SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year	……………2017…………………………………………
Project Title:	……… The Role of the Asian Summer Monsoon as a driver of European Summer Circulation Variability ……………………………………………………….
Computer Project Account:	……… spgbwool …………………………………..……
Principal Investigator(s):	………………………Dr Steven Woolnough, Dr Laura Baker , Dr Antje Weisheimer…………………………..……
Affiliation:	…National Centre for Atmospheric Science, Unveristy of Reading(SW, LB) and University of Oxford (AW)
Name of ECMWF scientist(s) collaborating to the project (if applicable)	……………………………………………………..……
Start date of the project:	………1st Jan 2017…………………………..……
Expected end date:	………31st December 2018……………………………..……

Computer resources allocated/used for the current year and the previous one
(if applicable)
Please answer for all project resources

		Previous year		**Current year**	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	X	X	8380800	0
Data storage capacity	(Gbytes)	X	X	24000	0

Summary of project objectives
(10 lines max)

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The main objective of the project to is assess the role of the Asian Summer Monsoon as a driver of European Summer Climate Variability. To do this we propose a set of seasonal hindcast simulations with relaxation of the circulation in the monsoon region to determine the forced response of the European circulaton.

In initial analysis of forecast skill of the model we have identified errors in both the forcing region and over Europe and we will also peform experiments to explore the role of European circulation as a driver of the Asian Summer Monsoon

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Summary of problems encountered (if any)
(20 lines max)

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None as yet, we are just setting up the experiments

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Summary of results of the current year (from July of previous year to June of current year)

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We have analysed the Monsoon-Europe teleconnections in observations and an existing set of seasonal hindcasts with a coupled version of the IFS. The model captures some of the broad features of this teleconnection well, but there are some differences. We have also analysed the skill of this hindcast data set and found regions of negative skill which develop in centres of action of these teleconnection patterns, including over Europe. We are setting up a set of relaxation experiments to determine the dynamical relationship between these areas of negative skill. (see attached progress report)

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List of publications/reports from the project with complete references

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None as yet

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Summary of plans for the continuation of the project
(10 lines max)

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Although we have not yet used any HPC resource we are currently in the process of setting up a control hindcast and a set of relaxation experiments to begin running within the next month or two, and we fully expect to be able to use our project allocation during the year. The summary report also indicates some potential additional experiments, depending on the results of these initial experiments which would plan to run early in 2018.

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1 ECMWF Special Project Progress Report

1.1 Introduction

This project is part of a PhD project at the University of Reading in collaboration with the University of Oxford and within a wider NERC-funded project (SummerTIME). The overall aim of the SummerTIME project is to explore the drivers of variability and change in the European summer circulation. The focus of the PhD project is on the role of the Asian Summer monsoon as one of these drivers. Our ability to predict European climate at extended ranges (sub-seasonal to seasonal and beyond) depends on the ability of our models to correctly represent remote drivers of the European circulation and the teleconnection pathways from those remote drivers.

Two main mechanisms have been proposed for the role of the Indian summer monsoon (ISM) in influencing the climate over Europe. Rodwell and Hoskins (1996) suggested that remote diabatic heating in the ISM region can induce a Rossby wave pattern to the west, which, through interaction with the midlatitude westerlies, can lead to enhanced decent over the Mediterranean. Ding and Wang (2005), and subsequently Ding and Wang (2007), proposed a mechanism whereby strong convection over the northern ISM (NISM) region is triggered by the west-central Asian high pressure associated with a wave train extending from northwest Europe. This convection then reinforces the west-central Asian high through the excitation of Rossby waves, which then propagate downstream to eastern Asia and beyond. They called this teleconnection pattern the circumglobal teleconnection (CGT) and it was shown in both Ding and Wang (2005) and Ding and Wang (2007) that the CGT has significant impacts on both European climate and the strength of the ISM. In addition, the ISM plays an important role in the maintenance of the CGT during the boreal summer.

1.2 Progress to date

Initial work focussed on the observed relationship between the CGT, ISM and European weather. There was found to be a significant relationship between both the geopotential height in west-central Asia and ISM precipitation and weather conditions in Europe, although the relationships vary month-to-month. The most significant correlations in Europe were found in August, with significant negative correlations over much of northwest Europe between west-central Asia geopotential height and both precipitation and temperature in this region.

We have recently begun analysing a set of seasonal hindcasts run using model version CY41R1 (Experiment ID: gcai). These are coupled 4-month long simulations initialised on 1st May over the hindcast period 1981-2014 using 25 ensemble members and done in a similar resolution as System 4 (TL255L91). The focus of the analysis carried out thus far has been on the representation of the CGT in the model, in comparison to what is observed in ERA-Interim. Figure 1 shows the observed CGT pattern for May-August in ERA-Interim (1981-2014 to fit with the model forecast period) as defined in Ding and Wang (2005) as the correlation between the 200hPa geopotential height at the base point in west-central Asia and the 200hPa geopotential height elsewhere. In order to get an idea of the mean model response, but without using the ensemble mean (which will over-emphasise the forced response), these correlations were calculated for each of the 25 ensemble members, and the average of these 25 correlations maps is shown in Figure 2. In these plots, the data has been high pass filtered to remove the decadal variability and long term trend.

In May, the model does a good job at simulating what little signal of the CGT that there is (pattern correlation of 0.87 in the northern hemisphere), with the overall pattern and the location of the centres of positive correlation over west-central Asia and east Asia accurate. In June, the model fairly accurately captures the effect of the Rodwell and Hoskins mechanism, albeit with less of a westward extension than is observed. The centre of action over east Asia is also very accurately simulated, both in location and magnitude, and this seems to be one area in which the model does well in all months. By July the model has developed a positive correlation across much of the northern hemisphere and the tropics, and the pattern correlation has fallen to 0.60, and this persists into August, although the location of the centres of positive correlation in the CGT (centres of action) are still broadly captured. The negative correlations, particularly in August, are virtually non-existent, probably in part as a result of the developing positive correlations.

To explore the impact of the model representation of the CGT on forecast skill we first analyse the ensemble mean skill for 200hPa geopotential height. Figure 3 shows the model skill when compared to ERA-Interim for

May-August. For the first month of the forecast, the model shows good skill in the tropics, and reasonably good skill in the extratropics, with positive skill everywhere with the exception of a small region across northern Scandinavia and correlations ranging between 0.5 and 0.8 in most regions. In June, the forecast skill in the northern hemisphere has reduced, and some negative skill has developed across the North Atlantic and the UK. By July, this skill has decreased further to reach values between -0.2 and -0.3. Perhaps most significantly, an area of negative skill has also grown across western Asia, in almost the exact location of the area used for calculation of the D&W Index. By August the magnitude of the area of negative skill over west-central Asia has decreased, but there is now a pattern of reduced skill across the northern hemisphere that bears a striking resemblance to the CGT pattern, with negative skill in the location of the centres of action over northwest Europe, west-central Asia, east Asia and the North Pacific. It is this pattern of decreased 200hPa geopotential height skill in the northern hemisphere that motivates the experiments that we will start in the next month (see section 1.3).

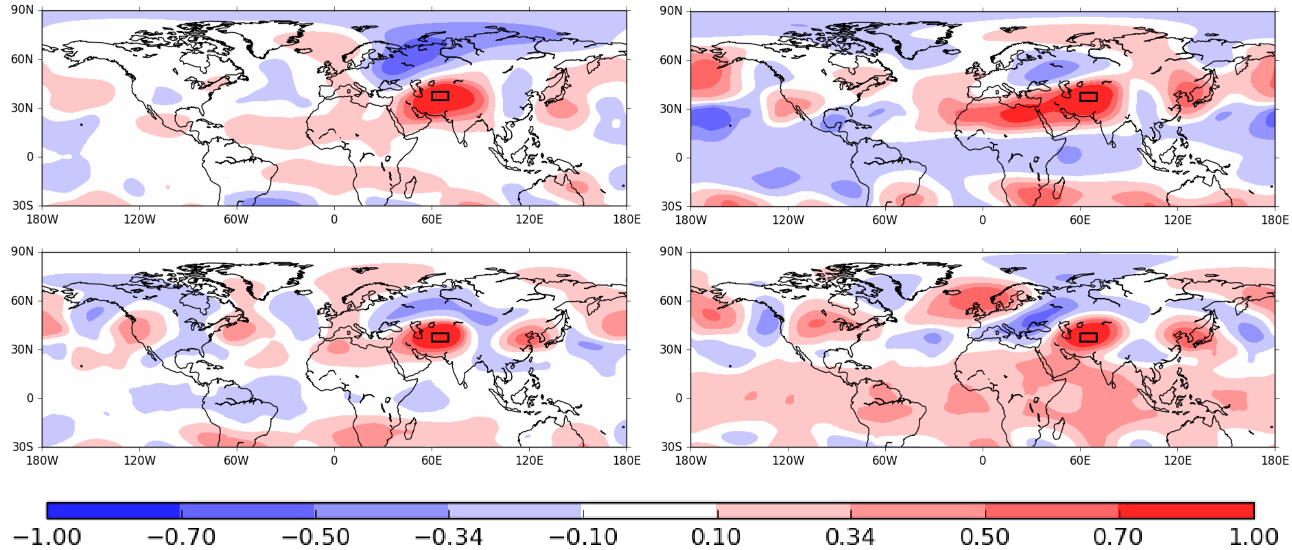

Figure 1: *One-point correlation between 200hPa geopotential at the base point (box, 35°-40°N, 60°-70°E) and 200hPa geopotential elsewhere in the ERA-Interim (1981-2014) reanalysis dataset, for May, June, July and August. Correlations of ±0.34 are significant at the 5% level*

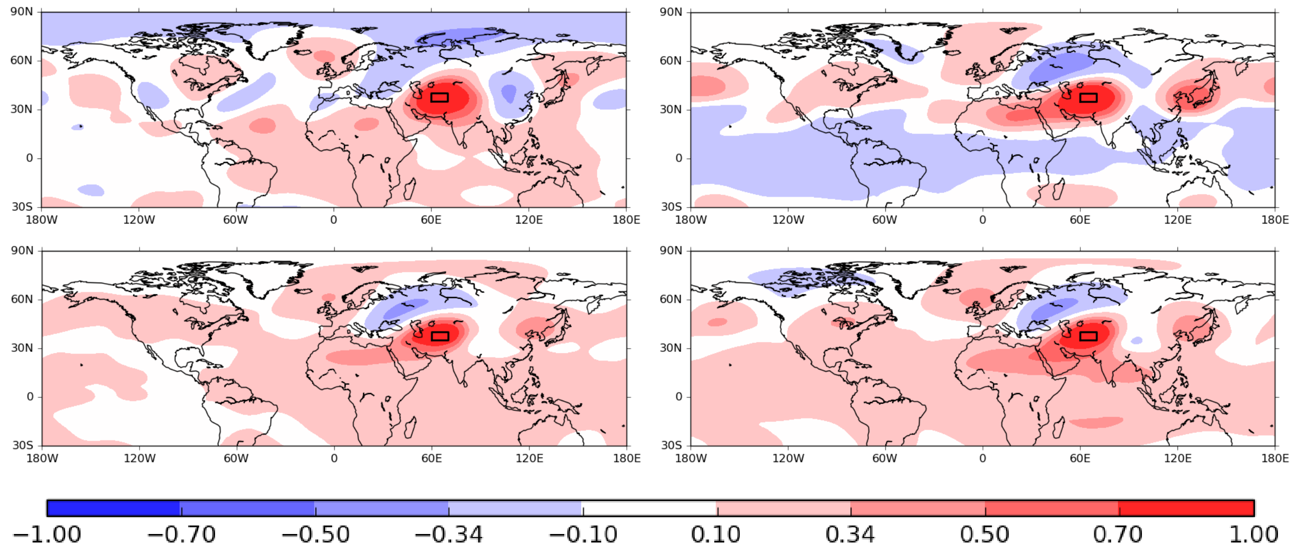

Figure 2: *One-point correlation between 200hPa geopotential at the base point (box, 35°-40°N, 60°-70°E) and 200hPa geopotential elsewhere in the ERA-Interim (1981-2014) reanalysis dataset, for May, June, July and August.Average of 25 ensemble member correlations between the D&W Index (box) and 200hPa geopotential elsewhere in the model hindcasts, for May, June, July and August*

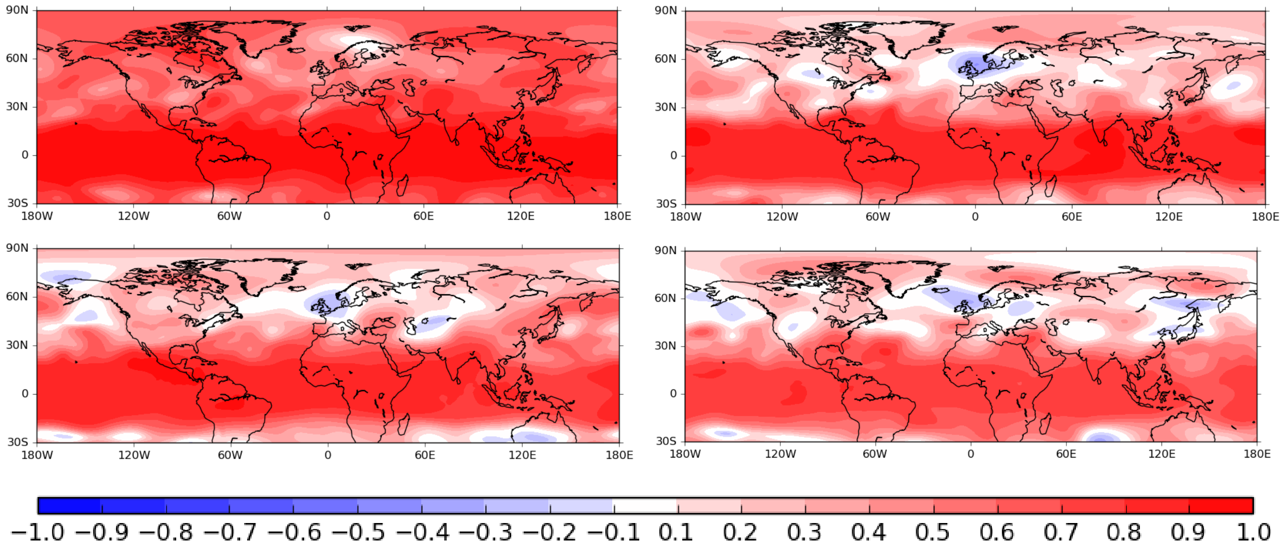

Figure 3: *Correlation between ERA-Interim and model ensemble mean 200hPa geopotential (model skill) - May, June, July and August*

1.3 Future work

We are currently setting up modelling experiments to begin within the next month. Motivated by the results shown in Figure 3, we will carry out relaxation experiments, following the method of e.g. Jung et al. (2010), to attempt to understand the dynamical relationship between the areas of poor skill and the centres of action of the CGT. Initially we will perform a set of experiments in which we relax the winds, temperature and humidity-based variables in the entire atmosphere of the model towards ERA-Interim in northwest Europe and west-central Asia to look at the reponse and subsequent impact on skill for the entire northerm hemisphere circulation. Following these experiments we expect to perform further sensitivity experiments, the exact design of which will be based on the findings from the earlier experiments, but will likely consist of:

- A repeat of earlier experiments but with a later start date to explore the impact of model bias evolution on the teleconnection pathway
- An additional set of hindcasts for a nudging region in the ISM region
- Uncoupled experiments to explore the impact of air-sea coupling on the teleconnection

References

Ding, Q. and B. Wang, 2005: Circumglobal Teleconnection in the Northern Hemisphere Summer. *J. Climate*, **18**, 3483–3505, doi:10.1175/JCLI3473.1.

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Jung, T., T. Palmer, M. Rodwell, and S. Serrar, 2010: Understanding the Anomalously Cold European Winter of 2005/06 Using Relaxation Experiments. *Mon. Wea. Rev.*, **138**, 3157–3174.

Rodwell, M. J. and B. J. Hoskins, 1996: Monsoons and the Dynamics of Deserts. *Quart. J. Roy. Meteorol. Soc.*, **122**, 1385–1404, doi:10.1002/qj.49712253408.