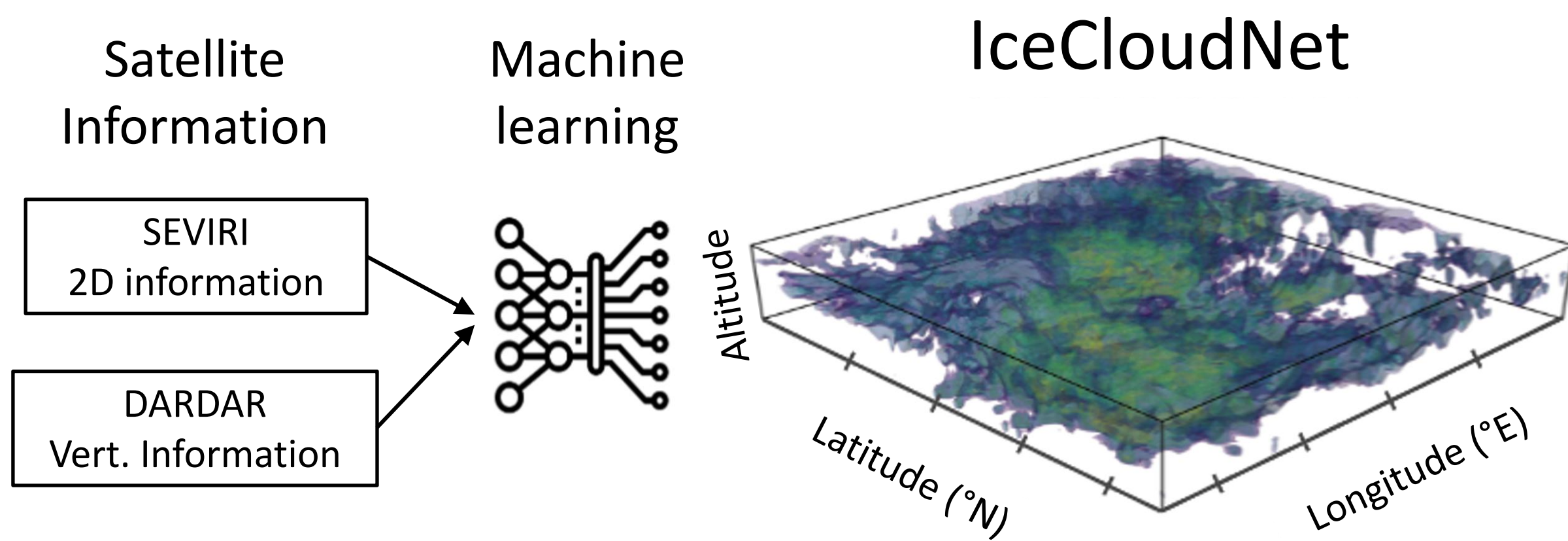


A new way of studying clouds

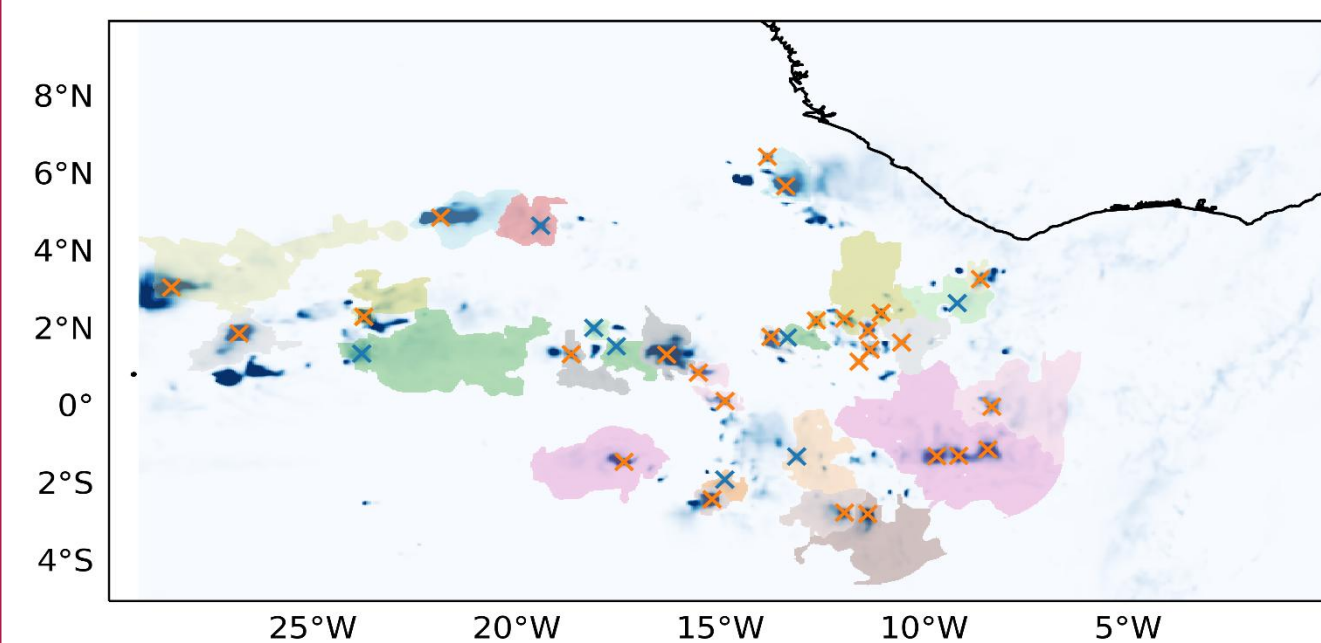
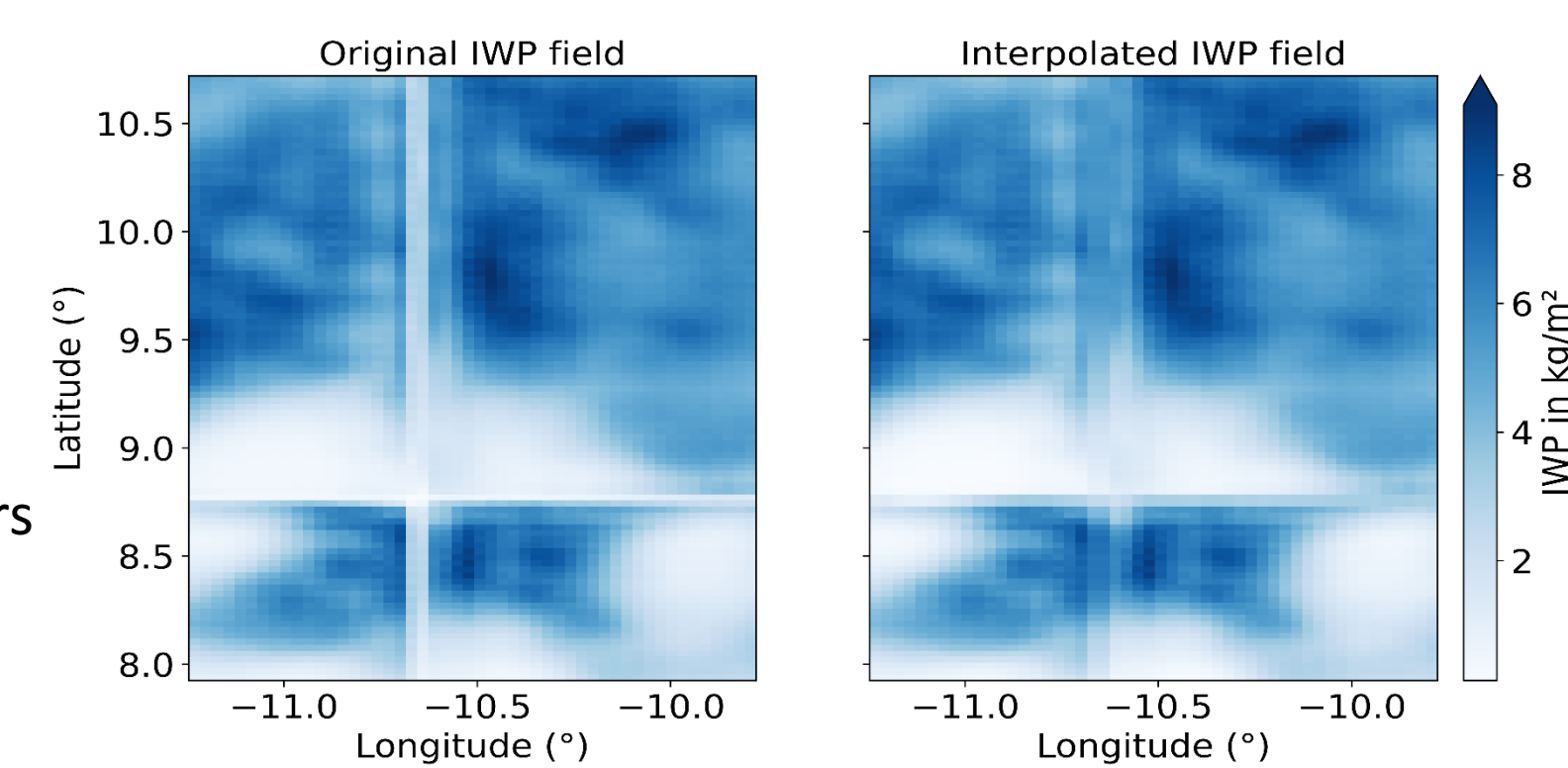
- Deep convective systems strongly influence the atmospheric energy and water cycles through vertical transport and radiatively active ice anvils.
- Our aim is to understand how these systems evolve over their lifetime in a **3D perspective**, using ice water content and ice crystal number concentration, coming from a novel dataset called **IceCloudNet**¹, that was generated by using machine learning to fill observational gaps.



Data preparation and tracking workflow

1. Eliminate IceCloudNet artefacts

- Calculate IWP > 10km as tracking variable
- Interpolate chunk borders

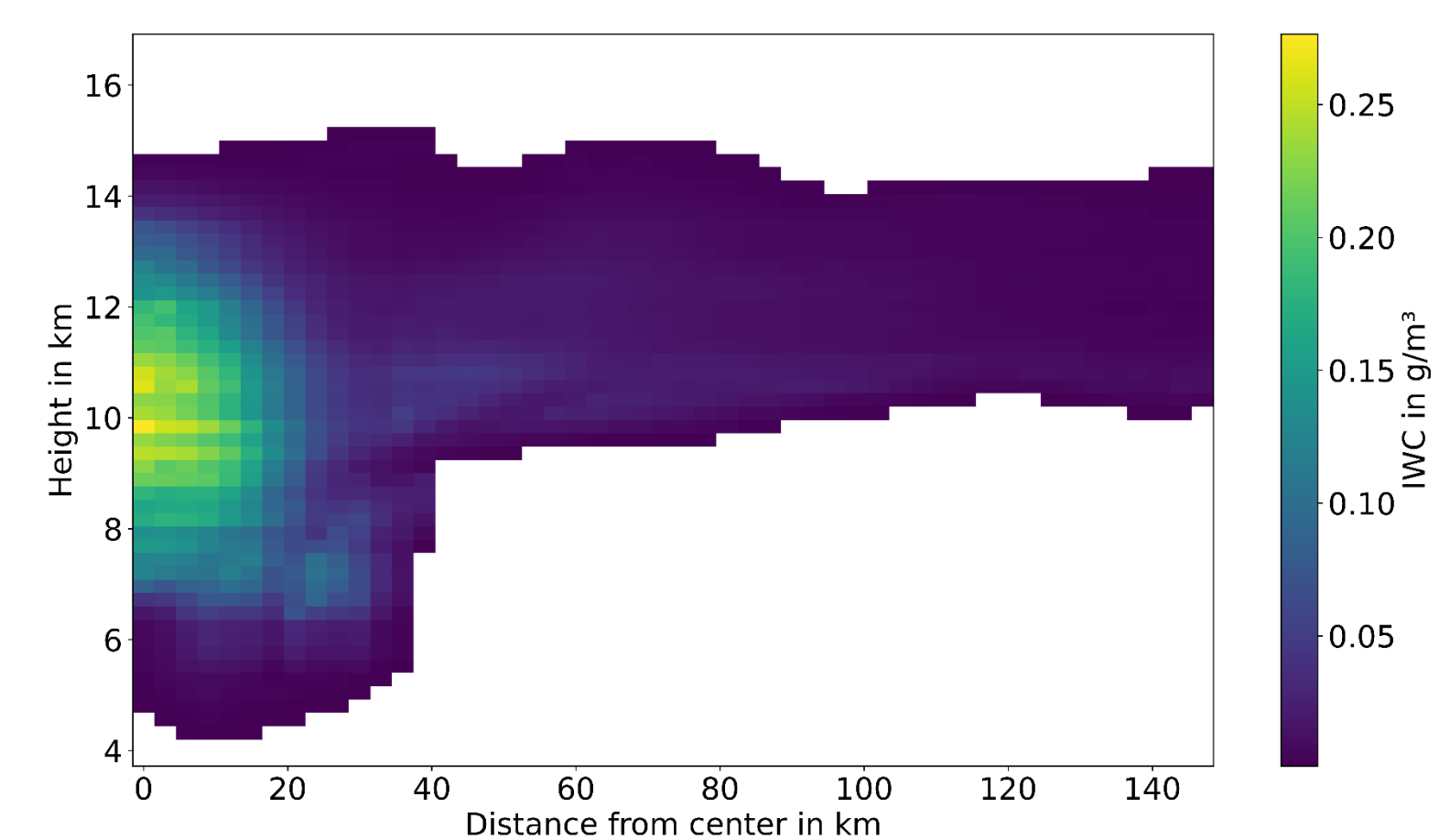


2. Tracking (TOBAC²):

- Feature detection based on IWP
- Temporal linking between features
- 2D Segmentation
- Removal of <1.5h long storms

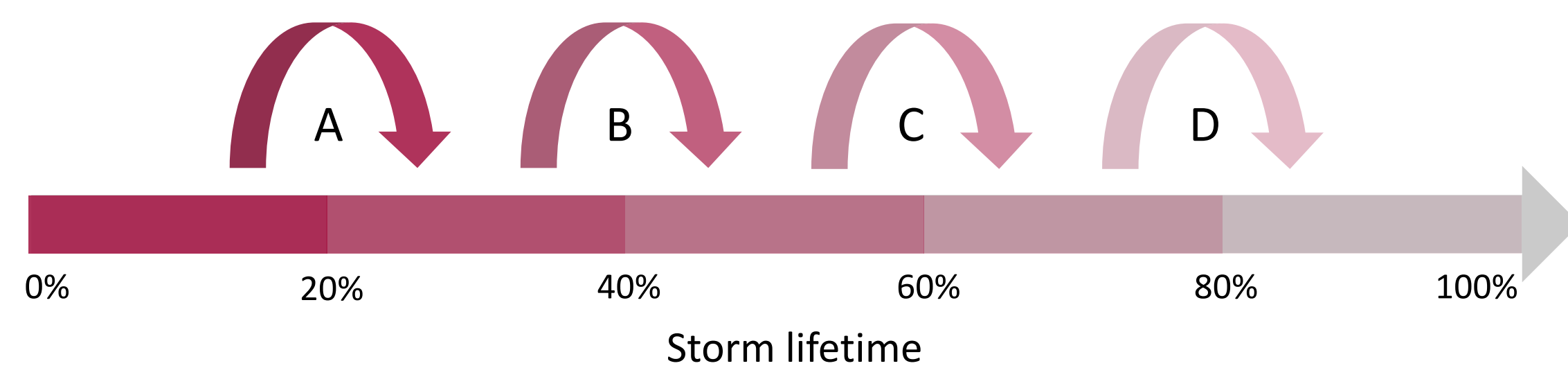
3. Derivation of vertical structure

- Radial binning of individual updraft centred snapshots
- Filtering of off-centred systems



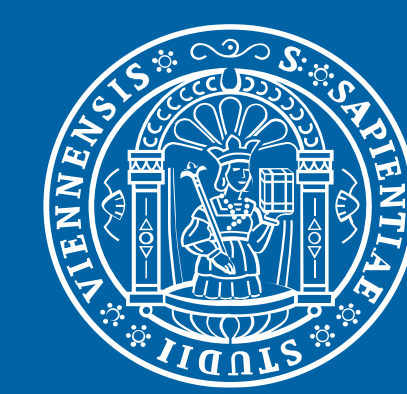
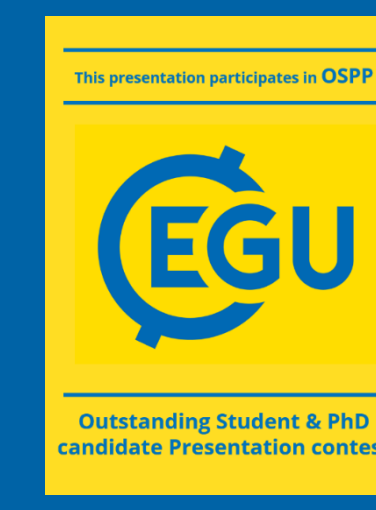
4. Lifecycle Analysis

- Classification into 5 age groups based on relative age
- Calculation of temporal differences (A-D)



References

- K. Jeggle, M. Czerkawski, F. Serva, B. L. Saux, D. Neubauer, and U. Lohmann. IceCloudNet: 3DReconstruction of Cloud Ice from Meteosat SEVIRI. Artificial Intelligence for the Earth Systems, 92025. doi: 10.1175/aies-d-24-0098.1
- G. A. Sokolowsky, S. W. Freeman, W. Jones, J. Kukulies, F. Senf, P. J. Marinescu, M. Heikenfeld, K. N. Brunner, E. C. Bruning, S. M. Collis, R. Jackson, G. R. Leung, N. Pfeifer, B. Raut, S. Saleeby, P. Stier, and S. C. van den Heever. tobac v1.5: Introducing fast 3D tracking, splits and mergers, and other enhancements for identifying and analysing meteorological phenomena. Geoscientific ModelDevelopment, 17:5309–5330, doi: 10.5194/gmd-17-5309-2024.



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Temporal Evolution of the Vertical Structure of Tropical Deep Convective Systems in IceCloudNet

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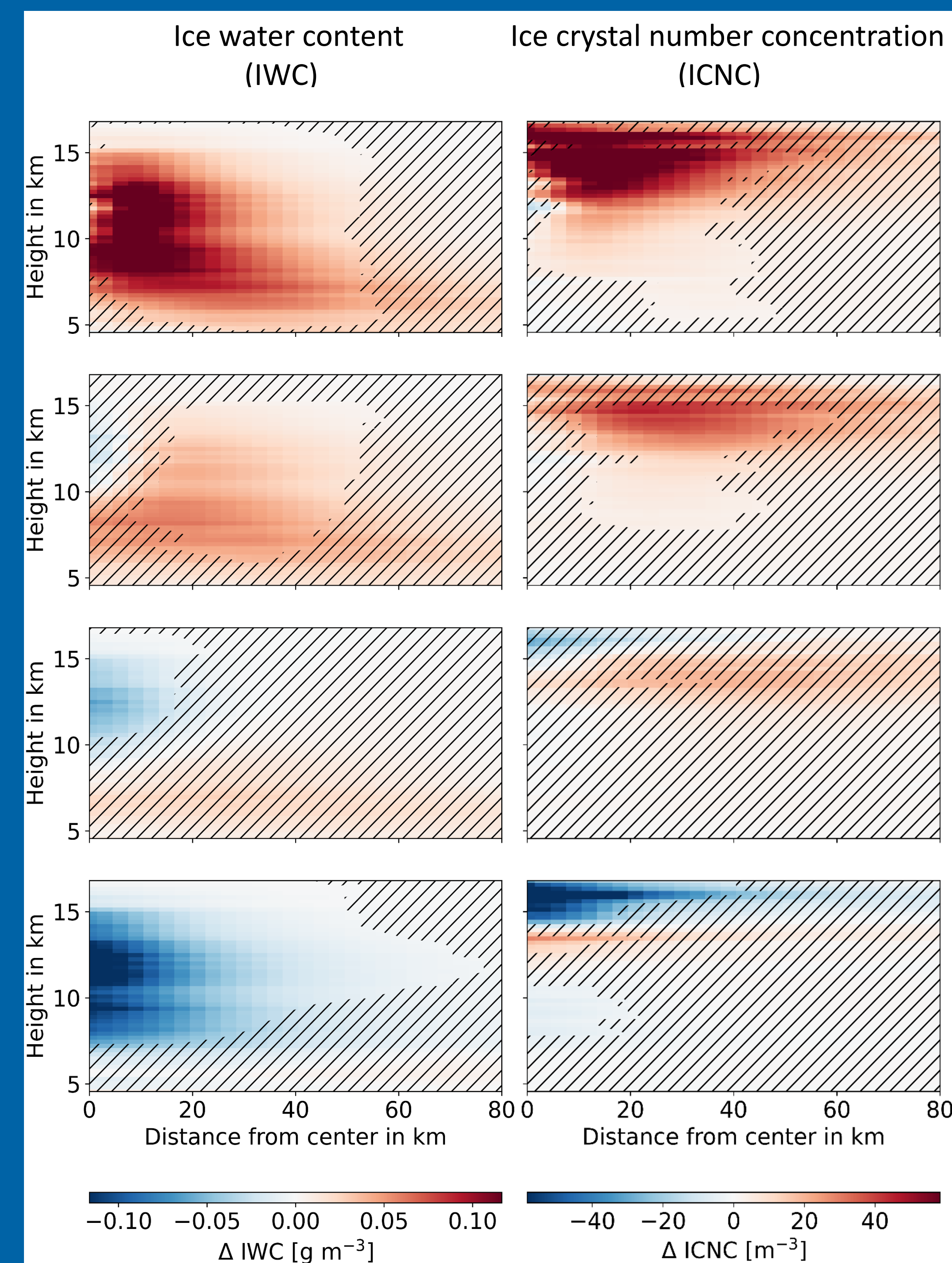
The convective lifecycle

A
Strong increase of both variables near main updraft

B
Continued but weaker increase in areas further away from updraft

C
Decrease of IWC in the upper column. High case to case variability in ICNC.

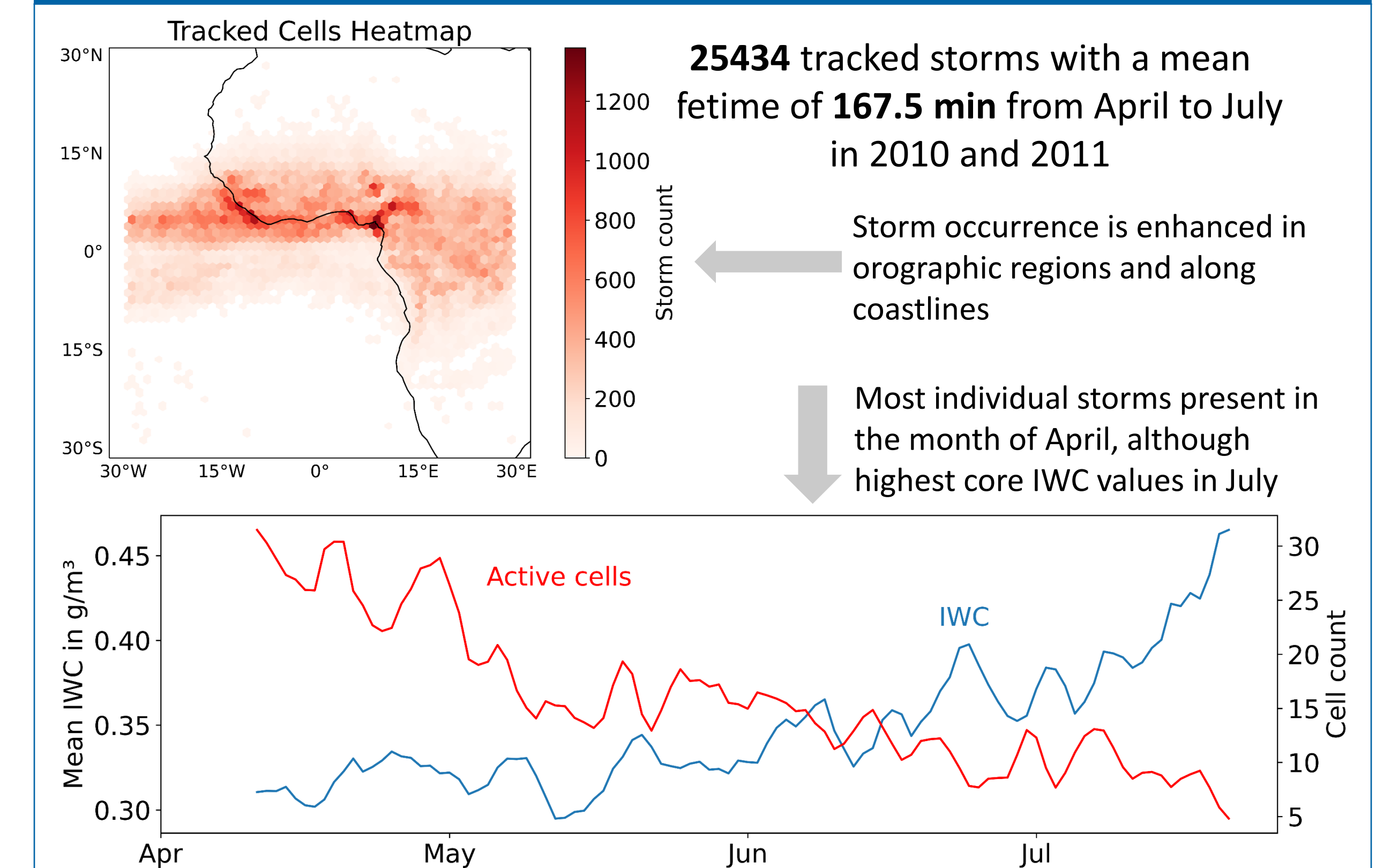
D
Strong and consistent decrease in IWC. Dipole structure in ICNC.



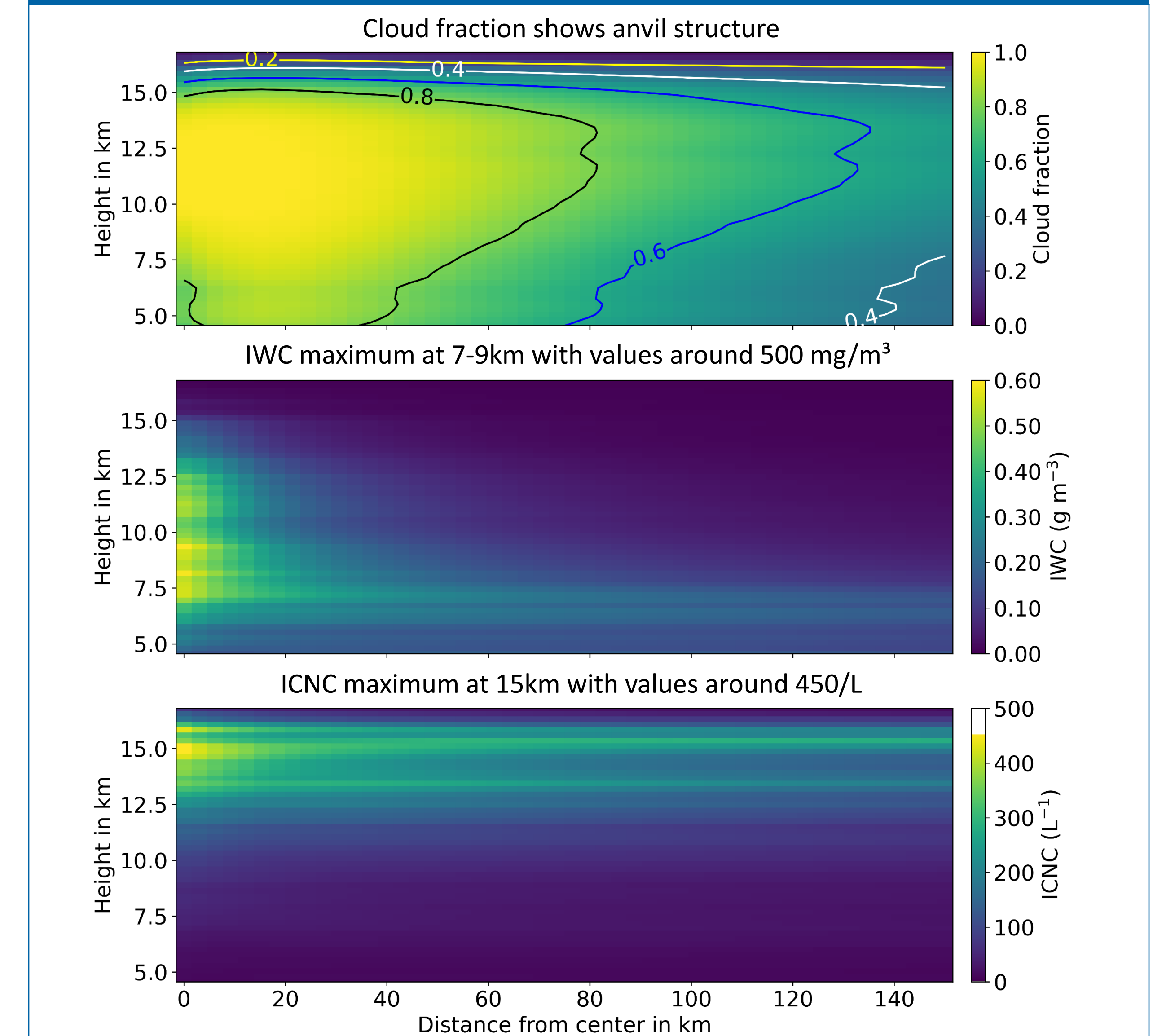
Mean evolution of IWC and ICNC across five evenly spaced relative lifecycle stages. Hatching marks regions where less than 60% of storms agree on the sign of change.

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Tracking shows expected patterns of tropical convection

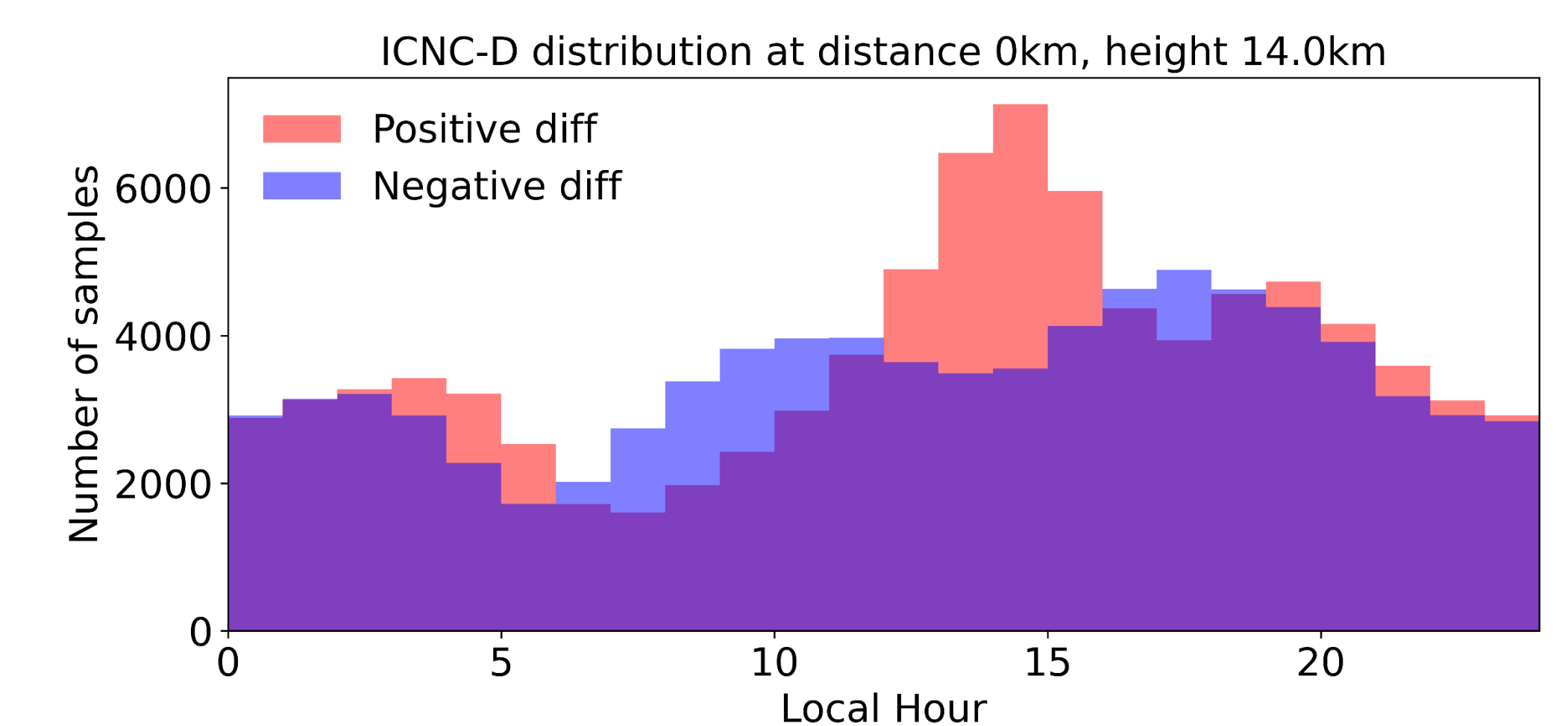


What does the vertical structure look like?



Are differences in the evolution patterns caused by regimes?

Poor sign agreement between samples could indicate different evolution pathways based on external conditions



Diurnal variations influence the sign of lifecycle changes in many regions and age stages