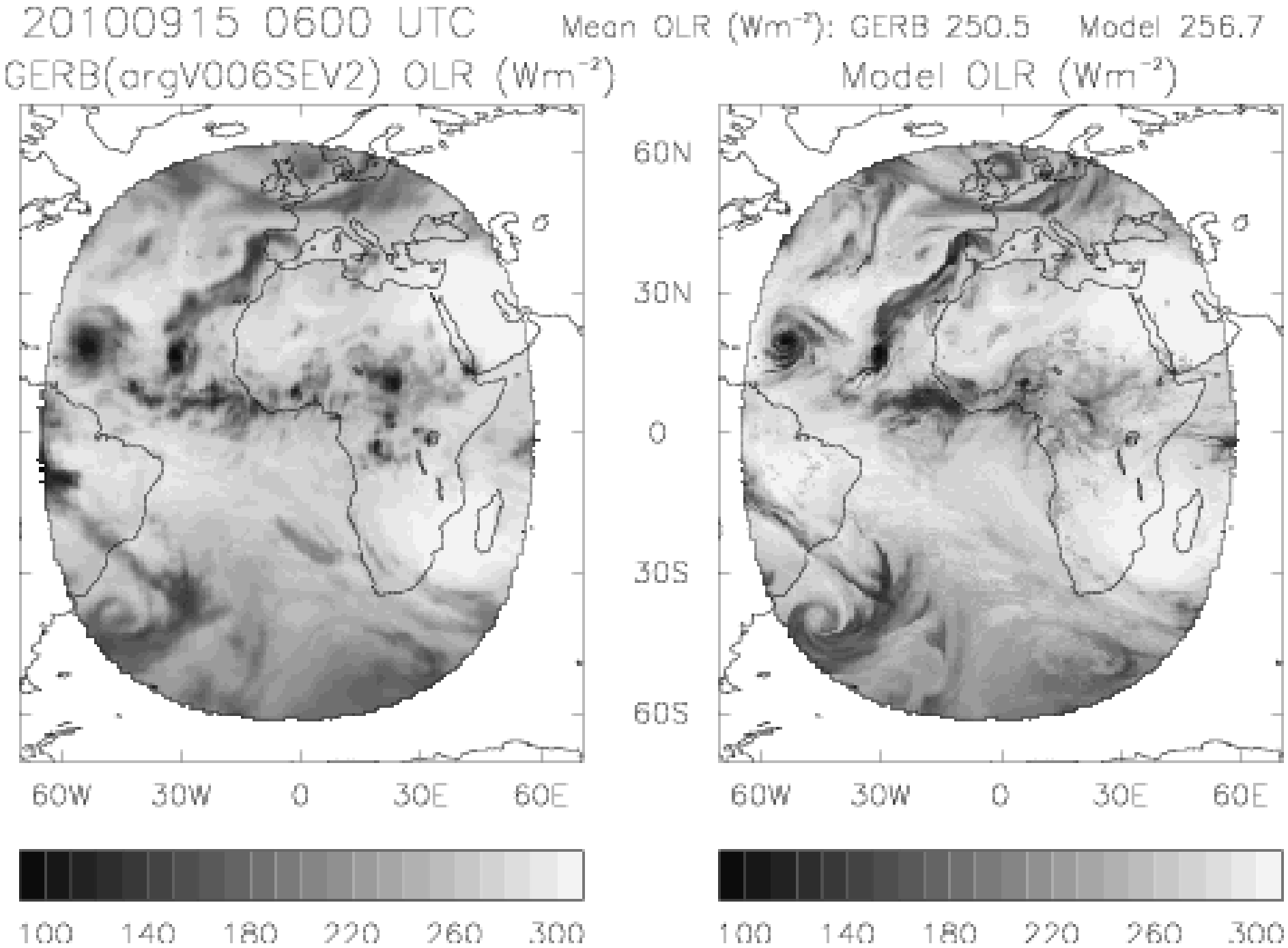
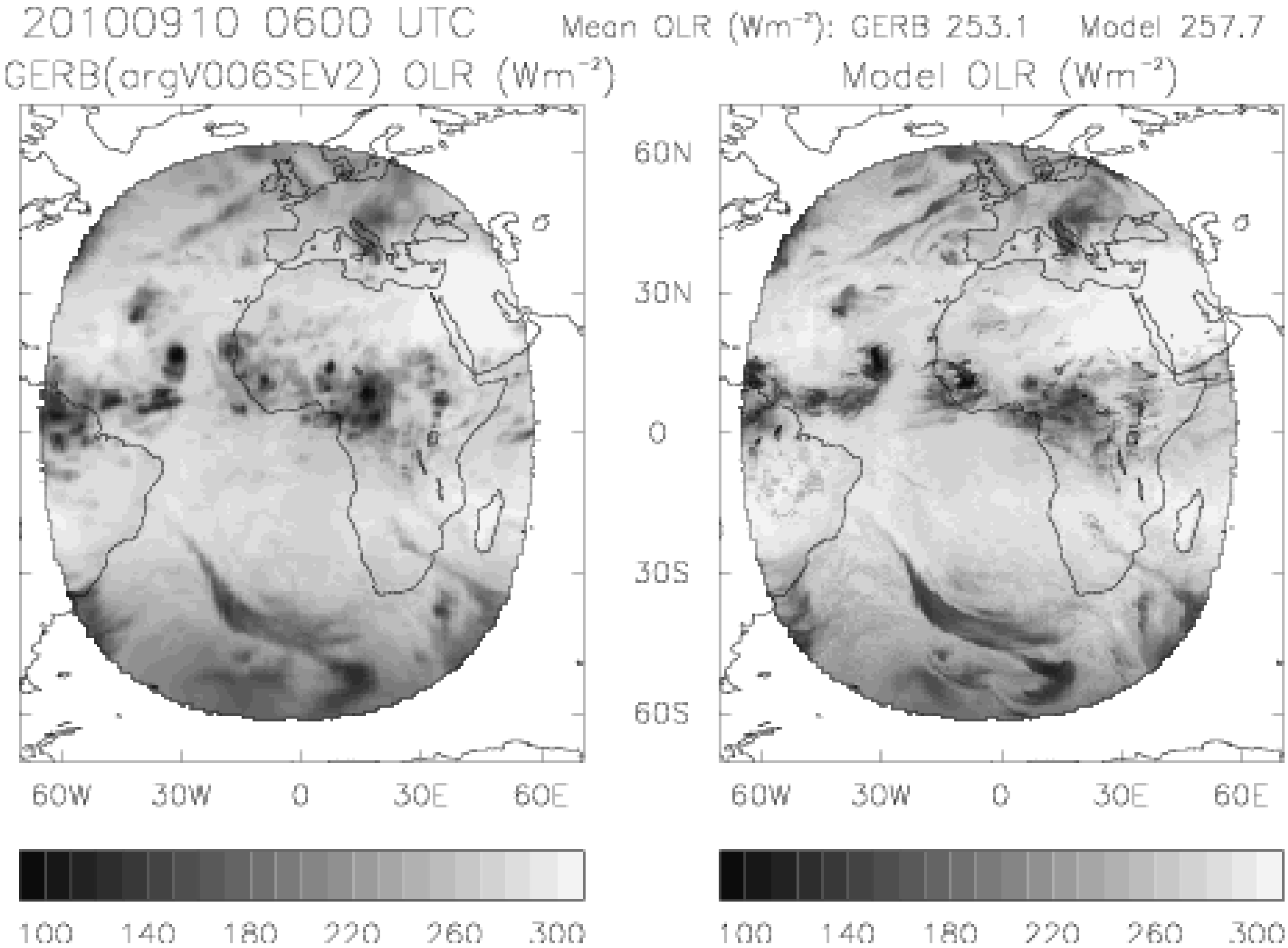

20100915 0600 UTC
Mean OLR (Wm⁻²): GERB 250.5 Model 256.7
GERB(argV006SEV2) OLR (Wm⁻²)
Model OLR (Wm⁻²)
60N
30N
0
30S
60S
60W 30W 0 30E 60E
60W 30W 0 30E 60E
100 140 180 220 260 300
100 140 180 220 260 300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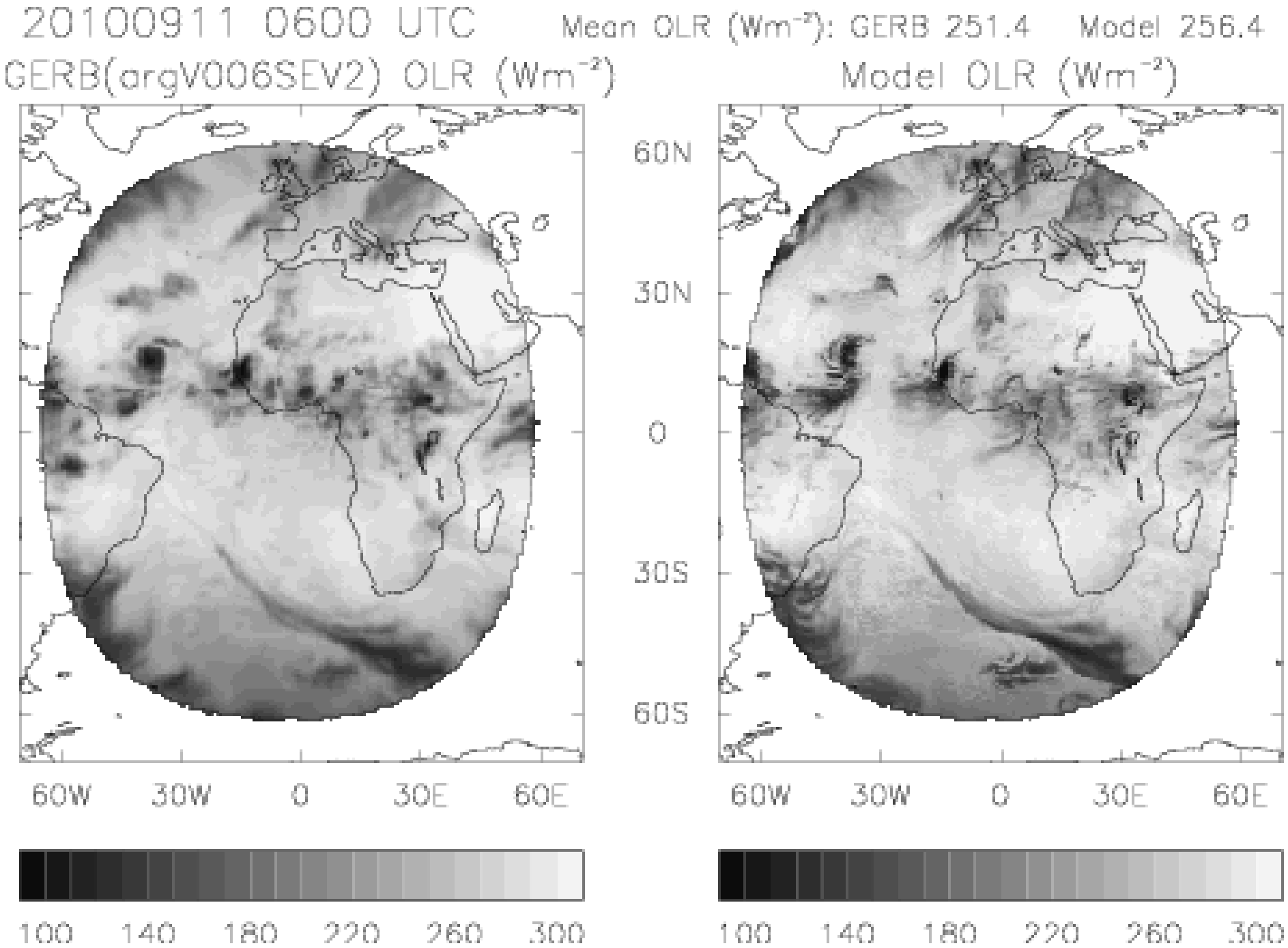
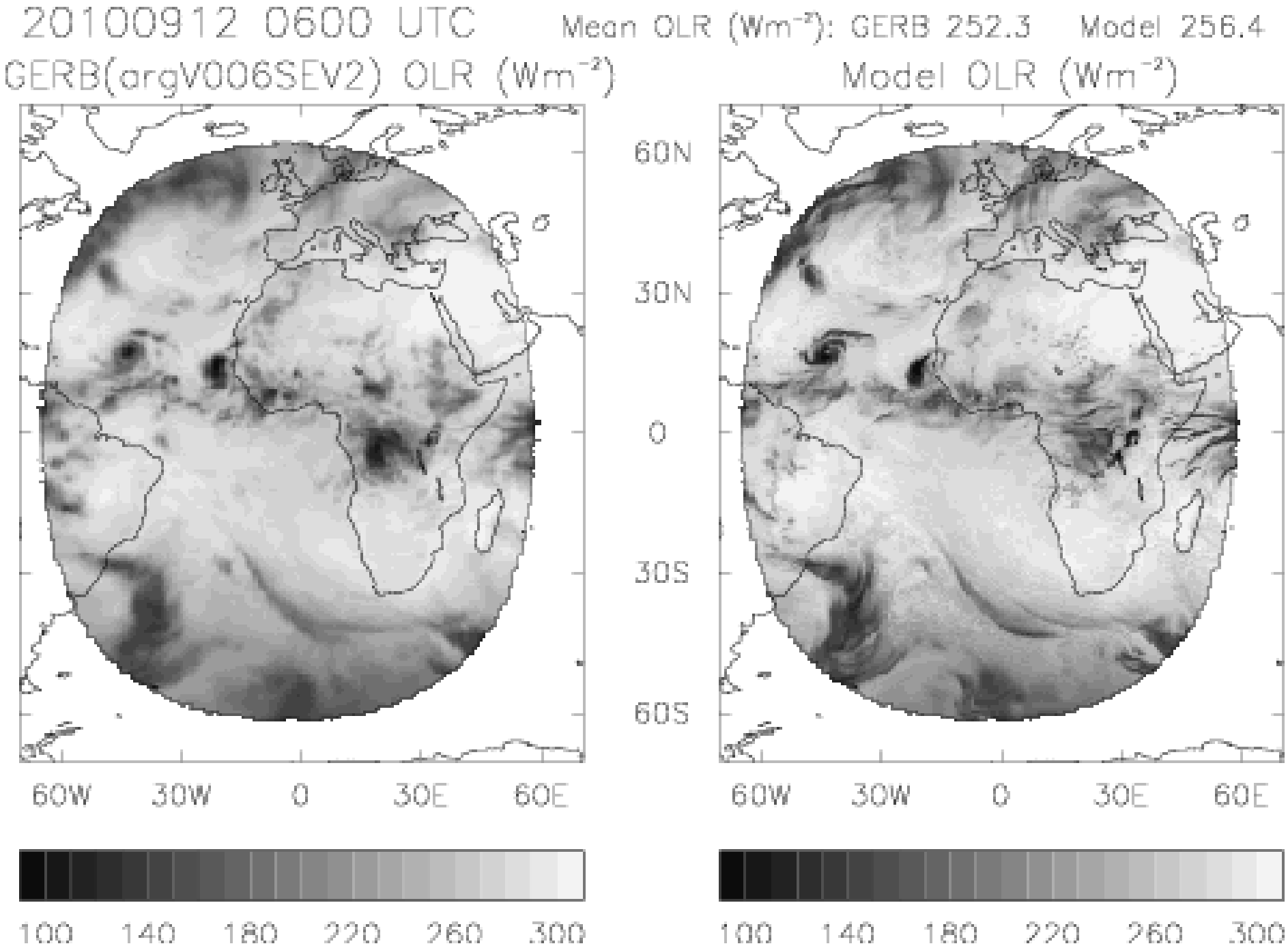
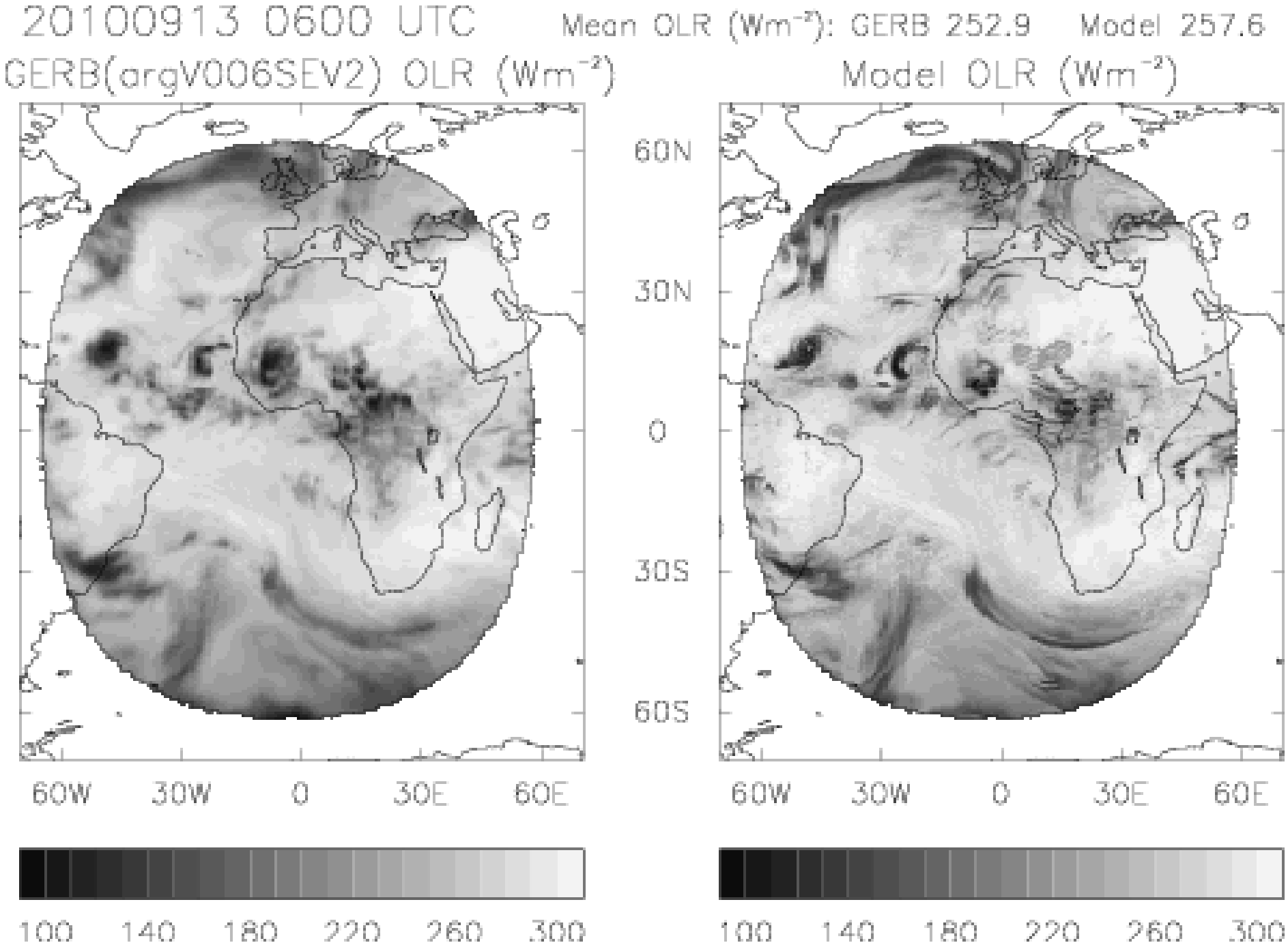
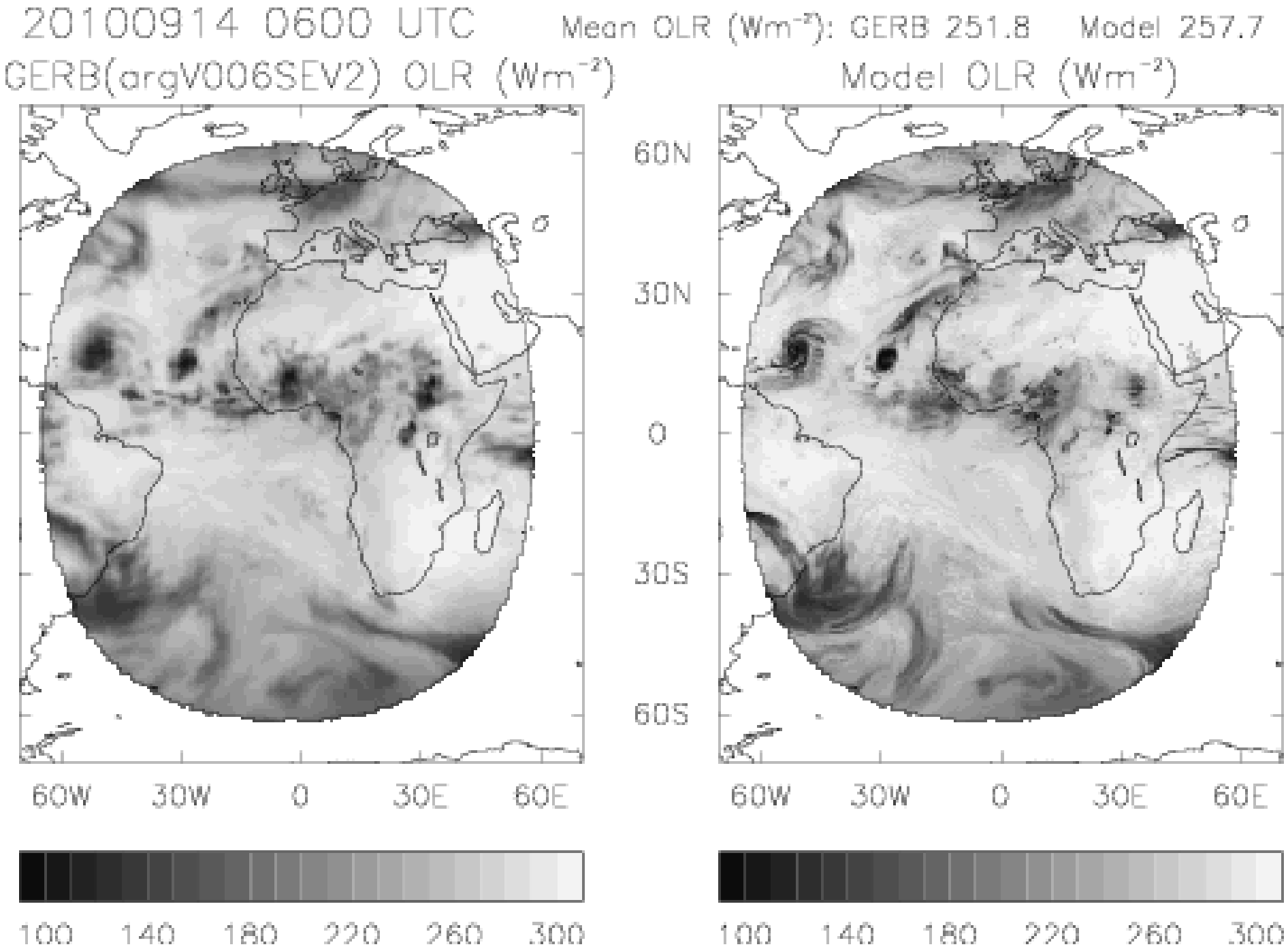
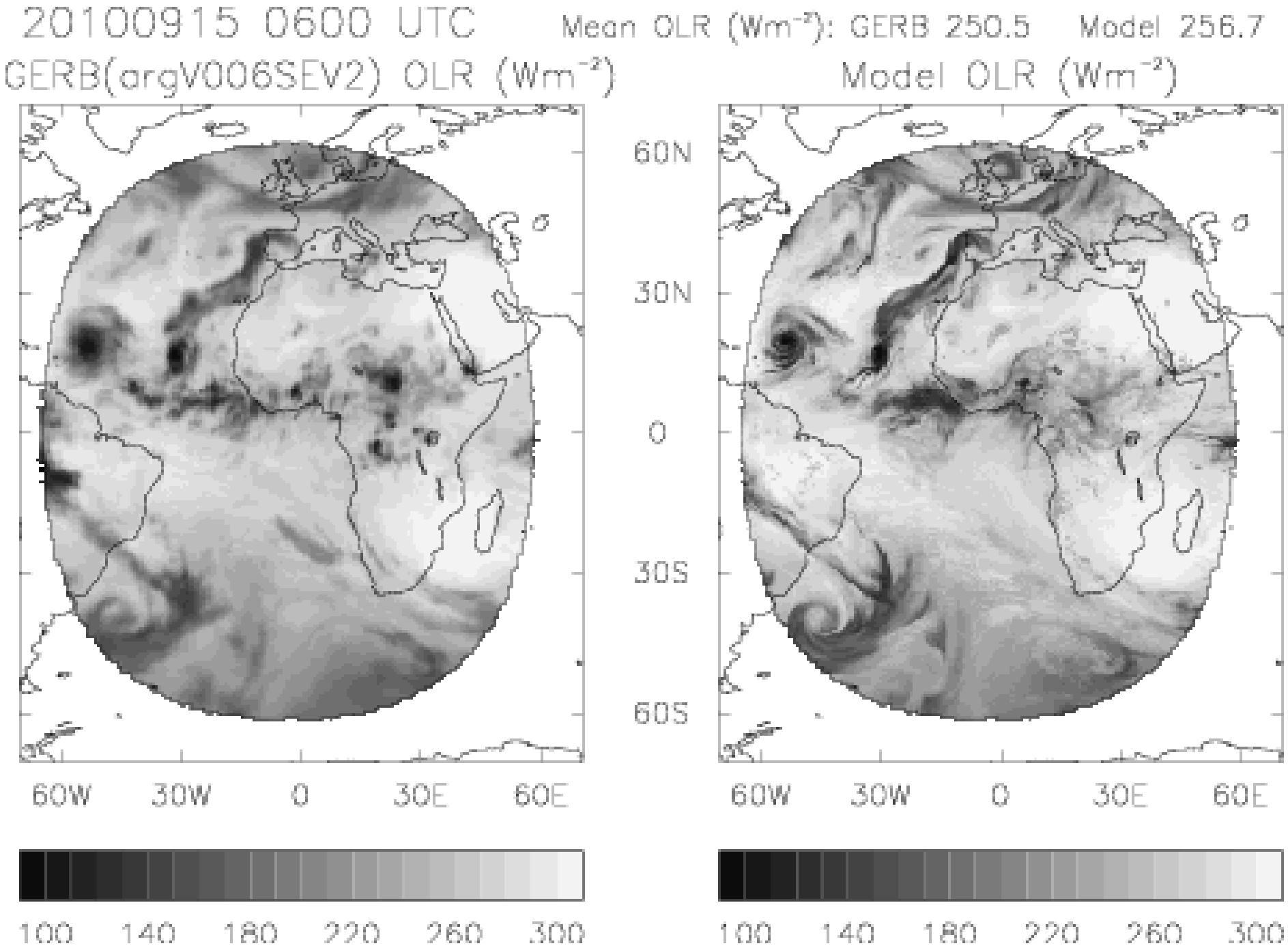
Mean OLR (Wm⁻²): GERB 253.1 Model 257.7
GERB(argV006SEV2) OLR (Wm⁻²)
Model OLR (Wm⁻²)
60N
30N
0
30S
60S
60W 30W 0 30E 60E
60W 30W 0 30E 60E
100 140 180 220 260 300
100 140 180 220 260 300


20100911 0600 UTC
Mean OLR (Wm⁻²): GERB 251.4 Model 256.4
GERB(argV006SEV2) OLR (Wm⁻²)
Model OLR (Wm⁻²)
60N
30N
0
30S
60S
60W 30W 0 30E 60E
60W 30W 0 30E 60E
100 140 180 220 260 300
100 140 180 220 260 300


20100912 0600 UTC
Mean OLR (Wm⁻²): GERB 252.3 Model 256.4
GERB(argV006SEV2) OLR (Wm⁻²)
Model OLR (Wm⁻²)
60N
30N
0
30S
60S
60W 30W 0 30E 60E
60W 30W 0 30E 60E
100 140 180 220 260 300
100 140 180 220 260 300

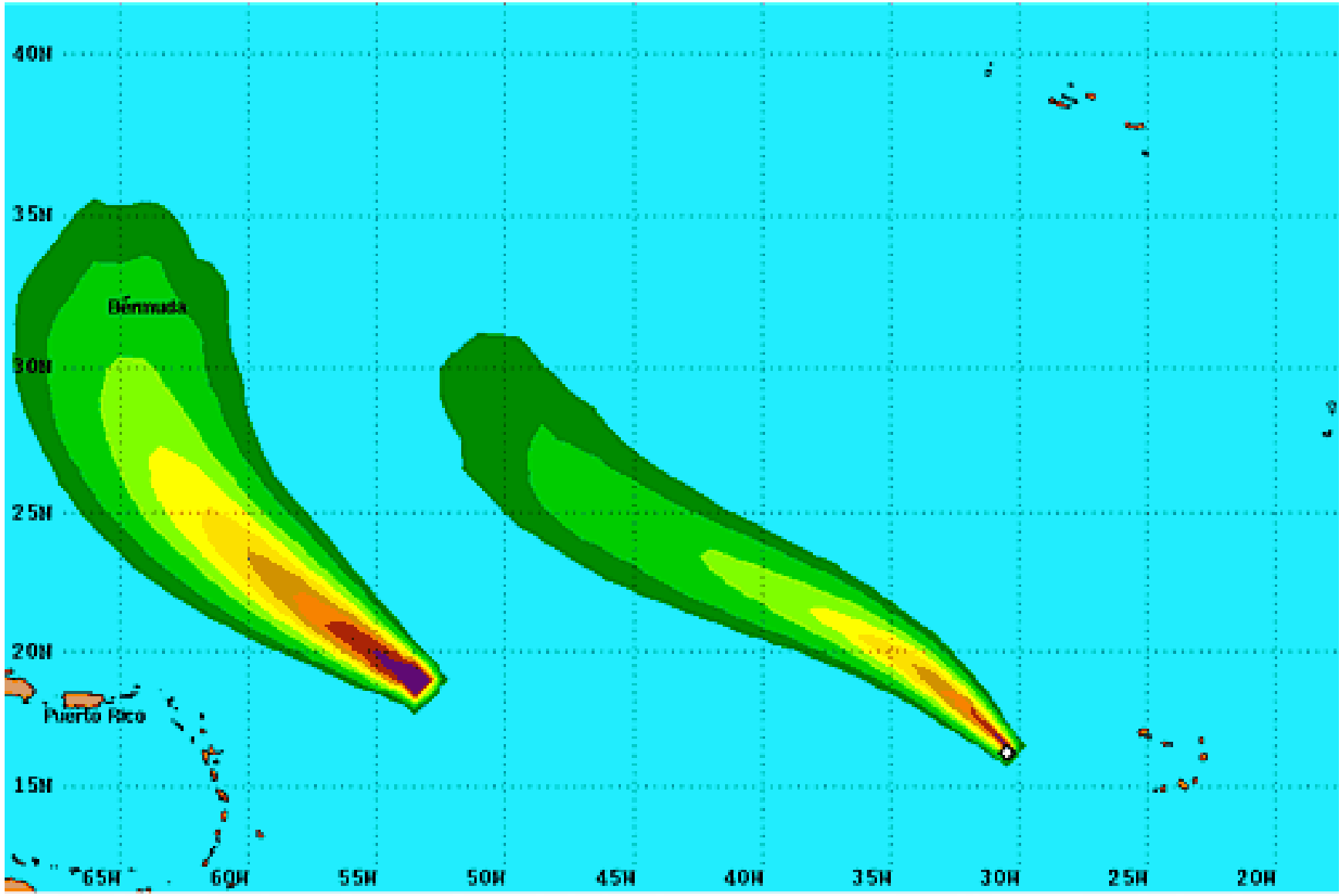

20100913 0600 UTC
Mean OLR (Wm⁻²): GERB 252.9 Model 257.6
GERB(argV006SEV2) OLR (Wm⁻²)
Model OLR (Wm⁻²)
60N
30N
0
30S
60S
60W 30W 0 30E 60E
60W 30W 0 30E 60E
100 140 180 220 260 300
100 140 180 220 260 300


20100914 0600 UTC
Mean OLR (Wm⁻²): GERB 251.8 Model 257.7
GERB(argV006SEV2) OLR (Wm⁻²)
Model OLR (Wm⁻²)
60N
30N
0
30S
60S
60W 30W 0 30E 60E
60W 30W 0 30E 60E
100 140 180 220 260 300
100 140 180 220 260 300


20100915 0600 UTC
Mean OLR (Wm⁻²): GERB 250.5 Model 256.7
GERB(argV006SEV2) OLR (Wm⁻²)
Model OLR (Wm⁻²)
60N
30N
0
30S
60S
60W 30W 0 30E 60E
60W 30W 0 30E 60E
100 140 180 220 260 300
100 140 180 220 260 300

Hurricane Force Wind Speed Probabilities

For the 120 hours (5 days) from 8 PM AST Tue Sep 14 to 8 PM AST Sun Sep 19



Probability of hurricane force surface winds (1-minute average >= 74 mph) from all tropical cyclones

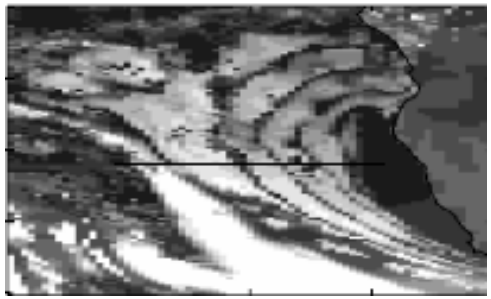
◇ indicates HURRICANE JULIA center location at 8 PM AST Tue Sep 14 2010 (Forecast/Advisory #11)

5% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Using GERB, CERES and ScaRaB to Investigate Systematic Model Biases Relating to Cloud, Mineral Dust and Aircraft Contrails

Richard Allan
Department of Meteorology, University of Reading

Thanks to: Jim Haywood (Met Office), Margaret Woodage (ESSC)



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Mineral Dust Aerosol

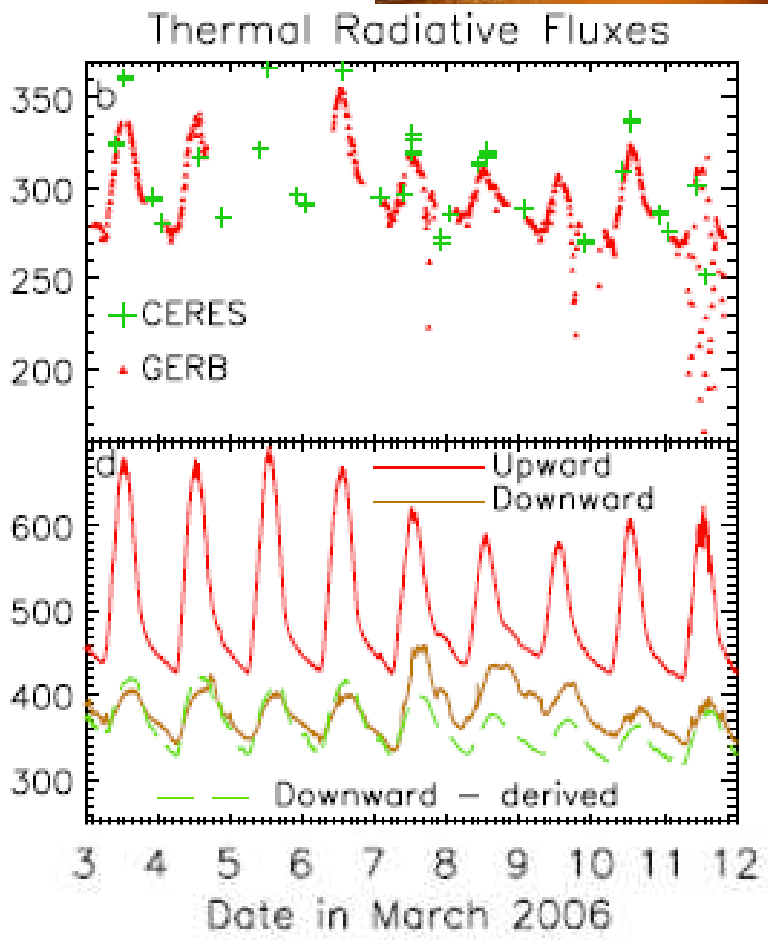
- LW effect of mineral dust aerosol substantial over north Africa

  e.g. Haywood et al. (2005); Zhang and Christopher (2003);

  Slingo et al. (2006) →

- Model bias systematic and substantial in May-July (up to ~40 Wm^{-2})

  e.g. Allan et al. QJRMS in prep.



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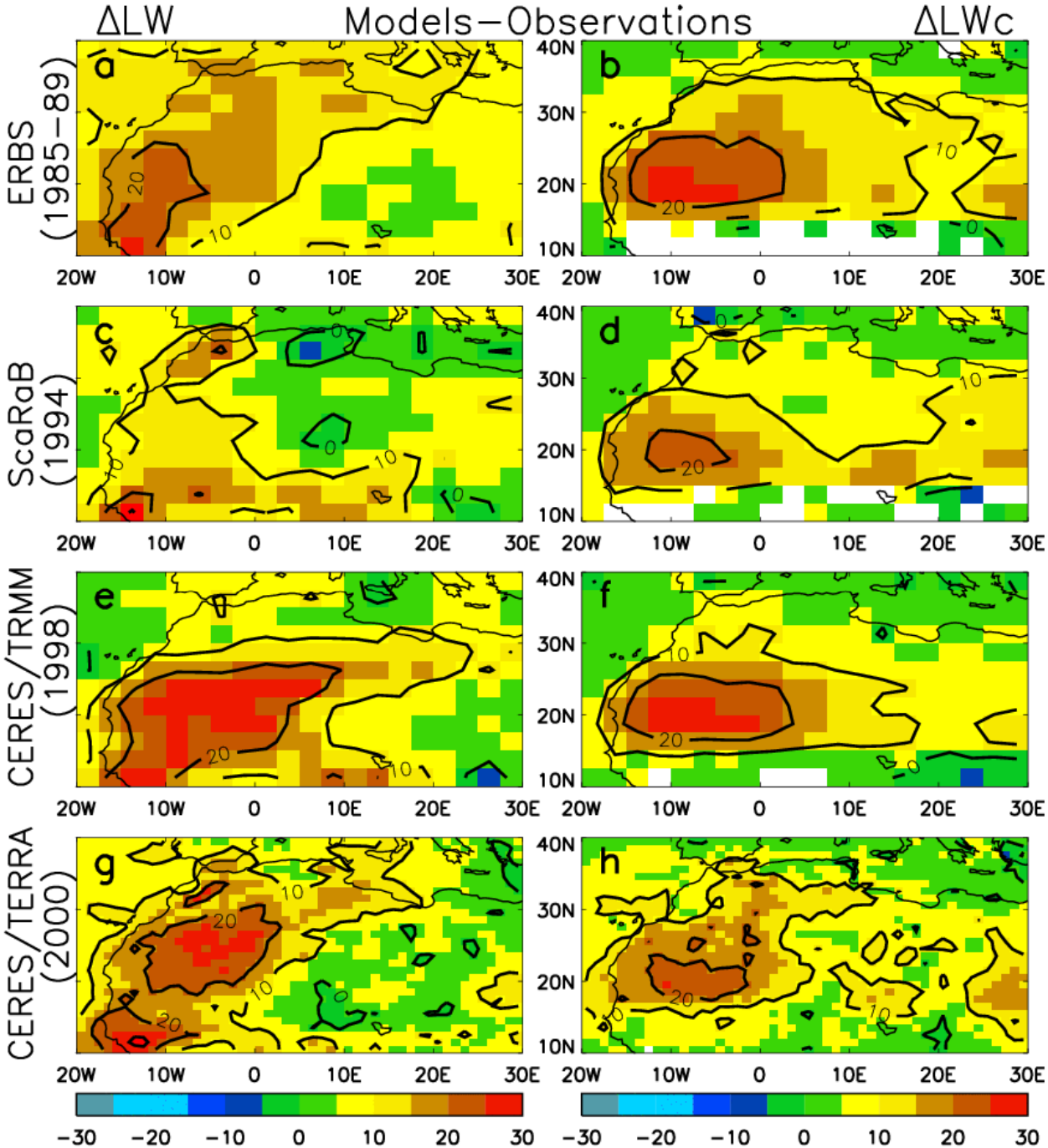
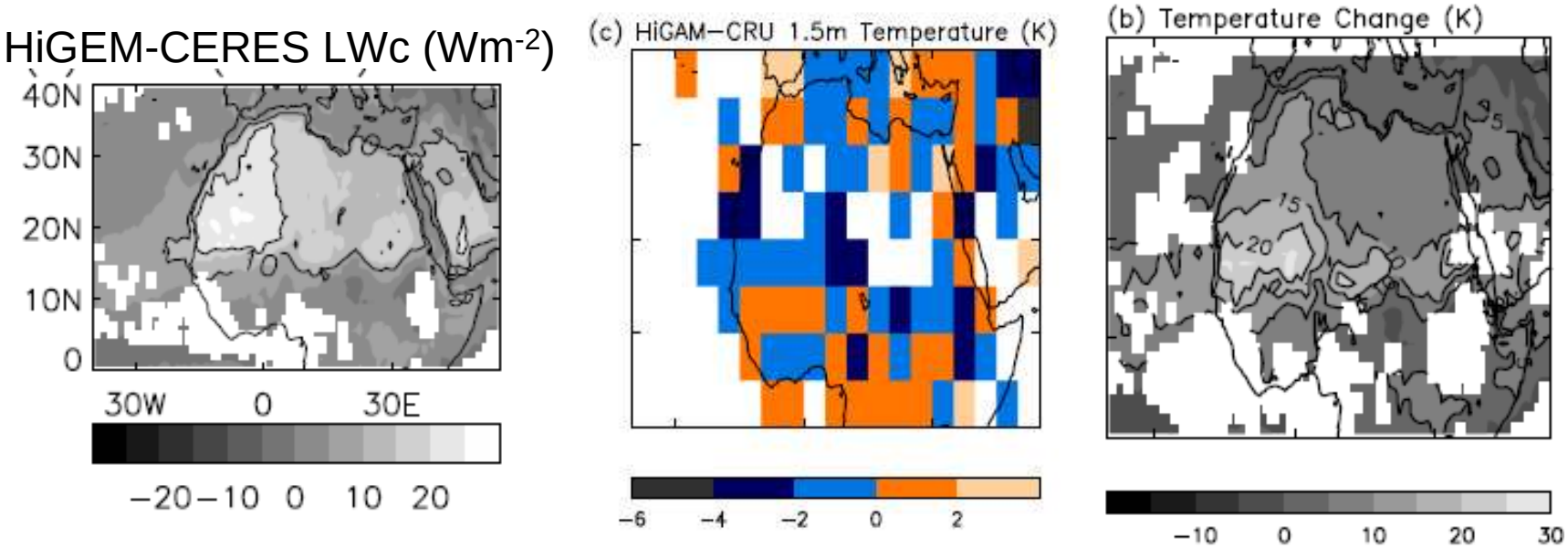
LW bias in climate models May-July

Average clear-LW bias over whole region 3-15 Wm^{-2} depending upon model & satellite dataset/period



HiGEM climate model:
i) perturbation experiment



- Similar magnitude bias in HiGEM (>20 Wm^{-2})
- West Sahara LW difference cannot be explained by surface temperature or emissivity errors

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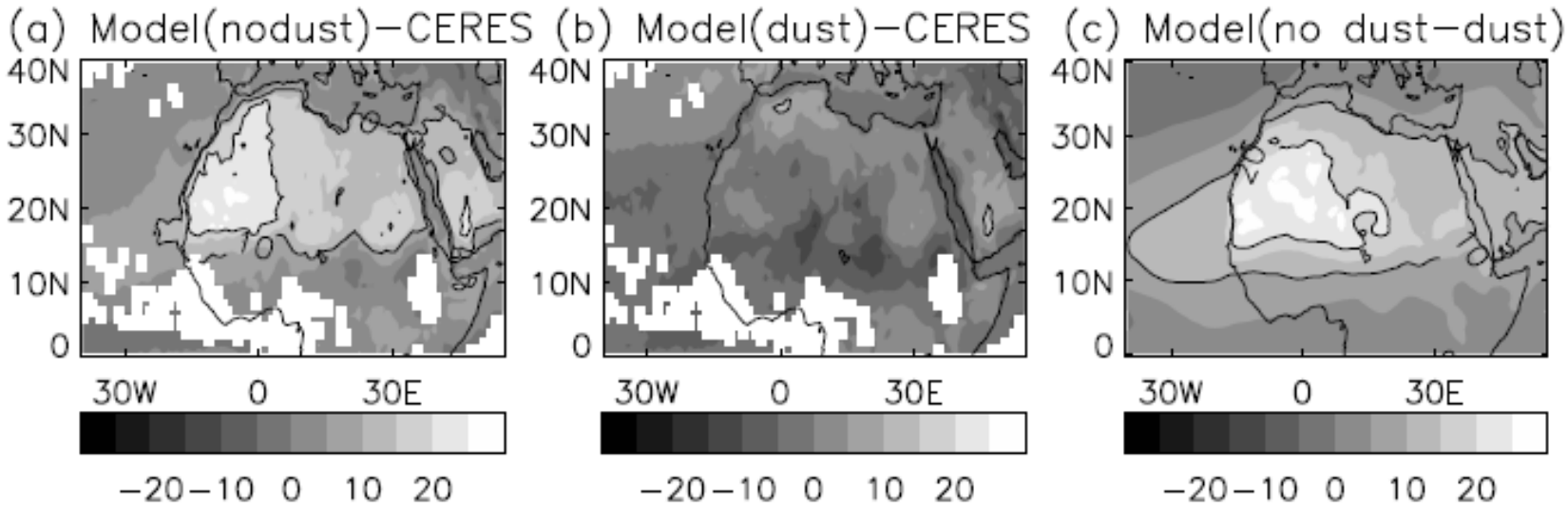
HiGEM climate model:
ii) Interactive dust experiment



- Incorporating an interactive mineral dust scheme removes the LW bias
- Additional feedbacks on atmospheric circulation

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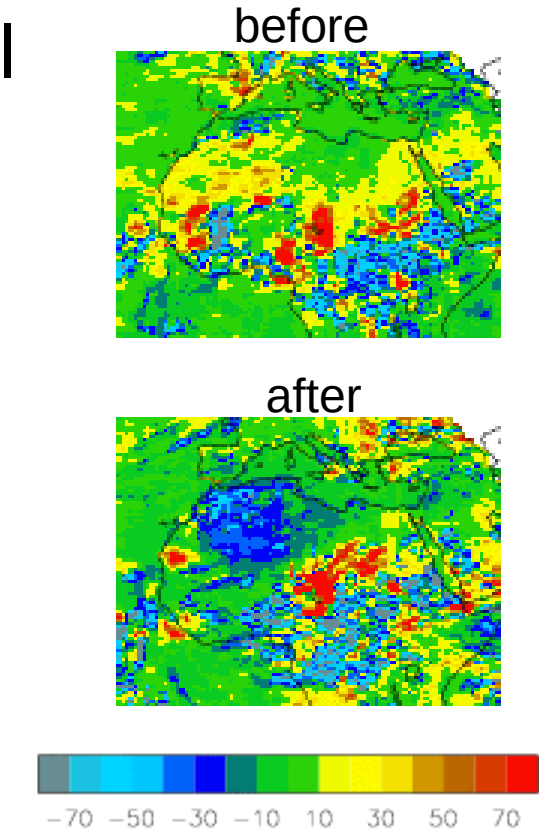
Improving the NWP model

- Incorporating an interactive mineral dust scheme in the NWP model is too costly
- Solution (imperfect): seasonal dust climatology introduced 17 July 2010
  - LW overestimation removed
  - LW underestimation introduced
    - In particular: Algeria when little dust
- GERB/CERES ADM errors?



Model-GERB LW (Wm^{-2})

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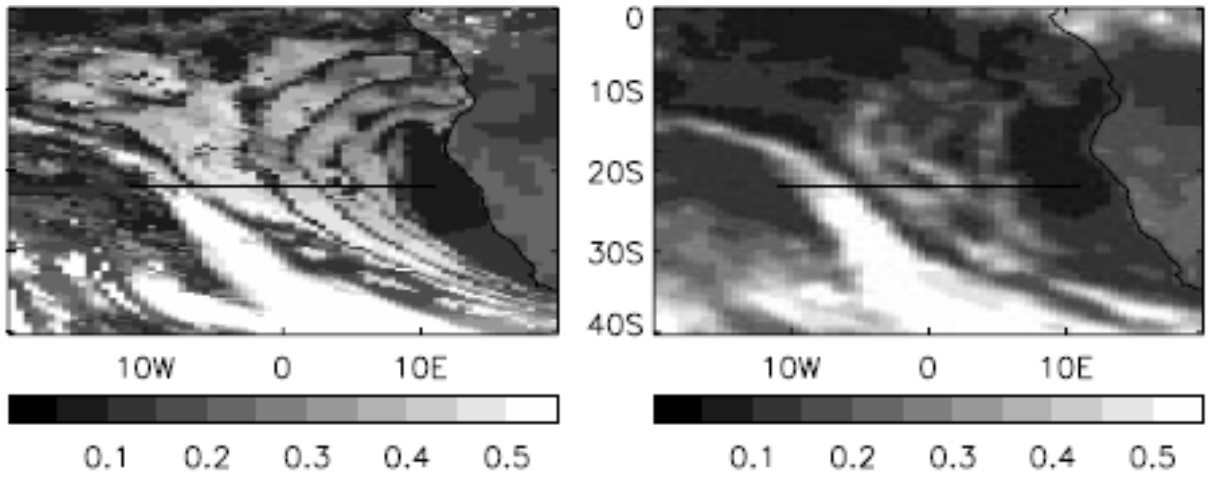
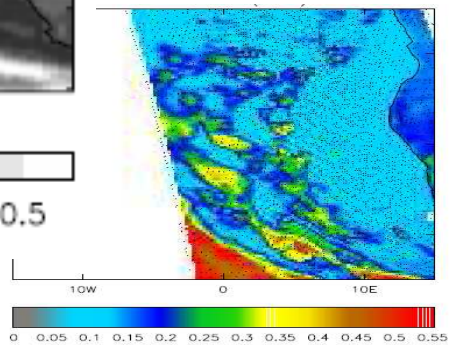
Marine stratocumulus

- Key in determining model uncertainty in climate sensitivity e.g. Bony and Dufresne (2005); Clemment et al. (2010)
- Model biases in physical properties

Model albedo 5 June 2006 12:00 GERB albedo



CERES FM3 (Aqua) -SSF Albedo 13:11



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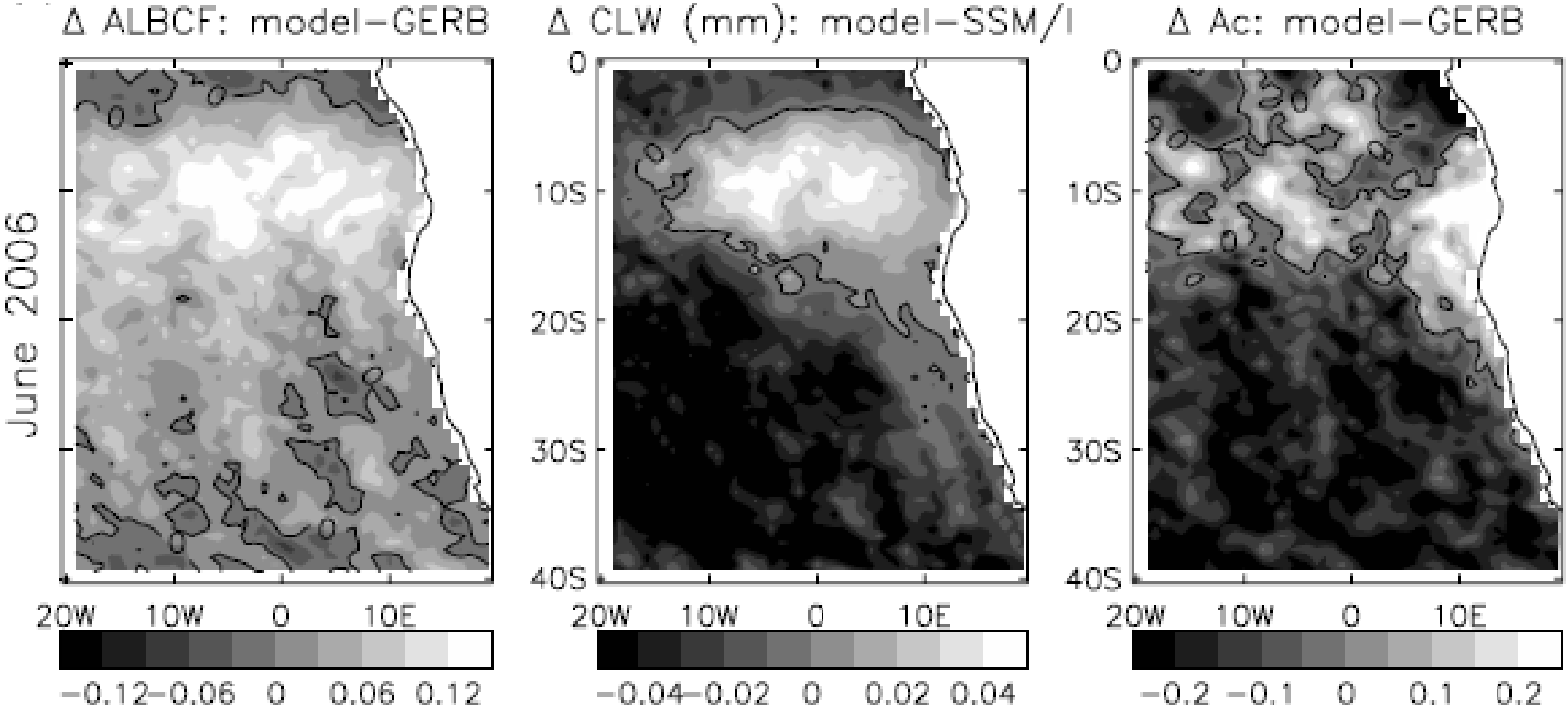
Model stratocumulus cloud: too bright, too much water

- Implications for Cloud Feedback, e.g. Stephens (2010).



Allan et al. (2007) QJRMS

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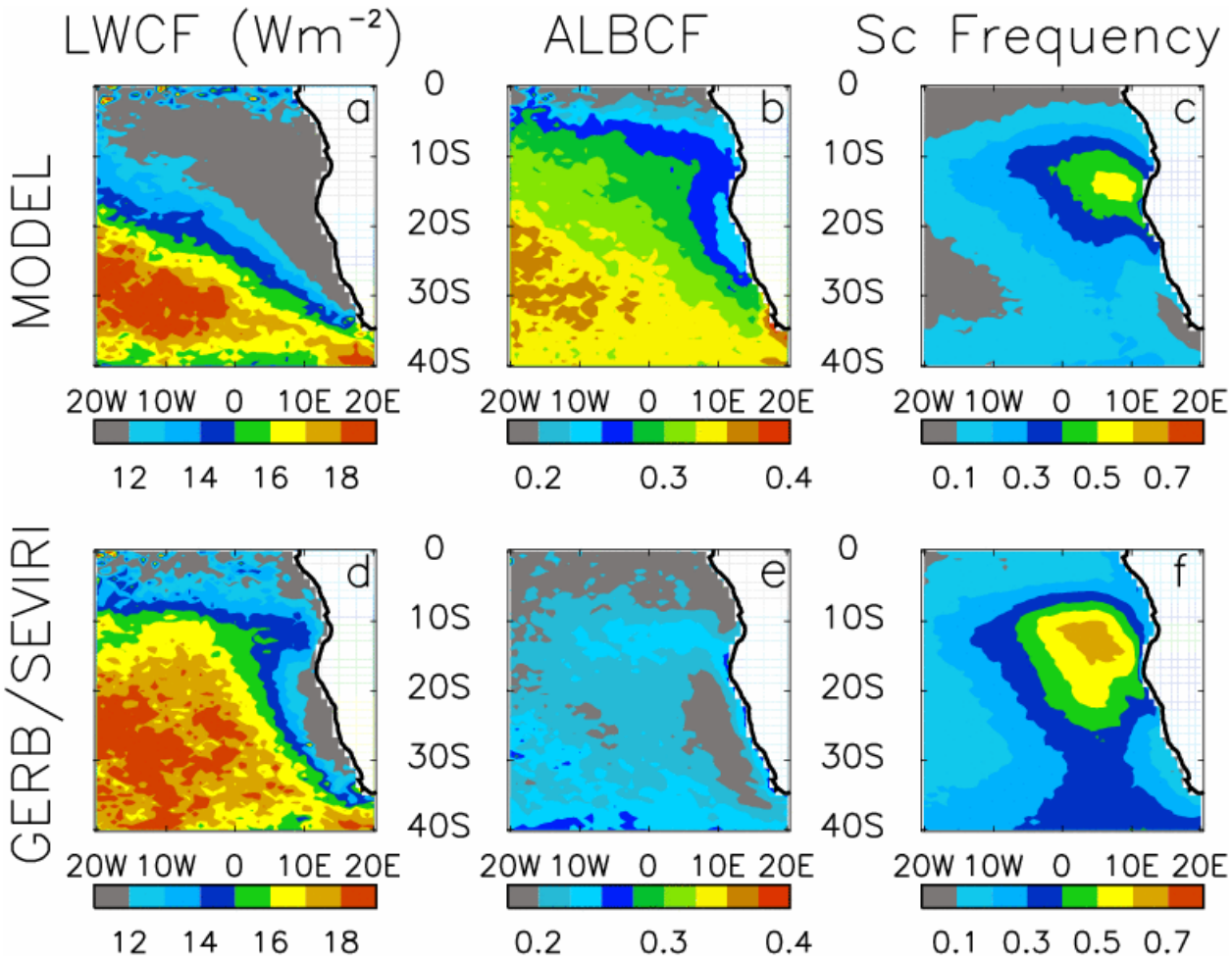
NWP model cloud radiative bias:

overcast Sc-cover pixels only (2003-2010)

- LW cloud effect too small by about 5 Wm^{-2}
- SW cloud effect too large...
- ...yet too little stratocumulus cloud cover



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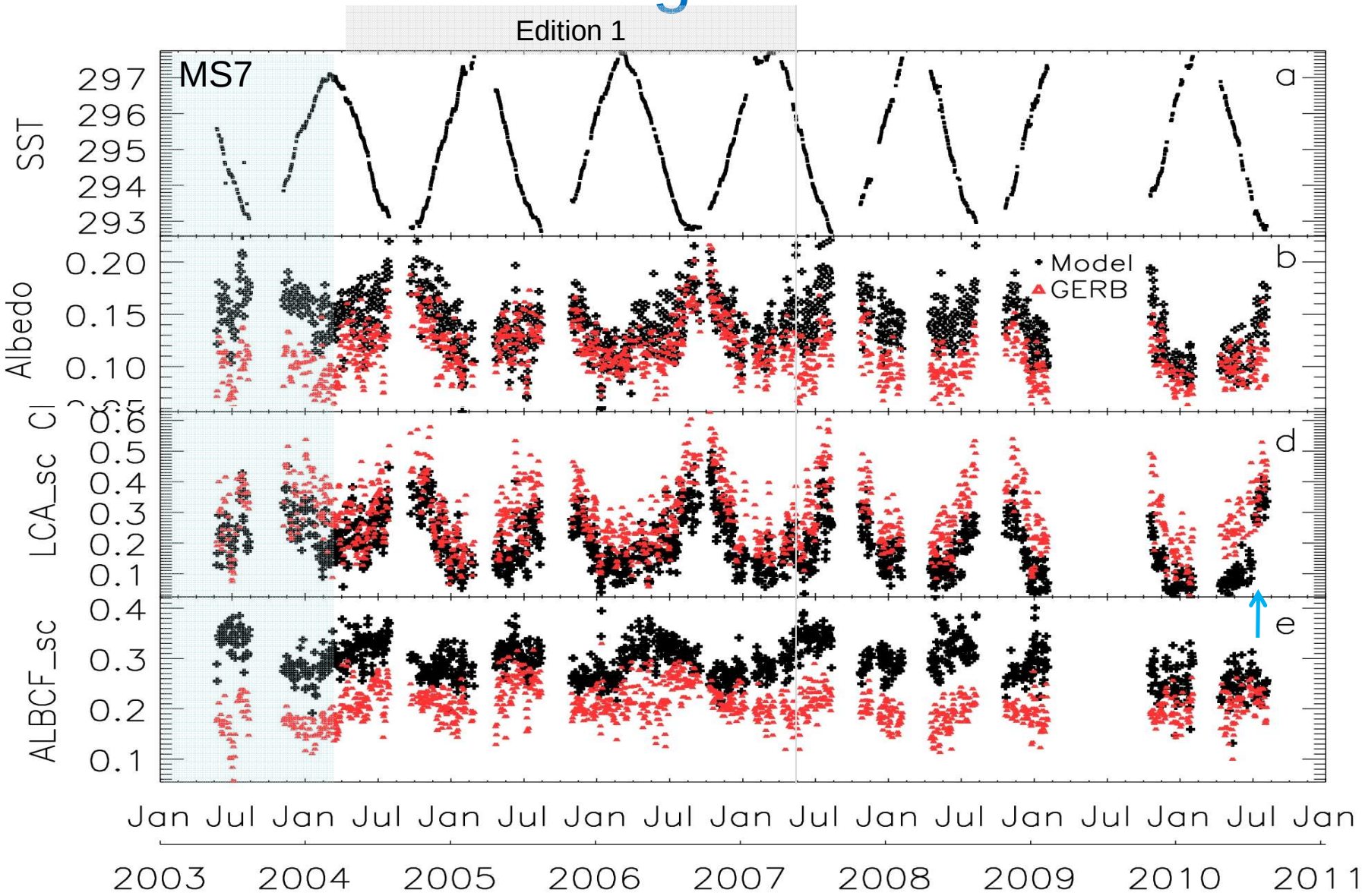
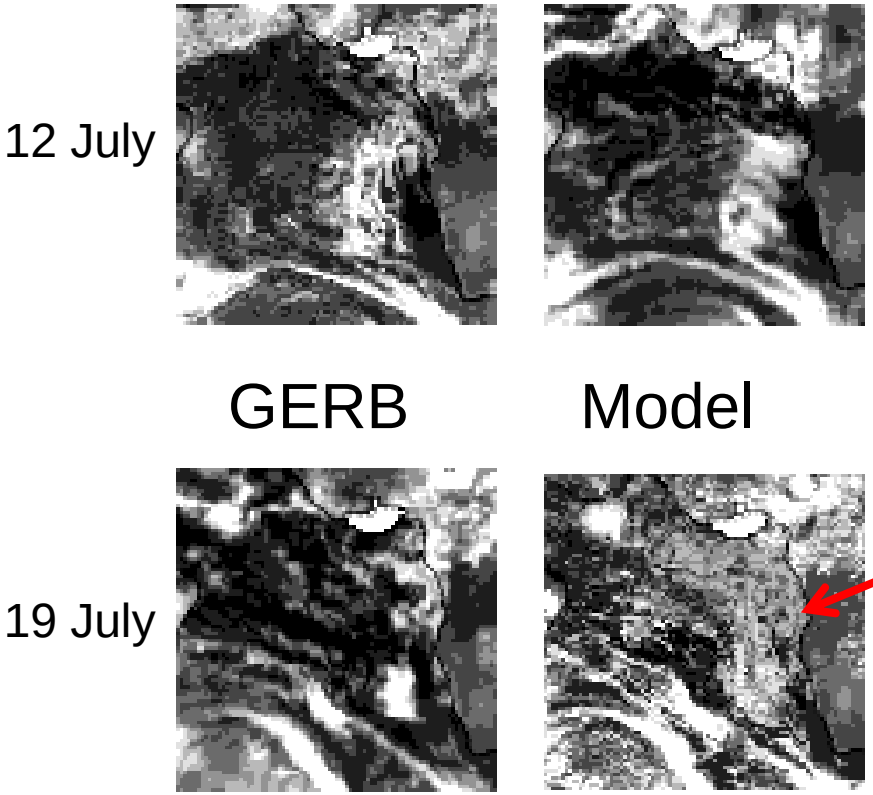
Namibia stratus region timeseries



Recent SW albedo comparisons



- Major model parametrizations updates 15 July 2010
- Stratocumulus cloud now too extensive

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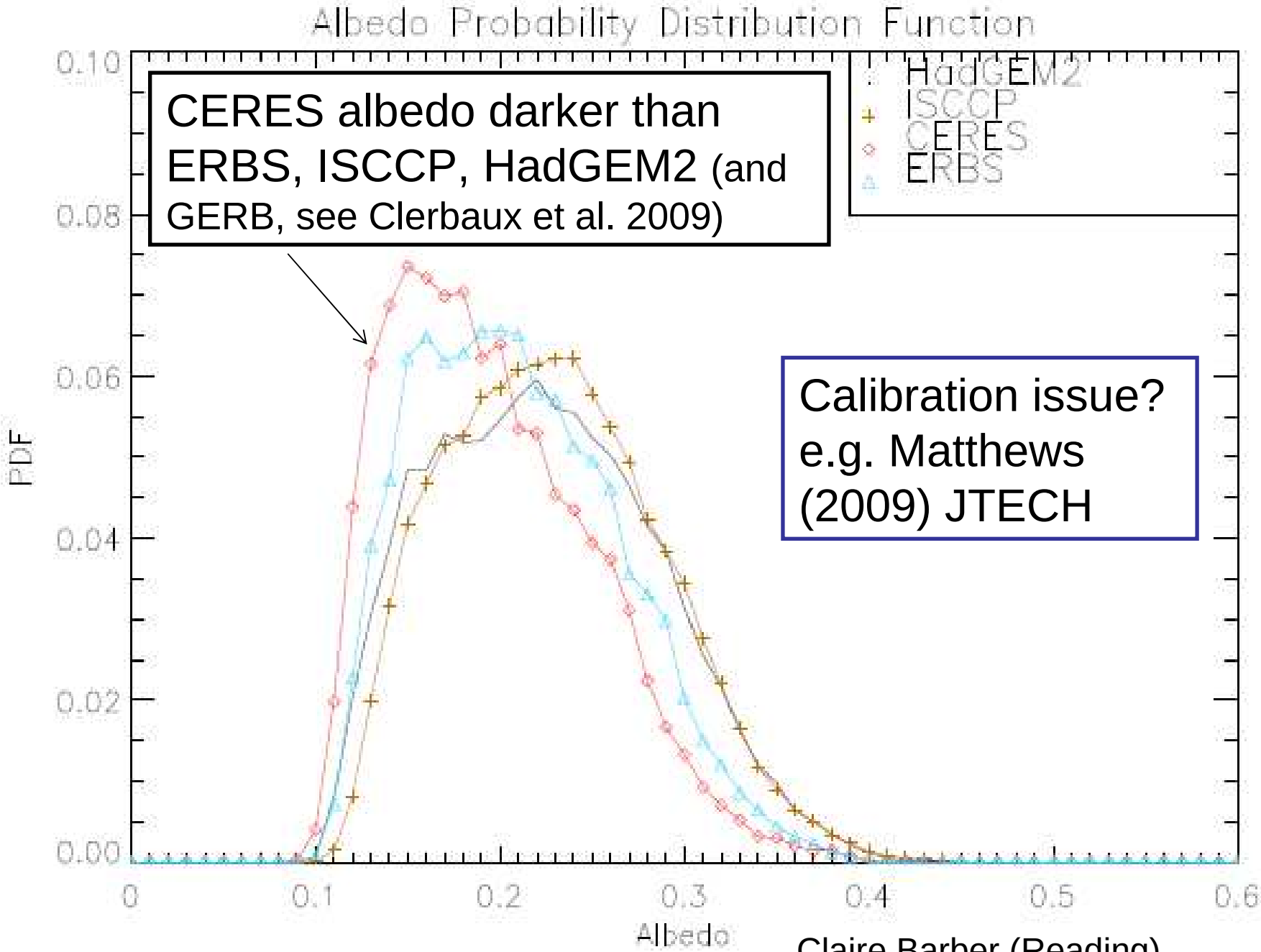


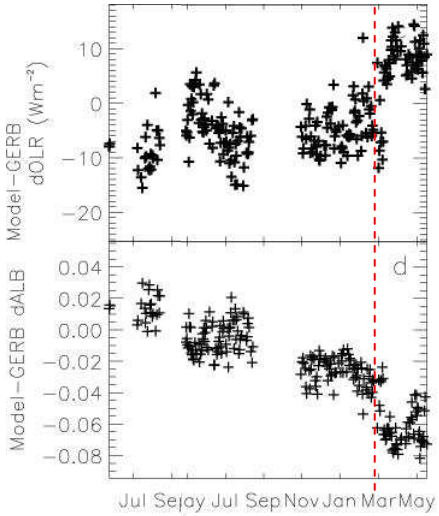
CERES albedo darker than ERBS, ISCCP, HadGEM2 (and GERB, see Clerbaux et al. 2009)

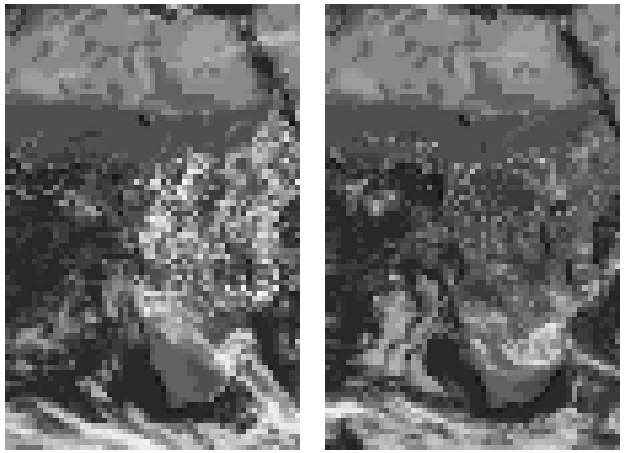
Calibration issue? e.g. Matthews (2009) JTECH

Claire Barber (Reading)

Ongoing evaluation: continuous monitoring of models using GERB

1 Change in model minus GERB flux differences: relate to change in model physics implementation

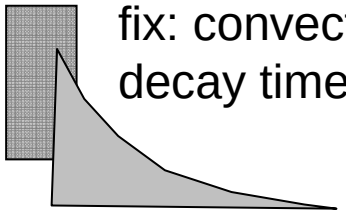




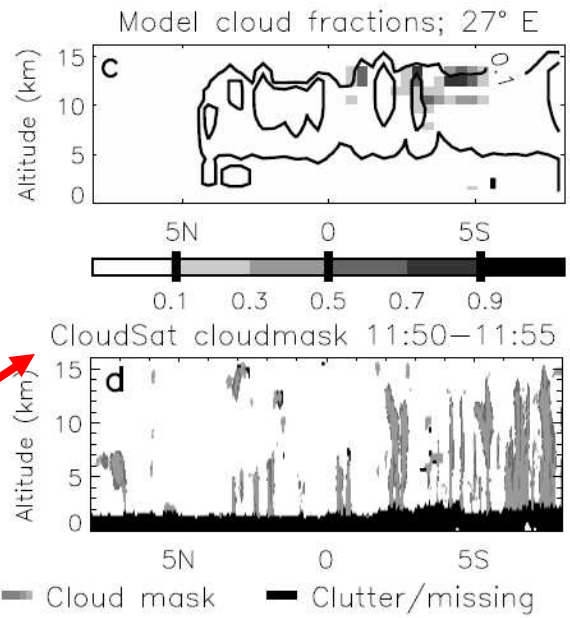
13th March | 14th March 2006

Model SW albedo

2 Identify problem and fix: convective cloud decay time-scale



3



Allan et al. (2007) QJRMS

Monitor improvement using GERB/CloudSat

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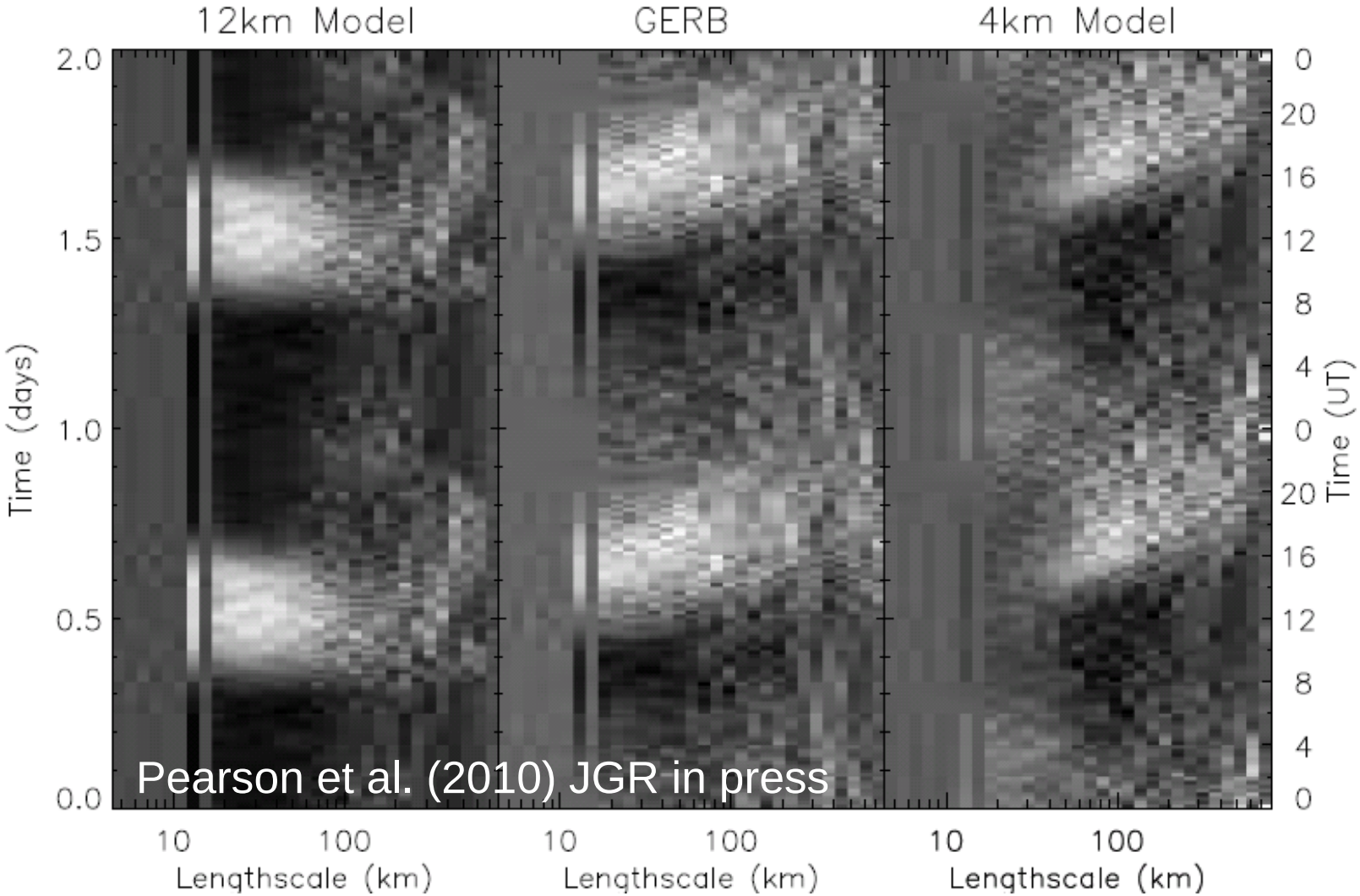
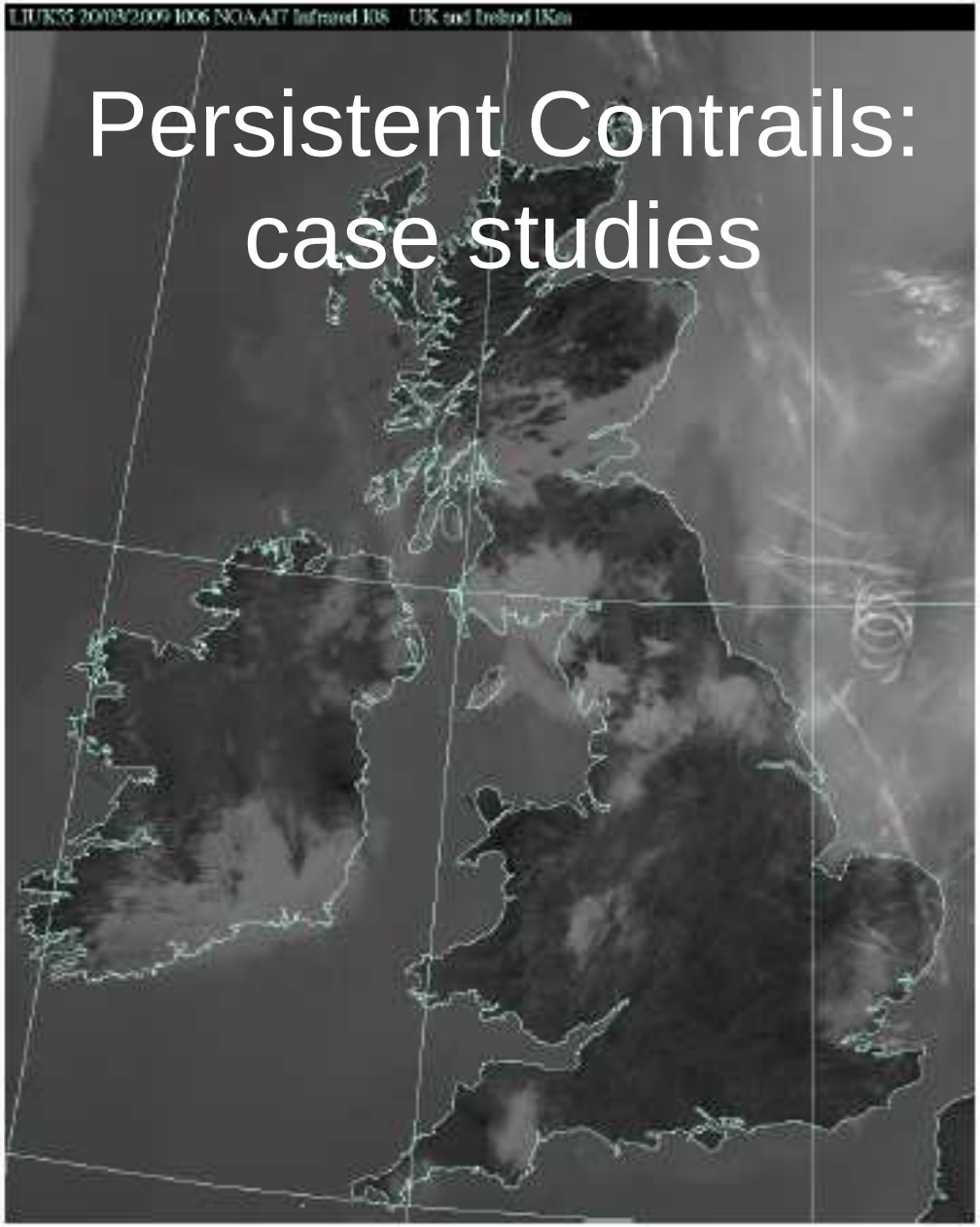
Ongoing evaluation: diurnal cycle of convection in high resolution models



Pearson et al. (2010) JGR in press

Persistent Contrails: case studies

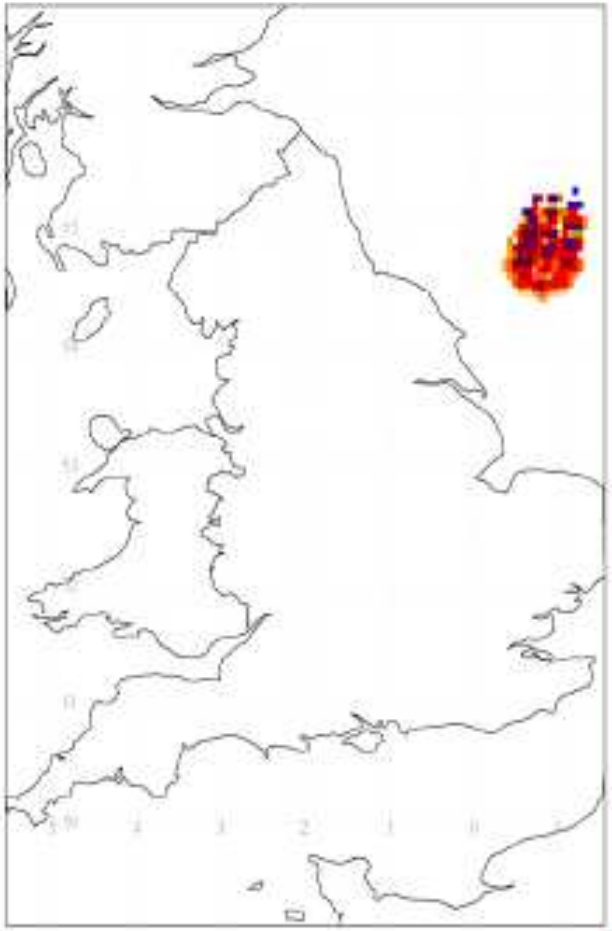
NOAA17 satellite image 20 March 2009 10:06



10:06

Met Office

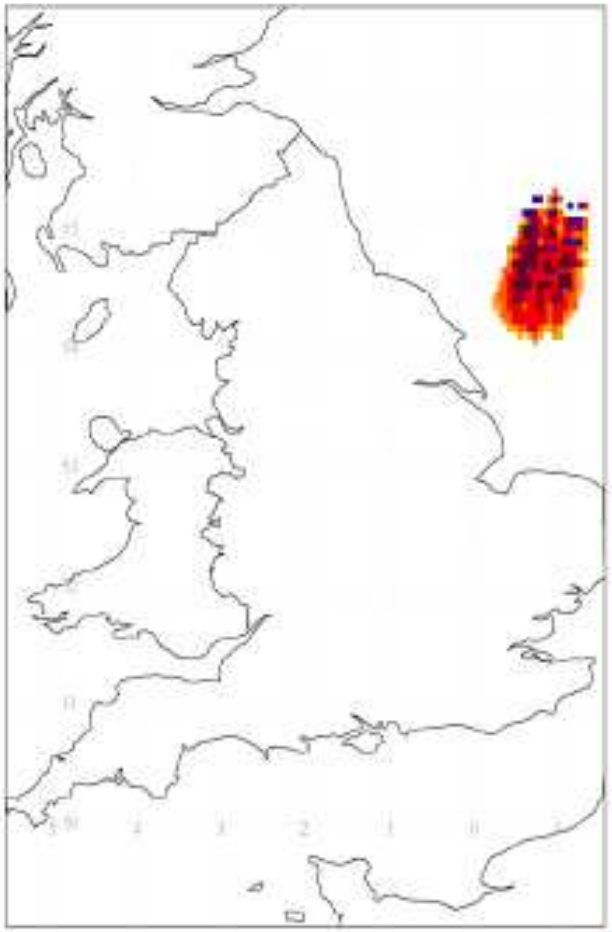
Met Office NAME model

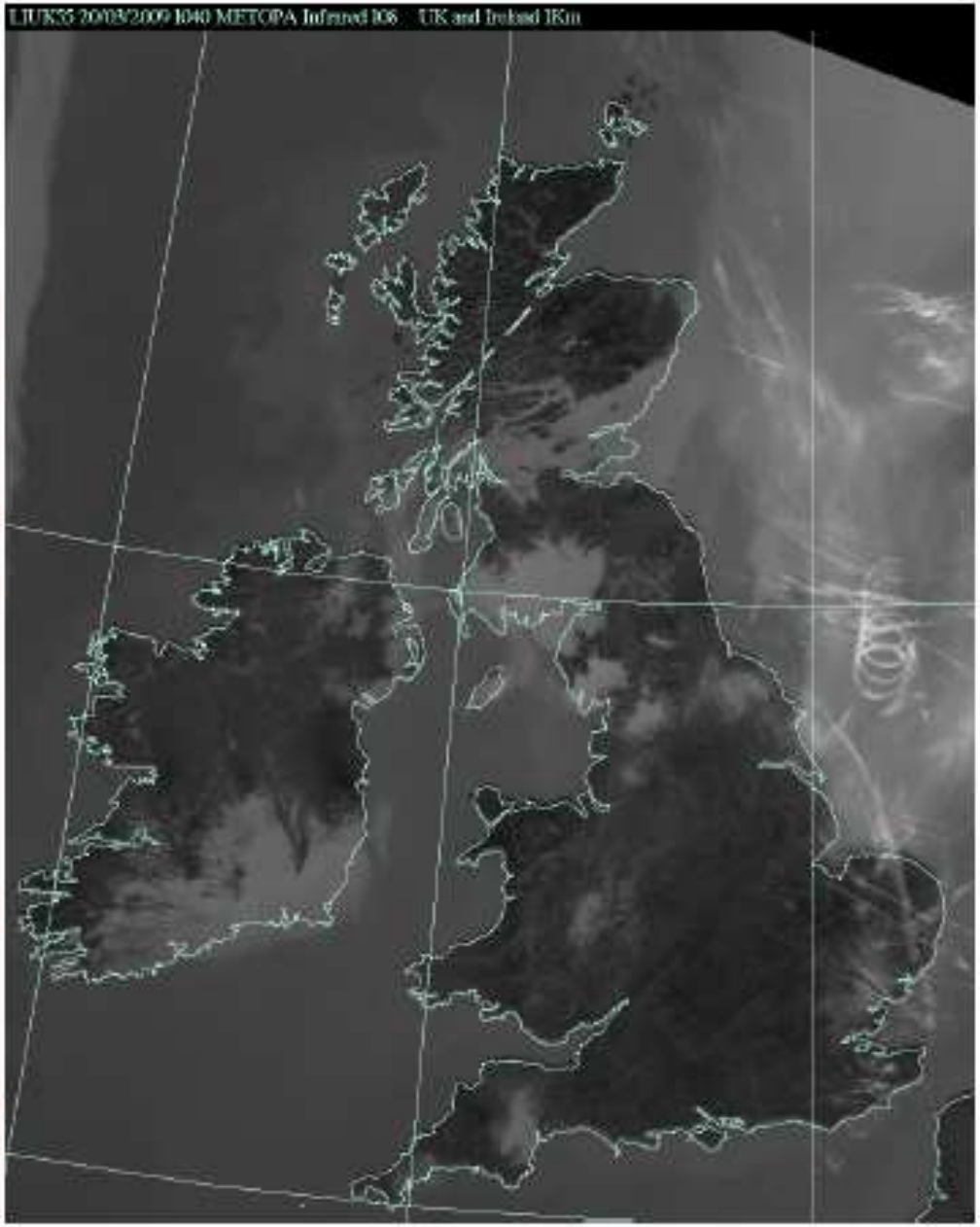


Courtesy of Jim Haywood

Met Office

10:40

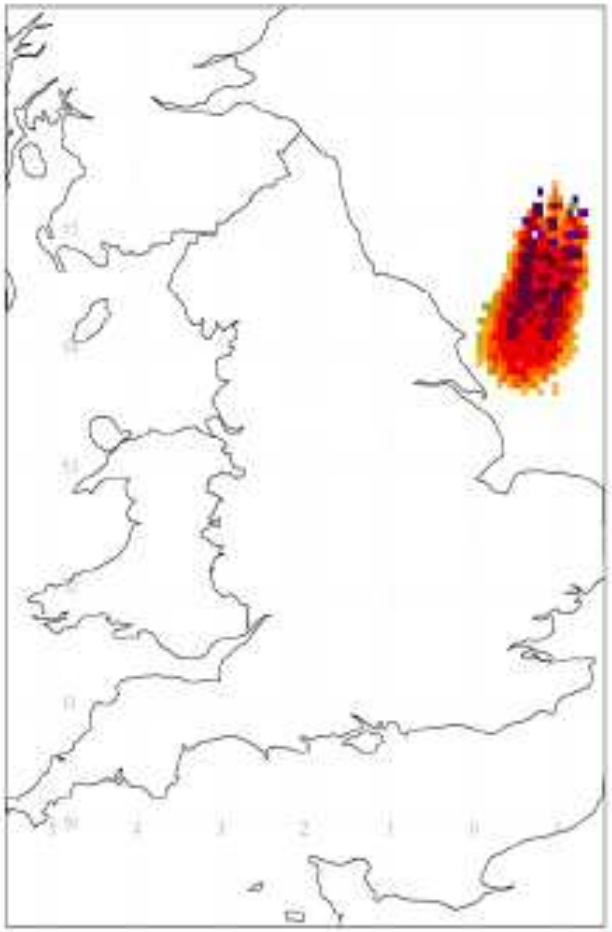


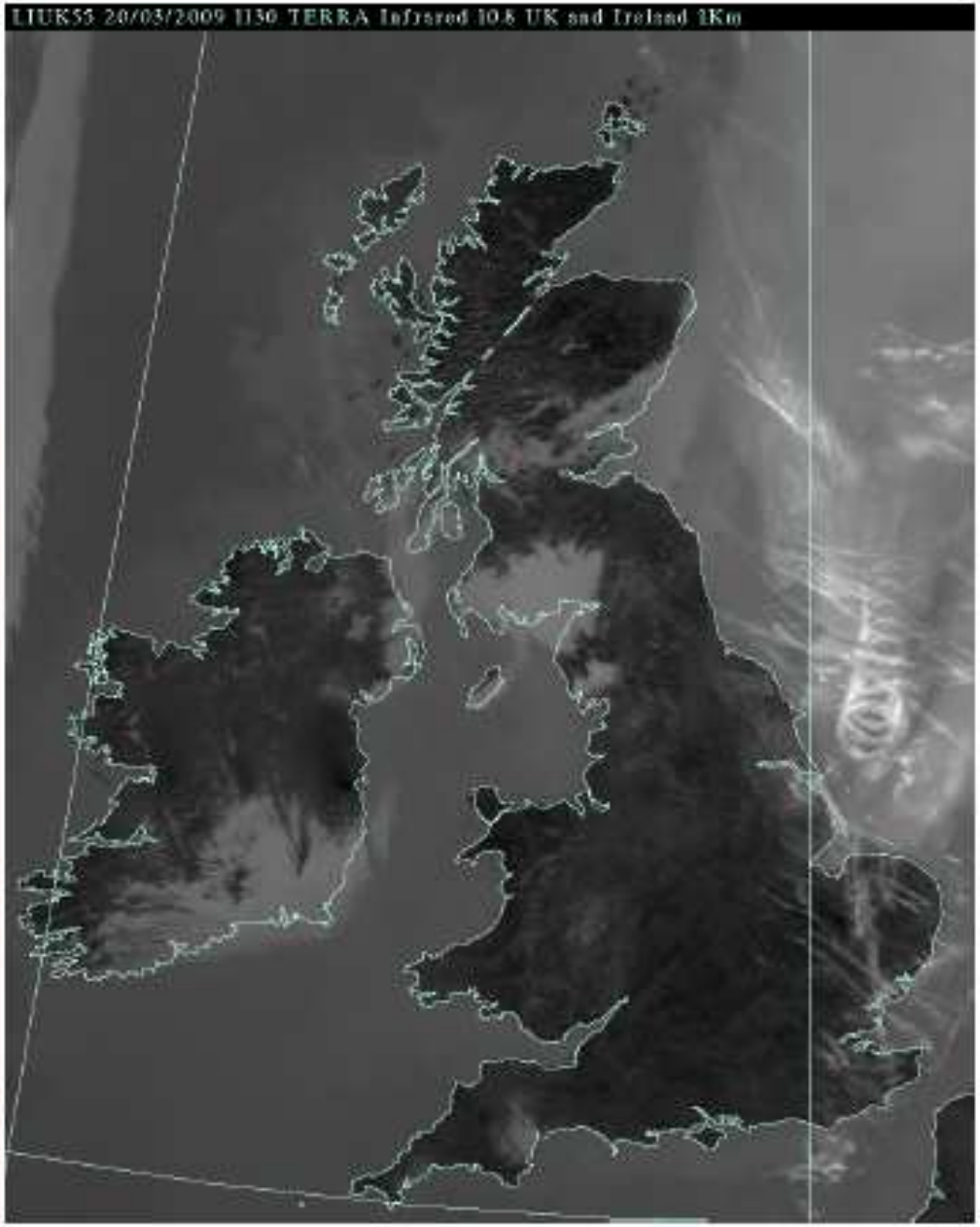


Courtesy of Jim Haywood

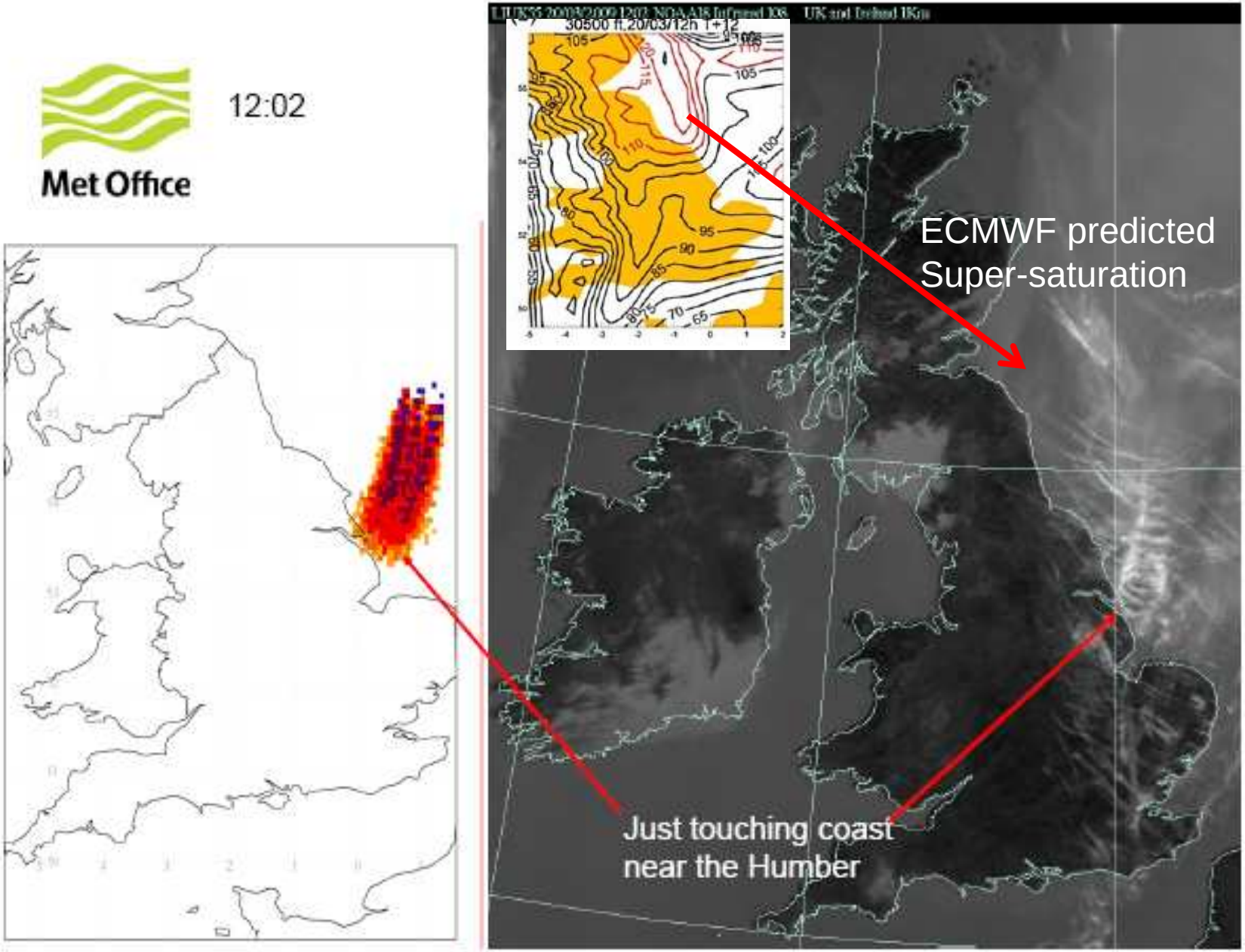
Met Office

11:30





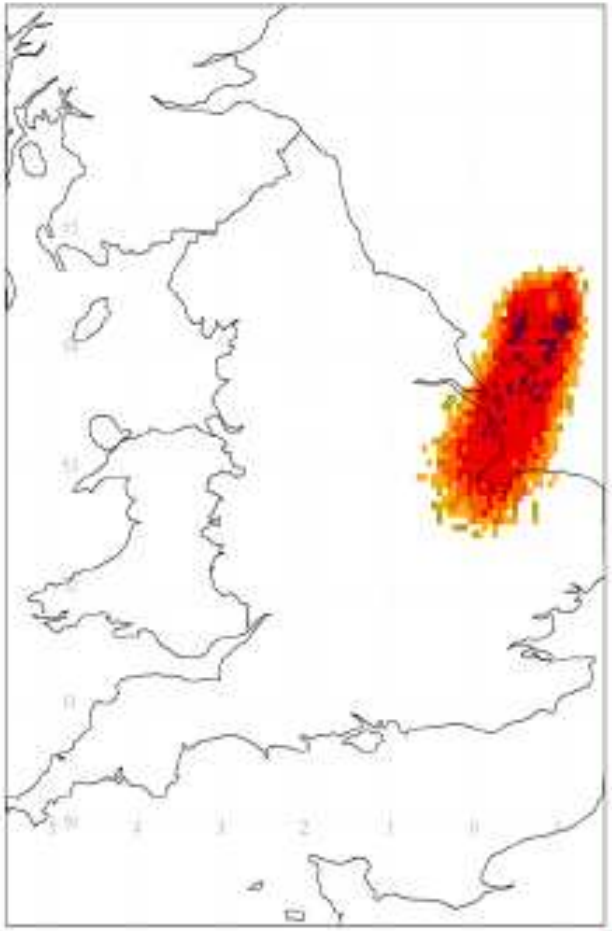
Courtesy of Jim Haywood

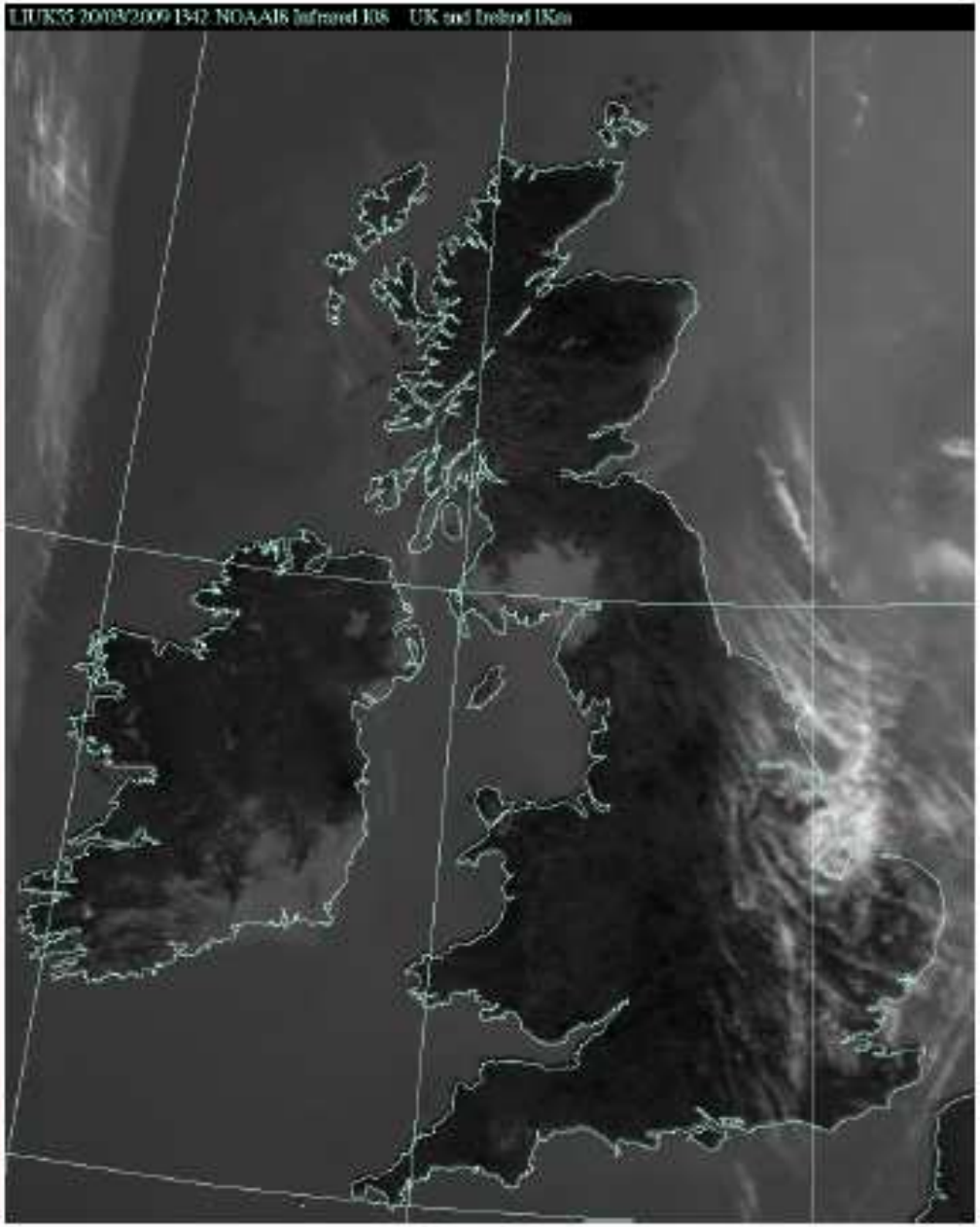


Courtesy of Jim Haywood

Met Office

13:42

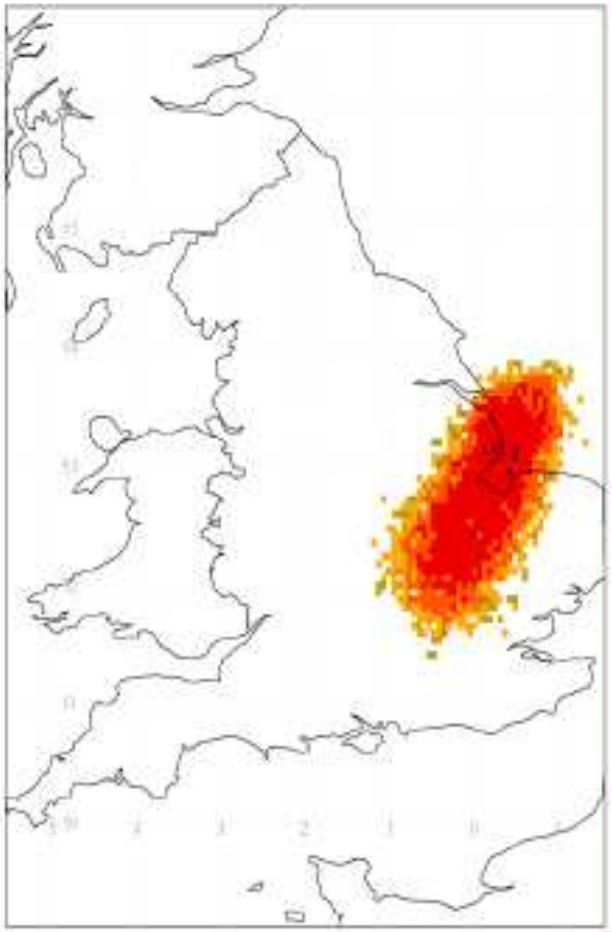


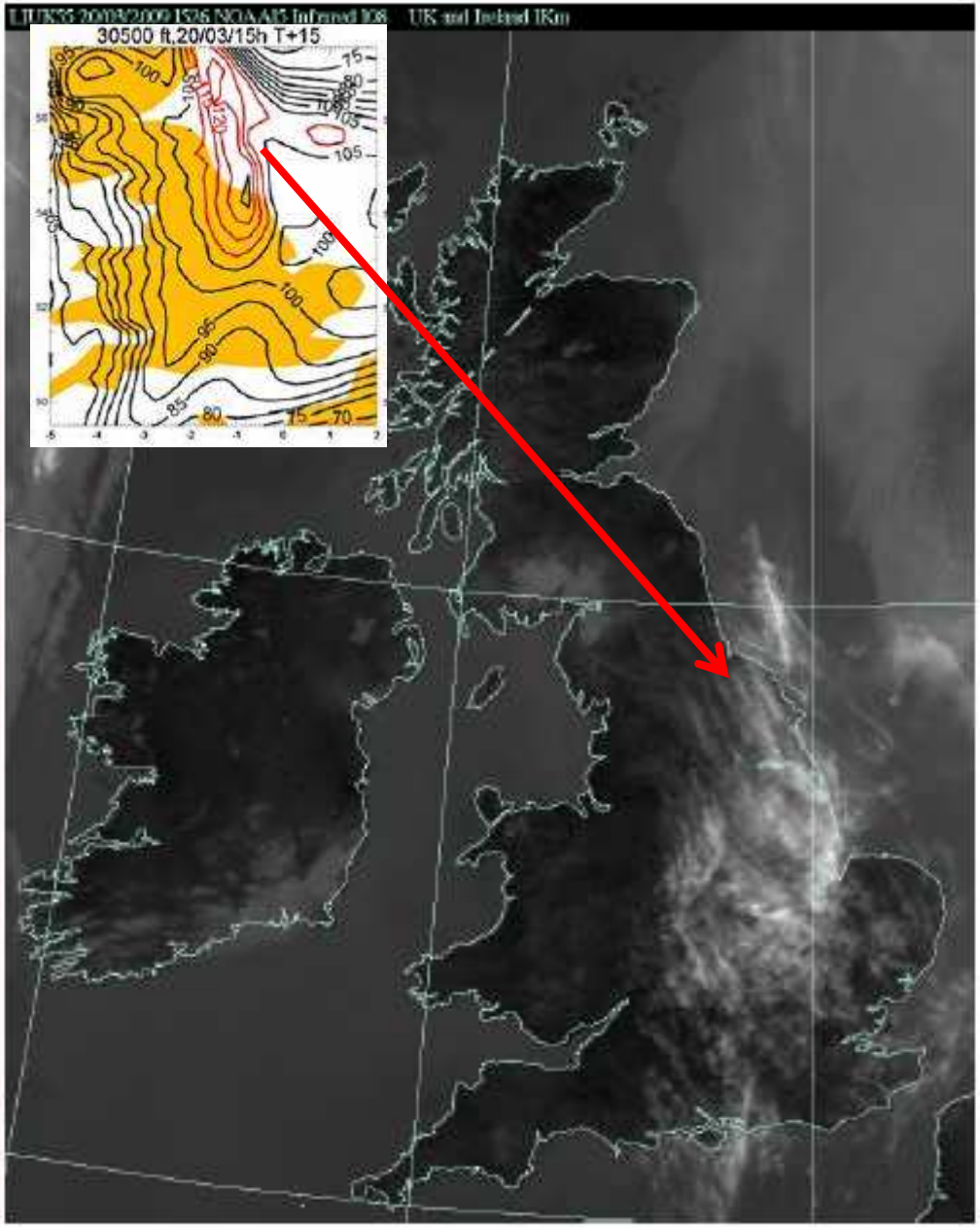


Courtesy of Jim Haywood

Met Office

15:26

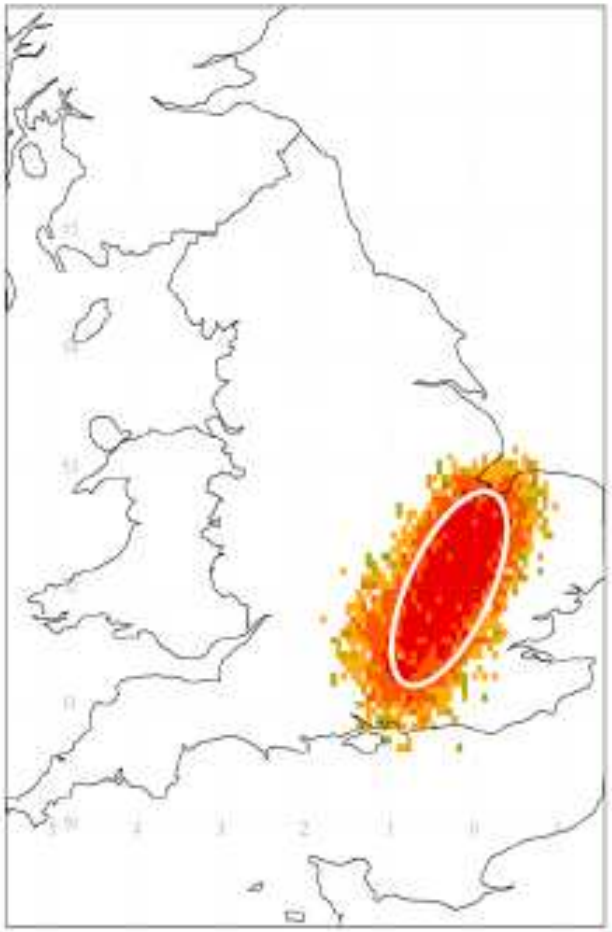


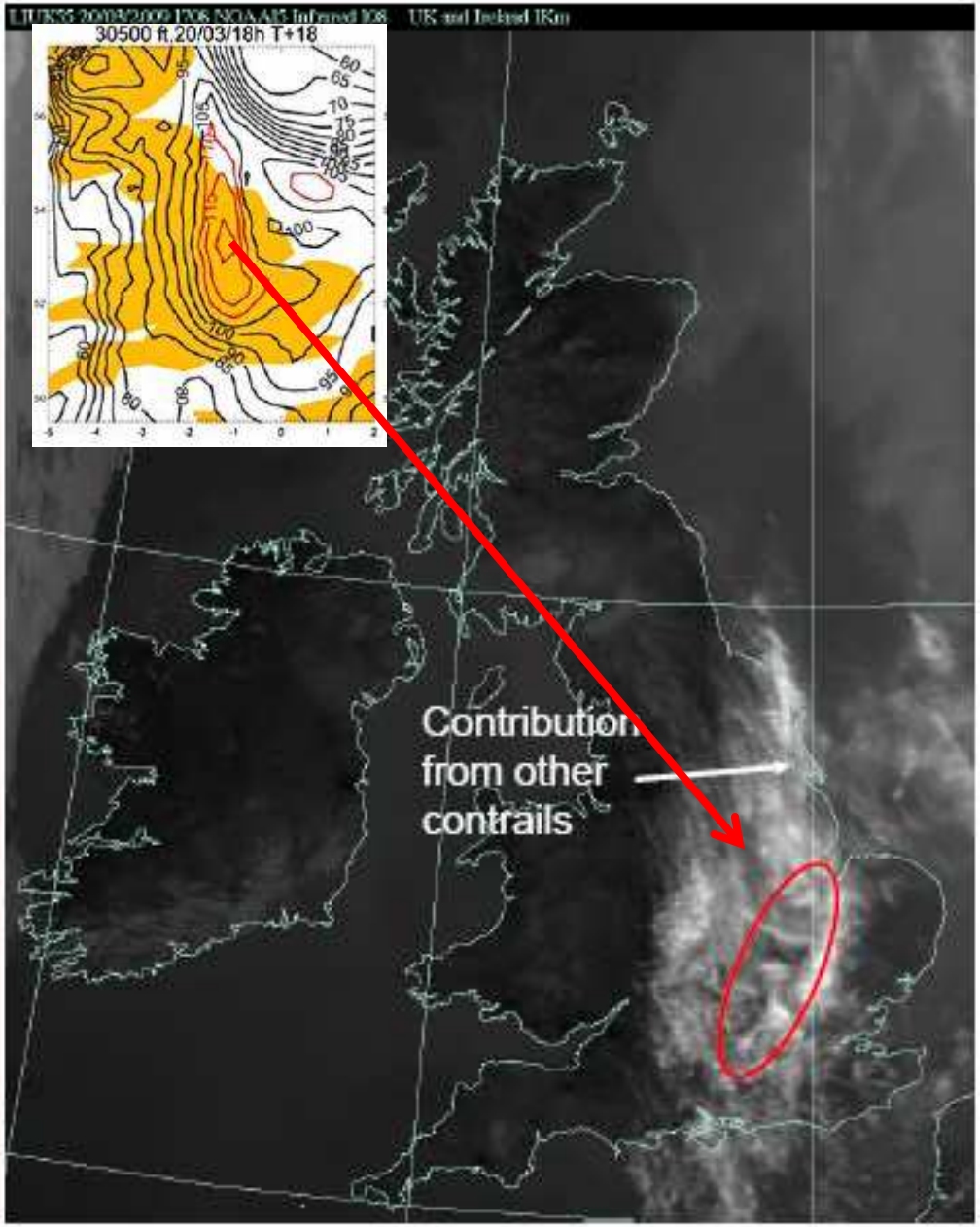


Courtesy of Jim Haywood

Met Office

17:08

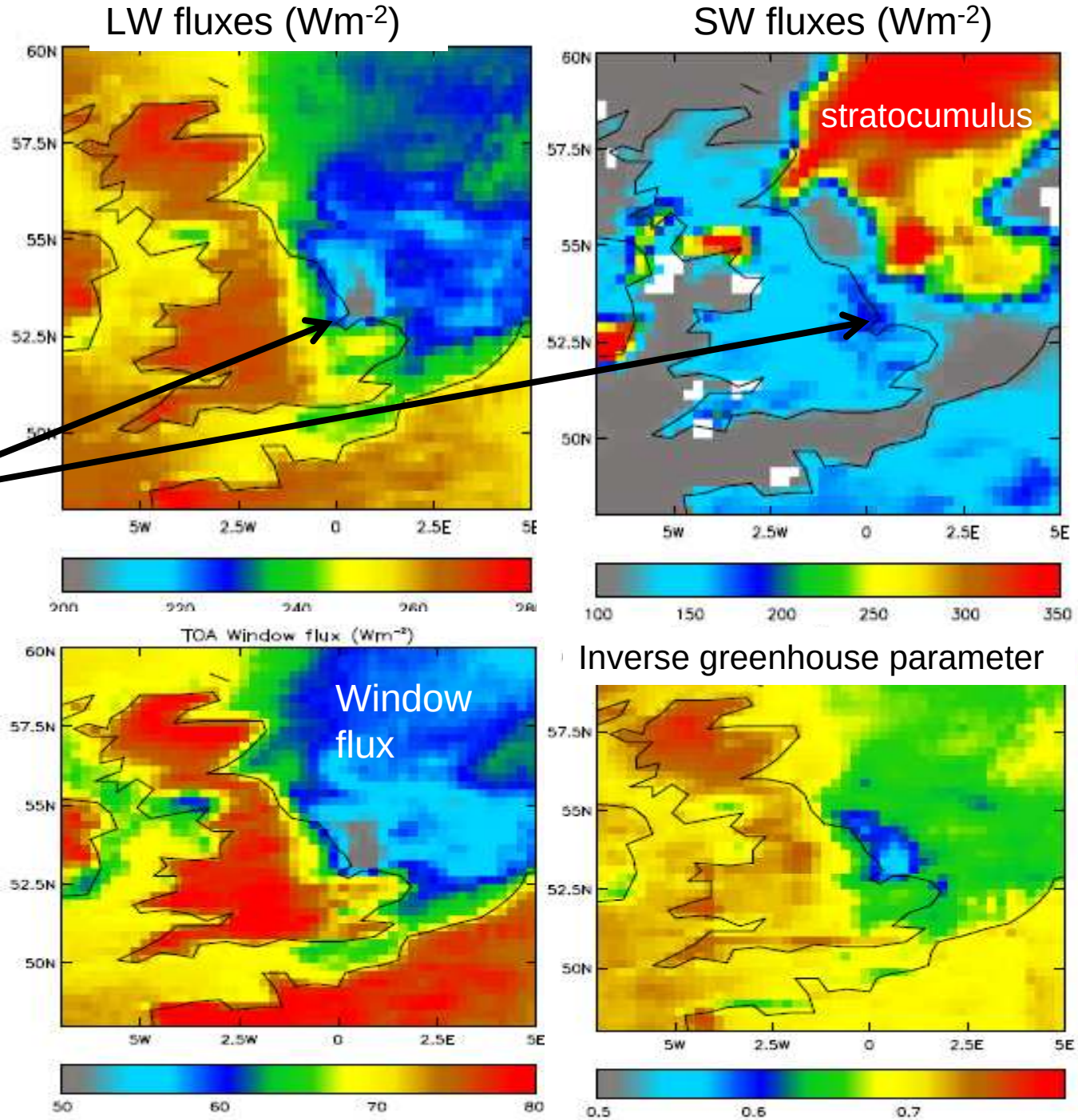




Courtesy of Jim Haywood

CERES FM3 (Aqua) FLASH fluxes 13:25

Contrail induced cirrus



Using GERB/NWP model estimate radiative effect of contrail cirrus:

LW ~ 40 Wm^{-2}

SW up to 80 Wm^{-2}

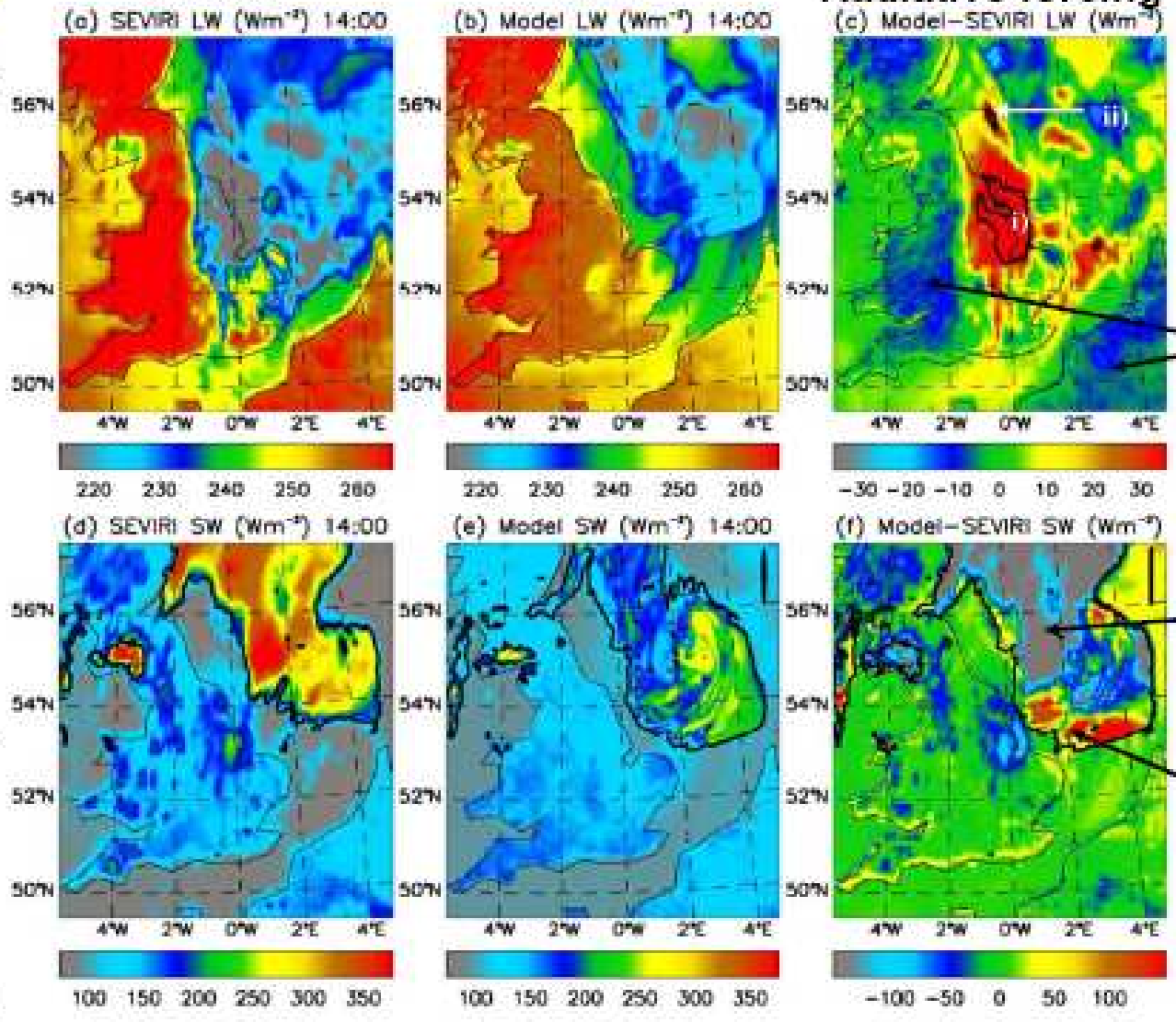
Using GERB-like/SEVIRI to quantify contrail radiative effects

Example at 14:00Z

SEVIRI | **UK4** | **UK4-SEVIRI: Radiative forcing**

LW (no cloud screening)

SW (cloud mask shown)



i) & ii) Areas > 40Wm⁻²

Cold bias over land in UK4 model in cloud free regions (*John Edwards, pers comm*)

Very large differences in brightness of Sc.

Some positional errors of the model Sc

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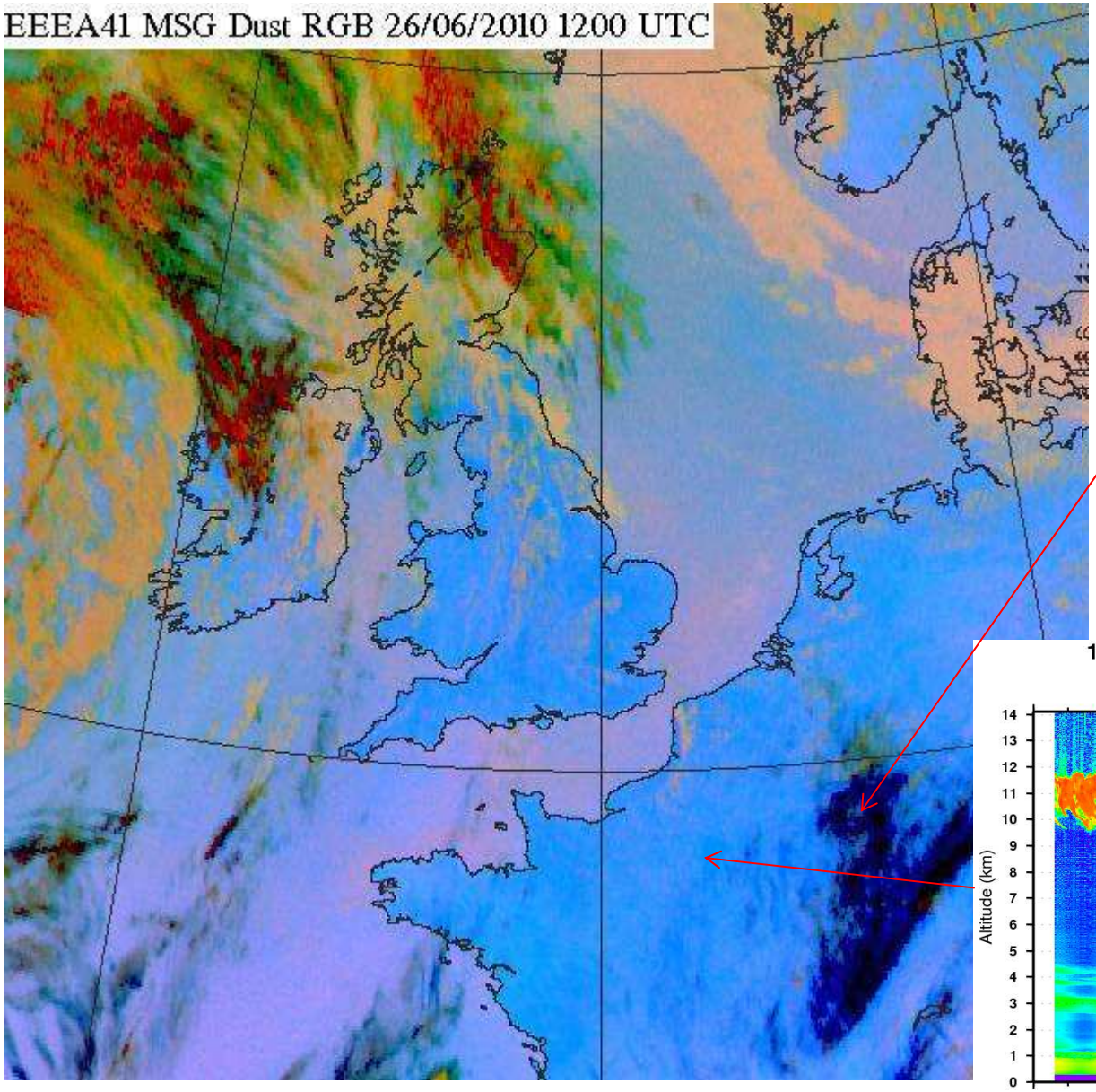
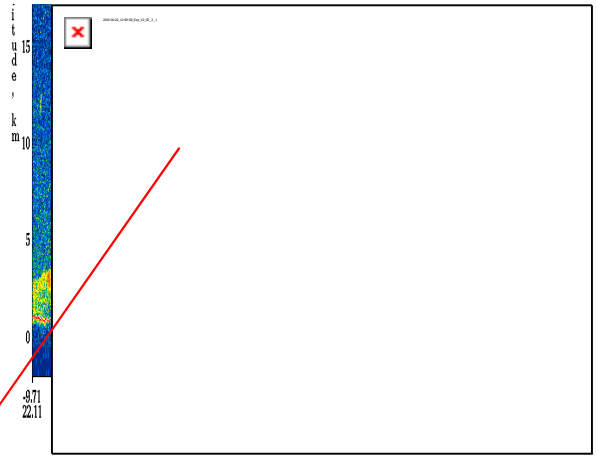
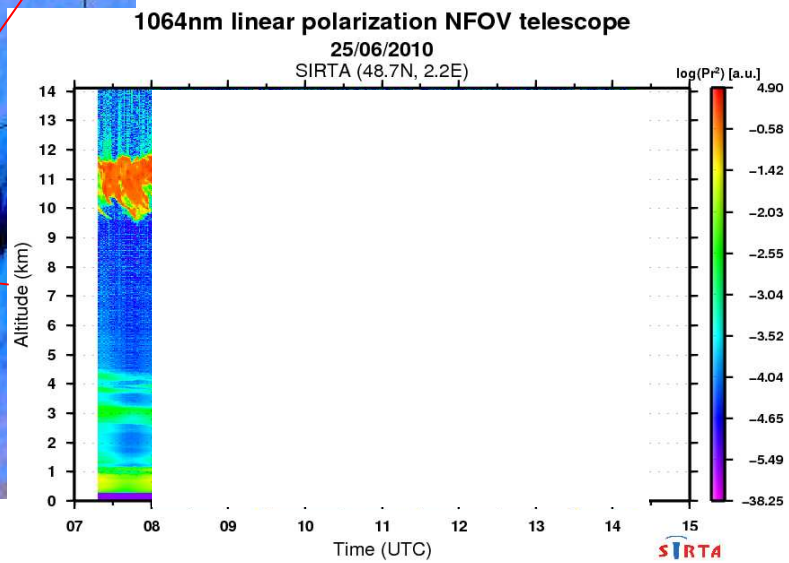
Haywood et al. (2009) JGR

Case II: 25-26/06/2010

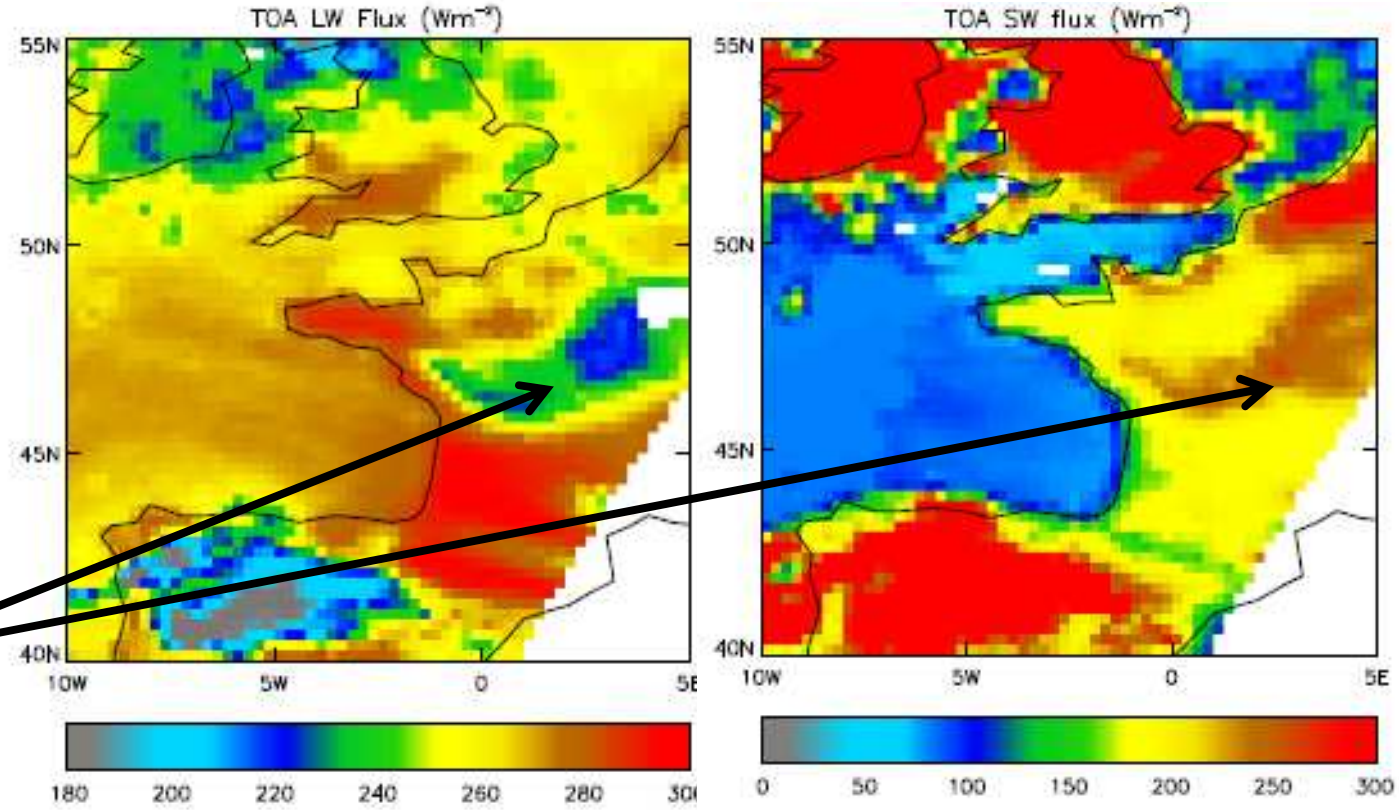






LW and SW radiation: CERES

- CERES FM1 FLASH flux (Terra) 11:45am 25th June 2010
- LEFT: TOA LW (Wm^{-2})
- RIGHT: TOA SW flux (Wm^{-2})

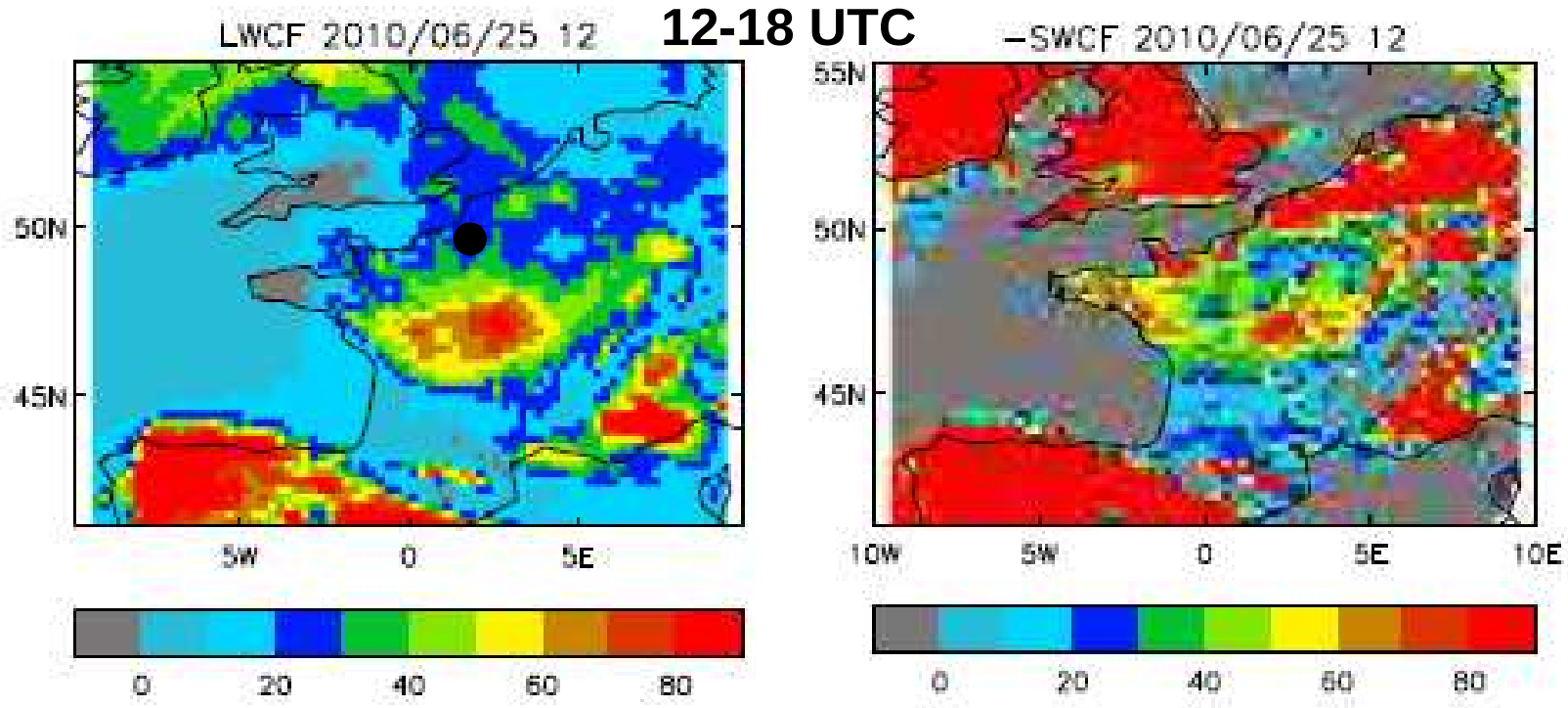


Contrail induced cirrus

LW and SW cloud radiative effect

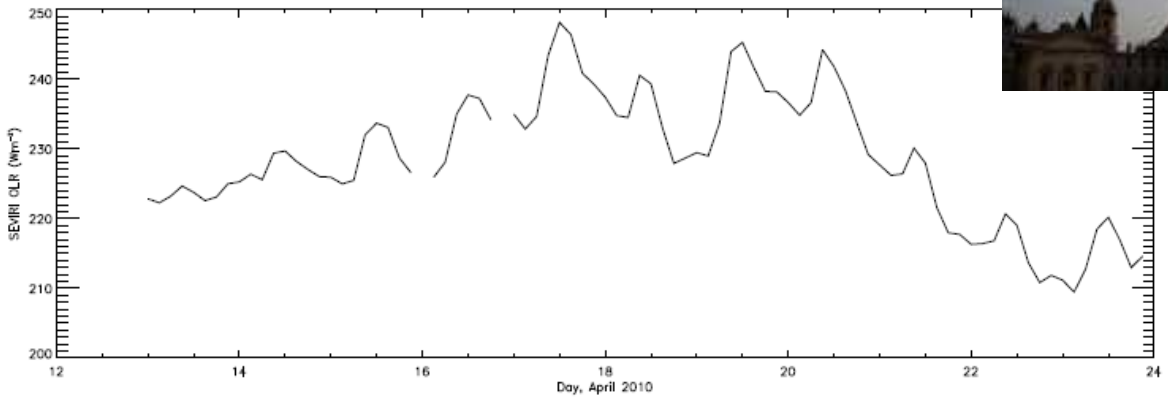
- Estimated using GERB/SEVIRI minus NCEP clear-sky
- LW and SW cloud radiative effect up to 80 Wm^{-2} (small net effect at midday)
- But would cirrus have formed anyway?

12-18 UTC

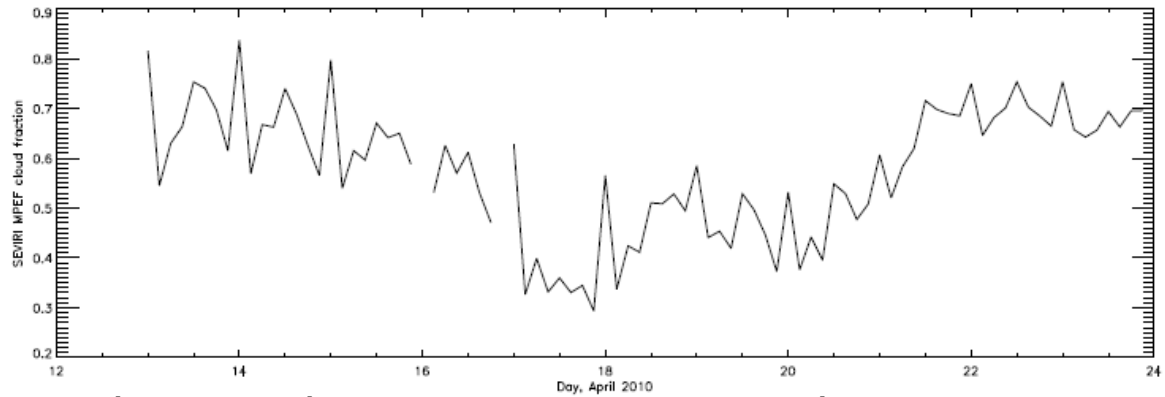


Was there any contrail effect following the Iceland Volcano?

SEVIRI OLR



MPEF Cloud



Airspace closure → Airspace reopens →

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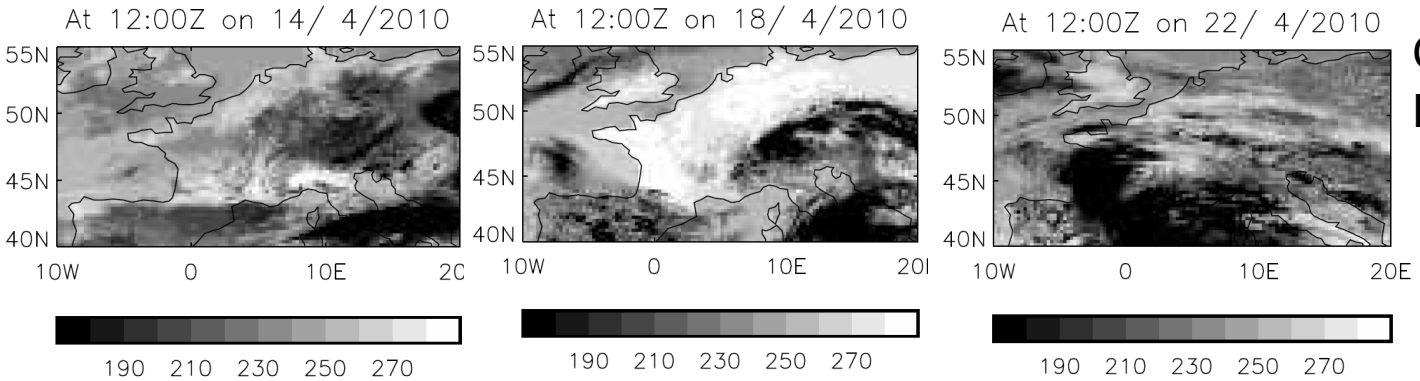
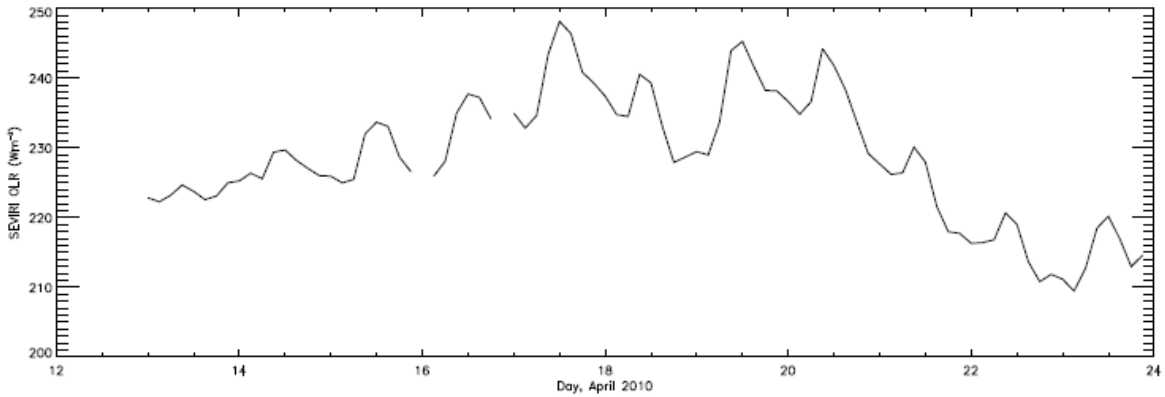
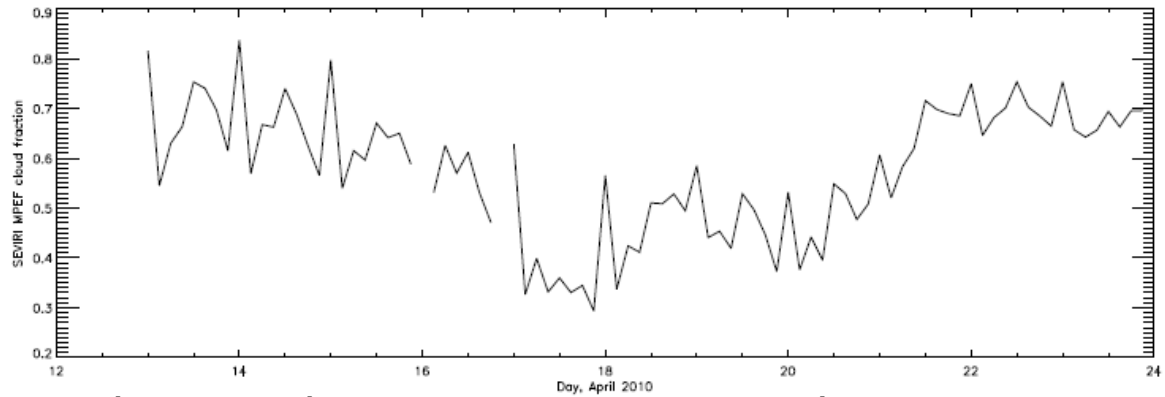


GERB HR (V003)
LW fluxes

SEVIRI OLR



MPEF Cloud



Airspace closure → ← Airspace reopens

...unlikely! Probably more related to advection of dry air and subsequent encroachment of mid-latitude system.

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Summary

- Mineral dust aerosol
  - LW radiative effect at TOA up to 40 Wm^{-2}
  - GERBILS field campaign
- Model Cloud
  - Stratocumulus too bright?
  - Cannot tune to TOA radiation; need to get bulk physical properties right
  - Very sensitive to model changes (e.g. Convection)
- Persistent contrail cirrus
  - Up to 80 Wm^{-2} LW and SW radiative effect
  - Small net effect, but large dynamical forcing
- Further work: Radiative divergence, Monitoring of ERB & precipitation drifts, evaluation of climate model regimes

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Recommendations for GERB monthly products

- Based upon consultation with scientists at Met Office/DWD and from CERES team
- FORMAT
  - NetCDF regular gridded data highly desirable
  - 0.25x0.25 degree high resolution product?
- PRODUCTS
  - Monthly mean diurnal cycle for each month
  - Also single file containing all monthly diurnal means
  - Daily means?
- VARIABLES
  - Incoming and Reflected SW (+clear for mean products)
  - Outgoing LW (+clear-sky for mean products)
  - Cloud fraction
  - Uncertainty estimates for each product

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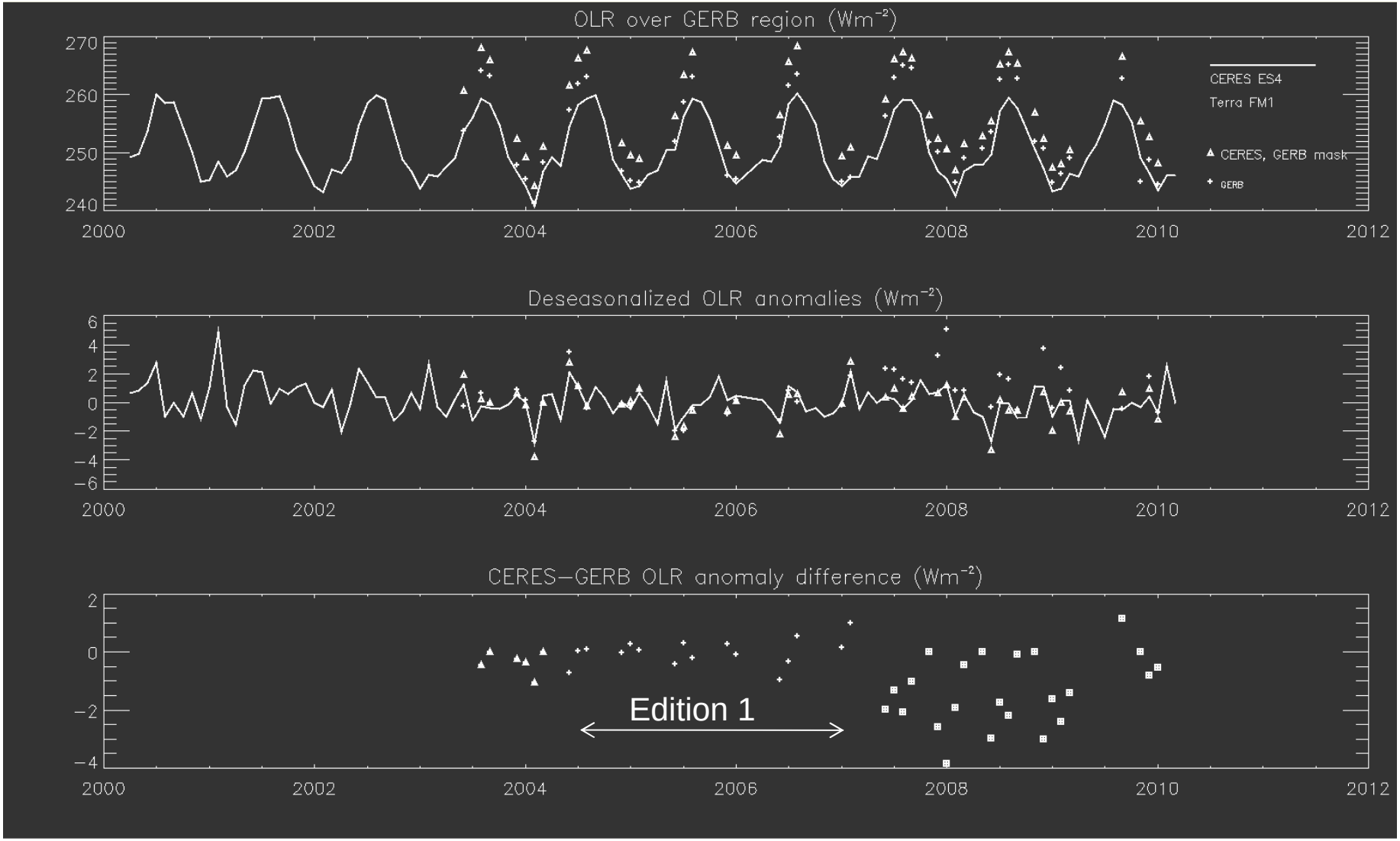
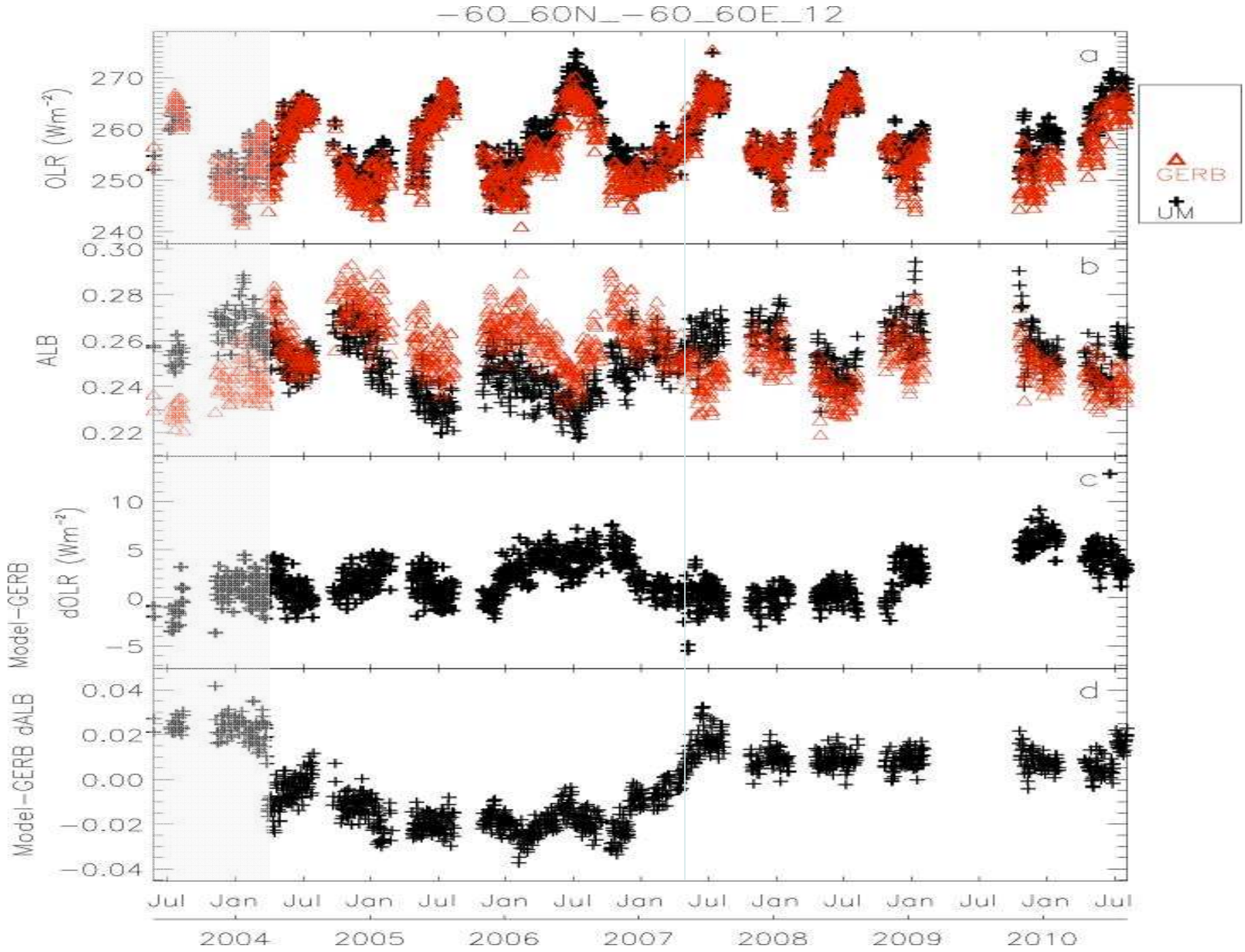
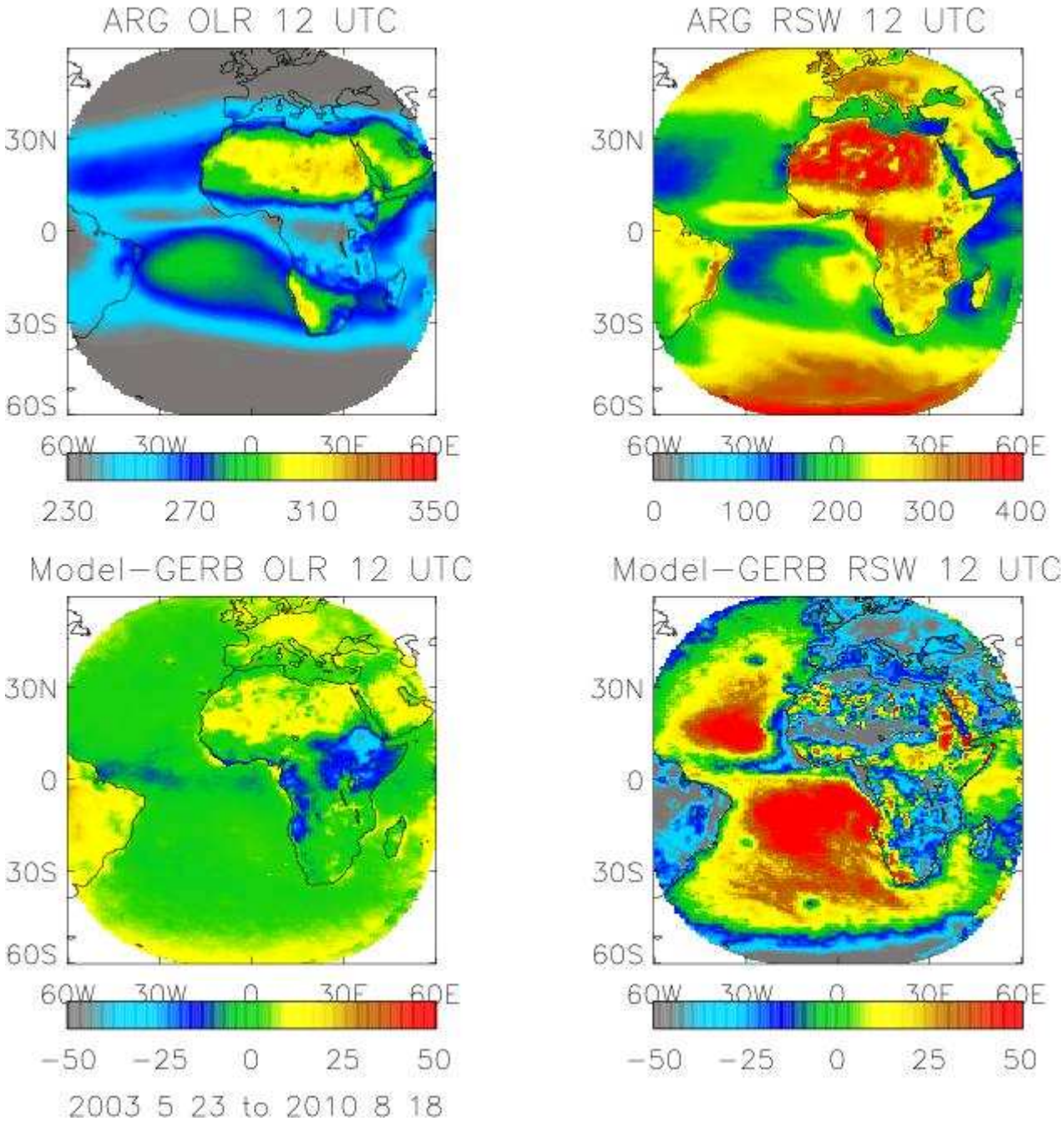
GERB/CERES comparison




−60_60N_−60_60E_12
a
b
c
d
OLR (Wm^{-2})
ALB
Model−GERB dOLR (Wm^{-2})
Model−GERB dALB
GERB
UM
Jul
Jan
2004
2005
2006
2007
2008
2009
2010



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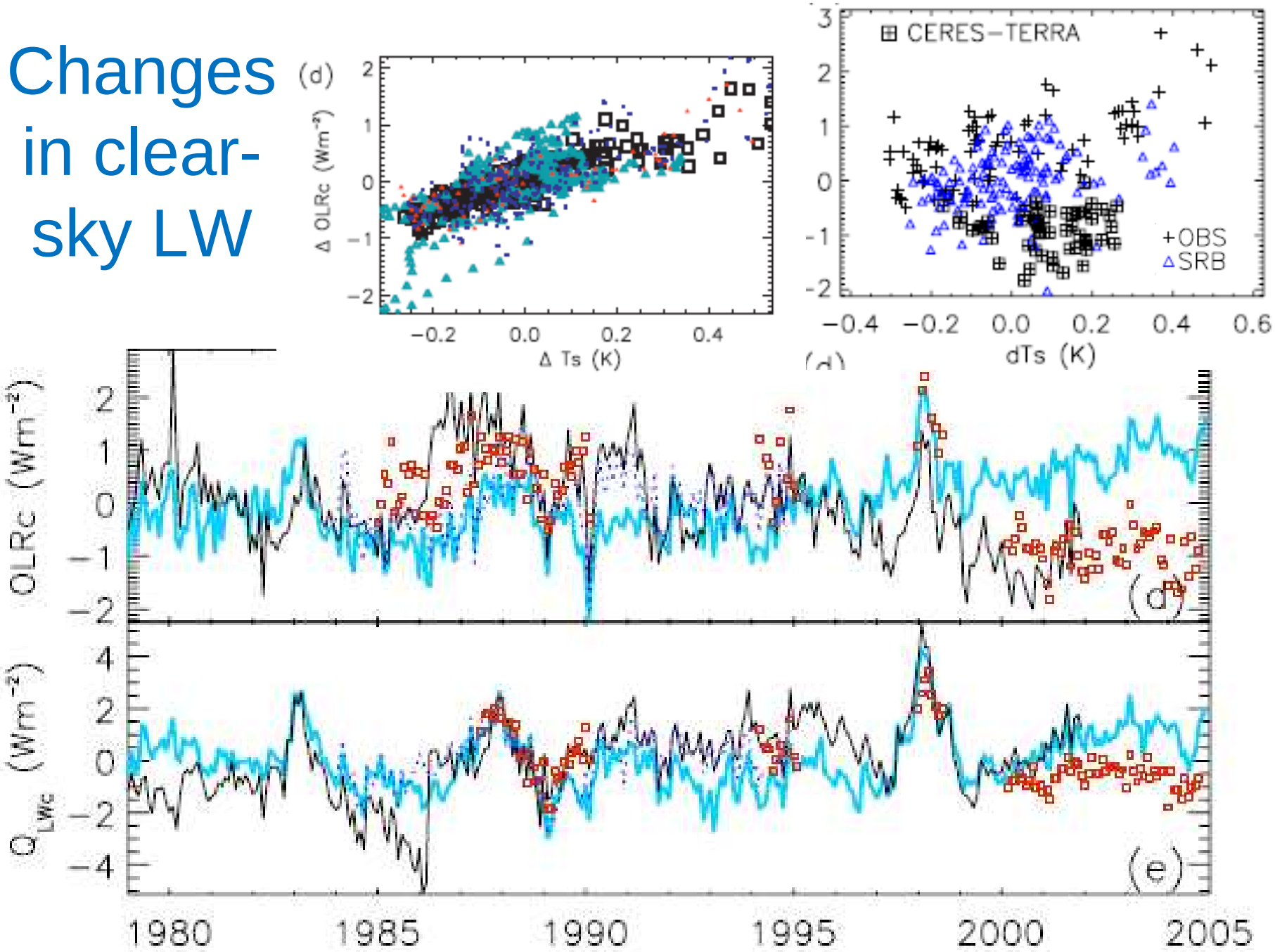
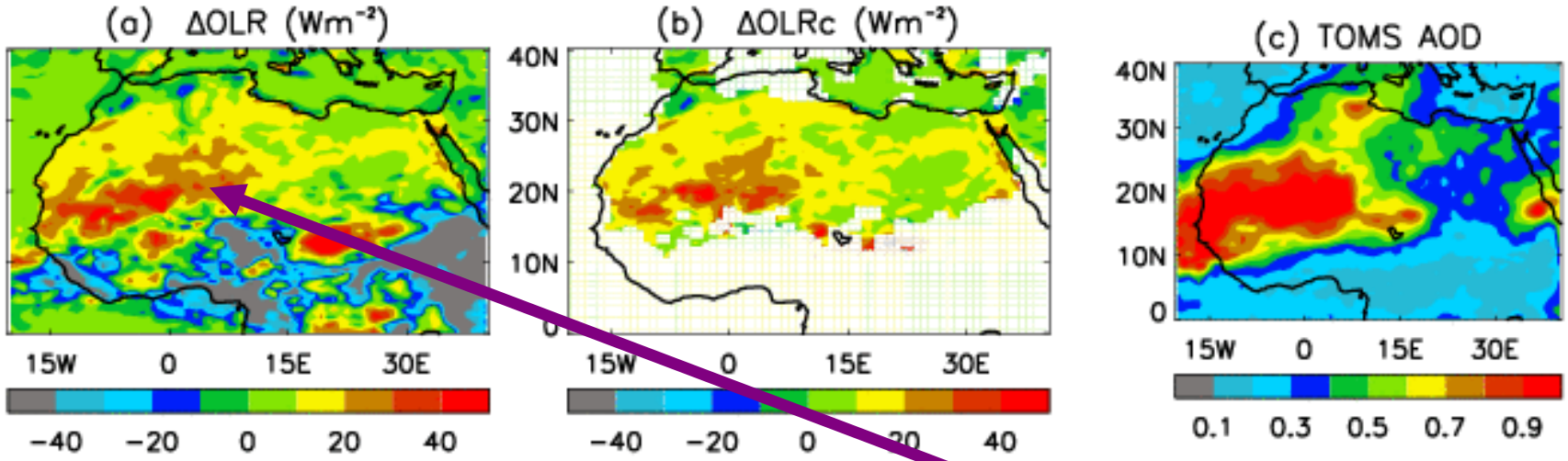
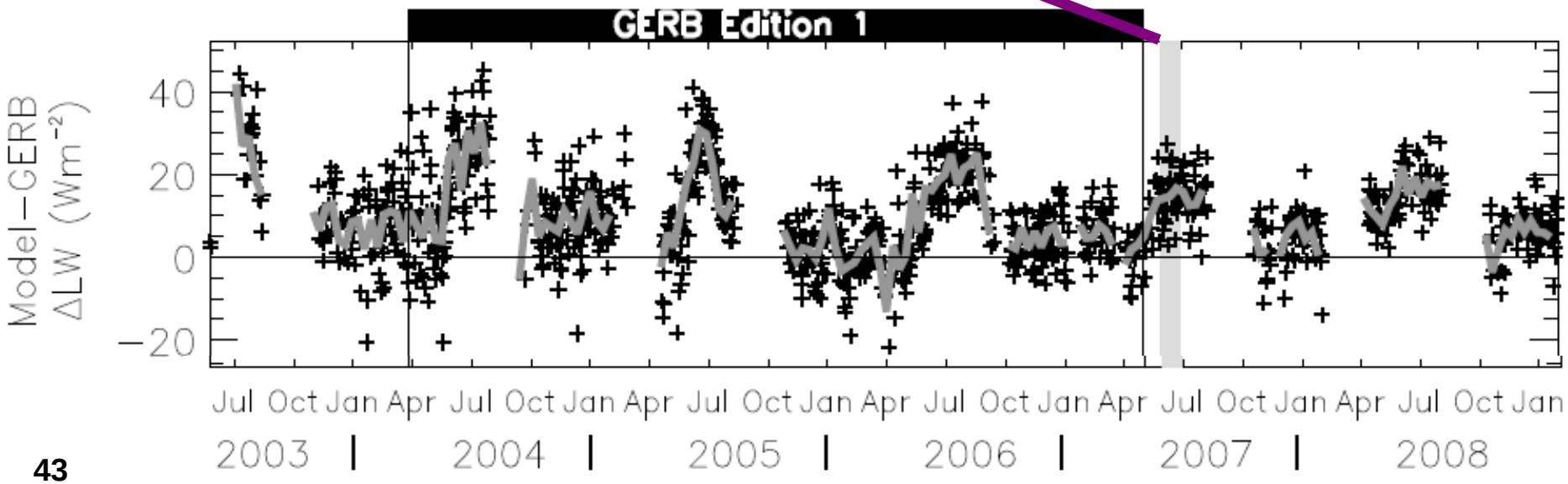
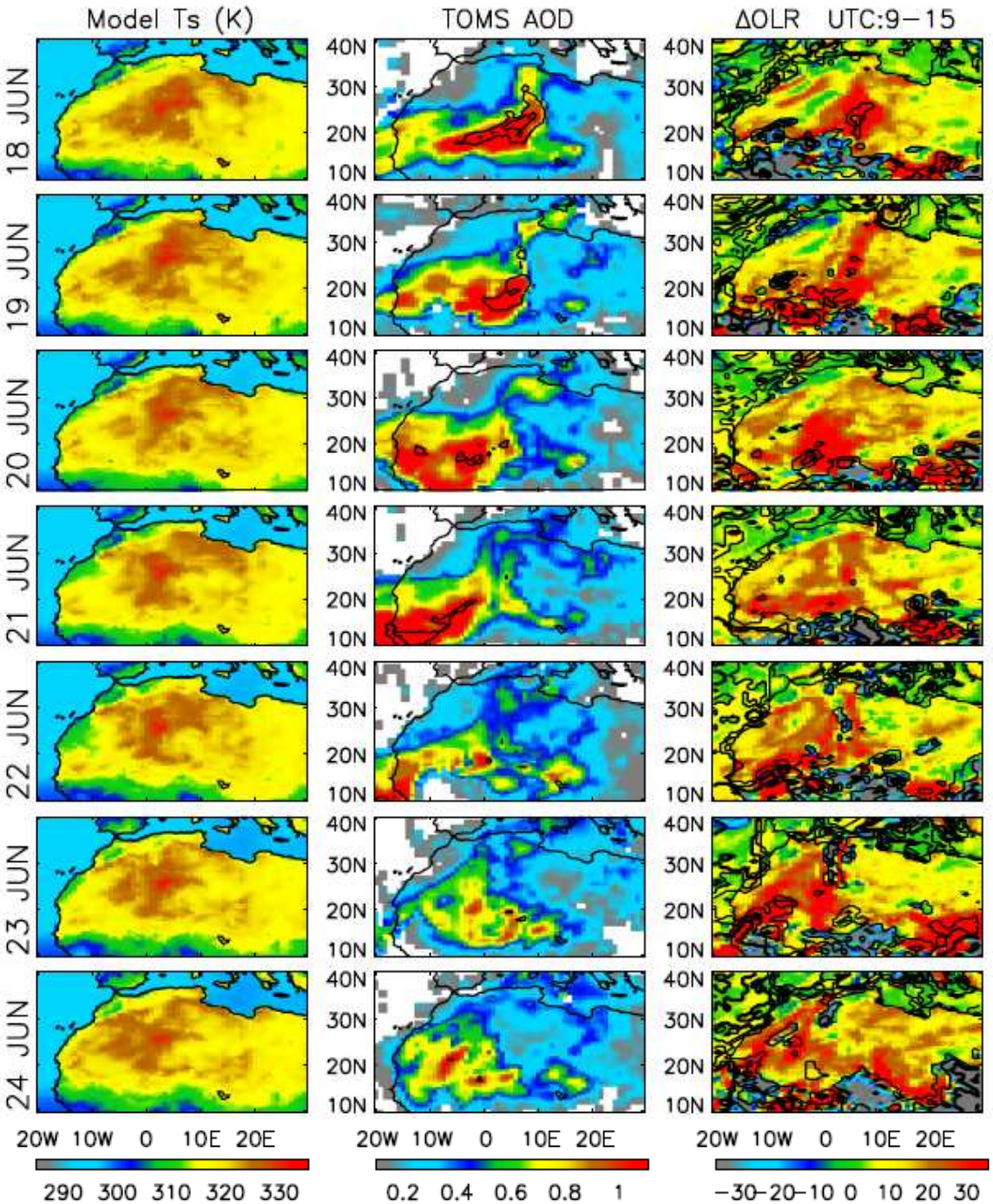
Changes in clear-sky LW



GERBILS 18-28 June 2007







Model-GERB

University of Reading

Aircraft field campaign to investigate radiative effect of dust over West Sahara and improve model simulations

Lead by Jim Haywood (UK Met Office)

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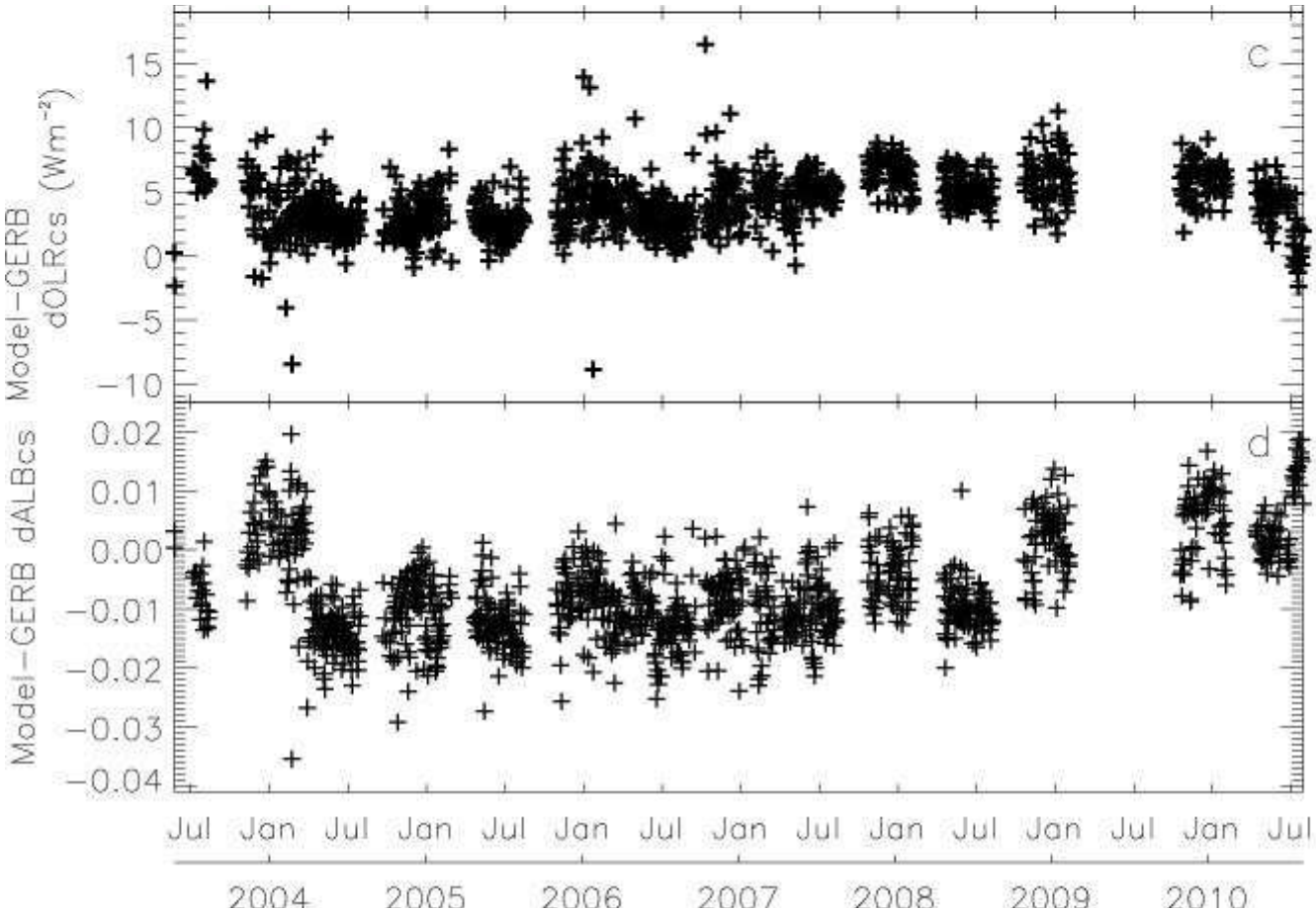
Clear Ocean



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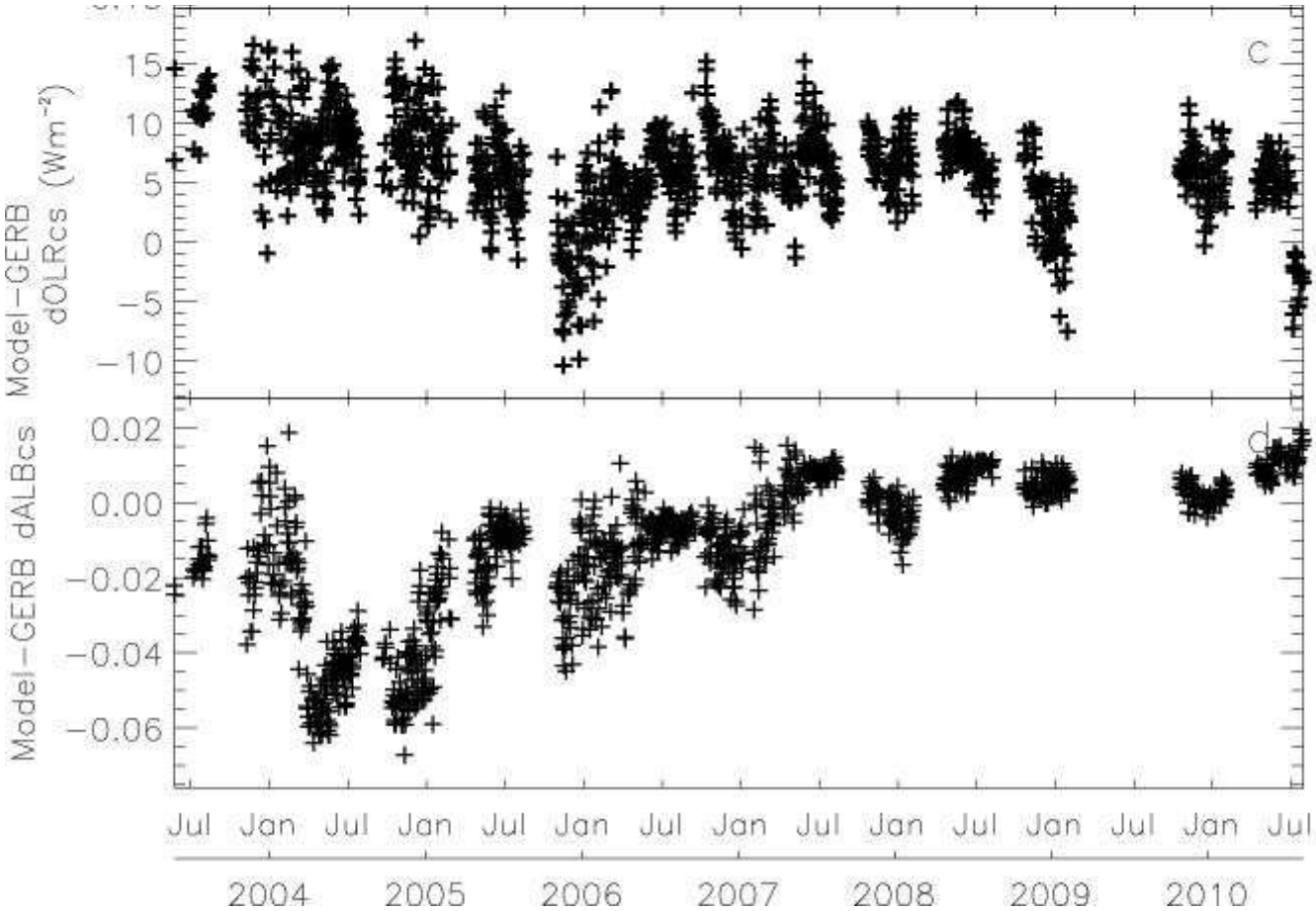
Clear Land



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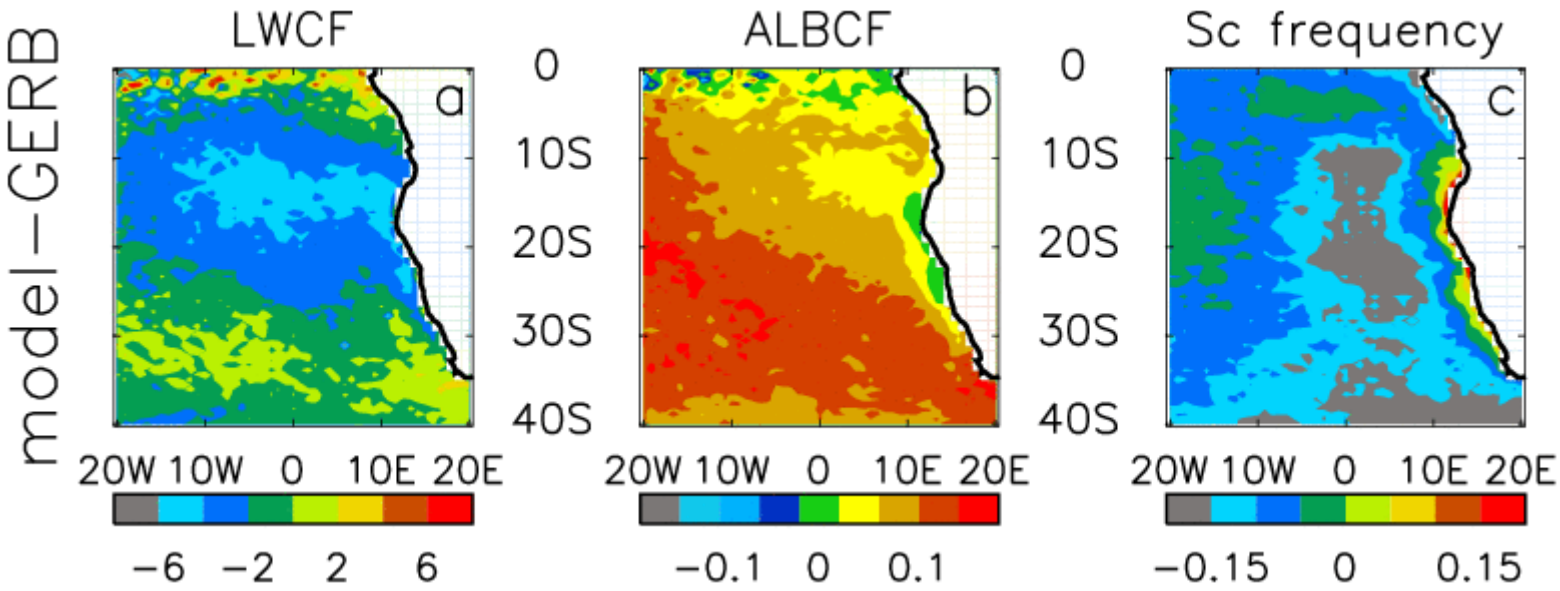
NWP model cloud radiative bias:
overcast Sc-cover pixels only (2003-2010)



- LW cloud effect too small (~ -5 Wm^{-2})
- SW cloud effect too large
- Too little stratocumulus cloud cover

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