Comparison of RT codes via BBHRP

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BBHRP with different RT models

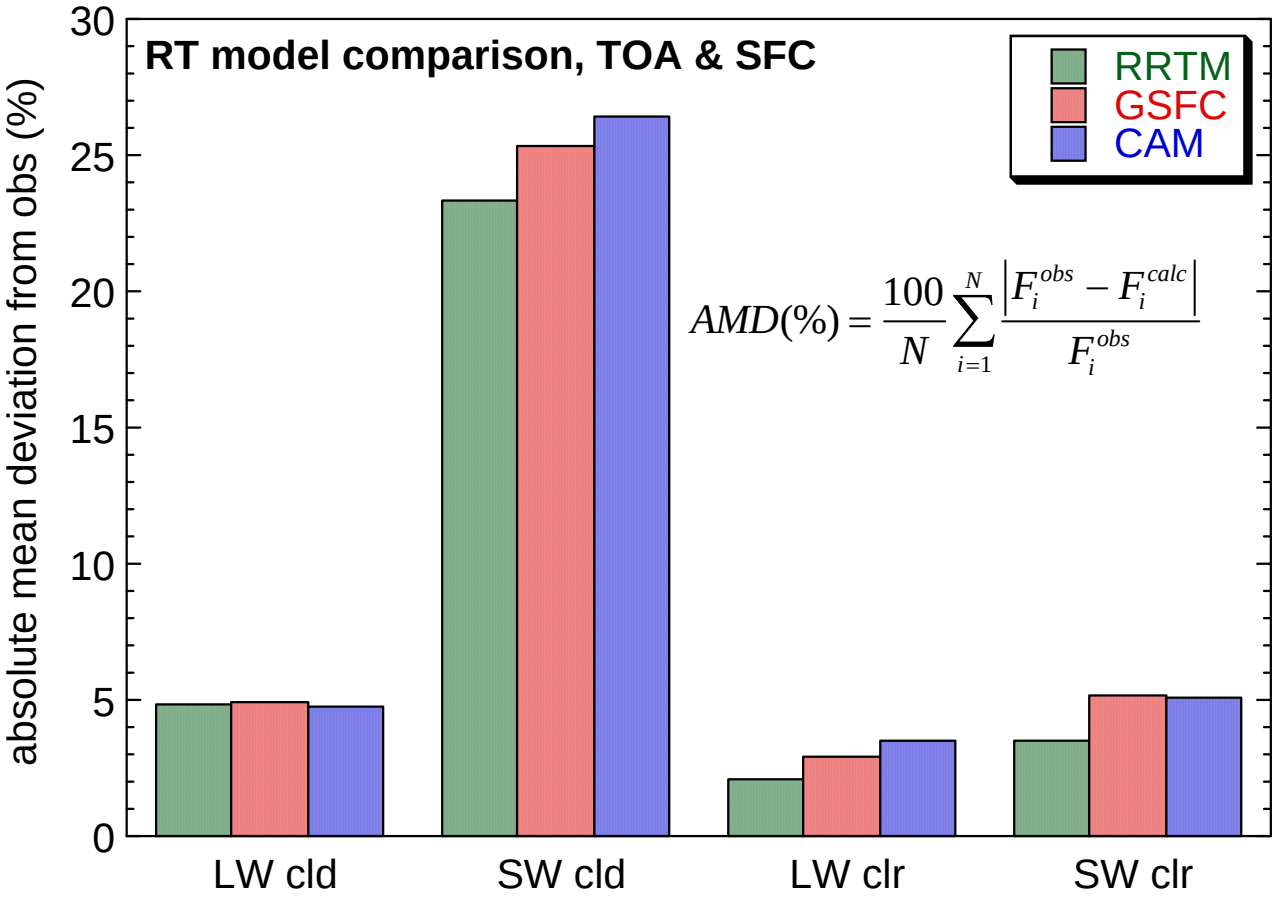
(see also Oreopoulos et al. poster)

Our goal: To learn when and why we succeed or fail to achieve radiative flux closure in BBHRP.

Our tools: The BBHRP dataset itself and radiative fluxes calculated as in BBHRP (aka our “shadow” dataset) with two pairs (SW and LW) of additional RT algorithms: from CAM3 and from GSFC’s fvGCM. BBHRP uses AER’s SW and LW RRTM codes.

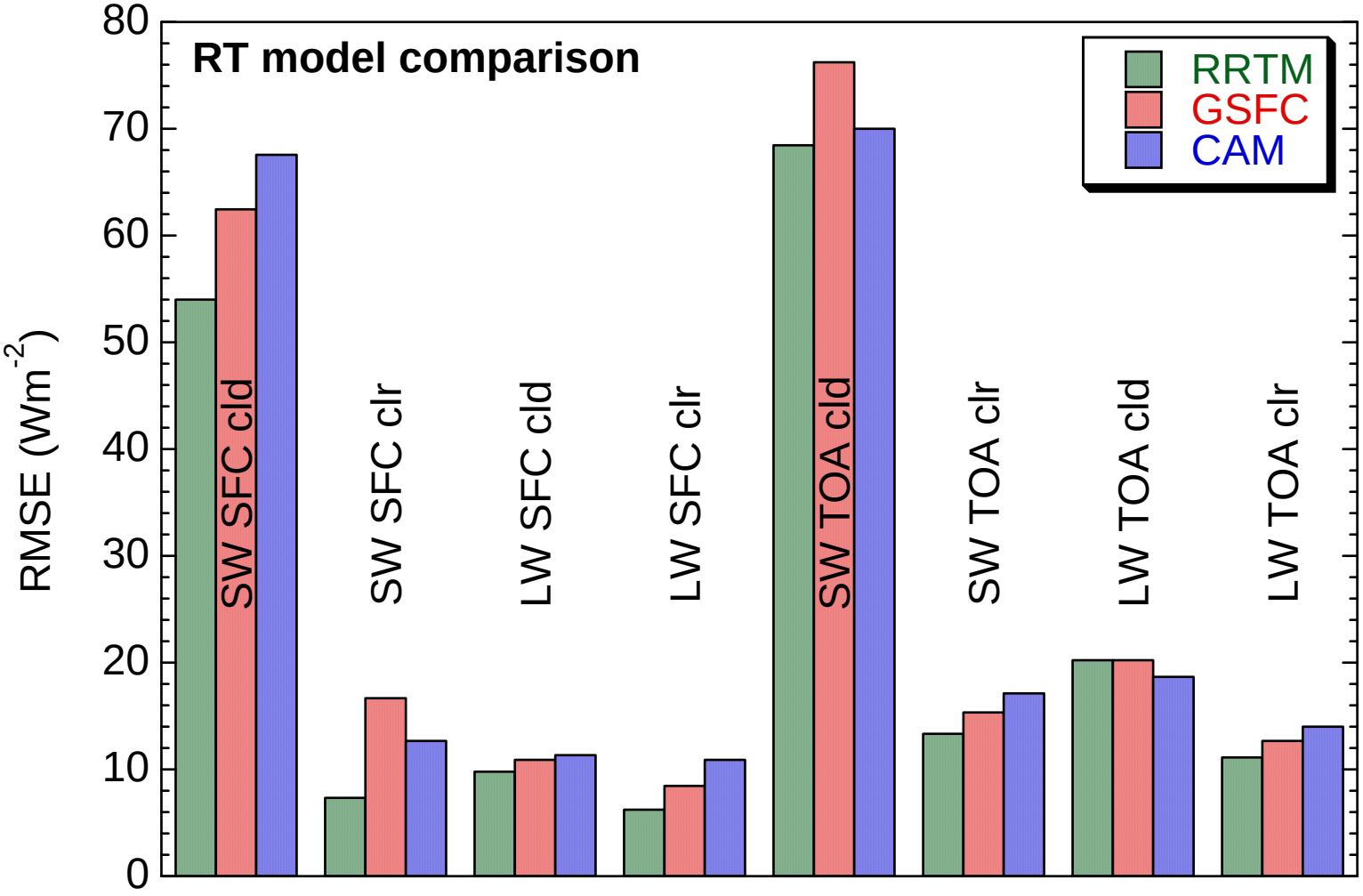
How we learn: If the RT models tend to agree, but disagree with the observations for particular types of conditions the input is suspect; if on the other hand, for the same conditions only some models fail, these models are suspect.

BBHRP with different RT models



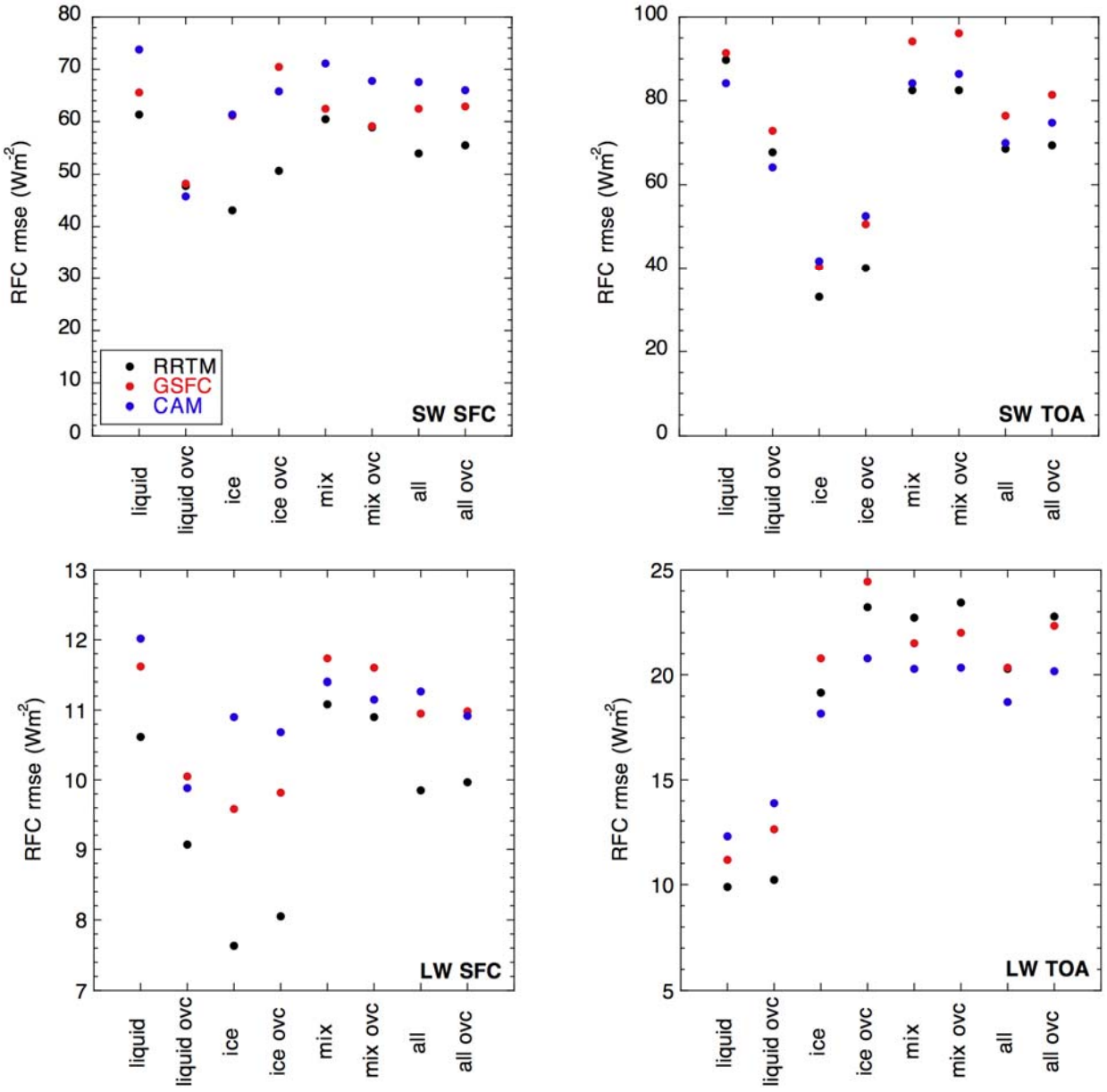
BBHRP with different RT models

(more details: SFC vs. TOA)



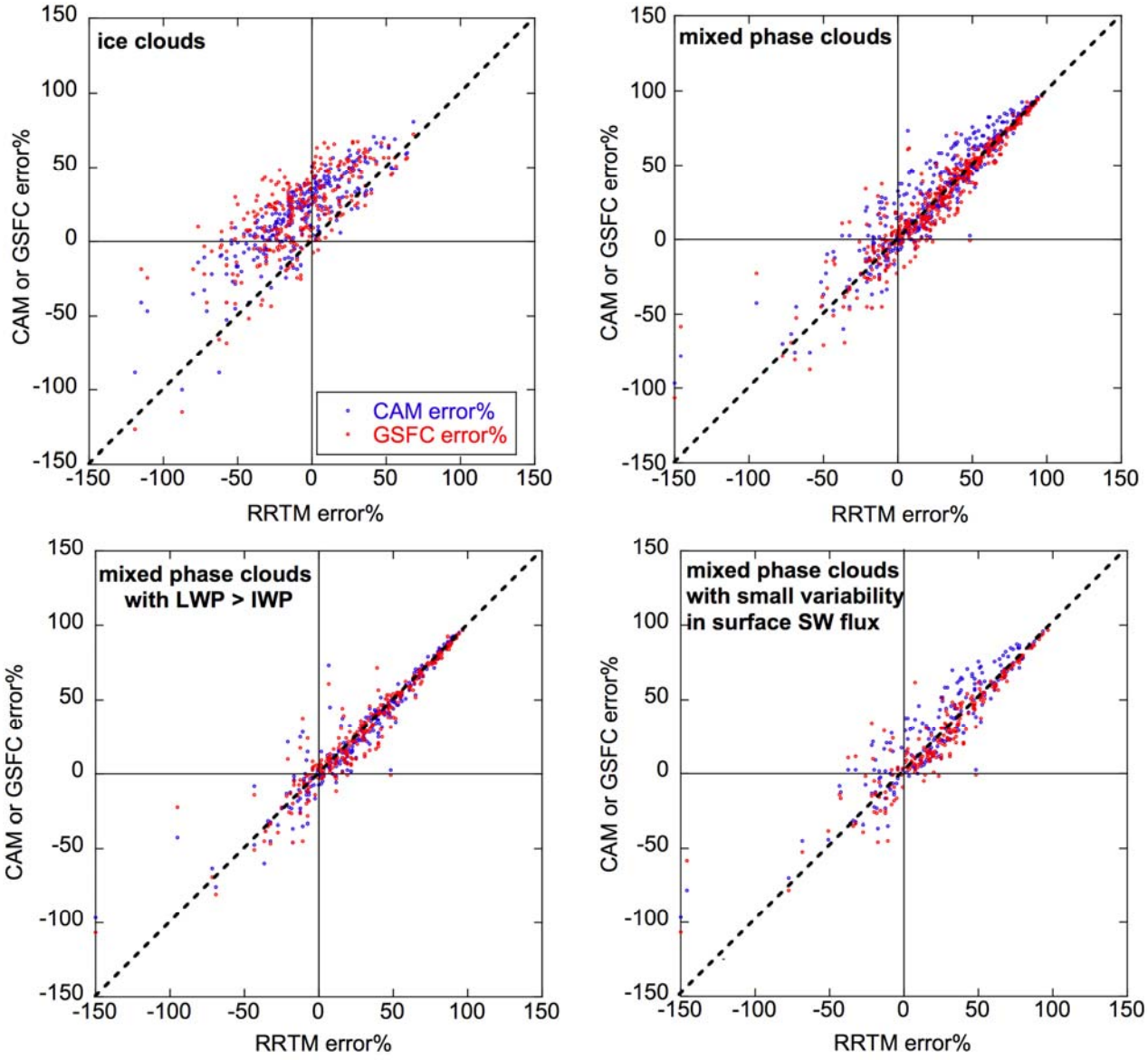
BBHRP with different RT models

(more details: cloud type)



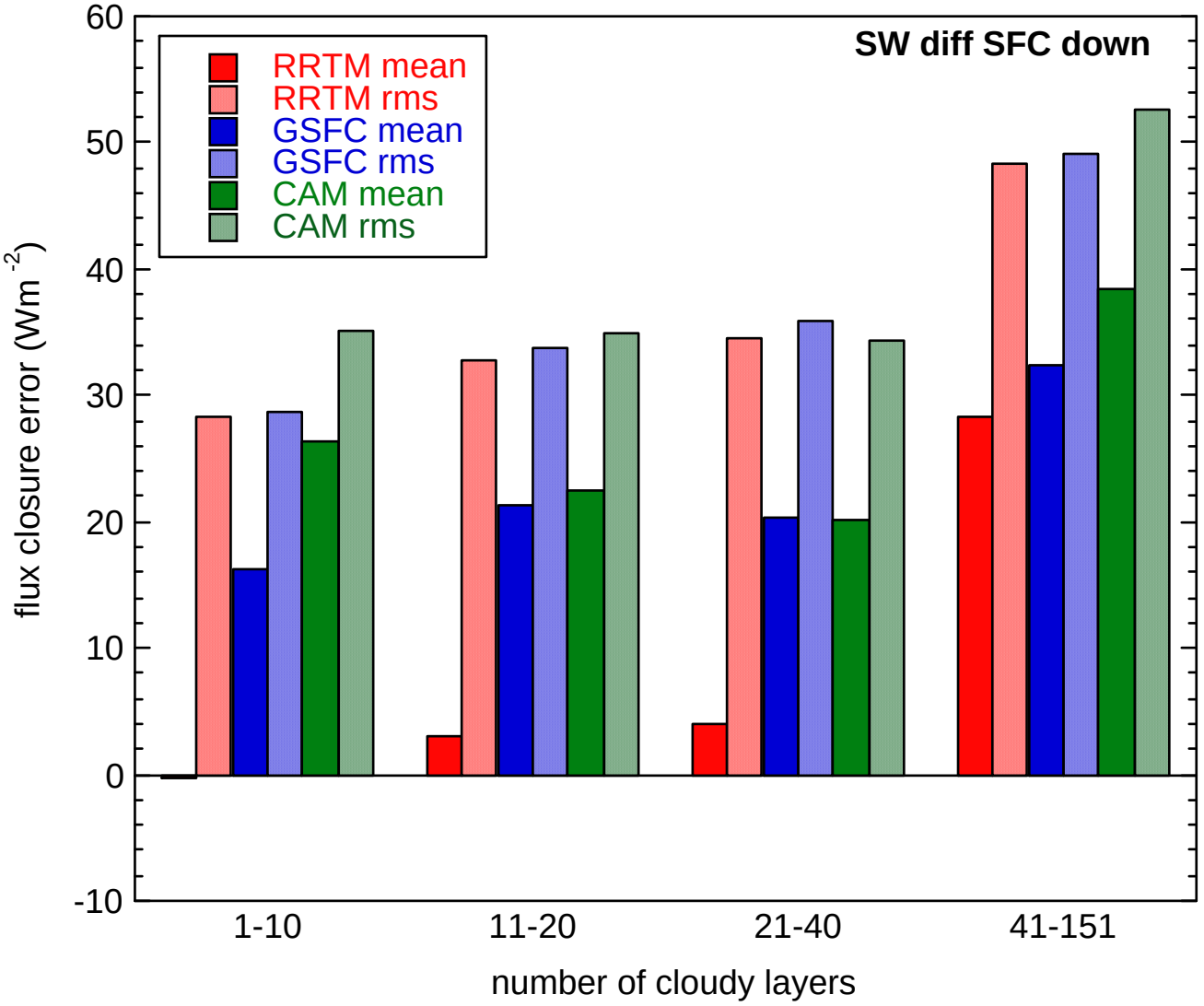
BBHRP with different RT models

(more details: ice and mixed clouds)



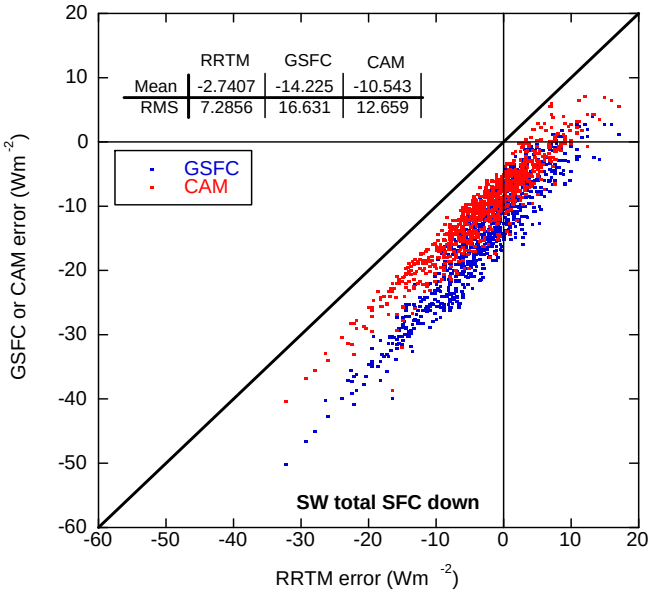
BBHRP with different RT models

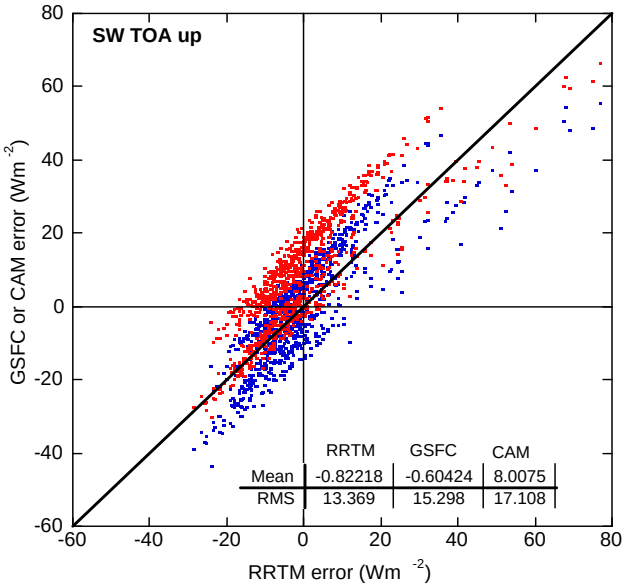
(cloud complexity)

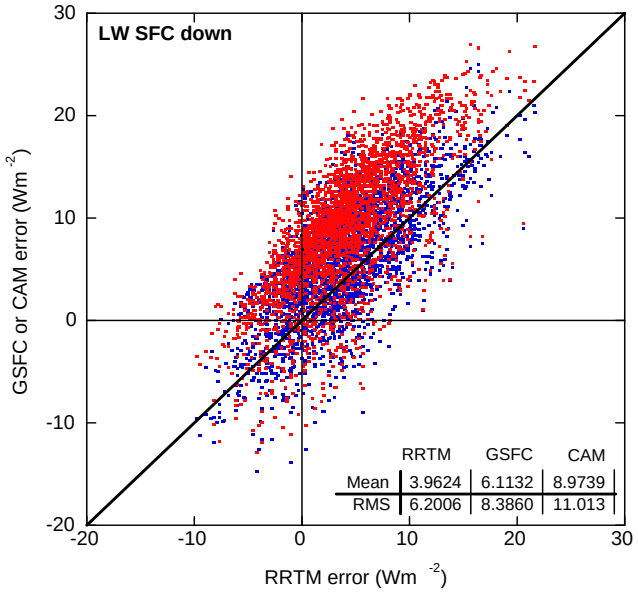


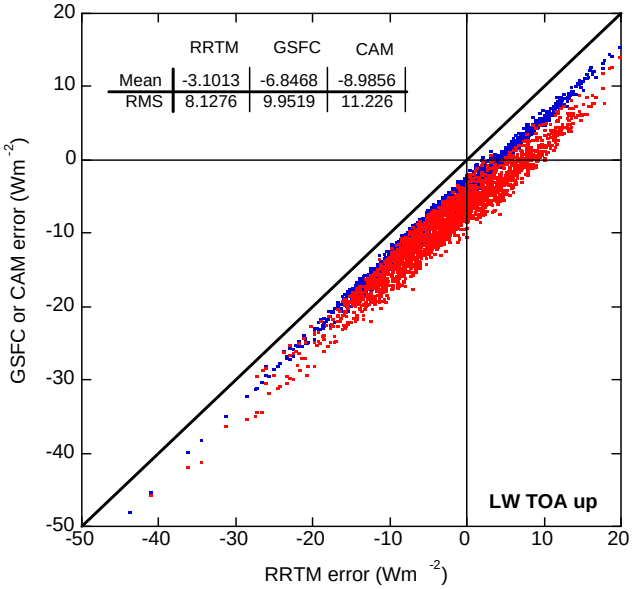
BBHRP with different RT models

(more details: clear sky scatter)





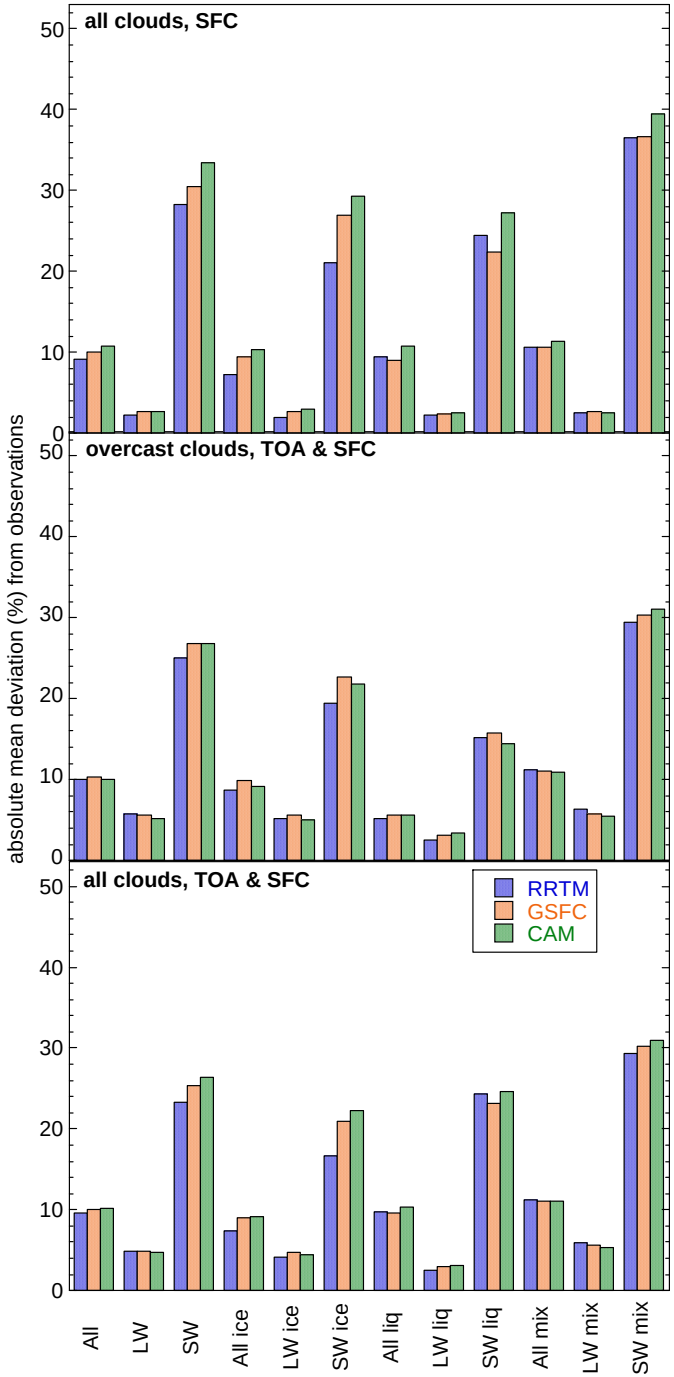


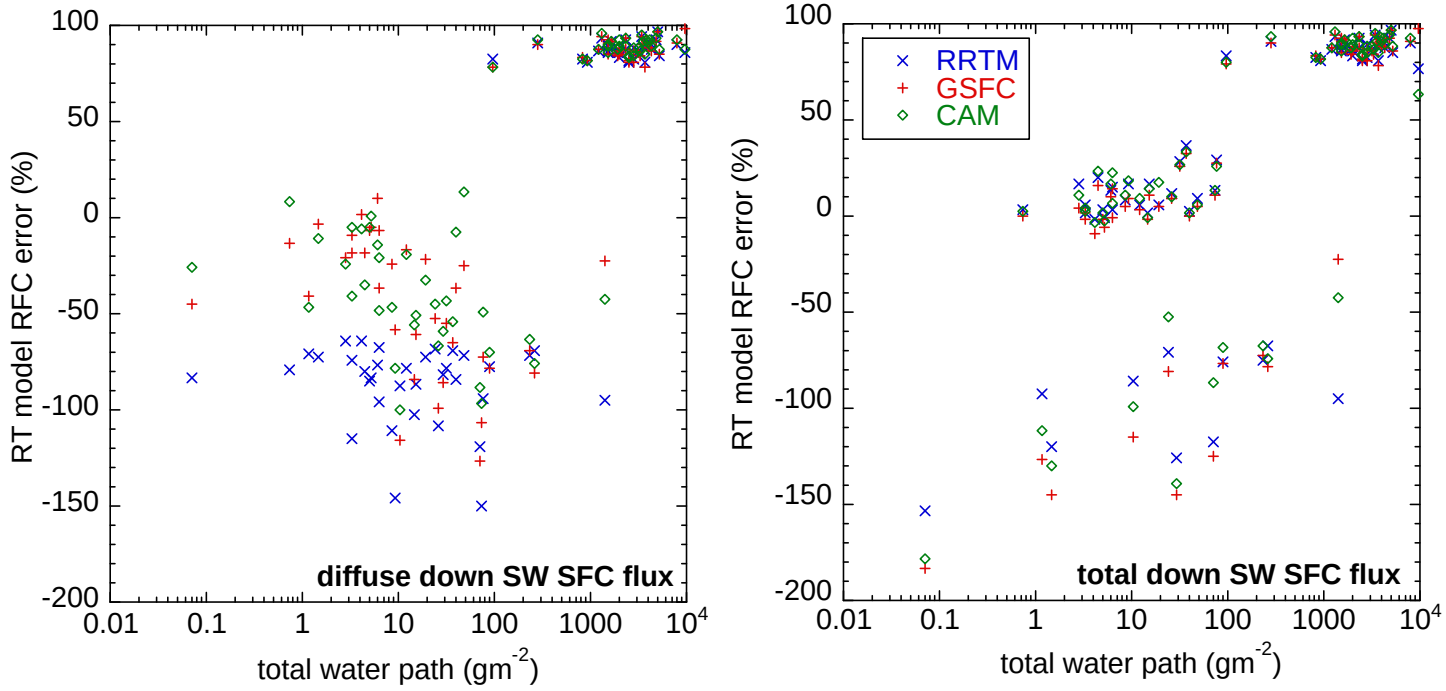


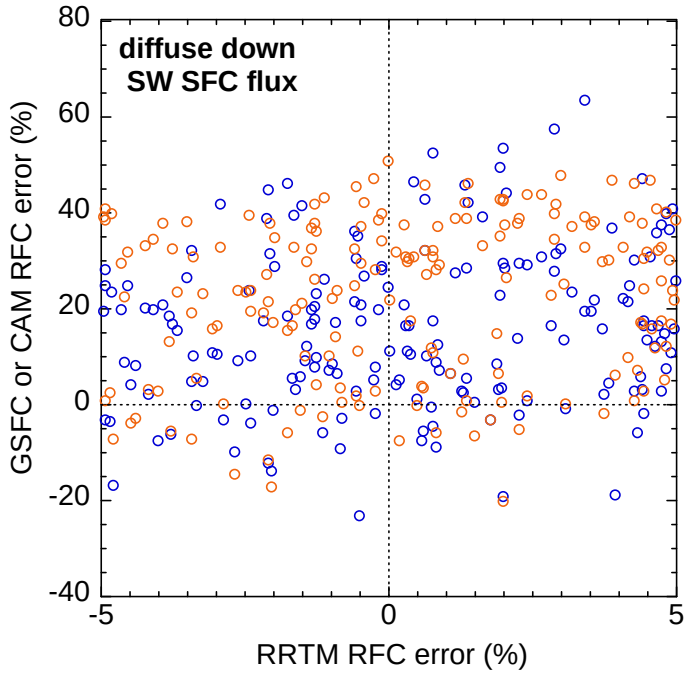
Main findings
(while a lot of questions remain)

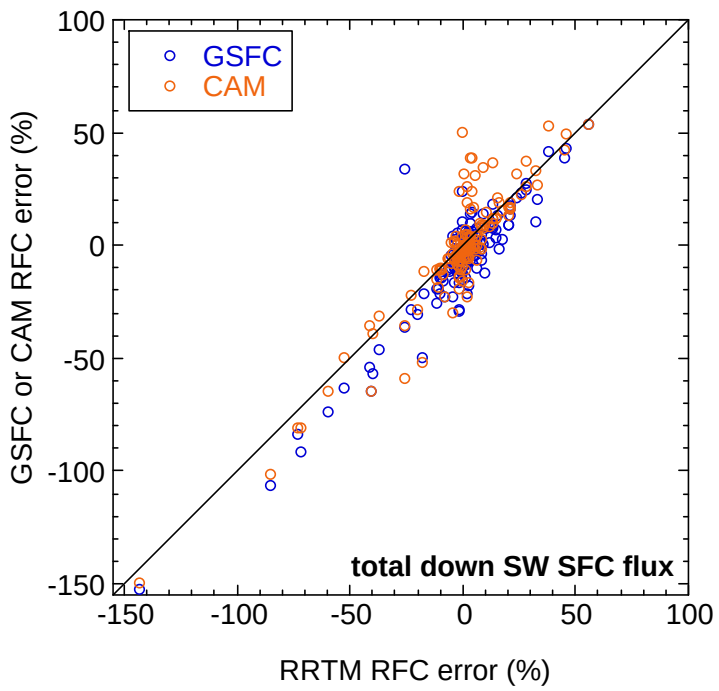
- There is broad consistency between the BBHRP (RRTM) closure errors and those of the “shadow” dataset (GCM codes), pointing to problems in the values or interpretations of the input.
- Inter-model inconsistencies are greater for ice and mixed-phase clouds.
- Many large SW SFC closure errors are associated with very thick clouds
- For clear skies the GCM codes always produce higher values than RRTM for SW down at SFC and OLR (needs to be investigated).
- RRTM performs overall better than the GCM codes.
- When all radiation budget components are accounted for (SW & LW, TOA & SFC), under all conditions, the overall flux closure error is ~10%. This is driven largely by the LW, but is still remarkable.

Additional slides


all clouds, SFC
overcast clouds, TOA & SFC
all clouds, TOA & SFC
RRTM
GSFC
CAM
absolute mean deviation (%) from observations
0
10
20
30
40
50
All
LW
SW
All ice
LW ice
SW ice
All liq
LW liq
SW liq
All mix
LW mix
SW mix


RT model RFC error (%)
100
50
0
-50
-100
-150
-200
0.01
0.1
1
10
100
1000
10^4
total water path (gm^{-2})
diffuse down SW SFC flux
RRTM
GSFC
CAM
total down SW SFC flux


diffuse down
SW SFC flux
GSFC or CAM RFC error (%)
RRTM RFC error (%)
80
60
40
20
0
-20
-40
-5
0
5


GSFC
CAM
total down SW SFC flux
GSFC or CAM RFC error (%)
RRTM RFC error (%)
100
50
0
-50
-100
-150
-150
-100
-50
0
50
100