



## (EURO-)CORDEX Remapping Tool

*Erik van Meijgaard (KNMI) and several colleagues being involved in EURO-CORDEX:  
developed original tool some years ago*

*Hans-Juergen Panitz (KIT/IMK-TRO): wrote some „adds-on“ within the frame of  
Convection FPS ; this required also to modify the original version*

**Purpose and „highlights“ of the tool** (cited from an explanation given by Erik and from the minutes of a Telco in June 2014):

- remapping variables from a native grid, e.g. EUR-44 or EUR-11 or ALP-3, to the respective regular grid, e.g. EUR-44i or EUR-11i or ALP-3i
- variables which have a strong land/sea contrast will be remapped on land and sea points separately in order to conserve the land-sea contrast
- To generate a more consistent target data set a common target land/sea mask will be used
- tas, tasmax, and tasmin will be height corrected to a common target orography
- Recommended remapping method: First order conservative remapping  $\equiv$  remapcon in the „language“ of CDO



## (EURO-)CORDEX Remapping Tool



### Main „adds-on“:

- Script around the actual remapping tool that “steers”, according to user settings, what the actual tool should do .
  - Essentially: Which variables should be considered at which frequencies
- Steering script contains
  - Script to create fields of remapping weights; has to be done only once per RCM and target/destination domain
  - Script to create final files of orography and land-sea fraction for destination grid



## (EURO-)CORDEX Remapping Tool

The whole new package consist of“:

- steering script "**EUR\_CORDEX\_Remapping.sh**"
- script "**create\_weights.sc** " to create fields of weights
- script "**create\_fx.sh**" to create files of orography and land-Sea fraction for destination grid
- actual remapping/interpolation script "**doremap.sc** " ("do remapping")

### 3 necessary input data

1. On the native grid the already CMORized data that should be remapped
2. On the native grid the already CMORized fixed (fx) fields of orog (orography in m) and sftlf (Land\_Sea\_Fraction in %)
3. A NetCDF file named **orog\_sftlf\_\${destDomain}.nc** containing common orography (orog in m) and land-sea fraction (sftlf units=1) of the target domain; has to be created before performing the remapping; **\${destDomain}** stands for the name of the target domain, e.g. ALP-3i
  - The package contains three examples of such common orog-sftlf files
    - orog\_sftlf\_ALP-3i.nc ; should be used for the remapping of FPS Convection data
    - orog\_sftlf\_EUR-44i.nc ; had been used for the remapping of EUR-44 data
    - orog\_sftlf\_EUR-11i.nc ; had been used for the remapping of EUR-11 data



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### Software Prerequisites

- LINUX OS with bash-and tcsh shells (original remapping tool uses tcsh; I did not change this)
- NetCDF library
  - ncdump
  - nccopy
- CDO package; I recommend most recent versions, at least with version No.  $\geq 1.9.1$
- NCO library
  - ncrename
  - ncks
  - ncatted
  - ncap2
  - ncwa



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Application Examples and further hints based on

- FPS-C evaluation and „near-future“ runs with CCLM (COSMO-CLM)
- Period: 1999 – 2016, 2041 - 2050
- carried out by H.-J. Panitz, KIT/IMK-TRO

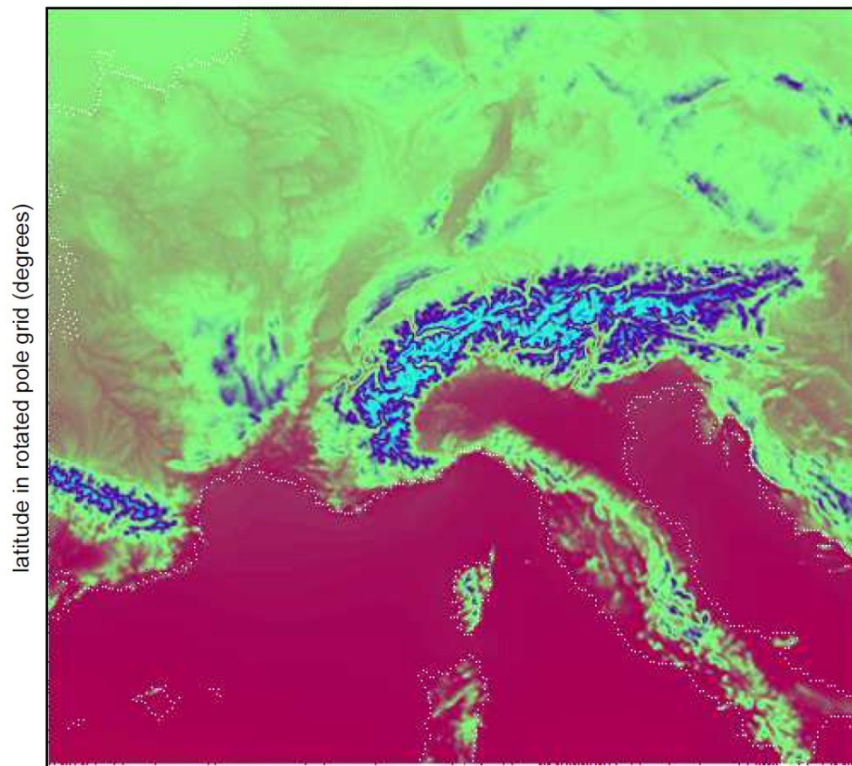


## (EURO-)CORDEX Remapping Tool

**Near surface temperature tas (seasonal mean MAM 2000)**  
**Range of values identical in both figures**

ALP-3 domain

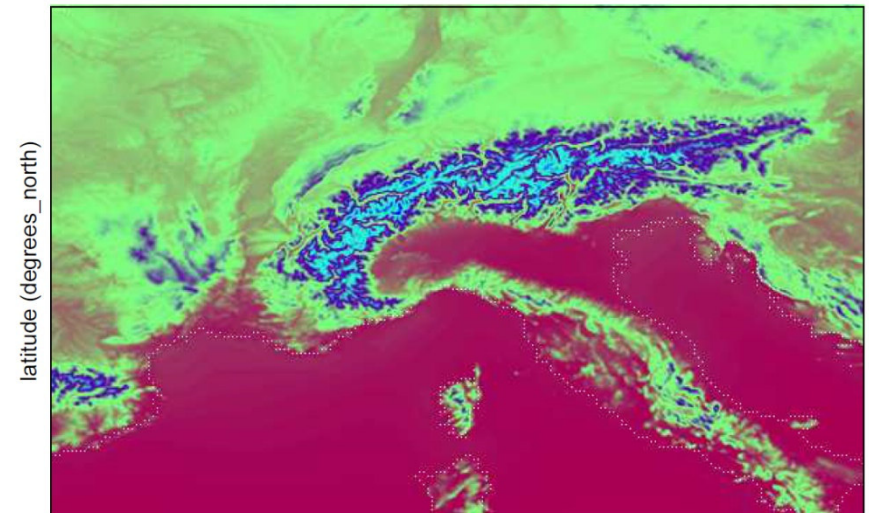
Near-Surface Air Temperature (K)



longitude in rotated pole grid (degrees)

ALP-3i domain

Near-Surface Air Temperature (K)



longitude (degrees\_east)



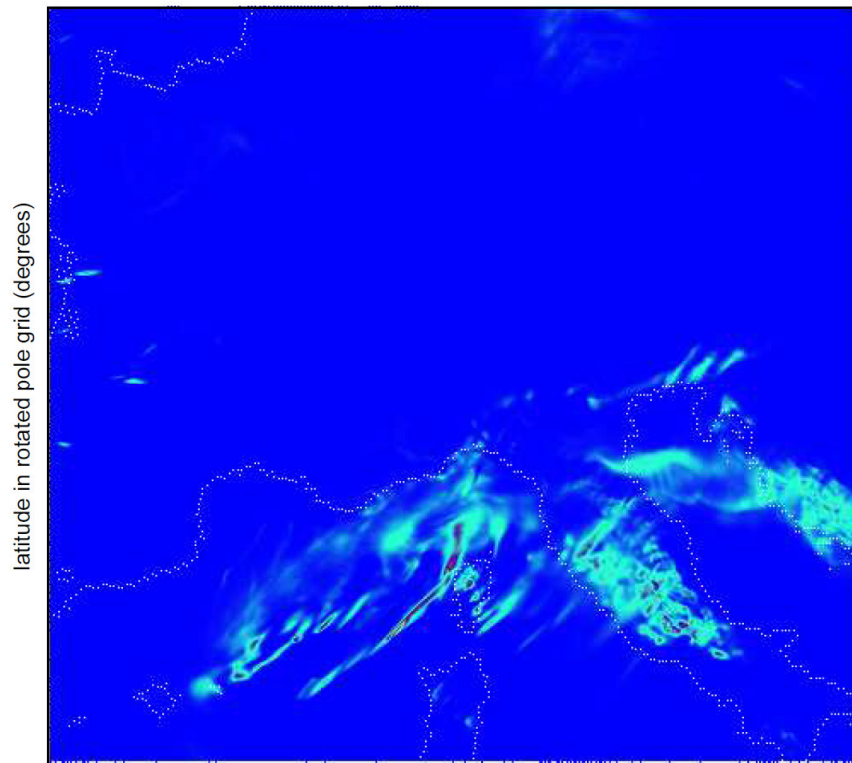


## (EURO-)CORDEX Remapping Tool

**Precipitation flux pr (2041-01-10, 01:30)**  
**Range of values identical in both figures**

ALP-3 domain

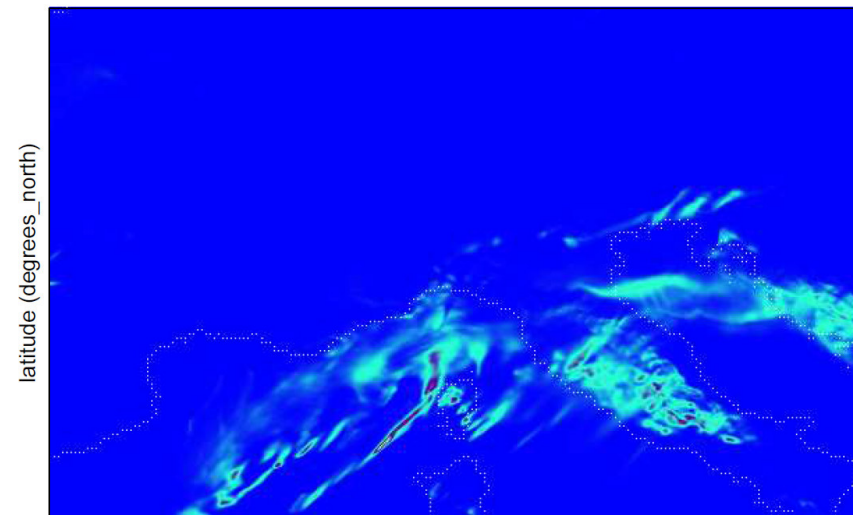
Precipitation ( $\text{kg m}^{-2} \text{s}^{-1}$ )



longitude in rotated pole grid (degrees)

ALP-3i domain

Precipitation ( $\text{kg m}^{-2} \text{s}^{-1}$ )



longitude (degrees\_east)



## (EURO-)CORDEX Remapping Tool

### variables with an "extreme" land-water contrast

- there might be, at least for CCLM, some variables with an "extreme" land-water contrast
- "extreme" means that these variables are only defined over land but not over any kind of water body (open sea, rivers, lakes)
- in CCLM these variables are represented by the missing value ( $=1.E20$ ) at grid points over water
- in CCLM these variables are: snc, snd, mrros, mrro, mrso1, mrso
- this "extreme" land-water contrast is kept also in the target grid depending on the land-sea mask of the target domain; missing value at grid points over water
- This is in contrast to the original version of remapping tool, where such grid points got the value "Zero"





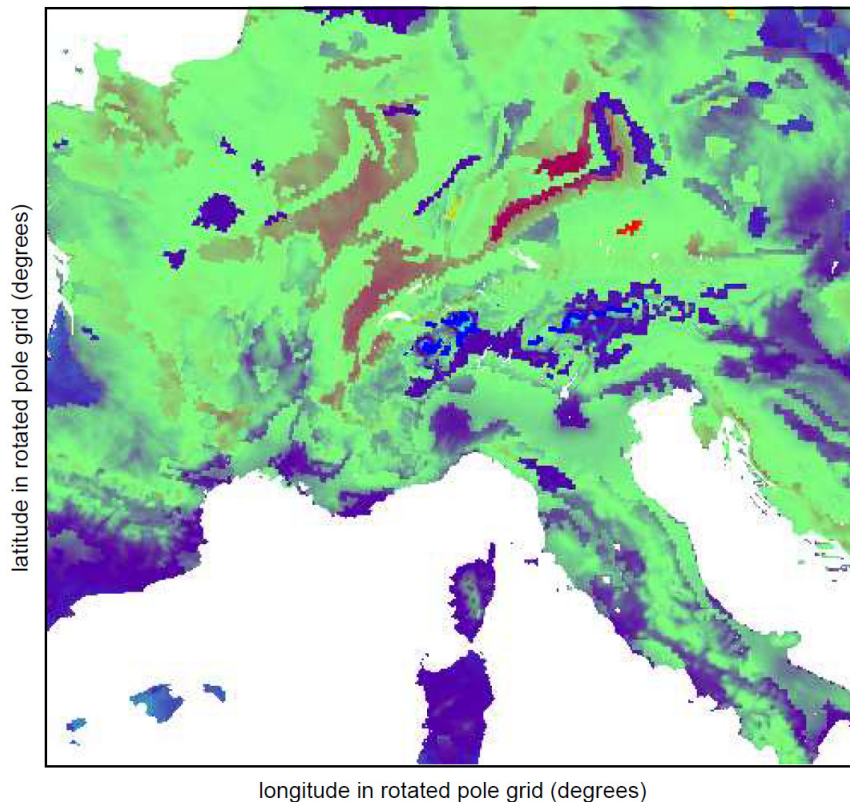
## (EURO-)CORDEX Remapping Tool



**mrso as example for variables with an "extreme" land-water contrast  
(seasonal mean MAM 2000) Range of values identical in both figures  
White areas show water bodies where mrso is not defined, at least in CCLM**

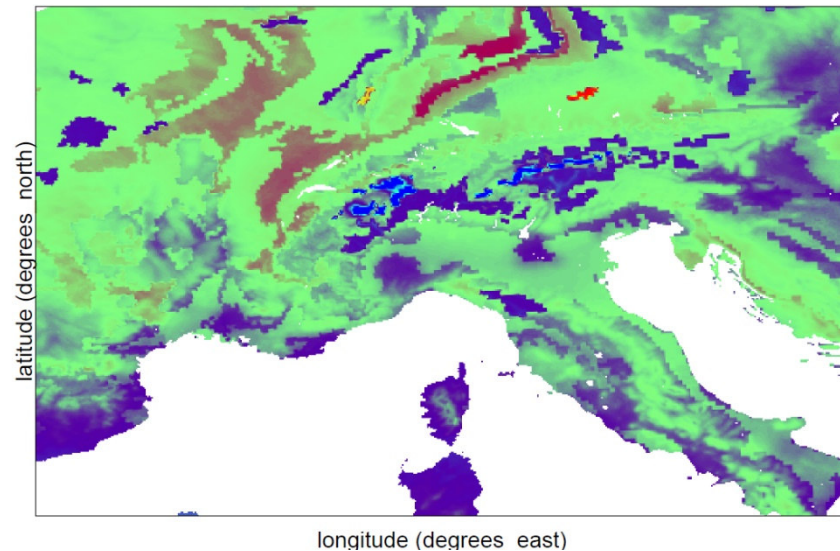
ALP-3 domain

Total Soil Moisture Content (kg m<sup>-2</sup>)



ALP-3i domain

Total Soil Moisture Content (kg m<sup>-2</sup>)





## (EURO-)CORDEX Remapping Tool

mrso as example for variables with an "extreme" land-water contrast  
Range of values identical in both figures

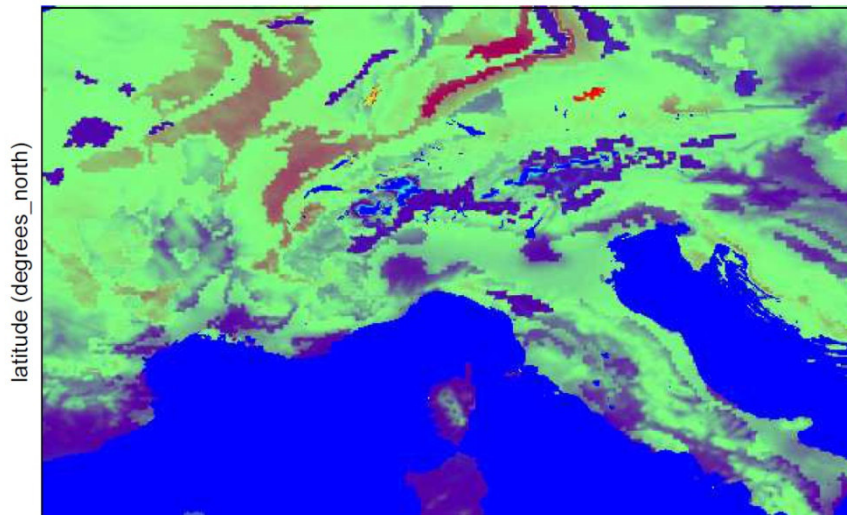
ALP-3i domain

Result of **original** version of tool

Blue areas: = 0 kg m<sup>-2</sup>

Spatial mean: 801.85 kg m<sup>-2</sup>

Total Soil Moisture Content (kg m<sup>-2</sup>)



longitude (degrees\_east)

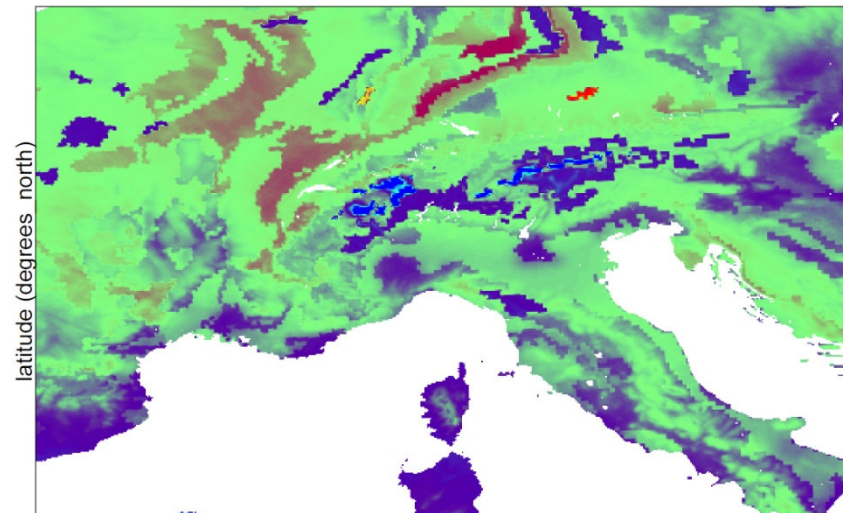
ALP-3i domain

Result of **modified** version of tool

White areas: undef=1.E20

Spatial mean: 1117.3 kg m<sup>-2</sup>

Total Soil Moisture Content (kg m<sup>-2</sup>)



longitude (degrees\_east)



## (EURO-)CORDEX Remapping Tool

### Variables with inhomogeneously distributed missing values

- A "special" variable might be **CIN** (and perhaps also others).
- At least for CCLM, this variable might have grid points with missing value (1.E20), which are distributed inhomogeneously over the whole source domain.
- This means, the missing values are not constrained to grid points representing any kind of water body only.
- The tool is able to treat such a variable, but the remapping might take quite a long time.





## (EURO-)CORDEX Remapping Tool

### Example for CIN

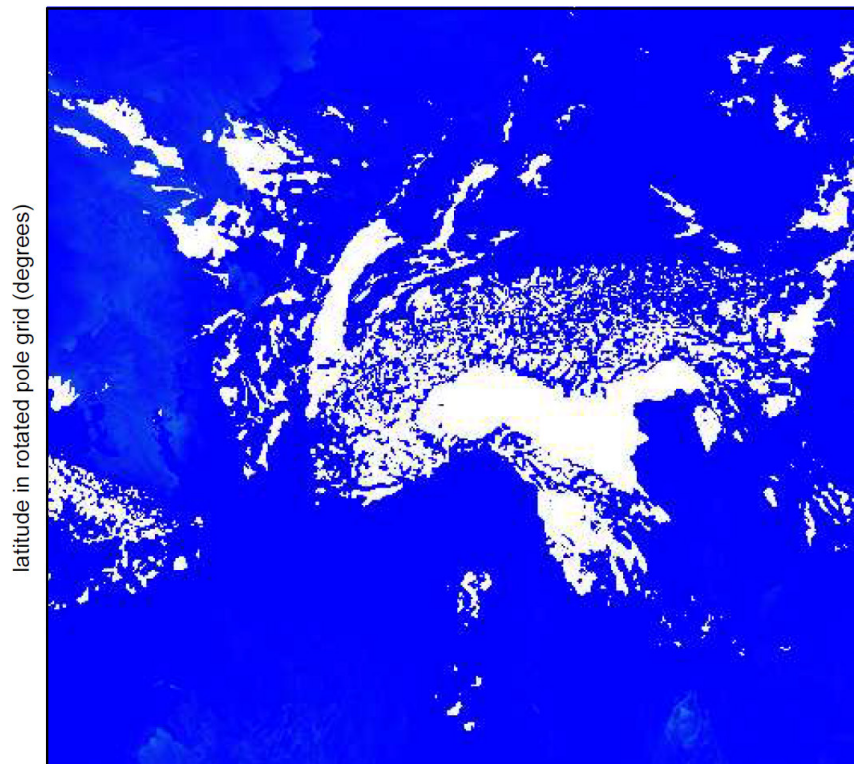
Figures show daily maximum in January

Range of values identical in both figures

In white areas CIN is represented by missing value 1.E20

ALP-3 domain

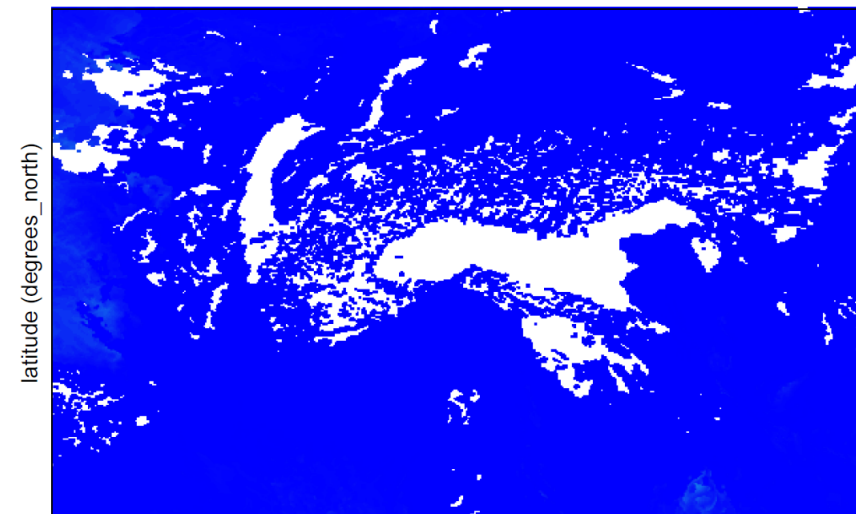
2-D convective inhibition (J kg<sup>-1</sup>)



longitude in rotated pole grid (degrees)

ALP-3i domain

2-D convective inhibition (J kg<sup>-1</sup>)



longitude (degrees\_east)



## (EURO-)CORDEX Remapping Tool

### Example for CIN

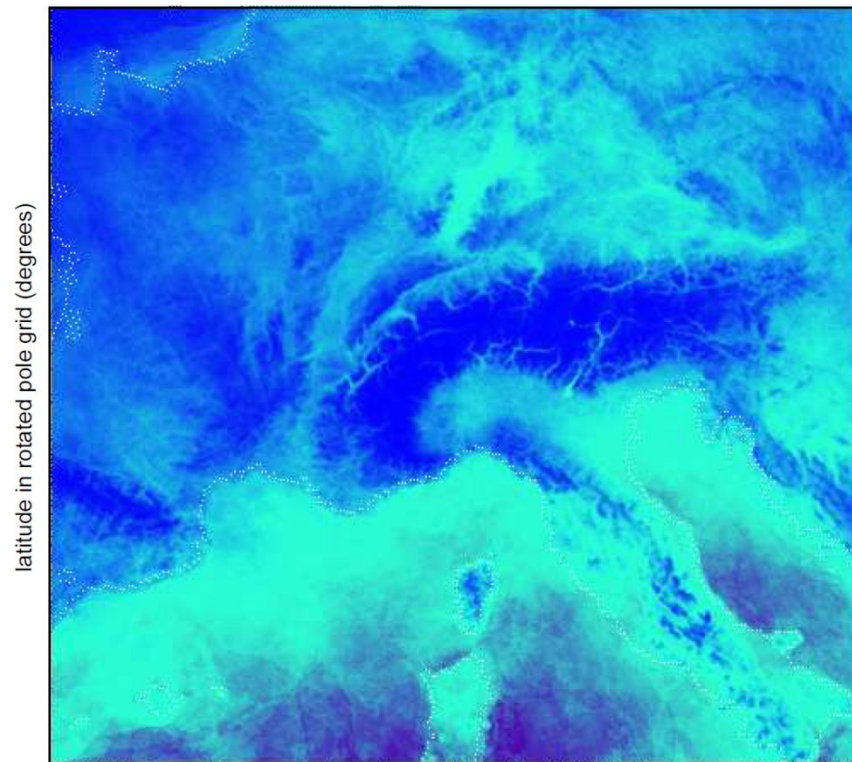
Figures show a season mean

no missing values anymore due to the consideration of averages

Range of values identical in both figures

#### ALP-3 domain

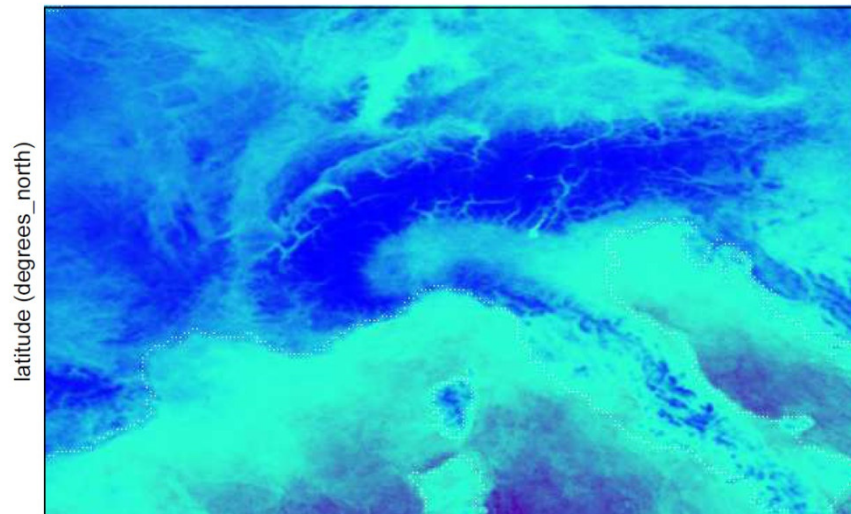
2-D convective inhibition ( $\text{J kg}^{-1}$ )



longitude in rotated pole grid (degrees)

#### ALP-3i domain

2-D convective inhibition ( $\text{J kg}^{-1}$ )



longitude (degrees\_east)





## (EURO-)CORDEX Remapping Tool

### Performance of the Tool

- tool was running as batch job on CRAY XC40 at HLRS, Stuttgart.
- Remapping of FPS evaluation data for the simulation period 2000 until 2014 (15 years).
- much more variables per frequency and more frequencies considered than actually required for the Convection FPS



## (EURO-)CORDEX Remapping Tool

### Performance of the Tool CIN not included

Frequency	remarks	time needed
1hr	1 variable, 5 yearly files simultaneously; for more than 5 files I got memory problems	about 60 min
3hr	30 variables, 15 yearly files simultaneously	about 130 min
6hr	12 variables, 15 yearly files simultaneously	about 37 min
day	70 variables, 4 files simultaneously, chunked into 1y/5y/5y/4y chunks, respectively	about 210 min
mon	70 variables, 3 files simultaneously, chunked into 1y/10y/5y chunks, respectively	about 19 min
sem	70 variables, 3 files simultaneously, chunked into 1y/10y/5y chunks, respectively	about 18 min



## (EURO-)CORDEX Remapping Tool

### Performance of the Tool for CIN only Sub-daily frequencies not considered

Frequency	remarks	time needed
day	1 variable, 15 yearly files simultaneously; missing values are still present; I don't recommend chunking of daily data before the remapping; chunked files might become rather large and remapping would take much more time; 5 hours computing time were not enough	about 120 min
mon	1 variable, 3 files simultaneously, chunked into 1y/10y/5y chunks, respectively; no missing values anymore due to the consideration of monthly averages	about 4 min
sem	1 variable, 3 files simultaneously, chunked into 1y/10y/5y chunks, respectively; no missing values anymore due to the consideration of seasonal averages	about 9 sec



## (EURO-)CORDEX Remapping Tool

### Summary

- tool should be used in order to generate remapped/interpolated data sets that are consistent due to the use of a common target land/sea mask and common remapping method
- this is certainly an advantage when comparing RCM results achieved by different RCMs
- a few add-ons have been added to make the usage of the tool more user friendly
- the package contains a **README.rst** giving more hints for a successful application; please, read it first.
- All scripts contain some kind of „online“ documentation and explanations in terms of comment lines; please, have also a thorough look at these before you apply the tool