RMetS Virtual Student & Early Career Scientists Conference 2020

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Session 8 – Poster Session C

On the linearity of the stratospheric and Euro-Atlantic sector response to ENSO

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The dependence of the winter stratospheric and Euro-Atlantic climate response on ENSO amplitude is investigated using the HadGEM3 model. Experiments are performed with imposed east Pacific sea surface temperature perturbations corresponding to Niño-3.4 anomalies of ±0.75, 1.5, 2.25, and 3.0 K. In the North Pacific, El Niño (EN) deepens and shifts the Aleutian low eastward, while the equivalent magnitude La Niña (LN) perturbations drive anomalies of opposite sign that are around 4 times weaker. The muted North Pacific response to LN can be traced back to the weaker response of tropical convection and the associated anomalous Rossby wave source. The EN perturbations weaken the Arctic polar vortex, with the winter mean zonal mean zonal wind at 60°N and 10 hPa decreasing approximately linearly with Niño-3.4 anomaly by around −3.6 m s−1 K−1. For the strongest EN case (+3 K), the frequency of sudden stratospheric warmings (SSWs) increases by ~60% compared to the control experiment. Hence the results do not support a saturation of the stratospheric pathway for strong EN as suggested in previous literature. The equivalent amplitude LN perturbations cause a weak strengthening of the polar vortex and no substantial change in SSW frequency, in contrast to some reanalysis-based studies. EN induces a negative North Atlantic Oscillation (NAO) index throughout boreal winter, which increases approximately linearly with the Niño-3.4 anomaly by around −0.6 standard deviations K−1. Only the response to the strongest LN perturbations projects onto a weak positive NAO in November, suggesting that the mechanism for the Euro-Atlantic response to LN may be distinct from EN.

Estimating charges on aerosols near the surface of Venus

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University of Manchester, Student

There has long been a debate regarding the existence of lightning on Venus. Theories applicable to the generation of electric charge in Earth's atmosphere cannot be applied to Venus due to its extremely high pressures and lack of water clouds. Up to today, all studies on the electrical charging of Venus have focused on the mid-upper atmosphere for two reasons: firstly, a thick cloud layer between 50-70 km altitude provokes interest, and secondly because observations are easier to obtain in the upper atmosphere from orbiters and flybys. This project aims to estimate the charges on aerosols near the surface of Venus, something which has never been done before. While the data available is limited, the Venera 13 & 14 lander missions measured extinction (used for estimating aerosol radius and number distribution), and discharge current, which can be used to make inferences about the atmospheric charge. This project aims to combine this data to make estimations of the dynamics of the lower Venusian atmosphere, specifically focusing on aerosol charging profiles. These estimations can be used to inform future lander missions to improve instrument sustainment and functionality in the hostile conditions of Venus's near-surface, as well as further contributing to the debate on lightning on Venus.

Study of the meteorological profile of Ahmedabad City and its relation to air pollutant dispersion in the city

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Air pollution is a major problem around the world, and urban centres, having all kinds of emission sources and a large number of people living there, and with huge economic importance are very crucial. Ahmedabad City is the industrial hub of the western state of Gujarat, India. The city is host to almost 3000 industrial units, which includes 855 chemical factories, 511 foundries, 300 textile plants, and it also has one coal-fired power plant (400 MW). The present study has two parts. First, the development of a meteorological profile of Ahmedabad City based on 10 years of meteorological data (2010-2019), which was acquired from Ahmedabad station of India Meteorological Department (IMD) and second, the study of air pollution dispersion to understand how various meteorological parameters affect the pollutant dispersion and ambient air quality in the city. For this, emission data of 26 stacks from 20 industries of the textile industry cluster were analysed for SO2, NO2, and PM (TSP). AERMOD (AMS/EPA Regulatory Model) was used to simulate air quality in the city and to analyse how meteorological parameters can affect the pollution dispersion under various meteorological conditions. The output of meteorological pre-processor, AERMET were used to generate the meteorological profile of the city based on the parameters such as surface heat flux, Monin-Obukhov length, convective and mechanical boundary layer generation, and its dynamics, surface friction velocity, convective velocity scale, etc. Temporal evolution and dynamics of these meteorological parameters were studied on the daily, diurnal, seasonal, and annual timescales. The 24-hour, monthly, and annual average pollutant concentration from dispersion study were analysed and compared with the National Ambient Air Quality Standard (NAAQS). The results showed that annual average concentration for none of the pollutants was breached while 24-hour average values breached for considerable times. Also, the horizontal (spatial) concentration gradient for each pollutant was analysed for the same meteorological conditions, to study how different dispersion of different pollutant changes under the same meteorological conditions. The study can be scaled-up to assess the seasonal atmospheric carrying capacity of airshed of Ahmedabad city. It can also be useful for strategic town planning, site selection for industries, simulating various emission scenarios, and selecting the most efficient option for pollutant reduction for industries.

Investigating how the U.S. insurance industry could be impacted by the use of comprehensive flood maps: Hurricane Harvey Case Study

Steph Hodsman
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There is a vast number of uninsured properties in the US for flood protection. When hurricane Harvey hit Texas in 2017, less than 20% of the properties affected had flood insurance. Private insurers have blamed this on the lack of detailed and useable flood data in the US market.

Modelling inland flood and its interaction with storm surge from hurricanes can be very difficult. Currently, the most widely used maps in the US are those developed by the Federal Emergency Management Agency (FEMA) in the 1970's. Whilst the flood maps for many

areas have been updated since the first FEMA release, it is widely accepted that many areas remain significantly out of date. These maps have proven to be deficient in the recent hurricane seasons, and therefore there is a gap in the market for comprehensive inland flood maps to be created. These are crucial for the market, to provide insurers and reinsurers with a complete understanding of river, surface water and storm surge flood risk. At JBA Risk Management, we have developed a national US inland flood map to a 5m resolution. We have addressed the insufficiencies of other comparable datasets that are available; this includes incorporating the interaction between storm surge and river flooding, increasing the maximum volume of rainfall we incorporate into our models to accommodate the probable maximum flood (PMF) and developing a new method to represent defences. The JBA 5m US Flood Map has been cross-referenced with the areas known to have flooded during Hurricane Harvey. I will investigate how the proportion of claims may have differed had these maps been available prior to 2017 and discuss how the use of comprehensive flood maps can play a role in reducing the flood protection gap in the US.

Meteorological influences on lightning strength in a changing climate
Isabel Smith
University of Reading, Final Year Undergraduate on an Integrated Masters
Due to lightning's violent and dangerous nature, it was the purpose of this research project to understand how lightning discharge may change in regards to climate change. The majority of scientific literature around this subject focuses on the frequency of lightning. There is a gap in the literature for studies investigating how much the cloud itself is being electrified and the overall current output of the storm. If the electric field builds to even greater values, then much more damaging strikes will be evident in future thunderstorms across the UK and the world. More protection will be a necessity for areas already potentially experiencing damages. The key methodology of the investigation is to understand and quantify the relationships between meteorological/climate variables and lightning peak current. Understanding how these variables are likely to change could give an insight on future lightning strikes. The data used was sourced from the ECMWF ERA5 data file and the lightning detection system LINET. A case study period of the 1st and 2nd of November 2012 was elected due to the surplus of lightning strikes within a storm system over the English Channel at this time. An important objective of this project was to find an appropriate way to compare two very physically different quantities. Lightning strikes are instantaneous discharges, whereas the ERA5 data are calculated hour averages over large grid spaces. Conclusive funding's are still under investigation, but variables such as surface temperature, convective available potential energy (CAPE) and low-level convergence have the strongest correlations at this time.

Weatherproofing for a smarter, resilient and more sustainable agri-sector
Joanna Raymond
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Over the last 1-2 decades, the UK has been one of many countries observing plateaus in key crop yields, despite farming practice innovations such as the adoption of precision agriculture and advanced plant breeding programmes. The agricultural industry also continues to witness strong yield impacts arising from inter-annual weather variability. Evidently, identification and development of climate-resilient crop varieties is a key priority. We are quantifying the specific impact of weather variability on wheat, sugar beet and

oilseed rape production with a focus on process understanding through crop modelling. Given that the UK imports almost half of its food each year, our focus extends to international supply chains. We present examples of the development of ‘best in class’ historical time-series records of key agro-meteorological variables by inter-comparing and combining different types of in-situ and remotely sensed observational and re-analysis products (including MÉRA). We will showcase early findings of the added value of applying these datasets to the (a) modelling of UK crop yield, (b) interpretation of inter-annual crop production data, and (c) production of long-term UK agro-climatological averages, such as drilling dates.