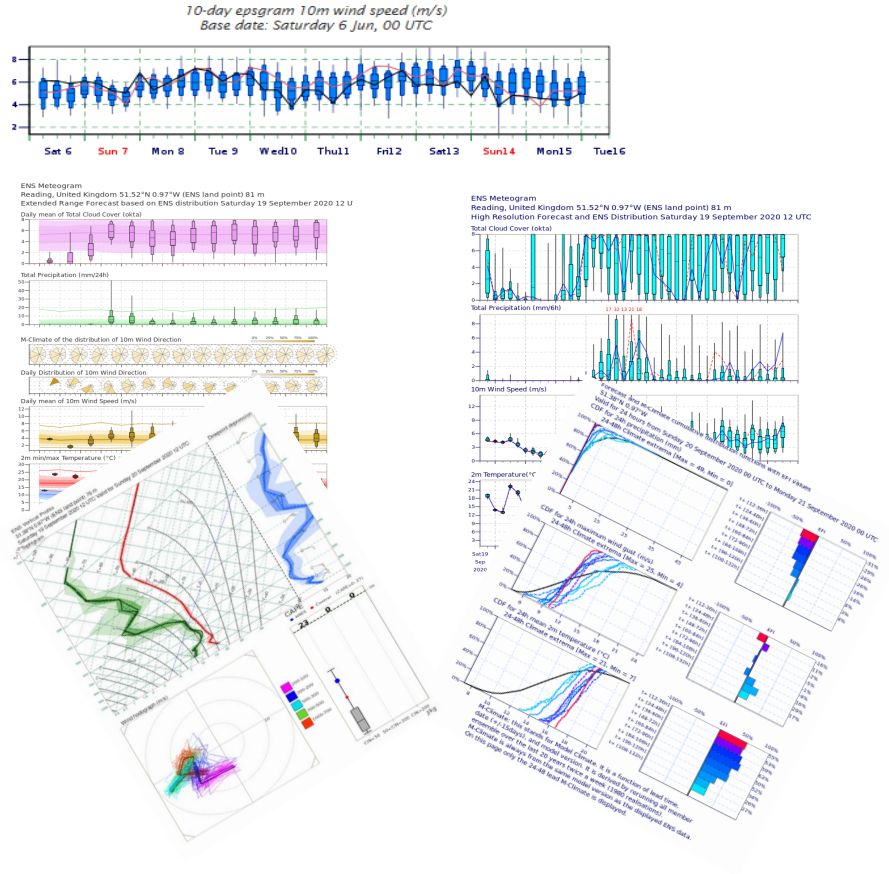
Meteograms with changing resolution and visibility meteograms

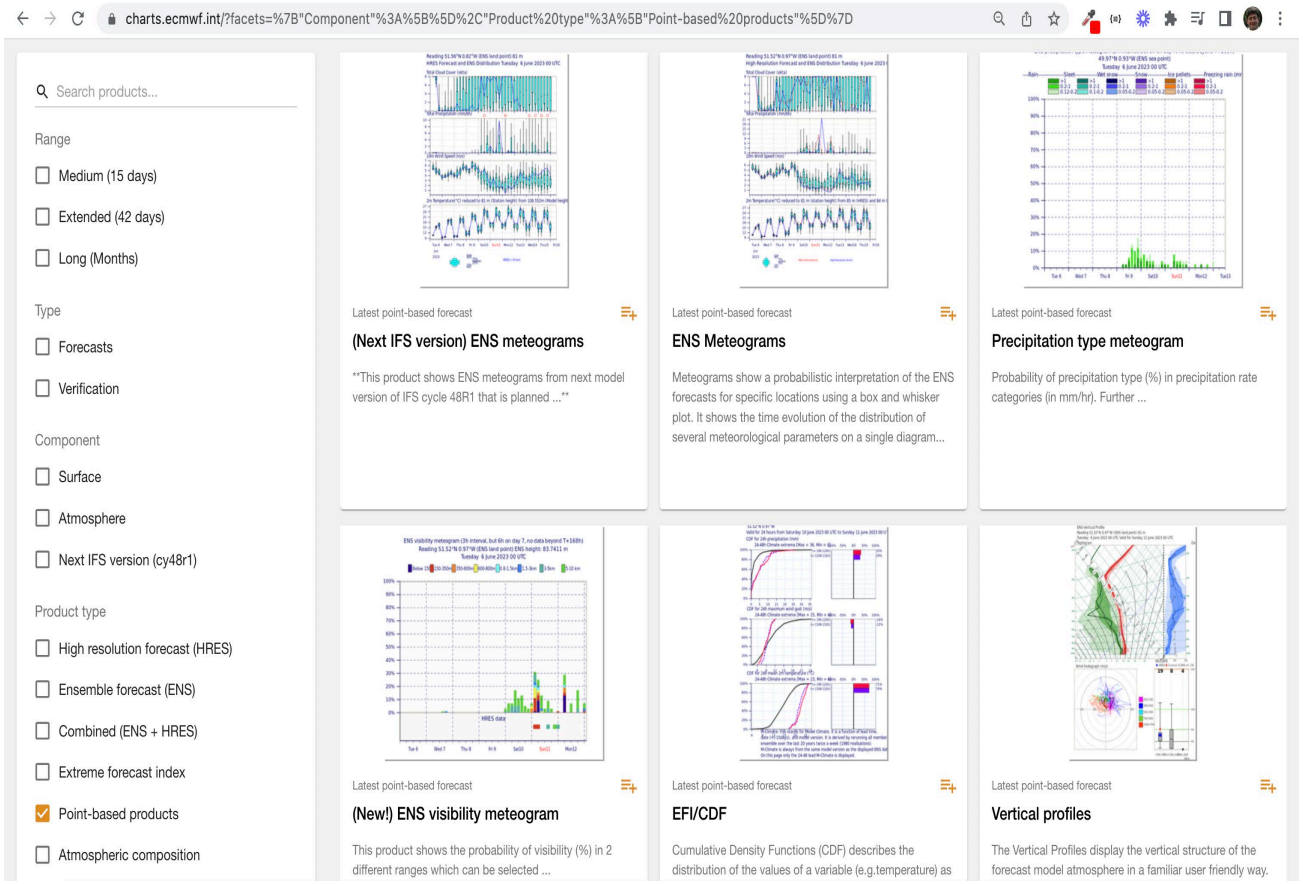
Cihan Sahin, Axel Bonet, Sylvie Lamy-Thepaut, Tim Hewson & Many other colleagues



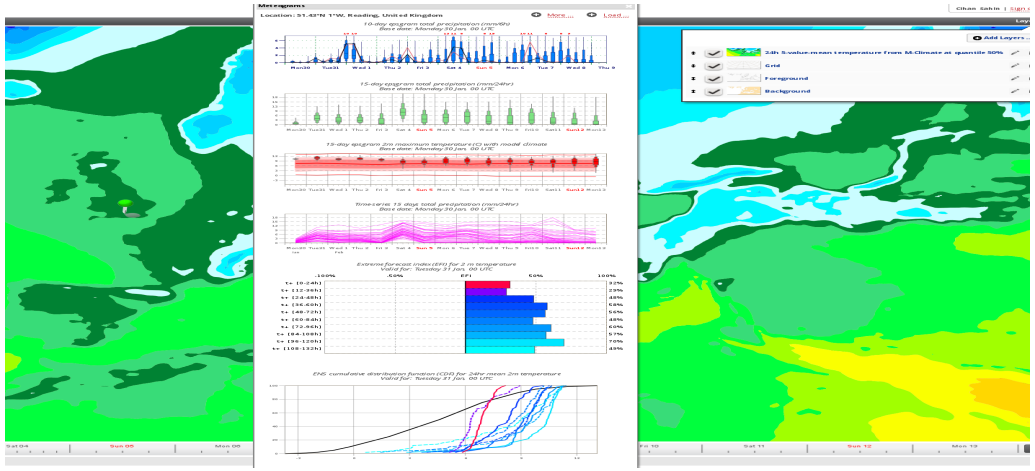
Ensemble Meteograms (point data)

Point data in graphical form come in different shapes but all based on Ensemble data

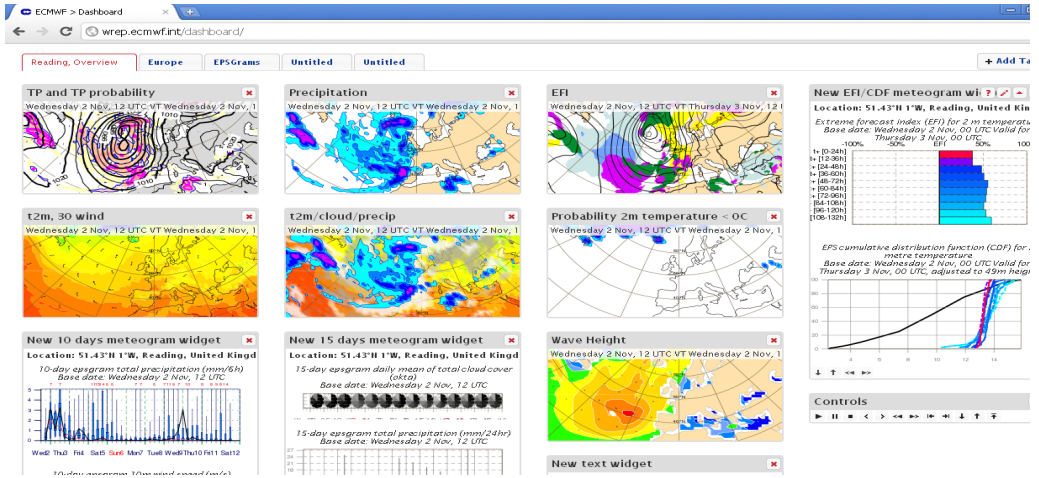
- 10-day meteograms
- 10-day meteograms for wave parameters
- 15-day meteograms
- 15-day meteograms with model climate
- Plumes
- Precipitation type
- Visibility meteogram
- EFI and CDF diagrams
- ENS Vertical profiles
- Extended range meteograms (Anomalies)
- Extended range CDFs



Access to Meteograms

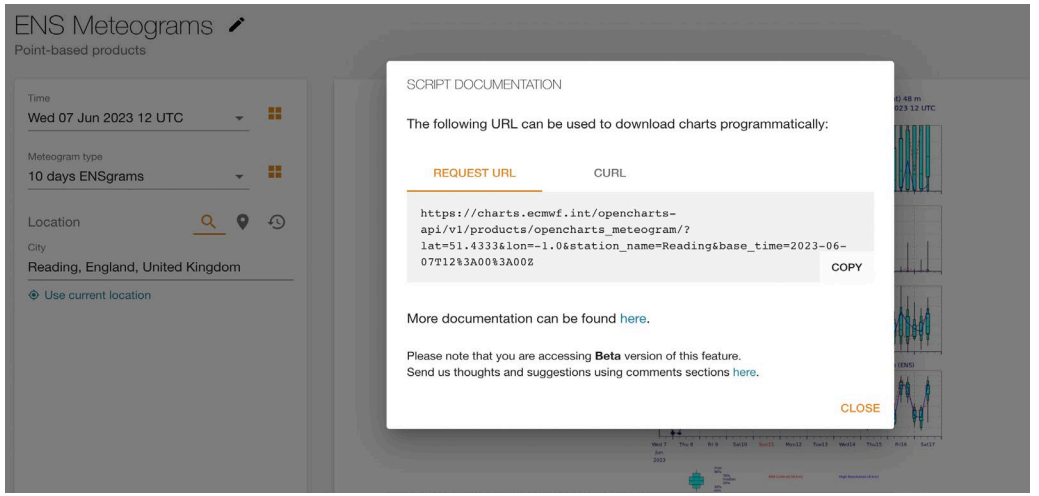


ecCharts (An interactive application for expert users)



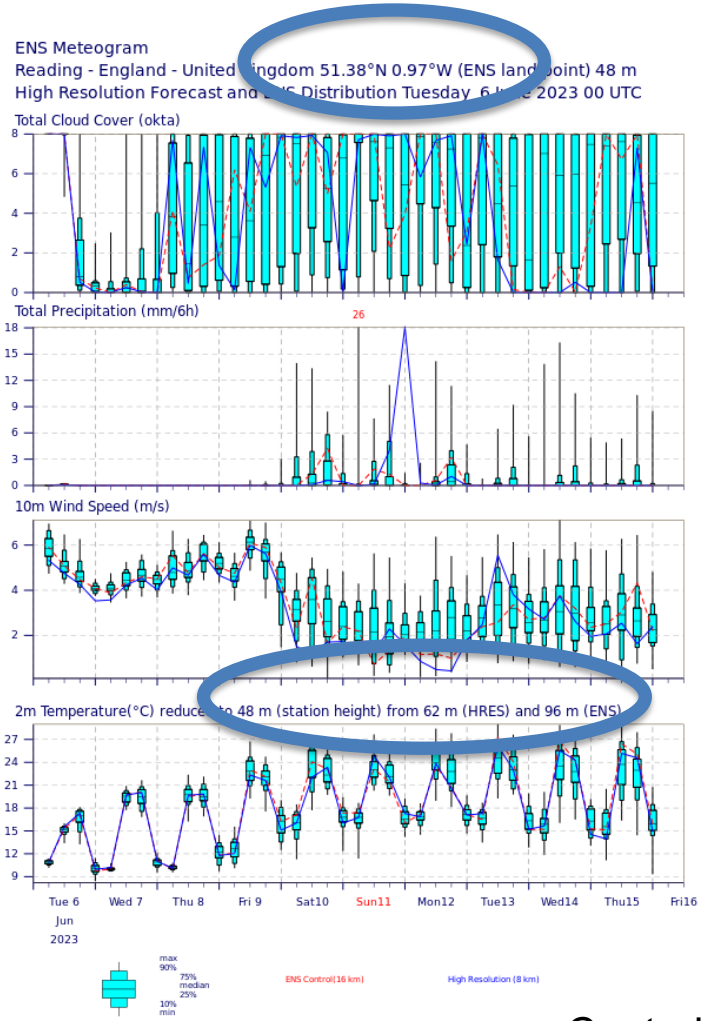
Dashboard (A portal to visualise product collectively)

Opencharts (General public access)



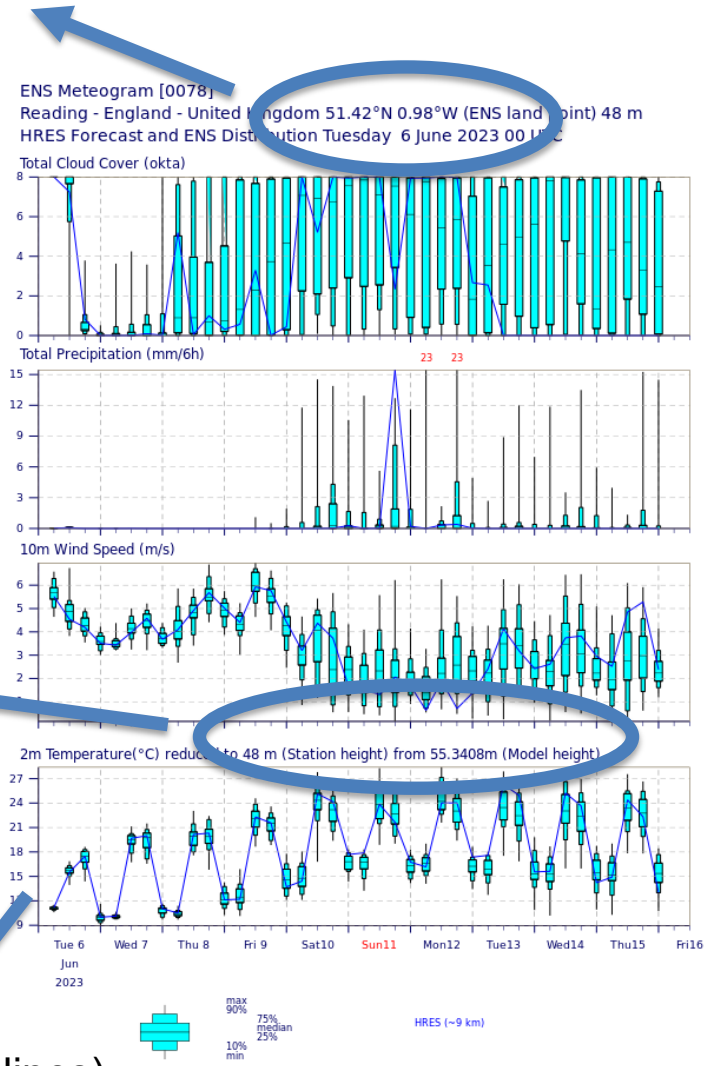
Batch Access to Graphs & WebAPI access to data

48r1 changes



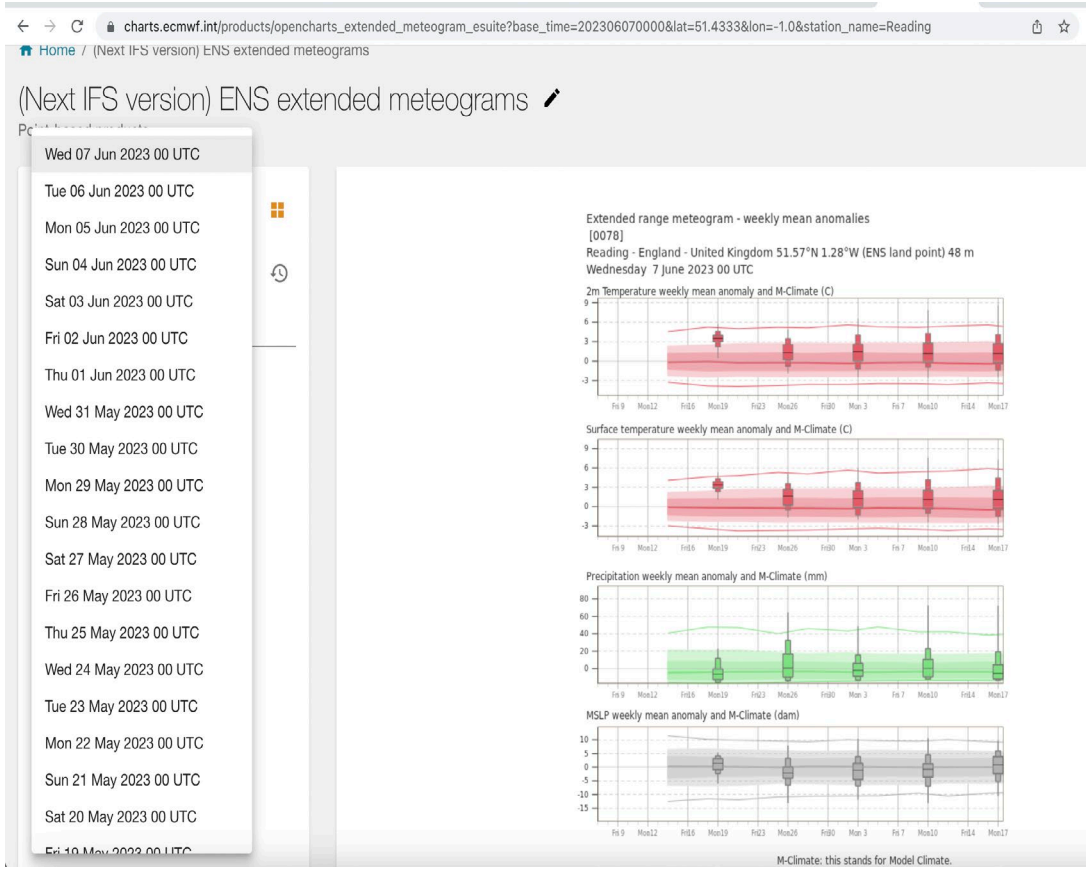
Different nearest grid point – mostly closer

HRES model orography T correction different

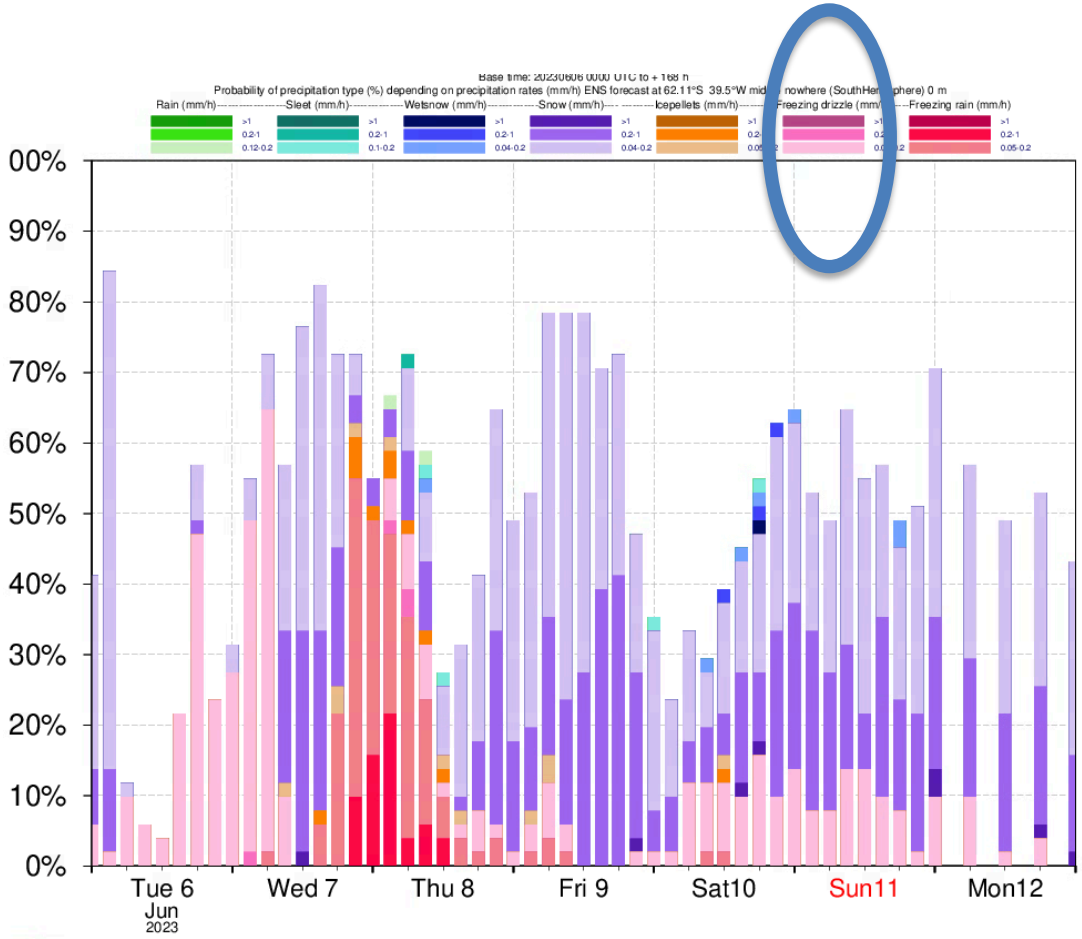


Control removed (No red lines)

Other changes …



Freezing drizzle added

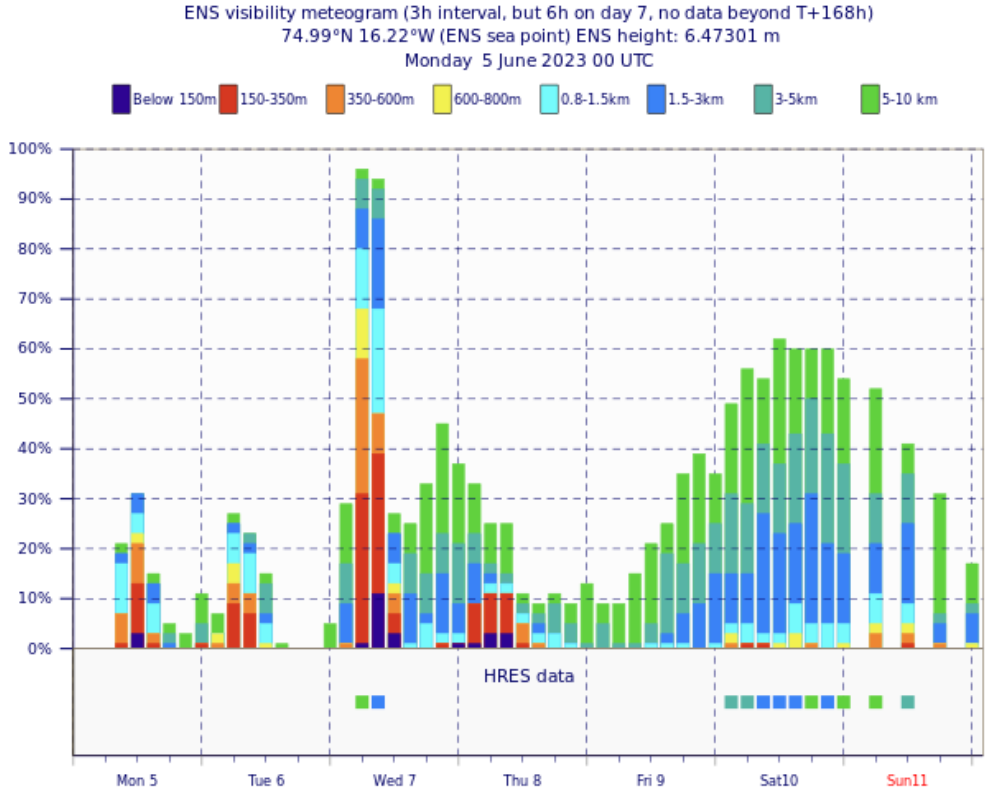


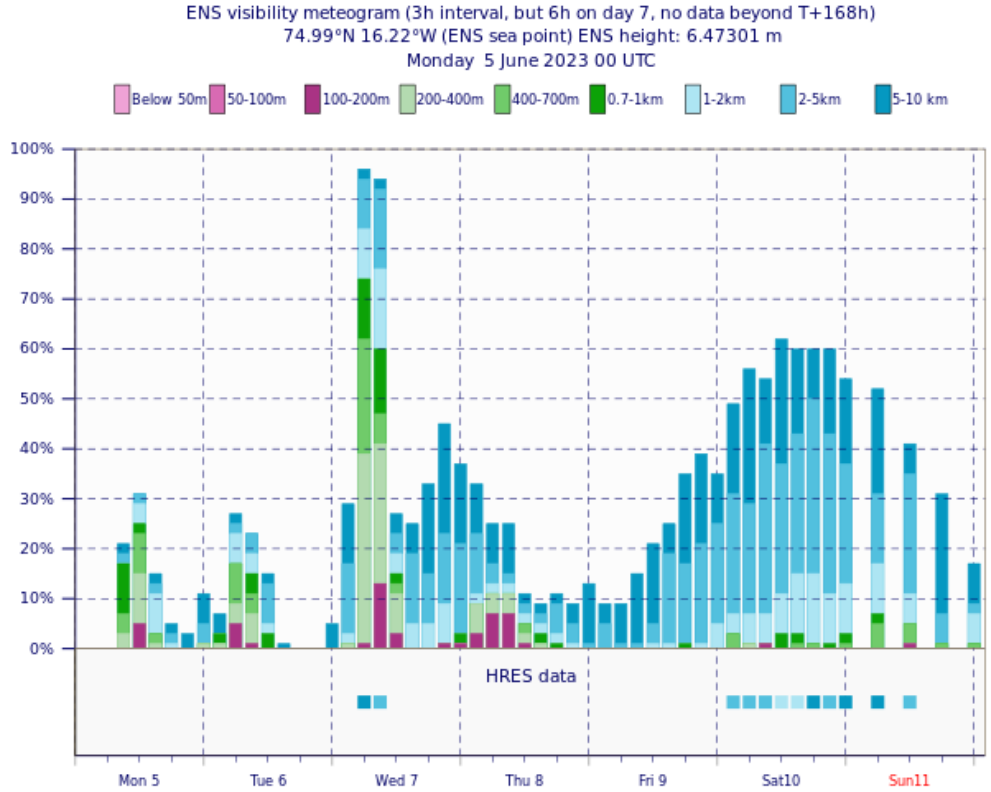
Thanks to Esti for the plot

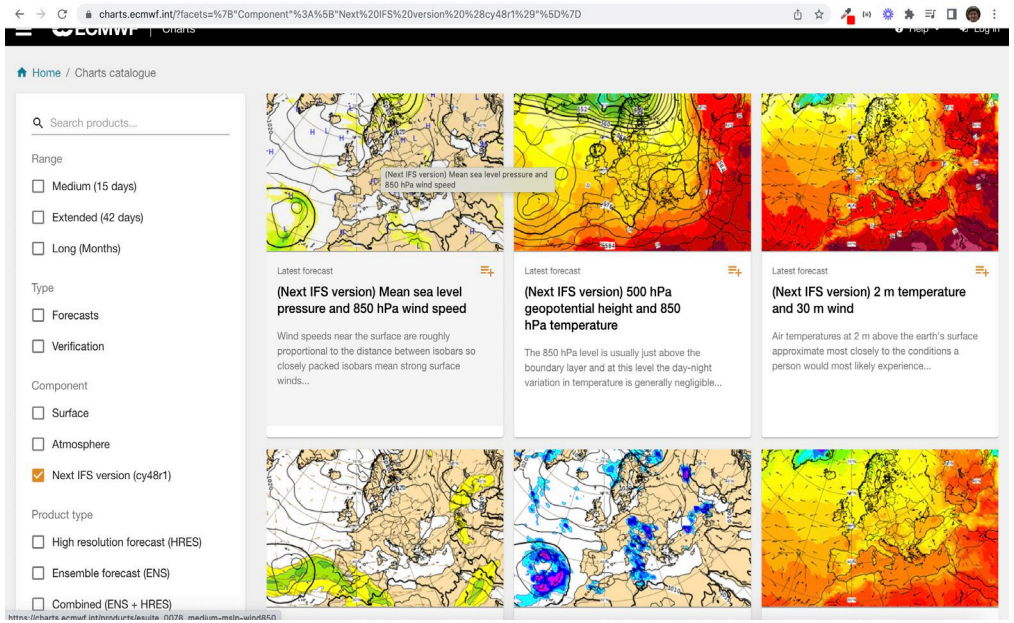
Freezing drizzle will also be on Precipitation type/Most probable precipitation type maps

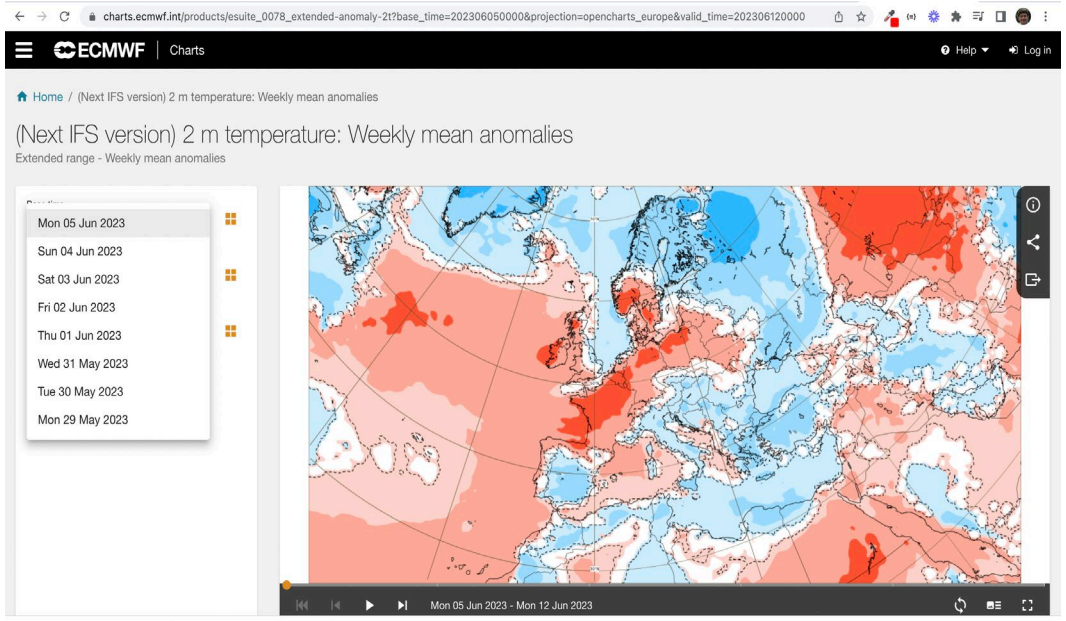
New visibility meteogram

- A collaborative work with Hungarian Met Service (Thanks to Istvan and Livia)
- Aviation requirements (ICAO ranges) & General public requirements (Lower visibility highlighted)
- HRES displayed at the bottom

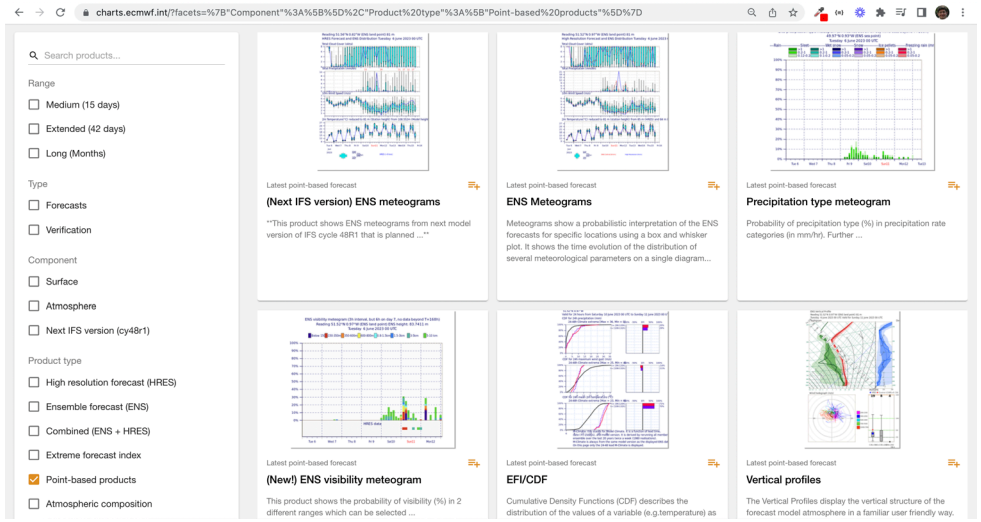


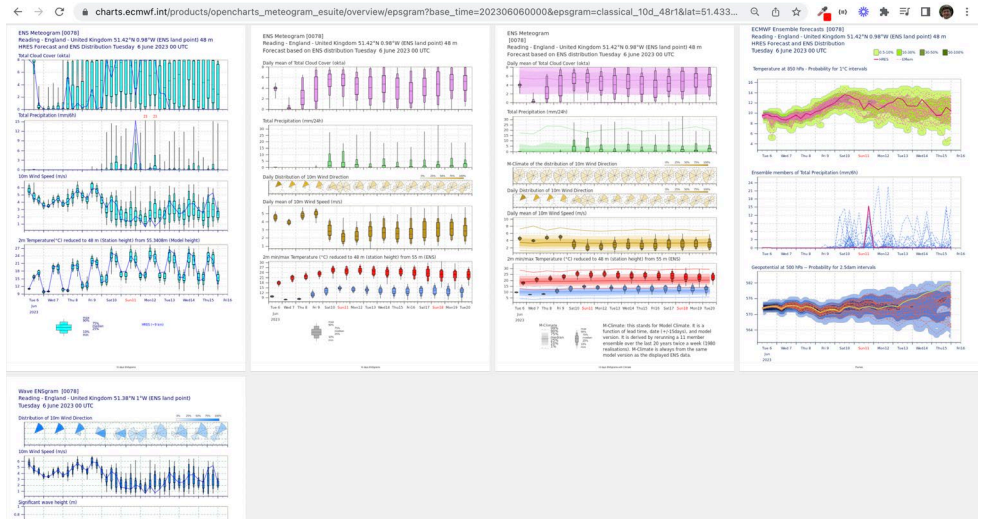






Cycle 48r1 products available on charts.ecmwf.int and ecCharts.





Convection products

Plans and Changes

Ivan Tsonevsky

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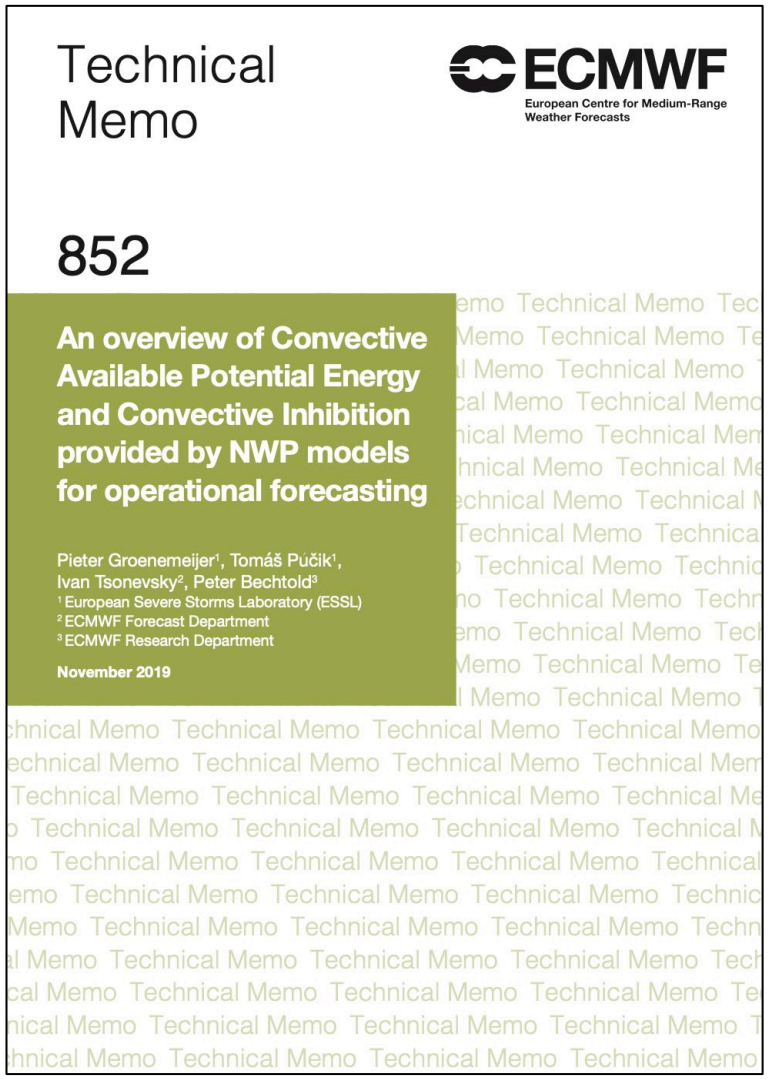
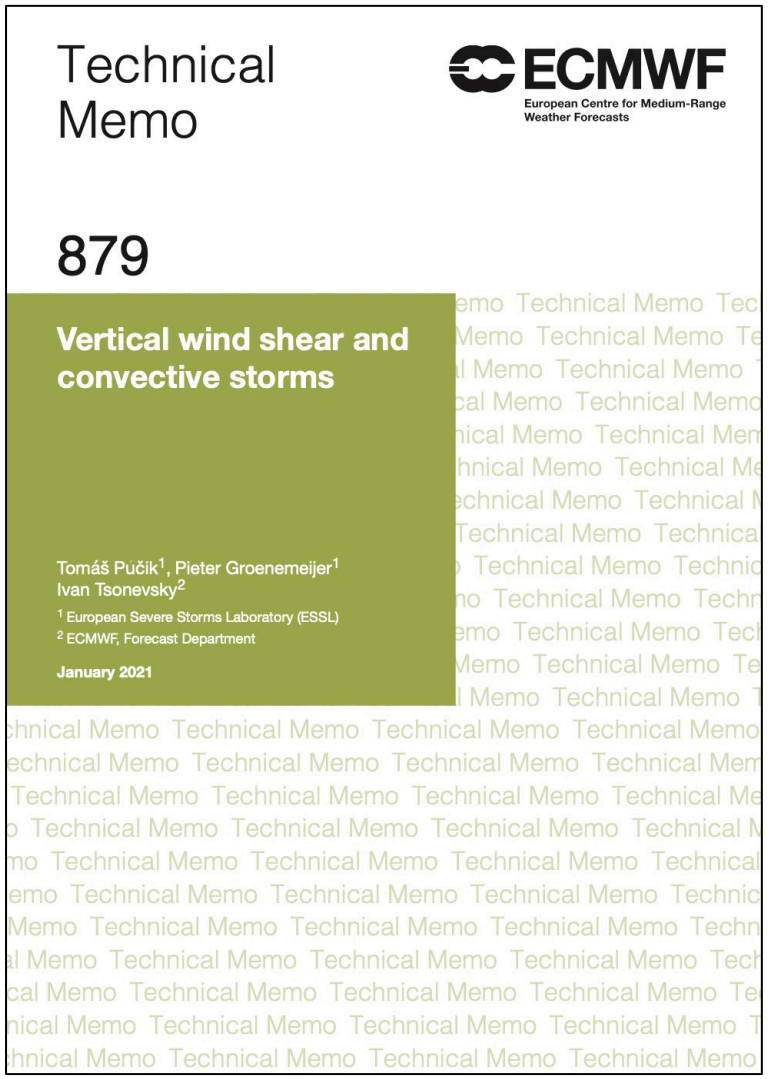
ECMWF

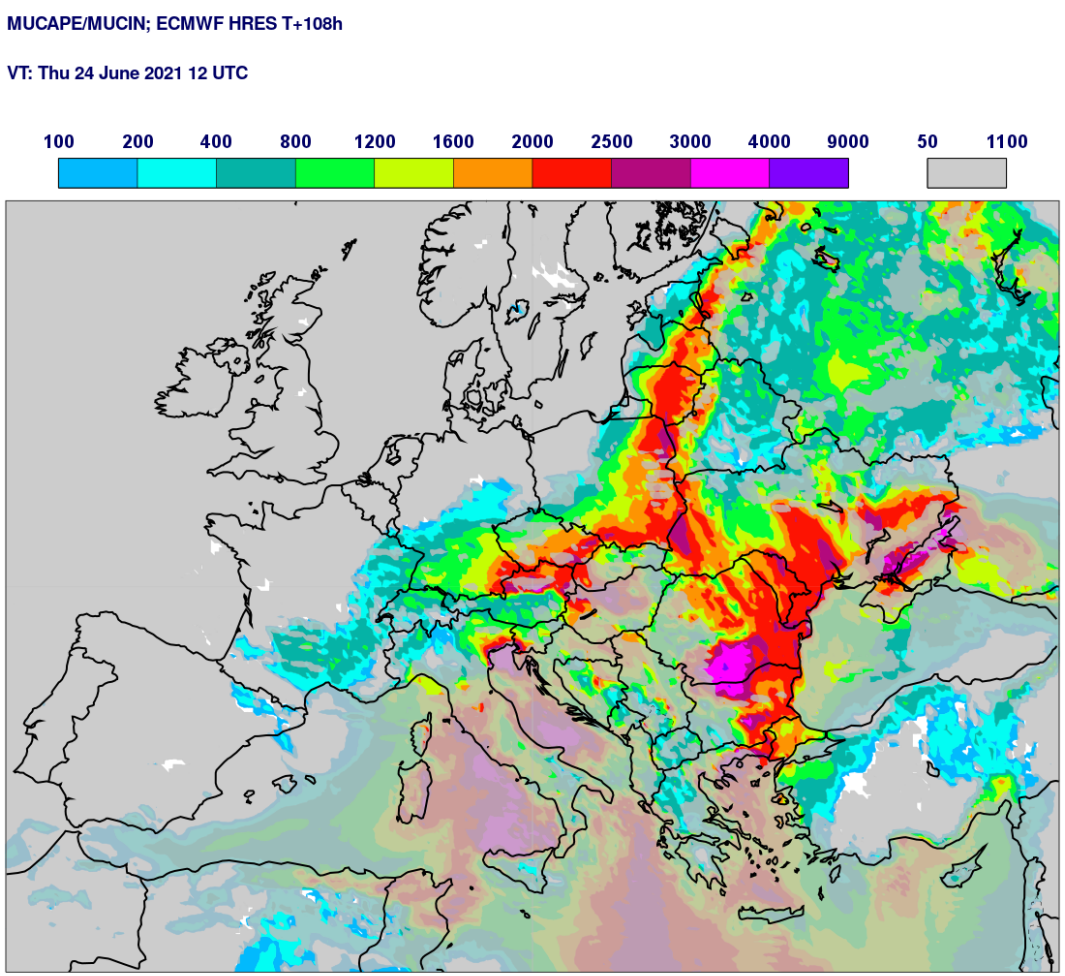
ECMWF-ESSL collaborations





- Revision of CAPE and CIN parameters from IFS
- Vertical wind shear and convective storms – an overview
- Forecasting convective hazards – large hail, strong winds

Revised CAPE and CIN from the IFS



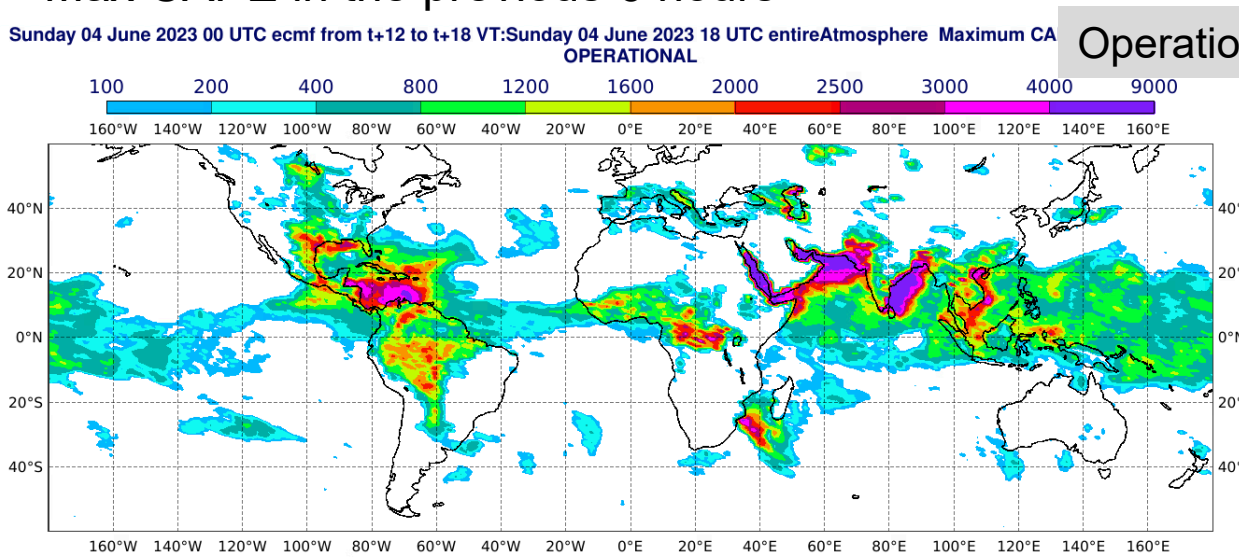
- Various CAPE and CIN parameters:
  - ✓ MUCAPE/MUCIN
  - ✓ MLCAPE/MLCIN for 50- and 100-hPa mixed layers;
- MUCAPE/MUCIN:
  - ✓ no surface layer considered, instead 30-hPa mixed layer parameters for each model level in the lowest 60-hPa layer;
  - ✓ as before the search for the most-unstable parcel goes up to 350-hPa pressure level
  - ✓ departure level in Pa of the most-unstable parcel provided as a model output
- Revised computation:
  - ✓ uses virtual potential temperature instead of equivalent potential temperature as before
- Still few technical things to sort out.

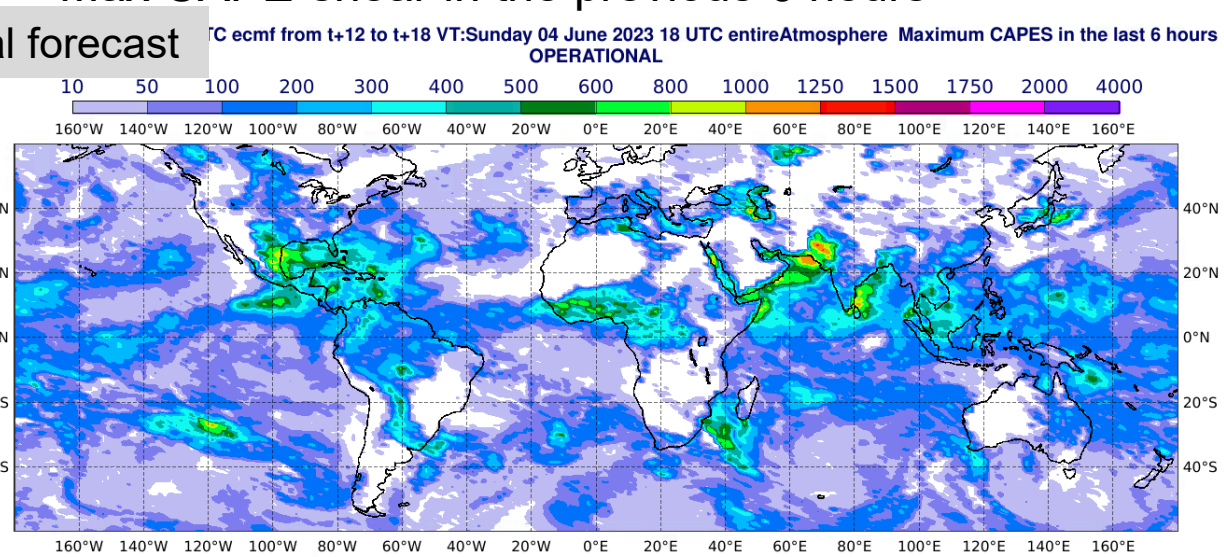
mxcape6 and mxcapes6 use MUCAPE in 48r1

Max CAPE in the previous 6 hours

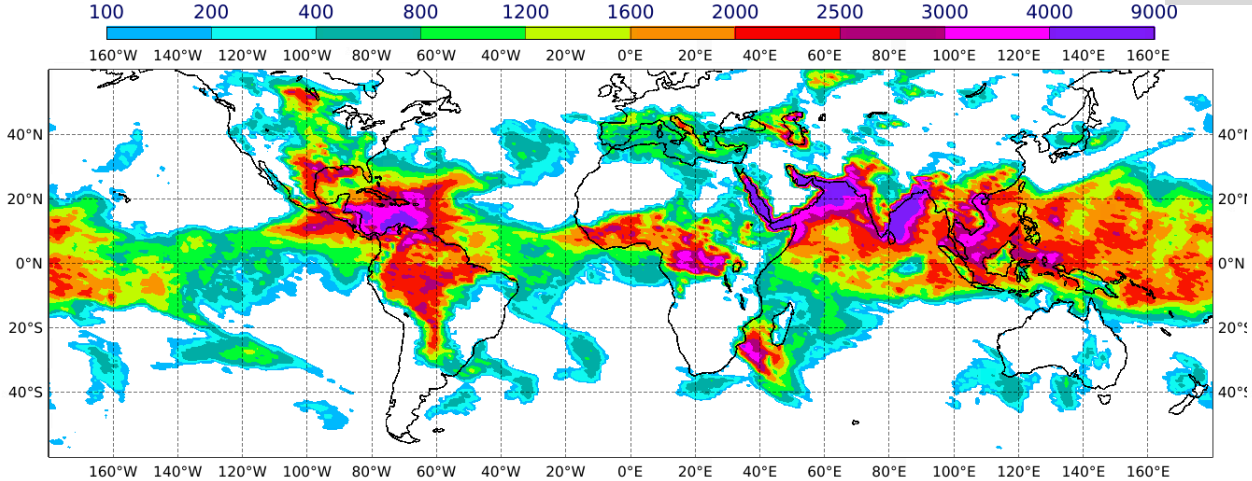
Max CAPE-shear in the previous 6 hours

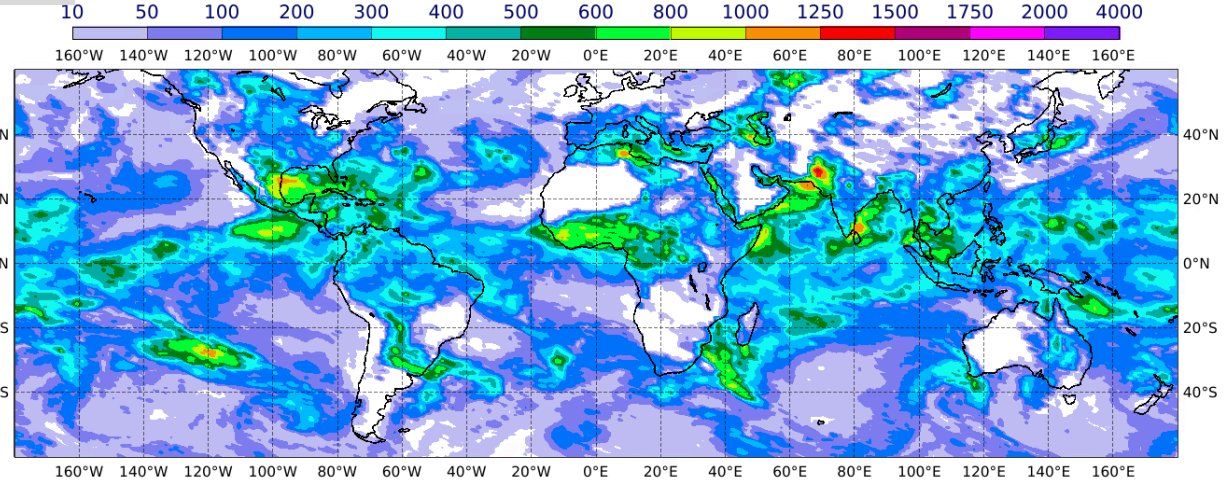
Operational forecast



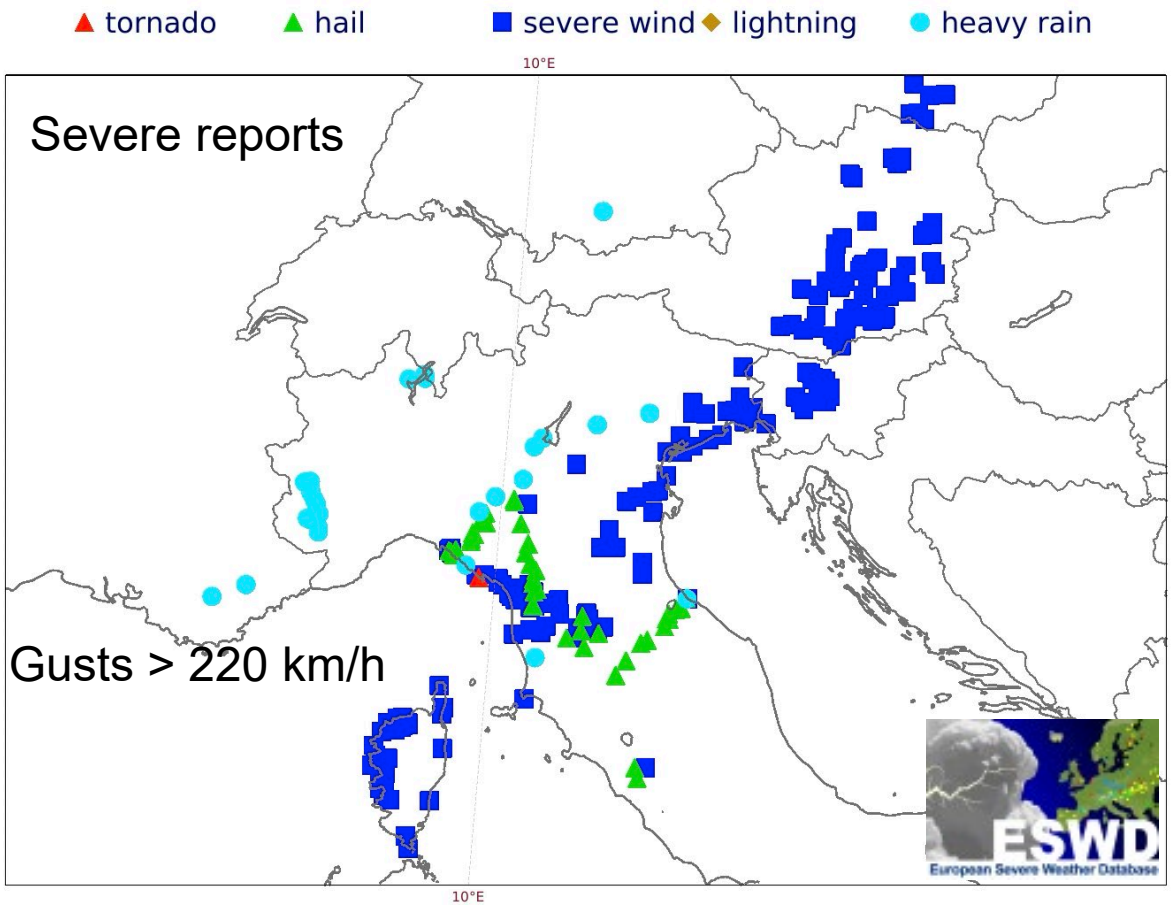


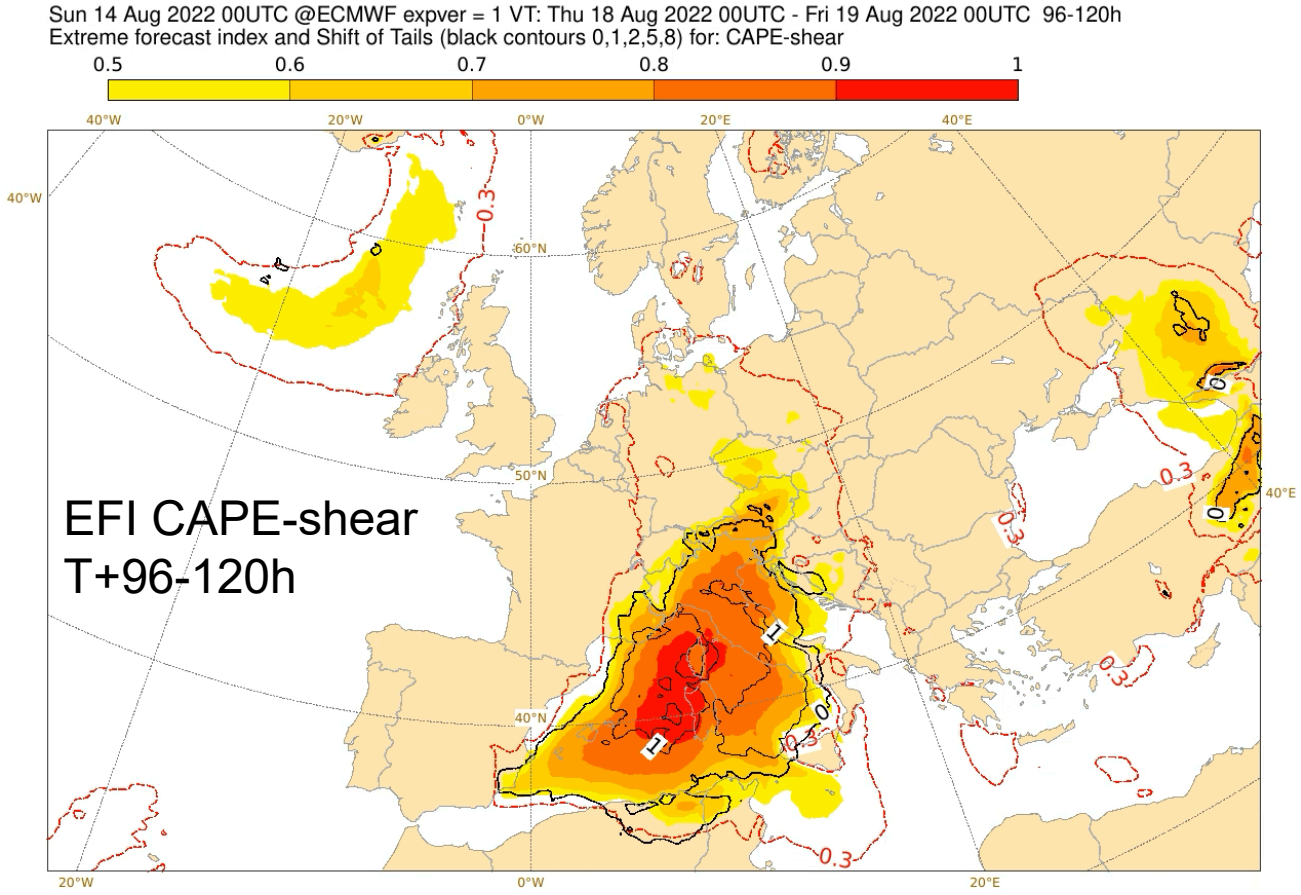
48r1





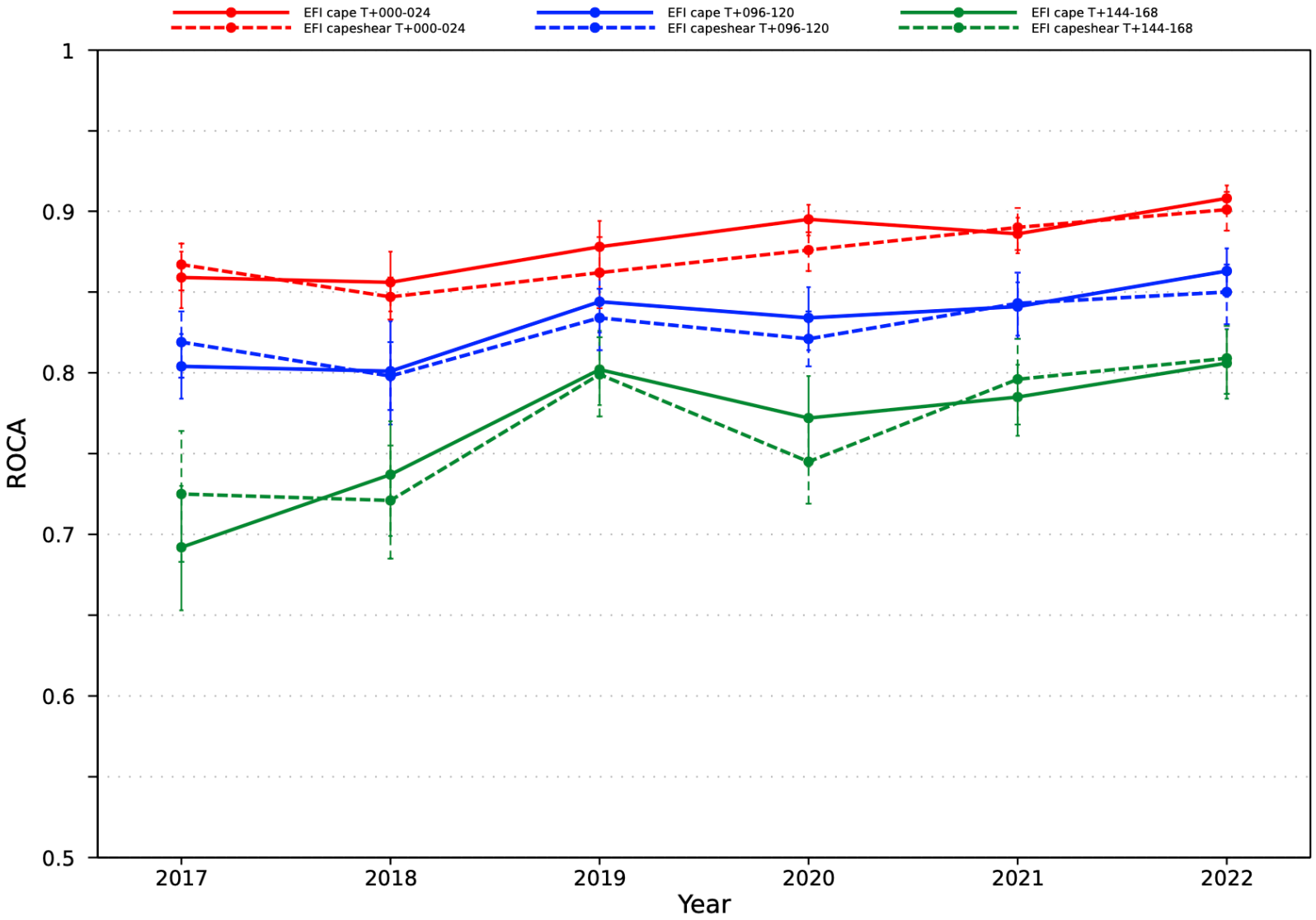
Derecho – 18 August 2022





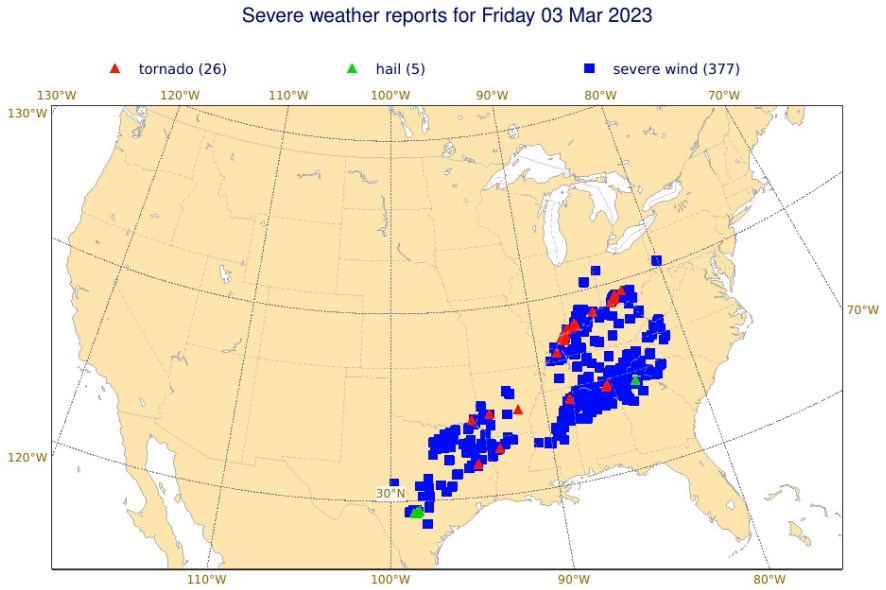
- 12 fatalities associated with the derecho
- EFI for CAPE-shear – highlighted this severe convective outbreak in the medium range (5 to 7 days in advance).

Verification of convective EFIs



- EFI for CAPE and CAPE-shear has been verified against ESWD reports and ATDnet lightning (over Europe) and SPC reports (over the USA)
- Area under the ROC curve is used as a skill measure.
- Convective season (April to September) skill scores shown on the plot.
- So far we notice an upward trend in the skill scores.

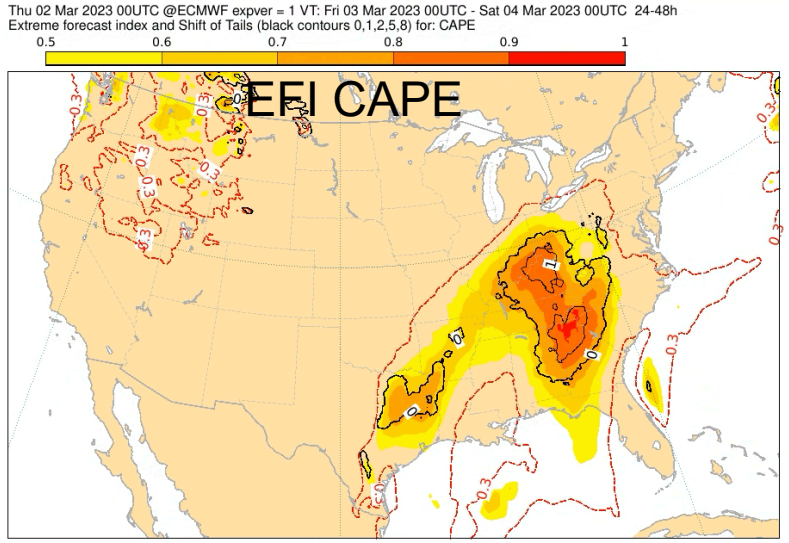
Severe Convection – USA, 2-3 March 2023

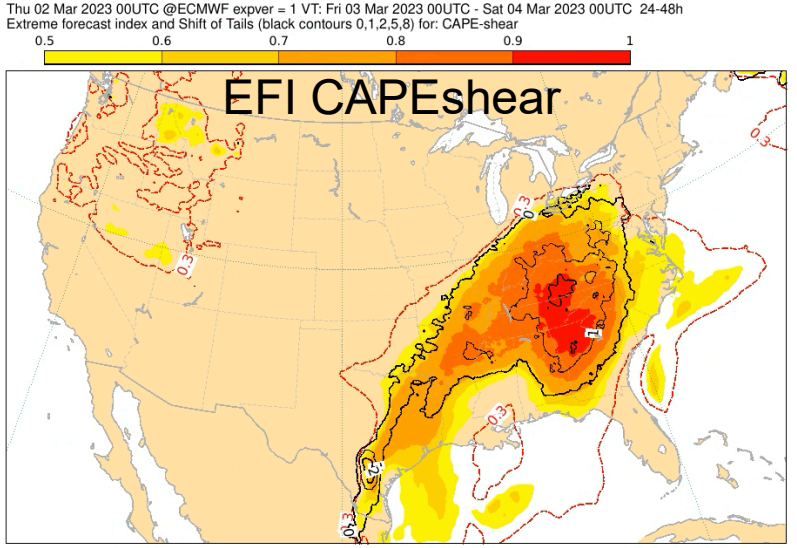


- Convective EFIs use mxcape6 and mxcapes6 and therefore they will make use of the MUCAPE parameter implemented with IFS cycle 47r3.
- No striking differences as expected.

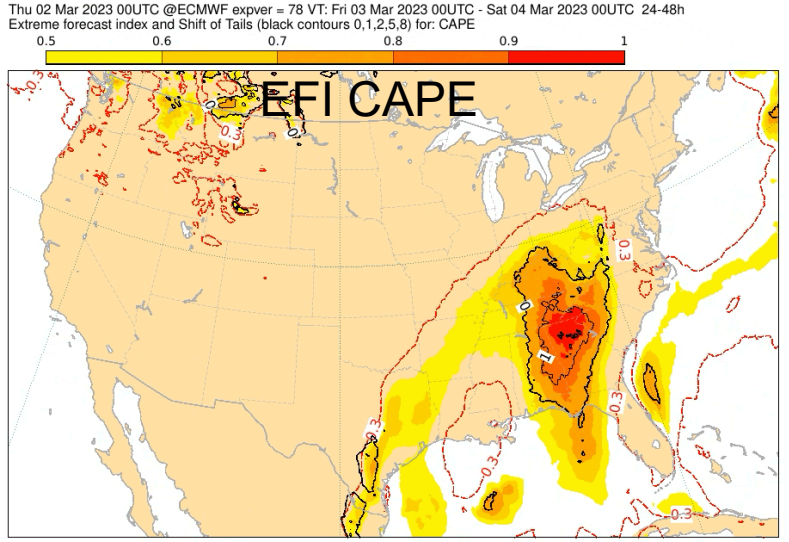
- Both versions, the operational and 48r1, captured well severe convection over the USA.

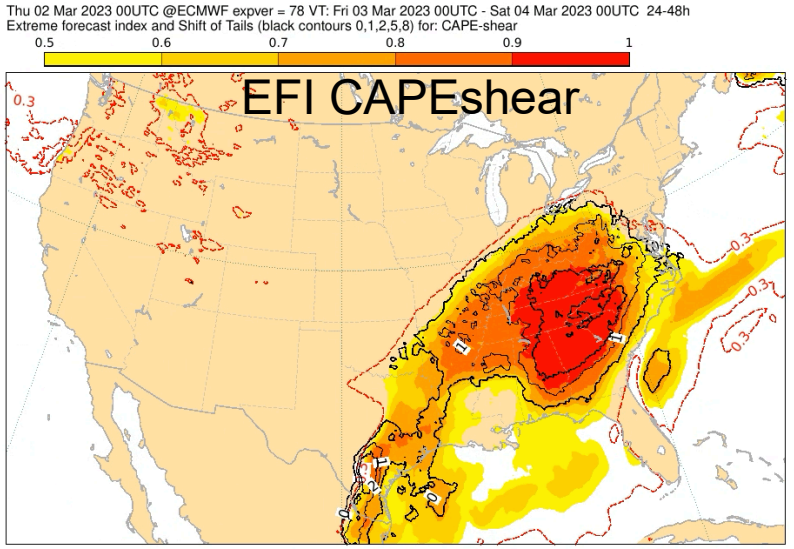
Operational





48r1

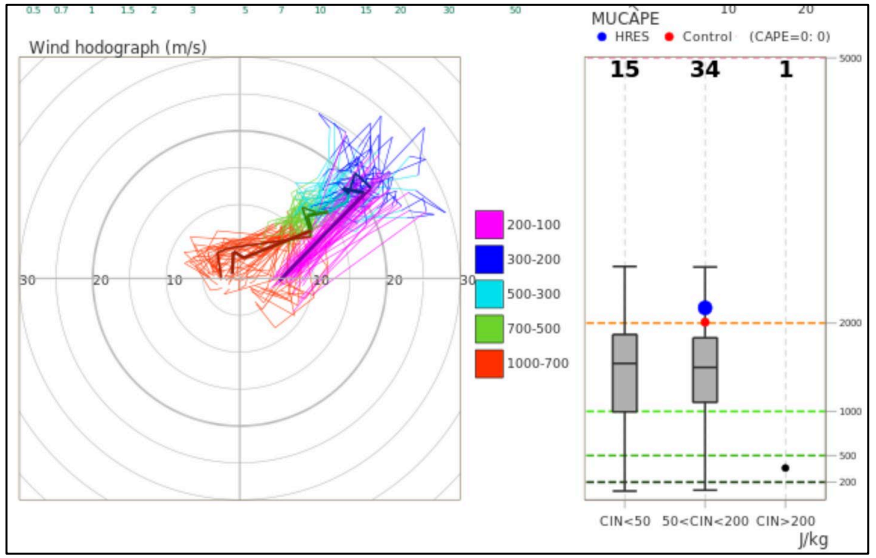




Plans for 49r1

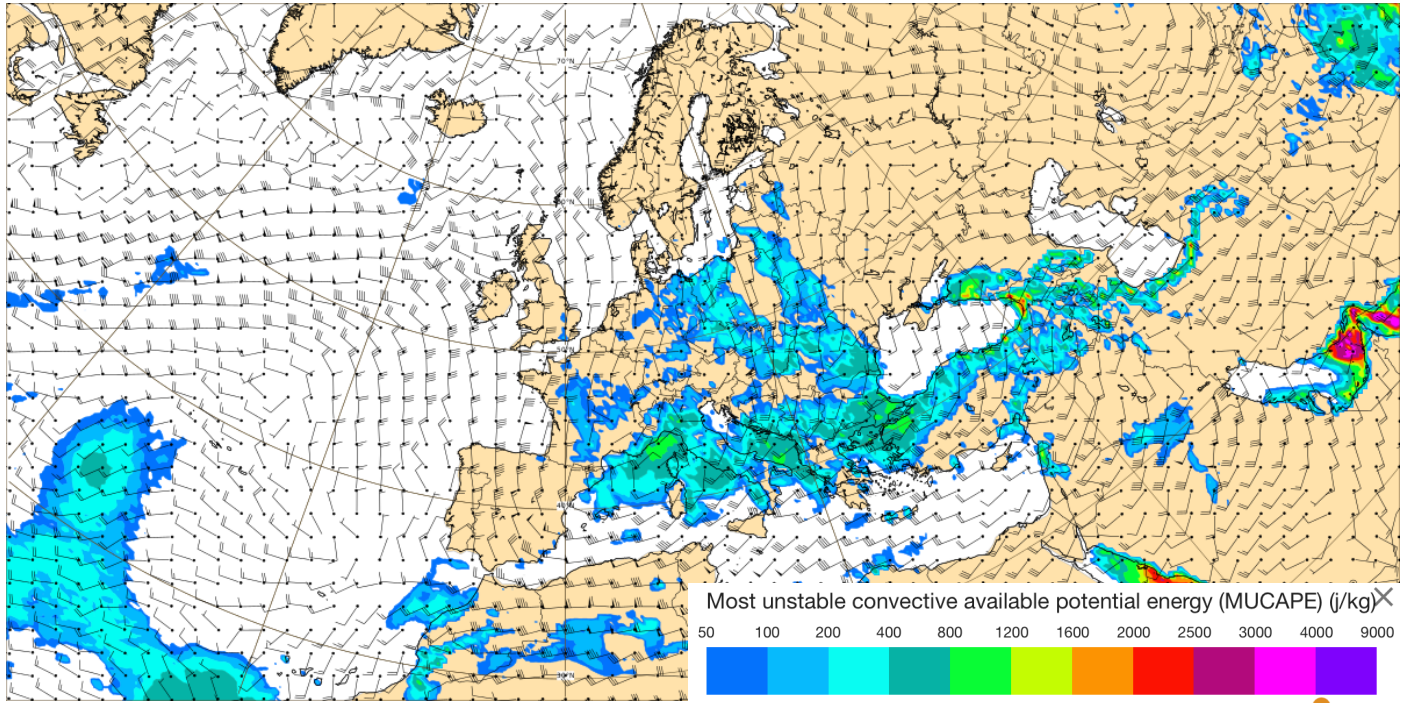
Parameter details

Parameter ID	228236
Name	Most-unstable CIN
Short Name	mucin
Units	J kg^{-1}
Description	Convective Inhibition (CIN) is a measure of the amount of energy needed to be overcome for storm initiation. CIN reflects the strength of the capping inversion. In the IFS MUCIN refers to the most unstable parcel (the parcel with the largest CAPE) found in the atmosphere from the surface up to 350 hPa. For all the model levels in the lowest 60 hPa, 30-hPa mixed-layer parameters are used.
Insert date	2020-10-09
Update date	2020-10-09
Contact	ECC-1155

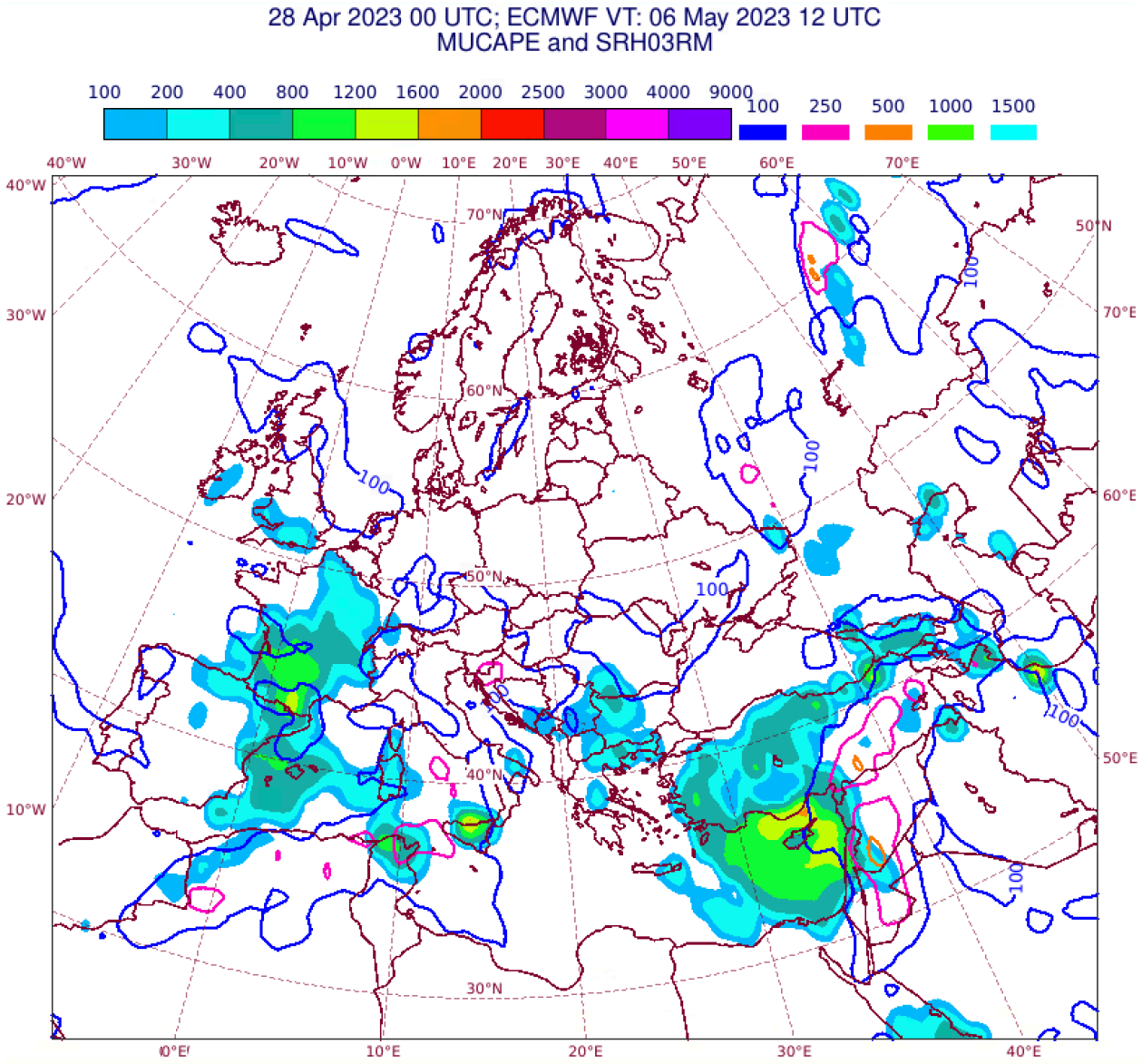


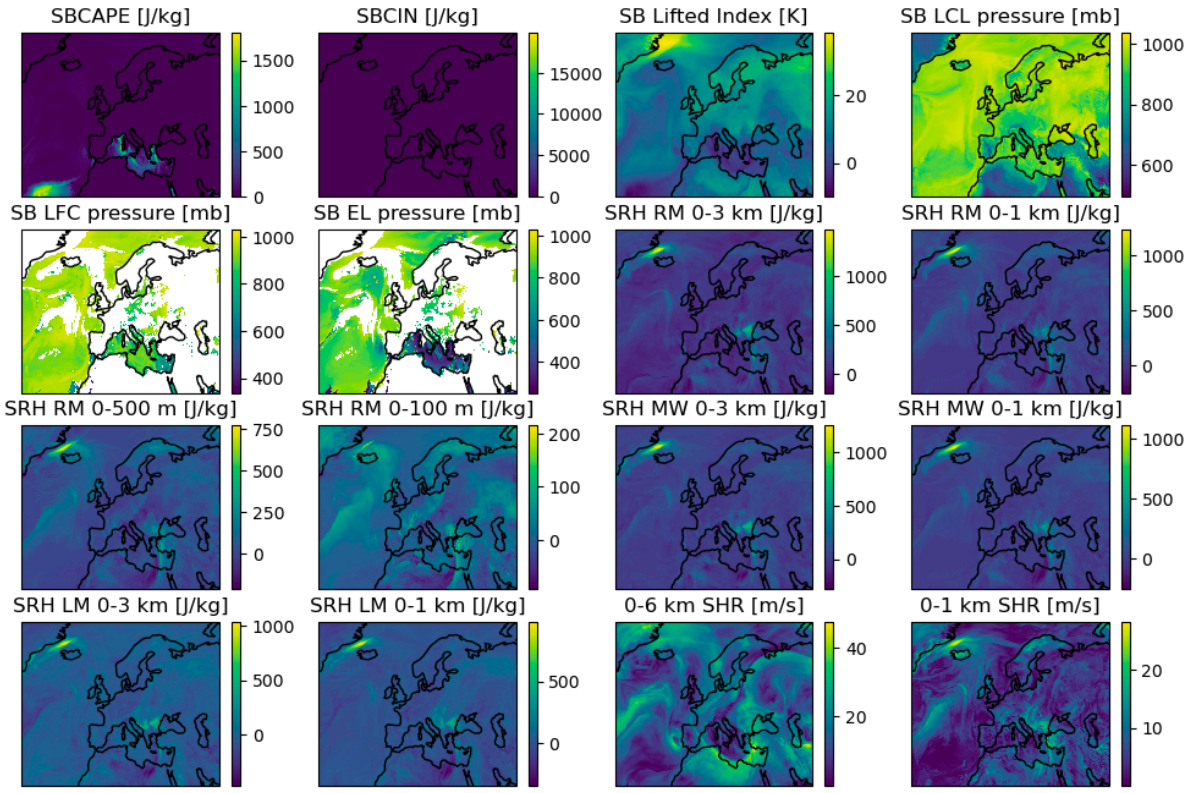
- ”Old” CAPE will be stopped. New parameters shown on the web.
- CIN will be renamed to MUCIN and parameterID changes as well from 228001 to 228236

0-6km wind shear and MUCAPE



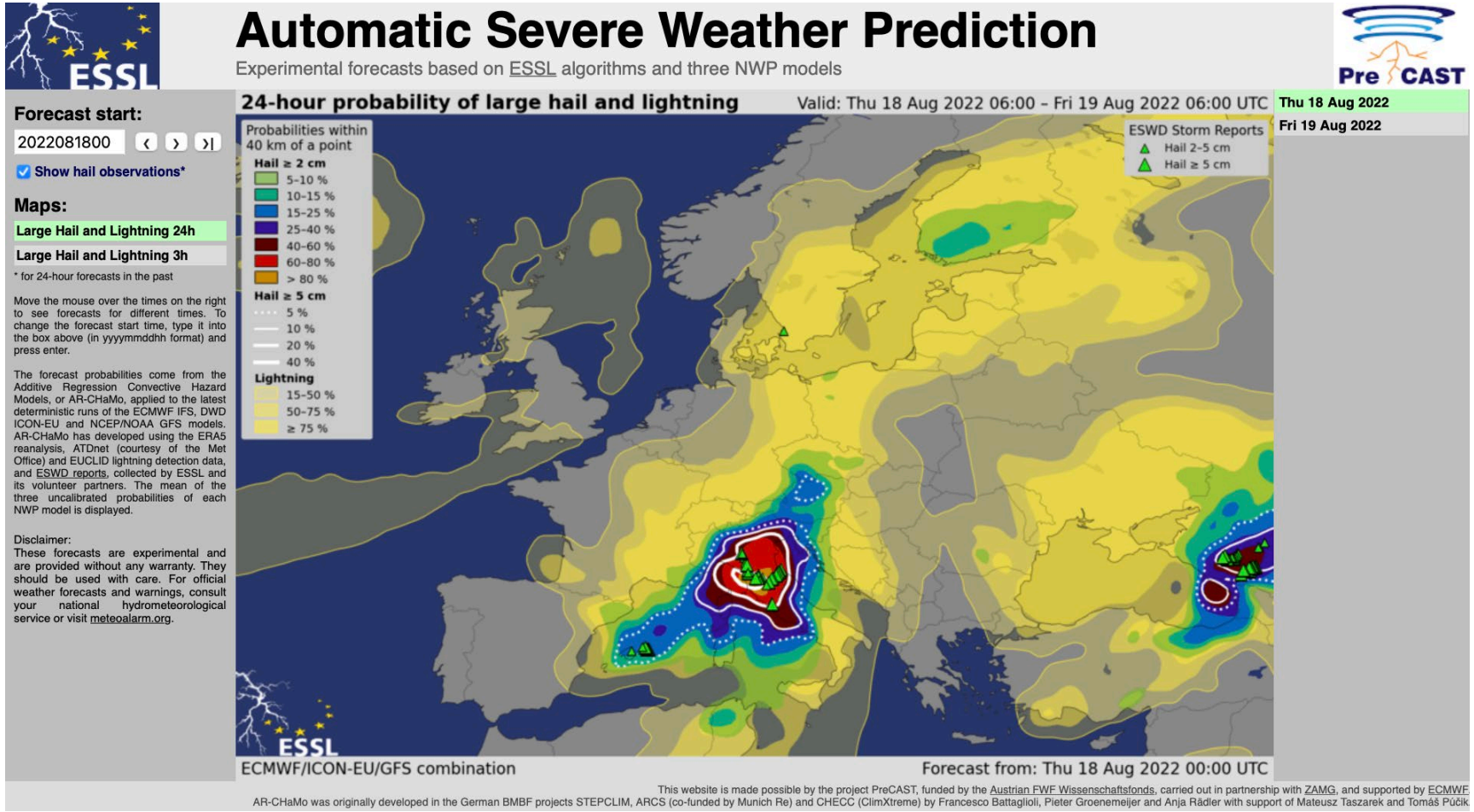
Storm Relative Helicity





- Computational code for a number of convective parameters including SRH has been provided by ESSL as a Jupyter notebook.
- On LHS an example of MUCAPE (shaded) and 0-3 km SRH for a right-moving storm (contours)

Probability of convective hazards



- Probability of lightning, large hail (and severe wind gusts) using AR-CHaMo.
- An example – hailstorms during a derecho event – 18 Aug 2022.
- AR-CHaMo + ECMWF ENS – PreCAST & ECMWF-ESSL collaborative project

More on poster P41.

Precipitation Types : an upgrade in 48r1

Tim Hewson

tim.hewson @ ecmwf.int

Thanks to Esti Gascon, Richard Forbes, Axel Bonet

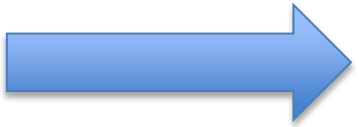
ECMWF

Precipitation Types

- From cycle 48r1 onwards we will diagnose these precipitation types (for precipitation falling at valid time) :

- Previously freezing drizzle would have been in the “rain” class
- Now it’s a separate entity…

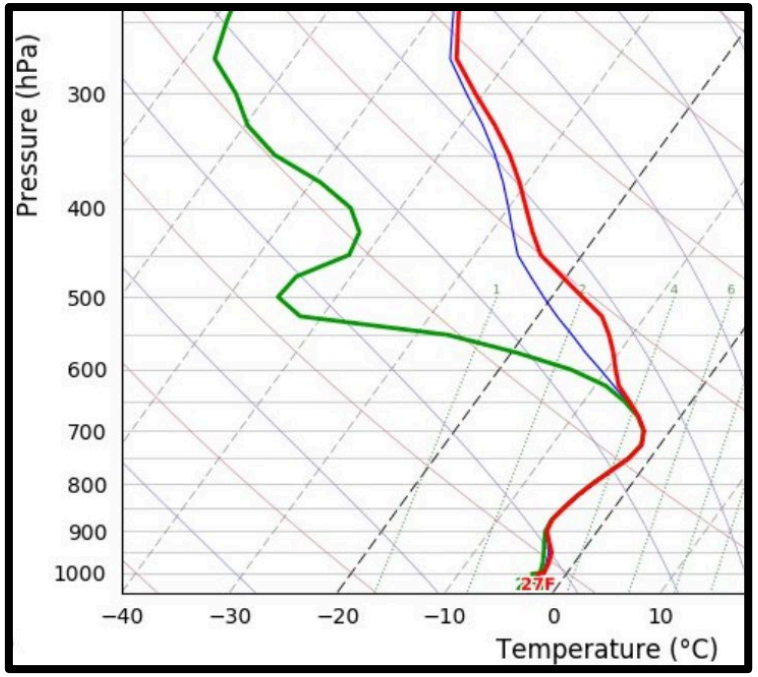
New



Code	Description	Severity
0	No precipitation	0
1	Rain	1
3	Freezing rain	7
5	Snow	4
6	Wet snow	5
7	Mixture of rain and snow	2
8	Ice pellets	3
12	Freezing drizzle	6

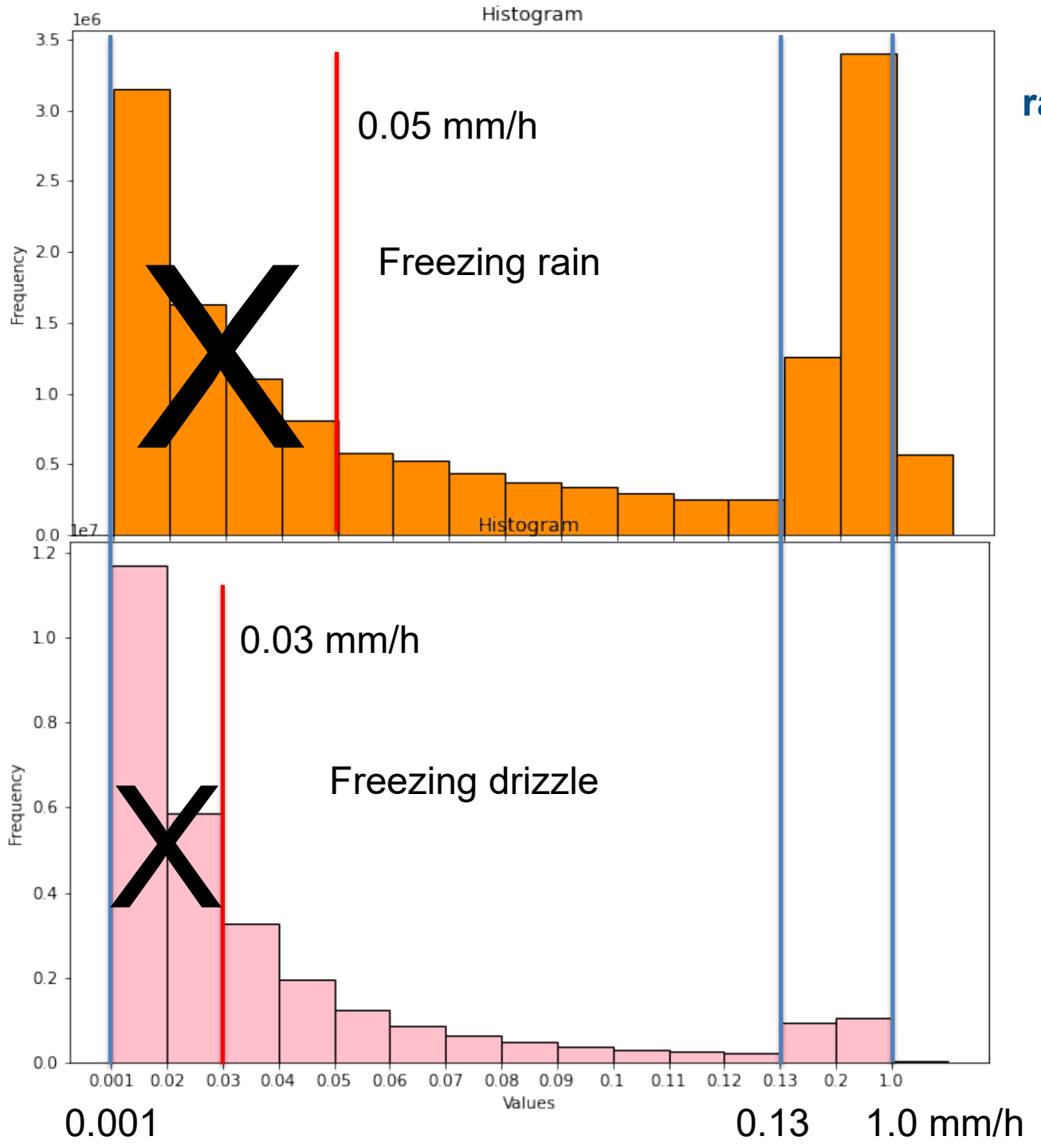
What is Freezing Drizzle ?

- Freezing drizzle, as defined for our IFS output, is liquid precipitation falling through air with a temperature <0C, that has no ice phase history at higher altitudes
- This implies a relatively shallow cloud source
- Hence rates tend to be low, and droplet size small
- Hence the term “freezing drizzle” (though small raindrops would be possible)



- Given more moisture at high levels – this would be snow
- Given higher temperatures ~650-850mb (>0C) - this would be freezing rain (or ice pellets)

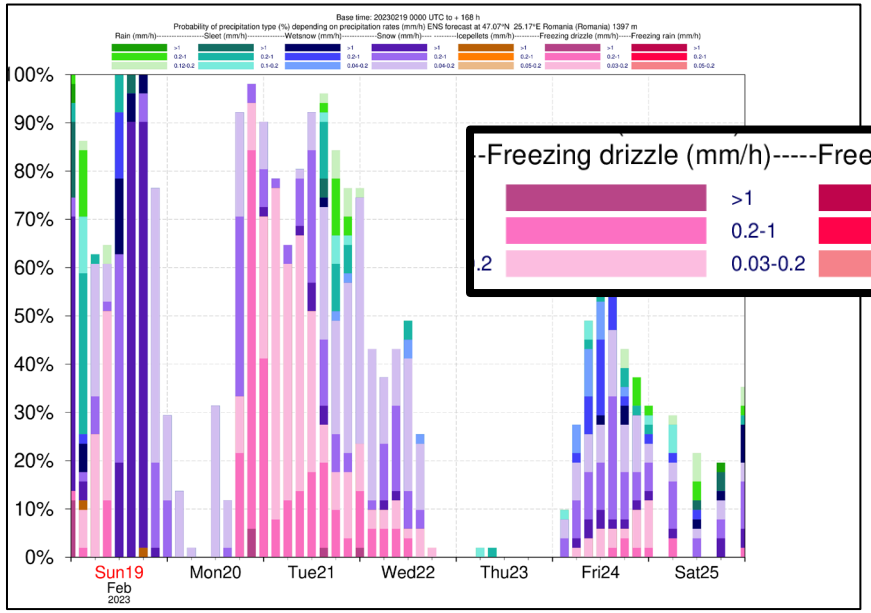
Frequency distributions of precipitation rates for two precipitation types – 48r1 HRES forecasts for test period in winter 2022/3



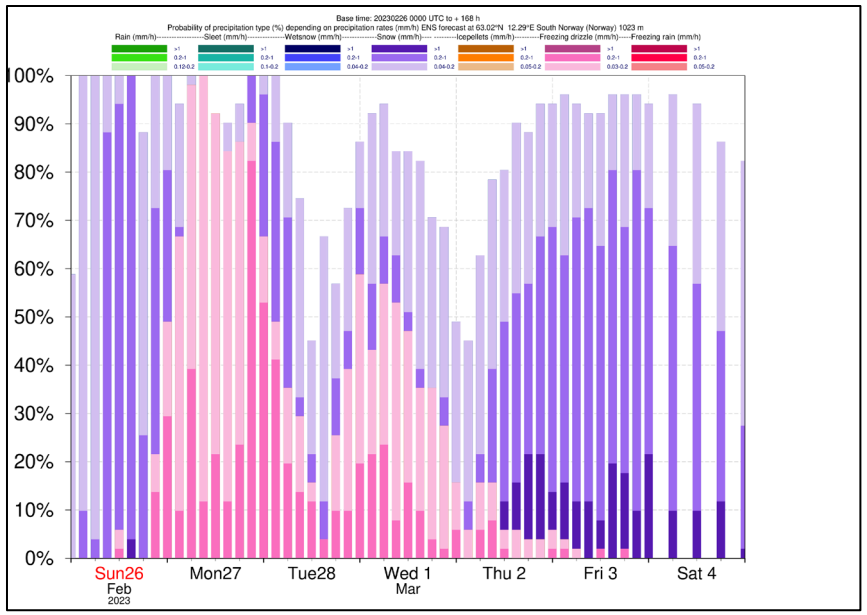
- When a certain precipitation type is diagnosed, what is the precipitation rate?
- Extremely low rates can be delivered by the model, but are of no practical relevance
- Therefore for products (ecCharts and OpenCharts) we use a cut-off minimum rate for each precipitation type
- The strategy for minimum rate selection is to minimize frequency of occurrence bias, versus manual synop obs
- For freezing drizzle we do not have enough observations to do this successfully
- One intrinsically expects freezing drizzle to have lower rates overall than freezing rain (due to implied lesser cloud depth) – as histograms here show
- We compromised and set the minimum rate accepted rate to 0.03mm/h (versus 0.05mm/h for freezing rain)

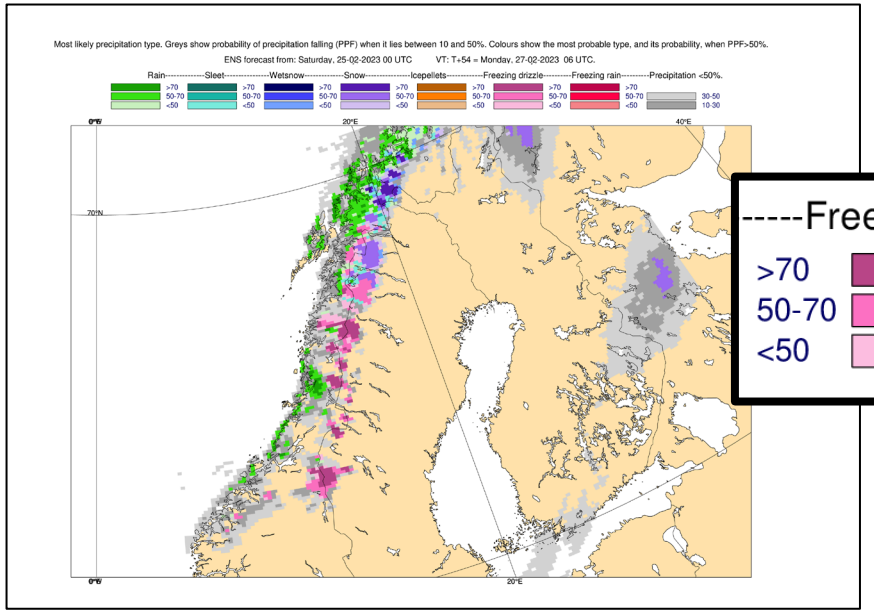
So how will the resulting products look different ?

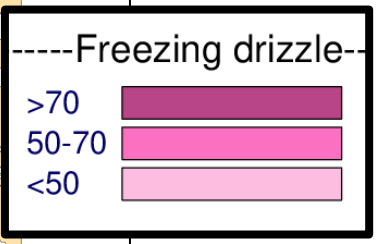
Examples follow:



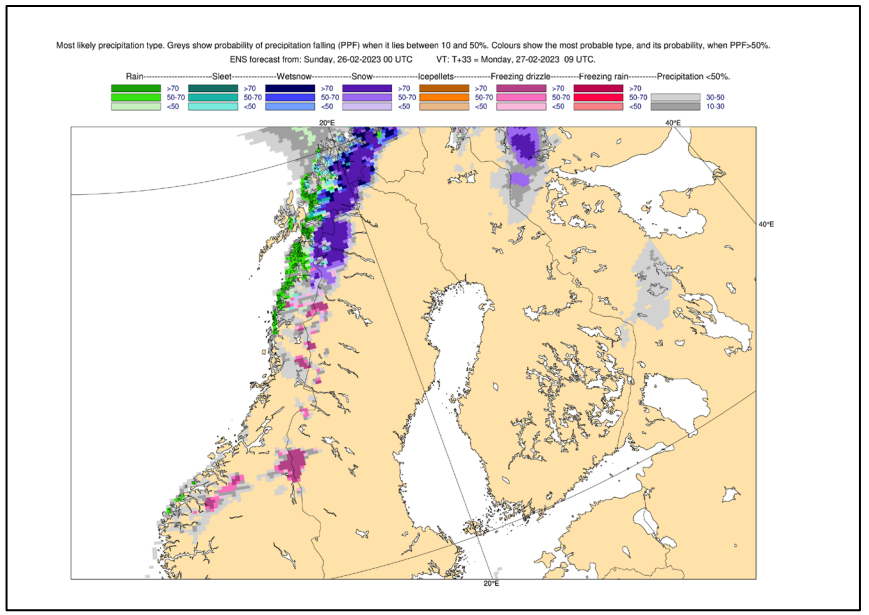
Precipitation Type Meteograms







Most Probable Precipitation Type



What products/variables will be affected ?

- Precipitation Type meteograms (OpenCharts, ecCharts)
- Most Probable Precipitation type maps (OpenCharts, ecCharts)
- HRES instantaneous precipitation type (ecCharts – can tailor the minimum rate threshold)
- Instantaneous precipitation type (model output)
- Accumulated freezing rain (freezing drizzle accumulation now included) (ecCharts, OpenCharts, model field)

- Most severe precip type in last 1,3,6 hours (new model output variable, includes fz drizzle)
- Most common precip type in last 1,3,6 hours (new model output variable, includes fz drizzle)

What else will change ?

- Following the minimum-rate-recalibration exercise we will be making the following additional change:
  - Snow & wet snow minimum rates will change from 0.05 to 0.04mm/h
  - This relates to a characteristic of 48r1 which is to generate 5% less snow
  - This should help keep the frequency of occurrence of both these precipitation types the same on products as they are in observations

- We do not see much lead-time dependence of frequencies of occurrence in different types in forecasts – expected but also a relief (!)

We welcome feedback on these new developments at UEF next year ☺

(or whenever you are ready!)

ENS Extended Range Forecasts

… products

Fernando Prates & Laura Ferranti

fernando.prates@ecmwf.int laura.ferranti@ecmwf.int

ECMWF

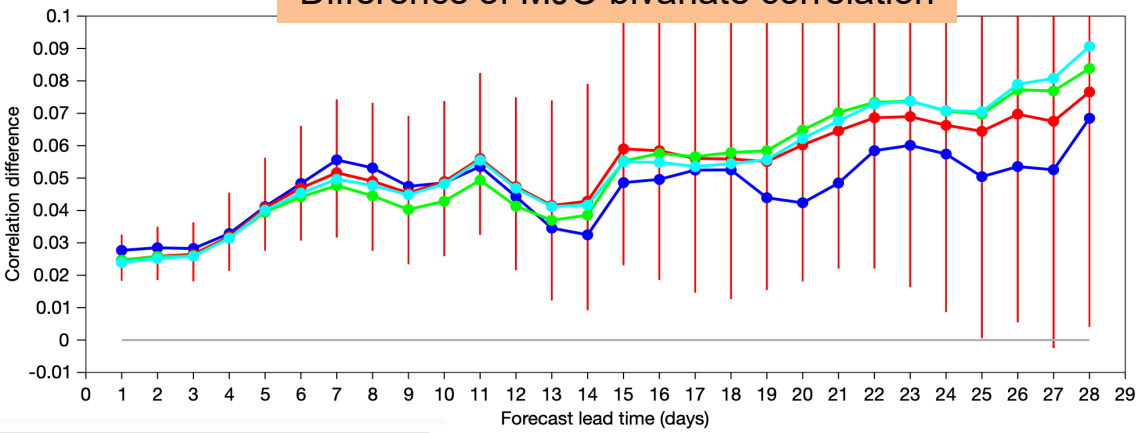
New ENS Extended Range Forecast

- A new configuration to meet the user's' feedback (survey 2021) will be implemented on 27th June
- ENS frequency and ENS size matters
  - From Mon & Thu to daily (00Z) forecasts
  - From 51 to 101 ENS members
- ENS Extended decoupled from the ENS Medium Range
  - Forecasts $T_{co}319$ from 0 to 46 days
  - Hindcasts $T_{co}319$ from 0 to 46 days (20-years,11 members, Mon & Thu)
- CY49r1 Hindcasts (**next year**):
  - 10 perturbed members +CTRL runs on fixed dates once every 2 days, over the past 20-years

Skill sensitivity of the forecast configuration - frequency

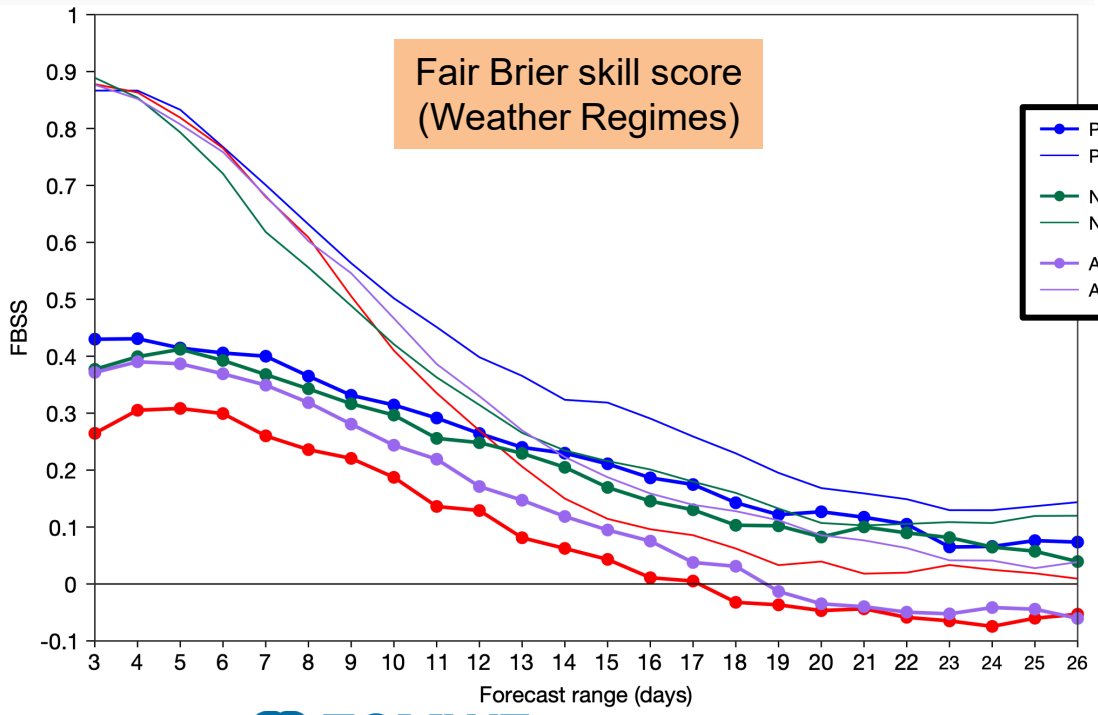
Difference between forecasts starting on day 0 and 3 days earlier
Difference between lagged forecasts starting on days 0 to –1 and forecasts starting 3 days earlier
Difference between lagged forecasts starting on days 0 to –2 and forecasts starting 3 days earlier
Difference between lagged forecasts starting on days 0 to –3 and forecasts starting 3 days earlier

Difference of MJO bivariate correlation



Vitart & Takaya, QJRMS,2021

Fair Brier skill score
(Weather Regimes)



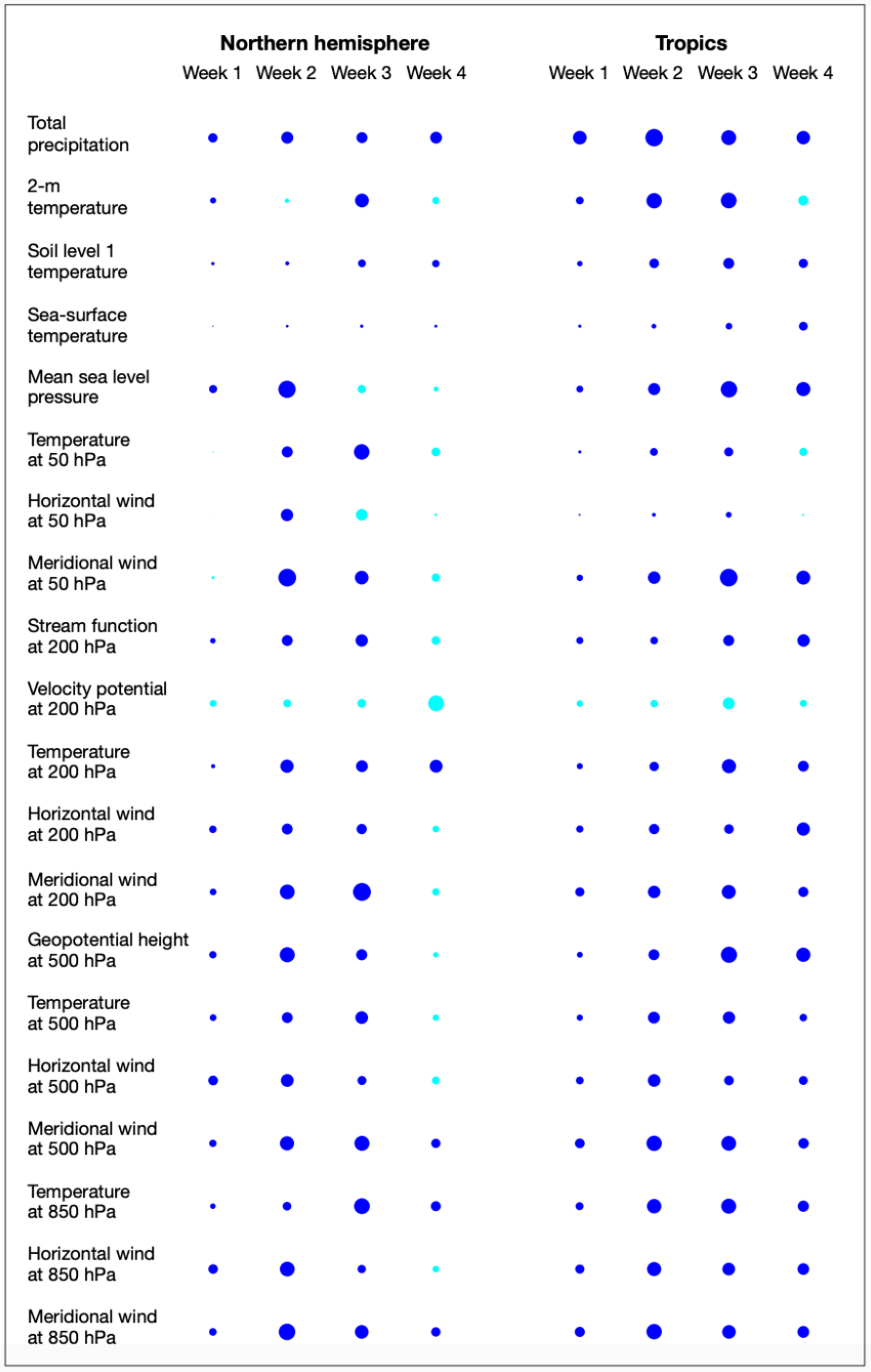
Positive phase of North Atlantic Oscillation (bi-weekly forecasts)
Positive phase of North Atlantic Oscillation (daily forecasts)
Negative phase of North Atlantic Oscillation (bi-weekly forecasts)
Negative phase of North Atlantic Oscillation (daily forecasts)
Atlantic Ridge (bi-weekly forecasts)
Atlantic Ridge (daily forecasts)
Blocking (bi-weekly forecasts)
Blocking (daily forecasts)

Newsletter No. 173

Skill Sensitivity of ENS size: 51 vs 101 member

Skill score is significantly improved when ENS size 51 → 101

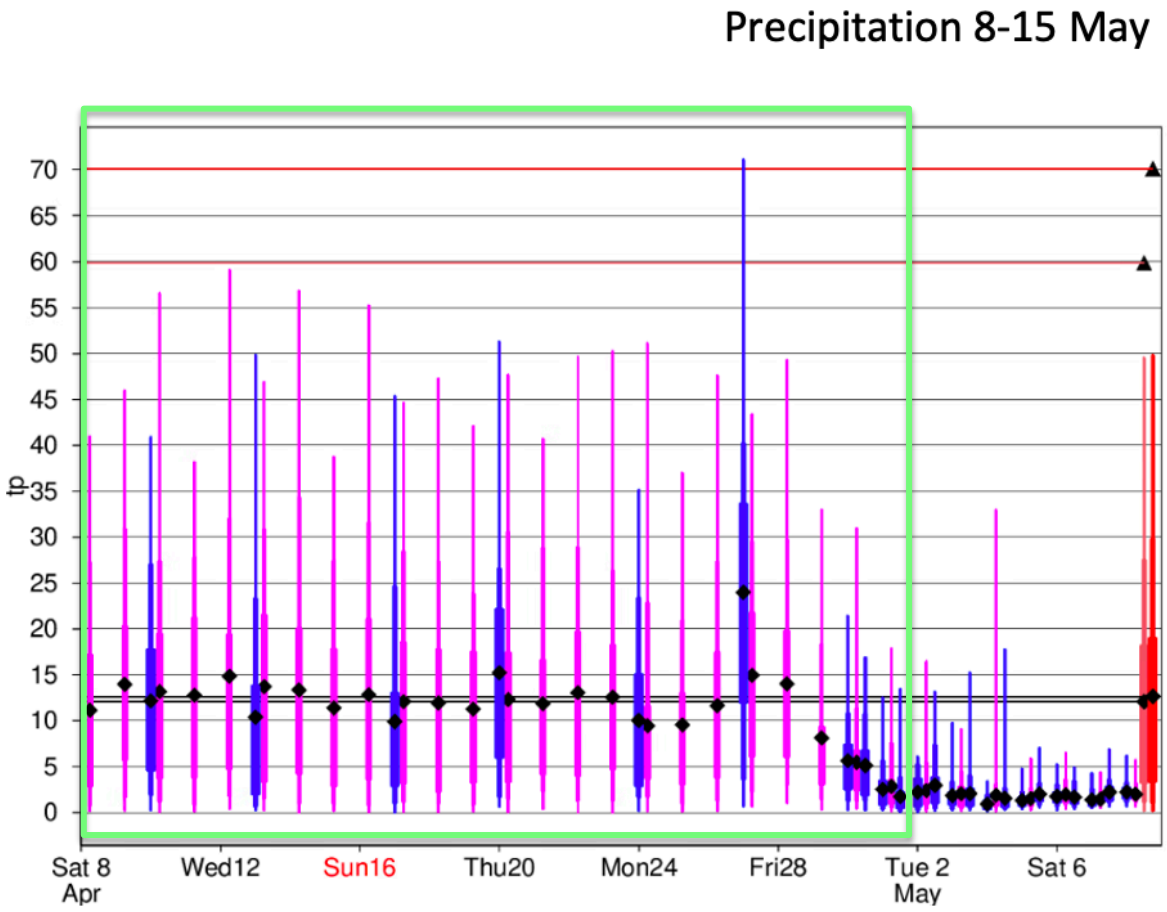
Difference in Continuous Rank Probability Skill Score

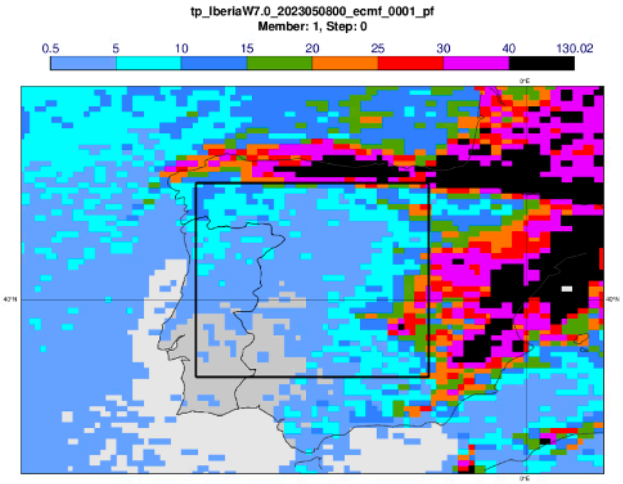


- Positive – significant
- Positive – not significant
- Negative – significant
- Negative – not significant

ECMWF EUROPEAN CENTRE FOR MEDIU

New configuration performance



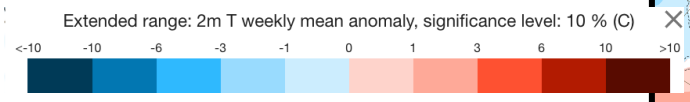


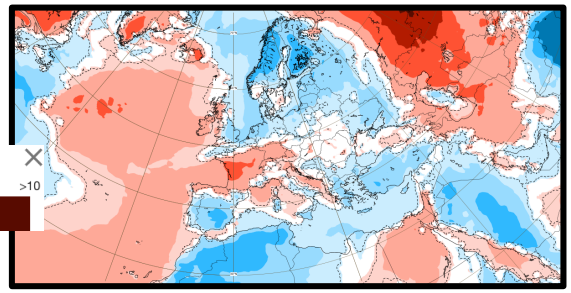
ENS Operational
ENS reforecast Operational
ENS Extended 48r1
ENS Extended reforecast 48r1
ENS mean – diamonds
Reforecast maximum - triangles

Linus M., Daily Report, 8th May

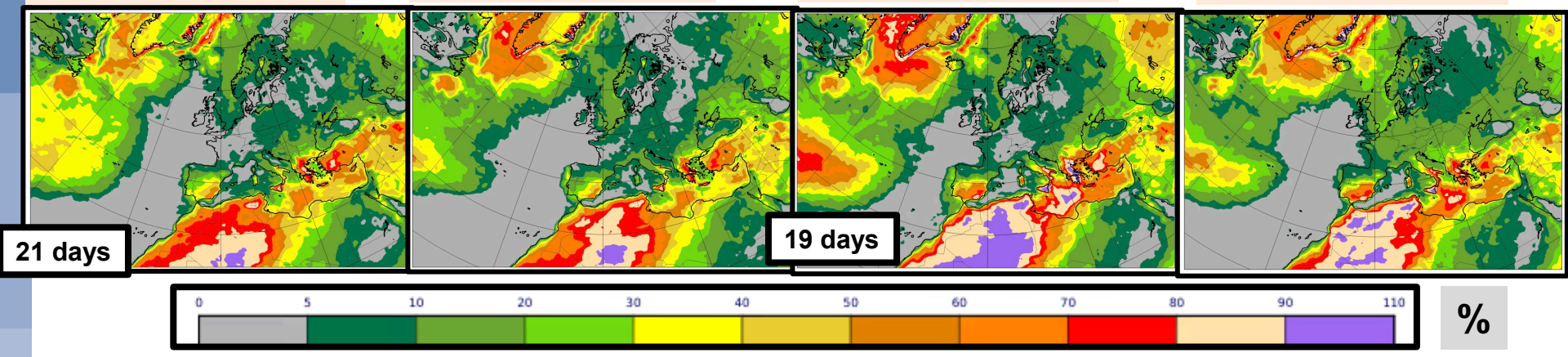
New Configuration performance

2mTemp
Prob weekly lower tercile





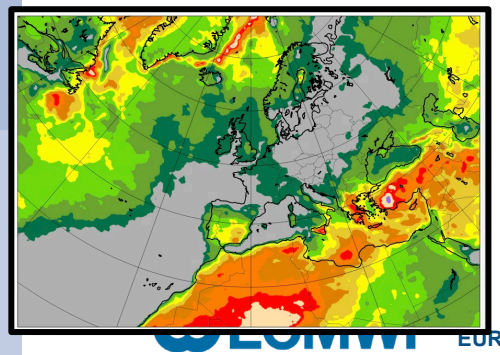
BT: 15 May (Mon) | **BT: 16 May (Tue)** | **BT: 17 May (Wed)** | **BT: 18 May (Thu)**



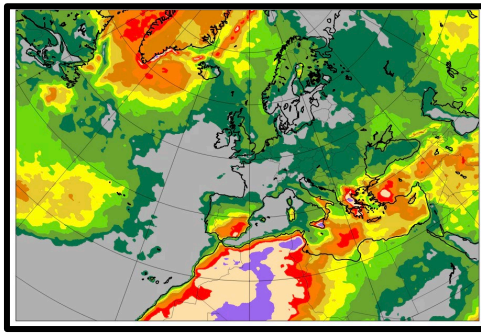
%

VT: 29 May – 05 Jun 2023

BT: 15 May (Mon)



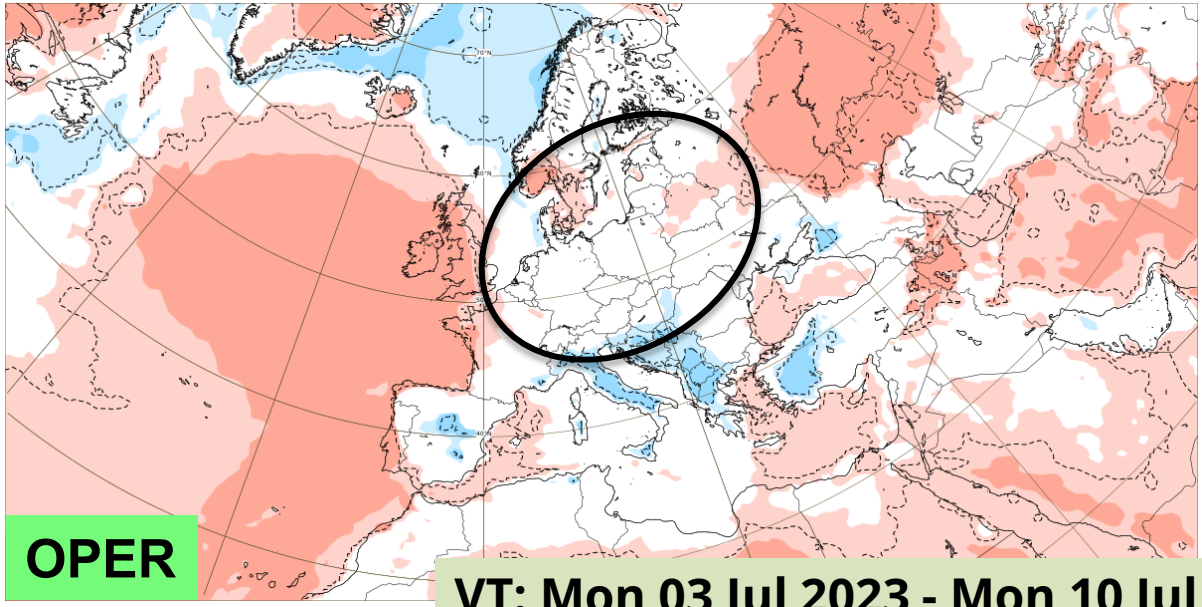
BT: 18 May (Thu)



ENS- Ext captures better the tail of the probabilistic distribution across the North Africa

Operations

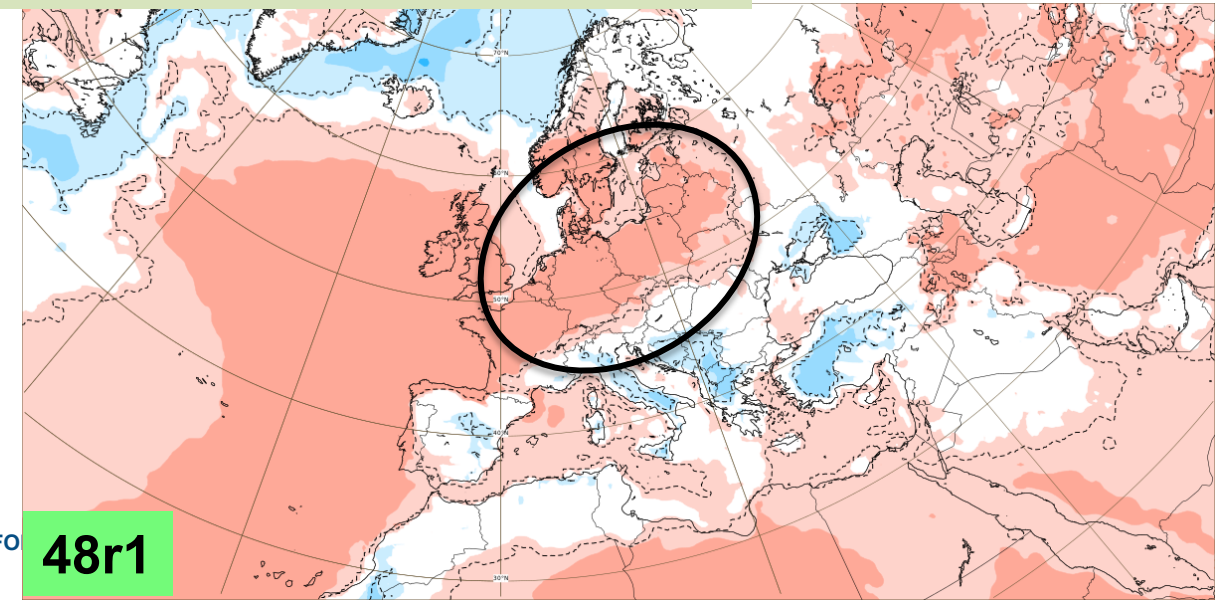
New Configuration performance



2 m temperature: Weekly mean anomalies

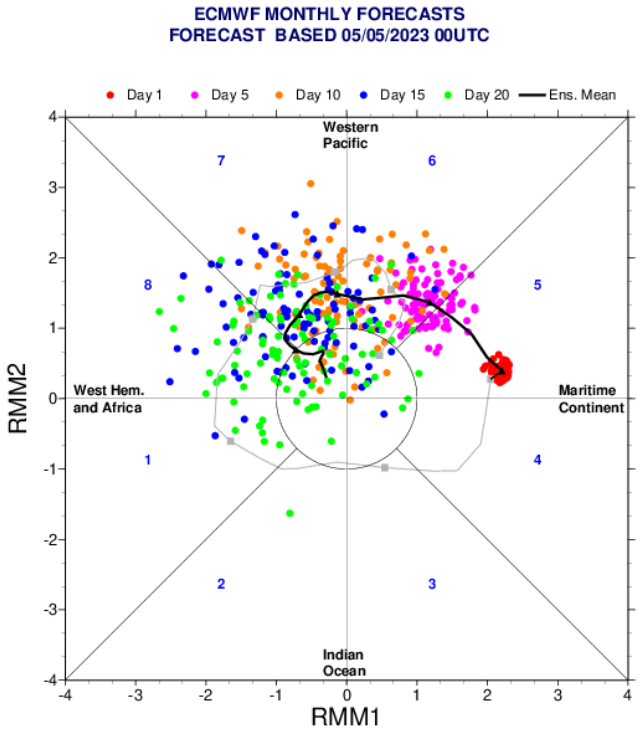
VT: Mon 03 Jul 2023 - Mon 10 Jul 2023

BT: Thu 01 Jun 2023

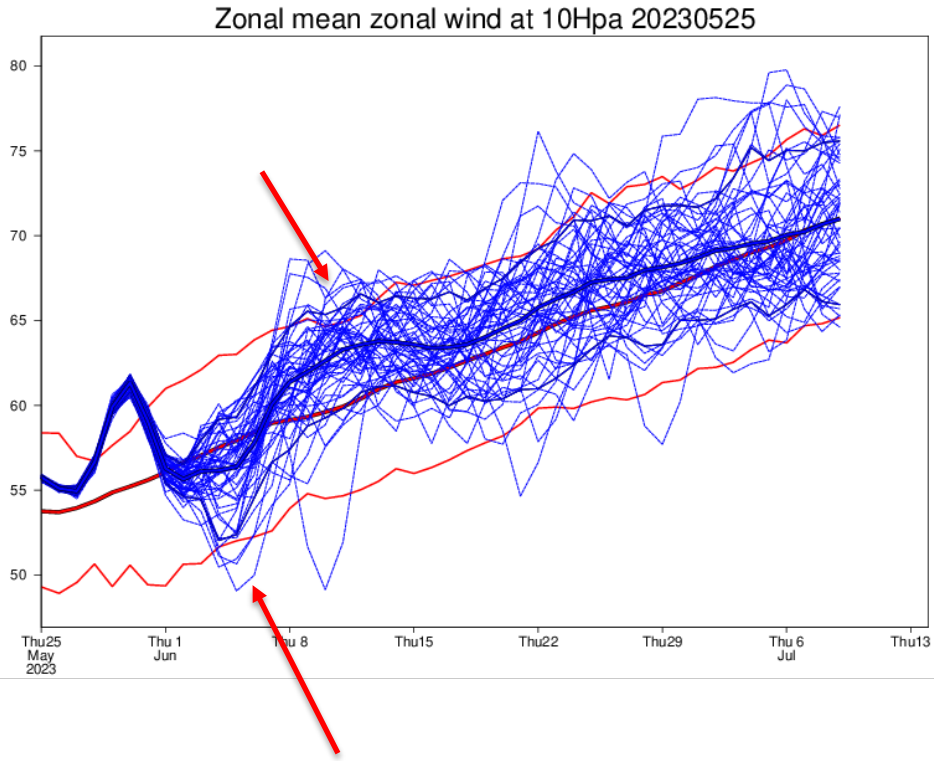


ENS Extended Range Forecast Products (48r1)

Madden-Julian Oscillation Index

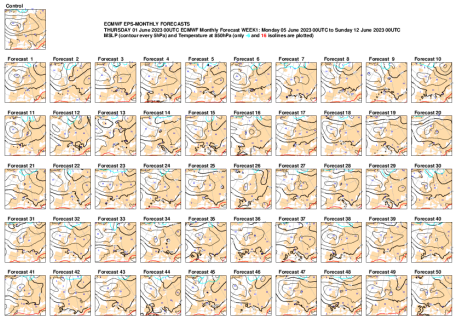


ZMZW South Hemisphere

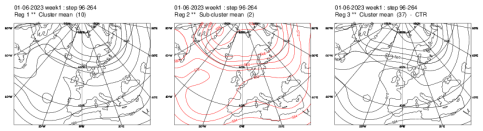


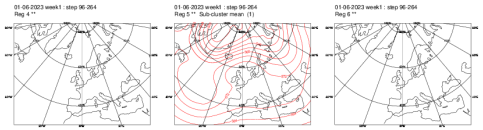
Extended Range: discontinued products

- Stamp Maps (MSLP & Z500)

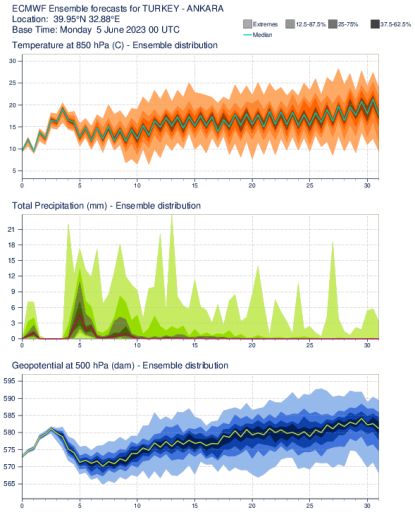


- Old regime product

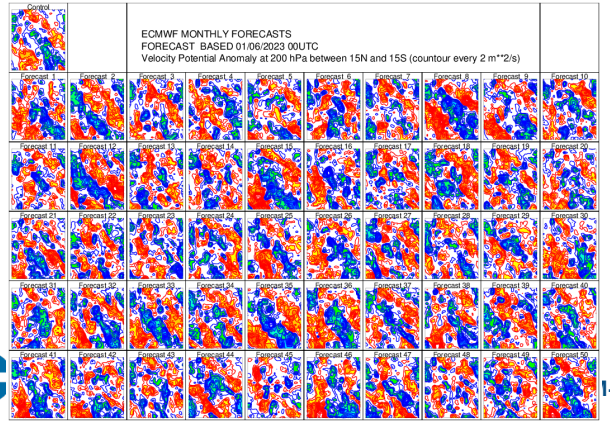




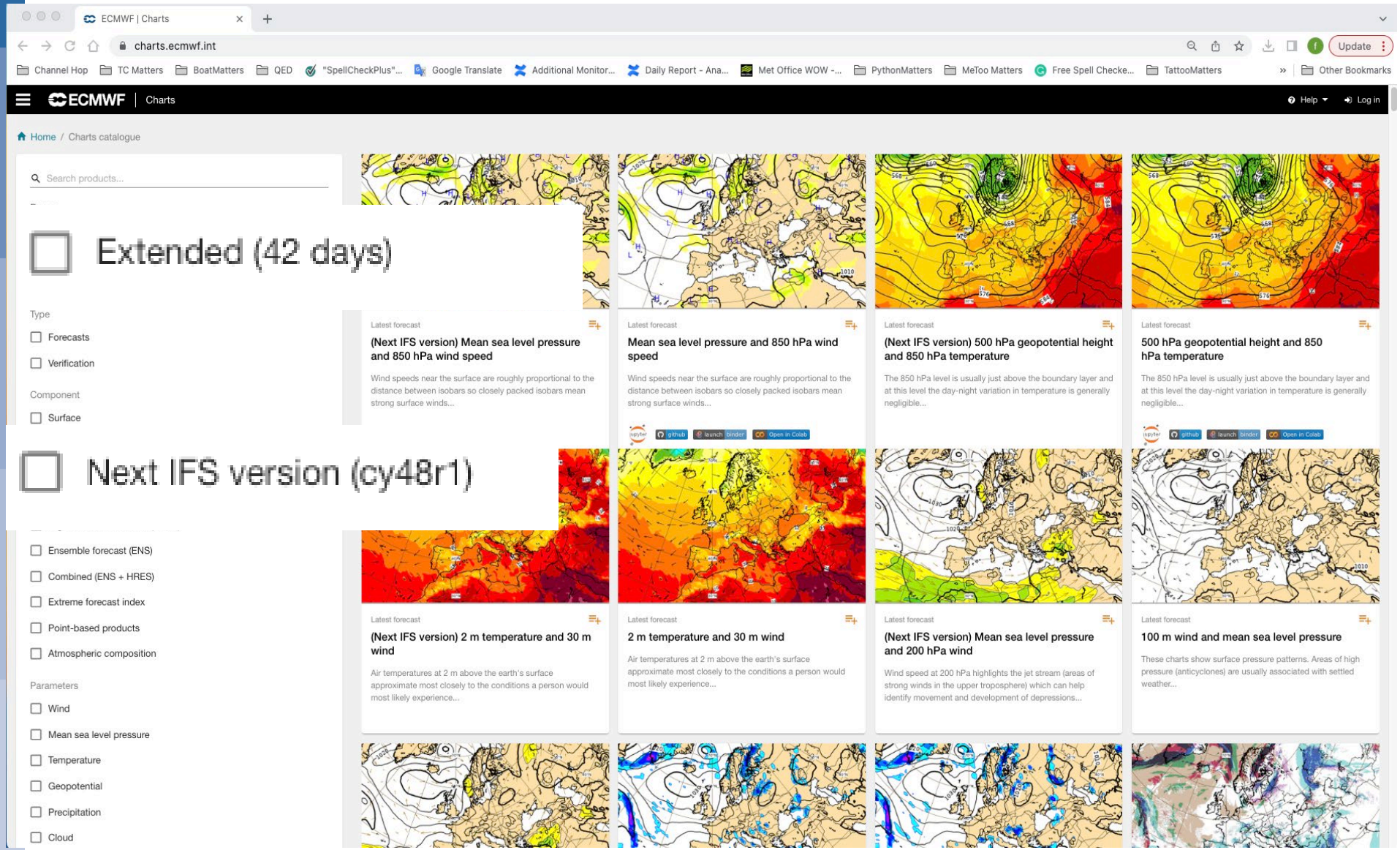
- Plumes (to be revisited)



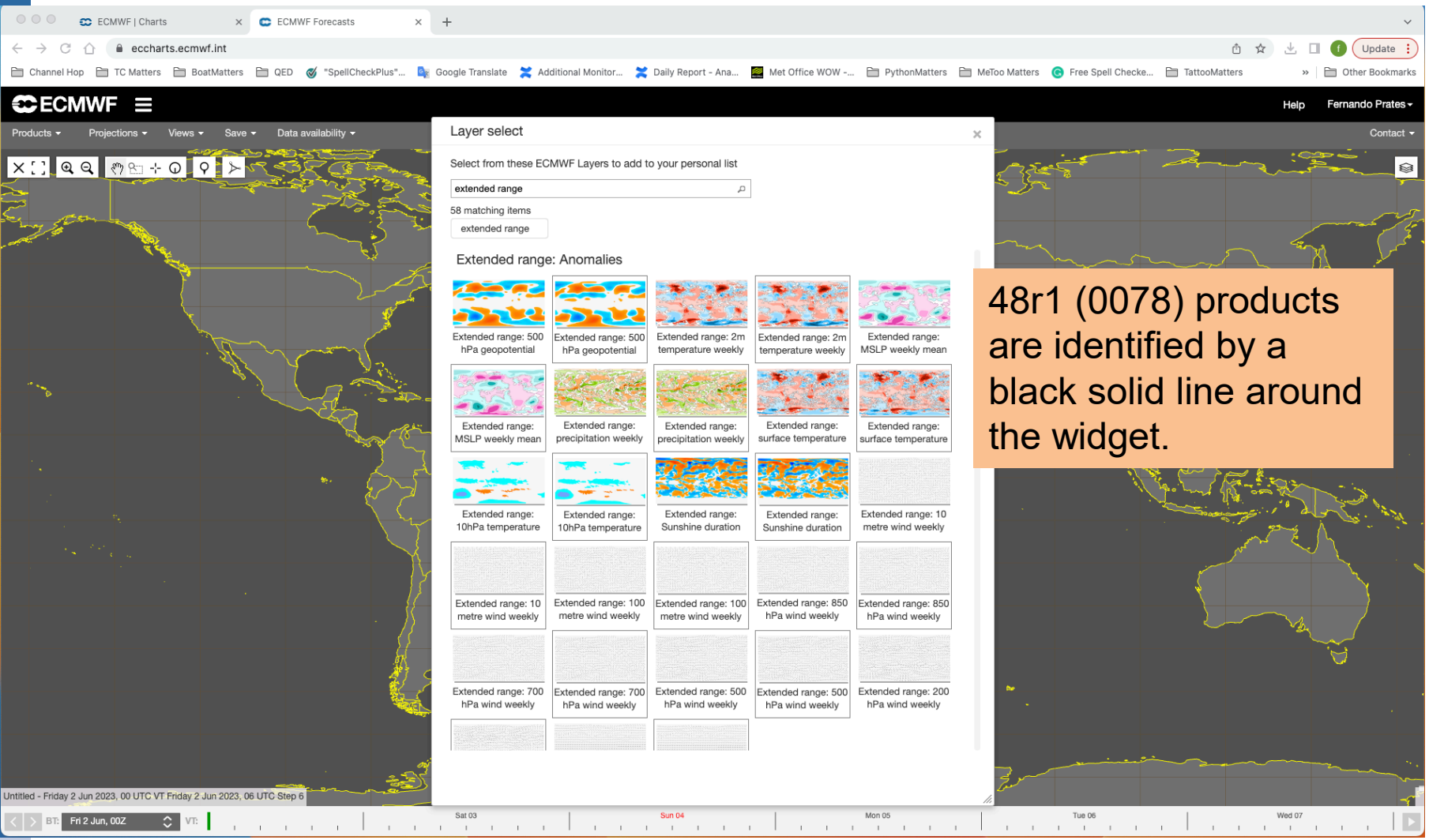
- MJO Hovmoeller stamp



Graphical products https://charts.ecmwf.int



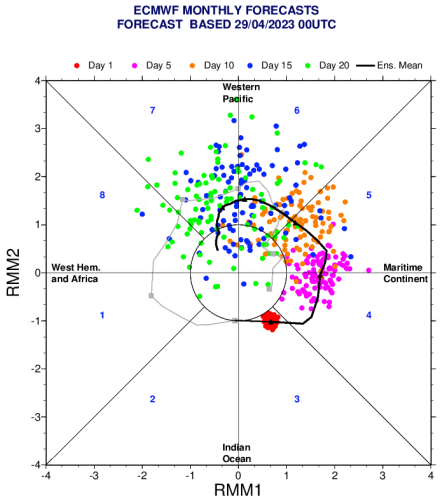
Graphical products: https://eccharts.ecmwf.int



48r1 (0078) products are identified by a black solid line around the widget.

Summary

- New ENS-Extended configuration is in-line with users demands
  - Increasing ENS **size** and **frequency**
- Benefit: increase of skill from forecasts issue twice a week to daily (MJO, Weather Regimes)
- Daily products (ex: weekly means) consistent with the new configuration including new product streams
- Hindcast configuration unchanged in 48r1 (10 ENS + CTRL x 20-years on Mon &Thu) but independent from ENS Medium Range hindcasts
- Newsletter article https://www.ecmwf.int/en/newsletter/173
- Confluence page https://confluence.ecmwf.int/display/FCST/Implementation+of+IFS+Cycle+48r1
- With the EN-Ext 48r1 provides more flexibility for the users to develop products



The new snow scheme in IFS CY48R1

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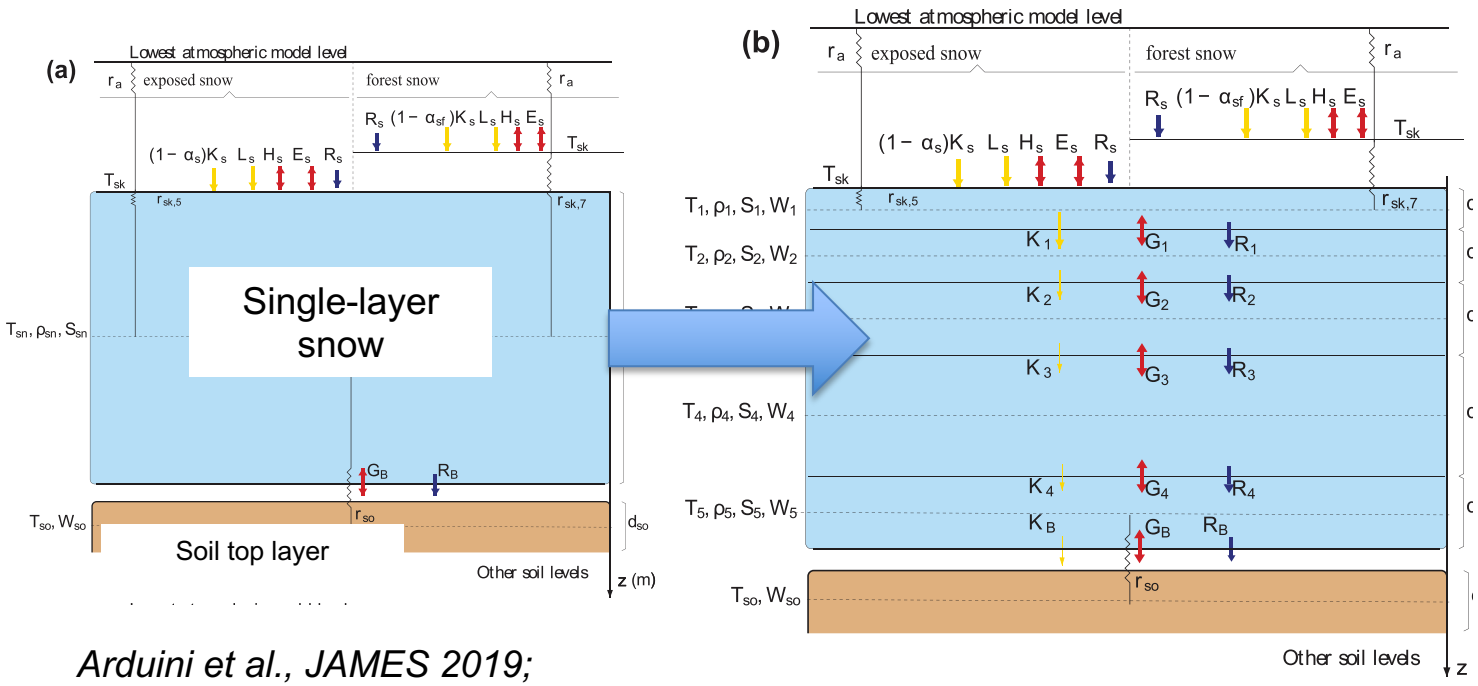
UEF2023

ECMWF

A multi-layer snow scheme for the IFS CY48R1



Arduini et al., JAMES 2019;
Boussetta et al., Atmosphere, 2021

- "Intermediate complexity":
  - No microstructure
- 5-layer snow scheme
- SWE, density, temperature **+ liquid water content** on 5-layers

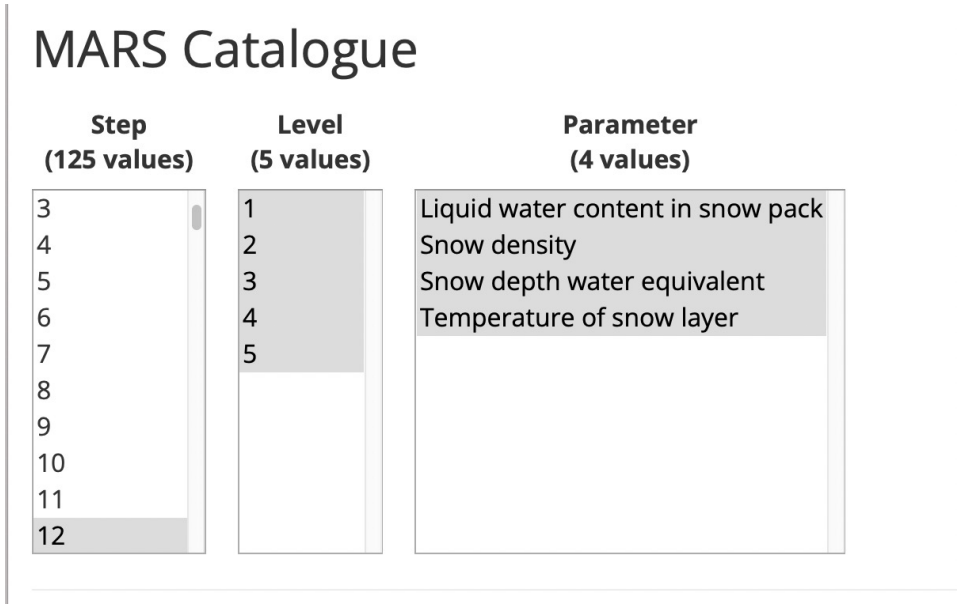
- **Integrated** ("total") variables still available as diagnostic output

YOPP YEAR OF POLAR PREDICTION

APPLICATE.eu
Advanced prediction in polar regions and beyond

Technical details, MARS, metadata

- GRIB2 output, ccsds packingType
- “New” Levtype=sol ; typeOfLevel=”snowLayer”
- **SI units**: snow depth water equivalent is now in kg m^{-2}
  - Difference of factor 1000 (i.e. density of water) compared to CY47R3!



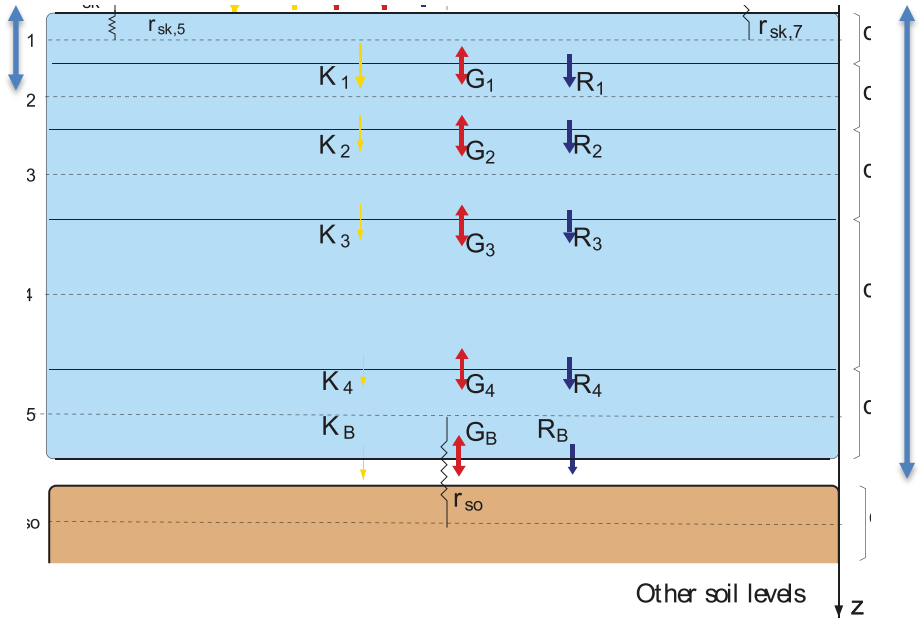
edition	dataType	stepRange	typeOfLevel	level	shortName	packingType	max
2	fc	3	snowLayer	1	sd	grid_ccsds	150.723
2	fc	3	snowLayer	2	sd	grid_ccsds	155.461
2	fc	3	snowLayer	3	sd	grid_ccsds	195.387
2	fc	3	snowLayer	4	sd	grid_ccsds	325.961
2	fc	3	snowLayer	5	sd	grid_ccsds	9400

Backward compatibility: can I still use single-layer snow fields?

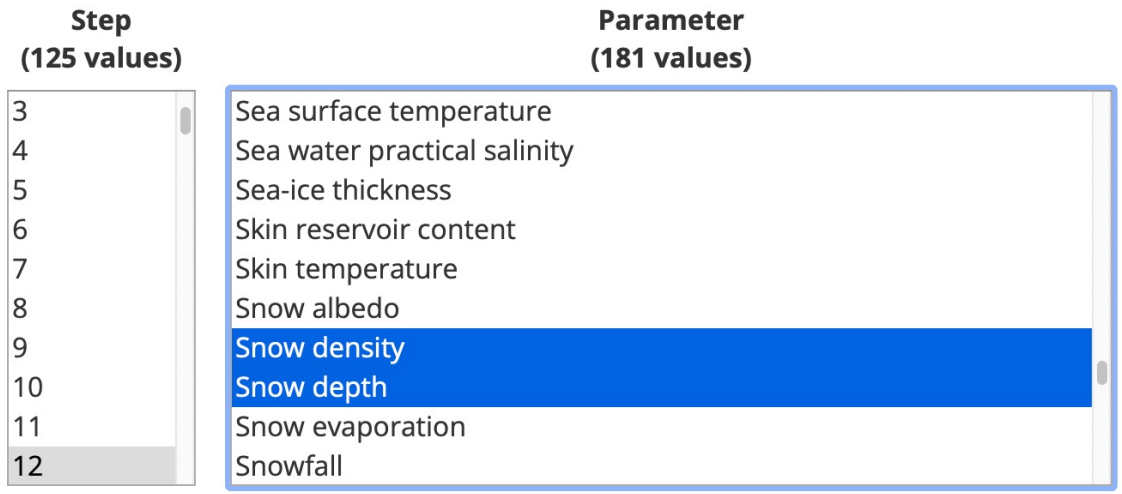
Backward compatibility is maintained:

- **SD, RSN, TSN "single-layer" still part of levtype=sfc output**
  - SD(sfc), RSN(sfc) so that total snow depth can be computed as in previous cycles, e.g. SnowDepth(m) = 1000*[SD(sfc)/RSN(sfc)]
  - TSN(sfc) is equivalent to the temperature of the topmost snow layer (level=1)

TSN(sfc)



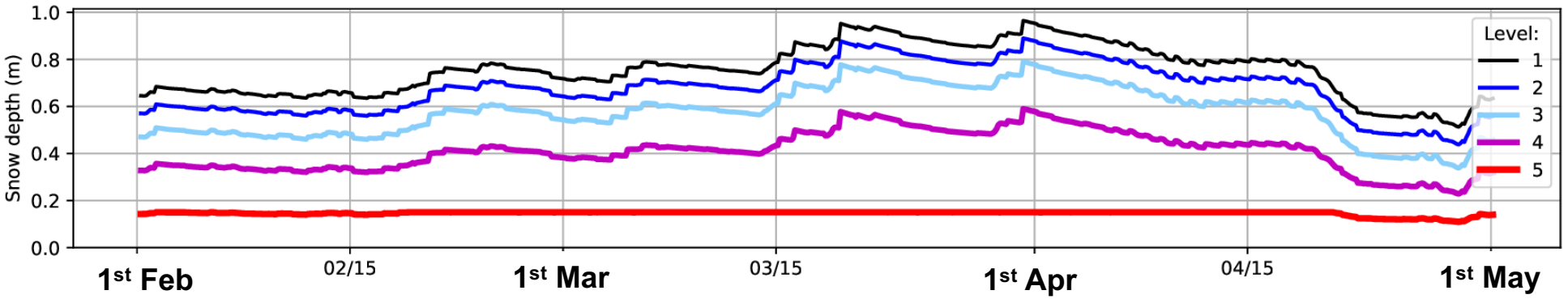
SD(sfc), RSN(sfc)



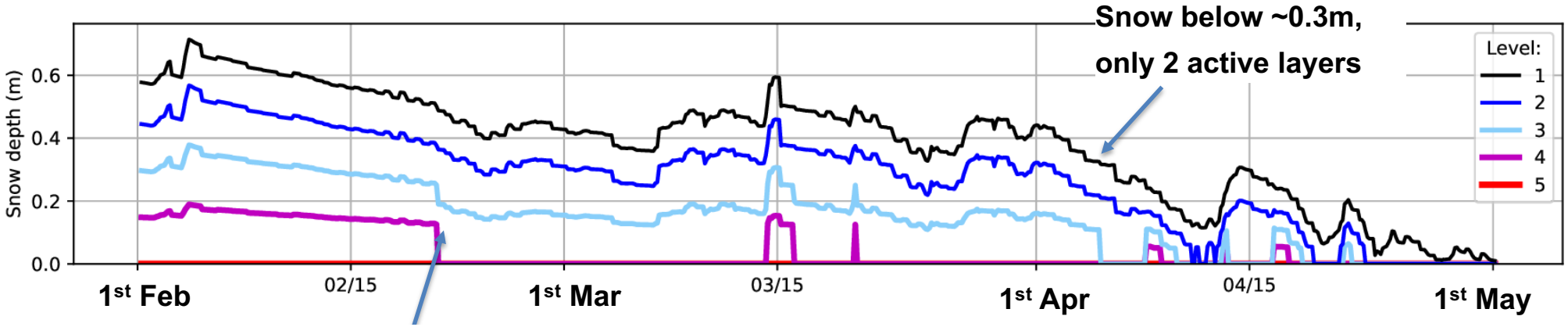
Multi-layer snow scheme – Snow depth

- Finer vertical discretization for layer in contact with the atmosphere (level=1)
- Dynamical vertical grid: number of active layers depends on snow depth

Snow depth at Sodankyla, Finland; concatenated FC t+3 to t+24



Snow depth near Bolzano, Italian Alps; concatenated FC t+3 to t+24



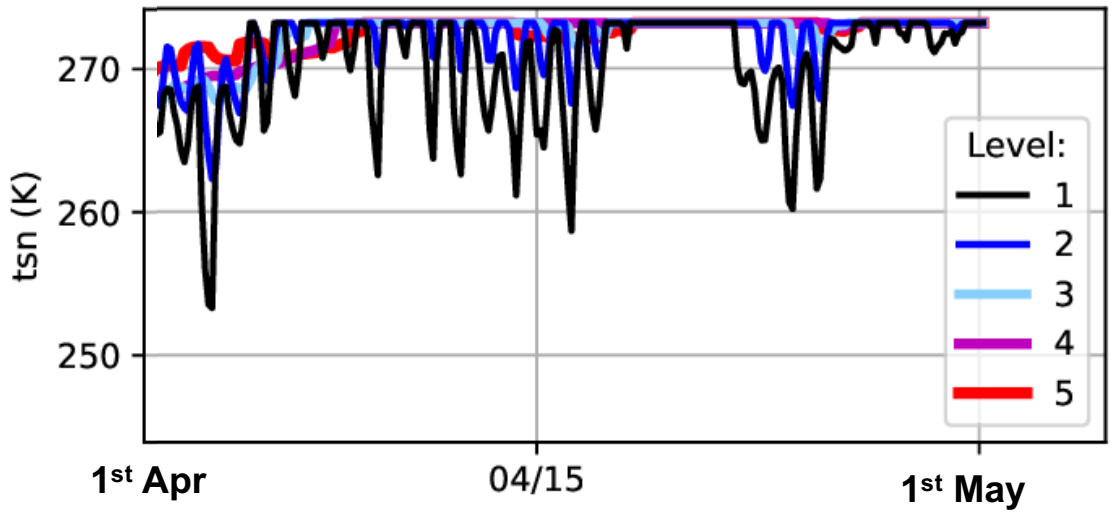
Snow below ~0.5m only 3 active layers

ECMWF

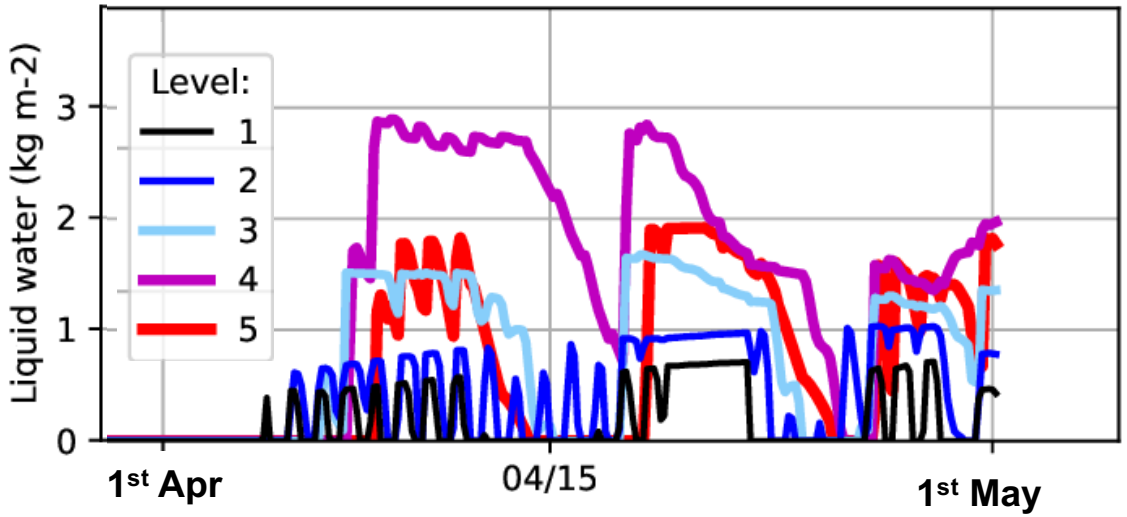
Multi-layer snow scheme – Snow temperature

- Multiple snow layers allow representing multiple time-scales:
  - topmost snow layer reacting faster to atmospheric forcing
  - bottom layer responding to longer time-scales
- Liquid water content allow representing melting/refreezing cycles within the snowpack

Snow temperature at Sodankyla, Finland; concatenated FC t+3 to t+24



Snow liquid water content, Sodankyla; FC t+3 to t+24

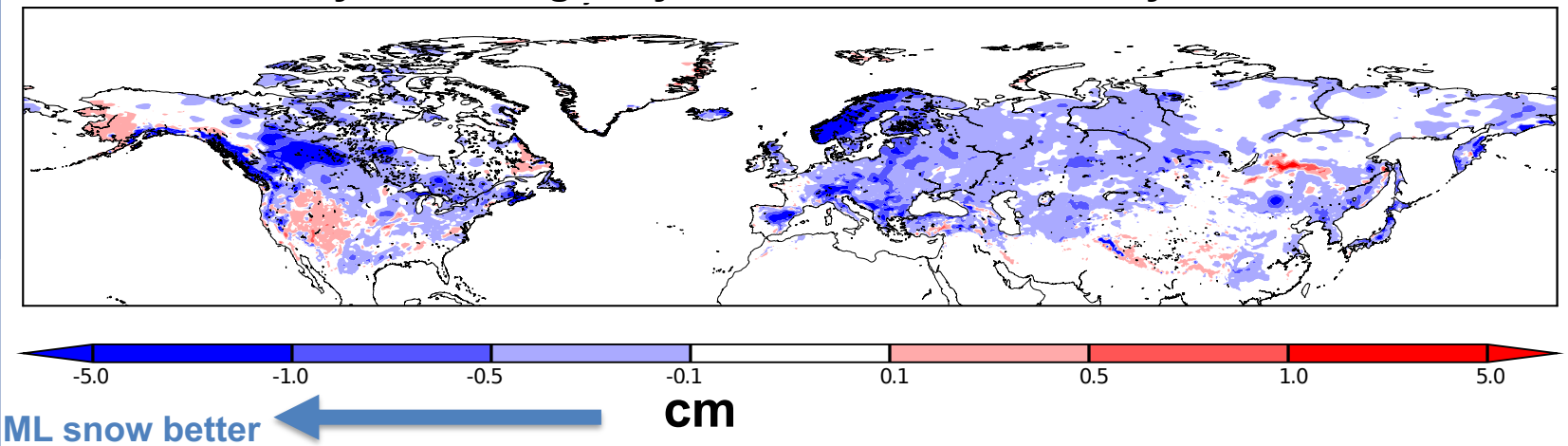


ECMWF

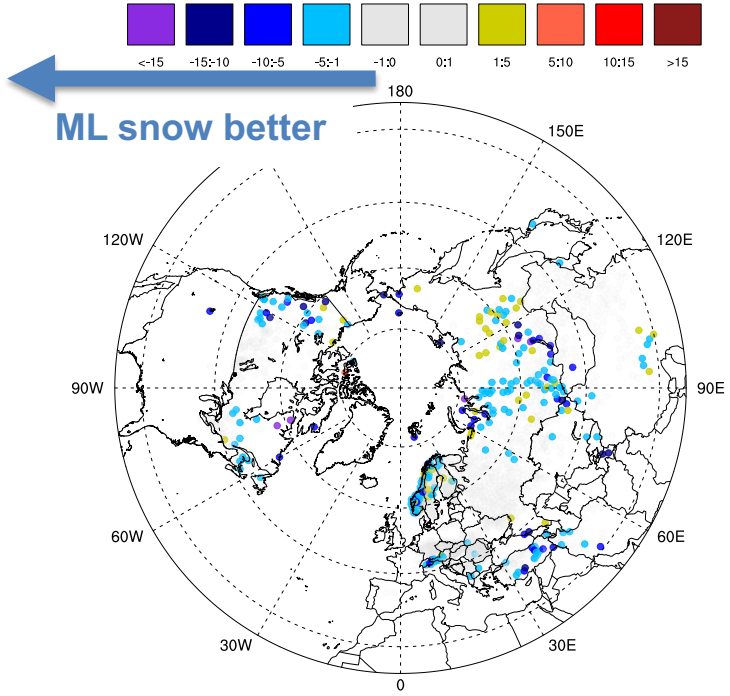
Multi-layer snow scheme – improved snow forecast

- **Improved snow depth in short-range forecasts**
- **Snow depth errrors reduced for increased forecast range**

RMS difference of analysis increments (12h forecast – analysis) of snow depth, between multi-layer and single-layer snow scheme, January 2021



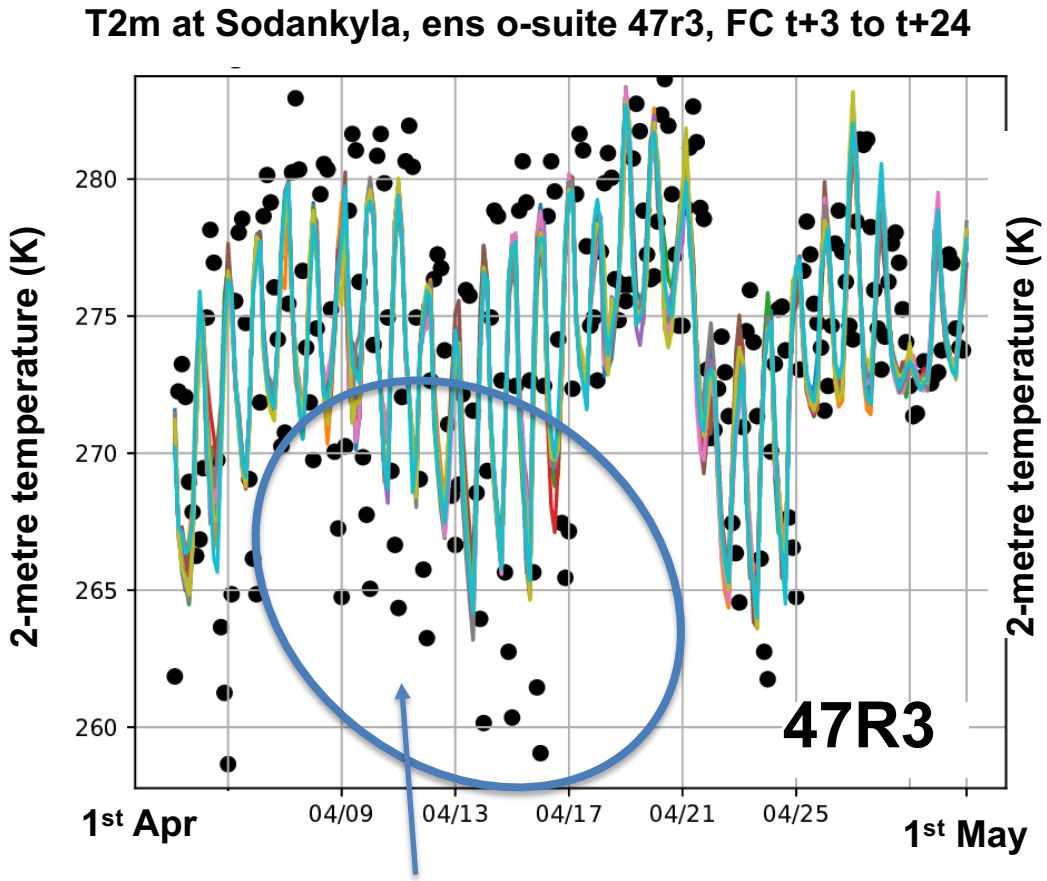
RMSE difference of forecasts at day 5 (compared with synop station), Winter 20/21

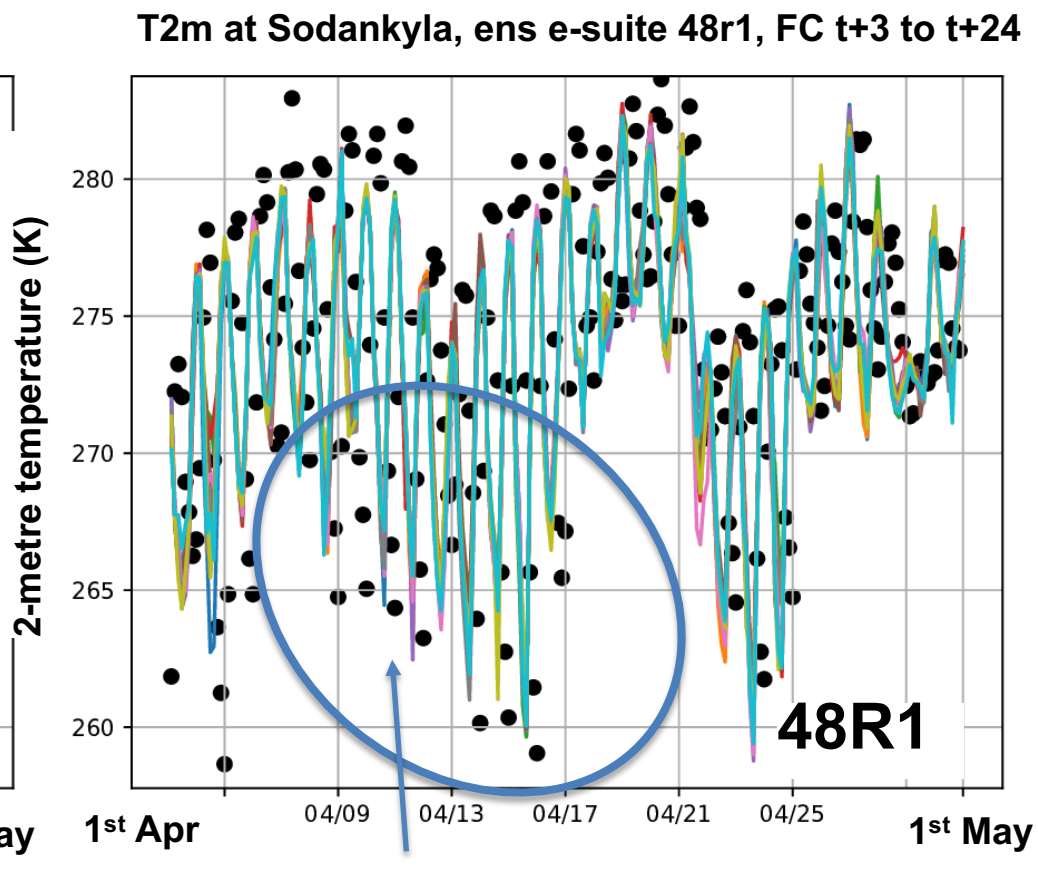


ECMWF

Multi-layer snow scheme – impact on T2m ensemble

- Thinner top snow layer allow representing colder temperatures
- Increased ensemble spread over snow-covered surfaces





Large minimum temperature errors

Errors reduced in 48r1

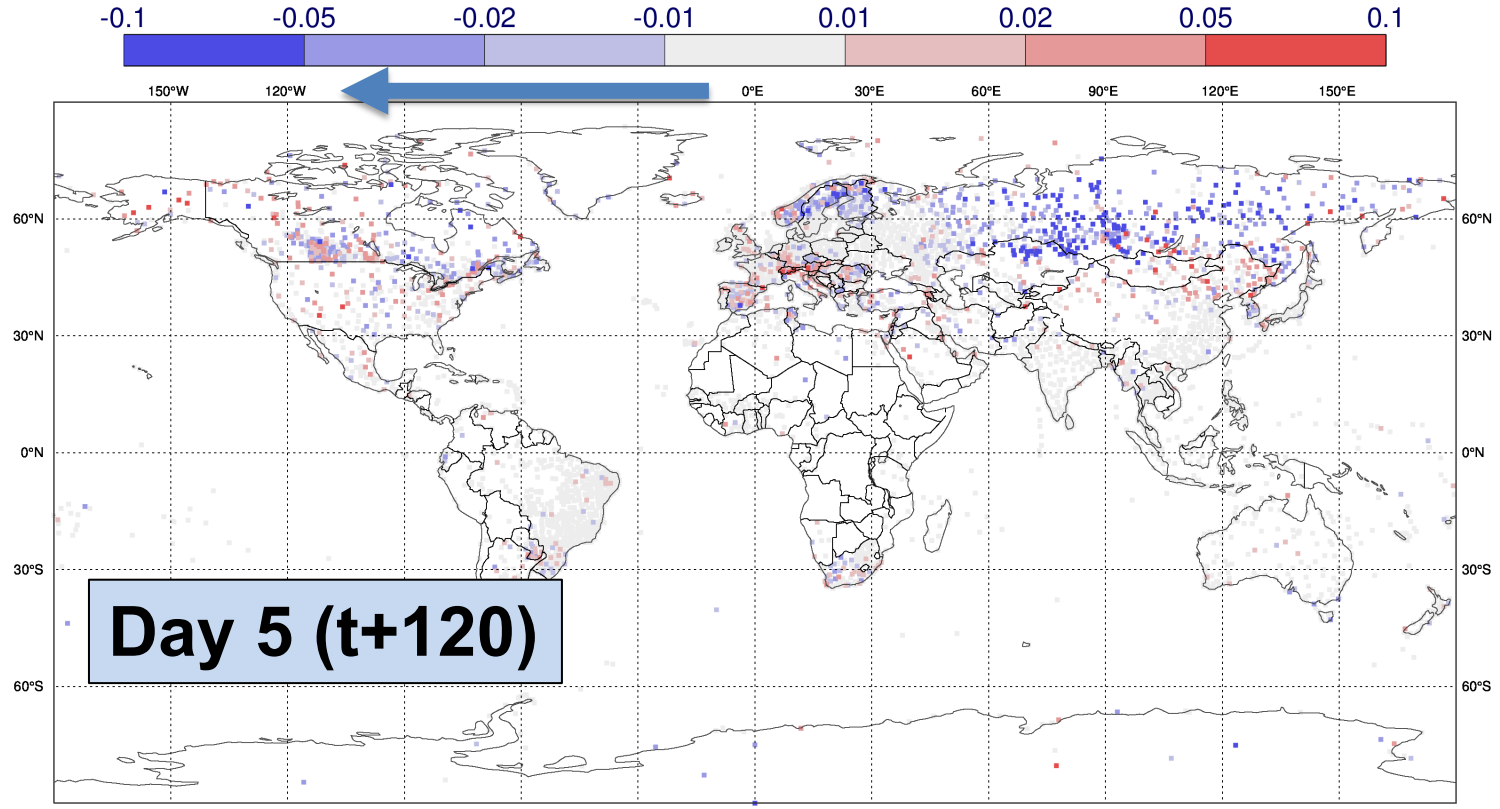
ECMWF

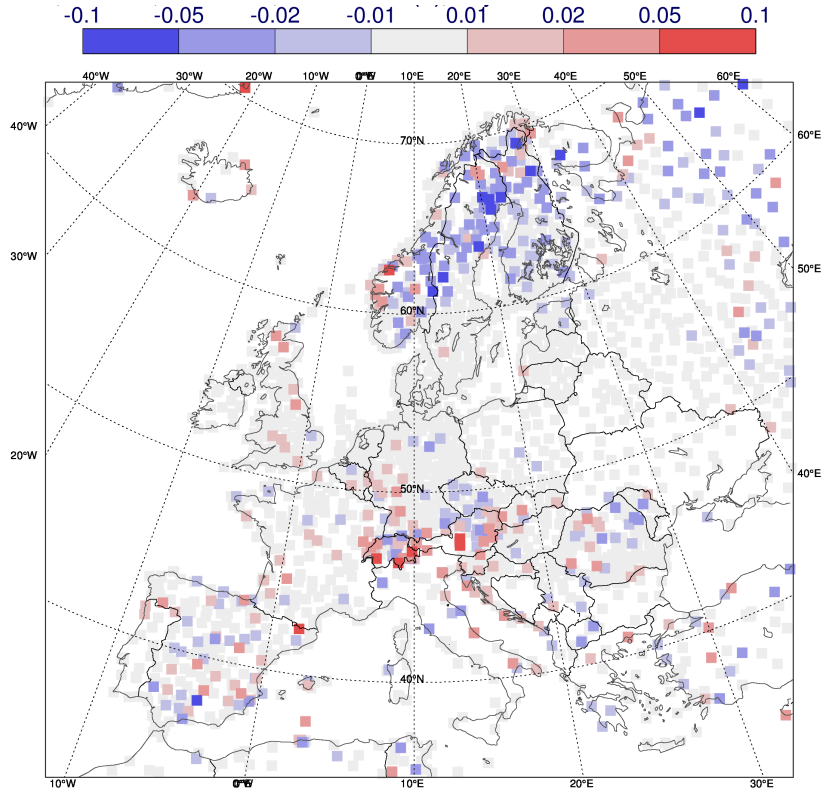
Multi-layer snow scheme – improved ensemble forecasts

Reduced fraction of large errors in ensemble

Fraction of CRPS errors in 2-metre Temperature > 5K in ensemble forecasts, Winter 2019/2020

Multi-layer snow reduces errors





ECMWF

Summary

- A multi-layer snow scheme with up to 5 layers is introduced in CY48R1
- “Equivalent” single-layer snow fields are maintained in the output, derived from the multi-layer fields
- Snow depth forecasts generally improved at short and medium-ranges
- Increased T2m spread and better representation of minimum temperatures

Questions?