Arctic clouds and their role for the *wintertime* surface energy balance

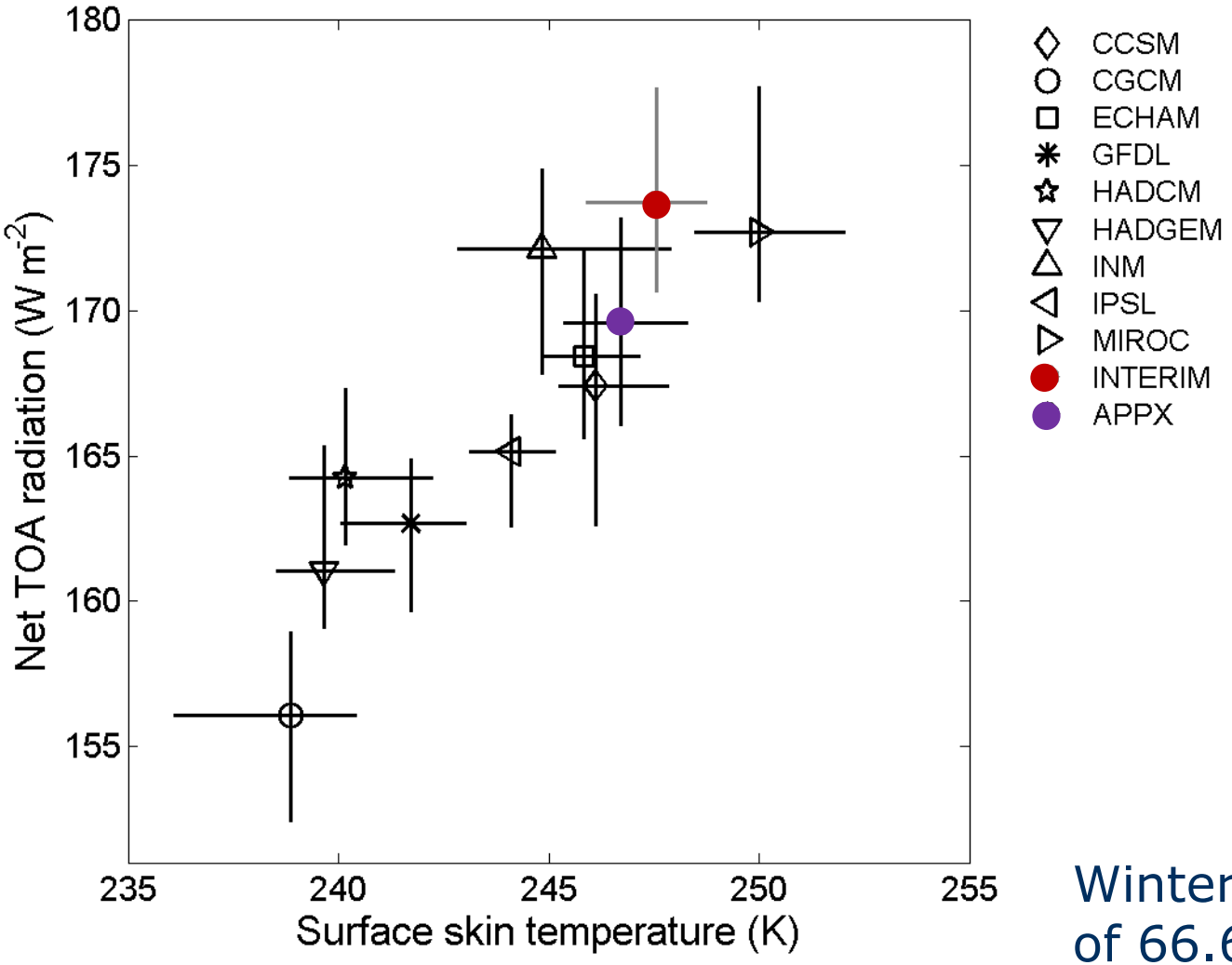
Gunilla Svensson and Johannes Karlsson

Department of Meteorology
and
Bert Bolin Centre for Climate Research

and many others as Jen Kay, Michael Tjernström, Anders Engström, Joe Sedlar, …

Arctic clouds in the CMIP3 models

Stockholm University

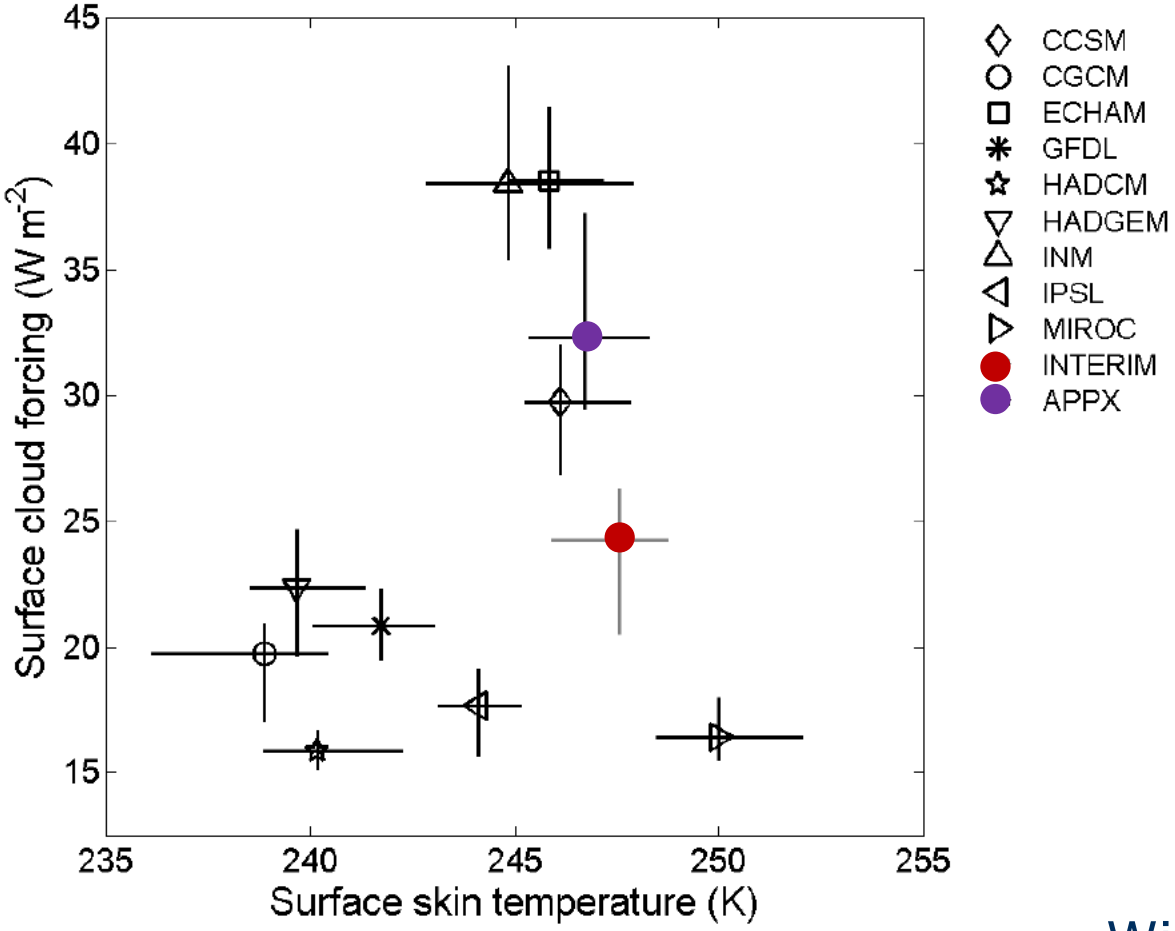


Wintertime (DJF) north of 66.6°N

Svensson and Karlsson, 2011

Arctic clouds in the CMIP3 models

Stockholm University

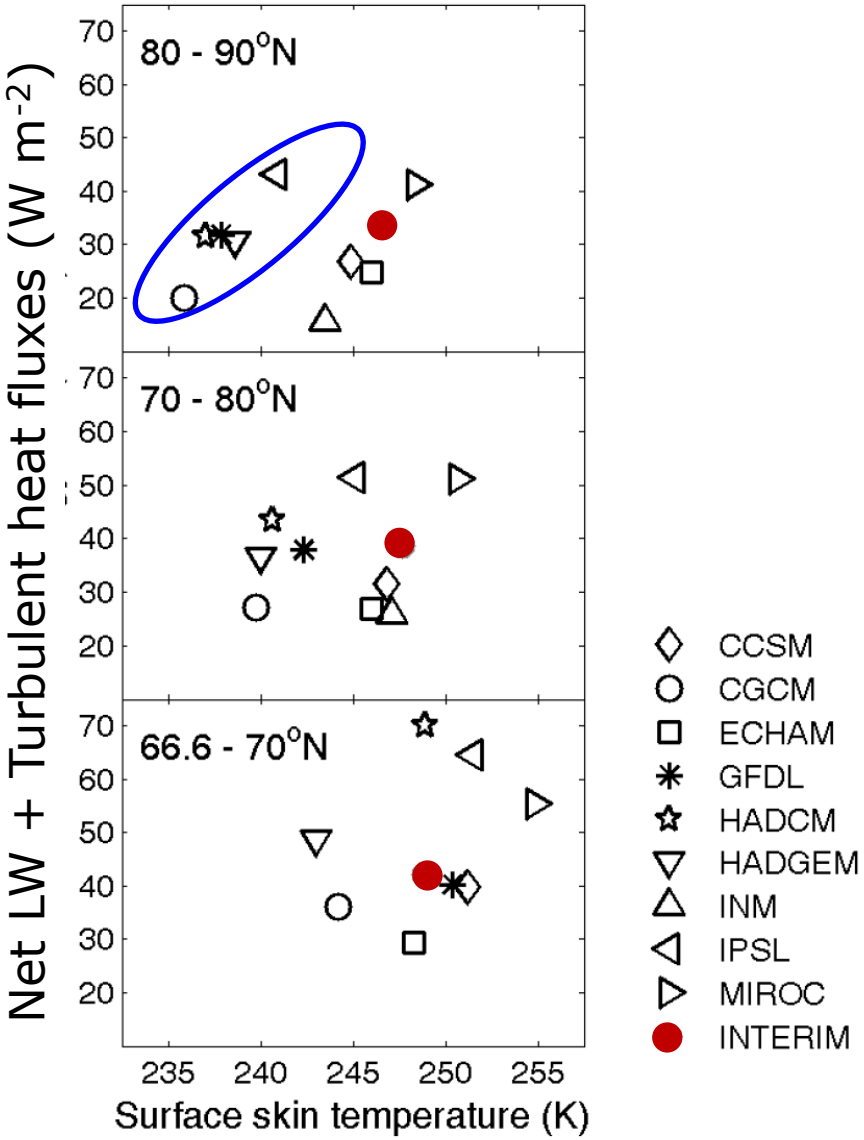


Wintertime (DJF) north of 66.7°N

Svensson and Karlsson, 2011

CMIP3 results: Surface energy flux

Stockholm University

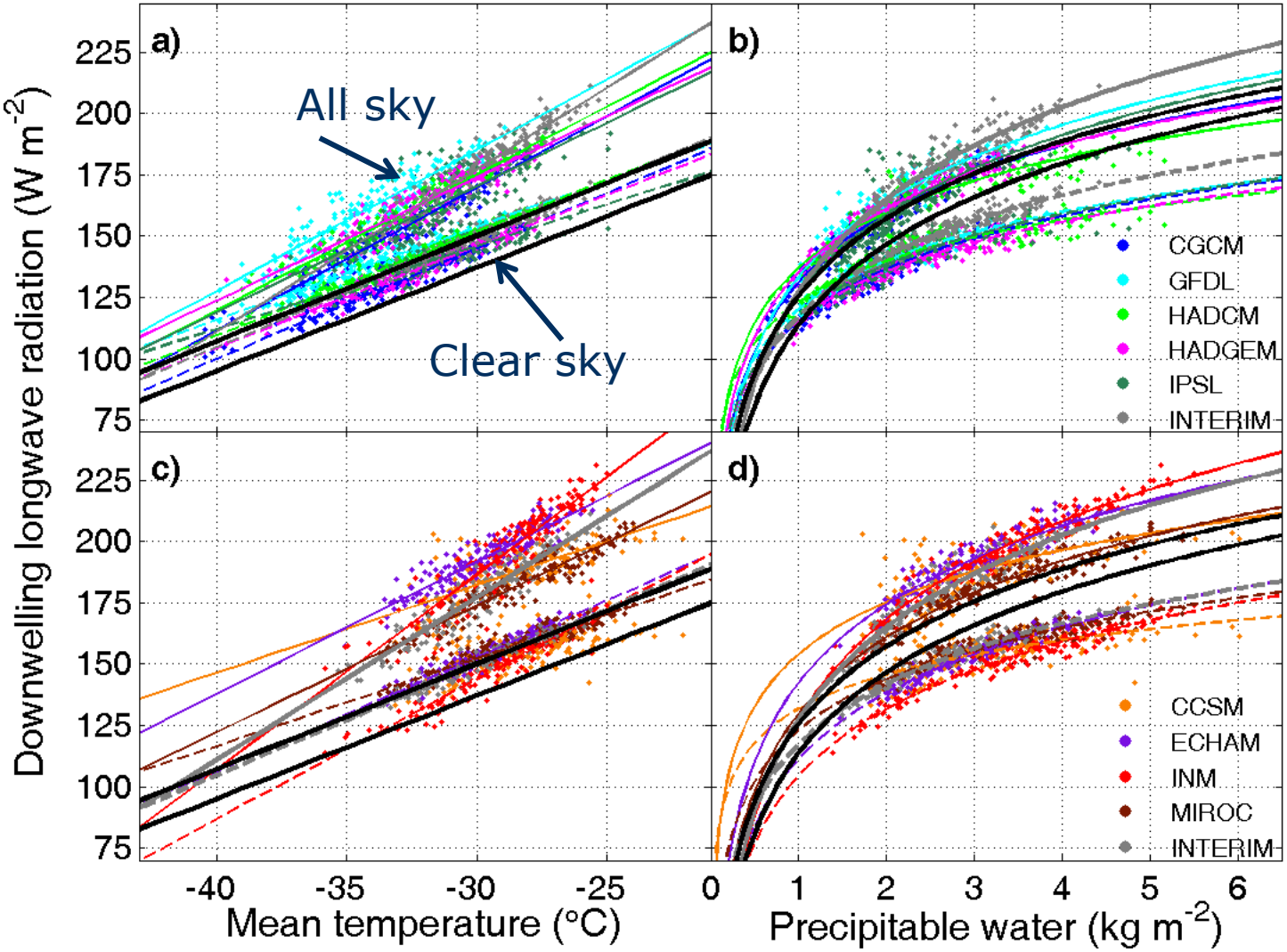


Wintertime (DJF) over sea-ice north of 66.7°N

Svensson and Karlsson, 2011

Downwelling long-wave radiation

Stockholm University



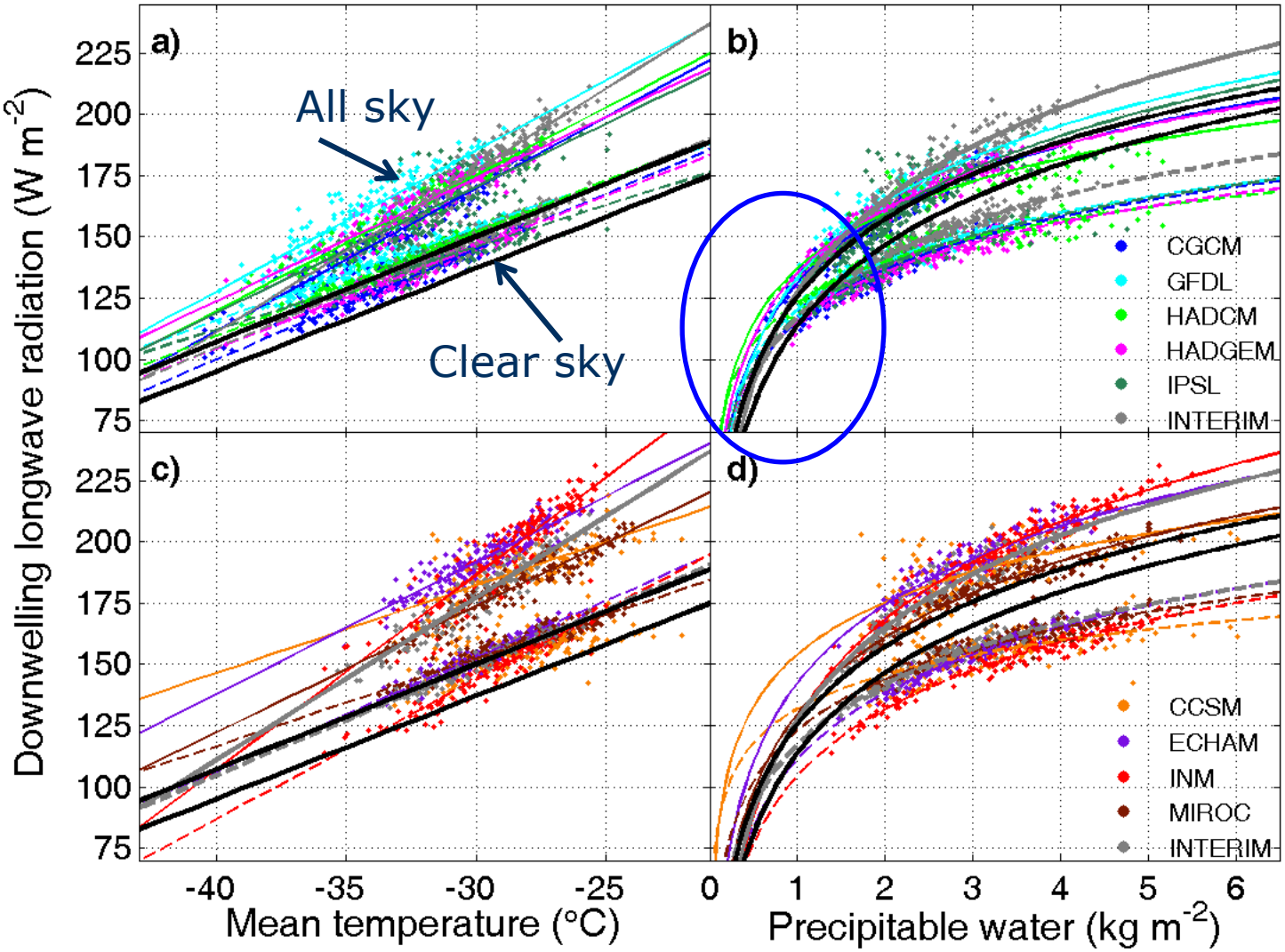
"Bad models"

"Good models"

Svensson and Karlsson, 2011

Downwelling long-wave radiation

Stockholm University



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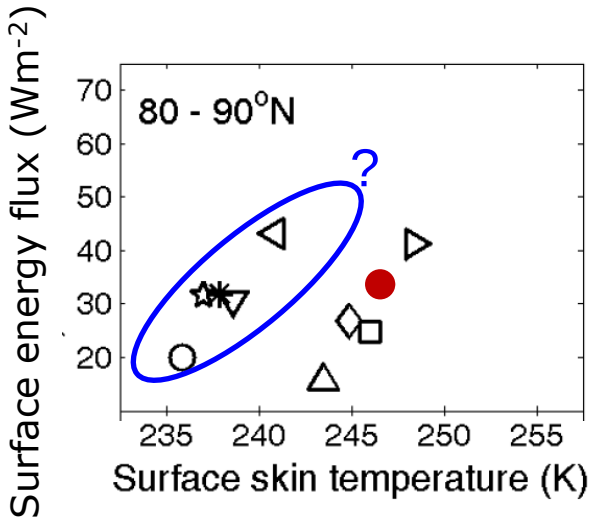
CMIP3 results: Surface energy flux

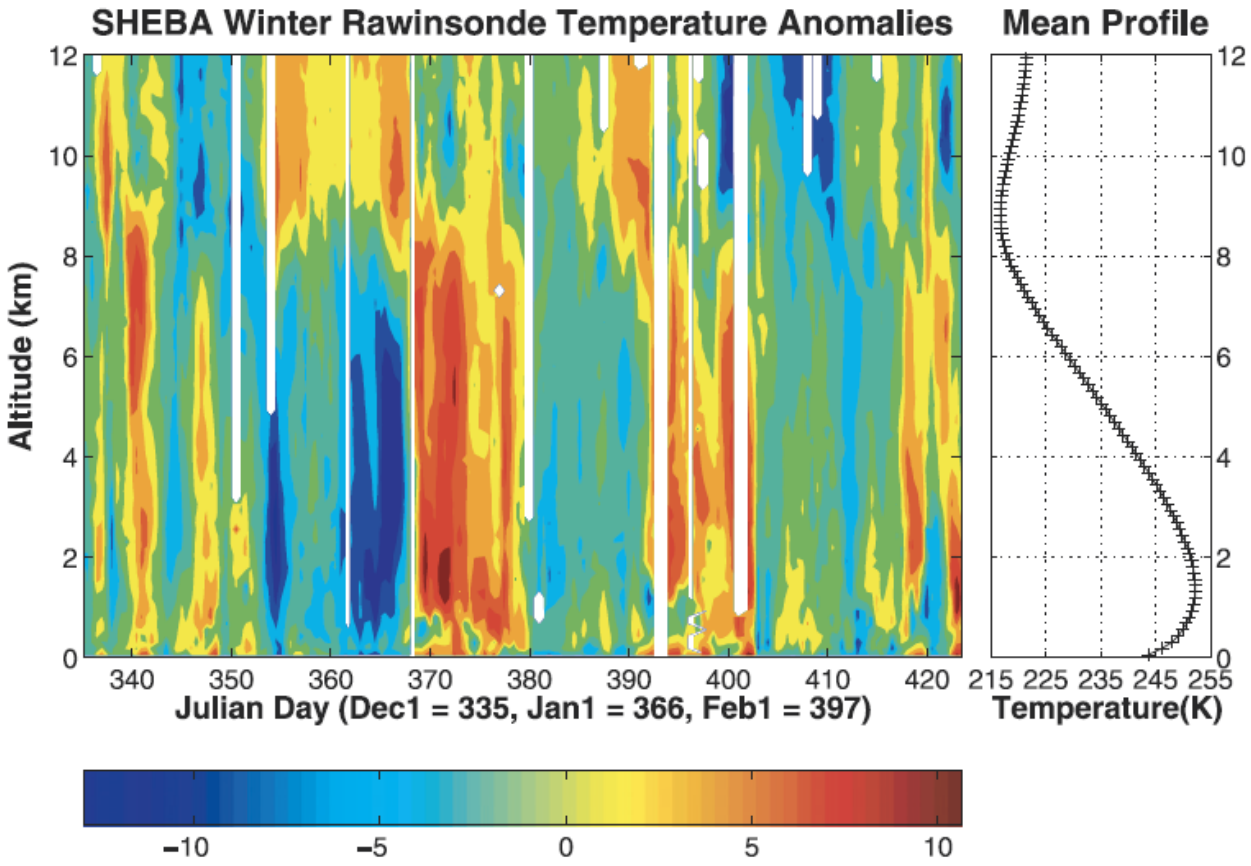


- Too little downwelling long-wave radiation to the surface – properties of the airmass (temperature, humidity, clouds) important
- Clouds could play a role in cooling the atmosphere/changing it's properties too quickly or too little exchange of airmasses (too few baroclinic storms)
- CMIP3 monthly mean data not enough to investigate this

Wintertime (DJF) over sea-ice north of 66.6°N

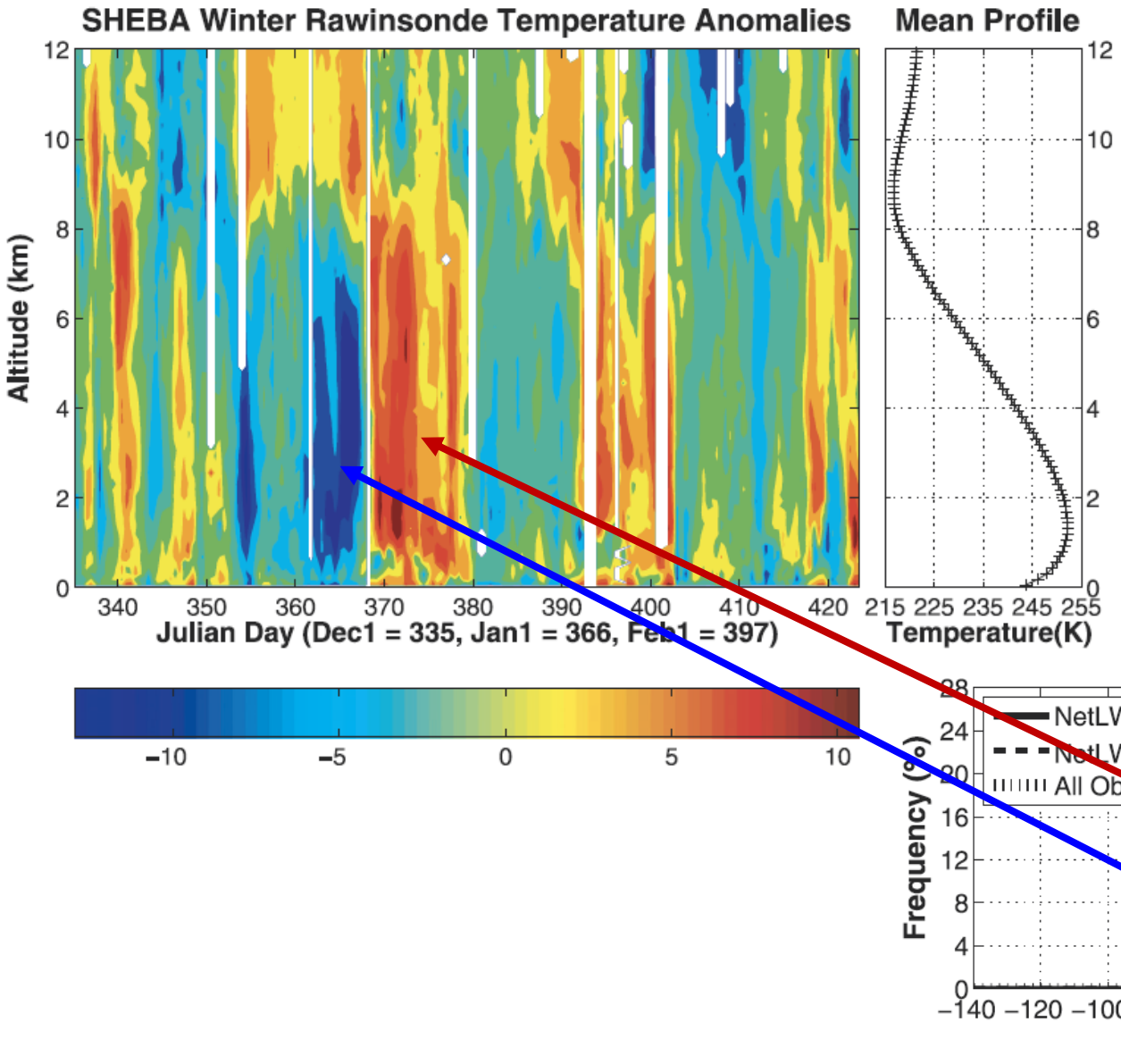
Svensson and Karlsson, 2011

SHEBA data



Stramler et al., 2011

SHEBA data



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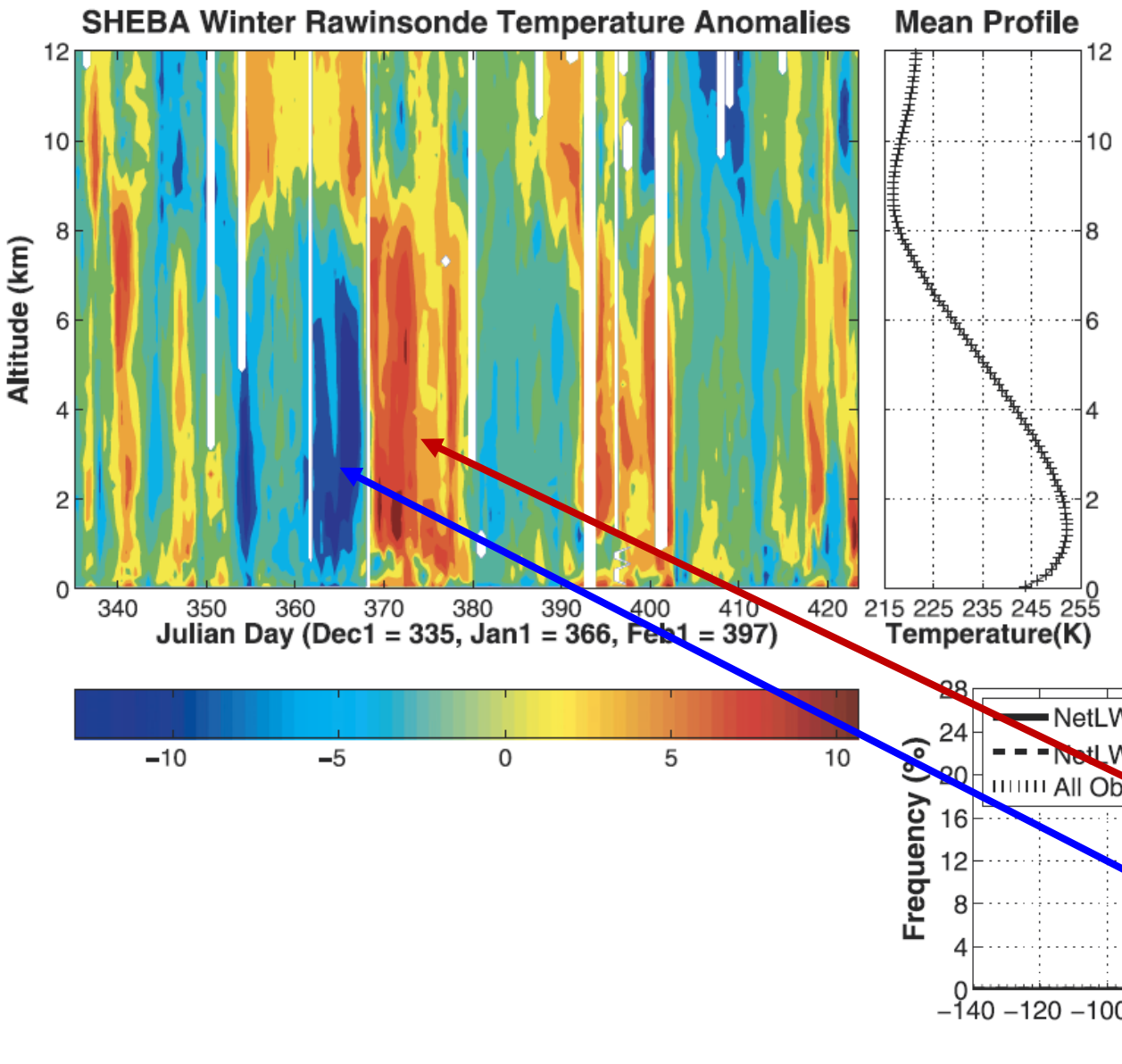
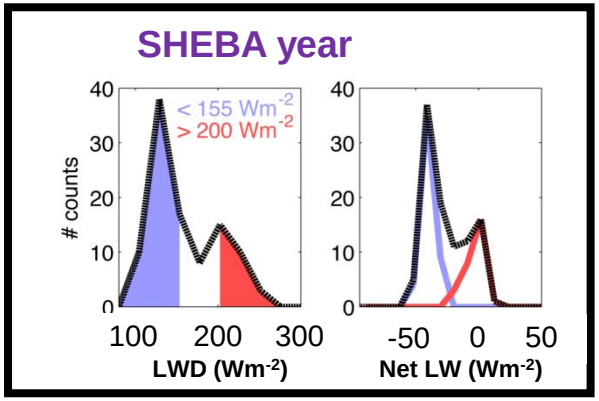


Can we see this in CMIP5 models?

Stramler et al., 2011

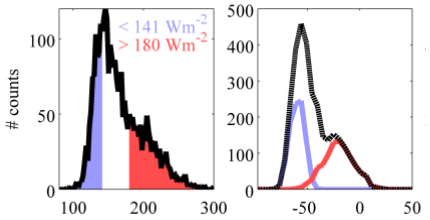
CMIP5 models – SHEBA location



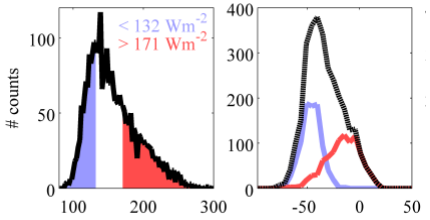
CMIP5 models – SHEBA location

Stockholm University

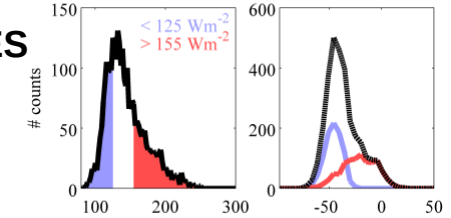
INTERIM



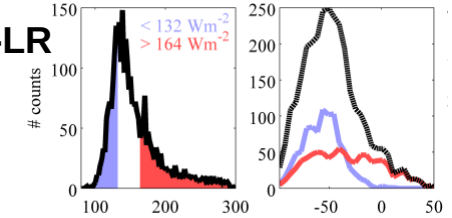
CanESM2



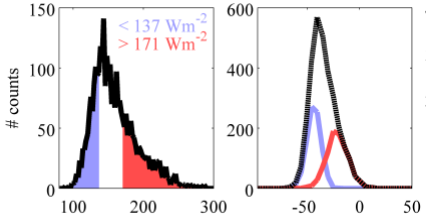
HadGEM2-ES

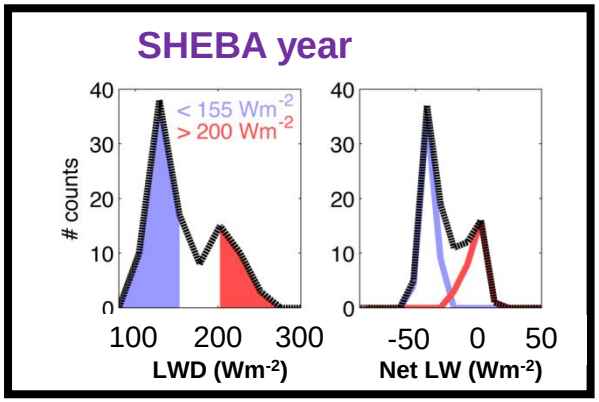


IPSL-CM5A-LR



MIROC5





CMIP5 (Historical) statistics based on daily averages for DJFM 1980-2004

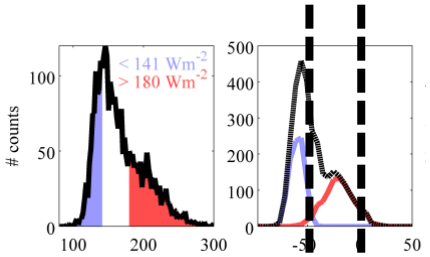
30% lowest LW down

30% highest LW down

CMIP5 models – SHEBA location

Stockholm University

INTERIM



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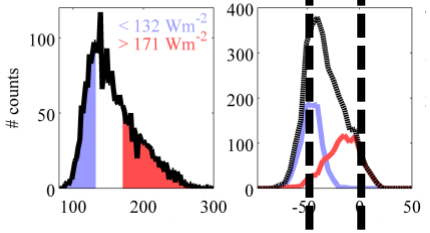

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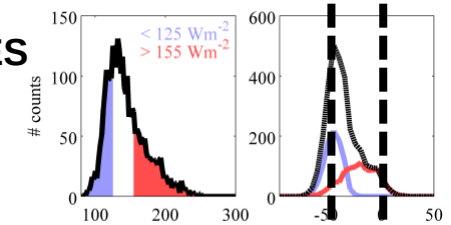

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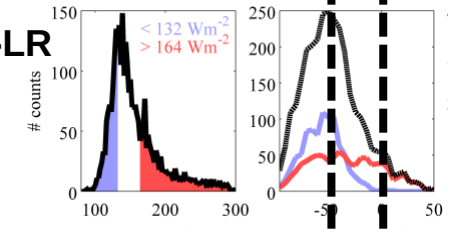

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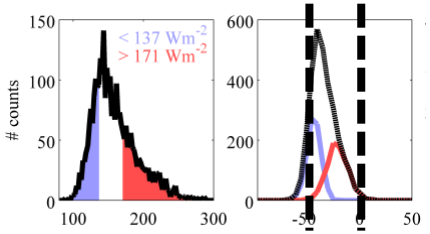

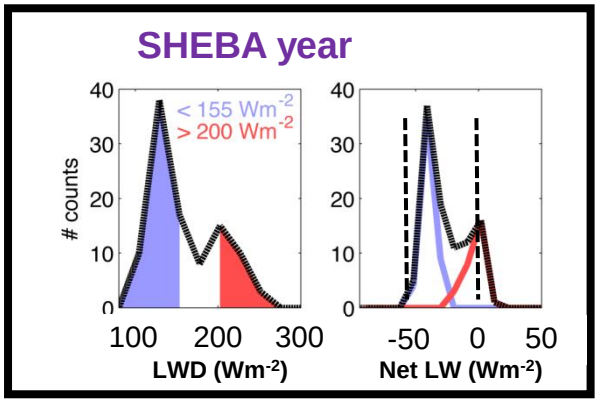

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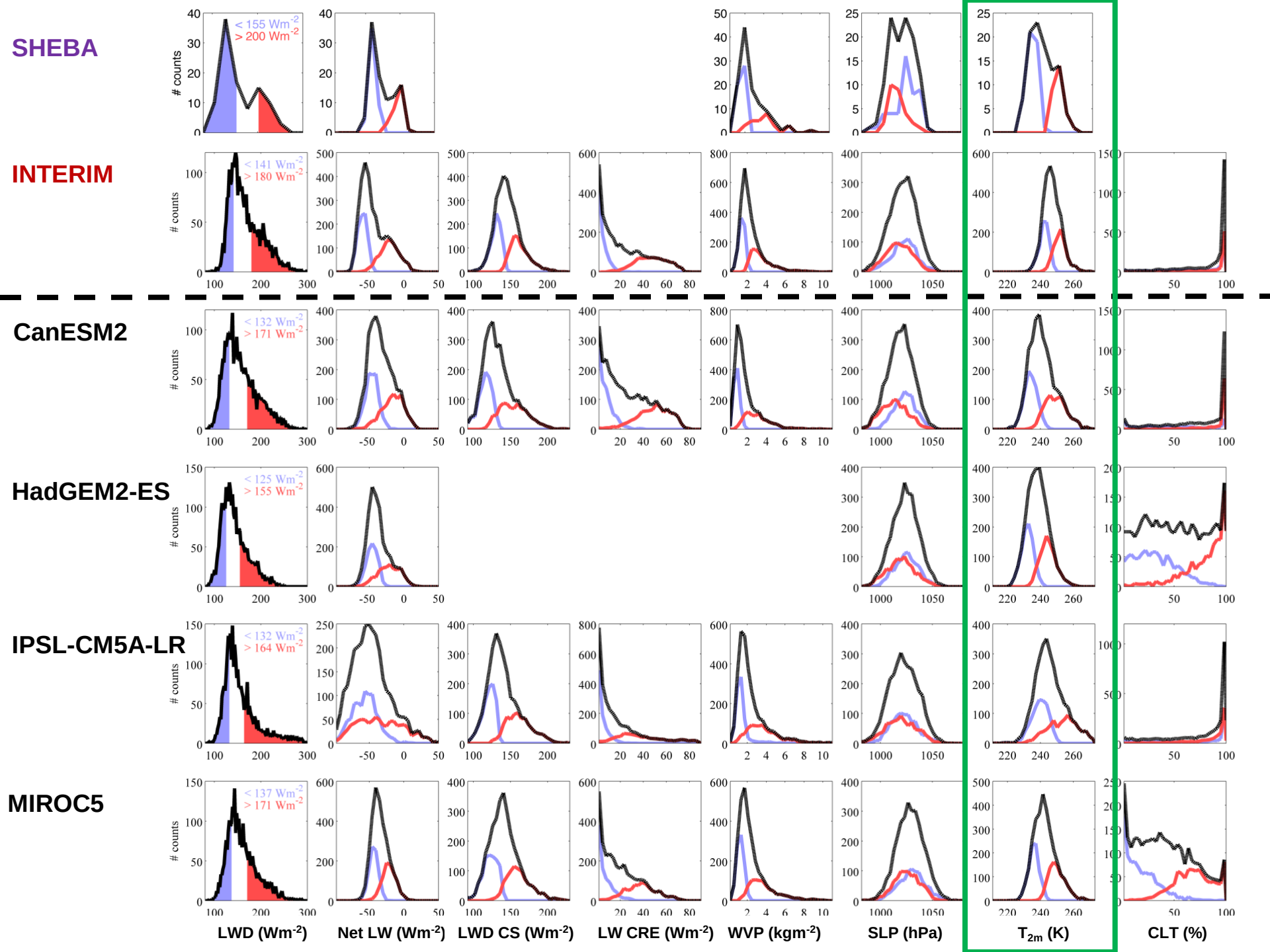
SHEBA
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CanESM2
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IPSL-CM5A-LR
MIROC5
counts
< 155 Wm-2
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< 132 Wm-2
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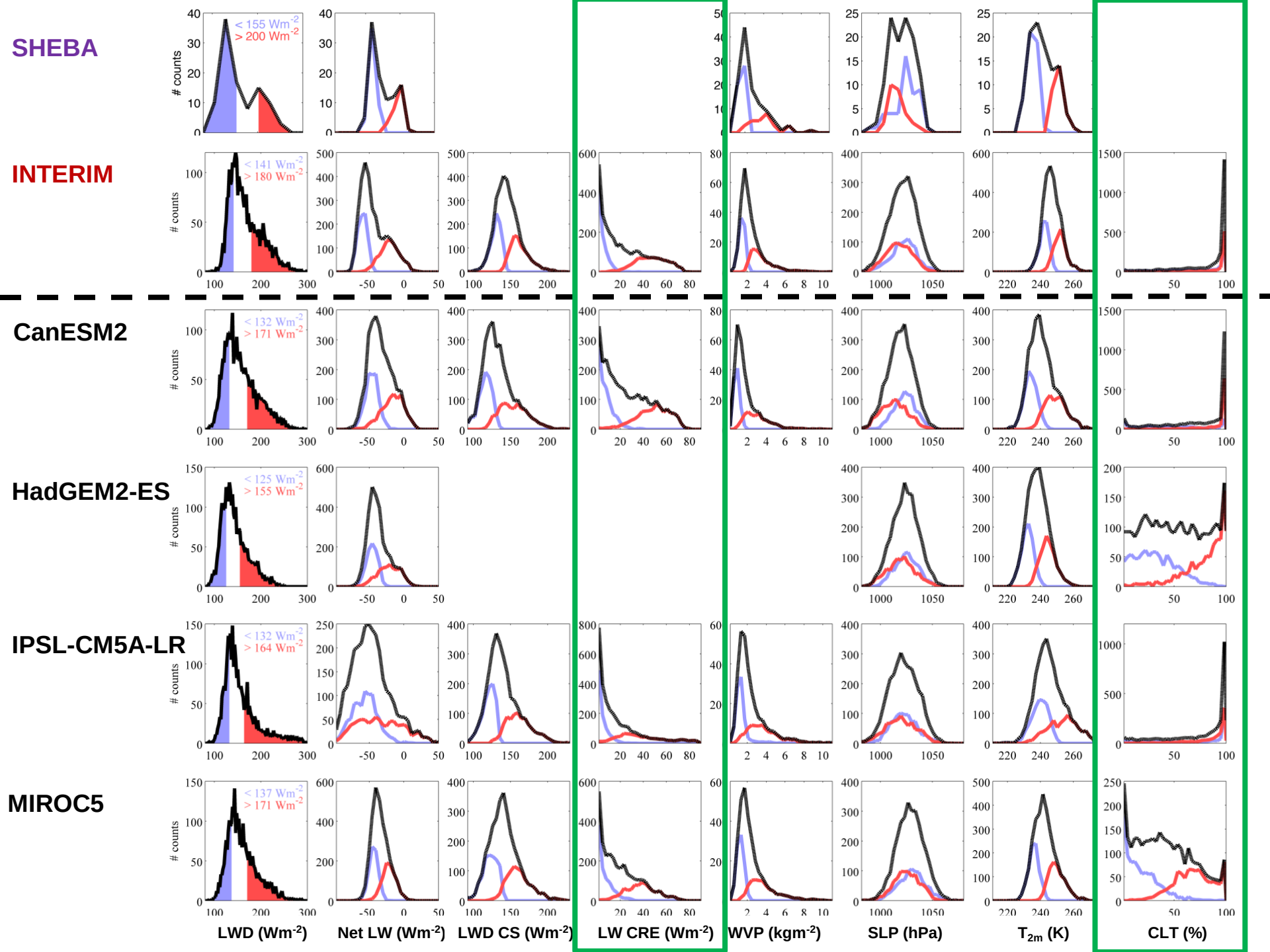
< 132 Wm-2
> 164 Wm-2
< 137 Wm-2
> 171 Wm-2
LWD (Wm-2)
Net LW (Wm-2)
LWD CS (Wm-2)
LW CRE (Wm-2)
WVP (kgm-2)
SLP (hPa)
T2m (K)
CLT (%)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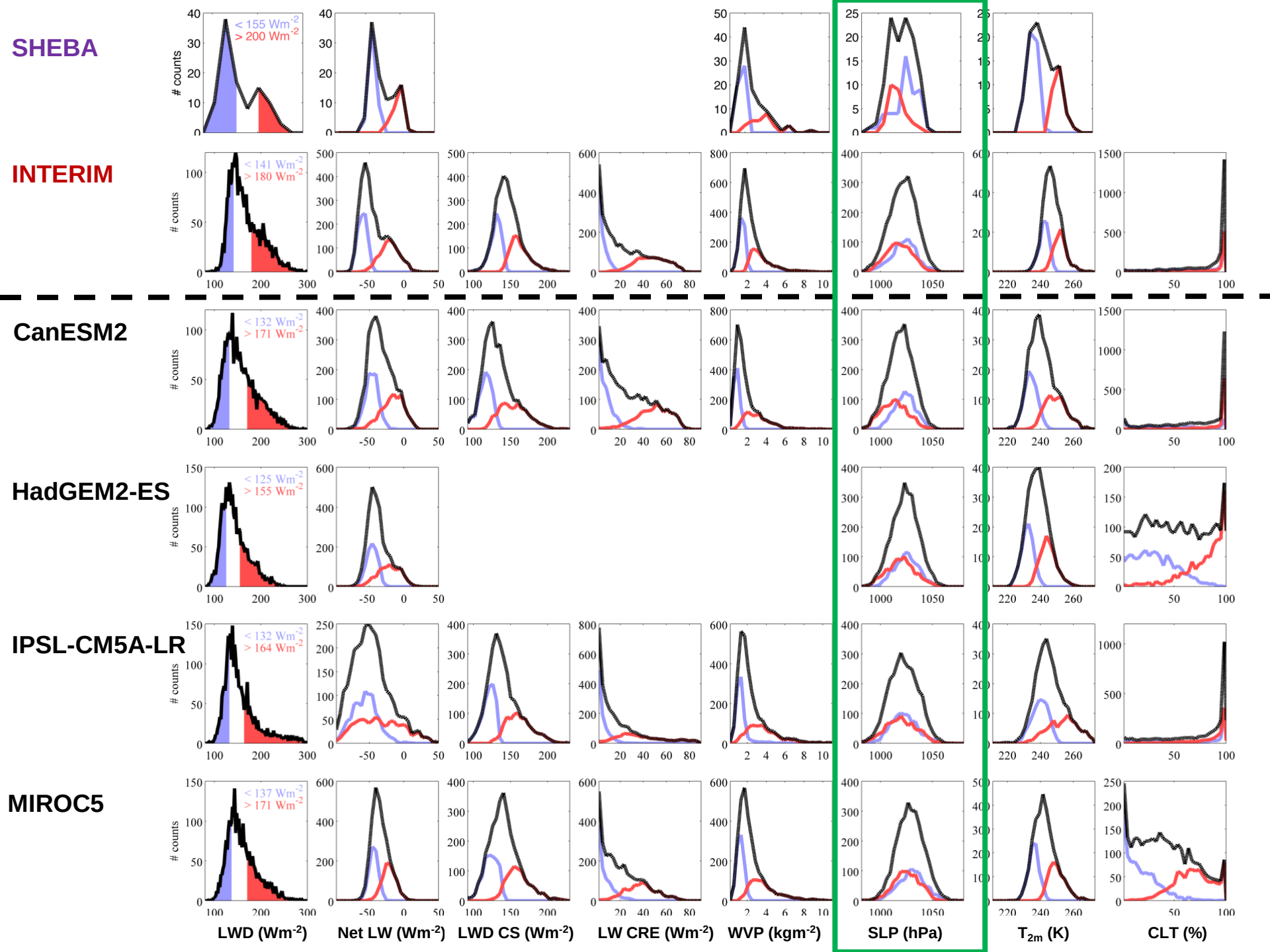
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LWD for winterseasons (DJFM, 1980-2004)

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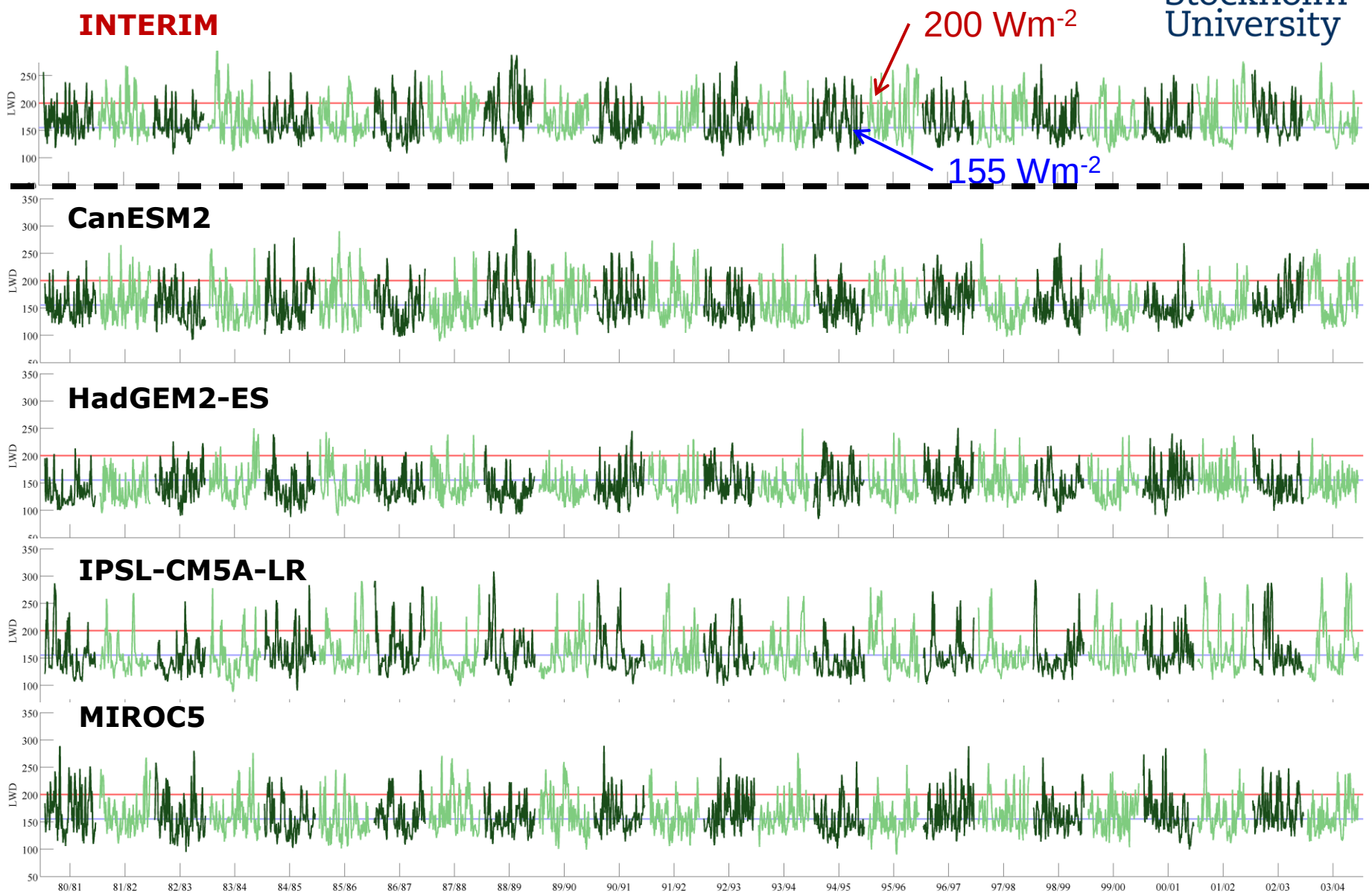
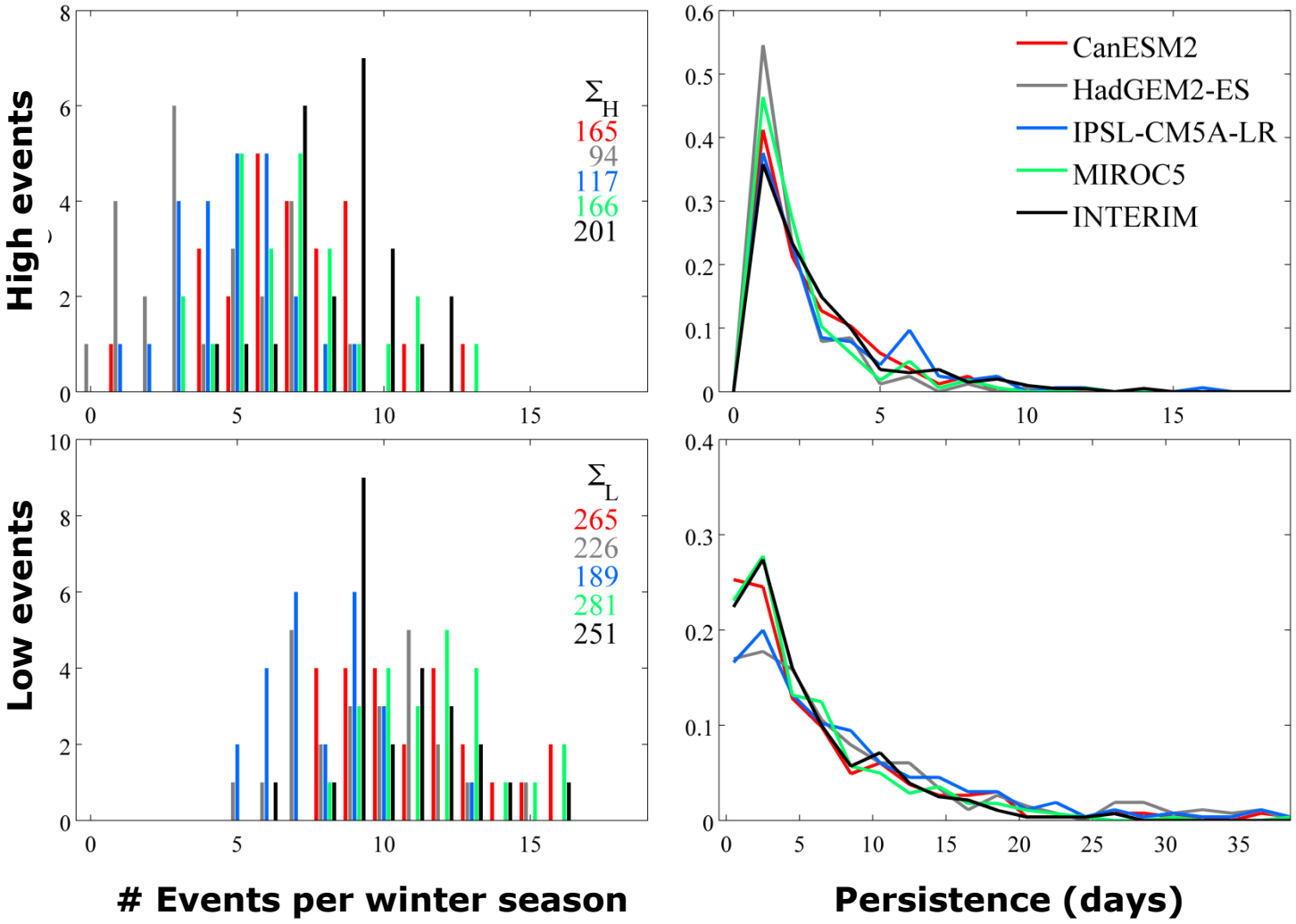


High and low LWD events



Summary

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- CMIP3 and CMIP5 models show large variations in surface temperature of the sea-ice covered wintertime Arctic
- Properties of the airmass (temperature, humidity and clouds) are important for the downwelling radiation – and thus for the surface temperature
- Preliminary analysis of a few CMIP5 models show:
  - a skewed and not a double-peak distribution of downwelling long-wave radiation
  - different CRE and no clear relation to SLP for the warm/cold days
  - too few and too short events of high LWD
- More analysis needed to understand the reason why models tend to underestimate the LWD, clearly a strong coupling to large-scale circulation

Photo: M. Tjernström

LWD at the SHEBA location

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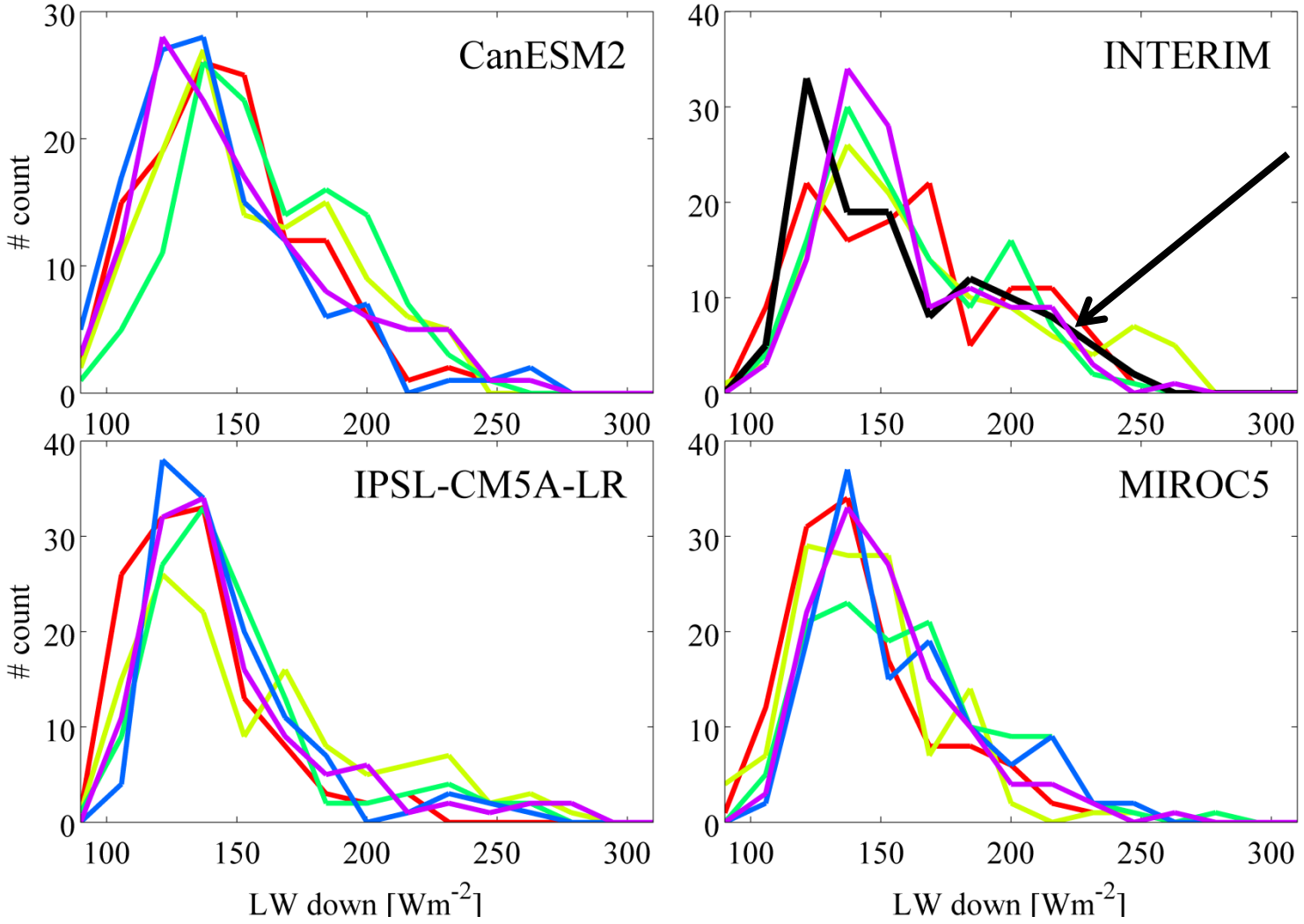

SHEBA winter 97/98