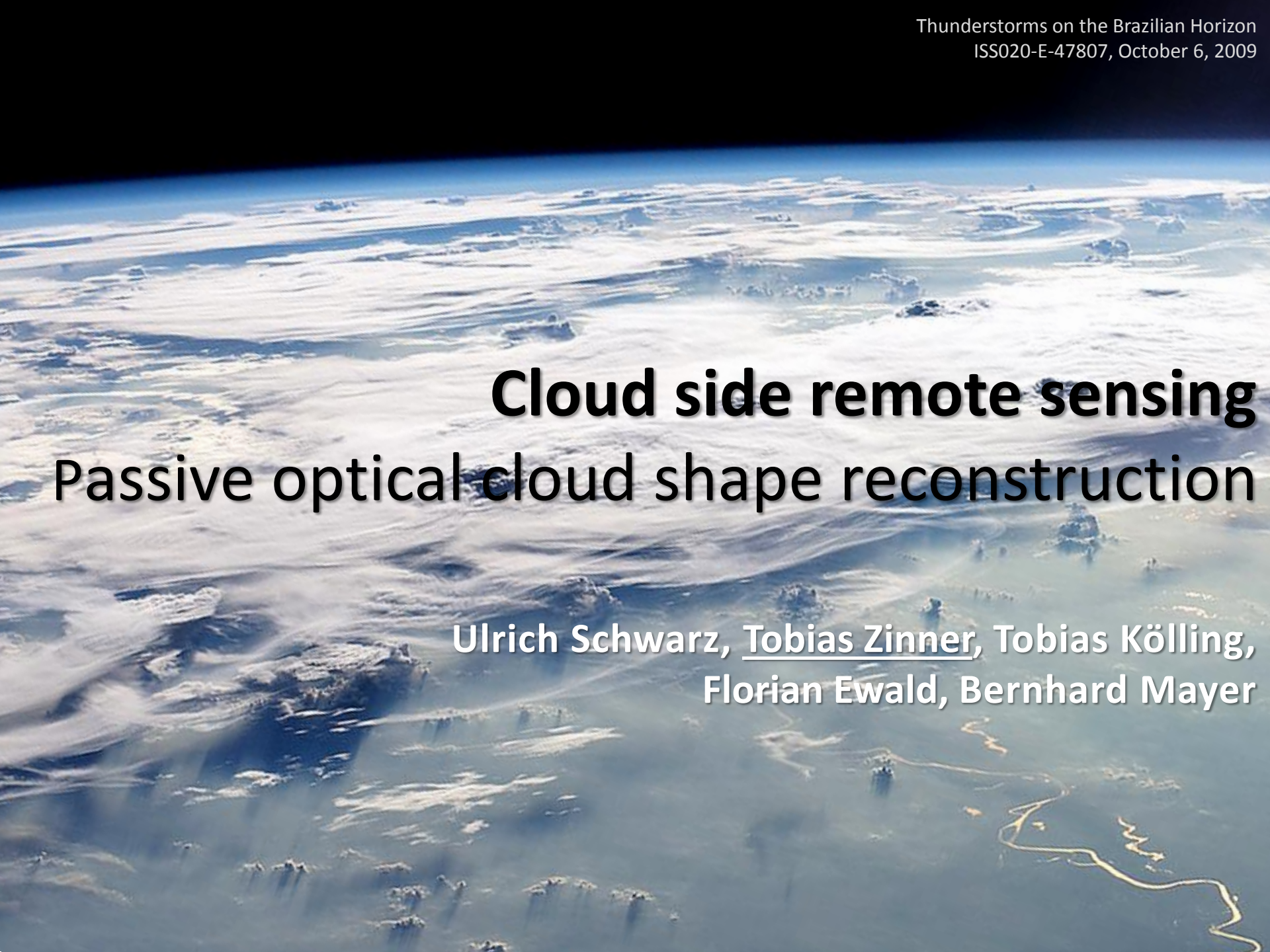
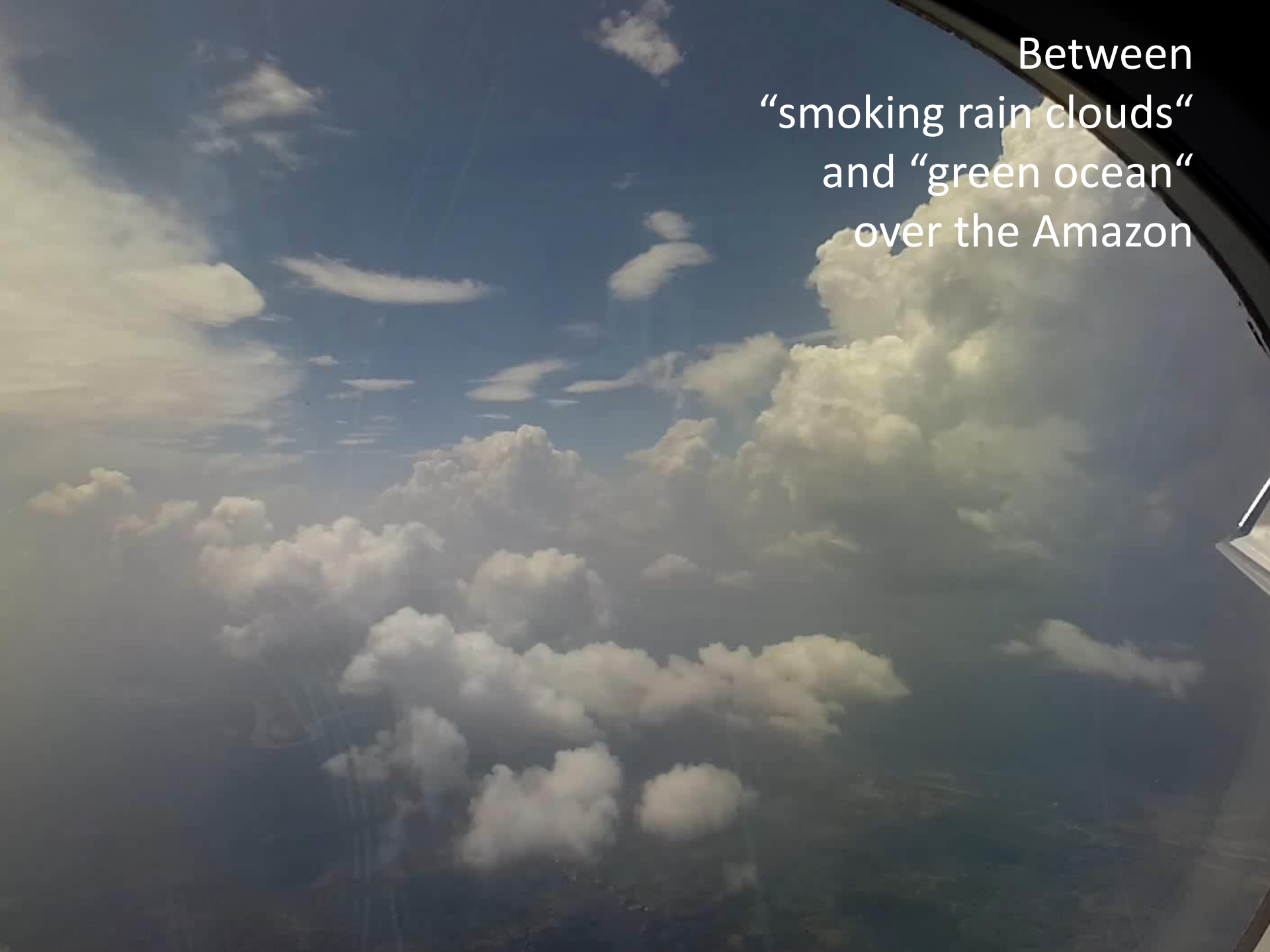
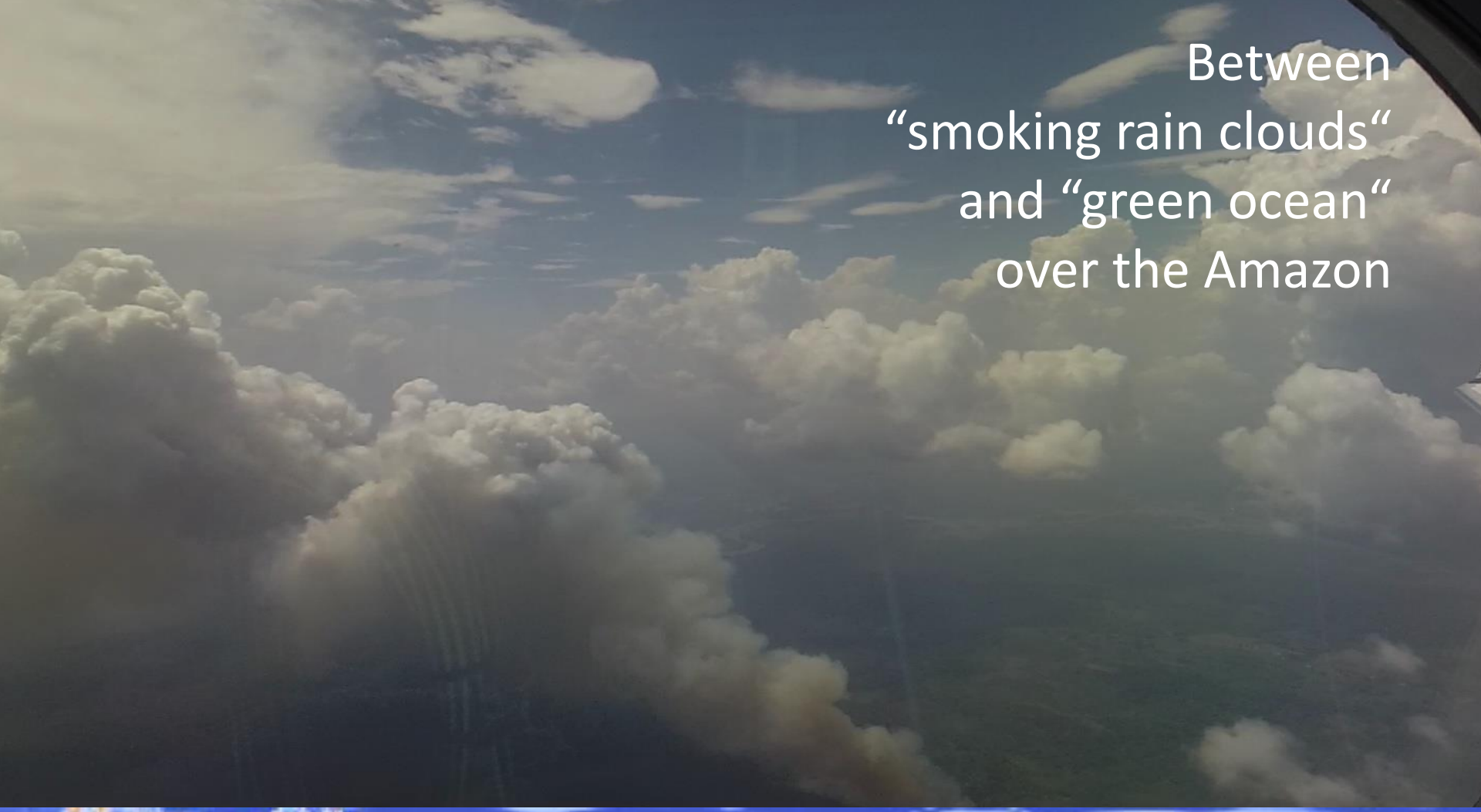


Cloud side remote sensing

Passive optical cloud shape reconstruction

Ulrich Schwarz, Tobias Zinner, Tobias Kölling, Florian Ewald, Bernhard Mayer

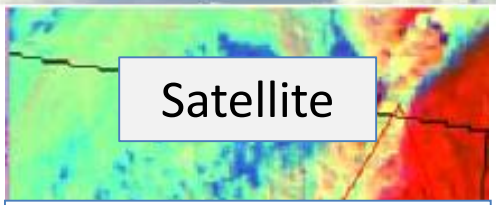

Between
“smoking rain clouds“
and “green ocean“
over the Amazon

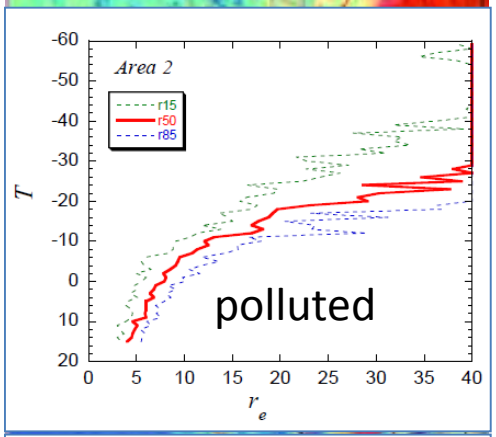

Between
“smoking rain clouds“
and “green ocean“
over the Amazon

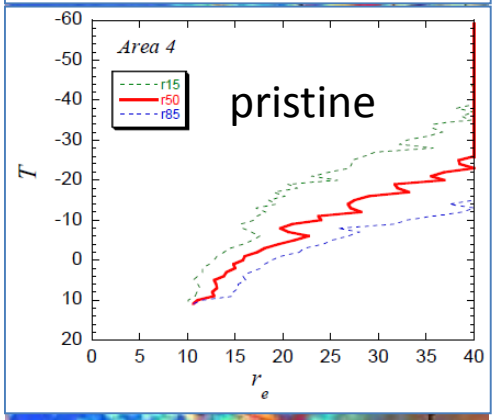

radiance at 2.1 µm

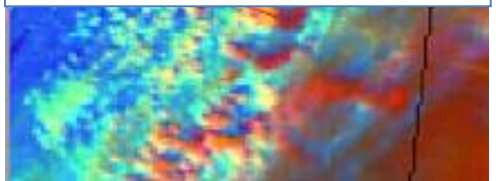
Condensation nuclei and droplet size profile

Satellite



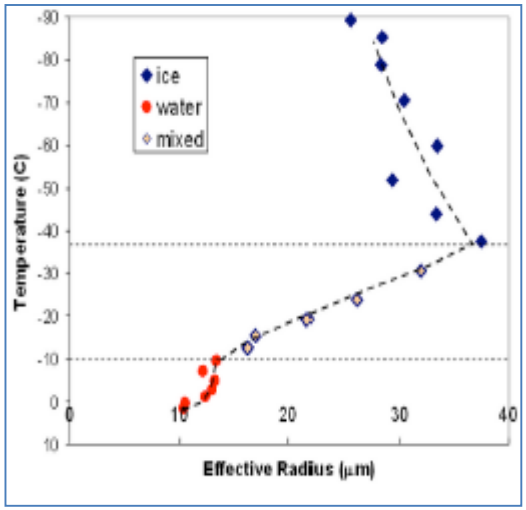






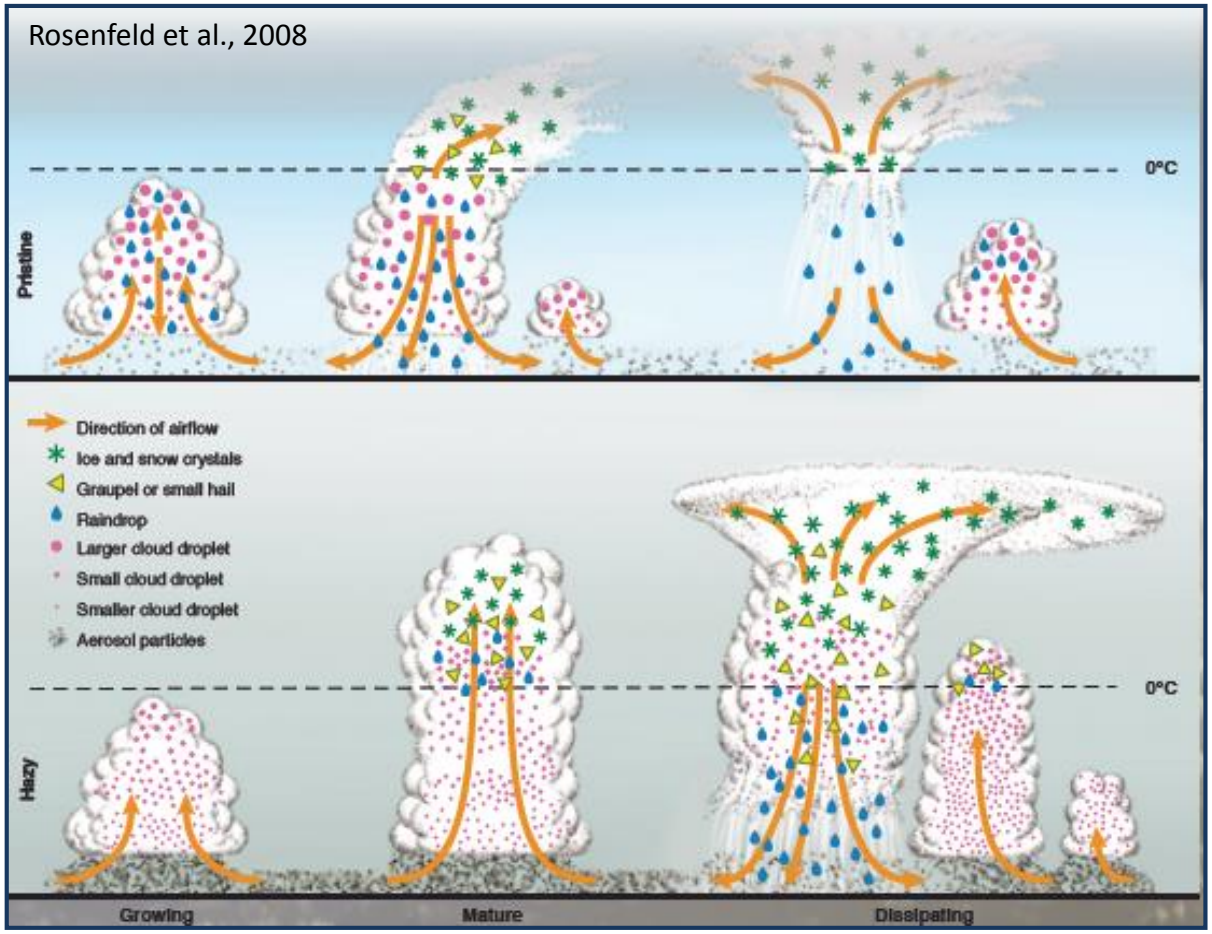
Rosenfeld et al. (2008)
Lensky+Rosenfeld (2006)

Cloud side remote sensing



Martins et al. (2011)

Aerosol and Convection



Cloud side remote sensing

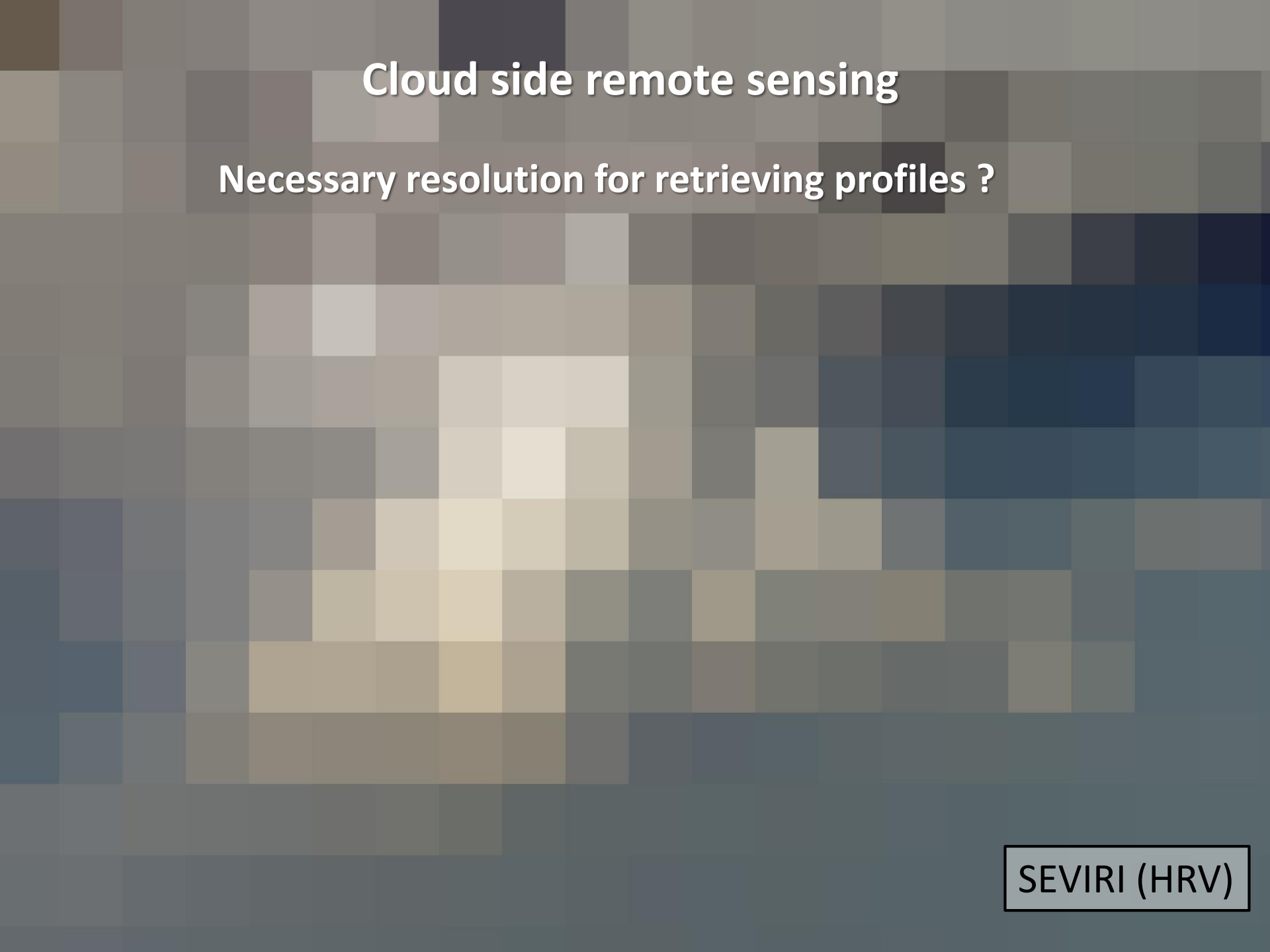
cloud particle phase (z), habit (z)
r_{eff}(z) LWC (z)
3D structure

↕

aerosol, activation, CCN, type, mixing/ entrainment

Cloud side remote sensing

Necessary resolution for retrieving profiles ?



Cloud side remote sensing

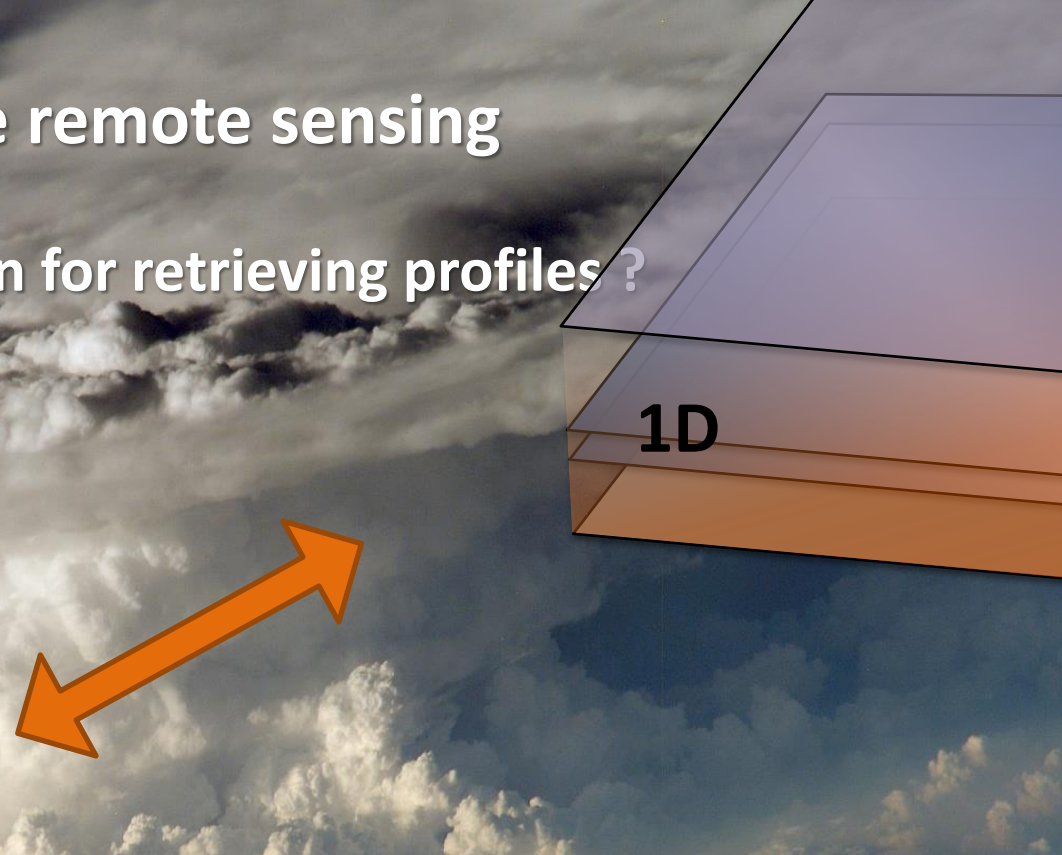
Necessary resolution for retrieving profiles ?

Cloud side remote sensing

Necessary resolution for retrieving profiles ?

Cloud side remote sensing

Necessary resolution for retrieving profiles ?



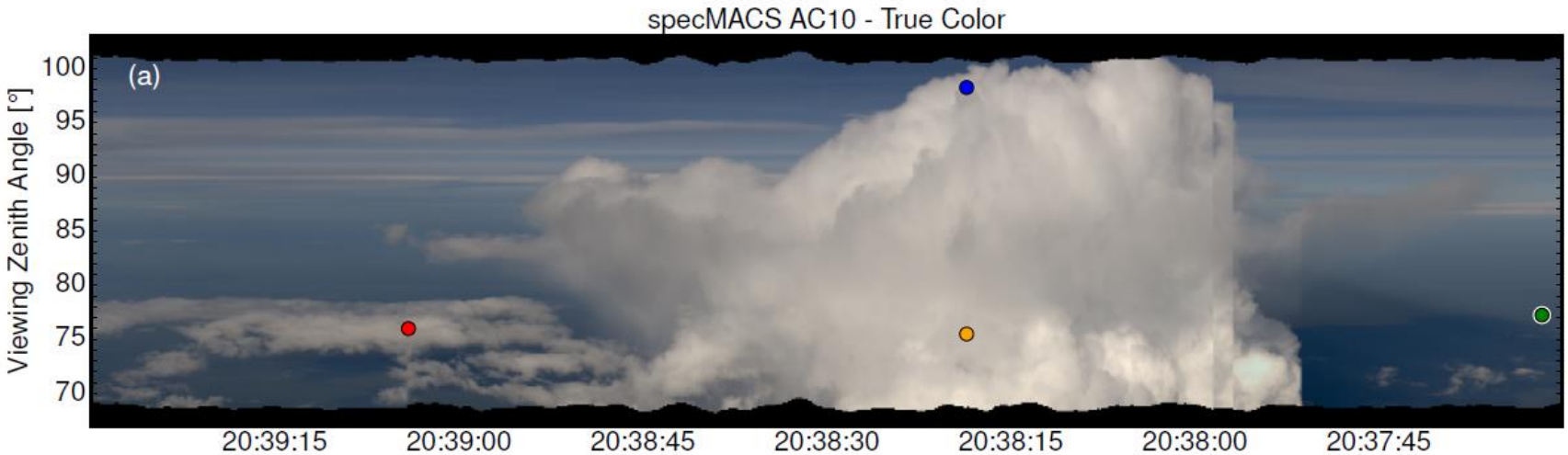
Necessary resolution: ~ 100 m!

→Retrieval methods considering 3D radiative transfer effects necessary!

Thunderstorm Off the Coast of República de Chile
ISS015-E-27038, September 7, 2007

20 m

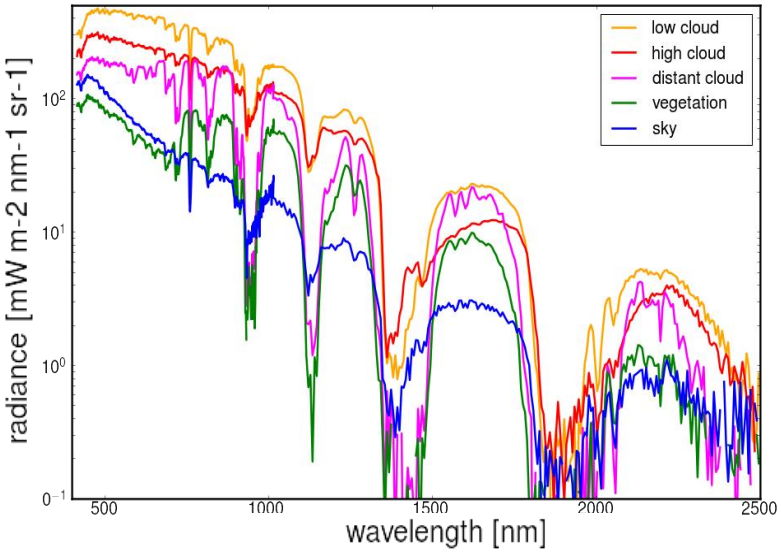
Cloud side observations with specMACS



specMACS

- hyper-spectral observations
- 400 – 2500 nm
- 2.5-12 nm spectral resolution
- spatial resolution 10 – 50 m ?

→ distance? altitude? profile?



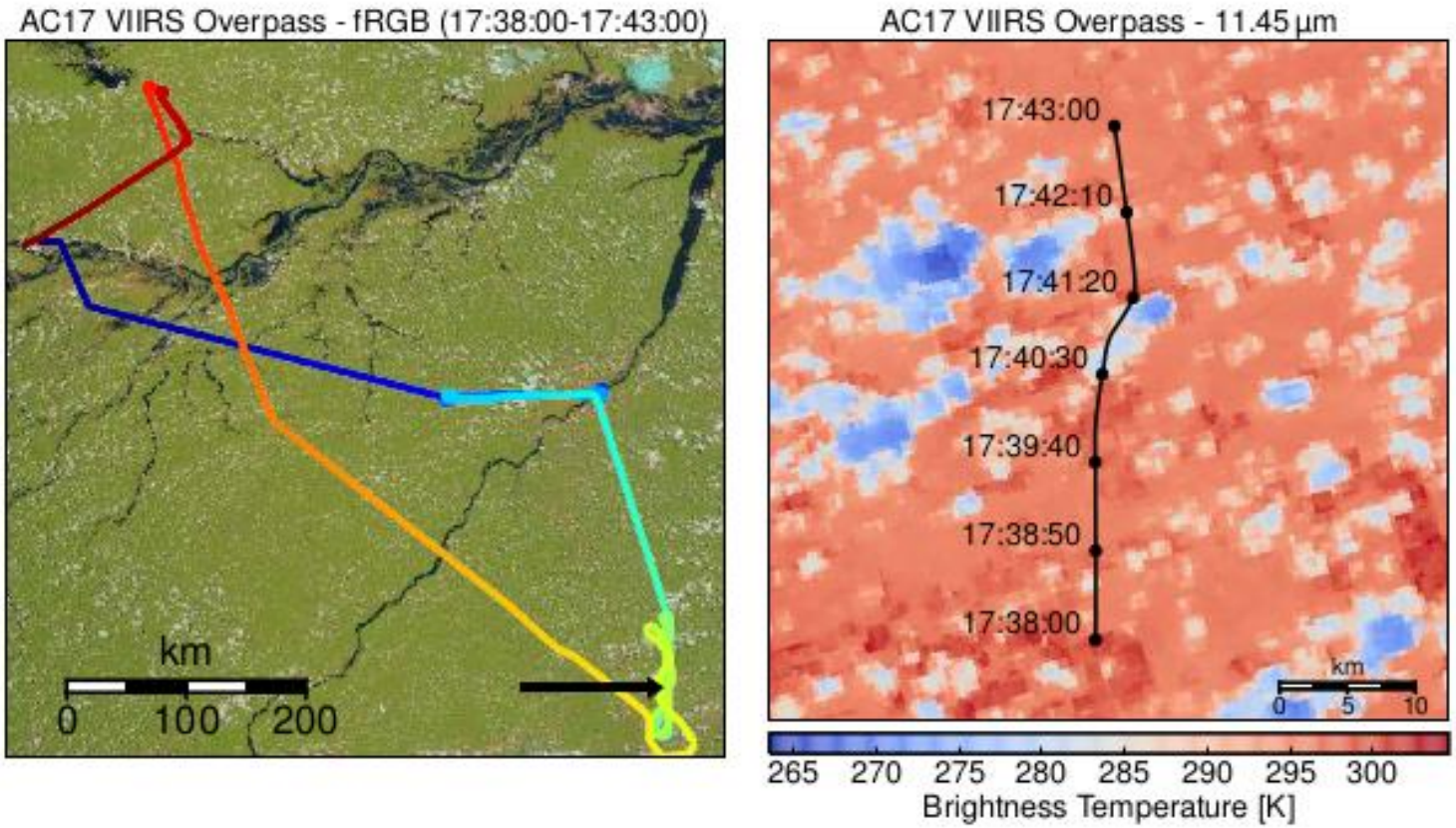
Ewald, Kölling et al., AMT(D), 2016

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Distance? altitude? profile?

MIM

VIIRS



LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Distance? altitude? profile?

MIM

stereo cloud geometry from GoPro movie frames

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Distance? altitude? profile?

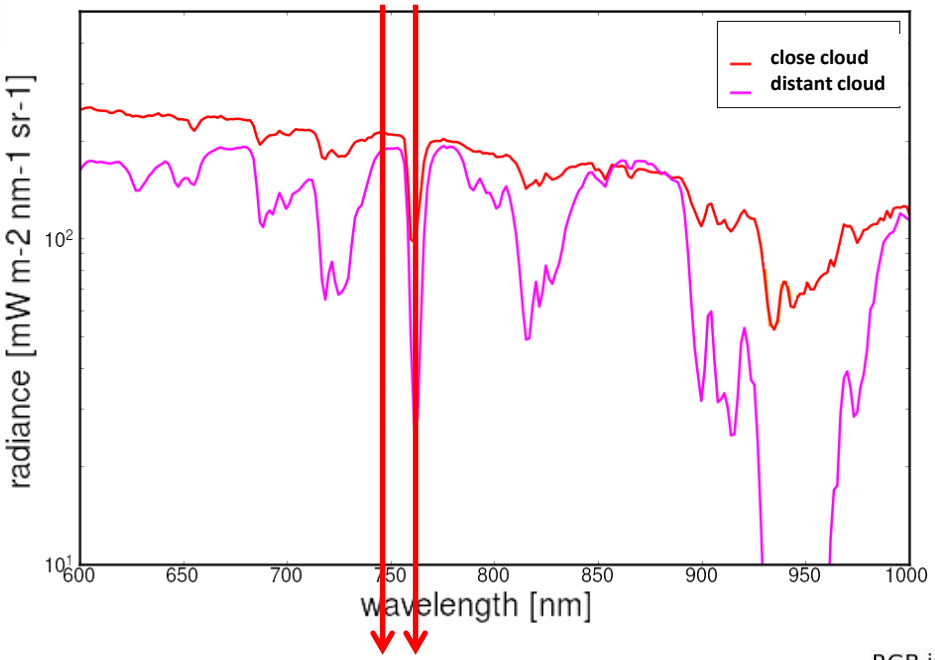
MIM

stereo cloud geometry from GoPro movie frames

Stereo distance

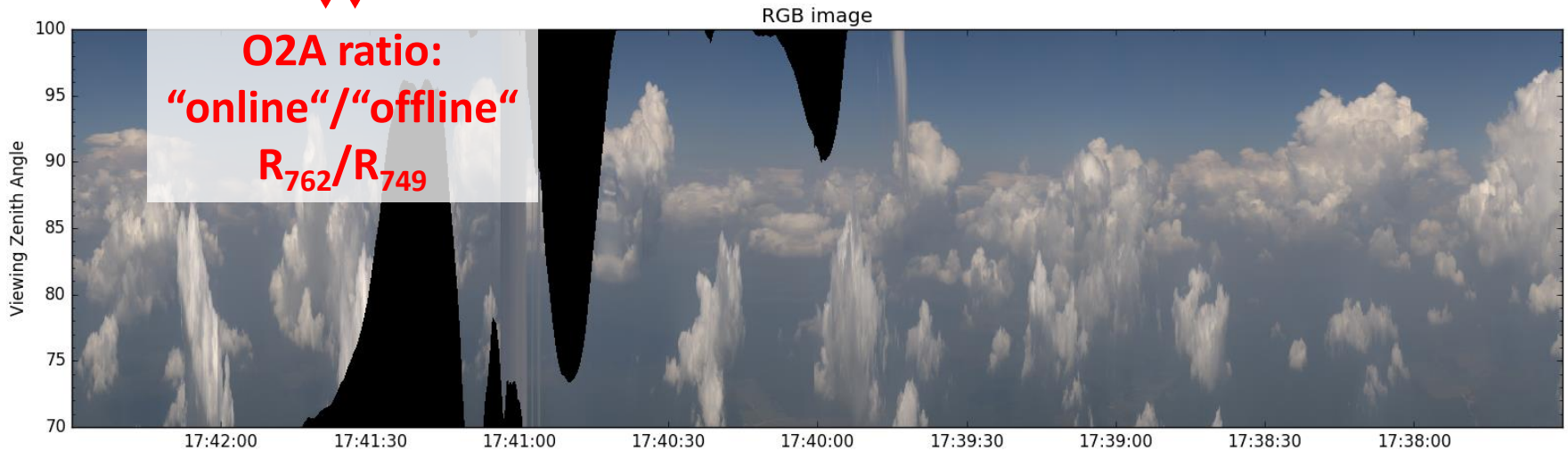
stereo cloud geometry from GoPro movie frames

O2A distance

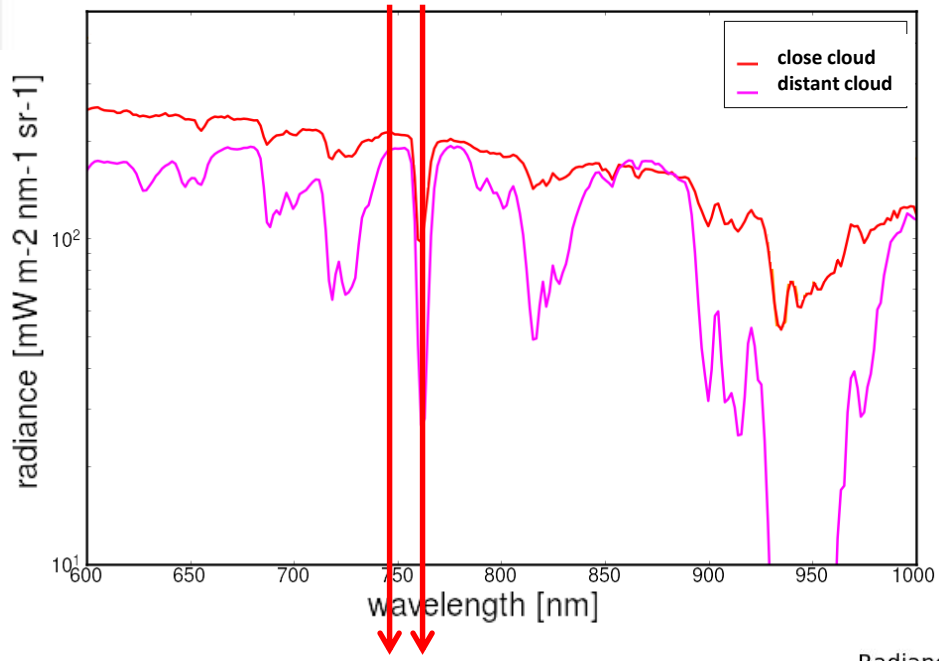


stereo cloud geometry from GoPro movie frames

+ radiance ratios using O2A band

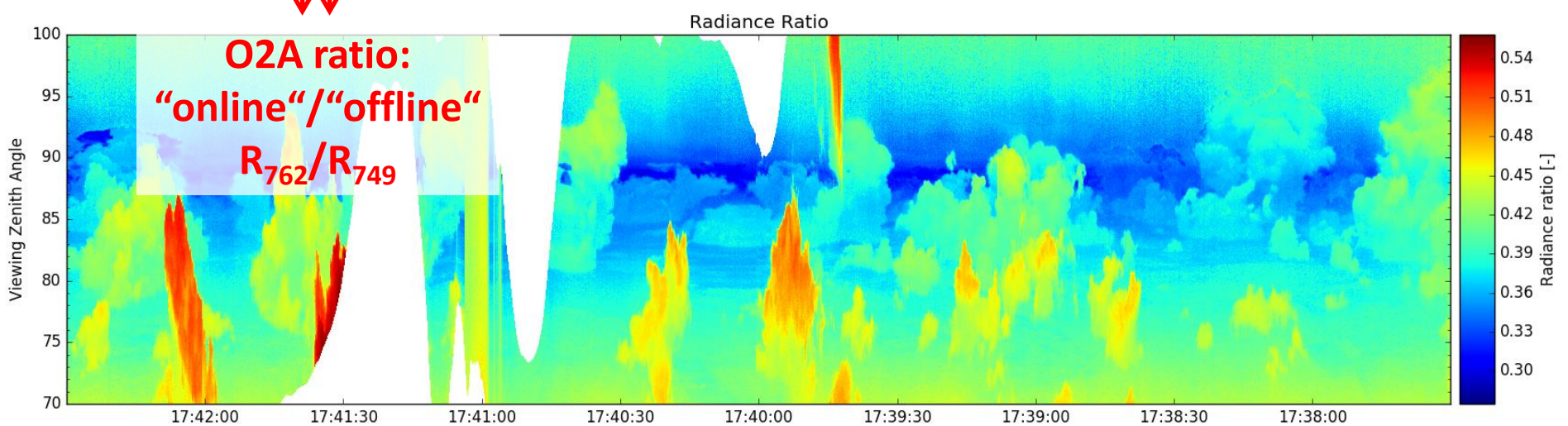


O2A distance

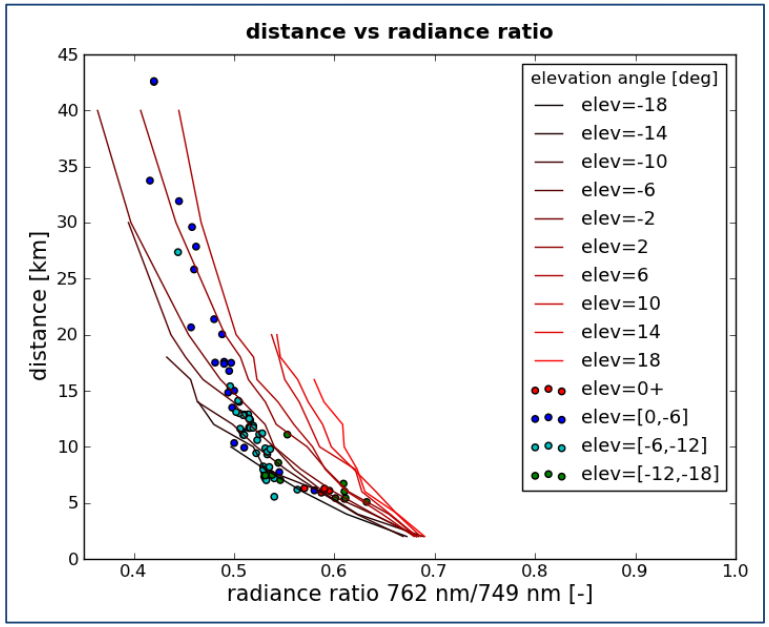


stereo cloud geometry from GoPro movie frames

+ radiance ratios using O2A band

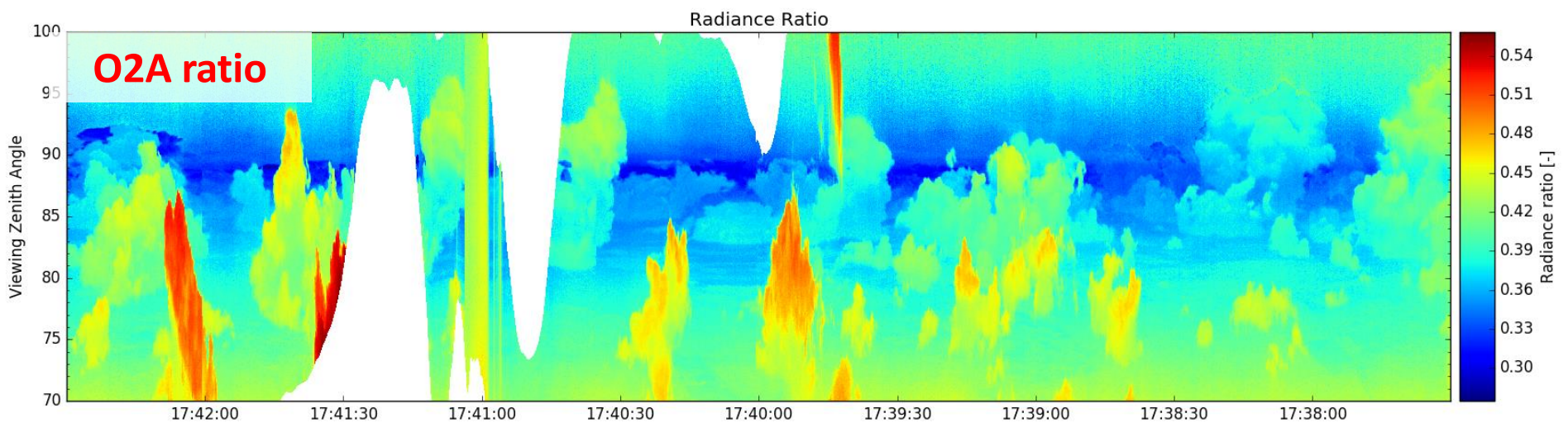


O2A distance

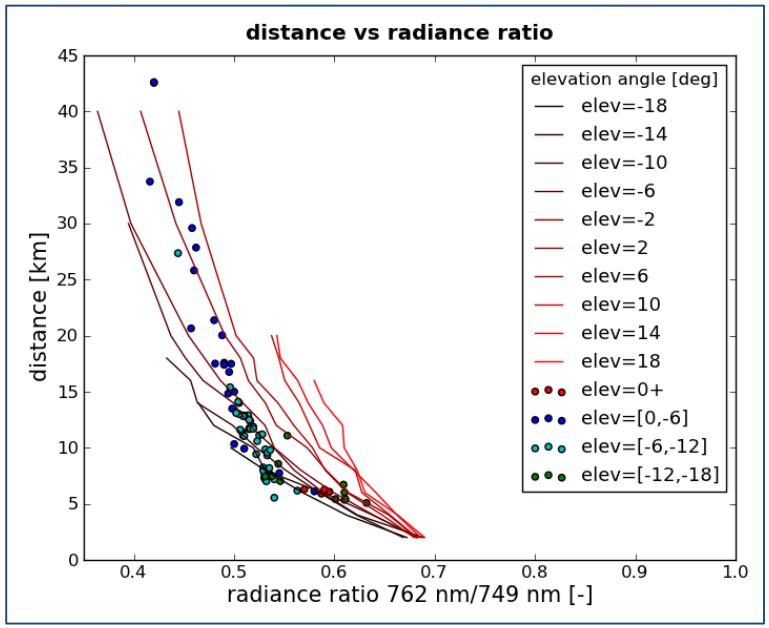


stereo cloud geometry from GoPro movie frames

+ radiance ratios using O2A band

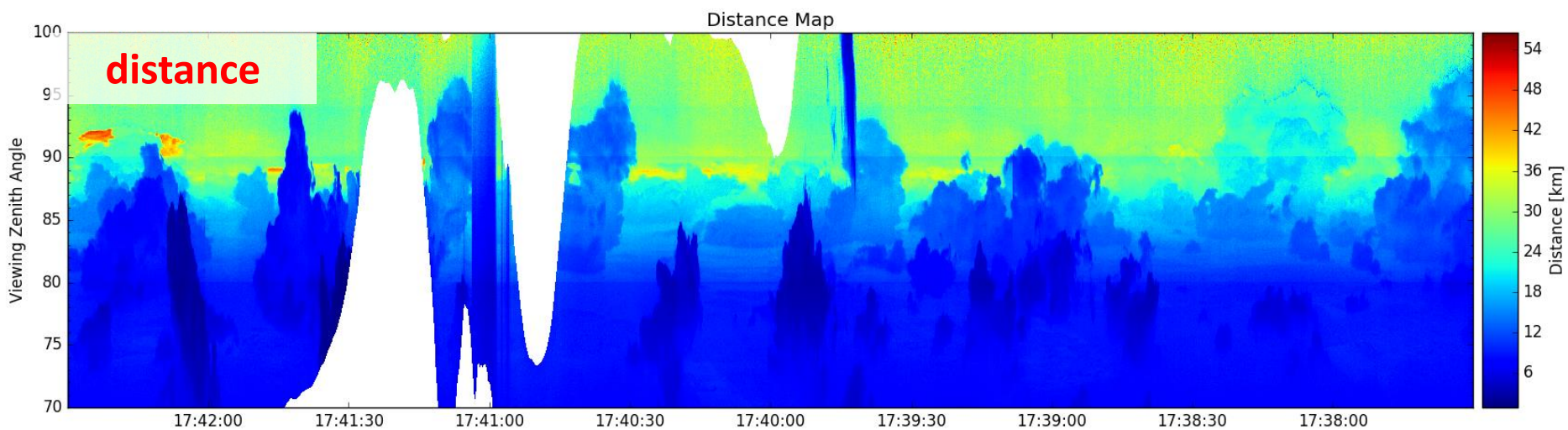


O2A distance

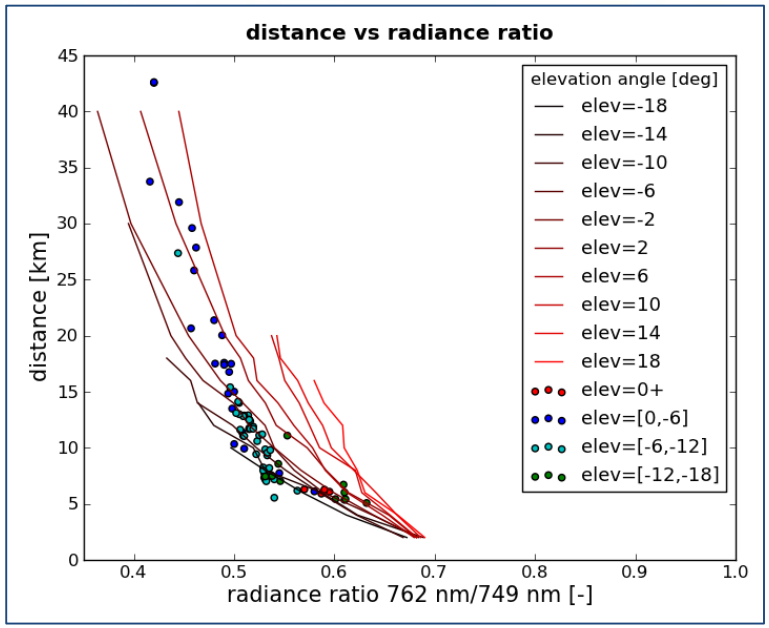


stereo cloud geometry from GoPro movie frames

+ radiance ratios using O2A band

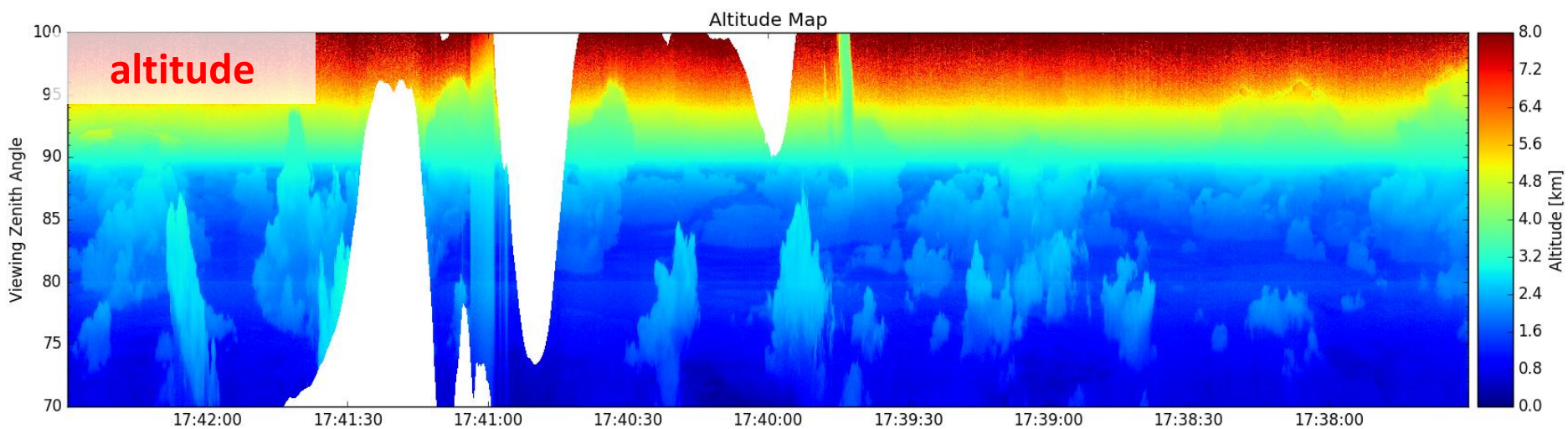


O2A distance

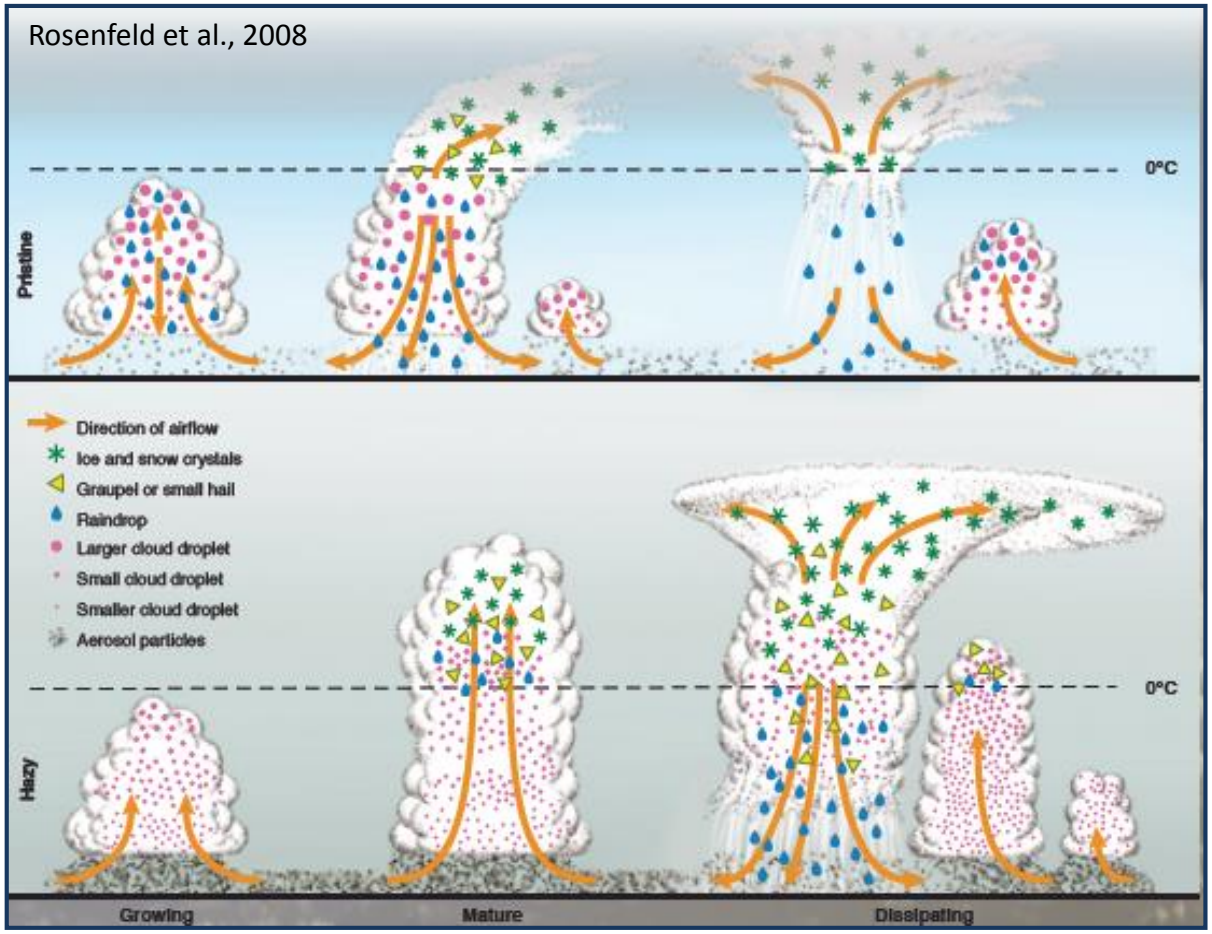


stereo cloud geometry from GoPro movie frames

+ radiance ratios using O2A band



Aerosol and Convection



Cloud side remote sensing

cloud particle phase (z), habit (z)
r_{ef} (z) LWC (z)
3D structure

↕

aerosol, activation, CCN, type, mixing/ entrainment

Thunderstorms on the Brazilian Horizon
ISS020-E-47807, October 6, 2009