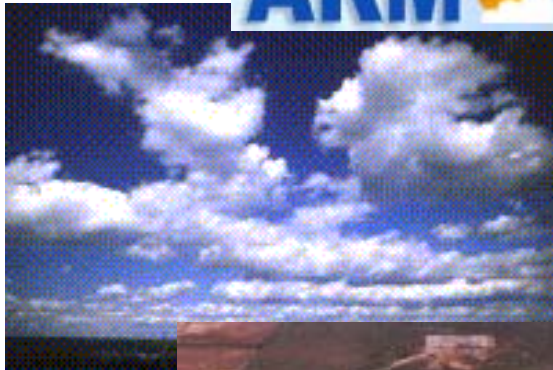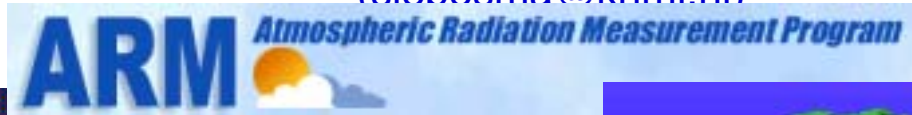# Diurnal Cycle of Shallow Cumulus over Land

Geert Lenderink,   *A. Pier Siebesma*
(siebesma@knmi.nl)

ARM *Atmospheric Radiation Measurement Program*

North Slope Alaska Region

Southern Great Plains Region

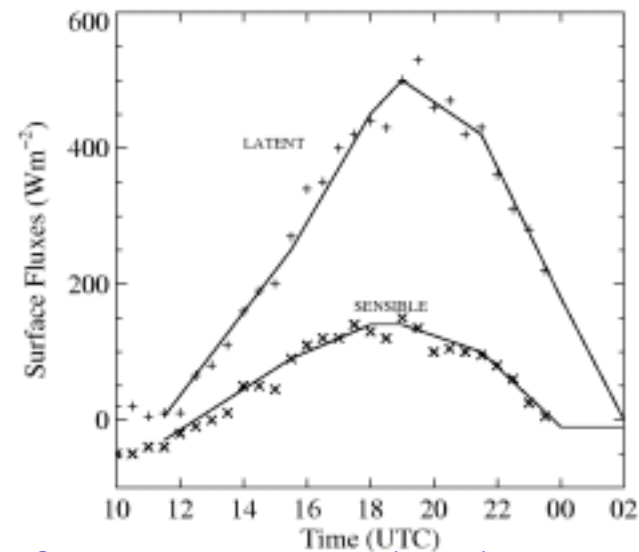Tropical Western Pacific Region

Koninklijk Nederlands Meteorologisch Instituut

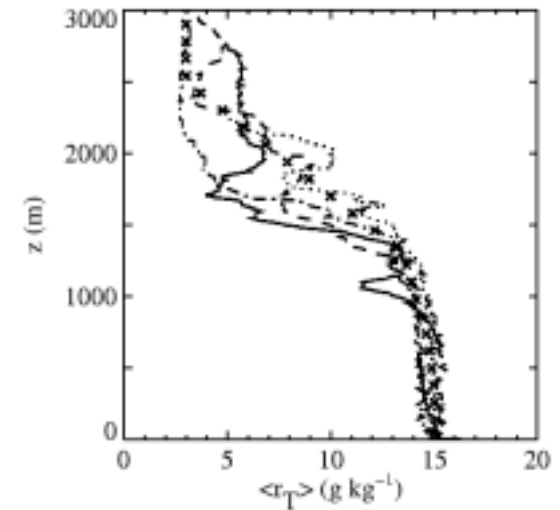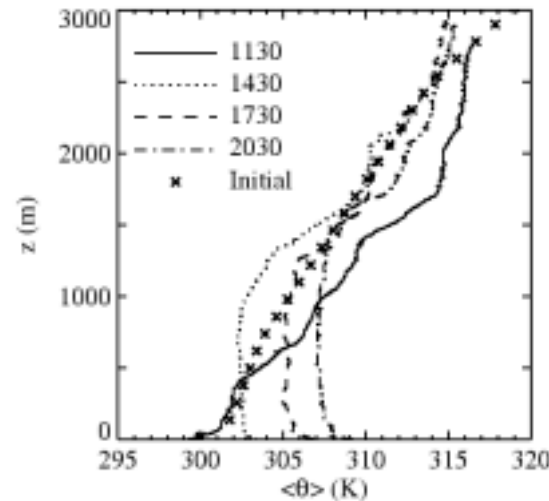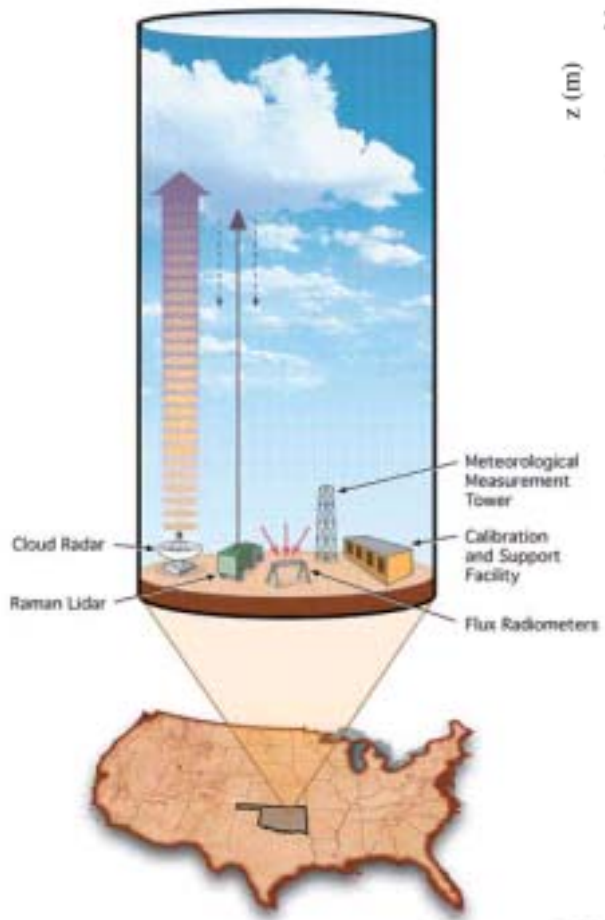**Questions:**
- Do models reproduce correct timing?
- Do scaling laws still apply?
- How is subcloud layer affected by cu?

Set up of the case.

For details see: A.R. Brown et al. Q.J.Met.Soc. 128, 1075-1094 (2001) or:

www.knmi.nl/samenw/eurocs

LES Simulations

EUROCS

| Institute	Scientist	Form.	Subgrid	ADV
Met office	Brown/Lock Macvean	Anelastic	Smagor-inski	Monotone
MPI	Chlond	Boussinesq	TKE	Monotone
KNMI	Neggers	Boussinesq	TKE	Centered
NCAR	Moeng	Boussinesq	TKE	Monotone
WVU	Lewellen	Boussinesq	TKE	Monotone
CSU (LES)	Khairout-dinov	Anelastic	TKE	Monotone
CSU (RAMS)	Golaz	Compressible	TKE	Centered
UCLA	B. Stevens	Anelastic	Smagor-inski	monotone

Set up of the LES model

- ✓ Domain size: 6400m X 6400m X 4400m
- ✓ Resolution: 66.7m X 66.7 X 40m
- ✓ No microphysics
- ✓ Prescribed: surface fluxes, radiative fluxes, advection
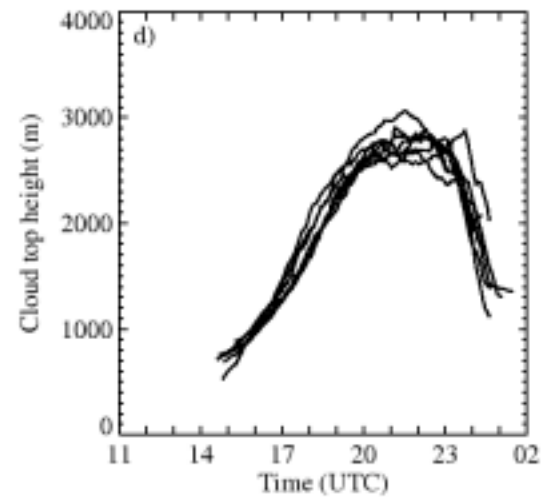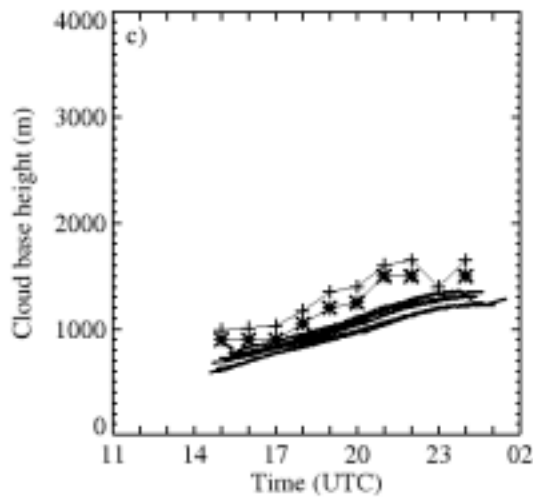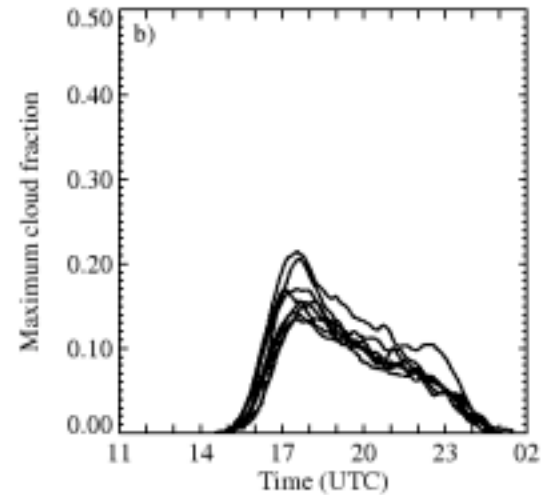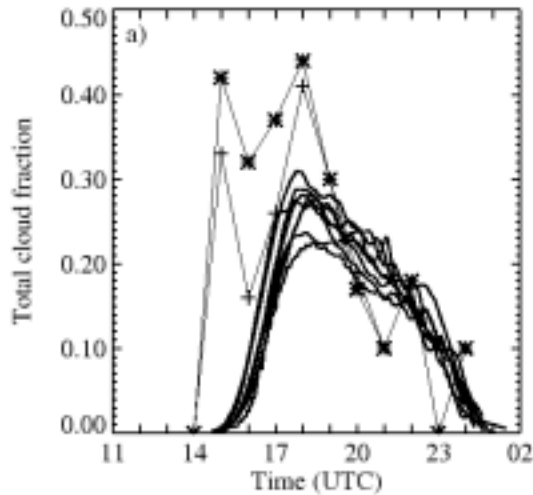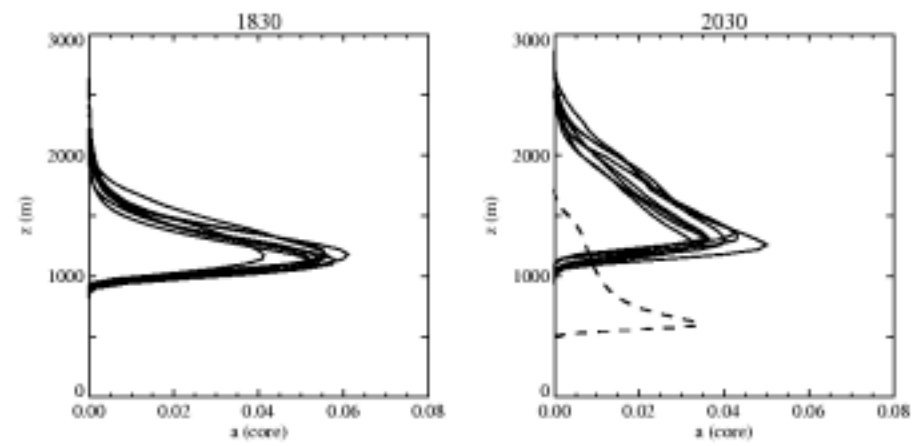- ✓ Simulation from 11:30 UTC to 02:00UTC

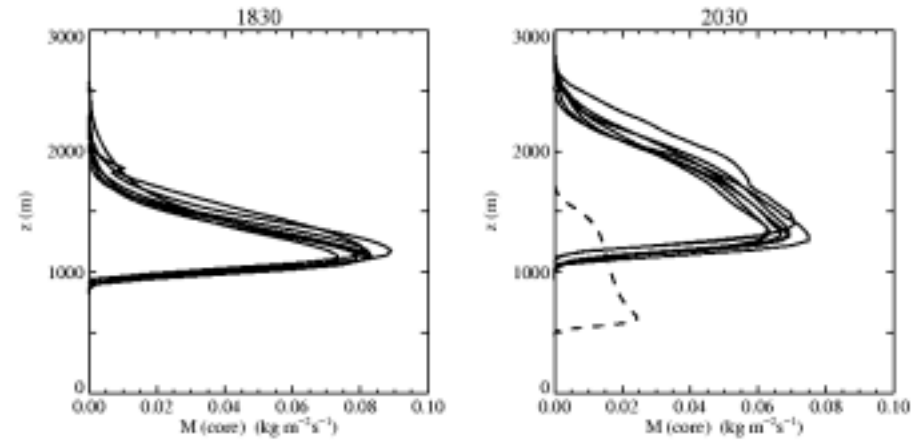(Neggers 2001)

KNMI
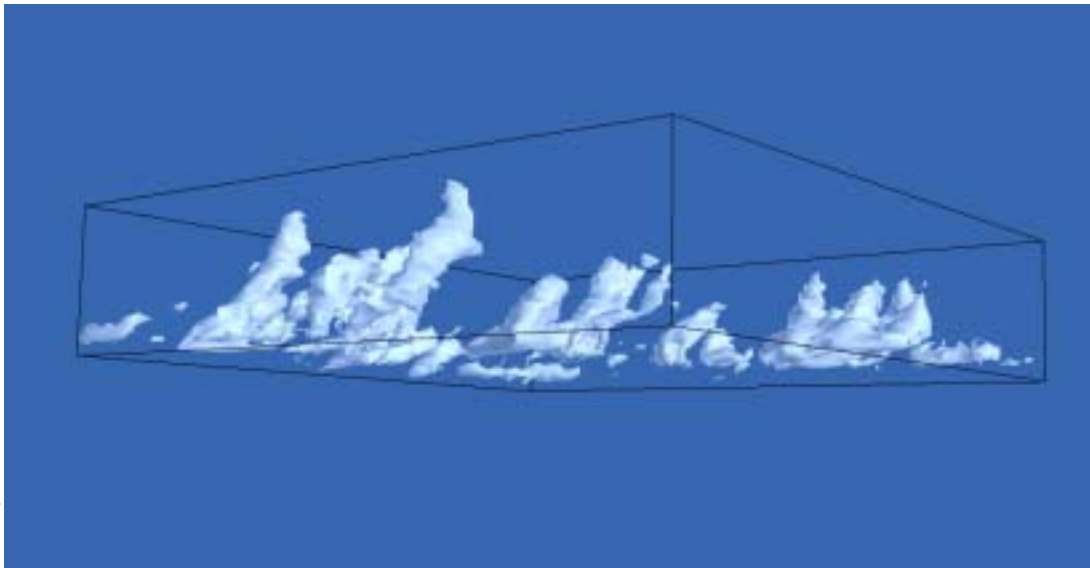
Results (1):   Mean Profiles
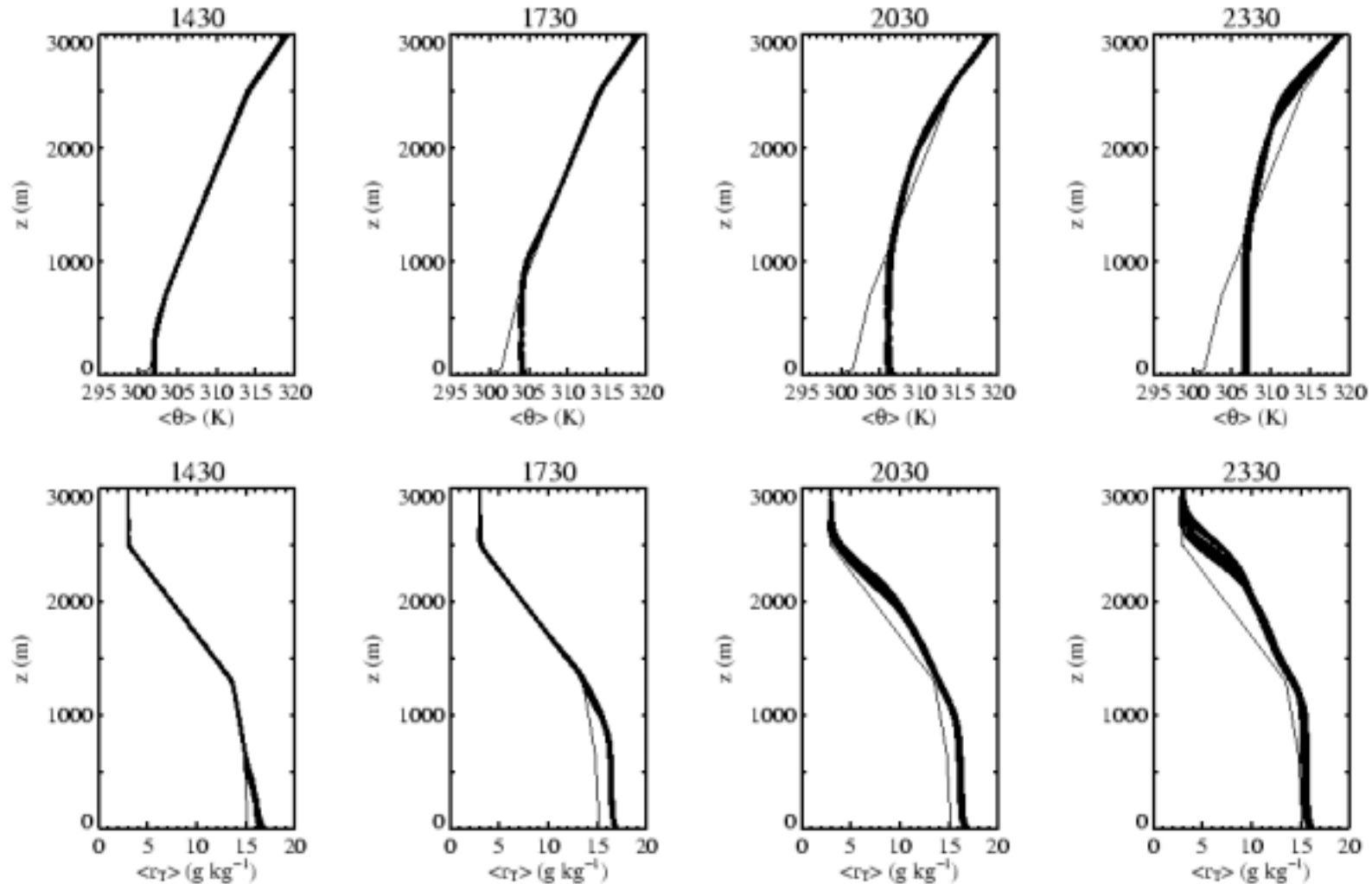
Results (2): Time series of cloud variables
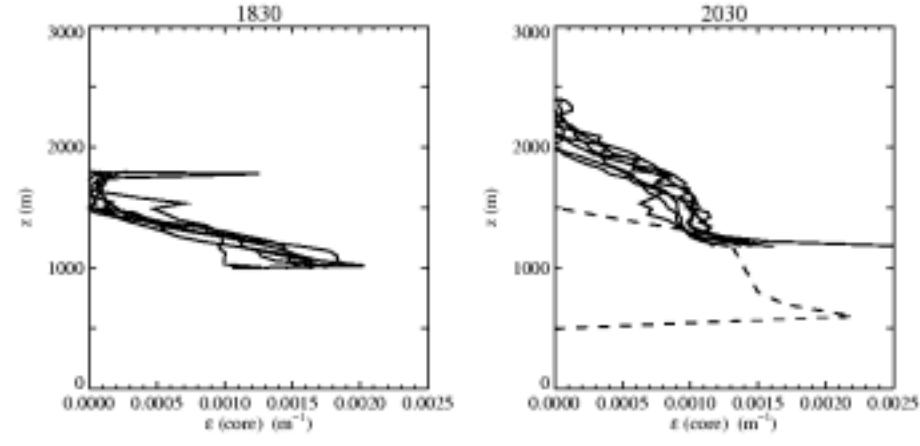
Core cover

Mass flux

Fractional Entrainment

Conclusions (LES-Results

1. Surprisingly consistent LES results

2. Similar results as for previous steady-state cases (if properly rescaled)

3. Demanding case for parameterizations since a number of different regimes have to be modelled

(stable) => (clear convective) => (cumulus topped bl) => clear convective

with realistic constraints from (LES/obs)

Results are published: A.R. Brown et al. Q.J.Met.Soc. 128, 1075-1094 (2001)

LES data available :   www.knmi.nl/samenw/eurocs

Single Column Model (SCM) Results

- Same set up as for the LES models
- All SCM's with same vertical resolution (~200m)
- Standard Run plus run with updated physics
- Results:
    - Preprint ready:

        Lenderink + coauthors: The diurnal cycle of shallow cumulus over land: A single column model intercomparison study.

   - Data available: www.knmi.nl/samenw/eurocs

Single Column Model (SCM) Results

| Model	Scientist	Diffusion	Conv	Cloud
Met office	Irons	PRO	MF (GR)	Statistical
ECHAM5	Chlond/ Mueller	TKE m	MF (T)	Prognostic ql, RH-based cc
RACMO	Lenderink	TKE m	MF (T)	Prognostic ql, RH-based cc
ARPEGE	Marquet/ Cheinet	TKE d	No (KF)	Statistical
ECMWF	Siebesma	PRO	MF (T)	Prognostic ql,cc
MESO-NH	Soares	TKE m	KF	Statistical
HIRLAM	Olmeda/ Sanchez/ Jones	TKE d	KUO	

Results (1) : Cloud Cover
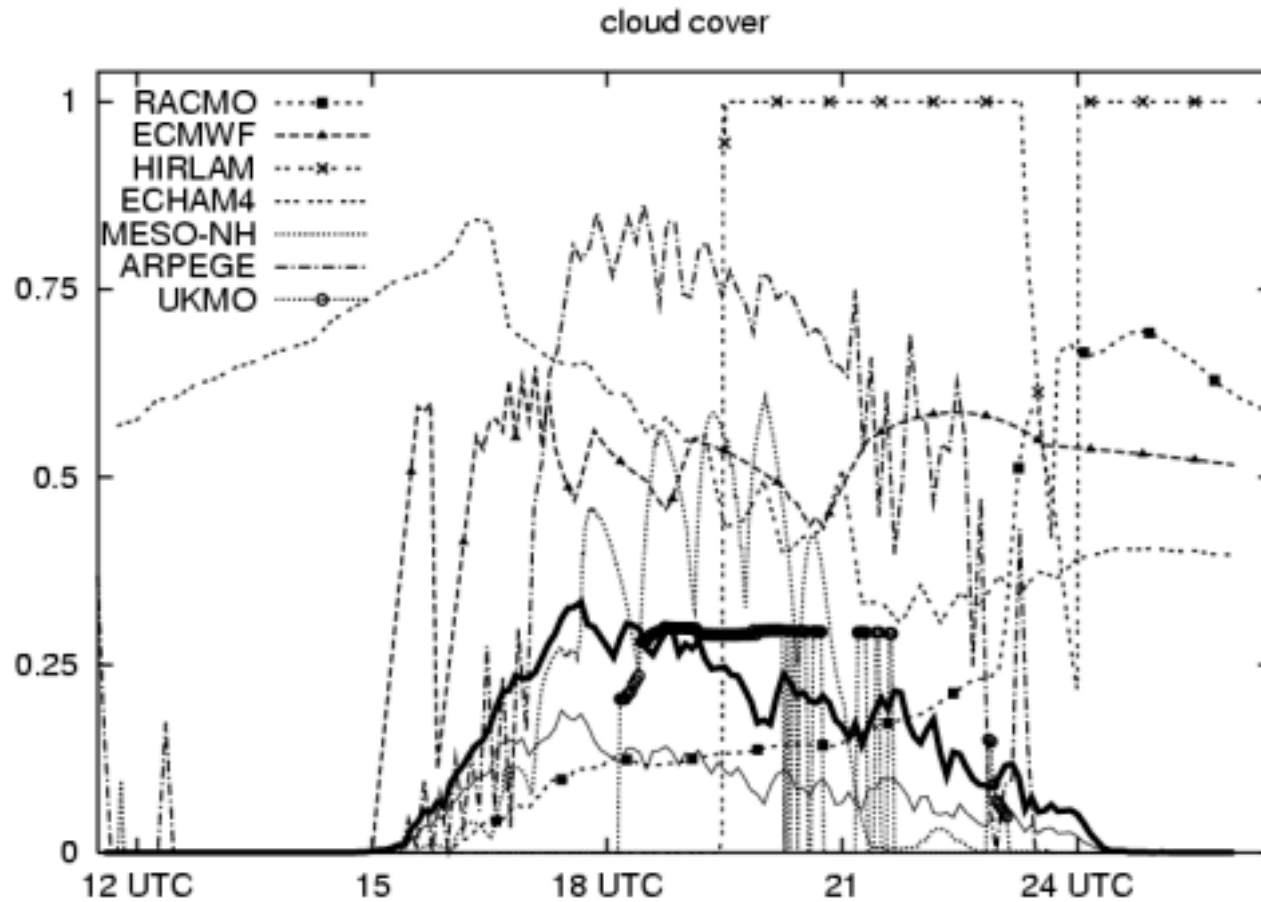
cloud cover

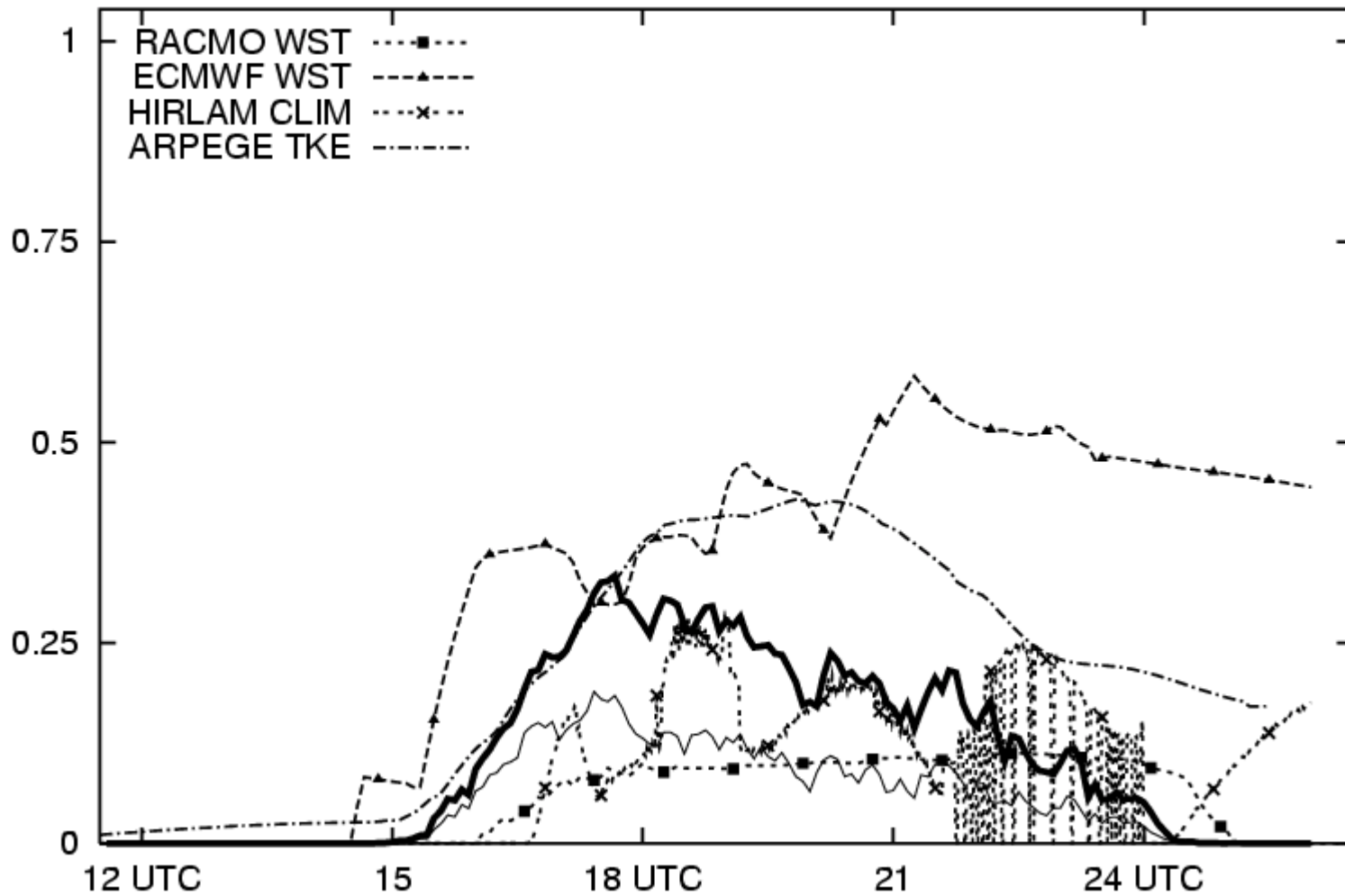# Results (2) Liquid Water Path.

liquid water path
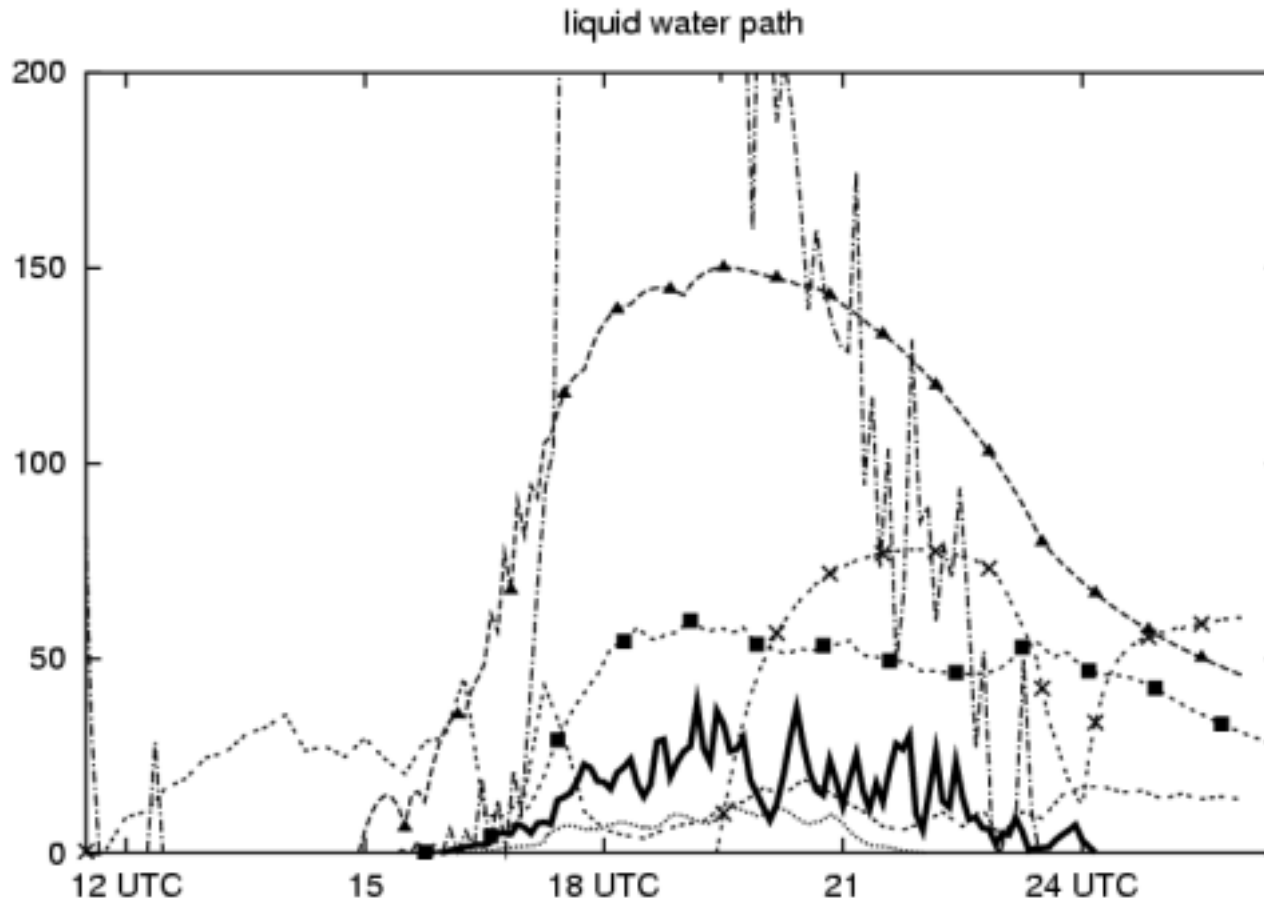
Updates!!

cloud cover

Conclusions

1. Collective Overestimation of Cloud Cover and LWP

2. Clouds do not disappear at the end of the day.

3. Unwanted interactions between the various schemes leading to numerical noise.

4. This afternoon more specific analysis why!!

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