Usage of IASI at global NWP centres and intercomparison of IASI impact assessment

Vincent GUIDARD — Météo-France & CNRS / CNRM
vincent.guidard@meteo.fr

S. Heilliette — Environment Canada
R. Eresmaa, M. Matricardi — ECMWF
F. Smith — MetOffice
A. Collard — NOAA/NCEP
B. Ruston — NRL

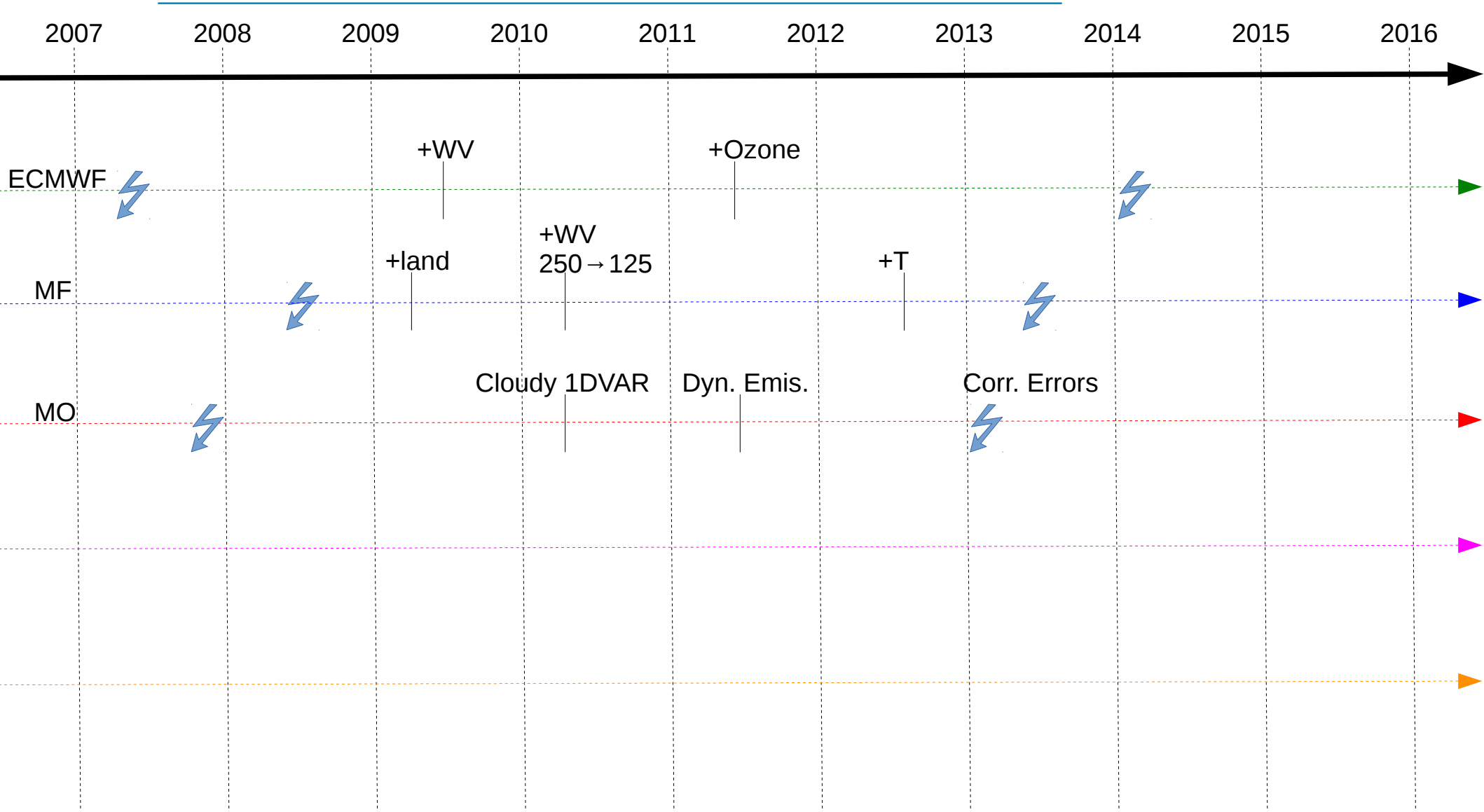
4th International IASI Conference, Antibes, 13 April 2016

Outline

- IASI usage in global NWP models
- IASI impact in global NWP models

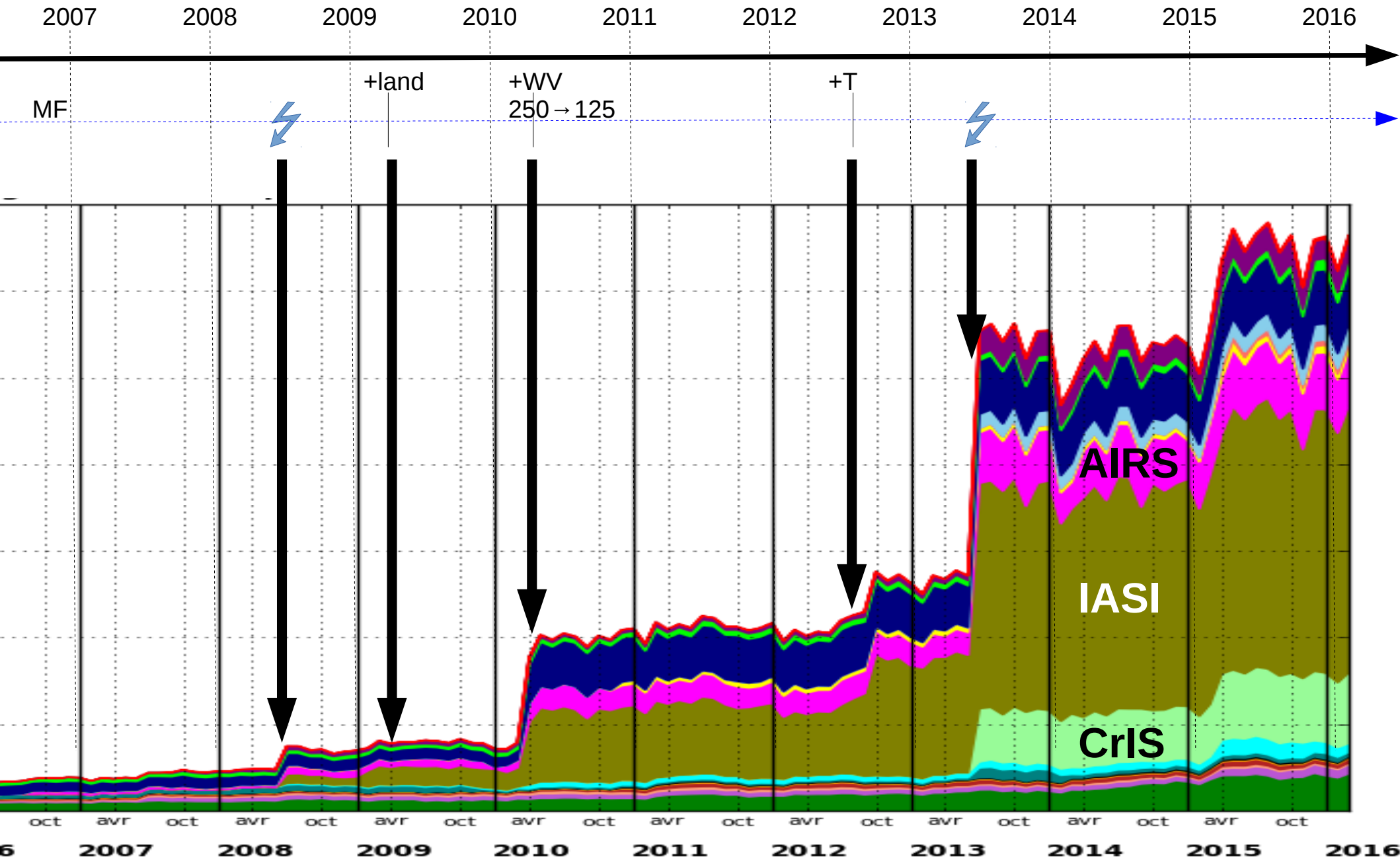
10 years in orbit!

Major milestones



10 years in orbit!

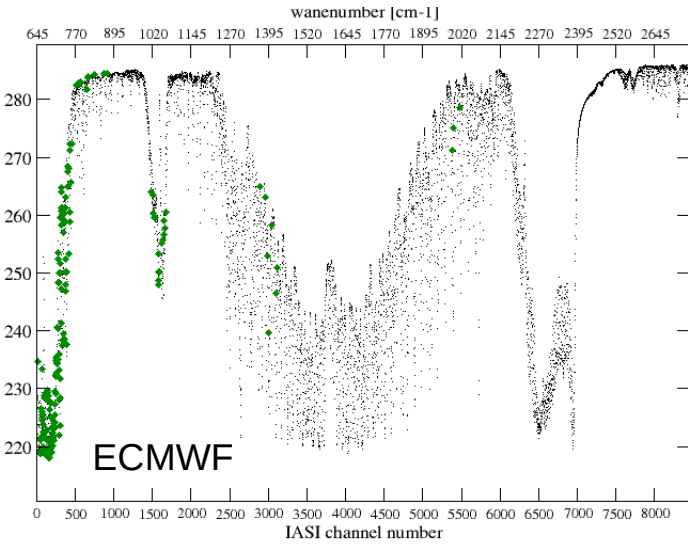
Major milestones

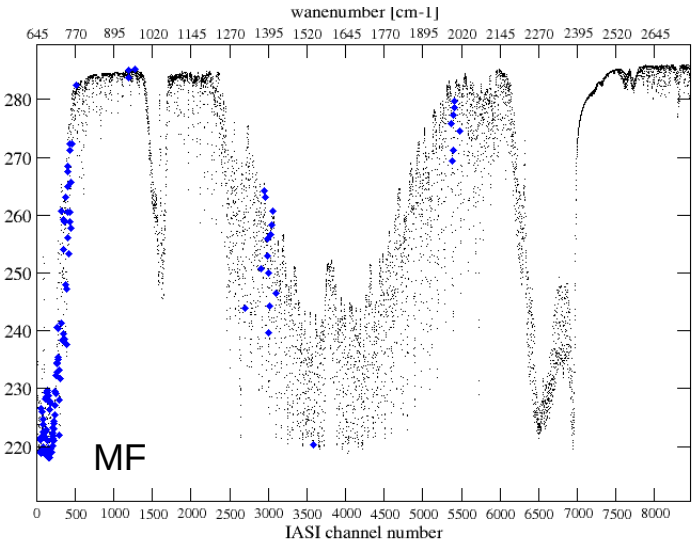


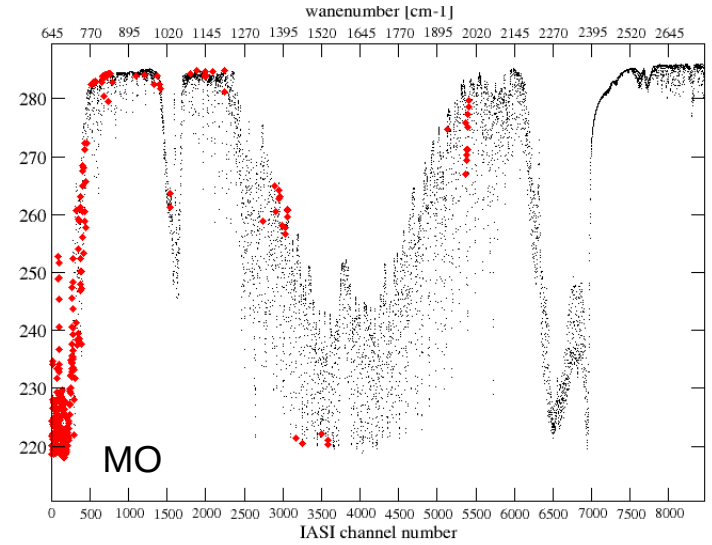
RT model

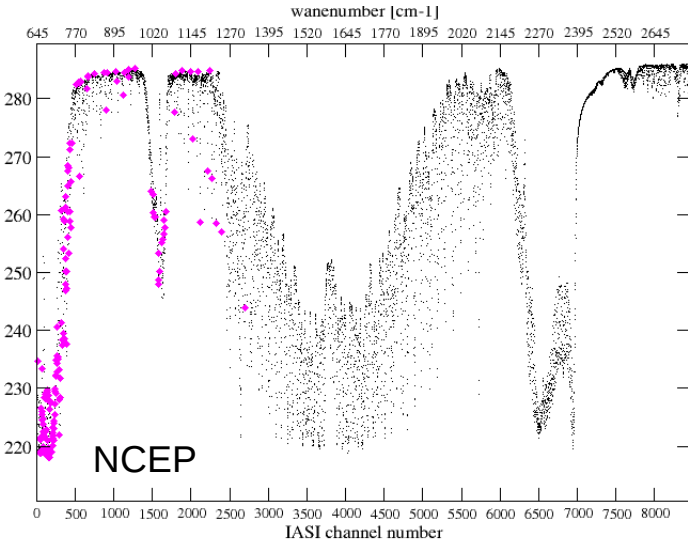
	RT model	RT levels	NWP levels
CMC	RTTOV10	44L	80L up to 0.1hPa
ECMWF	RTTOV11.2	44L	137L up to 0.01hPa
MF	RTTOV11.1	101L	105L up to 0.1hPa
MO	RTTOV9	43L	70L up to 80km
NCEP	CRTM v2.1.3	64L	64L up to 0.27hPa
NRL	CRTM v2.2.1	100L	60L up to 0.04hPa

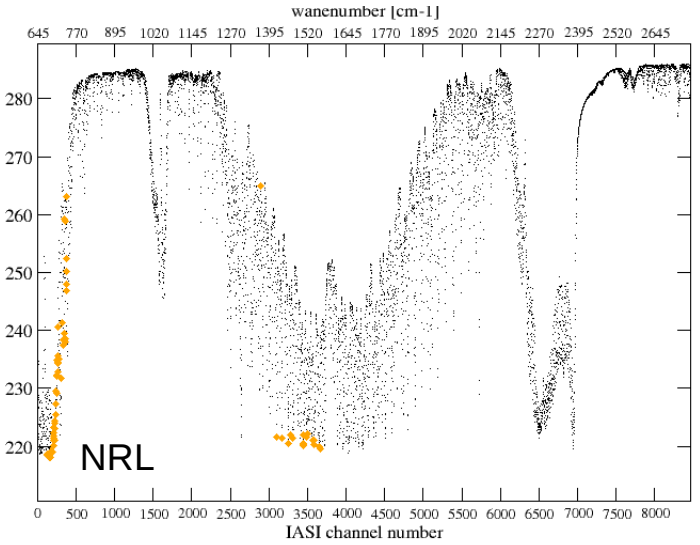
Channels used in global NWP models



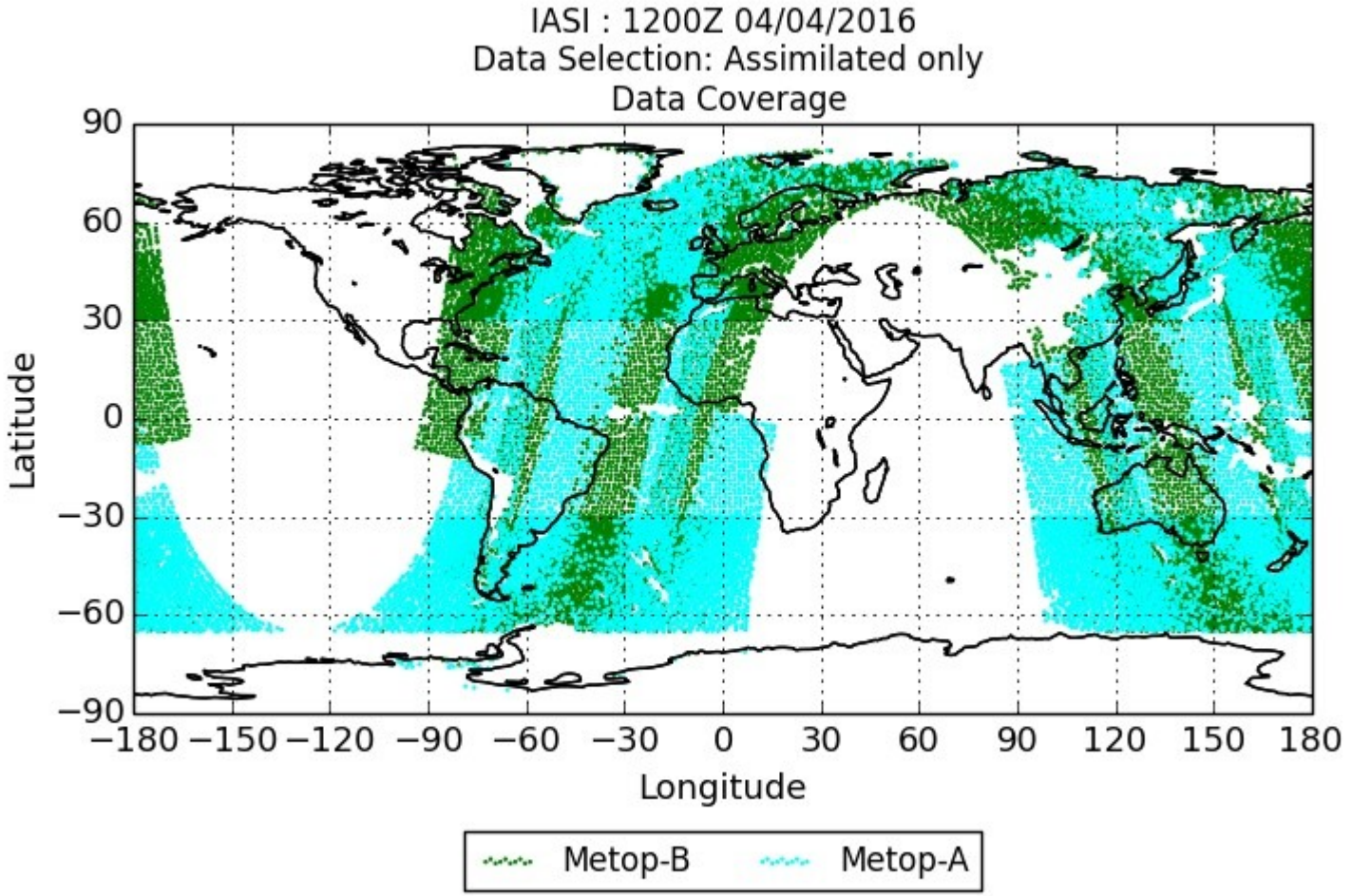






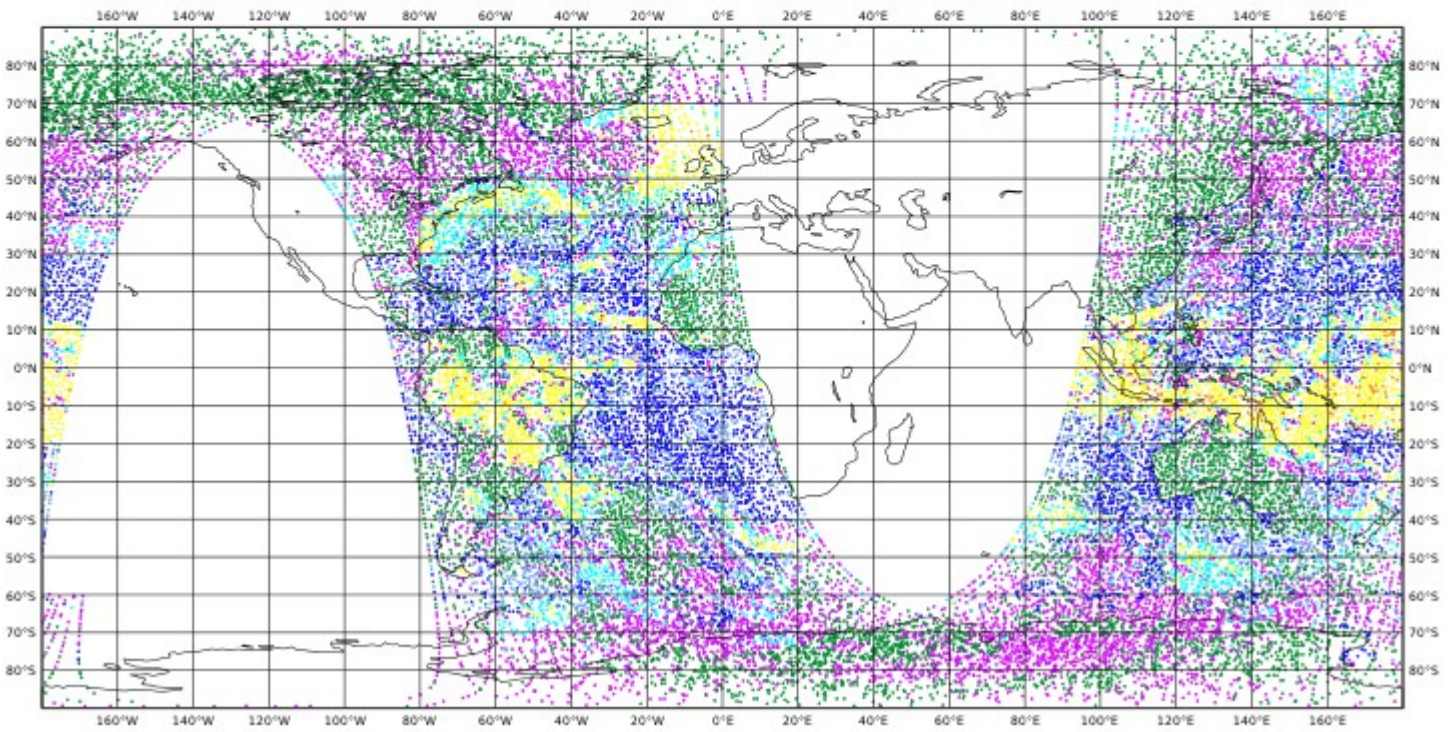


Data coverage – example @ MetOffice – 12 UTC



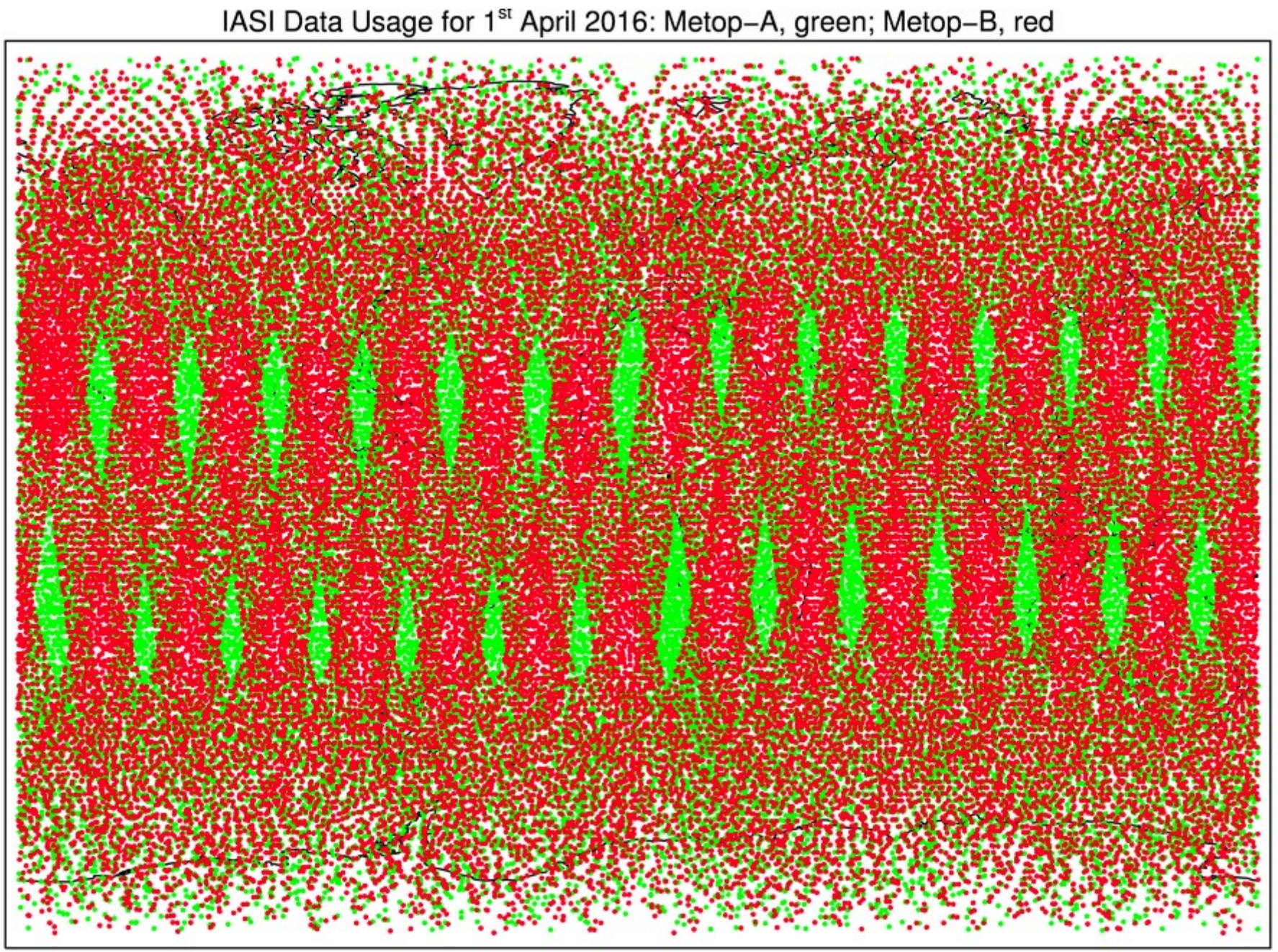
Data coverage – example @ Météo France – 00 UTC

Colours indicate number of channels assimilated per pixel



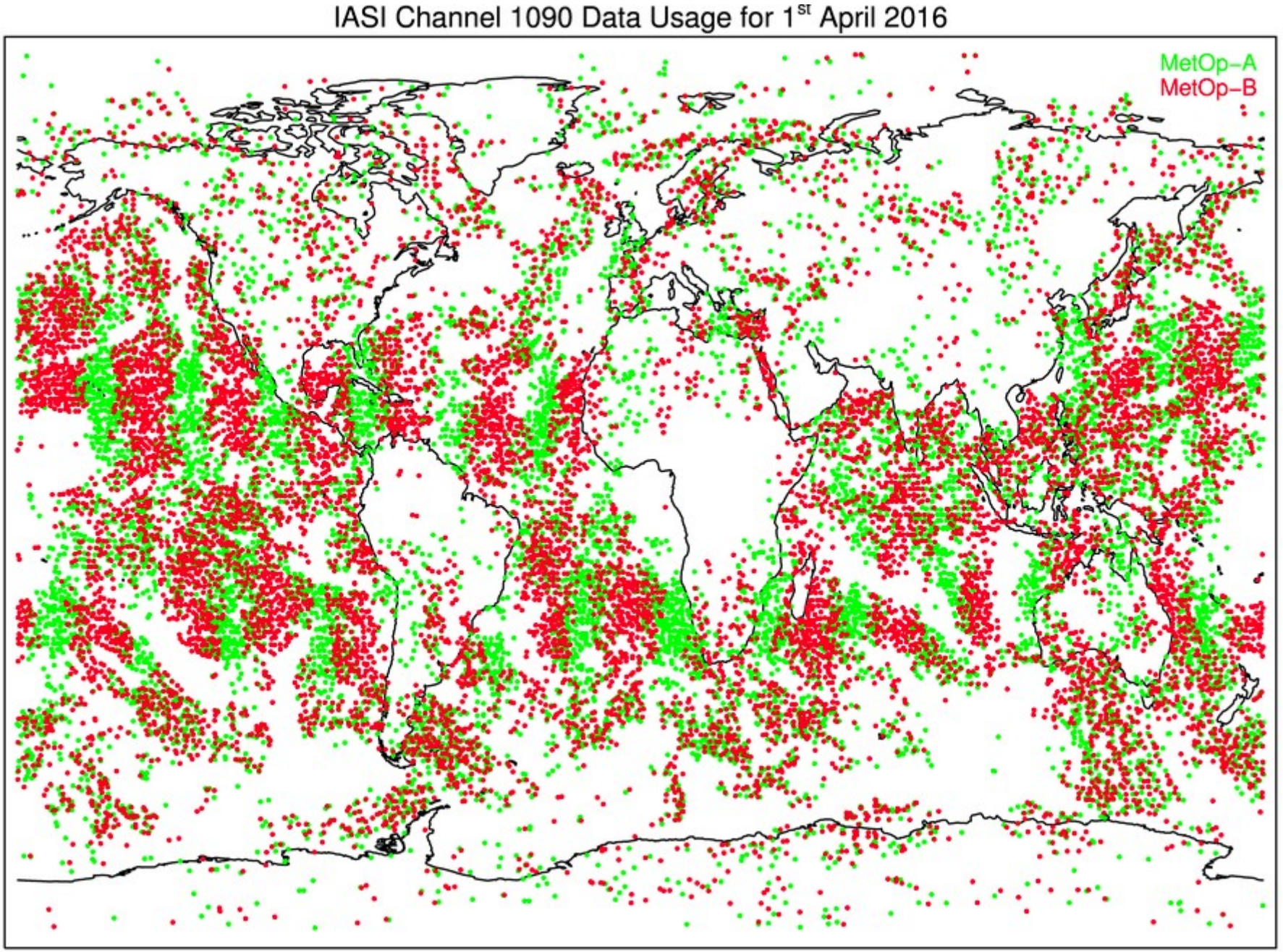
Data coverage – example @ NCEP whole day

Assimilated pixels



Data coverage – example @ NCEP whole day

Assimilated pixels – window channel 1090



Bias Correction

- Environment Canada
  - Dynamic BC (air-mass predictors)
    based on an off-line 3D-VAR analysis without any radiance
- ECMWF
  - VarBC (air-mass and scan-dependent predictors)
- Météo France
  - VarBC (air-mass and scan-dependent predictors)
- MetOffice
  - VarBC for air-mass predictors
  - Legendre polynomial for scan-dependent bias
- NCEP
  - VarBC (scan-dependent and binomial of lapse-rate convolved with Jacobian and land surface emissivity)
- NRL
  - VarBC (air-mass and scan-dependent predictors)

Pixel selection

	prior	Thinning		
CMC		150km		
ECMWF	Warmest in the FoR except detector 4	125km		
MF	Detector 1	125km		
MO	Most homogeneous in the FoR	154km in the Tropics, 80km extra-Tropics		
NCEP		150km		
NRL	Warmest in the FoR	110km		

Surface properties

	LST	LSE	SST	SSE
CMC	forecast	CERES classification	Own SST analysis	ISEM ?
ECMWF	No IASI over land			ISEM ?
MF	forecast	0.98	OSTIA	ISEM
MO	retrieval	retrieval	retrieval	ISEM ?
NCEP	NCEP LST analysis	NPOESS reflectivity db		
NRL	Only high-peaking channels			

Cloud / Aerosol detection

No	Cloud detection	Aerosol detection	
CMC	AVHRR cluster + window channel check + Garand&Nadon		
ECMWF	MNW + AVHRR cluster	Yes, indepedent of cloud detection and of innovations	
MF	MNW	No	
MO	1D-VAR		
NCEP	Eyre & Menzel		
NRL	MNW		

MNW = McNally & Watts

Cloud properties – Cloudy radiances assimilation

	Cloud top/ne	Cloudy radiances assimilation ?
CMC	CO2-slicing	No
ECMWF	Retrieval from 4 channels	
MF	Co2-slicing (32 channels)	Yes : over sea, AVHRR overcast, CFrac=1, Ctop in [650-900hPa]
MO	1D-VAR	
NCEP		
NRL		

IASI impact in global NWP models

- What was said in IASI science plan (in the 1990's) :

  IASI will improve forecasts by 1 day

IASI impact in global NWP models

- What was said in IASI science plan (in the 1990's) :

  IASI will improve forecasts by 1 day

IASI impact in global NWP models

- What was said in IASI science plan (in the 1990's)

  IASI will improve forecasts by 1 day

- What I said at the 3rd IASI conference

  We gain 4 hours of predictibility at day 3

IASI impact in global NWP models

- What was said in IASI science plan (in the 1990's)

  IASI will improve forecasts by 1 day

- What I said at the 3rd IASI conference

  We gain 4 hours of predictibility at day 3

- What I will say today

  No numbers !

Setup

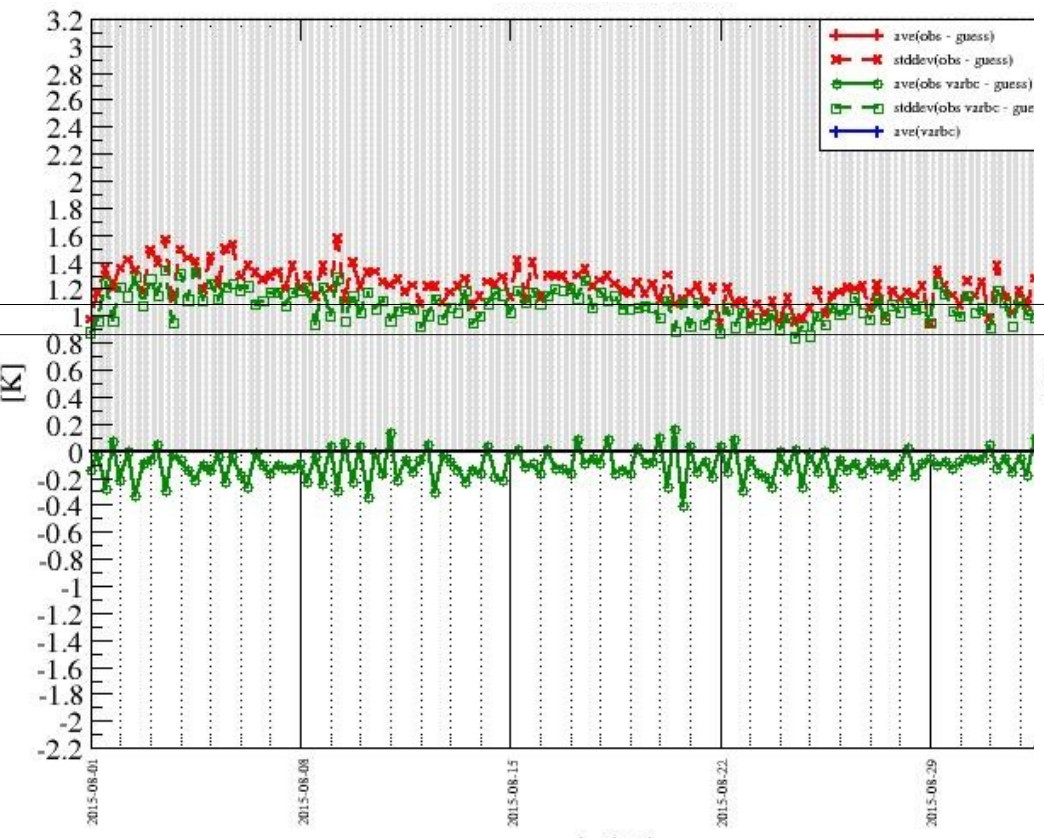
- 3-month assimilation experiments
  from 1 August 2015 to 31 October 2015
- Control
  - Also called IASI hereafter, should corresponds to operational version
- Denial
  - Also called noIASI hereafter
  - Control minus IASI data

Impact on other observations – AIRS channel 75

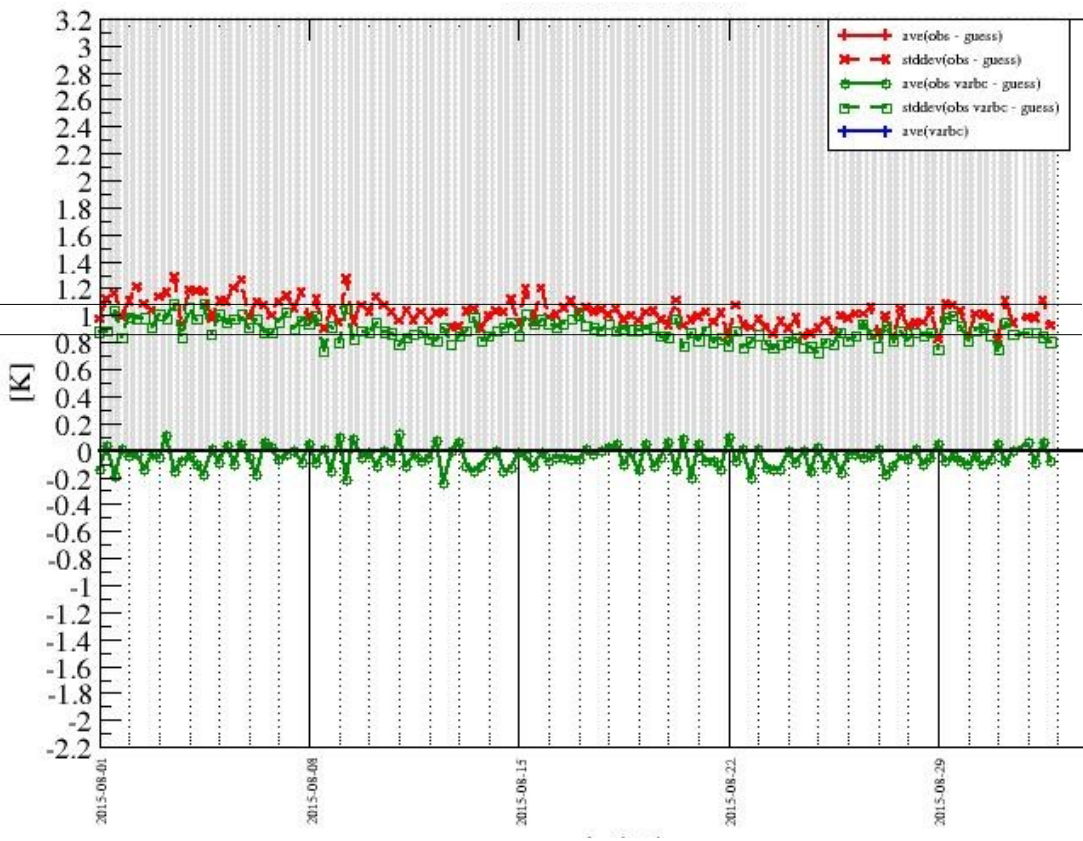
Very high stratospheric channel

Reduction of standard deviation of obs. - background

NoIASI



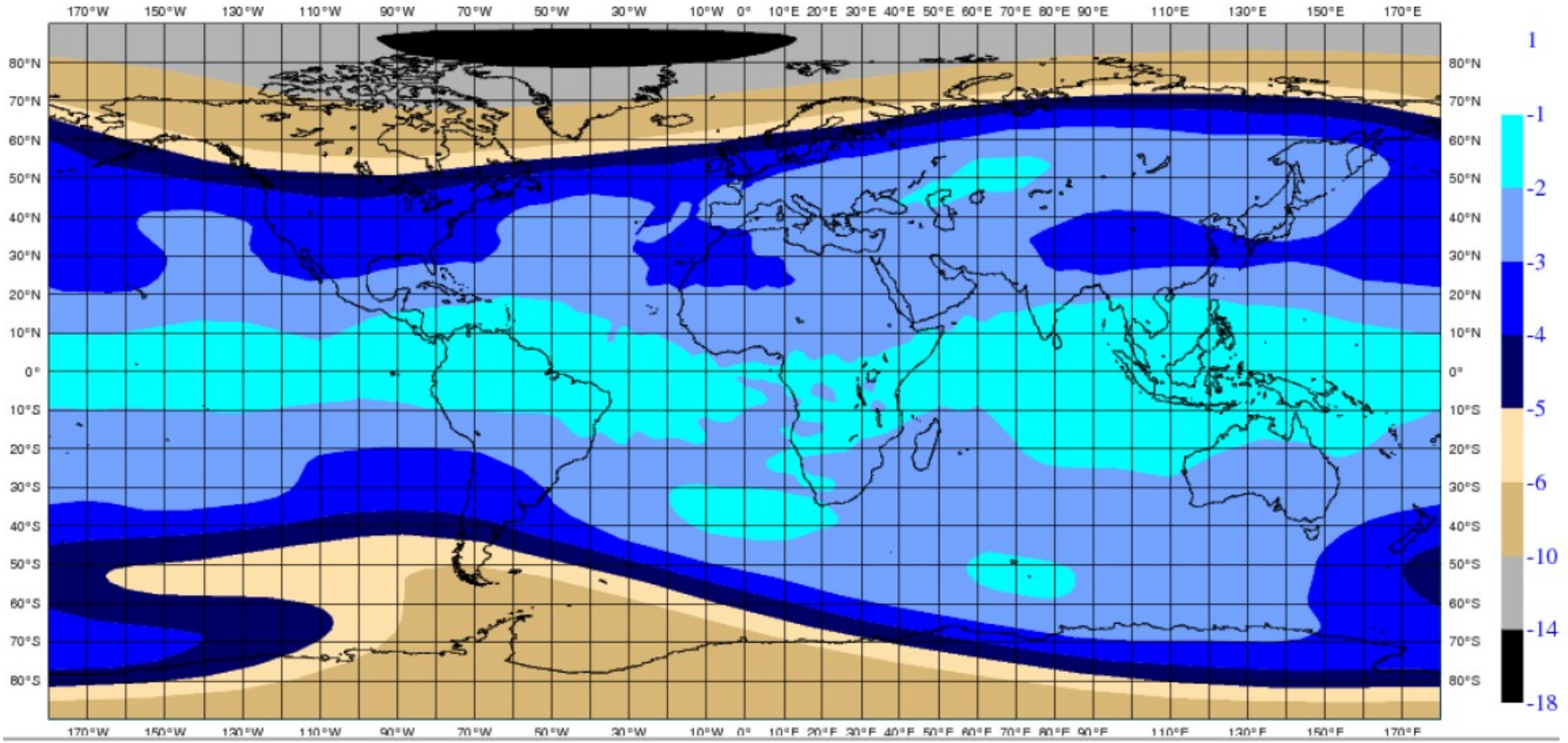
IASI



Impact on other observations – AIRS channel 75

Very high stratospheric channel

1 hPa temperature analysis differences averaged over 120 Cases. Units: K.

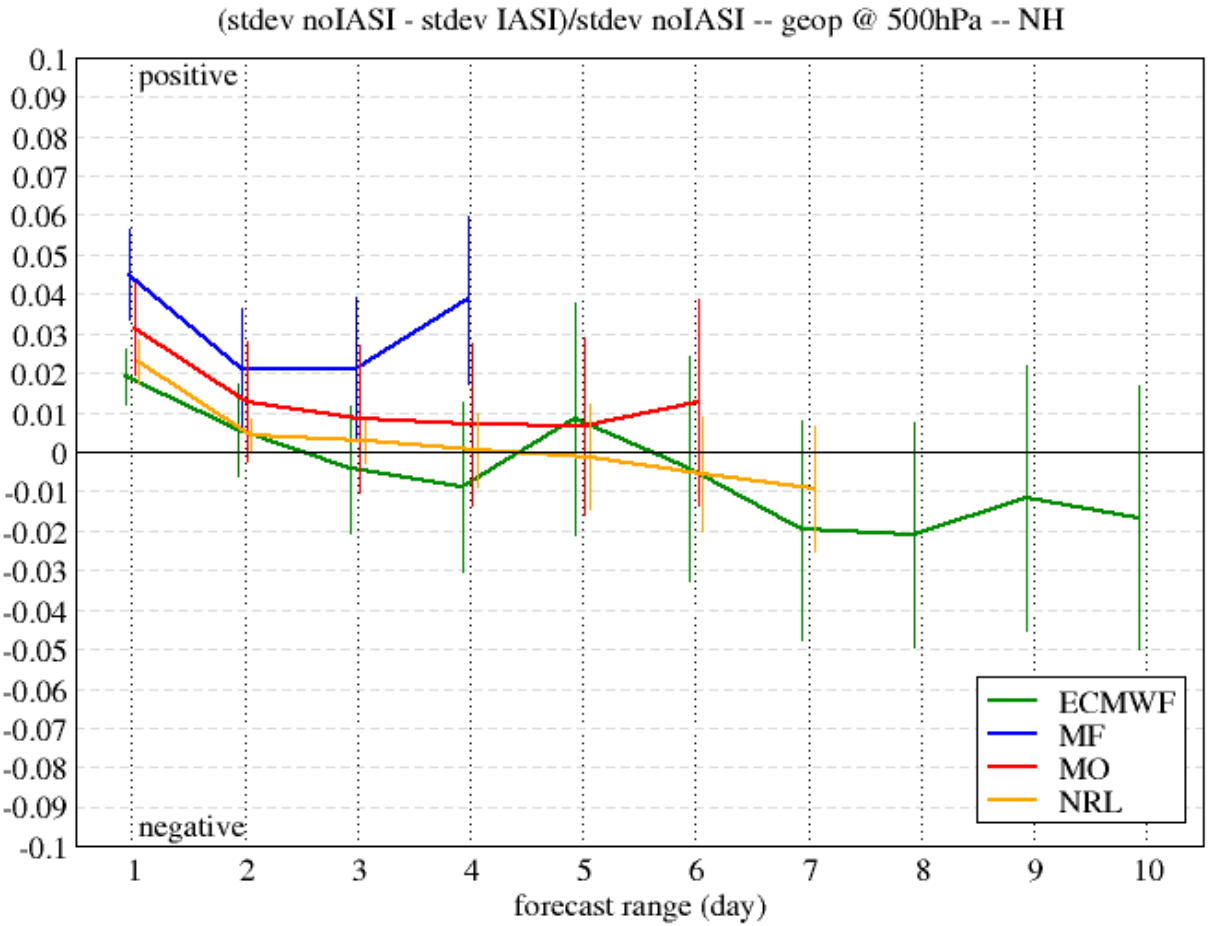


Verification

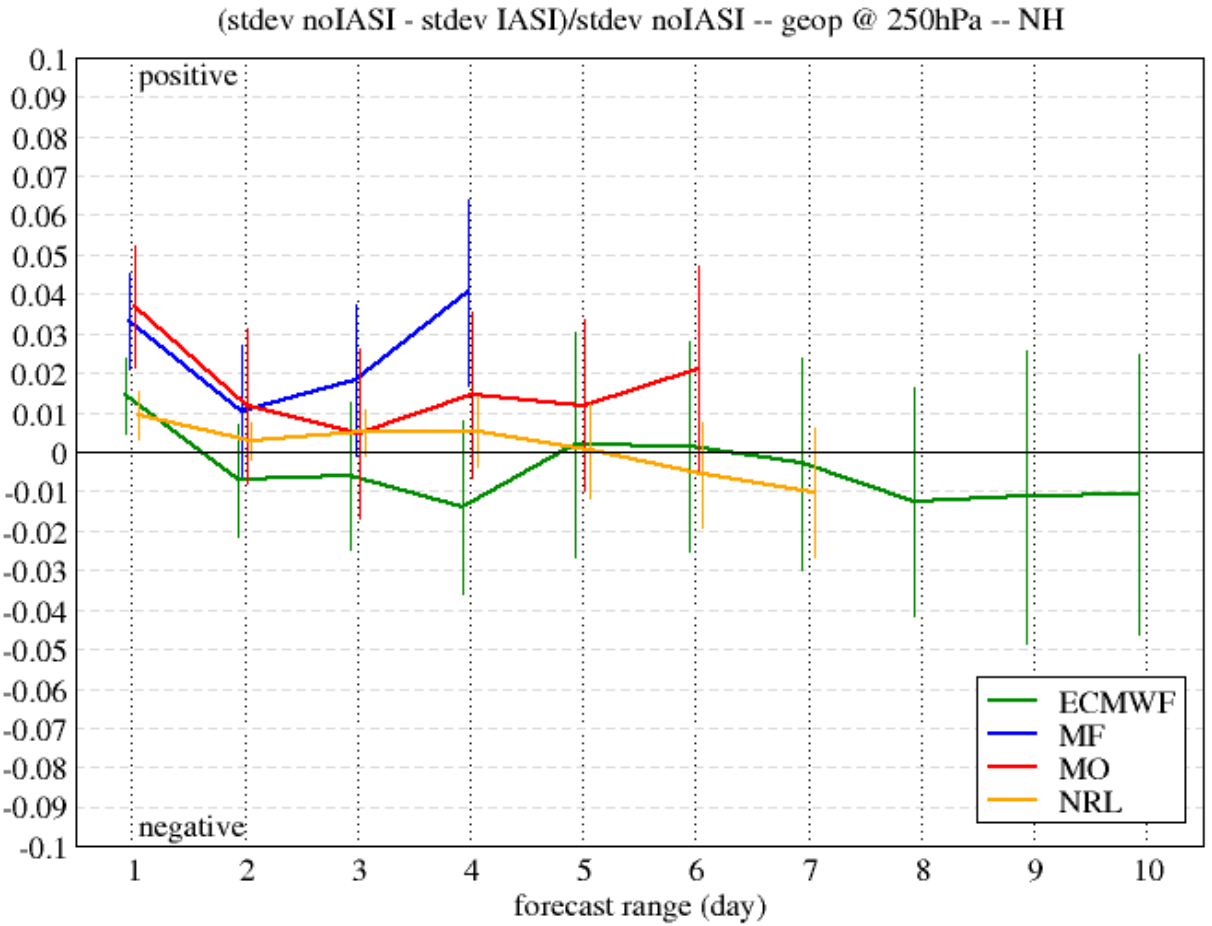
- Stdev IASI =
  Standard deviation of (control forecast minus control analysis)
- Stdev noIASI =
  Standard deviation of (denial forecast minus control analysis)
- Relative reduction of standard deviation wrt to control analysis =
  (Stdev noIASI – Stdev IASI) / Stdev noIASI
  positive value = IASI improves forecast

- Geopotential Height
- Temperature
- Humidity

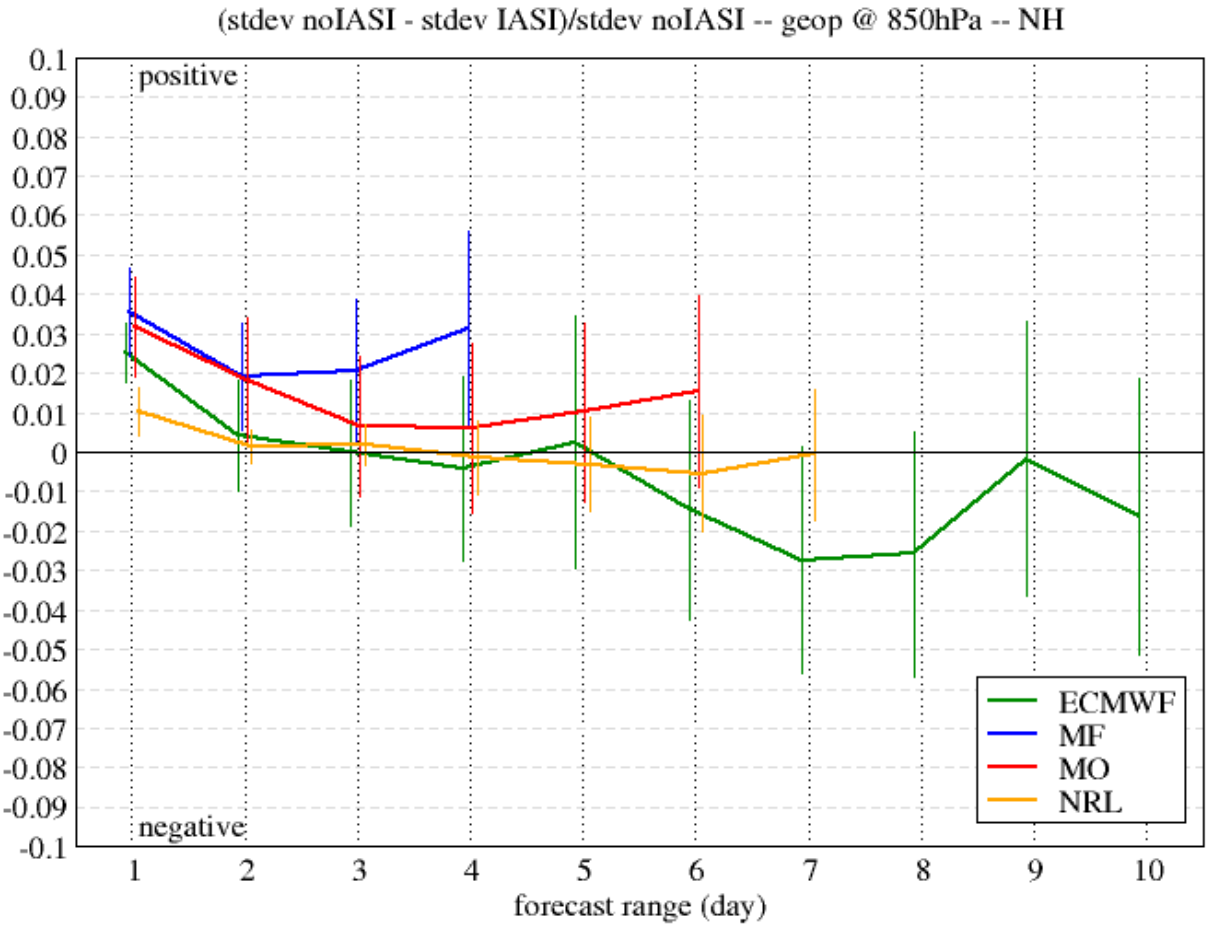
Relative reduction of standard deviation wrt to control analysis – Z @ 500 hPa NH



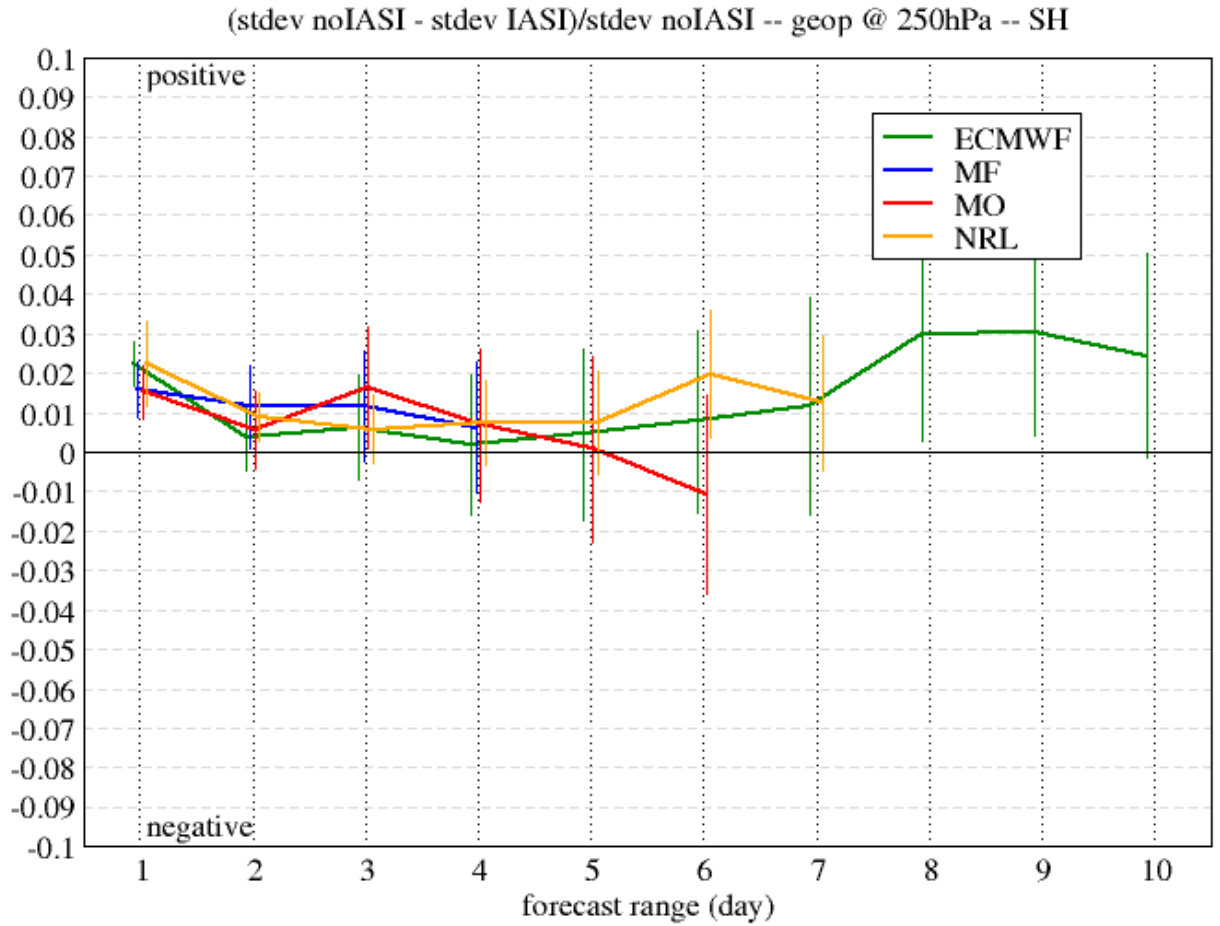
Relative reduction of standard deviation wrt to control analysis – Z @ 250 hPa NH



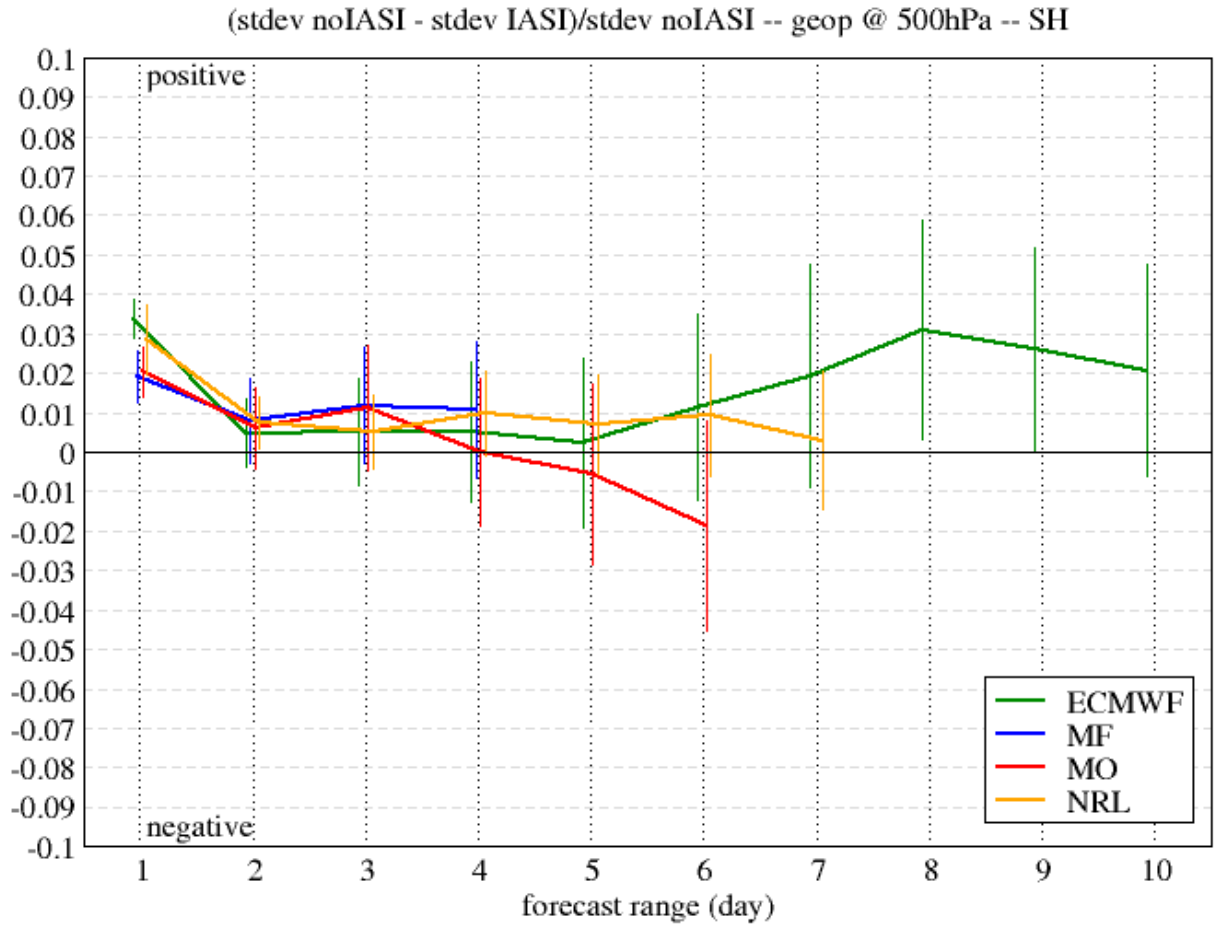
Relative reduction of standard deviation wrt to control analysis – Z @ 850 hPa NH



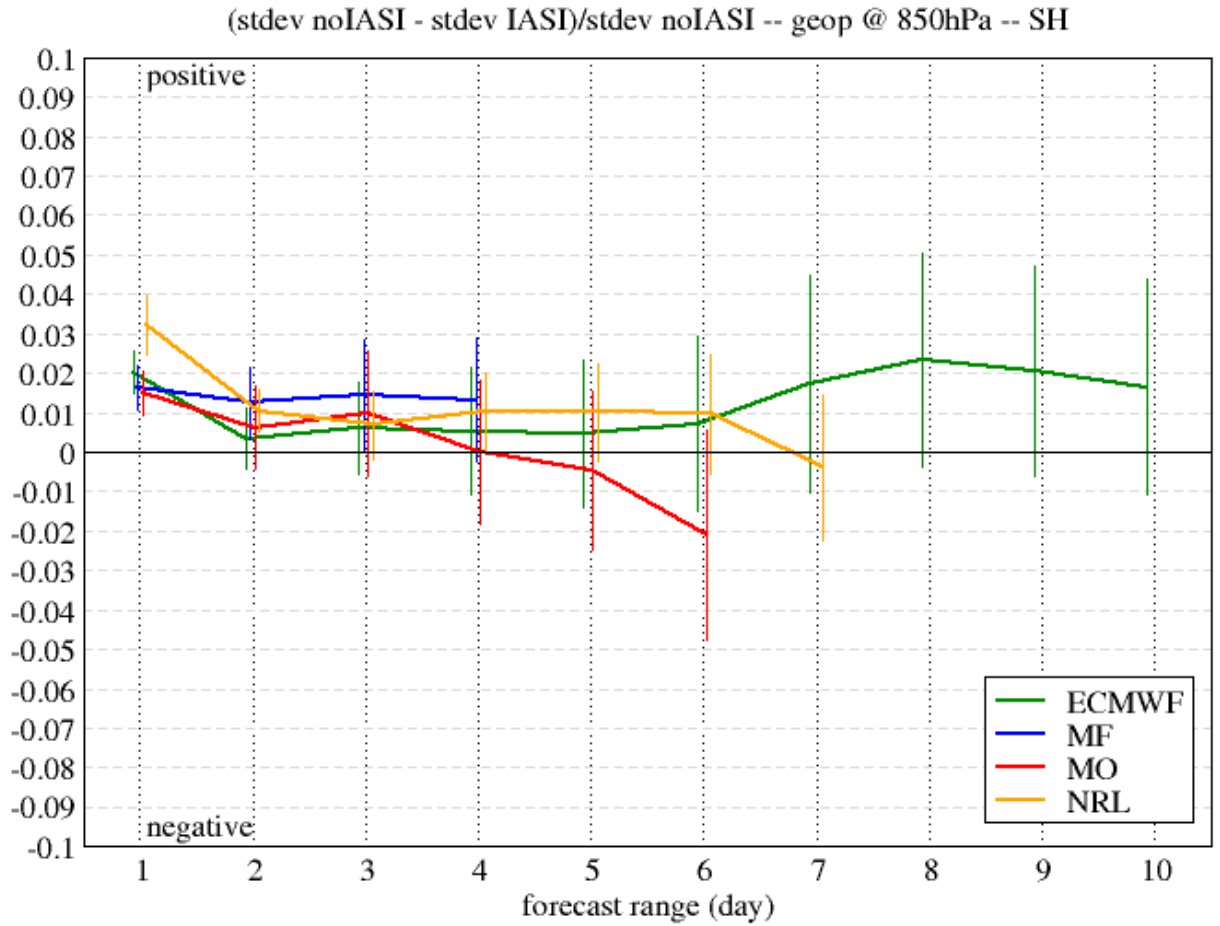
Relative reduction of standard deviation wrt to control analysis – Z @ 250 hPa SH



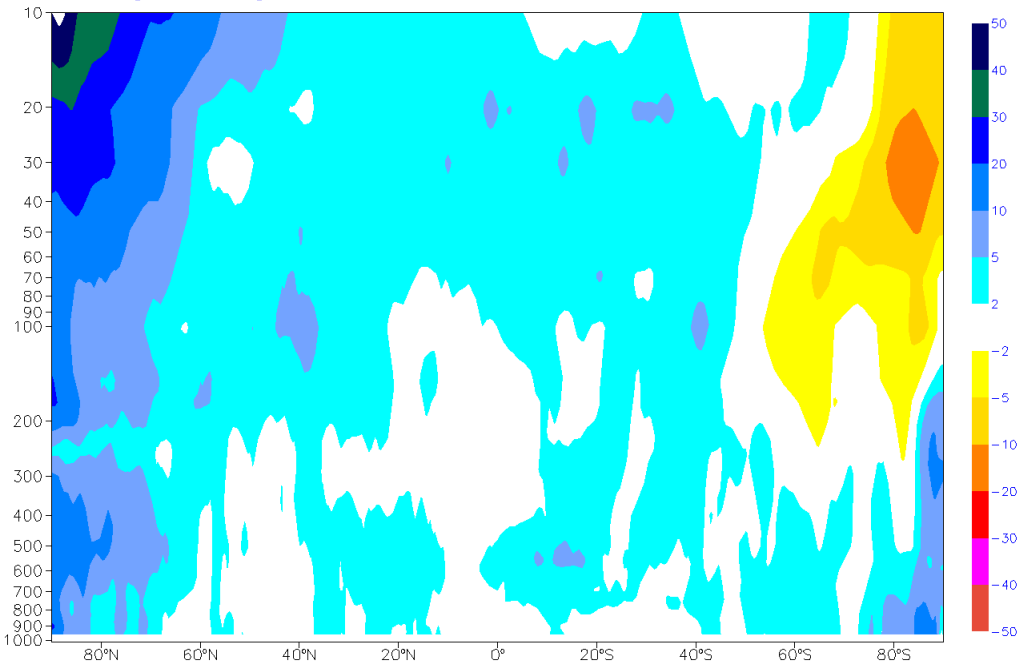
Relative reduction of standard deviation wrt to control analysis – Z @ 500 hPa SH



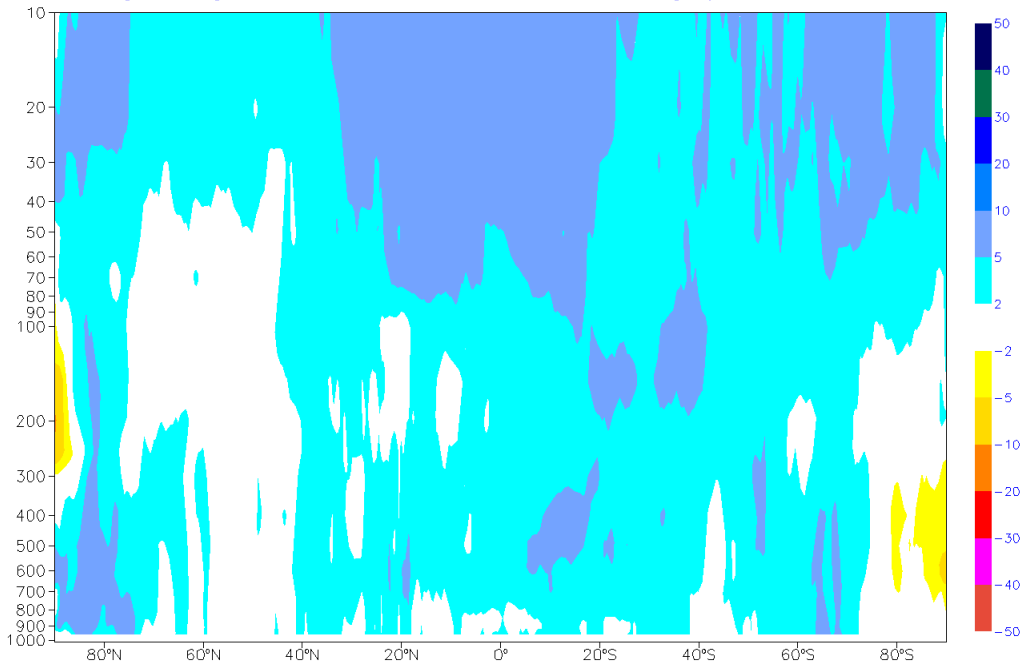
Relative reduction of standard deviation wrt to control analysis – Z @ 850 hPa SH



Relative reduction of standard deviation wrt to control analysis – Z – D+1 – zonal average

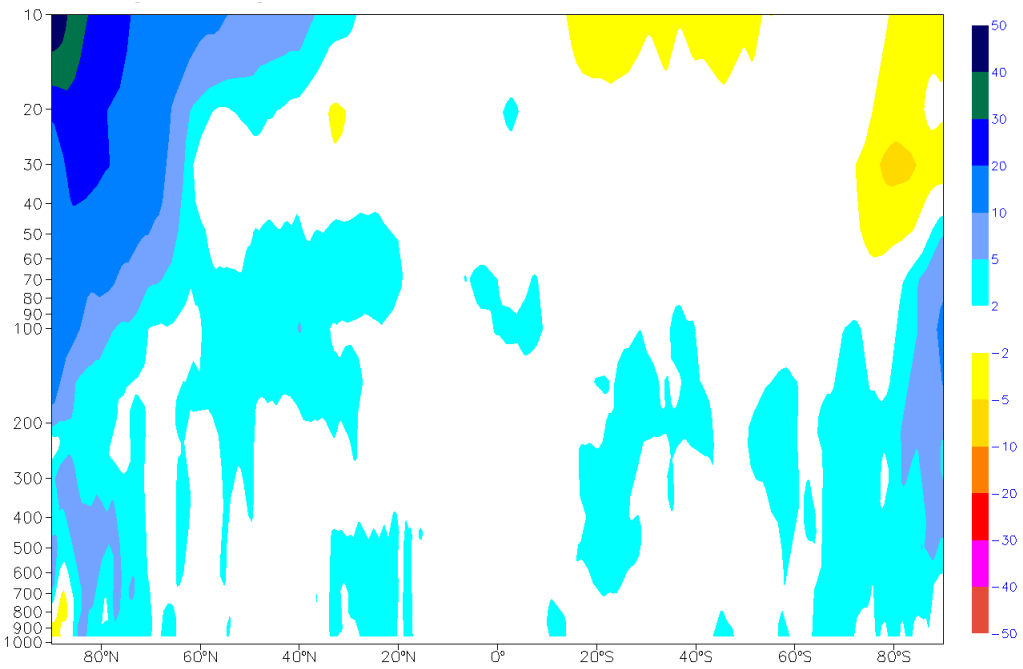


MF

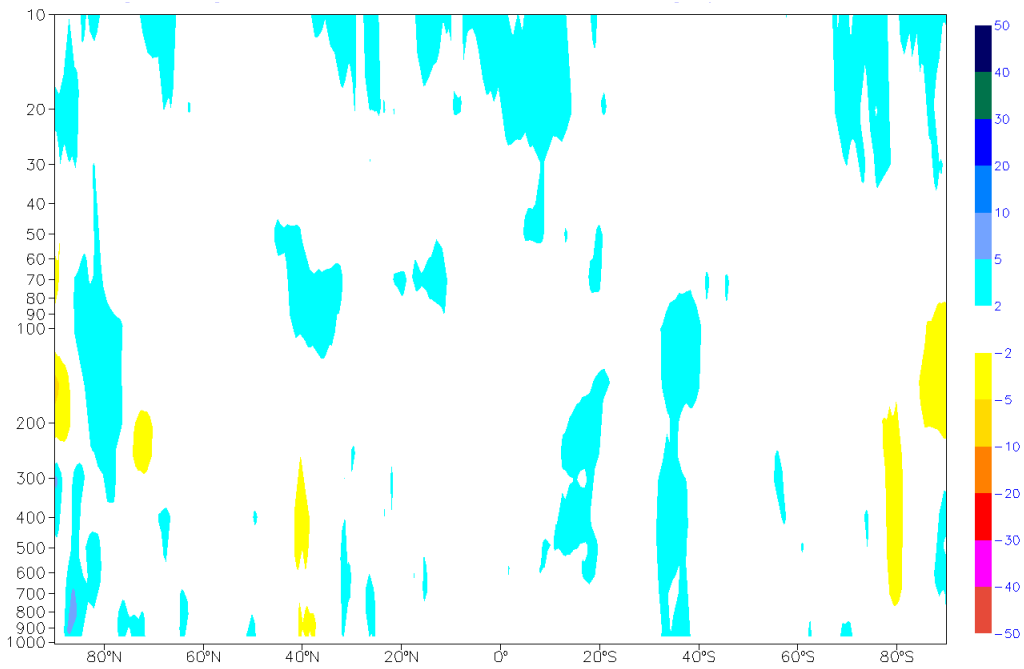


ECMWF

Relative reduction of standard deviation wrt to control analysis – Z – D+2 – zonal average

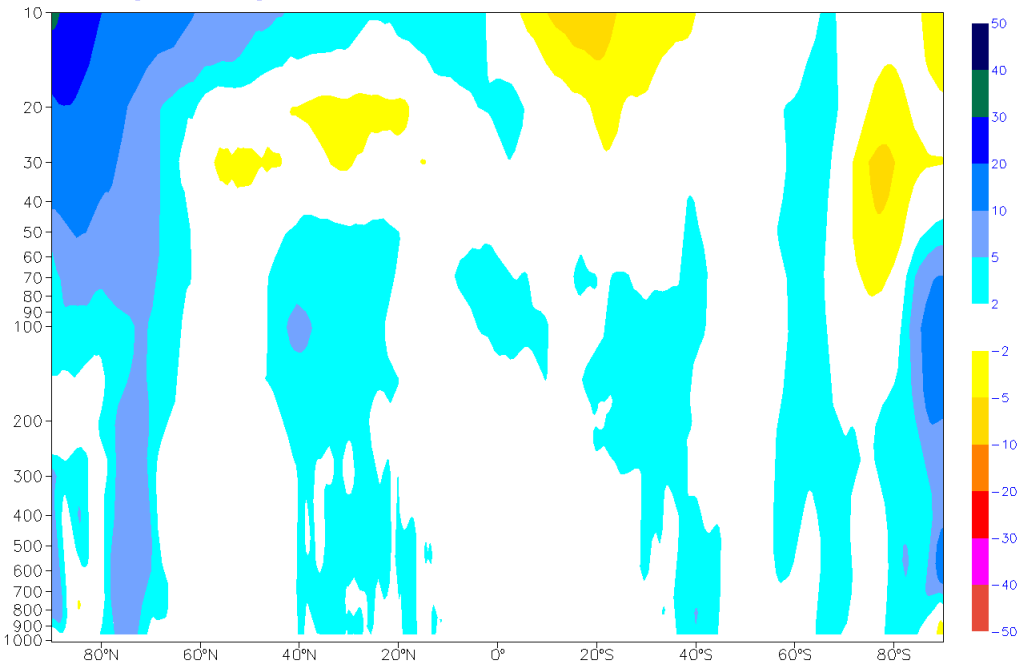


MF

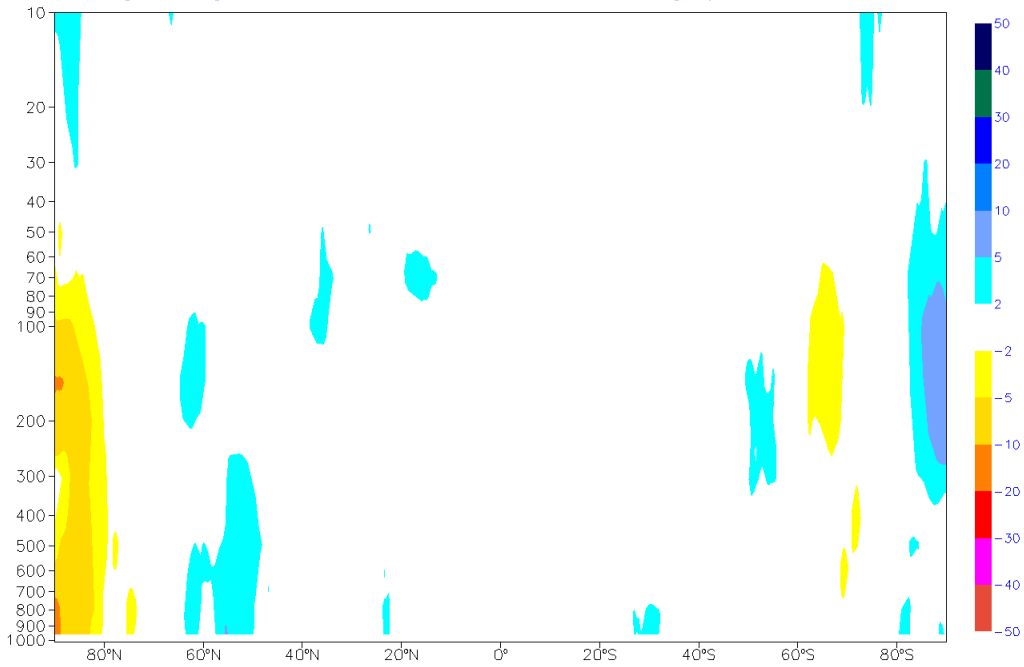


ECMWF

Relative reduction of standard deviation wrt to control analysis – Z – D+3 – zonal average

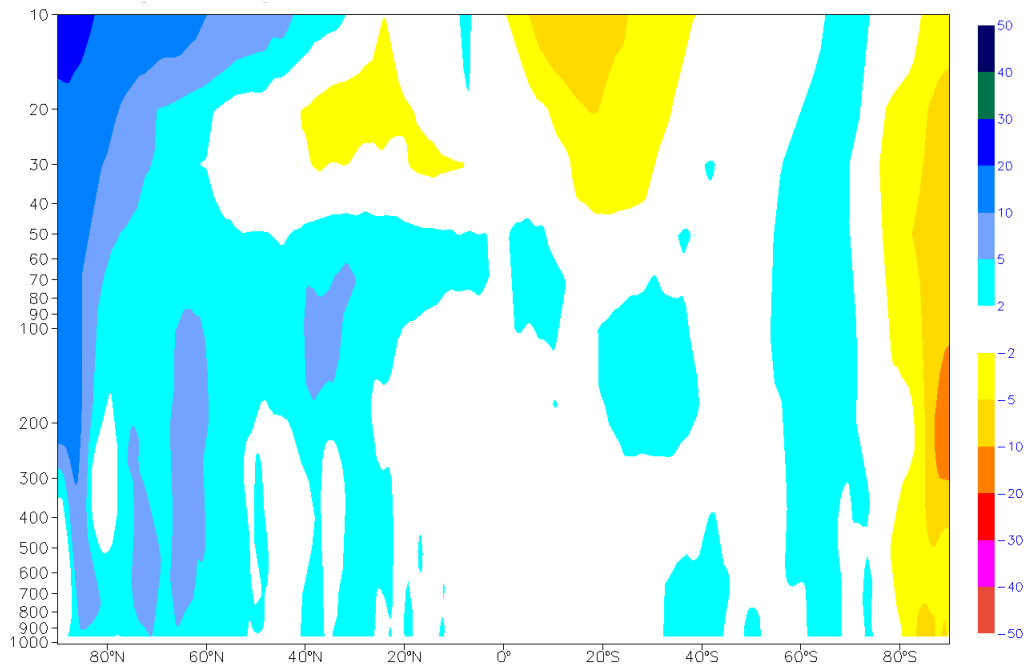


MF

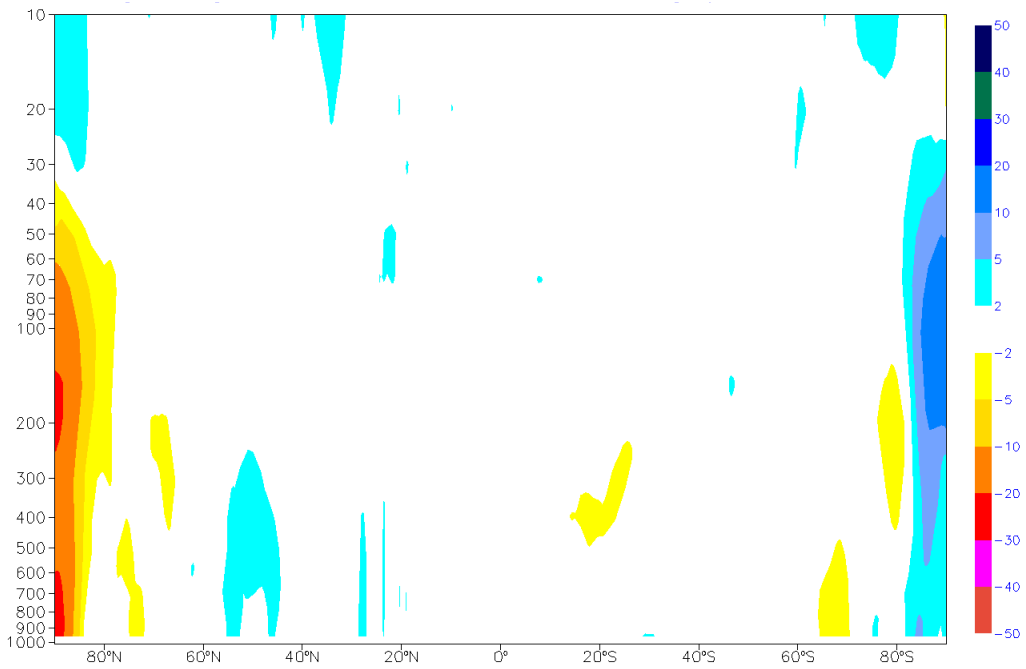


ECMWF

Relative reduction of standard deviation wrt to control analysis – Z – D+4 – zonal average



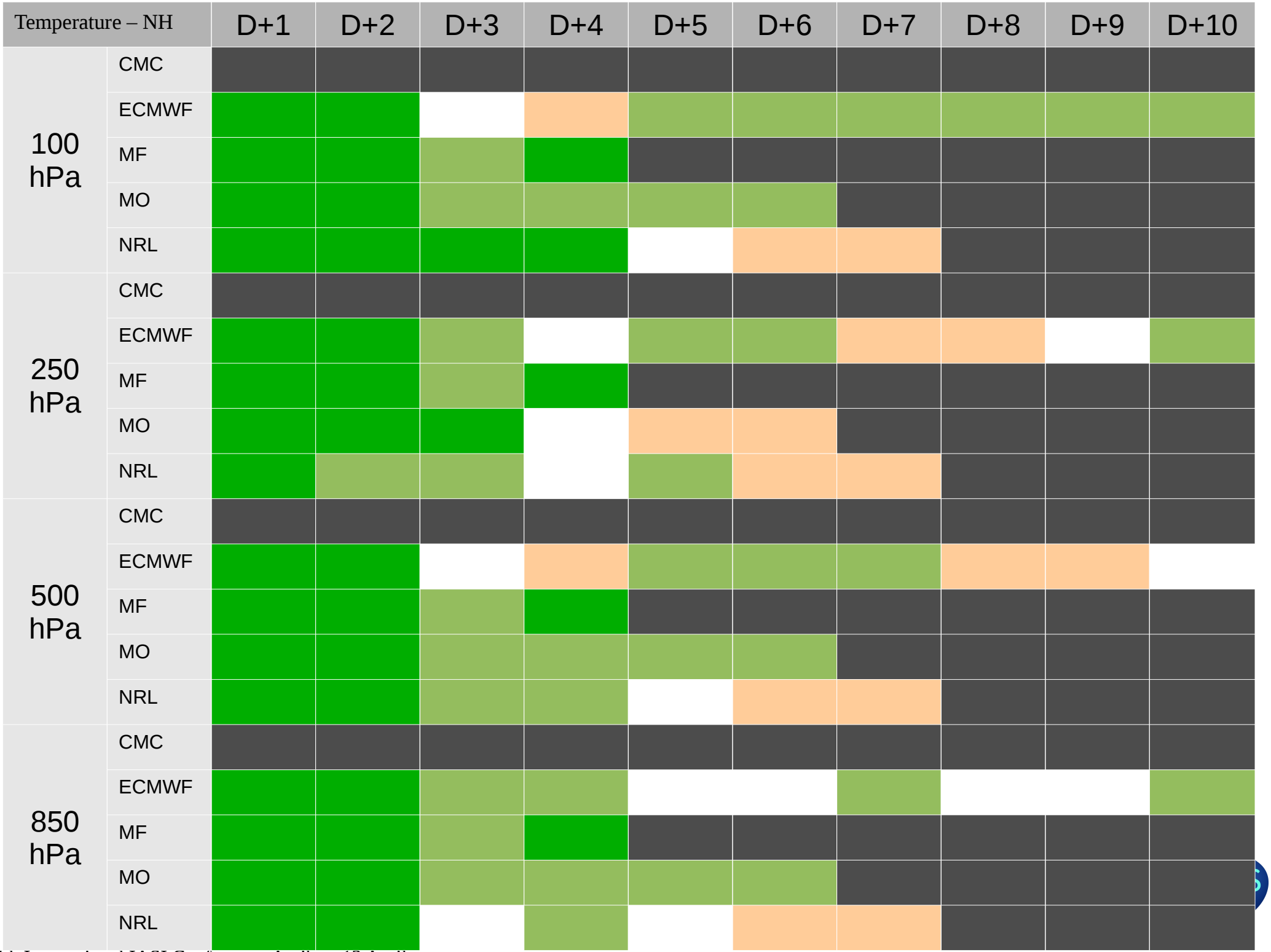
MF

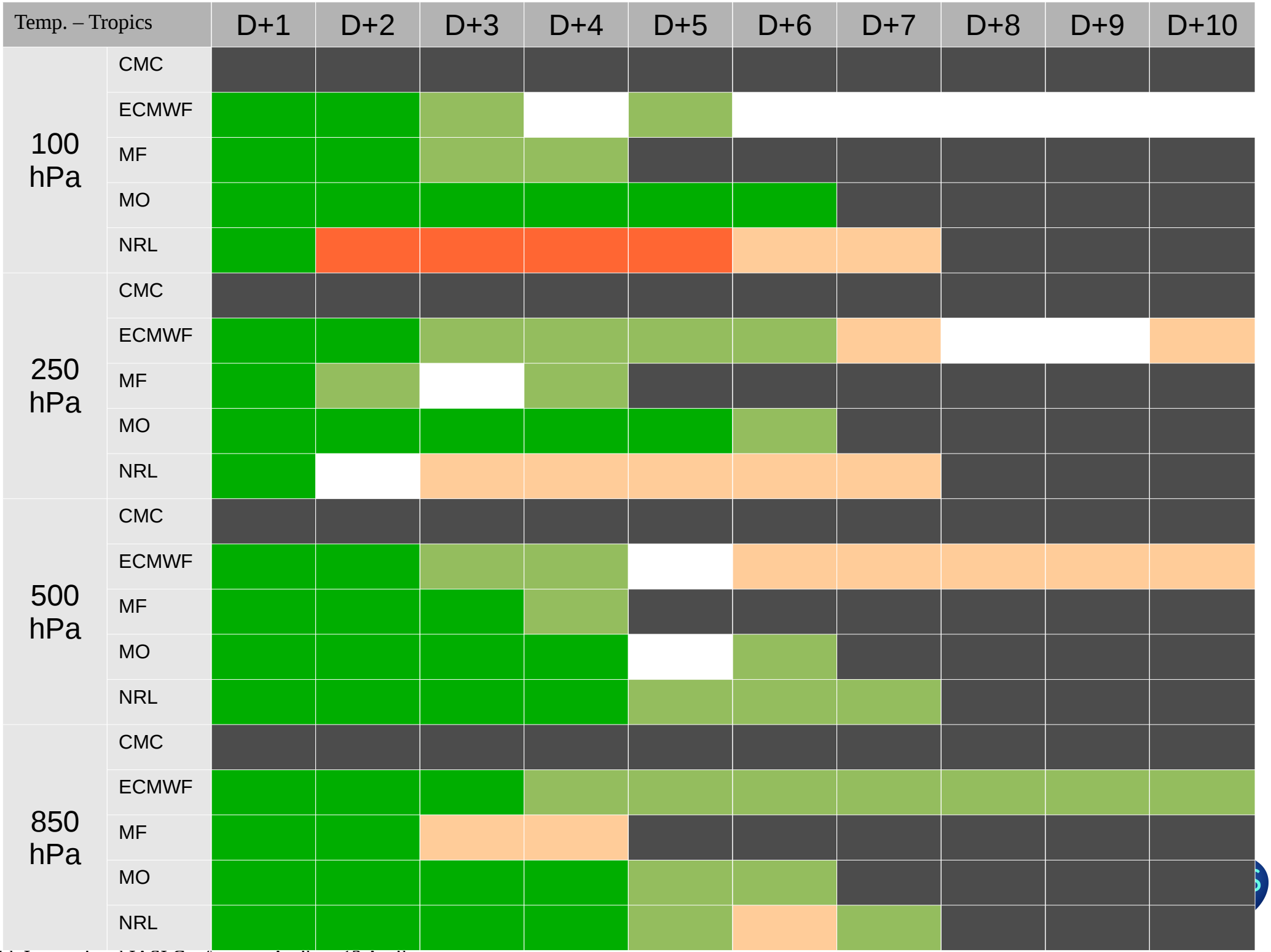


ECMWF

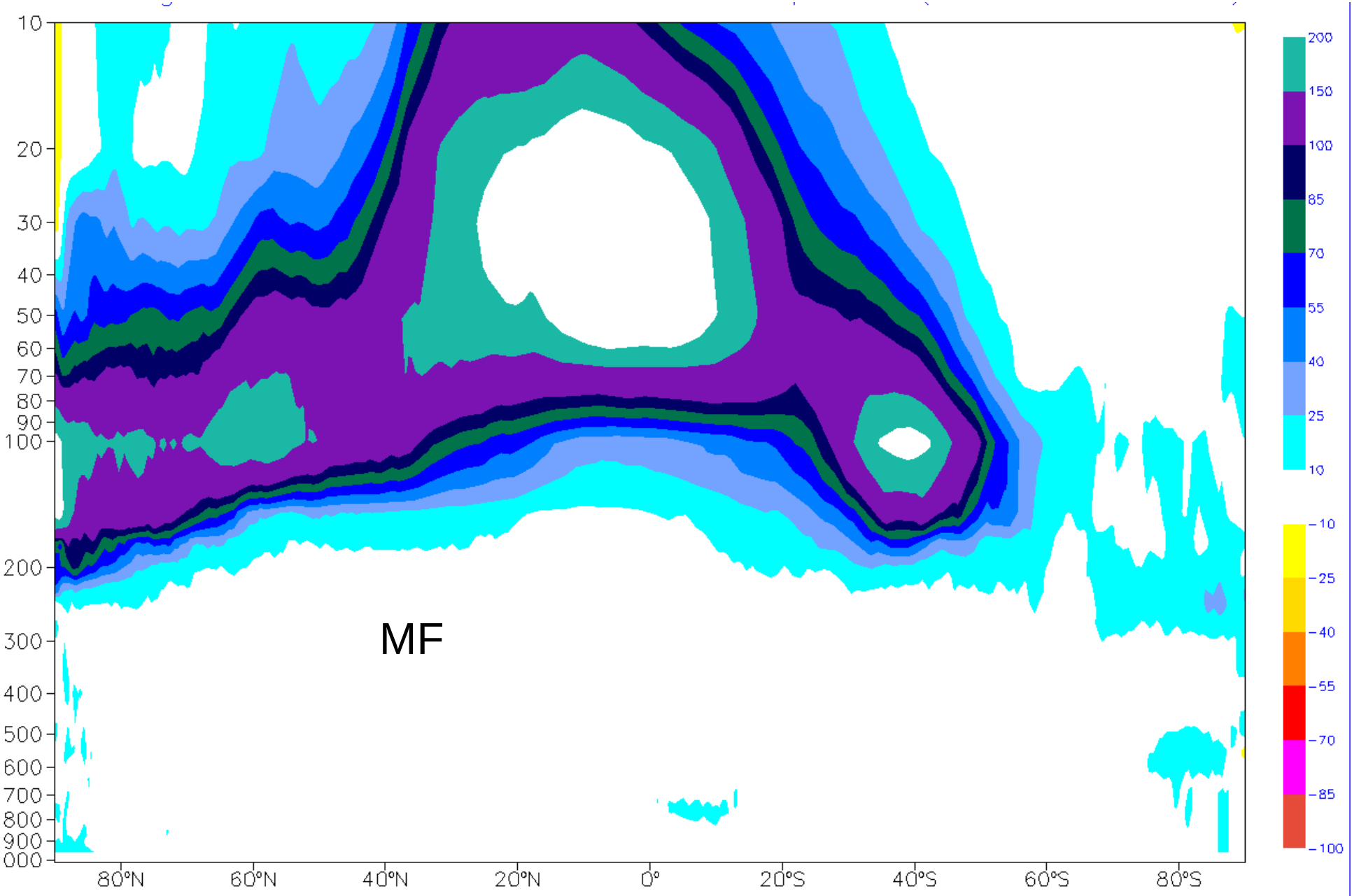
How to read tables on following pages

No data	
Positive impact – statistically significant	
Positive impact – not statistically significant	
Neutral impact	
Negative impact – not statistically significant	
Negative impact – statistically significant	

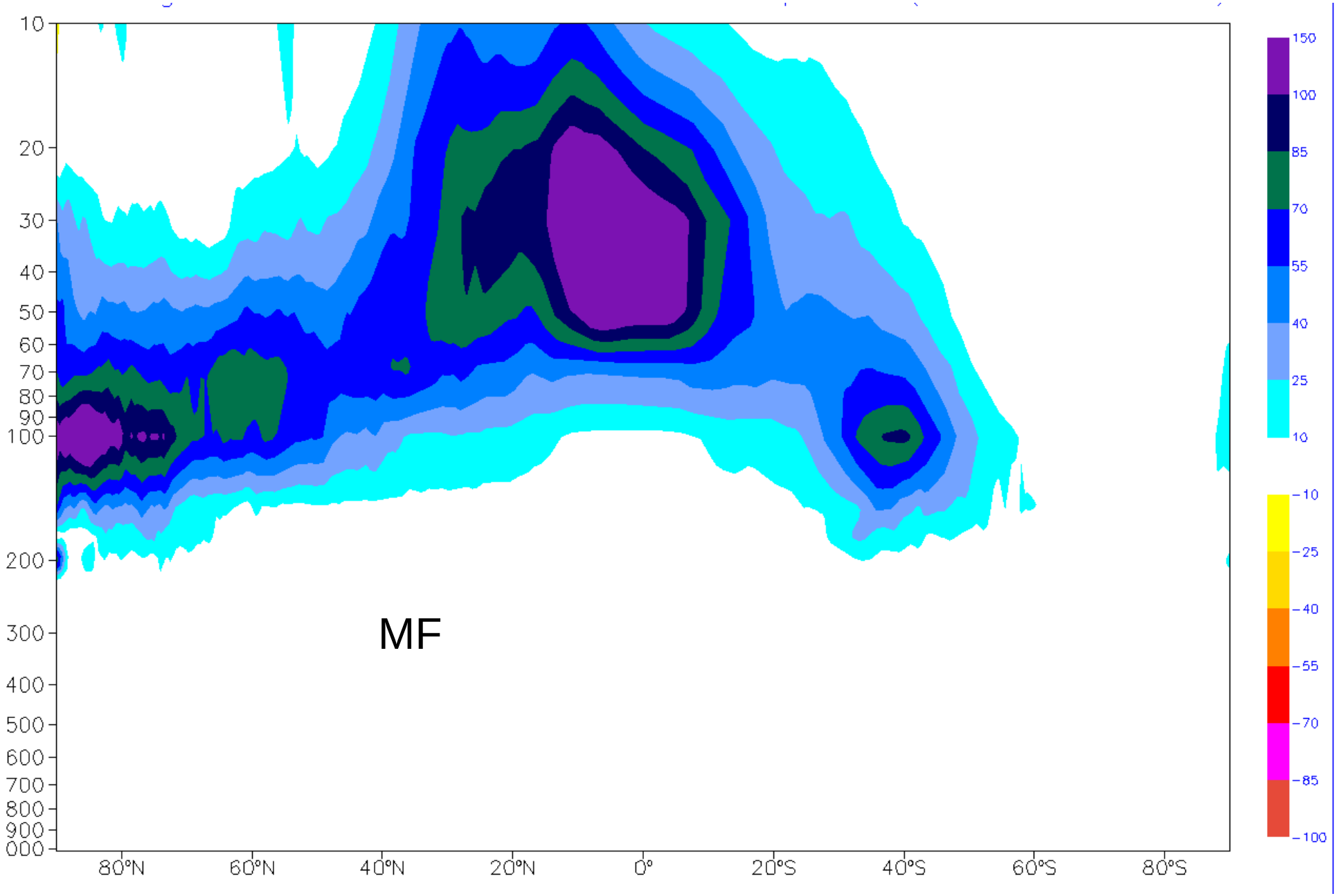

Temperature – NH
D+1
D+2
D+3
D+4
D+5
D+6
D+7
D+8
D+9
D+10
100 hPa
CMC
ECMWF
MF
MO
NRL
250 hPa
CMC
ECMWF
MF
MO
NRL
500 hPa
CMC
ECMWF
MF
MO
NRL
850 hPa
CMC
ECMWF
MF
MO
NRL


Temp. – Tropics
D+1
D+2
D+3
D+4
D+5
D+6
D+7
D+8
D+9
D+10
100 hPa
CMC
ECMWF
MF
MO
NRL
250 hPa
CMC
ECMWF
MF
MO
NRL
500 hPa
CMC
ECMWF
MF
MO
NRL
850 hPa
CMC
ECMWF
MF
MO
NRL

Relative reduction of standard deviation wrt to control analysis – RH – D+1 – zonal average

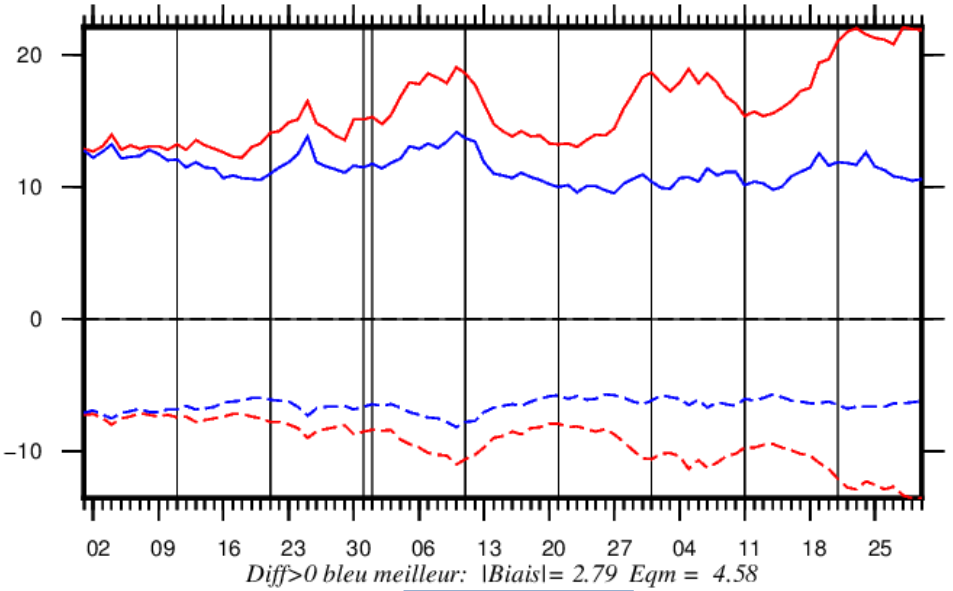


Relative reduction of standard deviation wrt to control analysis – RH – D+3 – zonal average



Time series of RMSE for D+1 humidity MF forecast versus ECMWF analysis - 100hPa

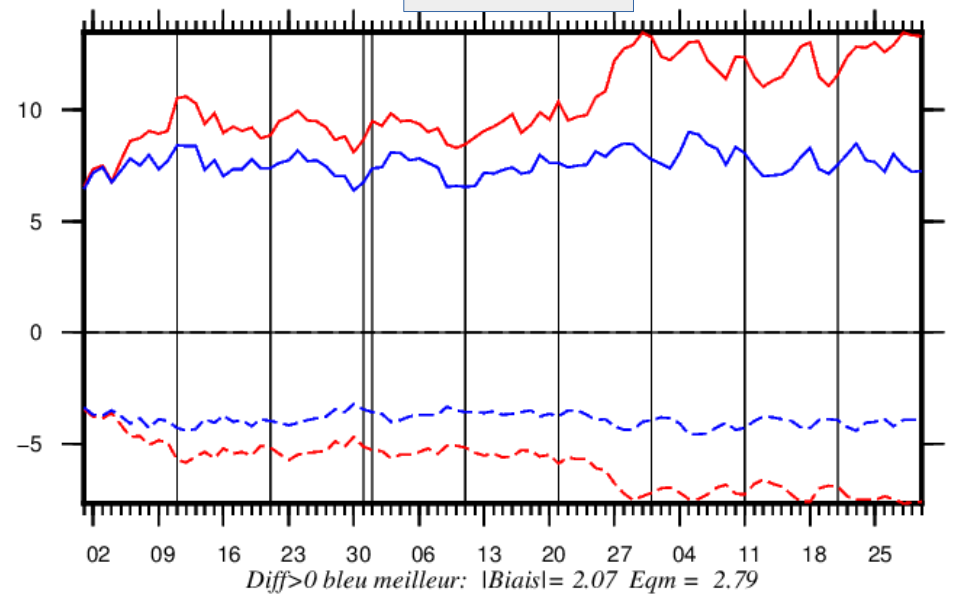
NH



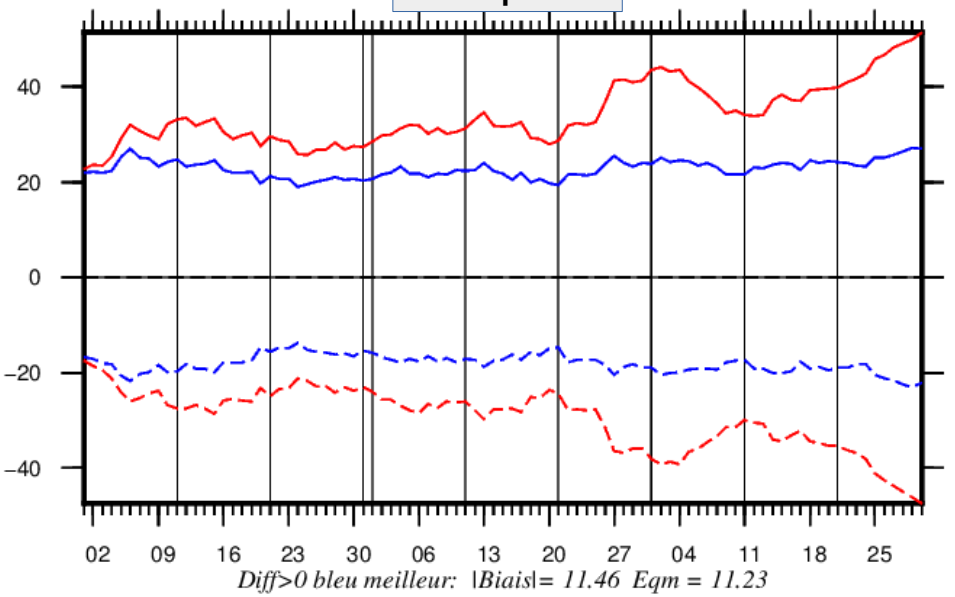
IASI (**blue**) – noIASI (**red**)
RMSE (solid) – Bias (dashed)

Assimilating IASI implies large modification in humidity fields in lower stratosphere

SH



Tropics



Summary

- IASI is an important part of the observing systems assimilated in global NWP models, but other sensors are now part of the game (CrIS, sounding SSMIS, Chinese sensors, etc.)
- Thus, IASI impact seems lower now than years ago
- IASI still significantly modify analyses and forecasts
  - In the stratosphere
  - Positive impact in all global models
    (but be cautious wth scores at very short range!)

- More results to come, as other centres will provide their denial experiments, more diagnostics, impact on ensemble data assimilation, etc.
  - Paper to be submitted by the end of the year

Challenges

- Using the full spectrum ?
  - Assimilation of PC scores
    - M. Matricardi's talk
  - Assimilation of reconstructed radiances
    - J. Andrey Andres' talk and F. Smith's poster (S6-119)
- Properly describe observation errors
    - Talks by W. Campbell and R. Eresmaa and C. Hyoung-Wook's poster (S6-130)
- Clouds and Aerosols
  - Detection : Stiller (S6-125), Letertre-Danczak (S7-17)
  - Cloud properties : Farouk (S7-21)
  - All sky : Li (S6-123) / Cloud clearing : Liu (S6-131)
- Surface properties and assimilation over land (talk by Boukachaba S5)
- Coupling with Chemestry (Coopmann S6-127)