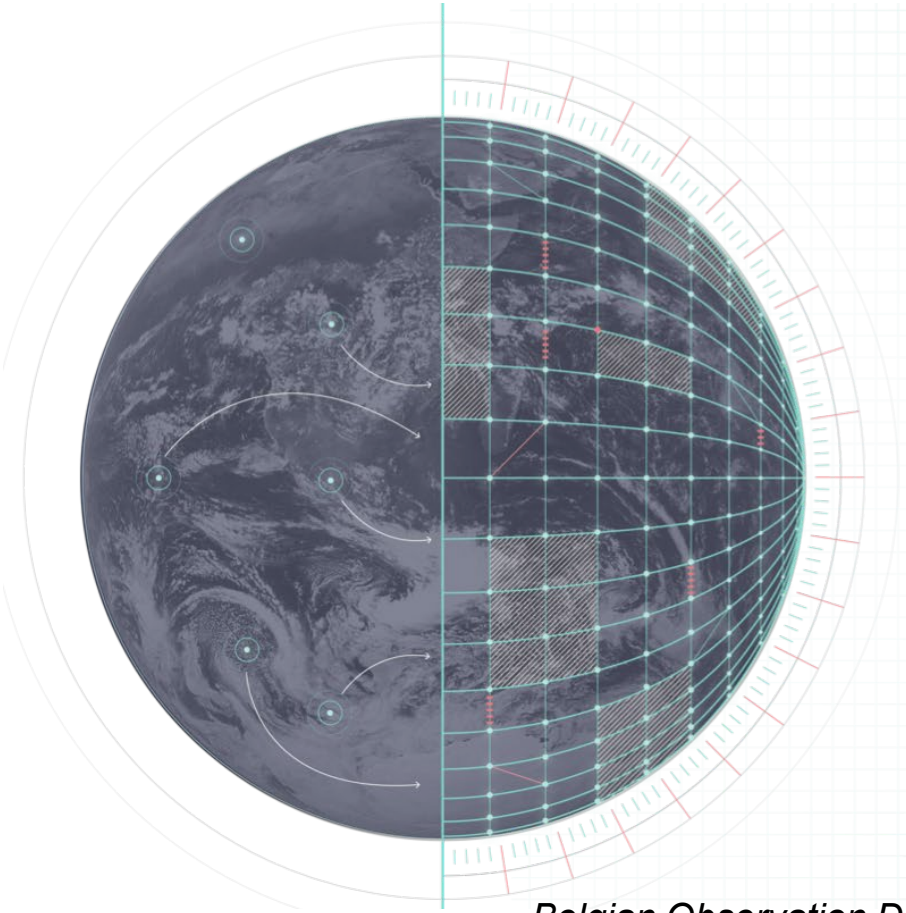


DESTINATION EARTH

Destination Earth from the perspective of the Belgian National Met Service

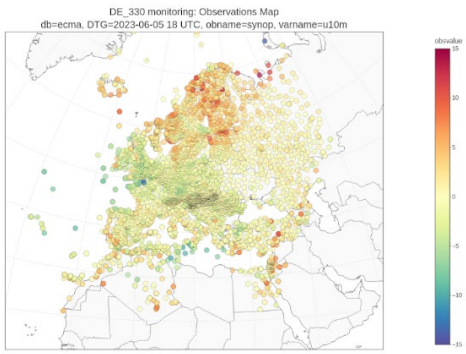
Piet Termonia
Kristian Pagh Nielsen,
Roger Randriamampianina,
&
The On-Demand Extremes Team

Belgian Observation Days, 14 May 2024, Hasselt, Belgium

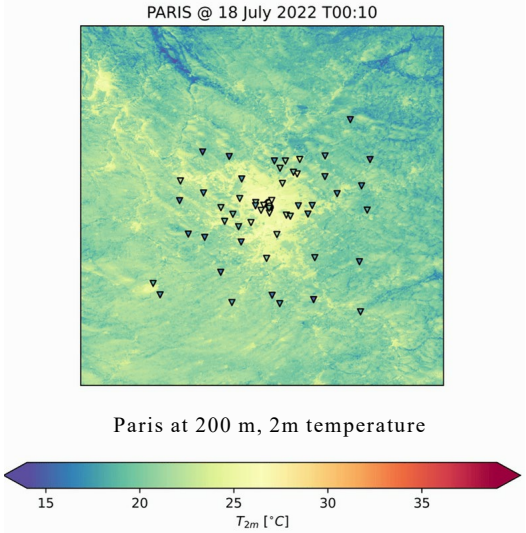
Funded by the European Union
Destination Earth implemented by ECMWF esa EUMETSAT

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)

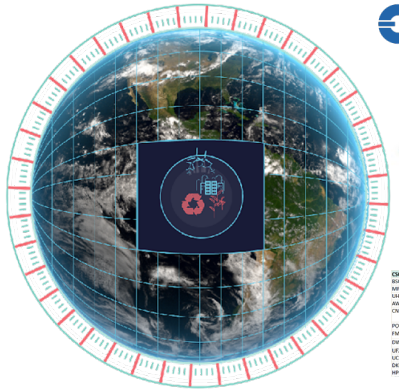


Jean Wurtz (Météo France) and Natalie Theeuwes, (KNMI)

ECMWF Funded by the European Union

FIRST HIGH PRIORITY DIGITAL TWINS SUPPORT THE GREE

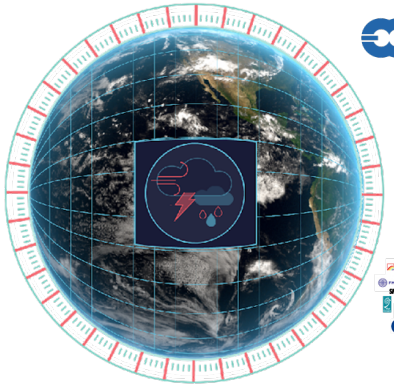
Climate change adaptation



To support policymaking for adaption

Multi-decadal timescales

Weather-induced extremes

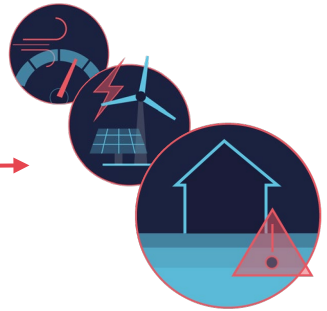


For rapid response to extreme events

For a few days ahead

THE EXTREMES DT : A MAGNIFYING GLASS AT EXTREME WEATHE

DETECTION/ TRIGGERING



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

IFS-NEMO

ECMWF

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

Arome
Harmonie-Arome
Alaro

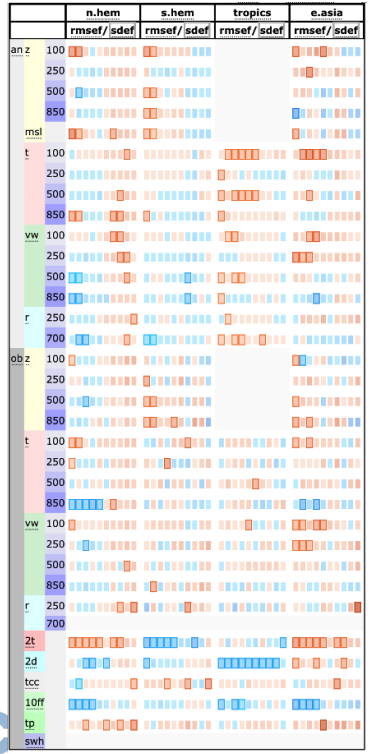
METEO FRANCE
À VOS CÔTÉS, DANS UN CLIMAT QUI CHANGE

Impact-sector models:
Forecast evaluation for societal impacts

Norwegian Meteorological Institute · METEO FRANCE · Danmarks Meteorologiske Institut · AEMet · FMI · SMHI · LVGMC · IPMA · RMI · DHMZ · Met Éireann · CHMI · TAL TECH · Republic of Estonia Environment Agency · ZAMG · Koninklijk Nederlands Meteorologisch Instituut · HNMS · Icelandic Met Office · ARSO METEO Slovenia · INRAE · csc · Lietuvos hidrometeorologijos tarnyba · RIVM · Barcelona Supercomputing Center · SHMÚ · Országos Meteorológiai Szolgálat · GeoSphere Austria

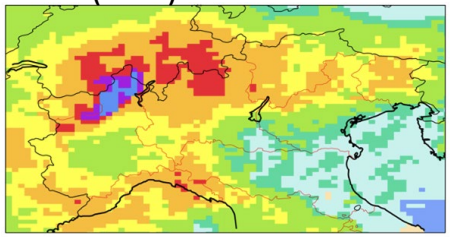
First comprehensive evaluation of a global km-scale weather forecast

DestinE vs HRES (15 dates)

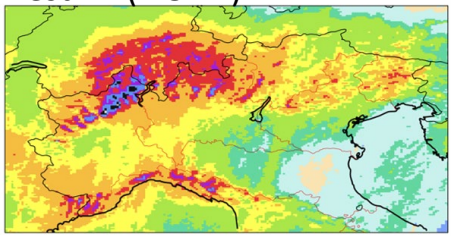


… but higher resolution is beneficial for TC prediction and orographic precipitation (e.g. Storm Alex, 24h precipitation, VT 2020-10-01, Step 72)

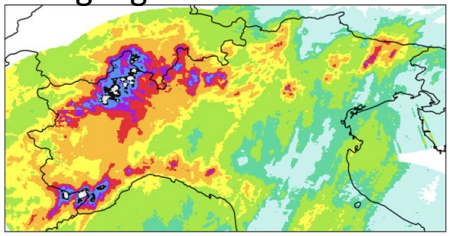
HRES (9km)

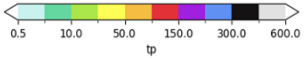


DestinE (2.8km)

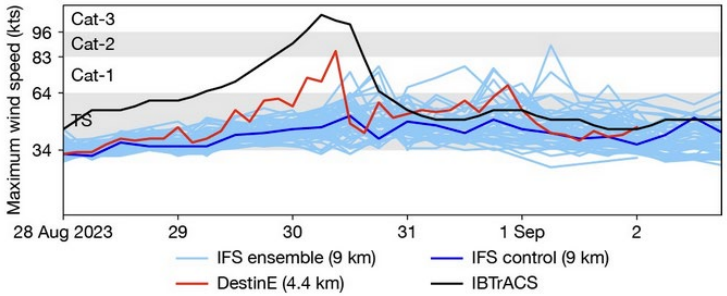


Rain gauges





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



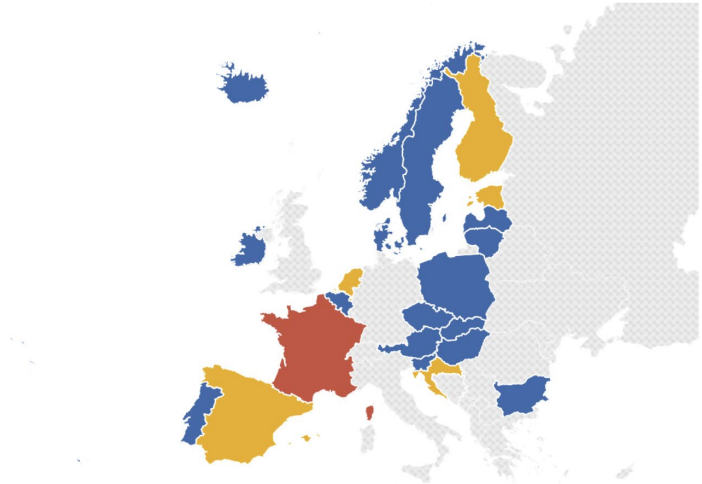
On-DEmand Extremes DT Team

Norwegian Meteorological Institute
METEO FRANCE
Danmarks Meteorologiske Institut
AEMet
FMI
SMHI
LVGMC
IPMA
RMI
DHMZ
Met Éireann
CHMI
TAL TECH
Republic of Estonia Environment Agency
ZAMG Zentralanstalt für Meteorologie und Geodynamik
Koninklijk Nederlands Meteorologisch Instituut Ministerie van Infrastructuur en Milieu
IM GW
Icelandic Met Office
ARSO METEO Slovenia
INRAE
CSC
Lietuvos hidrometeorologijos tarnyba
RIVM
Barcelona Supercomputing Center Centro Nacional de Supercomputación
SHMÚ
Országos Meteorológiai Szolgálat
GeoSphere Austria

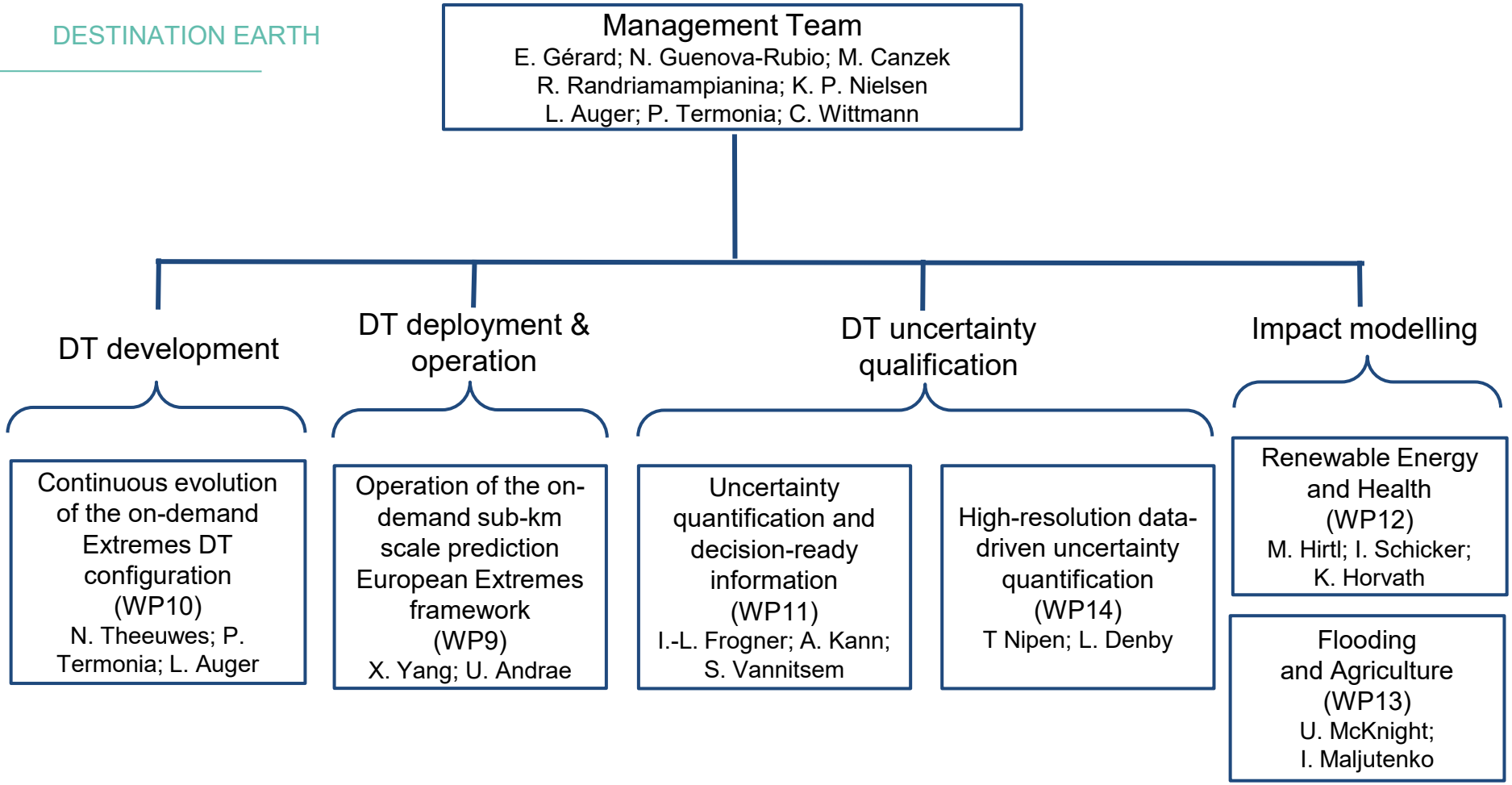
DestinE On-Demand Extremes (DE_330_MF) digital twin map of partner countries

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

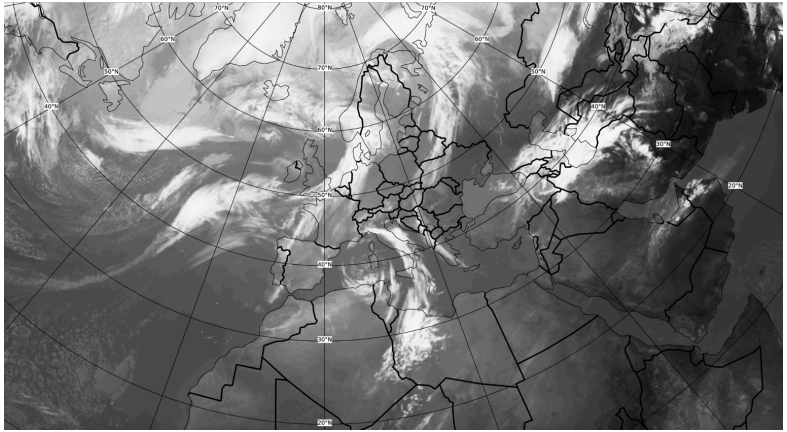


Source: MeteoFrance • Hover in the countries to read the entities involved.
Yellow: Countries with another agency involved in addition to the National Hydro-Meteorological Service. Otherwise Blue when only the NHMS is a partner.


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

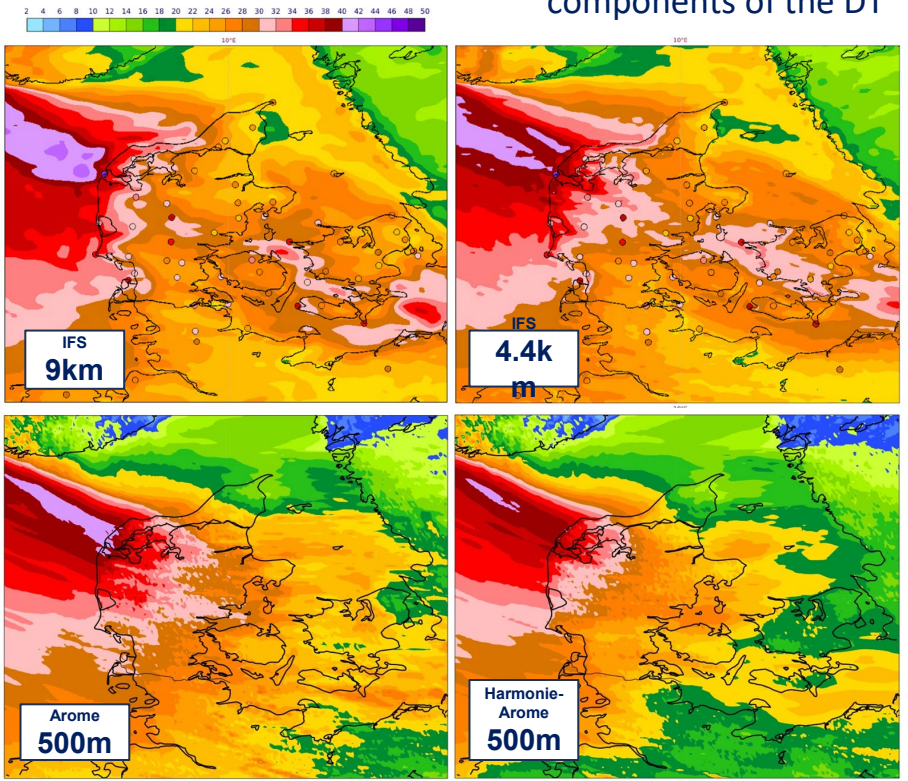
Running daily the Global DT and selected extreme events in the DEODE

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



Brightness temperature (K)
2024-04-08 00Z, VT 2024-04-11 06Z, Step 78

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

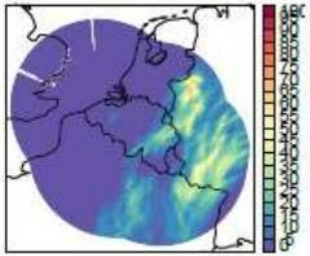


Storm Pia, 24h-max 10m-wind gust
2023-12-20 00Z, VT 2023-12-22 00Z

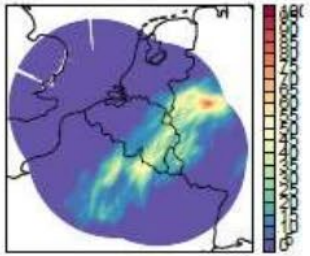
ECMWF

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

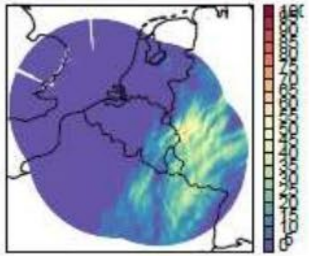
ao13 precipitation
20210714 1−12h cumulated
12h in advance



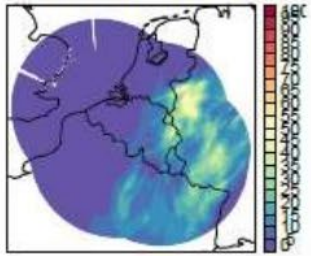
OBS precipitation
20210714 1−12h cumulated



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

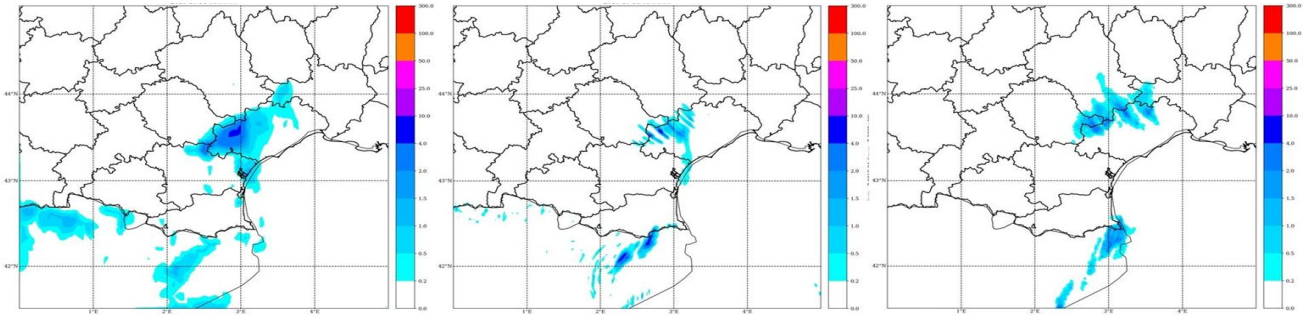


ao40 precipitation
20210714 1−12h cumulated
12h in advance



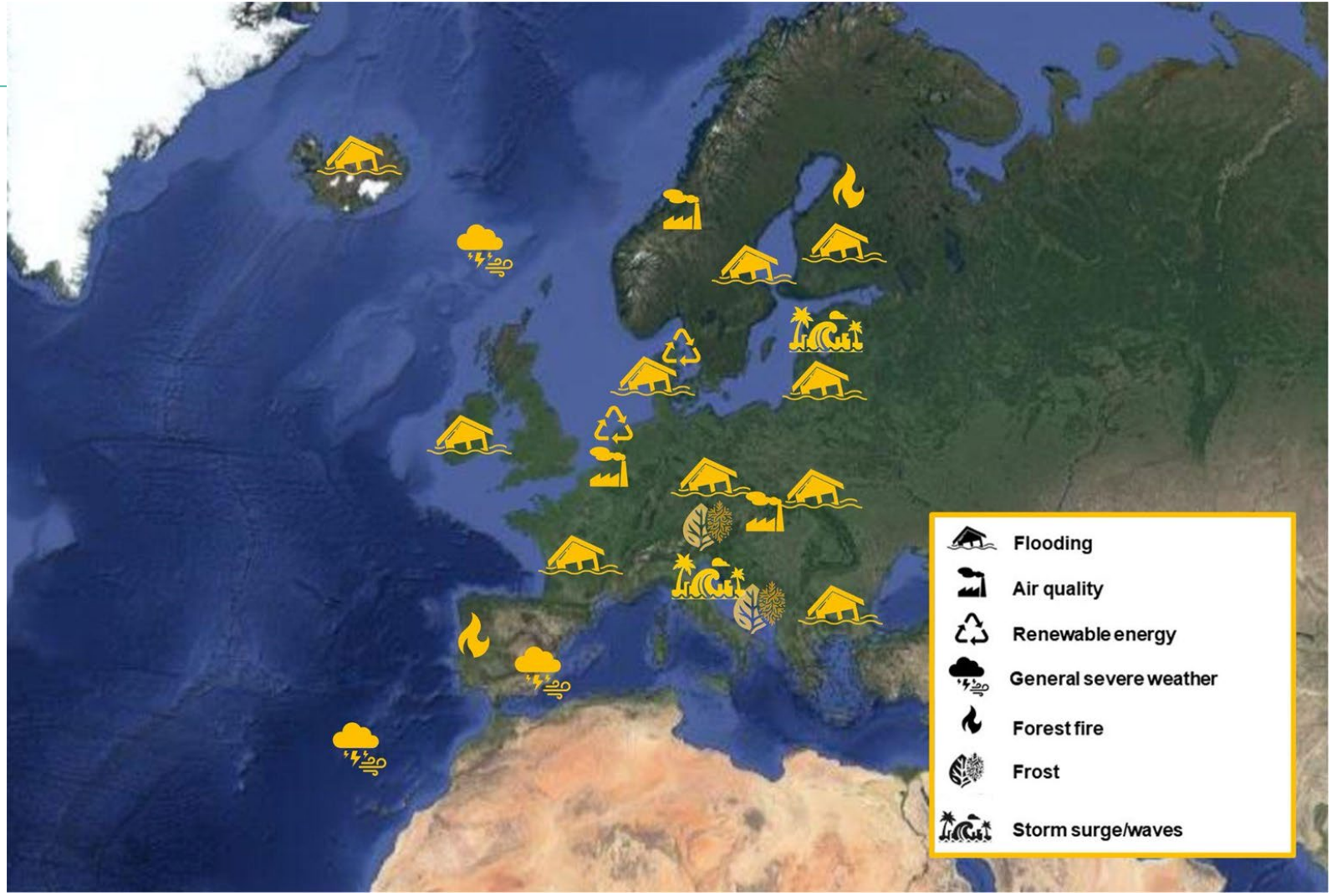
National Meteorological Services depend on state-of-the-art NWP systems.
In 2021 RMI used this configuration of the AROME model at a resolution of 1.3 km

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



global DT | LAM DT@500m | observations

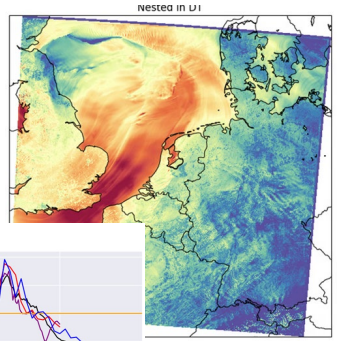
2018 Aude case : Precipitation patterns and maxima are much better represented with the LAM DT at 500m resolution thanks to higher resolution and more realistic microphysical scheme

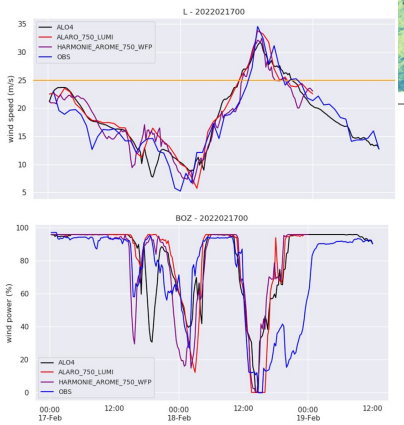

Flooding
Air quality
Renewable energy
General severe weather
Forest fire
Frost
Storm surge/waves

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

Renewable energy

Storm Eunice in North Europe, 2022-02-18

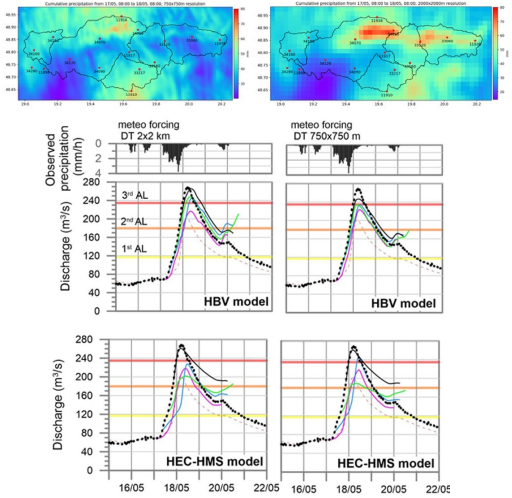




Floods

9 national hydrology models + E-HYPE

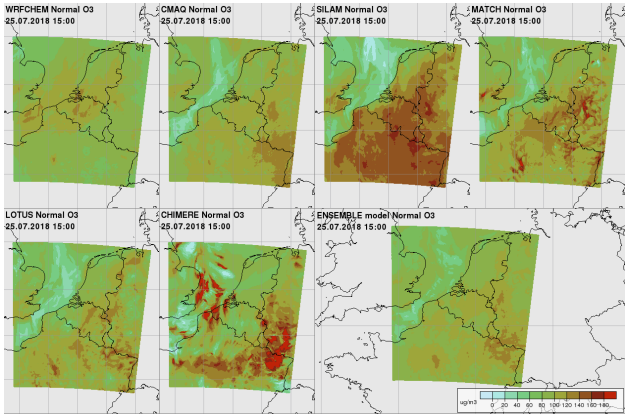
Floods in Slovakia, 2021-05-17



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!

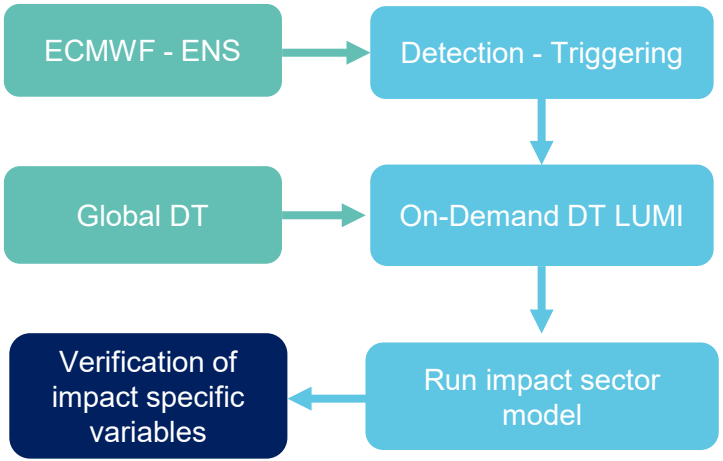
Feb 18th 2022 : Storm Eunice, one of the strongest in 30 years, led to good production but not as good as the mark set a few days before… why?

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

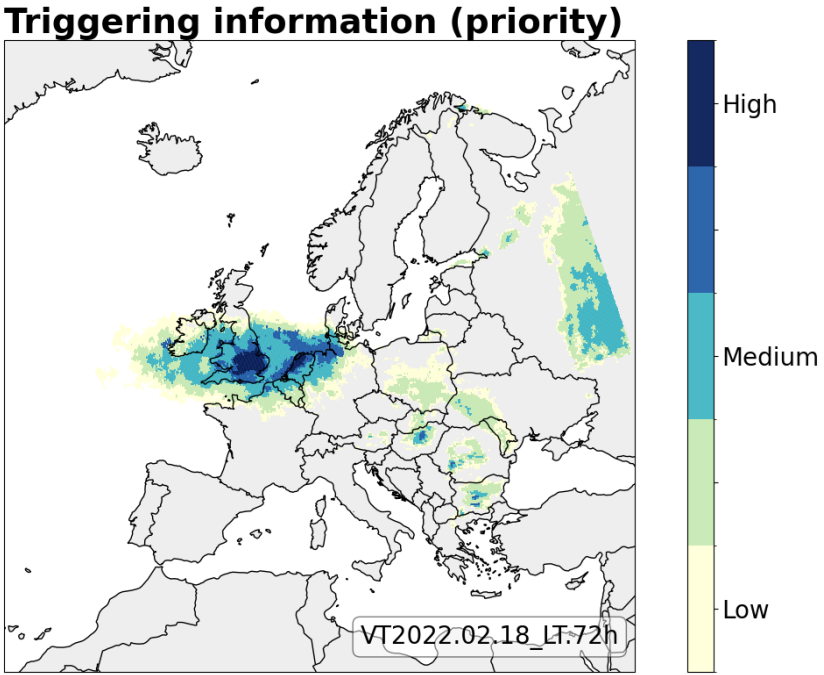
End-to-end demonstration : predicting wind power during storm Eunice

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

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?



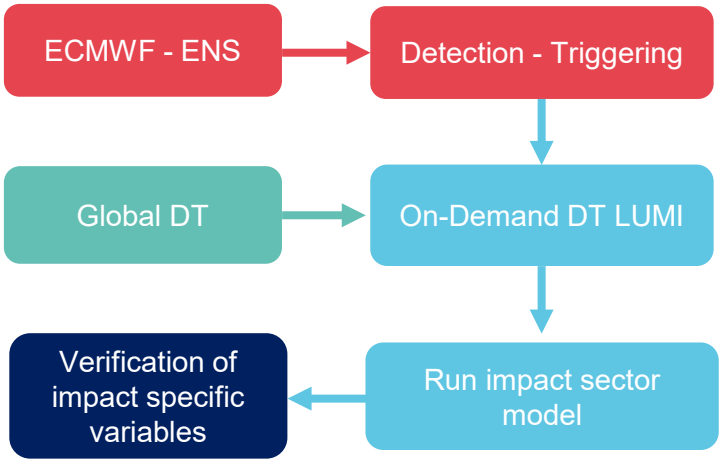
End-to-end demonstration : predicting wind power during storm Eunice



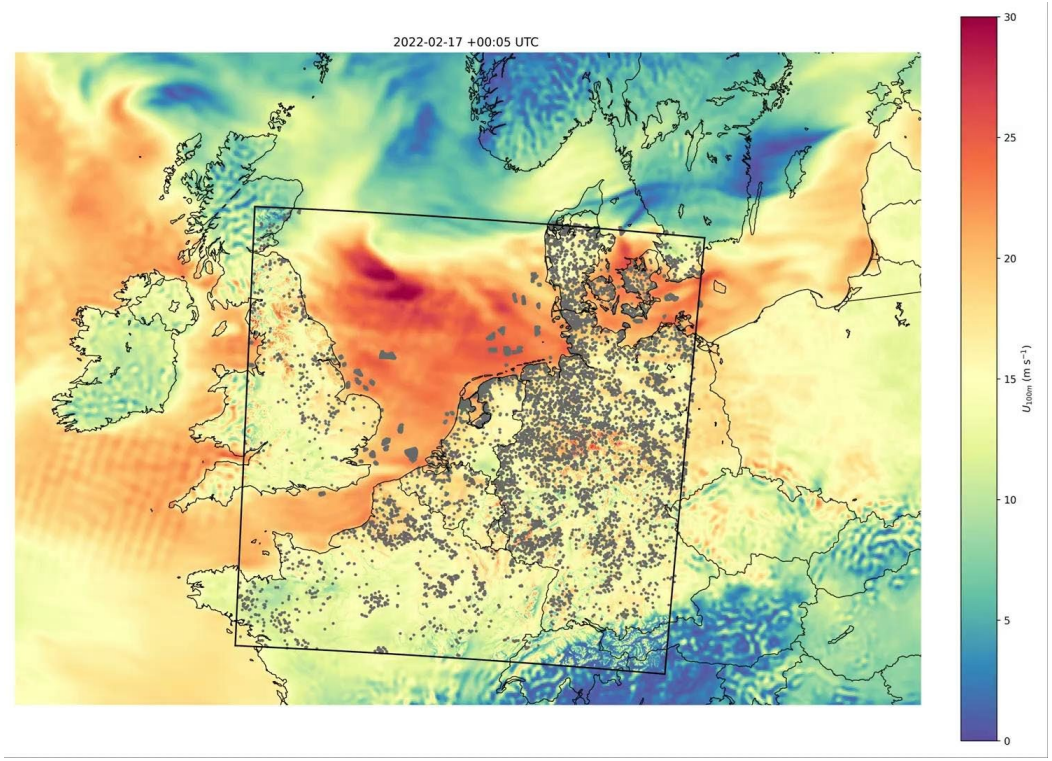
10m day max wind gust, base time 2022-02-16 00Z, VT 2022-02-18 (Step 48-72)

Every day extreme detection diagnostics. Alerts for :

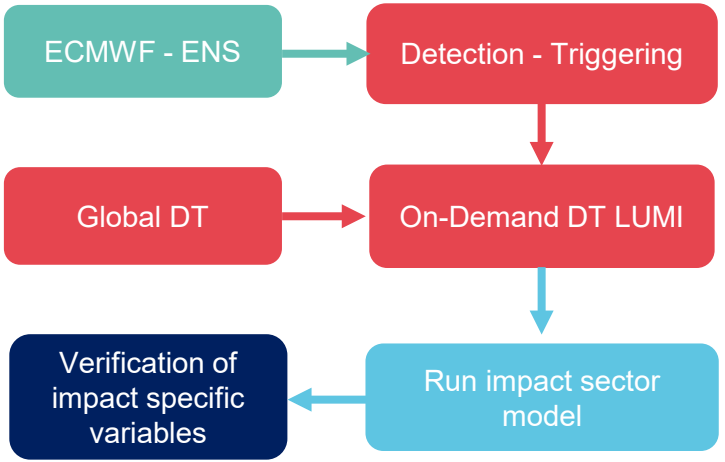
- total precipitation
- CAPE shear
- 10m-wind gust



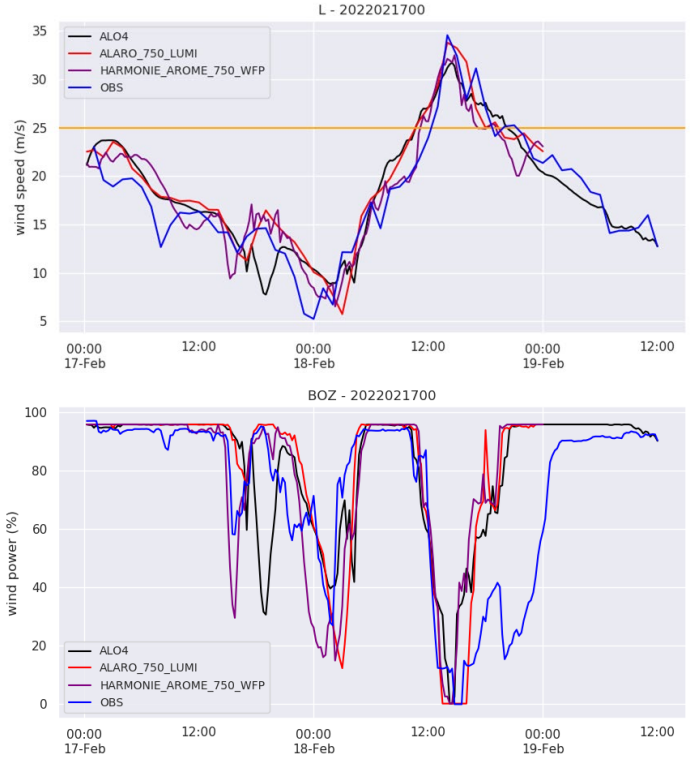
End-to-end demonstration : predicting wind power during storm Eunice

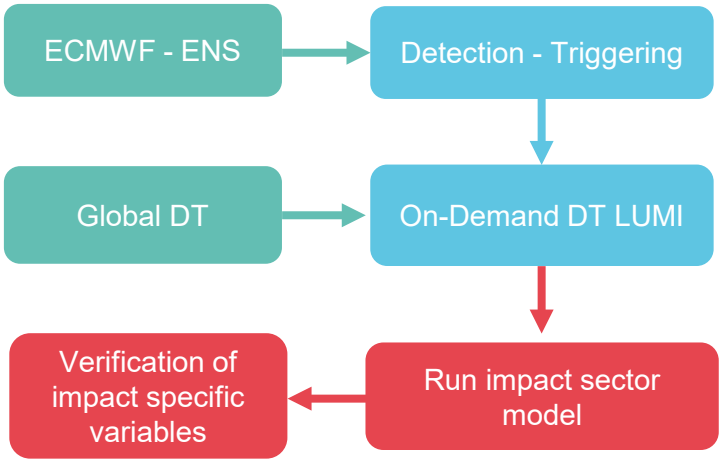


100m wind speed, base time 2022-02-17 00Z, lead time T+0 to T+48



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





base time 2022-02-17 00Z, lead time T+0 to T+60

HYDROLOGY: EXTREME FLOODS

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

Description

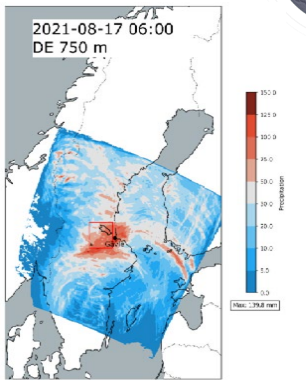
- Research units, closely linked to national operational flood forecasting divisions, are involved in the generation of the Extremes DT service

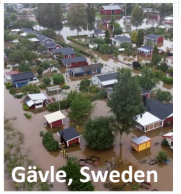
Users involved

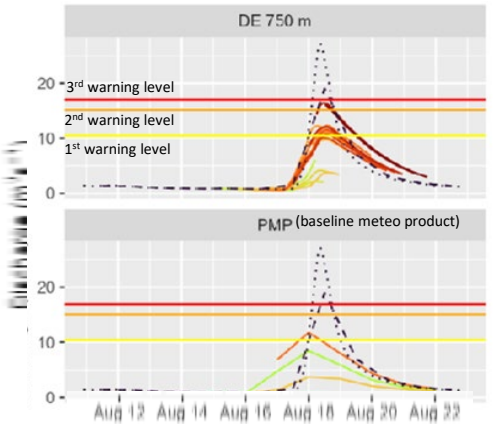
- Operational flood forecasting hydrologists; local/regional authorities; emergency services

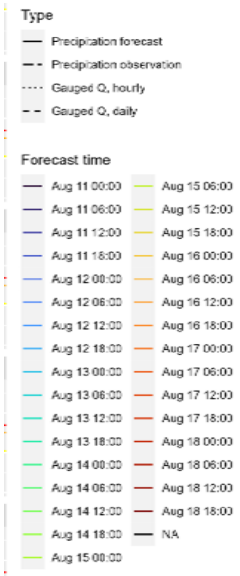
Main uncertainties

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

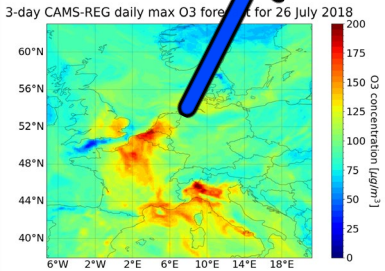


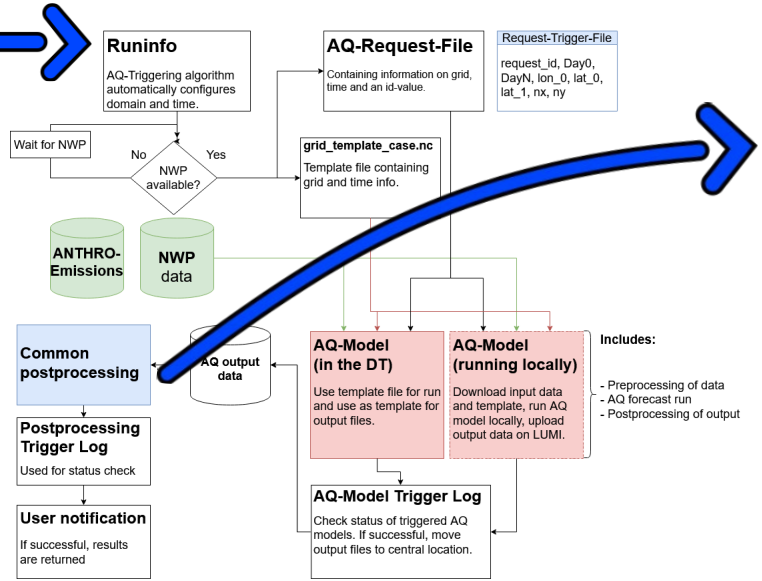


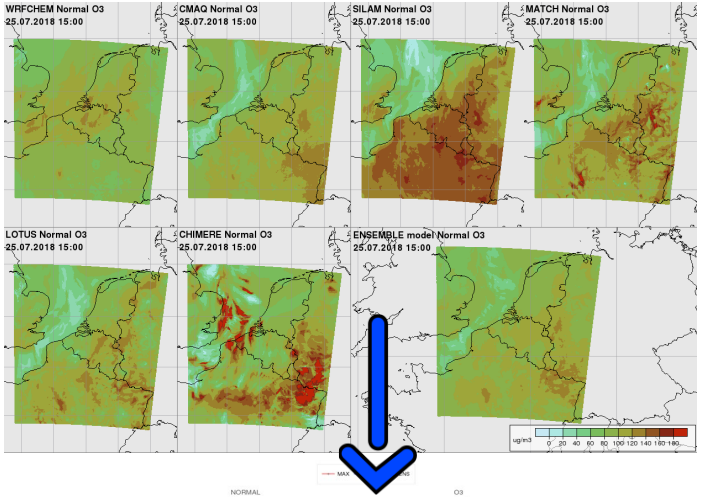


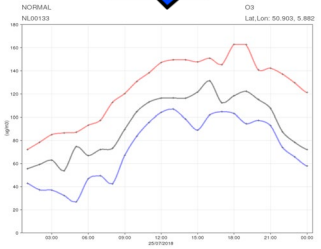


Air quality - workflow





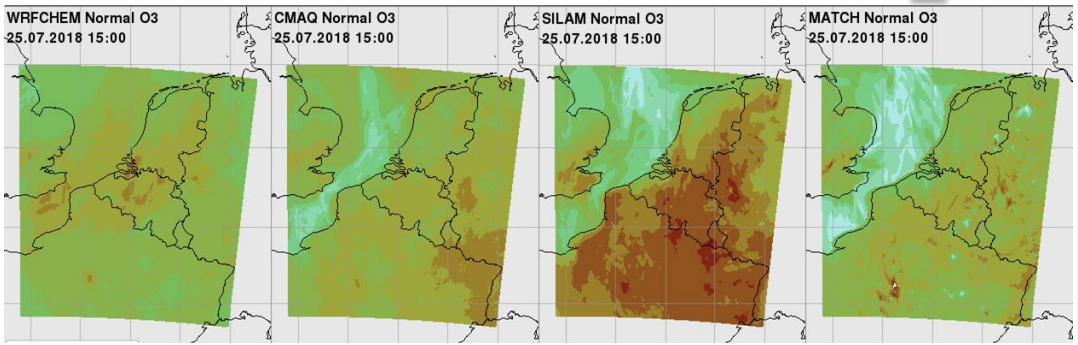


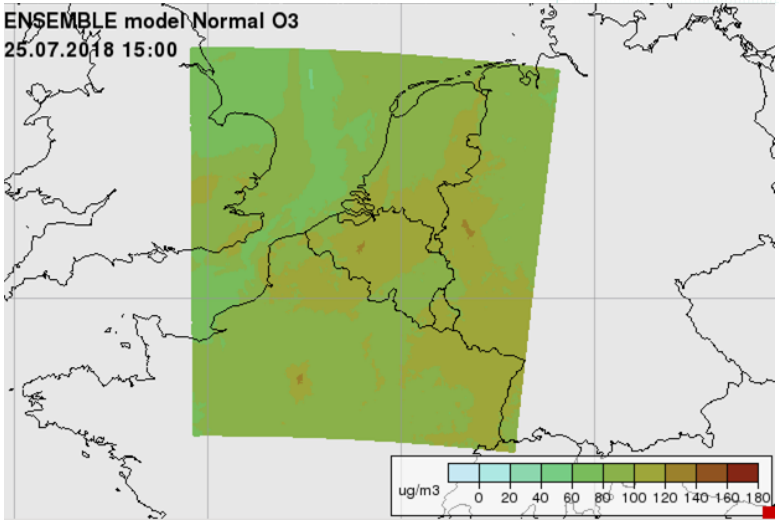


RIVM · Országos Meteorológiai Szolgálat · SMHI · GeoSphere Austria · FMI · SHMÚ · RMI

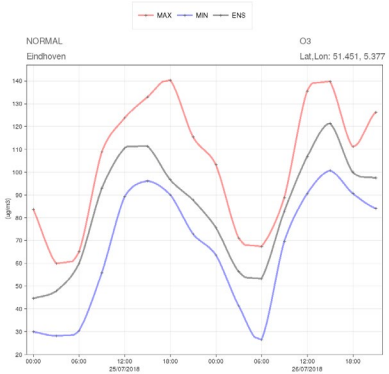
ECMWF

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.

ECMWF Funded by the European Union

Thank you for you attention!

Funded by the European Union Destination Earth implemented by ECMWF esa EUMETSAT