Uncertain projections help to reveal the truth about future climate change

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A team of four scientists from the US and the UK explain how differing climate model projections can be used collectively to reduce uncertainties in future climate change, in a paper published in the journal *Nature Climate Change*.

Despite major advances in climate modelling over the last 30 years, there are still a wide range of projections for global warming by 2100, even when the same scenarios of carbon dioxide emissions are assumed in each model. This is because there are continuing uncertainties in climate feedbacks, such as the snow-albedo feedback.

This is how much declining snow-cover under global warming will amplify the global warming by making the Earth's surface darker so that it absorbs more sunlight.

The range of climate projections is primarily used to assess the uncertainties and possible risks associated with greenhouse gas emissions , but the authors of this new study describe a more constructive way to use the model spread, called Emergent Constraints.

The basic idea is to use the models to tell us which aspects of the current climate are most related to differences in the future climate. Then a measurement of those aspects in the real world can be used to select out the most likely future climates.

"Emergent constraints will help developers make models that better predict the future because they identify which observations they should get their model to replicate. This is particularly valuable on the subject of clouds, for which it is not easy to know which of the many diverse aspects of the clouds we observe are relevant to their future evolution", explained co-author Dr. Steve Klein of the Lawrence Livermore National Laboratory in the US.

The first emergent constraint was identified on the snow-albedo feedback by lead author Professor Alex Hall of the University of California in Los Angeles,who said: "we found that the seasonal variation in the amount of snow-cover was closely related to the strength of the snow albedo feedback in the future, across a wide-range of

climate models.

"As we have satellite measurements of snow-cover variations in the recent past, we can use these observations to select the most likely values of snow-albedo feedback across the models".

Alex Hall's co-authors were inspired by his early work to look for emergent constraints on other aspects of the climate and carbon cycle system.

Co-author Professor Peter Cox of the University of Exeter added: "We applied the emergent constraint approach to how the carbon stored in forests and soil might change in the future, and to estimate the likelihood of Amazon forest dieback due to climate change".

The paper also warns of the dangers of misusing emergent constraints, which could lead to being over-confident about future change. The authors suggest ways that this could be avoided though, including testing against the many new climate models that will becoming online soon.

Overall the tone of the study is a very positive about emergent constraints which enable the ensemble of climate models being developed worldwide, to be more than the sum of the parts.

Professor Chris Huntingford, study co-author based at the UK Centre for Ecology and Hydrology summarised this shared perspective: "An enormous amount of effort has gone into developing climate models by research groups around the world. Unfortunately, there remain significant differences between their projections.

"This uncertainty has to be reduced to help policymakers plan. At present, the only game in town to aid uncertainty removal is that of Emergent Constraints."

Progressing emergent constraint on future climate change by Alex Hall, Peter Cox, Chris Huntingford, Steve Klein appears in *Nature Climate Change*.

More information: Progressing emergent constraints on future climate change, *Nature Climate Change* (2019). DOI: 10.1038/s41558-019-0436-6 , www.nature.com/articles/s41558-019-0436-6

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