

A Consortium for CO_nvection-scale modelling
Research and Development

**Building an ACCORD single-column NWP environment
for enhancing model validation**

Metodija (Meto) Shapkalijevski (SMHI) **on behalf of ...**

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Acknowledgements to ...

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Emily Gleeson (Met Éireann),
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Ana Sljivic (CHMI),
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Daniel Deacu (GeoSphere Austria),
et al.

1. **Concept: A Single -Column Model**
2. **ACCORD challenge**
3. **Unified Single Column Model (MUSC)**
4. **Environment for MUSC Simulations - EMS: motivation**
5. **ACCORD - EMS: development & application**
6. **Upcoming activity**

1. **Concept:** from full 3D system (NWP) ...

$$E.g. : \frac{\partial q^{l,s}}{\partial t} + \mathbf{v} \nabla q^{l,s} = -\frac{1}{\rho} \nabla F^{l,s} + S^{l,s} + \frac{1}{\rho} \frac{\partial P^{l,s}}{\partial z}$$

- ▶ Non-linear interplay between momentum, energy, and matter exchange:
 - large scale dynamics (thermodynamics)(e.g. horizontal advection, subsidence)
 - subgrid-scale mixing (e.g. turbulence (including convection))
 - individual microphysical processes (e.g. condensation, freezing) and their rates
 - precipitation and sedimentation fluxes
 - surface-atmosphere coupling (lower atmospheric BC)

... to 1D system (Single Column Model):

$$\frac{\partial q^{l,s}}{\partial t} + \mathbf{v} \nabla q^{l,s} = -\frac{1}{\rho} \frac{\partial F^{l,s}}{\partial z} + S^{l,s} + \frac{1}{\rho} \frac{\partial P^{l,s}}{\partial z}$$

Physics parameterization in NWP: develop/improve, validate, compare

2. **Challenge:** ACCORD's NWP has 3 "different" Canonical System Configurations (CSCs):

▶ AROME

▶ ALARO

▶ HARMONIE-AROME

Differences in dynamics, physics parameterization, coding, ...

$$\frac{\partial q^{l,s}}{\partial t} + \mathbf{v} \nabla q^{l,s} = -\frac{1}{\rho} \frac{\partial F^{l,s}}{\partial z} + S^{l,s} + \frac{1}{\rho} \frac{\partial P^{l,s}}{\partial z}$$

3. MUSC history and status

- ▶ The first documentation (report) on MUSC (unfinished, CY31T1): [Malardel, Sylvie, 2004](#)
- ▶ MUSC is widely used by each of the ACCORD members, e.g. [Gleeson et al. 2020](#)
- ▶ Development and documentation on **Environment for MUSC Simulation (EMS)**: [Roehrig, Romain's, GitHub](#)

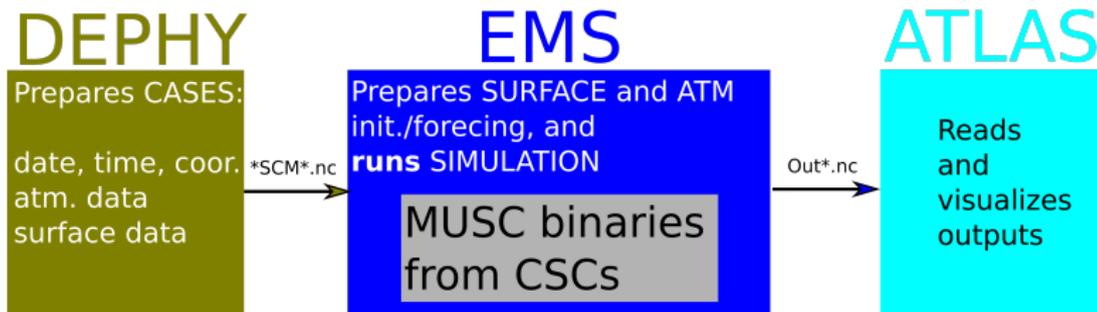
We decided to work with **EMS** and adjust it to the ACCORD needs.

- ▶ Documentation on setting the EMS on a common ECMWF (Atos) platform (EMS, CY46(T/h)1), [Eoin Whelan](#):

`master/EMS ↔ ACCORD/EMS/Main ↔ ACCORD/EMS/Users`

Why EMS? - How it works?

4. Motivation



- ▶ Well structured and efficient (easy for further development)
- ▶ **One** command to run and **one** to plot
- ▶ We have integrated and documented the system based on HARMONIE binaries
 - switching the different (CSC) namerlist manually

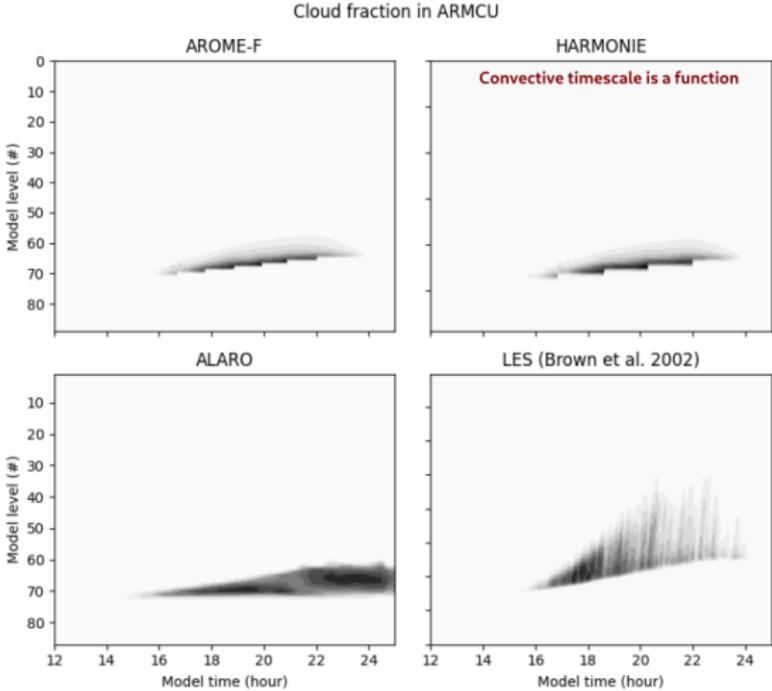
5. Application: run and compare USED cases

```
Apptainer> ems_list_cases.py
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2024-09-30 09:14:38,555 - ems.cases - INFO - GABL51 REF /perm/snl/metapp_harm/ems/ems/./share/CASES/GABL51_REF_SCM_driver.nc
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ver.nc
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nc
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nc
2024-09-30 09:14:38,556 - ems.cases - INFO -----
Apptainer>
```

5. Application: run and compare USED cases (StCu)

```
Apptainer> ems_list_cases.py
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ver.nc
2024-09-30 09:14:38,555 - ems.cases - INFO - ARPEGE_SODANKYLA /perm/snl/metapp_harm/ems/ems/./share/CASES/ARPEGE_SODANKYLA_SCM_driver.nc
2024-09-30 09:14:38,555 - ems.cases - INFO - AYOTTE_00SC /perm/snl/metapp_harm/ems/ems/./share/CASES/AYOTTE_00SC_SCM_driver.nc
2024-09-30 09:14:38,555 - ems.cases - INFO - AYOTTE_00WC /perm/snl/metapp_harm/ems/ems/./share/CASES/AYOTTE_00WC_SCM_driver.nc
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Apptainer>
```

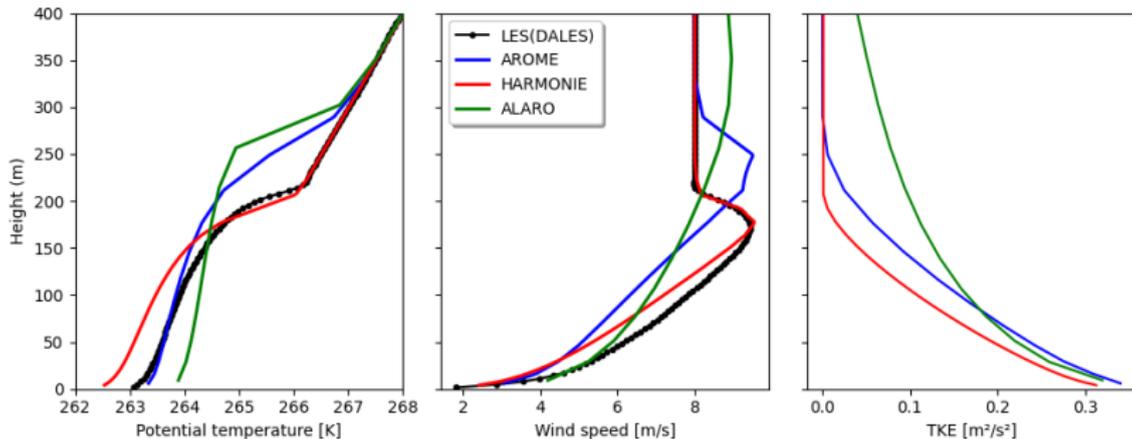
5. Application: run and compare USED cases (e.g. StCu)



5. Application: run and compare USED cases (SBL)

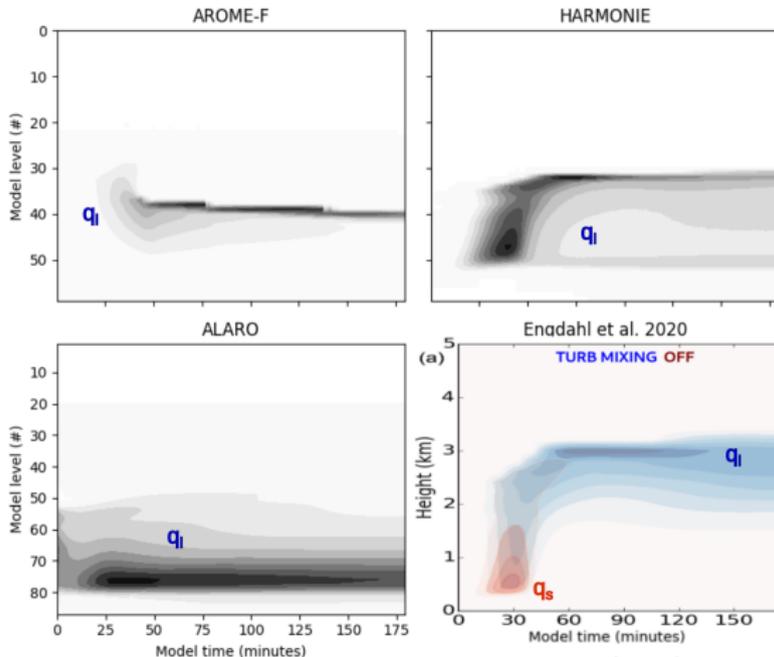
```
aptainer> ems_list_cases.py
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2024-09-30 09:14:38,555 - ems.cases - INFO - AYOTTE_00WC /perm/snl/metapp_harm/ems/ems/./share/CASES/AYOTTE_00WC_SCM_driver.nc
2024-09-30 09:14:38,555 - ems.cases - INFO - AYOTTE_03SC /perm/snl/metapp_harm/ems/ems/./share/CASES/AYOTTE_03SC_SCM_driver.nc
2024-09-30 09:14:38,555 - ems.cases - INFO - AYOTTE_05SC /perm/snl/metapp_harm/ems/ems/./share/CASES/AYOTTE_05SC_SCM_driver.nc
2024-09-30 09:14:38,555 - ems.cases - INFO - AYOTTE_05WC /perm/snl/metapp_harm/ems/ems/./share/CASES/AYOTTE_05WC_SCM_driver.nc
2024-09-30 09:14:38,556 - ems.cases - INFO - AYOTTE_24SC /perm/snl/metapp_harm/ems/ems/./share/CASES/AYOTTE_24SC_SCM_driver.nc
2024-09-30 09:14:38,556 - ems.cases - INFO - IHOP_REF /perm/snl/metapp_harm/ems/ems/./share/CASES/IHOP_REF_SCM_driver.nc
2024-09-30 09:14:38,556 - ems.cases - INFO - SCMS_REF /perm/snl/metapp_harm/ems/ems/./share/CASES/SCMS_REF_SCM_driver.nc
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2024-09-30 09:14:38,556 - ems.cases - INFO - SANDU_FAST /perm/snl/metapp_harm/ems/ems/./share/CASES/SANDU_FAST_SCM_driver.nc
2024-09-30 09:14:38,556 - ems.cases - INFO - SANDU_SLOW /perm/snl/metapp_harm/ems/ems/./share/CASES/SANDU_SLOW_SCM_driver.nc
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nc
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nc
2024-09-30 09:14:38,556 - ems.cases - INFO -----
aptainer>
```

5. Application: **modify**, run and compare USED cases (e.g. GABLS1)

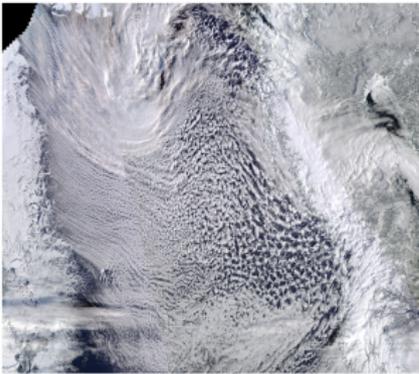
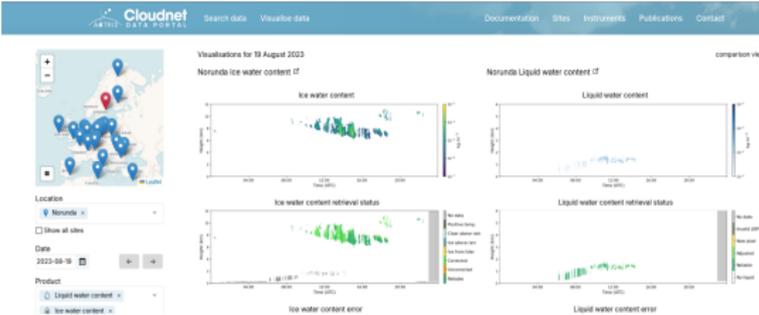


5. Application: Create, run and compare NEW cases (e.g. SCLD)

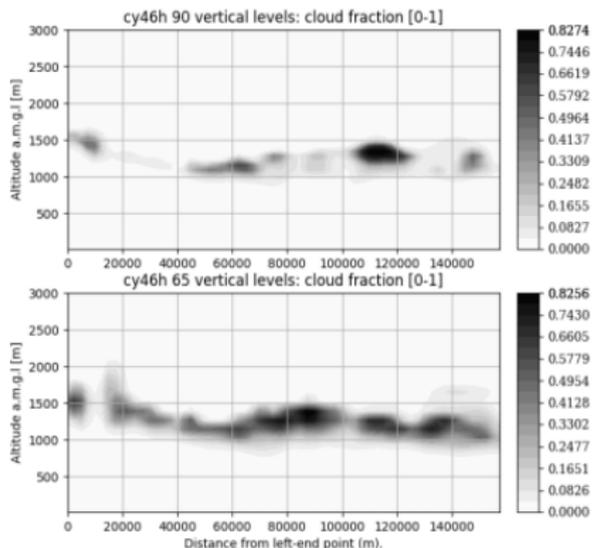
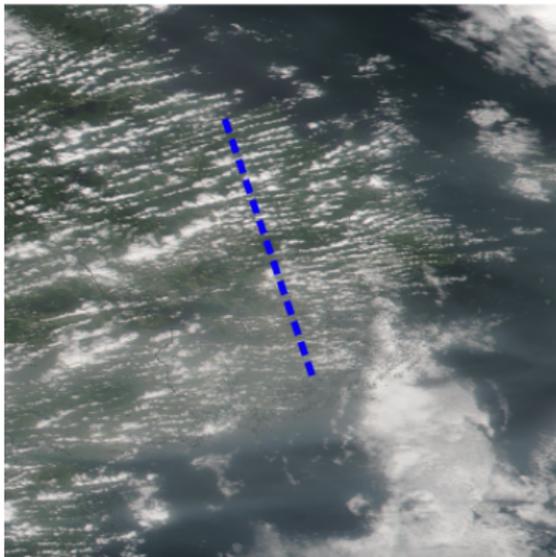
Specific Mass of Cloud Liquid Water in SCLD (Engdahl et al. 2020)



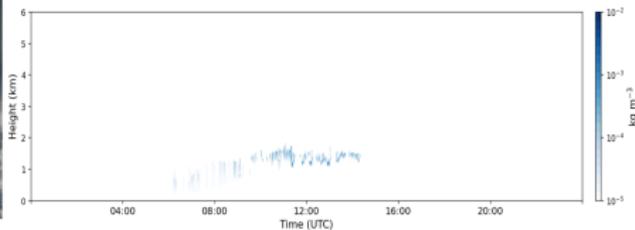
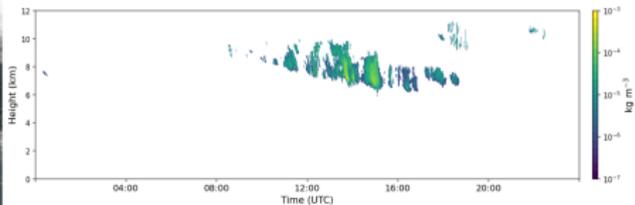
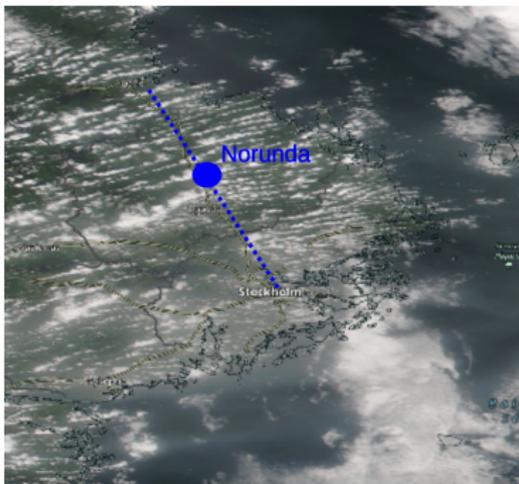
5. Application: Create, run and compare REALISTIC cases



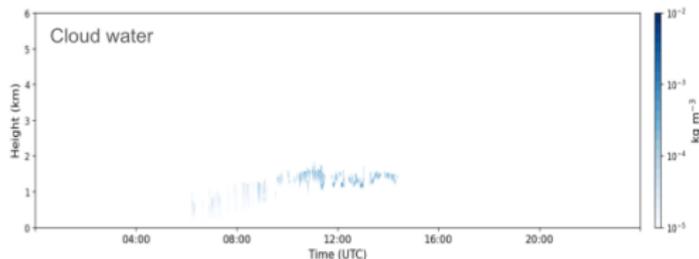
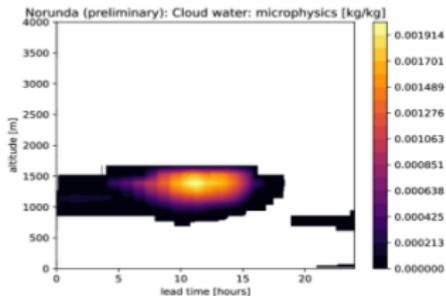
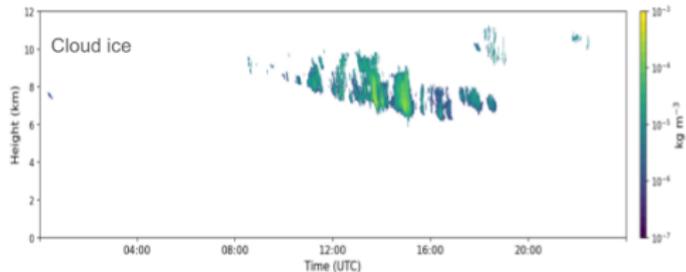
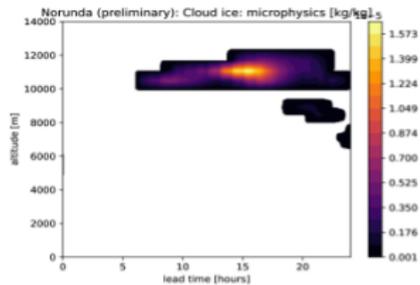
5. Application: Create, run and compare **REALISTIC** cases



5. Application: **Create**, run and compare **REALISTIC** cases

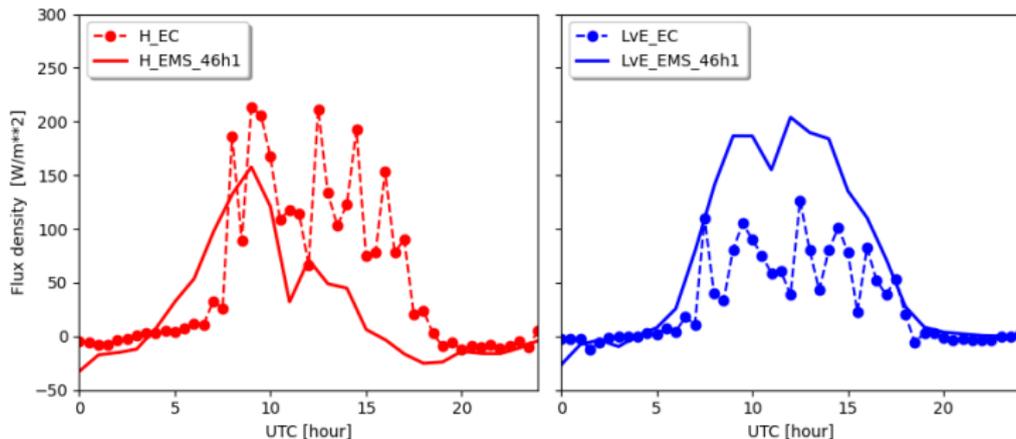


5. Application: Create, run and compare REALISTIC cases



5. Application: **Create**, run and compare **REALISTIC** cases

Studying the surface-atmosphere continuum for specific meteorological (atmospheric) processes



6. Status and plans

- **Building a sophisticated, efficient and robust system (procedure) for the process (physics)-based verification**
- **ACCORD-EMS a base tool next to an integrated list of idealized and realistic cases (against well established observational data and LES)**
- **Linking the surface, large (meso) scale (dynamics), and subgrid-scale processes and their feedback in the verification procedure**
- **Integrate the dynamic tendency in the (EMS) forcing and verification, as well as more frequent model output - DDH**

6. Thank you!

