ECMWF updates and plans

ACCORD – December2025

Andy Brown, Director of Research

THE STRENGTH OF A COMMON GOAL

ECMWF STRATEGY 2025–2034

Our Vision:

World-leading monitoring and predictions of the Earth system enabled by cutting-edge physical, computational and data science, resulting from a close collaboration between ECMWF and the members of the European Meteorological Infrastructure, will contribute to a safe and thriving society

ECMWF in 2035:

- Innovating at the cutting edge of physical, computational and data science for environmental monitoring and prediction
- Delivering forecast tools and products of unprecedented quality, exploiting data-driven methods anchored on physics-based modelling
- Integrated in and collaborating with the wider European meteorological community to deliver maximum value to society

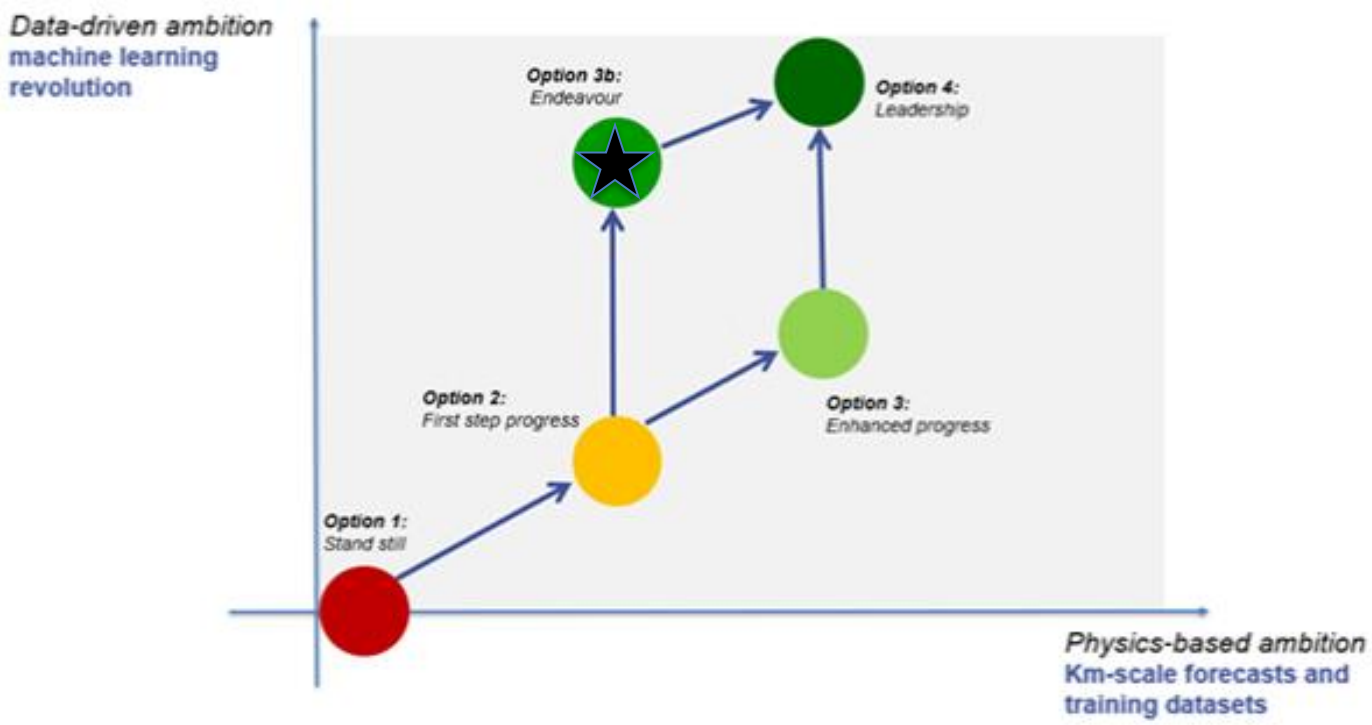
Our Mission: Deliver global numerical weather predictions focusing on the medium-range and monitoring of the Earth system to and with our Member States

Strategic Pillars and Actions:

Science & Technology	Impact	Organisation & People
Improve use of observations & Earth system data assimilation	Meet users' needs & deliver world-leading quality products	Increase organisational performance, resilience & effectiveness
Improve seamless Earth system models	Optimise provision & sharing of data, tools & resources	Enable a thriving multi-site environment with an emphasis on sustainability
Exploit high-performance computing, technology & computational science for numerical weather prediction	Enhance partnerships, training & communications	
Harness artificial intelligence/machine learning for data-driven forecasting		
Optimise system design & enhance flow from research to operations & vice versa		

https://www.ecmwf.int/en/about/what-we-do/strategy

Next HPC



July 2025: Council approval to launch procurement (Option 3b)

October 2025: ITT launched

December 2026: Council approval for Contract signature

2027(-2028): Transition to new HPC

Progress along both axes allows fuller exploitation of investments in satellite data e.g. EUMETSAT

While the 10-year plan for the IFS is very tricky, the 4-year plan is clearer

FORGE - Forecast System Regeneration

A major initiative to regenerate the code

- Tackling technical debt over the coming 5 years (2025-2029)

Software engineering principles

- Separation of concerns / encapsulation
  - Restructure model code and data structures
  - Modernise the workflows supporting software stack
- More detailed testing and improved test coverage
- Governance (ownership, review, standards, R2O)

Increased resilience in a changing environment

- Ease deployment and use on external systems
- Ease the addition of new capabilities
- Long-term sustainability

Added value to Member States

Focus for 2026:

- Continue modularisation
- Prune the IFS
- Increase the test coverage
- Workshop on code modernisation for physical NWP models

- Regular ongoing discussions through IFS-ARPEGE meetings – and with ACCORD

IFS model to open source? [December 25 Council]

- **Potential to enhance collaboration**
- Encouraging work on computational science and engagement of HPC vendors
- Internal efficiency
- Easier scientific publication
- Political drivers in some Member States

- **Loss of competitive advantage**
- Concerns over limited support levels available (expectation management and ability to take advantage of enhanced collaboration opportunity)

Reduced concern that opening IFS model would cause loss of competitive advantage:

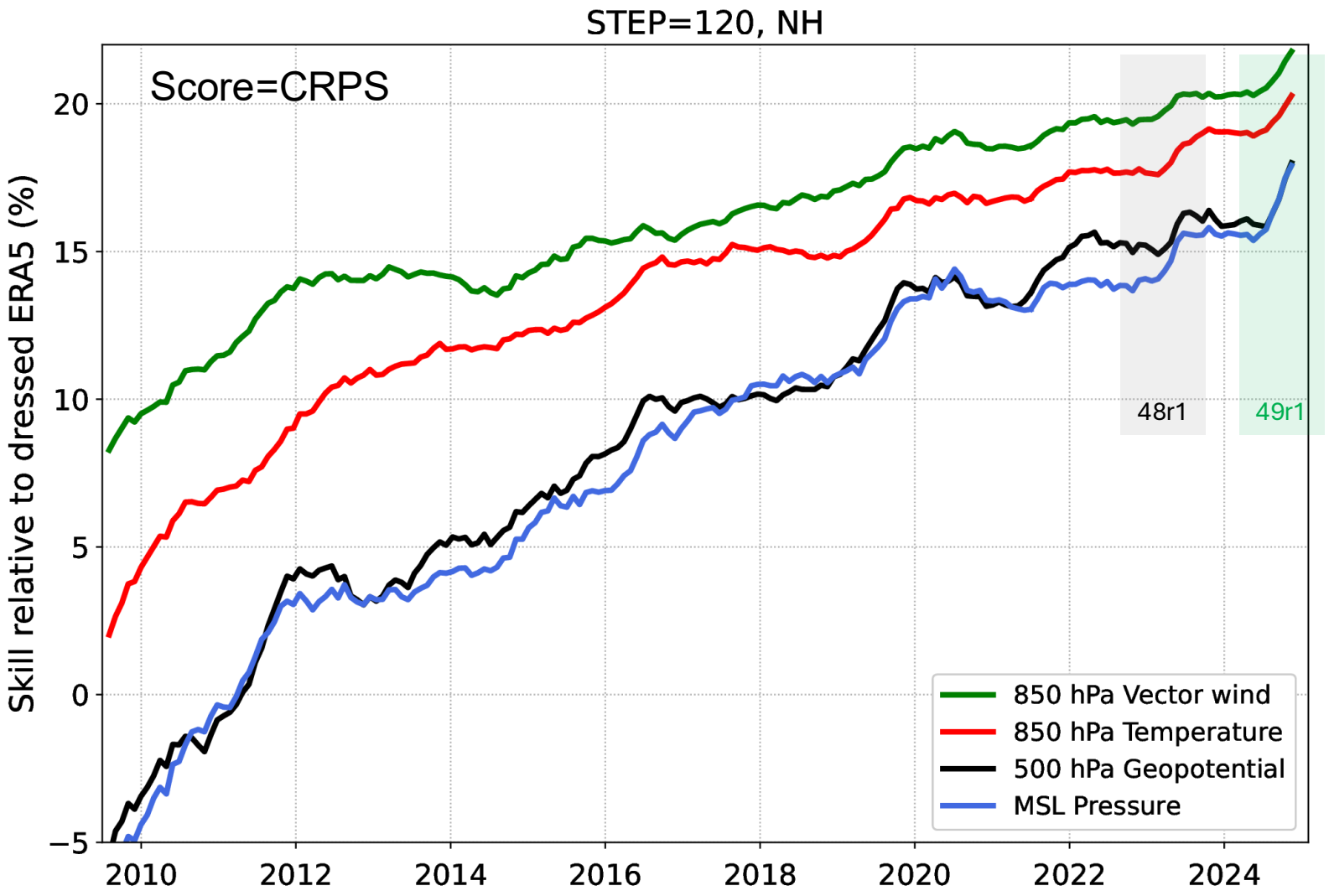
- Technology companies far more likely to invest in and compete with data-driven approaches (and AIFS/anemoi open already)

- Other leading physical models (e.g. ICON) are available even if IFS is not

⇒ Balance of considerations now favours full model to open source (Option 3)

"Additionally, and in the spirit of 'open science' and in order to further collaboration (e.g. with academia) and better serve the scientific community, ECMWF will build on the successful OpenIFS efforts and move to an open-source approach for the whole of the forecast model." (ECMWF strategy 2025-2034)

Five-day skill forecast for northern hemisphere: impact of cycle 49r1

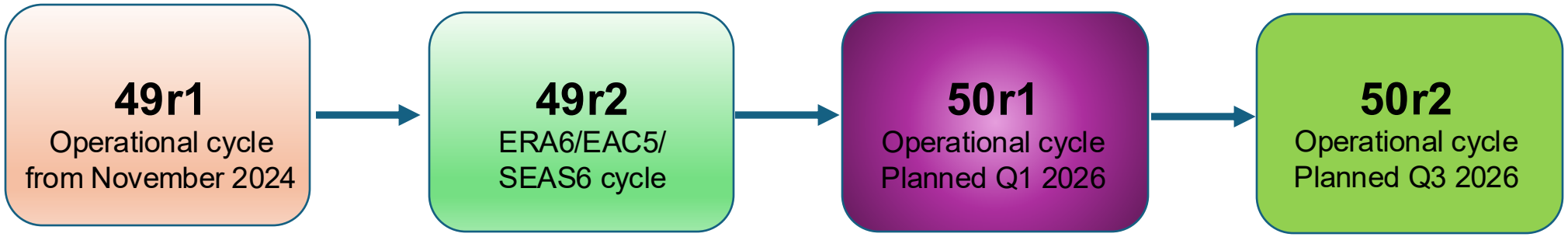


850 hPa Wind
850 hPa Temperature

500 hPa Geopotential
MSL pressure

Very clear improvement from 49r1!

IFS evolution: From 49r1 to 50r2



- ERA6/EAC5 historical reanalyses
- SEAS6 seasonal forecast system
- Output in GRIB2

- All science from 49r2 + additional science upgrades
- Output in GRIB1

- Purely technical cycle for GRIB2 transition
- Output in GRIB2

Towards ERA6

- ✓ higher resolution
- ✓ additional 8 years R&D
- ✓ more observations
- ✓ ocean component

➔ **Better extremes**

Tons of rocks bury Assos village in Kefalonia hit by Medicane Ianos

https://www.keeptalkinggreece.com/2020/09/20/assos-kefalonia-buried-rocks-medicane-ianos/

FEATURED / SOCIAL / WEATHER

September 20, 2020 | 2 min. read

BAMS Article

Ianos—A Hurricane in the Mediterranean

K. Lagouvardos, A. Karagiannidis, S. Dafis, A. Kalimeris, and V. Kotroni

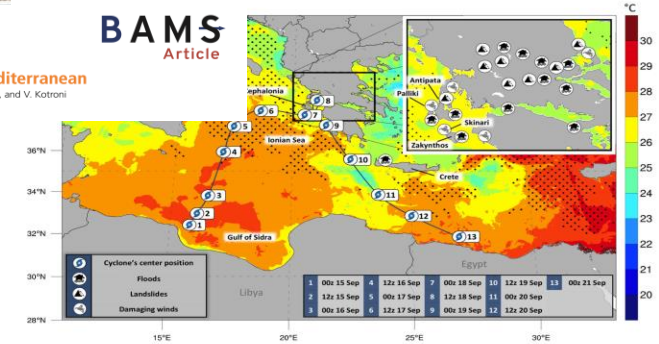


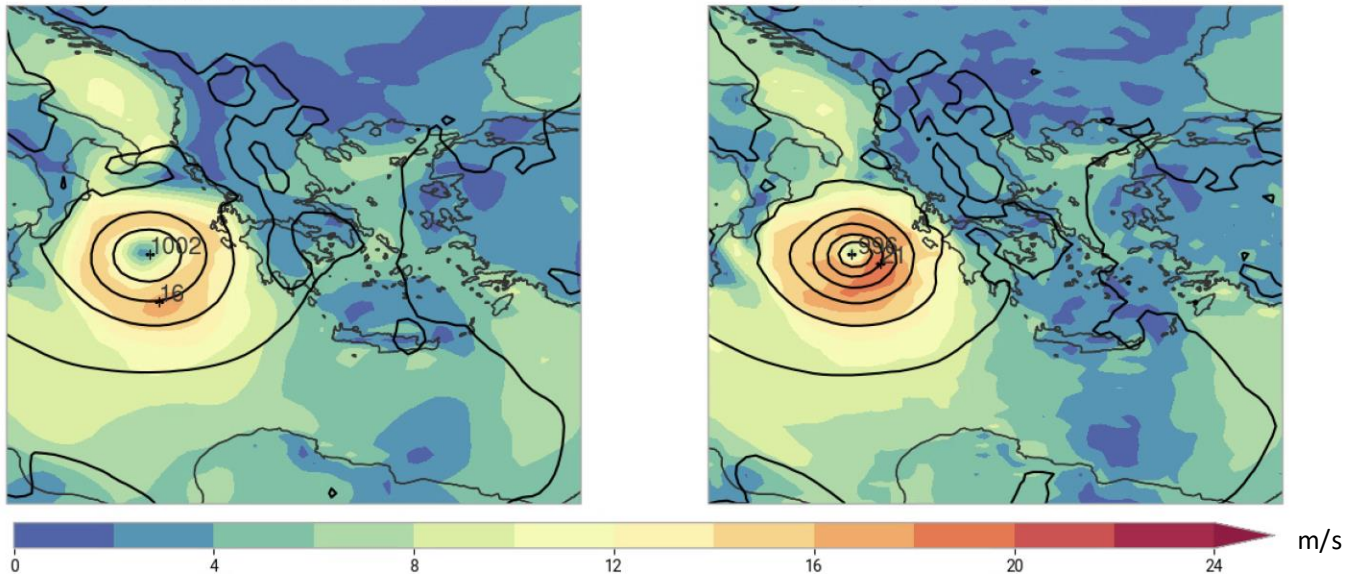
Fig. 1. Path of Medicane Ianos, from 0000 UTC 15 Sep up to 0000 UTC 21 Sep 2020. Shading denotes the SST (at 1-K intervals), and the black dots the daily SST anomaly higher than 2 K on 15 Sep 2020. Symbols for floods, landslides, and damaging winds are placed over the most affected areas.

Lagouvardos, et al, 2022: Ianos—A Hurricane in the Mediterranean. Bull. Amer. Meteor. Soc., 103, E1621–E1636, https://doi.org/10.1175/BAMS-D-20-0274.1.

Example: Medicane Ιανός (Ianos)

ERA5 Ten-meter wind speed, MSLP
valid on 2020-09-17 12 UTC

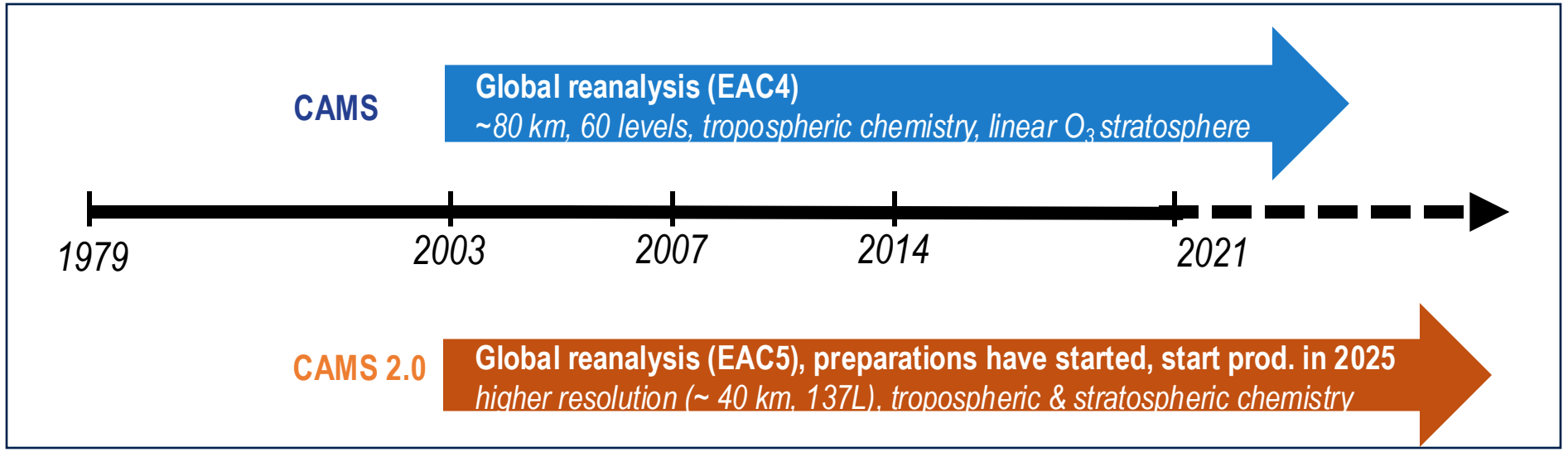
ERA6P2 Ten-meter wind speed, MSLP
valid on 2020-09-17 12 UTC

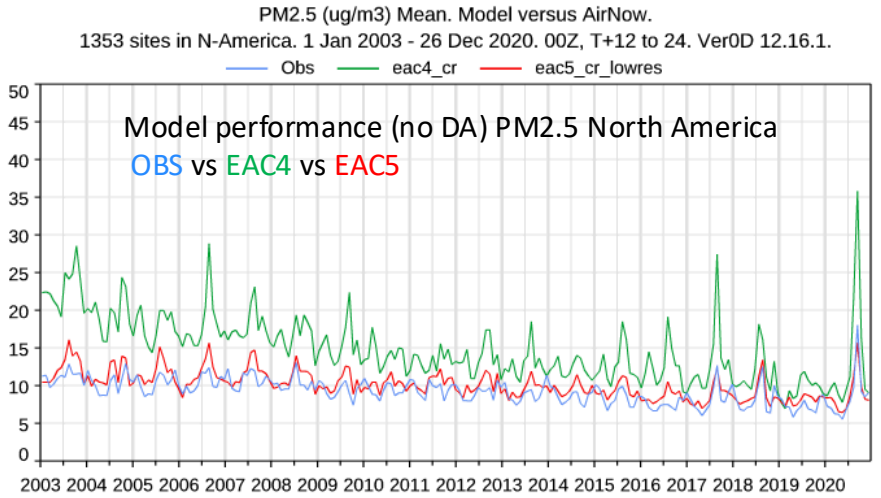


Lowest pressure: **1002** hPa in ERA5 ➔ **996** hPa in ERA6 prototype
Strongest wind: **16** m/s in ERA5 ➔ **21** m/s in ERA6 prototype

Production period (2026-2028)

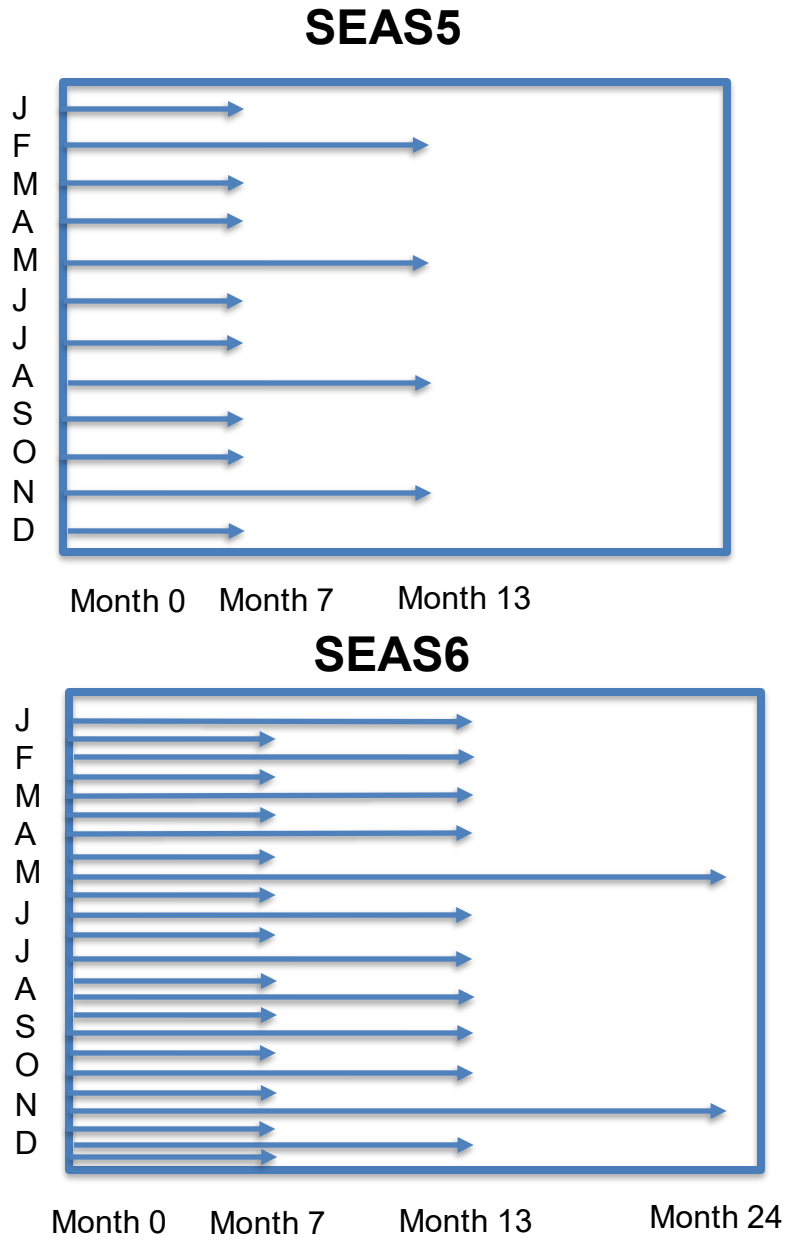
A new CAMS reanalysis (EAC5) in prep





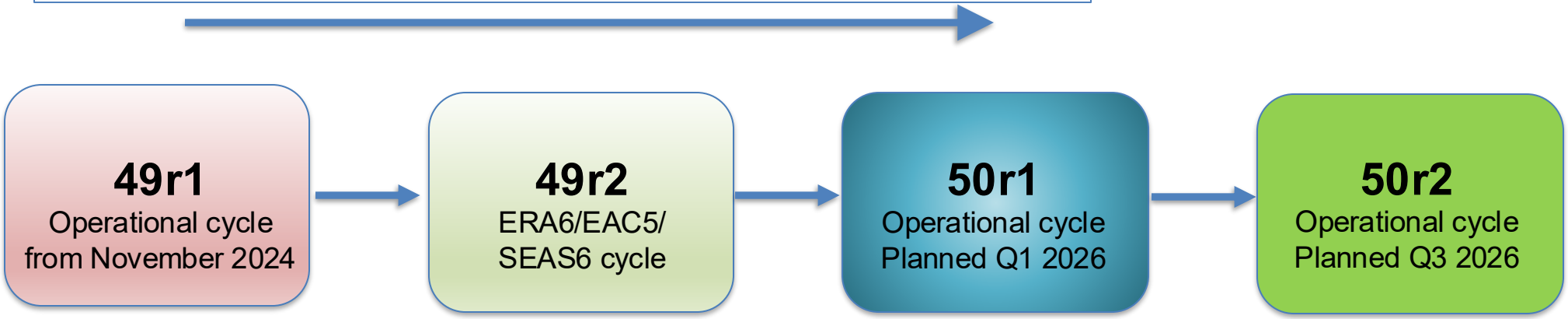
SEAS6 configuration – operational Q3 2026

- **Enhancement 1: Real-time 101 member ensemble**
  - Currently 51 members
- **Enhancement 2: Issue SEAS twice per month**
  - Initial date 1st and 16th of each month
- **Enhancement 3: Expand annual-range ENSO forecasts**
  - Issue forecast monthly not quarterly
  - Twice per year, increase range to 24 months
- **Enhancement 4: More comprehensive reforecasts**
  - Larger ensemble sizes and larger set of years
  - Some reforecasts will extend to the 1960s
  - Bias correction of products will continue use a recent period (e.g. 1993 onwards) for consistency with C3S and improved anomalies relative to a changing climate



IFS evolution: From 49r1 to 50r2

Numerous upgrades to observation usage between cycles
e.g. global MODE-S; Meteosat-12; Arctic Weather Satellite; more wave observations…..



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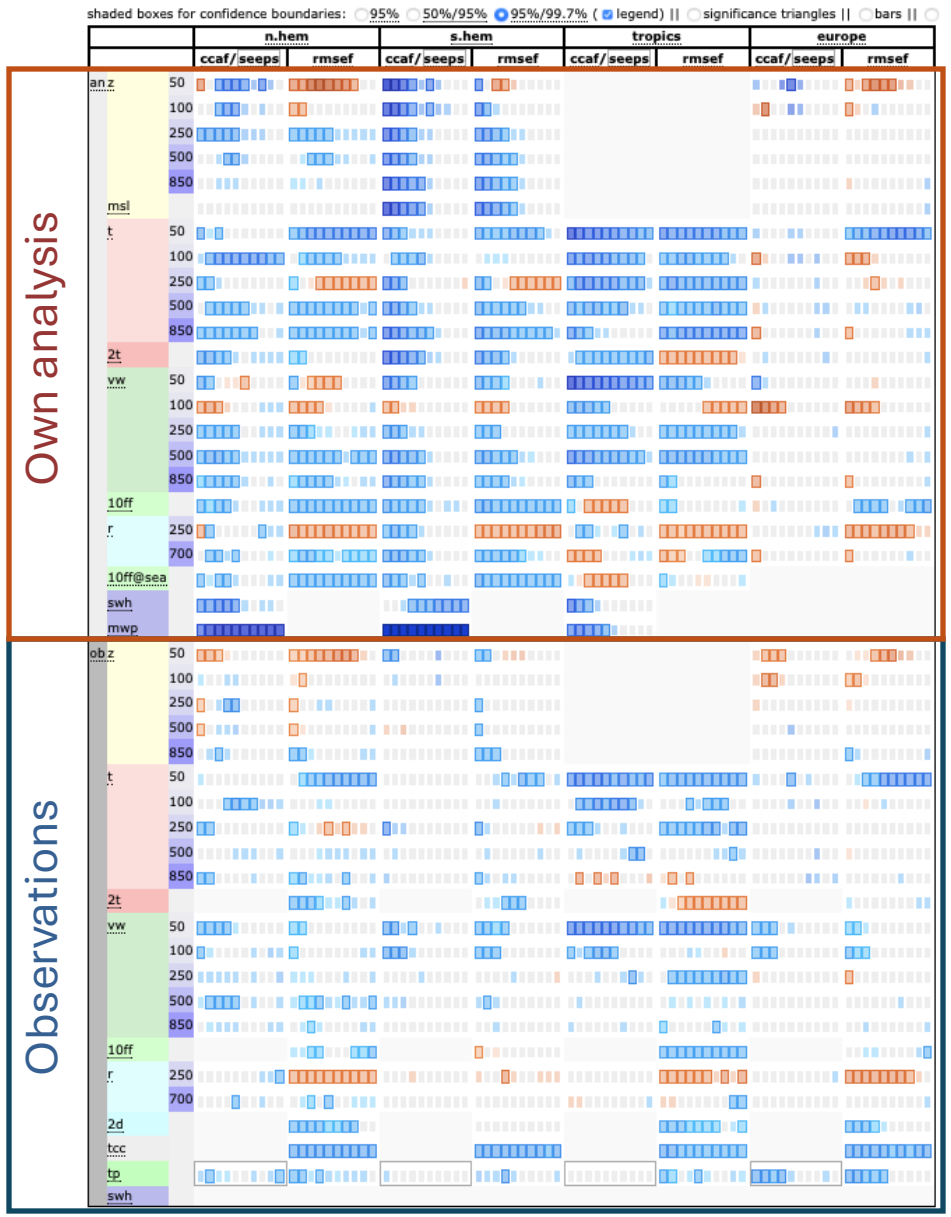
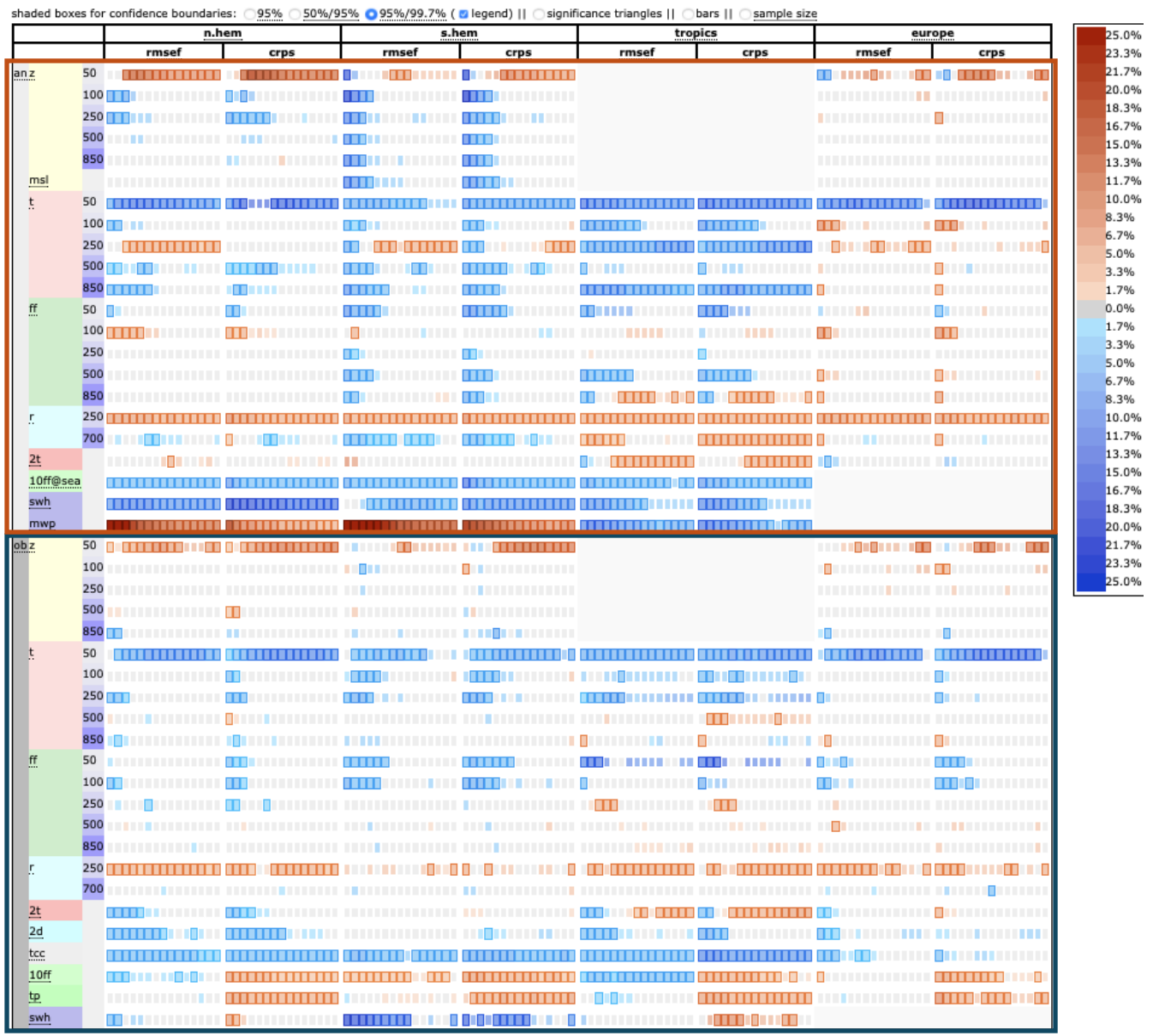
ECMWF

50r1 RD esuite: score cards (summer + winter combined)

ENS Control (=HRES) (430 forecasts)



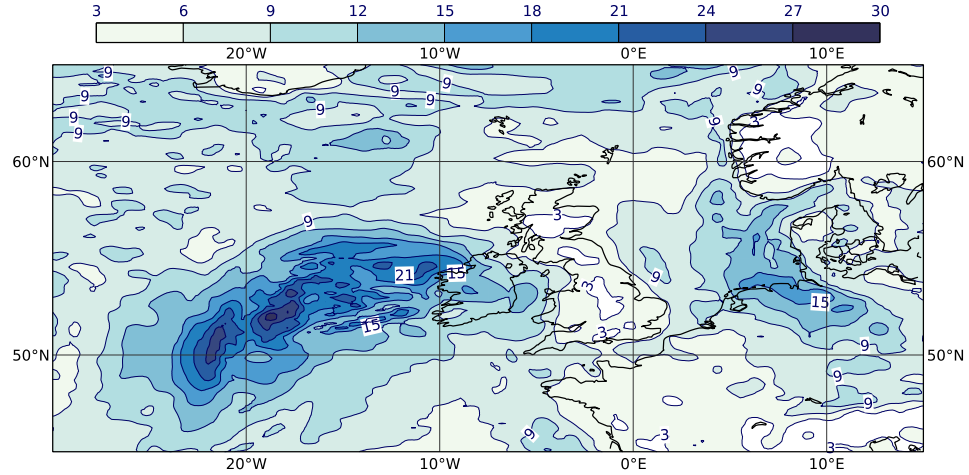
50-member ENS (142 forecasts)



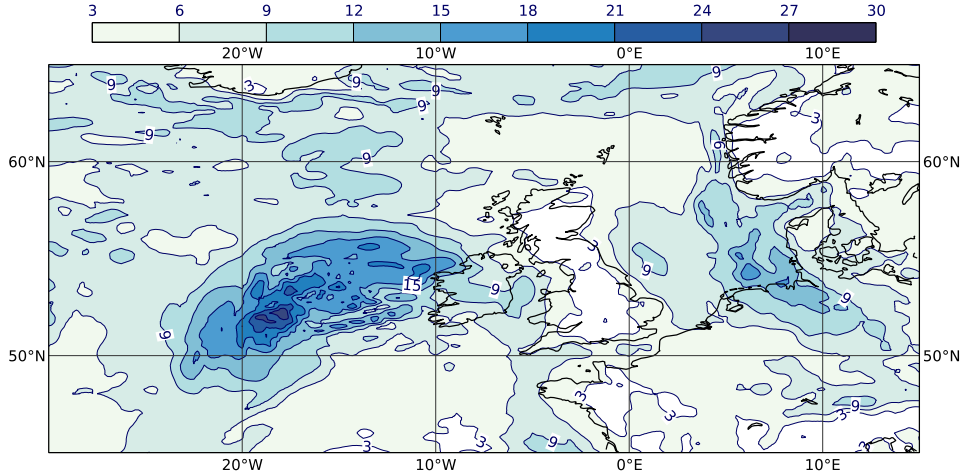
50r1: Responding to known issues

Ensemble range in 10m wind for Storm Daragh (m/s)

49r1

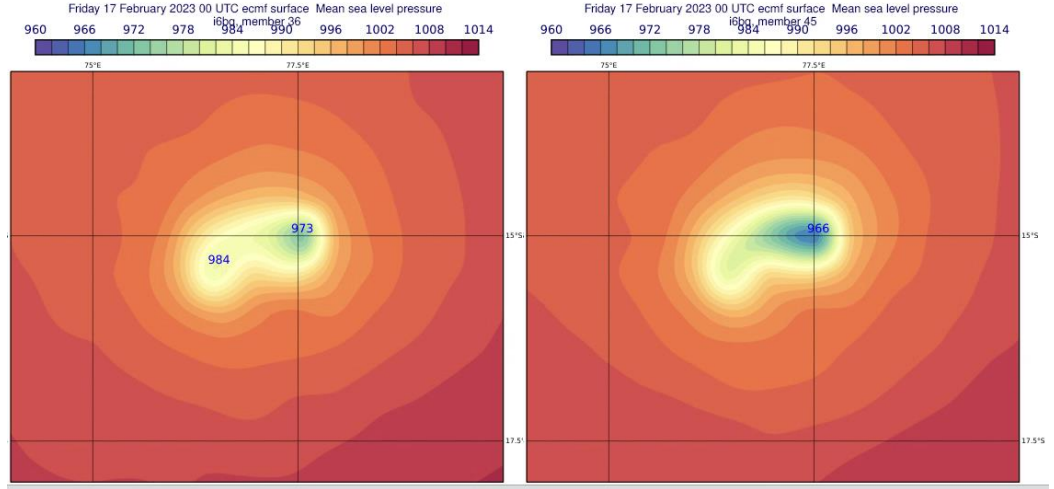


50r1

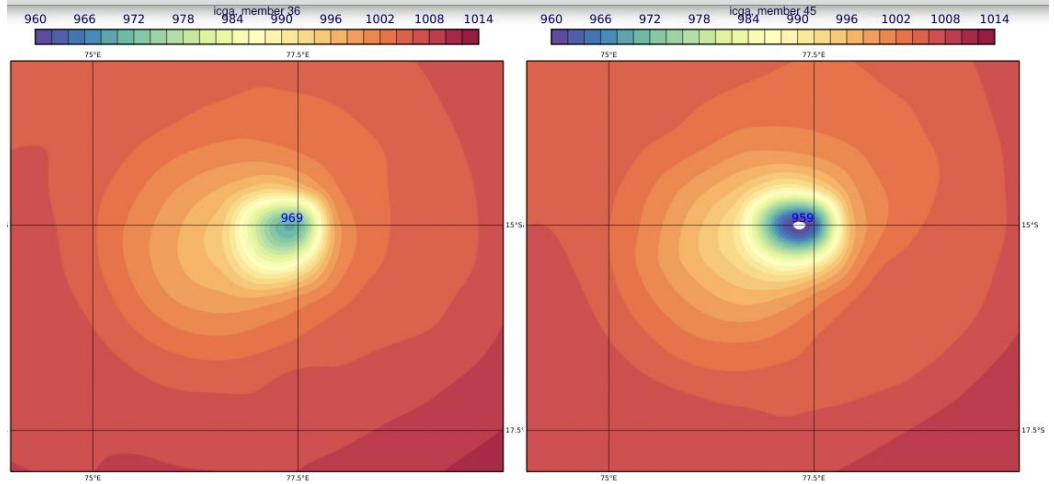


Mean sea level pressure initial conditions, TC Freddy, Two selected ensemble members

49r1



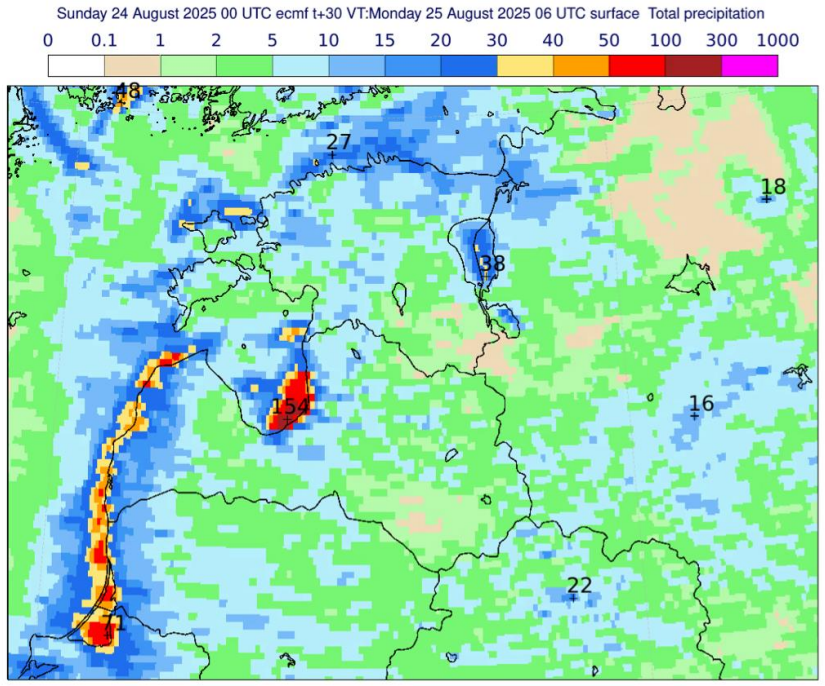
50r1



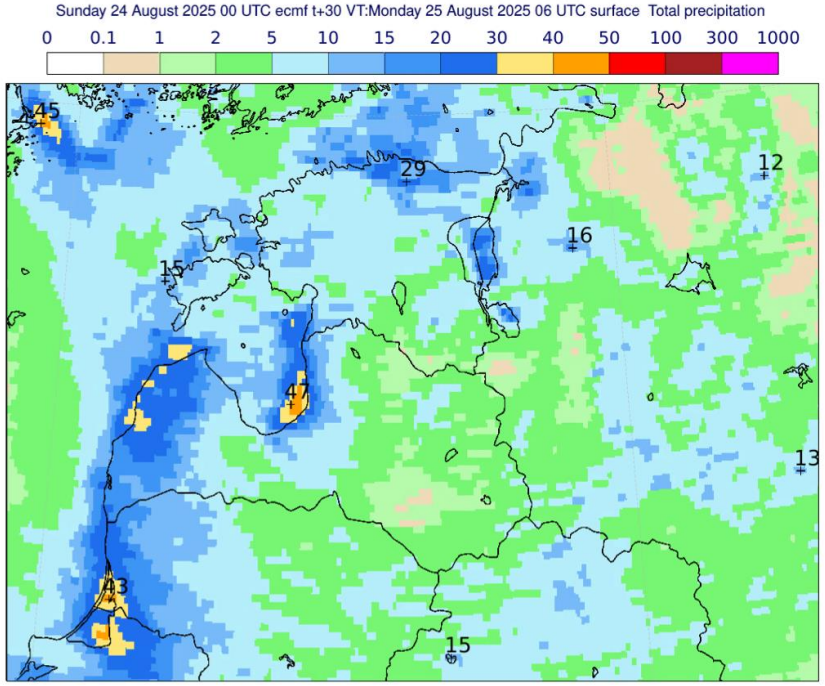
50r1: Responding to known issues

Inland penetration of convection

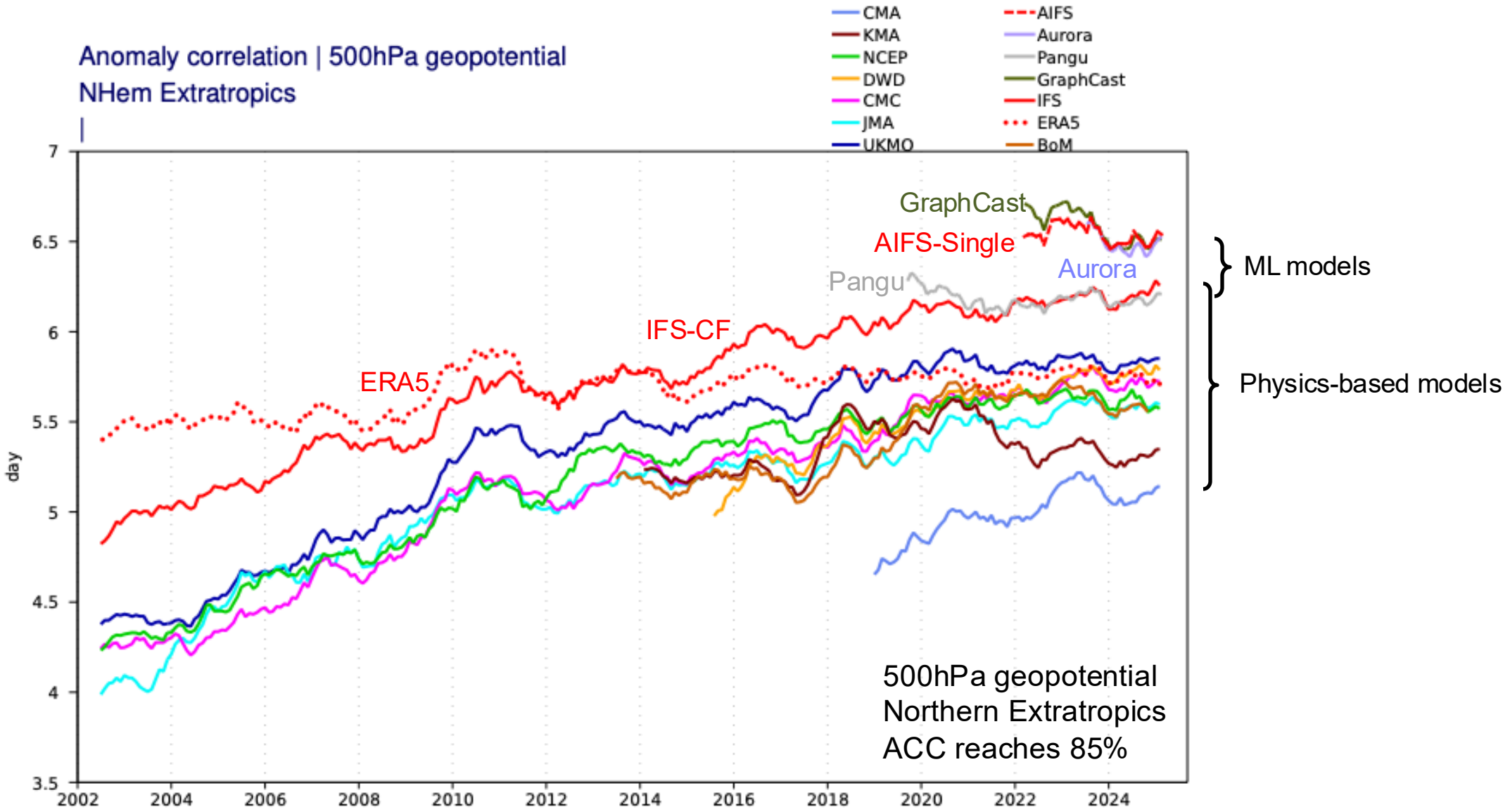
49r1 Total precipitation



50r1 Total precipitation

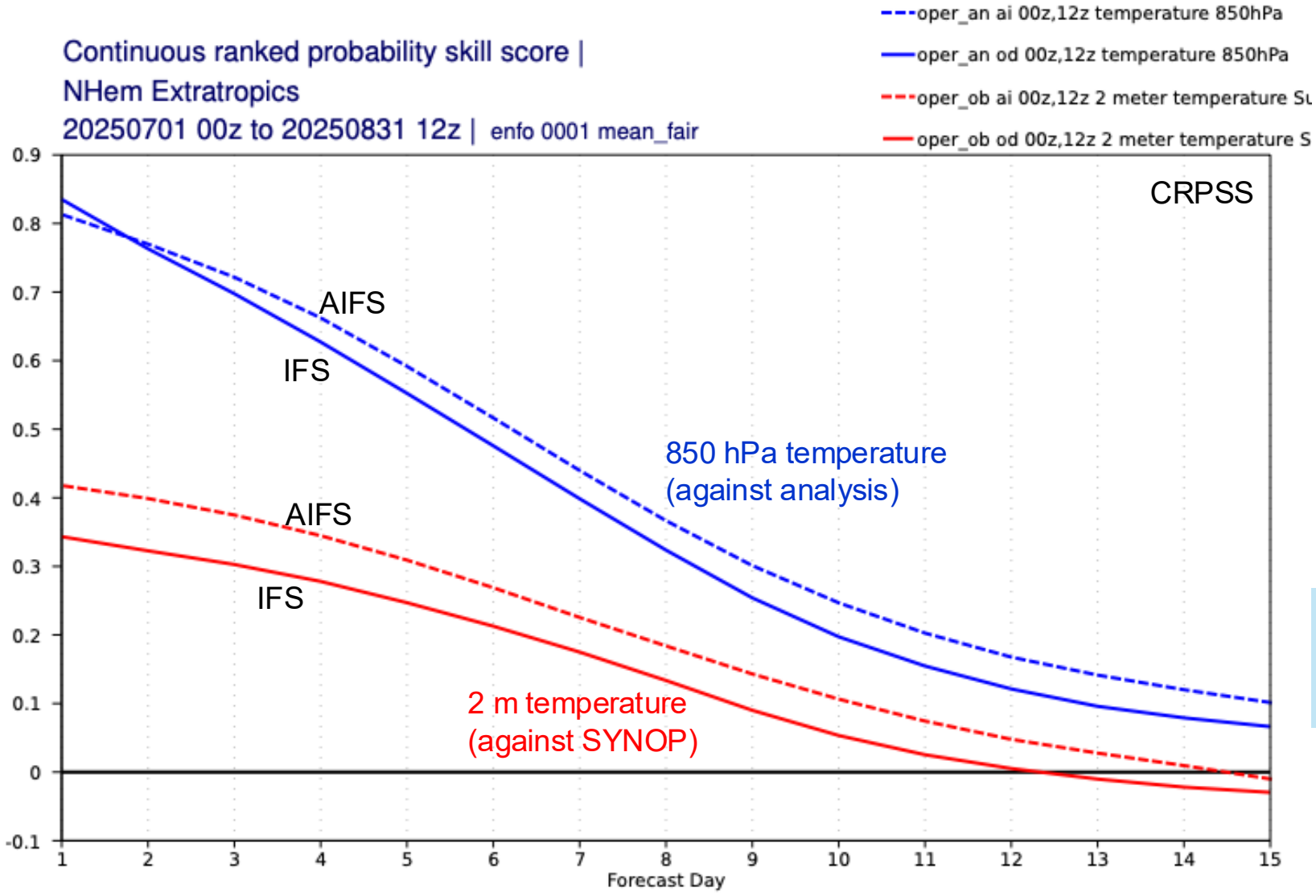


Machine learned models outperform physics-based model for many metrics



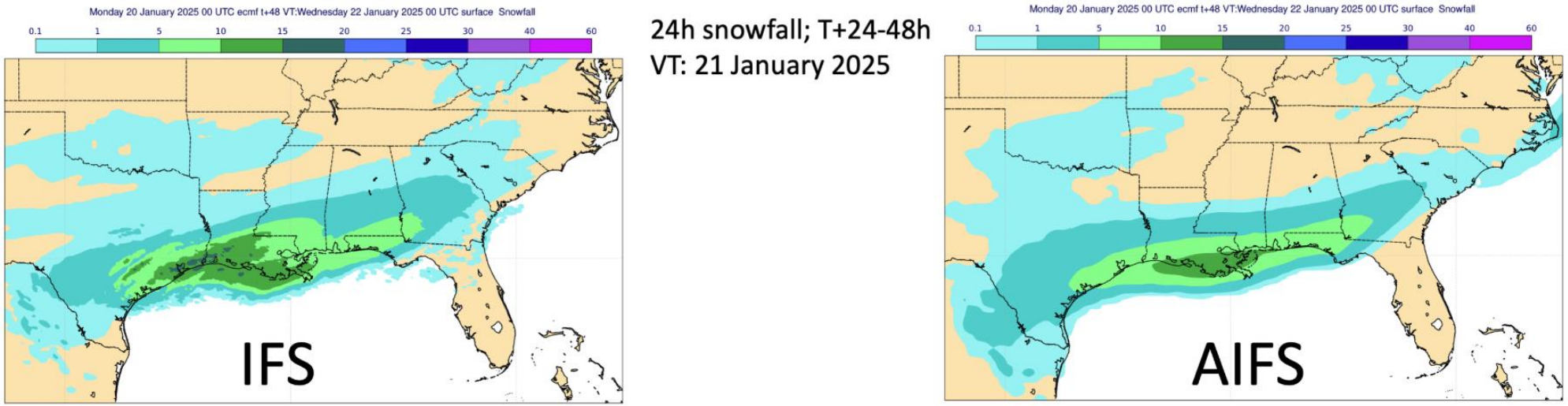
AIFS-ENS (operational since 1 July 2025)

July-August 2025



AIFS generally improves on IFS for upper-air and surface variables

Case Studies: AIFS Single v1

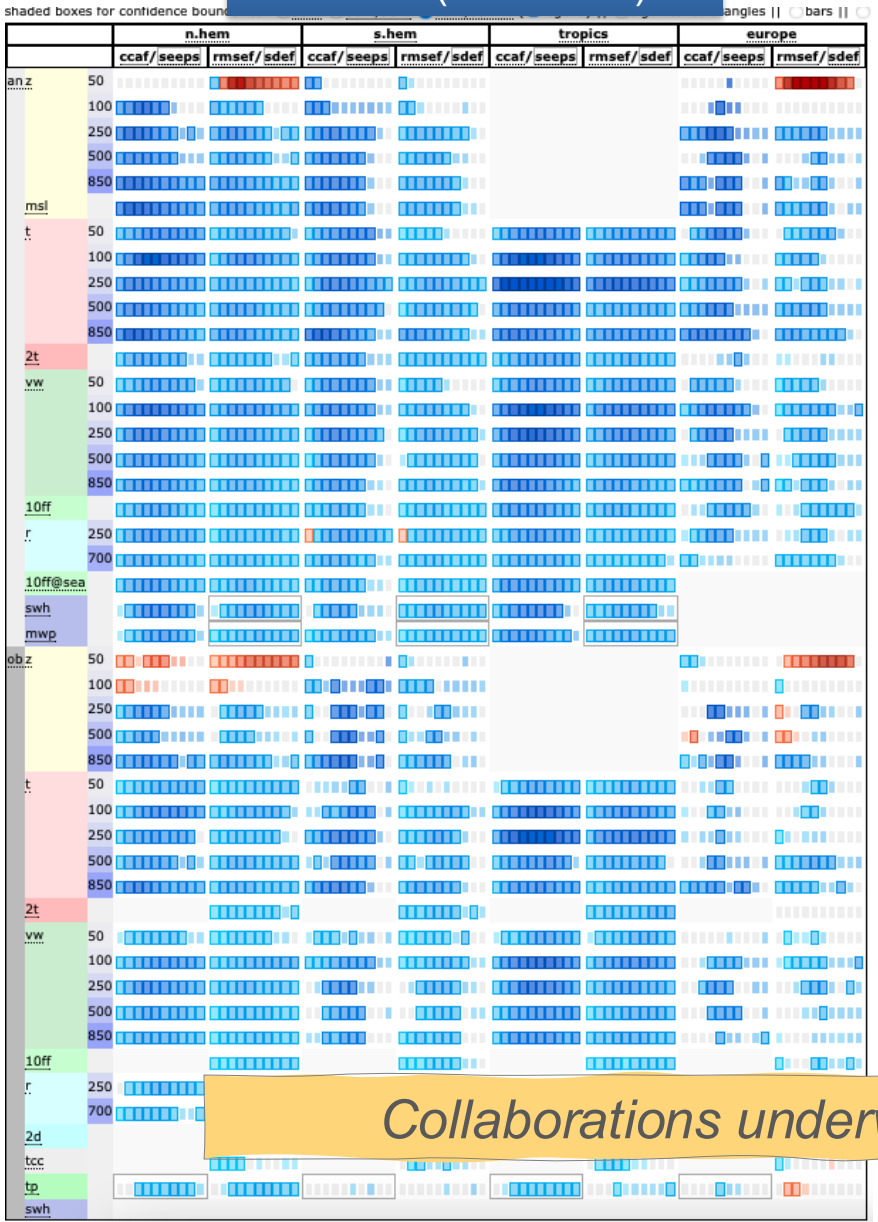


Rare snow along the Gulf Coast

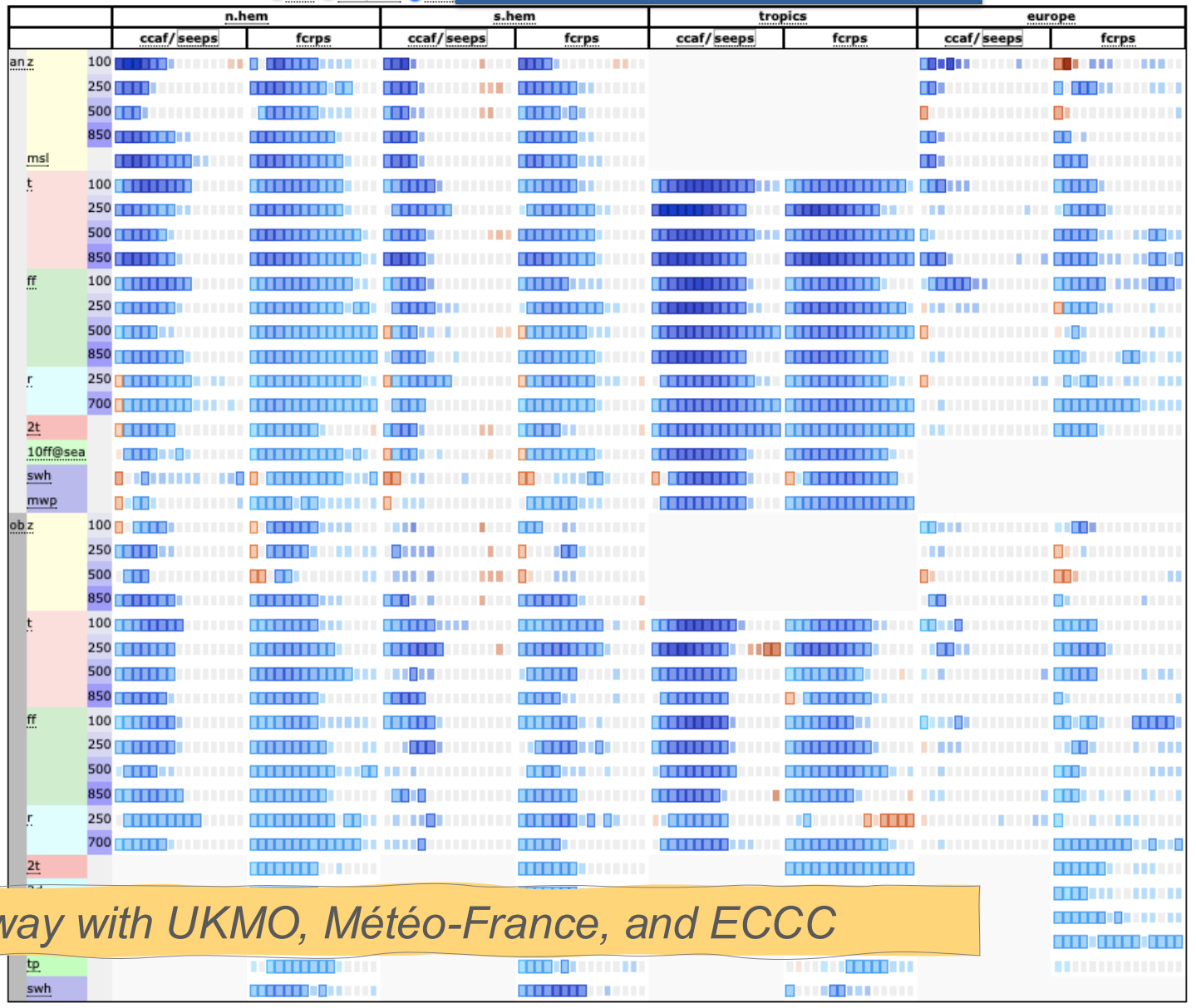
Structure well-predicted but underestimated intensity.

Nudging IFS to AIFS on large scales: CF & PF

CF: 2024 (580 dates)



PF: July-Sept 2024 (175 dates)



Collaborations underway with UKMO, Météo-France, and ECCC

Pros and cons and implementation options

Pros:
- Easiest way to improve scores for the physical model.
- ”Simple” to introduce into R2O as nudging is independent and only switched on “after” model development.
- Often the best of both worlds.
- Products will stay the same.

Cons:
- May not stay the best of both worlds as we increase resolution in AIFS.
- Still needs much more in-depth evaluation in weather discussions etc.
- Needs changes to operational pipeline.

Efforts for implementation:
Additional tests in cycle versioning; re-calibrate AIFS on RD e-suite; switch on nudging in FD e-suite; change of operational workflow to run AIFS version first; load fields for nudging when running CNT and ENS.

Options for implementation:
- Conservative: Introduce new “hybrid” deterministic product next to ENS and CNT.
- Disruptive: Change the physical ENS into a nudged ENS (or 50/50).
  - *Avoiding separate L137 AIFS version? Hindcasts? No-EFI? Limited-area model initialization?*

Timeline?

Thank you