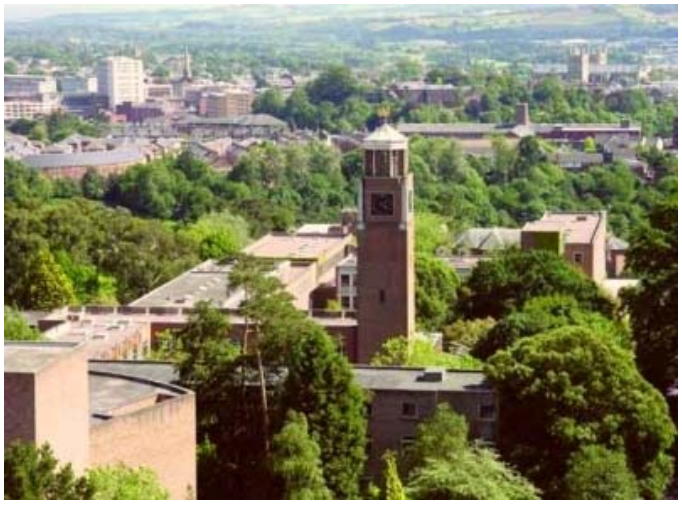
Welcome to the Royal Meteorological Society Student Conference on Atmospheric and Oceanic Sciences

30 June to 2 July 2011

University of Exeter



UNIVERSITY OF EXETER

PAGE BROS

World Meteorological Organization
Working together in weather, climate and water

June 2011

Dear All,

I would like to take this opportunity to welcome you to the Royal Meteorological Society Student Conference 2011. We have a broad selection of talks and posters this year, so I hope this conference will provide an enjoyable opportunity to exchange ideas with other PhD students and young scientists working in meteorology.

Many thanks to our sponsors, Page Bros and the World Meteorological Organization.

I look forward to meeting many of you during the course of the conference.

Best Wishes,

Flora MacTavish
Chair, RMets Student Conference 2011

Contents

1. Travel information, arrival and maps

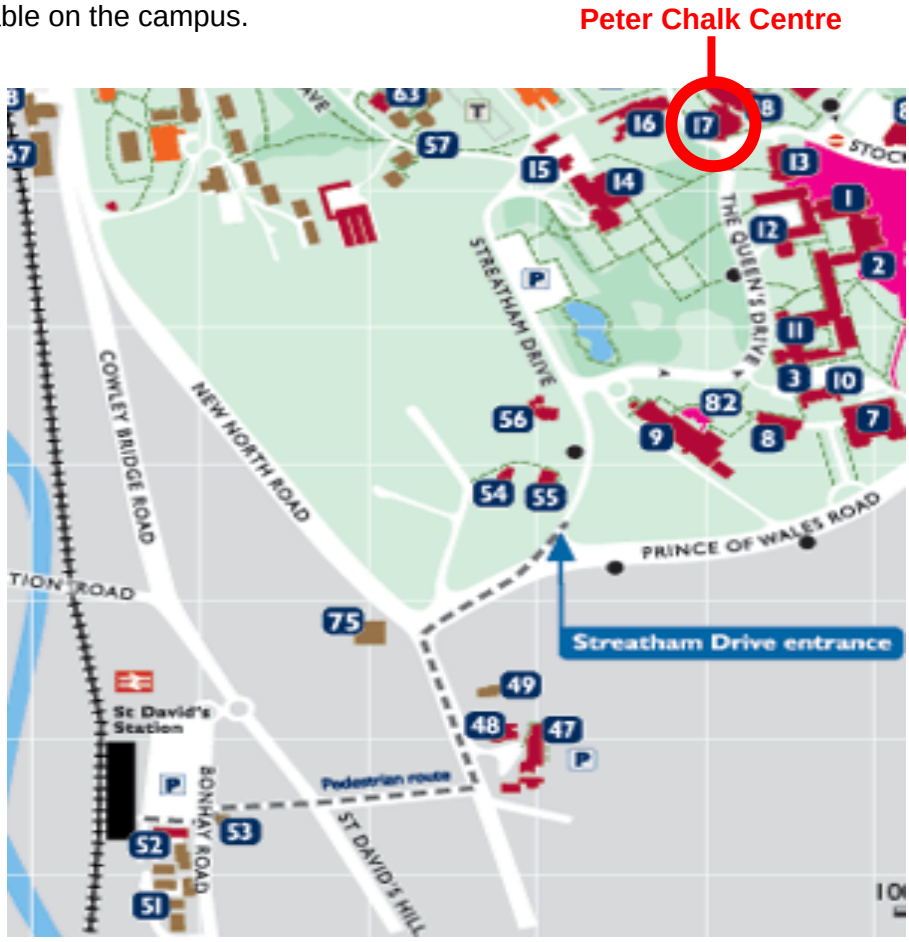
The conference will take place in the Peter Chalk Centre on the Streatham Campus, University of Exeter, with accommodation provided in Holland Hall also located on the Streatham Campus. **Please go to the Peter Chalk Centre upon arrival as this is where registration will take place.**

Please call Flora Mactavish (07788652157) or Vivien Bright (07841015817) if further assistance is needed.

1.1 Getting to the Streatham Campus, University of Exeter

On foot

The University is within easy walking distance of Exeter city centre. Map 1.1.1 below shows the location of the Streatham Campus, plus routes between the Peter Chalk Centre and Exeter St David's and Exeter Central train stations, all within walking distance. Cycle parking is also available on the campus.



1.1.1 Map indicating route to from St David's station

By car

Satellite navigation postcode: **EX4 4QJ.**

The M4/M5 links Exeter directly to London, the Midlands, South Wales and the North including Scotland. The average journey time from either London or the Midlands is 3 hours.

From the M5

Leave at Junction 29, signed Exeter Airport.
• At the traffic lights at the end of the motorway off slip road, turn right onto the B3015, signed City Centre, and at the first roundabout turn right, signed Exeter Business Park.
• Go straight over at the next two roundabouts, signed Pinhoe, and join the Monkerton Link Road. At the traffic lights bear left onto the B3212, signed City Centre. Take the right-hand lane and at the second set of traffic lights turn right, signed University.
• Pass under the railway bridge (Polsloe Bridge), drive up the hill and at the fourth set of traffic lights turn right onto Mount Pleasant Road, signed University. (Henry's Bar is on the corner of this junction).
• At the first roundabout take the second exit onto Union Road. Go straight over at the first set of traffic lights onto Prince of Wales Road.
• Continue along Prince of Wales Road and the **University's Streatham Drive entrance** is on your right, please use this entrance.

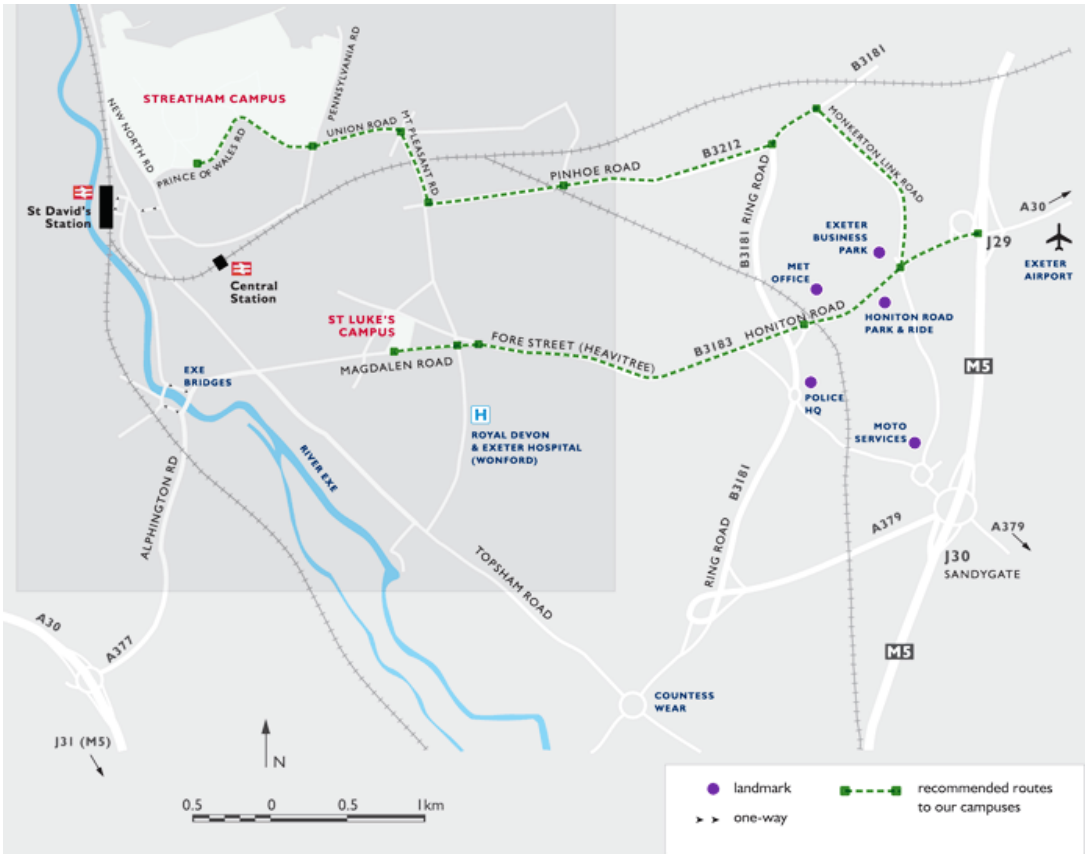
From the East via the A303/A30

After the junction with the M5 (J29) follow the signs for Exeter Business Park. The route then follows the directions given under 'From the M5'.
From the West via the A30
If you are unfamiliar with Exeter or are travelling at peak times, when this route can be congested, we recommend that you join the M5 and follow the instructions from Junction 29.

• Alternatively, leave the A30 at the Dawlish and Marsh Barton turning. Turn left at the large roundabout into Alphington Spur (A377), which becomes Alphington Road. Continue on this road until the large Exe Bridges roundabout; Riverside Leisure Centre is on your left.
• Take the third exit (Bonhay Road), signed Exeter St David's station. After passing the station on your left, turn sharp right at a double roundabout onto St David's Hill.
• Turn left at the first mini roundabout and then left at the next set of traffic lights into New North Road. Take the second right into Streatham Drive and the **University's Streatham Drive entrance** is on your left, please use this entrance.

By bus/coach

The Streatham Campus is served by the D and H bus routes. The **D** bus route includes Digby, St Luke's Campus, the City Centre and Streatham Campus. For the D bus timetable: http://www.stagecoachbus.com/PdfUploads/Timetable_9244_D.pdf. The **H** bus route includes the RD&E hospital, St Luke's Campus, the City Centre, St David's station, Cowley Bridge and Streatham Campus. For the H bus timetable: http://www.stagecoachbus.com/PdfUploads/Timetable_9114_H.pdf



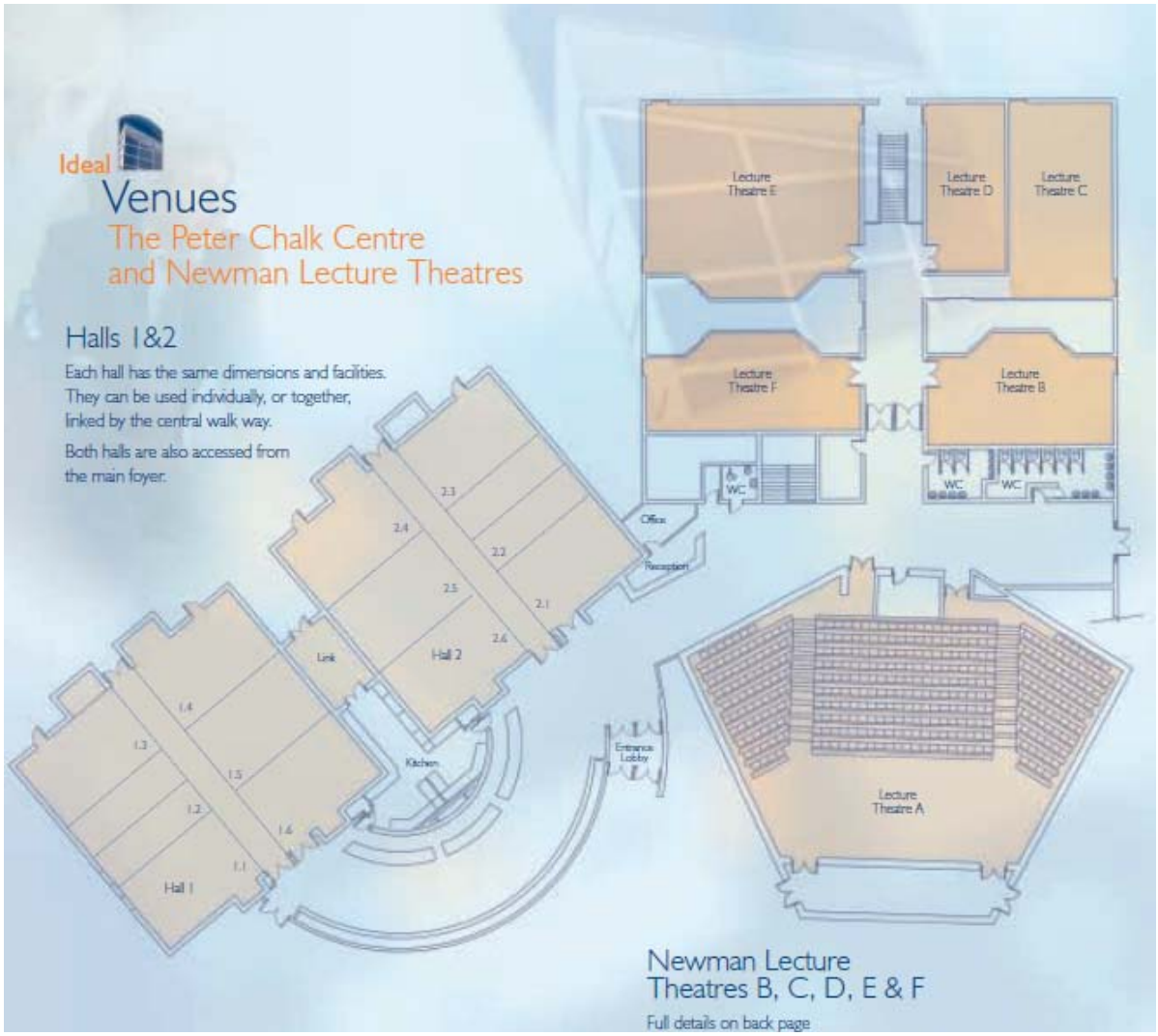
1.1.2 Map indicating route to Streatham campus

By rail

Exeter has two railway stations - Exeter St David's (main station) and Central. Exeter St David's Station is approximately 10 minutes walk from the Streatham Campus and taxis are also available. Taxis can also be found outside the main entrance to the station (turn right at the exit). The average journey time from London Paddington is 2 hours 30 minutes to Exeter. To get to the Streatham campus from Exeter St David's please see map 1.1.1.

1.2 Peter Chalk Centre

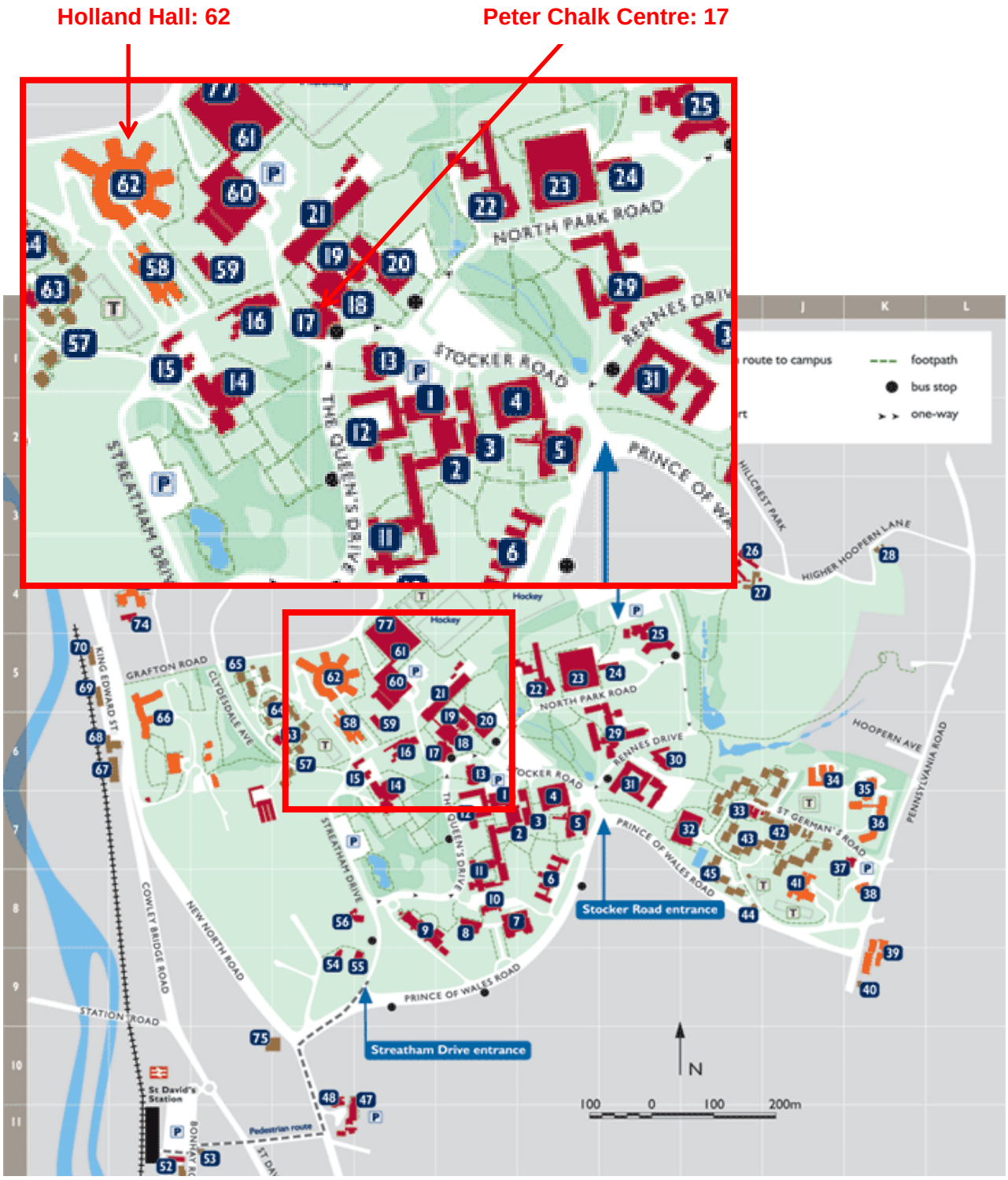
The Peter Chalk Centre is located on the Streatham Campus indicated as building 17 on Maps 1.1.1 and 1.3.1. Registration, lunch, tea and coffee will all be held in Peter Chalk Centre, Hall 2 and posters will be displayed here throughout the conference (see 1.2.1 below). The first session, talks from International Scientists, held jointly with the main conference, will be held in Newman Lecture Theatre A. All other sessions will be held in Newman Lecture Theatre B.



1.2.1 The Peter Chalk Centre and Newman Lecture Theatres

1.3 Accommodation at Holland Hall

Accommodation provided within the Conference Package is located at Holland Hall (building 62 on maps below) which is also located on the Streatham campus and is only a short walk from the conference facilities at Peter Chalk Centre (Map 1.3.1).



1.3.1 Location of Peter Chalk Centre and accommodation at Holland Hall

1.4 Arrival and overview

Upon arrival please go straight to the Peter Chalk Centre and **not** Holland Hall accommodation. Bags can be stored during the initial sessions in the Peter Chalk Centre. Registration will be held from 1130 to 1400 hrs on Thursday 30 June 2011 at the Peter Chalk Centre near the main entrance. If you arrive late on Thursday please contact Flora Mactavish on 07788652157 in order to arrange late registration.

Oral presentations will be collected by the committee during registration.

Posters should be put up during the **tea and coffee break on Thursday from 1630 hrs in Peter Chalk, Hall 2**. Posters will be displayed here throughout the conference. Poster boards are 2m high and 1m wide, Velcro fixing will be provided. The poster session will be held between 1600 and 1730 hrs on Friday giving the opportunity for delegates to talk to the presenters and ask questions related to their work. There will also be a prize, sponsored by the WMO, for the best poster. Posters should be **removed** from the boards by **1400 hrs** (the end of lunch on **Saturday**).

A joint session with the main conference will open the student conference on Thursday 30 June at 1400 hrs. From 1700 hrs onwards there will be a keynote talk delivered by Professor Sir Brian Hoskins CBE, FRS and Director of the Grantham Institute for Climate, 'Predictability beyond the deterministic limit'. The keynote talk will be followed by a careers session which will consider the career paths of an expert panel and will include a question and answer session. The panel will include Professor Sir Brian Hoskins CBE, FRS, Dr Nicola Ranger (Research Fellow, Centre for Climate Change Economics and Policy), Dr Heather Ashton (Hydro-meteorological forecast scientist at the Met Office) and Professor Paul Hardaker (Chief Executive of RMetS).

If you are staying in the **Conference Accommodation**, following the last session on day 1, delegates will be directed to the conference accommodation at Holland Hall, University of Exeter. You will be shown to the Hall of Residence in order to collect your room key and leave your bags.

If you plan to arrive outside the above mentioned times or have any questions please email sue.brown@rmets.org or, on the day, please call Flora Mactavish on 07788652157.

Following accommodation check in and up to half an hour of free time an evening of Ice Breakers will begin at 1900 hrs with dinner at Holland Hall followed by icebreaker activities until 2300 hrs at Holland Hall, during this period a cash bar will be available. All delegates are encouraged to attend providing an opportunity to meet other PhD students and early career researchers in an informal environment.

The Conference Dinner will be at Holland Hall on the Friday night which will include an after dinner speech given by Dr Vicky Pope (Head of climate science advice at the Met Office) whose areas of expertise include climate science relevant to policy and planning, climate modelling and communication of climate science. There is no dress code at the dinner.

1.5 Emergencies and useful contacts

Delegates who require special assistance in the event of an emergency evacuation should inform Holland Hall Reception. If you require assistance during the conference please call Flora Mactavish (07788652157) or Vivien Bright (07841015817).

1.6 Taxis

Local Taxi numbers include:

A1 Cars	01392 218 888
Capital Taxis	01392 433 433
Gemini Taxis	01392 666 666

1.7 Badge Information

Red coloured badges indicate RMetS Student Organising Committee Members

Blue coloured badges indicate RMetS Staff

White coloured badges indicate assembly delegates

2. Meals and local facilities

2.1 Breakfast

For those who have booked conference accommodation at Holland Hall breakfast will be served in the hall dining area from 07.30 until 8.30 on Friday 1st and Saturday 2nd July. If you are staying on the Saturday night, breakfast will be served on Sunday morning between 08.00 and 09.00.

2.2 Lunch

A buffet lunch is provided for ALL delegates between 1230 and 1400 hrs on Thursday and Friday and 1230 and 1400 on Saturday in Peter Chalk, Hall 2.

2.3 Evening Meals

2.3.1 Thursday 30 June 2011

Ice breaker meal at 1930 hrs will take place in Holland Hall. **Ice breaker events** will follow from 2030 until 2330 hrs in Holland Hall a cash bar will be available during this period.

2.3.2 Friday 1 July 2011

The Coference Dinner will take place at 1930 hrs in Holland Hall and will be followed by an after dinner speech. There is no dress code for this event.

2.4 Tea and coffee breaks

Tea and coffee will be served in Peter Chalk 2 from 1030 to 1100 hrs Friday and Saturday and again at 1530 to 1600 hrs on Friday.

2.5 Local facilities

There are a number of shops and a Natwest bank on the Streatham campus and the city centre is only a 15-minute walk away.

3. Business and timetable

3.1 Oral presentations

Presentations (excluding the joint session with the main conference) will be held in the Newman B Lecture Theatre. Each presentation should last for 12 minutes plus 3 minutes for questions (15 minutes in total). Please do ensure that you stay within the allotted time. You should bring your presentation on a memory stick and all presentations will be downloaded onto a central computer during registration at the beginning of the conference.

Please click on the following link for a list of the software provided on the conference centre computers: http://as.exeter.ac.uk/it/equipmentandsoftware/software/openaccess/. If you have any specific queries about computer equipment, please email Kathy Maxwell at Kathy.Maxwell@rmets.org

Speakers are asked to meet their session chairperson (wearing a committee member badge) at the front of the lecture theatre 10 minutes before the start of their session to ensure their presentations are ready to run.

- **All presentations must be pre-loaded to ensure they run**
- **Mobile phones must be switched off whilst in the main conference room**

3.2 Poster presentations

Posters should be put up on Thursday at 1630 and displayed in Peter Chalk, Hall 2. Posters will be displayed throughout the conference with the dedicated poster session held between 1600 and 1730 hrs on Friday. Presenters are required to stand with their poster during this session. Posters boards are 2 m in height and 1 m in width.

3.3 Internet access

Internet access is available at Holland Hall, free of charge, and is available for the duration of the stay for those that requested it at the time of registration.

3.4 Timetable

Thursday 30 June 2011

1130	Registration open (near entrance to Peter Chalk Centre)
1230	**Buffet lunch** – Peter Chalk, Hall 1 & 2
1400	**Joint session with Main Conference** – Newman Lecture Theatre A
1630	**Tea and coffee break** – Peter Chalk, Hall 2
1700	**Keynote talk: Predictability beyond the deterministic limit,** Professor Sir Brian Hoskins – Newman Lecture Theatre B
1800	**Careers session:** Panel Members to include Professor Sir Brian Hoskins, Dr Nicola Ranger, Dr Heather Ashton and Professor Paul Hardaker
1900	Check in for delegates staying at Holland Hall Reception
1930	**Ice Breaker Meal in Holland Hall dining room**
2030	**Ice Breaker in Holland Hall** – All delegates are encouraged to attend

Friday 1 July

0730 **Breakfast** for delegates staying in Holland Hall (Holland Hall dining room)

Please note: all oral sessions will take place in Newman B lecture theatre

Session 1: Atmospheric and Climate Modelling

Chair: Luke Smallman

0900 **Chimene Laure Daleu**

Modelling the interactions between tropical convection and large scale dynamics

0915 **Christopher Steele**

Devising a sea breeze selection method suitable for applications in wind power meteorology

0930 **Peter Watson**

The Holton-Tan relationship in the Met Office climate model

0945 **Jessica Standen**

Development of a Wind Atlas over the United Kingdom from Met Office forecast data

1000 **Aidan Brocklehurst**

The Effect of Building Design on Urban Energy Supply and Demand

1015 **Sajjad Saeed**
Precipitation variability over the South Asian monsoon heat low and associated teleconnections

1030 **Tea and coffee break**

Session 2: Climate: Past, Present and Future

Chair: Ross Maidment

1100 **James Pope**

Plio-QUMP: Quantifying Uncertainty in Model Predictions for the Pliocene

1115 **Clare Duggan**

Calibration and Validation of a Spectral Wind-Wave Model for the use in identifying the Past, Present and Future Wave Climate for the North Atlantic

1130 **Charlie Tomlinson**

Combining GIS and remote sensing techniques for spatial climate change adaptation risk assessment in the UK

1145 **David Whittleston**

Principal component analysis of atmospheric anomaly fields: a guide to constraining past, present and future rainfall over the Sahel

1200 **Robert Graham**

Multi-Decadal Variability of Southern Ocean Fronts

1215 **Thomas Cropper**

Air-Sea Interaction and Climate Variability in the Azores, 1870-2010

1230 **Emma Ward**

Teleconnections and their use for statistical downscaling of precipitation in the Peruvian Andes

1245 **Buffet lunch** – Peter Chalk, Hall 1

Session 3: Ocean Sciences, Hydrology and the Biosphere

Chair: Nuala Carson

1400 **Nuala Carson**

Landfast Sea Ice

1415 **Flora MacTavish**

The restratification after open ocean deep convection

1430 **Nataliya Frolova**

Biological Reception Possibilities of Dangerous Hydrometeorlogical Phenomena

1445 **Alex West**

Modelled slowdown in retreat of Arctic sea ice

1500 **Alistair McVicar**

Flow past topography in relation to the Antarctic Circumpolar Current

1515 **Matthew Donnelly**

Modelling the Lazarev Sea: An Inverse Approach to Determining Mass Transport

1530 **Tea and coffee break**

1600 **Poster Session – Peter Chalk, Hall 2**

Chair: Vivien Bright

1730 **Conference discussion session**

1830 **Return to Holland Hall and free time**

1930 **Conference dinner in Holland Hall with Guest Speaker Dr Vicky Pope**

Saturday 2 July

0730 **Breakfast for delegates staying in Holland Hall (Holland Hall dining room)**

Session 4: Weather and Small Scale Features

Chair: Zadie Stock

0900 **Simon Peatman**

Scale interactions between the diurnal cycle and organized tropical weather systems over the maritime continent

0915 **Tim Baker**

Modelling the Microphysical Sensitivities of a Secondary Frontal Wave

0930 **Alex Roberts**

Moist convective dust storms in the Sahara.

0945 **Johannes de Leeuw**

Moisture sources for the storms and UK flooding of Summer 2007

1000 **Sian Lane**

Measuring winds over London using a Doppler LiDAR

1015 **Wagner Nogueira Neto**

Street Canyon Ventilation using Wind Tunnel Modelling

1030 **Tea and coffee break**

Session 5: Atmospheric Chemistry, Composition and Dispersion

Chair: Imogen Heard

1100 **Imogen Heard**

A comparison of atmospheric dispersion model predictions with observations of sulphur dioxide and sulphate aerosol from volcanic eruptions

1115 **Lois Huggett**

Ash Dispersion from a Hypothetical Large Eruption of Katla

1130 **Zadie Stock**

The impact of mega-cities on regional and global atmospheric composition: a modelling study

1145 **Jim Walker**

Using laser light to trap and probe aerosol particles in the laboratory

1200 **Buffet lunch** – Peter Chalk, Hall 1

Session 6: Earth Observations and Data Assimilation

Chair: Jim Walker

1330 **Katie Lean**

Development of version 2 of the bias corrected AVHRR Pathfinder sea surface temperature dataset (1985-2008) for HadISST2

1345 **Peter Weston**

Accounting for correlated observation error in the assimilation of high resolution sounders

1400 **Tom Emery**

Combined 1Dvar retrievals using AMSU and IASI data

1415 **Joanne Pocock**

Errors of representativity

1430 **Chris Burrows**

Assimilation of GPS Radio Occultation data at the Met Office

1445-1530 **CLOSE**

4. Leaving the conference

4.1 Feedback sheets

Feedback sheets will be handed out during the conference. These should be completed and returned to one of the committee members before the end of the conference.

4.2 Facebook group

A facebook group called Royal Met Soc Student Members has been set up so feel free to join this. The group page will have information on the conference and will provide a good means of keeping in touch after the conference.

5. Conference abstracts- Oral presentations

Atmospheric and Climate Modelling

Modelling the interactions between tropical convection and large scale dynamics

Chimene Laure Daleu

Contact: chimenedaleu@yahoo.fr

A computationally cheap framework for examining the interactions between tropical convection and the large scale circulation is built based on the weak temperature gradient (WTG) approximation. The WTG approach is used to couple a Large Eddy Model (LEM) to a reference column through an approximation of large-scale (LS) circulation driven by convection. This is done under the assumption that the role of the LS circulation is to redistribute the density anomalies such as to maintain uniform density on isobarical surfaces. Results of experiments have been compared to previous studies. However, some differences and similarities will be highlighted. The same approach is extended to couple the LEM to another LEM. The equilibrium response of the coupled LEMs to symmetric boundary conditions and perturbed initial conditions is examined. The results allowed us to answer a fundamental question in tropical meteorology: Can (and if so how, and under what conditions, does) a LS circulation driven by convection develops in a homogeneous environment? Moisture and energy budgets are not strictly closed in the reference column approach. However, by choosing an appropriate representation of horizontal advection, the sensitivity of the coupled LEMs to closing the moisture and energy budgets is examined.

Keywords: Weak temperature gradient, large scale circulation

Devising a sea breeze selection method suitable for applications in wind power meteorology

Christopher Steele

Contact: christopher.steele@uea.ac.uk

Offshore wind power is expanding to the extent that 5.5GW of installed capacity will be reached by 2015. Since wind speed is highly variable and power output is proportional to its cube, it is vital that forecasts are accurate, if the demands of the national grid are to be met. Many studies, so far, have solely concentrated within, moderate to high wind speeds, but few have looked into low speed conditions; a situation that has been suggested to become more common due to climate change. During these conditions, the sea breeze, which has been known since the time of Aristotle but is still notoriously difficult to forecast, is a common feature. They are influenced by many factors, including; the synoptic pattern, land-sea thermal contrast, local topography, coastal morphology and land use. Thus far, little attention has been paid to the seaward extent of the system, especially when the cell fails to reach the coastline. It is the aim of this study to therefore determine, with the aid of data from offshore wind farms, the extent to which sea breezes influence wind power output and how well this can be modelled. The first part of the project involves producing a comprehensive sea breeze selection method, in order to identify suitable study periods. So far, NCEP final analysis have been used to determine weather types, using the Jenkinson-Lamb scheme, for the last decade. To aid in determining critical values for the method, the Weather Research and Forecasting (WRF) model has also been used to produce idealized simulations. The preliminary results of the selection method and case studies will be presented here.

Keywords: sea breeze, wind power meteorology, WRF

The Holton-Tan relationship in the Met Office climate model

Peter Watson

Contact: watson@atm.ox.ac.uk

The quasi-biennial oscillation of equatorial stratospheric winds is known to affect the development of the Northern hemisphere polar night jet, with a stronger, less disturbed jet with fewer stratospheric sudden warmings in years when the equatorial winds are westerly. This is known as the Holton-Tan relationship. The latest generation of climate models include a fully resolved stratosphere and provide an opportunity to examine this relationship taking into account full variability of the climate system over a time scale of several centuries. I will present analysis of output from the latest Met Office coupled ocean-troposphere-stratosphere general circulation model, including examination of which other factors may influence this relationship and whether the relationship shows non-stationary behaviour.

Keywords: QBO, extratropical stratosphere, Holton-Tan relationship, general circulation model

Development of a Wind Atlas over the United Kingdom from Met Office forecast data

Jessica Standen

Contact: jessica.standen@metoffice.gov.uk

The capability to produce a wind atlas over the United Kingdom from multiple years of forecasts from the Met Office Unified Model is currently being developed. The techniques used are based on a selection of the methods currently utilised by the Met Office for consultancy services to the wind renewables industry. Corrections are applied, where necessary, to the forecast data for orographic roughness and height differences, based on neutral linear theory. These corrections are necessary as the true orography is not fully represented in the model due to resolution. The effects of sub-grid scale orography are parameterised in the model, resulting in the forecast winds not being fully representative of the observed wind speeds, in particular over complex orography, where the wind speeds are often under forecast. After these corrections are applied the corrected wind speeds and directions are meaned to produce wind climatologies in the form of wind atlases. This presentation will discuss the development of this method, including the initial work to create a wind atlas at the same resolution as the model data, 4km, and will then go on to discuss the downscaling of the data onto a higher resolution grid to produce a higher resolution wind atlas.

Keywords: wind atlas, forecast, downscaling, climatology

The Effect of Building Design on Urban Energy Supply and Demand

Aidan Brocklehurst

Contact: a.f.brocklehurst@pgr.reading.ac.uk

The UK government aims to reduce CO2 emissions by 80% by 2050, and achieving this will require significant reductions in energy consumption by buildings, which currently account for 46% of national consumption (where the EU average is 40%). Most buildings that will be in use in 2050 are already built, so older buildings must reduce their energy use. Projected rises in average temperatures will cause a shift in energy demand between summer and winter, and overheating in summer months is becoming an increasing problem in cities such as London. Existing boundary layer models predominantly treat buildings very simplistically, often as a cube/canyon wall with a constant temperature, whilst models of building energy use may make simplifications regarding the external temperature. If an integrated modelling approach which incorporates anthropogenic heat flux can lead to a better understanding of internal temperatures then the threat of over heating in a warming climate can be examined. Buildings in Westminster use temperature projections based on Heathrow weather stations data, but summers in Westminster are hotter than at Heathrow. Examination of energy use for central London to the highest possible precision will enable prediction of how increased overheating will lead to greater summer time energy use and may lead to a higher risk of brownouts. This study aims to find out precisely which boundary layer conditions lead to high temperatures inside buildings and what impact overheating will have on energy use. Measurements of internal and external temperatures of a building in central London will be related to other micrometeorological measurements from rooftop and nearby weather stations and a station on top of the BT tower will provide an up to date background weather profile. The measurements will be interpreted using both simple 1D urban surface energy balance models and internal building temperature models.

Keywords: Overheating, Energy Use, Building Temperature

Precipitation variability over the South Asian monsoon heat low and associated teleconnections

Sajjad Saeed

Contact: sajjad.saeed@zmaw.de

The present study examines the precipitation variability over the South Asian monsoon heat low region and associated teleconnections using high resolution (T106L31) climate simulations performed with the ECHAM5 model. It is found that an intensification of the heat low in response to enhanced precipitation / convection over northwestern India-Pakistan (NWIP) can induce large-scale circulation anomalies that resemble the northern summer circum-global teleconnection (CGT) wave-like pattern extending well into the Asian monsoon region. Accordingly the wave-like response to rainfall increase over the heat low region is associated with anomalous ascent over northern China and descent over the South China Sea. Additionally, small but statistically significant lead-lag correlations between the heat low and precipitation over northern China further suggest that the detected signal pertains to the true features of the process. On the other hand, suppressed convection and rainfall over the heat low region do not reveal any significant large-scale circulation anomalies.

Reference:

Saeed, S., W. A. Müller, S. Hagemann, D. Jacob, M. Mujumdar, and R. Krishnan (2011), Precipitation variability over the South Asian monsoon heat low and associated teleconnections, Geophys. Res. Lett., 38, L08702, doi:10.1029/2011GL046984.

Plio-QUMP: Quantifying Uncertainty in Model Predictions for the Pliocene

James Pope

Contact: eejop@leeds.ac.uk

The mid-Piacenzian Warm Period is an interval of Earth history when global temperatures were sustained at 2 to 3°C above pre-industrial values, caused at least in part by higher levels of CO2 in the atmosphere (~380 to 425 ppmv). With a palaeo-geography almost identical to today, this interval provides an opportunity to examine the potential long-term effects of global warming through the use of modelling studies and data comparison. However, the uncertainty in model predictions of mid-Piacenzian climate has not been explored. The aim of Plio-QUMP (Quantifying Uncertainty in Model Predictions for the Pliocene) is to produce uncertainty estimates for model predictions by creating a series of ensembles based on Perturbed Physics in the UK Met Office Climate Model. Here we show results from an initial perturbed physics ensemble using the Hadley Centre Coupled Climate Model Version 3 (HadCM3). The ensemble was created using a single climate model and perturbing the parameterisations of sub-grid scale processes (elements of the climate system that happen on a scale smaller than the resolution of the climate model). Three simulations where run, a Pliocene Standard, a High Sensitivity and Low Sensitivity simulation. The high sensitivity simulation perturbs the settings of 33 parameters in the model so that in combination they produce the highest possible equilibrium climate sensitivity, with the opposite in place for the low sensitivity simulation. The model results where tested using two palaeo-datasets, a sea surface temperature dataset produced by the USGS Pliocene Research Interpretation and Synoptic Mapping (PRISM) group and a vegetation dataset produced in Salzmann et al., (2008). This enables the model results to be thoroughly tested and the results showed that the high sensitivity simulation performed best compared to the SST dataset, but was not as strong when compared to the vegetation dataset as the standard version of HadCM3.

Keywords: Perturbed Physics Ensemble, Palaeo-climate, Data/model comparison

Calibration and Validation of a Spectral Wind-Wave Model for the use in identifying the Past, Present and Future Wave Climate for the North Atlantic

Clare Duggan

Contact: cduggan09@qub.ac.uk

A change in global climate is expected to affect the intensity, frequency and location of individual storm events. With respect to ocean and coastal engineering this will have an impact on offshore and nearshore wave climate conditions. The objectives of this project is to access future wave climate trends in relation to past and present variability of the wave climate conditions for the North Atlantic Ocean using the most recent set of Global Climate Model information. A spectral wind-wave model of the North Atlantic has been set-up using MIKE 21 SW by DHI, Denmark to identify the trends for significant wave heights, mean wave periods and mean wave directions. Before the future wave climate can be determined, the model needs to be calibrated and validated against past wave climate data. ERA-Interim Reanalyses wind data from the European Centre for Medium Range Weather Forecasting (ECMWF) is available from 1989 to present and has been used to run simulations on the spectral wind-wave model of the North Atlantic (NAWM). The resulting wave data, obtained from the simulation of the NAWM is statistically analysed against ERA-Interim wave data to correlate the model. The NAM model is then checked against the Marine Institute, Ireland and UK Met Office wave buoy data to further validate the model. In collaboration with Met Éireann (Irish Meteorological Service), access has been granted to past, present and future wind data from EC-Earth, an earth system model based on ECMWF's seasonal forecasting system, and will be used to drive the NAWM. This resulting wave data obtained from the NAWM will be analysed to identify the changes in future wave climate for the North Atlantic.

Keywords: North Atlantic, Wave Climate, Climate Change

Combining GIS and remote sensing techniques for spatial climate change adaptation risk assessment in the UK

Charlie Tomlinson

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Climate change adaptation is a growing field with truly international importance, and GIS and remote sensing techniques are extremely useful given the global nature of climate change. This paper focuses at the conurbation level on Birmingham, the UK's second city, but the methodology shown could be applied internationally. The output is a spatial risk assessment that can be linked to climate change projections in order to help adaptation plans. This paper uses a number of GIS datasets including national vector mapping, high resolution social information, aerial photography and more to develop a spatial risk assessment methodology that can be utilised at a variety of scales, for a number of different end users. This is combined with satellite remotely sensed urban heat island measurements derived from land surface temperature data from the MODIS sensor in order to evaluate heat risk as a specific case study. This is an important step, as most climate change projections currently ignore urban effects which can be significant in both absolute temperature terms and when the high population density of urban areas is taken into account. The techniques shown for spatial heat risk assessment could be applied to other risks, for example flooding, as required. The work shown is influencing local policy in Birmingham, UK, through strategic links with the local council, illustrating the importance of geographical information technology within the public sector and to provide an evidence base for decisions.

Keywords: UHI, MODIS, Climate Change Adaptation, GIS, Remote Sensing

Principal component analysis of atmospheric anomaly fields: a guide to constraining past, present and future rainfall over the Sahel

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To date, a multitude of modelling studies have failed to arrive at a consensus on 21st century rainfall projections over the West African Sahel. This disagreement has been due to the presence of conflicting rainfall mechanisms in this region, coupled with user bias when parameterizing sub-resolution rainfall processes. To circumvent these deficiencies, we sought to diagnose relationships between planetary scale atmospheric patterns and rainfall over the Sahel. Principal Component Analysis (PCA) was performed on MERRA reanalysis data to calculate the key, independent modes of atmospheric variation over Africa. These patterns were then correlated to GPCP derived rainfall time series', identifying those associated with rainfall over the Sahel. The leading Empirical Orthogonal Function (EOF) of geopotential height at both 200 and 500 hPa are shown to be expressions of the El Niño Southern Oscillation, with no clear link to rainfall. The temporal strength of the second EOF at 200 hPa, however, exhibits a remarkably strong correlation with rainfall. Analysis of the easterly wind component at 150mb suggests this pattern is associated with the varying strength of the Tropical Easterly Jet (TEJ). This relationship is strongest in the northern Sahel, weakening further south, possibly due to the addition of coastal influences. Our results confirm the importance of dry dynamics in determining rainfall over West Africa and the Sahel. The strong correlation at 200 hPa suggests atmospheric anomalies relating to the TEJ, as appose to the lower level African Easterly Jet, are requisite for wave activity and subsequent rainfall over the Sahel. This approach has proven successful in identifying key planetary scale atmospheric patterns associated with regional scale rainfall. By assessing atmospheric output of future simulations, we believe this approach has the potential to aid in constraining 21st century climate variability over the Sahel.

Keywords: Sahel, Rainfall, Reanalysis data, Principal Component Analysis, Tropical Easterly Jet

Multi-Decadal Variability of Southern Ocean Fronts

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Paleoclimate studies spanning the Last Glacial Maximum (LGM) have identified rapid changes in ocean temperature. These are often interpreted to represent shifts in Southern Ocean fronts. However, very few studies are able to demonstrate a change in sea surface temperature (SST) gradient, due to the lack of data points. Therefore there is a degree of uncertainty in the conclusion that these temperature changes correspond to the movement of fronts. The significance of whether these temperature changes result from local frontal shifts or a broader scale change in temperature is very large in terms of the heat energy associated each scenario. Moreover, recently studies suggest that the location of fronts can influence global climate. It is believed the position of the sub-tropical front off the coast of South Africa modulates the volume of Agulhas Leakage into the Atlantic Ocean. This water acts as a source of salinity to promote the formation of North Atlantic deep water, a driver of the global thermohaline circulation. Satellite altimetry has allowed a high resolution dataset of sea surface height (SSH) to be collected. Fronts can be identified and tracked by regions of heightened SSH gradients. This data has helped improve knowledge regarding the variability of fronts dramatically. However, as the dataset only spans approximately fifteen years, it gives us little insight into the variability over multi-decadal time scales. Here the temporal and spatial variability of Southern Ocean fronts is investigated using 100 years of output, from a climate change experiment on the high-resolution coupled climate model HiGEM1.1. Initial results do not show any zonally coherent signal. However, regions have been identified where fronts intensify, dissipate and shift. Examples have also been found where previously meandering fronts become fixed in time and space. There is also evidence of regions where fronts are topographically confined.

Keywords: Southern Ocean Fronts, Last Glacial Maximum, HiGEM, Multi-decadal variability, Climate Change

Air-Sea Interaction and Climate Variability in the Azores, 1870-2010

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This presentation will detail the findings of the first year of PhD research into climate variability across the Macaronesian Islands with a specific emphasis on the Azores. A statistical approach has been applied which focuses upon seasonal analysis to examine the variability of and relationship between land based temperatures (from meteorological stations) and ocean temperatures (from the HADISST dataset) from 1870-2010. Furthermore the relationship with the North Atlantic Oscillation is considered and examined due to the importance of the Azores High to the teleconnection.

Keywords: Azores, Climate, NAO

Teleconnections and their use for statistical downscaling of precipitation in the Peruvian Andes

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The application of statistical downscaling in complex environments such as tropical mountain regions is still in its infancy. Little research has been done, particularly on the identification of large scale drivers (teleconnections) of precipitation patterns and the representation of spatial and temporal variability. This study aims to understand the effect of large scale circulation processes on rainfall in the Peruvian Andes and its inclusion in statistical downscaling. We use a generalised linear model, taking a logistic regression to predict rainfall occurrence, and a gamma distribution to predict rainfall amount. The model is calibrated for a network of rain gauges and has parameters including monthly averages of NCEP R1 reanalysis data, seasonality and rainfall occurrence on previous days. Teleconnections were identified between NCEP R1 variables and rainfall occurrence and amount by examining the maximum likelihood of model fits. This was undertaken sequentially for every NCEP R1 pixel within the South American region. NCEP R1 variables considered include sea level pressure, maximum temperature and wind speed. Simulation of rainfall was undertaken to infill gaps in data and to explore the uncertainty in rainfall estimates. Generalised linear models (GLMs) have generally been applied over areas where rainfall does not vary significantly in space. Therefore the application of the GLM approach to the Peruvian Andes offers a useful case study on the applicability of the model to a mountainous region in the Andes. Spatial dependence is accounted by a multivariate normal distribution for rainfall amount and by a beta-binomial distribution for rainfall occurrence. In a next part of the research, we will use the model to simulate the possible effects of climate change on precipitation, by applying the delta change method to NCEP R1 variables under different scenarios of climate change.

Keywords: Teleconnections, downscaling, generalised linear models, NCEP, Andes

Landfast Sea Ice

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Landfast sea ice is defined as ice that is contiguous with the land and lacks detectable motion for approximately 20 days, becoming fast due to coastal morphology, bathymetry, ice characteristics, and external forcings. It acts as an extension of the land over the continental shelf modifying the exchanges between the atmosphere and ocean, as well as affecting ocean dynamics, polynya location, and economic activities in the Arctic. Current models fail to capture the production and seasonal progression of fast ice for a number of reasons. In this study, we address the failure of sea ice models to simulate ice that remains fast to the shore during offshore wind events. We show that the inclusion of pinning points within the ice pack allow ice to remain fast during stand alone sea ice simulations. Pinning points are regions of deformed pack ice that become anchored on shallow bathymetry as they drift inshore. We present results from the Los Alamos sea ice model CICE, where we create pinning points as grid points with zero ice velocity. Initial results prescribe the number and location of the pinning points but this is extended so that the model identifies where and when pinning occurs. The probability of the ridged ice becoming grounded depends upon the depth of the sea floor, depth of ridged ice and the fraction which both of these occur within each grid cell. Investigation into the critical distribution and shape of pinning points is vital in the advance of this method. Initial results suggest that this is a viable method for modelling fast ice.

Keywords: Landfast, sea ice, pinning points, ridging

The restratification after open ocean deep convection

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Open ocean deep convection occurs in various regions of the ocean, including the Labrador Sea. When convection ceases, the dense column mixes with the stably stratified ocean, forming eddies due to baroclinic instability. Dense water formed during deep convection joins the meridional overturning circulation, so a good model of the restratification is important to our understanding of the ocean circulation. Fluidity-ICOM is a non-hydrostatic, finite element ocean model with a mesh made up of unstructured tetrahedra. Our tests show that arbitrarily unstructured tetrahedra cannot be used for basin-scale simulations because the high aspect ratio of the elements creates errors. Instead, we use a mesh known as a two-plus-one mesh, created by extruding a two-dimensional mesh in the vertical. This mesh still allows different regions of the mesh to have different resolutions in both the vertical and horizontal. We ran an idealised model of the restratification after open ocean deep convection using a two-plus-one mesh. The results verify that it is possible to use an unstructured finite element grid for oceanographic simulations as long as a two-plus-one mesh is used and not a fully unstructured mesh. This allows for multiscale adaptive meshes to be used in basin-scale simulations.

Keywords: Ocean

Biological reception possibilities of dangerous hyrdrometeorological phenomena

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The research is concerned with the problems of possible animal reception hydrometeorological dangerous phenomena. This problem is very important, it is directly concerned with hydrometeorological tasks – monitoring and forecasting of dangerous nature processes. The especial attention is devoted to the fish as inhabitants of water environment. There is alien to land animals rather special signal system in the aquatic area that is used by the fish and other water animals. This system apparently is the same effective in comparison with the system created by man. The aim of my research is to consider the influence of geomagnetic disturbances caused both by solar activity and the sector structure of interplanetary magnetic field on fish moving activity and their reaction on cyclone and anticyclone passage. Investigations of electromagnetic fields of extremely-low frequencies in geophysical processes are carried out at RSHU more than 20 years. It was shown that natural electromagnetic fields in narrow spectral bands corresponding to resonances are the source of important information on biological dangerous processes. Hydrometeorological dangerous processes include earthquakes, tsunami, cyclones, atmospheric fronts and sea storms. All these processes are accompanied by generation of special natural electromagnetic fields. At present it is known that there is dependence of fish activity on geomagnetic storms in basic periods with rather high correlation coefficients. The stronger the storm the more anxious (for sheat-fish) or the more depressed (for carps) the fish are. Considerations of these phenomena are highly important as it may help to progress the development of aquaculture.

Keywords: Fish moving activity, geomagnetic disturbances, hydrometeorological dangerous phenomena

Modelled slowdown in retreat of Arctic sea ice

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The wind-stress impinging The Arctic sea ice cover has been declining for a number of years. The annual minimum coverage of sea ice occurs in September, and a record low value was observed in September 2007. Despite some recovery since then, the last four years have seen the four lowest ice extents on record. The Met Office Hadley Centre climate model HadGEM1 captures the long term decline in Arctic ice extent, as observed during the satellite era, and has a similar level of interannual variability. However, while observations suggest that the rate of decline of the ice extent has been increasing over recent years, a number of projections from the HadGEM1 model simulate a slowing of the decline, which continues into the coming decades. This is evident in both the ice extent and the ice volume. This talk discusses possible mechanisms for the slowdown, including the Atlantic meridional overturning circulation, changes in ice circulation (possibly linked to the Arctic Oscillation), or cloud feedbacks.

Keywords: Sea, ice, Arctic, model, extent, HadGEM1

Flow past topography in relation to the Antarctic Circumpolar Current

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The wind-stress impinging upon the Antarctic Circumpolar Current (“ACC”) in the Southern Ocean is substantial at around 0.2 Nm-2. The associated northward-flowing Ekman drift must be opposed by a southward geostrophic mass flux below the mixed layer. However, the nature of the balancing geostrophic flow is hotly debated with the principal contenders being either transient jets and eddies or the time mean flow. This problem is rendered more tractable by using scaled idealised domains in which multiple sensitivity tests can be evaluated in a computationally efficient manner. Fluidity-ICOM (http://amcg.ese.ic.ac.uk/) is being used, which uses unstructured meshes and a new stable mixed discontinuous/continuous finite element pair (P1DG-P2). This combination allows small-scale processes in high Reynolds number flows to be modelled and analysed. The classical problem of flow past a cylinder is broadly analogous to flow past topographic highs in the ACC. The model set-up incorporates a barotropic flow in a non-dimensional, periodic, beta-plane channel. The flow structure is dependent on Reynolds number and the non-dimensional beta parameter. Low beta-parameter regimes have been verified against theoretical, laboratory and other modelling studies. The high Reynolds number flows lead to the formation of eddies and Rossby waves down-stream of the cylinder and the creation of jets through the bunching of pressure contours upstream. The momentum balance has been decomposed to illustrate the change in the balance of terms and the eddy forces associated with the Reynolds stresses as the flow evolves from laminar to vortex shedding and then to turbulence. Analysis of the transient small-scale eddy structures associated with the wake provides additional insight into the role of the various forces acting upon the ACC. These simulations highlight the importance of jets and eddies in closing the momentum balance in the Southern Ocean circulation.

Keywords: Jets, Eddies, Reynolds Number

Modelling the Lazarev Sea: An Inverse Approach to Determining Mass Transport

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The Lazarev Sea is the deep water gateway to the Weddell Sea, with the topographic constraints of Maud Rise and Astrid Ridge having a noticeable impact upon the distribution of the hydrographic properties of the Warm Deep Water. The Lazarev Sea Krill Experiment (LAKRIS) cruises conducted by the RV Polarstern between 2004 and 2008 provide a suitable density of CTD sections to detect the variable hydrographic properties of the region. These patterns highlight key circulation features including a jet on the northern flank of Maud Rise, the Taylor column above the rise, and the apparent pooling of Warm Deep Water to the south-west of the rise. We are developing an inverse box-model in order to infer the circulation of a given region using CTD data from cruises with multiple parallel sections: providing a grid of data. The model is based upon the multiple linear regression of mass conservation and Duhem–Margules equations for all of the boxes in the grid, where each box is composed of four neighbouring stations. The regression provides an estimate of the mass transport across each neighbouring station pair face and for a specified number of layers. The model is currently set-up to use the density data from the LAKRIS cruises, but could be adapted for other parameters, regions and programmes. We aim to evaluate the robustness of our approach in determining the general and localised transport of large ocean areas such as the Lazarev Sea and consequently use all available data to quantify the circulation of the Lazarev Sea during the different seasons during which the LAKRIS campaign was conducted.

Keywords: circulation, mixing, Weddell, Lazarev, LAKRIS, inverse model

Scale interactions between the diurnal cycle and organized tropical weather systems over the maritime continent

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The mean diurnal cycle of convection in the tropics is well documented. Over the maritime continent, which is within the oceanic warm pool, the diurnal cycle is particularly pronounced. Rainfall peaks over the land in the late evening, triggering a gravity wave which causes the rain clouds to propagate offshore during the night. General circulation models tend to exhibit systematic biases over the maritime continent due to a poor representation of the diurnal cycle; these biases lead to errors in global climate through the propagation of planetary waves in the model. The Tropical Rainfall Measuring Mission (TRMM) provides rainfall estimates for the whole of the tropics at 0.25 degree horizontal resolution, every three hours since the start of 1998. The presence of other organized weather systems over the maritime continent could modulate the diurnal cycle, for example strengthening or weakening its amplitude, or shifting its phase. TRMM data are used to track precipitation features over the maritime continent; the diurnal cycle may then be compared in the presence or absence of such features. The Cascade project seeks to improve understanding of tropical convection by running the Met Office Unified Model (UM) at 40km, 12km, 4km and 1.5 km resolutions. The same analysis as described above is applied to output from the UM at each of these resolutions, and the results compared with those from TRMM observations, with the ultimate aim of improving the model parameterization scheme.

Keywords: diurnal cycle, maritime continent, scale interactions, tropics, feature tracking, Cascade

Modelling the Microphysical Sensitivities of a Secondary Frontal Wave

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Mesoscale features within extratropical storms are often responsible for the most extreme and damaging localised weather effects. As part of the DIAMET (Diabatic Influence on Mesoscale Structures in Extratropical Storms) project, the role of microphysics in the development of mesoscale features within extratropical storms will be examined. The scale and complexity of microphysical processes means that they must be parameterised in numerical weather prediction models. Microphysics schemes used for operational forecasting and research vary in complexity and hence, computational expense. They extend from simple single-moment bulk schemes to complex spectral bin schemes. In the long run, the project will focus on selected case studies of weather events from the DIAMET observation periods in autumn 2011 and summer 2012 where microphysical processes can be expected to play an important role. An initial case study of the 13 November 2009 has been chosen from the project test flight period. This case looks at a secondary frontal wave feature forming and moving north and east from the south coast of the UK. The system exhibited intense mesoscale precipitation bands and high winds causing localised flooding and wind damage in southern England. High-resolution numerical modelling using the Weather Research and Forecasting (WRF) model is carried out for the chosen case study. A number of different microphysics parameterisation schemes are tested and compared, along with observational data from surface readings and from research flights using the FAAM BAe-146 aircraft. The WRF modelling allows for the sensitivities of the storm development and mesoscale features to the microphysics schemes to be analysed and compared to the observations.

Keywords: microphysics, mesoscale, WRF-modelling, aircraft measurement, secondary-wave

Moist convective dust storms in the Sahara

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It is widely recognised that the Sahara desert is the world's largest source of deflatable soil dust. However, many meteorological processes controlling dust uplift such as low-level jets, convectively produced cold pools and small-scale boundary layer processes are poorly understood. This makes it very difficult to quantify how much dust is deflated due to different atmospheric phenomena or which processes are able to lift dust into the Saharan Air Layer (SAL) making it available for long-range transport. One of the mechanisms responsible for dust uplift in the Sahara is convectively generated dust storms known as Haboobs. These are produced along the turbulent leading edge of evaporatively cooled air flowing away from a deep convective storm system. Typical gust fronts produced by convective storms are short lived, limiting Haboob size and duration to a scale similar to the storm that initiated them. However, some Haboobs reach sizes much larger than would be expected, occasionally spanning over 1000km and propagating across huge distances of the desert equivalent to the entire latitudinal extent of the Sahara (1500km). In order to better understand the meteorology of the Sahara, especially in the region of the Saharan heat low, data will be gathered as part of the multi-platform Fennec field campaign that involves satellites, a series of automatic weather stations, radiosondes, radiative flux towers, lidar and the FAAM BAe-146 aircraft to gather data relating to radiative fluxes, dust uplift and synoptic and mesoscale meteorology. With a pilot campaign in early April and the intense observing period in June 2011 the project should greatly improve the understanding of Haboobs and their behaviour. Observations from Fennec will also provide high quality data of case studies for modelling in the Weather Research and Forecasting (WRF) model, to ascertain the driving forces for the propagation of large and long-lived Haboobs.

Keywords: Haboobs, Dust, Sahara, WRF-modelling, Convection, Fennec

Moisture sources for the storms and UK flooding of summer 2007

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This project investigates the origins of moisture for UK precipitation, focussing on extreme events that lead to flooding and the observed upward trend in precipitation intensity. Initial work on the storms that led to flooding over England and Wales during Summer 2007 is described. A fine scale back-trajectory model is applied to meteorological analyses. This model is used to estimate precipitation from moisture changes along ascending trajectories. Results are compared with observations and short term precipitation forecasts made as part of the analysis cycle, in both ECMWF operational analyses and ERA-Interim reanalyses,. Initial results for the Summer 2007 storms show good agreement of precipitation patterns, but precipitation amounts are under-estimated. Possible reasons for this discrepancy are being investigated. Furthermore back trajectories are used to trace the origins of moisture for air entrained into the precipitating storms, from the last contact with the boundary layer. This analysis allows us to study the separation of dynamic and thermodynamic signals, which will be the study focus for the longer period.

Keywords: flooding, precipitation, back-trajectories, ERA-Interim

Measuring winds over London using a Doppler LiDAR

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This study involves the use of a Doppler LiDAR to measure wind speed and direction at a site in central London, and assesses whether the technique used is suitable for producing robust wind profiles in an urban boundary layer. The use of this remote sensing technique allows wind profiles to be plotted which extend through most of the depth of the boundary layer, unless limited by low cloud or rain. This makes it possible to examine features present in the urban boundary layer, some of which will be presented here. The wind data was acquired using the Doppler Beam Swinging (DBS) technique, which has been suggested as particularly suited to the measurement of wind speeds above heterogeneous surfaces. The LiDAR data was compared with wind speed and direction measurements made using a weather station located on top of the BT Tower. The LiDAR site is ~1 km away, on the Marylebone Road. In order to reduce the variability in the LiDAR data, 30 minutes of wind speed measurements are averaged together to produce a more representative profile, and these are compared with 30 minute averaged data from the BT tower. Initial results suggest an agreement to within 1 m/s in most cases. There are some cases where this agreement is not present, which require further investigation. The data collected using the LiDAR, and other instruments located in central London, will be used in a comparison with the UK4 (4 km grid length) and UKV (1.5 km grid length) configurations of the UK Met Office's Unified Model (UM). Some preliminary results of this comparison will be presented.

Keywords: Doppler lidar, Doppler beam swinging, remote sensing, urban boundary layer, London, wind

Street Canyon Ventilation using Wind Tunnel Modelling

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According to UN demographics, today over 50\% of the world's population reside in urban areas. Understanding the transfer of heat, pollution and other scalars from the surface layer to the air aloft is crucial to improve the quality of life, but still little is known about the influence of urban morphology on scalar transfers. In this project, wind tunnel modelling will be used to assess the ventilation for different building layout and designs using a mass transfer technique. Previous experiments have studied scalar transfers from one of the simplest possible geometry, a street canyon with flat roof. In these experiments, the incident wind flow perpendicular to the orientation of the canyon. The first approach of this project is to investigate the influence that roof shape can have on turbulent transport from the street and building surfaces. Previous experiments indicate that steeply pitched roofs, a design very common in the UK, can decrease street level ventilation by as much as 40\%. Results to test the sensitivity of fluxes to both the upwind fetch and roof shape will be presented. The parameters derived from the wind tunnel experiments will be used to develop a street canyon model for pitched roof, originally formulated for flat roofs, by Harman et al. (2004). This models is based on the assumption that fluxes from each surface can be derived according to the bulk aerodynamic formulation.

Keywords: Street Canyons, Wind Tunnel, Mass Transfer

A comparison of atmospheric dispersion model predictions with observations of sulphur dioxide and sulphate aerosol from volcanic eruptions

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The Lagrangian Numerical Atmospheric dispersion Modelling Environment (NAME) has previously been used operationally to model volcanic ash at the London VAAC (Volcanic Ash Advisory Centre), including that from the eruptions in Iceland of Eyjafjallajokull in 2010 and Grimsvotn in 2011. To prepare the model for possible future eruptions, the ability of NAME to model the release and dispersion of volcanic SO_2, the chemical processes leading to the production of sulphate aerosol, and the subsequent dispersion of sulphate aerosol, has been investigated. The eruptions of Sarychev in 2009, Kasatochi in 2008 and Eyjafjallajokull in 2010 were simulated and results for SO_2 and sulphate aerosol optical depth (AOD) were compared with satellite observations. NAME results compare favourably with available observations in terms of both geographical distribution and air concentration for all three cases. NAME modelled concentrations of SO_2 are of the same order of magnitude as those observed by satellite for the eruption of Sarychev, and over 70% of modelled values of sulphate AOD are within a factor of 2 of those observed for both Sarychev and Kasatochi. Although significant uncertainties are present in both the model and observations, this work shows that NAME is able to model SO_2 and sulphate from volcanoes. Therefore NAME could be used for this purpose, in addition to volcanic ash modelling, in future eruptions where significant quantities of SO_2 are released.

Keywords: volcano, sulphur dioxide, sulphate, atmospheric dispersion

Ash Dispersion from a Hypothetical Large Eruption of Katla

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The eruption in Eyjafjallajökull from April 14th 2010 to May 23th 2010 caused significant disruption to air traffic over the United Kingdom due to the ash cloud travelling south and east, particularly during the first week of the eruption. Eyjafjallajökull is, however, a relatively small volcano, and other Icelandic volcanoes have the potential to eject much larger volumes of ash to greater heights, and therefore cause even more difficulties for aviation. Using the NAME atmospheric dispersion model, this study considers the case of an eruption of Katla to 15 km above sea level in identical meteorological conditions to those experienced between April 14th 2010 and April 21st 2010, and compares the predicted ash cloud to the best estimates of the ash cloud from Eyjafjallajökull.

Keywords: Volcanic ash dispersion Eyjafjallajokull Katla NAME

The impact of mega-cities on regional and global atmospheric composition: a modelling study

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The world's urban population currently includes 21 mega-cities, each with 10 million or more inhabitants. These mega-cities act as large sources of damaging pollutants, and hence there is increasing concern for the impact they may have on local, regional, and global air quality. In 2008, a new European collaborative project was initiated with the aim of better quantifying mega-city impacts and air pollution exposure, investigating the interactions between local air quality, emissions, global atmospheric composition and climate. As part of the ongoing project, this study investigates how changes to mega-city emissions could impact global air quality. Results will be presented from a number of present-day simulations using a global chemistry-climate model, allowing analysis of the impacts of mega-cities on global atmospheric composition. The simulations aim to quantify the effect of altering mega-city emissions, by both reduction and redistribution scenarios. One of the key studies consists of changing the spatial distribution of emissions on a regional scale, moving emissions out of the concentrated urban centers, to quantify the effects of mega-city dilution on a global scale. Results are compared to both the model base run for the year 2005, and to satellite observations for the same year. The global significance of these scenarios is set against the significance of an annihilation scenario for the same year, where anthropogenic emissions from mega-cities are completely removed. These redistribution and annihilation studies allow us to investigate how future changes in mega-cities may influence the global scale.

Keywords: mega-cities, emissions, global atmospheric chemistry

Using laser light to trap and probe aerosol particles in the laboratory

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The impact of aerosols on the radiative balance of the Earth's atmosphere represents one of the largest uncertainties in quantifying future climate change. Laboratory studies of individual aerosol particles are integral if we are to reduce this uncertainty. This work demonstrates how modern techniques such as optical tweezers and optical guiding are used to trap, manipulate and probe single aerosol particles. These techniques have been used to yield precise data on the cloud forming and radiative properties of aerosols. For example, high precision measurements of aerosol hygroscopicity (a governing factor in the activation of aerosol particles into cloud droplets) have been made by probing the size response of aerosol particles to changes in relative humidity.

Keywords: Aerosol, hygroscopicity, thermodynamics

Development of version 2 of the bias corrected AVHRR Pathfinder sea surface temperature dataset (1985-2008) for HadISST2

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Data from the AVHRR instruments provide a long time series of sea surface temperatures (SSTs) which can be used in the Hadley Centre SST climate data set, HadISST2. Previous work in improving AVHRR data included using the more accurate SSTs from (A)ATSR and information on aerosols from TOMS to bias correct the AVHRR SSTs leading to a better quality data set. Current work aims to extend the use of aerosol data where TOMS becomes unavailable by using OMI data and to further develop the error estimates on the AVHRR SSTs.

Keywords: AVHRR, SST, bias

Accounting for correlated observation error in the assimilation of high resolution sounders

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Currently high resolution sounders, such as AIRS and IASI, use diagonal fixed observation error (R) matrices within the assimilation scheme, assuming no correlation between channels. This is inadequate due to the presence of errors of representativeness, forward model error and errors associated with the pre-processing of satellite data. Previous work both at the Met Office and ECMWF has demonstrated that correlations exist in IASI data particularly for channels sensitive to water vapour. It is likely that a better description of the error correlations in 4D-Var will allow for improved use of the water vapour channels. Using a generalised R matrix complicates the processing within the assimilation scheme. In particular the inverse of R needs to be computed at every iteration for each profile which could turn out to be too costly to contemplate. Representing the correlations as block diagonals or a matrix with an inverse that can be reconstructed efficiently may be the practical solution. This will hopefully allow for a more realistic R matrix to be efficiently implemented into the operational assimilation system. This poster will show the results of performing a Desroziers diagnostic on AIRS and IASI data for both 1D-Var and 4D-Var output to estimate the true structure of the R matrix. A comparison between analysis increments produced using non-diagonal and diagonal R matrices, and the corresponding timings of the assimilation using these two matrices will also be shown.

Keywords: Error, correlations, IASI, AIRS, Desroziers, diagnostic

Combined 1Dvar retrievals using AMSU and IASI data

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Remote sensing of the atmosphere by 1 dimensional variational retrieval (1DVAR) requires a background profile as a starting point for the retrieval. Currently most background profiles are taken from model fields or nearby observations (such as sondes). In order for the retrieval to be successful the error characteristics of this background profile must be known. Hyper spectral sounders such as IASI contain huge amounts of information about the atmosphere below. The inversion problem (going directly from radiances to state) is ill-conditioned: there are infinitely many different atmospheric states that give the same radiance spectra. Here I describe a method for obtaining a first guess of the atmospheric state using a statistical regression from radiance principal components to atmospheric state which is also represented in principal components. Using this method I can obtain a “first guess" of the atmospheric state which can be used as a background for 1DVAR retrieval. This is especially useful when other sources of background profiles are not readily available.

Keywords: Remote sensing, IASI, 1dvar

Errors of representativity

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Data assimilation is the incorporation of observational data into a numerical model to produce a state which accurately describes the observed reality. Data assimilation schemes include an observation error covariance matrix which accounts for the errors in the observations and observation operators. This error matrix can be split into two components; one contains the information on the instrument error, the other contains information on the errors of representativity. Errors of representativity are errors that arise when observations can resolve spatial scales that the model cannot. Currently these errors of representativity are not modelled correctly in data assimilation schemes. We follow some previous derivations for equations for error of representativity and use these to calculate errors of representativity in a few simple situations. We consider observations calculated using different weighting functions and observations operators that both correctly and incorrectly represent these observations. As expected we find that the error of representativity is reduced when the observation operator correctly models the observations. We also see that the structure of the error of representativity changes when the observation weighting is altered. Finally we see that assuming different covariance models for the true state can alter the size of the errors of representativity by approximately an order of magnitude.

Keywords: Representativity error, Observation error correlation matrix

Assimilation of GPS Radio Occultation data at the Met Office

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An important aspect of numerical weather prediction (NWP) is the assimilation of observational data which acts to make the model state a more accurate representation of the true state of the atmosphere. A key source of such data comes from meteorological satellites. Global Positioning System Radio Occultation (GPSRO) is a technique which probes the atmosphere using radio waves transmitted from GPS satellites (hence it is an active technique). As these rays glance past the earth and through the atmosphere, they are refracted and the angle they are refracted by is measured by instruments on board meteorological satellites. Because the receiving satellite is in motion relative to the earth and the GPS satellites, profiles throughout the height of the atmosphere are obtained close to the occultation point. From the model background state, a 'forward modelled' bending angle can be calculated based on the pressure, temperature and specific humidity at the occultation point. From this and the observed profile, variational data assimilation is used to provide the optimal resultant model state based on the errors associated with the two profiles. Each day, the Met Office assimilates over 1000 GPSRO profiles into the global model and these are spread uniformly across the globe. This is important as other observations which provide similar data such as radiosondes are mainly released over land. The GPSRO technique is based on a number of assumptions, and while it provides an important source of unbiased observations, errors in the observations are currently handled inflexibly, and drift of the ray's tangent point is not currently taken account of. In this presentation I will discuss the physics of GPSRO, the basics of its assimilation and future ideas to improve its implementation at the Met Office.

Keywords: GPSRO, satellite, sensing, observation, assimilation

6. Conference abstracts- Poster presentations

1. Impacts of urban heat island and climate changes in the operations and ageing rate of the transformers

Tatiana Prieto-Lopez

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The lack of atmospheric data in many urban areas across the world is a major limitation to urban climate research. This paper details the deployment of a low cost micrometeorology network across the city of Birmingham, UK, and the applications of data to adapt and mitigate the effects of climate change and urban heat island in the UK energy industry. The network consists of 35 sites instrumented with iButtons to record air and transformer temperatures, plus a transect of six weather stations set up in a north to south orientation. The data has been initially analysed to investigate the average summer urban heat island and its correlations with transformers temperature between June and August 2010. The impacts of climate change on the transformers' operations have been analysed using UKCP09 medium emission scenarios for 2020, 2050 and 2080. Results in every site indicate a positive correlation between air and transformer temperature. These results point out areas in the city where the replacement and maintenance program of transformers will be focused.

Keywords: Urban heat island, micrometeorology, air temperatures, energy industry, sensor network, Birmingham

2. Birmingham Urban Climate Change with Neighbourhood Estimates of Environmental Risk

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UK climate projections indicate a 3.7^{o}C temperature increase for Birmingham by 2080 (medium emissions scenario). The 2003 heat-wave that caused an extra 2139 deaths in England and Wales will become an average summer by 2040. By the end of the century, the 2003 heat wave will be considered a cool summer. The dense urban fabric of Birmingham has created a warming effect when compared to surrounding rural areas. This has been found to exacerbate heat waves by over 3.5^{o}C. Termed the urban heat island (UHI), past studies have found the exact nature to be related to city size, moisture availability, land-use, anthropogenic emissions, building materials and geometry. The UHI effect can lead to heat stress and air pollution problems which are a major health concern. Birmingham's UHI is not currently modelled. More specifically the UK climate projections treat Birmingham as a homogeneous slab of grassland. The inclusions of the urban areas in a climate model will show an intensification of the likely heat risk in future projections. The JULES (Joint UK Land Environment Simulator) model has been setup and run for Birmingham and surrounding areas. Currently the models performance is being evaluated against air temperature observations. Once validated the aim is to use UKCP09 weather generator data to drive the model up to 2100. Model outputs will allow for GIS vulnerability data to be overlaid, highlighting the area's most at risk. This will allow for better planning of resilience measures to combat heat and health. Altering the model parameters will also allow for the insertion of green infrastructure in areas to assess its effectiveness in cooling the city. This project is a knowledge transfer partnership between the University of Birmingham and Birmingham City Council to develop the BUCCANEER (Birmingham Urban Climate Change with Neighbourhood Estimates of Environmental Risk) planning tool.

Keywords: Birmingham, Urban, Heat, Risk, Climate Change

3. Future Resilient Transport Networks

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There will be many implications for both road and rail transport as a result of climate change with impacts being felt as a result of increasing summer temperatures, decreasing winter temperatures, increased heavy precipitation, greater numbers of extreme weather events and rises in sea level. In order for transport to react appropriately to the potential changes in climate, it is essential to understand how the road and rail networks may be affected and to build strategies for adaptation and mitigation into plans for future developments for both modes. Focusing on the road network, this research concentrates on understanding how traffic flows and speeds are affected by precipitation events and the impacts that may be experienced in the future as a result of climate change.

Keywords: climate change, transport, road network, precipitation

4. A regional rainfall model for drought risk assessment in south-east England

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To support regional drought assessment, two issues need to be addressed. First, drought risk assessment requires long-term rainfall records especially in the regions where a range of drought types, including inter-annual droughts, are of potential concern. The south-east of England is an example of such a region where the recurrence of extreme historical inter-annual droughts could lead to disastrous water shortages under current and future demands for water. Second, spatially consistent estimates of rainfall are needed to support regional and inter-regional scale assessments, especially where water transfers are used to alleviate local deficits. The research presented here addresses these challenges by developing a spatially and temporally consistent stochastic model of monthly rainfall for south-east England. A set of stochastic regression models is established for characterizing rainfall variability, and infilling and simulating monthly rainfall. 50 long-term rain gauges in south-east England with records spanning from 1855-2008 are used to identify and assess the models. The large-scale climate variables used as inputs to the regression are generally consistent with the findings of previous research on UK rainfall: air pressure, air temperature and North Atlantic Oscillation. It is found that, although both spatial and temporal biases exist, the model results are generally consistent with the observed record including for a range of inter-annual droughts and spatial statistics. Simulations show that some of the most severe inter-annual droughts on the record may recur, despite a trend towards generally wetter winters. Comments are made about the suitability of the models for extending the record under climate change scenarios.

Keywords: rainfall, stochastic, downscaling, water resources, water transfers, extremes

5. Urban Street Canyons: Coupling Dynamics, Chemistry and Atmospheric Pre-processing

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The composition of air within a street canyon is determined by the composition of background air mixed in from above, advection of air into and out of the canyon, vehicle exhaust and other emissions from within the street, together with the mixing and chemical processing of pollutants within the canyon. This occurs on a timescale of a few seconds to minutes and as a result, within-canyon atmospheric processes can have a significant effect on atmospheric composition on such timescales.

This paper outlines the results of a modelling study of composition on the street canyon scale, integrating the combined effects of emissions, dynamics and chemistry. The work builds upon an existing dynamical model of canyon atmospheric motion (Large Eddy Simulation (LES) model) by adding a detailed chemical reaction scheme. Previous studies have considered basic NOx-O_3 cycles with only a small number of chemical reactions included. Initially, a zero-dimensional box model was used to develop and assess the accuracy of a suitable reduced chemical scheme to be included within the LES. The reduced chemical scheme, based upon a subset of the Master Chemical Mechanism (MCM), includes 51 chemical species and 136 reactions.

A comparison is made of oxidant levels within the canyon calculated using the LES model, i.e. integrating both dynamics and chemistry, with those determined using the box model. The results are used to investigate the extent of within-canyon processing of exhaust emissions before their escape to the wider atmosphere. A representative flux of pollutants out of the urban canopy into the overlying boundary layer is also determined. This may then be applied, as a modification to the raw emission rates, in larger scale regional and neighbourhood models.

Keywords: Street canyon, Emissions, Large Eddy Simulation, Box model, Chemical scheme

6. Characterising dust emission events over West Africa using surface observations

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Current model estimates of the dust cycle over West Africa are uncertain. At the heart of this problem is insufficient understanding of key dust emitting processes such as Haboobs (cold pools generated through evaporation of convective precipitation), Low-Level Jets, and dry convection (dust devils and dust plumes). Scarce observations in this region, in particular in the Sahara, make model evaluation difficult. The Fennec field campaign in June 2011 aims to improve this situation with a new surface observation network located in the central Sahara, supplemented with aircraft and satellite data. This work aims to fully utilise all available observations, including surface, upper air, reanalysis, satellite and field campaign datasets to compute the most comprehensive climatology of dust emissions to date. Surface observations are particularly useful in the analysis of Haboob dust storms, as current satellite products cannot observe this phenomena beneath clouds which are inherent with the Haboob's formation. The climatology is the prerequisite to identifying the relative importances of these key processes and forms the basis for improved model evaluation. Dust emission events in the Sahara will be presented along with details of their temporal and geographical variability. The methodology involves incorporating both observational and reanalysis data. Initial results and challenges encountered are presented.

Keywords: Climatology, dust emission, West Africa, surface observations

7. Moist convective dust storms in the Sahara

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It is widely recognised that the Sahara desert is the world's largest source of deflatable soil dust. However, many meteorological processes controlling dust uplift such as low-level jets, convectively produced cold pools and small-scale boundary layer processes are poorly understood. This makes it very difficult to quantify how much dust is deflated due to different atmospheric phenomena or which processes are able to lift dust into the Saharan Air Layer (SAL) making it available for long-range transport. One of the mechanisms responsible for dust uplift in the Sahara is convectively generated dust storms known as Haboobs. These are produced along the turbulent leading edge of evaporatively cooled air flowing away from a deep convective storm system. Typical gust fronts produced by convective storms are short lived, limiting Haboob size and duration to a scale similar to the storm that initiated them. However, some Haboobs reach sizes much larger than would be expected, occasionally spanning over 1000km and propagating across huge distances of the desert equivalent to the entire latitudinal extent of the Sahara (1500km). In order to better understand the meteorology of the Sahara, especially in the region of the Saharan heat low, data will be gathered as part of the multi-platform Fennec field campaign that involves satellites, a series of automatic weather stations, radiosondes, radiative flux towers, lidar and the FAAM BAe-146 aircraft to gather data relating to radiative fluxes, dust uplift and synoptic and mesoscale meteorology. With a pilot campaign in early April and the intense observing period in June 2011 the project should greatly improve the understanding of Haboobs and their behaviour. Observations from Fennec will also provide high quality data of case studies for modelling in the Weather Research and Forecasting (WRF) model, to ascertain the driving forces for the propagation of large and long-lived Haboobs.

Keywords: Haboobs, Dust, Sahara, WRF-modelling, Convection, Fennec

8. Wing mounted optical particle counters on the FAAM BAe146 Research Aircraft

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FAAM is the result of a collaboration between the Met Office and the Natural Environment Research Council and has been established as part of the National Centre for Atmospheric Sciences to provide an aircraft measurement platform for use by all the UK atmospheric research community on campaigns throughout the world. Along with many other applications, the aircraft is equipped with a suite of wing mounted instruments which measure cloud and aerosol properties; an understanding of which is vital in understanding cloud microphysics, atmospheric composition and radiative forcing which influence climate forcing and extreme meteorological events.

The poster will provide the following information on the 5 wing-mounted optical particle counters:

- Measurement capabilities for each instrument (size distributions, measurement parameters)
- Measurement techniques & instrument overview (theory of operation)
- Data samples from past projects (images & plots)
- Photos/figures of the instruments and the research aircraft.

(Instruments: Cloud Droplet Probe (CDP), Cloud Imaging Probe x2 (CIP100 & CIP15), Passive Cavity Aerosol Spectrometer Probe (PCASP), 2D-C Optical Array Probe (2D-C OAP))

9. Examination of aircraft and rainfall radar data for a cold air outbreak case study

Kirsty McBeath

Richard Cotton, Paul Field

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This study investigates a case of cold air outbreak off the North West coast of Scotland in January 2010, using operational rainfall radar data. Data from the radar is examined over an area 150km2 and compared to simulated reflectivity fields from the Met Office UKV model which has a 1.5km resolution. During this case study, the FAAM BAe-146 research aircraft undertook a flight in the same region, over-flying the radar. Data from the aircraft is also examined to provide additional comparisons to the model data, and to gain more information about the structure of precipitating clouds. Comparisons of reflectivity profiles across the full area of interest for both datasets were done. The radar and model data are examined using cluster analysis to identify and track single cells of rainfall. Allowing statistics about the dataset as a whole, such as size, lifetime and observed reflectivity to be extracted and compared. The initial results of the profile comparisons show strong agreement between the two datasets at heights between 2 and 3km, with the model data showing a much smoother profile than the observations. Comparisons of the cluster analysis show that the model is in quite good agreement with the observations, however has lower mode and mean values of cell size and cell lifetime. The model does produce good agreement with the observed data when comparing the relative growth rate of the cells, producing a mean growth rate of 0.444 compared to the observed mean cell growth rate of 0.482.

Keywords: Radar, Precipitation, Aircraft, High Resolution

10. Accounting for correlated observation error in the assimilation of high resolution sounders

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Currently high resolution sounders, such as AIRS and IASI, use diagonal fixed observation error (R) matrices within the assimilation scheme, assuming no correlation between channels. This is inadequate due to the presence of errors of representativeness, forward model error and errors associated with the pre-processing of satellite data. Previous work both at the Met Office and ECMWF has demonstrated that correlations exist in IASI data particularly for channels sensitive to water vapour. It is likely that a better description of the error correlations in 4D-Var will allow for improved use of the water vapour channels. Using a generalised R matrix complicates the processing within the assimilation scheme. In particular the inverse of R needs to be computed at every iteration for each profile which could turn out to be too costly to contemplate. Representing the correlations as block diagonals or a matrix with an inverse that can be reconstructed efficiently may be the practical solution. This will hopefully allow for a more realistic R matrix to be efficiently implemented into the operational assimilation system. This poster will show the results of performing a Desroziers diagnostic on AIRS and IASI data for both 1D-Var and 4D-Var output to estimate the true structure of the R matrix. A comparison between analysis increments produced using non-diagonal and diagonal R matrices, and the corresponding timings of the assimilation using these two matrices will also be shown.

Keywords: Error, correlations, IASI, AIRS, Desroziers, diagnostic

11. Modelling the interactions between tropical convection and large scale dynamics

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A computationally cheap framework for examining the interactions between tropical convection and the large scale circulation is built based on the weak temperature gradient (WTG) approximation. The WTG approach is used to couple a Large Eddy Model (LEM) to a reference column through an approximation of large-scale (LS) circulation driven by convection. This is done under the assumption that the role of the LS circulation is to redistribute the density anomalies such as to maintain uniform density on isobarical surfaces. Results of experiments have been compared to previous studies. However, some differences and similarities will be highlighted. The same approach is extended to couple the LEM to another LEM. The equilibrium response of the coupled LEMs to symmetric boundary conditions and perturbed initial conditions is examined. The results allowed us to answer a fundamental question in tropical meteorology: Can (and if so how, and under what conditions, does) a LS circulation driven by convection develops in a homogeneous environment? Moisture and energy budgets are not strictly closed in the reference column approach. However, by choosing an appropriate representation of horizontal advection, the sensitivity of the coupled LEMs to closing the moisture and energy budgets is examined.

Keywords: Weak temperature gradient, large scale circulation

12. Conditional symmetric instability in two extra tropical cyclone cases

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The release of conditional symmetric instability (CSI) is known to play an important role in weather conditions such as rain banding in baroclinic zones and high surface winds from sting jets. To find out the relative roles of CSI and conditional instability (CI) (the release of which lead to slantwise and upright convection respectively) in extratropical cyclones, two contrasting systems are analysed for the presence and the release of CI and CSI. The first case was a barotropic summer time low from 6 July 2009, which was characterised by rain bands formed from wrapped up occlusions. This is compared with the second case, 13 November 2009, which is an autumn/wintertime low that formed as a frontal wave, exhibiting a double cold front and a double cloud head structure. Four diagnostics designed around complementary ideas of parcel ascent and insitu instability for both upright and slantwise instability are applied to Met Office forecast and analysis data. In the summer time case most of the convection appears to be due to the release of CI, but the release of CSI plays a role in some of the rain bands over continental France. CSI release is shown to play a more major role in the wintertime case where SCAPE values are much larger than CAPE values; the presence and release of CSI are linked to the rain banding.

Keywords: Conditional symmetric instability, Extra tropical cyclones

13. Latent heat release in extratropical cyclones in climate models and observations

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Intense extratropical cyclones are one of the major weather risks in the mid-latitudes. To have confidence in the predictions of how extratropical cyclones might change in a warmer climate, it is essential that climate models can simulate the key processes that drive the intensification of extratropical cyclones. One key process is latent heat release through the condensation of water vapour. This project aims to evaluate how realistically high-resolution climate models represent latent heat release by comparing climate model simulations against a range of observational remote sensing data and global reanalyses. The evaluation is being carried out using an innovative storm compositing technique developed using the tracking program of Kevin Hodges. The project looks firstly at remote sensing and observational data to quantify the role of latent heat in these systems, then compares these results to reanalysis data. The reanalysis and observations are then compared to output of the HiGEM high resolution climate model. HiGEM has been shown to produce a realistic structure of extratropical cyclones (Catto et al, 2010) and this work will enable verification of whether the model adequately resolves this key process. The poster will exhibit recent work, drawing on case studies to demonstrate how the technique works and the results it produces.

Keywords: extratropical cyclones, latent heat, tracking, HiGEM

14. Intensification of Tropical Cyclone: A thermodynamical analysis

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Despite the improvement in our understanding of Tropical Cyclones (TCs), producing reliable intensity forecasts has remained a difficult task. In the past decades, a lot of research effort has been put into understanding how pre-existing mesoscale disturbances evolve into larger storms. Currently the most widely accepted intensification mechanism is the WISHE theory proposed by Kerry Emanuel which emphasises the establishment of a positive feedback loop between surface windspeed and moisture flux into the boundary layer and TC intensity. However, recent modelling studies have shown that initial disturbances can still intensify even if the surface fluxes are decoupled from windspeed and kept at climatological values. This suggests surface fluxes may not be critical to TC intensification and there may be other equally important processes that should be accounted for. Here the intensification of TCs is studied through examination of their energy cycle, in particular energy production and dissipation. Available potential energy (APE) is an appropriate diagnostic tool. It is defined as the deviation of the system state from a hypothetical reference state where the potential energy is minimized. With the aid of a axisymmetric TC numerical model, a time series of APE is produced while the sources and sinks of APE throughout a TC intensification period are examined. This gives a clearer view of the processes linked to APE generation in TCs and ultimately provides better insight into the intensification process

15. Modelling the Microphysical Sensitivities of a Secondary Frontal Wave

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Mesoscale features within extratropical storms are often responsible for the most extreme and damaging localised weather effects. As part of the DIAMET (Diabatic Influence on Mesoscale Structures in Extratropical Storms) project, the role of microphysics in the development of mesoscale features within extratropical storms will be examined. The scale and complexity of microphysical processes means that they must be parameterised in numerical weather prediction models. Microphysics schemes used for operational forecasting and research vary in complexity and hence, computational expense. They extend from simple single-moment bulk schemes to complex spectral bin schemes. In the long run, the project will focus on selected case studies of weather events from the DIAMET observation periods in autumn 2011 and summer 2012 where microphysical processes can be expected to play an important role. An initial case study of the 13 November 2009 has been chosen from the project test flight period. This case looks at a secondary frontal wave feature forming and moving north and east from the south coast of the UK. The system exhibited intense mesoscale precipitation bands and high winds causing localised flooding and wind damage in southern England. High-resolution numerical modelling using the Weather Research and Forecasting (WRF) model is carried out for the chosen case study. A number of different microphysics parameterisation schemes are tested and compared, along with observational data from surface readings and from research flights using the FAAM BAe-146 aircraft. The WRF modelling allows for the sensitivities of the storm development and mesoscale features to the microphysics schemes to be analysed and compared to the observations.

Keywords: microphysics, mesoscale, WRF-modelling, aircraft measurement, secondary-wave

16. A Seamless Approach to Assessing Model Uncertainties in Climate Projections of Severe European Windstorms

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Extratropical cyclones and anticyclones dominate weather patterns in Europe. A spatial shift of the storm track, higher frequency or increased intensity storms are likely to have a severe impact in such a densely populated region. Studies to date disagree about the effects of climate change on cyclone activity in the North Atlantic, particularly about the frequency or intensity distributions of storms, but most agree that the storm track will shift north. Potential reasons for this inconsistency are differences between climate models such as different dynamical cores, parameterisations, and horizontal and vertical resolutions. These can lead to differences in the model basic state and the representation of intense storms. Furthermore, there are different methods of identifying and tracking cyclones, in a range of fields, which hampers comparability between different studies. Other sources of uncertainty include the emissions scenario and internal variability. This project will examine case studies of winter windstorms, that were either intense, severe, or both. Numerical weather prediction (NWP) forecasts of these case studies from several forecast centres will be evaluated, in terms of both quality and predictability. In the future, this work will investigate NWP simulations of these storms using climate models. By comparing bias, spread, and horizontal resolution between models, this project aims to identify and quantify the major causes of uncertainty in climate predictions of extratropical storms.

Keywords: extratropical, windstorms, climate projections, uncertainty

17. Validation of a combined SVAT and a mesoscale weather model

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The role of the land surface as a driver for global change remains uncertain. Global models operate at spatial resolutions too coarse to detect local scale variation (e.g. interactions between adjacent land covers), potentially missing significant impacts on climate and carbon balance. In this project I intend to use a high resolution (5 km grid spacing) coupled model, Soil Plant Atmosphere (SPA) model coupled to Weather Research and Forecasting (WRF) model, to investigate land-atmospheric exchanges. Presented here initial model validation of land atmosphere exchanges across multiple vegetation types from the CarboEurope eddy covariance sites across Scotland and vertical profiles of CO_2.

Keywords: Feedbacks, vertical profiles, carbon dioxide, coupled modelling, mesoscale

18. Dynamics and Organisation of Mesoscale Precipitation Systems

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This project is focused on improved understanding of the dynamics and organisation of mesoscale precipitation systems by constructing a climatology of UK precipitation structures (bands) using existing datasets, and using this climatology to examine the dynamics of a few representative, high-impact events. Eventually a climatology is to be developed for a typical westerly flow regime, characterised by frequent cyclones and high moisture. For the first year of the project, however, an unusual flow regime in which the UK has found itself during the winters of 2009-10 and 2010-11 is being studied. This is characterised by easterly and northerly geostrophic flow with few cyclones passing and relatively low moisture. Distinctive bands have been observed using the NIMROD images, primarily over the English Channel (EC) and Irish Sea (IS). The data strongly suggests that, during this regime, the organisation of precipitation over these two locations is principally determined by the local direction of the flow with roughly easterly and roughly northerly flow favouring organisation over the EC and IS respectively. The requirement of flow parallel to the direction in which these bodies of water are elongated suggests that the contrast between warm sea surface temperatures and cool air aloft is critical in producing the observed bands and this is to be investigated using the Weather Research and Forecasting (WRF) model.

Keywords: Mesoscale, precipitation, bands, banding, convection, self-organisation

19. Heatwaves in England: an investigation of the frequency of exceeding heatwave thresholds in England using the latest probabilistic climate model projections, UKCP09

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The high mortality rates caused by the August 2003 heatwave in Europe highlight the importance of an effective managed response to extreme events such as heatwaves. This led to the development of heat-health action plans in several European countries, including England. The latest IPCC assessment report stated that 'it is very likely that heatwaves will be more intense, more frequent and longer lasting in a future warmer climate'. This study has investigated the frequency of summer heatwaves in the nine administrative regions of England, using the latest probabilistic climate projections, UKCP09, in the context of the current Heatwave Plan for England. It is based on the UK Met Office's regional heatwave thresholds for daily maximum and minimum temperature. The number of summer heatwaves per year has been calculated for the current (1977-2006), baseline (1961-1990) and four future (the 2020s, 2030s, 2040s, and 2050s) climatic averaging time periods. The 10th, 50th and 90th percentiles of the UK Probabilistic Projections of Climate Change over Land were used for the four future time periods. Two heatwave indices were developed and analysed, the average number of heatwaves per year, and the frequency of the number of heatwaves per year, to give the number of years with heatwaves and the number of heatwaves that occur in any one year, for each time period. There is a clear increase in the number of heatwaves per year by the 2050s, across all percentiles, in all administrative regions in England, except for one. The central estimate (50th percentile) indicates an average of (2.1-3.0) to (5.1-6.0) heatwaves per year across England by the 2050s. Heatwaves, as they are currently defined, will no longer be 'rare' events in the 2050s. The Heatwave Plan for England will need to evolve from a disaster response approach to the continual management of consistently hotter summers and frequent heatwaves.

Keywords: climate change, health, heatwaves, extremes, probabilistic projections, UKCP09