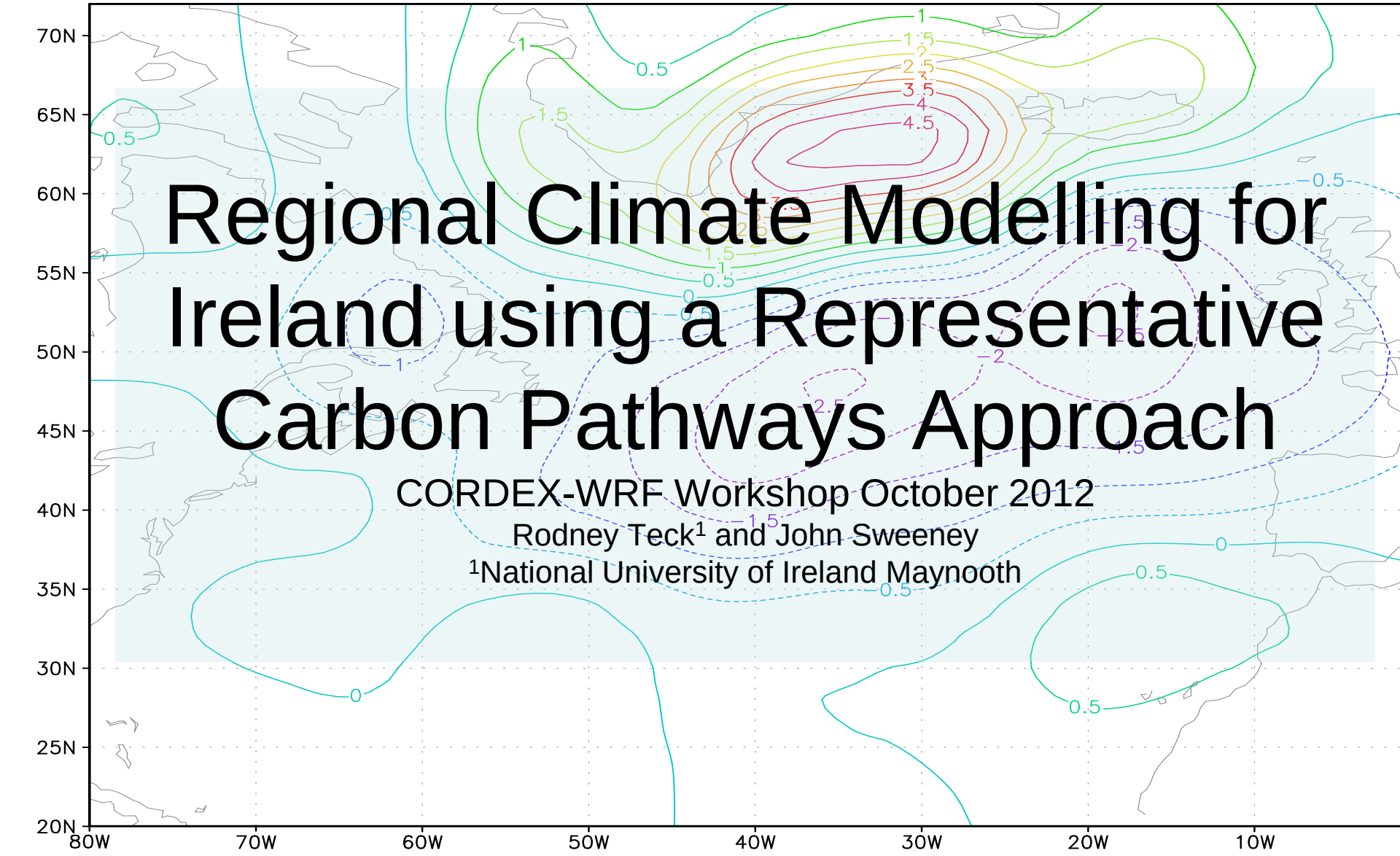


Regional Climate Modelling for Ireland using a Representative Carbon Pathways Approach

CORDEX-WRF Workshop October 2012

Rodney Teck[1] and John Sweeney

[1]National University of Ireland Maynooth

Purpose of this Research

- Improve regional climate simulations for Ireland and Wales through the use of Representative Carbon Pathways (RCPs)
- Provide monthly temperature and precipitation data for research into forest pests and diseases.
- Provide input data to drive Hydrological Models

IPCC and RCPs

- ECMWF Consortium of 11 Member States (Met-Eireann one of the 11 MS)
- Earth System Model (EC-Earth)
- Fully Coupled Atmosphere-Ocean-Land and Sea-Ice
- RCP Output Data Compliant With IPCC CMIP5 and AR5
- Four emission trajectories based on the heating they produce at the top of the atmosphere at end of the 21st Century (8.5, 6,4.5 and 2.6 watts per square metre)
- Four Future runs (2005-2100)
- One Historical run (1870-2005)

Regional Climate Modelling

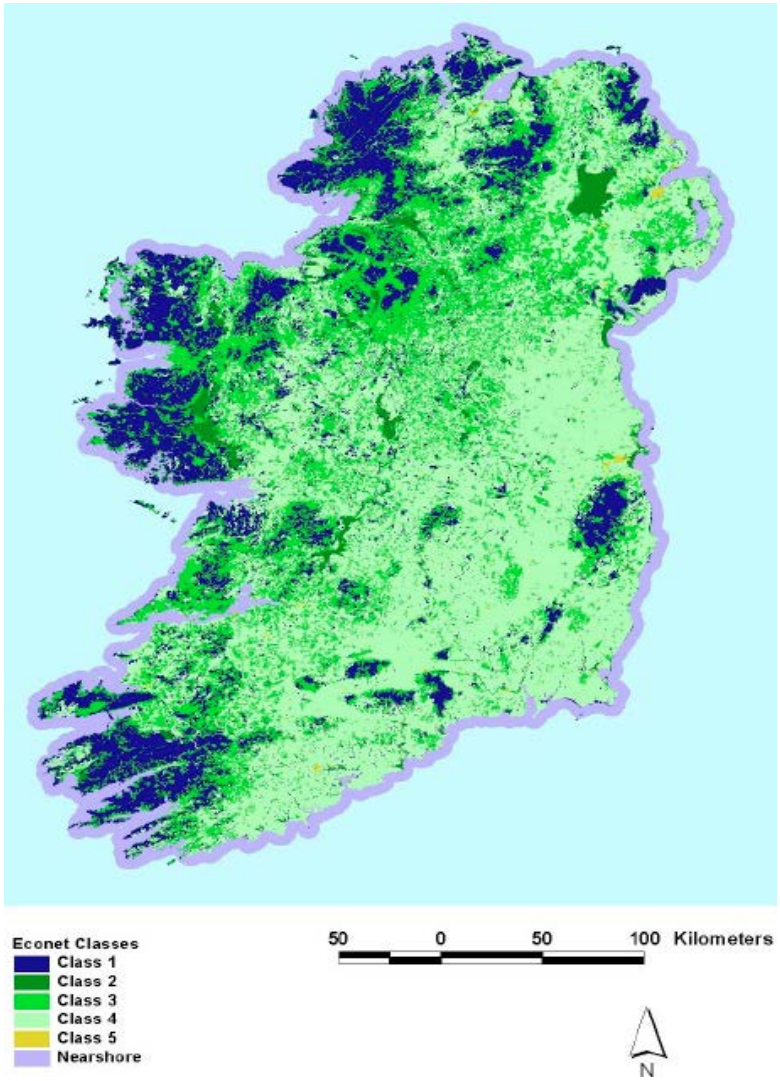
- Allows for more precise description of regional forcing effects over small scale orographic features.
- Higher resolution climatic scenarios important for resource management and impact assessment.
- Higher resolution does not necessarily imply greater accuracy in climate simulations (Duffy *et al.* 2003)
- Depending on the domain size and resolution RCM simulations can be computationally demanding.

Research Objectives

- To use WRFV3 as a Regional Climate Model (RCM)
- Dynamically Downscale the Historical (RCP) output from EC-Earth GCM data for the period 1961-1990 (Reference Period).
- Compare a Future EC-Earth Simulation 8.5 Wm^{-2} (2041-2100) against the same model run in the current climate (1961-1990).
- Compare Results with NCARs GCM CCSM3 data over the same spatial and temporal domain
- Use the results to plan for the future of Irish - Welsh Forestry and Water Resource Management.

The Irish Sub Domain

- Principal Domain
- United Kingdom and Ireland
- 100 x 108 grids
- 10km x 10km Spatial Resolution
- Lambert Projection
- Ref Lat 54.626
- Ref Lon -4.195
- Sub Domain
- Ireland
- Ref Lat 51.4211 55.3401
- Ref Lon -10.4901 -5.4001

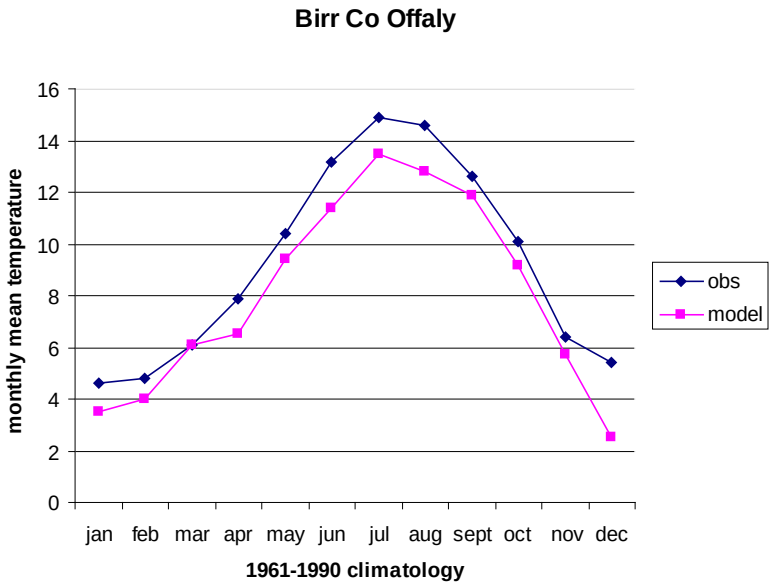


Model Description

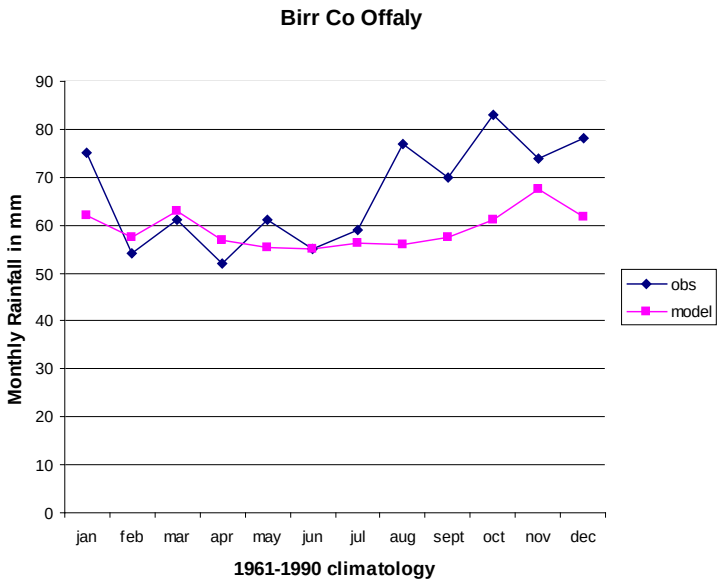
WRF model	Version 3.1.1
Microphysics	WSM3
Cumulus	Kain-Fritsch
PBL	YSU
Short Wave Radiation	MM5 (Dudhia)
Long Wave Radiation	RRTM
Land Surface	Noah
Time Step	60 mins

Central Irish Meteorological Station Birr Co Offaly 1961-1990 Mean Observations

- **1961-1990 Temperature Climatology**



- **1961-1990 Precipitation Climatology**



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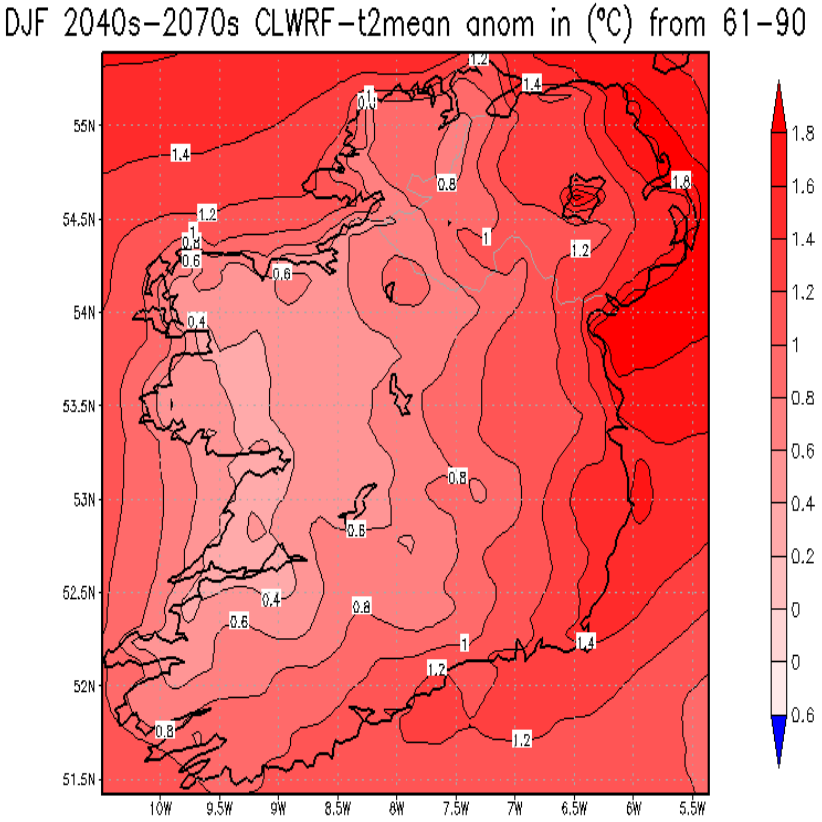
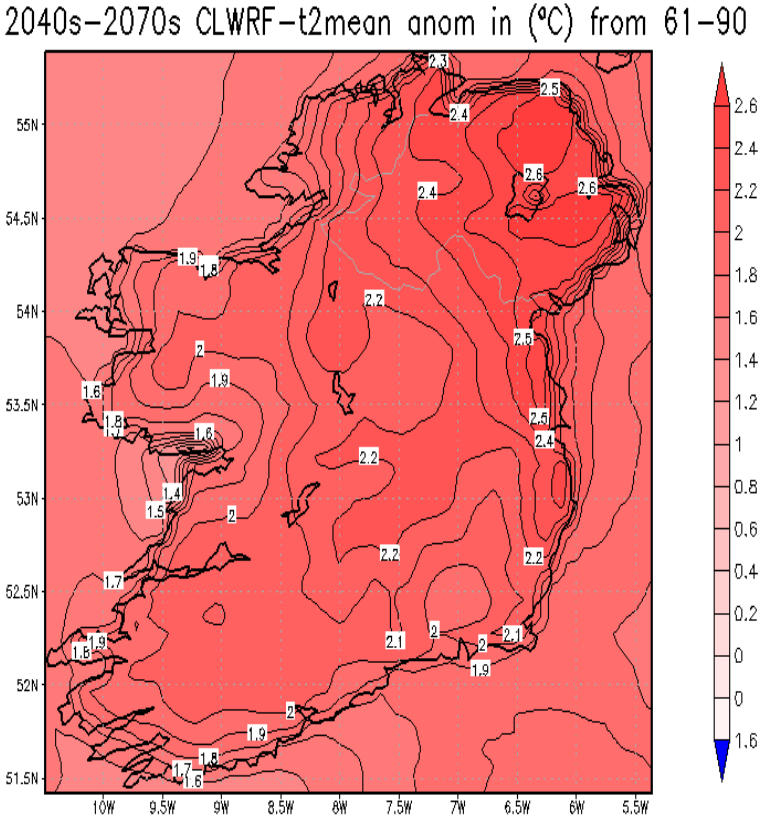
2040-2070 Temperature Divergence from 1961-1990 Driven by EC-Earth 8.5Wm^{-2} RCPs





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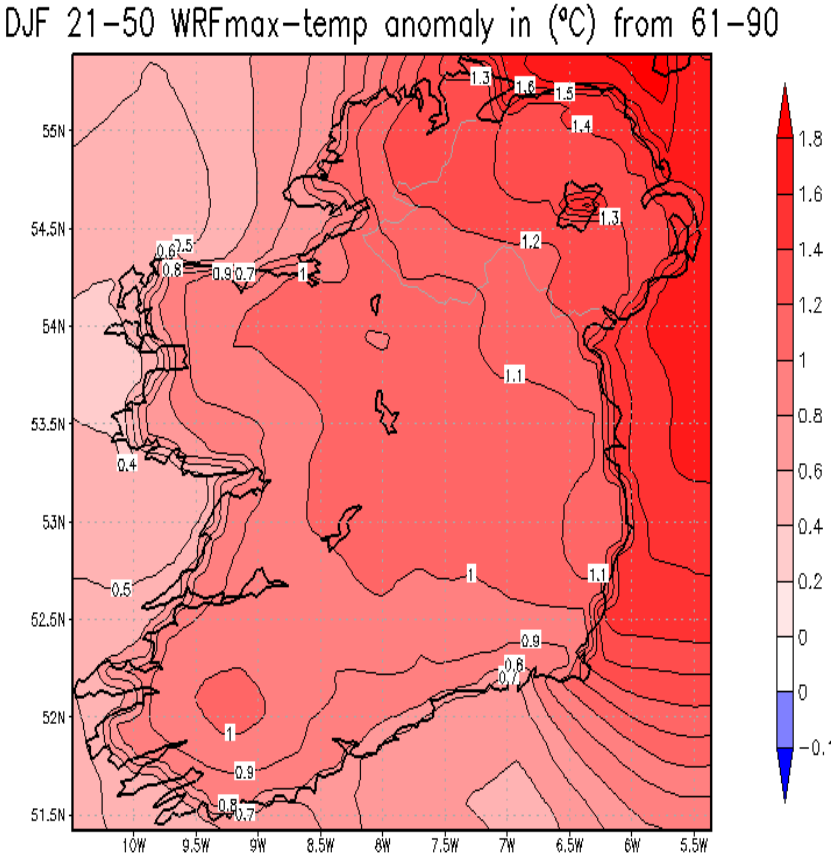
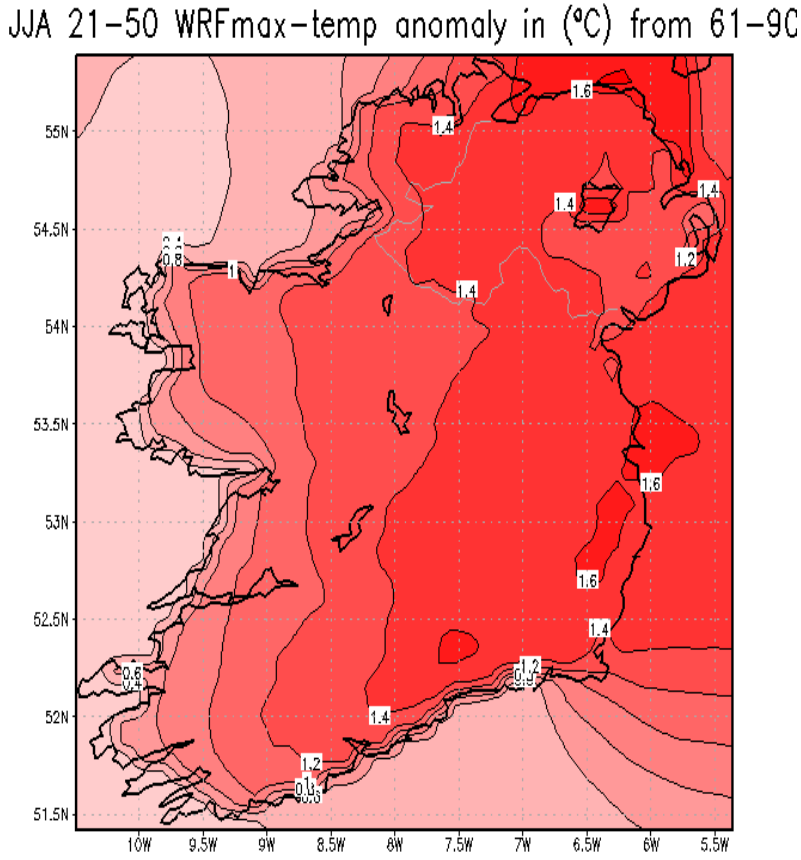
2020-2050 Temperature Divergence from 1961-1990 Driven by CCSM3 A2 SRES Data





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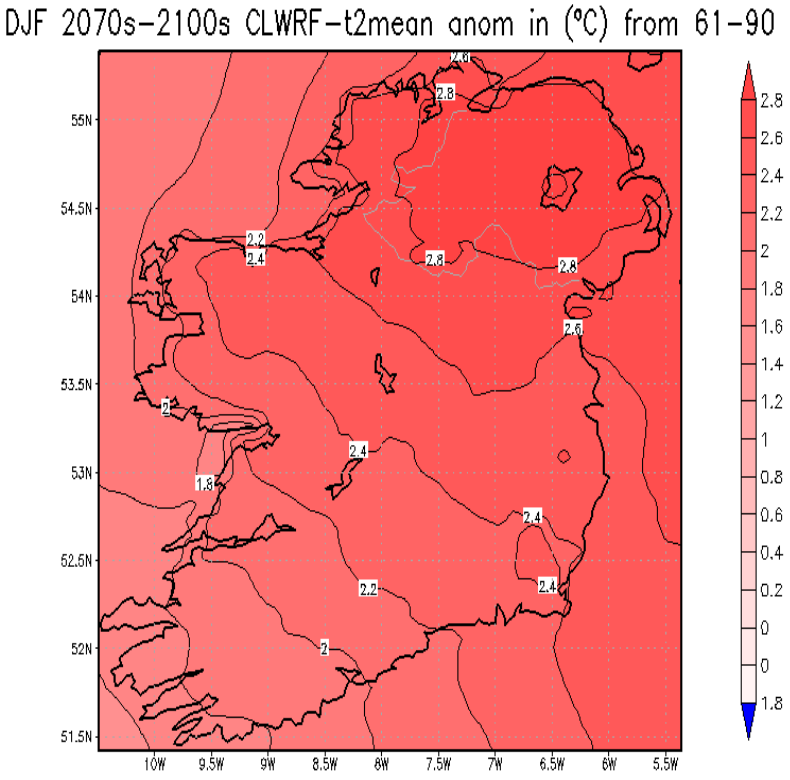
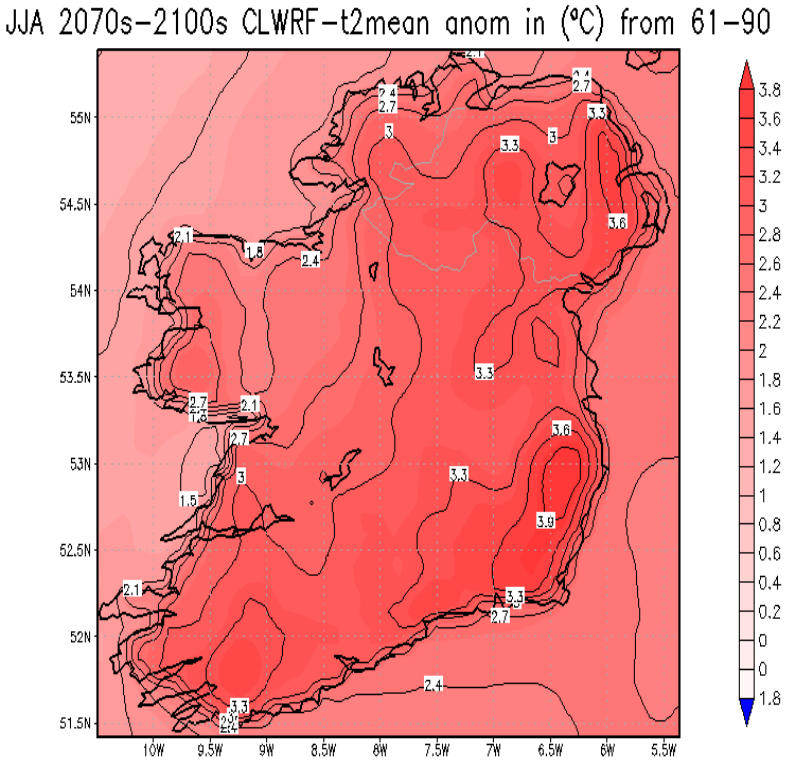
2070-2100 Temperature Divergence from 1961-1990 Driven by EC-Earth 8.5Wm^{-2} RCPs





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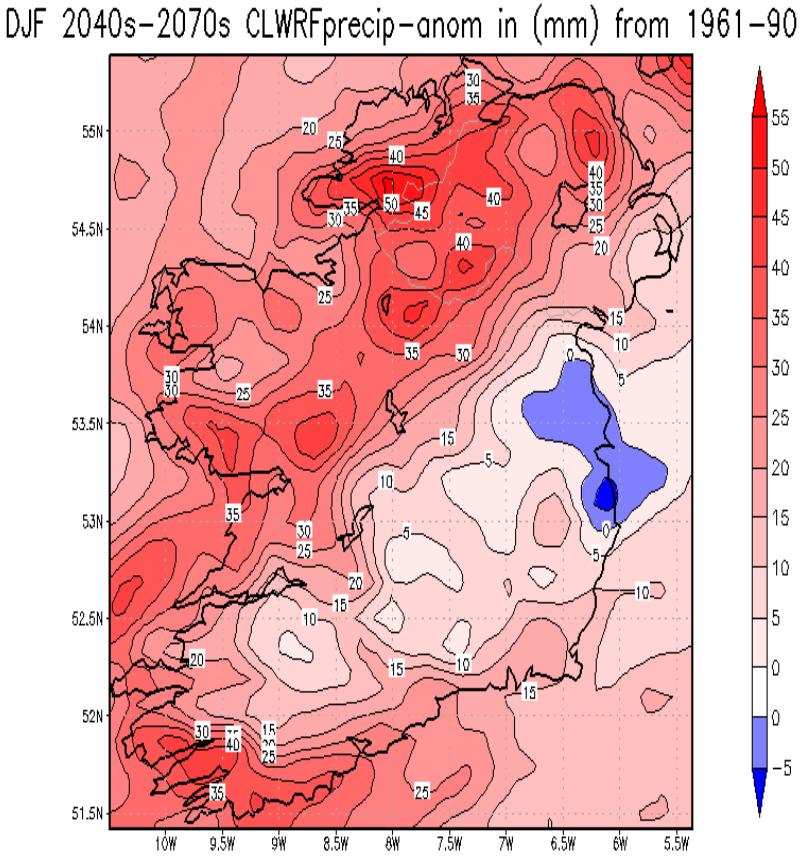
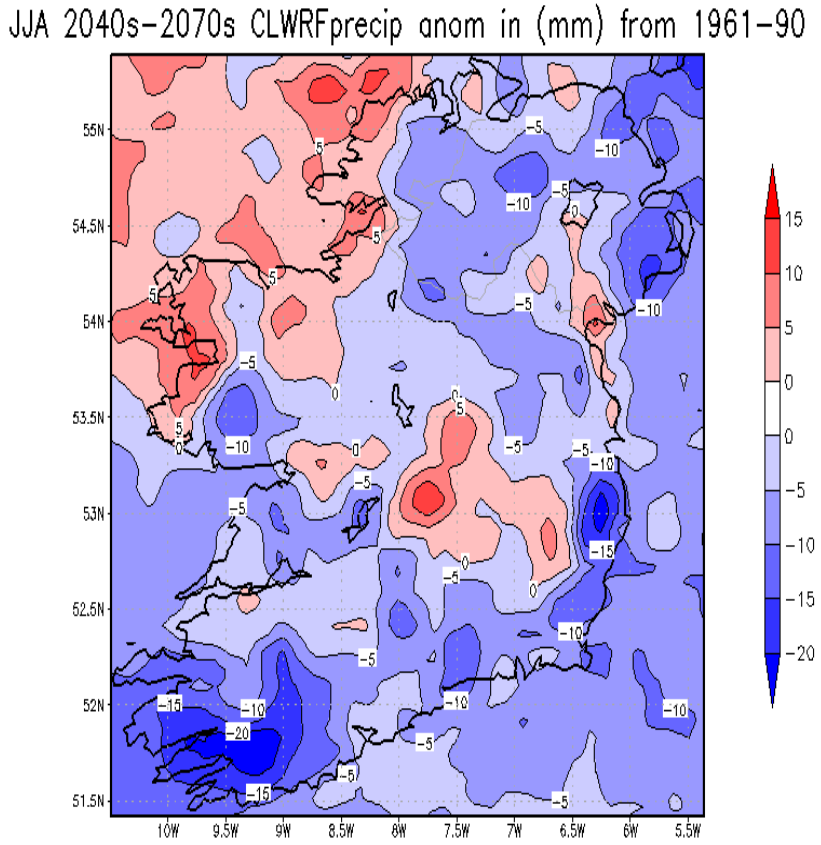
2040-2070 Precipitation Divergence from 1961-1990 Driven by EC-Earth 8.5Wm^{-2} RCPs

2040-2070 DJF Precipitation



2040-2070 JJA Precipitation



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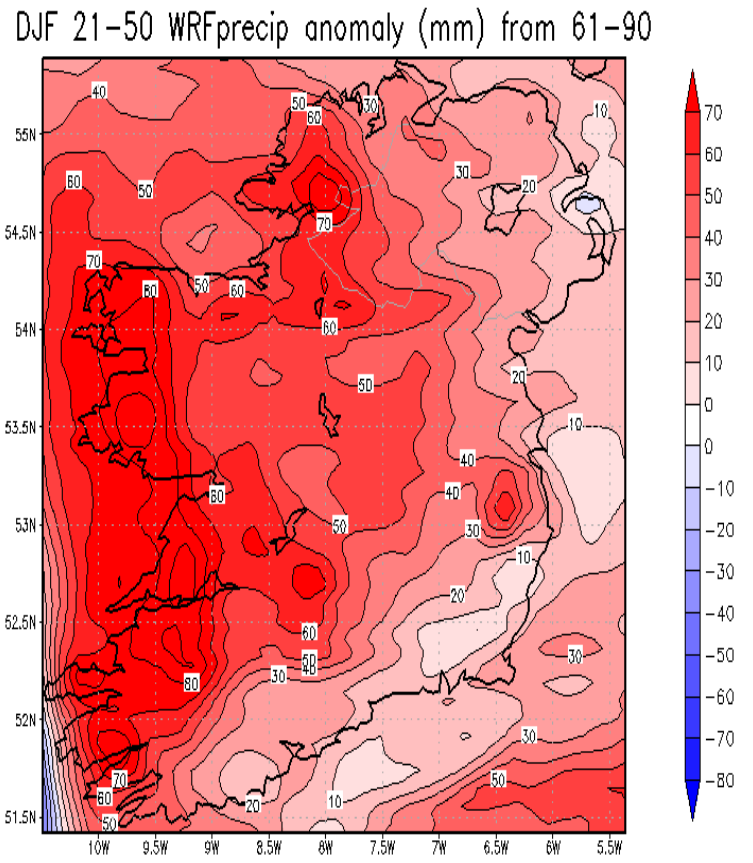
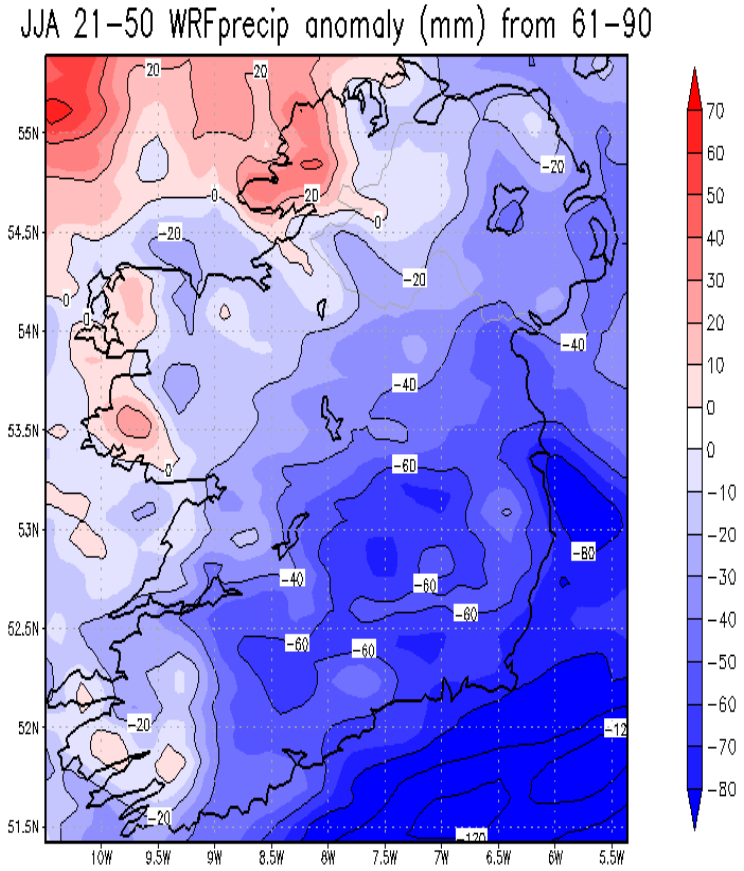
2020-2050 DJF Precipitation



2020-2050 JJA Precipitation



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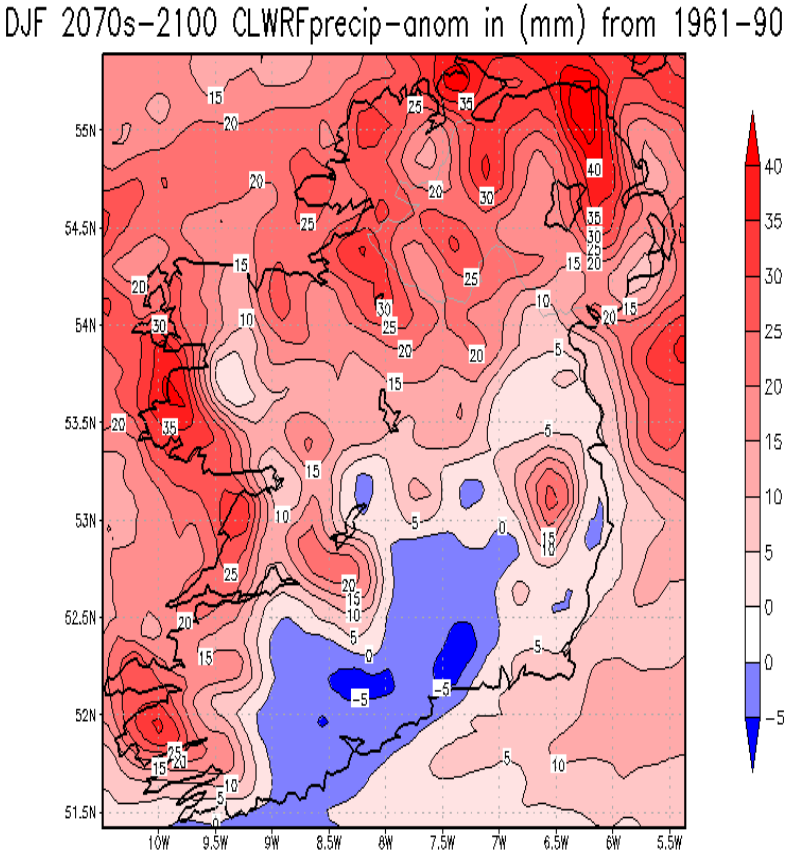
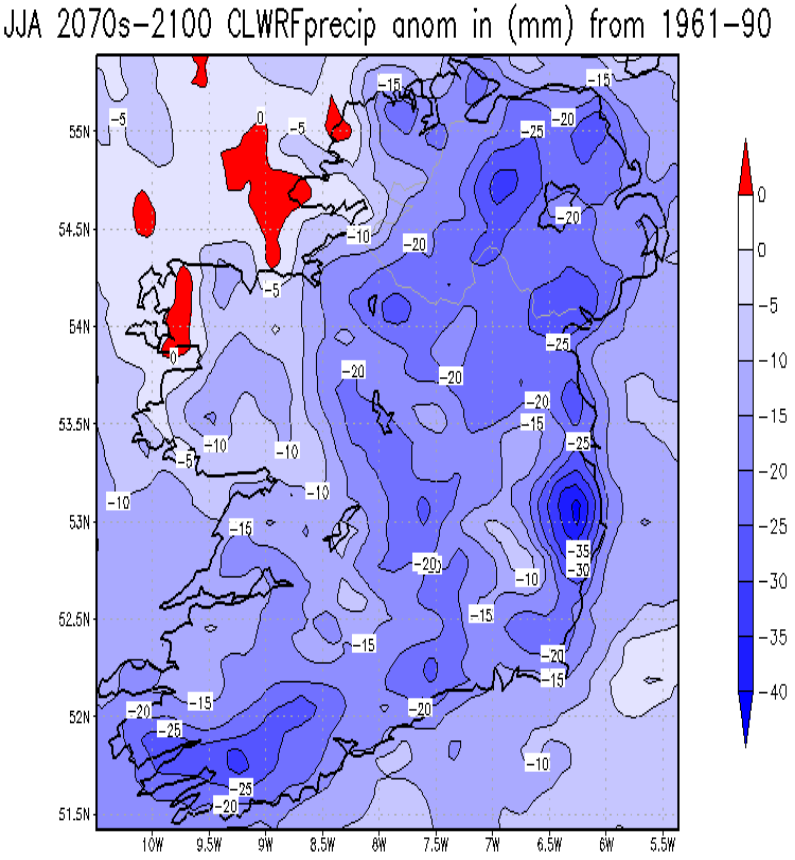
2070-2100 Precipitation Divergence from 1961-1990 Driven by EC-Earth 8.5Wm^{-2} RCPs

2070-2100 DJF Precipitation



2070-2100 JJA Precipitation



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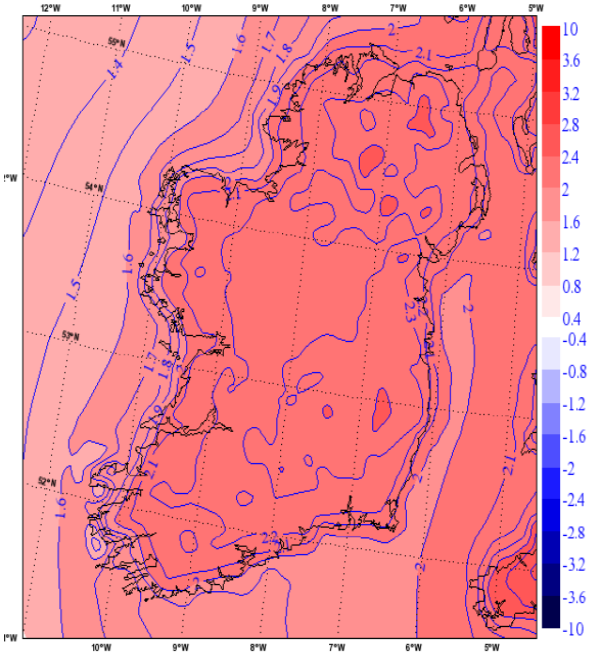
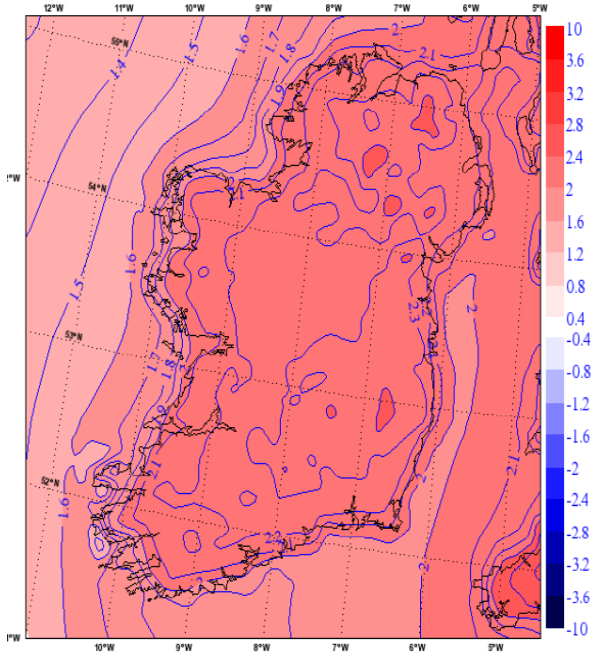
Future CLWRF Temperature Projections using EC-Earth 8.5 Wm^{-2} 2040-2100 compared to 1961-1990

Predicted Temperature Change [^{o}C]

Average January 1.5 -2.8^{o}C Warmer



Average July 2.1-3.8^{o}C Warmer



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Changing Climate: Consequences for Irish Forestry?

- Important for Irish economy
- Plays a large part in Irish commitment to Kyoto agreement
- Forest management of Pest and Disease
- Temperature and Precipitation Changes a key element in pest and disease control

Pine Weevil

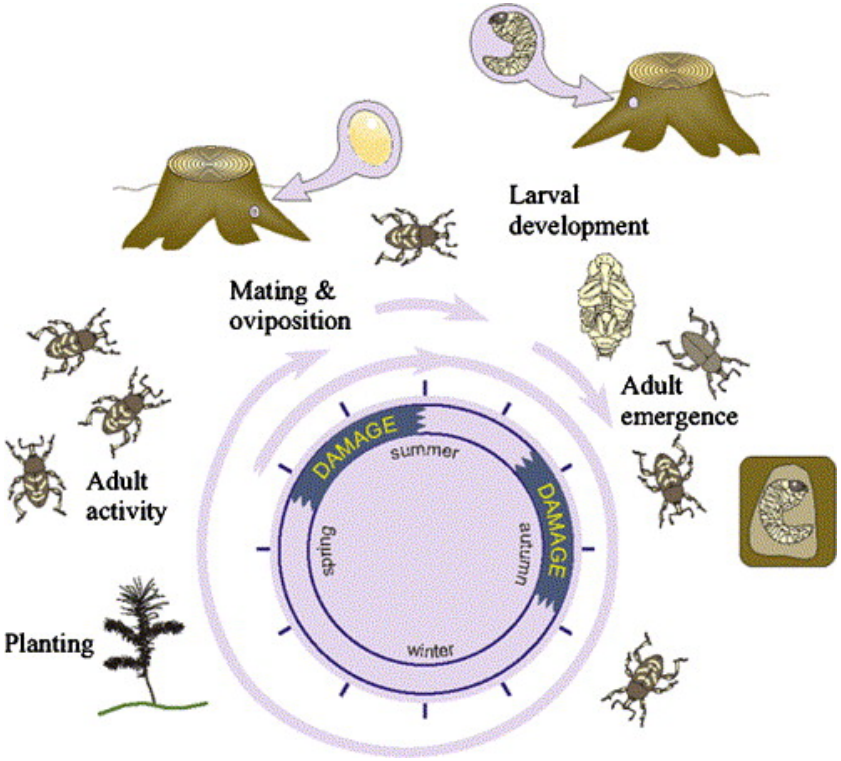
Hylobius abietis

- The most damaging pest for young Irish conifer plantations
- Feeds on the bark of young trees and typically can kill 30%- 100% of unprotected new plantings.

- Up to 150,000 weevils per hectare can exist in Ireland in suitable locations, especially in clearfell areas with lots of tree stumps

Pine Weevil Life Cycle

- Female lays eggs in stumps of conifers
- Development takes 12-36 months in Ireland, with over wintering occurring in the stump or in leaf litter
- Emergence of new weevils in September
- Can fly if temperatures are warm enough, typically spreading 10km or more



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Damage from Pine Weevils

Pine Weevil – Climate Influences

- Activity in spring triggered at 8-9^{o}C, very active at 13-16^{o}C
- Development stages shortened with warmer days
- Weevils consume 5x as much bark at 20^{o}C than at 10^{o}C
- Flight takes place when temperatures exceed 16-18^{o}C

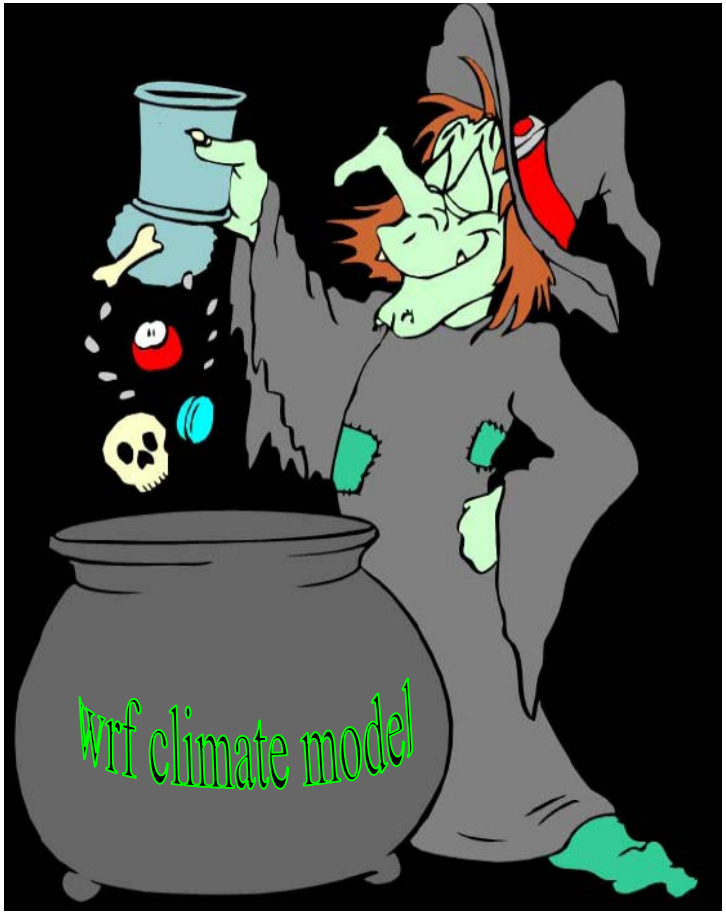
Preliminary Conclusions

- Over Ireland from the middle to the end of the century the mean temperature for DJF is set to rise by an average of 1.5-2.8^{o}C and 2.1-3.8^{o}C over the same period for JJA.
- Precipitation is set to increase during the winter months over the north-west, west and south-west of Ireland with an average of 20-60mm. Whereas the north-east and east coasts will experience a precipitation deficit during the summer period of approximately the same magnitude.
- The threat to forestry from pests and disease will intensify. However conifer forests will grow faster with incresed temperature and precipitation plus the added bonus of increased carbon in the atmosphere, this may mitigate to some degree the damage from Pine Weevils and other forest pests.

The Future of Climate Modelling?

"If you can look into the seeds of time and say which grain will grow and which will not, speak then to me…"

Banquo to witches in Shakespeare's Macbeth



Acknowledgements

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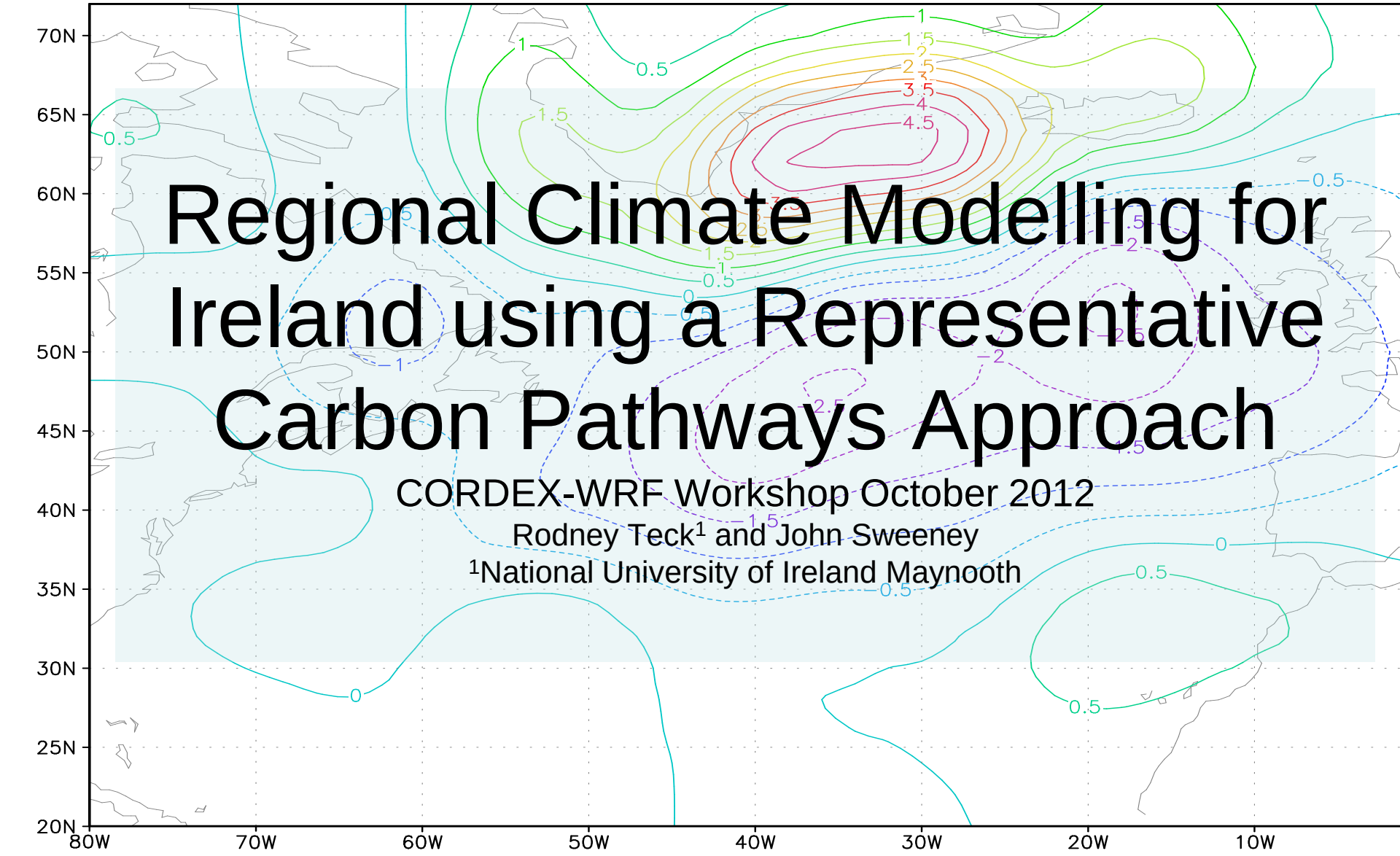

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