AVOID is a UK research programme funded by DECC/Defra and led by the Met Office in a consortium with the Walker Institute, Tyndall Centre and Grantham Institute

AVOID—providing key advice to the UK Government on avoiding dangerous climate change

Can we limit warming to 2°C?

AVOIDnote Number 2 (December 2009)

Key findings

- AVOID has shown that limiting global warming to 2°C is possible but challenging. **Early global action** increases our chances of remaining below this level.
- There is some flexibility in **the year of peak emissions** (between 2014 and 2020). However, a later peak year must be coupled with much stronger action to reduce emissions after the peak and attain a low or zero long-term level of net emissions in the medium to long term. Such strength of action may be beyond economic and technological feasibility. There is thus a strong argument for early action.
- **Emissions after 2050 matter**. For instance an extra 100 years of CO_2 emissions at just a fifth of the year 2000 level could add more than 0.3°C to peak warming.
- **Global average warming is only an indicator** of the response of the climate system to global emissions. Additional quantities, such as rainfall, sea-level rise, ocean acidification, regional variations and changes in extremes all influence the climate change impacts on people and natural systems.

"Sometimes we think about climate change as a theoretical prospect for the future. It isn't, it is a reality today."

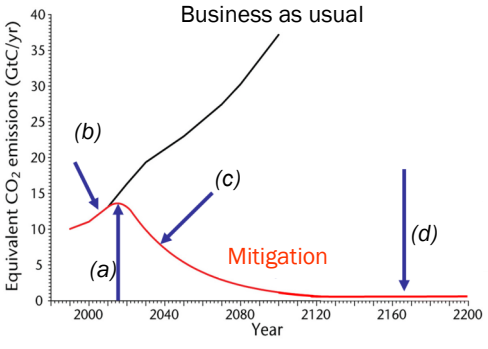
Ed Miliband, former UK Secretary of State for Energy and Climate

What is a 2°C limit?

There is now agreement in the G-20 that to avoid dangerous climate change, warming should be limited to 2°C or less above pre-industrial levels. Greater warming will lead to unacceptable levels of climate impacts and is more likely to trigger accelerated or irreversible environmental change.

AVOID has demonstrated that the definition of a '2°C warming limit' crucially affects the amount of mitigation action that is needed. To define this warming limit, the following issues need to be considered:

- **What is the definition of the pre-industrial period?** Here we interpret pre-industrial as being 1750.
- **How far into the future does the 2°C limit apply?** Here we ensure the limit is met up to 2500.
- **What is an acceptable level of risk?** The UK's Committee on Climate Change worked with the aim of staying below 2°C at 2100 with at least a 50% probability based on scientific uncertainties. We continue to use this level of risk in AVOID.



Mitigation scenario *— Key parameters to vary: (a) year of peak emissions, (b) rate of pre-peak emission increase, (c) post-peak rate of emission reduction, (d) long-term emissions floor.*

Can we limit warming to 2°C?

The AVOID results show that it is possible to restrict warming to 2°C or less during the 21st century with at least a 50% probability (**Figure 1**). For example, for a mitigation scenario with emissions peaking in 2016 and a rate of emission reduction of 4% after 2016, the warming target would stay below 2°C. Early action to reduce emissions maximises our chances of remaining below 2°C.

If we want a 90% chance of staying below 2°C, AVOID results show that we will need negative emissions and/or some geo-engineering intervention.

There is some limited flexibility in the year of peak emissions. A later peak at around 2020 can be compatible with limiting warming to 2°C by 2100. However, a later peak year must be coupled with stronger action to reduce emissions after the peak and the trajectory must attain a low or zero long-term level of net emissions in the future.

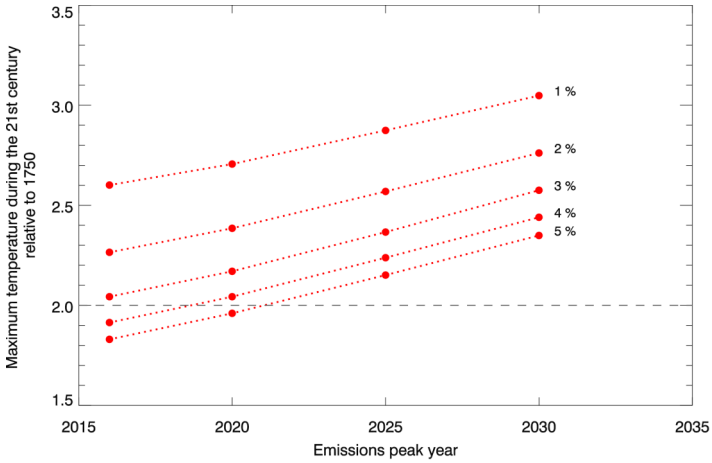


***Figure 1**: Which emission trajectory yields a temperature that remains below 2°C, 3°C or 4°C with at least a 50% probability? The 2°C limit is taken here to mean 2°C at 2100 relative to pre-industrial (1750).*

Global average warming is only an indicator

Global average warming is an indicator of the response of the climate system to global emissions, enabling simple intercomparison of different mitigation policies. However, AVOID also considers regional climate changes in the atmosphere, on land and in the oceans, which are more relevant to impacts on people and natural systems.

Some of the key findings are:

- Projections of temperature and rainfall vary significantly with location. For temperature, the increase over land is usually greater than the global average and many high northern latitudes warm much more. For precipitation, the regional distribution is more uncertain. In the tropics some locations shows large increases whereas others show decreases. Some significant changes are also seen in the mid-latitude storm tracks, which could affect European weather conditions.
- Sea-level rise is caused by expansion of the ocean and the addition of water from land based glacier and ice sheets. Although it takes the ocean and ice sheets a long time to fully respond to changes in atmospheric greenhouse gas concentrations it is possible to offset some 21st century sea-level rise by reducing emissions (**Figure 2a**).
- Reducing carbon dioxide emissions can also avoid much of the acidification of the upper ocean expected under business-as-usual conditions during the 21st century. This reduced acidification has benefits for the health of corals and other aspects of marine ecosystems (**Figure 2b**).

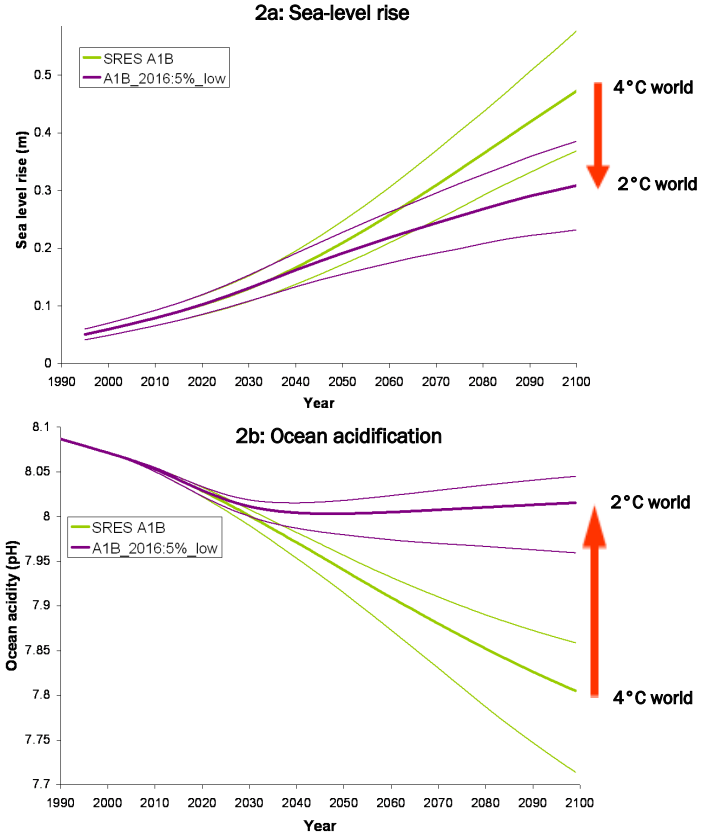


***Figure 2**: The green lines show the response in an unmitigated world that reaches 4°C by 2100, compared to a world with rapid and early mitigation that limits warming to 2°C by 2100 (purple lines). The thick lines correspond to the medium model response and the thin lines show the uncertainty range.*

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How to reference this AVOIDnote:

AVOIDnote2 (2009): Can we limit warming to 2°C? *AVOIDnote number 2*. M Noguer, J Cook and J Lowe (eds) on behalf of the AVOID Consortium and Network.