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

Peter Duynkerke
Stephan de Roode
Herve Grenier*

Institute for Marine and Atmospheric Research Utrecht (IMAU), Utrecht, The Netherlands
** Meteo France Toulouse*

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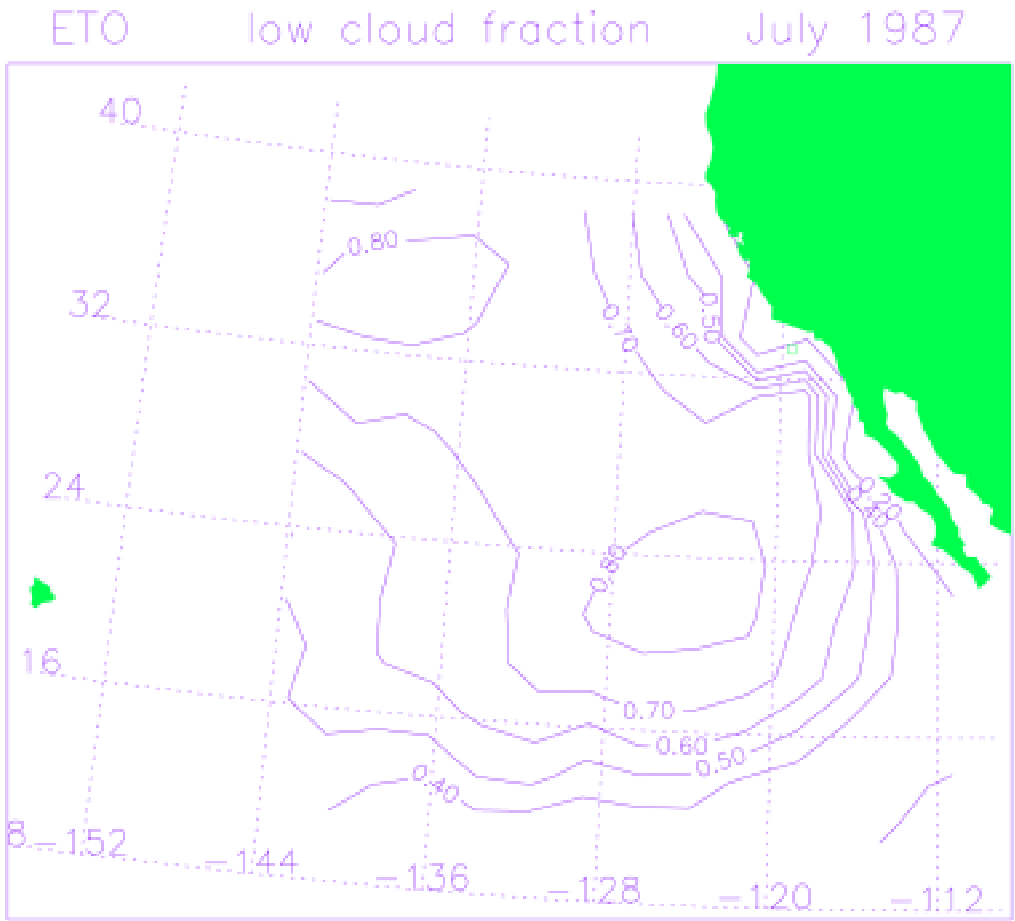
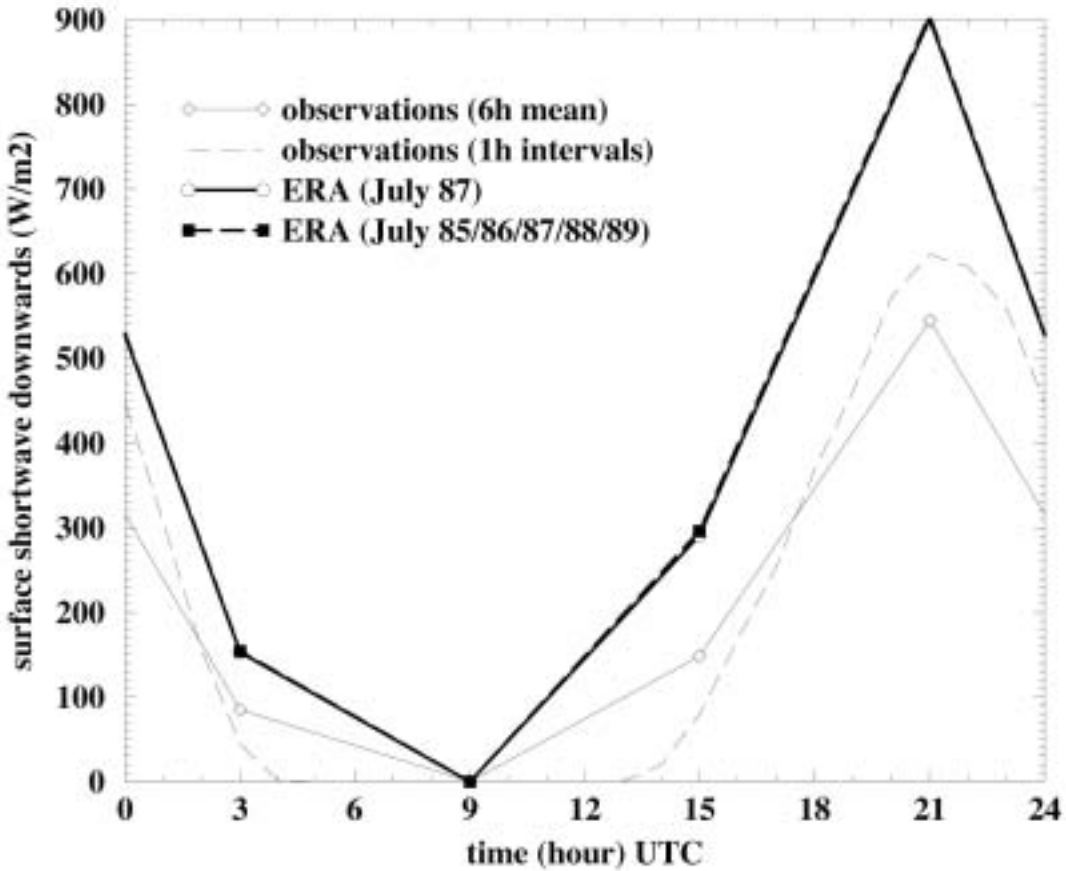
- Description of the EUROCS stratocumulus case
- Results from LES and Single Column models
- Sensitivity studies
- Summary & Conclusions

The EUROCS stratocumulus case:
The diurnal cycle of stratocumulus as observed during FIRE



(GOES satelllite)

Motivation



Source: Duynkerke and Teixeira 2001

The EUROCS stratocumulus case

Observations

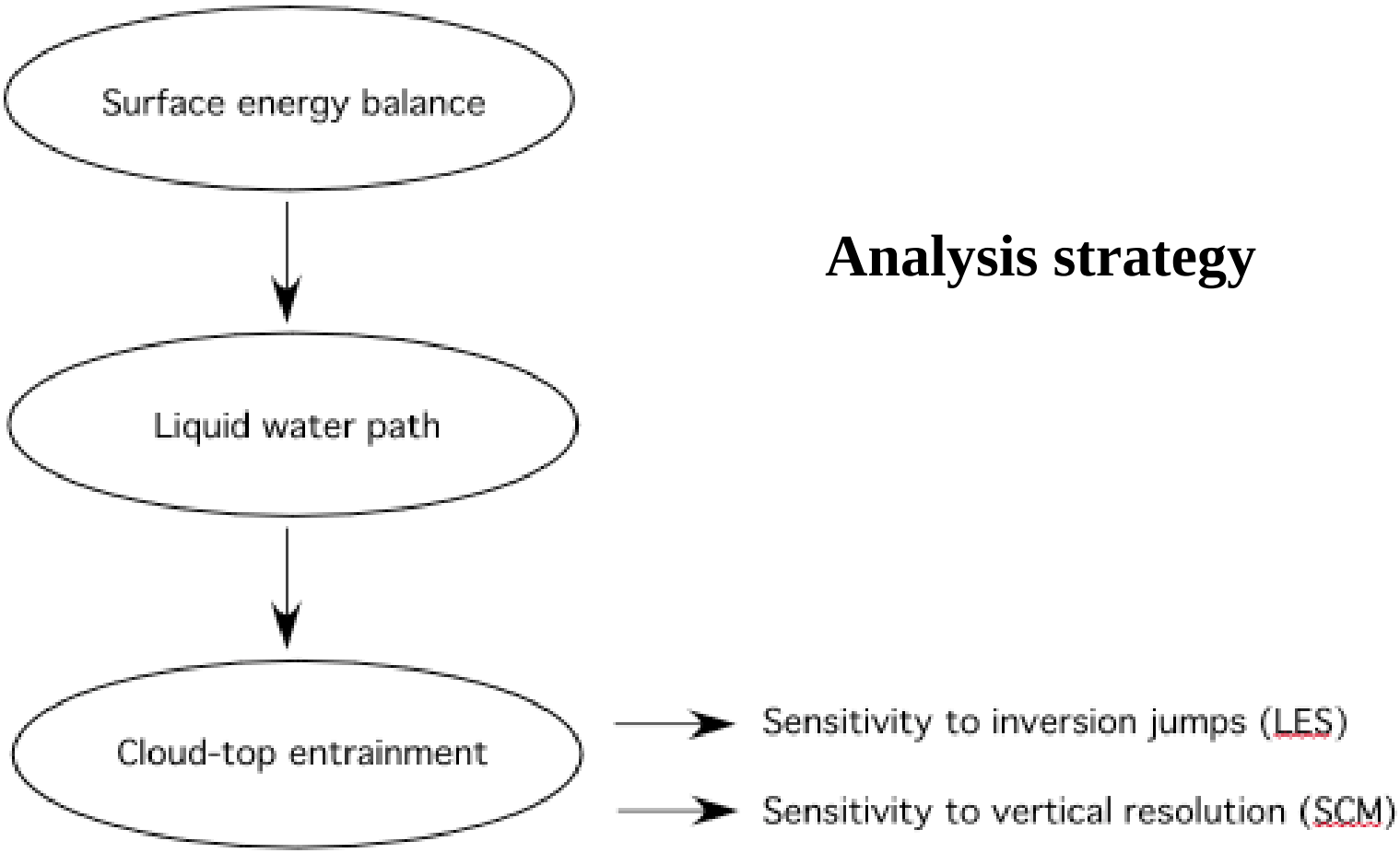
- radiosonde (mean vertical profiles)
- sodar (inversion height)
- ceilometer (cloud base)
- aircraft (turbulence)
- microwave radiometer (liquid water path)

Numerical simulations

- Large-Eddy Simulation & Single Column Mod
- same radiation schemes
- prescribed large-scale forcing

Contractors + associated	LES	SCM
CNRM-GAME		**y**
ECMWF		**y**
KNMI		**y**
UL		
INM	y	**y**
SMHI		
IMAU	y	
LMD		y
MPI	y	**y**
UKMO	y	**y**
GCSS-WG1	2	1
TOTAL	**6**	**8**

Analysis strategy

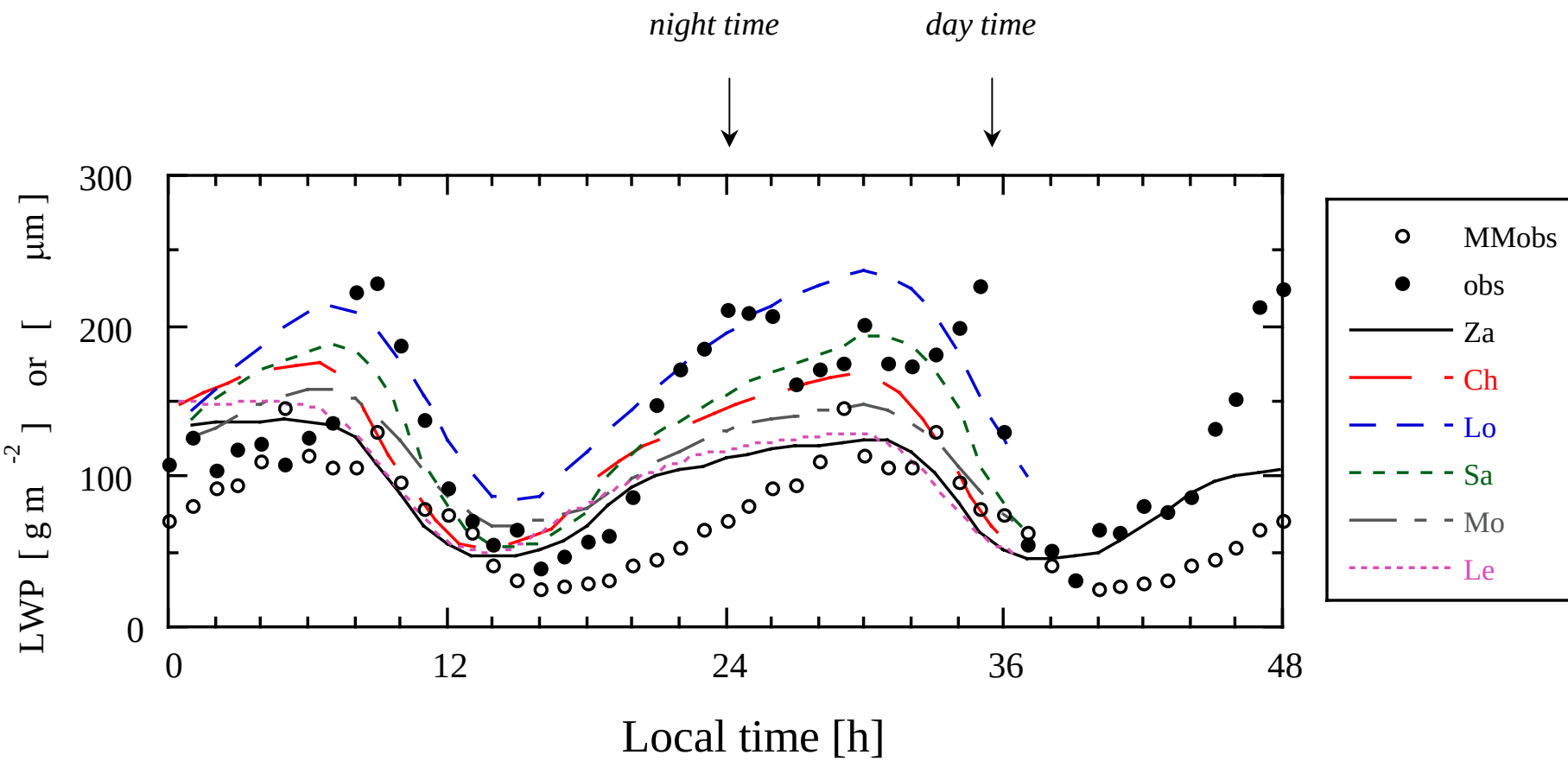


LES results - Mean surface energy balance from 12 to 36 LT

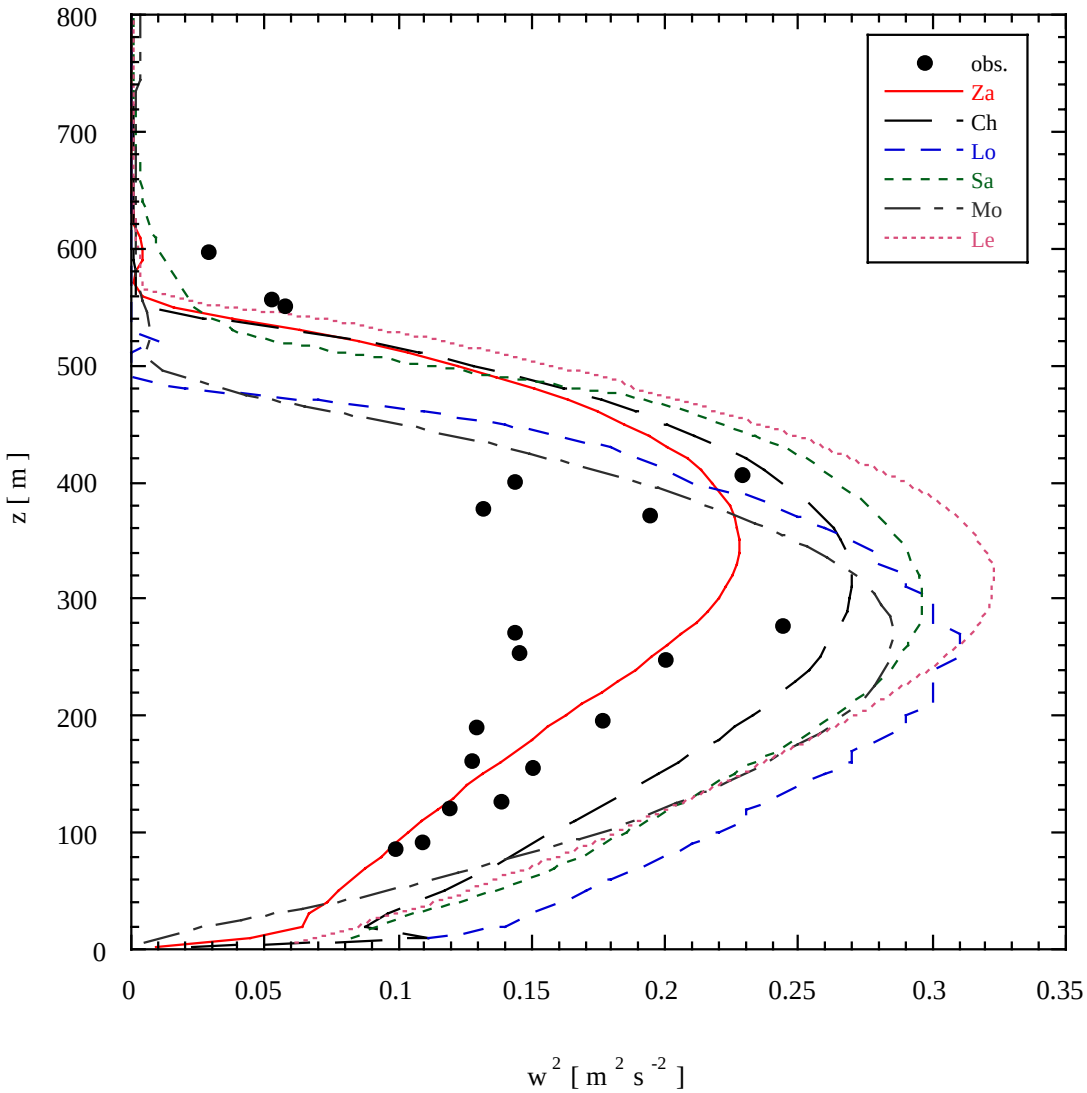
Laboratories	H [W m^{-2}]	LE [W m^{-2}]	$F_s(z=0)$ [W m^{-2}]	LWP [g m^{-2}]
IMAU	3.1	23.1	211	90
MPI	4.1	23.0	171	116
UKMO	7.4	20.3	134	166
INM	5.1	22.6	178	128
NCAR	13.9	24.3	201	109
WV	8.6	28.1	185	95
mean LES	7.0 ± 3.9	23.6 ± 2.6	180 ± 27	117 ± 28

Mean observed F_s: 190 Wm^{-2}

LES results - Liquid water path

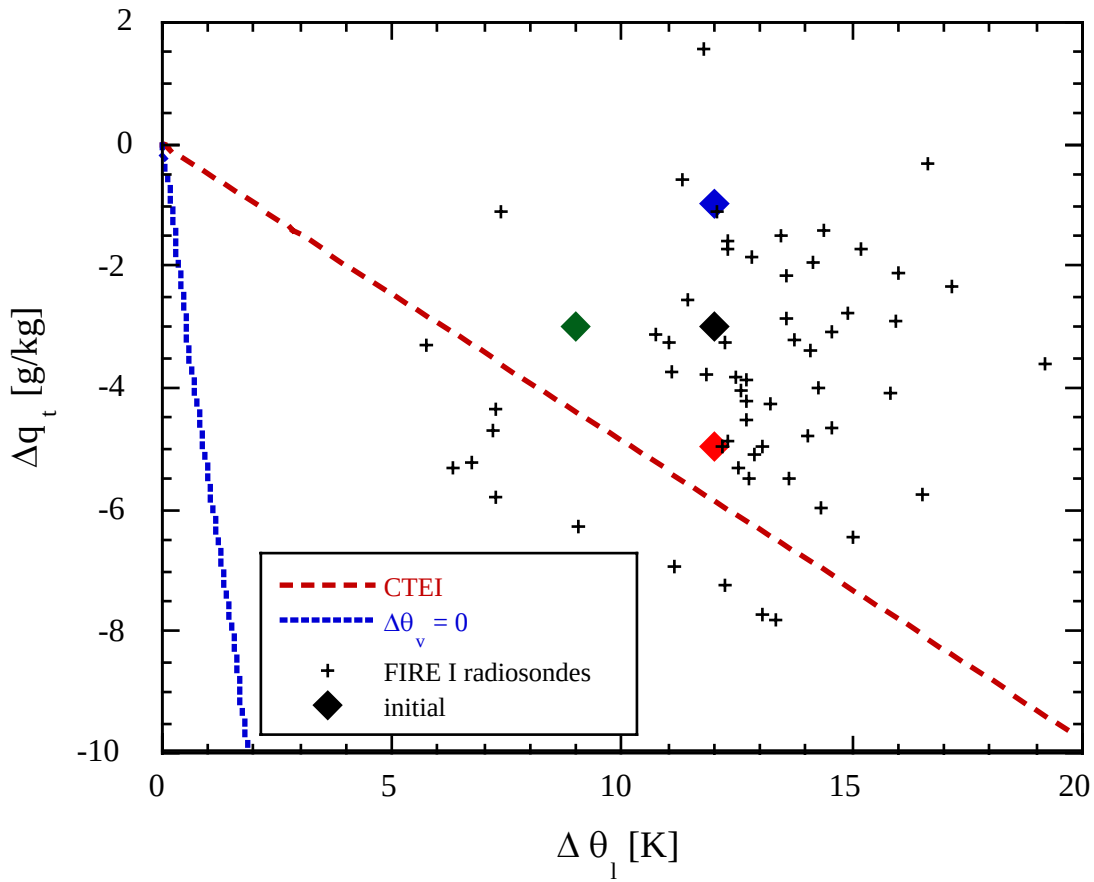


LES results - Turbulence

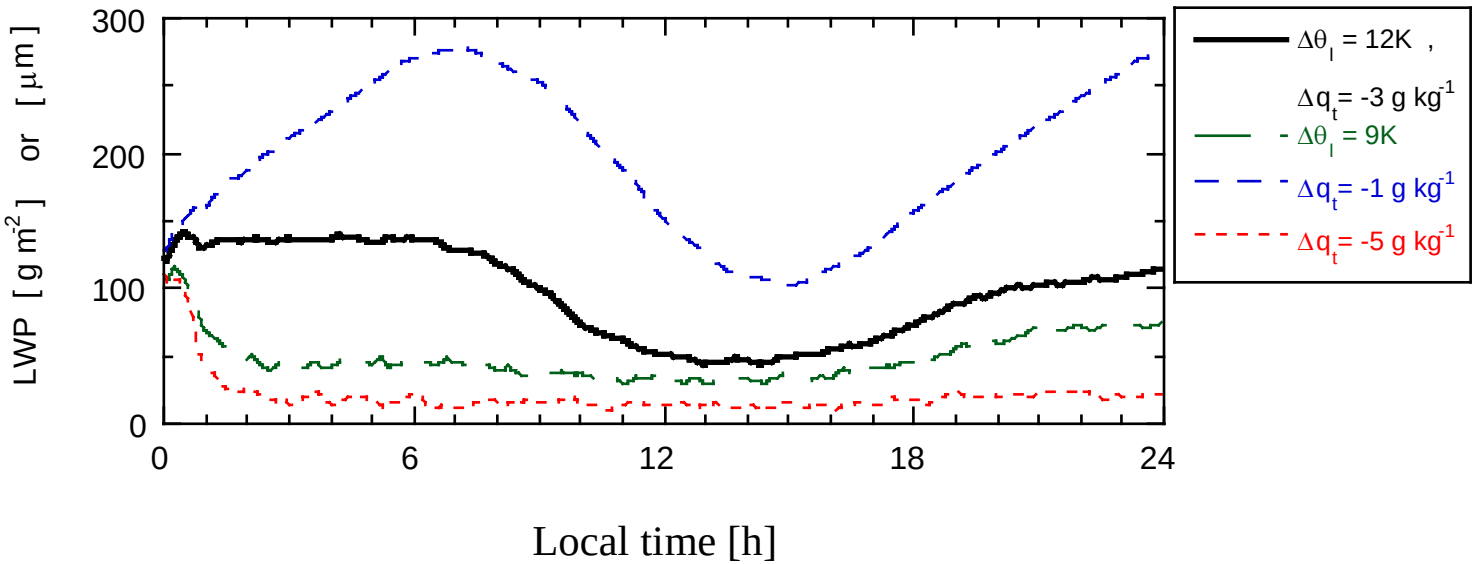


vertical velocity
variance during the ni

LES results - Sensitivity to inversion jumps



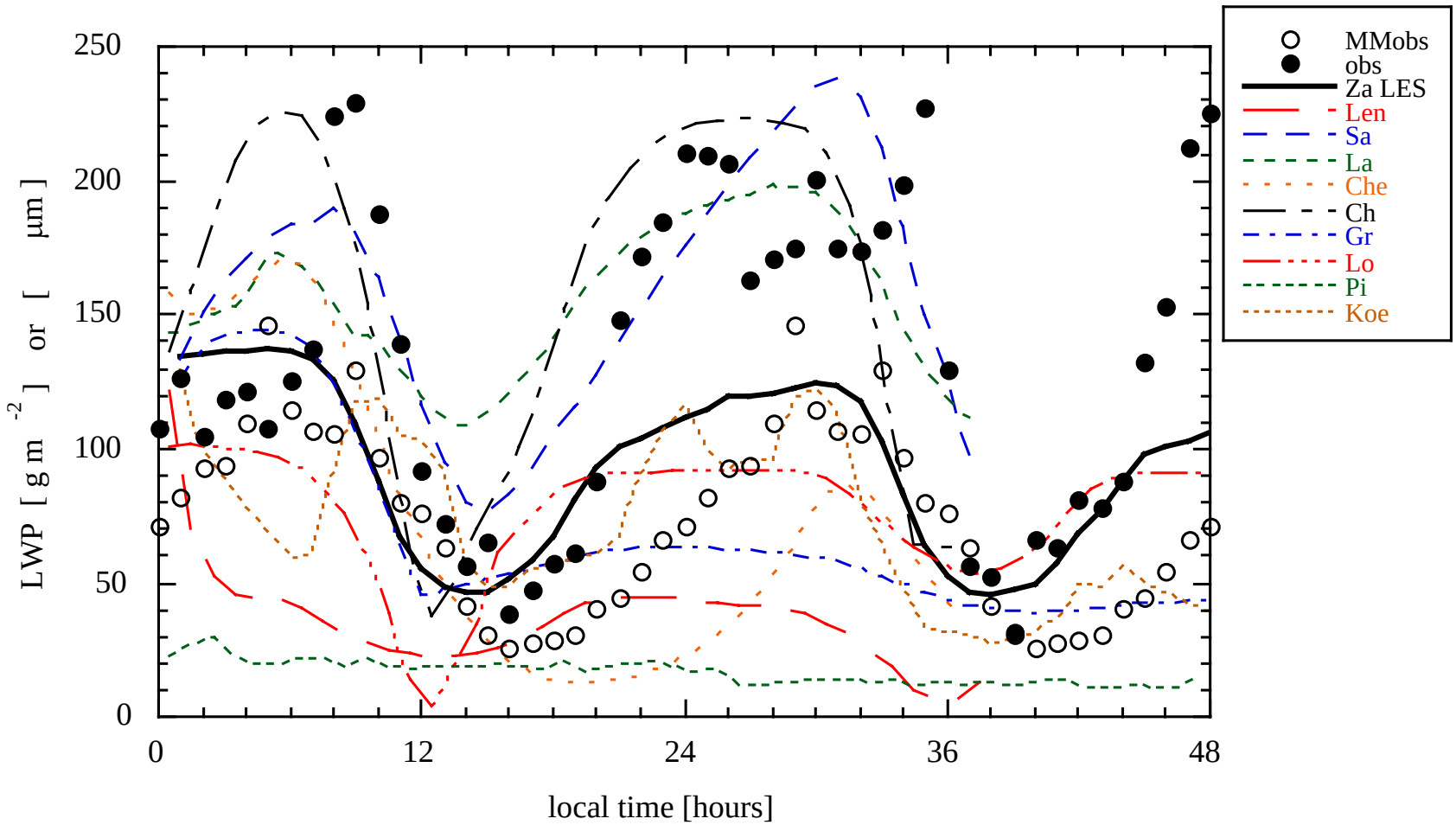
LES results - Sensitivity to inversion jumps - LWP



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

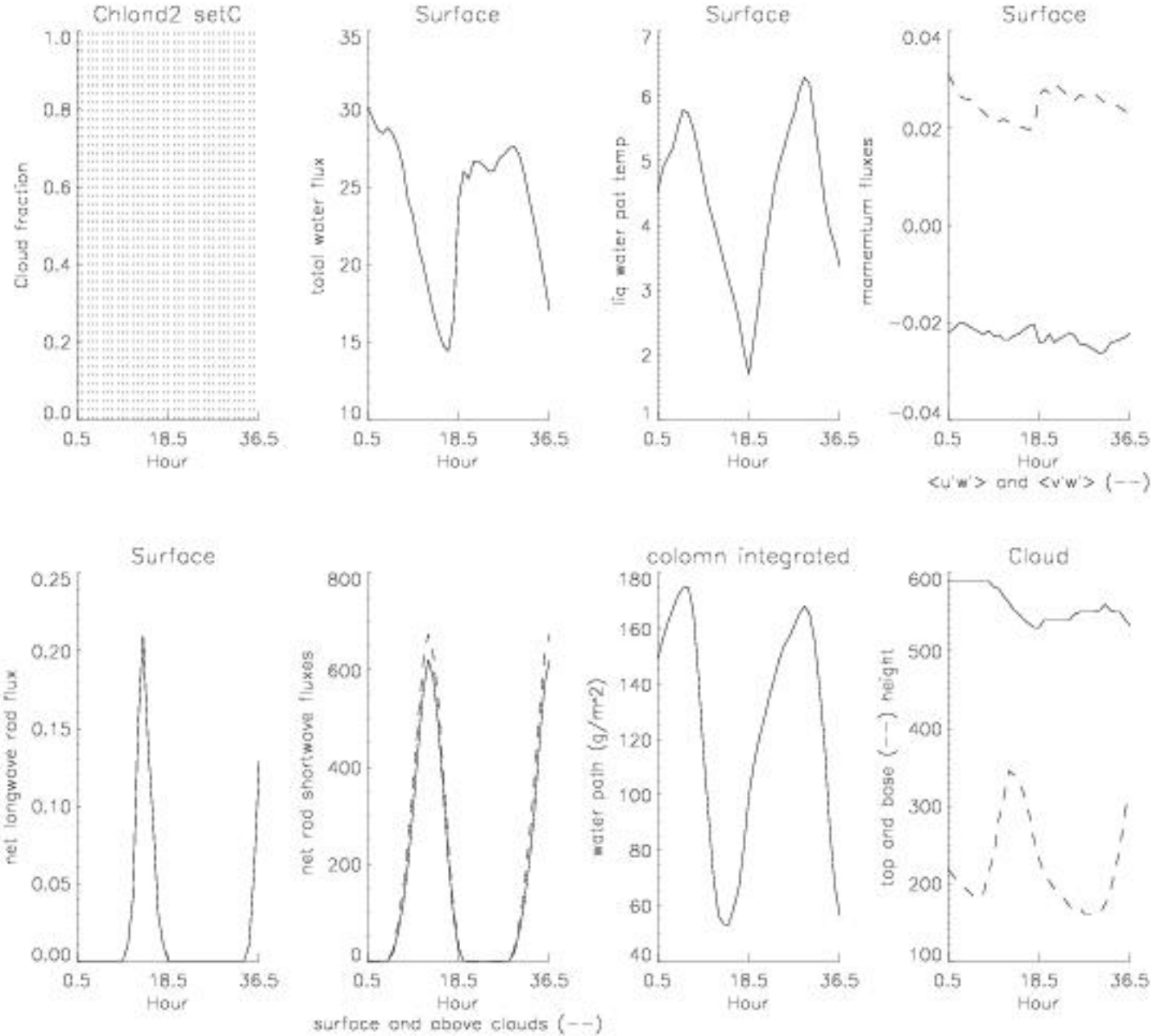
SCM results - LWP



Data availability

http://www.phys.uu.nl/~wwwimau/research/atm_dyn/EUROCS_PART_I/eurocs.html

LES:	SCM:
A Chlond 3D LES 2.5 km	A Chlond SCM: Version May03
A Chlond Quasi 3D LES 2.5km	A Cheinet (LMD) SCM
D Lewellen 3D LES Standard	Herve Grenier Version May04 CNRM-standart
D Lewellen 3D Shear at inversion	Martin Koehler (standard)
A Lock standard	C Lappen SCM
A Lock D=7.5E-6 17m, horiz resolution	G Lenderink SCM
A Lock shear at inversion	A Lock GCM standard resolution
A Lock 17m horiz resoln	A Lock GCM resolution D=7.5E-6
M van Zanten (IMAU) 3D LES 2.5km domain	JM Piriou SCM 60 levels timestep 300.000
CH Moeng 3D LES 2.5km domain	E Sanchez/J Cuxart SCM
E Sanchez/J Cuxart 3D-LES FIRE case	
Sensitivity results with IMAU LES	


Chland2 setC
Cloud fraction
Hour
Surface
total water flux
Hour
Surface
liq water pot temp
Hour
Surface
momemtum fluxes
Hour
<u'w'> and <v'w'> (--)
Surface
net longwave rad flux
Hour
net rad shortwave fluxes
Hour
surface and above clouds (--)
colomn integrated
water path (g/m^2)
Hour
Cloud
top and base (--) height
Hour

Papers

• P. G. Duynkerke, S. R. de Roode + case participants: The EUROCS stratocumulus case: Observations and numerical simulations of the diurnal cycle of stratocumulus.

• M. Kohler, M. C. van Zanten and S. R. de Roode: The impact of the diurnal cycle of the subsidence on the EUROCS stratocumulus case.

• A. Chlond, F. Müller and I. Sednev: Numerical simulation of the diurnal cycle of marine stratocumulus during FIRE - A LES, SCM and GCM modelling study

Related work

• S. R. de Roode, P. G. Duynkerke and H. J. J. Jonker, 2002: Large Eddy Simulation: How large is large enough? Submitted to the *J. Atmos. Sci.*

Conclusions: What did we learn?

- **EUROCS stratocumulus case**
  - Contains all the relevant physical processes (turbulence, radiation)
    - -> first intercomparison of the diurnal cycle including **shortwave radiation**
  - LES models simulate the diurnal cycle fairly well

- **Surface energy balance**
  - Solar downwelling radiation major component (**LWP**)
  - Computed liquid water paths lead to largest uncertainties (**entrainment**)

- **Single column models**
  - Large individual variation in the results
  - Complete data set available (observations & LES results)
    - -> facilitates the assessment of strength and weaknesses of individual SCMs