Comparing LEM simulations with aircraft data from RICO: Preliminary results

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Introducion

- RICO dataset provides a tool to enable the validation of how well trade wind cumulus are represented in Cloud Resolving Models (CRMs), which in turn are used to guide the development of parameterisations for inclusion into large scale models.

- Have performed some preliminary comparisons of aircraft data with simulations carried out with the Met Office LEM. Results are at an initial stage!!

  - Horizontal resolution   = 250 m
  - Horizontal domain size   = 40 x 40 km
  - Vertical resolution   = 40 – 200 m
  - Vertical domain size   = 0 – 10 km

Model profiles

Profiles initialised with obs from Jan 19th 2005

Wind components
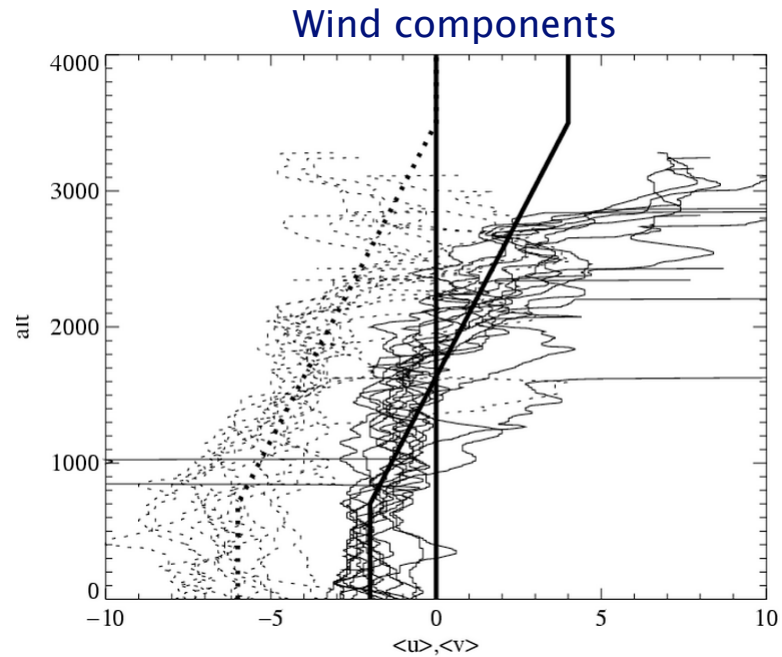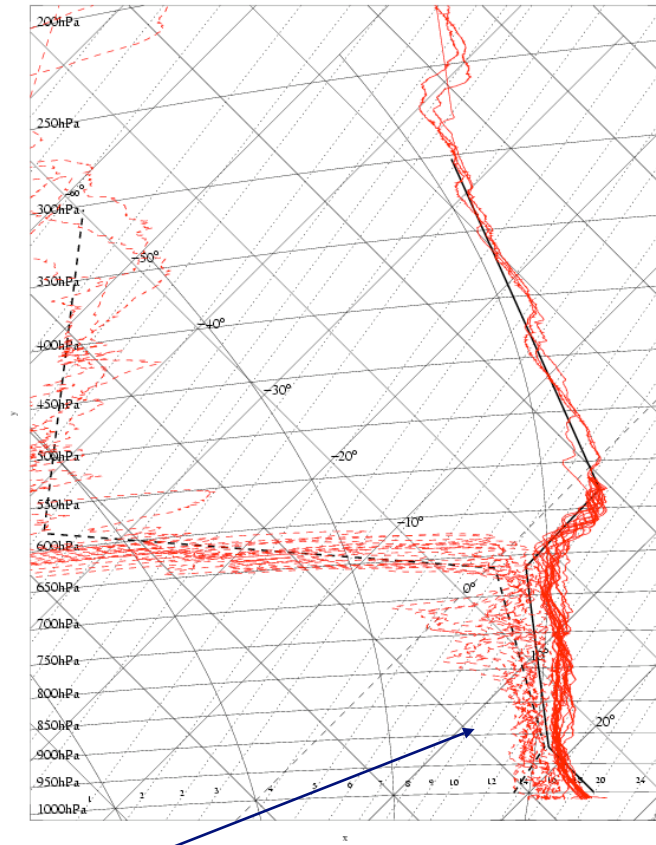
Black = LEM
Red   = Barbuda radiosondes and C-130 dropsondes
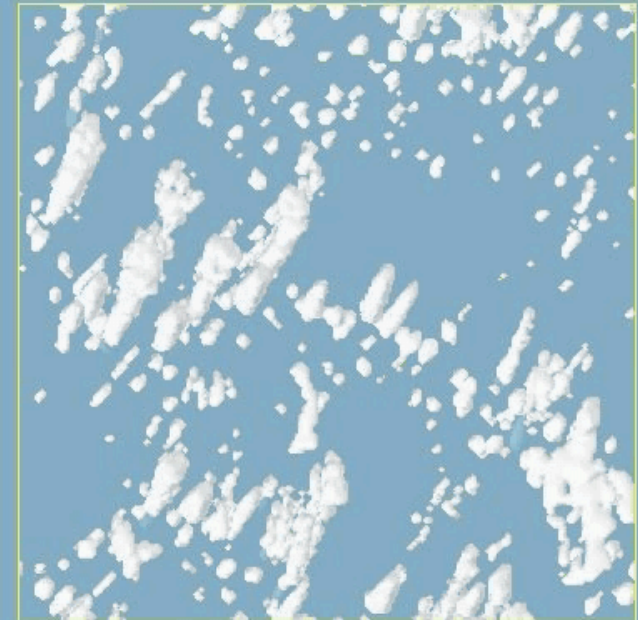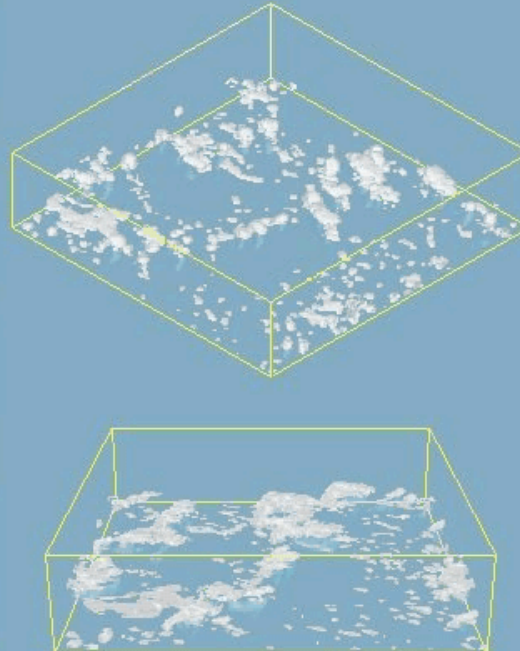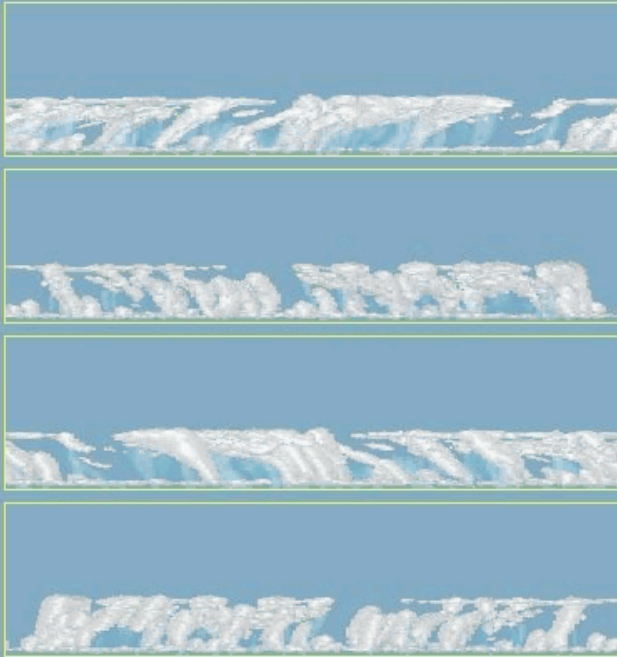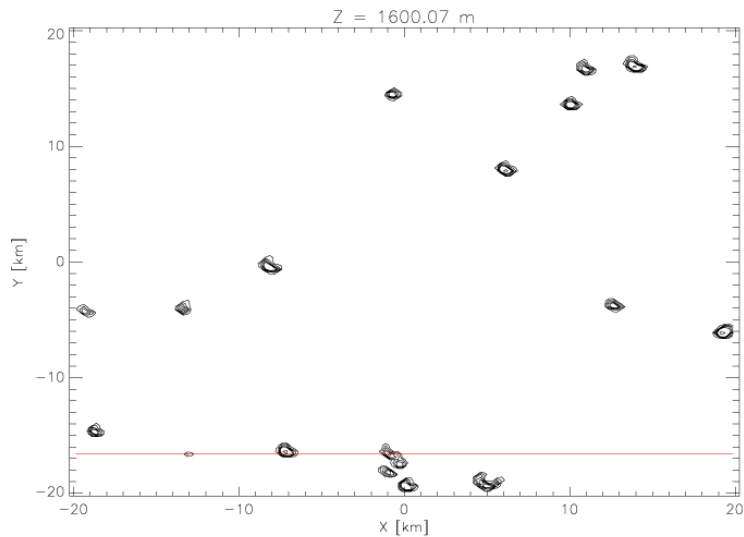
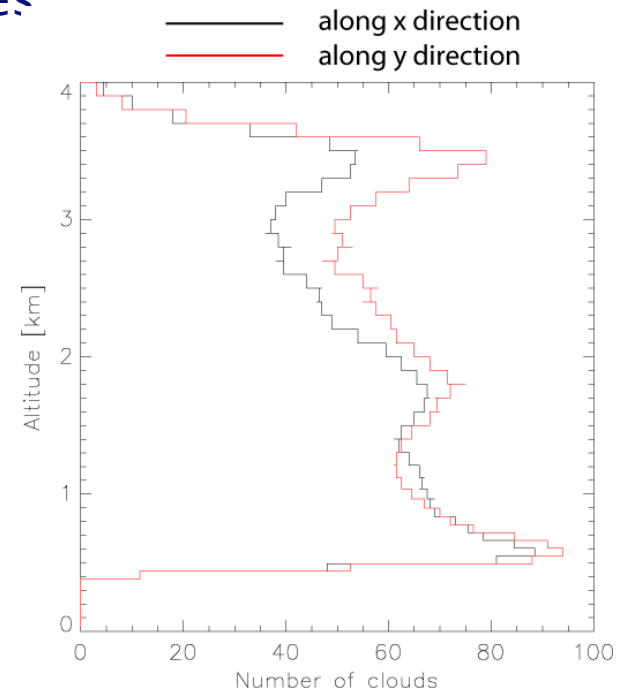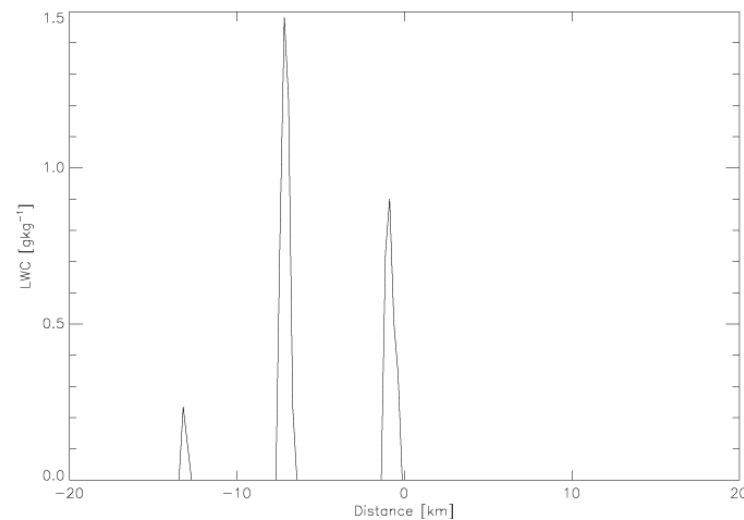# Snapshot of simulated clouds (play movie as well)

Constructing 2d series from LEM to compare with aircraft data

How do we compare LEM data with that from the aircraft?

• At each altitude level in LEM construct a 2D series of given parameter in both x and y directions (example given for LWC to left) in order to replicate an "aircraft time-series"

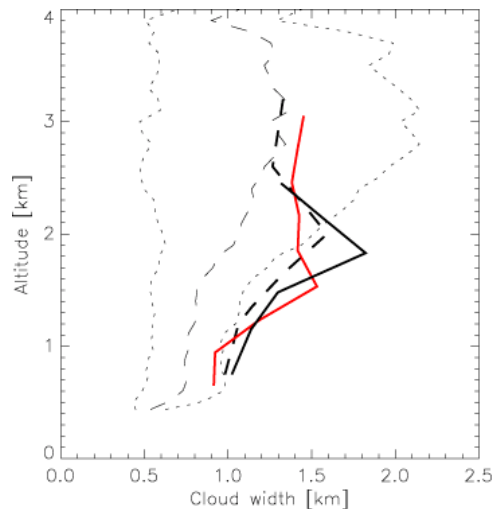# Comparison of LEM with aircraft: Bulk cloud properties

Figures show average cloud width, mean cloud LWC, and mean cloud rain LWC (2DP for aircraft) as a function of altitude.

Cloud definitions
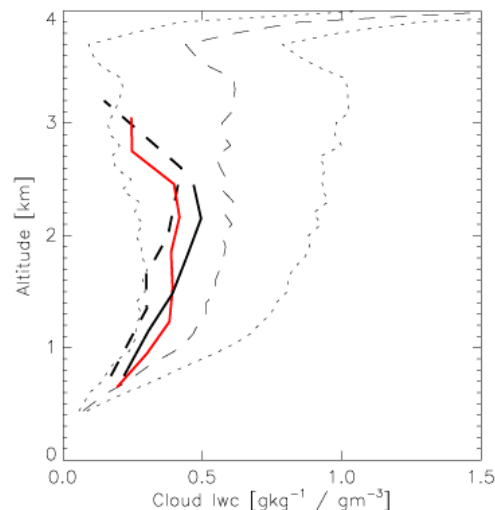LEM: LWC exceeds 0.05 gkg^{-1} for 500 m.
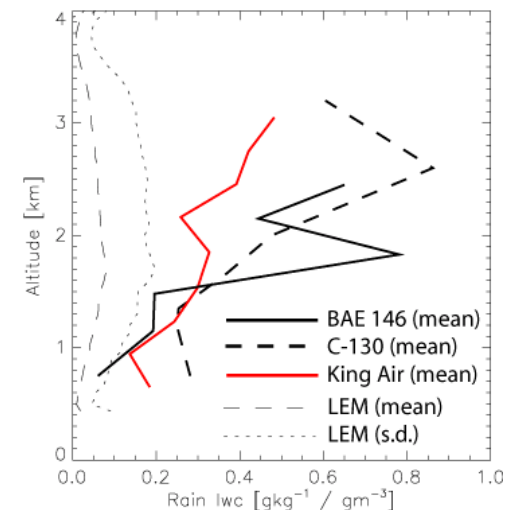Aircraft: LWC exceeds 0.05 gkg^{-1} and FSSP exceeds 5 cm^{-3} for 500 m.

Cloud width smaller in LEM

LWC larger in LEM but does have same shape of profile

Rain LWC smaller in LEM

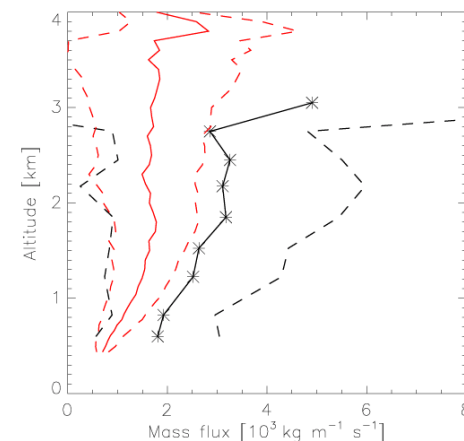# Comparison with aircraft: Updraft cores
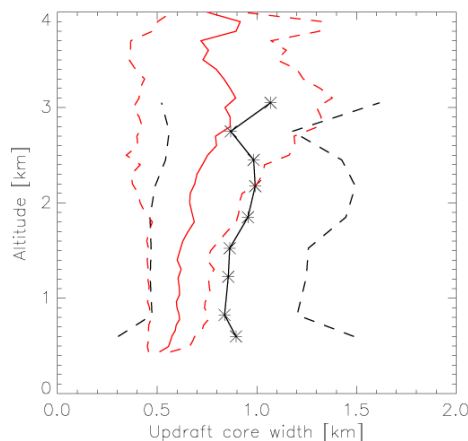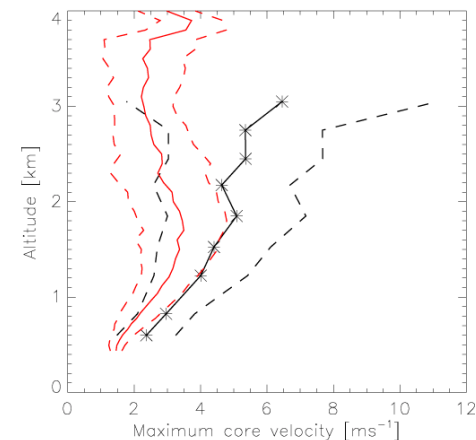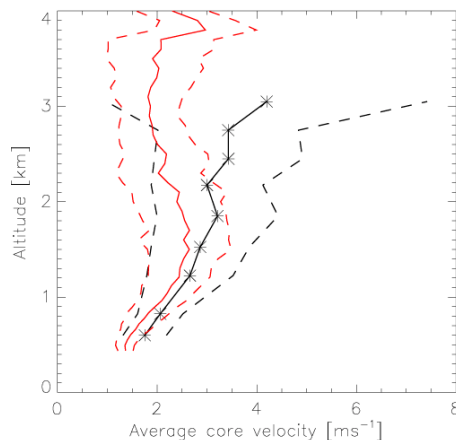
Black = Aircraft
Red = LEM

Updraft core definition

Vertical velocity exceeds 1 ms^{-1} and LWC exceeds 0.05 gkg^{-1} for 500 m.

Updraft core width and velocity smaller in LEM, particularly at higher altitudes.

Same is true of mass flux, M
M = v$_{avg}$ x width x ρ$_{air}$

Avg values over all updrafts using all three aircraft plus LEM

Summary

- A LEM simulation initialised with measured profiles from RICO (<u>one day</u>) is compared with aircraft data.

- LEM appears to have an excess of in cloud LWC and not enough rain LWC. Possible explanations are a misrepresentation of the
  - Conversion of liquid to rain water   (not enough)
  - Not enough entrainment   (result in excess LWC)
  - Size of rain drops in LEM   (if drops are too large fall out of cloud too quickly)
  - Need to look in more detail at rainshafts (only showed in cloud rain LWC)

- Cloud widths smaller in LEM.
  - Aircraft versus model sampling bias
  - Individual cloud sizes are sensitive to horizontal resolution of model.

- Updraft core velocity and width smaller in LEM.
  - Smaller width expected from typical smaller cloud widths.
  - Smaller vertical velocity (less buoyancy) suggests that the entrainment in the LEM is not the cause of too high in cloud LWC. One would expect if the entrainment was too low in the model the vertical velocity would be larger.

Future work

- Run the LEM with different initial profiles from RICO. The model runs presented use profiles from 19th Jan 2005 whereas aircraft data from the whole campaign.

- Can we improve the LEM simulations (in comparison to the aircraft measurements) by making changes to some of the parameterizations i.e. rain droplet size, auto-conversion process etc?

- How does the LEM compare with the radar data from Barbuda, satellite data etc?

- Any other ideas........