How Significant are the Longwave Radiative Effects of the Cloud-Aerosol Transition Zone?

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The “transition (twilight) zone”

Special conditions in the region between the cloudy and so-called cloud-free skies.

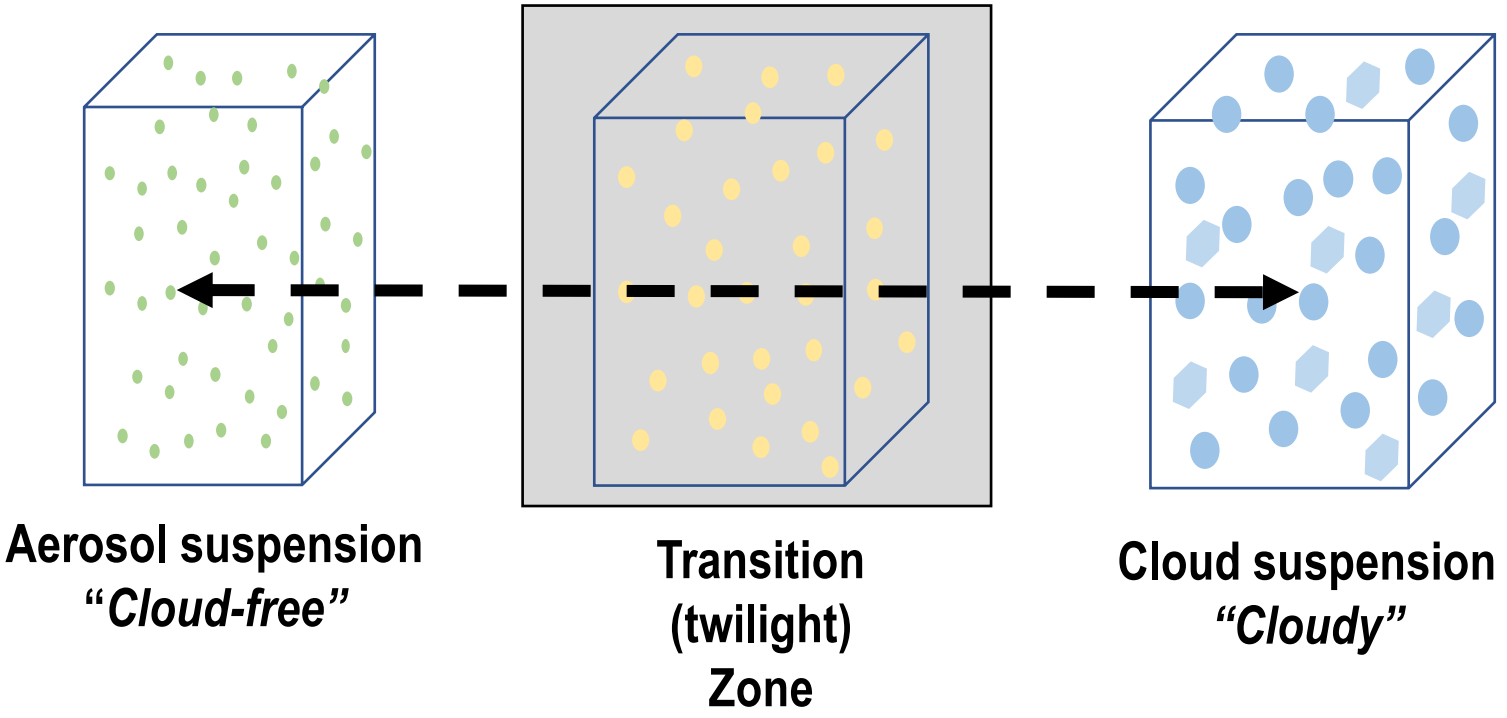
Characteristics of the suspension lay between those corresponding to the adjacent clouds and the surrounding aerosols.

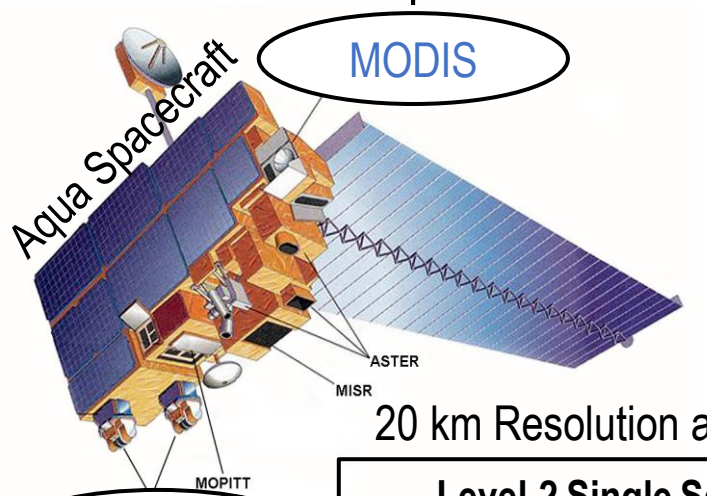
These conditions consist of:

- **A** mixture of liquid droplets and ice crystals
- **H**umidified to dry aerosols

and involves various processes such as:

- **C**loud dissipation/formation
- **A**erosol hydration/dehydration
- **S**hearing of cloud fragments
- **C**louds becoming undetectable
- **O**ther





20 km Resolution at nadir

Level-2 Single Scanner Footprint (SSF)

- **TOA Outgoing LW Radiance (5-100 um)**
- **Geolocation**
- **Viewing and Solar Geometry parameters**
- **Time**
- **Surface Emissivity**

1 km Resolution at nadir

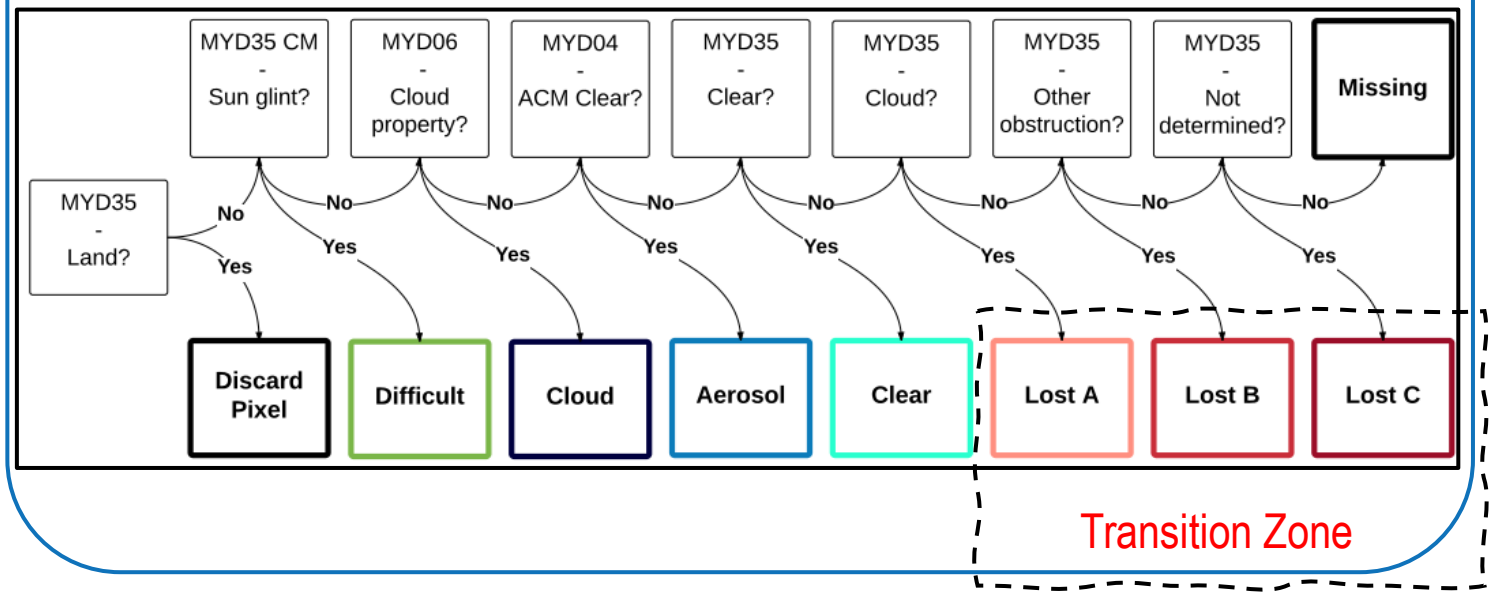
Daytime Ocean, Schwarz et al. (2017)*

Geolocation (MYD03)

Level-2 Aerosol (MYD04)

Cloud Mask (MYD35)

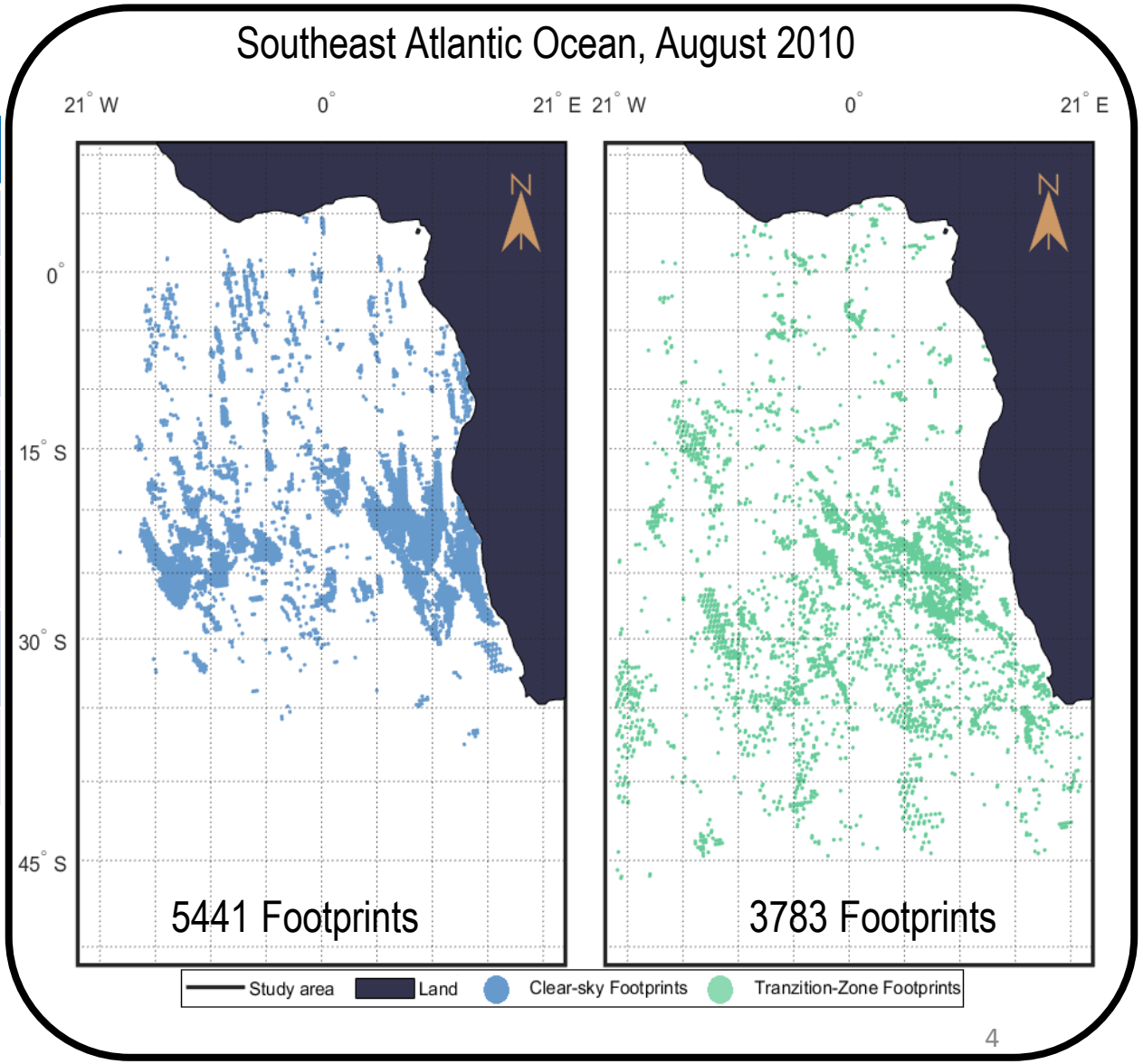
Level-2 Cloud (MYD06)



*Schwarz et al. (2017). Mapping the Twilight Zone—What We Are Missing between Clouds and Aerosols. Remote Sensing: 9(6):577

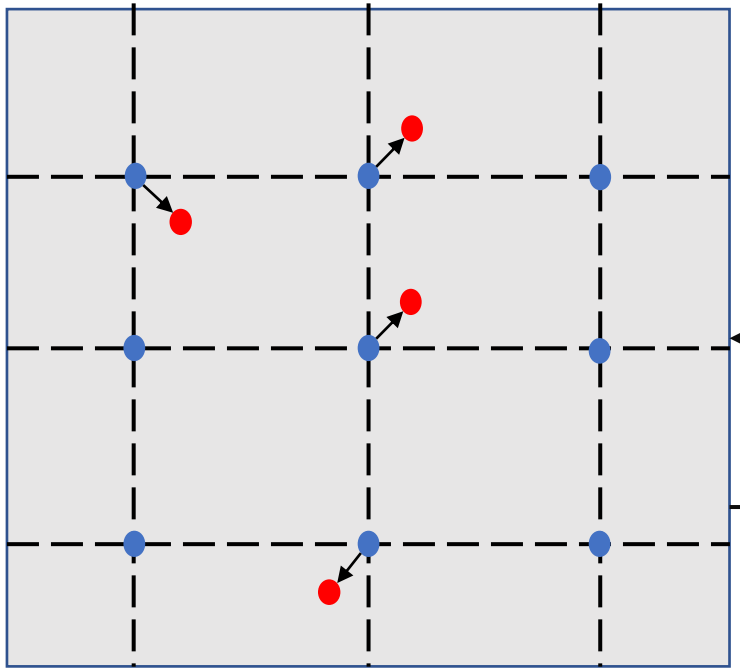
Selection of clear-sky and transition zone footprints

Variable	clear-sky	Transition zone
AOD	0	Any
COD	0	Any
Land Fraction	0%	0%
Lost Fraction	< 10%	≥ 90%
Difficult Fraction	< 10%	-
Solar Zenith angle	≤ 60°	≤ 60°
Viewing Zenith angle at surface	≤ 60°	≤ 60°
Total number of MODIS pixels	≥ 300	≥ 300



Radiative transfer simulations

ERA5 Reanalysis at Single Levels (hourly)
ERA5 Reanalysis at Pressure Levels (hourly)
CERES Geolocation



CERES Footprints
ERA5 Grids

CERES time of observation

CERES Emissivity

Interpolated in time

CERES Viewing Geometry Parameters

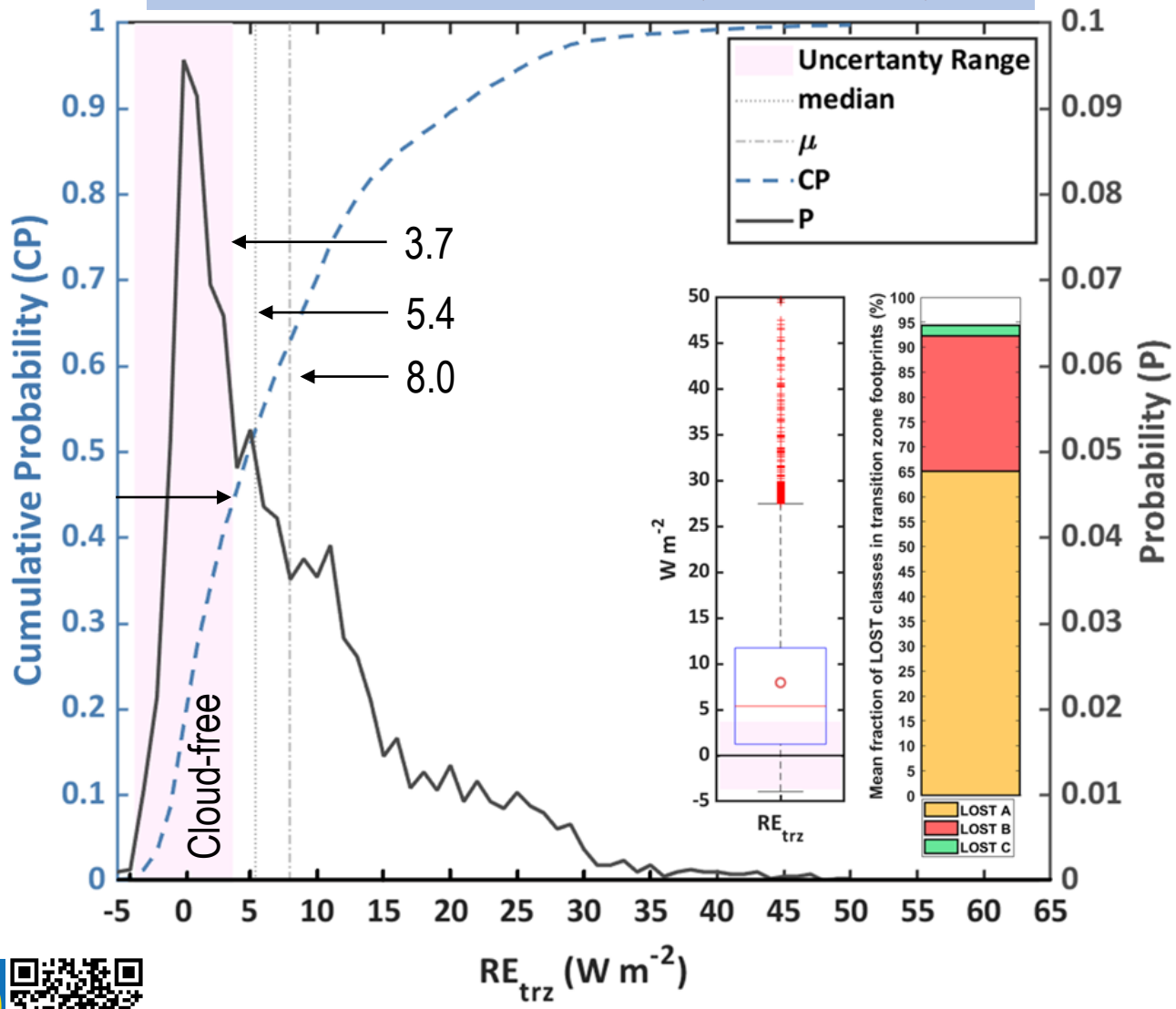
Santa Barbara DISORT Atmospheric Radiative Transfer model (SBDART)

Broadband (5-100 μm) TOA Upwelling Clear-sky Radiances in the Direction of CERES Viewing Angles (↑ $L_{RTM,clr}$)

Validated against CERES Clear-sky Observations (↑ $L_{CERES,clr}$)

Radiative effects

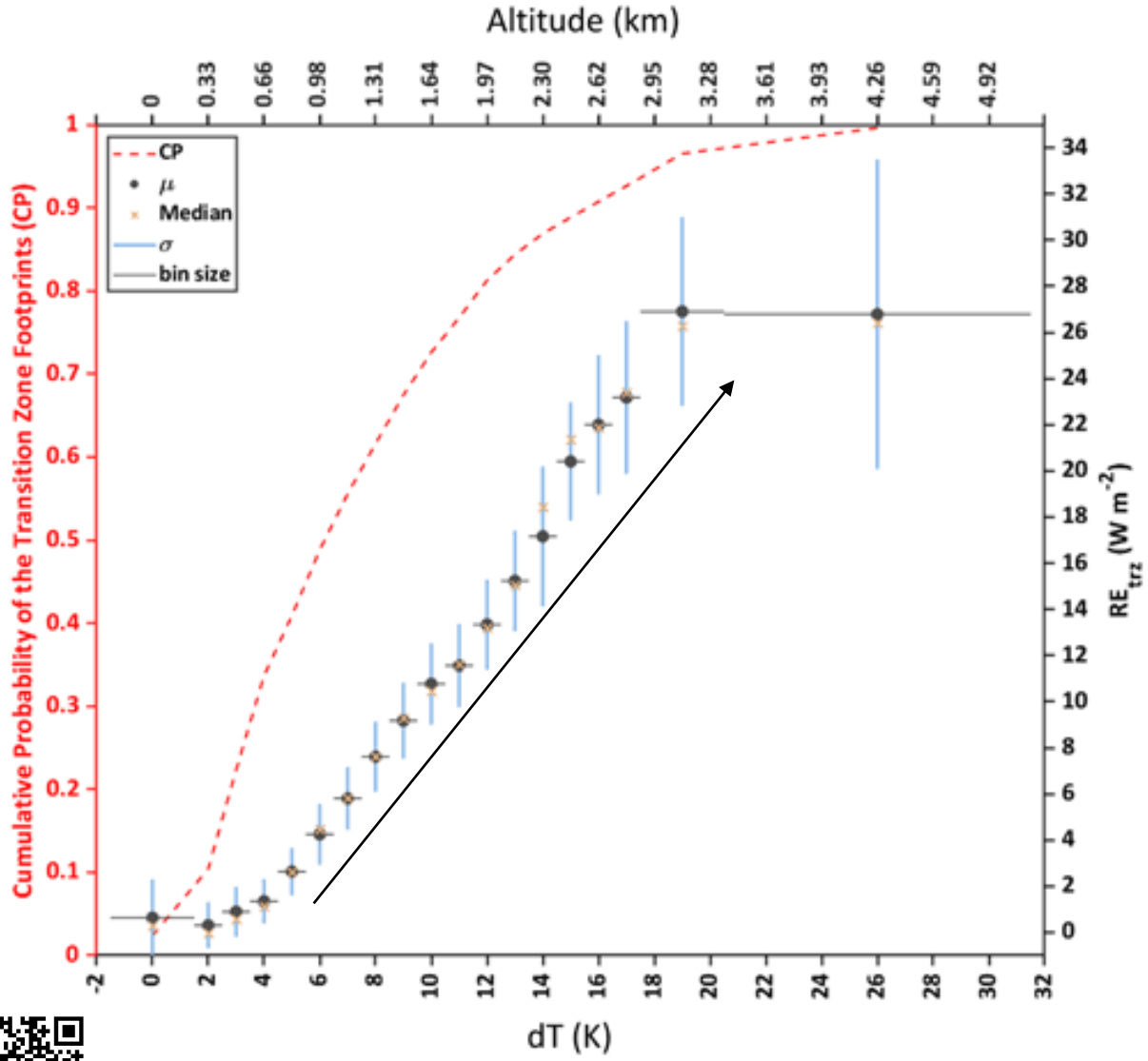
$$RE_{trz} = \pi \uparrow L_{CERES,trz} - (\pi \uparrow L_{RTM,clr})$$



Accuracy at 95% confidence level: ± 3.7 W/m2

- The transition zone occurs over vast areas.
- The broadband longwave radiative effect was on average equal to 8.0 W/m2 (heating effect; median: 5.4 W/m2).
- Cases with radiative effects as large as 50 W/m2 were observed.

Radiative effects vs dT



dT = ERA5 near surface Temp. – Suspension top Temp.

dT ~ Altitude

- The radiative effects correspond to the transition zone conditions occurring at various altitudes.
- Low-level transition zone conditions (defined as those with suspension top height below 2 km) on average produced a radiative effect of about 4.6 W/m2.
- The lowest layers (temperature difference less than 4 K) produced on average a radiative effect of 0.8 W/m2.

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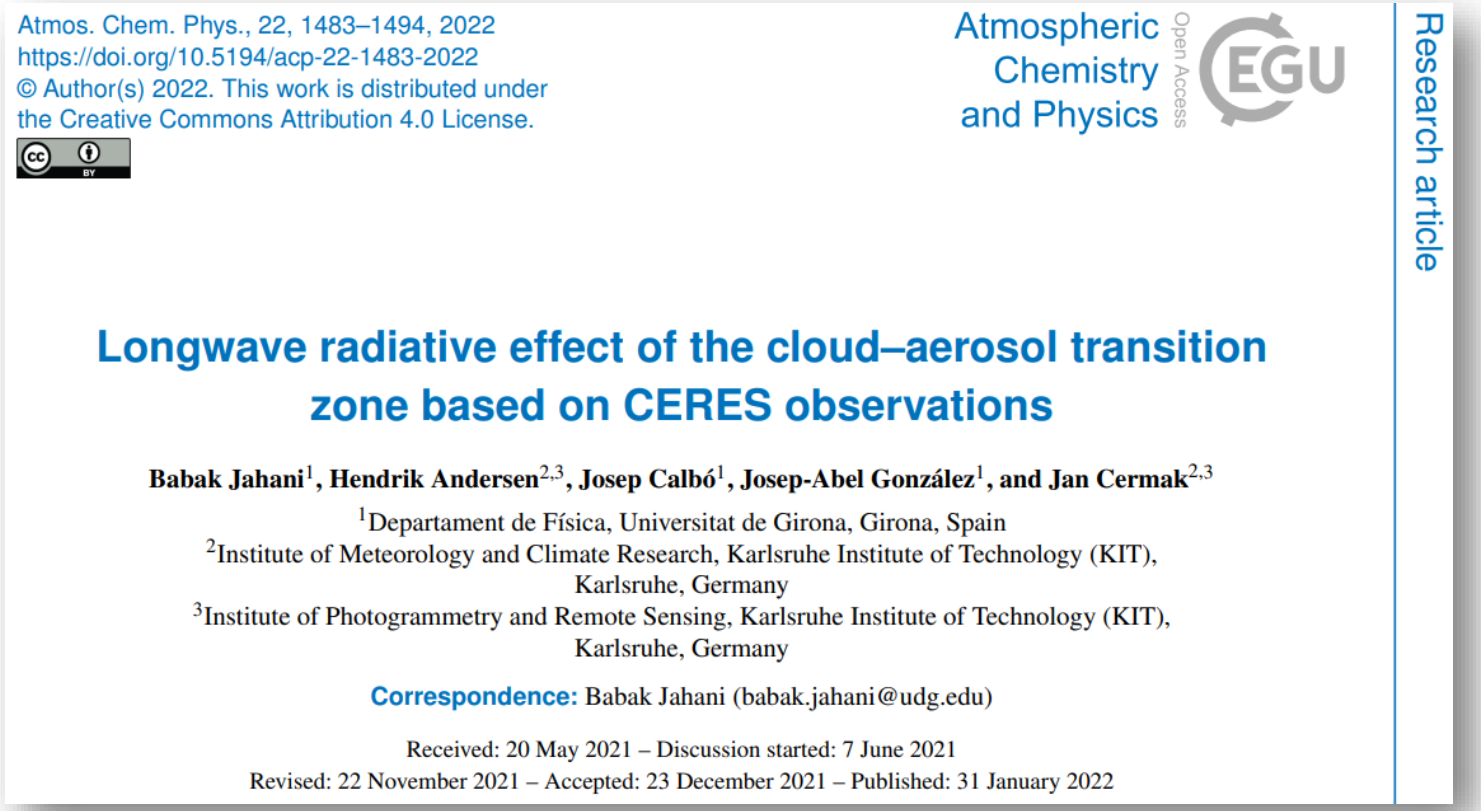

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Research article

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