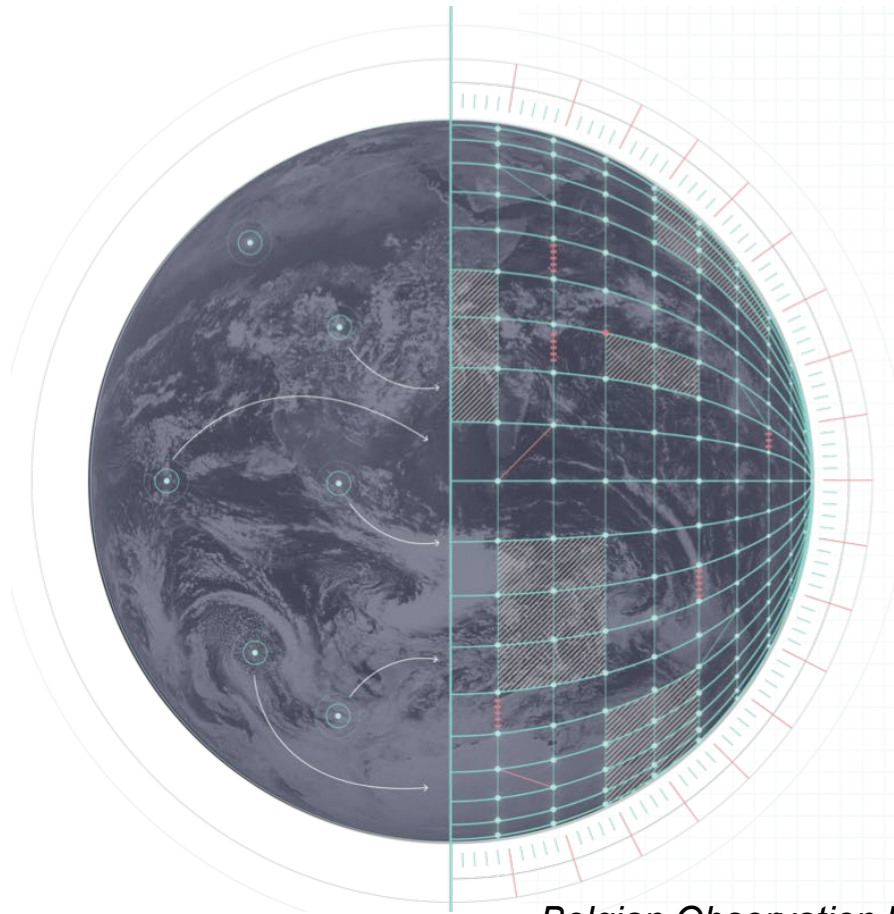


DESTINATION EARTH



Destination Earth from the perspective of the Belgian National Met Service

Piet Termonia

Kristian Pagh Nielsen,
Roger Randriamampianina,
&
The On-Demand Extremes Team

Belgian Observation Days, 14 May 2024, Hasselt, Belgium



Funded by
the European Union

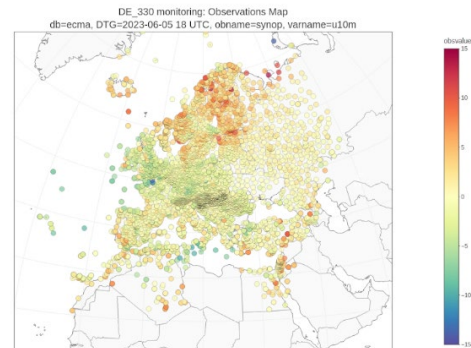
Destination Earth

implemented by



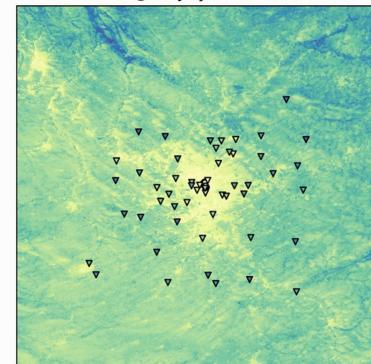
The objectives, among others:

- 1) Pan-European observation processing for verification, post-processing and data fusion
- 2) Configurable, flexible, scalable, and integrated workflows with hectometric resolution weather and impact models
- 3) Load on energy efficient supercomputer platforms (EuroHPC)
- 4) Value demonstration
- 5) Focussed output streams with hypercube selection

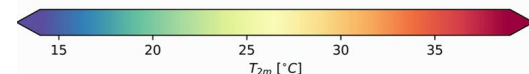


Benedikt Strajnar (ARSO)

PARIS @ 18 July 2022 T00:10



Paris at 200 m, 2m temperature



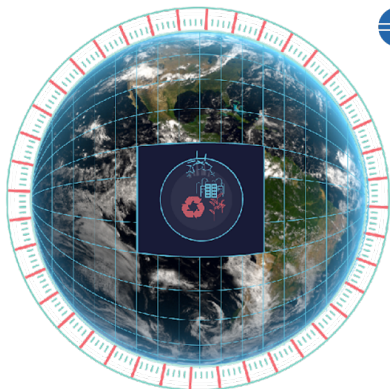
Jean Wurtz (Météo France) and Natalie Theeuwes, (KNMI)



FIRST HIGH PRIORITY DIGITAL TWINS SUPPORT THE GREEN

Climate change adaptation

Weatherinduced extremes



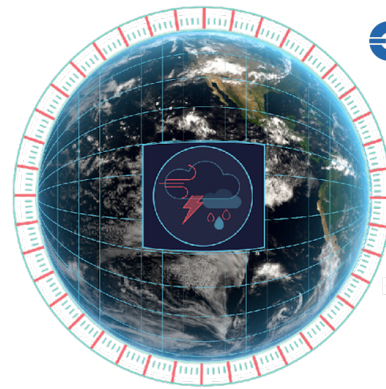
ECMWF



CMC	CMC-IT Center for Science	IT
CSIR	Space Weather Forecasting Center/Centro Nazionale de Supercomputazione	ES
IMR-IM	Max Planck Institute for Meteorology	DE
IASI	University of Toronto	CA
IASI	Applied Engineering Institute, National Centre for Polar and Marine Research	PK
CMR-IAC	Consiglio Nazionale delle Ricerche, Istituto di Scienze dell'Atmosfera e del	IT
	Clima	
IPU/IT	Politecnico di Torino	IT
IMM	French Meteorological Institute	FR
DWD	National Meteorological Service of Germany	DE
UIJT	Institute for Environmental Research	BE
UKMO	University Corporation for Atmospheric Research	US
CMR	Centro Meteorologico	IT
HRF	Research Park of the University of Helsinki	FI

To support policymaking for adaption

Multi-decadal timescales



ECMWF



For rapid response to extreme events

For a few days ahead

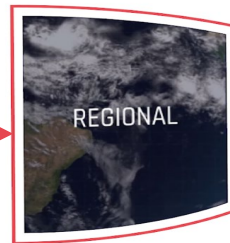


THE EXTREMES DT : A MAGNIFYING GLASS AT EXTREME WEATHER

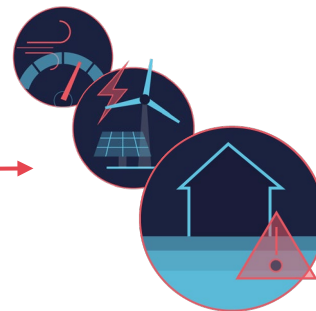


GLOBAL

DETECTION/
TRIGGERING



REGIONAL



Global and **daily** monitoring of extreme weather
4 days ahead at **4.4km**

IFS-
NEMO



On-Demand regional simulations
2 days ahead at **750m** to **500m**

Arome
Harmonie-Arome
Alaro

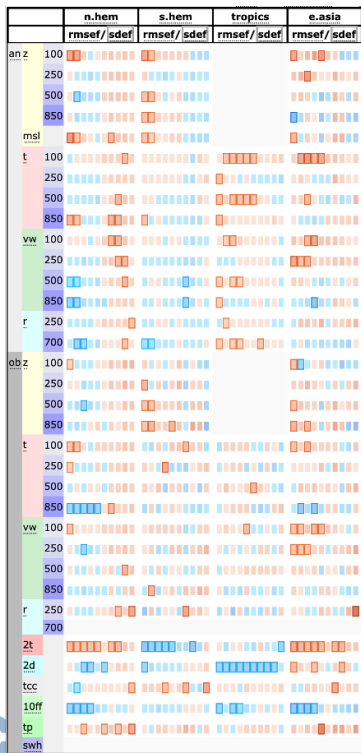


Impact-sector models:
Forecast evaluation for societal impacts



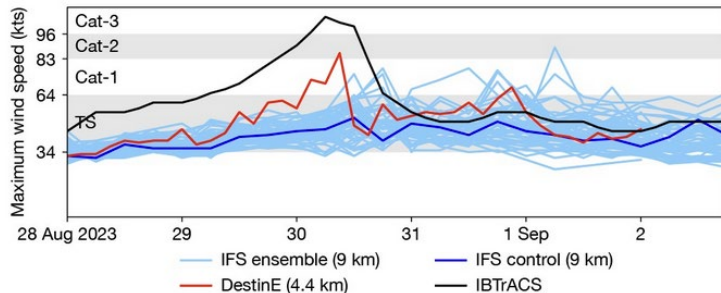
First comprehensive evaluation of a global km-scale weather forecast

DestinE vs HRES (15 dates)

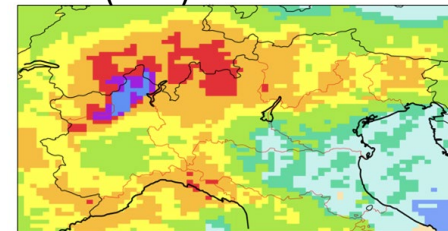


... but higher resolution is beneficial for TC prediction and orographic precipitation (e.g. Storm Alex, 24h precipitation, VT 2020-10-01, Step 72)

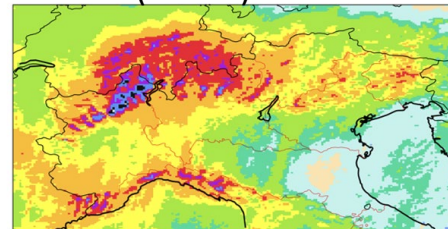
Medicanes and tropical cyclones (e.g. TC Idalia, init 2023-08-28)



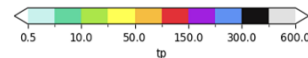
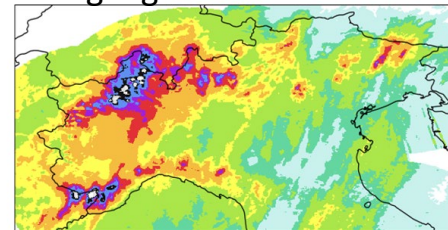
HRES (9km)



DestinE (2.8km)



Rain gauges



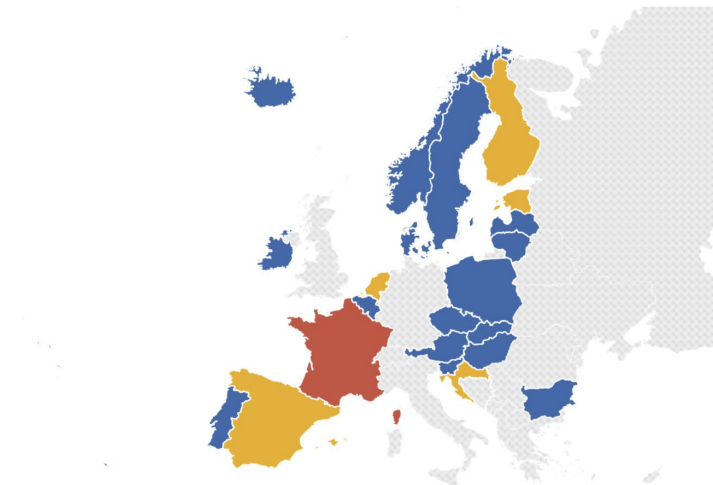
DESTINATION EARTH On-Demand Extremes DT Team



DestinE On-Demand Extremes (DE_330_MF) digital twin map of partner countries

Participant Countries and agencies

- Sweden ■ Spain ■ Slovenia ■ Slovakia ■ Portugal ■ Poland ■ Netherlands ■ Lithuania ■ Latvia
- Ireland ■ Iceland ■ Hungary ■ Finland ■ Estonia ■ Denmark ■ Czech Republic ■ Croatia
- Bulgaria ■ Belgium ■ Austria ■ France ■ Norway



Source: MeteoFrance • Hover in the countries to read the entities involved.
 Yellow: Countries with another agency involved in addition to the National Hydro-Meteorological Service. Otherwise Blue when only the NHMS is a partner.

Management Team
E. Gérard; N. Guenova-Rubio; M. Canzek
R. Randriamampianina; K. P. Nielsen
L. Auger; P. Termonia; C. Wittmann

DT development

DT deployment & operation

DT uncertainty qualification

Impact modelling

Continuous evolution of the on-demand Extremes DT configuration (WP10)
N. Theeuwes; P. Termonia; L. Auger

Operation of the on-demand sub-km scale prediction European Extremes framework (WP9)
X. Yang; U. Andrae

Uncertainty quantification and decision-ready information (WP11)
I.-L. Frogner; A. Kann; S. Vannitsem

High-resolution data-driven uncertainty quantification (WP14)
T Nipen; L. Denby

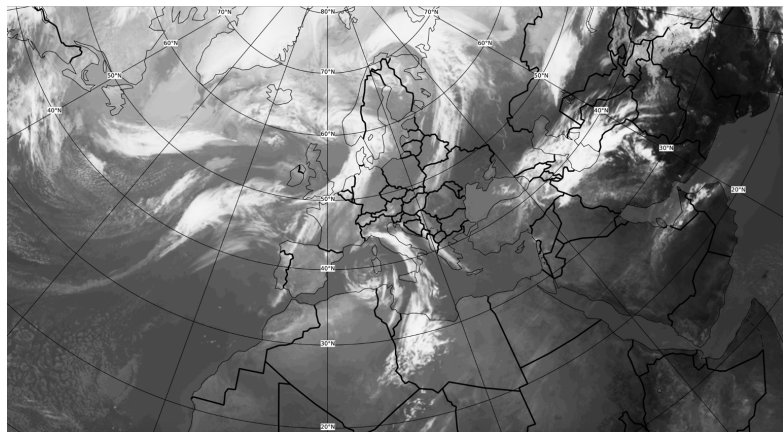
Renewable Energy and Health (WP12)
M. Hirtl; I. Schicker; K. Horvath

Flooding and Agriculture (WP13)
U. McKnight; I. Maljutenko

Running daily the Global DT and selected extreme events in the DEODE

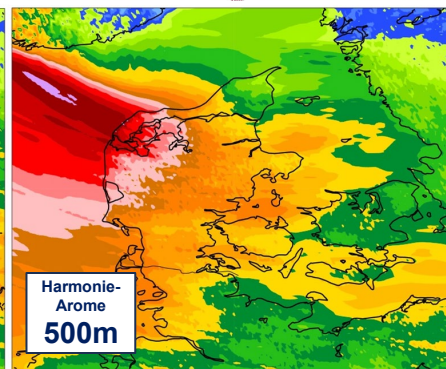
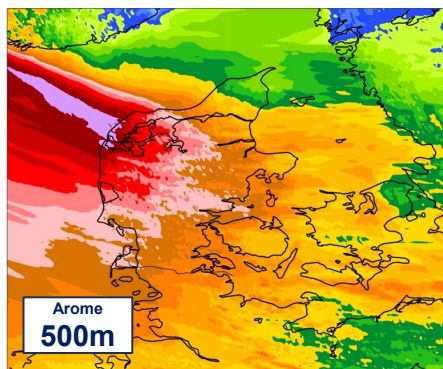
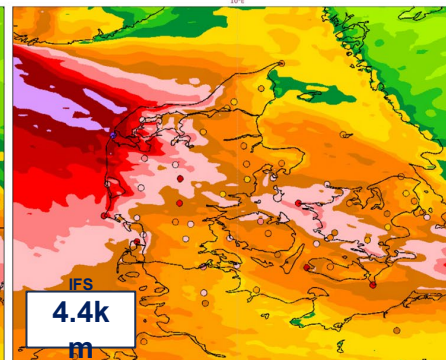
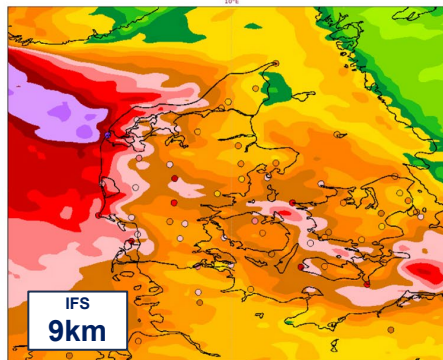
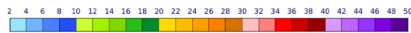
Running daily the first global medium-range forecasts at less than 5km in near real-time and pushing diagnostics to ecCharts...

... and verifying jointly extreme events in the two components of the DT



Brightness temperature (K)

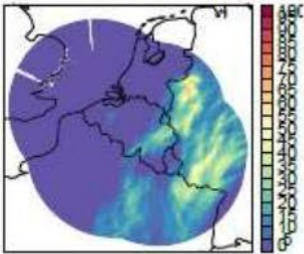
2024-04-08 00Z, VT 2024-04-11 06Z, Step 78



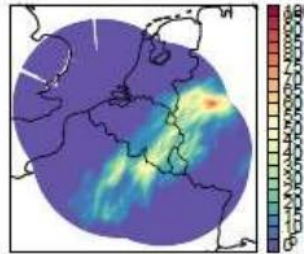
Storm Pia, 24h-max 10m-wind gust
2023-12-20 00Z, VT 2023-12-22 00Z

Floodings in 2021, Vesdre, Belgium, state of the art: 1.3-km resolution forecast

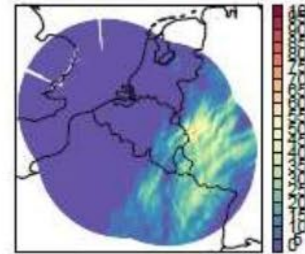
ao13 precipitation
20210714 1-12h cumulated
12h in advance



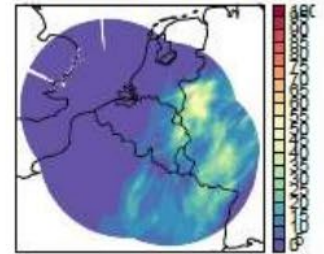
OBS precipitation
20210714 1-12h cumulated



ar13 precipitation
20210714 1-12h cumulated
12h in advance

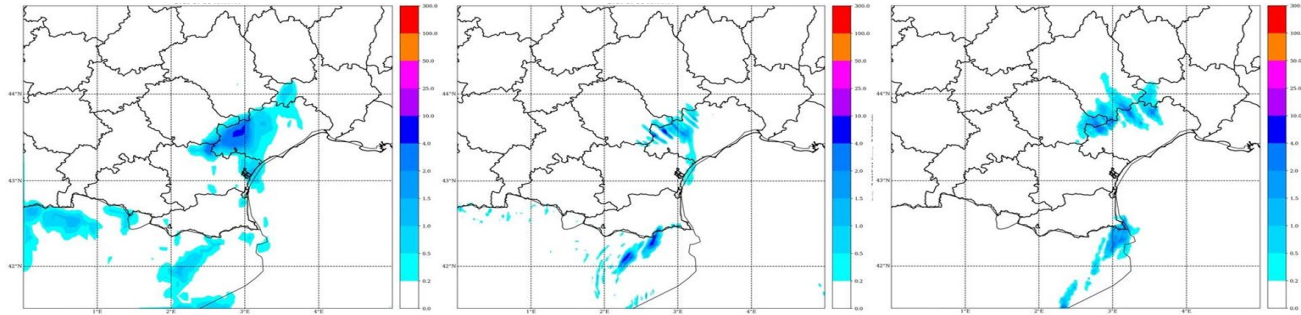


ao40 precipitation
20210714 1-12h cumulated
12h in advance



*National Meteorological Services depend on state-of-the-art NWP systems.
In 2021 RMI used this configuration of the AROME model at a resolution of 1.3 km*

Added value of the sub-km scale in the On-Demand DT

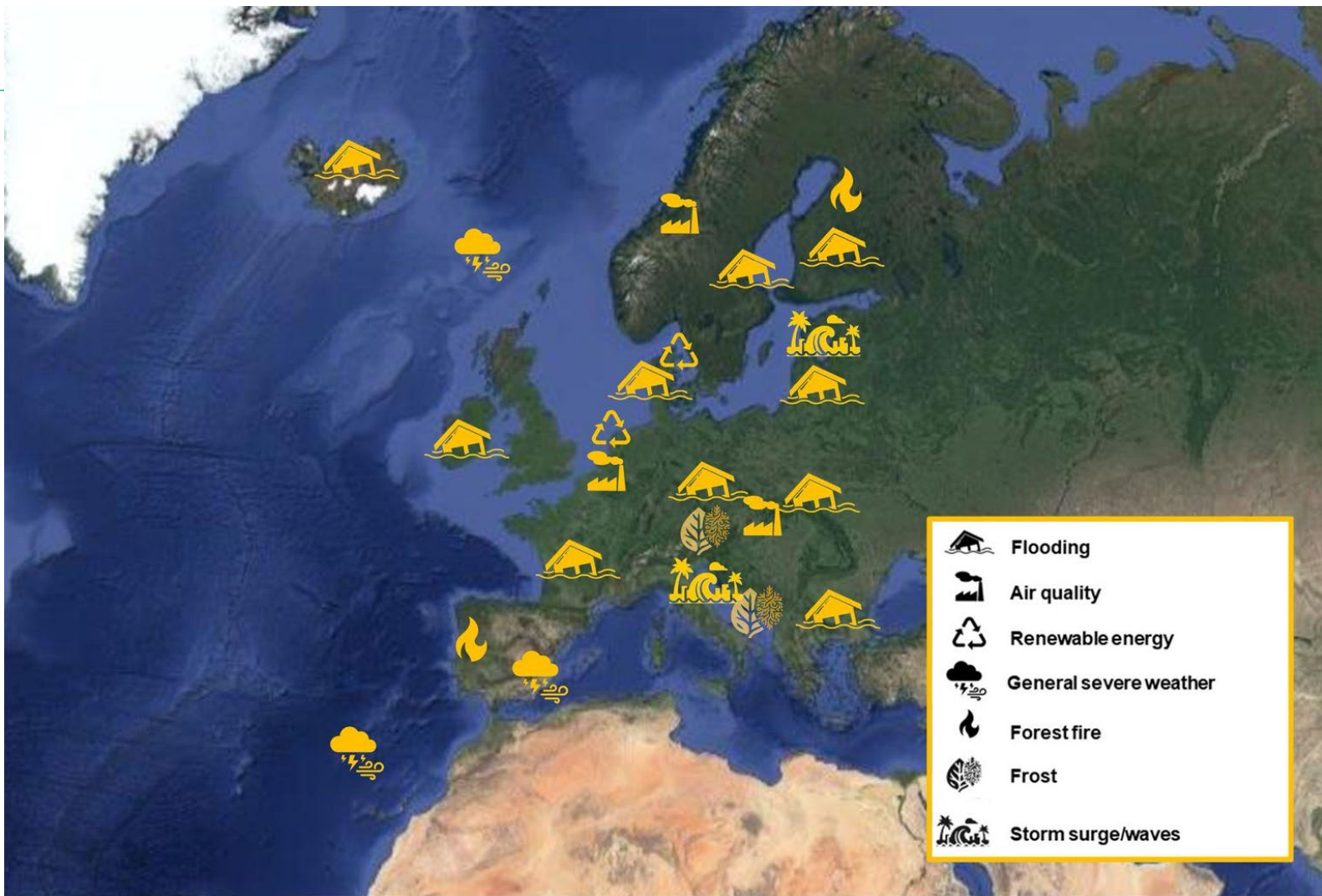


global DT

LAM DT@500m

observations

2018 Aude case : Precipitation patterns and maxima are much better represented with the LAM DT at 500m resolution thanks to higher resolution and more realistic microphysical scheme



Flooding



Air quality



Renewable energy



General severe weather



Forest fire



Frost



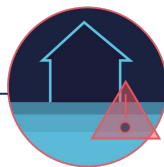
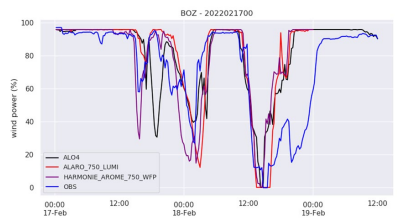
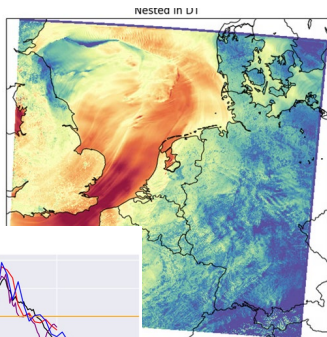
Storm surge/waves

Successful integration of impact-sector models in the On-Demand DT



Renewable energy

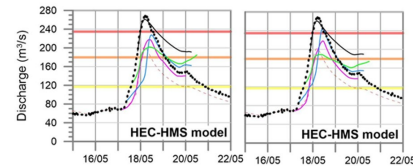
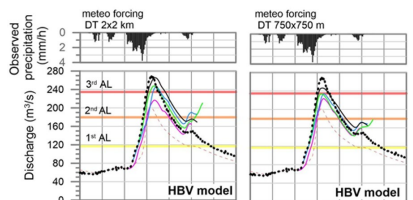
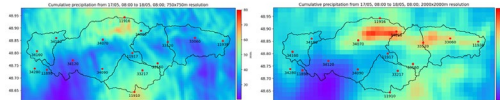
Storm Eunice
in North Europe,
2022-02-18



Floods

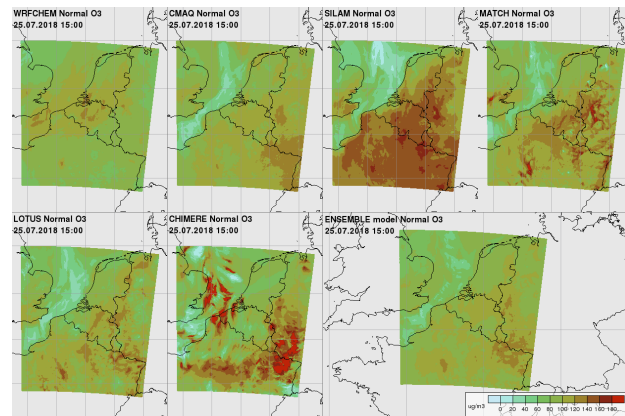
9 national hydrology
models + E-HYPE

Floods in Slovakia, 2021-05-17



Air quality

6 atmospheric chemistry models
Ozone pollution in Benelux, 2018-
07-25



End-to-end demonstration : predicting wind power during storm Eunice

Feb 6th, 2022 : Belgian offshore wind farms generated 94,400 MWh and set a record!

Feb 18th 2022 : Storm Eunice, one of the strongest in 30 years, led to good production but not as good as the mark set a few days before... why?

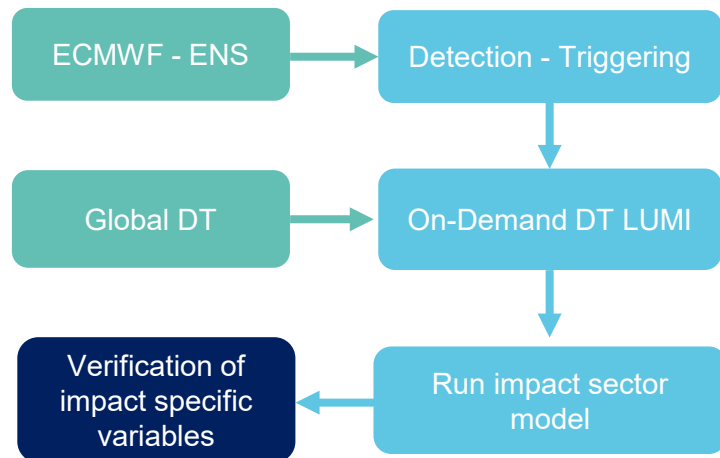


... this situation would have been successfully predicted by the prototype Extremes DT!

End-to-end demonstration : predicting wind power during storm Eunice

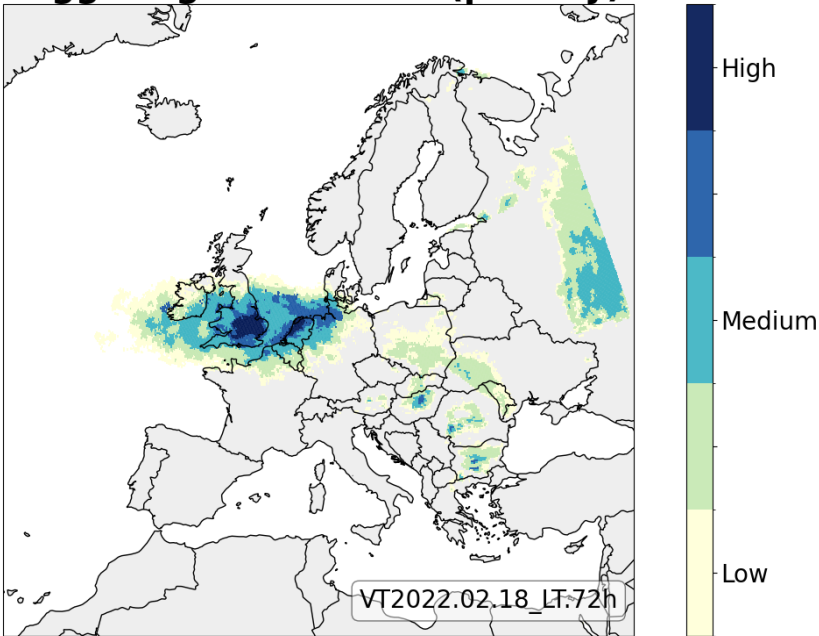
Feb 6th, 2022 : Belgian offshore wind farms generated 94,400 MWh and set a record!

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End-to-end demonstration : predicting wind power during storm Eunice

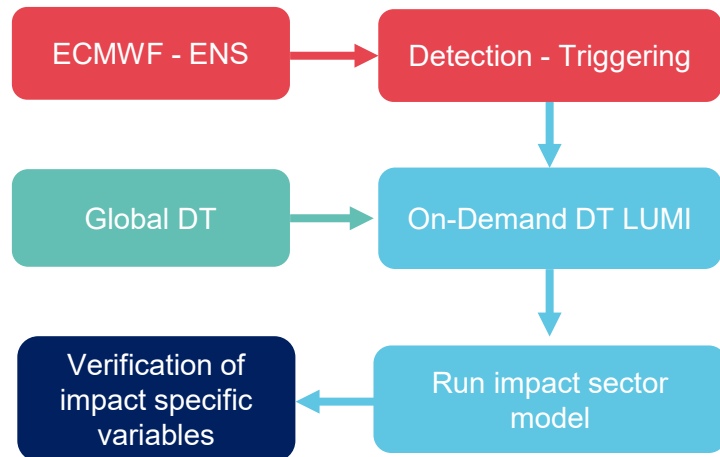
Triggering information (priority)



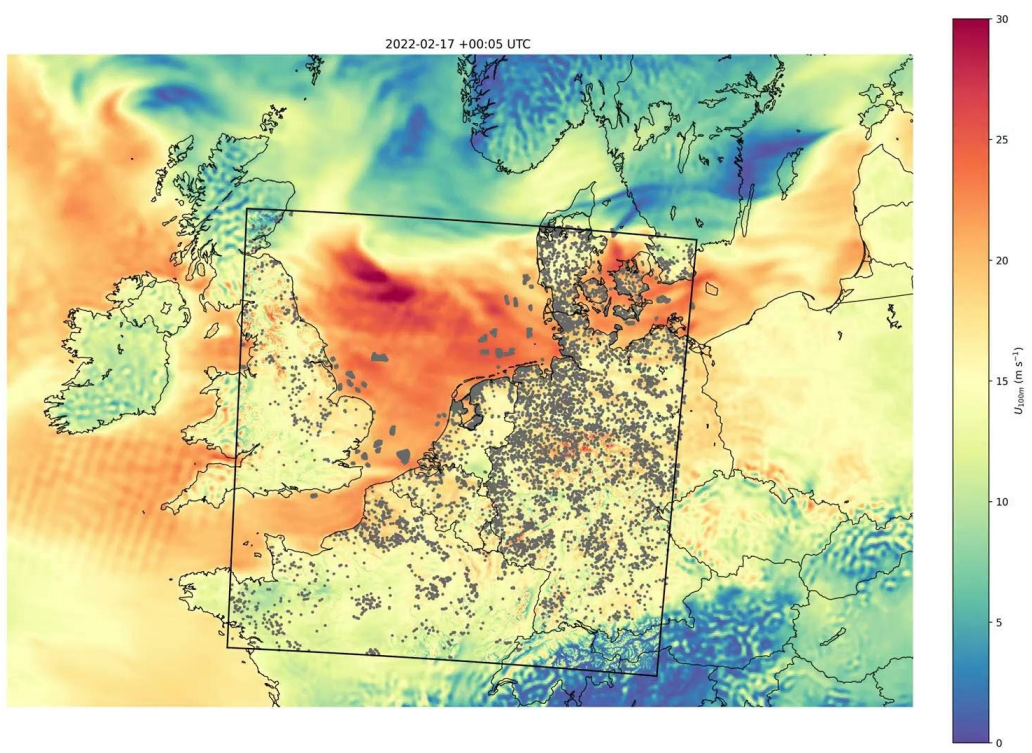
10m day max wind gust, base time 2022-02-16 00Z, VT 2022-02-18 (Step 48-72)

Every day extreme detection diagnostics. Alerts for :

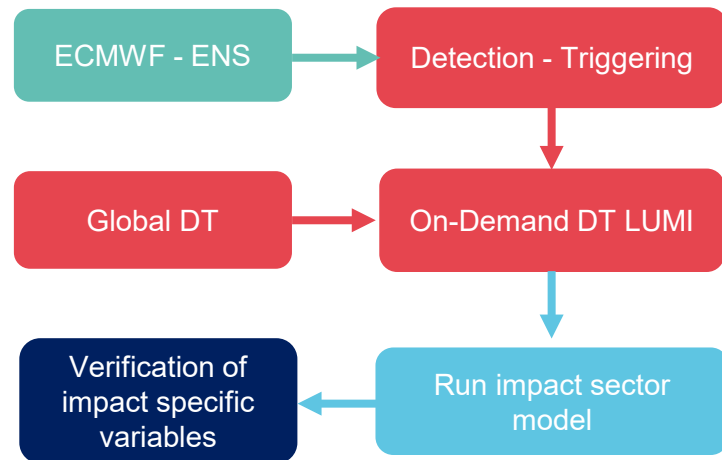
- total precipitation
- CAPE shear
- 10m-wind gust



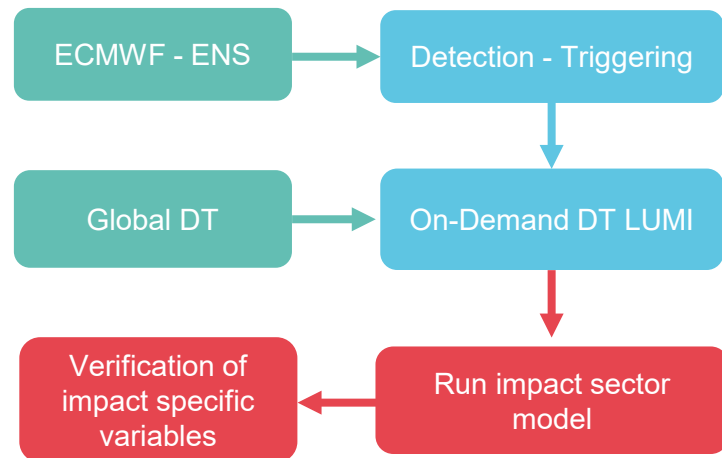
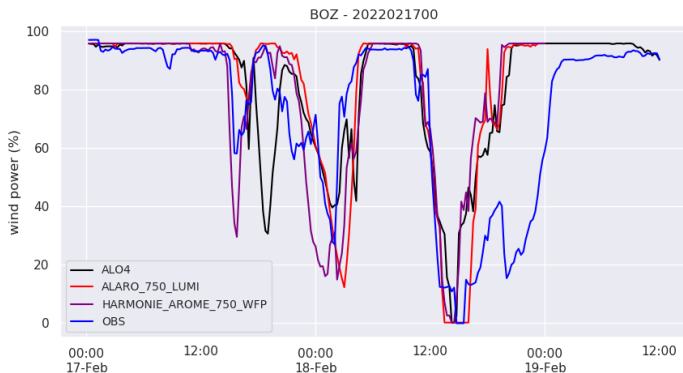
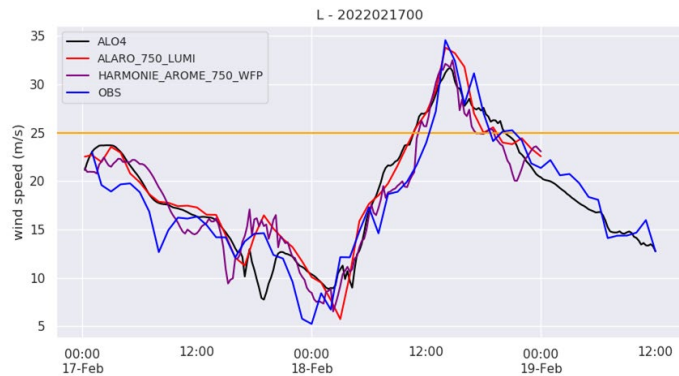
End-to-end demonstration : predicting wind power during storm Eunice



100m wind speed, base time 2022-02-17 00Z, lead time T+0 to T+48



End-to-end demonstration : predicting wind power during storm Eunice





HYDROLOGICAL EXTREME FLOODS

Complementing the capacity to forecast and prepare for extreme flood events, supporting the NMHSs for their warnings.

Description

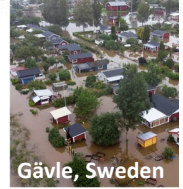
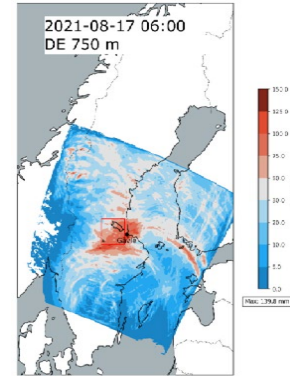
- Research units, closely linked to national operational flood forecasting divisions, are involved in the generation of the Extremes DT service

Users involved

- Operational flood forecasting hydrologists; local/regional authorities; emergency services

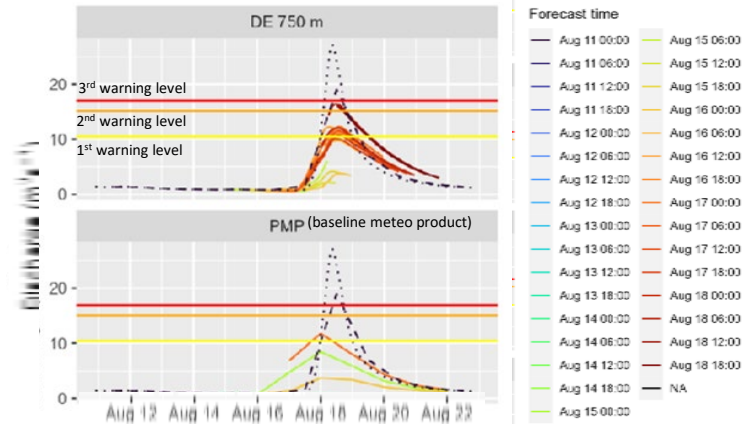
Main uncertainties

- Initialisation is critical in many areas; *we need the European-scale OPERA radar + rain gauge product!*
- The uncertainty of the precipitation input



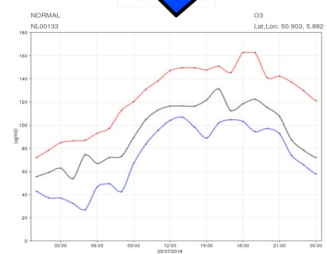
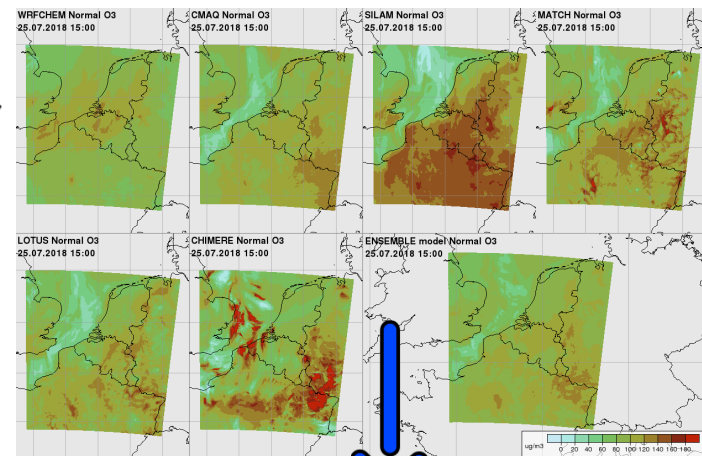
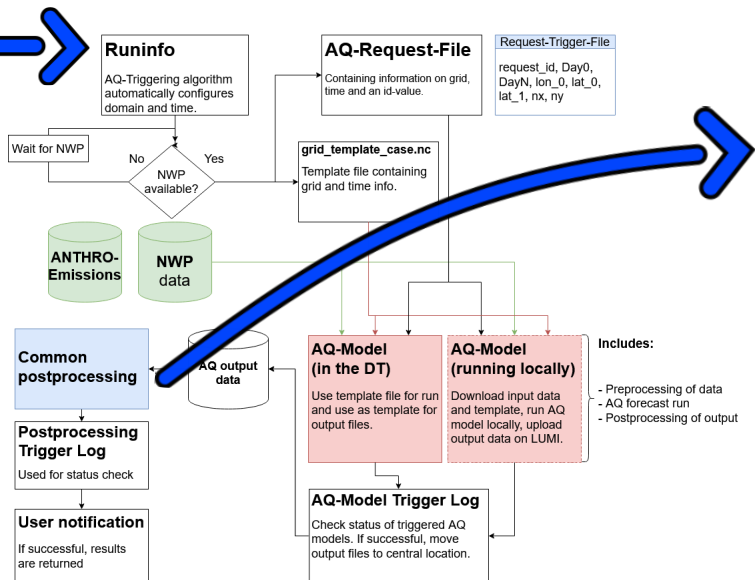
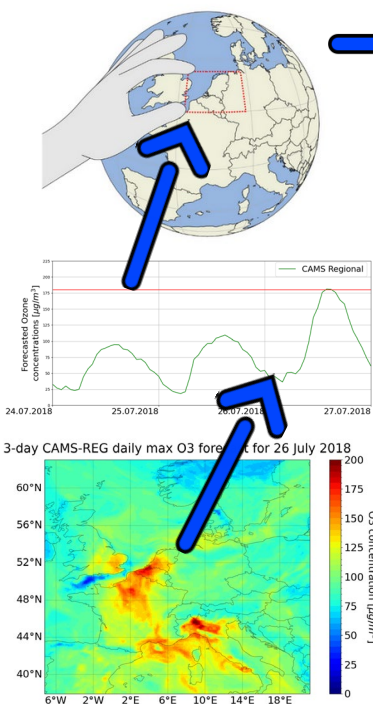
Type

- Precipitation forecast
- Precipitation observation
- Gauged Q, hourly
- Gauged Q, daily



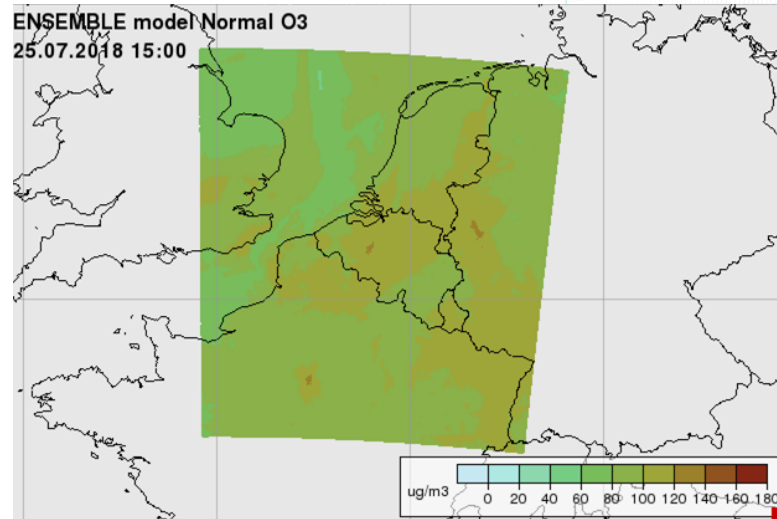
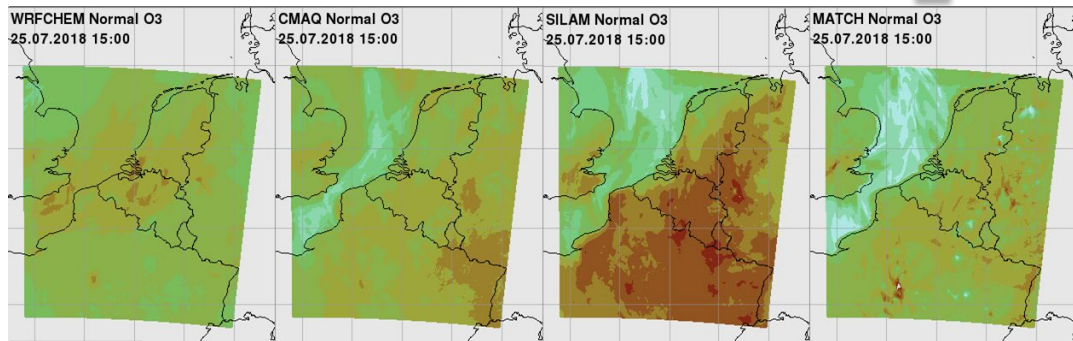


Air quality-workflow

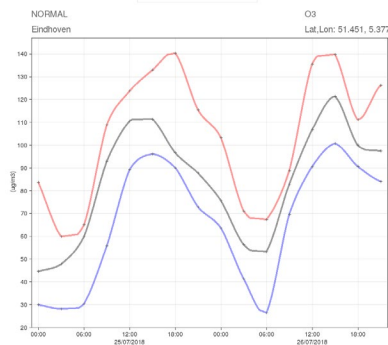




Air quality highlights



Ozone results of individual AQ - models during a 2018 heat wave



Ensemble of the AQ -models for a selected time



Time series at selected location (max/med/low)



Destination Earth seen from the perspective of the RMI

- Destination Earth is boosting our joint development with ECMWF and international partners.
- It provides direct access and experience on EuroHPC machines, including new technologies; GPUs.
- It will increase awareness to extreme cases (triggering). This has to be developed in cooperation with our weather office (and of the partner Met Services).
- Creates a platform for developing applications, see e.g wind energy. But others will follow on air pollution, hydrology, heat waves and urban effects... This will help to extend our national weather service portfolio.

