DESTINATION EARTH

On-Demand DT Prototype and Simulation of Extreme Events

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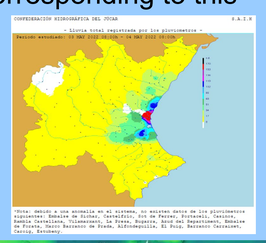
CONVECTIVE STORM OVER VALENCIA (SPAIN)

- **Valencia event:** On 3 May 2022, a very high-impact static convective system over south-east Spain (mainly formed in front the city of Valencia) led to heavy rainfall (>100 mm in 2 hours) and flash-floods in Valencia and its metropolitan area, beating rainfall records for May.
- This event had a very low predictability in high-resolution convective-allowing models.
- None of the national meteorological services' operational models (AROME – 1.3 km, HARMONIE-AROME 2.5km, etc.) showed signals of convective system developed in the east of Spain.
- We evaluate this quasi-stationary system with very high-resolution numerical simulation (500 m) with the HARMONIE-AROME model.

Acknowledgement to the AEMET(Spain) team: Javier Calvo, Daniel Martin, Samuel Ciana and Antonio J Garrote, and Carlos Calvo-Sancho, Univ of Valladolid.

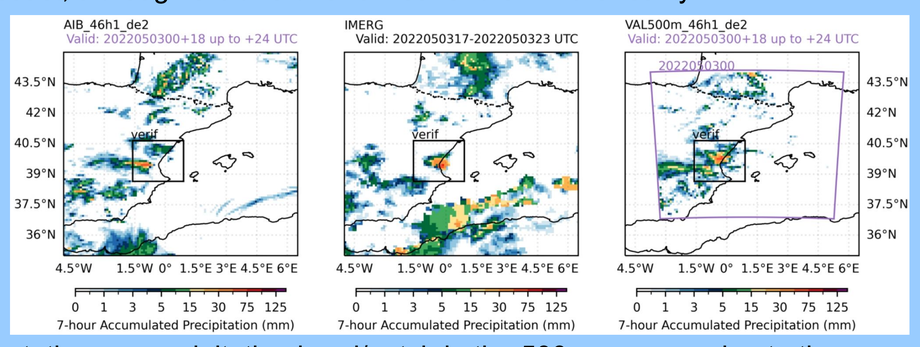
OBSERVATIONS AND PERFORMED EXPERIMENTS

- Between 18z and 22z of day 3, there was a stationary precipitation band/patch over the coast of Valencia in the observations (IMERG-NASA precipitation) corresponding to this mesoscale convective system.
- We initially use IMERG-NASA to compare against the model.
- Experiments:
  - **AIB_46h1_de2**
    - HARMONIE-AROME cy46 DE_330 release
    - 3D-Var with 3hr cycling using conventional observations
    - Surface OI assimilation
    - Nested in IFS operational forecasts (6 hr lag) each hour
    - Cycling starting from an operational First Guess
    - Operational structure functions
  - **VAL500m_46h1_de2**
    - 3D-Var with 3hr cycling using conventional observations
    - Surface OI assimilation
    - Nested in IFS operational forecasts (6 hr lag) each hour
    - Interpolated structure functions from 2.5km domain
    - 7 days warmup

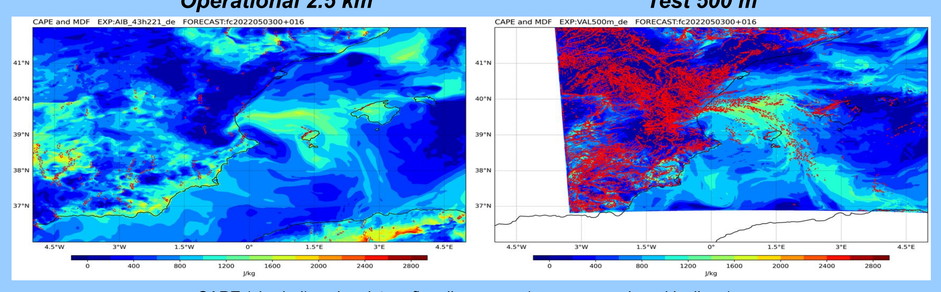


RESULTS

- This stationary precipitation band/patch over the coast of Valencia is not present or very weak in the operational 2.5 km run (AIB_46h1_de2).
- The 2.5 km run only saw convective cells being advected westward by the flow and orographically rain enhancement, which also left strong precipitation but not in a stationary manner as in reality.
- The 500 m run (VAL500m_46h1_de2) start to see a stationary band of heavy rainfall over the coast, although a bit north and weaker than in the reality.

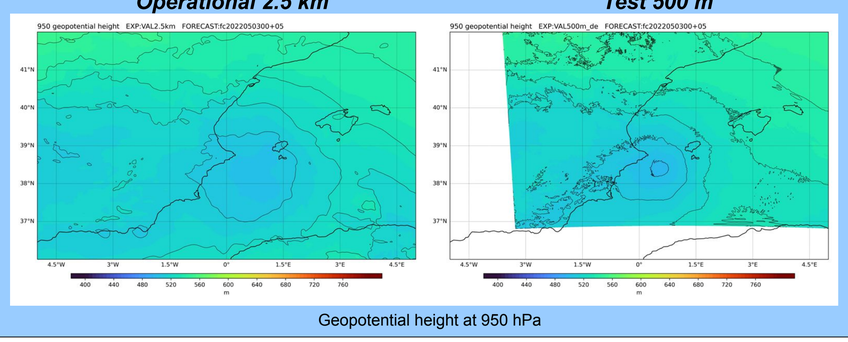


- This stationary precipitation band/patch in the 500 m run was due to the presence of a moisture flux convergence line in presence of high instability (CAPE). This convergence line was not present in 2.5 km.
- Instability (CAPE) seems to be similar in both runs, although in 500 m it gets further into the coast.



CAPE (shaded) and moisture flux divergence (convergence in red isolines)

- Why 500 m is the one able to get a convergence line? Probably due to a better representation of the low and stronger pressure gradient with the anticyclonic region to the northeast, which promotes convergence.

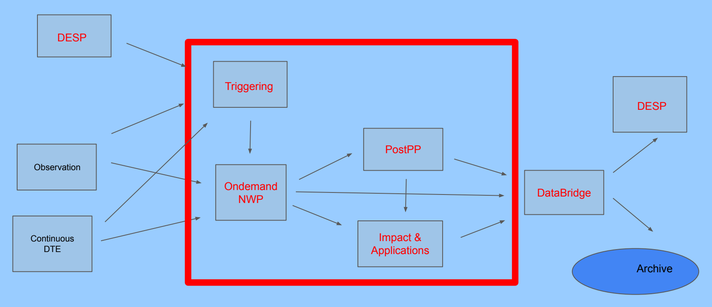


Geopotential height at 950 hPa

CONCLUDING REMARKS AND FURTHER WORK

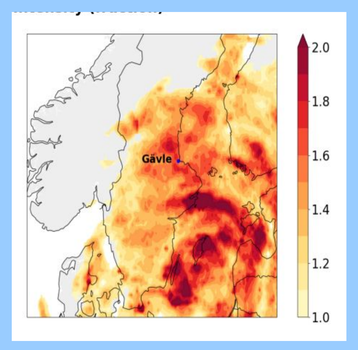
- Good performance of test 500 m run vs operational 2.5 km run.
- Better simulation of dynamical mechanisms responsible for the triggering of the event.
- Still needed to evaluate the exact causes of the differences between the runs because it is not trivial and it does not seem to be related to orography.
- Incorporate new high resolution observations such as OPERA radar and satellite SEVIRI and crowdsourced observations.

DEVELOPMENT OF THE ON-DEMAND DT WORKFLOW



The prototype of the On-demand DT workflow has been established, providing test environment around ACCORD-based NWP systems. Using the ECFLOW workflow scheduler, the system enables configuration and running of forecasts at sub-km resolution for on-demand domains. Operational as well as NearRealTime global DT data can be used as lateral boundaries. The system supports selection of physics flavours featured by the different ACCORD Canonical System Configurations (CSC).

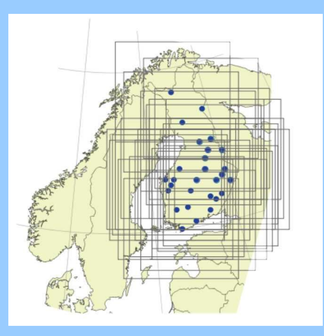
DETECTION OF EXTREME EVENTS



Probability distribution map around the historical flooding case on Aug 18 2021 in Gävle, Sweden. (Courtesy Petter Lind, SMHI & task team on extreme detection)

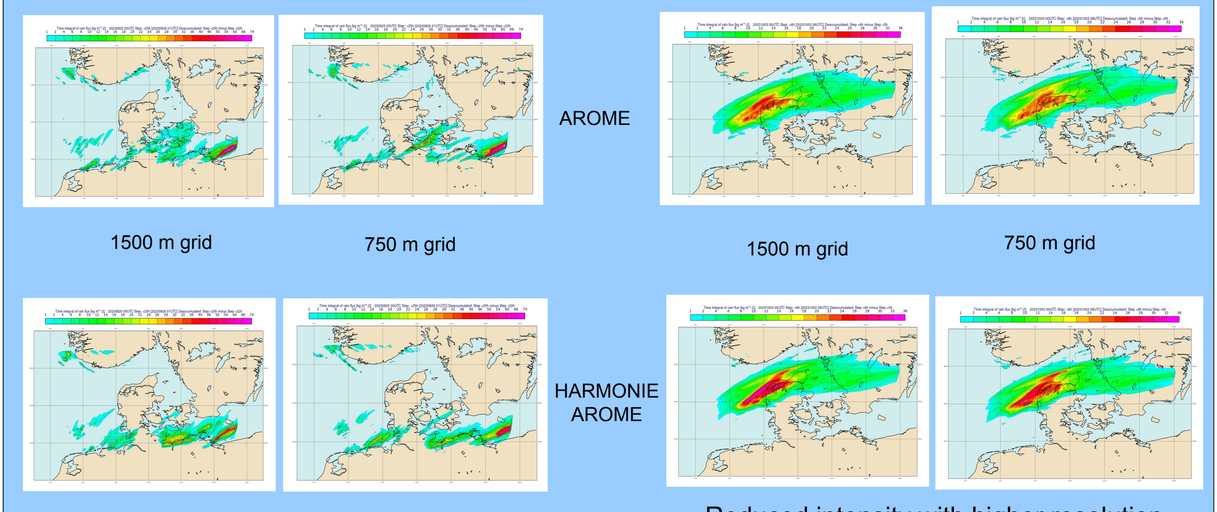
ACTIVATION OF THE ON-DEMAND DT

Triggering



The NWP experiments performed with 750 m DT prototype centered around different parts of Finland for a series of historical extreme events. (Courtesy Erik Gregow, FMI)

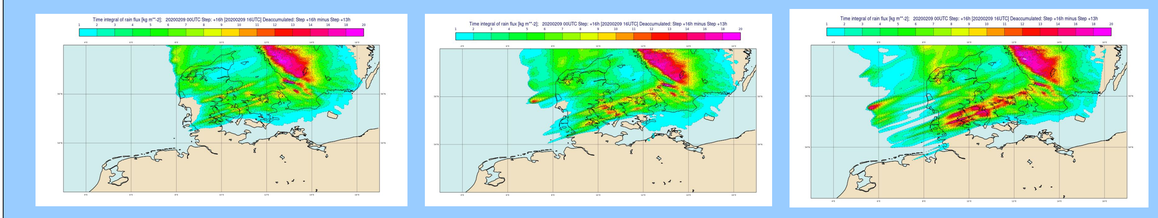
Which model configuration to choose?



Increased intensity with higher resolution

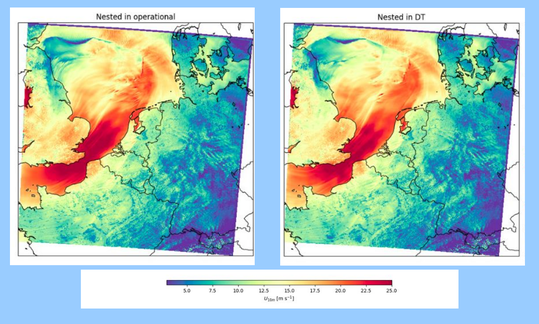
Reduced intensity with higher resolution

Which domain size would be appropriate?

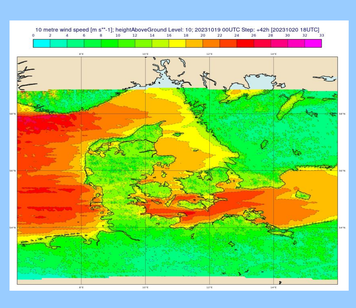


Simulation of a severe rain event over Denmark on Feb 9 2021 by the On-demand DT prototype at 750m using Harmonie-arome. The illustrated 3 simulations are equivalent except that the domain coverage have been shifted horizontally toward west in b) by 150 km and c) by 250 km. The extent of the domain coverage is shouns to be essential to capture the system developed from west side. (Courtesy Fabrizio Baordo, DMI)

Towards near real time deployment in Phase 2



Boundary coupling to operational IFS (9 km, left) vs continuous DT (4.8 km, right). (Courtesy Natalie Theeuwes, KNMI)



NRT simulation using the prototype on-demand with HARMONIE and 750 m for Bebet storm, Oct 21 2023 (Courtesy Bolli Palmason, IMO)

Using the on-demand DT workflow prototype, the DE_330 team will be exploring configuration-activation of the on-demand DT about feasible and optimal setup, taking into account various factors such as technical readiness, types of the extremes, adequate model setup, potential of added values, integration of workflow with inclusion of downstream application and end-users, cost efficiency etc.

A phased approach is envisaged in operationalisation of the on-demand DT workflow during the coming phase, in order to introduce, stepwise, functionalities with increased sophistication, something like:

- A technical infrastructure covering main components of the integrated workflow
  - A baseline NRT workflow including manual triggering to launch DT for selected events
    - A NRT workflow with simple (manuel) triggering deployable for 1-2 impact sectors
      - Deployment of NRT DT with first automated triggering
        - Deployment of NRT DT with automatic triggering for targeted impact sectors