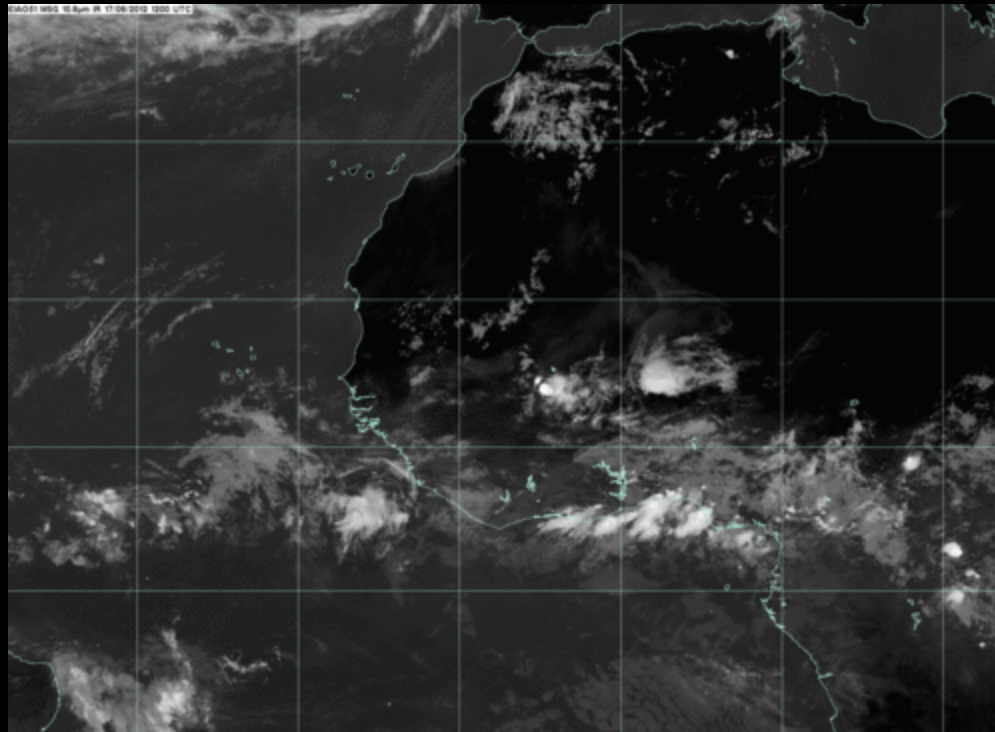


The Diurnal Cycle Storms v. African Easterly Waves

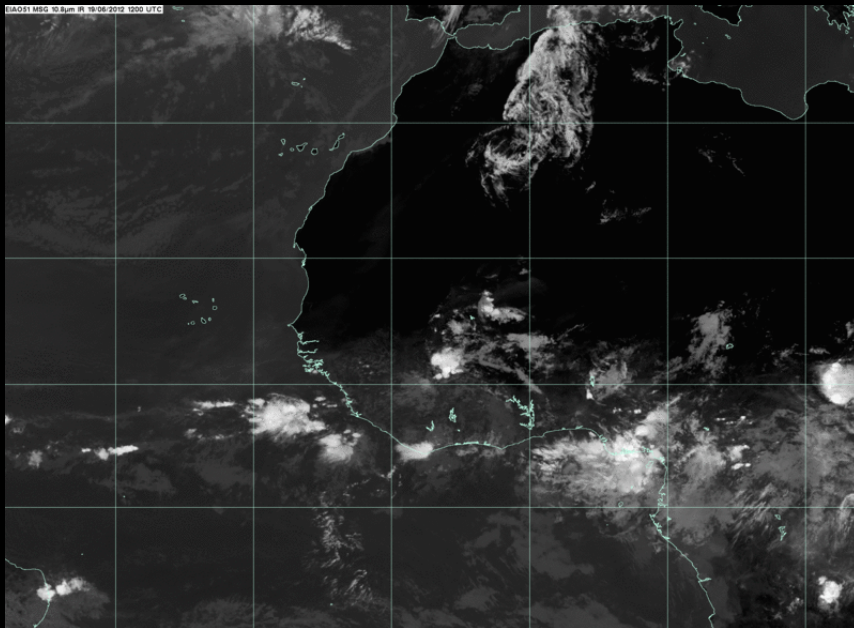
Caroline Bain

Met Office, Exeter, UK

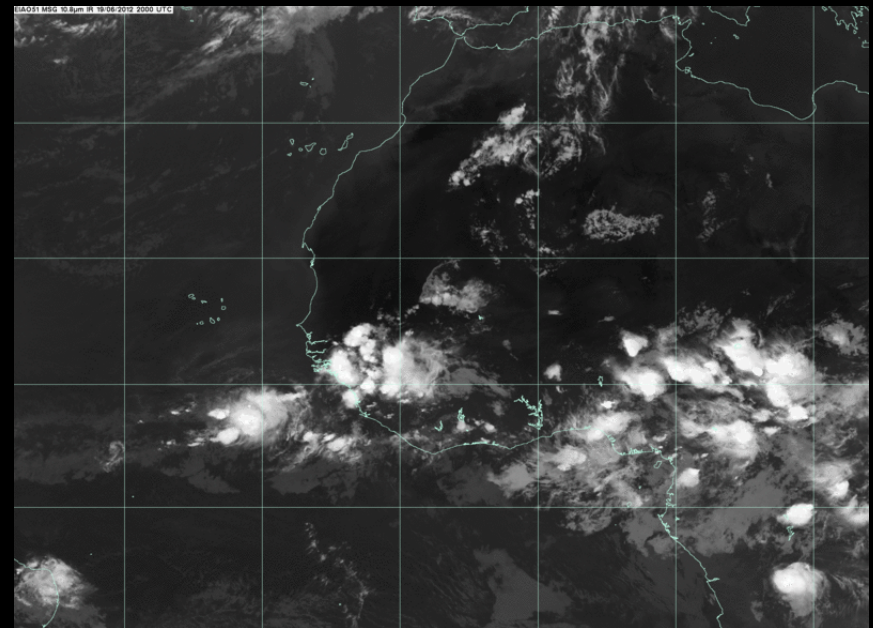
IR Satellite: 17-19th June 2012



What is the impact of the diurnal cycle on storms?



12:00 19th June 2012



20:00 19th June 2012

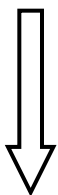
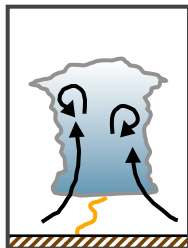


Met Office

Impact of the diurnal cycle on storms

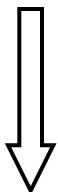
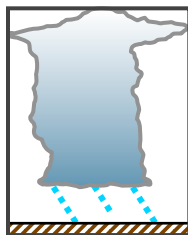
storm growing

- strong updrafts
- lots of graupel production
- lightning peaks



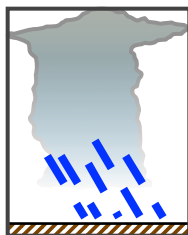
storm early mature stage

- anvil formation
- coldest cloud top
- overtopping



storm later mature stage

- peak rainfall

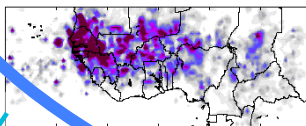


Enhanced phase

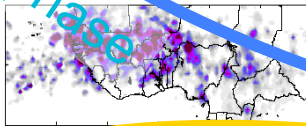
Suppressed phase

Enhanced phase

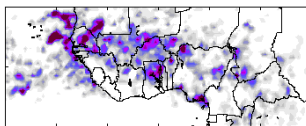
Diurnal cycle of Lightning
(no. strikes): JAS 2010



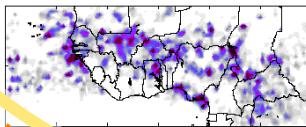
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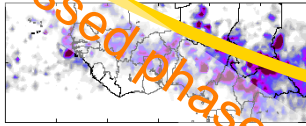
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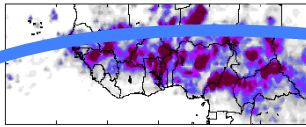
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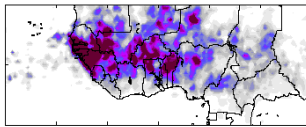
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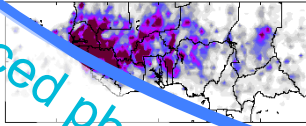
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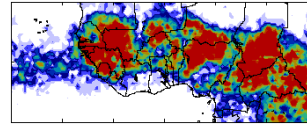
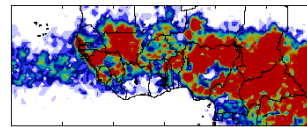
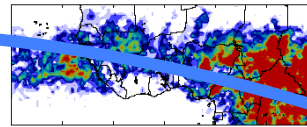
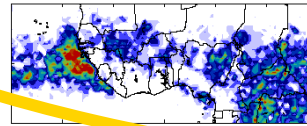
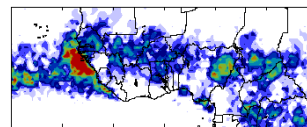
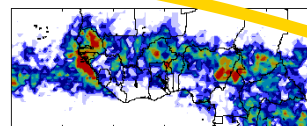
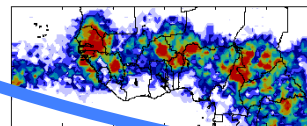
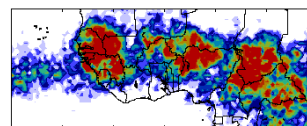
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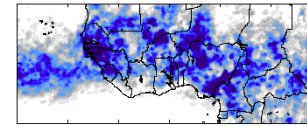
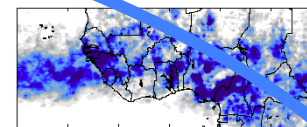
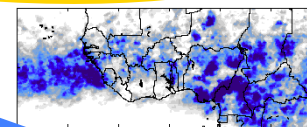
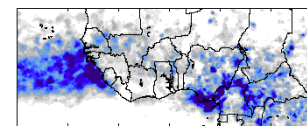
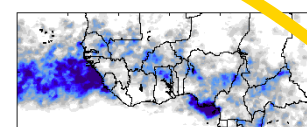
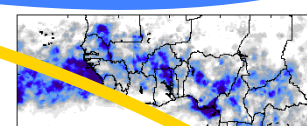
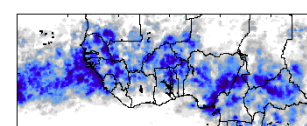
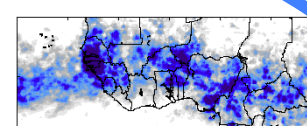
21



Diurnal cycle of Cloud<220K
(%): JAS 2005



Diurnal cycle 11.1MM
(mm/day): JAS 2009



Impact of diurnal cycle on storms

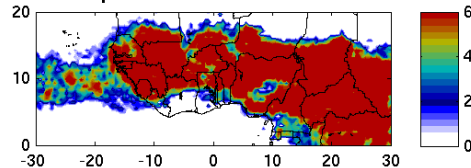
COLD CLOUD (2005)

TRMM RAIN (2009)

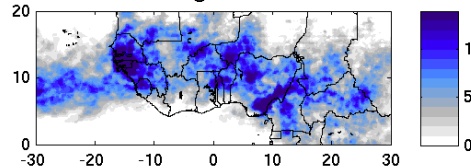
LIGHTNING (2010)

Mean Storms during
evening (18-21)

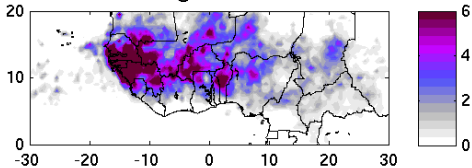
Mean Deep Cloud % EVENING 18-21 UTC



Mean TRMM during EVENING 21-00 UTC

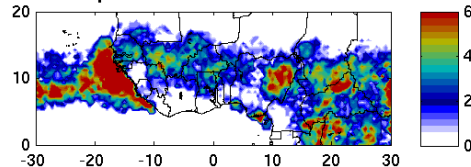


Mean ATD during EVENING 18-21 UTC

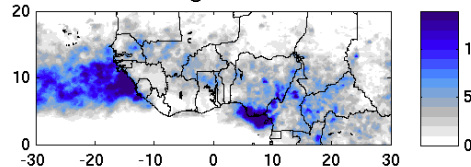


Mean Storms during
morning (09-12)

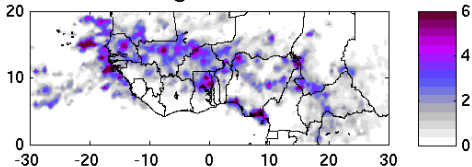
Mean Deep Cloud % MORNING 09-12 UTC



Mean TRMM during MORNING 09-12 UTC

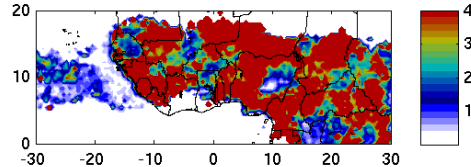


Mean ATD during MORNING 06-09 UTC

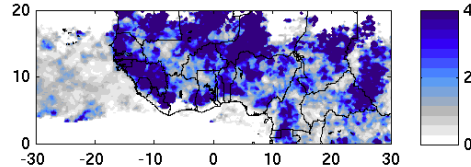


Diurnal enhancement

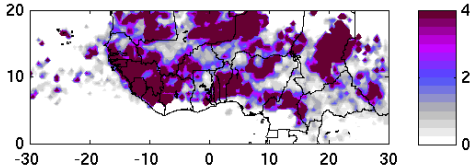
EVENING/ MORNING enhancement



EVENING/ MORNING enhancement



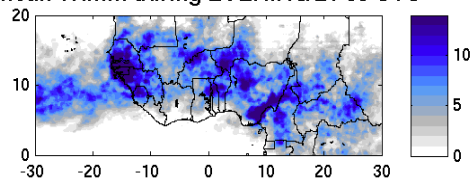
EVENING/ MORNING enhancement



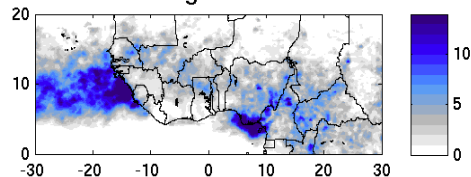
Diurnal cycle in MetUM: Climate mode Atmosphere only N96 GA3

Observations

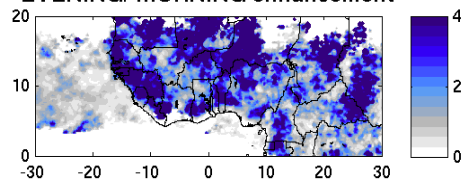
Mean TRMM during EVENING 21-00 UTC



Mean TRMM during MORNING 09-12 UTC

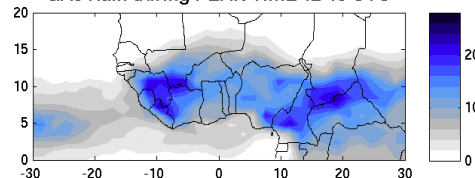


EVENING/ MORNING enhancement

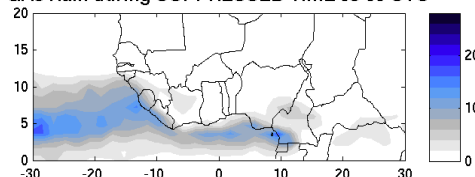


Model

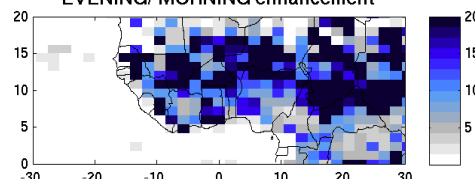
GA3 Rain during PEAK TIME 12-15 UTC



GA3 Rain during SUPPRESSED TIME 03-06 UTC

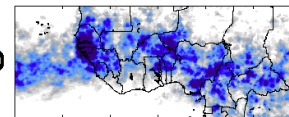


EVENING/ MORNING enhancement

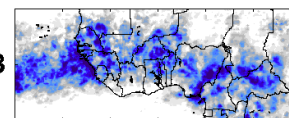


Diurnal cycle TRMM
(mm/day): JAS 2009

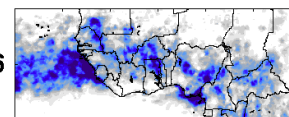
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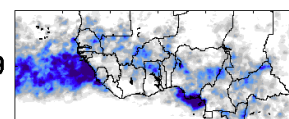
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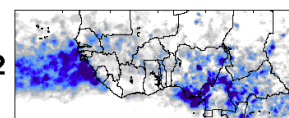
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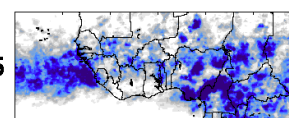
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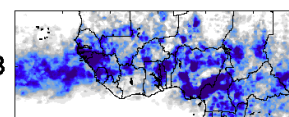
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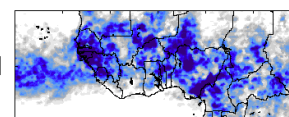
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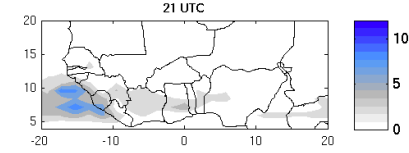
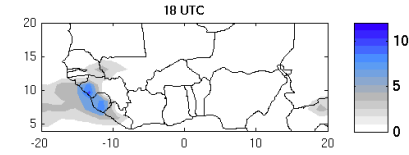
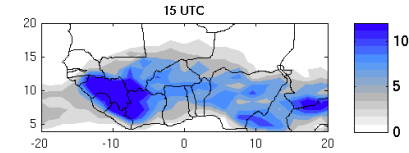
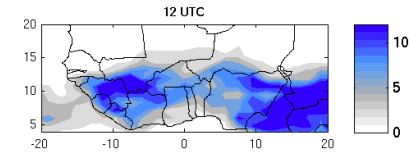
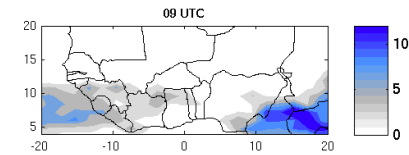
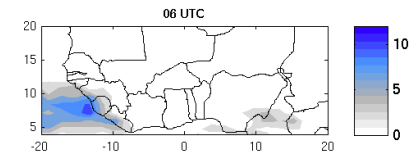
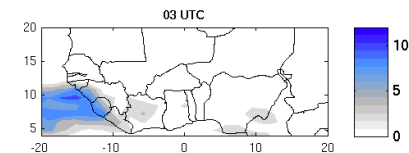
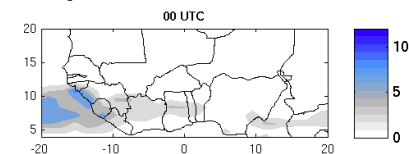
18



21



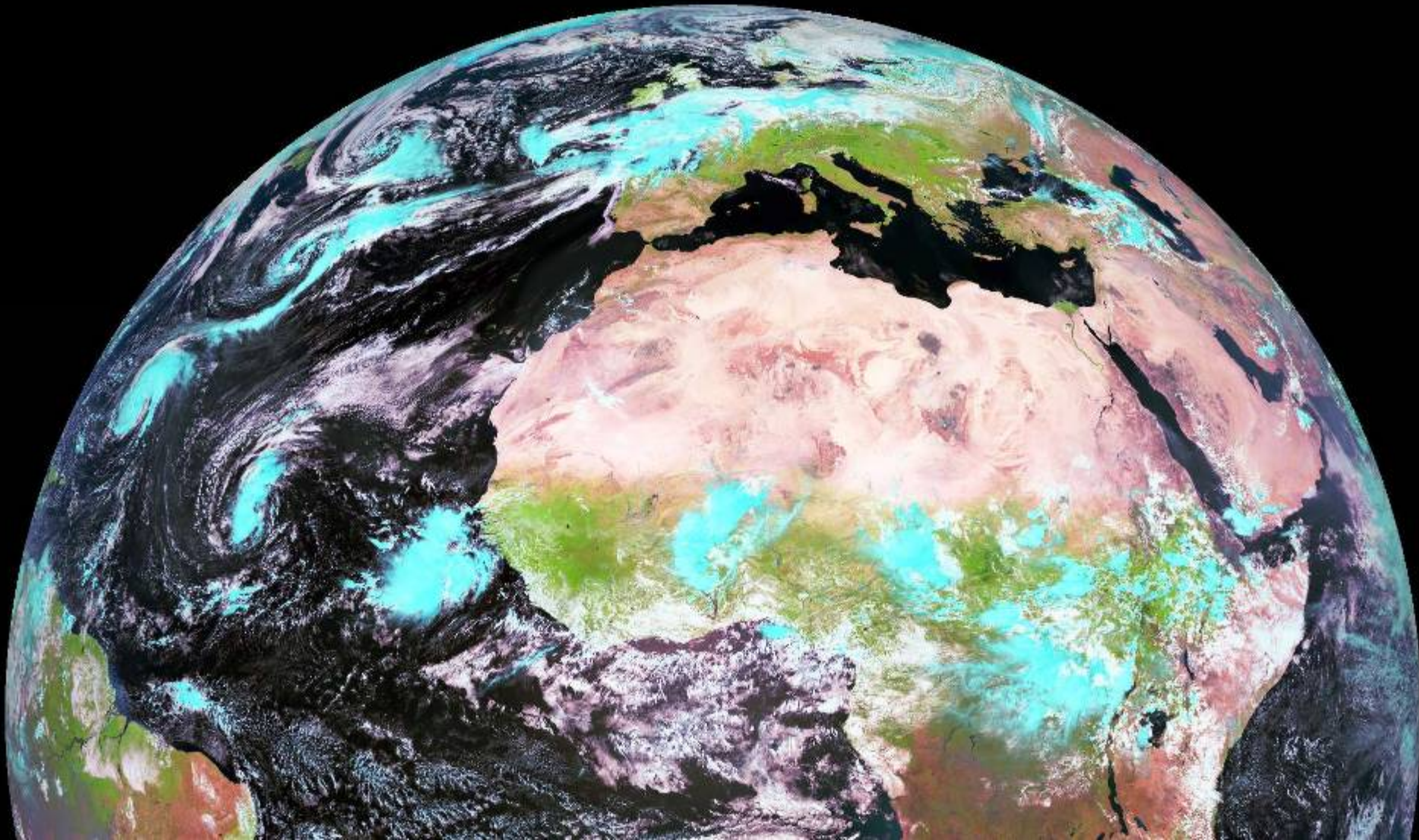
super-mean GA3



0 5 10

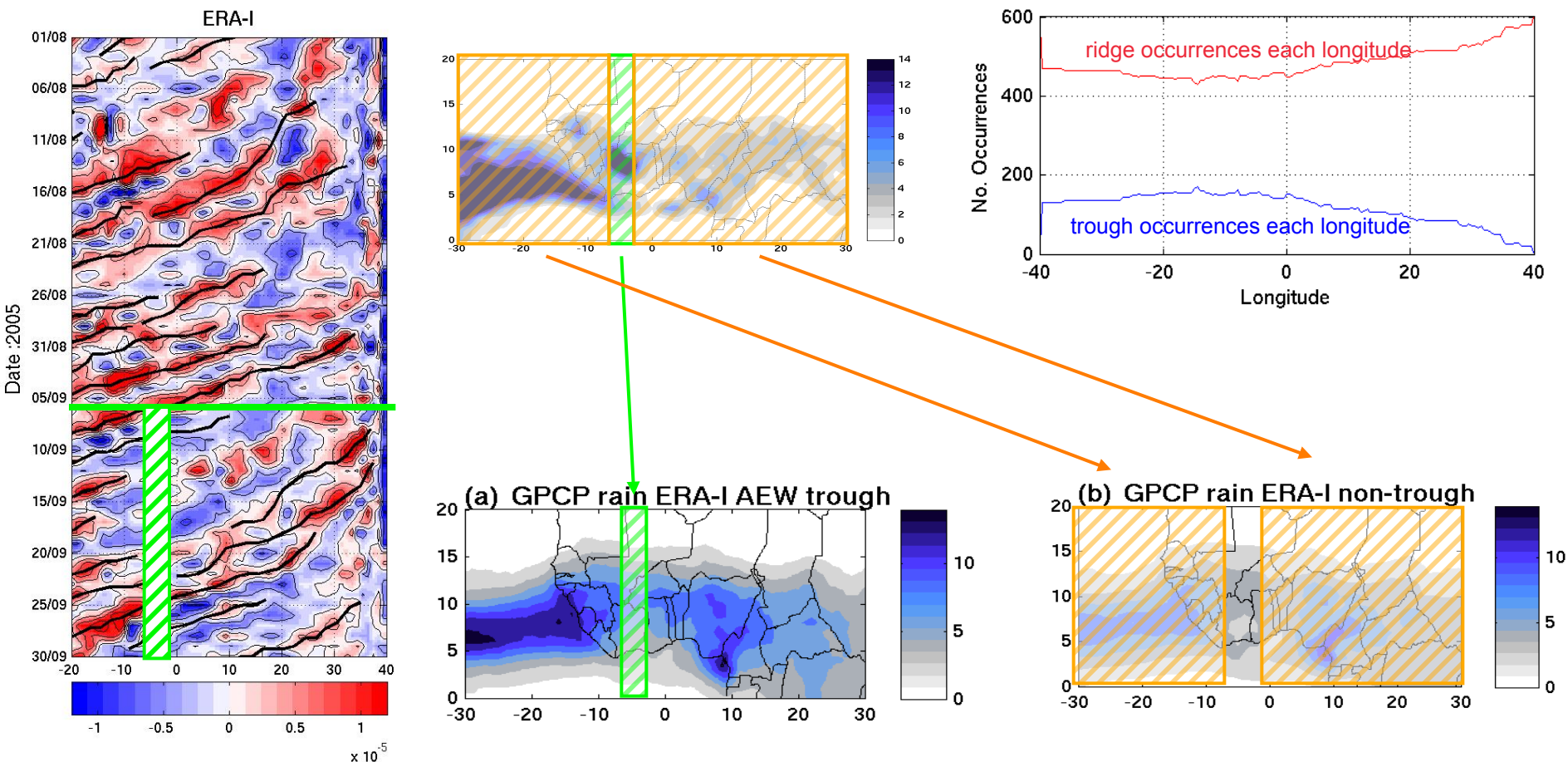


What is the impact of African Easterly Waves on storms?



Impact of trough passage on convection

Method of data construction



Hovmoller (Longitude
v. Time) of curvature
vorticity 700hPa 5-15N

Impact of trough passage on convection

GPCP RAIN (1997 to 2008)

COLD CLOUD (2005)

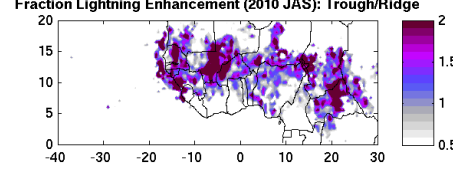
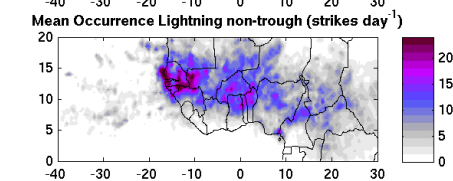
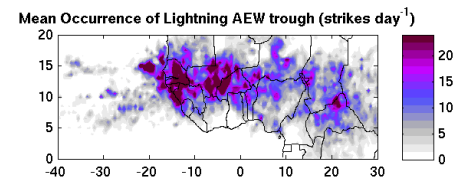
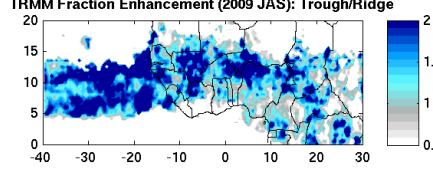
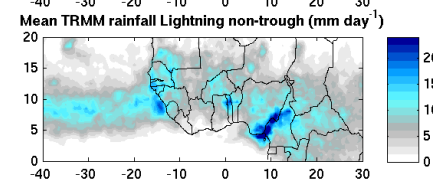
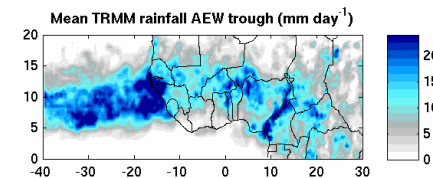
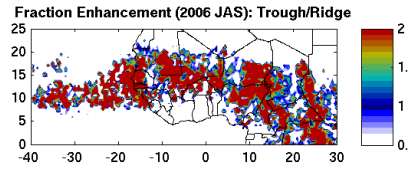
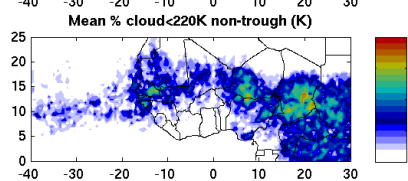
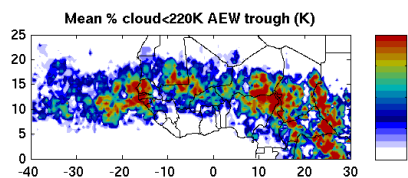
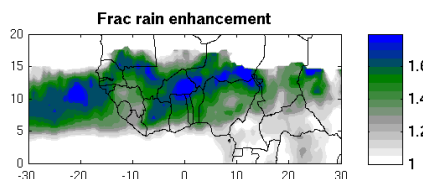
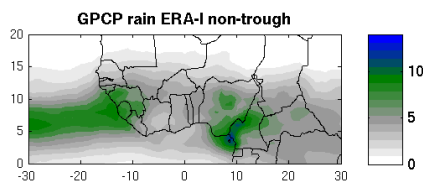
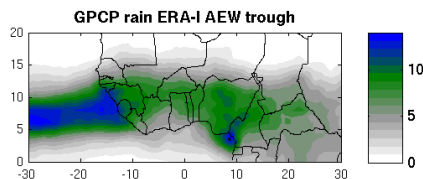
TRMM RAIN (2009)

LIGHTNING (2010)

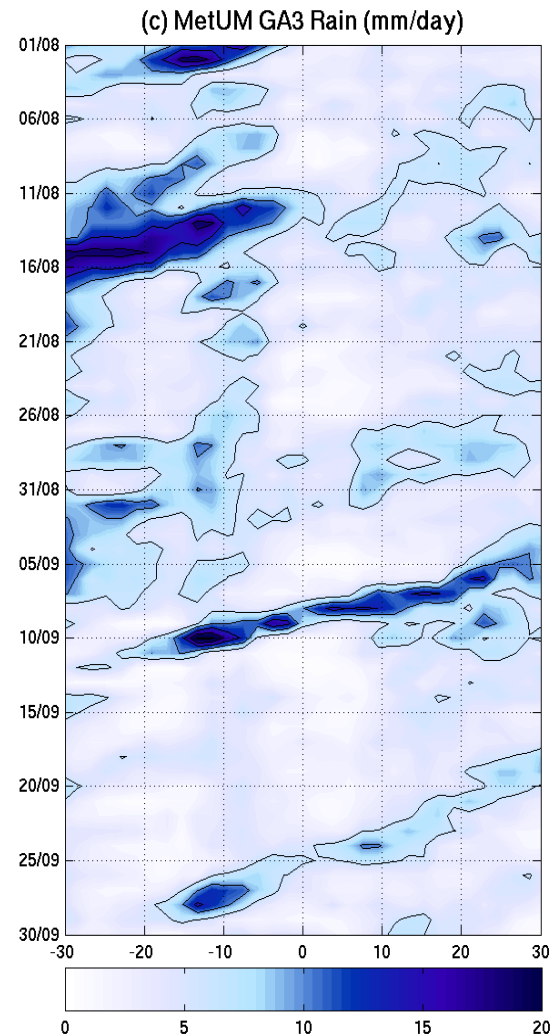
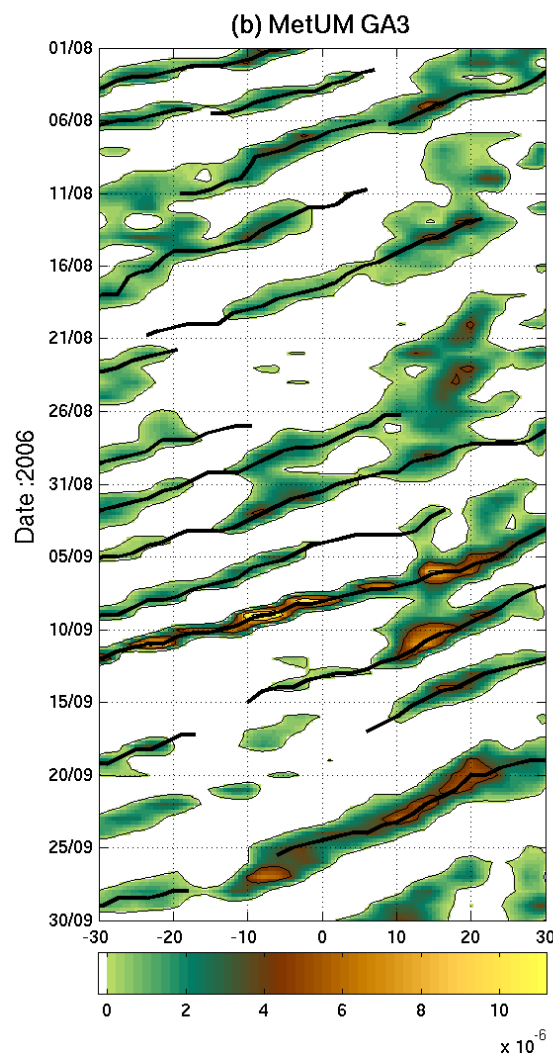
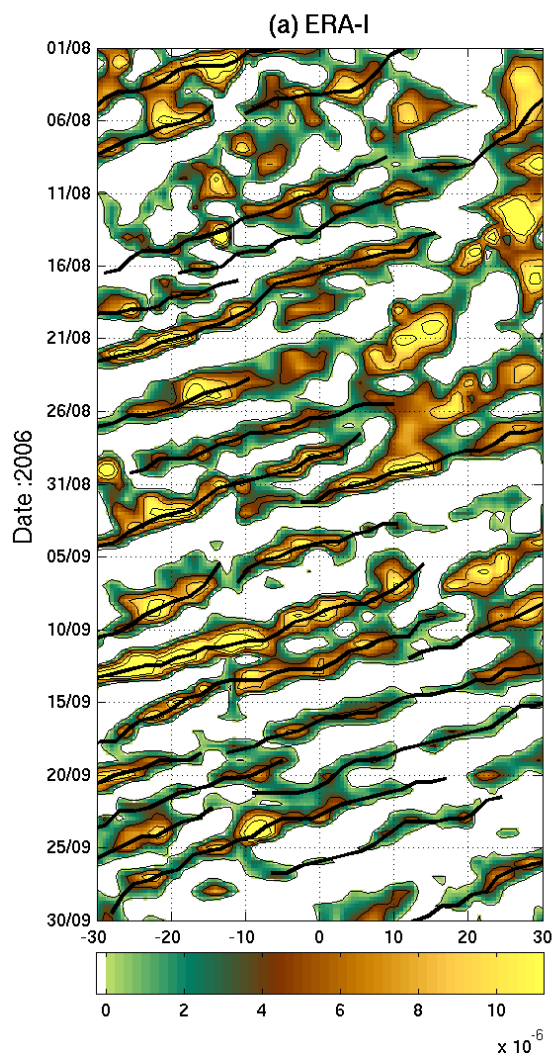
TROUGH

RIDGE

TROUGH
RIDGE



African Easterly Waves in MetUM: Climate mode Atmosphere only N96 GA3



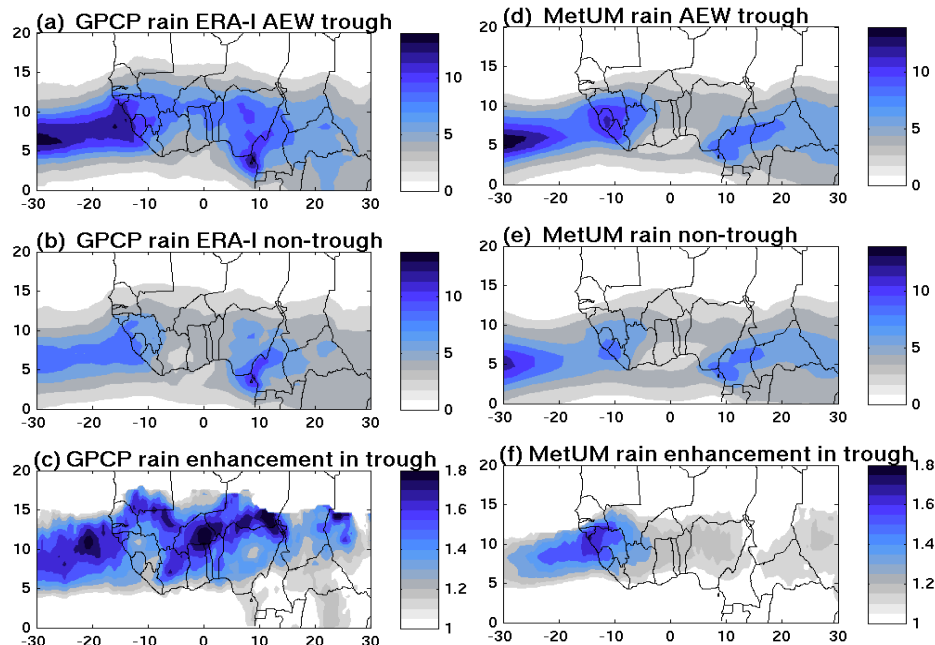
African Easterly Waves in MetUM: Climate mode Atmosphere only N96 GA3

Hypoactive dynamical affect
on storms in model

Hyperactive diurnal affect
on storms in model

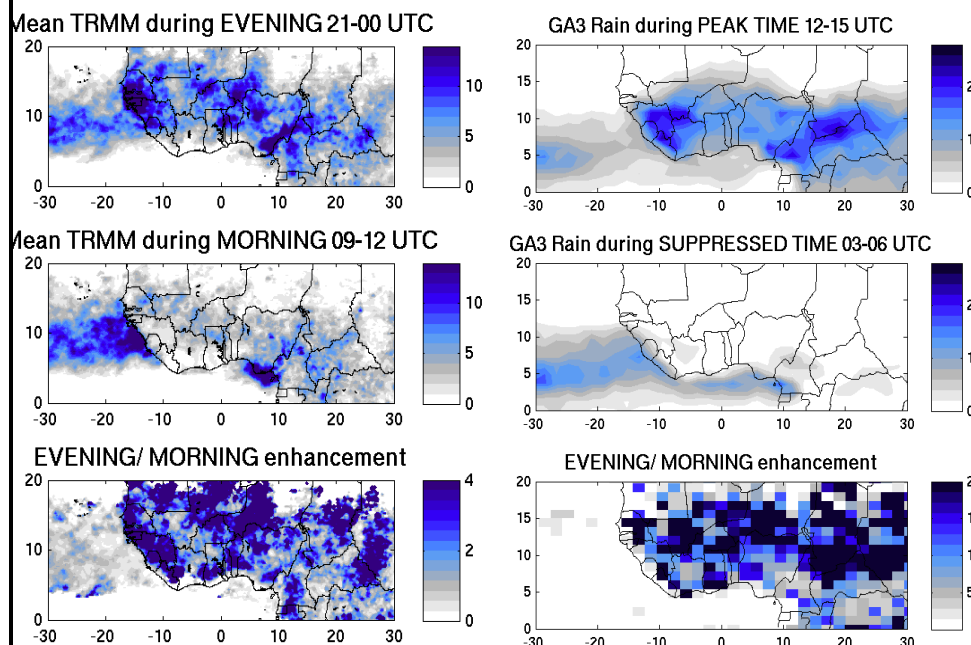
Observations

Model



Observations

Model

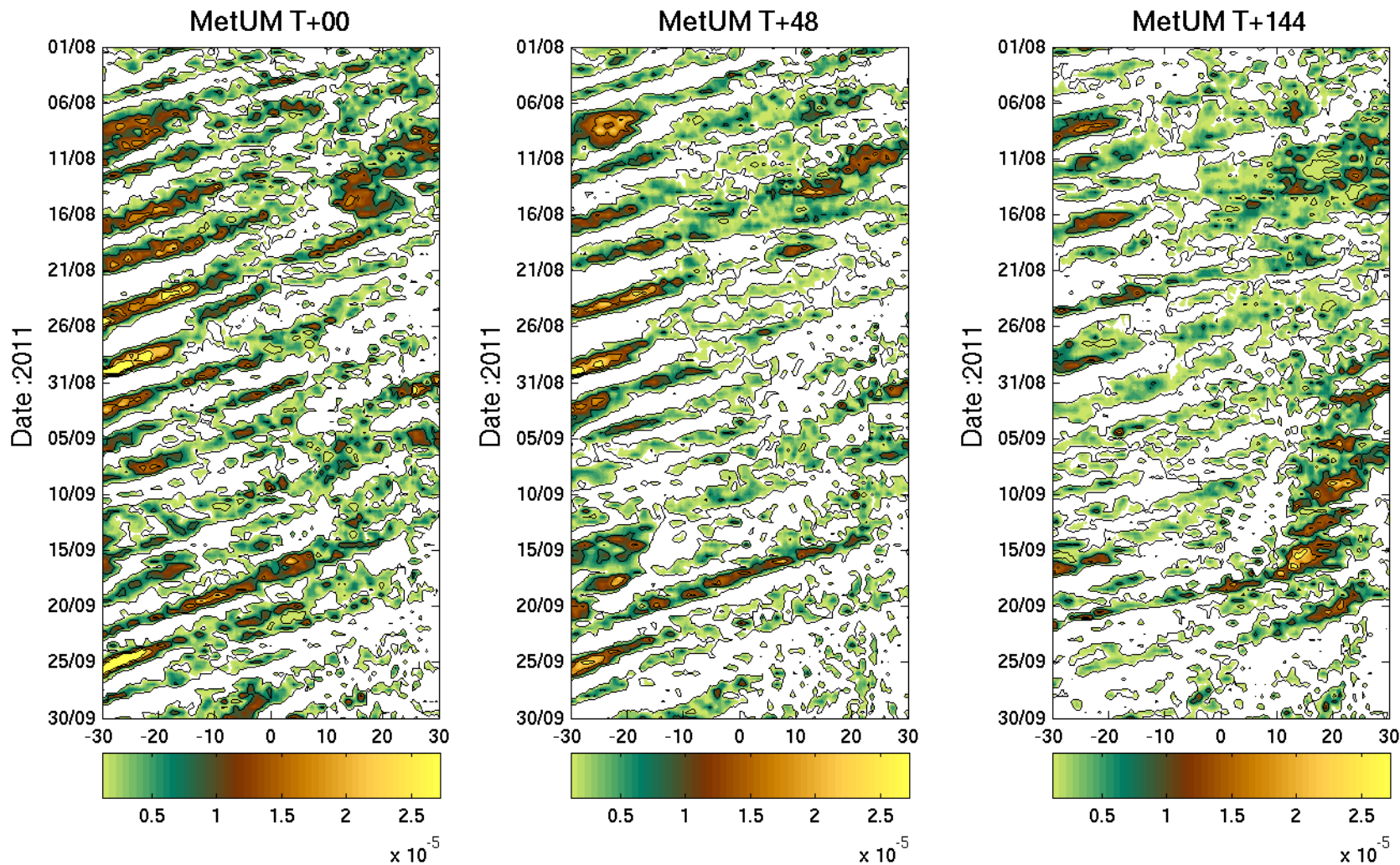


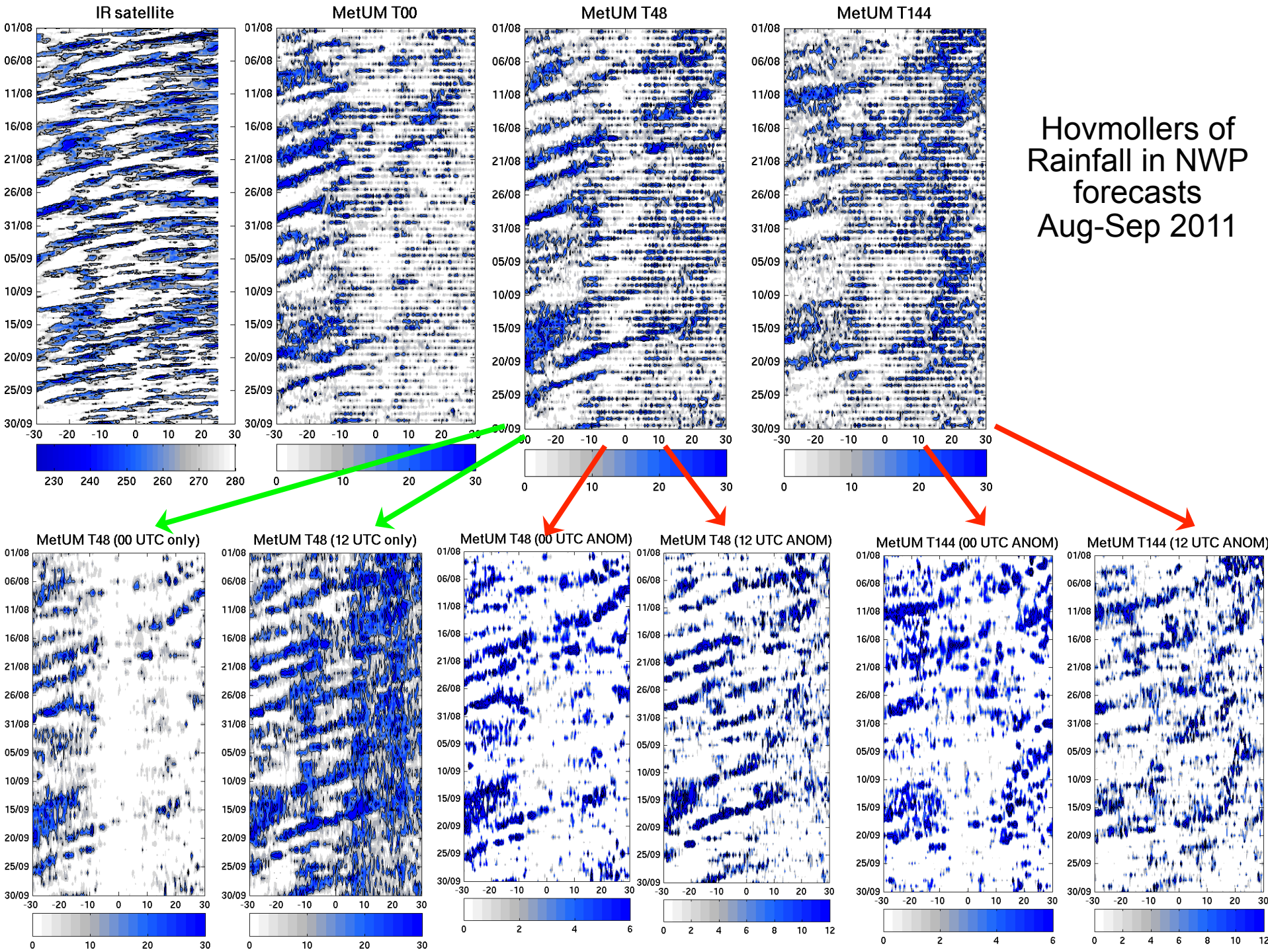


Met Office

African Easterly Waves in MetUM:

Operational Numerical Weather Prediction Aug-Sep 2011







Summary

1. Both African Easterly Waves and the diurnal cycle modulate convection over West Africa
 - Storms (deep cloud, rainfall and lightning) are enhanced during late afternoon/evening and suppressed in the morning
 - Storms are enhanced in the trough regions (positive vorticity at 700hPa) of African Easterly Waves
2. MetUM is currently underestimating the vorticity strength and convection coupling of African Easterly Waves
3. When the vorticity is stronger, the convection couples more to it
4. The degradation in vorticity strength happens on short timescales in NWP
5. The strong diurnal cycle in the model is not limiting the coupling to African Easterly Waves
6. Future work will continue to investigate what is limiting the strength and convective coupling of waves



Thank you for listening, any questions?