



Vertical profiles of thermodynamic phase and identification of mixed-phase layers in tropical deep-convective clouds

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Conference on "Aerosol-cloud-precipitation interaction in Amazonia during the ACRIDICON-CHUVA campaign" Ilha Bela | Brazil | 29 February – 2 March 2016

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1. Motivation

2. Phase discrimination method

3. Examples

Data selection Height determination Phase index profiles Comparison with MODIS and insitu data

4. Conclusion & Outlook

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Thermodynamic phase

Radiative energy budget

Retrieval of particle size

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LMU

188 888



Conclusion

Motivation



UNIVERSITÄT LEIPZIG **Motivation** LMU Faculty of Physics and Earth Sciences Thermodynamic phase **Precipitation formation Radiative energy Retrieval of** & cloud lifetime budget particle size -40 Maritime -30 Continental Ice Temperature (°C) -20 Mixed-phase $\odot \circ \overset{\circ}{\square} \overset{\frown}{\square} \circ$ -10 Μ Coalescence 0 Ο 0 R 0 0 10 0 Diffusion ° 。 20 5 10 15 20 25 30 35 0 Effective Radius (µm) Rosenfeld and Woodley (2003)

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Motivation





Method





Imaging spectrometer (specMACS)

- 1312+320 spatial pixels in line
- 400 + 256 spectral pixels (VIS+NIR)



Motivation

Examples

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Method





- 1312+320 spatial pixels in line
- 400 + 256 spectral pixels (VIS+NIR)



Method





Jäkel et al. (2013)

Phase index: $I_{\rm p} = \frac{I_{1700} - I_{1550}}{I_{1700}}$

 $\begin{array}{r} \text{positive} \rightarrow \text{ice} \\ \text{negative} \rightarrow \text{liquid water} \end{array}$



Jäkel et al. (2013)

Phase index: $I_{\rm p} = \frac{I_{1700} - I_{1550}}{I_{1700}}$

 $\begin{array}{c} \text{positive} \rightarrow \text{ice} \\ \text{negative} \rightarrow \text{liquid water} \end{array}$

Phase index depends on:

- particle size
- viewing geometry

Motivation

Method

Examples

Conclusion

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Motivation Method Examples Conclusion



Motivation

Examples





Cloud mask





significant fraction of diffuse radiation originated from unknown directions

Motivation

Examples





AC13

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#4: 18:54 – 18:56 UTC







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l C e

Liquid

AC13

Data Selection



#1: 17:54 – 17:57 UTC

#2: 18:06 - 18:09 UTC



Conclusion

Method

Examples



#3: 18:48 – 18:50 UTC

#4: 18:54 – 18:56 UTC



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Examples



#5: 18:57 – 19:03 UTC



Data selection ✓ Height determination

AC13

Examples



Motivation

Height Determination



Stereogrammetry

• Image correction (roll, pitch, camera distortion)





FOVh = 91° FOVv = 59°



Method





Tie point selection



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Examples

Conclusion



Distance to cloud (km)





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Examples



Distance to cloud (km)





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10000



Phaseindex Profiles





Motivation

Phase Identification

14 12 10 Altitude (km) 8 6 ice 2 mixed phase liquid 0 11 12 13 14 15 16 17 2 3 1 5 6 8 10 Cloud #

AC13 – polluted case

Data selection ✓
Height determination ✓
Phase index profiles ✓
Phase identification

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Data selection ✓
Height determination ✓
Phase index profiles ✓
Phase identification ✓
Comparison with MODIS and insitu data

Comparison

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Data selection ✓
Height determination ✓
Phase index profiles ✓
Phase identification ✓
Comparison with MODIS and insitu data

Comparison

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Data selection ✓
Height determination ✓
Phase index profiles ✓
Phase identification ✓
Comparison with MODIS and insitu data

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Data selection ✓
Height determination ✓
Phaseindex profiles ✓
Phase identification ✓
Comparison with MODIS and insitu data

Comparison

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Comparison









AC12

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Method

Examples

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AC12

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AC10

Comparison

G

Liquid



AC10





#4



Gopro

SpecMACS RGB

SpecMACS Phaseindex





AC10

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Examples

Conclusion

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880 839 888 839



-40

-20

Temperature (°)

AC10

Cloud #

Motivation

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Examples

Conclusion



AC18

Motivation

Method

Examples

Conclusion

Comparison



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Conclusion & Outlook



18.828 UTC 18.832

8.830

Conclusion:

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- Advantage of imaging technique
- Mixed-phase layer could be identified
- Highly variable phase profiles observed
- So far: no impact on pollution on vertical distribution of phase

Outlook:

- Link to CCN data?
 Comparison with insitu effective radius profiles
 Advice for the future: stick on one cloud
 Ground-based measurements at ATTO
 - Ground-based measurements at ALIC (combination with IR-camera)



18.824

18.826

140 120

100 80 60



Extra









Screenshot –Data selection Tool

-10

-20

0

Gopro-Image



SAVE



2000

1000

3000



END







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