[1]Institute of Meteorology and Climate Research,
Karlsruhe Institute of Technology, Karlsruhe, Germany

# Investigation of the cloud phase distribution and related parameters with datasets from a passive satellite sensor and reanalysis models

Olimpia Bruno[1] (olimpia.bruno@kit.edu), Corinna Hoose[1], Martin Stengel[2], Quentin Coopman[1]
[2]Deutscher Wetterdienst, Offenbach, Germany

## Motivation

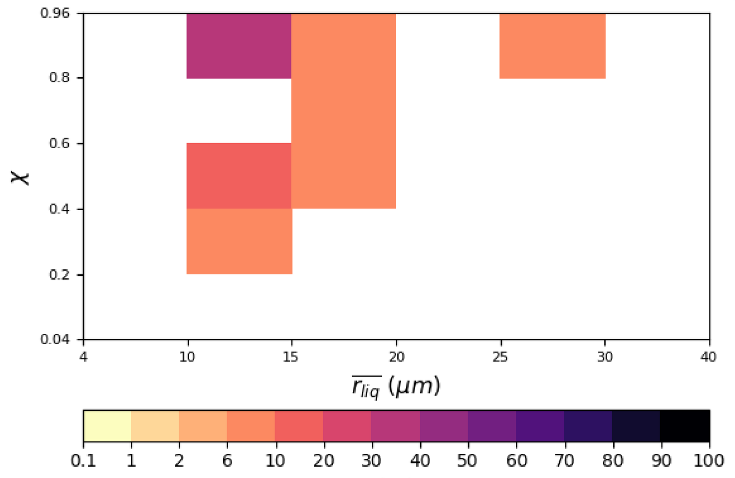
The liquid and ice partitioning in clouds influences strongly the radiation transfer to and from the Earth as well as the precipitation types, which are an important and uncertain component of weather forecasts. Our study aims at a better understanding of mixed-phase clouds by the introduction of mixed-phase (MP) regimes and the comparison of several datasets.

## Data and Methods

Used datasets:
- Cloud_cci AVHRR-PMv2 (Stengel et al., 2017), CLARA-A2 (Karlsson et al., 2017), and Cloud_cci AVHRR-PMv3 (Stengel et al., 2019) based on AVHRR measurements
- MERRA-2 (Gelaro et al., 2017) reanalysis
- Time period: 1 June 2009 - 31 May 2013 (*)
- Resolution: 7200x3600 pixels (0.05°x0.05°) for the satellite datasets, 576x361 pixels (0.5°x0.625°) for the reanalysis one

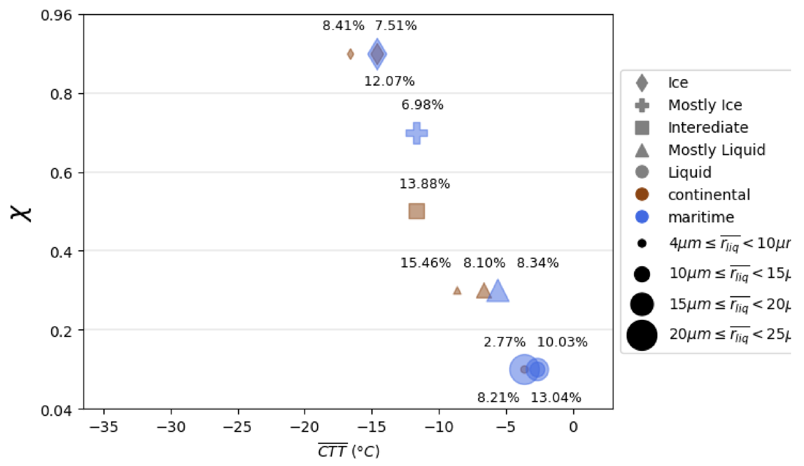
Joint histograms computed by k-means clustering:
- Ice pixel number fraction ($\chi$) vs mean liquid effective radius ($\overline{r_{liq}}$) – combined in four or five principal regimes
- Cloud optical thickness ($\tau$) vs cloud top pressure ($CTP$) – combined in six or seven principal regimes
- Number of daily histograms: 240x120 (30x30 pixels) for the satellite datasets, 192x120 (3x3 pixels) for the reanalysis one

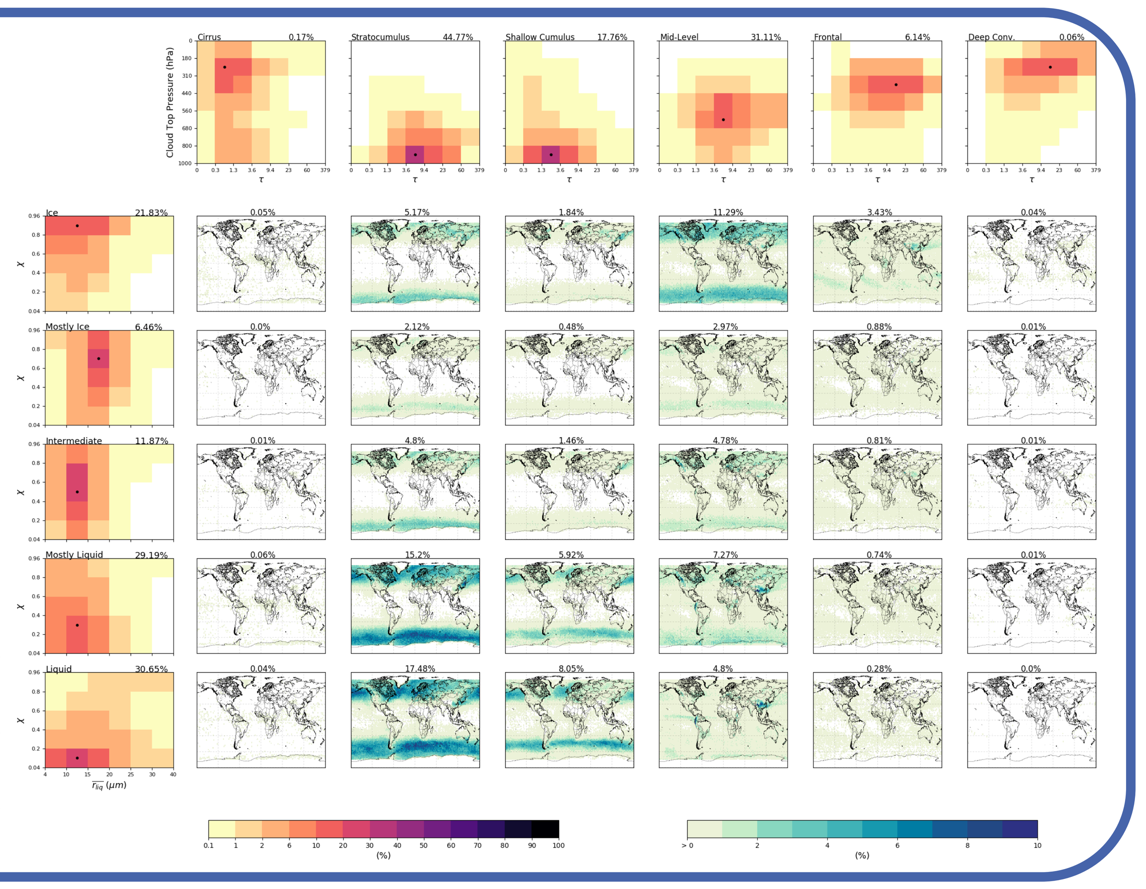
*MERRA-2: ~25% of total days in that range



*Example of $\chi$-$\overline{r_{liq}}$ histogram. $\chi$ is the ice pixel number fraction. $\overline{r_{liq}}$ is the mean liquid effective radius.*

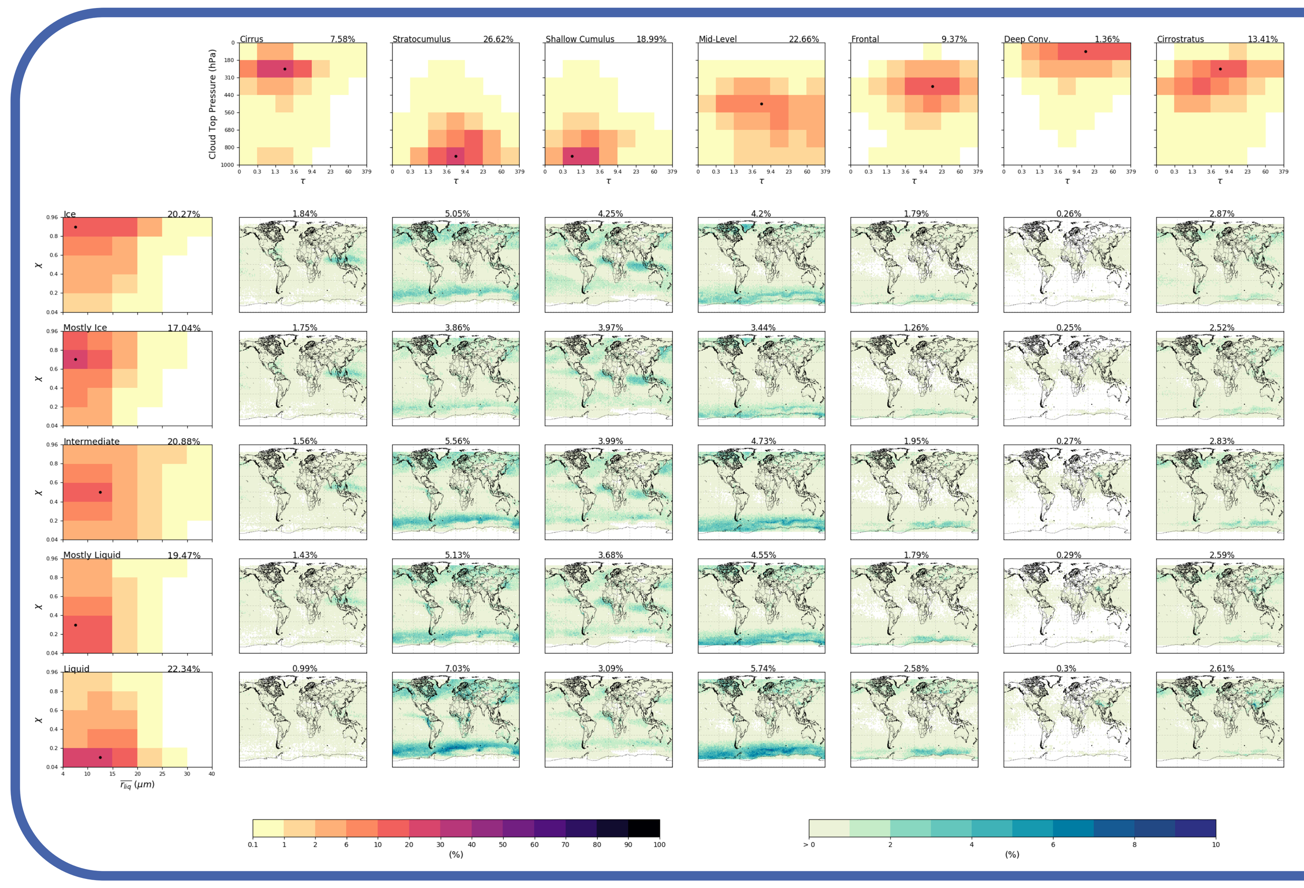
## Cloud_cci AVHRR-PMv2

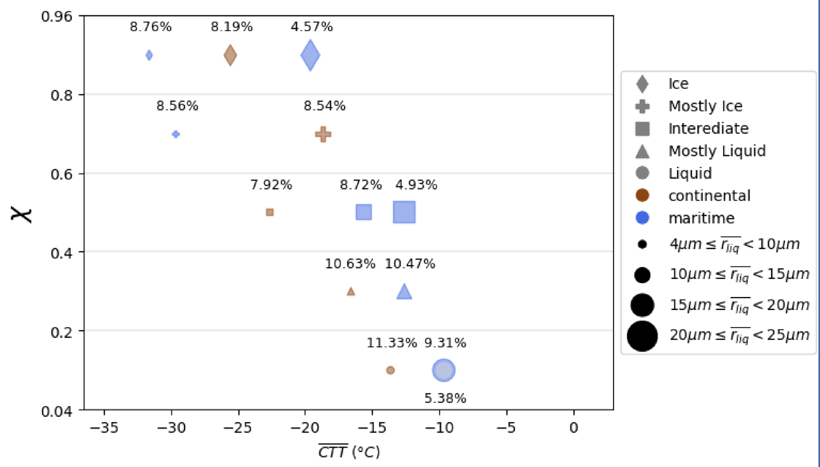




*(Top:) Most frequent mean cloud top temperature ($\overline{CTT}$) depending on ice pixel number fraction ($\chi$) for different MP regimes, before they are combined into five regimes. Colors and percentages of markers refer to the mostly continental/maritime contribution. Percentages below the markers refer to smaller overlapped markers.*

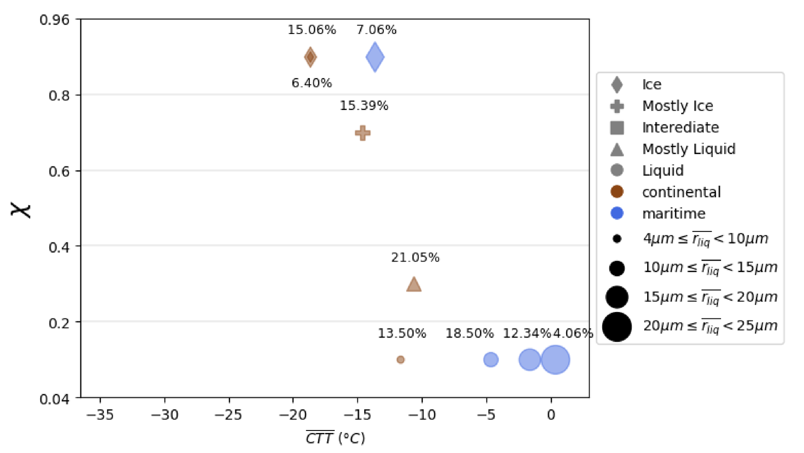
## CLARA-A2

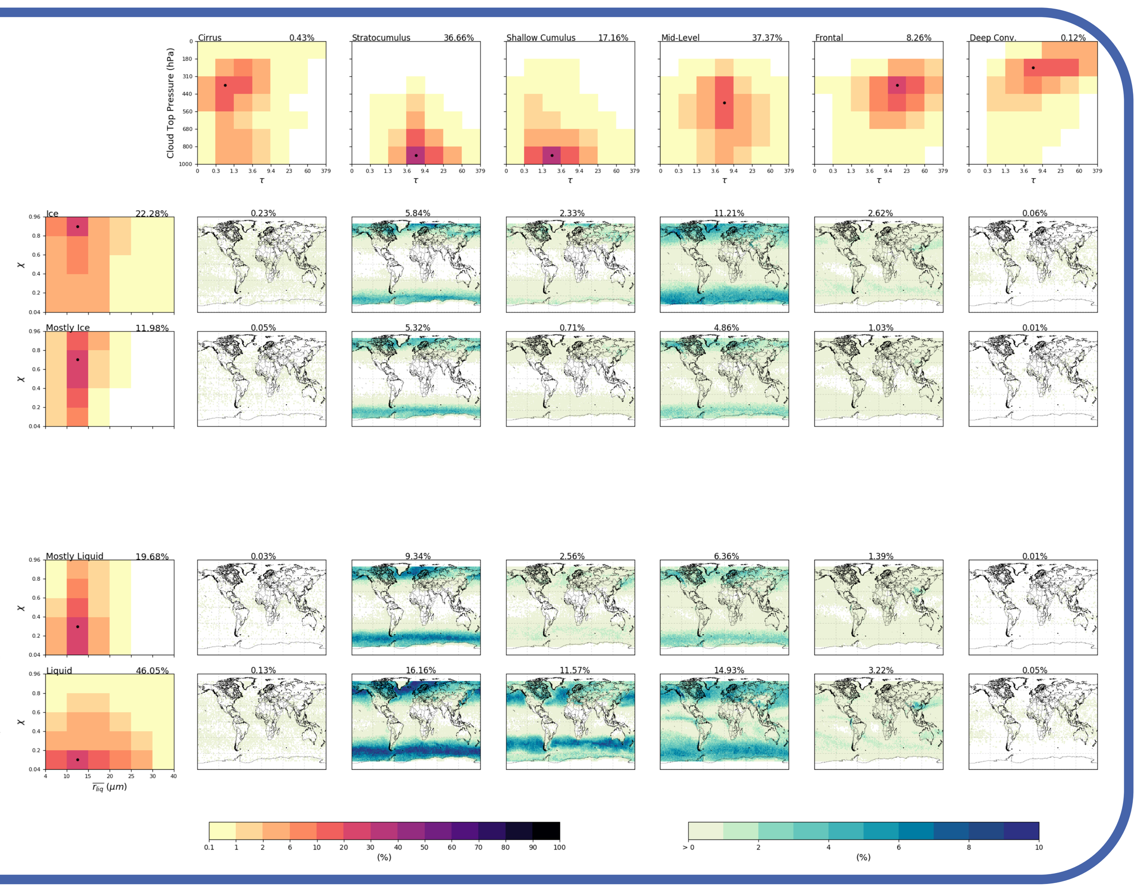




*(Top:) Most frequent mean cloud top temperature ($\overline{CTT}$) depending on ice pixel number fraction ($\chi$) for different MP regimes, before they are combined into five regimes. Colors and percentages of markers refer to the mostly continental/maritime contribution. Percentages below the markers refer to smaller overlapped markers. The grey marker indicates no prevalent contribution.*

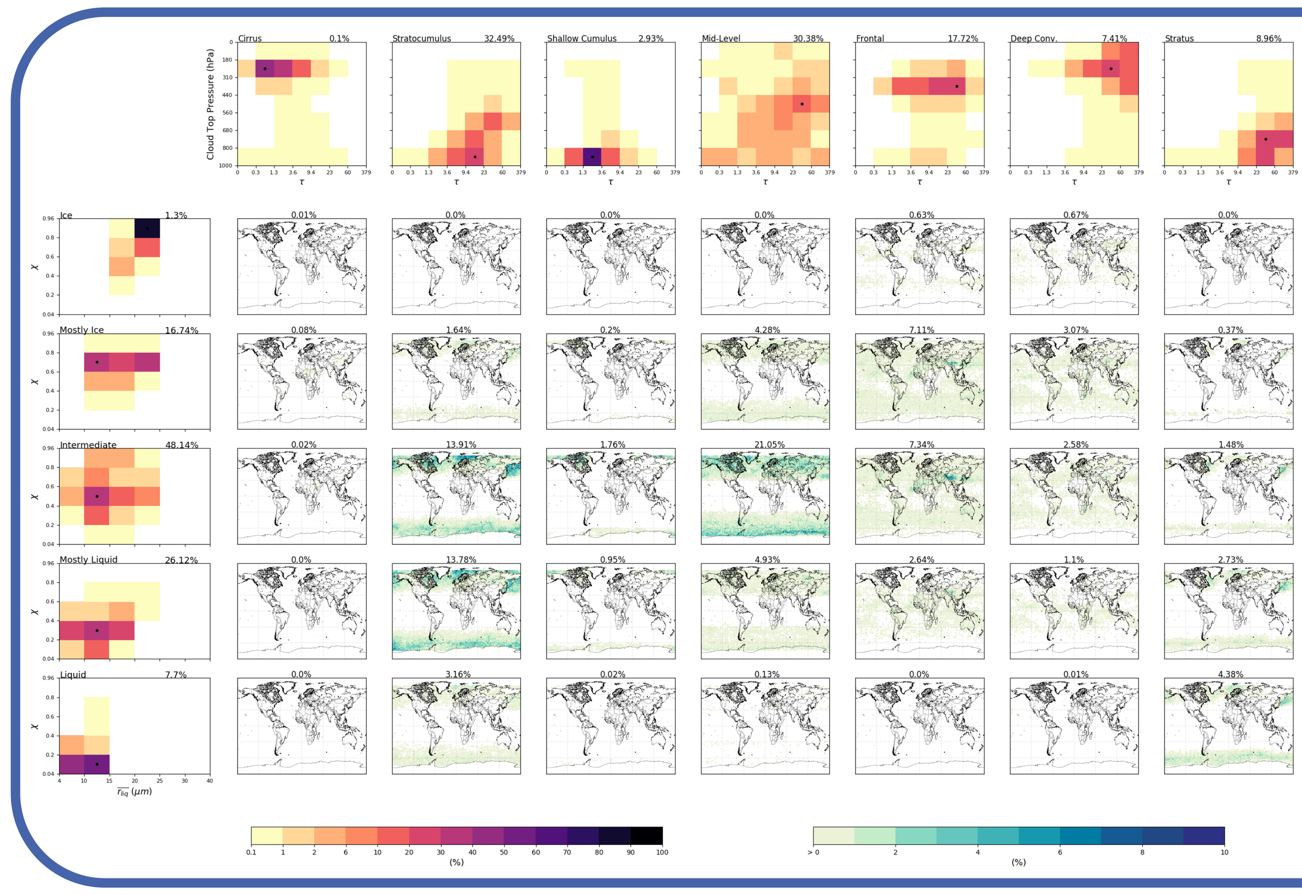
## Cloud_cci AVHRR-PMv3

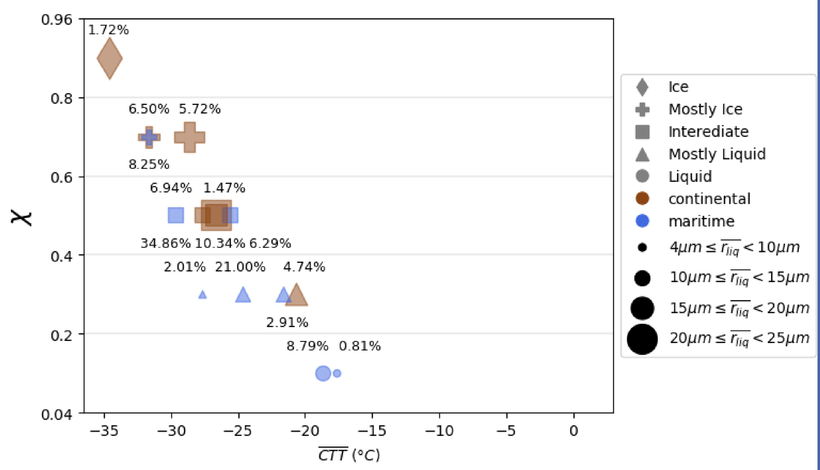




*(Top:) Most frequent mean cloud top temperature ($\overline{CTT}$) depending on ice pixel number fraction ($\chi$) for different MP regimes, before they are combined into four regimes. Colors and percentages of markers refer to the mostly continental/maritime contribution. Percentages below the markers refer to smaller overlapped markers.*

## MERRA-2





*(Top:) Most frequent mean cloud top temperature ($\overline{CTT}$) depending on ice pixel number fraction ($\chi$) for different MP regimes, before they are combined into five regimes. Colors and percentages of markers refer to the mostly continental/maritime contribution. Percentages below the markers refer to smaller overlapped markers.*

## Results

- More MP regimes in mid-high latitudes
- MP regimes mostly linked to stratocumuli, shallow cumuli, and mid-level clouds (cirrus and deep convective clouds almost absent)
- Maritime regimes mostly larger mean droplet radii and higher CTT than continental regimes for the same $\chi$ range (no MERRA-2)

## Outlook

- Comparison with other datasets (e.g., reanalysis and GCMs)
- Analysis of 3D datasets and own simulations with ICON for local events

**Acknowledgements**

We acknowledge the usage of the named datasets obtained from CM SAF, ESA Cloud_cci, and NASA. This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme under grant agreement No 714062 (ERC Starting Grant „C2Phase“).

**References**

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