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Droplet size comparison from different retrieval algorithms: A case study at Cloudnet Granada station

M. Tolentino, M.J. Granados-Muñoz, F. Navas-Guzmán, J.L Guerrero-Rascado, L. Alados-Arboleda, J.A. Bravo-Aranda

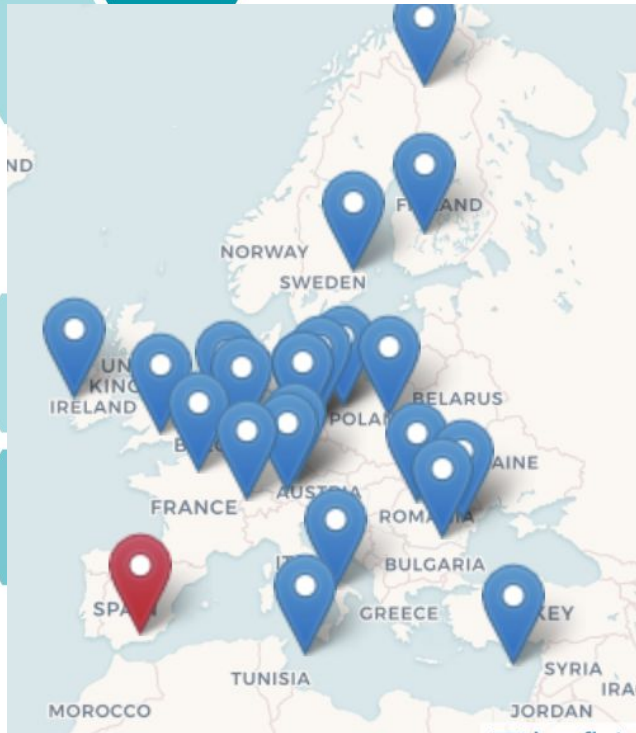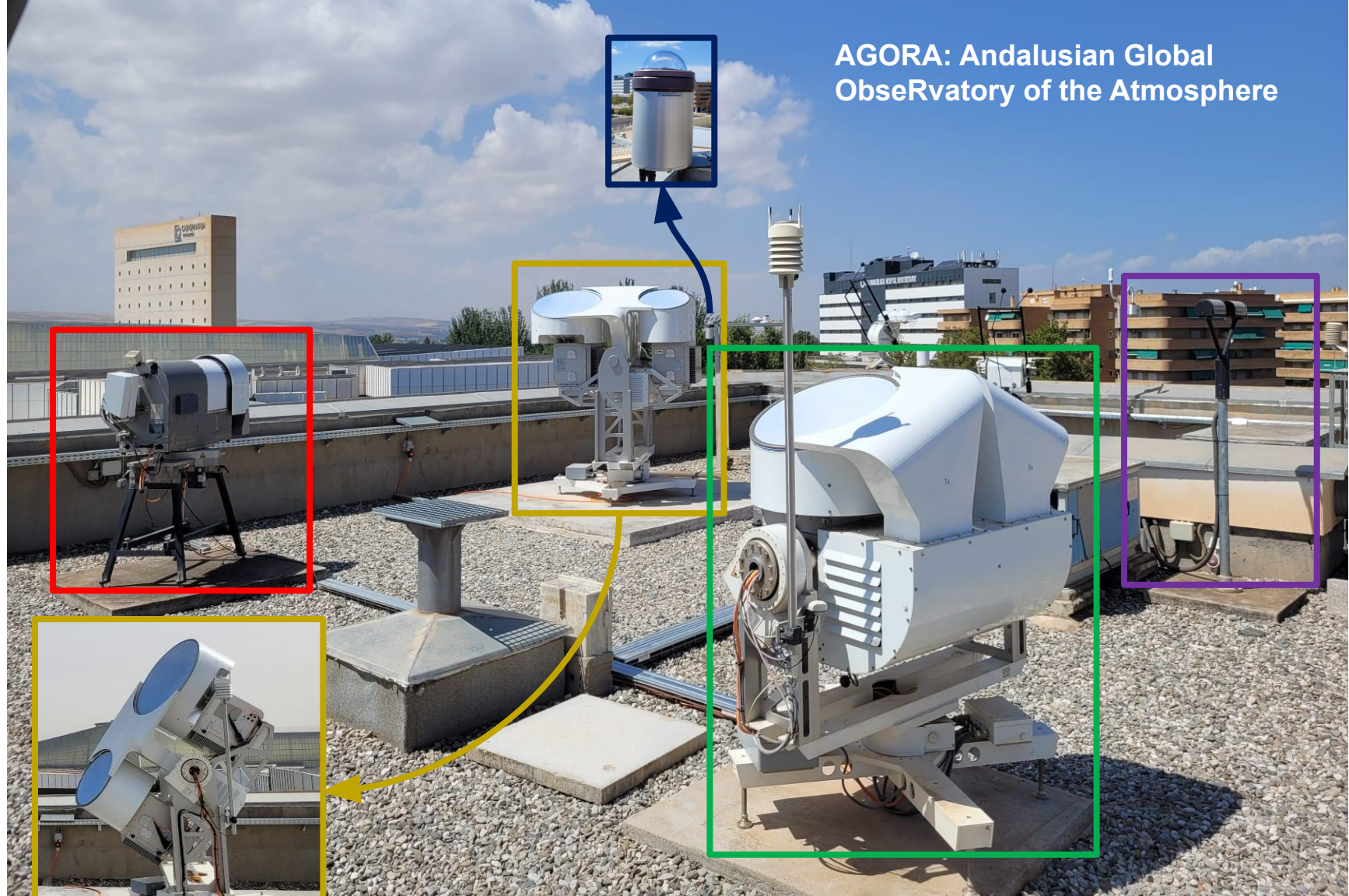# Motivation

- **Accurate cloud microphysics are needed to enhance the estimation of their radiative effect**

- **Quantify differences between retrievals to identify their limitations**

  - **Trustful reflectivity is crucial, anything else?**

AGORA ACTRIS CCRES station (Granada Station)

AGORA: Andalusian Global ObseRvatory of the Atmosphere

Available in CLOUDNET

Scanning capability

HATPRO-G2
RPG Dual frequency cloud radar (35,94GHz)

Sky camera
RPG 94-GHz Cloud radar

Disdrometer Parsivel OTT[2]

Instruments and products for microphysical retrieval

RPG HATPRO – G2

RPG FMCW Dual frequency – 35 – 94 radar

35 Ghz   94Ghz

	Range (m)	
Chirp 1	100 - 600	25.6
Chirp 2	600 - 2,000	26.5
Chirp 3	2,000 -12,000	37.7

Time (cloudnet): 30s

Bands	22-31 GHz (K-band) 51-58 GHz (V-band)
Measured	Brightness Temperature
Product	Liquid water path (LWP)

Bands	35 (Ka band) 94 GHz (W band)
Measured	Doppler velocity spectra (DVS)
Product	Reflectivity (Z)

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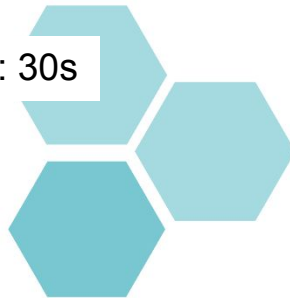
Cloud classification
by cloudnet target classification
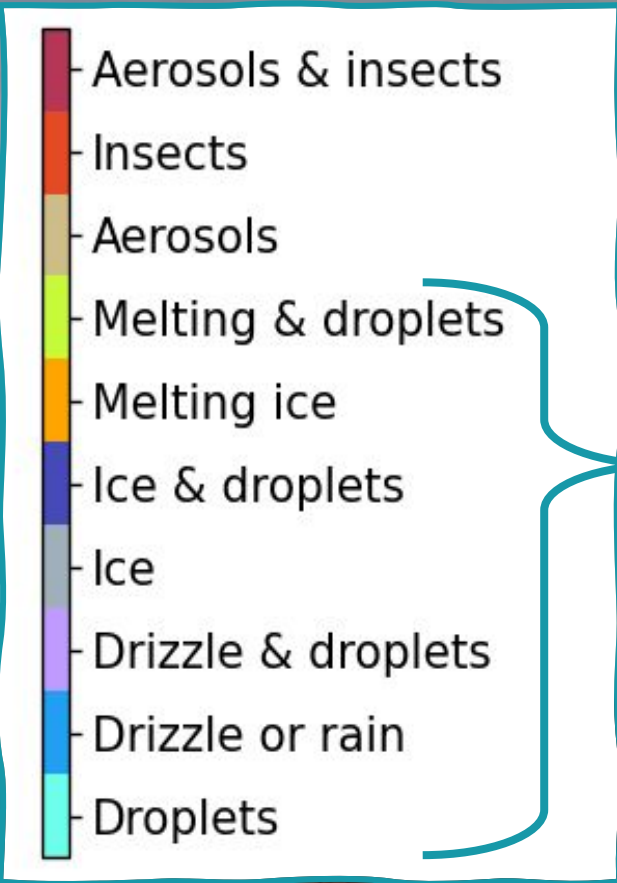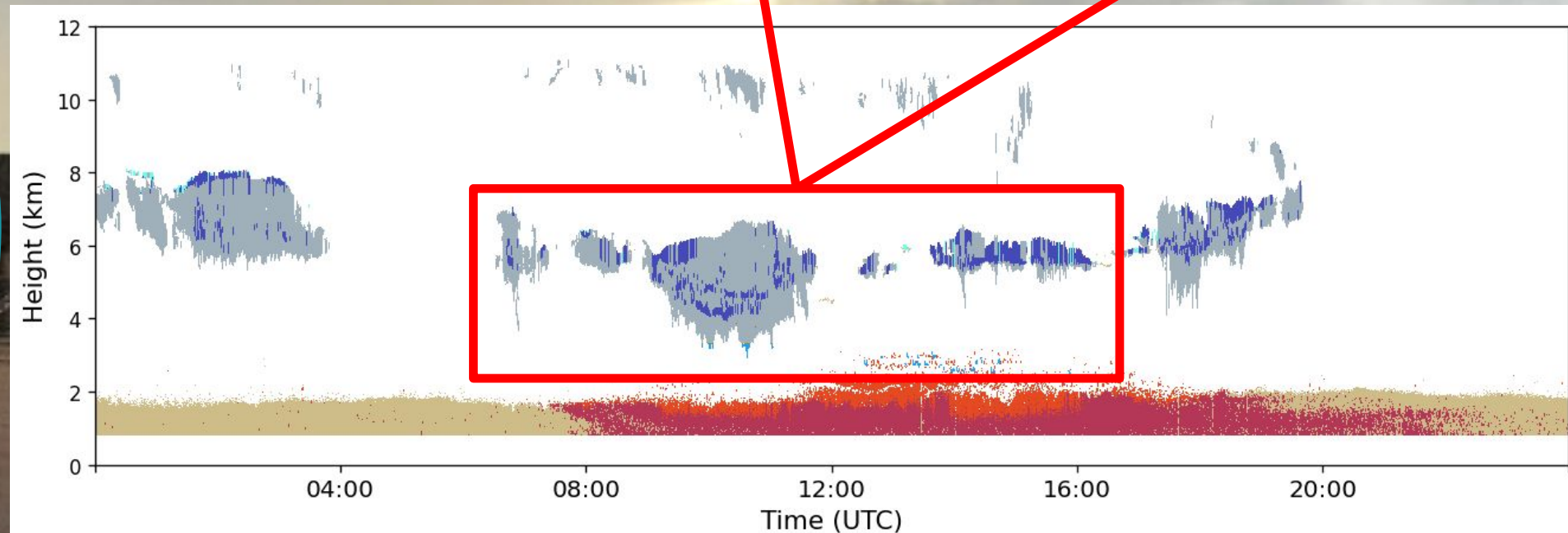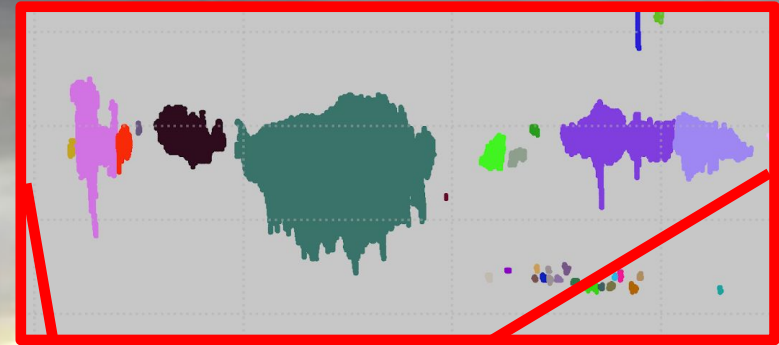
Cloud classification by Hydrometeor cluster

Droplets, Drizzle & droplets, Ice & droplets, Ice, Melting ice, Melting & droplets, Drizzle or rain

Unknown

no   yes

100 pixels? (without rain)

Cloud Mask

Pixel Dilatation

Pixel Contraction

Connect nearby clouds
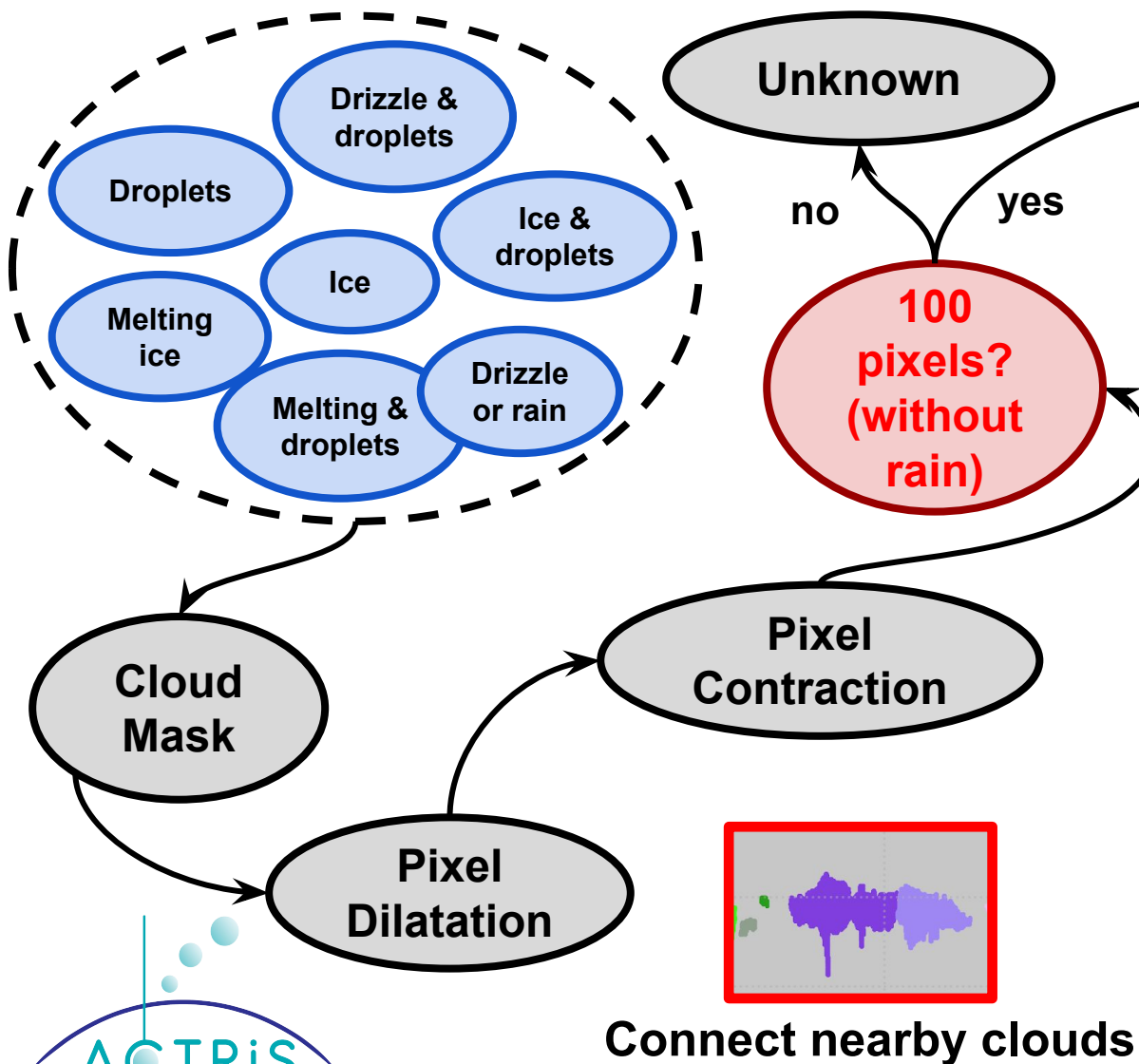
Cluster Classification

Nomenclature:
P(X) = percentage of X

1) P (Droplets) + P (Drizzle & Droplets) > 70%   **yes** → *Liquid*

no

2) P(Ice) > 90 % **or**
P(Ice & Droplets) + P(Droplets) < 10%   **yes** → *Ice*

no → *Mixed-Phase*

Cloud category

3) 10 pixels of "Drizzle or rain"
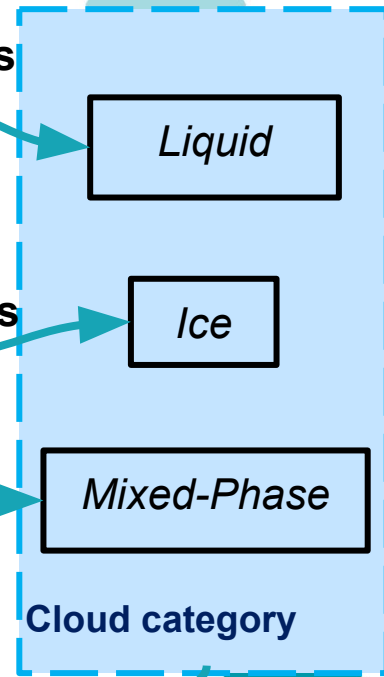
yes → Precipitating - **cloud category**

Multi layer clouds were filtered out

M. Tolentino et al., **in preparation**

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Microphysical retrievals

Applied to liquid pixels: Droplets, Drizzle & Droplets, Ice & Droplets
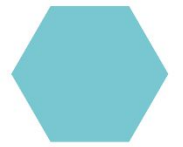
Method	Equation	Assumptions	Default	Reference
Cloudnet	$r_e(h) = \frac{1}{2}\left(\frac{Z(h)}{N}\right)^{1/6} exp(-0.5\sigma_x^2)$	Lognormal, $f(r;N,\sigma_x)$ N and σ_x are const with h	Z (W-band) N = 200 #/cm3 σ_x= 0.35	Frisch et al., 2002

Droplet effective radius comparison

DSD parameters from Fog-Monitor (02/2023)
Lognormal: N = 150 #/cm^{-3}, σ_x = 0.28
Gamma: ν = 13.4

Cloudnet corrected

N = 150 #/cm^{-3}
σ_x = 0.28

Cloudnet scaled corrected

N = 150 #/cm^{-3}
σ_x = 0.28

Knist

ν = 13.4

X Default

X Default

Droplet efective radius assesment
Liquid cloud (09/06/2024)
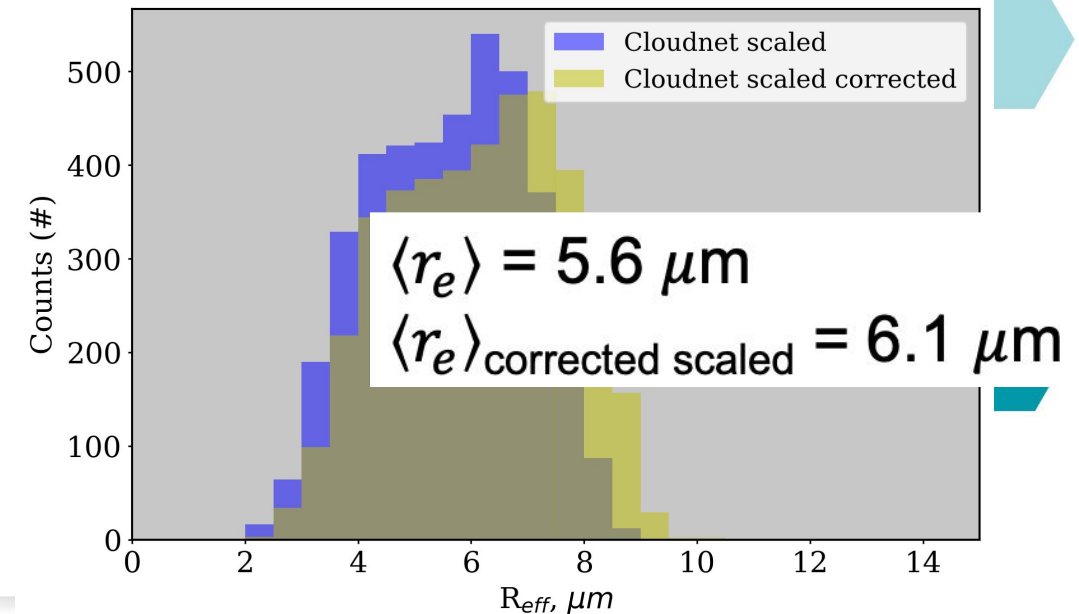

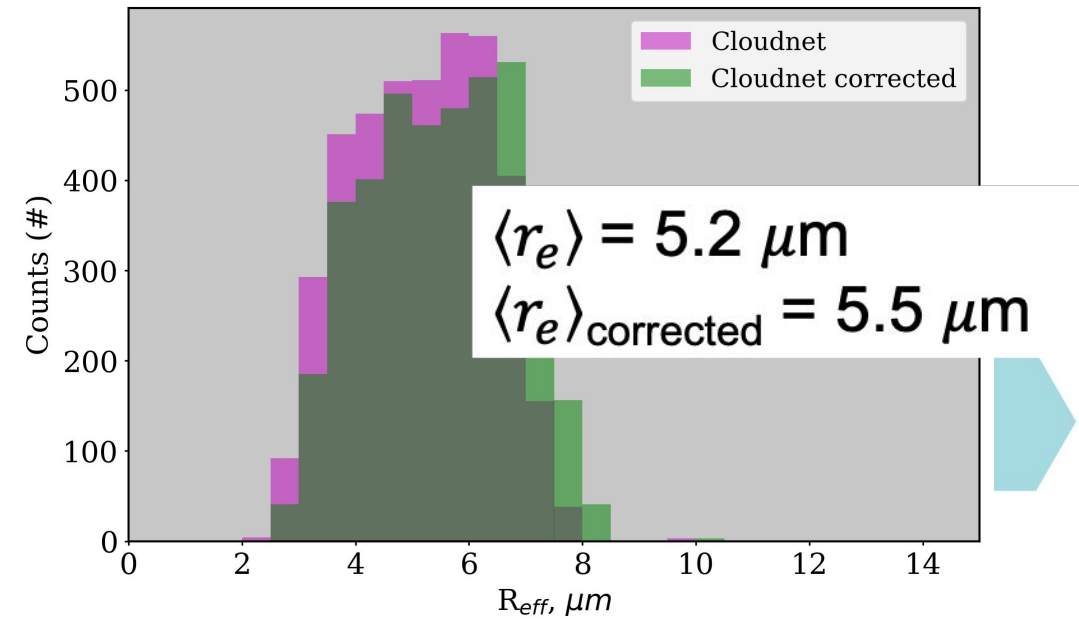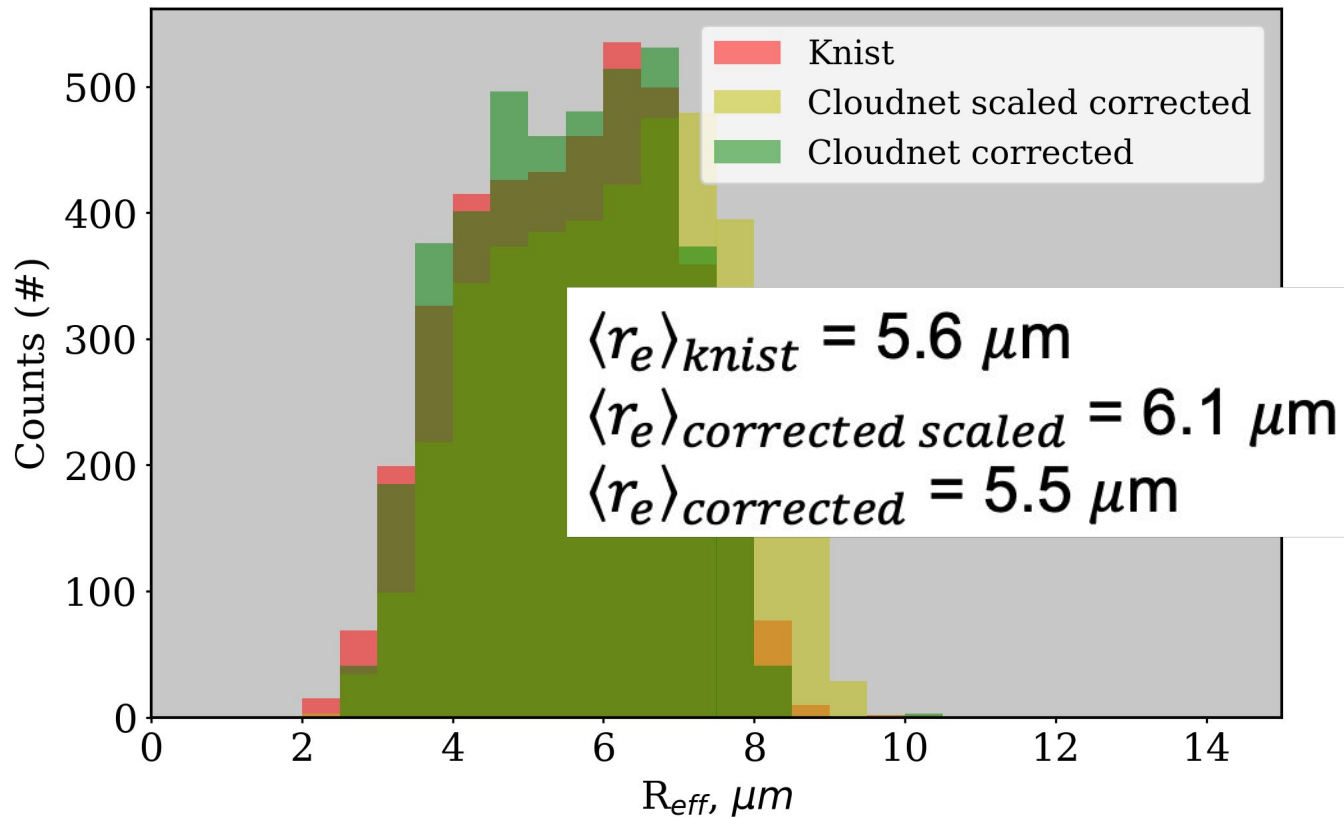**Cloudnet target classification**

Cloud classification from cluster classification

Liquid clouds are made of "Droplets" and "Drizzle & Droplets"
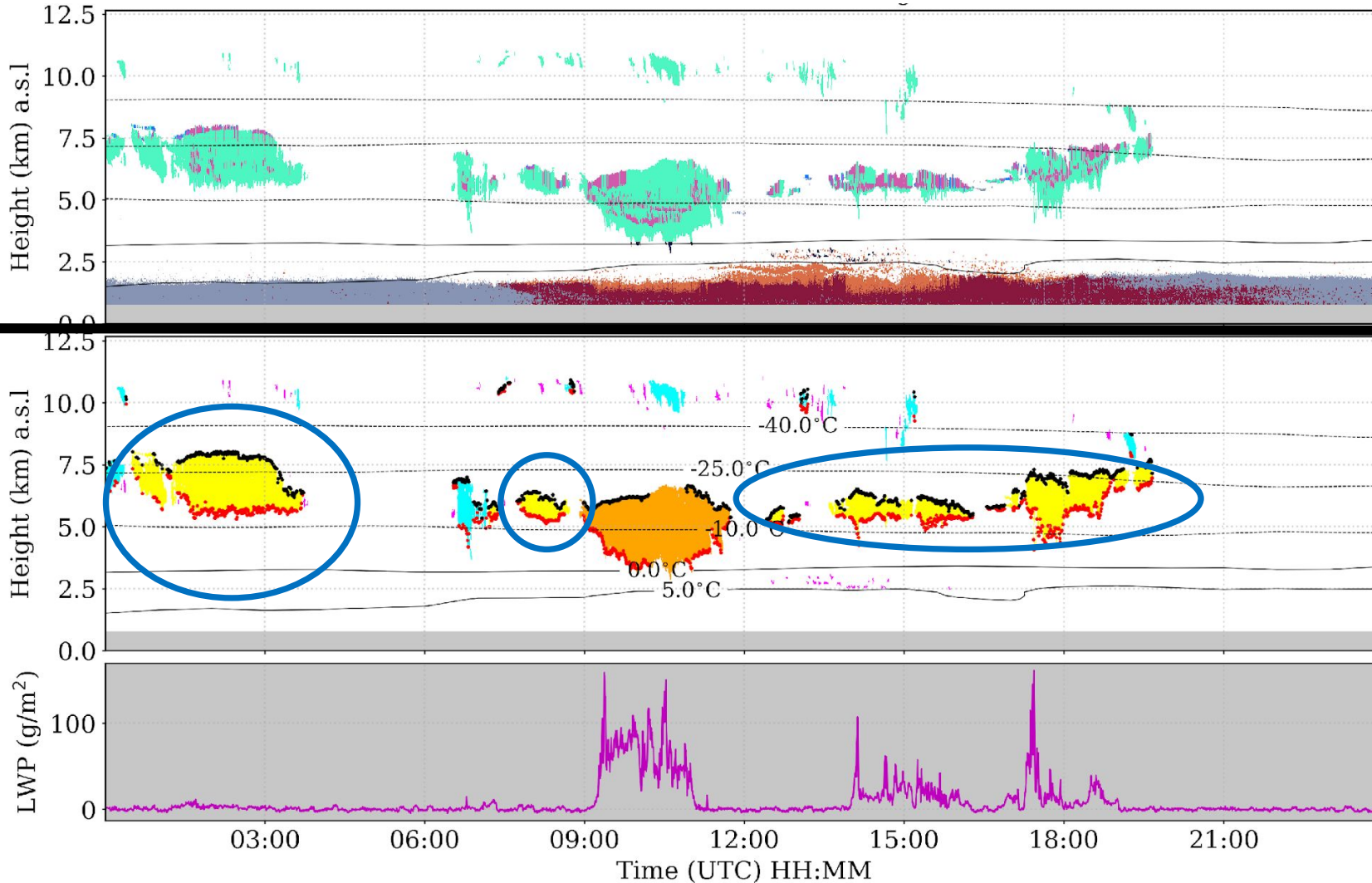
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Liquid cloud (09/07/2024)

Retrieval applied to "Droplets" and "Drizzle & Droplets"

Droplet effective radius from different retrievals are similar

$$\langle r_e \rangle = 5.2 \ \mu m$$
$$\langle r_e \rangle_{corrected} = 5.5 \ \mu m$$

$$\langle r_e \rangle_{knist} = 5.6 \ \mu m$$
$$\langle r_e \rangle_{corrected \ scaled} = 6.1 \ \mu m$$
$$\langle r_e \rangle_{corrected} = 5.5 \ \mu m$$

$$\langle r_e \rangle = 5.6 \ \mu m$$
$$\langle r_e \rangle_{corrected \ scaled} = 6.1 \ \mu m$$

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Mixed phase cloud (02/04/2024)
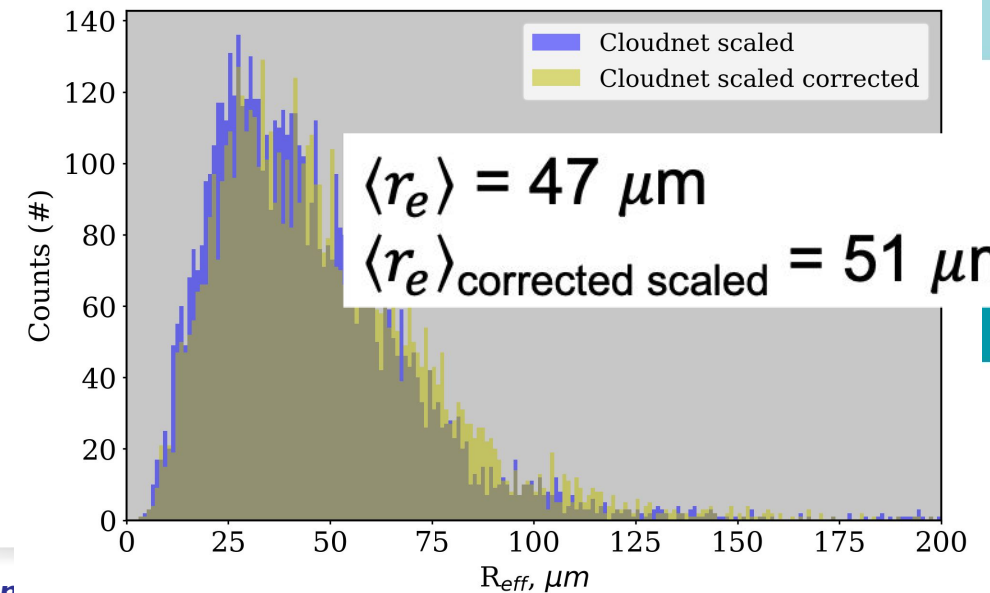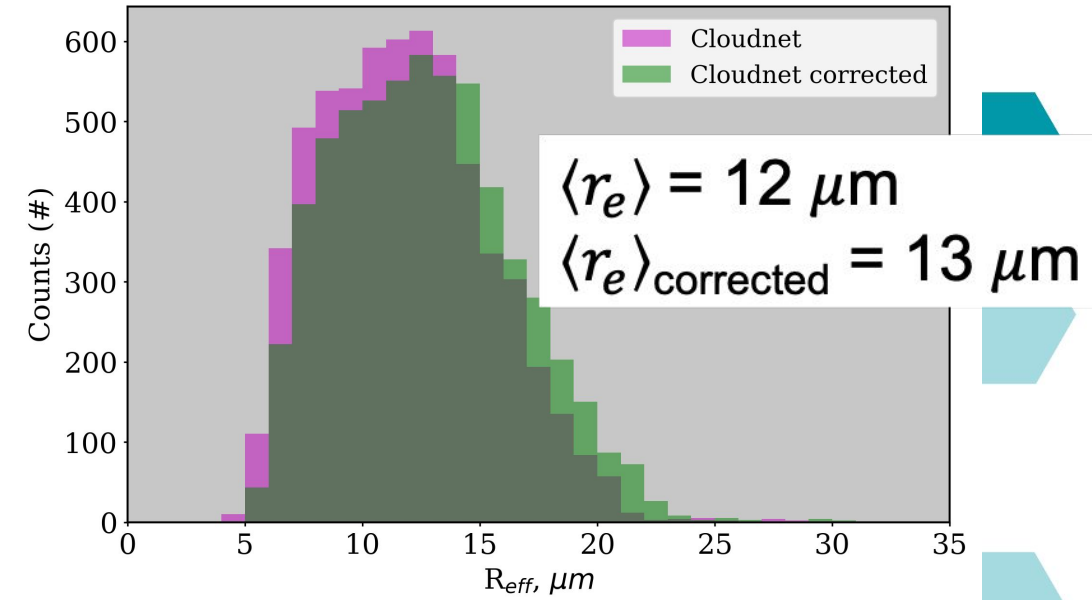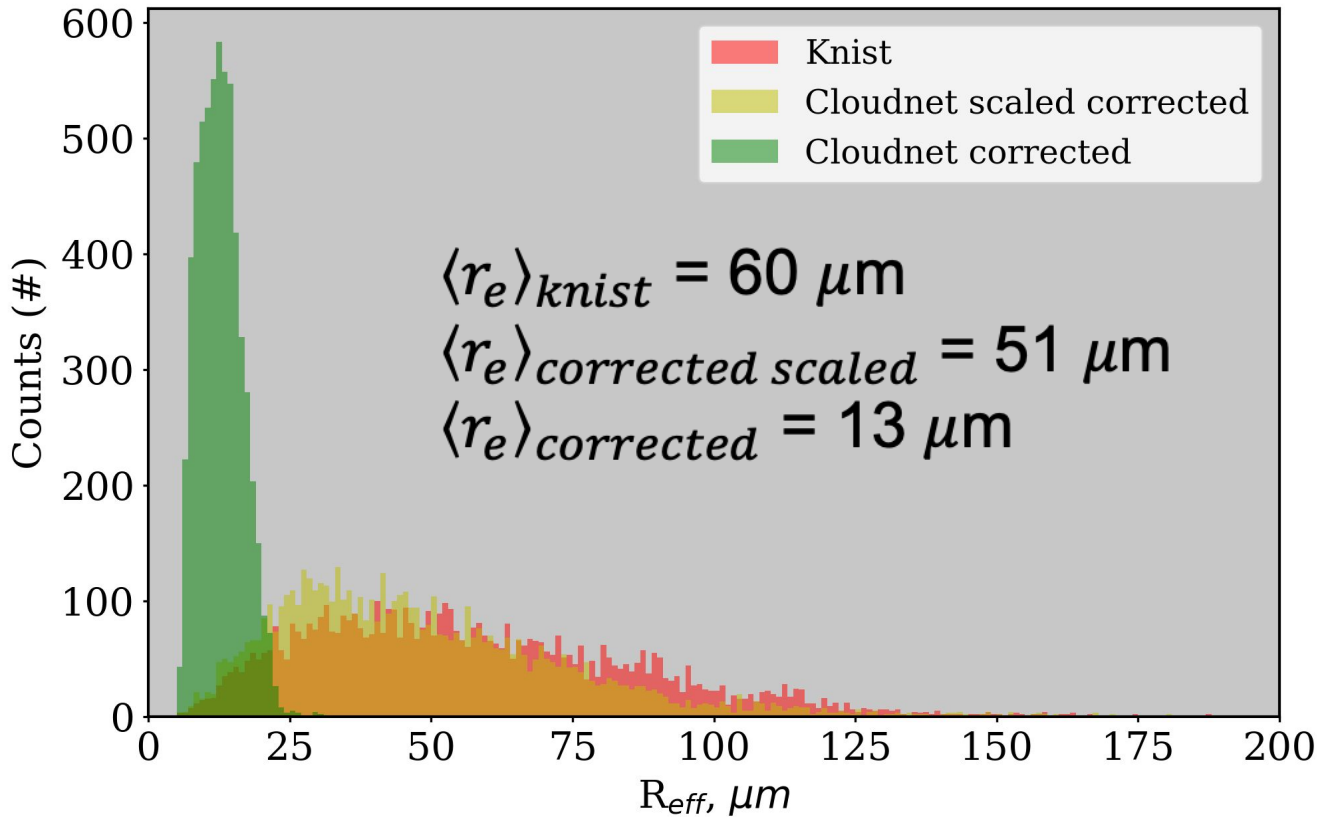

Cloudnet target classification

Cloud classification from cluster classification

Mixed phase clouds are made of "Ice" and "Ice & Droplets"

Mixed phase cloud (02/04/2024)

Retrieval applied to "Ice & Droplets"

- **Large discrepancies between retrievals using only Z and those using both Z and LWP**
- **Droplet r_e in Ice & Droplet pixels present large discrepancies**

$\langle r_e \rangle = 12\ \mu m$

$\langle r_e \rangle_{corrected} = 13\ \mu m$

$\langle r_e \rangle_{knist} = 60\ \mu m$

$\langle r_e \rangle_{corrected\ scaled} = 51\ \mu m$

$\langle r_e \rangle_{corrected} = 13\ \mu m$

$\langle r_e \rangle = 47\ \mu m$

$\langle r_e \rangle_{corrected\ scaled} = 51\ \mu m$

Concluding Remarks

Cloud droplets effective radius retrieval comparison between different algorithms were evaluated for liquid and mixed-phase clouds

- **Cloudnet default (LWP scaled and not scaled) x Cloudnet with DSD parameters from Fog-Monitor**
  - **Default parameters of DSD in Cloudnet are valid for the Granada station**

Thank you