minimizing adverse impacts.”

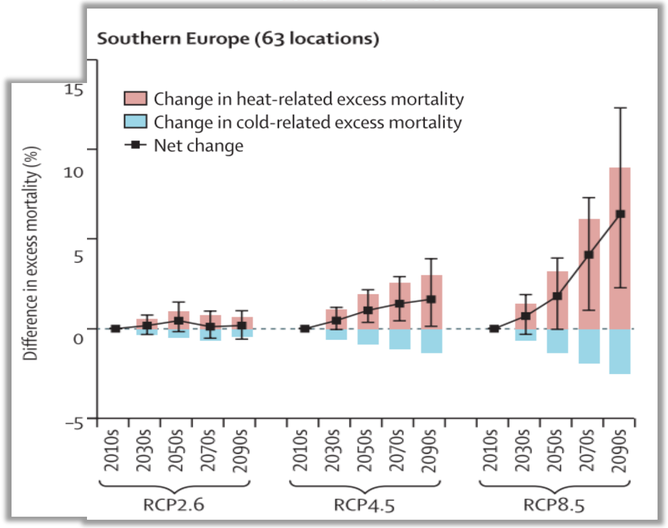
Climate & Air pollution modelling



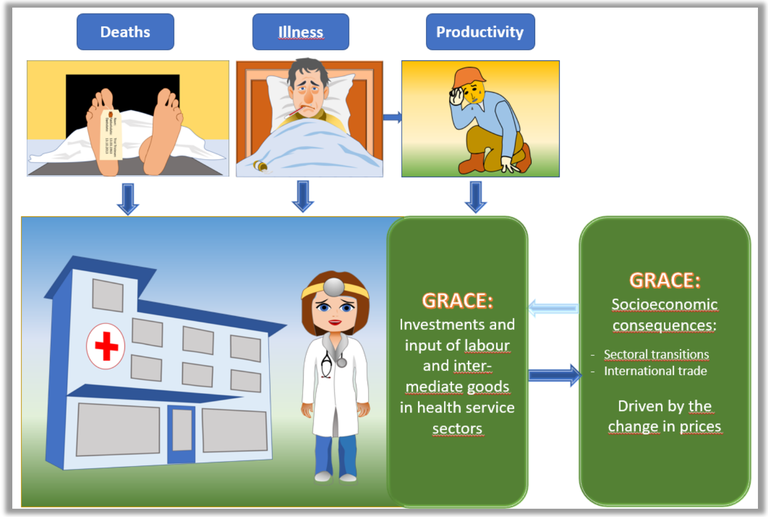
Epidemiology



Health burden



Socio-economic consequences

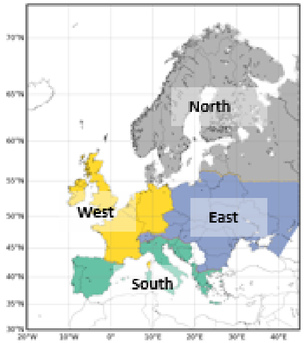


Near-past and future trends of European extreme heat and heat waves from WRF downscaling experiments

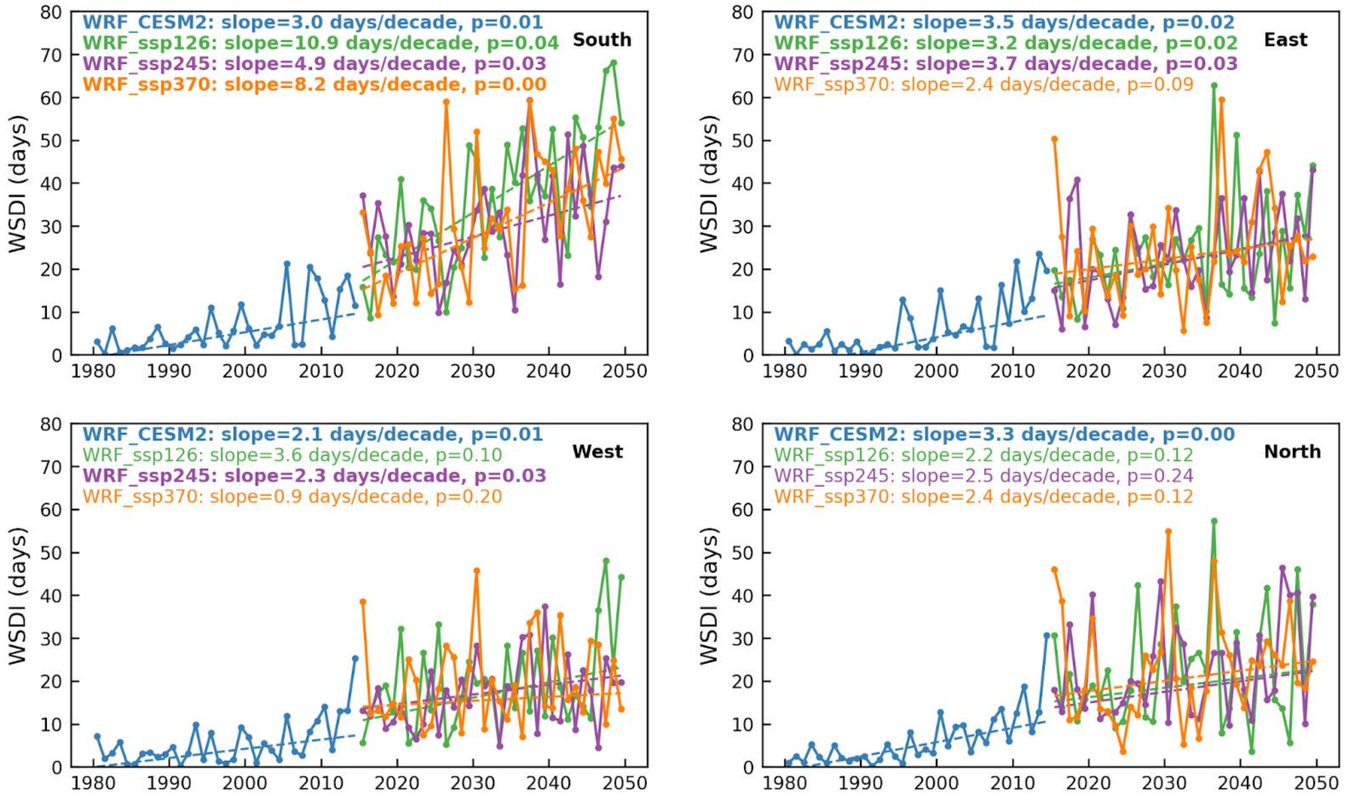
WRF Downscaling Experiments

20km resolution; 54 vertical layers up to 10hPa; spectral nudging, 6 waves

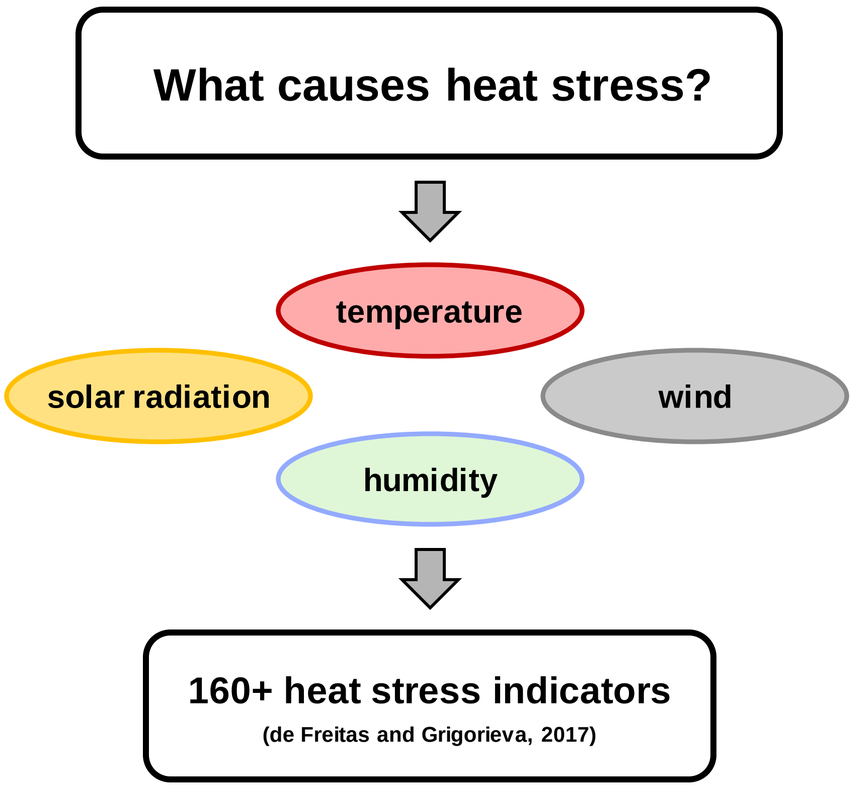
Case	Driven by	Period
WRF_CESM2	CESM2 global	1980-2014
WRF_ERA5	ERA5 reanalysis	1981-2010
WRF_ssp126	CESM2 ssp126	2015-2049
WRF_ssp245	CESM2 ssp245	2015-2049
WRF_ssp370	CESM2 ssp370	2015-2049



Warm-spell duration index



Heat stress indicators: How do they evolve with global warming?



Goal: Estimate future evolution of health relevant heat stress indicators as function of global mean temperature (GMT)

- Using temperature and humidity only (calm conditions in the shade)
- 20 climate models (historical data + scenario projections)
- Focus on highly populated regions

8 heat stress indicators (HSIs):

Health effects

1. Air temperature (TX)
2. Apparent temperature (AT)
3. Universal Thermal Climate Index (UTCI)
4. Wet bulb temperature (T_{WB})

Heat warnings

5. NOAA heat index (HI)
6. Humidex (Hu)

Economic impacts

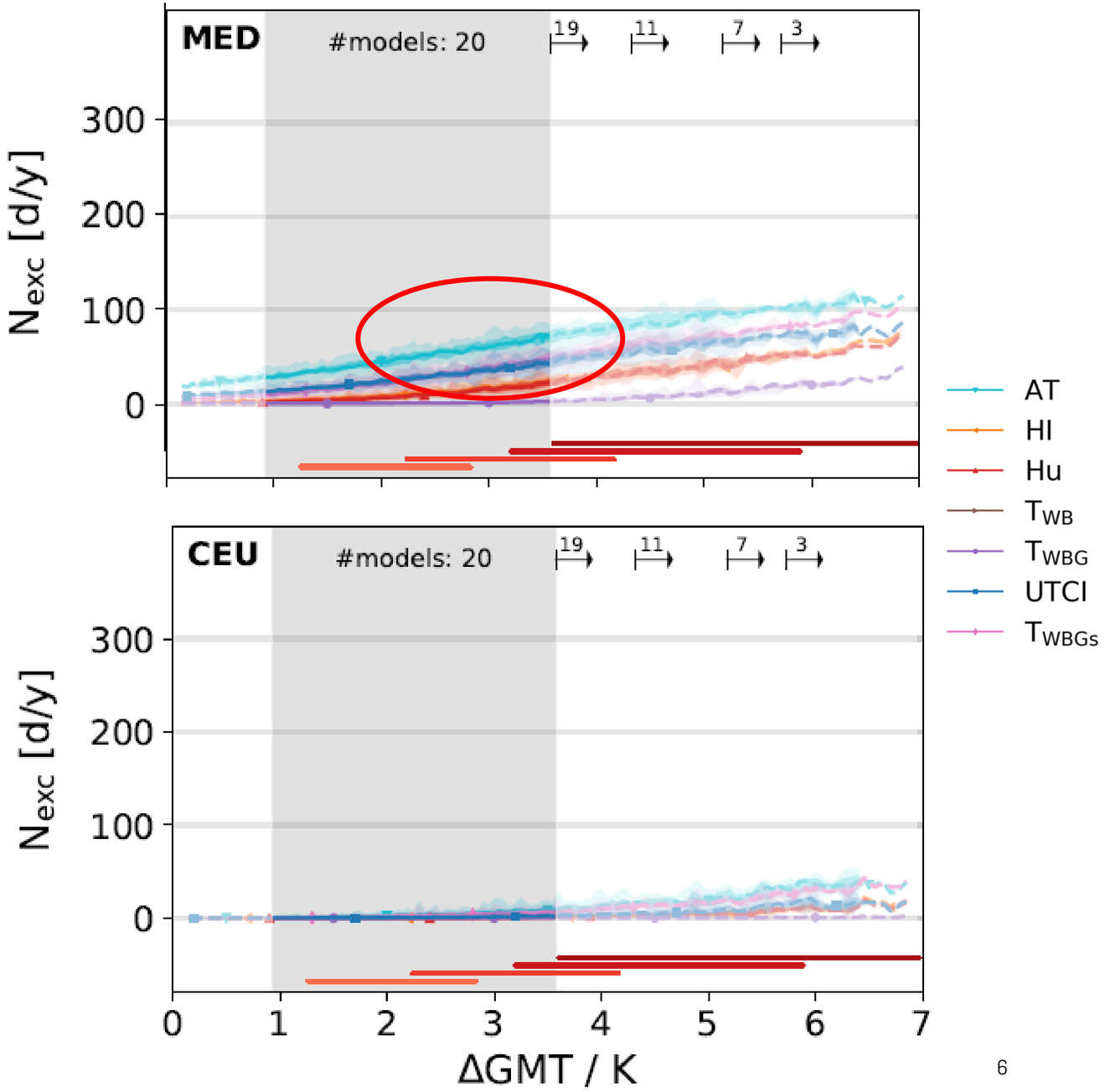
7. Wet bulb globe temperature (T_{WBG})
8. Simplified T_{WBG} (T_{WBGs})

Schwingshackl et al. 2020. Heat stress indicators in CMIP6: Estimating future trends and exceedances of impact-relevant thresholds (submitted).

Number of days per year with ‘very hot’ conditions given alternative levels of global warming

- Most HSIs increase faster than the global mean
- **Mediterranean**: Apparent T (perceived outdoor T) reaches ‘level 3’ **(very hot) up to 80-90 days per year** under 2-4 degr warming

	AT	HI	Hu	T_{WB}	T_{WBG} & T_{WBGs}	UTCI
Level 1 (warm)	28.0 °C	27.0 °C	30.0 °C	-	29.0 °C	26.0 °C
Level 2 (hot)	32.0 °C	32.0 °C	40.0 °C	-	30.5 °C	32.0 °C
Level 3 (very hot)	35.0 °C	41.0 °C	45.0 °C	-	32.0 °C	38.0 °C
Level 4 (extreme)	40.0 °C	54.0 °C	54.0 °C	35.0 °C	37.0 °C	46.0 °C



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Climate extreme indices and heat stress indicators derived from CMIP6 global climate projections

Overview | Download data | Documentation

Clear all

Variable

At least one selection must be made

Extreme value indices (ETCCDI)

- [ ] Cold days (TX10p)
- [ ] Cold spell duration index (CSDI)
- [ ] Consecutive wet days (CWD)
- [ ] Extremely wet day precipitation (R99p)
- [ ] Growing season length (GSL)
- [ ] Ice days (ID)
- [ ] Maximum 5-day precipitation (Rx5day)
- [ ] Minimum value of daily maximum temperature (TXn)
- [ ] Minimum value of daily minimum temperature (TNn)
- [ ] Simple daily intensity index (SDII)
- [ ] Total wet day precipitation (PRCPTOT)
- [ ] Very heavy precipitation days (R20mm)
- [ ] Warm days (TX90p)
- [ ] Warm spell duration index (WSDI)
- [ ] Cold nights (TN10p)
- [ ] Consecutive dry days (CDD)
- [ ] Diurnal temperature range (DTR)
- [ ] Frost days (FD)
- [ ] Heavy precipitation days (R10mm)
- [ ] Maximum 1-day precipitation (Rx1day)
- [ ] Maximum value of daily maximum temperature (TXx)
- [ ] Maximum value of daily minimum temperature (TNx)
- [ ] Number of wet days (R1mm)
- [ ] Summer days (SU)
- [ ] Tropical nights (TR)
- [ ] Very wet day precipitation (R95p)
- [ ] Warm nights (TN90p)

Select all

Heat stress indicators (HSI)

- [ ] Heat index
- [ ] Universal thermal climate index
- [ ] Wet-bulb globe temperature index
- [ ] Humidex
- [ ] Wet-bulb temperature index

Select all

Select all

Projecting wildfires and associated air pollution

Develop the IS4FIRES fire information system to make it capable of "forecasting" fires:

- Establish the statistical relationship between meteorological parameters/fire danger indices (ERA5 data) and fire radiative power (FRP) (MODIS data) or its time-integral, fire radiative energy, FRE.

- Meteorologial parameters then replaced by projections (CESM model output) to enable scenario projections

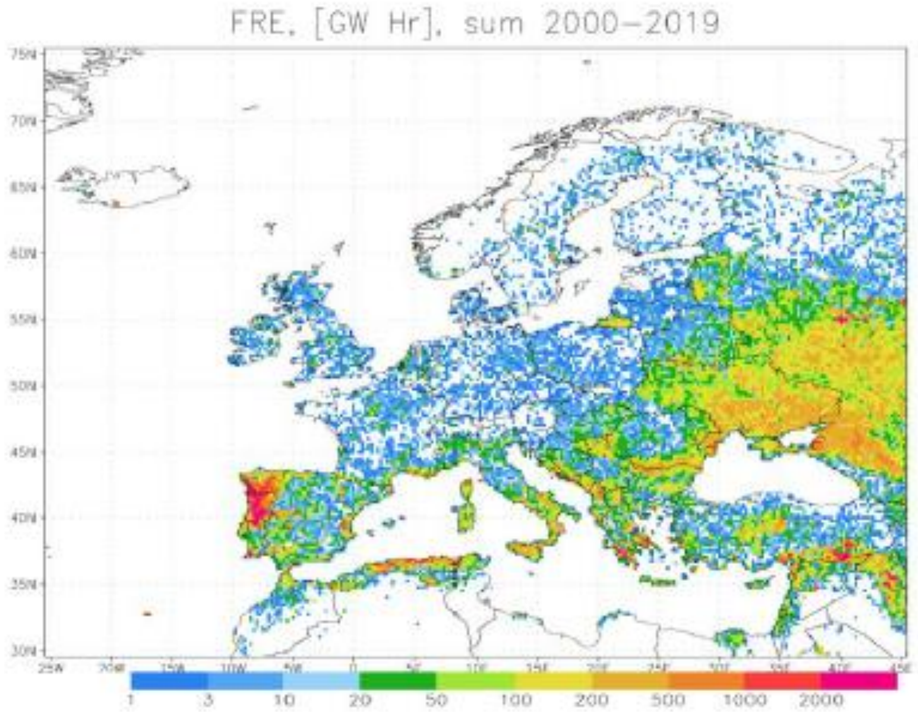
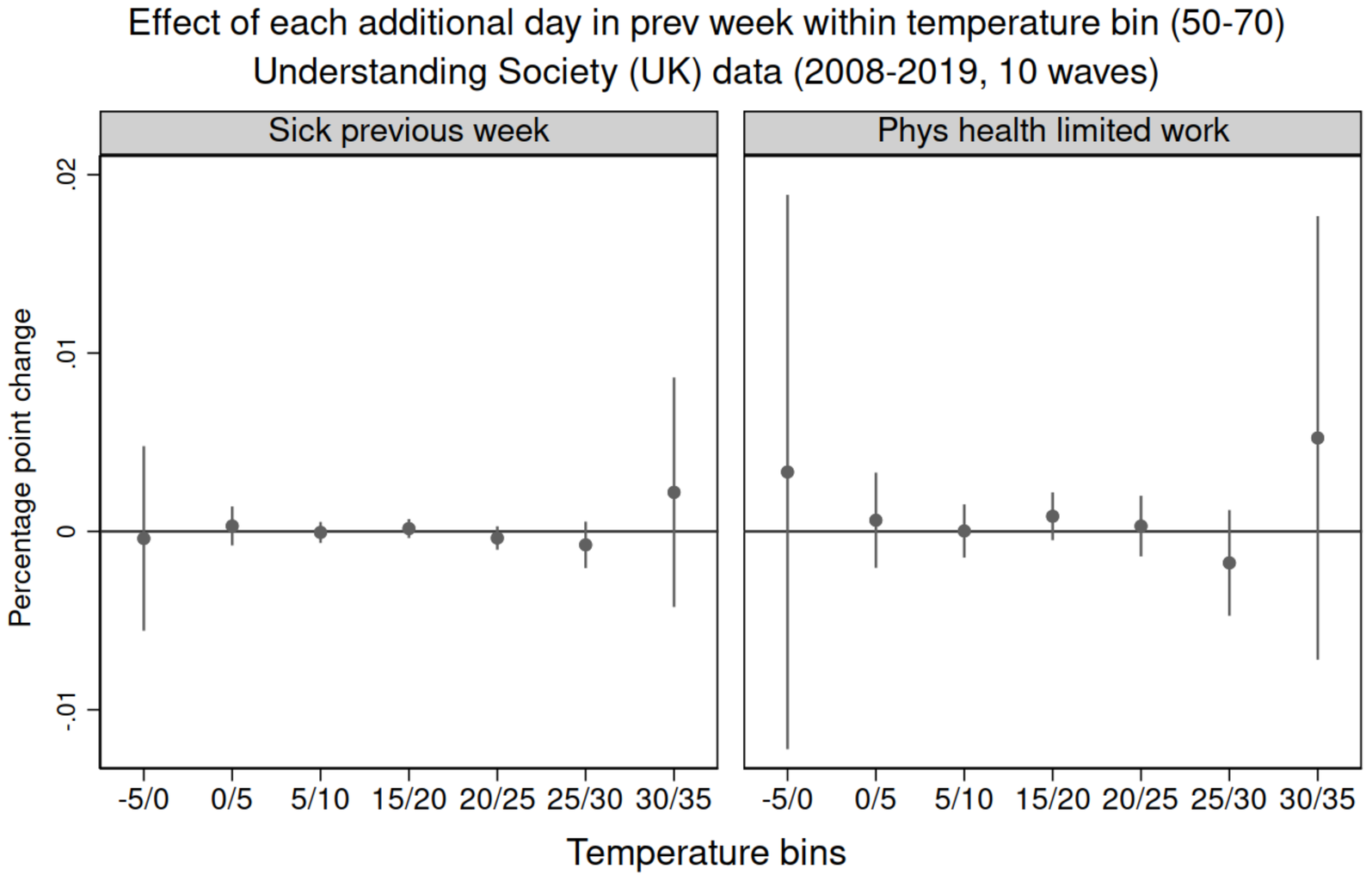


Figure 18. Figure 4 repeated: A map of total FRE release 2000-2019 in Europe. Grid cell size is 0.25° x 0.25°.

Assessing the impact of excessive heat on labour market performance

- Preparatory work: literature review and screening of available datasets Europe-wide
- Used UK data from a major national longitudinal survey (“Understanding Society”) as initial test case (other data from eg Norway identified and currently being analysed, too)
- Objective:
  - Assess impact of heat periods on productivity outcomes
- Data:
  - Station-level data (HadUK-Grid), interpolated 1x1 km grid, daily Tmax/Tmin
  - Understanding Society Panel, 10 waves (2008-2019)
- Methods:
  - Data linkage of survey data with temperature data at highly disaggregated regional level (LSOA)
  - Econometric analysis: Linear probability models using pooled sample (so far)
- Exposures:
  - Average daily max temperature during previous week categorised into 5°C bins
  - Number of days in prev. week with max temperature within specific bin
- Outcomes
  - Self-reported **work absence due to sickness and injury**, previous week
  - Self-reported **limitation at work due to physical health issues**, previous 4 weeks
- Preliminary results available (writing up currently)

Illustrative results (preliminary)

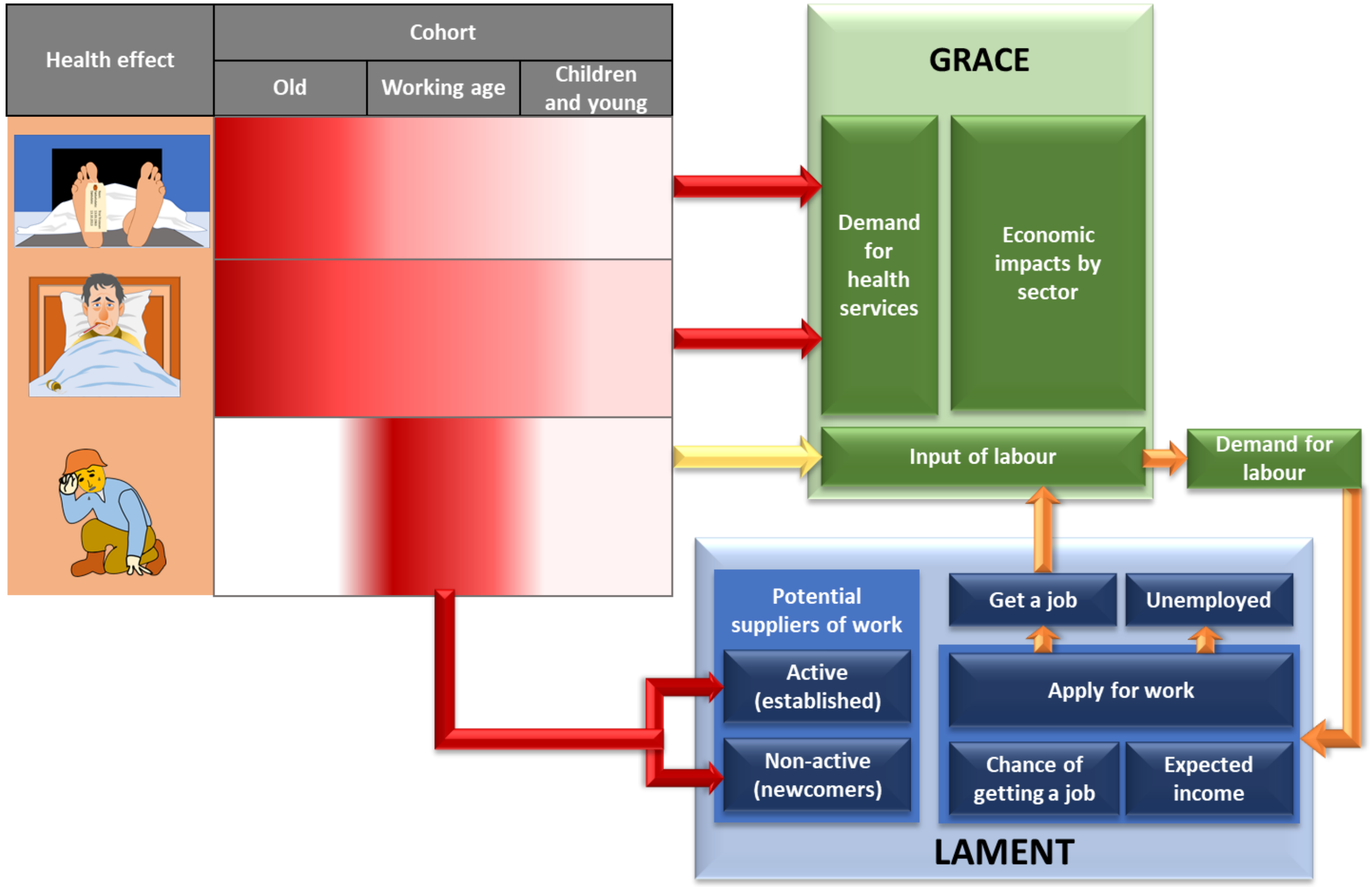


Note: Linear prob. model, 95% CI. Controls: age, sex, wave, education, month
Reference category: 10-15°C bin
Outcome 1: Did not work in previous week due to sickness
Outcome 2: Phys. health often or very often limited work in prev. 4 weeks

Economic consequenses at the national level

The modelling:

It's not only a question of how much less we get out of those who work



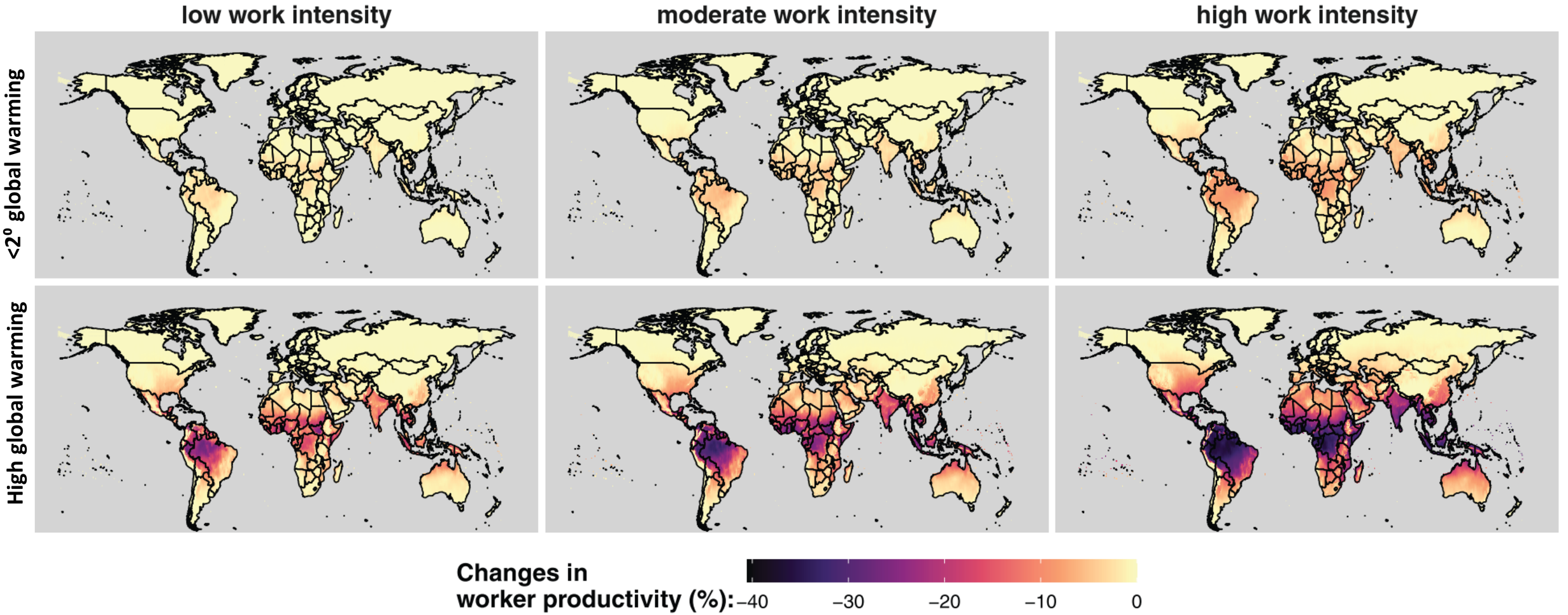
Constructed case (Norway):

Impacts on the labour market of a 1 percent reduction in labour productivity. No. of people

	Reference	Impact
Supply, active workers	2 472 098	10 500
Supply, non-active	46 518	6 295
New positions	65 629	-7 971
Vacancies	71 351	-7 911
Unemployment	105 067	24 705
Wage rate for newly hired people (%)	93.9	-30.0

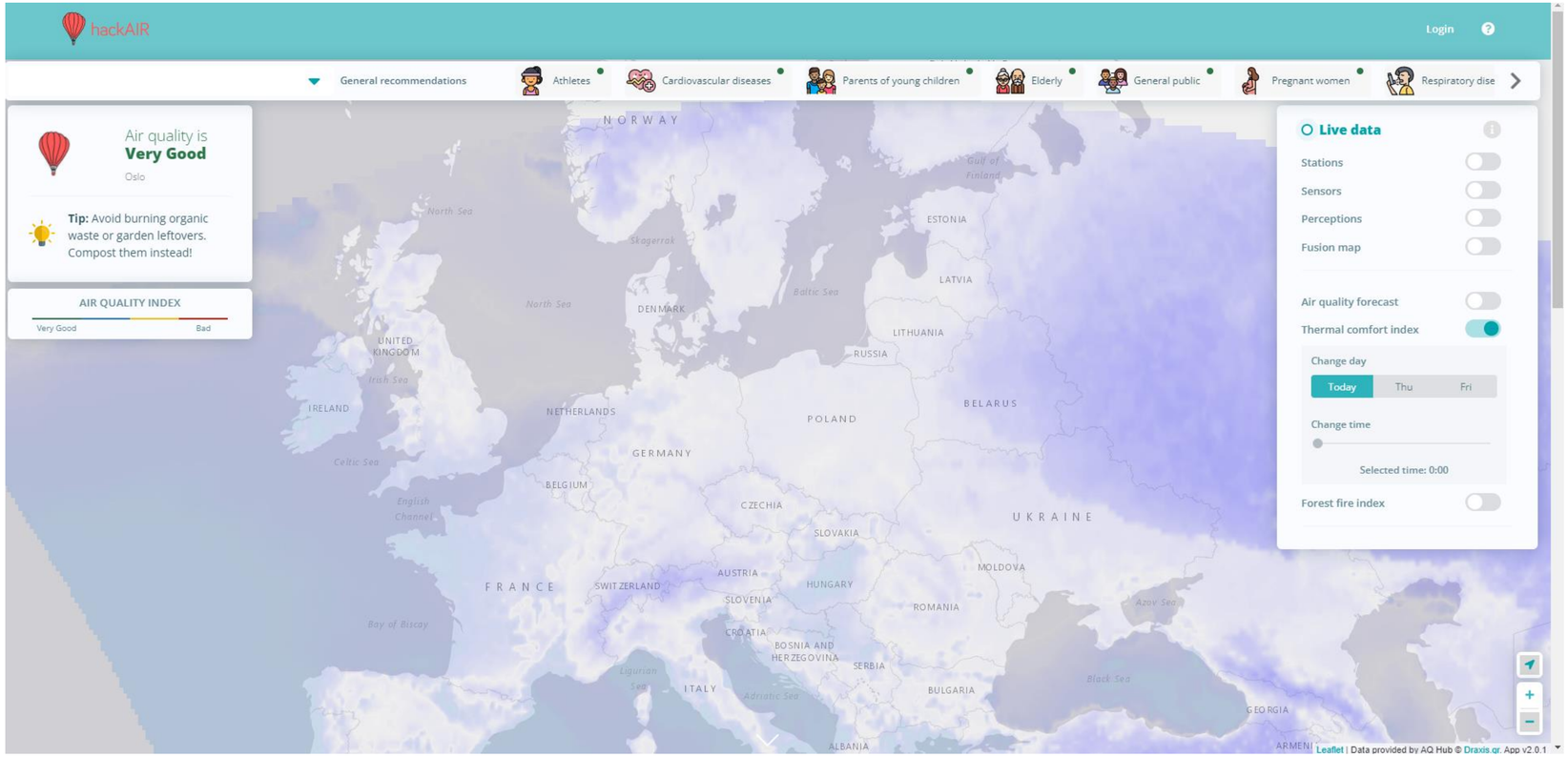
Note: *This case refers to pure assumptions on how variables and relationships in LAMENT are affected by health effects*

Global worker productivity loss in 2100



Orlov, A. (2020). Economic costs of heat-induced reductions in worker productivity due to global warming. *Global Environmental Change, 63*.

Citizen engagement tool
- hackAIR web app & mobile app (Android & iOs) being developed



hackAIR

hackAIR - Get informed on air quality, extreme heat events and probability of forest fires

hackAIR (https://platform.hackair.eu/) is an open technology platform that you can use to access air quality information in Europe. It was created as part of an EU-funded project on 'Collective Awareness Platforms for Sustainability and Social Innovation'. hackAIR complements official data with community-driven data sources, for collecting, analysing and sharing air quality measurements through low-cost open hardware sensors, easily assembled by citizens.

In a new research endeavor, we are about to enhance hackAIR with additional functionalities and data that may help people further protect their health and wellbeing. These will include information about extreme heat events and the probability of forest fires.
* An extreme heat event is a period of summertime weather when the temperature and/or the humidity for a given location at that time of the year are significantly higher than their mean average counterparts (U.S. Environmental Protection Agency).

The purpose of this questionnaire is to extract useful, not sensitive or confidential, information regarding the new functionalities of hackAIR, in order to enable technical partners to better comprehend your needs.
It will only take you 5'!

Thank you in advance for your contribution!
Contact the hackAIR team (for DRAXIS Environmental S.A.): info@hackair.eu
Visit hackAIR: https://platform.hackair.eu/

** DRAXIS Environmental S.A. (https://draxis.gr/) is responsible for processing of your personal data. We process your personal data in accordance with the General Data Protection Regulation (EU) 216/679. The personal data that will be gathered in this study is your email address, only if you provide your consent to be contacted in future studies.

Contributions from EXHAUSTION so far

- Results from EXHAUSTION so far confirm previous research, but add detail, geographic resolution, and modelling sophistication
- Contributes new insight regarding economic impacts, by integrating high-resolution estimates of worker productivity loss in CGE model

EXHAUSTION

https://exhaustion.eu

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