RMetS Virtual Student & Early Career Scientists Conference 2021

Poster Titles and Abstracts | Monday 28 and Tuesday 29 June 2021

1 - Pressure Drag for Shallow Cumulus Clouds: From Thermals to the Cloud Ensemble
Jian-Feng Gu, University of Reading

This study takes the first step to bridge the gap between the pressure drag of a shallow cloud ensemble and that of an individual cloud composed of rising thermals. It is found that the pressure drag for a cloud ensemble is primarily controlled by the dynamical component. The dominance of dynamical pressure drag and its increased magnitude with height are independent of cloud lifetime and are common features of individual clouds except that the total drag of a single cloud over life cycle presents vertical oscillations. These oscillations are associated with successive rising thermals but are further complicated by the evaporation-driven downdrafts outside the cloud. The horizontal vorticity associated with the vortical structure is amplified as the thermals rise to higher altitudes due to continuous baroclinic vorticity generation. This leads to the increased magnitude of local minima of dynamical pressure perturbation with height and consequently to increased dynamical pressure drag.

2 - Quantifying Rainfall Seasonality across South Africa on the basis of the Relationship between Rainfall and Temperature
Sarah Roffe, Postdoctoral Fellow, University of Witwatersrand

South Africa spans the subtropics at the interface between tropical, subtropical, and temperate weather systems, and consequently experiences distinct summer-, winter- and year-round rainfall zones (SRZ, WRZ and YRZ). Spatio-temporal characteristics of the various weather systems are broadly understood, however, the rainfall seasonality classification at the transition between these rainfall zones remains disputed. This surrounds the complexity of rainfall regimes, however, metrics with dissimilar rainfall seasonality definitions have been applied, hindering comparability. To address this dispute, meteorological data spanning 1987–2016 from 46 weather stations is used to assess the utility of a metric posited to quantify rainfall seasonality through a seasonality score derived from a ratio of monthly rainfall: temperature. This score statistically discriminates SRZ, WRZ and YRZ conditions, fulfilling an important requirement for a metric applied to South Africa. Nelspruit (NEL; score = 1.59) represents the strongest SRZ conditions across 30 eastern and central locations with scores > 0.30. Cape Town Wo (CTW; score = − 1.04) represents the strongest WRZ conditions across seven southwestern Cape and west coast locations with scores < − 0.30. Characterising the SRZ-to-WRZ transition region with scores from − 0.30 to 0.30, nine YRZ locations were classified. With the weakest score, Oudtshoorn (OUD; score = − 0.05), within the Cape Fold mountains, most represents YRZ conditions. Applicability across all weather stations, compatibility with known rainfall drivers, and agreement with known spatial rainfall seasonality characteristics demonstrates the ratio's utility. Strong correspondence of scores between station and gridded data applications demonstrates additional confidence in the ratio, establishing its value for further application.

3 - The Local and Remote Atmospheric and Human Health Impacts of Africa's 21st Century Aerosol Emission Trajectory
Chris Wells, PhD Student, Imperial College London

Aerosols are a major climate forcer, but their historical effect has the largest uncertainty of any forcing, and so their mechanisms and impacts are not well understood. Due to their short lifetime, aerosols have large impacts near their emission region, but they also have effects on the climate in remote locations. In recent years, studies have investigated the influences of regional aerosols on global and regional climate, and the mechanisms that lead to remote responses to their inhomogeneous forcing. Using the Shared Socioeconomic Pathway scenarios (SSPs), transient future experiments were performed in UKESM1, testing the effect of African emissions following the SSP3-RCP7.0 scenario as the rest of the world follows SSP1-RCP1.9, relative to a global SSP1-RCP1.9 control. SSP3 sees higher direct anthropogenic aerosol emissions, but lower biomass burning emissions, over Africa. Experiments were performed changing each of these sets of emissions, and both. A further set of experiments additionally accounted for changing future CO2 concentrations, to investigate the impact of CO2 on the responses to aerosol perturbations. Impacts on radiation fluxes, temperature, circulation and precipitation are investigated, both over the emission region (Africa), where microphysical effects dominate, and remotely, where dynamical influences become more relevant.

4 - Climatology and Evolution of Synoptic and Mesoscale Environments for Banded Precipitation in Extratropical Cyclones over the UK and Ireland
Tianhang Zhang, PhD Student, University of Manchester

Banded precipitation in extratropical cyclones can produce heavy rain or snow and occur in situations associated with strong winds, which can disrupt society, causing damage, injuries, and sometimes death. Although many studies investigate the formation of banded precipitation, few studies focus on its whole lifetime. Therefore, it is important to investigate synoptic and mesoscale changes in environmental conditions to better understand the dynamical and structural evolution of banded precipitation. In this study, radar observations are used to establish a climatology of banded precipitation in the UK. Preliminary results from November 2019 to April 2020 are used to calculate the lifetime and types of banded precipitation relative to its parent extratropical cyclone (e.g., narrow cold-frontal band, warm-frontal band, warm-sector band). Most banded precipitation during this period was located to the southeast of the cyclones and along the coasts, suggesting that the land–ocean contrasts (e.g., temperature, humidity, friction) may be important for the intensification of the bands. Several typical cases will be chosen and then analysed by ERA5 reanalysis data and modelled using the Weather Research and Forecasting (WRF) model. The aim is to investigate the change in synoptic and mesoscale environmental conditions of banded precipitation. This study will address the following questions:

1. How did low-level frontogenesis and upper-level winds change during the life cycle of banded precipitation in my cases?
2. How did the temperature advection influence the evolution of banded precipitation?
3. Was instability (symmetrical, conditional, and inertial instability) important in the life cycle of the bands in these cases?
4. How did the latent heating influence the evolution of banded precipitation?

5 - Biases in Two Leading Seasonal Forecast Systems
Ned Williams, PhD Researcher, University of Exeter

The chaotic nature of the global circulation means that future climate dynamics, and consequently the spatial character of climate variability and change, require large ensembles of predictions. However in climate predictions months to years ahead a 'signal-to-noise paradox' has been observed, where the sign of anomalies (e.g. positive/negative NAO) is correctly predicted despite large ensemble spread, but the magnitude of the modelled anomalous signal is inconsistently weak given the correlation with observations. An improved understanding of the origin of this phenomenon may allow for significant improvement in climate predictions, and a potential cause is model biases. The biases in the mean state and interannual variability of sea level pressure and upper tropospheric zonal wind in northern hemisphere winter (DJF) seasonal forecasts from two centres (UK Met Office GloSea5 and ECMWF-IFS) are analysed and presented. These biases have been calculated by comparing to two different reanalyses (JRA55 and ERA5) with two different climatological periods in order to test robustness. Preliminary results include a weaker Aleutian Low and less variability in the North Atlantic Oscillation in models than reanalyses, and biases in the mean state have been found to be more robust to the use of a different reanalysis period than biases in variability. These biases may lead to incorrect predictions of tropical-to-extratropical teleconnections.

6 - Borderless Heat Stress
Chloe Brimicombe, PhD Researcher, University of Reading

Heatwaves pose an ever increasing risk to African Communities. Exposure to a heat extreme can have a drastic change to an individuals' life and in some cases can even result in death, it also directly impacts infrastructure, for example, power lines. This project, uses ERA-5 reanalysis data of the UTCI – a bio-meteorological heat stress index- and temperature, to study the climatology and trends of heat at different scales and forecasting of heat extremes. Further, atmospheric drivers of extreme heat will be discussed with specific mention to North African synoptic systems. All of this together, will provide the evidence for the development an early warning system and the implementation of climate change adaptation to build resilience to heat stress.

7 - Incorporation and Evaluation of the CRI v2.2 Chemical Mechanism in UKESM1: An Alternative Mechanism with Updated Isoprene Chemistry for Investigating the Influence of BVOCs on Atmospheric Composition and Climate
James Weber, PhD Student, University of Cambridge

We present the first incorporation and evaluation of the Common Representative Intermediates version 2.2 chemistry mechanism, CRI v2.2, for use in the United Kingdom Earth System Model (UKESM1). Tuned against the MCM v3.3.1, the CRI v2.2 mechanism builds on the previous CRI version, CRI v2.1, in UKESM1 (Archer-Nicholls et al., 2020) by updating isoprene chemistry and offers a more comprehensive description of tropospheric chemistry than the standard chemistry mechanism STRAT-TROP (ST).

CRI v2.2 adds state-of-the-art isoprene chemistry with the introduction of HOx-recycling via the isoprene peroxy radical isomerisation pathway, making UKESM1 one of the first CMIP6 models to include this important chemistry. HOx-recycling has noticeable effects on oxidants in regions with large emissions of biogenic volatile organic compounds (BVOCs). Low altitude OH in tropical forested regions increases by 75-150% relative to ST, reducing the existing model low bias compared to observations. Consequently, isoprene surface mixing ratios decrease considerably (25-40%), significantly improving the model high bias relative to ST. Methane lifetime decreases by 2% and tropospheric ozone burden increases by 4%.

Aerosol processes also differ between CRI v2.2 and ST, resulting in changes to the size and number distributions. Relative to ST, CRI v2.2 simulates an 8% decrease in the sulphate aerosol burden with 20% decreases in the nucleation and Aitken modes. By contrast, the secondary organic aerosol (SOA) nucleation mode burden increases by 11%. Globally, the average nucleation and Aitken mode aerosol number concentrations decrease by 20%.

The differences in aerosol and gas phase chemistry between CRI v2.2 and ST are likely to have impacts on the radiation budget. We plan to use CRI v2.2 and ST to investigate the influence that the chemical mechanism has on the simulated chemistry-climate feedbacks from BVOCs. In addition, CRI v2.2 will serve as the basis for the addition of a scheme describing the formation of highly oxygenated organic molecules (HOMs) from BVOCs, facilitating a semi-explicit mechanism for new particle formation from organic species.

8 - Forgotten Accounts of Tropical Cyclones Making Landfall in Tanzania
Hellen Msemo

Landfalling tropical cyclones are basically unheard of in Tanzania. It has been suggested that cyclone Kenneth, which occurred in 2019, was the first tropical cyclone to make landfall in Tanzania. This paper brings to light tropical cyclones that made landfall in Tanzania in 1872 and 1952. We draw on eye-witness accounts and meteorological observations to raise the profile of these seemingly forgotten tropical cyclones, which devastated lives and economic activities. The severe societal impacts, and potential link to climate change, of landfalling tropical cyclones in Tanzania encourages further investigation into the drivers of tropical cyclones in the southwest Indian Ocean.

9 - Using High Resolution Climate Models to Investigate Atmospheric turbulence
Isabel Smith, PhD Student, University of Reading

Atmospheric turbulence has a serious, dangerous, and costly impact on aviation. Turbulence makes up the majority of weather-related inflight injuries and costs the global aviation sector up to $1 billion US every year. Upper-level turbulence can be broken down into four main types: Clear-Air Turbulence (CAT), Convectively Induced Turbulence (CIT), Near-Cloud Turbulence (NCT), and Mountain Wave Turbulence (MWT). Aviation is often impacted by CAT, which is not visible on radar and is therefore very hard to detect. Previous literature has shown that climate change is strengthening CAT globally, with increased severity particularly over the North Atlantic, a busy flight route, within the winter months. These findings have been based on CMIP3 and CMIP5 climate models, which have now been superseded by CMIP6 models with higher resolution. The purpose of this project is to build on these previous findings

using the CMIP6-HighResMIP PRIMAVERA simulations at resolutions between more than 100 km and about 20 km to understand the dependence of CAT metrics on resolution. Further study to look at resolving individual patches of CAT in the atmosphere and investigating CIT are still on going. However, current results suggest that indices used to diagnose turbulence, especially those involving horizontal gradients, are highly dependent on the resolution of the climate model. This behaviour is expected, because higher-resolution models can resolve sharper gradients at the grid scale. This confirms that calibrated threshold values for light, moderate, and severe turbulence are model-dependent rather than universal.

10 - Urban Flood Risk in Dhaka Bangladesh: Basic Statistical Characteristics and Trends of Rainfall in Dhaka Bangladesh (1953-2019)
Farzana Ahmed Mohuya, PhD Researcher, Newcastle University

Dhaka, the capital city of Bangladesh lies on the lower reaches of the Ganges Delta, one of the major and most densely populated cities in South Asia. Urban flooding from extreme rainfall is a recurring phenomenon, with historic floods in 1988, 1998 and 2004 amongst the most catastrophic events in Dhaka. Prolonged urban flooding or water logging is a major concern for both Dhaka North and South City Corporation areas over the years. This research will explore how “Citizen Science” or “Crowd Science” could help individuals, communities and organisations understand and manage the risk of current and future urban flooding integrated with the formal flood risk management of the city. Furthermore the study will explore extreme rainfall patterns and trends and how they influence urban flooding given climate change and variability. Preliminary results on initial rainfall data analysis for Dhaka will be presented.

11 - Austral Summer Droughts and their Driving Mechanisms in Observations and Present-day Climate Simulations across Malawi
Emmanuel Likoya, Post Graduate Researcher, University of Leeds

The societal relevance of droughts in Africa underscores the need for improved understanding of the atmospheric processes that drive them. This study examined drought characteristics across Malawi, and the associated atmospheric circulation patterns, in observations, reanalysis and global climate models. Droughts were identified using the Standardised Precipitation and Evapotranspiration Index (SPEI) for the period 1965 to 2018. Atmospheric circulation patterns during droughts were examined and the main moisture fluxes into Malawi were identified. Despite differences in the frequency, and events being asynchronous at times, droughts exhibited characteristics that were statistically similar between northern and southern Malawi. Droughts in both regions were associated with anomalous circulation that typically worked to diminish moisture advection and thus convection. Differences in the structure of the anomalies were indicative of differences in mechanisms associated with droughts in the north and south of Malawi. Three main moisture flux pathways were identified, and categorized as northeasterly, southeasterly, and northwesterly, each with a unique correlation structure with precipitation and global SSTs. Positive and negative biases of varying magnitudes were noted for drought and rainfall characteristics across the range of CMIP5 models. Such biases can be attributed to biases in moisture fluxes whose variability was found to be a key driver of summer precipitation variability across Malawi. Despite biases in moisture fluxes and their influence on precipitation biases, the majority of models exhibited moisture flux-precipitation

correlations consistent with observations and reanalysis. Results from the study highlight the extent to which climate models are reliable in simulating droughts and therefore of value in developing narratives of climate variability essential for long-term development planning.

12 - Mixed-Phase Clouds' Microphysical Properties in the Southern Ocean under Different Synoptic Conditions Observed during CAPRICORN I and II Field Campaigns
Estefania Montoya Duque, PhD Student, University of Melbourne

Large biases in the radiation budget over the Southern Ocean (SO) continue to exist in climate models and reanalysis products, which are largely attributed to a poor understanding of clouds and precipitation in this region. This limited knowledge is due, to a significant degree, to sparse observations available in this remote region. In response to the need for better understanding the SO climate system and improving model simulations, unprecedented field campaigns were carried out in the Australian Sector of the SO from March 2016 to April 2018, providing a rich dataset for studying clouds, aerosols, precipitation, radiation and their interactions.

In this study, we investigate the cloud and precipitation processes from synoptic to micro scales using observations from the shipborne field campaigns (CAPRICORN 2016 and 2018) aboard the RV Investigator. An overflight during the SOCRATES field campaign which provides concurrent in-situ observations was also analysed. Using shipborne data collected by the cloud radar, lidar, disdrometer and radiosonde soundings, we characterise the cloud and precipitation properties under different synoptic scenarios (i.e. synoptic regimes, distance from cyclones and fronts). Cloud radar reflectivity, Doppler velocity, and lidar attenuated backscatter are examined using the Contour Frequency by Altitude/Temperature Diagrams (CFADs/CFTDs) to provide direct insight into the cloud thermodynamic phase and microphysics. Overall, clouds associated with frontal and cyclonic activities are characterised by deeper structure, more heterogenous microphysical processes and heavier precipitation. Clouds associated with other regimes are relatively shallow, where non-precipitating particles are more commonly present in the lower troposphere. The SOCRATES overflight associated with a warm front regime reveals a variety of ice habits observed across a range of temperatures below freezing, consistent with our interpretation of the CAPRICORN data. Enhanced ice production likely due to rime splintering is notable between 0 and -5°C when the aircraft was around the RV Investigator.

13 - Jet Tilt and the Understanding of North Atlantic Jet Variability and Regimes
Jacob Perez, PhD Student, University of Leeds

The Polar Jet Stream (PJS) is the main driver of extreme weather events occurring in the mid-latitudes in the Northern Hemisphere. The ‘Beast from the East’, that brought high levels of snowfall and flooding to the UK in Feb 2018, is a key example of such an event. It is essential to be able to forecast the position of the PJS over the North Atlantic to accurately predict these weather events.
Recent studies have shown that the PJS occupies three preferred states, or regimes, over the North Atlantic during the winter representing a Northern, Central and Southern located jet. Each of the regimes influence the surface weather differently, but it is unclear what drives each of the regimes and how the mechanisms that causes the PJS to transition between them.

One limitation of current 1-D analyses of the jet latitude index is that they rely on sectoral averaging over the North Atlantic basin, thereby smoothing out the tilted structure of the jet which is a canonical feature of the circulation in the North Atlantic. This study applies an approach to reanalysis data (ERA5) that attempts to account for both the jet latitude and tilt, thereby extending earlier analyses. We consider the extent to which cases with a Greenland tip jet influence the North Atlantic jet latitude index and whether accounting for the tilt of the jet provides additional information about jet variability. Plans for future work will be outlined, with the intent to derive/develop a dynamical systems model that captures the regimes of the PJS, with the intent to use this model for further studies.

14 - Identifying and Quantifying the Origins of Extreme Rainfall in South Africa Using Storm Track Analysis and Unsupervised Machine Learning Techniques

Rhys Phillips, Undergraduate, University of Bath

Extreme weather events, in particular extreme rainfall events, have a detrimental impact on both human life and infrastructure – regularly being ranked as one of the number one risks globally. Climate change is likely to exacerbate the frequency and impact of extreme weather events and so developing an understanding of the underlying causes of events such as extreme rainfall will be key to improve infrastructure resilience and the prediction of such events for early warning systems. This will be particularly important for countries more vulnerable to flooding and with lower infrastructure resilience.

Traditional rainfall and river flood estimates are based on the statistical analysis of historical information, often with a factor added to account for future climate change impacts, however, these methods fail to capture the underlying causes of these highly destructive events. In order to develop a deeper understanding of the processes that cause these extreme weather events the storm tracks – the pathways that the air parcels took prior to rainfall being recorded – for a series of historical maximum daily rainfall events in South Africa will be extracted using the HYSPLIT method and clustered into distinct groups using unsupervised machine learning techniques. By extracting and clustering storm tracks the pathways that moisture took prior to being deposited as precipitation can be identified and correlated with known atmospheric processes in the region.

This will allow a quantification of the contribution of different atmospheric systems to extreme rainfall events in terms of the frequency of the events and the volume of rainfall. This understanding will facilitate improved early warning systems based on monitoring atmospheric systems and parameters as well as improving the prediction of design floods for civil engineering infrastructure.

15 - Dispersion of PM2.5 during Transboundary Haze in Greater Kuala Lumpur, Malaysia.

Jayaprakash Murulitharan, PhD Student, University of Cambridge

Trans-boundary haze is a major annual air pollution occurrence in Malaysia during the south west monsoon season (between February to May and August to October). During this season which also experiences dry and hot weather, ASEAN Specialised Meteorological Center

(ASMC) has been reporting the increase of biomass burning hotspots particularly in Sumatera and Kalimantan which includes forest areas and peatlands. The meteorological conditions play a significant role in transporting smoke from Kalimantan and Sumatera to Malaysia which eventually leads to the rise of the Air Pollutant Index (API) in Malaysia. A major pollutant that has been incorporated into the API since 2017 in Malaysia is Particulate Matter 2.5 (PM2.5) which is a major air pollution load and is closely associated with acute and chronic respiratory illnesses such as pneumonia and chronic bronchitis, cardiovascular diseases such as coronary heart disease, congestive heart failure, and premature death. This research aims to explain the association of PM2.5 in smoke-haze and to understand the dispersion of PM2.5 in Klang Valley, Malaysia during the trans-boundary haze. The research will analyse air pollutant parameters and meteorological parameters from 8 Continous Monitoring Stations and analyse samples from 3 manual stations in Klang Valley, Malaysia from the year 2018-2020. The research would involve the development of chemical measurements of aerosol species to understand the sources and extensive analysis of observations and modelling. The research would be contributing towards a methodology to generate predictions of PM2.5 driven haze to be incorporated into the existing National Haze Action Plan in Malaysia which would allow improvisation of mitigation actions by relevant agencies and reduce the significant impact towards public health during trans-boundary haze. The current analysis of hourly averaged PM2.5 data's in 2019 shows evidence of wind and PM2.5 concentration correlation during trans-boundary haze.

16 - Thunderstorm Modeling with WRF: Parametrization Study for Istanbul
Ilgar Akalin, Meteorological Engineering Student, Istanbul Technical University

The intensity and frequency of severe weather events have been changed due to global climate change, thus forecasting these events has been a necessity to detect potentially dangerous situations. It is easier than ever to make realistic predictions and accurate analysis, with the help of increased computing capacity of modern processors and improved numerical weather prediction models. Furthermore, the increase in developed and newly created options also led to the improvement of model performance. These options can perform depending on the case, therefore each case has to be treated uniquely as every parametrization set may not suit well for specific situations. In this study, a thunderstorm event that occurred in Istanbul on 26 September 2017 was investigated. WRF v4.2.2 model has been used to simulate the case by using the Global Data Assimilation System (GDAS) data with 0.25° resolution as an input with three-nested domains. To get optimum results, different parameter combinations for microphysics, boundary layer, and cumulus options were used for several runs in the WRF model. Results were compared with observations and the statistical analysis made with various error metrics.

17 - Investigating the Phase Composition of Mixed-phase Clouds
Erin Raif, Undergraduate Student, University of Leeds

Understanding the persistence of mixed-phase clouds (clouds formed of both ice particles and liquid water droplets) is vital to better predicting the effects of cloud feedback mechanisms on climate change. Current models do not represent mixed-phase clouds well, and they are poorly understood theoretically. Using a 2D kinematic model, this project investigated the persistence of mixed-phase clouds by considering the impact of realistic microphysical

assumptions on the long-term evolution of the liquid water content (LWC) of the clouds. With a three-phase ice microphysics scheme, two mixed-phase cloud profiles were simulated with a variety of initial ice concentrations and updraught speeds.

Interim results show that cloud-average LWC undergoes damped harmonic oscillations about a steady-state value of LWC. The level of damping is strongly negatively correlated to the steady-state LWC, which in turn is related to the updraught speed and ice concentration. It is thought that these oscillations may be caused by the sublimation of falling graupel and snow at the bottom of the cloud, but ongoing further investigations are required to explain this effect and develop a mathematical relationship between LWC, damping time and ice concentration.

18 Monsoonal Flood-Risk Maps for Power Substations in Malaysia
Wenzhu Li, PhD Student, University of Manchester

The northeast monsoon between November and March brings heavy rainfall to Malaysia. Continuous rains often cause flooding and affect infrastructure and human well-being. In recent years, Malaysia has been increasingly hit by severe flooding, with two 1-in-50-year flood events occurring in late 2014 and late 2020. Although some studies have investigated the formation of monsoonal flooding in Malaysia, its impact on power-system infrastructure is still to be well understood. Substations are a key element in the power supply network and previous flood events have highlighted their vulnerability across many regions of Malaysia. Based on the preliminary statistics above, this study will firstly employ recorded rainfall and flooding data to set up different scenarios, and secondly, generate rainfall and flood regression curves for each scenario. Finally, the fitted curves will be overlain with the performance indicators (e.g., elevations of substations, flood protection measures) of substations to predict when and where they will be affected by flooding. This study will produce flood-risk maps for electrical power substations under different flooding scenarios, which will benefit power-system planners and operators in Malaysia and other countries in early flooding prevention and post-disaster mitigation.

19 - Impact of Global Modes of Variability on Rossby Wave Packets during Southern Hemisphere Summer
Iago Pérez, PhD Researcher, Universidad de la República (Uruguay)

Rossby Wave Packets, or RWPs are key to extending the forecast range. The goal of this study is to understand the impact of low-frequency climate modes on the statistics of RWPs during Southern Hemisphere summer. We focus on long-lived RWPs, (lifespan above 8 days), and study how El Niño-Southern Oscillation (ENSO) and Southern Annular Mode (SAM) affect their frequency of occurrence and the main areas where RWPs develope and disappear. To do so, we use daily meridional winds at 300 hPa during December to March in the period 1979 to 2020 taken from the NCEP-DOE dataset. The methodology to track RWPs is based on Zimin et al (2003). Results show that the maximum number of long-lived RWPs are detected in El Niño years and negative SAM events. Years with the highest numbers of long-lived RWPs detected display a narrow and zonally symmetric upper level jet which is shifted northwards from the climatological position. Nonetheless, a small number of long-lived RWP is observed when the jet is shifted southward in the southwestern Pacific basin. Thus, negative SAM favours the generation of long-lived RWPs and positive SAM does the opposite. El Niño establishes atmospheric conditions that increase the appearance of long-lived RWPs whereas

La Niña years present high interannual variability in the number of long-lived RWPs detected. Furthermore, during El Niño events a main formation area is detected between 61-120ºE and a main dissipation area between 301-360ºE, while during La Niña events, the main formation area moves to 241-300ºE and no main area of dissipation is observed. In positive SAM events, two main formation areas are detected at 61-120ºE and 241-300ºE, and two main dissipation areas are located between 61-120ºE and 241-300ºE. Finally, during negative SAM only one main formation area at 241-300ºEº is detected and no main dissipation area is observed.

20 - Storm Properties of Tropical Cyclones over Bay of Bengal and the Arabian Sea as Observed by GPMDPR
Sunil Khadgarai

The Indian subcontinent extends southwards into the Indian Ocean with the Arabian Sea (AS) to the southwest and the Bay of Bengal (BoB) to the southeast. Most of the Coastal regions are highly vulnerable to the consequences of tropical cyclones form over two basins. We have investigated the storm macro/microphysical properties of Tropical Cyclones (TC's) in the light of different regions in TC's over the BoB and the AS for the period of 2014-2019 using GPM-DPR swath data. During the study period, 20 cyclone cases are examined. Reflectivity factor (Ze), storm top height (STH), near-surface rain rate, bright band height and width, and mass-weighted mean diameter (Dm) from the GPM-DPR products are used for the analysis. Stroms from over BoB show active bright band features and larger Dm, dominantly in the eyewall region of TC's. Surface rain rate and STH are higher in the case of BoB irrespective of different areas within TC's. Nevertheless, different rainfall regimes such as stratiform and convective within eyewall, inner rain band, and an outer rainband region depict apparent differences in terms of surface rain rate and storm height over BoB and AS. Stratiform rain puts a significant contribution to total rainfall in BoB prominently in eyewall region. Two-dimensional histogram analysis using Dm and Z at different heights reveals that the coalescence process seems to be much prominent for convective nature precipitation than stratiform in EW and IB regions. Break up process has broader distribution in the EW region over BoB. However, this feature is not present over AS. Overall, the microphysical drop growth/breakup processes are dominant in convective rainfall regimes dominantly over the eyewall region. Though the breakup process is hardly observed in stratiform rainfall regimes, it is significantly observed in eyewall regions of cyclones over AO. The relative availability of moisture over BoB influences the drop growth over BoB, dominantly in eyewall region.

21 - The Schools Clean Air Monitoring Project in Abingdon (SCAMPA)
Abingdon Science Partnership, Science Ambassadors, Abingdon School

The Schools Clean Air Monitoring Project in Abingdon (SCAMPA) involved thirteen primary and secondary schools in deploying nitrogen dioxide diffusion tubes and particulate matter sensors attached to Raspberry Pi microcomputers as well as collecting daily weather observations and using survey methods to investigate air quality. Sixth form students have supported younger pupils through configuring hardware, writing air quality science briefing sheets and producing web platforms for analysis and display of data collected. Pupils at the schools involved will be submitting reports on their findings to a competition sponsored by the Abingdon ATOM Festival of Science and Technology and the University of Oxford's Department of Physics. The project was funded by a schools outreach grant from the Royal

Society of Chemistry and supported by the Royal Meteorological Society Education Committee.

22 - Winds and Tides of the Antarctic Mesosphere and Lower Thermosphere: One Year of Meteor Radar Observations over Rothera (68°S, 68°W) and Comparisons with WACCM and eCMAM

Shaun Dempsey, PhD Student, University of Bath & British Antarctic Survey

Tides are crucially important to the dynamics of the MLT. Therefore, models which aim to span the whole atmosphere must be capable of reproducing these tides, making observations of tides vital to constrain model development. Here, we present a novel climatology of 12- and 24-hour tides, measured at heights of 80–100 km by a meteor radar over the Rothera Station, Antarctica (68°S, 68°W). We use these observations to test two GCMs: WACCM and eCMAM (the latter 24-hr only). Our observations reveal large-amplitude tides with strong seasonal variability. The 12-hour tide maximises around the equinoxes and the smaller-amplitude 24-hour tide maximises in summer. WACCM reproduces 12-hour tidal amplitudes at 80 km well, but not their increase with height or equinoctial maxima, and reproduces the observed small variation in 24-hr tidal amplitude with height well but with anomalously-large amplitudes. eCMAM reproduces observed 24-hr tidal amplitudes and their small variation with height. Our observations also reveal sizeable day-to-day variability in tidal amplitude at planetary wave periods, which we suggest originates from non-linear tidal/planetary-wave coupling. Furthermore, we see notable differences between observed and model background winds which are not reproduced in the models; we propose these differences may arise from the lack of in-situ gravity-wave sources in the models.

23 - The Global Impacts of the Madden-Julian Oscillation

Daniel Skinner, PhD Student, University of East Anglia (UEA)

The Madden-Julian Oscillation (MJO), discovered in the early 1970s, is one of the key modes of instability in the tropical atmosphere. The MJO is characterised by an area of increased convection (in its active phase) which moves eastward from the eastern Indian Ocean to the western Pacific over the course of 1-2 months. Its effects are seen in different weather systems around the globe. The energy released by increased convection over the tropical warm pool excites Rossby waves in the upper troposphere which in turn propagate that energy into the extra-tropics, interacting with jet streams and other systems. These interactions are known as teleconnection patterns.

Methods for diagnosing MJO events will be discussed, along with some analysis of how teleconnection patterns present in different meteorological phenomena. The study will combine model data from the Coupled Model Intercomparison Project phase 6 (CMIP6) data archive with reanalysis data to assess how well these teleconnections are being represented in the current suite of coupled atmosphere-ocean models.

Plans for further research will be briefly highlighted, including the need to consider how climate change may effect MJO teleconnection patterns and how we can consider teleconnections for other modes of tropical instability.

24 - Estimation of Air Pollution Effects for Dilovası Region by using BenMAP-CE Program

Zeynep Feriha Ünal, Masters Student, Istanbul Technical University

It has been proven by many scientific studies that air pollution directly affects almost every living being and their ecosystem. In addition to that, air pollution effects continue to differ and current effects increase day by day. The impact analysis of air pollution caused by natural causes and anthropogenic causes for human life includes especially health, economy, agriculture and the estimation of potential future air pollution effects are valuable for deciding on new ways to reduce air pollution. There are many low-populated industrial regions near to big cities such as Istanbul and Ankara in Turkey. In this study, the Dilovası region is selected as a target region due to being a low-populated industrial region close to Istanbul and proved to be a region in which related air pollution diseases and death due to air quality conditions. While making air pollution impact estimations on health and economic aspects, the Environmental Protection Agency's BenMAP-CE program and Dilovası's air pollution data were used. Since the most available data is found on particular matter and nitrogen dioxide and due to their effects on the human body, these pollutants are more focused for Dilovası region. In this study, it is aimed to show expressing how much this region is affected by air pollution is significant to increase the public awareness and to help reduce existing air pollution in this area. For the final point, it is necessary to say this study carries the feature of being one of the first studies in this particular field in Turkey.

25 - Sub-daily Extreme Rainfall in Europe: Climatology and Dynamical Drivers

Anna Whitford, PhD Student, Newcastle University

Sub-daily extreme rainfall events are a major driver of flash flooding in Europe, particularly in urban areas and in small steep catchments. These events often occur with little warning due to the difficulties of forecasting small-scale extreme events. There is also a consensus that the frequency and intensity of these events will increase as global temperatures rise. This means we urgently need to improve our understanding of the processes driving these events and find better methods of forecasting when they may occur.

Large-scale atmospheric circulations are much easier to model and forecast than individual rainfall events. Therefore, this project aims to identify relationships between these dynamical drivers and the occurrence of extreme sub-daily rainfall. This information can then help to predict when extreme rainfall and flash flooding may occur.

A climatological analysis of the frequency, intensity and timing of extreme sub-daily events in Western Europe has been undertaken using a set of newly developed indices generated from the quality-controlled Global Sub-Daily Rainfall (GSDR) dataset. The results of this analysis show strong seasonal and spatial patterns in the characteristics of extreme events across Europe. Individual extreme events have been extracted from the GSDR dataset and correlated spatially and temporally with weather patterns from the Met Office set of 30 weather types, to identify the conditions that tend to produce extremes. Subsequently, this information will be combined with reanalysis data to build a detailed understanding of the atmospheric conditions leading to extreme hourly rainfall across Europe.

26 - Statistical Analysis of Aerosols Hygroscopicity based on Observation over Western Ghats, India

Avishek Ray, PhD Student, Indian Institute of Tropical Meteorology Pune

Hygroscopicity determines the capacity of water uptake by the particles under given atmospheric conditions such as temperature and relative humidity. It controls the size (hygroscopic growth) and refractive index of aerosols thus it impacts visibility and direct radiative forcing. Hygroscopicity is also highly related to aerosols' activation to Cloud Condensation Nuclei and hence plays a role in cloud formation. So, for the first time in India, a long term (May 2019 – April 2020) size segregated observation was conducted at High Altitude Cloud Physics Laboratory (HACPL) at Mahabaleshwar (17.92º N, 73.66º E; 1378m AMSL) using Humidified Tandem Differential Mobility Analyzer (HTDMA). The hygroscopic growth factor for dry diameters ranges from 32 nm to 260 nm was measured with the help of HTDMA at 90% relative humidity and the hygroscopicity is calculated. The entire observation period is divided into two categories: (1) Maritime airmass (2) Continental airmass period. Hygroscopicity is higher in pre-monsoon (March to May) and monsoon (June to September) time due to the presence of higher hygroscopic sea salt as marine aerosols dominate during this period. Continental aerosol dominating during October to February period and hence hygroscopicity is comparatively lower for all the measured diameters. Particles having diameter of 50 nm and 150 nm, the hygroscopicity is 0.206 and 0.186 respectively in maritime airmass period and in continental airmass period those values reduced to 0.162 and 0.158, respectively. In both periods, the hygroscopicity value reduces till 75 nm diameter and thereafter it increases till the last observed diameter of 260 nm. A prominent peak is observed in the early morning time for all the diameters in the maritime period, but the diurnal variation curve is almost flat for the continental period except for 32 nm diameter for which there is one secondary peak at evening time along with the early morning primary peak. Further chemical analysis of particles will be used for better understanding of the seasonal and diurnal variation of hygroscopicity.

27 - Numerical Simulation of Tropical Cyclones in the Philippines using the Weather Research and Forecasting (WRF) and Cloud-Resolving Storm Simulator (CReSS) model.

Kate Esguerra, Science Research Specialist, DOST- Philippine Atmospheric, Geophysical and Astronomical Services Administration

The Philippines is situated between the western part of the Pacific Ocean and the South China Sea which subjects it to numerous tropical cyclones that form in the northwestern Pacific (NWP) basin. With these tropical cyclones that occurred near the Philippine archipelago, it impacted numerous socio-economic hazards brought by the tropical cyclone induced precipitation. In this study, two (2) numerical prediction models namely Cloud Resolving Storm Simulator (CReSS) and Weather Research and Forecasting was assessed to simulate two (2) tropical cyclones that occurred on 2018; Typhoon Mangkhut (Local name: Ompong) occurred on September 13-15, 2018 and Tropical Depression Usman that occurred on December 28-29, 2018. In addition, this study aims to investigate the performance of the models in capturing the track and precipitation of each cases. Generally, both models were able to capture the track of an intense tropical cyclone well but performed poorly when capturing the track of a weak tropical cyclone at tropical depression intensity. In terms of the capturing the central

pressure of each tropical cyclone, CReSS outperformed WRF however WRF surpasses the performance of CReSS in capturing the maximum wind speed of the tropical cyclones. The analysis on the precipitation shows that CReSS produced overestimated precipitation on both cases than of WRF. This overestimation was possibly caused by the high relative humidity of CReSS than of WRF and resulted in a domain-wide higher precipitation value.

28 - Meteorological Analysis of Floods in Ghana
Samuel Ansah, Meteorologist, Ghana Meteorological Agency

The first episodes of floods caused by heavy rainfall during the major rainy season in 2018 occurred in Accra (5.6°N and 0.17°W), a coastal town, and Kumasi (6.72°N and 1.6°W) in the forest region on the 18th and 28th of June, respectively. We applied the Weather Research and Forecasting (WRF) model to investigate and examine the meteorological dynamics, which resulted in the extreme rainfall and floods that caused 14 deaths, 34076 people being displaced with damaged properties, and economic loss estimated at $168,289 for the two cities according to the National Disaster Management Organization (NADMO). The slow-moving thunderstorms lasted for about 8 hours due to the weak African Easterly Wave (AEW) and Tropical Easterly Jet (TEJ). Results from the analysis showed that surface pressures were low with significant amount of moisture influx aiding the thunderstorms intensification, which produced 90.1 mm and 114.6 mm of rainfall over Accra and Kumasi, respectively. We compared the rainfall amount from this event to the historical rainfall data to investigate possible changes in rainfall intensities over time. A time series of annual daily maximum rainfall (ADMR) showed an increasing trend with a slope of 0.45 over Accra and a decreasing trend and a slope of –0.07 over Kumasi. The 95th percentile frequencies of extreme rainfall with thresholds of 45.10 mm and 42.16 mm were analyzed for Accra and Kumasi, respectively, based on the normal distribution of rainfall. Accra showed fewer days with more heavy rainfall, while Kumasi showed more days with less heavy rainfalls.

29 - Impact of Users' Feedback on Weather Forecast Evaluation in Ghana, West Africa
Maureen Ahiataku

Evaluation of issued weather forecasts is essential for ensuring user trust is maintained and where possible advanced. A major way to evaluate issued forecasts is by real-time in situ data collection, which enables co-benefits for both forecast producers and users in terms of: (i) active participation of users in local evaluation of the skill of forecast models and, (ii) expanding on the available resources for advancing operational forecasting. In most of West Africa including Ghana, there are limited weather stations for recording meteorological data so the obvious alternative is through engaging users in a 'citizen science' method of data collection. Ghana has seen an increase in demand for timely and accurate weather/climate services as most users raise concerns on the untimely nature of forecast communication, with accompanying limited access and practical advice on likely impacts. Communication gaps in weather and climate service delivery have been identified as a key challenge to the operation of the Ghana Meteorological Agency. The growing trend in the use of social media was thus leveraged on to communicate weather forecasts and warnings to public users to aid early warning systems for disaster risk reduction. This study assesses users' feedback from five different WhatsApp platforms on three rainfall events that occurred on the 10th, 28th and 30th May 2020 across Ghana for forecast evaluation in tandem with both user feedback and the

available rain gauge network. In areas where there are no gauges to obtain rainfall information on the event's occurrence, distribution and intensity, this feedback helped in evaluating the skill of the forecast models. This forms a basis for collaborative improvement of forecast models, with users appreciating their respective contributions. The users' feedback conforms with most areas that experienced the rainfall events and this approach increases users' level of confidence and trust in issued forecasts.

30 - Control of the Dust Vertical Distribution in the Saharan Air Layer by Convection and Scavenging

Habib Senghor, Postdoc, National Agency of Meteorology of Senegal (ANACIM)

We focus on the meteorology of a large dust storm produced over the Sahara on 27th June 2018 and the subsequent transport of dust away for the region of emission. The dust raised was transported across the Atlantic and was detected over the USA 3 days later. Dust was initially lifted by a haboob, a type of dust storm produced by strong winds along the leading edge of a convective cold pool (LECCP). Haboob occurrence strongly impacts the annual variability of airborne desert dust in northern West Africa with more dust raised from erodible surfaces in the early summer (monsoon) season when deep convective storms are common but soil moisture and vegetation cover are low. Here, we use satellite observations, ground-based measurements and the Weather Research Forecast model coupled with the Chemistry/Aerosol module (WRF-Chem) simulations to describe the mesoscale processes and estimate the dust concentration during and after the event. Dust mass estimated from Moderate-Resolution Imaging Spectroradiometer (MODIS) Aerosol optical depth (AOD) at 550 nm show that approximately 93% of emission was removed from the atmosphere between sources (10°N–25°N; 1°W–8°E) and the African coast (6°N–21°N; 16°W–10°W). Comparisons between observations and simulations show that WRF-Chem reproduces observed dust aerosol distribution and meteorological fields in the entire domain. Model and Observations show that the main dust sources are located in the region of southern Algeria, northeast Mali, and northwest Niger. The WRF-Chem Convection-permitting model (CPM) shows strong 10 meters winds which induced a large dust emission along the LECCP. The CPM indicates that approximately 6171 tons of dust were transported over the West African coast [16°W-10°W; 6°N-21°N] and available for long distance transportation on 27th June between 1100 and 1500 UTC. As well as raising a large amount of dust the studied haboob caused considerable damage along its route.

31 - The Unusual 2019/2020 QBO Disruption in Aeolus Wind Lidar Observations

Timothy Banyard, Postgraduate Student, University of Bath

The quasi-biennial oscillation (QBO) is a regular cycle of alternating winds which dominates the behaviour of the tropical stratosphere. It is extremely technically challenging to model, and for this reason wind observations are vital to understand it fully. Characterised by downward propagating easterly and westerly regimes, the QBO progressed uninterrupted for more than 60 years until a highly anomalous deviation from its normal pattern in 2016. During 2019/2020, the start of a second disruption was seen in atmospheric analyses and radiosonde observations. Here, we exploit novel data from the European Space Agency's Aeolus satellite to demonstrate its ability to measure the QBO in unprecedented detail. A special adjustment of Aeolus' onboard range bin settings was implemented to observe this new disruption as it

happened, providing a unique platform for studying the evolution of the event and the broader atmospheric effects triggered by it. In this presentation, we will show results from this special mode, highlighting how it has helped study the disruption, and how Aeolus and similar satellites can deepen our understanding of the QBO more generally.

32 - A Parametric Seasonal Model for Extreme Discharge Events in the La Plata Basin based on Climate Indices.
Melanie Meis, Post-Doctoral Researcher, CIMA, CONICET

Monitoring and forecasting the possible occurrence of extreme events is crucial for any country. Particularly, this work focuses on the ones that take place in river's discharges. We propose to analyse extreme streamflow events in the La Plata Basin. We start by obtaining the diphase between NIÑO 3.4, SOI, PDO indices and seasonal discharges. Based on this result, we align the series and use the copula method to fit a joint distribution. We end up with a model that is particularly useful for quantifying the probability of occurrence of extreme events and monitoring their return periods. The results obtained might be useful for the decision makers, by expanding their set of available tools for assessing options for mitigation of negative impacts related to discharges.

33 Updating and Improving DMS Oxidation Chemistry in Earth System Models
Bea Cala, MPhil Student, University of Cambridge

Natural aerosols contribute to large uncertainties in understanding changes in the climate system. A major precursor to aerosol is DMS (dimethyl sulfide), a gas released by phytoplankton in the sea surface. The CLAW hypothesis postulates a negative climate feedback loop between phytoplankton, DMS emissions, aerosols, and cloudiness, with DMS acting as a climate regulator. However, evidence to support this hypothesis has been lacking. But now our understanding of DMS in the climate system is being questioned by the recent discovery of a new DMS oxidation product, HPMTF (hydroperoxy methylthioformate). Currently, little is known about the fate of HPMFT in the atmosphere and its impacts. The data suggests that a majority of DMS is oxidized via the formation of HPMTF, a mechanism never before considered and not implemented in climate models.

Here, a box model is set up to investigate DMS oxidation chemistry including new, possible HPMTF chemistry. The mechanistic sensitivity of the chemical system is quantified, and the mechanism constrained by available observations. The impacts of this mechanism will be tested in the global UKCA model, running simulations of the pre-industrial atmosphere, the present-day and the year 2100 with the updated chemistry.

As of now, the implications on the climate are uncertain but could be significant: The formation of HPMTF to be extremely temperature dependent, potentially enabling strong climate feedbacks. Oxidation of DMS to HPMTF recycles OH (hydroxyl radical), which could have wider implications for the atmosphere's oxidizing capacity. With a faster pathway for DMS oxidation, the mechanism likely also impacts aerosol and cloud formation in the marine boundary layer.

The fate of HPMTF is uncertain but it presumably will alter our understanding of the marine sulfur cycle and help re-evaluate the CLAW hypothesis.

34 - Soil Moisture: The Need of Multiple Sources Facing Data Gaps
Lucía Cappelletti, PhD Student, Universidad de Buenos Aires

Soil water storage is a variable that controls multiple processes and feedbacks within the climate system, intervening in water and energy balances. In recent years, significant progress has been made in the characterisation of soil moisture (SM) at regional scales, through remote sensing estimates and the implementation of new in situ networks. Each of these databases has intrinsic characteristics, such as the dynamic range of the SM and the temporal frequency of acquisition. Another relevant factor is the period of data availability. In this context, this paper analyses and exposes different sources of SM data gaps over long periods of time, using information from in situ stations and from the SMOS and SMAP satellite systems. In addition, examples are presented that show the relevance of examining the availability of information and the importance of considering various sources of information.
The study focuses on a sector of the Pampean Plains (Argentina) with advantages such as relatively homogeneous landscapes in terms of land types and land use, and an extremely flat topography, in addition to having in situ measurements of SM. These advantages, alongside the fact that the region is not irrigated, experiences marked seasonal dynamics and a synchronised cropping rhythm, offer a natural laboratory of SM conditions. The study period covers April 2015 - November 2019.

35 - Temporal Characterization of the Urban Heat Island (UHI) of Buenos Aires City
Malena Lozada Montanari, PhD Student, CIMA-CONICET / DCAO-UBA

Urbanization produces one of the most dramatic changes introduced by humans in an ecosystem: a natural environment with vegetation and a permeable surface becomes an urban landscape accompanied by the introduction of new surface materials. These modifications cause surface temperatures to rise several degrees compared to temperatures in nearby suburban or rural areas, particularly during the evening hours. This phenomenon is known as Urban Heat Island (UHI) and its magnitude is calculated as the difference in temperature between urban and rural/suburban areas.

This work describes the temporal variability of the Urban Heat Island in Buenos Aires, Argentina. Buenos Aires is one of the world's largest cities. The metropolitan area extends for around 3900 km2 and has 13.9 million inhabitants. This highlights the need to advance in a major knowledge of urban climatic conditions.

The UHI is analysed using 40-year hourly temperature data for the period 1978-2017. Temporal evolution of the mean annual temperature in the meteorological reference stations shows positive trends, but this result is not observed in the intensity of the UHI. Nocturnal UHI shows significant negative trend annually but also in winter and summer, whilst diurnal IUC shows an opposite behavior with significant positive trends, although of smaller magnitude.

36 - Assimilation of Conventional and Satellite Observations in a Deep Convection Case during RELAMPAGO using the WRF-GSI-LETFK System
Paola Corrales

The impact of assimilating high-resolution surface networks and satellite observations using the WRF-GSI-LETKF is evaluated. This is the first attempt to use the GSI system in Argentina

as well as to assimilate satellite radiances in a regional context. We conducted a case study corresponding to a huge mesoscale convective system (MCS) developed over central and north-eastern Argentina during November, 22th. The accumulated precipitation observed during the transit of the MCS was quite high with values over 200 mm over the northern part of the domain. This MCS developed during the Intense Observing Period (IOP) 08 (Severe, Upscale Growth handoff) of the RELAMPAGO field campaign during Nov. 2019.

Analysis with 10-km horizontal grid spacing were produced with GSI-4DLETKF assimilating observations every hour from 11/20 18Z to 11/23 12Z at 10 minutes time slots. We used a 60-members ensemble which at the first assimilation cycle is initialized from the deterministic GFS run adding random perturbations with climatological covariance. A multiphysics approach is also used to represent model errors. The ensemble members used different physics configurations (a combination of PBL and convection parameterizations). Four assimilation experiments were conducted using different sets of observations: only conventional observations from prepBUFR (CONV), observation from prepBURF plus automatic station networks (AUT), the same as AUT plus satellite-derived winds (SATWINDS) and an experiment including satellite radiances from AMSU, HIRS, MHS, ATMS, AIRS and IASI (RAD). Ensemble forecasts initialized every 6 hours between 11/22 00Z and 11/22 06Z were also performed to evaluate the impact of the different observing networks. Results and conclusions from these experiments will be presented at the conference.

37 - Analysis of Rainfall Trends and Extreme Precipitation during the Minor Season of Ghana

Mohammed Braimah, Meteorologist, Ghana Meteorological Agency

Over the past few years, policymakers and the general public have raised concerns about increasing cases of rainfall and related floods during the minor season (September, October, November season) of southern Ghana. In this study, linear regression and Mann Kendall Test were used to establish trends of total rainfall amounts, and the total number of rainy days (frequency) during the minor season from 1981 to 2018. To better understand the recent behaviour of the minor season, we computed seasonal anomalies of rainfall for 2014, 2015, 2016, 2017, and 2018. Linear regression equations for most stations over southern Ghana show positive slopes for both rainfall and number of rainy days, a signal of an increasing trend. R - squared (coefficient of determination) values which were calculated show that rainfall variability between 0.7% and 10.4%, and variability in total rainy days between 3.3% and 27% were explained by the linear regression. Mann Kendall test results indicate dominantly non-significant trends of total rainfall amount but significantly increasing trends of the number of rainy days. The rainfall anomalies also give station by station rainfall extremes for recent years. The results of this work suggest that the frequency of rainfall in the minor rainy season between 1981 and 2018 has increased significantly but the total rainfall amounts in the season have not changed significantly. This work may serve as reference material for urban planning and flood prevention over specific areas in southern Ghana.

38 - Convective Response to Different Types of Idealised Environmental Forcing

Rebecca Smith, Student, University of Reading

One of the largest sources of uncertainty in general-circulation models (GCMs) comes from the representation of impacts of small-scale convective motions and cloud-related processes

on the resolved large-scale flow. Convective parameterisation (CP) schemes have been developed to represent these unresolved small-scale processes. Despite improvements in CP, there remains a wide range of uncertainties when simulating cloud feedbacks under a changing climate. Recent work under the ParaCon (Parameterisation of Convection) programme, jointly run by the NERC (Natural Environmental Research Council) and the UK Met Office has led to the development of a new generalised convection scheme known as CoMorph (Convection Morph). This study tests whether the CoMorph scheme better represents atmospheric responses to idealised forcings than the currently used CP scheme, named the MassFlux scheme. Results from single-column model simulations using these two CP schemes are compared to those obtained from a three-dimensional cloud system resolving model (CSRM), which explicitly resolves convection. All simulations are initially run to achieve radiative-convective equilibrium (RCE) and are the control simulations. Temperature or moisture tendency perturbations are first applied at two chosen levels and the simulations run again until a new RCE state is achieved. The difference of the vertical profiles at the RCE state between the perturbed and control simulations are taken as the response to the perturbation. The results show that the CoMorph scheme matches the response obtained in the CSRM more closely than those of the MassFlux scheme. To verify this, perturbations are then applied across all atmospheric levels for each scheme and resulting response matrices are generated. The results obtained confirm the improved performance of the CoMorph scheme. It is hoped that the results presented in this study will be of use to those developing the CoMorph scheme and will enable further evaluations to be conducted in the future.

39 - Analysing the Influence of Climate Change on Rainfall Forecasting using Machine Learning

Kiran Abdeljalek Torres, Undergraduate, University of Bath

Climate change has had substantial societal, economical and environmental impact in the United Kingdom. The most influential factors are the increase in frequency and magnitude of rainfall events. Currently, statistics-based climate models are used to produce long-range rainfall forecasts. However, machine learning methods are becoming an attractive alternative due to their ability to forecast anomalies and handle the non-linearity of rainfall and climate change. This study evaluates the importance of incorporating climate change into rainfall forecasting in the United Kingdom as a means of improving long-range forecasting accuracy. Three year-long rainfall forecasts were produced using five machine learning methods and monthly meteorological data ranging from 1971 to 2019 for one of four selected locations in the United Kingdom. Each model employs one of the five machine learning methods. Each of the five methods was trialled using different variables. The first set of variables included: precipitation, humidity and mean sea level pressure. The second expands on set one to include mean temperature, maximum temperature and minimum temperature. Finally, the third variable set substitutes the temperature variables from set two for climate change attributes, namely, a standardised value for a given month based on the mean temperature of that month within the dataset's range. A comparison of Root Mean Square Error (RMSE) values for each forecast showed a minimal difference between using no temperature attributes, raw temperature attributes and the calculated climate change attributes. An average of the forecasts for each combination of variables gave RMSE scores of 43.8, 41.8 and 42.6 mm of rainfall for sets one, two and three, respectively. The results challenge the initial assumption that rising temperature trends are responsible for increasing the magnitude

and frequency of rainfall events in the United Kingdom and suggest improvement in long-range rainfall forecasting accuracy by replacing temperature with other climate drivers.