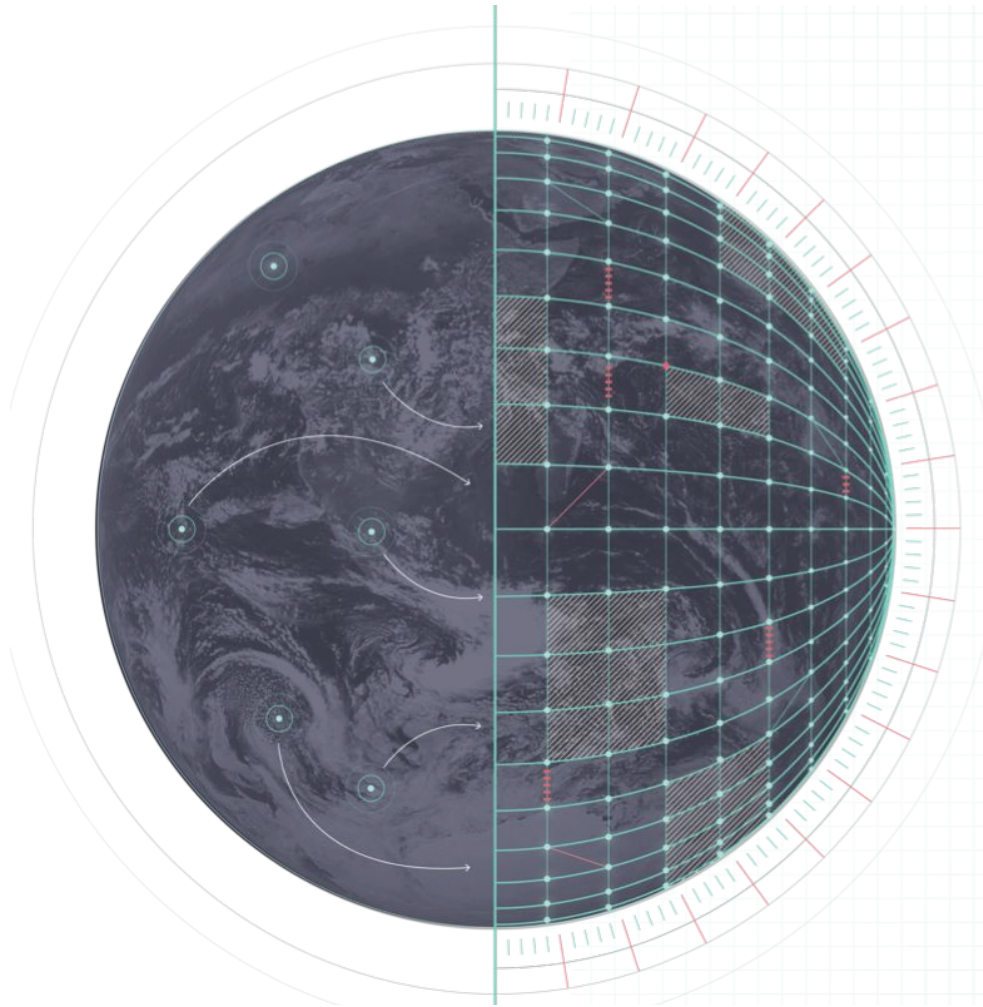


DESTINATION EARTH



The On-Demand Extremes workflow in Destination Earth

Ulf Andrae & Xiaohua Yang
With the
On-Demand Extremes WP5 Team and
contributions from other in project
WP's

4th ACCORD All Staff Workshop 15-19 April, Norrköping and hybrid



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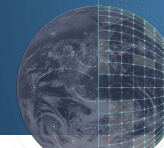




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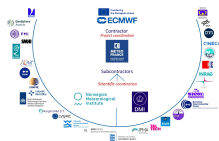
implemented by



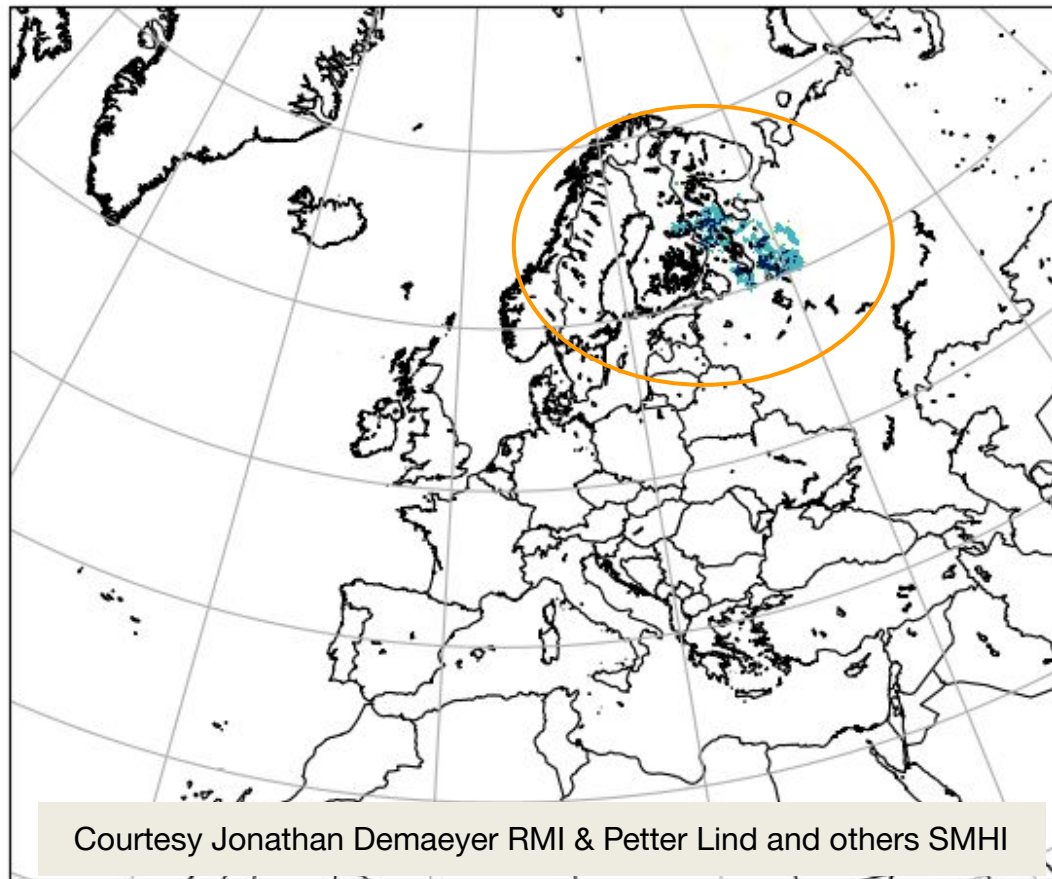
The project mission

- 1) Detect an incoming extreme event. We produce daily maps of detected high impact events which could be related to (currently) strong wind, precipitation or strong convective activity

To the right we see the trigger index for 10m maximum wind gust. The index is a combination of an extreme value combined with the probability as represented by IFSENS



Max gust speed trigger index
valid 2024-04-12

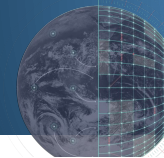




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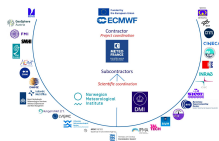
implemented by



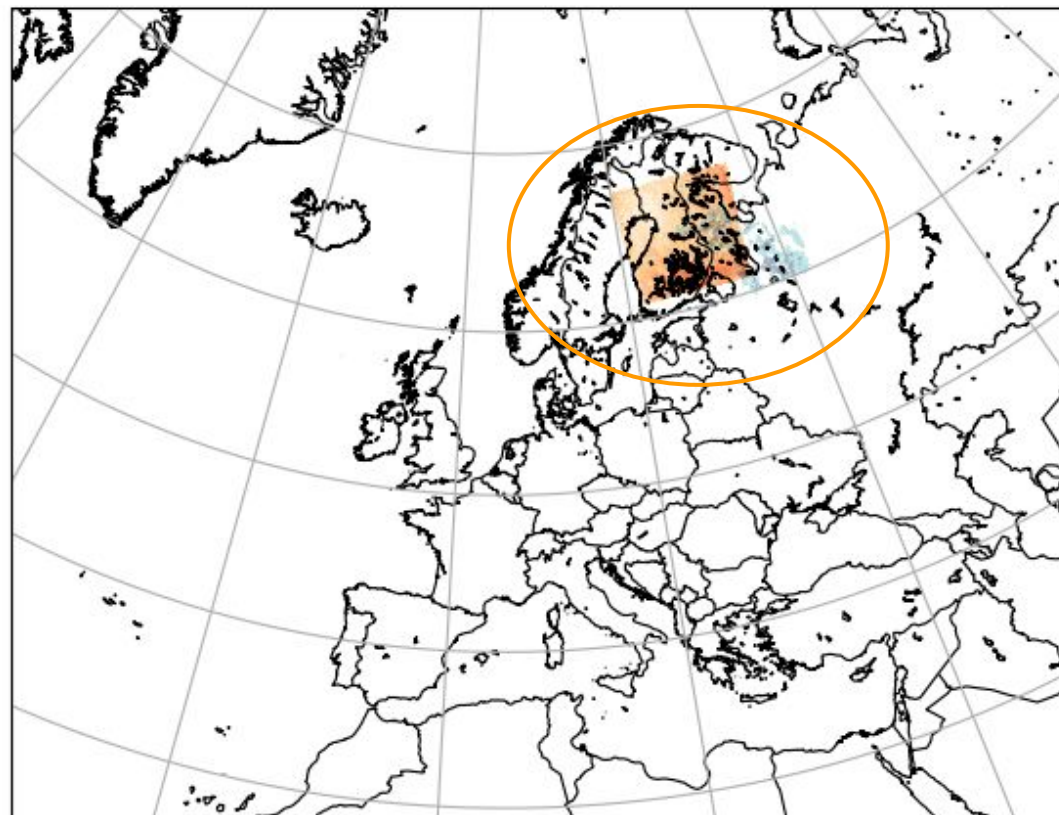
The project mission

- 1) Detect an incoming extreme event. We produce daily maps of detected high impact events which could be related to (currently) strong wind, precipitation or strong convective activity
- 2) Automatically find the most appropriate domains and issue a forecast

The triggering algorithm will locate the domain at the max value given some search radius for the N highest values



Max gust speed trigger index and selected domain
valid 2024-04-12



Courtesy Paulo Medeiros SMHI



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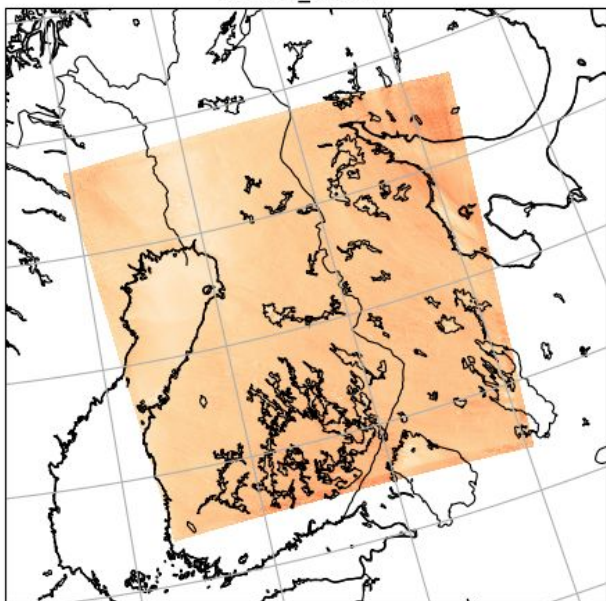


The project mission

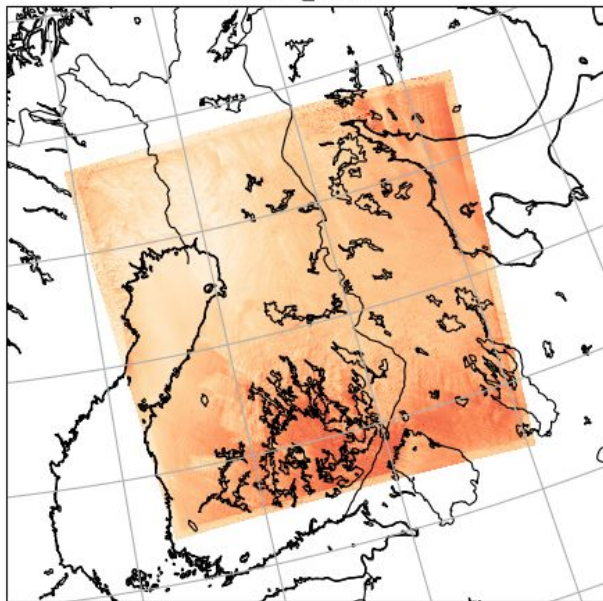
The choice of CSC will depend on the geographical area, but the capability is all inclusive

Example domain is 1500x1500x90 points with $dx=500m$, $dt=20s$, linear grid using the global 4.4km DT as initial conditions and LBC

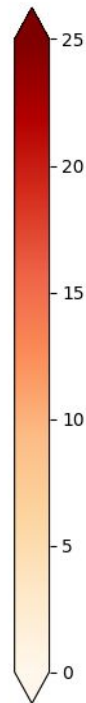
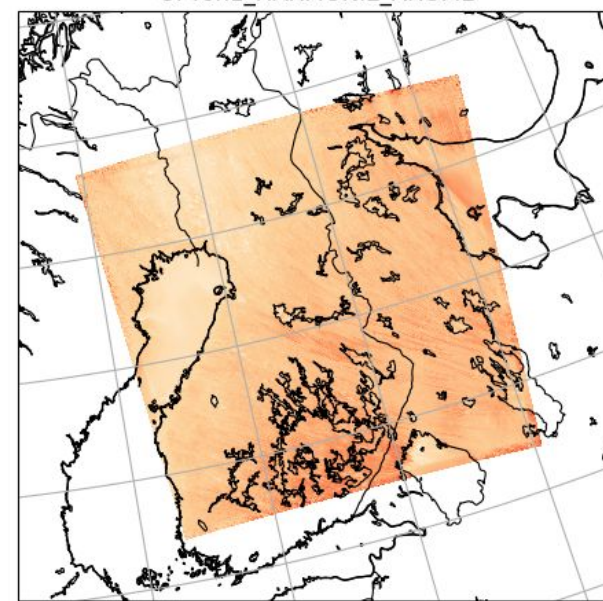
Max gust speed 2024-04-12+0012
CY48t3_AROME

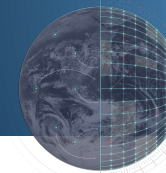


Max gust speed 2024-04-12+0012
CY48t3_ALARO



Max gust speed 2024-04-12+0012
CY46h1_HARMONIE_AROME



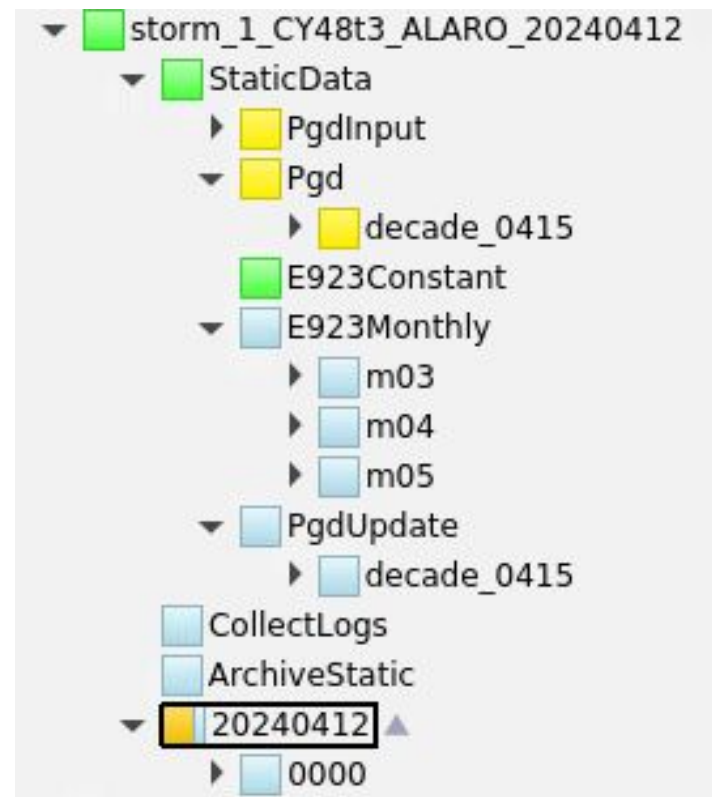


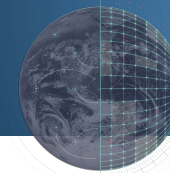
How do we configure our runs?

Domain generation is in the time critical path => requires a different approach for e.g. ECOCLIMAP SG. Cost reduced from hours to minutes

The procedure respects the “usual way” of doing things e.g.

- Spectral smoothing by truncation for AROME
- ALARO runs without surfex but uses fields from PGD
- HARMONIE-AROME filters with LSPSMORO=T





How do we configure our runs?

- The lateral boundaries comes from the global 4.4km DT. But there is support for running with HRES, IFSSENS or any of the ECMWF RD experiments available for the project such as the 2.8km global runs. Close collaboration with ECMWF!
- Fullpos (c903) is used for the boundary interpolation
- Prep is used to initialize the SURFEX state
- The suite can be run in either cold start or cycled mode

[boundaries]

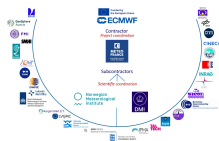
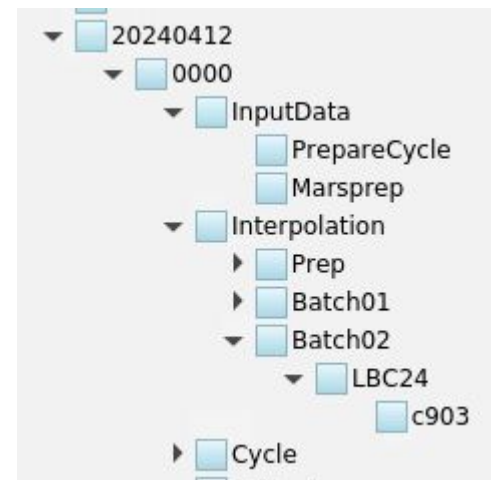
```
bd_has_surfex = false
bdcycle = "PT24H"
bdint = "PT1H"
bdmodel = "IFS"
bdshift = "PT0H"
bdtasks_per_batch = 24
humi_gp = false
ifs.selection = "ATOS_DT"
ifs.bdmember = ""
```

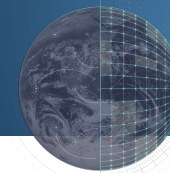
[ATOS_DT]

```
default = "RD_DEFAULT"
expver = "i4ql"
start_date = "2023-09-09T00:00:00Z"
```

[ATOS_DT.stream]

```
00 = "OPER"
```





How do we configure our runs?

The output is streamlined for various targeted applications

- Baseline forecast variables with special cases for hydrology, air quality models, renewables, ...
- Output frequency from minutes to hours
- Writing GRIB2, ccsds packing, directly from fullpos (not yet SURFEX)
- All I/O done using the IO-server

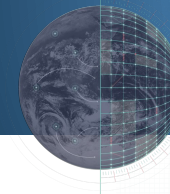
```
[fullpos]
config_path = "@DEODE_HOME@/deode/namelist_generation_input/@CYCLE@/fullpos"
selection = ["rules", "namfpc_header", "master_selection", "sol_selection"]
```

[general.output_settings]

```
fullpos = "PT15M"
history = "PT1H"
nrazts = "PT1H"
surfex = "PT1H"
```

```
1 # Do the selection of fields below.
2 # Note that xxt00000000 inherits from xxtddddhhmm
3 selection:
4   xxtddddhhmm: &default
5   NAMFPPHY:
6     CLCFU:
7       - 'SURFRAYT SOL CL'
8       - 'SURFRAYT THER CL'
9       - 'SURFDIR NORM IRR'
10      - 'SURFRAYT DIR SUR'
11
12 xxtddddhh00:
13   <<: *default
14
15 xxt00000000:
16   <<: *default
```





How do we configure our runs?

Post-mortem tasks

- Produce harp friendly sqlite files directly from the GRIB2 output
- Produce GRIB2 files for SURFEX using the new WMO approved templates
- Archive data on ecfs (atos) or fdb (lumi/atos)
- Once the data is in fdb other mechanisms take over and make the data available to users on the data lake



```
parameter_list = "@DEODE_HOME@/deode/data/sqlite/param_list@CSC@.json"
selection = "PT1H"
sqlite_model_name = "@CASE@"
sqlite_path = "@ARCHIVE_ROOT@/sqlite/"
sqlite_template = "FCTABLE/{MODEL}/{YYYY}/{MM}/FCTABLE_{PP}_{YYYY}{MM}_{HH}.sqlite"
station_list = "@DEODE_HOME@/deode/data/sqlite/station_list_default.csv"
```



Eccodes releases supporting our work

- 2.33 : tile support
- 2.34 : Sub-hourly steps
- 2.35 : Introduce some missing variables

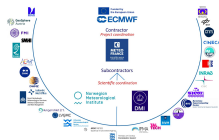
All GRIB2 output WMO compliant!

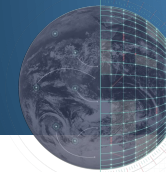




Current capabilities and limitations

- ECMWF atos@Bologna successfully used as development platform. (eats SBU's for breakfast ...)
- The machine aimed for our main runs, LUMI, still challenges us in many ways (software stack, crashes, queues, uptime, ...) although ALARO runs on mixed CPU/GPU
- Runtime for the whole suite is still too long. Optimisation required (single precisions, GPU, ...)
- No assimilation nor EPS functionality included (parts will come in phase II)





IAL version and settings currently used

AROME (CY48T3)

- 3 patch multilayer soil scheme, ECOCLIMAP SG
- Dynamics settings for improved stability

ALARO (CY48T3)

- Surface characteristics updated with PGD info

HARMONIE-AROME (CY46h1)

- 2 patch multilayer soil scheme, ECOCLIMAP SG
- Scale aware shallow convection
- Diffusion settings to fit $dx=500m$

Misc improvements of CY48t3

- Fixes for parallel execution of PREP/PGD
- Fixes for ECMWF input to PREP
- Cclds packing and subhourly grib encoding
- Add mean wind and mean radiant temperature

Misc improvements in CY6h1

- Introduce Wind farm parameterisation
- Scale aware shallow convection
- Faster PGD/PREP

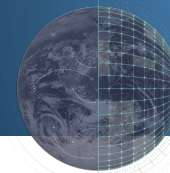




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How have we achieved this?

- The developed runtime environment, the “Deode-Prototype”, allows to run all CSCs under the same umbrella
- It's built to work as the operational and development platform within the project, and also with the ACCORD needs in mind
- It's been co-developed by a wide group of developers from within the ACCORD family



README
MIT license

GITHUB
GITHUB PAGES

Linting Checks passing
Unit Tests passing
codecov 85%

DEODE Scripting System

About

The [DEODE Scripting System](#) provides a `deode` python package that runs the [Destination Earth on Demand Extremes system](#).

See the [project's documentation page](#) for more information.

System Requirements

Prepare your environment on the HPC machines

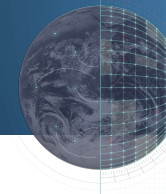
Start by putting the `$HOME/.local/bin` directory in your `PATH` :

```
export PATH="$HOME/.local/bin:$PATH"
```

We **highly recommend** you to also put the statement listed above in your shell configuration file, so you don't need to do this the next time you log in. Then, run:

- On Atos (`hpc-login`)

```
module load python3/3.10.10-01
module load ecflow
```



The Deode-Prototype in short

- Python based using toml/yaml/json for configuration
- Poetry dependency handling
- Enforced linting and unit testing. Currently 85% code coverage
- Built to be portable, future will tell...
- Separation of tasks and scheduler (ecflow). Allows us to test single tasks stand alone
- Json-schema validation which provides configuration documentation for free
- Namelist handling by yaml files or user provided static namelists (for easier development)
- Command line functionalities like

```
deode start suite [--config-file file]
```

```
deode run -task TASKNAME [...]
```

```
deode show namelist [...] -n forecast
```

```
deode show config [...] archiving.ecfs
```





The strength of working tight together...



uandrae commented last week

Author ...

With the latest changes based on tests and advice from [@ovignes](#) we now have the following numbers for a 1500x1500x90 domain.

- Current: 24 nodes, 3058 MPI ranks, 14 I/O-tasks, 1 OpenMP thread. Takes 1184s for a 3h forecast
- Ref: 20 nodes, 2548 MPI ranks, 12 I/O-tasks, 1 OpenMP thread. Takes 1766s for a 3h forecast
- New: 20 nodes, 624 MPI ranks, 16 I/O-tasks, 4 OpenMP threds. Takes 988s for a 3h forecast



kastelecn commented last week • edited

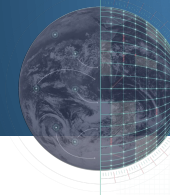
Author ...

CY48t3

1500x1500x90 3h forecast:

AROME: from 2948s to 1748s

ALARO: from 2814 to 1390s. It looks like ALARO forecast doesn't work with current develop settings for large domain, there are some OMP error, so I ran it with:



Conclusion and outlook

- We've built a workflow that enables us to run on-demand forecasts on the hectometric scale
- A lot of work remains, both technically and scientifically, to bring the full value
- The runtime environment, the "Deode-Prototype", is a good starting point for a common ACCORD system. A large part thanks to the wide engagement

Thanks for the attention!

