The role of the stratosphere on reliability on extreme event attribution

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1. INTRODUCTION

A large proportion of extreme weather events in Western Europe are a result of storms travelling across the Atlantic Ocean. There is still disagreement over how extreme storms will impact Western Europe in the future with climate change. This calls for a need for more reliable event attribution. Many attribution studies do not include a stratosphere in their analysis, although it is known that the stratosphere can have an impact on the weather at the surface. Thus, we aim to investigate the role increasing vertical resolution in the stratosphere has on such event attribution statements.

2. ISCA MODEL

Isca is an atmosphere only idealised climate model (Vallis *et al*. 2018). It has various levels of complexity and realism, allowing users to choose the appropriate settings for their experiments. Some settings for this experiment are:

- Rapid Radiative Transfer Model (RRTM) Radiation scheme
- Fixed sea surface temperatures for 2013 and 2014 (Fig. 1.)
- Simple ice model
- Ocean mixed layer (20m)
- Carbon dioxide (395ppm)
- Realistic Continents (ERA-Interim)

3. DATA

	Number of Vertical Levels	Model Lid Height	Horizontal Resolution	Number of Ensembles
Isca Control	40	0.03hPa	T42	50
Isca Double All	80	0.03hPa	T42	50
Isca Double Tropo	47	0.03hPa	T42	50
ERA5 Reanalysis	137	1hPa	T639	

4. METHOD

A large ensemble of three experiments with varying vertical resolution are compared to ERA5 reanalysis.

- 'Control' has 40 vertical levels;
- 'Double all' has 80 levels, with the new 40 levels inserted equidistant between original levels;
- 'Double Tropo' has double the amount of vertical levels around tropopause (130-300hPa).

The model runs are initialised with sea surface temperatures (sst) from 2013 and 2014 using data from Climateprediction.net.

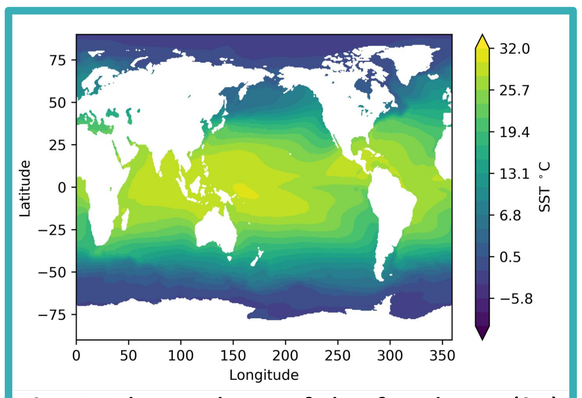

Fig. 1. Climatology of the fixed ssts (°C) used in this ISCA model run. Data from climate prediction.net

Each experiment is ran 50 times, creating a large ensemble. Using minima mean sea level pressure (mslp) output from the Isca experiments and ERA5 reanalysis, extratropical cyclones are identified and tracked using the storm tracking algorithm from Massey (2012;2016).

5. PRELIMINARY RESULTS

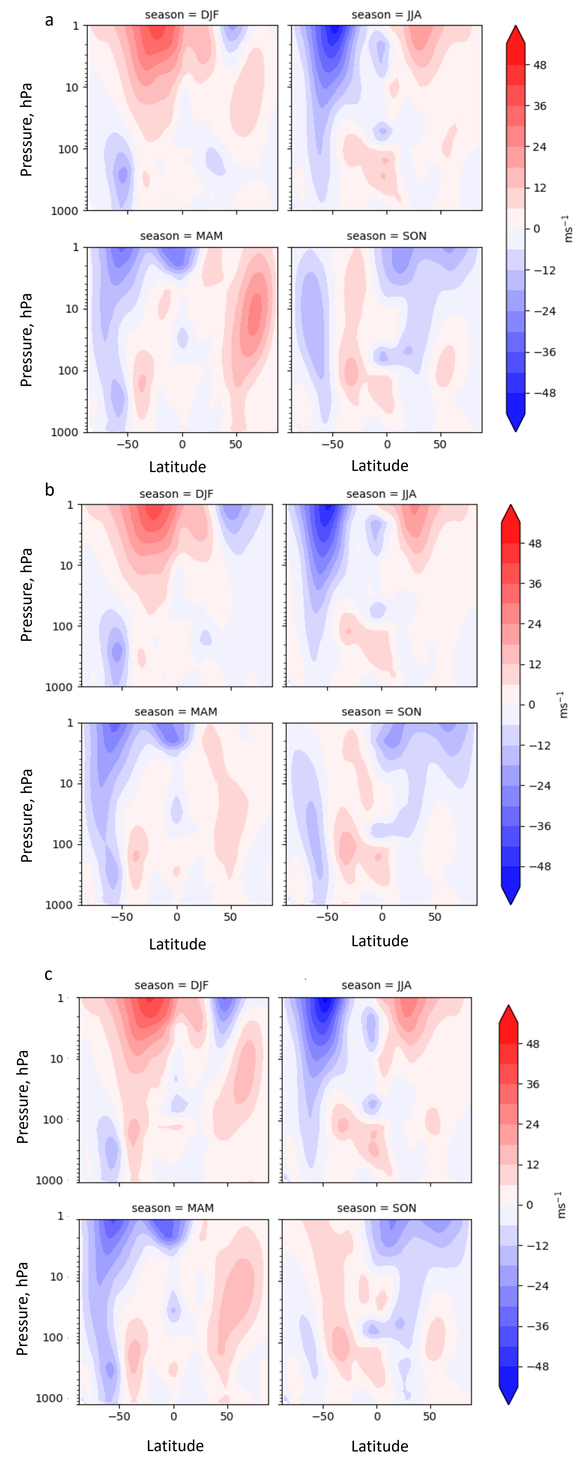

Fig 2. Zonal mean zonal winds for (a) Isca control ensemble mean minus ERA5 reanalysis, (b) Isca Double All ensemble means minus ERA5, and (c) Isca double Tropo ensemble mean minus ERA5. Panels showing seasonal means between 2013-2014.

Table 1. Number of storms in the Northern Hemisphere (30-90°N) for winter months (DJF) from 1989-2009, for ERA5 and from a 20 year run for Isca.

	ERA5	Isca
	Northern Hemisphere (90W-0E, 30-90N)	
Time (hrs)	1989-2009 (DJF)	20 years (DJF)
24	15043	18181
48	5695	5823
72	2613	2248
96	1294	1005
120	627	421
144	281	174
168	120	83

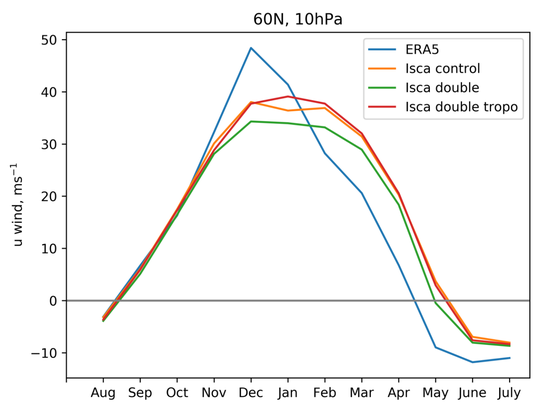

Fig 3. Zonal mean zonal winds (ms^{-1}) at 60°N and 10hPa for ERA5 reanalysis (blue), ensemble means for Isca control (orange), Isca double (green) and Isca double tropo (red) between 2013-2014.

- The number of winter storm tracks in the Northern Hemisphere varies slightly between Isca and ERA5 during 1989-2009 (Table 1). Isca shows a higher number of short lived and fewer long lived storms.
- Isca has stronger zonal winds in the stratosphere than reanalysis, especially during MAM in the Northern Hemisphere (Fig 2a).
- Doubling the vertical levels can reduce the Northern Hemisphere strong jet bias (Fig 2b), yet doubling levels in the tropopause only shows a slight improvement (Fig 2c).
- The stronger jets during MAM (Figure 2a) may be due to having a later final warming than reanalysis. Fig 3. shows that the final warming dates are later in all experiments and that doubling vertical levels improves this only slightly. Doubling the levels around the tropopause shows an improvement in strength of zonal winds during winter but doesn't improve the final warming dates.

6. FUTURE WORK

- What are the implications on storm tracks when increasing resolution in the Stratosphere?
- Increasing vertical versus increasing horizontal resolution experiment.
- Event attribution study – is climate change to blame?
- What are the controlling mechanisms of changes?

REFERENCES
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