Status of surface assimilation at MF

E. Bazile
with several contributions from GMAP and GMME
Météo-France/CNRM

Aladin/Hirlam
Joint 26th Workshop All Staff Meeting
Lisbon 4-7 April 2016

Introduction

- Plan for SURFEX in ARPEGE ..
- Some words of MESCAN

SURFEX in ARPEGE …
(Y. Bouteloup, F. Taillefer, F. Bouyssel and GMAP team)

- Use the ECOCLIMAP v1 database : ECOCLIMAP (1km), HWSD @ 1km (sand, Clay), GMTED2010 (1km, not used), Albédo MODIS (only available in V8)
- Sea surface fluxes from ECUME or COARE

- ISBA-3L vs ISBA-2L
- One layer snow scheme from Douville.
  - differences with the ARPEGE snow scheme: snow inertia, snow fraction over bg and vegetation, soil freezing.

ARPEGE/ALADIN

(based on Douville et al, 1995, Bazile et al 2002 for the snow fraction on the vegetation)

To take into account the snow on the leaves and the fall below the canopy, a function F was introduced. F is a decreasing function of both the LAI and the snow age through the snow albedo equation

$$P_{sn}^{bg} = \frac{SNW}{SNW + 10}$$

$$P_{sn}^{veg} = P_{sn}^{bg} \cdot F(Lai, snow_age)$$

$$F = 1 - \frac{Lai}{7} \cdot \frac{\alpha_1 - \max(\alpha_0, \alpha_{SN})}{\alpha_1 - \alpha_0} \qquad \alpha_0 = 0.84 \quad \alpha_1 = 0.87$$

$$LAI \le 2.9 \Rightarrow F = 1$$

AROME (Douville et al, 1995)

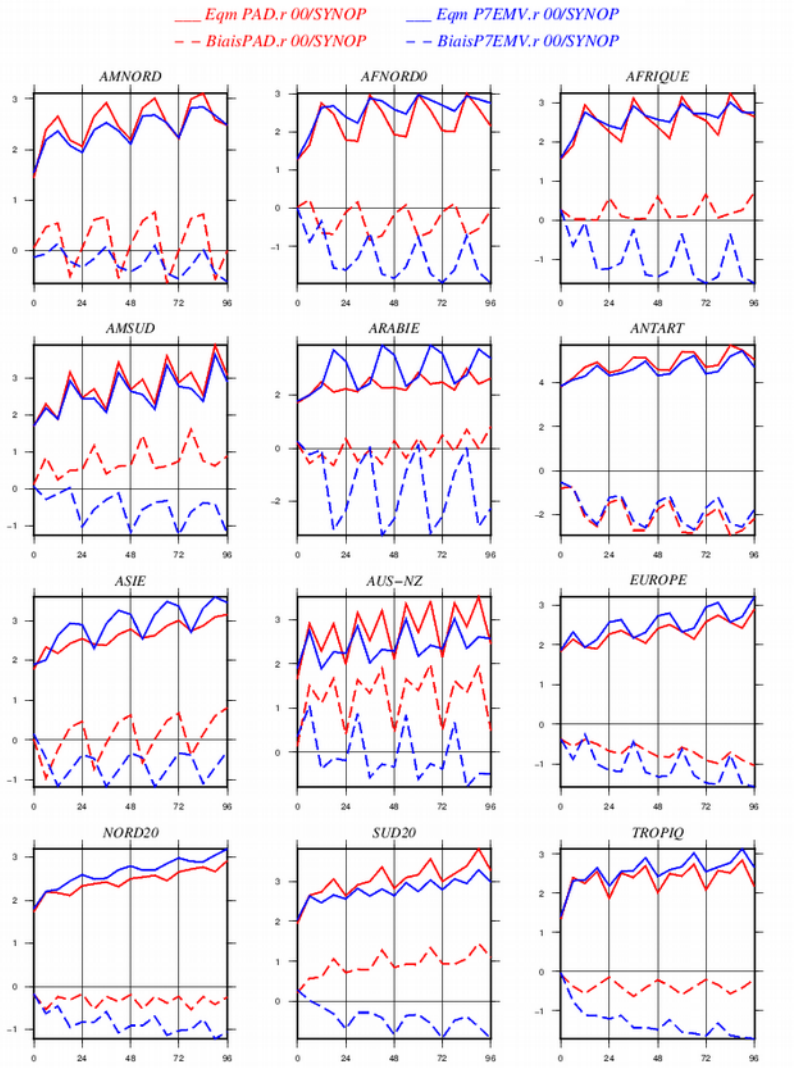
$$P_{sn}^{bg} = \frac{SNW}{SNW + 10 \cdot (1 + z_{0_oro})}$$

$$P_{sn}^{veg} = \frac{h_n}{h_n + 5 \cdot z_{0_veg}} \qquad h_n = \frac{SNW}{\rho_{sn}}$$

$$p_{nc} = \min(1, \frac{SNW}{70})$$

Preliminary test in dyn. adaptation (Y. Bouteloup, F. Taillefer, F. Bouyssel and GMAP team)

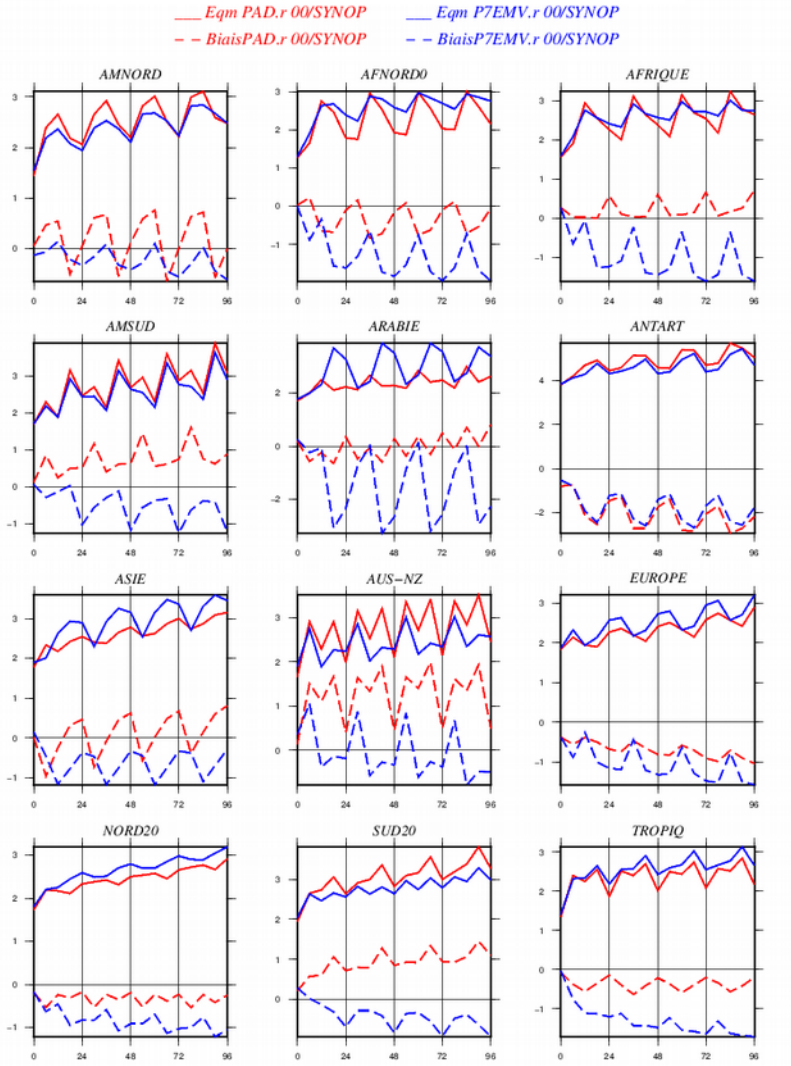
T2m 20151011-20151024
ARPEGE-SURFEX-Conf AROME(blue)
ARPEGE(red)



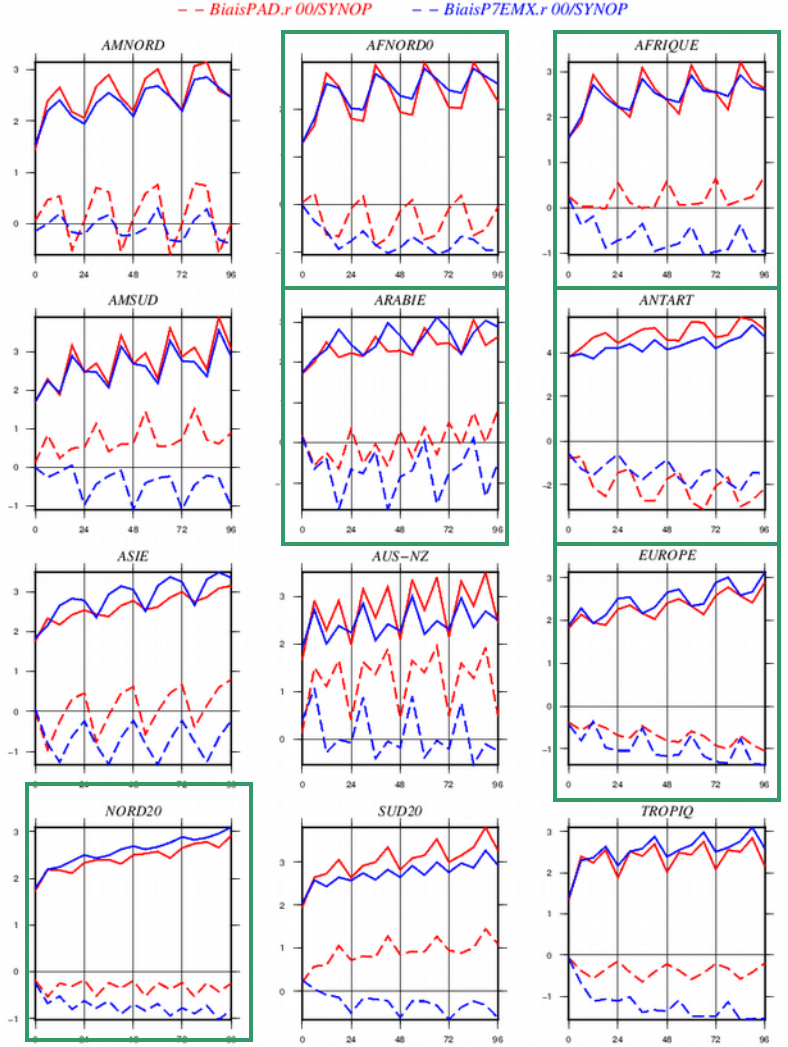
T2m 20151011-20151024
ARPEGE-SURFEX-with modified Cg
and min snow albedo=0.65
ARPEGE(red)

Preliminary test in dyn. adaptation
(Y. Bouteloup, F. Taillefer, F. Bouyssel and GMAP team)

T2m 20151011-20151024
ARPEGE-SURFEX-Conf AROME(blue)
ARPEGE(red)

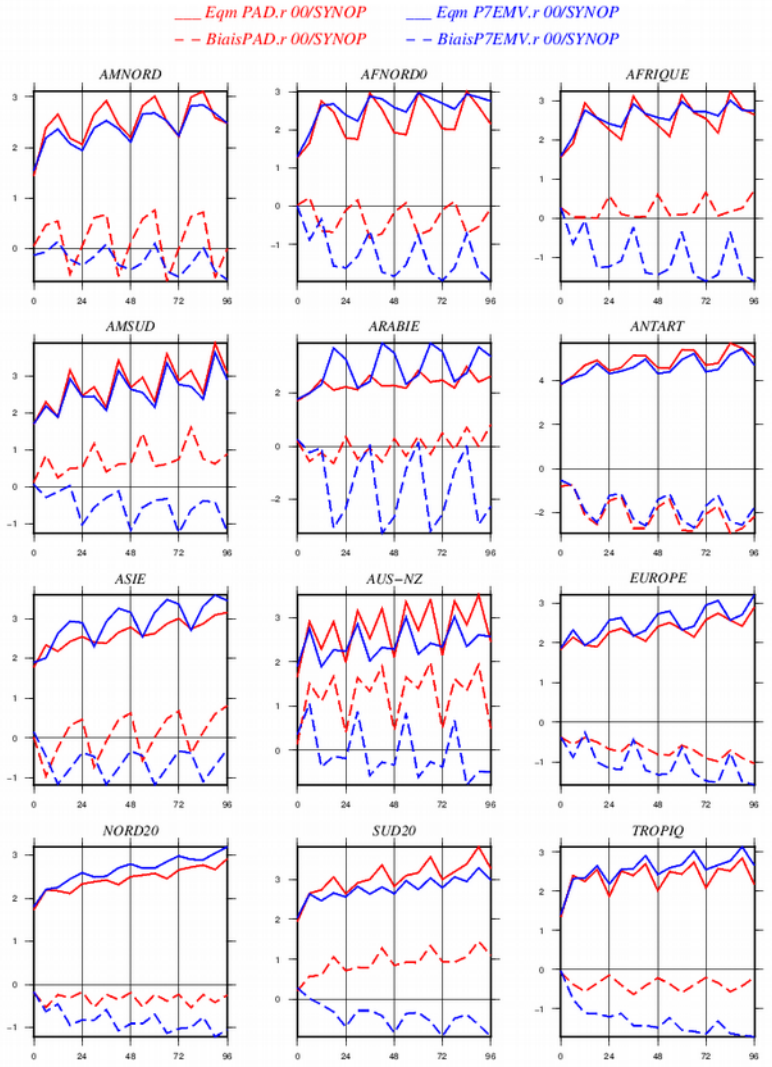


T2m 20151011-20151024
ARPEGE-SURFEX-with modified Cg
and min snow albedo=0.65
ARPEGE(red)

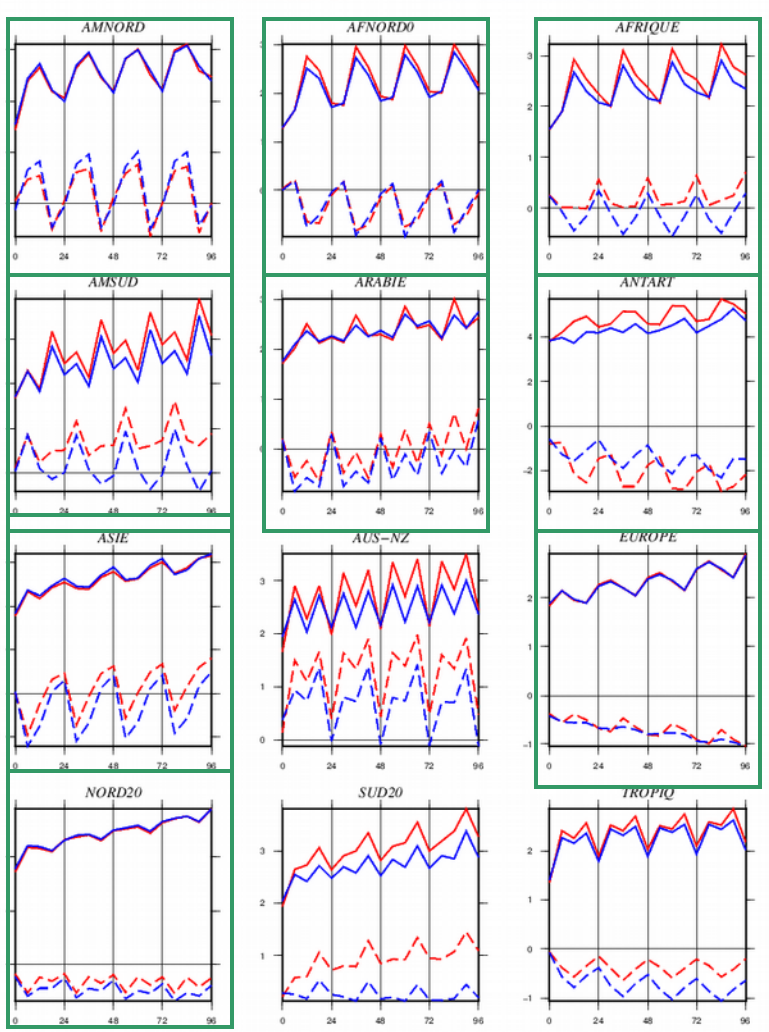


Preliminary test in dyn. adaptation
(Y. Bouteloup, F. Taillefer, F. Bouyssel and GMAP team)

T2m 20151011-20151024
ARPEGE-SURFEX-Conf AROME(blue)
ARPEGE(red)

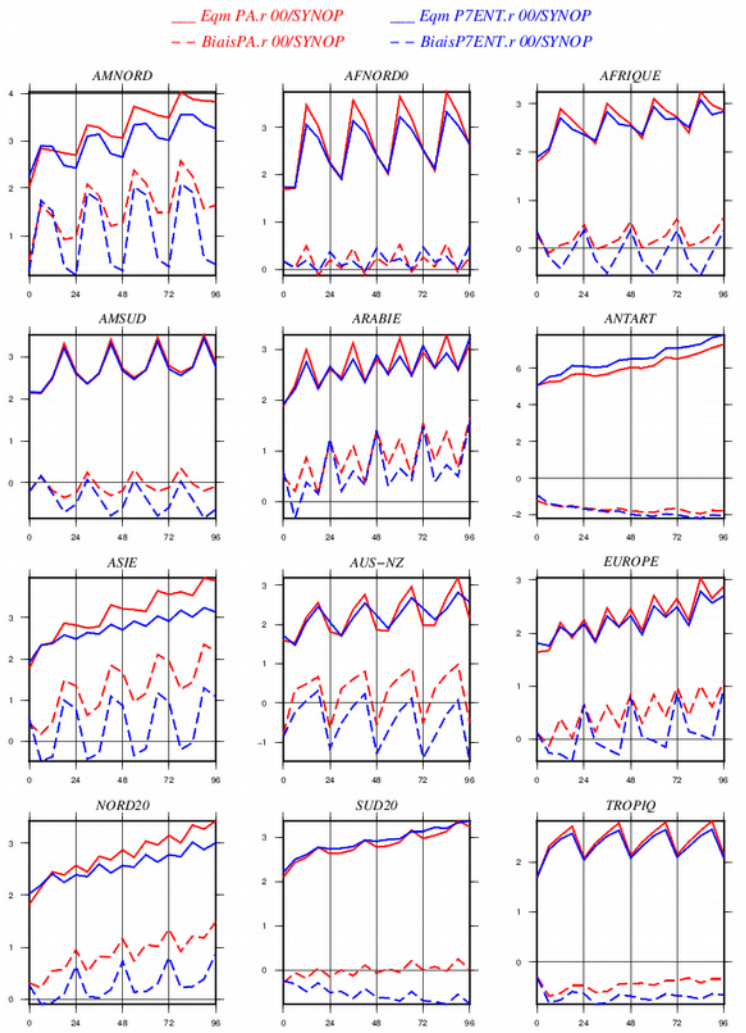


T2m 20151011-20151024
ARPEGE-SURFEX-with modified Cg,
Cv, min snow albedo=0.65, soil freezing
ARPEGE(red)

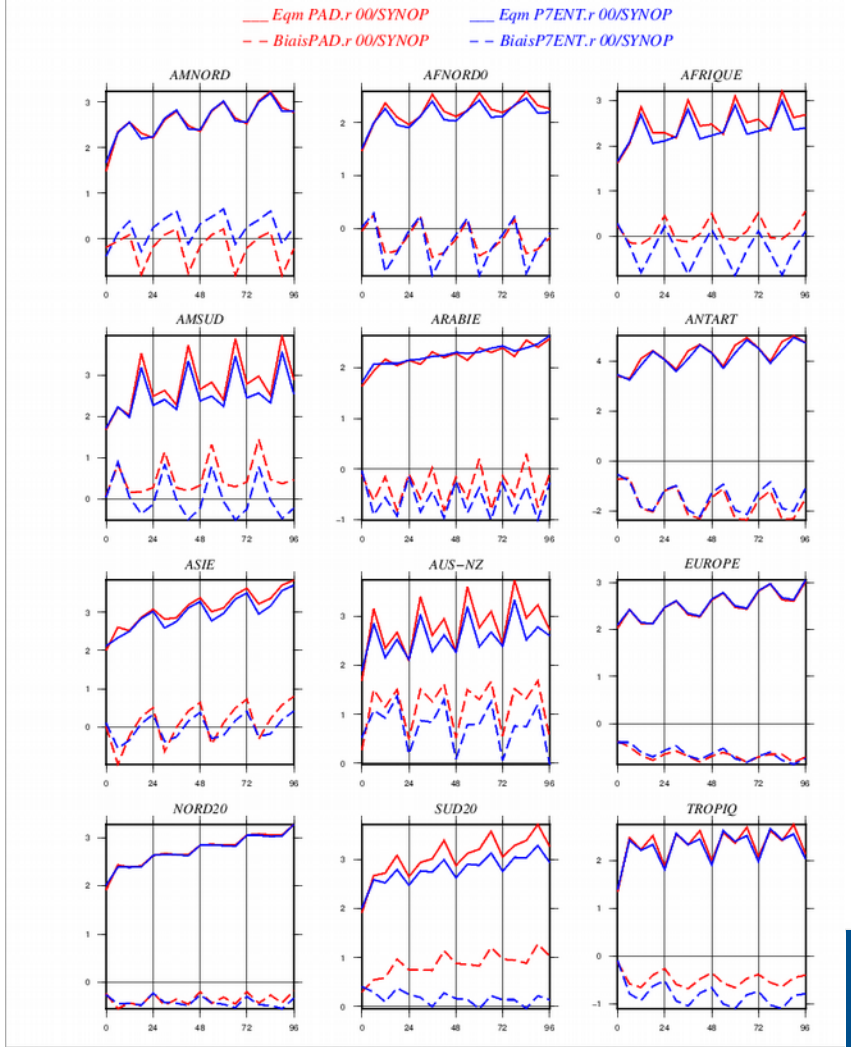


Preliminary test in dyn. adaptation
(Y. Bouteloup, F. Taillefer, F. Bouyssel and GMAP team)

T2m 20150615-20150819
ARPEGE-SURFEX (blue)
ARPEGE(red)



T2m 20151011-20151207
ARPEGE-SURFEX (blue)
ARPEGE(red)



Preliminary test in dyn. adaptation (Y. Bouteloup, F. Taillefer, F. Bouyssel and GMAP team)

- Status: dynamical adaptation from ARPEGE-ISBA works using coupling surf. **Results are globally positive (in dyn. Adaptation) with** modifications in the SURFEX namelist compared to AROME such as :
- */surfex/SURFEX/ini_data_param.F90

  PCV(JLOOP,:)=0.8E-5 ← 2.E-5 (default)

< IF(PTYPE(JLOOP,NVT_TREE)>0.) PCV(JLOOP,NVT_TREE)= 0.8E-5 ← 1.E-5 (default)

< IF(PTYPE(JLOOP,NVT_CONI)>0.) PCV(JLOOP,NVT_CONI)= 0.8E-5 ← 1.E-5 (default)

< IF(PTYPE(JLOOP,NVT_EVER)>0.) PCV(JLOOP,NVT_EVER)= 0.8E-5 ← 1.E-5 (default)

- */surfex/SURFEX/modd_isba_par.F90

< REAL, PARAMETER :: XTAU_ICE = 25000. ← 3300 (default) (in ARPEGE 1./CGGEL~33000 s)

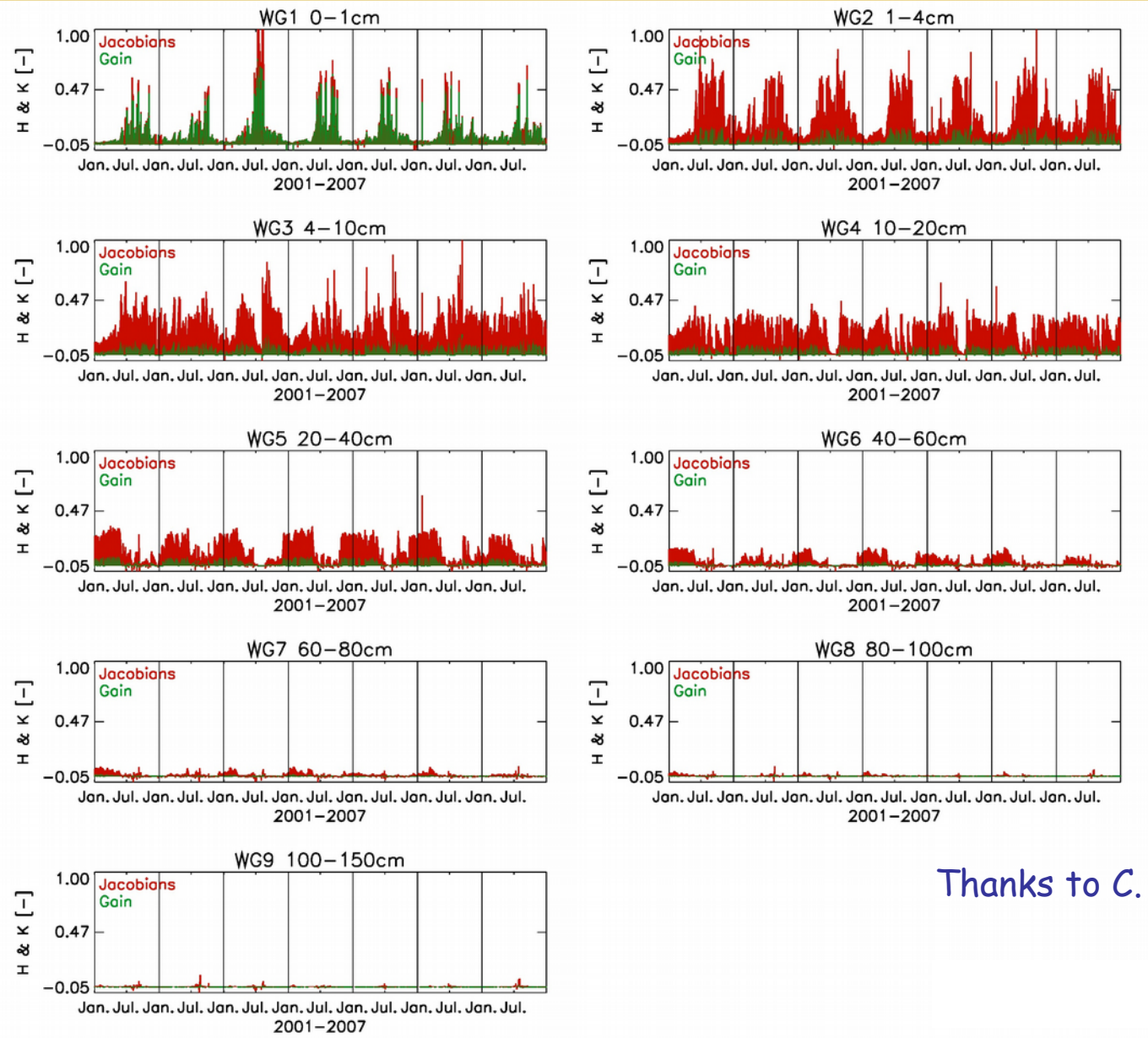
- XANSMIN=0.65
- More evaluation especially during winter for the snow scheme and the soil freezing parameter. Ideally during a full year with surface assimilation (including soil moisture assimilation)
- Rh2m better, neutral for cc and RR. Wind depends on the area …
- For the 4D Var: no SURFEX in the 131. 4Dvar not yet tested.
- several surface and soil outputs are necessary: required several modifications in mse
- Time computation +3% for the ARPEGE forecast.

SURFEX

- Surfex V8 off-line : ok. V8 will be available soon after test in Meso-NH et CNRM-CM6
- Free Surfex V8 summer 2016, V8.1 summer 2017 (?), V9 for 2018 for scientific developments
- Operational cycle:
  - Cy42_op1 + v7.3
  - Cy43t1 with v8.0

- ISBA-DF with SODA (C. Albergel): very preliminary results
  - Option ISBA-DF works with SODA (1D study and over France off line), superficial soil moisture assimilation
  - Use only layer 2,3,4,5 (6) for the control variable ? Need to be confirmed on a longer period with more active day …

ISBA-DF in SODA : SMOSREX 2001-2007

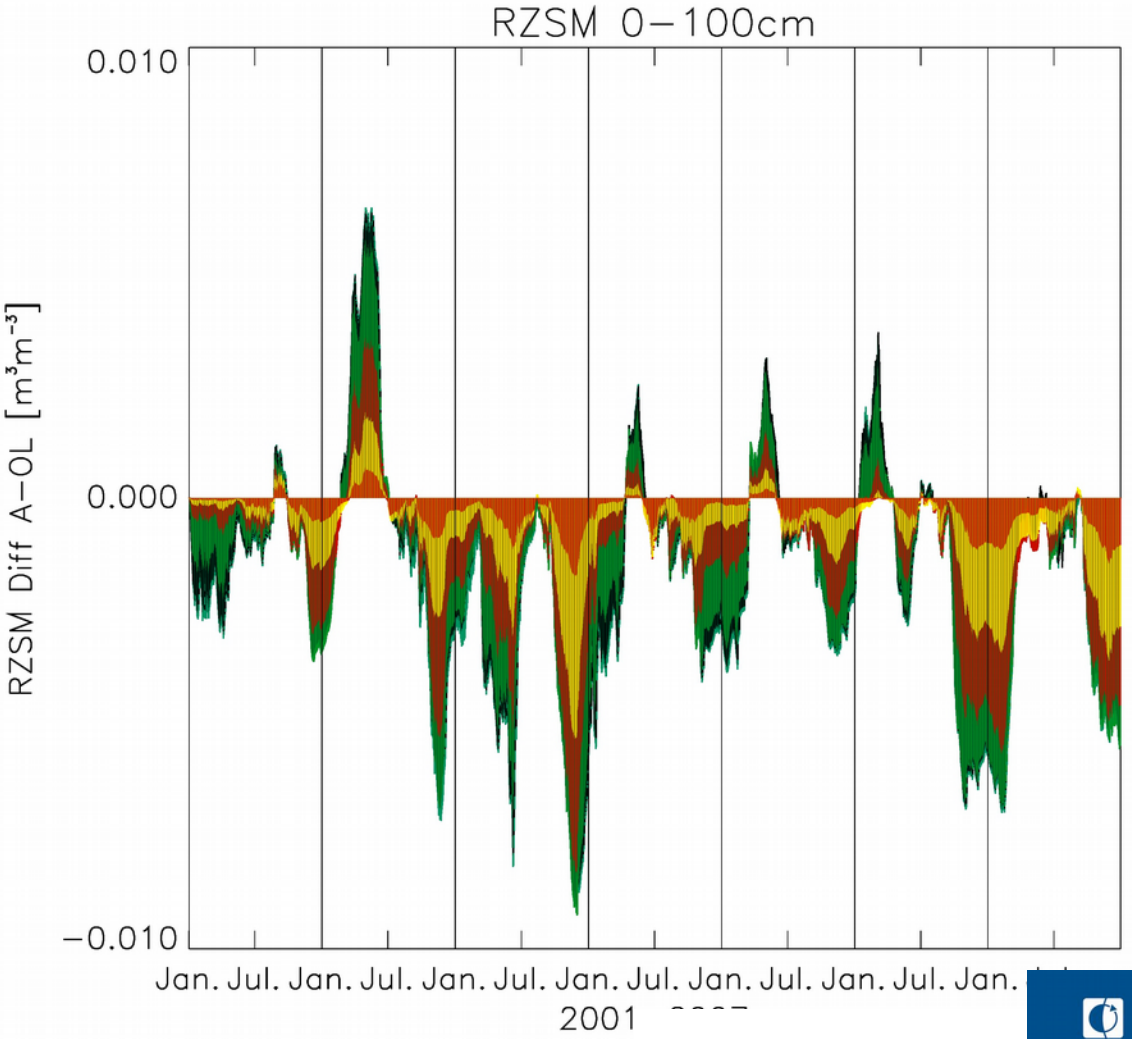


Thanks to C. Albergel

ISBA-DF in SODA : SMOSREX 2001-2007

- Differences between RZSM without analysis (open-loop, OL)

- OL – Analyse(W1_2)
- OL – Analyse(W1_3)
- OL – Analyse(W1_4)
- OL – Analyse(W1_5)
- OL – Analyse(W1_7)
- OL – Analyse(W1_9)

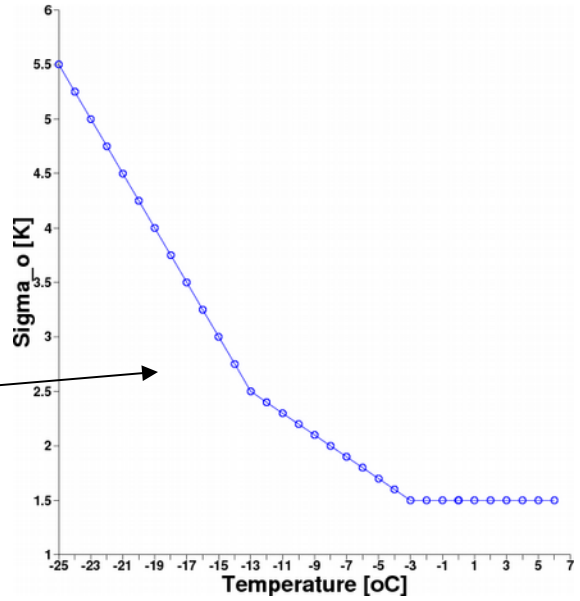


Thanks to C. Albergel

MESAN features introduced in the CANARI analysis system

- Error statistics:

CANARI (reference: oper settings)		MESAN (+ experiments in CANARI)	
σ_b	σ_o	σ_b	σ_o
1.6K	1.4K	winter: 8K summer: 5K	1.5K+ $f(T_{2m})$



- Correlation functions:

Old:

$$Corr_{CAN}(r) = e^{-0.5\frac{r}{d_1}}$$

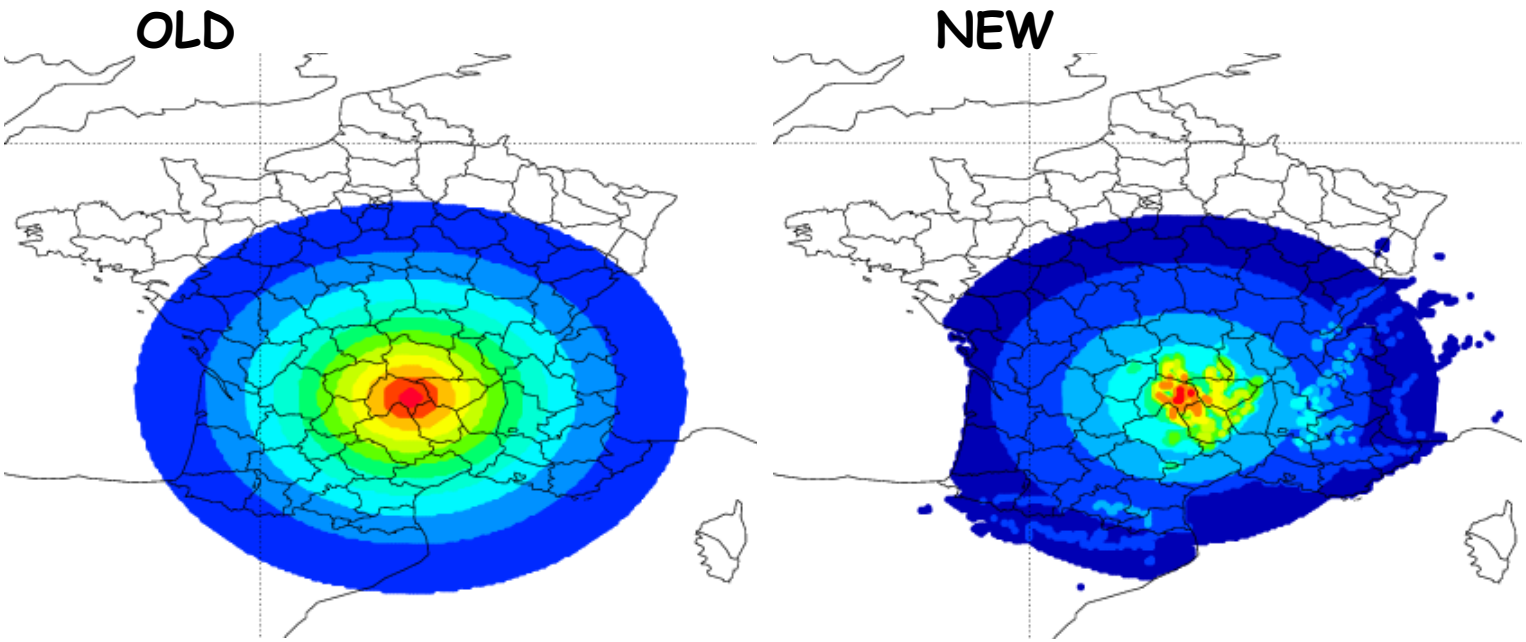
New:

$$Corr_{MES}(r, d_p, d_z) = 0.5\left[e^{-\frac{r}{d_2}} + \left(1 + \frac{2r}{d_2}\right) e^{-2\frac{r}{d_2}} \right] \cdot F_p(d_p) F_z(d_z)$$

after Häggmark et al, 2000, Tellus, 52A, 2-20.

MESCAN = MESAN error statistics and structure function in CANARI system for EURO4M

T2m analysis increments for a single obs experiment



The new anisotropic correlation function creates more realistic analysis increments (right Figure) by accounting for height difference and land-sea mask.

Analysis of accumulated precipitation in MESCAN

Principle:

- Based on the OI code used also for the analysis of T2m and RH2m

- **Background field**: accumulated precipitation forecasted by a numerical model (ARPEGE, AROME, ALADIN, HIRLAM).

- **Observations**: cumulated precipitation from raingauge measurements (at this stage)

- Possibility of producing 24-h, 12-h, 6-h, 3-h or 1-h accumulated precipitation analysis, the only limiting factor is that the background and the observations must span the same period.

- The analysis is performed at the background horizontal resolution

Analysis of accumulated precipitation in MESCAN (2)

- **Two options are available**:

1. **MESCAN-Log**: analysis in log-space on a transformed variable ln(RR+1)

   $RR \sim LN(0, \sigma_1^2) \rightarrow \ln(RR) \sim N(0, \sigma_2^2)$

   Preliminary error statistics: σ_o=0.6 et σ_b =0.71, L=43km

   [after Mahfouf *et al.*, 2007 for CAnadian Precipitation Analysis Project (CAPA)]

2. **MESCAN-RR**: analysis in physical space on $RR \sim N(0, \sigma^2)$

   Preliminary error statistics: σ_o =5 et σ_b =13, L=35km (as in SAFRAN)

- **Correlation function:**

$$Cor(r) = (1 + \frac{r}{L}) \cdot e^{-\frac{r}{L}}$$

Preliminary validation over France at 5.5 km grid

- **Test period** : October 2009 – June 2010
- **First guess:** ALADIN operational downscaled with fullpos

- Indirect validation of the **MESCAN** analysis system by forcing with its output (analyses of **T2m, RH2m, RR24**) the surface scheme ISBA and the hydrological module MODCOU.

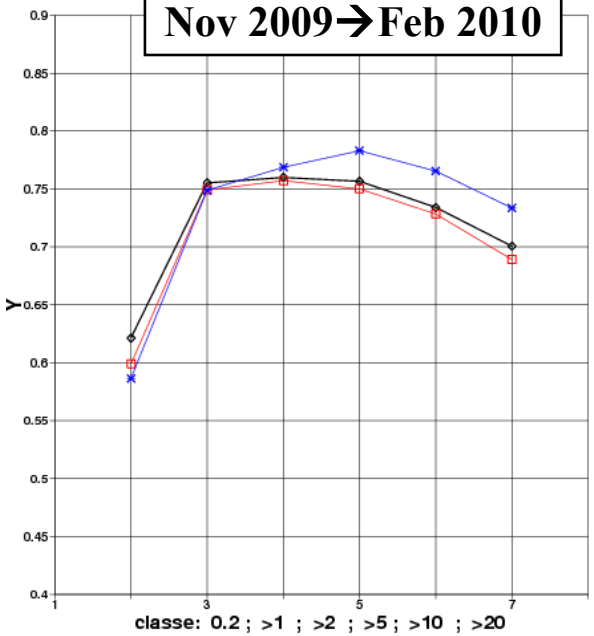
  Evaluation of the impact of changing the surface forcing variables (**T2m, RH2m, RR24, 10-m wind speed, downward SW and LW radiation**) on:

  - **River flow**, and
  - **Snow Depth**

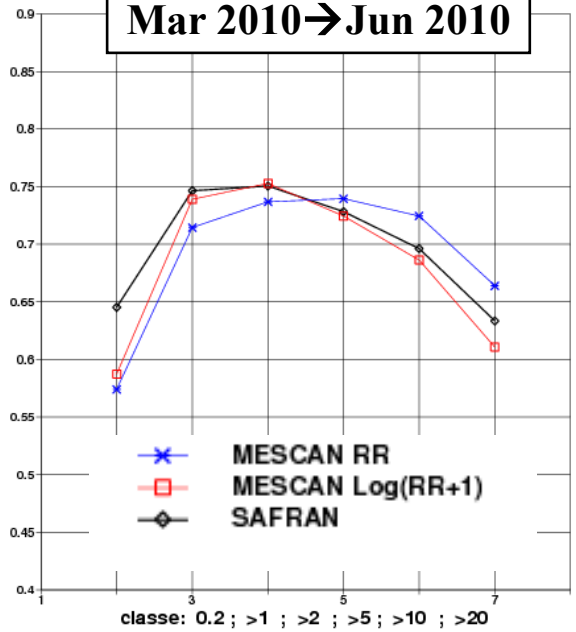
  The reference system used for validation is the operational system called **SIM** (SAFRAN-ISBA-MODCOU)

Validation of MESCAN precipitation analysis vs SAFRAN over France

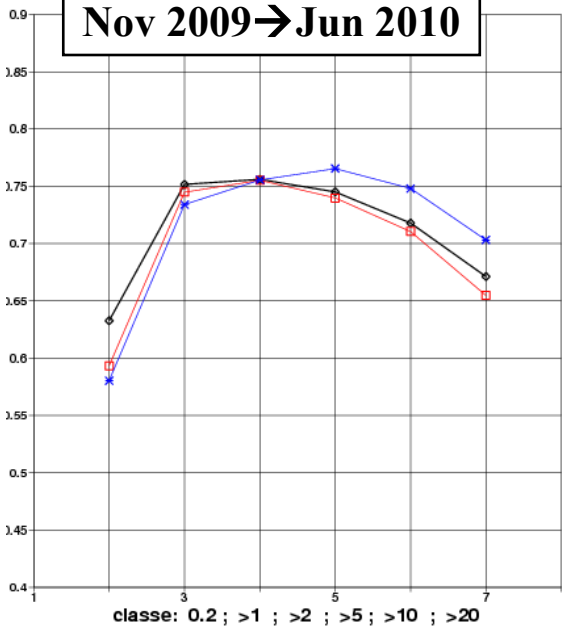
Heidke Skill Score
Nov 2009→Feb 2010



Heidke Skill Score
Mar 2010→Jun 2010



Heidke Skill Score
Nov 2009→Jun 2010



~ 4200 obs for computing scores
~ 1700 obs for analyses

- MESCAN-RR compared to SAFRAN and MESCAN-Log for spring (Mar-Jun):
  - improves the HSS for RR > 5mm/day, but
  - deteriorates HSS for RR < 2mm/day

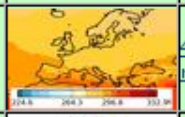
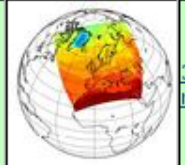
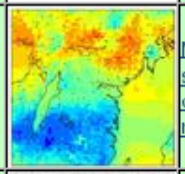
	Bias	Absolute error
FG	0.40	1.87
MESCAN-RR	-0.08	0.87
MESCAN-Log	-0.27	0.96
SAFRAN	-0.06	0.93

EURO4M available products
(more info on www.euro4m.eu)

Surface Re-analyses @ 5.5km :	Downscaled fields @ 5.5km :
▪ 6-h T2m and RH2m ▪ 24-h precipitation	▪ 6-h SW, LW, U10m and V10m
SURFEX output @ 5.5km: snow height, snow albedo, surface fluxes etc …	

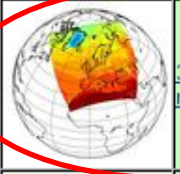
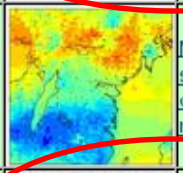
- **Period**: 01/01/2007 – 31/12/2010
- **Model domain**: Europe, 1080x1000 grid points, Δx=5.5 km, Lambert conformal proj.
- **First guess:** HIRLAM forecast from 3DVAR reanalysis at 22km downscaled at 5.5km
- **Observations:** MF operational database for T2m and RH2m analyses. Data from SMHI, MF, ECA&D (v6) merged by SMHI (T. Landelius) for RR24 analyses
- **ARCHIVE MESCAN** : 4 files per day (00,06,12,18 utc); archive of about 212 GB
  - Hendrix: /home/soci/EURO4M/MESCAN-EU/ANALYSE
    - NetCdf : sous netCDF_files_EU ou bientot en Grib1 sous grib1_files_EU

EURO4M available products
(more info on www.euro4m.eu)

										2943-2972; doi:10.3390/rs5062943
13*	Atmospheric surface and upper-air variables		4D-VAR regional reanalysis (D2.1)	Met Office	Europe, North Africa and the Middle East	12 km	6 hourly	2008-2009	NetCDF	Factsheet: Met Office 4D-VAR Reanalysis.
14*	Atmospheric surface and upper-air variables		3D-VAR regional reanalysis (D2.3)	SMHI	Europe, North Africa and the Middle East	0.2 degree	6 hourly	1989-2010	GRIB	Factsheet: HIRLAM 3D-VAR dynamical downscaling re-analysis.
15	Atmospheric surface variables		MESAN 2D surface downscaling reanalysis (D2.4)	SMHI	Europe, North Africa and the Middle East	0.05 degree	daily	1989-1997	GRIB	Factsheet: MESAN 2D surface downscaling re-analysis.
16	Atmospheric surface variables		MESCAN 2D surface downscaling reanalysis (D2.6)	MF	Europe	0.05 degree	6 hourly	2007-2010	netCDF	Factsheet: Surface downscaling reanalysis.

- Report F. Mounier et al. (2011) Radar-guided control and interpolation of rain gauge precipitation data over France
- Deliverable D2.10 (2011) Soci et al : Comparison between MESAN, CANARI and SAFRAN
- Deliverable D2.6 (2014) Soci et al. : MESCAN documentation and evaluation
- Deliverable D2.11 (2014) Coustau et al : Résultat de MESCAN-SURFEX

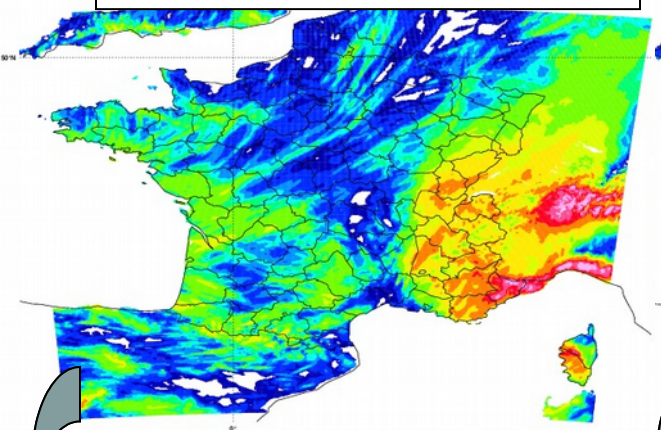
EURO4M available products
(more info on www.euro4m.eu)

										2943-2972; doi:10.3390/rs5062943
13*	Atmospheric surface and upper-air variables		4D-VAR regional reanalysis (D2.1)	Met Office	Europe, North Africa and the Middle East	12 km	6 hourly	2008-2009	NetCDF	Factsheet: Met Office 4D-VAR Reanalysis.
14*	Atmospheric surface and upper-air variables		3D-VAR regional reanalysis (D2.3)	SMHI	Europe, North Africa and the Middle East	0.2 degree	6 hourly	1989-2010	GRIB	Factsheet: HIRLAM 3D-VAR dynamical downscaling re-analysis.
15	Atmospheric surface variables		MESAN 2D surface downscaling reanalysis (D2.4)	SMHI	Europe, North Africa and the Middle East	0.05 degree	daily	1989-1997	GRIB	Factsheet: MESAN 2D surface downscaling re-analysis.
16	Atmospheric surface variables		MESCAN 2D surface downscaling reanalysis (D2.6)	MF	Europe	0.05 degree	6 hourly	2007-2010	netCDF	Factsheet: Surface downscaling reanalysis.

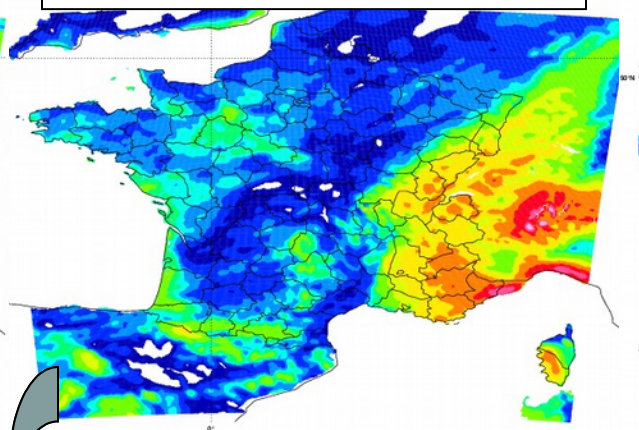
- Report F. Mounier et al. (2011) Radar-guided control and interpolation of rain gauge precipitation data over France
- Deliverable D2.10 (2011) Soci et al : Comparison between MESAN, CANARI and SAFRAN
- Deliverable D2.6 (2014) Soci et al. : MESCAN documentation and evaluation
- Deliverable D2.11 (2014) Coustau et al : Résultat de MESCAN-SURFEX
- Soci C., E. Bazile, F. Besson & T. Landelius "High-resolution precipitation re-analysis system for climatological purposes" Tellus (accepted l

MESCAN @ 2.5km avec guess AROMEvsARPEGE

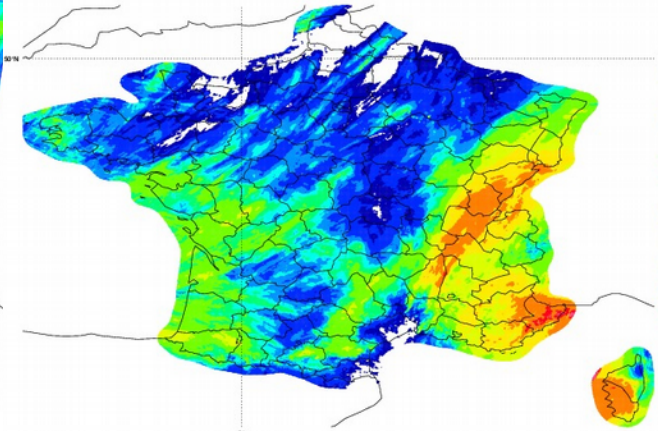
AROME FC 2013122506+24h



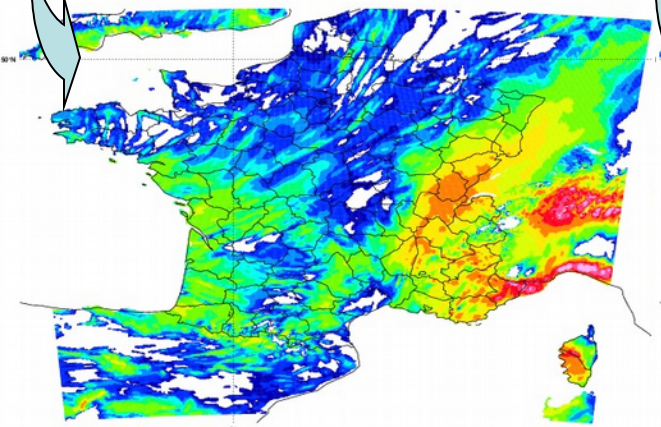
ARPEGE FC 2013122506+24h



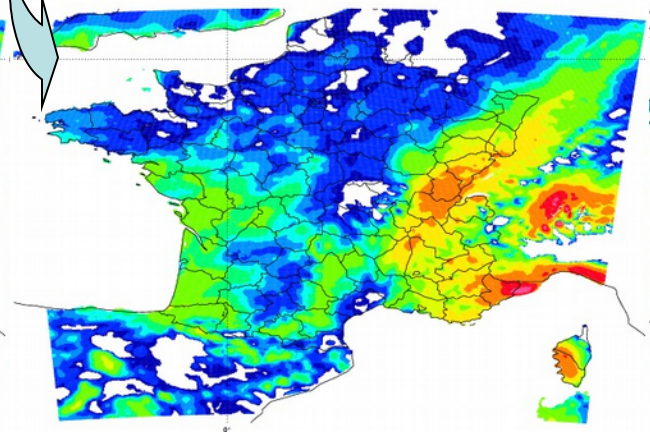
ANTILOPE



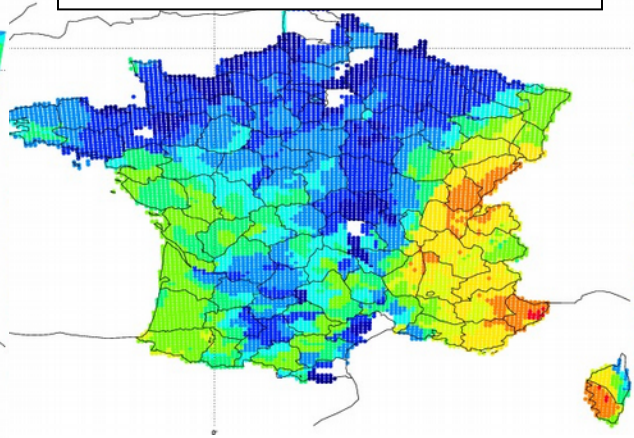
MESCAN 2013122506+24h

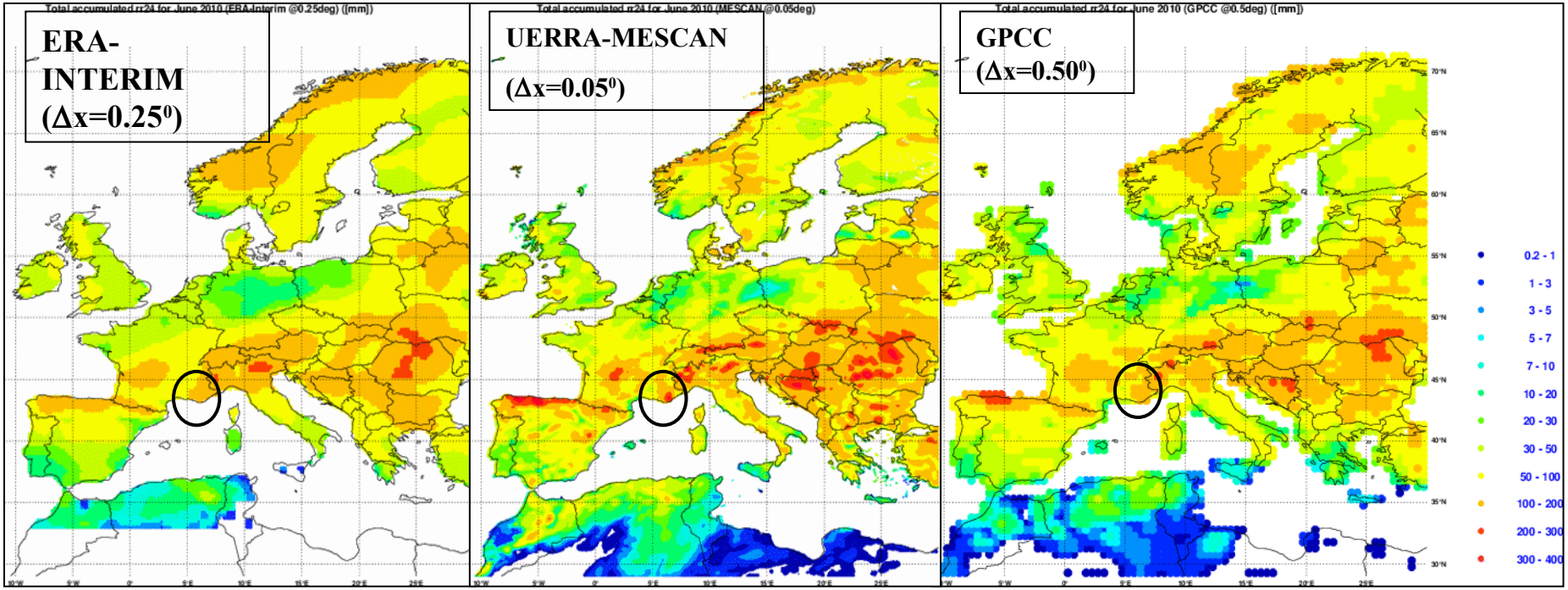


MESCAN 2013122506+24h



SAFRAN



From C. Soci (Workshop ALADIN/HIRLAM 2014)

Monthly mean RR24 analysis for June 2010: MESCAN vs ERA-Interim and GPCC