Regional Cooperation for
Limited Area Modeling in Central Europe

LACE
nwp central europe

ALARO-1 experience in Hungary

ALARO-1 WD 12-14 September 2016 Brussels

Hungarian Meteorological Service
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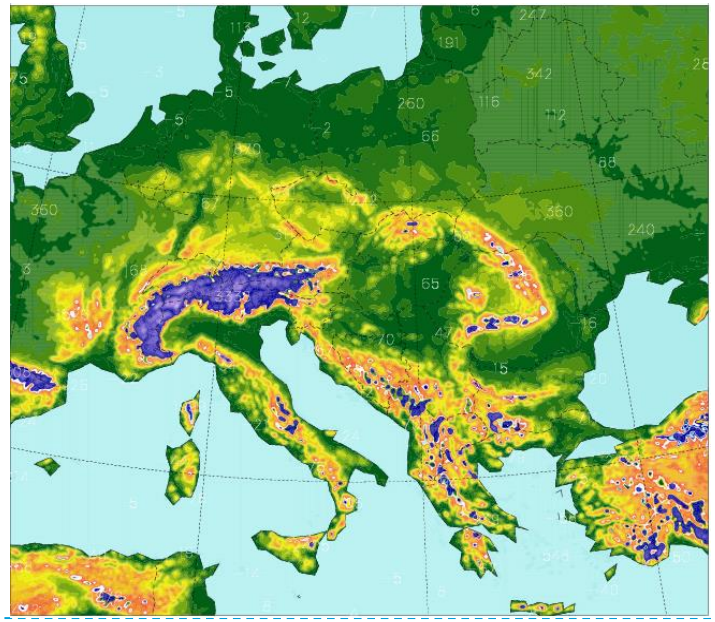
Contests

- Our operational model configuration
- 'Versions' of ALARO we have used:
  - General overview about the updates of cycles and ALARO versions
  - **Verification results of changing from ALARO-0-baseline to ALARO-1**
- Local settings and problematic parts:
  - **Negative BIAS in 2meter temperature**
  - Positive BIAS in wind and wind gust
  - Local namelist modifications in cloud diagnostics

Operational model configuration

- 'Deterministic' system:
  - With data assimilation
  - Coupled to IFS
  - ALARO is operational since March, 2012
  - Later represented scores are from the verification of this system
- Ensemble system:
  - Dynamical adaptation of the first 11 members

  from PEARP
  - ALARO is operational since November, 2011
- Resolution:
  - 8km horizontal
  - 49 vertical levels
  - 300s time steps



Updates in our system

Cy33 with old settings of ALADIN

Update was in March, 2012

Cy35 with an ALARO modset and namelist from Prague

Update was in September, 2013

Cy36 with ALARO-0-baseline version

Update was in September, 2015

Cy38 with ALARO-0-baseline version

Update was in August, 2016

Cy38 with ALARO-1

Update to ALARO-1

Cy38 with ALARO-0-baseline version

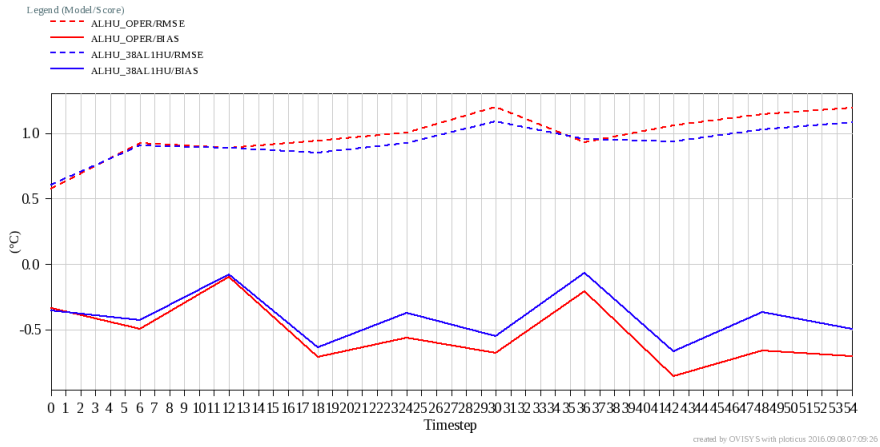
Cy38 with ALARO-1

Update was in August, 2016

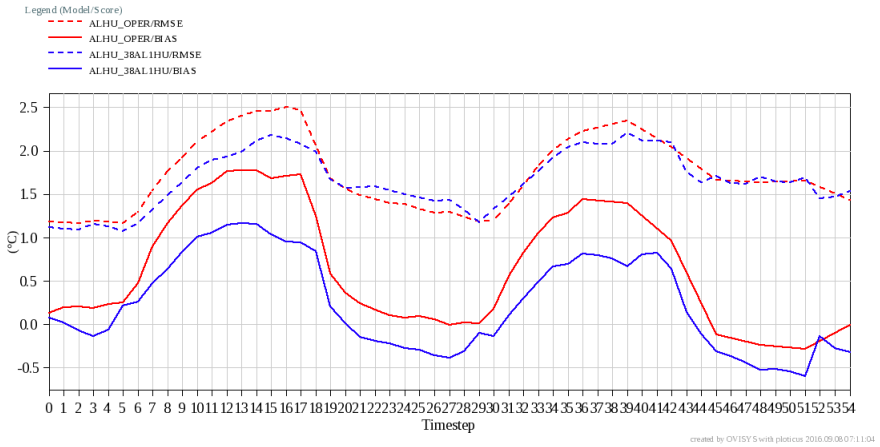
- **Results showed moderate impact on many variables:**
  - ALARO produced better scores in verification against radiosonde measurements;
  - 2meter dewpoint has been improved;
  - Significantly less cloudiness in average;
  - Slight increasement in wind gust on the top of an existing positive bias;
  - Smaller but more intense precipitation objects in comparison with radar measurements.

Update to ALARO-1

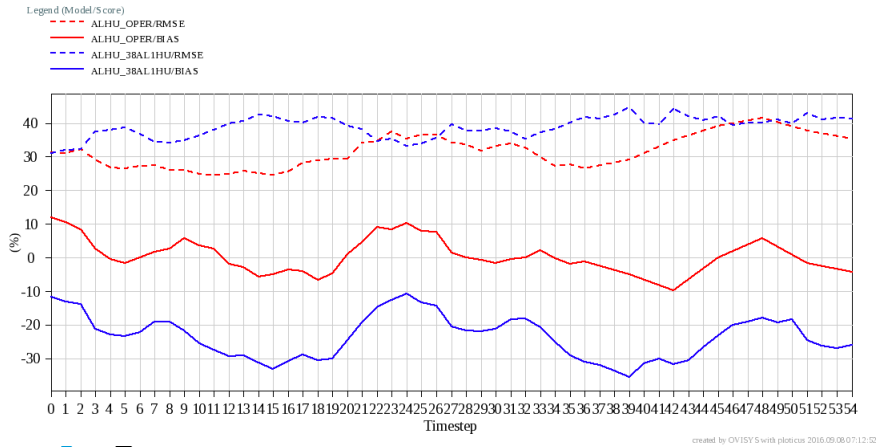
Period: **07/15/2016 - 07/31/2016**
Area: **ALADIN**
Variable: **Temperature (850 hPa)**
Runhour: **00**



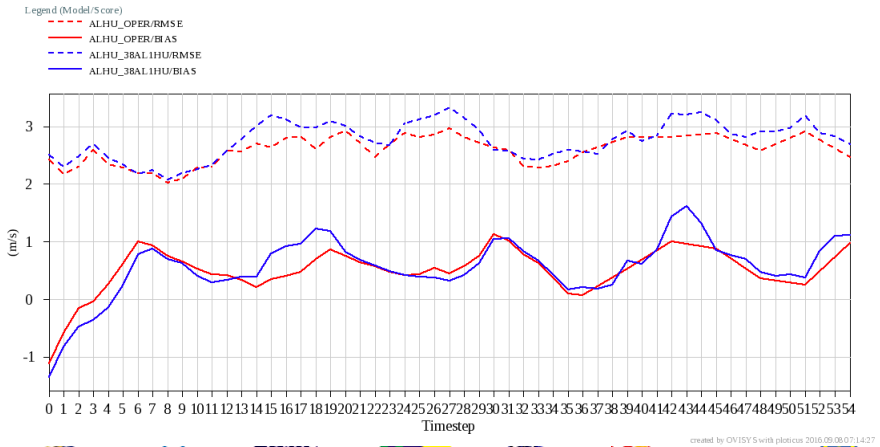
Period: **07/15/2016 - 07/31/2016**
Area: **HUN_ALL SYNOP max 400m**
Variable: **Dewpoint**
Runhour: **00**



Period: **07/15/2016 - 07/31/2016**
Area: **HUN_ALL SYNOP max 400m**
Variable: **Cloudiness**
Runhour: **00**

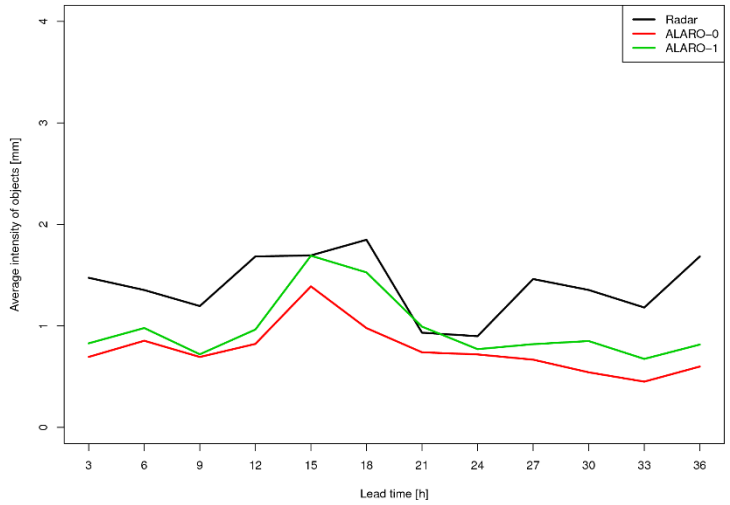


Period: **07/15/2016 - 07/31/2016**
Area: **HUN_ALL SYNOP max 400m**
Variable: **Wind gust**
Runhour: **00**

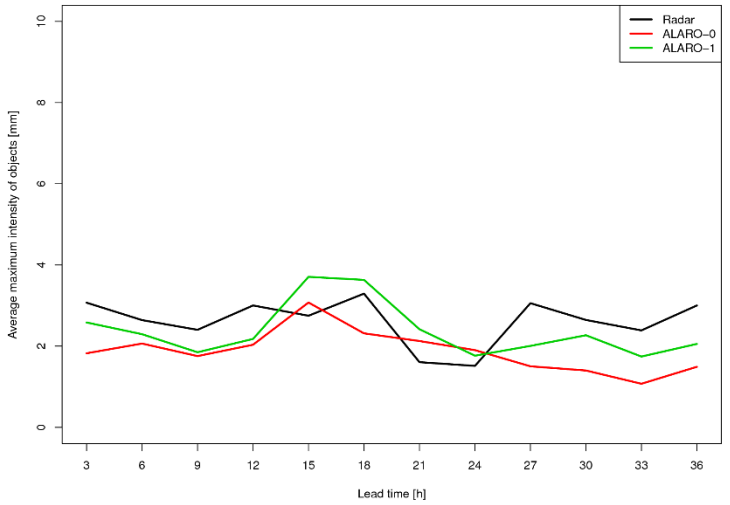


Update to ALARO-1

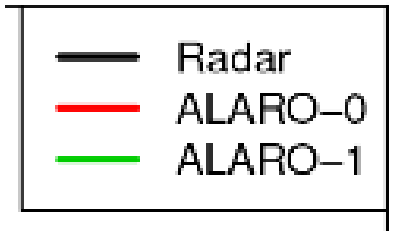
Average intensity of objects [mm]

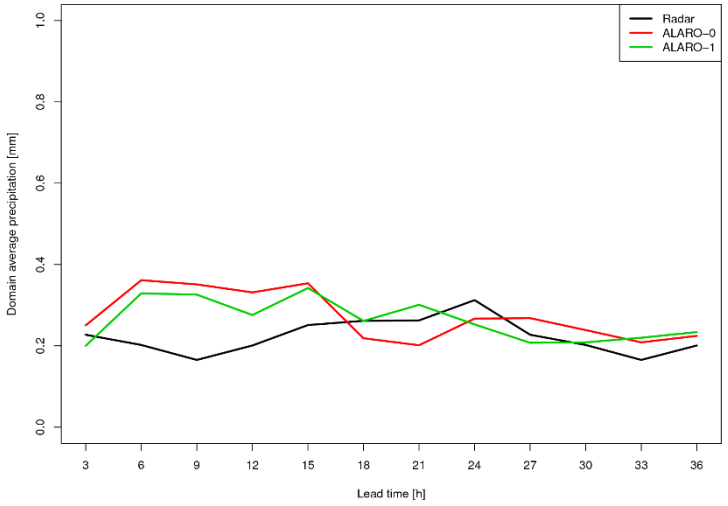


Average maximum intensity of objects [mm]



Domain average precipitation [mm]



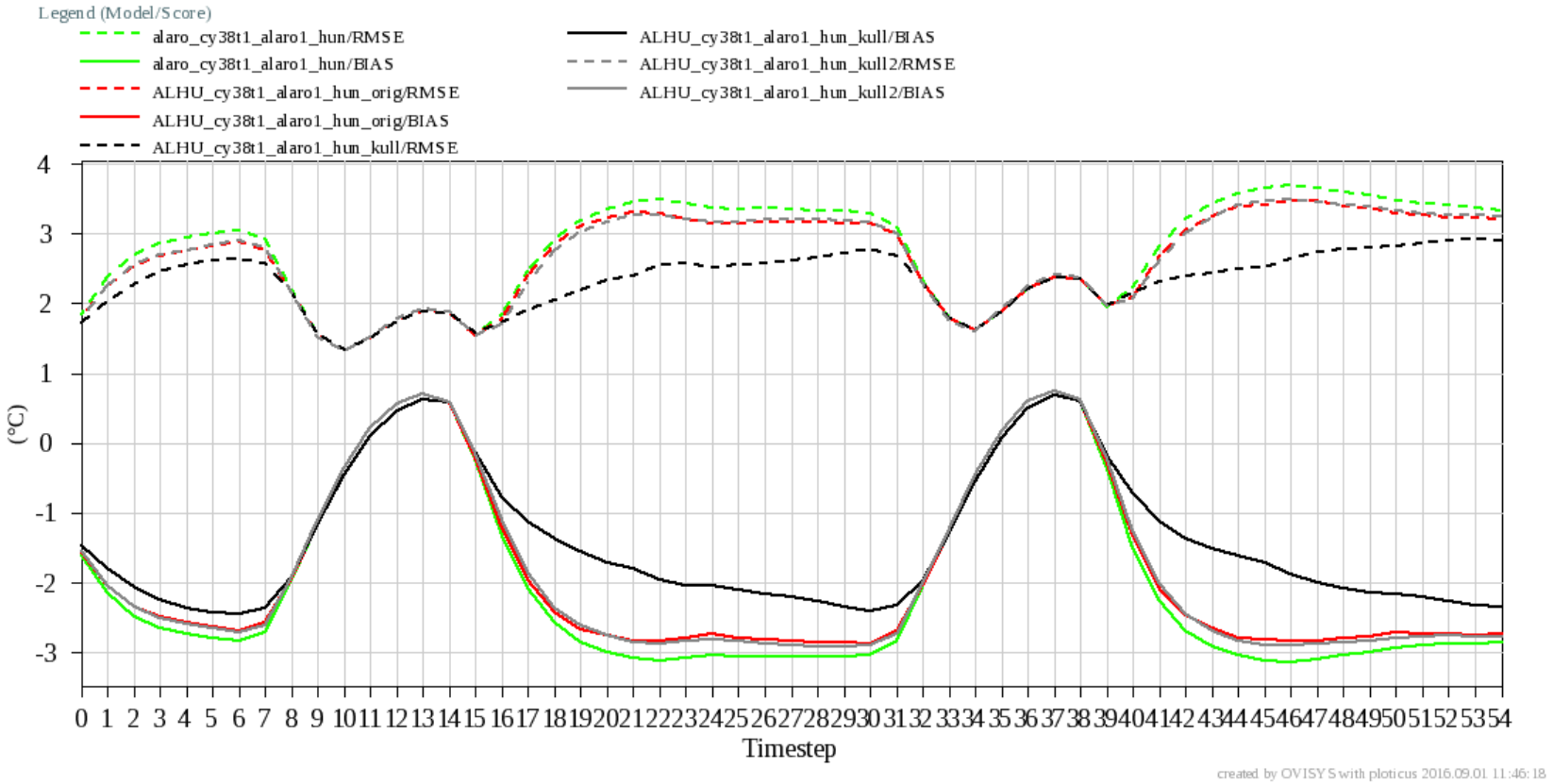


2m diagnostic

- Testing of methods for 2m interpolation:
  - New modset from LACE stay in Prague – Martin Dian, Ján Mašek (alaro1)
  - Original Geleyn + Kullmann - currently used (alaro1_orig)
  - Kullmann solution (alaro1_kull)
  - Upgraded Kullmann solution – Ri number dependent (alaro1_kull2)
- 2 type of RCTVEG (vegetation thermal coefficient)
  - HUN – $2.0*10^{-5}$
  - CZ – $0.8*10^{-5}$

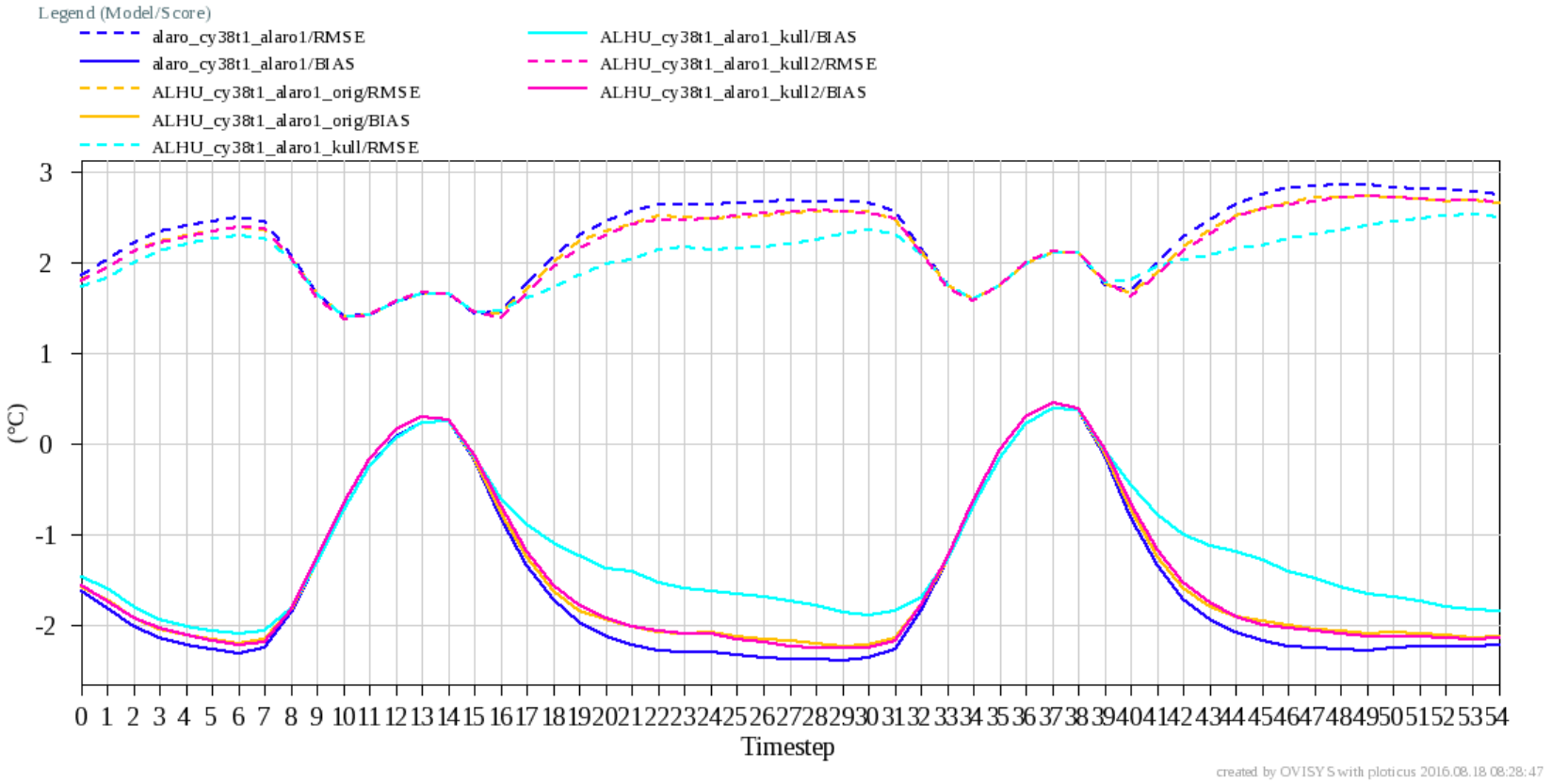
2m temperature (HUN RCTEG)

Period: **12/04/2015 - 12/10/2015**
Area: **HUN_ALL max 400m**
Variable: **Temperature (2m)**
Runhour: **00**



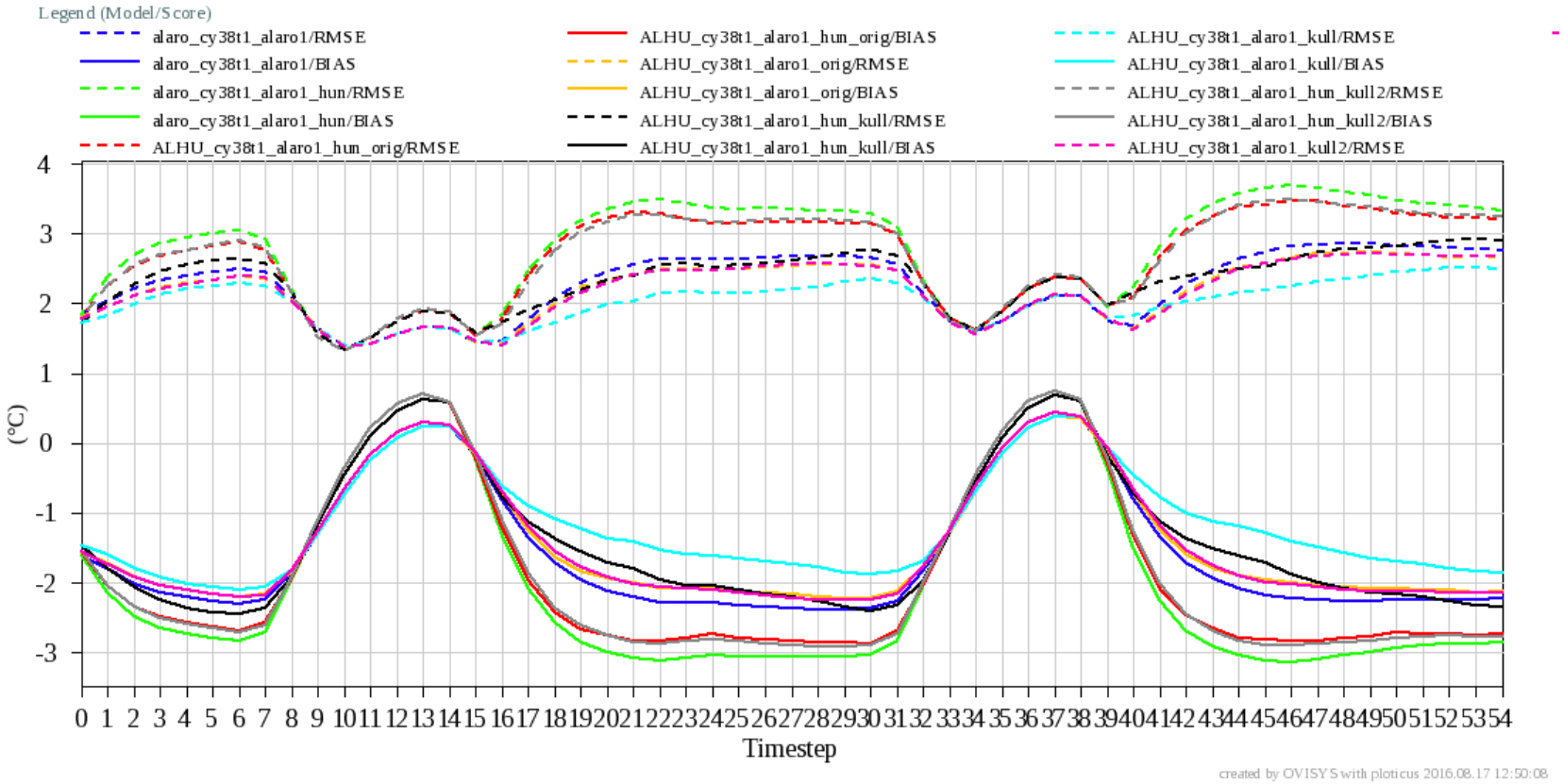
2m temperature (CZ RCTEG)

Period: **12/04/2015 - 12/10/2015**
Area: **HUN_ALL max 400m**
Variable: **Temperature (2m)**
Runhour: **00**



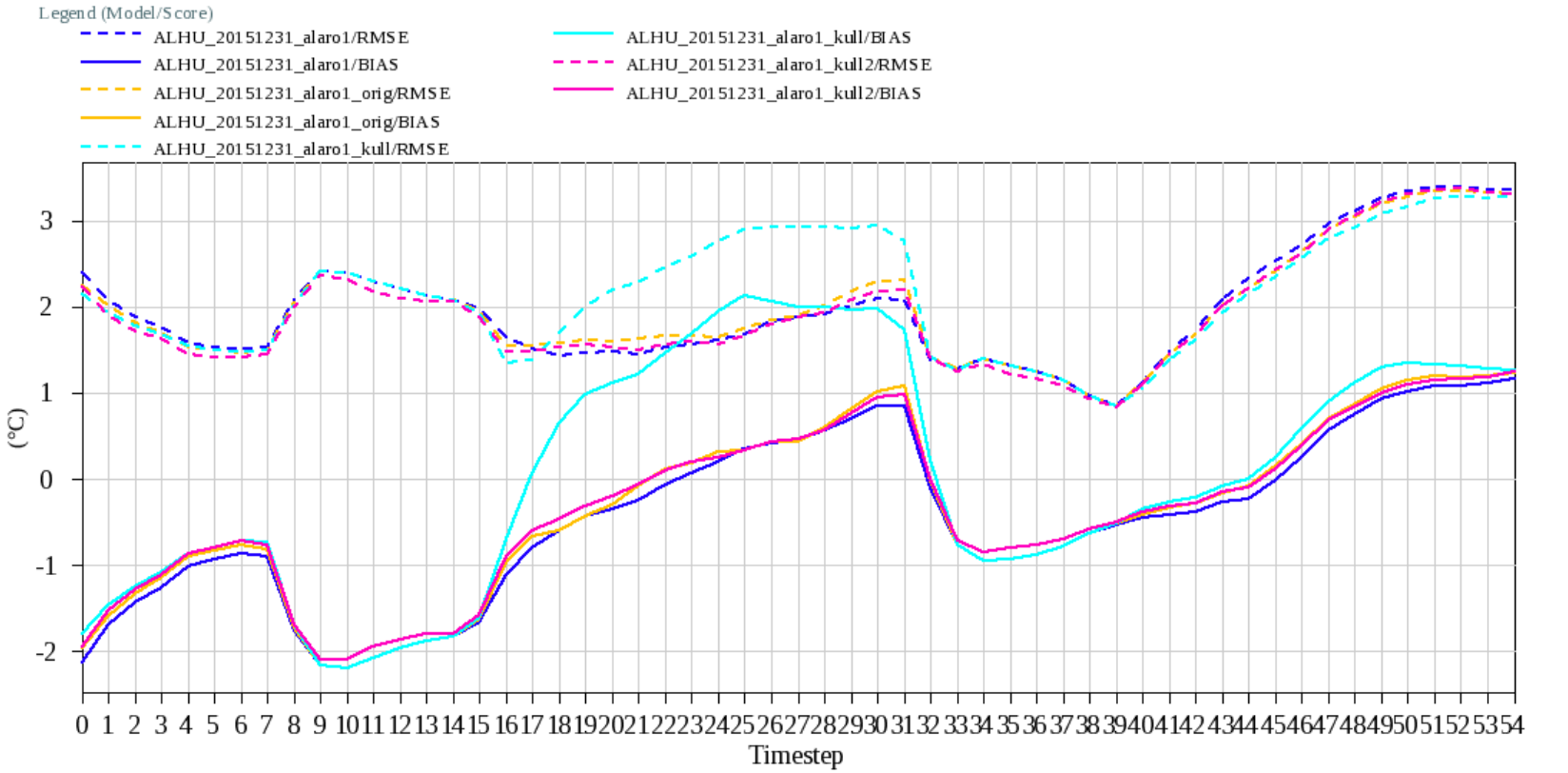
2m temperature

Period: **12/04/2015 - 12/10/2015**
Area: **HUN_ALL max 400m**
Variable: **Temperature (2m)**
Runhour: **00**



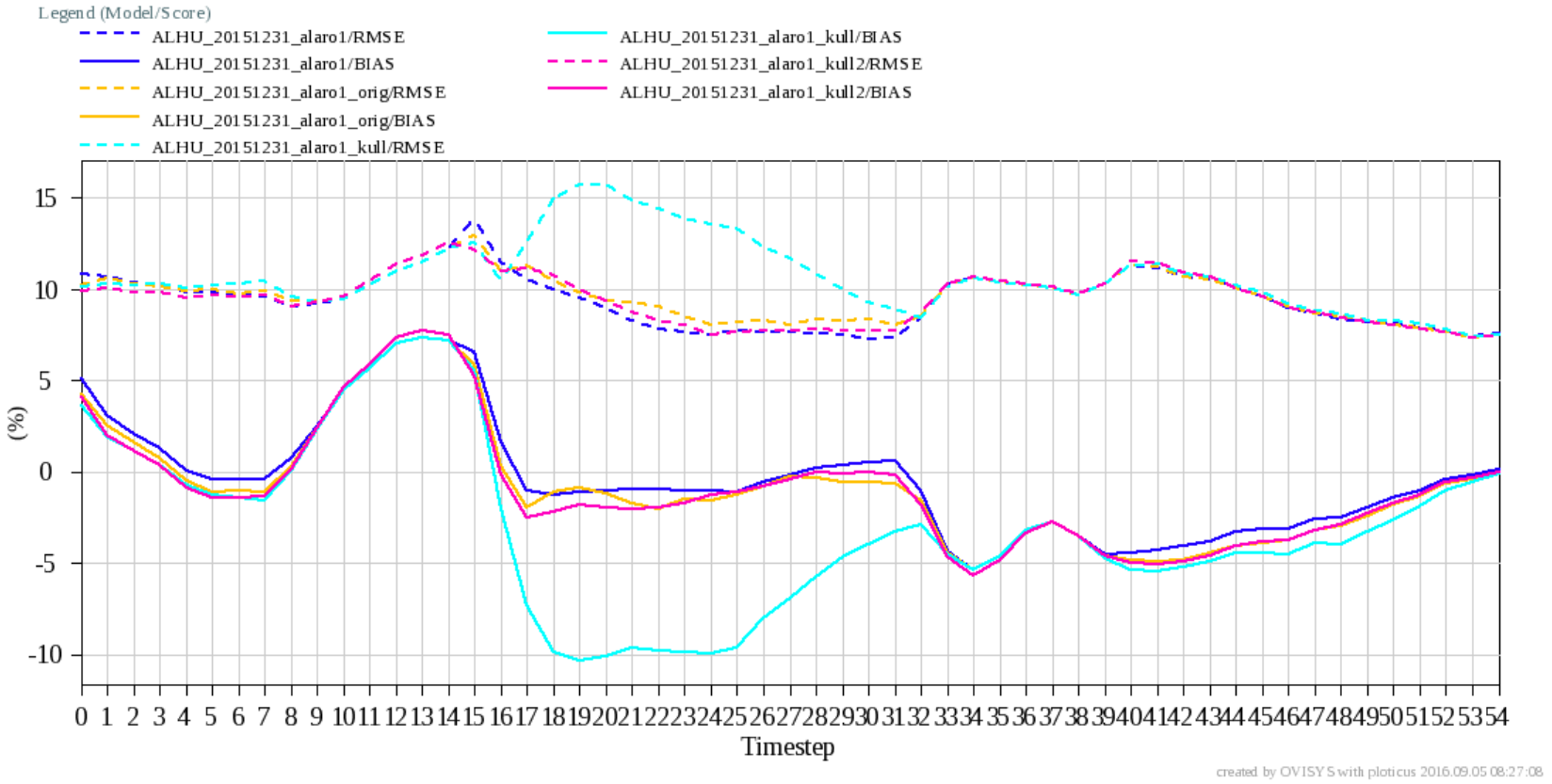
2m temperature

Period: **12/31/2015 - 01/01/2016**
Area: **HUN_ALL max 400m**
Variable: **Temperature (2m)**
Runhour: **00**



2m relative humidity

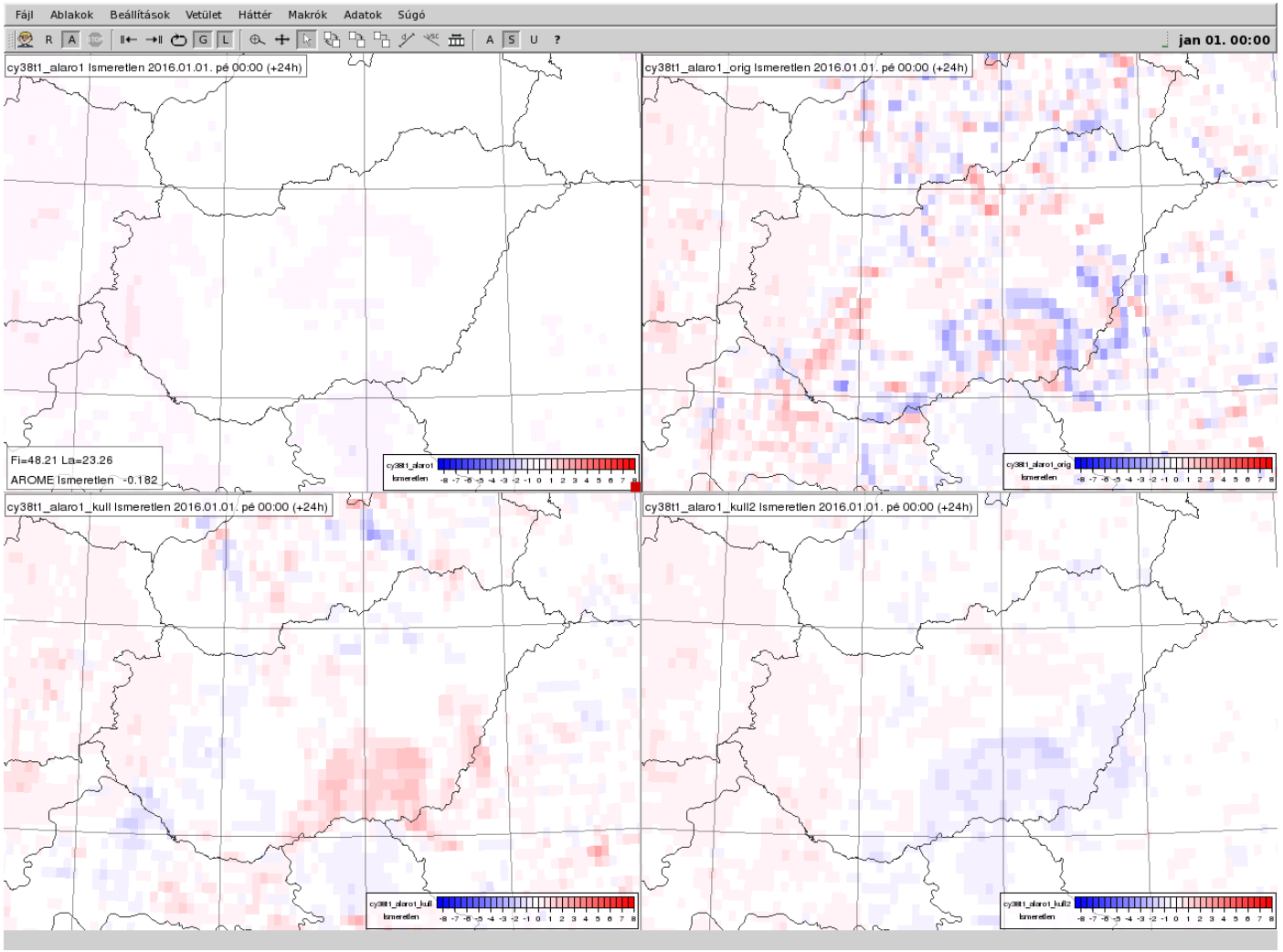
Period: **12/31/2015 - 01/01/2016**
Area: **HUN_ALL max 400m**
Variable: **Relative humidity (2m)**
Runhour: **00**



2m diagnostic

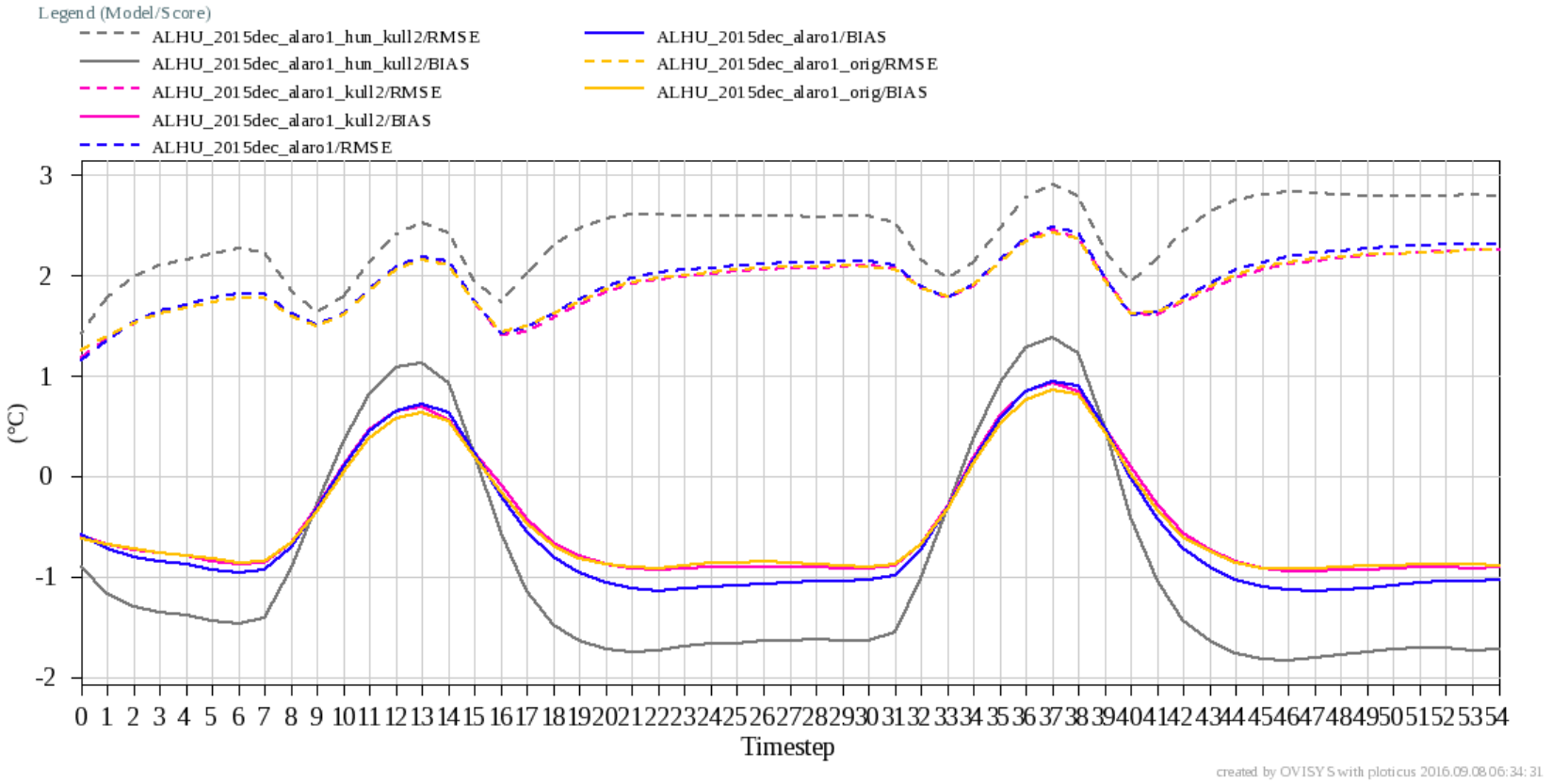
alaro1	**alaro1_orig**
alaro1_kull	alaro1_kull2

2m Temp. difference 12/31/2015 (24h-23h)



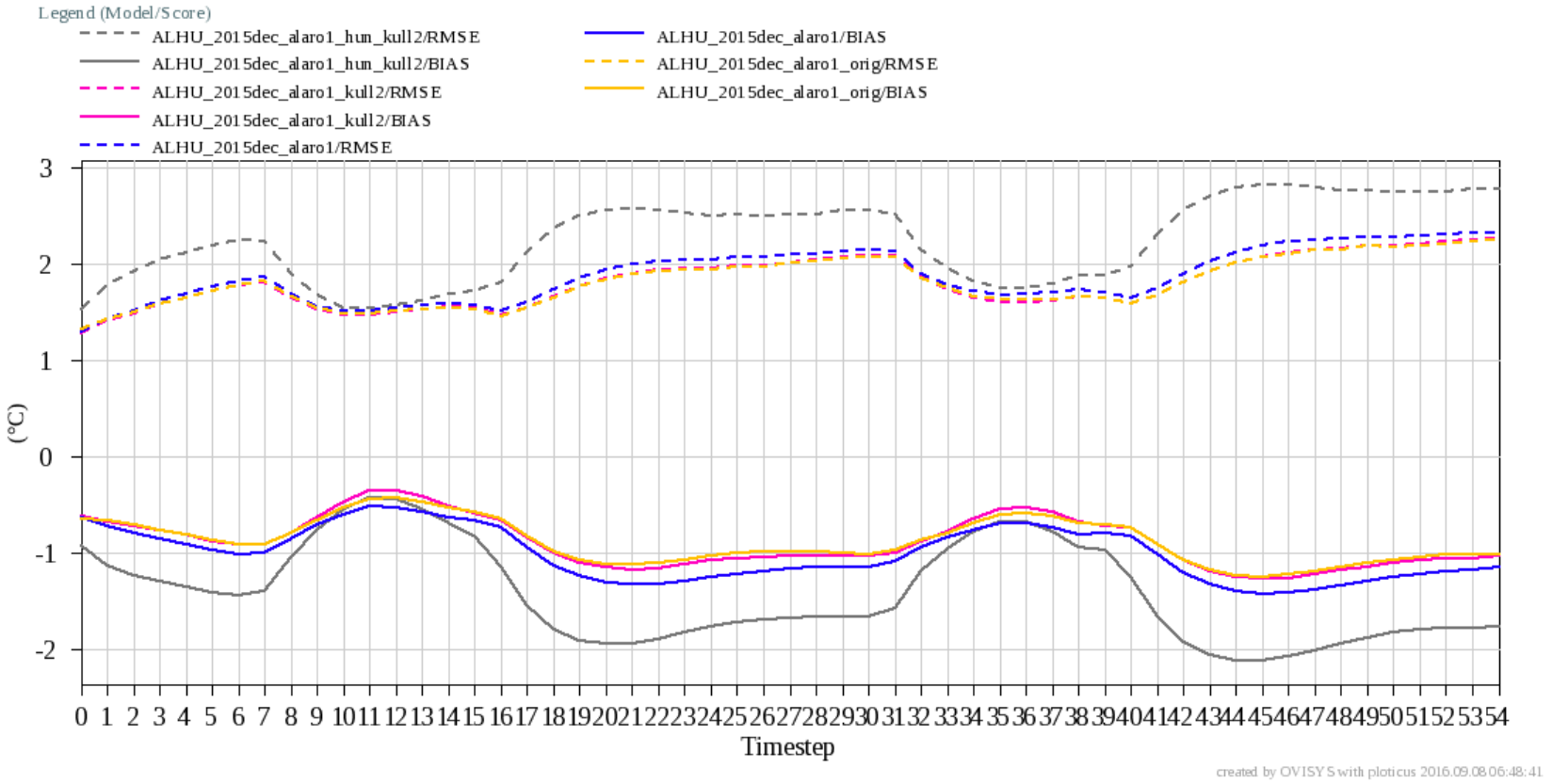
2m temperature

Period: **12/02/2015 - 12/31/2015**
Area: **HUN_ALL max 400m**
Variable: **Temperature (2m)**
Runhour: **00**



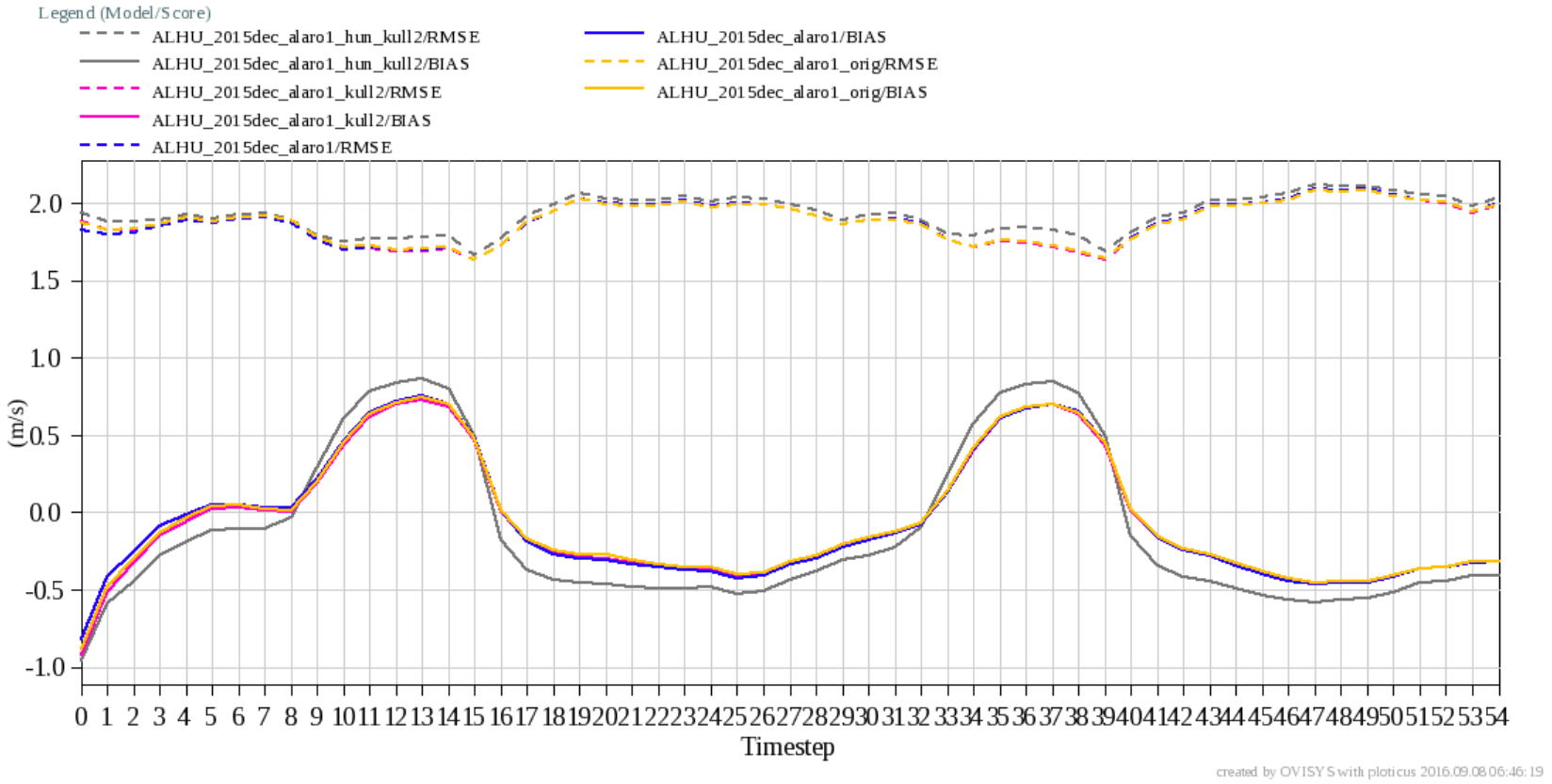
Dewpoint

Period: **12/02/2015 - 12/31/2015**
Area: **HUN_ALL max 400m**
Variable: **Dewpoint**
Runhour: **00**



Wind gust

Period: **12/02/2015 - 12/31/2015**
Area: **HUN_ALL max 400m**
Variable: **Wind gust**
Runhour: **00**



Further namelist modifications

- Wind gust values were too strong especially in low wind situations:
  - FACRAF=10 moderation (original: 12)
  - Positive bias is still existing but it originates from wind itself (not wind gust diagnostics)
- We modified some cloud diagnostics parameter (we have only 49 levels)
  - QXRTGH=3.5 (original: 1.6)
  - QXRAL=130. (original: 150.)
  - These modification was introduced under the really first ALARO version (before ALARO-0) and has not been revised since then.

THANK YOU FOR YOUR ATTENTION!

2m diagnostic

- Original Geleyn + Kullmann - currently used (alaro1_orig)

```
ZBN=VKARMN/SQRT(PCDN(JLON))
ZBNH=C3TKEFREE*VKARMN*SQRT(PCDNMR(JLON))/PCDNH(JLON)
ZBD=VKARMN/SQRT(PCD(JLON))
ZBH=C3TKEFREE*VKARMN*SQRT(PCDMR(JLON))/PCH(JLON)
ZBH=MIN(ZBH,ZBNH+ZSECU*ZAH)
ZRU=PDPHIV(JLON)/PDPHI(JLON)
ZRS=PDPHIT(JLON)/PDPHI(JLON)
ZLOGU=LOG(1.0_JPRB+ZRU*(EXP(ZBN)-1.0_JPRB))
ZLOGS=LOG(1.0_JPRB+ZRS*(EXP(ZBNH)-1.0_JPRB))
ZCORU=PSTAB(JLON)*ZRU*(ZBN-ZBD)+(1.0_JPRB-PSTAB(JLON))*LOG(1.0_JPRB+ZRU &
 & *(EXP(MAX(0.0_JPRB,ZBN-ZBD))-1.0_JPRB))
ZCORSG=-ZRS*(ZBH-ZBNH)
ZCORSK=-ZAH*LOG(1.0_JPRB+ZRS*(EXP(MAX(0.0_JPRB,(ZBH-ZBNH)/ZAH))-1.0_JPRB))
ZWEIGHT=(MAX(ZDBHN,MIN(ZDBHX,ZBH-ZBNH))-ZDBHN)*ZIDZDBH
ZWEIGHT=(3.0_JPRB-2.0_JPRB*ZWEIGHT)*ZWEIGHT*ZWEIGHT
ZCORSI=ZWEIGHT*ZCORSG+(1.0_JPRB-ZWEIGHT)*ZCORSK
ZCORS=PSTAB(JLON)*ZCORSI+(1.0_JPRB-PSTAB(JLON))*LOG(1.0_JPRB+ZRS &
 & *(EXP(MAX(0.0_JPRB,ZBNH-ZBH))-1.0_JPRB))
```

2m diagnostic

- New modset from LACE stay in Prague – Martin Dian, Ján Mašek (alaro1)

```
ZBN=VKARMN/SQRT(PCDN(JLON))
ZBNH=C3TKEFREE*VKARMN*SQRT(PCDNMR(JLON))/PCDNH(JLON)
ZBD=VKARMN/SQRT(PCD(JLON))
ZBH=C3TKEFREE*VKARMN*SQRT(PCDMR(JLON))/PCH(JLON)
ZRU=PDPHIV(JLON)/PDPHI(JLON)
ZRS=PDPHIT(JLON)/PDPHI(JLON)
ZLOGU=LOG(1.0_JPRB+ZRU*(EXP(ZBN)-1.0_JPRB))
ZLOGS=LOG(1.0_JPRB+ZRS*(EXP(ZBNH)-1.0_JPRB))
ZCORU=PSTAB(JLON)*ZRU*(ZBN-ZBD)+(1.0_JPRB-PSTAB(JLON))*LOG(1.0_JPRB+ZRU &
 & *(EXP(MAX(0.0_JPRB,ZBN-ZBD))-1.0_JPRB))
  ZDS=PCP(JLON,KLEV)*PT(JLON,KLEV)+PDPHI(JLON)-PCPS(JLON)*PTS(JLON)
  ZGL=PCPS(JLON)*PTS(JLON)*PCD(JLON)*SQRT(PCD(JLON))*          &
   & (PU(JLON,KLEV)*PU(JLON,KLEV)+PV(JLON,KLEV)*PV(JLON,KLEV))/   &
   & (VKARMN*PCH(JLON)*MAX(ZDS,ZEPS1))   ! g.L
  ZGZ0H=PDPHI(JLON)/(EXP(ZBNH)-1._JPRB)  ! g.z_0H
  ZAUX=MAX(ZEPS2,PDPHI(JLON)*ACLS_HS/(ACLS_HS*ZGZ0H+ZGL))
  ZCORSI=(ZBNH-ZBH)*                                    &
   & LOG(1._JPRB+ZAUX*PDPHIT(JLON)/PDPHI(JLON))/LOG(1._JPRB+ZAUX)
ZCORS=PSTAB(JLON)*ZCORSI+(1.0_JPRB-PSTAB(JLON))*LOG(1.0_JPRB+ZRS  &
 & *(EXP(MAX(0.0_JPRB,ZBNH-ZBH))-1.0_JPRB))
```

2m diagnostic

- Kullmann solution (alaro1_kull)

```
ZBN=VKARMN/SQRT(PCDN(JLON))
ZBNH=C3TKEFREE*VKARMN*SQRT(PCDNMR(JLON))/PCDNH(JLON)
ZBD=VKARMN/SQRT(PCD(JLON))
ZBH=C3TKEFREE*VKARMN*SQRT(PCDMR(JLON))/PCH(JLON)
ZBH=MIN(ZBH,ZBNH+ZSECU*ZAH)
ZRU=PDPHIV(JLON)/PDPHI(JLON)
ZRS=PDPHIT(JLON)/PDPHI(JLON)
ZLOGU=LOG(1.0_JPRB+ZRU*(EXP(ZBN)-1.0_JPRB))
ZLOGS=LOG(1.0_JPRB+ZRS*(EXP(ZBNH)-1.0_JPRB))
ZCORU=PSTAB(JLON)*ZRU*(ZBN-ZBD)+(1.0_JPRB-PSTAB(JLON))*LOG(1.0_JPRB+ZRU &
 & *(EXP(MAX(0.0_JPRB,ZBN-ZBD))-1.0_JPRB))
ZCORSG=-ZRS*(ZBH-ZBNH)
ZCORSK=-ZAH*LOG(1.0_JPRB+ZRS*(EXP(MAX(0.0_JPRB,(ZBH-ZBNH)/ZAH))-1.0_JPRB))
ZCORSI=ZCORSK
ZCORS=PSTAB(JLON)*ZCORSI+(1.0_JPRB-PSTAB(JLON))*LOG(1.0_JPRB+ZRS &
 & *(EXP(MAX(0.0_JPRB,ZBNH-ZBH))-1.0_JPRB))
```

2m diagnostic

- Upgraded Kullmann solution – Ri number dependent (alaro1_kull2)

```
 ZBN=VKARMN/SQRT(PCDN(JLON))
  ZBNH=VKARMN*SQRT(PCDN(JLON))/PCDNH(JLON)
 ZBD=VKARMN/SQRT(PCD(JLON))
  ZBH=VKARMN*SQRT(PCD(JLON))/PCH(JLON)
 ZRU=PDPHIV(JLON)/PDPHI(JLON)
 ZRS=PDPHIT(JLON)/PDPHI(JLON)
 ZLOGU=LOG(1.0_JPRB+ZRU*(EXP(ZBN)-1.0_JPRB))
 ZLOGS=LOG(1.0_JPRB+ZRS*(EXP(ZBNH)-1.0_JPRB))
 ZCORU=PSTAB(JLON)*ZRU*(ZBN-ZBD)+(1.0_JPRB-PSTAB(JLON))*LOG(1.0_JPRB+ZRU &
  & *(EXP(MAX(0.0_JPRB,ZBN-ZBD))-1.0_JPRB))
ZCLSAH0=0.1_JPRB
ZCLSAHA=20.0_JPRB
ZCLSAHB=1.5_JPRB
ZEXPCRIT=20.0_JPRB
   ZAH = ZCLSAHA*ABS(PRI(JLON))**ZCLSAHB+ABS(ZCLSAH0)
   ZEXP=MAX(0.0_JPRB,(ZBH-ZBNH)/ZAH)
   ZSECU=MAX(0.0_JPRB,SIGN(1.0_JPRB,ZEXP-ZEXPCRIT))
   ZCORS=-PSTAB(JLON)*ZSECU*(ZAH*LOG(ZRS)+MAX(0.0_JPRB,ZBH-ZBNH))   &
    &   -PSTAB(JLON)*(1.0_JPRB-ZSECU)*ZAH*LOG(1.0_JPRB+ZRS*(EXP(MIN(ZEXP,ZEXPCRIT))-1.0_JPRB)) + &
    &   (1.0_JPRB-PSTAB(JLON))*LOG(1.0_JPRB+ZRS*(EXP(MAX(0.0_JPRB,ZBNH-ZBH))-1.0_JPRB))
```

2m diagnostic

- New modset from LACE stay in Prague – Martin Dian, Ján Mašek (alaro1)

$$\varphi_H(\xi) = 1 + \alpha \frac{\xi}{1 + \alpha\xi}$$

- Original Geleyn + Kullmann - currently used (alaro1_orig)

$$\varphi_H(\xi) = 1 + \alpha_G \xi$$

$$\varphi_H(\xi) = 1 + a_K \frac{\alpha_K \xi}{1 + \alpha_K \xi}$$

- Kullmann solution (alaro1_kull)

$$\varphi_H(\xi) = 1 + a_K \frac{\alpha_K \xi}{1 + \alpha_K \xi}$$

- Upgraded Kullmann solution – Ri number dependent (alaro1_kull2)

Too strong wind gusts - formulation

- The formulation of wind gust calculation was not modified in ALARO
- PCD (surface exchange coefficint) calculation has changed in this formula

$$\mathrm{ZSCRAF} = 1 + \alpha \sqrt{\frac{C_D\,(U_N^2 + V_N^2)}{(U_{10m}^2 + V_{10m}^2) + (Z_{10m}\ \mathrm{GCISMIN})^2}} \sqrt{\frac{1}{1 + \left[\frac{\ln(1+Z_{10m}/Z_{0,lim})}{\ln(1+Z_{10m}/Z_0)}\right]^2}}$$

$$U_{raf} = \mathrm{ZSCRAF}\ U_{10m}$$

$$V_{raf} = \mathrm{ZSCRAF}\ V_{10m}$$

$\mathrm{GCISMIN} = 0.000067$: minimum value of shear
$\mathrm{GZ0RAF} = gZ_{0,lim} = 10$
$\mathrm{FACRAF} = \alpha = 15$