Making Ireland Weather and Climate Prepared

Forecasting Extreme Weather Events In A Warming world

Evelyn Cusack
Head of Forecasting Division,
Met Éireann

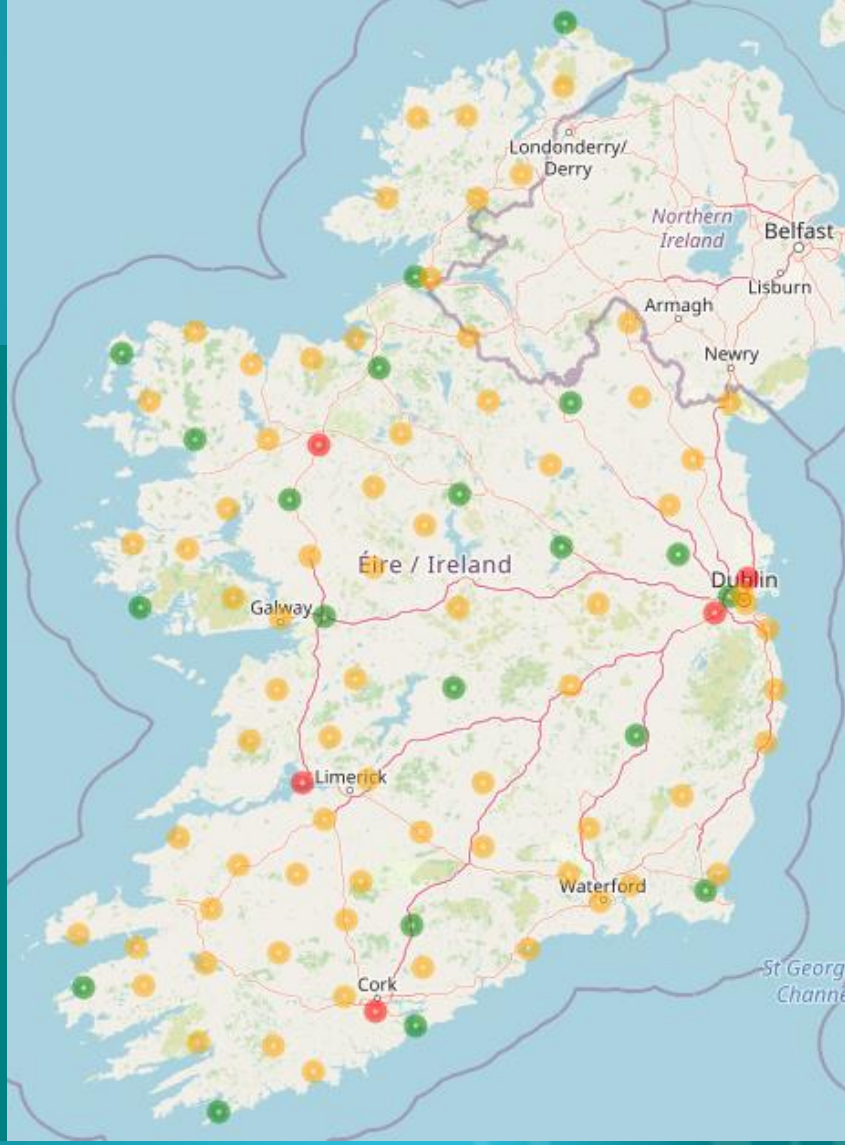
An Roinn Tithíochta,
Rialtais Áitiúil agus Oidhreachta
Department of Housing,
Local Government and Heritage

- Met Éireann is a Division of the Department of Housing, Local Government and Heritage

- Department HQ: The Custom House
- Met Éireann HQ: Glasnevin Hill

- Met Éireann is a Division of the Department of Housing, Local Government and Heritage

- Met. Observers at Airports: Dublin; Shannon; Ireland West (Knock); Cork; Casement
- 25 automatic synoptic stations
- 80 automatic climate stations



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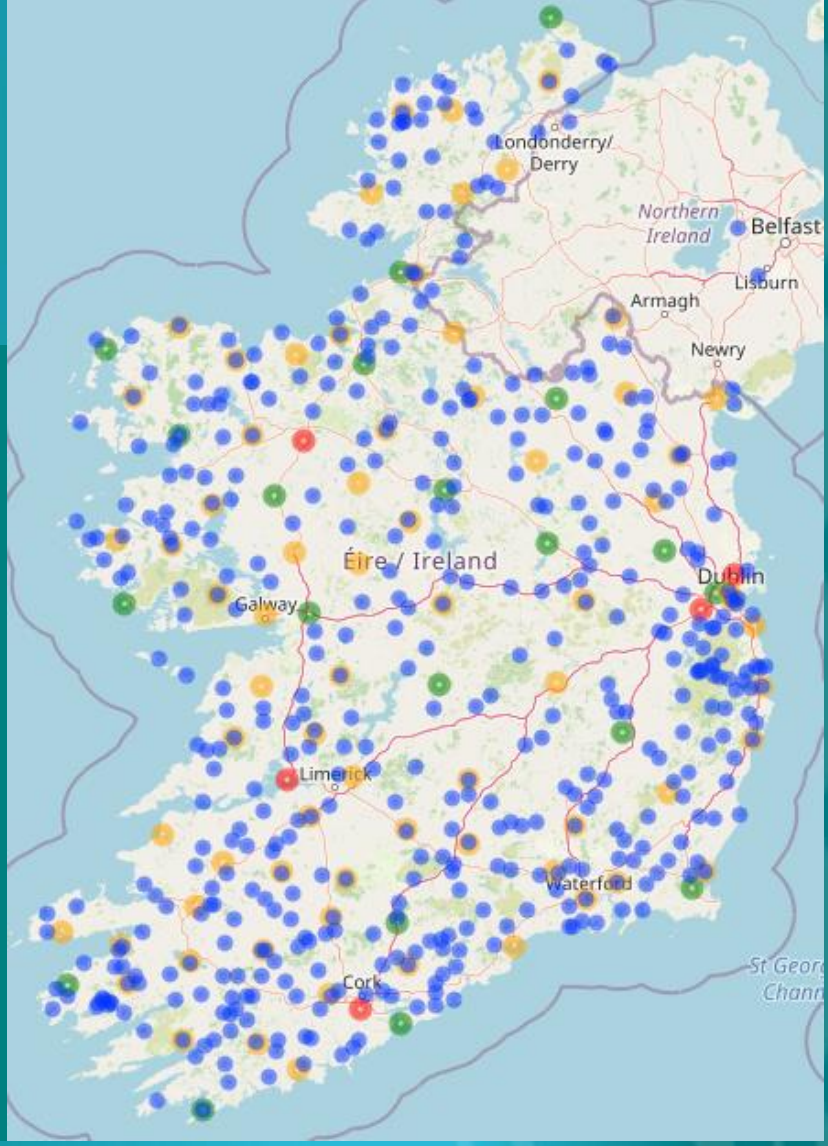

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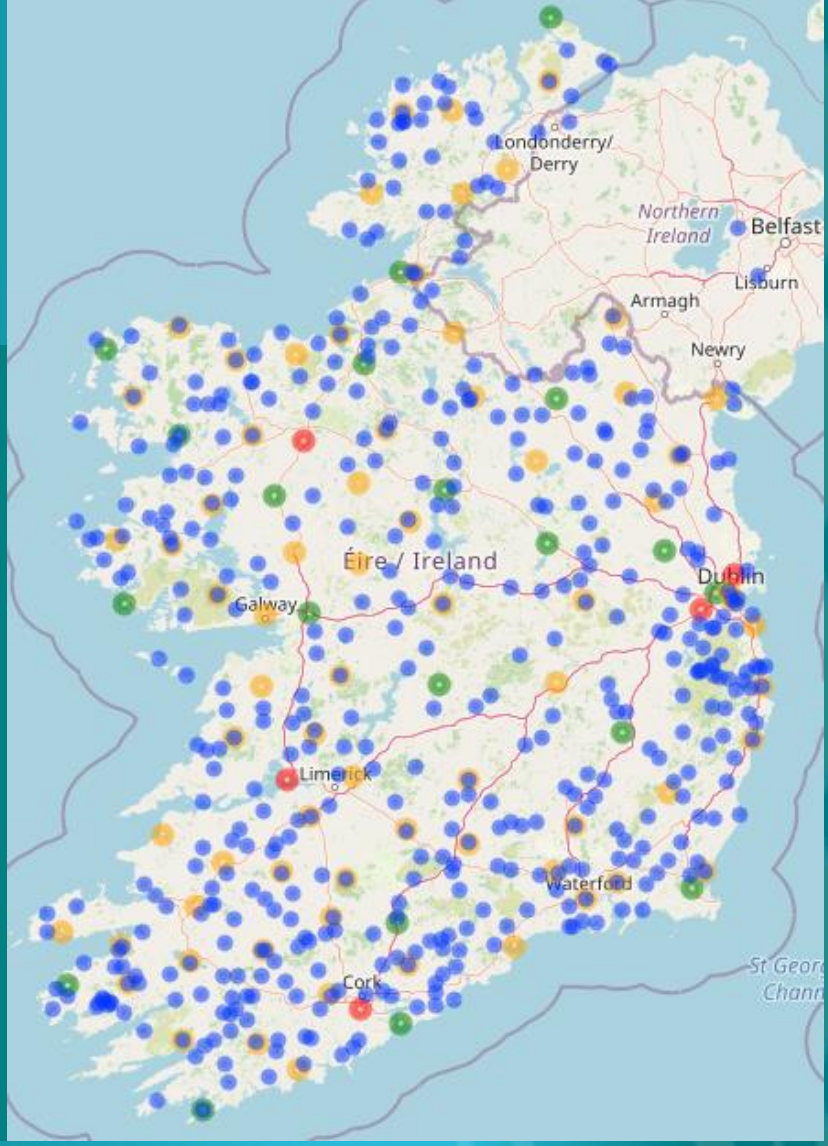


- We have 177 scientific staff: Meteorology; Physics; Mathematics;
- Engineering; Chemistry; IT
- Postgraduate Scholarship Programme Applicant deadline: 29 October 2020

Met Éireann Strategic Plan 2017–2027

Making Ireland Weather and Climate Prepared

Helping Irish society to be ready for and responsive to weather and climate risks

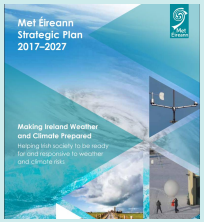
Goal 1:

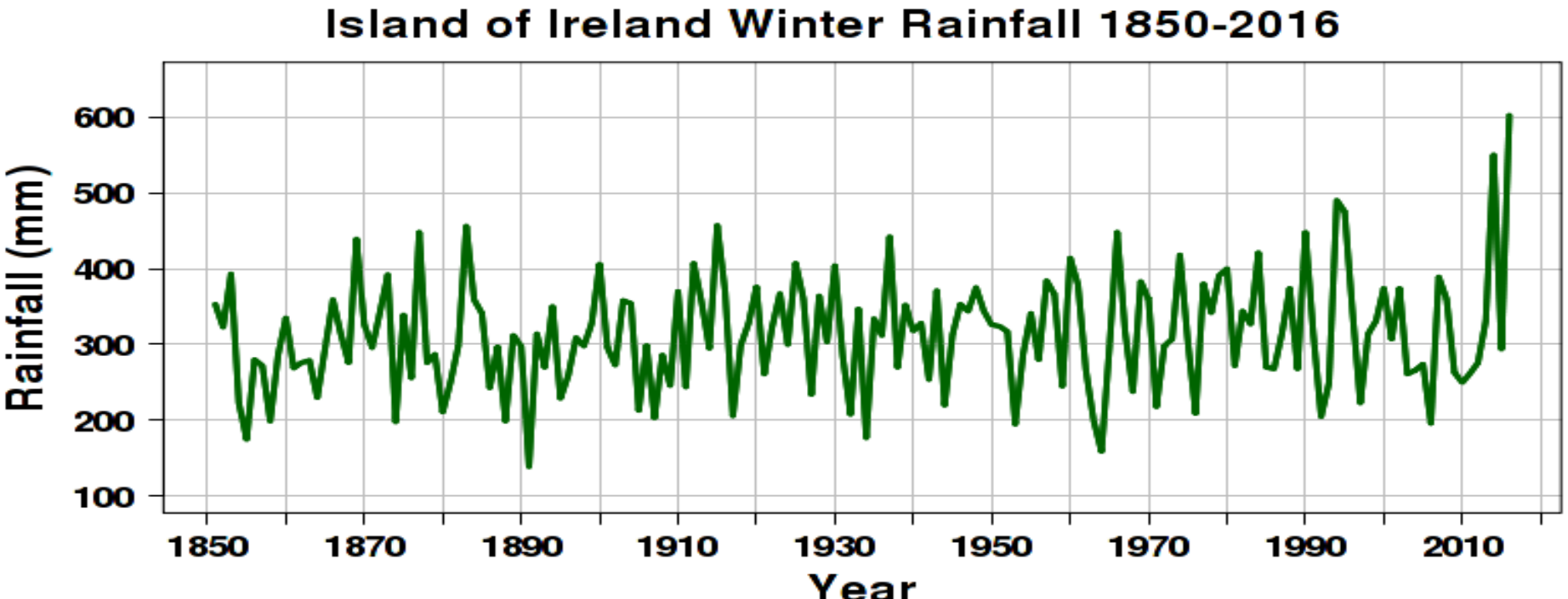
Enhance support for impact-based decision making for weather events……ensure the protection and safety of life and property by issuing weather forecasts and warnings…….

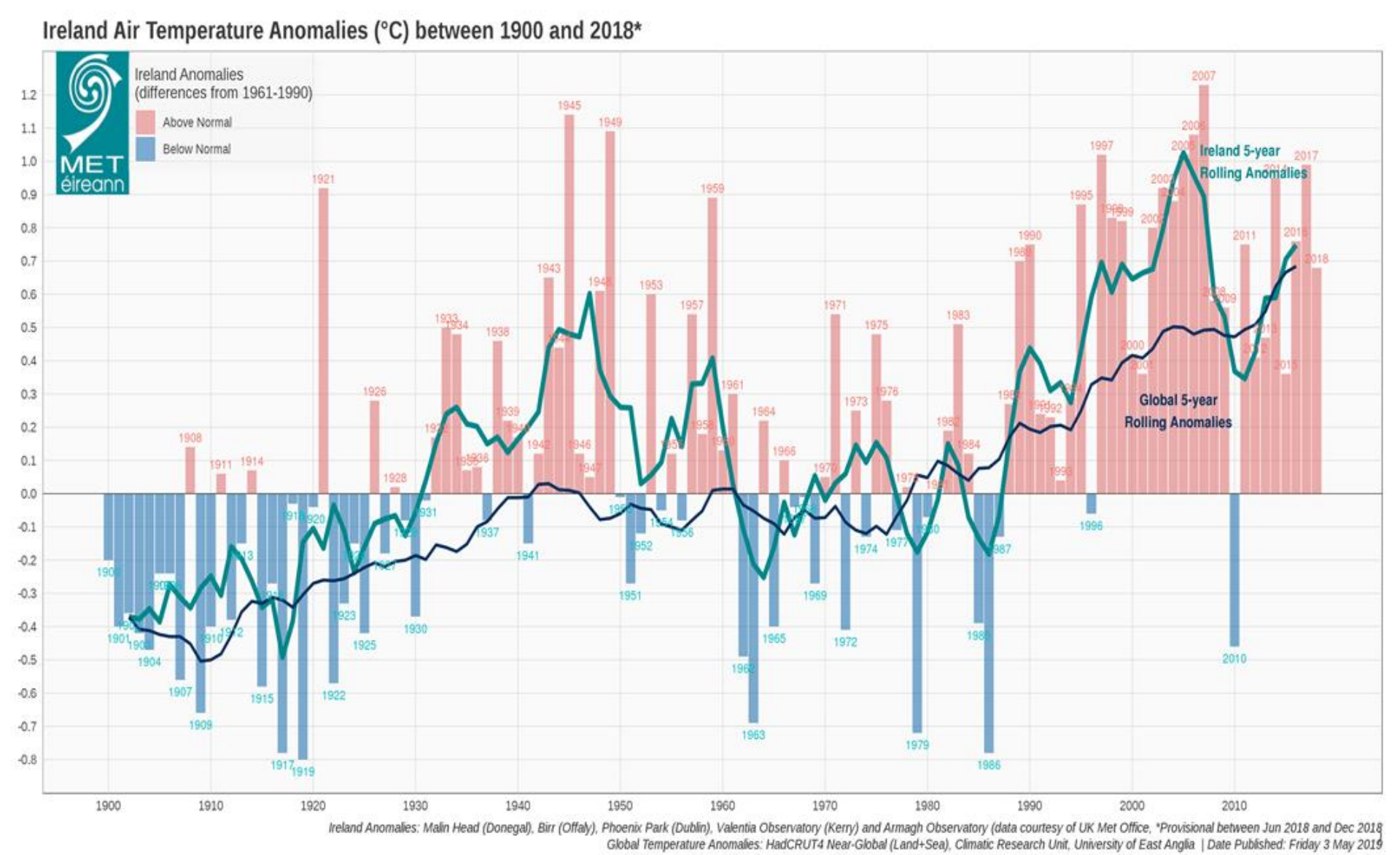
www.met.ie/warnings	STATUS YELLOW *Weather that does not pose a threat to the general population but is potentially dangerous on a localised scale.*	STATUS ORANGE *Infrequent and dangerous weather conditions which may pose a threat to life and property.*	STATUS RED *Rare and very dangerous weather conditions from intense meteorological phenomena.*
Wind *Mean wind: 10 minute (higher on coasts/high ground/funnelling effects etc)*	Widespread mean speeds between 50 and 65km/h and/or Widespread gusts between 90 and 110km/h	Widespread mean speeds between 65 and 80 km/h and/or Widespread gusts between 110 and 130 km/h	Widespread mean speeds in excess of 80 km/h and/or Widespread gusts in excess of 130 km/h
Coastal Wind Warnings *Mean speeds up to 30 nautical miles offshore*	Gale force 8 or strong gale force 9.	Storm force 10.	Violent storm force 11/Hurricane Force 12.
Rain *Amounts can be up to double on windward upper slopes & impacts vary with soil moisture deficits*	20mm – 30mm in 6 hrs or less. 30mm – 40mm in 12 hrs or less. 30mm – 50mm in 24 hrs	30mm – 50mm in 6 hrs or less. 40mm – 60mm in 12 hrs or less. 50mm – 80mm in 24 hrs	Greater than 50mm in 6 hrs or less. Greater than 60mm in 12 hrs or less. Greater than 80mm in 24 hrs or less.
Snow/Ice *Heavy rain can turn to snow when temperatures are around zero (up to around +4C)*	Guidelines only 3cm or greater in 24hrs.	Guidelines only 3cm or greater in 6 hrs 5cm or greater in 12 hrs 10cm or greater in 24 hrs	Guidelines only 10cm or greater in 6 hrs 15cm or greater in 12 hrs 30cm or greater in 24 hrs
Low temperature/Ice *Ground temperatures can be as much as 10 degrees lower than air temps*	Air minima of minus 3C or minus 4C expected over a wide area (localised lower values will occur). • *Dangerous surfaces due to ice and/or lying snow. Situation improving.*	Air minima of minus 5C to minus 10C (or lower) expected over a wide area. • *Dangerous surfaces due to ice and/or lying snow/freezing rain. Situation stable*	Air minima minus 10C (or below) for three consecutive nights or more. Maxima of minus 2C. • *Dangerous surfaces due to ice and/or lying snow/freezing rain. Situation likely to worsen*

GOAL 2: Provide climate information services which promote citizen safety and supports economic and environmental resilience

Goal 3: Deliver a National Flood Forecasting Service

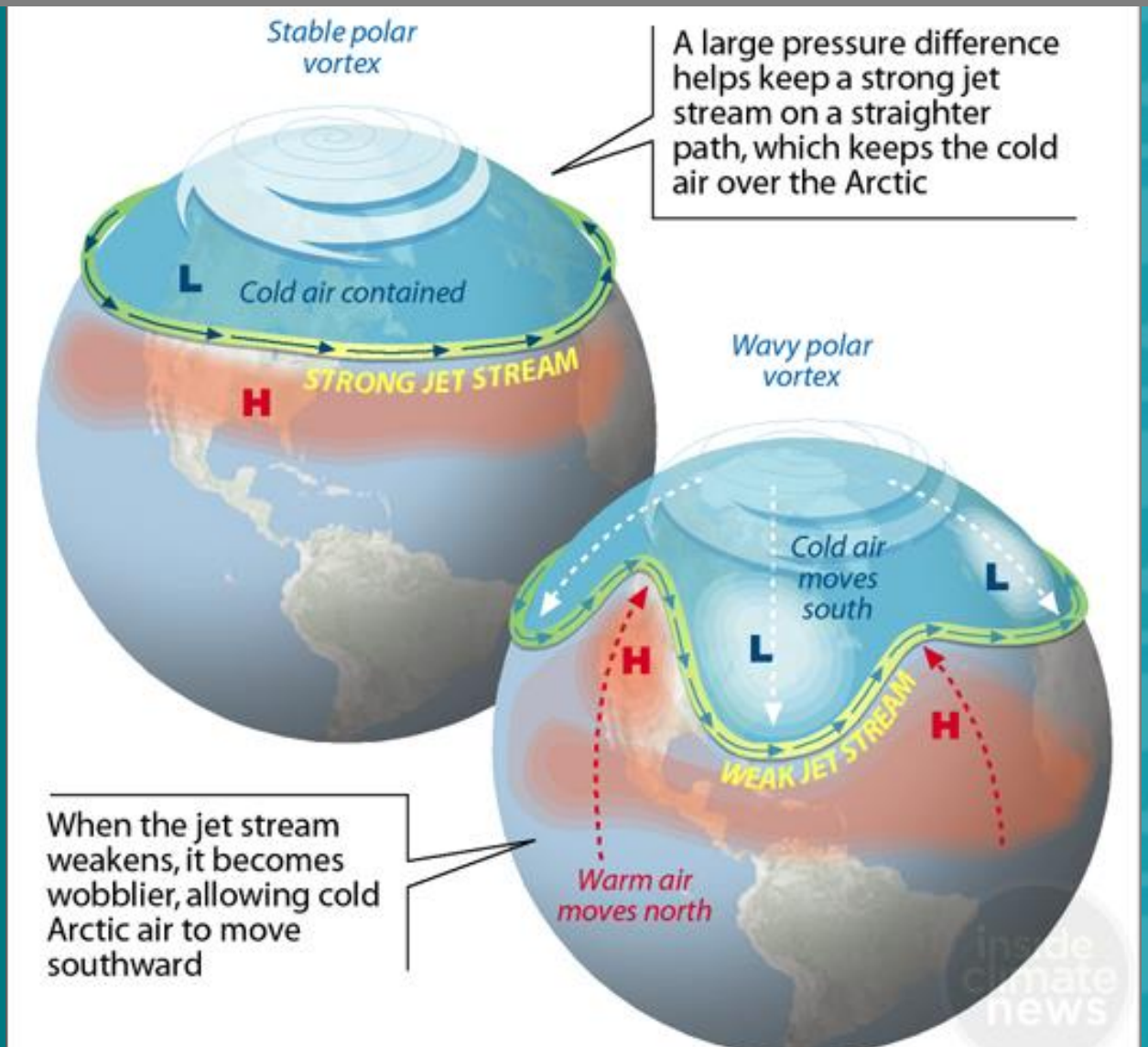






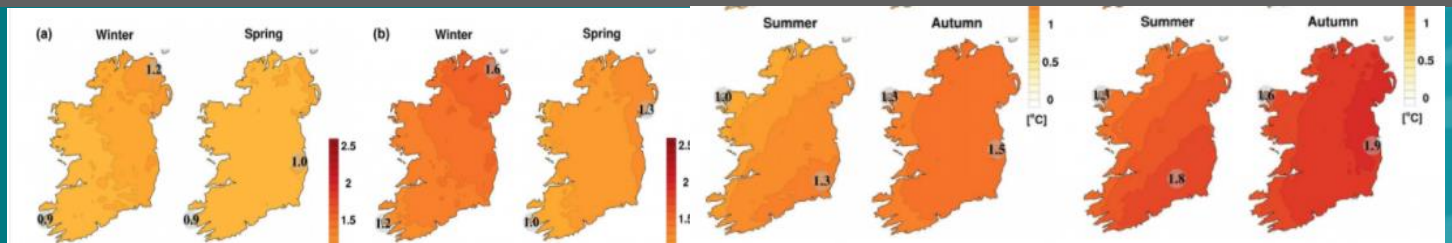
Temperature is increasing at an average rate of 0.08 Celsius per decade

The warming climate is changing the Jet Stream …blocking patterns are becoming more intense



New projections for 2041-2060
EPA-Met Éireann-Marine Institute
www.met.ie/epa-climate-projections-2020

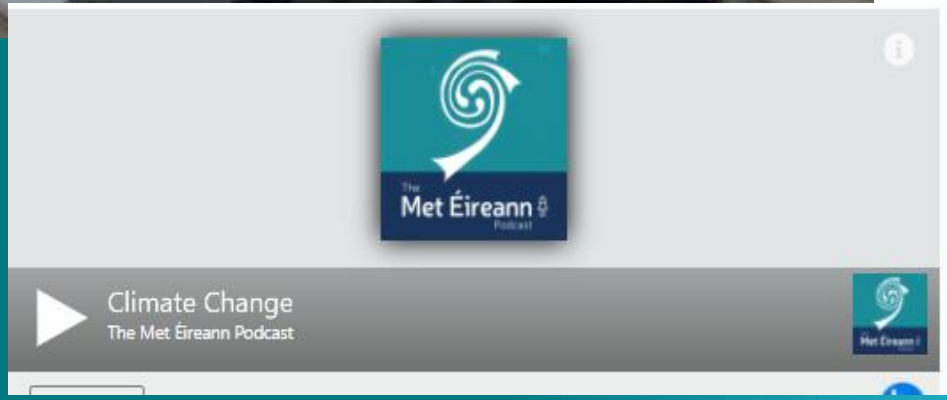
- summer heatwave events are expected to occur more frequently
- precipitation is expected to become more variable, with substantial projected increases in the occurrence of both dry periods and heavy precipitation events
- an overall reduction of ~10% in the numbers of storms affecting Ireland with an eastward extension of the more severe wind storms over Ireland and the UK;
- the number of frost and ice days -50%



MET éireann

met.ie

https://youtu.be/AU2_fdPg1dw



Met Éireann
@MetEireann

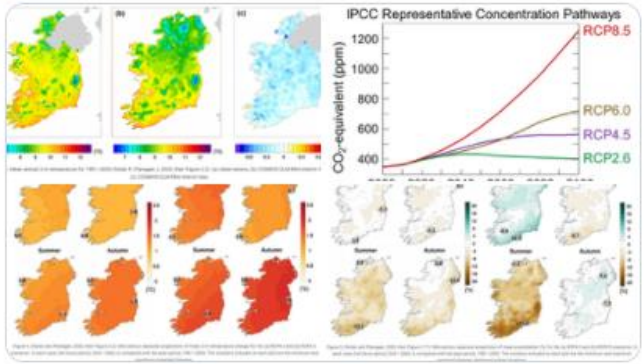
The Irish Meteorological Service

Ireland met.ie Joined September 2009

111 Following **257.7K** Followers

Met Éireann @MetEireann · Oct 8

A new set of mid-21st-century (2041-2060) high-resolution climate projections for Ireland have just been published: epa.ie/pubs/reports/r.... A summary of the report highlighting its key findings can be read here met.ie/epa-climate-pr...
@EPAIreland
@MarineInst
@ichec



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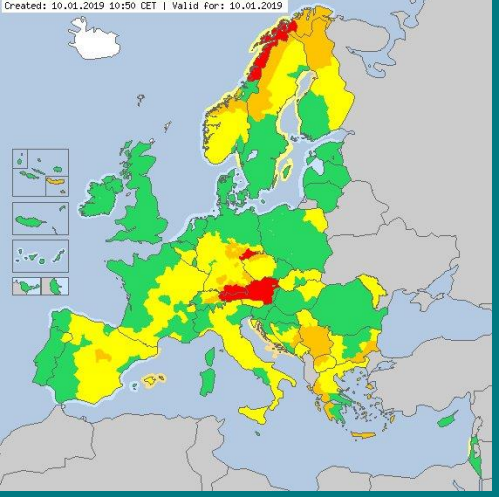


International Bridge

- WMO
- ECMWF
- EUMETSAT
- EUMETNET
- EC-EARTH
- HIRLAM
- MET ALLIANCE
- UWC

WMO

ICAO • OACI • ИКАО

U.W.C
United Weather Centres

Met Éireann

High Resolution Limited Area Model
Hirlam

EUMETNET
EUROPEAN METEOROLOGICAL SERVICES NETWORK

EUMETSAT

ECMWF

Irish bid to relocate ECMWF's EU-funded activities (Copernicus/Research)

Making Ireland Weather and Climate Prepared

Met Éireann

Ireland's Proposed New Facility

Copernicus
Europe's eyes on Earth

Destination Earth (DestinE)

An Roinn Tithíochta, Rialtais Áitiúil agus Oidhreachta
Department of Housing, Local Government and Heritage

Met Éireann

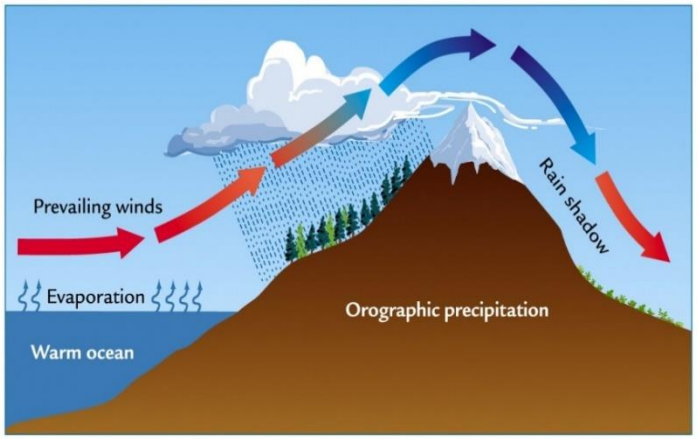
met.ie

Meteorological Service

EUMETSAT

EUMETSAT

European Organisation for the Exploitation of Meteorological Satellites

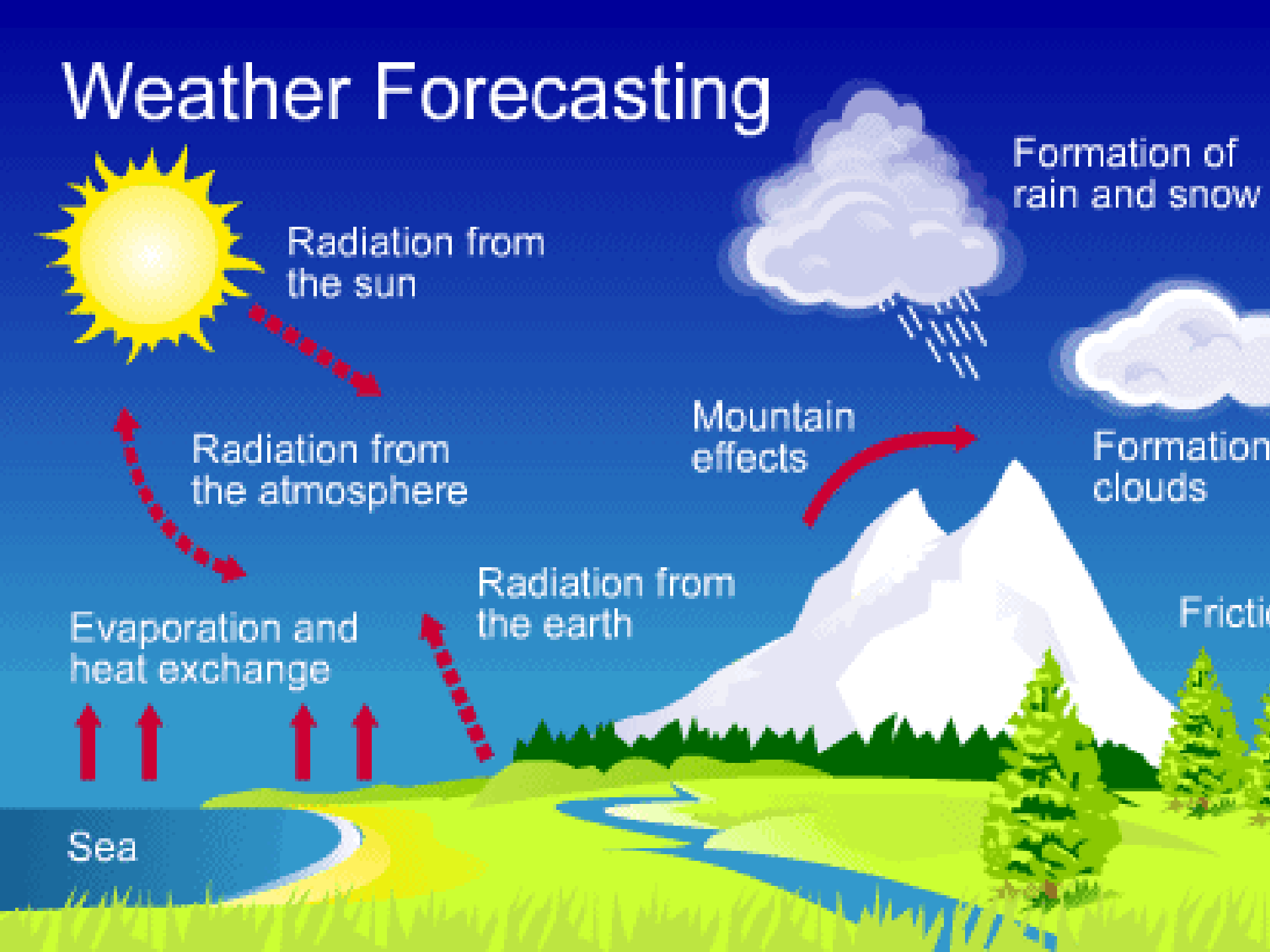


1981-2010 Mean Annual Rainfall (mm)

3600
2800
2400
2000
1600
1400
1200
1000
800
600
0

Highest annual rainfall total: 3964.9mm at Ballaghbeama Gap, Co Kerry in 1960.

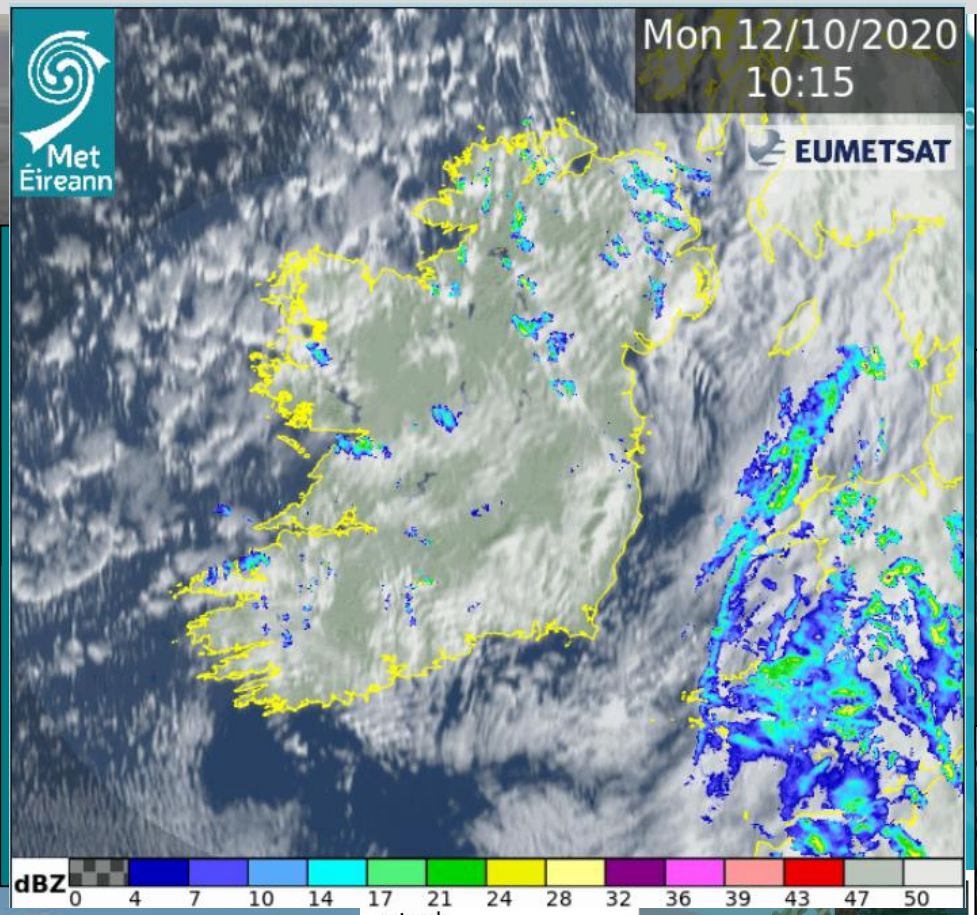
Weather Forecasting

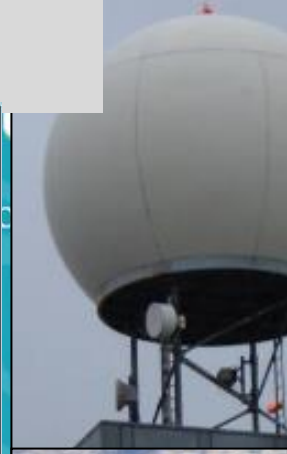


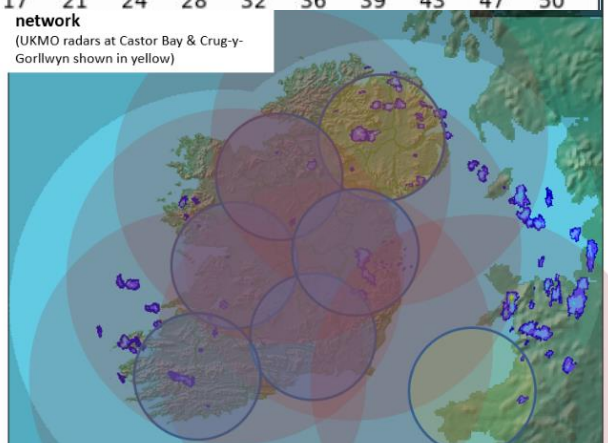
WMO Weather & Climate Observational Network

10,000 surface weather stations
1,000 upper-air stations
7,000 ships
100 moored and 1,000 drifting buoys
hundreds of weather radars
3,000 specially equipped commercial aircraft
16 meteorological and 50 research satellites.

Observation Platforms







The Equations of the Atmosphere

GAS LAW (Boyle's Law and Charles' Law.)
Relates the pressure, temperature and density
CONTINUITY EQUATION
Conservation of mass; air neither created nor distroyed
WATER CONTINUITY EQUATION
Conservation of water (liquid, solid and gas)
EQUATIONS OF MOTION: Navier-Stokes Equations
Describe how the change of velocity is determined by the pressure gradient, Coriolis force and friction
THERMODYNAMIC EQUATION
Determines changes of temperature due to heating or cooling, compression or rarifaction, etc.

Seven equations; seven variables (u, v, w, ρ, p, T, q).

The Primitive Equations

$$\frac{du}{dt} - \left(f + \frac{u\tan\phi}{a}\right)v + \frac{1}{\rho}\frac{\partial p}{\partial x} + F_x = 0$$

$$\frac{dv}{dt} + \left(f + \frac{u\tan\phi}{a}\right)u + \frac{1}{\rho}\frac{\partial p}{\partial y} + F_y = 0$$

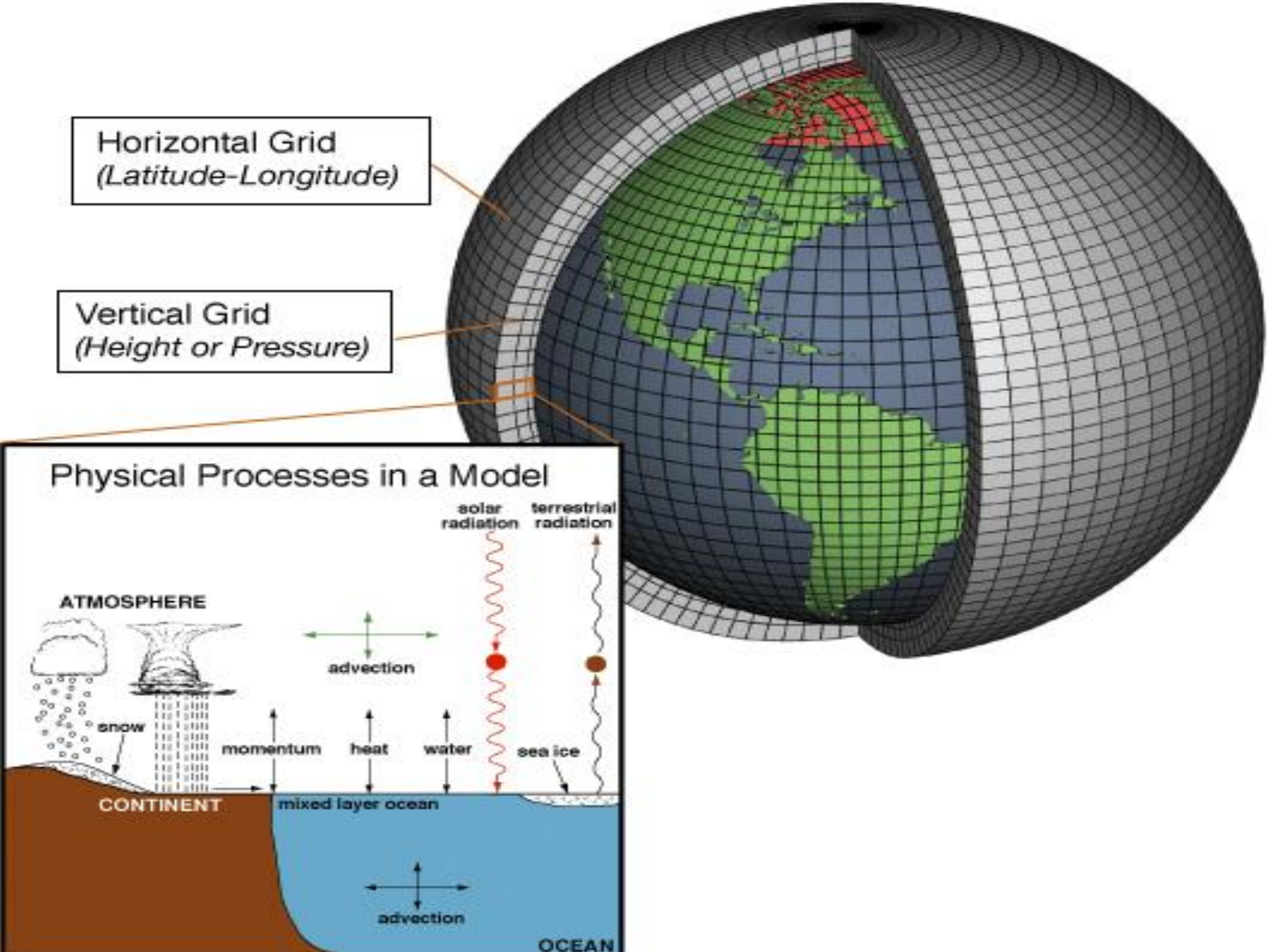
$$p = R\rho T$$

$$\frac{\partial p}{\partial z} + g\rho = 0$$

$$\frac{dT}{dt} + (\gamma - 1)T\nabla\cdot\mathbf{V} = \frac{Q}{c_p}$$

$$\frac{\partial \rho}{\partial t} + \nabla\cdot\rho\mathbf{V} = 0$$

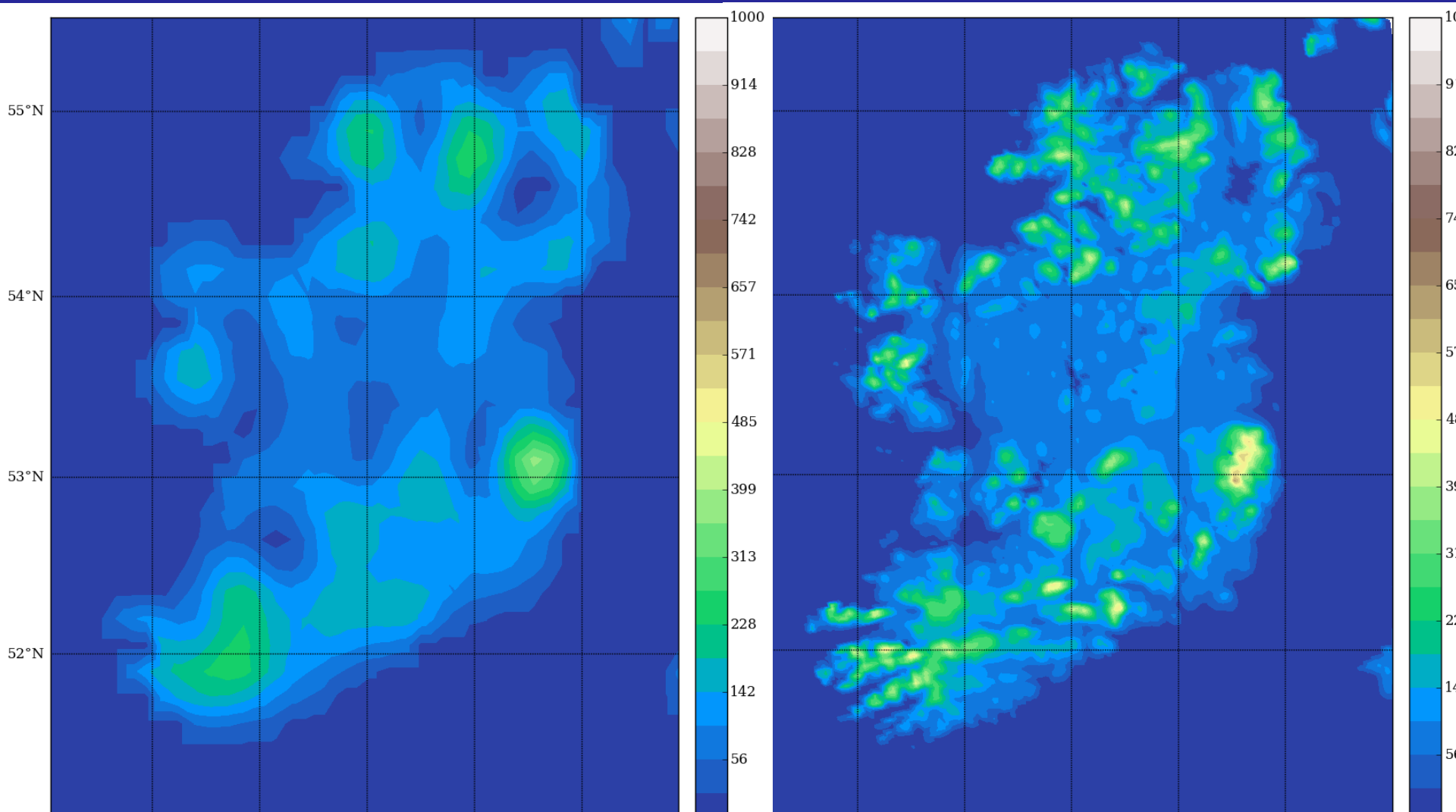
$$\frac{\partial \rho_w}{\partial t} + \nabla\cdot\rho_w\mathbf{V} = [\text{Sources} - \text{Sinks}]$$

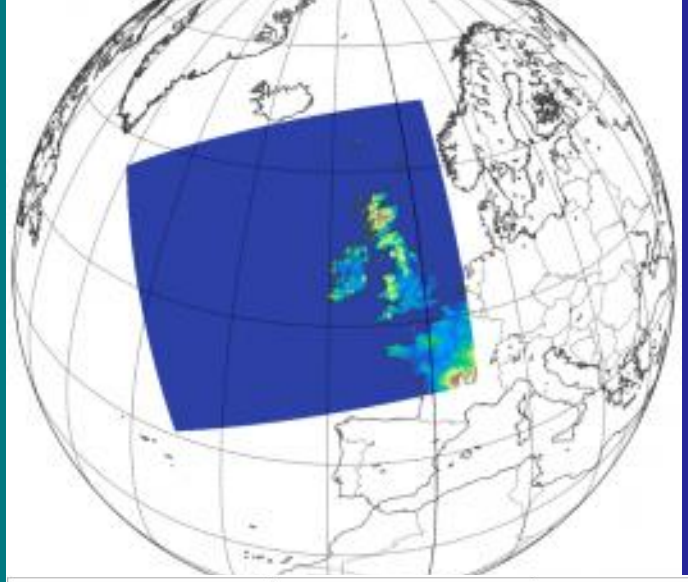

Horizontal Grid
(Latitude-Longitude)
Vertical Grid
(Height or Pressure)
Physical Processes in a Model
solar radiation
terrestrial radiation
ATMOSPHERE
advection
snow
momentum
heat
water
sea ice
CONTINENT
mixed layer ocean
advection
OCEAN

The ECMWF's Cray XC40 supercomputer can perform up to 2 quadrillion calculations a second.

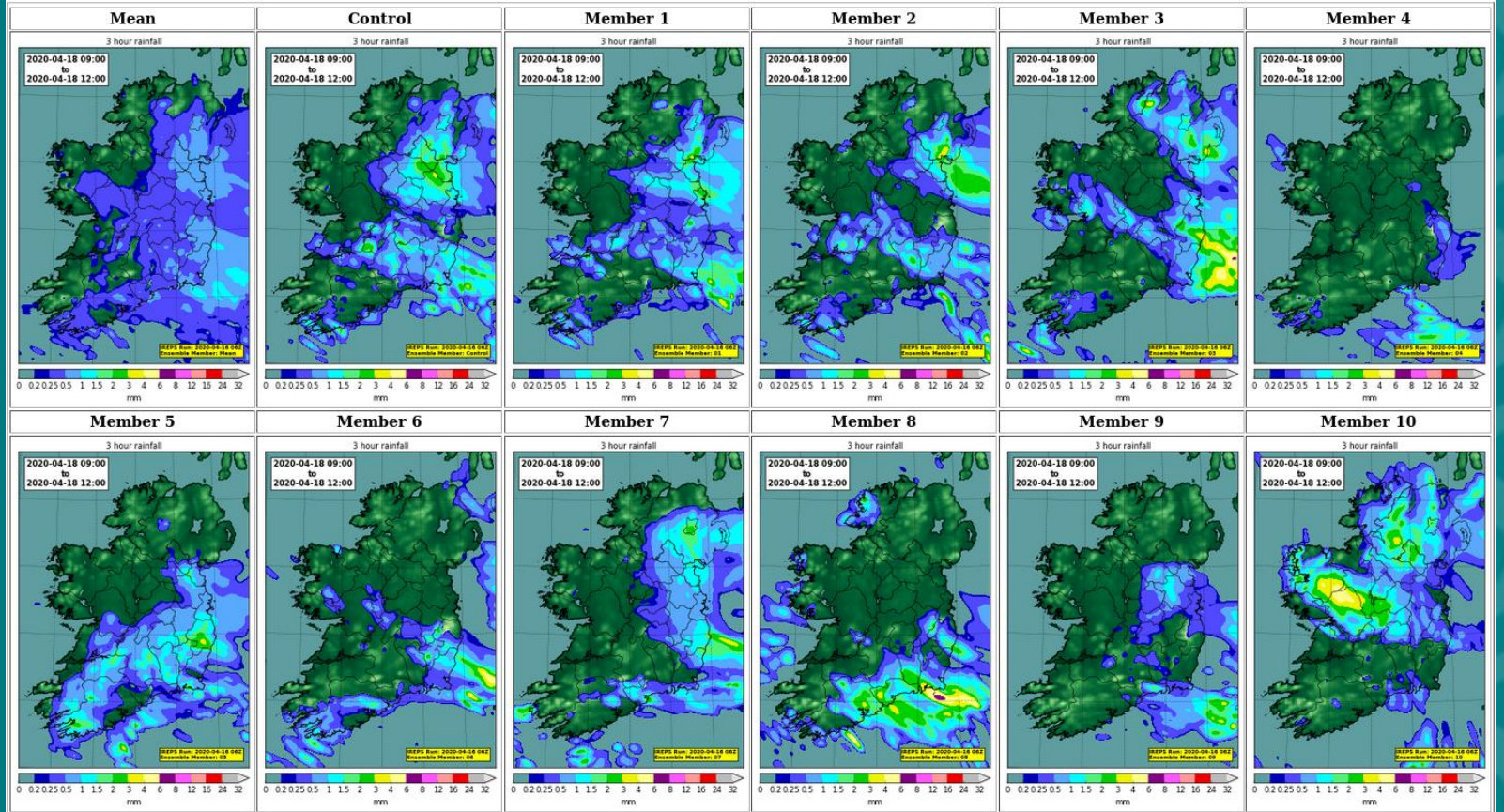
ECMWF Global model
9km resolution

MET Éireann 2.5km resolution
HARMONIE-AROME model





Met Éireann Ensemble high-resolution model for Ireland



SUMMARY

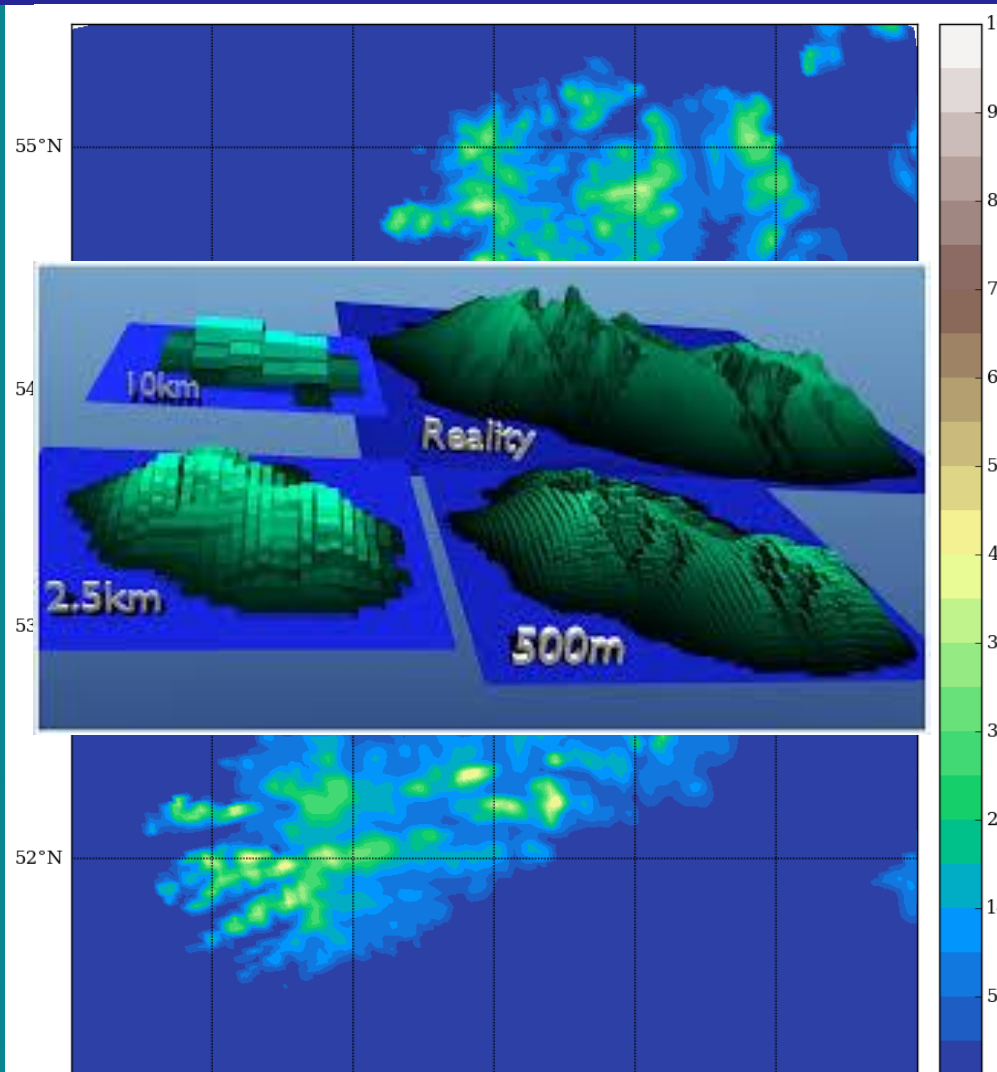
IREPS (Irish Ensemble Prediction System)

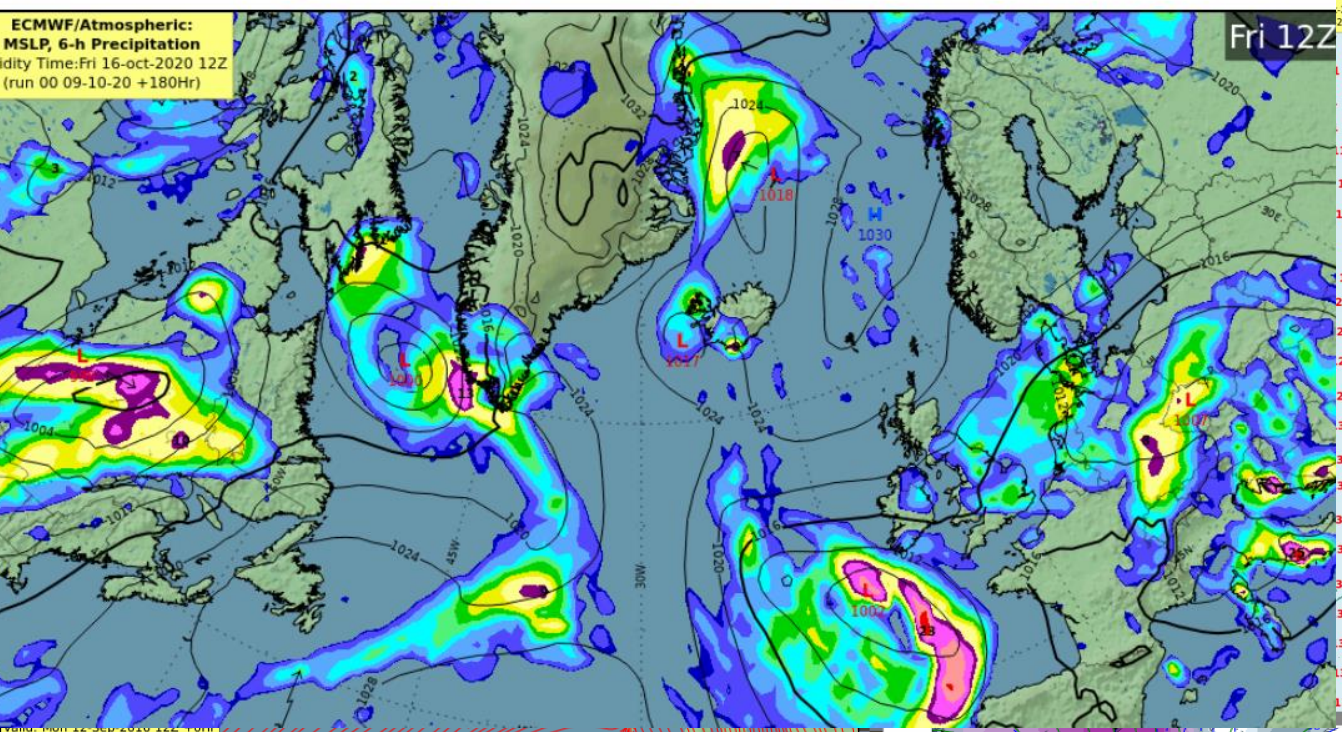
The observations (initial conditions) and the model are not perfect. Small errors in the initial conditions of a forecast grow rapidly, and affect predictability.

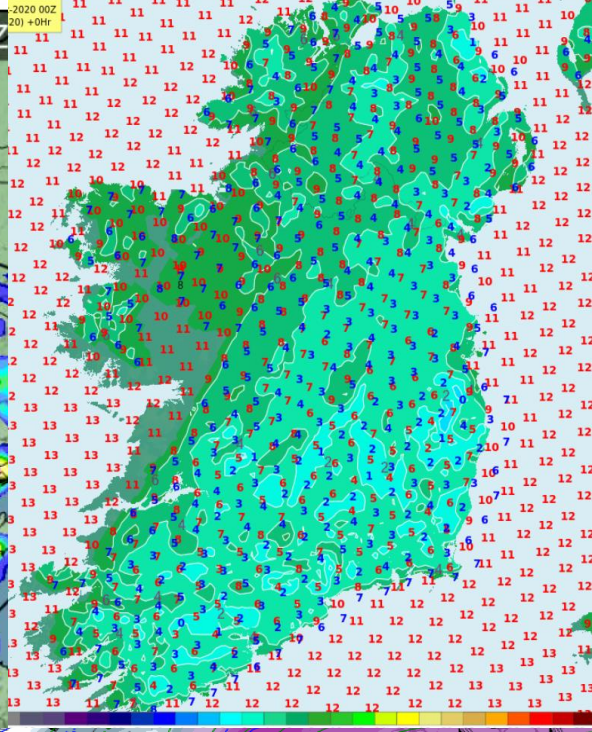
The ensembles provide forecasters with an objective way to predict the skill of a forecast and to estimate the most likely scenario. This will improve forecasts and warnings and enhance support for impact-based decision making for weather events and contribute to the safety of citizens and property.

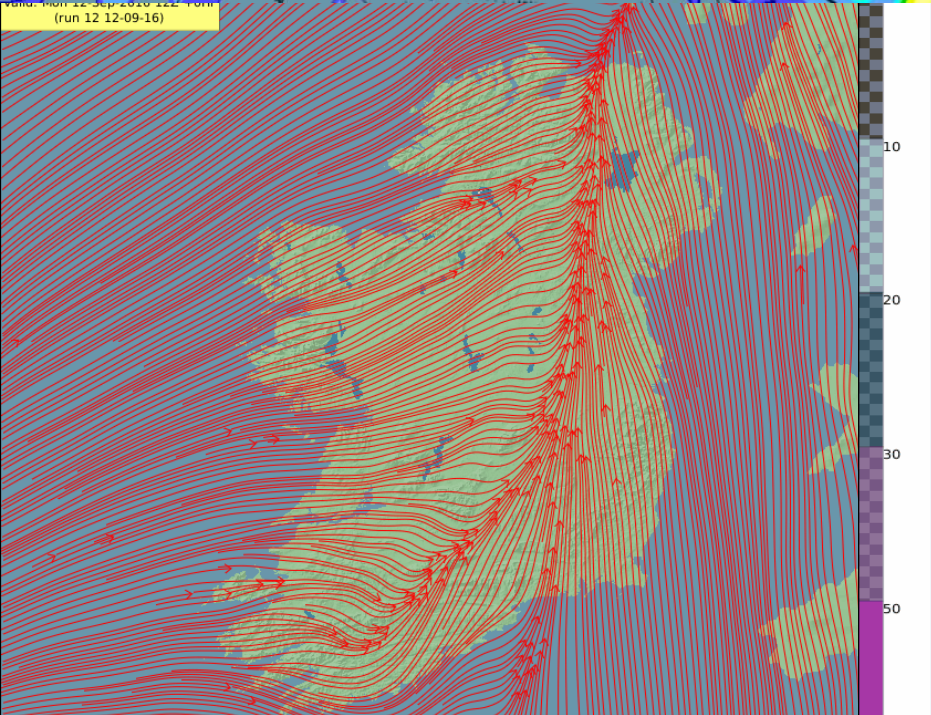
Met Éireann part of a new European collaboration (United Weather Centers UWC) to produce the best short-range forecasts

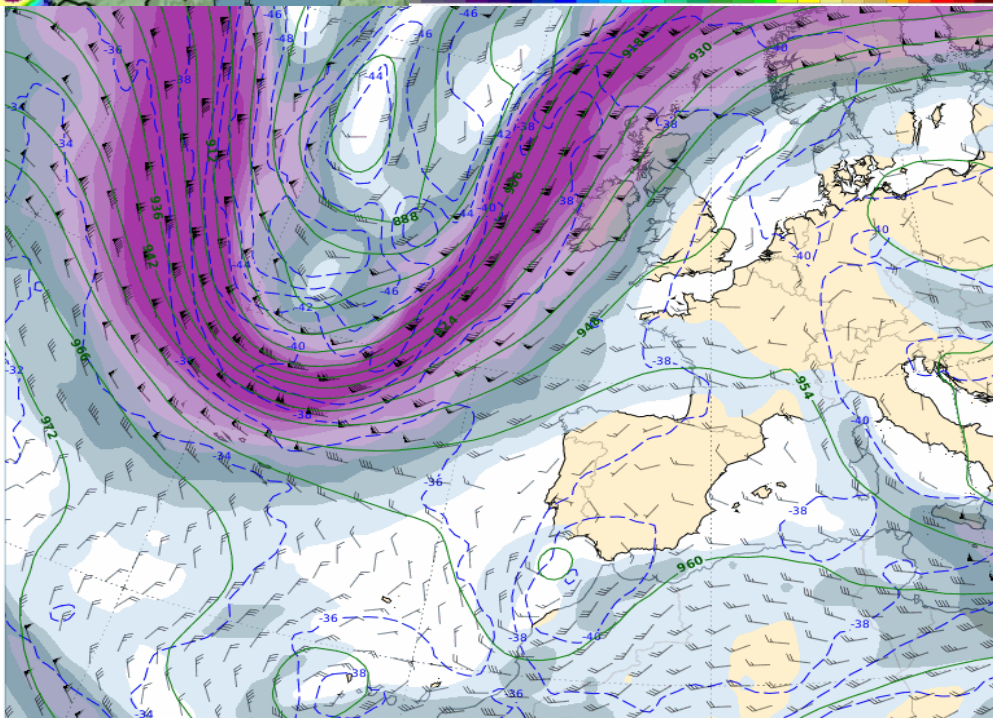
MET Éireann HARMONIE model …..increasing the resolution

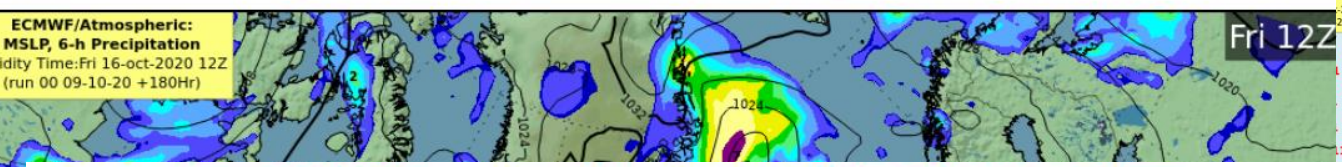



ECMWF/Atmospheric:
MSLP, 6-h Precipitation
idity Time:Fri 16-oct-2020 12Z
(run 00 09-10-20 +180Hr)
Fri 12Z


2020 00Z
20) +0Hr

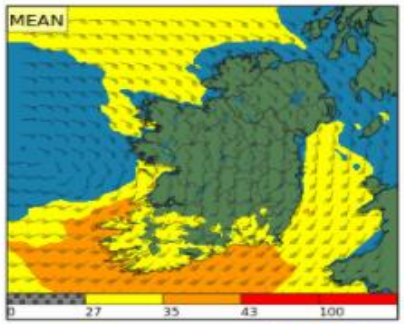

(run 12 12-09-16)
10
20
30
50

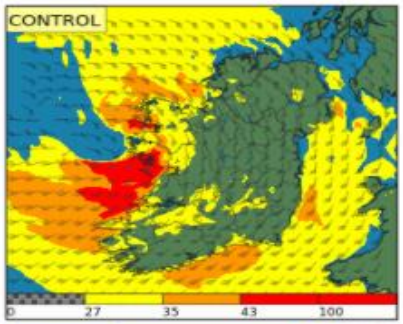


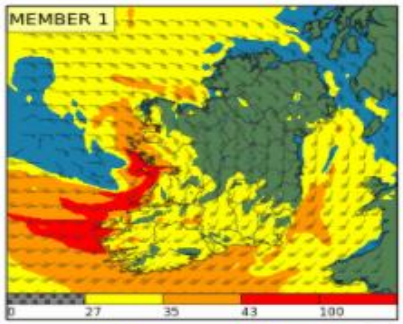


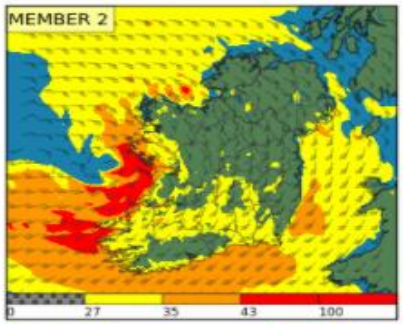
Model : Harmonie/IREPS **Run : 18** **Product : Wind_Warning_Colours**

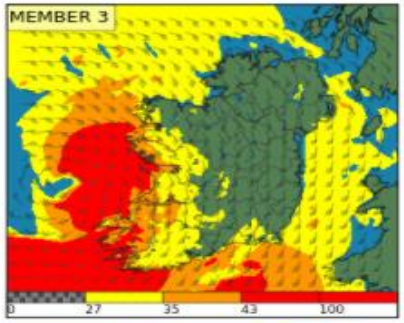
IREPS 10m Mean Wind (Kts) - Warning Colours
Run: Tue 18.08.2020 18Z. Frame: Thu 0Z

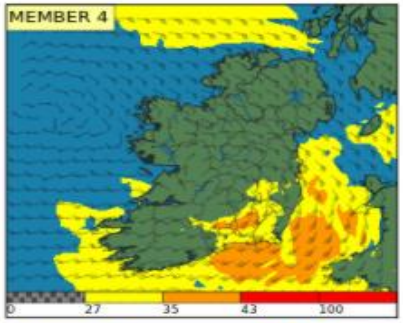


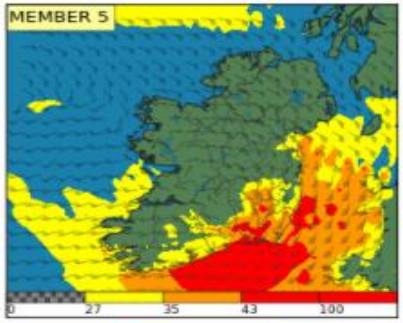


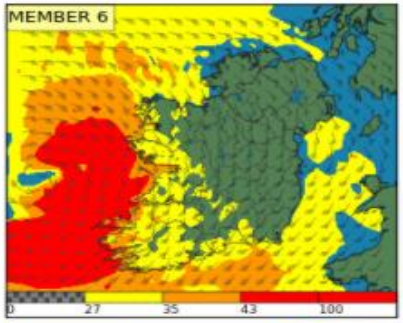


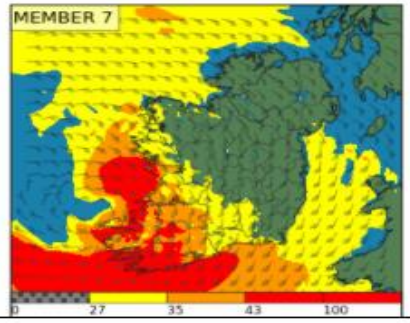


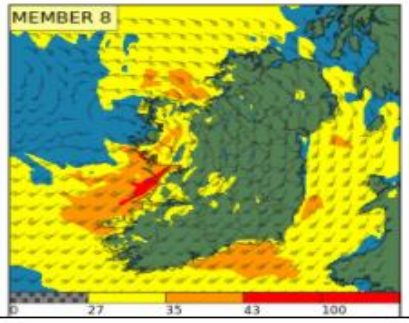


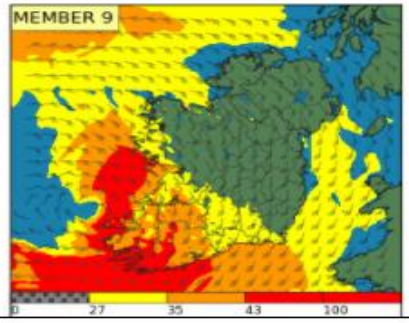


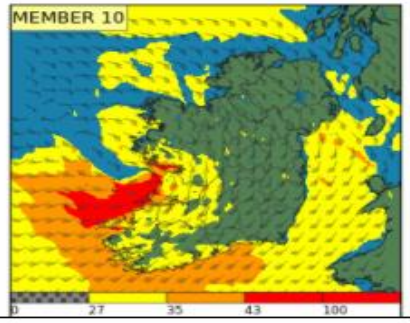


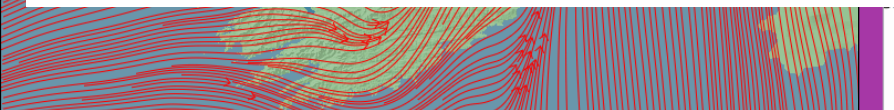


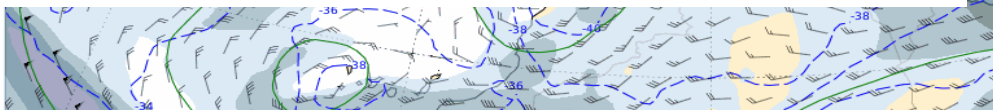












WARNINGS & ADVISORIES - TODAY FRIDAY 09 OCTOBER 2020

WEATHER WARNINGS

Currently no warnings in operation.

MARINE WARNINGS

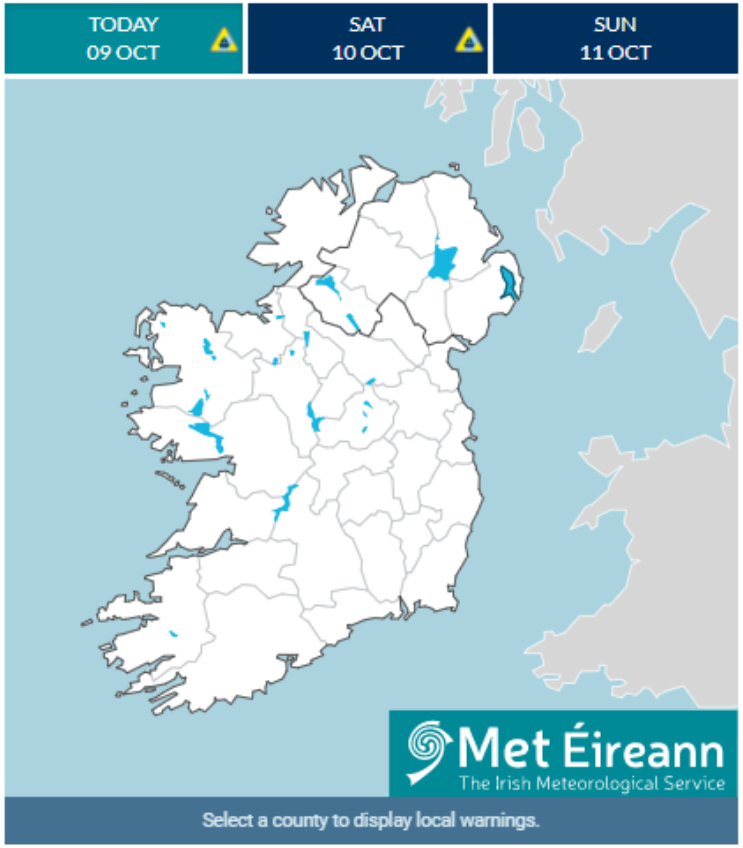
Small Craft Warning

West to northwest winds will reach force 6 or higher today (Friday) on all Irish coasts.

Issued: 05:00 Friday 09/10/2020

ENVIRONMENTAL WARNINGS

Currently no warnings in operation.



WARNINGS EXPLAINED

METEOROLOGIST'S COMMENTARY

MY WARNINGS LOGIN

MET éireann FINGAL 15 7° C MARINE Enter Location

met.ie

The Irish Meteorological Service Forecasts Latest Reports Climate Education Science About

WARNINGS & ADVISORIES - TODAY FRIDAY 09 OCTOBER 2

MET ÉIREANN Wed 09:53

Status Yellow Rainfall Warning Issued
Rainfall warning for Connacht, Cavan, Monaghan and Donegal
Valid: 10:00 Wed 2/09/20 to 21:00 Wed 2/09/20

WEATHER WARNINGS

Currently no warnings in operation.

MARINE WARNINGS

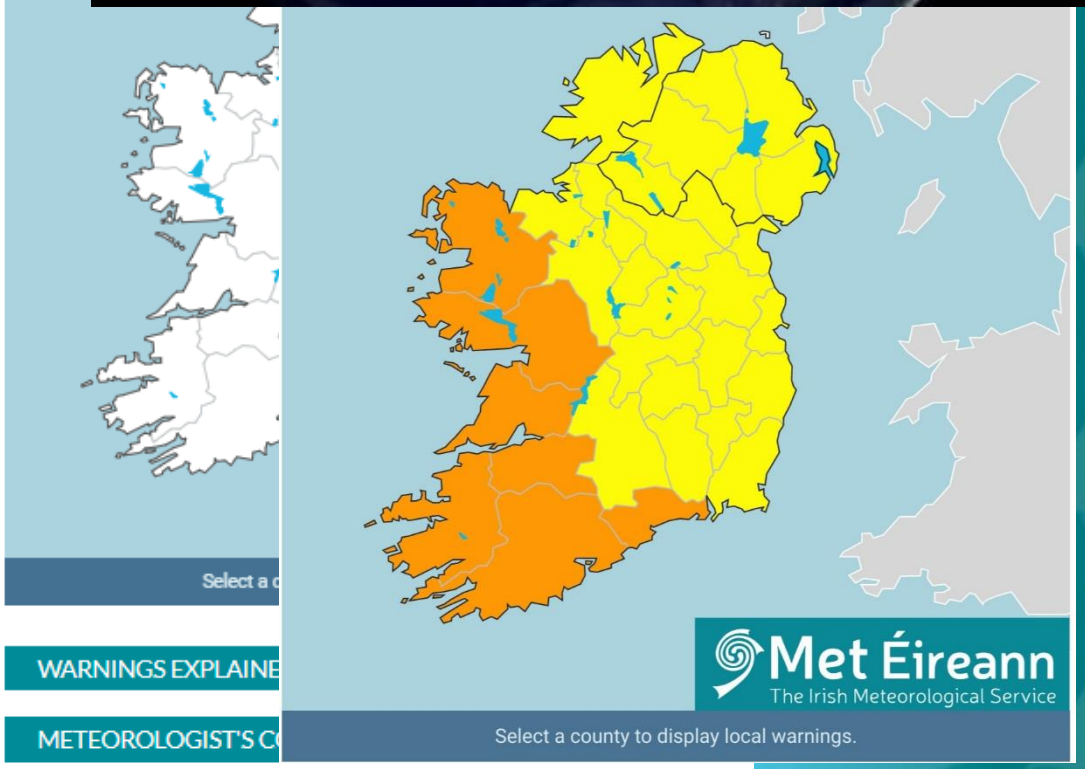
Small Craft Warning

West to northwest winds will reach force 6 or higher today (Friday) on all Irish coasts.

Issued: 05:00 Friday 09/10/2020

ENVIRONMENTAL WARNINGS

Currently no warnings in operation.



WARNINGS EXPLAINE

METEOROLOGIST'S C

MY WARNINGS LOGIN

Storm Naming

EUMETNET
EUROPEAN METEOROLOGICAL SERVICES NETWORK

- *Reach*, *engagement* and *influence* for warnings
- Authoritative Voice
- Single name
- Communication: ‘hashtag culture’
- Collaboration with adjoining NMS’s
- Useful post-event for reference

Ex-hurricane Ophelia (17 October 2017)

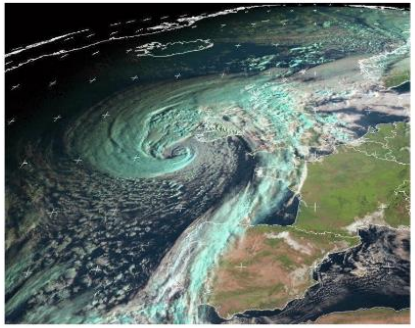
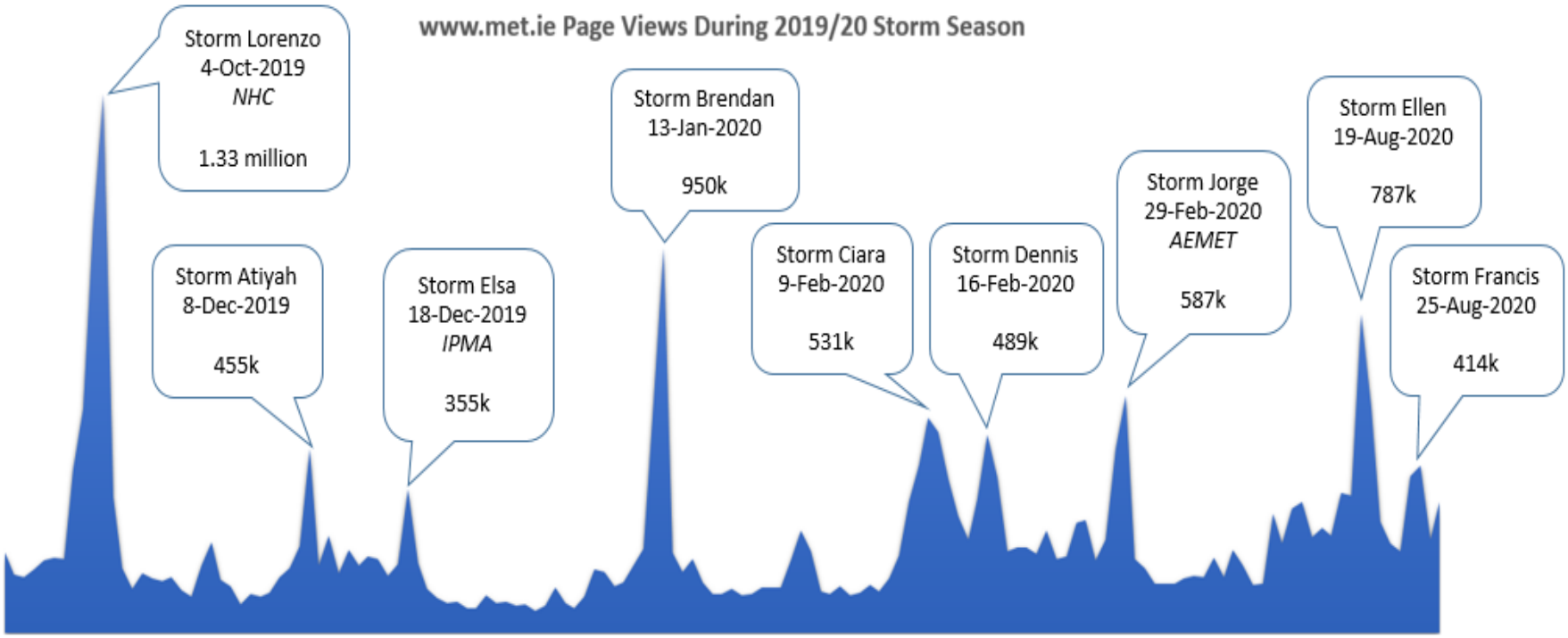


Image from Eumetsat

Storm Ophelia batters the west Cork coast at the Beacon near Baltimore. Photograph: Youen Jacob/Provision


www.met.ie Page Views During 2019/20 Storm Season
Storm Lorenzo
4-Oct-2019
NHC
1.33 million
Storm Atiyah
8-Dec-2019
455k
Storm Elsa
18-Dec-2019
IPMA
355k
Storm Brendan
13-Jan-2020
950k
Storm Ciara
9-Feb-2020
531k
Storm Dennis
16-Feb-2020
489k
Storm Jorge
29-Feb-2020
AEMET
587k
Storm Ellen
19-Aug-2020
787k
Storm Francis
25-Aug-2020
414k

Impact-oriented briefings via Webex with Met Éireann weather and flood Forecasters, the Local Authorities & the NDFEM

Keith Lambkin, Senior Climatologist, is working with the LA's on localised predictions for Ireland.

What will Ireland's future climate look like, and by knowing this how does this help us now?

www.met.ie/climate/services

Ireland must prepare for a changed climate.

- Extreme weather events will become more frequent and severe
- Infrastructure in coastal and low lying areas will become more vulnerable to erosion and storms.
- Increase occurrence and intensity of extreme precipitation events will bring increased risk of flooding.
- Changes in temperature will provide opportunities but also some risks.