

Changement climatique, extrêmes climatiques

Plan de l'exposé

- Impacts climat-santé
- Evolution actuelle des extrêmes climatiques et attribution
- Projections
- HIA

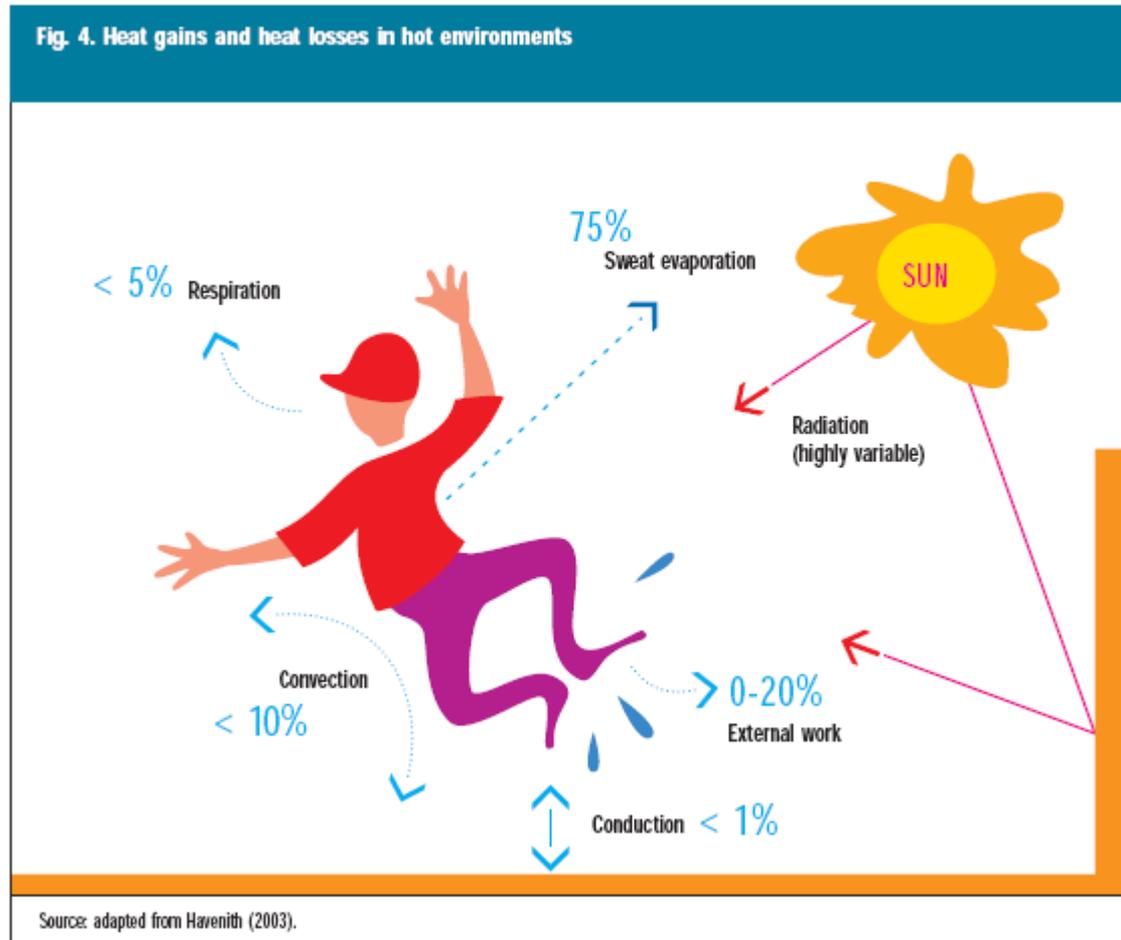
Changement climatique, événements extrêmes et santé

Impacts directs du climat (IPCC WGII, Chap 11)

- Impacts liés à la température
- Inondations et tempêtes
- Rayonnement solaire UV

Vagues de chaleur et vagues de
froid

Les conséquences sur la santé



La régulation thermique humaine et le rôle de l'eau

La vulnérabilité en stress thermique

Déshydratation

→ Fatigue

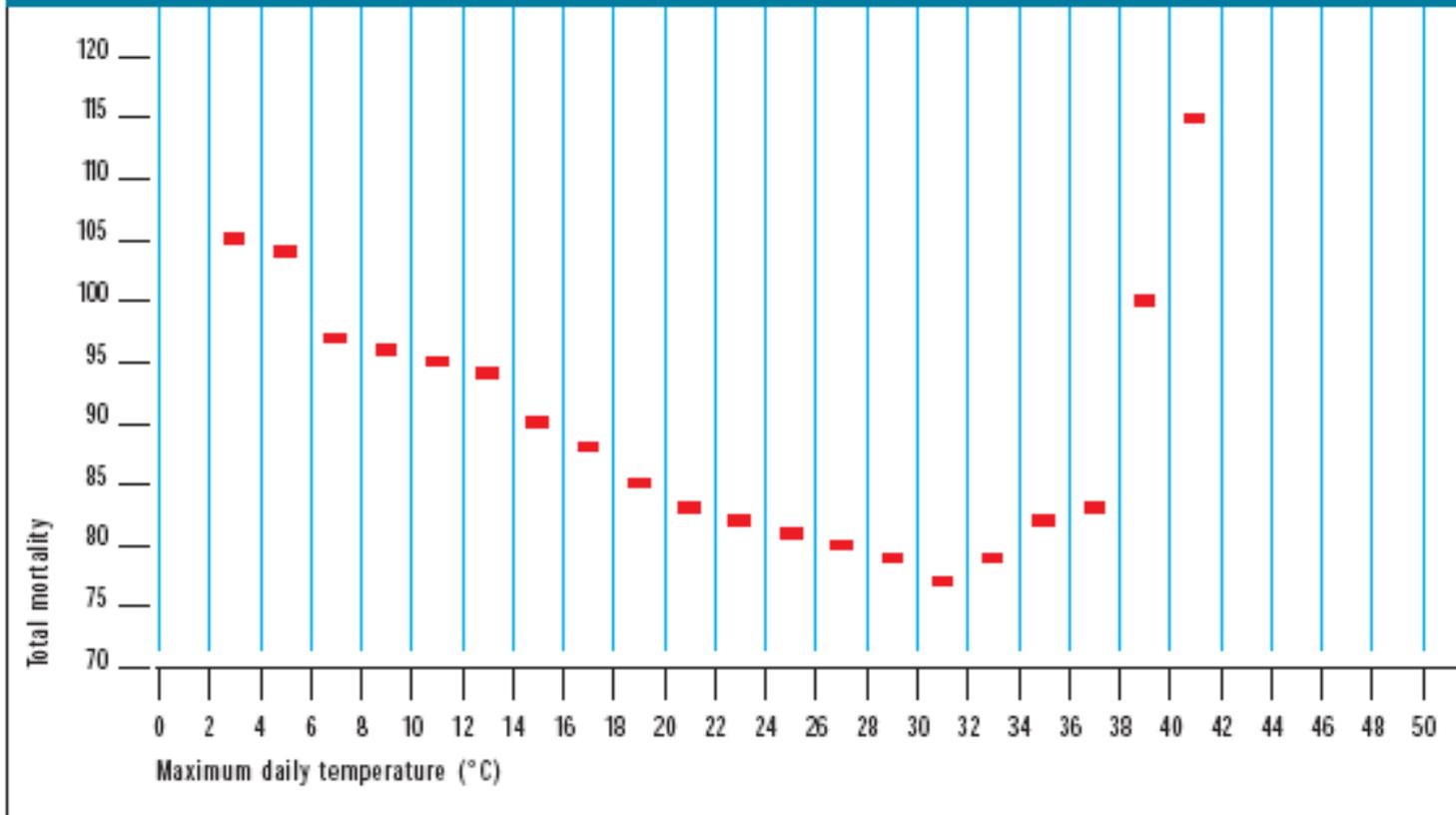
→ Syncope

→ ...

WHO, 2005

Mortalité journalière et température

Fig. 9. Relationship between all-cause mortality and maximum daily temperature in Madrid, 1986–1997

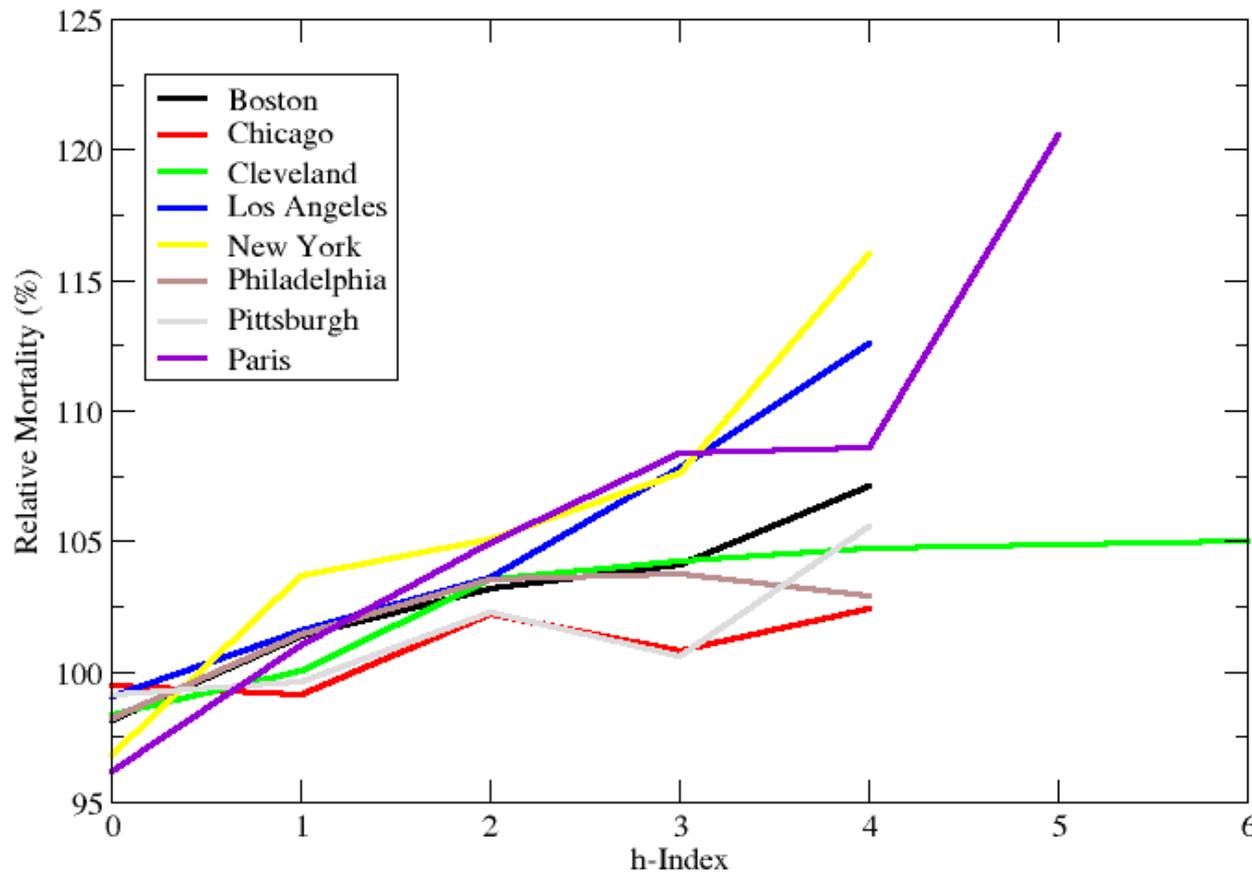


Source: Diaz & López Santiago (2003).

WHO, 2005

Mortality and H-index (unpublished)

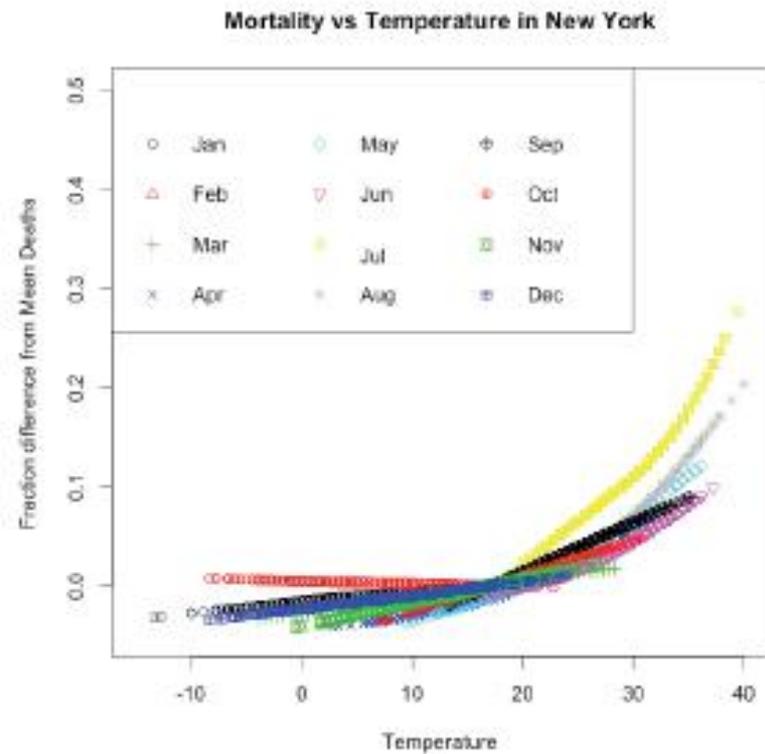
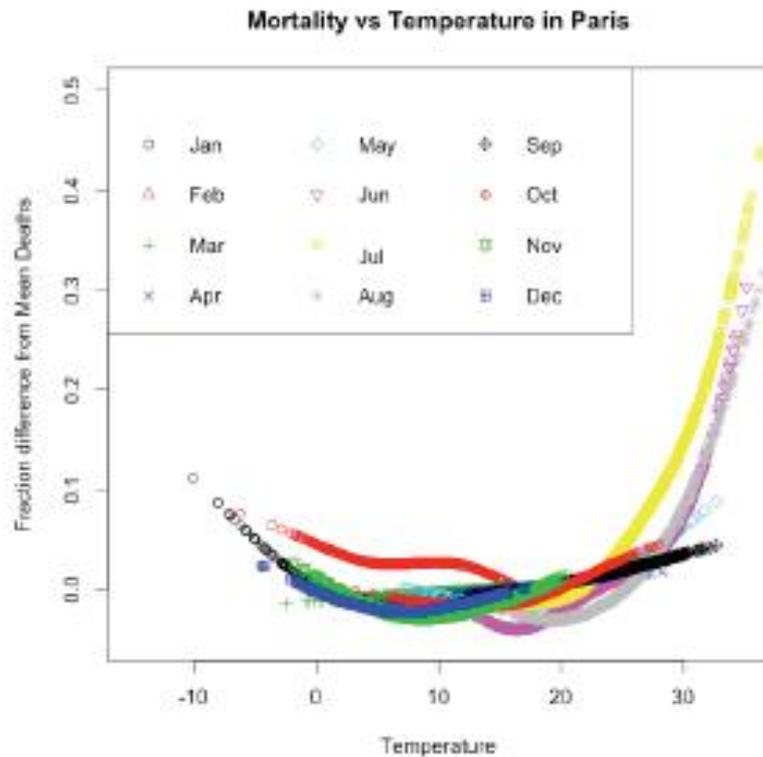
H index = higher number of H consecutive days with anomaly > H



Thanks to R Teuling, J Schwarz, M Pascal

Cold spell effects less marked than hot spells (+ slow effect)

Surmortalité par rapport à la normale de chaque mois



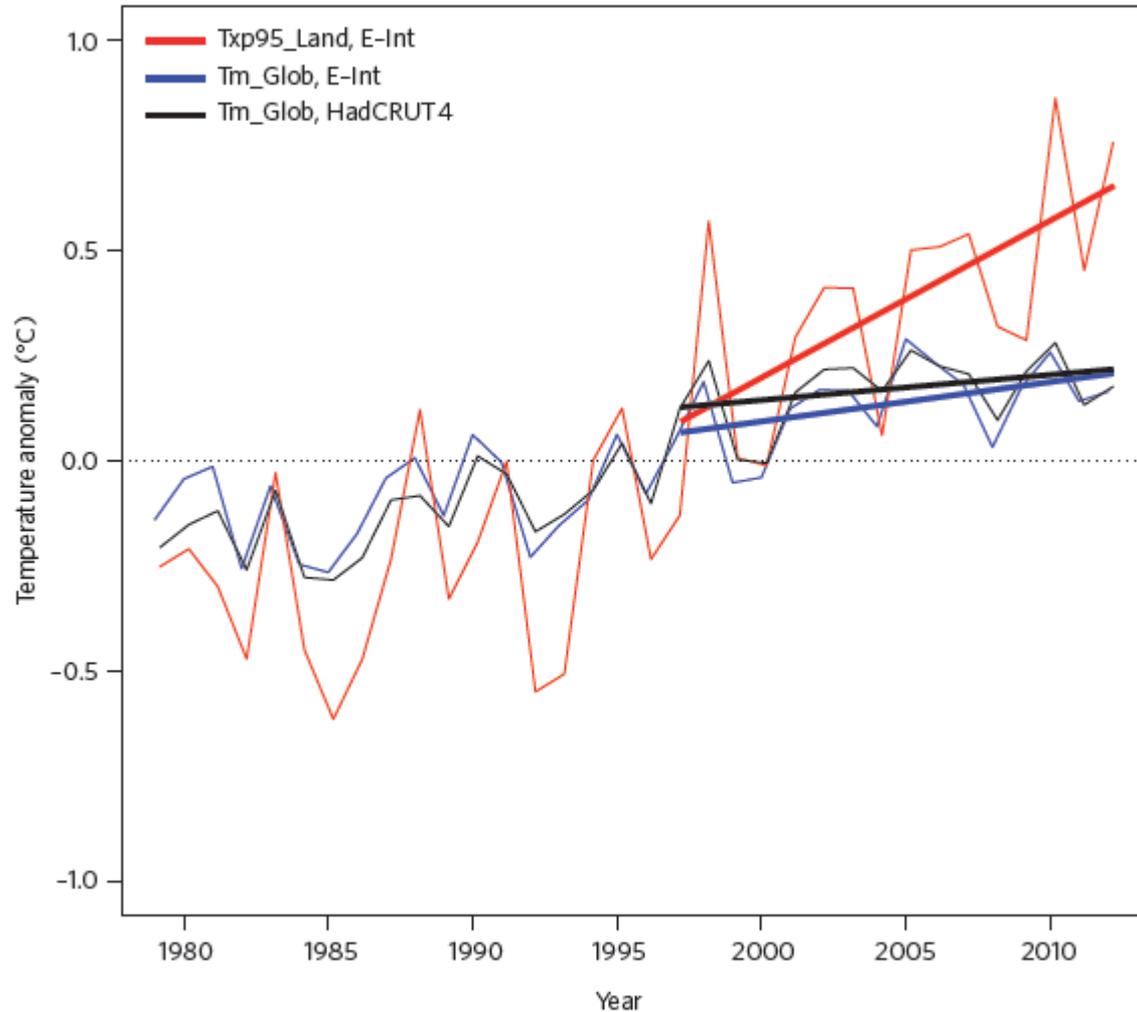
Inondations et tempêtes

- Blessures, noyades, accidents
- Effet sur santé mentale
- Maladies infectieuses
- Hypothermie

Evolution actuelles

Attribution

Pas de pause pour les vagues de chaleur continentales

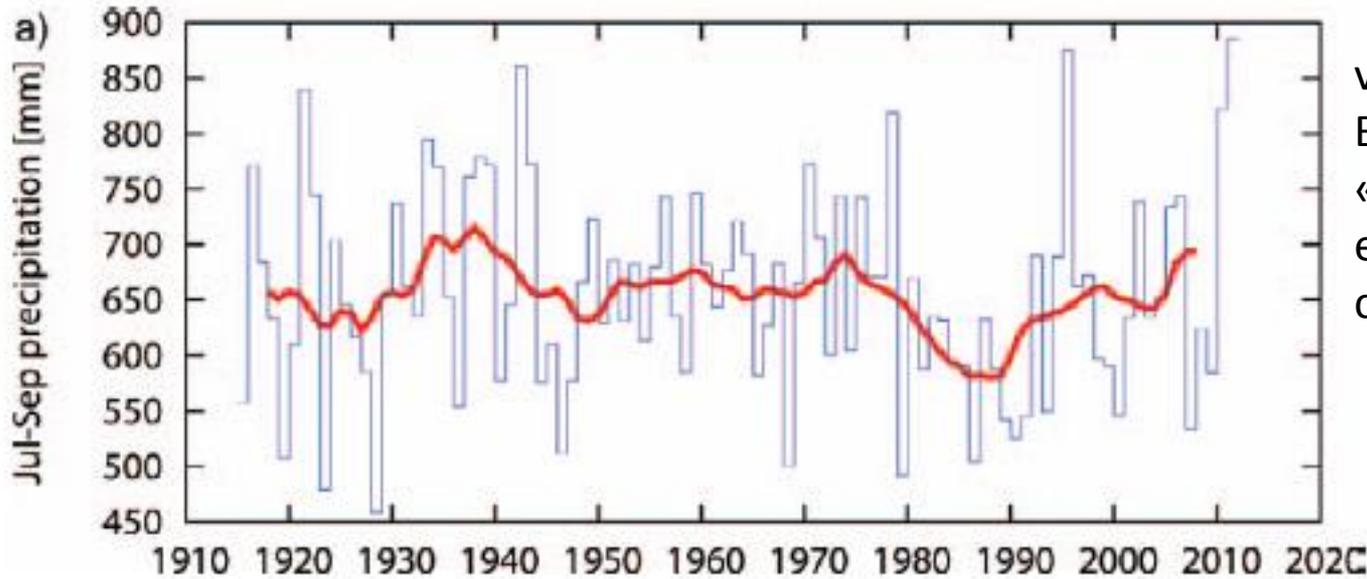


Quelle part attribuer au changement climatique dans chaque événement extrême individuel?

- Généralement aucune cause particulière n'est présente pour chaque phénomène extrême pris individuellement
- On examine le changement des propriétés statistiques et risques d'un événement
- Il est souvent difficile de faire une attribution quantitative
 - Nécessité d'un changement « significatif » au-dessus du bruit
 - Nécessité d'un plan d'expérience de modélisation
- De nombreux travaux autour des mécanismes physiques

Attention aux autres causes

Ex: inondations de Thaïlande en 2011



van Oldenborgh et al.,
BAMS, 2011
« explaining 2011
extreme event from a
climate prospective

Précipitations dans le bassin du Chao Phraya

11 Mds US\$ de pertes

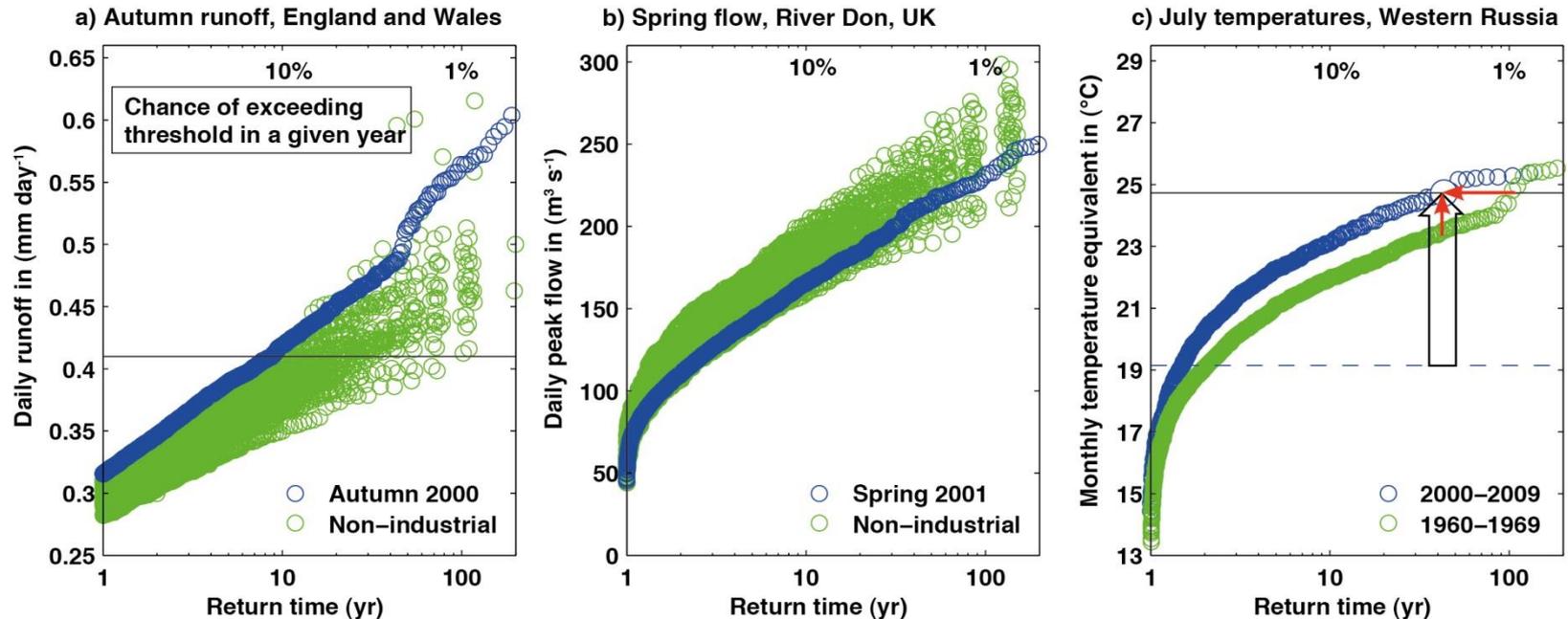
Pas d'évolution climatique → Changement d'exposition

Les méthodes d'attribution

Simulations avec et sans forçage de GES

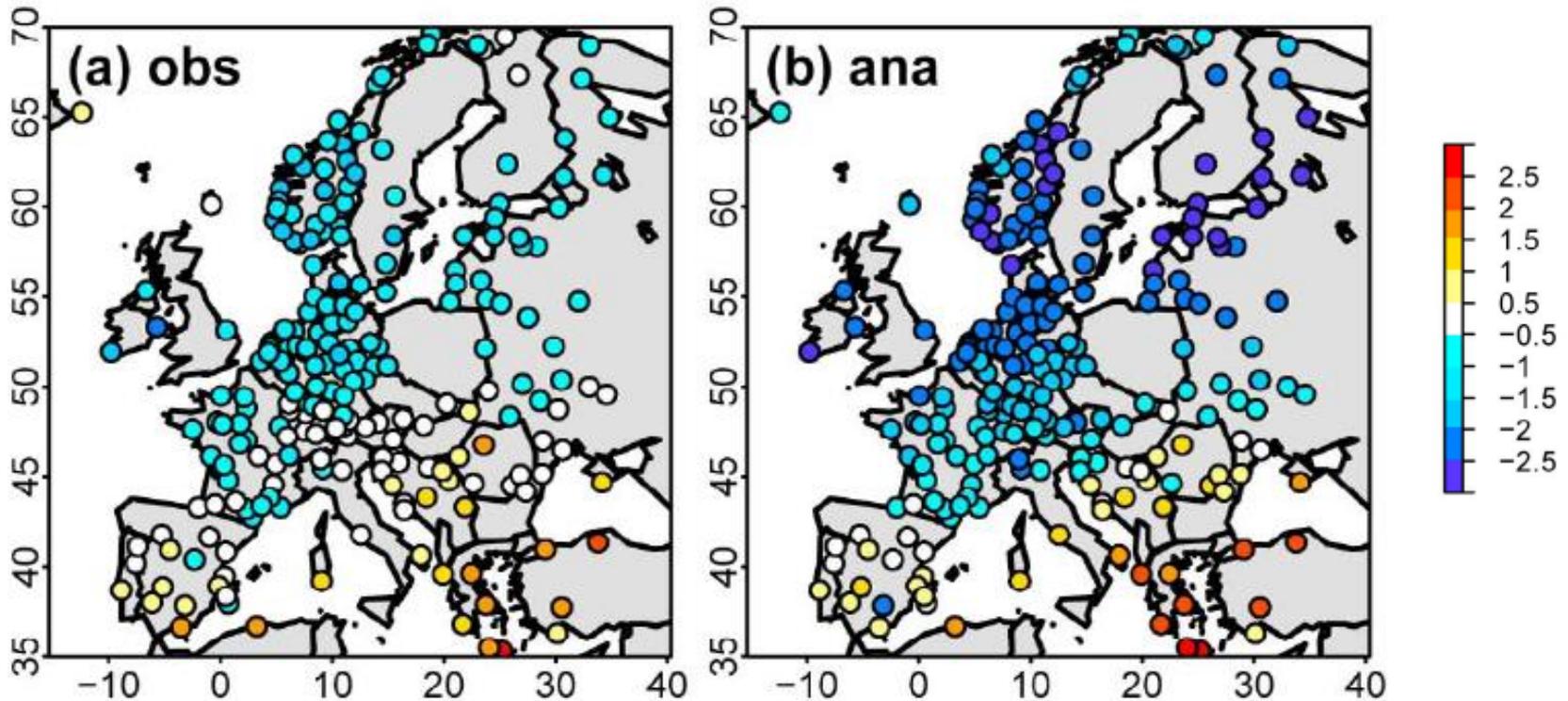
(ici modèle atmosphérique avec différentes SSTs)

→ Très nombreuses simulations nécessaires pour évaluer les extrêmes



Méthodes d'analogues

Hiver 2009-2010: une vague de froid qui aurait été 1.3°C plus froide avec les températures de circulations analogues
→ La circulation atmosphérique conduirait sans autre tendance à $\sim -2.7^{\circ}\text{C}$



Quelques résultats chiffrés

- Été 2003: il est très probable (90%) que l'influence humaine a doublé le risque de cet événement (Stott et al., 2004)
- Été 2010: même types de résultats + Augmentation de la durée des blocages d'été sur la région (Ruti et al., 2014)
- Automne/hiver 2006-2007: contribution de la tendance des SSTs estimée à 20-30%

De façon synthétique (IPCC WGI)

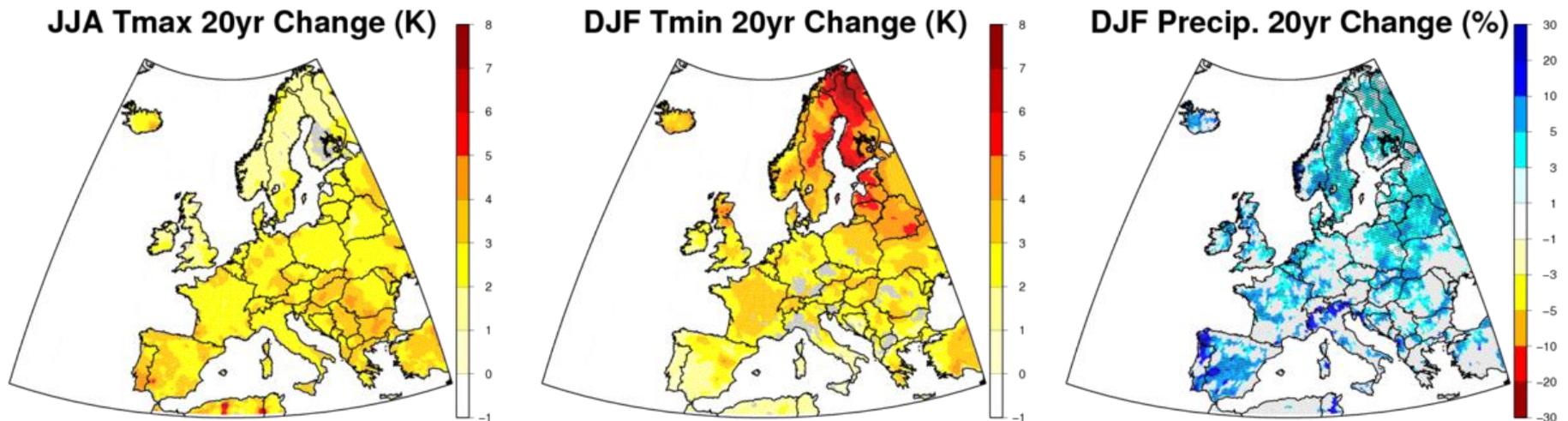
Signaux forts: température; signaux plus faible pour les autres phénomènes
 → Encore peu d'études, communauté internationale réduite

Phenomenon and direction of trend	Assessment that changes occurred (typically since 1950 unless otherwise indicated)	Assessment of a human contribution to observed changes	Likelihood of further changes	
			Early 21st century	Late 21st century
Warmer and/or fewer cold days and nights over most land areas	<i>Very likely</i> (2.6)	<i>Very likely</i> (10.6)	<i>Likely</i> (11.3)	<i>Virtually certain</i> (12.4)
	<i>Very likely</i> <i>Very likely</i>	<i>Likely</i> <i>Likely</i>		<i>Virtually certain</i> <i>Virtually certain</i>
Warmer and/or more frequent hot days and nights over most land areas	<i>Very likely</i> (2.6)	<i>Very likely</i> (10.6)	<i>Likely</i> (11.3)	<i>Virtually certain</i> (12.4)
	<i>Very likely</i> <i>Very likely</i>	<i>Likely</i> <i>Likely (nights only)</i>		<i>Virtually certain</i> <i>Virtually certain</i>
Warm spells/heat waves. Frequency and/or duration increases over most land areas	<i>Medium confidence</i> on a global scale <i>Likely</i> in large parts of Europe, Asia and Australia (2.6)	<i>Likely</i> ^a (10.6)	Not formally assessed ^b (11.3)	<i>Very likely</i> (12.4)
	<i>Medium confidence</i> in many (but not all) regions <i>Likely</i>	Not formally assessed <i>More likely than not</i>		<i>Very likely</i> <i>Very likely</i>
Heavy precipitation events. Increase in the frequency, intensity, and/or amount of heavy precipitation	<i>Likely</i> more land areas with increases than decreases ^c (2.6)	<i>Medium confidence</i> (7.6, 10.6)	<i>Likely</i> over many land areas (11.3)	<i>Very likely</i> over most of the mid-latitude land masses and over wet tropical regions (12.4)
	<i>Likely</i> more land areas with increases than decreases <i>Likely over most land areas</i>	<i>Medium confidence</i> <i>More likely than not</i>		<i>Likely</i> over many areas <i>Very likely over most land areas</i>
Increases in intensity and/or duration of drought	<i>Low confidence</i> on a global scale <i>Likely</i> changes in some regions ^d (2.6)	<i>Low confidence</i> (10.6)	<i>Low confidence</i> ^e (11.3)	<i>Likely (medium confidence)</i> on a regional to global scale ^b (12.4)
	<i>Medium confidence</i> in some regions <i>Likely</i> in many regions, since 1970 ^a	<i>Medium confidence</i> ^f <i>More likely than not</i>		<i>Medium confidence</i> in some regions <i>Likely</i> ^a
Increases in intense tropical cyclone activity	<i>Low confidence</i> in long term (centennial) changes <i>Virtually certain</i> in North Atlantic since 1970 (2.6)	<i>Low confidence</i> ^f (10.6)	<i>Low confidence</i> (11.3)	<i>More likely than not</i> in the Western North Pacific and North Atlantic ⁱ (14.6)
	<i>Low confidence</i> <i>Likely</i> in some regions, since 1970	<i>Low confidence</i> <i>More likely than not</i>		<i>More likely than not</i> in some basins <i>Likely</i>
Increased incidence and/or magnitude of extreme high sea level	<i>Likely</i> (since 1970) (3.7)	<i>Likely</i> ^a (3.7)	<i>Likely</i> ^l (13.7)	<i>Very likely</i> ^l (13.7)
	<i>Likely</i> (late 20th century) <i>Likely</i>	<i>Likely</i> ^a <i>More likely than not</i> ^a		<i>Very likely</i> ^m <i>Likely</i>

Projections climatiques

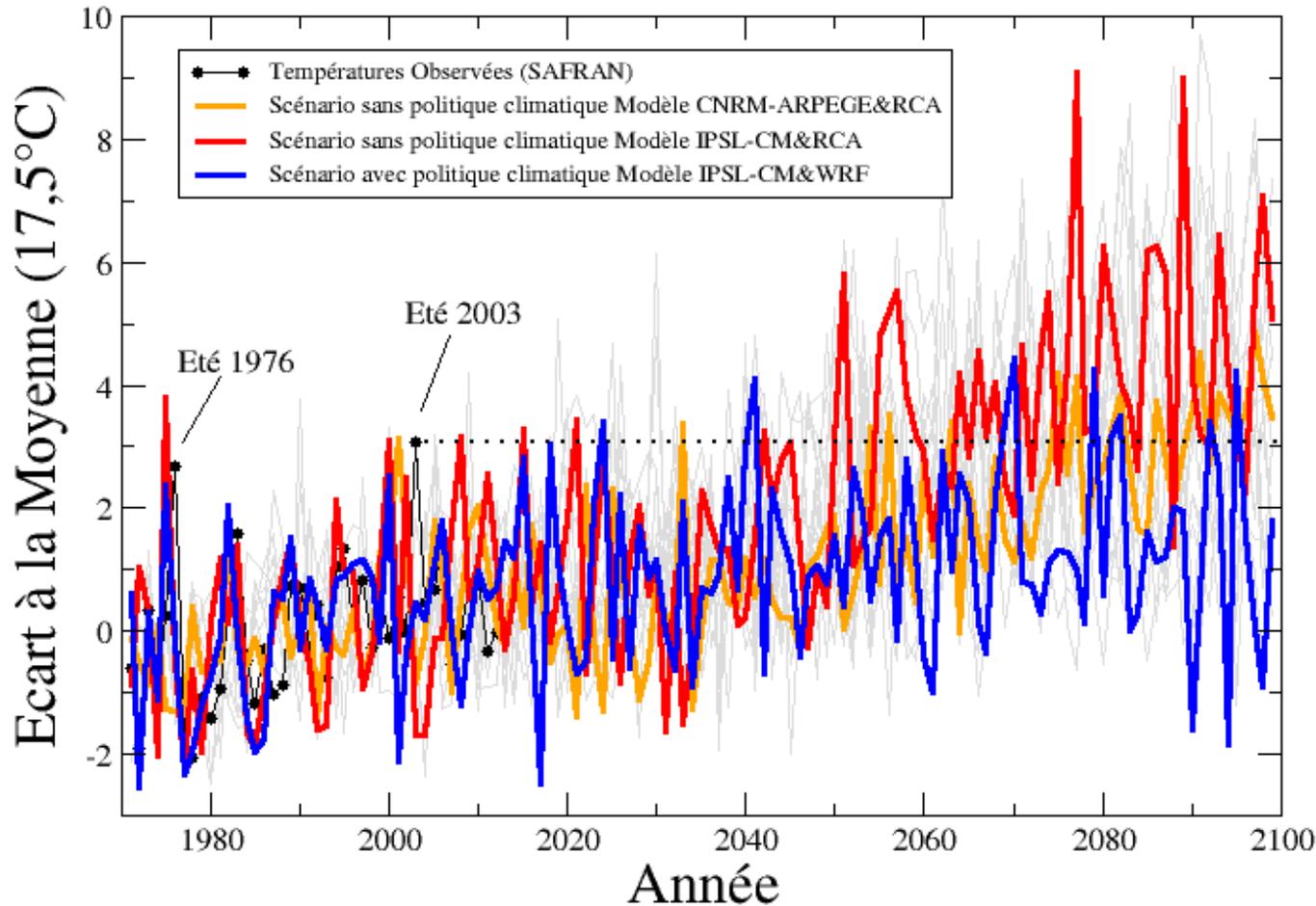
Changements “robustes” des extrêmes en Europe avec +2°C global

- Généralisation de l'augmentation des précipitations en toutes saisons
- Extrêmes de température 2-4°C plus chauds en été,

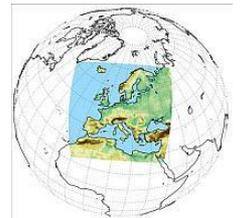


Changements dans les valeurs de “retour à 20 ans”

Evolutions projetées des changements de température estivale près de Paris selon les simulations EURO-CORDEX à haute résolution



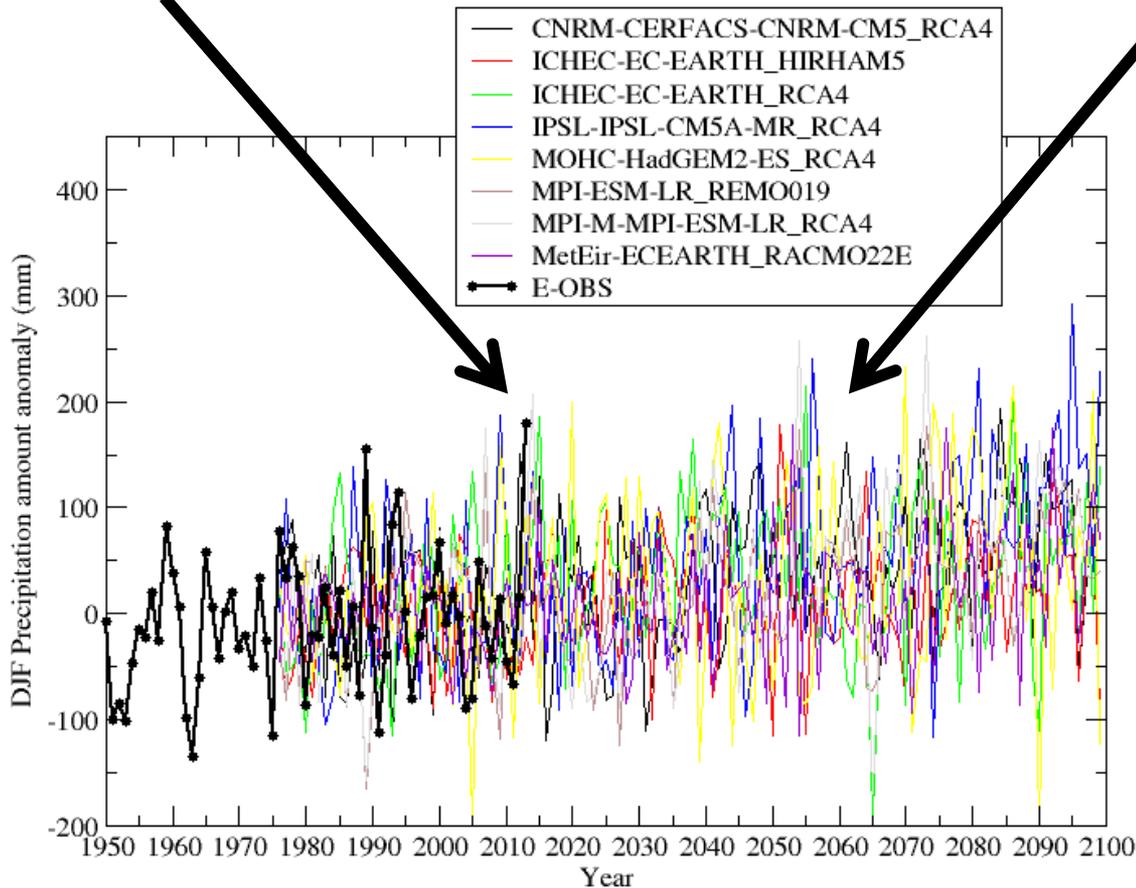
EURO-CORDEX



Précipitations sur l'Angleterre du sud

Simulations EURO-CORDEX

Cumuls saisonniers, observations (EOBS)



Eucleia

Evénement extrême de période de retour

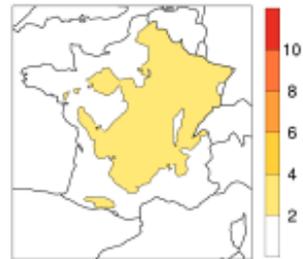
- estimée 50-150 ans (P. Yiou, pers. Comm.)
- pas de changement détectable significatif avec les modèles
- Diminution pour la fin de siècle d'un facteur 2-3 du temps de retour

Changements par rapport à 1976-2005

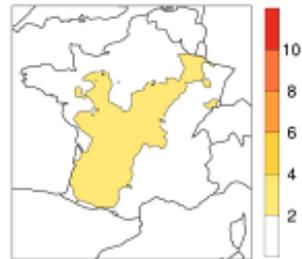
N. de vagues de chaleur en France (Rapport « Jouzel 2 »)

1976-2005

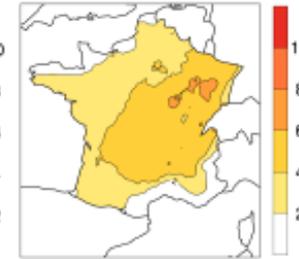
C25 - 1976-2005



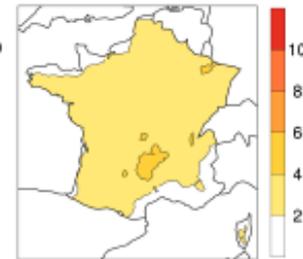
WRF - 1976-2005



Aladin-Climat- 1976-2005

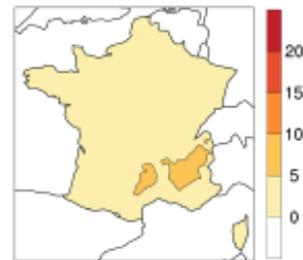


C75 - 1976-2005

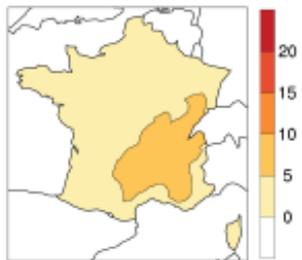


2021-2050

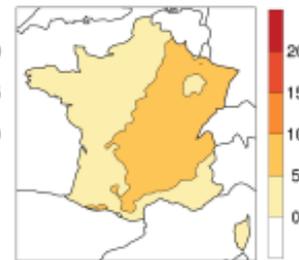
C25 - 2021-2050



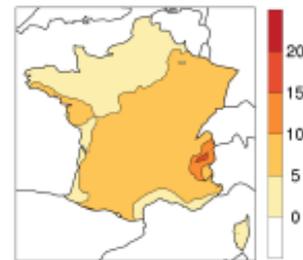
WRF - 2021-2050



Aladin-Climat 2021-2050

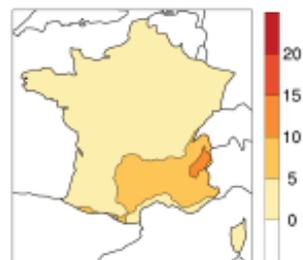


C75 - 2021-2050

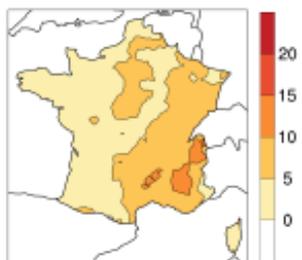


2071-2100

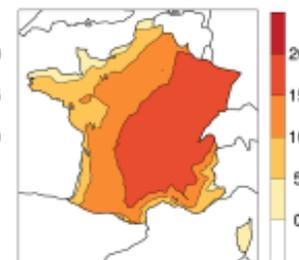
C25 - 2071-2100



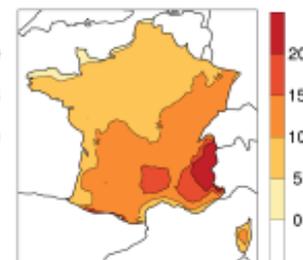
WRF - 2071-2100



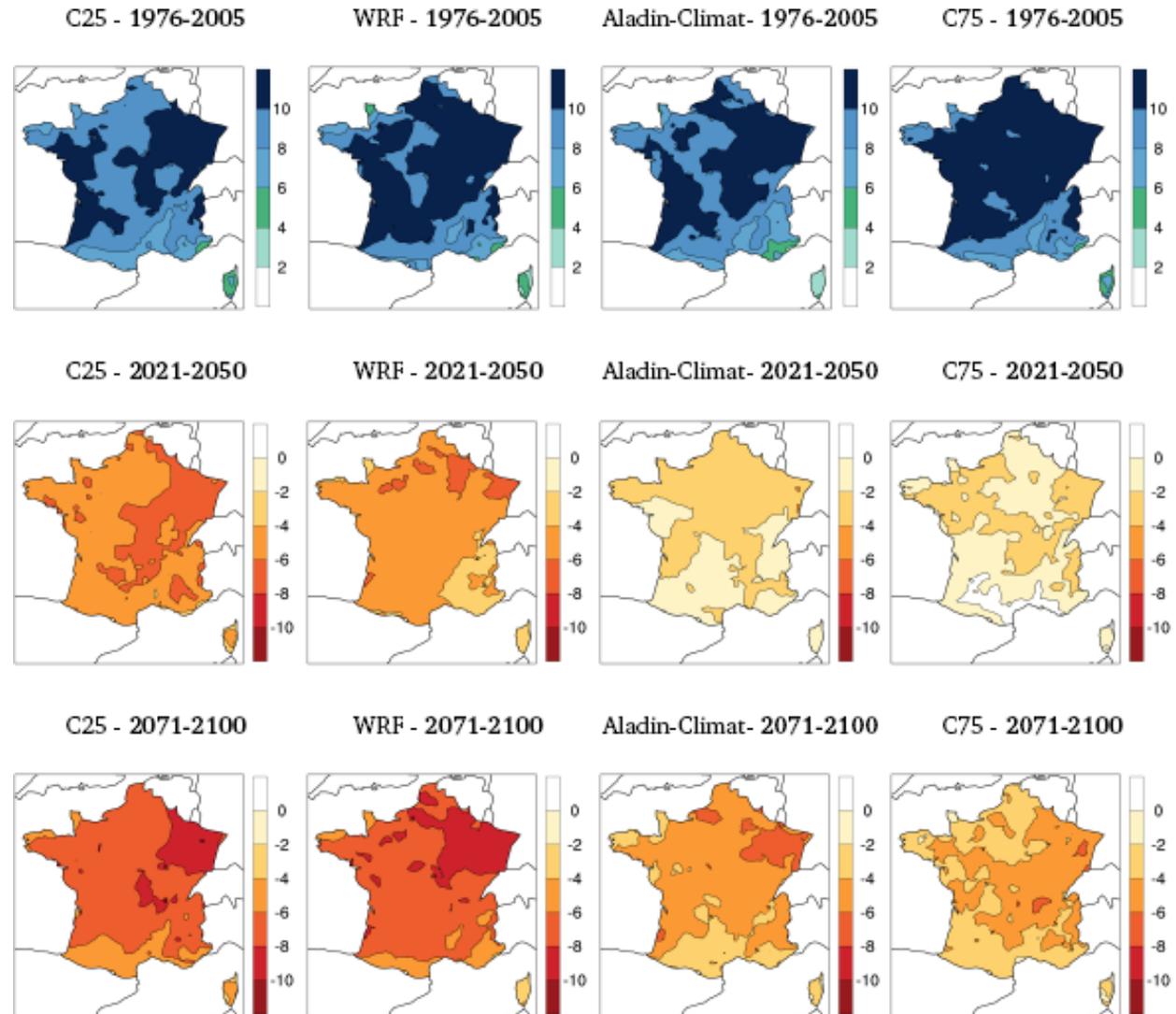
Aladin-Climat- 2071-2100



C75 - 2071-2100

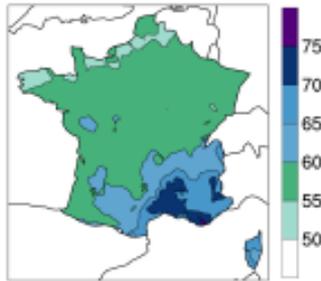


N. de vagues de froid en France

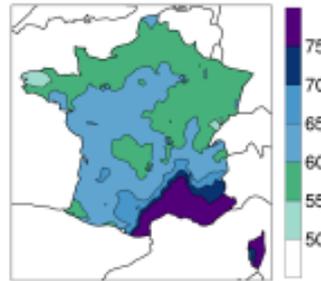


Précipitations extrêmes journalières

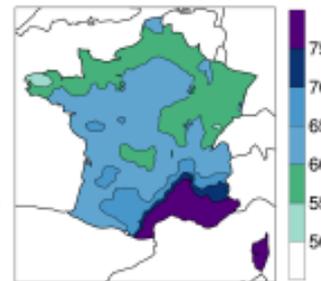
C25 - 1976-2005



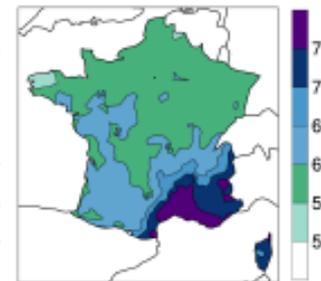
WRF - 1976-2005



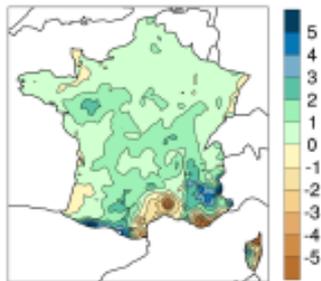
Aladin-Climat- 1976-2005



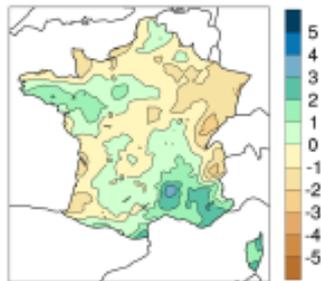
C75 - 1976-2005



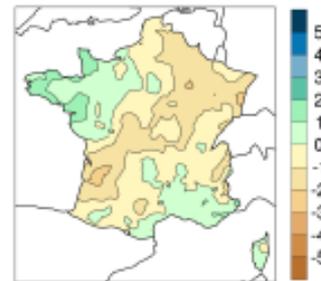
C25 - 2021-2050



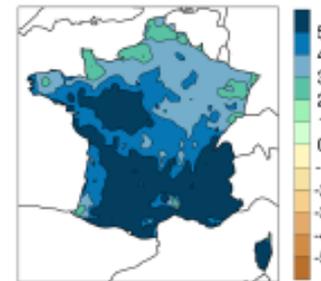
WRF - 2021-2050



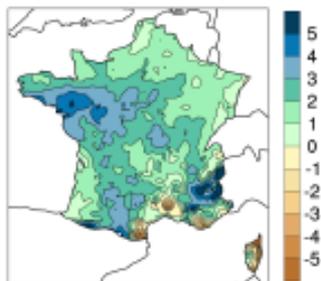
Aladin-Climat- 2021-2050



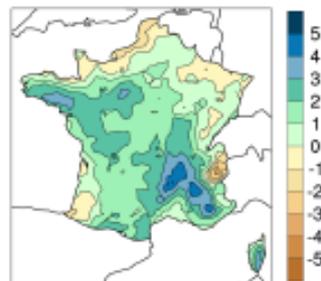
C75 - 2021-2050



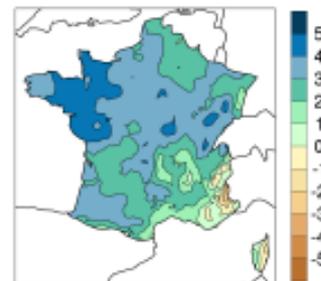
C25 - 2071-2100



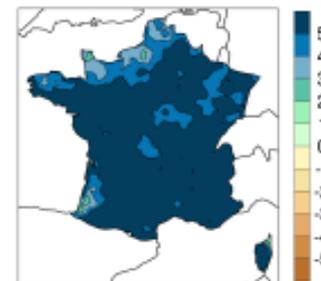
WRF - 2071-2100



Aladin-Climat- 2071-2100



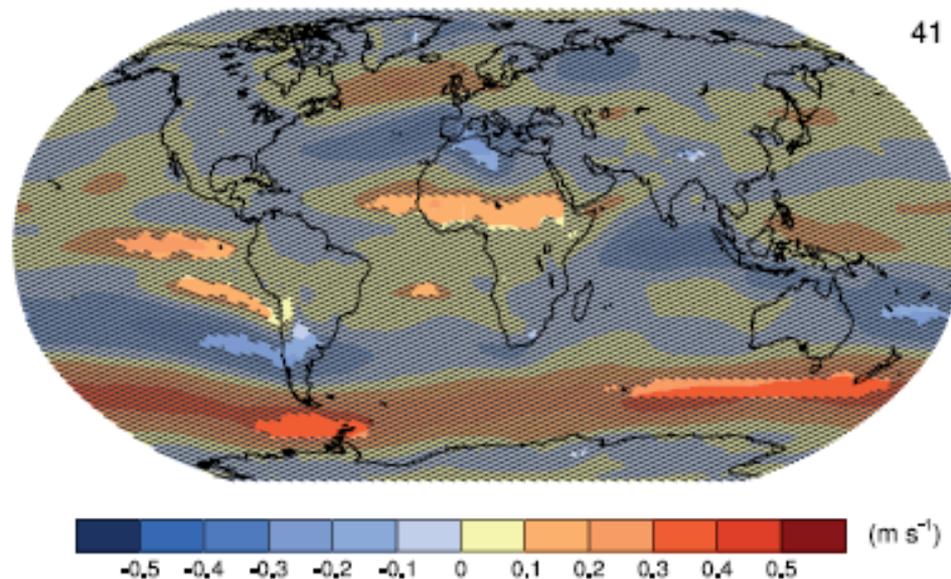
C75 - 2071-2100



Ce que dit le GIEC sur les tempêtes

There is *medium confidence* in near-term projections of a northward shift of Northern Hemisphere storm tracks and westerlies. {11.3.2}

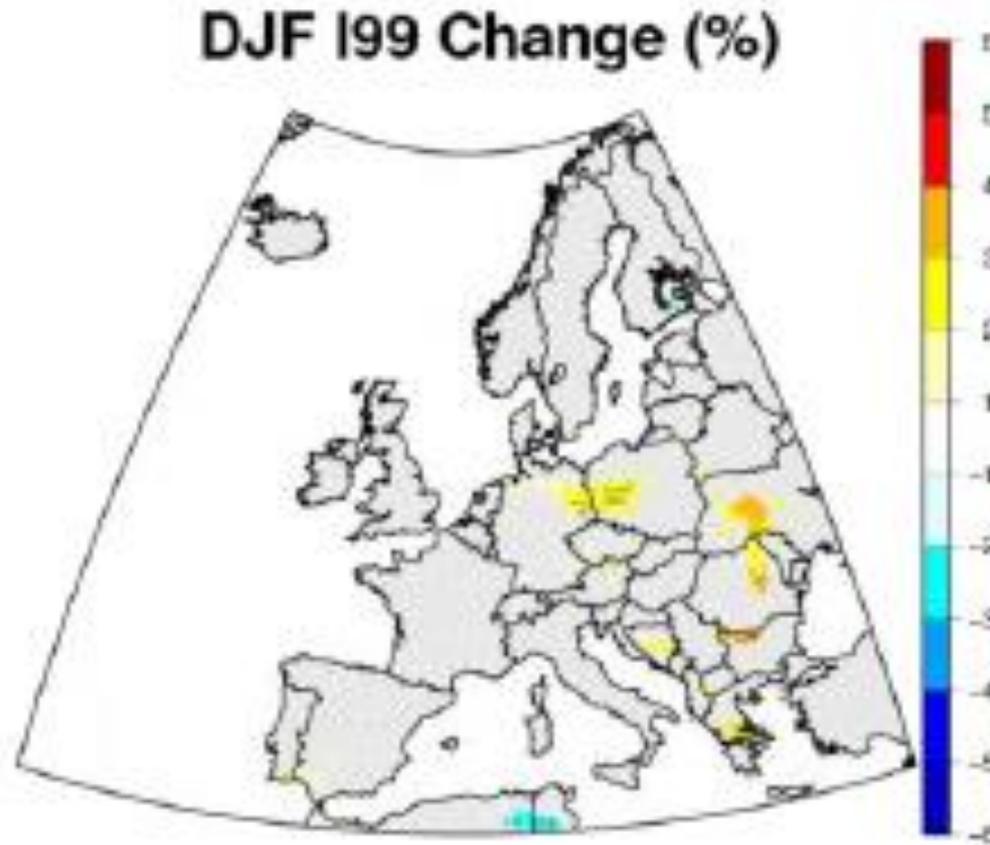
Annual mean zonal wind change at 850 hPa (RCP4.5; 2016-2035)



Mouvement des « storm-track vers les poles

Figure 11.15 | CMIP5 multi-model ensemble mean of projected changes (m s⁻¹) in zonal (west-to-east) wind at 850 hPa for 2016–2035 relative to 1986–2005 under RCP4.5. The number of CMIP5 models used is indicated in the upper right corner. Hatching and stippling as in Figure 11.10.

Changements des vents très forts



Projected evolution of mortality in the U. K.

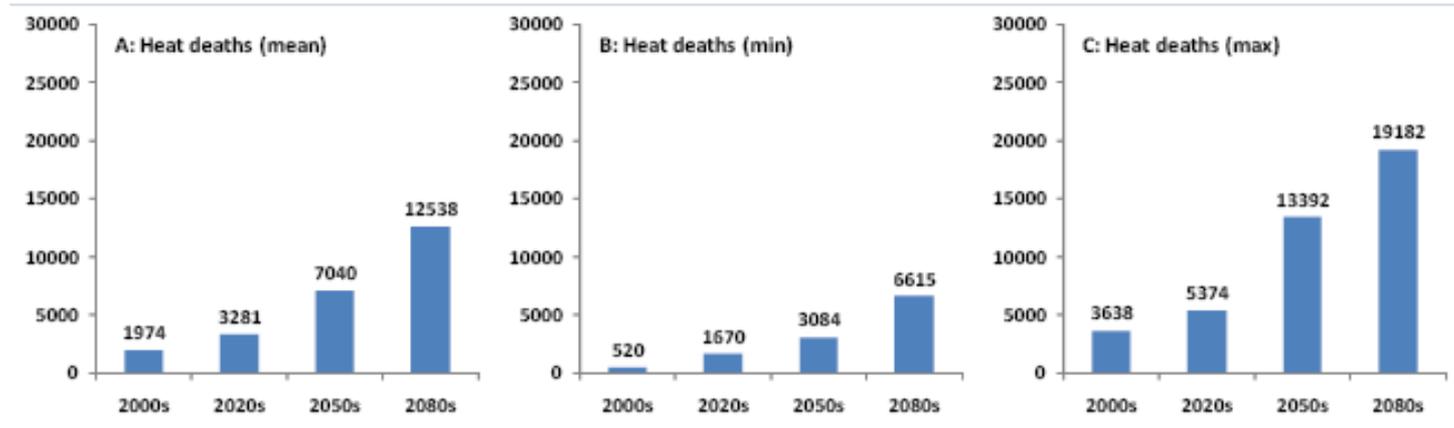


Figure 2.5. Mean (A), min (B) and max (C) estimates of heat-related deaths in the UK per year for all ages based on an ensemble of nine climate model realisations (the additional heatwave effect in London is not included).

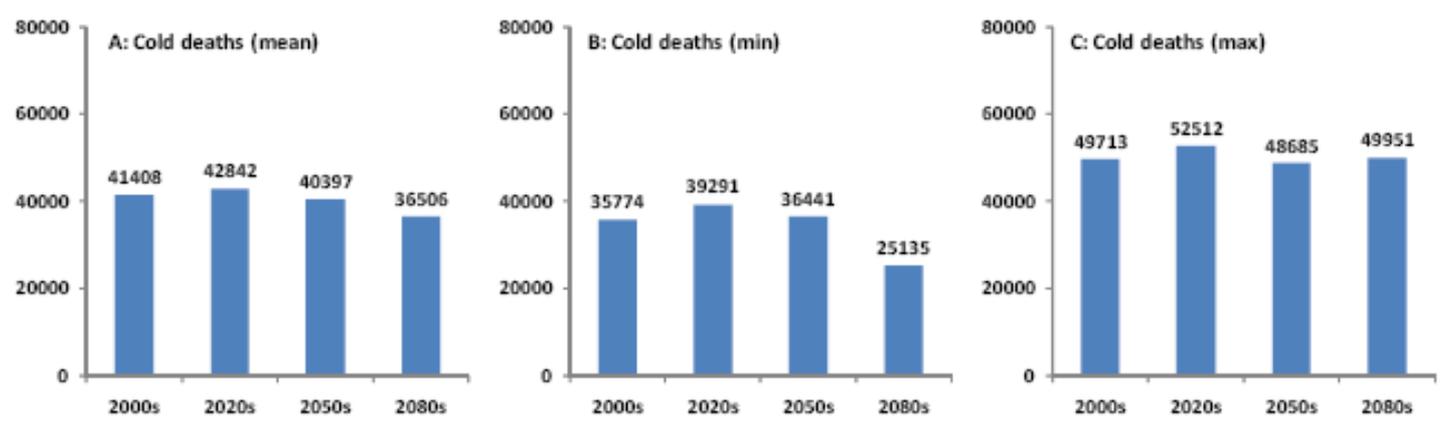


Figure 2.6. Mean (A), min (B) and max (C) estimates of cold-related deaths in the UK per year for all ages based on an ensemble of nine climate model realisations.

Conclusions

- Impacts du changement climatique sur la santé (extrêmes) encore difficile à quantifier
 - Science de l'attribution en émergence
 - Attribution pour les impacts à développer
- Nécessité d'une approche interdisciplinaire

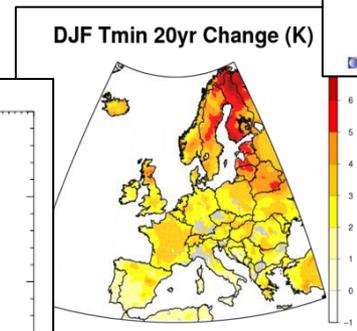
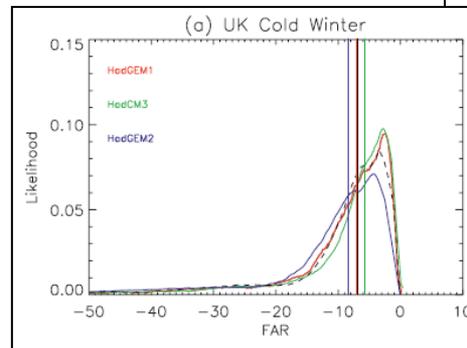
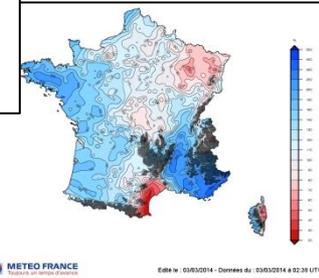
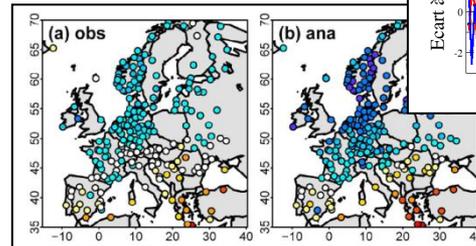
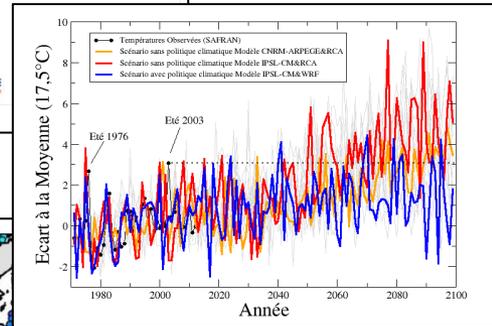
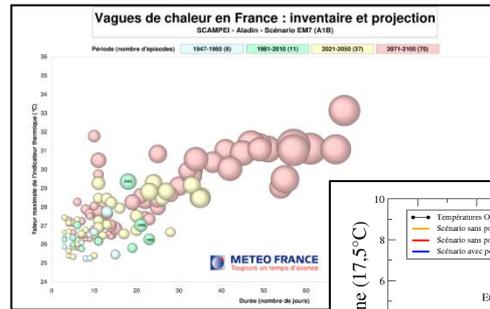
Projets *eXtremoscope* et *EUCLEIA*

interpréter les événements extrêmes dans un cadre climatique après leur survenue

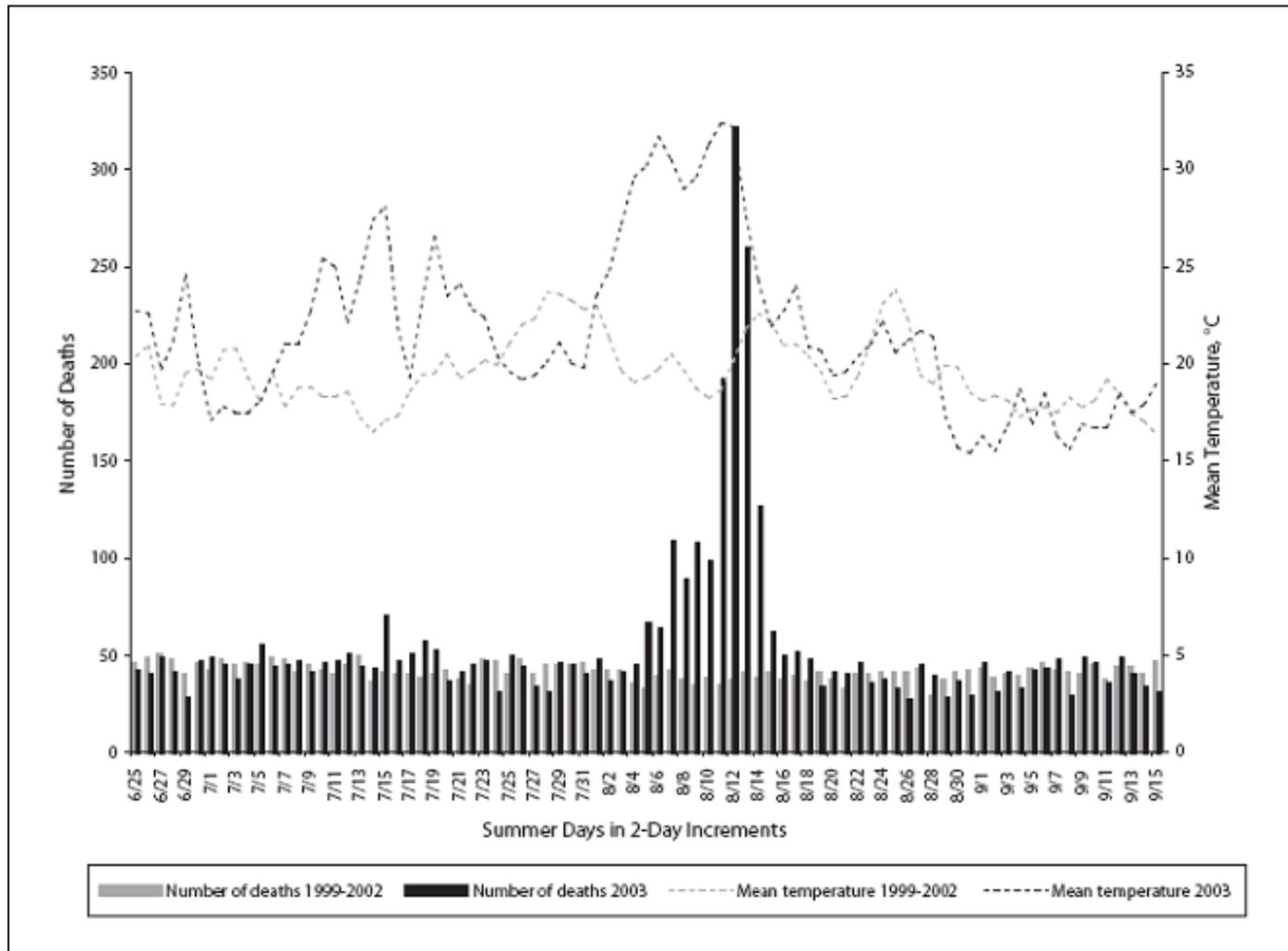
→ *Etat, médias, assurances*

- Quels liens au changement climatique?
- Les risques ont-ils évolué?
- prototype des événements futurs?
- Quels impacts dans la société actuelle et dans le futur?

→ Apport de la recherche aux diagnostics existants



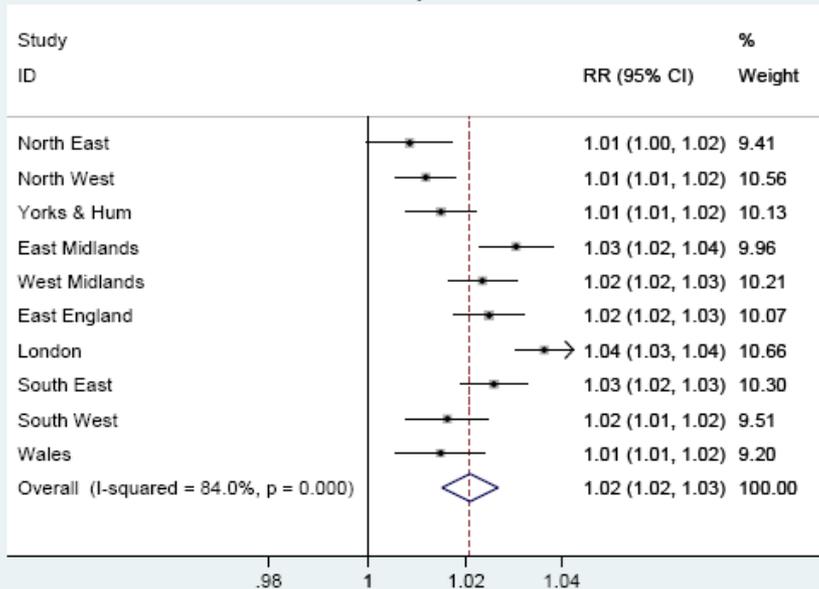
Mortalité à Paris en août 2003



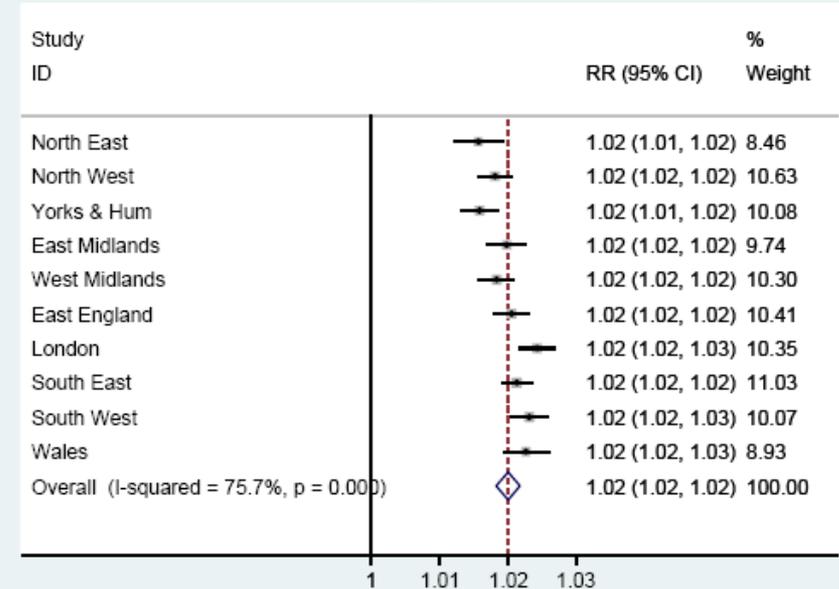
Health Impact assessment

- Calculate an increase in mortality for an increase/decrease in T after threshold
- Project for a temperature increase and population exposed
- **Lots of hypotheses!!**

heat effect: RR per 1C increase



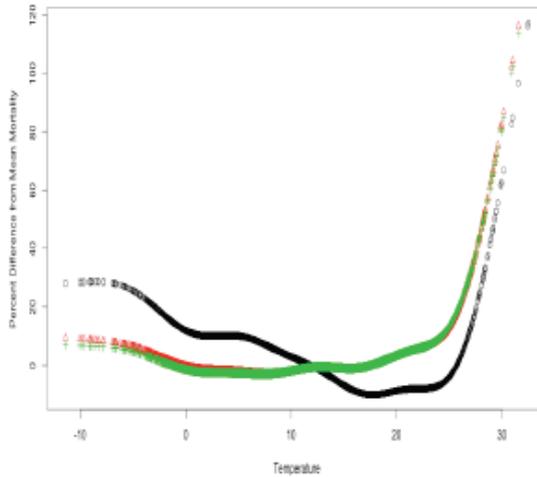
cold effect: RR per 1C decrease



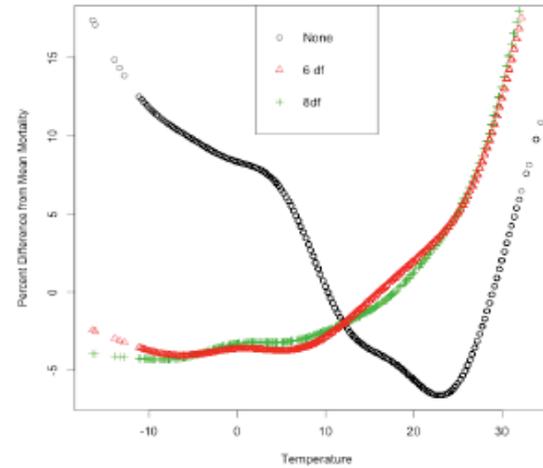
Source : Vardoulakis and Heaviside, 2012

Cold spell effects less marked than hot spells (+ slow effect)

Temperature and Mortality in Paris



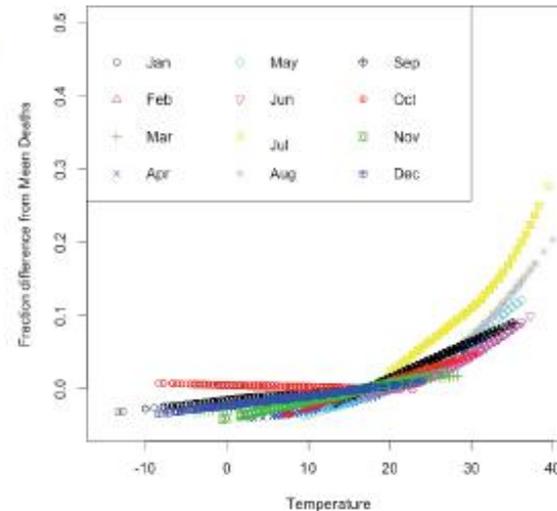
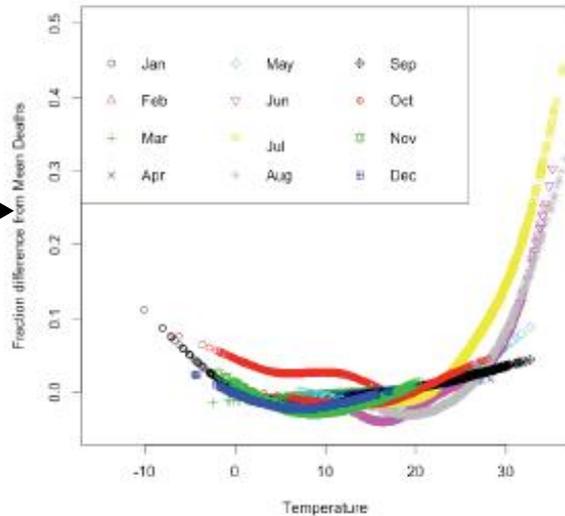
Temperature and Mortality in New York



Relations M/T
Total&court terme



Mois par mois



Kinney et al (yet unpublished)