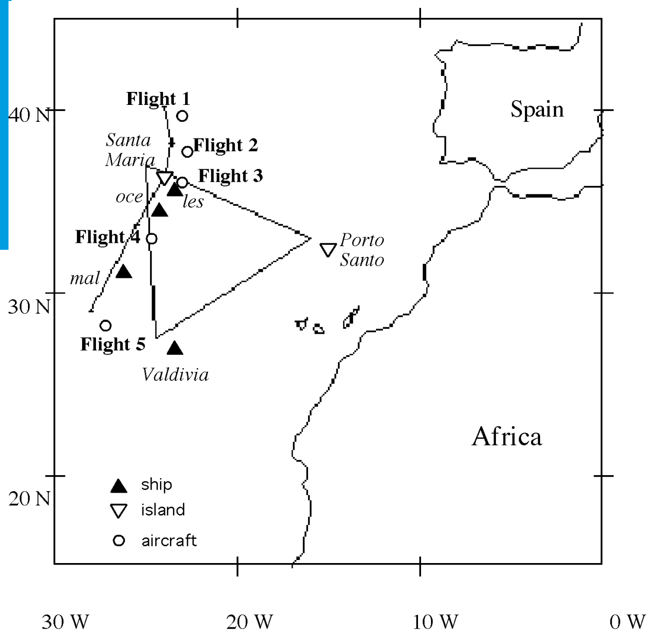
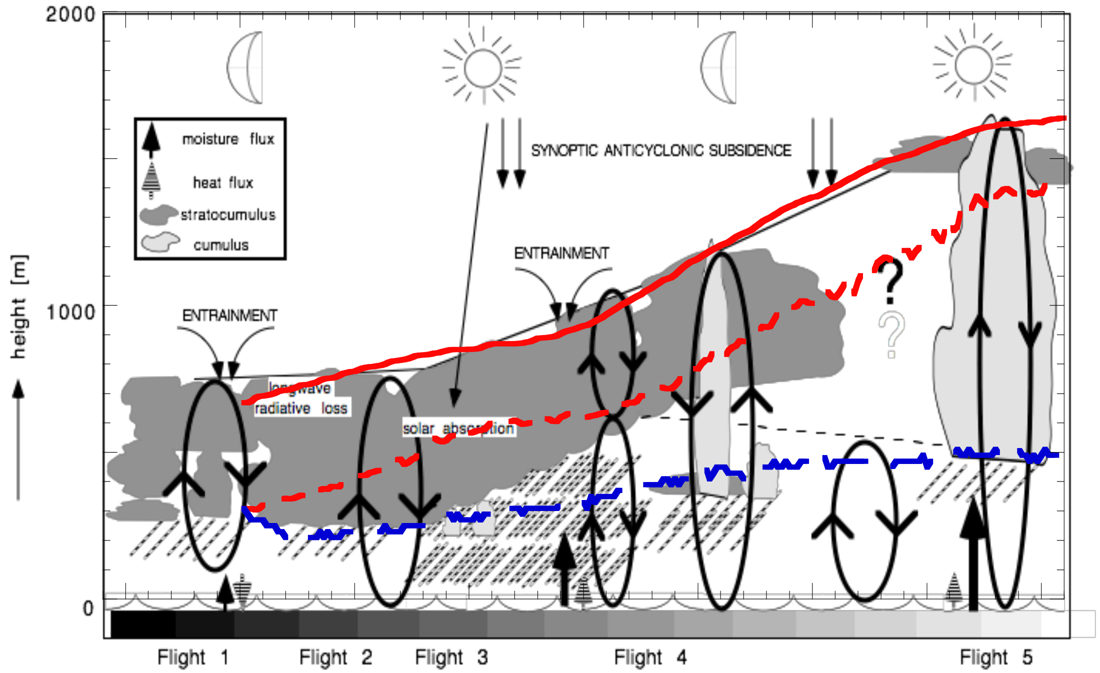
The ASTEX First Lagrangian





Stephan de Roode and Johan van der Dussen

Delft University of Technology, Netherlands

Irina Sandu (LES runs with the UCLA/MPI model)

Chris Bretherton (UW) (Large-scale forcing)

Contents

Modified set up (compared to Vancouver presentation)

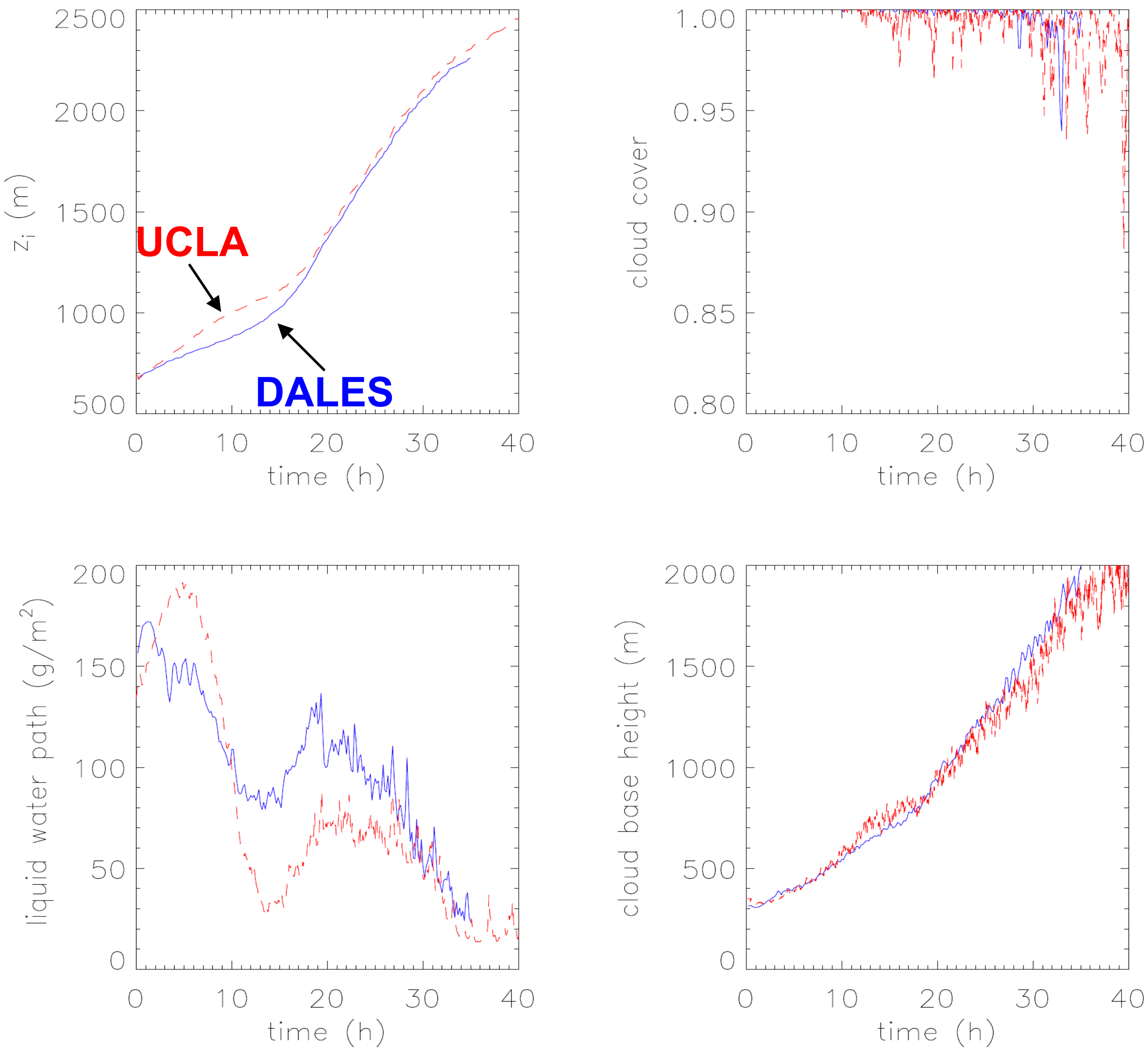
Science questions

Set up

Requested data

Case release, deadline

DALES & UCLA/MPI LES



using GCSS-DYCOMS radiation parameterization

40 hours simulation

64 x 64 x 160 (50m x 50m x 20m)

Case modification:

Use full radiation scheme

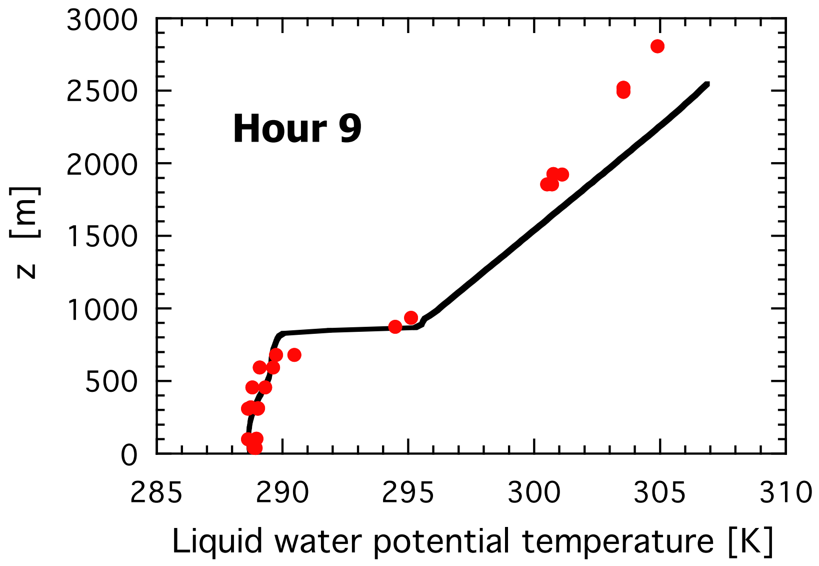
(CGILS or McICA)

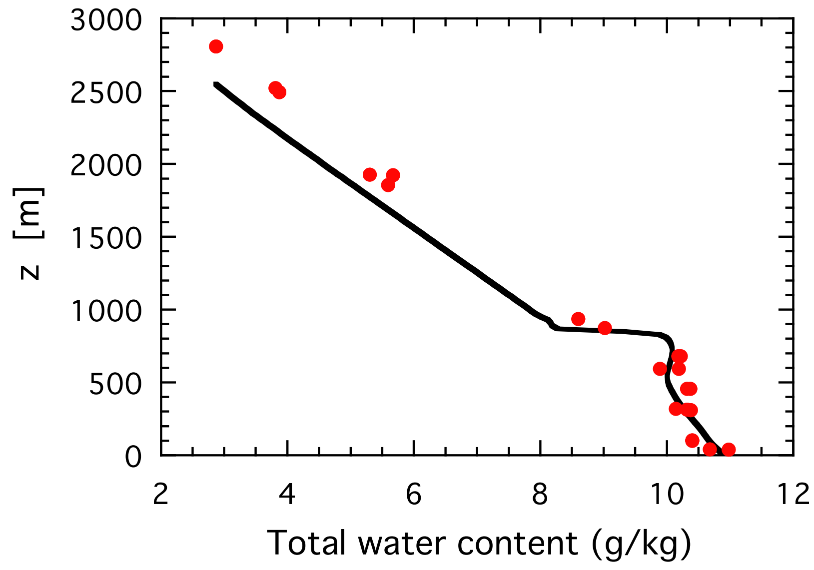
What can we learn from the ASTEX intercomparison?

Observations:

•Mean state evolution

•Second-order moments (fluxes and variances)

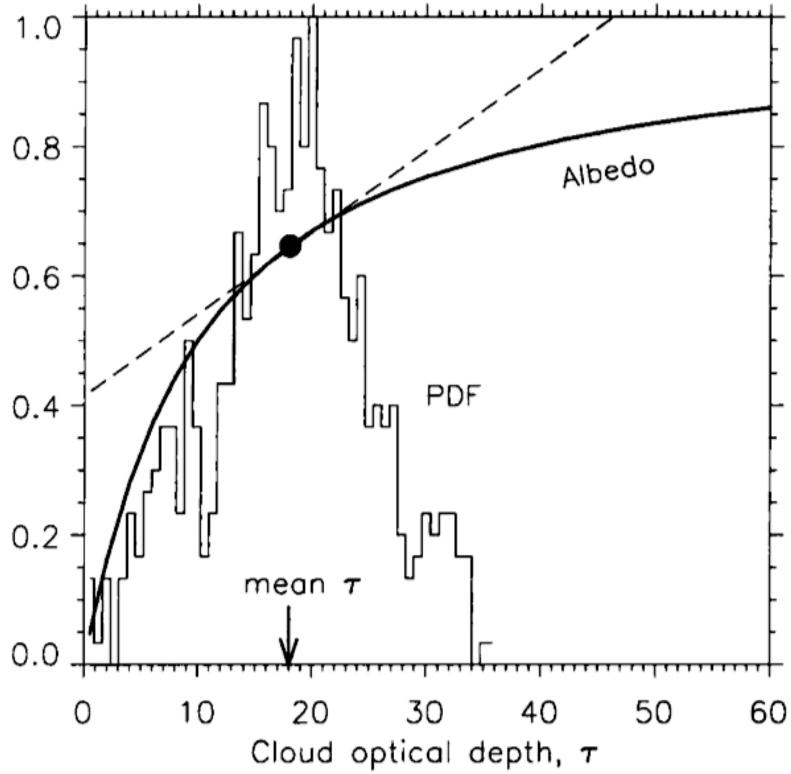




What can we learn from the ASTEX intercomparison?

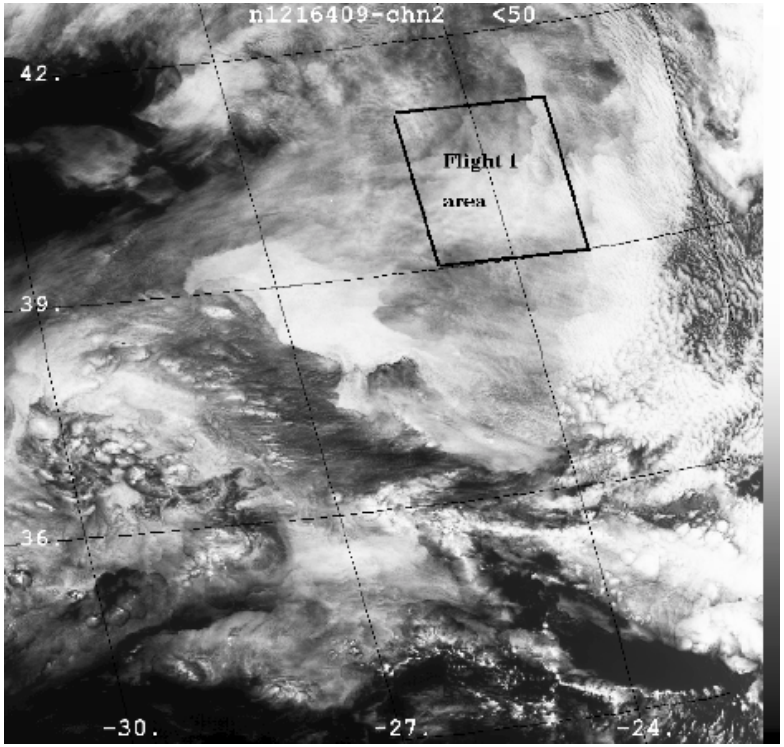
Observations:

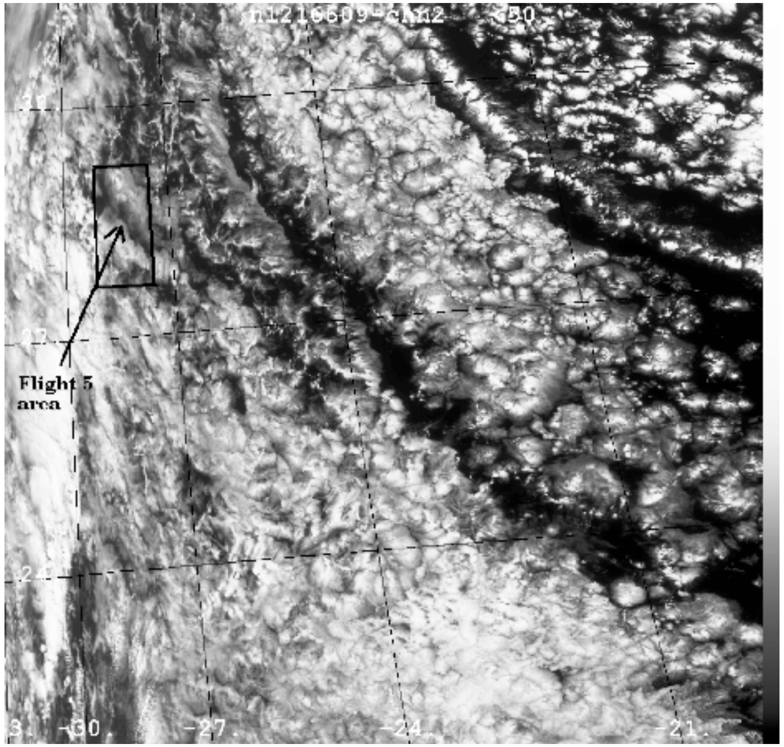
- Spatial distribution and PDFs (q_T, q_L, temp)

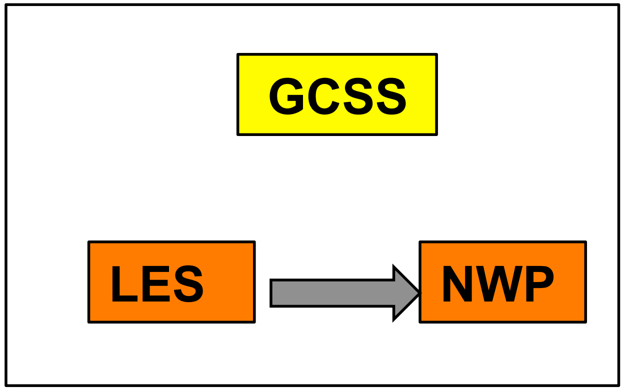


Los and Duynkerke, 1997

Satellite images Flights 1 and 5







LES

- Large domain simulations (~ 25x25 km^2)
- Instantaneous 3D LES fields are requested

  Postprocessing for detailed tailor made statistics relevant to NWP/GCM parameterizations

  (*massflux, eddy-diffusivity and cloud schemes*)

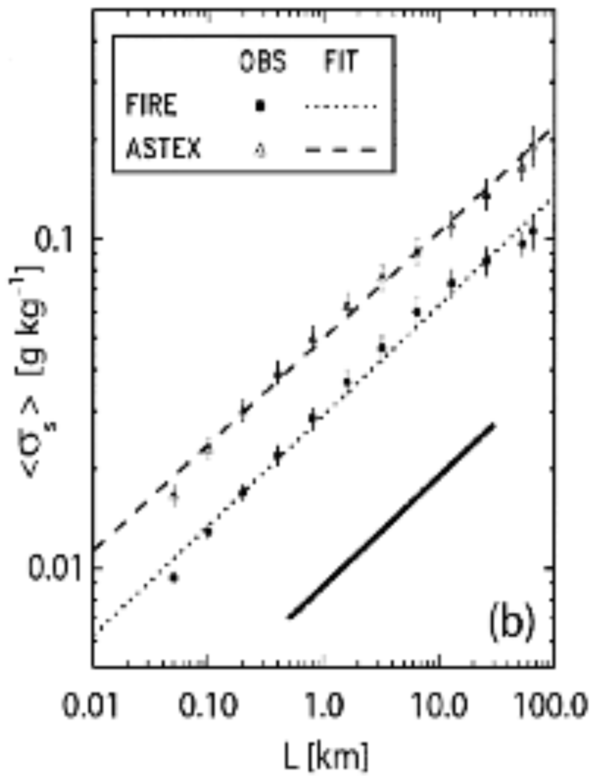
NWP issues:

- resolution goes to 1 km , parameterizations become scale dependent

  - turbulent transport => part will be resolved

  - scalar fluctuations (cloud schemes, McICA) => larger grid size, more variance

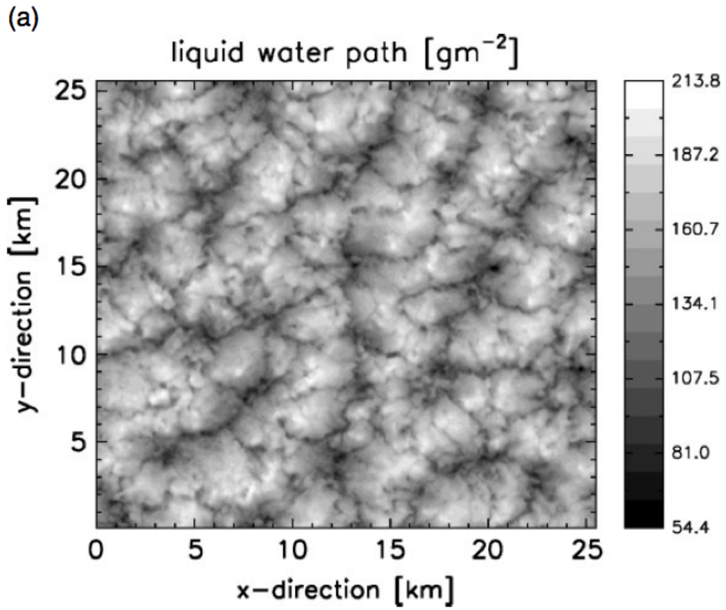
Variance depends on domain size

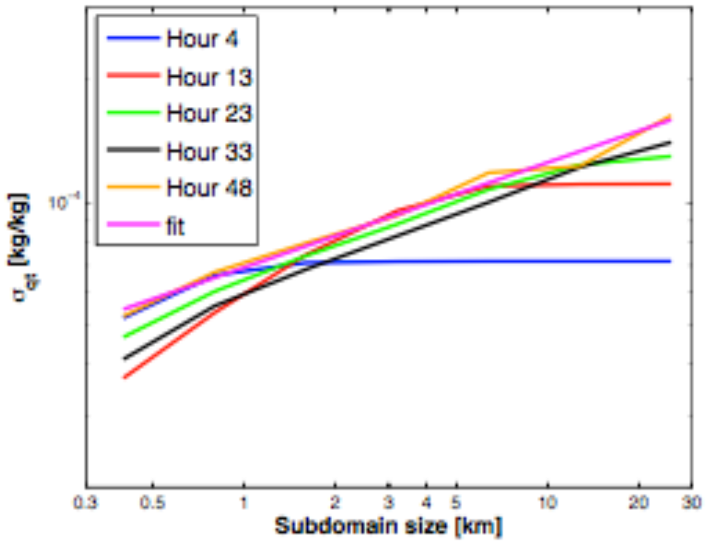


Observations

Wood et al. (2002)

Variance depends on domain size (LES of FIRE I)





De Roode and Los (2008)

Steven de Boer (MSc thesis)

LES of ASTEX Flight 2 shows rapid growth of mesoscale fluctuations

Jonker et al. (1999)

TU Delft

Spatial distribution of vertical transport (LES of FIRE I)

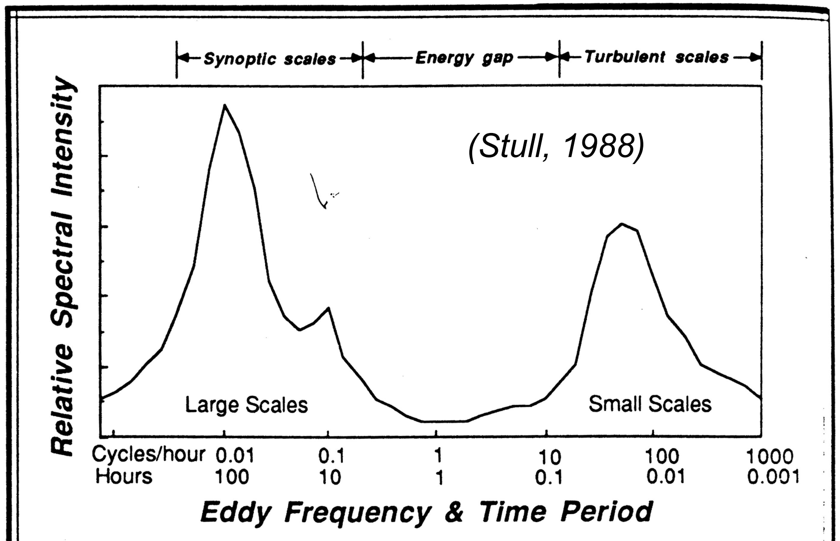
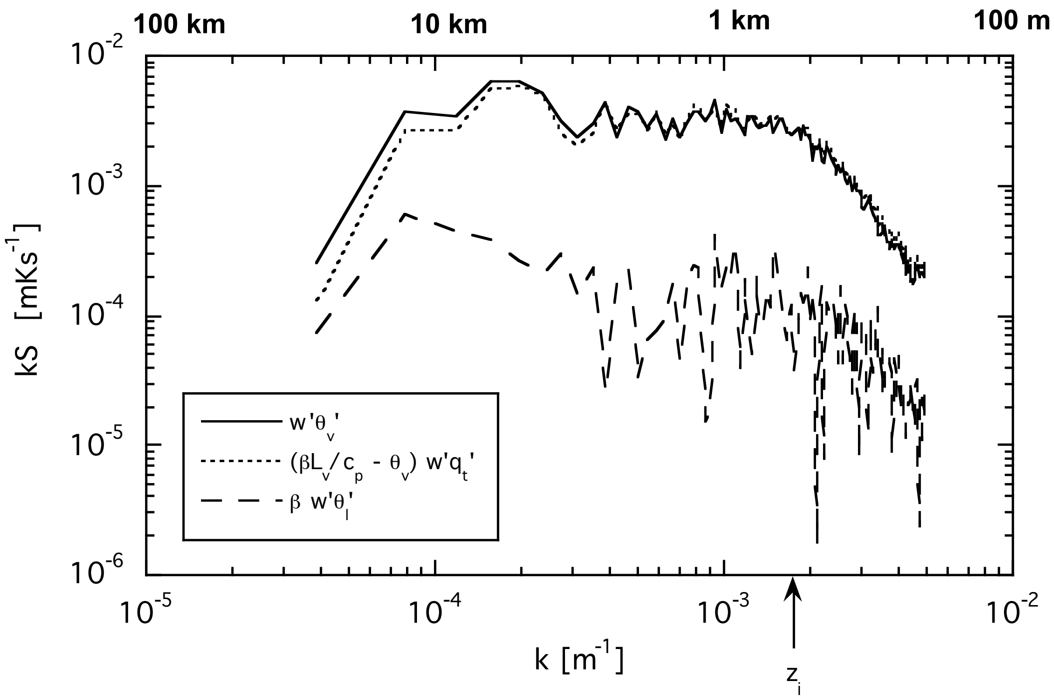
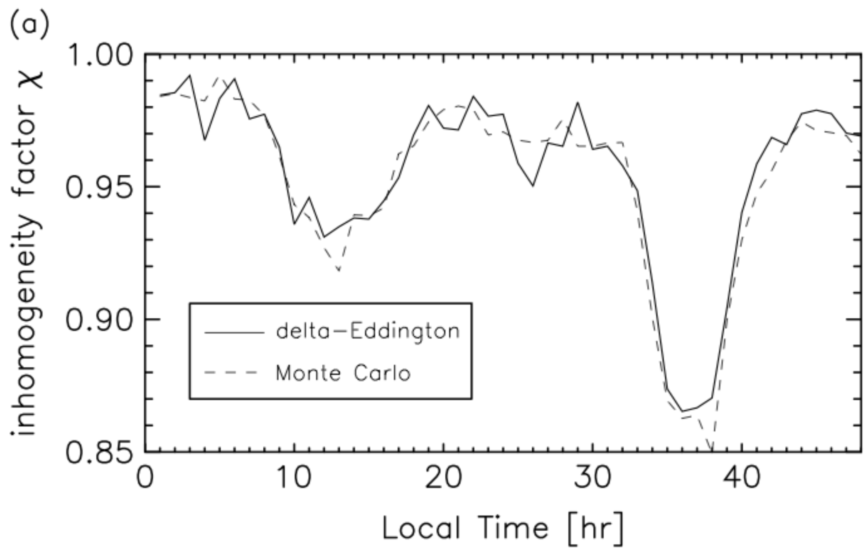


Fig. 2.2 Schematic spectrum of wind speed near the ground estimated from a study of Van der Hoven (1957).

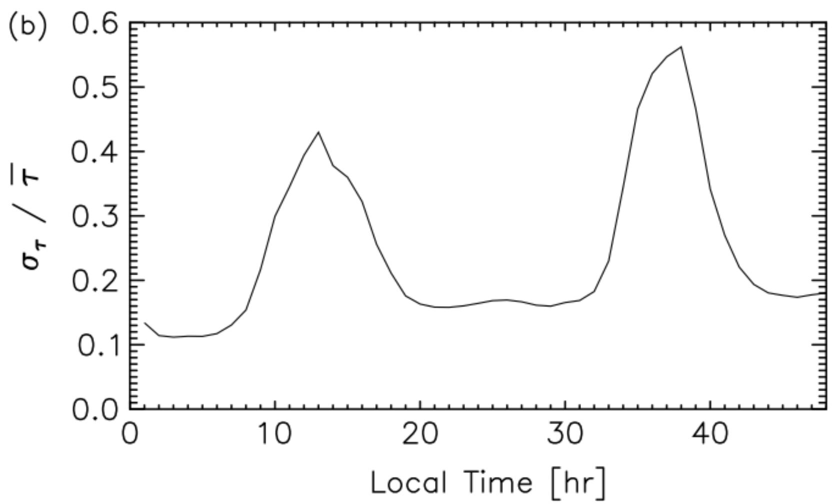


Albedo bias (LES results of FIRE I)

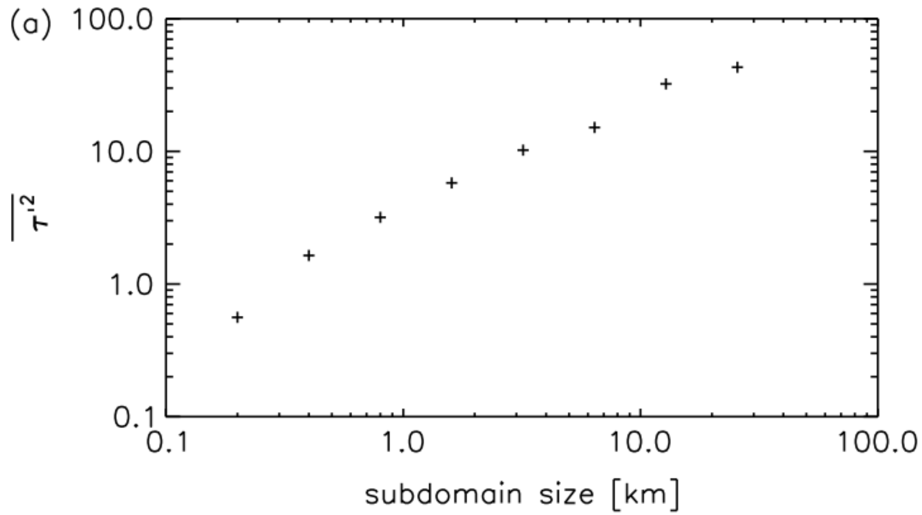


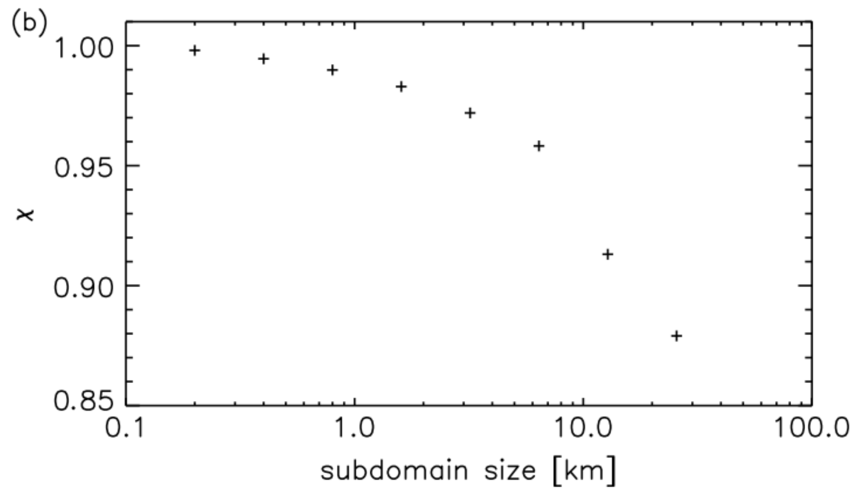
Some models correct for cloud inhomogeneity on radiative transfer by implementing an albedo bias factor

$\tau_{eff}=\chi\tau$, $\chi=0.7$



Scale dependency of albedo bias





De Roode and Los (2008)

www.srderoode.nl

ASTEX modeling intercomparison case

Introduction

The Atlantic Stratocumulus to Cumulus Transition Experiment (ASTEX) field campaign was conducted in June 1992 near the Azores (Albrecht et al. 1995). In the First Lagrangian of ASTEX five aircraft flights were made by the NCAR Electra and UKMO C130 aircraft (Bretherton and Pincus, 1995; Bretherton et al., 1995; De Roode and Duynkerke, 1997). Except for the last flight, these flights all took place in the same air mass which was being advected equatorwards. This experiment lasted about two days during which a transition from solid stratocumulus to cumulus penetrating thin and broken stratocumulus above was observed. Peter Duynkerke used the second flight ("A209") to set up a GCSS stratocumulus modeling intercomparison case that was based on ASTEX observations. As part of the EUCREM project data collected during the third flight ("RF06") was used to design another modeling incomparison case (Duynkerke et al. 1999). These two intercomparison cases were nearly identical except for the inversion jumps of temperature and moisture. The entrainment rates diagnosed from the LES modeling results showed that the weaker inversion stability caused larger entrainment rates during the third flight. Note that the control runs were made without drizzle. Recent results show that cloud droplet sedimentation and drizzle act to decrease the entrainment rate (Ackerman et al. 2004.)

Chris Bretherton organized a full ASTEX First Lagrangian modeling intercomparison study which was simulated with single-column model versions of weather forecast models (Bretherton et al. 1999). The models all predicted the observed deepening and decoupling of the boundary layer quite well, with cumulus cloud evolution and thinning of the overlying stratocumulus. These models all appeared capable of predicting transitions between cloud and boundary-layer types with some skill. The models also produced realistic drizzle rates, but there were substantial quantitative differences in the cloud cover and liquid water path between models. This case was not run with LES models. At the time of this full ASTEX Lagrangian intercomparison study supercomputers were just not powerful enough to allow

Instantaneous 3D data fields

To facilitate a detailed analysis of the model data, we ask the participants to save instantaneous 3D fields of the prognostic variables. In particular, the liquid water potential temperature θ_l [K], the total water content q_t [g/kg], the liquid water content q_l [g/kg], the rain water content q_r [g/kg], the rain droplet concentration N_r [cm^-3], the three components of the wind velocity u,v, and w [m/s], and the subgrid TKE, e [m^2/s^2]. In this way the data can be conditionally sampled offline with arbitrary sampling criteria, e.g. cloud core, cloud, updrafts, strongest thermals etc. In addition, energy spectra can be calculated which will provide insight to the spatial structure of the vertical turbulent transport and the spatial distribution of cloud liquid water, temperature etc.

These variables should be stored at time intervals of 5 minutes for the following hours:

2-3 (Flight 2, A209), so at hours 2:00, 2:05, 2:10, ..., 2:55, 3:00

7-8 (Flight 3, RF06)

11-12

19-20 (Flight 4, RF07)

23-24

35-36 (Flight 5, A210)

The time interval of 5 minutes is needed to calculate representative hourly mean values. As indicated above, the times are partly selected on the basis of data availability from the aircraft. If data are given by a float of 15 characters, then the memory needed for any variable for a simulation with 256x256x160 grid points is about 168 Mb. All variables should be stored in one data file for each time interval: yourname_inst_hhmm.nc. So in total 6 (hours)x12 (5-minute intervals)=72 data files are requested, which will need about 100 Gb

Time frame

21-22 April - Kick off meeting EUCLIPSE project

Case release

Deadline for submission

October 2010

Set-up of simulation

Initialization

Take vertical profiles from GCSS ASTEX A209 intercomparison case

Time varying forcing

SST and subsidence rate from Bretherton et al. (1999)

Geostrophic winds from observations

Domain size

256^3 grid points ($25.6 \times 25.6 \times 2.5$ km^3)