RC-LACE stay report

Implementation and preliminary evaluation of the ECOCLIMAP-SG physiography data in the ALARO-CMC model

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1 Introduction and motivation

This report summarizes the implementation and evaluation activities of the ECOCLIMAP Second Generation (SG) physiography within the ALARO-CMC, carried out during the ALARO + SURFEX Working Week (2–6 June) and the RC-LACE research stay (9–20 June) at Czech HydroMeteorological Institute (CHMI) in Prague. In doing so, the main goal was to (i) solve eventual technical problems, (ii) perform the preliminary assessment of ECOCLIMAP-SG against the corresponding ECOCLIMAP-II fields, and (iii) launch the forecast using the ECOCLIMAP-SG data. The report is organized as follows. The ECOCLIMAP-SG dataset is described in Section 2, followed by an elaboration of its implementation into the ALARO + SURFEX framework in Section 3. Section 4 presents a comparison of chosen fields with ECOCLIMAP-II equivalents. The preliminary insight into forecast performance is given in Section 5. Finally, a summary is provided in Section 6.

2 The ECOCLIMAP-SG dataset

ECOCLIMAP-SG is a newer global physiography dataset, succeeding the ECOCLIMAP-I and ECOCLIMAP-II, with a horizontal mesh of 300 m. It has been available since SURFEX version 8.1. In ECOCLIMAP-SG, the concept of covers is simplified, whereby each land cover is pure, i.e., contains a single vegetation type. There are 33 covers in ECOCLIMAP-SG: 20 vegetation, 10 urban, and 3 water types. The primary vegetation-related parameters, such as Leaf Area

Index (LAI), visible and near-infrared albedos for soil and vegetation, tree height, root, ground and sea ice depths, defined for each vegetation type and averaged by cover in the ECOCLIMAP-I and ECOCLIMAP-II, are now provided to the PGD step as maps, specified via the namelist NAM_DATA_ISBA. Alternatively, these parameters can be specified as uniform values, e.g., for depths, or as input maps derived from the satellite data.

The above-mentioned LAI and albedo data, covering the entire year, are available over 10-day segments (36 files for each) and can be accessed from the external FTP server at **ftp.umr-cnrm.fr**. In addition, the land cover and tree height data are provided as single files. The login credentials and depth data are provided at the ECOCLIMAP-SG wiki page: https://opensource.umr-cnrm.fr/projects/ecoclimap-sg/wiki. More details on the ECOCLIMAP-SG data can be found at: https://opensource.umr-cnrm.fr/attachments/download/2059/doc_ecosg.pdf.

3 The implementation process

To enable using the ECOCLIMAP-SG physiography, one needs to activate it via the **associated key** (LECOSG) and provide the name of the **cover file** as follows:

```
&NAM_FRAC
  LECOCLIMAP = .T.,
  LECOSG = .T.,
/

&NAM_COVER
  YCOVER = 'COVER_ECOSG_2010_V0.0',
  YCOVERFILETYPE = 'DIRECT',
/
```

Additionally, the namelist **NAM_DATA_ISBA** needs to be updated with the names of **files** used for the **primary parameters** (LAI, albedos and depths):

```
&NAM_DATA_ISBA
  NTIME = 36, ! Number of files
  CFNAM_H_TREE(1) = 'HT_ECOSG_2022_V1.0_c',
  CFTYP_H_TREE(1) = 'DIRTYP',
```

CFNAM_LAI(1,1) = ’LAI_SAT_0105_c’, ! 1st file for January

CFTYP_LAI(1,1) = ’DIRTYP’,

CFNAM_LAI(1,2) = ’LAI_SAT_0115_c’, ! 2st file for January

CFTYP_LAI(1,2) = ’DIRTYP’,

CFNAM_LAI(1,3) = ’LAI_SAT_0125_c’, ! 3rd file for January

CFTYP_LAI(1,3) = ’DIRTYP’,

... ! The remaining 33 files from February to December, containing LAI

CFNAM_ALBNIR_VEG(1,1) = ’ALB_SAT_NI_0105_c’, ! 1st file for January

CFTYP_ALBNIR_VEG(1,1) = ’DIRTYP’,

CFNAM_ALBNIR_VEG(1,2) = ’ALB_SAT_NI_0115_c’, ! 2nd file for January

CFTYP_ALBNIR_VEG(1,2) = ’DIRTYP’,

CFNAM_ALBNIR_VEG(1,3) = ’ALB_SAT_NI_0125_c’, ! 3rd file for January

CFTYP_ALBNIR_VEG(1,3) = ’DIRTYP’,

... ! The remaining 33 files from February to December, containing near-infrared albedo

CFNAM_ALBVIS_SOIL(1,1) = ’ALB_SAT_VI_0105_c’, ! 1st file for January

CFTYP_ALBVIS_SOIL(1,1) = ’DIRTYP’,

CFNAM_ALBVIS_SOIL(1,2) = ’ALB_SAT_VI_0115_c’, ! 2nd file for January

CFTYP_ALBVIS_SOIL(1,2) = ’DIRTYP’,

CFNAM_ALBVIS_SOIL(1,3) = ’ALB_SAT_VI_0125_c’, ! 3rd file for January

CFTYP_ALBVIS_SOIL(1,3) = ’DIRTYP’,

... ! The remaining 33 files from February to December, containing visible albedo

XUNIF_GROUND_DEPTH(1)=1.0,

XUNIF_GROUND_DEPTH(2)=0.2,

XUNIF_GROUND_DEPTH(3)=0.2,

... ! The remaining 17 values (taken from ECOCLIMAP-SG wiki page), containing soil depth

XUNIF_ROOT_DEPTH(1)=0.5,

XUNIF_ROOT_DEPTH(2)=0.2,

XUNIF_ROOT_DEPTH(3)=0.2,

... ! The remaining 17 values (taken from ECOCLIMAP-SG wiki page), containing root depth

XUNIF_DICE(1)=0.5,
XUNIF_DICE(2)=0.2,
XUNIF_DICE(3)=0.2,
... ! The remaining 17 values (taken from ECOCLIMAP-SG wiki page), containing ice depth
/

The full **NAM_DATA_ISBA** namelist can be found on **belenos**, incorporated within the script **/home/gmap/mrpe/hrastinskim/alaro+surfex/run_pgd_chmi_2325m_conf00**.

Several versions of the **cover file** are available. It is generally recommended to use the **latest version** (see ECOCLIMAP-SG wiki page). However, the **PGD step fails** when using versions **newer than V0.1**. Modifying the value of the suggested HALO parameter or reducing the domain size does not help to solve the problem. Therefore, we utilize the "**COVER_ECOSG_2010_V0.0**" file. The differences between V0.0 and V0.1 cover files will be investigated later.

Furthermore, activating the **GARDEN option** (LGARDEN=.T.), i.e., the third urban patch (the other two are building and road), leads to **additional issues**. On a single NODE, the associated job finishes **considerably faster** than without GARDEN option (LGARDEN=.F.), producing a **suspiciously small** PGD file. However, the **integration** with this file **crashes** at timestep zero due to NaN values for physical fluxes. The PGD step was also tested as an **MPI job** on 4 and 16 NODES, resulting in a crash due to **memory problems**. For these reasons, ECOCLIMAP-SG will be tested only with two urban patches (building and road, i.e., without garden) or without the Town Energy Balance (TEB) model.

4 The comparison of ECOCLIMAP-SG and ECOCLIMAP-II fields

The preliminary comparison suggested that the town fraction is increased in the ECOCLIMAP-SG dataset, while urban areas are also widened (Fig. 1a-b). Furthermore, there are no large areas with a low percentage of town fractions, as seen in ECOCLIMAP-II. By examining the sea fraction, we identified new features in ECOCLIMAP-SG, including the inner Novigrad Sea in Croatia (not shown). As an added value of ECOCLIMAP-SG data, we highlight the representation of inland waters, primarily rivers, such as the Drava, Rhine, Sava and Wisla (Fig. 2a-b). It is important to note that the input data were upscaled to ~ 8 times coarser mesh ($\Delta x = 2.3$ km), which can make the enhancements less visible.

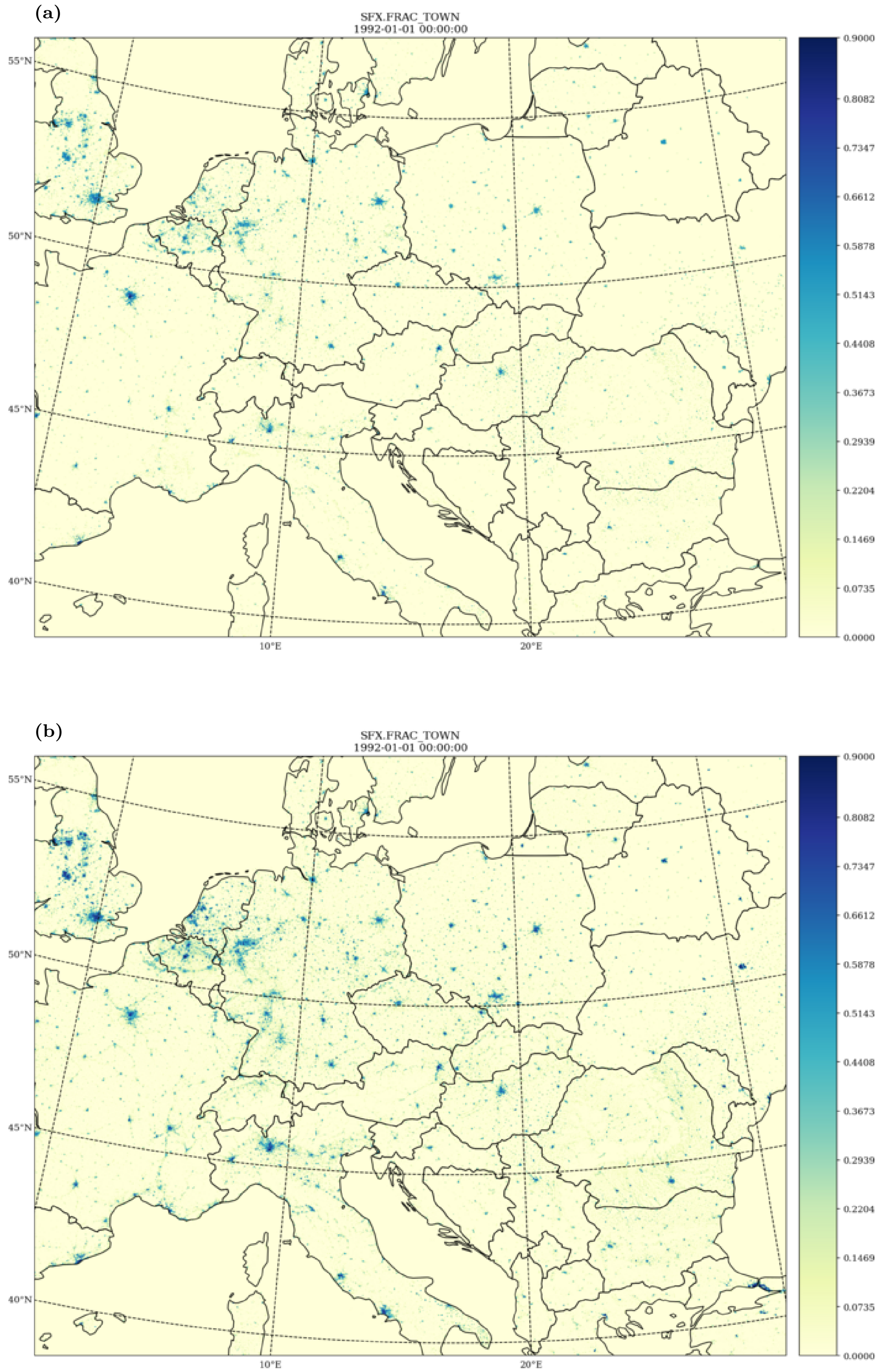

Figure 1: The town fraction for CHMI's operational domain obtained from: **(a)** ECOCLIMAP-II physiography with filtering of values $< 5\%$ and **(b)** ECOCLIMAP-SG physiography (without filtering).

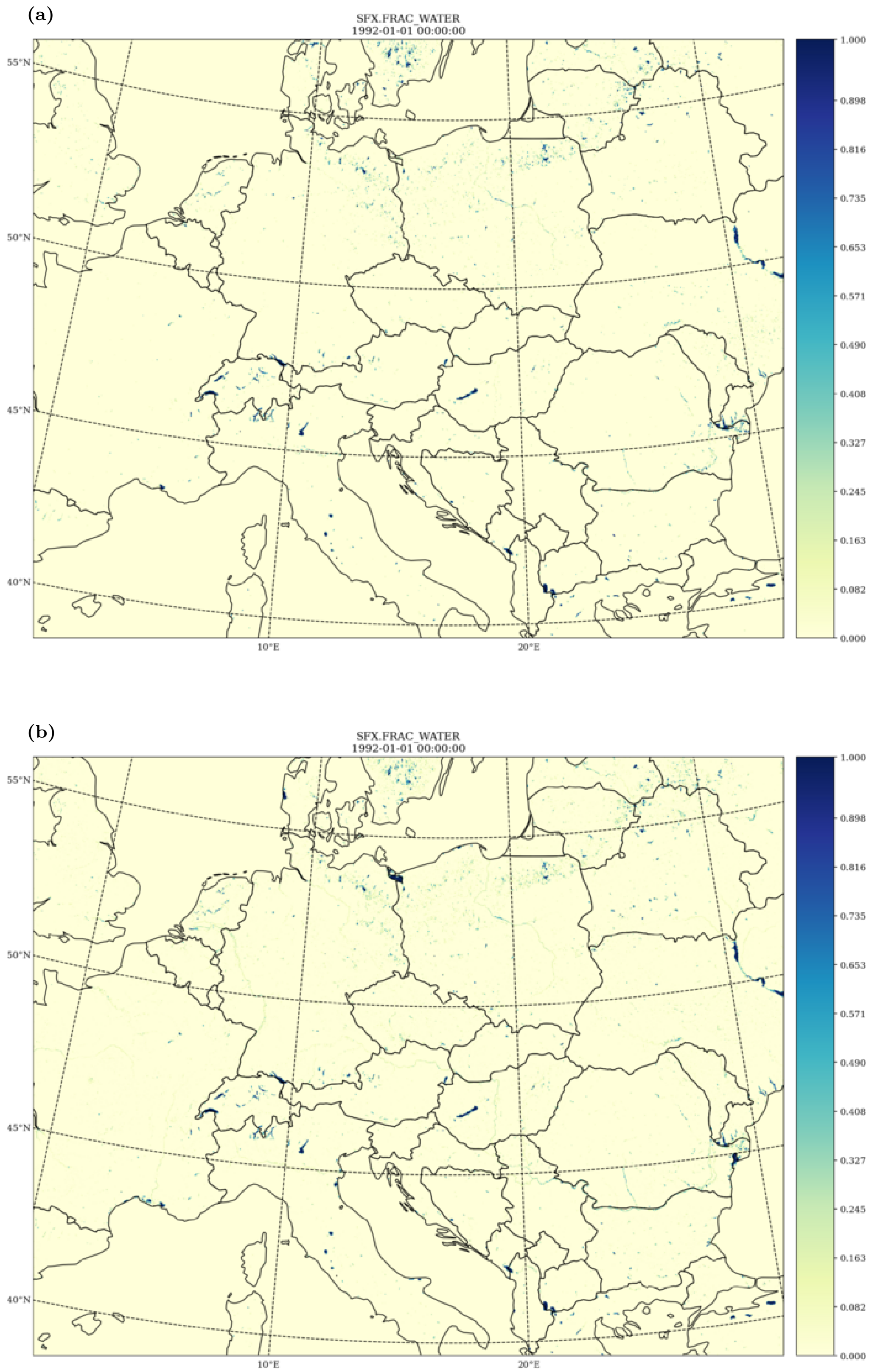

Figure 2: The inland water fraction for CHMI's operational domain obtained from: **(a)** ECOCLIMAP-II physiography and **(b)** ECOCLIMAP-SG physiography.

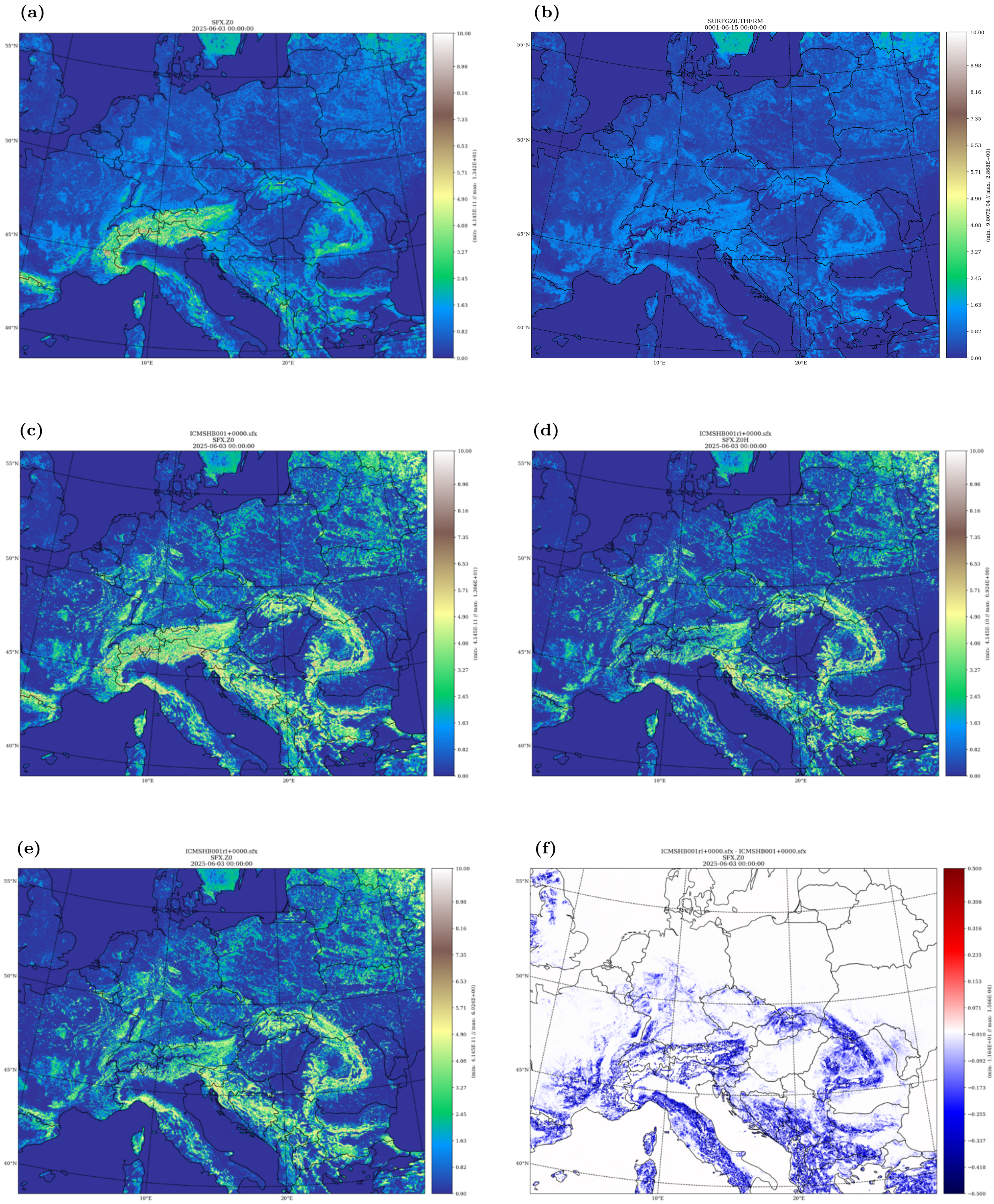

Figure 3: **(a)-(b)** Mechanical (z_{0m}) and 10 times the thermal roughness length (z_{0h}) derived from the ECOCLIMAP-II data; **(c)-(d)** same as **(a)-(b)** but from ECOCLIMAP-SG data; **(e)** z_{0m} from ECOCLIMAP-SG data without using the effective roughness length concept; **(f)** difference between panels **(c)** and **(e)**.

Given their impact on screen-level parameters, which are analyzed later, we also inspected the mechanical (z_{0m}) and thermal (z_{0h}) roughness length fields. The comparison of z_{0m} and z_{0h} from the ECOCLIMAP-II and ECOCLIMAP-SG datasets is shown in Fig. 3a-f. We emphasize that no scaling was applied to the tree heights at runtime in both cases. However, the resulting z_{0h} (Figs. 3b and 3f) was scaled during plotting to facilitate easier comparison with z_{0m}, although the scaling factor differed for ECOCLIMAP-II and ECOCLIMAP-SG data. Overall, the z_{0m} and z_{0h} values in ECOCLIMAP-SG are higher, while spatial transitions are sharper. Among others, we emphasize that in ECOCLIMAP-SG, z_{0h} values in southern Sweden and western Russia are reduced, while in ECOCLIMAP-II, they are even higher than in the Alps.

5 The prediction of the near-surface parameters

To study the impact of ECOCLIMAP-SG physiography, we employed ALARO-CMC with a non-hydrostatic dynamical core and the ALARO-1vB physics at $\Delta x \sim 2.3$ km, corresponding to CHMI's operational model. The model was launched on 12 January 2021 and 3 June 2025 at 00 UTC from the CHMI's operational analysis and integrated for 72 hours, with the surface initialized via FULLPOS-PREP. The lateral boundary conditions are taken from the global model ARPEGE with a 3-hour coupling frequency.

While analyzing the results, we focused on the domain-averaged 2-m temperature and 10-m wind speed. During the summer case, configurations using the ECOCLIMAP-SG physiography were generally warmer than those based on ECOCLIMAP-II, with a more pronounced impact of the TEB model, particularly in the nighttime (Fig. 4a-b). Compared to ISBA, ALARO with SURFEX was warmer during the daytime and cooler at nighttime.
In the winter case, the differences were larger, with all ALARO + SURFEX configurations considerably warmer than ALARO + ISBA, especially in the daytime (not shown). Furthermore, the ECOCLIMAP-SG configuration was ~ 0.1 K warmer than the ECOCLIMAP-II. Finally, the impact of physiography is dominant in the nighttime, while the TEB scheme takes over during the daytime. Similar conclusions apply to the surface and the lowest model level, wherein the impact decreases with the distance from the ground (not shown).

The 10-m wind speed follows the footprint of z_{0m}, resulting in slowing down with ECOCLIMAP-SG. The impact is more pronounced in the winter (> 0.2 m/s bias) than in the summer (~ 0.05 m/s bias; Fig. 5a-b), clearly indicating the necessity of tuning when changing the physiography.

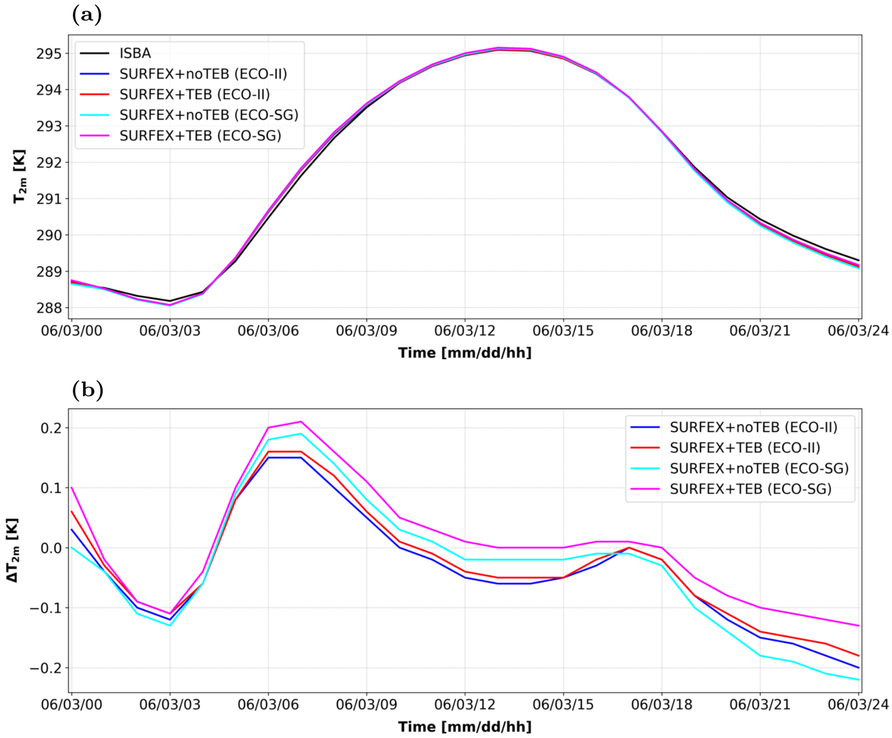

Figure 4: Domain-averaged: **(a)** 2-m temperature for various experiments (see legend) and **(b)** corresponding differences relative to the reference based on the ISBA scheme, for the summer case 3 June 2025.

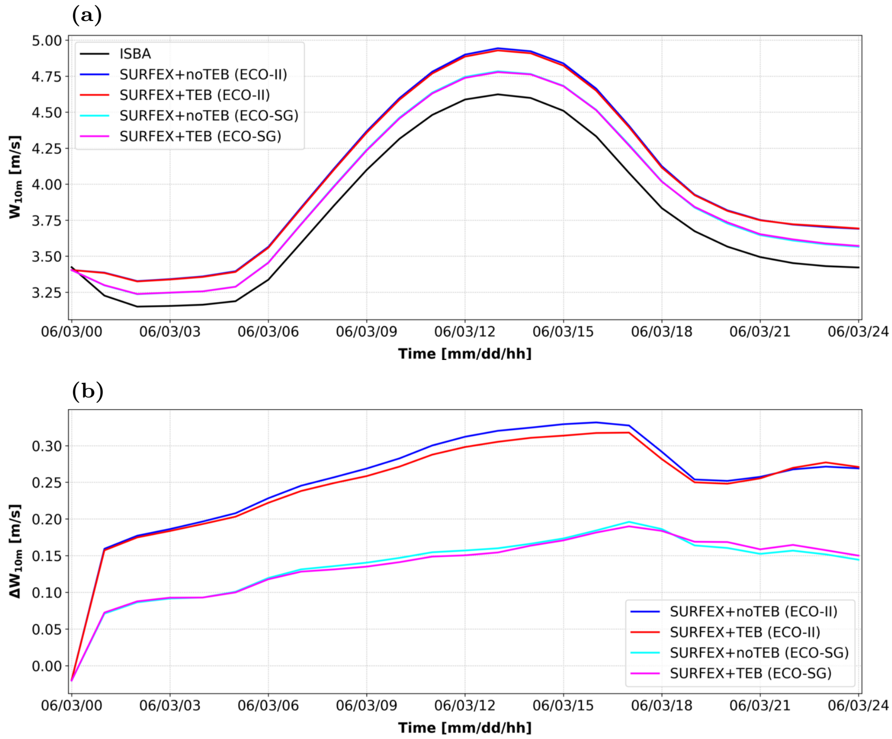

Figure 5: Domain-averaged: **(a)** 10-m wind speed for various experiments (see legend) and **(b)** corresponding differences relative to the reference based on the ISBA scheme, for the summer case 3 June 2025.

Unlike for temperature, the impact of TEB on wind speed is weak.

6 Summary

The ECOCLIMAP-SG physiography data were **successfully implemented** within **ALARO + SURFEX framework**, while using the **two urban patches (building and road, i.e., without garden)** or **without the TEB model**. However, there are remaining **memory issues** associated with the PGD step **for the additional patch**, i.e., LGARDEN=.T. option. While setting LGARDEN=.F. enabled completing the PGD step on a single NODE, the LGARDEN=.T. configuration failed even on 16 NODES. During the **ACCORD Autumn Surface Working Week 2025**, it was revealed that **issues with ECOCLIMAP-SG and the LGARDEN=.T.** option persist even in SURFEX V9.1; therefore, we will **set it aside** for the time being.

During the ECOCLIMAP-SG implementation, the PGD step **succeeded only** with **cover file versions V0.0 and V0.1**. Attempts with **versions V1.0 and V1.1 failed**, requesting a higher HALO parameter value, even though the maximum possible value was already used. In contrast, the **most recent** file was **successfully used** for the **tree height**.

The preliminary analysis of screen-level parameters obtained from the **ALARO + SURFEX** framework with the ECOCLIMAP-SG physiography suggested a **stronger impact of TEB** compared to ECOCLIMAP-II, likely due to a higher town fraction in ECOCLIMAP-SG. However, **significant differences** were observed for $\mathbf{z_{0h}}$ **field** (factor > 3; ECOCLIMAP-SG being higher), which **requires consultations** with the SURFEX support team.

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