

*Tipping point of the
climate system: risk,
impact and
resilience strategy for
society*

Didier Swingedouw

Special Report on the Ocean and the Cryosphere in a Changing Climate

Chapter 6: Extremes, Abrupt Changes and Managing Risks

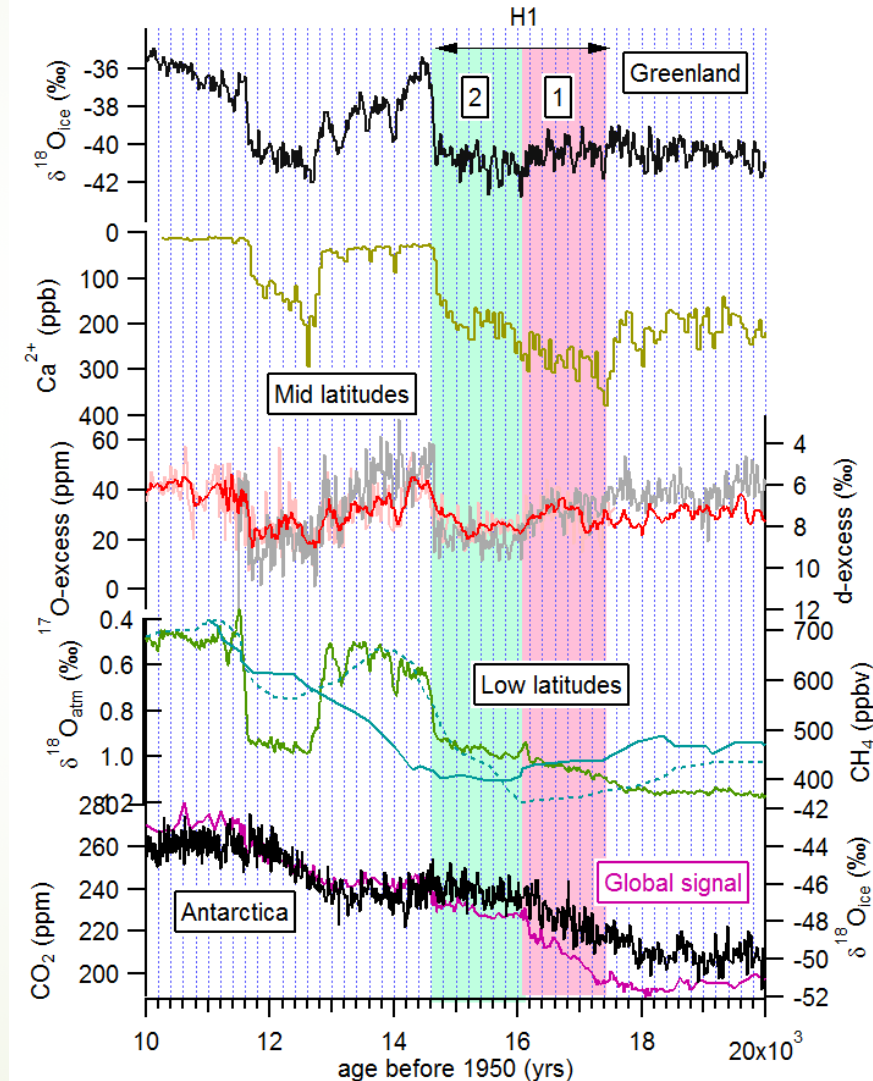
- Risks of abrupt change in ocean circulation and cryosphere and potential consequences
- Extreme ENSO events and other modes of variability and their implications
- Marine heat waves and implications
- Changes in tracks, intensity, and frequency of tropical and extra-tropical storms and associated wave height
- Cascading risks (e.g., storm surge and sea level rise), irreversibility, and tipping points
- Monitoring systems for extremes, early warning and forecasting systems in the context of climate change
- Governance and policy options, risk management, including disaster risk reduction and enhancing resilience

High-Resolution Greenland Ice Core Data Show Abrupt Climate Change Happens in Few Years

Jørgen Peder Steffensen,^{1*} Katrine K. Andersen,¹ Matthias Bigler,^{1,2} Henrik B. Clausen,¹ Dorthe Dahl-Jensen,¹ Hubertus Fischer,^{2,3} Kumiko Goto-Azuma,⁴ Margareta Hansson,⁵ Sigfús J. Johnsen,¹ Jean Jouzel,⁶ Valérie Masson-Delmotte,⁶ Trevor Popp,⁷ Sune O. Rasmussen,¹ Regine Röthlisberger,^{2,8} Urs Ruth,³ Bernhard Stauffer,² Marie-Louise Siggaard-Andersen,¹ Árný E. Sveinbjörnsdóttir,⁹ Anders Svensson,¹ James W. C. White⁷

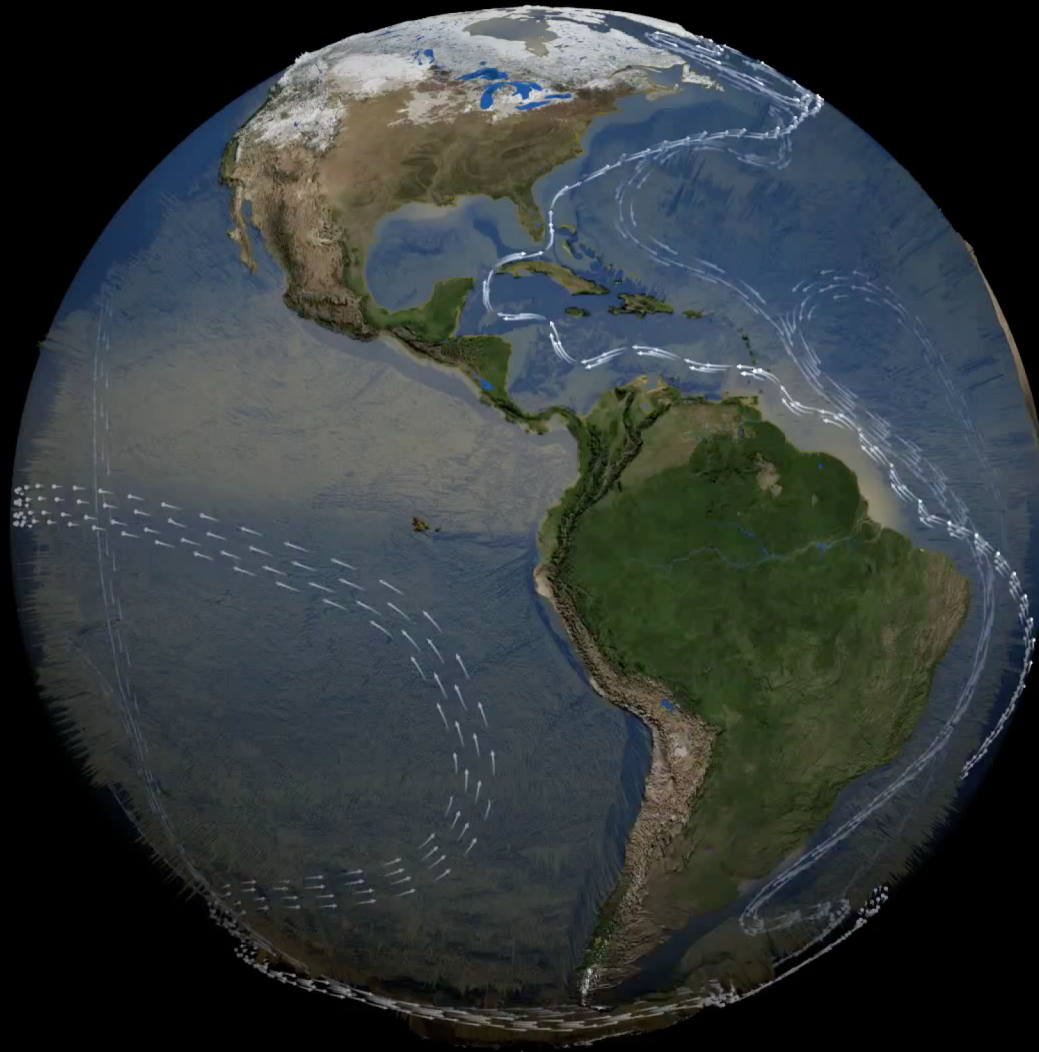
Lessons from the

- Abrupt changes over the recent past: little ice age (Michel et al. in prep.)
- High resolution proxies for the deglaciation
- Dangaard-Oeschger events

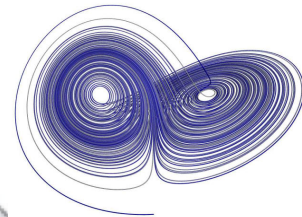
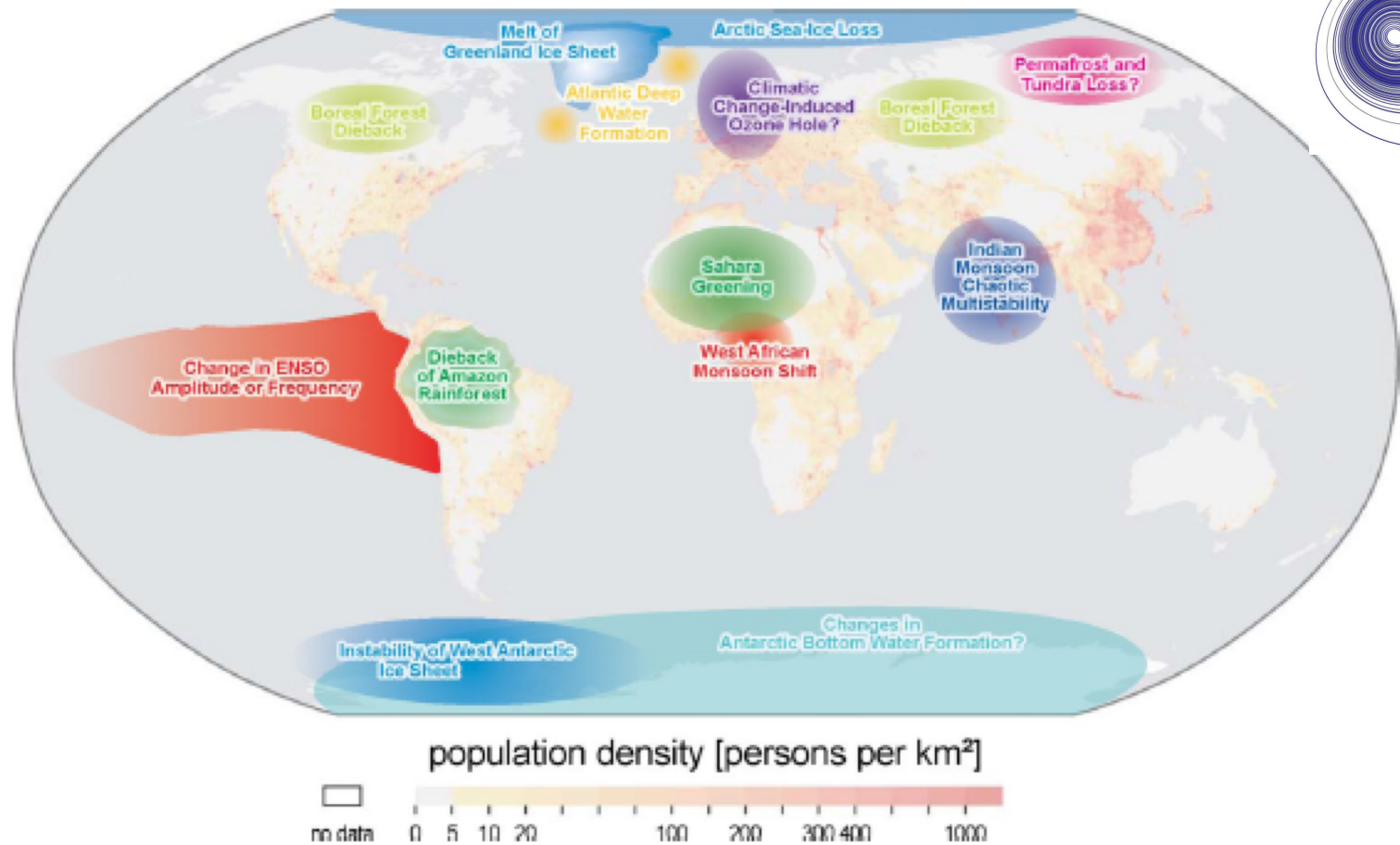


Landais et al. in prep.

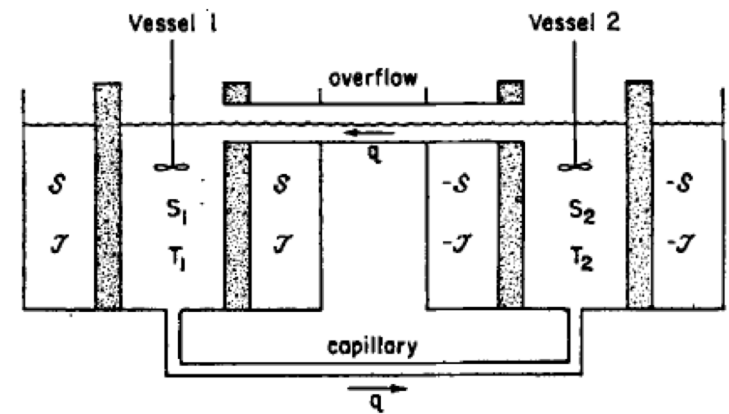
Meridional overturning circulation



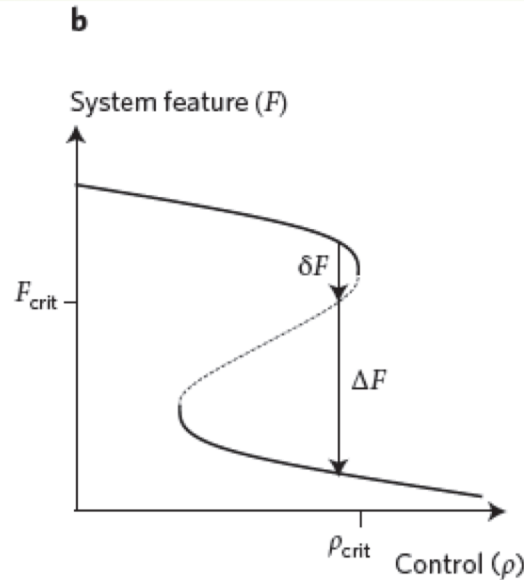
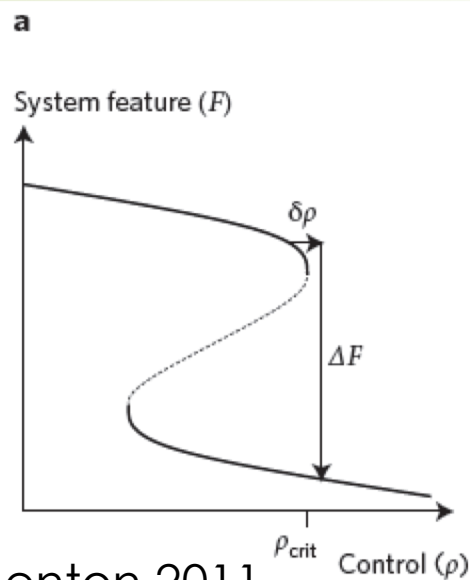
Definition from Lenton et al. (2008): The term “tipping point” commonly refers to a critical threshold at which a tiny perturbation can qualitatively alter the state or development of a system. Here we introduce the term “tipping element” to describe large-scale components of the Earth system that may pass a tipping point.



Tipping points



Stommel (1961)



Lenton 2011

Implications:

- Within an ensemble of simulations, some members can cross the threshold, other not: stochasticity matters
- Potential of early warning from analysis of changes in statistical properties in time windows (variance, AR1 model...)

Far from bifurcation:

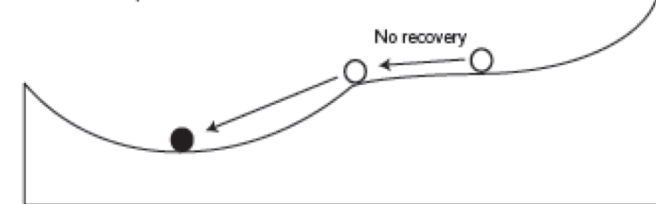


Larger deviations

Approaching bifurcation:



At bifurcation point:

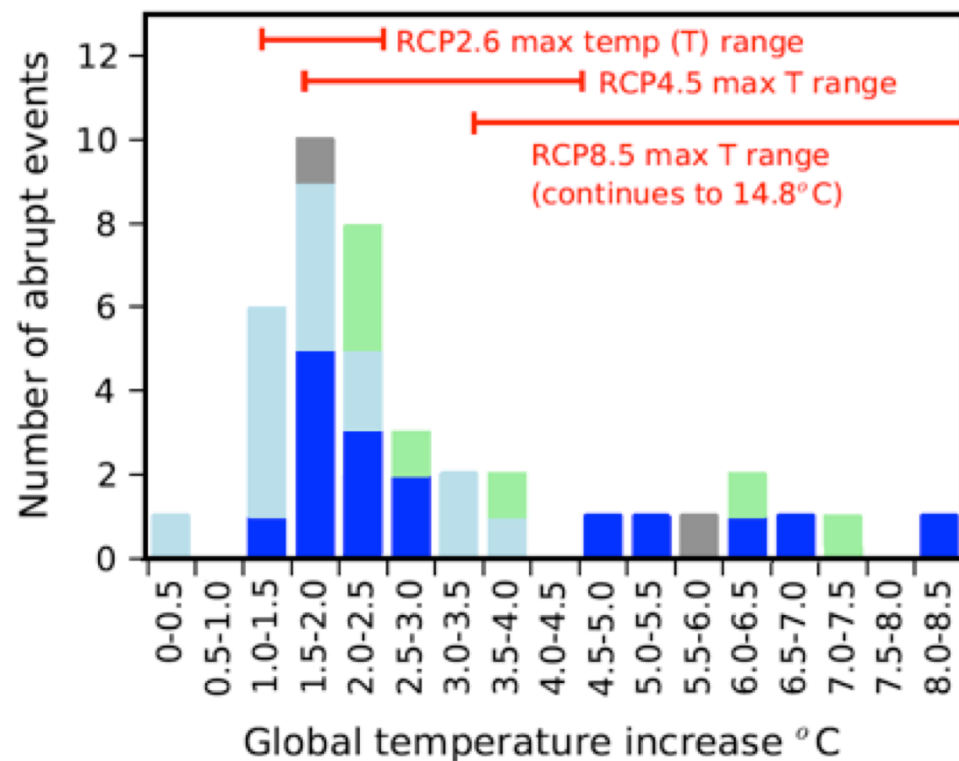


Catalogue of abrupt shifts in Intergovernmental Panel on Climate Change climate models

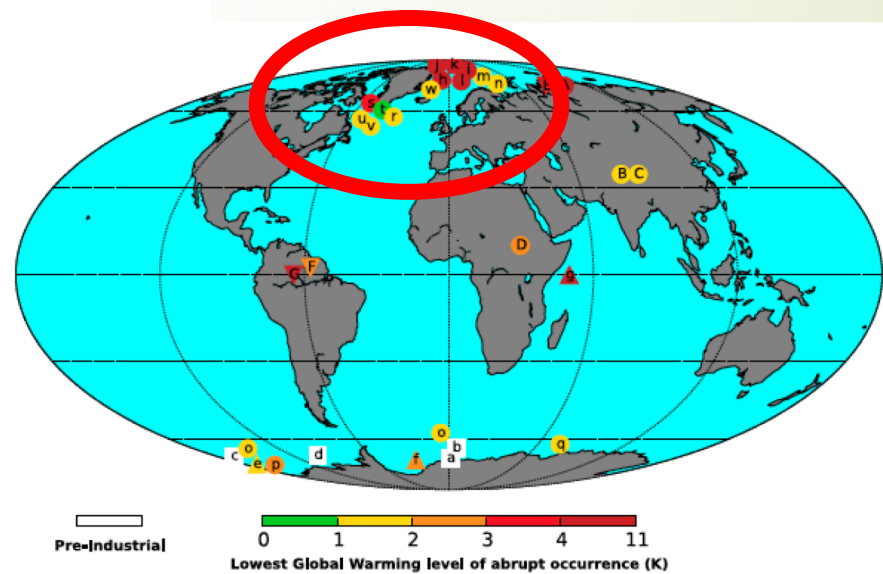
Sybren Drijfhout^{a,b,1}, Sebastian Bathiany^{c,d}, Claudie Beaulieu^b, Victor Brovkin^d, Martin Claussen^{d,e}, Chris Huntingford^f, Marten Scheffer^c, Giovanni Sgubin^g, and Didier Swingedouw^h

Are the models showing abrupt changes in the subpolar gyre trustworthy?

39 abrupt events (in 36% of the realizations)

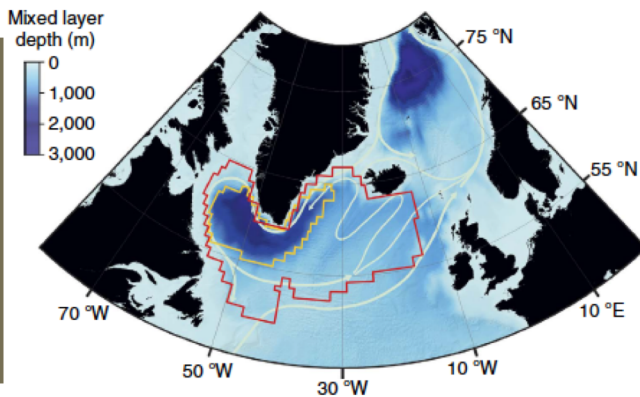


Sea ice
Circulation
Vegetation
Land Ice

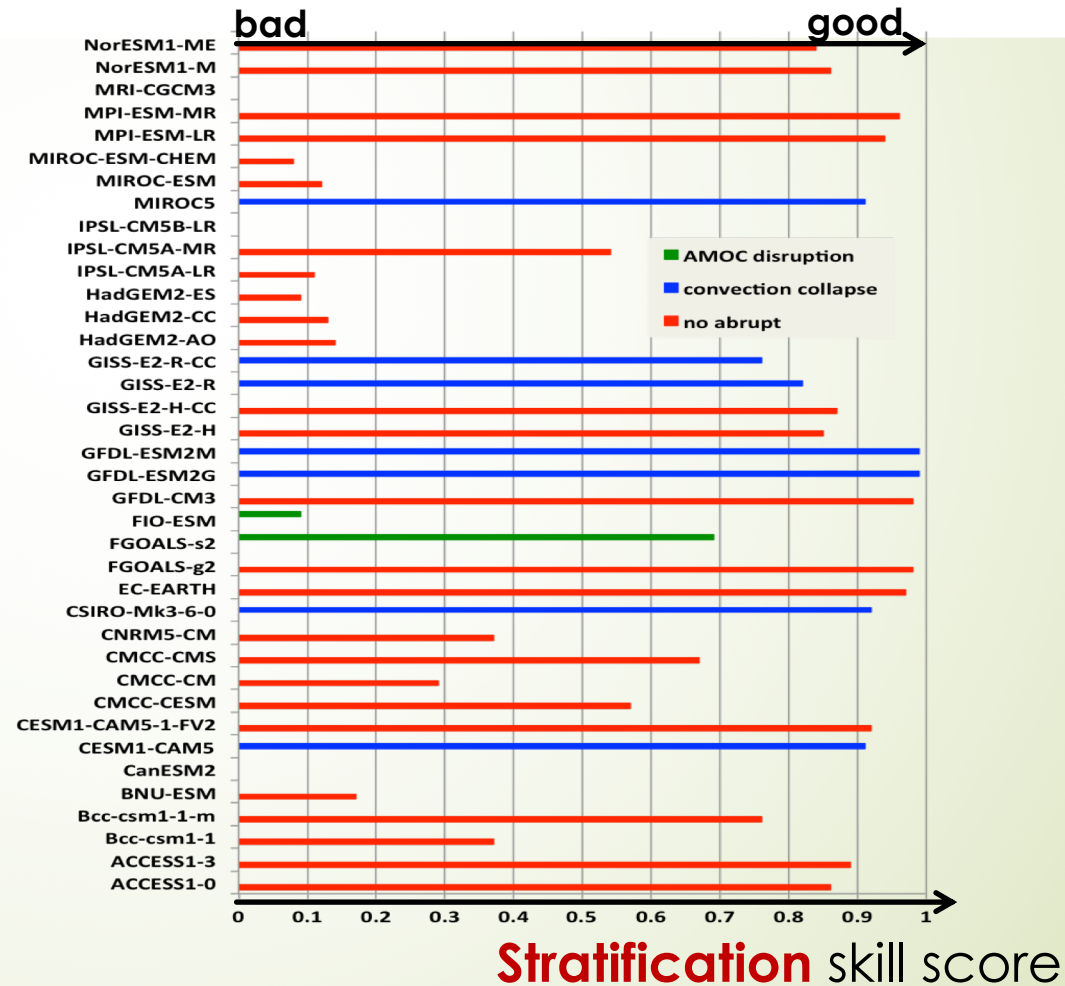
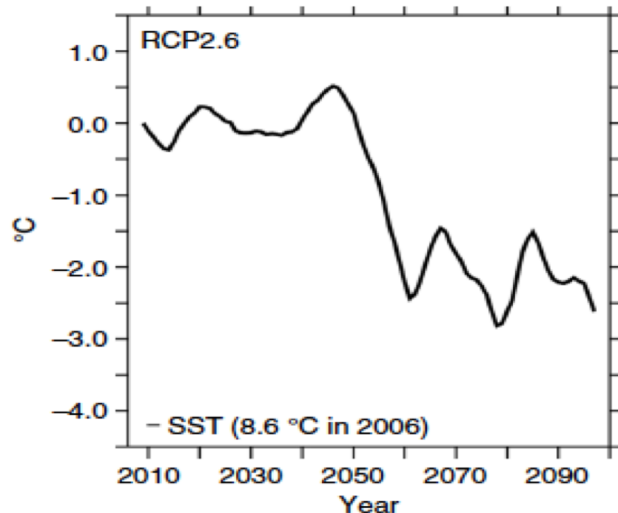


Abrupt cooling over the North Atlantic in modern climate models

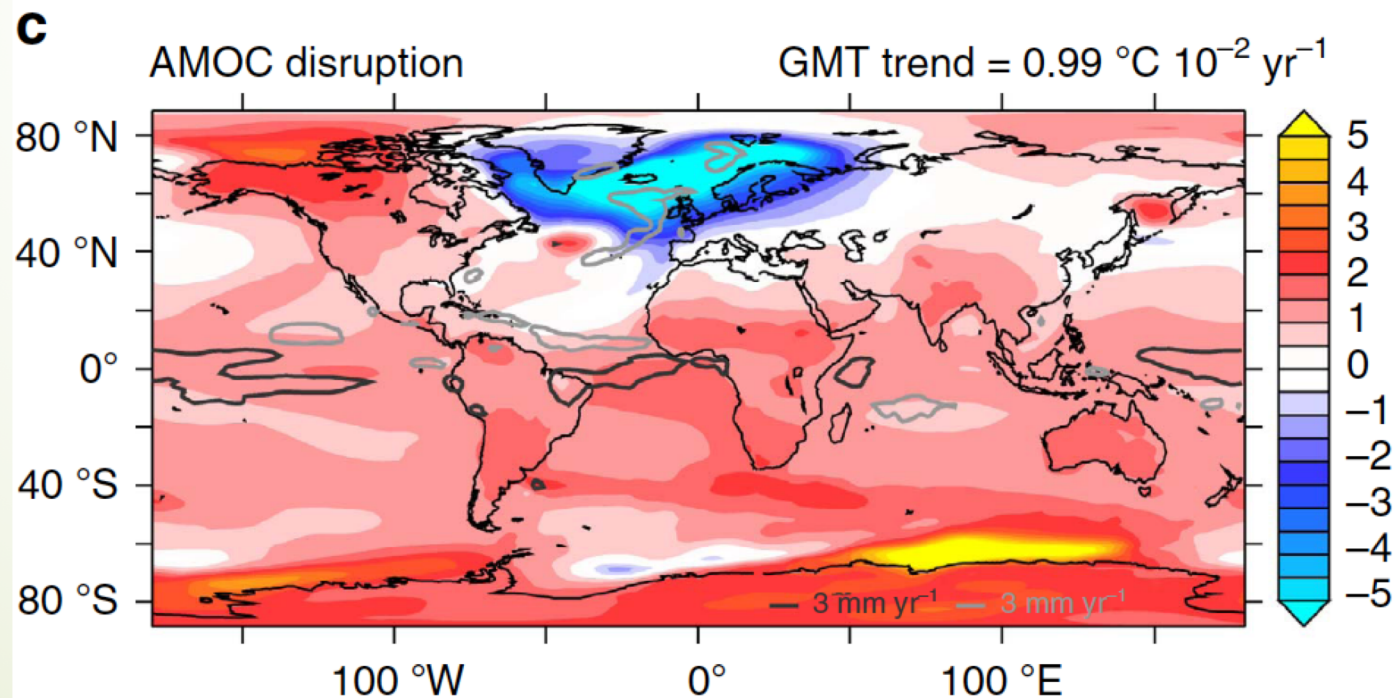
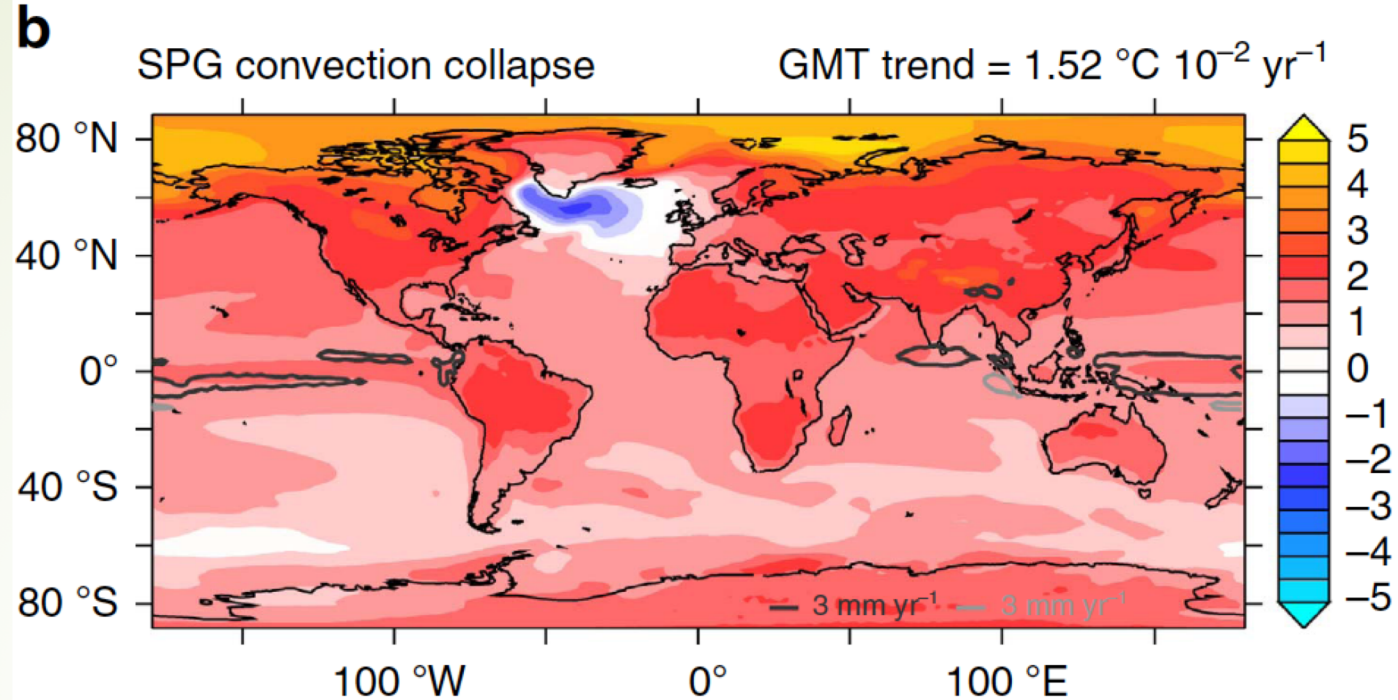
Giovanni Sgubin^{1,2}, Didier Swingedouw², Sybren Drijfhout^{3,4}, Yannick Mary² & Amine Bennabi⁵



GISS-E2-R
SPG convection collapse

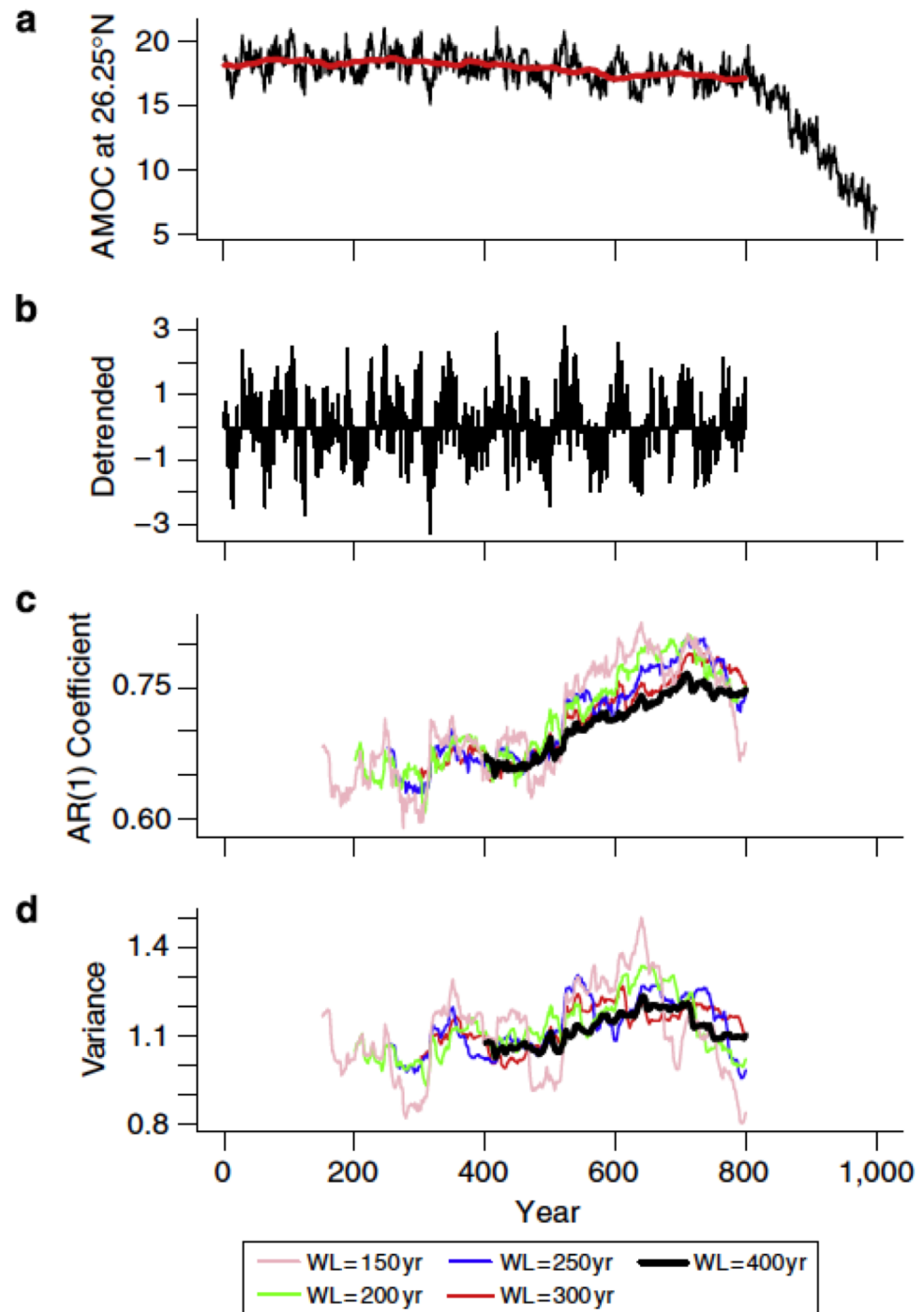


- Potentially large climatic impact
- **When** can it occur?



Early Warning

- Boulton et al. (2014): Early warning up to 250 years in advance if at least 500 years of AMOC monitoring
- Need for long enough reconstruction of AMOC variations
- What can be found with only 15 years of monitoring?



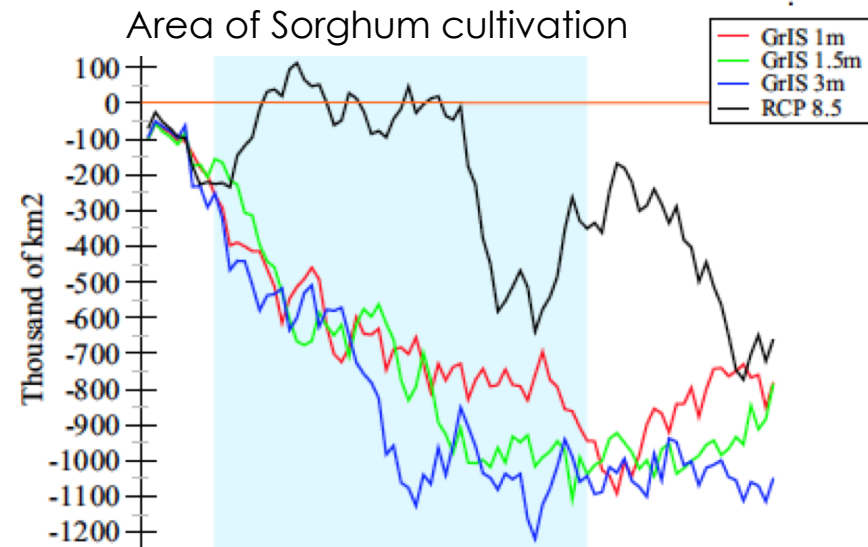
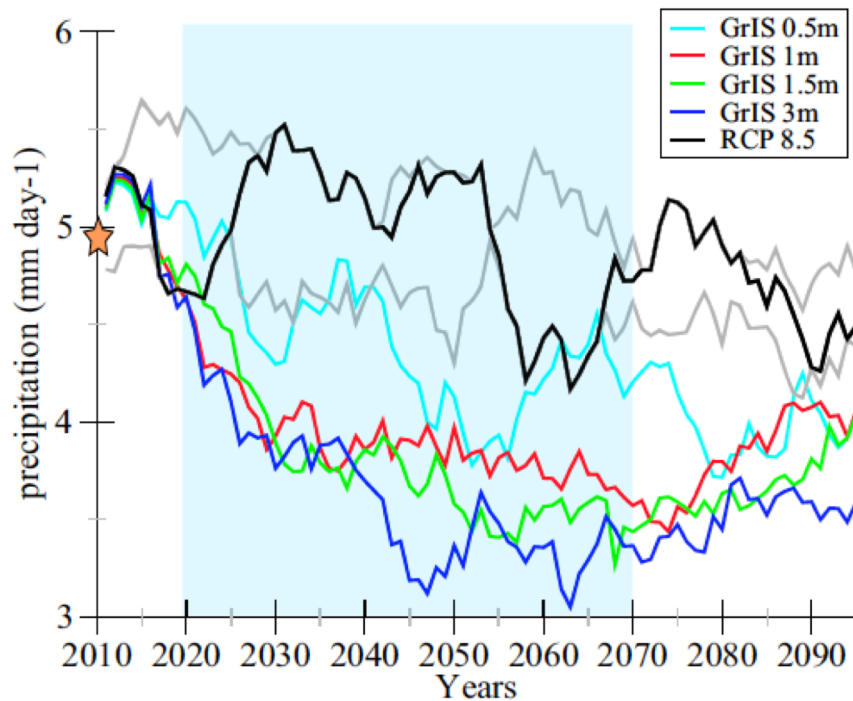
Impact

Consequences of rapid ice sheet melting on the Sahelian population vulnerability

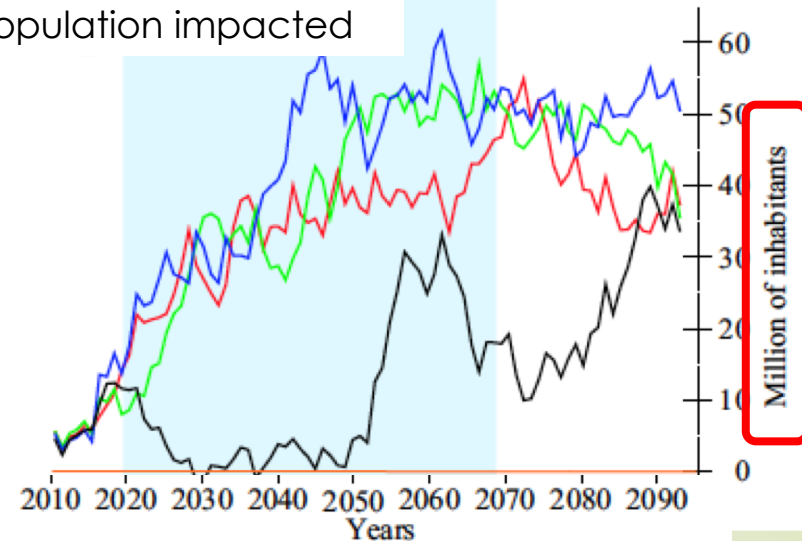
Dimitri Defrance^{a,b,1}, Gilles Ramstein^a, Sylvie Charbit^a, Mat
Didier Swingedouw^d, Christophe Dumas^a, François Gemeni

Adding GrIS freshwater in
the North Atlantic...

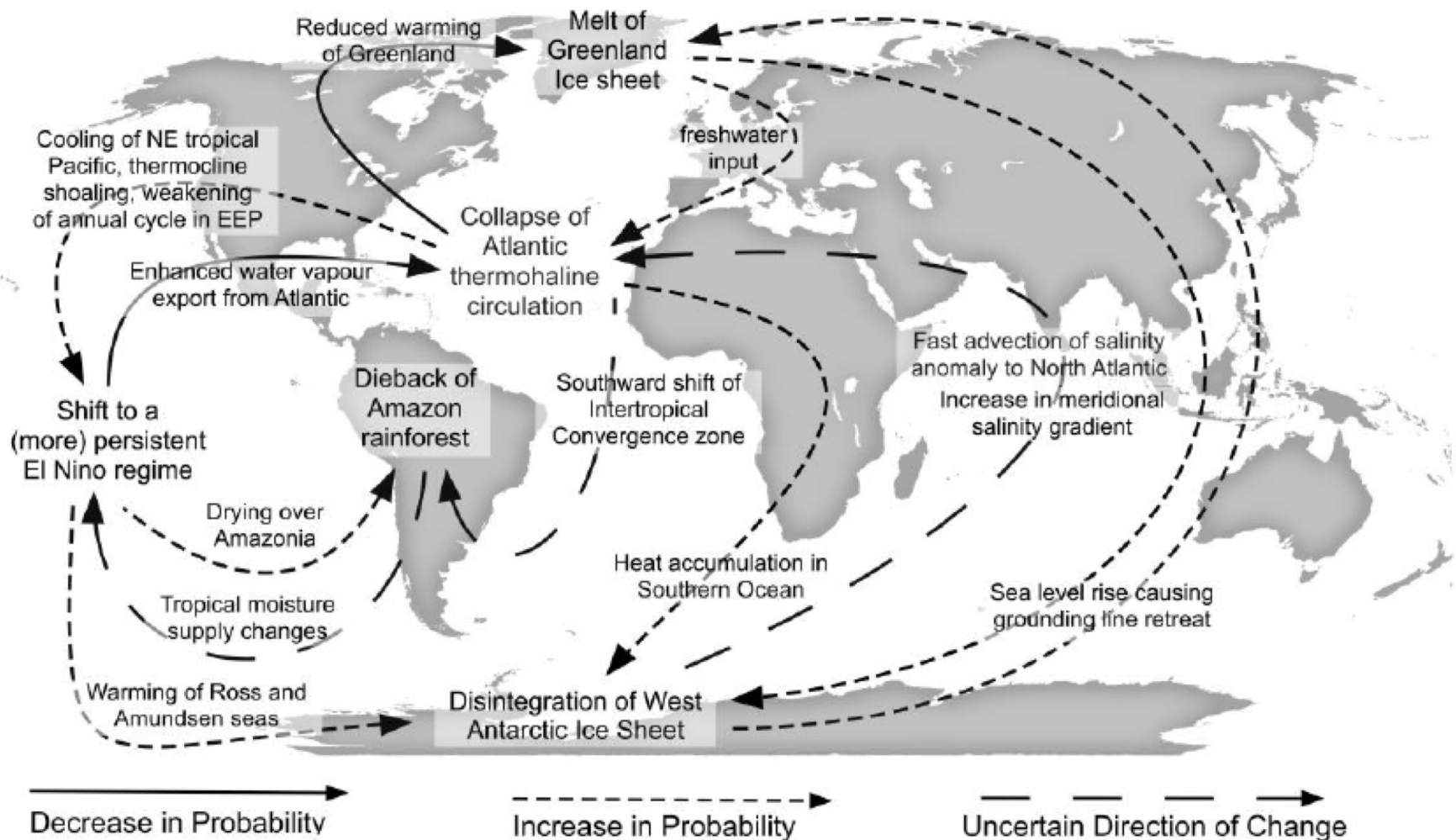
Precipitation changes in Sahel region



Population impacted



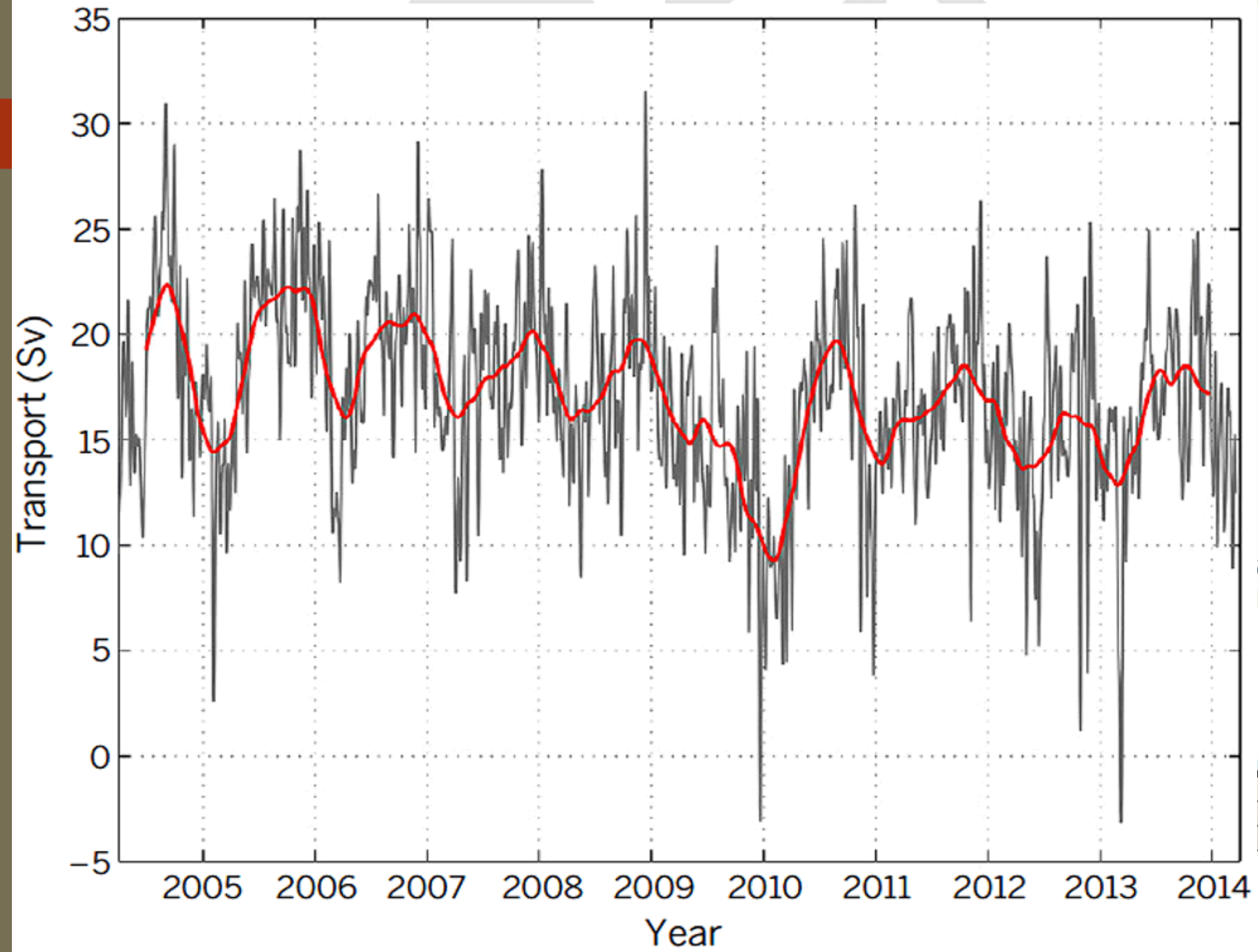
Interactions between tipping elements (Cai et al. NCC 2017)



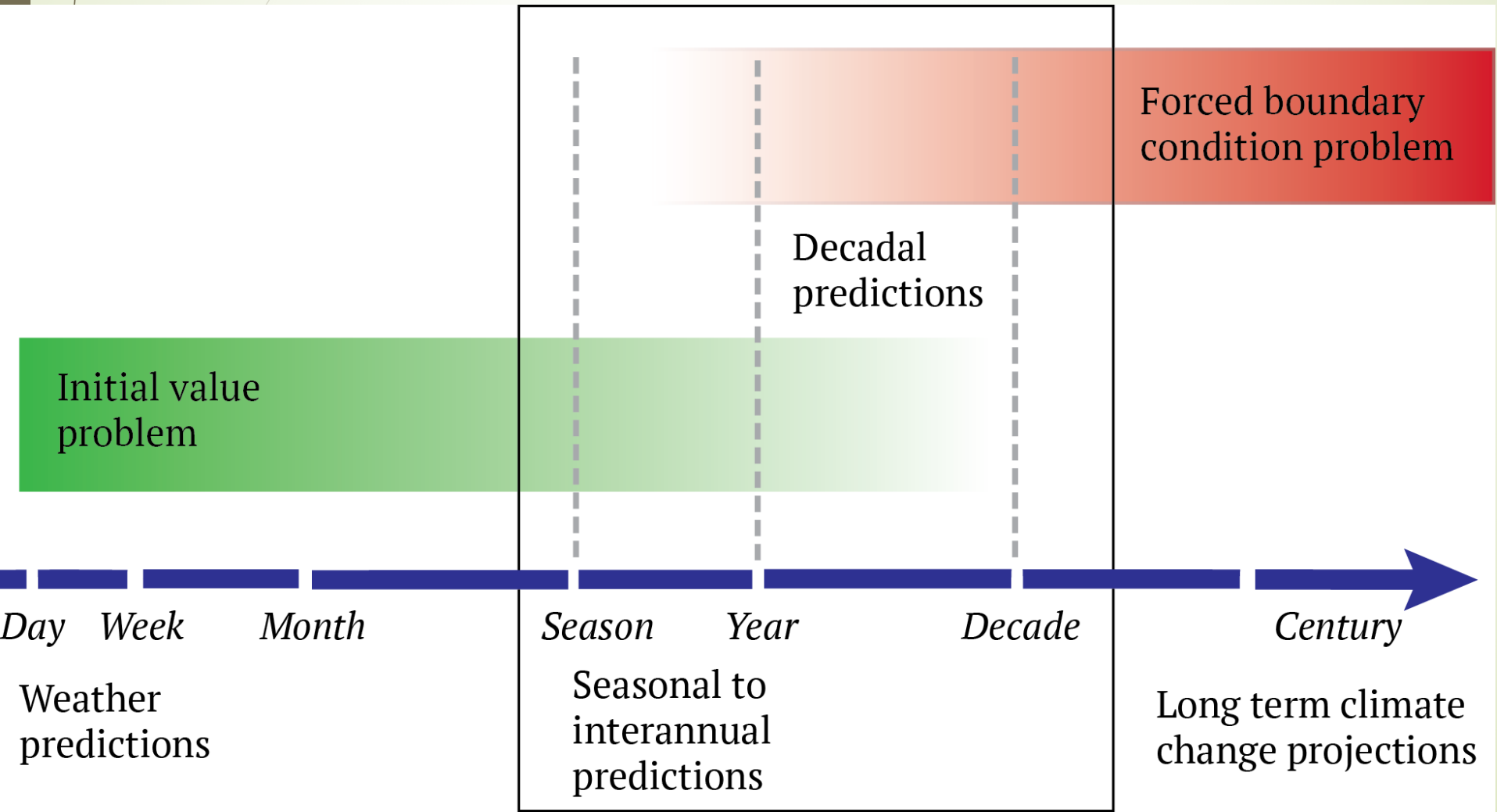


How to improve response from society

- Early warning system based on observations
- Decadal prediction systems
- Adaptation strategy: almost no literature!
- A European project to try to answer this with the red cross as a partner. Already submitted, but anyone interested in participating is welcome

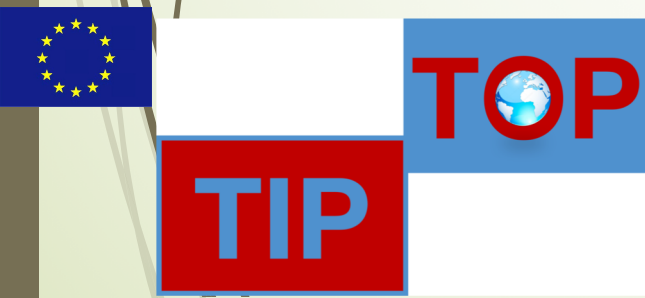
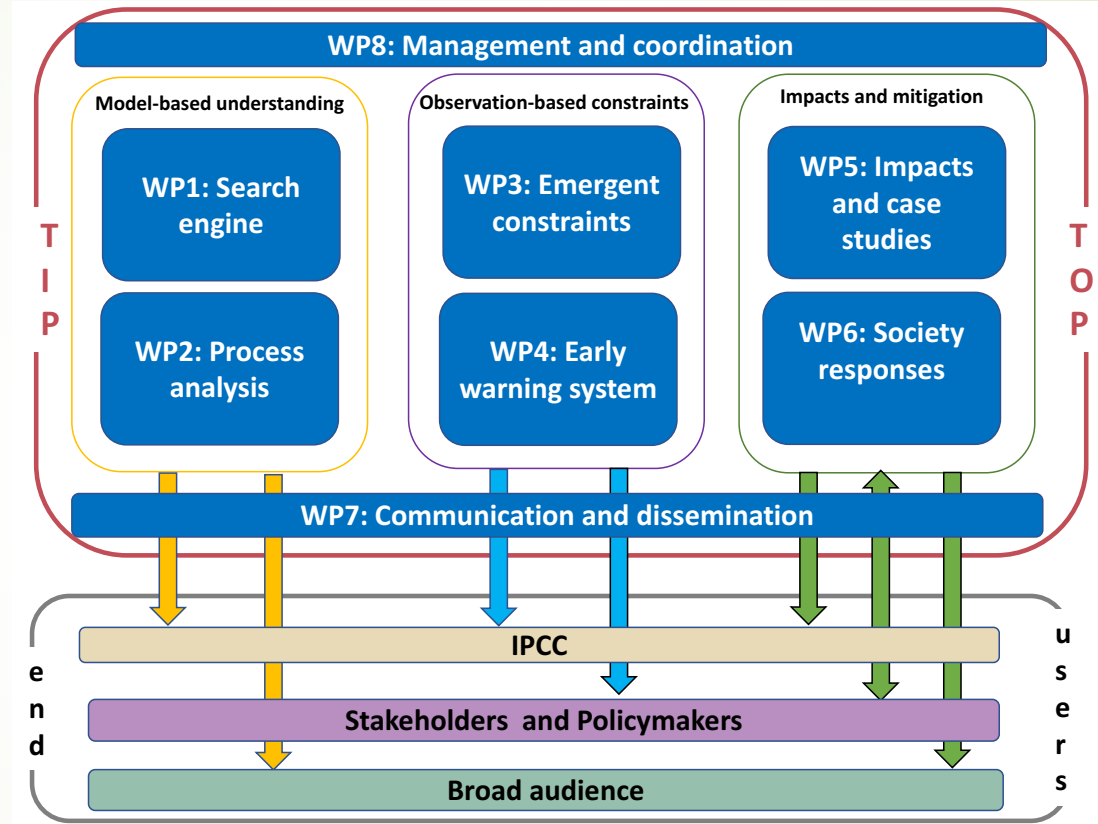


Decadal climate predictions




Anticipate and adapt to potential abrupt changes

- ❖ A European project (26 partners) named TipTop submitted to try to improve prediction resilience capacity of society to abrupt climate changes
- ❖ Link with Deltares (The Netherlands) and International Red Cross to prepare such an adaptation strategy.





Conclusions

- Potential for rapid changes in the climate system notably in the North Atlantic
 - Associated impact still poorly accounted for
 - No clear adaptation strategy identified yet
 - Sahelian region as the most vulnerable to changes in ocean circulation
- 



ENVIRONMENT
AGENCY

ENVIRONMENTAL PROTECTION ACT 1990

NO TIPPING

MAXIMUM FINE £20,000

If you see any tipping
here ring

0645 333111

to report the incident.

Thanks to the Environmental Protection Act - tipping is illegal in the UK