Programme and abstracts for the meeting **"Space weather: a dialogue between scientists and forecasters"**.

The meeting will be held on Friday 13th December at the Royal Astronomical Society, Burlington House, London, W1J 0BQ.

Time	Title, author(s) and Abstract
10:30	**The Carrington event - once in a lifetime? (Invited)** Sarah Matthews (UCL, Mullard Space Science Laboratory) The Carrington event of 1859 is now widely accepted as having been responsible for the largest geomagnetic disturbance ever recorded. The intensity of the naked eye observations of this 'white-light' flare imply energies in excess of X10 on the standard GOES X-ray classification scale, and the speed with which the geomagnetic disturbance subsequently arrived at Earth indicates one of the fastest coronal mass ejections (CME) ever documented. But how unique was it? Are even larger events possible, and on what timescales? In this presentation we discuss the origins of flares and CMEs, their frequency with regard to both the sunspot cycle and longer-term variations such as the Gleissberg cycle, and the likelihood that a similar or larger event will occur within the next 155 years.
10:50	**Predicting the unpredictable: current practice and performance of the flare forecasting community** Shaun Bloomfield (Trinity College Dublin) Solar flares mostly originate from active regions, with more complex magnetic field (and hence sunspot) arrangements producing more frequent, and often larger, magnitude flares. Historically, average flare rates have been used to calculate the Poisson probability of flaring in the following 24-hour period. Unfortunately, these rates are usually determined from sunspot group classification schemes with broad parameter classes. Here we report on recent advances made by the flare prediction community in terms of flare-predictive measures, prediction techniques and appropriate forecast verification.
11:05	**Exploiting the UK's STEREO Heliospheric Imagers for space weather applications** Richard Harrison and Jackie Davies (RAL Space) The unique out of Sun-Earth line observations of the UK-led Heliospheric Imagers have provided a wealth of wide-angle imaging data for the investigation of the propagation of Earth-bound Coronal

	Mass Ejections (CMEs) from source to impact. Indeed, these instruments provide the only capability for the imaging of CMEs actually approaching and passing over the Earth. The data have generated a wide range of scientific studies of CME onset, evolution and propagation and impact, as well as studies of co-rotating interaction regions, dust, comets etc.... The practical aspects of the HI technique for CME tracking and prediction are being considered actively for space weather applications. The belief is that such a capability is an essential component of any future space weather programme.
11:20	**Sun and showers: Forecasting Solar Energetic Particle Storms** Mike Marsh, Silvia Dalla, Timo Laitinen (University of Central Lancashire) Solar eruptive activity can eject a multitude of energetic charged particles into the inner heliosphere. These Solar Energetic Particle (SEP) events can give rise to, sudden, transient, increases in the flux of ionising radiation at Earth, having both technological and biological impacts. These events can affect areas ranging from satellite operations to the radiation dose received by astronauts and even aircrew. We present work carried out as part of the EU FP7 COMESEP (COronal Mass Ejections and Solar Energetic Particles) collaborative project. This work involves forecasting the risk of an SEP radiation storm following the detection of an eruptive event. We will describe our numerical test particle modelling approach, which simulates the physics of SEP propagation through the inner heliosphere. It is the general belief that propagation of SEPs across the interplanetary magnetic field is negligible. We show that this assumption is incorrect, and that particle drifts play a significant role in the propagation of space weather effective SEPs and the interpretation of in situ data. We show how the propagation of SEPs depends on latitude, energy and mass to charge ratio, and the resulting synthetic particle flux profiles measured at Earth. A goal of this work is to enable the transition from research tool to informing operational decisions affected by space weather. Further collaboration is sought to define what is desired by the operational community in comparison to the output from research. This work has received funding from the European Commission FP7 Project COMESEP (263252).
11:35	**The steady-state expansion of active regions into the slow solar wind (Invited)** Huw Morgan (Aberystwyth University)

	Active regions are areas of closed magnetic field containing hot, dense plasma which is generally thought to be isolated from contributing directly to the slow solar wind except through eruptions and small-scale reconnection at the closed-field boundaries. Recent advances in coronal observations and in image processing techniques have led to the discovery of active regions expanding directly into the solar wind, as nested systems of closed loops are seen to expand steadily outwards through the SDO/AIA field of view, and to heights of at least 15 solar radii in coronagraph data. These systems can expand continuously for several days, and are frequently observed above 'active' active regions. As such they are interpreted as a natural steady state for some active regions which demands a revision of current models linking the slow solar wind with sources at the Sun, and provides a fresh interpretation to some characteristics of in situ measurements of the slow wind. They also provide a non-eruptive mechanism to slow the increase in free energy within active regions, with implications for studies of CME initiation and prediction.
11:55	**Space weather forecasting at the Met Office (Invited)** Mark Gibbs (Met Office) This talk will provide an update on the development of a space weather forecasting capability at the Met Office and will explain the underlying ethos and thinking. Then I will describe the planned services and the capability that is used to support these services and thoughts on the future evolution of these services and capabilities. Finally, I will address the key scientific issues and challenges presented to an operational space weather forecaster.
12:15	**Forecasting the high-energy electron flux throughout the radiation belts using the BAS Radiation Belt model** S. A. Glauert, R. B. Horne, N. P. Meredith, T. Kersten (British Antarctic Survey) The flux of relativistic electrons in the Earth's radiation belts is highly variable and can change by orders of magnitude on timescales of a few hours. Understanding the drivers for these changes is important as energetic electrons can damage satellites. The BAS Radiation Belt model is a physics-based model that has been developed to simulate the energetic electron flux throughout the radiation belts, incorporating the effects of radial transport, wave-particle interactions and collisions. It is now used to forecast the energetic electron flux as part of the EU-FP7 SPACECAST project. Here we apply a new version of the BAS Radiation Belt model to different types of space weather events. We show that during quiet periods a new model for plasmaspheric hiss and lightning-generated whistlers can reproduce the behaviour of the electron flux in the slot region, where the new O3B satellites will operate. We also

	demonstrate that the large increases in flux that can be observed during both CME and CIR driven storms in the heart of the radiation belts, where GNSS satellites operate, are well reproduced using a recently published model for upper and lower band chorus waves. Finally, using solar wind data, we model changes in the outer boundary of the Earth's magnetic field and show how these changes can cause rapid radiation belt losses much closer to the Earth that can affect satellites in both MEO and GEO orbits.
12:30	**LUNCH**
13:50	**Space weather effects on airline communications in the high latitude regions** Farideh Honary, E.M. Warrington , N. Rogers, A.J. Stocker and D.R Siddle (University of Lancaster) Efficient air traffic management depends on reliable communications between aircraft and the air traffic control centres at all times. At high latitudes, and especially on polar routing, VHF ground infrastructure does not exist and the aircraft have to rely on HF radio for communications. HF relies on reflections from the ionosphere to achieve long distance communications. Unfortunately the high latitude ionosphere is affected by space weather events. During such events HF radio communication can be severely disrupted and aircraft are forced to use longer low latitude routes with consequent increased flight time, fuel consumption and cost. This presentation describes a new research programme at the University of Lancaster in collaboration with the University of Leicester, Solar Metrics Ltd and Natural Resources Canada for the development of a nowcasting and forecasting HF communications tool designed for the particular needs of civilian airlines. This project funded by EPSRC will access a wide variety of solar and interplanetary measurements to derive a complete picture of space weather disturbances affecting radio absorption and reflection.
14:05	**Radiation effects on aviation: historical measurements, calculations and future needs** Clive Dyer (University of Surrey Space Centre) Aviation is in the front line for solar particles as the energetic particles of concern travel at close to the speed of light giving minimal warning times. Hazards include dose to crew and passengers and single event effects in avionics. UK measurements on the ground, aircraft and spacecraft, together with modelling of the atmospheric radiation environment, illustrate the nature of the problem and the requirements of future work.

14:20	**Space weather and the national grid (Invited)** Andrew Richards (National Grid) We consider how the arrival of a geo-effective coronal mass ejection affects the high voltage electricity transmission network in the UK. We discuss the range of possible impacts this could have, and the likelihood of the differing levels of risk. We explain how the system operator, National Grid, is prepared for a serious space weather event, and briefly outline the modelling, monitoring and mitigation work that has been undertaken.
14:40	**Geophysical monitoring and modelling of geomagnetically induced currents (GIC) in power transmission systems** Alan Thomson (British Geological Survey) In the UK, BGS has been working with National Grid to assess current and hypothetical extreme hazards to the power system. We show some examples of 'worst cases' for the UK transmission system and describe an operational system, known as 'MAGIC', which presents monitoring, modelled and forecast data to National Grid. An initial model of GIC flow in the Irish power transmission system is also presented. We discuss how measurements of geoelectric fields can be used to validate GIC models and consider the significance and accuracy of current models of ground conductivity and magnetic variations across the country. Recent advances in GIC and geomagnetic activity forecasting are also described.
14:55	**Visualising space weather for end-users** Bryn Jones (Solarmetrics) and Liam Hayter (Independent State) Coronal Mass Ejections, high-speed solar wind streams, X-ray flares, magnetosphere, particle fluences, charts and plots of particle energies: all the language of the solar and space weather scientists. The impacts from any of these phenomena on our society and technology occur on a daily basis. But what do these terms actually mean to the layperson, society or businesses in terms of impact? What are the risks? Where is the relevant information they can understand? SolarMetrics and Independent State will present a new and unique digital visual language that will depict and describe the space environment (and potential risk levels) using simple, dynamic and interactive icons and symbols – a new information system for weather from space. The symbology will be customisable to provide the relevant information to reflect individual user or business needs and policies; define pro-active risk thresholds; and for the first time provide the right information (understandable and relevant) at the right time.

15:10	**Modelling the magnetic configuration of CMEs: can we determine the CME onset time? (Invited)** Duncan Mackay and Gordon Gibb (University of St. Andrews) TBC
15:30	**End and concluding remarks**