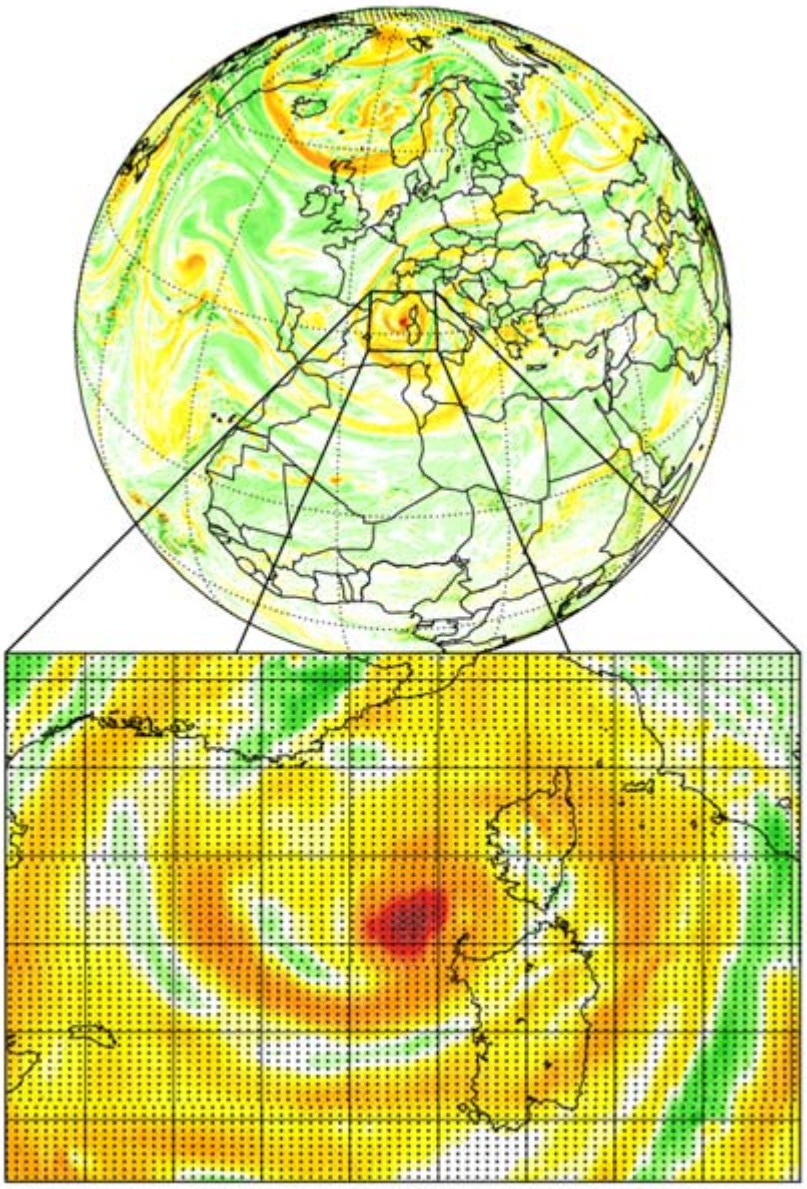


ECMWF Report

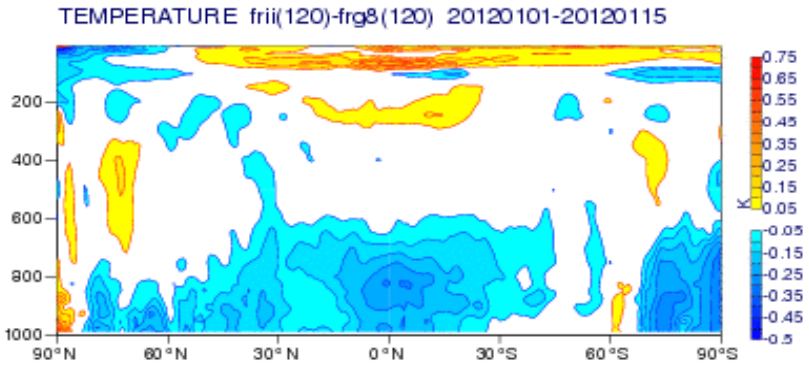
Implementations 2014-2017

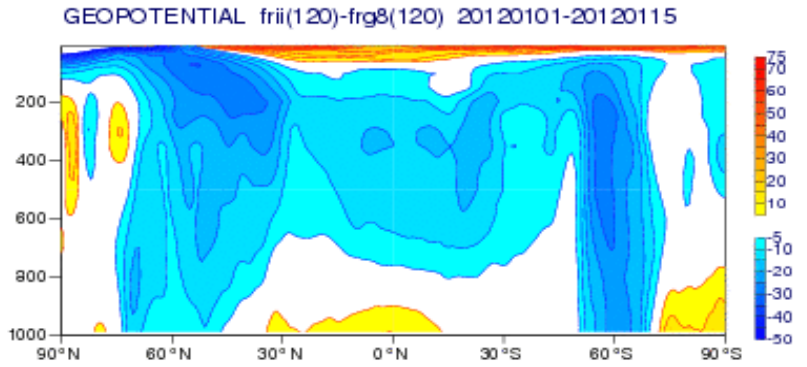
	2013	2014	2015	2016-7
Model components:				
-Atmosphere	Convection, clouds, PBL	Stratospheric noise filter	New PBL, mass conservation	
-Composition		MACC climatologies	Interactive ozone	Interactive aerosols
-Land surface		New orography, FLAKE	Multi-layer snow	Hires land-surface
-Waves	Wave effects on upper ocean		Surface currents - waves	Unstructured grid
-Ocean	ENS ocean coupling day-0		Sea-ice in ENS	Ocean in HRES
-Model error	Land surface perturbations	SKEB w/o GWD	Revised SPPT	
Data assimilation:				
-EDA	Covariances,			
-4D-Var	unbalanced CV	Balance stratosphere, **R**	Cloud CV, weak constraint 4DVAR	
-Surface	**B** L137, radiance q/c	LAI/snow in SEKF	Albedo in SEKF	
-Coupling	Snow analysis		Coupled reanalysis, sea-ice analysis	Weakly coupled 4DVAR
-Data		ASCAT, MSG-4, SMOS, MT	Sentinel-3/5p, Aeolus	EarthCARE
System configuration:				
-Resolution	HRES/4DVAR/EDA L137	EDA T511, 4DVAR T399	HRES T2047, ENS T1023, 1/4^{o} ocean	
-Ensembles	ENS L91, EDA M25	ENS reforecasts M15		EDA M50, System-5
-DA window			4DVAR 24h	4DVAR 36/48h?
Scalability:				
-Technical		Overlapped comms.		Unstructured sub-meshes
-Model		Lagged radiation	Multiple model grids	New eqs., transport, solver
-Data assimilation	3DVAR in OOPS		4DVAR in OOPS	
-Data processing	COPE prototype	COPE operational		
Services:				
-MACC		MACC-II end	MACC-III end/ Copernicus-AS start	
-ERA/ORA	ERA-Clim end	ERA-CLIM2/SAT start	ERA-I end	ERA-CLIM2 end
-OpenIFS	Phase-1 end	Phase-2 start		Phase-2 end

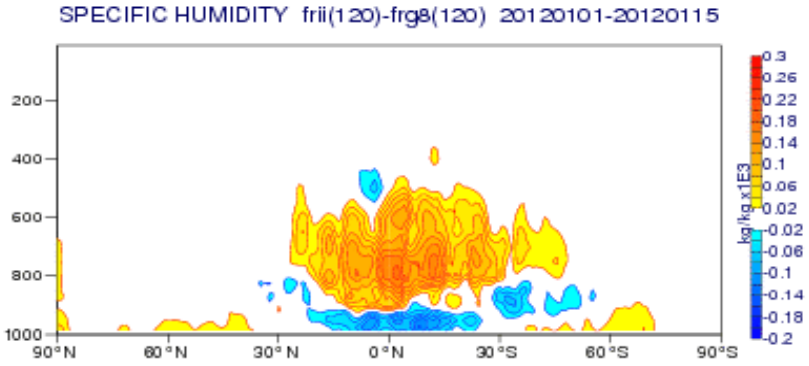
Cycles 38r2, 40r1

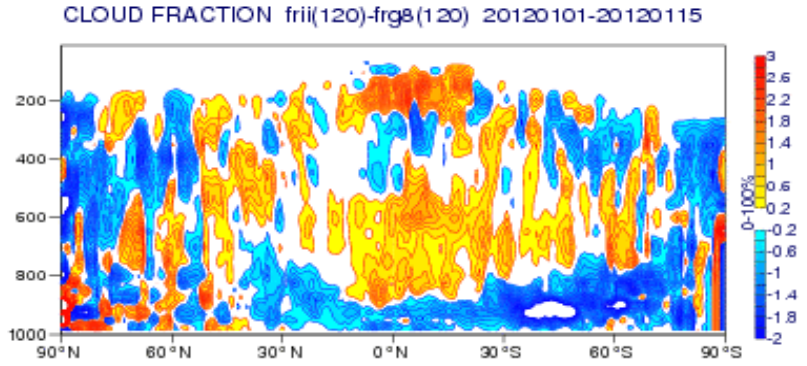
Cycle 38R2: Mean impact

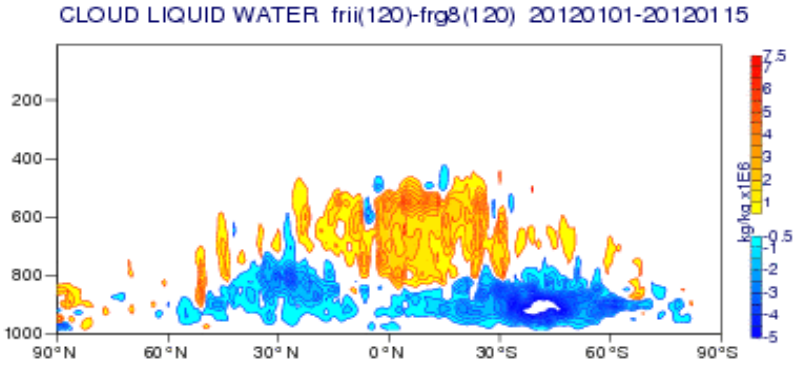
L137-L91, day-5 forecasts 1-15 January 2012

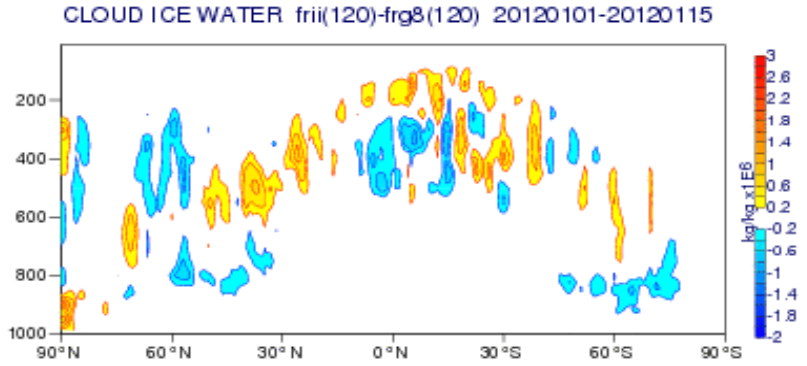






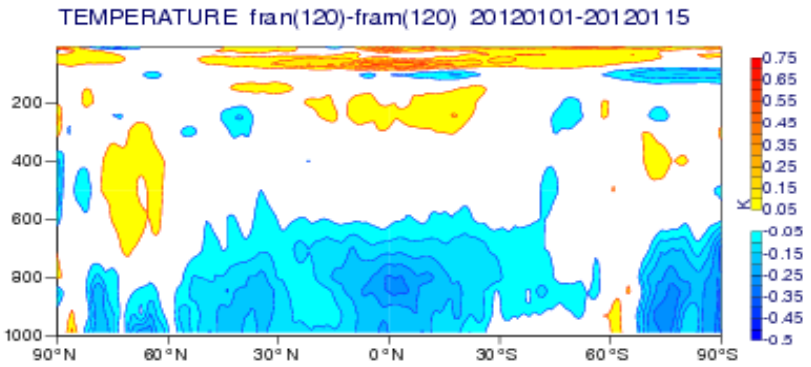


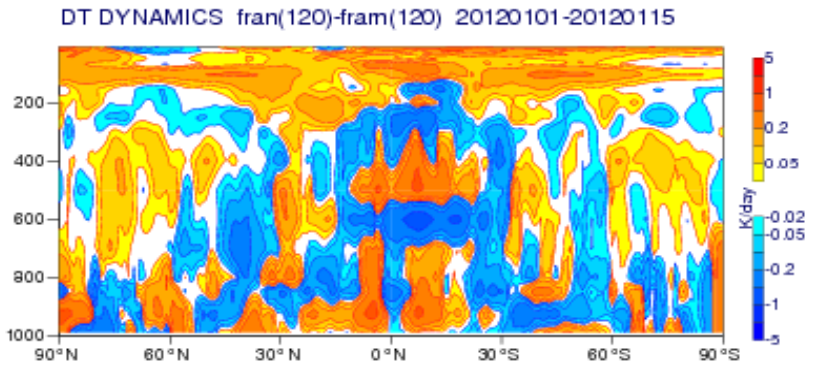


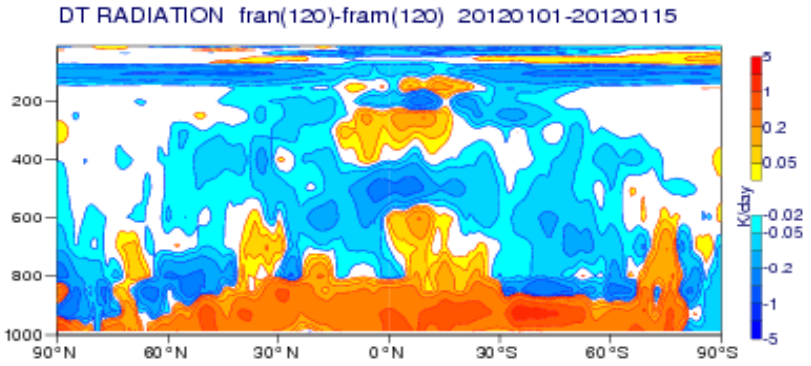


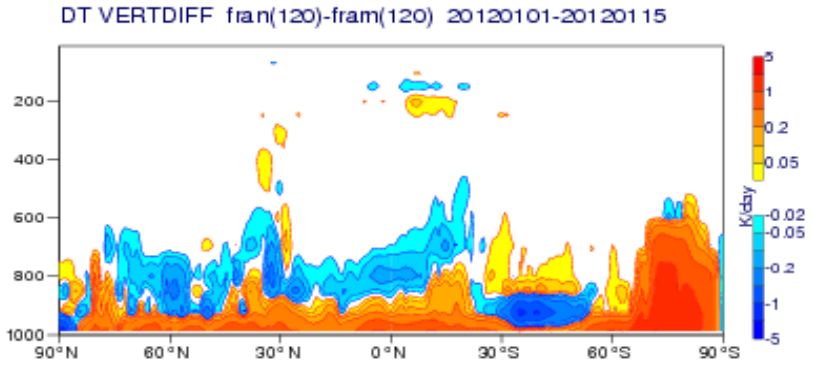
Cycle 38R2: Mean impact

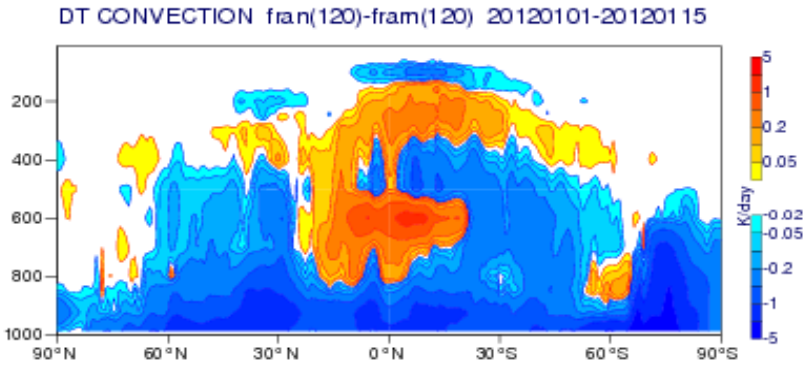
Temperature tendencies difference (K/day), day-5 accumulations (T159, 1-15 January 2012)

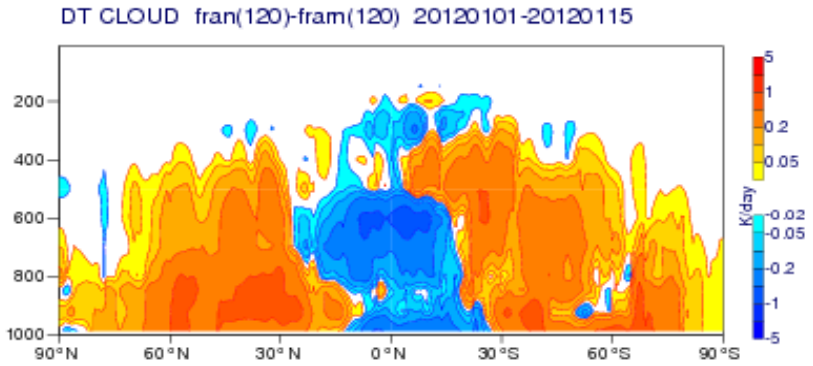








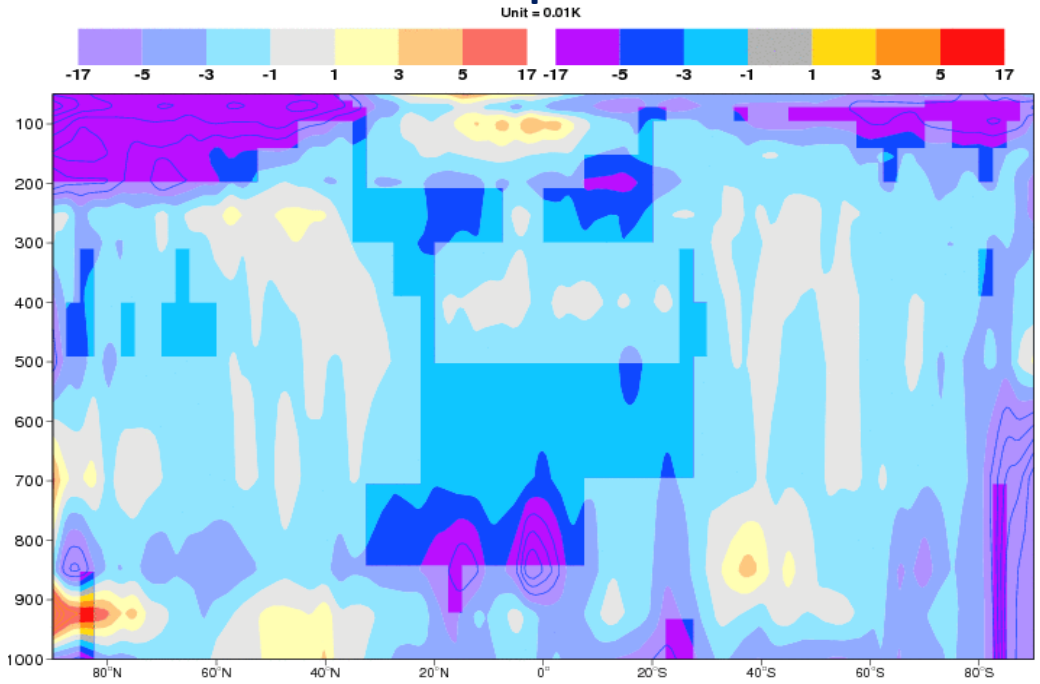




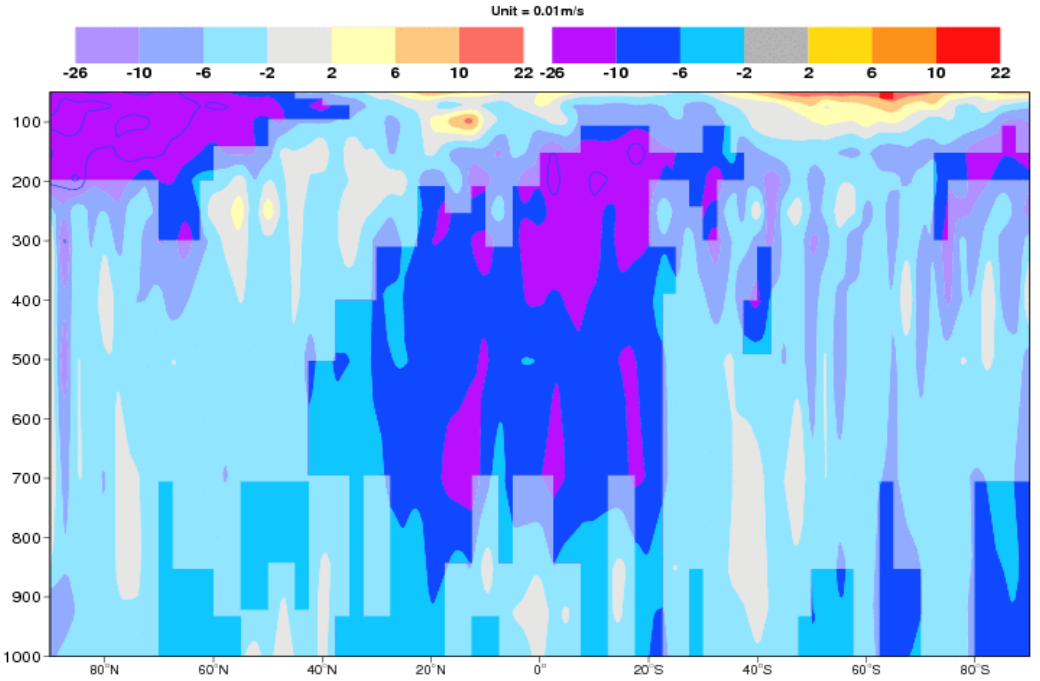
Cycle 38R2: Mean impact

38R2 (L137) – 38R1 (L91) day-1 forecast RMSE June-August 2012

Temperature



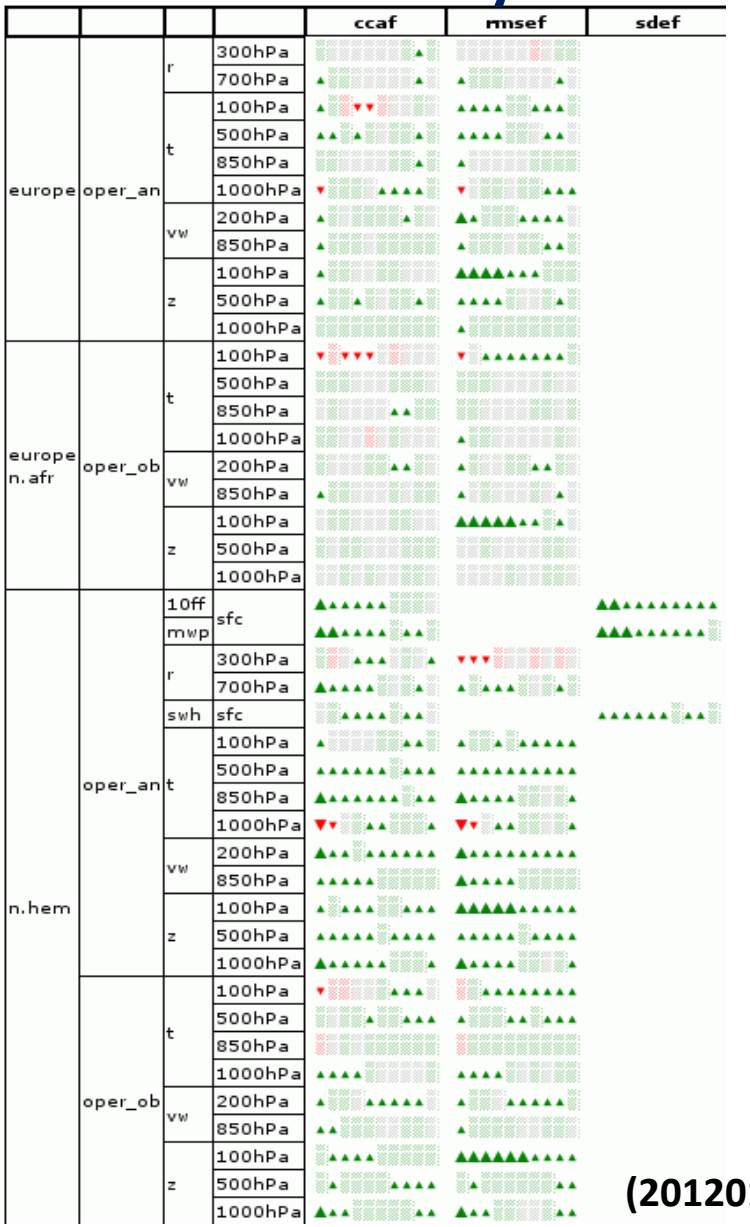
Zonal wind



Cycle 38R2 – HRES (OD)

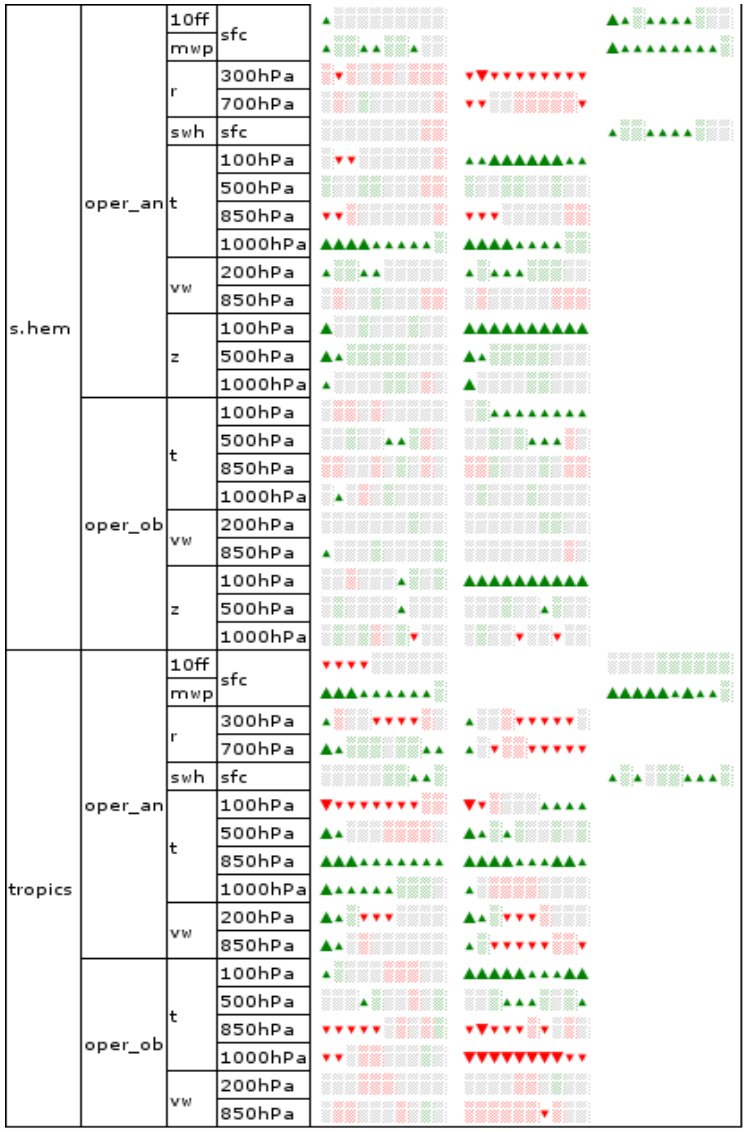
Europe

N. Hem.



S. Hem.

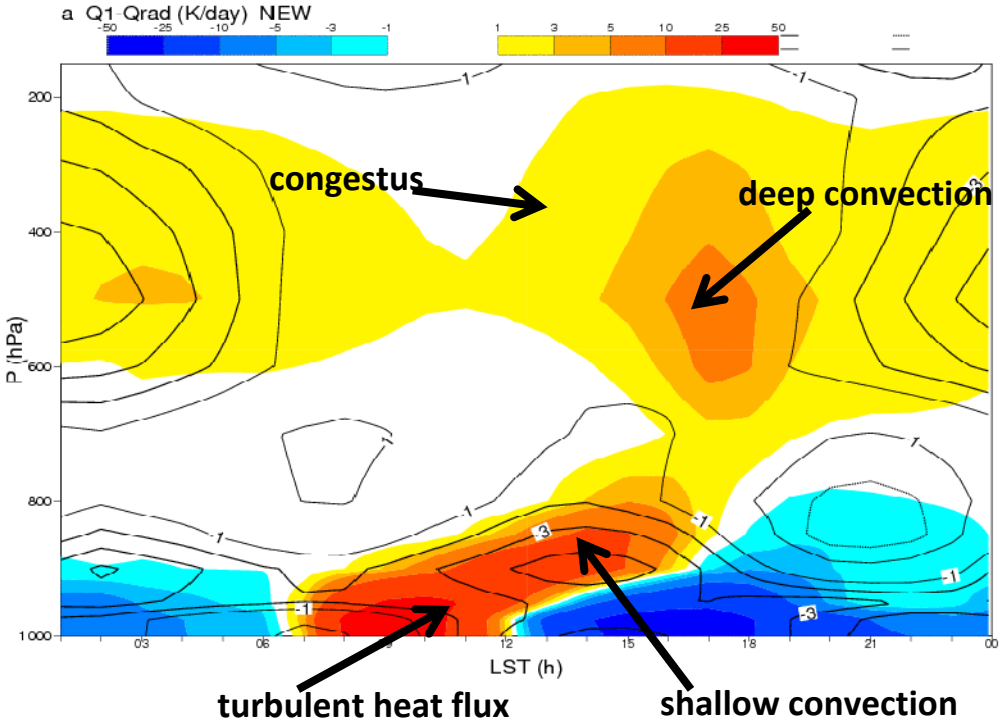
Tropics



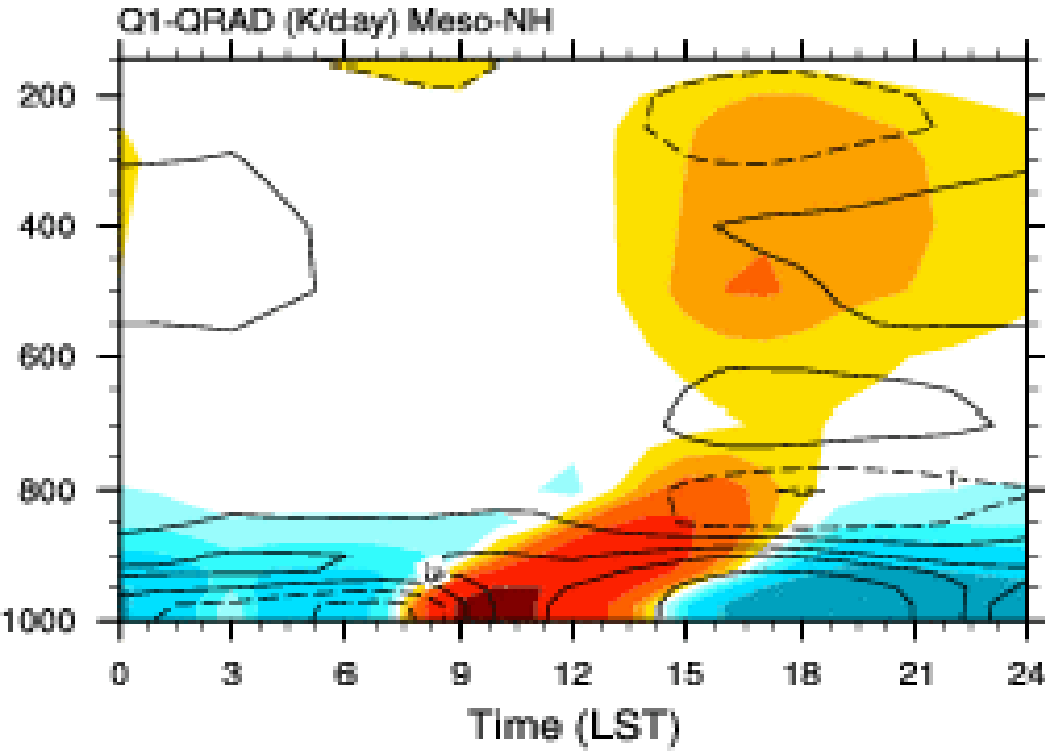
(20120101-20120314)

Cycle 40R1: Diurnal cycle convection

IFS (40 km)



Meso-NH (2.5 km)

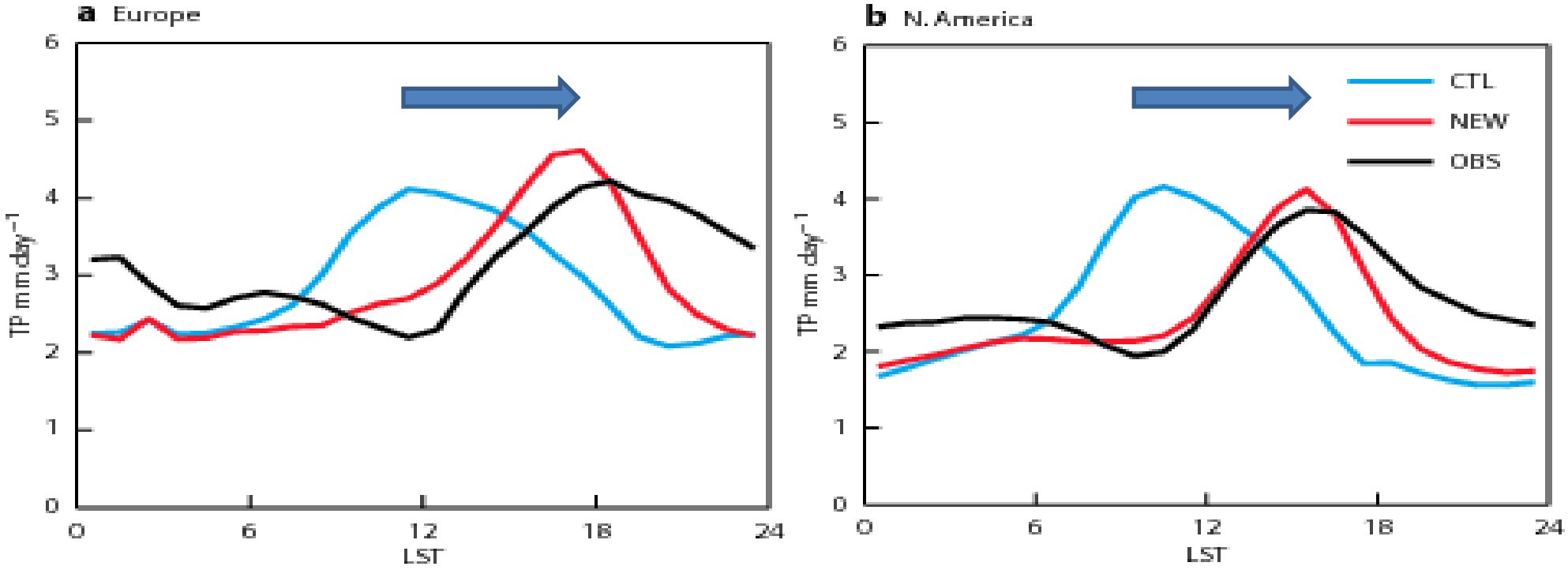


Colours: total heating - radiation

Contours: adiabatic (dynamical) tendencies= response to convective heating

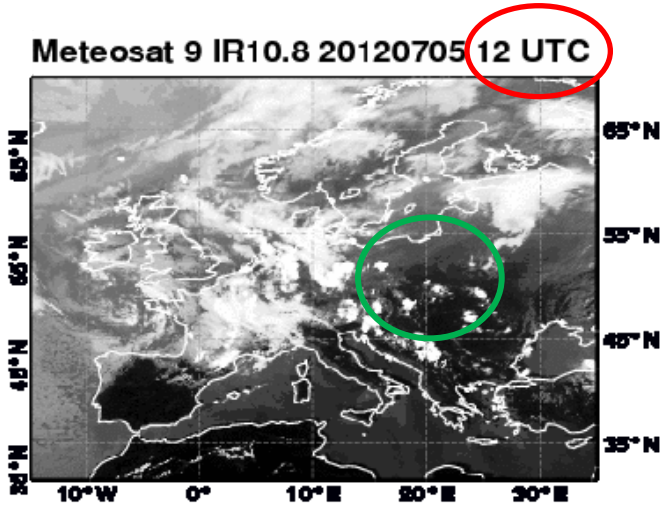
Cycle 40R1: Diurnal cycle convection

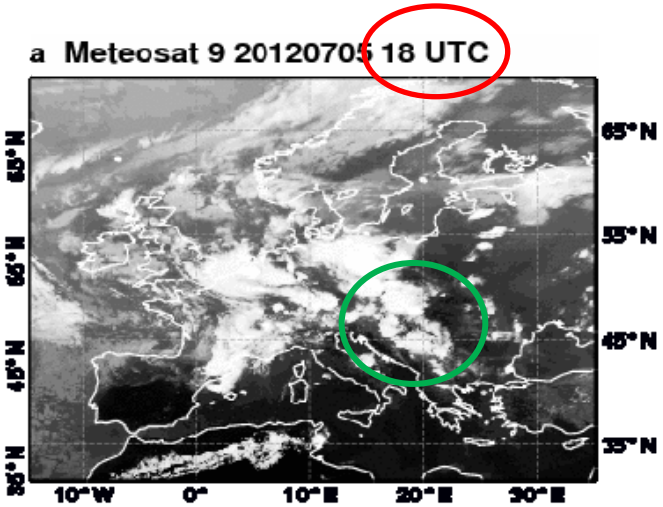
Radar verification for JJA 2011



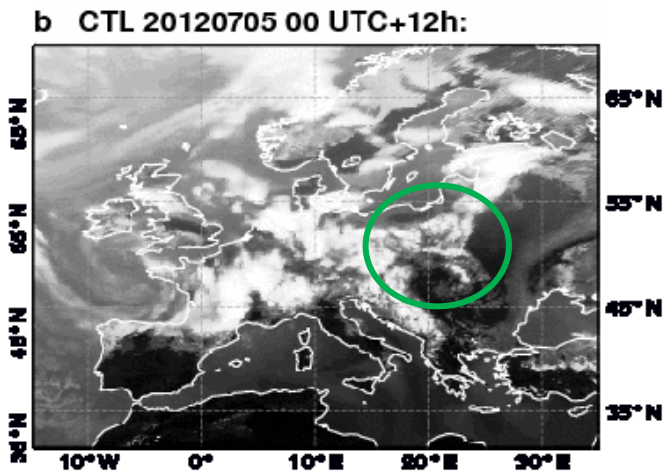
Cycle 40R1: Diurnal cycle convection

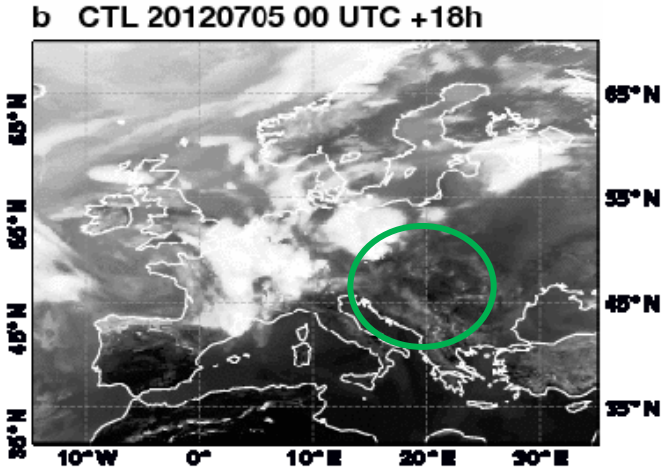
Observation



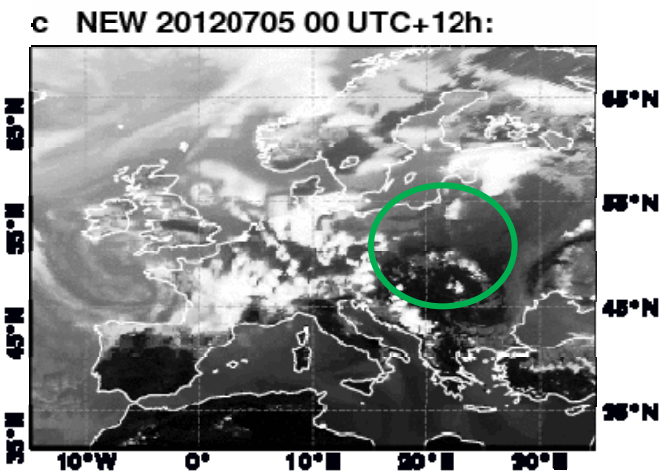


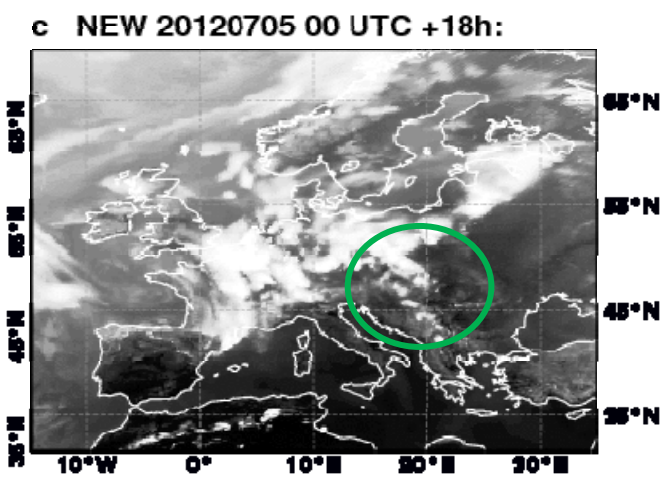
Current scheme





New scheme





Changes implemented in 40R1 building on Sandu et al, 2013

Turbulence closure for stable conditions:

$$K_{M,H} = \left|\frac{\partial U}{\partial Z}\right| l^2 f_{M,H}(R_i), \quad \frac{1}{l} = \frac{1}{kz} + \frac{1}{\lambda}$$

Up to 38R2

-long tails near surface, short tails above PBL

- λ =150m

-non-resolved shear term, with a maximum at 850hPa

From 40R1

-long tails everywhere

- λ = 10% PBL height in stable boundary layers

- λ = 30 m in free shear layers

+

Increase in drag over orography
Increase in atm/surf coupling

Consequence: net reduction in diffusion in stable boundary layers, not much change in free-shear layers, except at 850 hPa

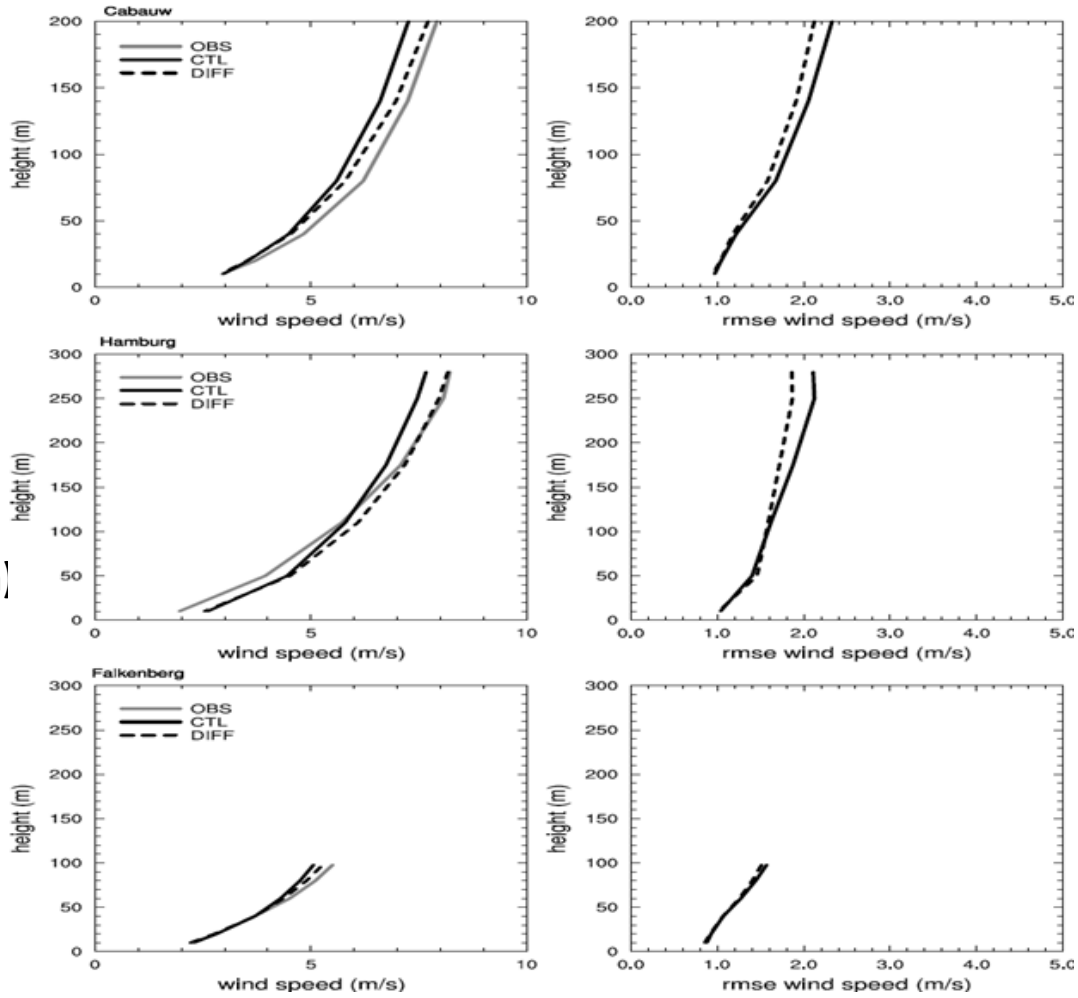
Cycle 40R1: Vertical diffusion and GWD

40r1 vs 38r2: RD e-suite verification with SYNOP

Period: 15/06-31/07/2013

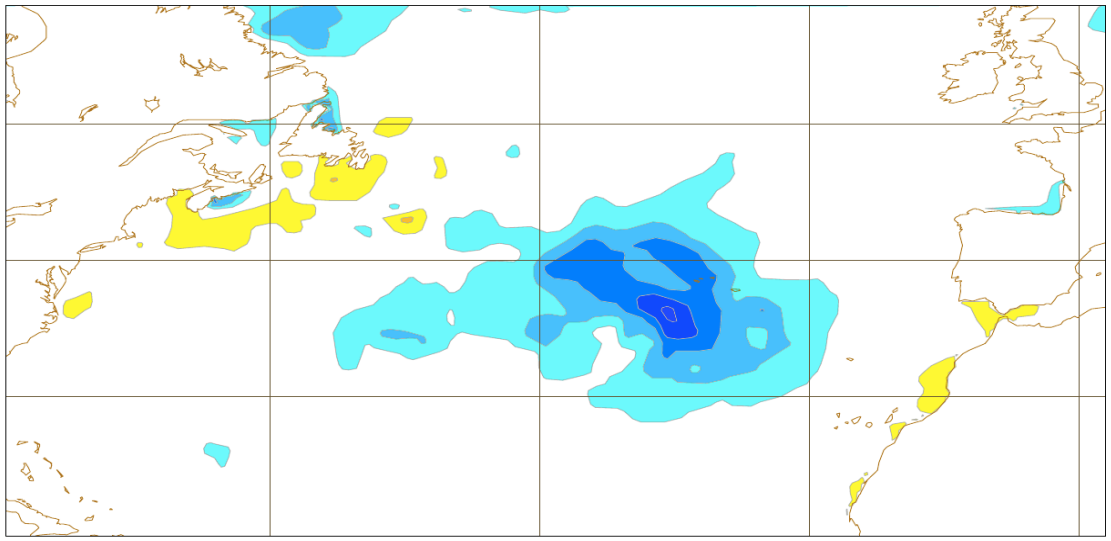
EXP	Mean error	RMSE
2-m temperature (C), 00 UTC (+60h):		
38r2	0.26	2.06
40r1	0.27	2.09
12 UTC (+72h):		
38r2	-0.34	2.67
40r1	-0.19	2.61
2-m dew-point temperature (C) , 00UTC (+60h)		
38r2	-0.30	2.26
40r1	-0.18	2.23
12UTC (+72h):		
38r2	-0.41	3.01
40r1	-0.41	3.01

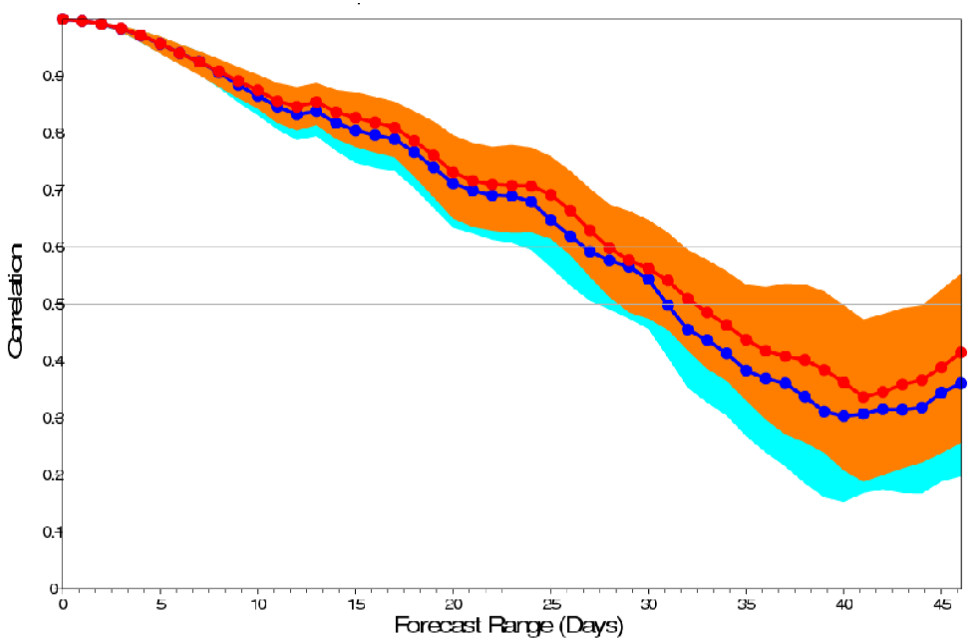
JJA 2012 24-hour forecasts



Cycle 40R1: Tendency coupling of ENS with NEMO from initial time

Hurricane Nadine – 19/09/2012
SST day 5 – day 0



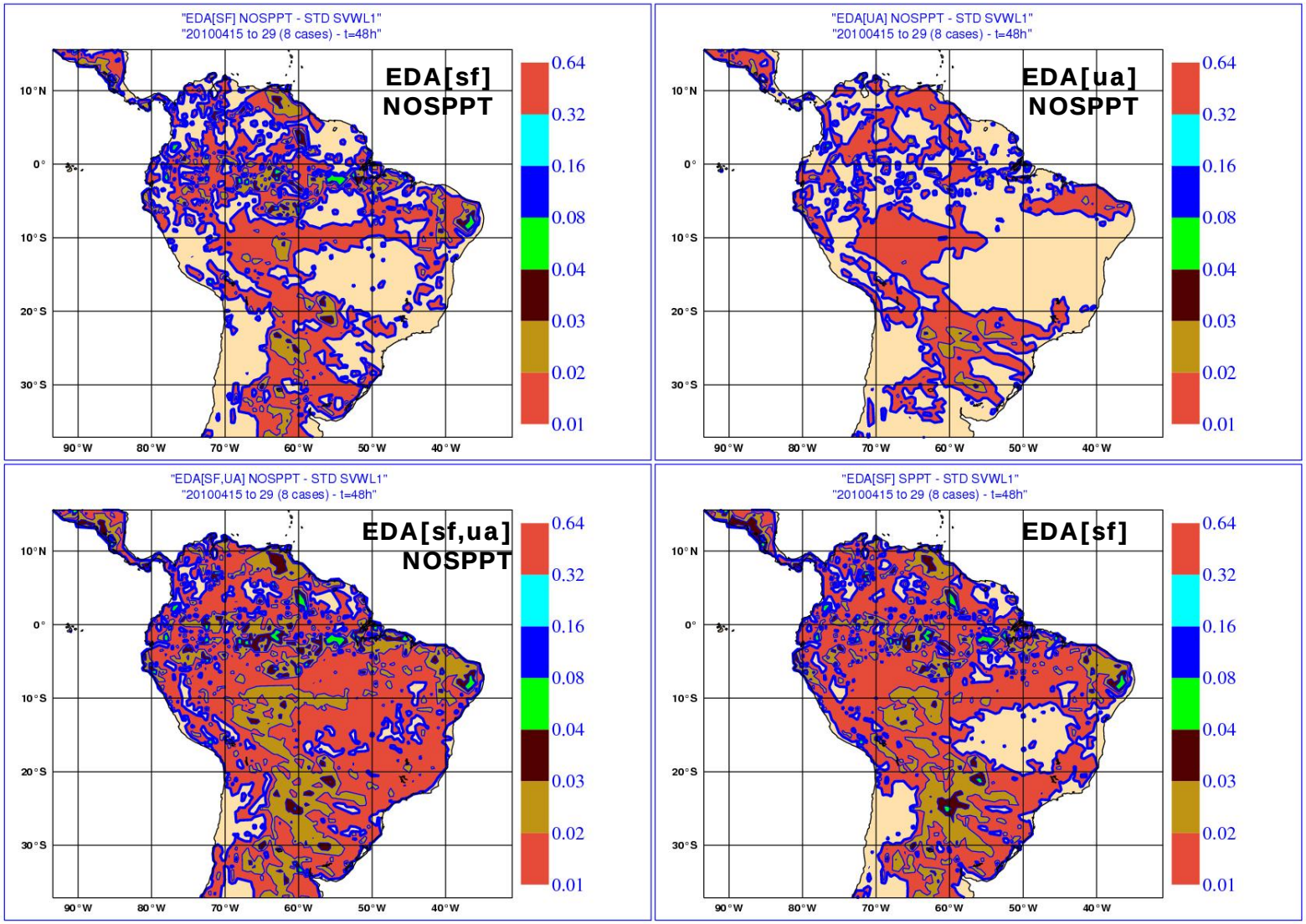


MJO bivariate correlation

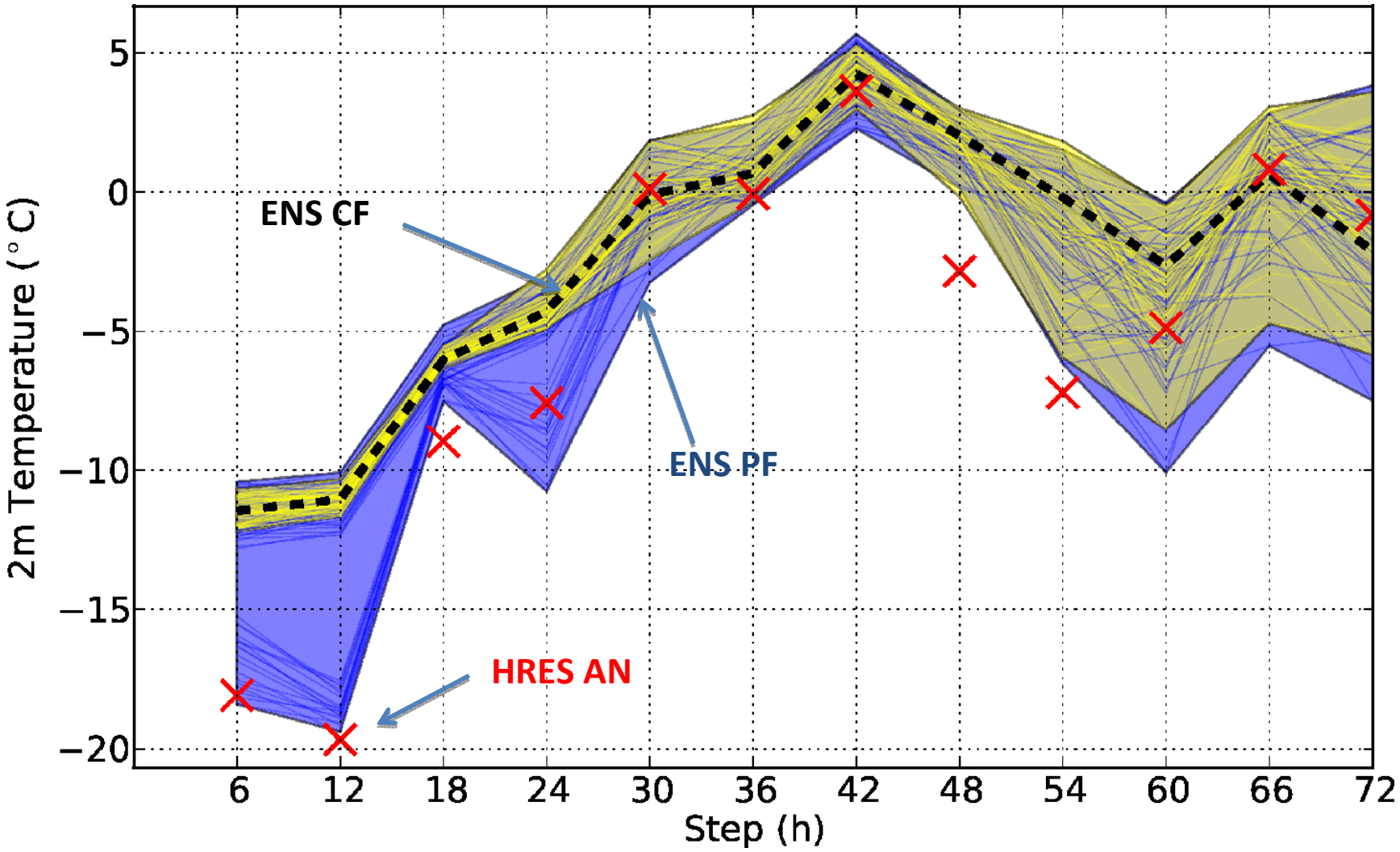
Tendency coupling
No coupling

Cycle 40R1: Land surface perturbations in EDA

ENS spread soil moisture top layer (t=48h)

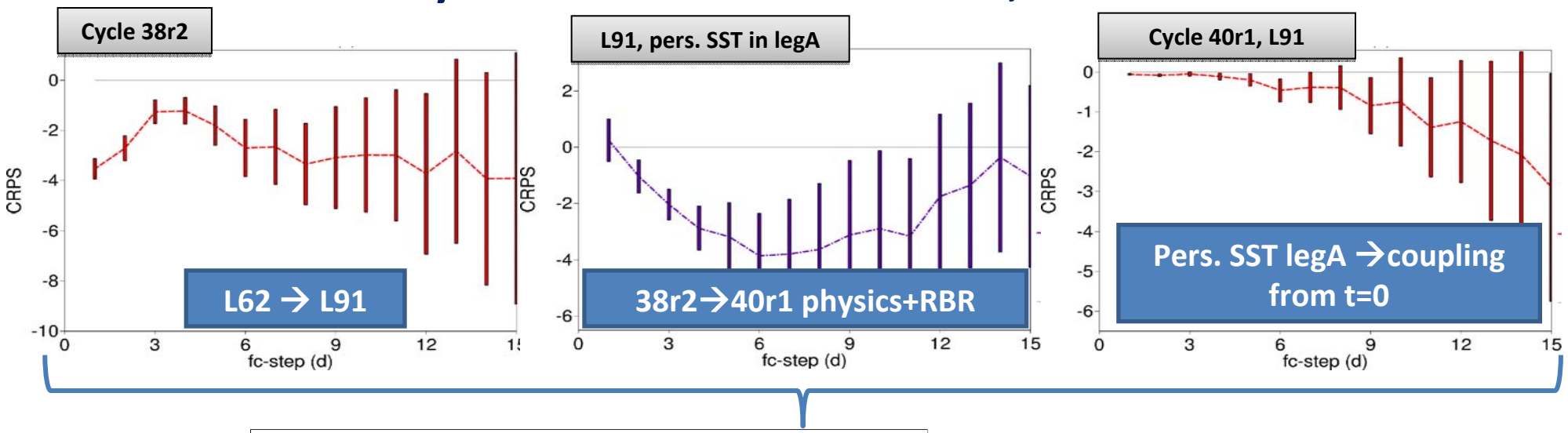


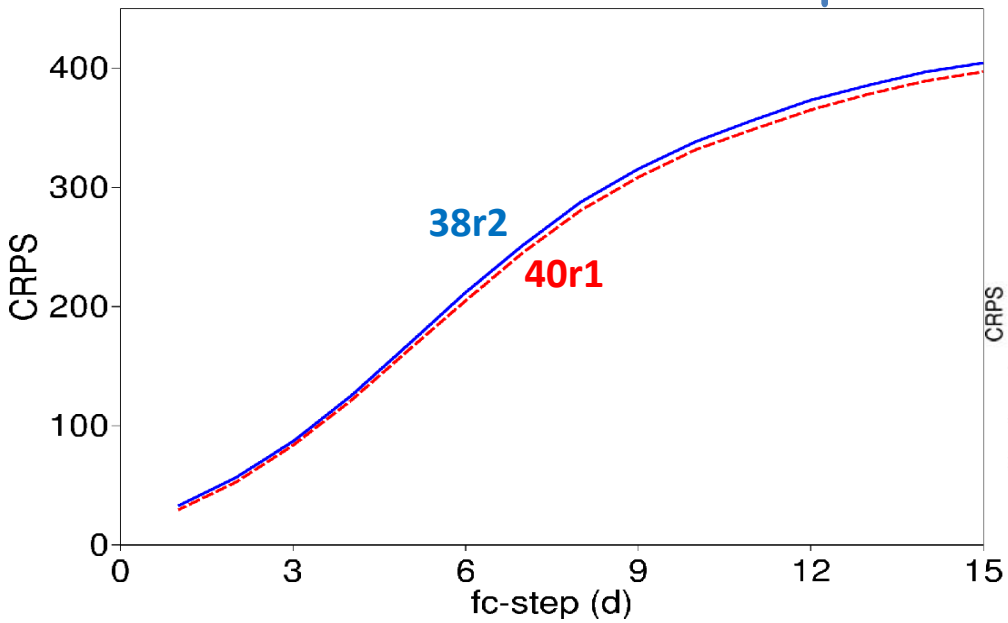
Cycle 40R1: Land surface perturbations in EDA

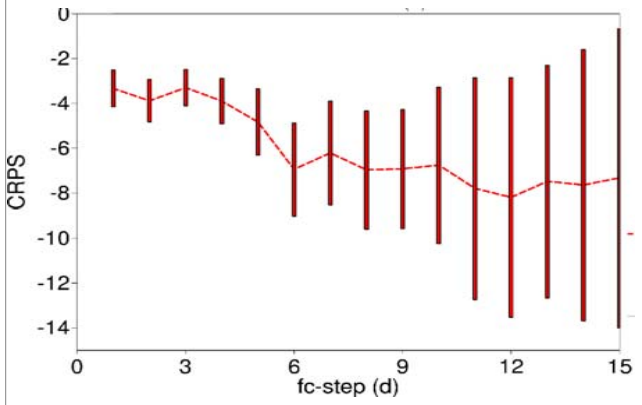


Grid point in South Dakota (44.1° N, 98.9° W), initialised on 2013-01-15, 00 UTC

Cycle 40R1: ENS forecast skill, z500 NET

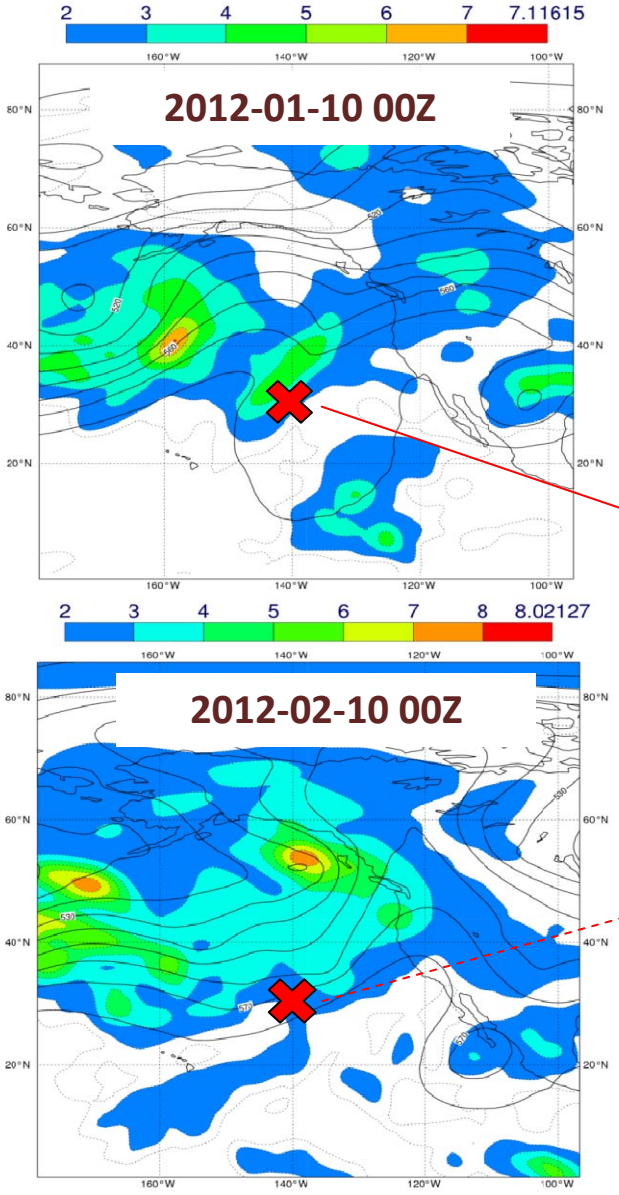




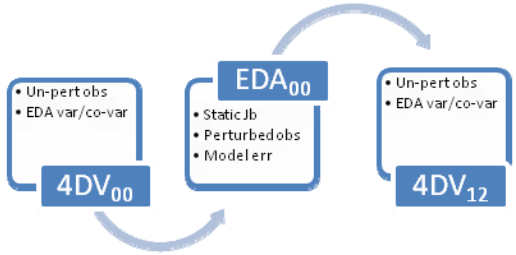


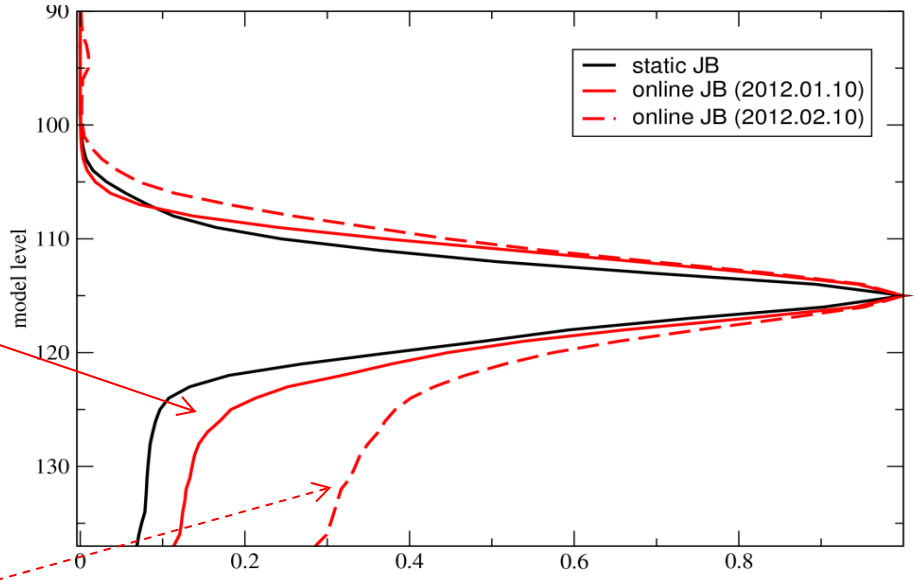
61 cases (Jan-Mar 2012, Jun-Aug 2012)
38r2 analyses and EDA perturbations

Cycle 40R1: EDA error covariances



MSLP analysis field (isolines) and EDA vorticity errors (colour shaded unit: 10^{-5} s^{-1}) at ML=115



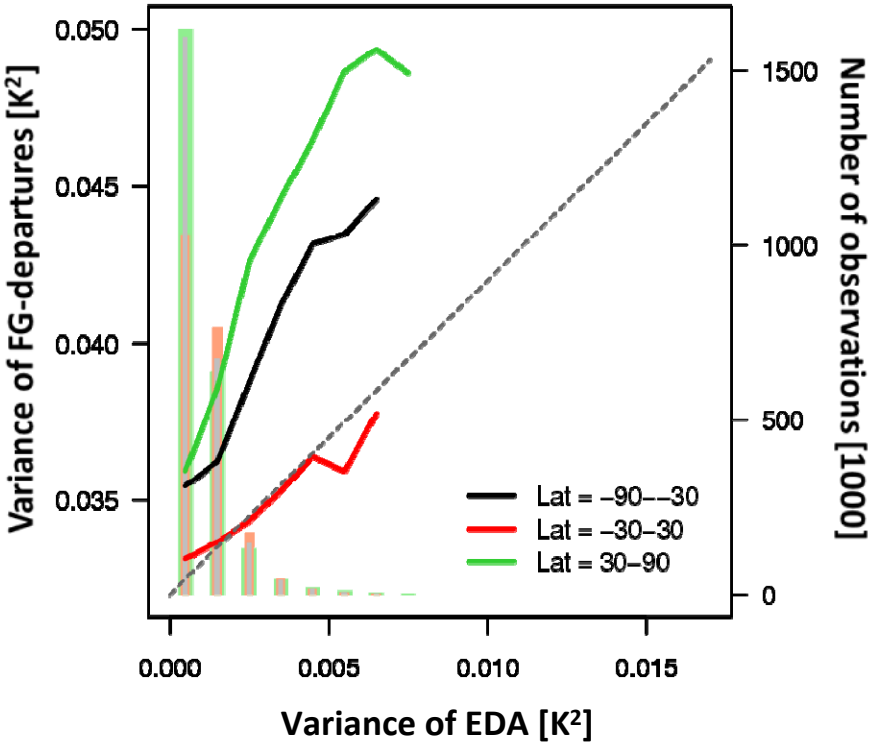


Vertical correlation of vorticity errors ML=115 at 30N 140W

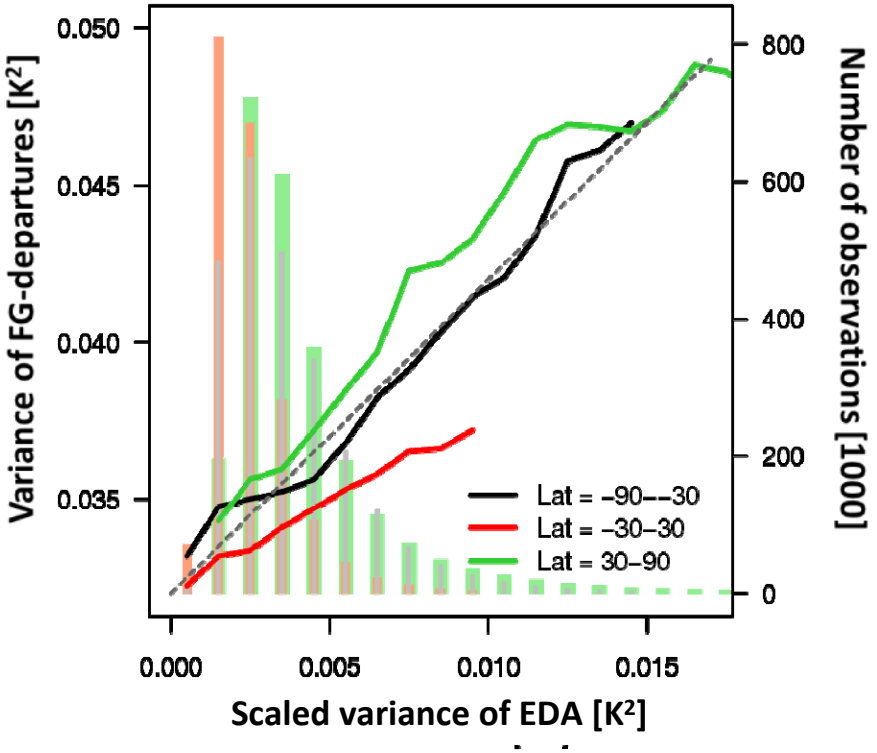
→ Broader low-level vertical correlations when PBL well-mixed (zonal flow)

Cycle 40R1: Radiance spread from the EDA

Example: AMSU-A channel 8 (upper tropospheric temperature channel)

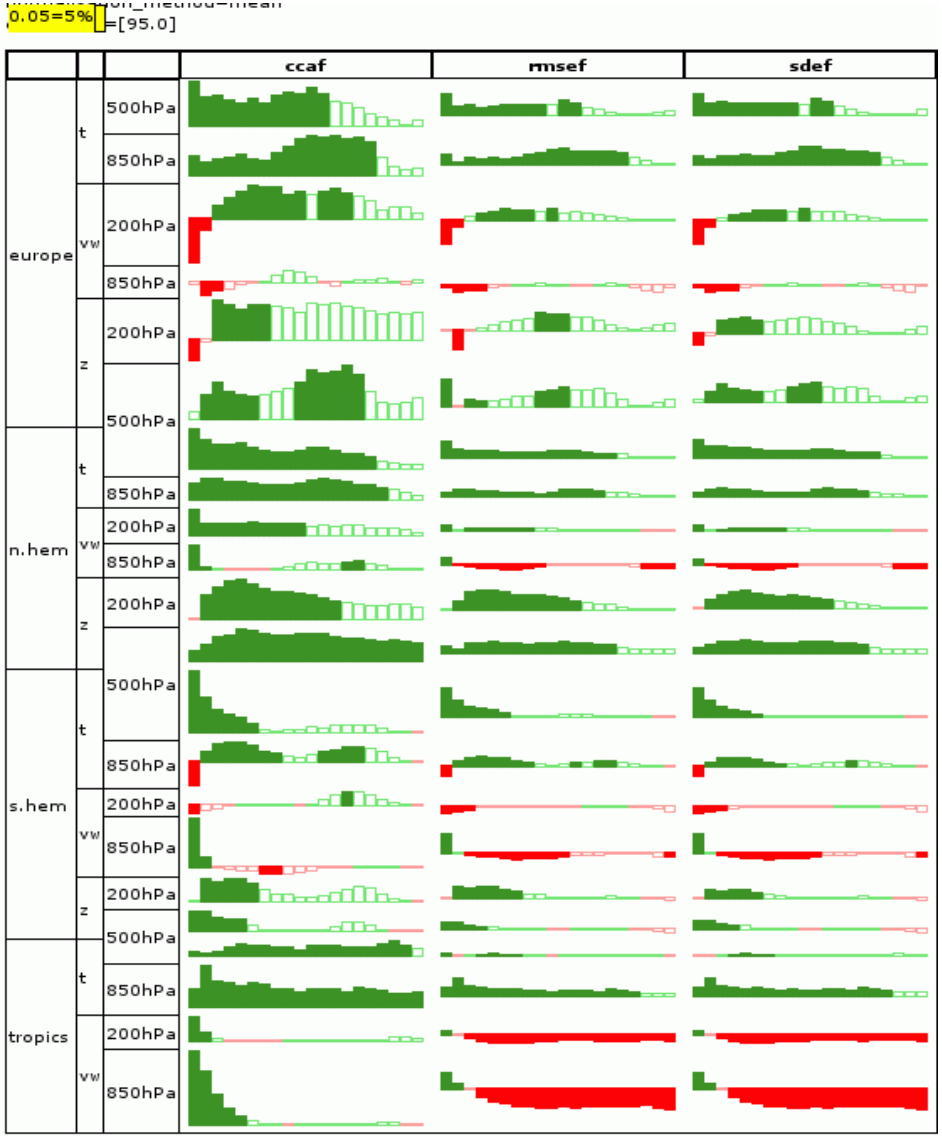


Calibration: Scaling of EDA spread



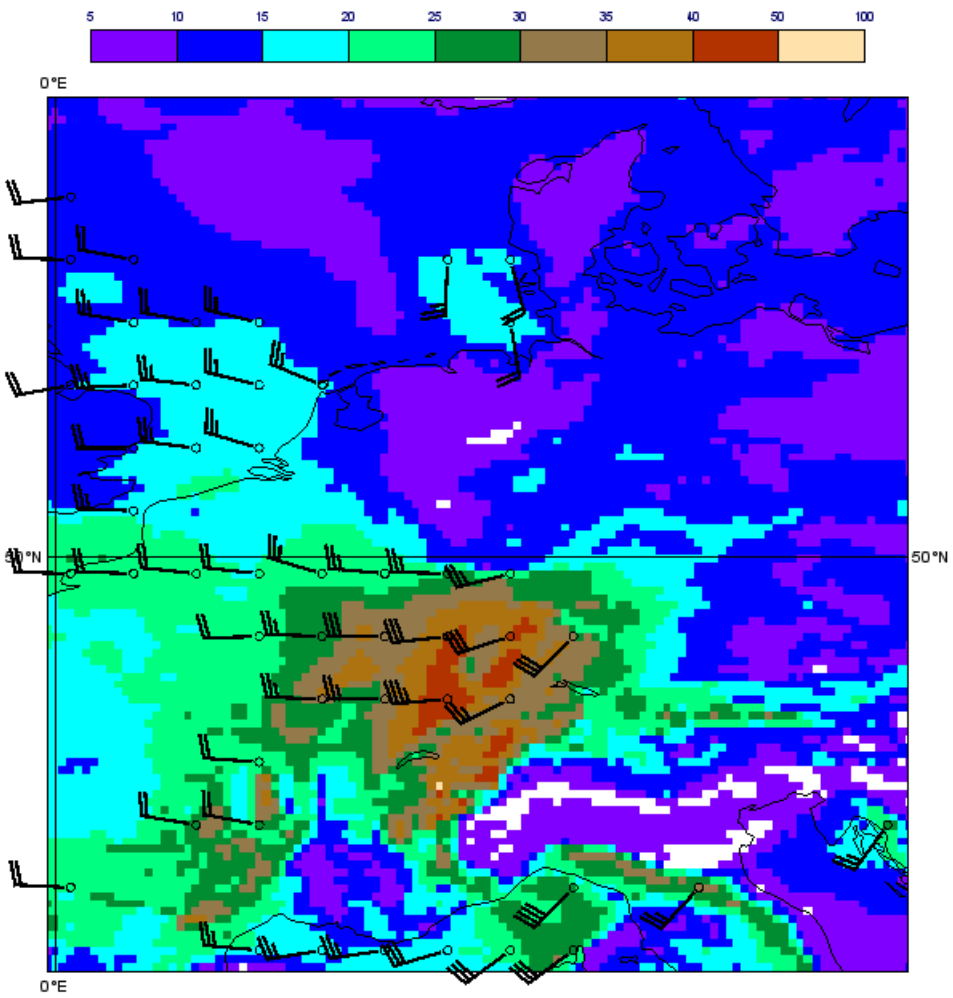
Model cycle 40r1

40r1 vs 38r2: June 2012-June 2013, vs own analyses

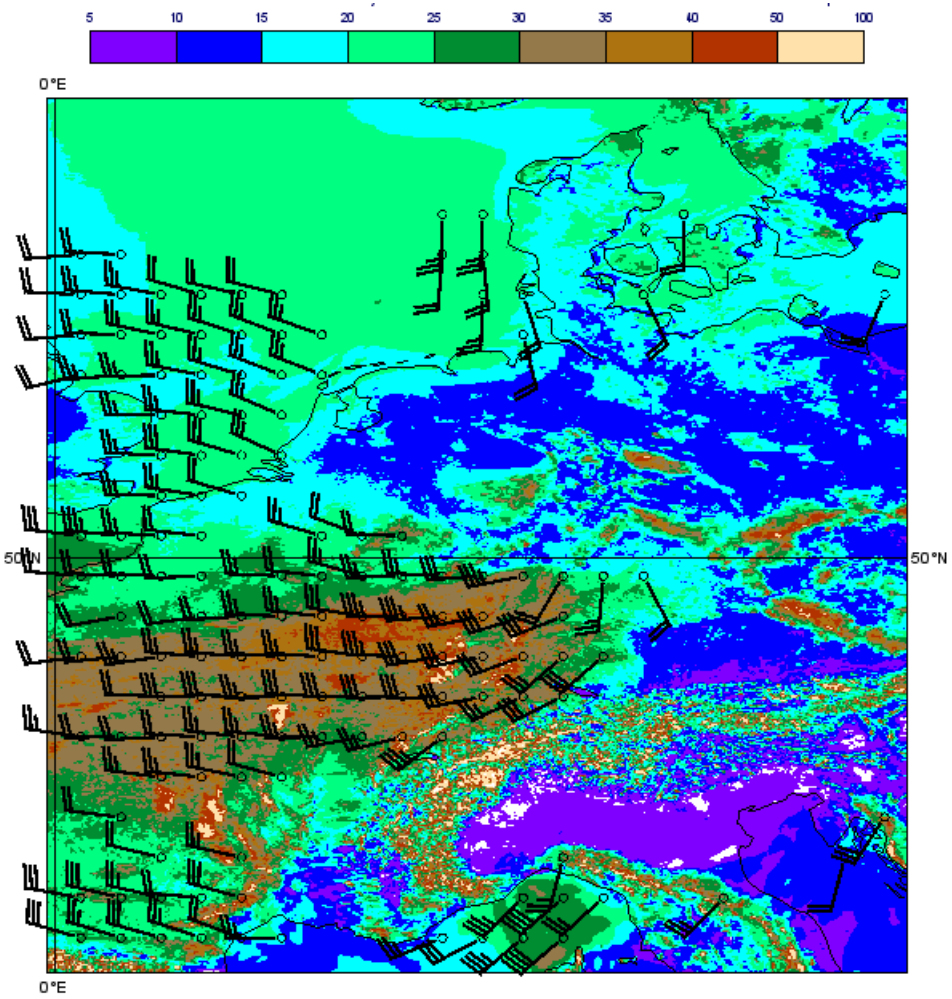


Experiments: T_L7999 (2.5 km) for Lothar (+11h)

T_L1279L40 (~ 16 km)

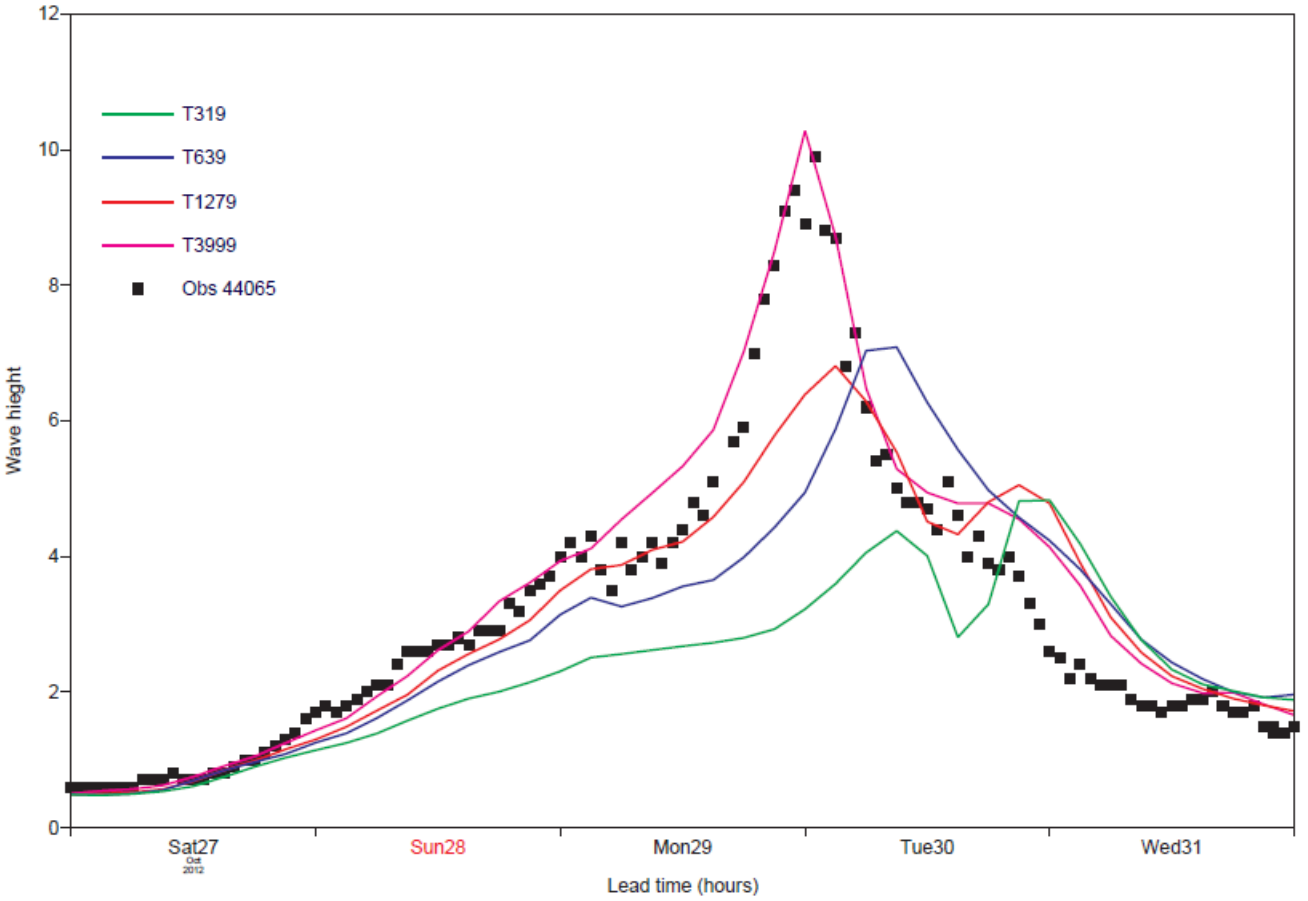


T_L7999L40 (~ 2.5 km)



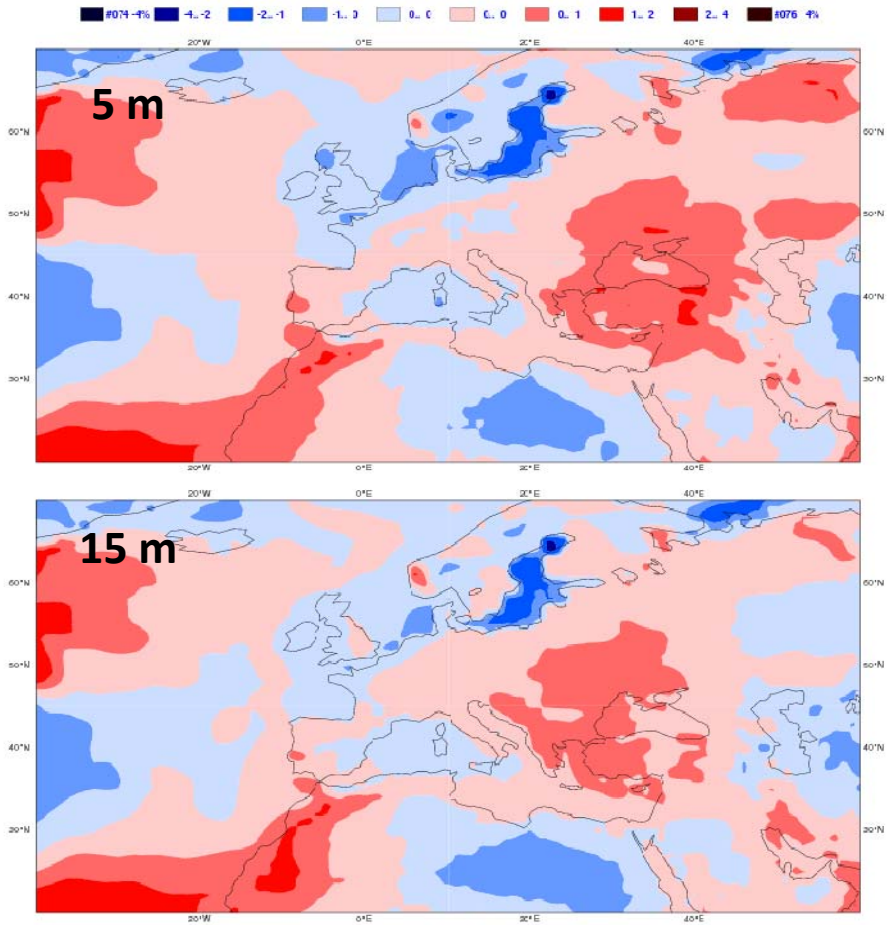
Experiments: T_L3999 (5 km) wave fc (+72h) for Sandy

Wave height for 00 UTC on 30 October 2012 coupled to a 0.5° to 0.1° (for T3999) global wave model.



Experiments: Extension of reforecast ensemble size from 5 to 15 members

Impact on calibration
2mtm anomalies – Day 26-32



Impact on verification
T850- Upper terciles – Week 4