“Regimes” of Continental Single Layer Liquid Water Clouds

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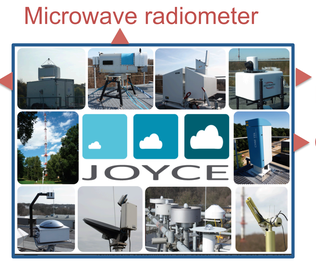
Single Layer Liquid Water Clouds

- Under which conditions do they exist?
- How do BL-dynamics, cloud microphysics and thermodynamics interact?

Crucial for improving the representation of cloud and cloud feedbacks in weather and climate models

Observations @ JOYCE:



Jülich ObservatorY for Cloud Evolution

- Cloud boundaries (*Cloudnet*)
- Vertical wind speed (w)
- Mixed layer height (MLH)
- Liquid Water Path (LWP)
- Integrated Water Vapor (IWV)

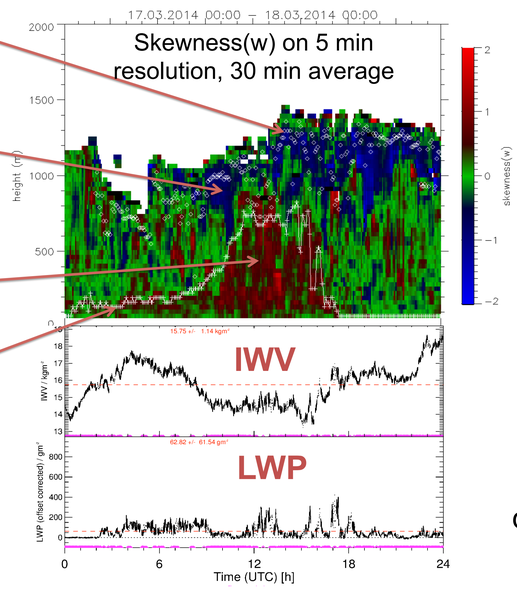
Measurement Synopsis

cloud base (diamonds) based on ceilometer backscatter

negative **skewness(w)**: downdraft plumes (LW cloud top cooling)

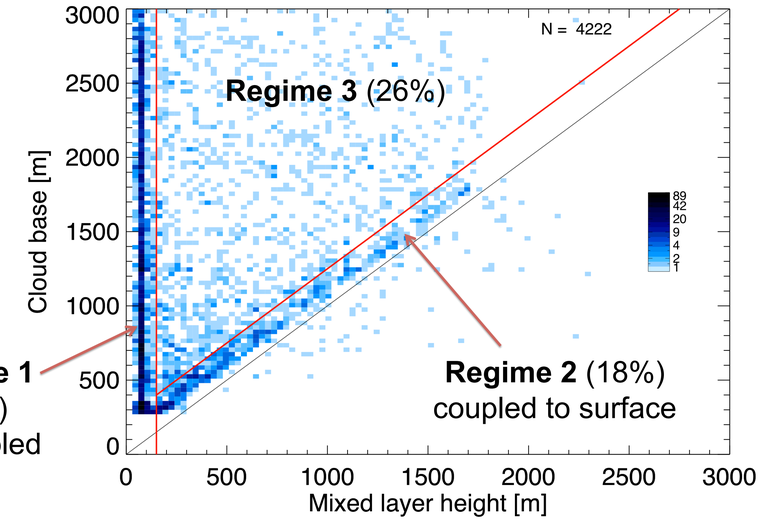
positive **skewness(w)**: updraft plumes (surface driven)

MLH (crosses) based on threshold of variance(w)

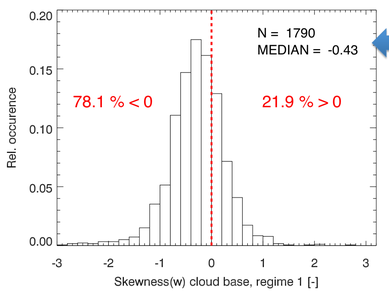


Liquid Water Cloud “Regimes”

based on **one year of JOYCE data** (03/2012 – 02/2013)



Regimes: Skewness

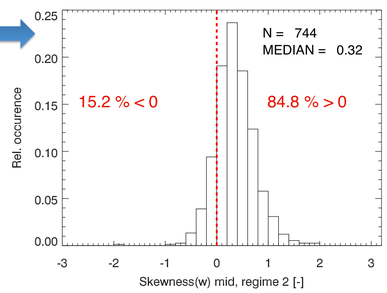


Regime 1: Skewness @ cloud base from Doppler Lidar

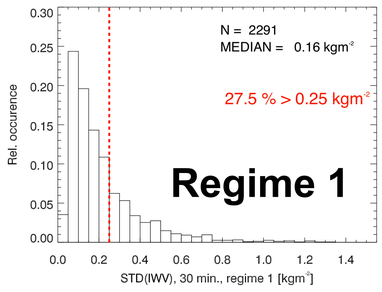
> 78% of Regime 1 clouds characterized by negative skewness, i.e. “downdraft plumes” driven by long-wave cloud top cooling (cf. Hogan et al. 2009)

Regime 2: Skewness between cloud base and surface

~85% of Regime 2 clouds characterized by positive skewness, i.e. “updraft plumes” driven diabatic heating from the surface

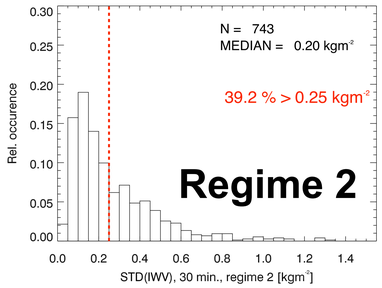


Regimes: IWV Variability

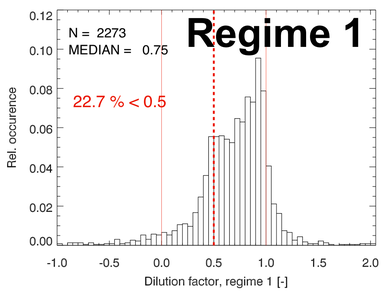


30-min *IWV standard deviation* from microwave radiometer around Doppler lidar measurement

Regime 2 clouds (coupled) show *higher IWV variability* than **Regime 1** clouds (de-coupled) due to BL mixing



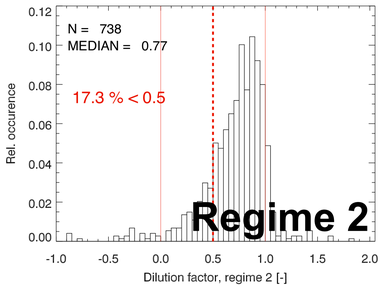
Regimes: LWP Dilution Factor (DF)



$$DF = \left(1 - \frac{LWP}{LWP_{adiab}}\right)$$

~dry air entrainment

- LWP from microwave radiometer
- LWP_{adiab} from Cloudnet cloud boundaries and temperature



only slightly higher dilution in Regime 2 (coupled) clouds (less adiabatic)