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Date: 24/04/2024 17:07:08

Green Book 2024 - aka Use and verification of ECMWF products in the Member and Co-operating States

Fields marked with * are mandatory.

Introduction

Welcome to ECMWF new "Green Book" online submission system (aka "Use and verification of ECMWF products in the Member and Co-operating States")

This time we have two options for completion:

- Filling out the online questionnaire below (new for this year based on feedback from the Meteorological Representatives meeting in November 2023)
- Producing a single report offline (as done in previous years), and emailing the report as detailed in Section 1.

Both methods ask the same questions, however the questionnaire method requires no formatting and aims to make analysis of all responses easier. The questionnaire option also allows you to part-complete, and save your entries to come back to later (using the "Save as Draft" button in the top right corner of this page). Note that the EUSurvey page will timeout after 60 minutes of no activity, responses are usually saved however to be sure please "Save as Draft" to avoid losing responses.

The deadline for all submissions is 23:59UTC on Wednesday 15th May 2024

A summary of responses will be presented at UEF2024 with a summary report available in the ECMWF Publications library in due course.

Section 1: Background - please fully complete

* **1.1 Which Country is your submission for?**

IE - Ireland

* **1.2 Please provide your name(s)**

Alan Hally, Colm Clancy, Aoife Kealy, Brandon Creagh, Liz Coleman

* **1.3 Please provide your organisation**

Met Éireann

* **1.4 Please select your preferred submission method:**

- ○ Producing a single report offline
- ◉ Online questionnaire

Online questionnaire

Please answer the following questions, and illustrate your answers, where appropriate, by also uploading clearly annotated images with image/figure numbers (max 1MB per file). More questions or options may appear, depending on answers to particular questions. Mandatory questions are marked with a '*'. Free text boxes have no word limit, answers don't need to fit the box size given, the boxes expand.

Responses to the questionnaire can be saved and returned to at a later date before submitting. To do this click the 'Save as Draft' button on the left, this will provide you with a link which you can return to to continue /complete your submission.

Section 2: Summary of major highlights

* **Please detail major highlights since January 2022**

You may wish to complete this section at the end, after completing all others**.**

Met Éireann continue to use ECMWF products/model output as primary guidance in the medium-range (3-10 days) and as lateral boundary conditions for operational limited area NWP models. This is currently via use of IFS-HRES but this will be expanded to included IFS-ENS once Met Éireann switches to relying upon the United Weather Centres (UWC) West NWP output.
Application and verification of products is outlined in sections 3 and 4. Comments on two case studies are included, one which could be classified as "Bad model guidance" and one which could be classified as "Good model guidance".
The primary users of ECMWF products in Met Éireann are our Forecasting, Flood Forecasting, Climate Services and Research and Applications Division.
Seasonal outlooks are now routinely produced using guidance from the C3S multi-model ensemble and are published to our public website.

Section 3: Forecast products

3.1. Please outline what direct use you make of standard ECMWF model products (on ecCharts / OpenCharts / own workstation), for operational duties, in the following 4 categories (noting that new AI model output should be dealt with separately, via question 3.4).

* **a) Medium Range (e.g. for high impact weather forecasting)**

• ECMWF forecast products are adapted to be used over Ireland mainly in the 3-10 day range. These products are used for heads up on severe weather. Products based on the control / deterministic forecast include max and min temperatures, rainfall amounts, snow and snowfall amounts, wind speeds, wind gusts, warning level gusts, wave heights, swell height, cape, Boyden indices and streamlines for convection, cloud cover, blight, visibility.
• A number of EPS meteograms and plumes are used for some of the main towns and cities across Ireland. The meteograms give helpful information on the uncertainty of the forecast. This information enables our forecasters to get a handle on the risk related to any severe weather events.
• On the Open Charts platform, the product used most is the 'Extreme Forecast Index' and 'Shift of Tails'. This product is useful for highlighting the potential for severe weather in the coming days.
The EFI charts most used are: 2m Temperature, wind speed, wind gusts, rainfall, snowfall.
• Probability threshold maps are also used for the main categories of warnings e.g. for wind, rainfall and temperature hazards.
• Extra-tropical cyclone database (CBD) products are used for forecasting the path/track of cyclones and associated fronts.

* **b) Extended Range (monthly)**

For our monthly text forecasts (which are published on our website) we operationally make use of the following output: Weekly surface pressure anomalies, weekly surface temperature anomalies, weekly rainfall anomalies and weekly 500hPa anomalies. Some of our forecasters also interact with the "Weather Regime Frequency" products.

* **c) Long Range (seasonal)**

For our seasonal forecasts (which are published on our website) we operationally make use of the following outputs: at 1 and 3 month resolution:- MSLP, T2m, Precipitation, SSTs and Z500 Geopotential Height , looking at the probabilities and anomalies. We also look Weather Regime Frequency, Monthly forecast of the MJO, the Zonal Mean wind at 10hpa for indications of SSW. For El Niño conditions we look at the SST anomaly plume and the Equatorial Southern Oscillation.

* **d) CAMS and Fire-related output (ecCharts mainly)**

Some CAMS products for pollen forecasting are used from time-to-time by our forecasters.

3.2. ECMWF cycle 48r1 went live at the end of June 2023. Changes included a much higher resolution medium range ensemble, and much more frequent monthly forecasts.

* **a) Please describe any positive impacts of model cycle 48r1 for your service**

The increase in the medium-range ensemble resolution was a very welcome and positive change. This allows our forecasters to get a better handle on the certainty of high-impact wind/rainfall events at longer lead-times. The increased frequency of monthly forecasts is also very welcome as this has become and increasingly popular product on our public website.

If you have any annotated graph/diagram/plot that would help clarify your answer to the previous question, please upload here.
File types: most accepted, File Size: max 1MB per file.

* **b) Please describe any negative impacts of model cycle 48r1 for your service**

The inclusion of the a multi-layer snow model in cycle 48r1 was expected to lead to more realistic snow melt. However, over the admittedly small number of snow events Ireland has had since 48r1 went live, our forecasters have not seen much of an improvement. From our forecasters perspective snow continues to linger too long after it has fallen.

If you have any annotated graph/diagram/plot that would help clarify your answer to the previous question, please upload here.
File types: most accepted, File Size: max 1MB per file.

* **c) Have you noticed any systematic changes in forecast output since model cycle 48r1 was implemented?**

- ○ Yes
- ◉ No

* **3.3: Do you modify ECMWF model output to create 'derived fields' (e.g. post-processed output, regimes, probabilities).**

- ◉ Yes
- ○ No

Please describe what you modify and how

IFS-HRES and ENS forecasts are converted to NetCDF format for ingestion by WDB (Weather DataBase software) for our public website/app and open api. Some statistical post-processing is conducted on ENS precipitation and solar radiation to extract quantiles for use by WDB and our website.

If you have any annotated graph/diagram/plot that would help support your answer to the previous question, please upload here.
File types: most accepted, File Size: max 1MB per file.

*

3.4: Do you currently use Artificial Intelligence (AI) and/or Machine Learning (ML) techniques in your service, in conjunction with standard ECMWF model output?

- ○ Yes
- ◉ No

* **3.5: Does your NMHS use ECMWF data for modelling purposes - e.g. by providing initial/boundary conditions for limited area model runs, or for hydrological models, or for dispersion models, etc...**

- ◉ Yes
- ○ No

Please describe these activities

ECMWF fields are used are boundary conditions for our limited area model, HARMONIE-AROME, producing 54-hour forecasts eight times per day in a 1+15 ensemble system called IREPS.

ECMWF fields are used as the meteorological input to the Hysplit dispersion model by Met Éireann, an important decision support tool for emergency management in radiation related events. We also generate a blue tongue virus threat product using Hysplit which is disseminated to our Department of Agriculture who in turn pass this information to vets and other interested parties around the country.

For coastal flood forecasting ECMWF forecasts are used as input to the Tide and Storm Surge Forecast (TSSF) model run by Met Éireann's Flood Forecasting Division. This is the most important operational tool for surge modelling at a national scale and supports local responses to potential flood events. It is planned that ECMWF forecasts (both HRES and ENS) will be used to run the national fluvial flood forecasting models.

If you have any annotated graph/diagram/plot that would help support your answer to the previous question, please upload here.
File types: most accepted, File Size: max 1MB per file.

* **3.6: In the last year or so ECMWF has made available, on ecCharts and OpenCharts, selected fields from AI models (e.g. Pangu Weather, AIFS). Were you aware of this?**

- ◉ Yes
- ○ No

* **a) What are your views on this initiative?**

This is a very welcome initiative and we salute ECMWF's leadership in this area. It has allowed our forecasters to get an initial feel for how AI models handle severe weather events such as named storms.

* **b) Do you currently use AI forecasts for operational purposes?**

- ○ Yes
- ◉ No

What would you need in order to use AI models in your forecast activities?

Output from AI models in grib format would make it easier to ingest into our operational visualisation software. Although we note that this has recently been made available for AIFS.

More training for end-users of the output from AI models would be very welcome, especially comparing how traditional NWP models differ from AI models and the advantages/deficiencies of both.

Section 4: Verification

ECMWF does extensive verification of its products in the free atmosphere. However, our verification of surface parameters is more limited and can be constrained to only using synoptic observations. More detailed verification of these surface weather parameters by National Services is always valuable to us. We are most interested in results for the last 1 or 2 years. Also, any evidence you have of performance changes since the introduction of cycle 48r1 would be very valuable.

* **4.1 Do you routinely verify raw model output from ECMWF model(s) and/or other operational models /ensembles?**

- (●) Yes
- ( ) No

Please describe your verification activities and show and discuss related scores in the the two lead-time categories shown below, including, where possible, comparisons with your own models /ensembles, and other models/ensembles.
Ideally focus on surface weather parameters in your own territory. Inclusion of conditional verification results is also strongly encouraged - e.g. stratification by a weather type - as these can provide very useful insights into model weaker points.

a) Short Range and Medium Range

Monthly point verification is carried out, comparing IFSHRES with our operational limited-area HARMONIE-AROME model particularly for surface variables (using synoptic and other national observational networks). We also carry out ensemble point verification, comparing IFSENS with the full IREPS system.

In terms of deterministic performance, we generally see IFSHRES scores are better for MSLP, although there are concerns over comparing like-with-like here. We typically compare, for example, the 00z IFSHRES with the 00z HARMONIE: however, this LAM run uses IFSHRES boundaries from the previous 18z run, and this perhaps a better comparison.

In terms of 10m wind, our current LAM system has a positive bias at lower wind strengths and IFSHRES outperforms here. However, in more extreme cases, we see the benefit from our higher resolution LAM; see the figure kss202312.png attached, showing Kuiper Skill Scores for December 2023.

For 2m temperature, the scatterplots (t2m202401.png) from January 2024 demonstrates behaviour that is often reported by forecasters: that IFSHRES is less successful at the more extreme minima.

If you have any annotated graph/diagram/plot that would help support your answer to the previous question, please upload here.
File types: most accepted, File Size: max 1MB per file.

0a3bb48a-1625-4f19-8009-840f4c76dea2/kss202312.png
c8a7ea48-0326-4d46-9db4-c3554d0617bc/t2m202401.png

b) Extended Range (Monthly) and Long Range (Seasonal)

No verification of these ranges currently.

If you have any annotated graph/diagram/plot that would help support your answer to the previous question, please upload here.
File types: most accepted, File Size: max 1MB per file.

* **4.2 Do you routinely verify post-processed products and/or tailored products delivered to users?**

- (○) Yes
- (●) No

* **4.3 Do you perform any subjective verification of forecasts?**

- (●) Yes
- (○) No

Please describe and illustrate any activities and results in this area

Usually there be an analysis of model performance after an extreme event, and a discussion with forecasters. The focus is more on our limited-area operational systems, but a background analysis of the IFS guidance is included, particularly since this can dominate through the boundaries (in a positive or negative way).

If you have any annotated graph/diagram/plot that would help support your answer to the previous question, please upload here.
File types: most accepted, File Size: max 1MB per file.

4.4: Case Studies. Please describe and illustrate any case study verification you have undertaken. Examples of both good and bad model performance are welcome. Severe weather events (and non-events) are of particular interest to us.

a) Case Study 1 - Please describe the forecast(s) and what happened

On the morning of the 1st of March 2024, a complex low pressure system passed over Ireland bringing a mix of rain, sleet and snow. This precipitation fell as moderate snow during the early hours of Friday, particularly

around our capital city, Dublin. The timing of this snow (morning rush hour) led to significant impacts for commuters. While all models available to forecasters gave an indication of the precipitation falling as snow, uncertainties in the location of the low pressure as well as forecaster mistrust in the models correctly capturing snowfall amounts led to the event being under-forecast.
Attached are some sample plots from successive IFS-HRES forecasts from 12, 18 and 00UTC on the 29th of February and 1st of March respectively. Areas in the south-west and north-west of Ireland did not see any snowfall during this event, however there is consistent forecasting of accumulating snow from all runs. IFS-HRES does demonstrate snow accumulating in the East of the country, however. The file attached which visualises snow accumulating out to +240 hours from the 00UTC run on the 1st of March shows that the snow was not predicted to melt away, even out to 10 days after the event. Whereas in reality, the snow melted away quite quickly due to a band of rain which moved in behind the snow showers. This fed into forecaster mistrust of how IFS was handling the overall situation.
From forecaster feedback of this event, it seems as if the positioning of the low pressure system in the Irish Sea shifted in the runs leading up to the event and this meant Dublin was more at risk of moderate snowfall than perhaps had been indicated. As our high-resolution model relies upon IFS-HRES for its lateral boundaries, and this shift in the position of the low pressure did not propagate down into high-resolution forecasts in time for warnings to be updated.

If you have any annotated graph/diagram/plot that would help support your answer to the previous question, please upload here.
File types: most accepted, File Size: max 1MB per file.

54e42262-e848-49e2-8820-7a2664649077/IBL_NWP_ECMWF_HighRes_Snow_Accum_00_20240301_012.png
13239db7-f012-4bc9-a155-9e81f0b50851/IBL_NWP_ECMWF_HighRes_Snow_Accum_00_20240301_240.png
9e15eabc-3f30-48bb-b353-2cf28df302b0/IBL_NWP_ECMWF_HighRes_Snow_Accum_12_20240229_024.png
1fa63269-a2c1-4a44-ba49-6b33d9587a9e/IBL_NWP_ECMWF_HighRes_Snow_Accum_18_20240229_018.png

Case Study 1 is an example of:

- ○ Good model performance
- ◉ Bad model performance
- ○ Mixed (good and bad) model performance
- ○ Other (please describe above)

Add another Case Study?

- ◉ Yes
- ○ No

b) Case Study 2 - Please describe the forecast(s) and what happened

Storm Kathleen impacted Ireland on the 6th of April 2024. The forecasts for this event were of excellent quality from IFS-HRES and IFSENS products available to our forecasters. This allowed us to prepare for the arrival of this event well in advance given the certainty of the forecast. It also meant that our high-resolution EPS system had a very good handle on how the event would unfold. Overall this led to very timely and accurate warnings for the Irish public.

If you have any annotated graph/diagram/plot that would help support your answer to the previous question, please upload here.
File types: most accepted, File Size: max 1MB per file.

Case Study 2 is an example of:

- (●) Good model performance
- ( ) Bad model performance
- ( ) Mixed (good and bad) model performance
- ( ) Other (please describe above)

Add a third Case Study?

- ( ) Yes
- (●) No

Section 5: Output Requests

5. Please describe, and illustrate if necessary, any particular requests you may have for new or modified ECMWF products.

a) Product request 1 - title / summary

Floating 24 hour period not 00UTC to 00UTC for EFI

Product request 1 - description of request

As was discussed during our Member State visit in October 2023 our forecasters would like to be able to access (via OpenCharts) a floating 24-hour period version of the EFI product.

If you have any annotated graph/diagram/plot that would help support your answer to the previous question, please upload here.
File types: most accepted, File Size: max 1MB per file.

Add another Product Request?

- ( ) Yes
- (●) No

Section 6: References

6. Are there any recent internal or external publications that relate to the questions in this survey? Please list them including the respective link/s. For any publications that cannot be readily downloaded via a link please attach a copy below (or email Becky Hemingway (becky.hemingway@ecmwf.int) and Tim Hewson (timothy.hewson@ecmwf.int) if too large to upload here).

Not applicable

If you have any annotated graph/diagram/plot that would help support your answer to the previous question, please upload here.
File types: most accepted, File Size: max 1MB per file.

Section 7: Additional comments and Feedback

7.1. Please use the box below if you have additional comments on topics that have not been covered in any of the questions above

No additional comments

If you have any annotated graph/diagram/plot that would help support your answer to the previous question, please upload here.
File types: most accepted, File Size: max 1MB per file.

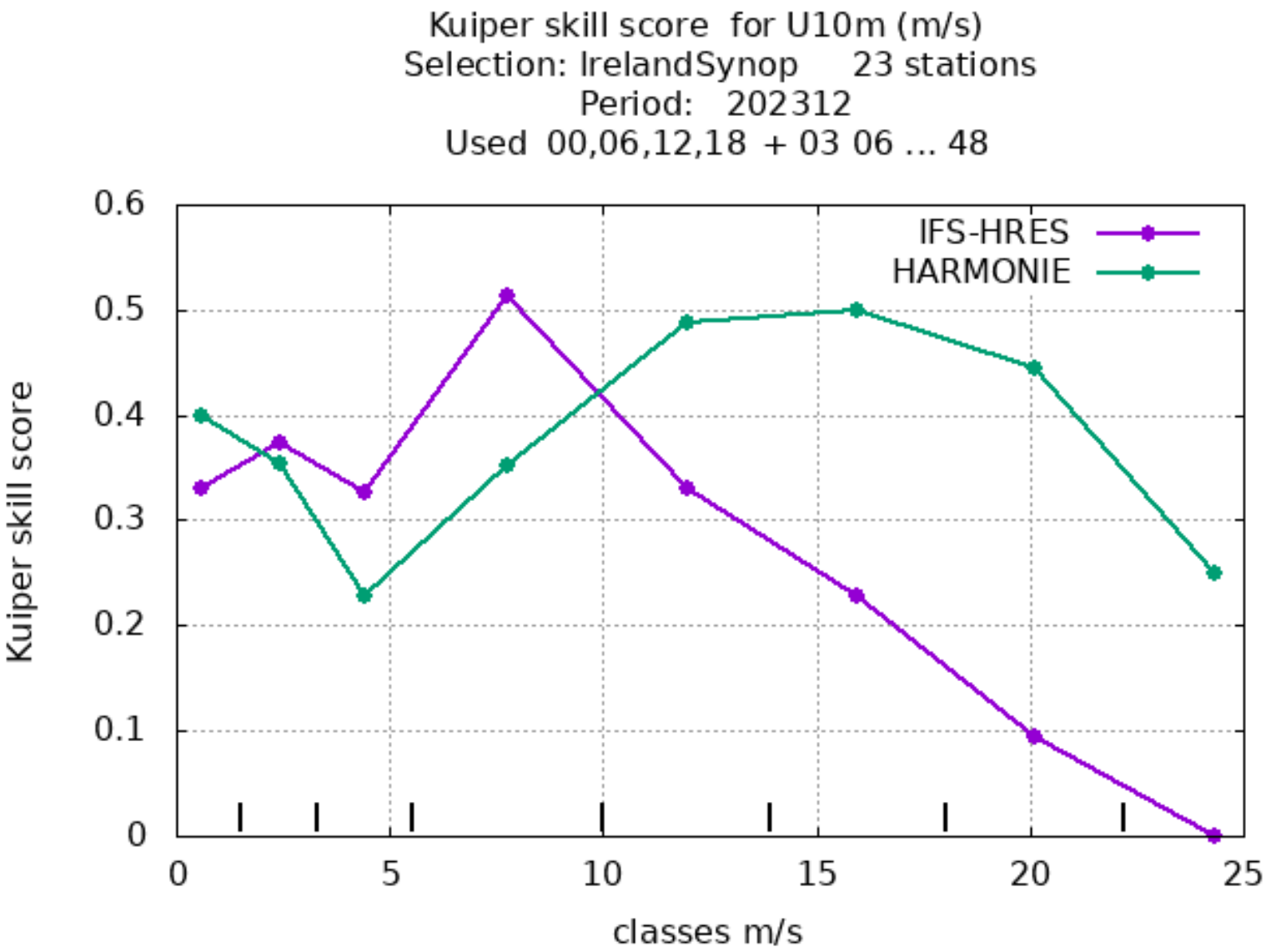
7.2. This is the first time we have used a survey style structure for Green Book submissions. You thoughts and feedback on this process are very welcome

We are very happy with this new method for the Green Book submissions. It easily allows multiple people to provide input without endlessly sharing many versions of a word document

Thank you for taking the time to complete your Green Book report. Your feedback and comments are very valuable to us!

Contact

Contact Form


Kuiper skill score for U10m (m/s)
Selection: IrelandSynop 23 stations
Period: 202312
Used 00,06,12,18 + 03 06 ... 48
IFS-HRES
HARMONIE
Kuiper skill score
classes m/s
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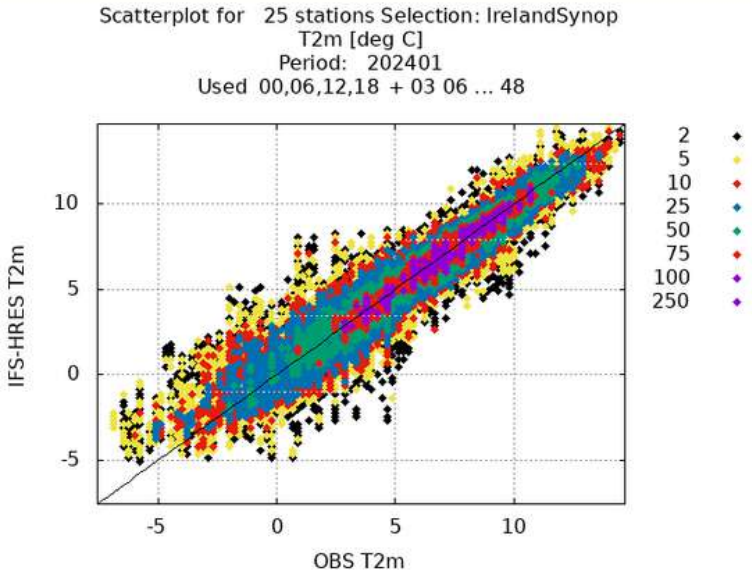
Scatterplot for 25 stations Selection: IrelandSynop
T2m [deg C]
Period: 202401
Used 00,06,12,18 + 03 06 ... 48
IFS-HRES T2m
OBS T2m
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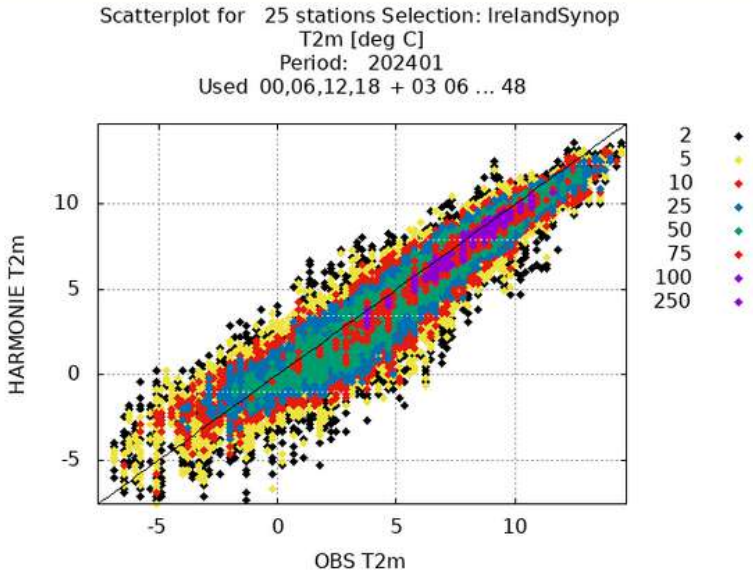
Scatterplot for 25 stations Selection: IrelandSynop
T2m [deg C]
Period: 202401
Used 00,06,12,18 + 03 06 ... 48
HARMONIE T2m
OBS T2m
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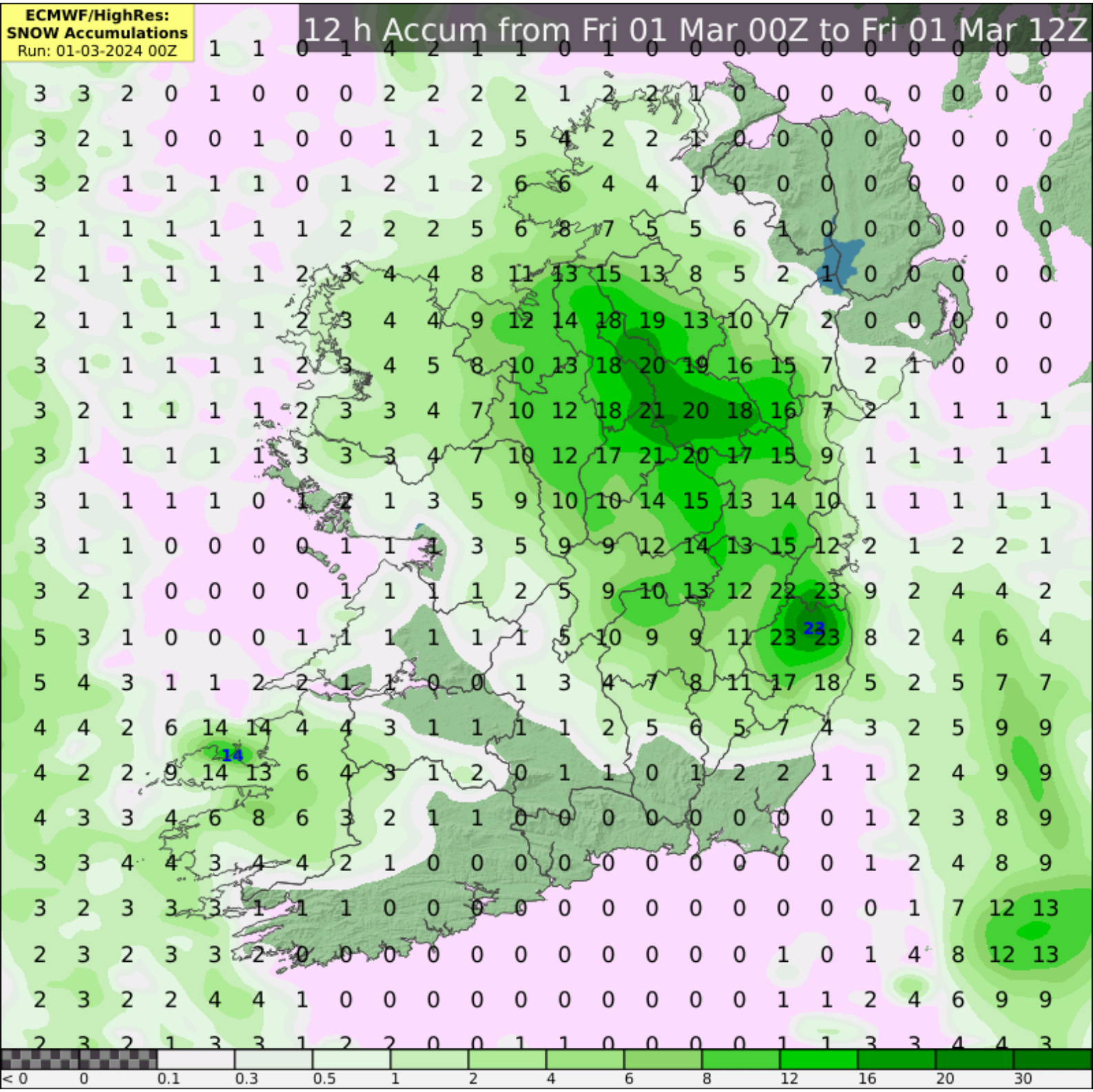
ECMWF/HighRes:
SNOW Accumulations
Run: 01-03-2024 00Z
12 h Accum from Fri 01 Mar 00Z to Fri 01 Mar 12Z
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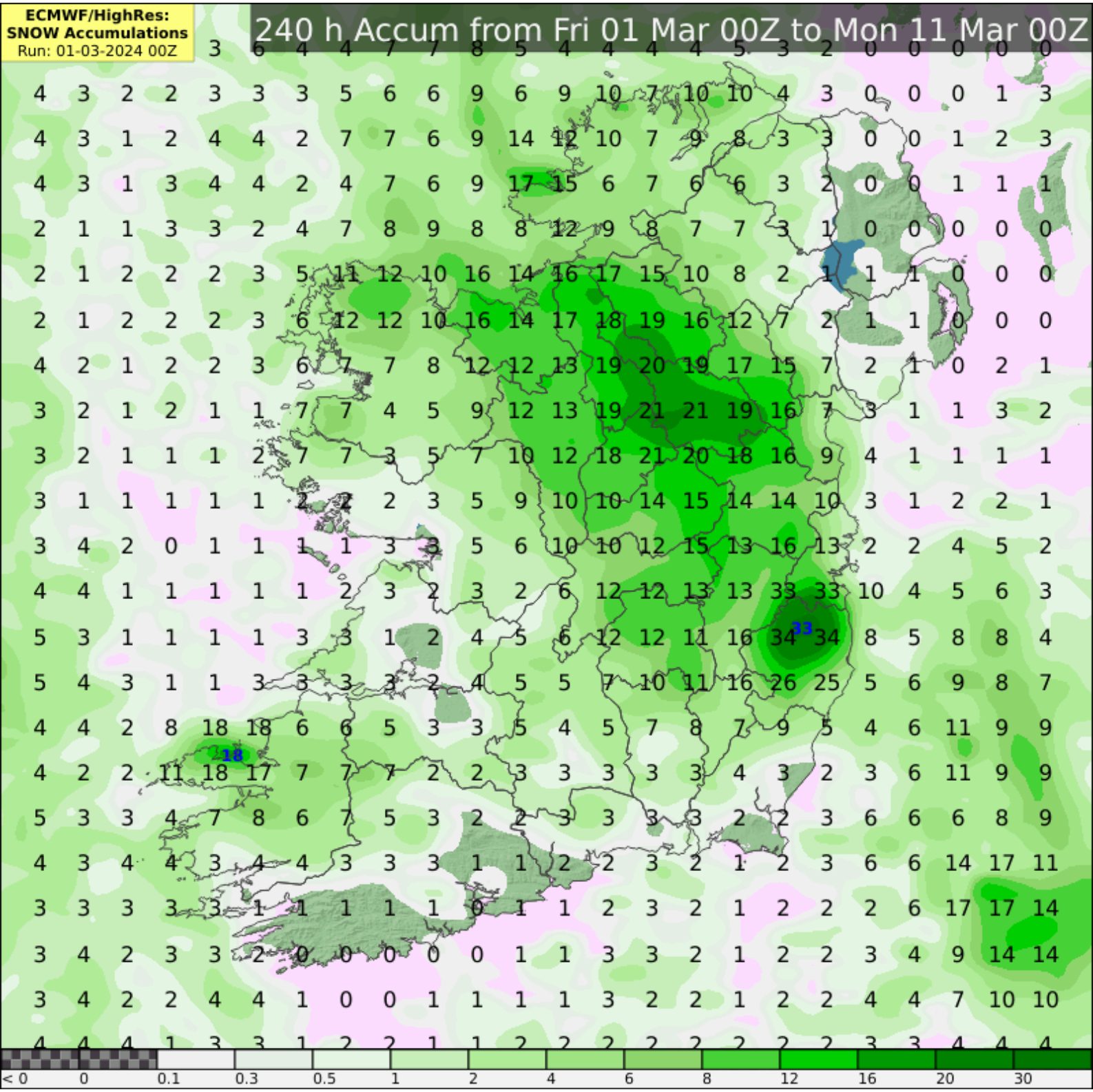
ECMWF/HighRes:
SNOW Accumulations
Run: 01-03-2024 00Z
240 h Accum from Fri 01 Mar 00Z to Mon 11 Mar 00Z
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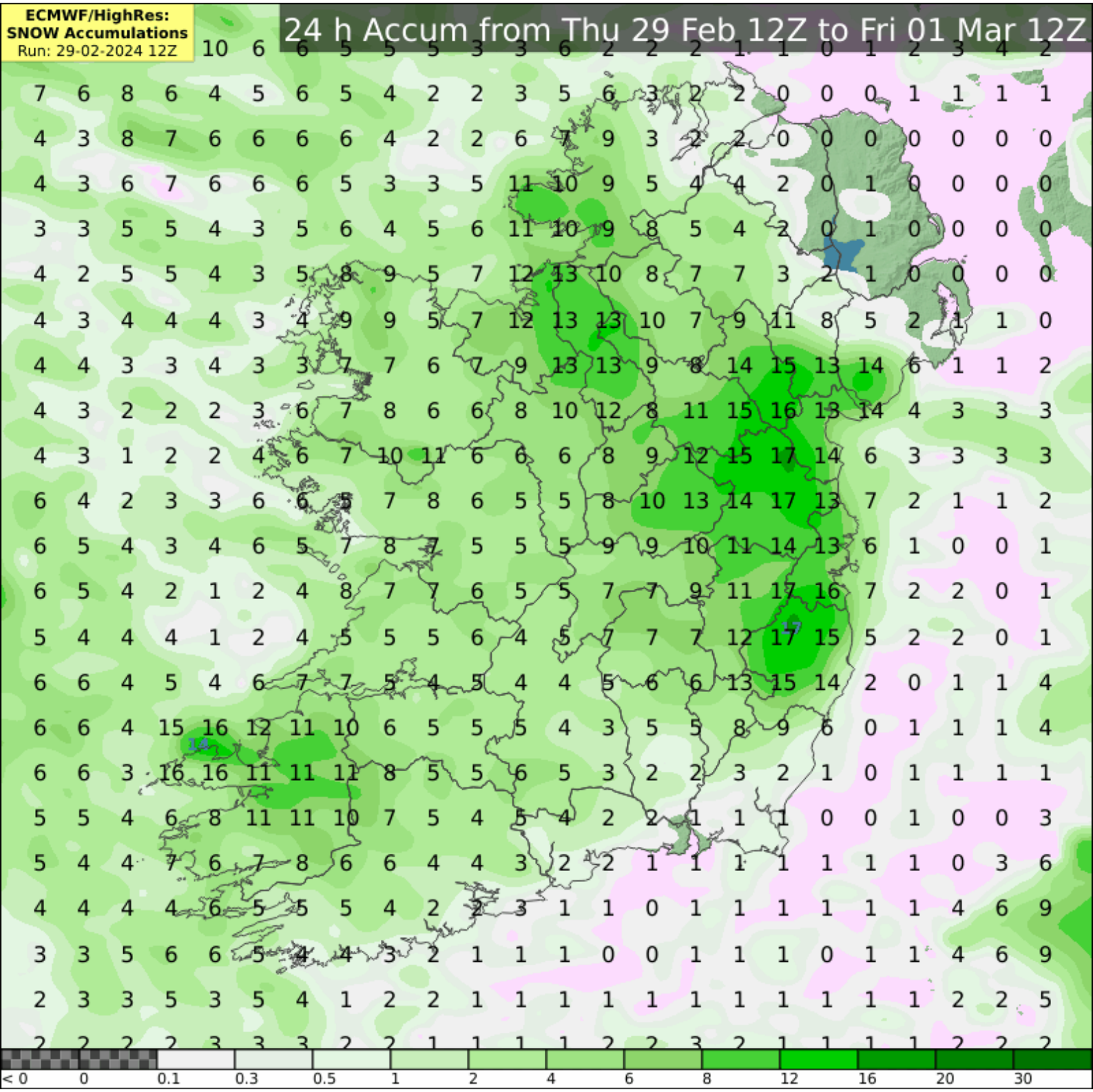
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SNOW Accumulations
Run: 29-02-2024 12Z
24 h Accum from Thu 29 Feb 12Z to Fri 01 Mar 12Z
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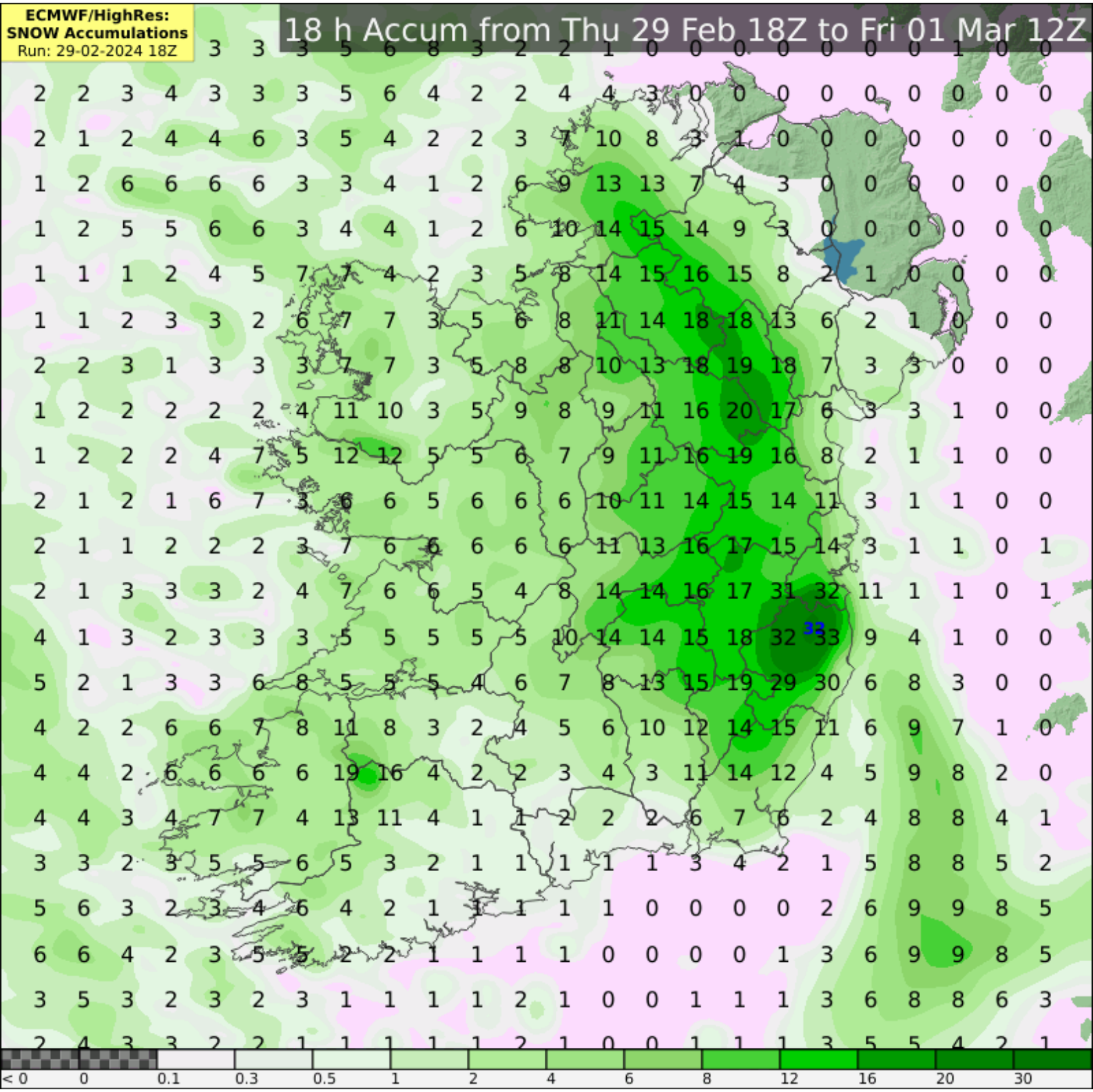
ECMWF/HighRes:
SNOW Accumulations
Run: 29-02-2024 18Z
18 h Accum from Thu 29 Feb 18Z to Fri 01 Mar 12Z
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