Regional Cooperation for
Limited Area Modeling in Central Europe

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Tools for improving physiography in E923 clim files

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Presentation outline

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- The problem
- Temporary solution
- Update of surface roughness fields
- Implementation on belenos
- Update of subgrid-scale orography
- Update of other physiography fields
- Bonuses for climate runs
  - import of SST from NEMO
  - update of lake temperature
- Conclusions

The problem

- Before AROME era, model physiography was prepared by **configuration E923.**
- E923 datasets have a **coarse resolution,** common in 1990s, and sometimes **questionable quality.**
- After AROME with SURFEX entered NWP service, E923 developments stopped (no interfacing with ECOCLIMAP).
- Therefore, pre-SURFEX configurations **cannot benefit from modern ECOCLIMAP** physiography.
- Such situation is infavourable for ALARO, due to the long lasting problems with its switch to SURFEX.
- Some **temporary solution was needed.**

The problem

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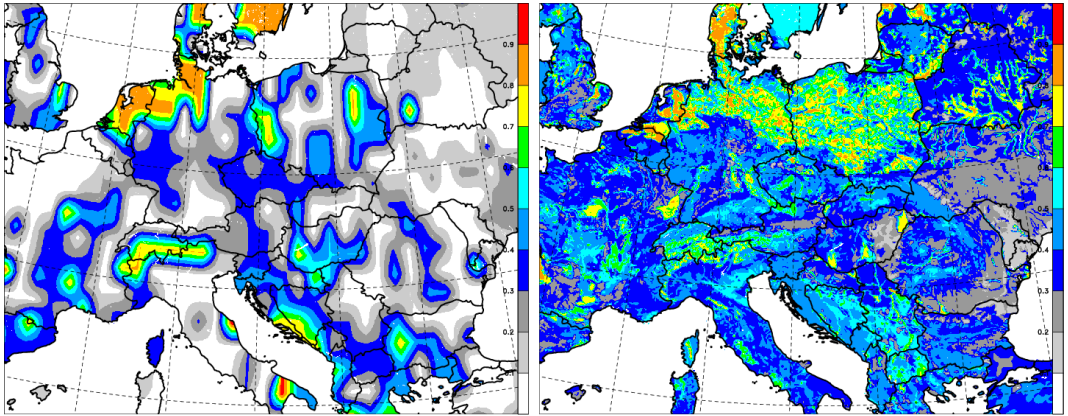
Sand fraction



E923 **ECOCLIMAP II**

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The problem

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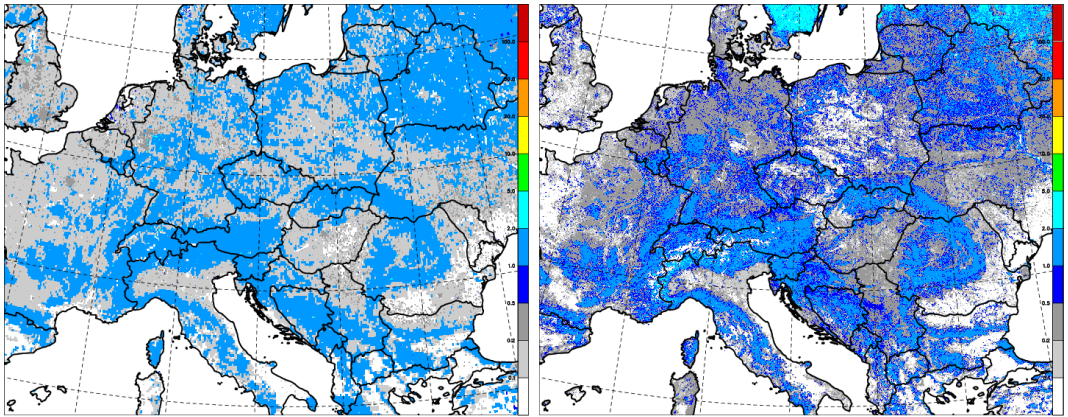
Vegetation roughness length in July [m]



E923 **ECOCLIMAP II**

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Temporary solution

- One possibility is to update E923 clim files by selected **fields extracted from SURFEX PGD file.**
- This can be done by external tool, however:
  - care must be taken to respect **different conventions,** units, etc.
  - evolving physiography fields are constructed from PGD inputs only during the **SURFEX integration**
- Therefore:
  - the tool has to be thoroughly designed and validated
  - procedure updating E923 clim files involves **one-step model integrations with SURFEX** for 15th day of each month

Update of surface roughness fields

- When horizontal resolution is increased, **key improvement** comes from more detailed **model orography.**
- **Surface roughness lengths** are also important, determining bottom boundary conditions for turbulent fluxes:

$$z_0^{\text{eff}} = \sqrt{(z_0^{\text{veg}})^2 + (z_0^{\text{orog}})^2} \qquad z_{0\text{H}} = z_0^{\text{veg}}/10$$

- To benefit from ECOCLIMAP II and GMTED2010 datasets, roughness lengths z_0^{veg} and z_0^{orog} can be **extracted from PGD file** and **injected to E923 clim files.**

Update of surface roughness fields

- A new tool **fa_sfx2clim** updates the roughness lengths in E923 clim files **consistently.**
- Roughness lengths may require **scaling** and **smoothing:**

  FACZ0 – scaling factor for orographic roughness
  FACZ0_VEG – scaling factor for vegetation roughness
  NLISSZ – number of smoothings for orographic roughness
  NLISSZ_VEG – number of smoothings for vegetation roughness

- fa_sfx2clim **prevents chess-board pattern** by using a Laplacian-like smoother, instead of problematic E923 one.
- The **tree height** can be adjusted in underlying SURFEX integrations via new namelist array XMUL_H_TREE(:).

Implementation on belenos

- The procedure was implemented on belenos:
  `/home/gmap/mrpm/masekj/e923_update/`
- Necessary steps (see the README file):
  1. run **climake** for your target domain (PGD step must be modified if you want to use ECOCLIMAP II physiography)
  2. run **EE927** to produce atmospheric coupling files
  3. run **FULLPOS-PREP** to produce SURFEX init files
  4. run set of **one-step SURFEX integrations** to get .sfx files
  5. **substitute roughness fields** from .sfx files to E923 clim files
- Climake step is independent, the rest is automated—it is sufficient to edit the run script.

Update of subgrid-scale orography

- **Subgrid-scale orography** is characterized by its standard deviation, anisotropy, and direction of the main axis.
- These quantities are needed by the parameterization of **orographic drag and lift.**
- In **E923** clim files they are calculated from **GTOPO30.**
- In **PGD** file they are calculated from **GMTED2010.**
- More reliable PGD fields can be injected to E923 by **modified subroutine EINCLI1** during step 1b.
- EINCLI1 takes care about **different PGD/E923 convetions** for fields describing the subgrid-scale orography.

Update of other physiography fields

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- Tool fa_sfx2clim can transfer **all needed physiography fields** from PGD and .sfx files to E923 clim files:
  - dominant vegetation index can be guessed from LSM and LAI
  - cheating with snow and vegetation fractions is needed to get SURFEX albedos of the bare ground and vegetation
  - for remaing fields the procedure is straightforward
- Significant impact of changed vegetation characteristics makes **retuning exercise on ISBA side impractical.**
- It will be more pragmatic to **retune ALARO-1 with SURFEX,** including not only ECOCLIMAP II physiography, but also new options like 3L soil scheme, TEB, FLAKE, . . .

Bonuses for climate runs

- In climate simulations, **special care** must be taken to **SST,** and also to **lake temperatures** if FLAKE model is not used.
- Two tools were created for this purpose:
  - **updsst** – non-overshooting interpolation of SST from NEMO ocean model, avoding its contamination due to SURFEX tiling
  - **updlake** – interpolation of lake temperature from surrounding SST, avoding use of climatological value from the nearest sea point
- Interpolation procedure **updlake is now integrated in tool updcli.**

Bonuses: import of SST from NEMO

- Tool **updsst** interpolates SST from NEMO grid to model grid using **inverse distance weighting** $w_i = 1/r_i^p$.
- Powers $p \leq 2$ produce **bull eyes,** while powers $p \gg 2$ are close to **nearest neighbour** interpolation.
- Reasonable compromise is a variant of modified **Shepard's method** ($p = 2$) with **search radius** R:

$$w_i = \max\left(\frac{1}{r_i^2} - \frac{1}{R^2}, 0\right)$$

- For NEMO grid with resolution $\sim 1°$, $R = 150$ km is used.

Bonuses: import of SST from NEMO

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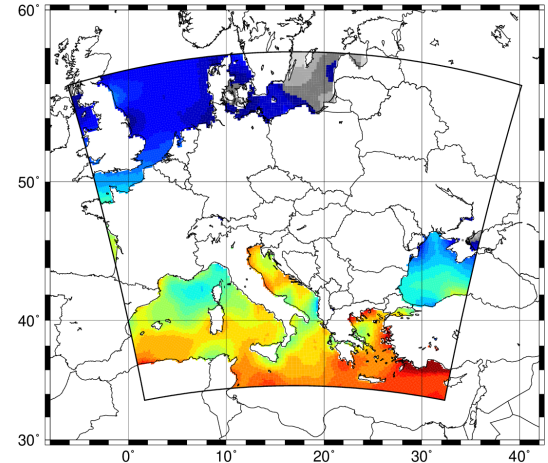
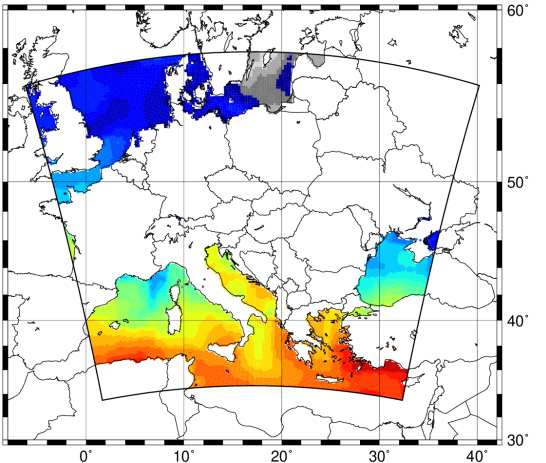
E927 interpolation from ARPEGE



updsst interpolation from NEMO



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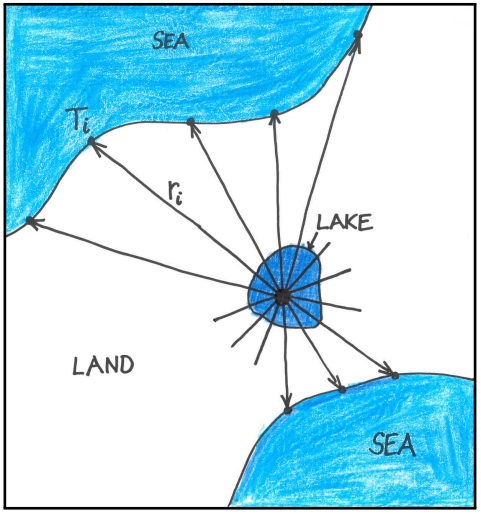
Bonuses: update of lake temperature

- Tool **updlake** determines lake temperature from **actual SST:**

$$T^{\text{lake}} = \frac{\sum_i \frac{1}{r_i} T_i}{\sum_i \frac{1}{r_i}} - \Gamma z$$

$$\Gamma = 6.5\,\text{K/km}$$

- It is a poor man's solution, **hopefully better** than T_{lake} from E923 climatology.



Conclusions

- Procedure for **updating roughness fields** in E923 clim files from PGD file was developed and implemented on belenos $\Rightarrow$ feel free to use it.
- **Tuning parameters** are **scaling factors** of the roughness lengths and tree height, plus the **numbers of smoothings.**
- Fields characterizing **subgrid-scale orography** can also be updated.
- More fields could be imported from PGD file, but the model needs **extensive retuning when vegetation is touched.**
- Preferable way is to switch ALARO to SURFEX when ready, and to **make retuning with new options included.**

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Thank you for your attention.

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