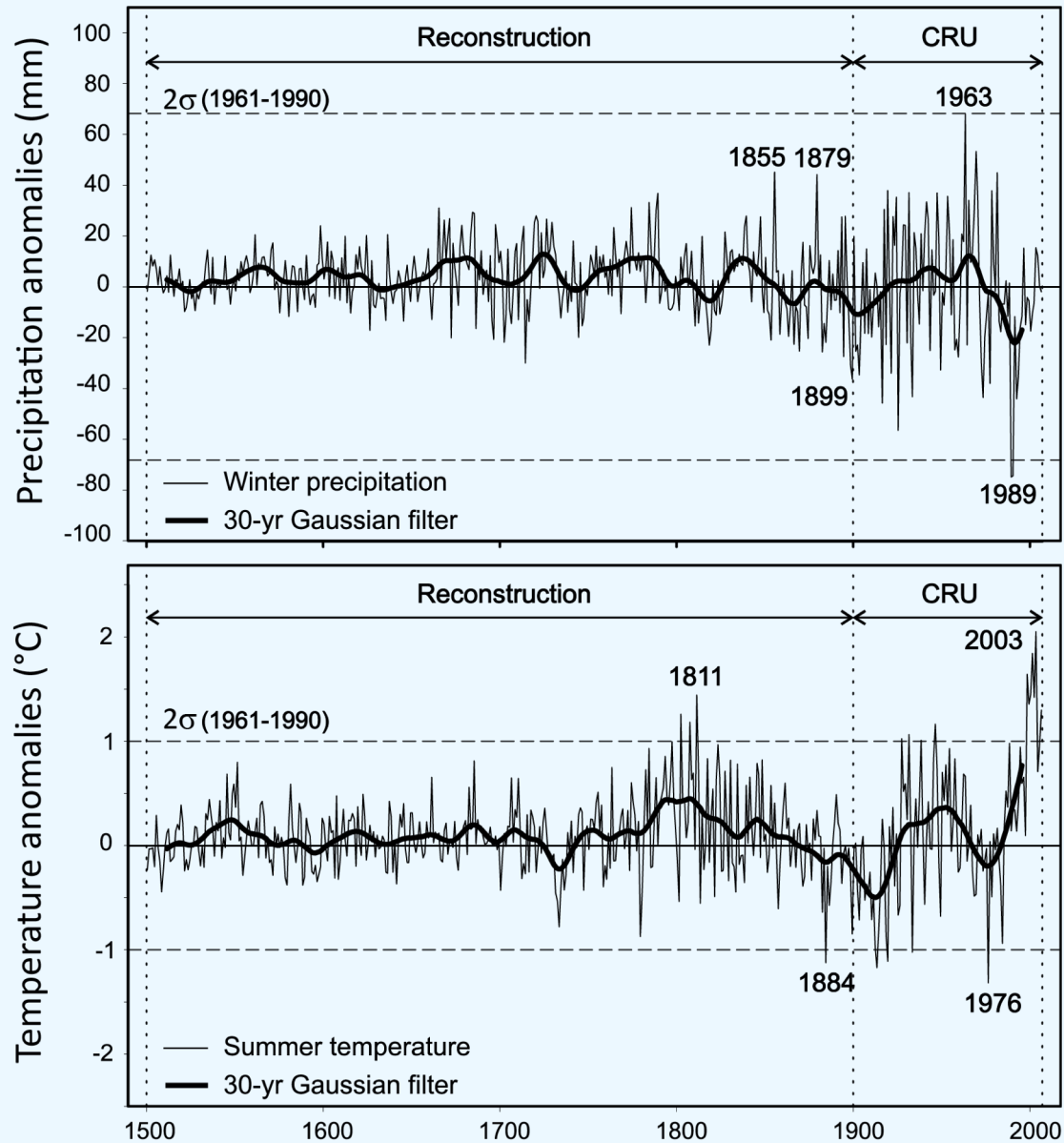# Climate change, weather extremes and impacts in the MENA
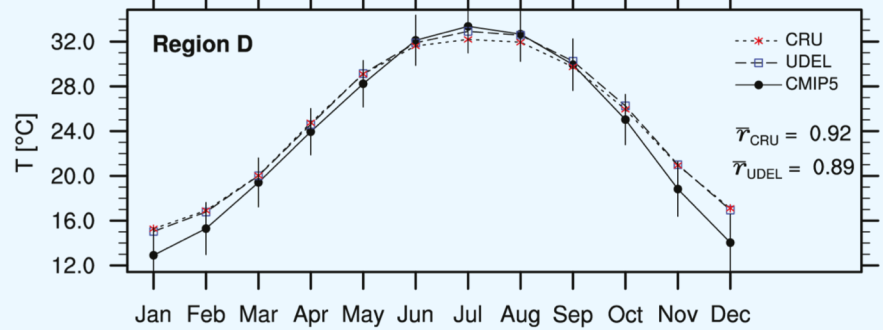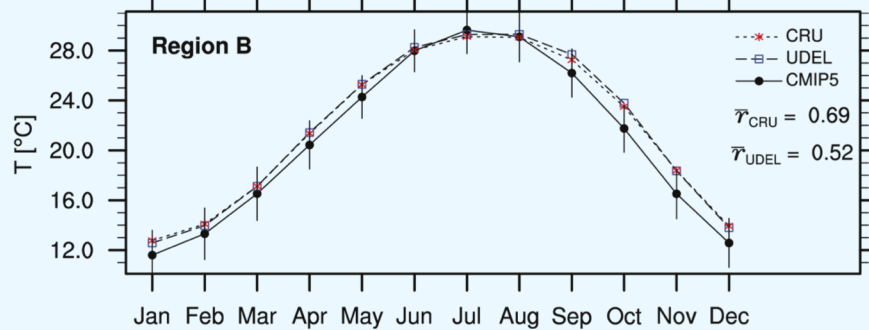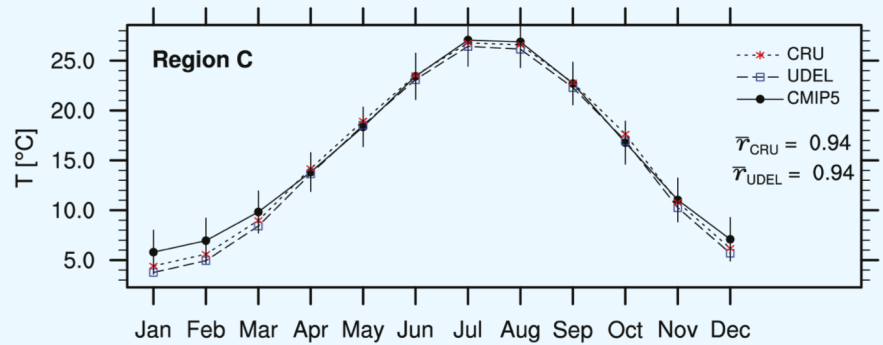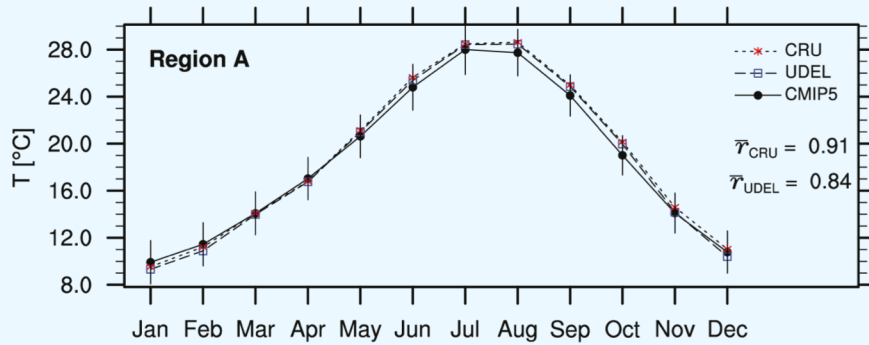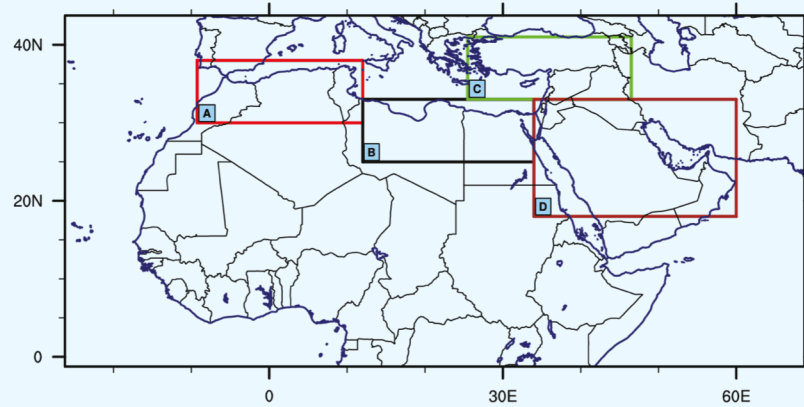
Jos Lelieveld

Panos Hadjinicolaou, Yiannis Proestos and George Zittis

Temperature and precipitation anomalies from climate proxies and recent data

CMIP5 temperature vs. observations in reference period (1986 – 2005)

Coupled Model Inter-comparison Project Phase 5 – CMIP5: temperature projections
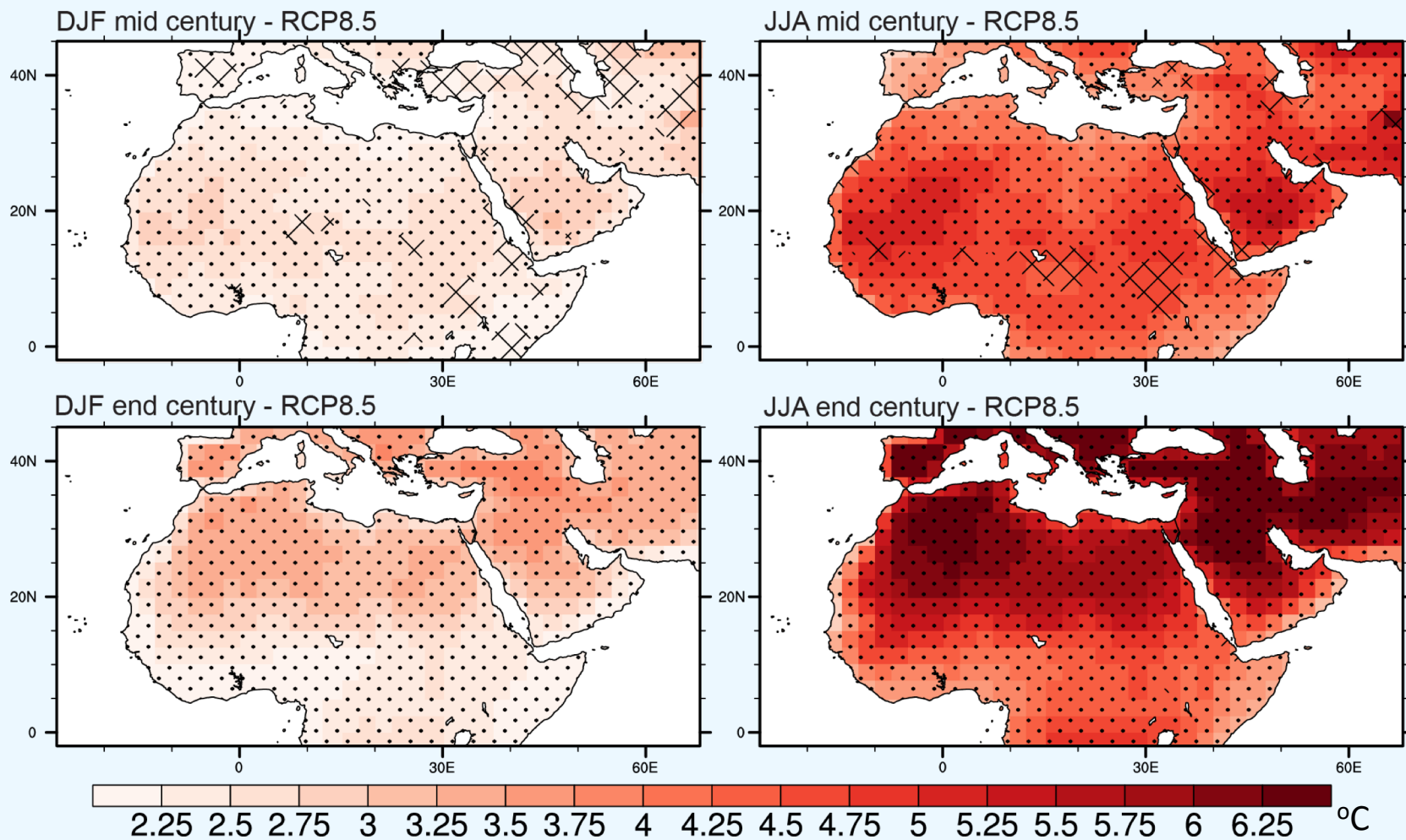
Model robustness high: dots R ≥ 0.85, and cross-hatching 0.5 ≤ R < 0.85

Coupled Model Inter-comparison Project Phase 5 – CMIP5: precipitation projections

DJF mid century - RCP8.5
JJA mid century - RCP8.5
DJF end century - RCP8.5
JJA end century - RCP8.5

lower robustness

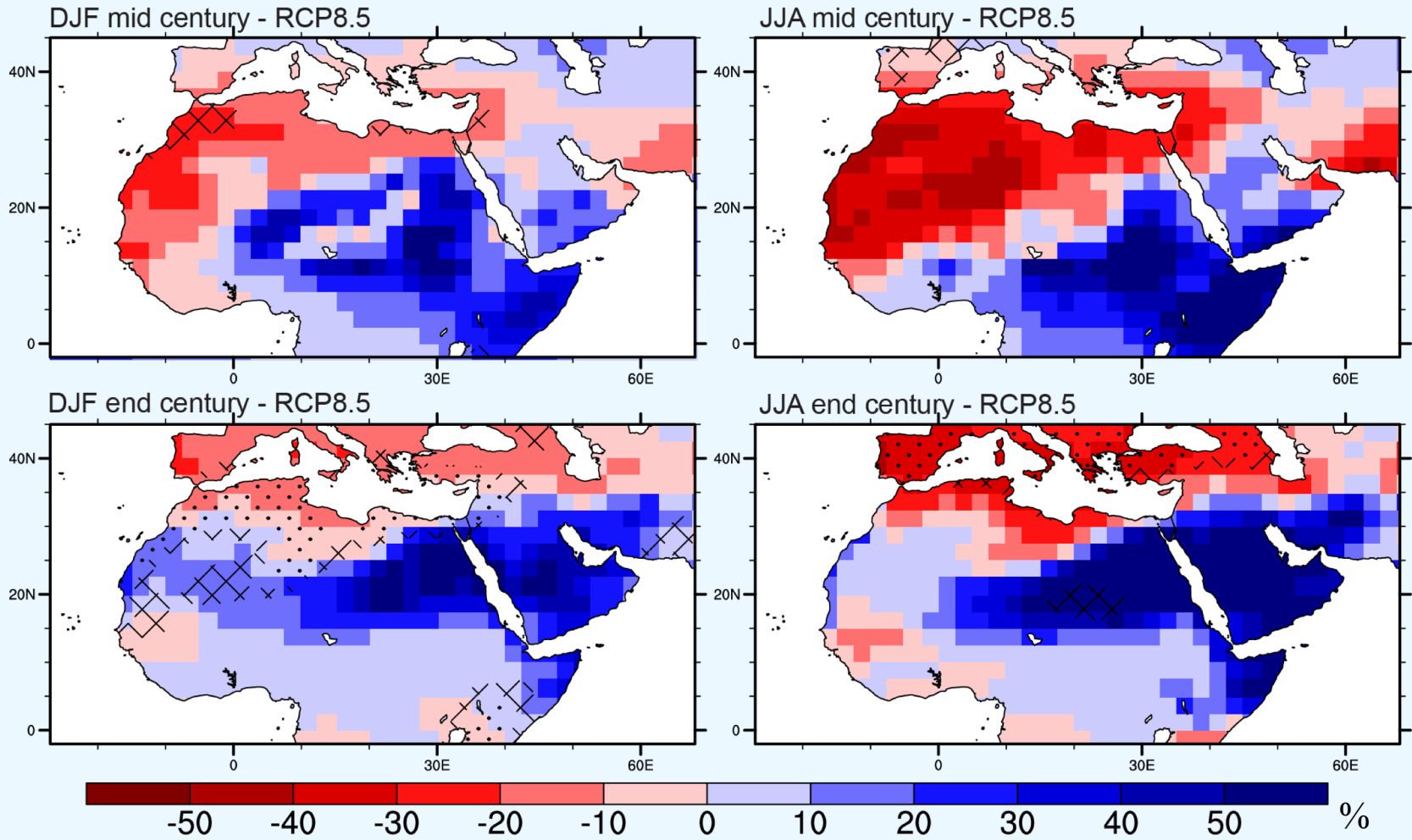# CMIP5: projected temperature indices, and observations in reference period

Cool nights (TN10p, %)

Warm nights (TN90p, %)

Cool days (TX10p, %)

Warm days (TX90p, %)

Hottest day (TXx, °C)

Warm Spell Duration (WSDI, days)

CMIP5 Mean
CMIP5 Spread
CMIP5 Min
CMIP5 Max
HadEx2
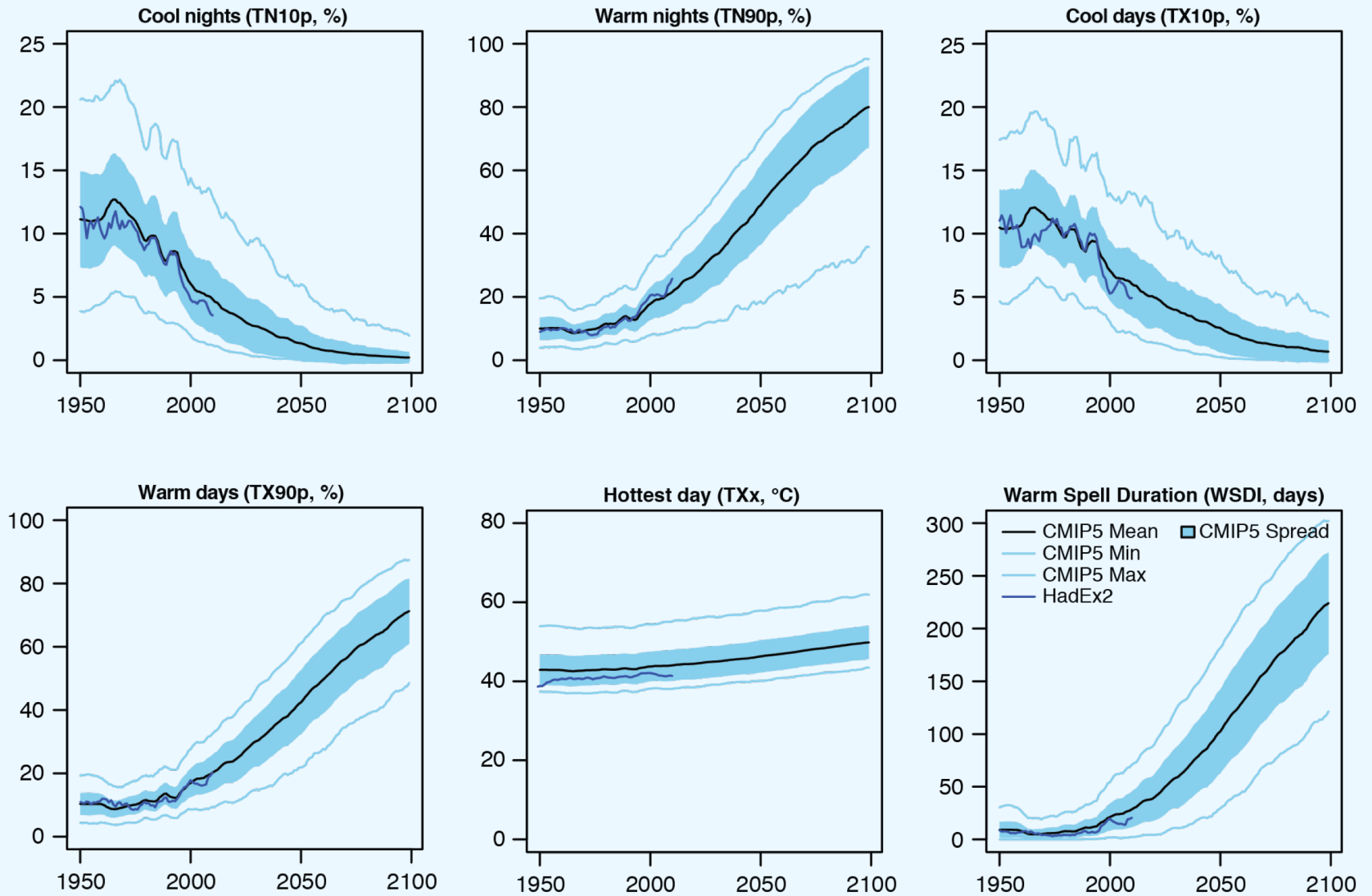
Observed (grey) and modeled (red) temperature changes relative to reference period 1961-1990
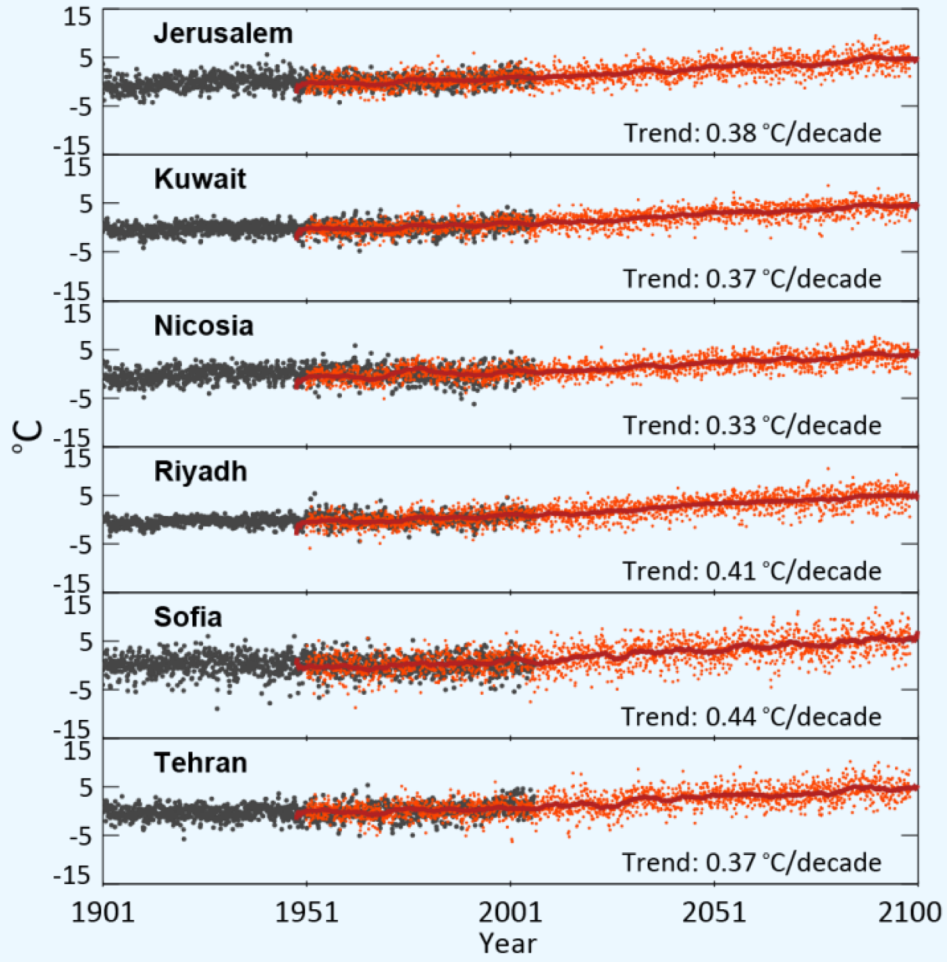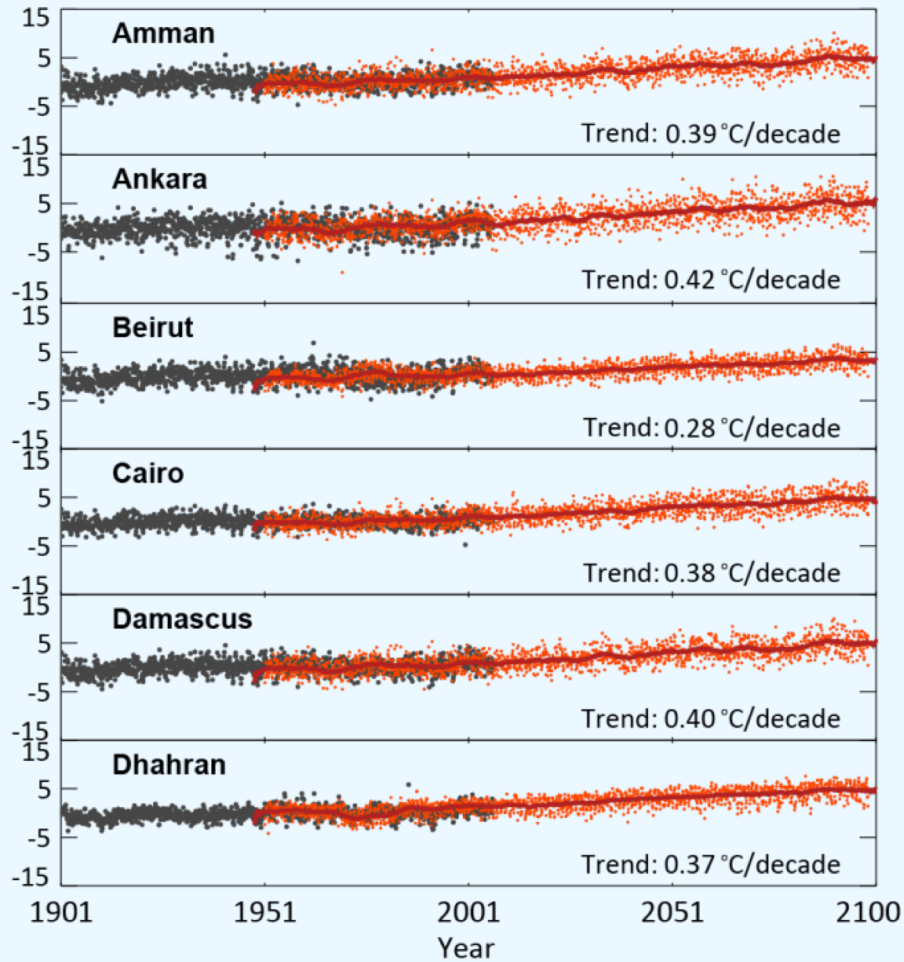
Heat waves are a major weather-related cause of premature mortality
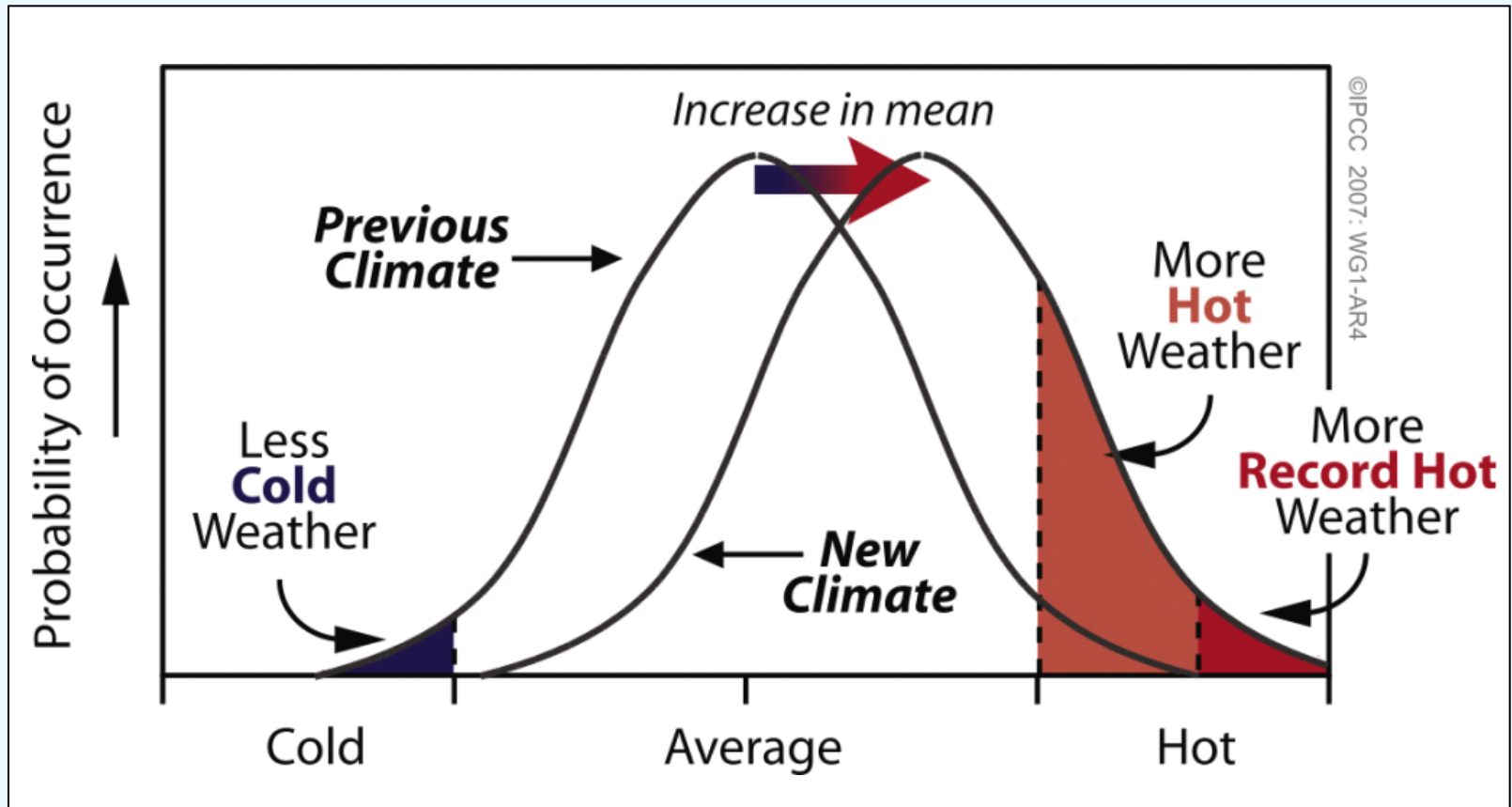
Probability distribution (PDF) of daytime maximum temperatures in summer (JJA)
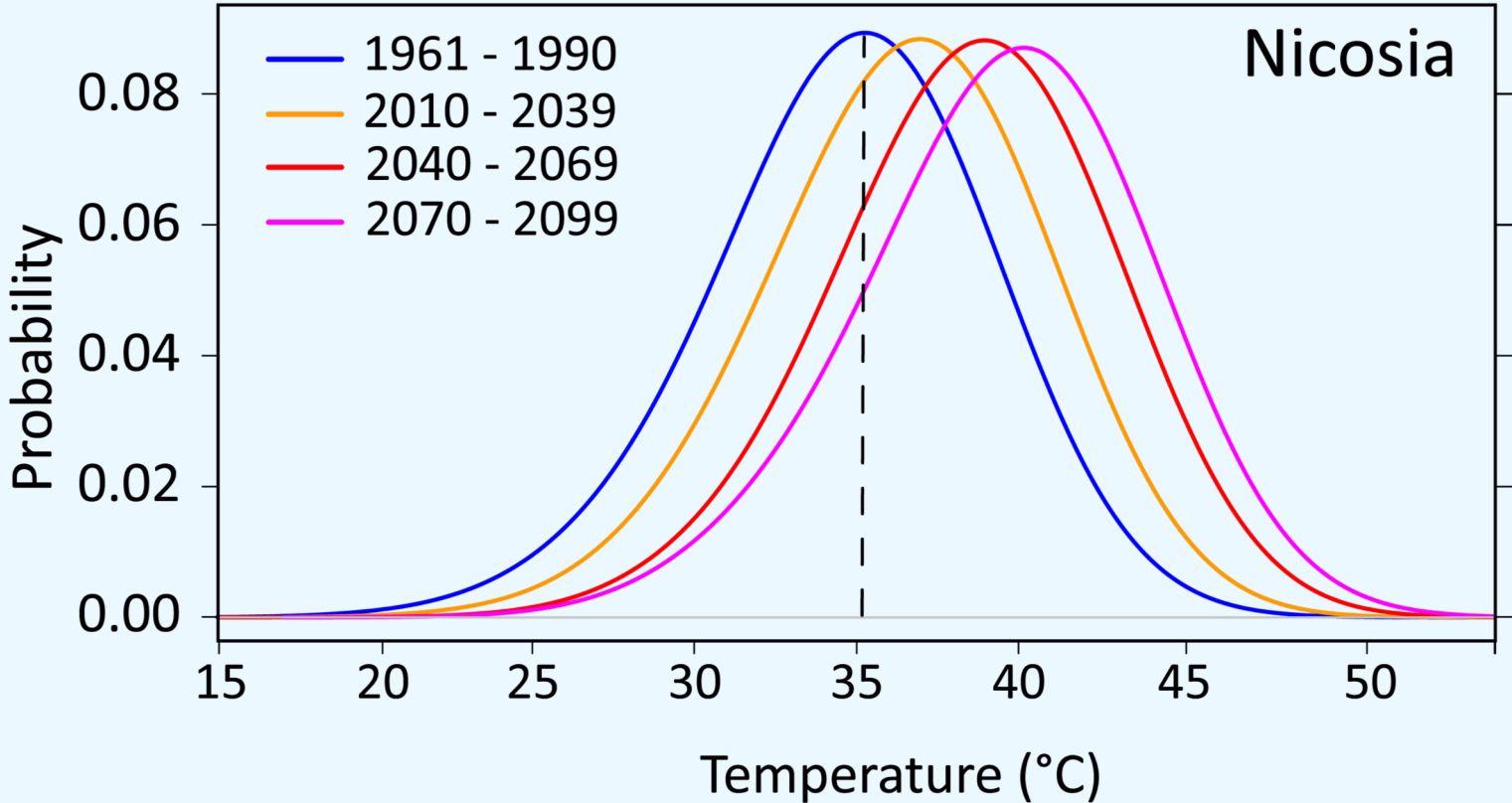
Nicosia

1961 - 1990
2010 - 2039
2040 - 2069
2070 - 2099

Probability distribution (PDF) of daytime maximum temperatures in summer (JJA)

Riyadh

Lubczyńska et al., 2015
Heat-related cardiovascular
mortality risk in Cyprus

Figure 2 Distribution of meteorological stations and the main urban areas.
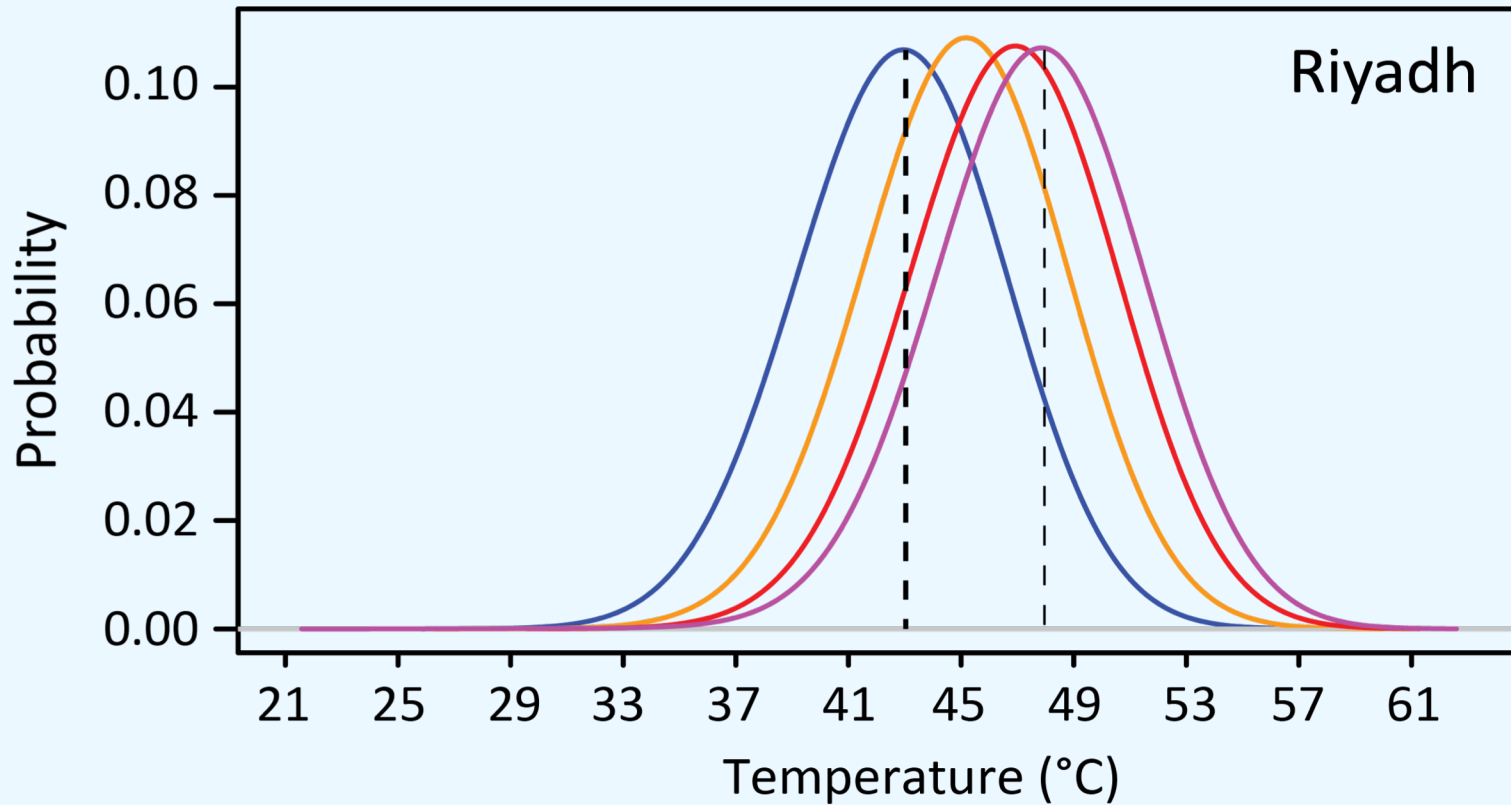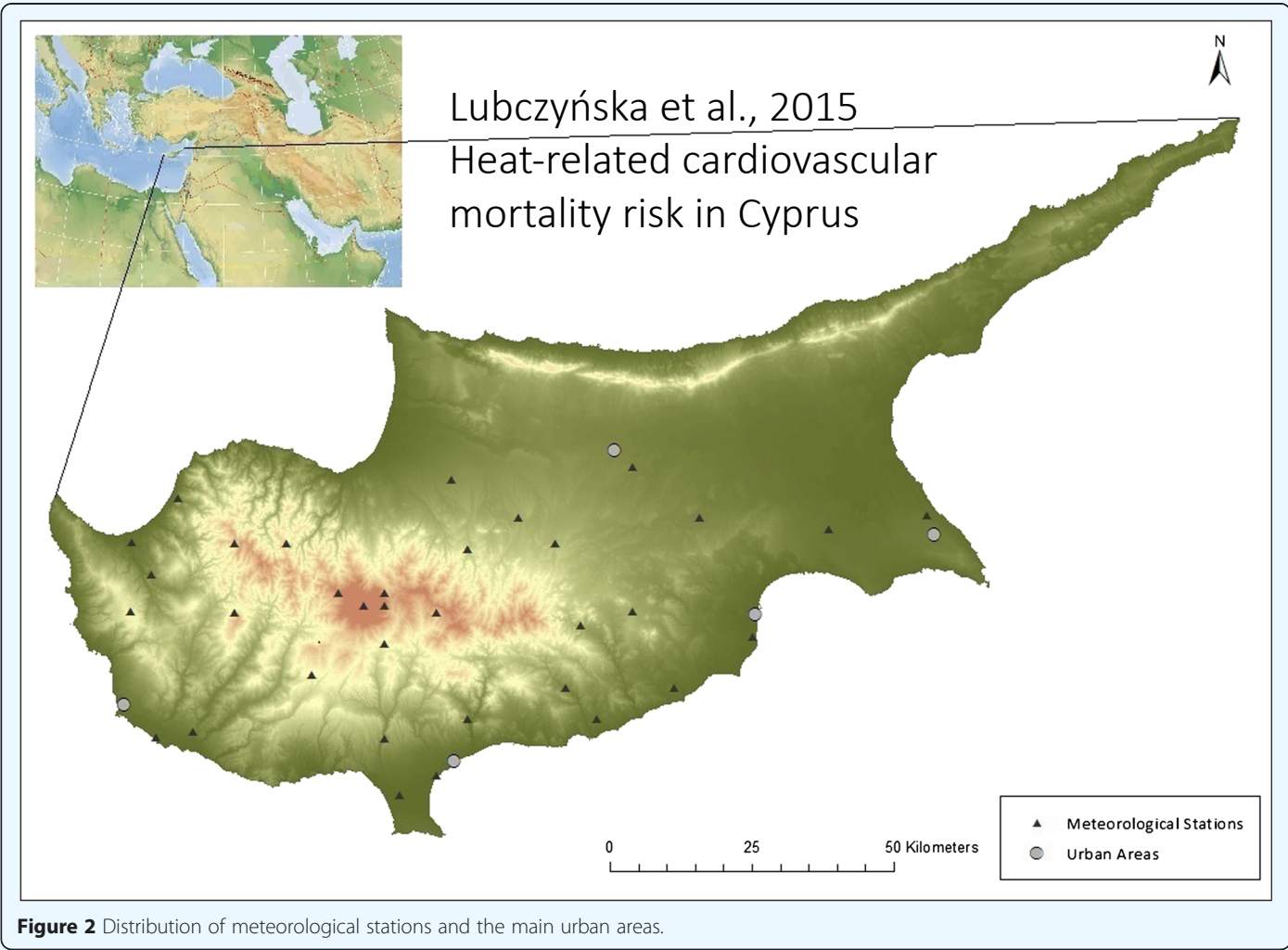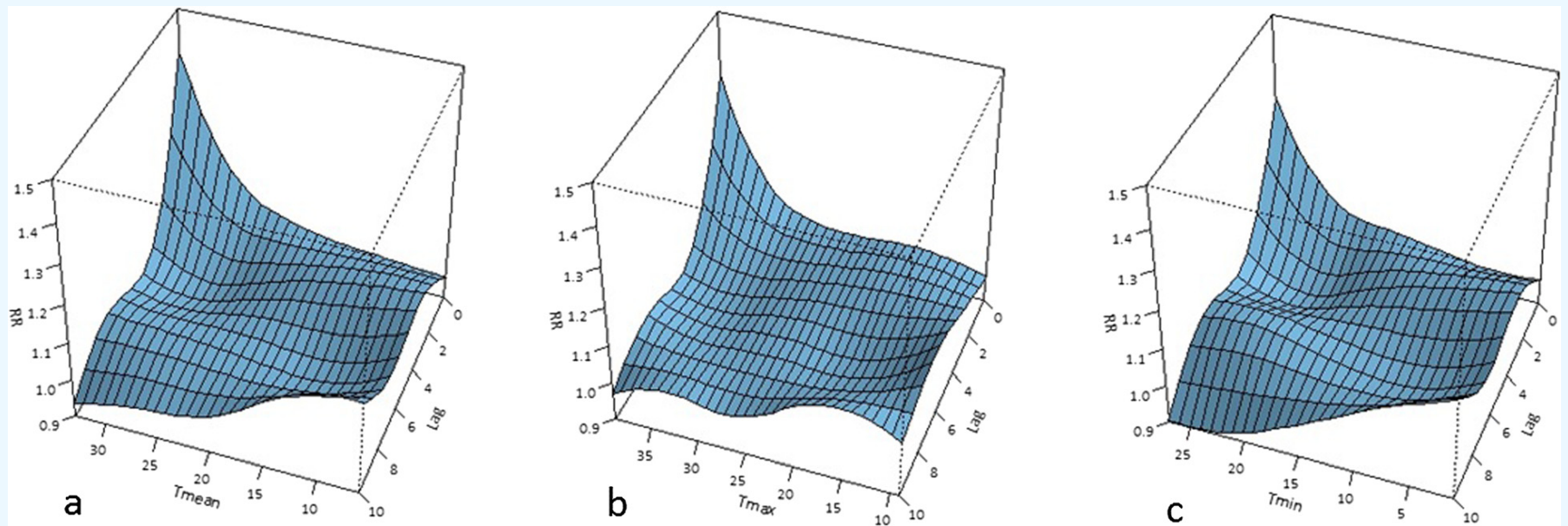
Figure 3 Relationship between temperature and relative mortality risks (RR) of aggregated cardiovascular diseases for lags ranging from 0 to 10 days for: **(a)** T_{mean}; **(b)** T_{max}; and **(c)** T_{min}.

Future temperature in southwest Asia projected to exceed a threshold for human adaptability

a TW_{max} HIST.
DOM = 27.0
LND = 26.4
AP = 26.7

b TW_{max} RCP4.5
DOM = 28.3
LND = 27.7
AP = 28.0

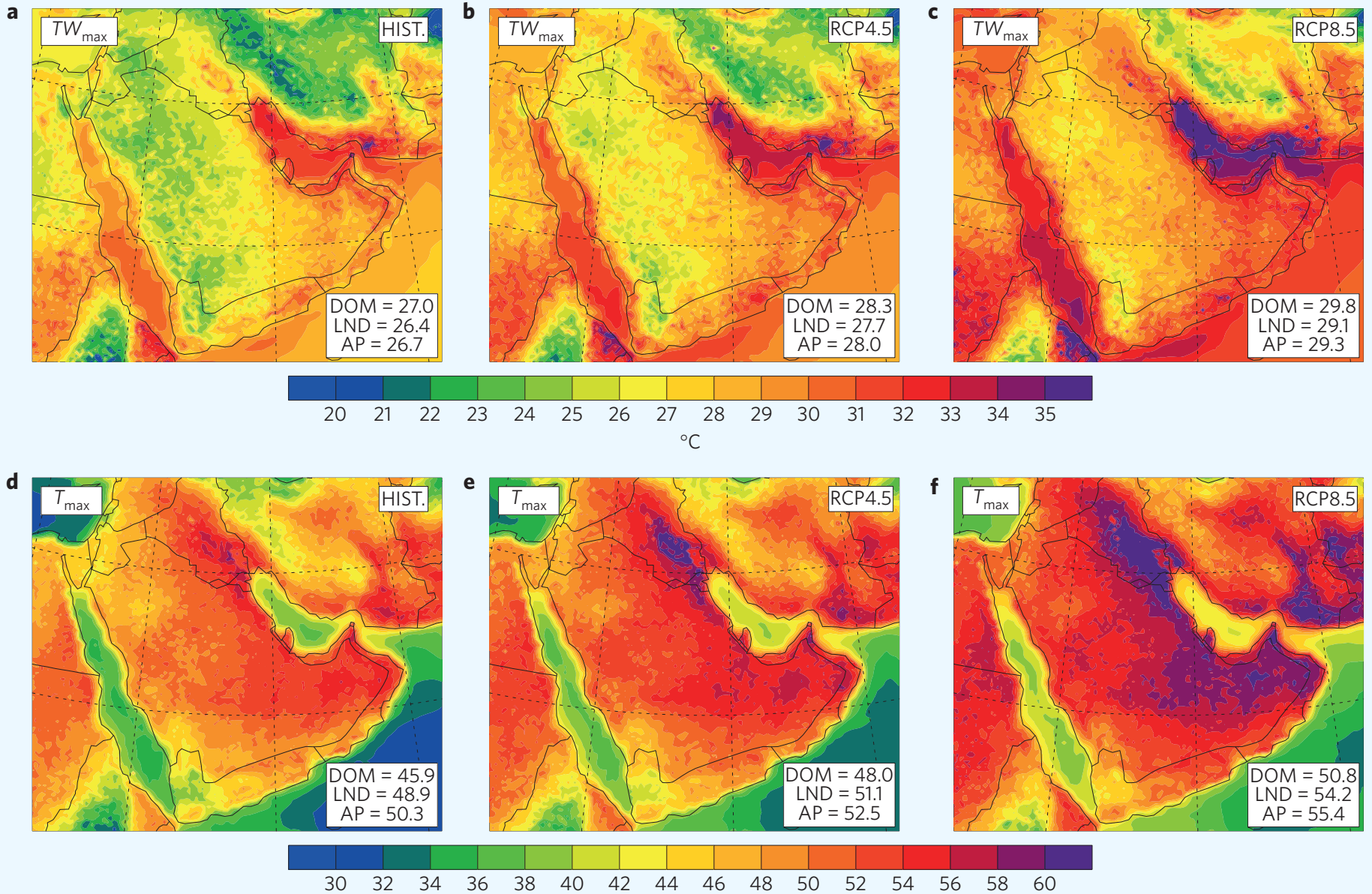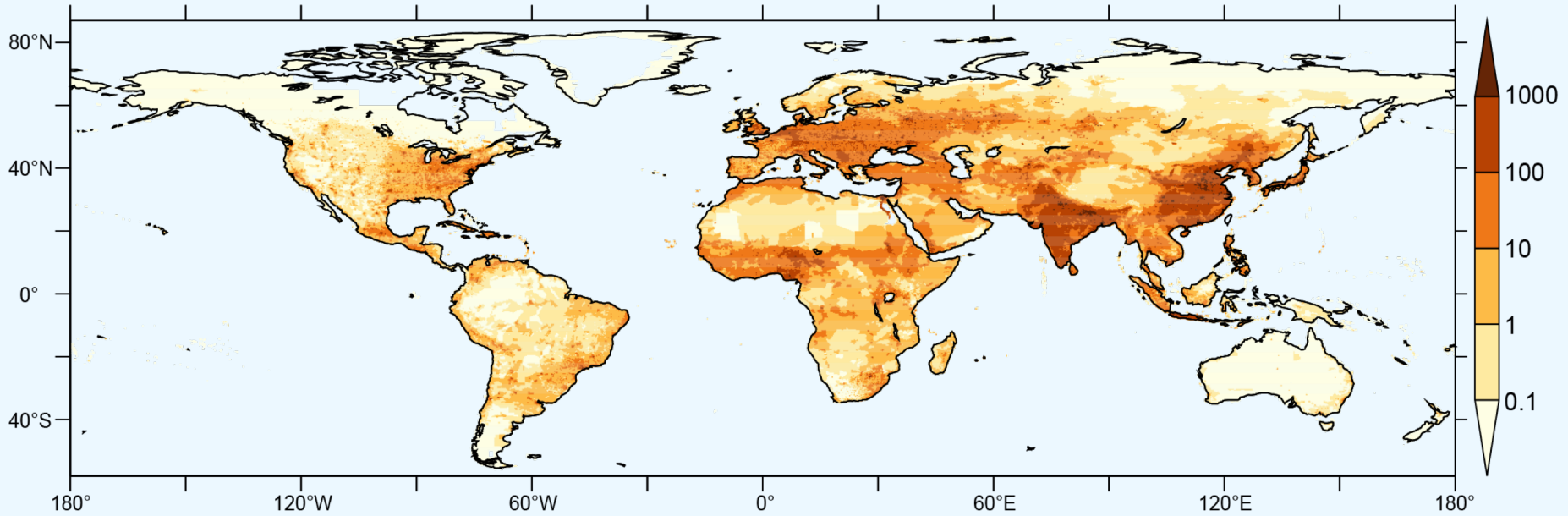c TW_{max} RCP8.5
DOM = 29.8
LND = 29.1
AP = 29.3

20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35
°C

d T_{max} HIST.
DOM = 45.9
LND = 48.9
AP = 50.3

e T_{max} RCP4.5
DOM = 48.0
LND = 51.1
AP = 52.5

f T_{max} RCP8.5
DOM = 50.8
LND = 54.2
AP = 55.4

30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60

Pal and Eltahir, 2015

Mortality attributable to ambient air pollution

Units: Individuals per area of 1,000 km^2/year

**The Lancet Commission on pollution and health:**

Pollution is the largest environmental cause of disease and death in the world today, responsible for an estimated 9 million premature deaths

Ambient air pollution causes respiratory and cardiovascular diseases, leading to 4.5 million premature deaths per year globally (8% of all deaths worldwide)
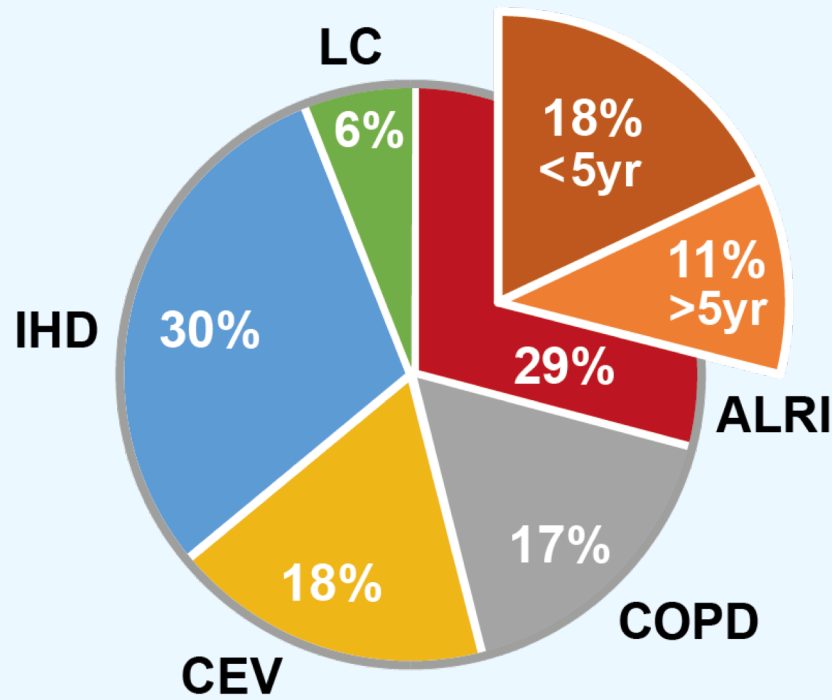
120 million years of life lost annually attributable to air pollution by ischaemic heart disease (IHD), chronic obstructive pulmonary disease (COPD), cerebrovascular disease (CEV), acute lower respiratory infections (ALRI) and lung cancer (LC):
18% due to child deaths in S/W-Asia and Africa

# Distribution of Aedes *lbopictus* in 2007
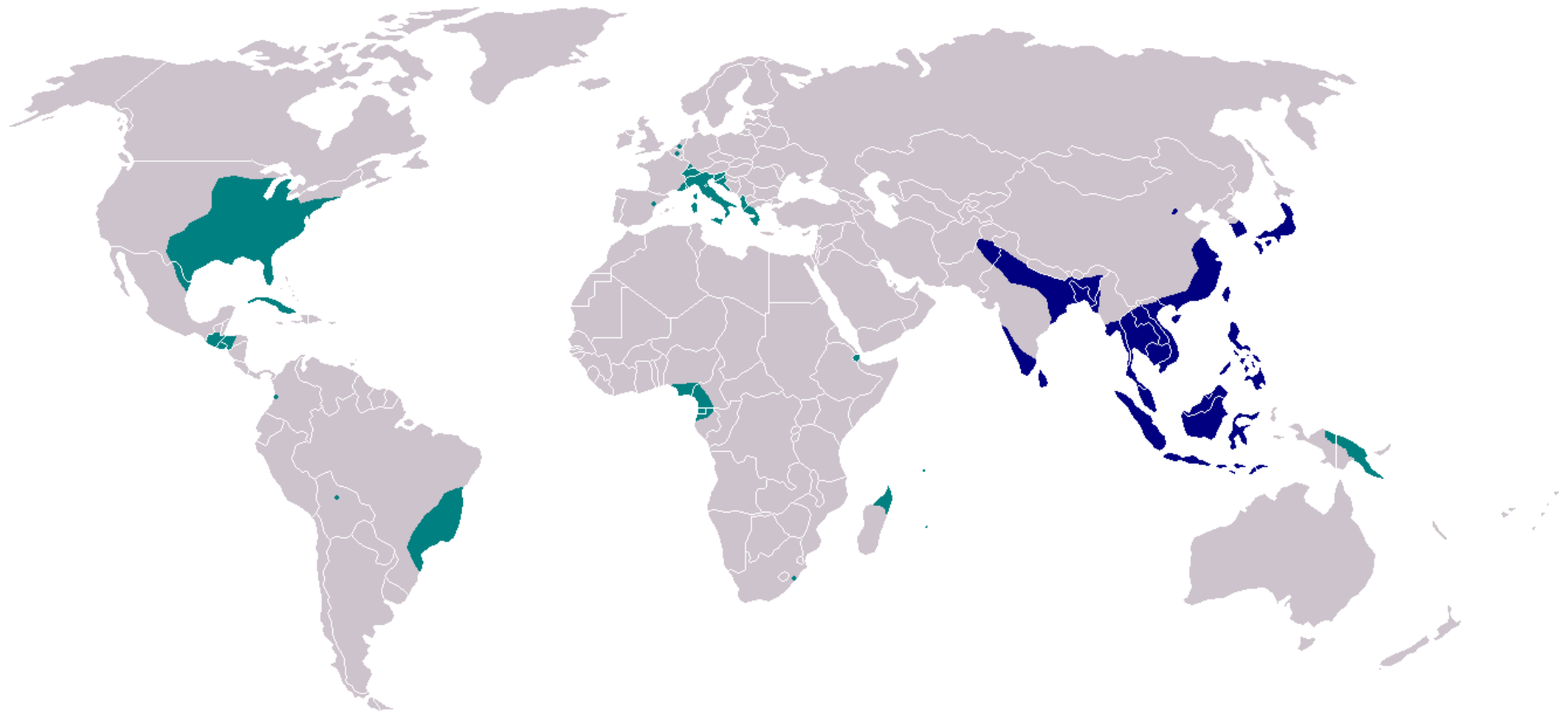
Aedes *albopictus* distributes pathogens that cause Chikungunya, Dengue fever, yellow fever and various encephalitides

Habitat suitability depends on mean, winter minimum and summer maximum temperature; precipitation amount and annual distribution; and relative humidity

Habitat suitability index change (scale 0-100) comparing middle with early 21ˢᵗ century
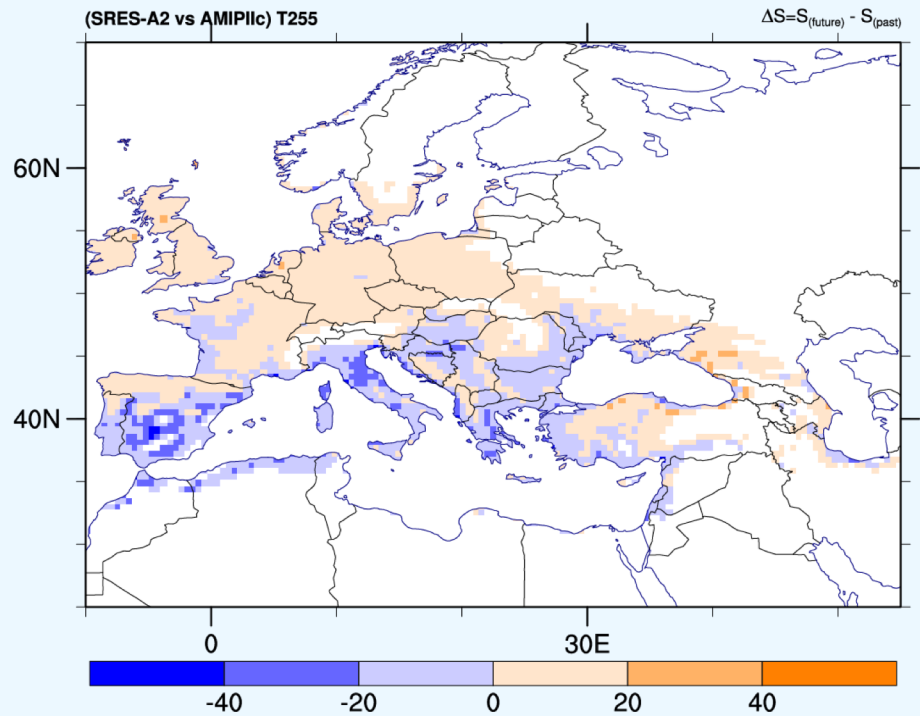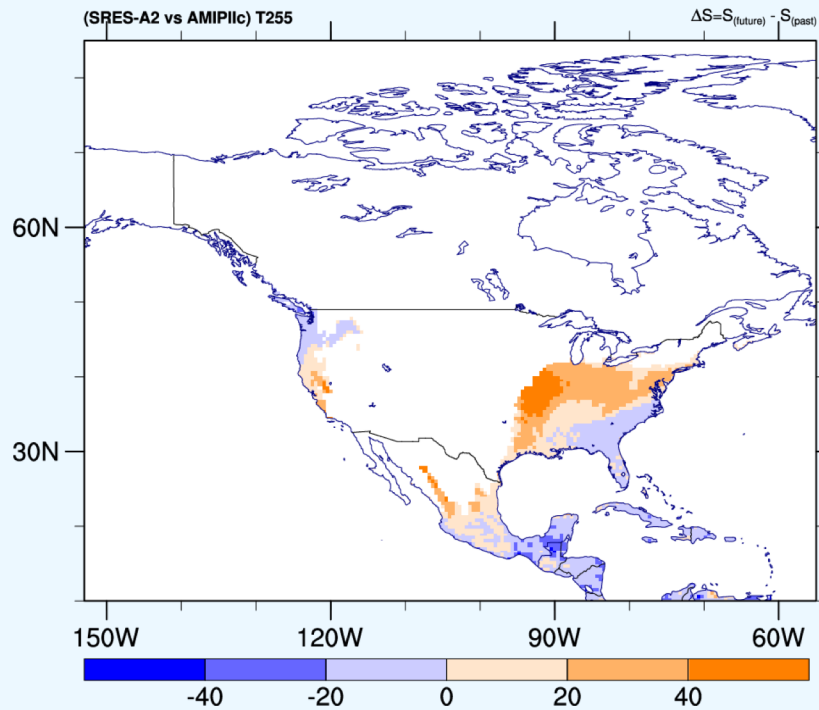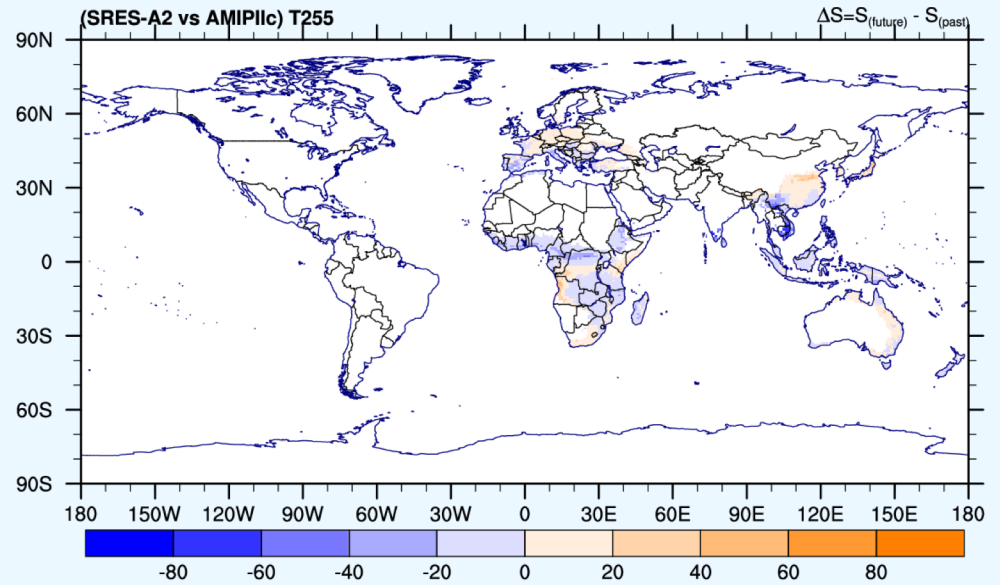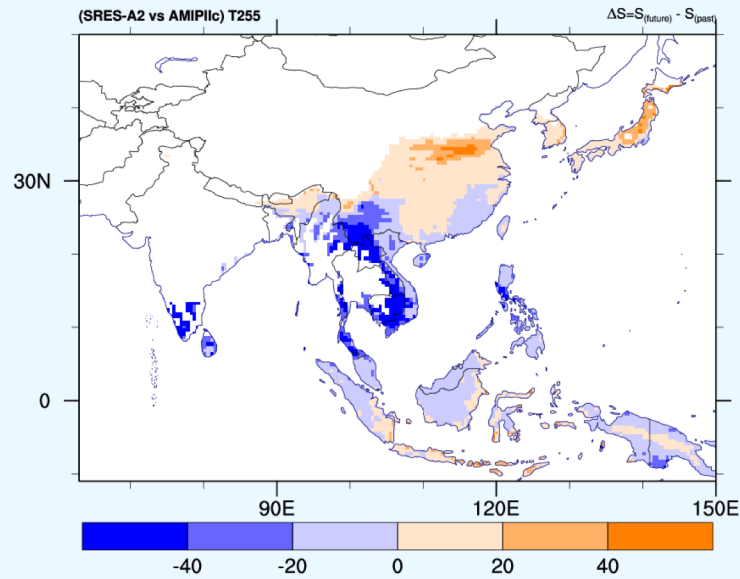
MENA is climate change hot spot

Strongly increasing temperature in summer (>2x winter): global temperature increase of 2^oC means $4-5^oC$ for MENA in summer

Projected temperature change is robust (high likelihood)

Warming amplification due to drying (Mediterranean) or arid soils

In several areas (e.g. Gulf), high humidity adds to discomfort

In urban locations heat stress combines with other environmental stresses (e.g., UHI effect, dust and air pollution)

Habitability for humans may be compromised

(climate change **+** poverty → migration)