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A novel approach to cloud classification: first results and challenges encountered

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Outline

1. **Motivation**
2. Methods of cloud classification
   a. Cloud assessment by time
   b. Cloud assessment by hydrometeor grouping
3. Results
   a. Comparison between cloud assessments
   b. Hydrometeor misclassification effect on cloud statistics (hydrometeor grouping)
4. Concluding Remarks

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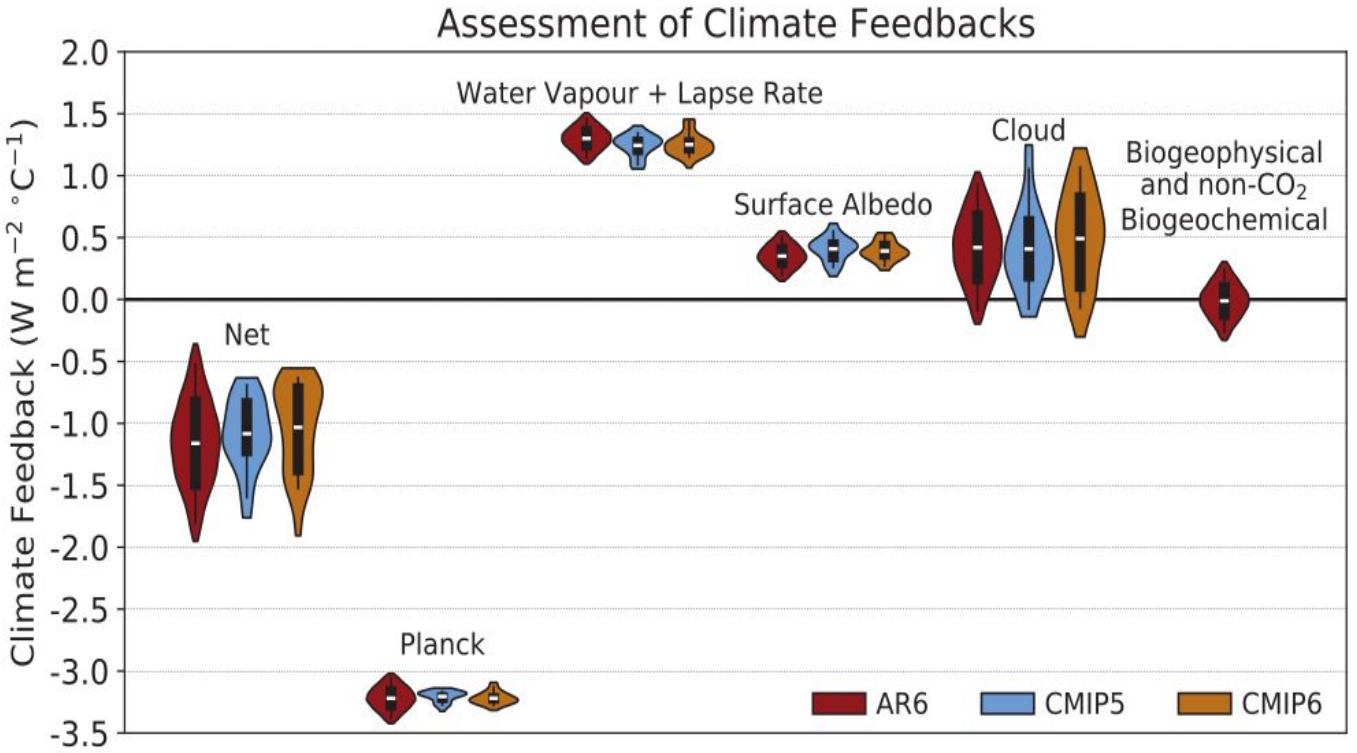
Motivation

Clouds are still poorly understood

- Their classification is one of the key components to improve the current knowledge of their physical properties and climate effects
- It is particularly important in regions affected by severe weather conditions
- The available 5 year dataset at UGR-CCRES is analysed in order to study cloud properties in the Western Mediterranean. For that, a new approach for cloud classification is explored



IPCC 2021

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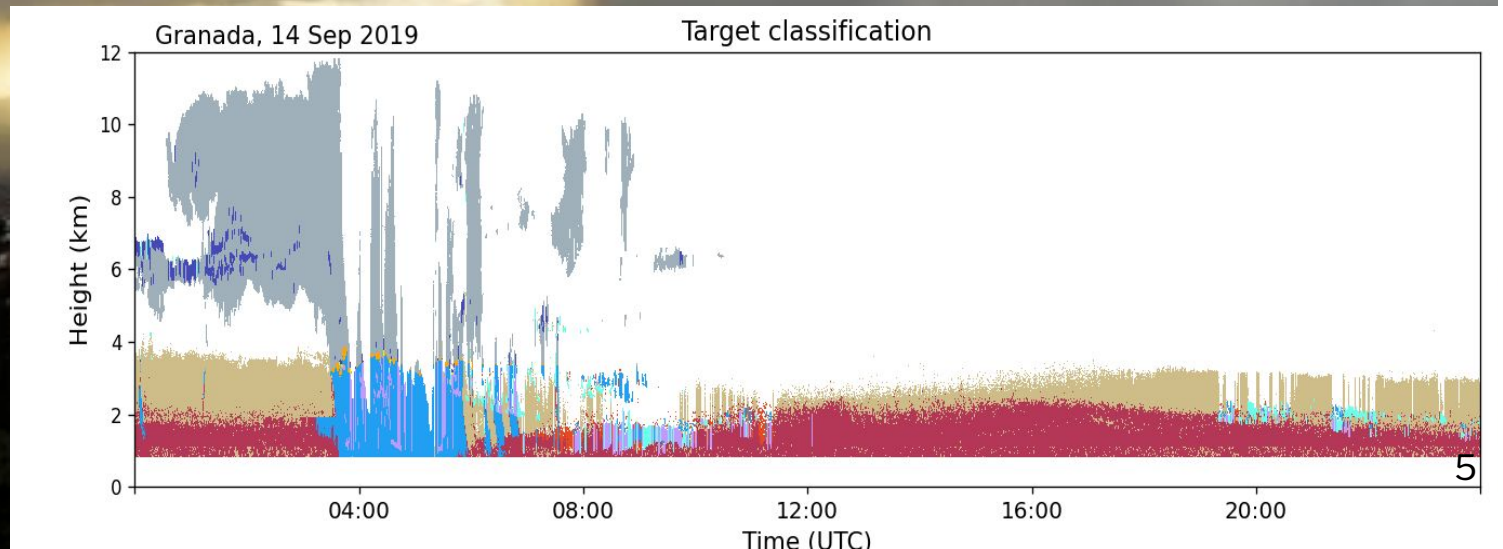
Cloudnet target classification

- Aerosols & insects
- Insects
- Aerosols
- Melting & droplets
- Melting ice
- Ice & droplets
- Ice
- Drizzle & droplets
- Drizzle or rain
- Droplets

hydrometeors



Classification by time

State-of-Art

1) Cloud layer identification

At each profile (30 s):

Cloud layer:

Consecutive sequence of hydrometeors

Some studies

i) 5 cloudy pixels (*Pirloaga et., al 2022)*

ii) 3 cloudy pixels (*Nomokonova et., al 2019)*

2) Single / Multi-layer classification

Multi-Layer

Layers separated by a sequence of non hydrometeors

i) 5 aer/inset/clear pixels of separation (Pirloaga et., al 2022)

ii) 1 clear pixels of separation (Nomokonova et., al 2019)

3) Raining clouds

Any pixel of "Drizzle or rain" bellow cloud?

yes → Precipitation

no → No precipitation

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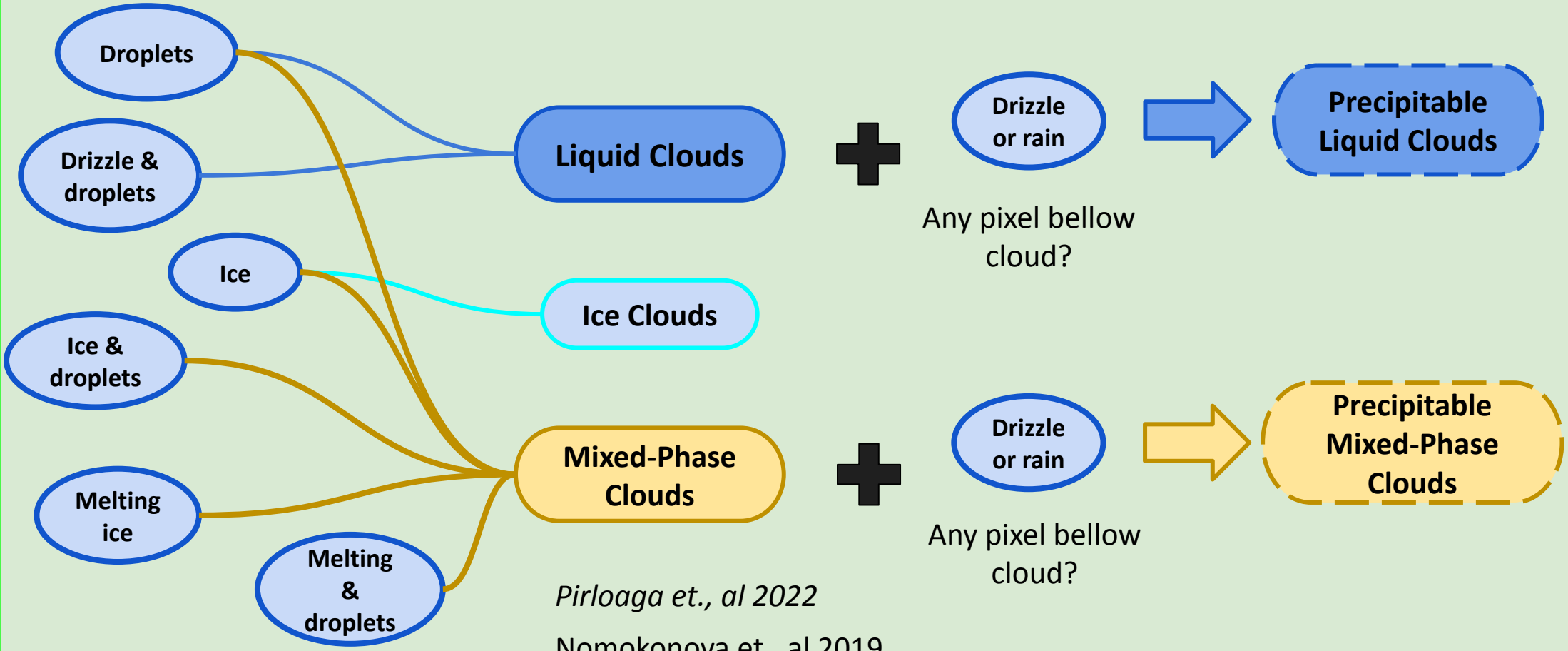
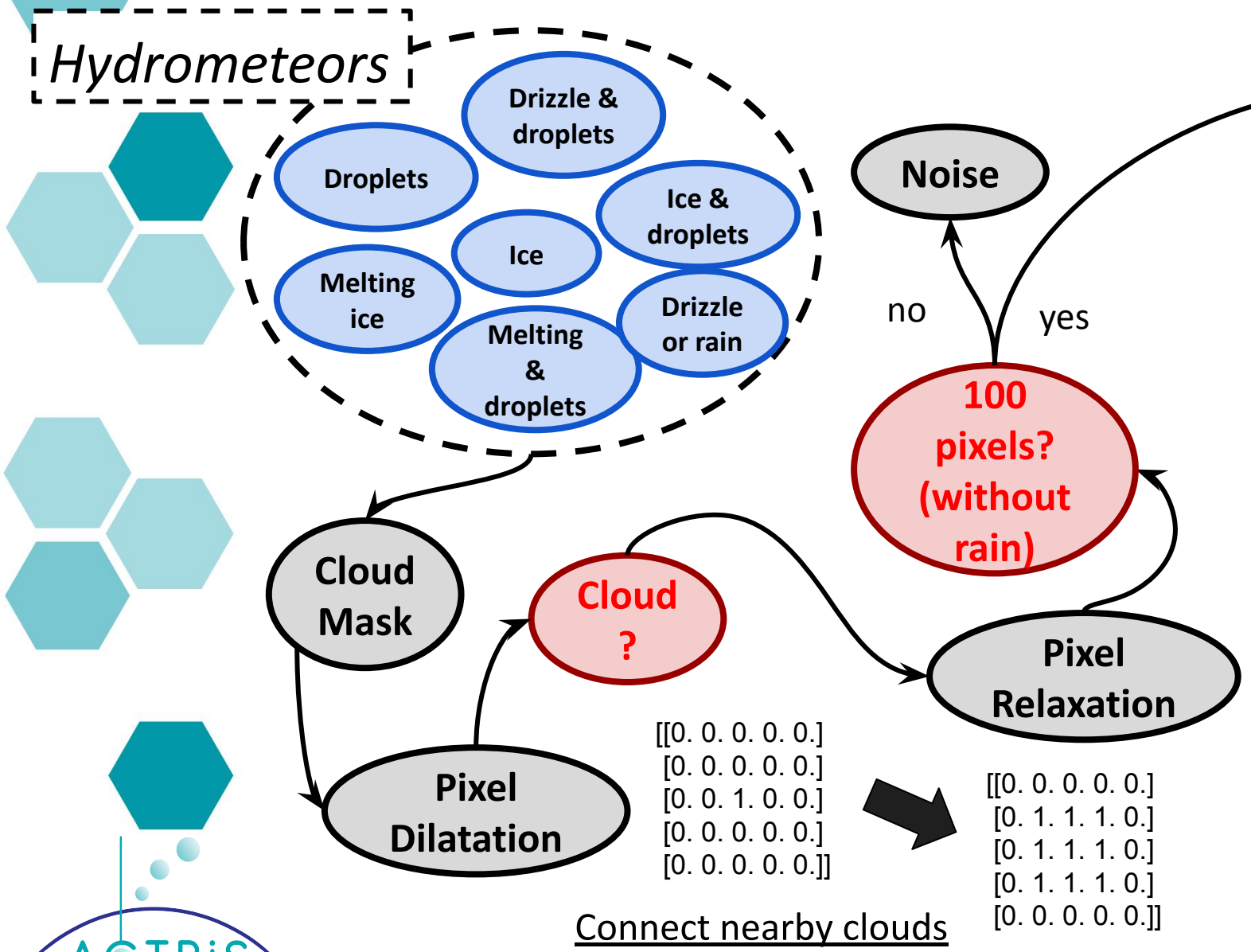
4) Single layer cloud classification by profile



Pirloaga et., al 2022

Nomokonova et., al 2019

Classification by hydrometeor grouping



Cloud classification

Nomenclature: P(X) = percentage of X

1) P (Droplets) + P (Drizzle & Droplets) > 70%

→ Liquid

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

→ Ice

Otherwise → Mixed-Phase

3) 10 pixels of "Drizzle or rain"

→ Precipitable-XXX Cloud

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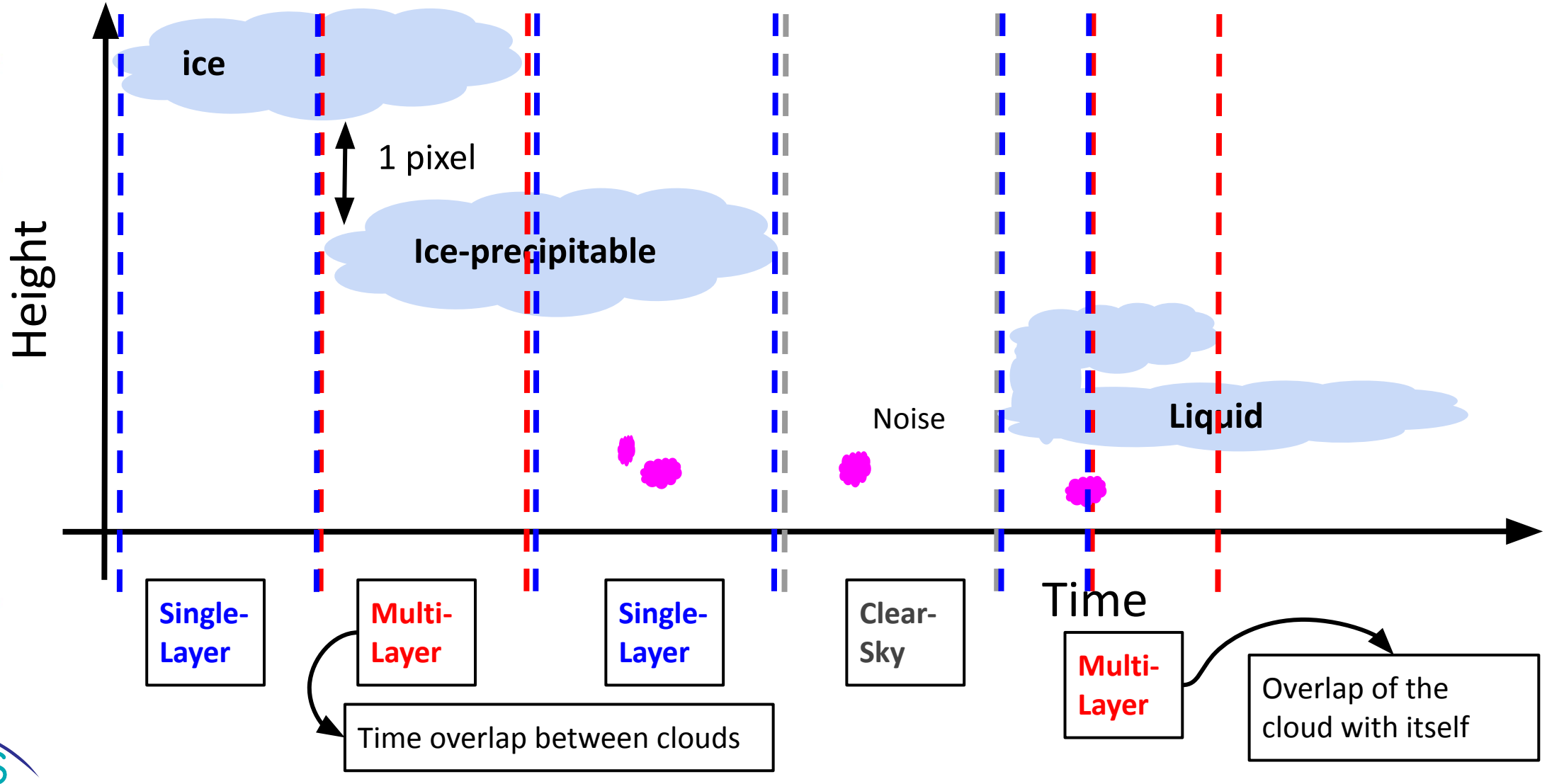
Single / Multi-layer classification



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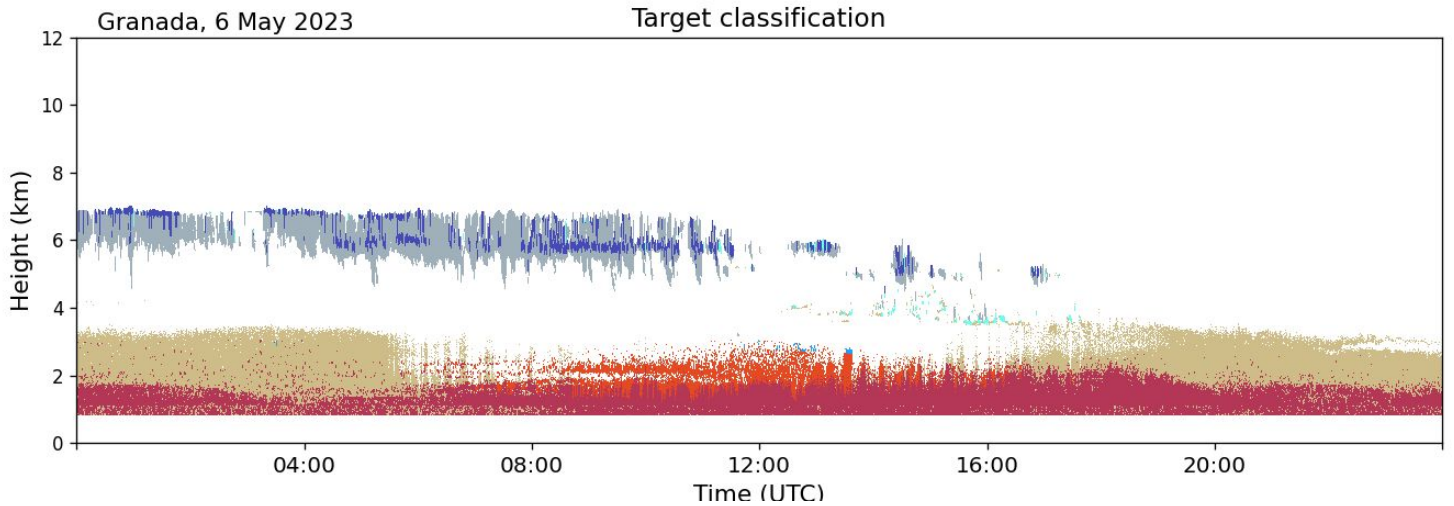
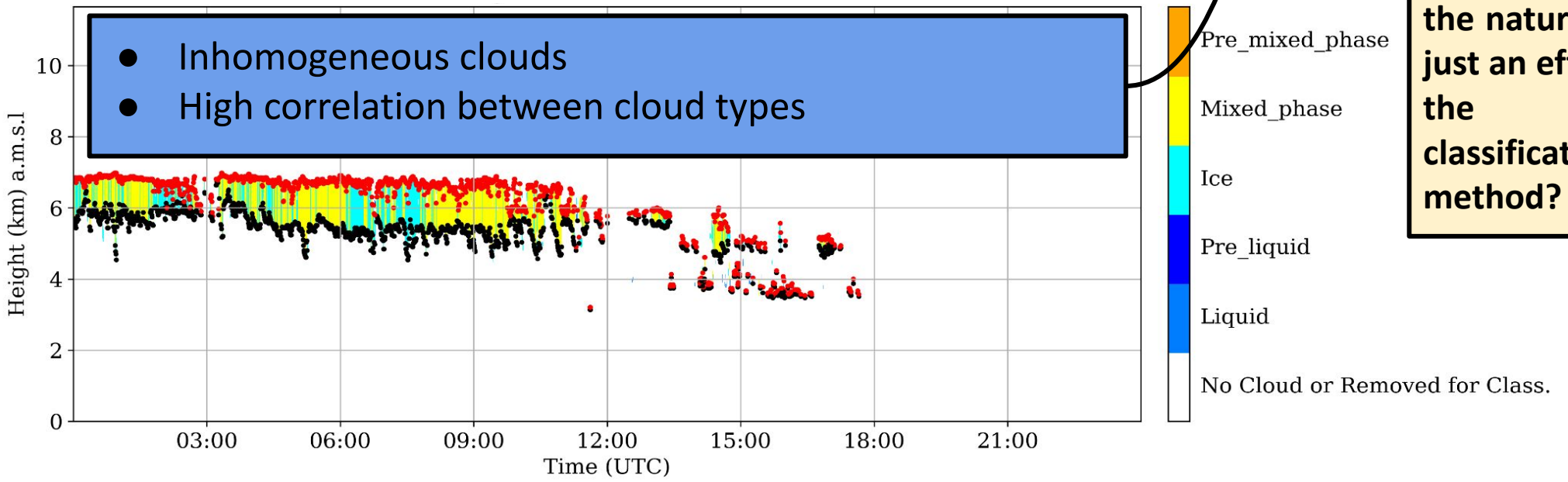
Cloud classification by time





- Inhomogeneous clouds
- High correlation between cloud types

Different clouds may have similar LWP/IWP

This happen in the nature or is just an effect of the classification method?

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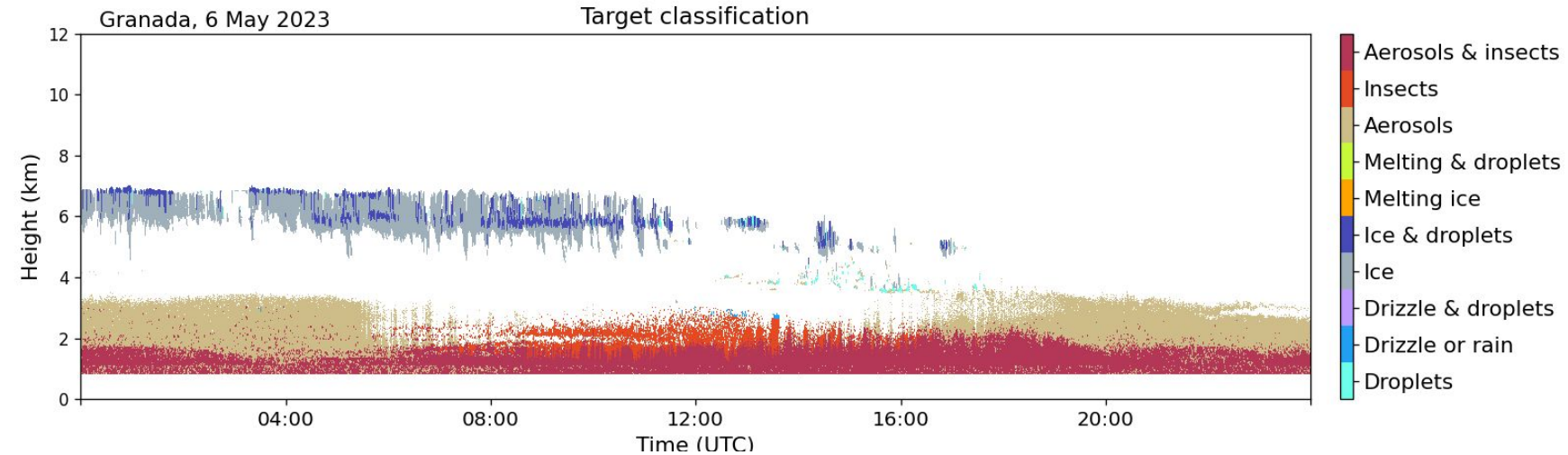
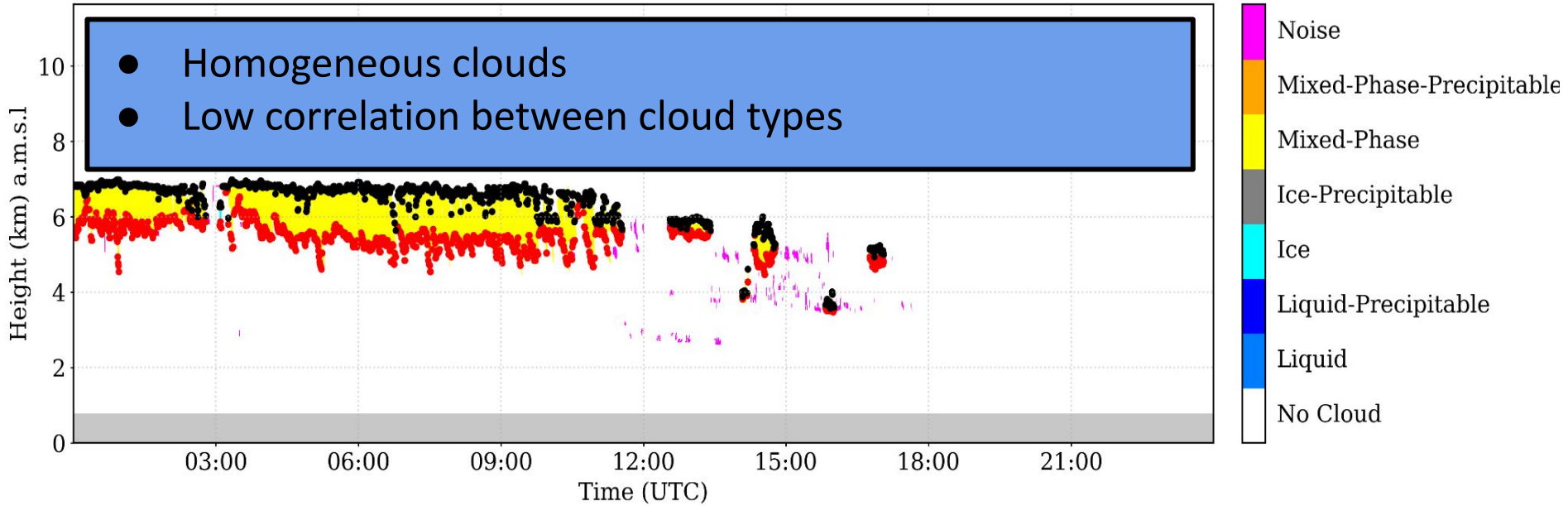
Cloud classification by hydrometeor grouping





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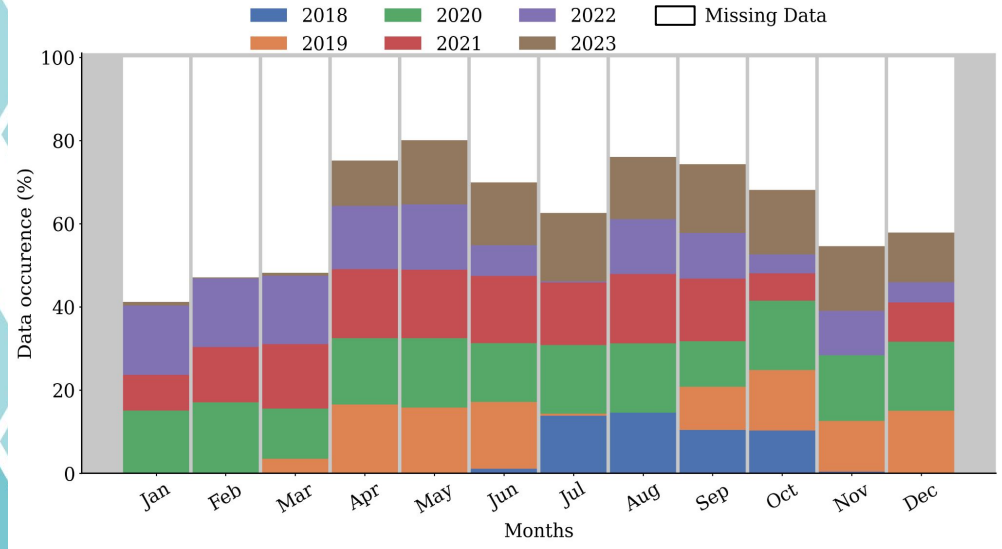
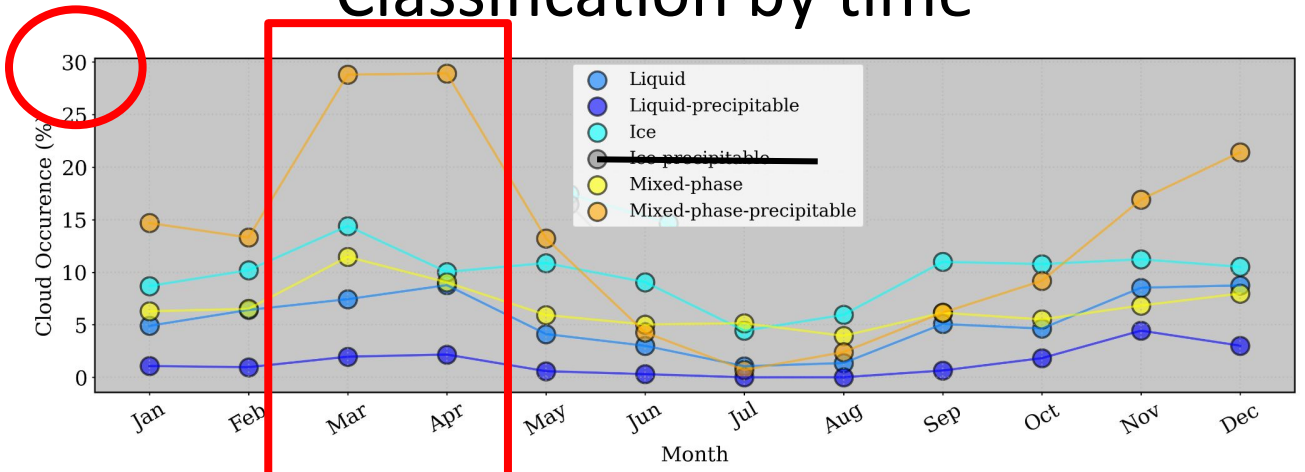
Changes on single layer cloud statistics

Data availability

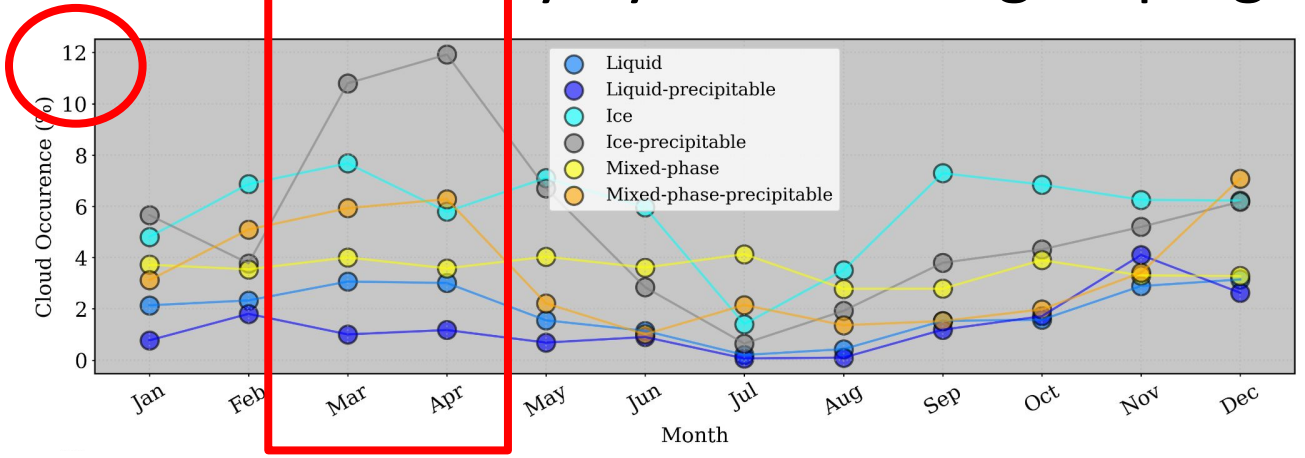


Different classification methods significantly changed the statistics

Classification by time



Classification by hydrometeor grouping



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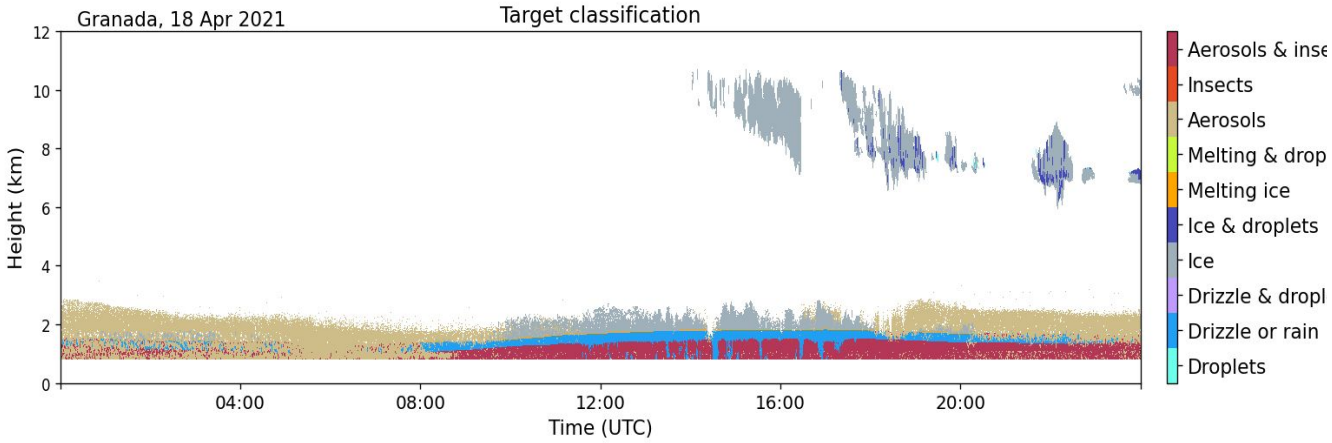
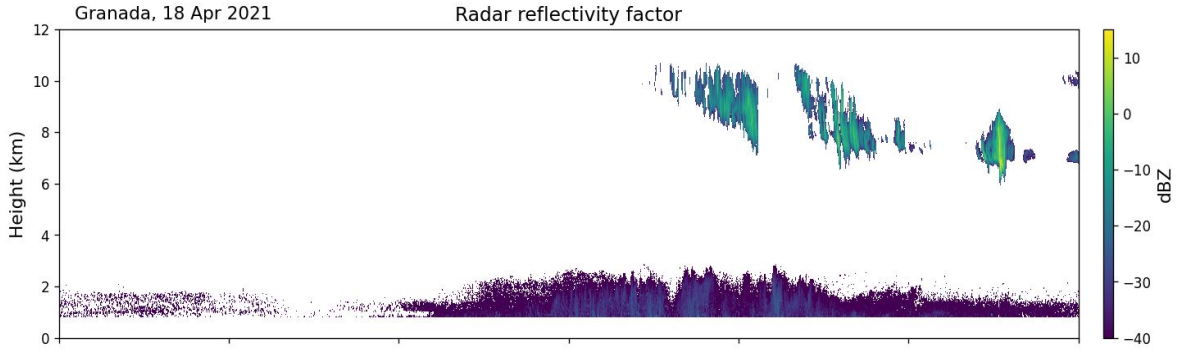
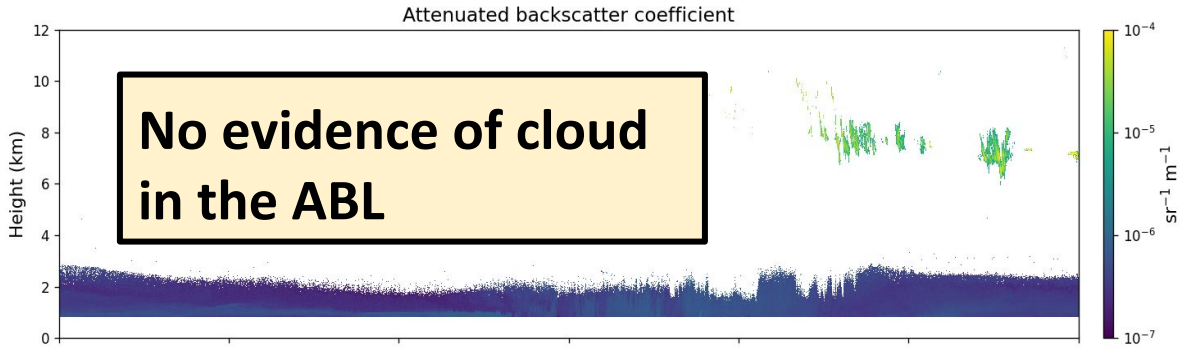
Misclassification on target classification product

Presence of ice and melting layer inside the ABL

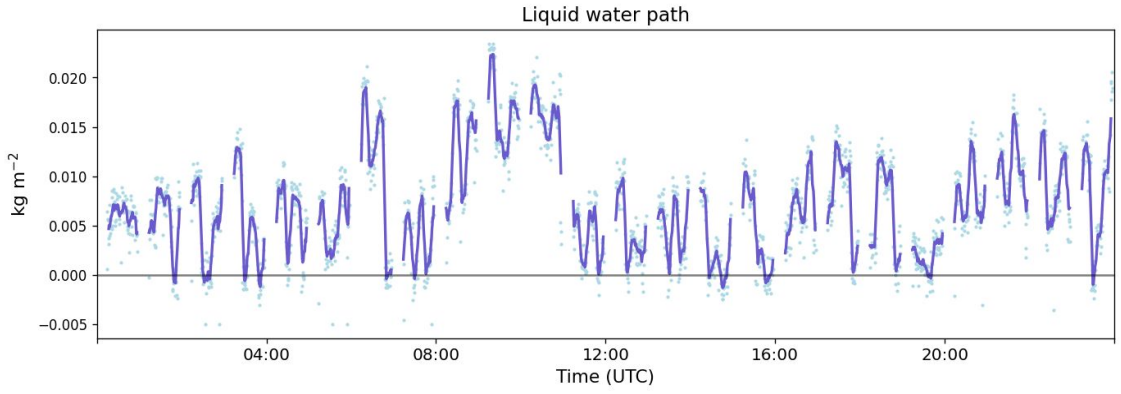


Cloudnet misclassification





No evidence of cloud in the ABL



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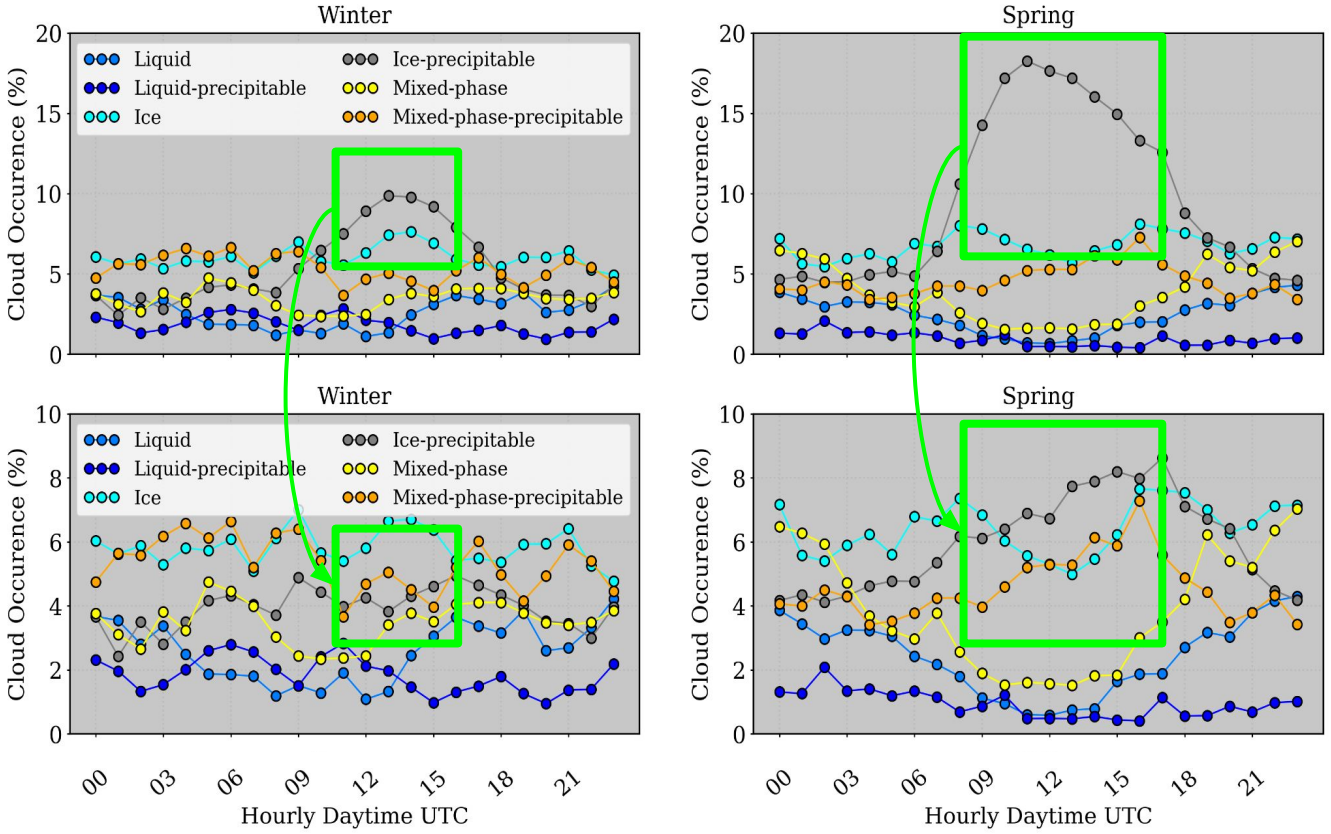
Effect on single layer cloud statistics



Hourly cloud occurrence **without filtering** Ice ABL "clouds"

Hourly cloud occurrence **filtering** Ice ABL "clouds"

Statistics were clearly affected by the hydrometeor misclassification

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Concluding remarks

Cloud classification: Time vs hydrometeor grouping

1) The new algorithm showed a more comprehensive cloud classification
   a) Homogeneous clouds
   b) Validation: low correlation between different cloud types expected

Cloudnet misclassification detected (UGR CCRES Station)

Atmospheric plankton is more intense in the South?

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Thank you

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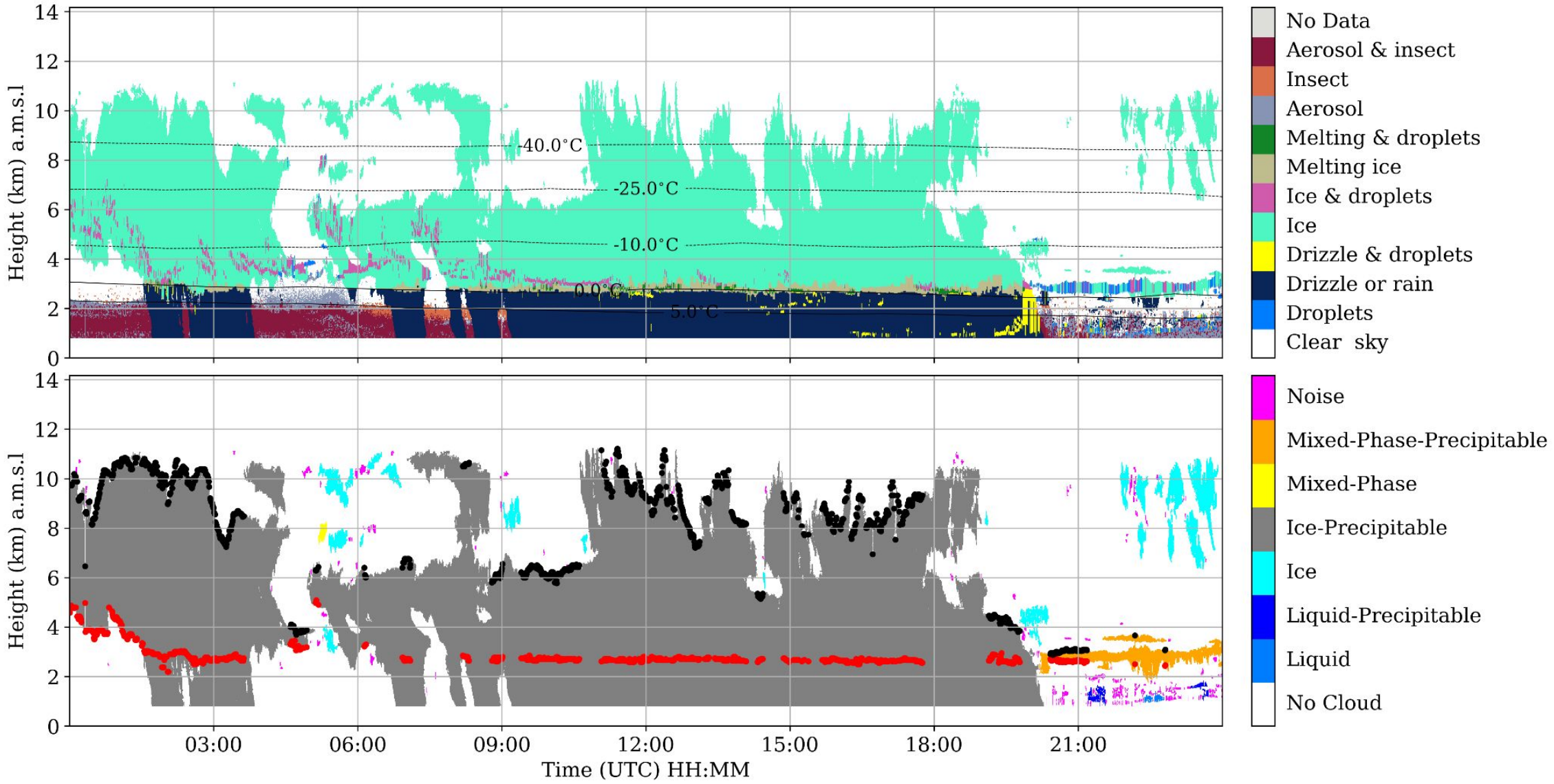
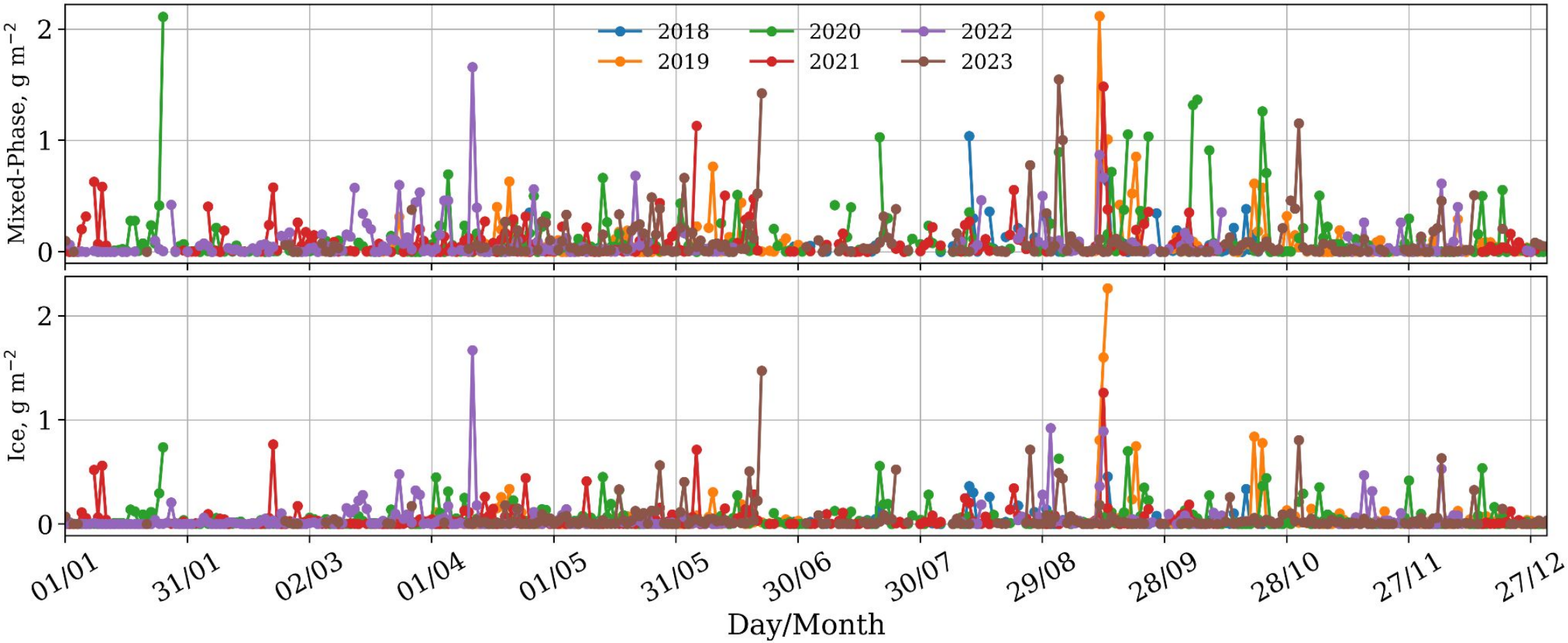
Backup Slides

Precipitable Ice Clouds



Daily Ice Water Path



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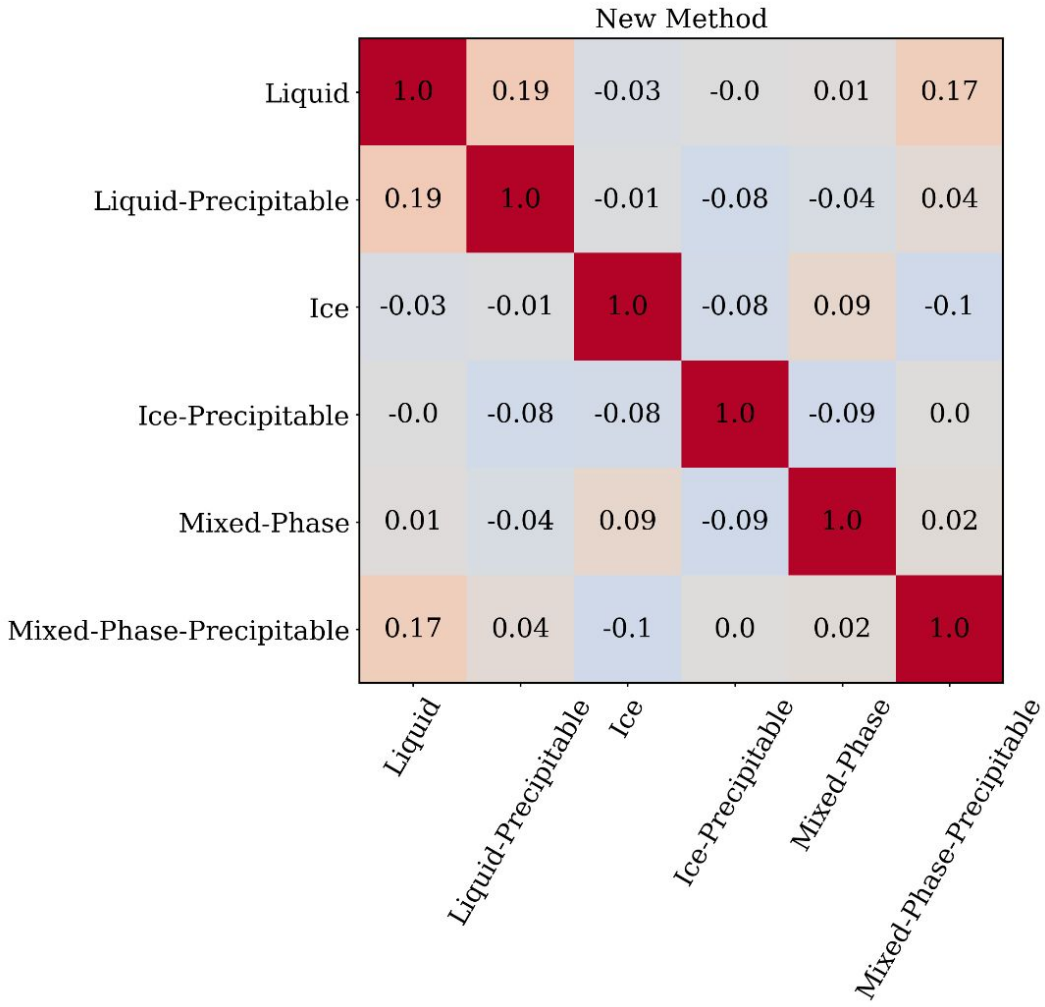
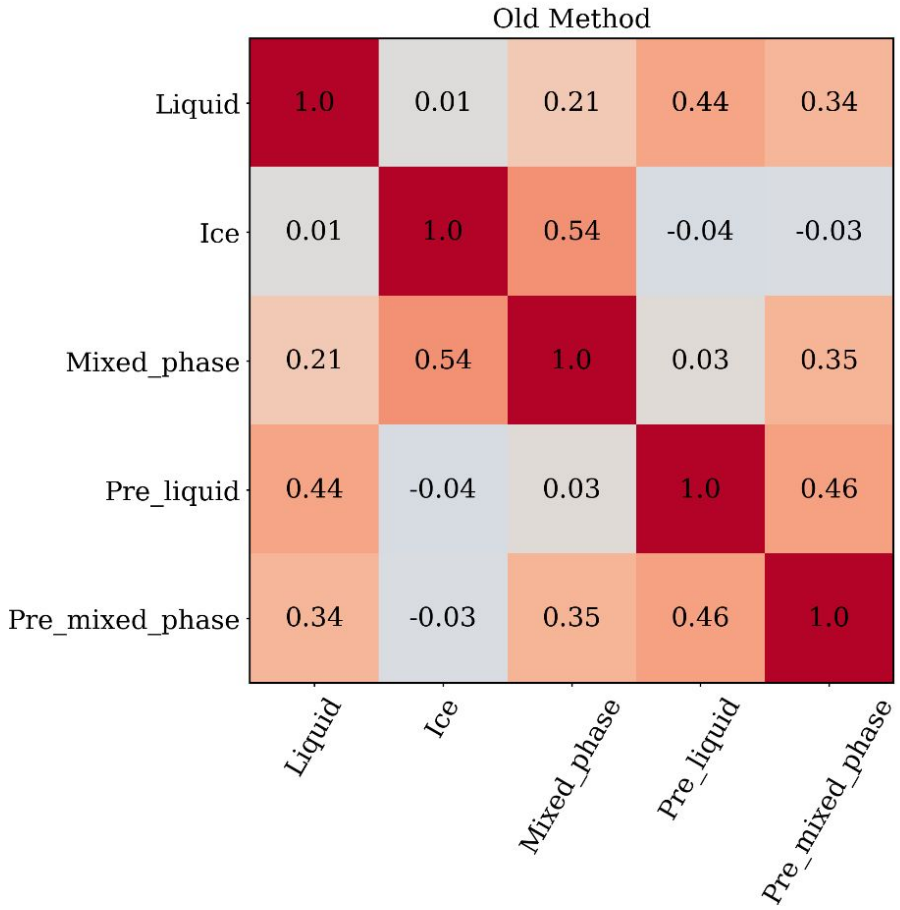
Correlation Matrix for Daily cloud Occurrence





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