EUREC^{4}A-GreyZone
Experimental protocol and output requirements

The second phase of the Grey Zone Project *EUREC^{4}A-GreyZone* model intercomparison case study is based on the EUREC^{4}A and ATOMIC field campaigns.
The aim of the project is to support and explore the development of appropriate, scale-aware physics in convective-scale models, both regional and global, and to compare and discuss different models and approaches.
Both limited-area models as well as global models are invited to participate in the intercomparison.

1. Model domains for limited-area model simulations

Two model domains are defined for limited-area models, a kilometre-scale domain and a hectometre-scale domain.
The kilometre-scale domain is: 67W to 37W, 0N to 27N.
The hectometre-scale domain is: 59.5W to 55.5W, 12N to 15N.

2. Model resolutions

The idea is to run limited-area models on the kilometre-scale domain with resolutions from 1km to about 5km, and to run limited-area models on the hectometre-scale domain with resolutions from 100m to about 600m.
Global models should have resolutions from about 2km to about 7km.
Models which are able to run a 100m-resolution simulation on the hectometre-scale domain are strongly encouraged to do so in order to provide “reference simulations”.

3. Initialisation and lateral boundary conditions

Models, in particular global models, should be initialised with ERA5 reanalysis. Limited-area models on the kilometre-scale domain should use ERA5 as lateral boundary conditions. For limited-area models on the hectometre-scale domain, the 1km-resolution simulation on the kilometre-scale domain should be used as lateral boundary conditions.

4. Initialisation times and length of run

Five initialisation times are proposed as follows:
January 23, 2020, 00:00 UTC (January 24 case)
February 1, 2020, 00:00 UTC (February 2 case)
February 4, 2020, 00:00 UTC (February 5 case)
February 6, 2020, 00:00 UTC (February 7 case)
February 8, 2020, 00:00 UTC (February 9 case)
The duration of the simulations should be 48 hours.

5. Output periods

For the different cases, output (as defined below) is required over the following time periods:
January 24, 10:00 UTC to 22:00 UTC (January 24 case)
February 2, 10:00 UTC to 22:00 UTC (February 2 case)
February 5, 10:00 UTC to 22:00 UTC (February 5 case)
February 7, 10:00 UTC to 22:00 UTC (February 7 case)
February 9, 10:00 UTC to 22:00 UTC (February 9 case)

6. Prioritisation of cases

For groups who do not want to run all five cases, the following prioritisation is suggested:
Priority 1: February 2 case, February 5 case, February 7 case.
Priority 2: January 24 case, February 9 case.

7. Sea surface temperatures

The models should use prescribed sea surface temperatures. It is recommended to base the simulations on the OSTIA sea surface temperature analysis, or a similar product.

8. Cloud droplet number concentrations

Aerosol or CCN concentrations are not specified. We suggest, however, to fix the cloud droplet number concentrations, if possible. The following estimates of cloud droplet number concentrations at cloud base may be used:
January 24 case: 200 cm-3
February 2 case: 600 cm-3
February 5 case: 400 cm-3
February 7 case: 150 cm-3
February 9 case: 600 cm-3

9. Sensitivity experiments

Apart from model resolution, other sensitivity experiments can be conducted. They should address the issue of scale-aware physics, or the role of the model dynamics, in one way or another. Sensitivity experiments should be designed in a controlled way and not include too many different changes in the model formulation at once.
A well-defined baseline model configuration, run at various resolutions, should be the baseline for the sensitivity experiments at the respective resolution.
For the sensitivity experiments a reduced set of outputs should be submitted (varying the resolution does not count as a “sensitivity experiment” here).

10. Output requirements

There are 3D data and 2D data.
The 3D data should be output 2-hourly for the time periods defined in Section 5.
The 2D data should be output hourly for the time periods defined in Section 5.
The variables for the 3D data are defined in Table 1.
The variables for the 2D data are defined in Table 2.
The 3D data should include **all the model levels up to 5500m height (and not higher)**.
There should be one, and only one, file for each case, each variable, each dimensionality, each resolution, and each experiment. The file should include all the respective time steps and vertical levels for the case, see Section 11.
All files should include the “latitude”, “longitude”, and “time” information.

11. Organisation of files and file name convention

The files should be NetCDF files. The structure of the file names is as follows:
YourModelIdentitifier_YourGroupIdentifier_Initialtime_DomainName_Dimensionality_TimeResolution_ModelResolution_ExperimentIdentifier_Varname.nc

YourModelIdentifier: Identifies your model, e.g. UMregional
YourGroupIdentifier: Identifies who runs the experiment (in case several groups use the same model): e.g. MOGMED (Met Office GMED group)
Initialtime: Initial time of the case, e.g. 20200201T0000Z (see Section 4)
DomainName: KMscale or HMscale or Global (see Section 1)
Dimensionality: 3D or 2D
TimeResolution: 2Hourly or Hourly (see Section 10)
ModelResolution: Model grid length, e.g. 1p1km, 100m etc.
ExperimentIdentifier: All participating groups should use the experiment identifier “Baseline” for their baseline model configuration, and other identifiers for sensitivity experiments
Varname: Variable names as defined in Tables 1 and 2.

Example:
UMregional_MOGMED_20200201T0000Z_KMscale_3D_2Hourly_1p1km_Baseline_ta.nc

12. Output domains

Simulations run on the kilometre-scale domain should submit the output on the kilometre-scale domain, simulations run on the hectometre-scale domain should submit the output on the hectometre-scale domain. Global models should submit the output on the kilometre-scale domain.

13. Data upload and sharing

Data will be shared via and uploaded to the JASMIN service of the Centre for Environmental Data Analysis (CEDA):
https://www.ceda.ac.uk/services/jasmin/
Once your results are ready please email Lorenzo Tomassini (lorenzo.tomassini@metoffice.gov.uk) for instructions about how to submit the data.

14. Soft and hard deadline

A first soft deadline for data submission is 31st of October 2021. A hard deadline will tentatively be 31st of December 2021.

15. Publication

All participants will be included as co-authors of an intercomparison paper.

Table 1: 3D data (2-hourly)

Variable name	Description	Unit
ta	Air temperature	Kelvin
hus	Specific humidity	kg/kg
rho	Air density	kgm-2
clw	Cloud liquid water	kg/kg
pra	Rain water flux	kgm-2s-1
va	Meridional wind	ms-1
ua	Zonal wind	ms-1
wa	Vertical wind	ms-1
hur	Relative humidity	%
plev	Pressure	Pa
htlev	Height	m
cl	Cloud area fraction	%
tnta_conv	Parameterized temperature tendency due to convection	Kelvins-1
tnta_turb	Parameterized temperature tendency due to turbulence	Kelvins-1
tnhus_conv	Parameterized specific	s-1

Variable name	Description	Unit
	humidity tendency due to convection	
tnhus_turb	Parameterized specific humidity tendency due to turbulence	s-1
tnclw_conv	Parameterized liquid water tendency due to convection	s-1
tnclw_turb	Parameterized liquid water tendency due to turbulence	s-1
tnta_rad	Tendency of air temperature due to radiative heating	Kelvins-1
tblhfl_sub	Subgrid vertical turbulent heat flux	Wm-2
tblmfl_sub	Subgrid vertical turbulent moisture flux	Wm-2
cmfl_sub	Subgrid mass flux from convection	kgm-1s-1
tke_sub	Subgrid TKE	m2s-2

Comments:
Pressure can be one-dimensional if constant over the area (i.e., if the model uses constant pressure levels as vertical coordinates).
Height can be one-dimensional if constant over the area (i.e., if the model uses constant height levels as vertical coordinates).
Variables which are zero do not need to be provided (e.g., if no convection parameterization is used, the respective tendencies do not need to be provided).

Table 2: 2D data (Hourly)

Variable name	Description	Unit
ts	Surface temperature	Kelvin
ps	Surface pressure	Pa
uas	10m eastward wind	ms-1
vas	10m northward wind	ms-1
tas	2m temperature	Kelvin

Variable name	Description	Unit
huss	2m specific humidity	kg/kg
rsds	Shortwave downwelling radiative flux at the surface	Wm-2
rsut	Shortwave upwelling radiative flux at the TOA	Wm-2
rlds	Longwave downwelling radiative flux at the surface	Wm-2
rlut	Longwave upwelling radiative flux at the TOA	Wm-2
pr	Surface total precipitation rate	kgm-2s-1
clt	Total cloud cover	%
clwvi	Liquid water path	kgm-2
prw	Water vapor path	kgm-2
hfls	Surface latent heat flux	Wm-2
hfss	Surface sensible heat flux	Wm-2
cl_low	Low cloud cover (if available)	%
cl_mid	Middle cloud cover (if available)	%
cl_high	High cloud cover (if available)	%
goes16_refl	GOES16 simulated reflectivity at 0.64 micro meter (if available)	
goes16_brt	GOES16 simulated brightness temperature at 11.2 micro meter (if available)	Kelvin
pr_conv	Surface convective precipitation rate	kgm-2s-1