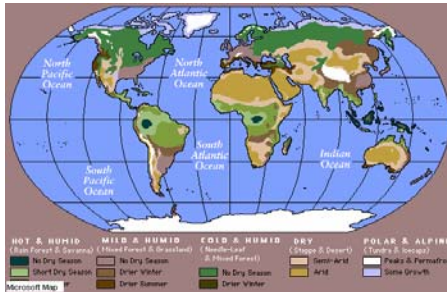


# 1 Global warming will make Europe cold and dry, abruptly, according to the National Research Council\*.

Why this opposite effect? To understand this, we need to look at

- the distribution of water on Earth, and water's latent heat, to see how global warming is likely to affect the northern and southern hemispheres differently, and
- the ocean currents that keep Europe unusually warm for its location.



Europe currently has an unusually warmer and wetter climate for its high-latitude location.

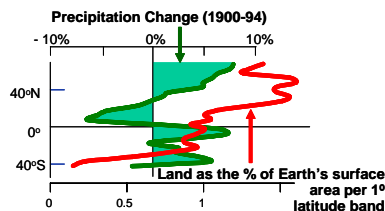
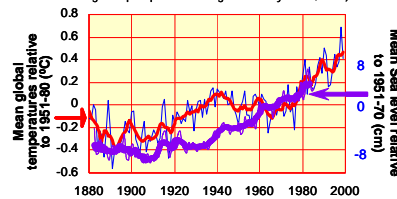
\* SCIENCE & POLICY IMPLICATIONS OF ABRUPT CLIMATE CHANGE: National Research Council (National Academy Press, Washington DC: April 2002)

# 3 The 20th century Data reflect this, with

- correlated rises, since 1900, of 0.6°C in mean global temperatures and ~10 cm in the mean sea level worldwide; and
- increased precipitation at higher latitudes, in the Northern hemisphere, and relative aridity at the lower latitudes, compared to
- greater precipitation throughout the Southern hemisphere, but for ~20°S.

Oceans modulate the climate, irrespective of whether global warming is anthropogenic or not.

Sources: (a) For temperature data: <http://www.giss.nasa.gov/data/update/gistemp/graphs>  
 (b) For sea level data: T.P. Barnett, in CLIMATE CHANGE (IPCC Working Group Report: Cambridge University Press, 1990)



Recomputed from the data in Thomas Karl, Neville Nicholls & Jonathan Gregory: The Coming Climate, Scientific American, May 1997

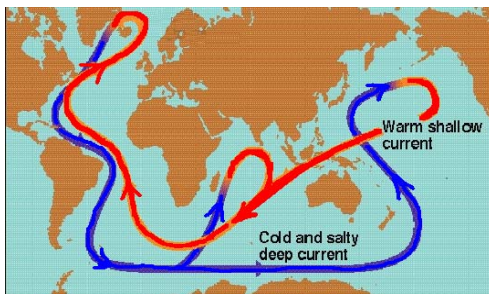
# 5 Two kinds of currents transfer this heat across the oceans:

- wind-driven surface currents like the Gulf Stream that carry warm tropical waters to the higher latitudes, and
- the Global Conveyor Belt<sup>1</sup> of thermohaline circulation that mixes all the surface and deep waters and is particularly sensitive to changes in the hydrological cycle<sup>2</sup>.



<sup>1</sup> W.S. Broecker: 'The great ocean conveyor', Oceanography, 4: 79-89 (1991) and 'Chaotic Climate', Scientific American, Nov 1995.

<sup>2</sup> S. Rahmstorf: Bifurcation of the Atlantic thermohaline circulation in response to changes in the hydrological cycle. Nature, 378: 145-149 (1995).



2 Earth has a hemispherically asymmetric distribution of land and water.

	N. Hemisphere	S. Hemisphere
Oceans	587.6 billion Km <sup>3</sup>	782.4 billion Km <sup>3</sup>
Icecaps, Sea-ice & glaciers	2.8 billion Km <sup>3</sup>	30.1 billion Km <sup>3</sup>
	1 Km <sup>3</sup> = 262.4 billion gallons	

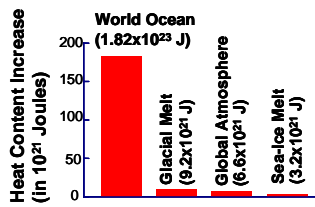
- Northern hemisphere is 60.7% sea and 39.3% land, while the Southern hemisphere is 80.9% sea and 19.1% land; and
- ice accounts for a smaller proportion of water in the Northern hemisphere (0.47%) than in the Southern hemisphere (3.7%).

- water's latent heat of fusion is 80 cal/gm, and its latent heat of evaporation is 585 cal/gm, i.e., the heat needed to evaporate a gram is water is enough to melt 7 times as much ice.

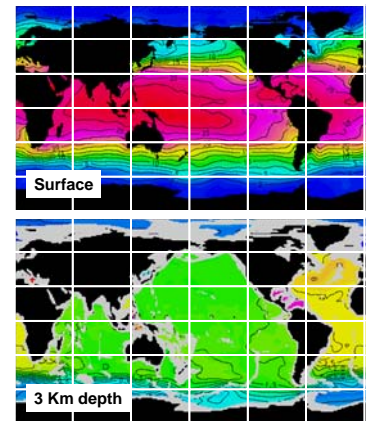
Therefore, global warming should affect the Northern and Southern hemispheres in significantly different ways.

- A recent analysis of Earth's heat balance\* goes a step further, by quantitatively demonstrating that, during the latter half of the 20th century, changes in the ocean heat content have dominated the changes in Earth's heat balance.

- Much of this heat appears to have gone particularly into the warming of Atlantic waters.



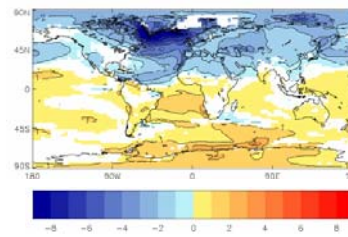
\* S. Levitus, J.I. Antonov, J. Wang, T.L. Delworth, K.W. Dixon & A.J. Broccoli: Anthropogenic warming of Earth's climatic system. Science, 292: 267-270 (2001).



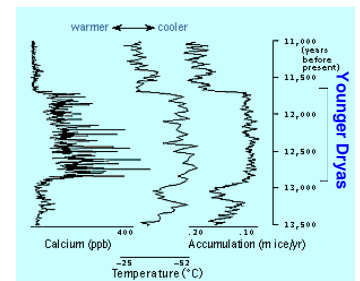
[http://www.nodc.noaa.gov/OCS/WOA98F/woaf\\_cd/search.html](http://www.nodc.noaa.gov/OCS/WOA98F/woaf_cd/search.html)

# The resulting change is likely to be abrupt\*,

- based on the evidence from Greenland and Antarctic ice cores, that the warming that began in the Younger Dryas started with the present Conveyor Belt and was accomplished rapidly; which
- raises the alarming possibility that Europe may suddenly revert to its Mini Ice Age (c. 1300-1900) in a matter of decades.



Temperature change expected by 2,050 AD should the present warming trend continue  
 Source: <http://www.giss.nasa.gov/data/update/gistemp>



Data Sources: Alley et al., Nature, 362: 527-529 (1993); Grootes et al., Nature, 336: 552-554 (1993); Blunier et al., Nature, 394: 739-743 (1998).

\* P.U. Clark, N.G. Pisias, T.F. Stocker & A.J. Weaver: The role of the thermohaline circulation in abrupt climate change. Nature, 415: 863-869 (2002).