Acidification

What is the issue?

When atmospheric CO_2 dissolves in the ocean, a weak acid is formed. Increasing atmospheric CO_2 leads to increasing acidity of the ocean (reflected by a lowering in pH). A potential feedback from increased acidity is that it may decrease the oceans ability to take up more CO_2 (Turley, 2008).

The effects of increased CO_2 in the ocean have only recently been seriously debated and the underlying knowledge base is presently small. As recently as the 1990s, awareness of the effects that acidification could be having was limited and the QSR 2000 did not mention CO_2 effects directly (OSPAR, 2000).

What has happened and how confident?

The ocean is becoming more acidic as it has taken up anthropogenic carbon since the start of the industrial revolution, with an average decrease in pH of 0.1 units (IPCC, 2007a). Current changes in ocean carbon chemistry are at least 100 times more rapid than any experienced over the past 100 000 years. During the 21st century this change could reach levels unprecedented in the past few million years (Feely *et al*., 2004). The basic chemistry of atmospheric CO_2 leading to decreased pH is well understood and there is high scientific confidence in the change in pH resulting from anthropogenic CO_2 increases (Key *et al.*, 2004).

Whilst there is some basic physiological understanding of processes, there is little in the way of field observations supporting impacts of the changed pH on organisms (ICES, 2008a).

What might happen?

Depending on the future trajectory of CO_2 emissions, scenario projections suggest a further reduction of about 0.2 to 0.5 pH units (Orr *et al*., 2005; Caldeira and Wickett, 2003).

Changed pH will have consequences for the carbonate saturation state of the seawater and increased difficulty for marine organisms to build carbonate shells. This would be likely to impact negatively upon some pelagic organisms, including potential key species of phytoplankton and zooplankton (ICES, 2008a) with potential consequences for the entire ecosystem structure (Hoepffner, 2006). Impacts of pH on other organisms than aragonitic and calcitic organisms are theoretically serious, notably through impacts on nutrient speciation and therefore primary production and biodiversity, but there has been little research on this (Turley, 2008).

Are there any OSPAR regional differences?

Since the last QSR, work by Bellerby *et al*. (2005, Fig 3.1.4 below) on an area relevant to OSPAR concluded that future change would not be uniform, with regional gradients associated with the transition between Atlantic and Arctic waters.

Ocean acidification may have the greatest impact in the Arctic (Region I) where an analysis of the effect of doubling atmospheric CO_2 concentration suggested the possibility of a complete undersaturation of aragonite by 2100 (EEA, 2008). A recent study warns that the impact of acidification may be imminent in the Arctic, suggesting that periods of undersaturation of aragonite could occur in some locations of the Arctic before 2020 (Steinacher *et al*., 2009).

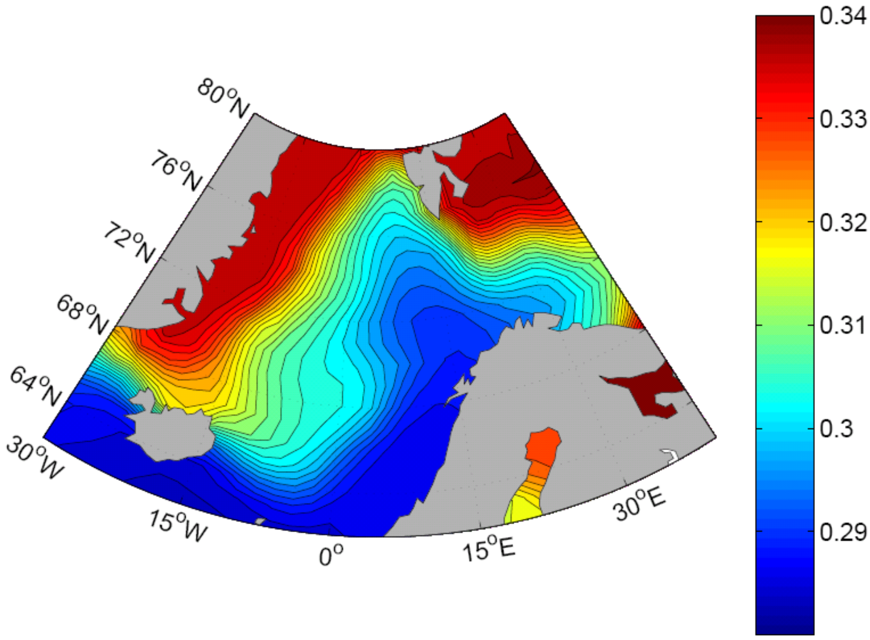

Figure 3.1.4. *From (Bellerby et al., 2005) shows the projected reduction in surface pH from 1997 to 2067 in a scenario where atmospheric CO_2 doubles during that time.*

➥ *Go to the full QSR assessment report on impacts of climate change (publication number 463/2009)*

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