Imperial College London

National Centre for Earth Observation
NATURAL ENVIRONMENT RESEARCH COUNCIL

Evolution of GERB Obs4MIPs product and application to CMIP6 model evaluation

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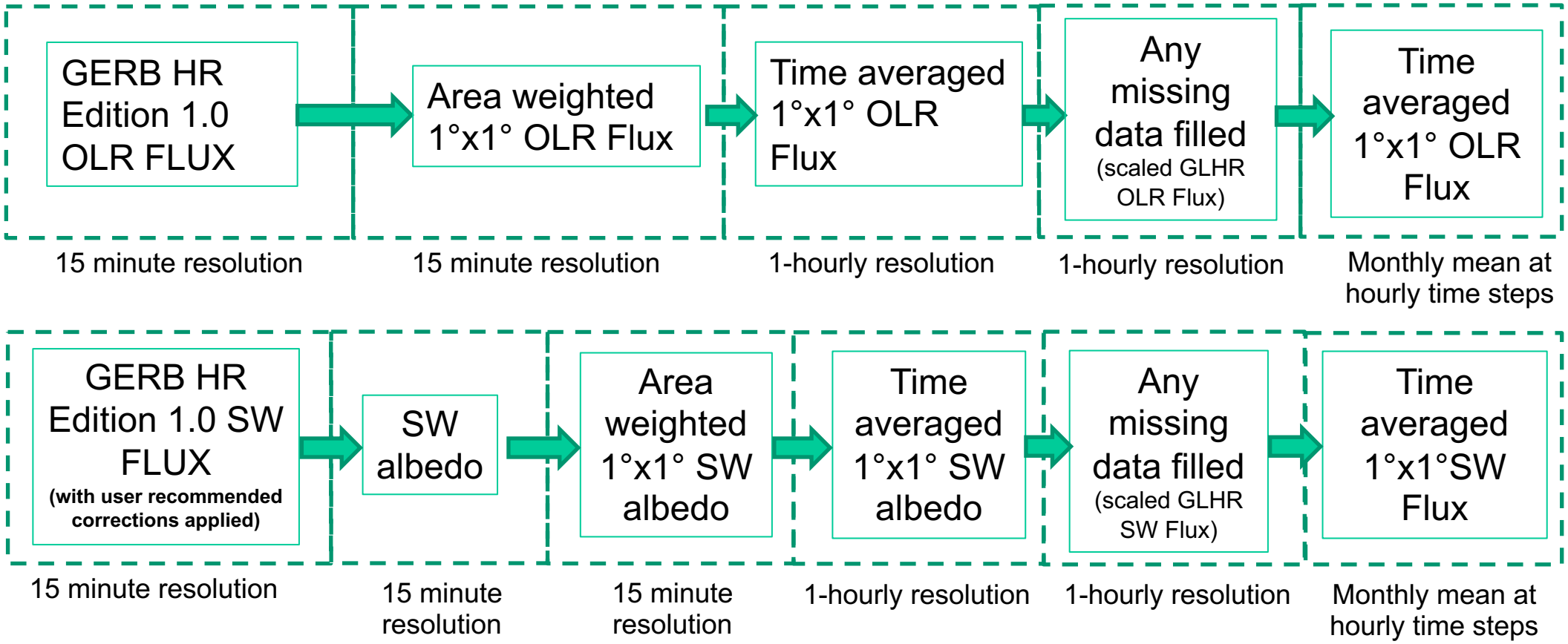
GERB Obs4MIPs Product (v2)

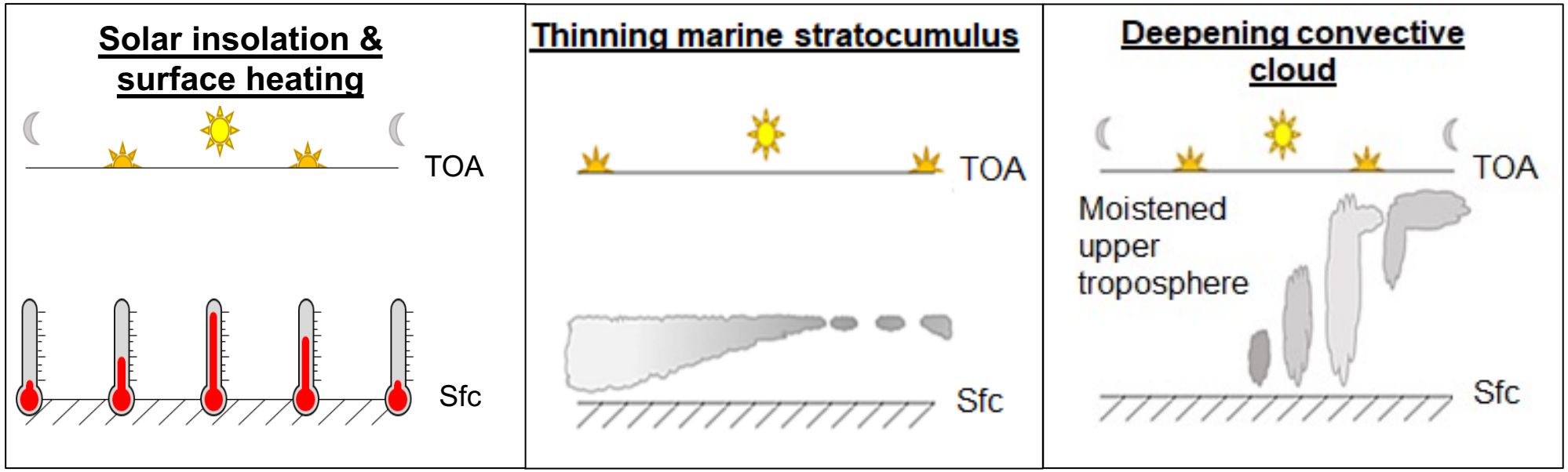


- Monthly, hourly mean 1 x 1º fluxes, covering 60-60º N/S 60-60º E/W
- November, December, January; May, June, July
- Currently 2007-2012, scope to expand to 2004-present

Is this a useful product for model evaluation?

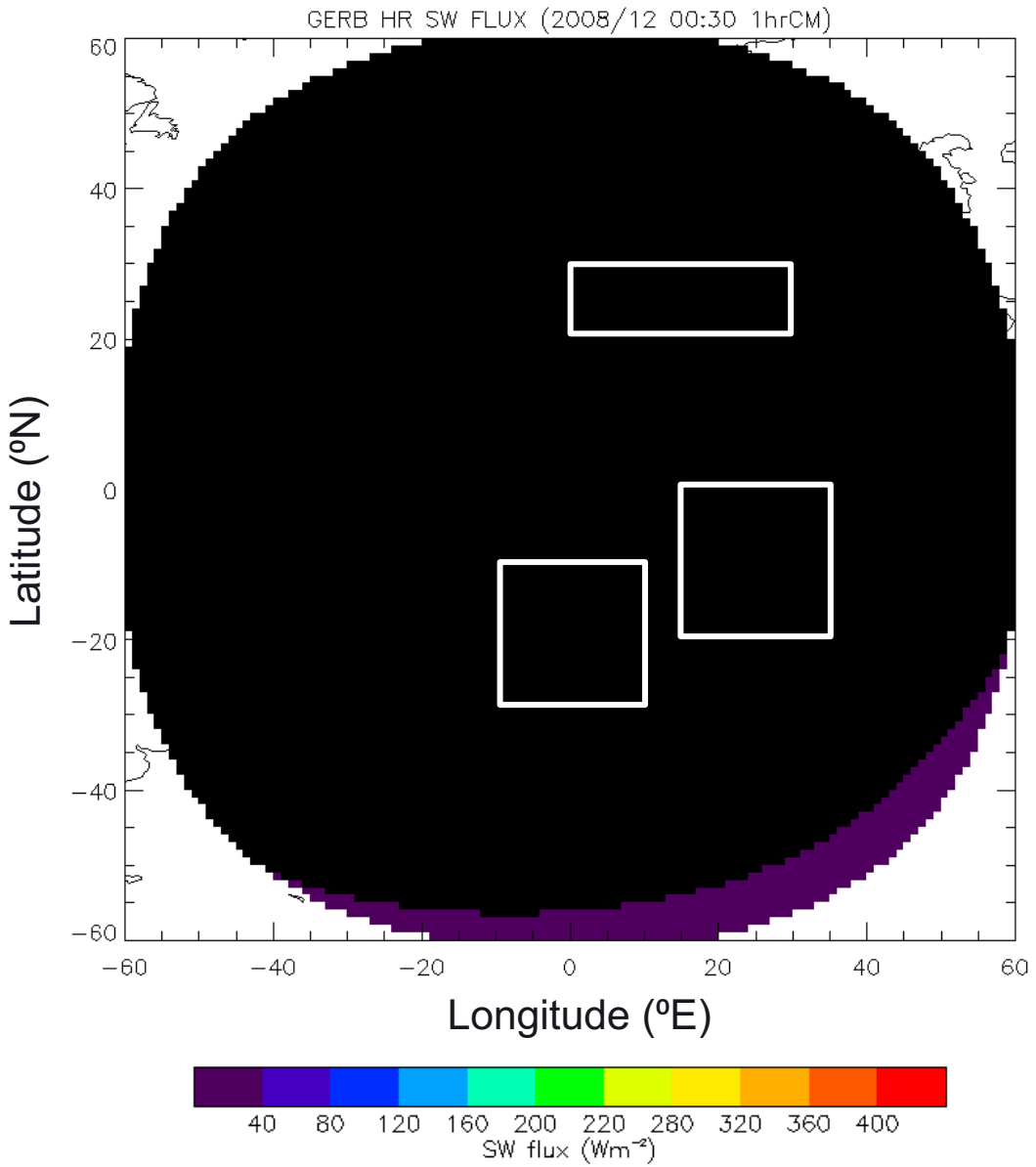
- How stable is the diurnal cycle from year to year? (limited data period)
- Can persistent biases in model output be identified (and are these important for climate)?
- Could the product (in theory) be used to track the impact of process improvements within models?

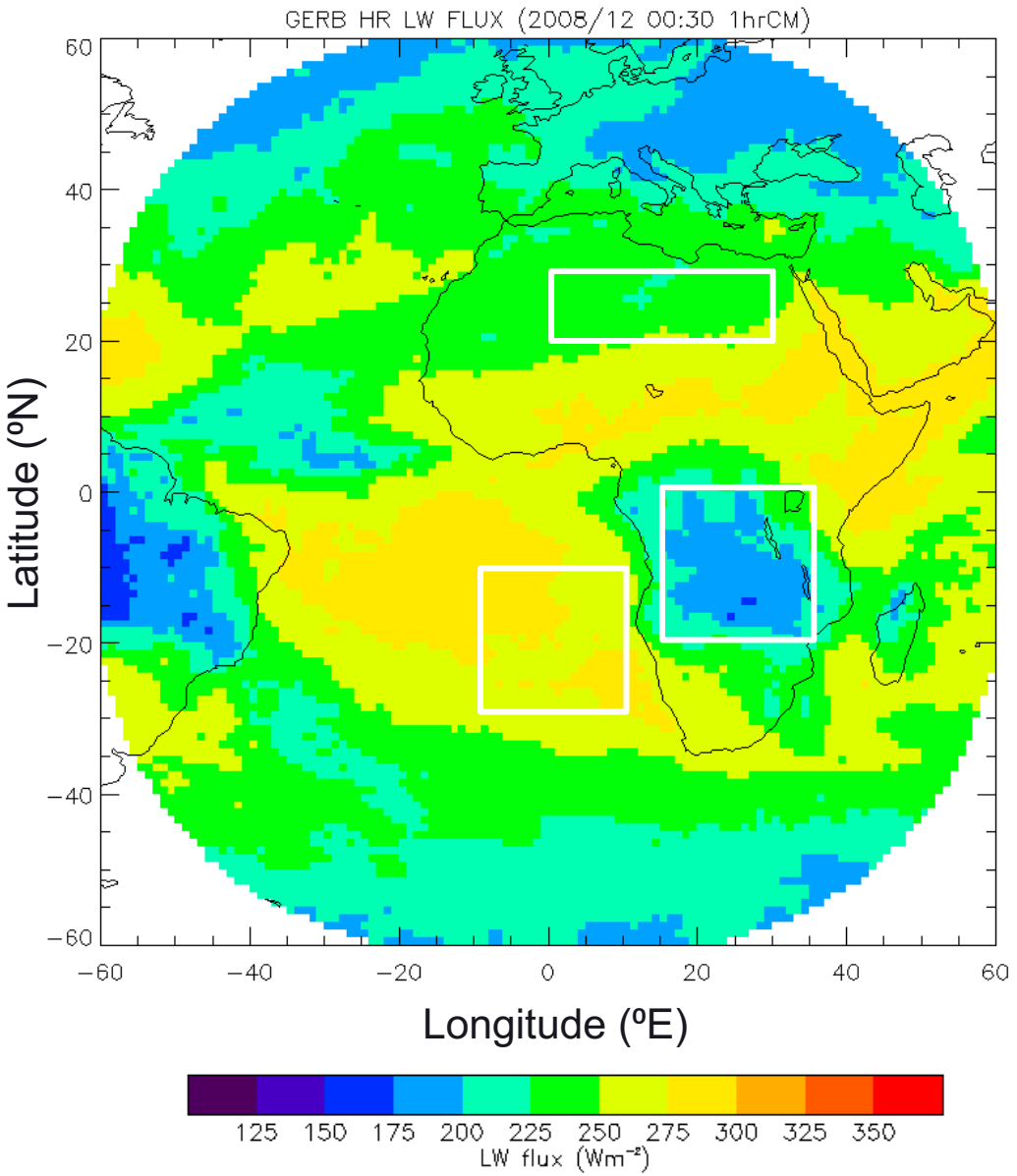
In the interests of time, 3 regions, focused on December 2007-2012 (results are consistent across other months)



Gristey et al., 2018

GERB Obs4MIPs output: December, 2007-2012

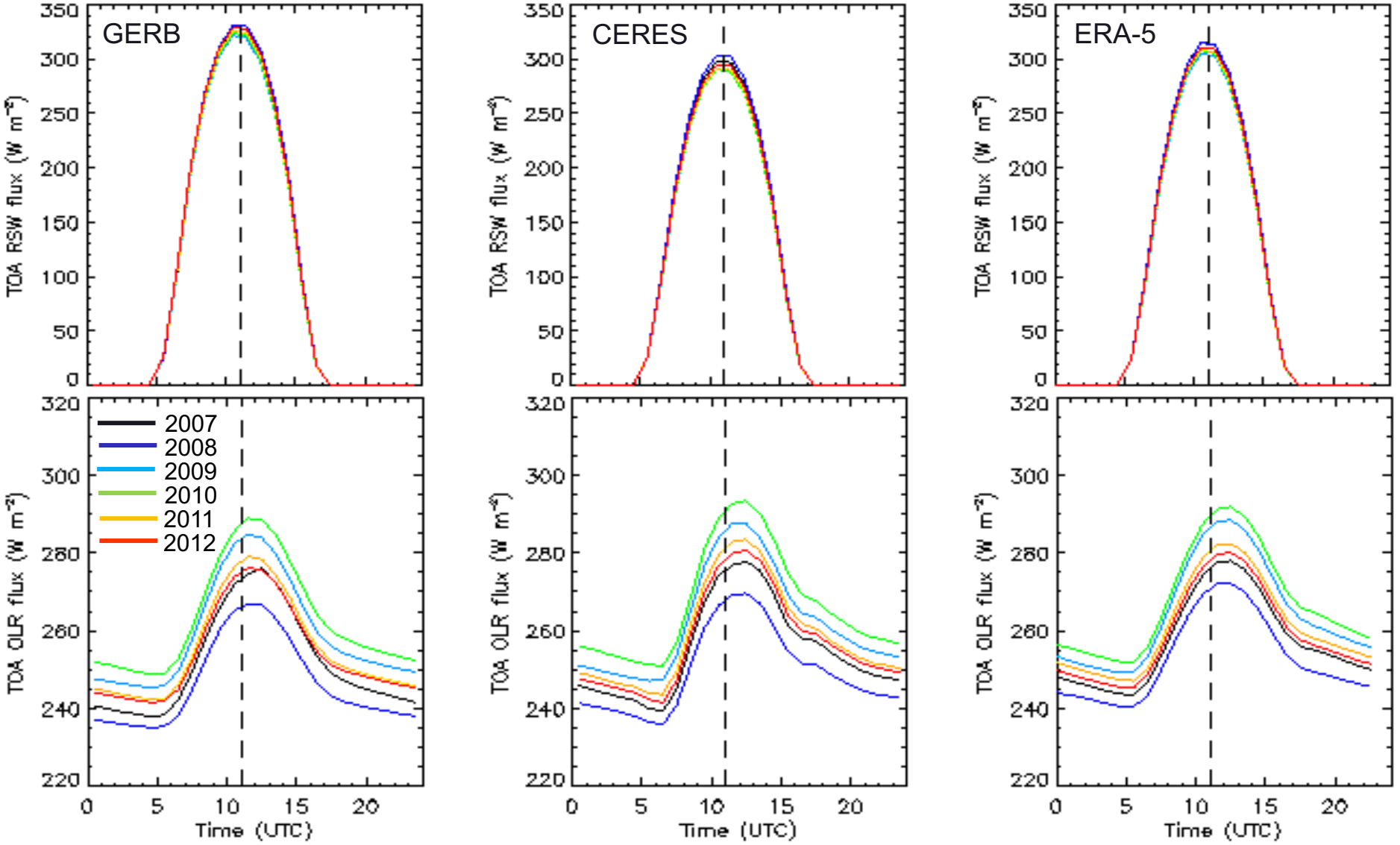


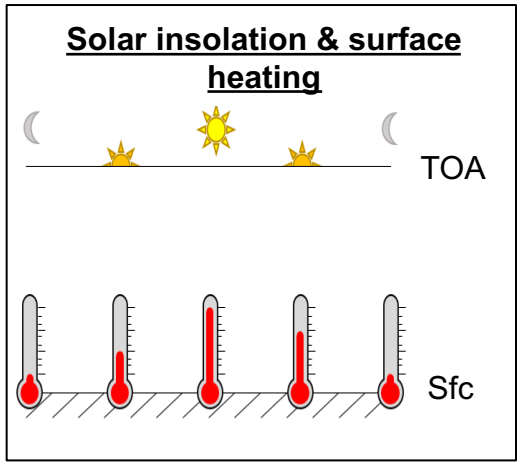


Starting point: How well does the GERB product compare with ‘equivalently’ treated

(a) CERES SYN fluxes

(b) ERA-5 reanalysis





Sahara:
20-30 N, 0-30 E

Broadly speaking similar behaviour, GERB ~ 5-6 % brighter than CERES, ERA-5 intermediate

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(a) CERES SYN fluxes

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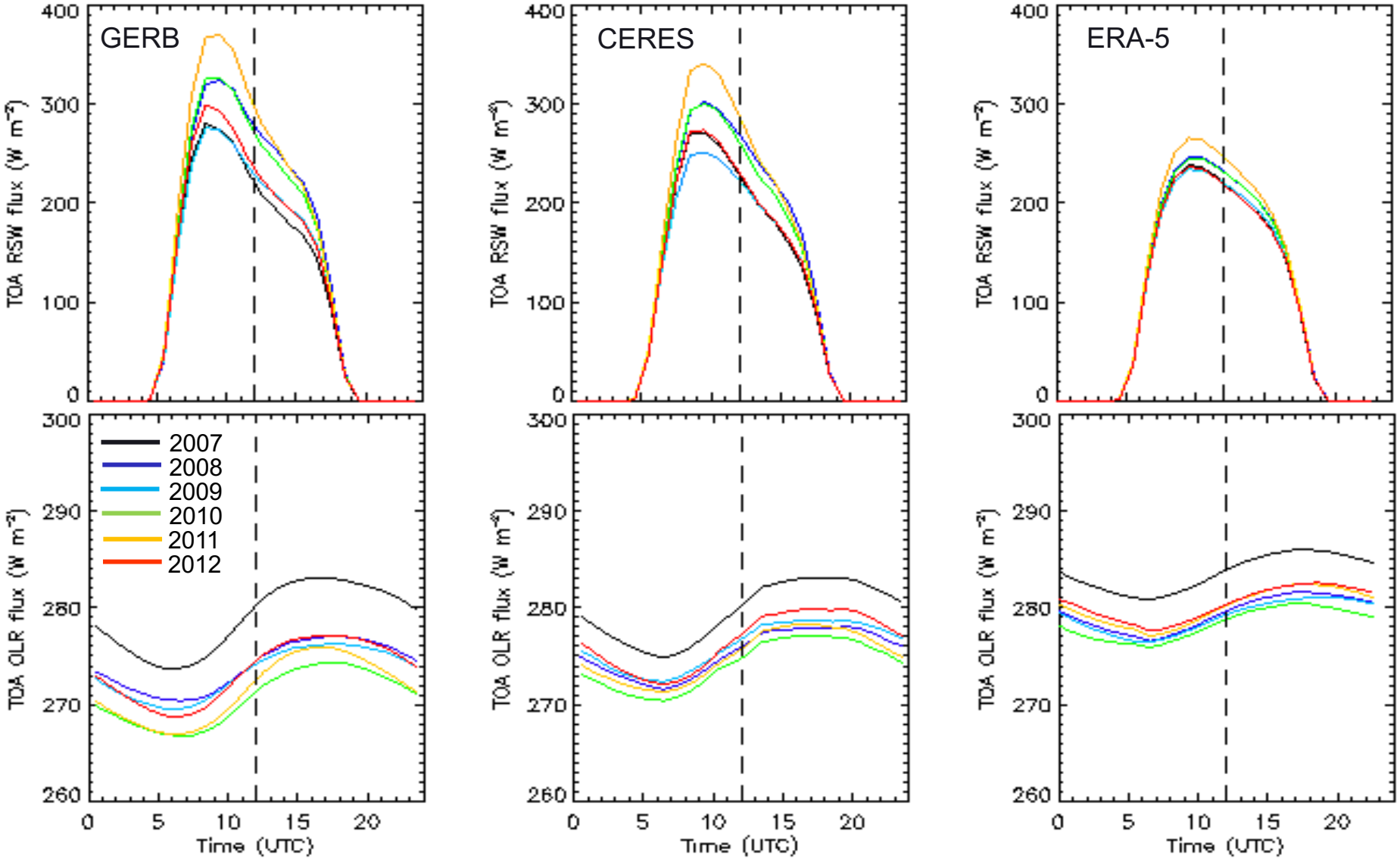

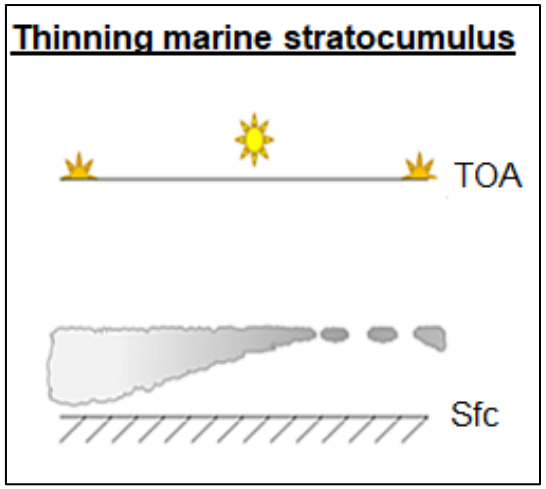

Marine Scu:
10-30 S, 10 W-10 E

GERB ~ 5-6 % brighter than CERES

ERA-5 significantly less reflective and more emissive, less year to year variation in SW fluxes

Starting point: How well does the GERB product compare with ‘equivalently’ treated

(a) CERES SYN fluxes

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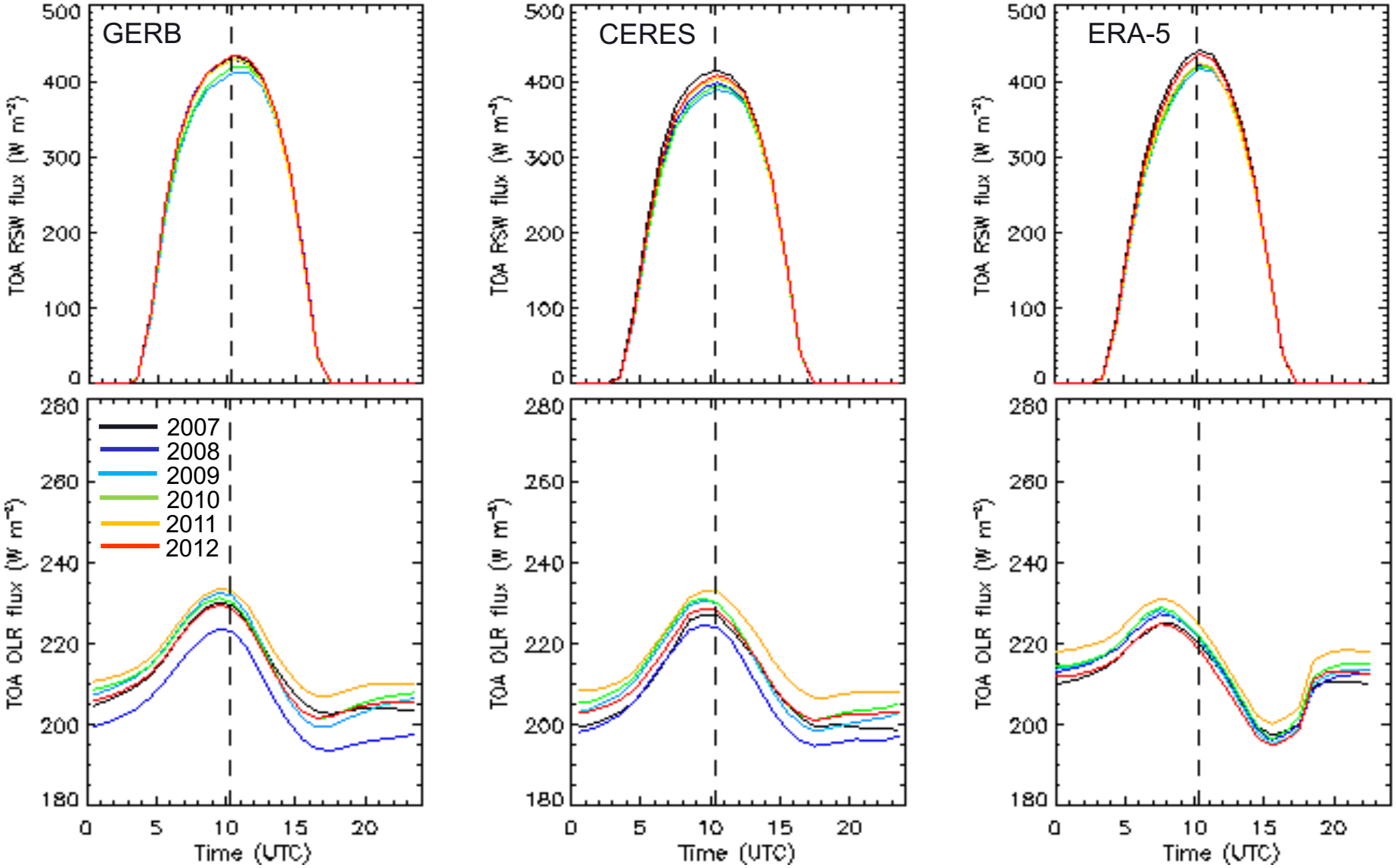
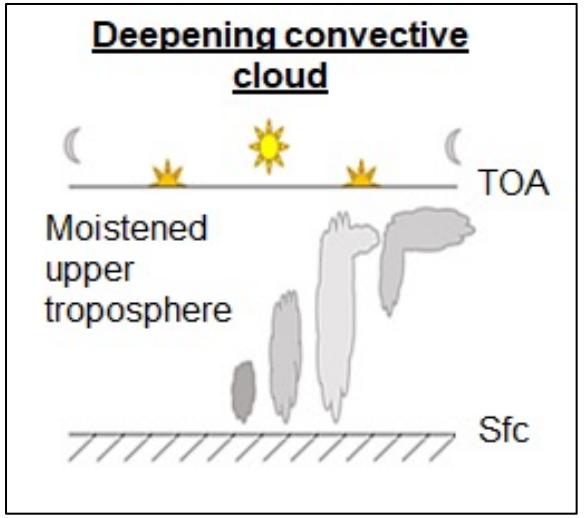




Deep Convection:
0-20 S, 15-35 E

GERB ~ 5-6 % brighter than CERES, ERA-5 intermediate

ERA-5 OLR fluxes peak earlier and show anomalous warming after sunset (rain out?)

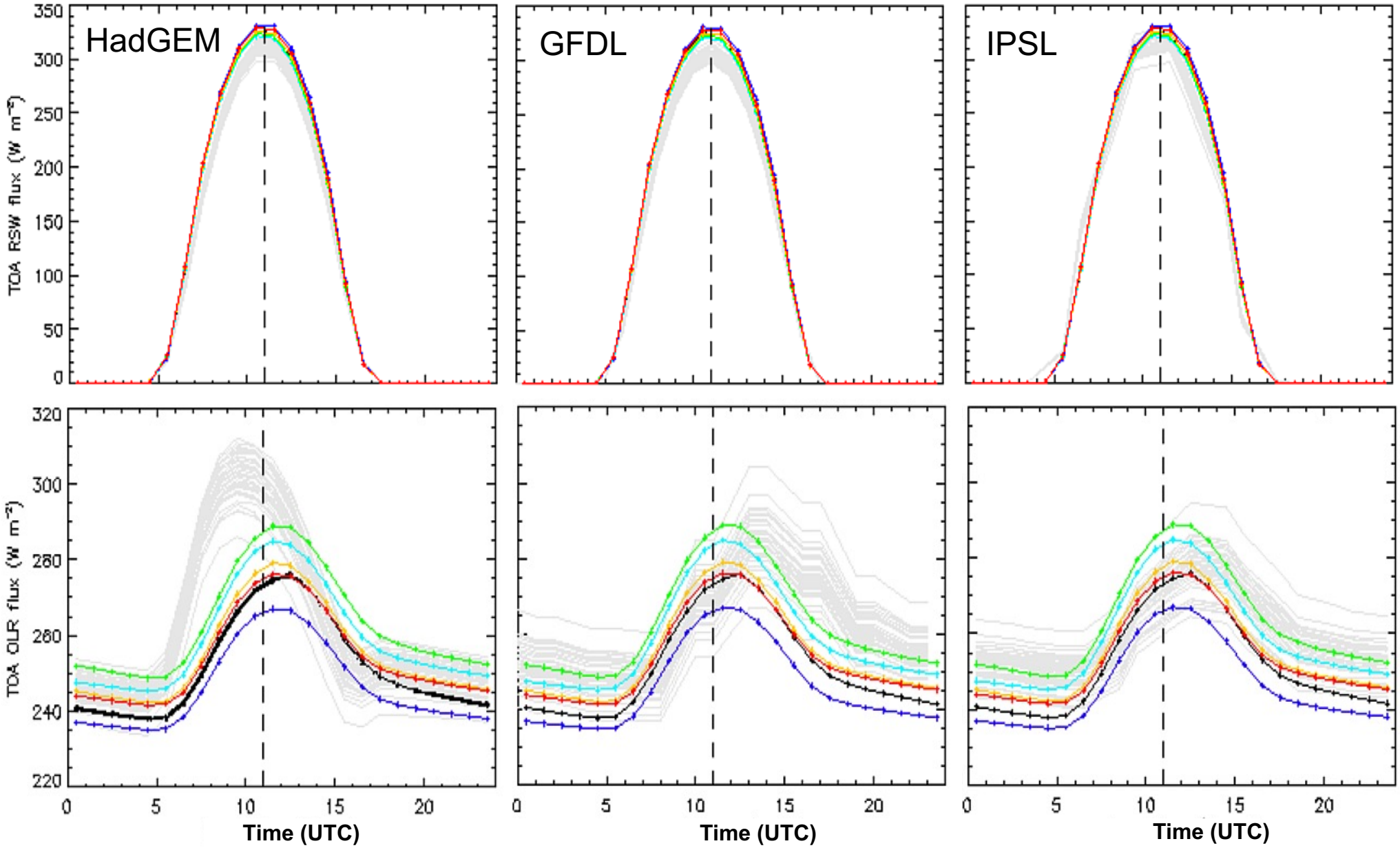
Comparison to bespoke AMIP6 runs

Participating models: HadGEM3-GC31-LL; IPSL-CM6A-LR; GFDL-CM4

Spatially resolved OLR and RSW fields at monthly, hourly mean resolution for 1979-2014, all-sky and clear-sky

Model	Atmos	Ocean	Land	Sea Ice	Aerosol	Interactive Chem	Ocean BGC
HadGEM	MetUM GA7.1 192 x 144 85 levels	Nemo GO6.0 400 x 180 75 levels	JULES GL7.1	CICE GS18	UKCA GLOMAP mode	No	No
IPSL	LMDZ6 144 x 143 79 levels	Nemo v3.6 360 x 180 75 levels	ORCHIDEE v2	LIM v3.6	No	No	Yes
GFDL	AM4 280 x 188 33 levels	MOM6 0.25^{o} 75 levels	LM4.0.1	SIS2.0	Yes	No	Diagnostic

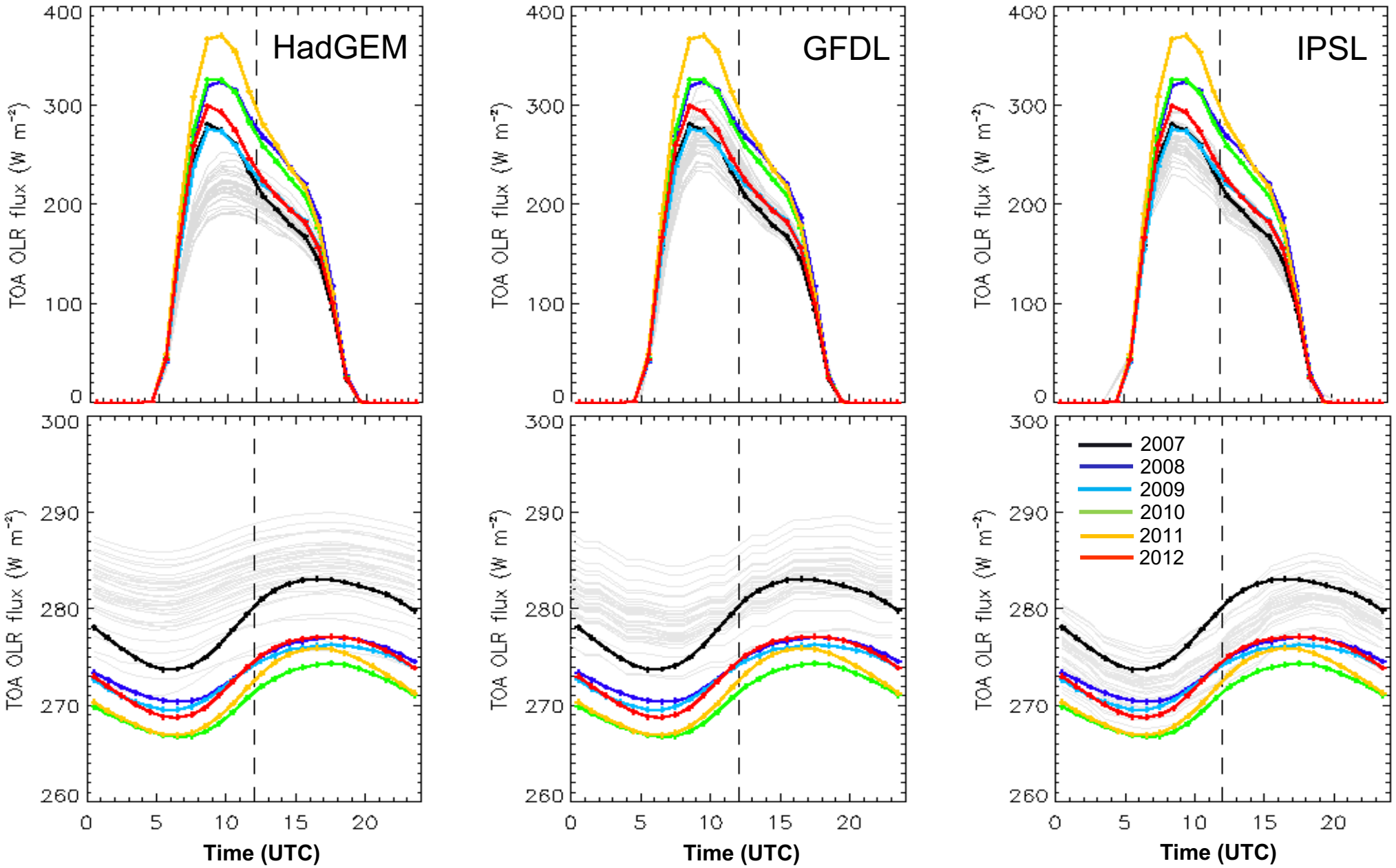
Sahara:
20-30 N, 0-30 E



Models systematically less reflective than GERB – more aligned with CERES

OLR phasing does not agree: GFDL and IPSL are phased late, HadGEM early (unphysical?) with markedly larger amplitude

Marine Scu:
10-30 S, 10 W-10 E



Phase generally looks good but models are typically less reflective, particularly HadGEM

HadGEM and GFDL typically too emissive
IPSL appears to better capture amplitude and magnitude

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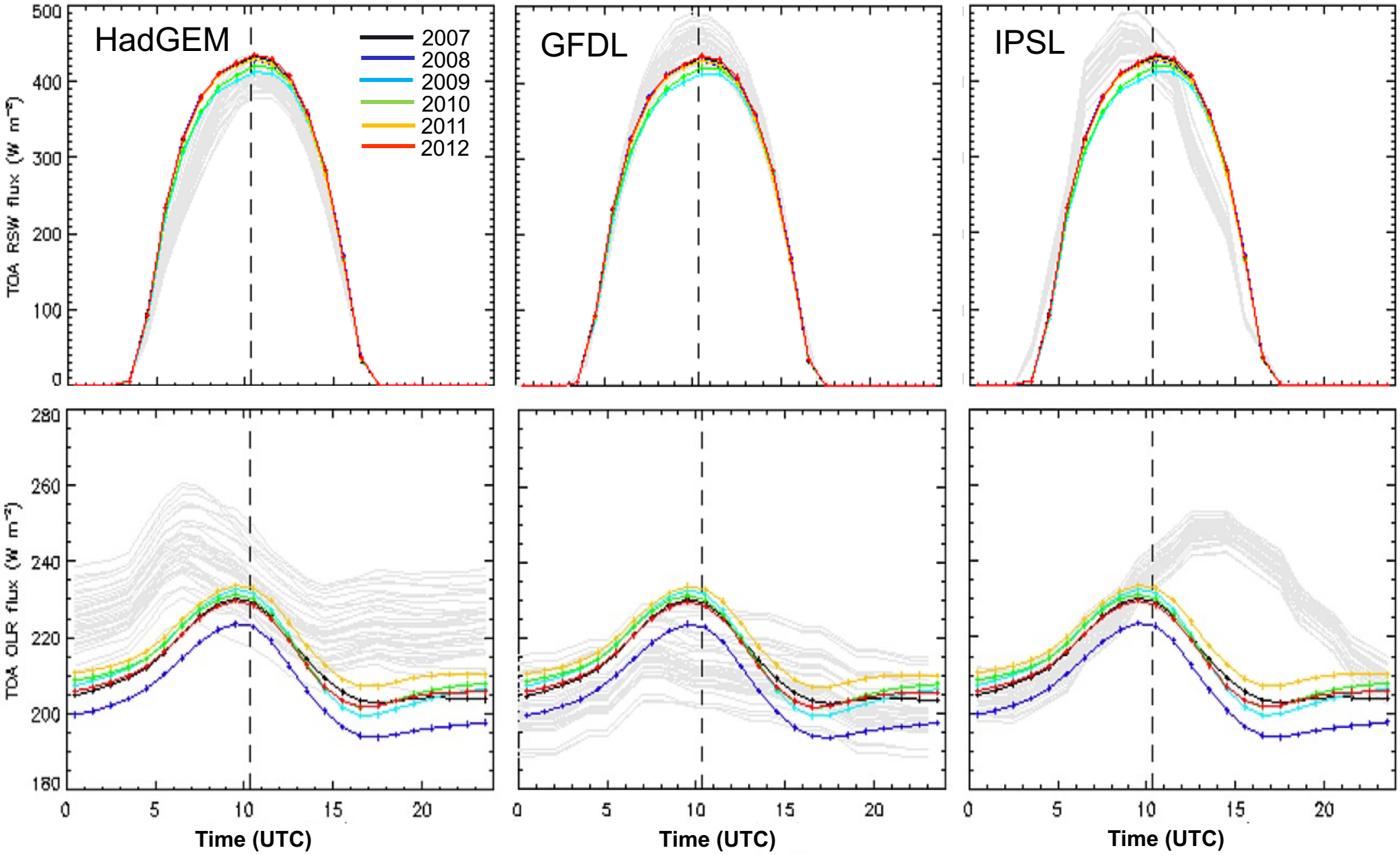

No systematic offset across models. IPSL has an odd-looking phasing, possible early rain-out/DC removal (see OLR)?

OLR phasing very different. GFDL has almost no cycle, HadGEM early (c.f. Sahara), IPSL late (early removal of DC?)

Summary

- GERB Obs4MIPs v2 products are now available for use: currently for GERB-1 period (2007-2012) but will be extended to cover 2004-2012 by early next year
- Initial comparisons with CERES SYN indicate the latter captures the diurnal cycle well, with some offset due to known differences between GERB and CERES absolute flux levels
- ERA-5 shows some discrepancies over marine Scu (less reflective/too emissive) and over land deep convection (instantaneous rain-out after sunset?)
- AMIP6 runs from three models show
  - a highly stable diurnal cycle phase across the 36 years of simulation in all three regions
  - consistently less RSW flux over morning maritime Scu, phase looks reasonable
  - very little agreement with each other or observations over deep convection region (phase, amplitude and magnitude)
  - instances of what appears to be unphysical behaviour
- This type of (simple!) analysis could easily be extended to additional models if the simulations were available but to unpick the mechanisms behind discrepancies requires additional fields to be archived
- Implications of model issues for longer term sensitivity?