



HR Wallingford
Working with water

Climate change issues for the navigation sector: an overview

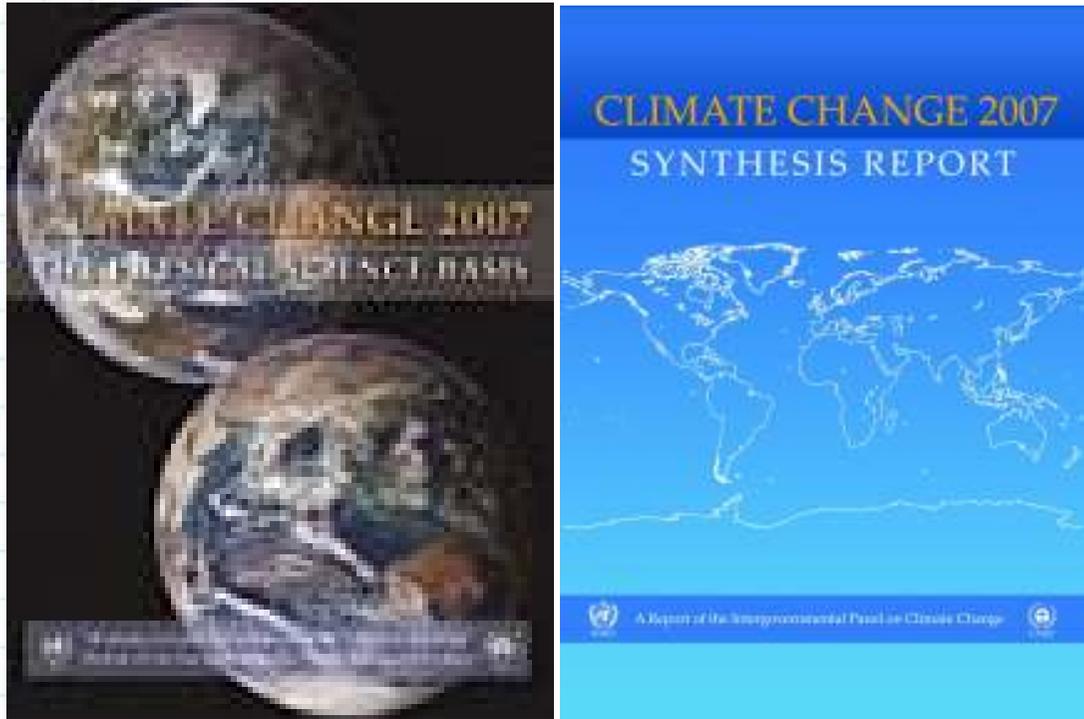
Peter Hawkes, HR Wallingford

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PIANC UK Meeting 21 October 2011

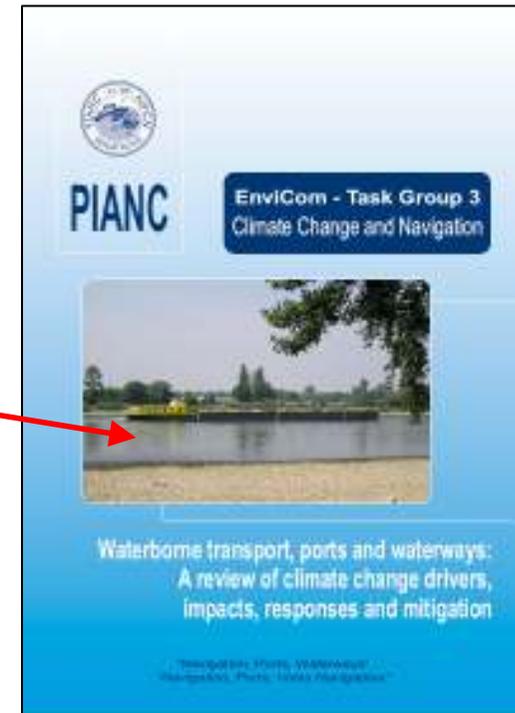
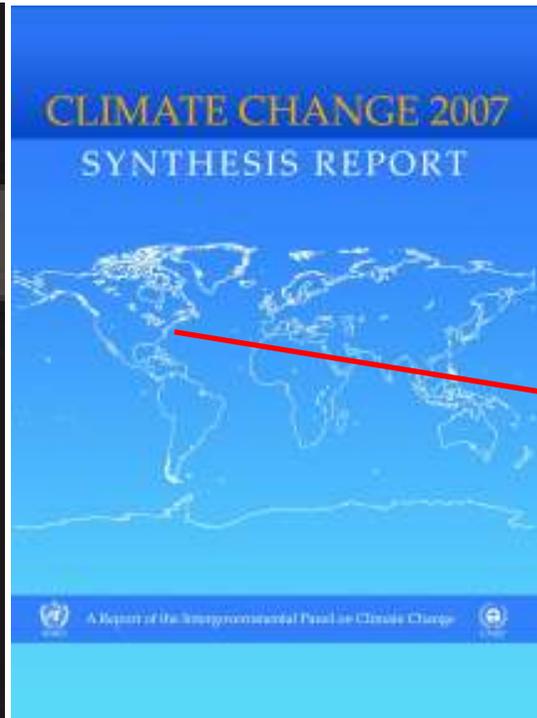


Information sources: starting at the top level



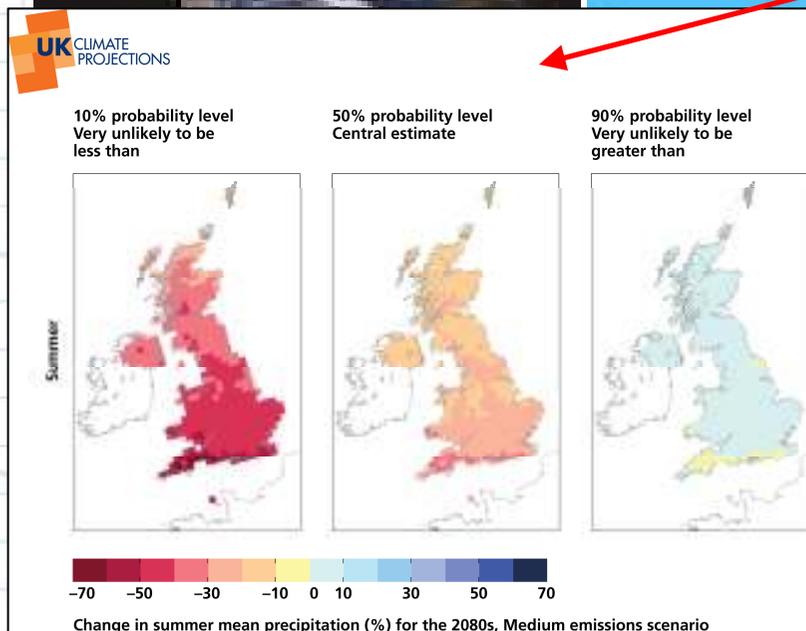
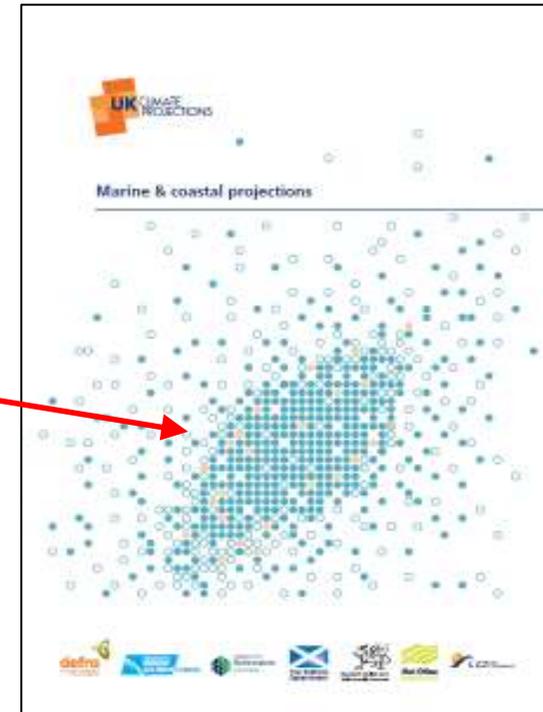
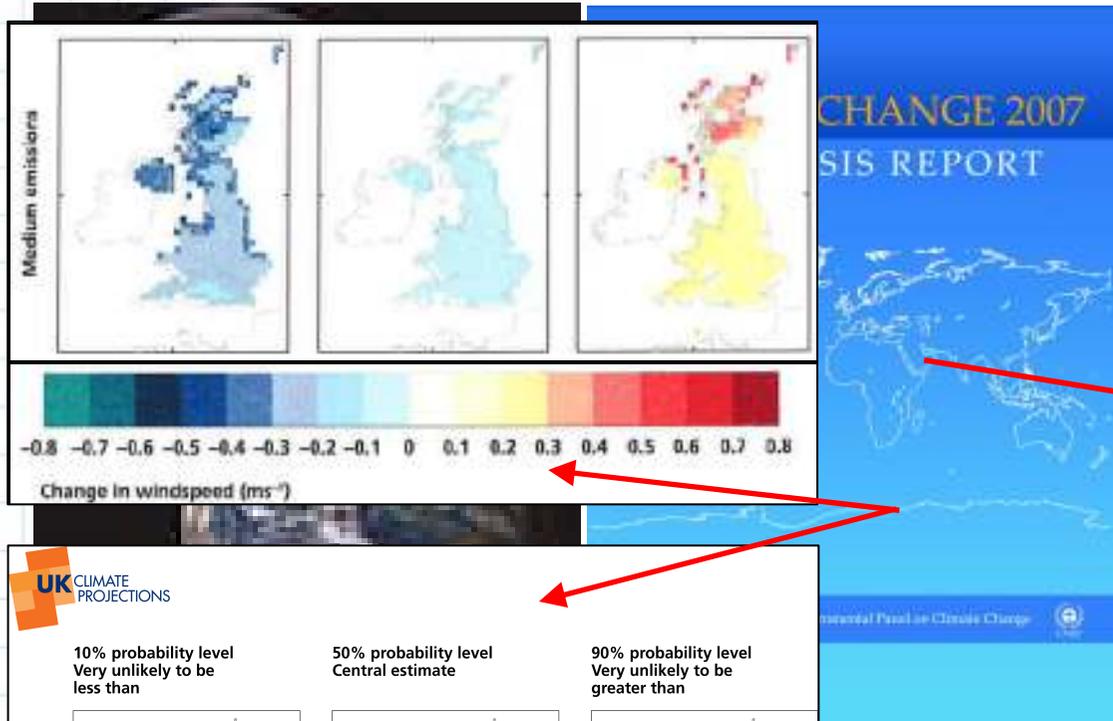
Sample reports from the Intergovernmental Panel on Climate Change, 2007: taken as the authority on past and future climate change (images from [IPCC](#) website)

Information sources: PIANC sector interest



PIANC Task Group 3 2008 report: how navigation may be affected by climate change: activities, adaptation, mitigation, opportunities (image from **PIANC** website)

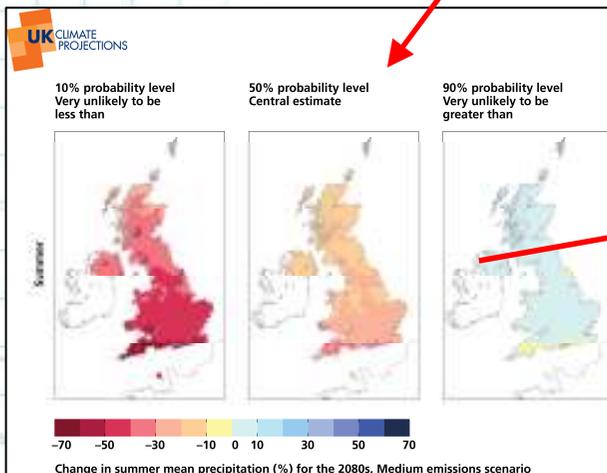
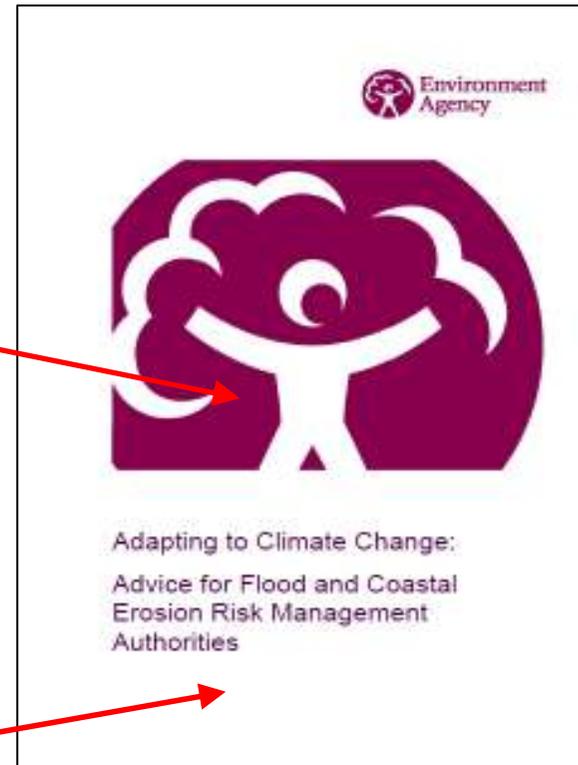
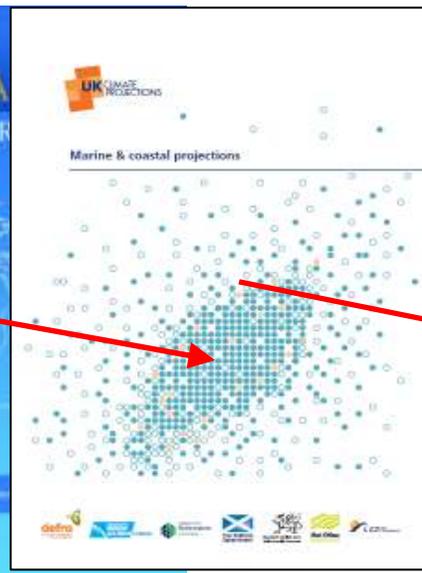
Information sources: UK country interest



Winter wind and Summer rainfall changes by 2080s (images from UKCIP website)

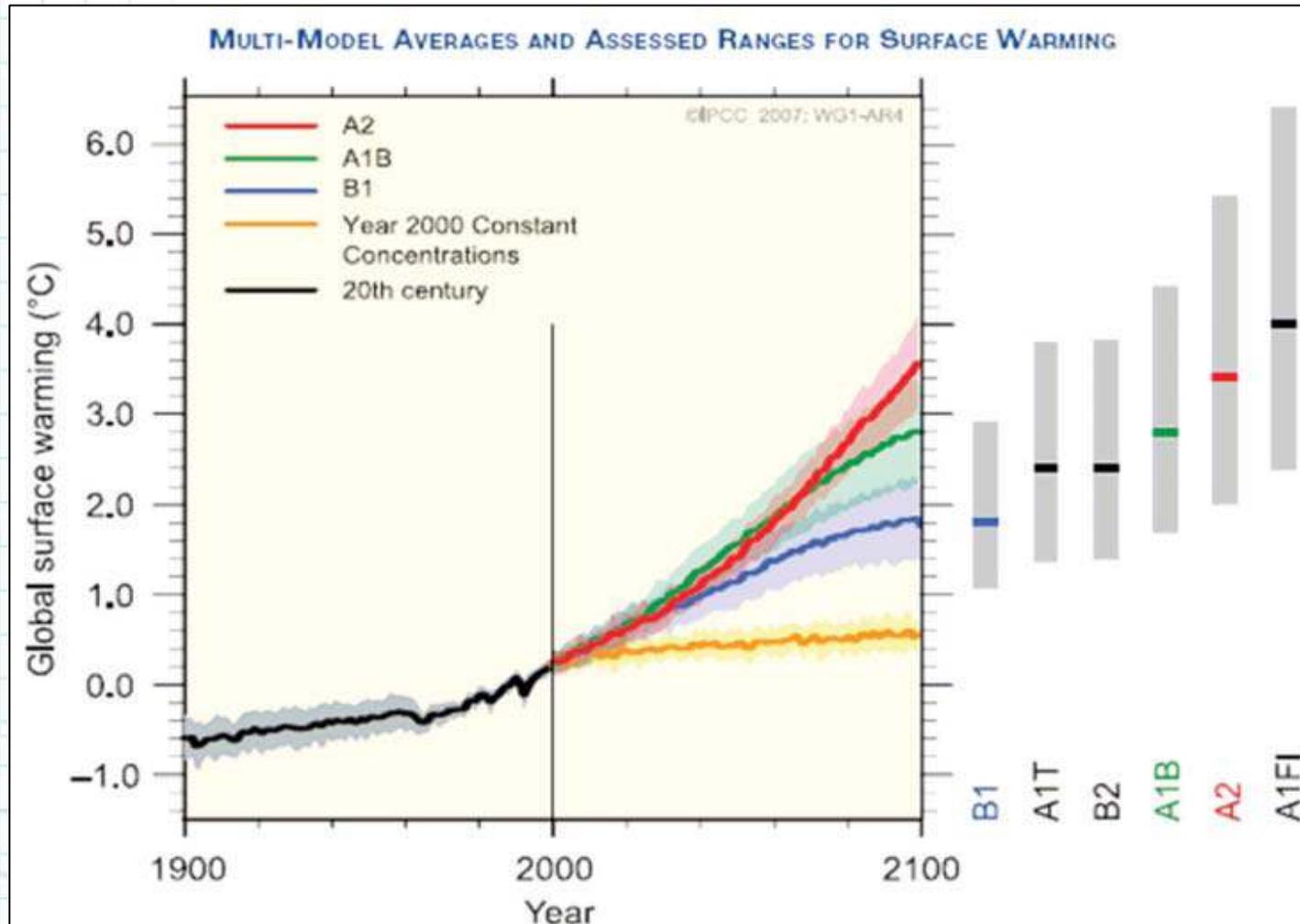
United Kingdom Climate Impacts Programme: UKP09 Marine and coastal projections 2009 report: changes in temperature, sea level, waves, storms (image from UKCIP website)

Information sources: UK flood risk interest



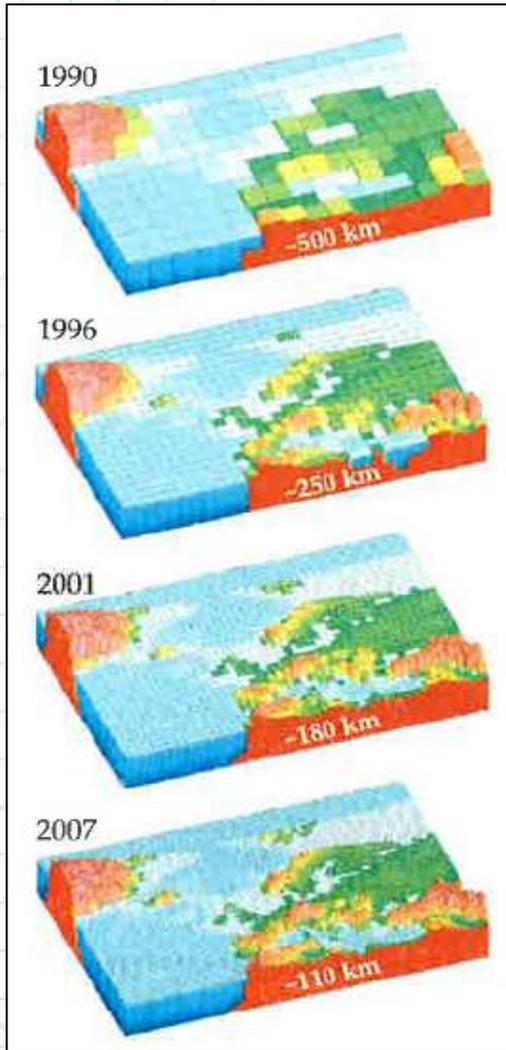
Environment Agency 2011 guidance report: changes in sea level, waves, storms, river flow, rainfall for use in flood risk assessments (image from [Environment Agency website](#))

Global average temperature



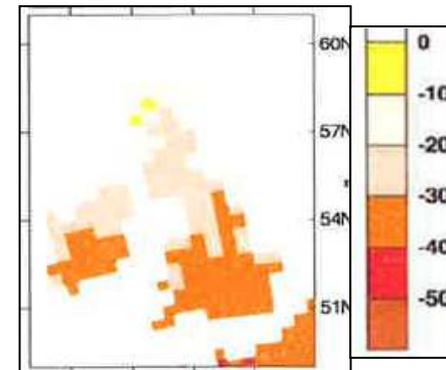
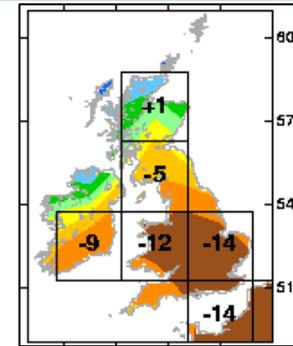
Historical and projected global average temperatures, 1900 to 2100 (image from IPCC, 2007)

Improving spatial resolution of climate models



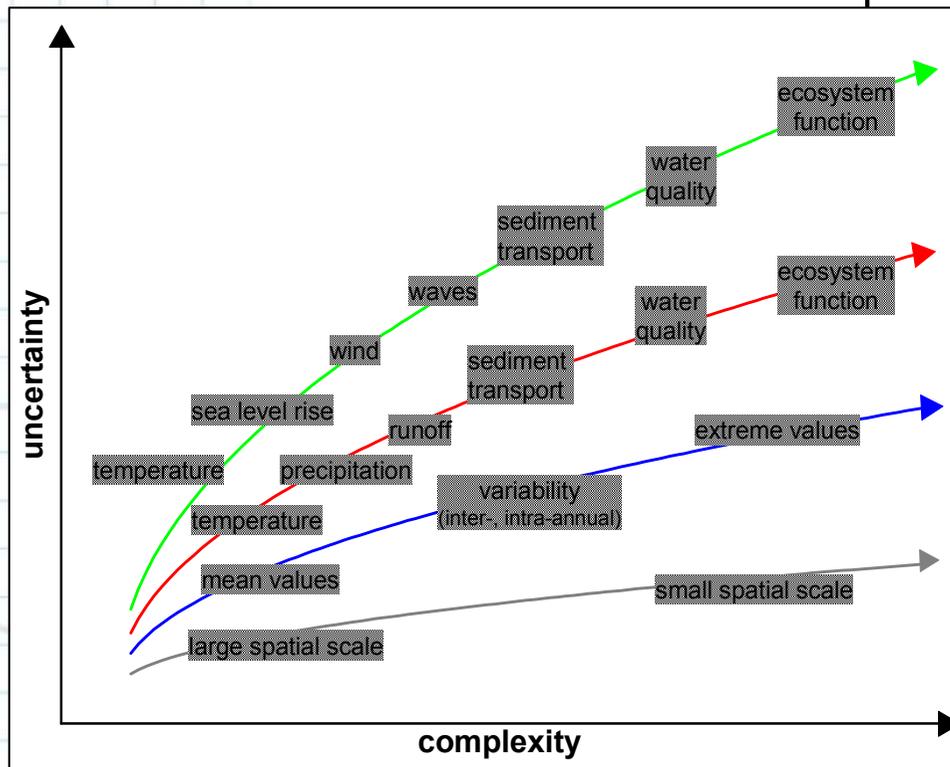
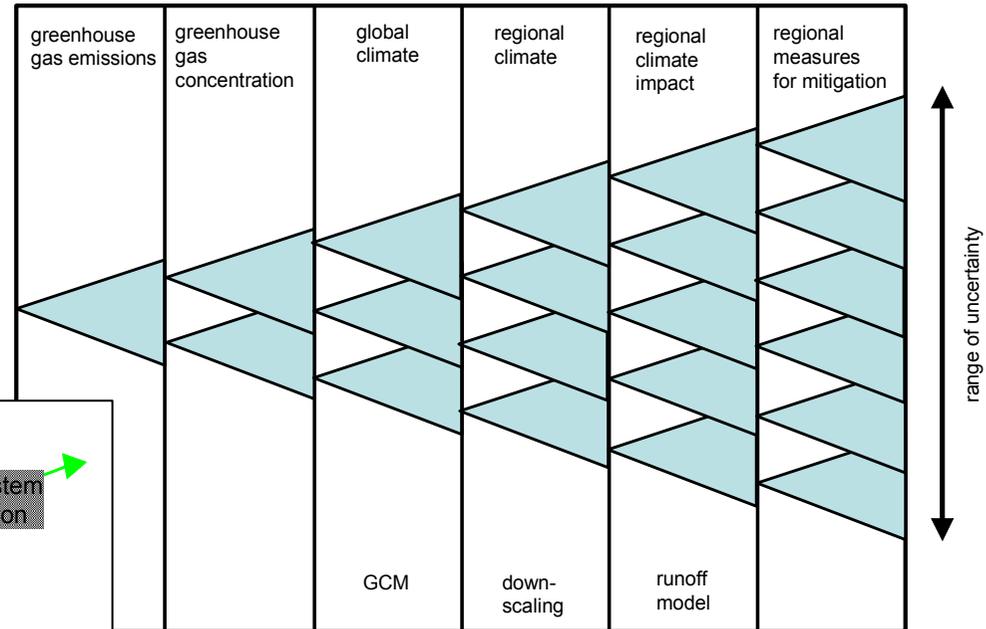
Spatial resolution used in the four main IPCC assessments (image from Somerville and Hassol, Physics Today, 2011)

Example Summer rainfall plots from UKCIP98, UKCIP02 and UKP09: changes from 1960-1990 to 2080s (partial images from UKCIP)



Spread of uncertainty from source to effects

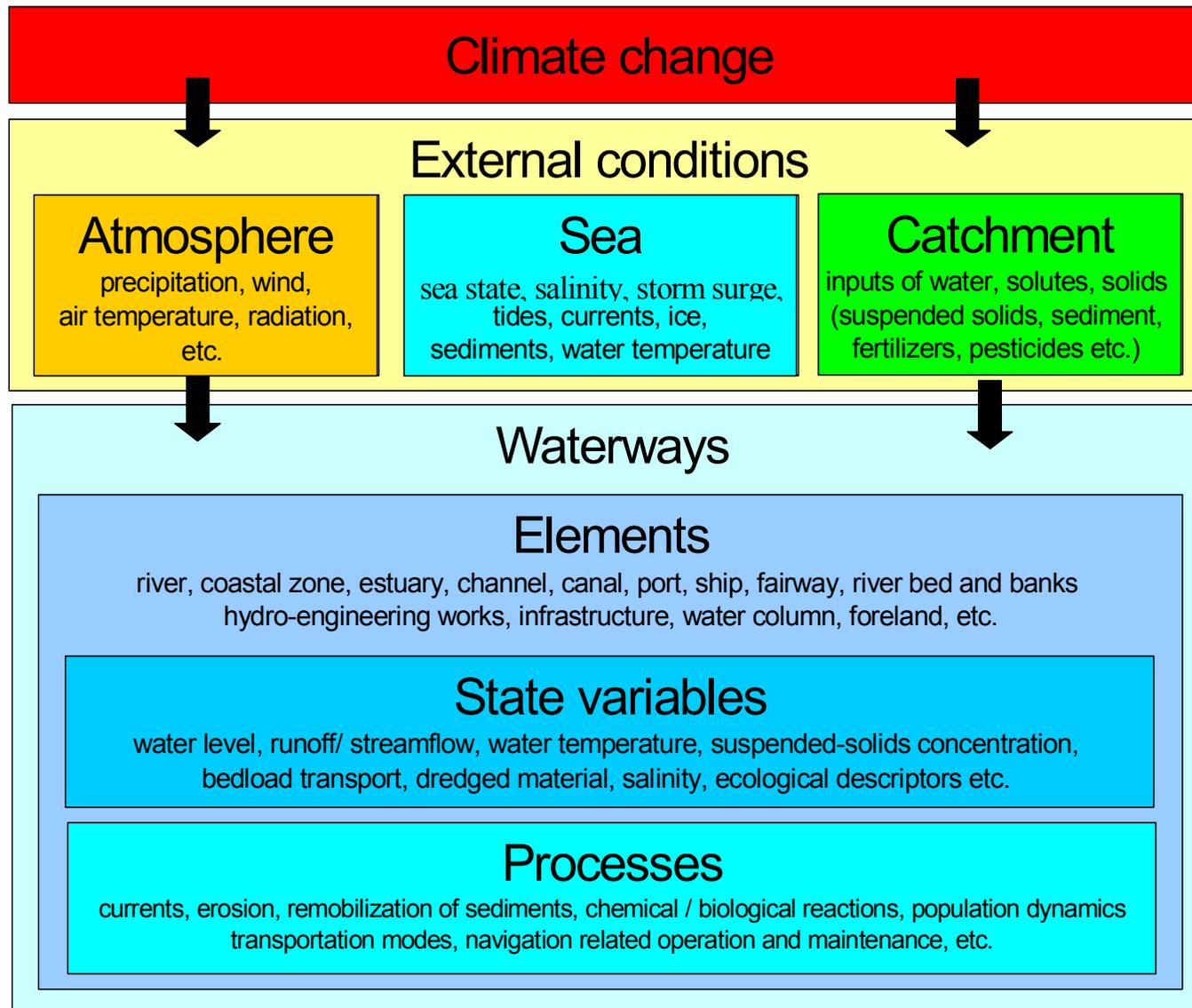
(images from PIANC, 2008)



large scale >> small scale
drivers >> impacts >> actions

maritime
inland
probability scale
spatial scale

Climate change impacts on waterways



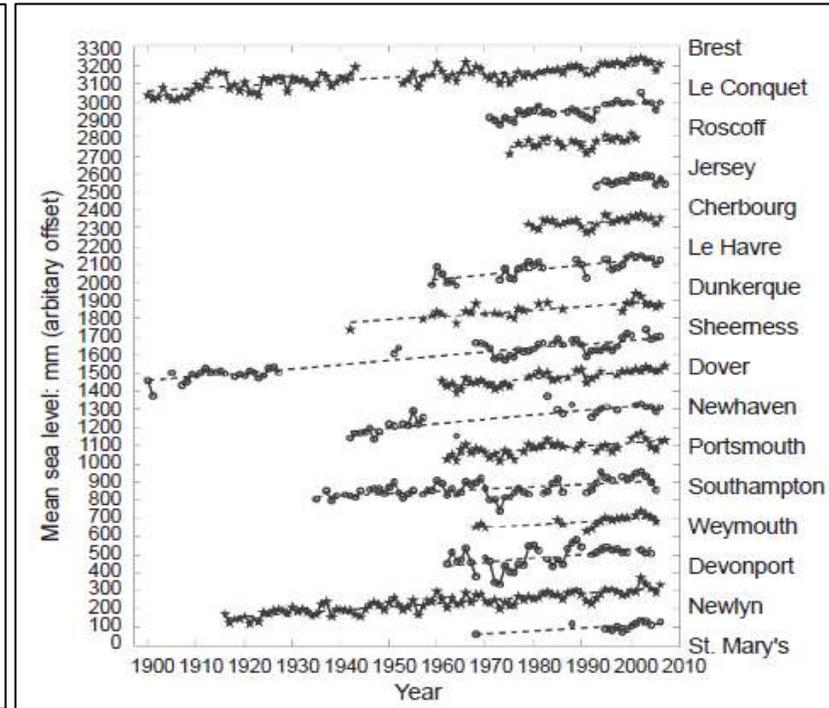
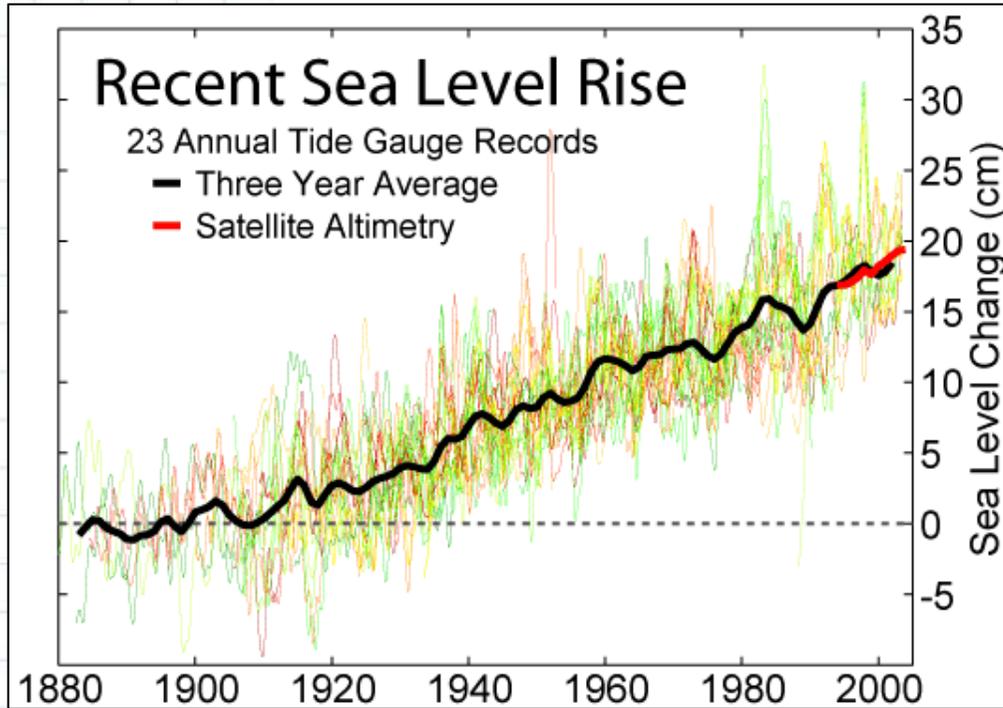
(image from PIANC, 2008)

drivers



impacts

Sea level rise: The last 100 years or so



Global average mean sea level 1880-2007

Black line from 23 tide gauges ~1.5-2.0mm/year

Red line from satellite data ~2.0-2.5mm/year

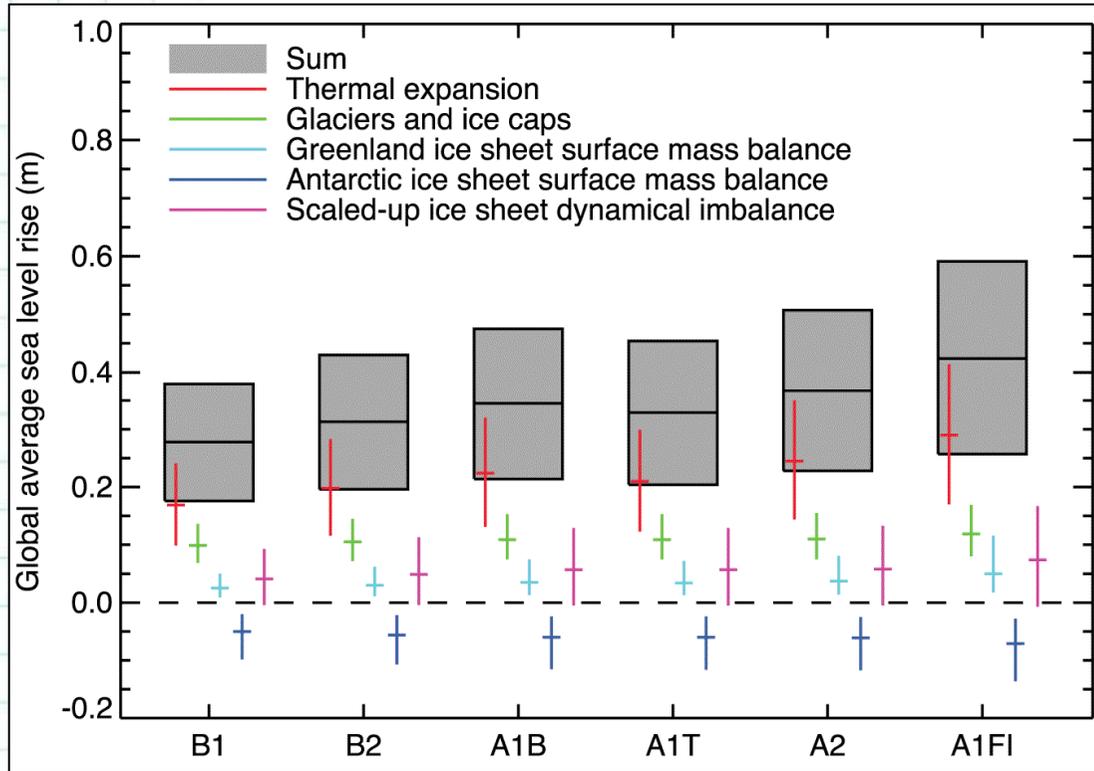
(image from wikipedia)

Mean sea level from English Channel tide gauges 1900-2008

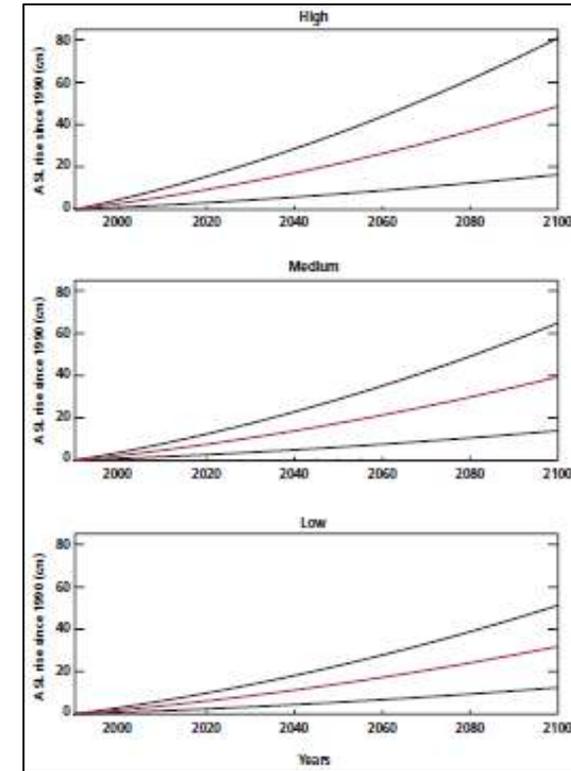
Average rates of rise 1.2-2.4mm/year

(image from Haigh et al, ICE Proceedings, 2011)

Sea level rise: Projections to 2100

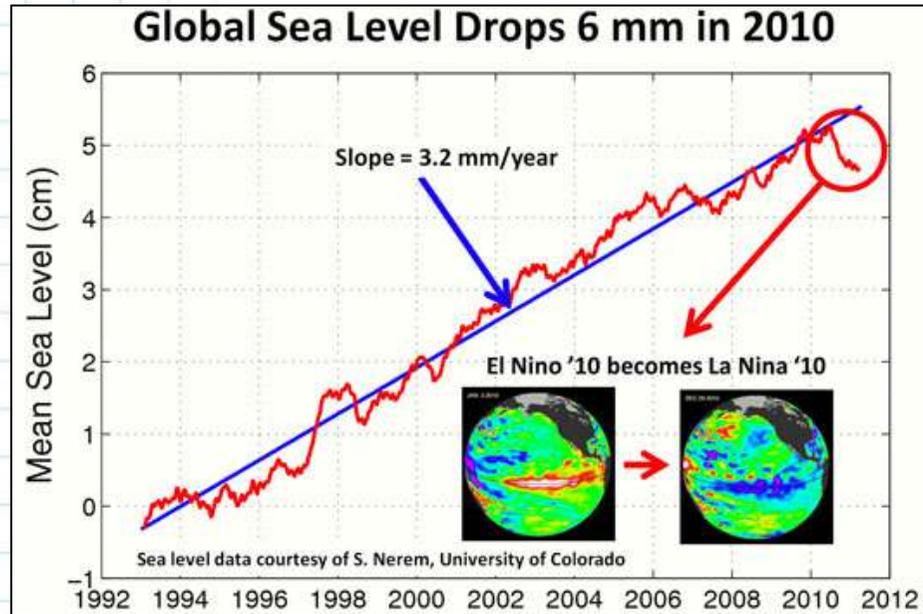


5, 50 and 95 percentiles of five components (and total) of globally averaged sea level rise during the 21st century (image from IPCC, 2007)



5, 50 and 95 percentiles for low, medium and high scenarios (image from UKCIP, 2009)

Sea level rise: Uncertain how much to 2100



Or, with a higher, but plausible additional allowance for ice melt, from 1960-1990 to 2100, for example:

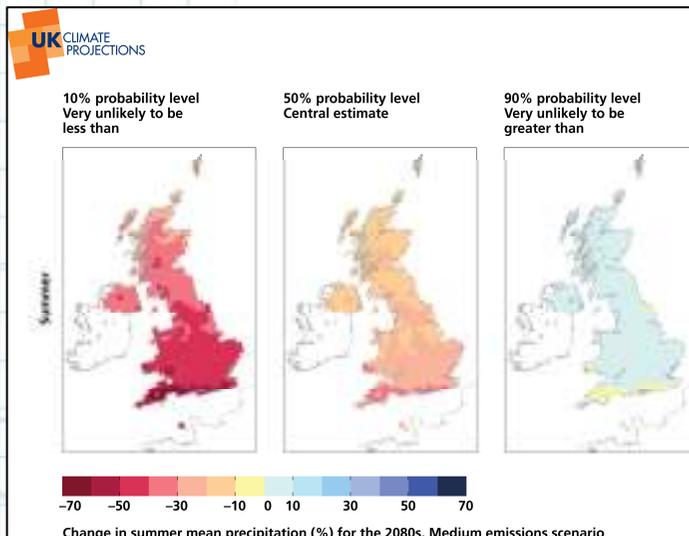
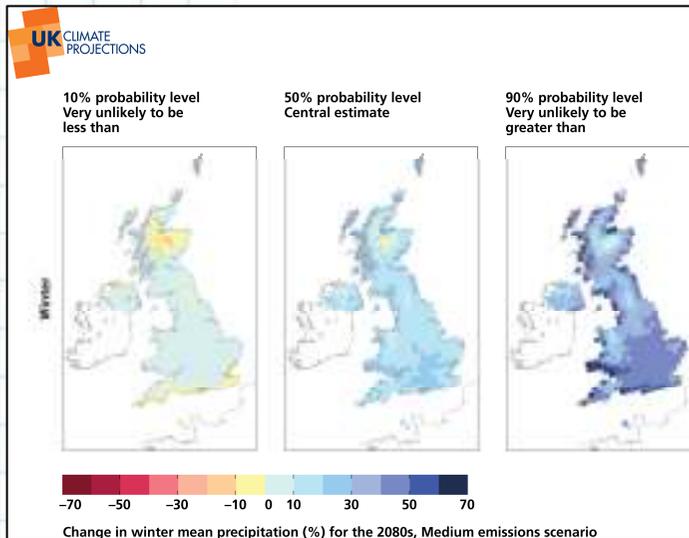
Rahmstorf (2007) 0.5-1.4m rise

Jevrejeva *et al* (2010) 0.6-1.6m rise

Pfeffer *et al* (2008) 0.8-2.0m rise

Satellite measurements show 3.2mm/year 1993-2009, but a two-year drop in 2010 (image from [NASA website](#), 2011)

Rainfall – potentially affecting river level



10, 50 and 90 percentile changes in mean seasonal rainfall for the Medium emissions scenario: (top) Winter and (below) Summer (images from UKCIP website)

Lower Summer rainfall could increase demand for limited fresh water, possibly reducing river flow and river level, potentially causing difficulties for inland navigation

Inland navigation vulnerability to water supply



Navigation during unusually low river flow and level in the River Rhine,

27 July 2006

(image from PIANC, 2008)

Inland navigation vulnerability to ice

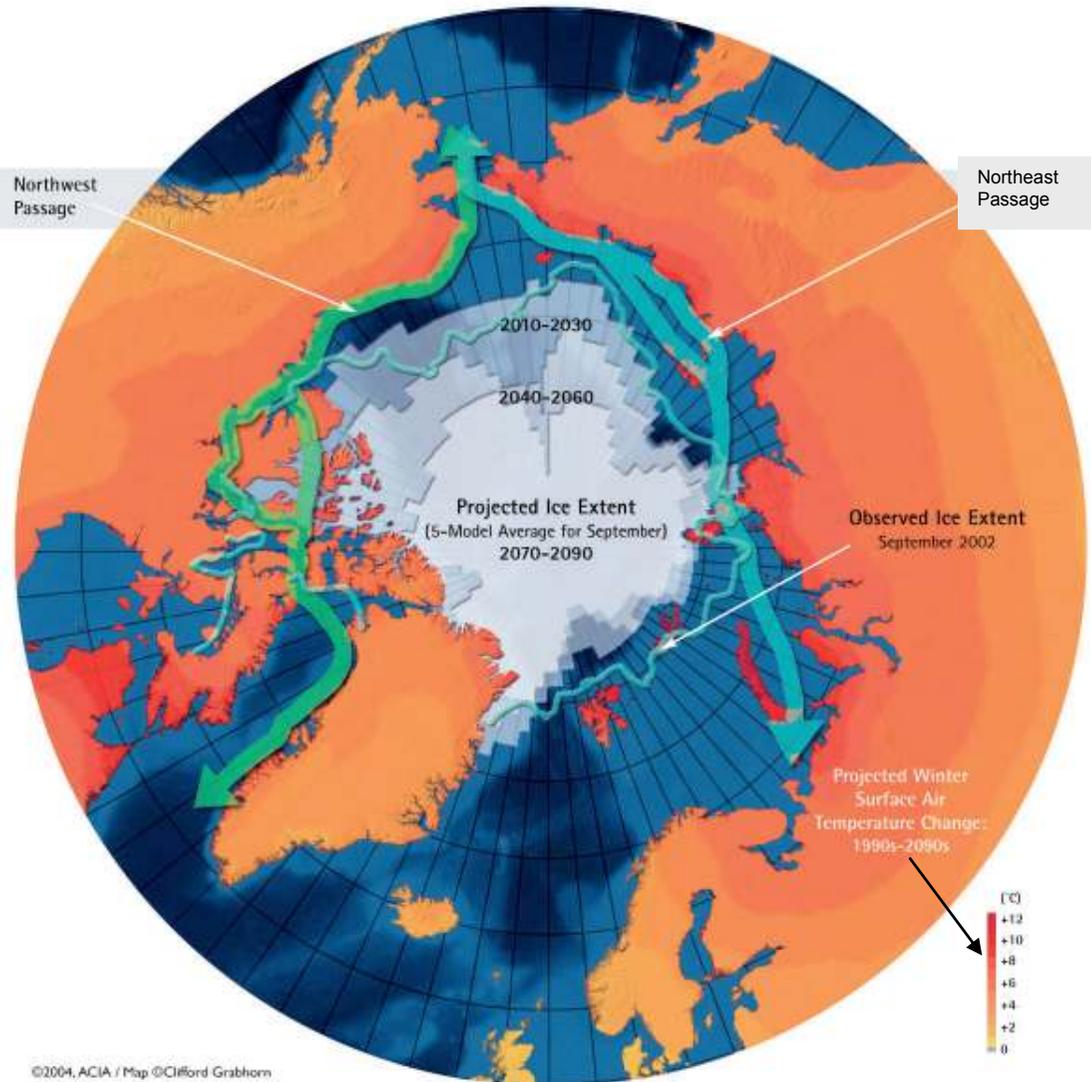


Navigation delayed
by ice blocking a
lock on the River
Mississippi,

February 2007

(image from PIANC,
2008)

Possible new Arctic navigation routes



Observed and projected Arctic sea ice extent and potential new Northwest and Northeast Passage navigation routes (image from [Arctic Climate Impact Assessment](#) website)

And in the Antarctic, potential new routes through Magellan Strait and around Cape Horn

Inland navigation (fresh water flow) is more vulnerable to climate change than maritime navigation. Precipitation changes would affect river flow, river level, water for locks and ice formation.

The main climate changes affecting maritime navigation are sea level rise (little direct impact) and reduced ice cover in Polar Regions (new opportunities for transport and exploration).

Navigation could be a beneficiary of climate change, through regulatory measures for climate change mitigation and the need to move to lower energy forms of transportation.

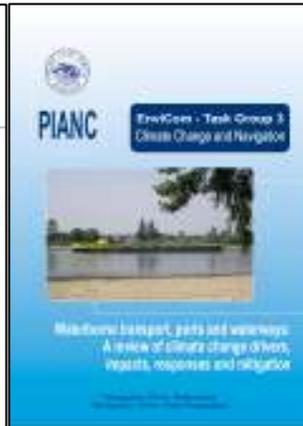
PIANC has a *Permanent Task Group on Climate Change*, with chairman Kate White and members representing PIANC's main permanent committees

Jan Brooke and Peter Hunter are members

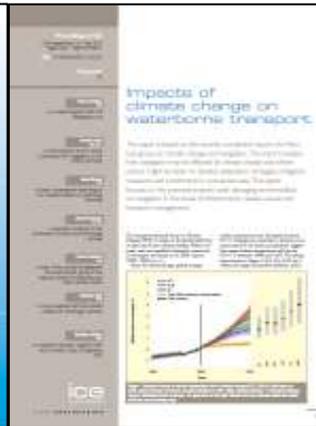
Further reading



UKCIP (2009)
UK climate
projections:
*Marine &
coastal
projections*



PIANC (2008)
Task Group 3:
*Climate
change and
navigation*



ICE Civil
Engineering
(2010) Hawkes
et al: *Impacts of
climate change
on waterborne
transport*



ICE
Proceedings
(2011) Haigh et
al: *Rising sea
levels in the
English
Channel 1900
to 2100*



Environment
Agency (2011):
*Adapting to
climate change:
Advice for flood
management*



HR Wallingford
(2011): *Carbon
accounting of
hydraulic
engineering
schemes*

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