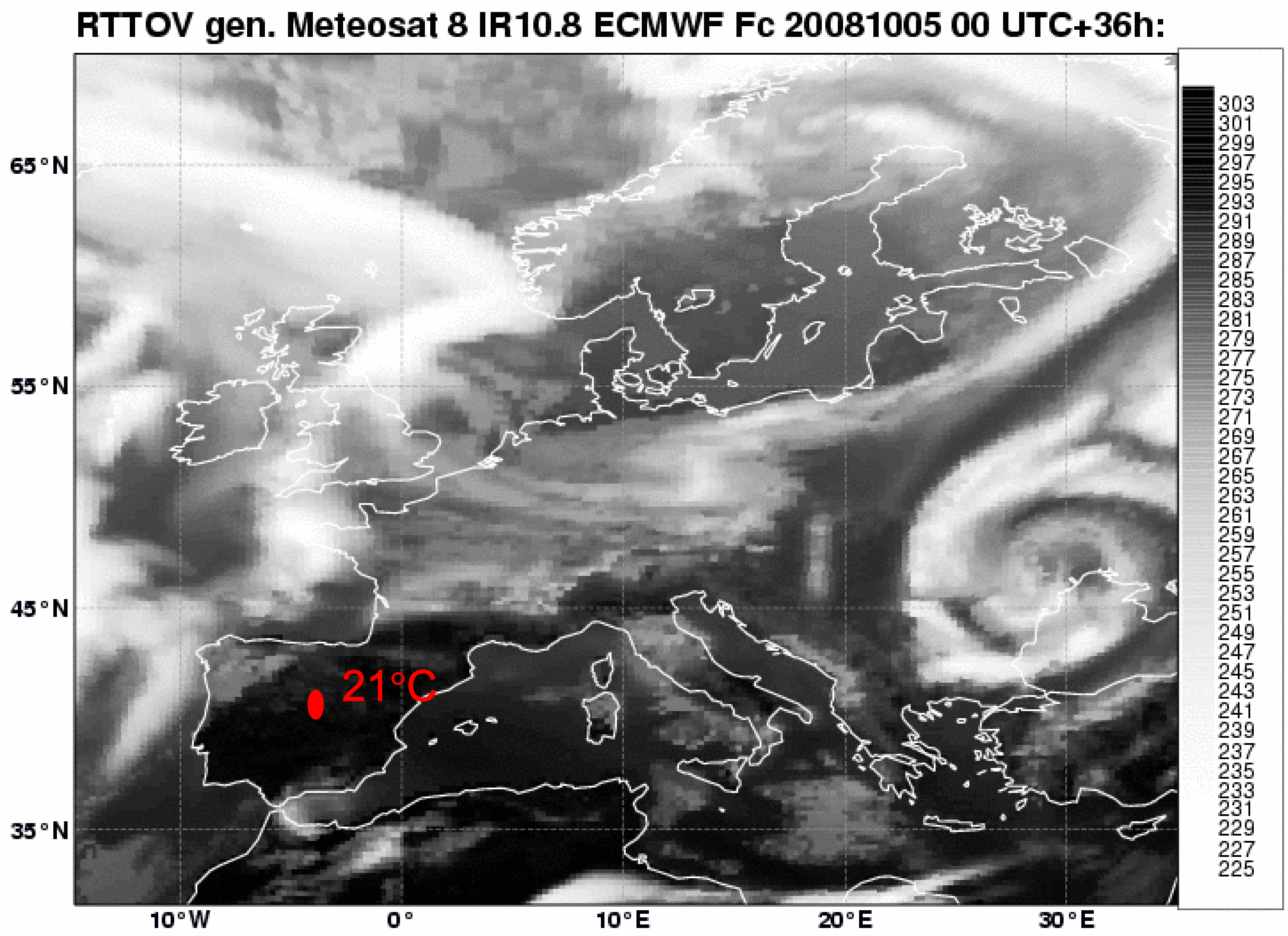
A bit from the Physics and mesoscale side

Content

- Model cycles in 2008
- Clouds: verification and future
- Convective gusts
- A bit about recent tropical cyclones
- Mesoscale convective systems
- Present and future of middle atmosphere

Today 12 UTC


RTTOV gen. Meteosat 8 IR10.8 ECMWF Fc 20081005 00 UTC+36h:
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Nov 6th 2007 IFS cycle 32r3

- Revision of the convection scheme, new formulation of convective entrainment and relaxation time scale
- Reduction in free atmosphere vertical diffusion
- New soil hydrology/runoff (HTESSEL)
- New radio-sonde temperature and humidity bias correction
- Increased amount of radio occultation data from COSMIC
- Assimilation of microwave AMSR-E, TMI and SSMIS window channels
- Assimilation of ozone SBUV from NOAA-17 and NOAA-18.
- Reduce of initial perturbation amplitude for EPS by 30%, use new moist physics package in computation of targeted tropical cyclone singular vectors.

Feb 3rd 2008 IFS cycle 33r1

ECMWF

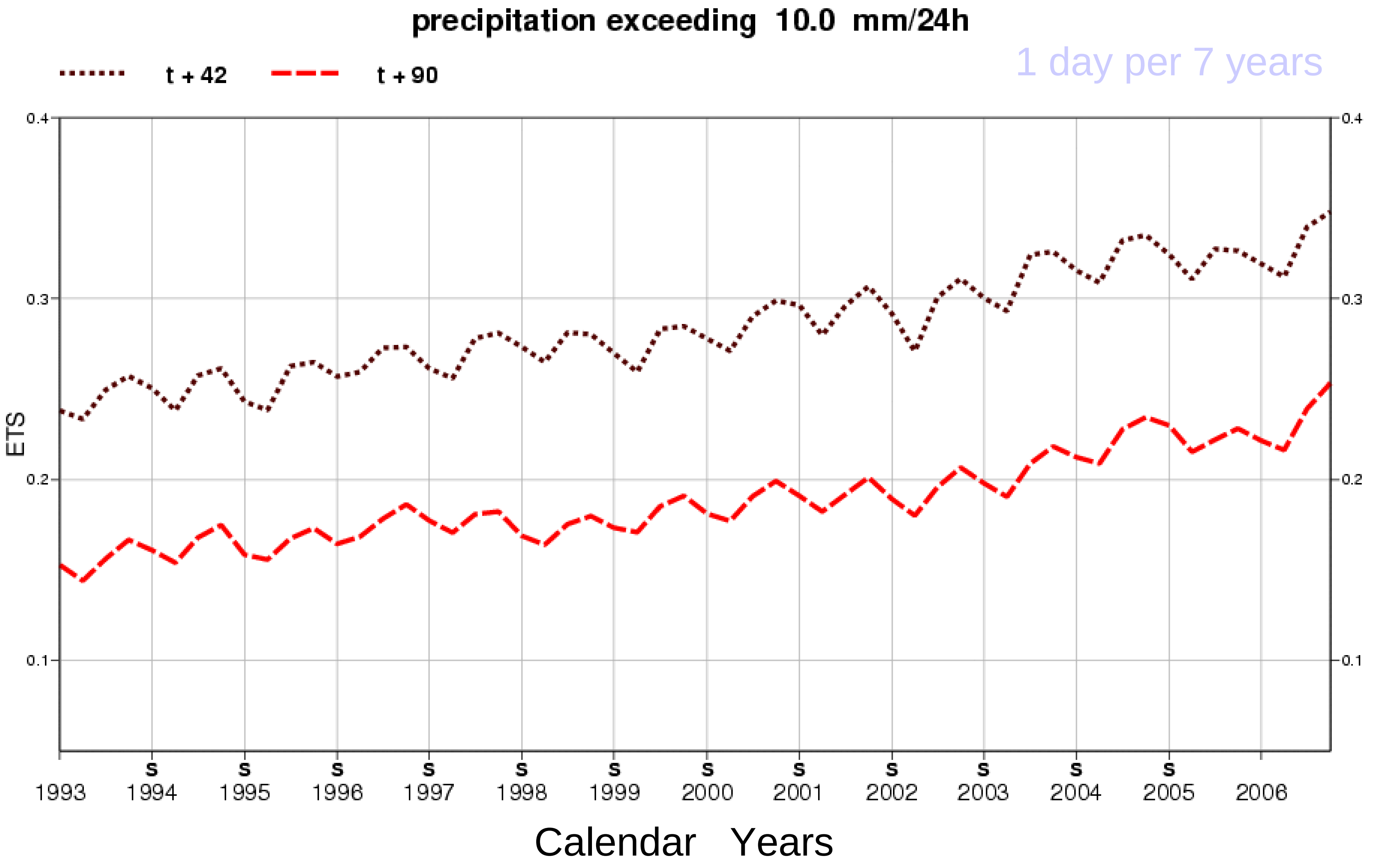
- Improved moist physics in tangent linear/adjoint of 4D-Var.
- Physics: Retuned entrainment in convection scheme. Bugfix to scaling of freezing term in convection scheme. Additional shear term in diffusion coefficient of vertical diffusion. Increased turbulent orographic form drag. Fix for soil temperature analysis in areas with 100% snow cover. Change in surface roughness for momentum.
- Modified post-processing of 2m T and q.
- Active assimilation of AMSR-E and TMI rainy radiances.
- Use of 4 wind solutions for QuikSCAT.
- Extended coverage and increased resolution of limited area wave model.
- Improved shallow water physics and modified advection for ocean wave model.

Sept 30th 2008 IFS cycle 35r1

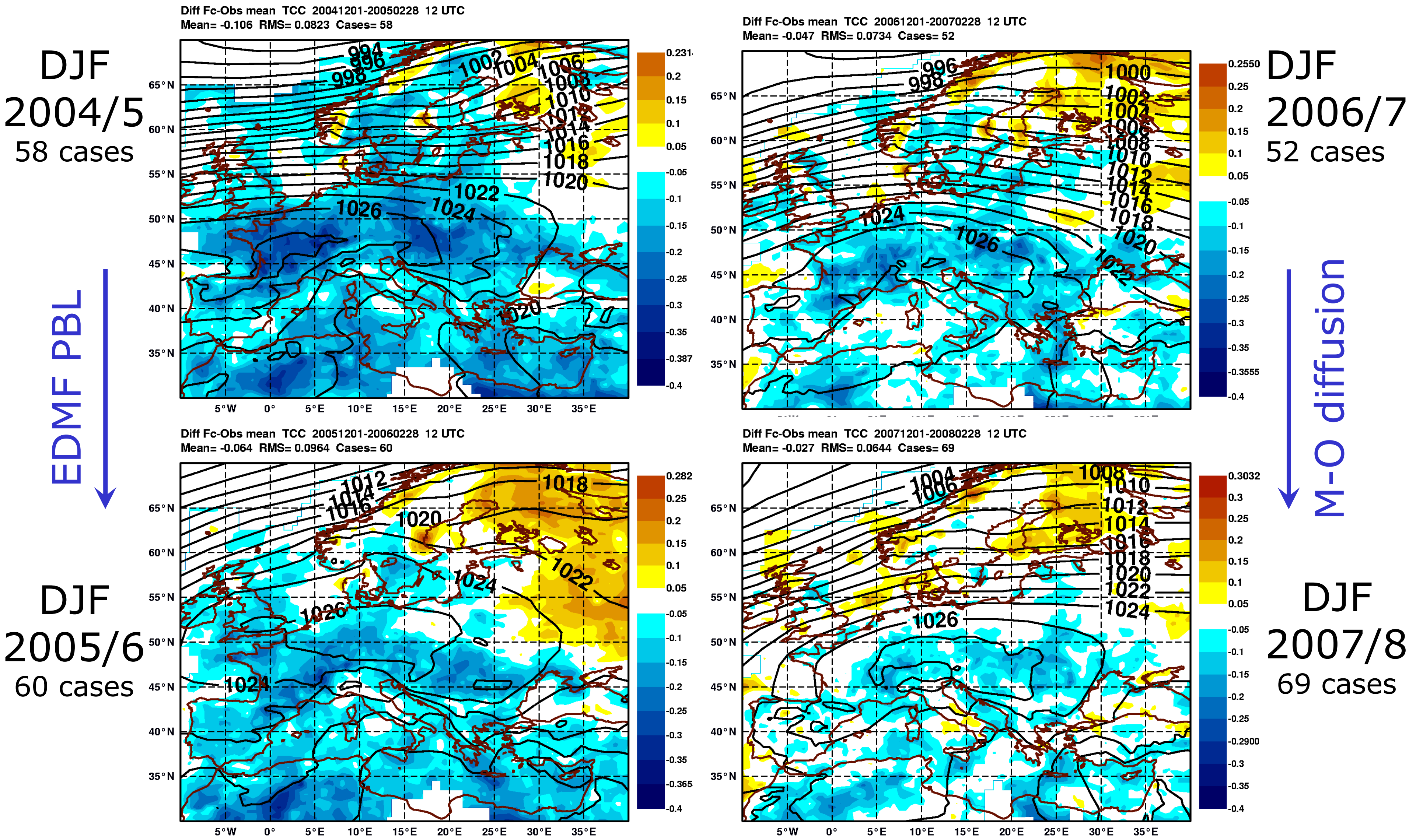
- OSTIA sea surface temperature and sea ice analysis
- Conserving interpolation scheme for trajectory
- New VARBC bias predictors to allow the correction of IR shortwave channels affected by solar effects
- Cleaner cold start of AMSUA channel 14
- New physics for melting of falling snow
- Increased albedo of permanent snow cover
- Cool skin/warm layer SST parametrization
- Revised linear physics
- Add convective contribution to wind gusts in post-processing
- Monitoring of MERIS data

Equitable threat score for European precipitation against SYNOP data

Curves show 12 month running mean of seasonal values



Winter Cloud Cover : 36h forecast versus SYNOP observation (for high pressure days over central Europe (last four winters))



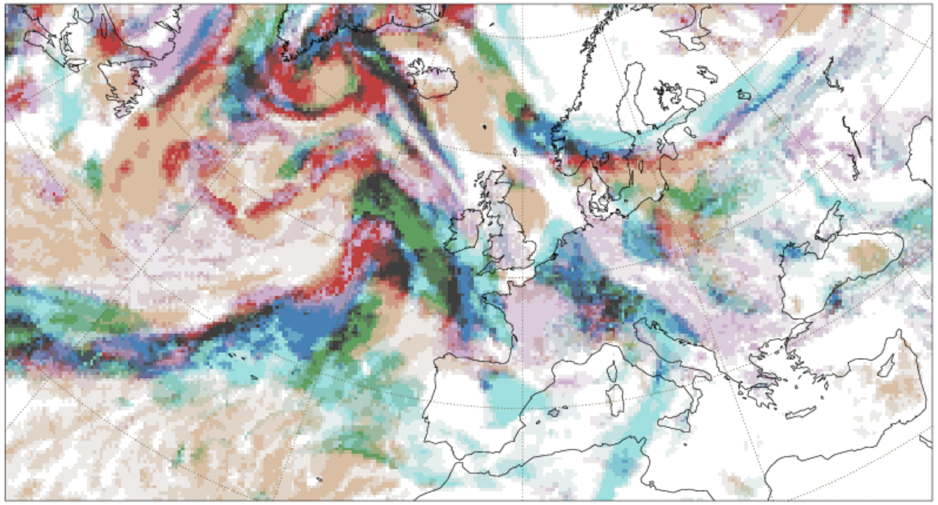
Cloud Overlap

- Cloud overlap assumption for cloud diagnostics made consistent with radiation scheme. ("exponential maximum-random" overlap).

- Identified differences and impacts between old and new cloud overlap assumptions.

- Fixed long-term bug in medium and low level cloud diagnostics (MCC, LCC)

Friday 1 June 2007 12UTC ECMWF Forecast t+ 0 VT: Friday 1 June 2007 12UTC
Low, L+M, Medium, M+H, High, H+L, H+M+L clouds



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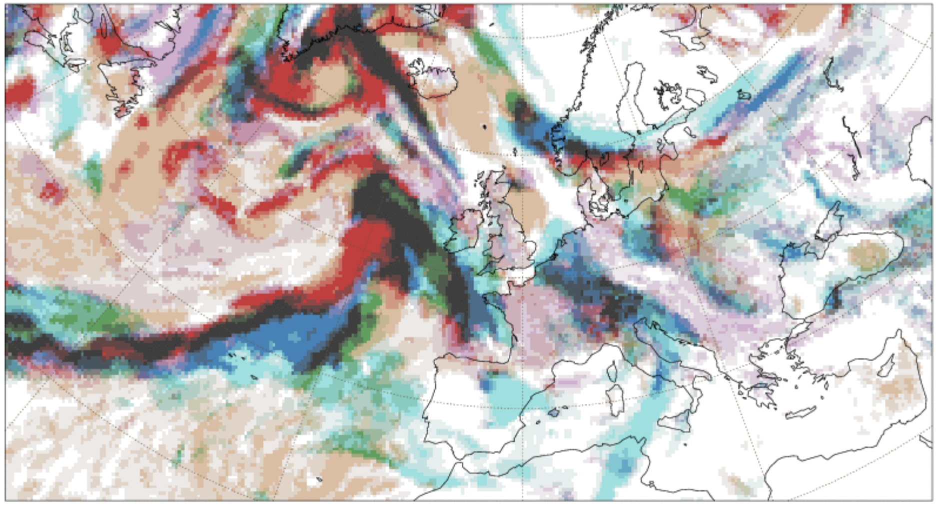
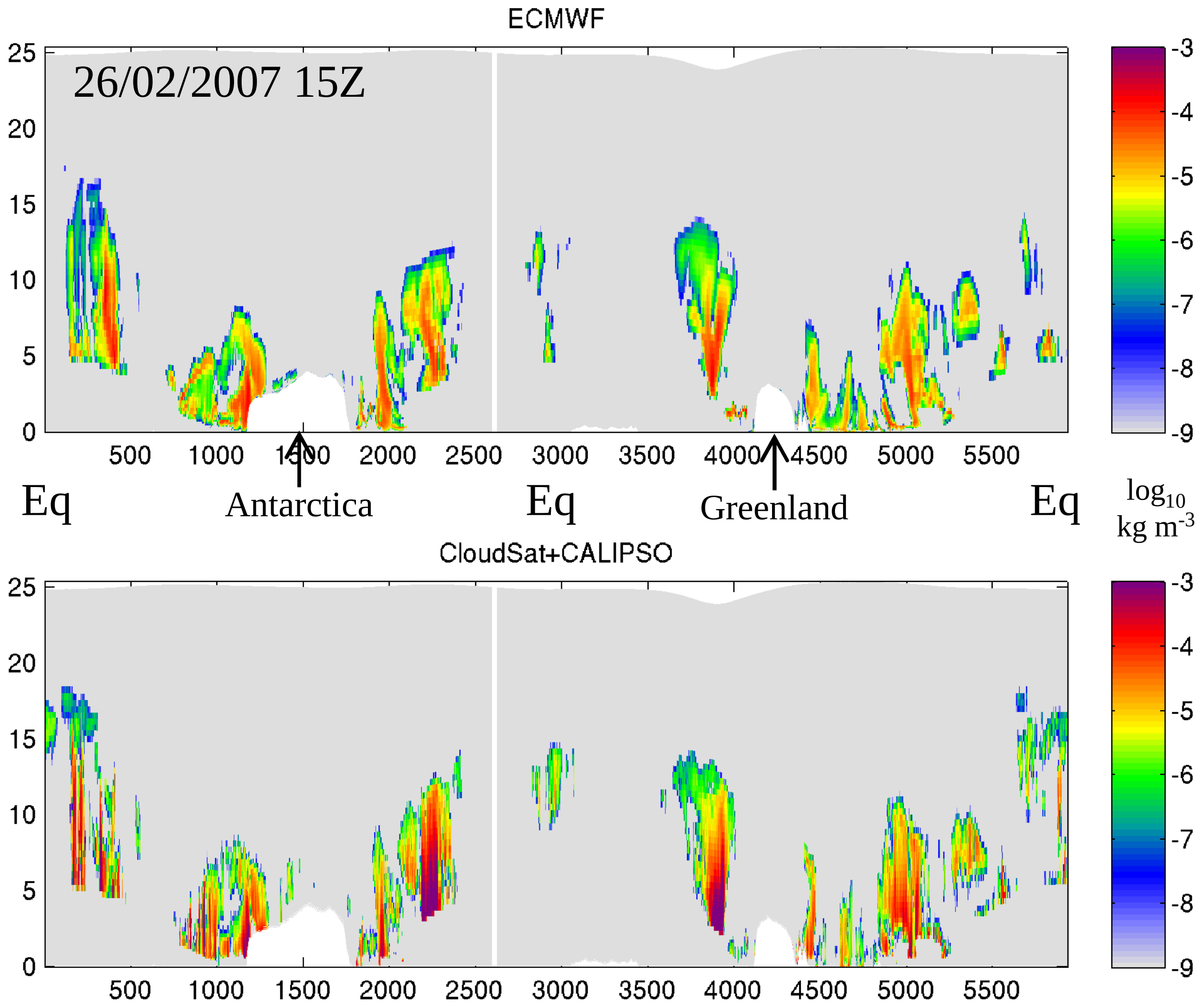
Low, L+M, Medium, M+H, High, H+L, H+M+L clouds



Cloud Verification
Obs-to-Model: Ice water content

Model ice water content (excluding precipitating snow).

Ice water content derived from a 1DVAR retrieval of CloudSat/ CALIPSO/Aqua



R. Forbes + M. Ahlgrimm

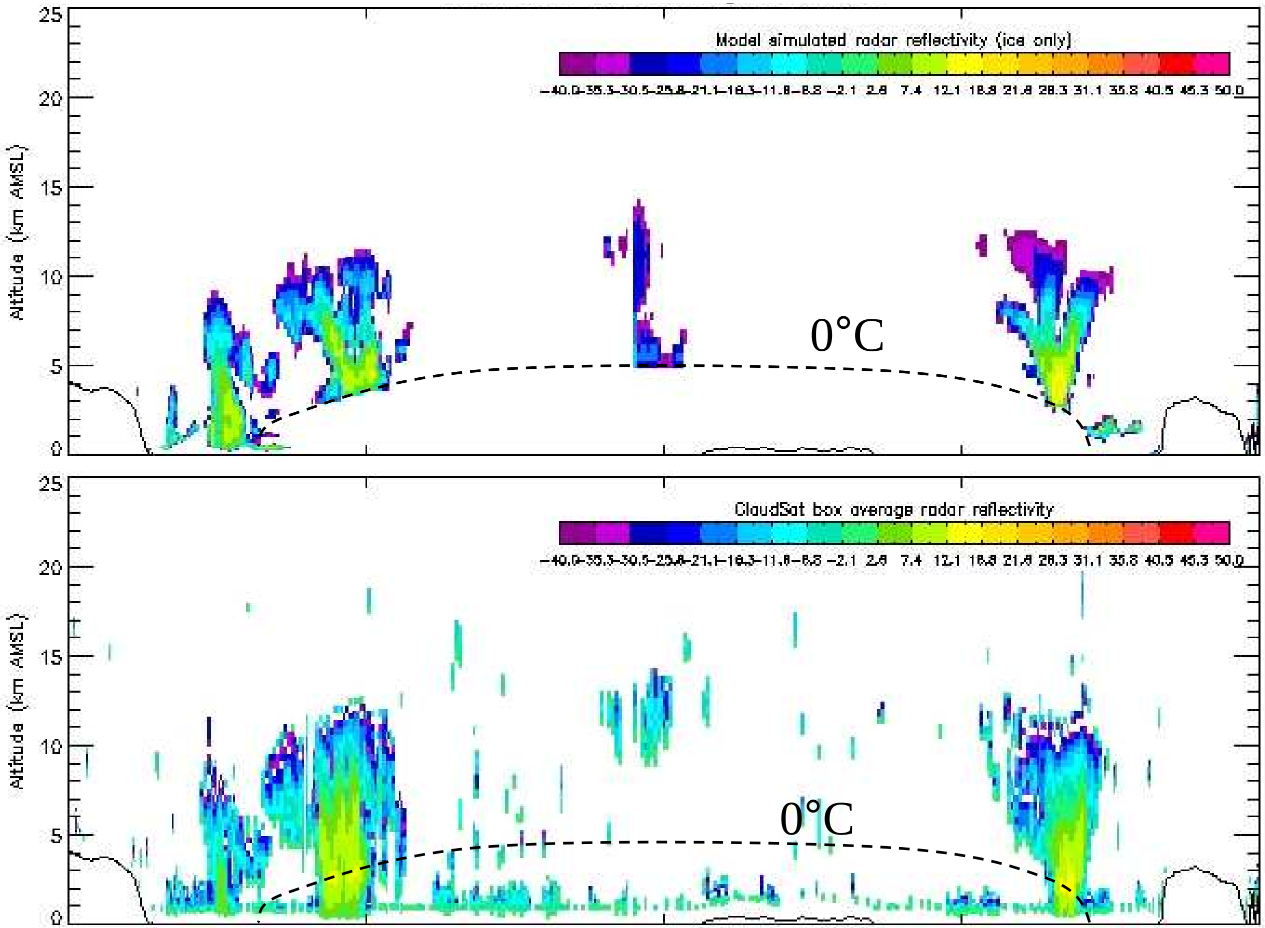
Cloud Verification

Model-to-Obs: Radar reflectivity

Simulated radar reflectivity from the model.
(ice only)

Observed radar reflectivity from CloudSat
(ice + rain)

26/02/2007 15Z

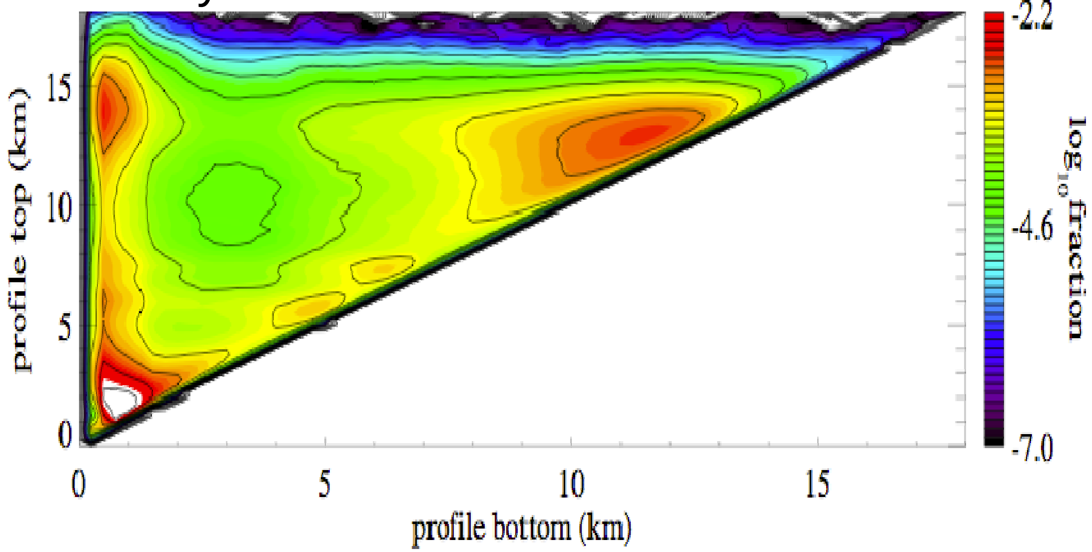


82°S Tropics 82°N

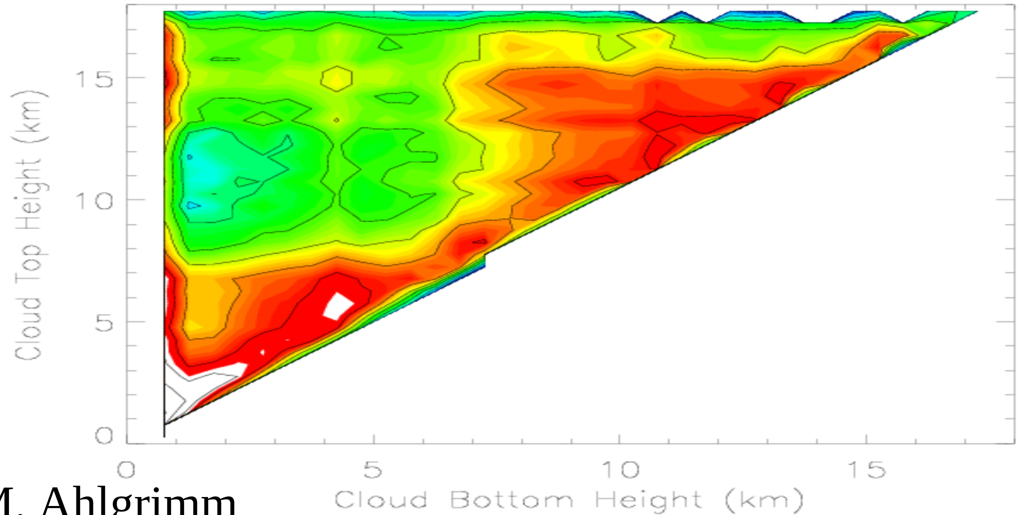
R. Forbes + M. Ahlgrimm

Cloud Verification
Tropical Cloud Height and Depth

1 year CloudSat data 20°S-20°N



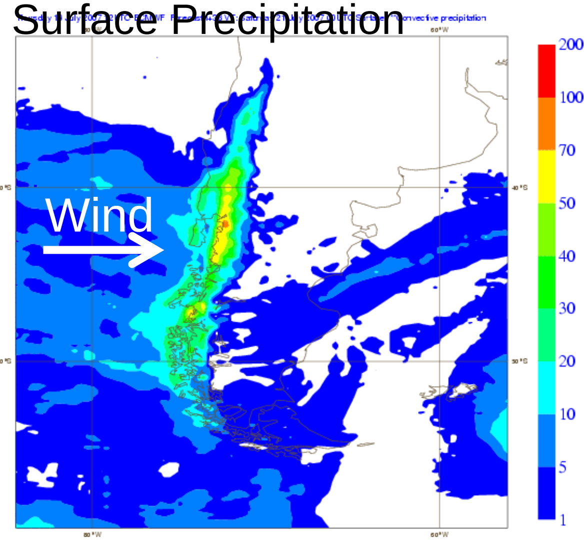
Snapshot of ECMWF model 06 Aug 2008 (20°S-20°N)



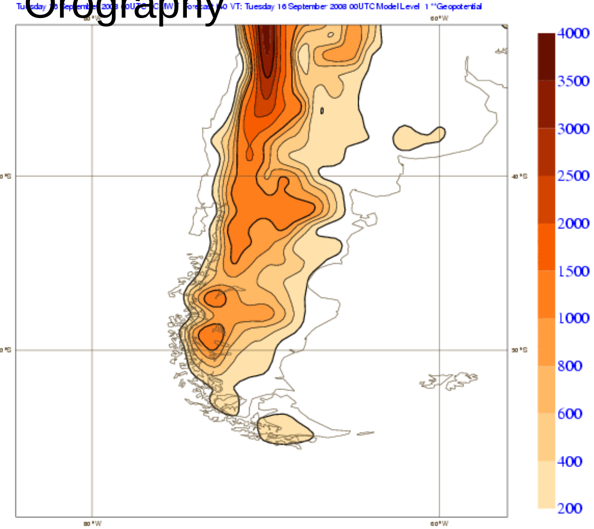
R. Forbes + M. Ahlgrimm

New 5-prognostic cloud microphysics
Falling snow and orographic forcing

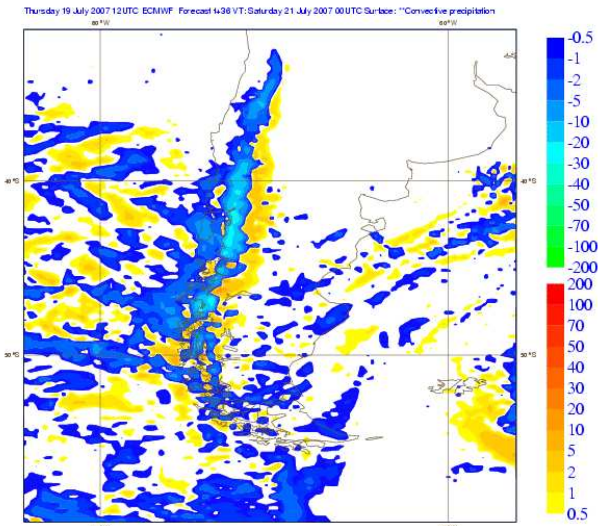
(36 hour acc.) Surface Precipitation



Orography

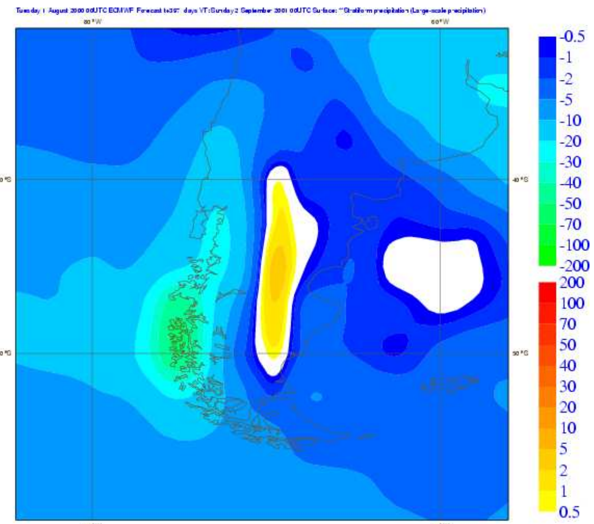


(36 hour acc)



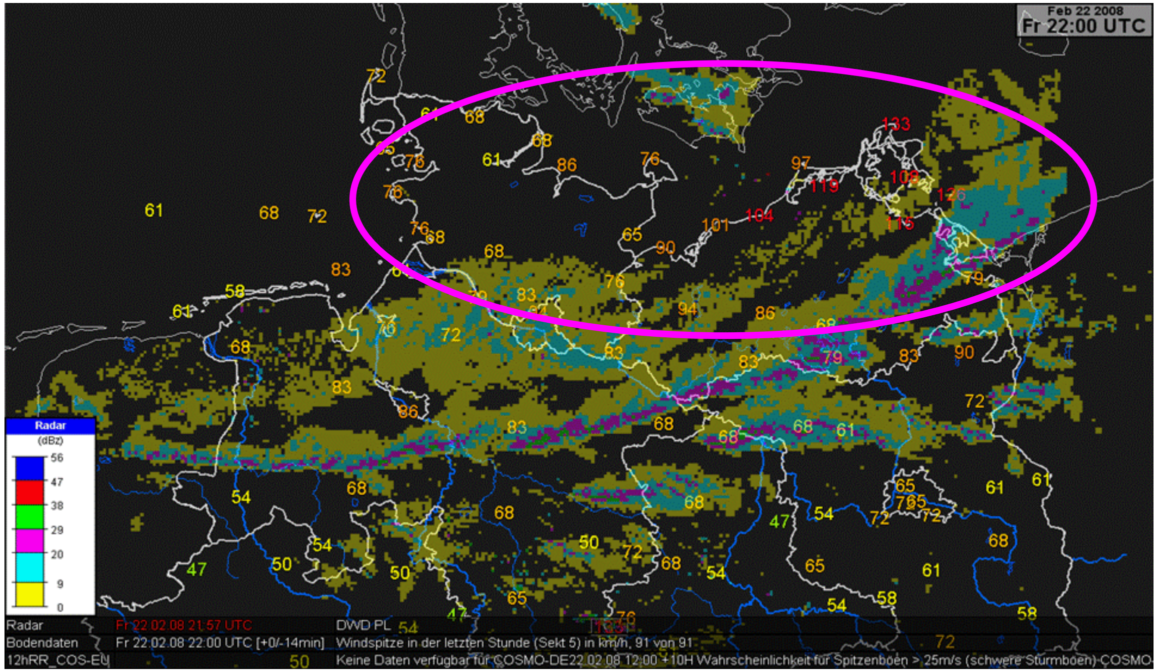
"Prognostic snow scheme" minus "Diagnostic snow scheme"

(1 year average)



"Prognostic snow scheme" minus "Diagnostic snow scheme"

Convective Gusts



Motivation: report about gust front by DWD

22 February 2008

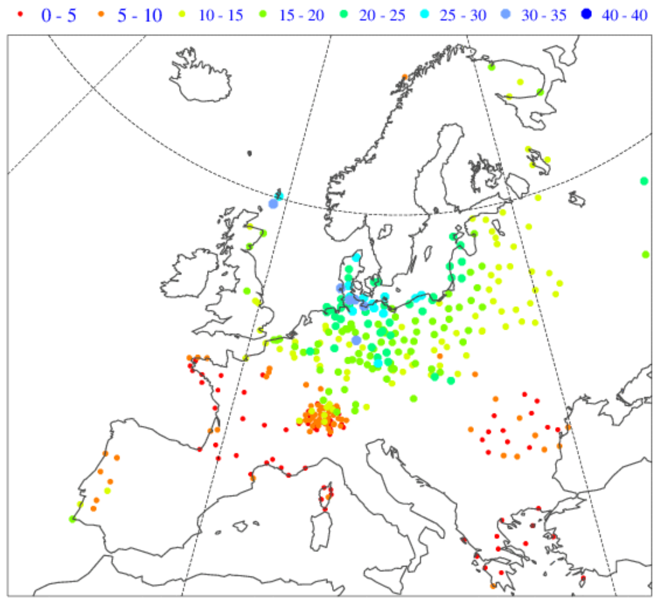
Proposition: Use low-level wind shear multiplied by mixing parameter α<1 when deep convection is active

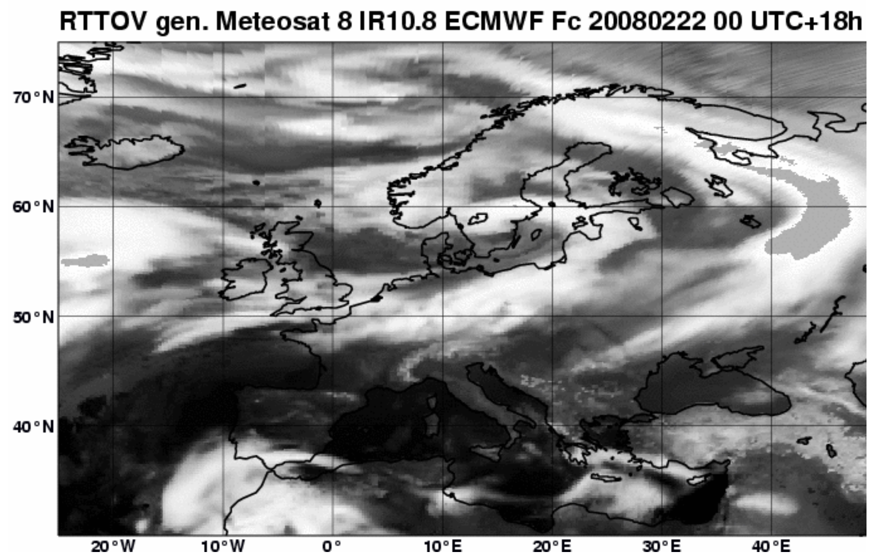
$$U_{10\,gustconv} = \alpha \max(0, U_{850} - U_{950})$$

Other formulations trying to simulate cold pool gust fronts using downdraught W or evaporation have been unsuccessful (too large perturbations over Oceans and in Tropics)

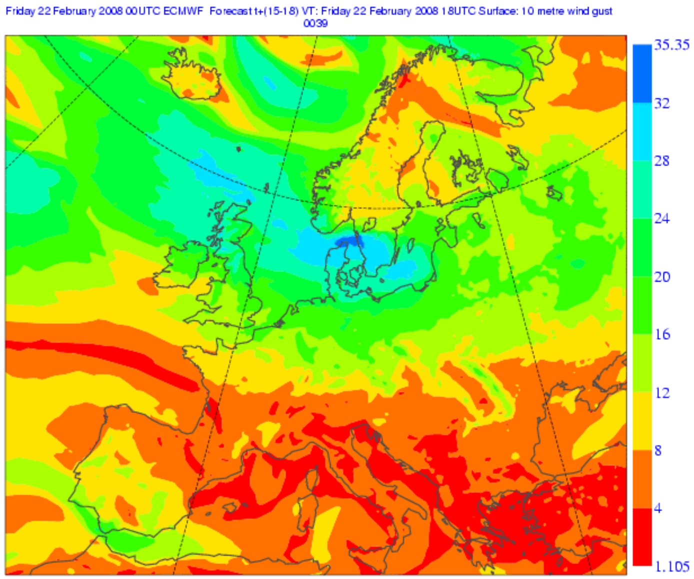
Wind gusts
case 22 February 2008 continued

Obs

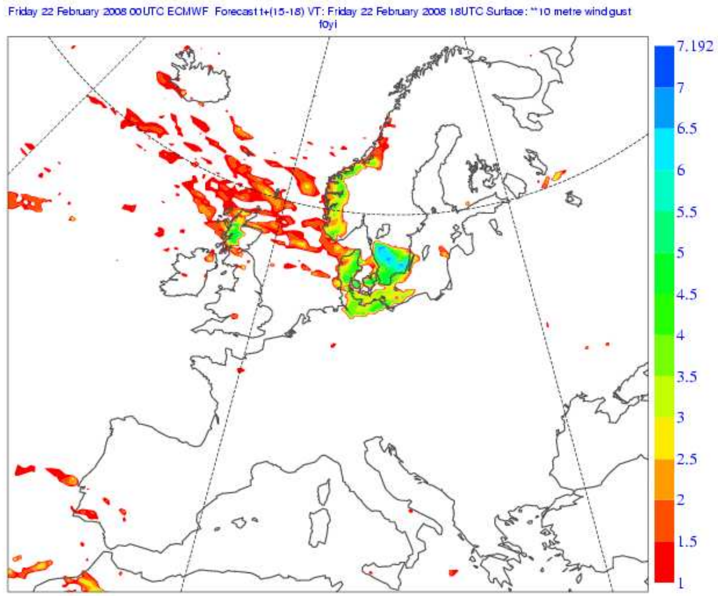




Oper

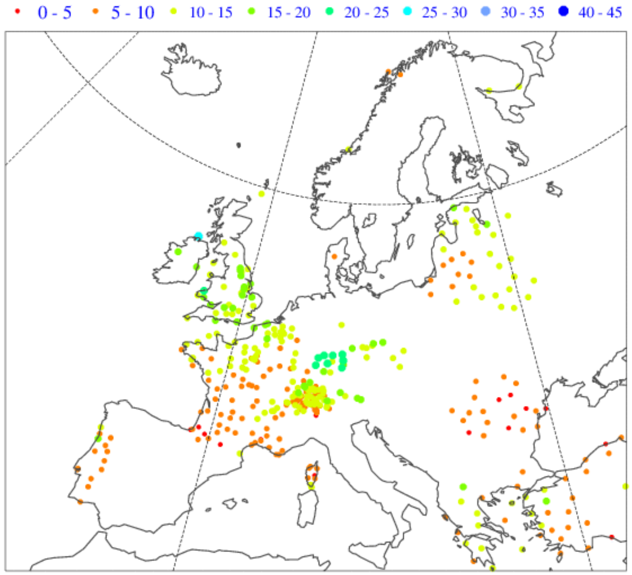


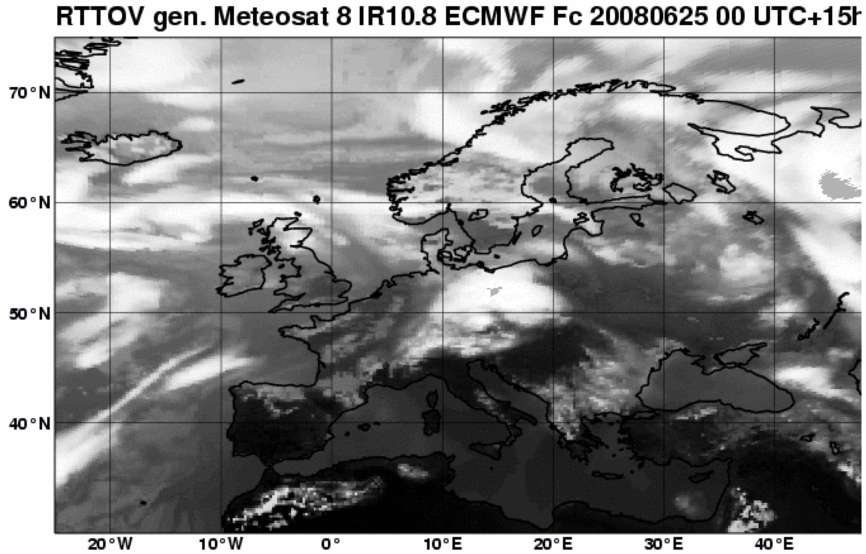
Conv



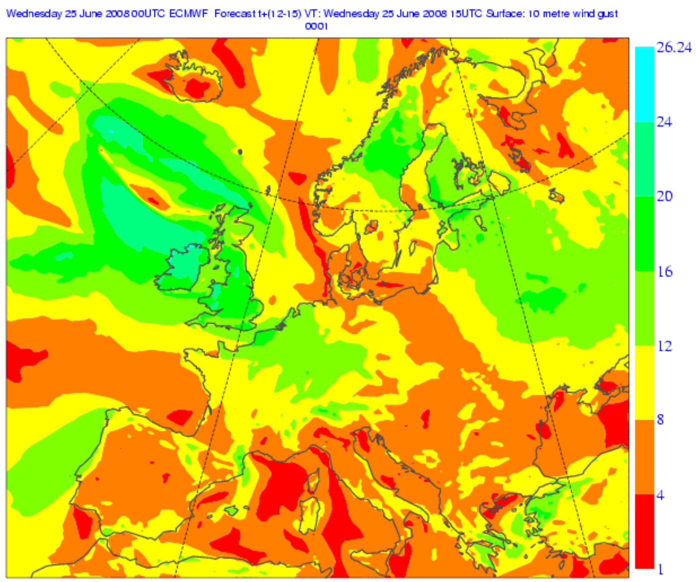
Wind gusts
summertime example 25 June 2008

Obs

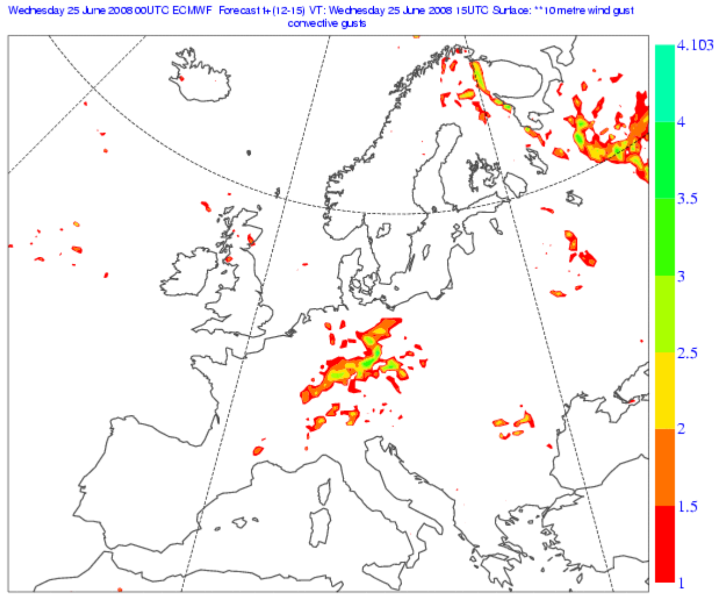




Oper



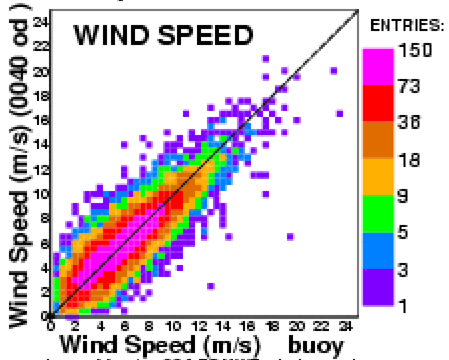
Conv



Wind 10m + gusts verif over Sea

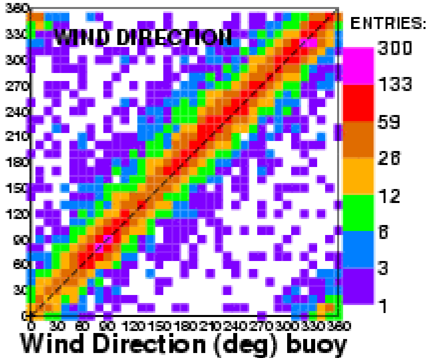
Buoy verification

All buoys 20080712 to 20080831



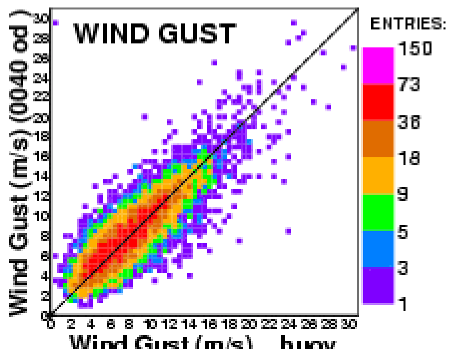
Comparison of fc step 024 ECMWF wind speeds with height corrected averaged buoy data.

ENTRIES = 12930
MODEL MEAN = 6.11 STDEV = 2.812
BUOY MEAN = 6.09 STDEV = 2.942
LSQ FIT: SLOPE = 0.827 INTR = 1.076
RMSE = 1.500 BIAS = 0.021
CORR COEF = 0.865 SI = 0.246
SYMMETRIC SLOPE = 0.995



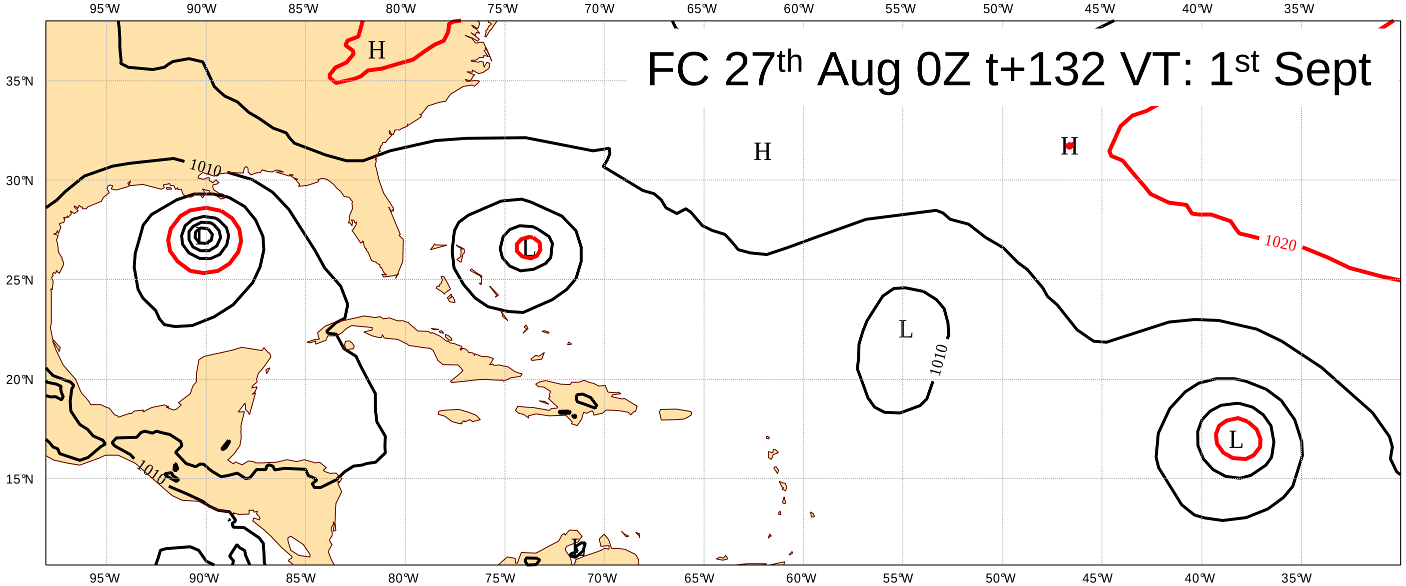
Comparison of fc step 024 ECMWF wind direction with averaged buoy data.

ENTRIES = 11622
MODEL MEAN = 241.25 STDEV = 98.736
BUOY MEAN = 219.99 STDEV = 99.325
LSQ FIT: SLOPE = ****** INTR = ******
RMSE = 39.001 BIAS = 21.255
CORR COEF = ****** SI = ******
SYMMETRIC SLOPE = ******

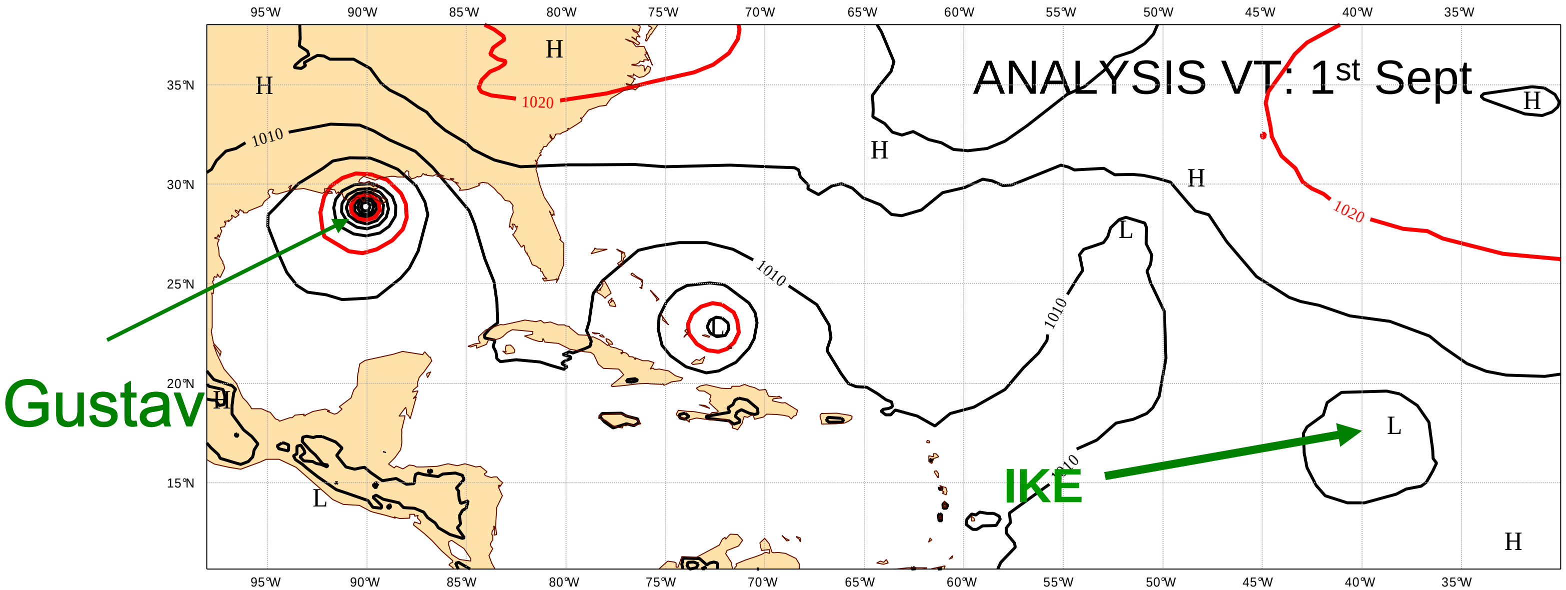


ENTRIES = 8251
MODEL MEAN = 8.46 STDEV = 3.450
BUOY MEAN = 8.41 STDEV = 3.632
LSQ FIT: SLOPE = 0.808 INTR = 1.673
RMSE = 1.946 BIAS = 0.057
CORR COEF = 0.850 SI = 0.231
SYMMETRIC SLOPE = 0.998

Wednesday 27 August 2008 00UTC ECMWF Forecast t+132 VT: Monday 1 September 2008 12UTC Surface: Mean sea level pressure

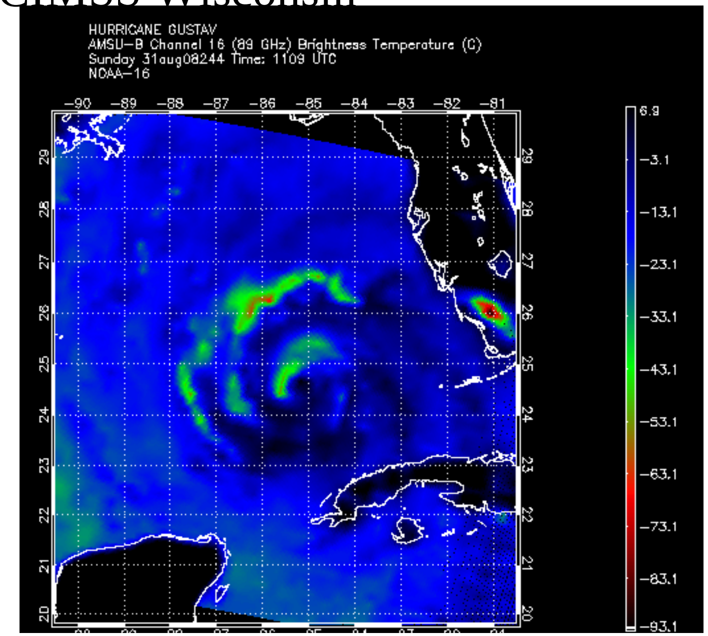


ECMWF Analysis VT:Monday 1 September 2008 12UTC Surface: Mean sea level pressure

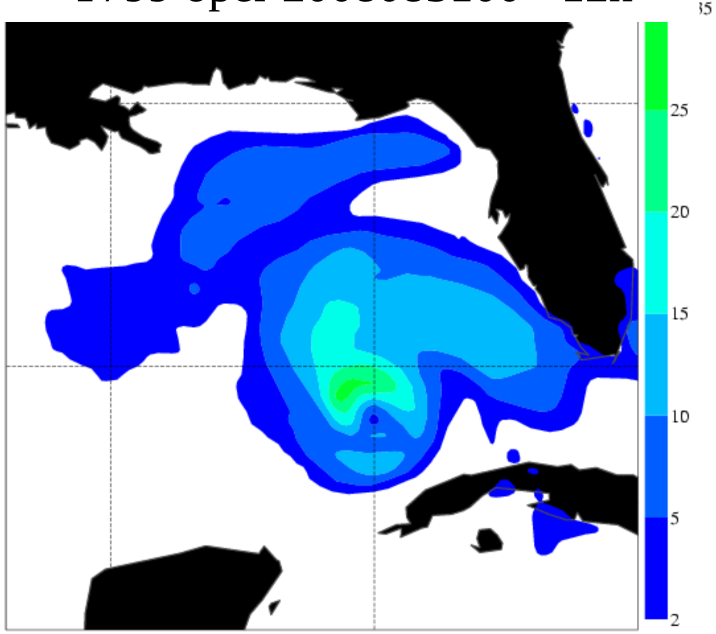


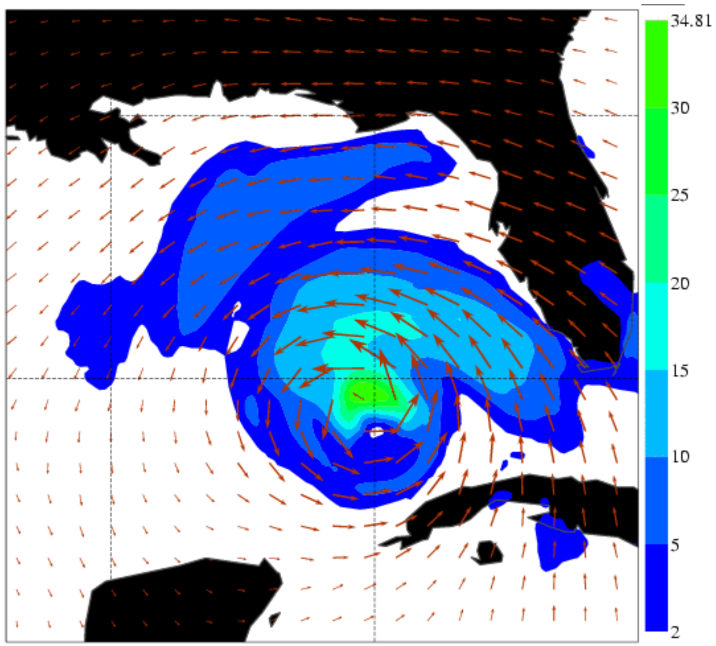
Hurricane Gustave AMSU-B and 9-12h rainfall

from CIMSS Wisconsin



T799 oper 2008083100 +12h

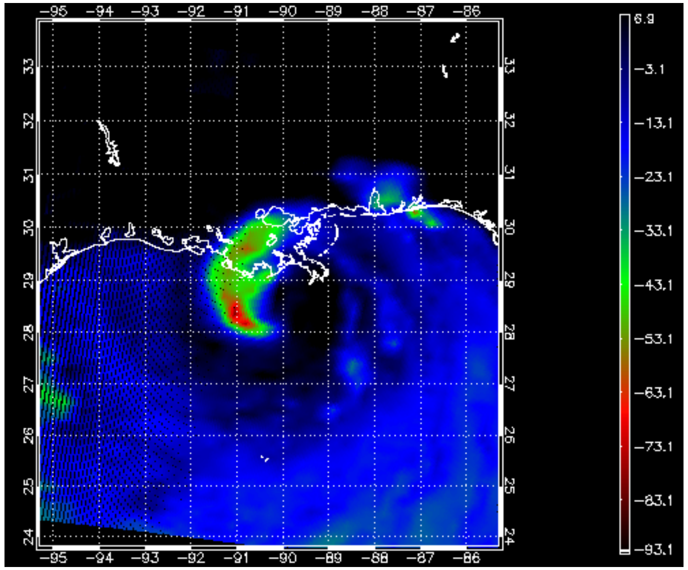




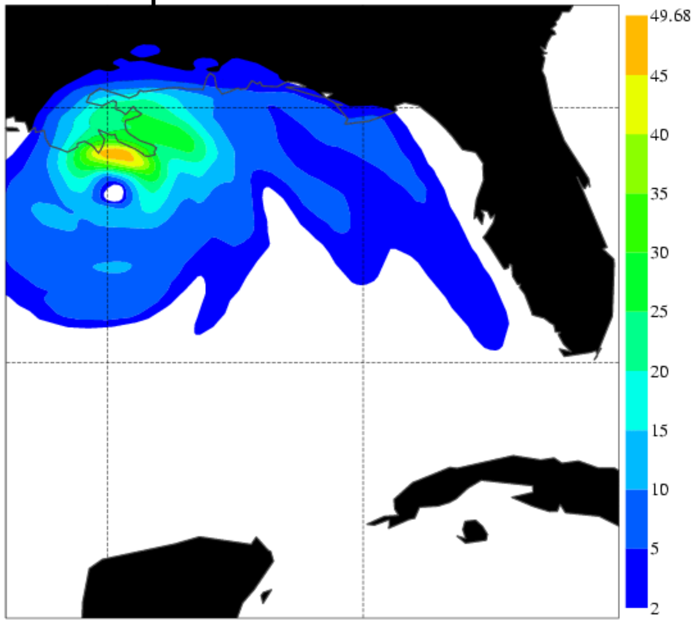
T1279 exper. forecast rain+wind 925hPa
without assimilation and wave model

Also “visual” test for adjustment time

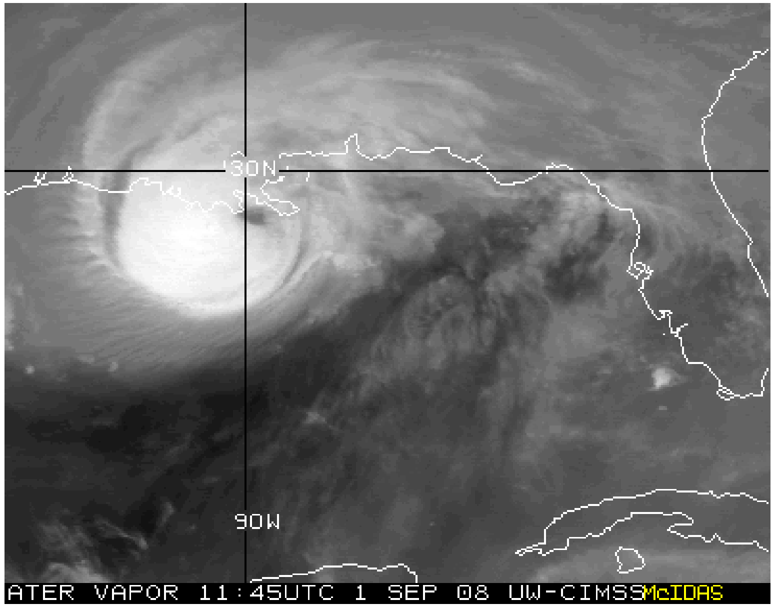
Hurricane Gustav AMSU-B and 33-36h rainfall



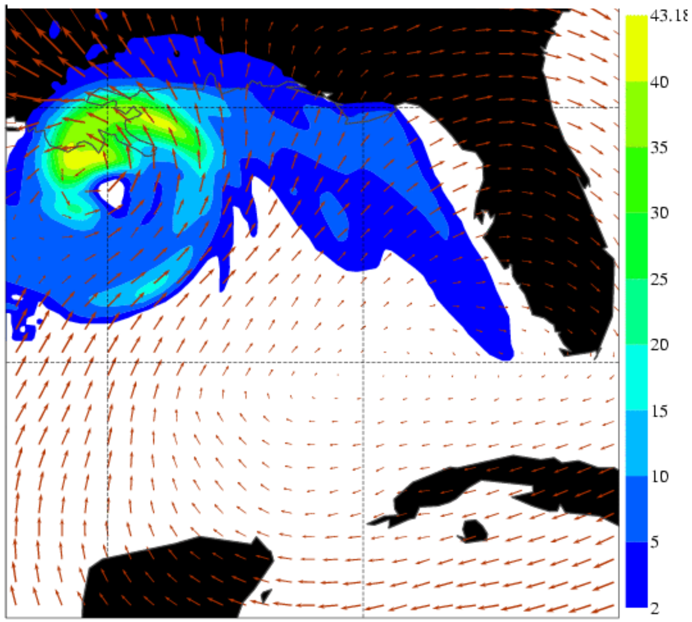
T799 oper 2008083100 +36h

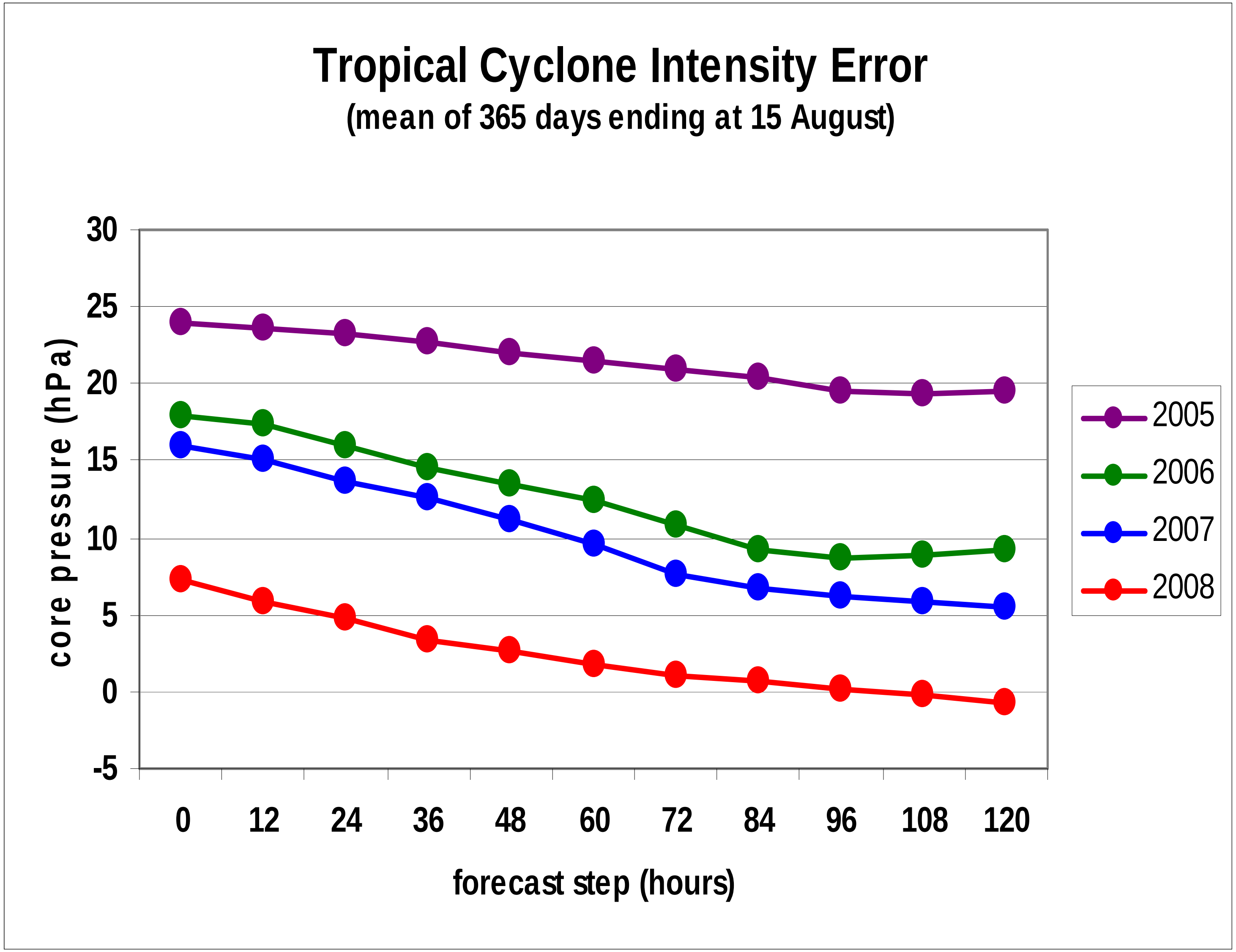


from CIMSS Wisconsin



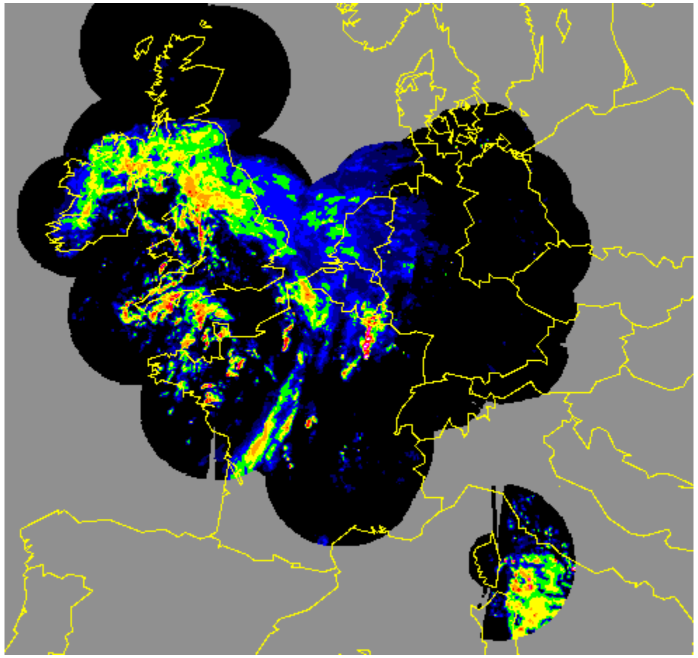
T1279 exper with 200hPa wind




Tropical Cyclone Intensity Error
(mean of 365 days ending at 15 August)
core pressure (hPa)
30
25
20
15
10
5
0
-5
0
12
24
36
48
60
72
84
96
108
120
forecast step (hours)
2005
2006
2007
2008

Model 1h Rain shortrange Fcs

20080905
15UTC



Radar

T799

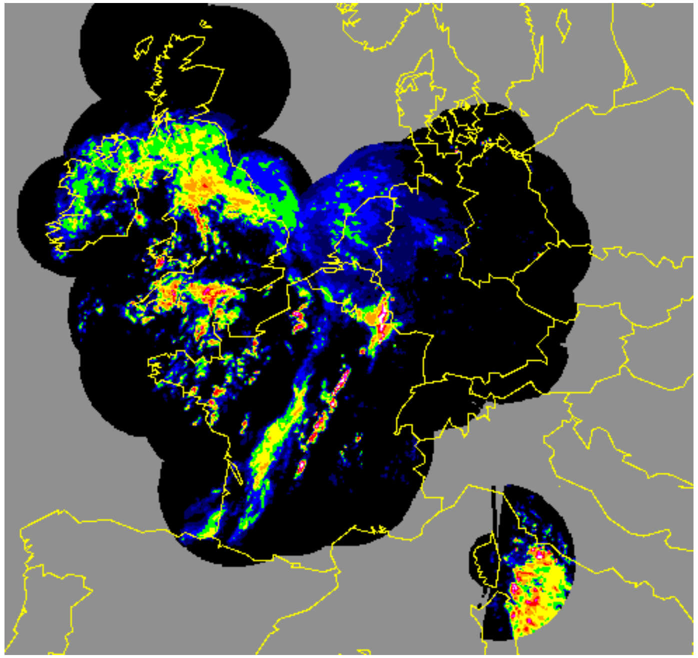
T1279

20
15
12
10
8
6
5
3
2
1
.5
.25
.1

20
15
12
10
8
6
5
3
2
1
.5
.25
.1

Model 1h Rain shortrange Fcs

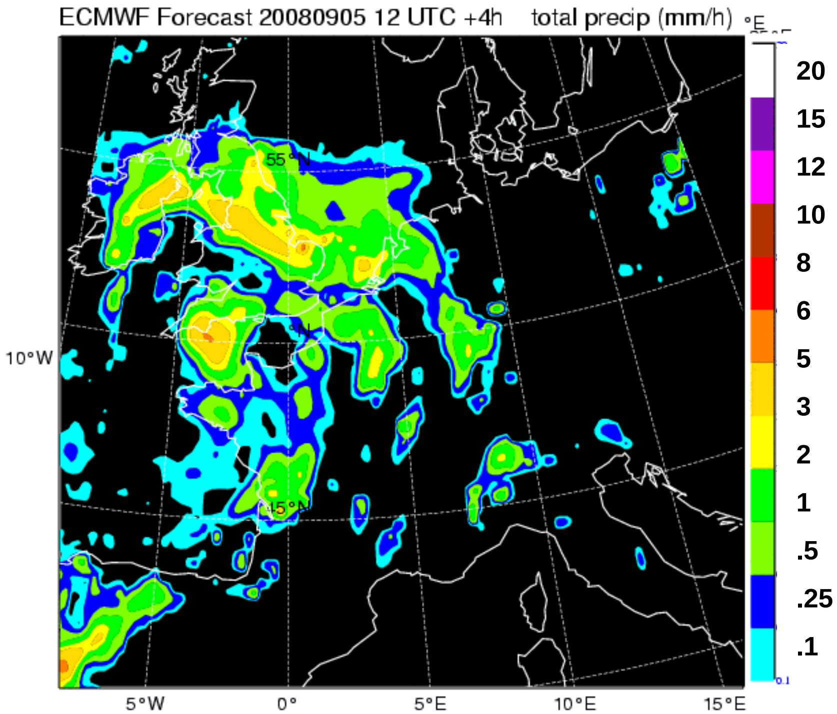
20080905
16UTC

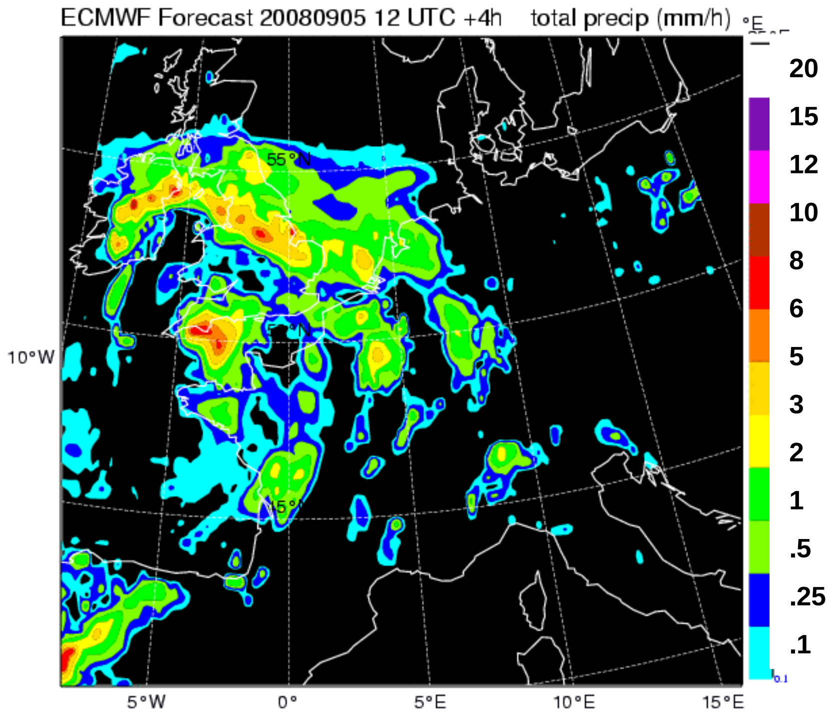


Radar

T799

T1279





Model 1h Rain shortrange Fcs

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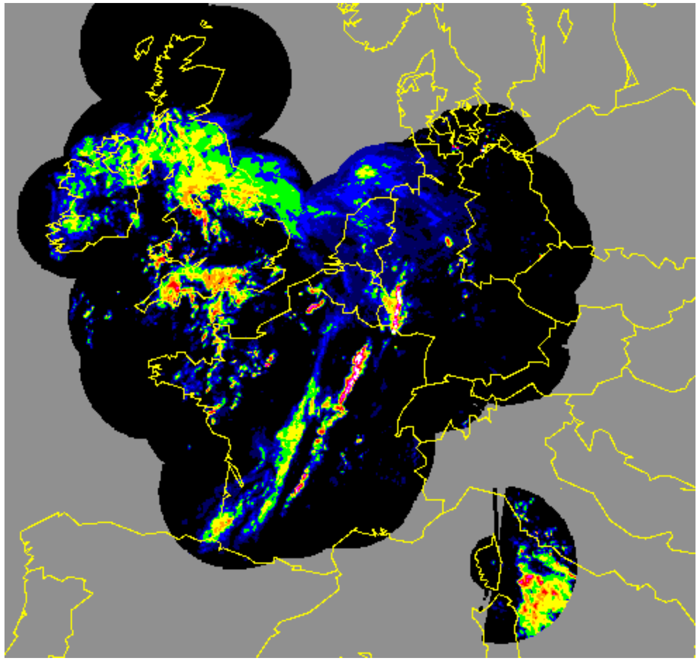
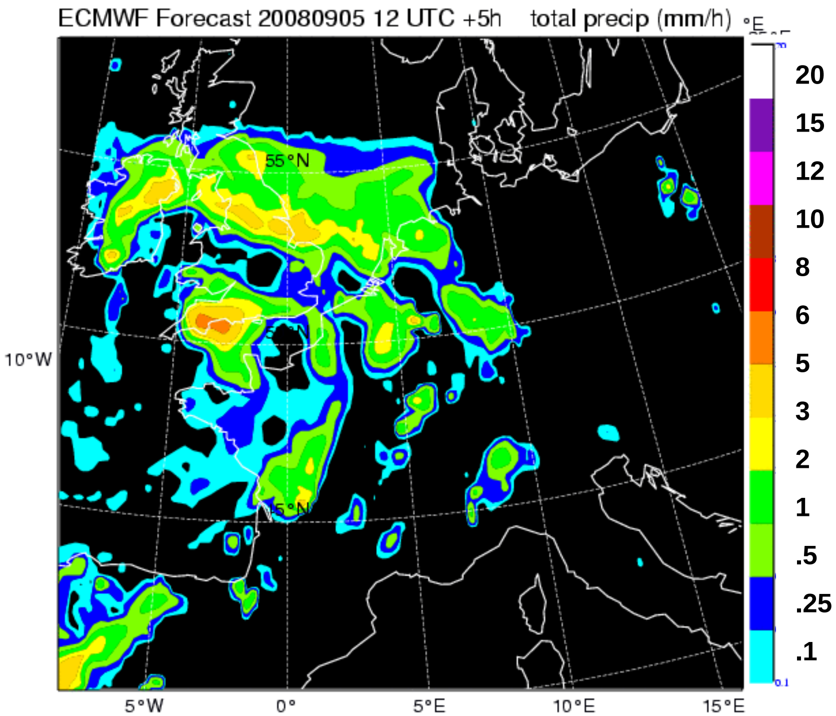
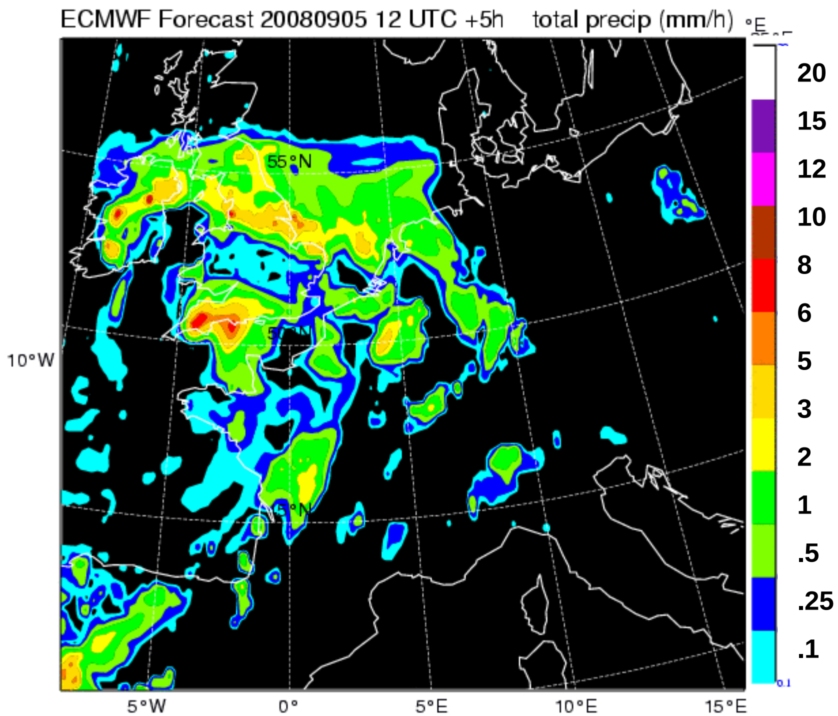


Radar

T799



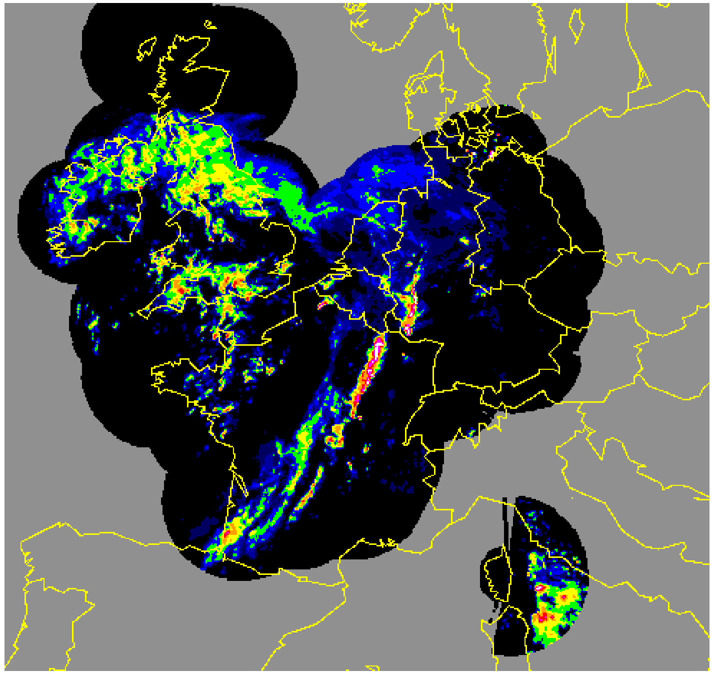
T1279



Model 1h Rain shortrange Fcs

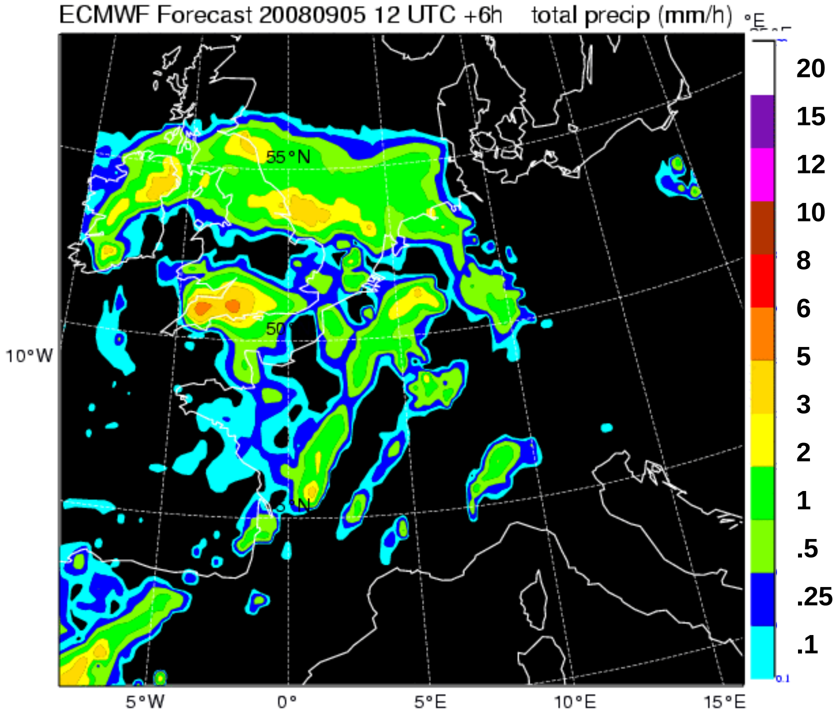
20080905
18UTC

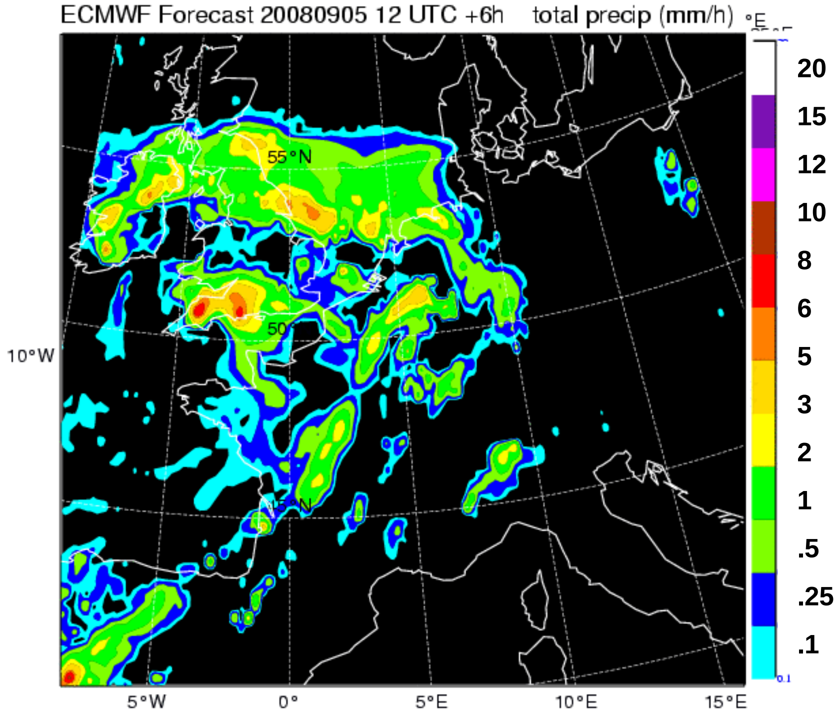
Radar



T799

T1279





Conclusion rainfall Maps

- T1279 looks subjectively ok and even more realistic, results (rainrates) are quasi resolution independent
- First assimilation tests of Radar rainrates (NEXRAD, planned is to use European archive) have been carried out by Philippe Lopez
- We know that we probably overestimate very small rainrates

Research project

Run a Cloud Resolving Model initialised with IFS Analysis over large domains and study:

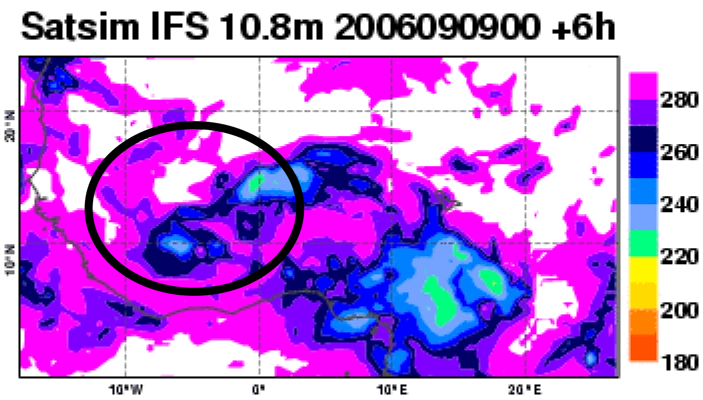
- Interaction of convection and dynamics through "diabatic heating" (including cold pools), and the propagation and upscale evolution of mesoscale convective systems.
- Diurnal cycle
- momentum flux in squall lines (line-normal one is upgradient)
- Identify and possible resolve deficiencies in IFS related to these issues.

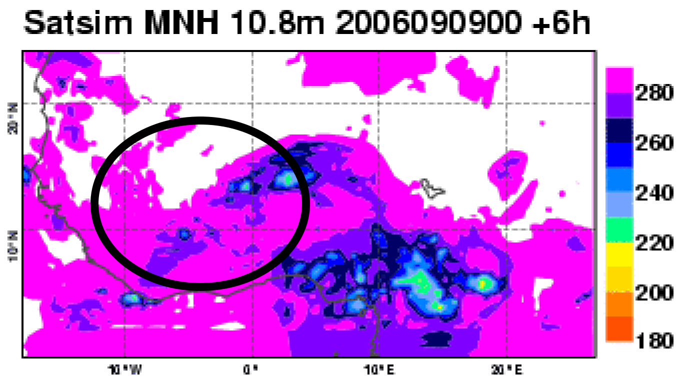
Realisation:

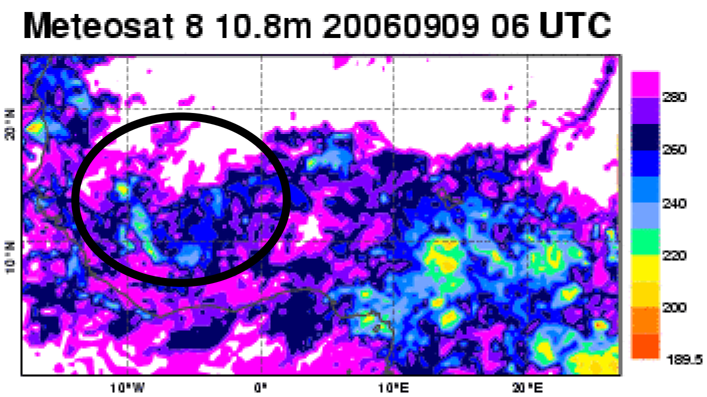
- Use the Meso-nh model in collaboration with J.P Chaboureau
- Focus on large mesoscale systems during AMMA using AMMA (Anna) reanalyses
- currently CRM resolution is set to 5 km, IFS is run at T511 (40 km) like Reanalysis, and first T1279 (15 km) forecasts are under way

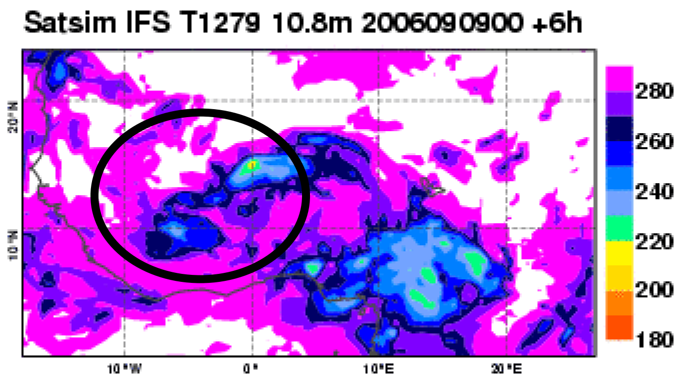
Ex of AMMA easterly wave case 36h
verification of convective systems using BTs 10.8μ

All images interpolated to T511 grid



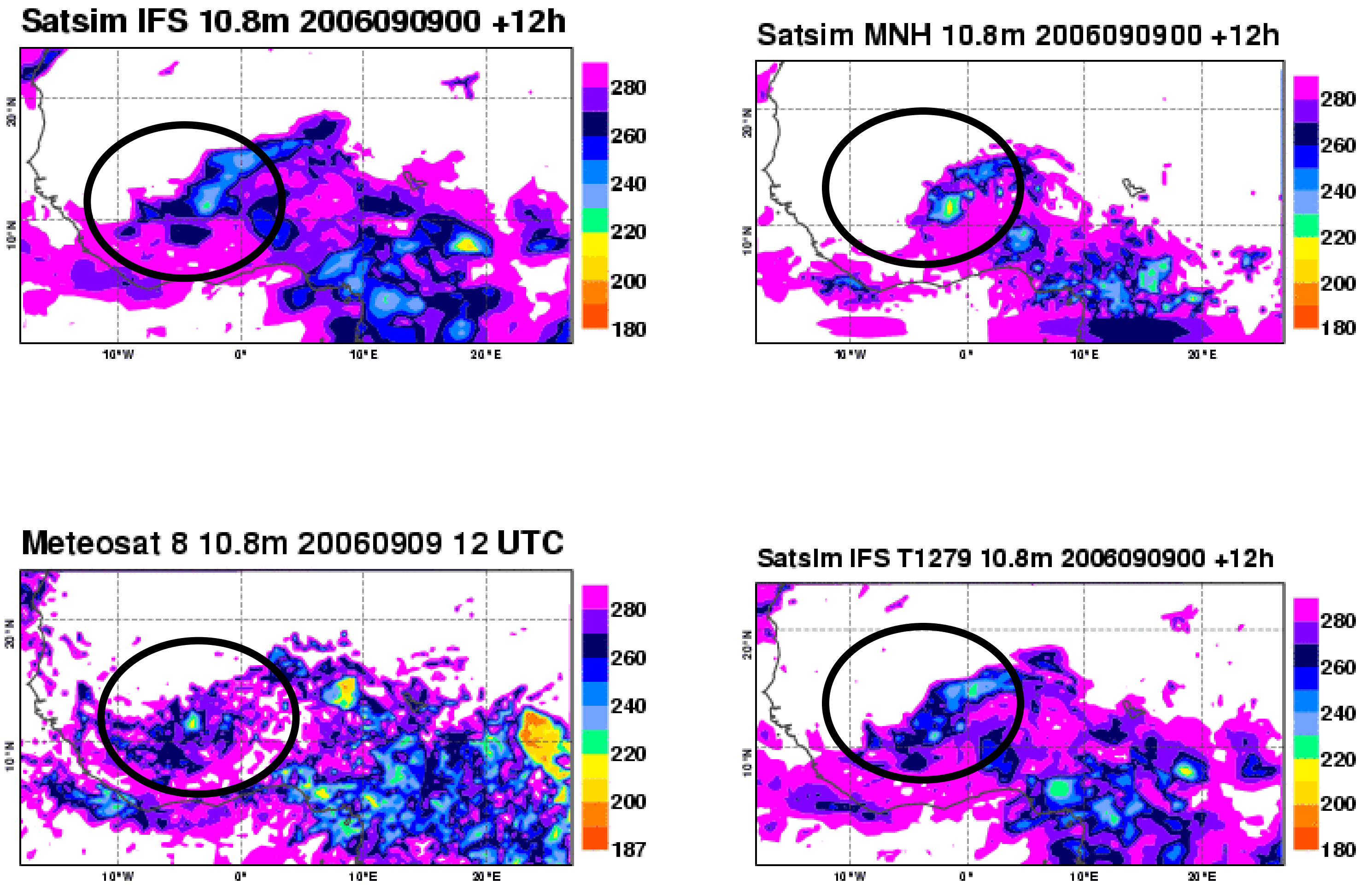






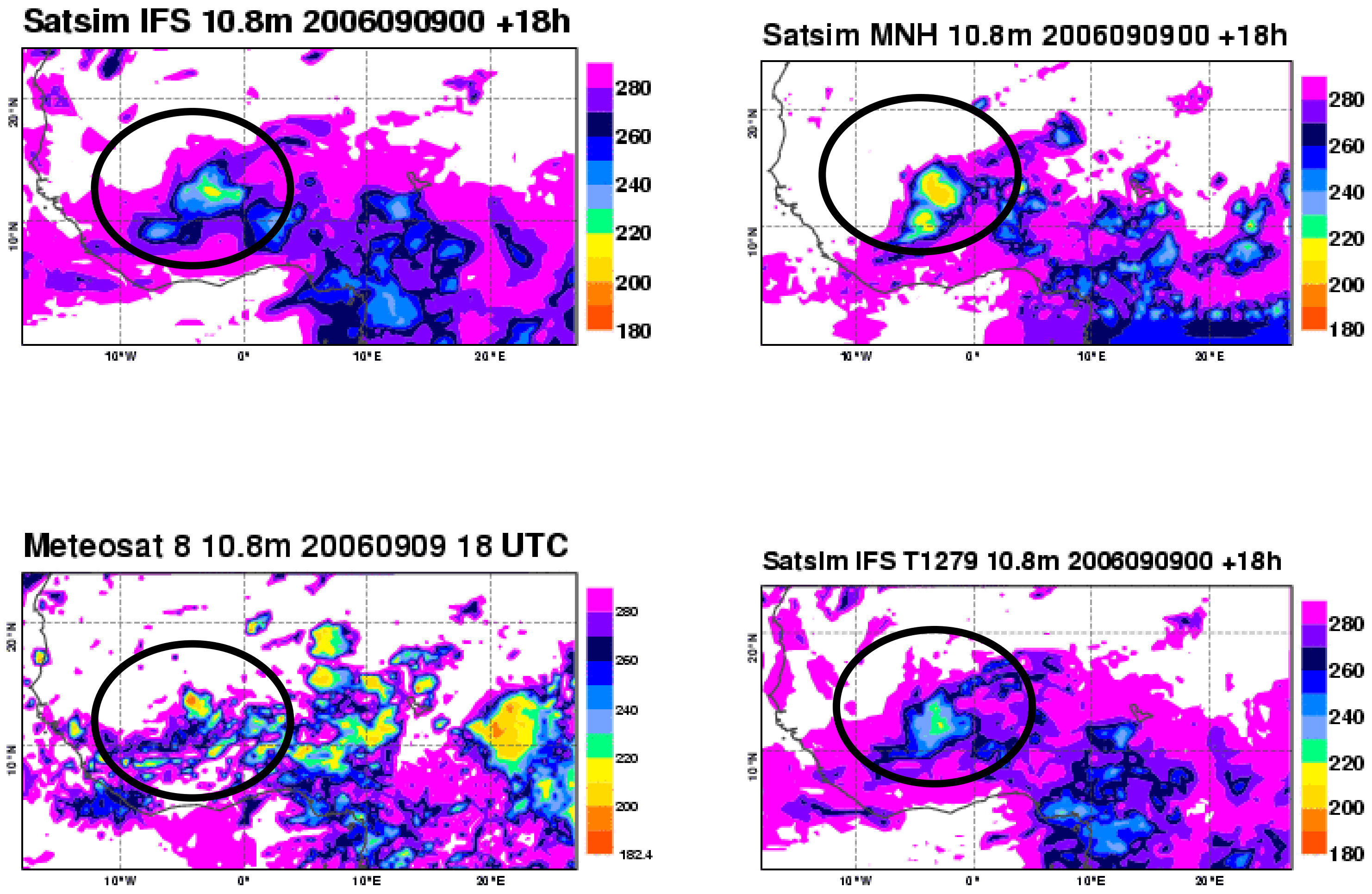
AMMA easterly wave case

verification of convective systems using BTs 10.8μ



AMMA easterly wave case

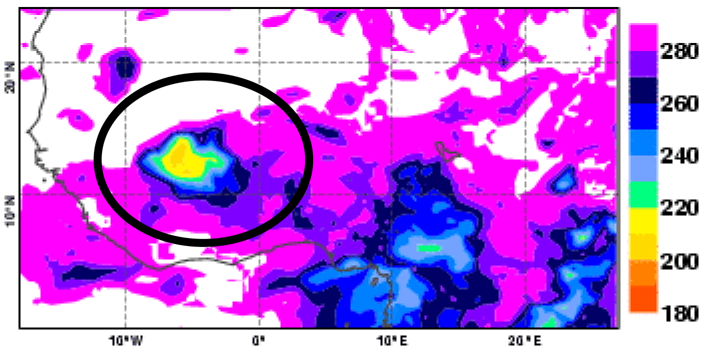
verification of convective systems using BTs 10.8μ



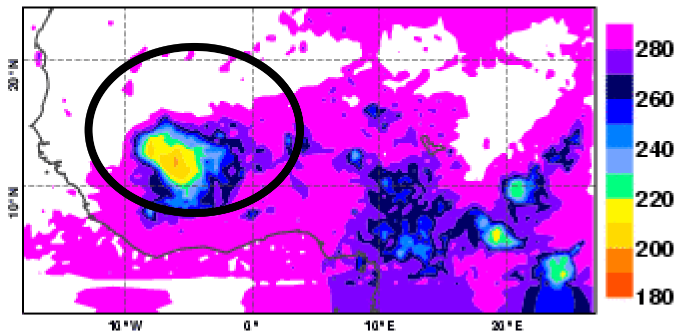
AMMA easterly wave case

verification of convective systems using BTs 10.8µ

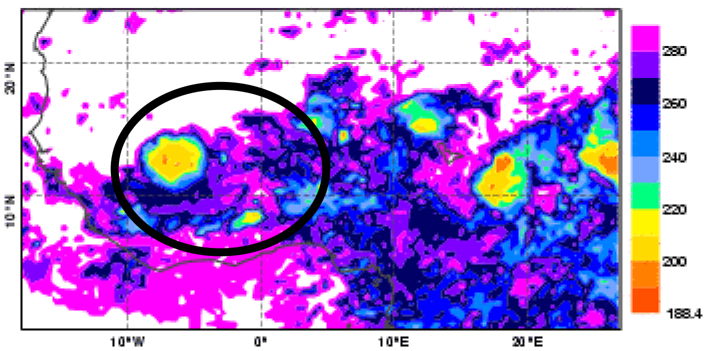
Satsim IFS 10.8m 2006090900 +24h



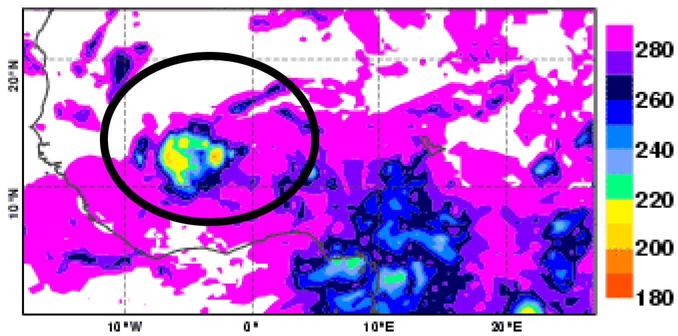
Satsim MNH 10.8m 2006090900 +24h



Meteosat 8 10.8m 20060910 00 UTC

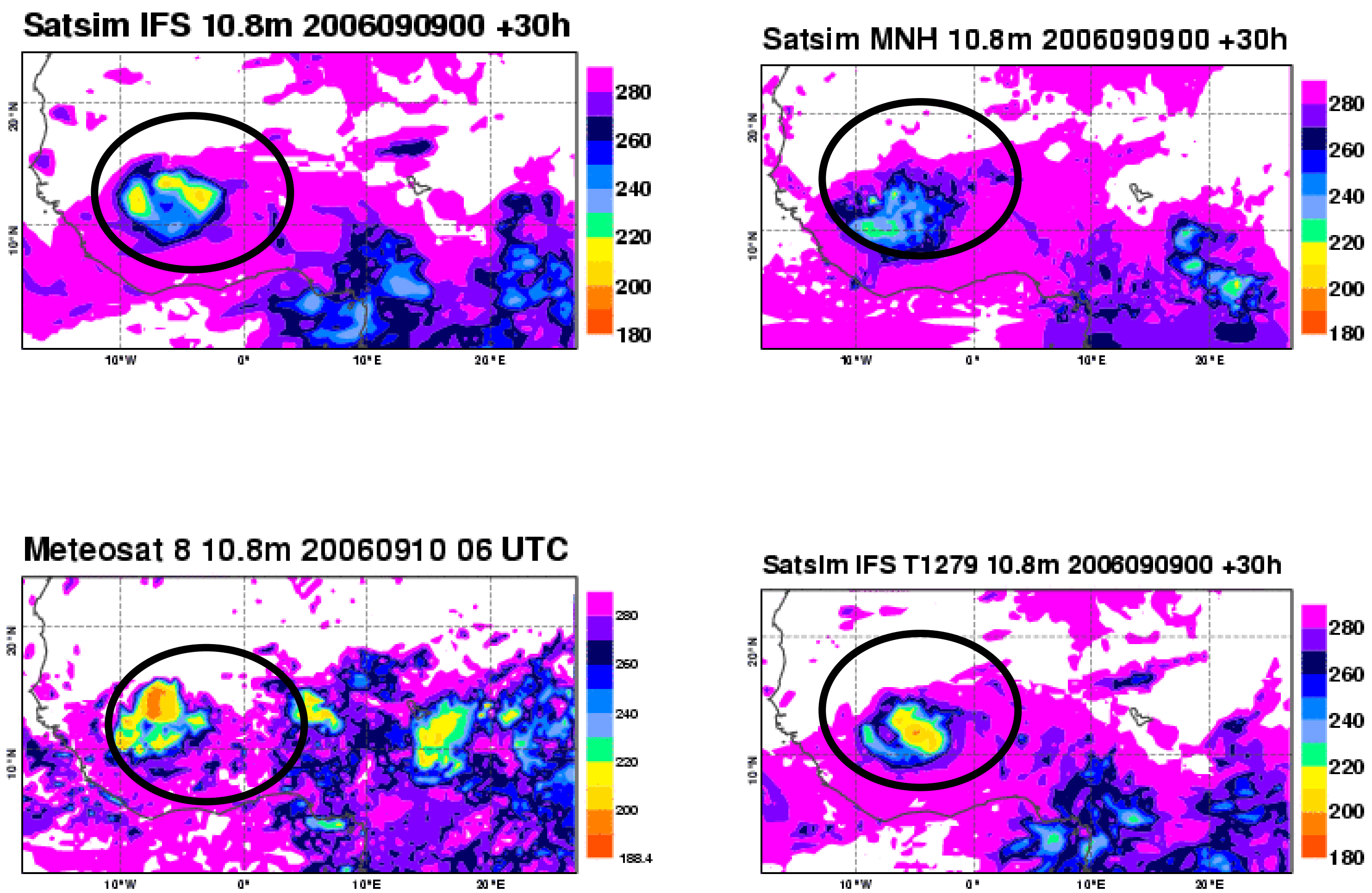


Satsim IFS T1279 10.8m 2006090900 +24h



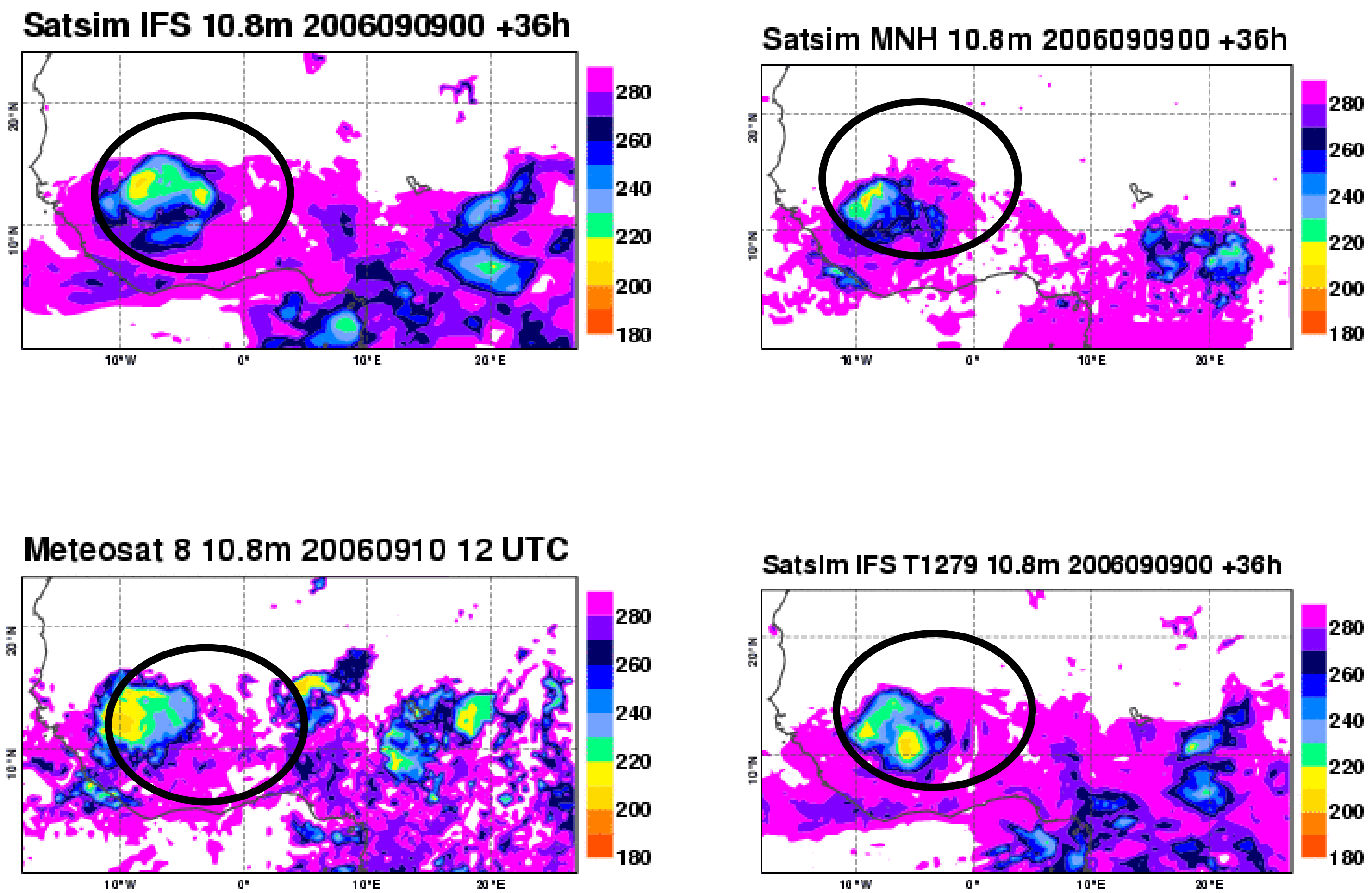
AMMA easterly wave case

verification of convective systems using BTs 10.8μ



AMMA easterly wave case

verification of convective systems using BTs 10.8μ

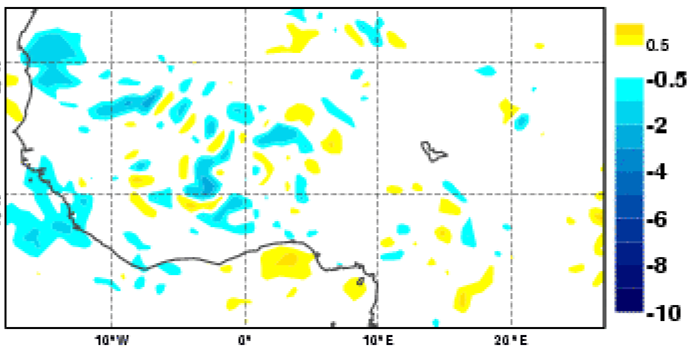


AMMA easterly wave case

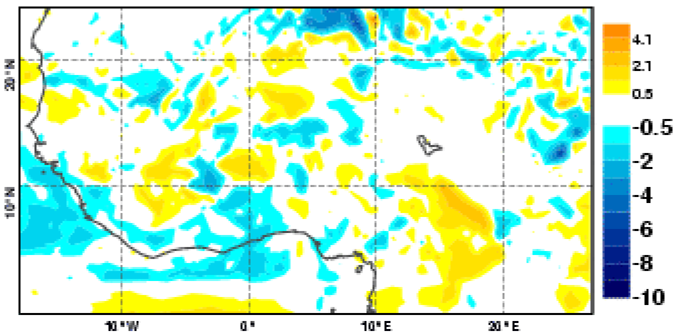
verification of convective systems using BTs 10.8μ

Both models produce low-level cold and warm inflow for mesoscale system

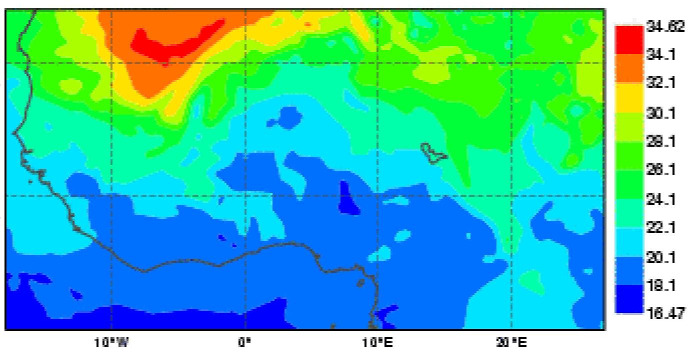
Diff IFS-Ana T (K) 20060909 6 925 hPa



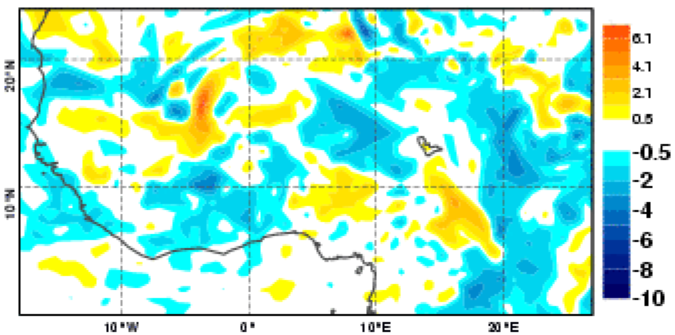
Diff MNH-Ana T (K) 2006090900 +6h 925 hPa



Ana T (K) 20060909 06 UTC 925 hPa



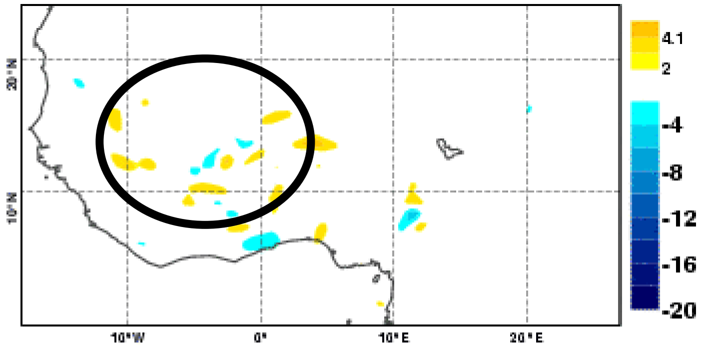
Diff AnaOp - ReAna T (K) 20060909 06 UTC 925 hPa



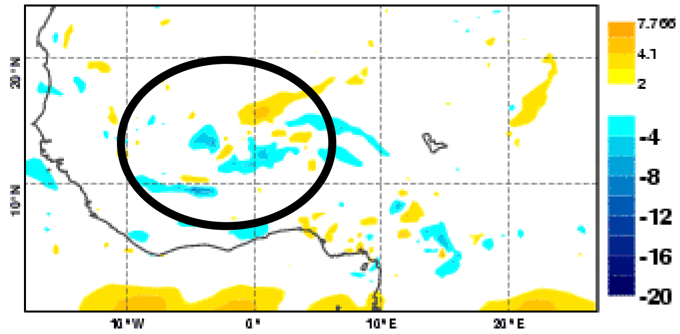
AMMA easterly wave case
verification of 925 T

Reasonable in both models, a bit more mesoscale system dynamics in Meso-nh

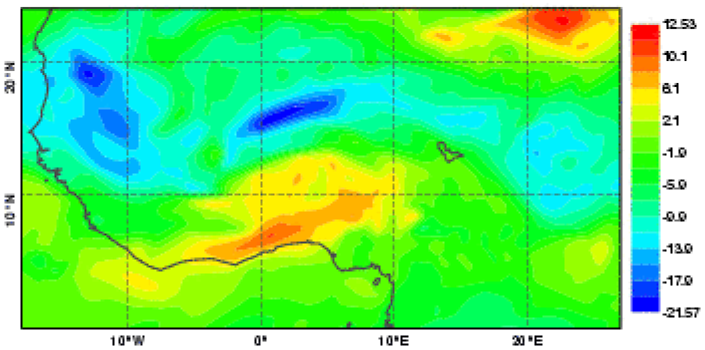
Diff IFS-Ana U (m/s) 20060909 6 700 hPa



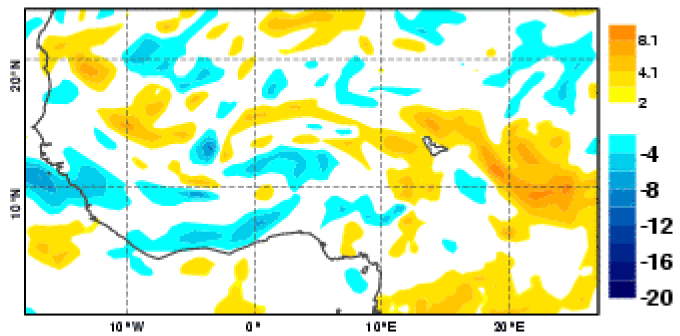
Diff MNH-Ana U (m/s) 2006090900 +6h 700 hPa



Ana U (m/s) 20060909 06 UTC 700 hPa



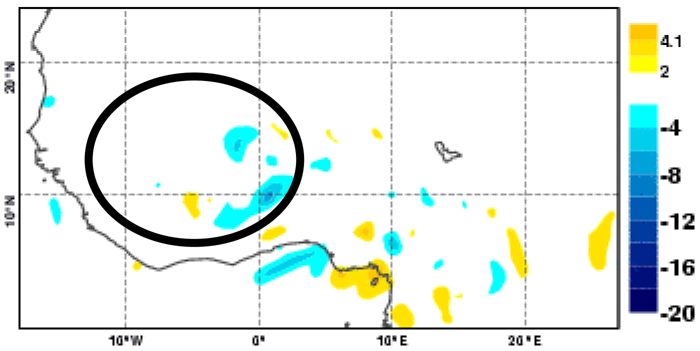
Diff AnaOp - ReAna U (m/s) 20060909 06 UTC 700 hPa



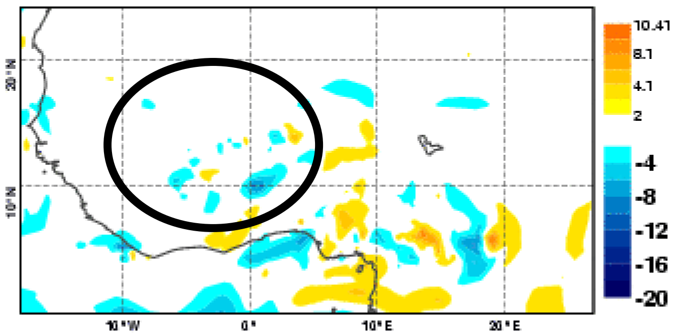
AMMA easterly wave case
verification of 200hPa U

Probably too strong system and upper level divergence (outflow in Meso-nh)

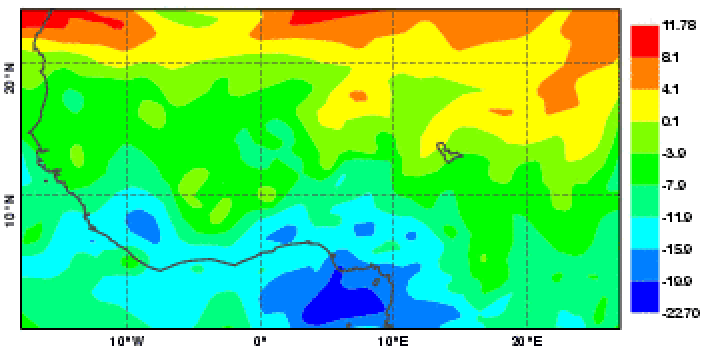
Diff IFS-Ana U (m/s) 20060909 6 200 hPa



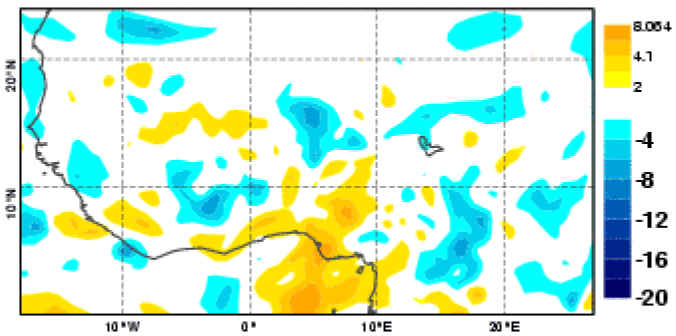
Diff MNH-Ana U (m/s) 2006090900 +6h 200 hPa



Ana U (m/s) 20060909 06 UTC 200 hPa



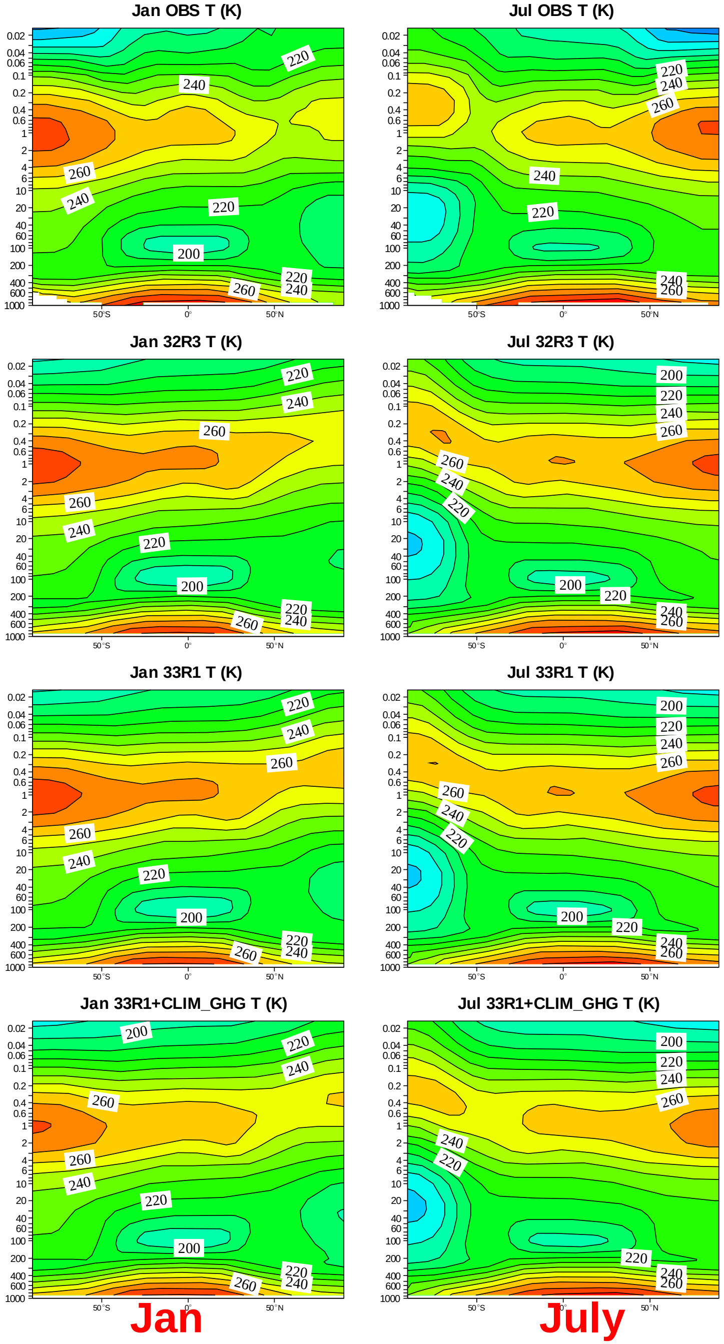
Diff AnaOp - ReAna U (m/s) 20060909 06 UTC 200 hPa



Preliminar statements

- 4 periods of 48h have bun run including easterly and non-easterly wave cases, and a case with convection penetrating into the stratosphere
- the IFS at 40 km and 15 km and the Meso-nh explicit at 5 km produce similar results in terms of success in producing and propagating mesoscale systems; the biases with respect to Reanalysis are also similar. Meso-nh produces some more systems but the onset of convection tends to be sometimes delayed by a few hours compared to observations, and upper-level outflow overestimated.
- cases with strong forcing (easterly waves) better represented
- need to do more data analysis
- Heating profiles still have to be produced for Meso-nh and analysed using e.g. EOFs

The ECMWF middle atmosphere climate and the parameterization of non-orographic gravity waves
by A. Orr +A. Untch +N.Wedi

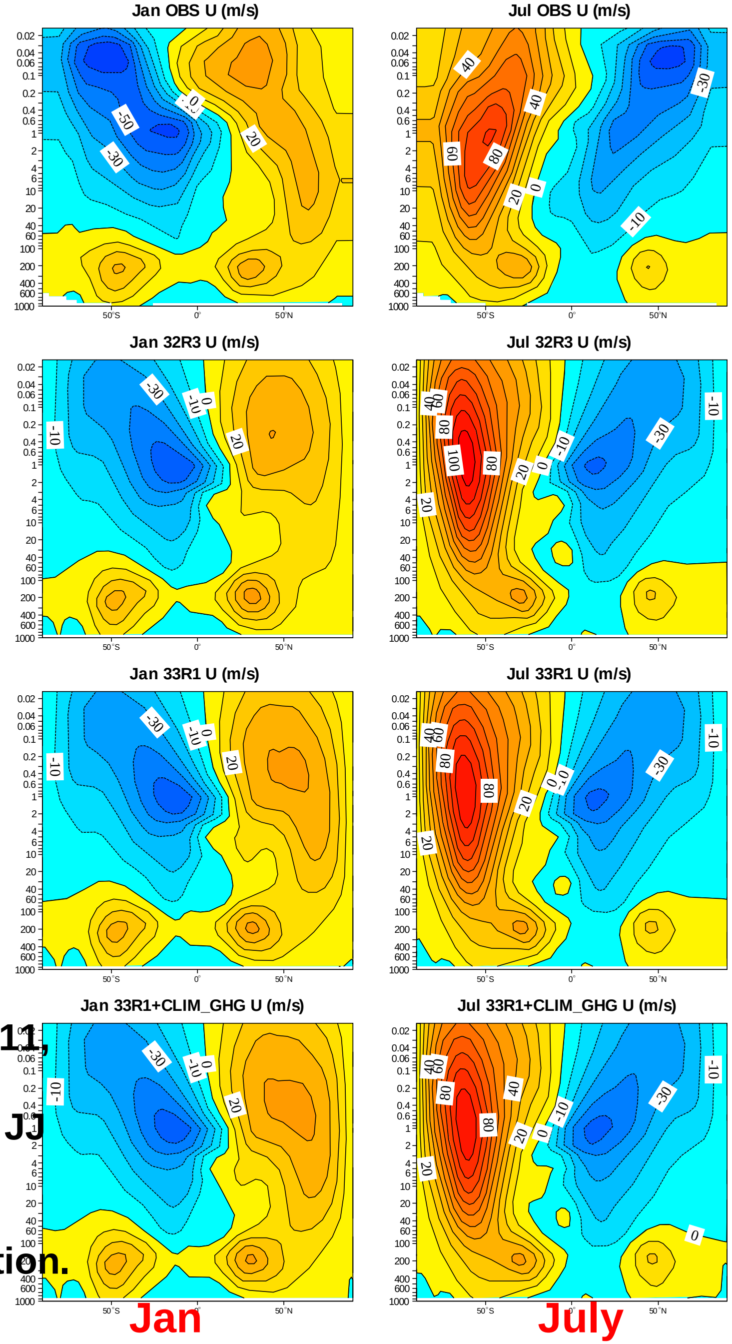


SPARC observed climatology

32R3
NH planetary wave activity over-estimated (Bechtold et al. 2008)

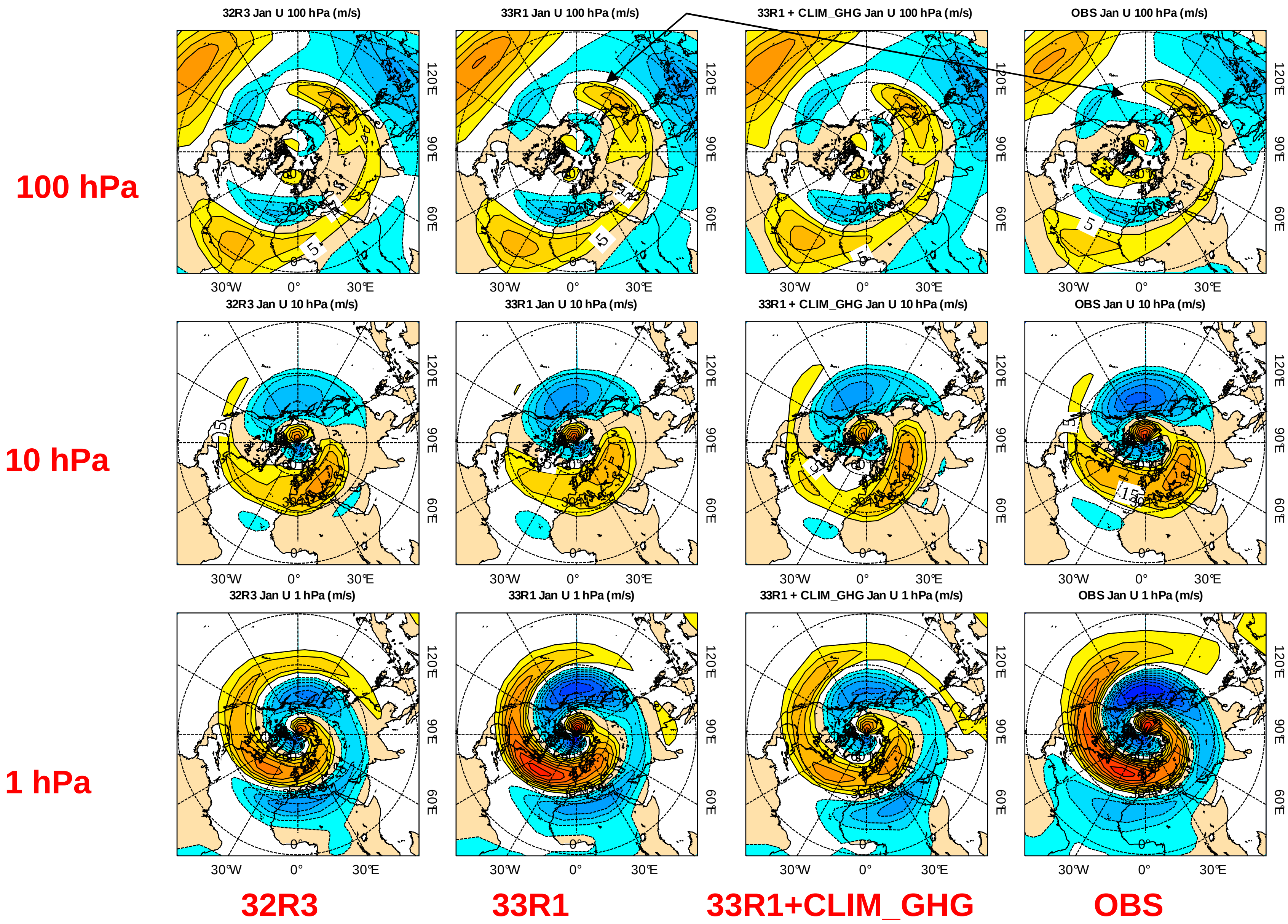
33R1
NH planetary wave activity better, but still biases

33R1 + improved GHG (O_3,CO_2,CH_4, N_2O, CFC11, CFC12, CFC22, CC14) climatology (D. Cariolle, JJ Morcrette, A Untch)
Towards realistic temperature and circulation.



Mean January and July zonal-mean temperature and zonal wind for observations (top), 32R3 (second top), 33R1 (third top), and 33R1 + CLIM_GHG (lower). Simulations are 8-year (1994-2001) averages.

Good agreement between 33R1 and observations



Mean (stationary) January northern winter planetary wave zonal wind amplitude (m/s) at (from top) 100 hPa, 10 hPa, and 1 hPa for the 32R3 (left), 33R1 (2nd left), 33R1 + CLIM_GHG (3rd left) simulations, and observations (right). Observations are ERA-interim reanalysis. Simulations are 8-year (1994-2001) averages.

Physically based gravity wave scheme

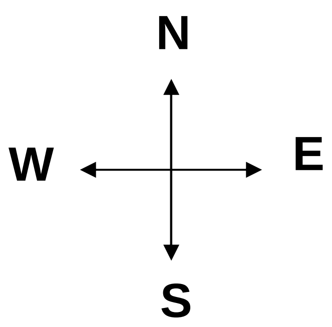
Consist of spectrum of waves via hydrostatic non-rotational dispersion relation

$$m^2 = \frac{k^2 N^2}{\tilde{\omega}^2} = \frac{N^2}{\tilde{c}^2}$$

$$m = \frac{2\pi}{\lambda_z}; k = \frac{2\pi}{\lambda_h}; \tilde{\omega} = \omega - kU; \tilde{c} = c - U$$

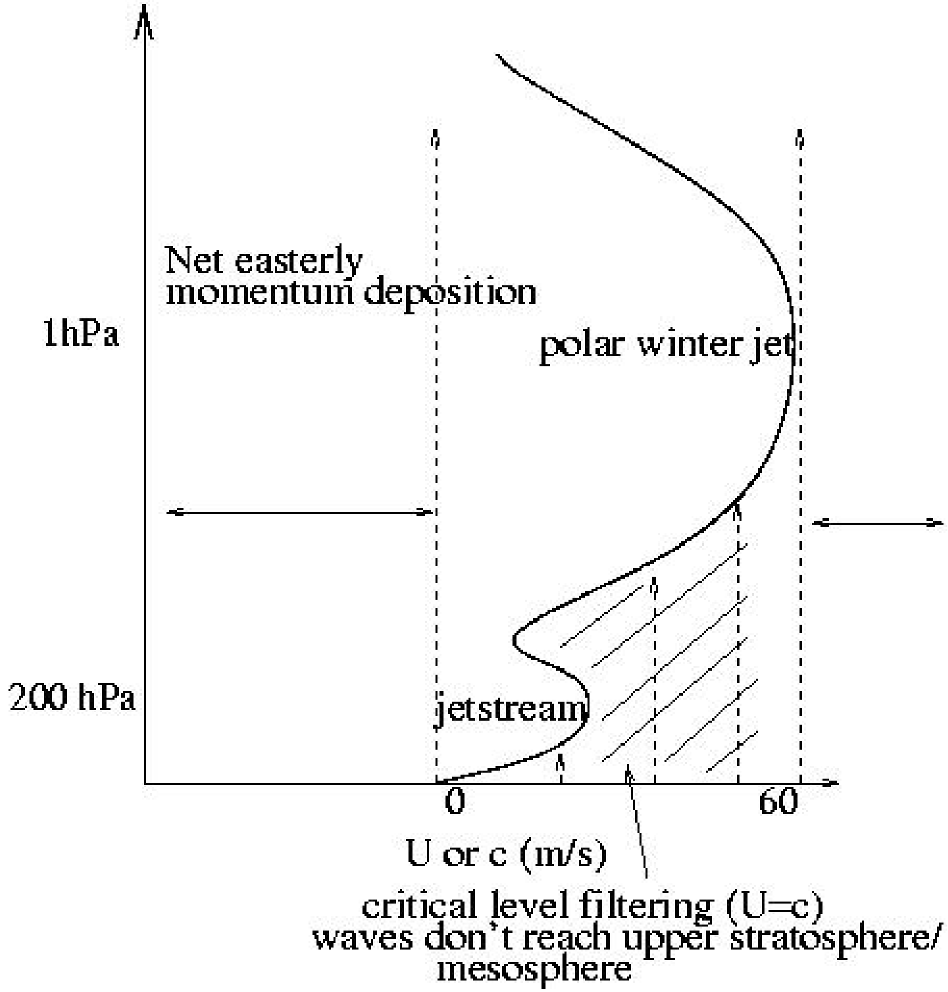
U: background wind; ***N***: buoyancy

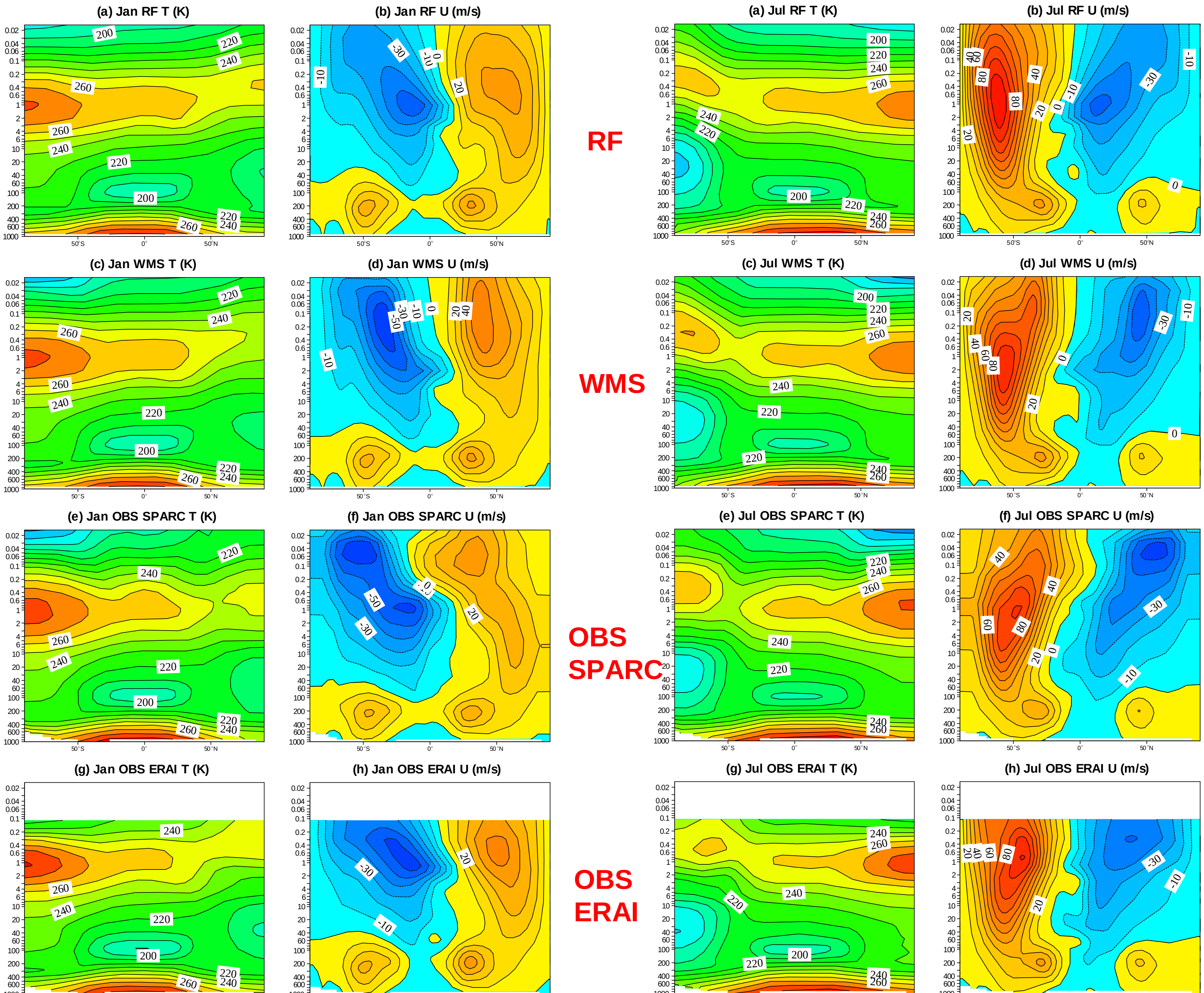
Gravity wave source: launch globally constant isotropic spectrum of waves at each grid point as function of, for example, ***c***. Assume constant input momentum flux



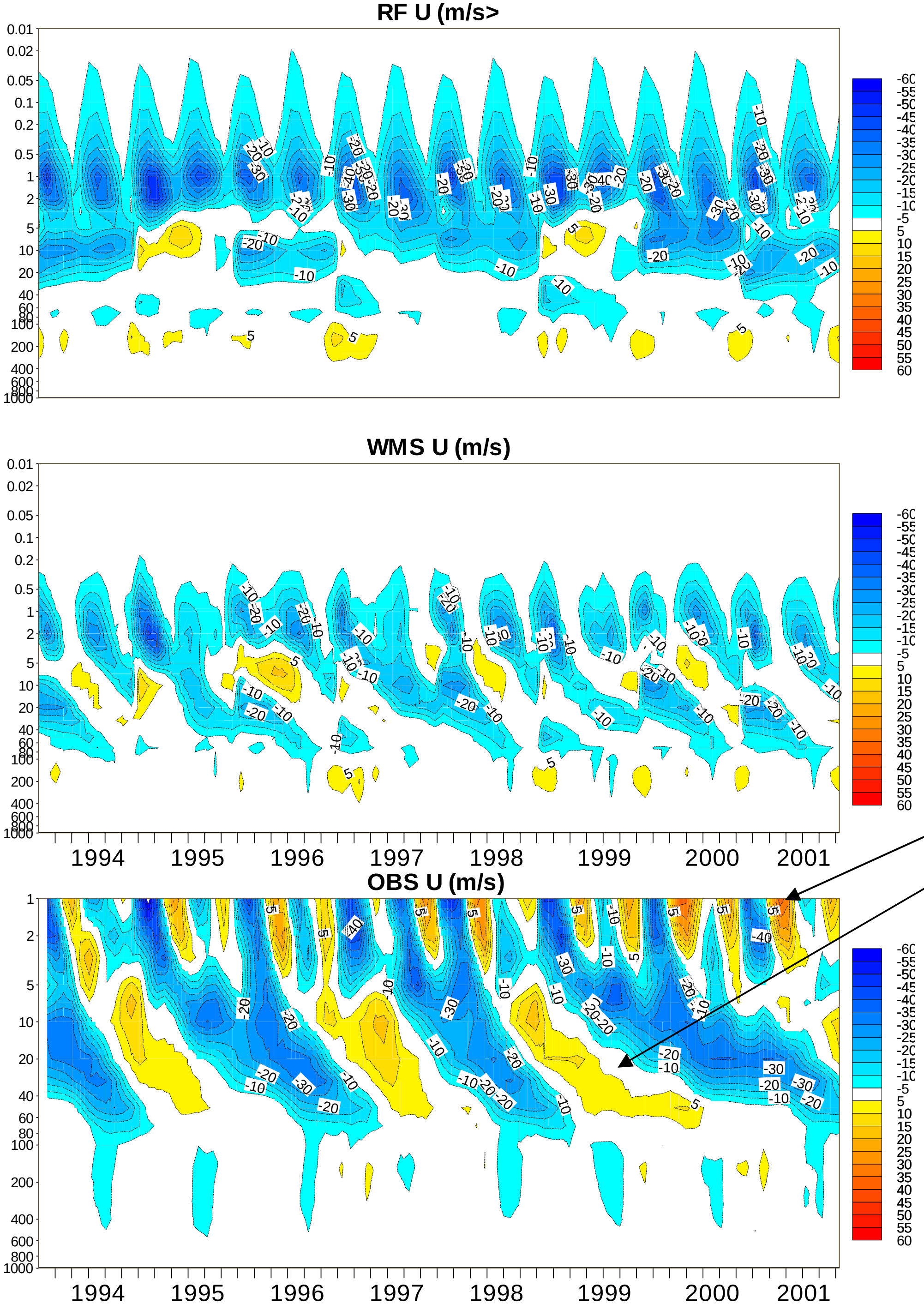
Net input momentum flux = 0

Rely on realistic winds to filter the upward propagating (unrealistic) gravity wave source.





Mean January and July zonal-mean temperature and zonal wind for Rayleigh friction (RF) and W and McIntyre (1996), Scinoccia (2003) scheme and observations. Simulations are 33R1 + CLIM_GHG 8-year (1994-2001) averages.



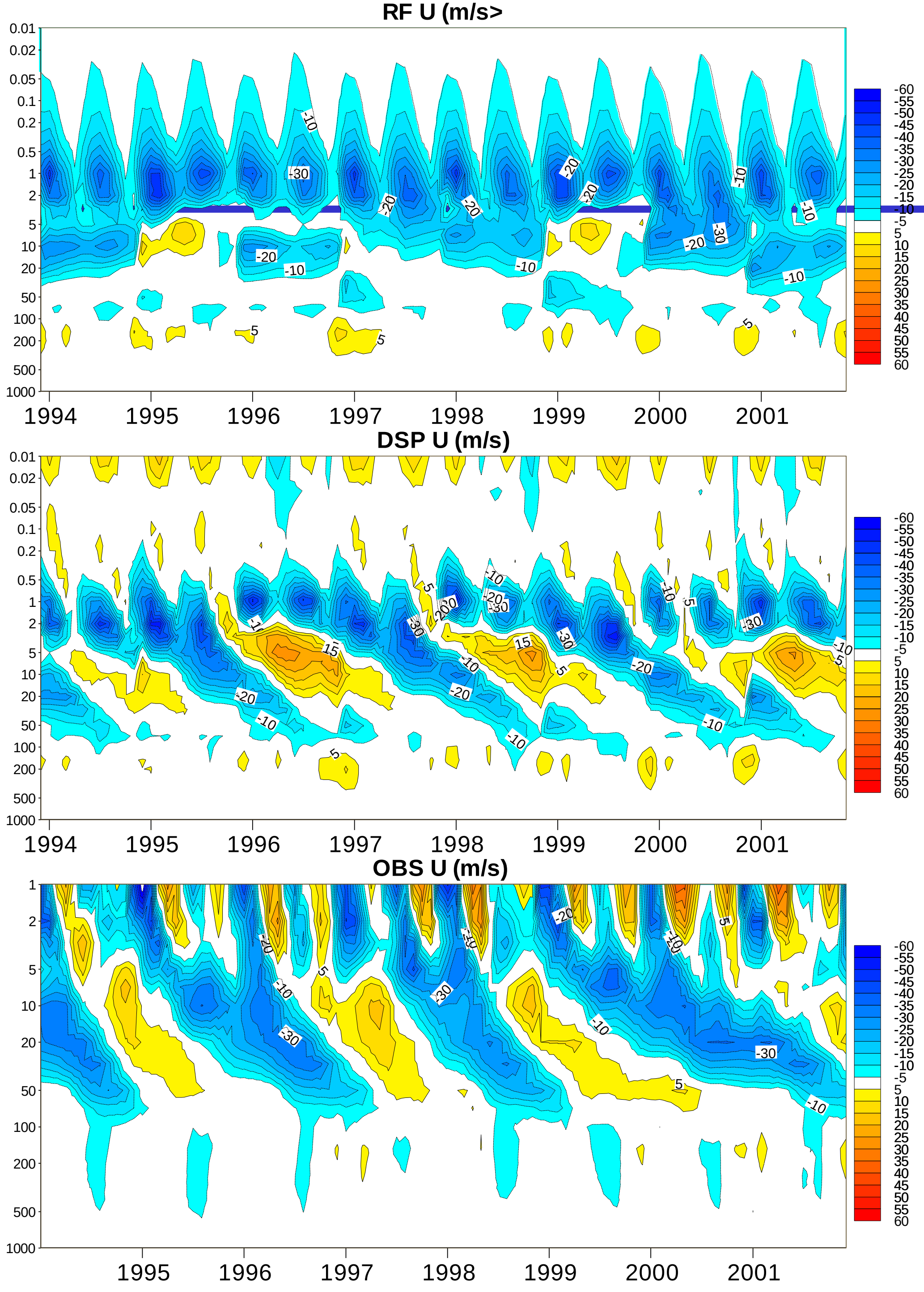
RF has easterly bias due to use of Rayleigh friction which damps U to zero

Westerly shear zone not captured?

Semi-annual oscillation (period~6 months)

Quasi-biennial oscillation (period ~ 27 months

Monthly mean zonally averaged zonal wind over the equator for the RF (upper) and WMS (middle) simulations, and observations (lower). Observations are ERAI reanalysis up to 1 hPa for the 1994-2001 period. The winds have been meridionally averaged between 10ºS and 10ºN.



Realistic QBO in tropics?

DSP produces waves carrying the necessary westerly momentum flux

Monthly mean zonally averaged zonal wind over the equator for the RF (top) and DSP (middle) simulations, and observations (lower). The observations consist of ERAI reanalysis for the 1994 to 2001 period. The simulation results are for the same period. The winds have been meridionally averaged between 10S and 10N. The contour interval is 5 m/s.

Hope to get this implemented within one year, together with new GHG climatology (monthly values instead annual average, and covering period 18xx to 2100) … need to maintain probably a bit Raileigh friction at model top