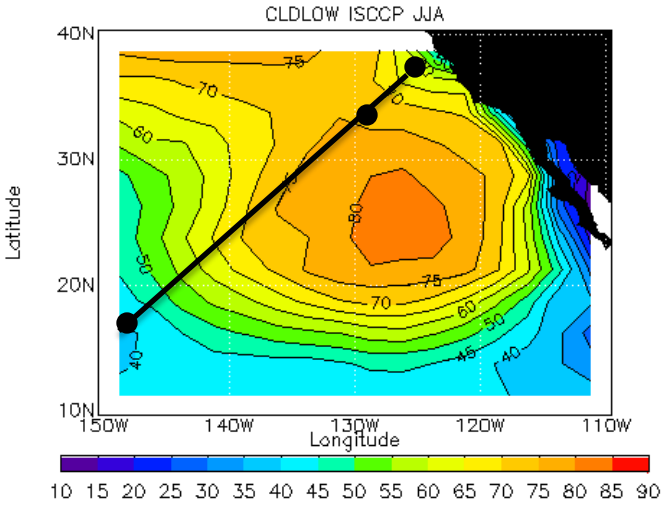
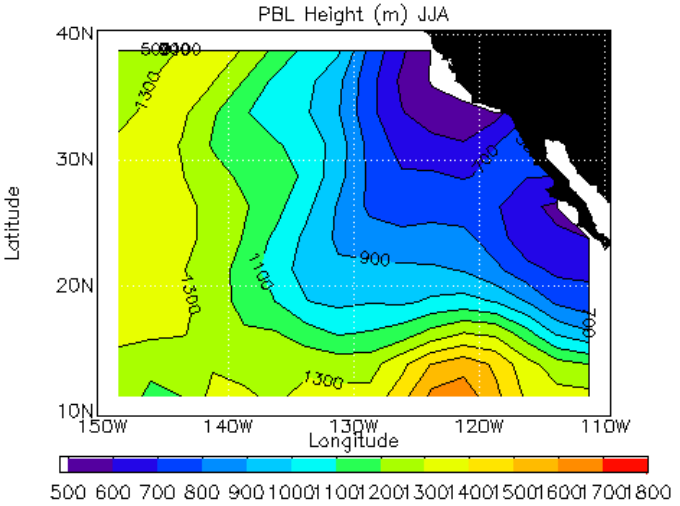
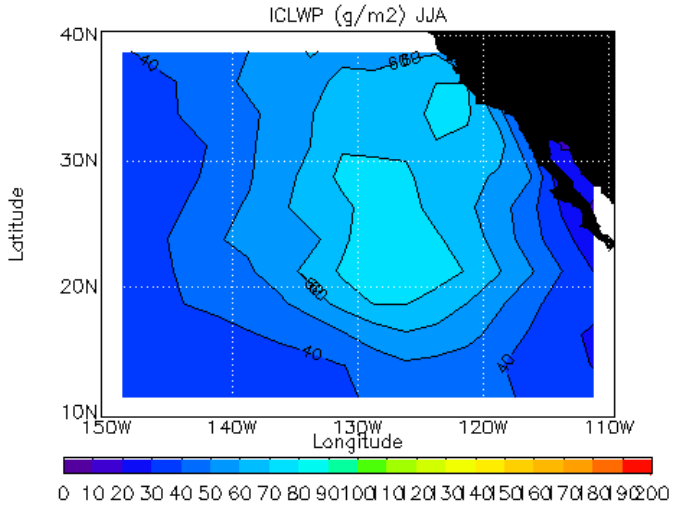
The CGILS Project

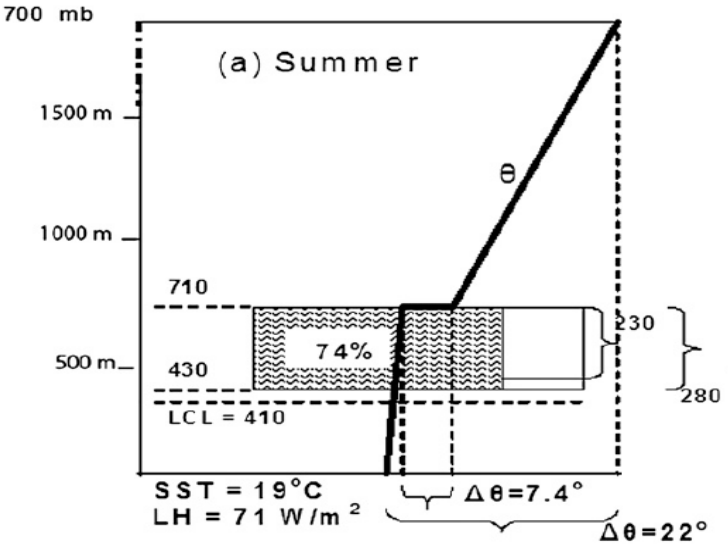
CFMIP-GCSS Intercomparison of Large-Eddy and Single-Column Models

Minghua Zhang, Christopher Bretherton, Peter Blossey and Participants



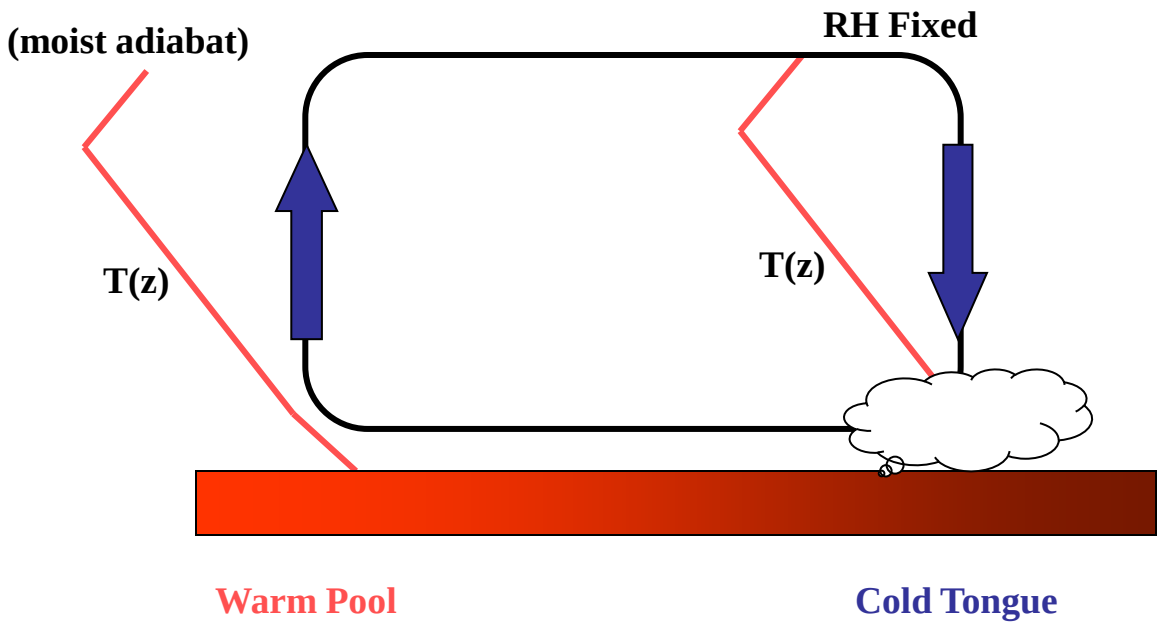






(Lin, Zhang and Loeb, JCL 2010)

Idealized Experiments



Need to be relevant to observations and GCMs

(Zhang and Bretherton, 2008)

Purpose:

To understand the causes of cloud feedbacks, and thus climate sensitivities of climate models.

Objectives:

1. **To understand the physical mechanisms of cloud feedbacks in SCMs**
2. **To interpret GCM cloud feedbacks by using SCM results**
3. **To Evaluate the SCM cloud feedbacks using LES simulations**

SCM (16)

CAM4
CAM5
CCC
CSIRO
ECHAM5
ECHAM6
ECMWF
GFDL
GISS
GSFC
JMA
KNMI-RACMO
LMD
SNU
UKMO
UWM

LES (5)

KNMI
SAM
UCLA
UCLA/LaRC
UKMO

CGILS Participants

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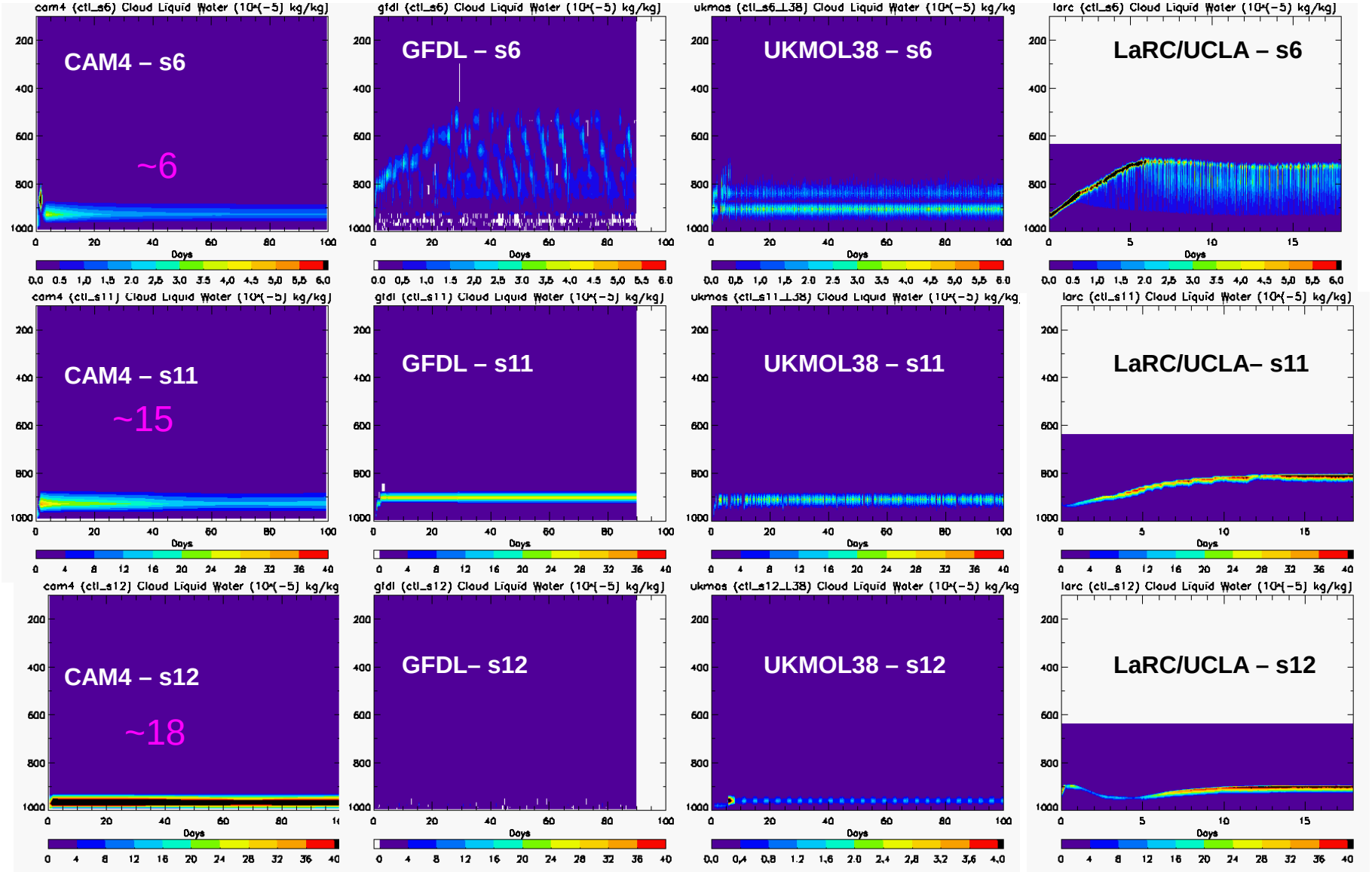
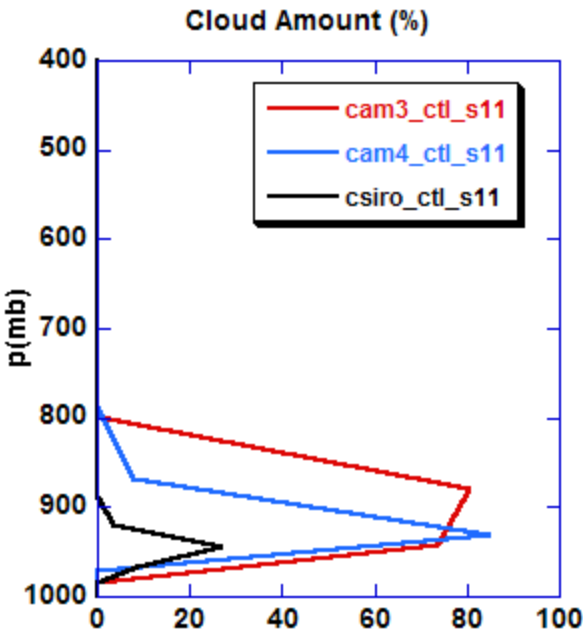
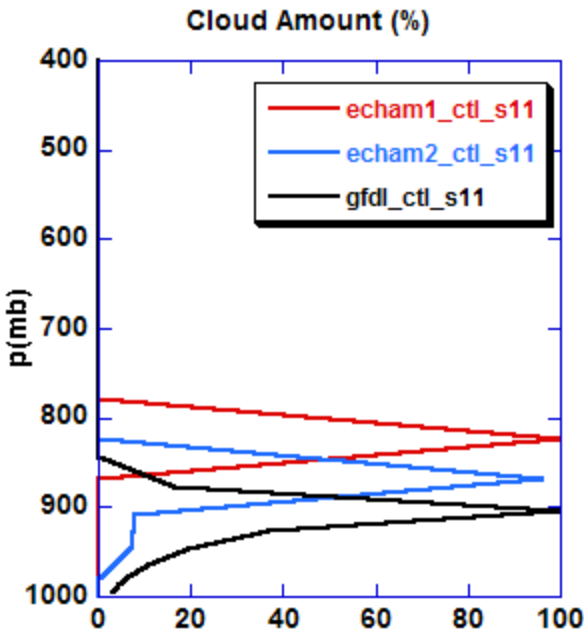
Cloud Liquid Water in Control Simulation




Cloud Amount (%)
cam3_ctl_s11
cam4_ctl_s11
csiro_ctl_s11
p(mb)
400
500
600
700
800
900
1000
0
20
40
60
80
100


Cloud Amount (%)
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echam2_ctl_s11
gfdl_ctl_s11
p(mb)
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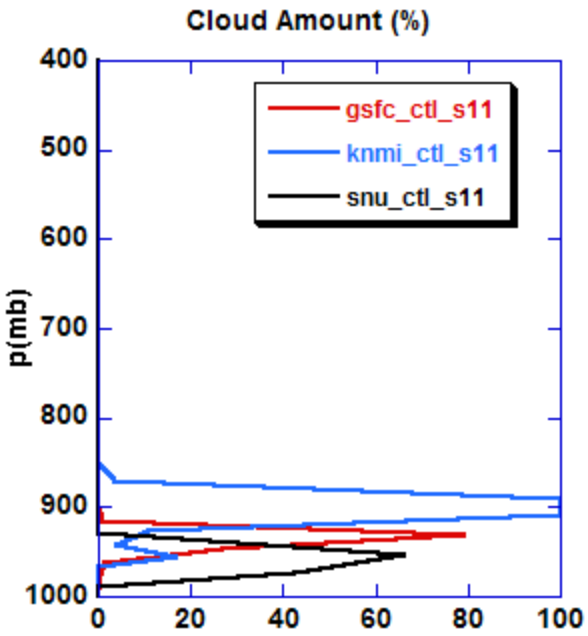
500
600
700
800
900
1000
0
20
40
60
80
100


Cloud Amount (%)
gsfc_ctl_s11
knmi_ctl_s11
snu_ctl_s11
p(mb)
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600
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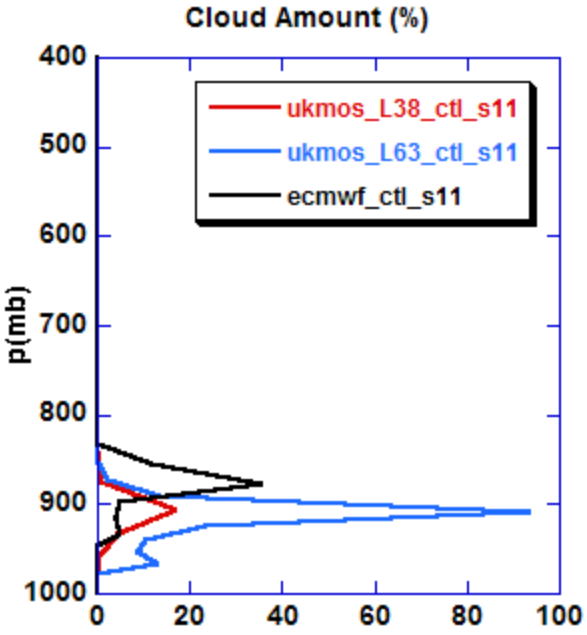
800
900
1000
0
20
40
60
80
100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ukmos_L63_ctl_s11
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p(mb)
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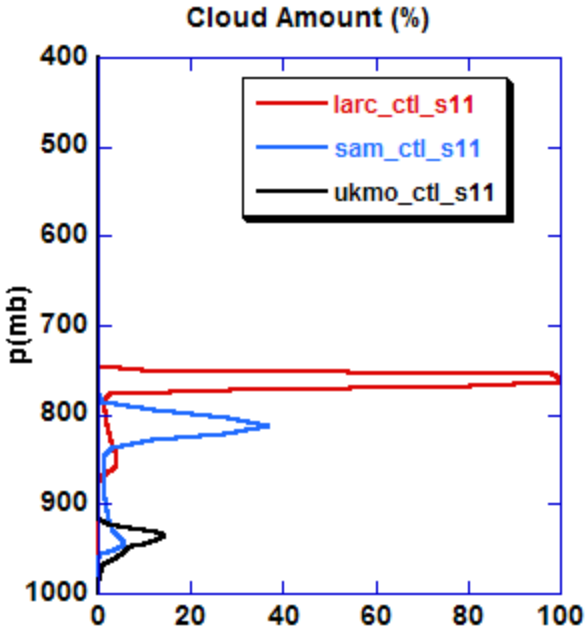
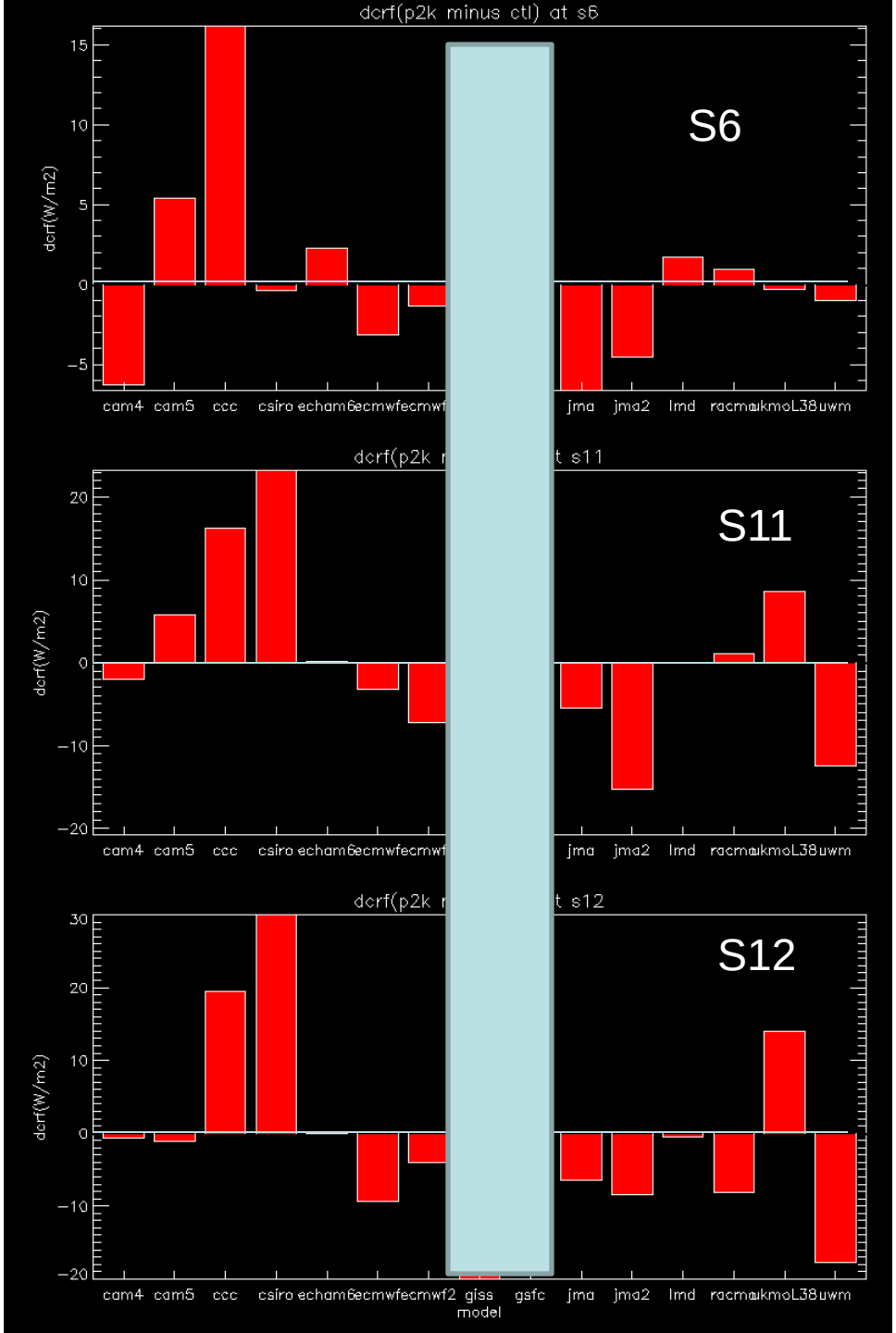
60
80
100


Cloud Amount (%)
larc_ctl_s11
sam_ctl_s11
ukmo_ctl_s11
p(mb)
400
500
600
700
800
900
1000
0
20
40
60
80
100

ΔCRF at S6

ΔCRF at S11

ΔCRF at S12



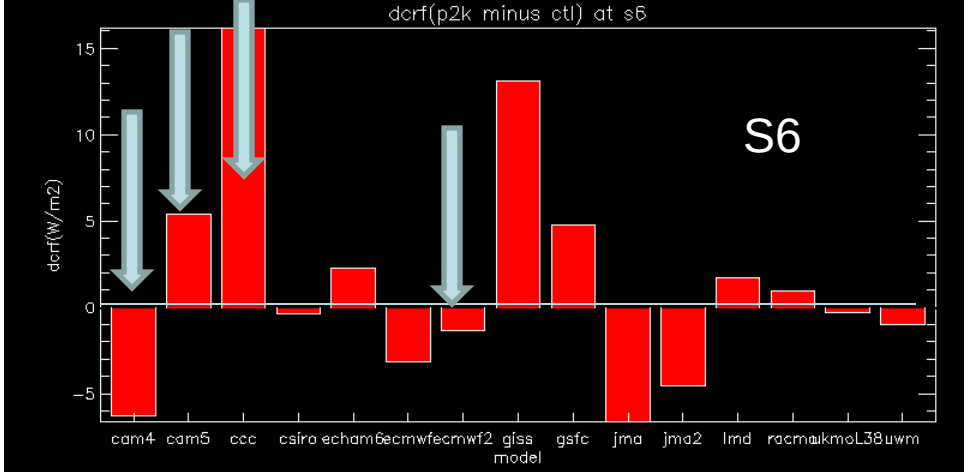
SCM Results

Negative feedback: CAM4, ECMWF, JMA, UWM

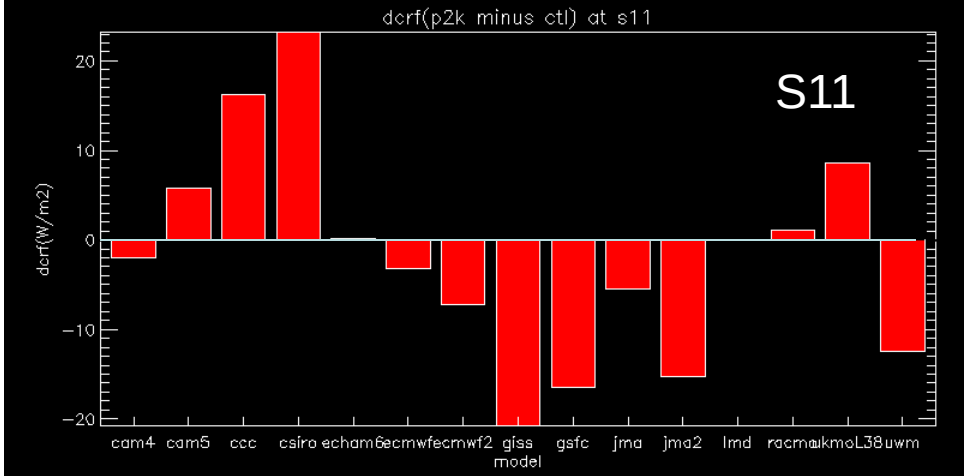
Positive feedback: CAM5, CCC, CSIRO, ECHAM6, GFDL, LMD, UKMO

Mixed: GISS, GSFC, RACMO (positive at s6, negative at s11, s12).

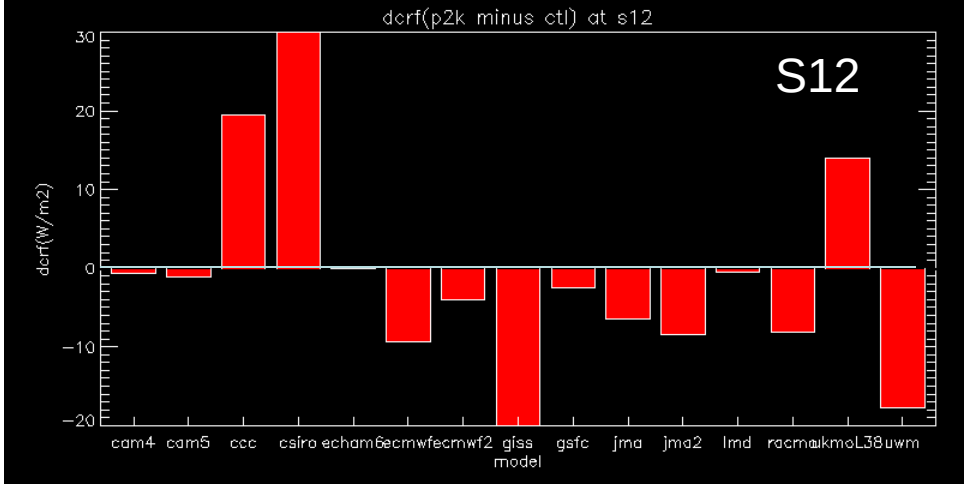
ΔCRF at S6



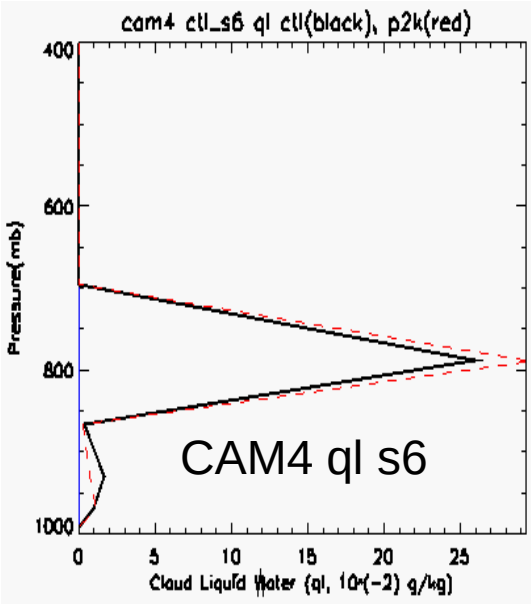
ΔCRF at S11

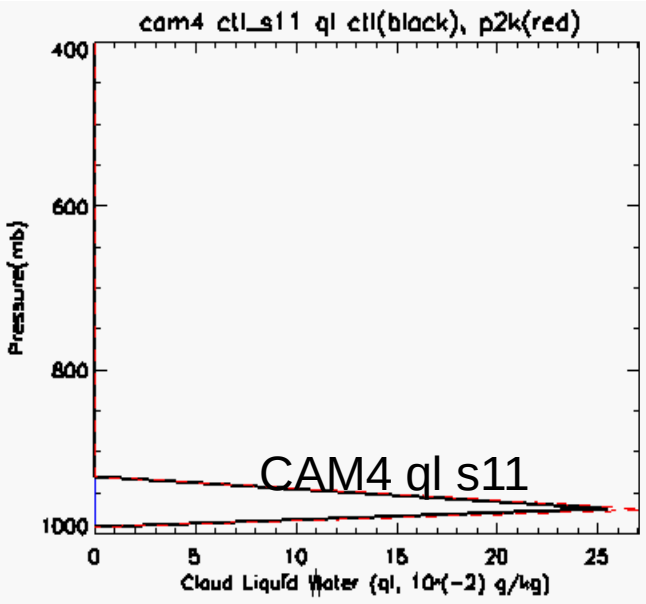


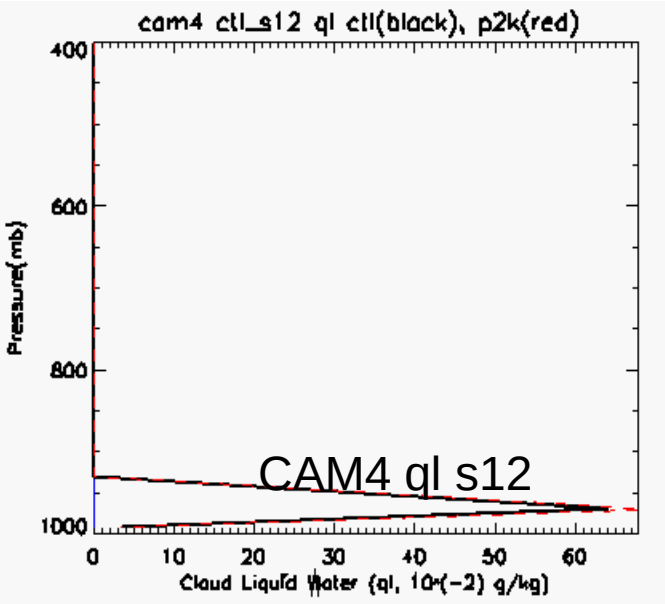
ΔCRF at S12



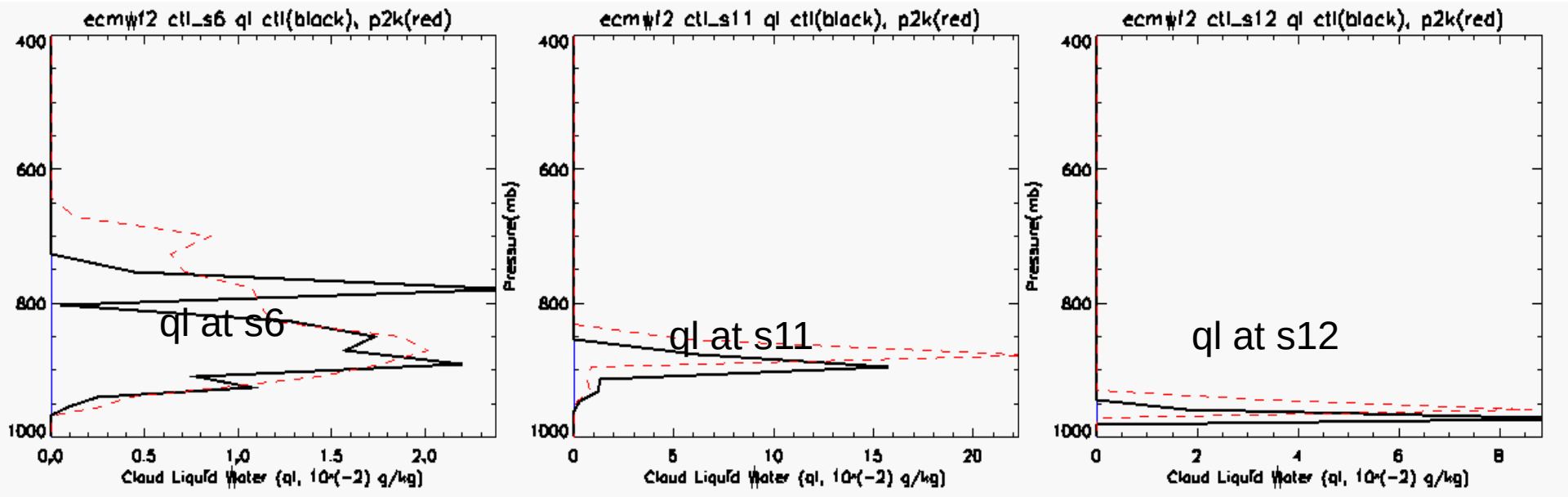
CAM4 Cloud Water (CTL and PSST)



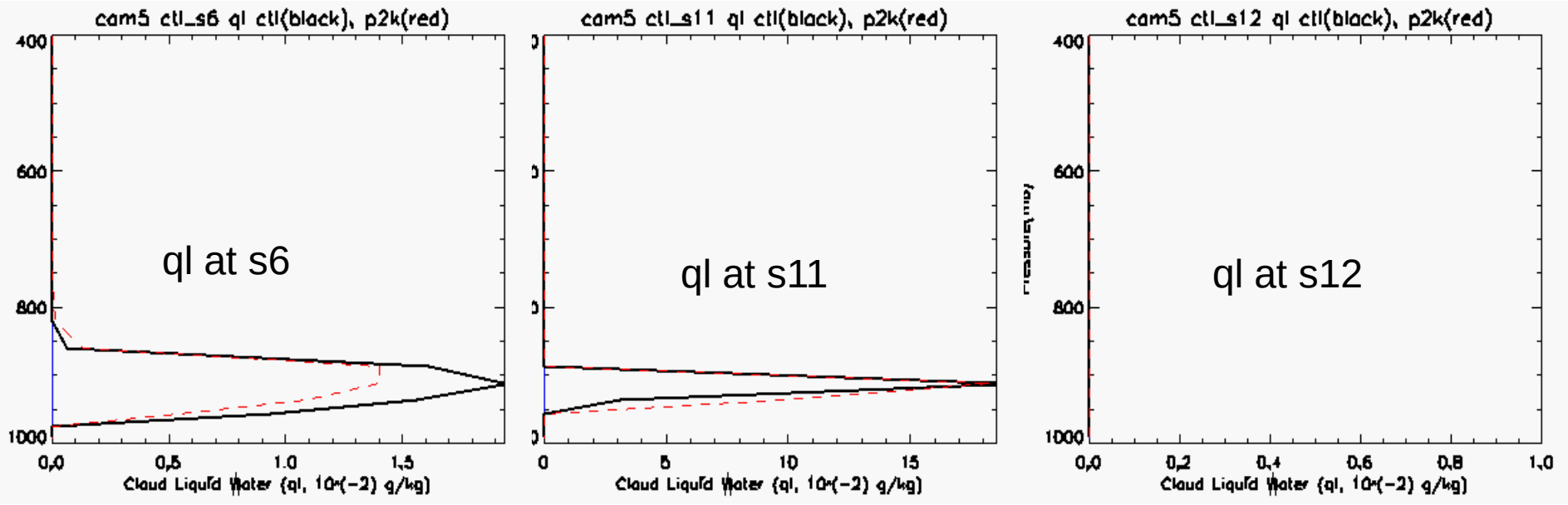




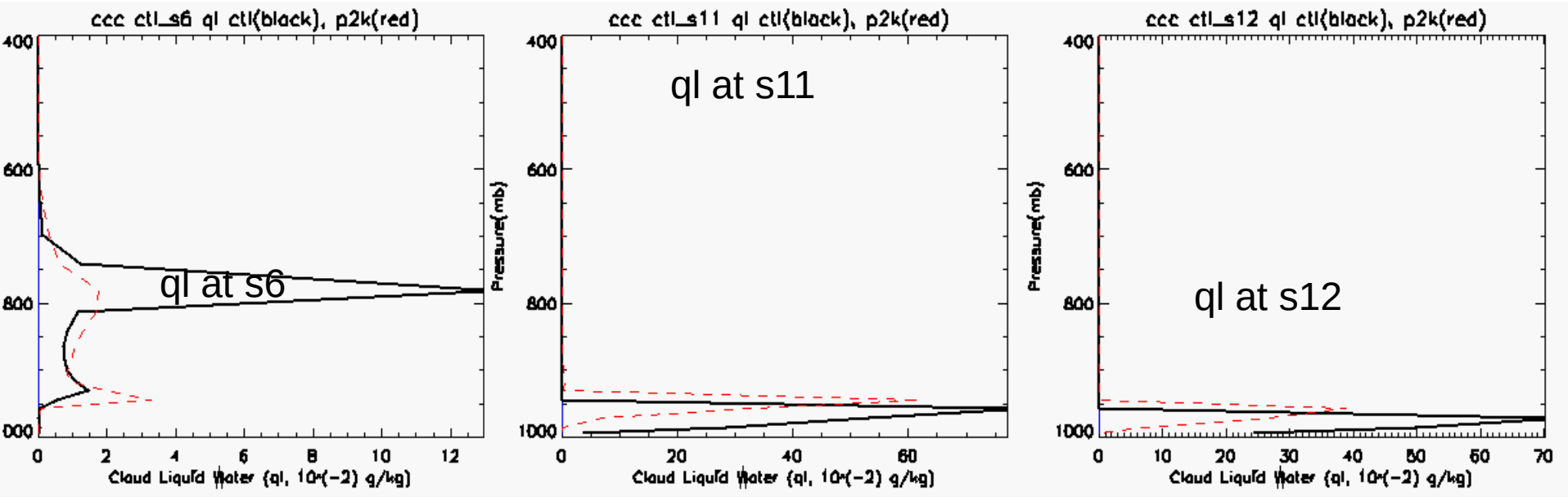
ECMWF Cloud Water (CTL and PSST)



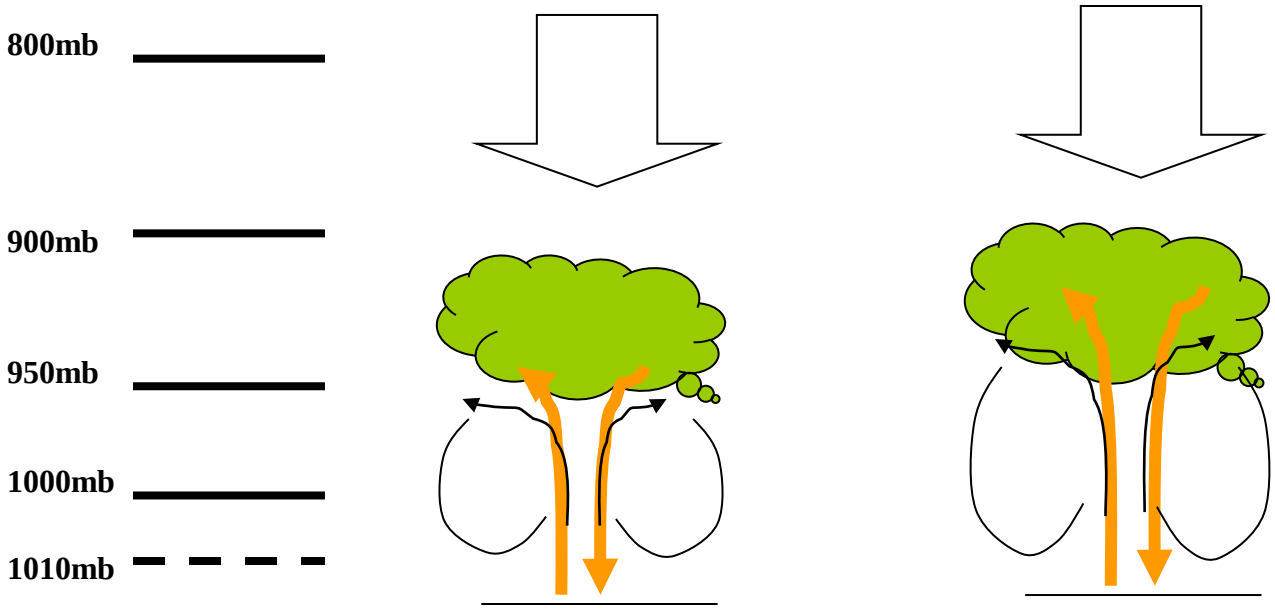
CAM5 Cloud Water (CTL and PSST)



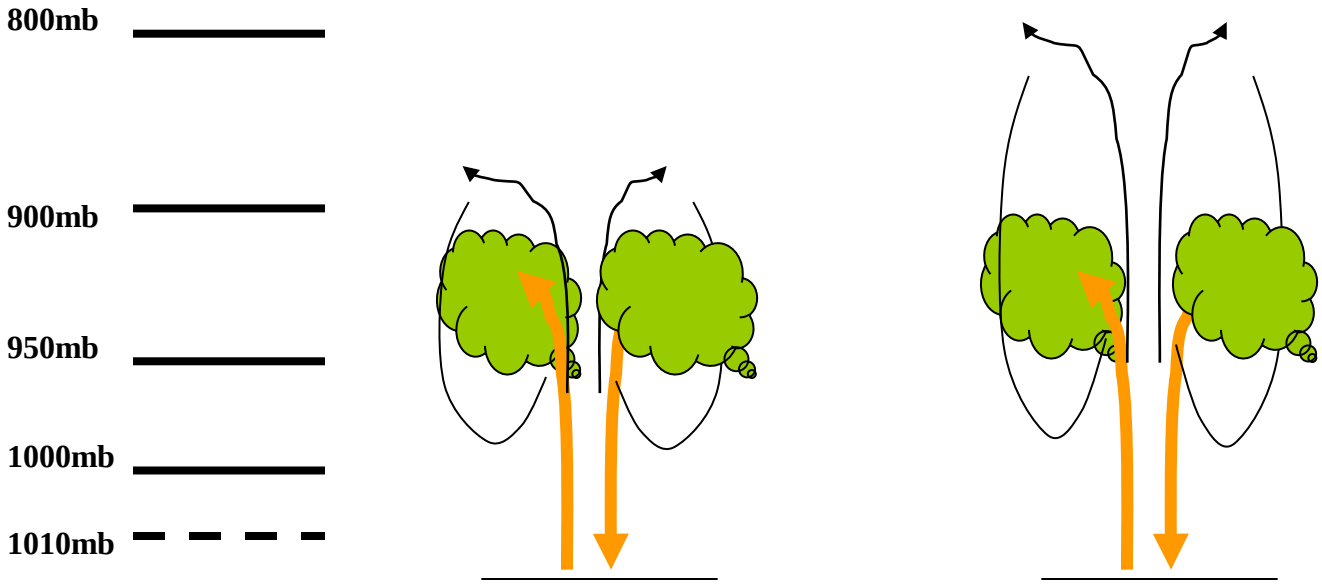
CCC Cloud Water (CTL and PSST)



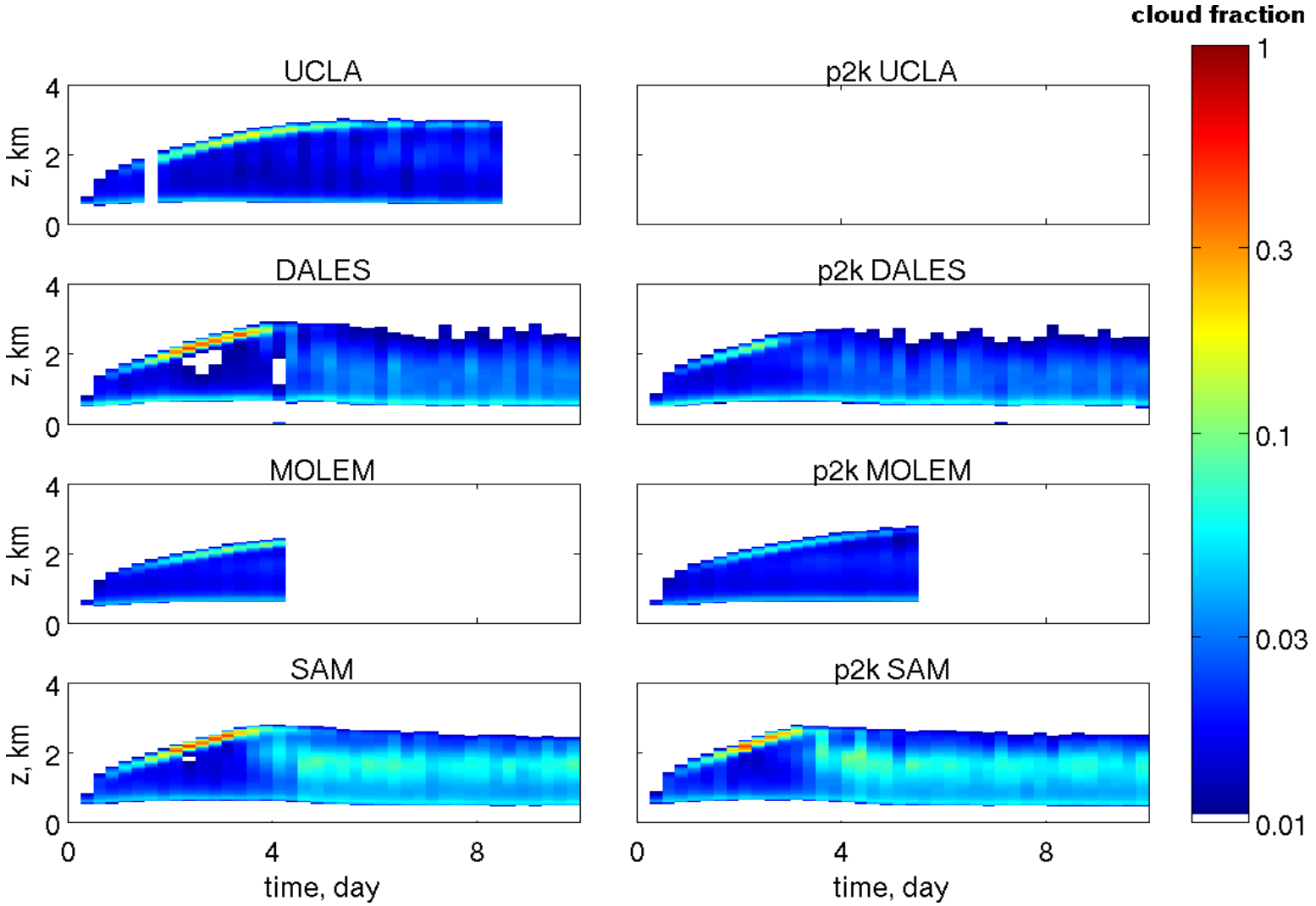
Negative feedbacks



Positive feedbacks
(Explicit cloud top entrainment mixing)
(more decoupling)



S6: LES results (dx/dz = 100/40

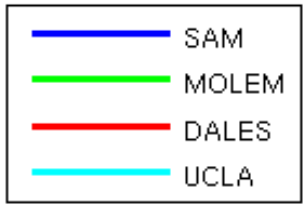


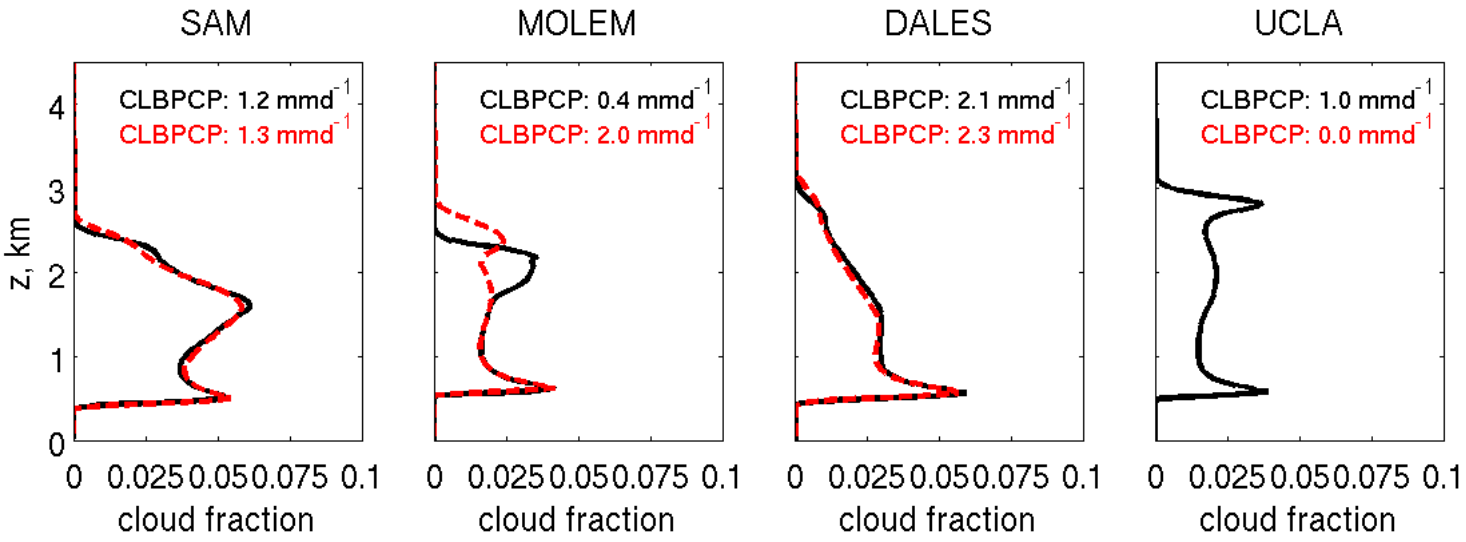
Fair agreement between LES models

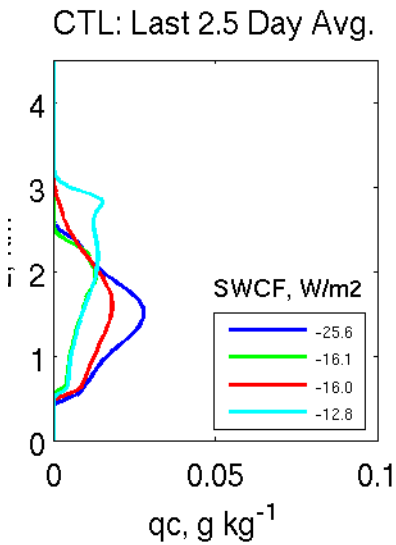
Cloud layer deepens; transitions to a Cu-only layer in SAM and DALES

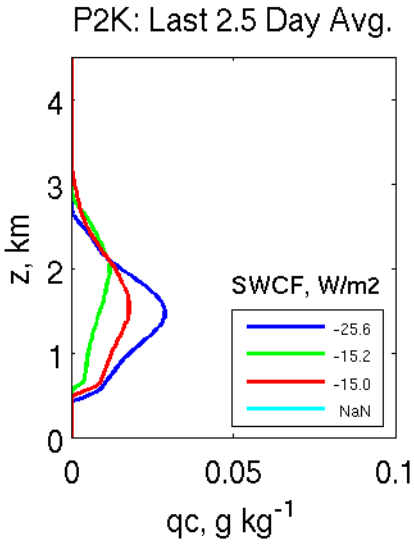
+2K changes are imperceptible

S6 cldfrc, LWP profiles



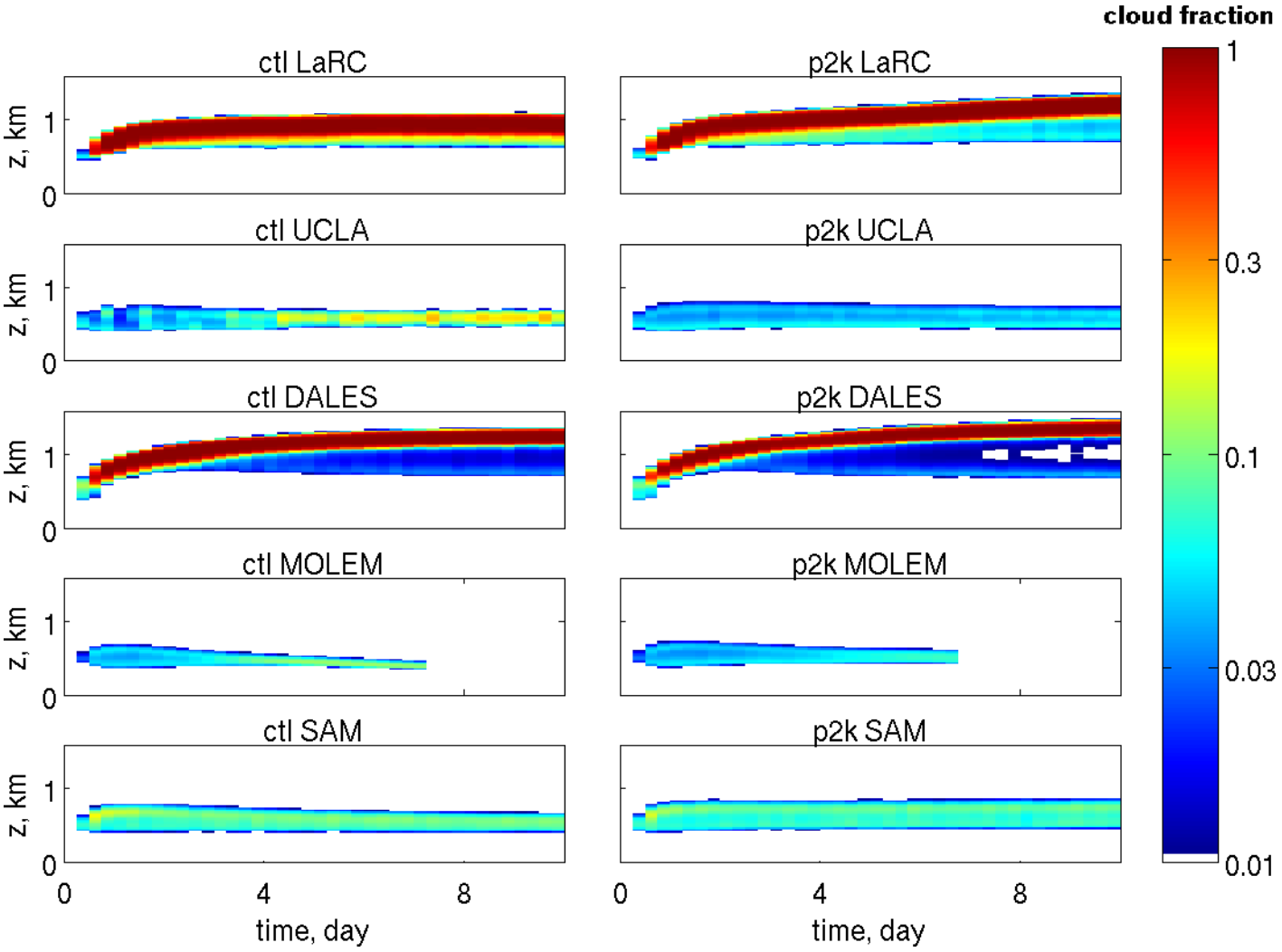






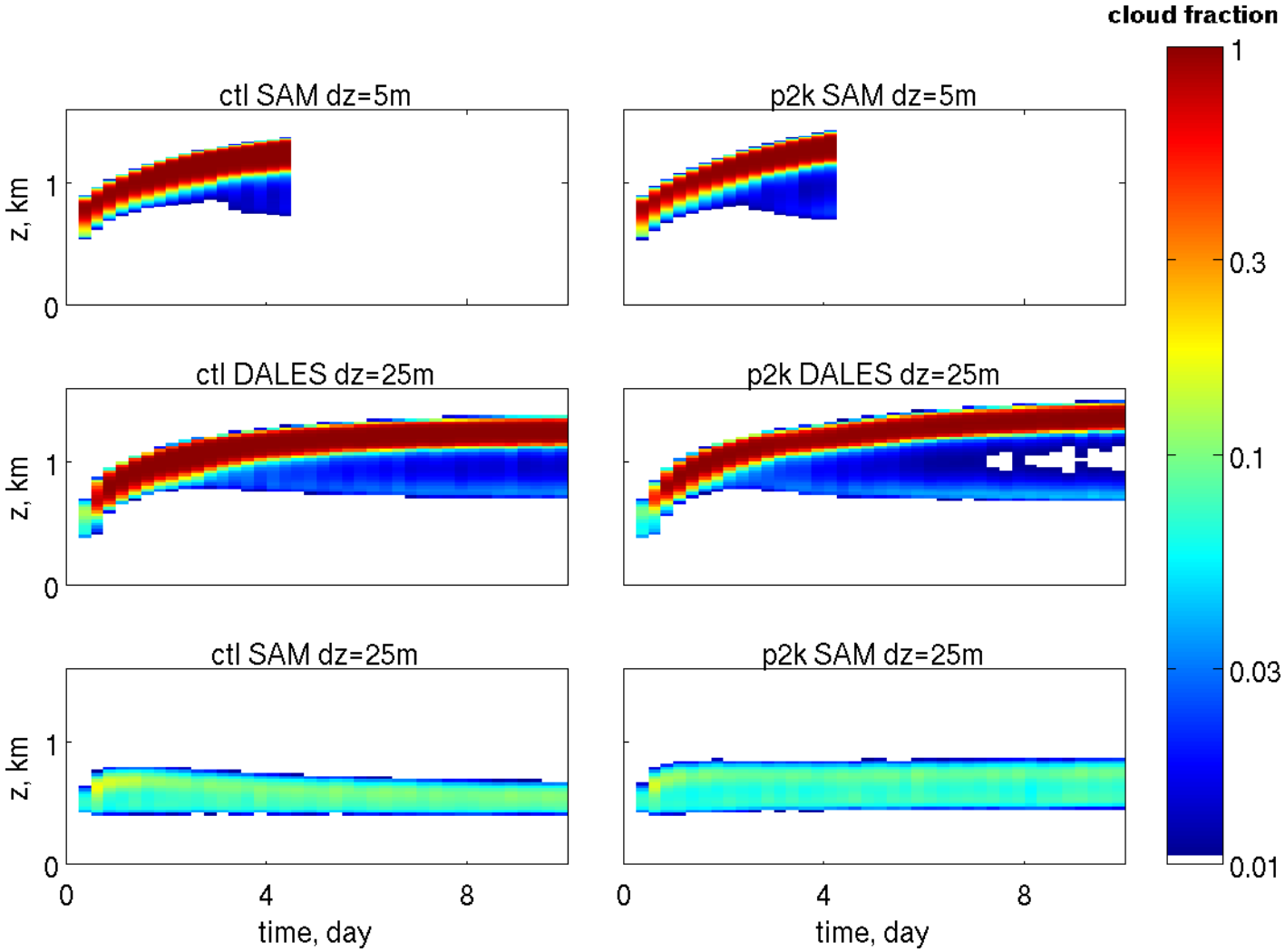
S6: No clear +2K change in SWCF, cldfrc, LWP for SAM, DALES

S11 control simulations (dx/dz =



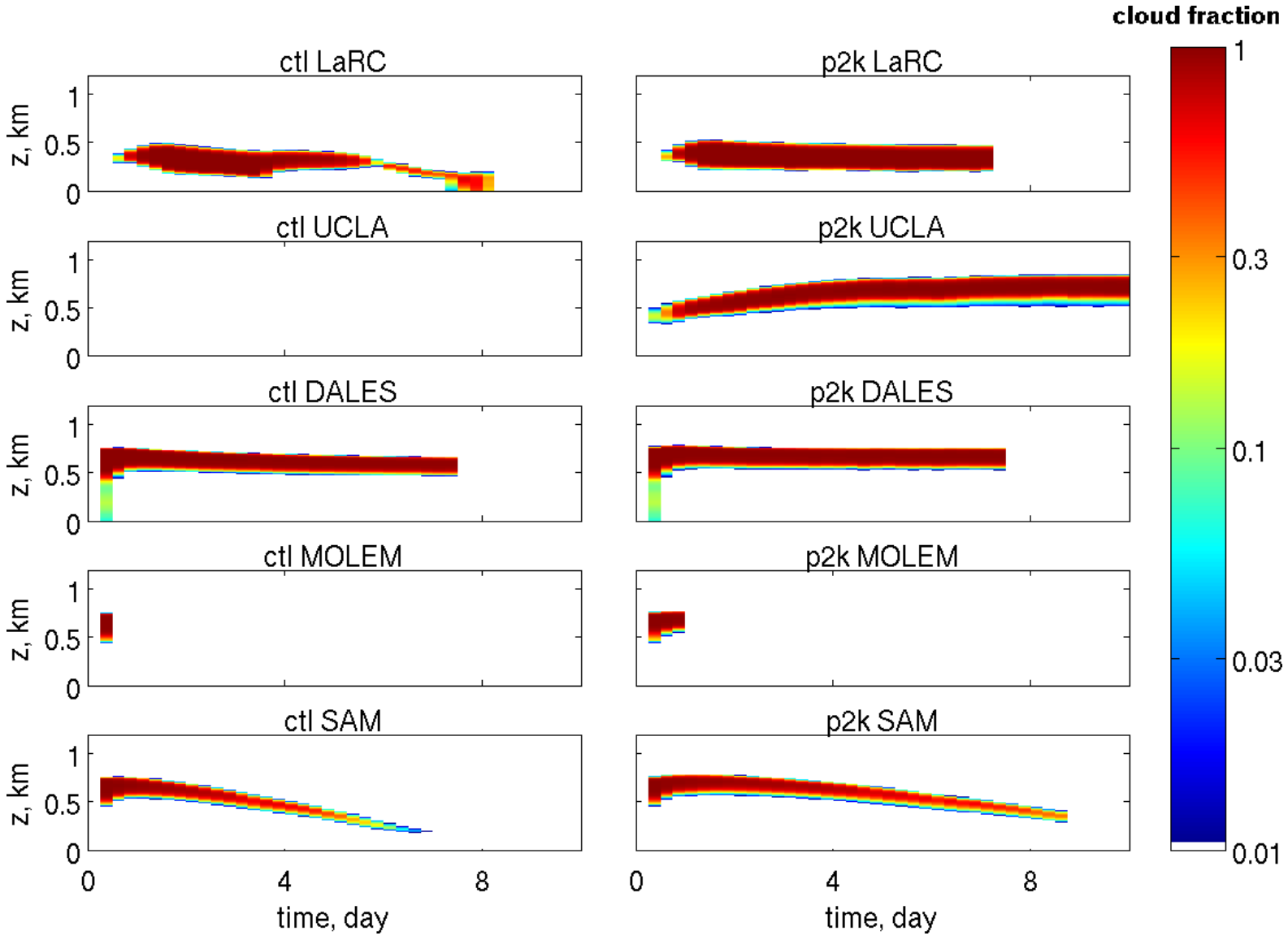
Simulations split into thin-cloud and solid-Sc regimes

…but sensitive to finer dz



SAM at dz=5 m looks like DALES at dz = 25 m

S12: dx/dz = 25/5 m at



Summary

1.The SCMs simulated a wide range of low clouds and cloud feedbacks at the three locations, consistent what CGILS intended to achieve.

2.Interaction of parameterization components plays a major role in explaining the processes

The relative roles of PBL and convection for turbulent mixing, and their interaction with the stratiform cloud scheme need to be understood to explain the cloud feedbacks

3.It appears that models with explicit cloud-top mixing have positive cloud feedbacks, while those without have negative feedbacks (related to moist flux in the PBL)

4.LES convergence experiments are still in progress.