THE UNIVERSITY of EDINBURGH

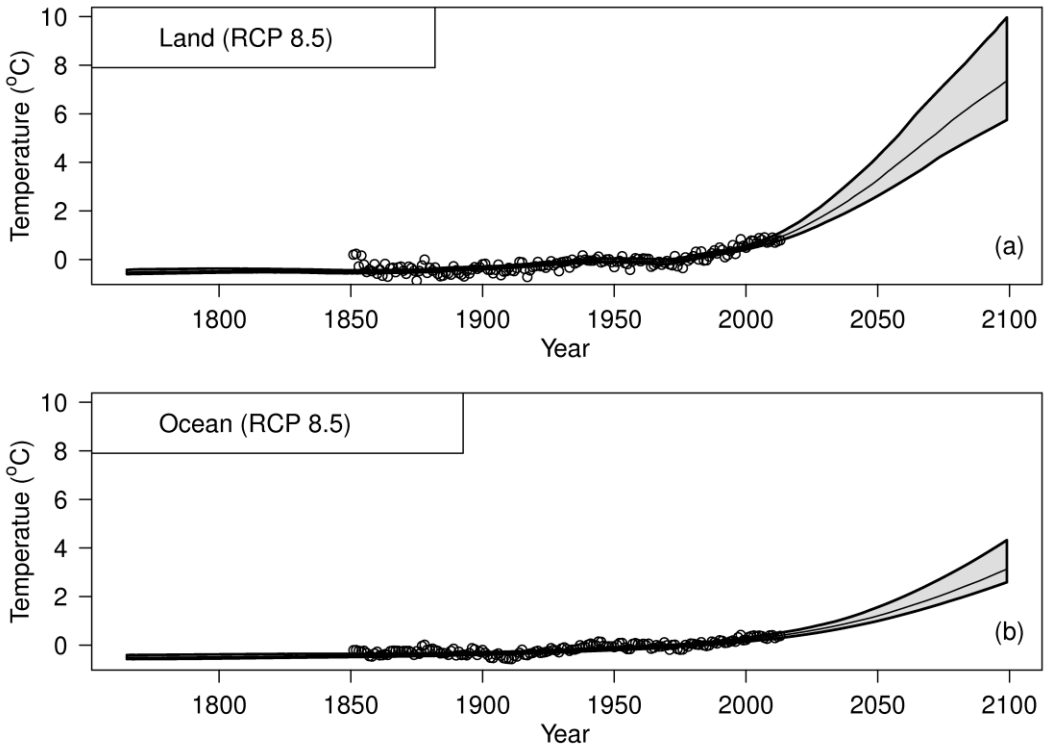
Climate outlook may be worse than feared, global study suggests

A new fast-track study suggests the impact of climate change may be worse than previously thought.

As world leaders prepare to hold climate talks in Paris, the research shows that land surface temperatures may rise by an average of almost 8°C by 2100, if significant efforts are not made to counteract climate change.

Such a rise would have a devastating impact on life on Earth. It would place billions of people at risk from extreme temperatures, flooding, regional drought, and food shortages.

The study calculated the likely effect of increasing atmospheric levels of greenhouse gases above pre-industrialisation amounts. It finds that if emissions continue to grow at current rates, with no significant action taken by society, then by 2100 global land temperatures will have increased by 7.9°C, compared with 1750. This finding lies at the very uppermost range of temperature rise as calculated by the Intergovernmental Panel on Climate Change.



Temperature forecast to the year 2100. Based on RCP8.5 emission projections, historical land and ocean temperature records (circles) and a simple heat-balance algorithm. Note how land temperatures

are predicted to rise by almost 8°C above preindustrial, the ocean by over 3°C. Confidence regions plotted in grey.

The global rise (land+ocean, of around 5°C) also breaches the United Nations' safe limit of 2°C, beyond which the UN says dangerous climate change can be expected.

Prof. Thompson's research first created a simple algorithm to determine the key factors shaping climate change and then estimated their likely impact on the world's land and ocean temperatures.

His method is more direct and straightforward than that used by the IPCC, which uses sophisticated, but more opaque, computer models. The new method's principal merit lies in the simplicity, interpretability, and transparency of the regression-based approach.

In the new approach an innovative energy-balance technique is employed to determine the sensitivity of the global climate to a doubling of CO_2. This allows an empirical, data-driven, estimate to be generated based solely on historical temperatures, changes in greenhouse gas emissions, sulphate aerosols, volcanic dust and the strength of El Niño episodes.

In this way historical data are linked with changes in radiative forcing through the thermal response times of the land and ocean.

In particular the new method accounts simultaneously for the atmospheric pollution effects, which have been cooling Earth by reflecting sunlight into space, and for the slow response time of the ocean. Both effects are found to have been strongly masking the greenhouse warming caused by fossil-fuel burning and by land-use change.

All the data sets used have been subject to rigorous scrutiny, while the basic energy-balance technique has been validated on 'state-of-the-art' GCMs.

The central outcome of the study has been to determine the strength of the anthropogenic greenhouse effect (the climate sensitivity) from observational data and basic physics alone, without recourse to the parameterisation of earth-system models and their inevitable uncertainties. The global temperature increase, for a CO_2 doubling, is found to lie (95% confidence limits) between 3.0°C and 6.3°C, with a best estimate of 4°C.

Particularly disturbing, at this time, is that even if every nation were to fulfil all promises made ahead of the UN Paris climate summit (28th Nov to 6th Dec 2015), their pledges would only achieve a weakening of the anticipated warming by less than half a degree by 2100.

In the light of the new estimate of climate sensitivity, the Paris pledges (INDCs) on greenhouse gas cuts are seen to be woefully inadequate for realising their objective of keeping the world within relatively safe climate limits.

The study may also help resolve debate over temporary slow-downs in global temperature rise.

Professor Roy Thompson who carried out the study, said:

> *"Estimates vary over the impacts of climate change. But what is now clear is that society needs to take firm, speedy action to minimise climate damage.*
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> *With 7.9ºC warming on land we would be looking at an entirely different planet. Life in the tropics would be particularly difficult as organisms are pushed beyond their optimal body temperatures. At the poles both ice sheets would be rapidly melting. Especially in maritime regions many plants would flower and bud two months earlier. Worldwide the behaviour of plants and animals would be to desynchronise, with weeds and pests being progressively favoured. Billions of people would face an increasingly tough battle to survive. Hardest hit would be those living in the poorest countries and in low-lying coastal areas.*
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> *Simultaneously the oceans would be acidifying, putting commercial species at ever greater risk as marine ecosystems react to ocean warming, pH decrease and deoxygenation. To find a comparable climate we have to turn the geological clock back 100 million years, beyond even the warmest periods of the Pleistocene and Pliocene, to the Cretaceous and the age of the dinosaurs."*

(For further details see Transactions of the Royal Society of Edinburgh, Issue 106.1, 2016, Earth and Environmental Science).

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