ECMWF – DESTINATION EARTH

PrePEP 2025 (Bonn)

PRECIPITATION FORECAST ENHANCEMENTS IN DESTINATION EARTH: ADVANCING TOWARD KM-SCALE GLOBAL SIMULATIONS

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ECMWF

Funded by the European Union

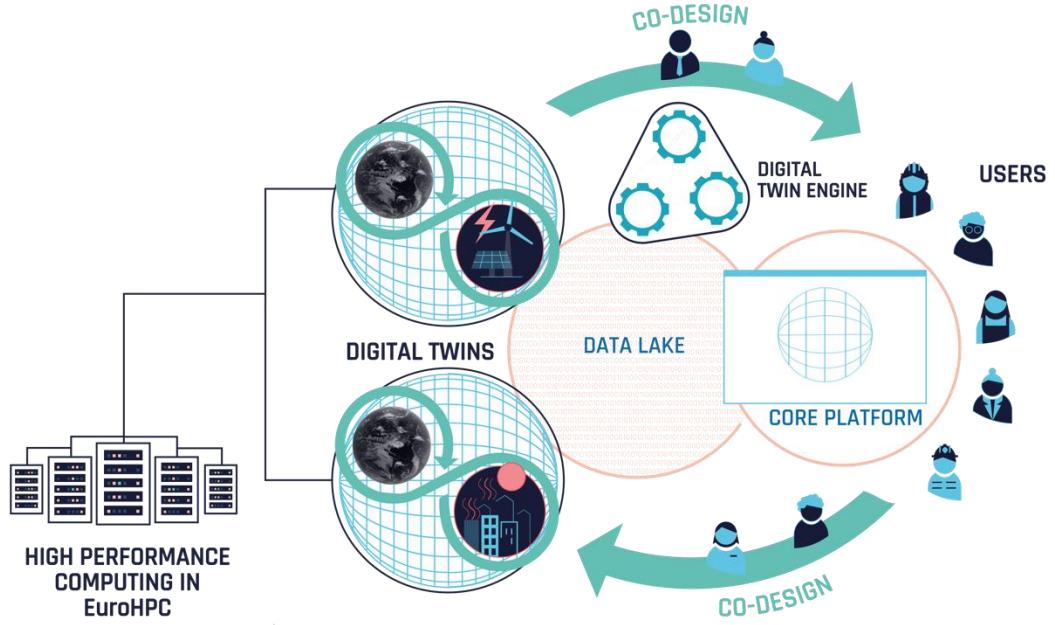
Destination Earth implemented by ECMWF esa EUMETSAT

DESTINATION EARTH (DESTINE) & THE DIGITAL TWINS

- **DestinE:** A European collaboration between ESA, ECMWF and EUMETSAT
- Develop highly-accurate digital model (**digital twin; DT**) of the Earth system
  - **More than physics:** Bringing together Earth-system physical and data-driven models and observations
  - **Realistic simulations:** Indistinguishable from physical world
  - **Goal:** Understand & simulate complex weather/climate interactions
  - **Applicability & interactivity:** Allows testing scenarios and therefore supports decision making

simulations

observations



THE EXTREMES DT : A MAGNIFYING GLASS AT EXTREME WEATHER EVENTS

From daily worldwide simulation of extremes…

… to on-demand refinement over Europe

Global DT

- IFS-NEMO
- 4.4km (¼ deg ocean)
- Hourly outputs
- Initialized at 00Z daily from ecmwf oper (9km)
- Lead time 4 days
- Impact sectors :
  - CaMa-Flood
  - Flexible prognostic aerosols

On-Demand DT

- Arome, Harmonie-Arome, Alaro (Accord consortium)
- 750 to 500m
- Sub-hourly outputs
- Initialized on-demand
- Lead time 2 days
- Impact sectors :
  - Hydrology (9+1 models), Storm surge
  - Air-quality (7 models)
  - Renewable energy (wind, solar)
  - Thermal comfort, Wildfire, Frost

FROM WEATHER FORECAST TO IMPACT SECTORS

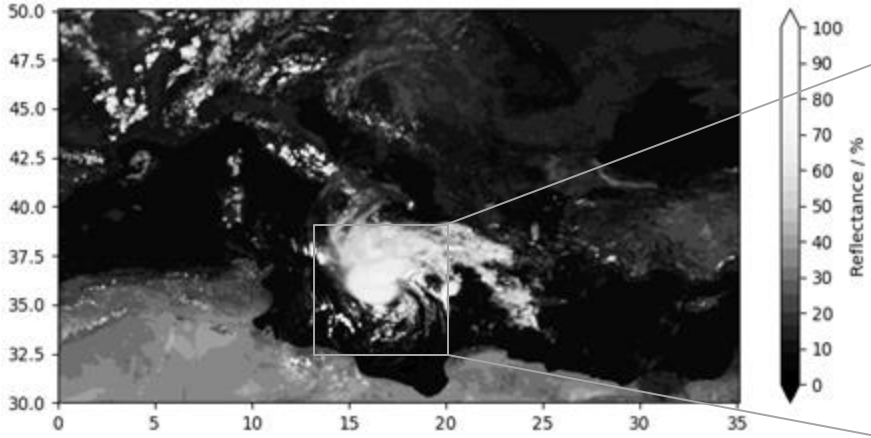
Medicane Ianos is approaching. What will be the state of rivers in 48 hours?

DETECTION / TRIGGERING

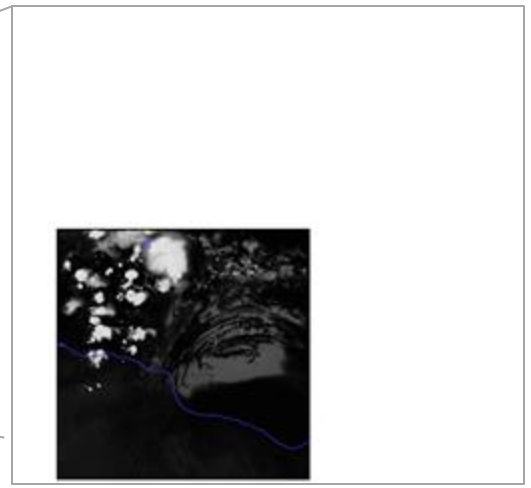
Daily and global monitoring of extreme events 4 days ahead at 4.4km

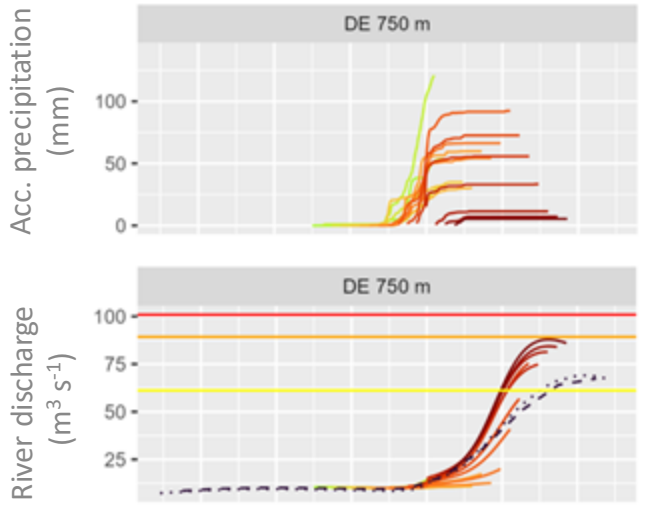
On-Demand regional forecasts of extreme events 2 days ahead at 500m

Impact-sector models:
Forecast evaluation for societal impacts



Storm Ianos, 2020-09-14 00Z, VT 2020-09-16 00Z



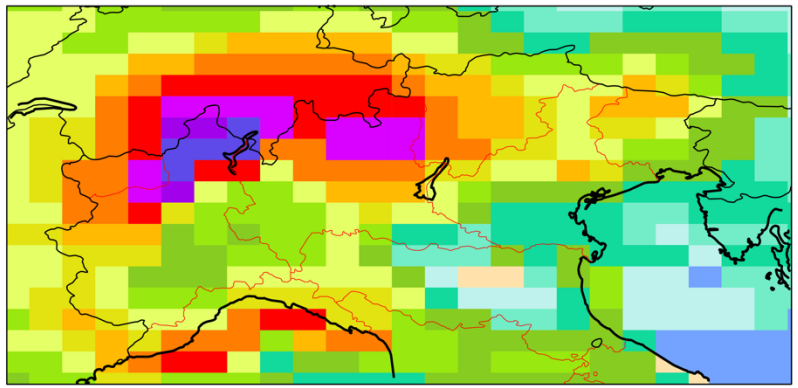


early ini

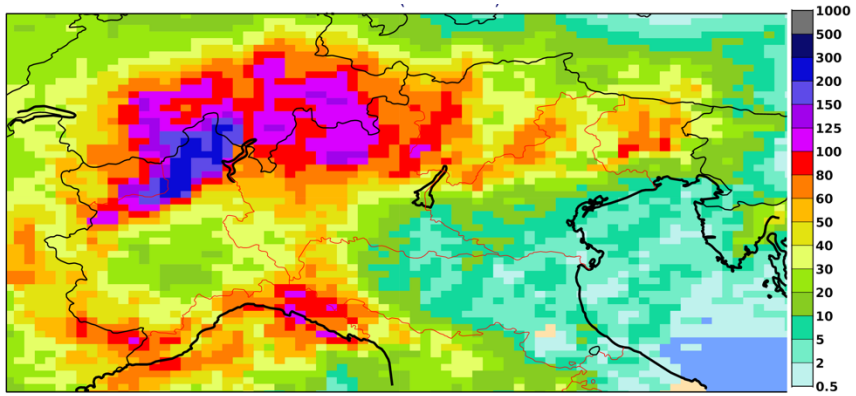
late ini

DOES PRECIPITATION IMPROVE IN KM-SCALE SIMULATIONS?

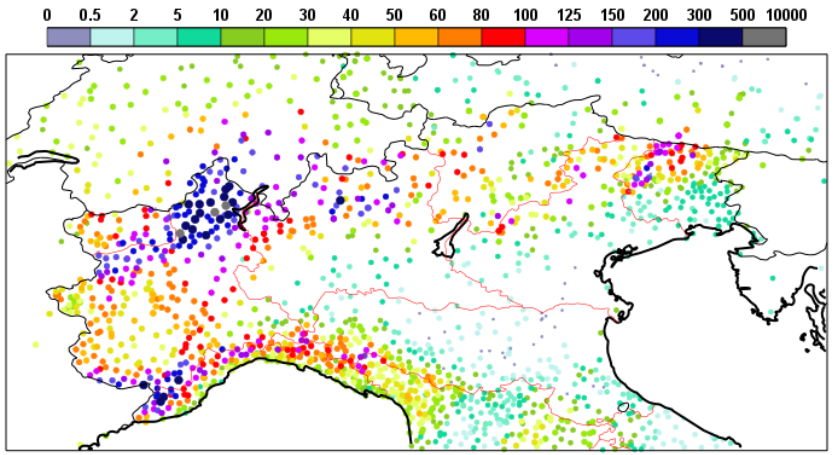
24h accumulated precipitation (mm)
Base time 01/10/2020 00 UTC (T+36h-T+60h).



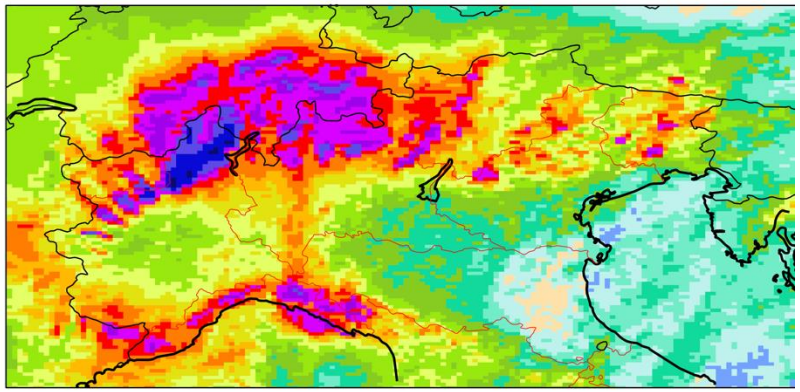
IFS 29 km



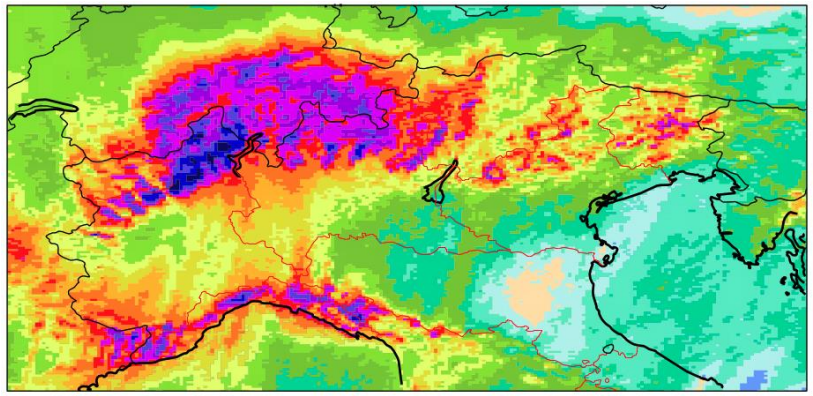
IFS 9 km



Observations



IFS 4.5 km



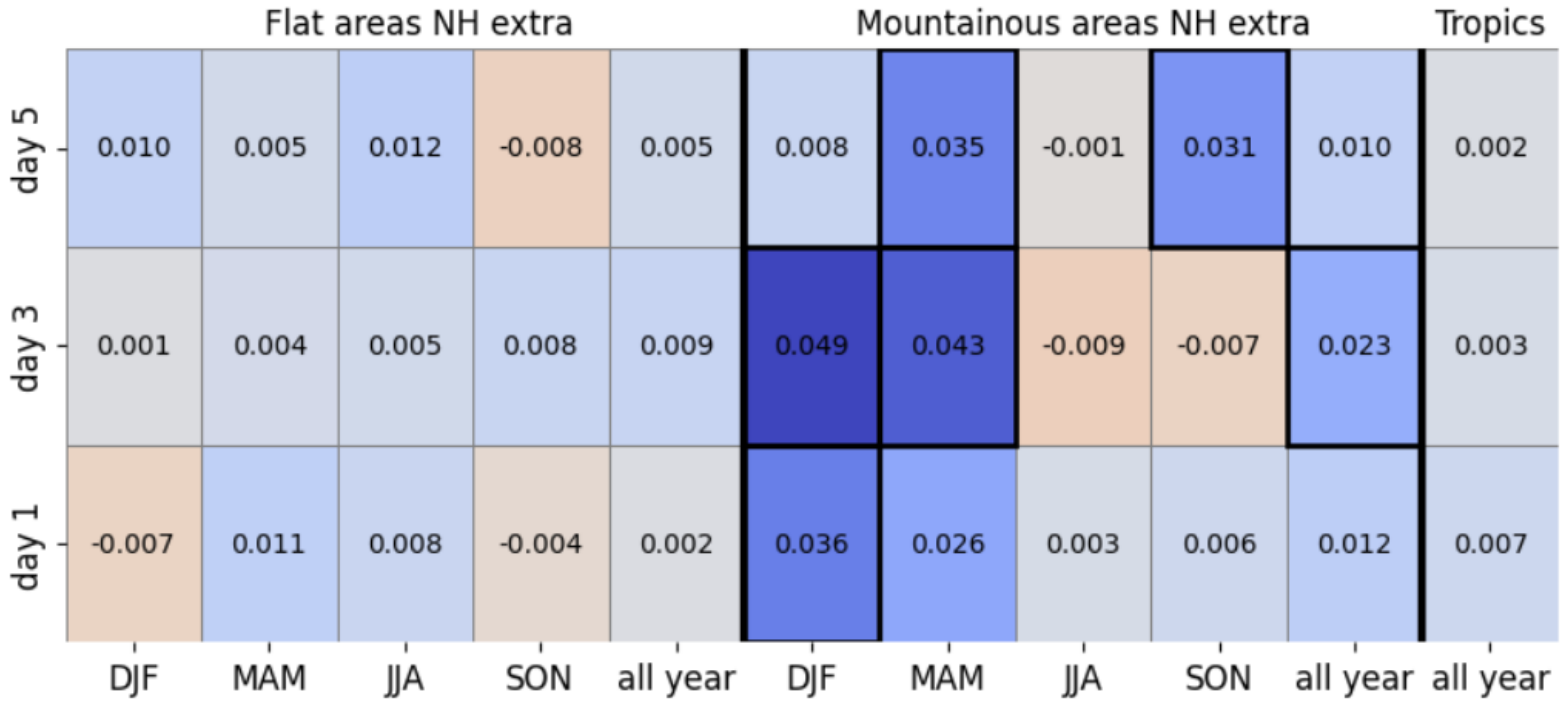
IFS 2.8 km

ECMWF

SCORECARDS FOR EXTREME PRECIPITATION (using the Equitable threat score)

- Tp24h > 99th percentile of the observations, defined for each condition.
- Values correspond to the differences between **DestinE (4.4 km) ETS – IFS (9km) ETS**
- Using nearest gridpoint for each SYNOP station location.

BLUE --> **DestinE** better than oper 9 km

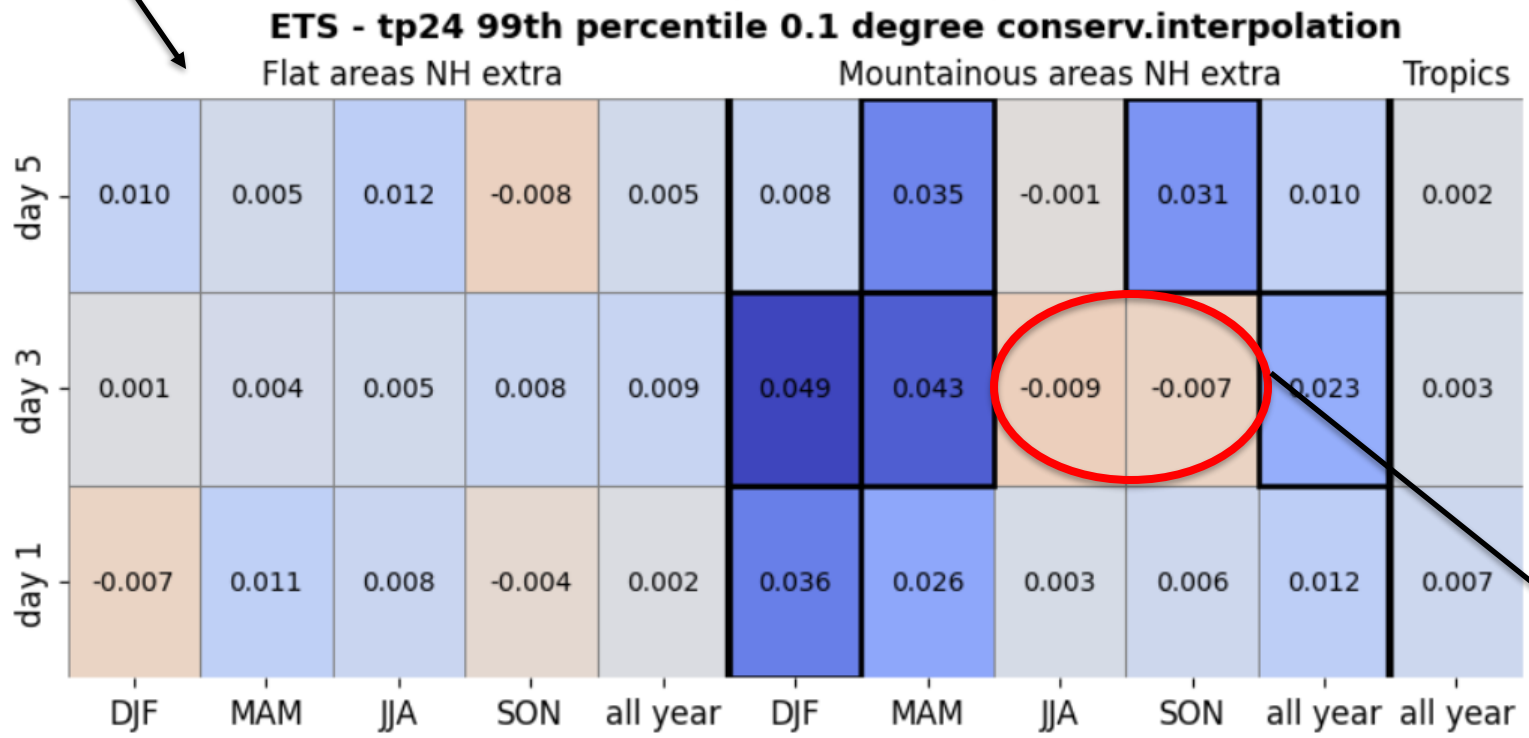


ETS for 99th percentile tp24h. Conservative interpolation applied with 0.1 degrees (both models)

NH extratropics + Tropics

No real improvement of tp24 extremes in DestinE for flat areas in the extratropics

Winter and autumn in mountainous areas, significant improvement. Large-scale precipitation in better represented orography



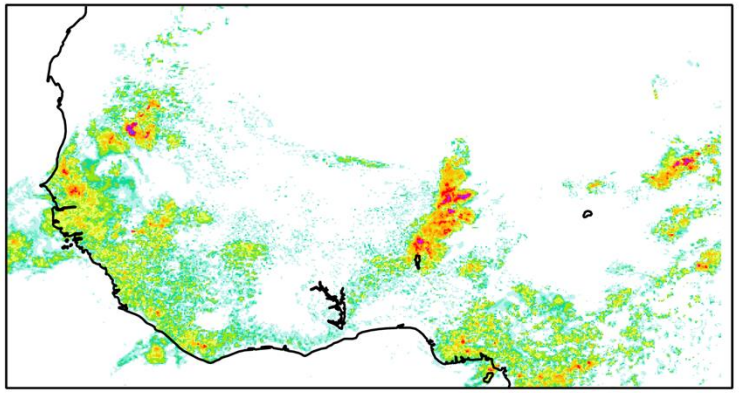
More significant improvements at longer lead times in mountainous areas

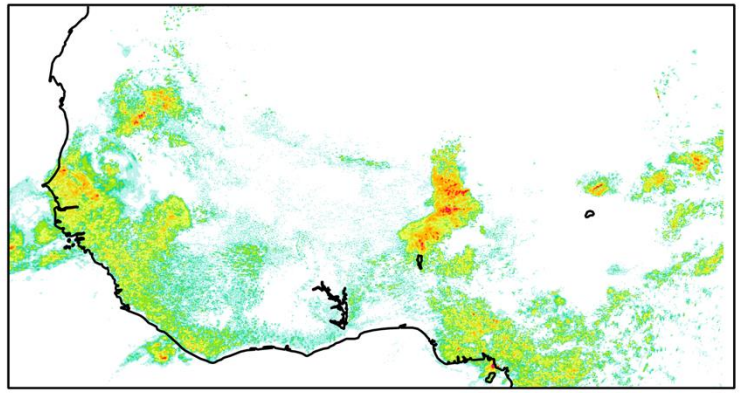
Summer and spring, slight degradation (no significant): more convective activity, probably localised convection: double penalty issue?

BUT… SQUALL LINES IN TROPICAL AREAS

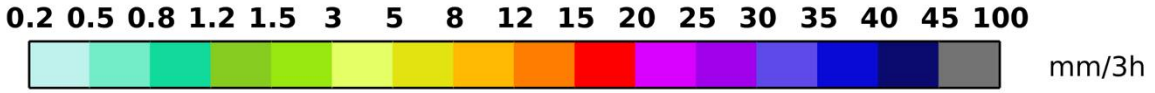
3h accumulated precipitation. Base time 30/07/2020 00 UTC

IFS 9 km



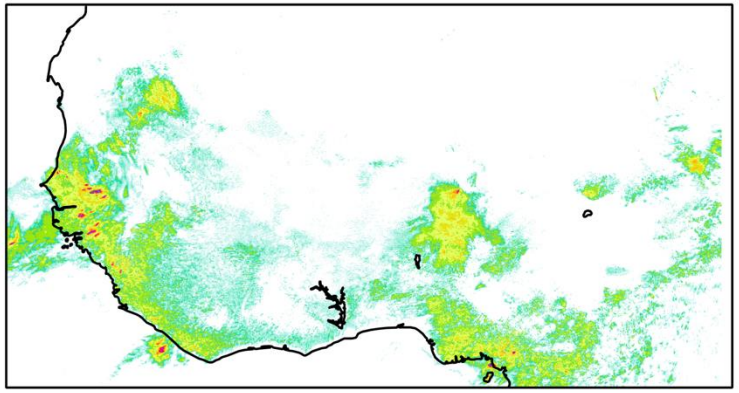


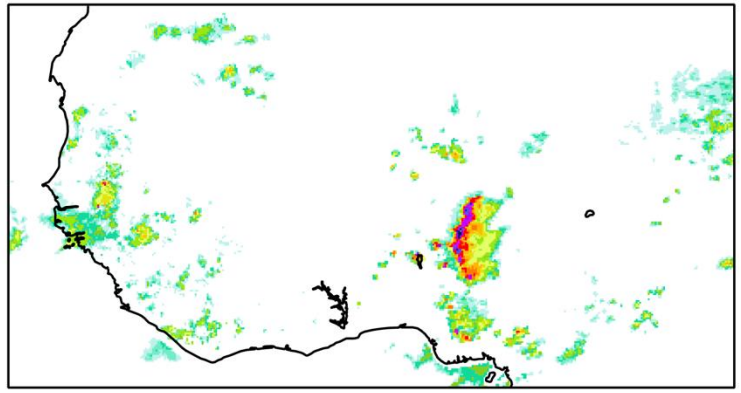
DestinE 4.4 km



T+18h

exp 2.8 km





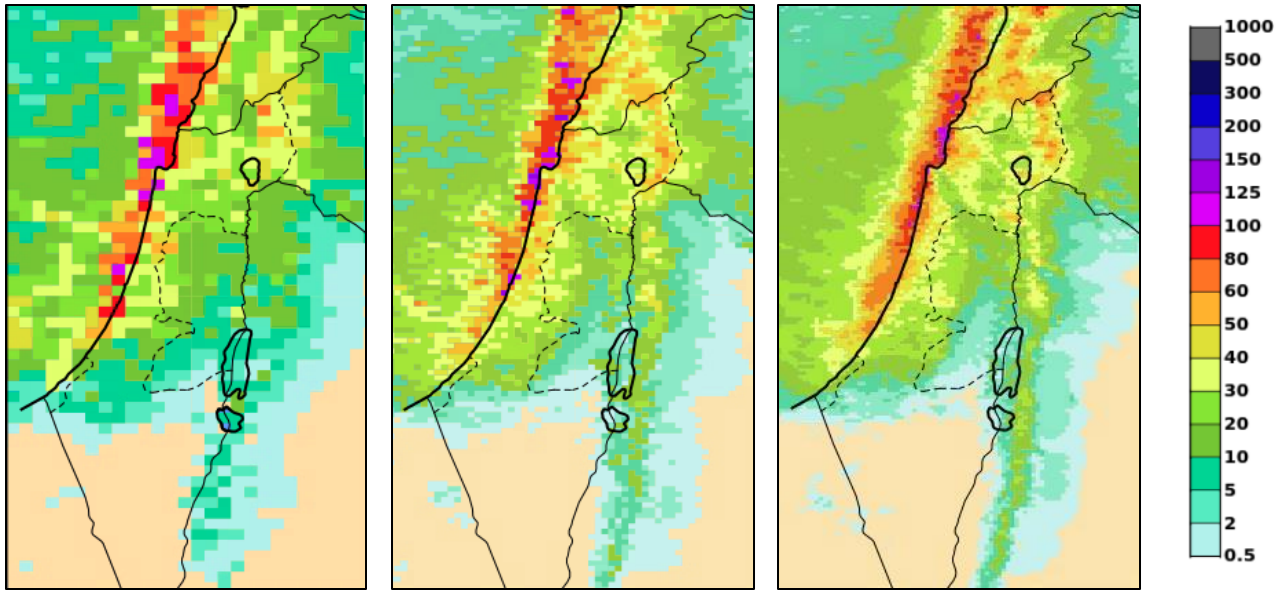
IMERG

BUT…CONVECTIVE PRECIPITATION ALONG THE COAST

Total precipitation in 24h (mm). Valid on 2023-02-01 at 00 UTC

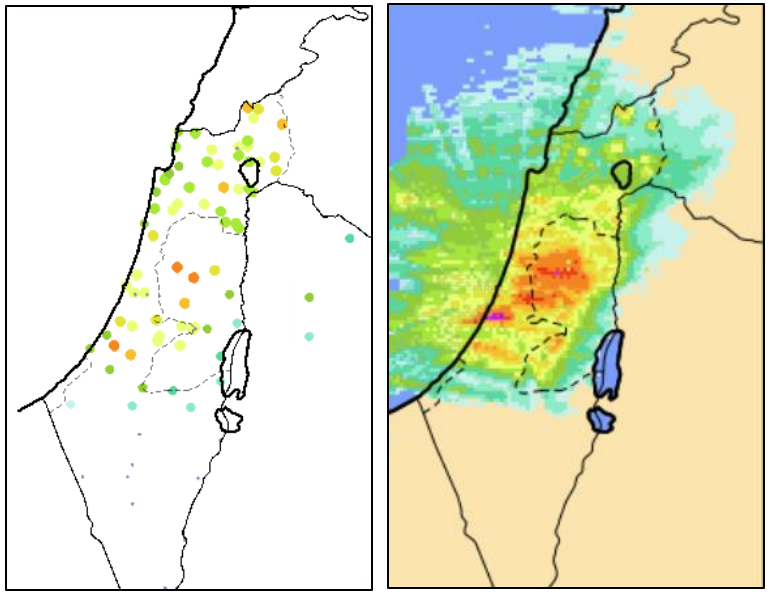
IFS @ T+48 (init 2023-01-30)

9km 4.4km 2.8km



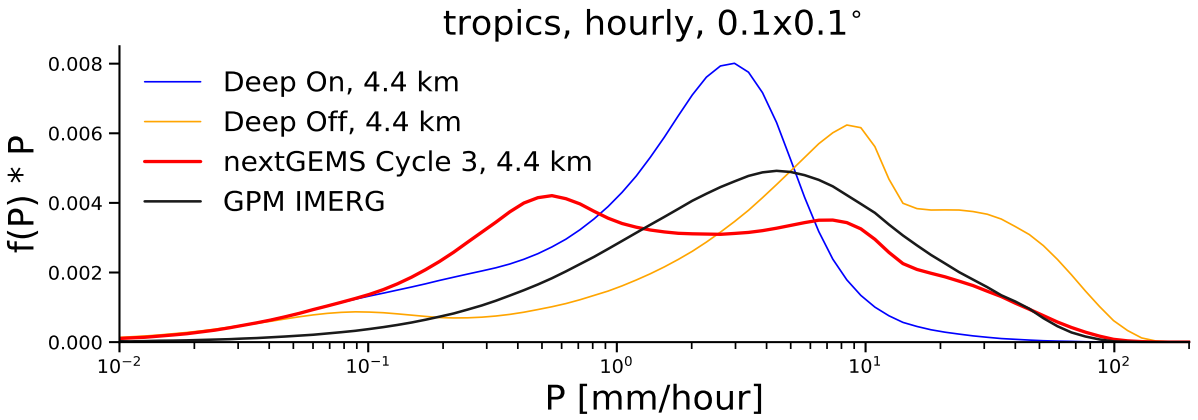
OBS

SYNOP IMS radar

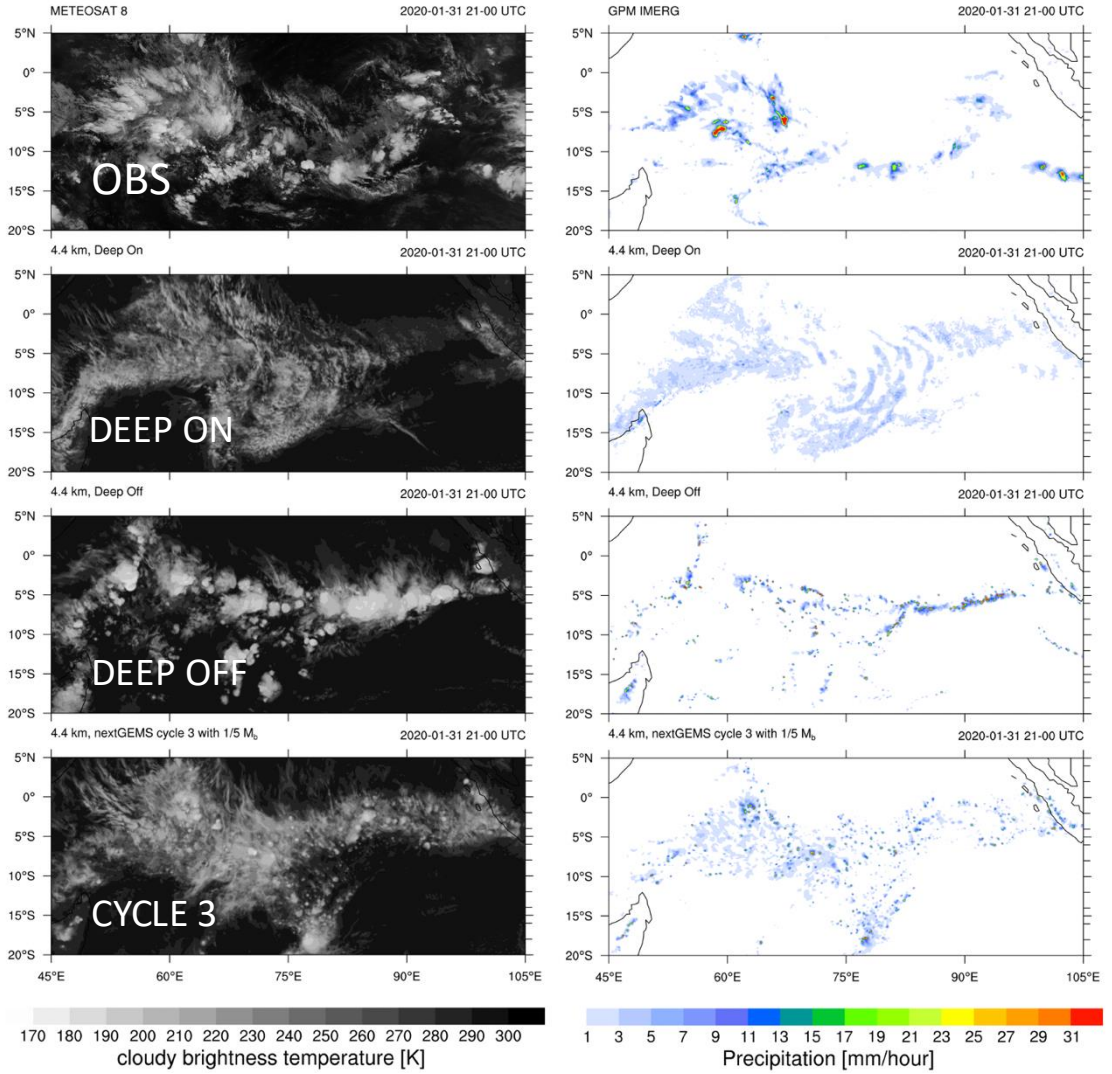


EXPLORING CHANGES IN THE MODEL PHYSICS: BEYOND THE LIMITS OF RESOLUTION

CAN WE TURN OFF THE PARAMETERIZATION OF DEEP CONVECTION?



… NO, but a careful modification of the scheme is required which optimizes both NWP scores and physical realism



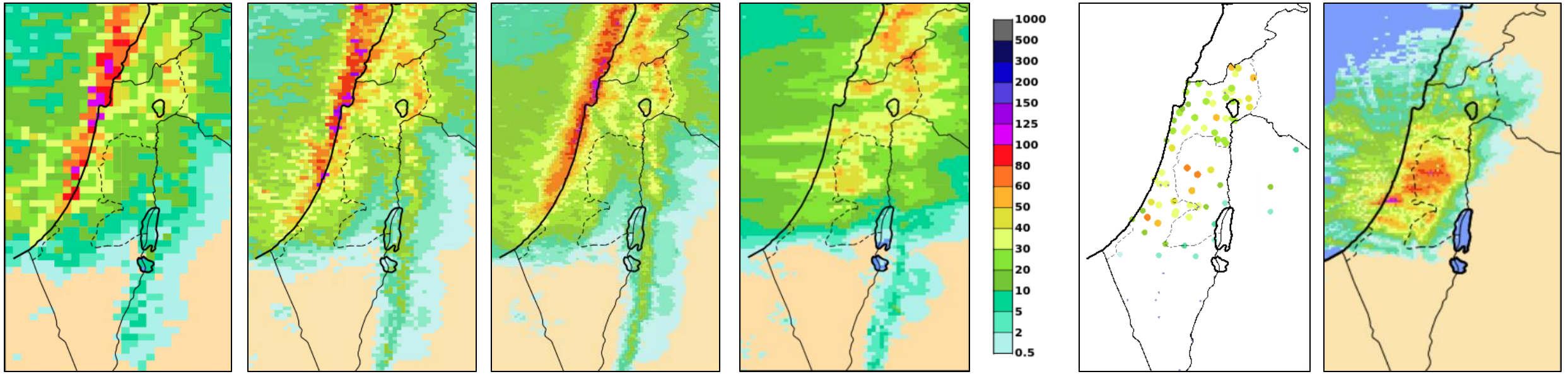
DEVELOPING GLOBAL KM-SCALE FORECASTS : IMPROVING THE MODEL PHYSICS

Total precipitation in 24h (mm). Valid on 2023-02-01 at 00 UTC

IFS @ T+48 (init 2023-01-30)

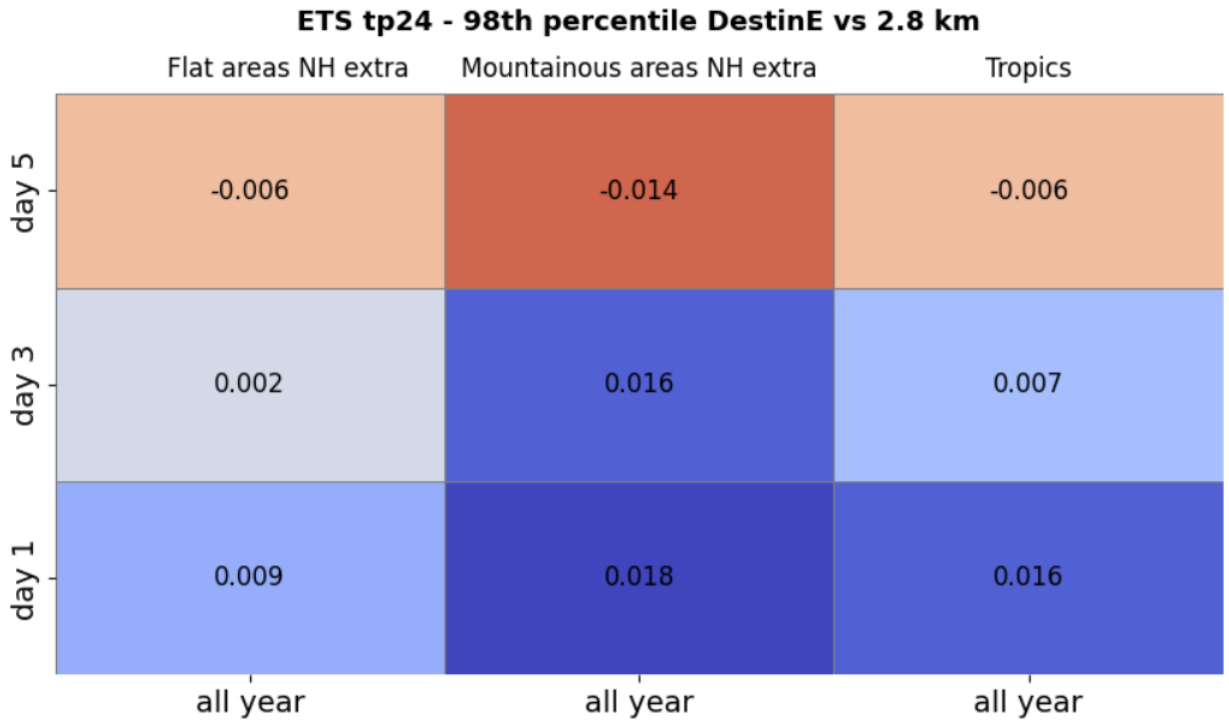
OBS

9km | 4.4km | 2.8km | 4.4km (reduced CBMF) | SYNOP | IMS radar

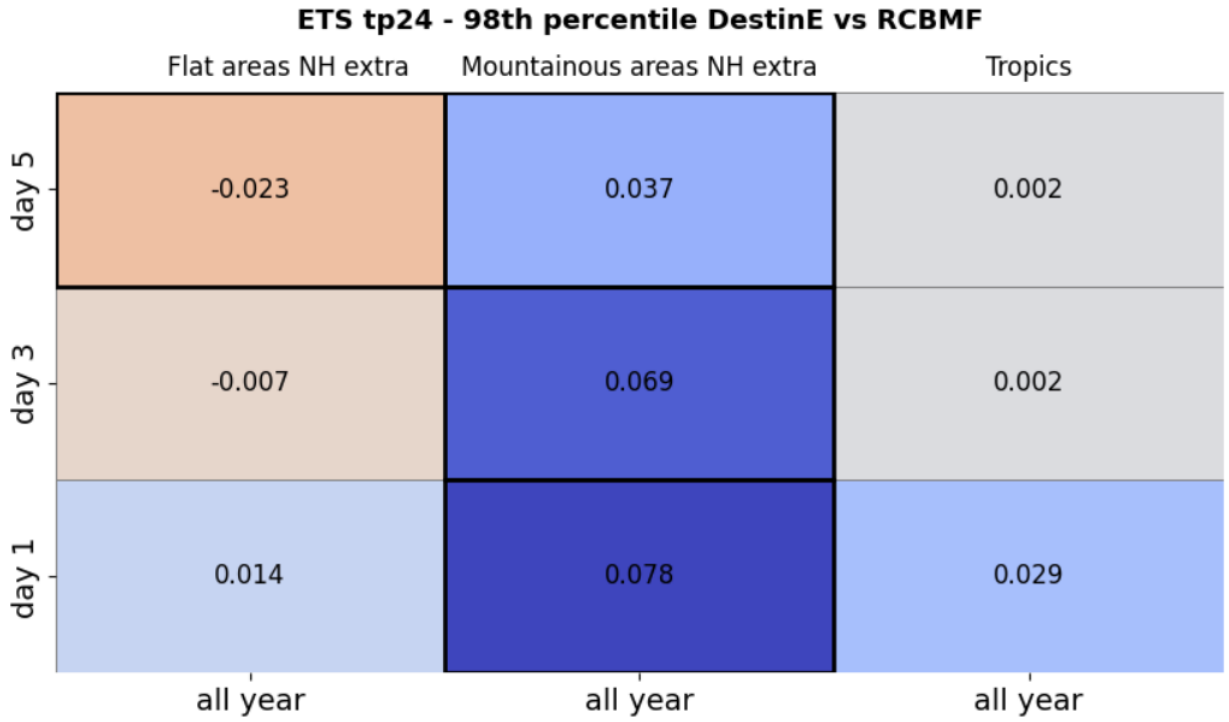


SCORECARDS FOR EXTREME PRECIPITATION: 2.8 KM AND RCBMF

BLUE --> **2.8 km** better than DestinE 4.4 km

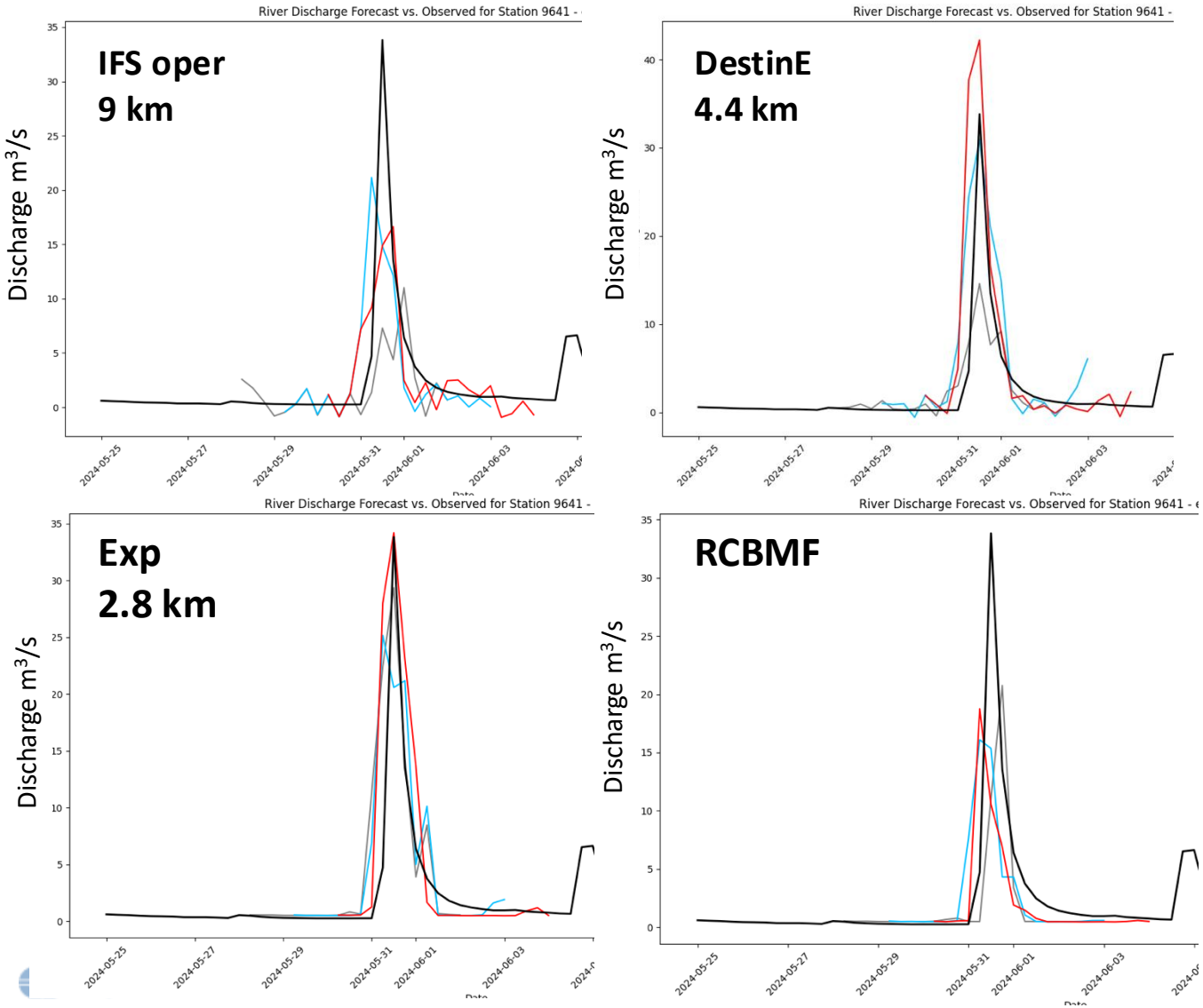


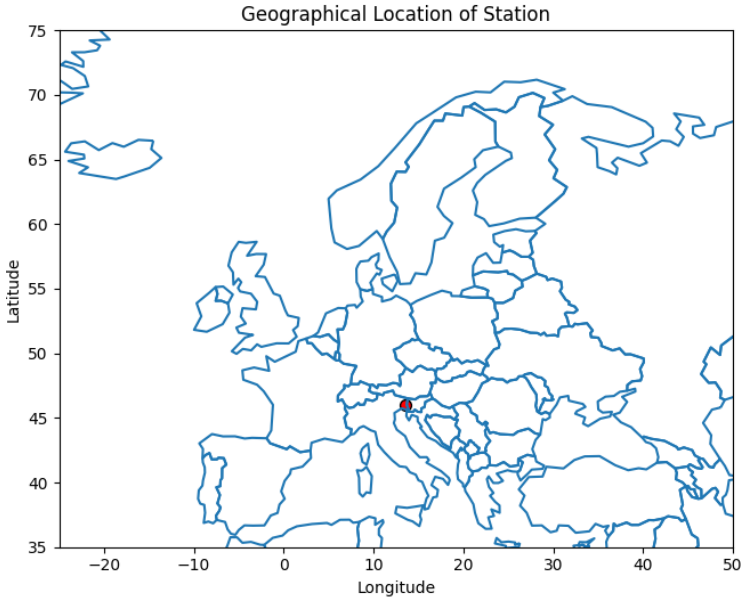
BLUE --> **RCBMF** better than DestinE 4.4 km



FROM WEATHER FORECAST TO IMPACT SECTOR MODELS

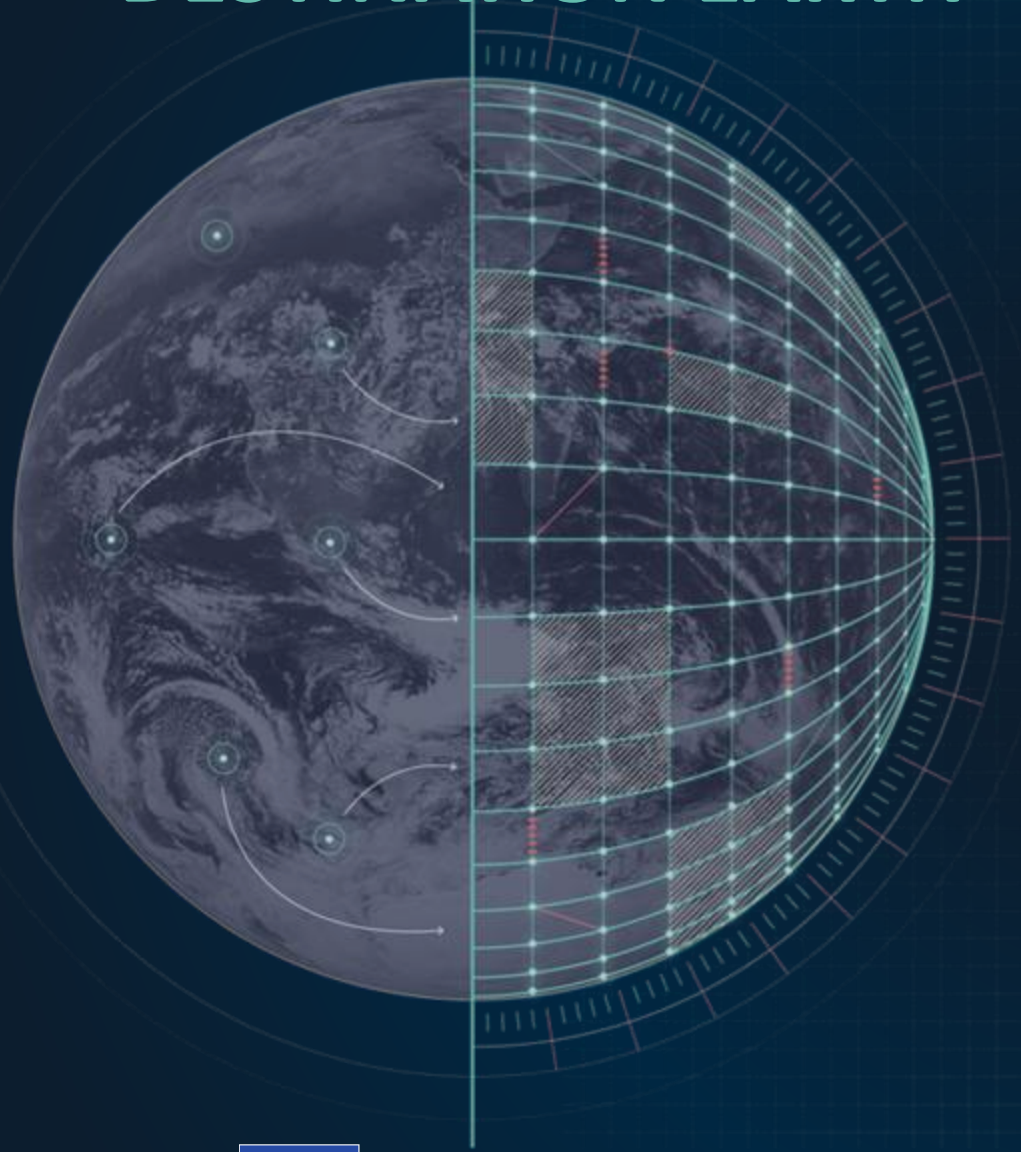
Maliko Tanguy





- Case study of **FLOODS** in northeast Italy on the 31 May 2024.
- Higher horizontal resolutions in NWP models improve the river discharge prediction in this case study.
- However, RCBMF experiment is not much better than the current operational IFS 9 km

DESTINATION EARTH



Thanks for your attention!

https://destination-earth.eu/

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