The EUROCS stratocumulus case: Observations and numerical simulations of the diurnal cycle of stratocumulus

Status on the intercomparison; data availability, deliverables, papers

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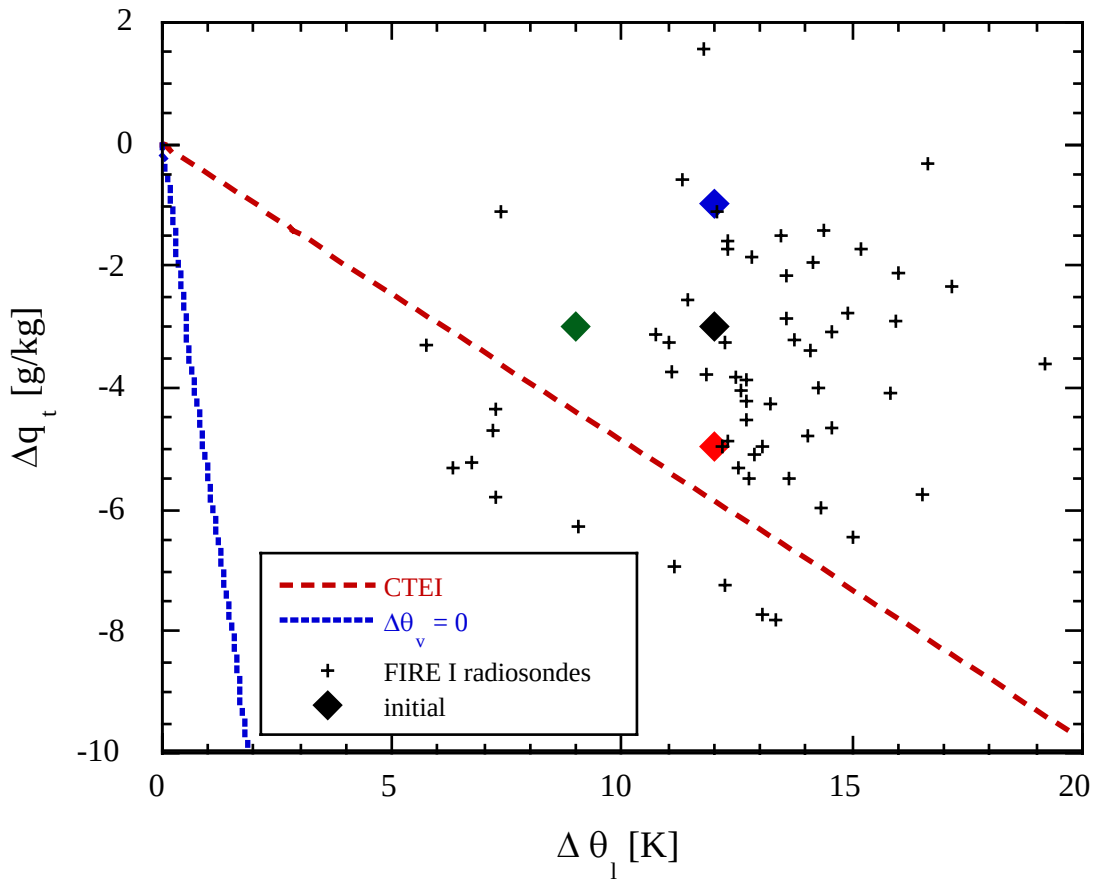
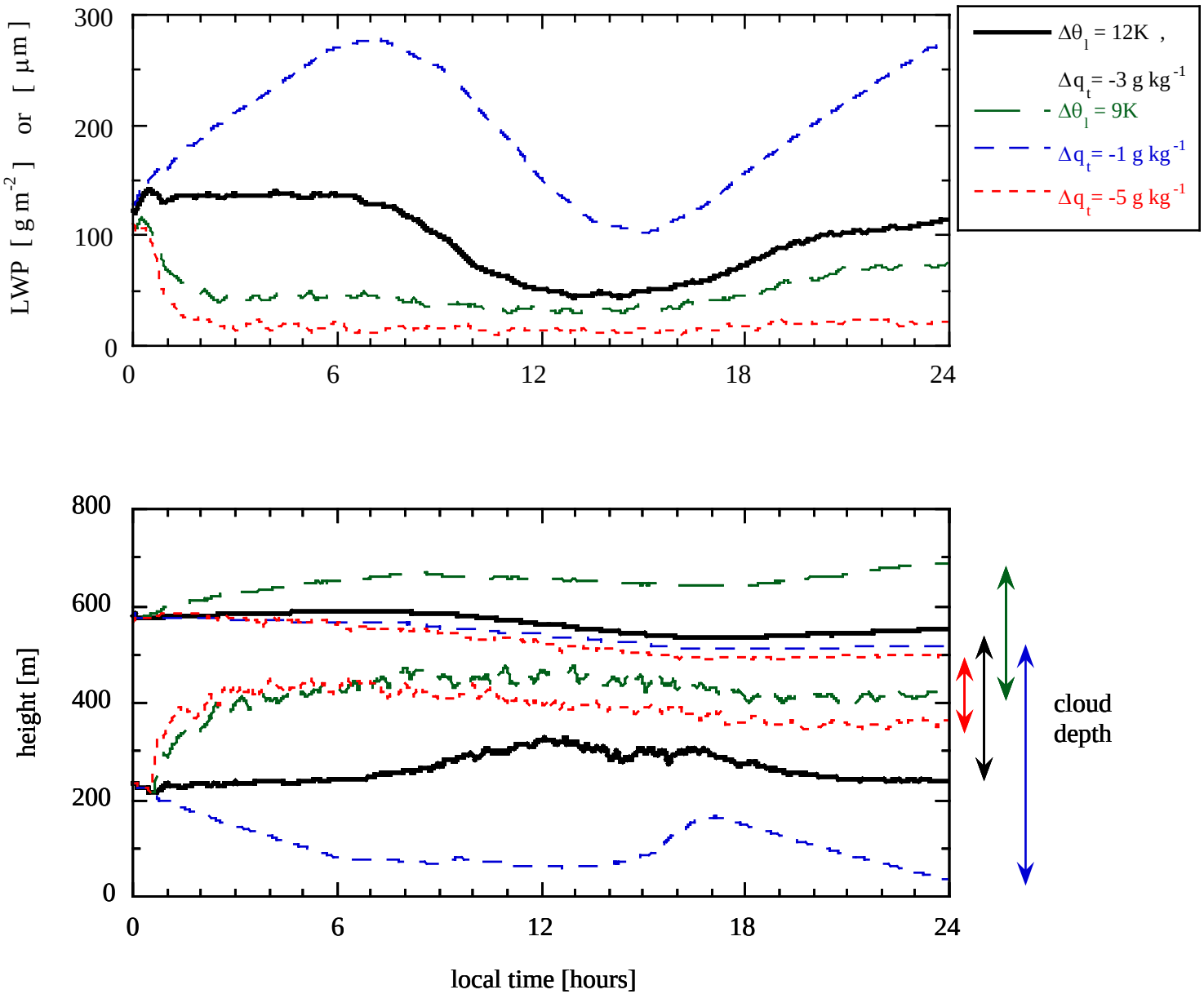
LES results - Sensitivity to inversion jumps



LES results - Sensitivity to inversion jumps - LWP



Large-scale subsidence

- No observations -> we rely on large scale models

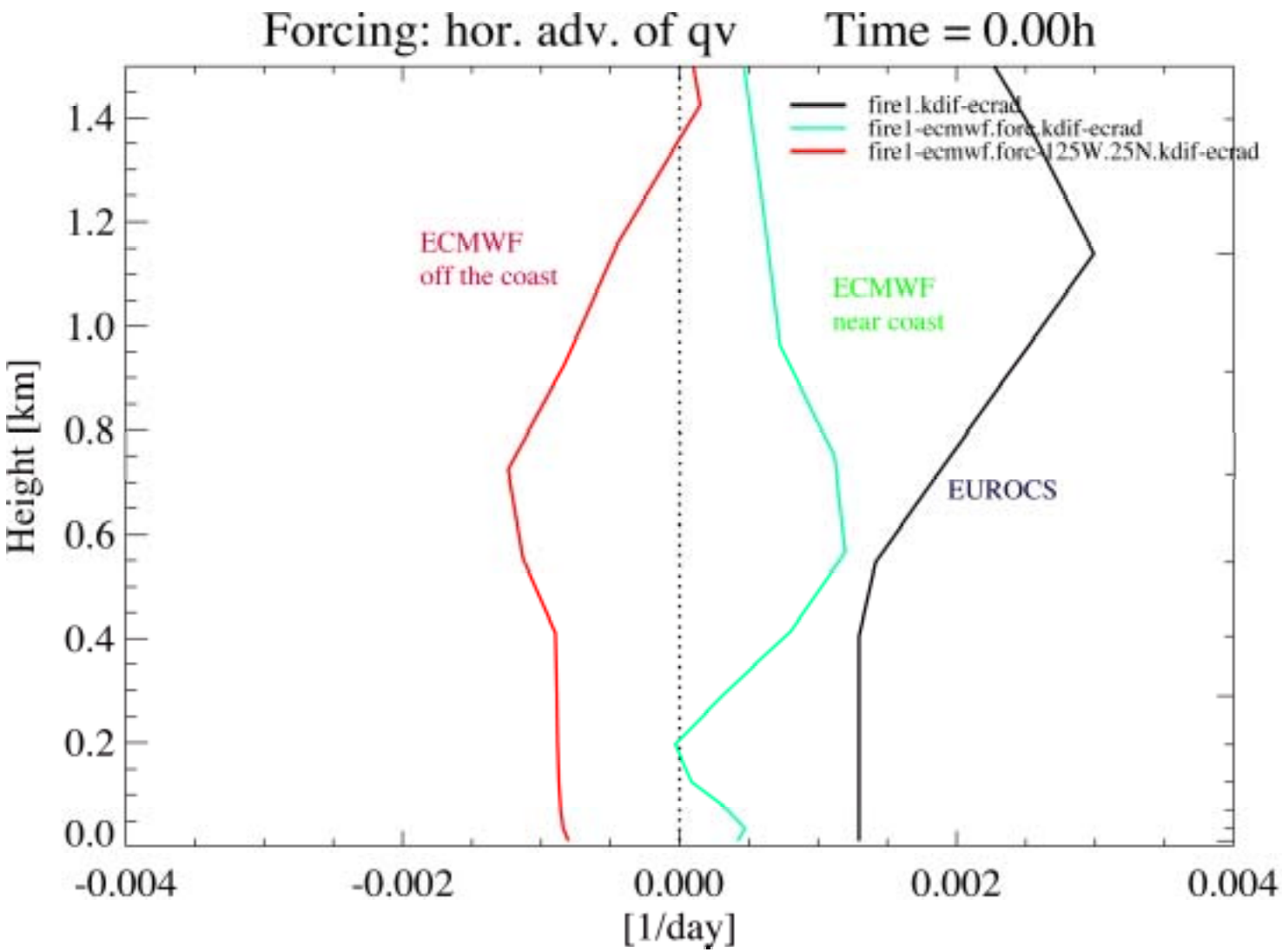
- Utrecht meeting:

  IMAU: model not sensitive to applied subsidence rate

  MPI : opposite finding

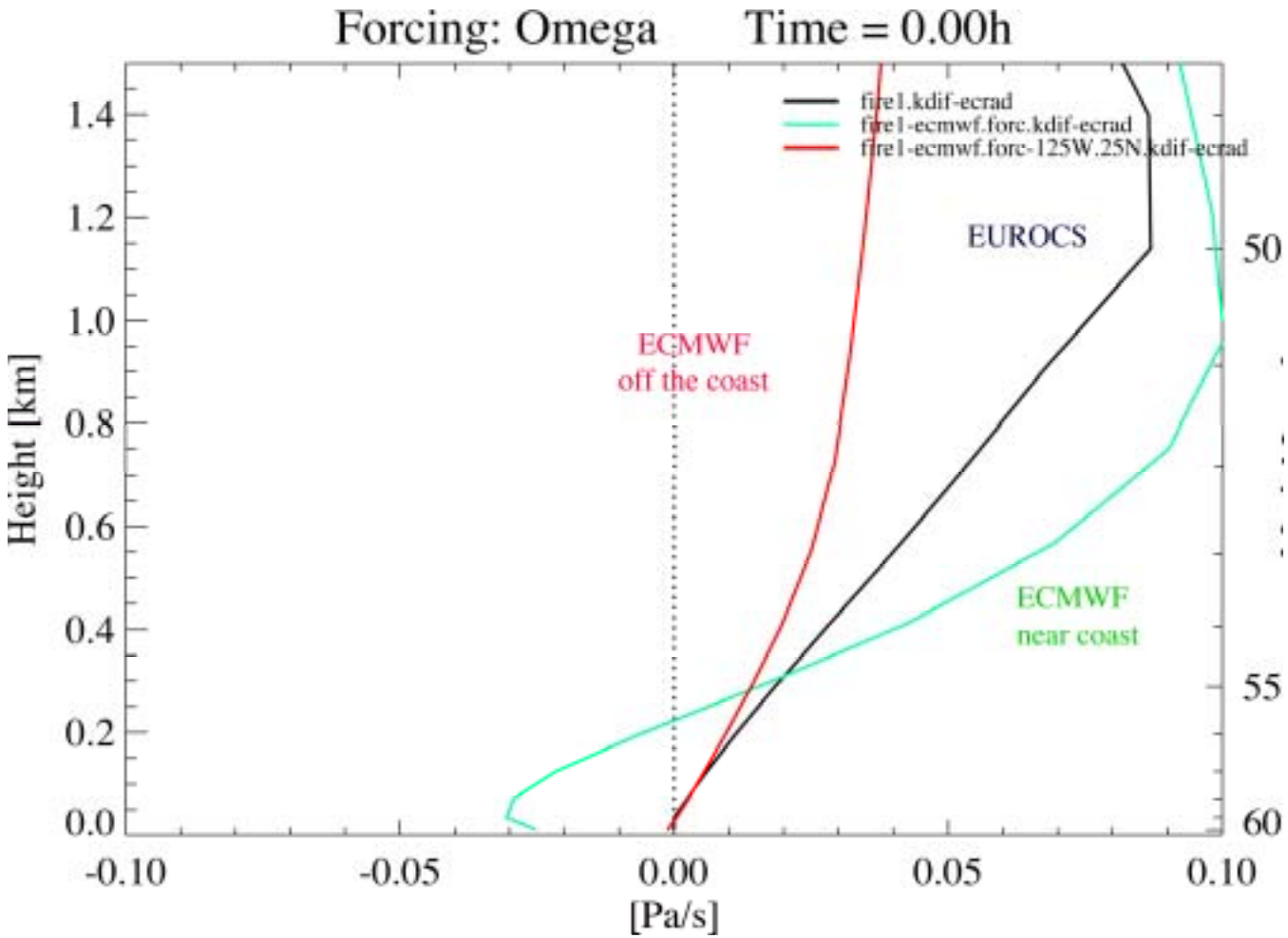
  ECMWF subsidence (Martin Koehler)

Large-scale forcing: EUROCS & ECMWF



Source: Martin Koehler (ECMWF)

Large-scale forcing: EUROCS & ECMWF subsidence



Tendencies due to large-scale advection in EUROCS case

Subsidence and horizontal advection balance: $d/dt(\theta,q)_{FA} = 0$

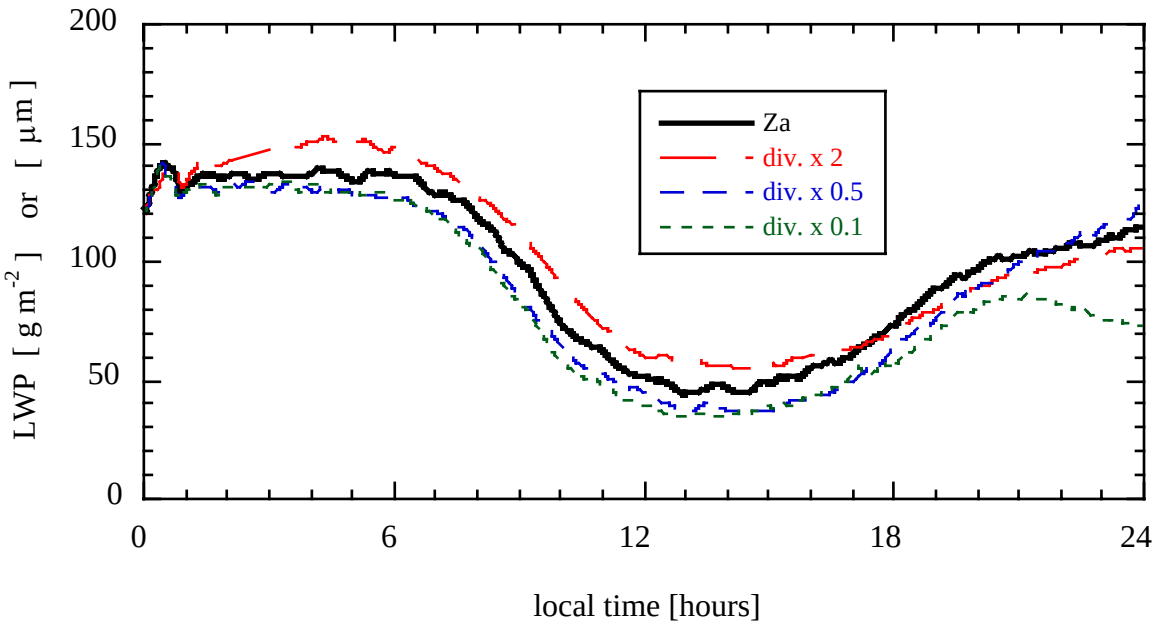
Large-scale forcing: LES sensitivity tests

1, Vary subsidence rate, but keep total large-scale forcing the same ($d/dt_{FA}=0$)
(Margreet van Zanten, IMAU)

2. Vary large-scale horizontal advection, same subsidence rate
(Andreas Chlond, MPI)

3. Vary large-scale horizontal advection in the boundary layer only
(Andreas Chlond, MPI)

LES results - Sensitivity to subsidence



LES results - Sensitivity to large-scale forcing (MPI)

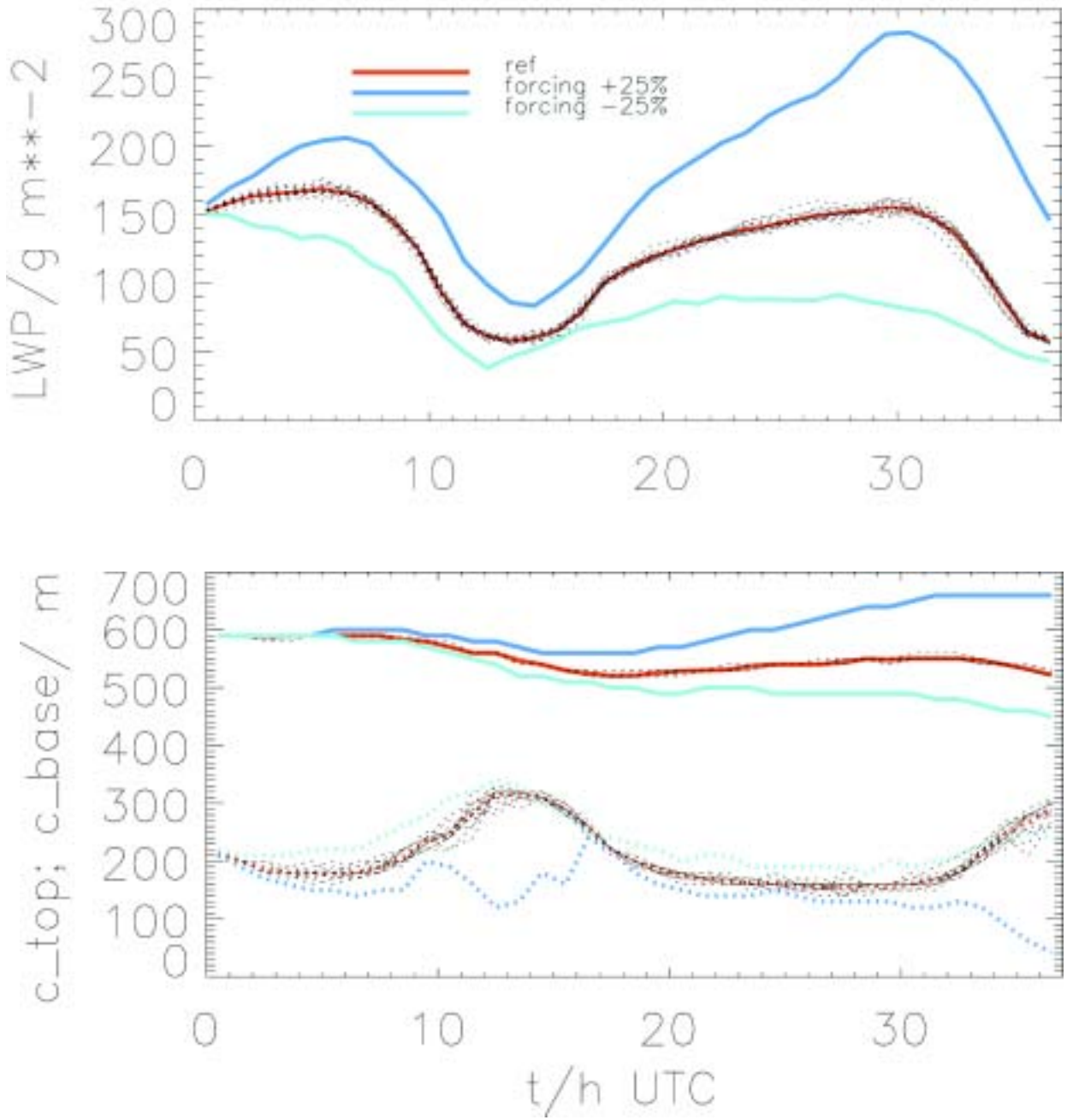
$$\left(\frac{d\theta_l}{dt}\right)_{LS} = -7.5 \cdot 10^{-8} \max(z, 500) \left[\mathrm{K s^{-1}}\right]$$

$$\left(\frac{dqt}{dt}\right)_{LS} = 3.0 \cdot 10^{-11} \max(z, 500) \left[\left(\mathrm{kg \cdot kg^{-1}}\right) \mathrm{s^{-1}}\right]$$

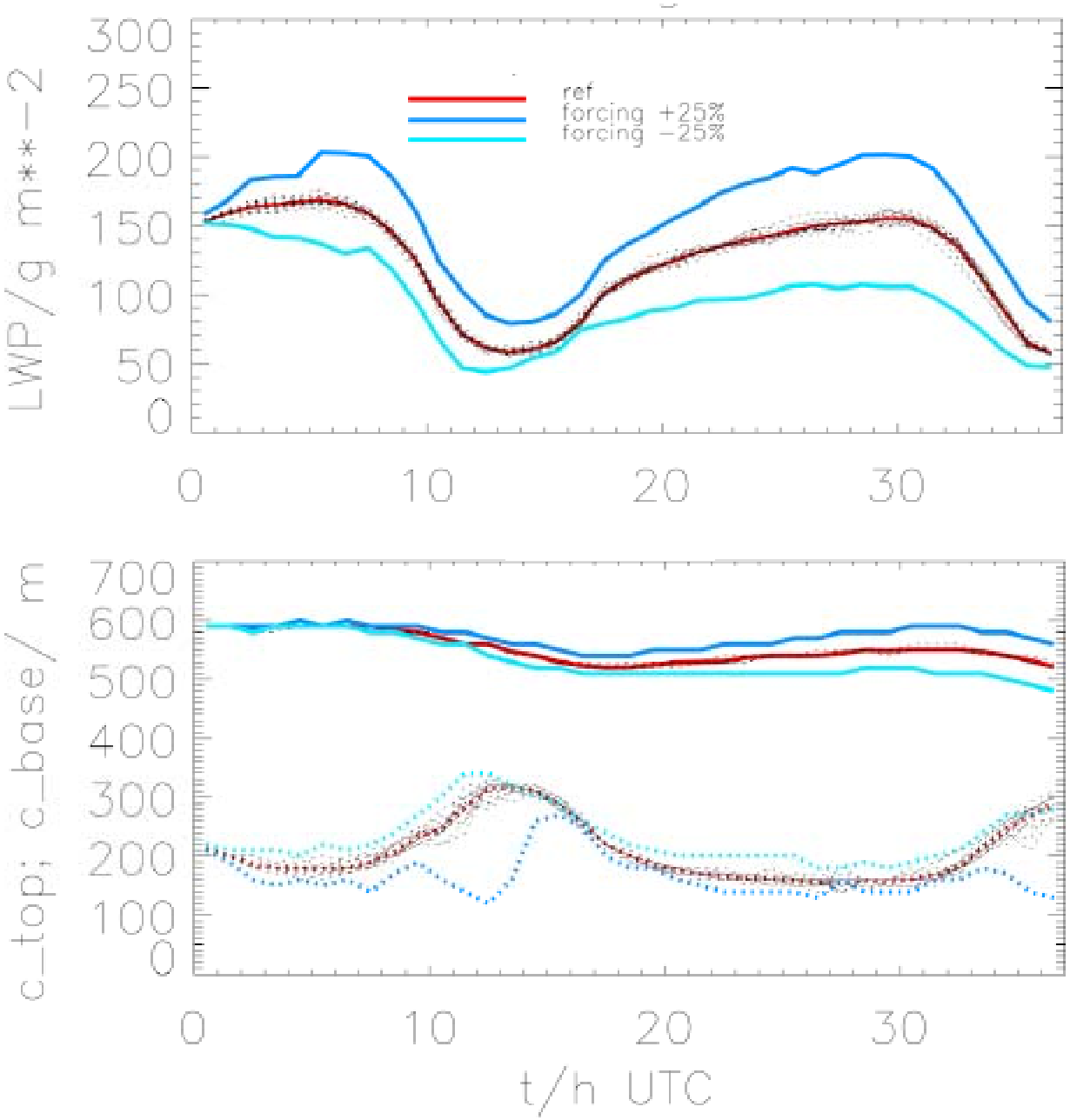
Experiment

- Change large-scale forcing over the whole domain by ±25%
- Same subsidence forcing

LES results - Sensitivity to large-scale horizontal advection



LES results - Sensitivity to large-scale horizontal advection in the BL only



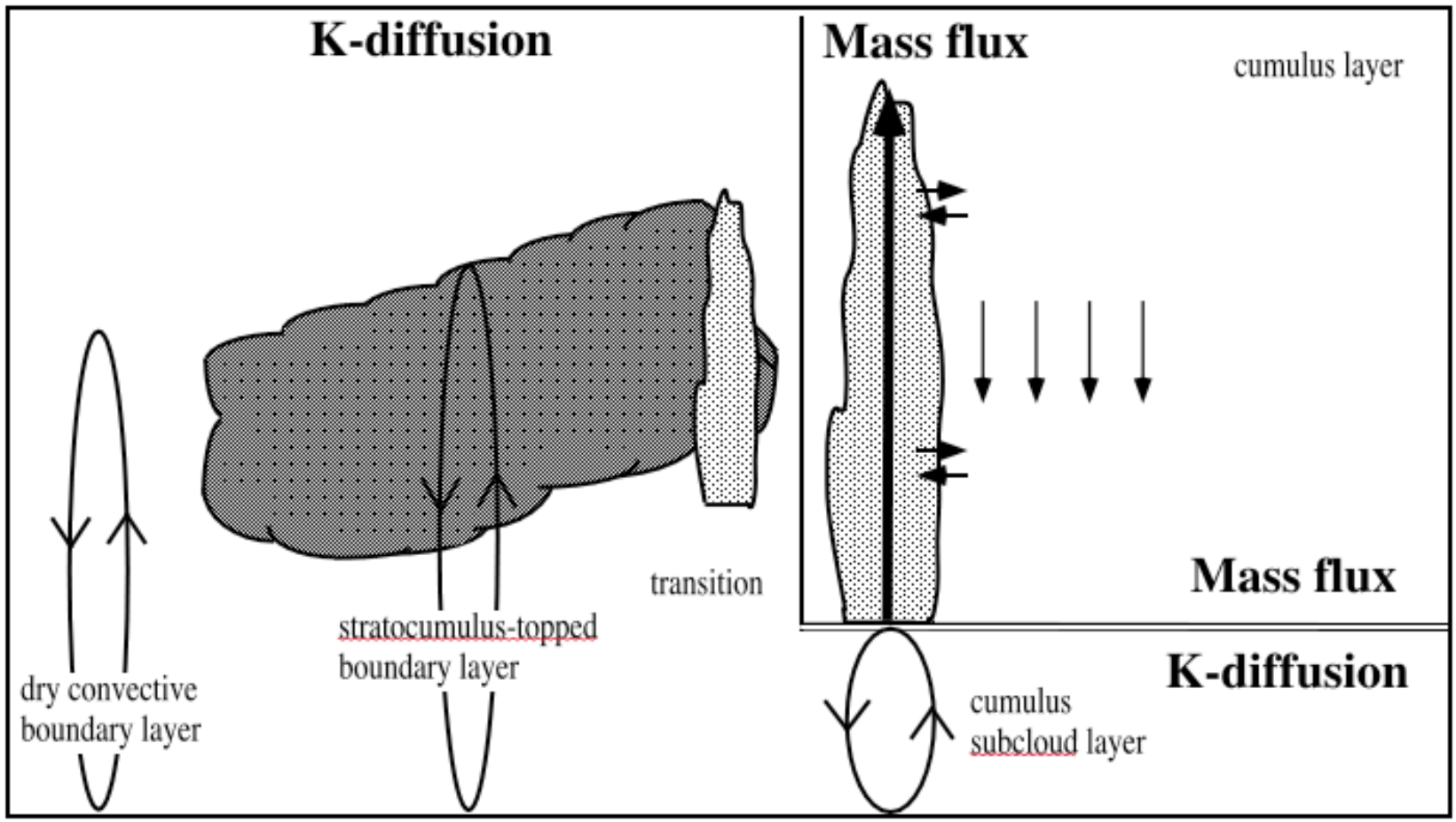
Large-scale tendencies: conclusion

Different results are due to different tendencies in inversion jumps

SCM results - Mean surface energy balance from 12 to 36 LT

Laboratories	H [W m^{-2}]	LE [W m^{-2}]	$F_s(z=0)$ [W m^{-2}]	LWP [g m^{-2}]
KNMI	4.0	26.2	272	33
INM	6.1	21.0	140	157
CSU	14.6	24.5	250	160
LMD	0.2	15.9	237	41
MPI	29.6	5.5	119	156
CNRM	23.9	24.2	281	56
UKMO	10.2	26.0	173	75
CNRM 2	-	29.7	271	16
ECMWF	0.1	39.0	280	79
mean SCM	9.9 ± 10.9	23.6 ± 9.2	225 ± 64	87 ± 59
mean LES	7.0 ± 3.9	23.6 ± 2.6	180 ± 27	117 ± 28

SCM results - Sensitivity to resolution and schemes



SCM results - Sensitivity to resolution and schemes

• Operational version

Additional sets: no precipitation, same radiation schemes:

• STD1A: No convection scheme
• STD1B: With convection scheme

STD1A_HR & STD1B_HR: high-resolution
-> reduce numerical errors

SCM results: data sets

	OPERATIONAL	STD1A	STD1B	STD1A_HR	STD1B_HR
MPI	Y	Y	Y	Y	Y
UKMO	Y	-	-	-	-
INM	Y	Y	Y	-	-
METFR	Y	Y	Y	Y	Y
KNMI	Y	Y	Y	Y	Y
ECMWF	Y	Y	Y	-	-

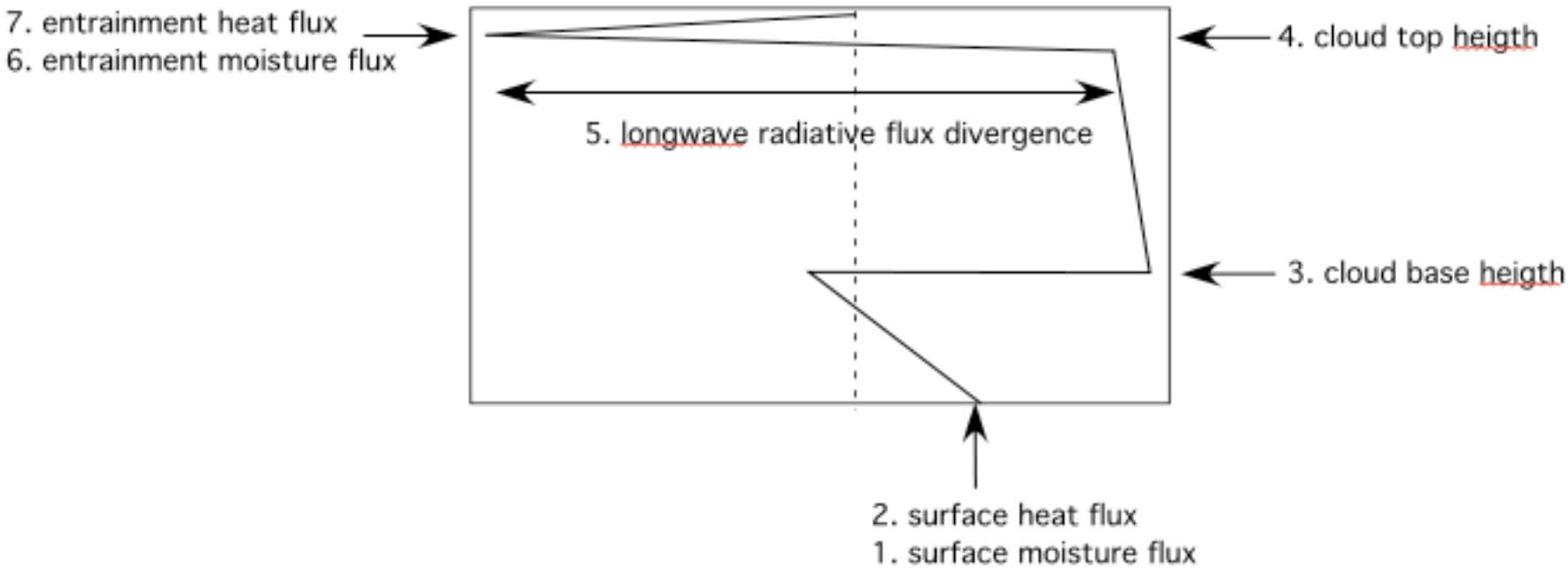
Hard to generalize findings

SCM results - Mean liquid water path [gm^{-2}] from 12 to 36 LT

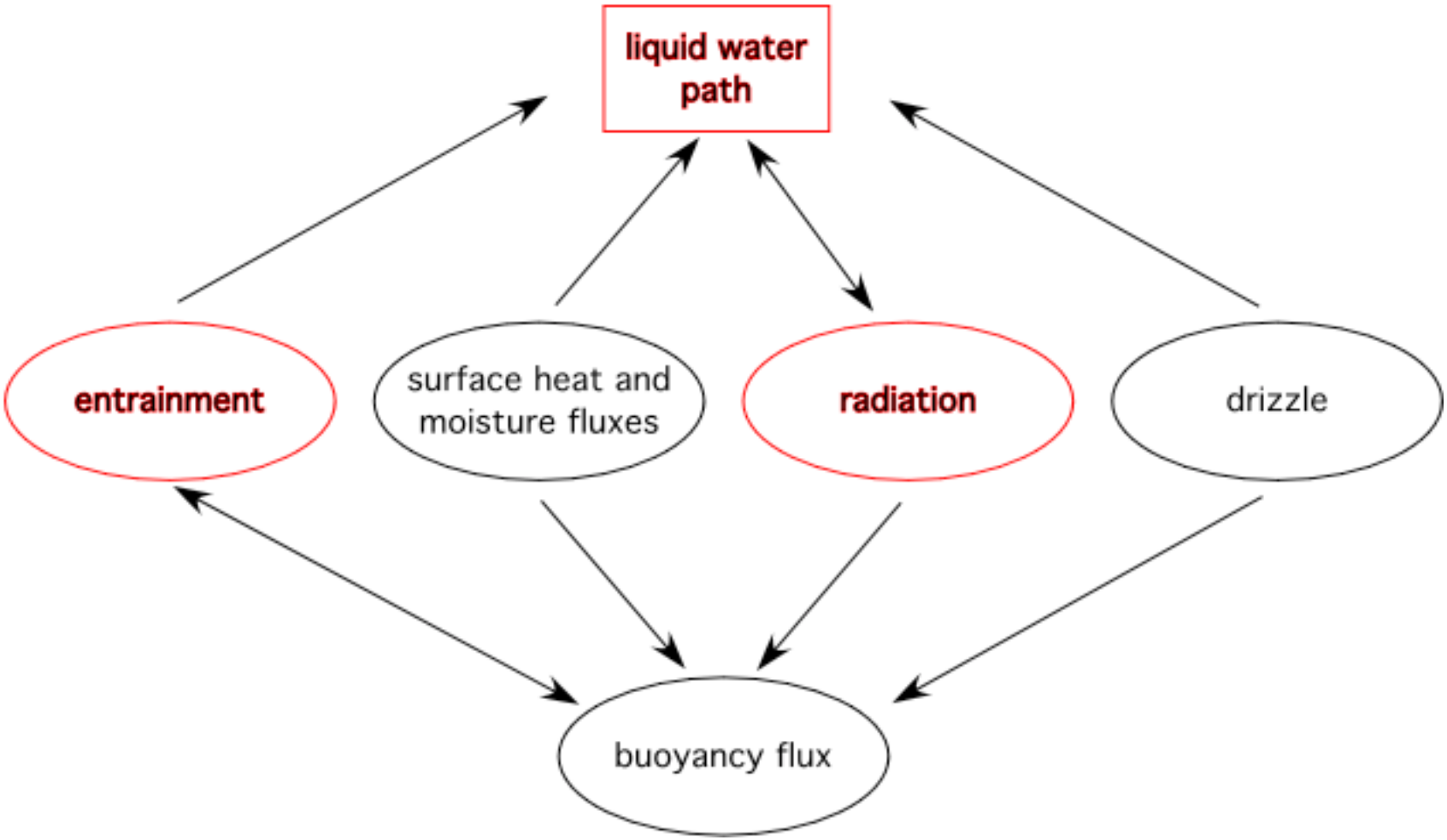
	OPERATIONAL	STD1A	STD1B	STD1A_HR	STD1B_HR
MPI	71.5	276.1	266.9	111.1	107.8
UKMO	-	-	-	-	-
INM	128.6	413.9	410.2	-	-
METFR(*)	0.1	30.7	31.9	38.7	43.9
KNMI	1.6	216.4	1.6	80.9	0.6
ECMWF	80.2	63.7	98.6	-	-

- Resolution: MPI, KNMI
- Convection scheme: KNMI

Buoyancy flux profile in nocturnal stratocumulus



Physical processes in stratocumulus



Conclusions

LES results and observations (to be included in summary paper)

- Surface energy balance
- Turbulence structure during night-time and day-time
- Sensitivity studies
  Inversion jumps, SST, windshear, subsidence

Other papers

- Subsidence diurnal cycle (Koehler et al., not sure to meet deadline)
- Chlond et al.

SCM results

- separate papers (model improvement, case study etc.)?????