Regional Cooperation for
Limited Area Modeling in Central Europe

LACE
nwp central europe

The quality of physiography data in clim files

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Clim files and e923

- contain "constant" fields (topography, surface, soil, vegetation),
- and monthly climatologies for soil and surface variables, ozone profile and aerosols.
- **used by ISBA scheme and data assimilation with any CMC** (but required to run almost anything)
- used in physics parametrisations (turbulence, gwd, radiation …)
- 12 monthly files created by configuration e923 in 8 steps
- **some fields unrealistic** (to be illustrated)
- **could be fixed by using fields from PGD**
- **compute the orography fields from new database**

Clim files and e923

Variable name	Description	year	sea	Range
SURFIND.TERREMER	Land/sea mask	no	0	0 - 1
SURFGEOPOTENTIEL	OUTPUT gp orography (*g)	no	-	-192- 29775
SURFET.GEOPOTENT	Std. dev. of orography (*g)	no	0	0 - 9246
SURFVAR.GEOP.ANI	Anisotropy of topography	no	1	0 - 1
SURFVAR.GEOP.DIR	Topography main direction	no	-	-1.71–1.71
SURFZ0.FOIS.G	Surface roughness (*g)	yes	0.001	0.001-114.7
SURFZ0REL.FOIS.G	Roughness length (*g)	no	0.001	0.001-113.8
SURFPROP.URBANIS	Proportion of urbanisation	no	0 (-)	0-0.383
SURFPROP.TERRE	percentage of land	no	<0.5	0-1

step 1 - definition of numerous fields describing orography and land-sea mask, depending on the namelist, few fields that describe topography can be created from a PGD file (using one database – the same as for SURFEX) while other fields are computed from the usual database (GTOPO30), creates one output file

Clim files and e923

Name of file	contents
Water_Percentage	Percentage of water surfaces, 0 for land, 100 for water
Oro_Mean	Mean height of orography in meters
Sigma	Subgrid standard deviation of the mean height in meters
Nb_Peaks	Number of subgrid peaks
Urbanisation	Fraction of grid occupied by urban areas
Dh_over_Dx_Dh_over_Dy	Component of orography variance tensor
Dh_over_Dx_square	Component of orography variance tensor
Dh_over_Dy_square	Component of orography variance tensor
Hmax-HxH-Hmin_ov4	$(H_{max}-H_{mean})*(H_{mean}-H_{min})/4$
Oro_Max	Maximum height of topography (not used in Step 1)
Oro_Min	Minimum height of topography (not used in Step 1)

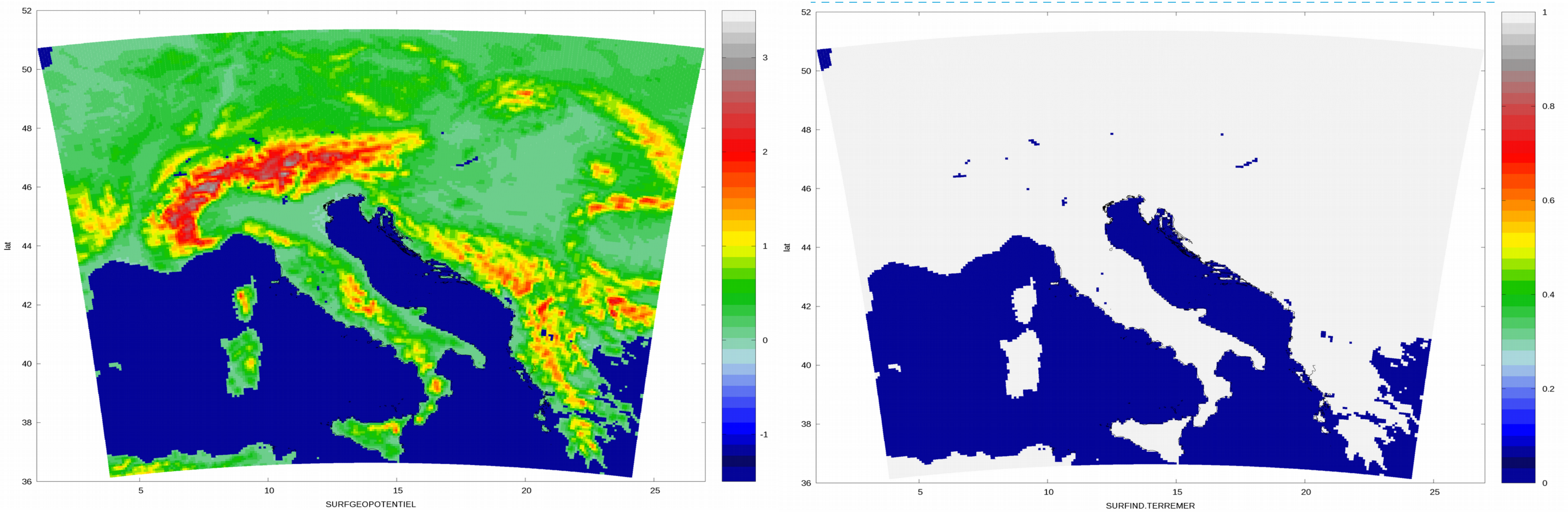
Files used as input for the Step 1 that defines the topography features

Clim files and e923

N923	1	2	3	4	5	6	8	9
LIEEE	T	T	T	T	T	T	F	F
NDATX	8640	360	432	360	860	240	144	72
NDATY	4320	180	216	180	420	120	73	45
coverage	global	global	global	global	SW(-25,30)	global	global	global
Resolution (degrees)	0.042	1	0.83	1	0.1	1.5	2.5	5

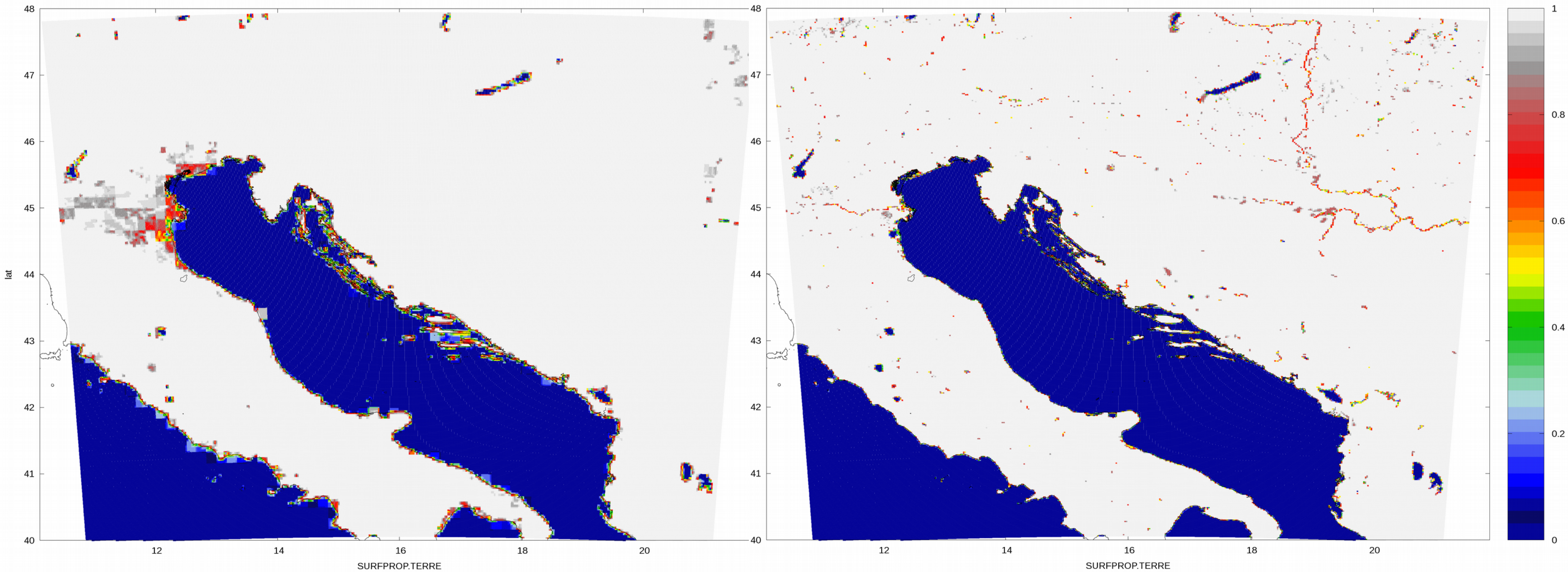
Original topography input in 0.042 degrees
NEW PGD use input 30" resolution:
ln -s ${DIR_DATA}/GMTED2010_30.EHdr.dir   orog.dir
ln -s ${DIR_DATA}/GMTED2010_30.EHdr.hdr   orog.hdr
But there is already an alternative
ln -s ${DIR_DATA}/GMTED2010_075.EHdr.dir orog.dir
ln -s ${DIR_DATA}/GMTED2010_075.EHdr.hdr orog.hdr
data in 7.5" resolution.

The new topography



Surface geopotentiel (a) (divided by 9.81 and 1000 to represent terrain height in km and forced to -1 above the sea) and land sea mask (b) with LNORO, and LNLSM true for the domain in 8 km resolution.

The land sea mask



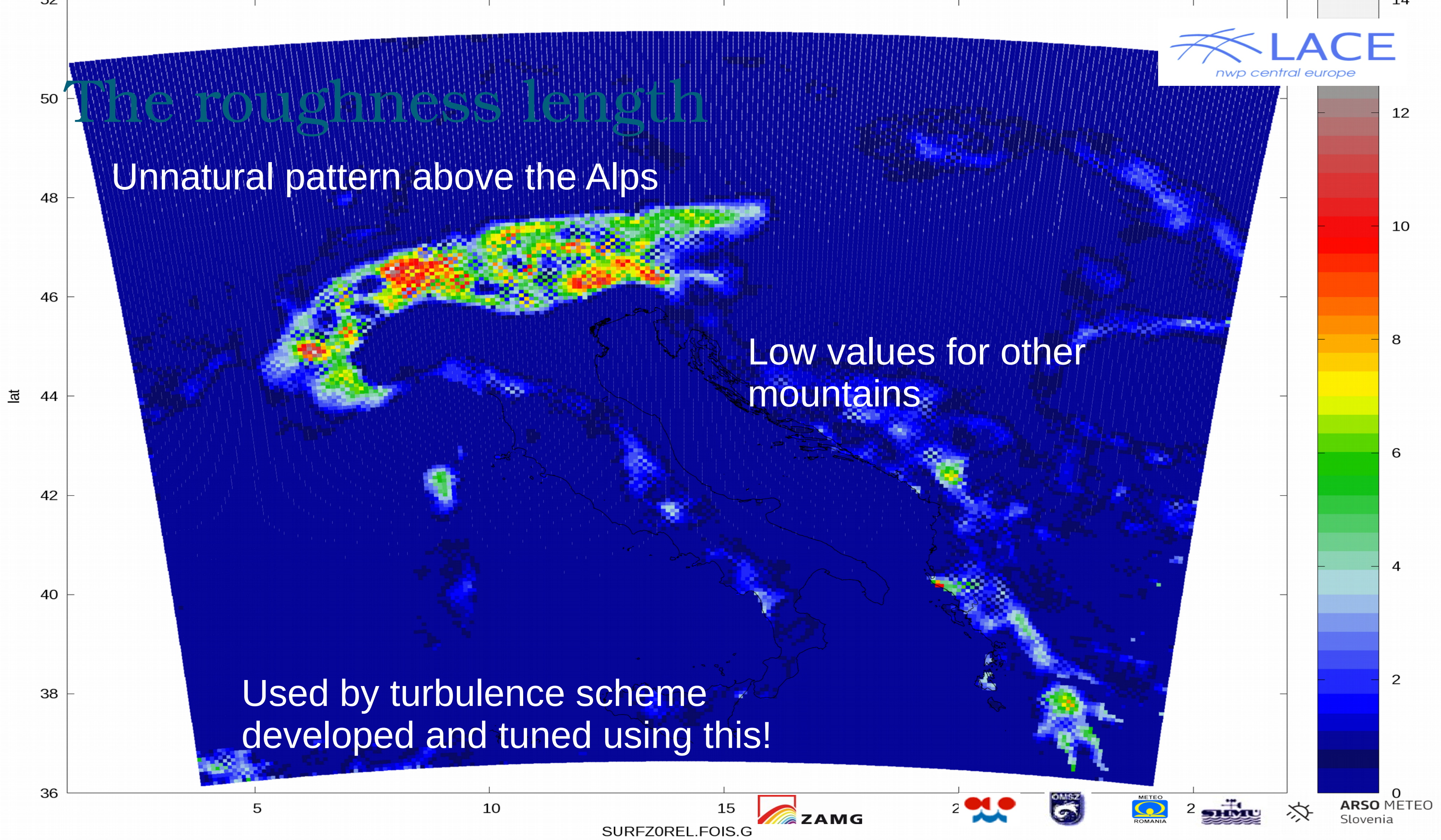
Proportion of land after the Step1 (a) and computed from the SURFEX PGD file (b). These figures show data for 2 km resolution domain.

The roughness length

Unnatural pattern above the Alps

Low values for other mountains

Used by turbulence scheme developed and tuned using this!



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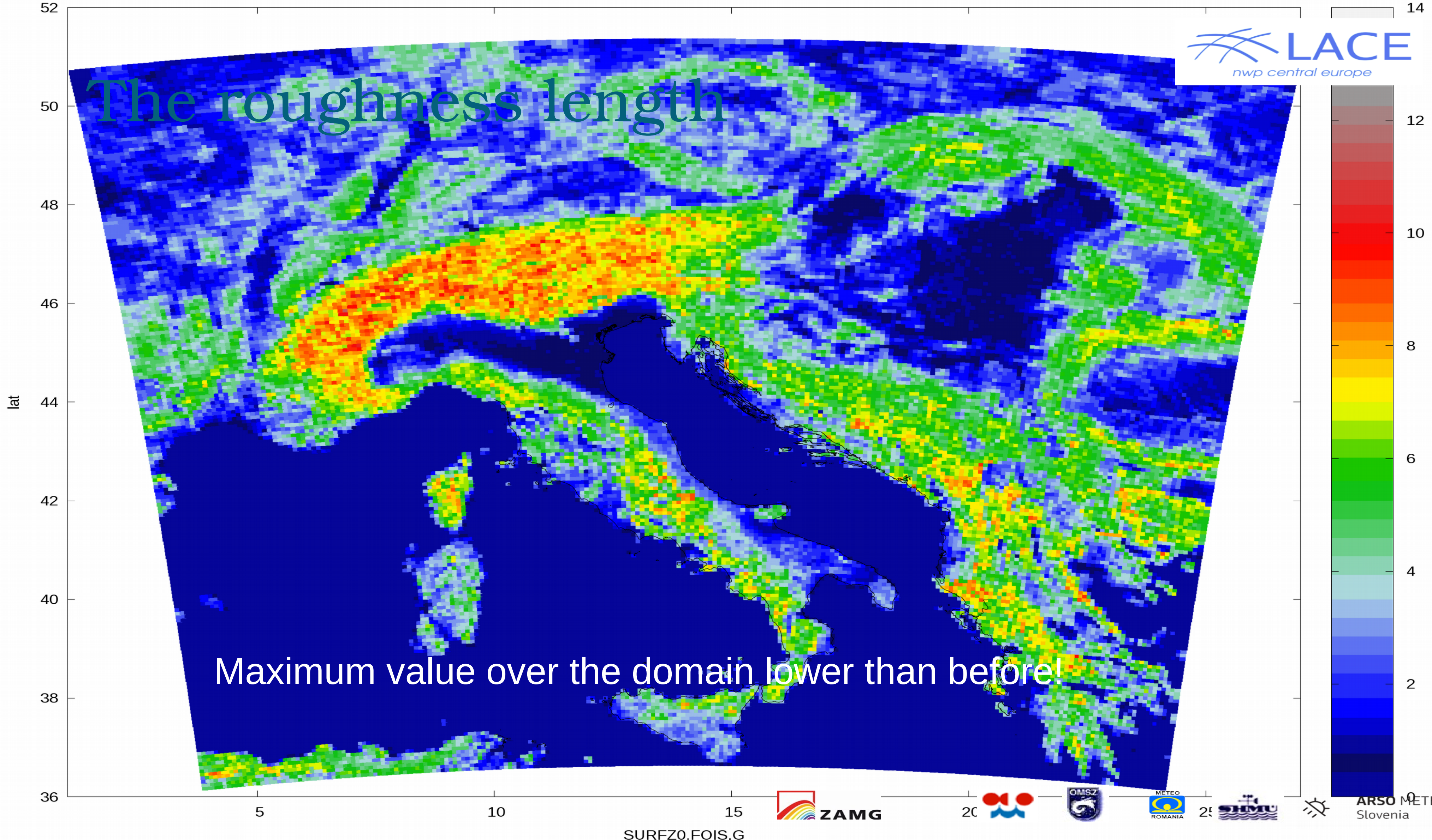
The roughness length



Maximum value over the domain lower than before!

The anisotropy and angle of unresolved orography from PGD

E923: square of anisotropy
Angle to x axis

$$\gamma^2 = \frac{P_1 + P_2 - \sqrt{(P_1 - P_2)^2 + 4P_3^2}}{P_1 + P_2 + \sqrt{(P_1 - P_2)^2 + 4P_3^2}}$$

$$\theta = atan\left(\frac{-(P_1 - P_2) + \sqrt{(P_1 - P_2)^2 + 4P_3^2}}{-2P_3}\right) - atan(\frac{gnordl}{gnordm})$$

$$P_1 = \frac{\left(\frac{\partial H}{\partial x}\right)^2 \sigma_H^2}{\left(\frac{\partial H}{\partial x}\right)^2 + \left(\frac{\partial H}{\partial y}\right)^2} + \frac{\left(\frac{\partial h}{\partial x}\right)^2 \sigma_h^2}{\left(\frac{\partial h}{\partial x}\right)^2 + \left(\frac{\partial h}{\partial y}\right)^2}$$

$$P_2 = \frac{\left(\frac{\partial H}{\partial y}\right)^2 \sigma_H^2}{\left(\frac{\partial H}{\partial x}\right)^2 + \left(\frac{\partial H}{\partial y}\right)^2} + \frac{\left(\frac{\partial h}{\partial y}\right)^2 \sigma_h^2}{\left(\frac{\partial h}{\partial x}\right)^2 + \left(\frac{\partial h}{\partial y}\right)^2}$$

$$P_3 = \frac{\frac{\partial H}{\partial x}\frac{\partial H}{\partial y} \sigma_H^2}{\left(\frac{\partial H}{\partial x}\right)^2 + \left(\frac{\partial H}{\partial y}\right)^2} + \frac{\frac{\partial h}{\partial x}\frac{\partial h}{\partial y} \sigma_h^2}{\left(\frac{\partial h}{\partial x}\right)^2 + \left(\frac{\partial h}{\partial y}\right)^2}$$

PGD: anisotropy
Angle to x axis, positive dir?

$$K = \frac{1}{2}\left(\left(\frac{\partial h}{\partial x}\right)^2 + \left(\frac{\partial h}{\partial y}\right)^2\right) \qquad L = \frac{1}{2}\left(\left(\frac{\partial h}{\partial x}\right)^2 - \left(\frac{\partial h}{\partial y}\right)^2\right) \qquad M = \frac{\partial h}{\partial x}\frac{\partial h}{\partial y}$$

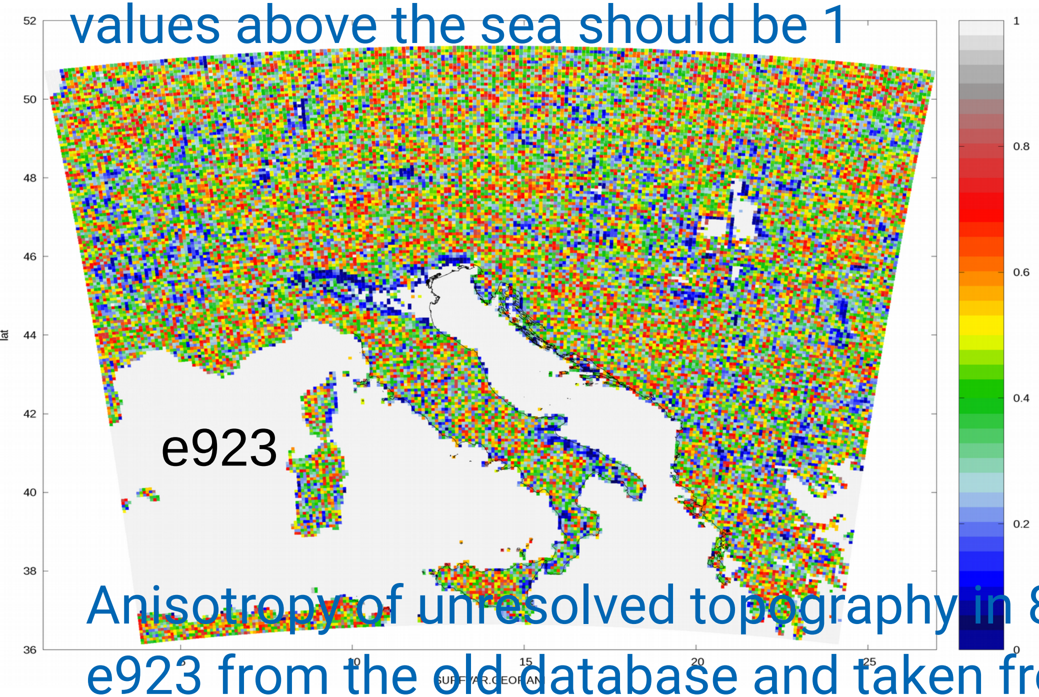
$$\theta = \frac{1}{2} atan\left(\frac{M}{L}\right) \qquad \gamma = \sqrt{\frac{K - \sqrt{L^2 + M^2}}{K + \sqrt{L^2 + M^2}}}$$

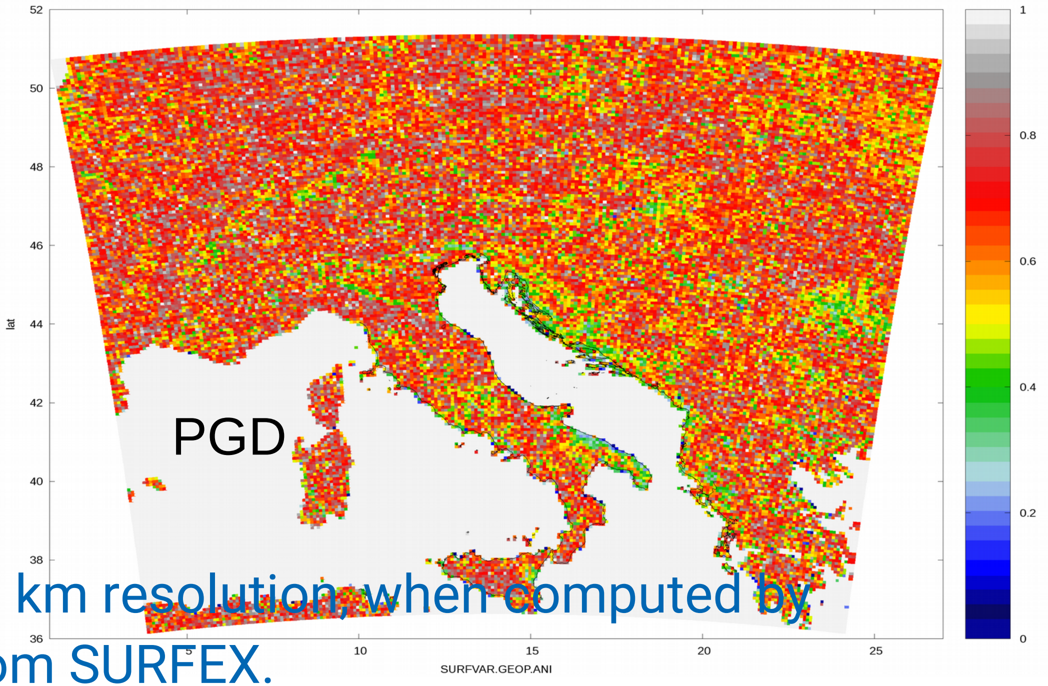
Assume equivalency

$$K = \frac{1}{2}(P_1 + P_2) \qquad L = \frac{1}{2}(P_1 - P_2) \qquad M = P_3$$

The anisotropy and angle of unresolved orography from PGD

Larger values means that the unresolved topography is more isotropic. Low values indicate that terrain is changing dominantly in one direction and the values above the sea should be 1





Anisotropy of unresolved topography in 8 km resolution, when computed by e923 from the old database and taken from SURFEX.

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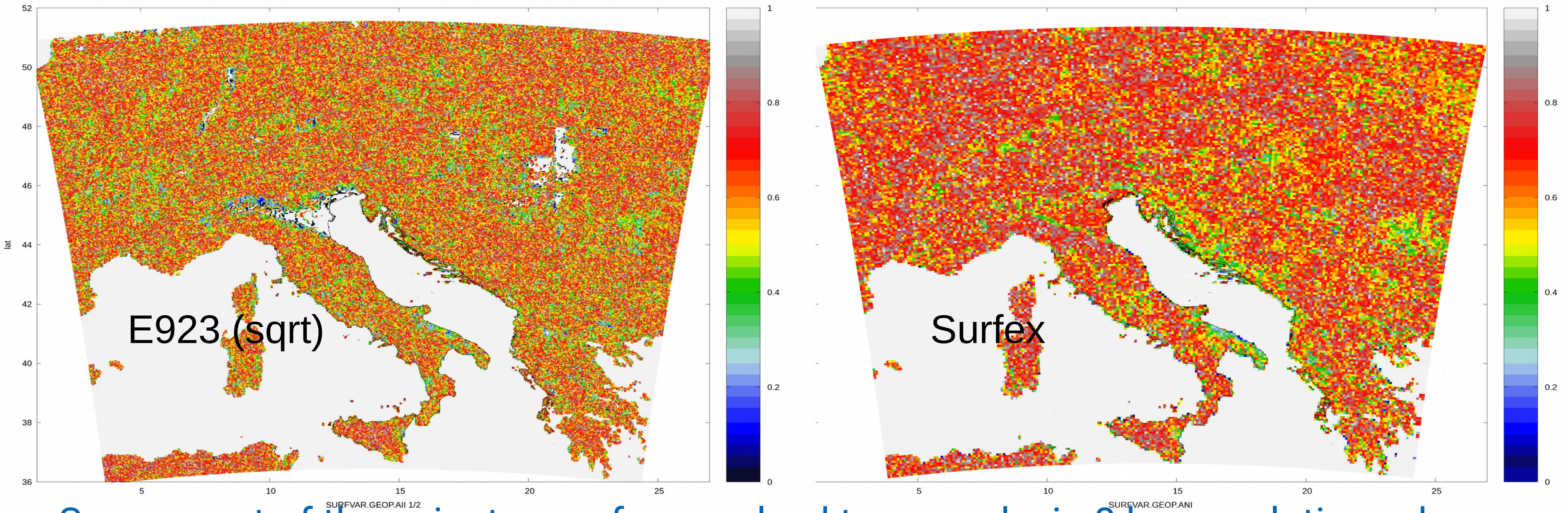
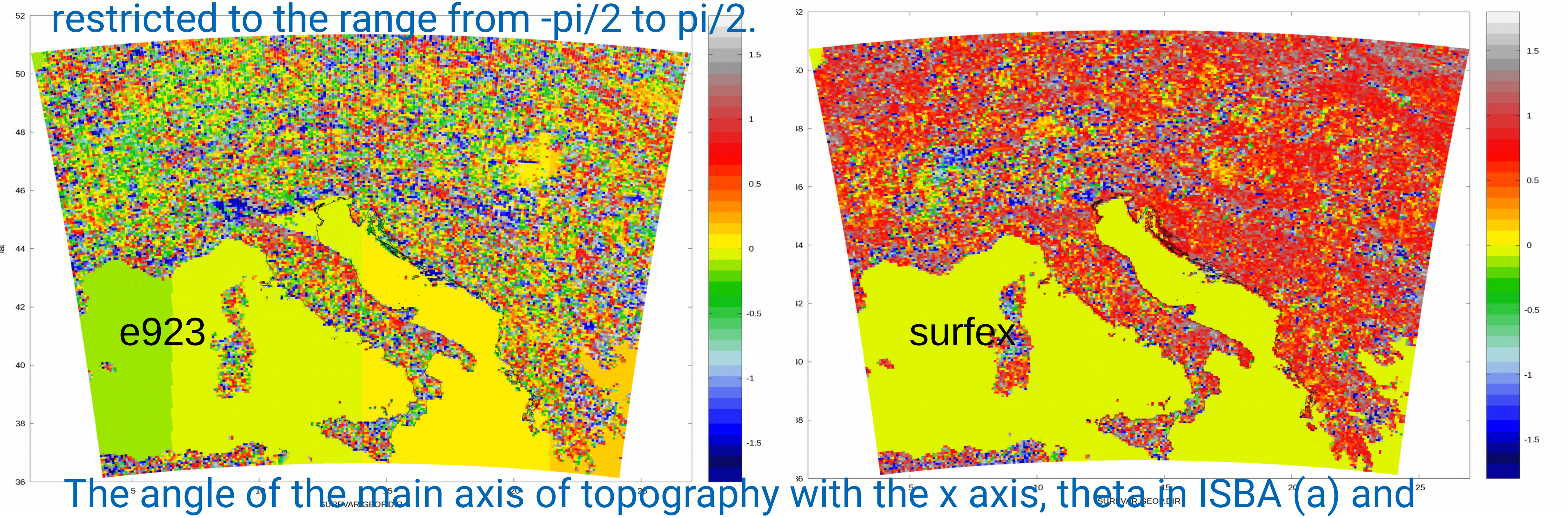
The anisotropy from PGD



Square root of the anisotropy of unresolved topography in 8 km resolution, when computed by e923 from the old database (left) and taken from PGD (right).

The angle of unresolved orography from PGD

The angle of topography is computed from the components of the tensor and then the angle of the grid orientation is added so the final angle theta is not restricted to the range from -pi/2 to pi/2.



The angle of the main axis of topography with the x axis, theta in ISBA (a) and in PGD (b) recomputed to be in radians

The angle of unresolved orography from PGD

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$$\theta = atan(\frac{-(P_1 - P_2) + \sqrt{(P_1 - P_2)^2 + 4P_3^2}}{-2P_3})$$

$$\theta = atan(\frac{-2L + \sqrt{4L^2 + 4M^2}}{-2M}) = atan(\frac{L - \sqrt{L^2 + M^2}}{M})$$

$$atan(x) = \frac{1}{2} atan \frac{2x}{1 - x^2} \qquad for \qquad |x| < 1$$

$$atan(x) = \frac{\pi}{2} + \frac{1}{2} atan \frac{2x}{1 - x^2} \qquad for \qquad x > 1$$

$$atan(x) = -\frac{\pi}{2} + \frac{1}{2} atan \frac{2x}{1 - x^2} \qquad for \qquad x < -1$$

$$\theta = \frac{1}{2} atan \frac{2\frac{L - \sqrt{L^2+M^2}}{M}}{1 - \left(\frac{L - \sqrt{L^2+M^2}}{M}\right)^2} = \frac{1}{2} atan \frac{2\frac{L - \sqrt{L^2+M^2}}{M}}{\frac{M^2 - (L^2 - 2L\sqrt{L^2+M^2} + L^2 + M^2)}{M^2}}$$

$$\theta = \frac{1}{2} atan \frac{2M(L - \sqrt{L^2 + M^2})}{-2L^2 + 2L\sqrt{L^2 + M^2}} = \frac{1}{2} atan \frac{2M(L - \sqrt{L^2 + M^2})}{-2L(L - \sqrt{L^2 + M^2})}$$

$$\theta = -\frac{1}{2} atan \frac{M}{L}$$

Then we start from the computations of theta in e923, how it is computed in eganiso, and insert the relations as defined above.

Since in SURFEX the angle theta is defined as one half of the arcus tangens function, one has to go to some basic trigonometic transformations.

The two angles are not defined the same way

$\Theta_{isba} \sim -\Theta_{surfex}$

This derivation is valid only for $|x|<1$

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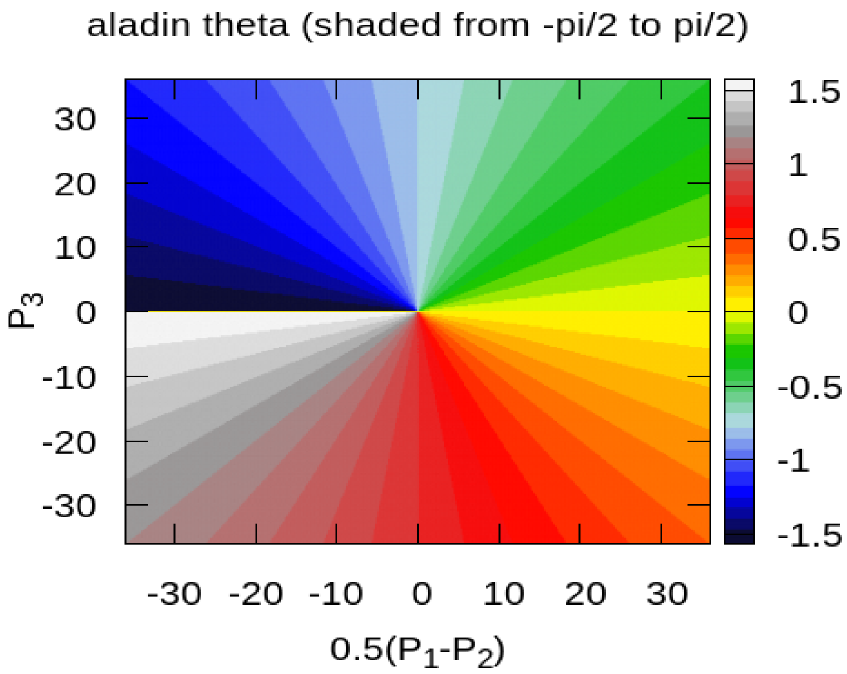
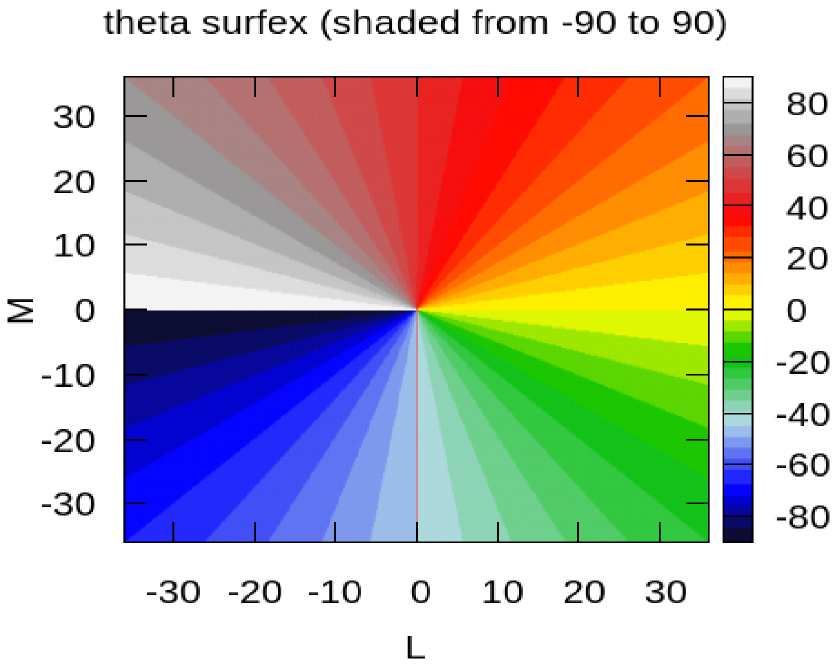
The angle of unresolved orography from PGD

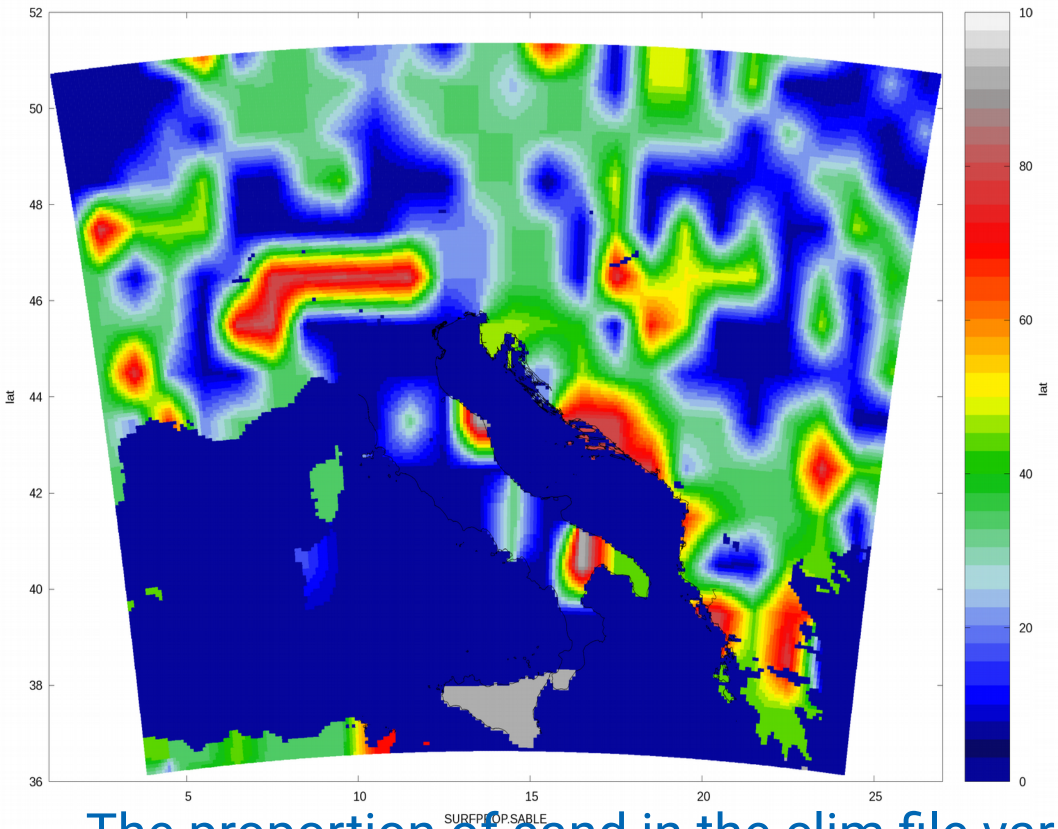


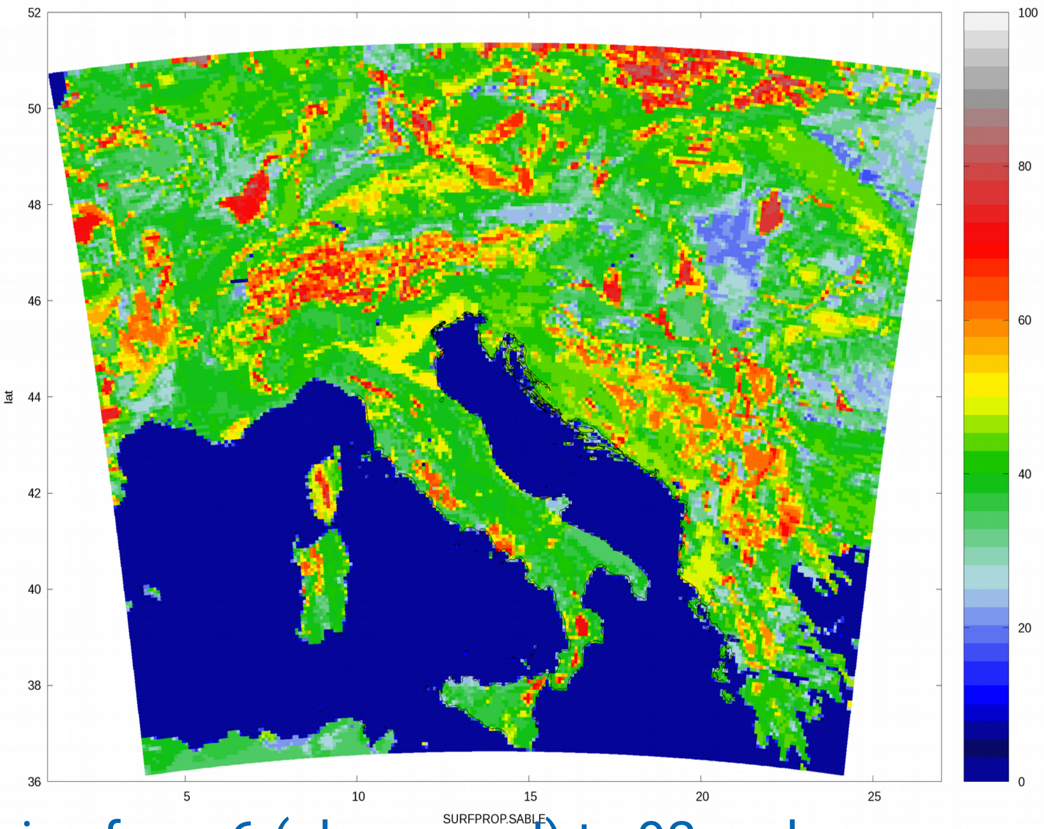


Assume equivalency

$$K = \frac{1}{2}(P_1 + P_2) \qquad L = \frac{1}{2}(P_1 - P_2) \qquad M = P_3$$

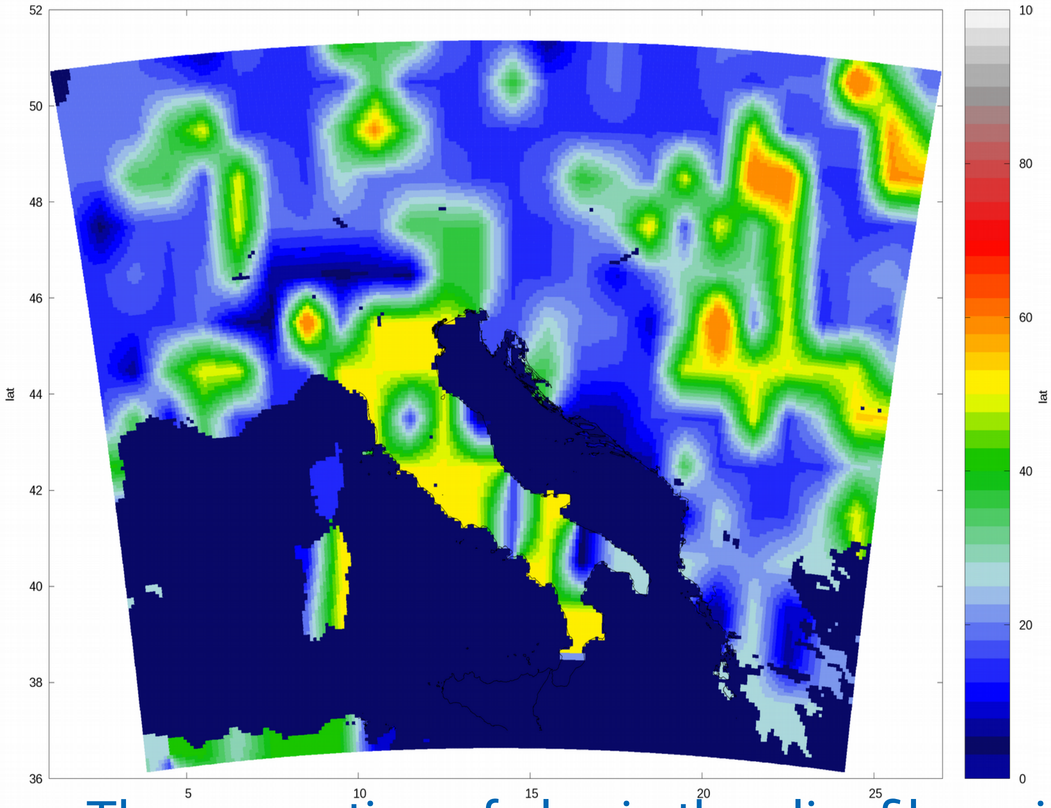
The proportion of sand

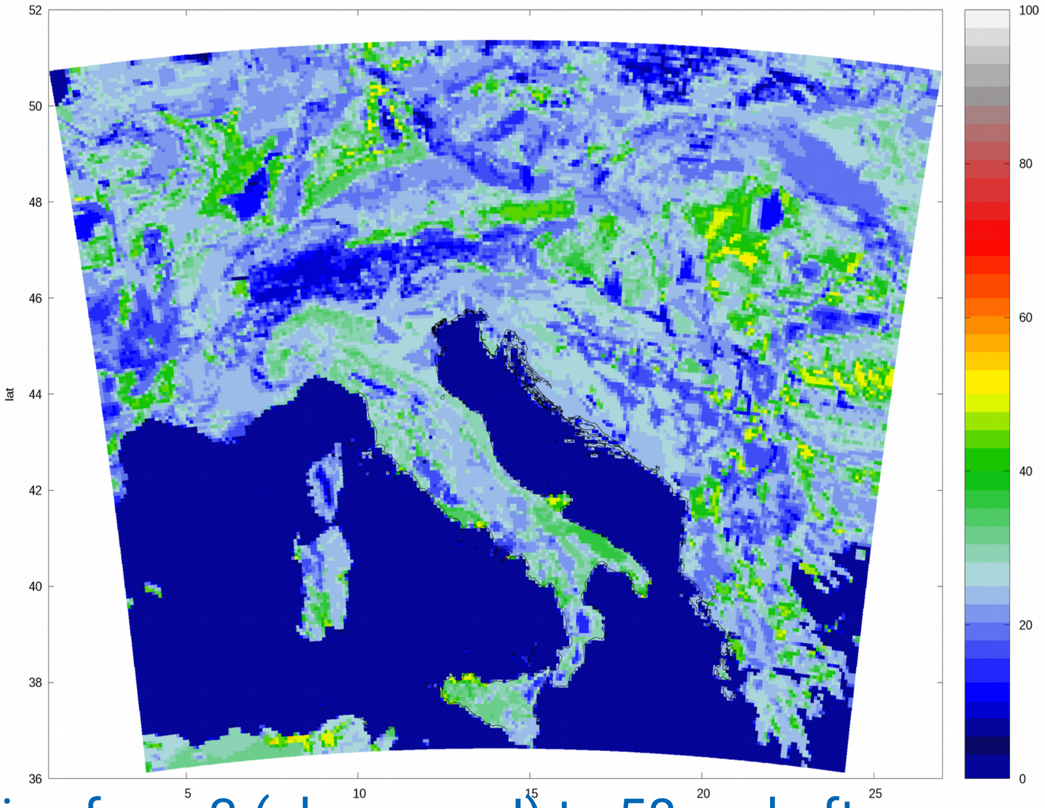




The proportion of sand in the clim file varies from 6 (above sea!) to 92 and after the correction using data from the SURFEX PGD file

The proportion of clay





The proportion of clay in the clim file varies from 3 (above sea!) to 58 and after the correction using data from the SURFEX PGD file.

The code

incli0.F90

call eincli1

call eincli2

call eincli3

…

```
!*
!     2  ACTIVE CALCULATION.
!        ------------------

!*       2.1   MEMORY ALLOCATION

IF ( N923 == 1 ) THEN
  CALL SUALCLIA
ENDIF

!*       2.2   NEW C923

!  TOPOGRAPHY
IF (N923 == 1) THEN
  IF (LELAM) THEN
    CALL EINCLI1
  ELSE
    CALL INCLI1
  ENDIF
ENDIF
!  FIXED FIELDS
IF (N923 == 2) THEN
  IF (LELAM) THEN
    CALL EINCLI2
  ELSE
    CALL INCLI2
  ENDIF
ENDIF
!  OLD CLIMATOLOGY FOR SOIL TEMPERATURE AND MOISTURE
IF (N923 == 3) THEN
  IF (LELAM) THEN
    CALL EINCLI3
  ELSE
    CALL INCLI3
  ENDIF
ENDIF
!  OTHER MONTHLY VARYING FIELDS - VEGETATION
IF (N923 == 4) THEN
  IF (LELAM) THEN
    CALL EINCLI4
  ELSE
    CALL INCLI4
  ENDIF
ENDIF
!  LOCAL MODIFICATION OF FIELDS ON LAND
IF (N923 == 5) THEN
                                          504,2          89%
```

```
!  LOCAL MODIFICATION OF FIELDS ON LAND
IF (N923 == 5) THEN
  IF (LELAM) THEN
    CALL EINCLI5
  ELSE
    CALL INCLI5
  ENDIF
ENDIF
!  NEW CLIMATOLOGY FOR SOIL TEMPERATURE AND MOISTURE
IF (N923 == 6) THEN
  IF (LELAM) THEN
    CALL EINCLI6
  ELSE
    CALL INCLI6
  ENDIF
ENDIF
!  LOCAL MODIFICATION OF FIELDS ON SEA/LAKES
IF (N923 == 7) THEN
  IF (LELAM) THEN
    CALL EINCLI7
  ELSE
    CALL INCLI7
  ENDIF
ENDIF
!  A, B, C COEFFICIENTS FOR OZONE PROFILES
IF (N923 == 8) THEN
  IF (LELAM) THEN
    CALL EINCLI8
  ELSE
    CALL INCLI8
  ENDIF
ENDIF
!  AEROSOLS (NEW)
IF (N923 == 9) THEN
  IF (LELAM) THEN
    CALL EINCLI9
  ELSE
    CALL INCLI9
  ENDIF
ENDIF
!  AQUA-PLANET
IF (N923 == 10) THEN
  IF (LELAM) THEN
    CALL EINCLI10
  ELSE
    CALL INCLI10
                                          548,1          97%
```

The code

incli0.F90

call eincli1

call eincli2

call eincli3

…

```
aladinhr@vihor:~/rootpack/38t1-bf03_main.01.INTEL.x/src/local/aladin/c9xx> ls *.F90
ebicli.F90   eganiso.F90   eincli1.F90  eincli4.F90  eincli7.F90  einter0.F90   einter2.F90  eintfac.F90
echk923.F90  egeo923.F90   eincli2.F90  eincli5.F90  eincli8.F90  einter10.F90  einter6.F90  eleci.F90
ecoptra.F90  eincli10.F90  eincli3.F90  eincli6.F90  eincli9.F90  einter1.F90   einter8.F90  elislap.F90
```

eincli 1

```
!     1. SET INITIAL VALUES
!        ------------------

!     1.1 Constants, initial setup of arrays.

ZEPS=1.E-06_JPRB

IADL(1:NDGLG)=NTSTAGP(1:NDGLG)-1

! Characteristic lengths for smoothing (z0, h)
ZPOR=4000._JPRB
ZPOZ=4000._JPRB

! Orography set to 0 at first
DO J=1,NGPTOT
  XREV(J)= 0.0_JPRB
ENDDO
DO JS=1,NSEFRE
  XRNM(JS)= 0.0_JPRB
ENDDO

! Same default
DO JC=1,8
  DO J=1,NDGLG*NDLON
    ZEXT(J,JC)= 0.0_JPRB
  ENDDO
ENDDO
DO J=1,NDGLG*NDLON
  ZWR(J,1)= 0.0_JPRB
ENDDO
DO JS=1,NSPEC2G
```

```
!     2.1 Read *MANU* tape.

OPEN(31, FILE='Water_Percentage',&
 & FORM='UNFORMATTED', ACCESS='DIRECT', RECL=NDATX)

OPEN(32, FILE='Oro_Mean',&
 & FORM='UNFORMATTED', ACCESS='DIRECT', RECL=2*NDATX)

OPEN(33, FILE='Sigma',&
 & FORM='UNFORMATTED', ACCESS='DIRECT', RECL=2*NDATX)

OPEN(34, FILE='Nb_Peaks',&
 & FORM='UNFORMATTED', ACCESS='DIRECT', RECL=NDATX)

OPEN(35, FILE='Urbanisation',&
 & FORM='UNFORMATTED', ACCESS='DIRECT', RECL=NDATX)

OPEN(36, FILE='Dh_over_Dx_Dh_over_Dy',&
 & FORM='UNFORMATTED', ACCESS='DIRECT', RECL=4*NDATX)

OPEN(37, FILE='Dh_over_Dx_square',&
 & FORM='UNFORMATTED', ACCESS='DIRECT', RECL=4*NDATX)

OPEN(38, FILE='Dh_over_Dy_square',&
 & FORM='UNFORMATTED', ACCESS='DIRECT', RECL=4*NDATX)

OPEN(39, FILE='Hmax-HxH-Hmin_ov4',&
 & FORM='UNFORMATTED', ACCESS='DIRECT', RECL=4*NDATX)
```

```
!   1 fraction of water covered area: ZS1=%w

DO JJ=NDATY,1,-1
  JA=NDATY-JJ+1
  READ(31,REC=JA)CL_CARRAY
  DO JI=1,NDATX
    I8=ICHAR(CL_CARRAY(JI))
    ZVA(JI,JJ)=REAL(I8,JPRB)/100._JPRB
  ENDDO
ENDDO
CALL EINTER1(ZVA,IDATY,IDATX,ITN,IFLD,ZS(1,1
 & IYFING,IXFING,ITFING,EDELX,EDELY,NPINT,IC

!   2 mean orography: ZS2=mo

DO JJ=NDATY,1,-1
  JA=NDATY-JJ+1
  READ(32,REC=JA)IARRAY16
  DO JI=1,NDATX
    ZVA(JI,JJ)=REAL(IARRAY16(JI),JPRB)
  ENDDO
ENDDO

CALL EINTER1(ZVA,IDATY,IDATX,ITN,IFLD,ZS(1,2
 & IYFING,IXFING,ITFING,EDELX,EDELY,NPINT,IC

! Now compute derived fields from mean orogr

!   3 square mean orography: ZS3=mo2

DO JJ=1,NDATY
  DO JI=1,NDATX
```

Conclusions

Configuration 923 reads precomputed input files and interpolates

Currently, the orography fields are computed as a mixture

Topography and LSM from the new database

Subgrid topography parameters from the old database – from precomputed files

These fields can be recomputed using fields from the PGD file

OR code computing the fields into 923

Current work: http://radar.dhz.hr/~tudor/clim/e923_v2016.pdf

Older report: http://radar.dhz.hr/~tudor/clim/clim_vars.pdf