Can space borne Far Infra Red observations constrain future climate change?

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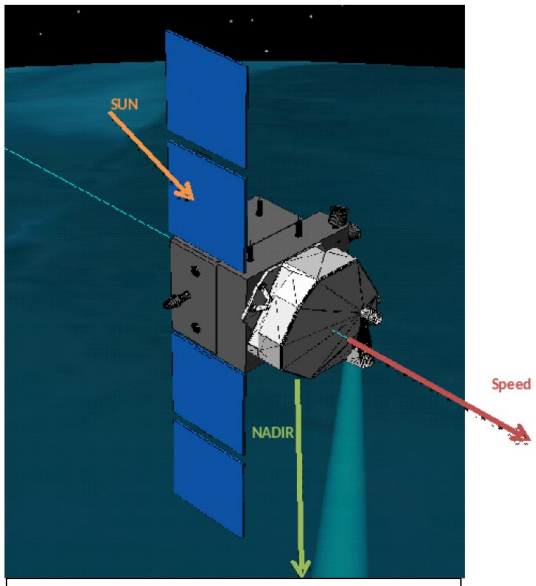
Project background

Making a case for expensive satellite instruments for climate science largely focuses on their importance for better understanding key processes in the climate system. However, identification of how processes might impact future climate change is difficult. The idea behind this project is to ask how different a model's response to greenhouse gases is when its simulation of large scale observations is perturbed. In this case the aim is to focus on a component of the outgoing radiation from the Earth: the Far InfraRed (FIR), which is infrared radiation with wavelengths greater than 15 microns. Half the outgoing energy from the Earth comes from this region (Harries et al, 2008). The FIR has been unobserved since the early 1970s and a satellite mission has been proposed to the European Space Agency to measure the FIR from space for three or more years.

Climate models need to parameterize many unresolved processes including clouds, and uncertainty in those parameterisations leads to uncertainty in future climate change – in both the magnitude and pattern of change (Stainforth et al, 2005). By changing parameters in models the behaviour of the model can be changed in both its simulation of current observations and how it responds to greenhouse gases and other climate drivers. Recently we (Tett et al, 2013; 2016) have been applying inverse methods to change model parameters in order to produce climate models in agreement with observations.



Proposed FORUM satellite

The aim of this project is to use these existing inverse methods to perturb the simulation of the FIR in the UK's atmospheric model **while** keeping the simulated total outgoing radiation from the Earth in agreement with satellite observations. Having done this, the effect of the perturbation on climate feedbacks and impacts will then be tested to see how much a FIR mission might additionally constrain climate change feedbacks and impacts. The planned work will build on the work of the NERC funded ICE-IMPACT project which aims to look at potential ice-emissivity feedbacks (Feldman et al, 2014) in the FIR and the PhD student will work alongside the ICE-IMPACT PDRA.

Key research questions

1. What parameters affect the FIR and outgoing radiation in the UK's atmospheric model?
2. Can the model parameters be adjusted to perturb the simulated FIR whilst keeping the broadband outgoing radiation consistent with observations?
3. How different are atmospheric feedbacks and other potential regional impacts in the perturbed model?

Methodology

Year 1: Student understands approach and uses existing software prototypes with a fast climate model. Establishes which parameters affect FIR and outgoing radiation in the UK atmospheric model.

Year 2: Student applies optimisation algorithm to perturb simulations of FIR while keeping outgoing radiation within observed error. Writes paper on results.

Year 3: Student explores effect of perturbed parameters on climate feedbacks and potential regional climate change. Writes papers on results.

Year 4: Student writes thesis synthesising results with implications for planned FIR mission.

Training

A comprehensive training programme will be provided comprising both specialist scientific training and generic transferable and professional skills. In addition the student will be trained in the use and analysis of climate models, super-computers, uncertainty analysis and controls on outgoing radiation.

Requirements Numerically able student with a strong interest in Climate.

Further reading

Tett et al, 2013. "Can Top-of-Atmosphere Radiation Measurements Constrain Climate Predictions? Part I: Tuning" doi: 10.1175/JCLI-D-12-00595.1

Tett et al, 2016. "Calibrating Climate Models Using Inverse Methods" To be submitted to Geophysical Model Development Discussions.

Feldman et al, 2014 "Far-infrared surface emissivity and climate", PNAS doi: 10.1073/pnas.1413640111

Harries et al, 2008 "The far-infrared Earth, Rev. Geophys., doi:10.1029/2007RG000233

Stainforth et al, 2004 "Uncertainty in predictions of the climate response to rising levels of greenhouse gases", Nature, doi: 10.1038/nature03301

Project summary Testing if new Far Infrared observations would significantly constrain the response of the climate system to greenhouse gases.