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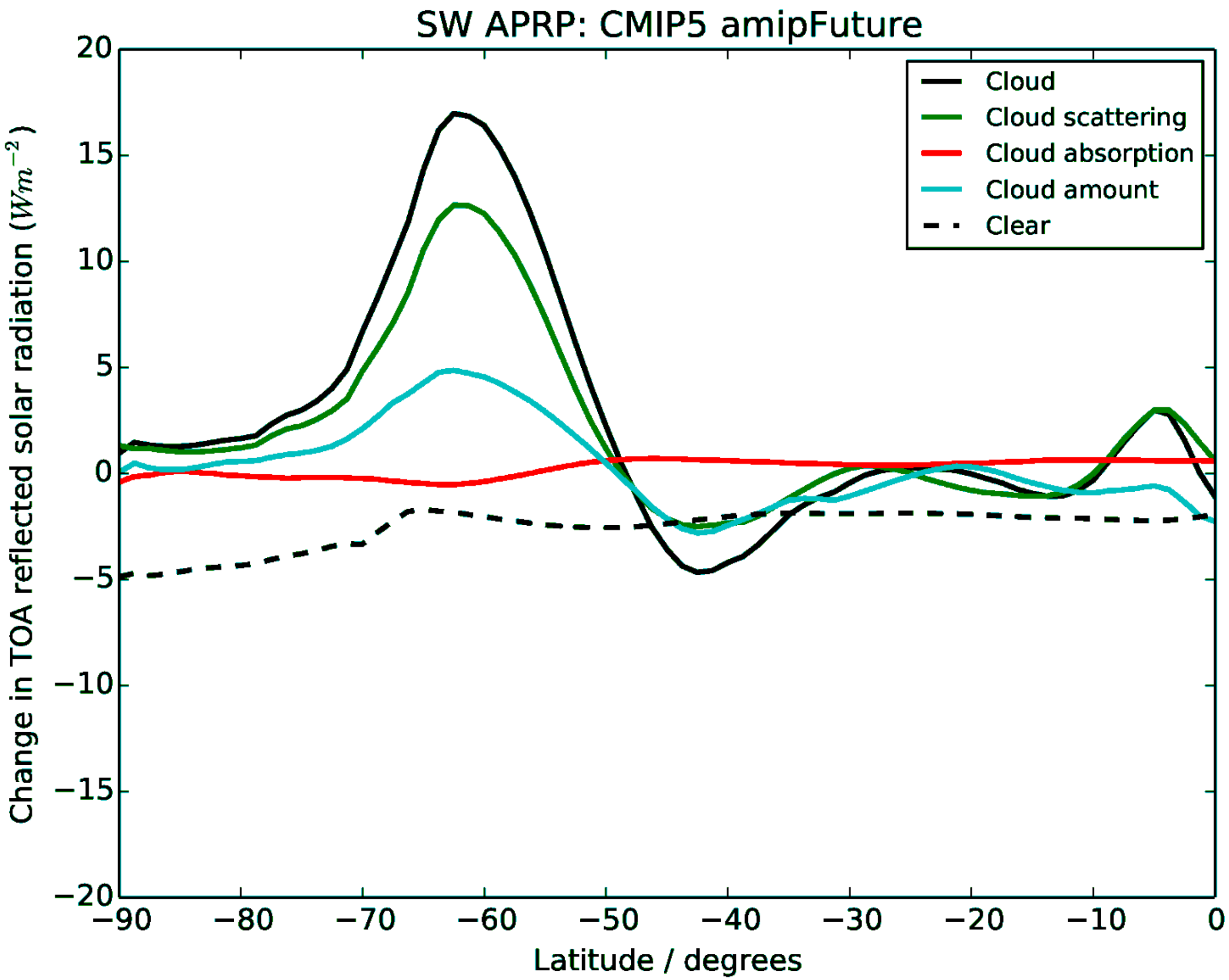
Cloud liquid water path and radiative feedbacks over the Southern Ocean

Alejandro Bodas-Salcedo

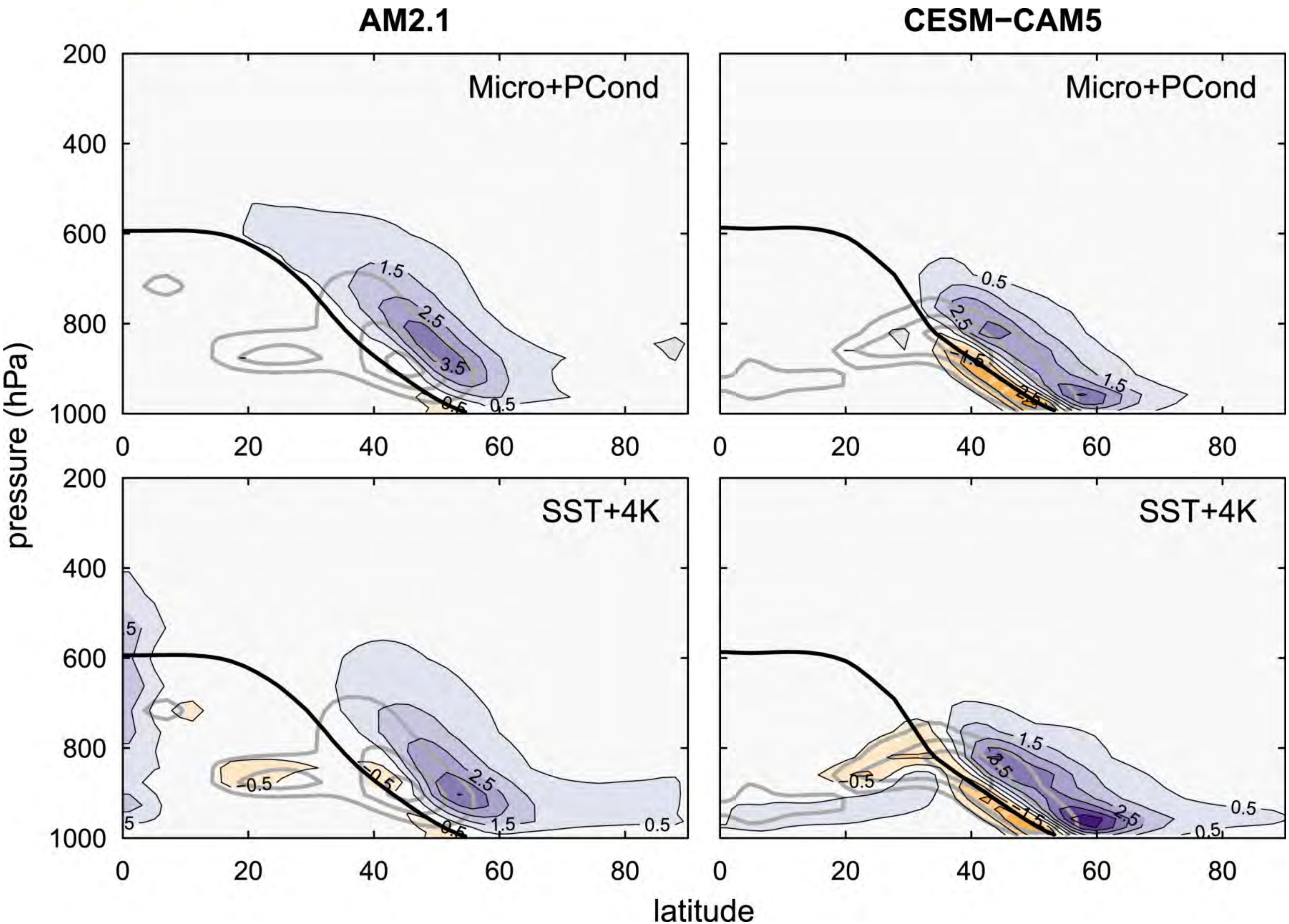
Thanks: P. G. Hill, K. Furtado, K. Williams, P. Field, J. Manners, P. Hyder, T. Andrews, M. A. Ringer , A. Karmalkar (U. Mass. Amherst), S. Kato (LaRC)

W. B. Rossow's symposium, New York, 6-8 June 2017

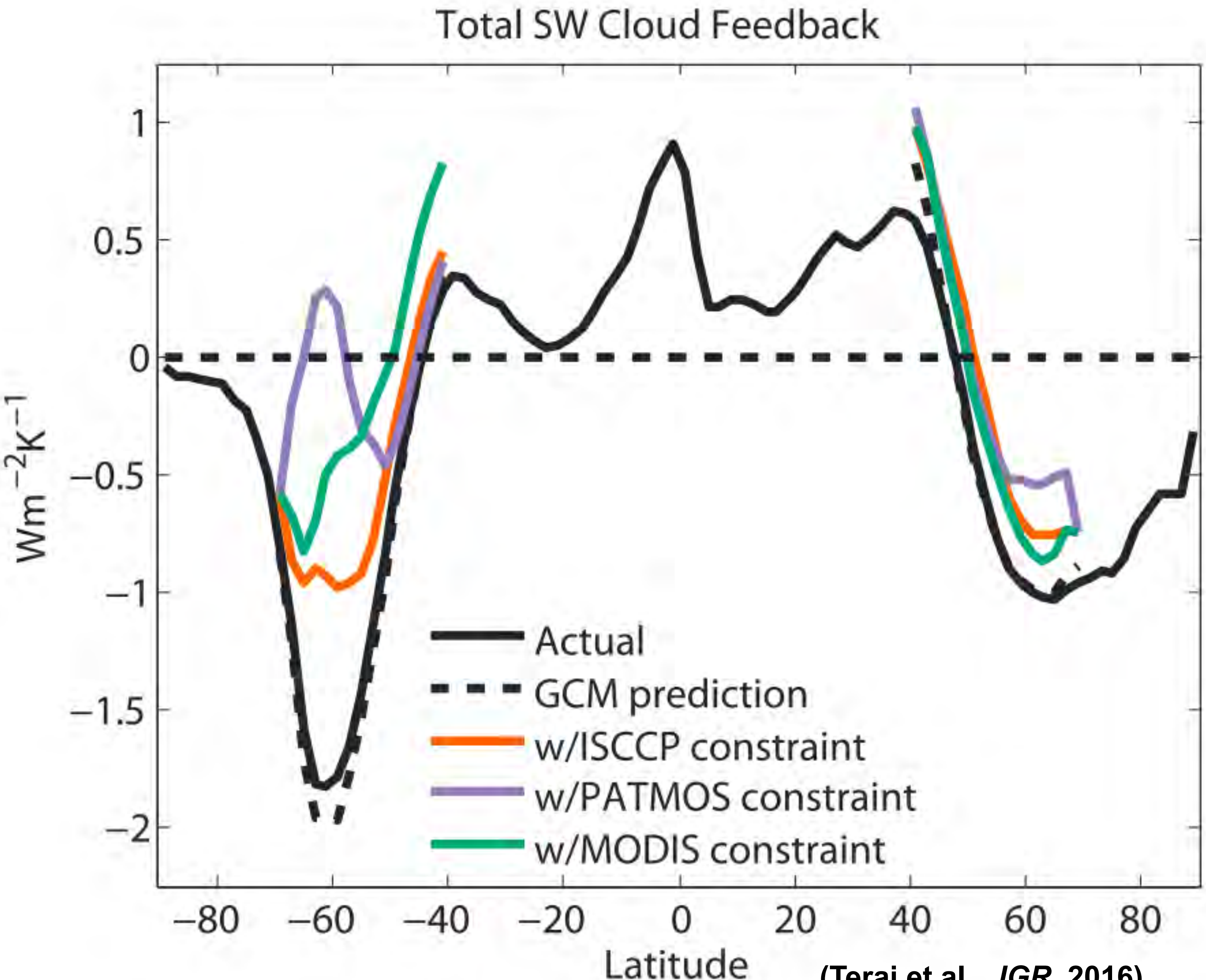
Cloud scattering dominates SW feedback



(Bodas-Salcedo et al., *GRL*, 2016. DOI: 10.1002/2016GL070770)



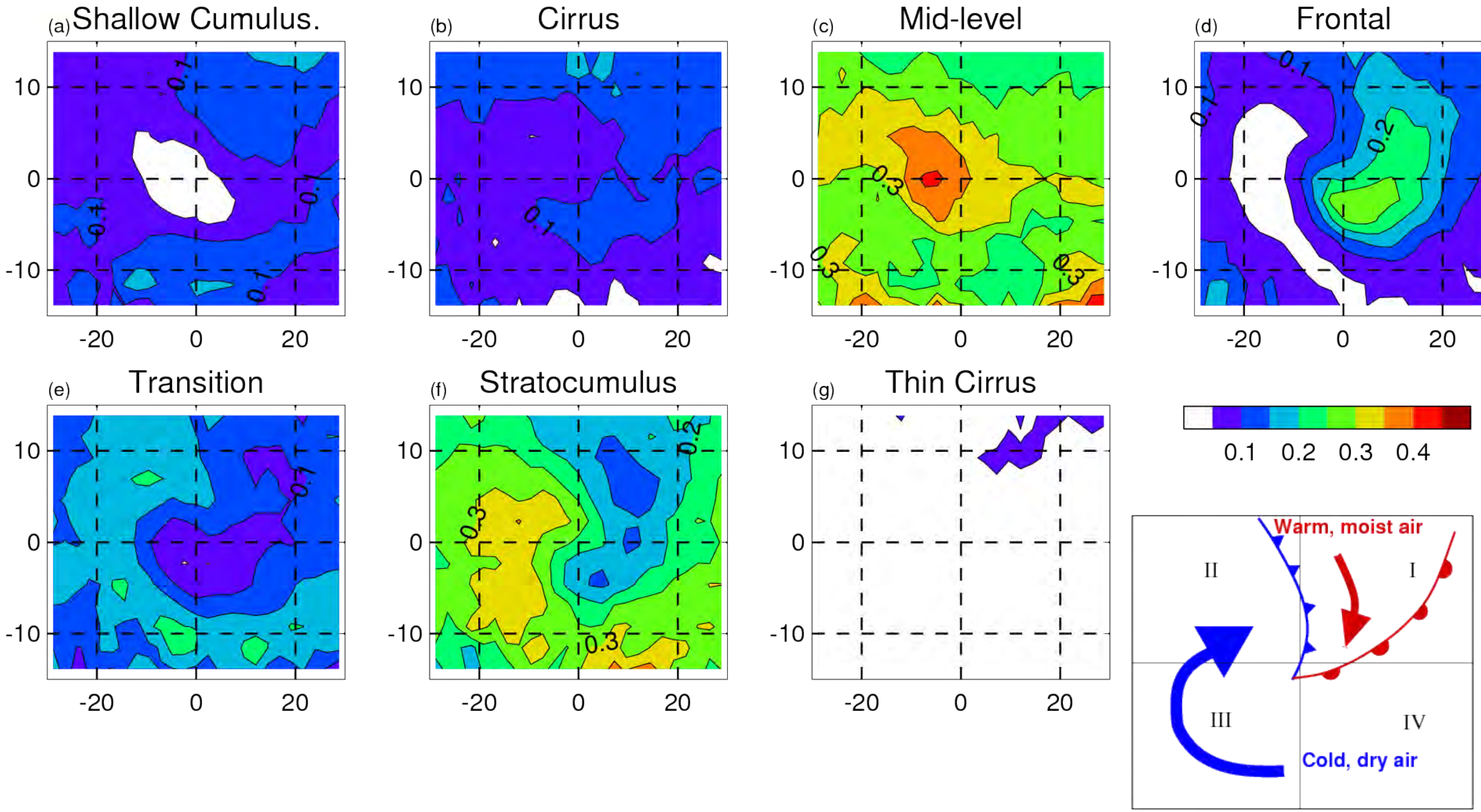
(Ceppi et al., *J. Climate*, 2016)



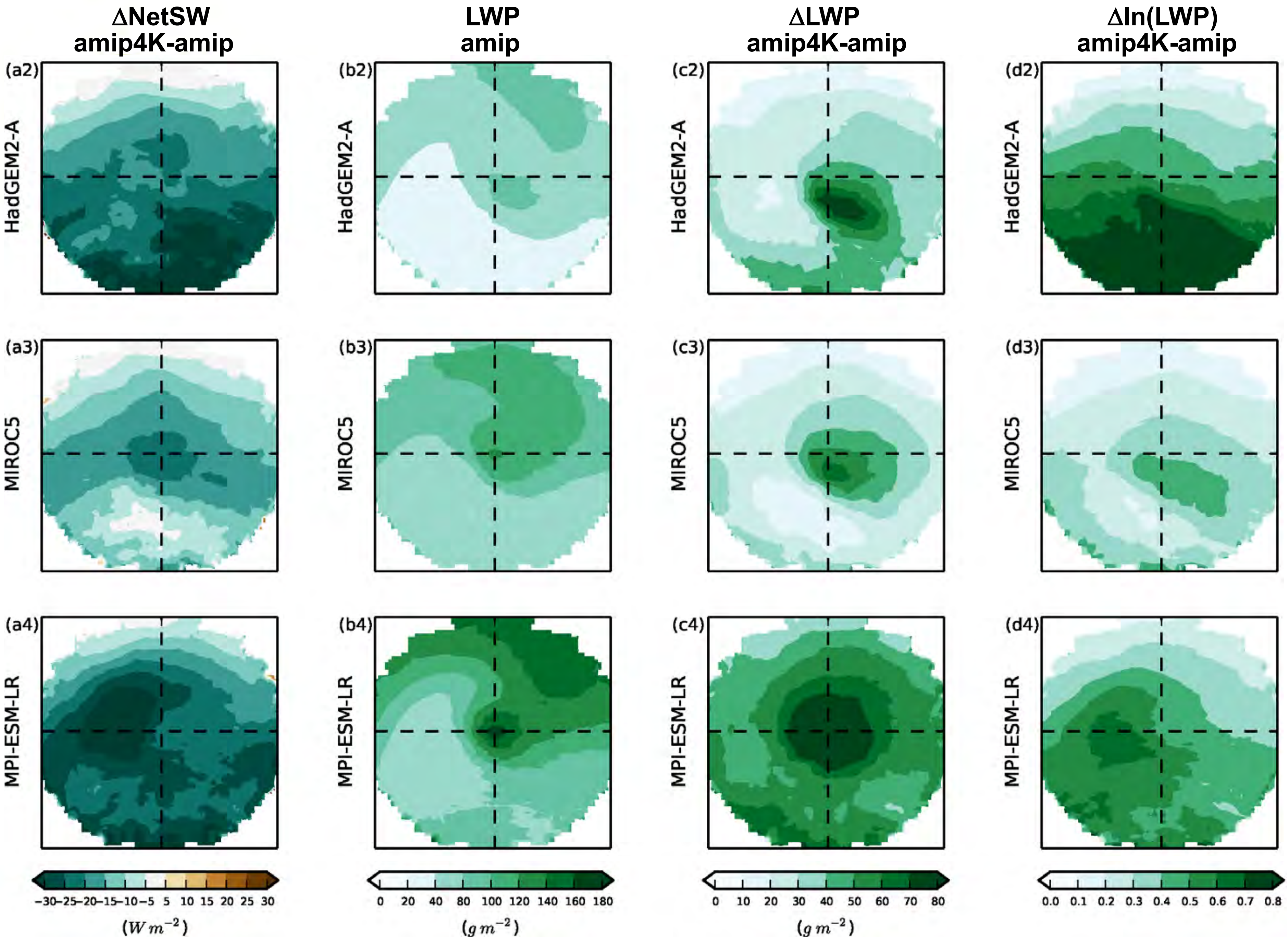
(Terai et al., *JGR*, 2016)

(Also: Tselioudis et al., *J. Climate*, 1992; Gordon and Klein, *JGR*, 2014; Ceppi et al., *GRL*, 2016)

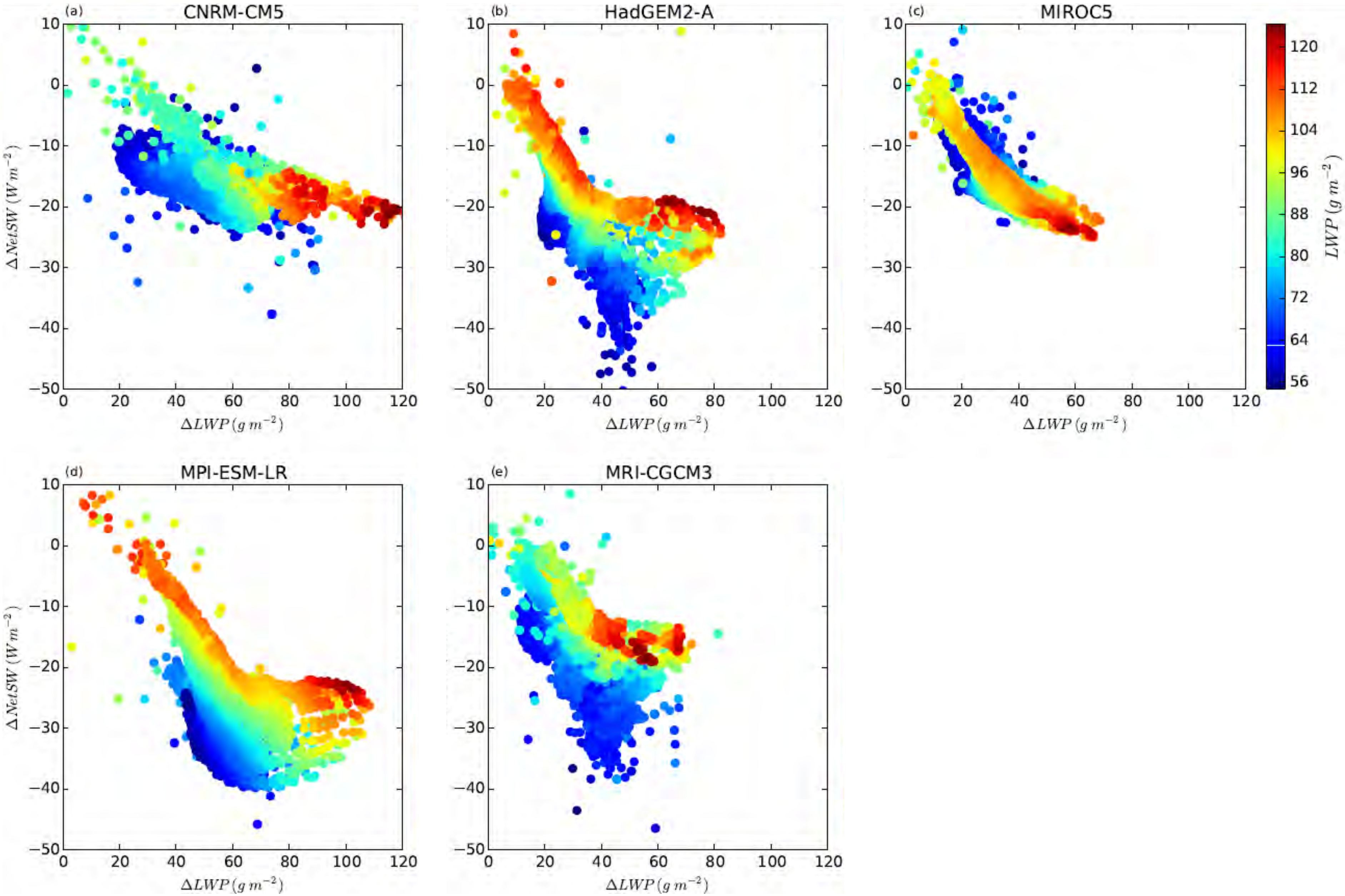
ISCCP regimes and cyclone composites



(Bodas-Salcedo et al., *J. Climate*, 2012)



(Bodas-Salcedo et al., *GRL*, 2016)

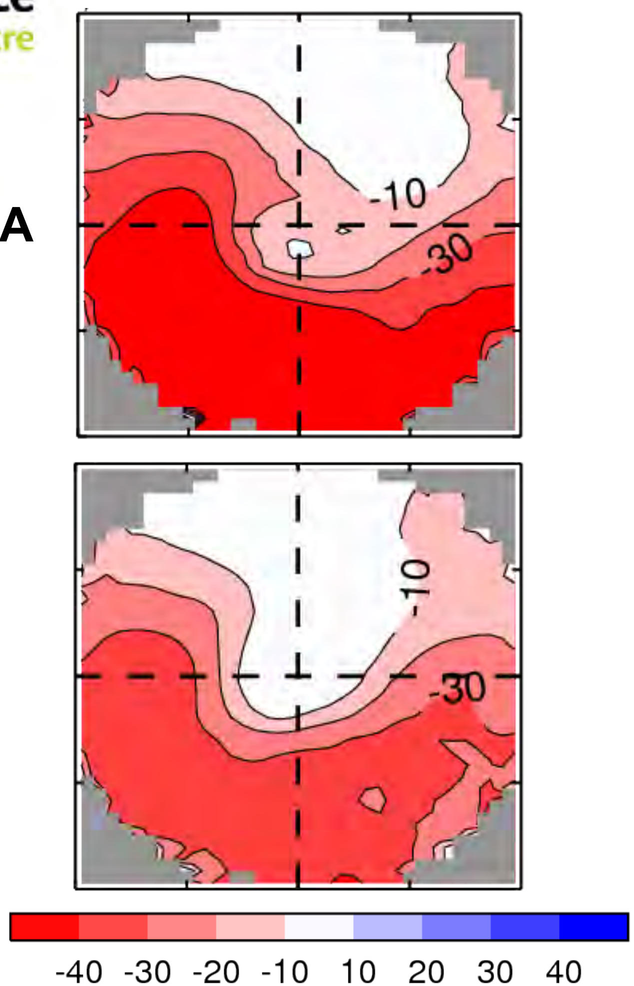


(Bodas-Salcedo et al., *GRL*, 2016)

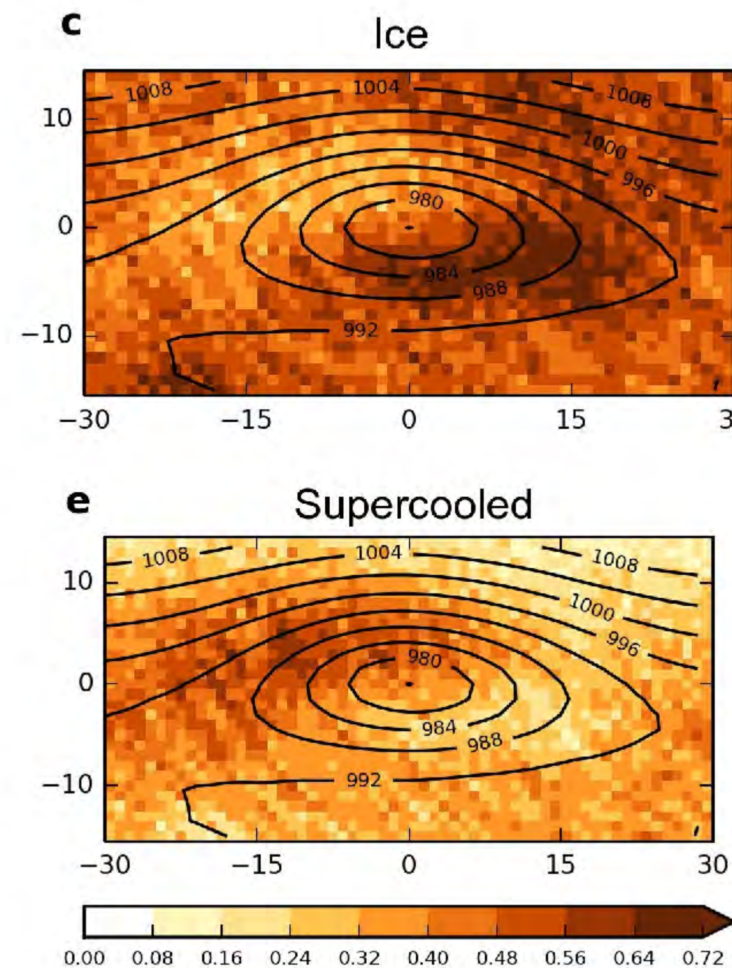
Potential role of biases in the control climate

HadGEM2-A

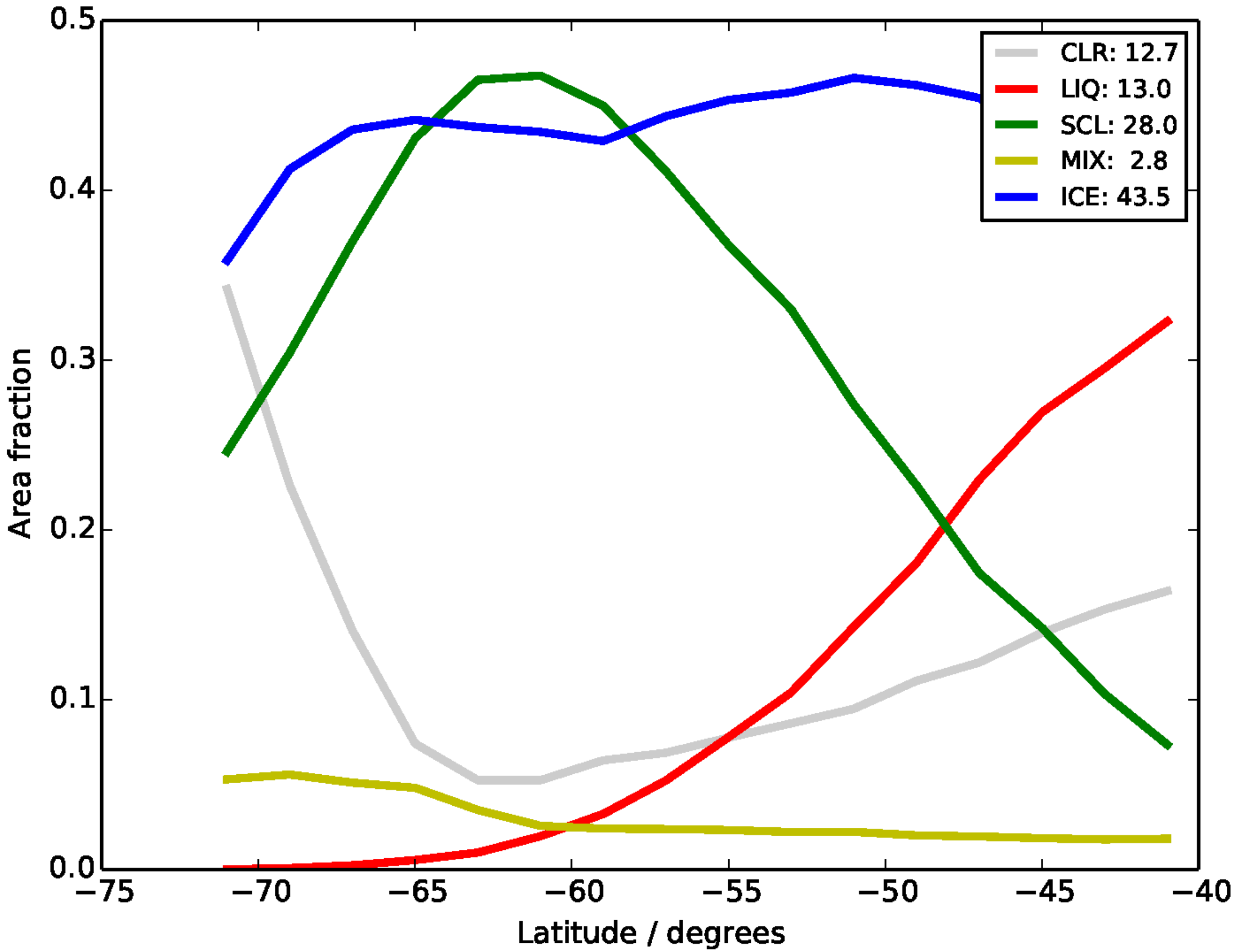
ERAI



(Bodas-Salcedo et al., *J. Climate*, 2014)



(Bodas-Salcedo et al., *J. Climate*, 2016)



- L: ~30%
- M*: ~18%
- H*: ~43%

- ICE: 45%
- SCL: 30%
- LIQ: 11%
- MIX: 6%

(Bodas-Salcedo et al., *J. Climate*, 2016)

Conclusions

- LWP and SW feedbacks depend on cloud type. The strength of the negative feedbacks in the midlatitudes will strongly depend on the LWP and cloud phase in the present-day climate.
- Strong negative SW feedbacks where supercooled liquid clouds dominate TOA radiation => negative feedbacks over the Southern Ocean may be overestimated (e.g. Tan et al., *Science*, 2016; Terai et al, *JGR*, 2016).
- Supercooled liquid clouds contribute 30% of the DJF TOA reflected SW. At the root of radiation biases in models.
- Cloud-phase change may not be the only mechanism that contributes to SW feedbacks.

Future work

- Better characterisation of cloud phase.
- Observational estimates of LWP and absorbed SW radiation sensitivities by cloud type.
- Use of idealised simulations: separate the contribution of thermodynamic and microphysical feedbacks to the total feedback in the midlatitudes.
- Use methods that separate cloud types so that the mechanisms that control the LWP and radiative feedbacks are clearly decoupled.

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Thanks!

Methodology

•Cyclone compositing (Field and Wood, J. Clim., 2007)

•ISCCP cloud regimes (Williams and Webb, Clim. Dyn., 2009)

•RT calculations:

- C3M data (Kato et al., JGR, 2010 & 2011)
- SOCRATES RT code
- 5 DJF seasons (2006-2010)
- 40S to 70S

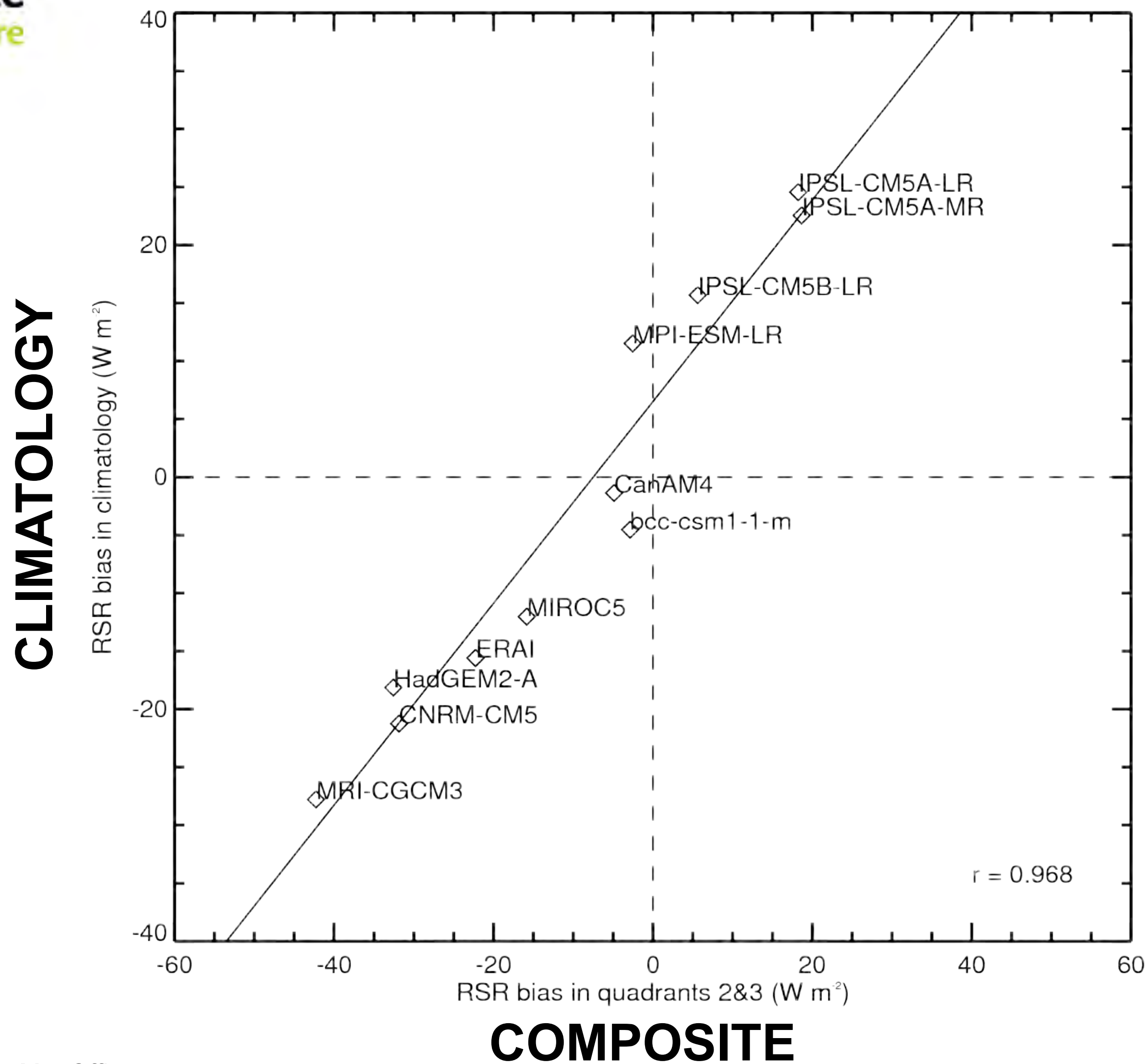
•Model experiments: amip, amip4K, amipFuture

Datasets

- CERES/CloudSat/CALIPSO/MODIS
- Edwards-Slingo RT code
- 5 DJF seasons (2006-2010)
- 40S to 70S

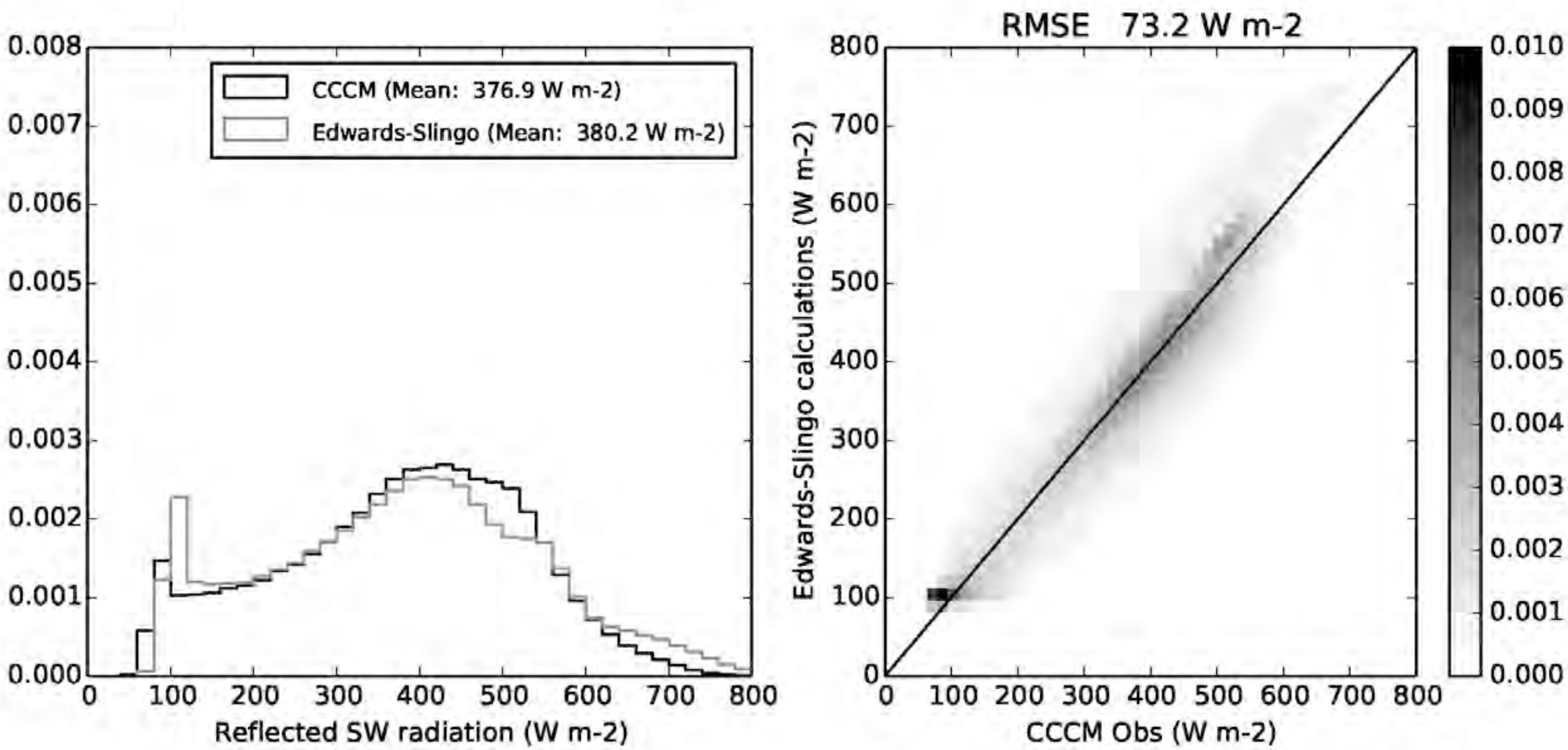
- Data from CMIP5: AMIP, amip4K, amipFuture

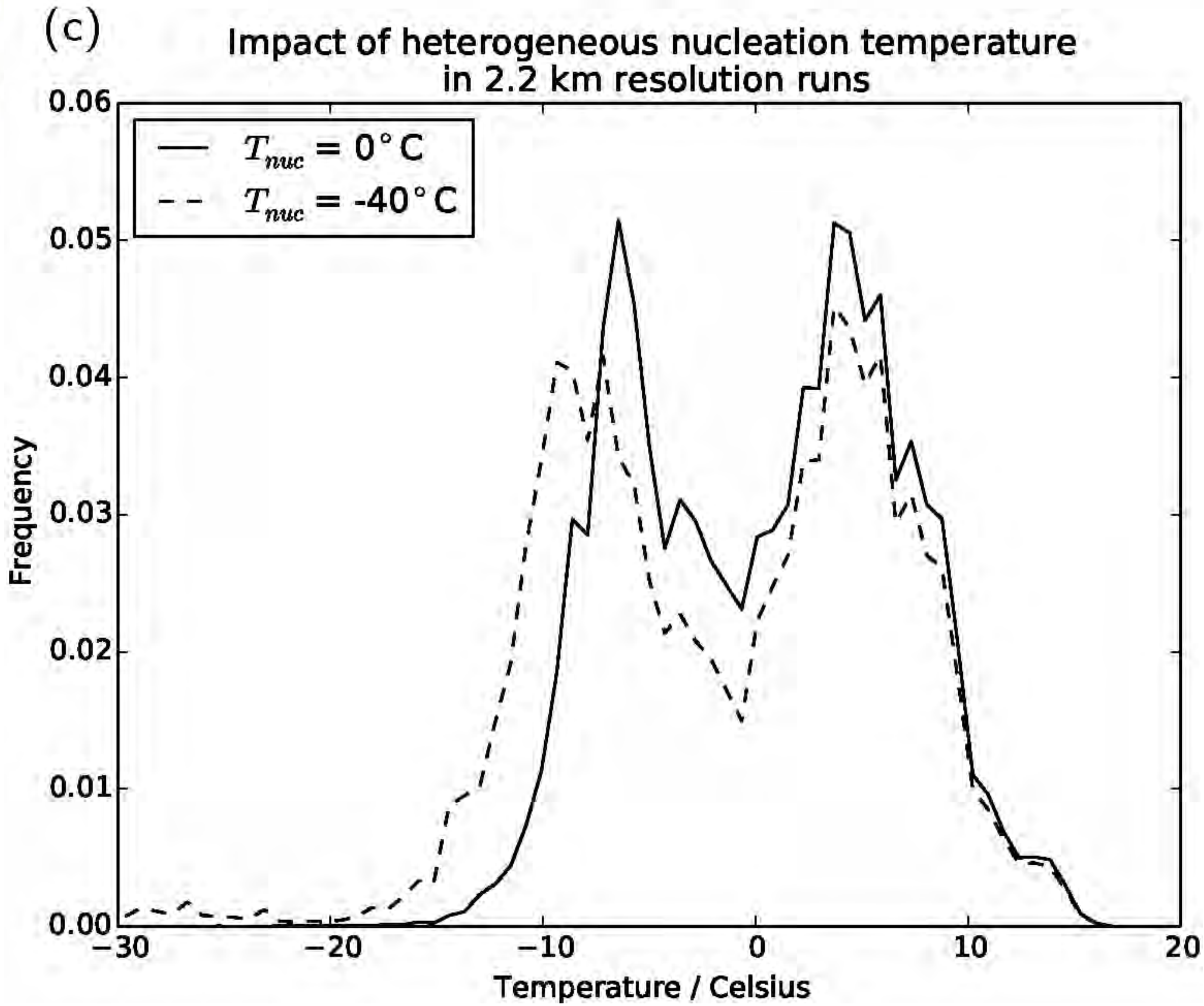
Bias in cold-air side correlates with climatological bias



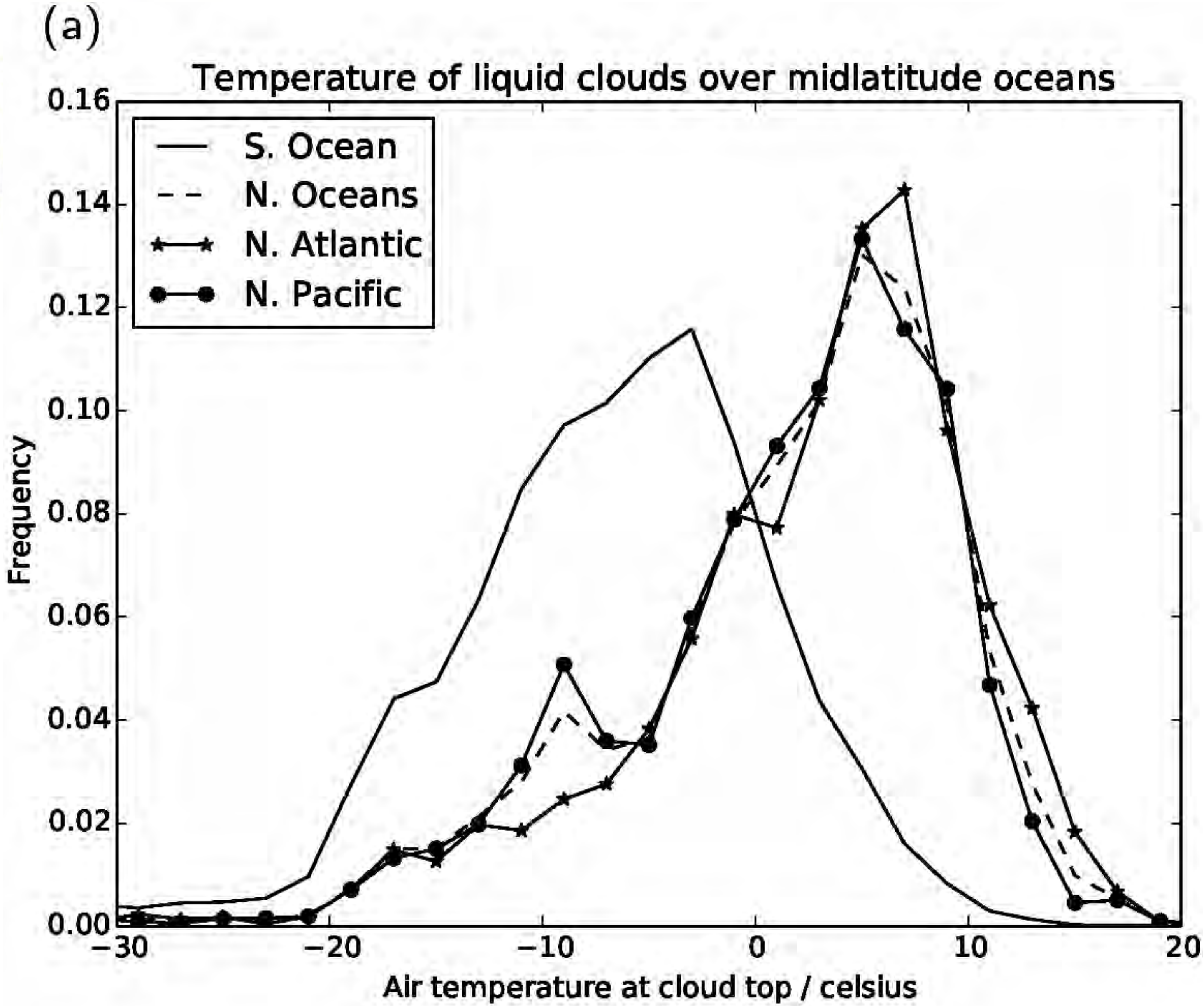
Evaluation of radiative transfer calculations

- 5 DJF seasons
- [40S, 70S]
- ~15 million profiles

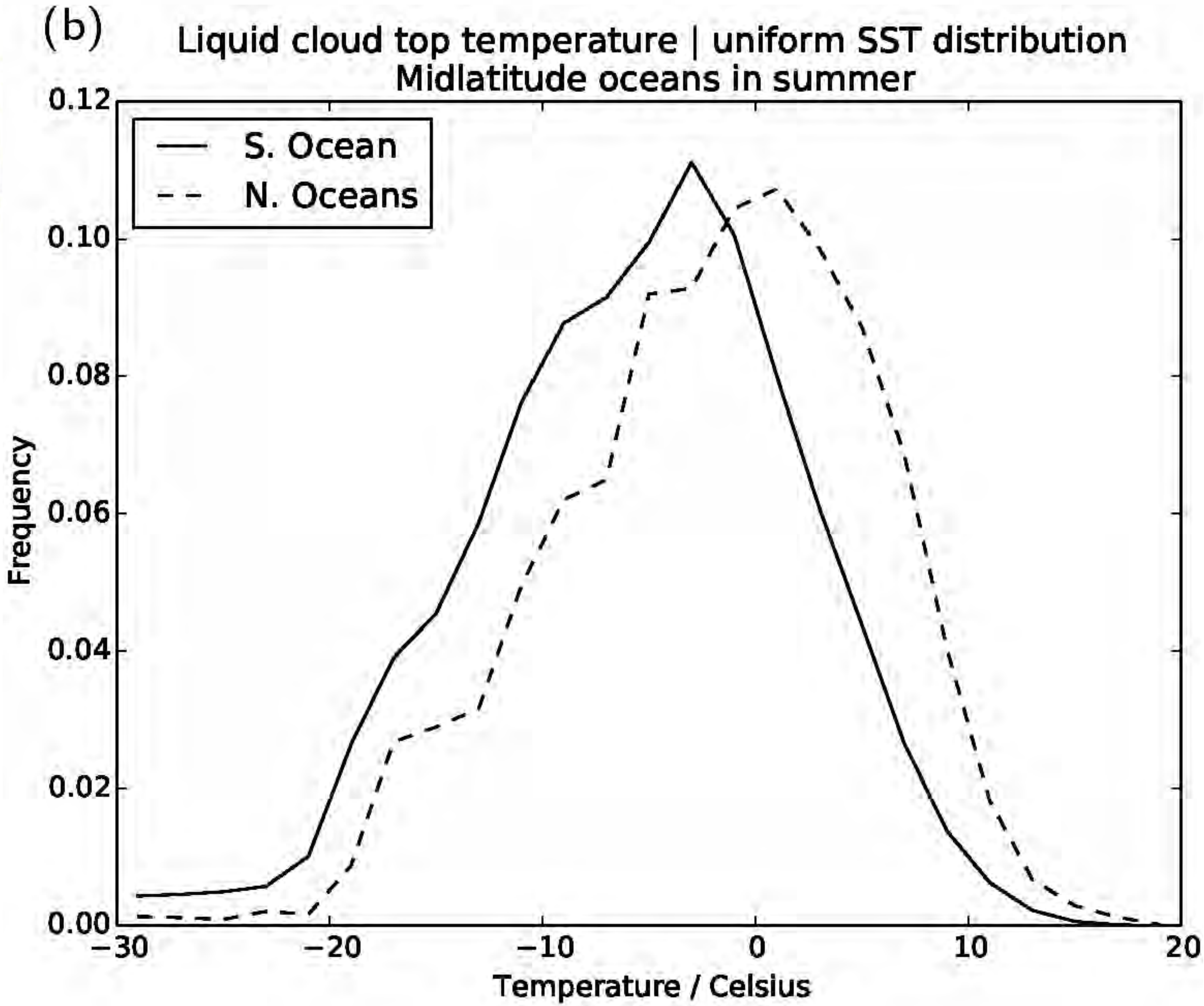




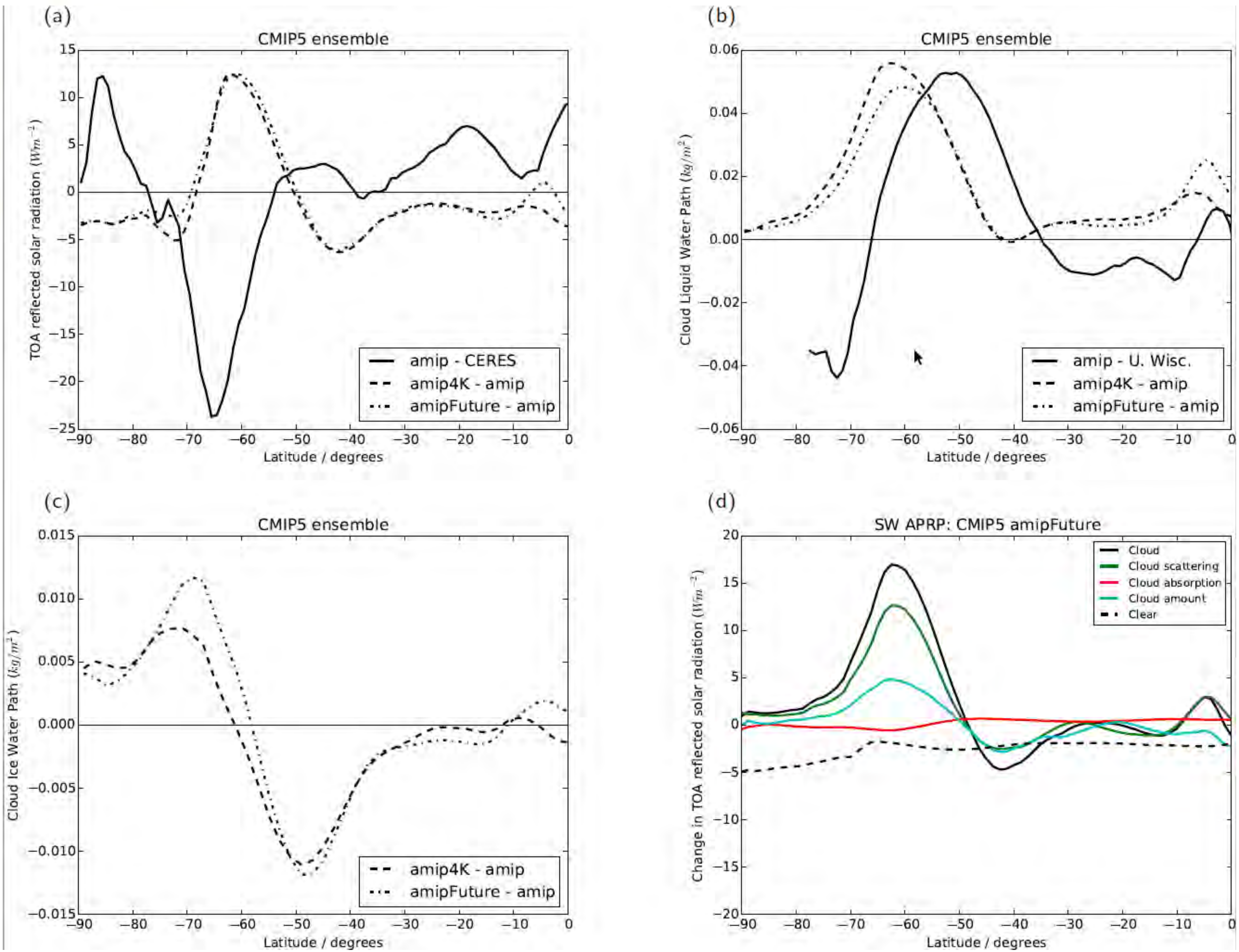
(Bodas-Salcedo et al., *J. Climate*, 2016. DOI:10.1175/JCLI-D-15-0564.1)



(Bodas-Salcedo et al., *J. Climate*, 2016)

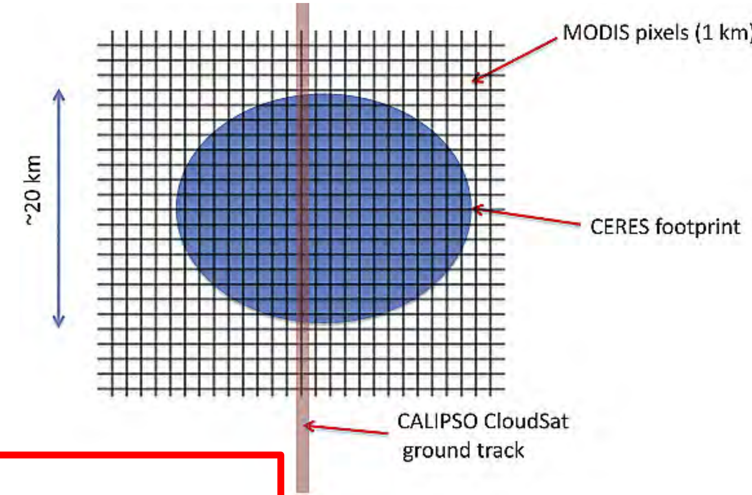


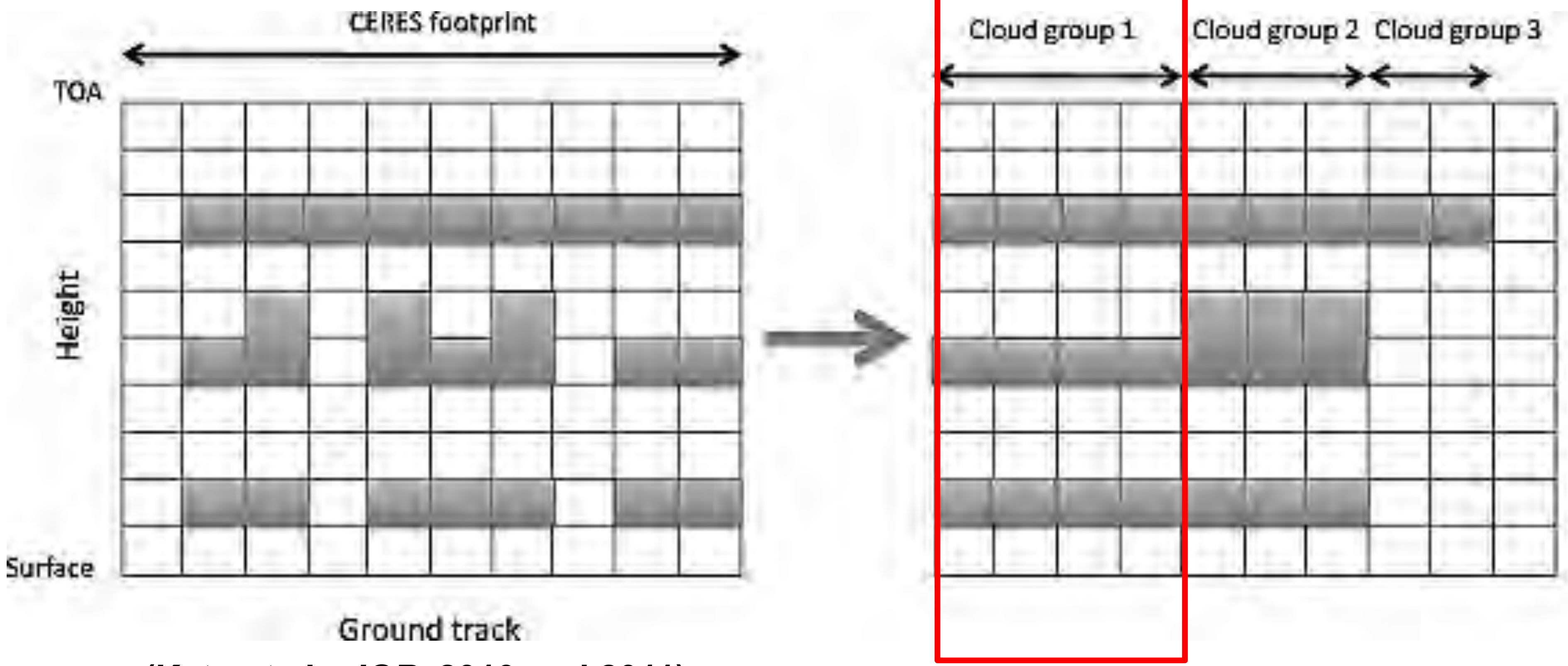
(Bodas-Salcedo et al., *J. Climate*, 2016)



(Bodas-Salcedo et al., *GRL*, 2016)

CCCM data + RT calculations





(Kato et al., *JGR*, 2010 and 2011)

RT calculations