MÉRA Workshop May 2nd 2019

National Botanic Gardens, Glasnevin, Dublin 9

Contact details: mera@met.ie

Practical Information

Workshop Venue:

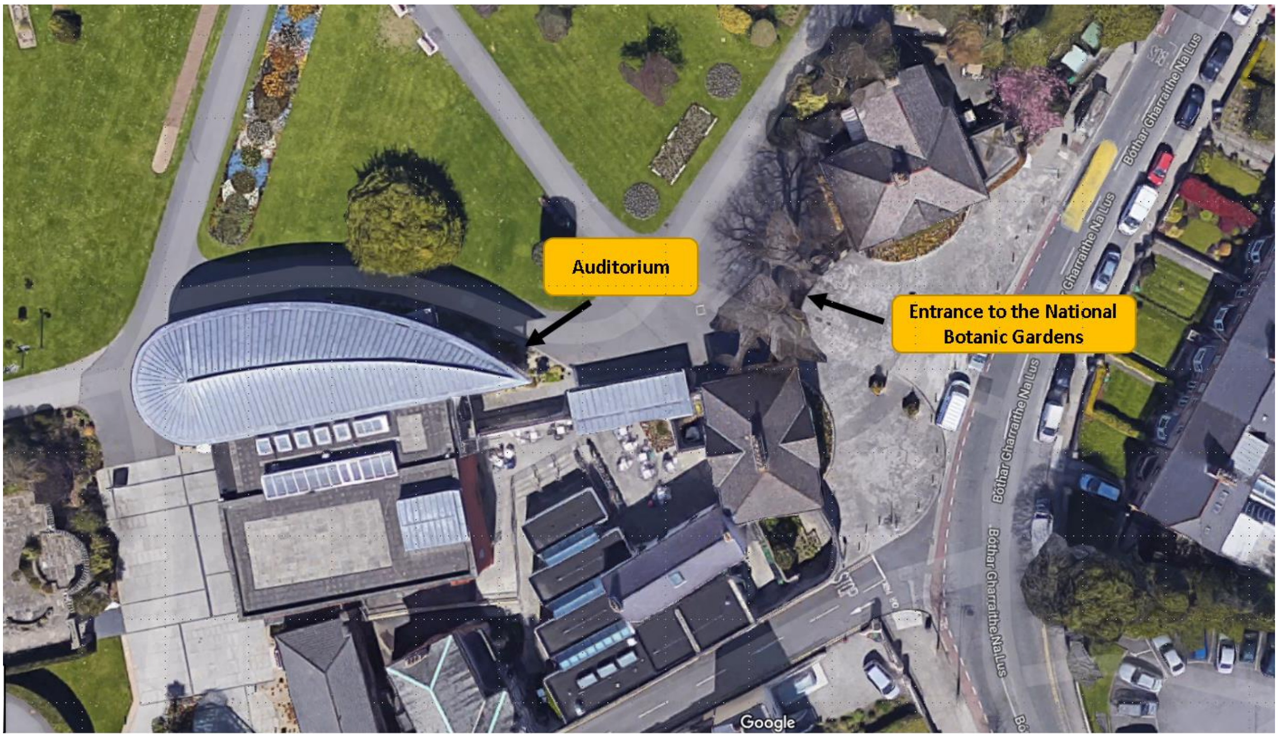
The workshop will take place in the Auditorium in the main building at the National Botanic Gardens.

Directions to the National Botanic Gardens:

The National Botanic Gardens are located in Glasnevin, Dublin 9. Here is a link to a map and directions: http://www.botanicgardens.ie/educ/gettingthere.htm. The following buses serve the area: 4, 9 and 83 and the nearest train station is Drumcondra (a 15 minute walk away).

How to get to the MÉRA workshop from the front gates of the National Botanic Gardens?

See map below.



Parking:

The National Botanic Gardens car park will be open from 9.00 am to 4.30 pm and costs 2 Euro for the first 2 hours and 2 Euro per hour for each subsequent hour. Space is limited (~ 60 spaces) so we would advise you to get there early. There is also some on-street parking in the area. Cars parked in the Addison Lodge (opposite the Botanic Gardens) will be clamped.

Registration:

Registration will take place in the foyer of the main building in the National Botanic Gardens from 9.30 am. We would like you to take your seat by 9.55 am. The workshop will commence at 10 am.

Abstracts

Session 1:

ERA5, the ECMWF C3S State-of-the-art Global Atmospheric Reanalysis

Cornel Soci[1], William Bell[1], Paul Berrisford[1], Hans Hersbach[1], Andras Horanyi[1], Julien Nicolas[1], Raluca Radu[1], Joaquin Muñoz Sabater[1], Dinand Schepers[1], Adrian Simmons[1]

[1] ECMWF, Reading, UK

The European Centre for Medium-Range Weather Forecasts (ECMWF) has been entrusted by the European Commission to implement the Copernicus Climate Change Service (C3S) and Copernicus Atmosphere Monitoring Service. These are two services out of six thematic areas of Copernicus, the European Union's Earth observation programme.

The C3S mission is to support European adaptation and mitigation policies by (i) building upon existing capabilities and infrastructures, (ii) providing consistent and authoritative information about climate, and (iii) stimulating the market for climate services in Europe. C3S users include scientists, consultants, planners and policy makers, the media and the public (more at https://climate.copernicus.eu/).

ERA5 is the first global reanalysis produced at ECMWF by the C3S. The ERA5 dataset provides global estimates of the atmosphere, land surface and ocean waves at much higher spatial (31 km horizontal grid spacing, 137 levels in the vertical from the model surface up to an altitude of about 80 km) and temporal (hourly) resolution than ERA-Interim, the well-known and very successful ECMWF reanalysis. A 10-member 4D-Var ensemble data assimilation system at a lower horizontal resolution (62 km grid) provides uncertainty information for ERA5 data products. At the moment, ERA5 covers the period from 1979 to the present, but an ERA5 extension spanning the period 1950 to 1978 is currently in production. In addition, a dedicated global high-resolution (9 km grid) land surface analysis is being produced. The ERA5 dataset is open access and free of charge for all uses, including commercial users, through the C3S Climate Data Store (https://cds.climate.copernicus.eu).

The ERA5 reanalysis system employs the ECMWF operational system of 2016. Thus, compared to ERA-Interim, it benefits from 10 years of progress in observation data assimilation, model dynamics and parametrizations. As such, ERA5 assimilates data from new satellite instruments (e.g. IASI, CrIS, ATMS etc.) as well as improved satellite reprocessed datasets.

This presentation will focus on the configuration, status and performance of ERA5.

Session 2:

Copernicus Regional Reanalysis for Europe

Semjon Schimanke, SMHI, Norrköping, Sweden

The Copernicus regional reanalysis for Europe (https://climate.copernicus.eu/regional-reanalysis-europe) is produced as part of the Copernicus Climate Change Service (C3S). The regional reanalysis (RRA) provides meteorological data from 1961 to near real-time with monthly updates.

The dataset contains analyses of the atmosphere, the surface and the soil. The essential climate variables are generated with the UERRA-HARMONIE and the MESCAN-SURFEX systems. UERRA-HARMONIE is a 3-dimensional variational data assimilation system, while MESCAN-SURFEX is a complementary surface analysis system. Data are available for all of Europe at a resolution of 11 km for the UERRA-HARMONIE system and at 5.5 km for the MESCAN-SURFEX system. The systems provide four analyses per day – at 0 UTC, 6 UTC, 12 UTC, and 18 UTC. Between the analyses, forecasts of the systems are available at hourly resolution. More than fifty parameters are available on the different level types. The data are available through Copernicus Climate Data Store (CDS), e.g.

https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-uerra-europe-single-levels?tab=overview.

This presentation will introduce the service and its main objectives. The focus will be on the available data and its quality. For instance, comparisons with ERA-Interim/ERA5 will be shown as well as homogeneity investigations.

MÉRA Dataset: The Haystack of Meteorological Data and the Needles Within.

Victor J Murphy, University College, Dublin

The MÉRA dataset is no less than 600 Tb in size. With current internet infrastructure, it is believed that a copy of this data would take 6 months to produce. How can one distil the information to a more manageable size to find extreme weather phenomena such as a Sting Jet? This project will attempt to find the many needles within this haystack by using modern machine learning and artificial intelligence to sort through the data. We aim to develop an AI capable of recognising different storms and weather events that occur on a regular basis off the coast of Ireland. Slices of the MÉRA dataset will initially be used as training-data, with the long-term goal of developing an AI that can be employed in storm tracking. This piece of software will be called Zeus.

Analysing the Effect of Atmospheric Rivers on Ireland’s Extreme Precipitation Events

Liam Woods, UCD School of Mathematics and Statistics, University College of Dublin

At any given time, on average, more than 90% of the total meridional water vapour transport through the mid-latitudes is concentrated in four or five narrow regions that total less than 10 % of the circumference of the Earth at that latitude (Zhu & Newell, 1998). These are atmospheric rivers, typically located in the warm sector of mid-latitude cyclones, and play a vital role in extreme precipitation events in places such as California. The purpose of this study is to create a climatology of Atmospheric Rivers that have passed over Ireland using ERA5 data. Once they have been identified, the MÉRA dataset will be used to investigate if these Atmospheric Rivers are linked to extreme precipitation in Ireland. Finally, a Lagrangian approach will be taken, using the MÉRA dataset along with a storm tracking algorithm to analyse water vapour fluxes within the Atmospheric River itself with the aim of identifying the source of the water vapour.

The use of MÉRA for the Development of a Bathing Water Prediction System in Ireland

Daniel Hawtree[1], Levent Görgü, Conor Muldoon, Bartholomew Masterson, John O’Sullivan, Wim G. Meijer, Gregory O’Hare,

[1]University College Dublin

The European Bathing Water Directive (BWD; 76/160/EEC 2006) requires the implementation of early warning systems for bathing waters which are subject to short-term pollution events. To this end, coastal water quality prediction models and alert systems are being developed which aim to provide ‘nowcasts’ of bathing water quality, based on the relationship between faecal indicator bacteria and multiple environmental variables. In this respect, Met Éireann's high resolution regional reanalysis dataset (MÉRA) has significant potential as a source of environmental variables at spatial and temporal resolutions exceeding those which are typically available from gauged data sources. The EU SWIM Project is utilising the MÉRA dataset to develop a nowcasting system at nine beaches in the Republic of Ireland and Northern Ireland, representing a range of different site conditions. This presentation will provide an overview of the end-to-end prediction system, a summary of the underlying models, and a discussion of the utility of MÉRA as a key input for the predictive system.

Intensification of Agriculture in the Boyne Catchment: Modelling the Environmental Impacts

Daniel Courtney, Maynooth University

Food Harvest 2020 was devised as a national plan to intensify Irish agricultural production in the livestock sectors – dairy, beef, sheep and pigs. Specific targets were set out for each of the categories. This study involved a wide-ranging environmental systems analysis to assess the environmental impacts associated with the projected intensification in the River Boyne catchment area. The environmental impacts were assessed using Life Cycle Assessment (LCA) modelling.

Global warming potential and acidification potential were used as impact indicators to assess the effects of increases in emissions of greenhouse gases and ammonia respectively. The findings indicated a 7% increase in global warming potential and a 10% increase in acidification potential. The agri-environmental model used in the study was devised by Cranfield University.

Future and Historical Renewable Energy Resources and Weather-related Demand in Ireland

Laura Cooke[1,2], Conor Sweeney[1,2], and Frank McDermott[1,3]

[1]*Energy Institute, University College Dublin*

[2]*School of Mathematics and Statistics, University College Dublin*

[3]*School of Earth Sciences, University College Dublin*

In planning for the future, a much better understanding of how climate change will impact the solar and wind energy resources, as well as weather-related demand for electricity is required. It is also very useful to have a reliable historical database to compare to. Climate models run on a range of possible Representative Concentration Pathway (RCP) scenarios, giving us a probabilistic view of future projections of weather variables relevant to the renewables sector. These projections can be used to investigate how climate change impacts on future energy systems.

This study utilises the output from five regional downscaled (12.5 km, 3 hourly) climate models over the European region. By applying a wind capacity model, solar capacity model and electricity demand model to historical simulations carried out using these climate models, renewable energy capacity and electricity demand are calculated for the island of Ireland. These are compared with those generated from the high-resolution regional reanalysis dataset, MÉRA (1981-2016). In addition, mid-term (2041-2060) and long-term (2081-2100) projections across three RCP scenarios (2.6, 4.5, 8.5) are produced. As there are five projections for each scenario, we can also calculate uncertainty bounds on energy capacity and demand projections. Solar and wind energy models are based on code from Renewables Ninja (www.renewables.ninja), while the electricity demand model is based on population-weighted weather variables from MÉRA and historical electricity demand data.

This work provides model-based mid- and long-term projections of renewable energy resources and demand in Ireland under different RCP scenarios, and a measure of the associated uncertainty. In addition, an historical (1981-2016) high-resolution model of wind and solar energy capacity for Ireland based on MÉRA will be generated. These historical and future model-derived data will be useful in planning future energy systems and will provide typical supply and demand profiles under future weather regimes.

Session 3:

Copernicus Climate Change Services (C3S) reanalysis of Greenland, Iceland, Svalbard and the Barents Sea region

Kristian Pagh Nielsen, DMI, Copenhagen, Denmark

We are running a multi-year (1997-2021) high-resolution (2.5 km) reanalysis of Greenland, Iceland, Svalbard, Northern Scandinavia and parts of the Russian and Canadian Arctic as a part of the Copernicus

Climate Change Service (C3S) regional reanalysis programme. The ongoing changes in the Arctic are very important to understand in this era of climate change, but the meteorology is very challenging to model due to an extreme topography and a sparsity of measurements.

The Greenland ice sheet is the largest ice volume in the rapidly warming Arctic and covers an area of 1.71 million square km. The solar-driven melt rate of this is determined by the albedo (whiteness) of the ice sheet. Current weather models and reanalysis products have poor ice sheet albedo representations. We have addressed this issue in our model by using observed albedo datasets. This also significantly improves our analysis of the general weather conditions in and around Greenland.

An optimised version of the HARMONIE-AROME model is used for the region, and is nested into the brand-new global ERA5 reanalysis dataset. The external albedo dataset, that has been included in the surface analysis, is the MOD10A1 collection 6 daily gap-filled satellite product which has a resolution of 500 m. We show the impact of including the MOD10A1 data, and estimate the uncertainties of the results relative to meteorological data from the synoptic weather station network.

Extreme Low Thicknesses during the 'Beast from the East' of 2018

Eddie Graham, University of the Highlands and Islands Stornoway, Scotland

Based on a study using NCEP/NCAR and NCEP DOE2 Reanalyses 1000-500 hPa thicknesses together with 850/500 hPa air temperature, Graham and Webb (2019) have already shown that the infamous 'Beast from the East' of 2018 was one of the most severe easterly cold pools to have crossed the UK and Ireland over the past 72 years. This new study will compare the NCEP/NCAR and NCEP DOE2 Reanalyses with the same parameters of the much higher resolution MÉRA reanalysis for the easterly cold pool phase of the 'Beast' of 2018.

Verification of extreme windstorms in the MÉRA dataset

Laura Zubiate, Met Éireann

Windstorms pose a significant risk to life and property through extreme wind speeds and waves. They can cost billions in insurance losses and have a negative impact on the activities of the forestry and offshore energy sectors. Detailed knowledge of the location, intensity and frequency of these storms can help with planning and mitigating for their detrimental effects. In particular, there is a need for high resolution information that allows for a better understanding of the spatial variability of extreme winds. Windsurfer is an ERA4CS (European Research Area for Climate Services) project that aims at developing new tools, methods and assessments of current and future extreme windstorm risk, with a focus on the insurance, forestry and energy sectors.
Selected historical windstorms from the MÉRA dataset have been analysed in the present study. In particular, 10 m wind speeds have been verified against observations from the Irish synoptic station network to evaluate the performance of the modelled data in characterising extremes in both sustained wind speeds and maximum gusts. Mean sea level pressure has also been verified with observations from the same network as well as vertical wind profiles using radiosonde data recorded at Valentia observatory.

Extreme Wave Events during the Winter of 2013/2014

Frédéric Dias[1,2]

[1]School of Mathematics and Statistics, University College Dublin, Ireland

[2]CMLA, ENS Paris-Saclay, France

To reproduce the wave events of February 2014, the WAVEWATCH III model was forced with MÉRA 10 m winds and ECMWF ERA-Interim two-dimensional wave spectra. The December 2013 to February 2014 period was simulated and events on the 1st and 12th February were analysed. Bearing in mind that the model underestimates the significant wave height (SWH) when compared to measurements, the maximum SWH of 15 m was reached by the model on the 1st of February at 12:00 UTC. These two events show different atmospheric conditions resulting in different sea states that can be equally dangerous. One can have a widespread and highly energetic sea state, or a more focused and unexpected energetic state, and among these sea states it is possible to even have rogue waves.

An Evaluation of Integrated Cloud Condensate in the MÉRA Reanalysis Dataset

Eadaoin Doddy[1,2], Emily Gleeson[3], Eoin Whelan[3], Conor Sweeney[1,2], and Frank McDermott[1,4]

[1]Energy Institute, University College Dublin

[2]School of Mathematics and Statistics, University College Dublin

[3]Met Eireann, Glasnevin, Dublin 9

[4]School of Earth Sciences, University College Dublin

This study further investigated previous suggestions that the thickest clouds in MÉRA may have cloud water loads that are too high. Integrated cloud water (ICW) and cloud ice (ICI) as well as total cloud cover in MÉRA were compared to those in KNMI's MSG Cloud Physical Properties (MSGCPP) dataset. MÉRA output is available for each forecast hour up to 33 hours for the 00 Z forecast each day. First, we evaluated the influence of spin-up in the model. Our results indicate a spin-up time of 5 or 6 hours is required for the HARMONIE-AROME model in terms of cloud water and cloud ice and for this reason it was decided to use the 09 h to 33 h forecasts in this study.
The period spanning January 2016 to May 2017 was used for this analysis, limited to the time period when both MÉRA and MSGCPP data were available. A common validation area (CVA) over Ireland was selected to eliminate negative influences from boundary effects. MSGCPP data are limited to daylight hours, so for comparison purposes, only the hours when the CVA is completely in daylight were examined. As we were interested in evaluating the properties of clouds, this study further limited the comparison to hours when only large cloud amounts were present in both datasets.
Our results show that MÉRA overestimates the cloud water path (CWP = ICW + ICI) compared to the MSGCPP data, particularly in the thickest clouds. Spatial analysis showed that the north west of the region performed worst. We also investigated individual case studies over the island of Ireland where the errors were particularly large. Preliminary analysis suggests that the CWP is overestimated by MÉRA when frontal clouds are present, but is underestimated during broken cloud cell features.

Coupled Ocean-Wave Model

Clément Calvino[1], Frederic Dias[1], Tomasz Dabrowski[1]

[1]School of Mathematics and Statistics, University College Dublin, Ireland

Following the revival of offshore drilling and coastal renewable energies the number of coastal engineering projects is increasing, and so is the need to obtain a better understanding and forecast capabilities of currents and waves in coastal areas. Operational ocean models are also using particle tracking features for a wide range of applications, like disease propagation among aquafarms or rescue missions, where the accuracy of the simulation is critical. The scope of the research is to improve the general modelling by focusing on the wave-current interaction.
The sea state is made up of a random succession of waves propagating on the surface of the ocean. These waves are influenced at different scales by bottom topography, shoreline geometry and currents, especially in coastal areas. Currents are also influenced by waves and the major well known contribution is the Stokes drift. This two-way wave-current interaction can alter significantly ocean circulations and wave characteristics.
A coupled regional application taking the wave-current interaction into account is developed for the west coast of Ireland, Galway Bay, using the Coupled Ocean Atmosphere Wave Sediment Transport (COAWST) model. COAWST agglomerates and enables a coupling between different numerical models. Each model is specific for a particular physics, the Regional Ocean Modelling System (ROMS) being used for the ocean model, and WAVEWATCH IIIR for the wave model. The surface boundary condition of the model is provided through a bulk formulation using the MÉRA data for the atmospheric forcing. The results of the simulation are compared with field data including the Spiddal observatory, several tidal gauges and ADCPs deployed in Galway Bay as well as data from an ADCP deployed during the winter 2016/2017.

Latest Insights into the Use of MÉRA Data for the Simulation of Storm Surges

N. Beisiegel[1], F. Dias[1,2]

[1]School of Mathematics and Statistics, University College Dublin, Ireland

[2]CMLA, ENS Paris-Saclay, France

Ireland has long been known for its stormy winters. In fact, extreme and storm waves occur regularly on all Irish coasts (see O'Brien et al., 2018). Storm surges pose an immense threat to local communities and infrastructure. They are not difficult to measure after the event, however, forecasts which are needed by emergency managers and the public alike require accurate, robust and efficient numerical simulations. At present modelling capabilities are lacking so that predictions cannot be made with the desired accuracy or in the required time. Spatial resolution plays an important role since it is directly correlated to accuracy as well as computational cost. For example, simulated surge heights are strongly influenced by topographic gradients (see Rappaport 2014) which is why areas with large topographic variation would ideally be finely resolved. In this presentation I will discuss a recently developed numerical model for storm surge simulations that is described in Vater et al. (2019) and Beisiegel and Behrens (2015) and that uses a non-uniform mesh as described in Behrens et al. (2005) for increased computational efficiency. As, ultimately, the quality of simulations largely depends on the quality of the input data, I will show how I use the MÉRA data set (see Gleeson et al., 2017) as well as a combination of several topographic data sets to set up simulations and discuss what I have learned along the way.