A method for characterizing the spatial organization of convection in deep convective systems’ cloud shield:

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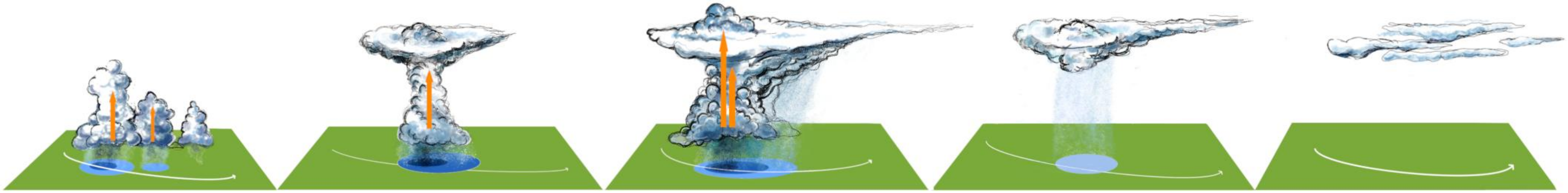
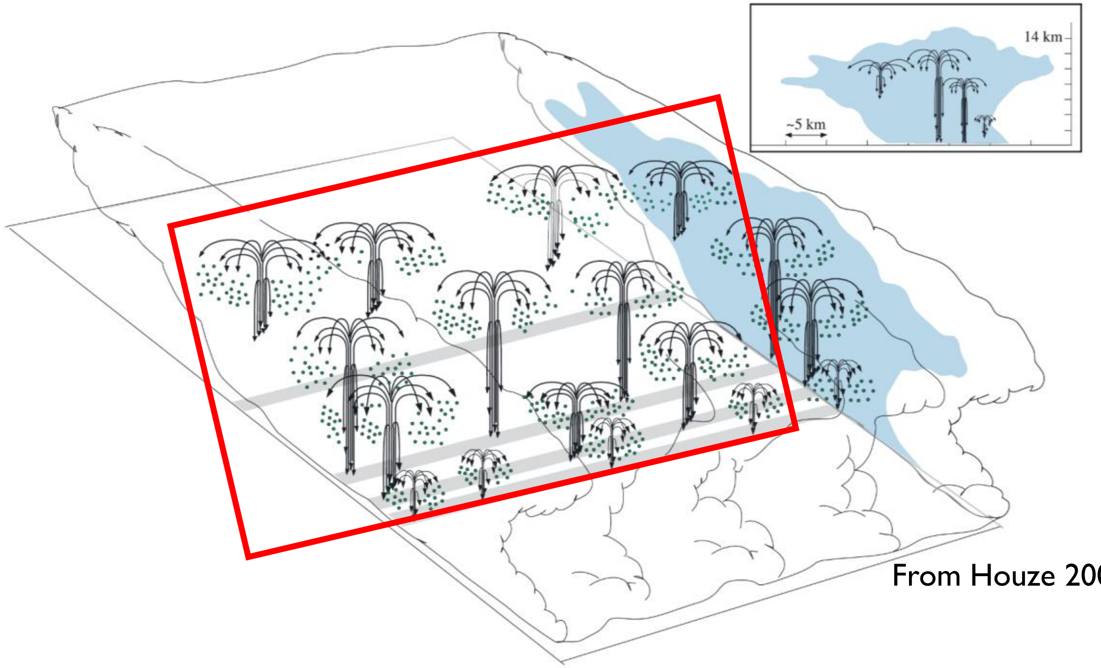
Picture from ISS (NASA)

CONTEXT AND OBJECTIVES (1/2)

- **Deep convective systems (DCSs)**
- **Life cycle**



- **External drivers : environmental**
  - Wind shear, instability, water vapor…
    (Yesterday's talk of Thomas Fiolleau)
- **Internal drivers**
  - Amount of deep convective cells, depth, mass flux,…
  - Microphysical: convective/stratiform precipitation
  - Dynamics : mesoscale circulation
  - Convective organization ?



From Houze 2004

CONTEXT AND OBJECTIVES (2/2)

1. How to quantify the spatial organization of deep convection within the cloud shield of deep convective systems ?

2. Is convective organization an internal driver of deep convective systems' morphology ?

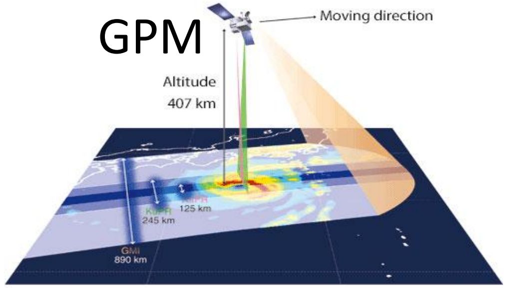
<u>Low-dimensional spirit</u> : not an unique/unified metric but a short set of parameters:

- Variables that will characterize the global convective field
- Variables that will be object-oriented to describe the convective pattern through its elementary blocks distribution

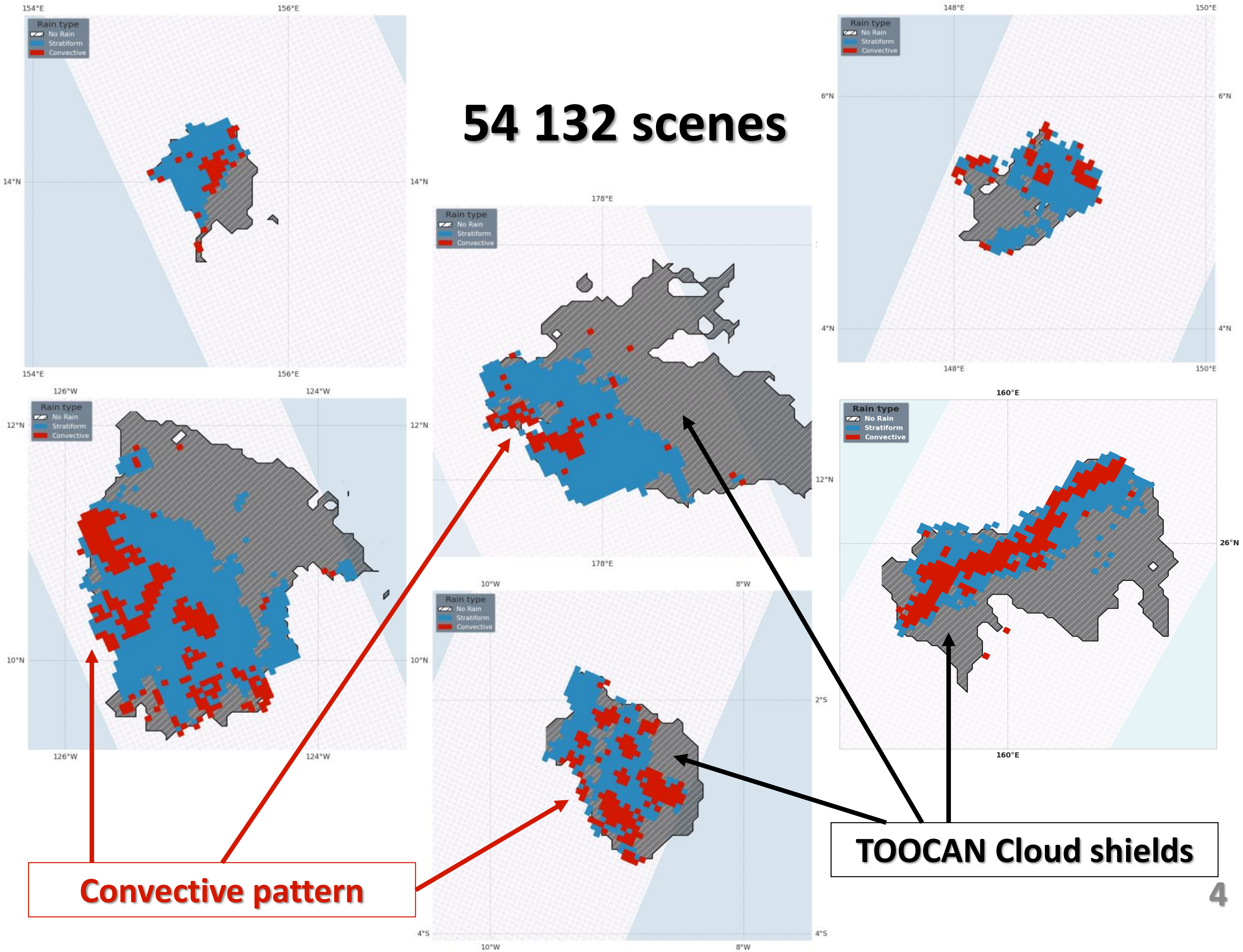
A large diversity of convective spatial arrangements

- DCSs' cold cloud shield identification using TOOCAN algorithm applied on IR georing data **2012-2020**

- Collocation procedure between DCSs identified by TOOCAN + spaceborne radar measurements from **TRMM-PR** and **GPM-DPR**
- Focus on the convective **precipitation classification**
- **DCS's cloud shields identified at 1 timestep of their life cycle** with their associated internal **convective field**

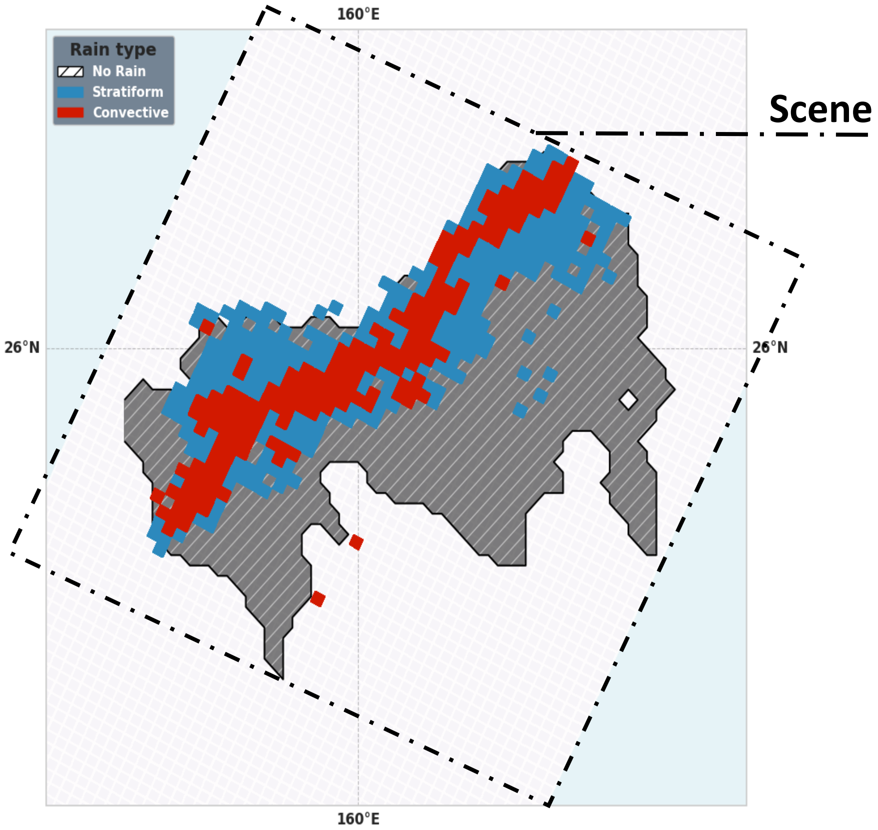


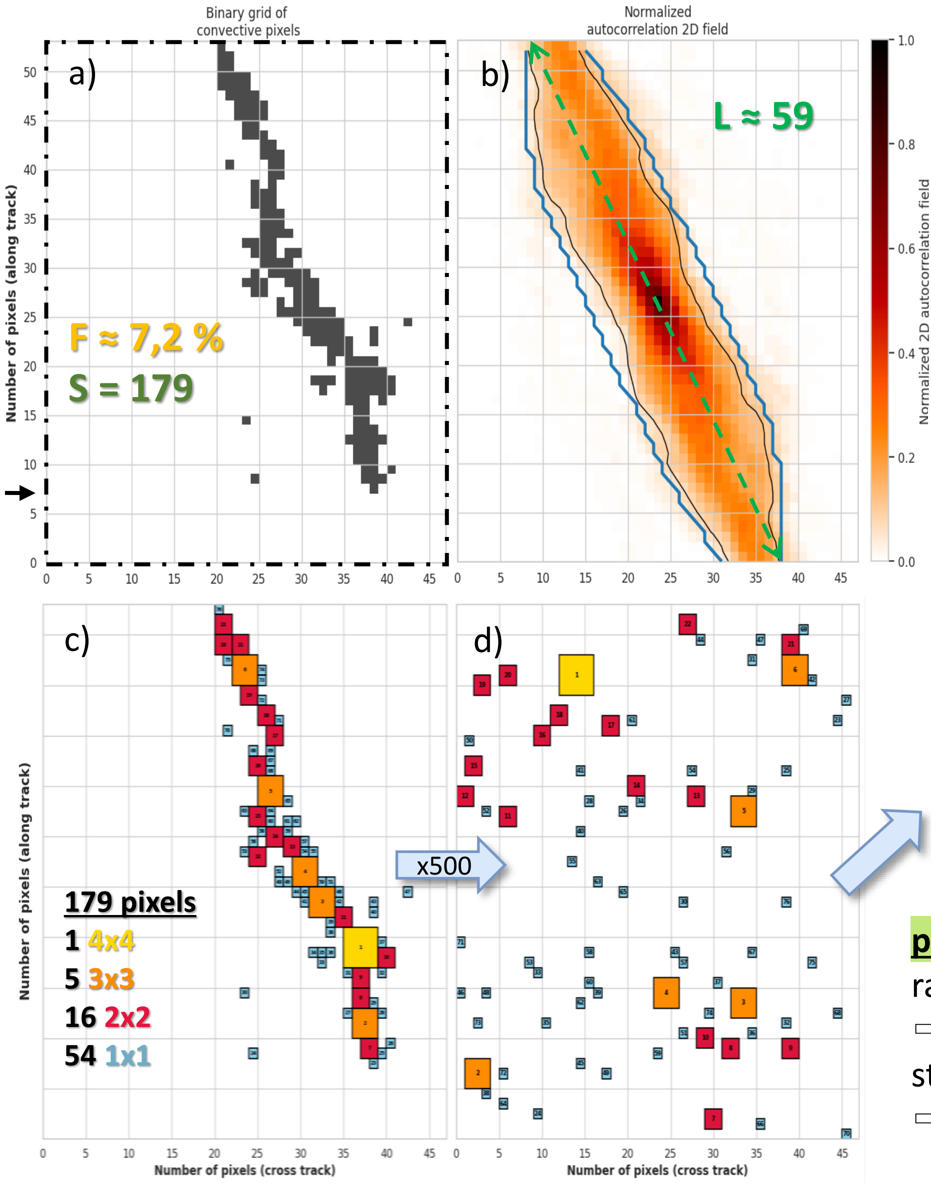
54 132 scenes



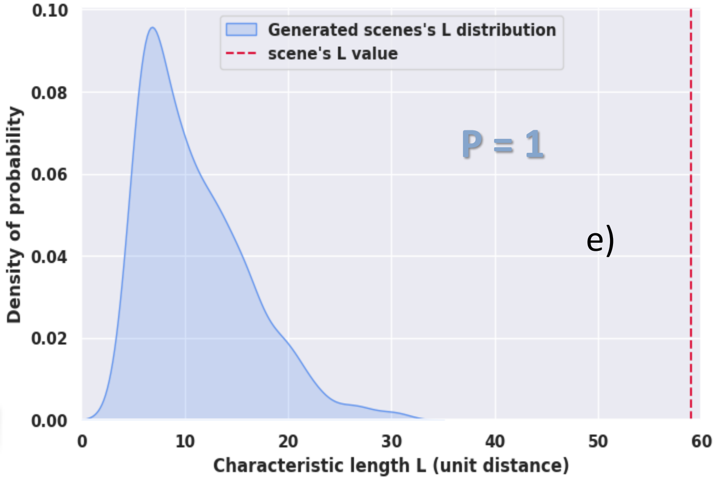
F, S, L, P = 4 key variables to fully characterize the organization

Scene = rectangular area that encompasses the cloud shield identified by the TOOCAN algorithm
convective fraction F = proportion (%) of convective pixels in the scene
convective surface S = number of convective pixels in the scene



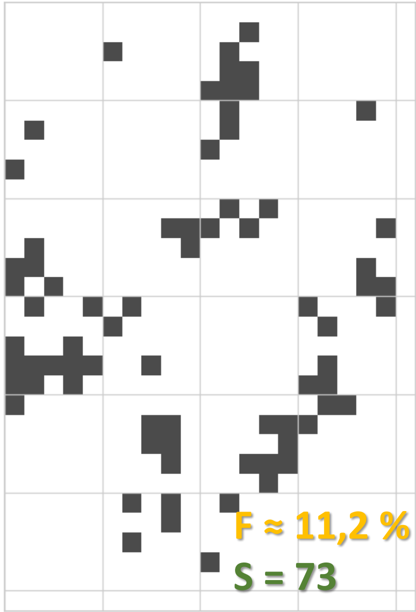


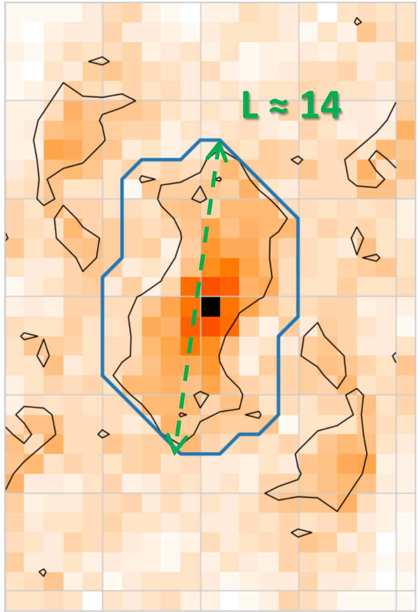
characteristic length L = maximum distance between any two pixels in the scene's normalized **2D autocorrelation** convex 10% contour
⇨ **L** is a distance that quantifies the scale of the convective field spatial coherence

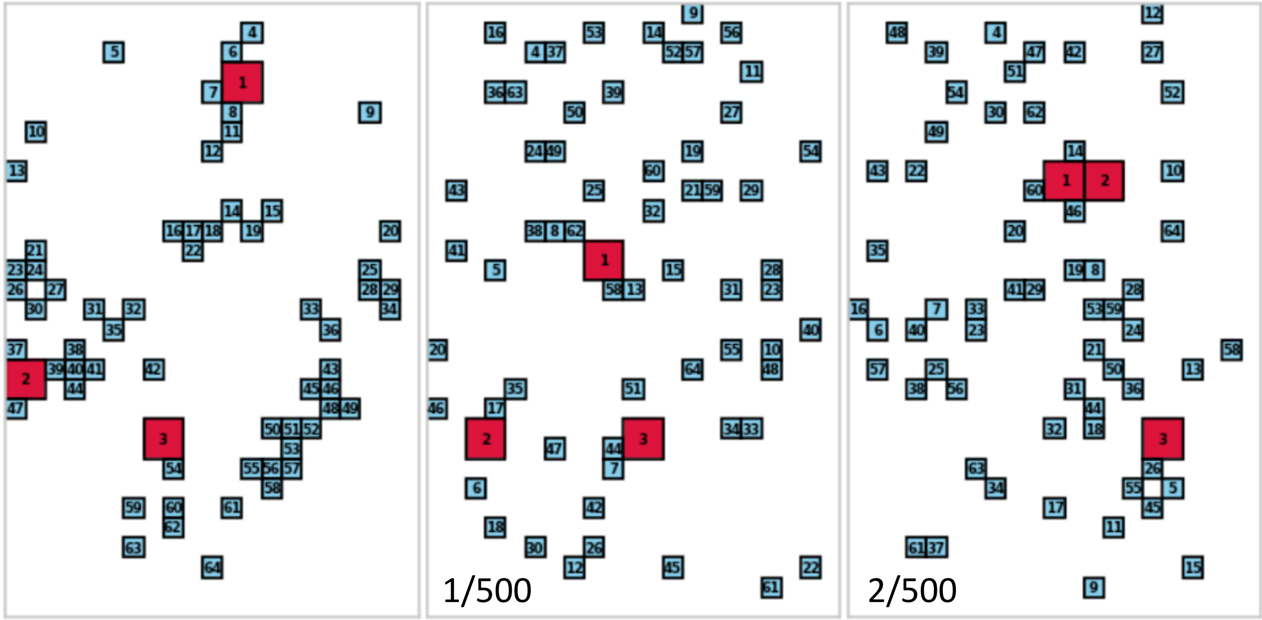


probability P = probability of deviation from a random spatial arrangement of convective cores
⇨ **Percentile of L** in a distribution derived from stochastic **500 random scene generations**
⇨ **(1-P)** = probability of randomly organized

One example of less organized convection







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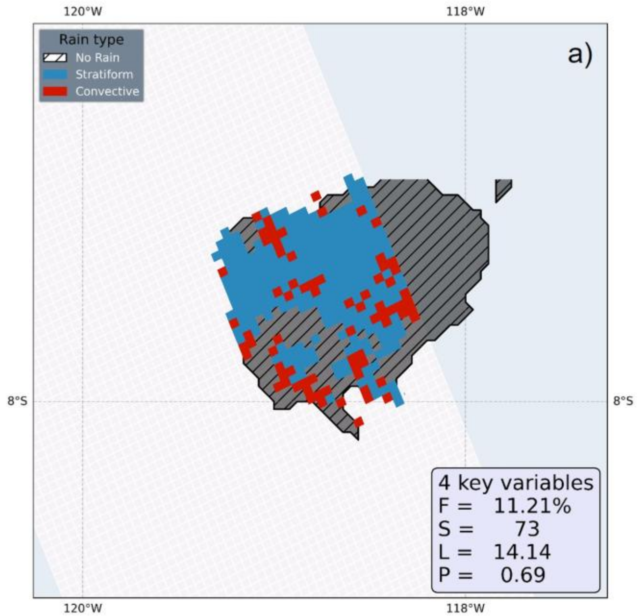
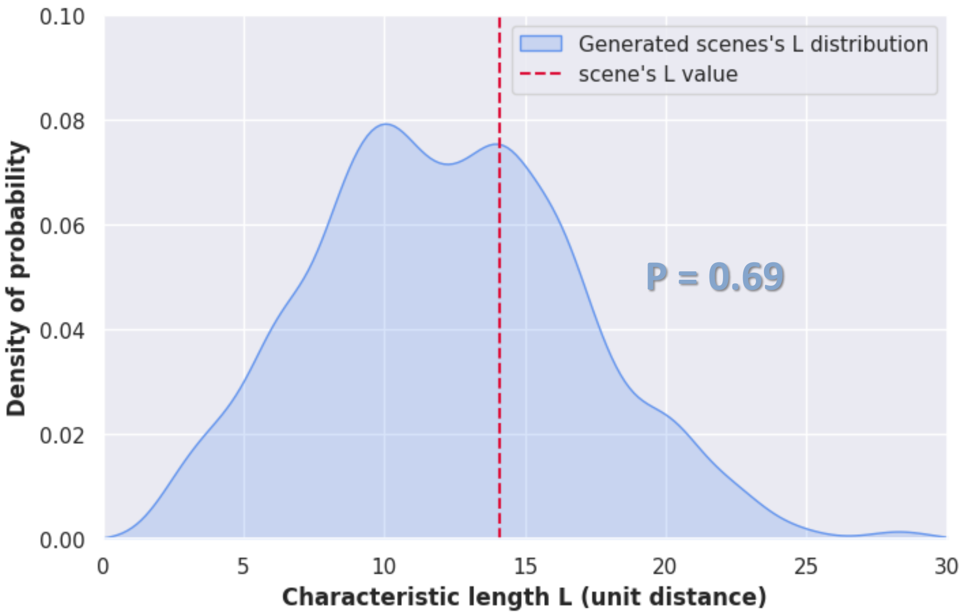
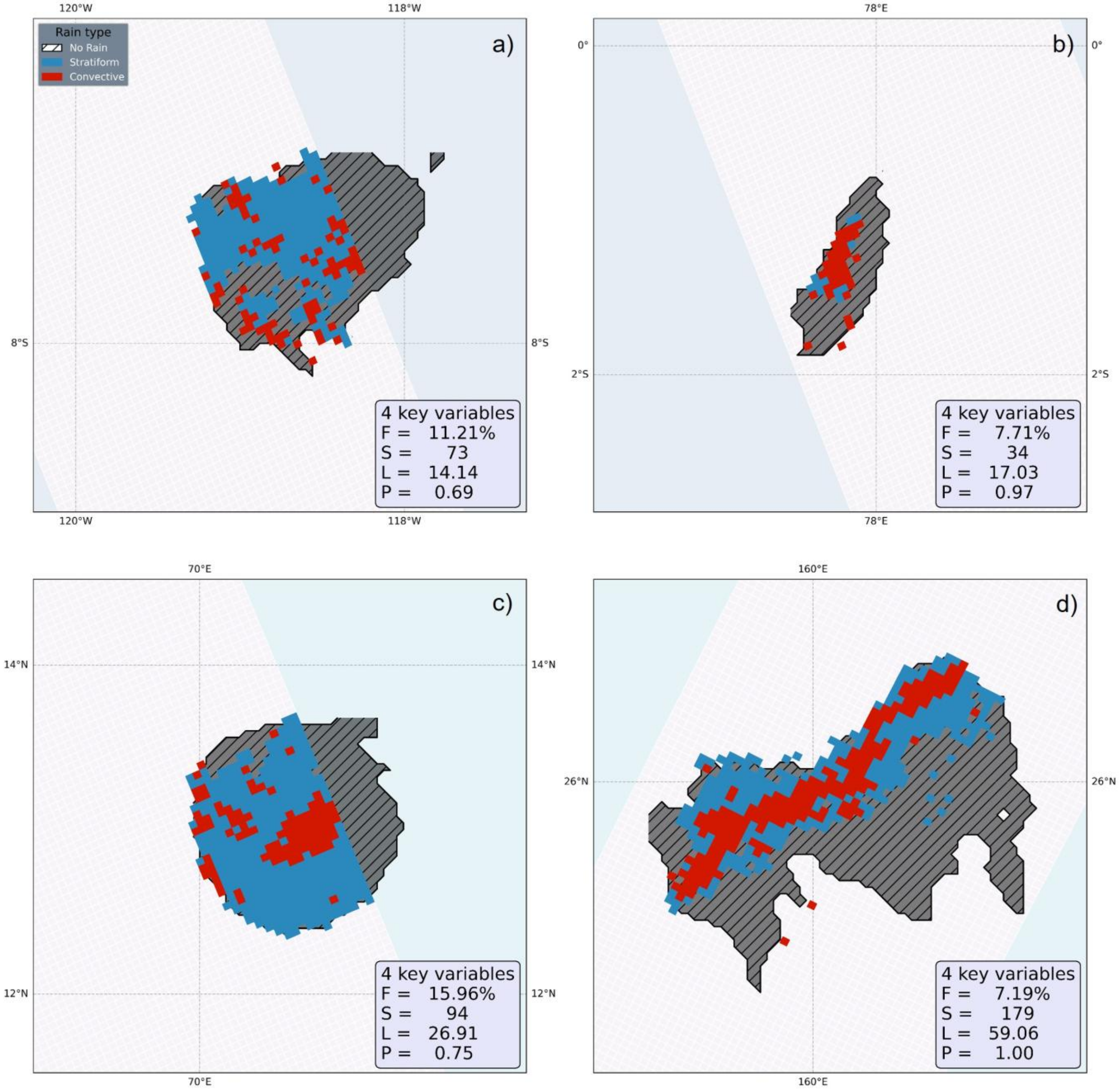




Unsupervized classification: physically sound and consistent

Likely random

Clustered small



Clustered large

Very Structured

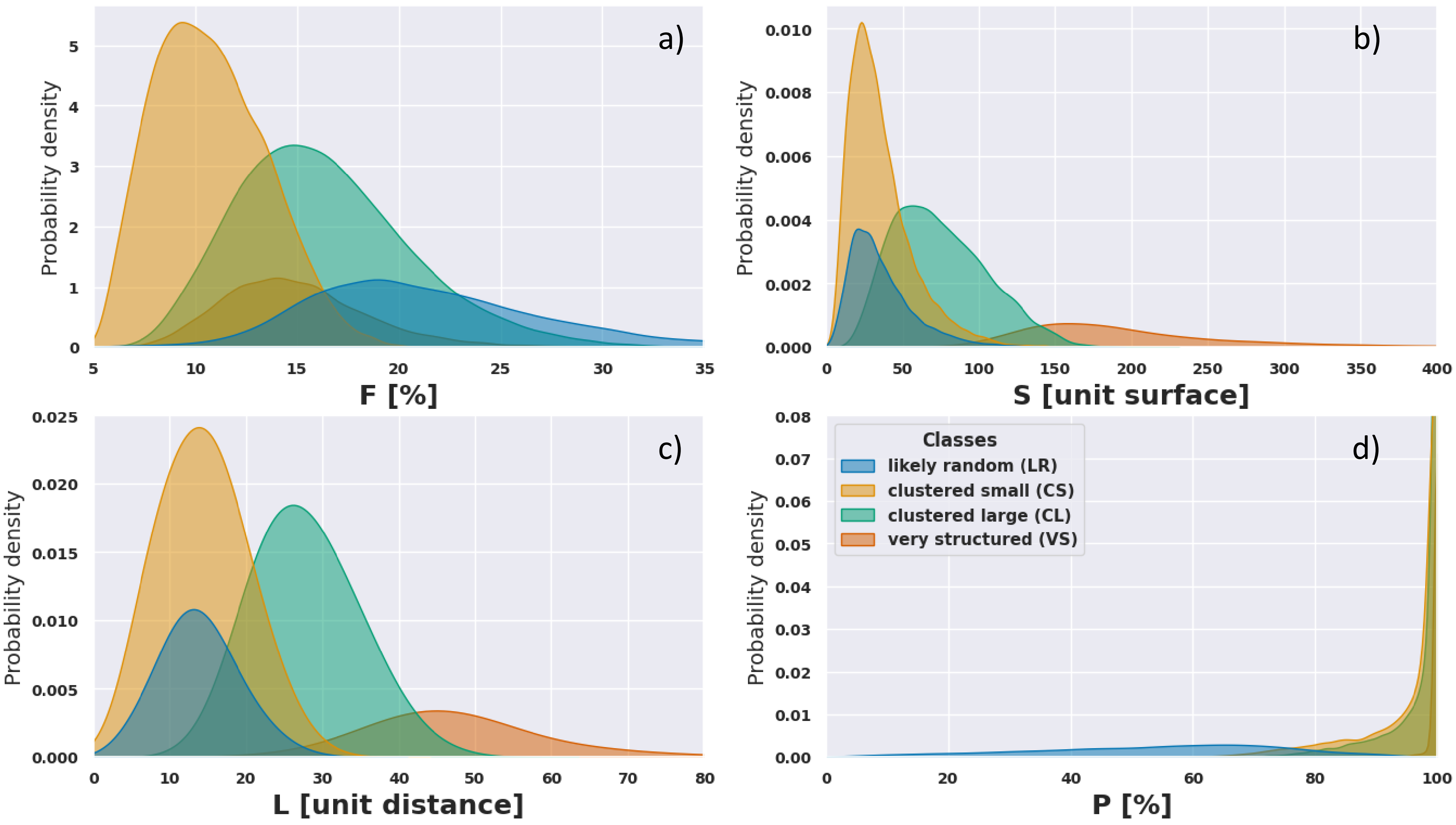
54 132 scenes classified in a 4-dimensional space

Likely random

Clustered small

Clustered large

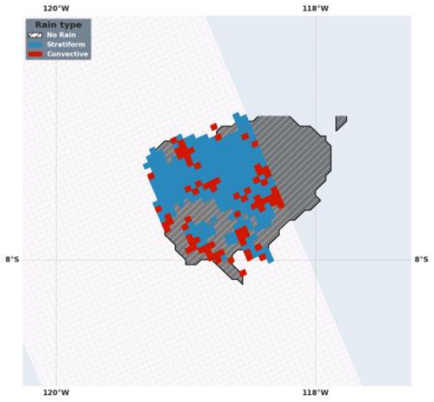
Very Structured

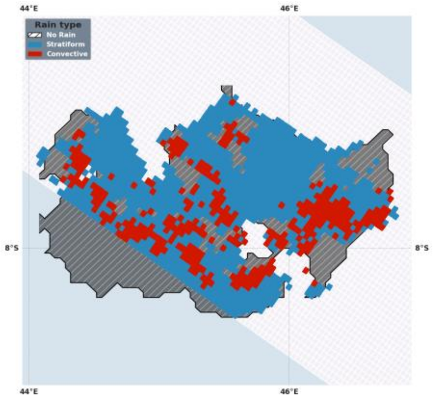


Comparison to existing metrics

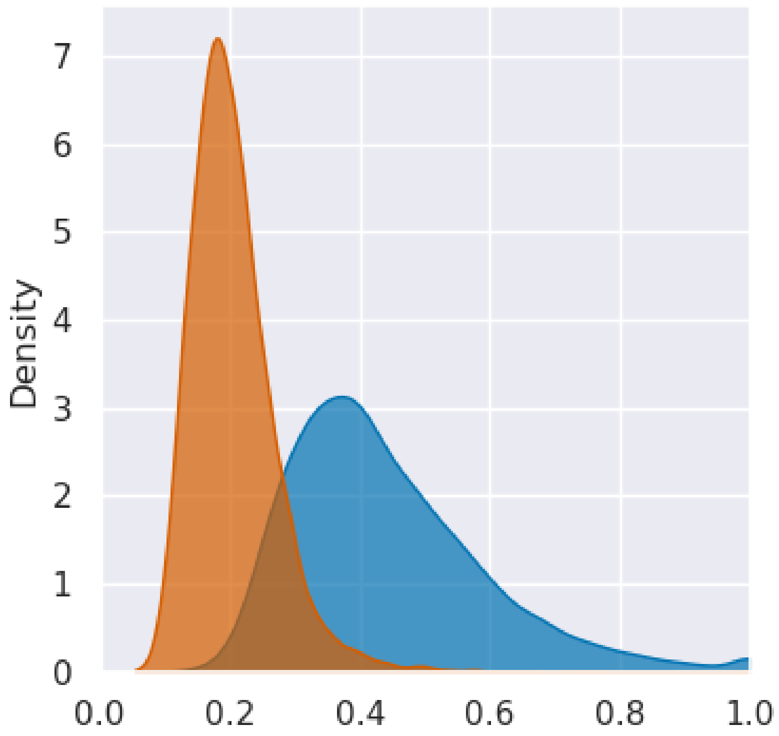
Likely random (LR) Very Structured (VS)

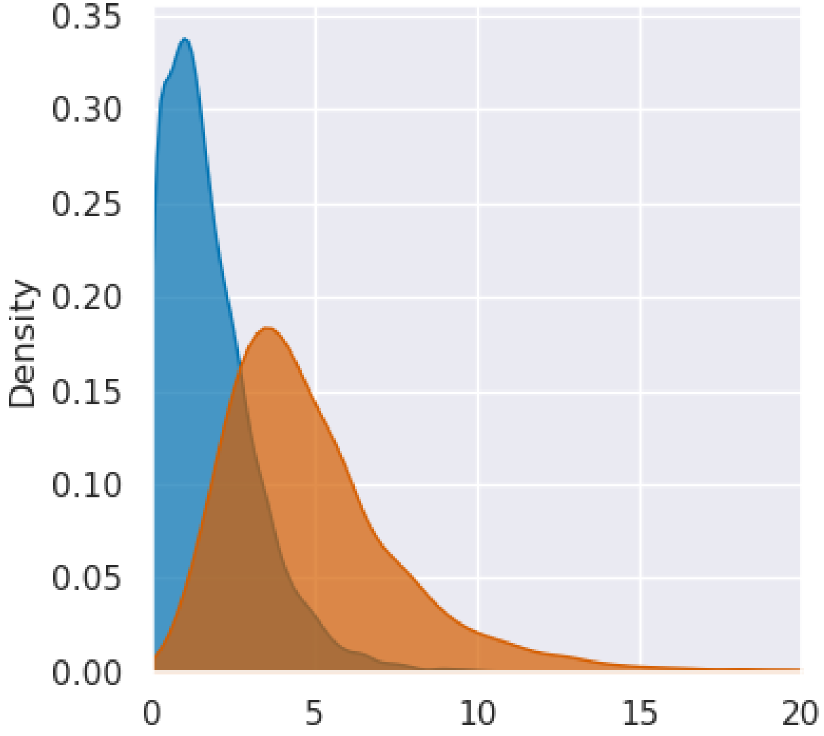
Least organized -

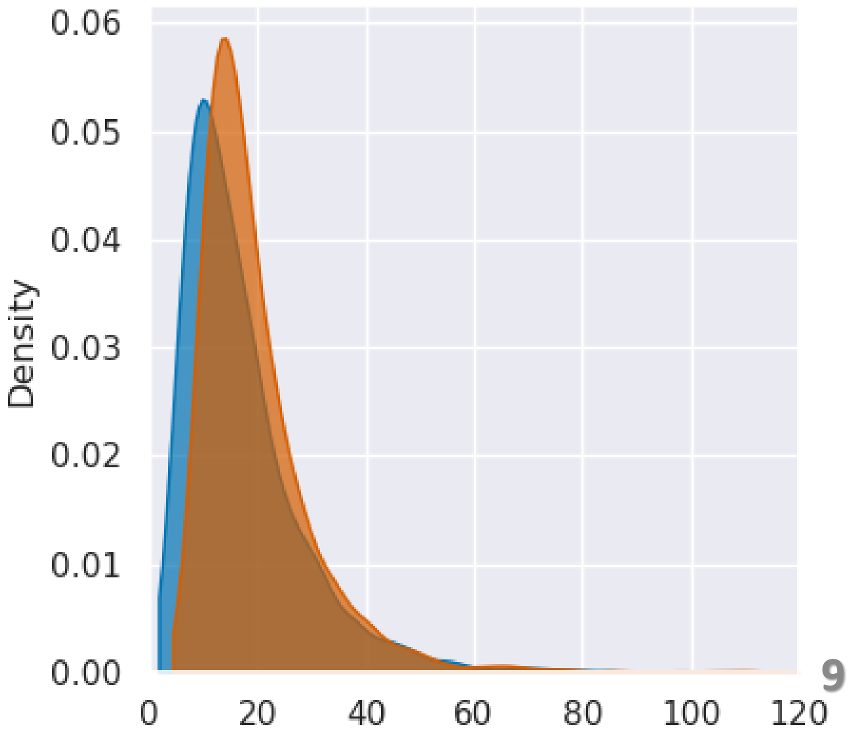




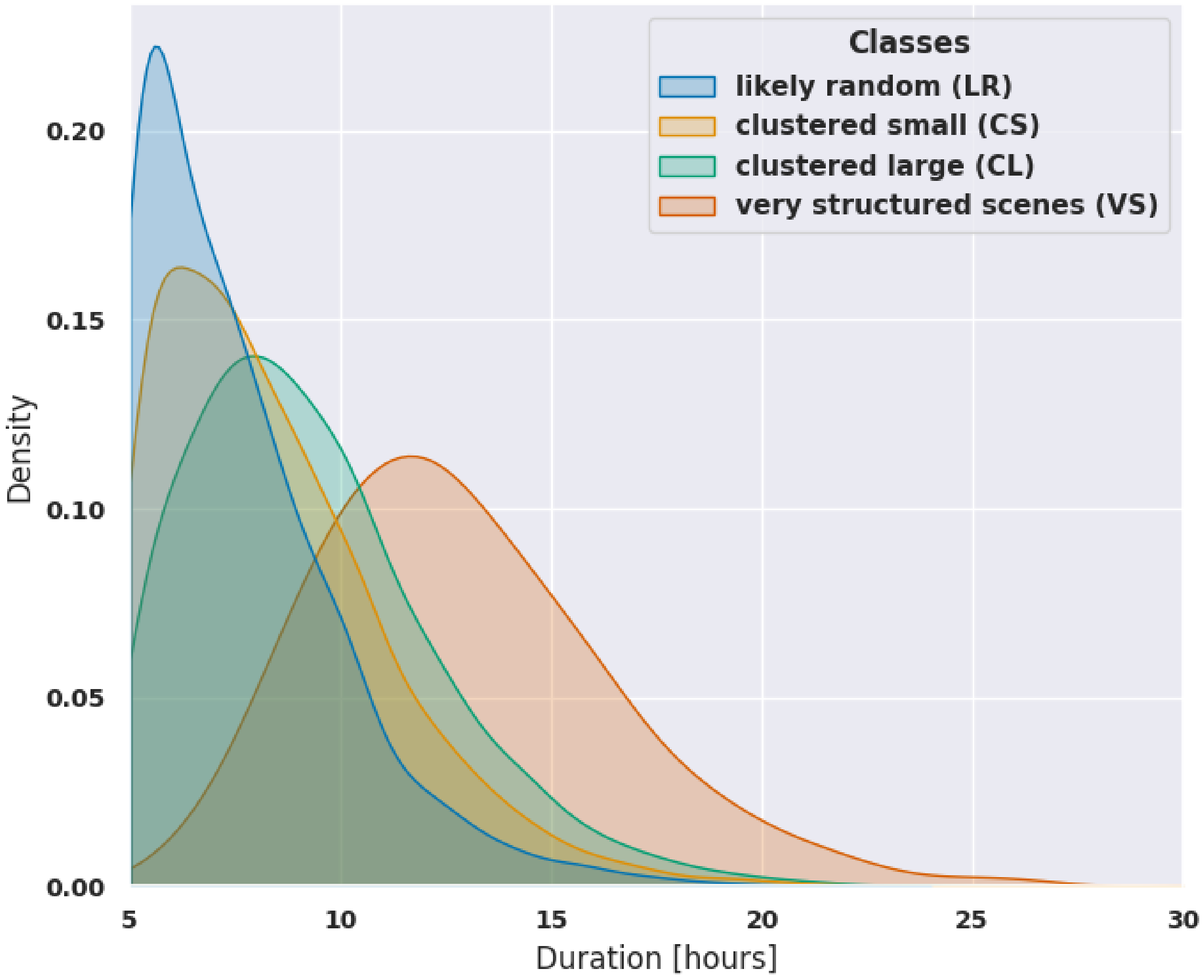
+ Most organized

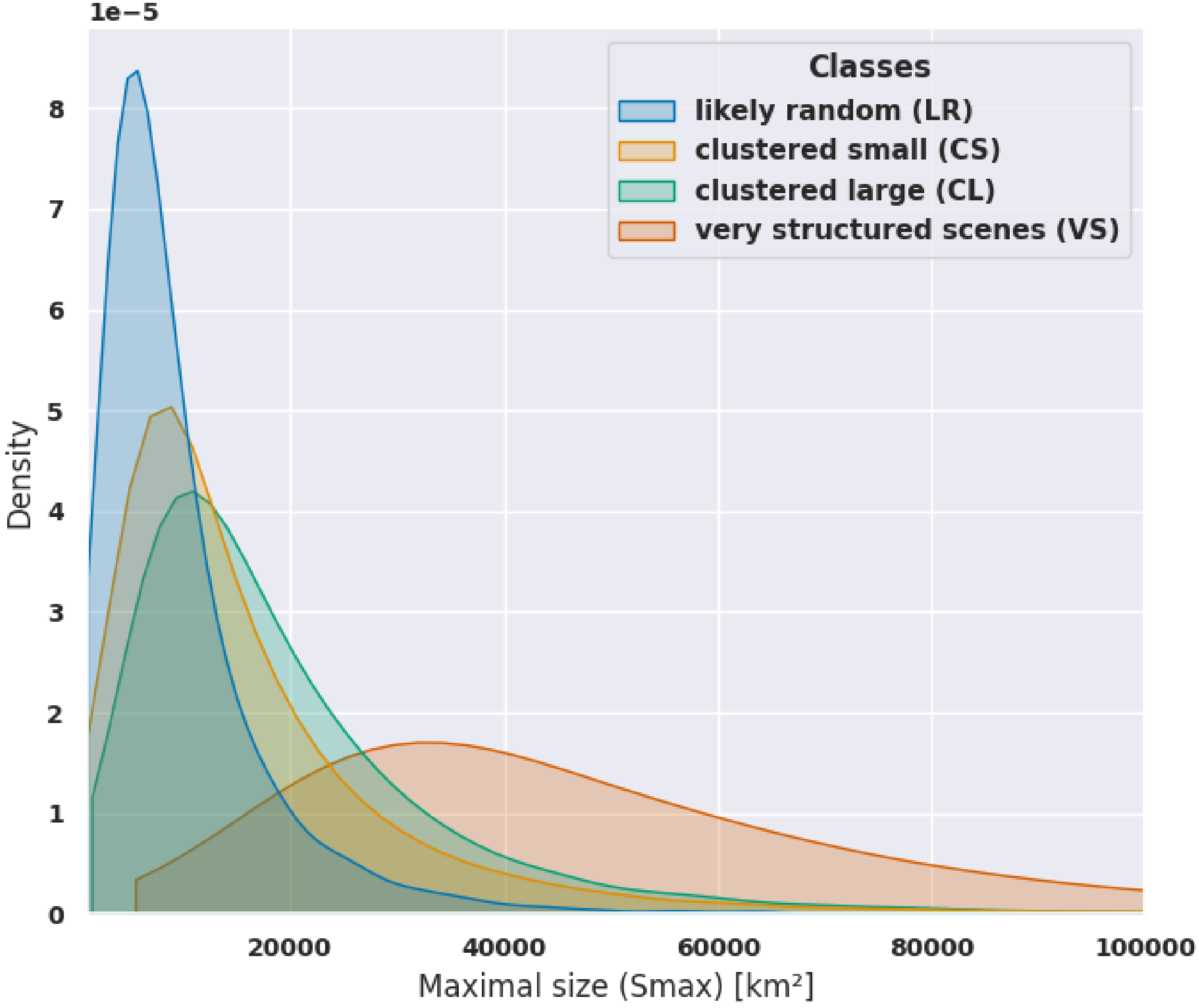






Convective organization = internal driver to DCS's morphology





CONCLUSION

This study introduces a new method to characterize the **spatial organization of deep convective cores:**

- Lagrangian perspective : spatial arrangement of identified convection **within the cloud shield of the associated DCSs**
- Convective organization is characterized using **4 key variables**: ⇨ <u>low dimensional characterization</u> of organization
  - Extracting a **characteristic scale** (L) of convective cores distribution based on the **2D autocorrelation**
  - The convective fields are **decomposed into elementary structures** as square aggregates and then **shuffled randomly in space** to assess stochastically the **deviation from a random arrangement of the cores**
- This method clarifies some ambiguities among existing metrics and shows that attempting to quantify convective complex spatial arrangements with a single index is a difficult task
- Convective organization is a significant driver of morphological properties of DCSs (max. extension and duration at least)

<u>Submitted in AMT</u>

Netz et al. 2025 (preprint)

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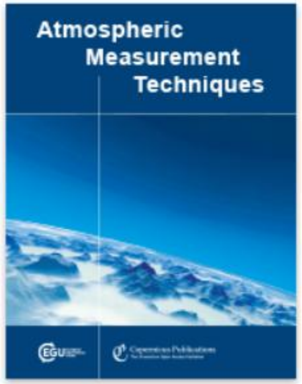

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Thank you!

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Image prise depuis l'ISS (NASA)

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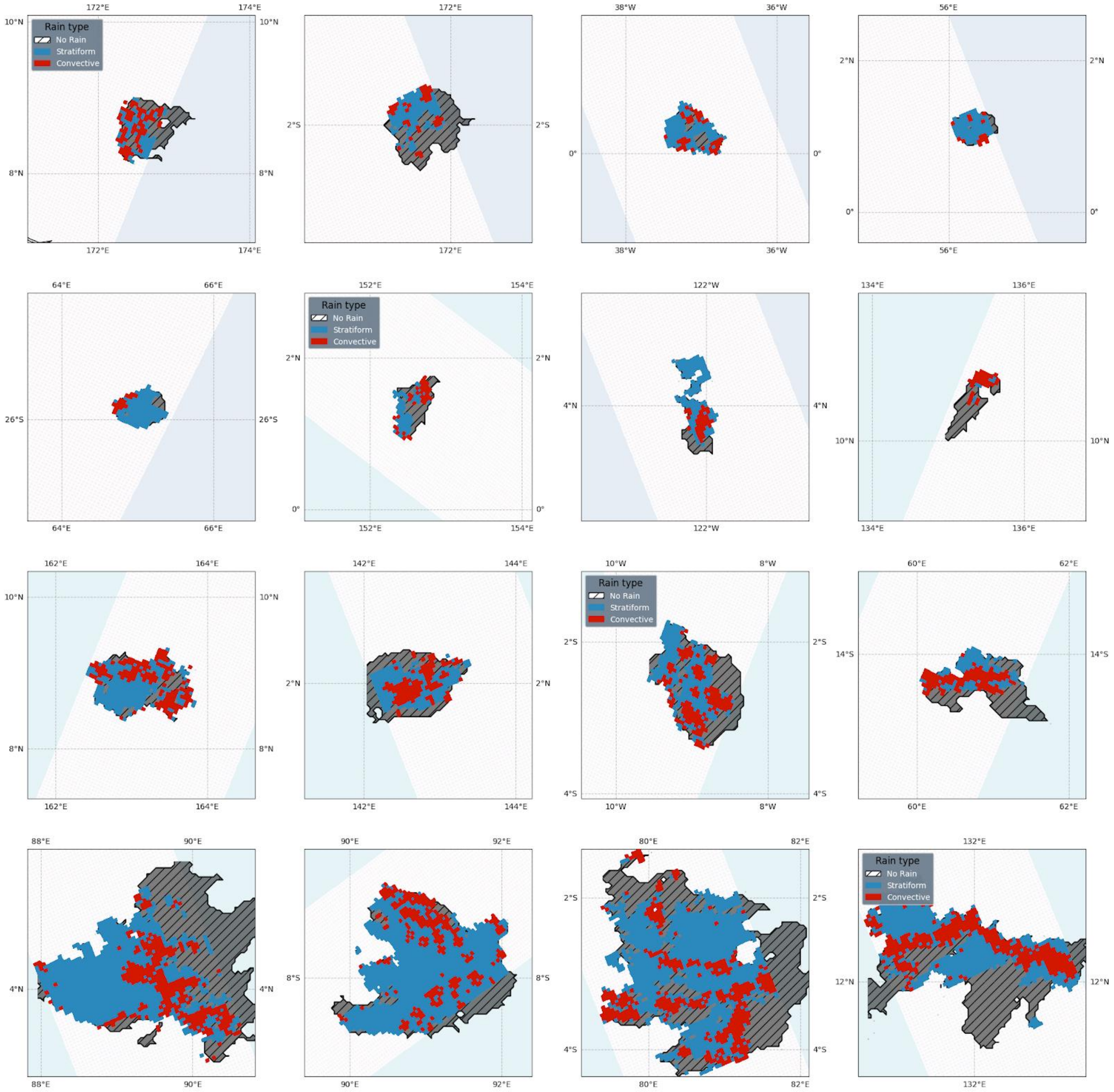

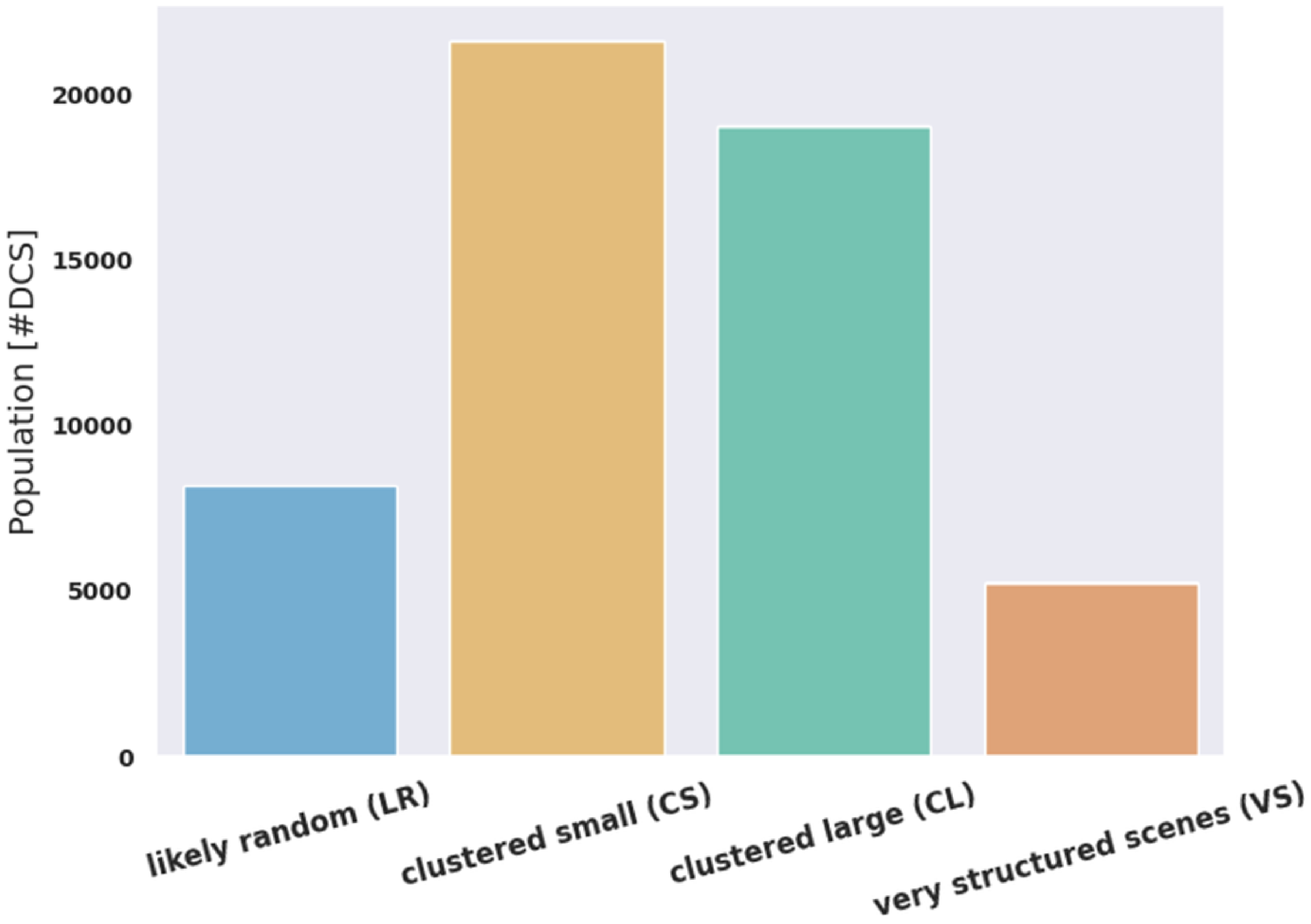

Population [#DCS]
20000
15000
10000
5000
0
likely random (LR)
clustered small (CS)
clustered large (CL)
very structured scenes (VS)