

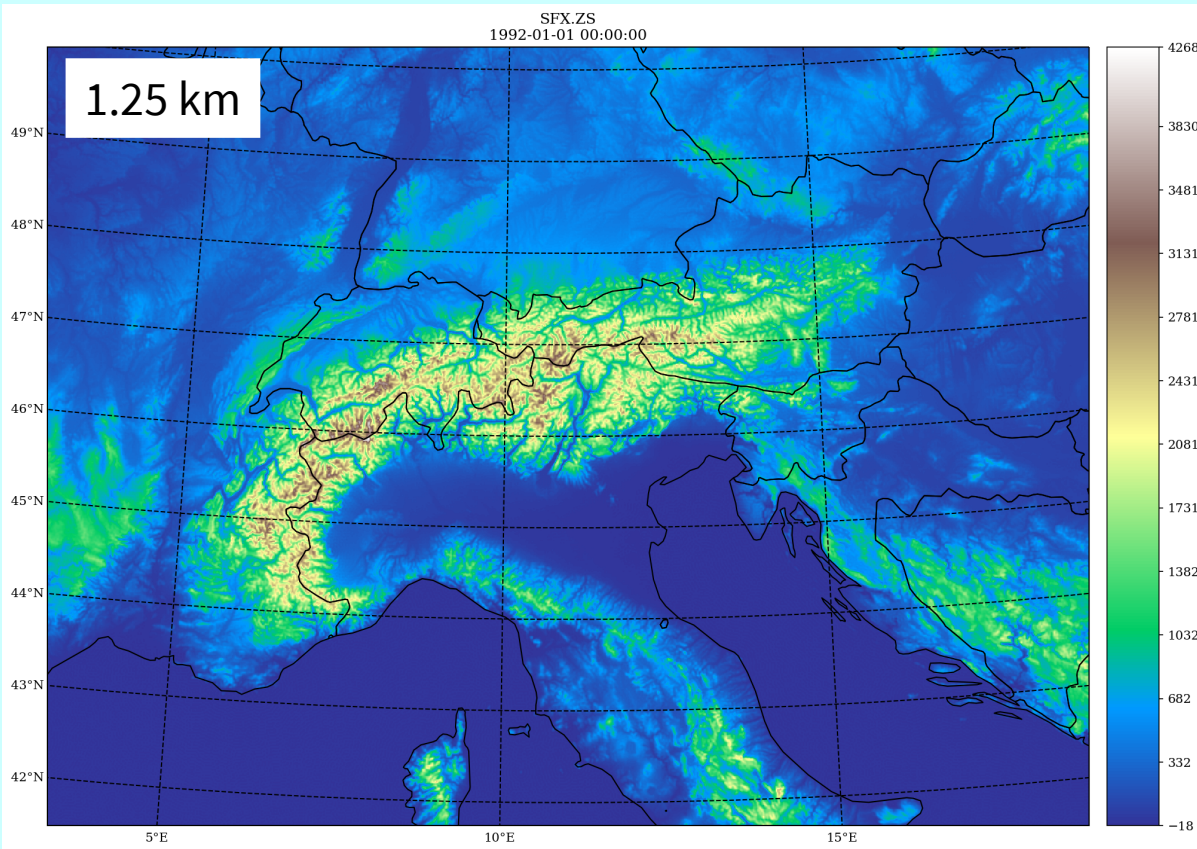
ACCORD

A Consortium for COnvection-scale modelling
Research and Development

**Impact of "pseudo 3D effects", shallow convection and
dynamics options for AROME-500m and 200m over Austria**

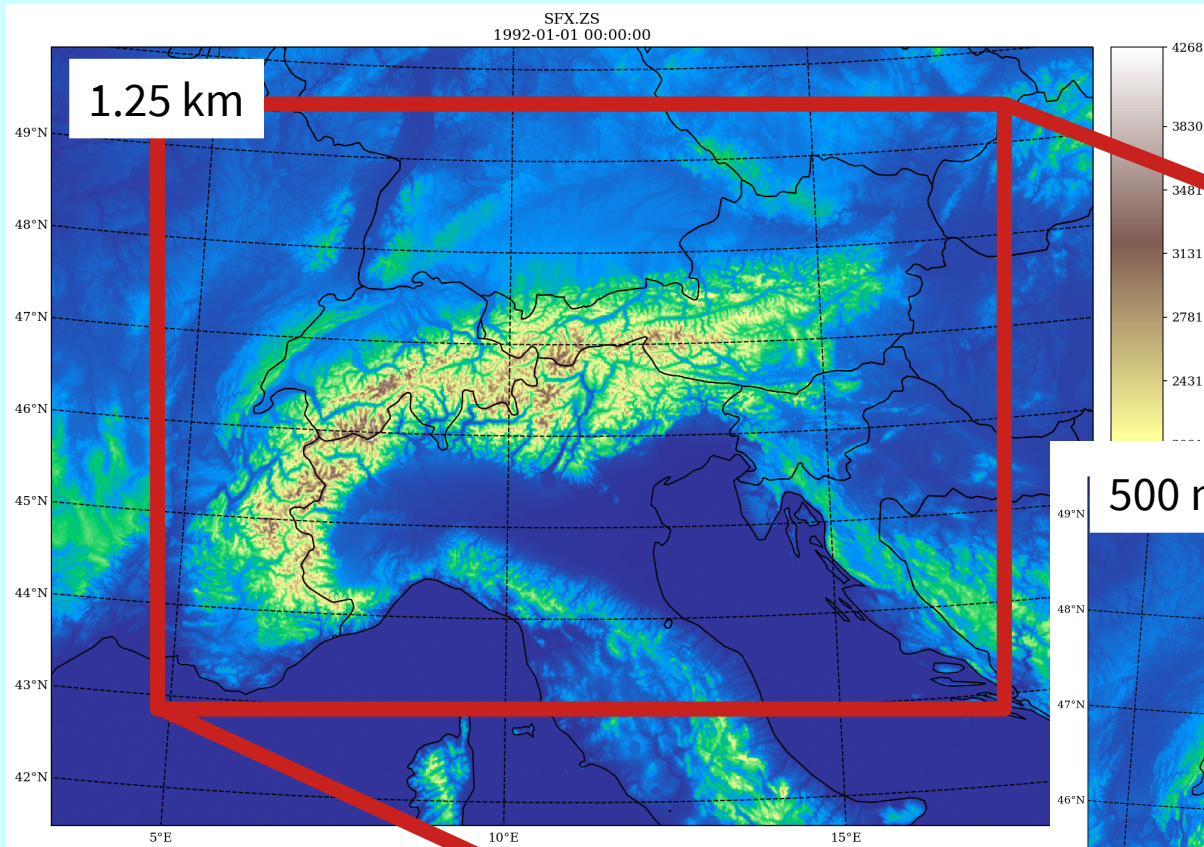
E. Bazile (AROME CSC) with
L. Auger, R. Honnert, M. Martet, C. Wittmann and ...
ASW2023, Tallin 30 March 2023

Several domains for the Alps with a focus on the Innsbruck Valley

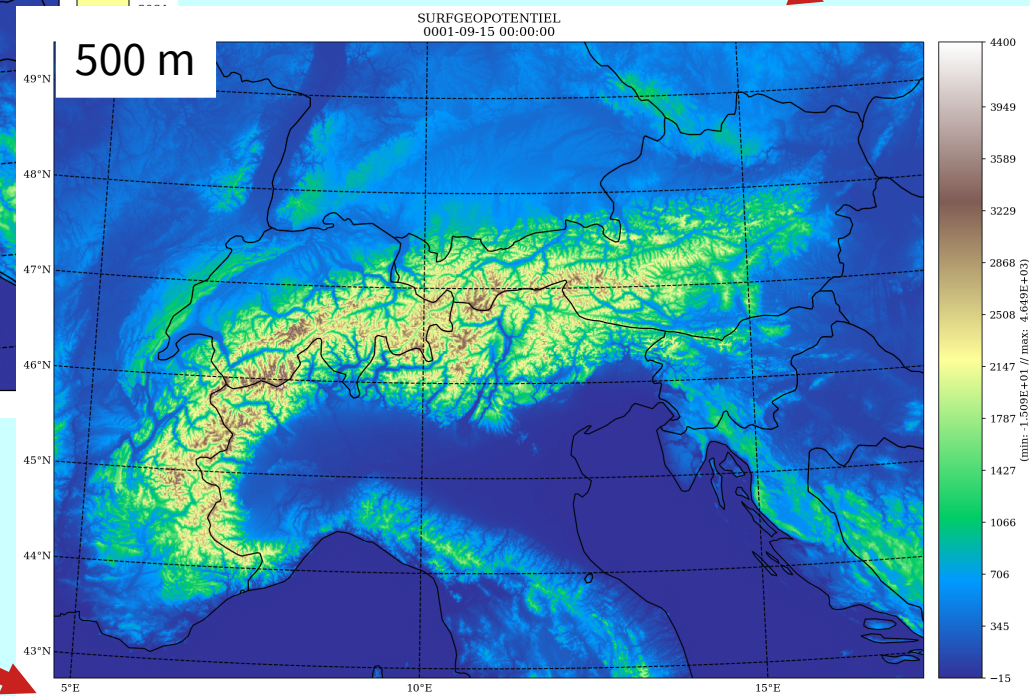


1.25km (1024x768) used for TEAMx for convective and PBL study and intercomparison. LBC from ECMWF or ARPEGE

Several domains for the Alps with a focus on the Innsbruck Valley

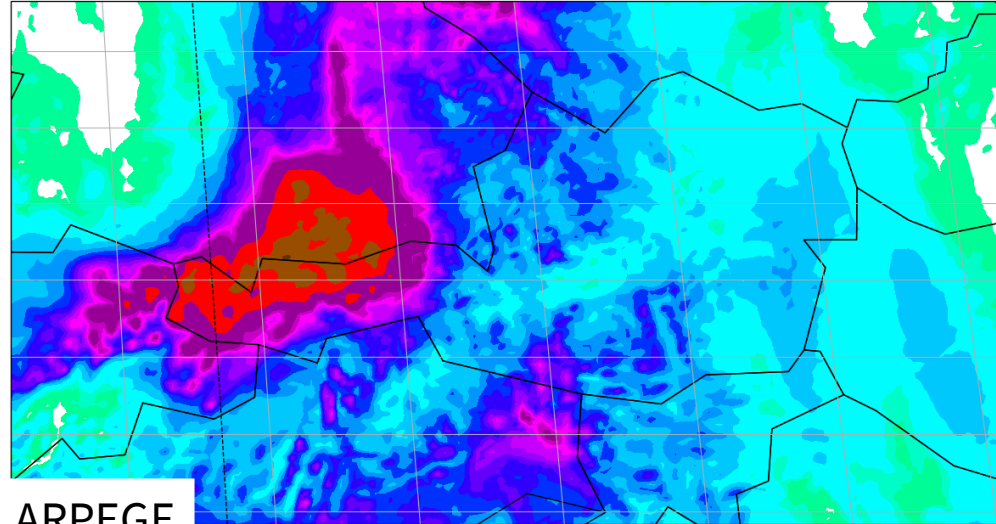


500 m : 2037x1489 grid points
linear grid with two input
topography GTOPO30 and SW3s



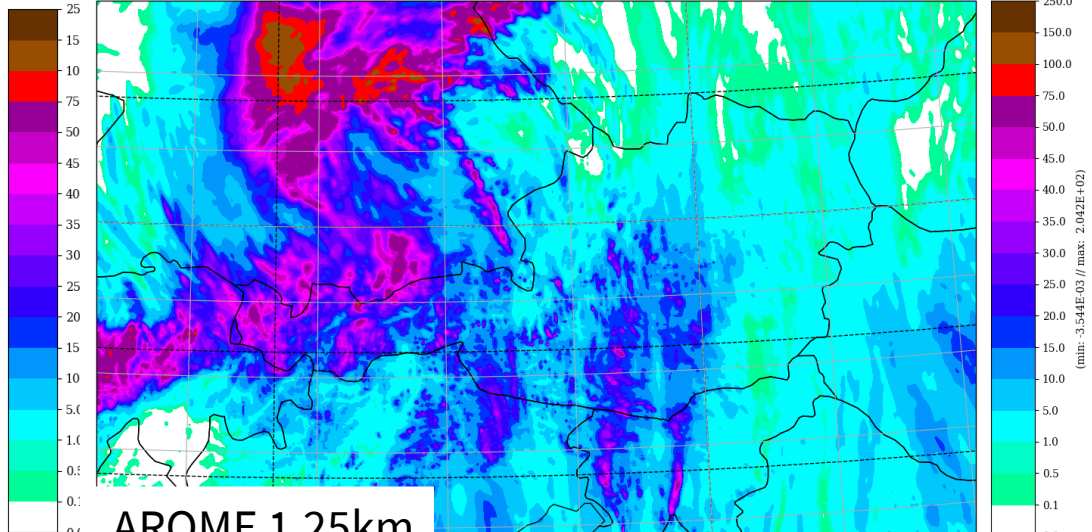
ARPEGE and AROME 1.25km 18 August 2022 00h: Rain +48h-24h

ARPEGE 5.5Km (OPER) Total Accumulated Precipitation 24h +48h Base=2022-08-18 00:00:00 Valid=2022-08-20 00:00:00



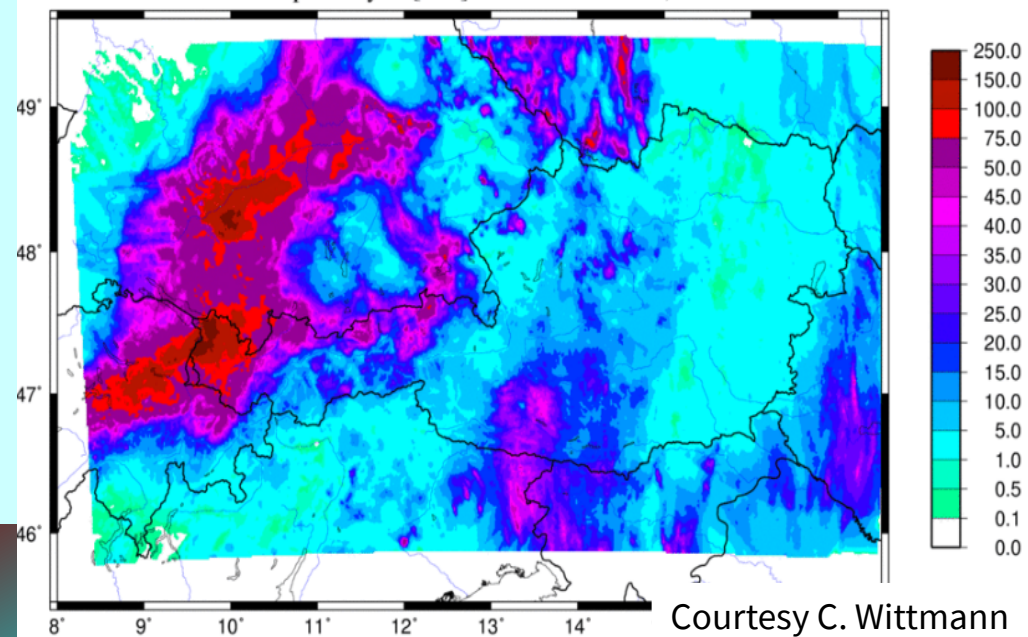
ARPEGE

AROME 1.25km (GL2B) Total Accumulated Precipitation 24h +48h Base=2022-08-18 00:00:00 Valid=2022-08-20 00:00:00



AROME 1.25km

INCA Precip. Analysis [mm] 20220820 00 UTC, 24 h sum



Courtesy C. Wittmann

Experiments : 18-20/08/2022

- AROME-France 1.3km L90 (1429x1525) TEI=195 days = REF unit=1
- AROME-TEAMx 1.25km L90 (1024x768) Cost=x 0.33 LBC/init from ARPEGE (GL2B)
- AROME-500m 2046x1500 LBC/init from AROME-TEAMx 1.25kmL90

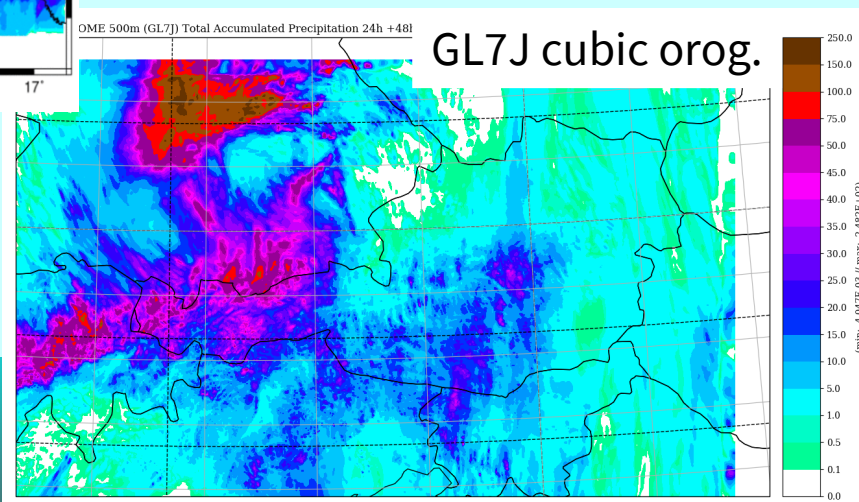
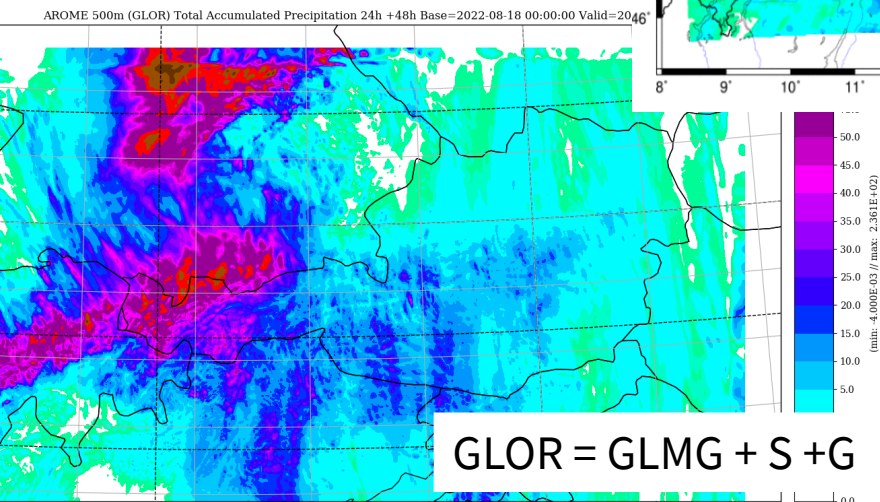
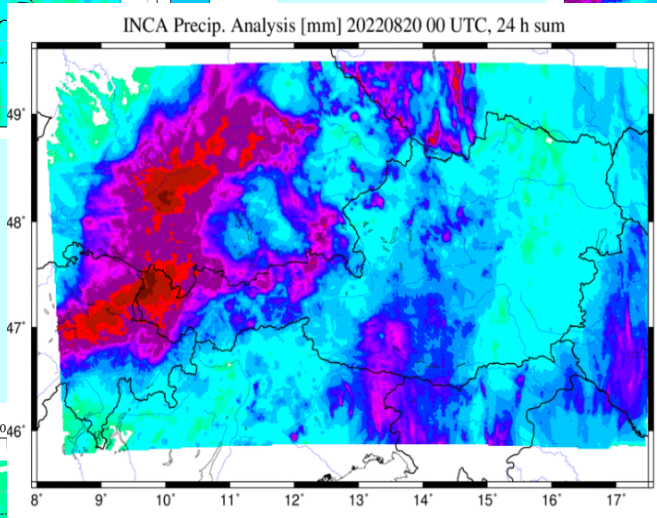
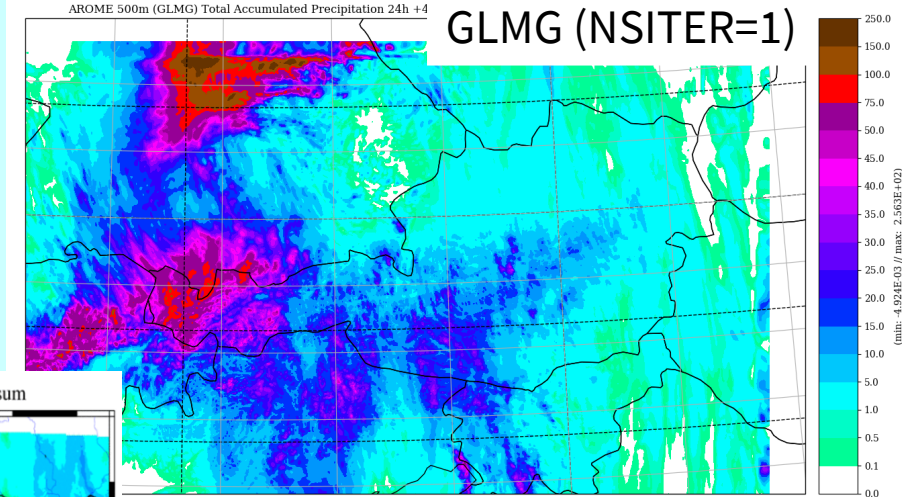
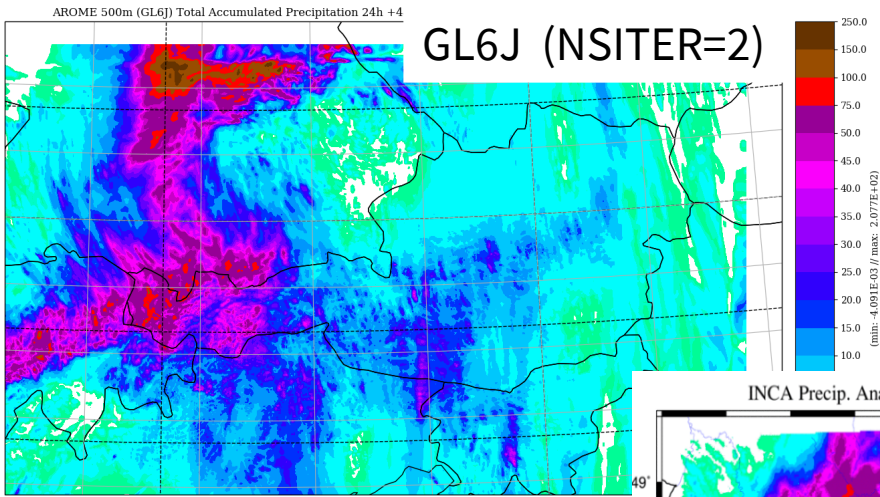
| 500m | dt | level | Shal XCMF | Goger | Rayt | SITRA | SIPR | NSITER | CHEAP | FULL | Cost |
|--------------|-----|-------|-----------|-------|------|-------|-------|--------|-------|------|------|
| GL6J | 20s | 90 | 0.065 | no | 360s | 50 | 60000 | 2 | F | T | x4.7 |
| GLMG | 20s | 90 | 0.065 | no | 360s | 50 | 90000 | 1 | F | T | x3.5 |
| GLOR | 20s | 90 | 0.03 | yes | 360s | 50 | 90000 | 1 | F | T | x3.8 |
| GLTR | 20s | 90 | 0.03 | yes | 800s | 50 | 90000 | 1 | F | T | x3.7 |
| GL7J cubic | 20s | 90 | 0.065 | no | 360s | 100 | 90000 | 1 | T | T | x3.2 |
| GMHP cubic*2 | 30s | 90 | 0.065 | no | 540s | 100 | 90000 | 1 | T | T | x1.8 |
| GMEQ | 30s | 90 | 0.03 | yes | 540s | 50 | 90000 | 2 | T | T | x2.9 |
| GMCR | 30s | 120 | 0.065 | no | 540s | 50 | 90000 | 2 | T | T | x3.7 |
| GMC4 | 30s | 120 | 0.03 | yes | 540s | 50 | 90000 | 2 | T | T | x3.9 |

Experiments : 01-03/11/2022

- AROME-France 1.3km L90 (1429x1525) TEI=195 days
- AROME-TEAMx 1.25km L90 (1024x768) TEI=64 days LBC/init from ARPEGE (GL2B)
- AROME-500m 2046x1500 LBC/init from AROME-TEAMx 1.25kmL90

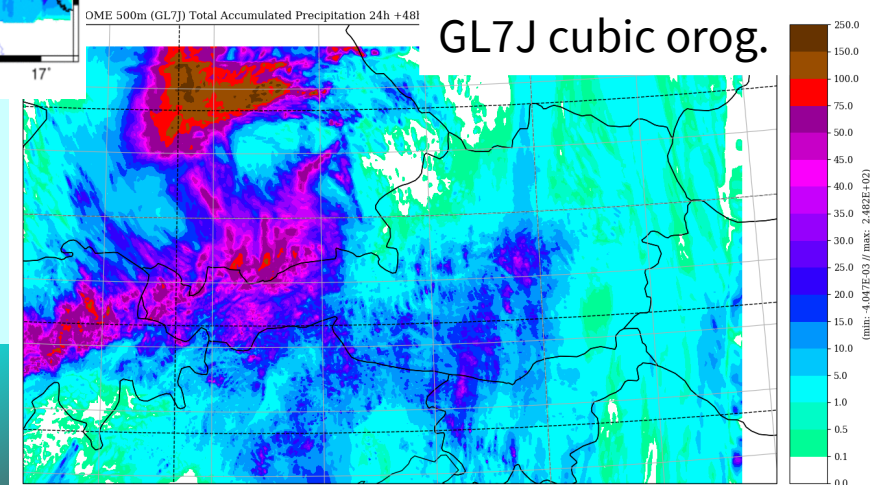
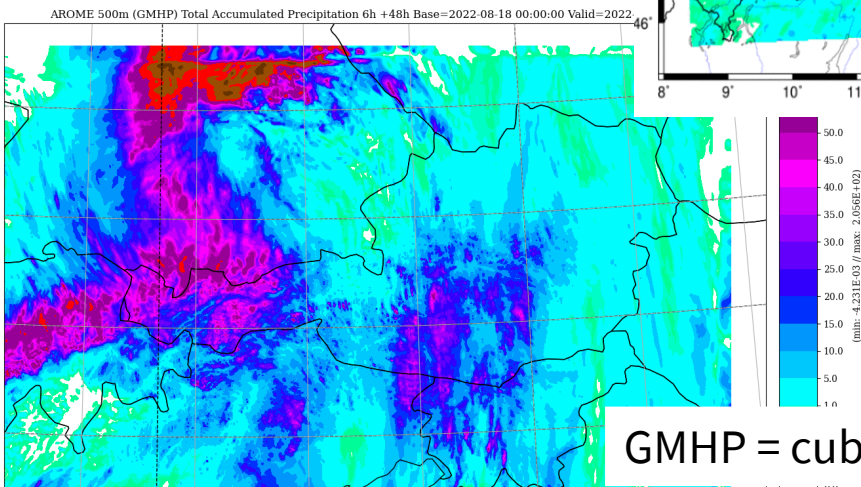
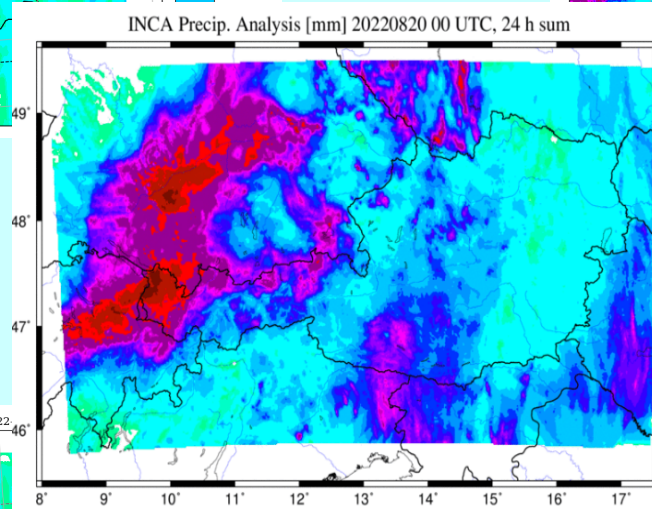
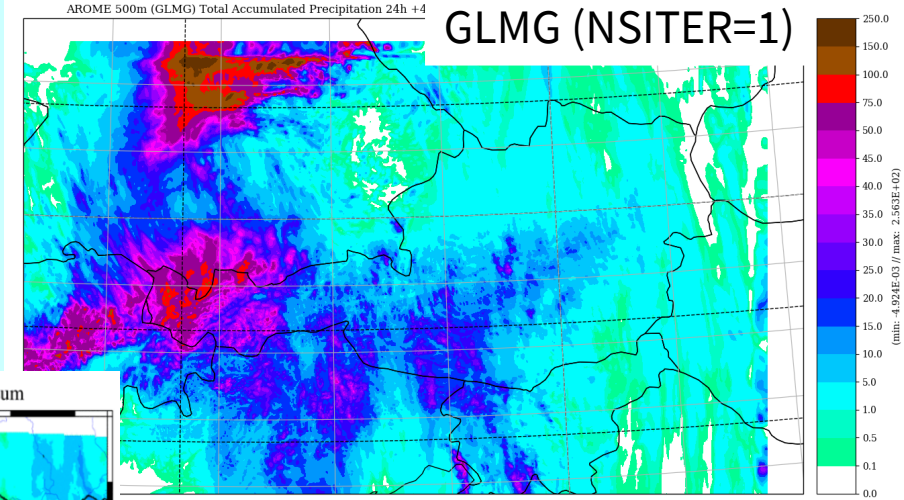
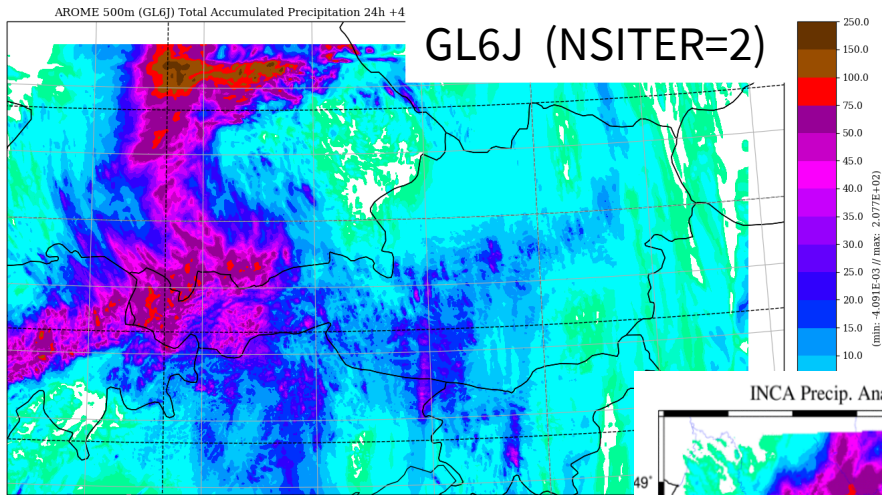
| 500m | dt | level | Shal XCMF | Goger | Rayt | SITRA | SIPR | NSITER | CHEAP | FULL | TEI |
|--------------|-----|-------|-----------|-------|------|-------|-------|--------|-------|------|------|
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| GLOR | 20s | 90 | 0.03 | yes | 360s | 50 | 90000 | 1 | F | T | x3.8 |
| GLTR | 20s | 90 | 0.03 | yes | 800s | 50 | 90000 | 1 | F | T | x3.7 |
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| GMHP cubic*2 | 30s | 90 | 0.065 | no | 540s | 100 | 90000 | 1 | T | T | x1.8 |
| GMEQ | 30s | 90 | 0.03 | yes | 540s | 50 | 90000 | 2 | T | T | x2.9 |
| GMCR | 30s | 120 | 0.065 | no | 540s | 50 | 90000 | 2 | T | T | x3.7 |
| GMC4 | 30s | 120 | 0.03 | yes | 540s | 50 | 90000 | 2 | T | T | x3.9 |

AROME-500m : 18 August 2022 00h: Rain +48h-24h

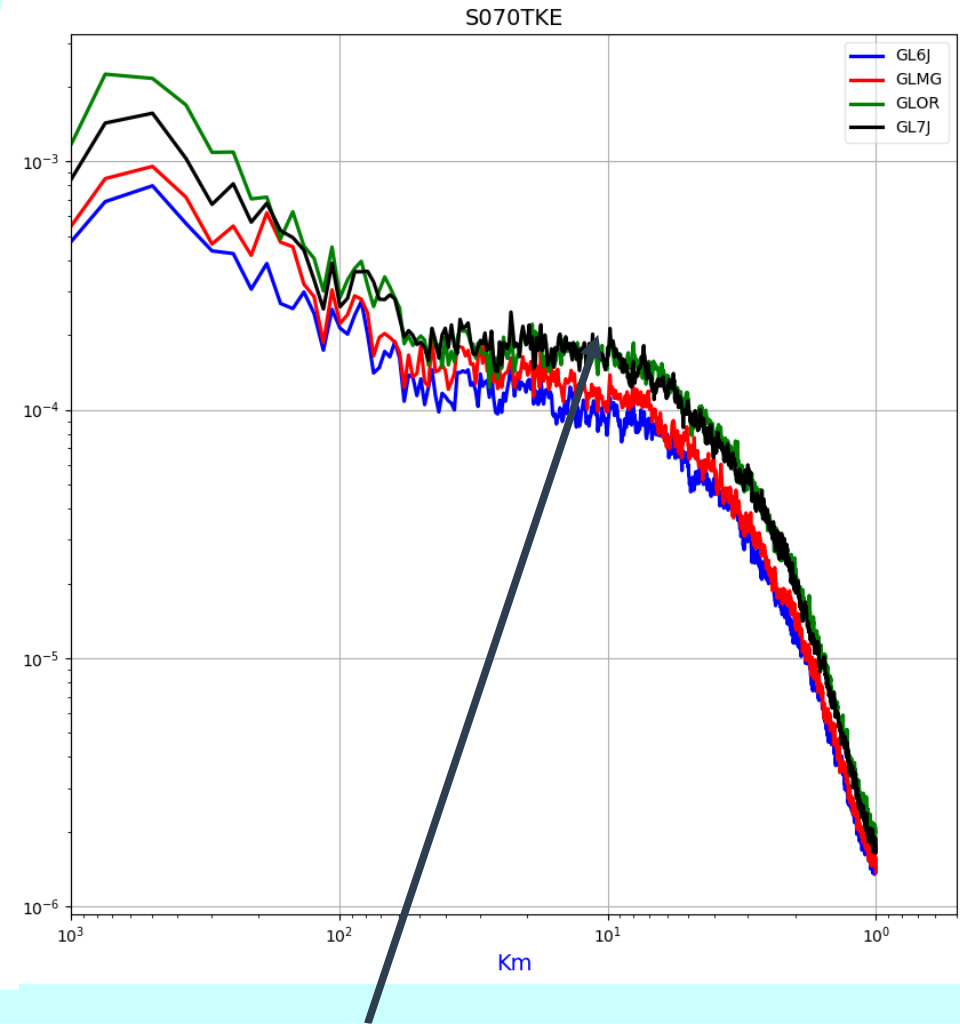
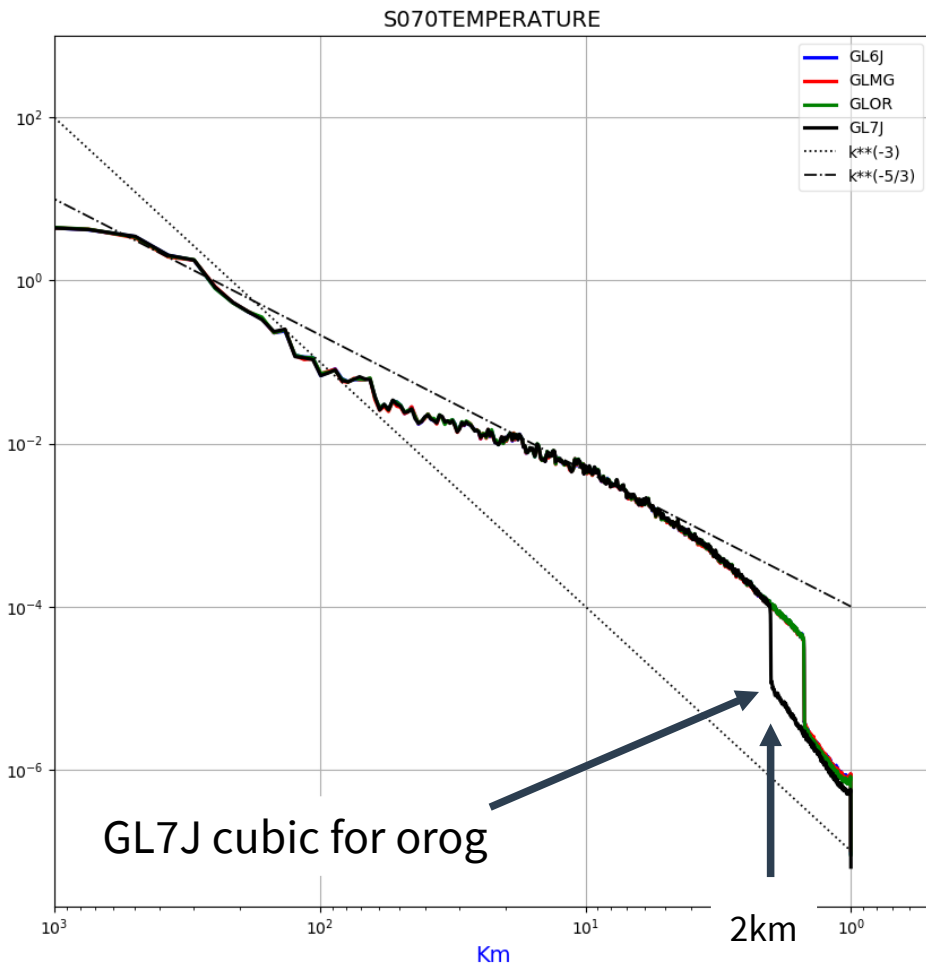


W 2023

AROME-500m : 18 August 2022 00h: Rain +48h-24h



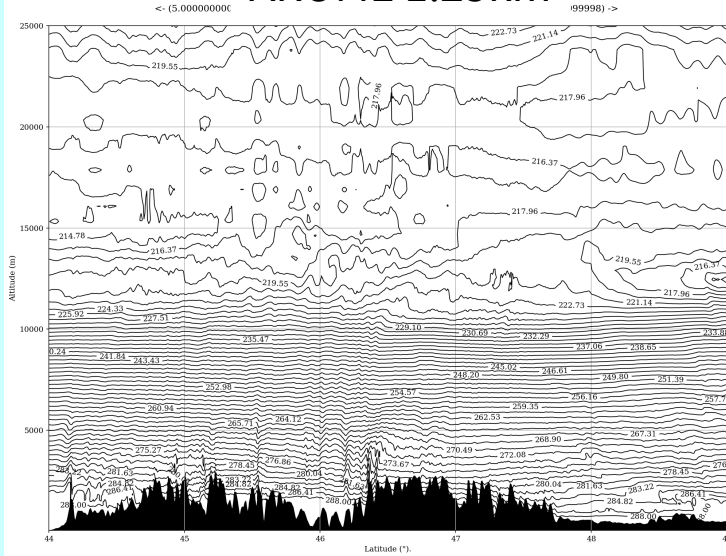
AROME-500m : 18 August 2022 00h + 48h



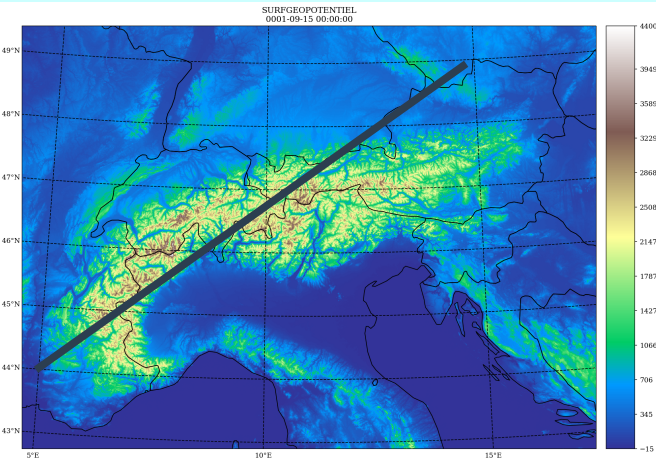
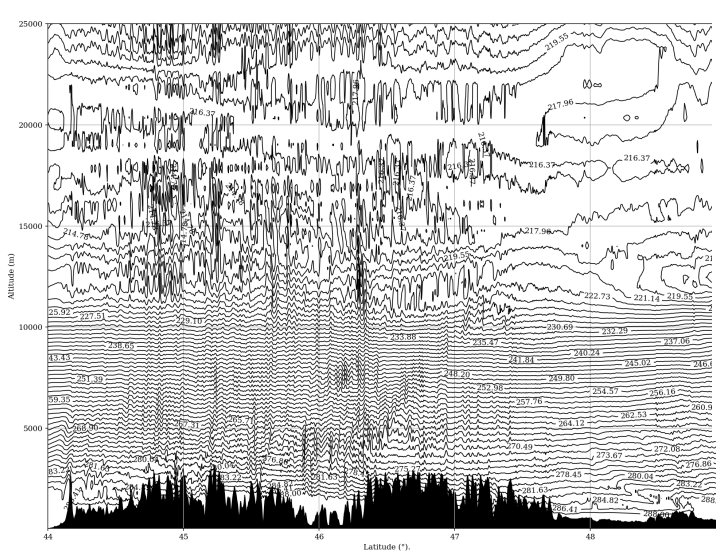
More TKE with a less effective resolution (cubic grid) in the PBL or with Goger and less shallow

AROME-500m : Base 20220818-00TU Temperature +48h

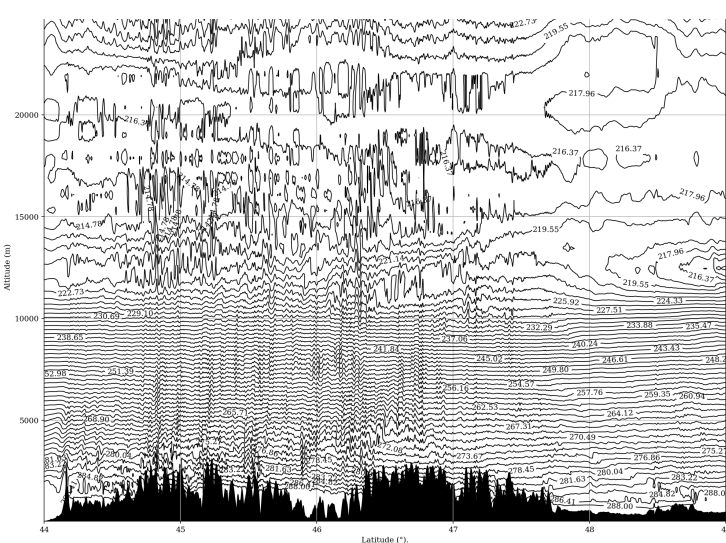
AROME 1.25km



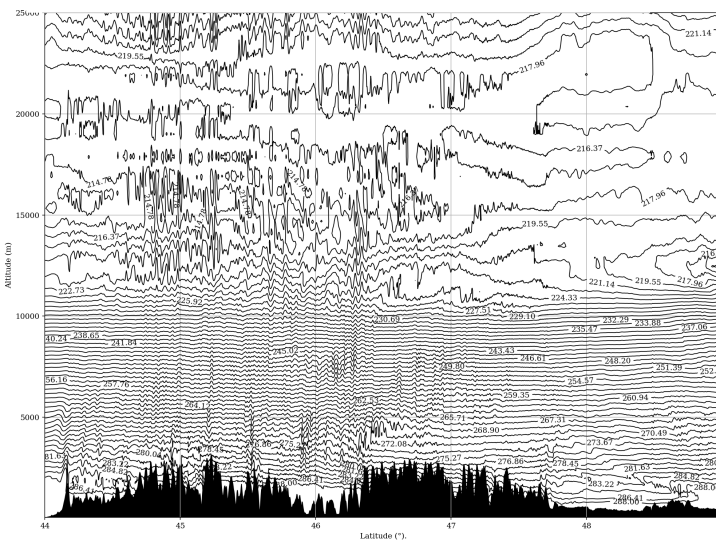
AROME 500m L90 20s GLOR



AROME 500m L90 30s Cubic2 GMHP



AROME 500m L90 30s GMEQ



Impact of Goger et al. (2018) in AROME 500m

- Since cy48t2 horizontal gradients are available in the physics (Honnert and El Khatib (2020))
- For complex terrain: Goger et al. (2018)

$$\left. \frac{\partial \bar{e}}{\partial t} \right|_{\text{shear}} = (C_s \Delta x)^2 \left[\left(\frac{\partial \bar{u}}{\partial x} \right)^2 + \left(\frac{\partial \bar{v}}{\partial y} \right)^2 + \frac{1}{2} \left(\frac{\partial \bar{u}}{\partial y} + \frac{\partial \bar{v}}{\partial x} \right)^2 \right]^{\frac{3}{2}}$$

where C_s is chosen to be the Smagorinsky constant.

Lh : various formulation tested in ALARO
in AROME with $C_s=0.2$...

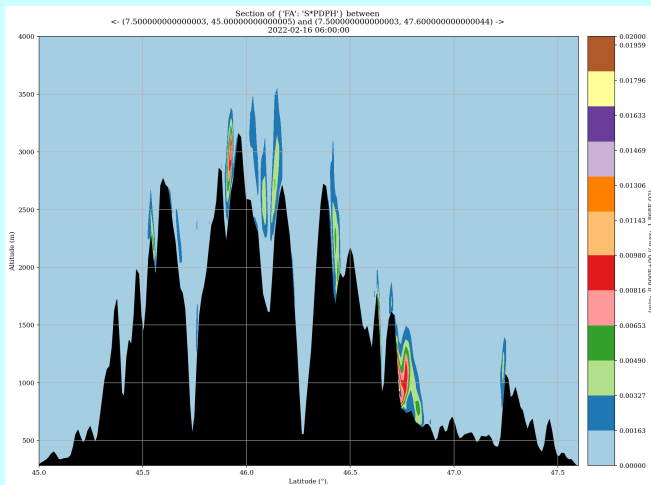
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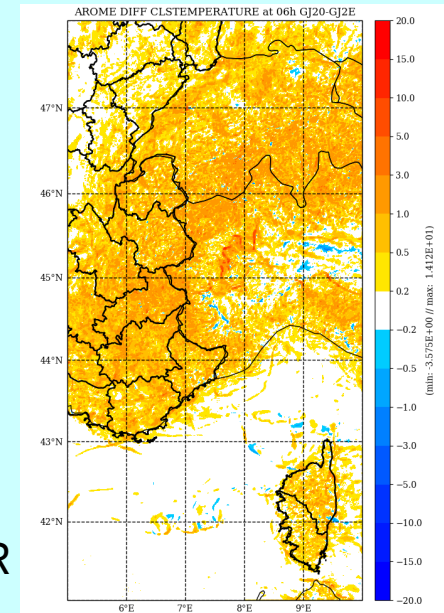
where C_s is chosen to be the Smagorinsky constant.

Prod Horiz 20220216 +06h
With dyn oper



Lh : various formulation tested in ALARO in AROME with $C_s=0.2$...

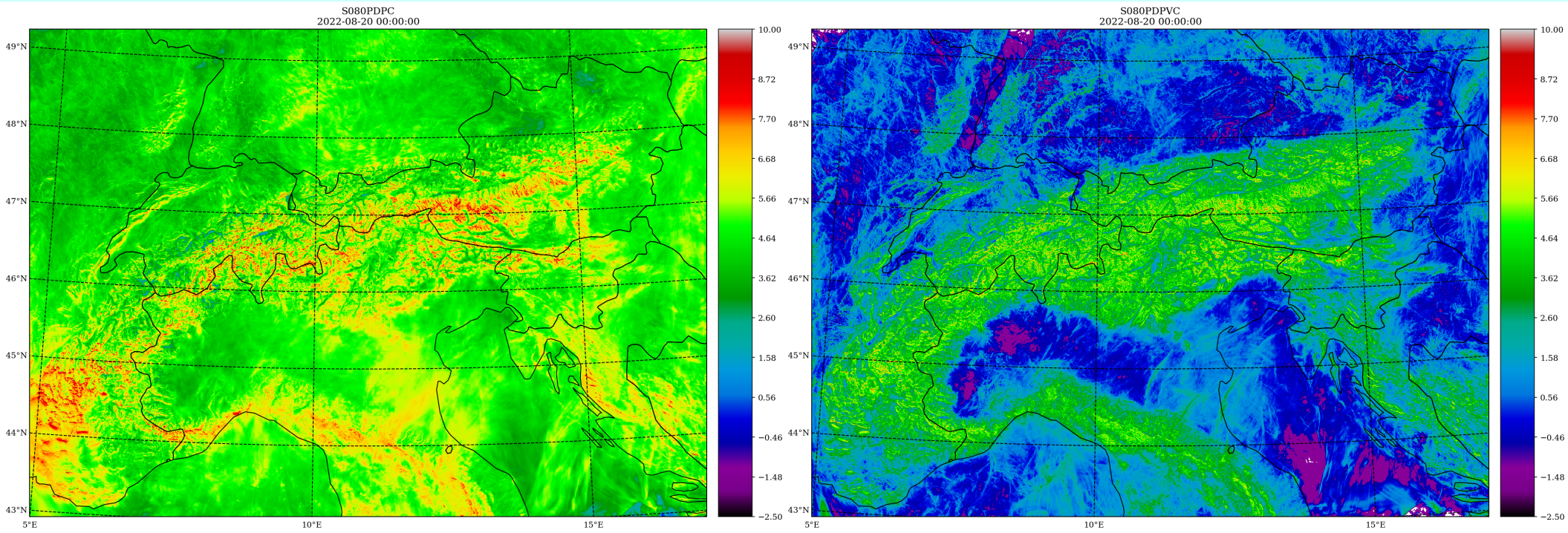
For the period 5-16 Feb 2022
Mean impact on T2m at 6UTC in AROME-FR



AROME-500m : TKE Dynamical production (GLOR)

log(total accumulated DP 48h) @ S080

log(horiz. accumulated DP 48h) @ S080

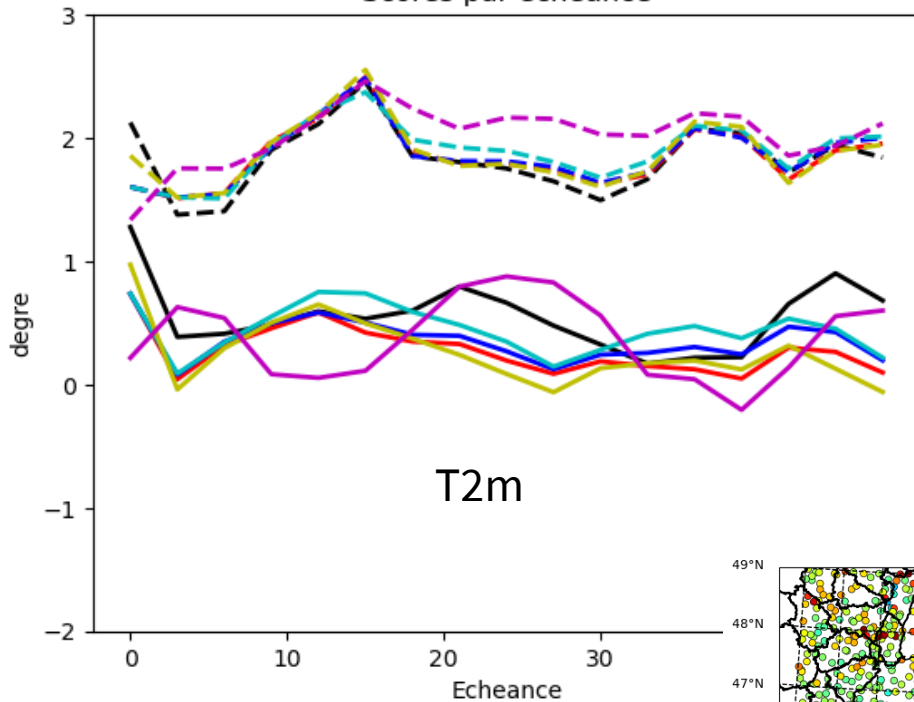


horiz. Accumulated Dynamical Production 48h @ S080 < 10% Total DP

AROME-500m : Skill score T2m and 10m wind 18-20 August 2022

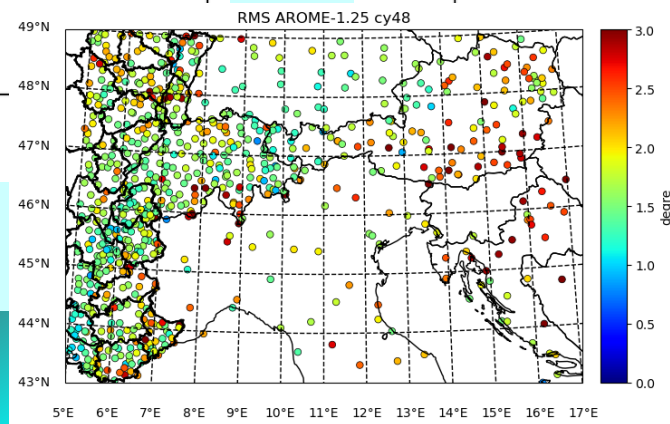
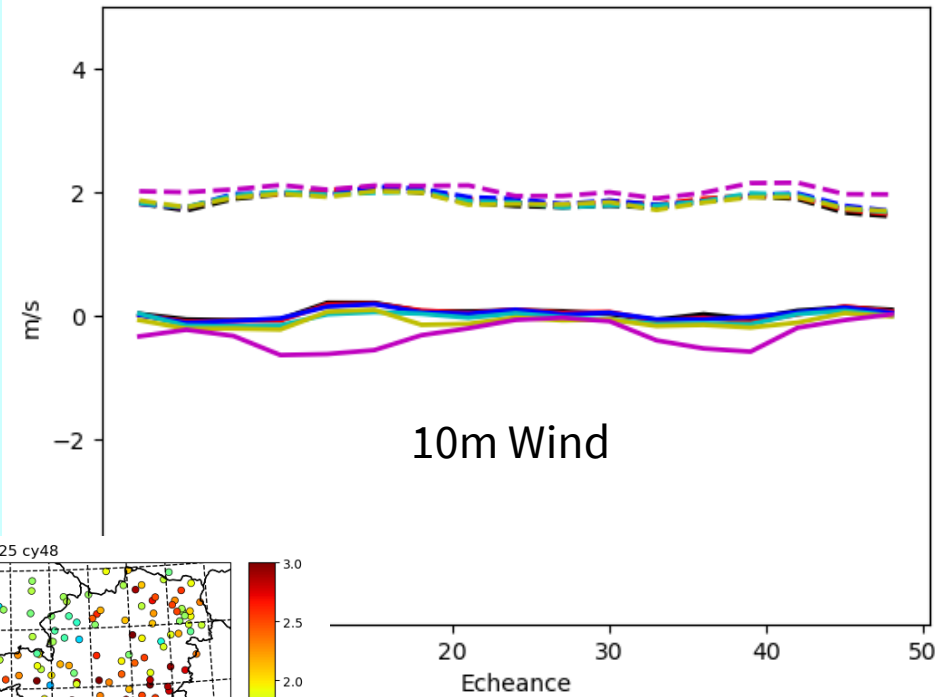
- Biais ARO-500-S-G-30s-L120
- - Rms ARO-500-S-G-30s-L120
- Biais ARO-500-Cubic2
- - Rms ARO-500-Cubic2
- Biais ARO-500-Cubic
- - Rms ARO-500-Cubic
- Biais ARO-500-S-G
- - Rms ARO-500-S-G
- Biais AROME-1.25 cy48
- - Rms AROME-1.25 cy48
- Biais ARPEGE
- - Rms ARPEGE

Scores par echeance

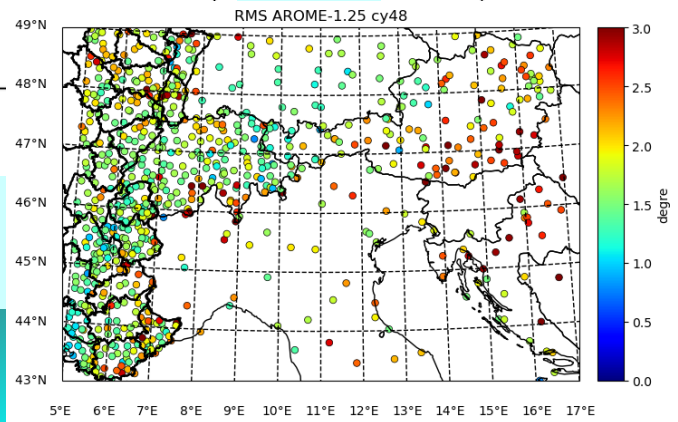
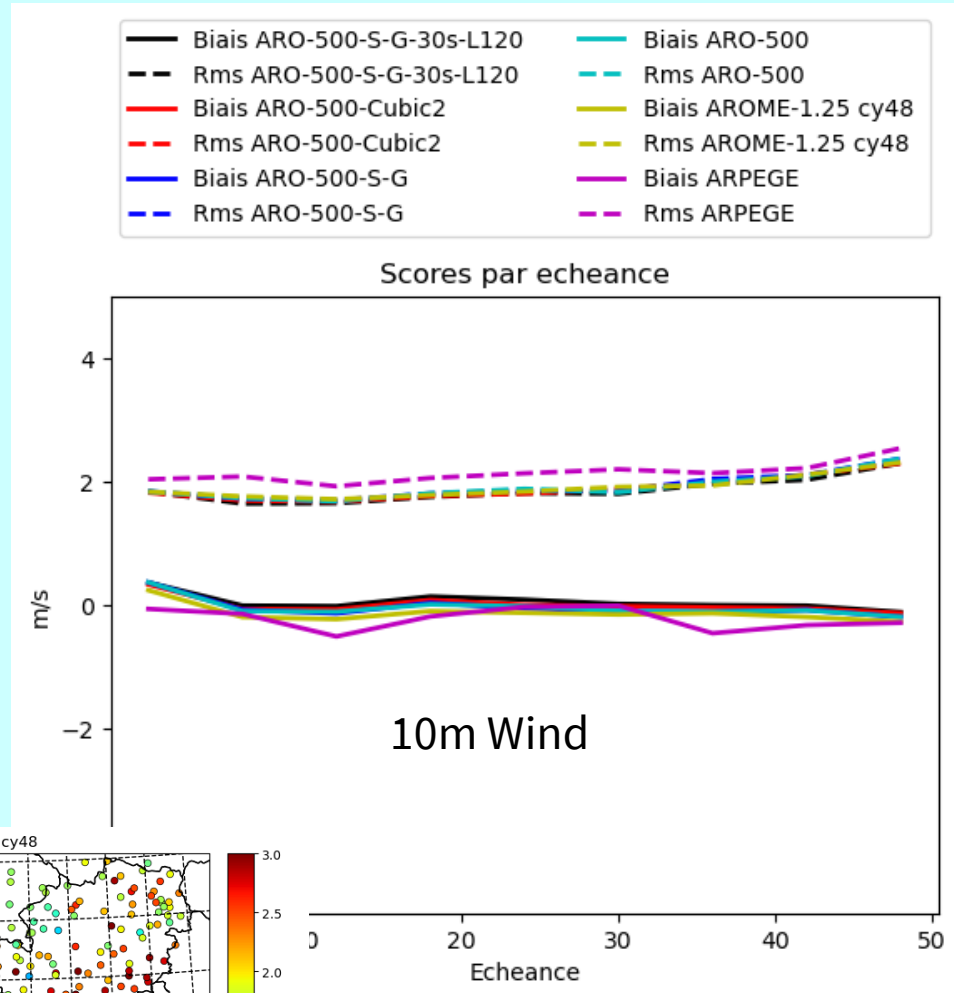
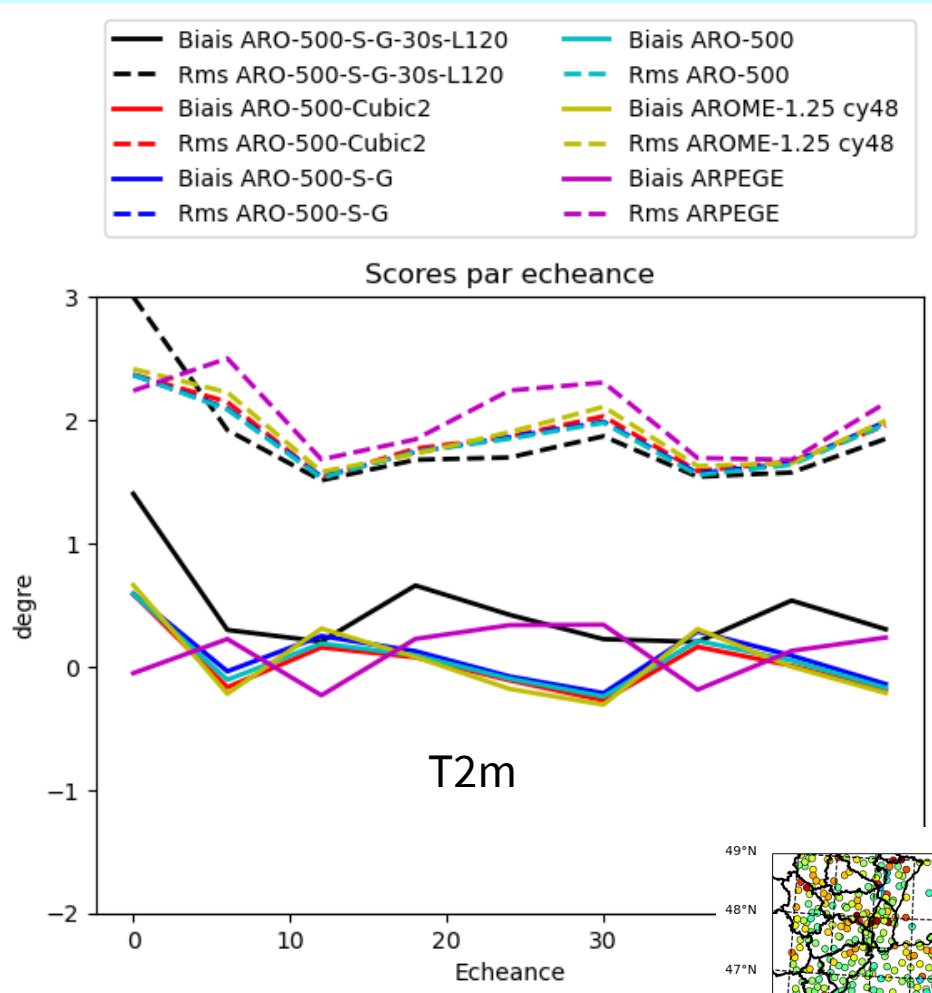


- Biais ARO-500-S-G-30s-L120
- - Rms ARO-500-S-G-30s-L120
- Biais ARO-500-Cubic2
- - Rms ARO-500-Cubic2
- Biais ARO-500-Cubic
- - Rms ARO-500-Cubic
- Biais ARO-500-S-G
- - Rms ARO-500-S-G
- Biais AROME-1.25 cy48
- - Rms AROME-1.25 cy48
- Biais ARPEGE
- - Rms ARPEGE

Scores par echeance

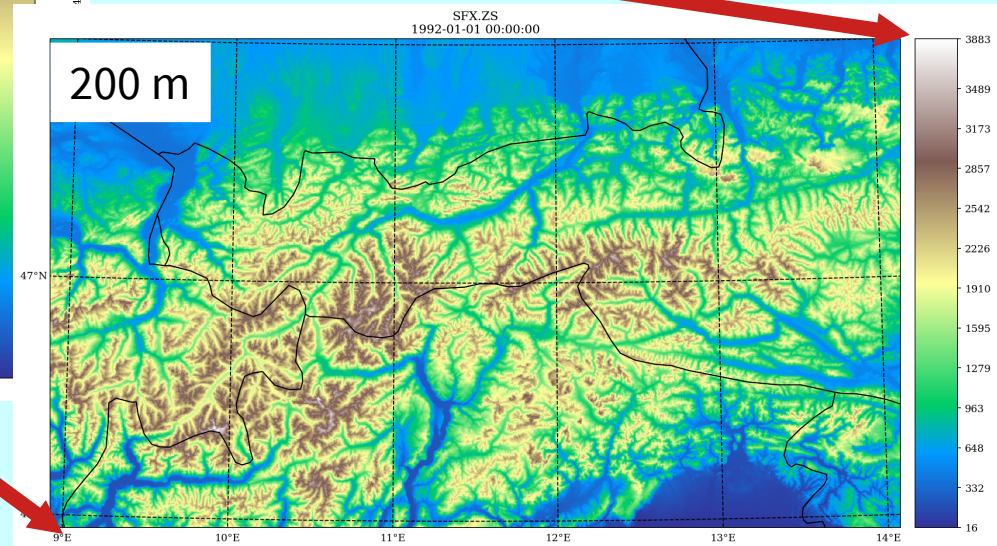
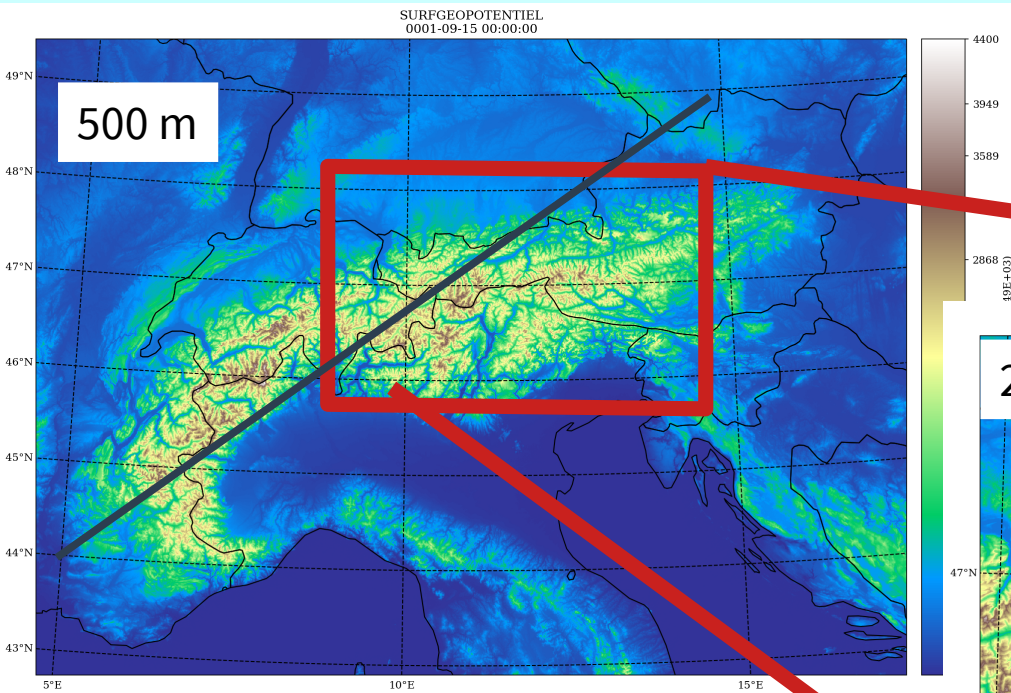


AROME-500m : Skill score T2m and 10m wind 01-03 November 2022



AROME 200m : 2000x 1152 L90 focus on the Innsbruck Valley

200 m : 2000x1152 grid points
linear or cubic grid with two
input orography GTOPO30 and
SW3s



Experiments : 2 dates 18/08/2022 and 03/11/2022

AROME-200m L90 (2000x1152) LBC and init from AROME-1.25km:

green Ok for the 2 dates Orange OK ONLY for 18/08/20022 2days forecast

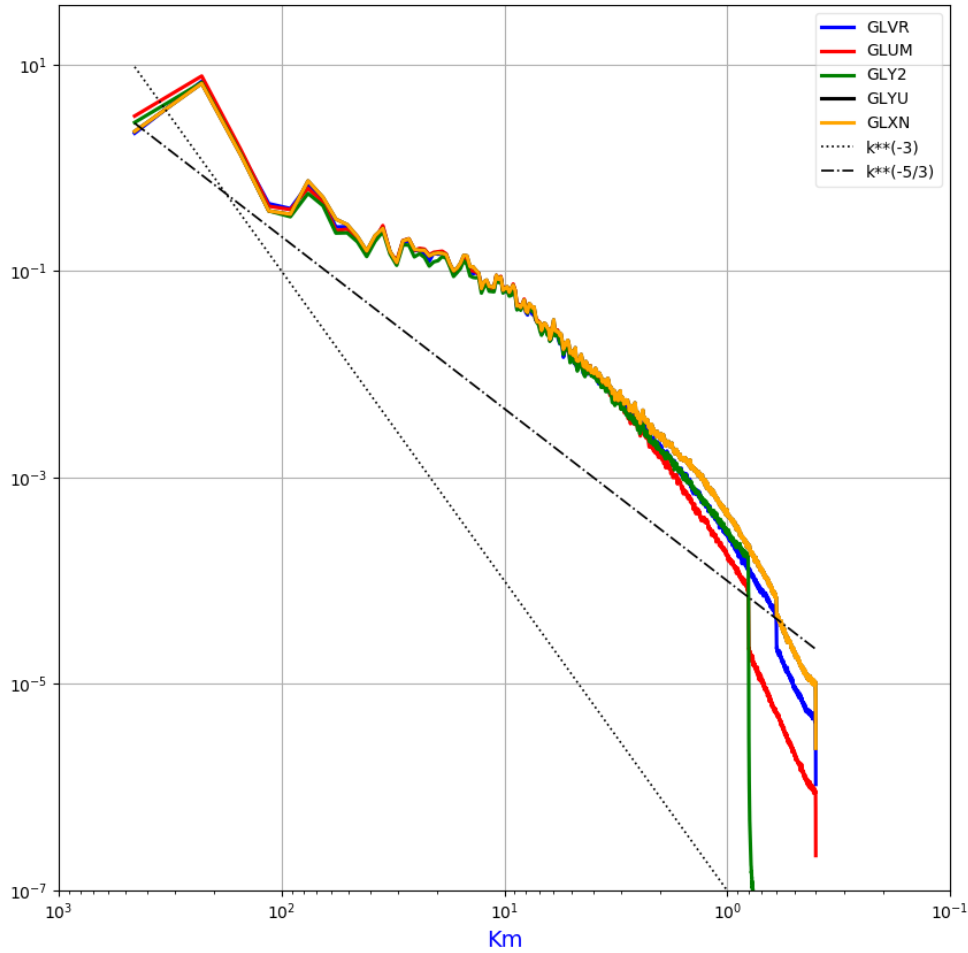
| | dt | Shal XCMF | Goger | Rayt | SITRA | SIPR | NSITER | CHEAP | FULL | Spec | TEI |
|-----------------|-----|-----------|-------|------|-------|-------|--------|-------|------|------|-------|
| GLSH | 5s | 0.01 | yes | 800s | 10 | 60000 | 1 | F | T | Def | x10,4 |
| GLXN | 5s | 0.01 | yes | 800s | 10 | 60000 | 1 | F | T | Mod | x10,4 |
| GLYU | 5s | 0.01 | NO | 800s | 10 | 60000 | 1 | F | T | Mod | x9.9 |
| GLUM cubic | 10s | 0.01 | yes | 800s | 50 | 90000 | 1 | F | T | Mod | x5,4 |
| GLY2 3j cubic*2 | 8s | 0.01 | yes | 800s | 10 | 60000 | 2 | F | T | Mod | x8,0 |
| GLYW cubic*2 | 8s | 0.01 | NO | 800s | 10 | 60000 | 2 | F | T | Mod | x7,6 |
| GLVR 3j | 6s | 0.01 | yes | 960s | 10 | 60000 | 2 | F | T | Def | x11,8 |

GLSH crashes after 1h50 for the November case

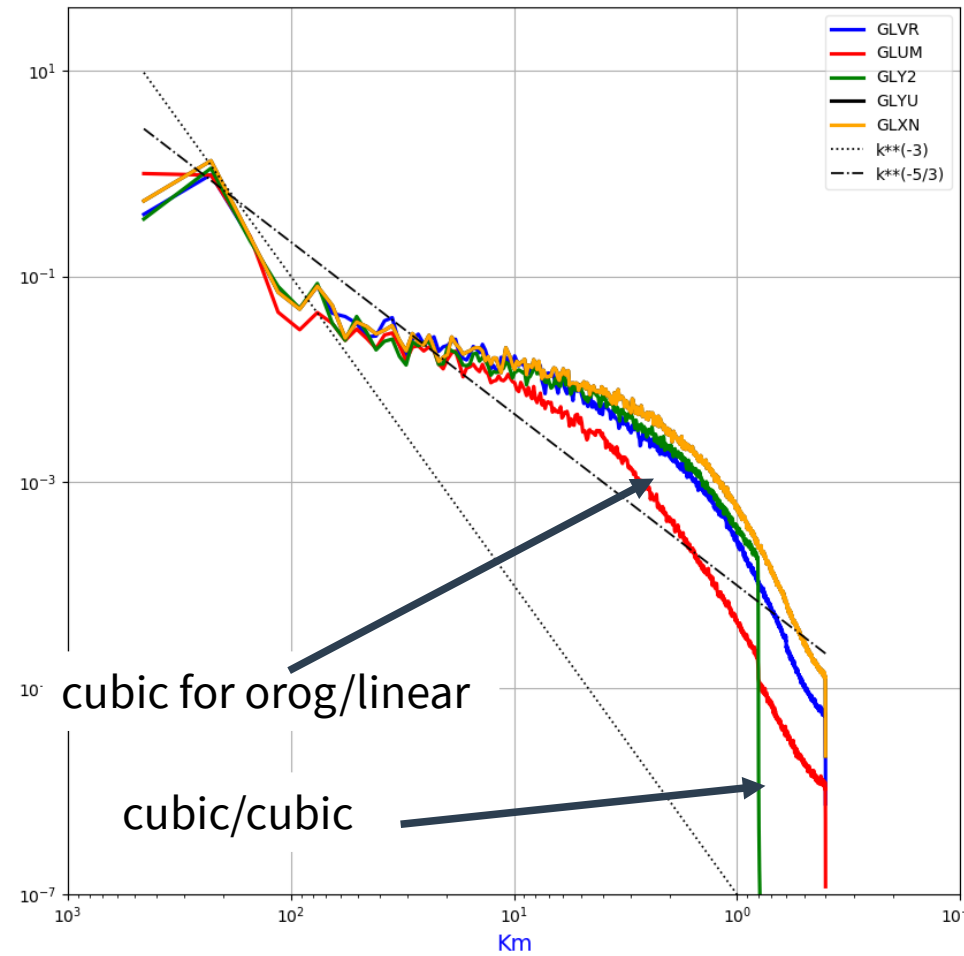
GLUM crashes at 30h many smilag under and out of atmo ...for the November case

AROME-200m : Temperature spectrum 48h

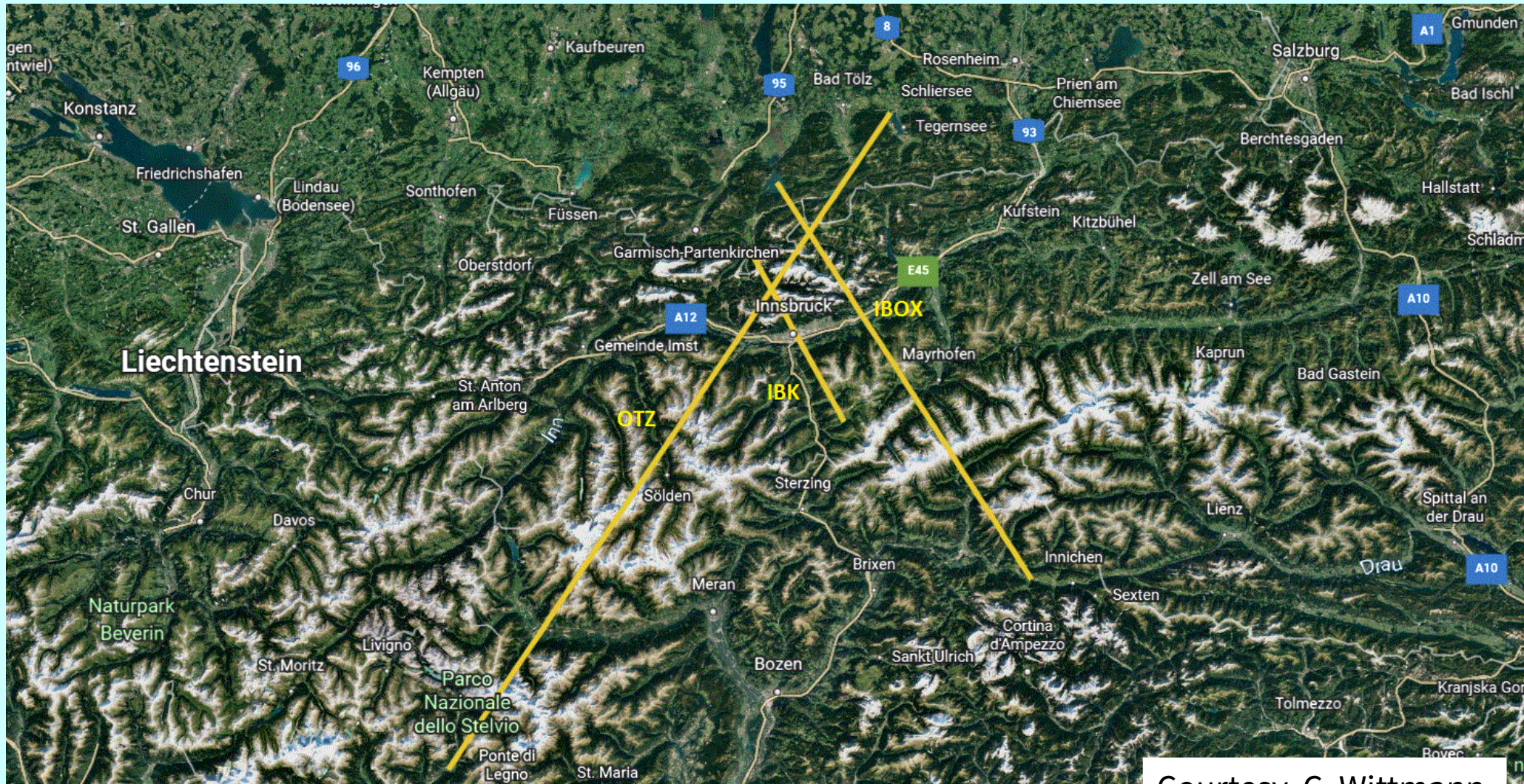
S070TEMPERATURE



S020TEMPERATURE



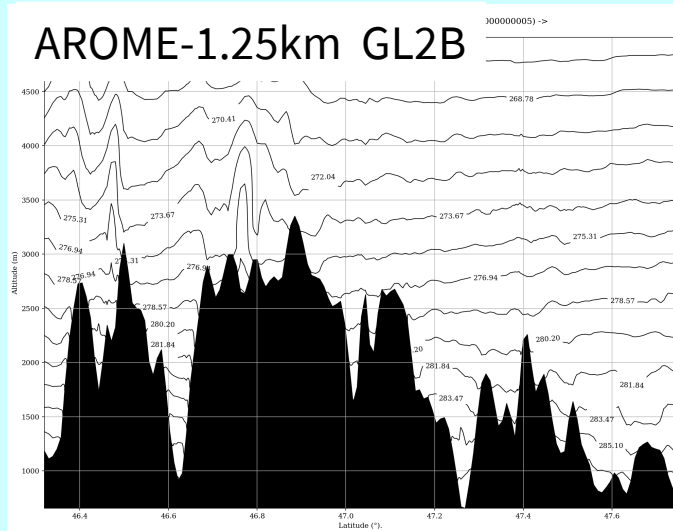
18 August 2022 00h: Cross section



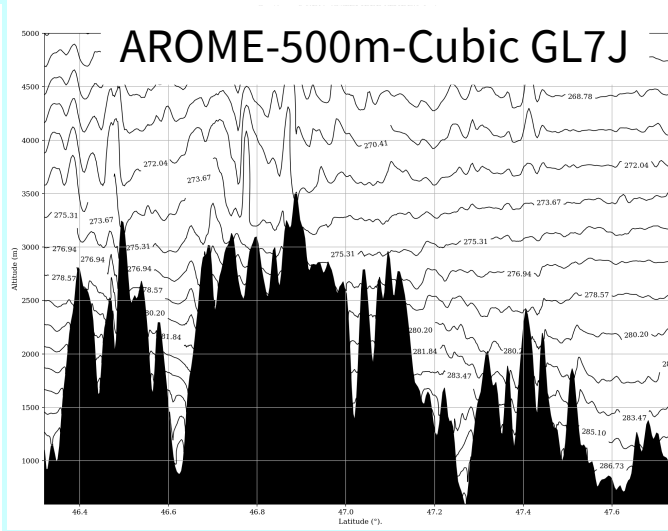
Courtesy C. Wittmann

18 August 2022 00h: Cross section OTZ PBL

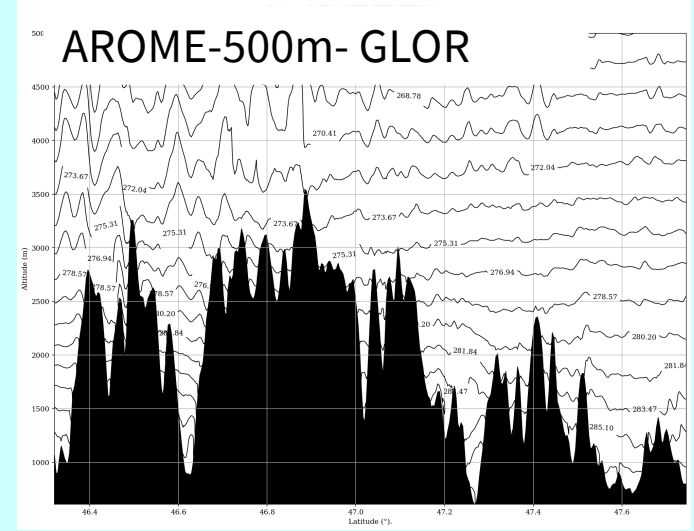
AROME-1.25km GL2B



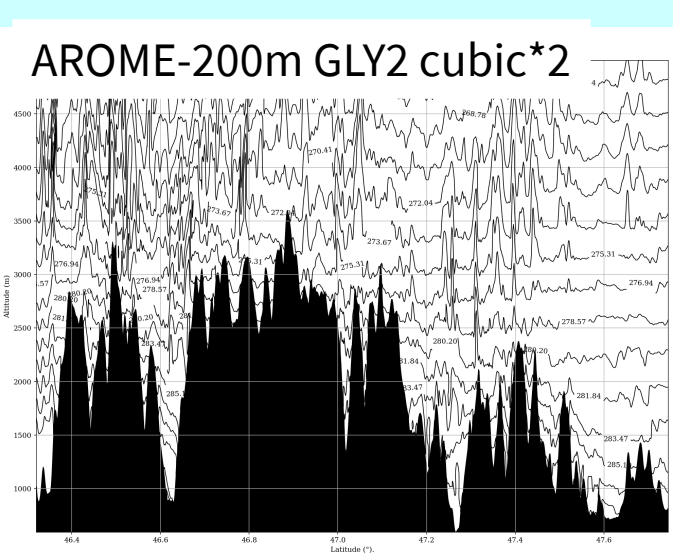
AROME-500m-Cubic GL7J



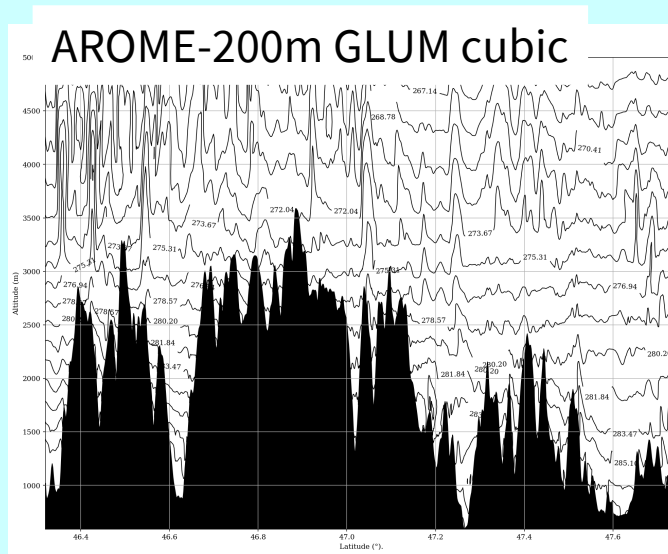
AROME-500m- GLOR



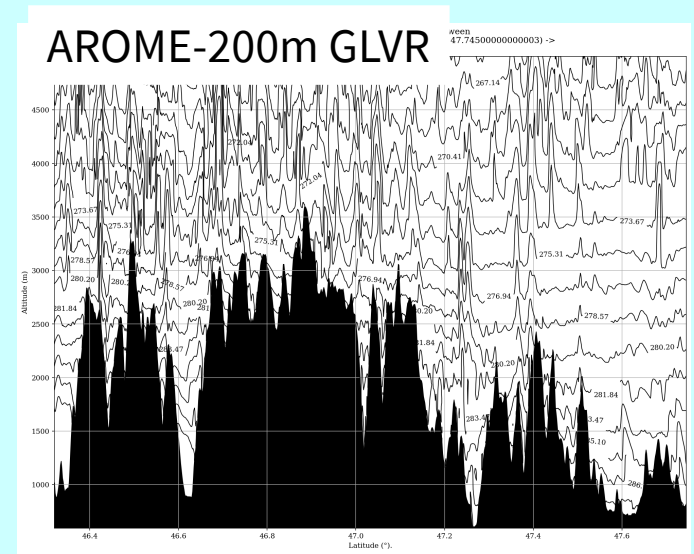
AROME-200m GLY2 cubic*2



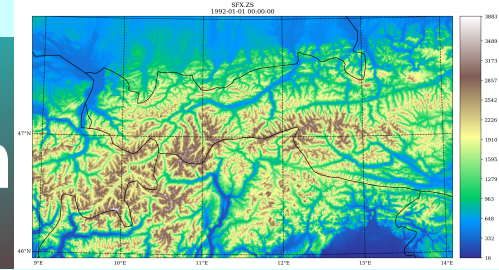
AROME-200m GLUM cubic



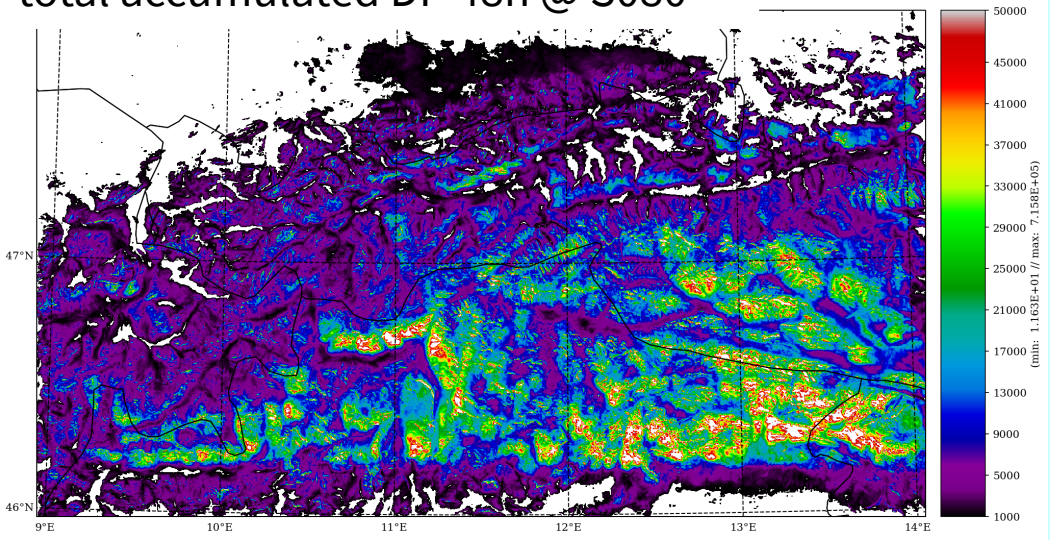
AROME-200m GLVR



AROME-200m : TKE Dynamical production

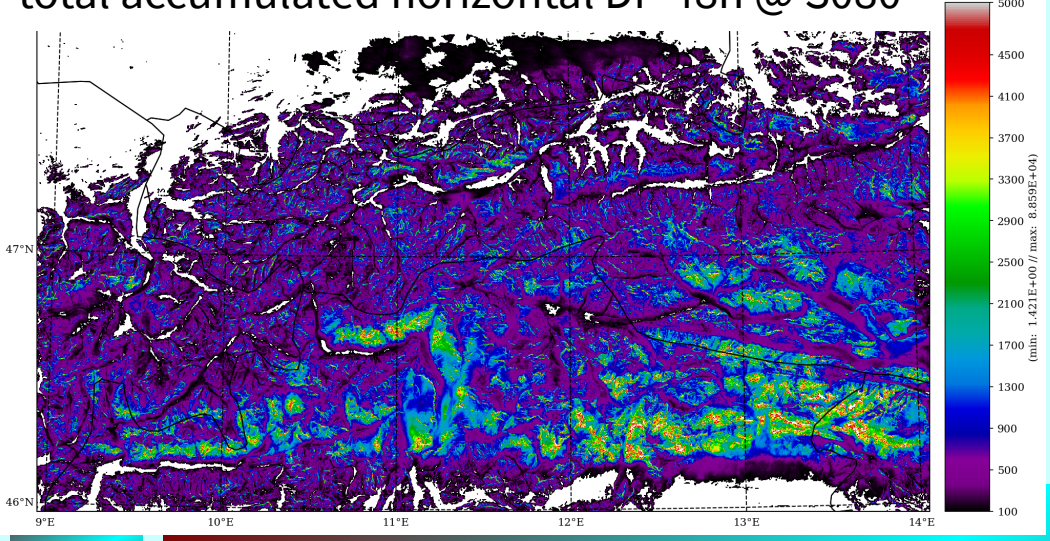


total accumulated DP 48h @ S080

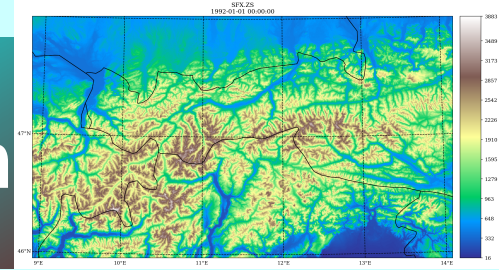


total accumulated DP 48h @ S080

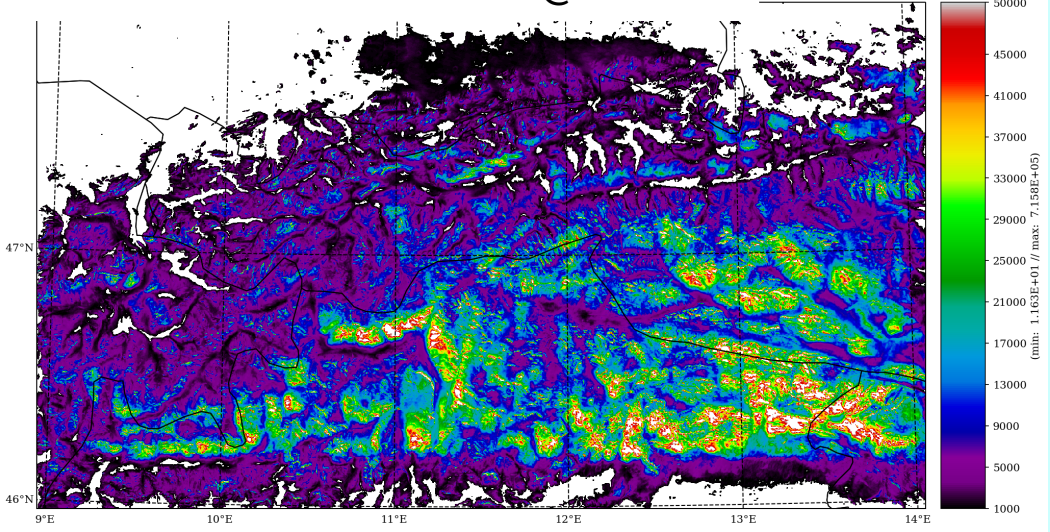
total accumulated horizontal DP 48h @ S080



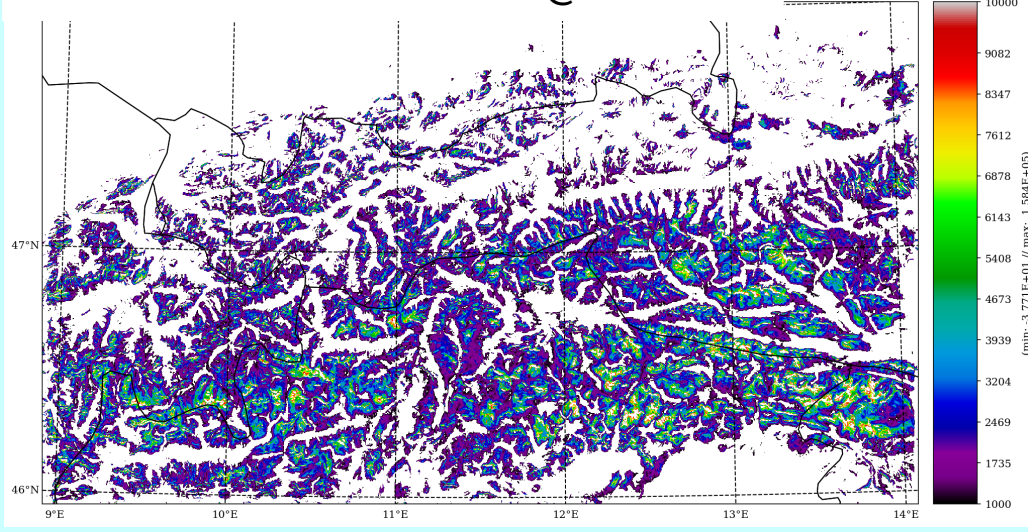
AROME-200m : TKE Dynamical production



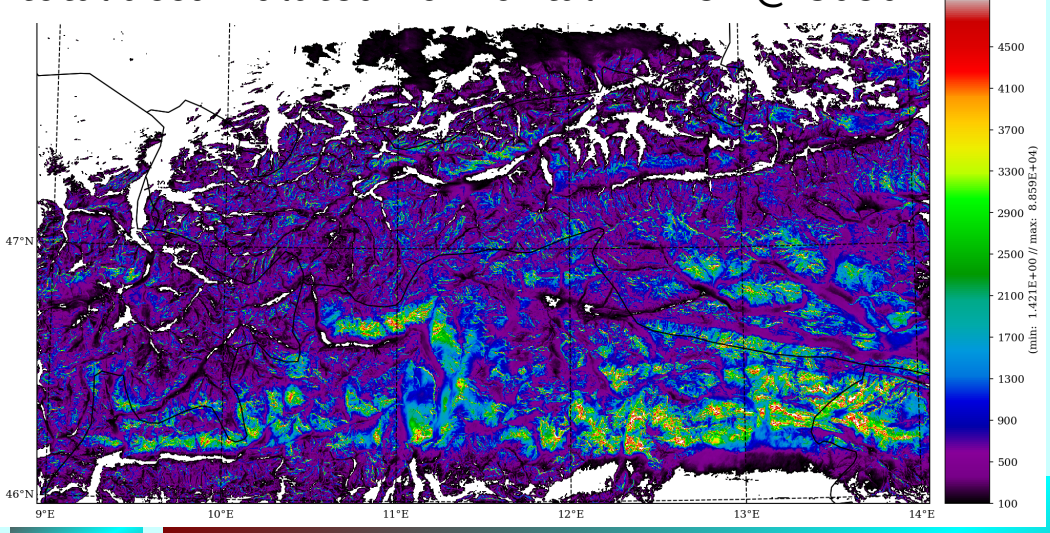
total accumulated DP 48h @ S080



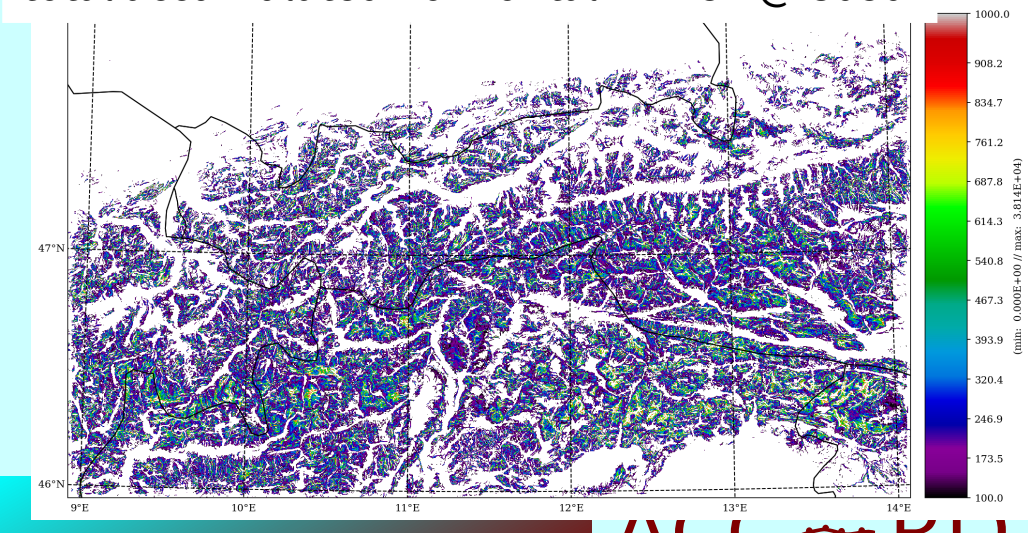
total accumulated DP 48h @ S080



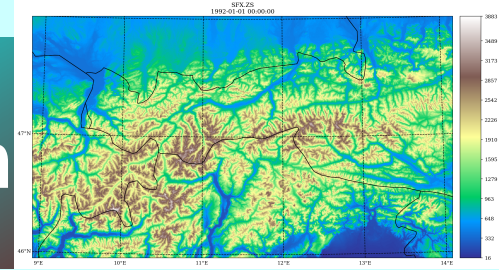
total accumulated horizontal DP 48h @ S080



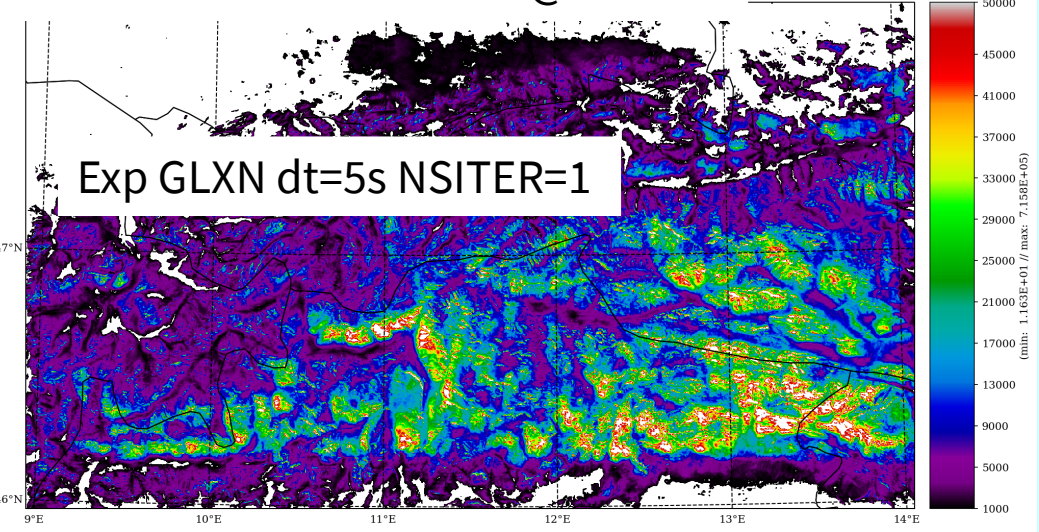
total accumulated horizontal DP 48h @ S080



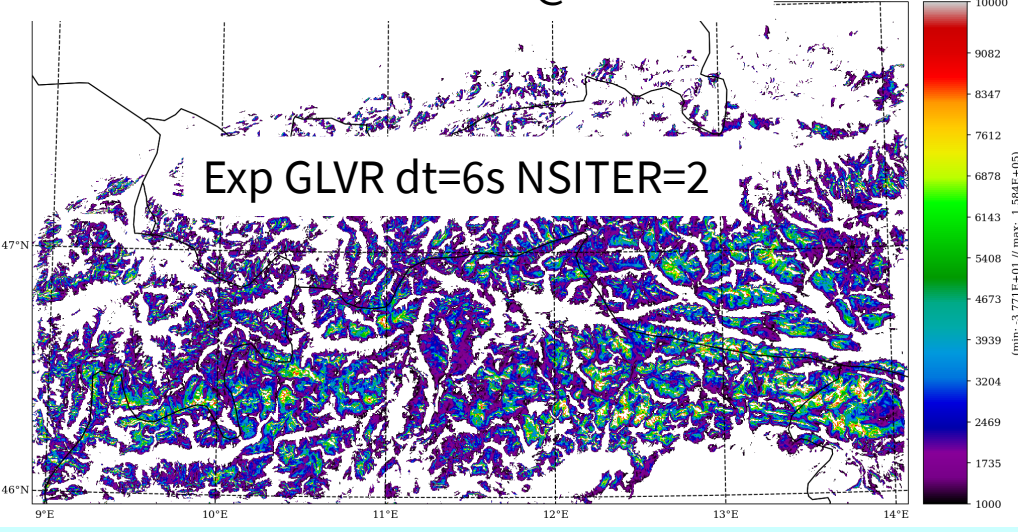
AROME-200m : TKE Dynamical production



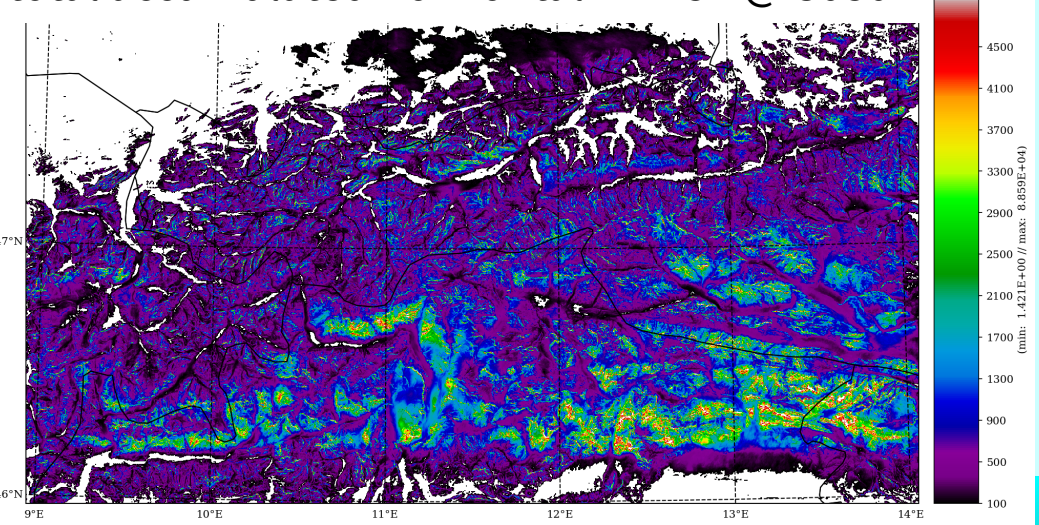
total accumulated DP 48h @ S080



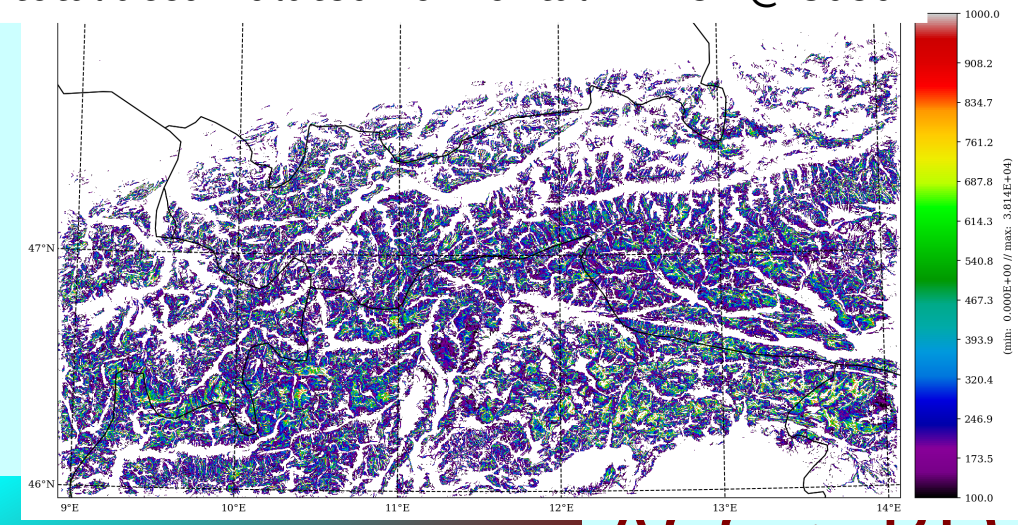
total accumulated DP 48h @ S080



total accumulated horizontal DP 48h @ S080

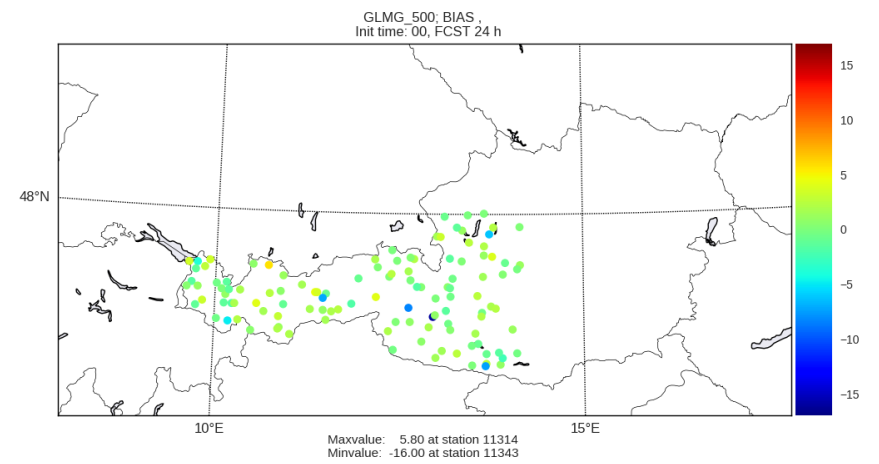
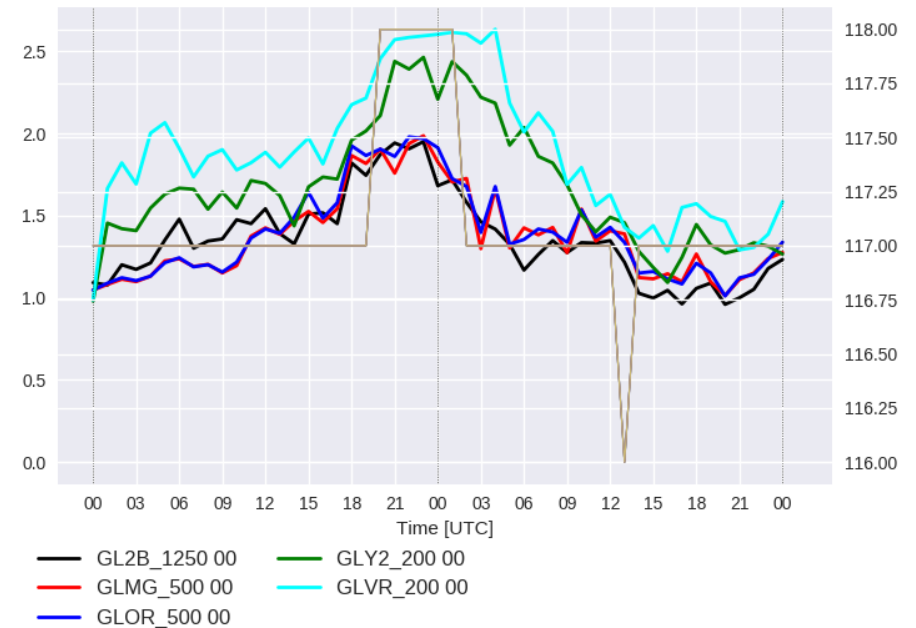


total accumulated horizontal DP 48h @ S080



3 November 2022 : 10m Wind Speed

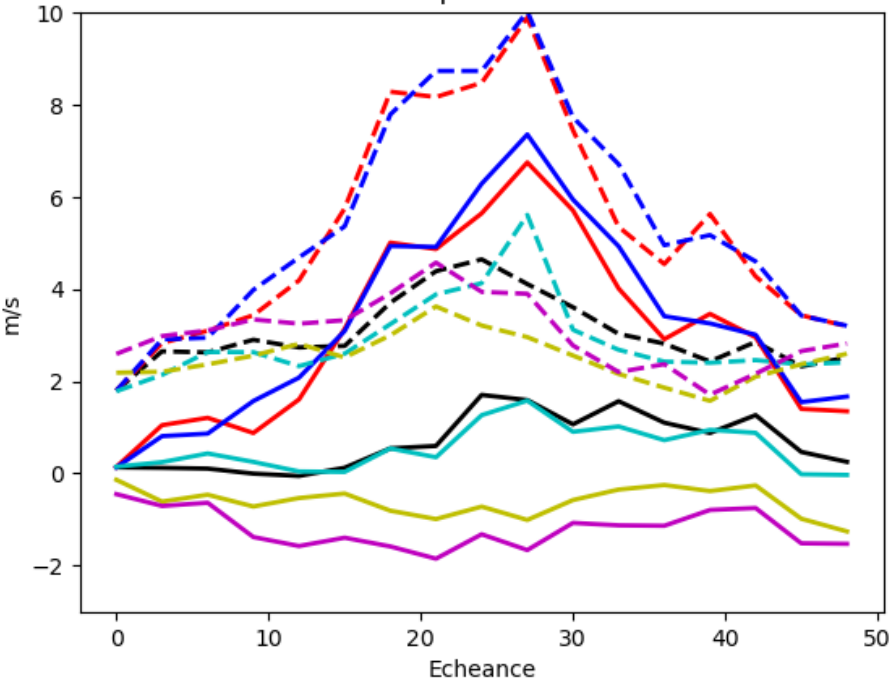
10m_wind: Mean MAE from: 20221103 to 20221103



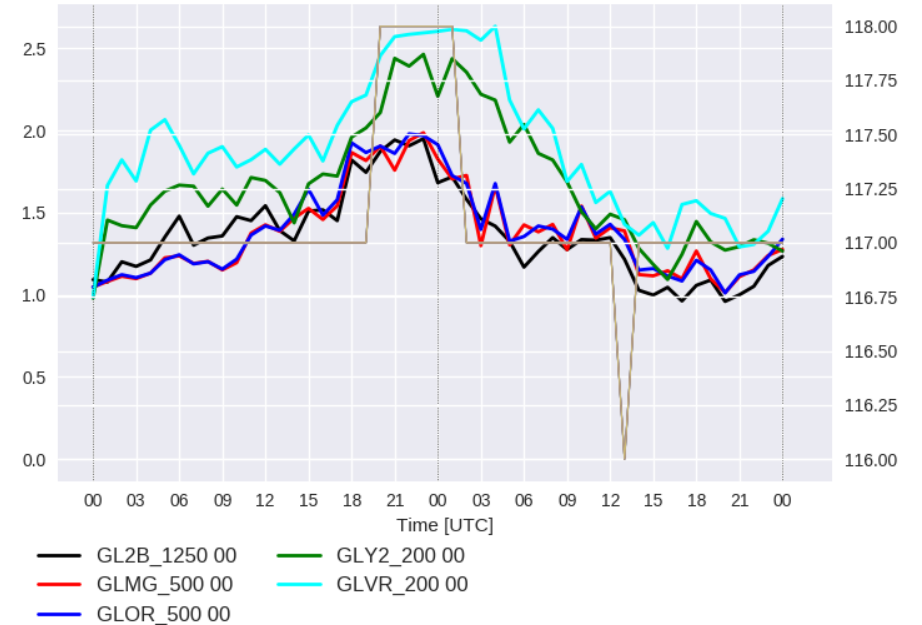
3 November 2022 : 10m Wind Speed

- Biais AROME-200m S+G 2
- - Rms AROME-200m S+G 2
- Biais AROME-200m Shal
- - Rms AROME-200m Shal
- Biais AROME-200m Shal-Gog
- - Rms AROME-200m Shal-Gog
- Biais AROME-200m Cubic-Shal-Gog
- - Rms AROME-200m Cubic-Shal-Gog
- Biais AROME-1.25 cy48
- - Rms AROME-1.25 cy48
- Biais ARPEGE
- - Rms ARPEGE

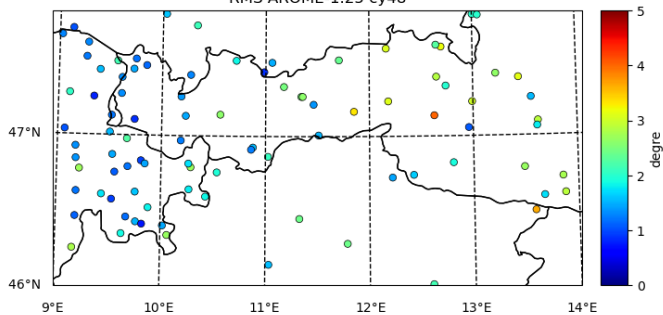
Scores par echeance



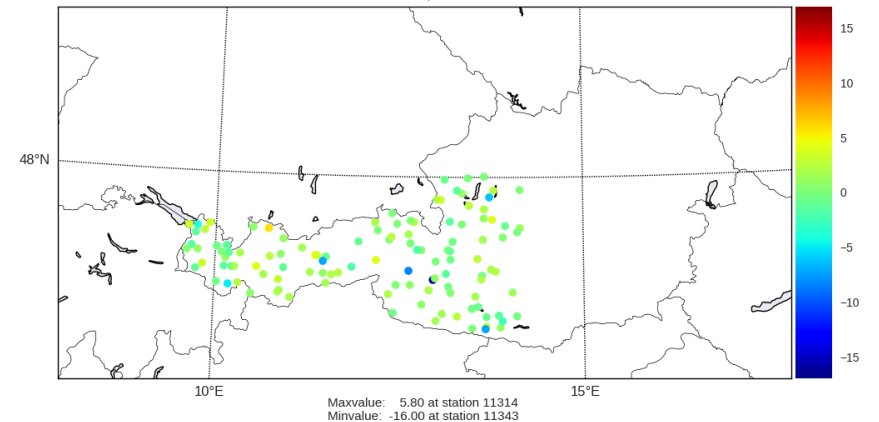
10m_wind: Mean MAE from: 20221103 to 20221103



RMS AROME-1.25 cy48



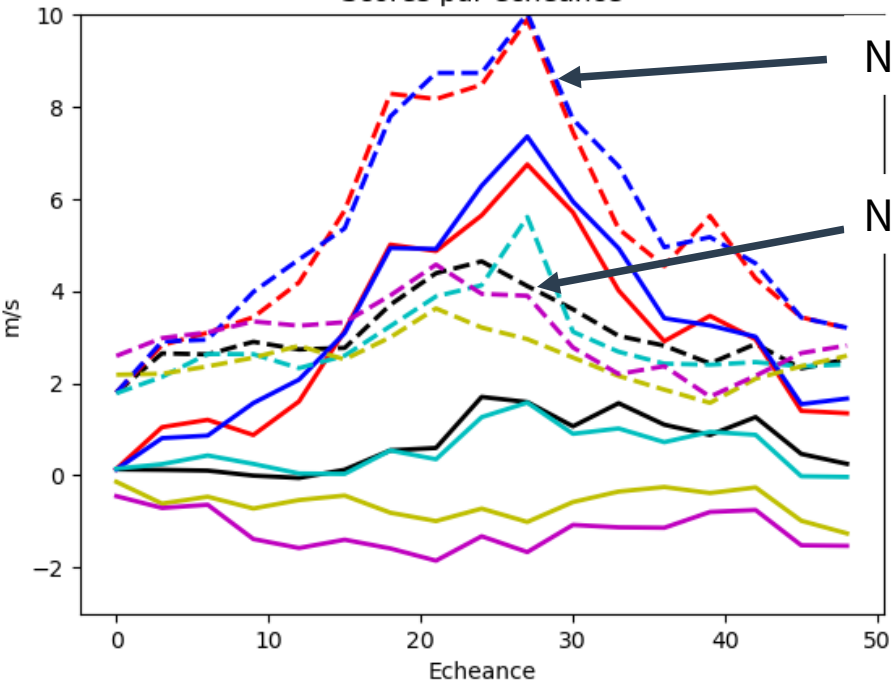
GLMG_500_BIAS
Init time: 00, FCST 24 h



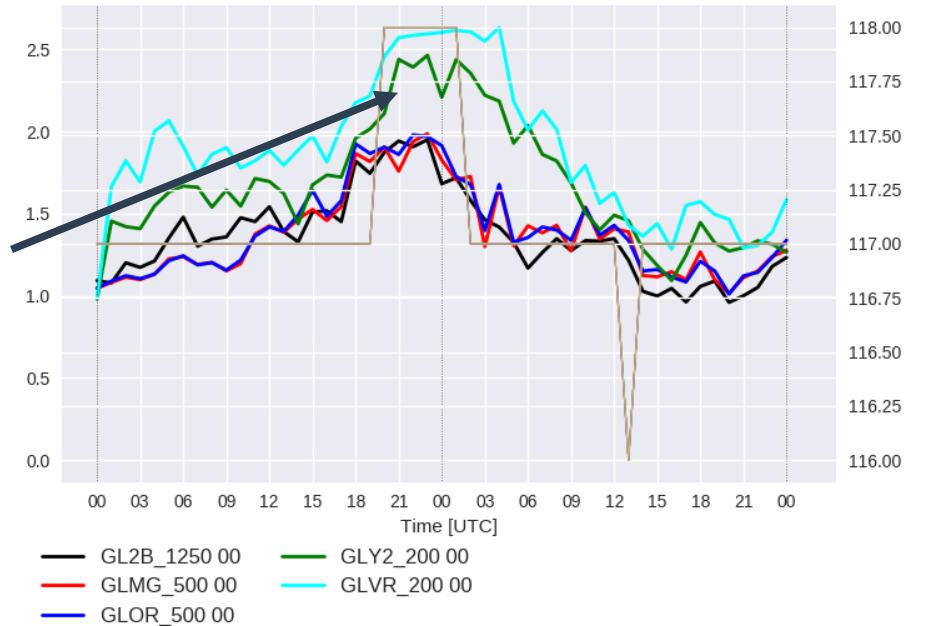
3 November 2022 : 10m Wind Speed

- Biaisi AROME-200m S+G 2
- - Rms AROME-200m S+G 2
- Biaisi AROME-200m Shal
- - Rms AROME-200m Shal
- Biaisi AROME-200m Shal-Gog
- - Rms AROME-200m Shal-Gog
- Biaisi AROME-200m Cubic-Shal-Gog
- - Rms AROME-200m Cubic-Shal-Gog
- Biaisi AROME-1.25 cy48
- - Rms AROME-1.25 cy48
- Biaisi ARPEGE
- - Rms ARPEGE

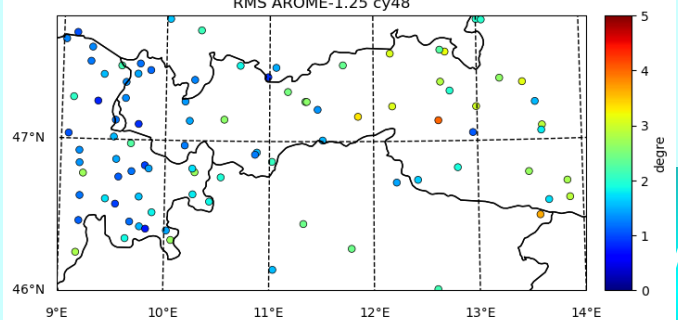
Scores par echeance



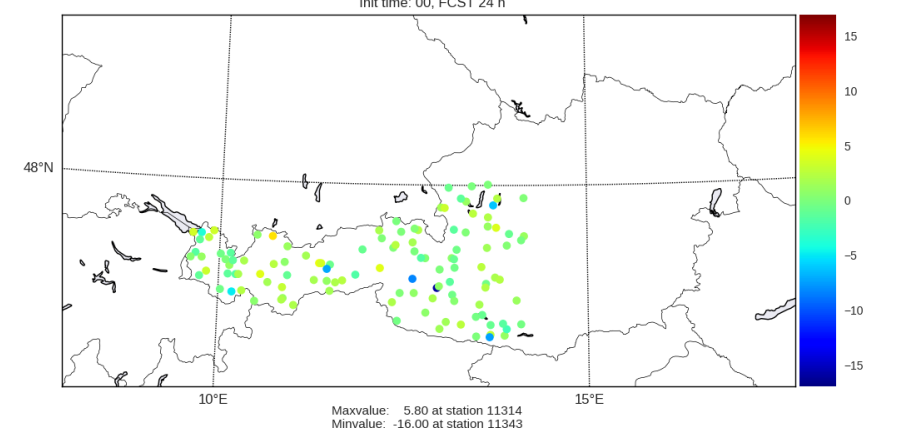
10m_wind: Mean MAE from: 20221103 to 20221103



RMS AROME-1.25 cy48

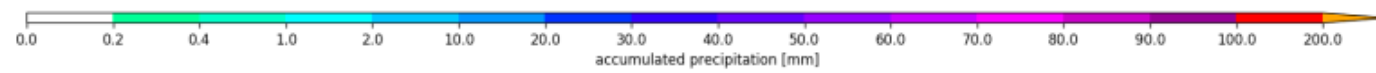
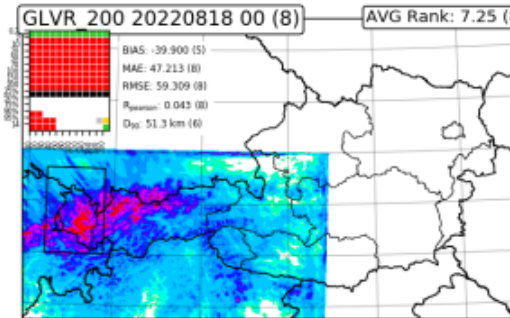
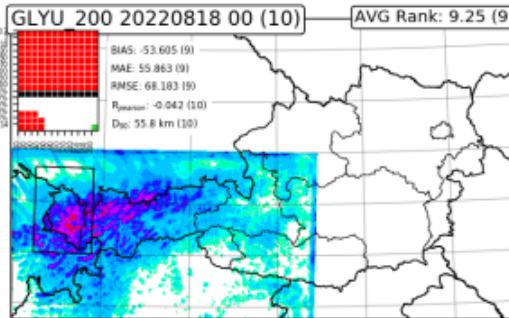
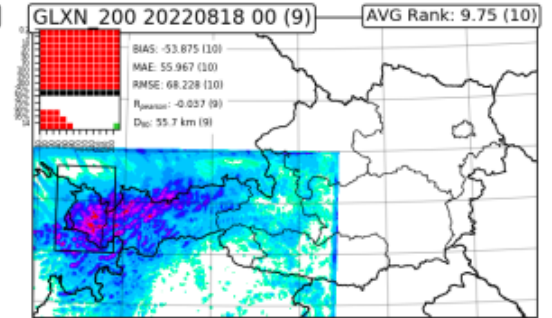
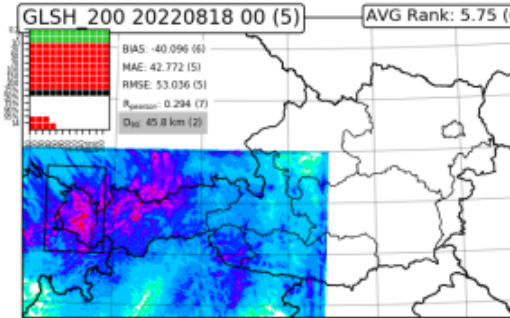
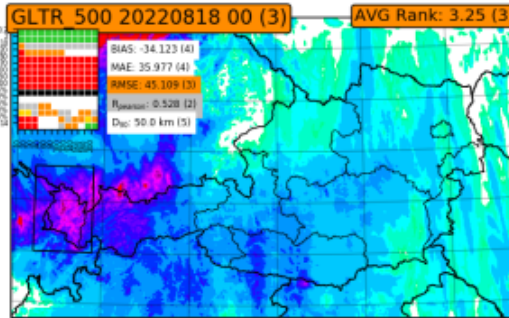
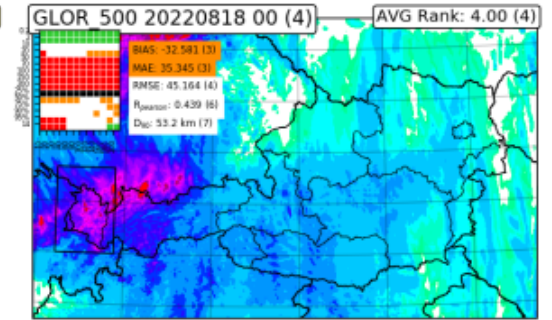
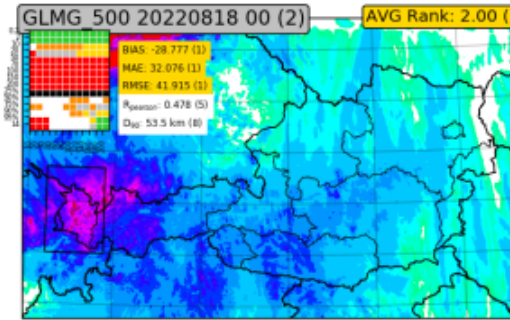
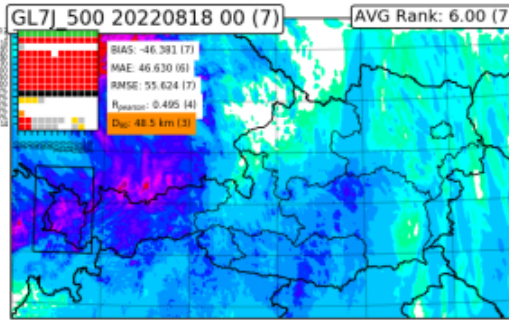
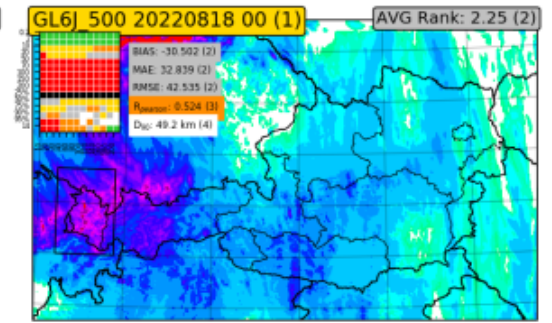
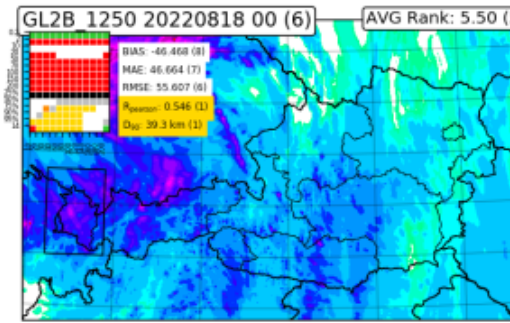
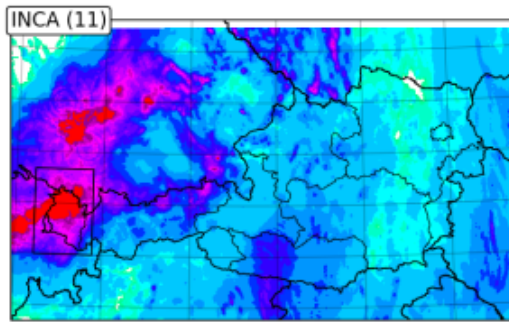


GLMG_500_BIAS
Init time: 00, FCST 24 h



18 August 2022

Acc. Precip. [mm] from 20220819 00 to 20220820 00 UTC



Some preliminary conclusions :

- @ 500m :
 - difficult to show the added value .. vs 1.25 km at least with 2 short periods
 - Small impact of the Goger term however we can expect more impact in stable boundary condition with more mixing probably with new tuning for Rimax and surface
 - Small improvement with the 120 levels but need SITRA=50 compared to the set up used in AROME-500m over Paris
 - Cubic grid neutral impact and cheaper but below 2km no “useful” information except at the surface
- @ 200m
 - Need SITRA=10 (less accurate), SIPR=60000, NSITER=2, LPC_CHEAP=F, dt =6s
 - In cubic grid possible to run with dt=8s
 - Suspicious of instability or noise in vertical cross section
 - Validation is not easy especially for the horizontal terms ... small scale vs noise
 - NSITER=2 with 6s significantly better than NSITER=1 and dt=5s at least for the November case

Now some questions :

- How to combine different grid for the orography, physics and dynamic
- In Meteo-France AROME use quadratic+ linear , In Harmonie-AROME : orography is filtered
- Several combination :
 - Orog : Quadra or Cubic
 - Model : Linear or cubic
 - Radiation on a coarser grid with a different time stepping (small impact)
 - Quid of the horizontal terms with a cubic grid ? No problem of consistency ?
 - **With a cubic grid → output fields only at 4 dx ! below no information except at the surface**
 - **Do we need patches in SURFEX @ 200m if radiation is running on a coarser grid ?**

Side meeting on 3D physics today at 16h30