Analysis of water vapour variability and its links with convection: some IHOP_2002 preliminary results

~ some information on our activities in the years to come + data

Guichard, F., Flamant, C., van Baelen, J., Bock, O., Couvreux, F., Parsons, D., Weckwerth, T., Pelon, J., Drobinski, P., Lhomme, K., Doerflinger, E.

International H_2O Project

IHOP_2002

IHOP : International H2O experiment

(see Weckwerth et al. 2003)

PIs: Tammy Weckwerth & D. Parsons

objectives

✓to get the best possible characterization of the 4D (x,y,z,t) water vapour field;

✓to evaluate how this can lead to improvement in our current understanding and prediction of convective processes.

motivations

✓poor forecast skill for rainfall (challenge for future NWP);

✓behind this, a lack of knowledge and understanding of small-scale processes and mechanisms involved in convective phenomena;

✓though moisture is a key parameter, it is not properly measured.

the IHOP experiment (when, where, who?)

13 May – 25 June 2002, in the Southern Great Plains

~250 researchers (USA, Germany, Canada & France)

~50 instrumented platforms (fixed and mobiles - 6 airplanes, trucks)
soundings (> 2500), radars, **lidars**, interferometers, **GPS**...

Lidar LEANDRE 2

measures of **water vapor mixing ratio** r_v

(differential absorption, 2 λ)

$\Delta x \sim 10$ m

on board the P-3 airplane

vertical cross section +

for the first time ever, **horizontal cross sections of r_v**

142 h of flight, ~ 25 cases

GPS (global positionning system)

measurements of **precipitable water**

continuous flow of data $\Delta t \sim 15$ min

tomography (dz ~ 200 m in BL to 1 km above)

7 stations added to the existing networks

(ongoing projects for future assimilation in NWF models)

- see **Van Baelen et al.** poster **G4- P0637 tomorrow**

SOME OF THE TOPICS INVESTIGATED WITHIN IHOP

boundary layer processes, **diurnal cycle**, **W-E gradients**

✓organization, rolls, variability
✓impact on convective initiation

the **« dryline »**, a common **mesoscale phenomena** there playing a strong role in **convective initiation**

✓moist air from the Gulf of Mexico meeting warm air from the Rockies
✓Strong moisture gradient in the boundary layer
✓(width ~10 km, length ~100 km and more)

✓convection typically develops within a few 10's of km from the dryline (Bluestein & Parker 1993)

bore-type events (very frequent, surprising observations from IHOP)

✓life cycle
✓impact on the maintenance of nighttime convection

quantitative precipitation forecast (QPF), see D. Parsons

SOME PRELIMINARY RESULTS

boundary layer evolution (diurnal cycle)

bore-type events

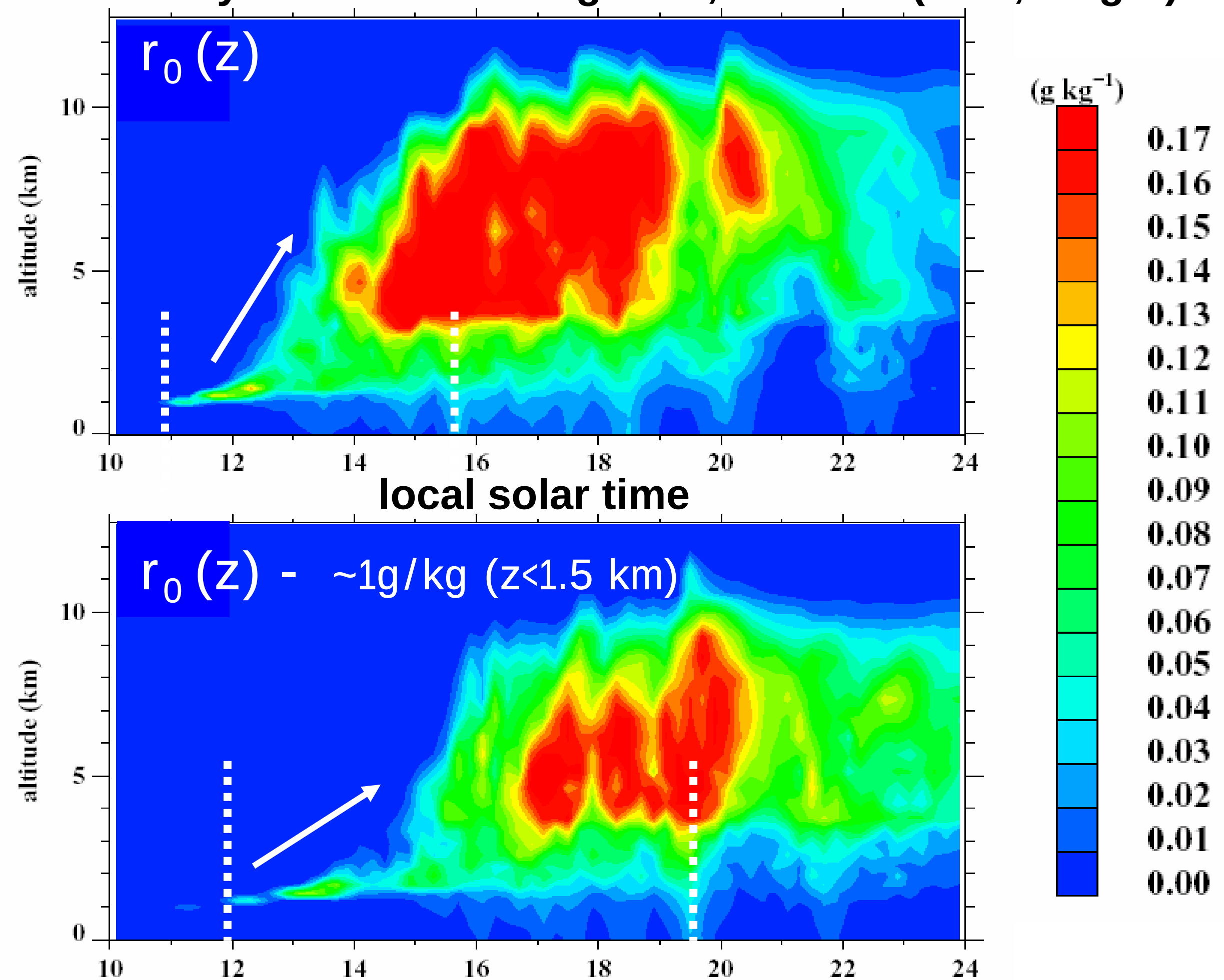
assimilation of boundary layer data in mesoscale model

boundary layer evolution: basic considerations

CRM simulation
Δx =2km

diurnal convection over land

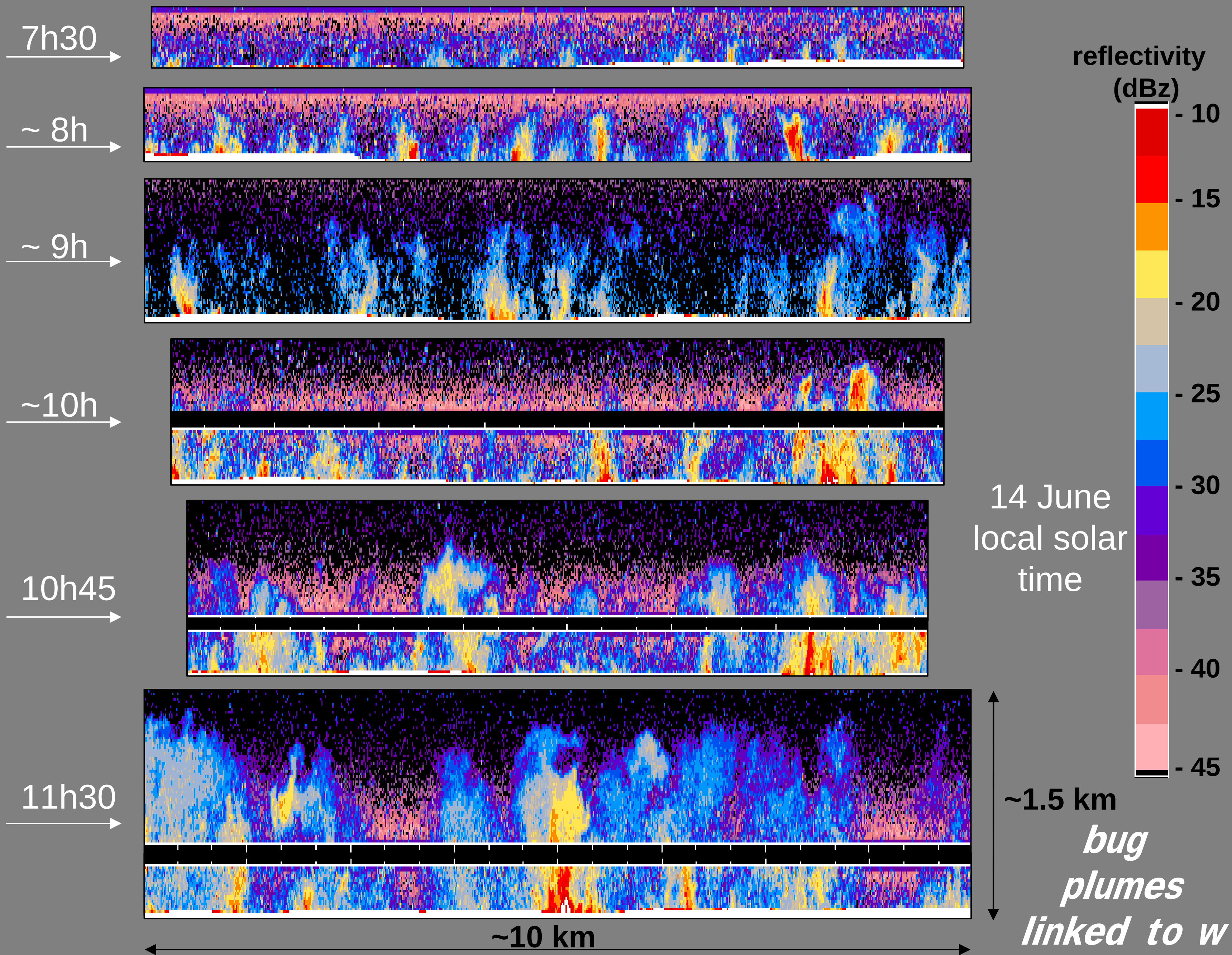
total hydrometeor mixing ratio, function (time, height)

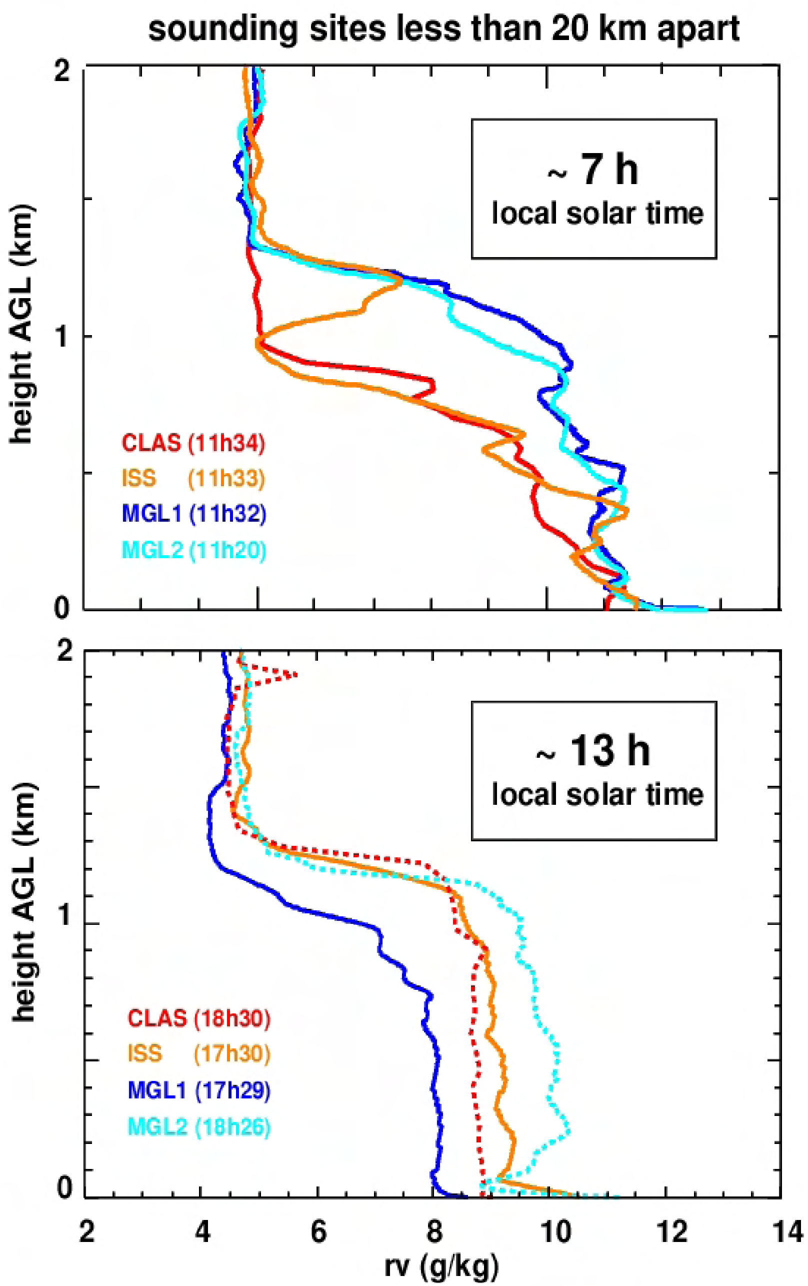


convection very sensitive to the initial moisture profile (Crook 1996)

before the onset of deep convection, the evolution is partly controlled by small scale boundary layer processes; results sensitive to subgrid-scale parameterizations *(«mechanistic» BL schemes recently developed)*

Boundary layer evolution: WCR (t-x,z) data, courtesy of B. Geerts

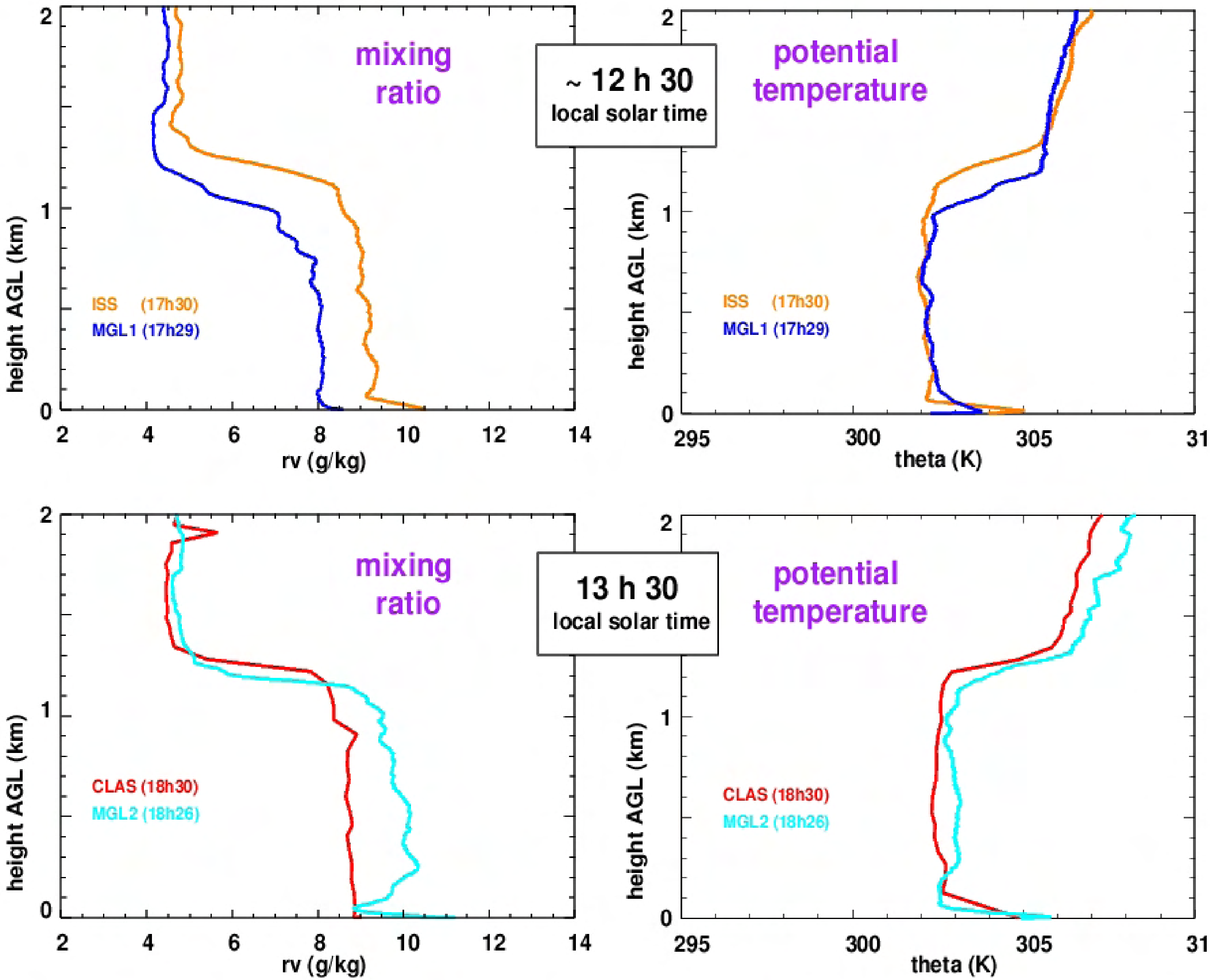




designing an LES case study

choice of initial conditions ?

evaluation of mean fields?



Δ r_v ~ 1 g/kg

$\Delta\theta$ < 1 K

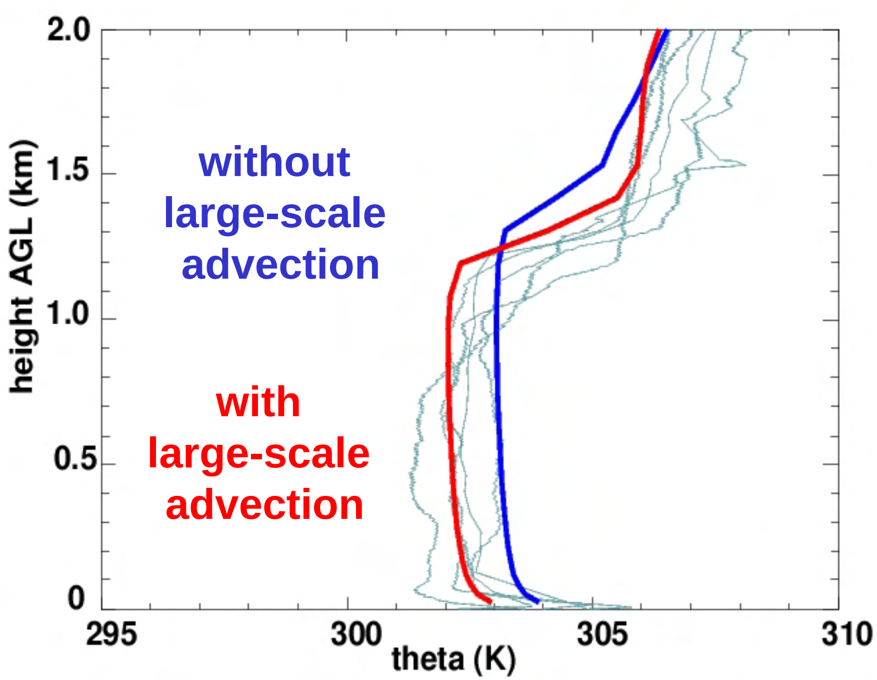
general agreement with Weckwerth (1996)

impact on the BL mean diurnal evolution
of uncertainties in

- ✓ the initial conditions *(mesoscale variability)*
- ✓ surface heat fluxes *(Bowen ratio)*
- ✓ larger-scale advection *(weak wind conditions)*

similar range of sensitivity

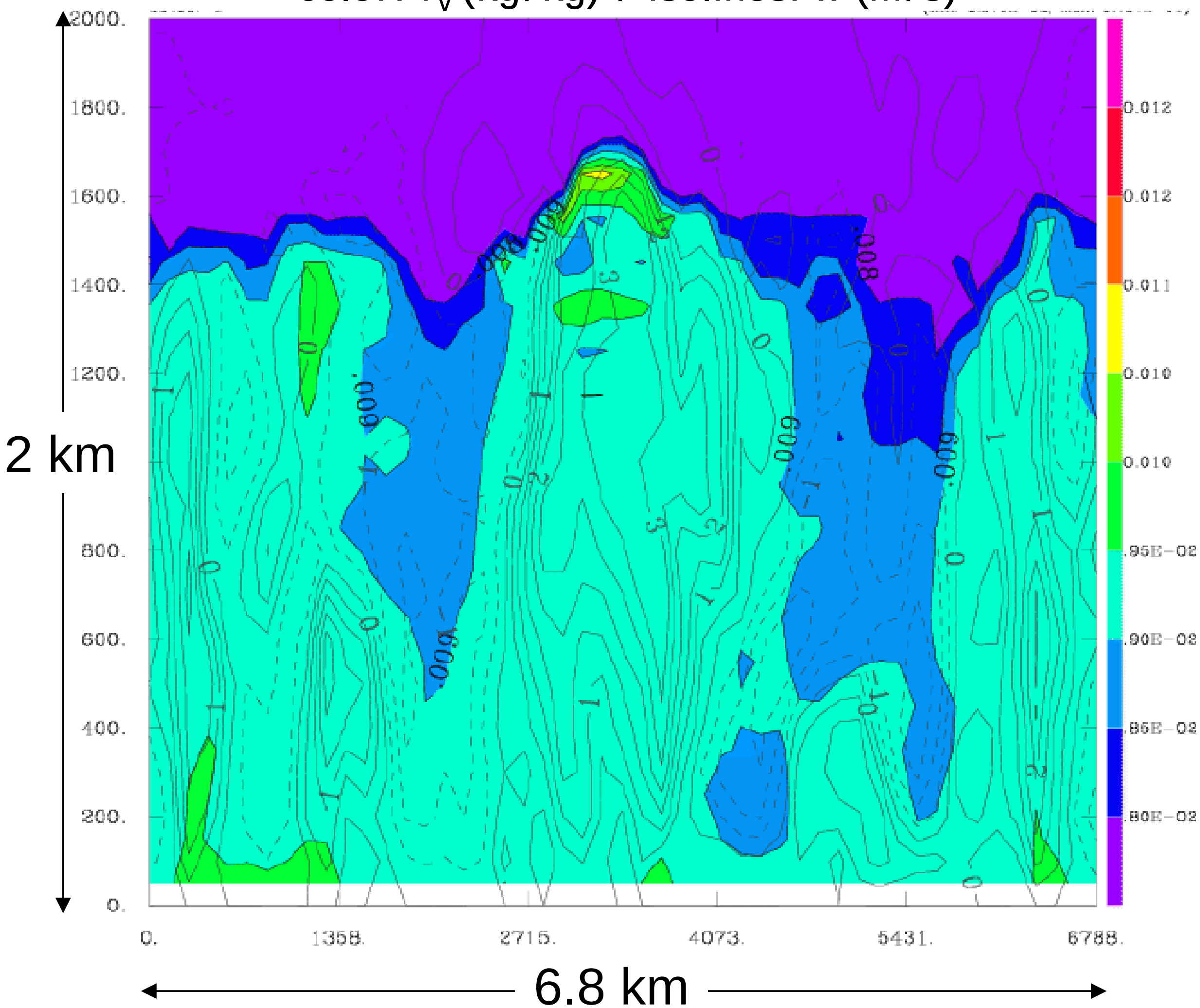
(1D tests with MesoNH)



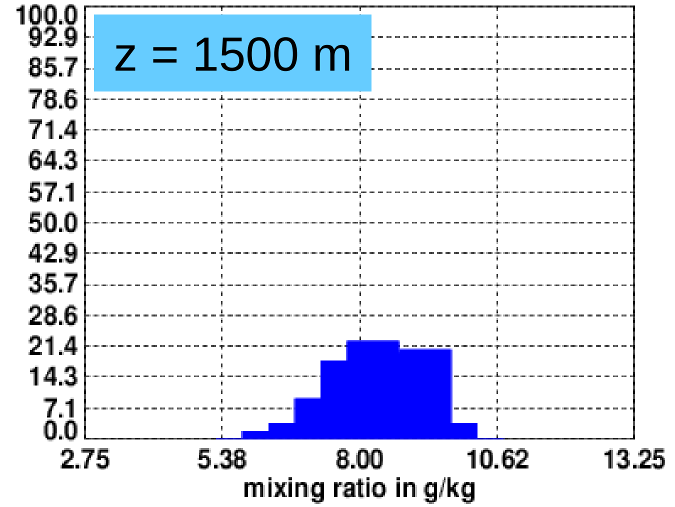
preliminary LES results with MesoNH

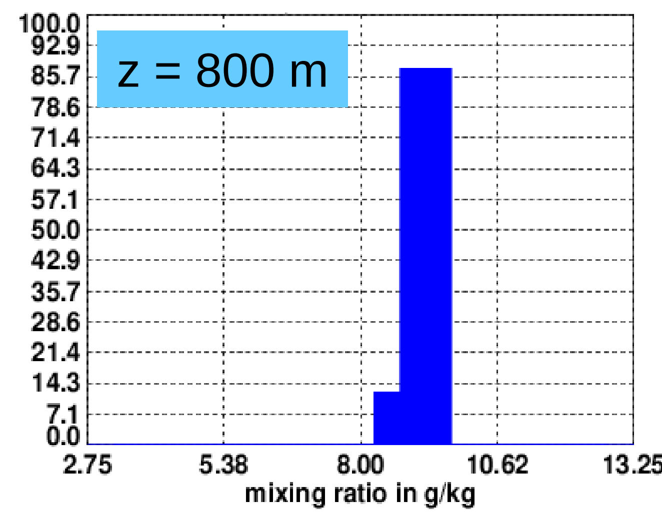
(dx = 100m Lx = 5 km)

color: r_v (kg/kg) / isolines: w (m/s)

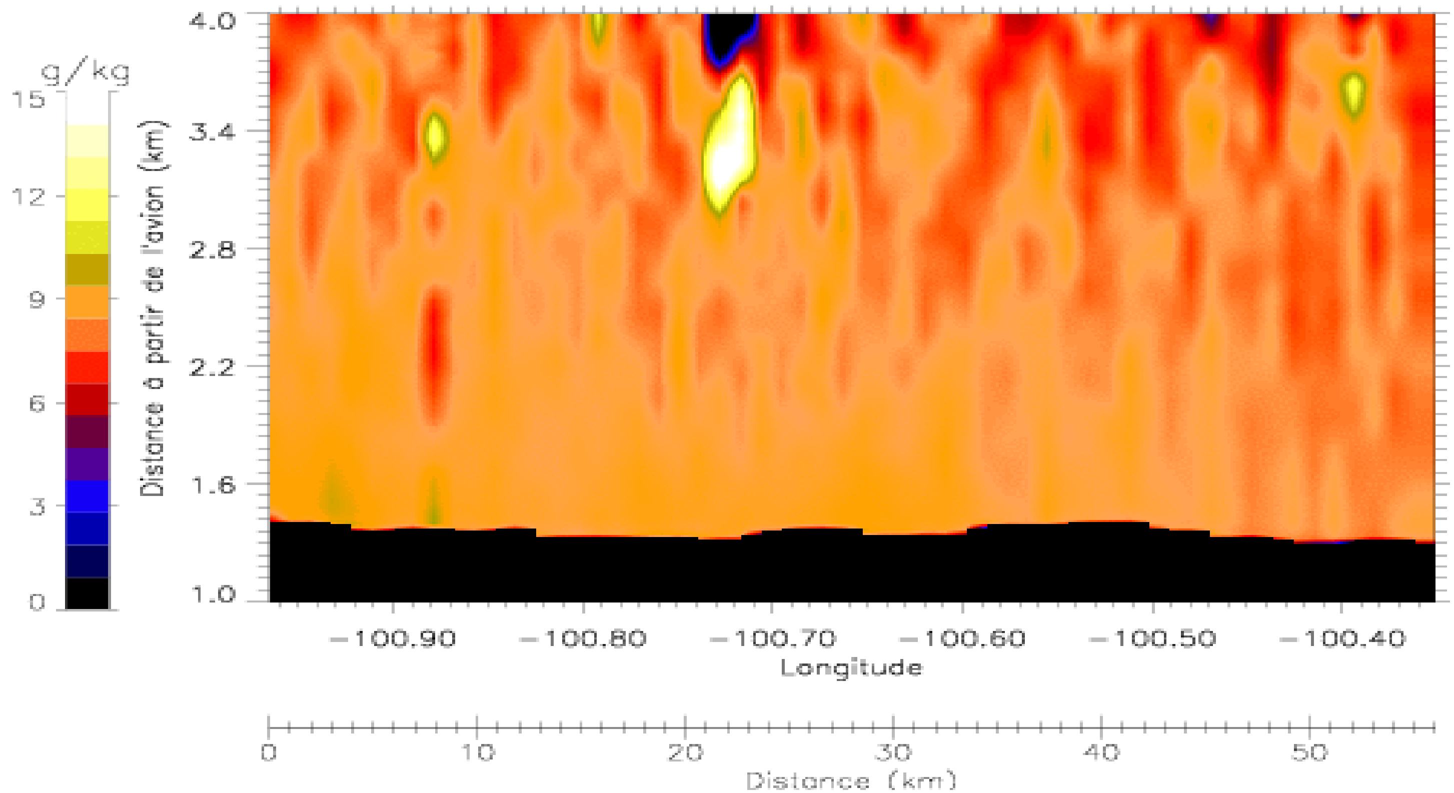


r_v distribution





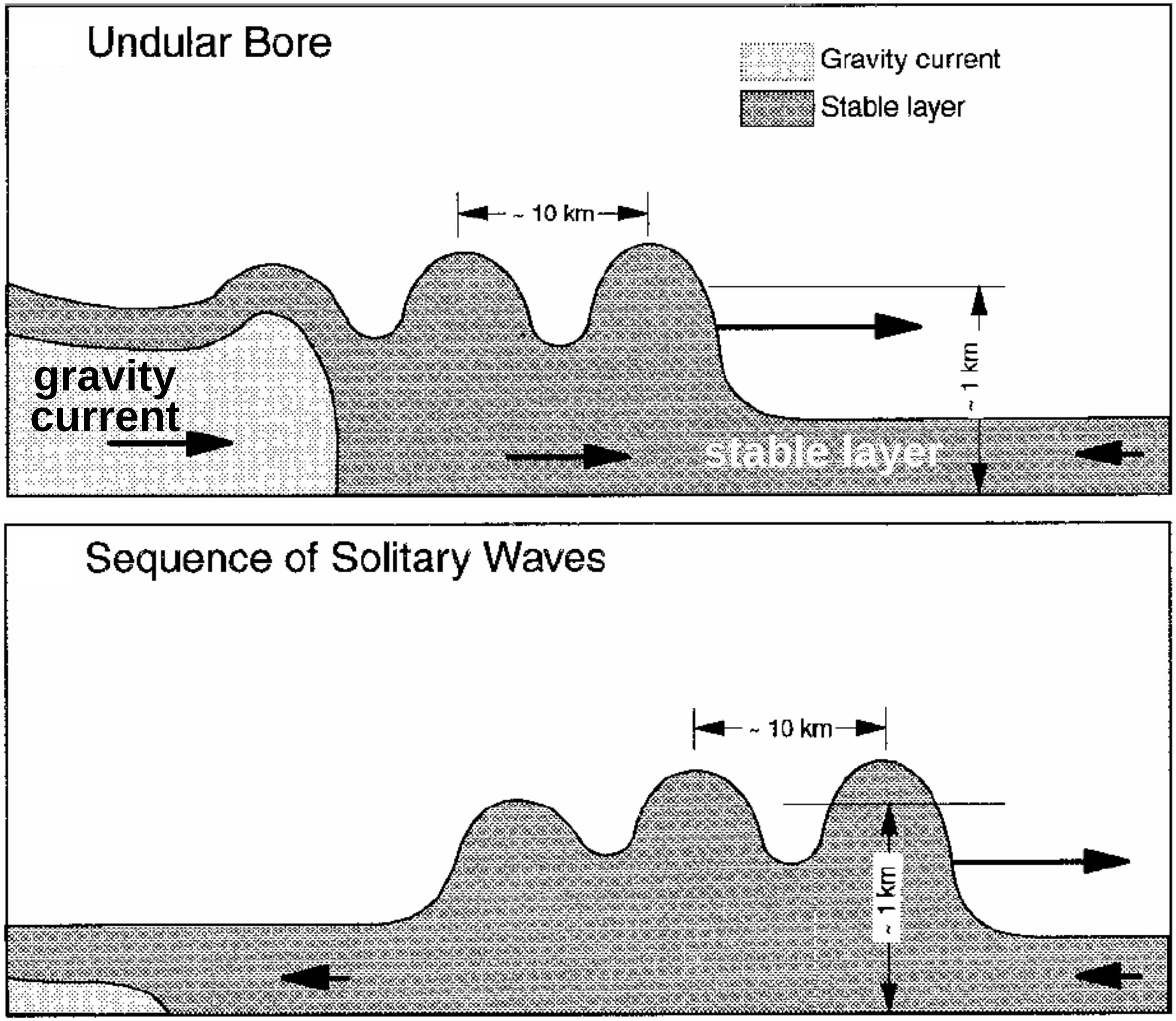
spatial & temporal organisation, variability,
comparison with LEANDRE 2 data
... ongoing work



L2 data, 14 June 2002

almost 30 bore-like events observed, not expected impact on convective initiation?

bore: type of gravity wave disturbance propagating ahead of a gravity current

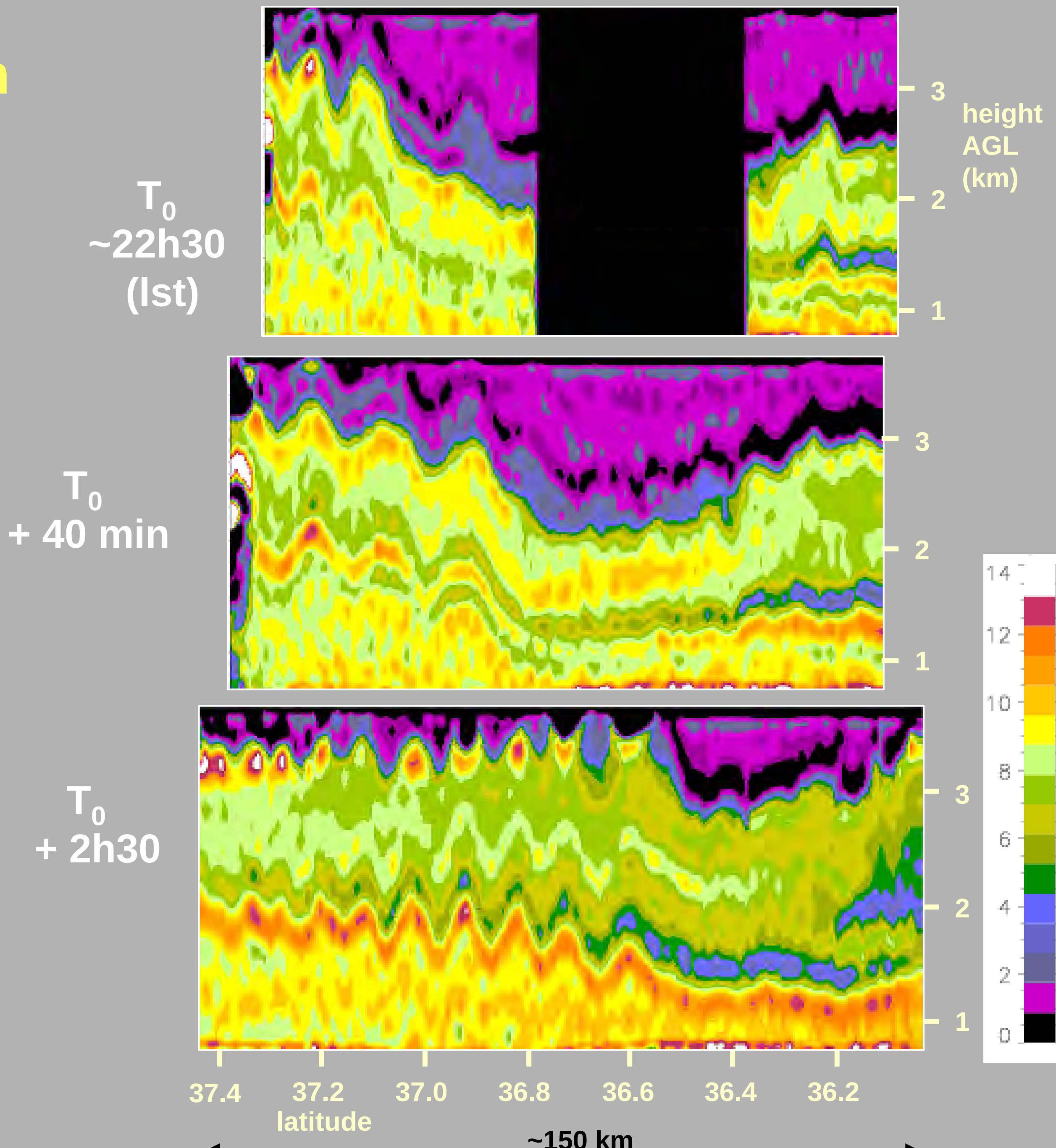


... that may further evolves into a sequence of solitary waves

... a very idealized picture

from Locatelli et al. (1998)

temporal evolution of a bore: mixing ratio rv (x,z) measured by LEANDRE2



other observations

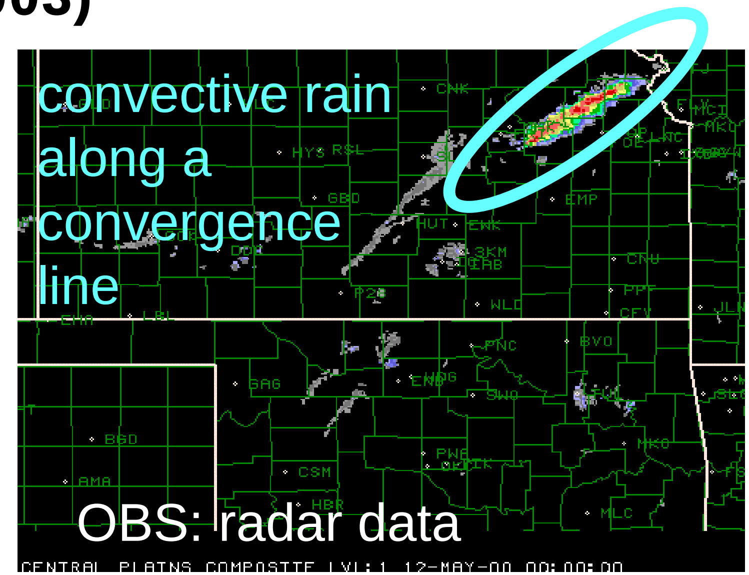
model performance

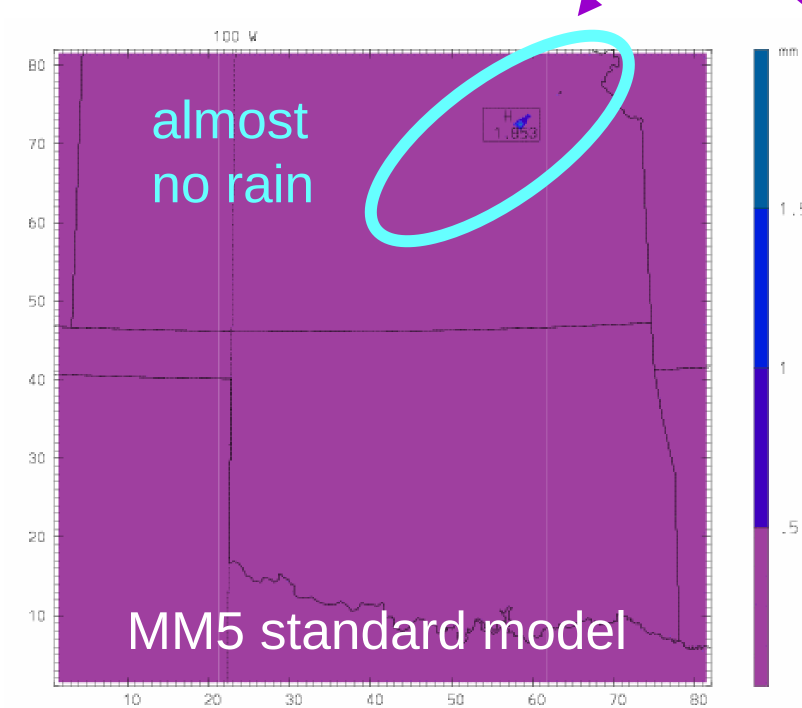
Couvreux, Weckwerth and Pinto (2003)

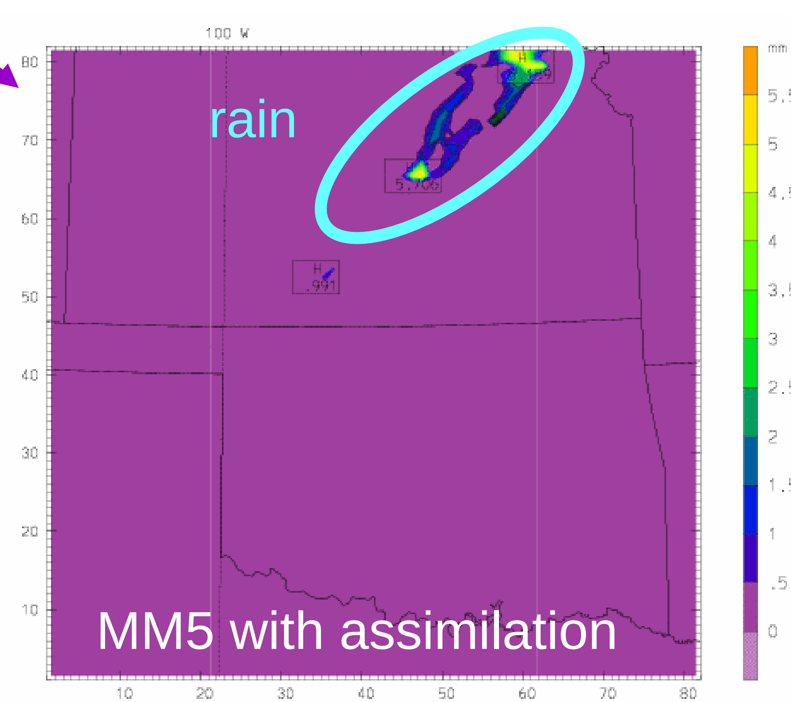
assimilation of data from
6 interferometers in a
mesoscale model (MM5)
Δx ~10 km
(θ & qv profiles below 3km)

can be quite positive

(IHOP period investigated)







conclusion, perspectives

a **very large dataset** has been collected documenting

- ✓boundary layer diurnal cycle
- ✓boundary layer spatial heterogeneity
- ✓convective initiation phases *(with/without convection)*
- ✓bore-type phenomena

On-going activity :

analysis of data, cross-instruments validation

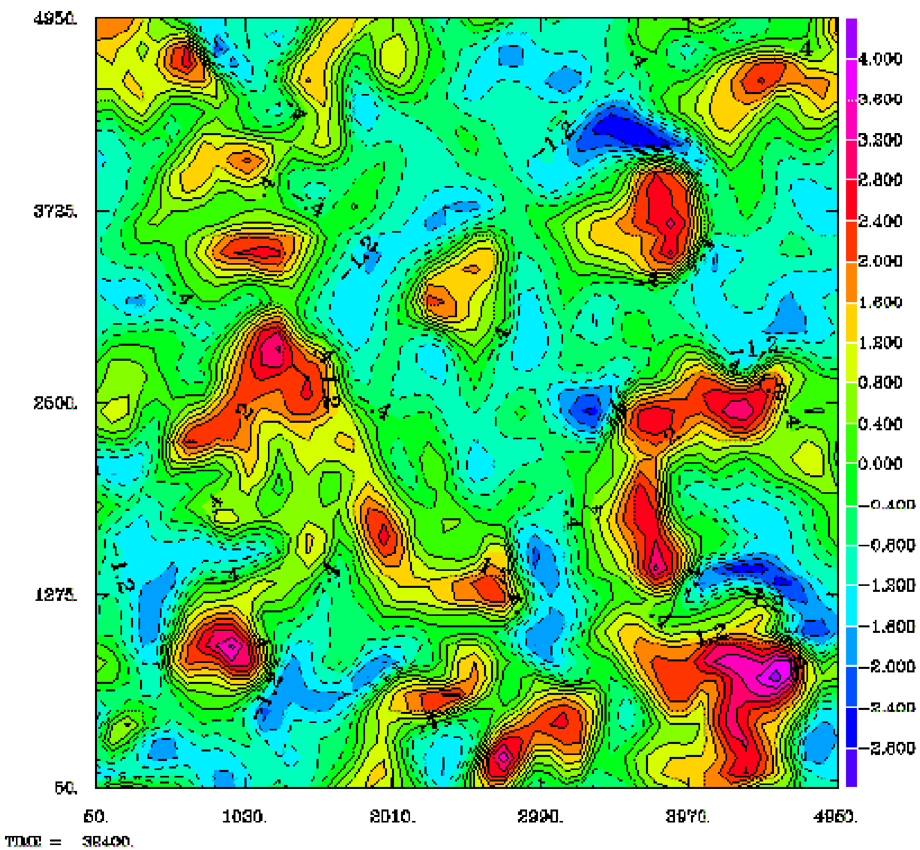
boundary layer evolution (regimes: rolls, plumes...)
LES validation (unique dataset)
modelling: jump to nested simulation, trajectory analysis

bore: true bore? life cycle? role in the maintenance of convection? agreement with hydraulic theories?

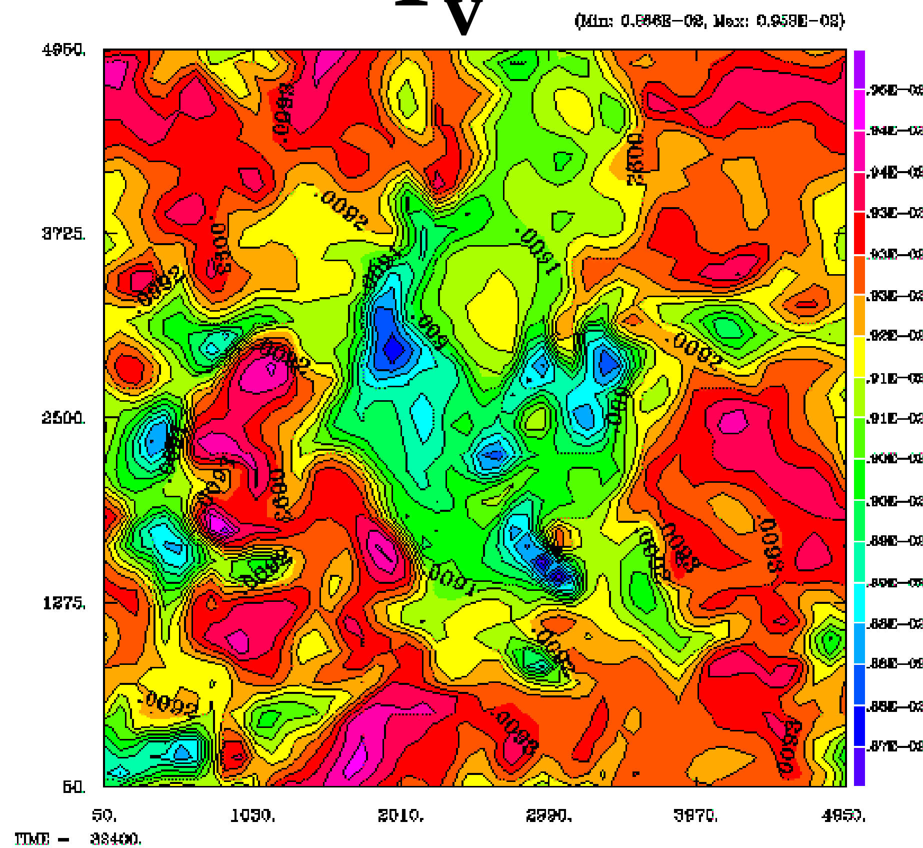
the end

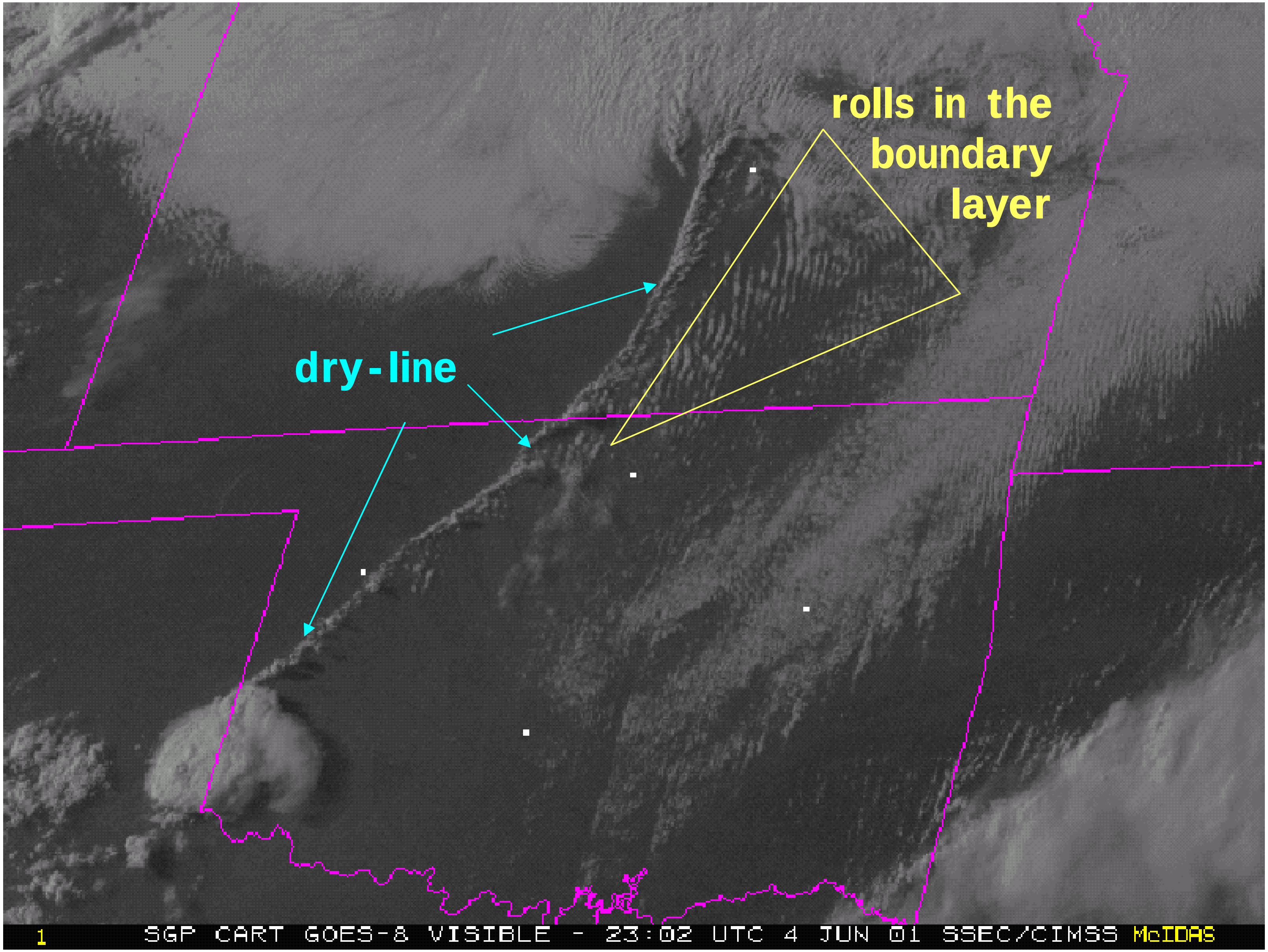
XY section in the middle of CBL (700 m) at 16h local solar time

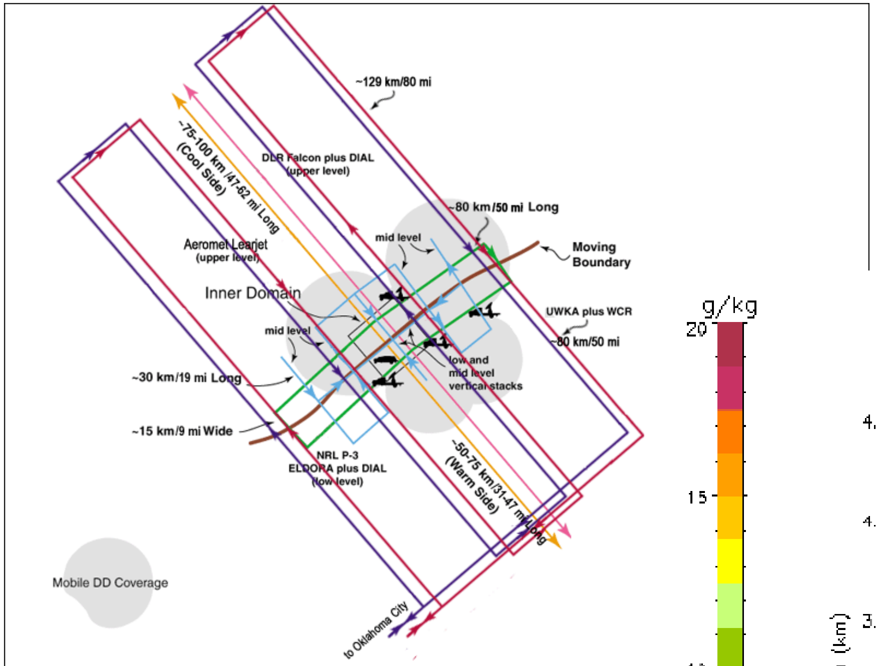
w

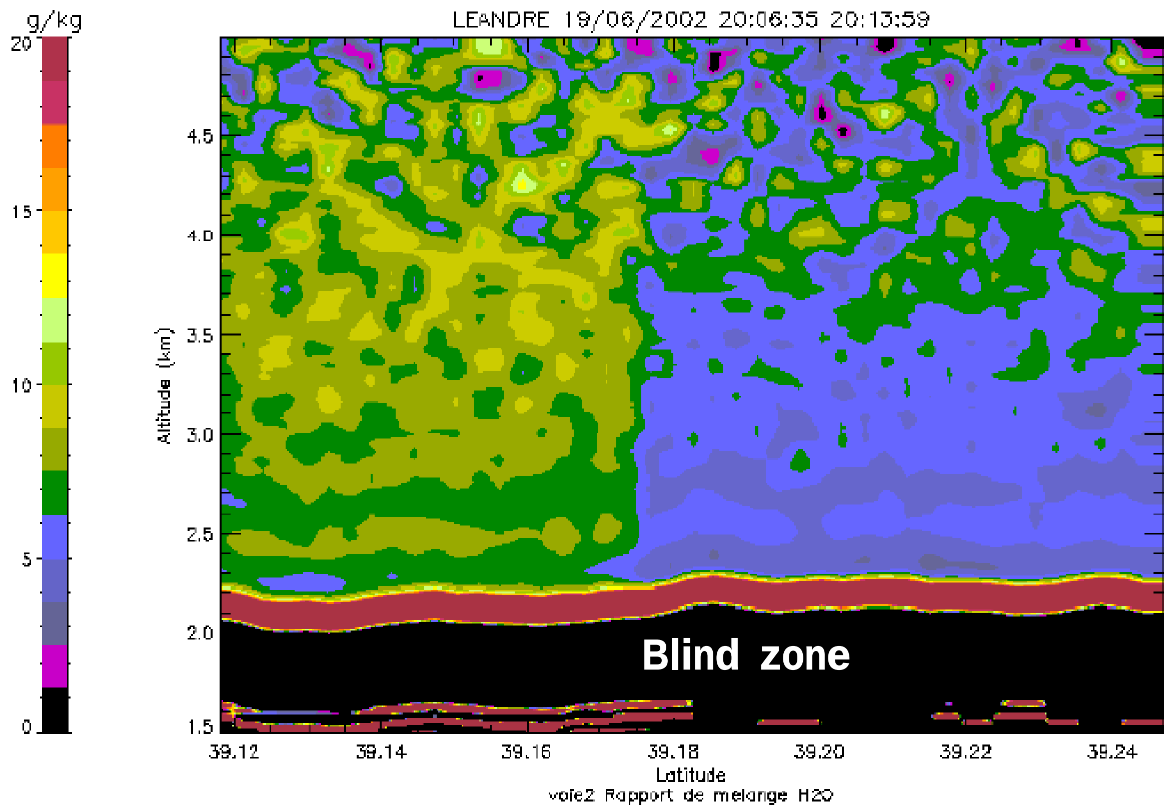


r_v



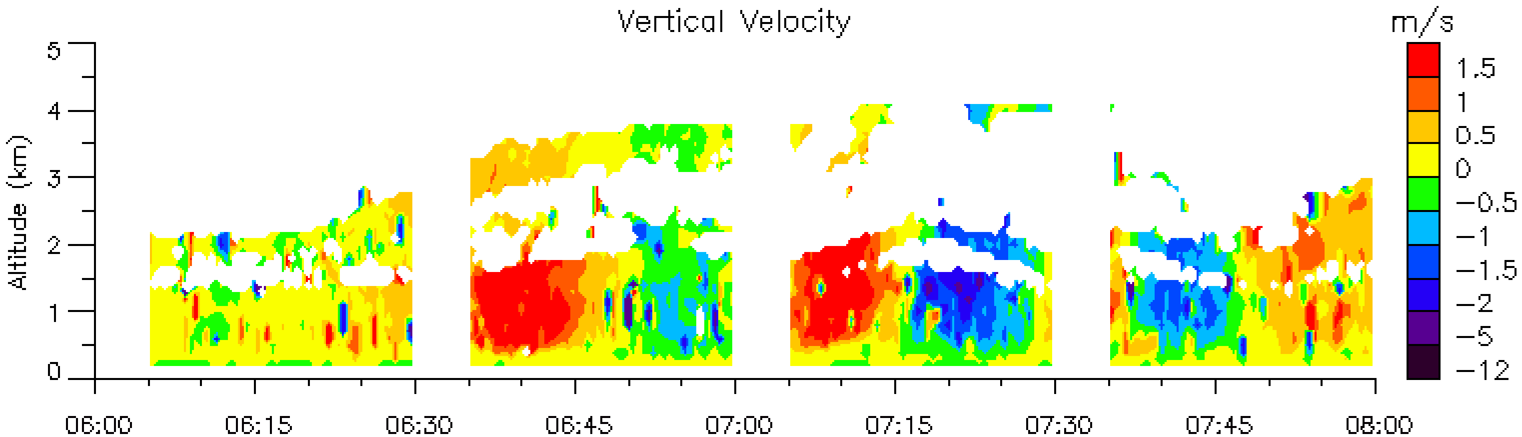

rolls in the
boundary
layer
dry-line
1
SGP CART GOES-8 VISIBLE - 23:02 UTC 4 JUN 01 SSEC/CIMSS McIDAS





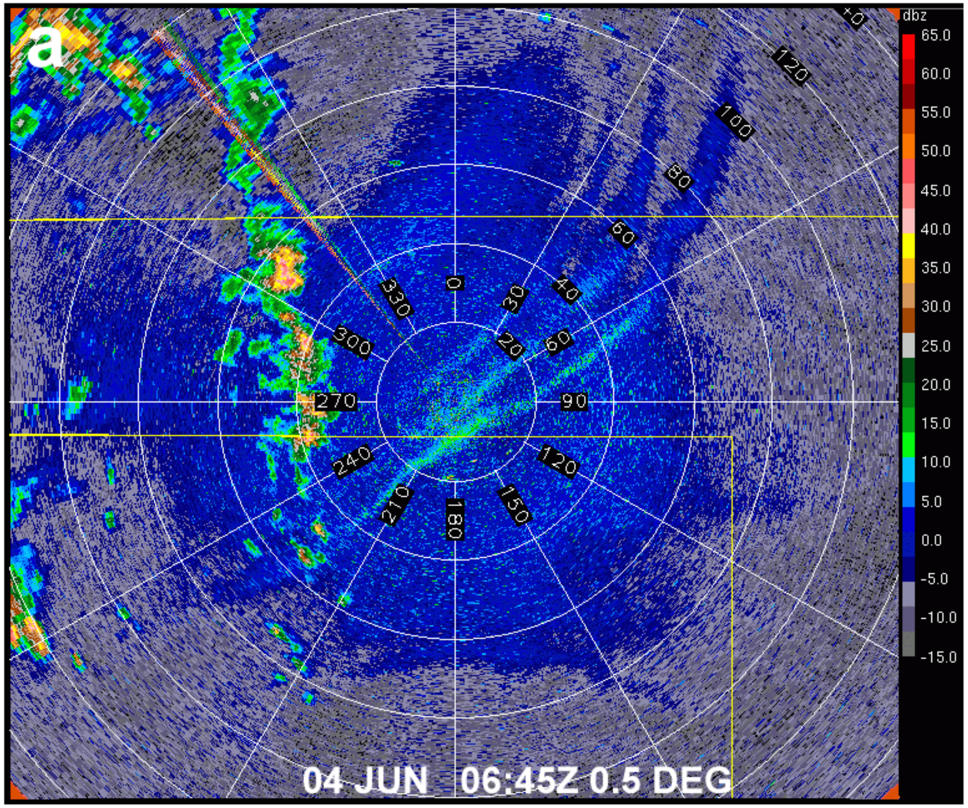
CI mission
19 June 2002

LEANDRE 2 data:
horizontal cross section of rv in the boundary layer,
1500 m AGL (sideway pointing) through a « dry-line »



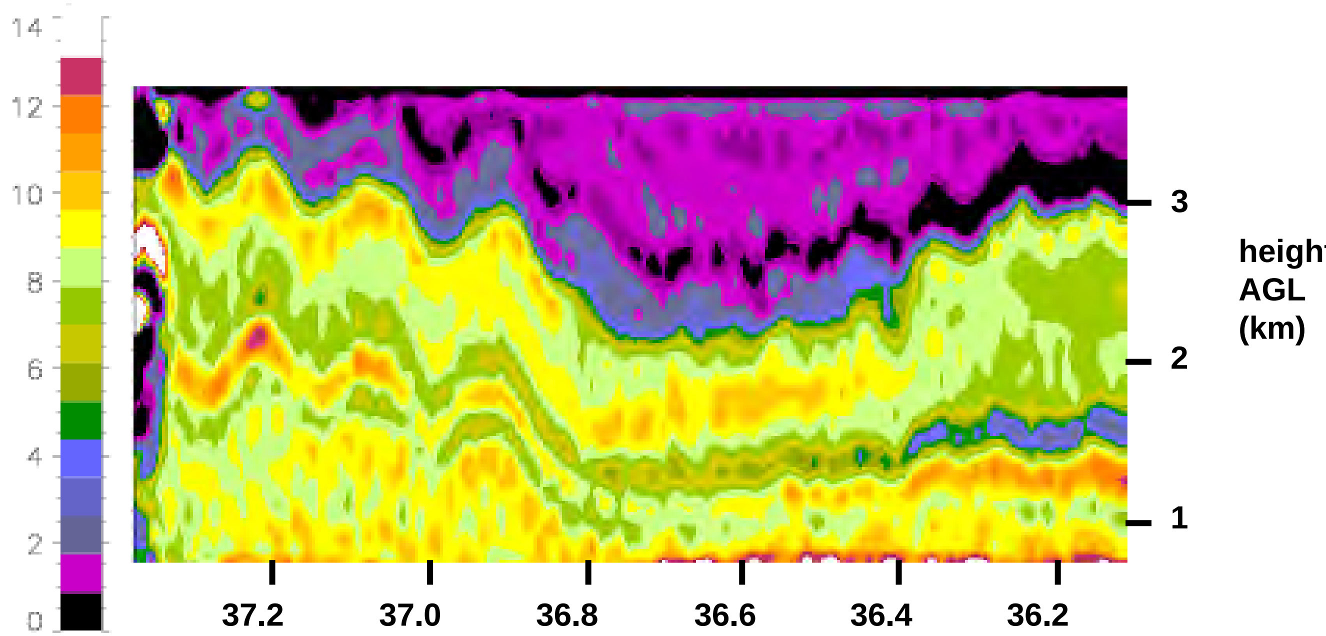
Solitary wavetrain within the bore system as seen in the MAPR vertical velocity data (4 June 2002)

S-Pol 0.5-degree elevation angle reflectivity 0645 UTC 4 June 2002.



from Weckwerth et al. (2003)

observations
LEANDRE 2



mesoscale
model
Δx = 10 km
(MM5)