Inter-comparison of high-resolution surface reanalysis over France within EURO4M project

C. Soci, E. Bazile, T. Landelius, and F. Besson

ALADIN/HIRLAM meeting
Norrköping, 5-8 April 2011

Outline

- Objectives
- Framework
- Downscaling issues
- Scores: T2m, RH2m, and 24-h RR
- Preliminary conclusions

Objectives

- Assessing MESAN, SAFRAN and CANARI analysis systems
  - at high-resolution (Δx=5.5km)
  - over the same region (France)
  - using the same observational dataset
    - about 1300 observation of T2m and RR
    - 900 observations of RH2m
  - … and for the same period
    (Dec 2009-Jan 2010, and June 2010).

Framework

- Surface reanalyses of T2m, RH2m, and 24-h accumulated precipitation:
  - MESAN reanalysis performed for 00, 06, 12 and 18 UTC:
    - 1st guess: +6h HIRLAM forecast (downscaling from ~22km to 5.5 km)
  - SAFRAN reanalysis, once per day for the last 25 hours (starting from 6utc, current day):
    - 1st guess: ARPEGE analysis (downscaling from ~15km to 5.5 km)
  - CANARI reanalysis (only for T2m and RH2m) performed for 00, 06, 12 and 18 UTC:
    - 1st guess: +6h ARPEGE forecast (downscaling from ~15km to 5.5 km)
  - Observations over France within 1-h temporal window.

Framework (2)

- Method: optimal interpolation

1. **MESAN**

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

where,

- $d = 190km$ is the horizontal scale;
- $F_p(d_p)$, and $F_z(d_z)$ empirical functions for land-fraction and difference of height respectively.

2. **SAFRAN**

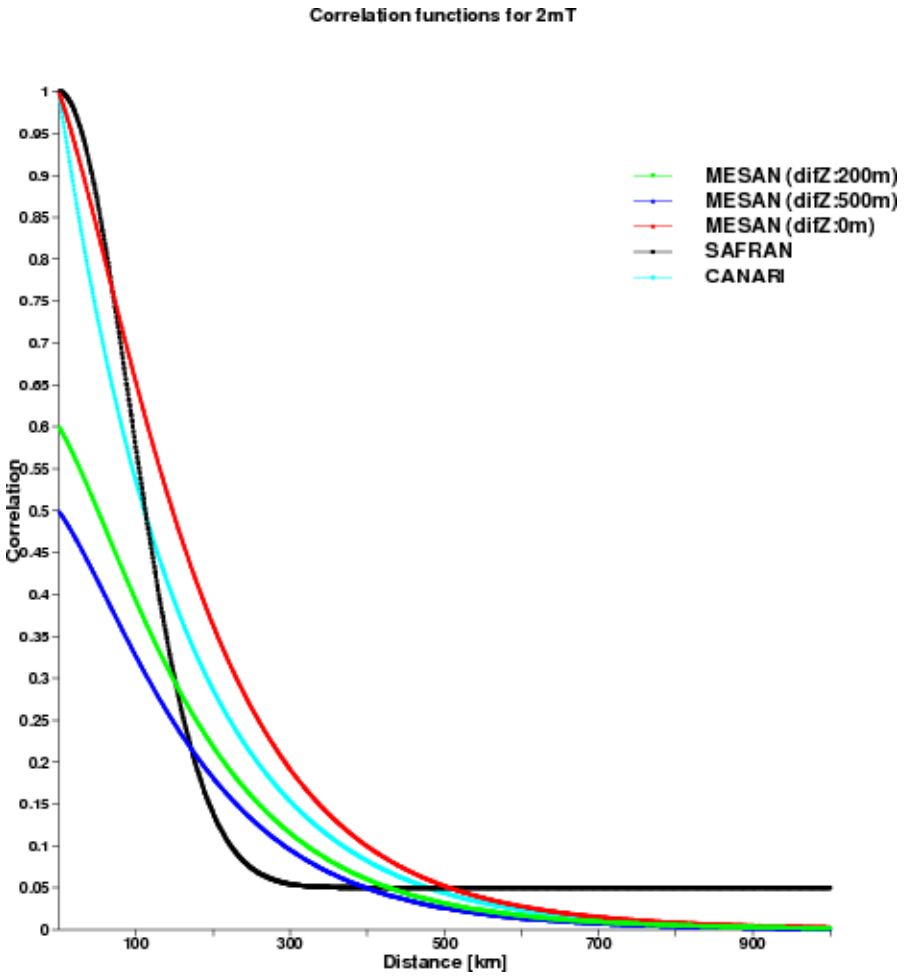
- $Corr(r) = f + (1 - f) \cdot e^{-\frac{r^2}{d^2}}$

f=0.05 denotes the large scale part of the signal, and d=130km.

3. **CANARI**

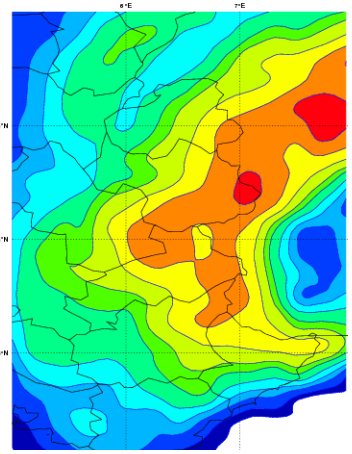
- $Corr(r) = e^{-0.5\frac{r}{d}}$

where, d=80km.

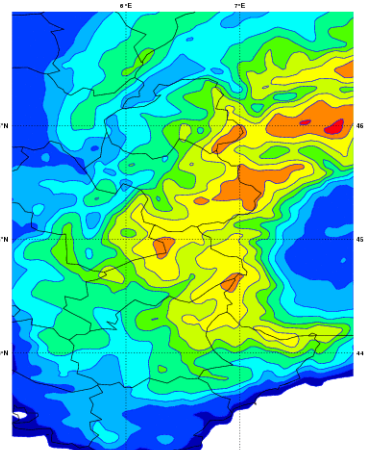


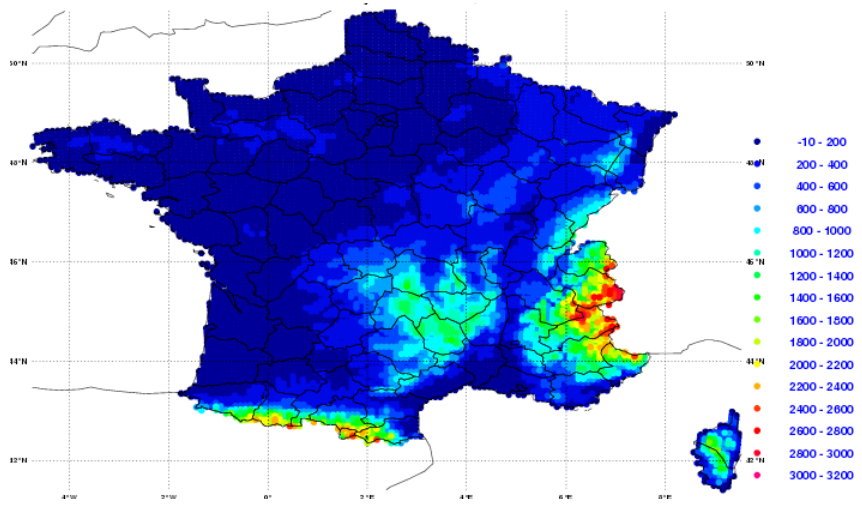
2D downscaling issues

Orography: 15km

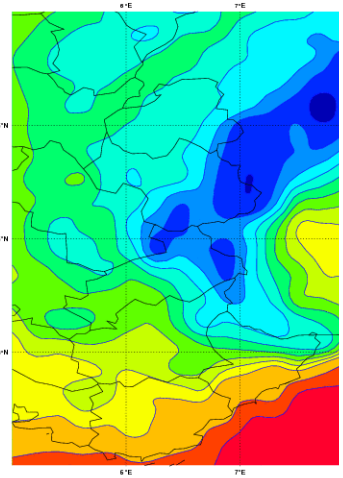


Orography: 5.5km

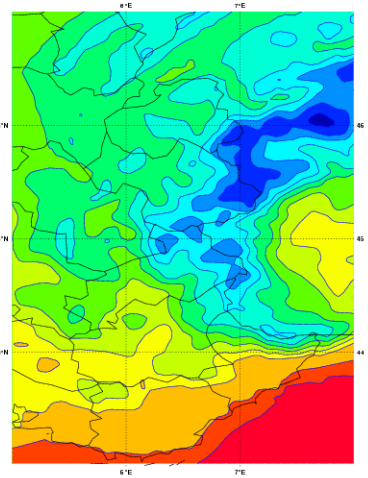




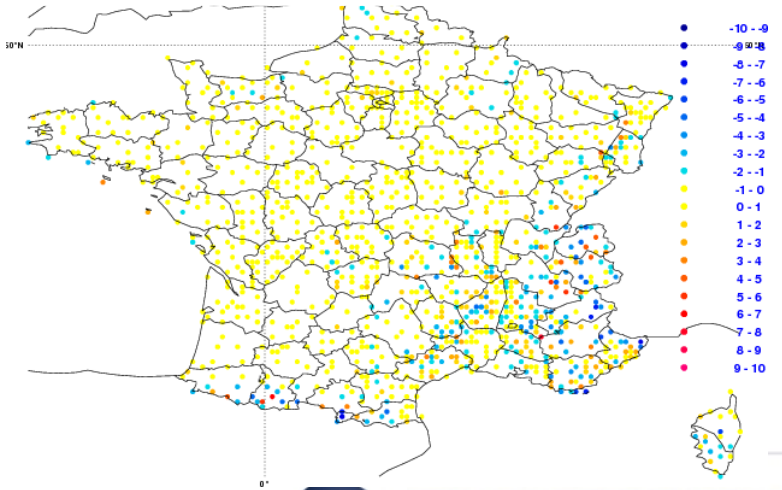
T2m 1st guess 15km
2009/12/15 00UTC+06h



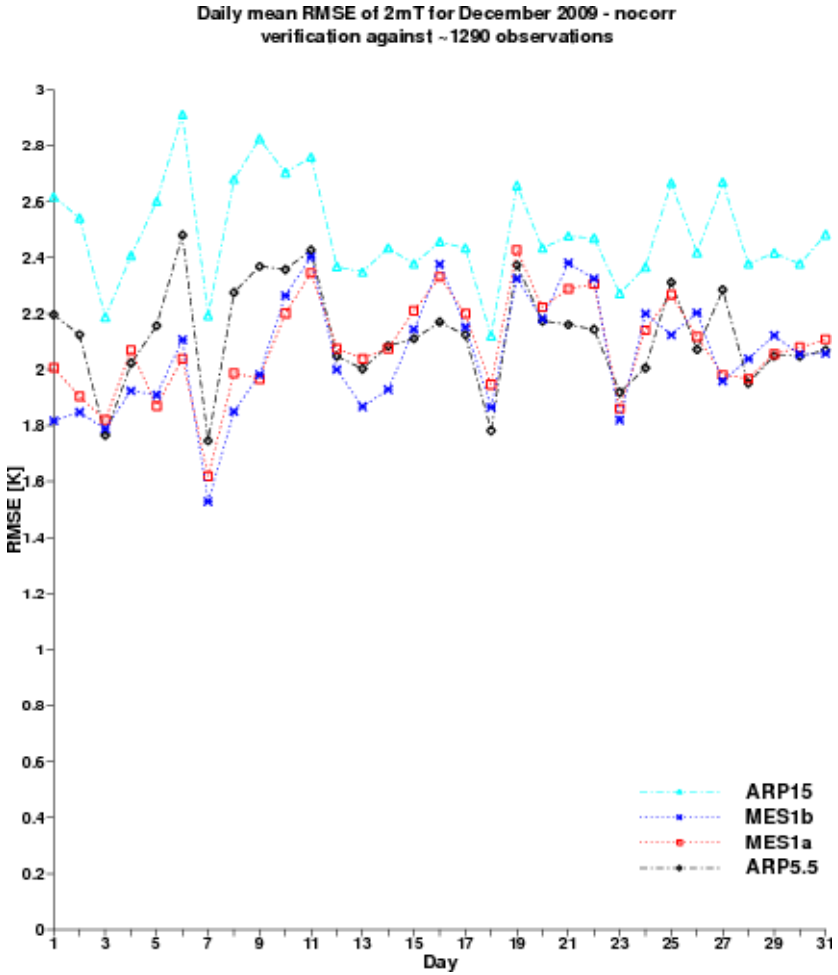
T2m 1st guess 5.5km
2009/12/15 00UTC+06h

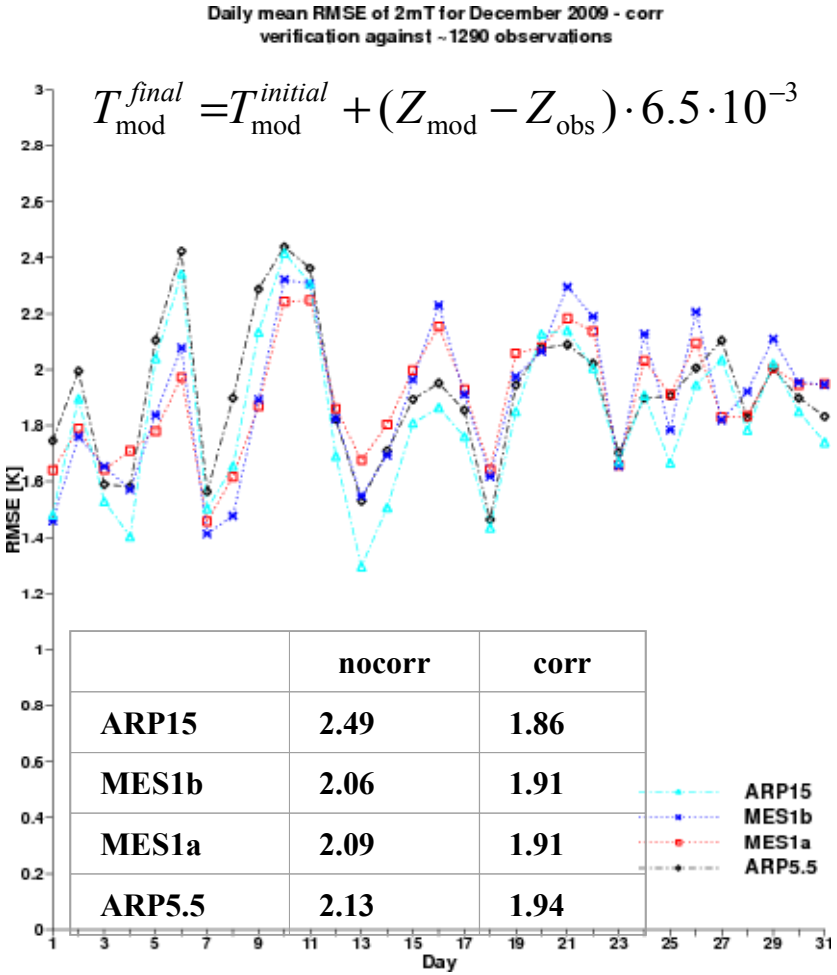


- Errors of T2m are important over high orography and along the coasts



2D downscaling issues – which first guess? (verification against ~1290 obs)

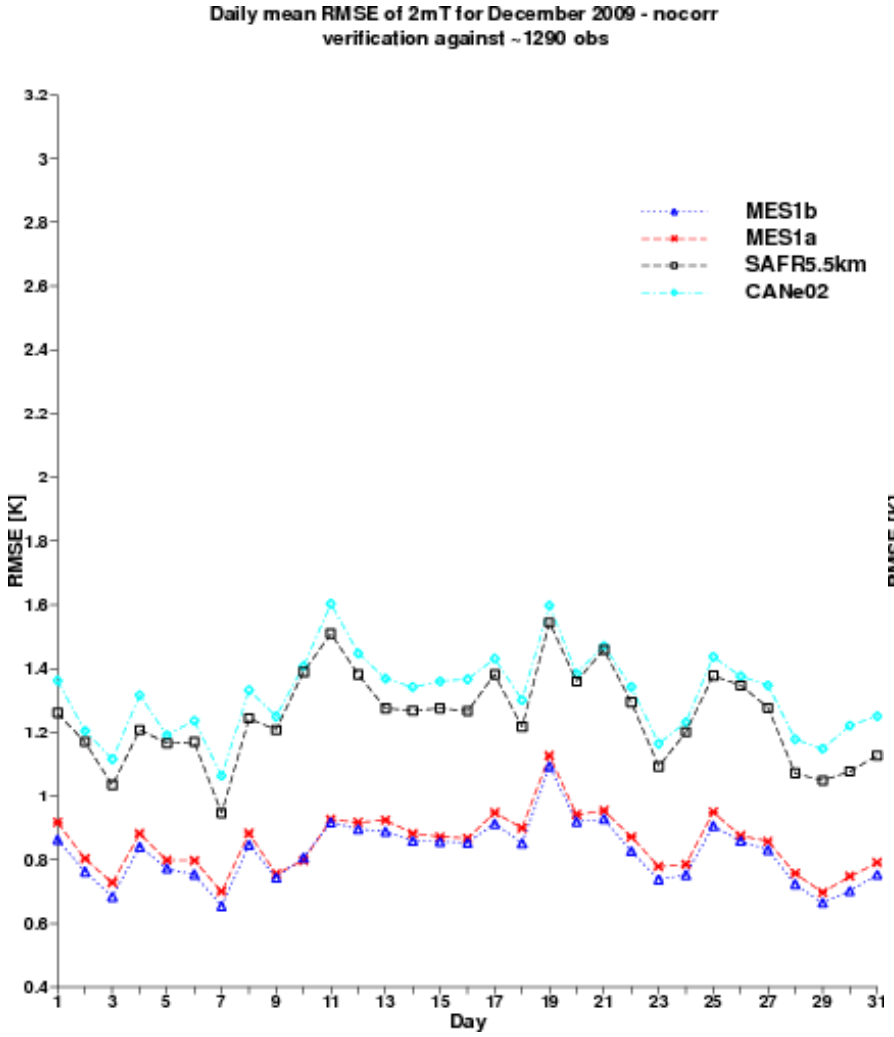


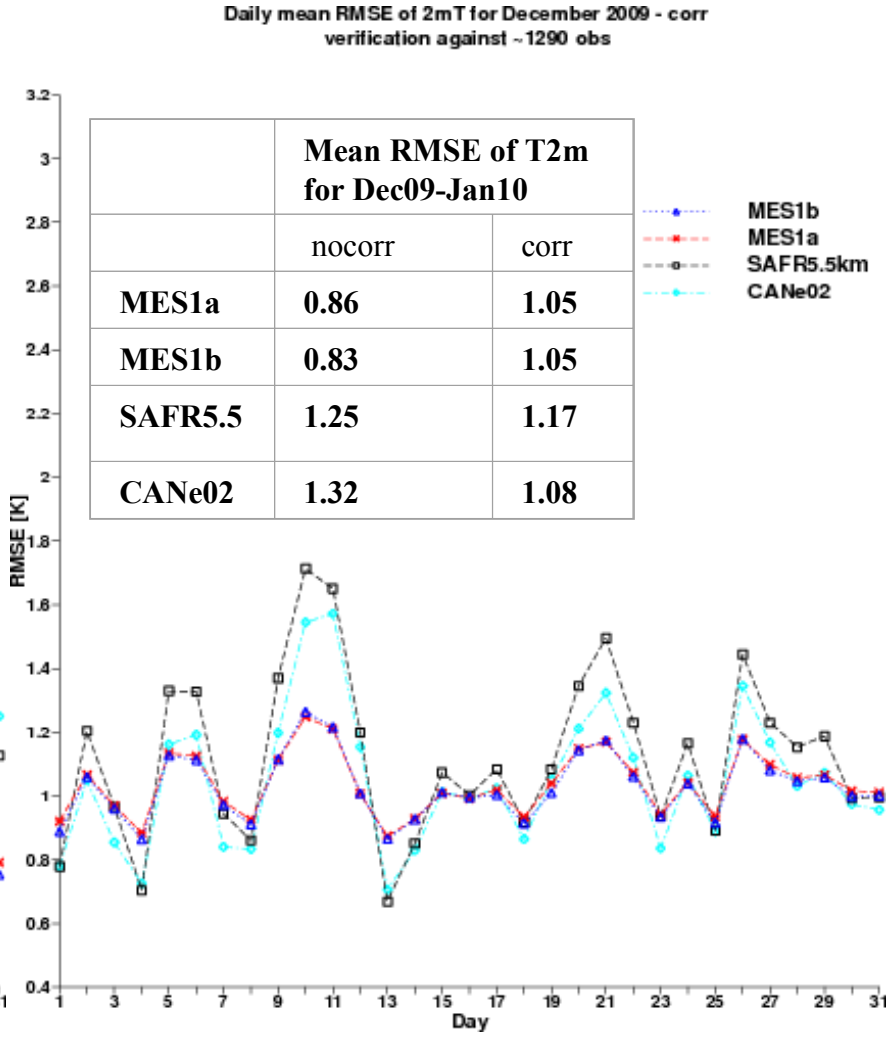


$$T_{\mathrm{mod}}^{final} = T_{\mathrm{mod}}^{initial} + (Z_{\mathrm{mod}} - Z_{\mathrm{obs}}) \cdot 6.5 \cdot 10^{-3}$$

	nocorr	corr
ARP15	2.49	1.86
MES1b	2.06	1.91
MES1a	2.09	1.91
ARP5.5	2.13	1.94

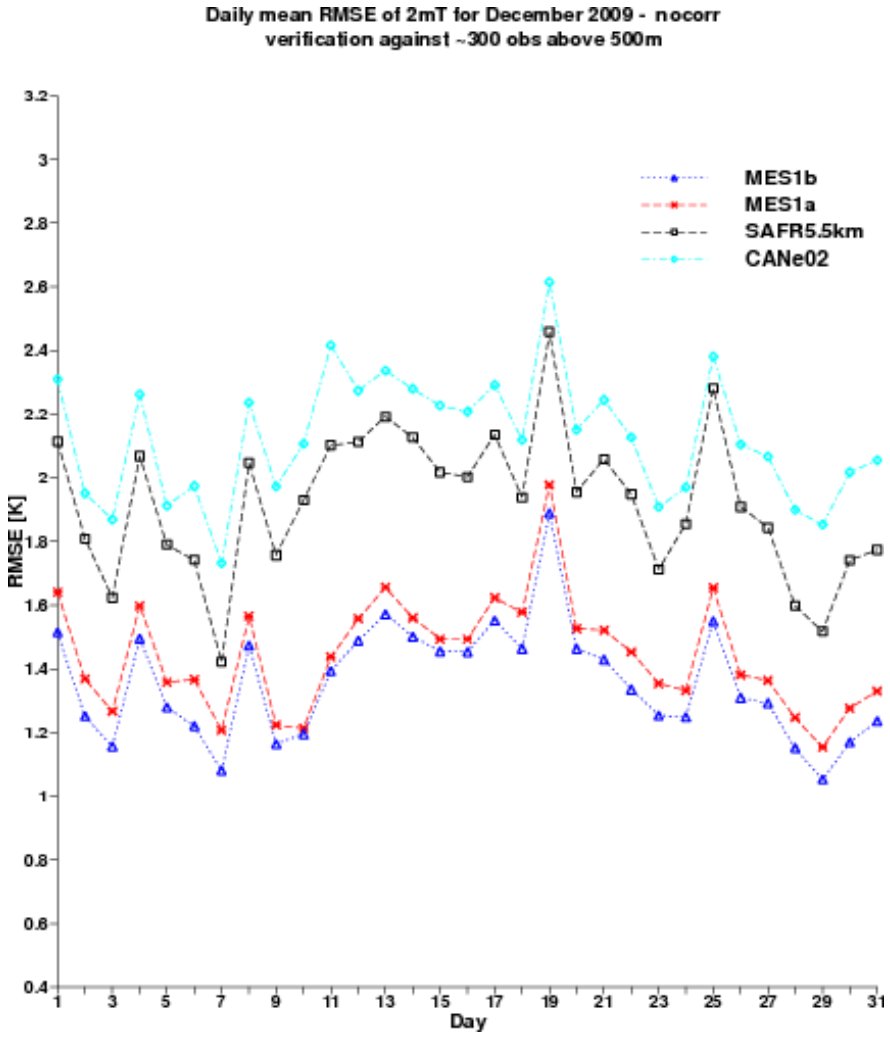
SCORES: Daily mean RMSE of T2m for December 2009 (verification against ~1290 obs)

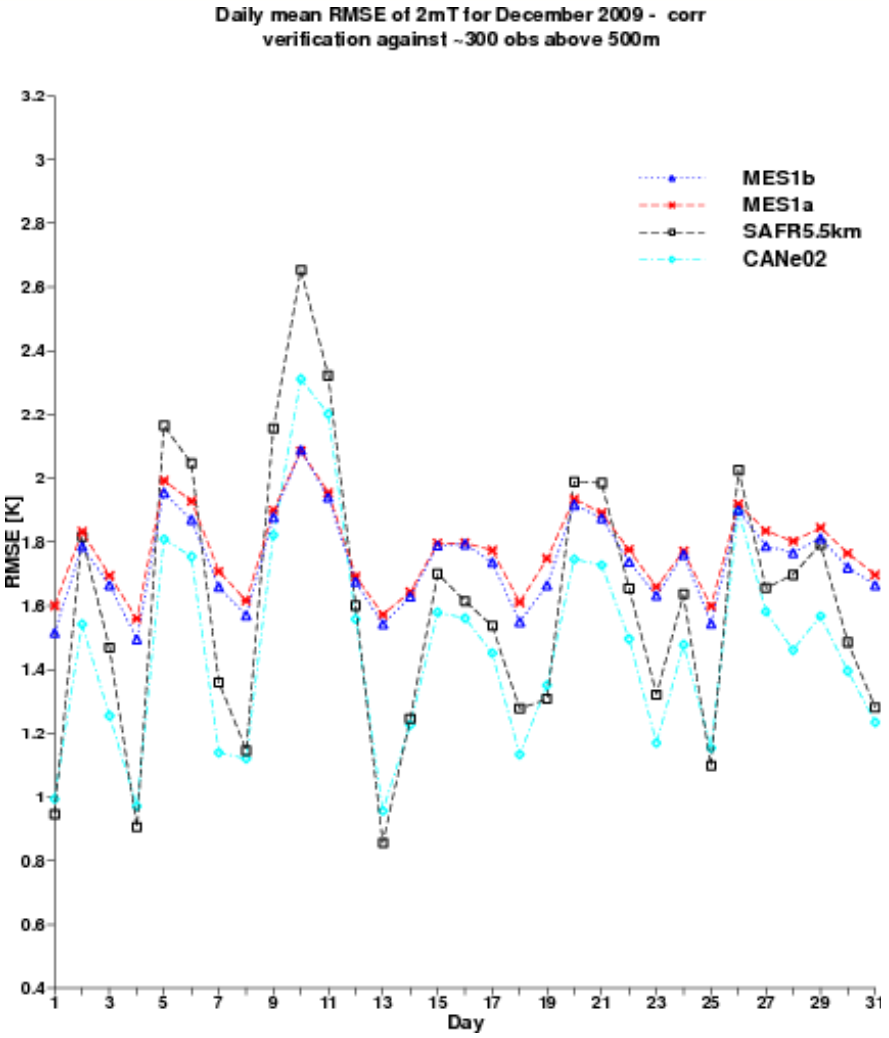




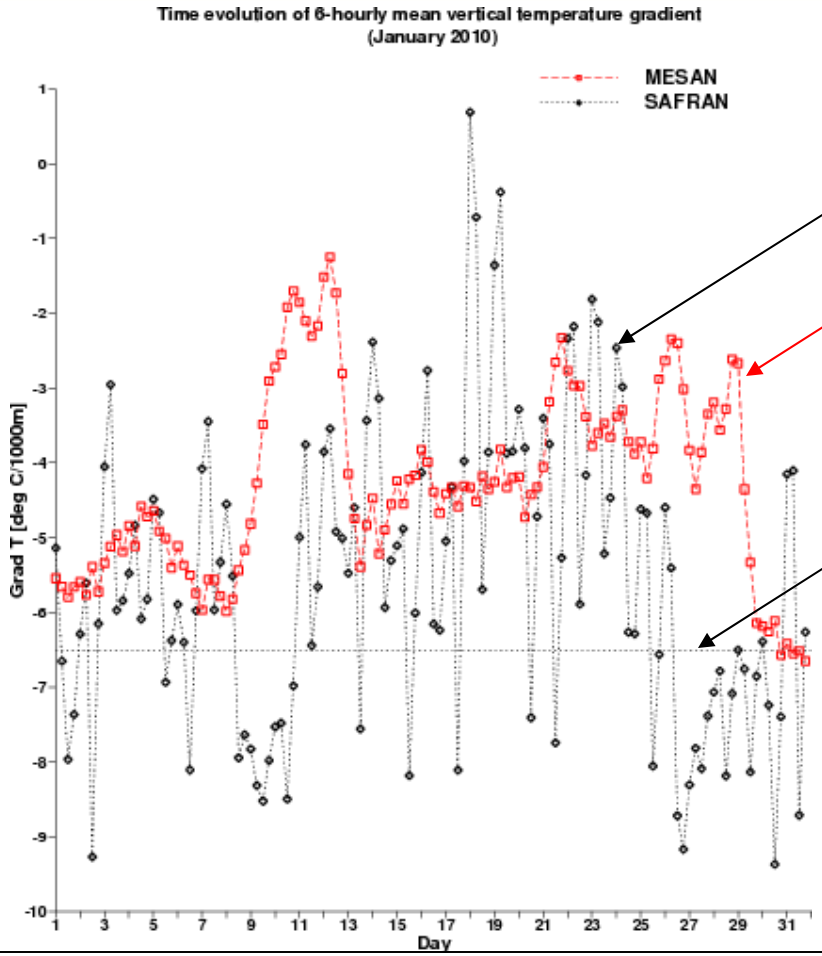
	Mean RMSE of T2m for Dec09-Jan10	
	nocorr	corr
MES1a	**0.86**	**1.05**
MES1b	**0.83**	**1.05**
SAFR5.5	**1.25**	**1.17**
CANe02	**1.32**	**1.08**

SCORES: Daily mean RMSE of T2m for December 2009 (observations above 500m)





6-hourly mean vertical temperature gradient computed in MESAN and SAFRAN



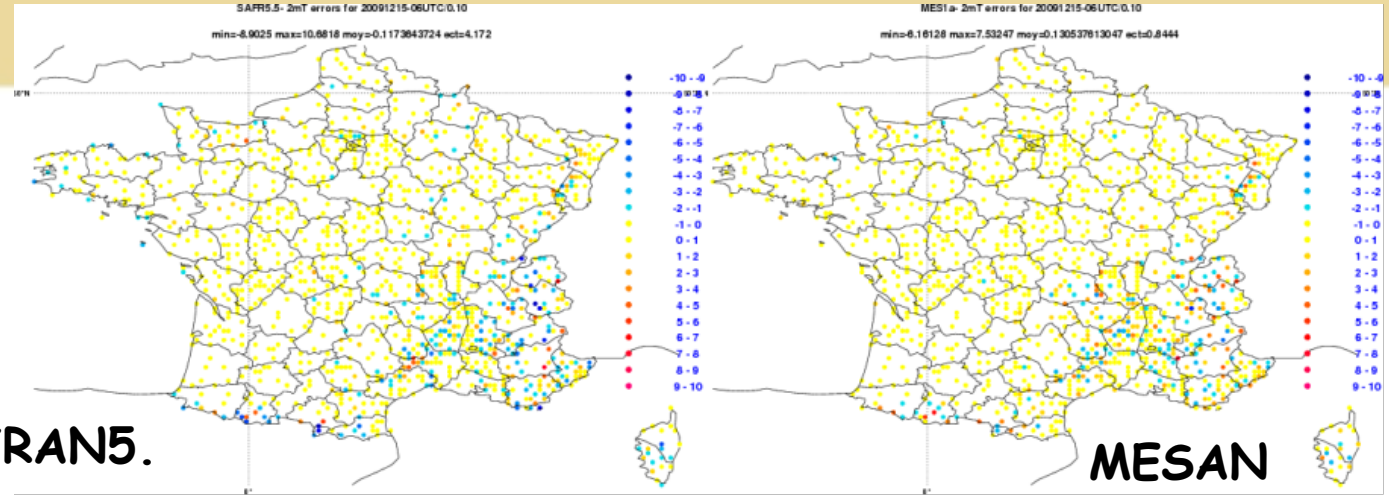
SAFRAN

MESAN

Standard vertical temperature gradient

- The analysis of T2m has to take into account the vertical profile of the atmosphere between the model height and the observation elevation.

T2m errors - important over high orography and along the coasts



(Hobs > 500m)

	DECEMBER-JANUARY				JUNE			
	BIAS		RMSE		BIAS		RMSE	
	corr	nocorr	corr	nocorr	corr	nocorr	corr	nocorr
SAFR5.5	0.11	0.03	1.77	1.96	-0.004	-0.12	1.48	2.32
MES1a	0.38	0.26	1.83	1.46	0.43	0.28	1.75	1.65
MES1b	0.32	0.21	1.80	1.38	0.37	0.23	1.71	1.53
MES1c	0.32	0.20	1.80	1.38	0.37	0.23	1.70	1.54
CANe02	-0.03	-0.11	1.60	2.15	-0.08	-0.19	1.41	2.40
SAFR5.5A	0.03	0.03	0.95	0.95	0.01	0.01	0.88	0.88

SCORES: 2mT
(verification against ~1290 observations)

	DECEMBER-JANUARY				JUNE			
	BIAS		RMSE		BIAS		RMSE	
	corr	nocorr	corr	nocorr	corr	nocorr	corr	nocorr
SAFR5.5	0.04	-0.07	1.17	1.25	0.01	-0.11	1.10	1.44
MES1a	0.21	0.09	1.05	0.86	0.19	0.07	1.05	1.00
MES1b	0.20	0.08	1.05	0.83	0.19	0.06	1.04	0.96
MES1c	0.20	0.08	1.04	0.82	0.19	0.06	1.04	0.96
CANe02	-0.01	-0.13	1.08	1.32	0.001	-0.13	1.06	1.48
SAFR5.5A	~0.00	~0.00	0.83	0.83	~0.00	~0.00	0.86	0.86

SCORES: RH2m
(verification against ~930 observations)

(Hobs>500m)	DECEMBER-JANUARY		JUNE	
	BIAS [%]	RMSE [%]	BIAS [%]	RMSE [%]
SAFR5.5	-0.92	10.47	0.31	8.65
SAFR5.5A	-0.77	6.16	0.24	5.97
MES3a	0.05	8.75	-0.13	7.39
CANe02	0.06	10.06	0.08	8.42

1) Verification against all available observations:

a) December-January

- Bias[%] between -0.15 and +0.15
- RMSE[%] between 5 and 6.5

b) June

- Bias[%] between ~0 and 1
- RMSE[%] between 6 and 7

2) Verification against the available observations below 500m:

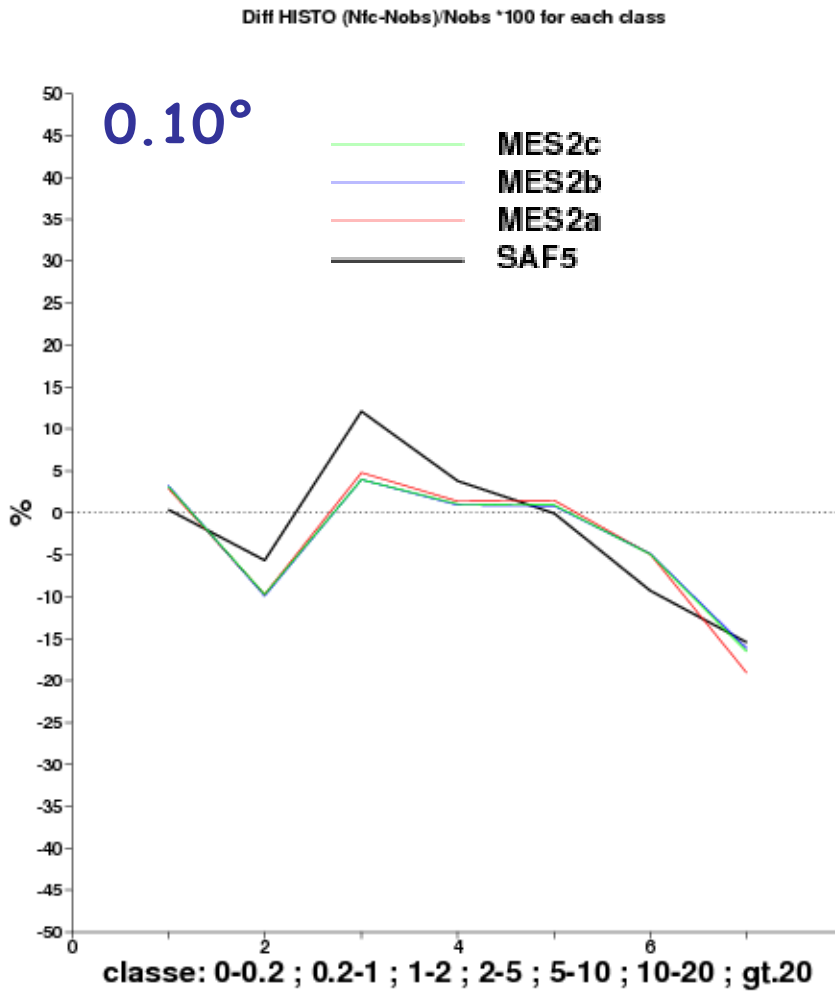
a) December-January

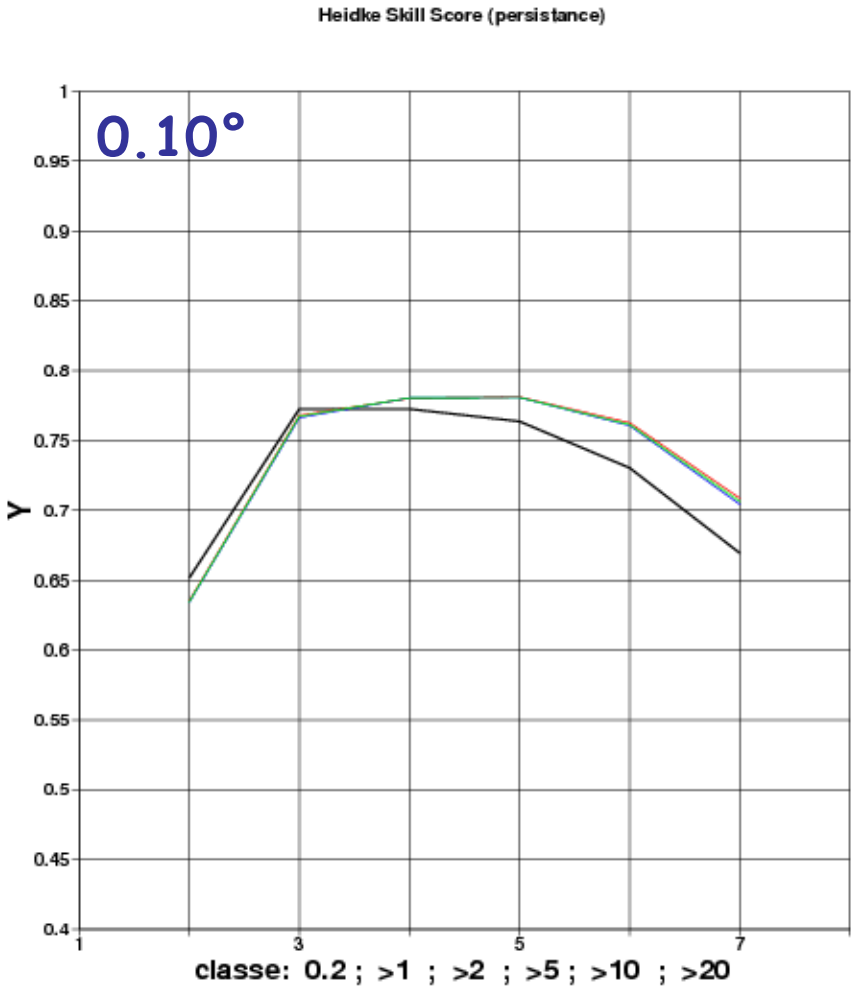
- Bias[%] is around 0%
- RMSE[%] between 4 and 5

b) June

- Bias[%] between ~0 and 1.5
- RMSE[%] between 5 and 6

SCORES: Verification of precipitation





Preliminary conclusions

- MESAN and SAFRAN analysis systems behave reasonably well (in terms of Bias and RMSE), however:
  1. T2m scores depend on correction/no correction with the standard vertical temperature gradient;
  2. scores are time-dependent (e.g. larger errors at 0600 UTC).

- The performance of the 2-D analysis system dependent on:
  1. 1st guess quality;
  2. the downscaling method;
  3. the complexity of both description of the land-sea fraction, and the vertical atmospheric profile.

Further work

- Coding in CANARI the structure functions used in MESAN for analyzing T2m and RH2m;
- Improving the downscaling method for T2m and RH2m (account for the vertical structure of the atmosphere);
- Analyzing in CANARI the Tx/Tm, and 24-h accumulated precipitation.

Acknowledgements

The research leading to these results has received funding from the European Union, Seventh Framework Programme (FP/2007-2013) under grant agreement n° 242093.

Questions/Discussions?