MBL cloud microphysical properties during well mixed and decoupled conditions (Azores-AMF)

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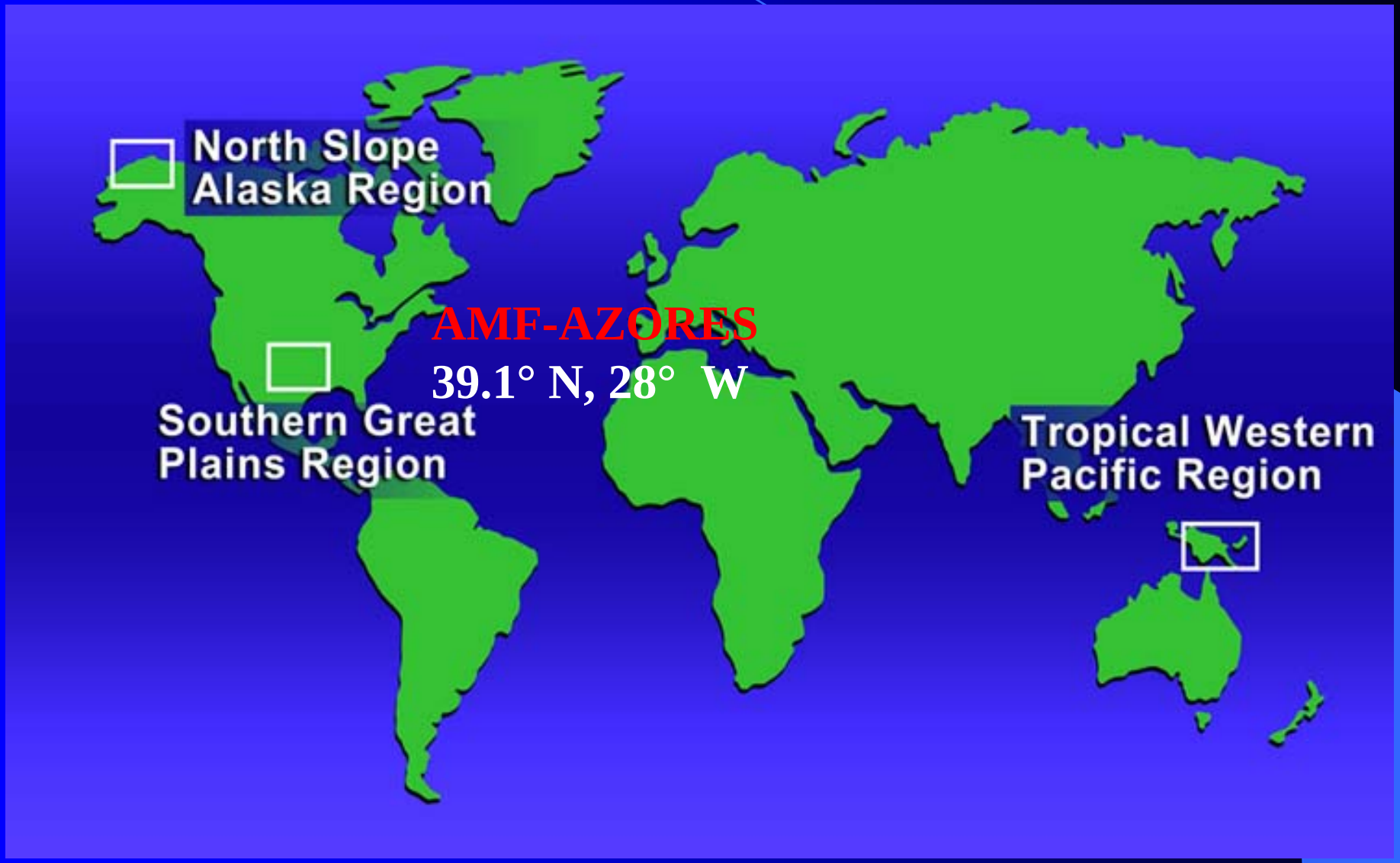
Location of DOE ARM sites



Outline

- Data
- Method
- Cases
- Summary

ARM Azores Data

- Cloud-base and -top heights: radar-lidar
- Cloud LWP: retrieved from a microwave radiometer
- Cloud microphysical properties Nd and re: Retrieved from radar-lidar-MWR method (Dong and Mace 2003)
- Surface CCN: Measured by ARM Aerosol Observation System at the Azores (SS=0.2%) (Wood)
- Merged soundings from the 4 soundings taken every day

Methods to identify well mixed and decoupled PBL

1)Using derived PBL heights given by ARM sites 4 times a day

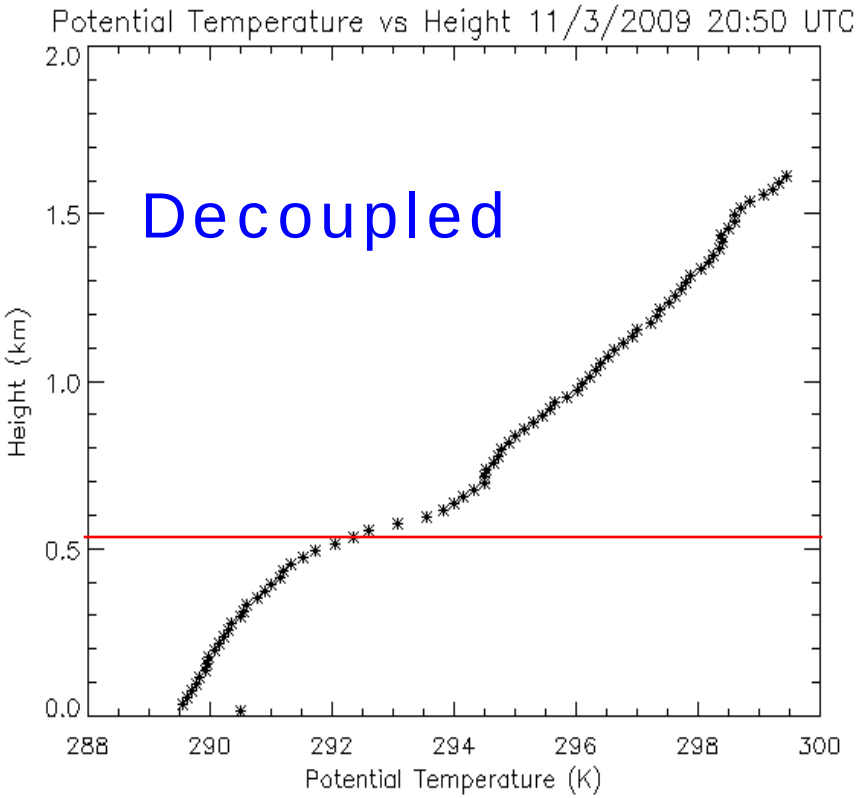
2) Using vertical profile of the PBL's potential temperature to define if the PBL is well mixed or not well mixed

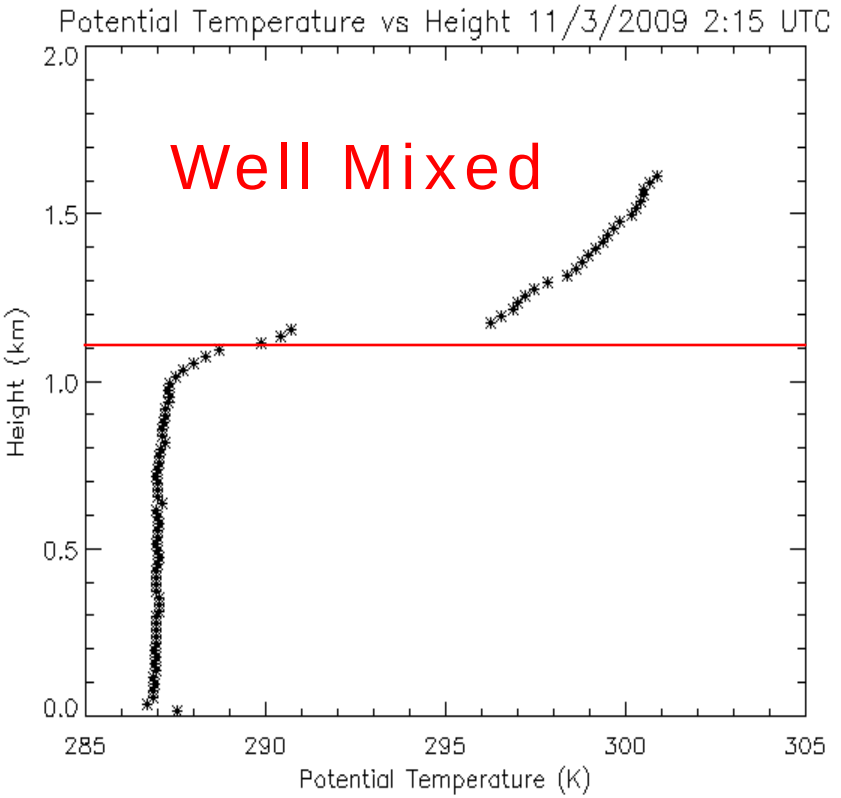
- PBL is well mixed if potential temperature is relatively constant (difference is < 1 K from top to bottom of PBL)

PBL Heights

- Hefter Method
  - Height defined using vertical potential temperature profile
  - Includes entrainment zone
- Liu Liang Method
  - Similar to Hefter Method, but when a shallow stable layer is present within a PBL, the Liu Liang method defines the top of the PBL as the top of the stable layer
  - If no stable layer, PBL height is defined at start of the entrainment zone
- Bulk Richardson Method
  - Only used for stable boundary layers

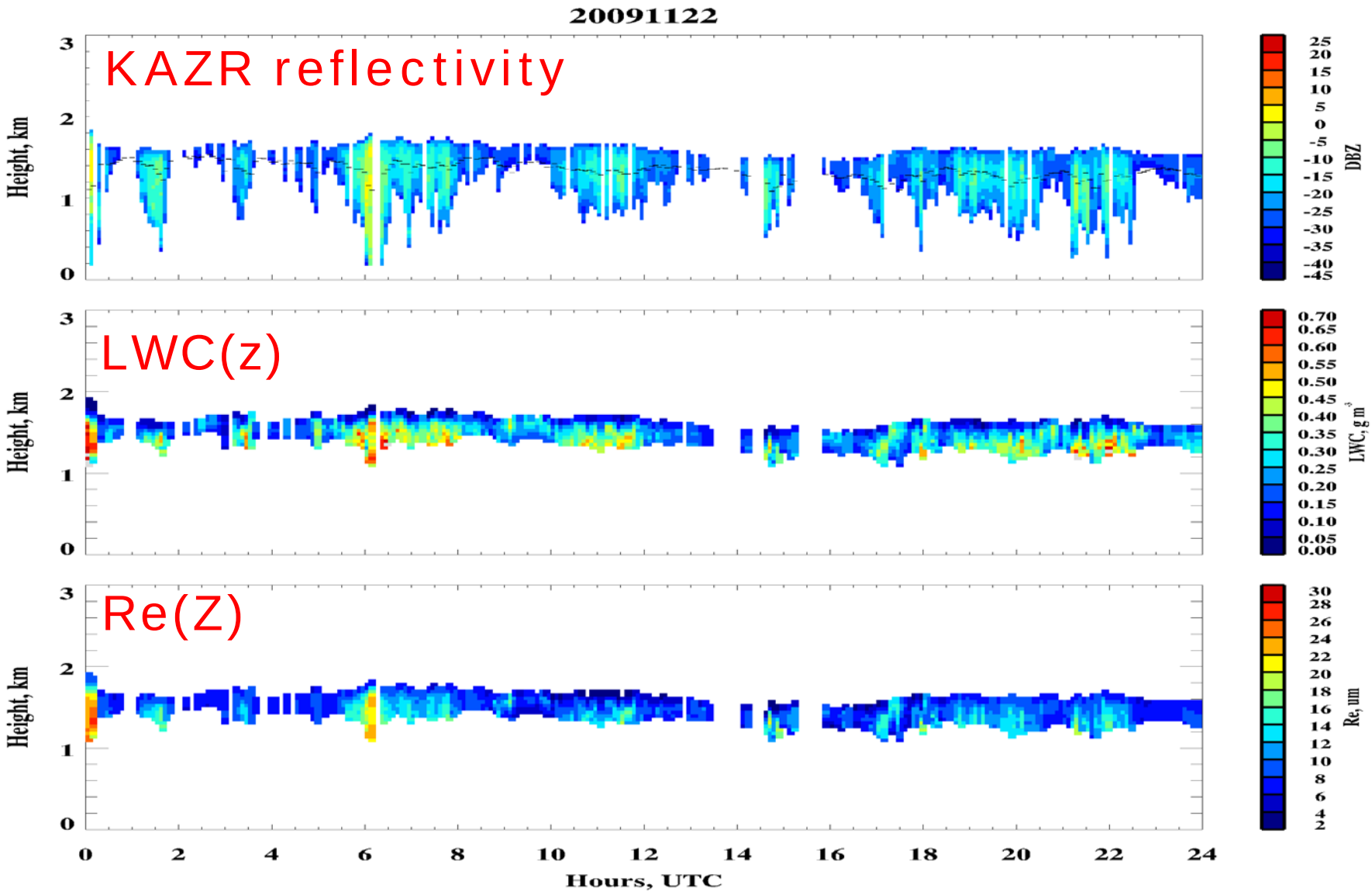
Examples

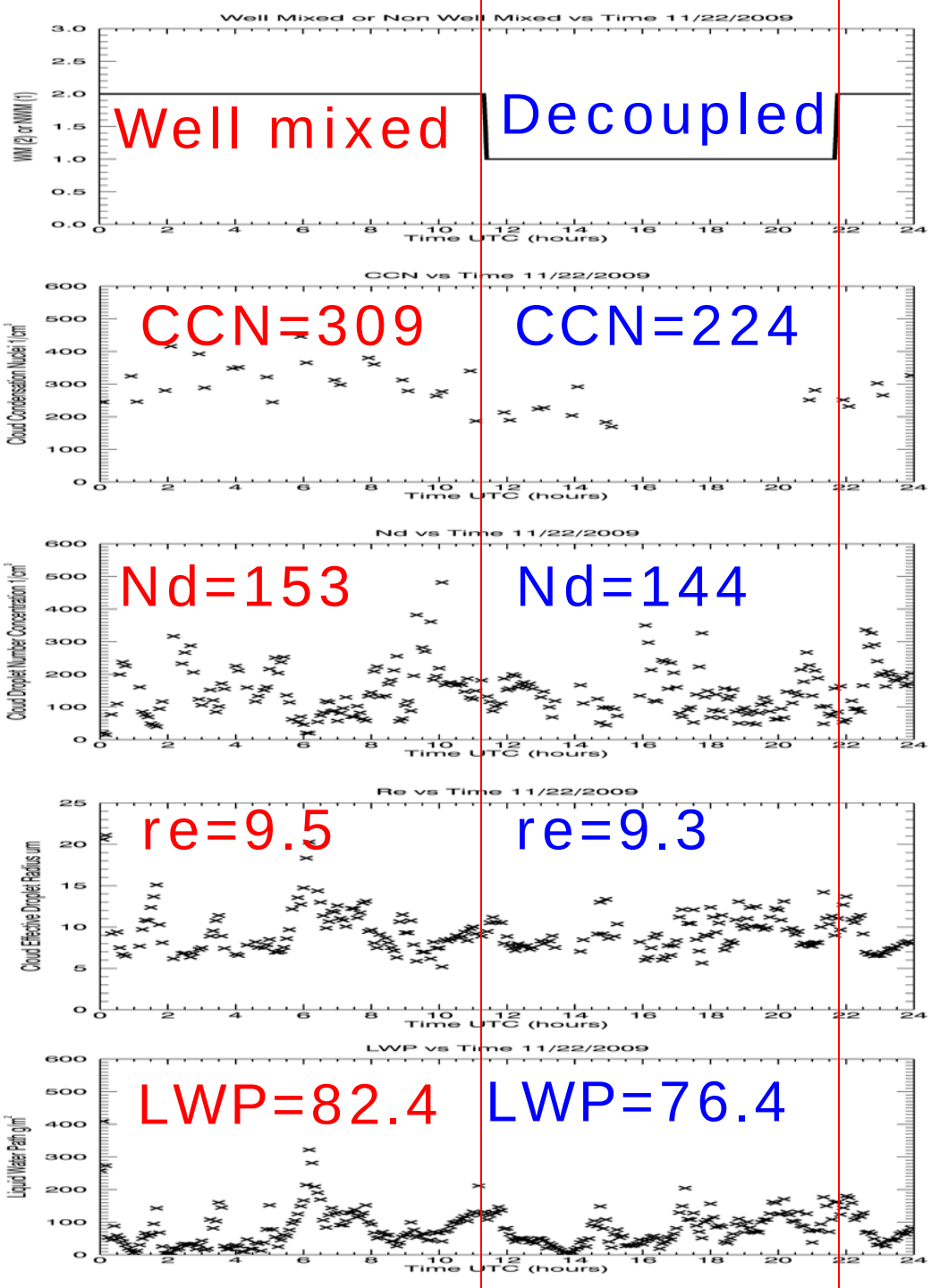




- Hefter PBL heights used (red line)
- Includes entrainment zone

Case 1: Nov. 22, 2009



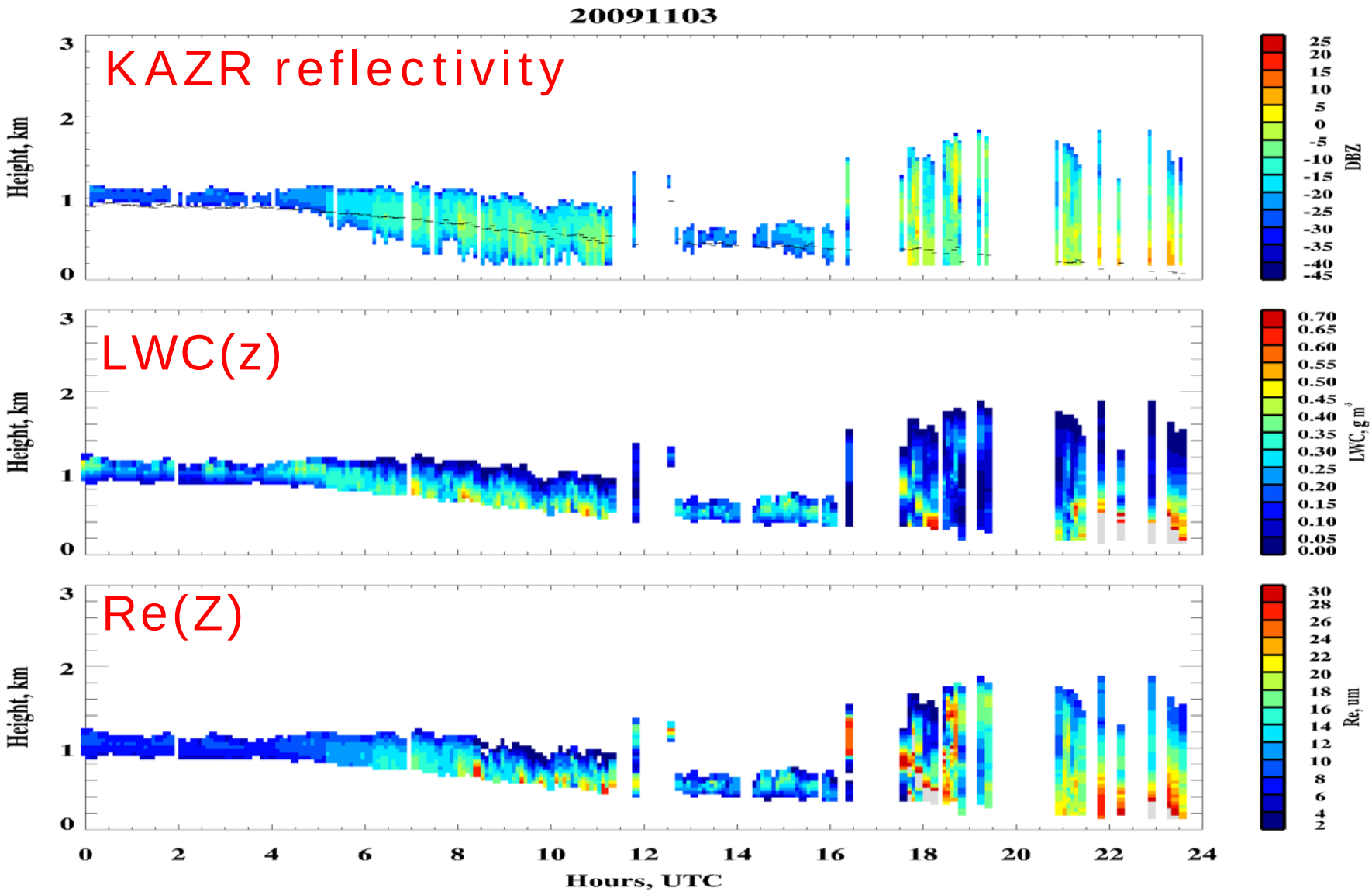


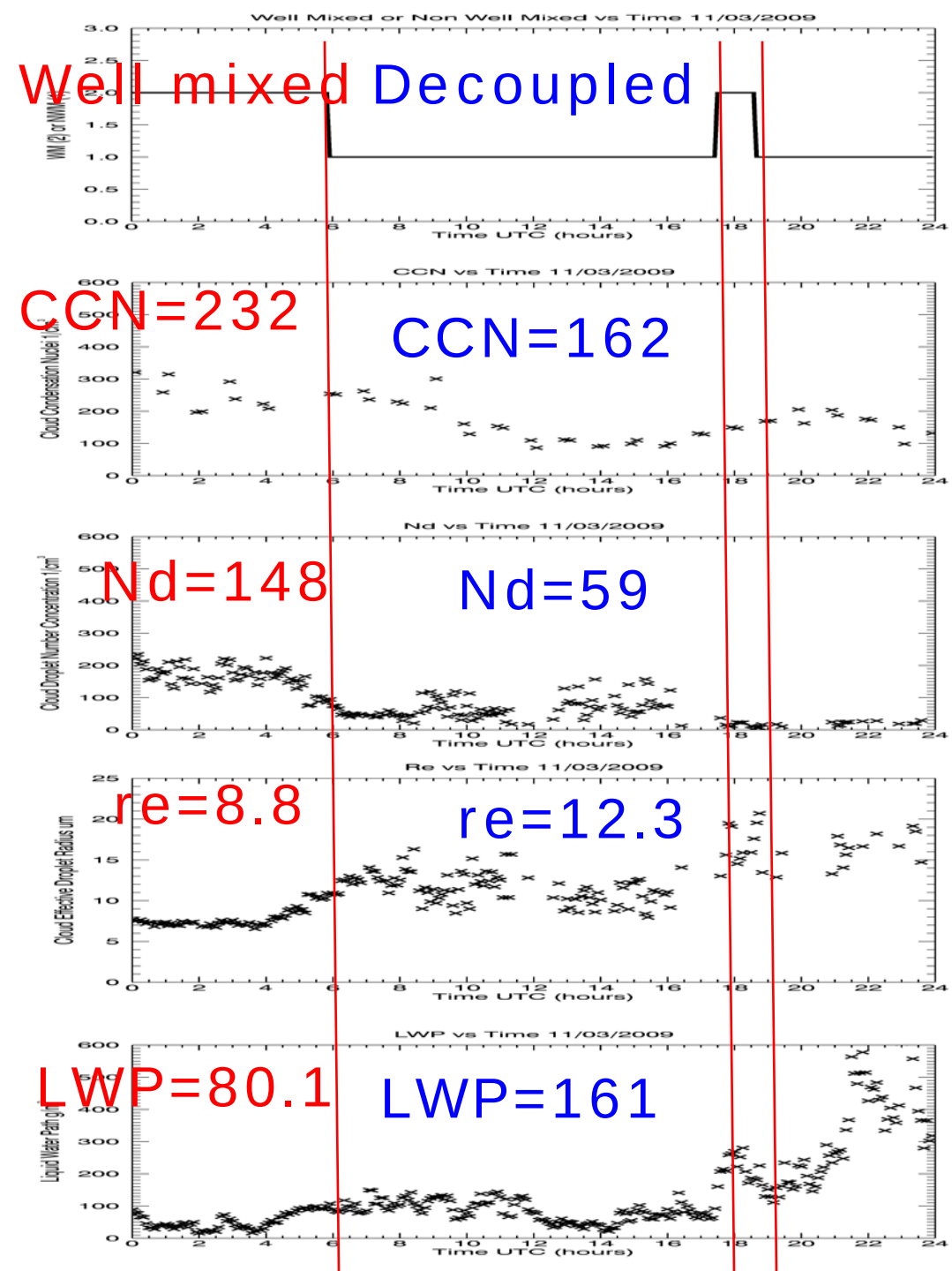
Case 1

For the well mixed region, CCN and Nd are higher than those from the decoupled region, it makes a physical sense; more CCN➔higher Nd.

re and LWP are similar to those over the decoupled region.

Case 2: Nov. 3, 2009



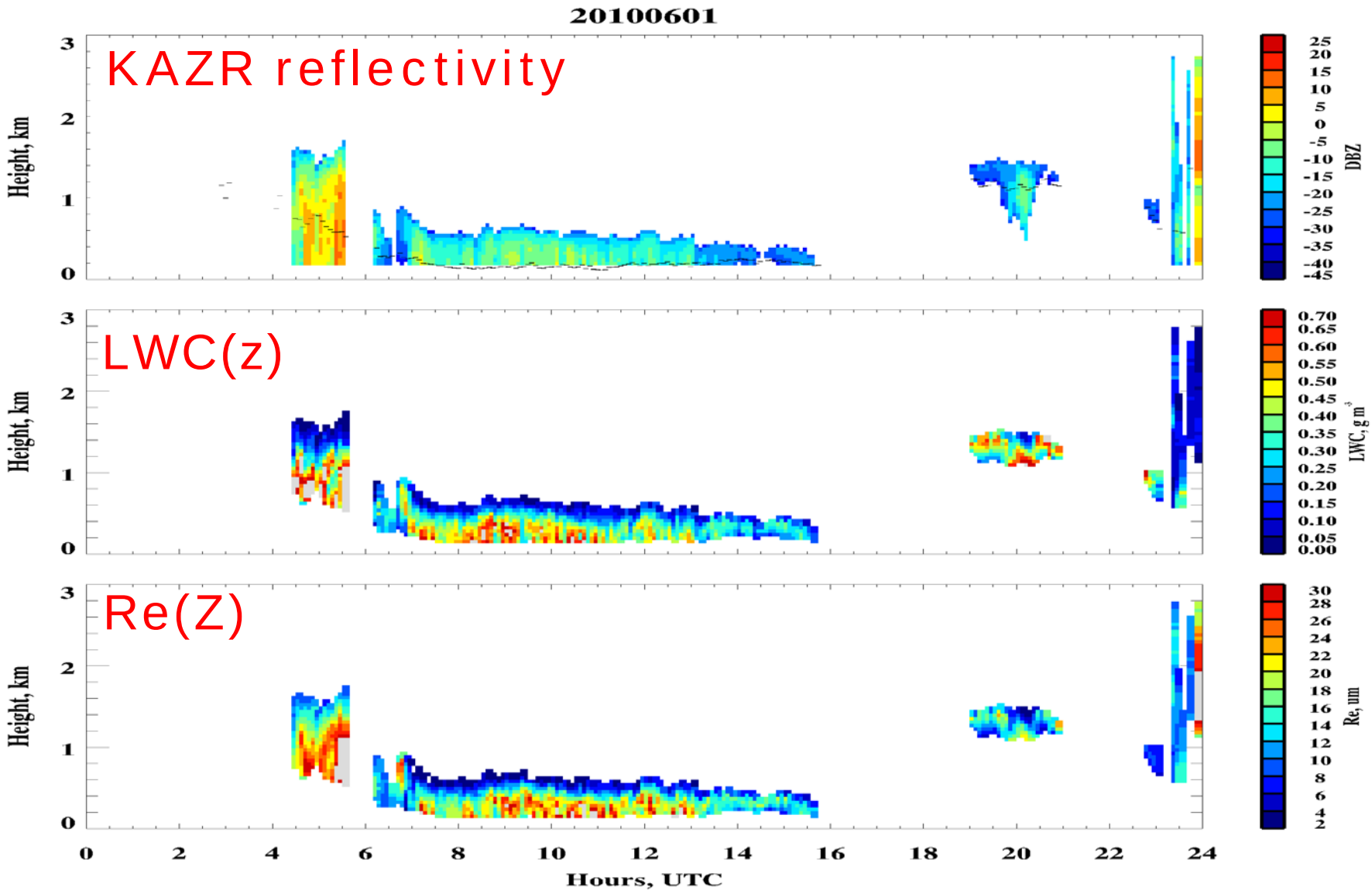


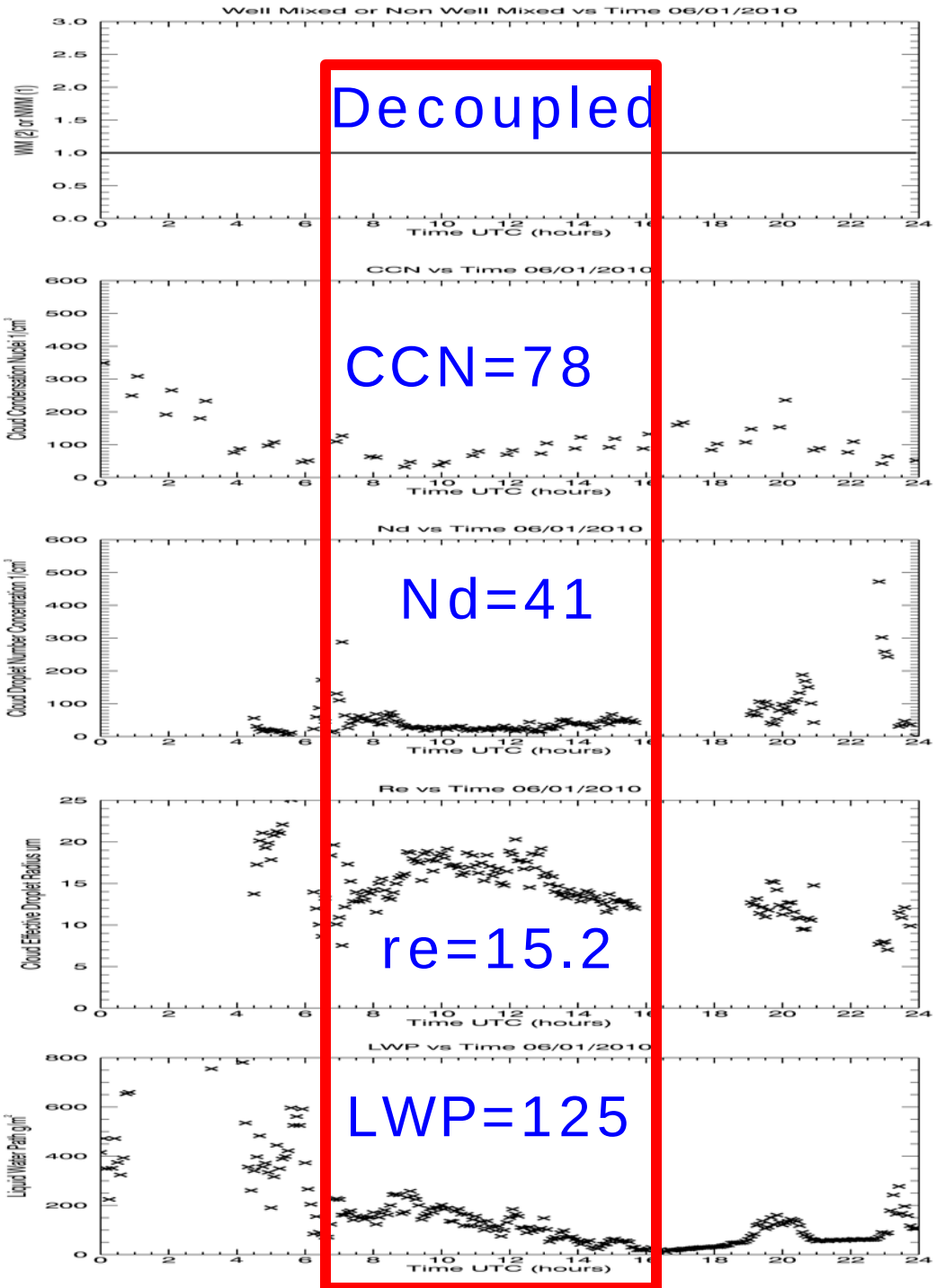
Case 2

CCN and Nd decrease from 0Z to 12Z, while re and LWP increase.

For well mixed region, CCN and Nd are higher than those from the decoupled region, re and LWP are smaller than those over the decoupled region.

Case 3: June 1, 2010





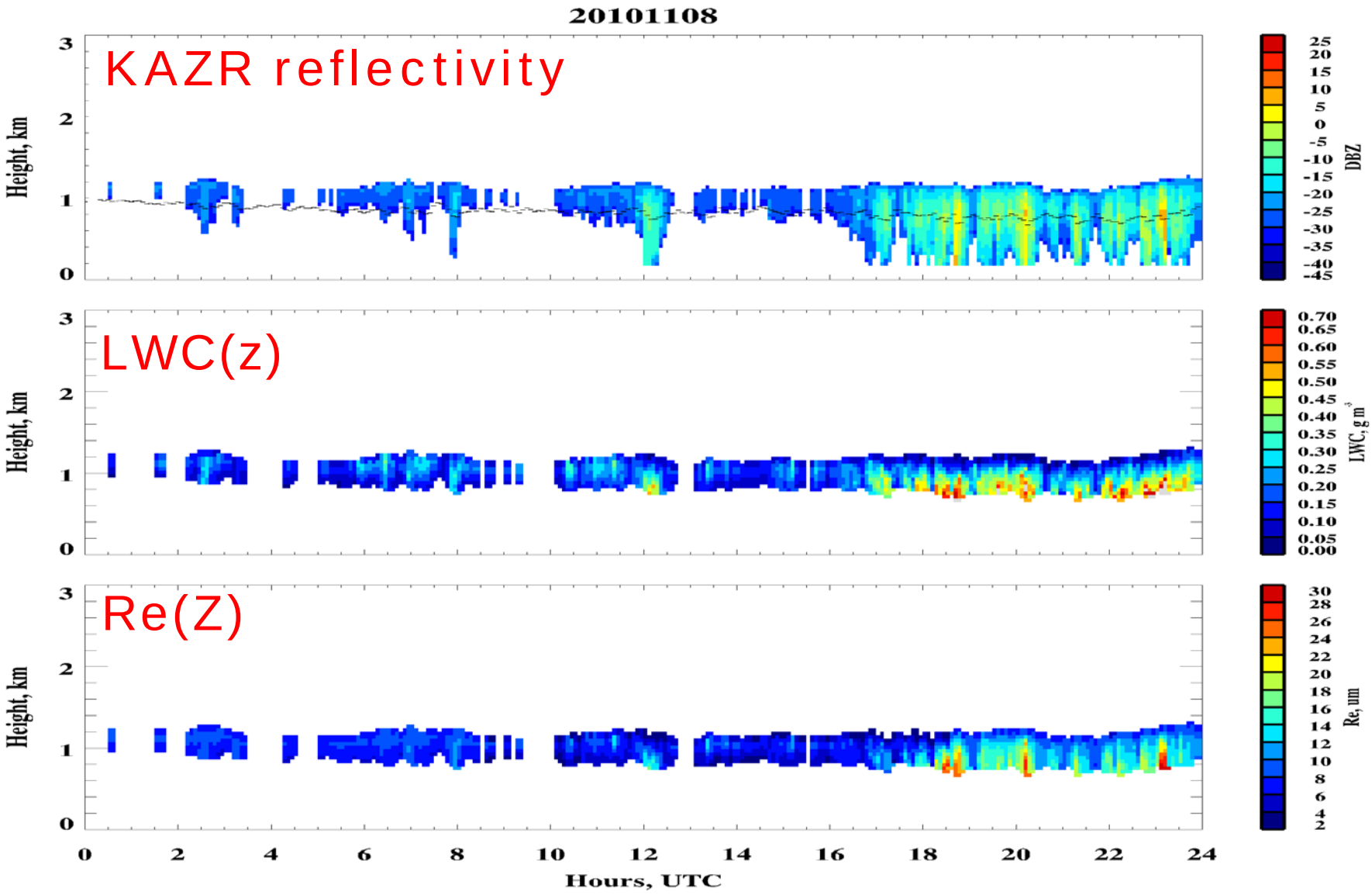
Case 3

CCN decreases from 6 to 9Z, then increases slightly until 16Z.

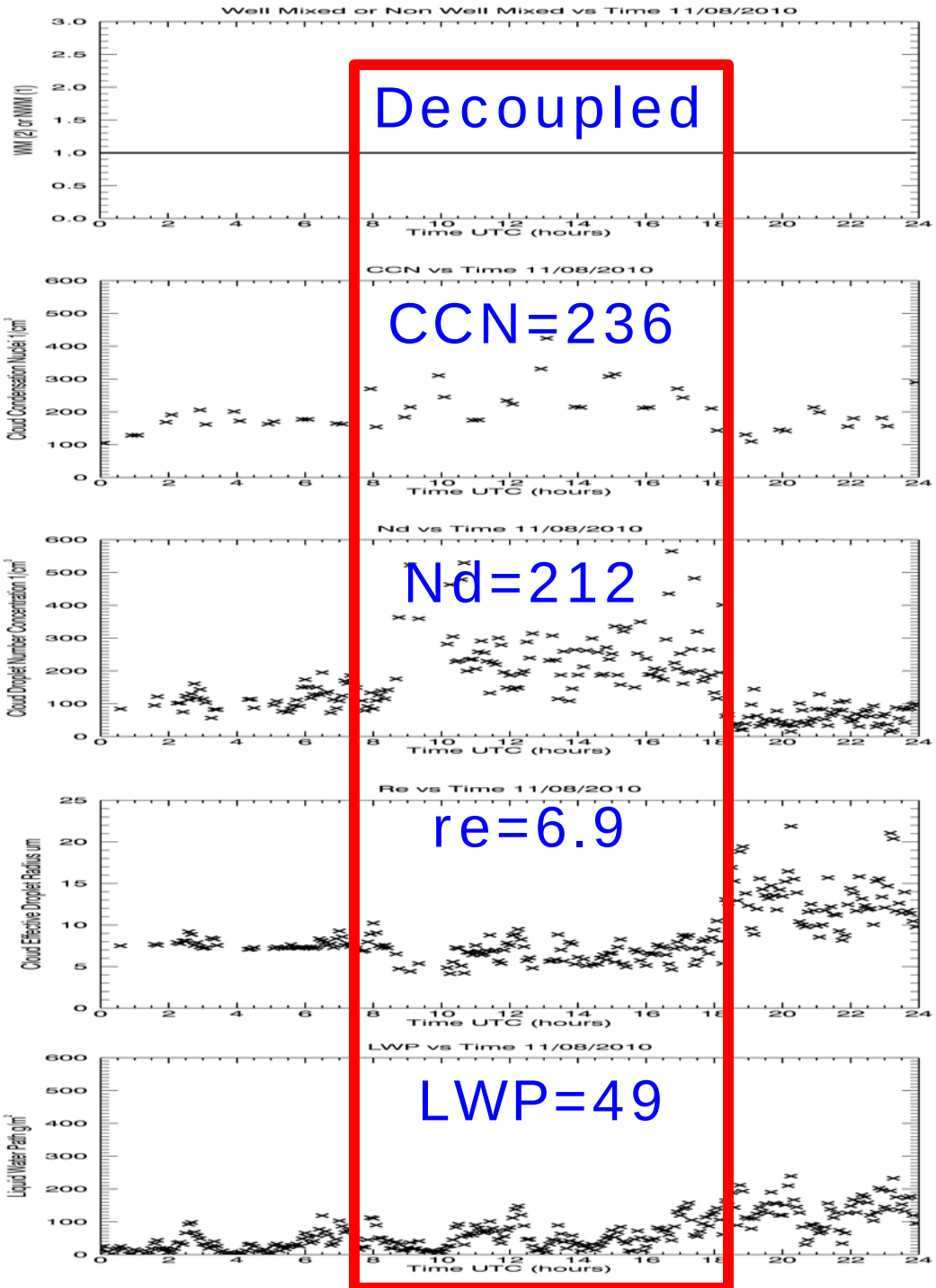
Nd is high during 6-9Z, then remains constant, correlating CCN well .

re increases from 6 to 9Z, reaches the max near 12Z, then decreases (same as LWP).

Case 4: Nov. 8, 2010



Case 4



During daytime with nearly constant LWP.

CCN is higher, resulting in higher Nd, and small re values.

Summary

- Drizzle and daylight are major factors in decoupling PBL.
  - If drizzle reaches surface, PBL is usually decoupled.
  - During heavy drizzle, the top of PBL becomes decoupled.
- Well mixed PBL's tend to have higher CCN and Nd, and small re and LWP values, but it is hard to draw a conclusion from 2 cases.
- Re values are large when drizzle is present.

Questions?

Cases	Well mixed Nd/CCN	Decoupled Nd/CCN
Case 1	0.5	0.64
Case 2	0.64	0.36
Case 3	0	0.53
Case 4	0	0.9