Comparing atmosphere-land surface feedbacks from models within the tropics.
Part 1: Evaluation of CMIP5 GCMs to simulate the land surface-atmosphere feedback

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1. INTRODUCTION

- Man-made transformations to the environment, and in particular the land surface, are having a large impact on the distribution of rainfall
- This is of particular importance for environmentally vulnerable regions such as many of those in the tropics, where widespread poverty, an extensive disease burden and pockets of political instability has resulted in a limited adaptative capacity to climate related shocks
- Recently the 5th Climate Modelling Intercomparison Project (CMIP5) has overseen the running of a number of latest generation general circulation/climate models (GCMs), using various present-day and future emission scenarios of greenhouse gases
- These model runs have provided an unprecedented amount of simulated data, and therefore the CALM project (**C**omparing **A**tmosphere-**L**and surface feedbacks from **M**odels) began in response to a call to exploit these data. This project has the overarching goal of furthering our understanding of how interactions between tropical rainfall and the land surface are represented in some of the latest GCM simulations, and aims to feed into the IPCC AR5
- Focusing on precipitation, soil moisture and near-surface temperature, we present preliminary results from this project, comparing the data from all of these models to see how the interactions between rainfall and the land surface differs (or agrees) between them

2. MODEL DETAILS AND METHODOLOGY

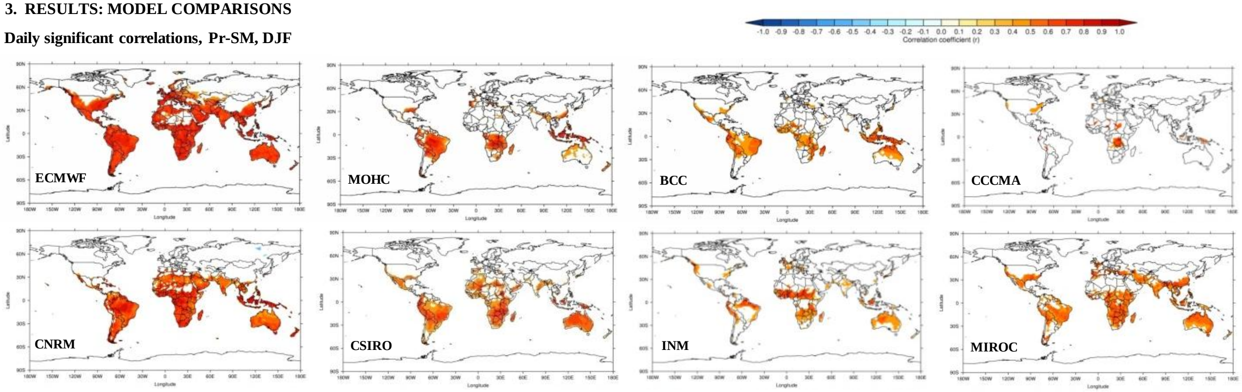
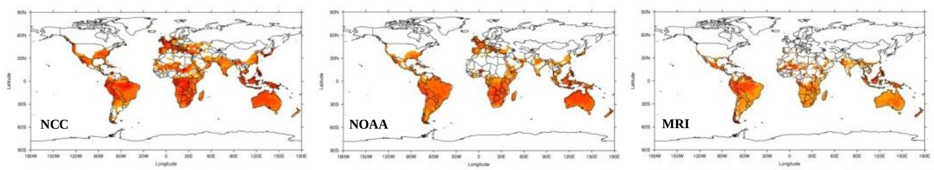
- Models used:

Institute	Model	Abbreviation
European Centre for Medium-range Weather Forecasts, UK	ERA-Interim	ECMWF
Met Office Hadley Centre, UK	HadGEM2-ES	MOHC
Beijing Climate Center, China	BCC-CSM1-1	BCC
Canadian Centre for Climate Modelling and Analysis, Canada	CanESM2	CCCMA
Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique, Meteo-France, France	CNRM-CM5	CNRM
Commonwealth Scientific and Industrial Research Organisation, Australia	CSIRO-MK3	CSIRO
Institute for Numerical Mathematics, Russian Academy of Sciences, Russia	INMCM4	INM
Division of Climate System Research, University of Tokyo, Japan	MIROC5	MIROC
Norwegian Climate Centre, Norway	NorESM1-M	NCC
Geophysical Fluid Dynamics Laboratory, National Oceanographic and Atmospheric Administration, USA	GFDL-ESM2M	NOAA
Meteorological Research Institute, Japan	MRI-CGCM3	MRI

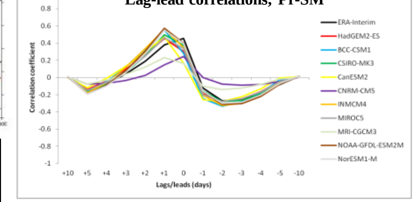
- Daily data covering 15 years (1990-2005) from historical run was analysed, including surface precipitation rate, soil moisture of upper soil layer and near-surface air temperature
- Correlations for globe calculated between above variables at daily and seasonal timescales. At daily timescale, we used anomalies calculated by removing a 10-day running mean
- Gradients for globe (i.e. slopes of linear regression) calculated at same timescales
- Lag-lead correlations calculated and averaged over tropics (e.g. at day +10, precipitation leads soil moisture by 10 days)
- One model, namely HadGEM2-ES, focused upon here as a case study to demonstrate results

3. RESULTS: MODEL COMPARISONS

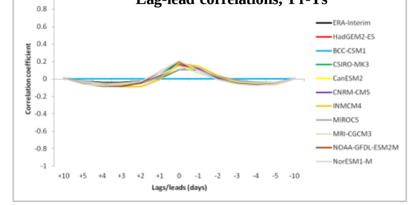
Daily significant correlations, Pr-SM, DJF

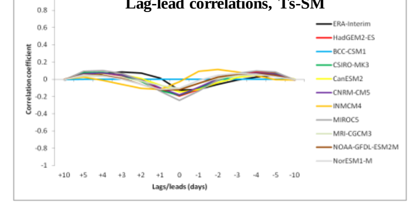
Lag-lead correlations, Pr-SM



Lag-lead correlations, Pr-Ts

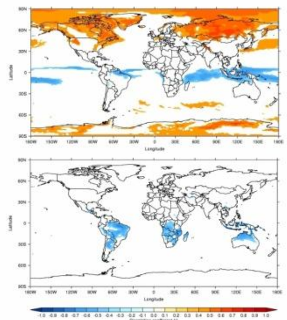


Lag-lead correlations, Ts-SM



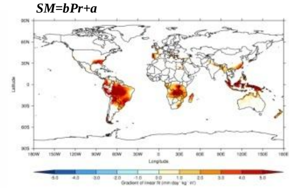
4. RESULTS: HadGEM2-ES CASE STUDY

Daily significant correlations, Pr-Ts & Ts-SM

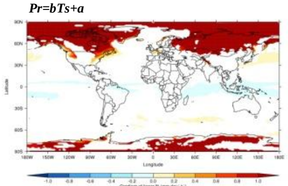


Daily gradients (where correlations are significant)

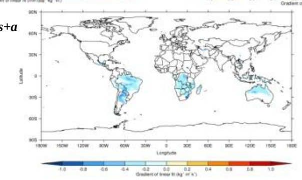
SM=bPr+a



Pr=bTs+a



SM=bTs+a



5. CONCLUSIONS

- Results suggest strong positive relationship between Pr-SM at both daily and seasonal timescales in all models, with weaker and negative relationship between Pr-Ts and SM-Ts (as shown by case study example)
- However, there is high variability in ability of models to reproduce this positive correlation, with some failing to show spatial extent or magnitude of relationship
- Difference in timings of the correlations – for Pr-SM lag-lead correlations, some models show highest positive correlations when precipitation leads soil moisture by one day whereas others show the highest correlations at day 0
- In case study example, there are "hotspots" of high linear gradients between Pr and SM, corresponding to high rainfall regions

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