

CCPP FASTER: **Improving the representation of cloud macrophysics in the RACMO and the IFS**

A short description of the models

Preliminary SCM results for 1999-2001 at ARM SGP. Two research topics:

** Evaluation of the impacts of the ice super-saturation function on high cloud occurrence*

** Evaluation of the impact of the new EDMF-DualM boundary layer scheme on the vertical structure of low-level clouds*

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ECMWF IFS

Integrated forecasting System (IFS) of the European Centre for Medium-range Weather Forecasts (ECMWF)

Current physics version: Cycle 36 R<something>

ERA Interim (CY31R1)

KNMI RACMO

Regional Atmospheric Climate Model (RACMO)

Consists of HIRLAM dynamics and IFS physics (currently C31R1)

Used for

- * Generation of future climate scenarios for Europe / The Netherlands*

- * Short-term forecasts (Initialization & domain boundaries: ECMWF analysis)*

- * Testing of experimental parameterization schemes (boundary layer)*

- * Provides forcings for the KNMI Parameterization Testbed (KPT)*

Two SCM versions participate in FASTER:

- * CY31R1 (also known as the “ECMWF SCM”)*

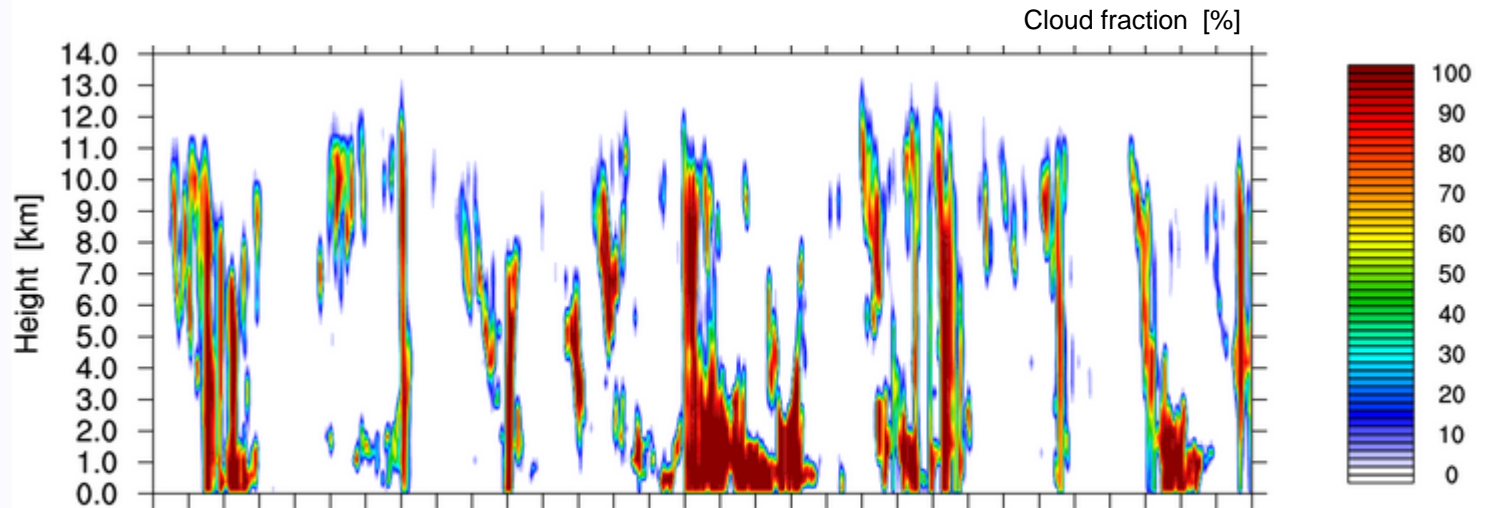
- * CY31R1 + EDMF-DualM*

Eddy Diffusivity - Mass Flux scheme (Seibesma et al, JAS 2007)

Dual Mass flux framework (Neggens et al, JAS 2009)

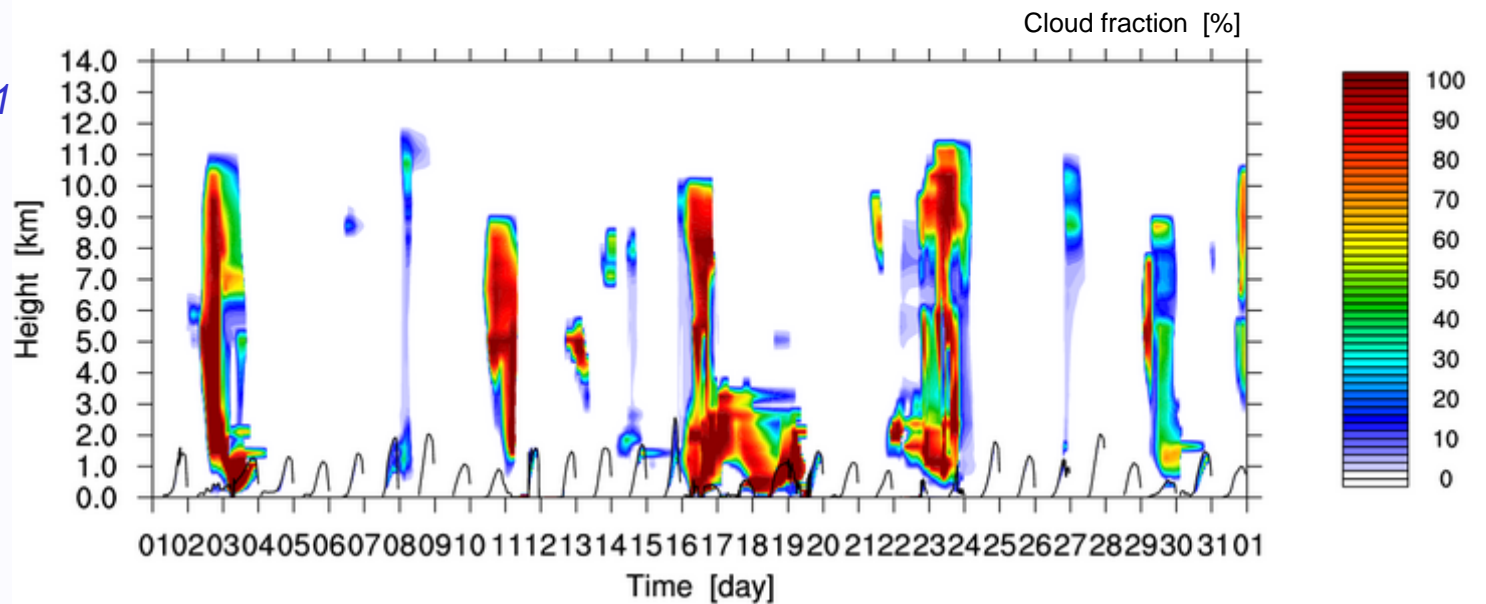
March 2000

ARSCL



SCM CY31R1

Driven by the
Constrained
Variational
Analysis

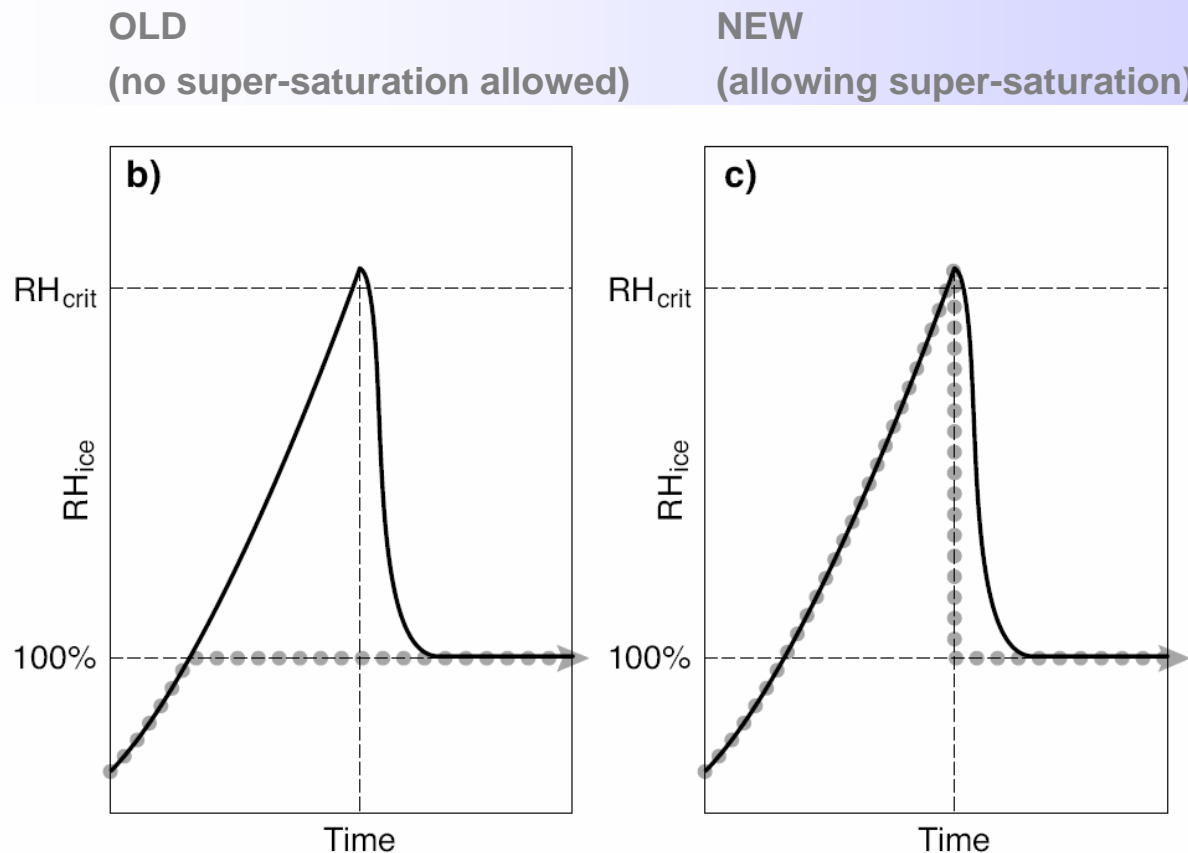


* The SCM picks up the major cloud structures

* Smaller-scale events at high levels are underestimated – do other SCMs show this too?

Topic I: Impact of the ice super-saturation function on the high cloud cover in the IFS

A (new) routine for ice super-saturation above $RH=100\%$ was introduced into the IFS in 2005:



*Tompkins et al.,
ECMWF Tech.
Memo 481, 2005*

*IFS GCM results: SuperSat – Control (no SuperSat)
yearly mean 200009-200109*

Tompkins et al., ECMWF Tech. Memo 481, 2005

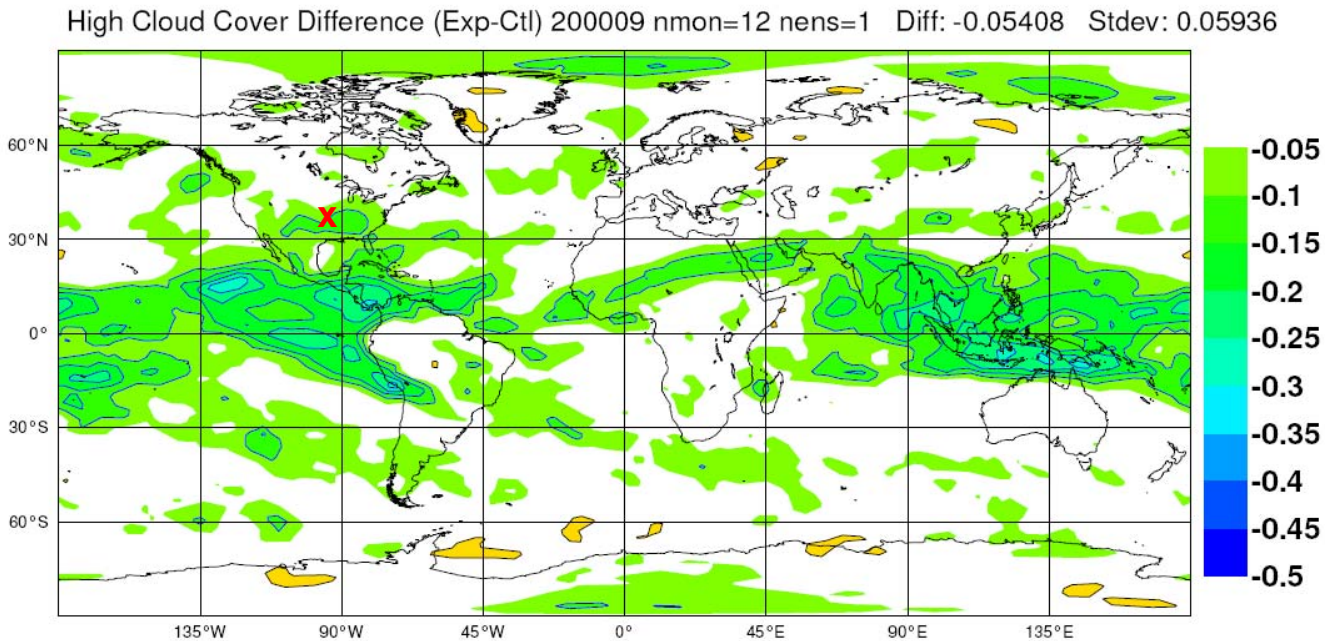


Figure 2: 12 month average difference in high cloud cover ($p < 450$ hPa approximately) between two experiments using the new nucleation parametrisation and the control, respectively.

Q: Is this reduction of high clouds an improvement?

Can we evaluate against ARM SGP measurements using the SCM technique?

March 2000

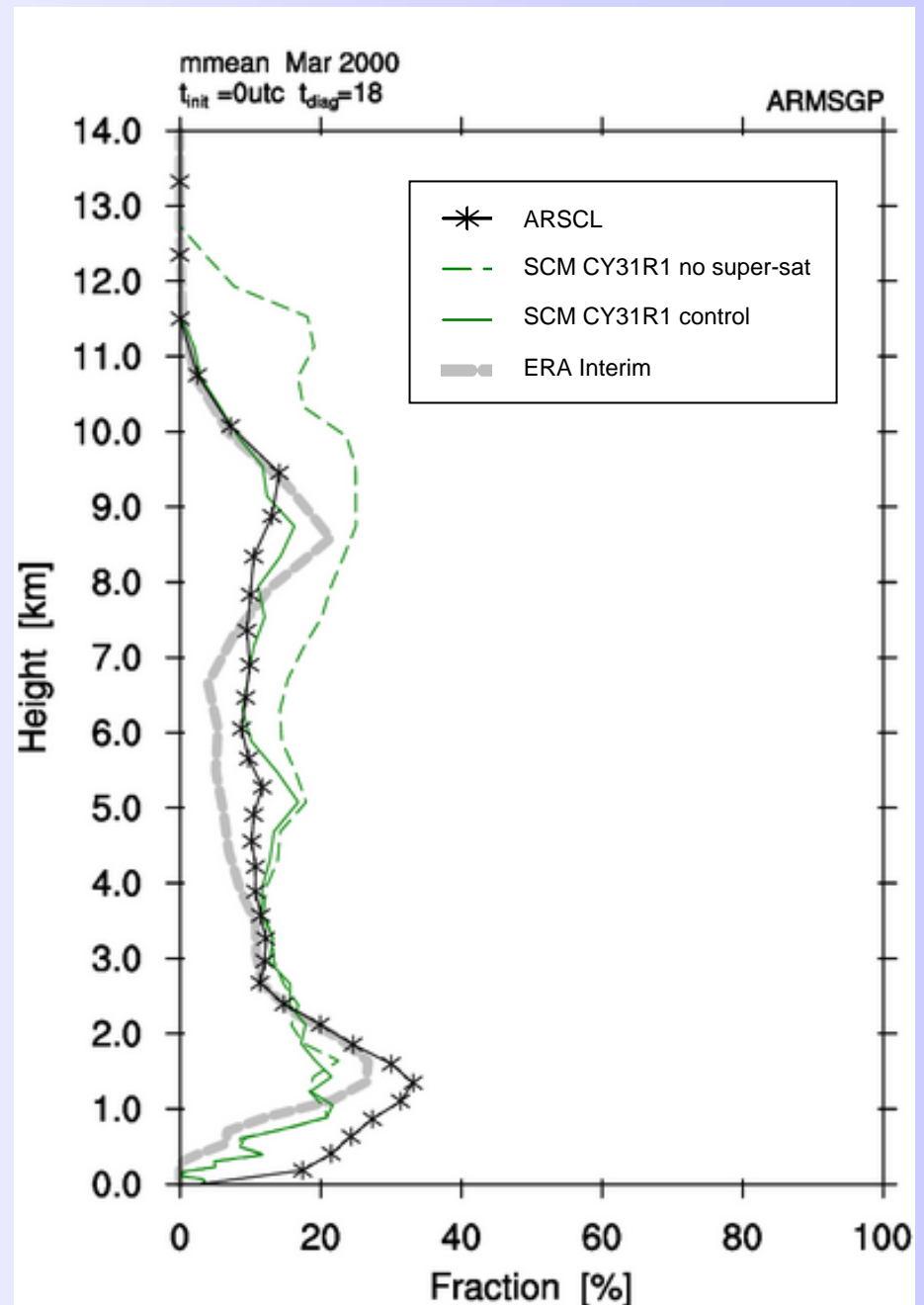
monthly mean at 18 UTC

*Sensitivity test on ice super-saturation:
it reduces the cloud fraction by about
10% at 10km height*

*This is in agreement with the GCM
results*

*According to ARSCL this is an
improvement (at least for this month)*

*Also note: the CY31R1 SCM
reproduces the cloud structure of ERA
Interim (CY31R1 physics) reasonably
well, even when driven by an
independent forcings dataset*



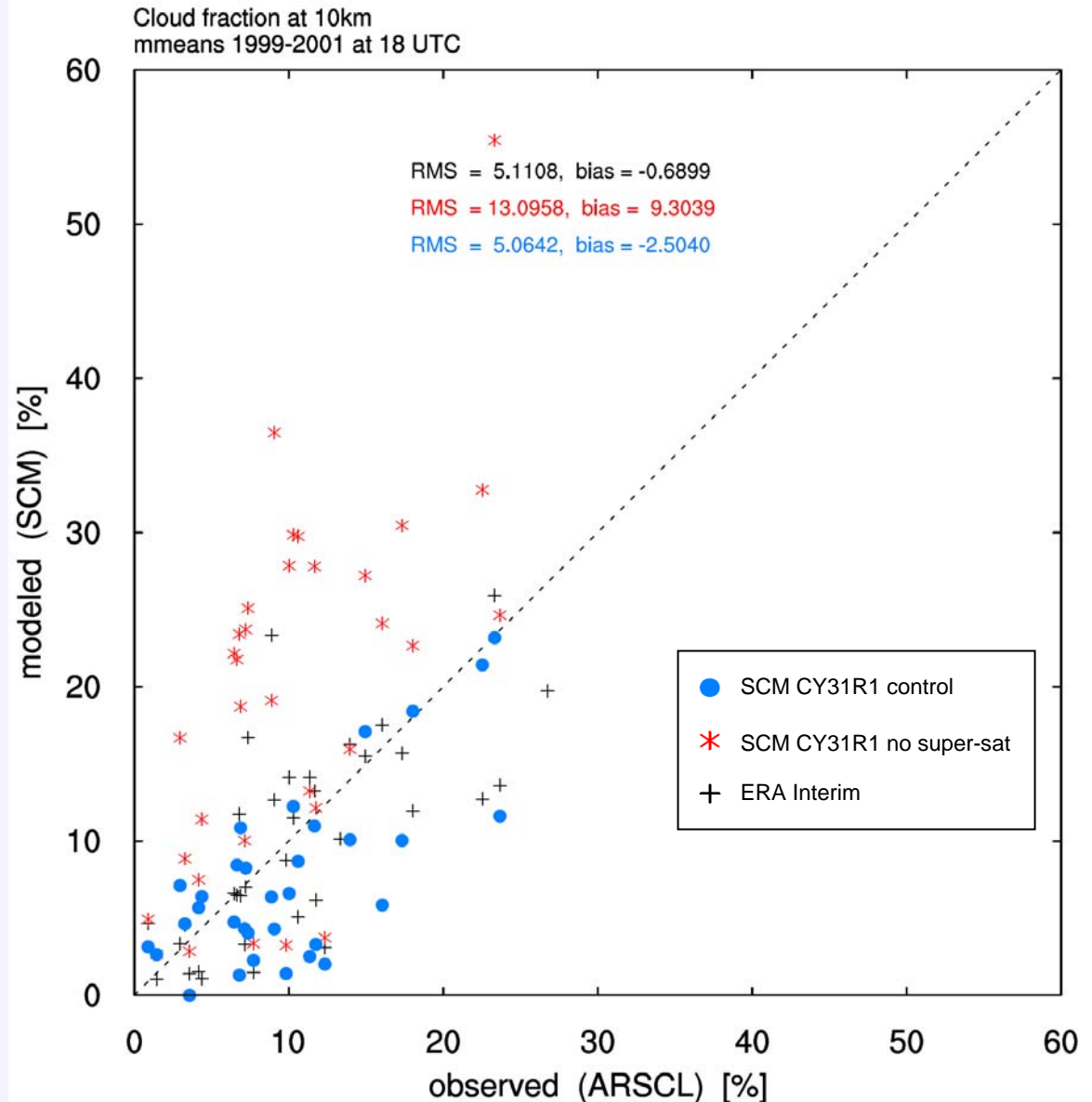
Better statistics:

Evaluation of the monthly mean cloud fraction at 10km height at 18 UTC against ARSCL for the period 1999-2001:

** The March 2000 result is representative of the longer-term*

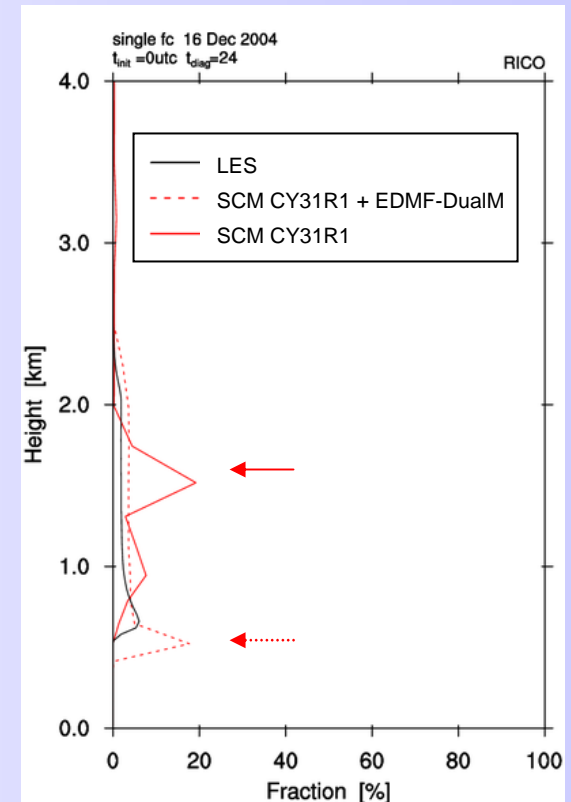
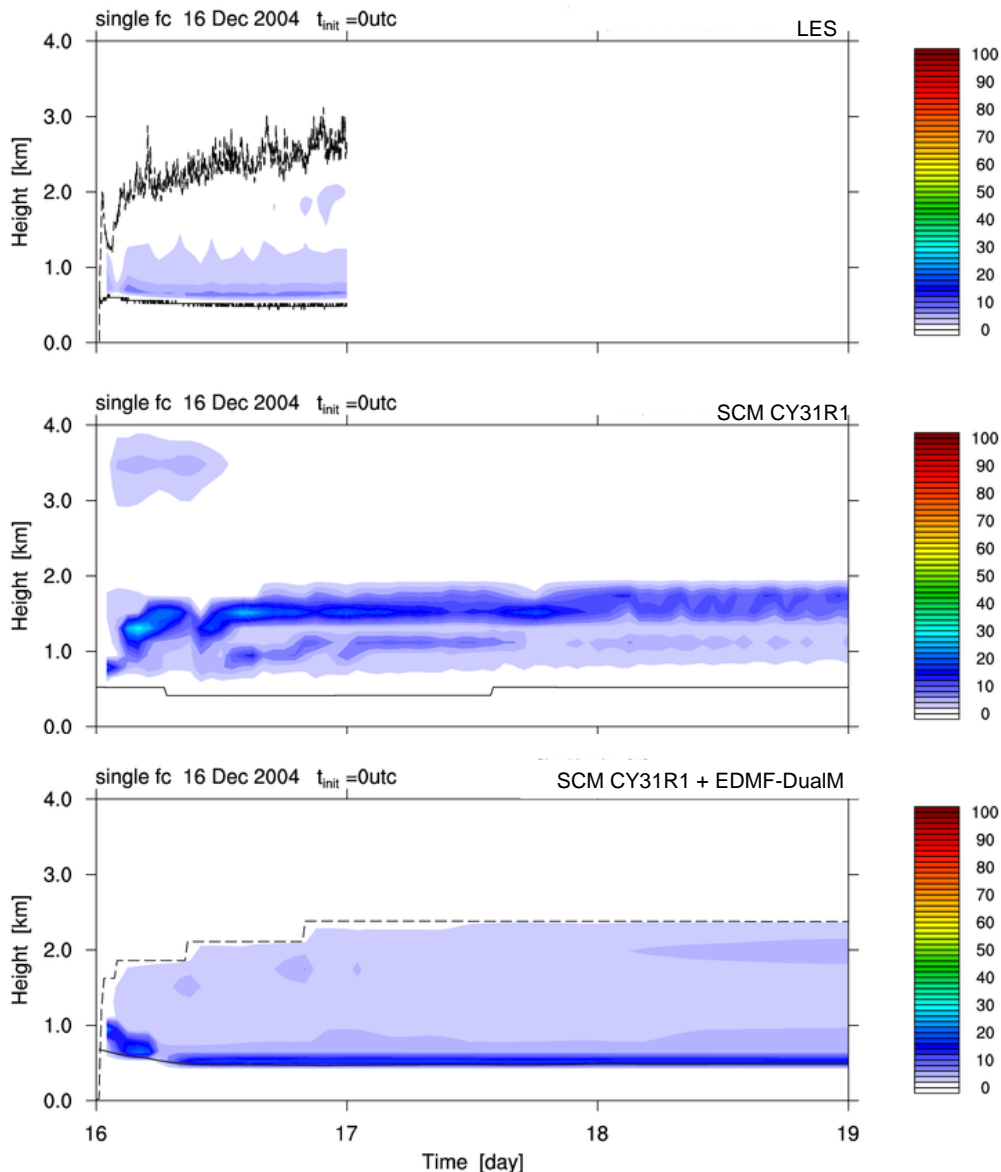
** The supersaturation function brings a statistically significant improvement*

** Not accounting for super-saturation leads to too much high cloud occurrence*



Topic II: Testing a new boundary layer scheme for RACMO / IFS

Results with the EDMF-DualM framework for the Rain In Cumulus over the Ocean (RICO) case of the Boundary Layer Working Group (BLWG) of the GCSS (<http://www.knmi.nl/samenw/rico/RICO>)

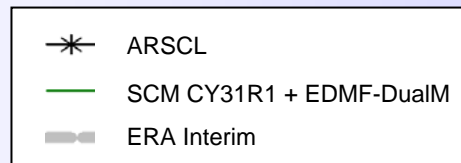
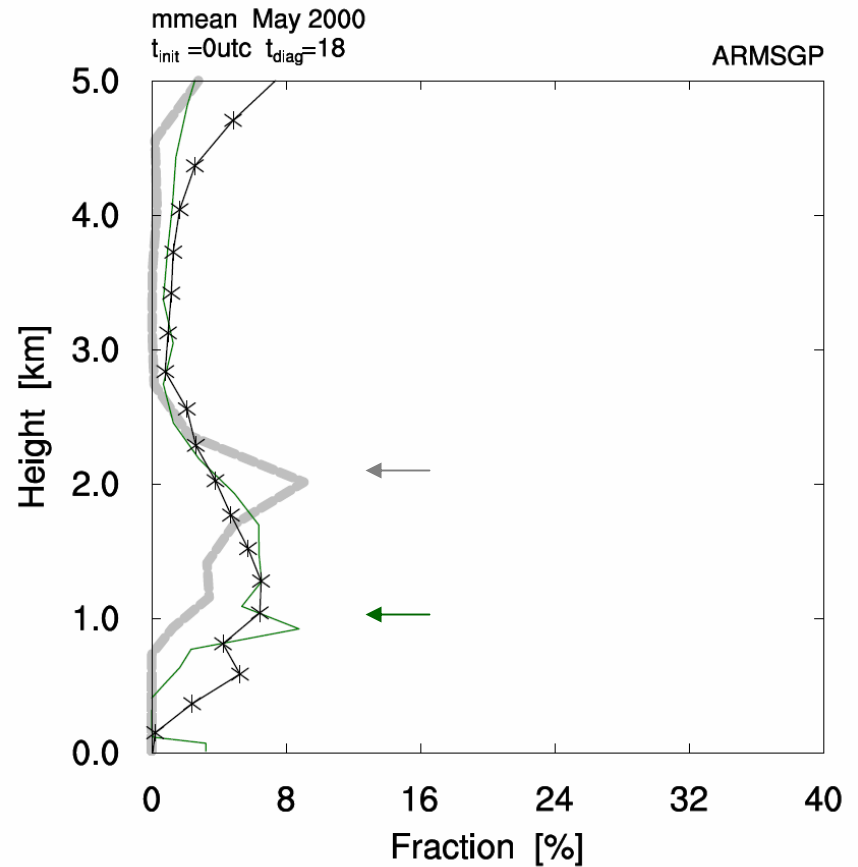
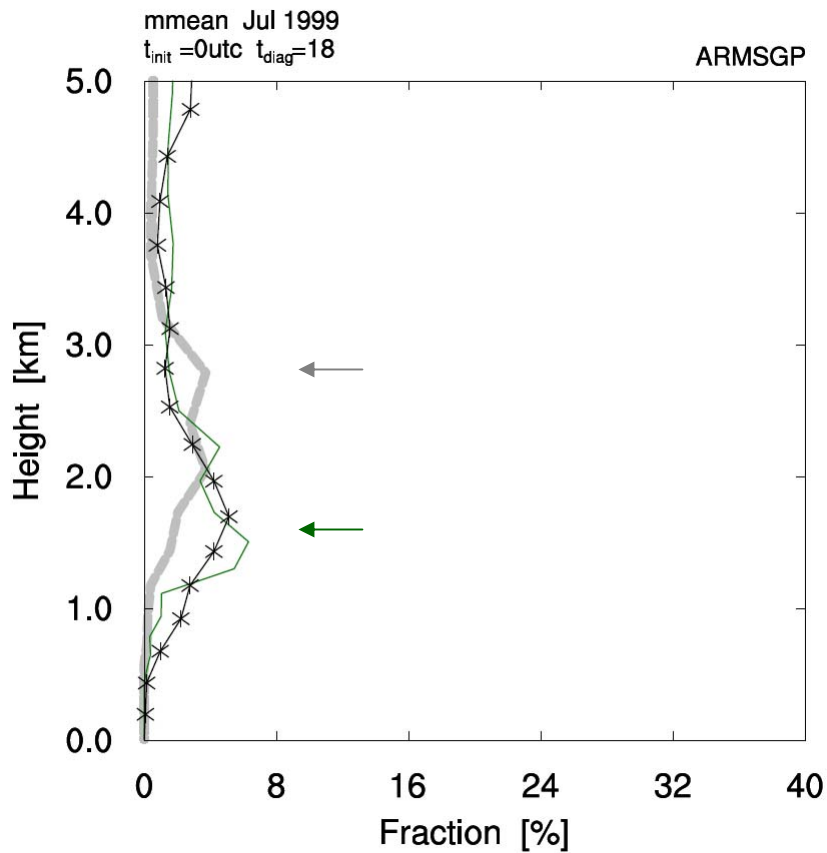


EDMF-DualM better reproduces the “bottom-heavy” profile of cloud-fraction as seen in LES

Q: This is an idealized case. Do these results carry over to the real world?

Spring/summer cloud fraction at SGP:

EDMF-DualM has its low-level maximum at a lower height compared to ERA Interim (CY31R1)

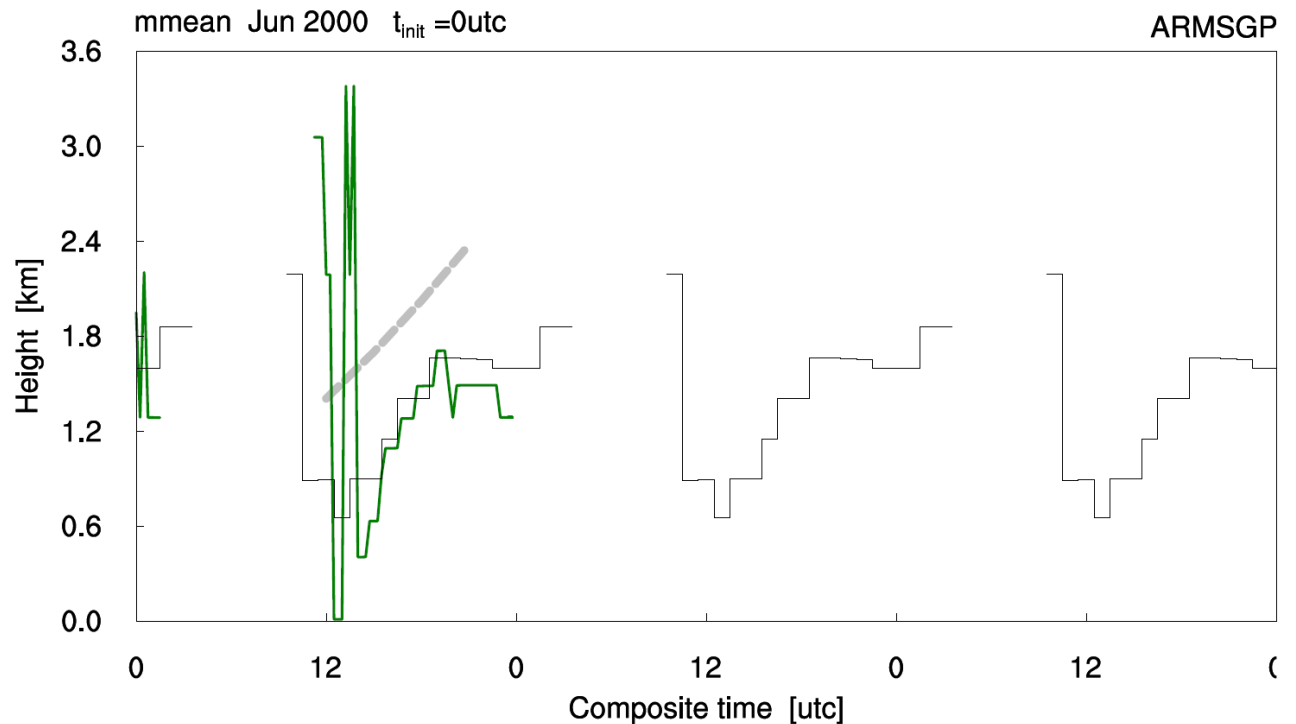
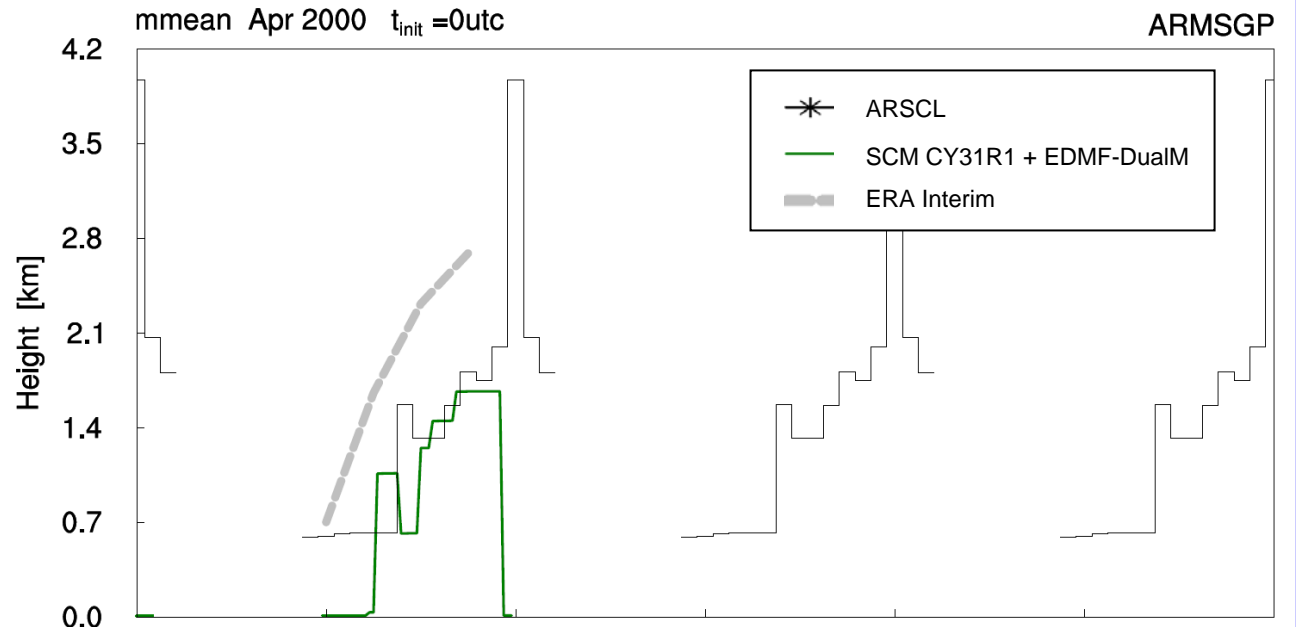


Process-level evaluation

Evaluation of the monthly mean height and time-development of the daytime maximum cloud fraction in the lowest 4km

* The typical diurnal rise of the peak in PBL cloud fraction can be distinguished

* EDMF-DualM agrees better with ARSCL

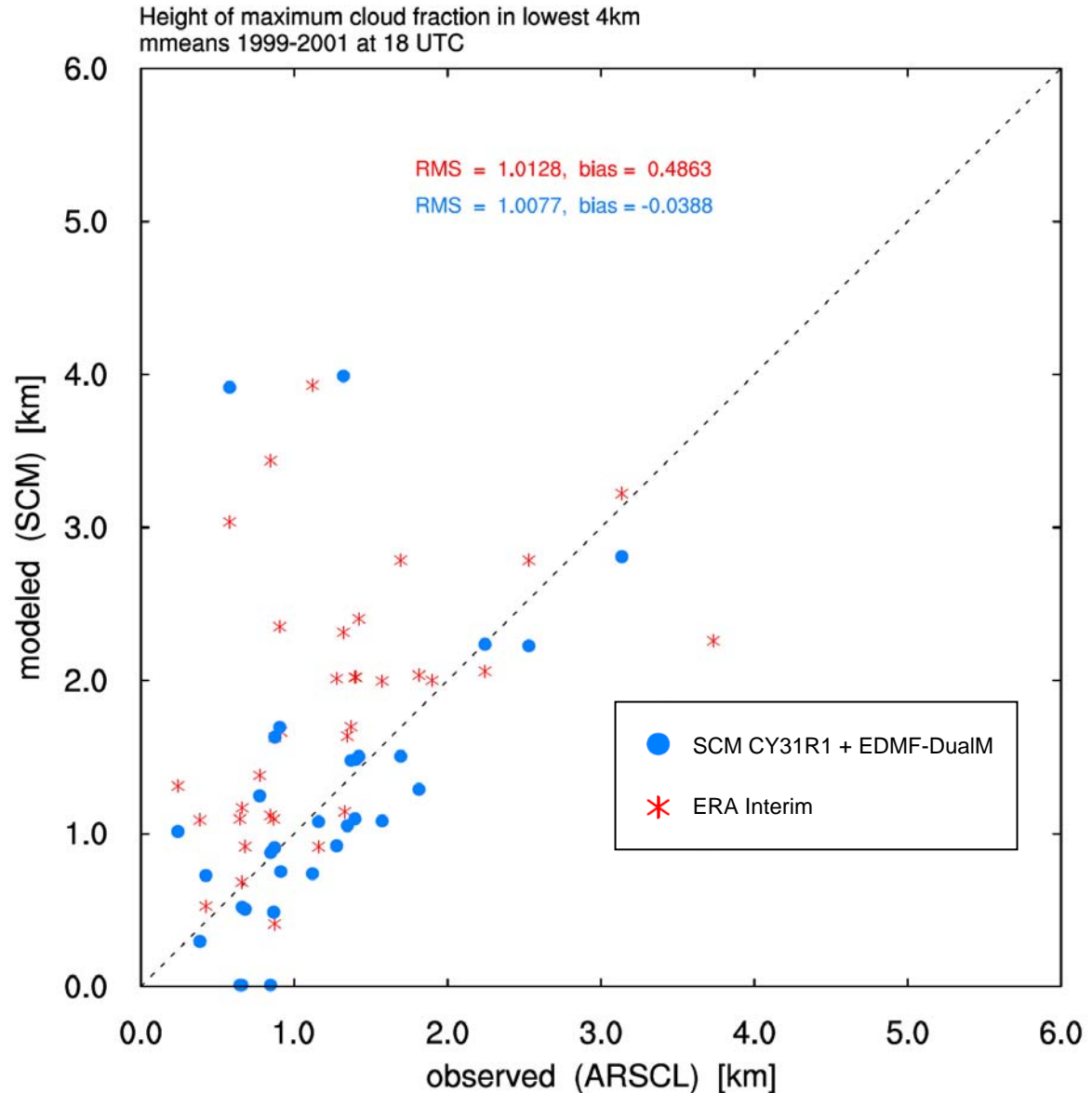


Better statistics:

Evaluation of the monthly mean height of the maximum cloud fraction in the lowest 4 km at 18 UTC against ARSCL for the period 1999-2001:

** CY31R1 overestimates this height, reflecting that it overestimates the occurrence of shallow cumulus outflow at the top of the PBL (“anvils”)*

** EDMF-DualIM agrees better with observations, reflecting that for fair-weather cumulus it typically puts the maximum cloud fraction at cloud base*



Summary / conclusions

Long-term SCM evaluation against ARM SGP datasets reveals that:

** The ice super-saturation routine in RACMO / IFS brings a significant improvement in high cloud occurrence*

** Typical results with EDMF-DualM on shallow cumulus cloud structure for the idealized GCSS RICO case also materialize in multi-year statistics at ARM SGP*

A more general statement: It is well possible to reproduce typical GCM behavior due to fast-acting sub-grid physics by means of long-term continuous SCM simulation



see also our paper “Continuous single-column model evaluation at a permanent meteorological supersite”, to be submitted to BAMS, available for viewing online at http://www.knmi.nl/~neggers/index_publ.html