



# Heat Waves: Causes, Consequences and Responses

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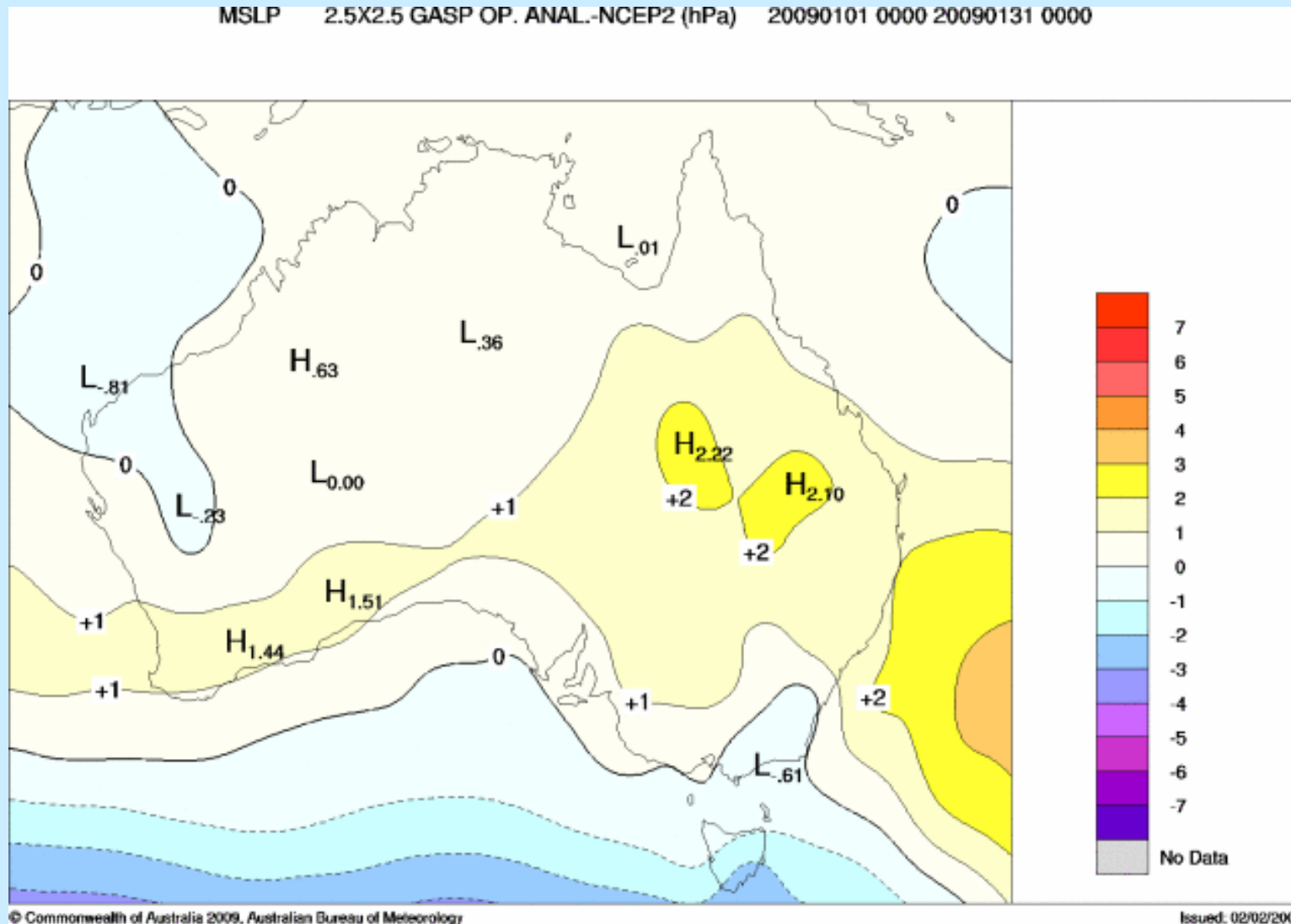
University of Auckland, NZ

# 1. Causes

## Heat Waves: A Product of Changes in the Progression of High and Low Pressure Systems From West to East

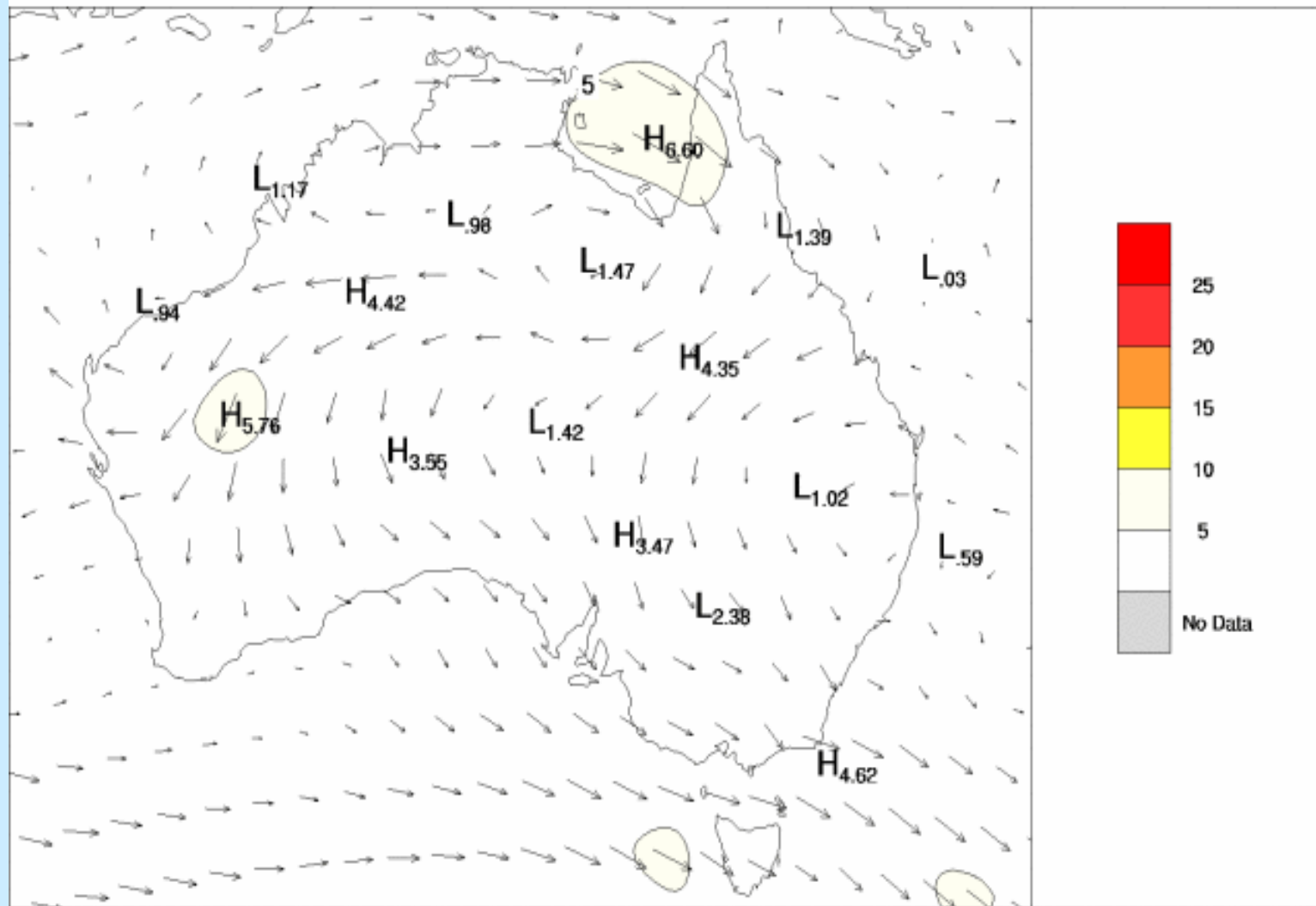
- High pressure system stalls and does not move east = blocking situation
- Air in the region of the high pressure system subsides, warms and dries
- Often there are clear skies – large solar radiation inputs and intense surface heating
- In cities much of the daytime heat may be stored in urban building materials and released in the evening to aid the development of a heat island
- At the larger geographical scale, there may be positive feedbacks which enhance the duration of anomalous heat
- Heat waves are often embedded in longer periods of drought

# Sea Level Pressure Anomaly Last Week of January 2009

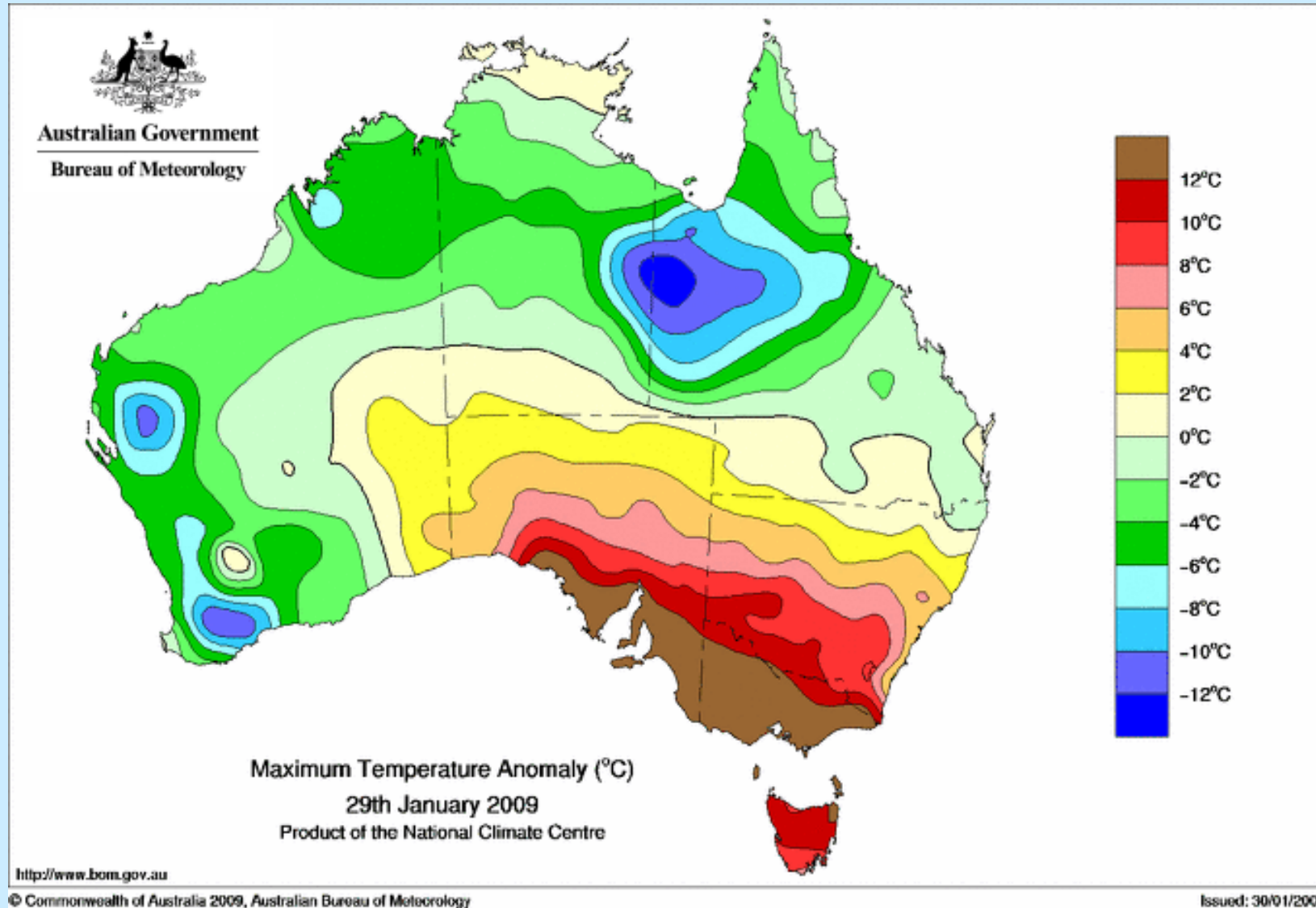


# Surface Wind January 31, 2009

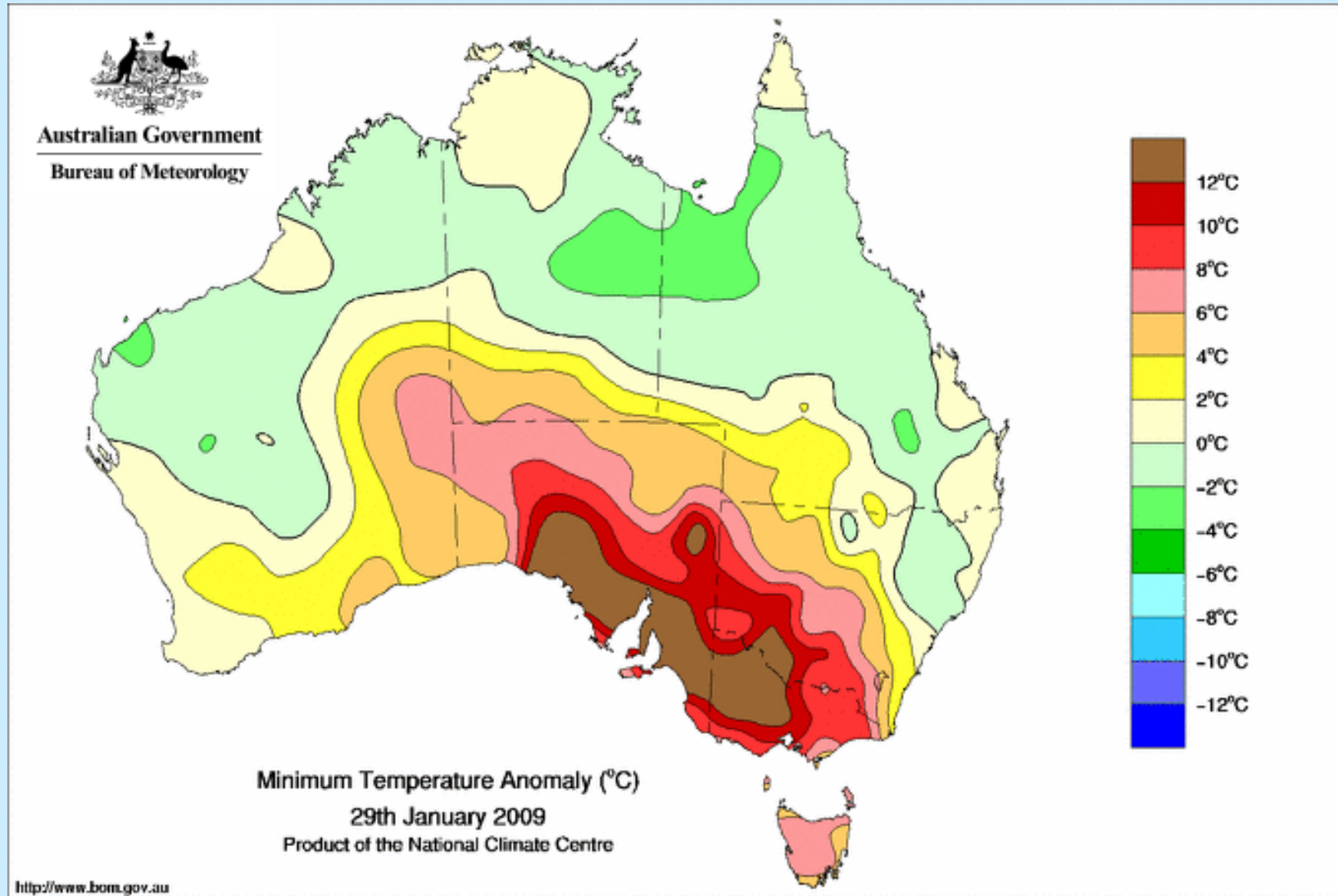
|V|0850 2.5X2.5 GASP OP. ANAL.-NCEP2 (M/S) 20090101 0000 20090131 0000



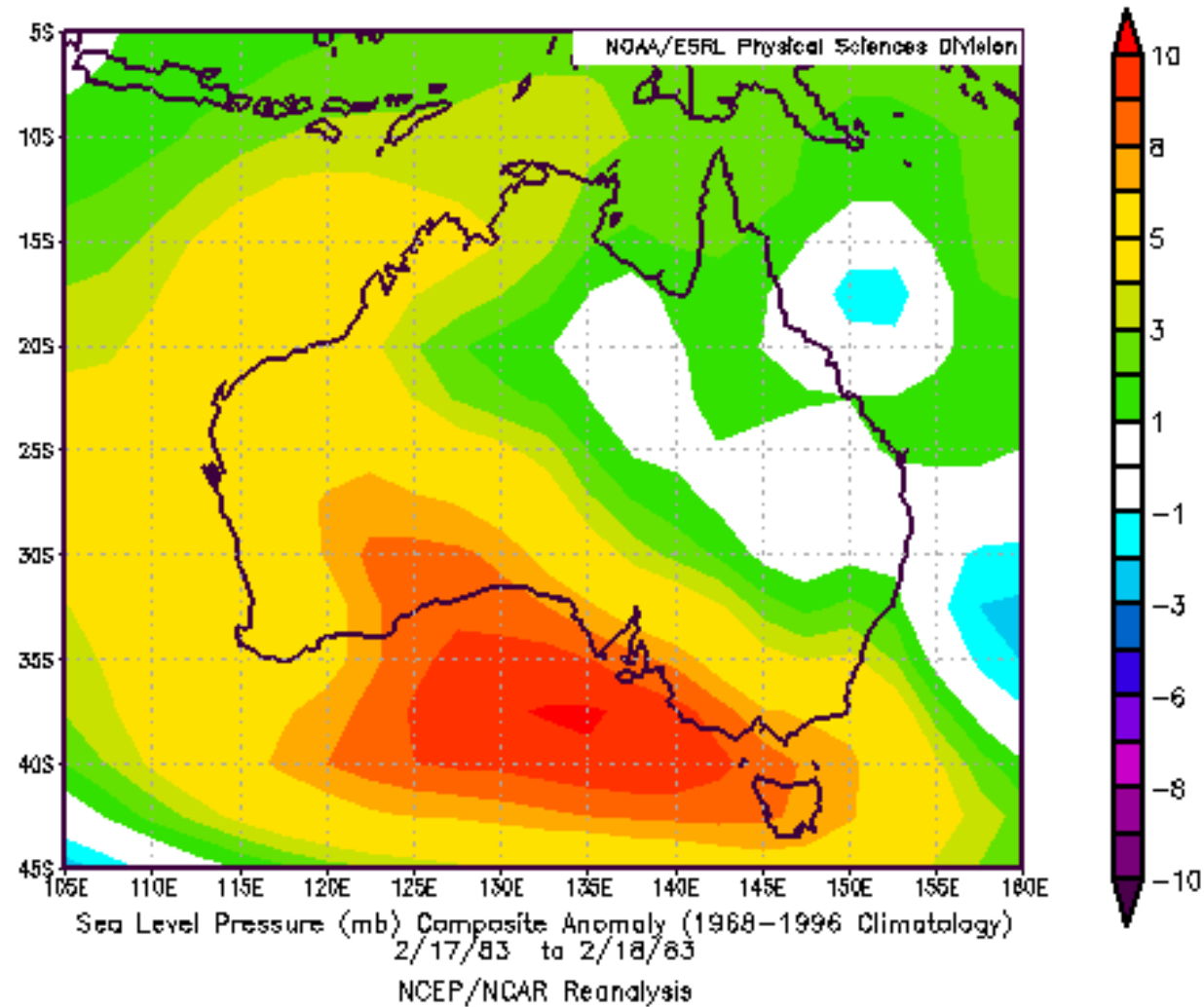
# Tmax Anomaly, Jan 29, 2009



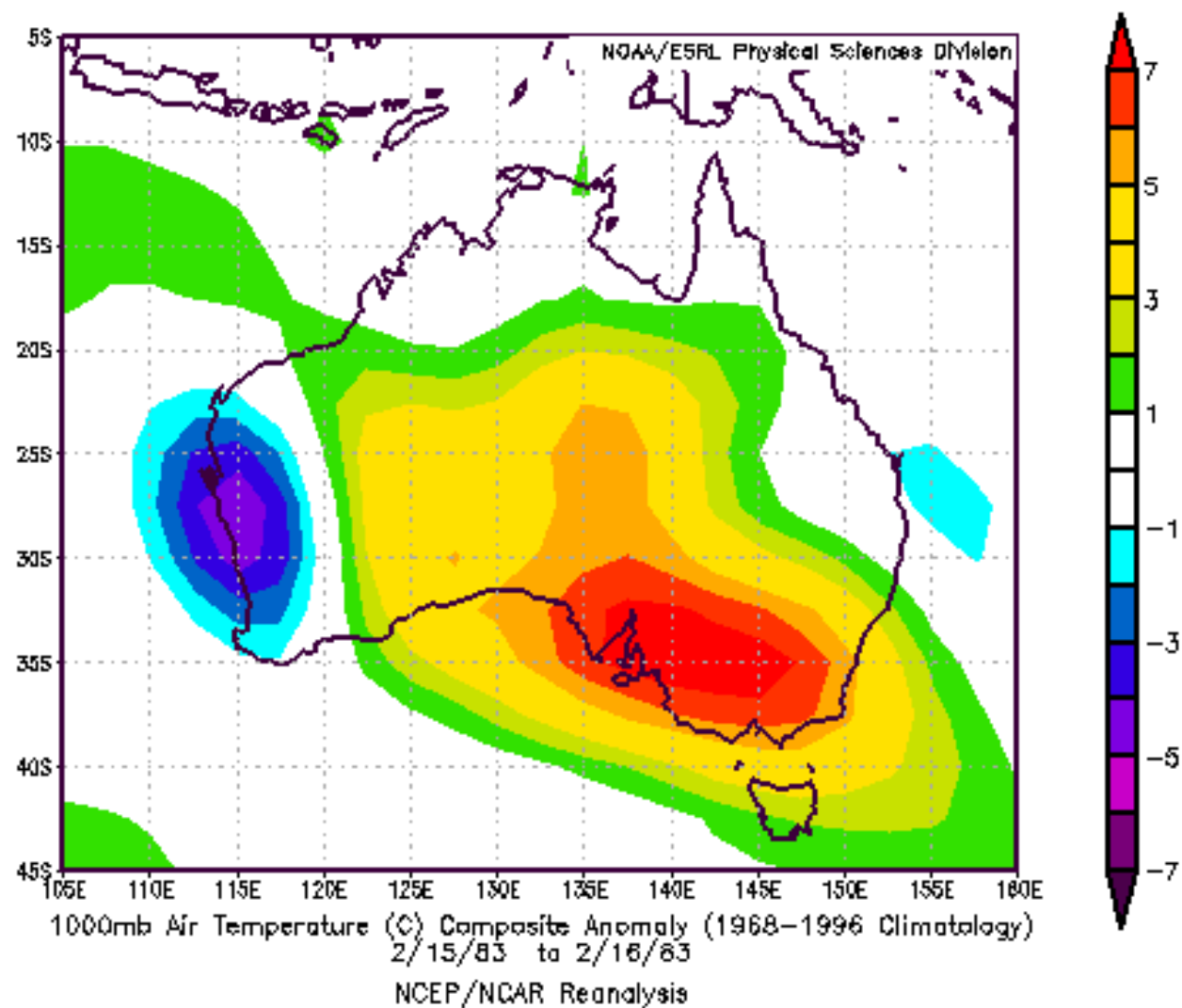
# Tmin Anomaly, Jan 29, 2009



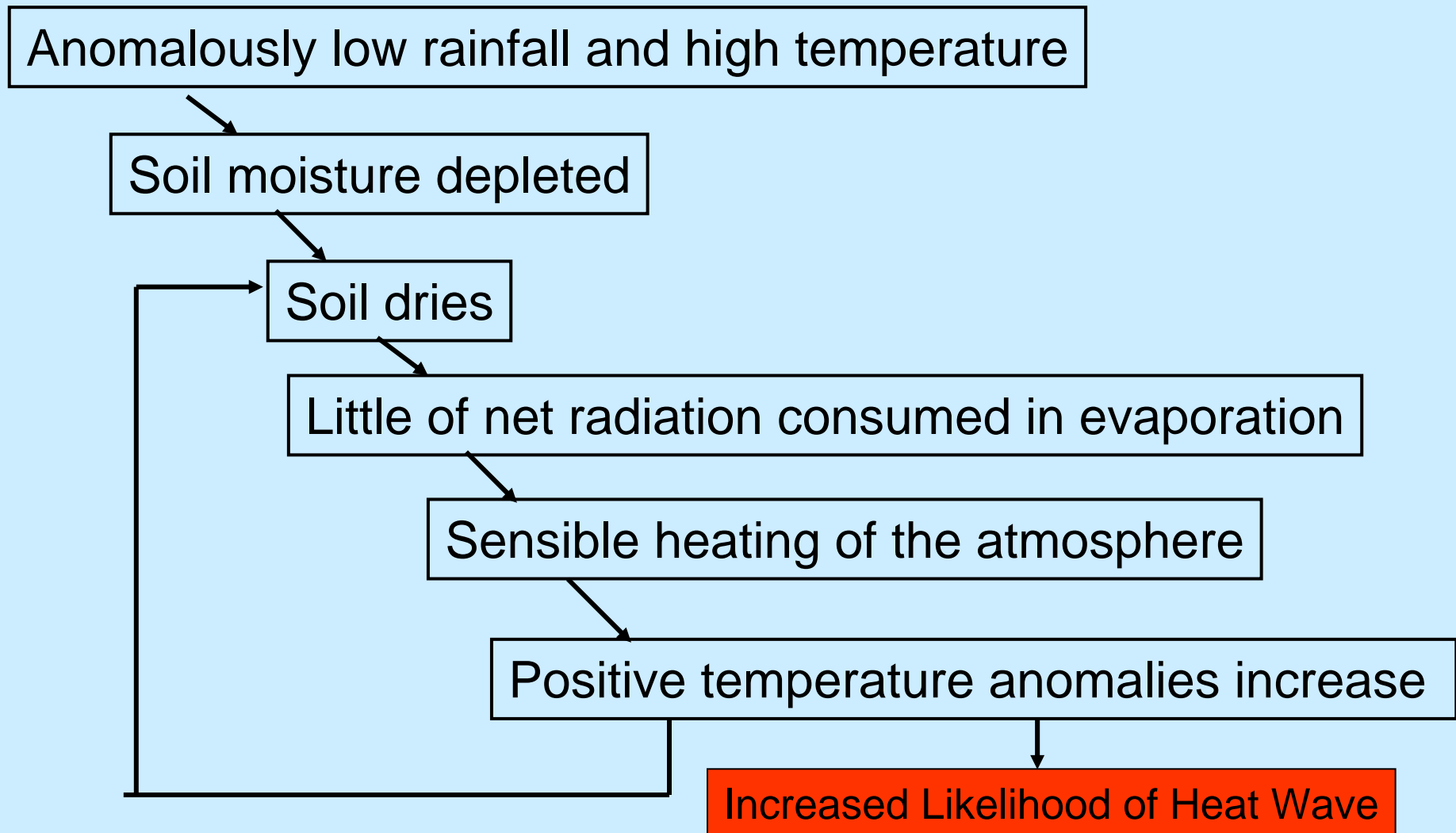
# Ash Wednesday, 1983: Pressure Anomaly



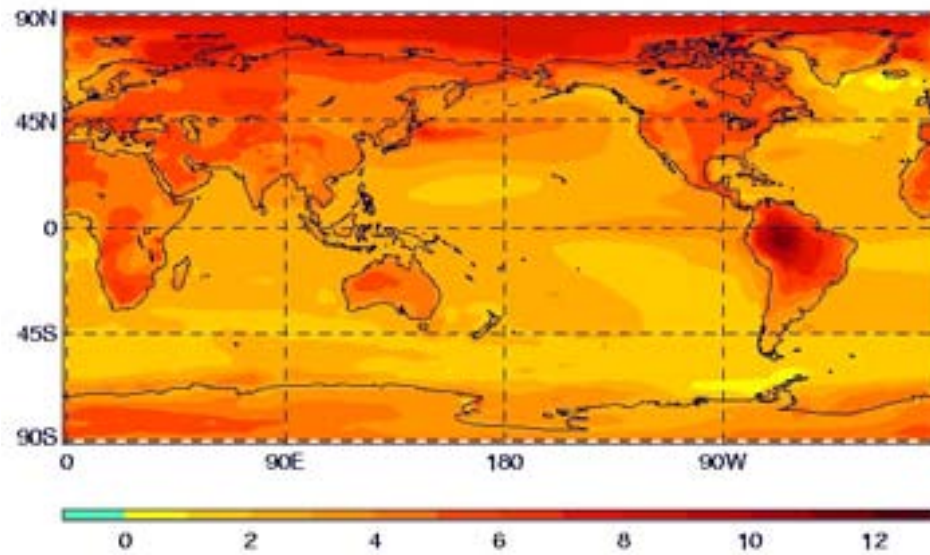
# Ash Wednesday, 1983: Air Temperature Anomaly



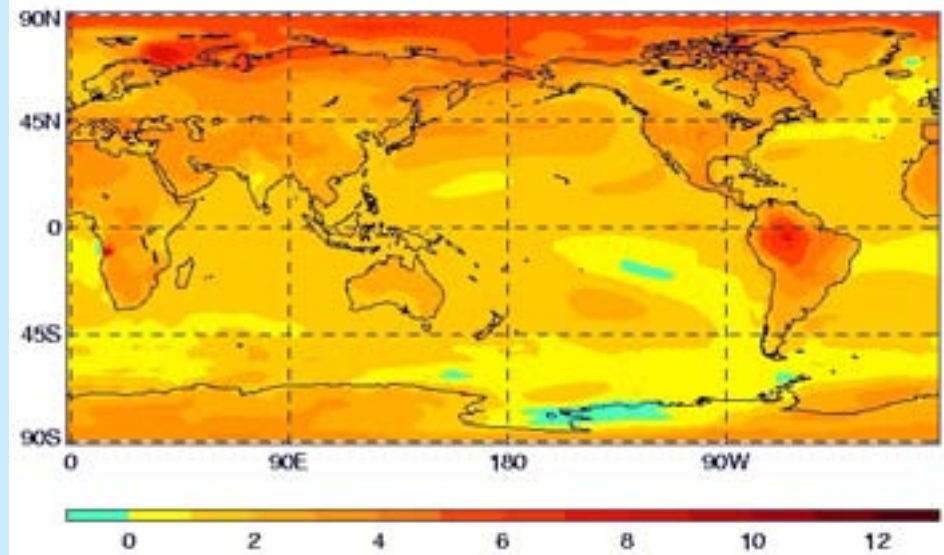
# Intensification of Summer Drought by Positive Land-Atmosphere Feedback



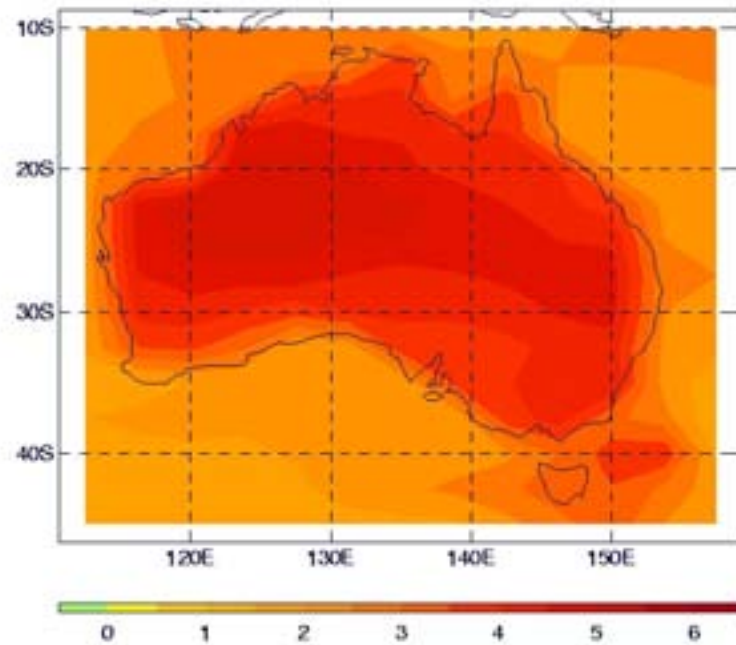
Maximum Temperature Change ( $^{\circ}\text{C}$ ) from Present by 2100 (SRES A2)



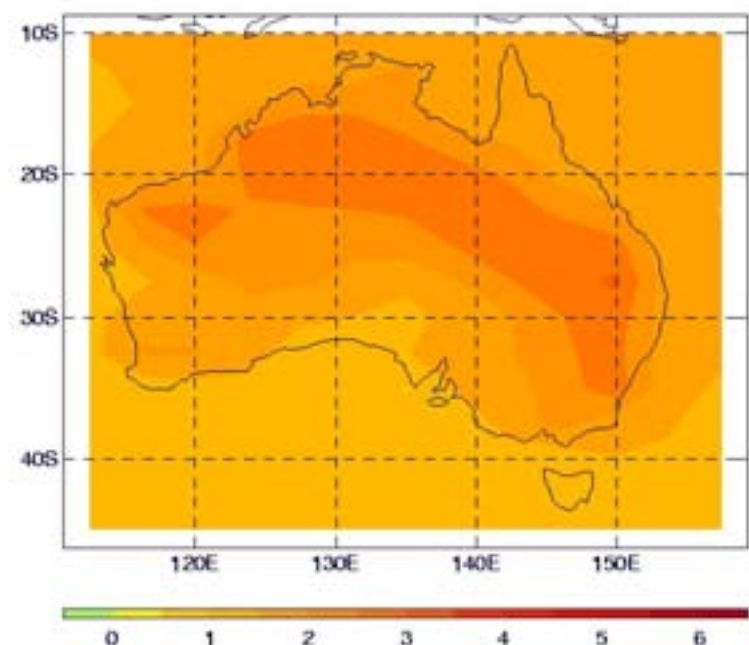
Maximum Temperature Change ( $^{\circ}\text{C}$ ) from Present by 2100 (SRES B2)



Maximum Temperature Change ( $^{\circ}\text{C}$ ) from Present by 2100 (SRES A2)

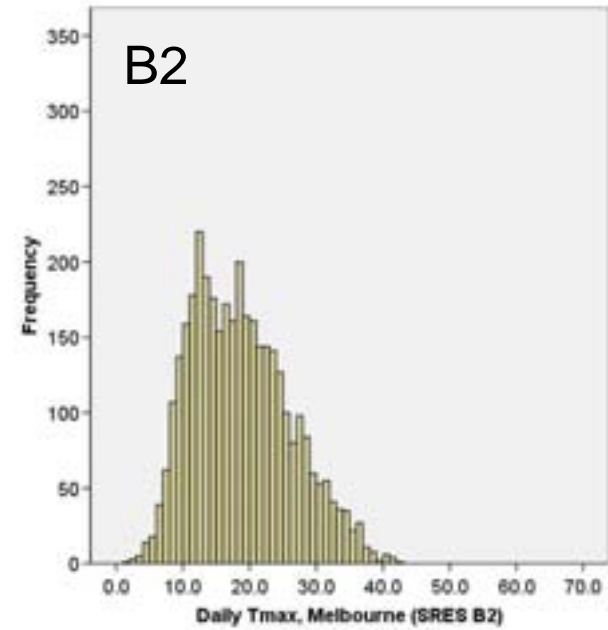
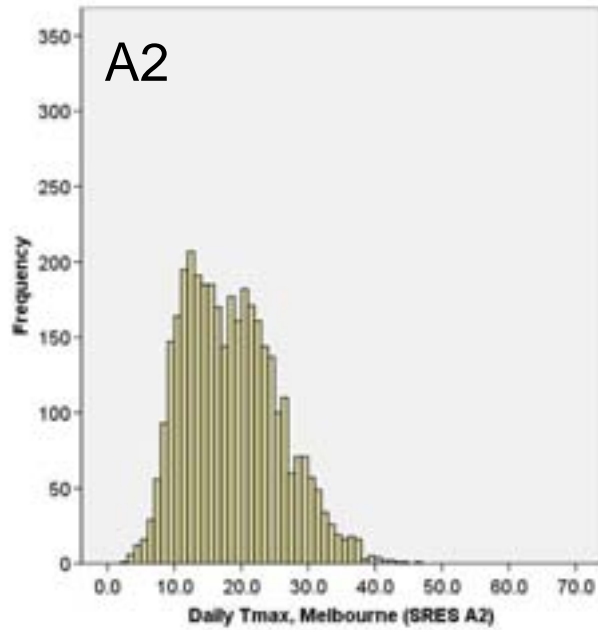


Maximum Temperature Change ( $^{\circ}\text{C}$ ) from Present by 2100 (SRES B2)

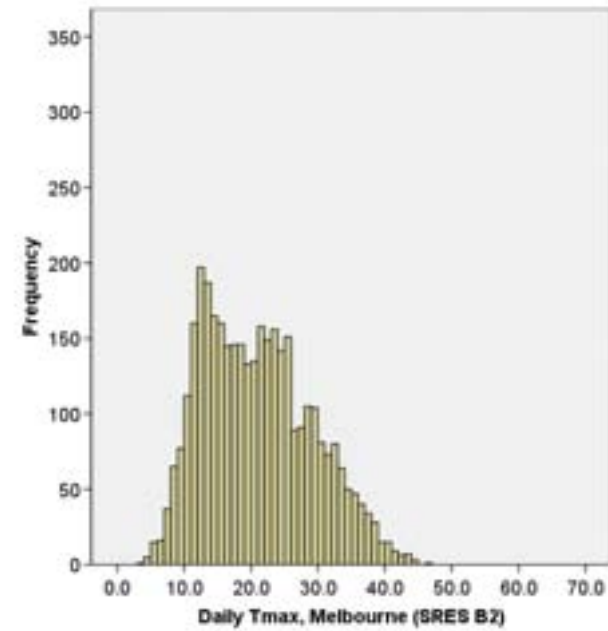
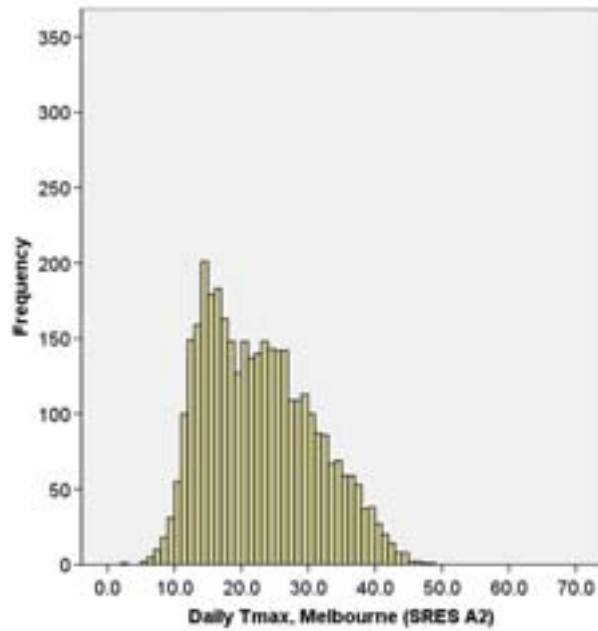


# Melbourne

2000-09

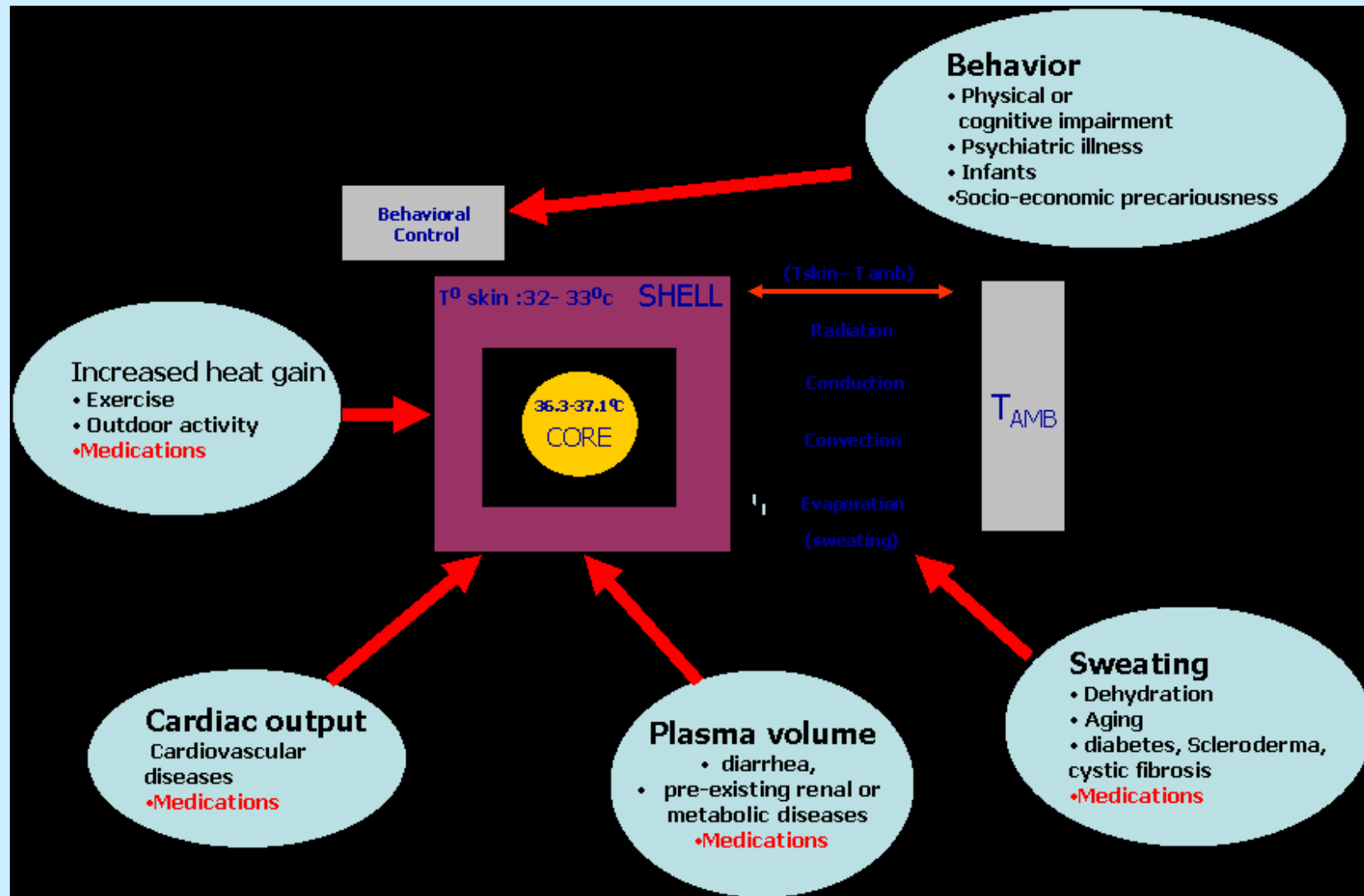


2090-99



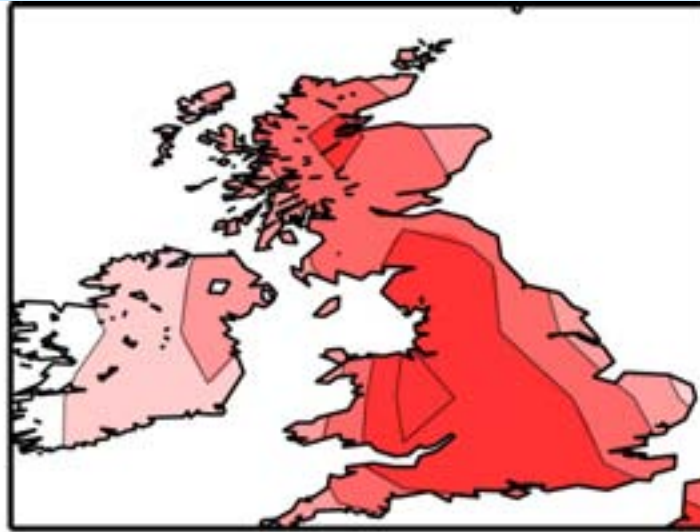
## 2. Consequences

# Factors Influencing Body's Thermoregulation

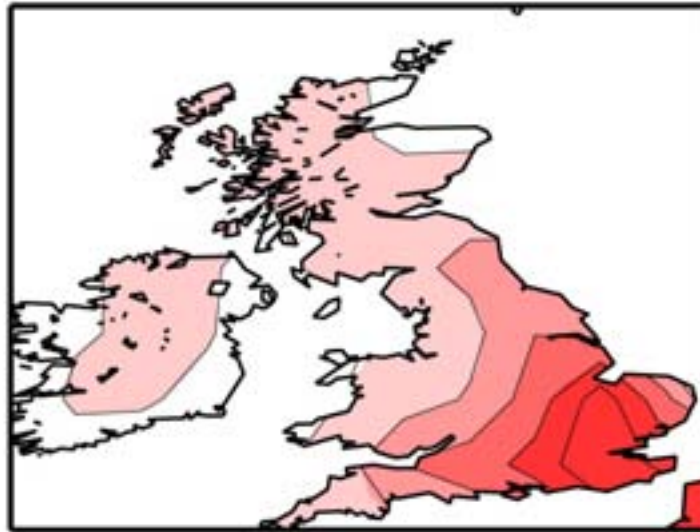


Source: Bouchama, 2007

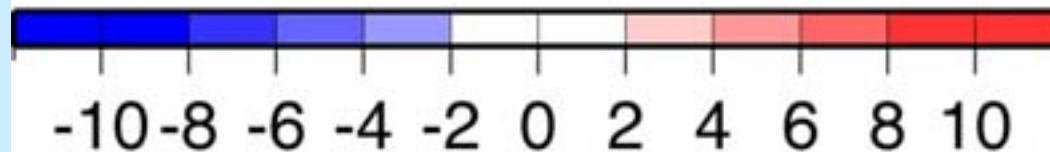
Temperature  
Anomalies  
Across UK  
(compared  
to  
1971-2000  
average)



**9th August**



**10th August**



# London August 2003

(Tmax, Tmin and Mortality)

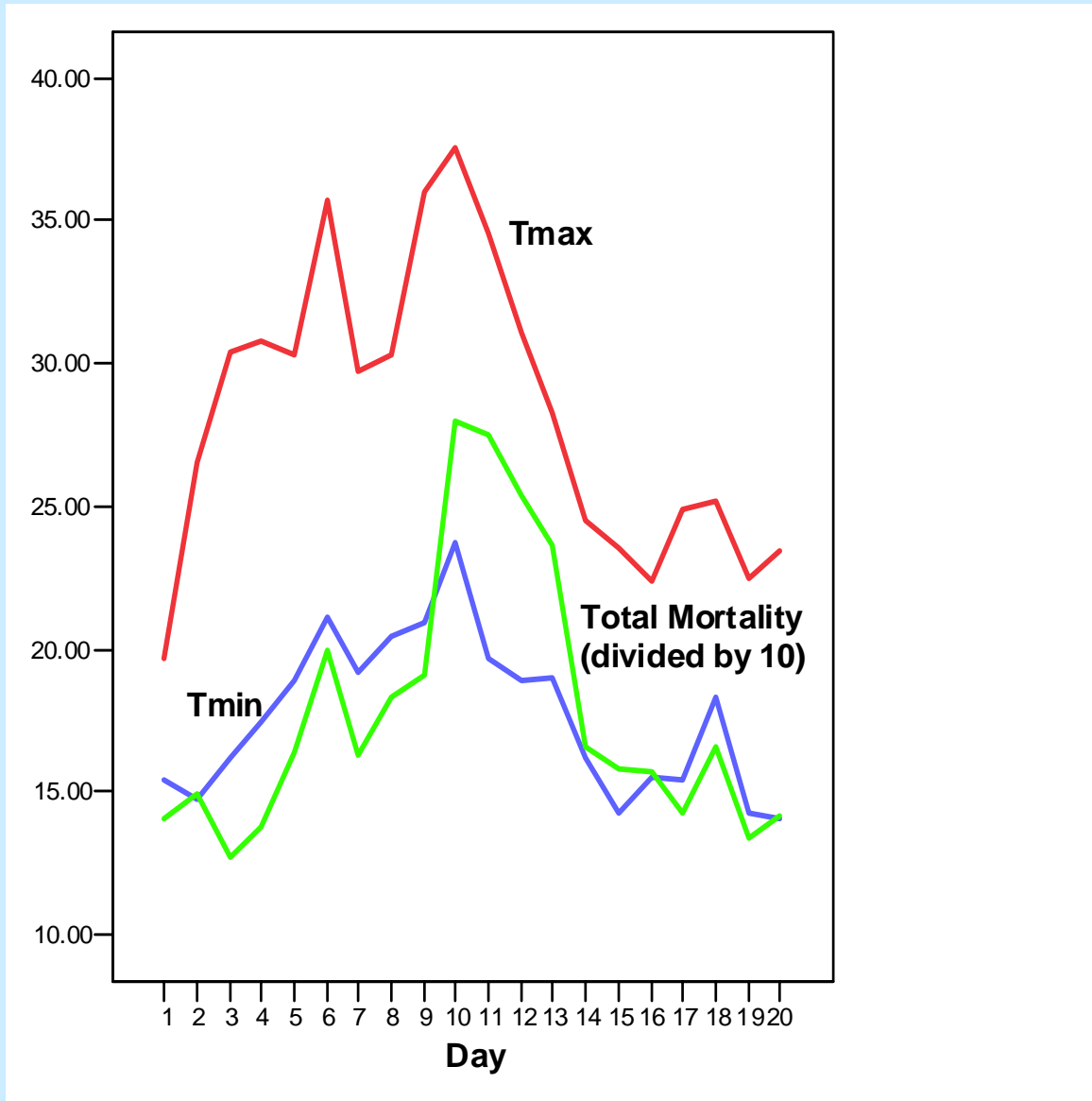
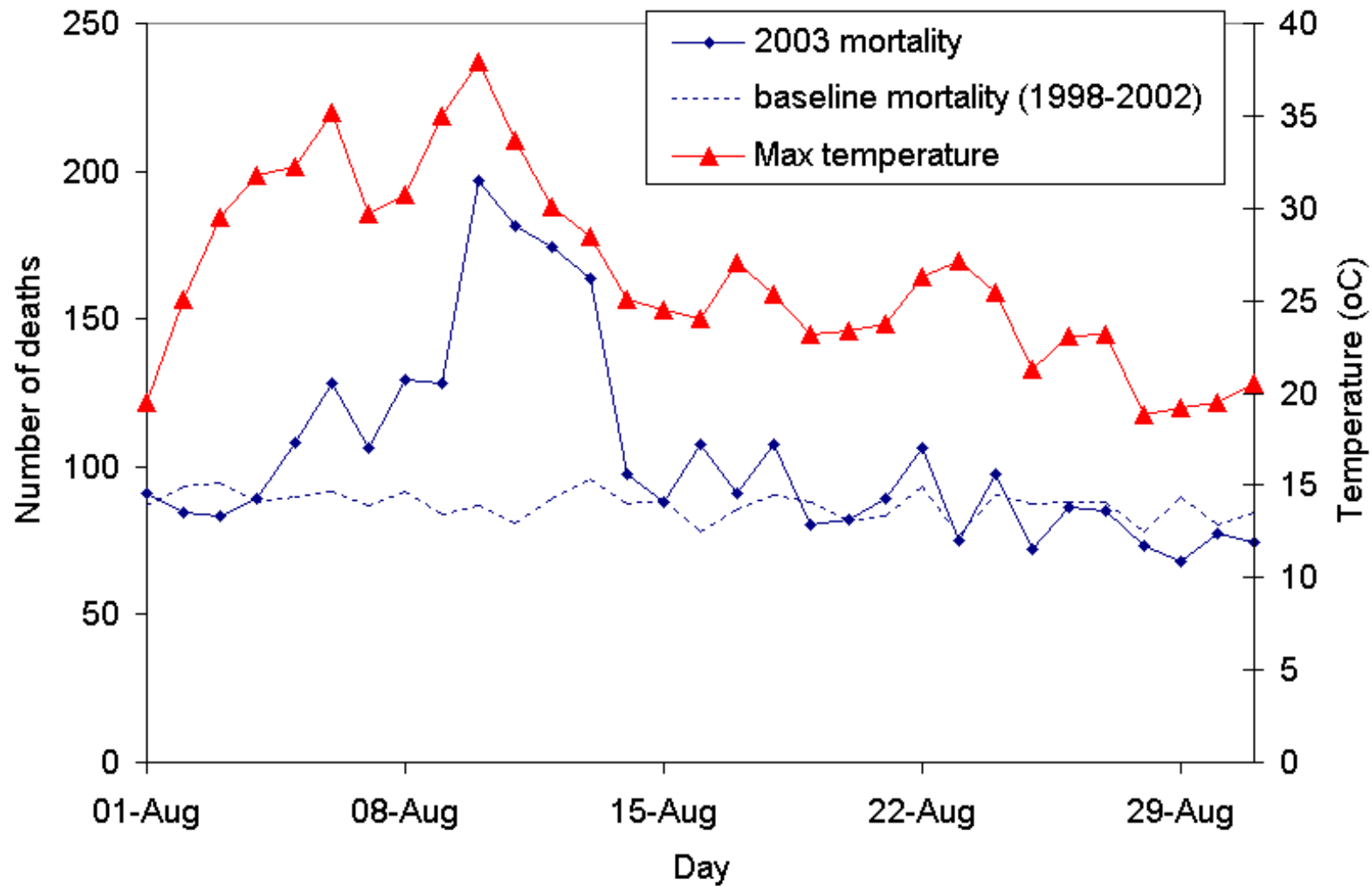
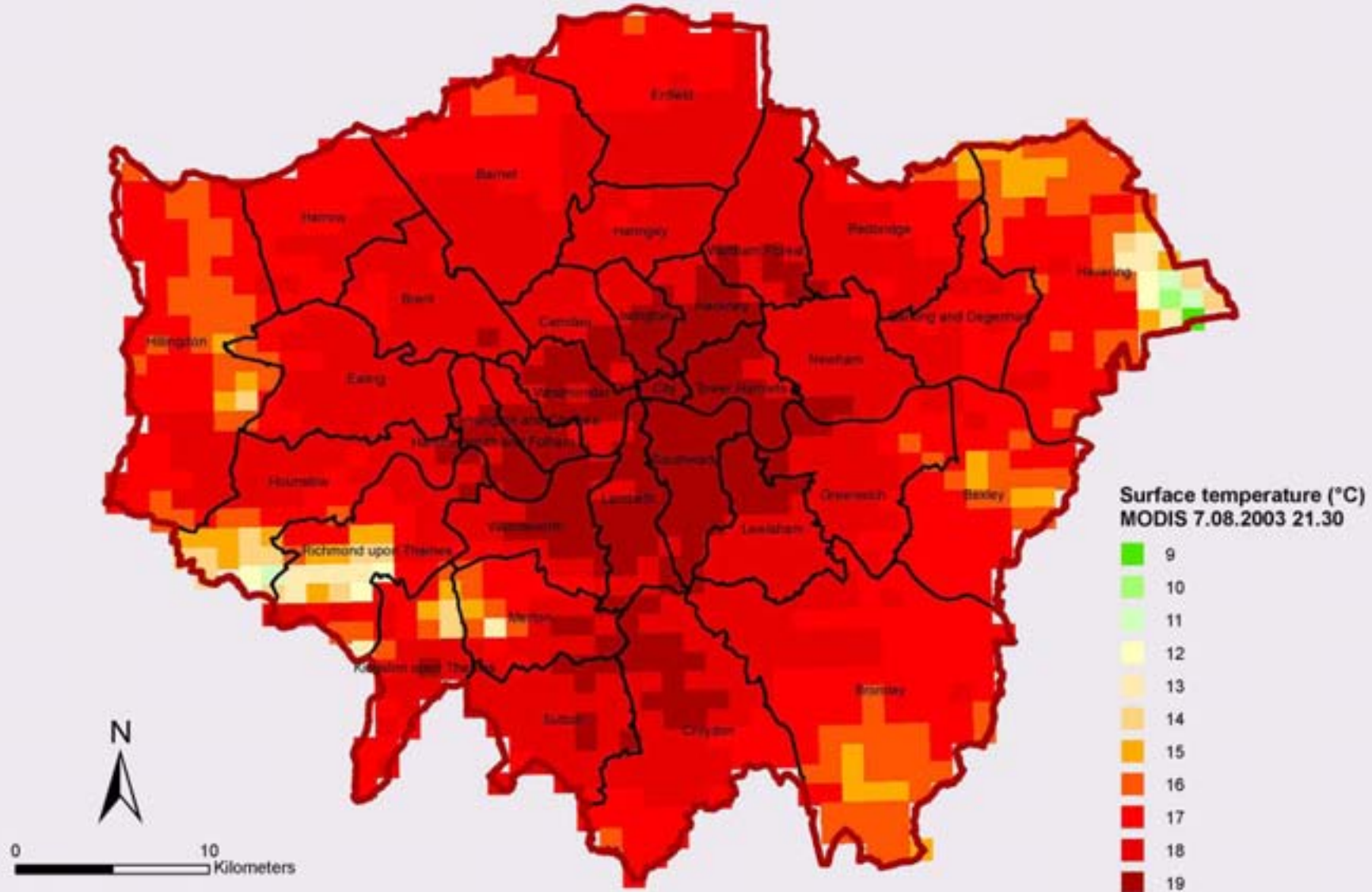


Figure 2: Daily mortality, 75+ years, London Government Office Region, August 2003



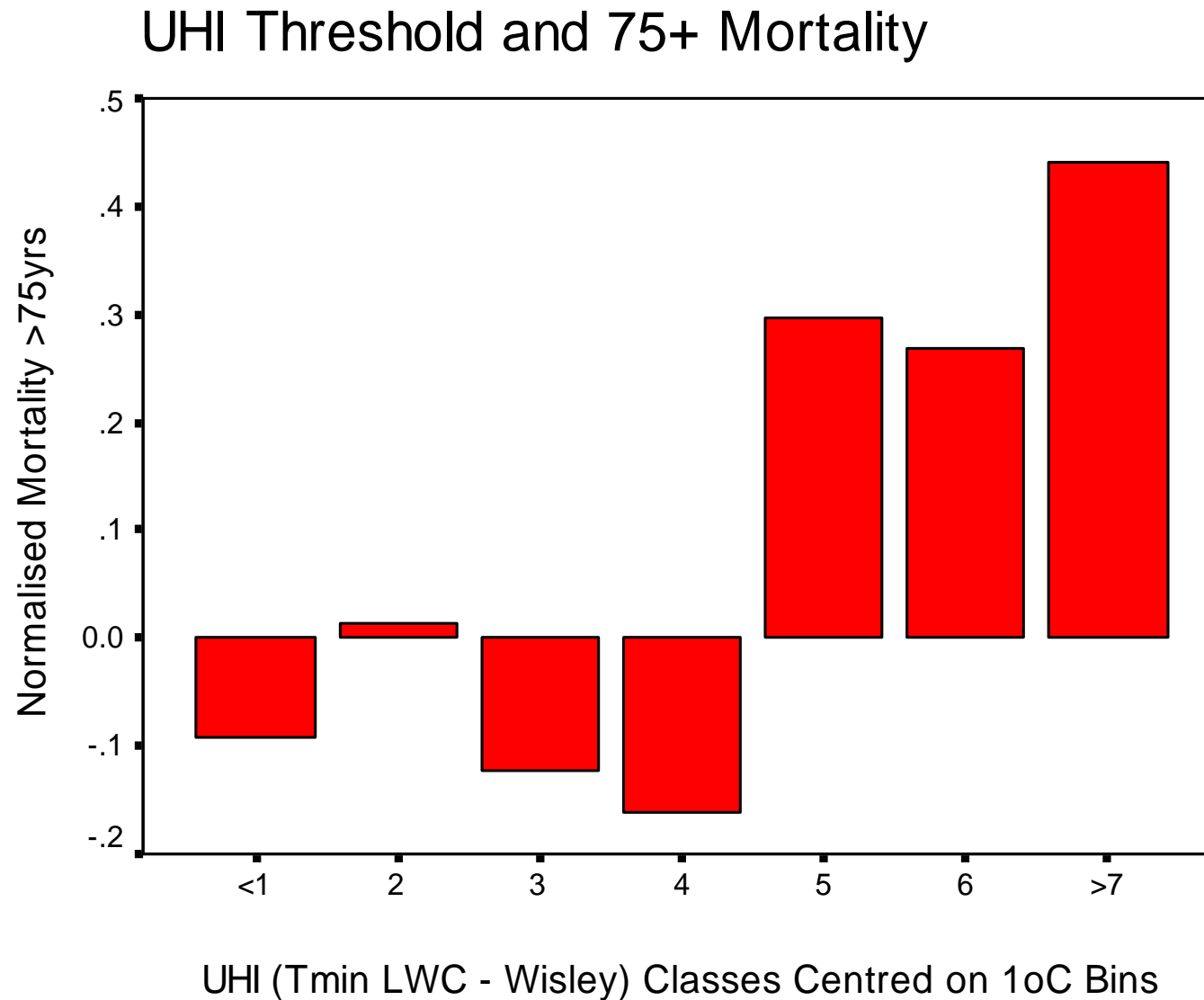
# London's Surface Heat Island

August 7, 2000 (2130hrs)

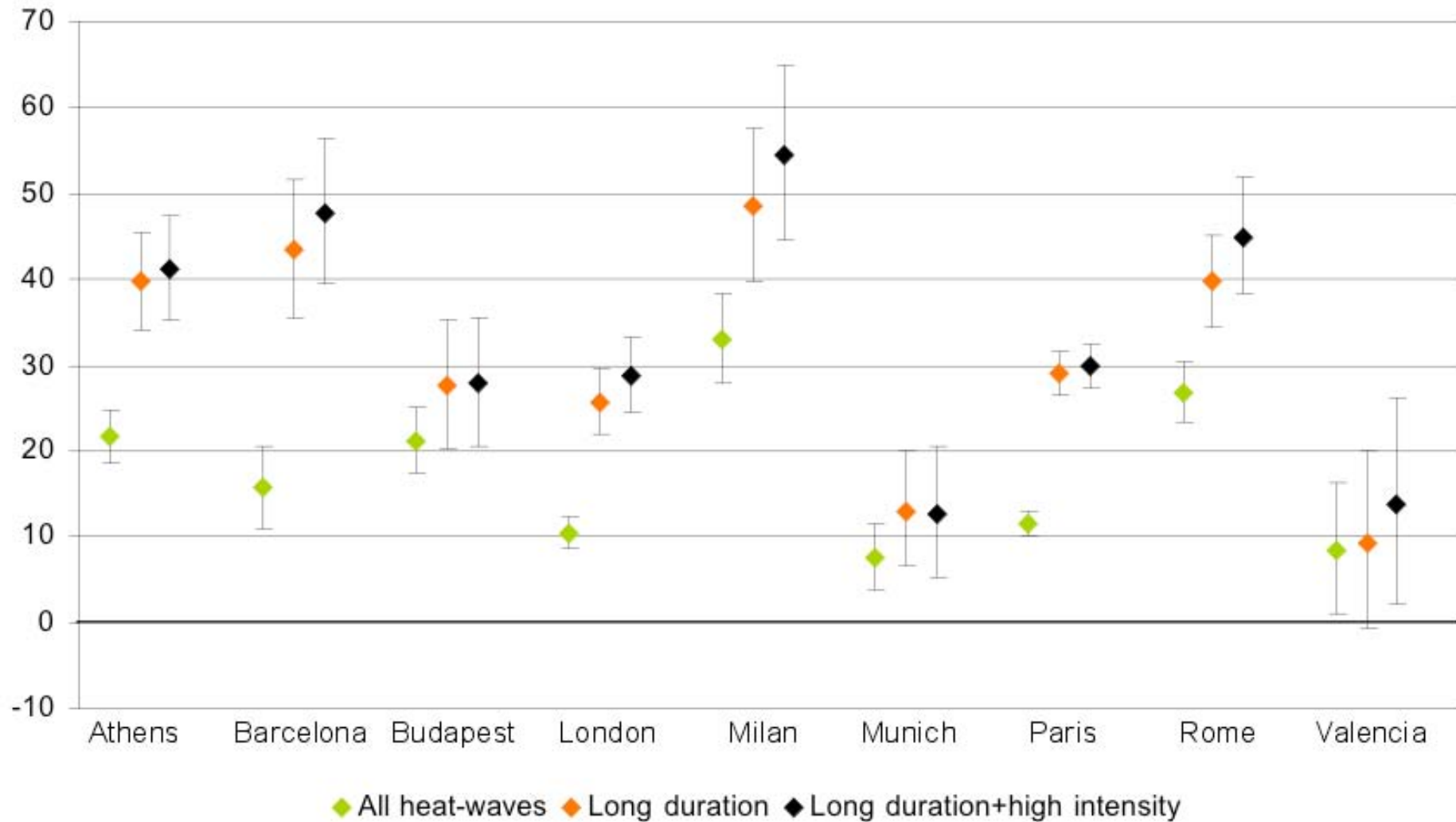


# UHI Threshold and 75+ Mortality

## JJA 1995 & 2003

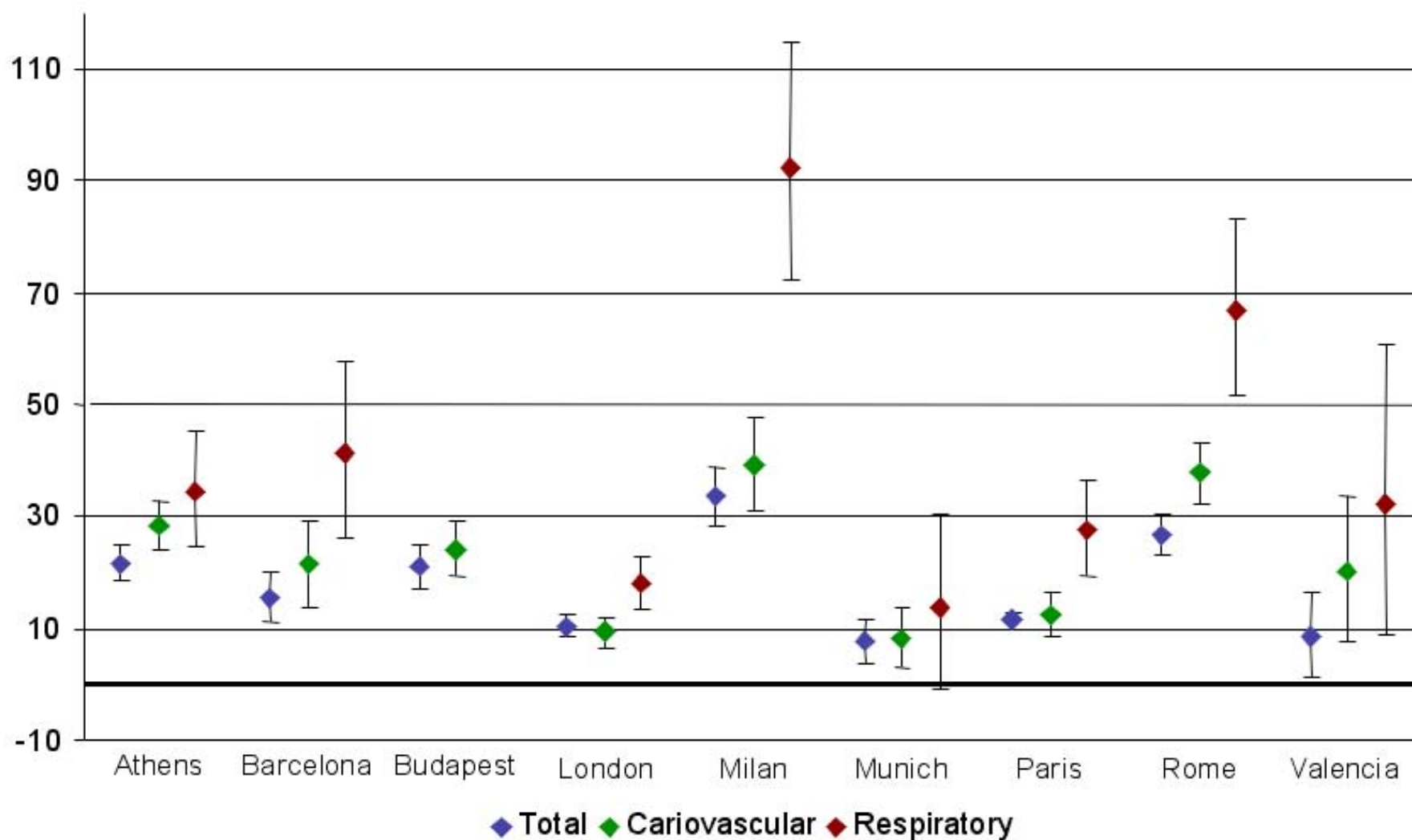


# Heat Wave Type and Percentage Increase in 65+ Mortality (Euroheat Project)



Source: WHO 2008 – “Heat Health Action Plans”

## All Heat Waves and Percentage Increase in 65+ Mortality by Cause (Euroheat Project)



Source: WHO 2008 – “Heat Health Action Plans”

## Other Consequences

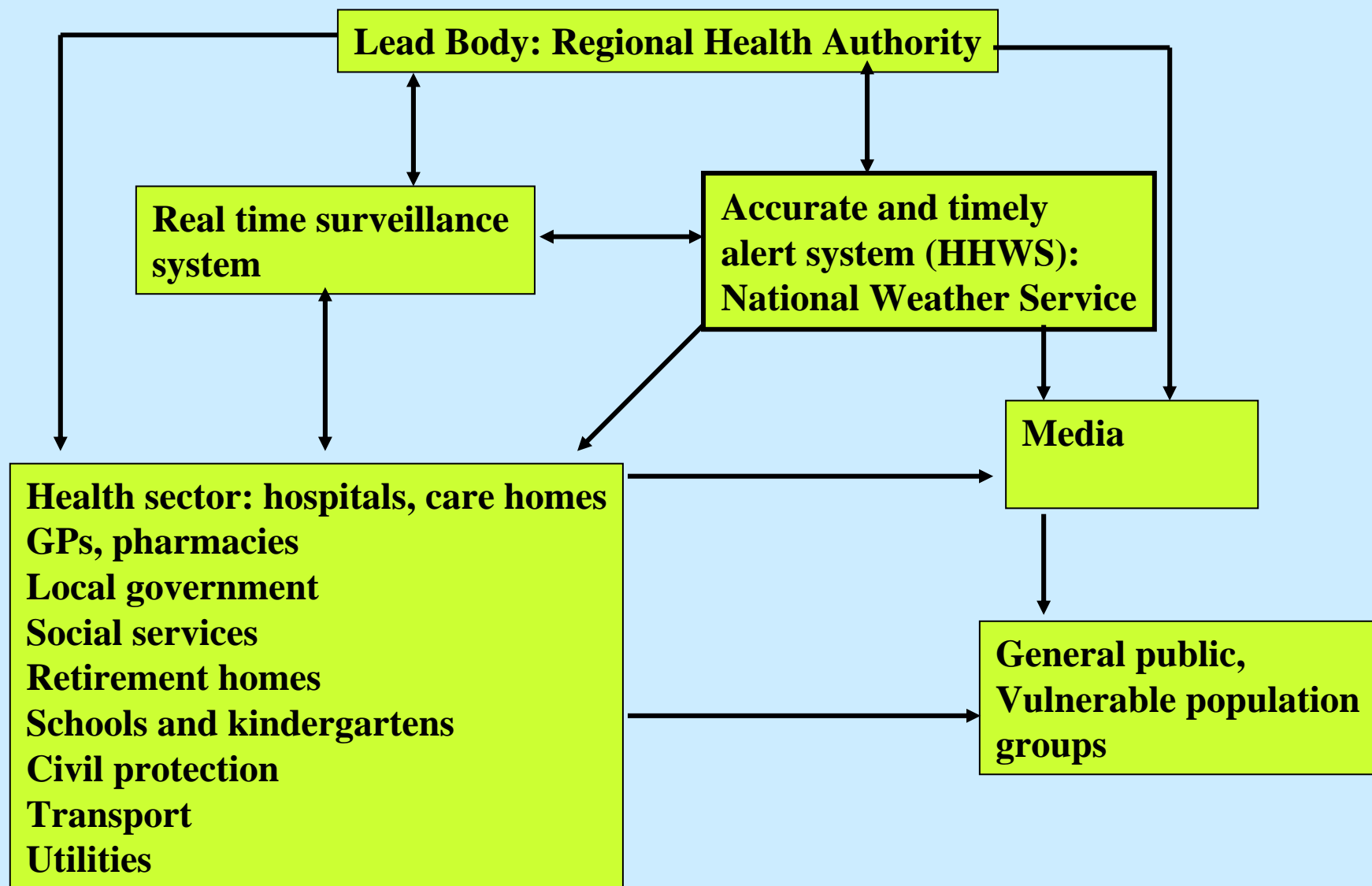
- Power outages – failure of air con and all electrically operated machinery (medical equipment, elevators)
- Water security (if embedded in period of severe drought)
- Impact on transport (rail, road, air)
- Water temperature increase - risk of algal blooms, decreased efficiency of water-cooled machinery
- Impacts on ecosystems
- Major events affected
- Impacts on commercial sector
- Possible social unrest and increase in violence

# 3. Responses

# Heat Plans: Essential Elements

- Establishment of collaborative mechanisms between bodies and institutions, and a lead body to coordinate responses;
- An accurate and timely alert system;
- Strategies to reduce individual and community exposure to heat;
- Particular care for “vulnerable” populations;
- Provision of health care, social services and infrastructure;
- Heat-related health information strategies;
- Real time surveillance, evaluation and monitoring

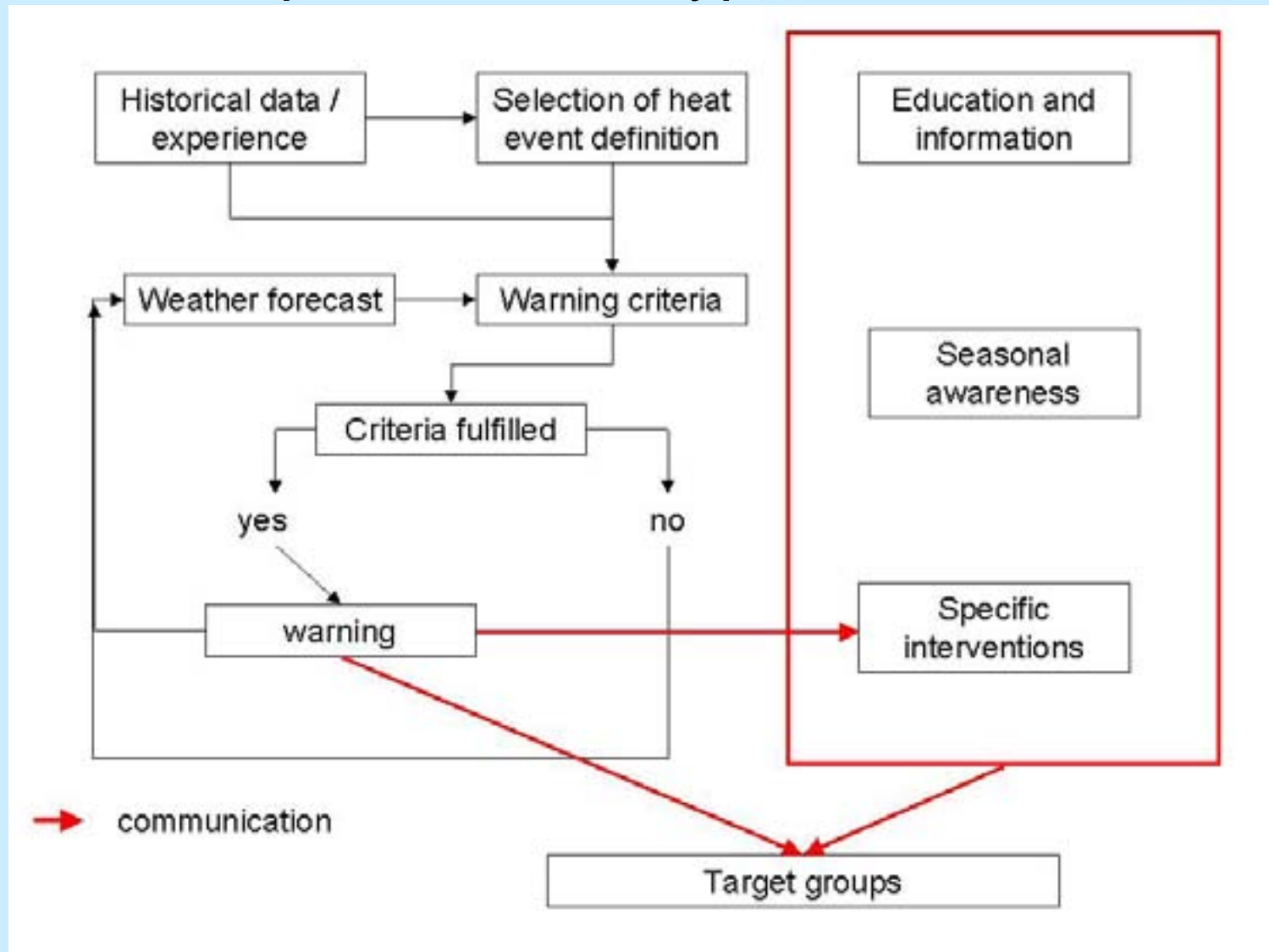
## Possible Flow of Information Between Lead Agency and Other Actors in Heat Plan



# Generic Starting Points for Heat Health Warning System (HHWS)

- All systems should consider local meteorology, demographics, and urban structure
- All systems should be based upon thresholds that are related to actual heat/health outcomes
- Nomenclature should be clearly understood by the public, local stakeholders, and decision-makers. Thus, on a state level, a standardized terminology along with understandable criteria and messages would help significantly with communication.
- All systems should be paired with a quality notification and response programme
- All systems should be evaluated to determine their effectiveness

# Operation of a Typical HHWS



Source: WMO Guidance Notes on HHWS (in prep)

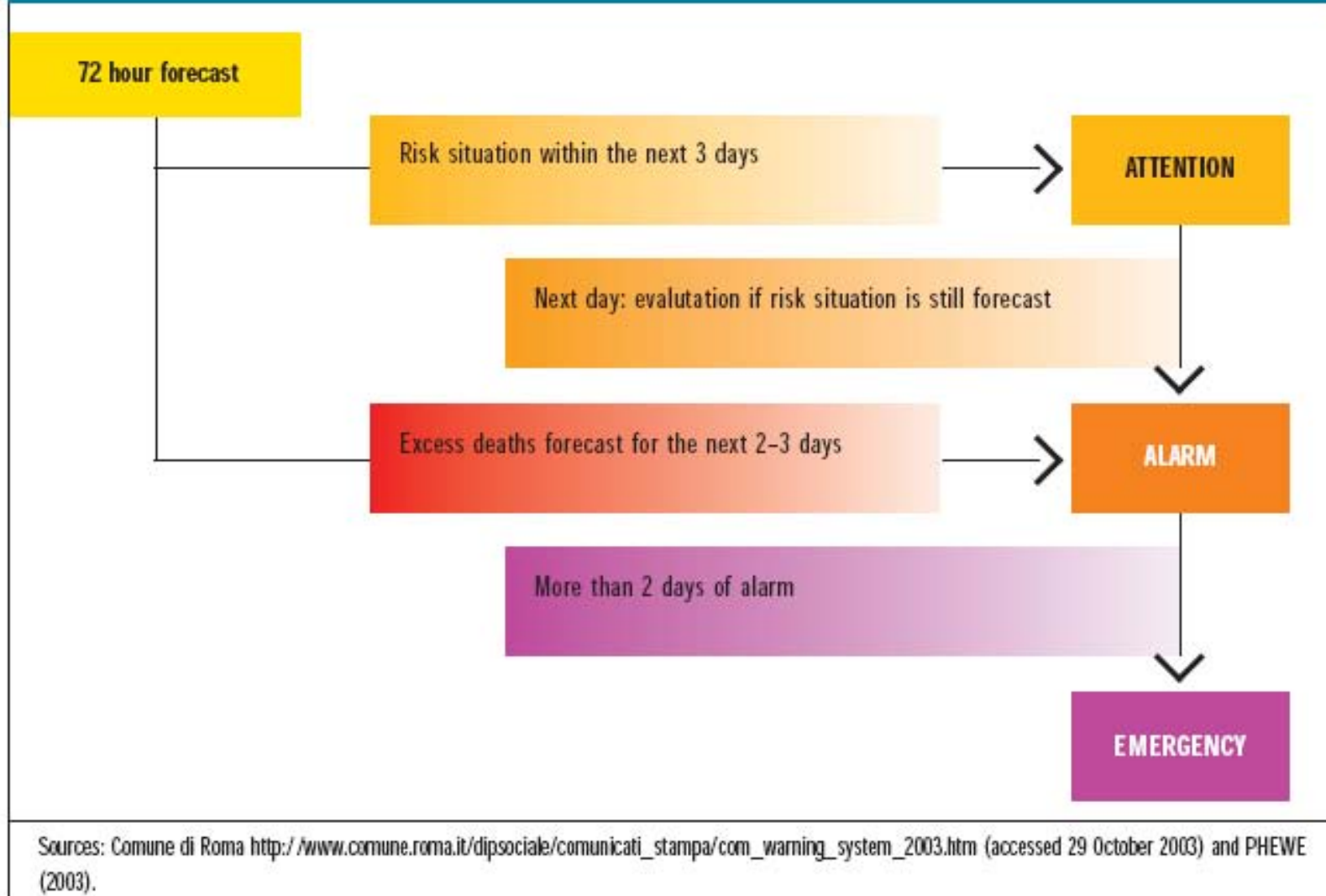


Greece	Tmax			X			
Hungary (Budapest only)	Tmean	X					
Italy	Air Mass/Tapp	X	X	X	X	X	
Latvia	Tmax			X			
Netherlands	Tmax			X			
Poland	Tmax/Tmin						
Portugal	Tmax	X	X	X		X	X
Romania	ITU						
Slovenia <sup>7</sup>	Forecaster						X
Spain	Tmax/Tmin	X				X	X
Switzerland	HI						
UK (England/Wales)	Tmax/Tmin	?		X		X	
USA							
Synoptic*	Air Mass	X	X	X	X	X	X
All other	HI			2 days		X	X

Source: WMO Guidance Notes on HHWS (in prep)

# Italian HHWS

Fig. 12. Flow chart of the heat warning procedure in Rome



Sources: Comune di Roma [http://www.comune.roma.it/dipsociale/comunicati\\_stampa/com\\_warning\\_system\\_2003.htm](http://www.comune.roma.it/dipsociale/comunicati_stampa/com_warning_system_2003.htm) (accessed 29 October 2003) and PHEWE (2003).

# Preparatory Planning

- Set in place actions to reduce risk before a heat wave (take advantage of existing health care plans)
- Know the vulnerable (pre-existing disease, age etc)
- Produce guidelines on preventing and managing heat
- Agree on workable intervention strategies
- Produce a strategy for assessing effectiveness of heat plans and associated actions

# Reducing the Risk Before a Heat Wave

(Source Heat Plan for England, DoH, 2007)

## Reducing the risk Before a heatwave

Heatwaves can happen suddenly, and rapid rises in temperature affect vulnerable people **very rapidly**. Make as much use as possible of existing care plans to assess which individuals are at particular risk, and to identify what extra help they might need.

Health and social care providers need to plan ahead to ensure that care and support for people at risk can be accessed in the event of a heatwave. Anyone living alone is likely to need at least daily contact, whether by care workers, volunteers or informal carers. People with mobility or mental health problems, who are on certain medication, or living in accommodation that is hard to keep cool, will probably need extra care and support.

If you are caring for someone in their own home, these are the steps you should take **before** the weather gets hot. Where possible, involve their family and any informal carers in these arrangements.

### Environment

- Check any south-facing windows, which let in most sunlight, can be shaded, preferably with curtains. Metal Venetian blinds may make things worse.
- Check the person's home or room can be properly ventilated, without causing any additional health risk, discomfort or security problems.
- Consider the possibility of moving the person to a cooler room. People living in top floor accommodation may be at particular risk as heat rises.

# Pre-existing Medical Risk Factors That Increase the Likelihood of Dying in a Heat Wave

<b>Diabetes, melitus, other endocrine disorders</b>	<b>E10-E14</b>
<b>Organic or mental disorders, dementia, Alzheimers</b>	<b>F00 – F09</b>
<b>Mental and behavioural disorders due to psychoactive substance abuse and alcoholism</b>	<b>F10 – F19</b>
<b>Schizophrenia, schiztypal and delusional disorders</b>	<b>F20 – F29</b>
<b>Extrapyramidal and movement disorders (e.g. Parkinsons)</b>	<b>G20 – G26</b>
<b>Cardiovascular disease, hypertension, coronary artery disease, heart conduction disorders</b>	<b>I00 – I99</b>
<b>Diseases of the respiratory system, chronic lower respiratory disease (COPD, bronchitis)</b>	<b>J00 – J99</b>
<b>Diseases of the renal system, renal failure, kidney stones</b>	<b>N00 – N30</b>

## **Guidelines on Preventing and Managing Heat (US CDCP)**

- Drink more fluids (nonalcoholic), regardless of your activity level. Don't wait until you're thirsty to drink. Warning: If your doctor generally limits the amount of fluid you drink or has you on water pills, ask him how much you should drink while the weather is hot.
- Don't drink liquids that contain caffeine, alcohol, or large amounts of sugar – they cause more body fluid loss.
- Avoid very cold drinks, because they can cause stomach cramps.
- Stay indoors and, if at all possible, stay in an air-conditioned place. If your home does not have air-conditioning call your local health department to see if there are any heat-relief shelters in your area.
- Electric fans may provide comfort, but when the temperature is higher than 35 °C, fans will not prevent heat-related illness.
- Taking a cool shower or bath or moving to an air-conditioned place is a much better way to cool off.
- Wear lightweight, light-coloured, loose-fitting clothing.
- NEVER leave anyone in a closed, parked vehicle.

# Philadelphia: Interventions

- Mass media publicize weather conditions and information on heat-related avoidance
- Mass media encourage people to make daily visits to elderly people.
- City identifies and trains block captains. They recruit citizens who have agreed to assist neighbours.
- *Heatline* is operated in conjunction with the Philadelphia Corporation for Aging. *Heatline* number is publicized by the mass media and also on a high visibility display seen over a large area of the Philadelphia city centre.
- Department of Public Health mobile field teams make home visits to people requiring more attention than can be provided over the *Heatline* but still not requiring emergency intervention.
- The Department of Public Health contacts nursing homes and other facilities to inform them of the high-risk heat situation and to offer advice on protecting residents.

# Urban Design and Planning (London)

Physical Scale	Policy Scale	Urban Climate Scale
Individual Building,/Street (façade and roof construction materials, design and orientation).	Building regulations and Building Control Urban design strategy Local Development Framework	1 – 10 m. Indoor climate and street canyon
Urban Design (arrangement of buildings, roads, green space)	Urban Design Strategy Area Action Plan Local Development Framework	10 – 1000 m. Neighbourhood scale, sub-urban variations of climate
City Plan (arrangement of commercial, industrial, residential, recreational and “natural” space)	Sub Regional Spatial Strategy Regional Spatial Strategy	1 - 50 km. City/Metropolitan scale, UHI form and intensity.

Source: McGregor et al. (2007) “London’s Urban Heat Island: A Summary for Decision Makers”

# Conclusions

- Heat waves are a pervasive diffuse natural hazard (*a silent killer*) that can exact a heavy toll on human systems affecting health, livelihoods and infrastructure.
- Natural systems can also be severely affected with the impacts sustained beyond the duration of the heat wave
- Global climate change is projected to further increase the frequency, intensity and duration of heat-waves and attributable deaths – adaptive responses are required.
- Melbourne 2009 was a wake-up call (*harbinger of the future ?*)
- Heat Plans are a short to medium term adaptive response option.
- Longer term, smart urban planning, building design, energy and transport policies will be needed to reduce heat exposure.