SEVIRI & SYNOP data assimilation

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LACE
nwp central europe

Acknowledgement: Gergely Bölöni, Roger Randriamampianina (HMS),
Thibaut Montmerle (Météo France)

Overview

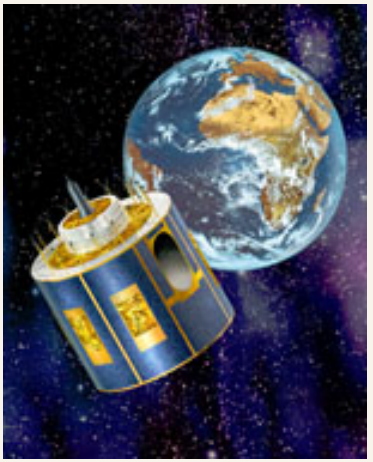
- Introduction
  - assimilation of SEVIRI data
  - experimental settings
  - impact of SEVIRI (upper-air scores)
- Impact of SEVIRI on precipitation
- Impact of SEVIRI & SYNOP
  - upper-air scores against observations
  - precipitation scores
  - upper-air scores against ECMWF analyses
- Conclusions

Assimilation of SEVIRI data

The Spinning Enhanced Visible & Infrared Imager observes the Earth in 12 spectral bands in visible light and infrared and delivers a picture every 15 minutes.

Essentials following development of Montmerle (2005)

- Ts channels 3.9 μm, 6.2 μm, 7.3 μm, 8.7 μm, 9.7 μm, 10.8 μm, 12.0 μm, 13.4 μm
- the associated constant fields: date, longitude and latitude position, azimuth and zenith angles
- the cloud type and cloud top pressure with theirs quality flags provided by SAF NWC (as IR channels are used in clear sky conditions and WV channels above mid-level clouds)



- 3.9 μm, 9.7 μm and 13.4 μm channels blacklisted
- one pixel of 5 extracted from SEVIRI data set
- thinning box of 70 km
- air-mass bias correction

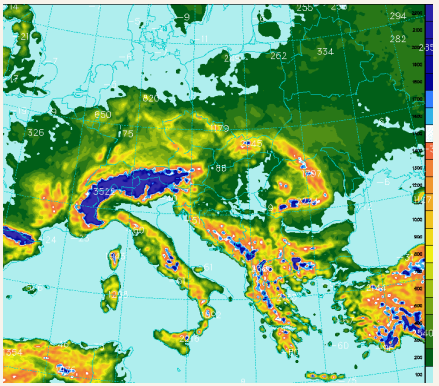
Experimental settings

impact studies

- impact of SEVIRI (with all obs and on the top of SYNOP and TEMP)
- tuning of SEVIRI observation errors
- NMC vs ensemble B matrix
- period from 20060826 till 20060923 (2 days warm-up + 27 days)
- 48 hours forecast from 00 UTC analysis

main characteristic of ALADIN/HU 3D-VAR system:

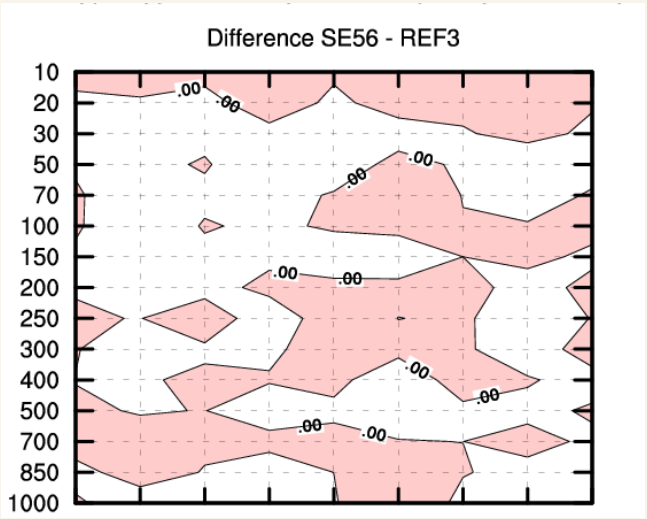
- ARPEGE/ALADIN cycle 30t1
- linear grid, 8km horizontal resolution and 49 vertical levels
- domain covers roughly the same area as LACE
- 6h assimilation cycle (00, 06, 12, 18 UTC)
- surface (soil) analysis is taken from ARPEGE - long cut-off analysis
- upper air fields are provided by the 3DVAR analysis
- B matrix is computed with ensemble method



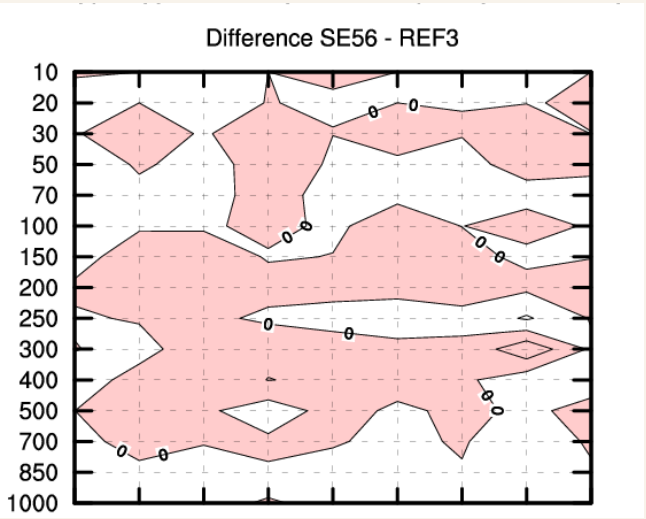
used observations:

- SYNOP surface reports (geopotential)
- TEMP upper air reports (temperature, wind, geopotential, specific humidity)
- ATOVS satellite observations (AMSU-A and AMSU-B radiance)
- AMDAR aircraft reports (temperature, wind)
- AMV atmospheric motion vector

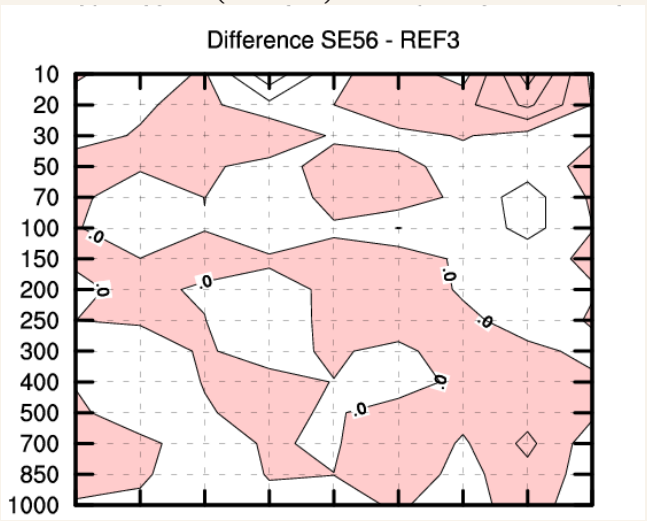
Impact of SEVIRI - RMSE differences



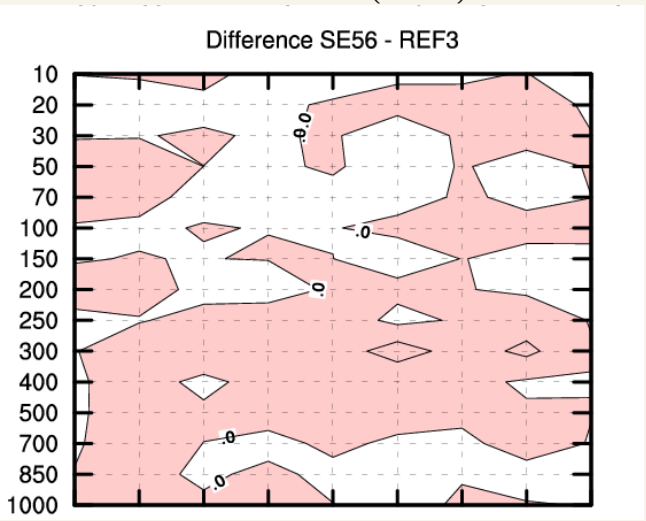
T $(\approx 0.1K)$



RH $(\approx 1\%)$



ϕ $(\approx 1m^2s^{-2})$



V $(\approx 0.2m/s)$

Impact of SEVIRI - significance test

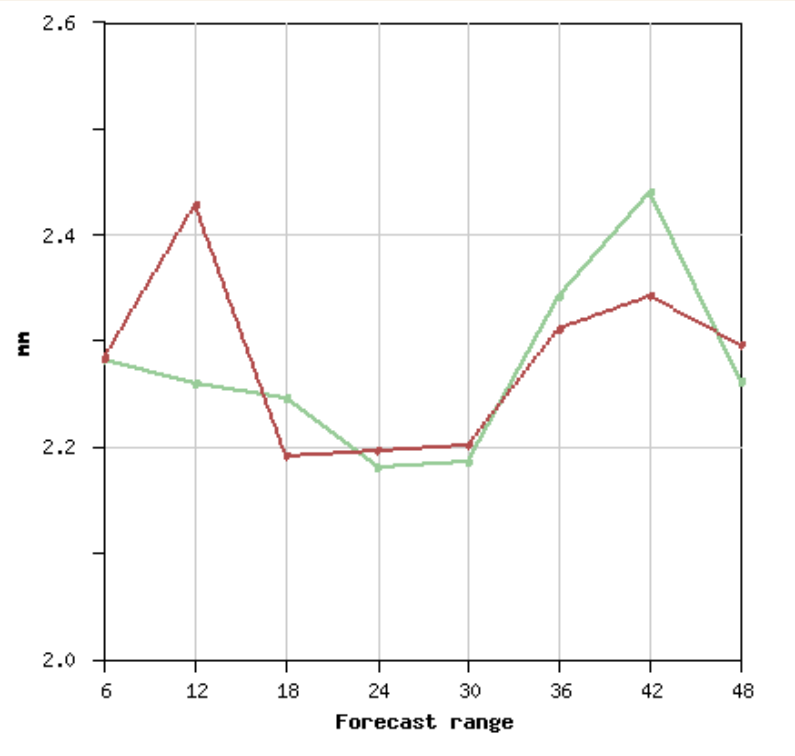
Parameter	Forecast	Significance at 90%	Parameter	Forecast	Significance at 90%
RH2m	+00H	worse	ϕ 700 hPa	+30H	**better**
	+18H	worse	RH 700 hPa	+42H	worse
V 10m	+48H	worse	V 700 hPa	+36H	worse
ϕ 1000 hPa	+12H	worse	RH 400 hPa	+24H	**better**
RH 1000 hPa	+00H	worse	V 300 hPa	+30H	**better**
ϕ 850 hPa	+12H	worse	RH 250 hPa	+30H	worse
RH 850 hPa	+24H	worse	V 250 hPa	+24H	**better**

List of parameters and forecast ranges where SEVIRI performs better/worse than REF3 in terms of RMSE scores against observation with significance 90 % two side confidence interval significance test.

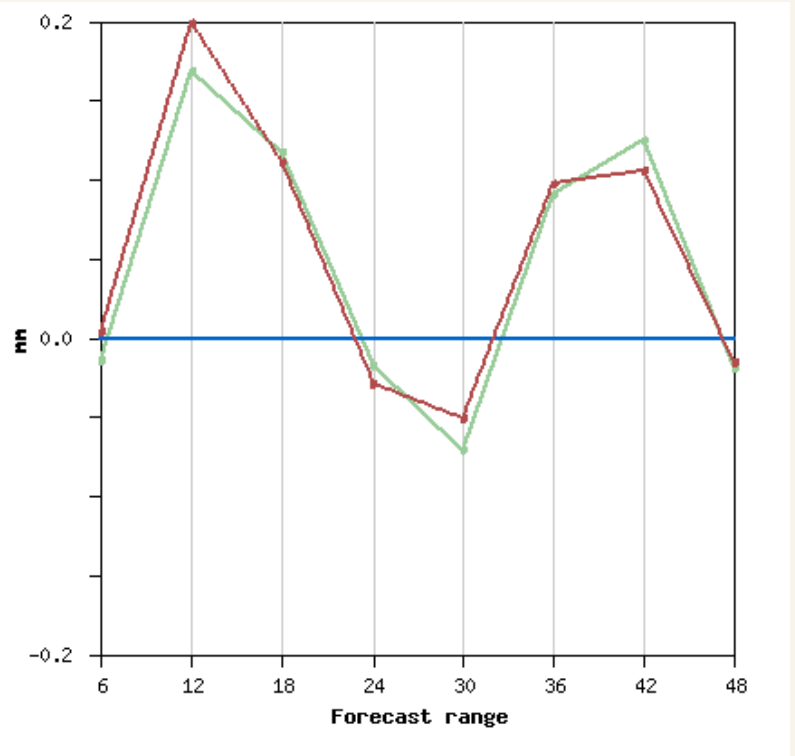
Resume

- **generally small impact of SEVIRI data**
- **different impact depending on parameter and model levels**
- **most undesirable degradation appear near the surface**

Impact of SEVIRI on 6h-precipitation



RMSE



BIAS

reference in green and SEVIRI added in brown color

Precipitation scores

		Observed yes	Observed no	Total
Forecast	yes	***hits***	***false alarms***	***forecast yes***
	no	***misses***	***correct negatives***	***forecast no***
Total		***observed yes***	***observed no***	***total***

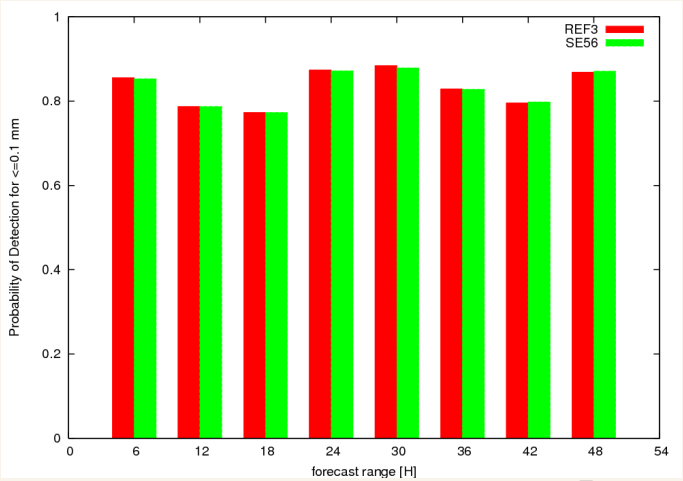
Following scores for thresholds for 6h precipitation

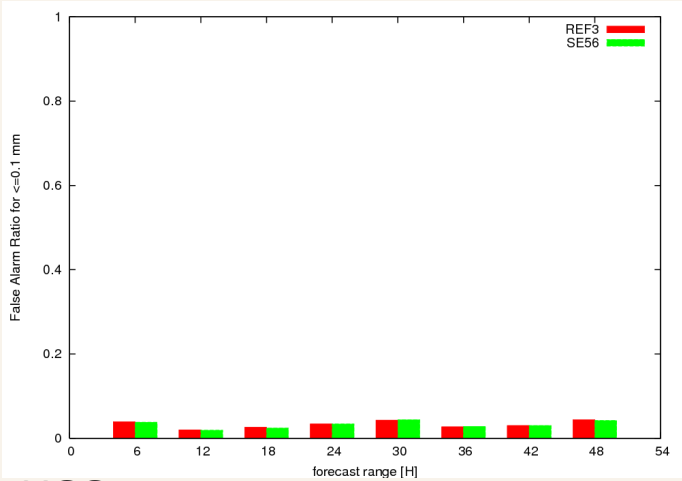
$<= 0.1mm$
$<= 2mm$
$<= 10mm$
$> 10mm$

- **Percent Correct (PC = (hits + rejections) / total sum)**
  range of PC is $< 0,1 >$, a perfect score = 1
- **False Alarm Ratio (FAR = false alarms / forecast yes)**
  range of FAR is $< 1,0 >$, a perfect score = 0
- **Probability of Detection (POD = hits / observed yes)**
  range of POD is $< 0,1 >$, a perfect score = 1
- **Bias or Frequency Bias (B = forecast yes / observed yes)**
  range of B is $< 0, infinity >$, an unbiased score = 1
- **Heidke Skill Score (HSS . . . PC adjusted to eliminate forecast which are correct due to random chance)**
  range of HSS is $< -infinity, 1 >$, a perfect score = 1, no skill forecast = 0

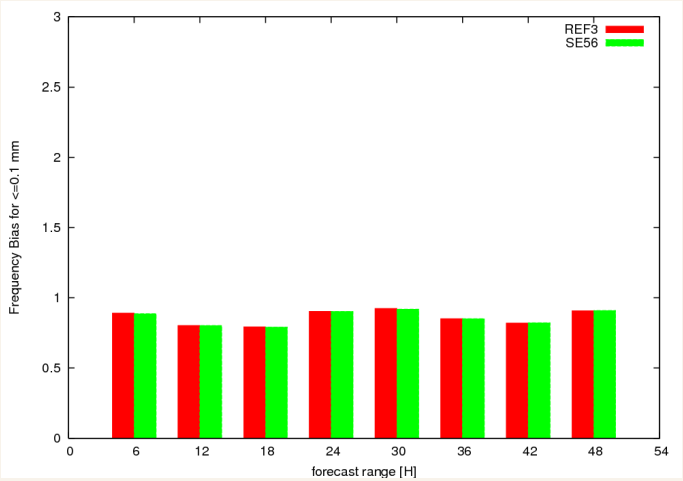
Impact of SEVIRI on 6h-precipitation $< 0.1mm$

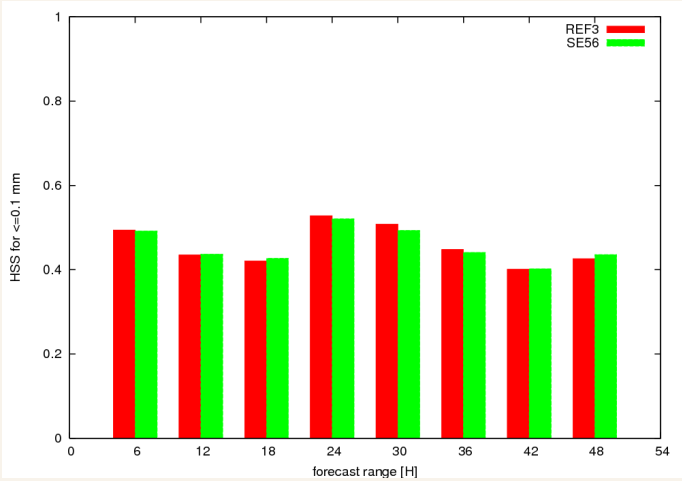
POD and FAR





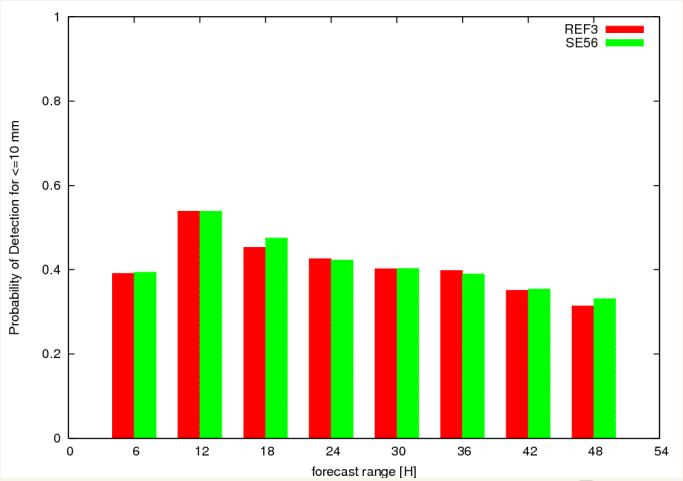
B and HSS

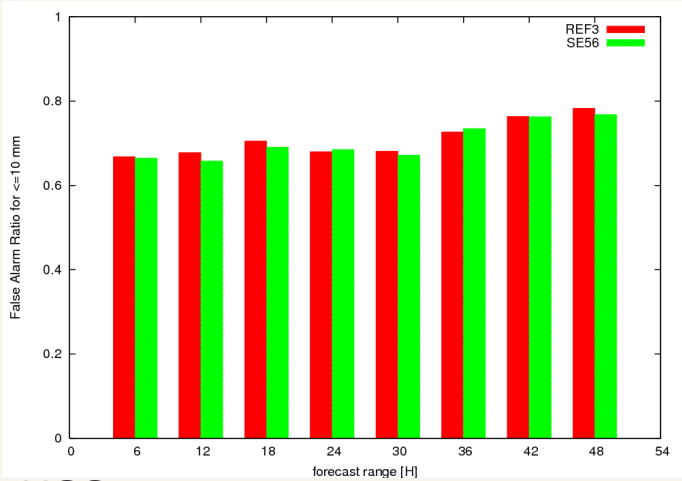




Impact of SEVIRI on 6h-precipitation $<= 10mm$

POD and FAR





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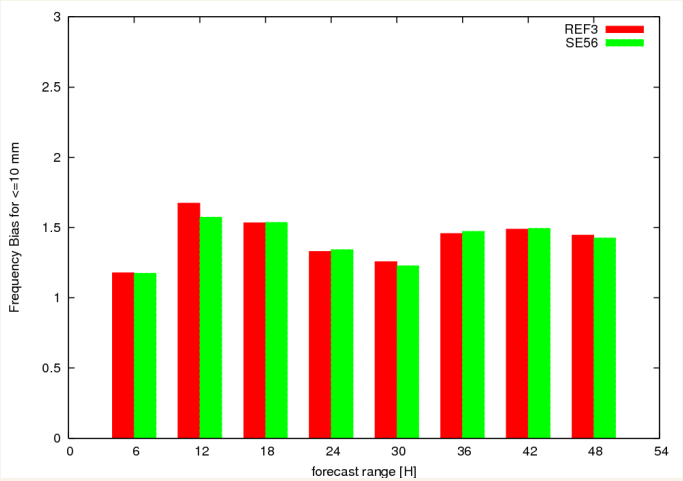
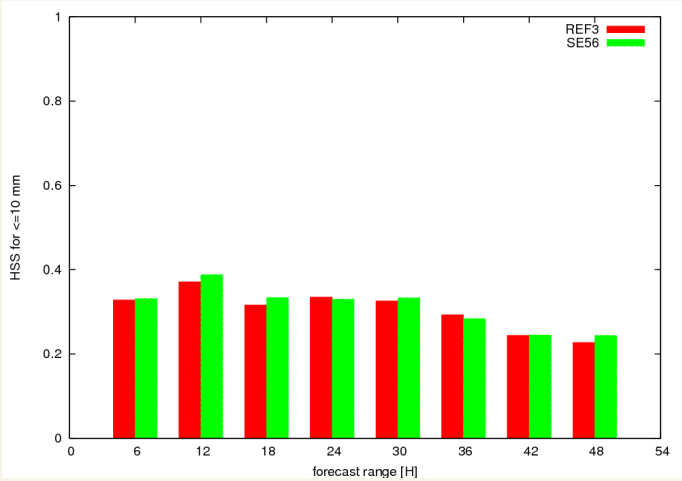
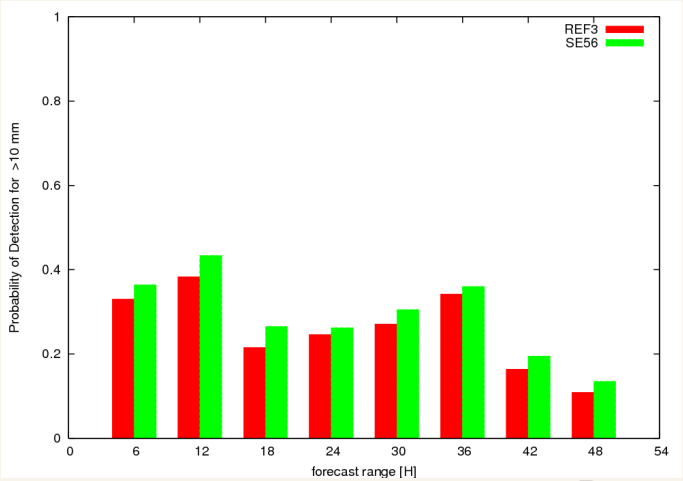
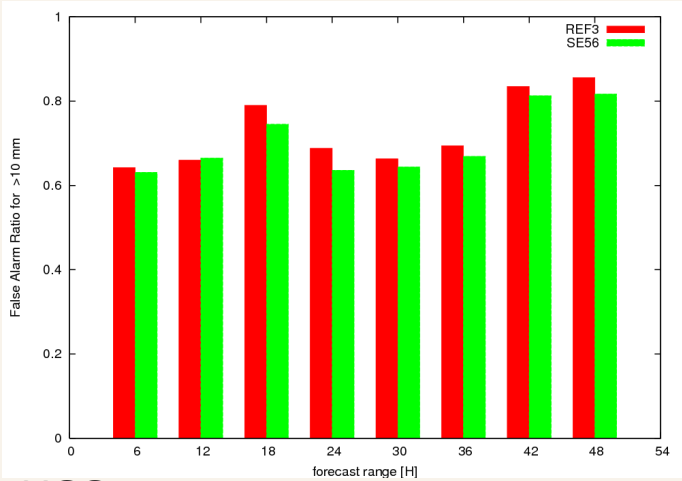




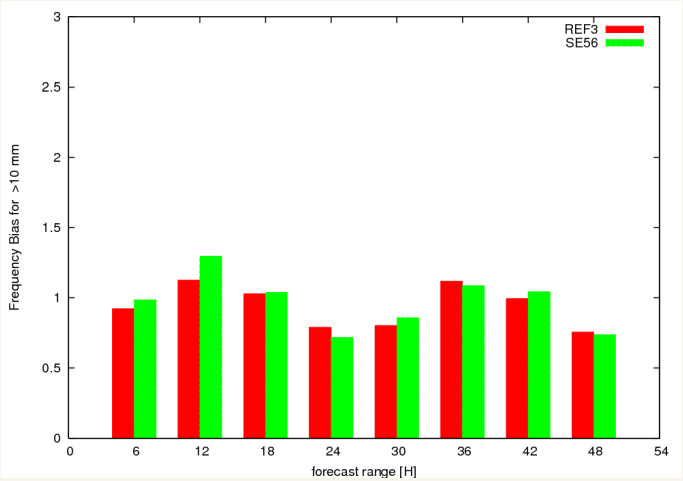
Impact of SEVIRI on 6h-precipitation $> 10mm$

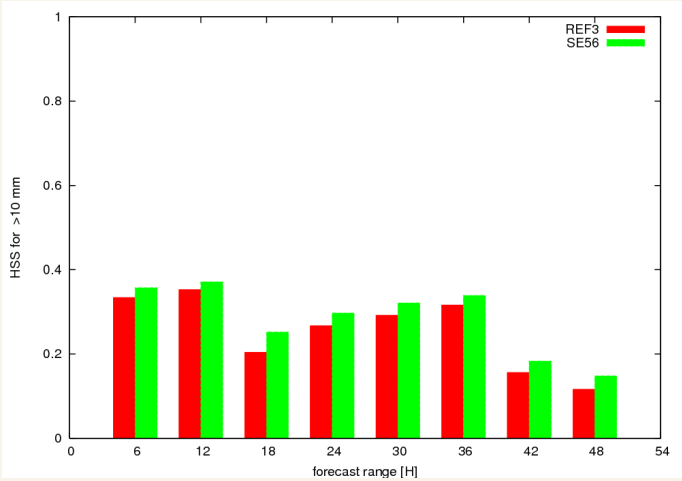
POD and FAR





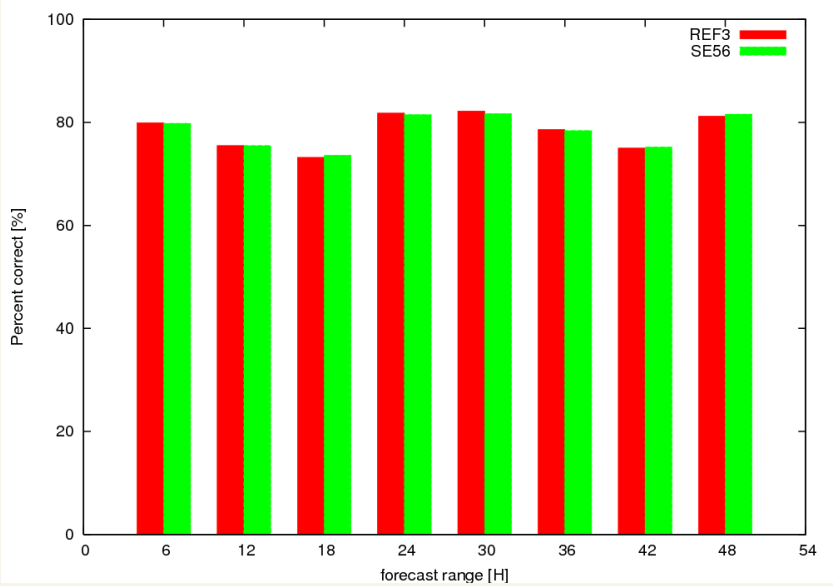
B and HSS

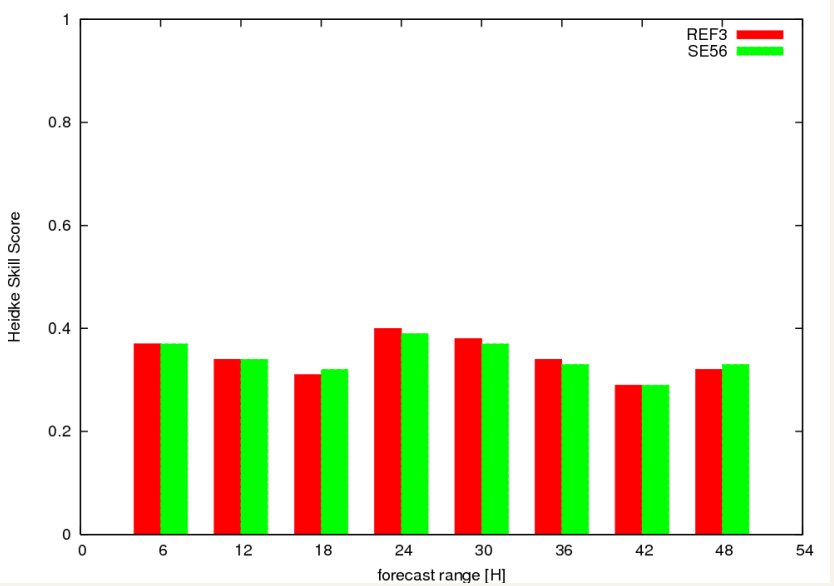




Impact of SEVIRI on 6h-precipitation

Overall PC and HSS - single score for all thresholds at given time range





Reference experiments is in red and SEVIRI added in green color

Resume

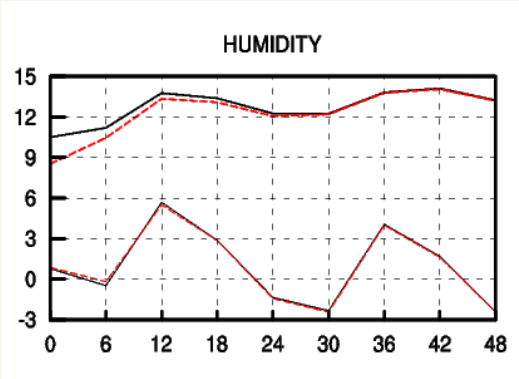
- small differences in overall scores PC
  (for +18H reference 73.2%, SEVIRI added 73.6 %)
- an improvement with SEVIRI data for 6h-precipitation more than 10 mm

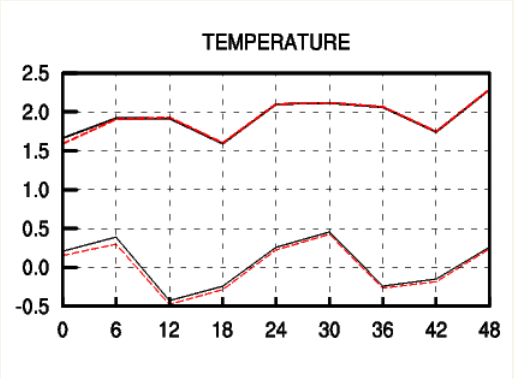
SEVIRI & SYNOP

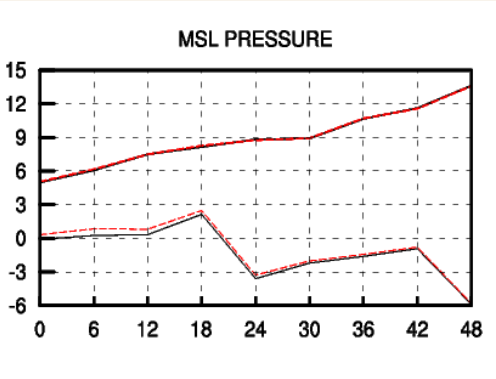
Use of SYNOP

- up to now ϕ only
- assimilation of 2m measurements potentially dangerous due to background error structure functions

Combination of SEVIRI and SYNOP (T2m and RH2m) observations following development done at Météo France

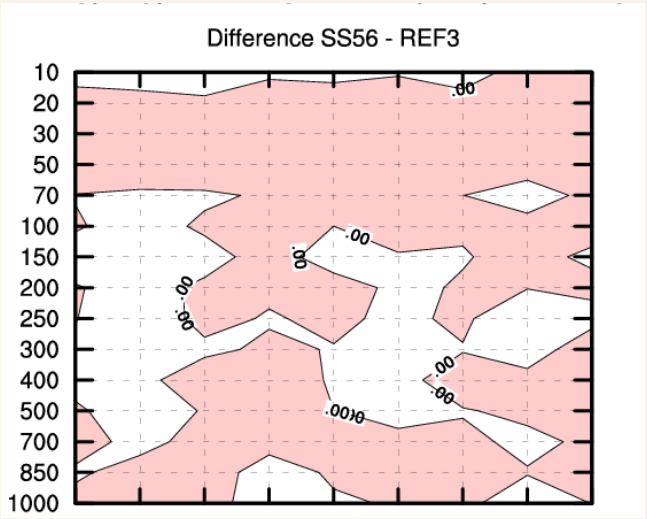




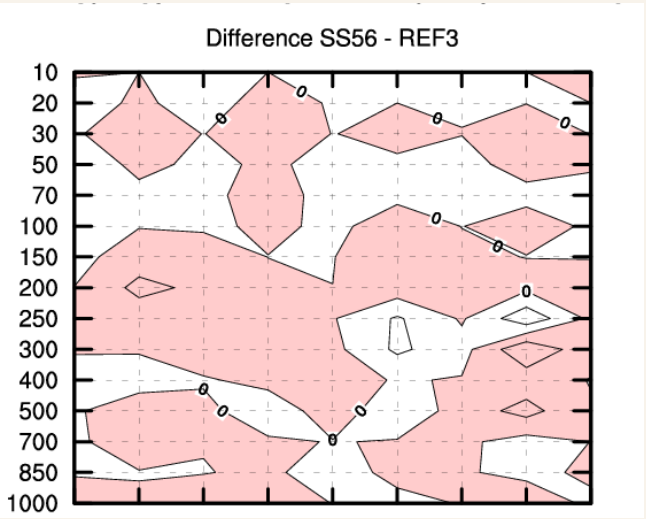


RMSE and BIAS SEVIRI & SYNOP in red color and reference in black.

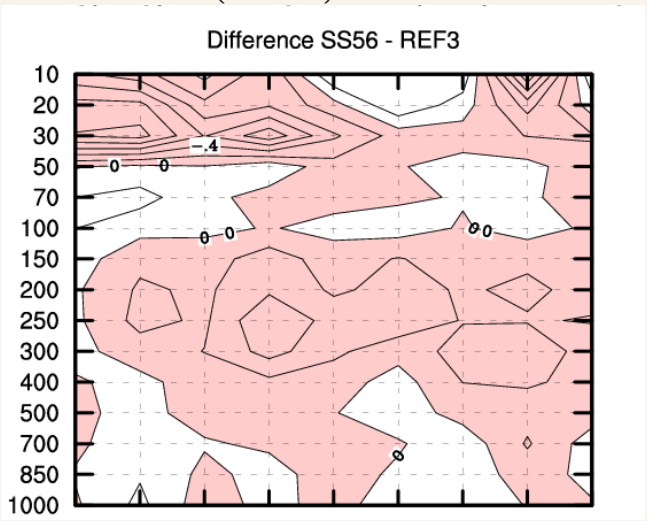
Impact of SEVIRI & SYNOP - RMSE differences



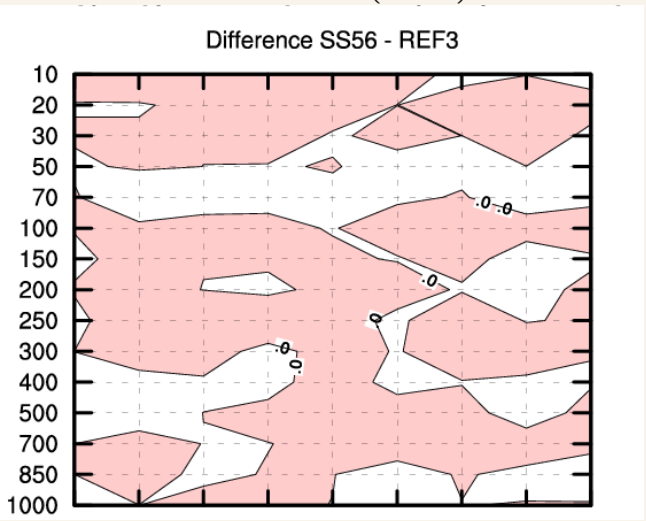
T $(\approx 0.1K)$



RH $(\approx 1\%)$



ϕ $(\approx 1m^2s^{-2})$



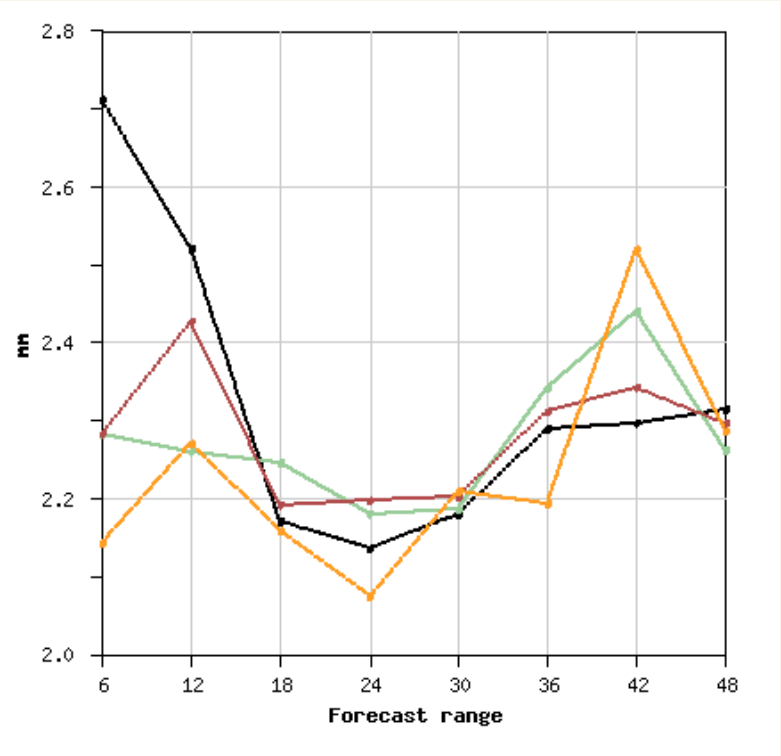
V $(\approx 0.2m/s)$

Impact of SEVIRI & SYNOP - significance test

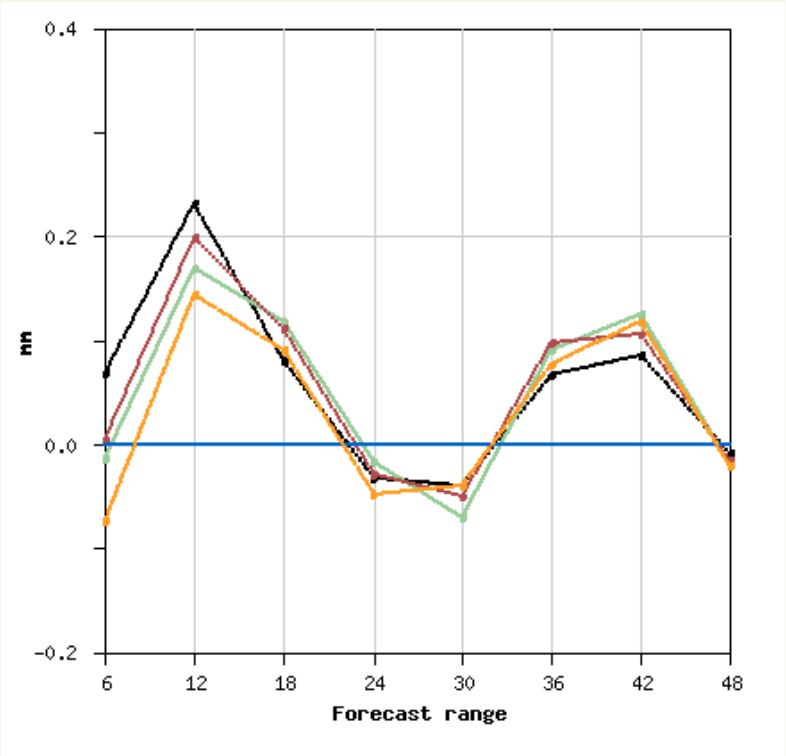
Parameter	Forecast	Significance at 90%	Parameter	Forecast	Significance at 90%
RH2m	+00H	**better**	T 850 hPa	+12H	**better**
	+06H	**better**	T 700 hPa	+00H	**better**
	+12H	**better**	RH 500 hPa	+24H	**better**
	+18H	**better**		+42H	**better**
	+24H	**better**	V 500 hPa	+24H	**better**
MSLP	+00H	worse	T 400 hPa	+12H	**better**
	+06H	worse	ϕ 300 hPa	+12H	**better**
T2m	+00H	**better**		+36H	**better**
	+06H	**better**	RH 300 hPa	+12H	**better**
V 10m	+00H	**better**	V 300 hPa	+36H	**better**
ϕ 1000 hPa	+06H	worse	ϕ 250 hPa	+12H	**better**
	+12H	**better**		+18H	**better**
	+24H	**better**		+36H	**better**
V 1000 hPa	+12H	**better**	RH 250 hPa	+12H	**better**
RH 1000 hPa	+00H	**better**		+30H	worse
	+12H	**better**		+42H	worse
RH 850 hPa	+24H	worse	V 250 hPa	+12H	**better**

List of parameters and forecast ranges where SEVIRI & SYNOP perform better/worse than REF3 in terms of RMSE scores against observation with significance 90 % two side confidence interval significance test.

Impact of SEVIRI & SYNOP on 6h-prec



RMSE

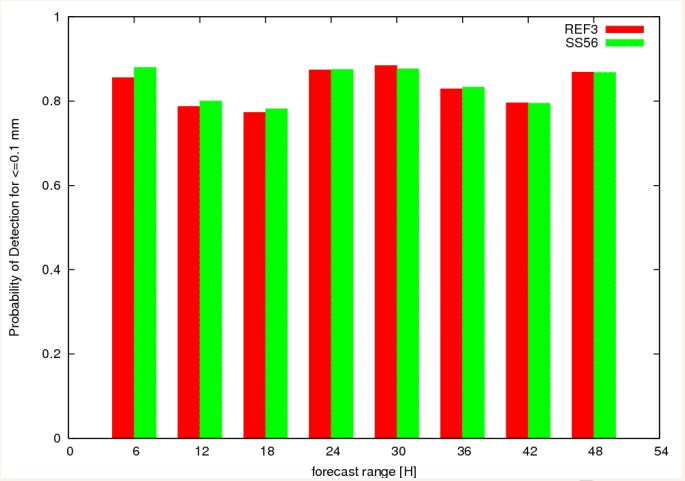


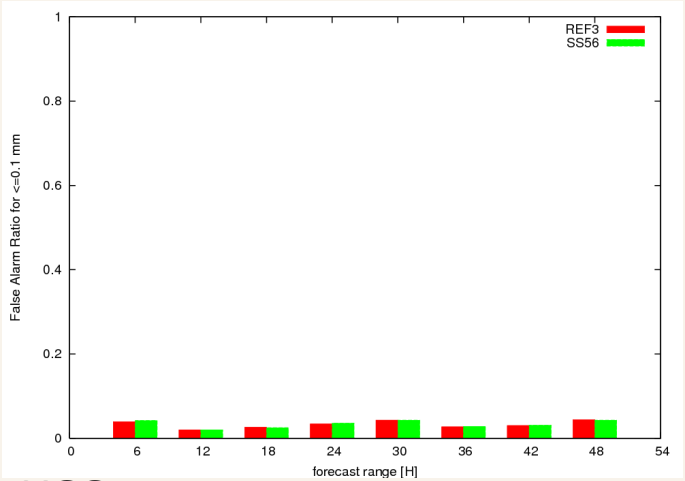
BIAS

reference in green and SEVIRI added in brown color
SEVIRI & SYNOP in yellow and dynamical adaptation in black

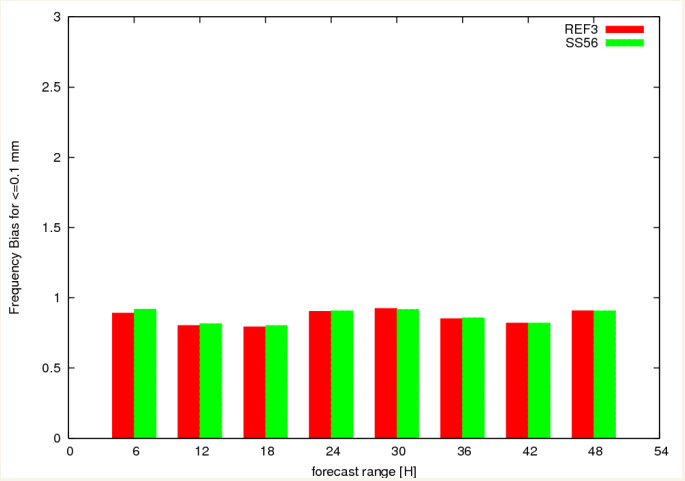
Impact SEVIRI & SYNOP on 6h-prec $< 0.1mm$

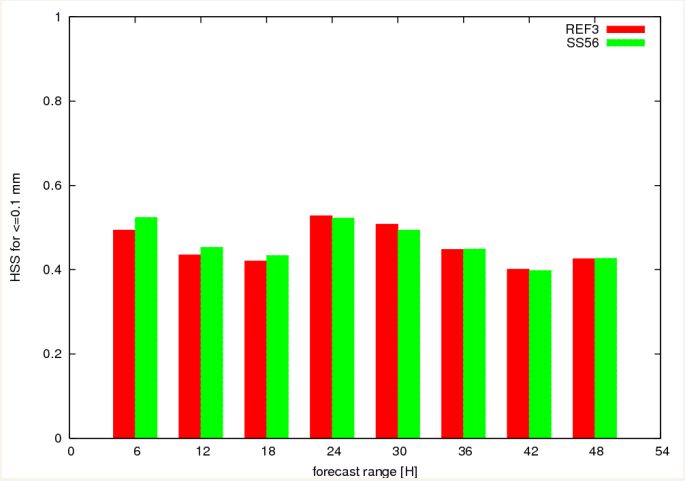
POD and FAR





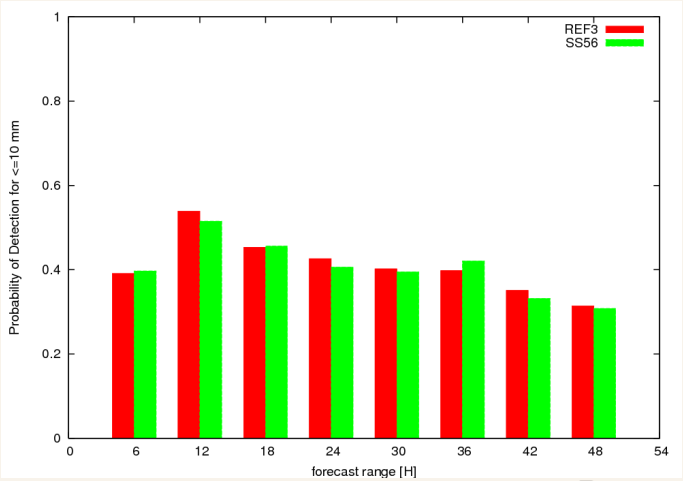
B and HSS

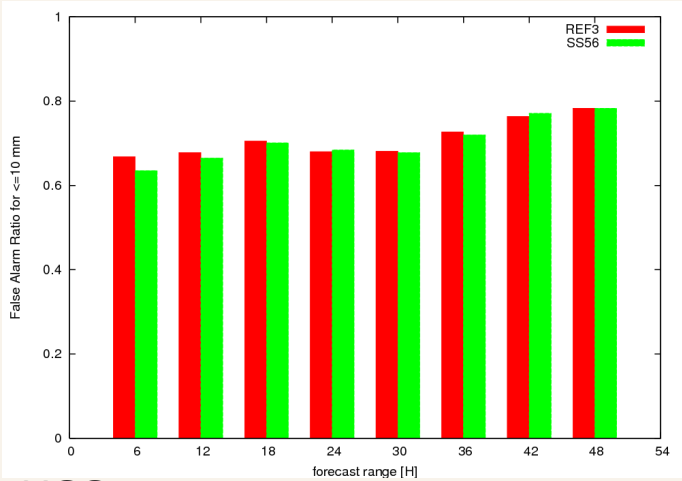




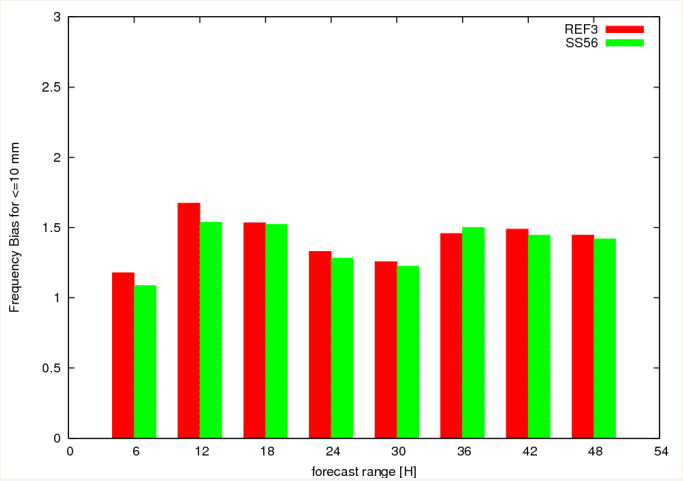
Impact SEVIRI & SYNOP on 6h-prec $< 10mm$

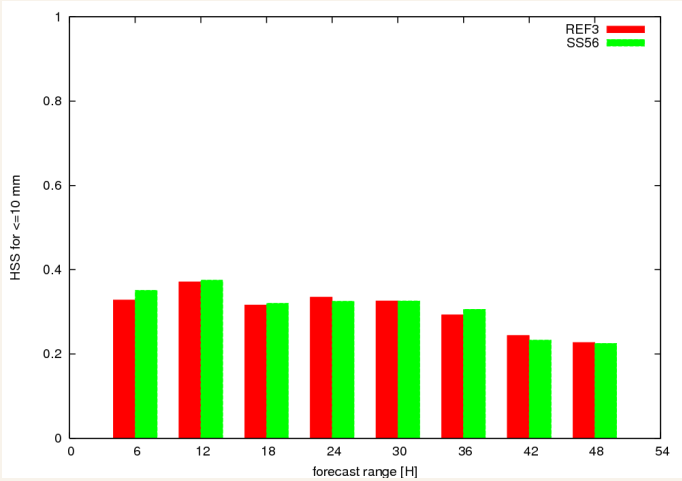
POD and FAR





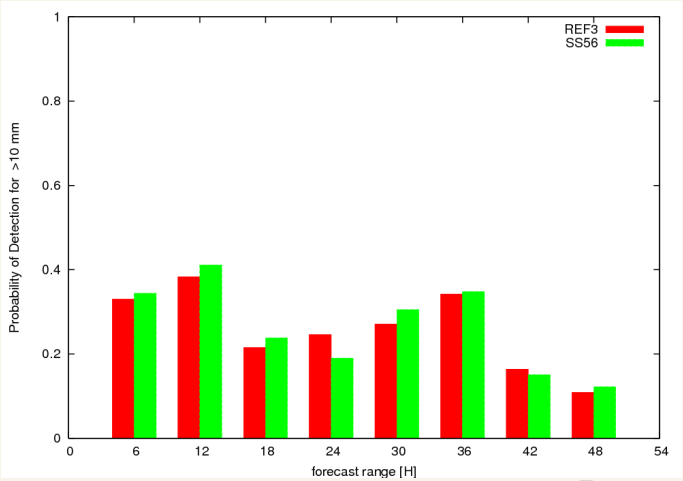
B and HSS

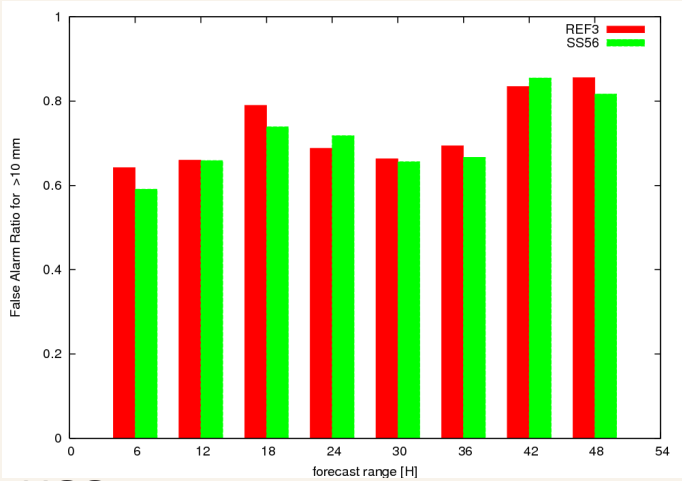




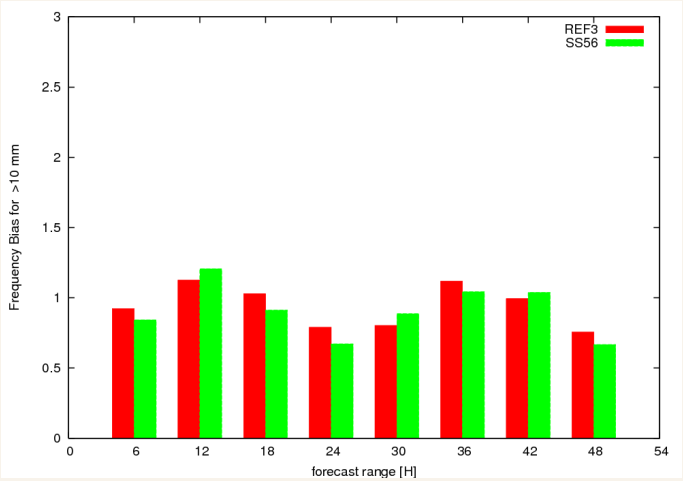
Impact SEVIRI & SYNOP on 6h-prec $> 10mm$

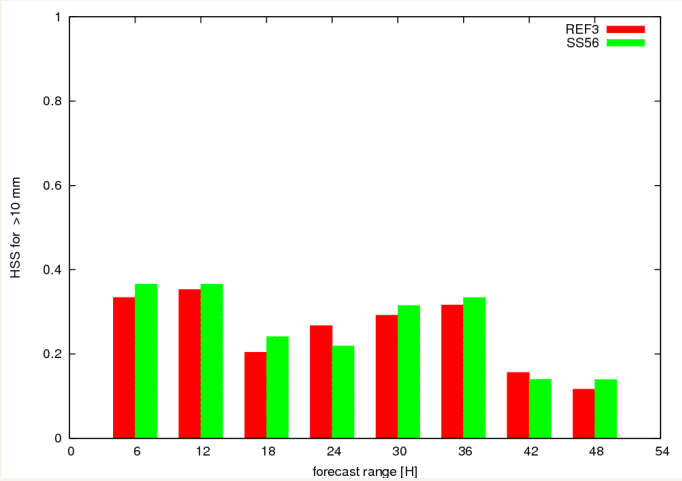
POD and FAR





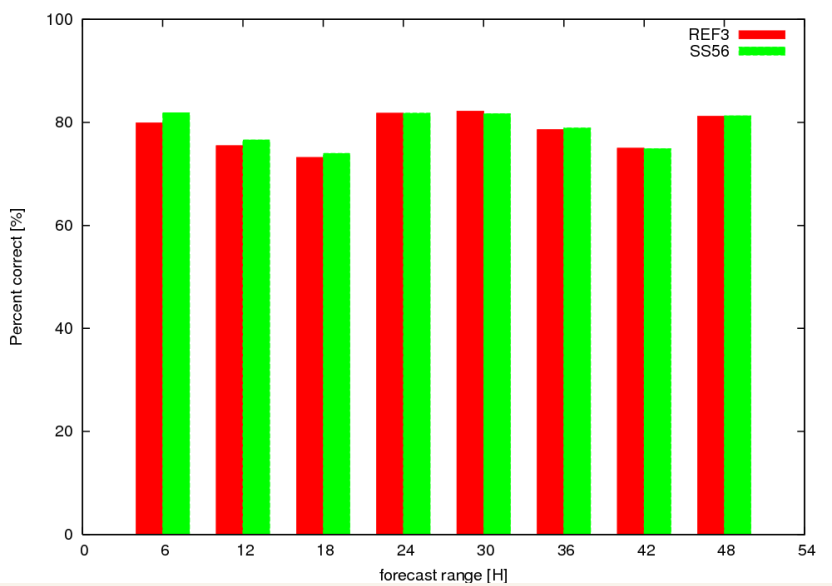
B and HSS

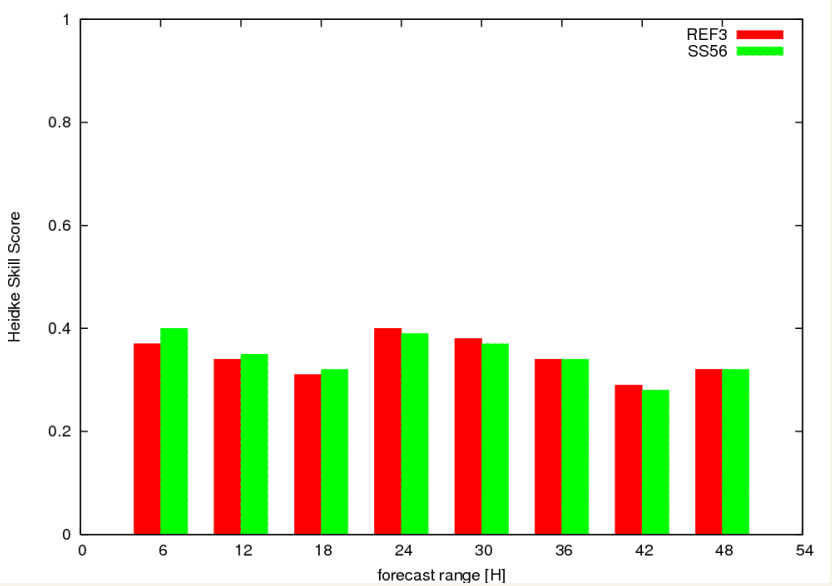




Impact of SEVIRI & SYNOP on 6h-precipitation

Overall PC and HSS - single score for all thresholds at given time range





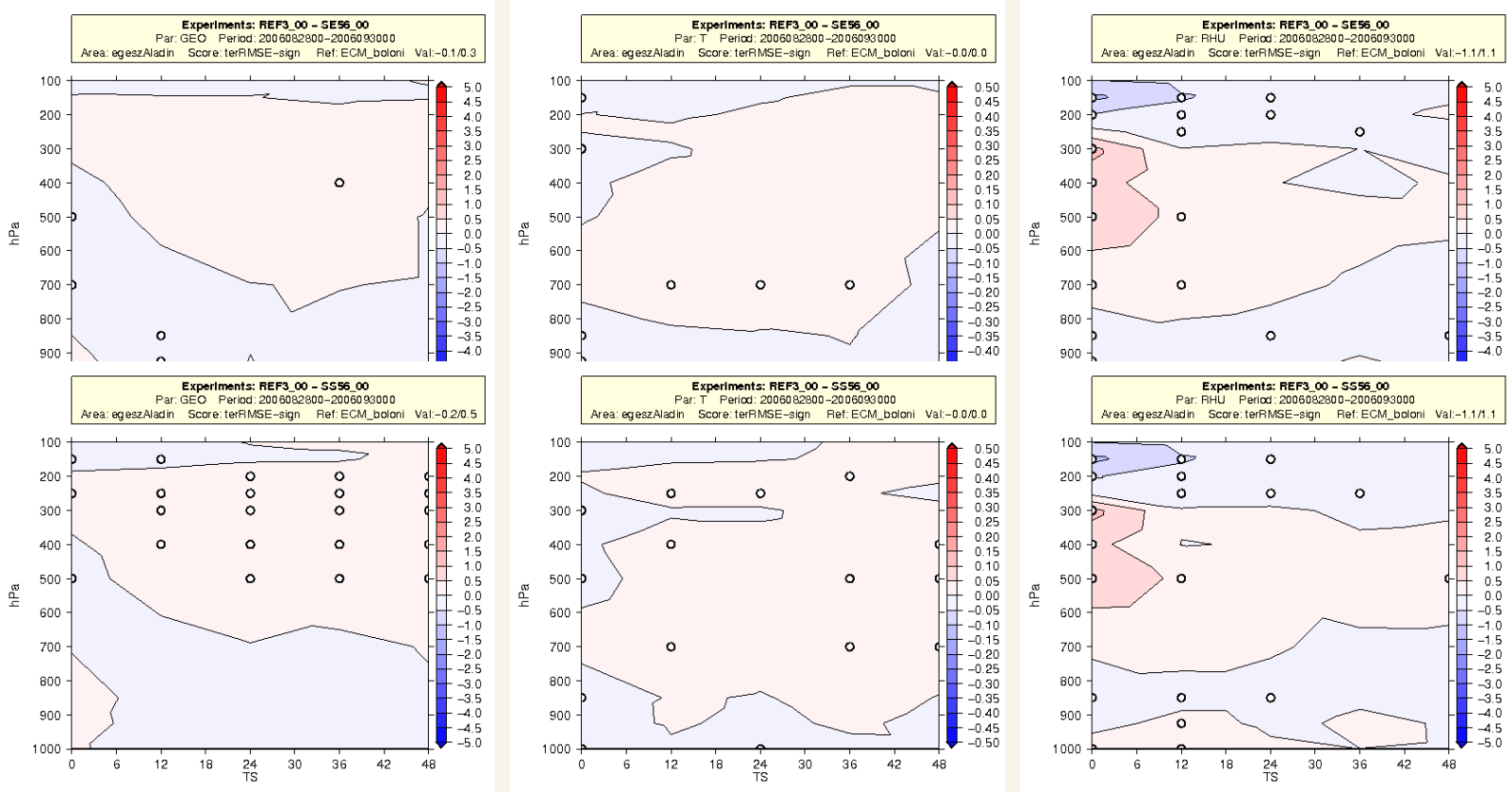
Reference experiments is in red and SEVIRI & SYNOP added in green color

Resume

- small improvement in overall scores PC and HSS
- HSS improved in all categories
- PC improved mainly in 0.1 mm and 2 mm category

Comparision with ECMWF analysis

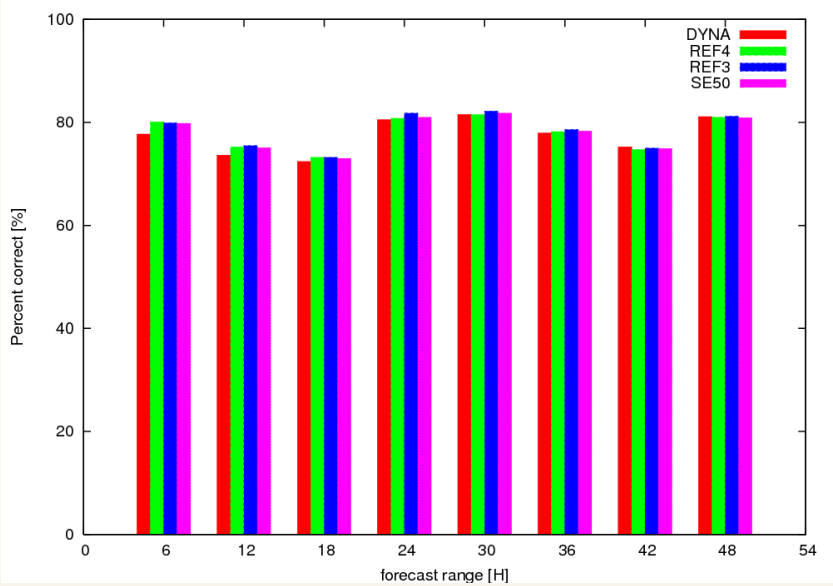
geop T RH

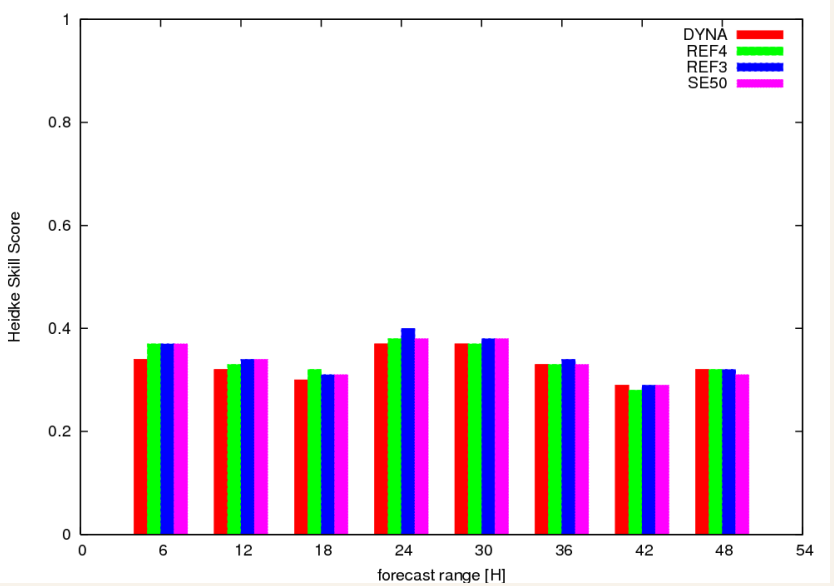


RMSE differences, red indicate SEVIRI (top) or SEVIRI & SYNOP (bottom) is better then REF. Circles difference significant on 90 % confidence level

Impact of various obs on 6h-precipitation

Overall PC and HSS - single score for all thresholds at given time range





Dynamical adaptation is in red
SYNOP+TEMP in green
SYNOP+TEMP+ATOVS+AMDAR+AMV in blue
SYNOP+TEMP+SEVIRI in violet

Resume

- impact of SEVIRI data is similar to that of ATOVS, AMDAR and AMV assimilated in high resolution

Conclusions

- Upper-air scores showed small impact of SEVIRI data alone against observations and ECMWF analysis
- Different impact was found depending on the parameters and model levels
- Precipitation scores showed small improvement when using SEVIRI data alone and that impact of SEVIRI data is similar to that of ATOVS, AMDAR and AMV assimilated in high resolution in our system
- SEVIRI & SYNOP (T2m and RH2m) assimilated together perform better than SEVIRI data alone

Pre-operational testing of SEVIRI & SYNOP DA is planned in ALADIN/HU 3DVAR system

Thank you for your attention.