Seasonal Outlook Winter (December January February) 2021/22

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November 29th 2021

Winter Forecast for Ireland - The overall signal for Ireland during December January February (DJF) is for above average temperatures, with average rainfall. There is a strong signal for high-pressure to be more prevalent during December, bringing drier than average conditions but also the possibility of cold intrusions from the north at times. There is also a signal for the pattern to revert to a mobile Atlantic setup through January and February, with low pressure to the north and high pressure to the south giving milder, wetter conditions. There is confidence from the models that the overall mean temperature for Ireland will continue above average for the DJF period and that precipitation will be close to average overall, which is consistent with a La Niña background state and a strong stratospheric polar vortex (SPV). However, with the increased likelihood of a disrupted and weak SPV this winter (see page 8), there is a high degree of uncertainty with the forecast.

1 Overview - Temperature

The C3S multi-model ensemble forecast indicates a warm signal for all of Europe during the DJF period. The probability of warmer than average temperatures is strongest in western and southern Europe and over the Atlantic to the south-west of Ireland, with a medium to high probability of above average temperatures over Ireland. Out of the individual model probability forecasts, most models show a medium to high probability for warmer than average temperatures over north-western Europe, including Ireland. One model shows a low probability of warmer than average temperatures for north-western Europe, with no models signalling below average temperatures. The IRI multi-model ensemble forecast predicts above average temperatures over most of Europe, including Ireland during DJF.

Precipitation

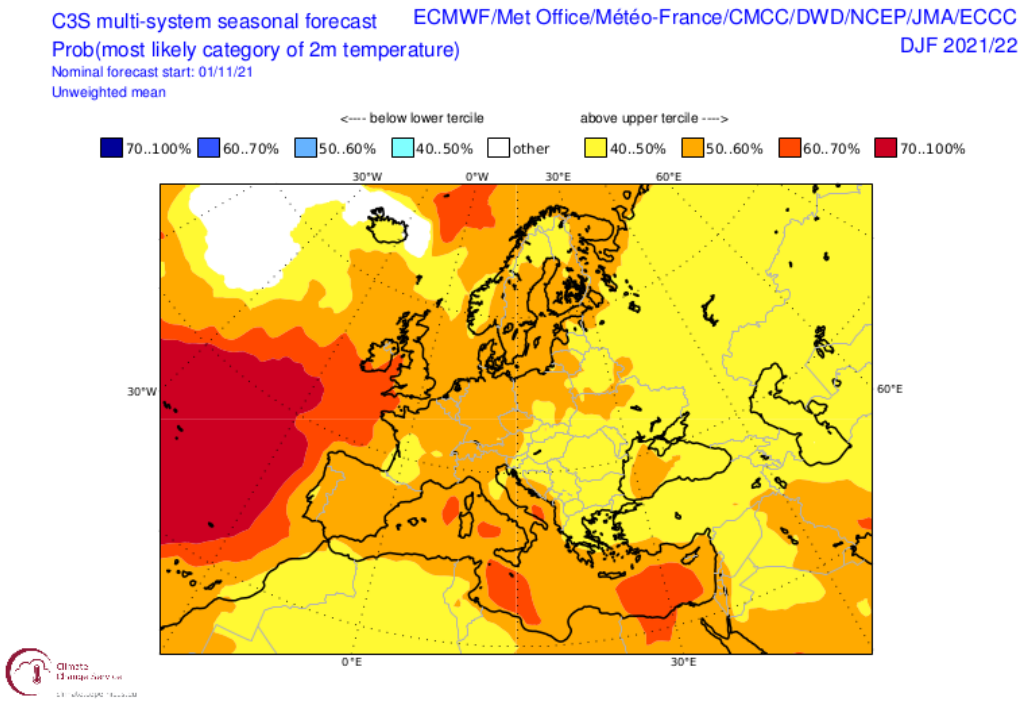
The C3S multi-model ensemble forecast for DJF indicates a weak signal for drier than average conditions over parts of France, the Balkans and south-eastern Europe. There are weak wet signals for parts of Scandinavia, northern and central Russia and to the west of Ireland over the Atlantic. Most of the rest of Europe, including Ireland, is showing no signal, Indicating equal probabilities of a dry, wet or average winter. Out of the individual model forecasts, some are showing weak wetter than normal signals near or over Ireland and some are showing weak drier than normal signals near or over Ireland. The IRI multi-model ensemble forecast has a weak wet signal over western Ireland and a weak dry signal over eastern Ireland and Wales.

Other Influencing Factors

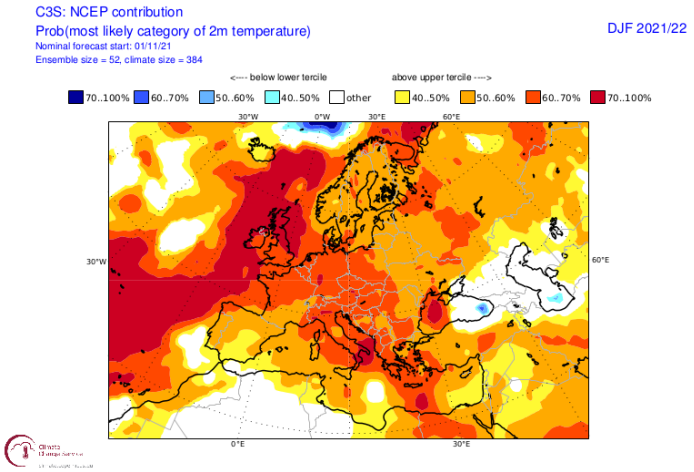
Several models are predicting mid-Atlantic and high latitude ridging to continue to dominate through December, with a flip to AO+ and NAO+ mode conditions during January and February. This is consistent with a La Niña background state and a strong SPV. The MJO is forecast to progress into the western Pacific (phase 6/7) over the next few weeks, also promoting high latitude blocking for the second half of December. As always the winter synoptic patterns for Europe are heavily influenced by what happens with the SPV. An easterly descending Quasi-biennial Oscillation (QBO), increases the chances of a disrupted SPV, which could lead to a sudden stratospheric warming (SSW) and a higher likelihood of a prolonged cooler than average period for northern and north-western Europe. In the winter of 2020/21, with a similar La Niña background state (but with a westerly descending QBO), the models predicted a milder than average winter for northern Europe. However, a disrupted SPV in December and a SSW in early January led to below average temperatures for January and February in northern Europe. In Ireland, it led to below average temperatures in December 2020, January 2021 and the first half of February 2021. The timeline of further disruption to the SPV is still uncertain but if the MJO does progress into the western Pacific during December, anticyclonic wave breaking associated with a Scandinavian/Urals blocking high pressure system becomes more likely. If this occurs the SPV is more susceptible to breakdown due to the easterly descending QBO.

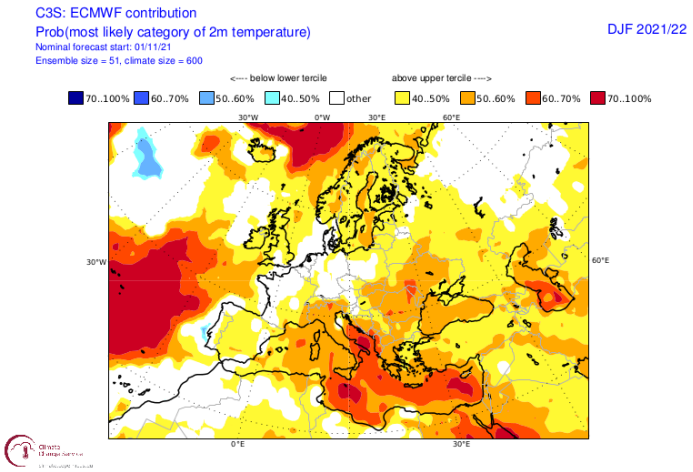
2 Temperature

The C3S multi-model ensemble shows all of Europe in low to medium (40-60%) probabilities of warmer than average temperatures for DJF. The probabilities of warmer than average temperatures are highest for western and southern Europe, especially southern Ireland and parts of the Mediterranean Basin, with very high (70-100%) probabilities of warmer than average temperatures over a large part of the North Atlantic to the southwest of Ireland where above average sea surface temperatures continue to be forecast. One area with no signal is forecast over parts of the North Atlantic south of Greenland, which means equal probability of a cold, a normal or a warm DJF here:

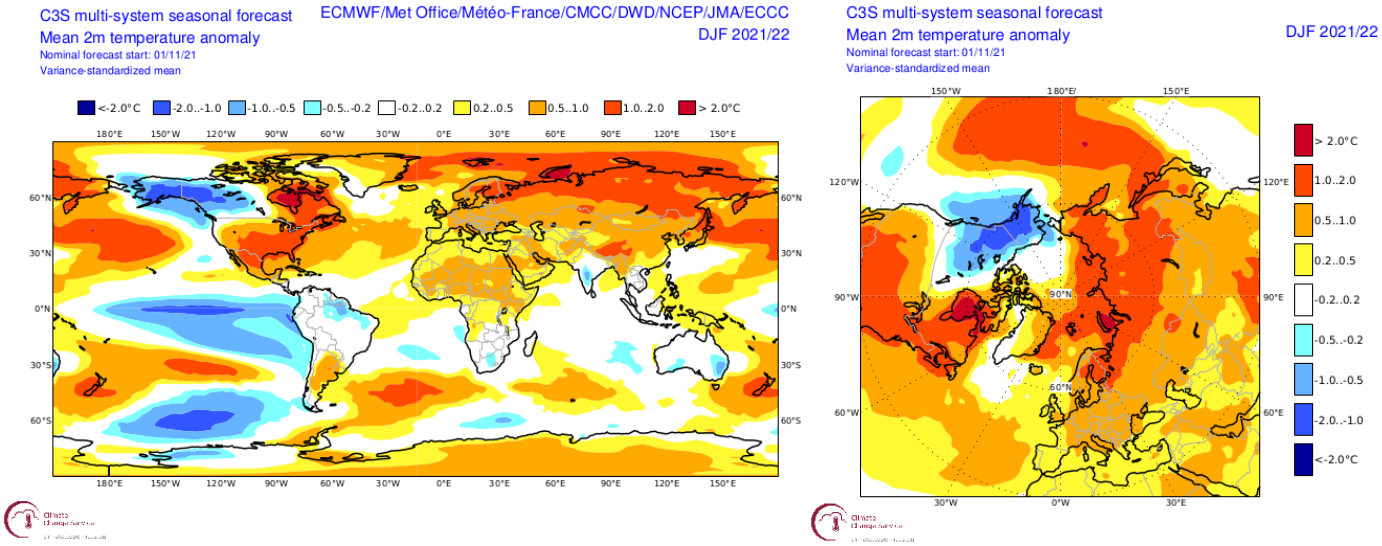


Out of the individual model probability forecasts for seasonal 2m temperatures for the DJF period, most models including NCEP (left panel below), DWD, CMCC, JMA, UKMO, ECCC and MF are showing varying degrees of higher probabilities of warmer than average temperatures over most of north-western Europe, including Ireland. Only the ECMWF (right panel below) has low probabilities of above normal temperatures over north-western Europe, including Ireland, with no model showing an increased probability of below normal temperatures for north-western Europe:

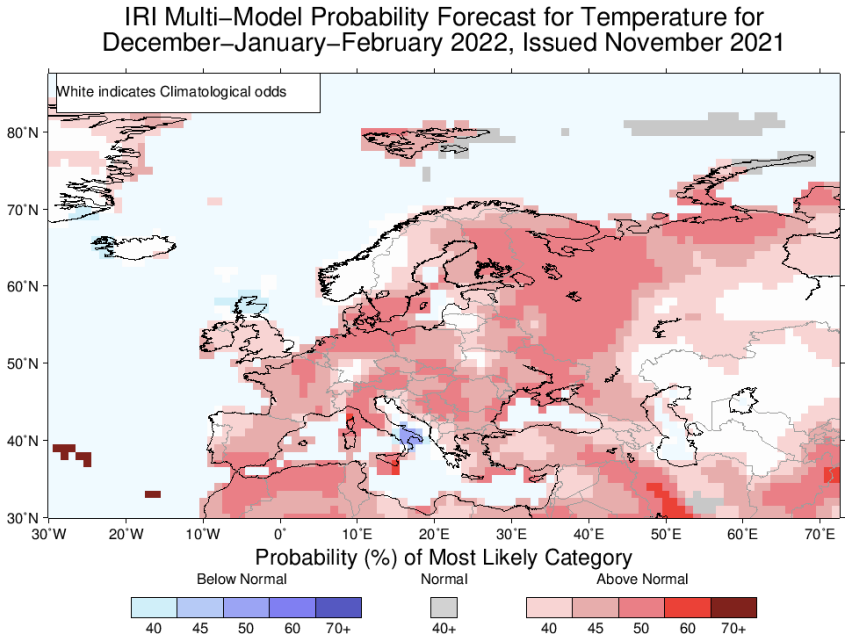




The C3S multi-model ensemble forecast for global 2m temperature anomalies (left panel below) shows medium to strong (0.5-2.0°C) negative temperature anomalies for DJF over three main areas. These are the northwest of Canada and Alaska (a typical La Niña footprint), to the west of South America over the Pacific (also associated with the re-strengthening La Niña) and north of Antarctica in the Pacific. Less intense negative temperature anomalies continue to be forecast for parts of southern Australia, India and Brazil. There are medium to strong (0.5-2.0°C) positive temperature anomalies forecast for DJF over much of the Northern Hemisphere, including most of the US, the central and western part of the North Atlantic and the North Pacific and most of Eurasia including the Arctic north of Siberia. This can be seen better from a Northern Hemisphere perspective (right panel below). Near average temperatures are expected over the North Atlantic to the south of Greenland:

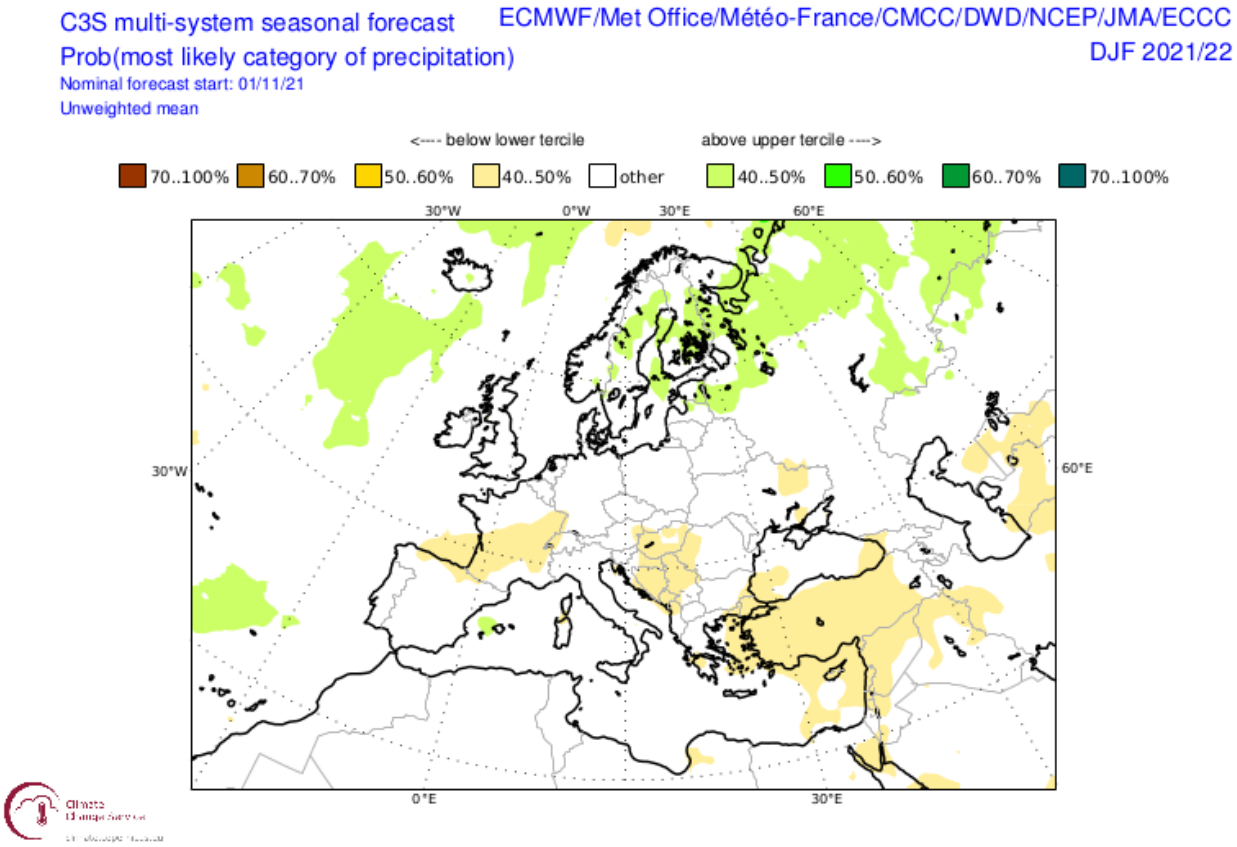


The IRI multi-model ensemble has low to medium (40-50%) probabilities of above normal temperatures over most of Europe, including Ireland. There is no signal, indicating normal temperatures, over a few parts of northern and eastern Europe, with a cool signal over Scotland and southern Italy:

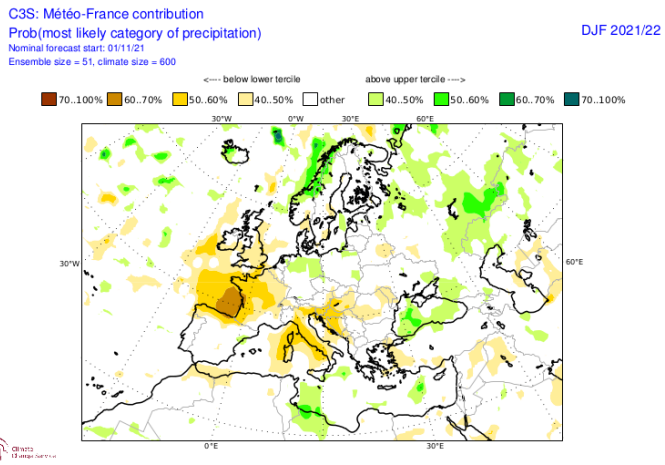


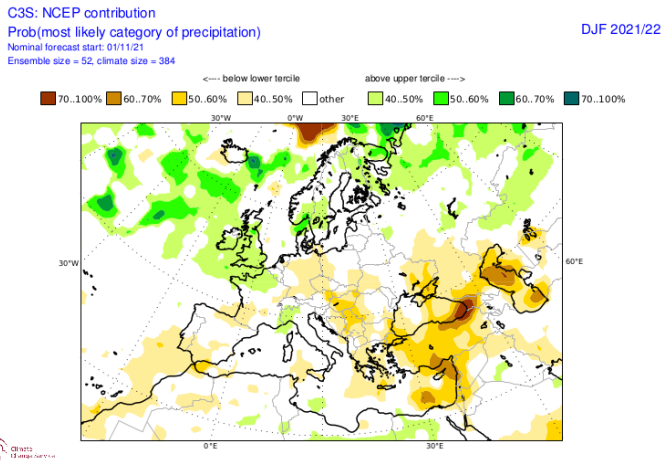
3 Precipitation

The C3S ensemble forecast is showing low (40-50%) probabilities of a drier than normal DJF over parts of France, the Balkans and south-eastern Europe. There are patches of low (40-50%) probabilities of wetter than normal DJF over Scandinavia, northern and central Russia and to the west of Ireland over the Atlantic. There is no signal (equal probability of a wet, a normal or a dry DJF) over central and north-western Europe including Ireland and the UK:

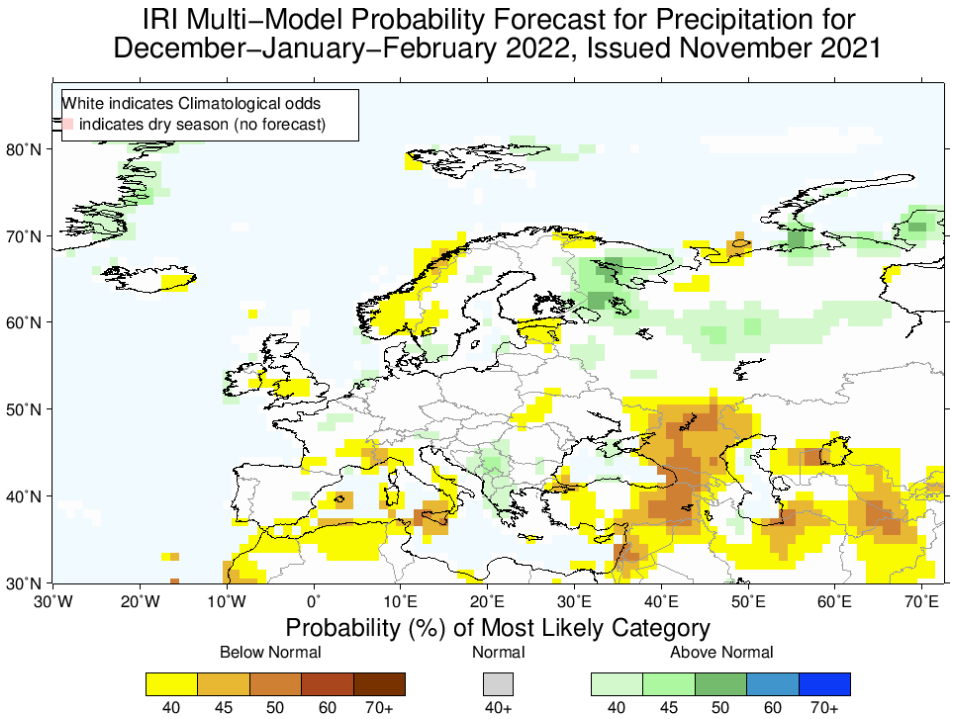


Some models, including MF (left panel below), JMA and DWD are showing a weak drier than normal signal over or near Ireland for the DJF period. The other models, including NCEP (right panel below), CMCC, ECCC, ECMWF and UKMO are showing a weak wetter than normal signal near or over Ireland for the DJF period:



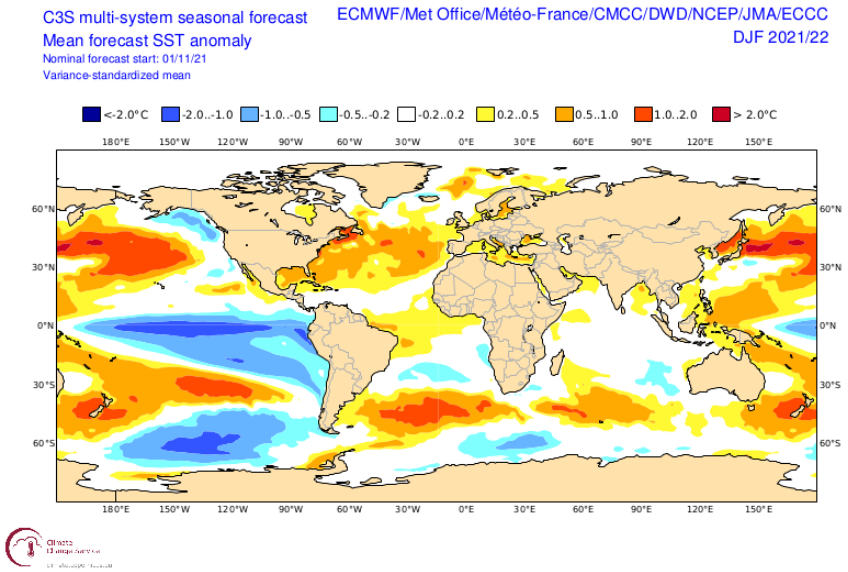


The IRI probability forecast of precipitation during the DJF period shows medium to high (50-60%) probabilities of below normal precipitation over the Middle East, with patches of low to medium (40-50%) probabilities of below normal precipitation over other parts of southern and northern Europe, including the east of Ireland and Wales. There are a few patches of low to medium (40-50%) probabilities of above normal precipitation, which include parts of Russia, Greece and western Ireland:

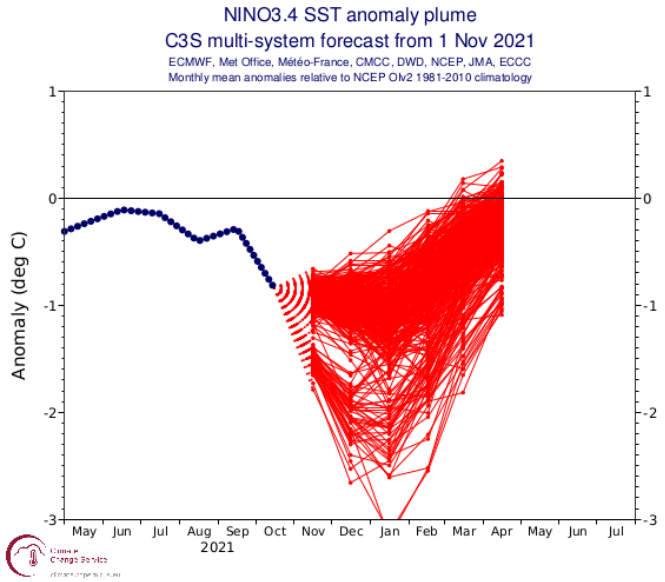


4 Sea Surface Temperature (SST) and ENSO (El Niño-Southern Oscillation)

Medium to strong positive SST anomalies are expected over many sea and ocean areas in the Northern Hemisphere for the DJF period, including most of the North Pacific, a large part of the North Atlantic and parts of the Arctic. The warm anomaly in the North Atlantic to the southwest of Ireland can add abundant moisture to a south-westerly airflow over Ireland, potentially increasing rainfall and mid-latitude storm intensities. A re-strengthening of a cold La Niña signal continues to be forecast in the South Pacific:

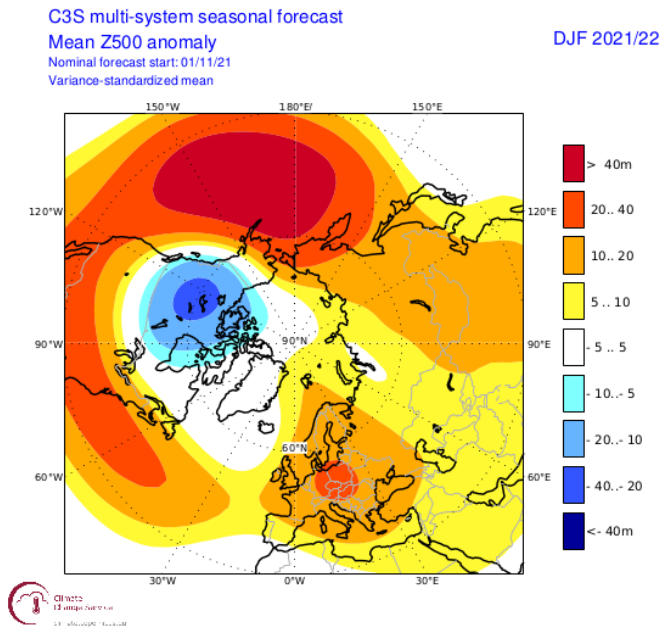


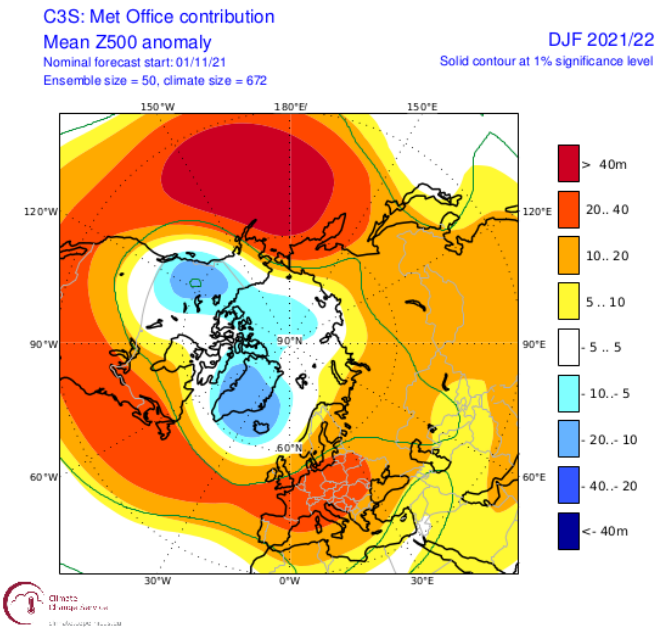
The Niño 3.4 index is the most commonly used index to define El Niño and La Niña events. El Niño or La Niña events are defined when the Niño 3.4 SST anomalies exceed +/- 0.4C for a period of six months or more. The multi-system ensemble Niño plume below for Niño 3.4 (5N-5S, 170W-120W) indicates that a moderate strength La Niña state is developing and will take hold over the next several months through the Northern Hemisphere winter period:



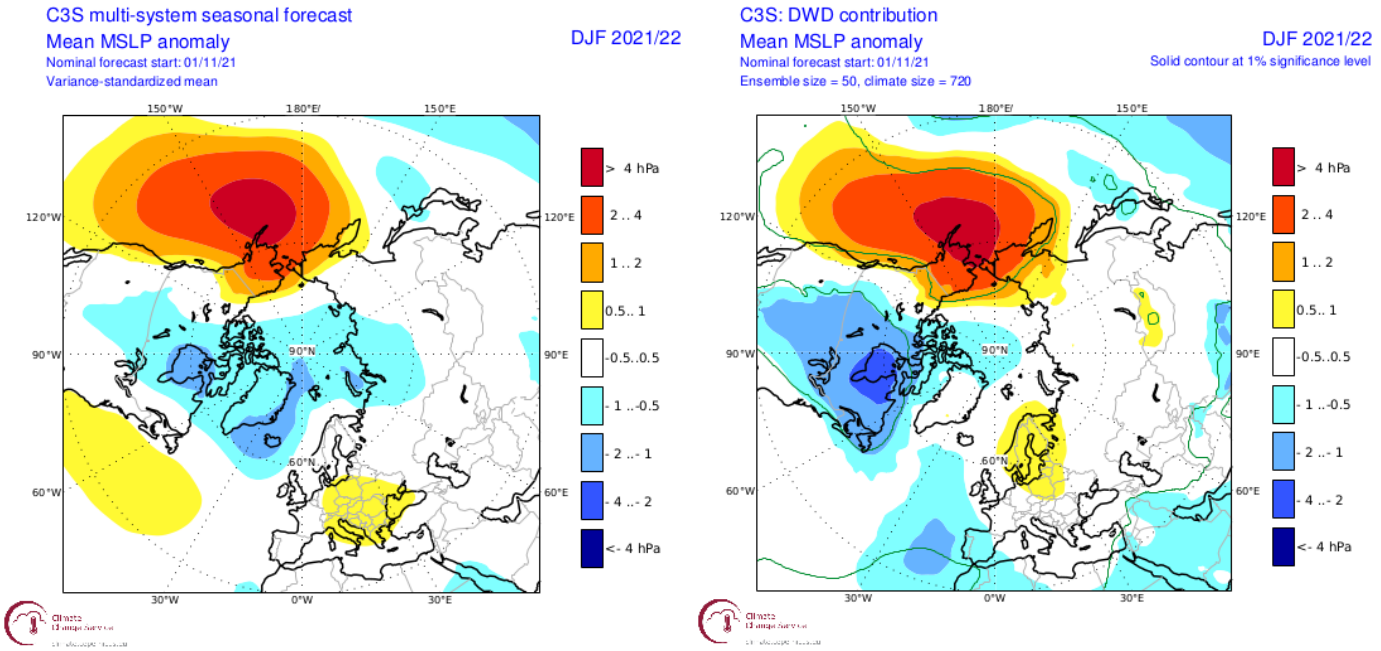
5 MSLP, 500 hPa geopotential height and MJO

500 hPa geopotential height— The C3S multi-model ensemble (left panel below) is showing positive Z500 anomalies for most of the Northern Hemisphere mid-latitudes, including Ireland, and over polar regions north of Scandinavia, with average or negative Z500 anomalies over other polar regions for the DJF period. The C3S individual models vary as to where the higher Z500 anomalies set up, but the general theme is for the early part of winter to be more blocked with negative arctic oscillation (AO-) and North Atlantic oscillation (NAO-) conditions favoured, followed by a switch to more AO+ and NAO+ conditions for the middle and latter part of the winter. This would bring cooler and drier conditions for north-western Europe during December, with mid Atlantic and high latitude blocking, followed by milder wetter conditions for north-western Europe during January and February with Atlantic westerlies dominating. This is reflected in the UKMO Z500 anomaly prediction (right panel below) and is consistent with a background La Niña state and a strong stratospheric polar vortex (SPV):



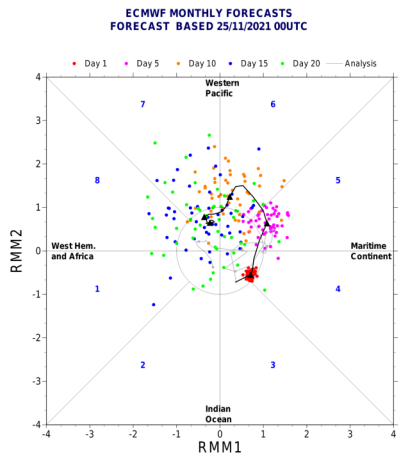


MSLP: In the C3S ensemble forecast for MSLP anomalies (left panel below), generally AO+ and NAO+ modes are signalled for the DJF period. However, a few models such as DWD (right panel below) have a more diluted signal for north-western Europe. This disagreement among the individual models suggests some of the models are holding the blocked AO- and NAO– modes pattern for longer into the winter season, perhaps through most of January, where as most of the models make the transition in early January to AO+ and NAO+ modes, making this signal more dominant in the three month plots:

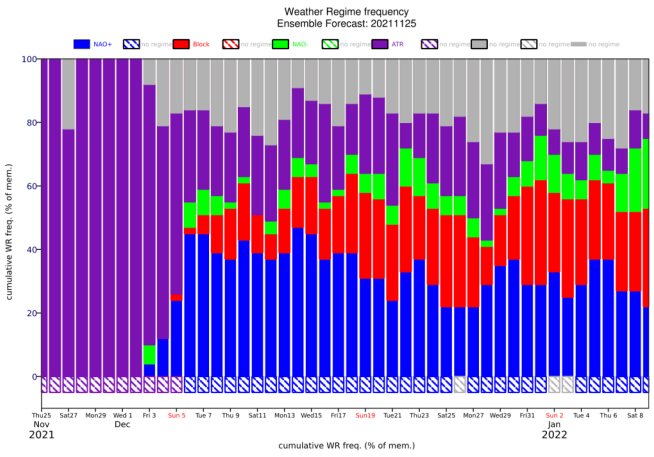


MJO and Weather Regimes Probabilities—The ECMWF extended range MJO (Madden–Julian oscillation) forecast (left panel below) shows the MJO is currently relatively inactive over the Maritime Continent (phase 4/5). It is forecast to stay relatively weak but with a progression into the Western Pacific, which would promote more high latitude blocking in the weeks that follow this progression. The latest weather regimes probabilities forecast from 25th November 2021 up to the 8th January (right panel below) from the ECMWF shows a strong signal for Atlantic ridging (ATR) over the next few weeks, followed by an extended period of NAO+ mode conditions during December. Previous runs were showing a strong signal for a Blocked setup (red - Scandinavian Block) for the second half of December and early January. This indicates there is still a high degree of uncertainty from mid-December onwards:

MJO index - Extended range forecast



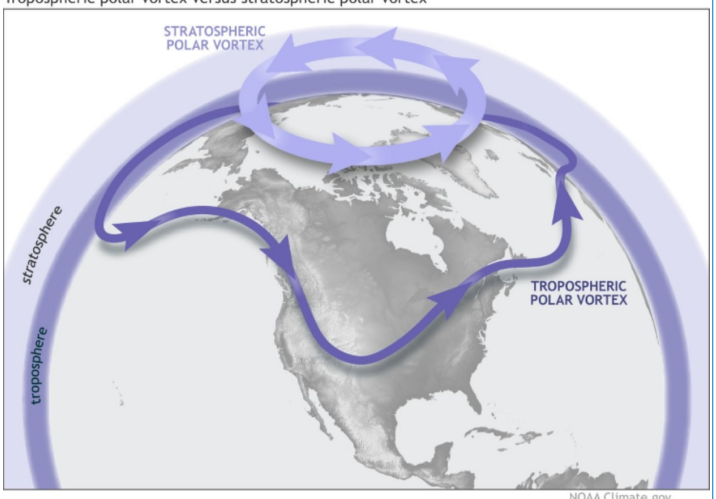
Weather Regimes probabilities



6 Stratospheric Polar Vortex (SPV)

Every year the Northern Hemisphere SPV forms and strengthens during Autumn. A universally accepted parameter for measuring the strength of the SPV is the zonal mean zonal wind (ZW) at 60°N and at 10 hPa height. This is the wind averaged around the whole hemisphere. This average wind goes from easterly in August to westerly in September as the SPV forms and increases in strength throughout autumn. A strong SPV during the late autumn, winter and early spring months, well coupled with the Tropospheric Polar Vortex (TPV), usually leads to strongly positive Arctic Oscillation (AO) and NAO modes, with a higher likelihood of a strong zonal jetstream in the North Atlantic. A weak SPV during the late autumn, winter and early spring months can lead to AO– and NAO– modes, with an increase in high latitude blocking with a more meridional flow and a weakened North Atlantic jetstream. This leads to a higher likelihood of cold intrusions from the north or east over northern and north-western Europe. See previous seasonal forecasts here for more information on the SPV.

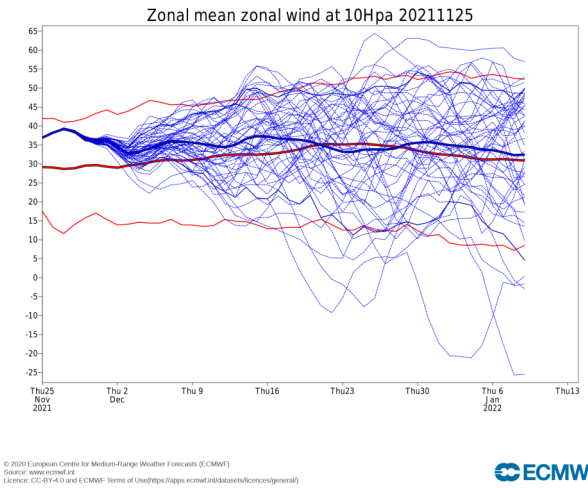
Tropospheric polar vortex versus stratospheric polar vortex



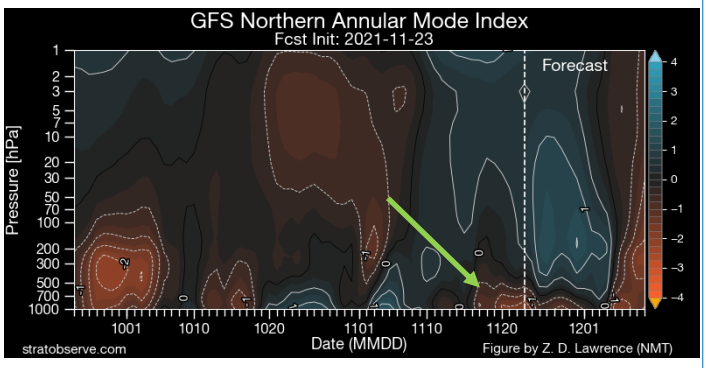
Current State and Forecast of the SPV

The SPV strengthened recently and is currently at above average strength. This is reflected in the strength of the ZW at 10 hPa and 60°N (right panel). It is forecast to stay strong over the next few weeks (blue lines) and then weaken to near average strength (red line) in December with a lot of uncertainty towards mid December (scattered blue lines). With the Quasi-Biennial Oscillation (QBO) currently in an easterly descending phase, the likelihood of further disruption to the SPV is higher than normal. Planetary wave breaking events (such as anticyclonic wave breaking associated with a Scandinavian/Urals high) can lead to a rapid breakdown of the SPV as the vertical wave energy, through strong eddy heat fluxes at 100 hPa, is absorbed by the SPV, possible leading to a sudden stratospheric warming (SSW).

Extended Zonal mean zonal wind at 10hPa



The northern annular mode index (right panel) is a representation of the AO throughout the atmosphere since October (before dotted line) and forecasted (after dotted line). The orange background colours represent AO- (or anomalously high pressure - weak SPV) and the blue background colours are showing AO+ (anomalously low pressure - strong SPV). Currently the SPV is strong, especially in the lower stratosphere, but has yet to couple with the mid and lower troposphere, allowing AO– conditions and high pressure to continue to dominate at the surface in polar regions. The weakening of the SPV at the end of October, as shown by the orange colours in the stratosphere, which then propagated downwards, likely helped lead to the current AO– conditions at the surface (green arrow), as discussed in previous seasonal forecasts. Further reading here and here.



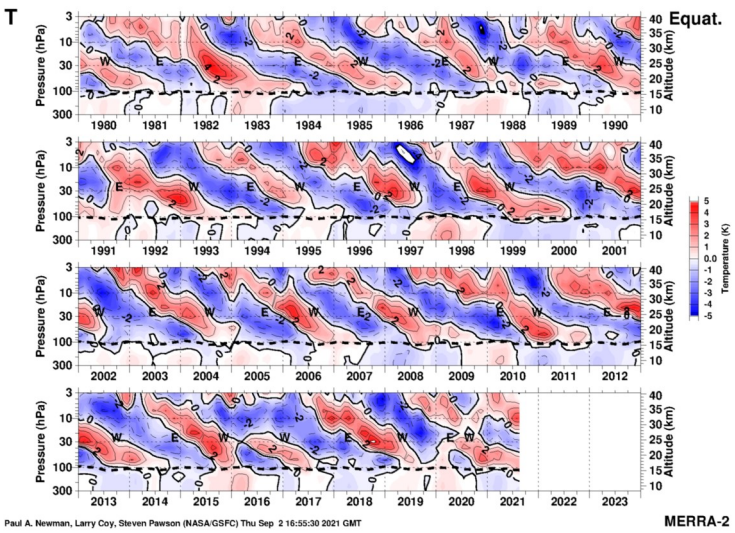
Madden–Julian oscillation (MJO)

The MJO is characterised by areas of eastward spreading enhanced tropical convection, observed over the Indian and Pacific Oceans. The area of enhanced tropical convection usually starts over the west Indian Ocean and spreads eastwards towards the tropical Pacific. A NAO+ mode, which brings milder and wetter weather to Ireland tends to follow MJO phase 3/4 10-14 days later. A NAO– mode, which brings a higher likelihood of a high latitude blocked pattern with cooler and drier weather for Ireland tends to follow an active MJO phase 6/7 10-14 days later.

The Quasi-biennial Oscillation (QBO) - Currently Easterly Descending

The Quasi-Biennial Oscillation is a downward propagating zonal wind variation in the tropical lower stratospheric, with an average period of 28 months. These tropical stratospheric winds travel in a belt around the planet, and approximately every 14 months they completely change direction. It the most regular slow variation in the atmosphere after the cycle of the seasons.

When the QBO is easterly, the chance of a weak jetstream, sudden stratospheric warming events and colder winters in Northern Europe increases. When the QBO is westerly, the chance of a strong jetstream, a mild winter, winter storms and heavy rainfall increases.



Explainer

This report is a summary of the seasonal outlook from the C3S and IRI multi-model ensembles, as well as the outlooks from some of the contributing centres. It looks at the current and predicted ENSO state and some of ECMWF's teleconnection indices and weather regimes probabilities. It also looks at the current state and forecast for the SPV, MJO, QBO, NAO and AO.

Copernicus Climate Change Service (C3S) is the provider of climate change services of the Copernicus Earth Observation programme of the European Union and it is implemented by the ECMWF. In 2018, DWD (Deutscher Wetterdienst) and CMCC (Centro Euro-Mediterraneo sui Cambiamenti Climatici) started contributing their seasonal forecast data to the service and recently, the NCEP (National Centers for Environmental Prediction of the United States), (JMA) Japan Meteorological Agency and (ECCC) Environment and Climate Change Canada were added as contributors. C3S release seasonal forecast graphical products of the multi-model ensemble comprising the ECMWF, UKMO, Météo-France, DWD, CMCC, JMA, ECCC and NCEP model data. *https://climate.copernicus.eu/seasonal-forecasts*

The International Research Institute (IRI) for Climate and Society was first established as a collaboration between NOAA's Climate Programme Office and Columbia University. They produce a seasonal forecast by recalibrating model output from the NOAA's North American Multi-Model Ensemble Project (NMME). *https://iri.columbia.edu/our-expertise/climate/forecasts/seasonal-climate-forecasts/*

Producing centres for Long-Range forecasts are: **ECMWF, UK Met Office, DWD, Météo-France , Hydrometeorological Centre of Russia, NOAA, Environment of Canada, South African Weather Service, Australian Bureau of Meteorology, Japan Meteorological Agency, Korean Meteorological Administration and Beijing Climate Centre.** *https://public.wmo.int/en/programmes/global-data-processing-and-forecasting-system/global-producing-centres-of-long-range-forecasts*, ***https://confluence.ecmwf.int/display/CKB/Description+of+the+C3S+seasonal+multi-system***