SCREEN CAPTURE WELCOME

One- and Three-Dimensional radiative effects in shallow cumulus cloud fields:

Large-Eddy Simulations and Observations

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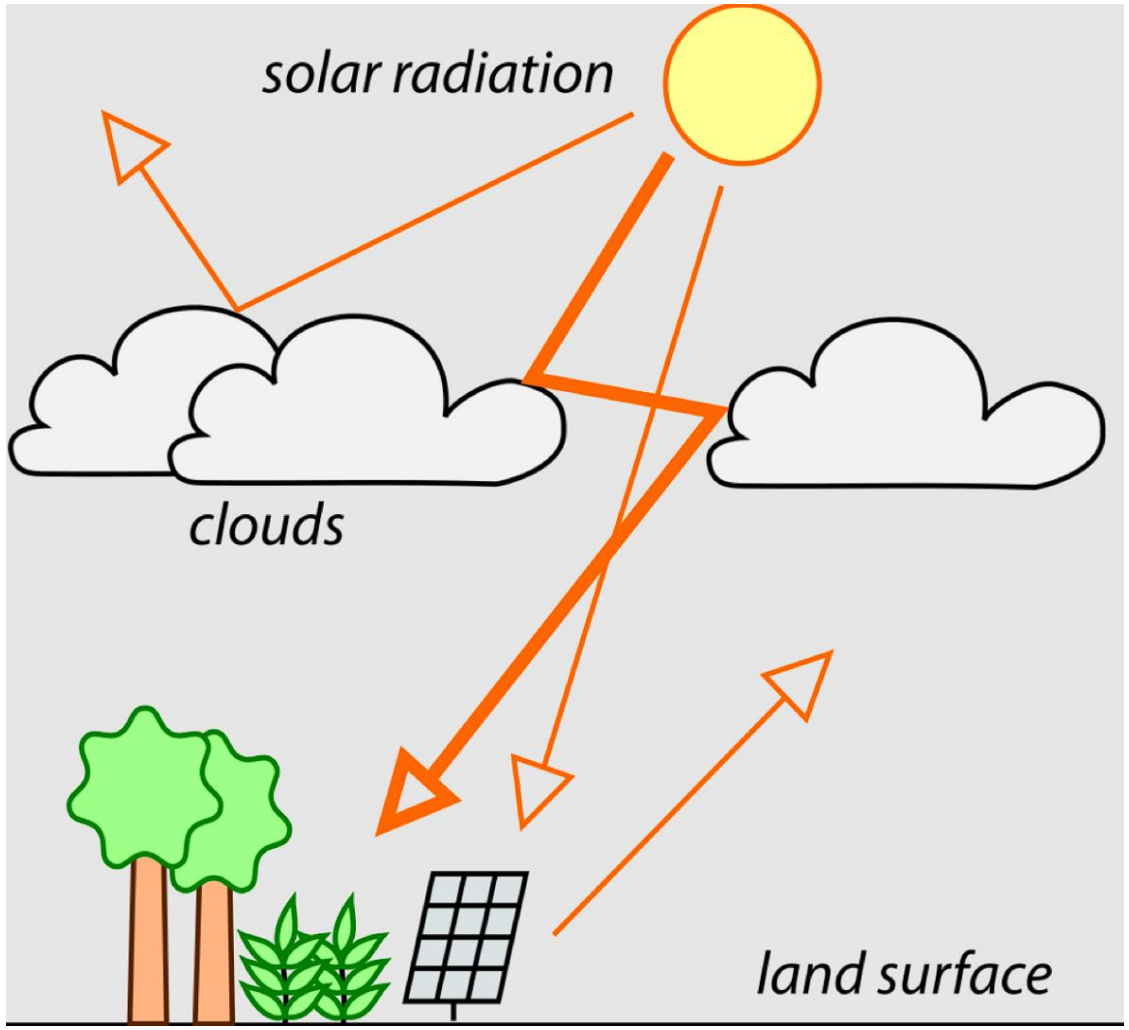
One and Three-Dimensional radiative transfer

Objective:

1. Compare modelled 1D and 3D radiative transfer to observations

2. Speed up 3D radiative transfer calculations



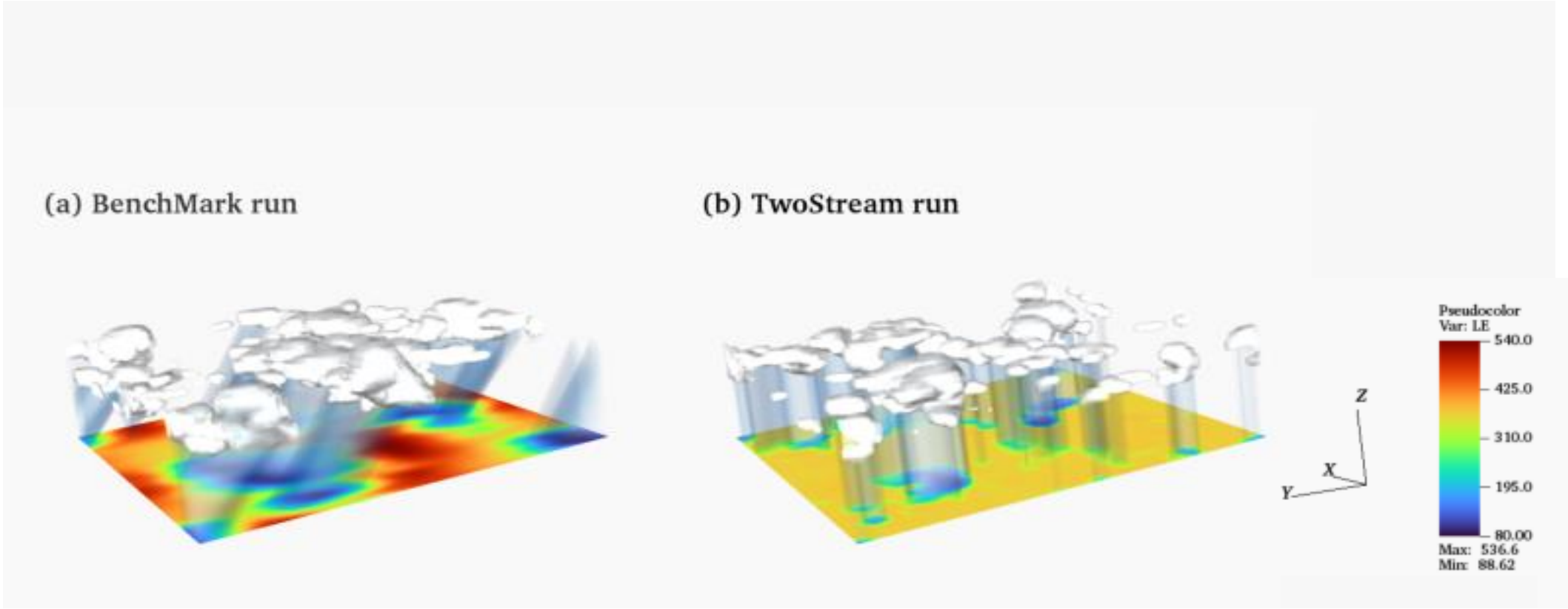
LES-setup

	DALES	
Transfer	1-D radiative transfer	3-D radiative transfer
Radiative Transfer solver	RRTMG	TenStream
Duration	12 hour	12 hour
Domain	25x25x8.0 km^3	25x25x4.775 km^3
Grid spacing	100x100 m^2	100x100 m^2

Observations: BSRN
Location: Cabauw (NLD)
Date: 15/08/2016

TenStream and TwoStream

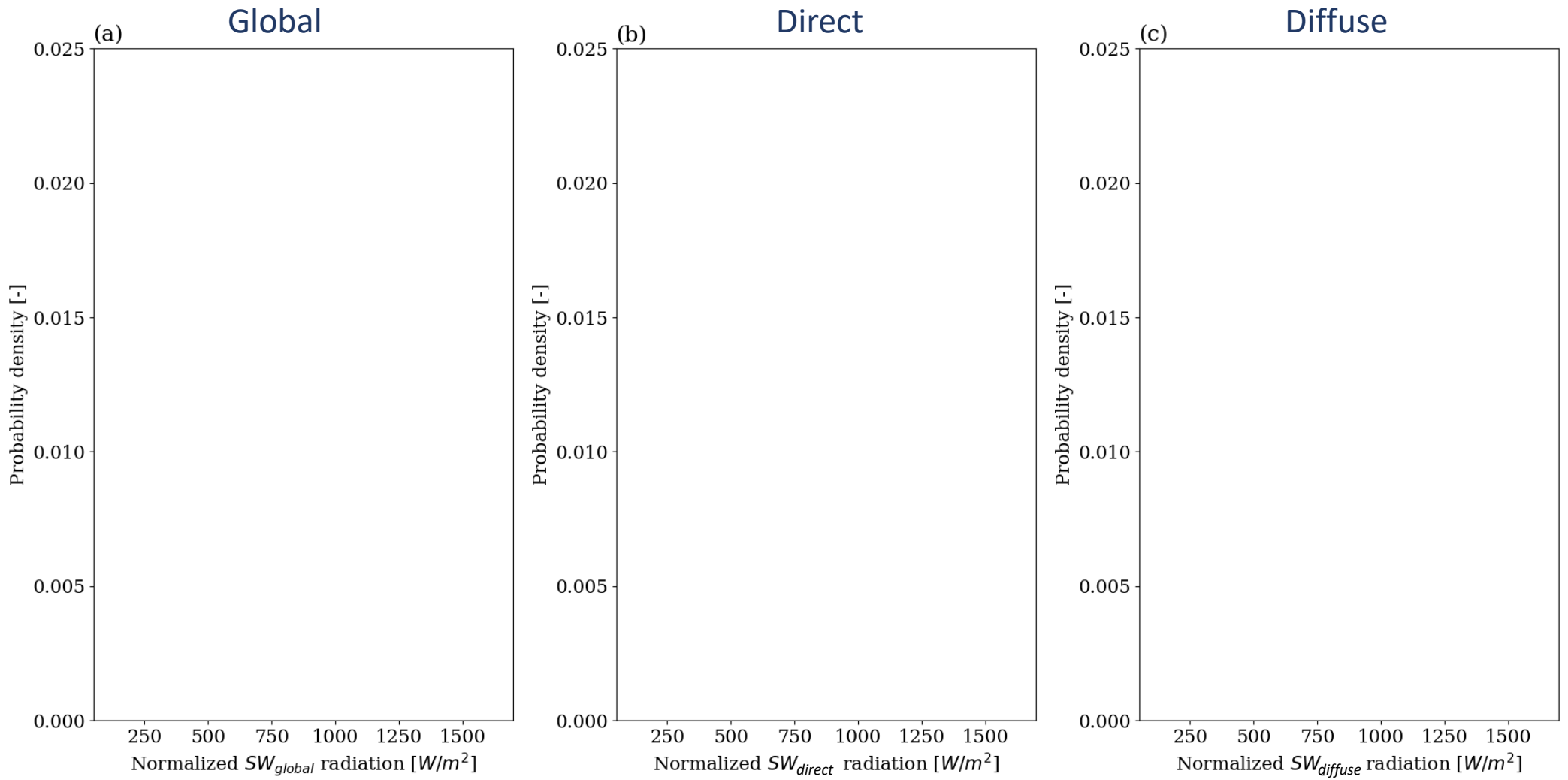
- No 3D radiative interactions with the TwoStream simulation (b)



Volume rendered plots at 12:00 UTC

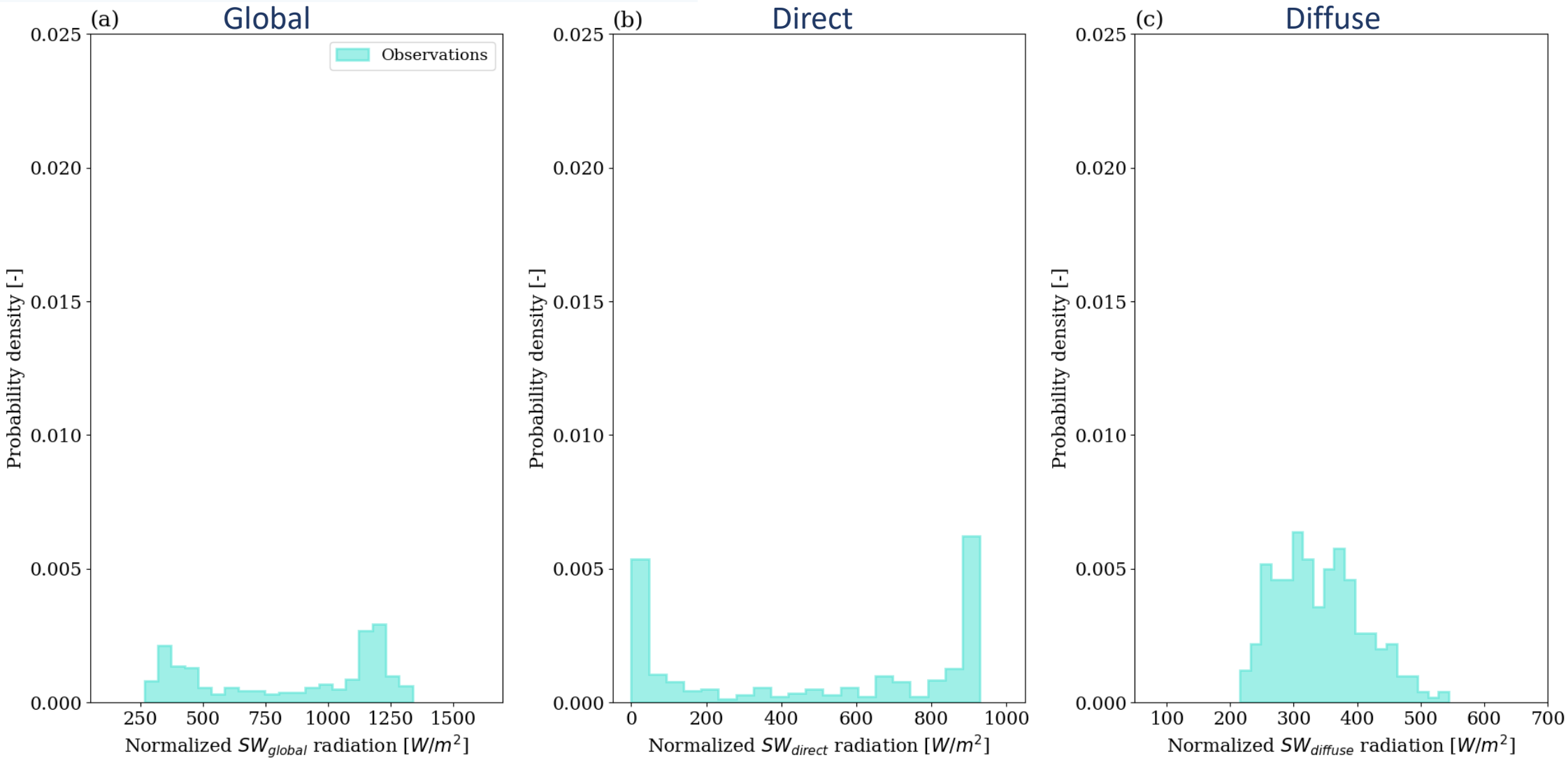
Probability Density Functions (PDF)

- PDFs between 10:00 and 14:00 UTC



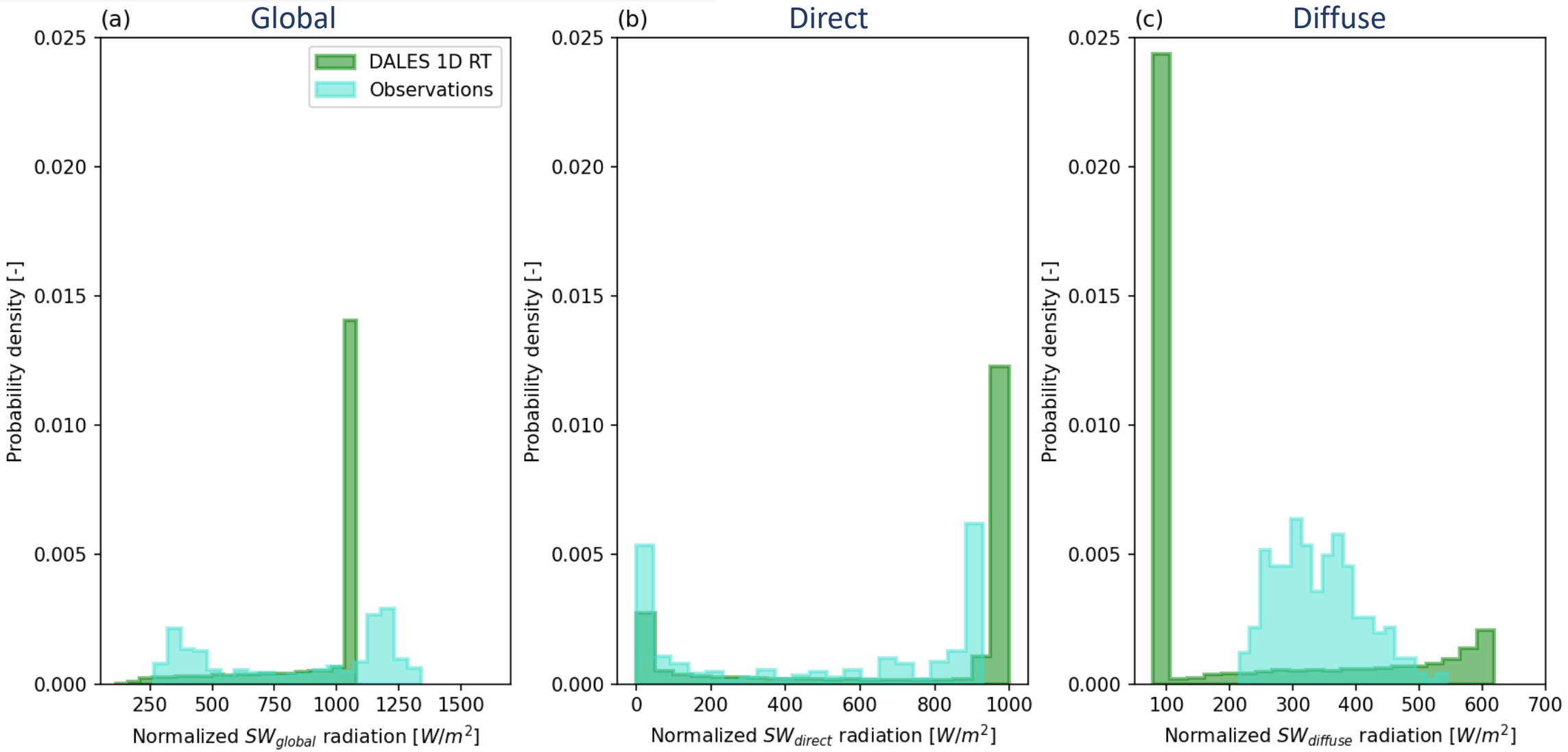
Observed PDF

- Observed PDF between 10:00 and 14:00 UTC



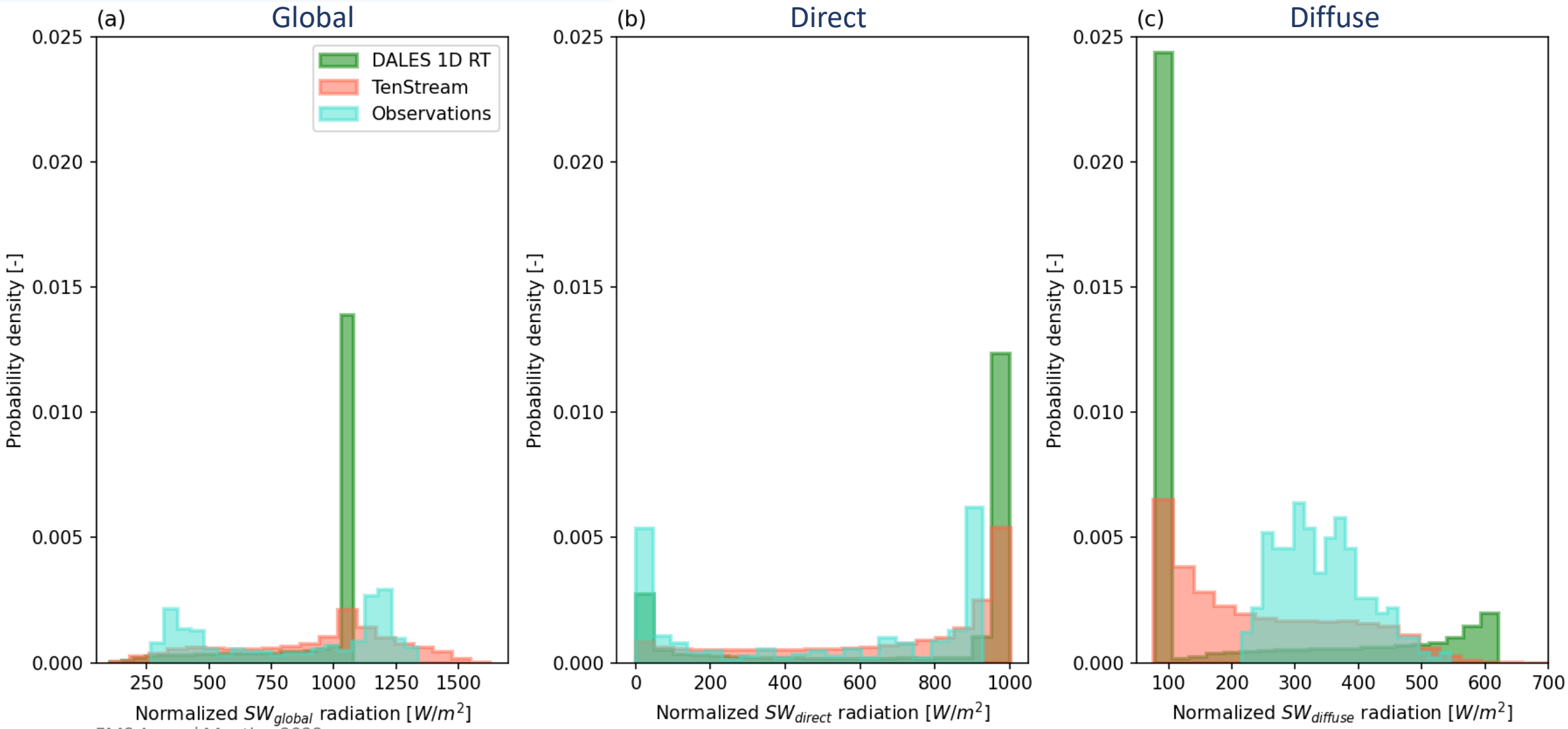
PDF with One-Dimensional radiative transfer

- PDFs between 10:00 and 14:00 UTC



PDF with Three-Dimensional radiative transfer

- PDFs between 10:00 and 14:00 UTC



Reducing computational burden TenStream (1/2)

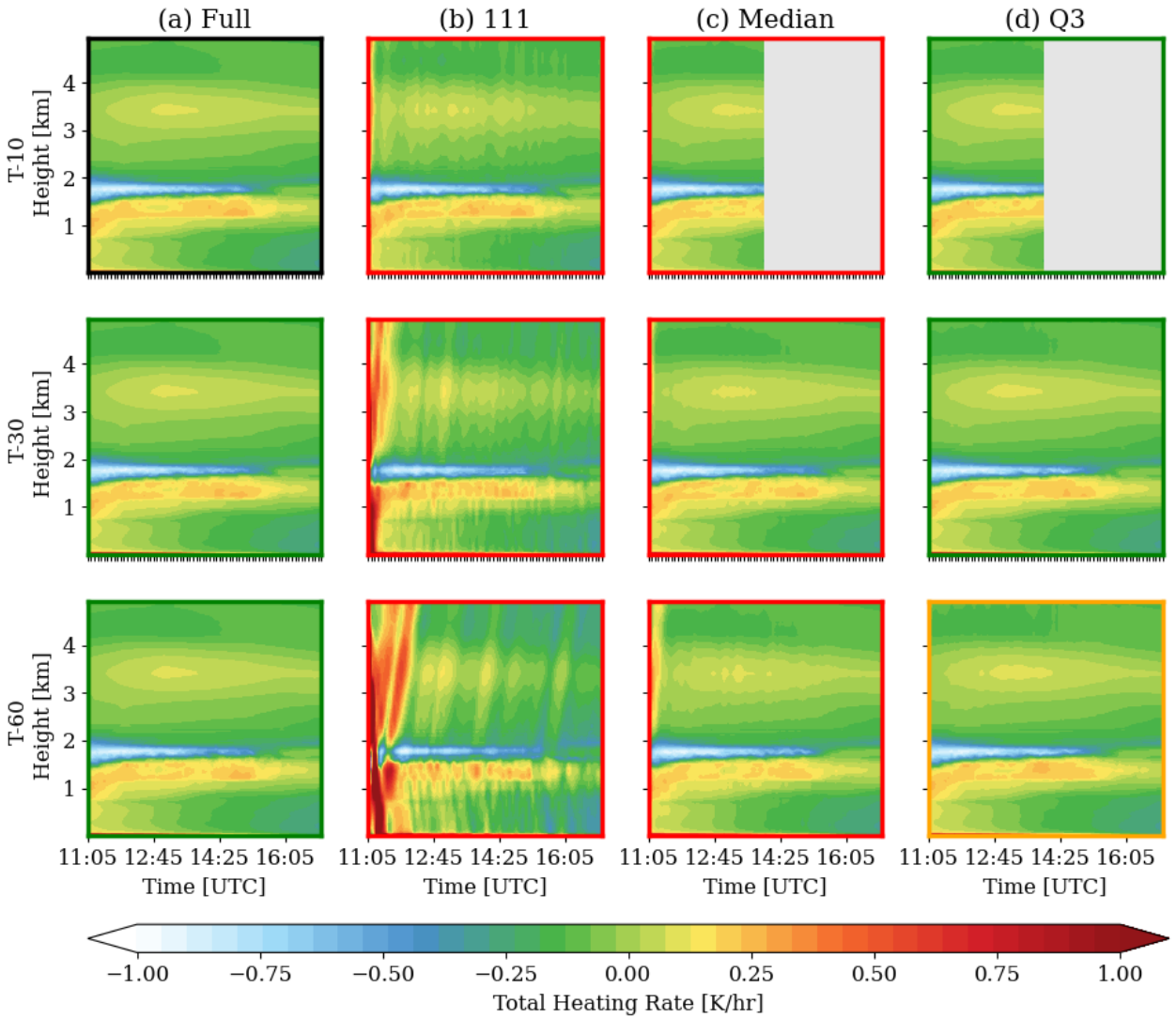
To achieve speedup:

A) Decrease radiation calling frequency

B) Decrease number of iterations

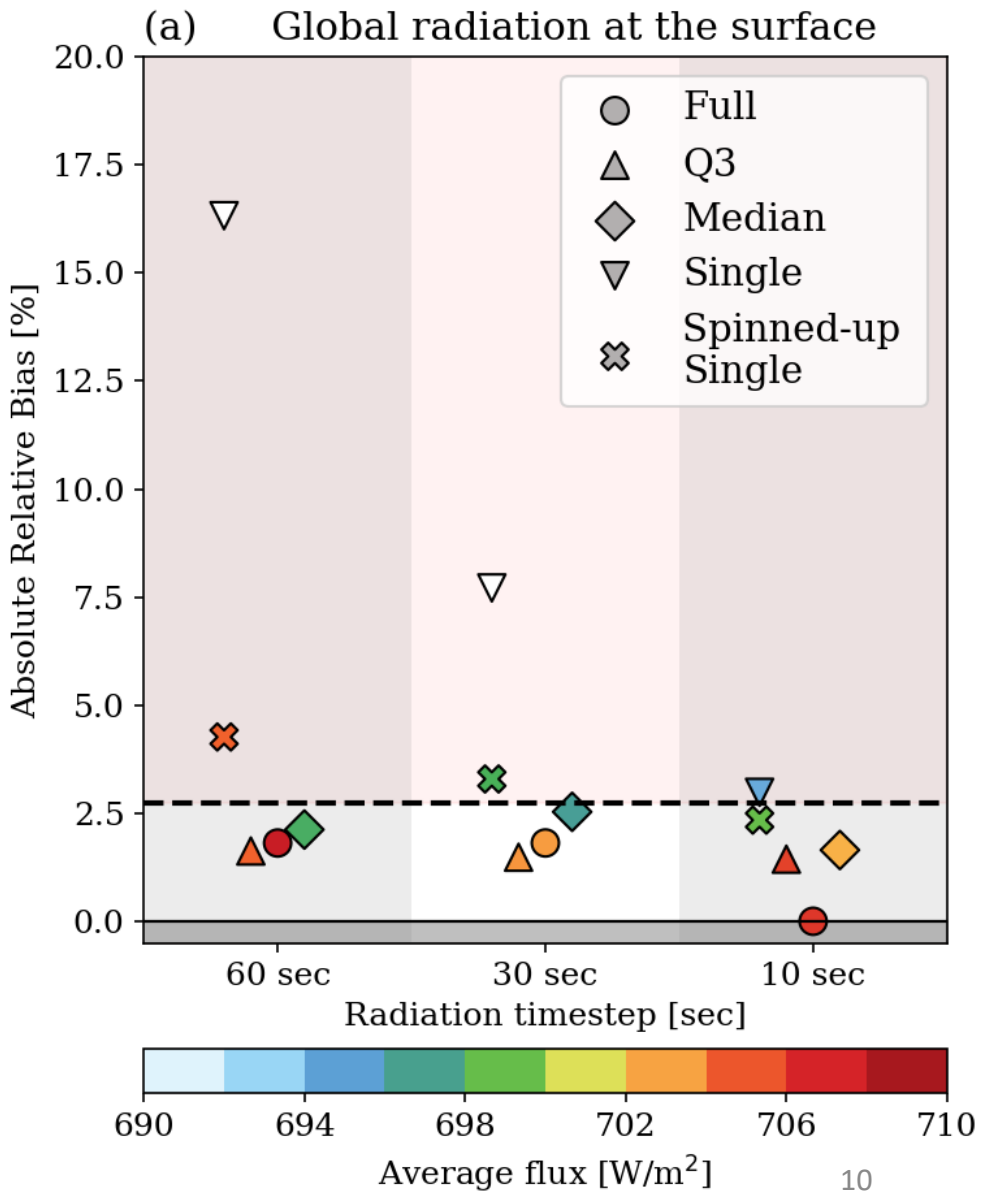
Computational cost of simulation normalized against:
(a) TwoStream run and (b) full TenStream run

	Full	Q3	Median	Single
(a) TwoStream simulation	40	25	19	12
(b) Full TenStream simulation	1	1.6	2.1	3.5



Reducing computational burden TenStream (2/2)

- Biases are computed using completely solved TenStream simulation as reference
- Increasing calling frequency increases bias
  - Mainly for single iteration runs
- On average, most biases are smaller than the TwoStream bias



Wrapping up

Conclusions:

- Three dimensional radiative transfer more accurate
  - Cloud shadow displacement
  - Cloud enhancements
- TenStream is too limited diffusive
- Incompletely solving 3DRT could increase computational speed without sacraficing too much accuracy.

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