University of Reading

Snow

PhD in Atmosphere, Oceans and Climate

Department of Meteorology

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Declaration

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

- Robert Lee

Abstract

0.1 Abstract

Bla bla bla bla bla bla BLA!!!!

Acknowledgements

Acknowledgements go here.

I acknowledge the World Climate Research Programme's Working Group on Coupled Modelling, which is responsible for CMIP, and I thank the climate modeling groups (listed in Table 2.1 of this thesis) for producing and making available their model output. For CMIP the U.S. Department of Energy's Program for Climate Model Diagnosis and Intercomparison provides coordinating support and led development of software infrastructure in partnership with the Global Organization for Earth System Science Portals.

GPCP Precipitation data provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their Web site at http://www.esrl.noaa.gov/psd/

Contents

Chapter 1:

INTRODUCTION

1.1 Motivations and aims of the thesis

Motivations / examples of storms and why its relevant to research how they might change in the future.
Aims and set of key scientific questions.

1.2 Extratropical storm tracks

Talk a bit

Chapter 2:

METHOD AND TOOLS

2.1 An technical overview of climate modelling

From a technical point of view, and detail how climate models can vary. AM's, AOGCMs and ESMs. Make sure to cite **?** and **?**.

2.2 CMIP5 models

Introduce the CMIP5 models. Make sure to cite summary of experimental design of CMIP5: **?**. Explain their resolution, and other important aspects introduced. All models listed in Table 2.1.

2.3 Reanalysis and GPCP data

Explain why reanalyses are the best way to assess biases in climate models with respect to the general circulation. Take observations and use data assimilation system and its forecast model to grid the observations and make them consistent across space and time. Explain why I have chosen ERA-Interim. ERA-Interim citation **?** Explain why using GPCP and not reanalysis for precipitation. GPCP: The currently operational procedure is described in **?** and **?** and has been used to produce the GPCP Version 2.2 Combined Precipitation Data Set, covering the period January 1979 through the present (with some delay). The primary product in the Version 2.2 dataset is a combined observation-only dataset, that is, a gridded analysis based on gauge measurements and satellite estimates of rainfall.

Table 2.1: Modelling data – the CMIP5 multi-model ensemble, and observationally derived data – the ERA-Interim reanalysis in addition for comparison.

Model	Resolution (lon×lat (Spectral), levels)	Ensemble Size Historical	AMIP	RCP4.5	RCP8.5
ACCESS1.0	$1.875° \times 1.25°$, L38	1	1	1	1
ACCESS1.3	$1.875° \times 1.25°$, L38	1	1	1	1
BCC-CSM1.1	$2.813° \times 2.813°$ (T42), L26	3	3	1	1
BCC-CSM1.1(m)	$1° \times 1°$ (T106), L26	3	3	1	1
BNU-ESM	$2.813° \times 2.813°$ (T42), L26	1	1	1	1
CanESM2	$2.813° \times 2.813°$ (T63), L35	5	-	1	1
CCSM4	$1.25° \times 0.9°$, L26	1	4	1	1
CMCC-CM	$0.75° \times 0.75°$ (T159), L31	1	3	1	1
CNRM-CM5	$1.406° \times 1.412°$, L31	10	1	1	1
CSIRO-Mk3.6.0	$1.875° \times 1.875°$ (T63), L18	10	10	10	10
EC-EARTH	$1.125° \times 1.125°$ (T159), L62	1	1	2	3
FGOALS-g2	$2.8° \times 2.8°$, L26	1	1	1	1
FGOALS-s2	$2.81° \times 1.66°$ (R42), L26	3	3	3	3
GFDL-CM3	$2.5° \times 2.0°$ (C48), L48	5	-	3	1
GFDL-ESM2G	$2.5° \times 2.0°$, L24	1	-	1	1
GFDL-ESM2M	$2.5° \times 2.0°$, L24	1	-	1	1
HadGEM2-A	$1.875° \times 1.25°$, L38	-	7	-	-
HadGEM2-CC	$1.875° \times 1.25°$, L60	2	-	1	2
HadGEM2-ES	$1.875° \times 1.25°$, L38	1	-	1	1
INM-CM4	$2.0° \times 1.5°$, L21	1	1	1	1
IPSL-CM5A-LR	$3.75° \times 1.875°$, L39	4	6	4	4
IPSL-CM5A-MR	$2.5° \times 1.25°$, L39	1	1	1	1
IPSL-CM5B-LR	$3.75° \times 1.875°$, L39	2	1	1	1
MIROC-ESM	$2.8125° \times 2.8125°$ (T42), L80	3	-	1	1
MIROC-ESM-CHEM	$2.8125° \times 2.8125°$ (T42), L80	1	-	1	1
MIROC5	$1.406° \times 1.406°$ (T85), L40	1	2	1	1
MPI-ESM-LR	$1.875° \times 1.875°$ (T63), L47	3	3	3	3
MPI-ESM-MR	$1.875° \times 1.875°$ (T63), L95	3	3	1	1
MRI-CGCM3	$1.125° \times 1.125°$ (T159), L48	3	5	1	1
NorESM1-M	$2.5° \times 1.9°$, L26	3	3	1	1
	Total ensemble members	**76**	**64**	**48**	**48**
	Total ensemble models	**29**	**22**	**29**	**29**

Reanalysis	Resolution	Data Assimilation
ERA-Interim	$0.75° \times 0.75°$ (T255), L60	4DVAR
GPCP	$2.5° \times 2.5°$	?, ?

2.4 TRACK

2.4.1 Tracking

Introduce TRACK. Explain why I have only tracked in 850hPa vorticity (referring back to **??**).

2.4.2 Statistics

Introduce TRACK statistics.

2.5 Multi-model ensemble methodologies

Explain the process of calculating ensemble means, multi-model means and stippling to be used in the following chapters.

2.6 Processes involved in calculating global circulation diagnostics

monthly means Eady geopot methodology boxes for zonal means