

A bit from the Physics and mesoscale side

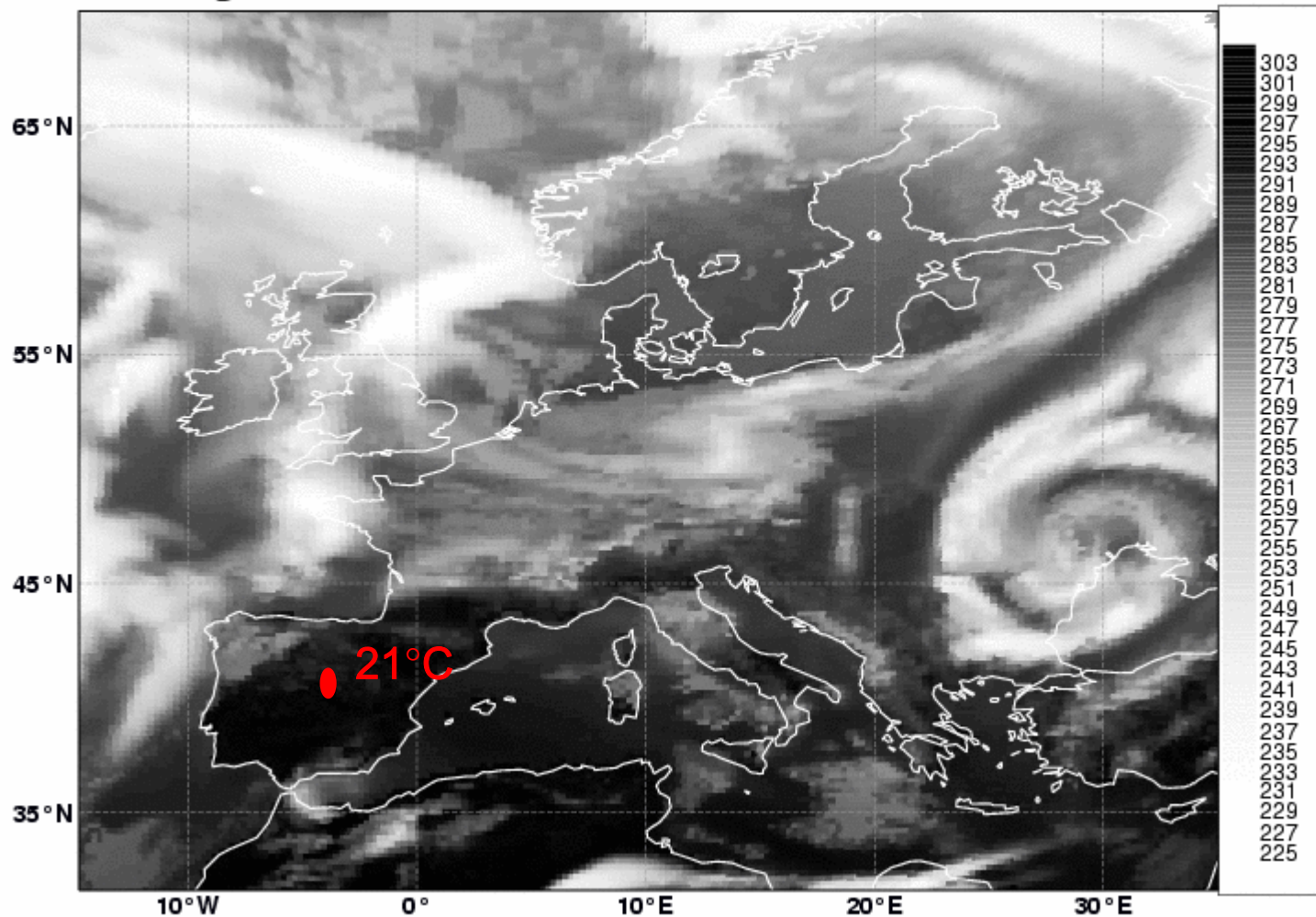
Content

- 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:



-
- 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.

-
- 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.

-
- 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

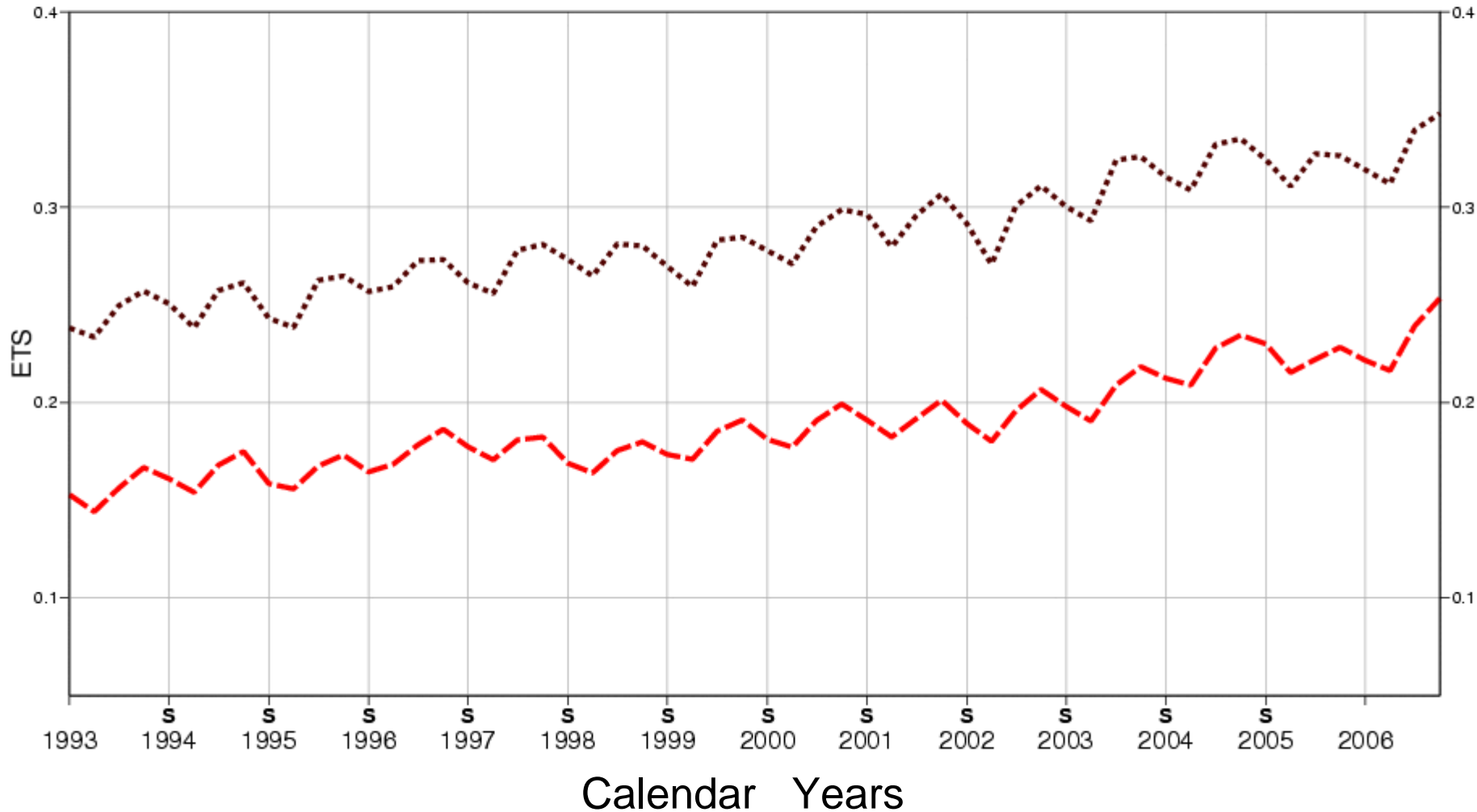
Equitable threat score for **European precipitation** against SYNOP data

Curves show 12 month running mean of seasonal values

precipitation exceeding 10.0 mm/24h

1 day per 7 years

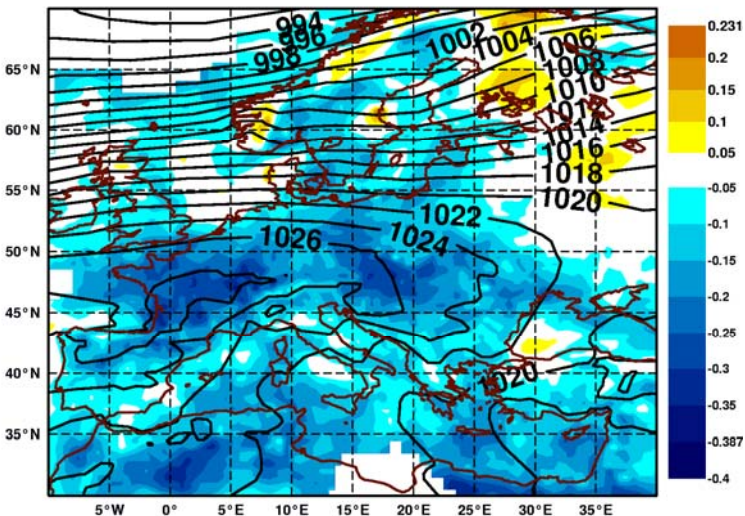
..... t + 42 - - - t + 90



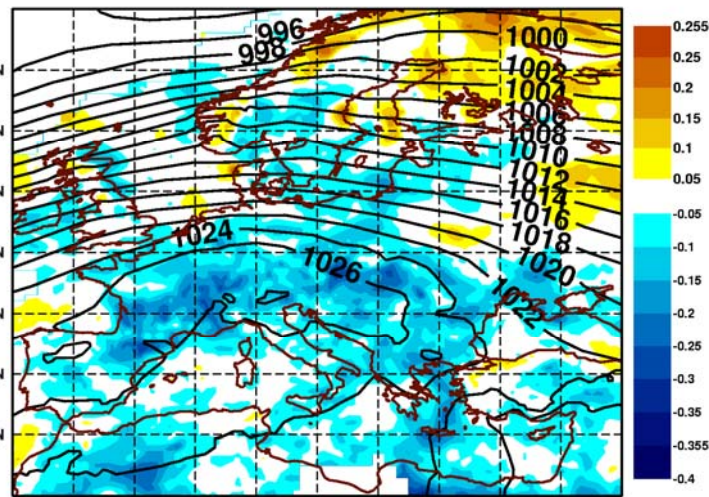
Winter Cloud Cover : 36h forecast versus SYNOP observation (for high pressure days over central Europe (last four winters))

DJF
2004/5
58 cases

Diff Fc-Obs mean TCC 20041201-20050228 12 UTC
Mean= -0.106 RMS= 0.0823 Cases= 58



Diff Fc-Obs mean TCC 20061201-20070228 12 UTC
Mean= -0.047 RMS= 0.0734 Cases= 52



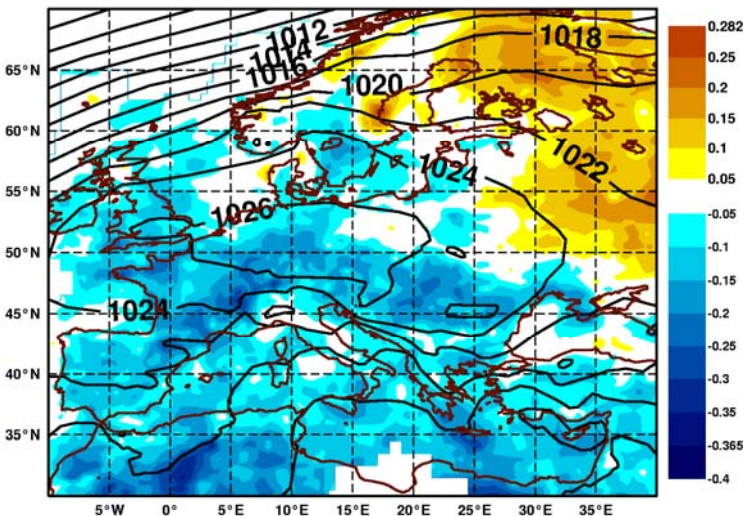
DJF
2006/7
52 cases

EDMF PBL

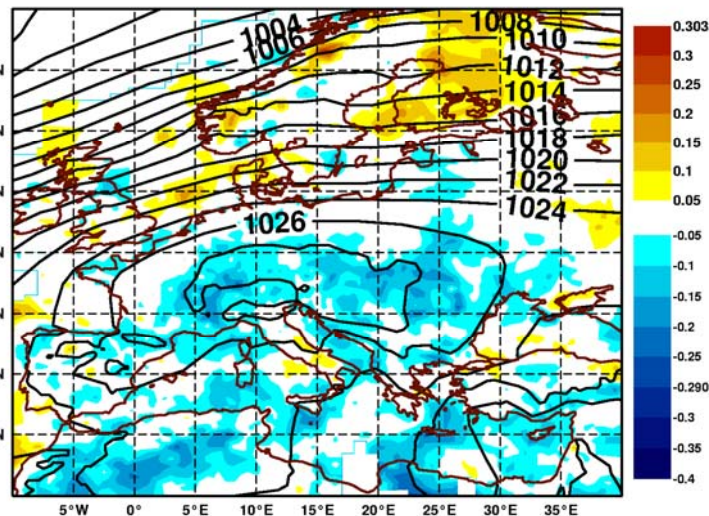
M-O diffusion

DJF
2005/6
60 cases

Diff Fc-Obs mean TCC 20051201-20060228 12 UTC
Mean= -0.064 RMS= 0.0964 Cases= 60



Diff Fc-Obs mean TCC 20071201-20080228 12 UTC
Mean= -0.027 RMS= 0.0644 Cases= 69

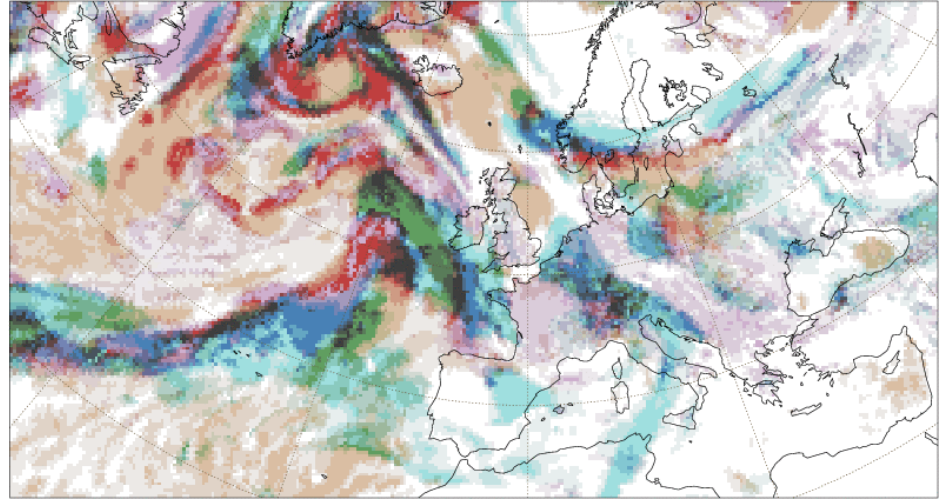


DJF
2007/8
69 cases

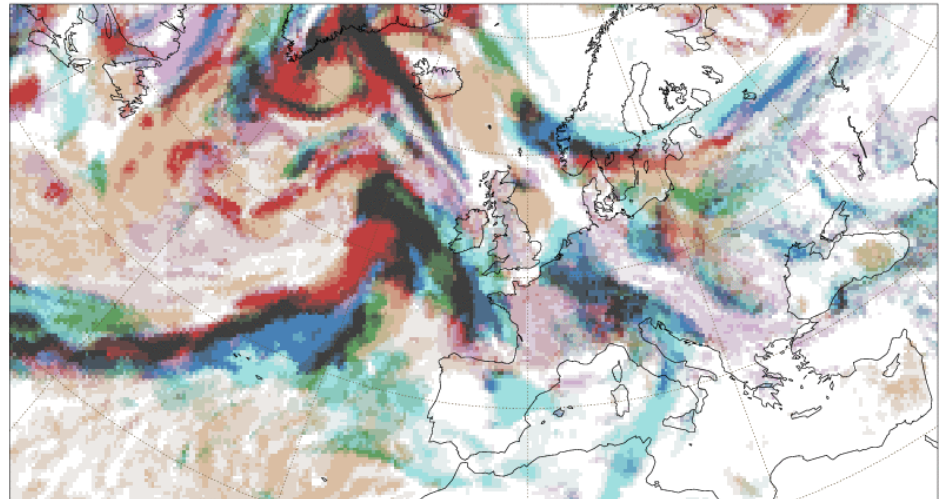
Cloud Overlap

- 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



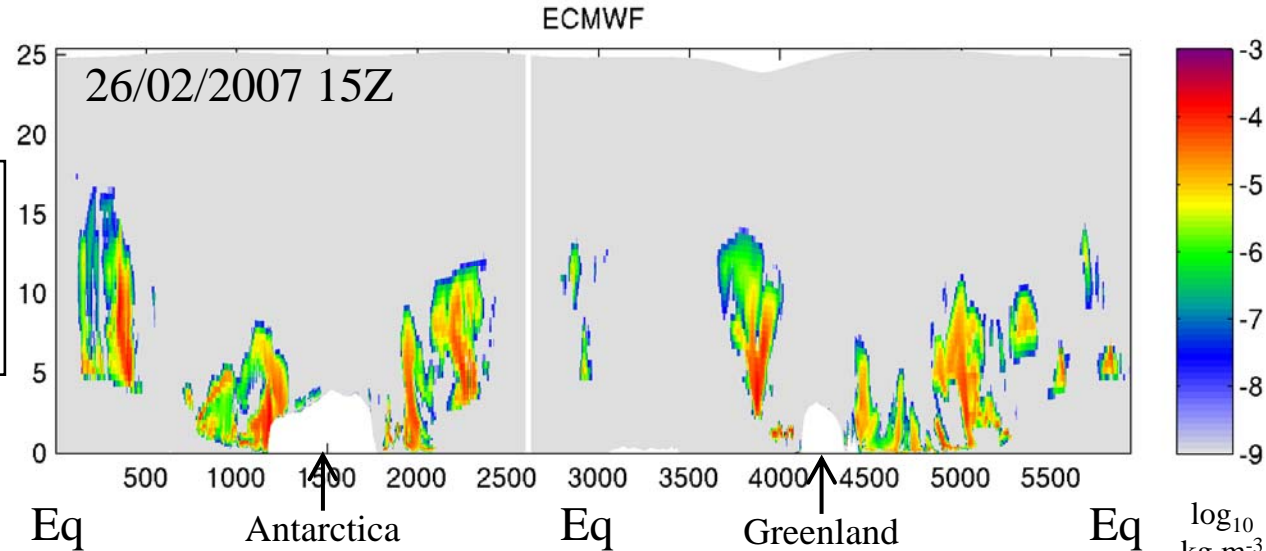
Friday 1 June 2007 12UTC ECMWF Forecast t+ 0 VT: Friday 1 June 2007 12UTC
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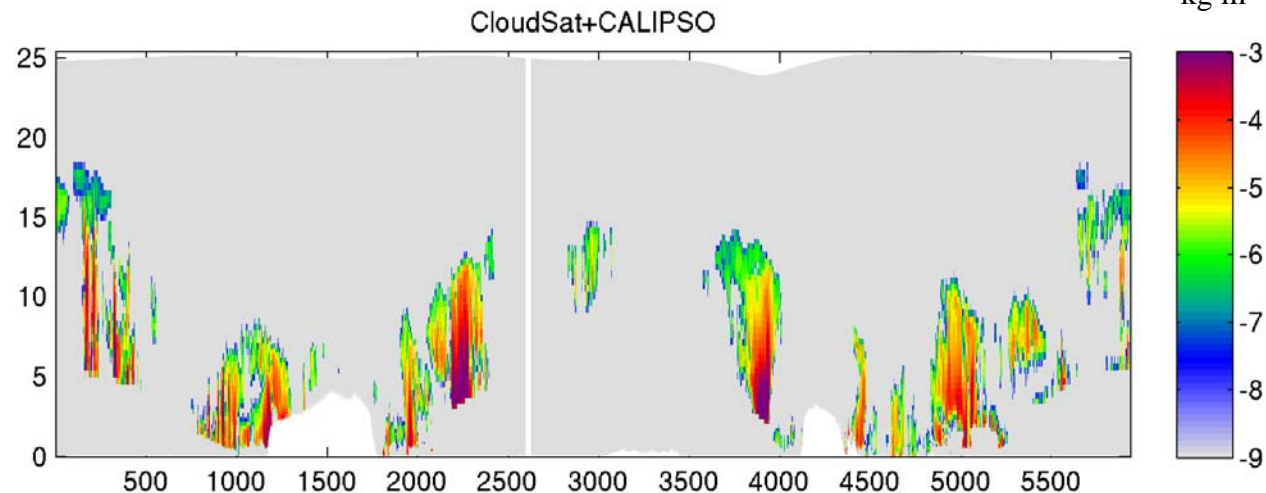
Cloud Verification

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

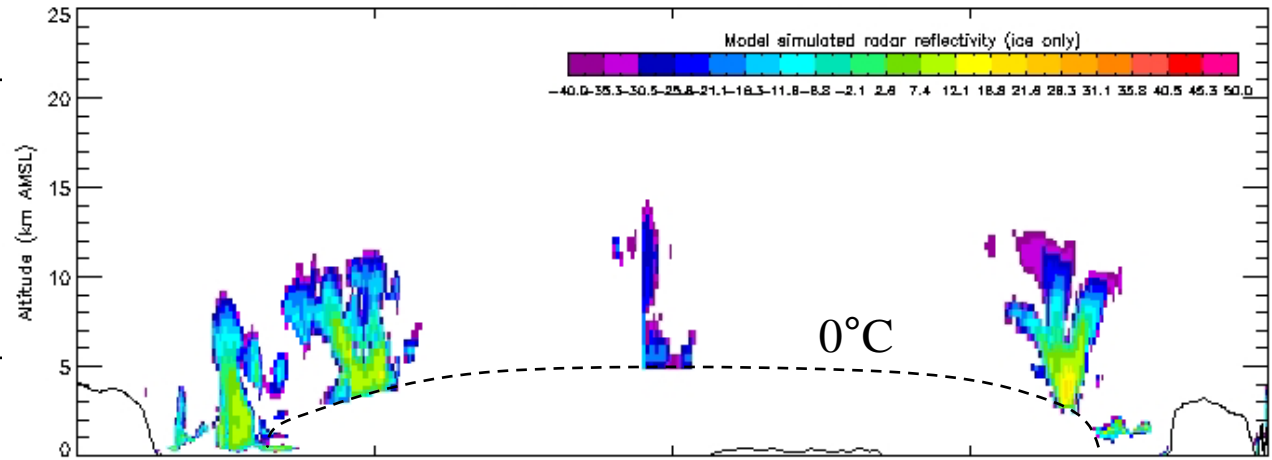


Cloud Verification

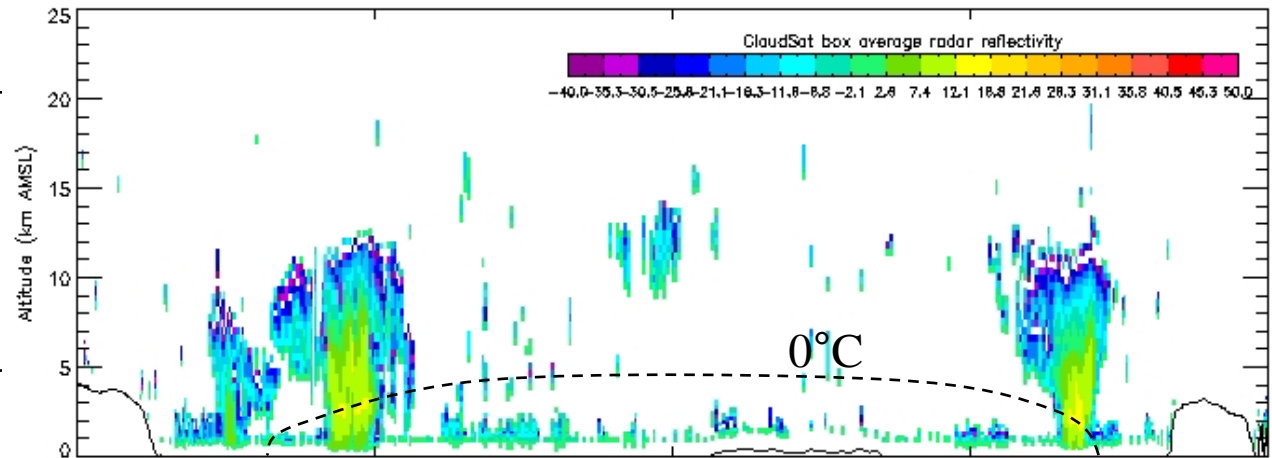
Model-to-Obs: Radar reflectivity

26/02/2007 15Z

Simulated radar reflectivity from the model.
(ice only)



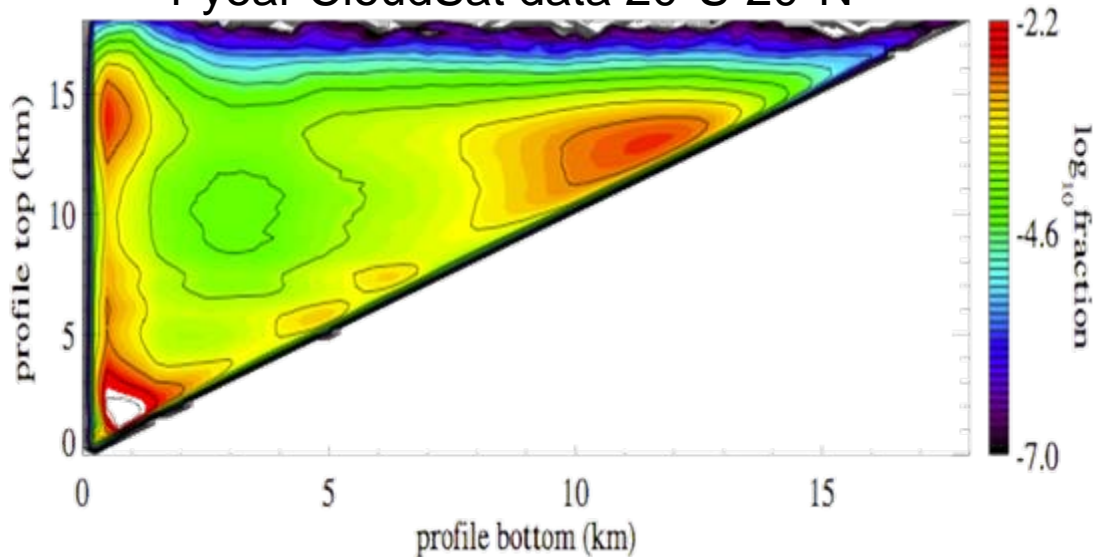
Observed radar reflectivity from CloudSat
(ice + rain)



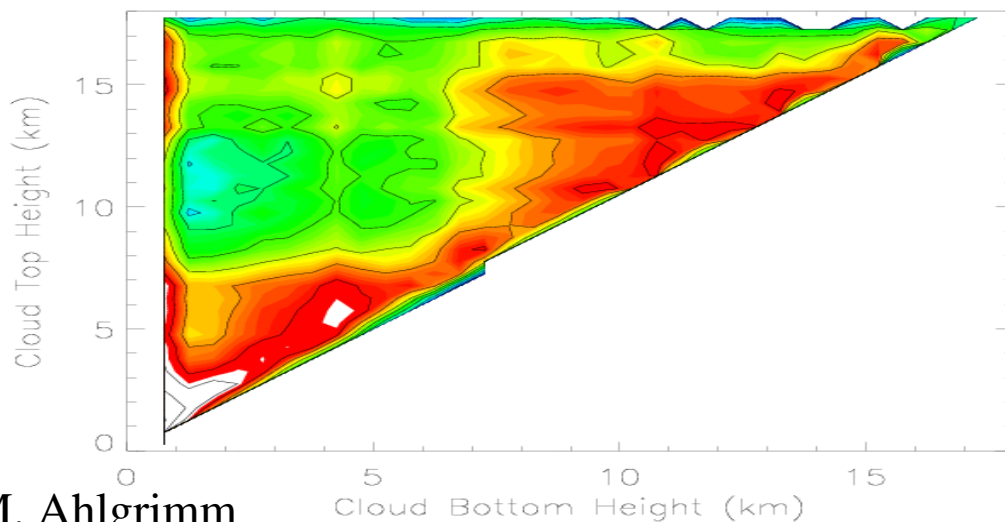
Cloud Verification

Tropical Cloud Height and Depth

1 year CloudSat data 20°S-20°N



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

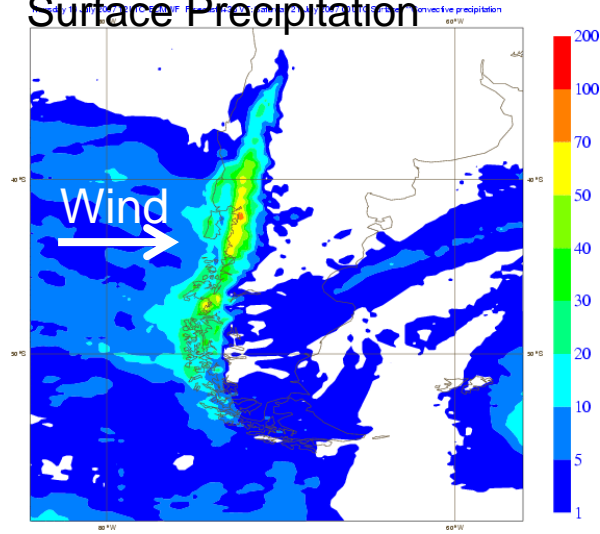


New 5-prognostic cloud microphysics

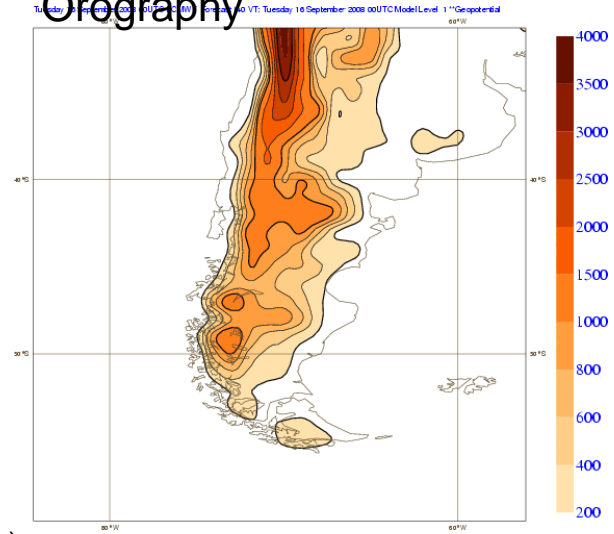
Falling snow and orographic forcing

(36 hour acc.)

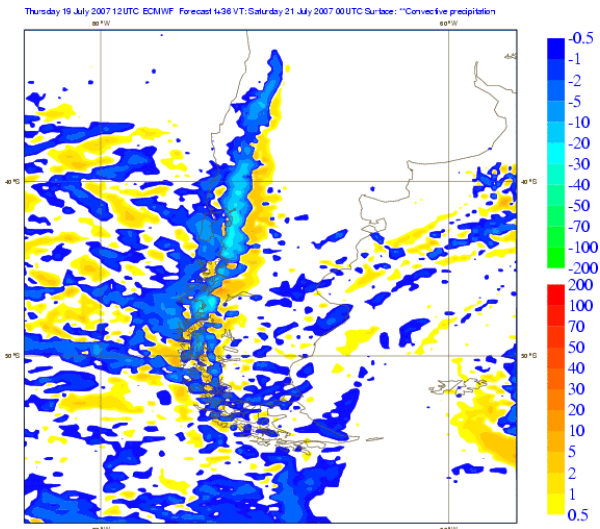
Surface Precipitation



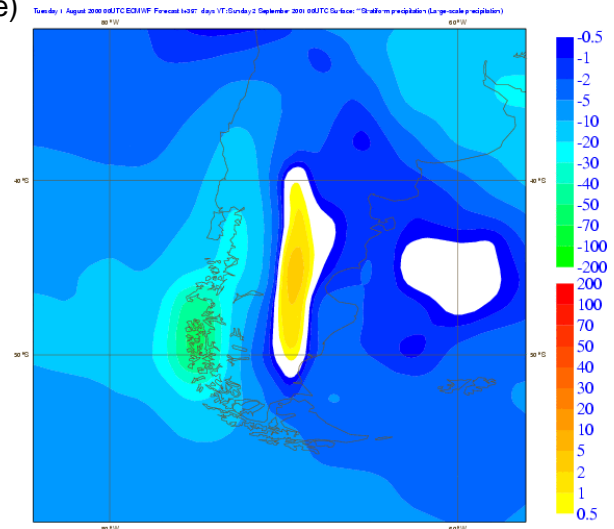
Orography



(36 hour acc)



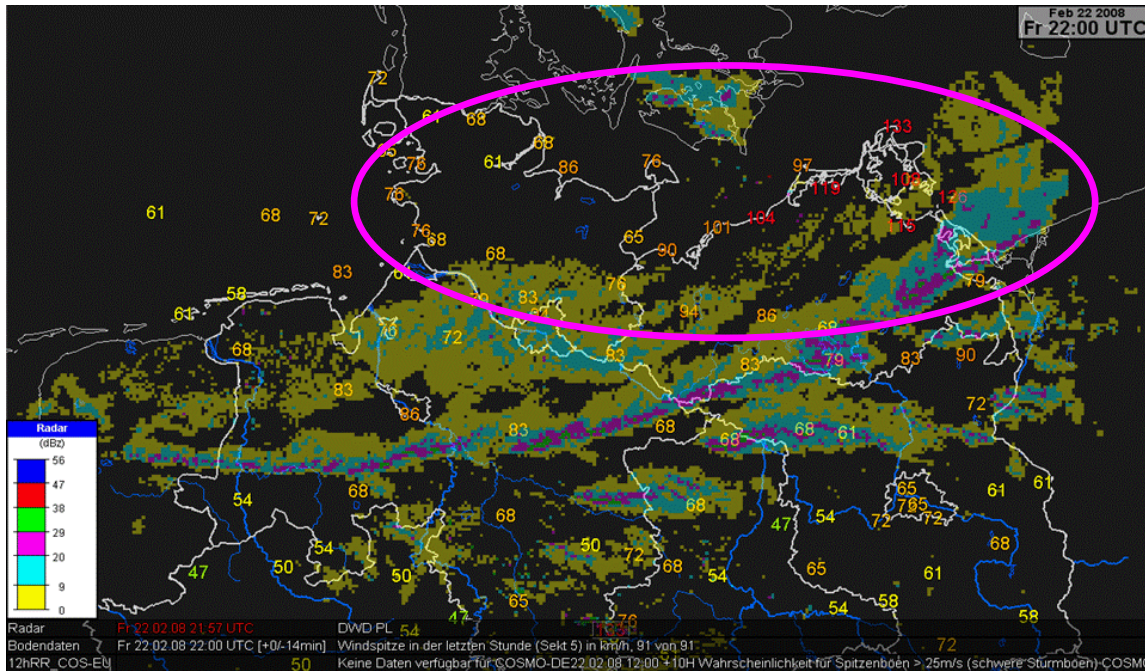
(1 year average)



“Prognostic snow scheme”
minus “Diagnostic snow scheme”

“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 $\alpha < 1$ when deep convection is active

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

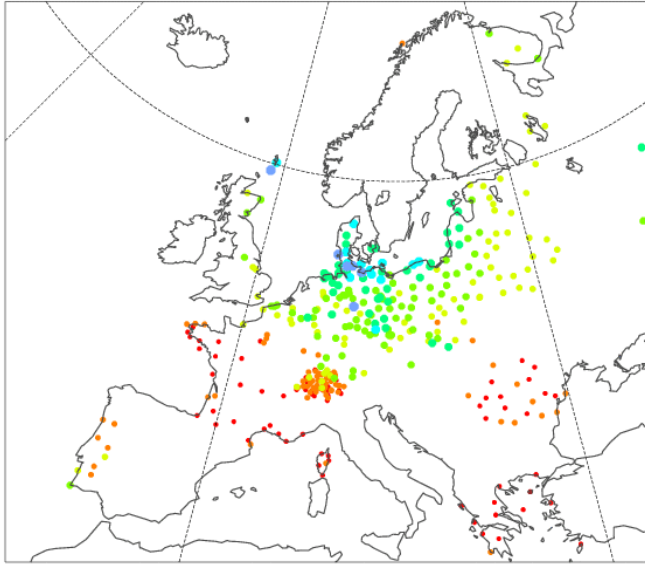
Other formulations trying to simulate cold pool gust fronts using downdraught W or evaporation have been unsuccessful (too large perturbations over Oceans and in Tropics)

Wind gusts

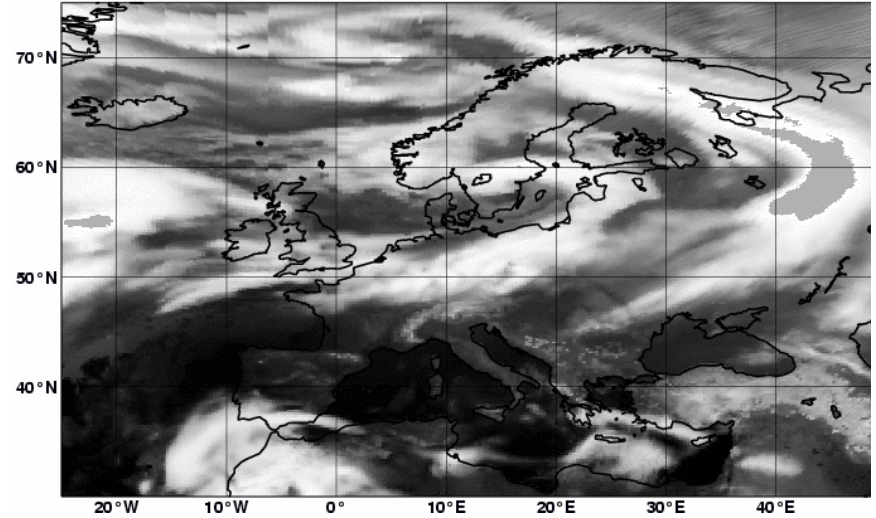
case 22 February 2008 continued

• 0-5 • 5-10 • 10-15 • 15-20 • 20-25 • 25-30 • 30-35 • 40-40

Obs

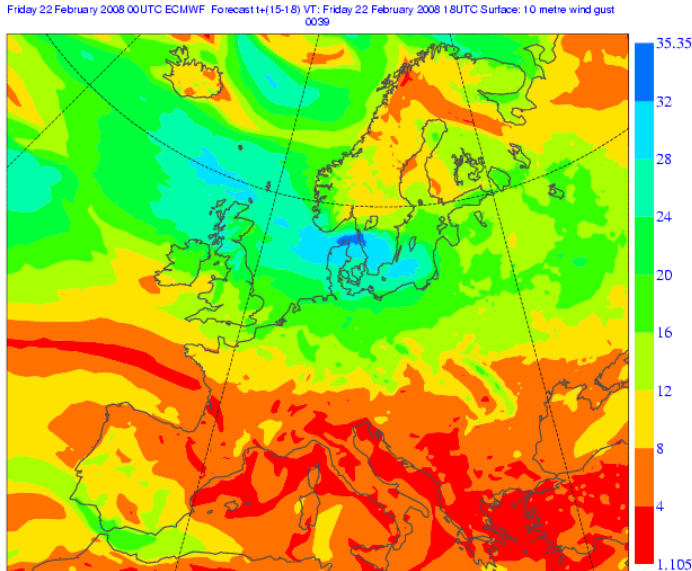


RTTOV gen. Meteosat 8 IR10.8 ECMWF Fc 20080222 00 UTC+18h

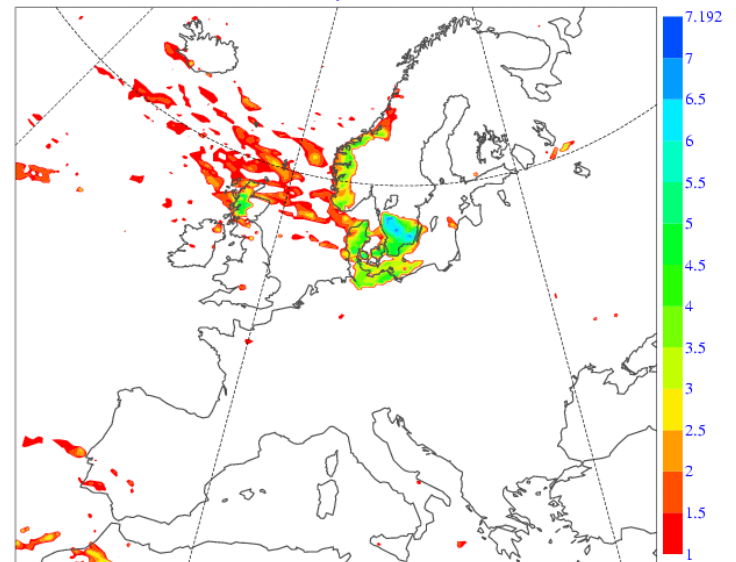


Friday 22 February 2008 00UTC ECMWF Forecast t+(15-18) VT: Friday 22 February 2008 18UTC Surface: **10 metre wind gust
10y1

Oper



Conv

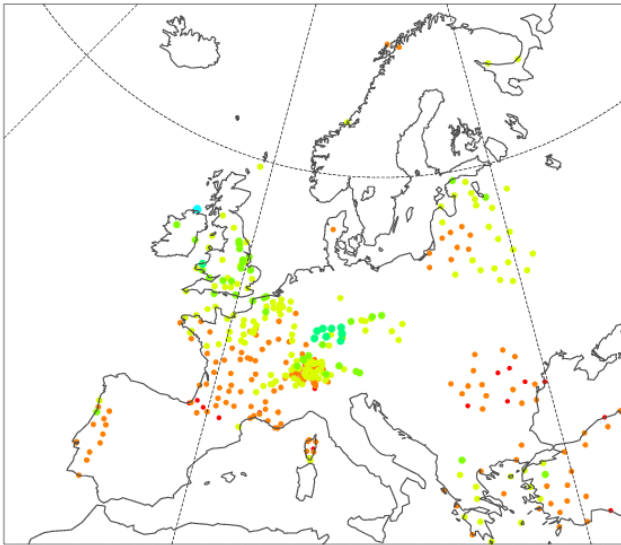


Wind gusts

summertime example 25 June 2008

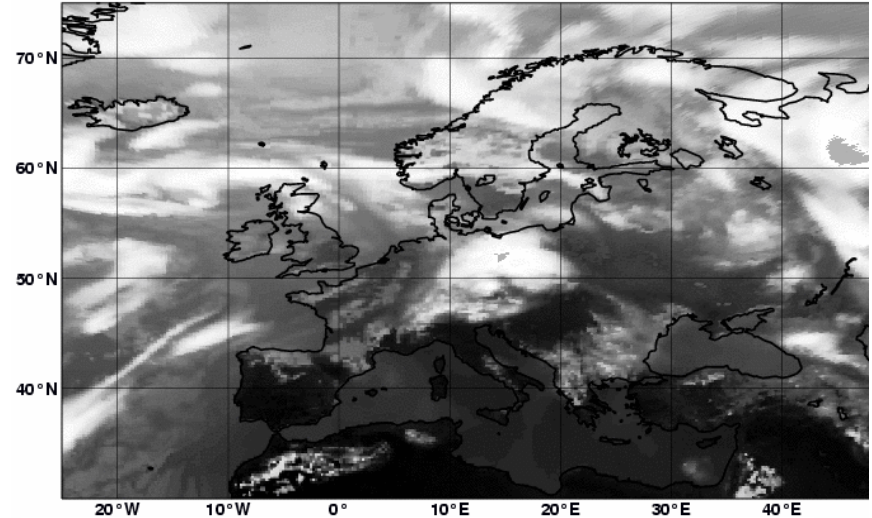
• 0 - 5 • 5 - 10 • 10 - 15 • 15 - 20 • 20 - 25 • 25 - 30 • 30 - 35 • 40 - 45

Obs



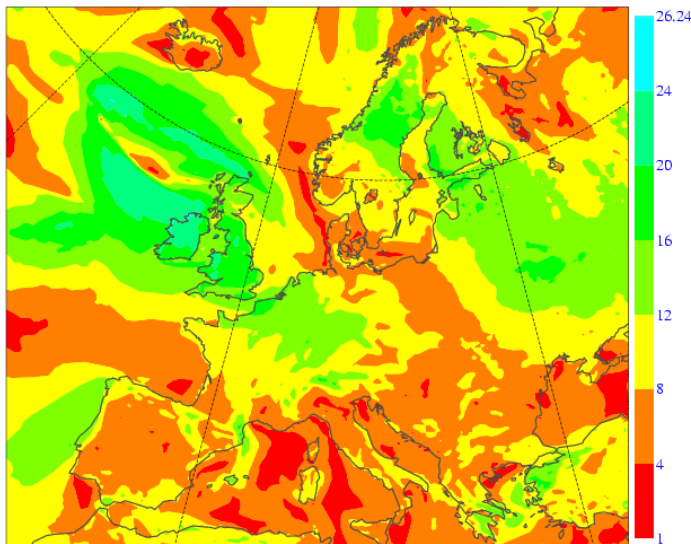
Wednesday 25 June 2008 00UTC ECMWF Forecast 1-(1-2-15) VT: Wednesday 25 June 2008 15UTC Surface: 10 metre wind gust 0001

RTTOV gen. Meteosat 8 IR10.8 ECMWF Fc 20080625 00 UTC+15h

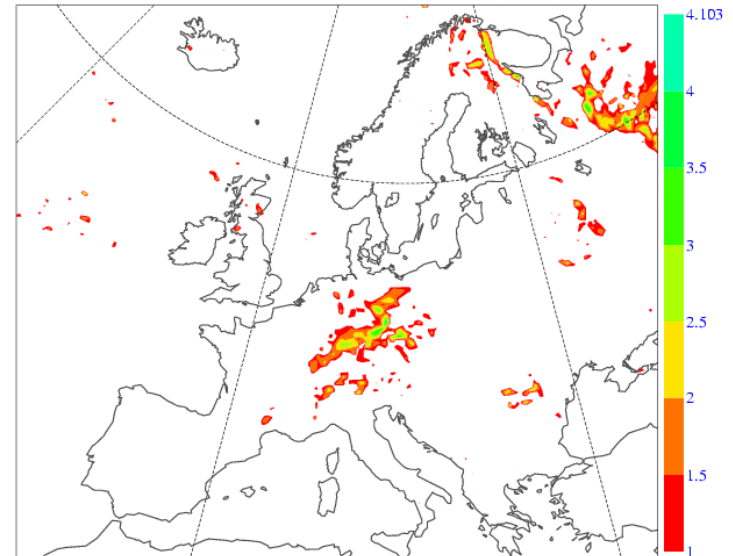


Wednesday 25 June 2008 00UTC ECMWF Forecast 1-(12-15) VT: Wednesday 25 June 2008 15UTC Surface: **10 metre wind gust convective gusts

Oper

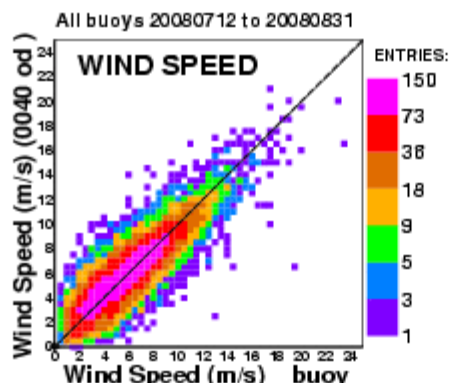


Conv



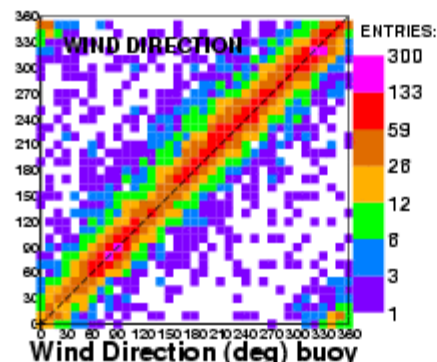
Wind 10m + gusts verif over Sea

Buoy verification



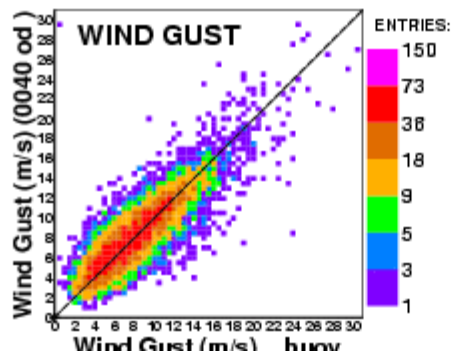
Comparison of to step 024 ECMWF wind speeds with height corrected averaged buoy data.

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



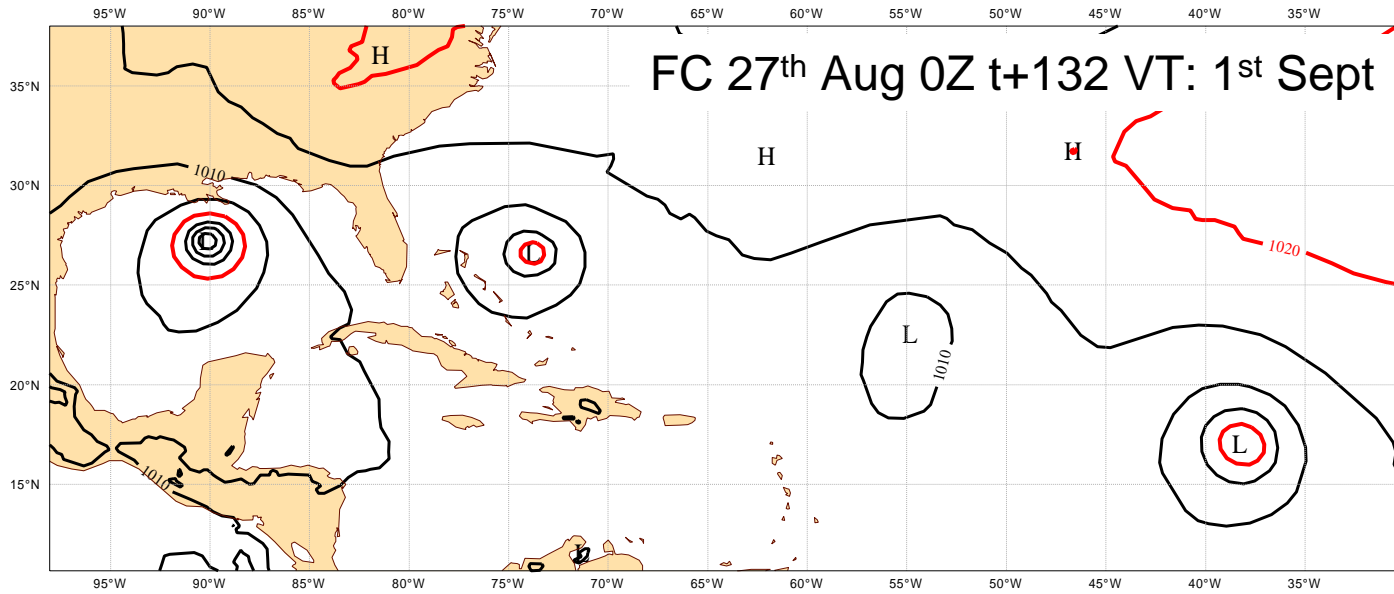
Comparison of to step 024 ECMWF wind direction with averaged buoy data.

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 = *****

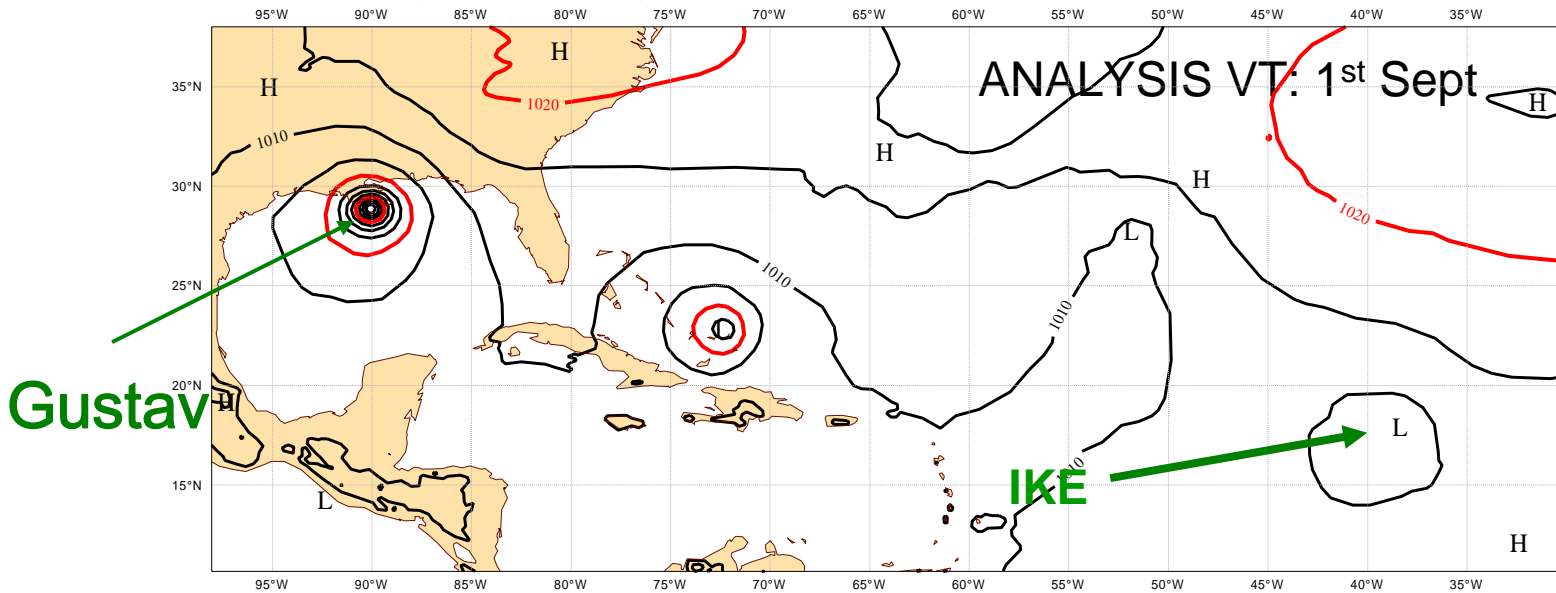


ENTRIES = 8251
 MODEL MEAN = 8.46 STDEV = 3.450
 BUOY MEAN = 8.41 STDEV = 3.632
 LSQ FIT: SLOPE = 0.808 INTR = 1.073
 RMSE = 1.946 BIAS = 0.057
 CORR COEF = 0.890 SI = 0.231
 SYMMETRIC SLOPE = 0.998

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

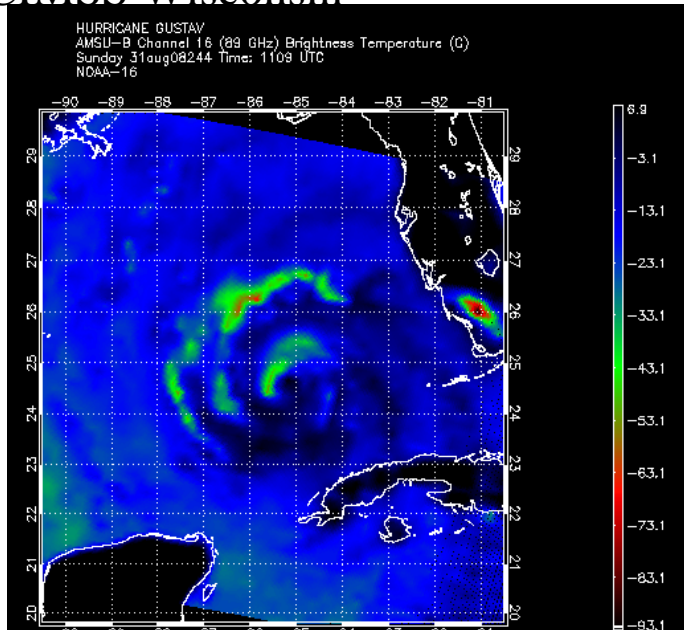


ECMWF Analysis VT: Monday 1 September 2008 12UTC Surface: Mean sea level pressure

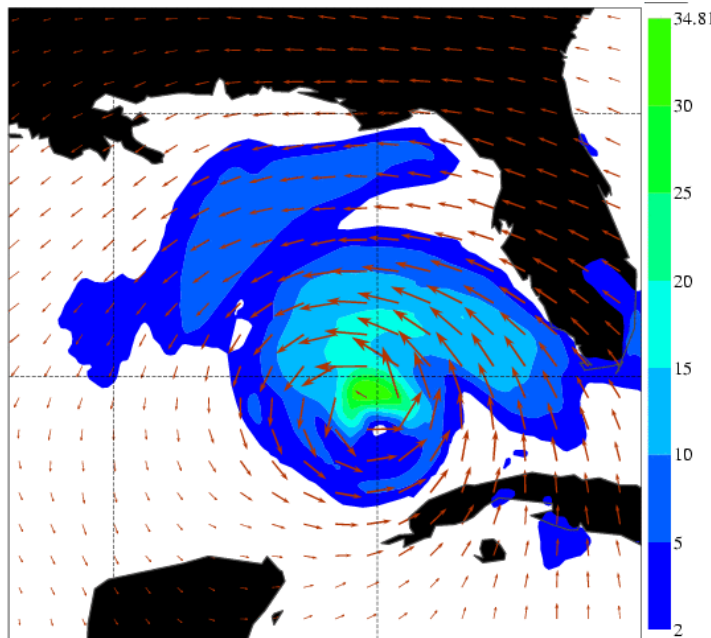
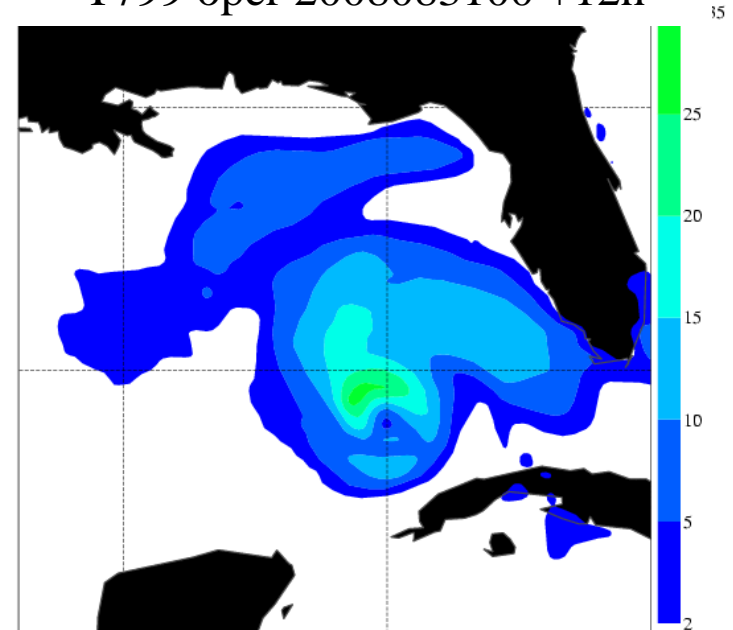


Hurricane Gustave AMSU-B and 9-12h rainfall

from CIMSS Wisconsin



T799 oper 2008083100 +12h

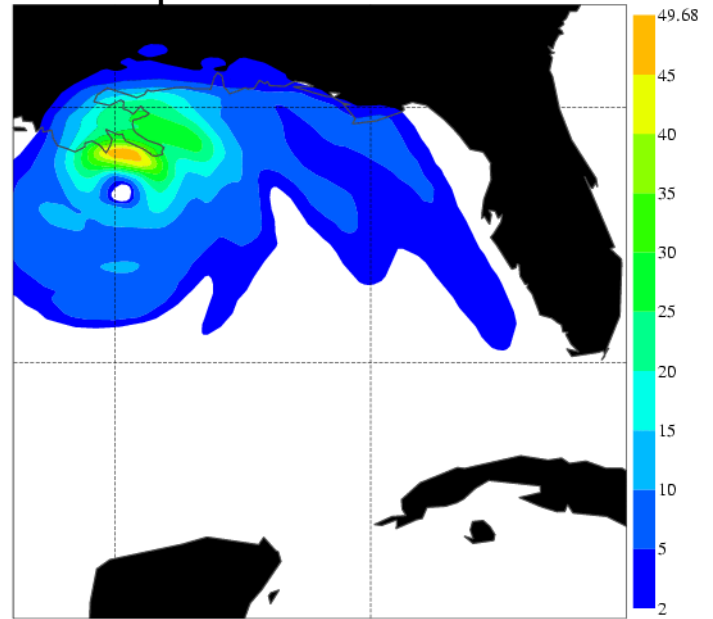
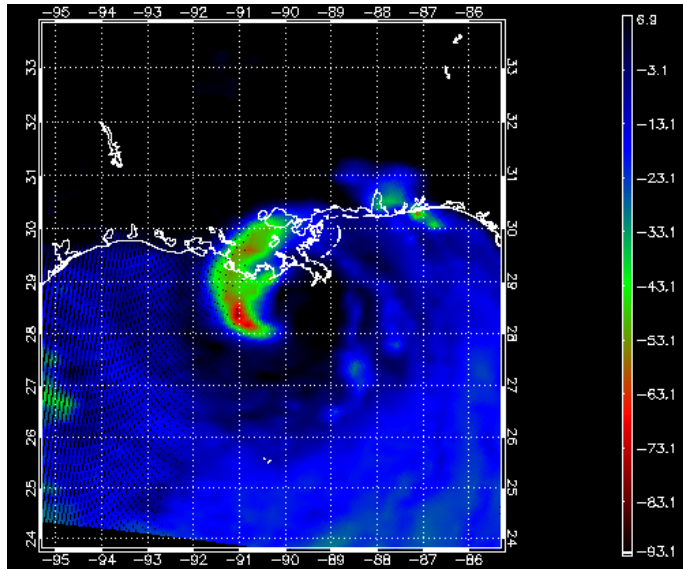


T1279 exper. forecast rain+wind 925hPa
without assimilation and wave model

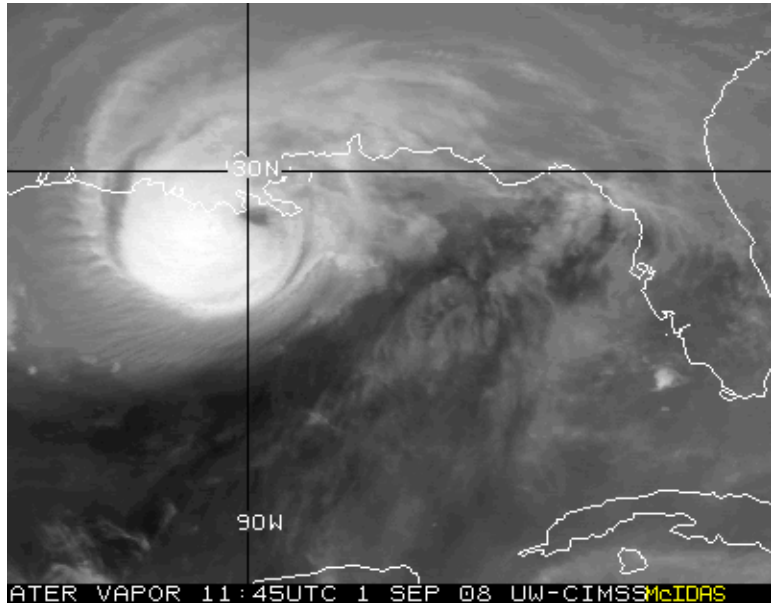
Also “visual” test for adjustment time

Hurricane Gustav AMSU-B and 33-36h rainfall

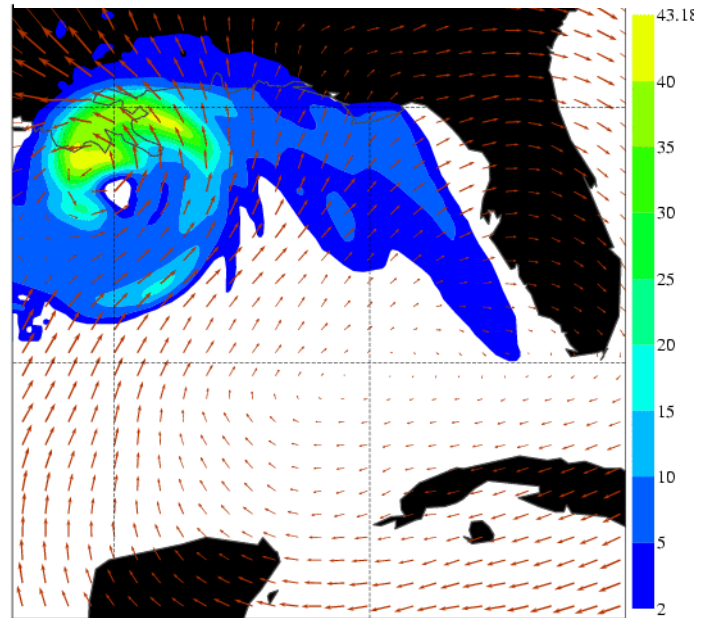
T799 oper 2008083100 +36h



from CIMSS Wisconsin

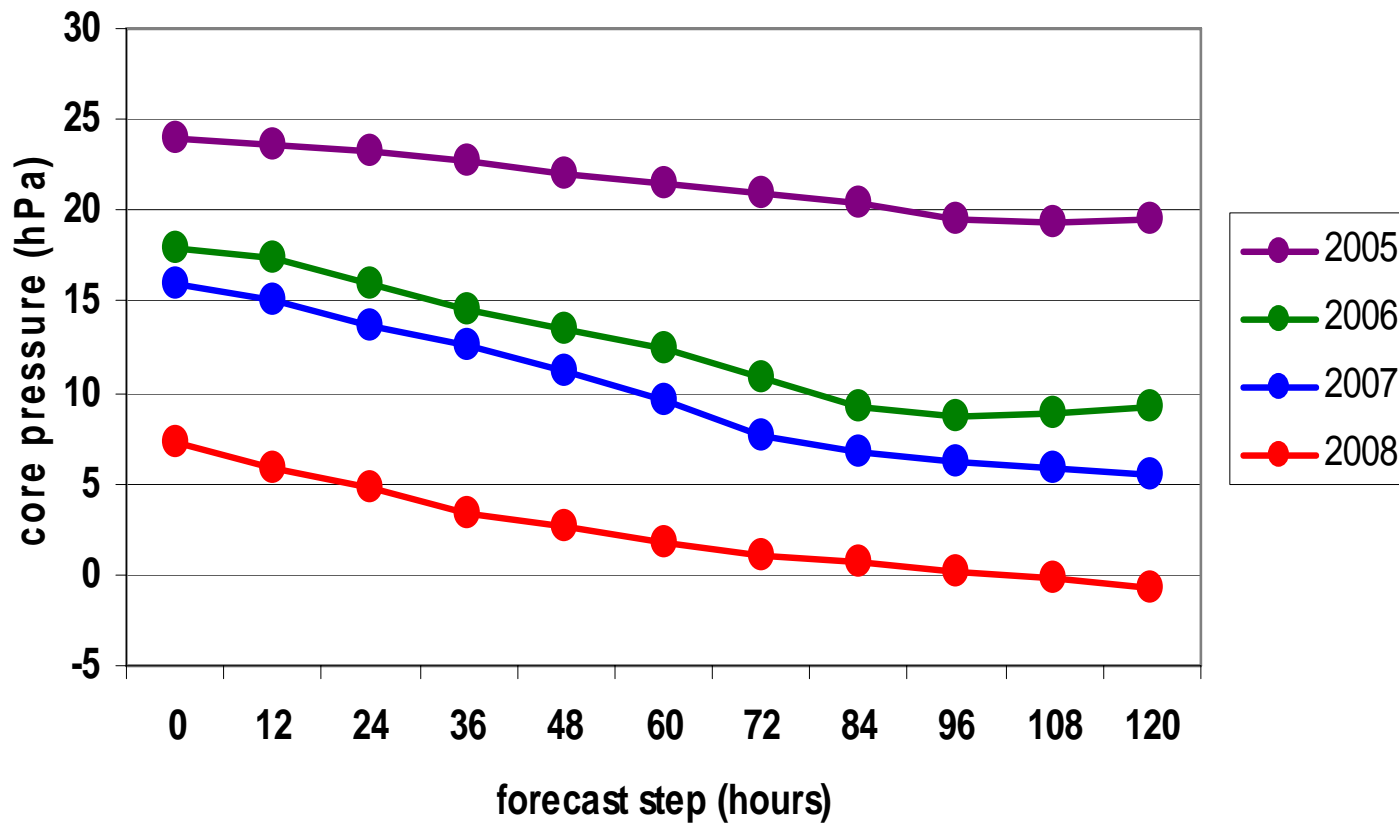


T1279 exper with 200hPa wind



Tropical Cyclone Intensity Error

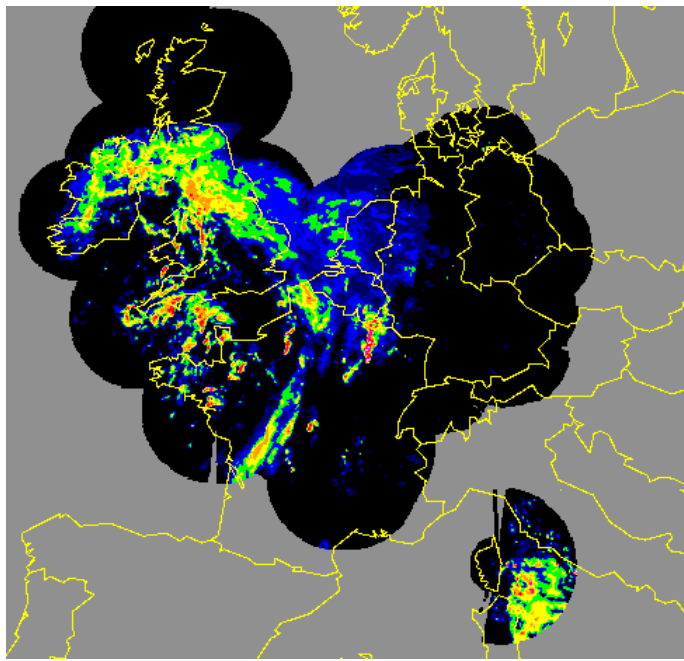
(mean of 365 days ending at 15 August)



Model 1h Rain shortrange Fcs

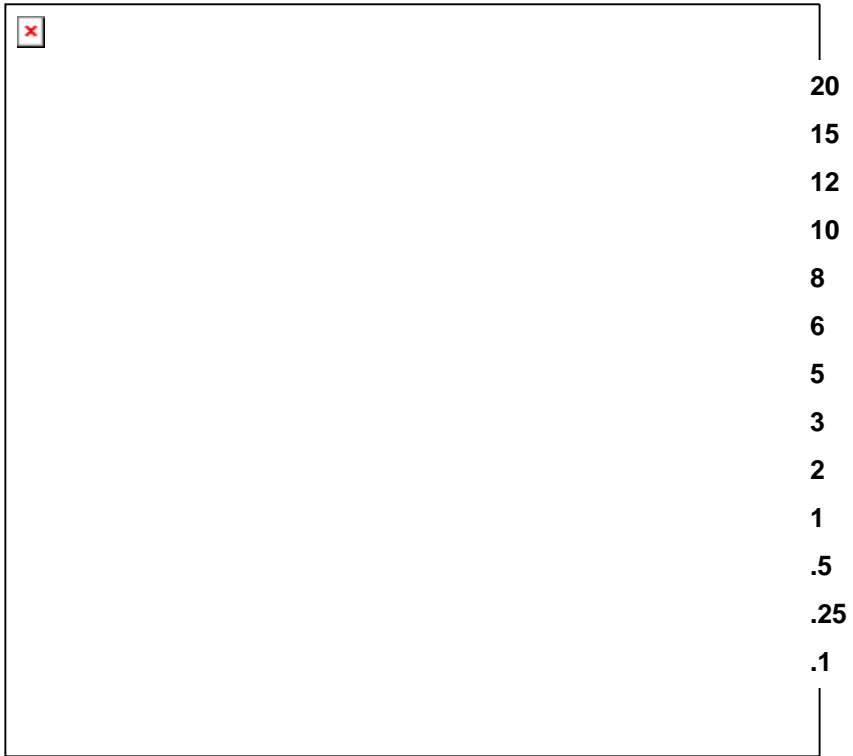
20080905
15UTC

T799



Radar

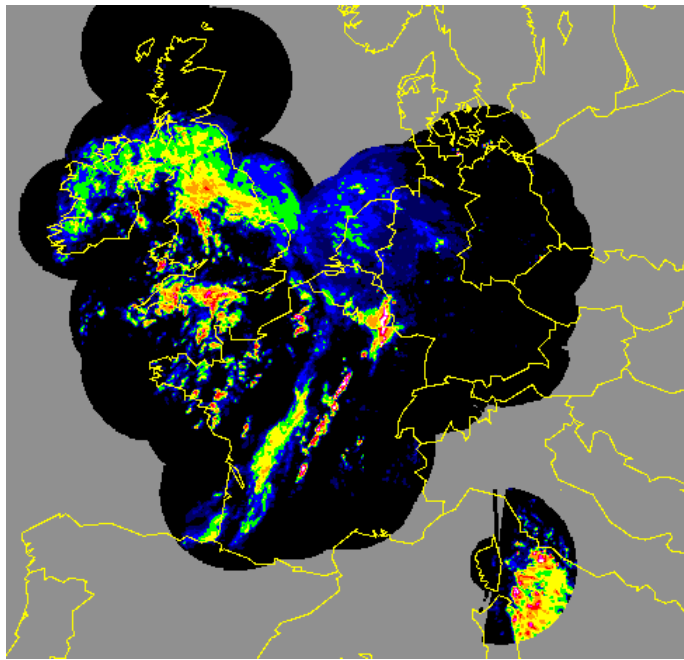
T1279



Model 1h Rain shortrange Fcs

20080905
16UTC

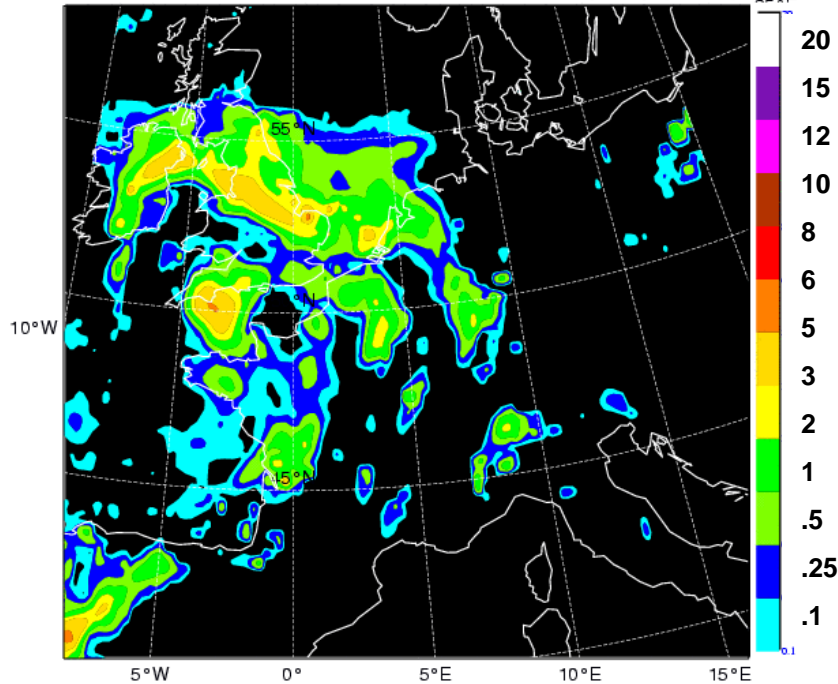
T799



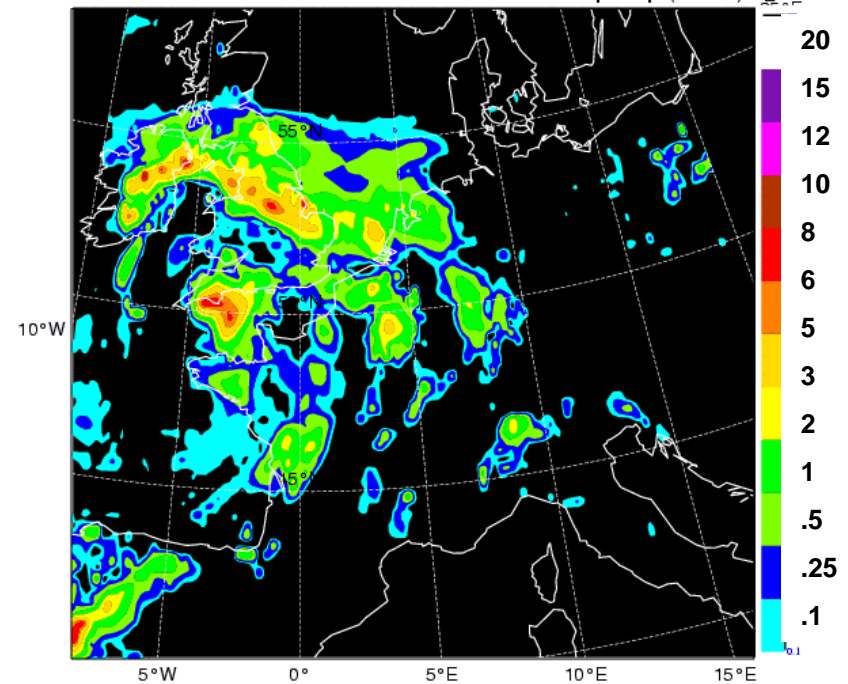
Radar

T1279

ECMWF Forecast 20080905 12 UTC +4h total precip (mm/h) °E



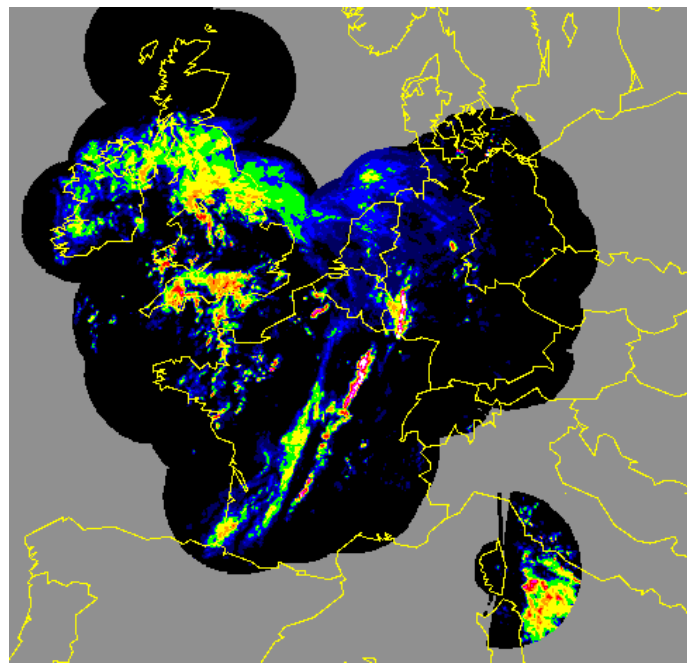
ECMWF Forecast 20080905 12 UTC +4h total precip (mm/h) °E



Model 1h Rain shortrange Fcs

20080905
17UTC

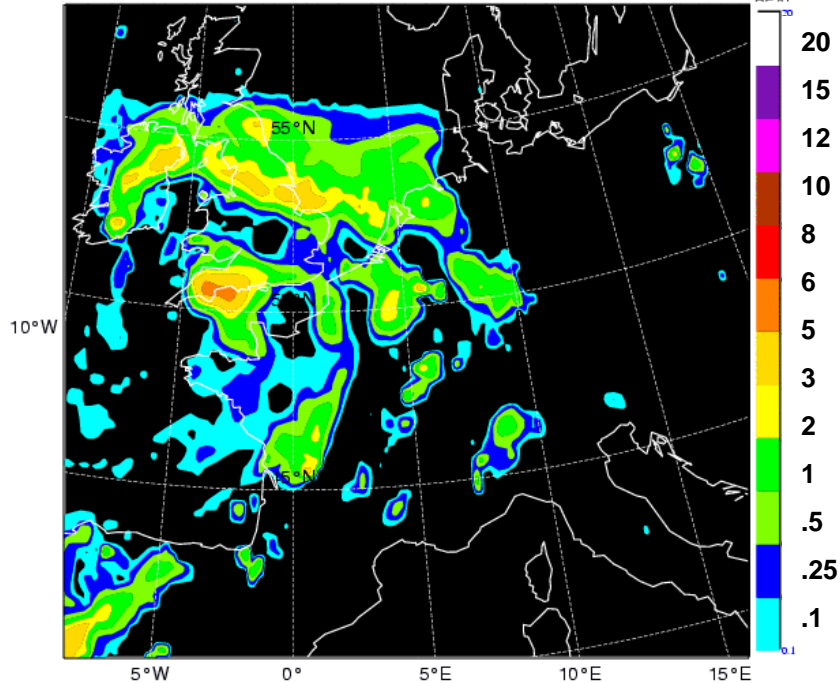
T799



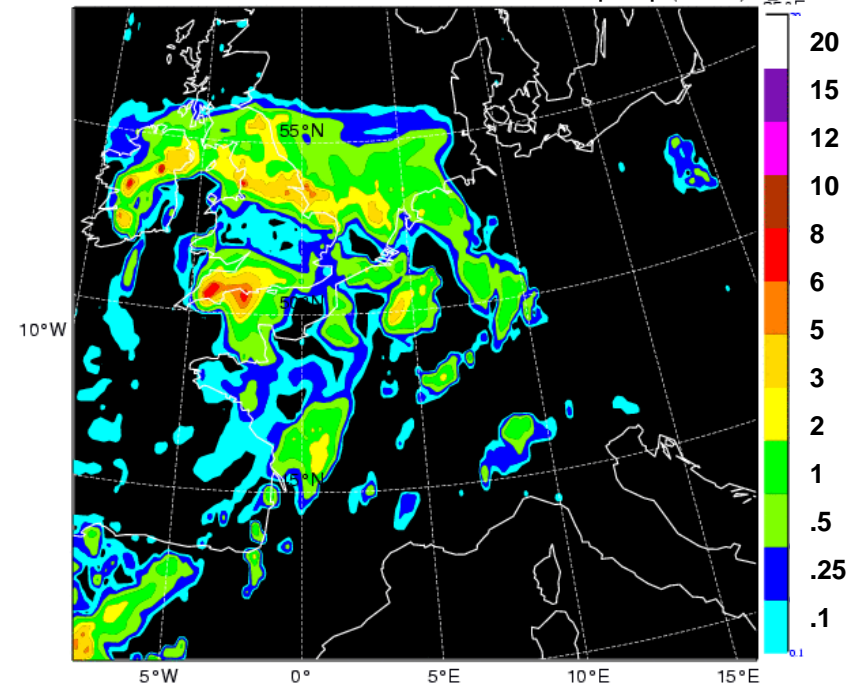
Radar

T1279

ECMWF Forecast 20080905 12 UTC +5h total precip (mm/h) °E



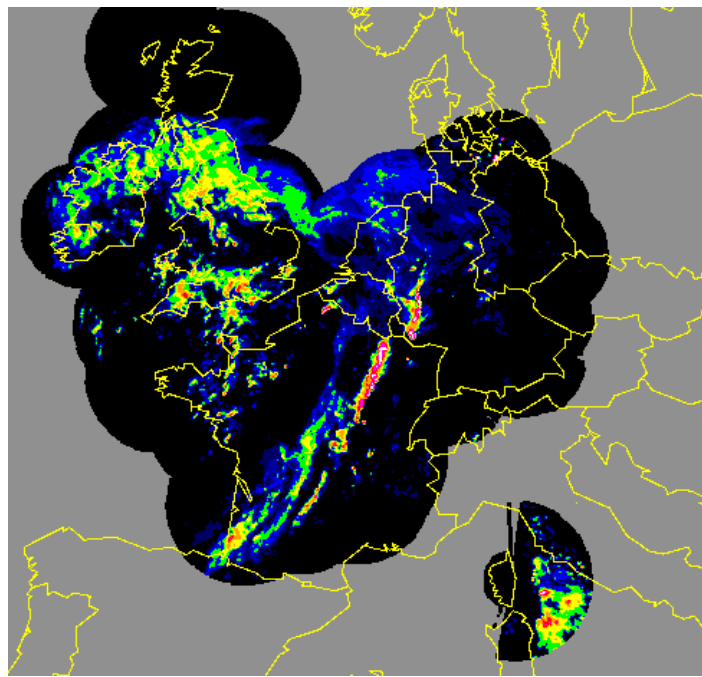
ECMWF Forecast 20080905 12 UTC +5h total precip (mm/h) °E



Model 1h Rain shortrange Fcs

20080905
18UTC

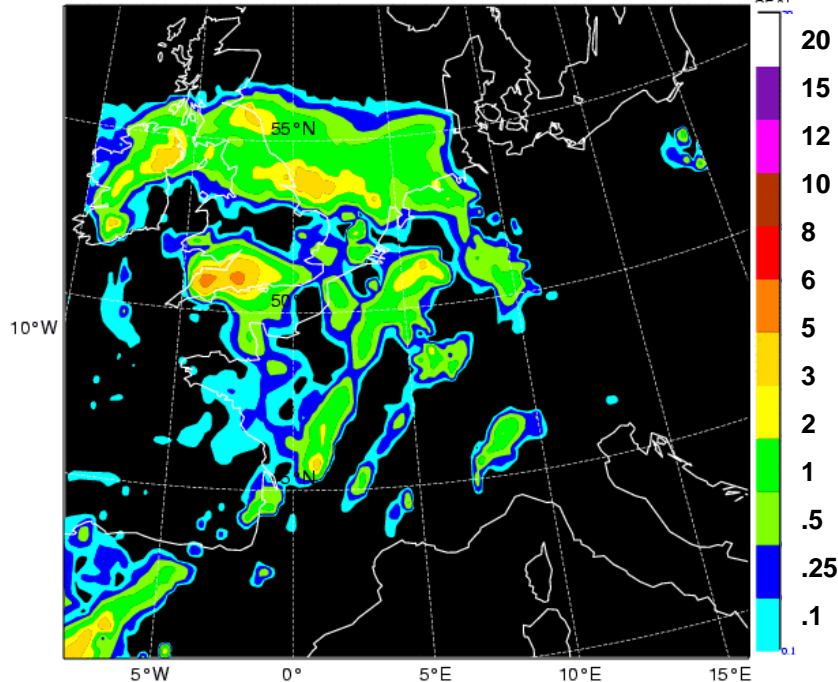
T799



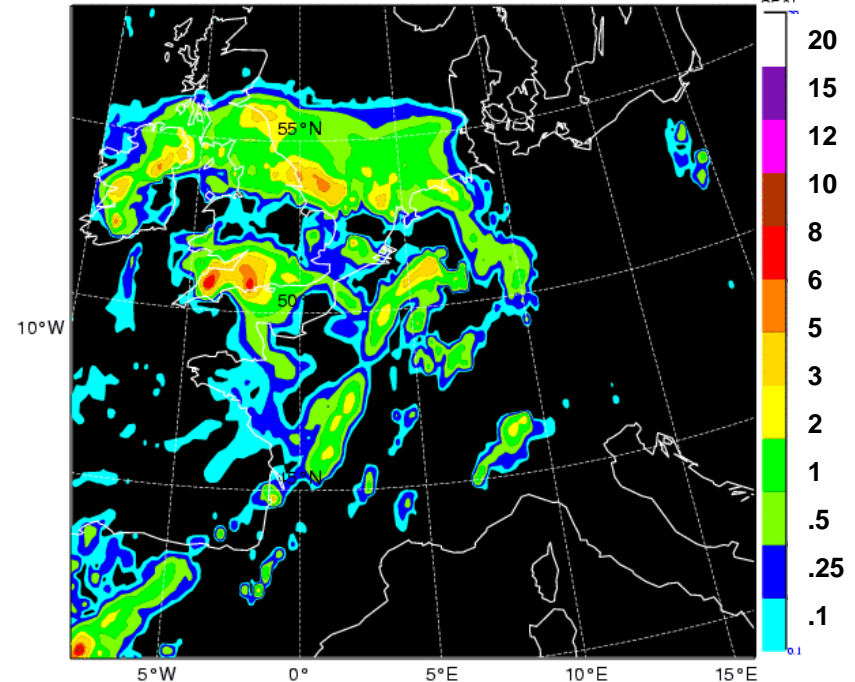
Radar

T1279

ECMWF Forecast 20080905 12 UTC +6h total precip (mm/h) °E



ECMWF Forecast 20080905 12 UTC +6h total precip (mm/h) °E



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 possibly resolve deficiencies in IFS related to these issues.

Realisation:

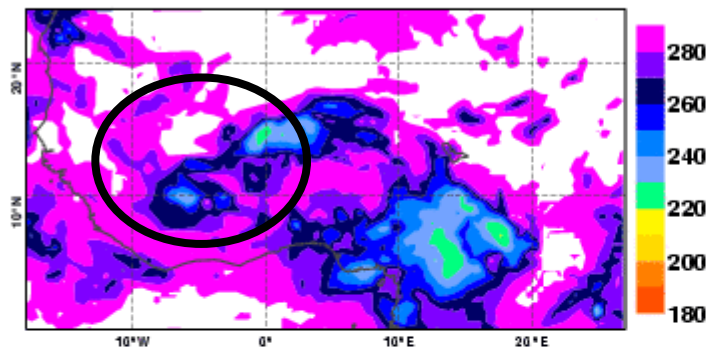
- Use the Meso-nh model in collaboration with J.P Chaboureau
- Focus on large mesoscale systems during AMMA using AMMA (Anna) reanalyses
- currently CRM resolution is set to 5 km, IFS is run at T511 (40 km) like Reanalysis, and first T1279 (15 km) forecasts are under way

Ex of AMMA easterly wave case 36h

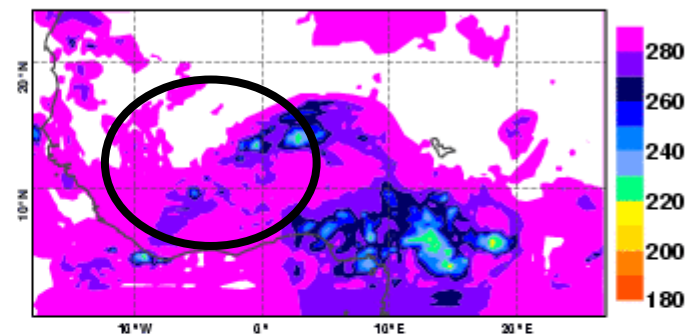
verification of convective systems using BTs 10.8μ

All images interpolated to T511 grid

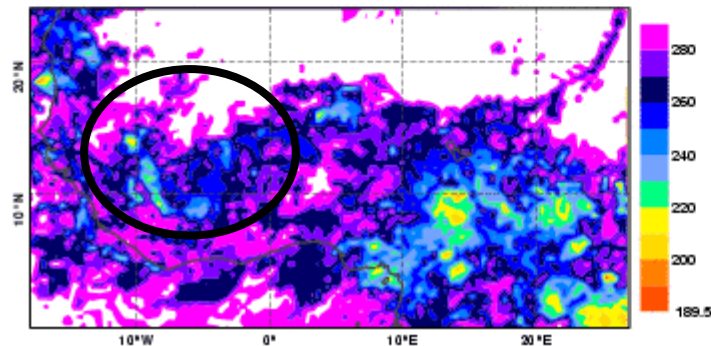
Satsim IFS 10.8m 2006090900 +6h



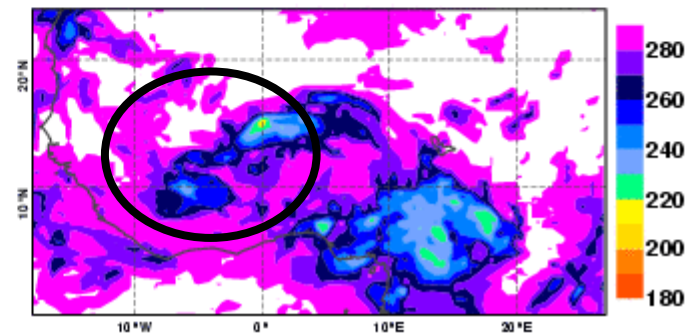
Satsim MNH 10.8m 2006090900 +6h



Meteosat 8 10.8m 20060909 06 UTC



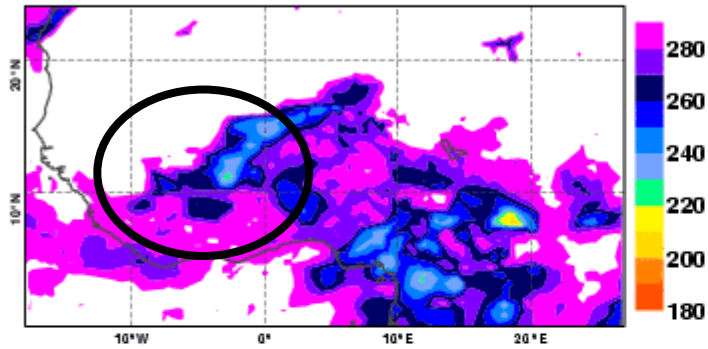
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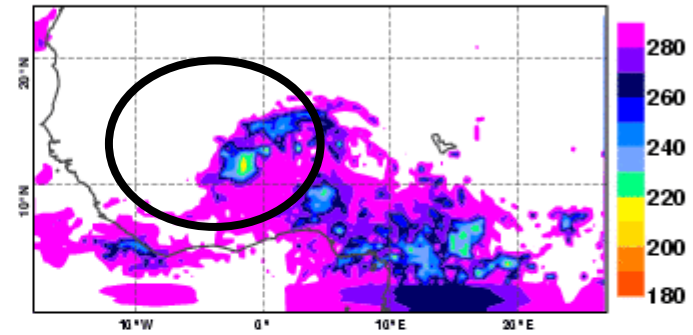
AMMA easterly wave case

verification of convective systems using BTs 10.8μ

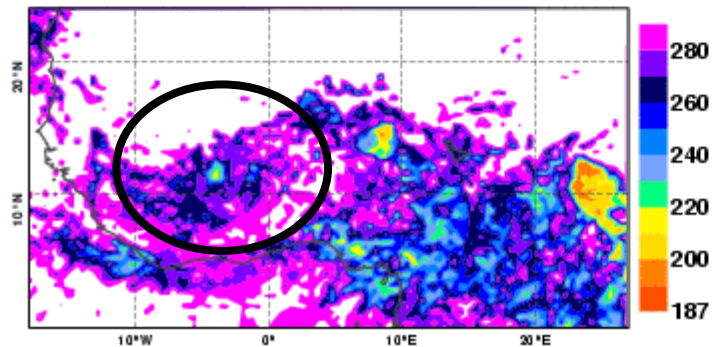
Satsim IFS 10.8m 2006090900 +12h



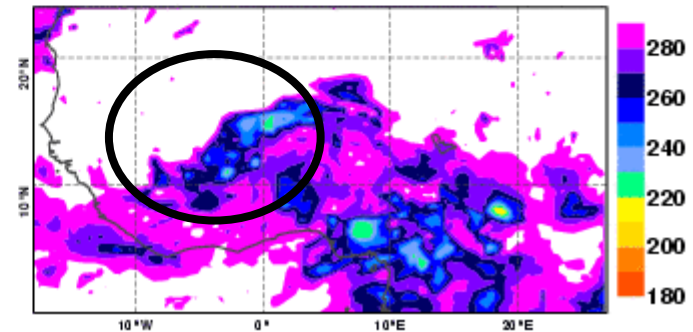
Satsim MNH 10.8m 2006090900 +12h



Meteosat 8 10.8m 20060909 12 UTC



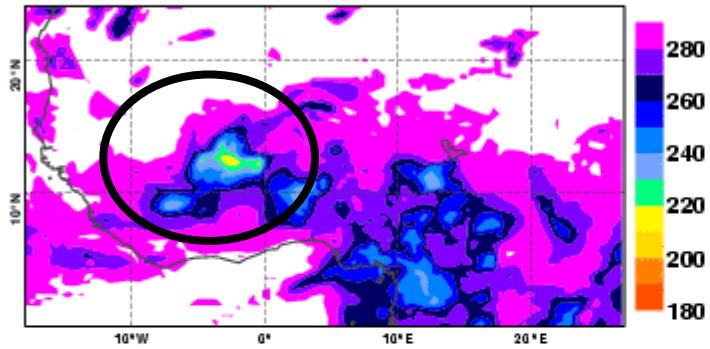
Satsim IFS T1279 10.8m 2006090900 +12h



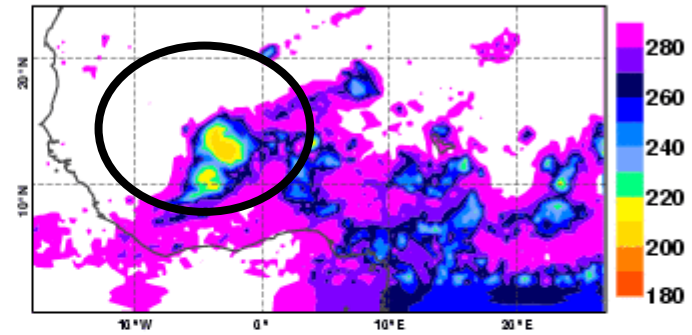
AMMA easterly wave case

verification of convective systems using BTs 10.8μ

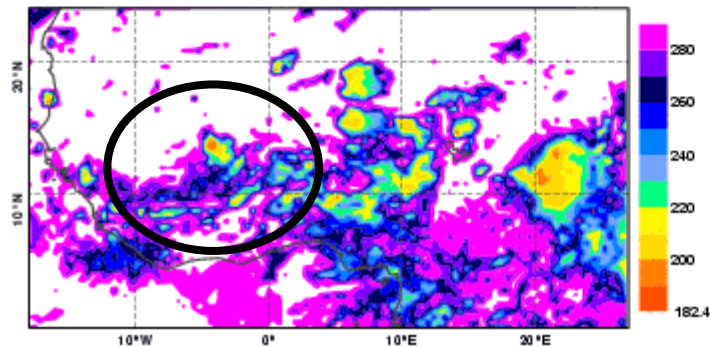
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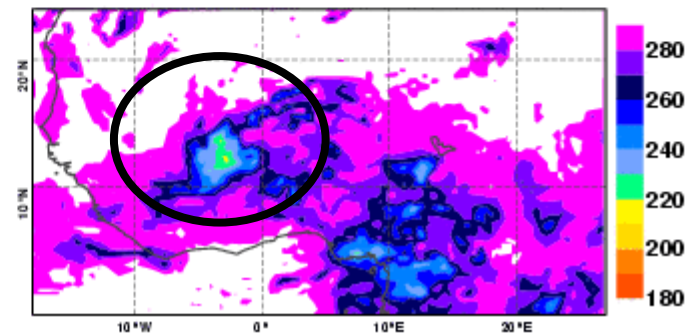
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Meteosat 8 10.8m 20060909 18 UTC



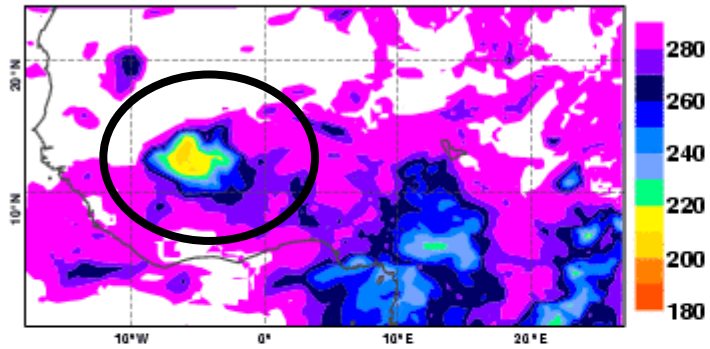
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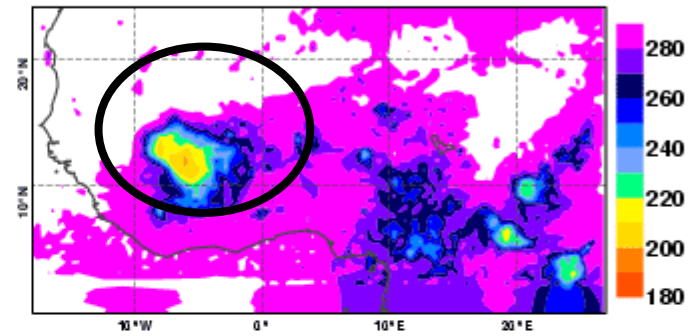
AMMA easterly wave case

verification of convective systems using BTs 10.8μ

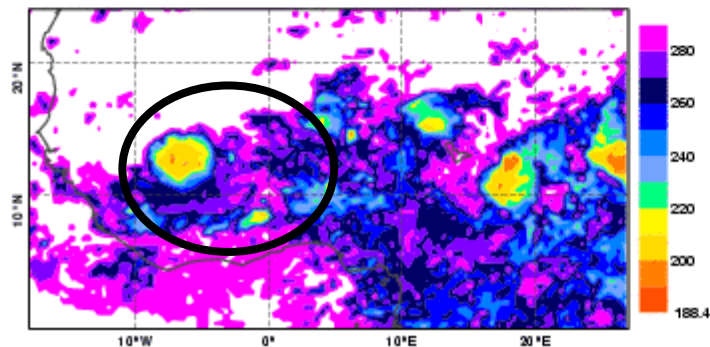
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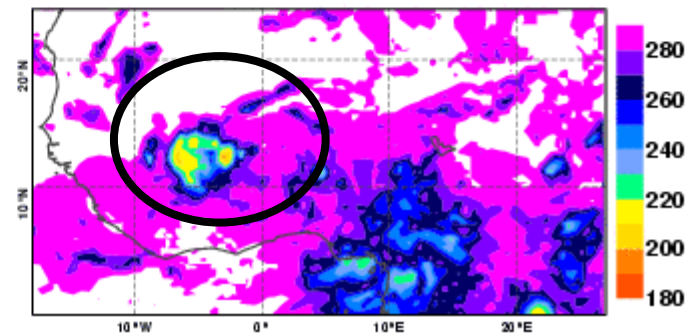
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Meteosat 8 10.8m 20060910 00 UTC



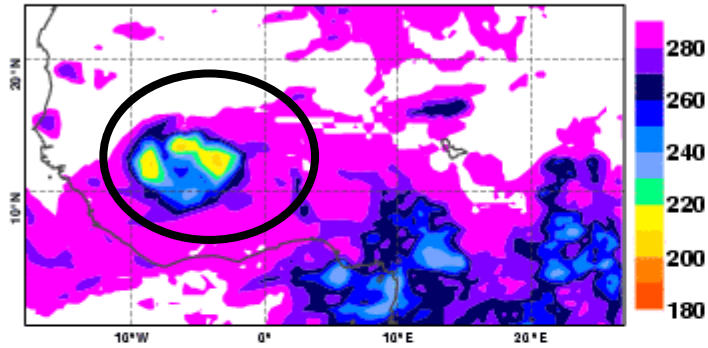
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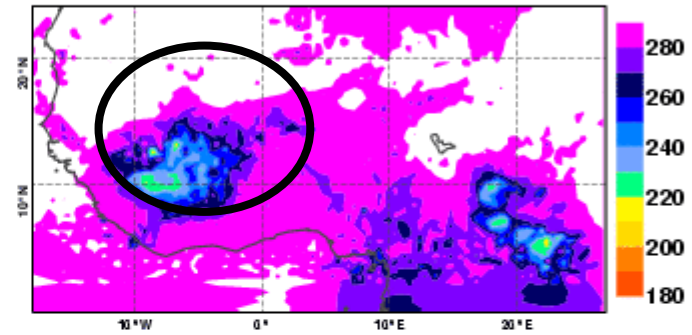
AMMA easterly wave case

verification of convective systems using BTs 10.8μ

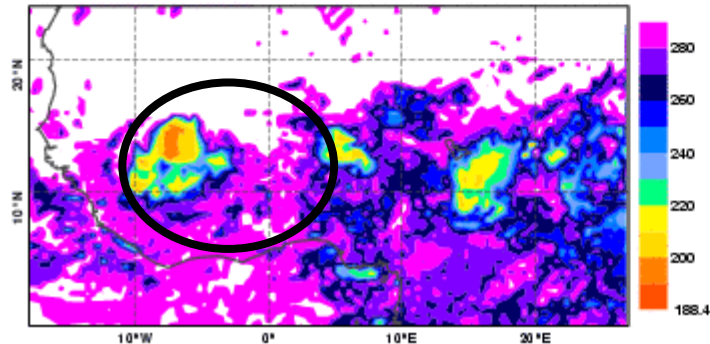
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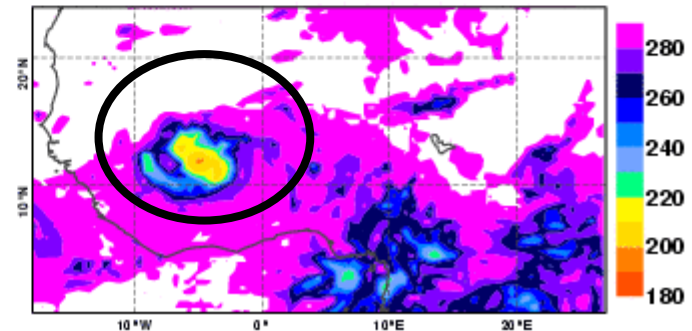
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Meteosat 8 10.8m 20060910 06 UTC



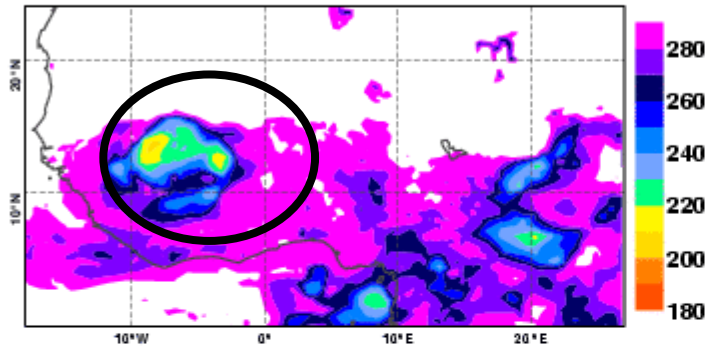
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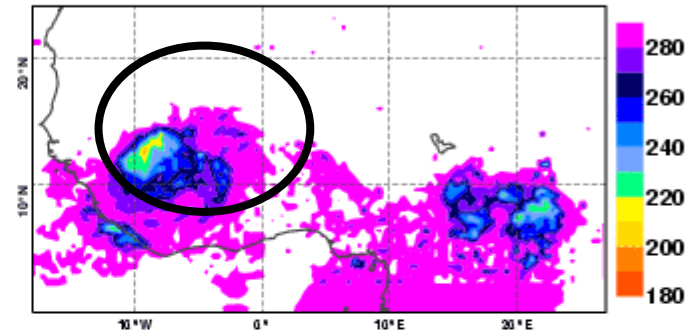
AMMA easterly wave case

verification of convective systems using BTs 10.8μ

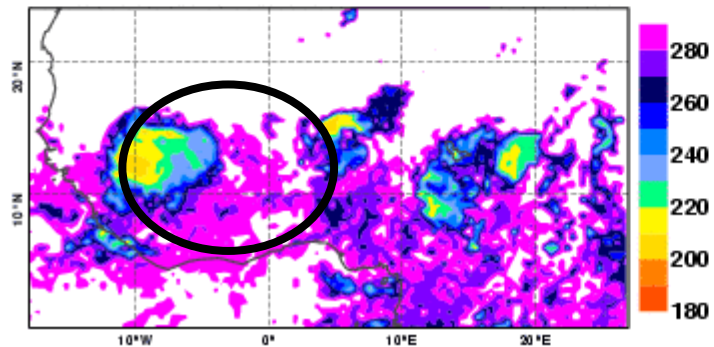
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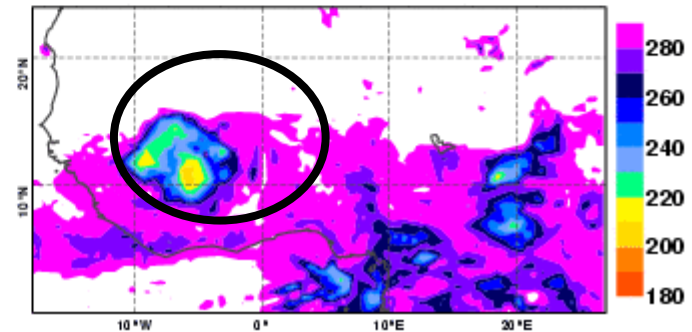
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Meteosat 8 10.8m 20060910 12 UTC



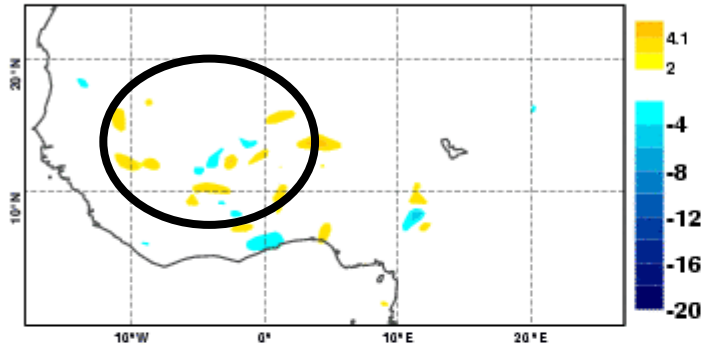
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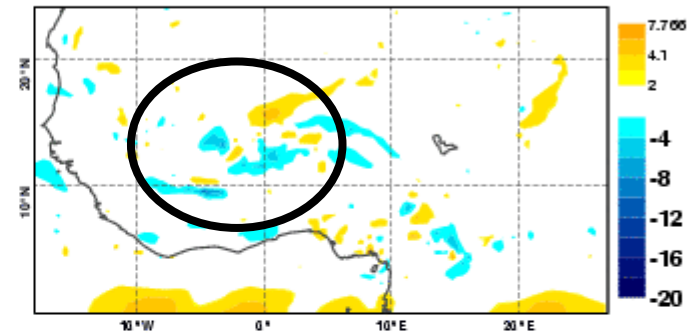
AMMA easterly wave case verification of 925 T

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

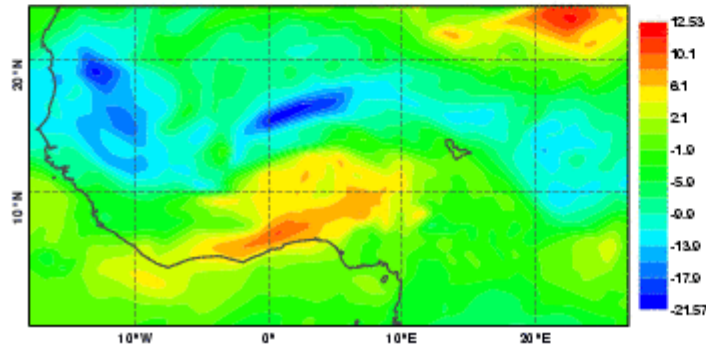
Diff IFS-Ana U (m/s) 20060909 6 700 hPa



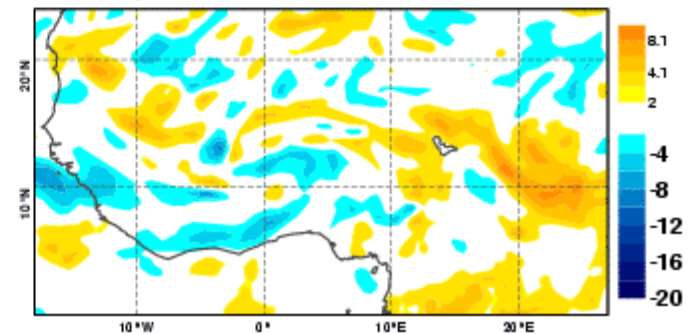
Diff MNH-Ana U (m/s) 2006090900 +6h 700 hPa



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



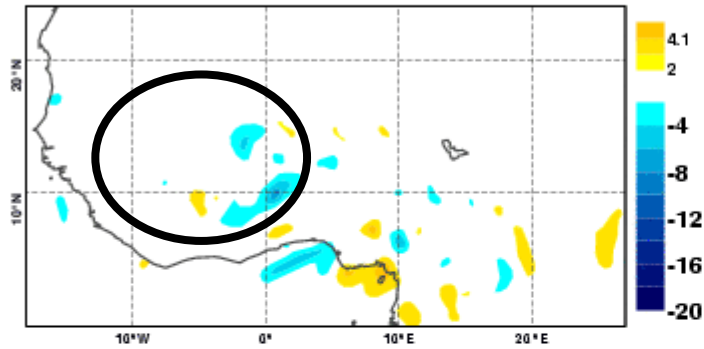
Diff AnaOp - ReAna U (m/s) 20060909 06 UTC 700 hPa



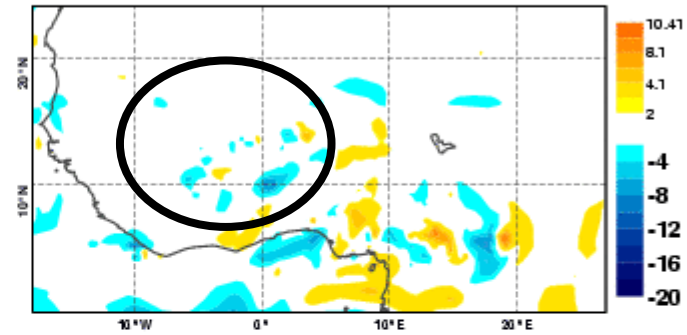
AMMA easterly wave case verification of 200hPa U

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

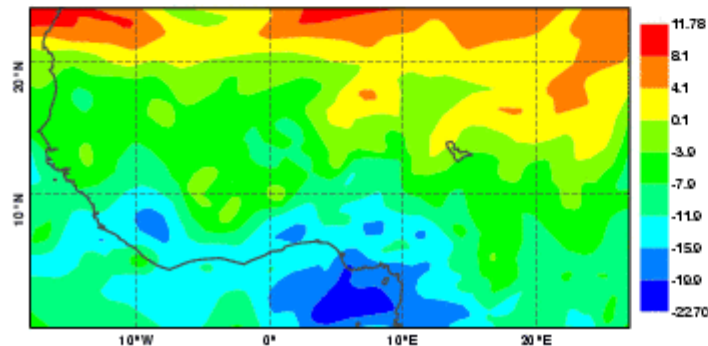
Diff IFS-Ana U (m/s) 20060909 6 200 hPa



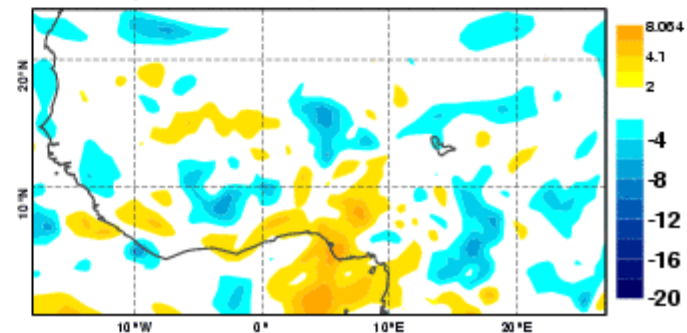
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Ana U (m/s) 20060909 06 UTC 200 hPa



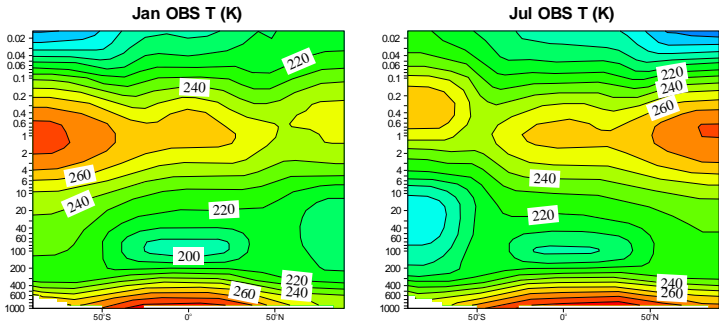
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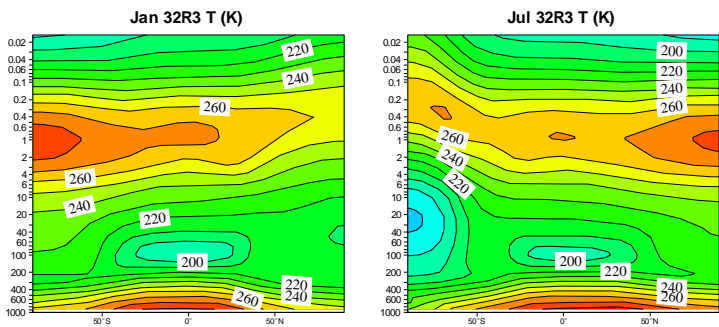
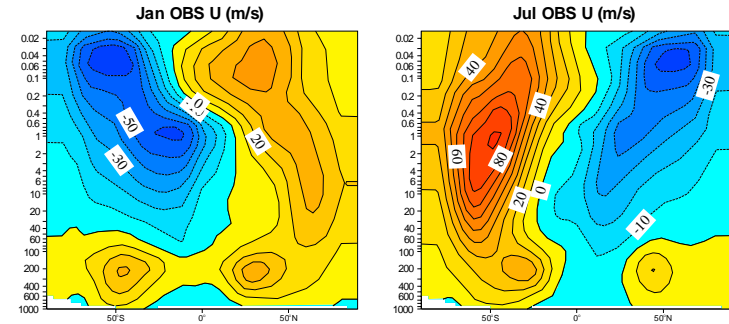
Preliminary statements

- 4 periods of 48h have been 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

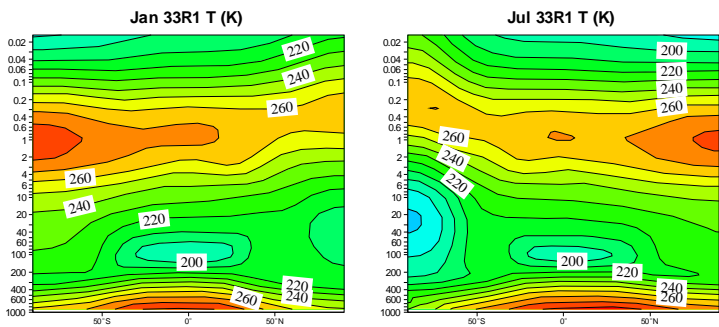
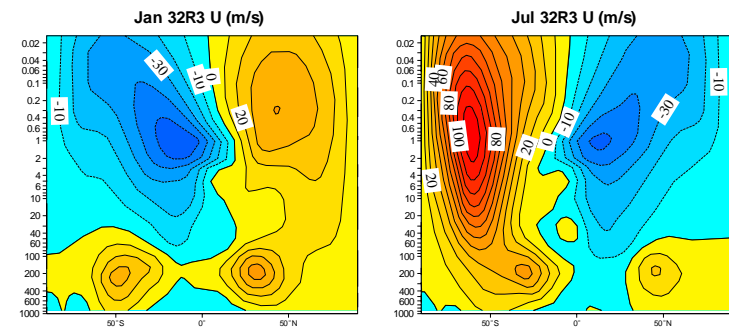
The ECMWF middle atmosphere climate and the
parameterization of non-orographic gravity waves
by A. Orr +A. Untch +N.Wedi



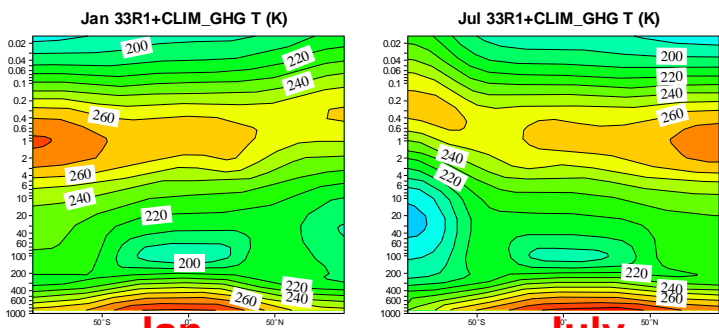
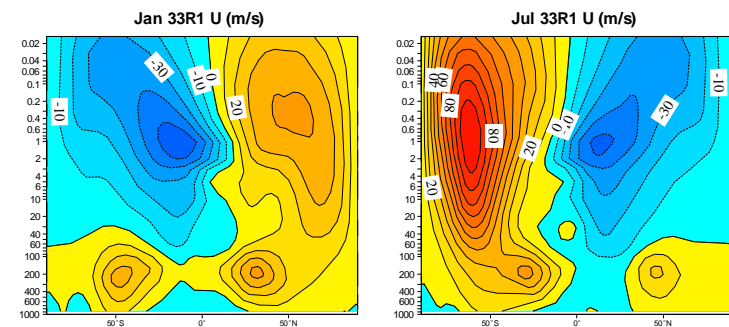
SPARC observed climatology



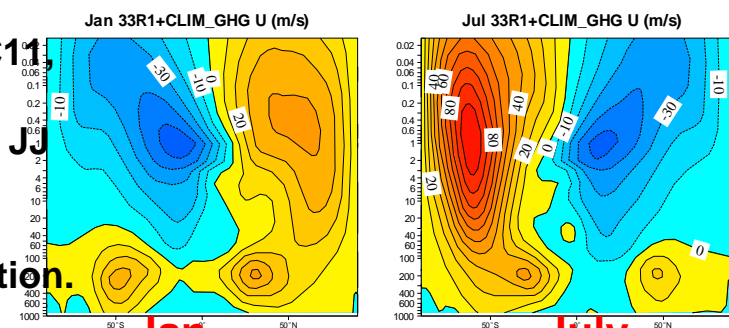
**32R3
NH planetary wave activity over-estimated (Bechtold et al. 2008)**



**33R1
NH planetary wave activity better, but still biases**



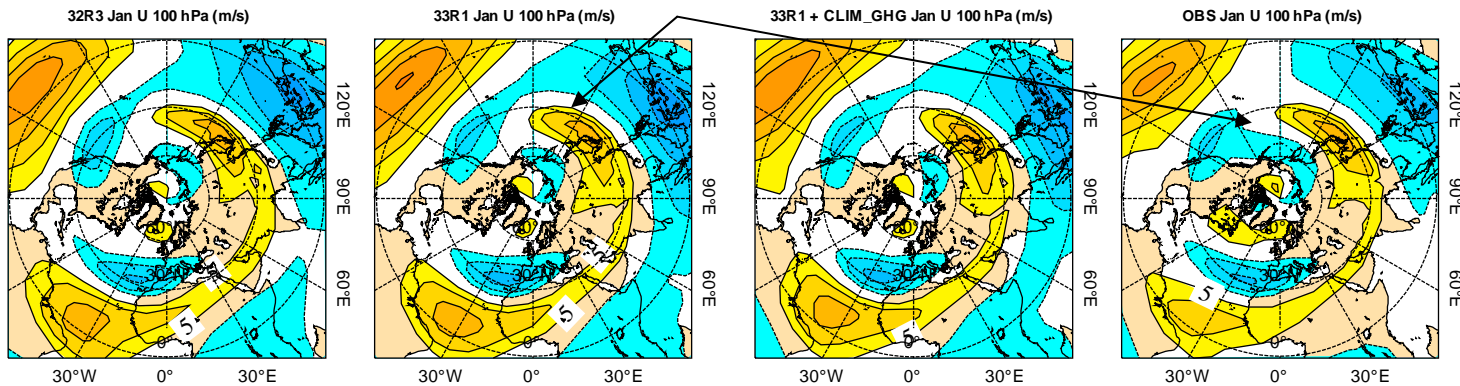
33R1 + improved GHG (O3, CO2, CH4, N2O, CFC11, CFC12, CFC22, CC14) climatology (D. Cariolle, J. Morcrette, A Untch) Towards realistic temperature and circulation.



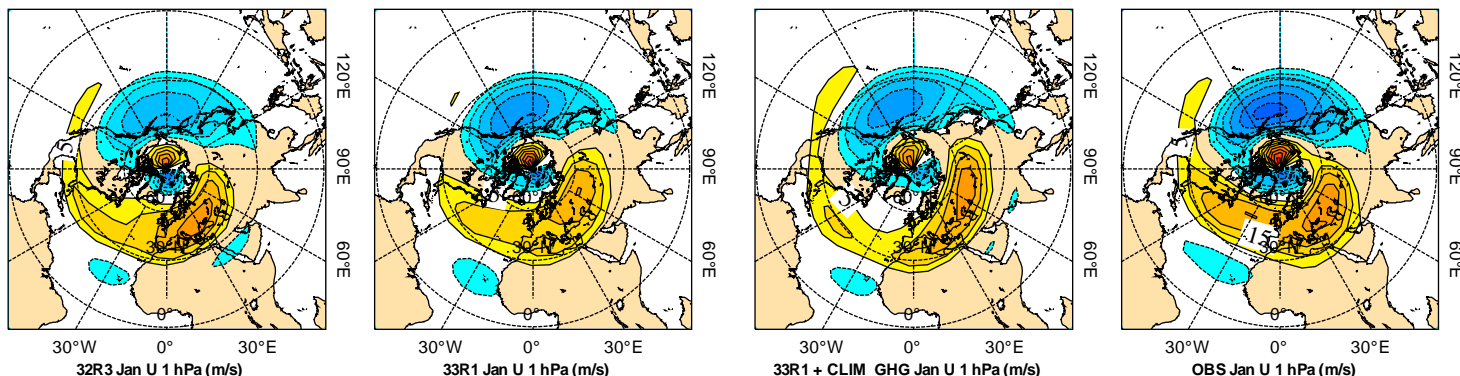
Jan July
Mean January and July zonal-mean temperature and zonal wind for observations (top), 32R3 (second top), 33R1 (third top), and 33R1 + CLIM_GHG (lower). Simulations are 8-year (1994-2001) averages.

Good agreement between 33R1 and observations

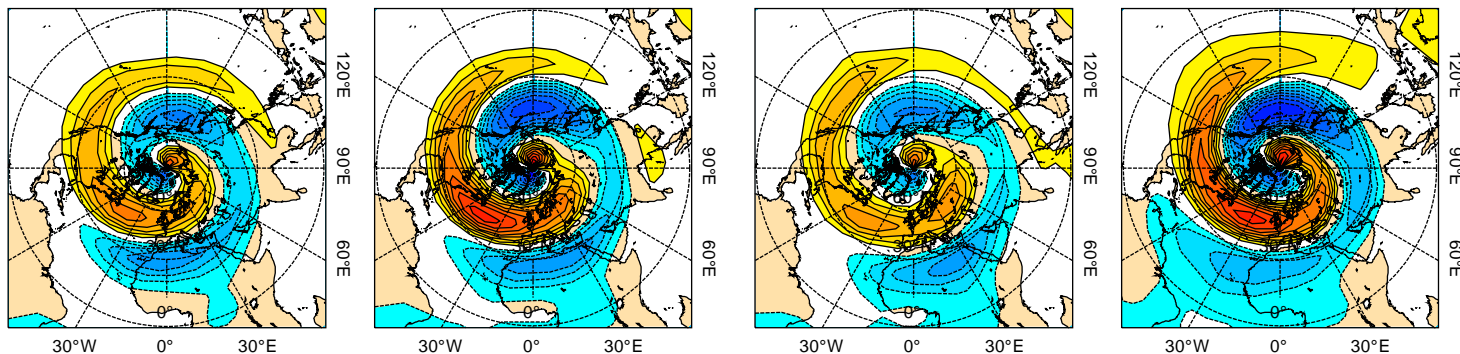
100 hPa



10 hPa



1 hPa



32R3

33R1

33R1+CLIM_GHG

OBS

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

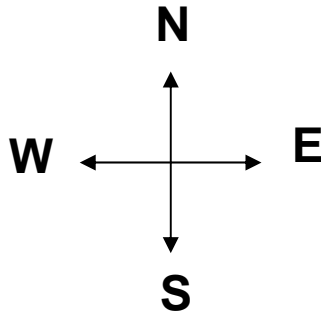
Consist of spectrum of waves via hydrostatic non-rotational dispersion relation

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

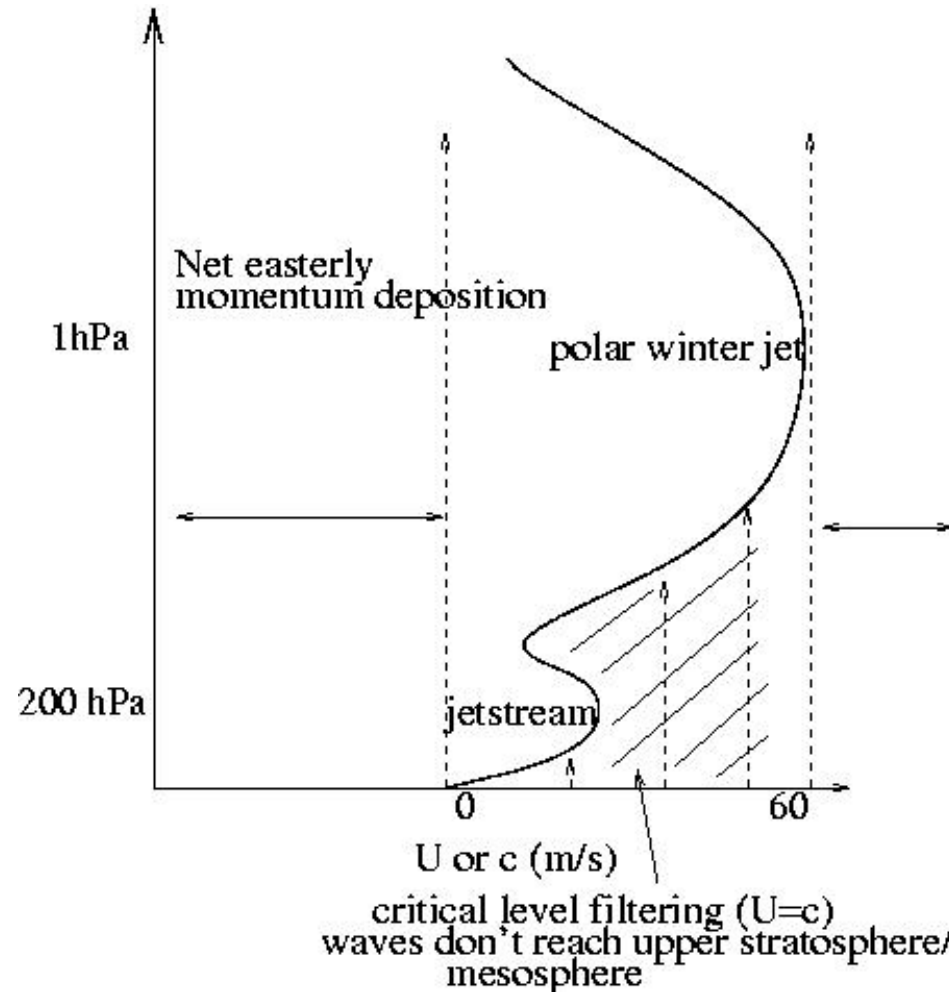
$$m = \frac{2\pi}{\lambda_z}; k = \frac{2\pi}{\lambda_h}; \tilde{\omega} = \omega - kU; \tilde{c} = c - U$$

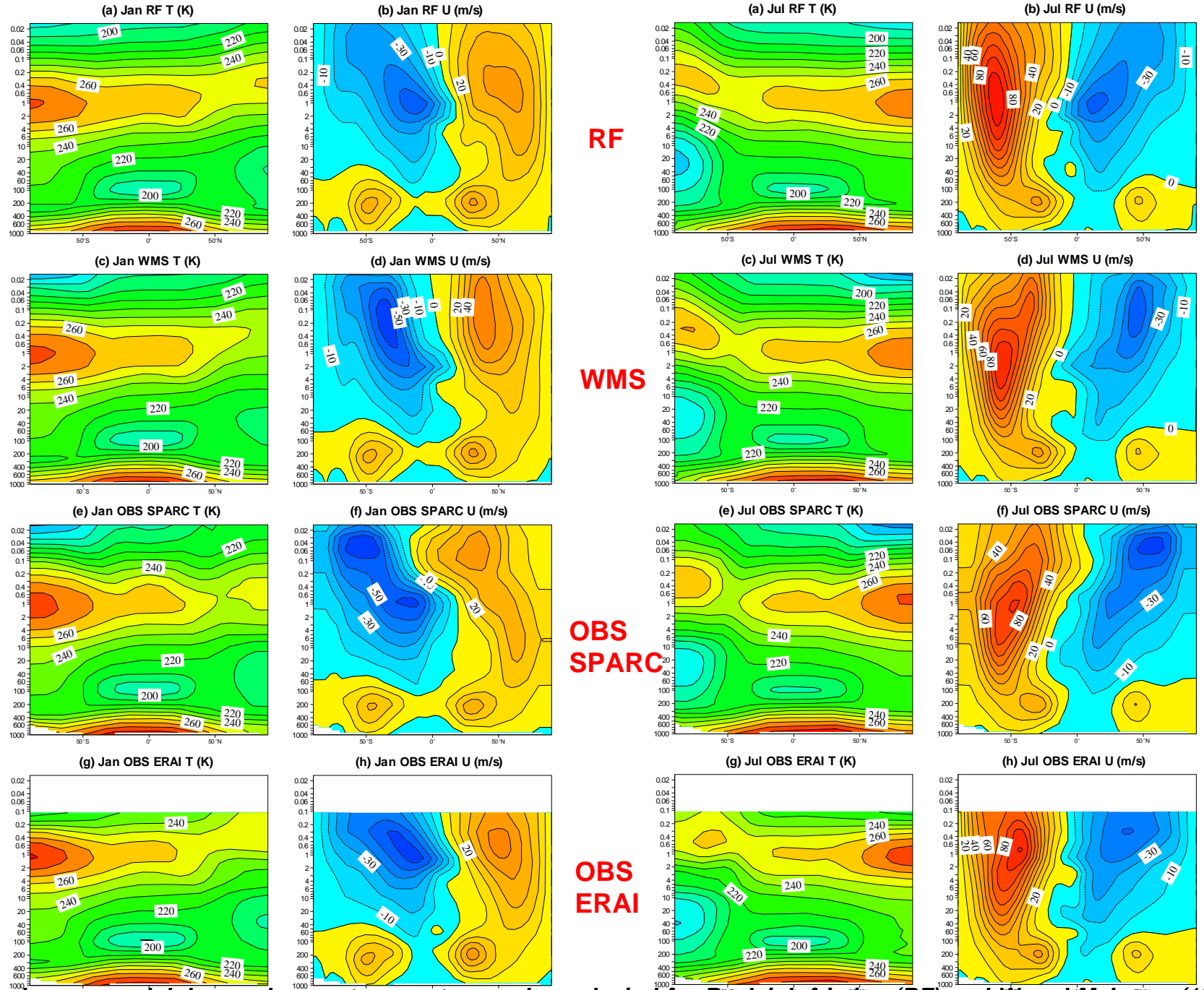
U: background wind; **N**: buoyancy

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

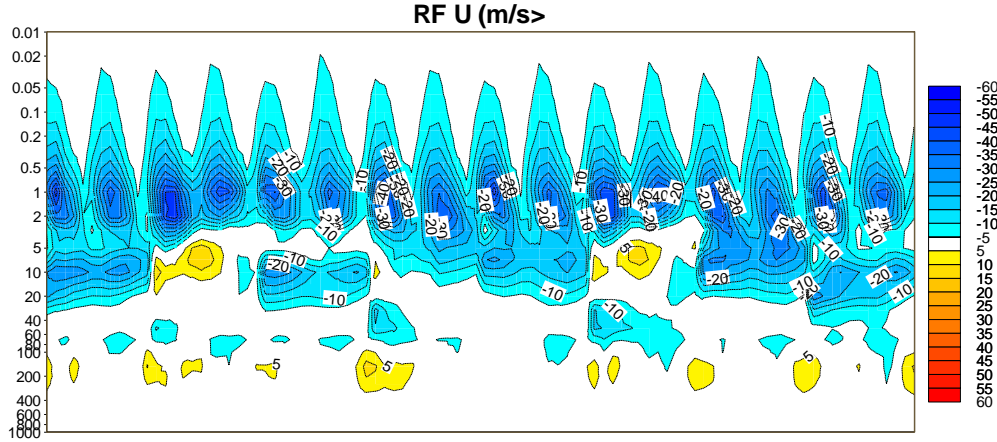


Rely on realistic winds to filter the upward propagating (unrealistic) gravity wave source.

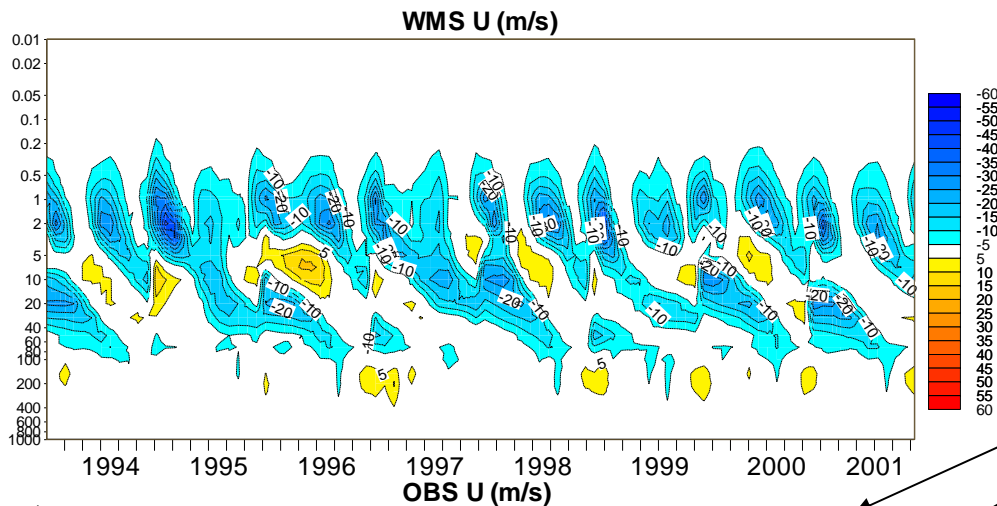




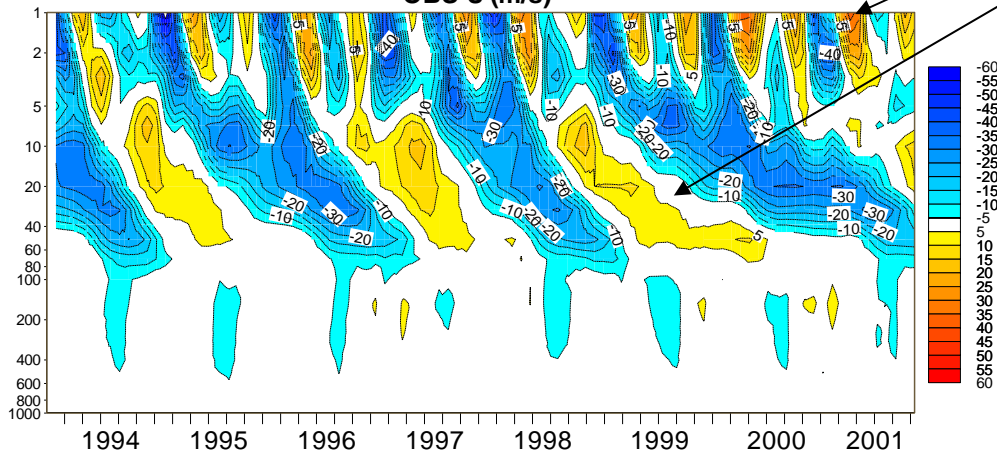
Mean January and July zonal-mean temperature and zonal wind for Rayleigh friction (RF) and W and McIntyre (1996), Scinoccia (2003) scheme and observations. Simulations are 33R1 + CLIM_GHG 8-year (1994-2001) averages.



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 10°S and 10°N.

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

