NWP related activities @SHMU

45th EWGLAM & 30th SRNWP meetings, 25.9.-28.9.2023, Reykjavík, Iceland

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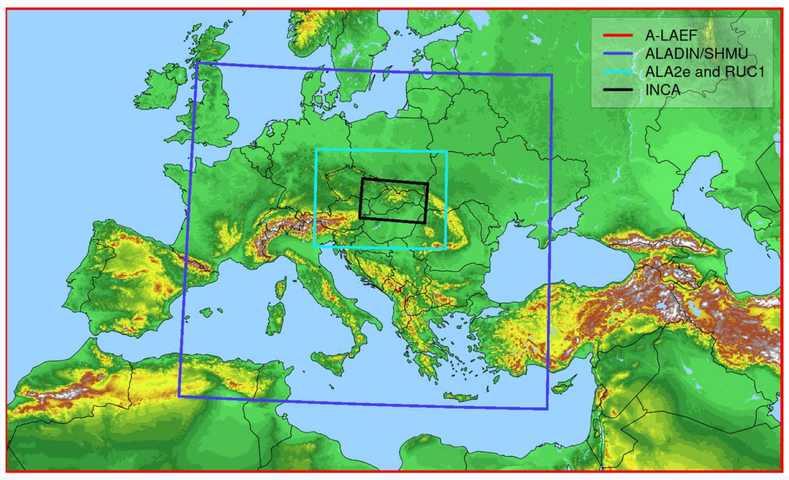
ACCORD — A Consortium for COnvection-scale modelling Research and Development
LACE — nwp central europe
ALADIN

ALADIN (ALARO) systems at SHMU

CSC	A-LAEF	ALADIN/SHMU	ALA2e	RUC1/ALA1
status	operational (common RC LACE)	operational		test mode
code version	CY40T1bf07+	CY43T2bf11		
physics	ALARO-1vB (multi-physics + surface SPPT)	ALARO-1vB		
dx	4.8 km	4.5 km	2.0 km	1.0 km
points	1250 x 750	625 x 576	512 x 384	1024 x 768
vertical levels	60	63	87	63
time step	180 s	180 s	90 s	30 s
forecast ranges + frequency	72/-/72/- hourly	78/72/72/60 hourly	72/-/72/- hourly	hourly, up to +12h or 48h (ALA1)
coupling model	ECMWF ENS (c903@cy48t2), 6h (time-lagged)	ARPEGE (long- & short cut off), 3h	ECMWF, 3h (time-lagged)	ARPEGE (time-lagged), 1h
surface data assimilation	ensemble surface data assimilation (ESDA) by CANARI	CANARI	A-LAEF CNTRL init downscaling	CANARI
upper-air data assimilation	spectral blending by DF	Blending by DF + 3D-Var		3D-Var
initialization	none	none	DFI	none
HPC	Atos Sequana XH2000 AMD (ECMWF)	NEC HPC – 240 nodes, 6230 Intel Xeon Gold Scalable Processors (Cascade Lake), Omni-Path, Linux		
nodes	85	40	40	40



Highlights of the research and development

Dynamics: DFI and IAU tests, hectometric scale (~ 250m resolution) experiments

Data assimilation: BlendVar CY43t2 operational, validated for the CY46t1
Slant Total Delays assimilation phased into CY49t0

RUC: Tests with cy46t1 and 87 levels, DFI, IAU and SCC case studies+echkevo

EPS: A-LAEF development (cy48r1 IFS/ENS fields for coupling, tech. upgrades)

ALA2e: Refactoring, optimization, time-lagged coupling, DFI tests

Climatological modelling: downscaling of ERA 5 reanalyses

Physics and diagnostics: Parameterization of wet snow and ice accretion on wires phased to cy49t0 (Github), graupel parameterization tested in cy48t3

Quality control: The implementation of new methods for data quality checks at stations

DE_330_MF (Deode) project: simulations on HR (ALA2) and hectometric (D75A) domains provided to partners in hydrology and air quality monitoring

Operational highlights

April 2023: 3D-Var operational . May 2023: ALA2e operational

Near future plans

Optimization of the RUC, switch to cy46 or cy48, convection-permitting EPS coupled to A-LAEF

A-LAEF development

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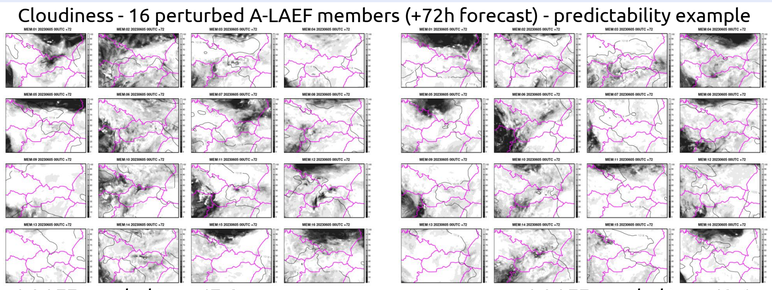
There were several technical upgrades of A-LAEF TC2 suite at ECMWF. Jobs' memory/time management was modified. SMS notification for failed jobs was implemented. Master cy48t2 (used for LBC preparation) was recompiled with the CCSDS decoding support. The suite was switched to the cy48r1 IFS/ENS coupling with increased spatial resolution (O640 -> O1280). The dissemination of A-LAEF products via ECPDS for SK, CZ and Turkey was made more reliable (adding transferred file size check). Furthermore, EPS based downstream products started to be generated for hydrological service. Visualization tool for A-LAEF epsgrams was upgraded. A-LAEF hindcast data has been provided for a diploma thesis and commerce. A tool for statistical processing of data read from A-LAEF multi-GRIBs via R-package was developed. Various case studies were investigated (heavy precipitation event in Italy from May 16, 2023 is shown down below).

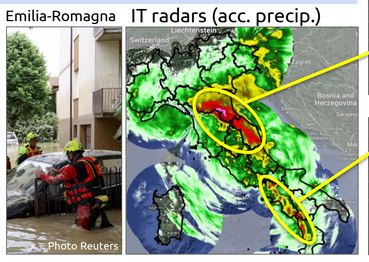
Cloudiness - 16 perturbed A-LAEF members (+72h forecast) - predictability example

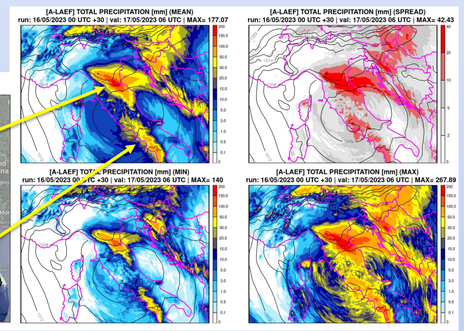


A-LAEF coupled to cy47r3 — A-LAEF coupled to cy48r1

Heavy precipitation event in Italy (May 16, 2023):

Emilia-Romagna — IT radars (acc. precip.)





Quality control with Harp & titanlib

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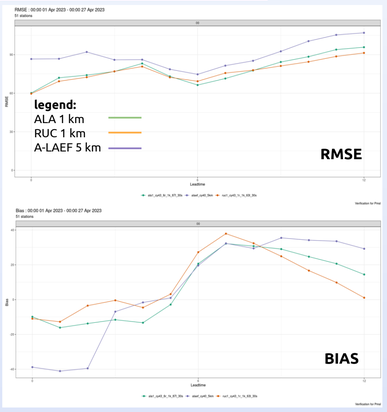
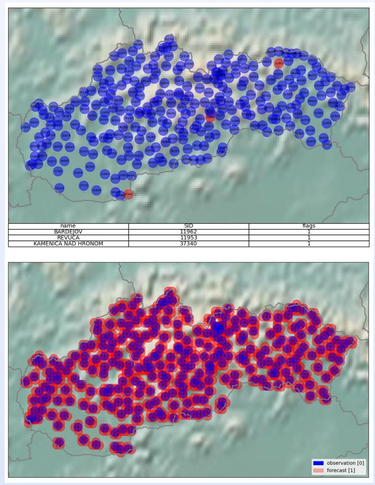


2023-04-01 - 2023-04-27 ruc1 (63l 8p) vs ala1 (dev 87l 16p): Verification of RUC1 runs with HARP and comparison with ALA1 and A-LAEF indicated some problems with transition from 63 to 87 levels (higher BIAS in certain forecasting periods).



Top panel: the *titanlib* applied - stations with unrealistic values are flagged in red.
Bottom panel: To improve the accuracy of the tests, forecasts derived from the model were assigned to each station (observations in blue dots, forecasts in red dots).

Investigation of numerical oscillations in offline SURFEX experiments

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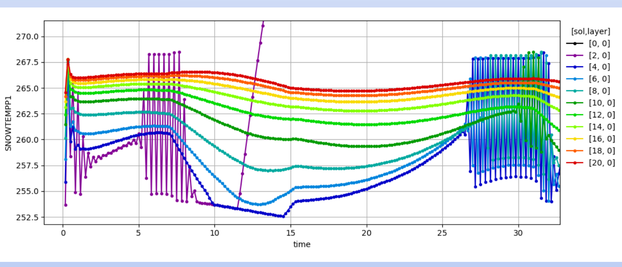

Numerical oscillations were detected in certain offline SURFEX experiments, those in which snow cover was present. These can be observed in the time evolution of snow and soil temperature but also in surface heat fluxes and screen level variables (Figure). The amplitude of oscillations increases with time step and is closely related to snow cover. These experiments were carried out using multi-layer snow schemes Explicit-Snow and Crocus and ISBA DF scheme for soil. We hypothesize that the oscillations can be related to calculation of snow surface heat balance, namely to errors introduced by linear approximation to nonlinear surface heat fluxes e.g. emitted thermal IR radiation heat flux, etc. An idealized model of surface heat balance was used to check this hypothesis.

RUC1 tests

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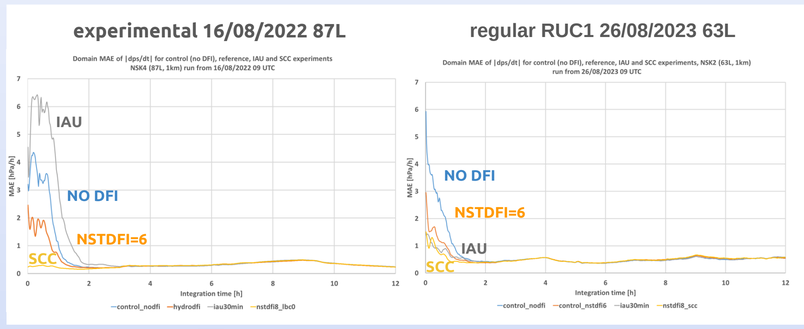
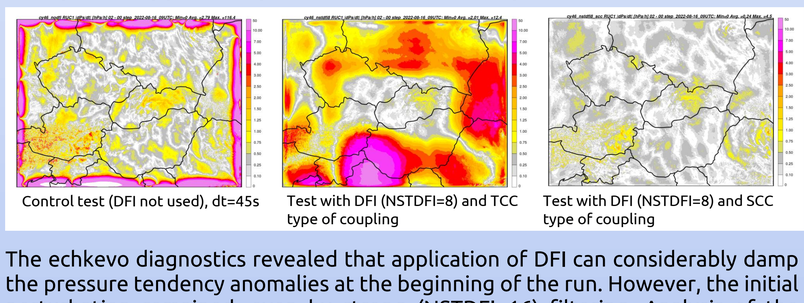
The RUC1 prototype is being prepared for a switch to cycle 46t1 and 87 levels. An extended run (ALA1) launched every 6h and up to the range of 48h is tested as well. Case studies with various modes of initialisation (DFI, IDFI, IAU) were provided and the Space-Consistent Coupling (SCC) was also investigated.

Echkevo diagnostics of pressure tendencies |dPs/dt| (domain MAE) in hPa/h for an experimental setup in the case of 16 August 2022 09 UTC (cy46t1, 87L) and from regular RUC1 run of 26 August 2023 09 UTC (cy43t2, 63L)



MAE of Pressure tendencies |dPs/dt| in hPa/h for the 16 August 2022 09 UTC experiment (cy46t1, 87L) between the 00 and 02 step of the run



Control test (DFI not used), dt=45s — Test with DFI (NSTDFI=8) and TCC type of coupling — Test with DFI (NSTDFI=8) and SCC type of coupling

The echkevo diagnostics revealed that application of DFI can considerably damp the pressure tendency anomalies at the beginning of the run. However, the initial perturbation remained, even by strong (NSTDFI=16) filtering. Analysis of the spatial distribution of the tendencies indicated a relationships with LBC-s and inconsistency of the initial analysis (3DVAR) and LBC. In the experimental run, Space-Consistent Coupling (SCC) applied together with DFI could largely damp the anomaly and associated oscillations but this feature was less pronounced in other types of weather situations. Similarly, the IAU method could also damp the perturbations but the rate of its impact was situation-dependent.

ALA2e oper and experiments

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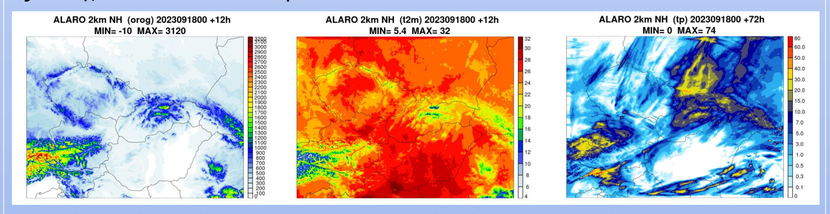
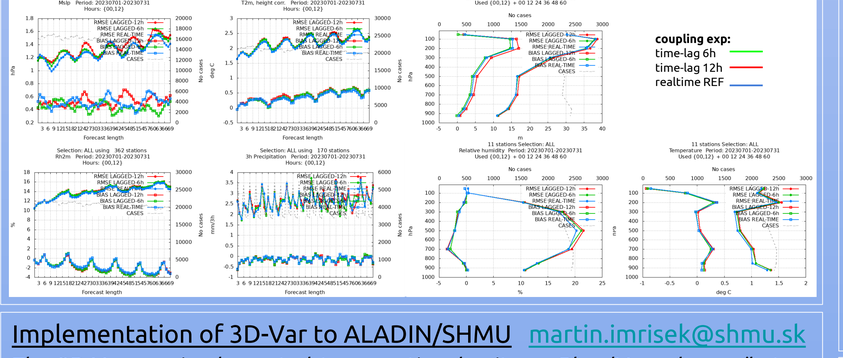
Configuration: ALARO NH 2 km / 87 lev (cy43t2, ALARO-1vB physics); A-LAEF control INIT (SDA + upper-air spectral blending by DFI @ Atos/ECMWF) + DFI; IFS 6h time-lagged coupling (LACE LBCs by ECMWF, frequency 3h); 00/12 UTC runs up to +72h (available 02:45 / 14:45 UTC).

Purpose: 3D NWP inputs for CMAQ (Community Multiscale Air Quality modeling system); Visual Weather maps for forecasters.



Time-lagged coupling experiments (6 and 12h vs real-time):

The 6h time-lagged coupling with IFS has comparable quality to the reference (real-time), while products being available significantly earlier (req. by CMAQ).



Climatological modelling

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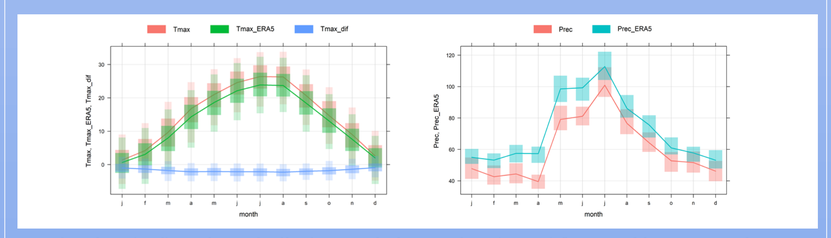
Reanalysis and validation runs (past weather) for the ALADIN/SHMU domain with a horizontal resolution of 4.5 km were computed for the period 2010 - 2019. The dynamic adaptation was driven by the global ERA5 reanalysis (boundary conditions with a 6-hour frequency), output spatial fields were integrated with a 30-hour forecast lead time (launched at 00 UTC).

Hourly simulations were postprocessed and validated (bias correction) using station data (Slovakia) and E-OBS gridded data.



Station data (red) vs. dynamically downscaled ERA5 data (green) for monthly mean maximum air temperature (left) and monthly mean precipitation sums (right) over the period 2010-2019.

DE_330_MF project and its applications

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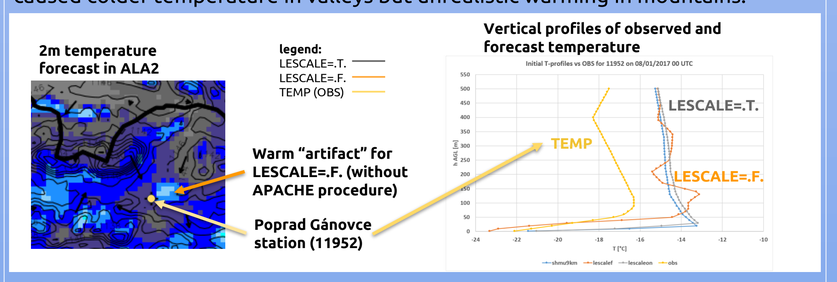
Experimental suite on a 2km res. domain (ALA2) was provided for a winter case of January 2017 (for air quality monitoring because of strong inversion) and for May 2021 (for hydrological modeling, due to floods). Dynamic adaptations at 750m resolution (D75A) were run as well. The experiments showed some interesting features related to coupling and interpolations (lancelot).

Case January 2017: Both ALA2 and D75A were tested as dynamic adaptations of the at that time operational ALADIN/SHMU model (9km resolution, L37). The Apache procedure for temperature (vertical interpolation in lancelot, described in Cassé et al., 2022) provides smoother fields but can partially degrade the information if there is a big difference in vertical levels between the source and target file (e.g. L37 in the coarse and 87L at high resolution). Omitting APACHE caused colder temperature in valleys but unrealistic warming in mountains.



Implementation of 3D-Var to ALADIN/SHMU

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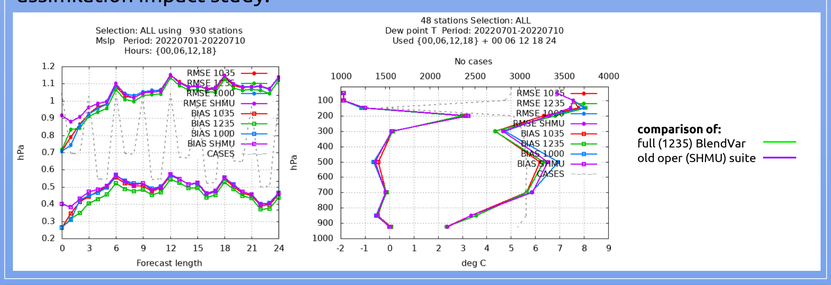
The 3D-Var was implemented to operational suite as BlendVar scheme (bator->e701->blending->e002->e131->e001). The SYNOP (1), AMDAR (2), AMV (3) and TEMP (5) data are assimilated to ALADIN/SHMU model with 6 hour frequency. Also the REDNMC and SIGMAO_COEF tuning was performed together with data assimilation impact study.



The upgrade to CY46

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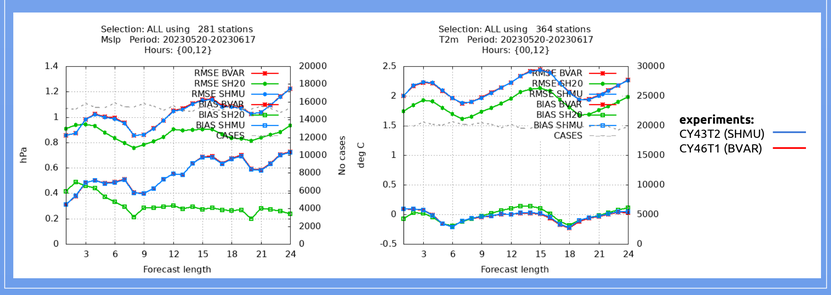
The upgrade of ALADIN/SHMU model from cycle CY43T2 (SHMU) to CY46T1 (BVAR) with few bug fixes was performed. E-suite is still under investigation.



Project URANOS: Use of maximum subgrid wind and gusts in ALADIN/SHMU reanalyses for the 2010-2019 period

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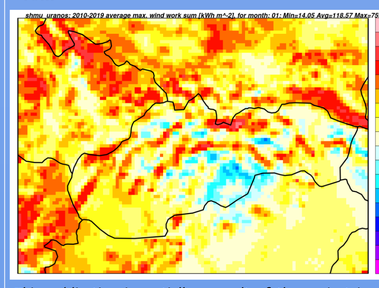
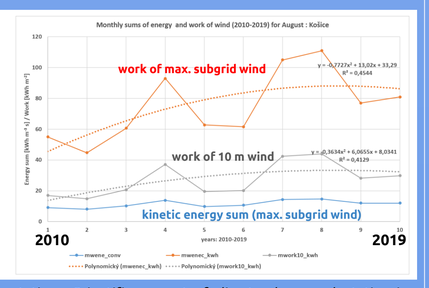
10 years of maximum subgrid wind data were calculated for the ALADIN/SHMU domain with 4.5 km horizontal resolution. The model runs were coupled from ERA5 reanalyses data. Integrated kinetic energy and wind work (daily integrals and monthly sums) were postprocessed. The maximum subgrid wind represents the effects of hidden (subgrid) orography and turbulence on wind strengthening in non-convective cases. It was parameterized upon statistics provided at high (325 m) resolution, based on TKE, wind shear and other parameters. Overall increase in wind speed over the period was detectable in the east of Slovakia, which can have consequences in stronger evapotranspiration and wind erosion.

Example of wind work sum map [kWh m^{-2}] in January, as an average for the years 2010-2019 and for the maximum subgrid wind at 10m



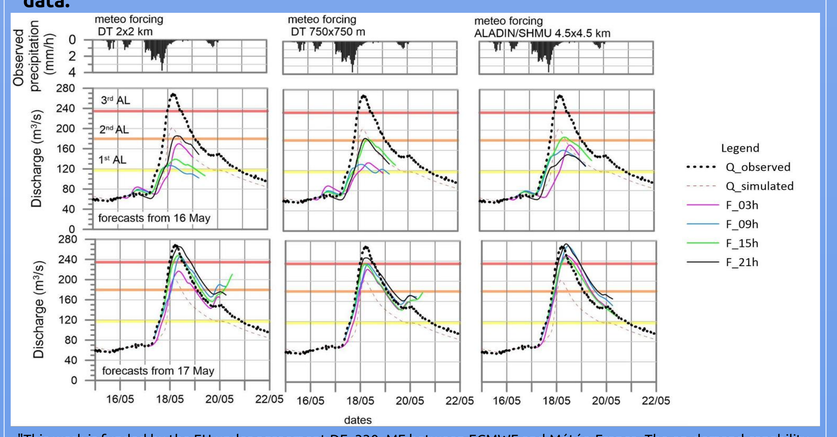
Evolution of wind work and kinetic energy sums in August, for the years 2010-2019 and for the area of Košice (eastern Slovakia)



This publication is partially a result of the project implementation: „Scientific support of climate change adaptation in agriculture and mitigation of soil degradation" (ITMS2014+ 313011W580) supported by the Integrated Infrastructure Operational Programme funded by the ERDF.

Use case May 2021: The flood situation was successfully forecasted with the use of 3 meteo forcing data with different spatial resolutions. Although DestinE (DT) at the hectometric scale underestimated the flood peak, results were the most persistent and five model runs indicated exceedance of the 2nd alert level (AL) before the event .

Measured, simulated (with national radar estimate) and forecasted (F_) discharges modelled by the hydrological HBV (IHMS6.4) model for the May 2021 flood on the Hron river, Banská Bystrica water gauging station, using different meteo forcing data.



"This work is funded by the EU under agreement DE_330_MF between ECMWF and Météo-France. The on-demand capability proposed by the Météo-France led international partnership is a key component of the weather-induced extremes digital twin, which ECMWF will deliver in the first phase of Destination Earth, launched by the EC."