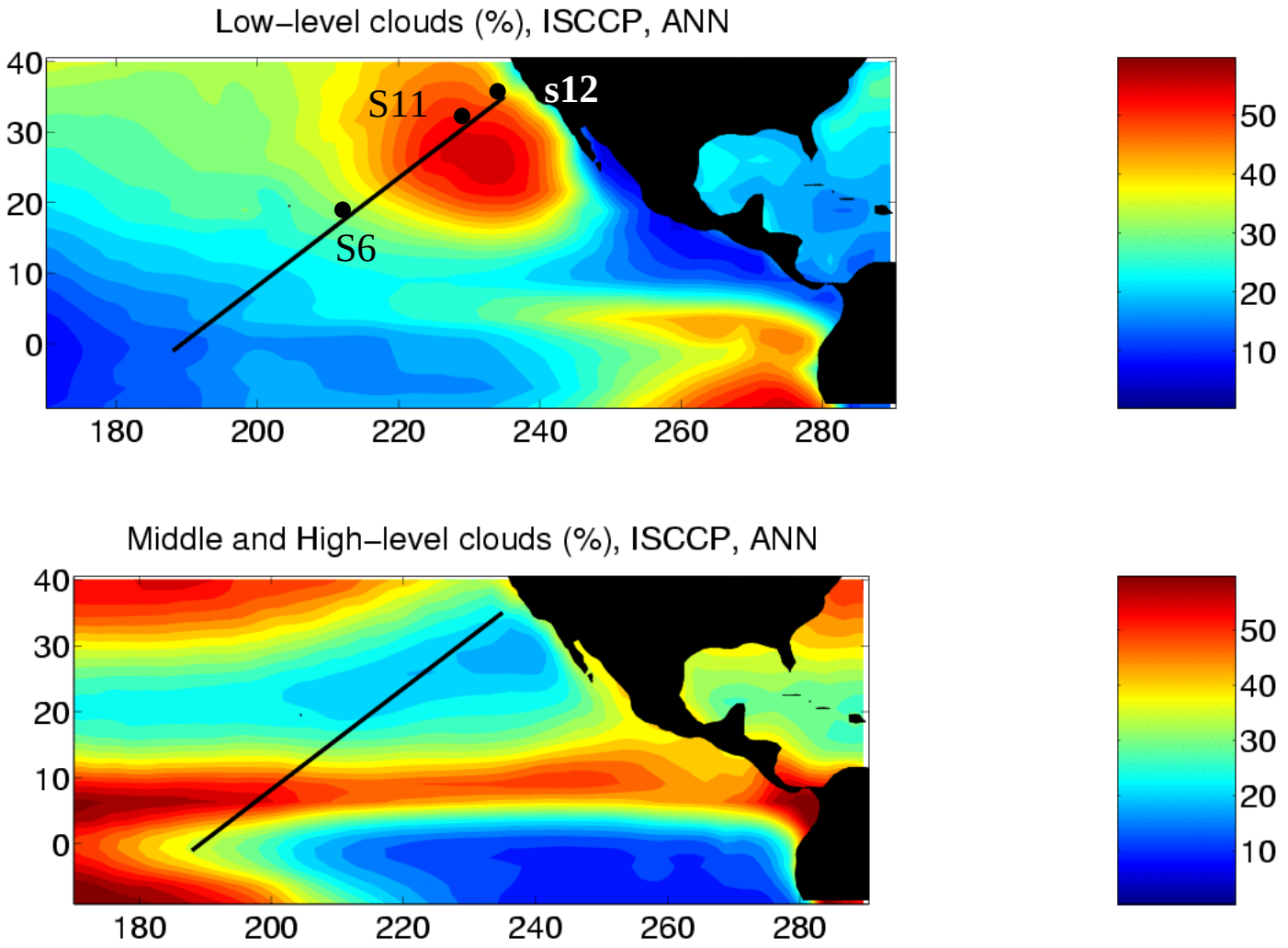
Concept and SCM Results of CGILS

Minghua Zhang and CGILS Participants

EUCLIPSE Meeting, September 27-28, Utrecht

GPCI

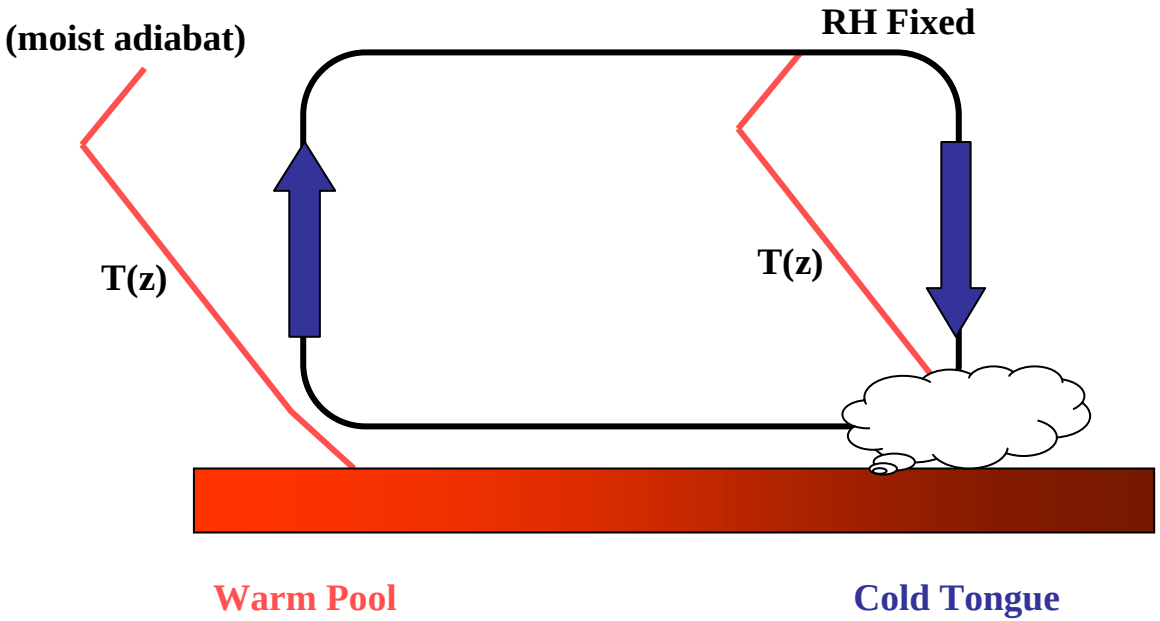

Low–level clouds (%), ISCCP, ANN
S11
s12
S6
40
30
20
10
0
180
200
220
240
260
280
50
40
30
20
10
Middle and High–level clouds (%), ISCCP, ANN
40
30
20
10
0
180
200
220
240
260
280
50
40
30
20
10

The concept : idealized simulations

1. Simple
   to understand processes, and to use LES

2. Climate change
   for cloud feedbacks

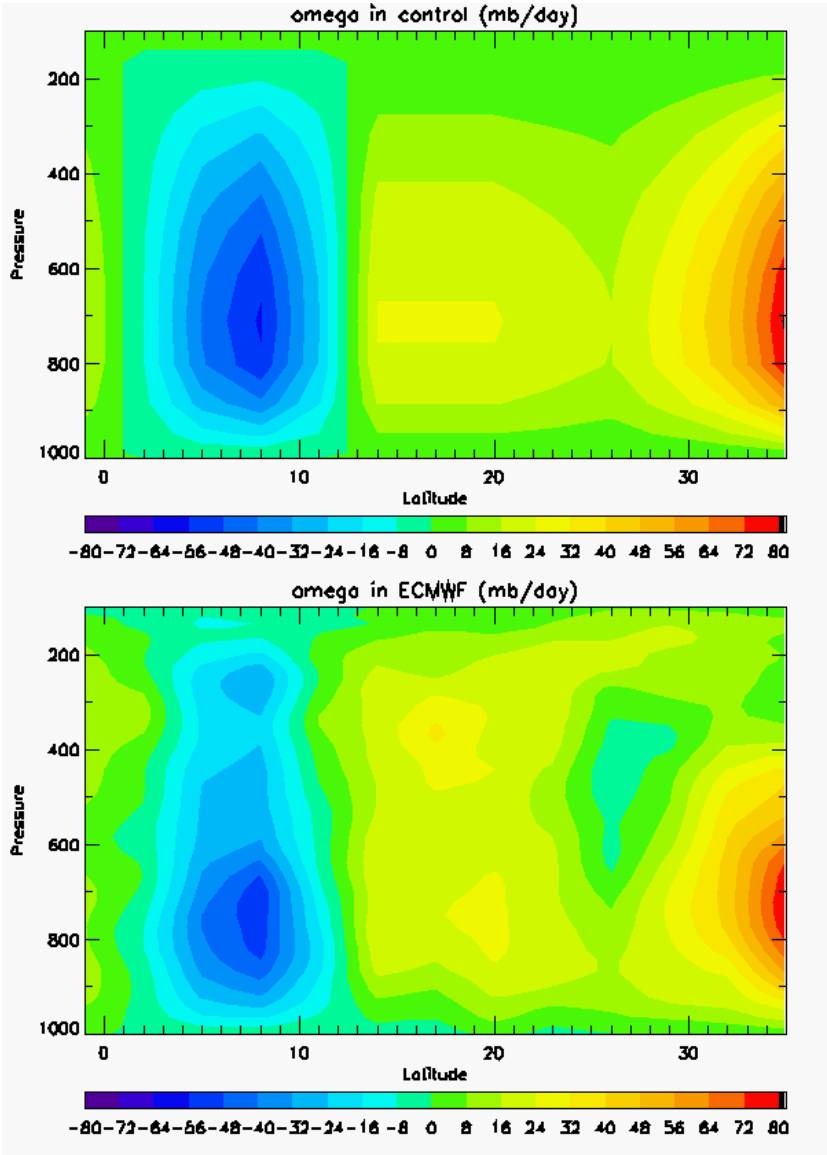
CGILS (CFMIP-GCSS Intercomparison of Large-Eddy and Single-Column Models)



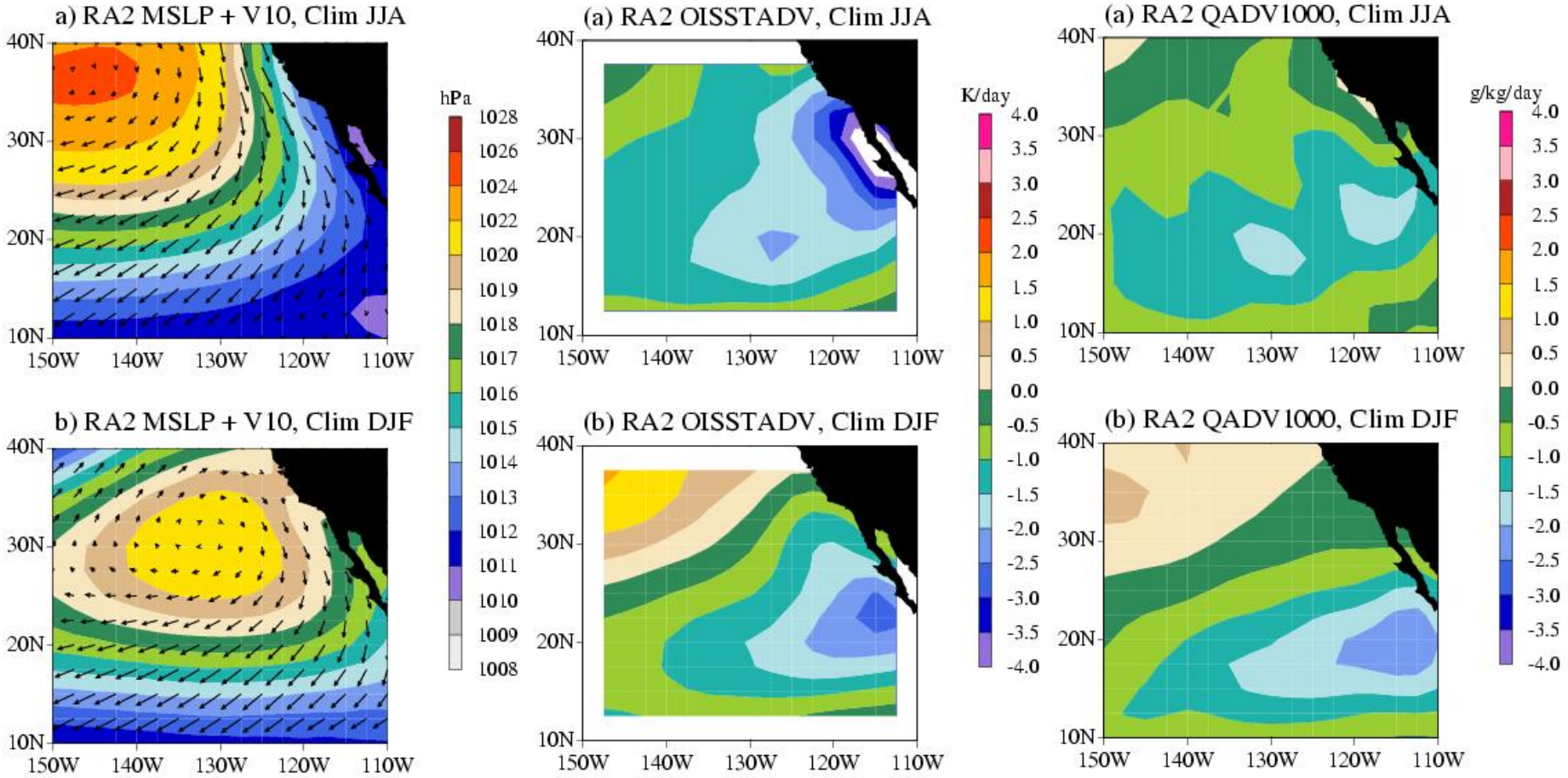
Need to be relevant to observations and GCMs

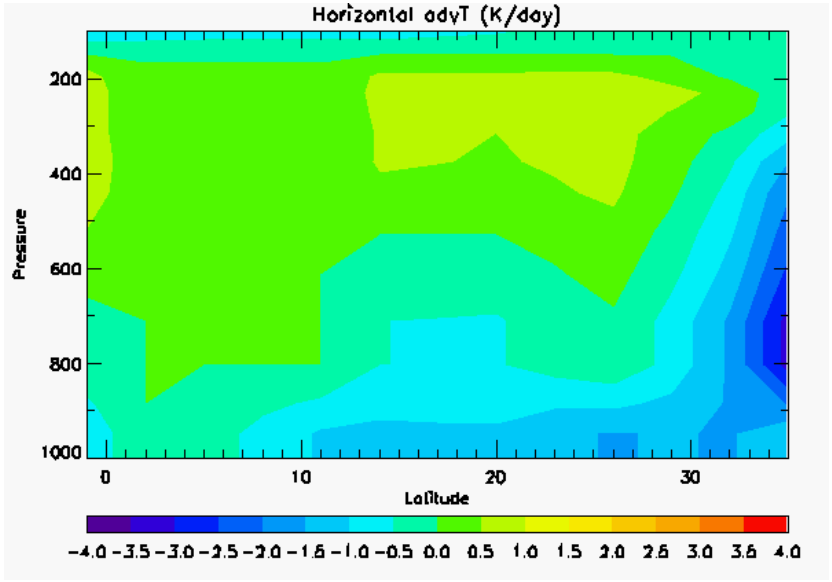
(Zhang and Bretherton, 2008)

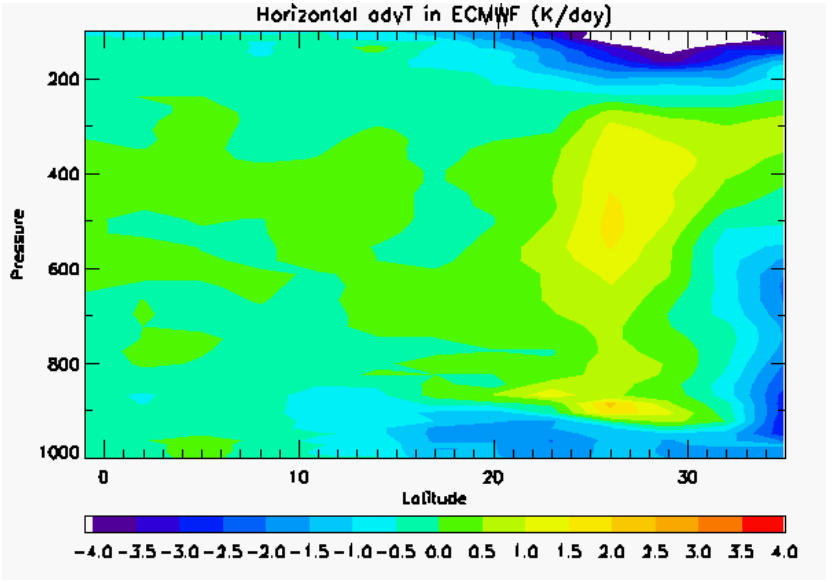
Omega in control and ECMWF

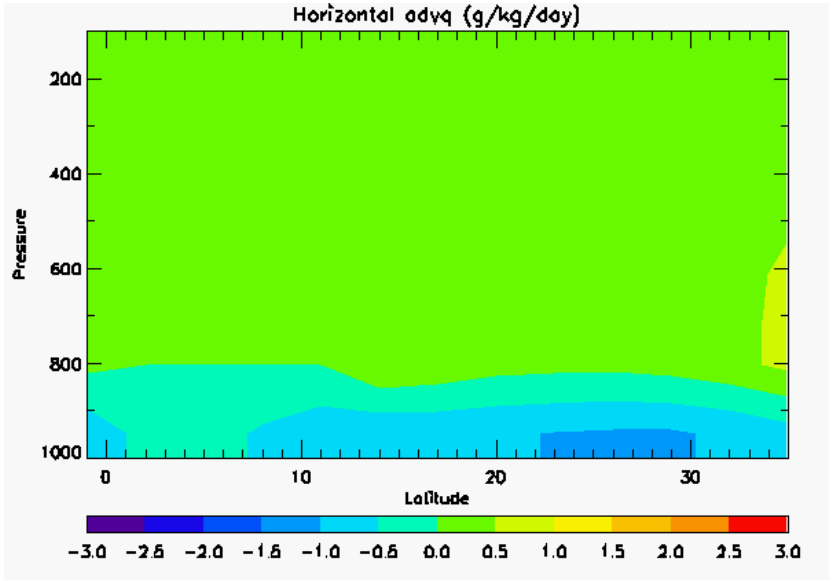


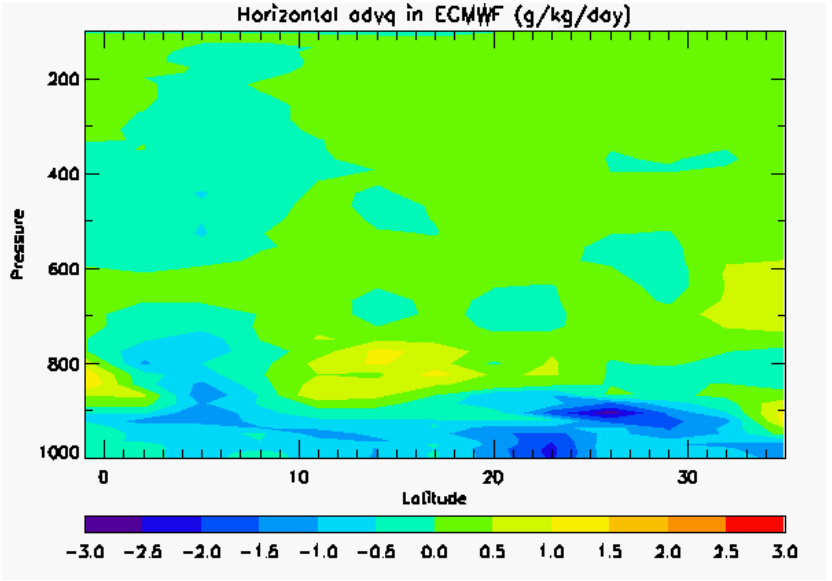
CAM PSL and Lowest Model Level Winds -------





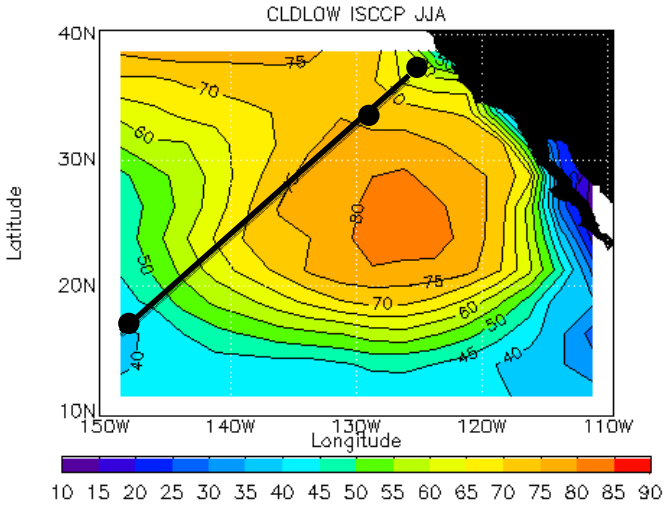


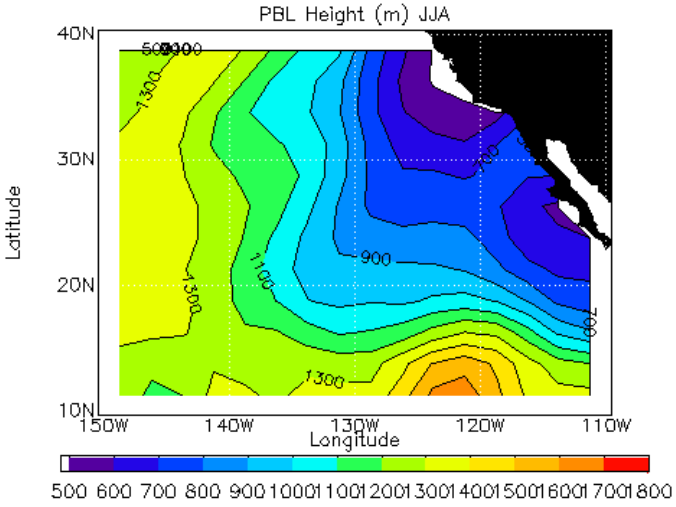


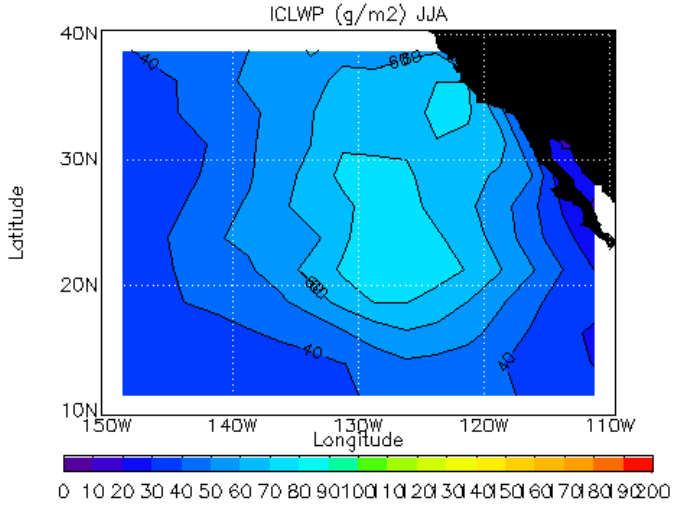


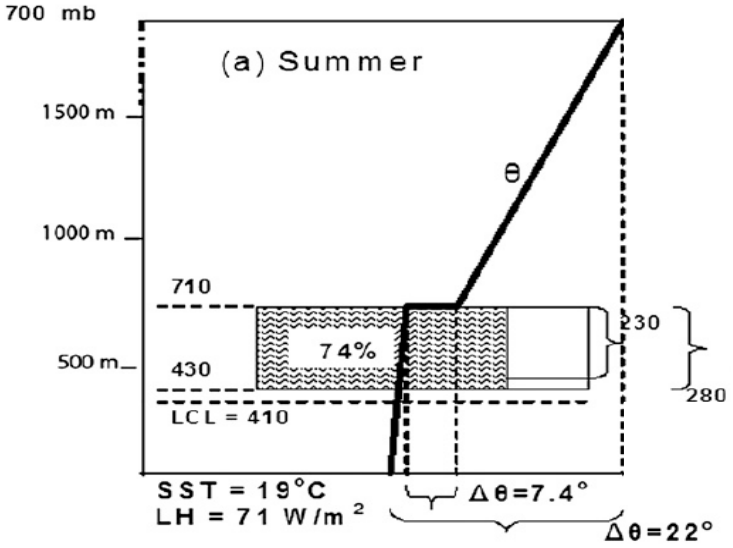
Horizontal T and q advection in CGILS

Horizontal T and q advection in ECMWF







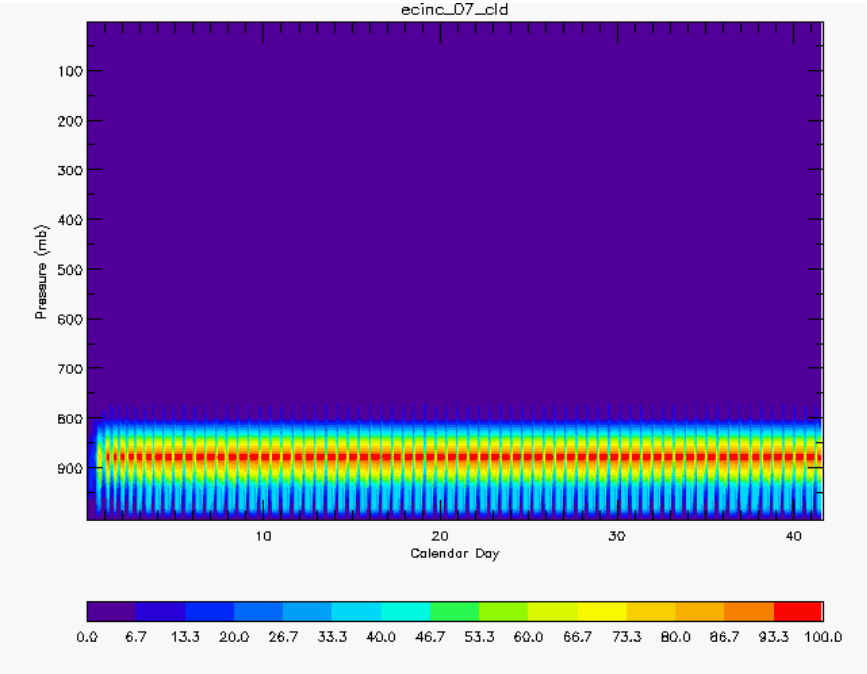


(Lin, Zhang and Loeb, JCL 2010)

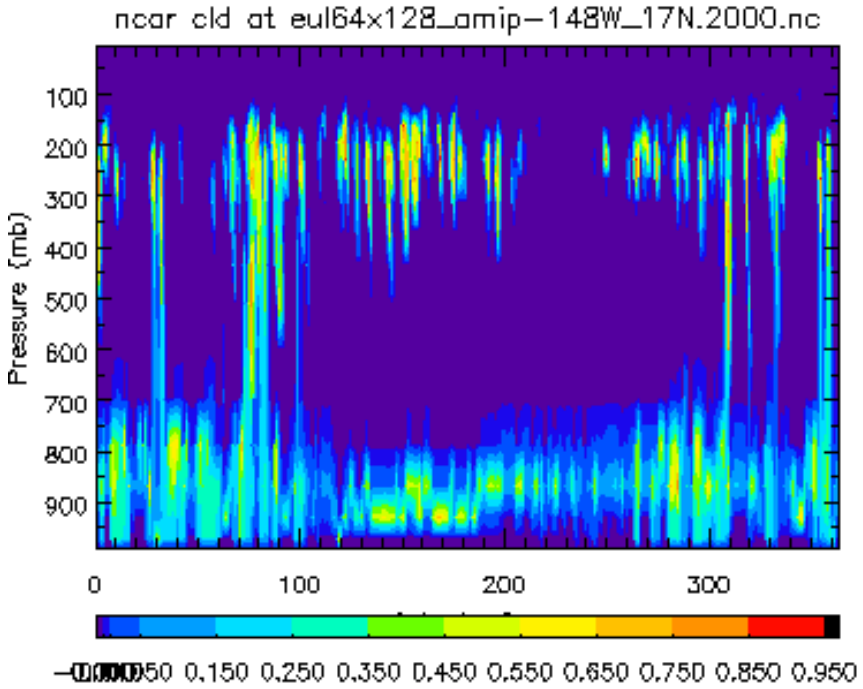
1. Can an idealized setup represent the transient large-scale atmospheric condition?

2. Can a few selected locations capture the behavior of a GCM?

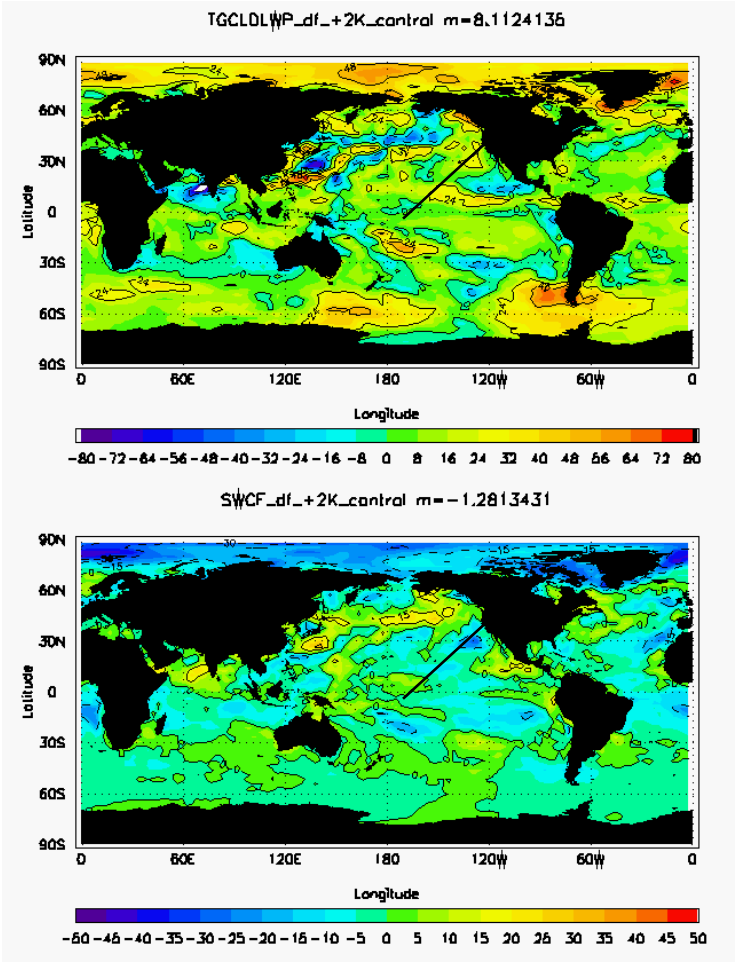
SCAM Clouds Using ECMWF July 2003 Forcing



Clouds from GCM



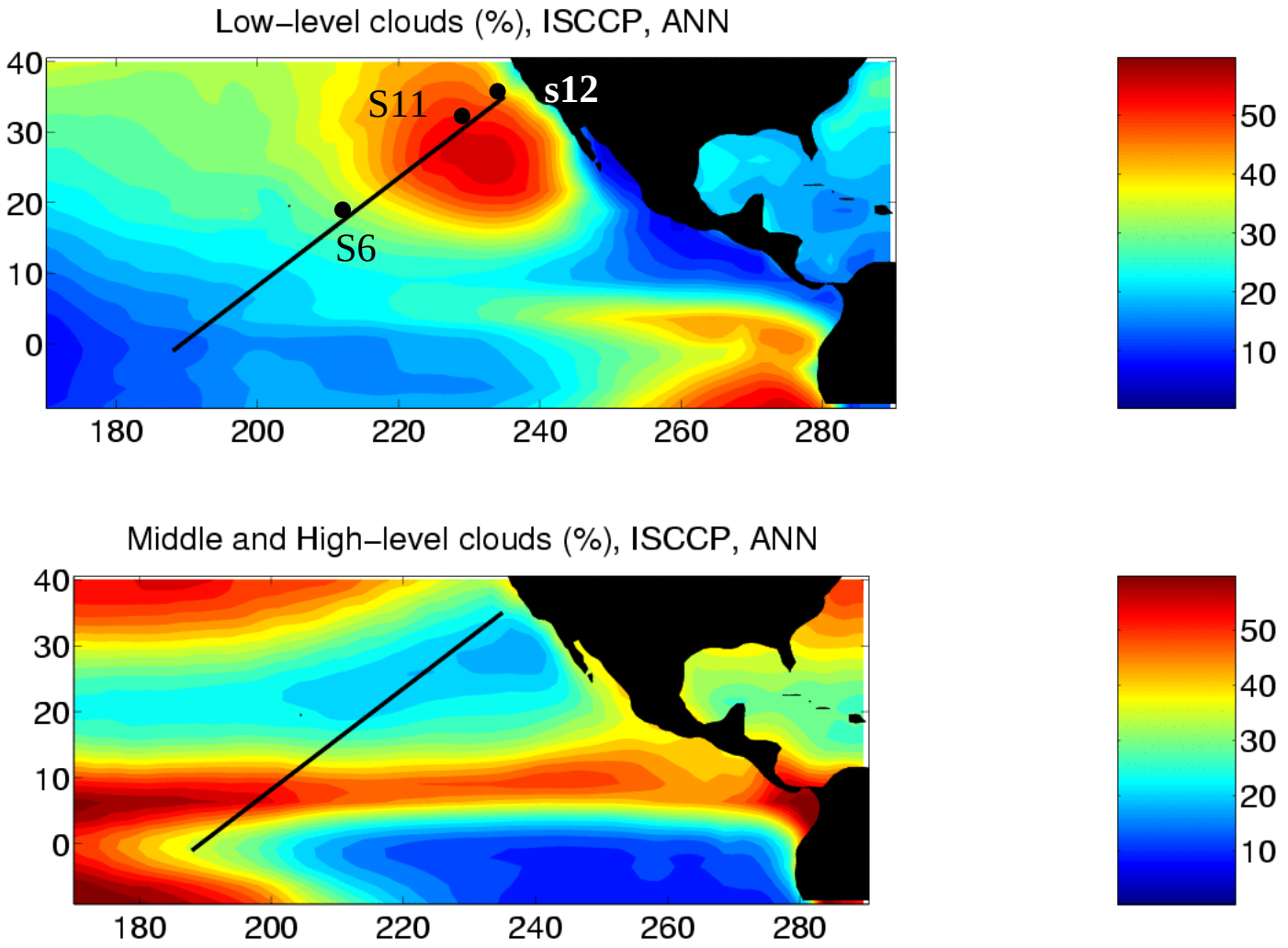
CAM-SP ΔSST=2K Change



ΔLWP

ΔSWCF

GPCI


Low–level clouds (%), ISCCP, ANN
S11
s12
S6
40
30
20
10
0
180
200
220
240
260
280
50
40
30
20
10
Middle and High–level clouds (%), ISCCP, ANN
40
30
20
10
0
180
200
220
240
260
280
50
40
30
20
10

	S6 Shallow Cu	S11 Stratocu-mulus	S12 Stratus
Latitude (Degrees North)	17°N	32°N	35°N
Longitude (Degrees)	149°W	129°W	125°W
SLP (mb)	1014.1	1020.8	1018.6
SST (°C)	25.6	19.3	17.8
Tair_surface (°C)	24.1	17.8	16.3
U_surface (m/s)	-7.4	-1.8	2.1
V_surface (m/s)	-2.7	-6.5	-8.0
RH_surface (m/s)	80%	80%	80%
Mean TOA insolation (w/m2)	448.1	471.5	473.1
Mean daytime solar zenith angle	51.0	52.0	52.7
Daytime fraction on July 15	0.539	0.580	0.590
Eccentricity on July 15	0.967	0.967	0.967
Surface Albedo	0.07	0.07	0.07

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

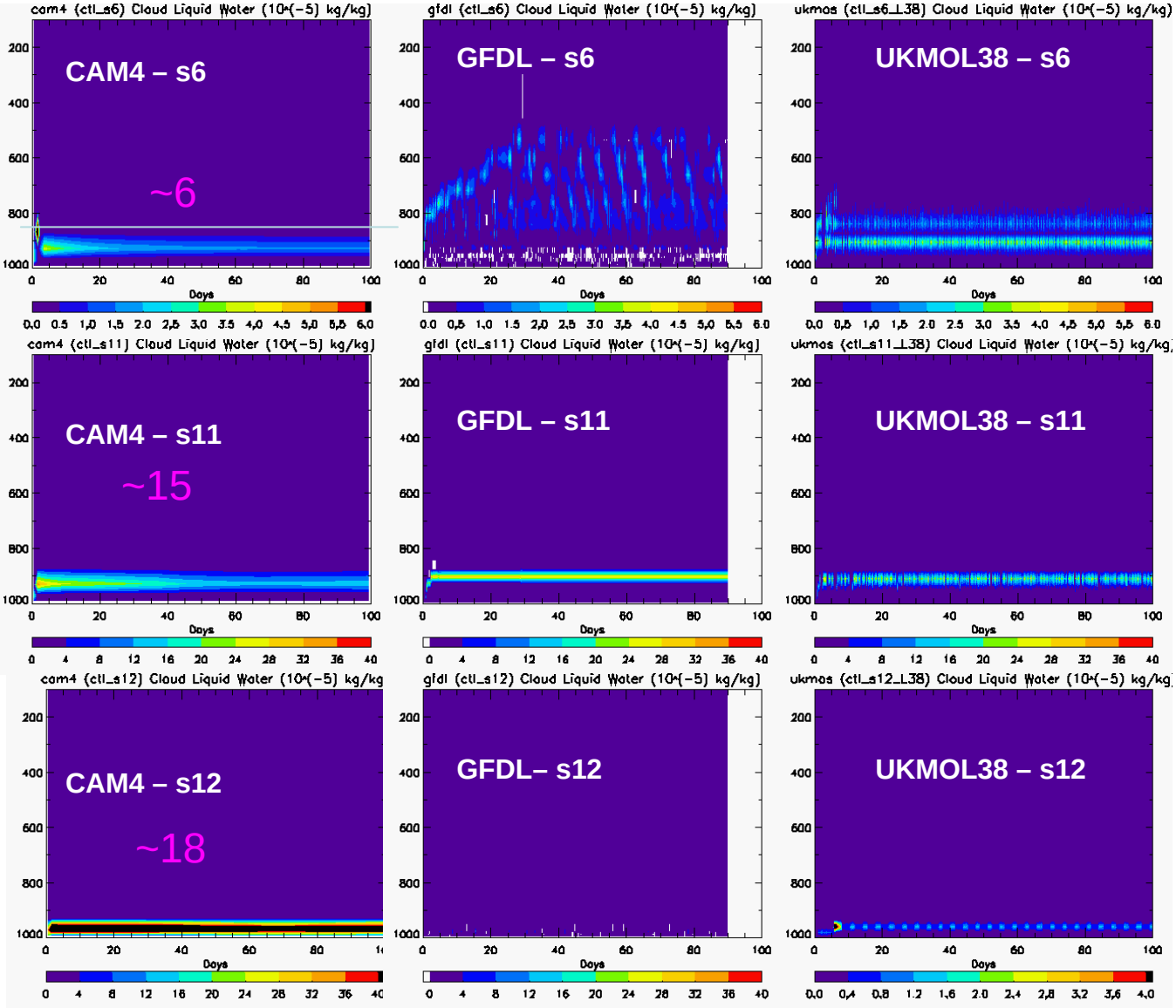
*** Indicates models that completed the revised runs**

Participants (to be updated)

Minghua Zhang (Stony Brook University)

Julio Bacmeister, Sandrine Bony, Chris Bretherton, Florent Brient, Anning Cheng, Stephan de Roode,Tony Del Genio, Charmaine Franklin, Chris Golaz, Cecile Hanny, Francesco Isotta, In-Sik Kang, Hideaki Kawai, Martin Koehler, Suvarchal Kumar, Vince Larson, Adrian Lock, Ulrike Lohman, Marat Khairoutdinov, Andrea Molod, Roel Neggers, Sing-Bin Park, Ryan Senkbeil, Pier Siebesma, Colombe Siegenthaler-Le Drian, Bjorn Stevens, Max Suarez, Kuan-man Xu, Mark Webb, Audrey Wolfe, Ming Zhao,

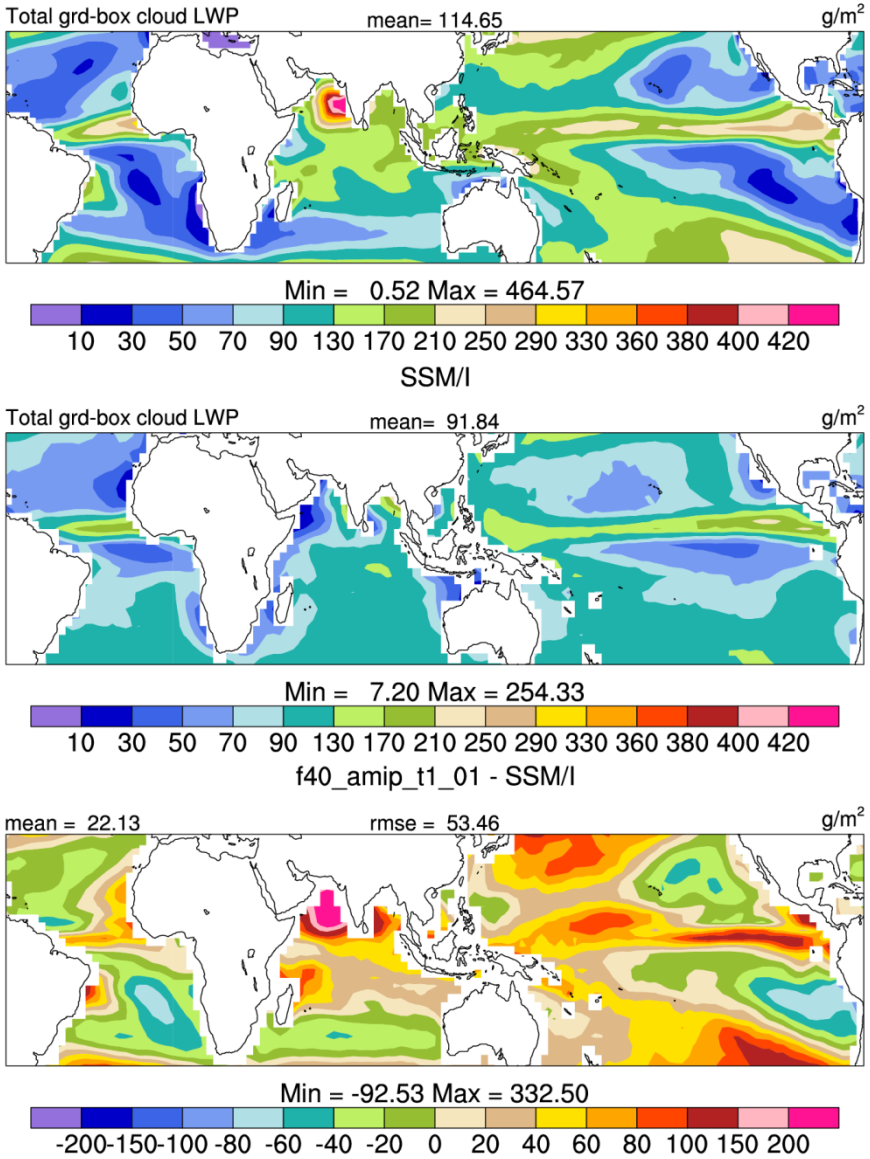
Cloud Liquid Water in Control Simulation



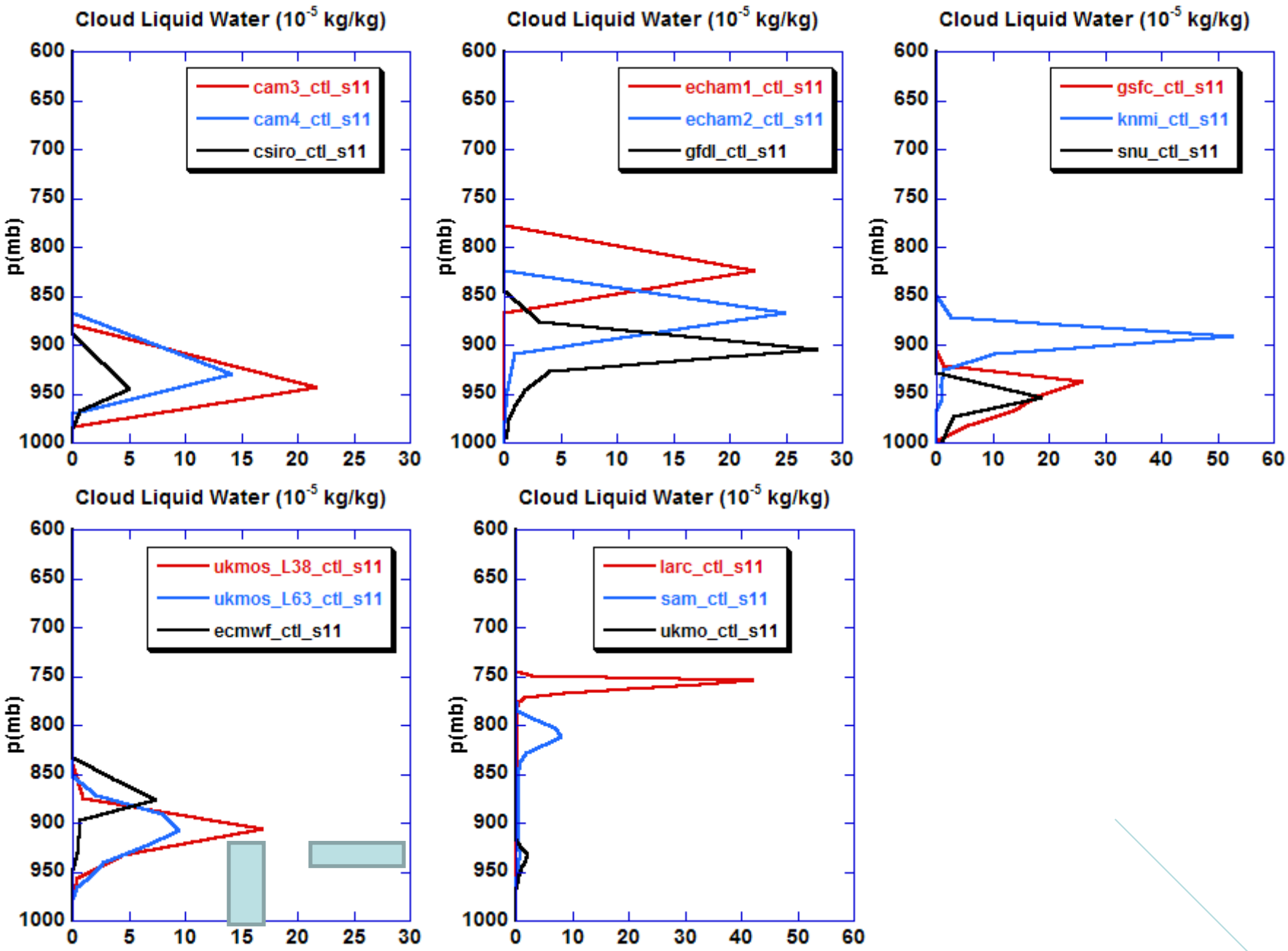
CAM4 LWP

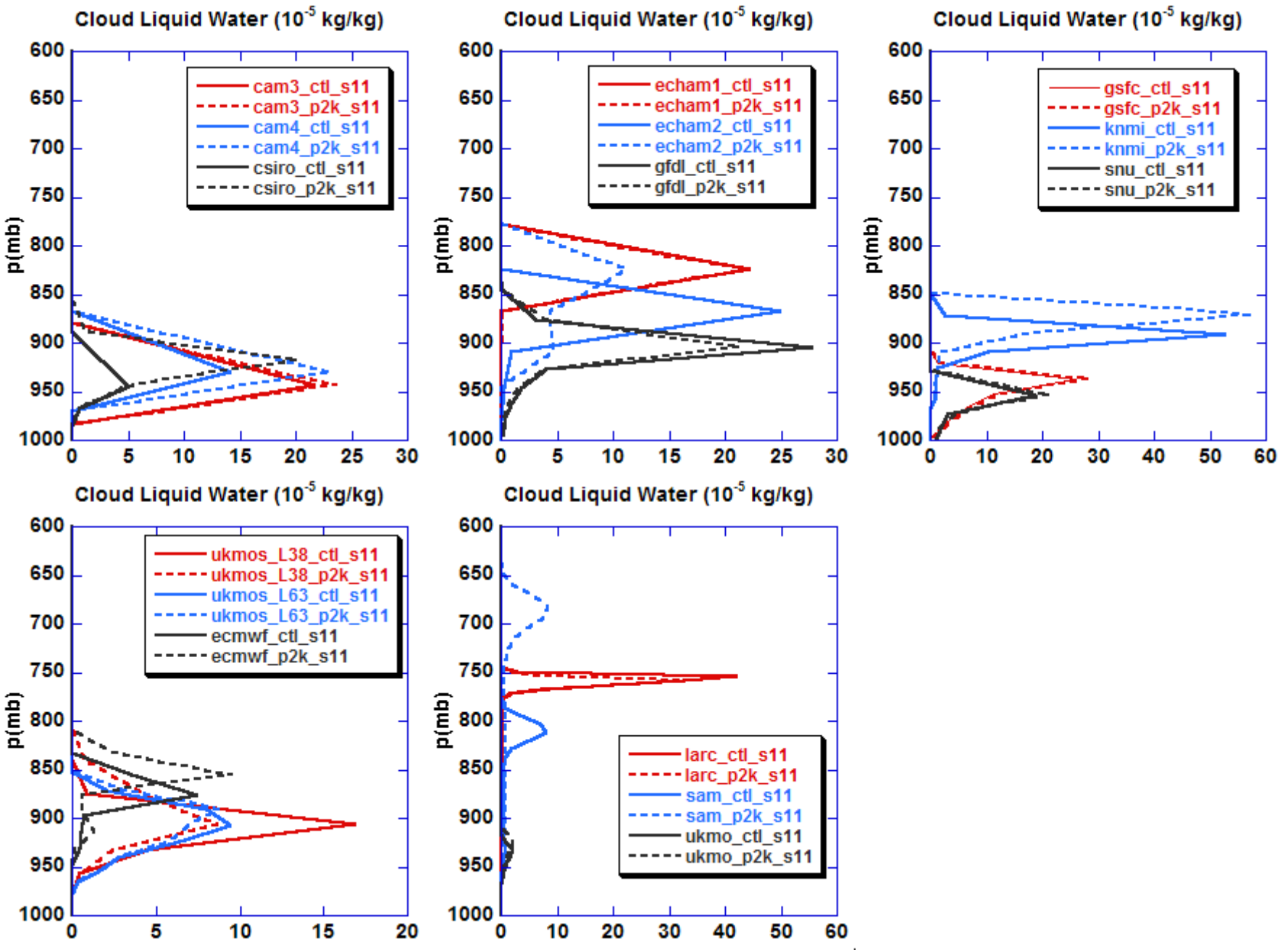
JJA

f40_amip_t1_01 (yrs 1978-2002)



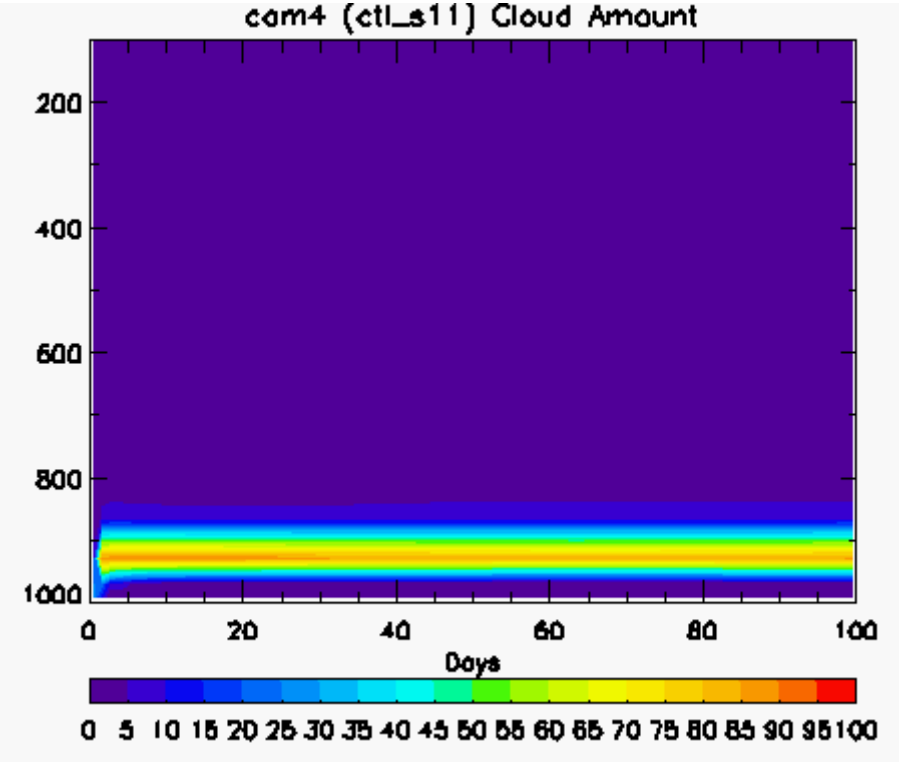
S11


Cloud Liquid Water (10^{-5} kg/kg)
p(mb)
cam3_ctl_s11
cam4_ctl_s11
csiro_ctl_s11
Cloud Liquid Water (10^{-5} kg/kg)
p(mb)
echam1_ctl_s11
echam2_ctl_s11
gfdl_ctl_s11
Cloud Liquid Water (10^{-5} kg/kg)
p(mb)
gsfc_ctl_s11
knmi_ctl_s11
snu_ctl_s11
Cloud Liquid Water (10^{-5} kg/kg)
p(mb)
ukmos_L38_ctl_s11
ukmos_L63_ctl_s11
ecmwf_ctl_s11
Cloud Liquid Water (10^{-5} kg/kg)
p(mb)
larc_ctl_s11
sam_ctl_s11
ukmo_ctl_s11

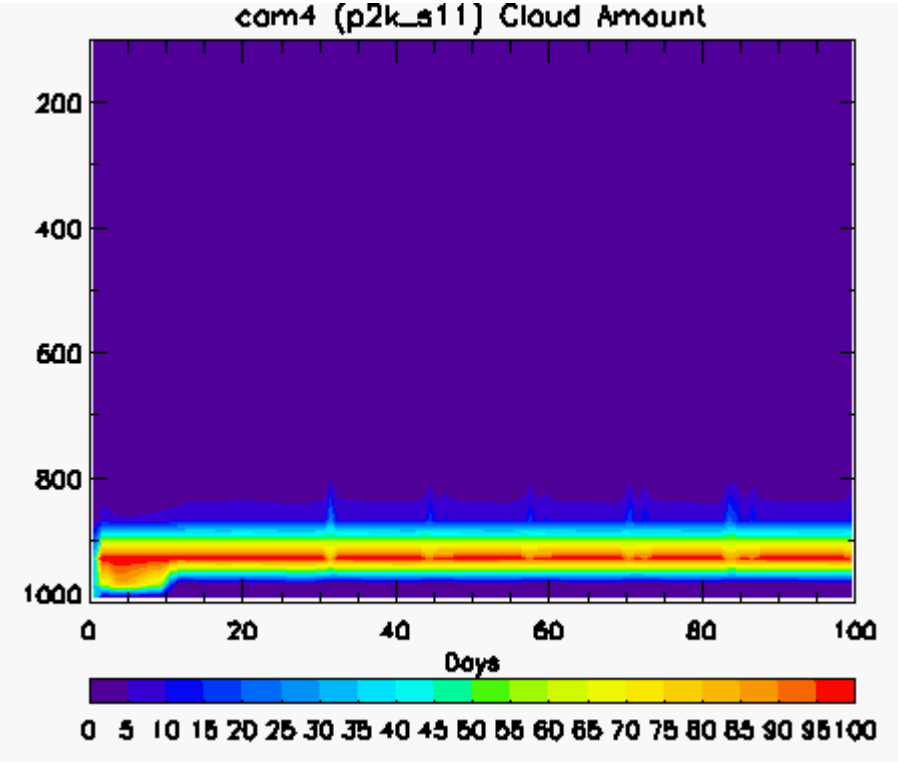

Cloud Liquid Water (10^{-5} kg/kg)
p(mb)
cam3_ctl_s11
cam3_p2k_s11
cam4_ctl_s11
cam4_p2k_s11
csiro_ctl_s11
csiro_p2k_s11
Cloud Liquid Water (10^{-5} kg/kg)
p(mb)
echam1_ctl_s11
echam1_p2k_s11
echam2_ctl_s11
echam2_p2k_s11
gfdl_ctl_s11
gfdl_p2k_s11
Cloud Liquid Water (10^{-5} kg/kg)
p(mb)
gsfc_ctl_s11
gsfc_p2k_s11
knmi_ctl_s11
knmi_p2k_s11
snu_ctl_s11
snu_p2k_s11
Cloud Liquid Water (10^{-5} kg/kg)
p(mb)
ukmos_L38_ctl_s11
ukmos_L38_p2k_s11
ukmos_L63_ctl_s11
ukmos_L63_p2k_s11
ecmwf_ctl_s11
ecmwf_p2k_s11
Cloud Liquid Water (10^{-5} kg/kg)
p(mb)
larc_ctl_s11
larc_p2k_s11
sam_ctl_s11
sam_p2k_s11
ukmo_ctl_s11
ukmo_p2k_s11

Negative Feedback in CAM4

ctl

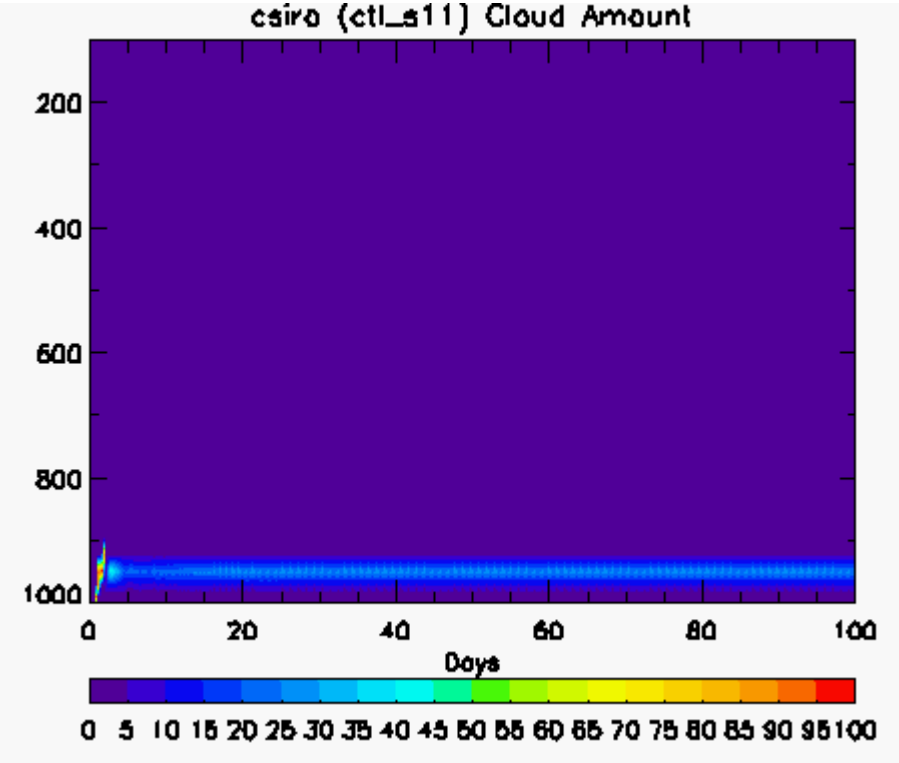


p2k

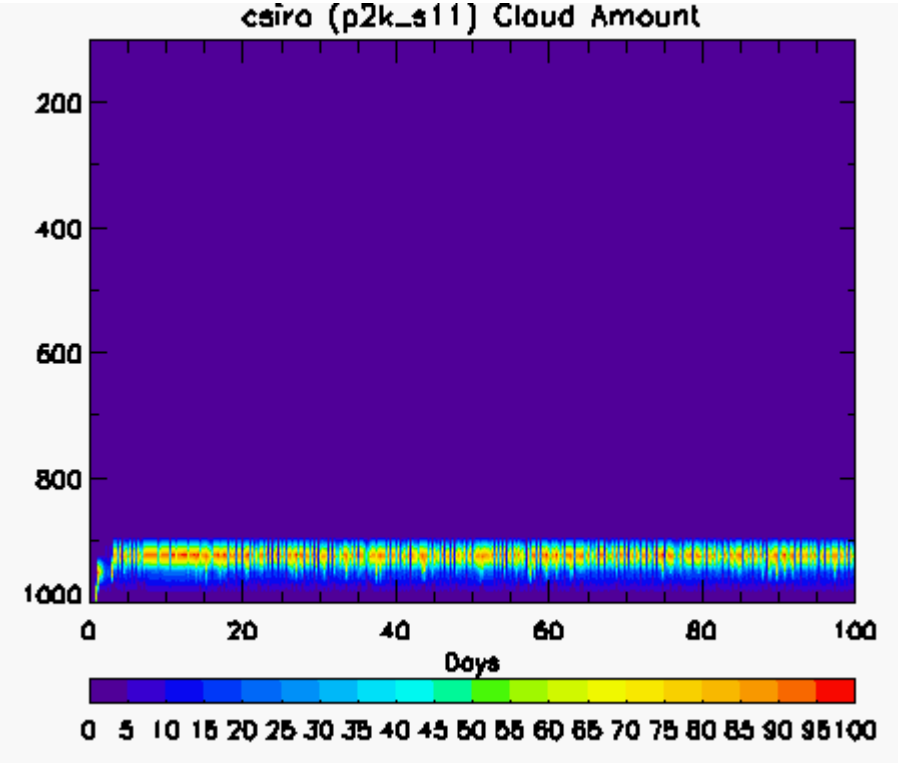


Negative Feedback in CSIRO

ctl

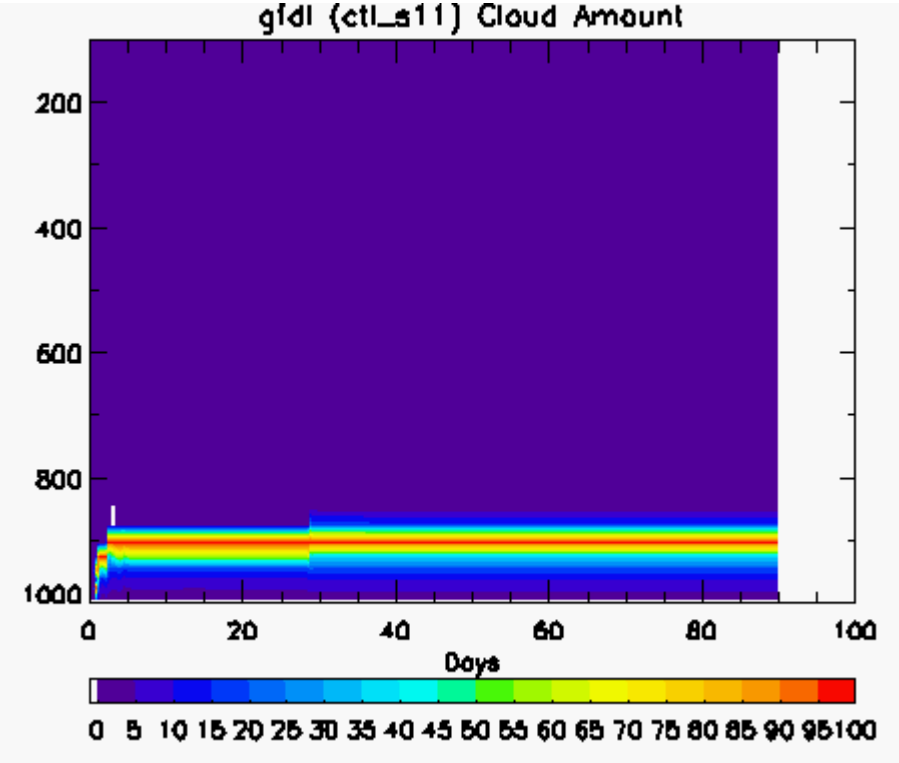


p2k

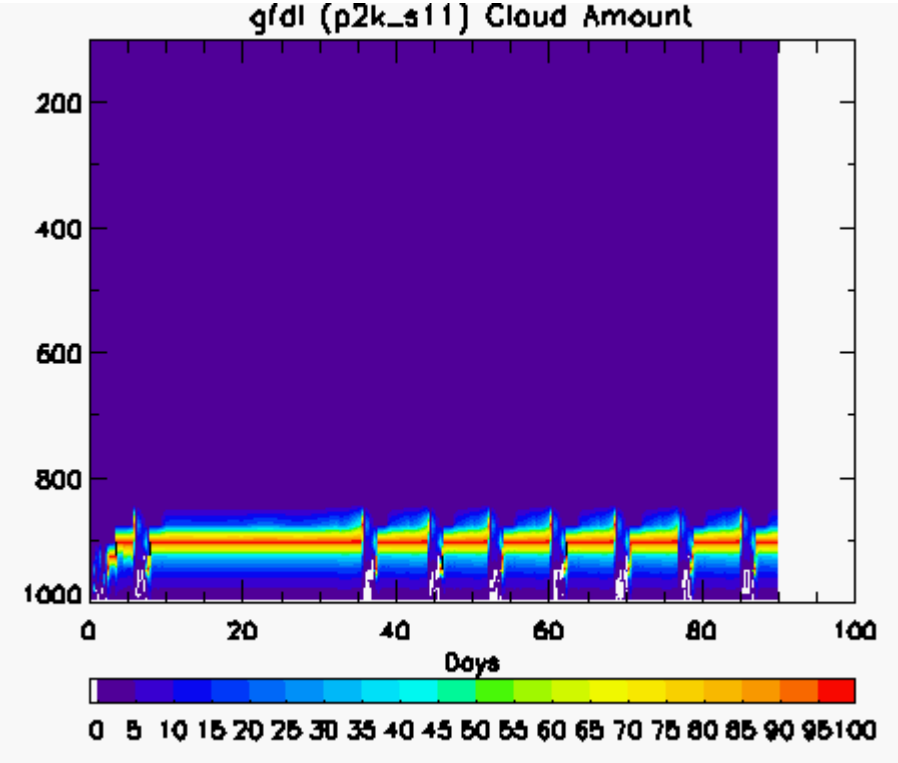


Positive Feedback in GFDL

ctl

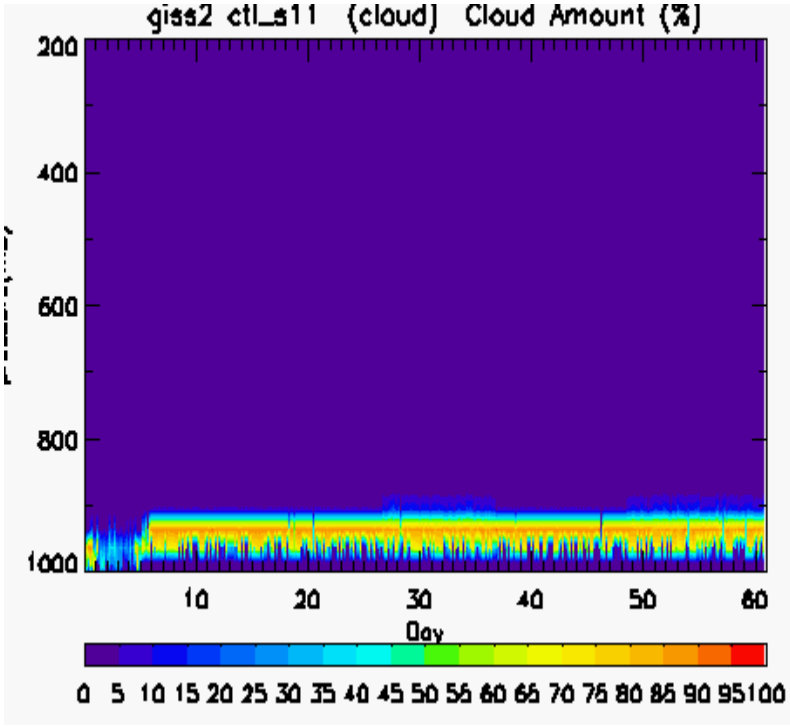


p2k

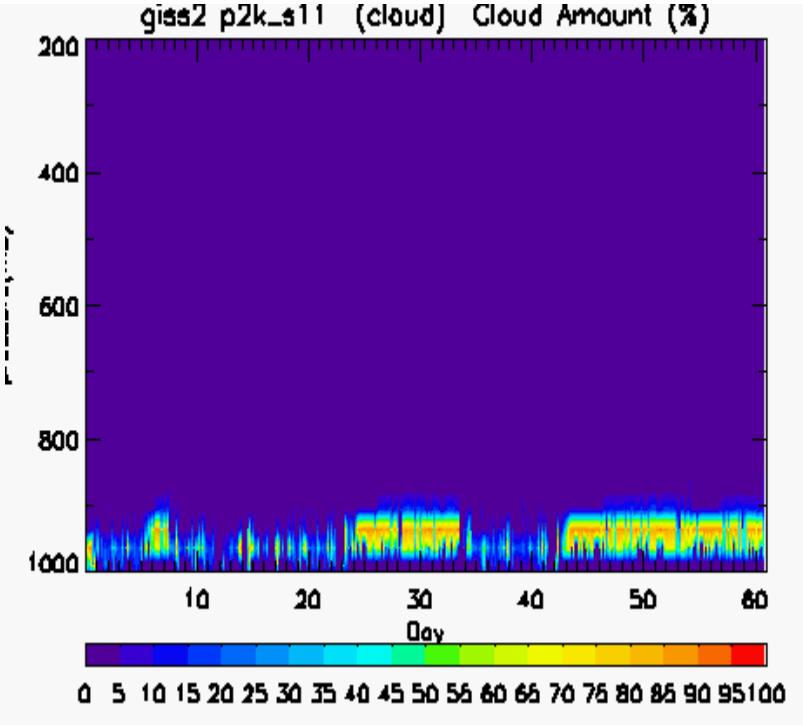


Positive Feedback in GISS2

ctl

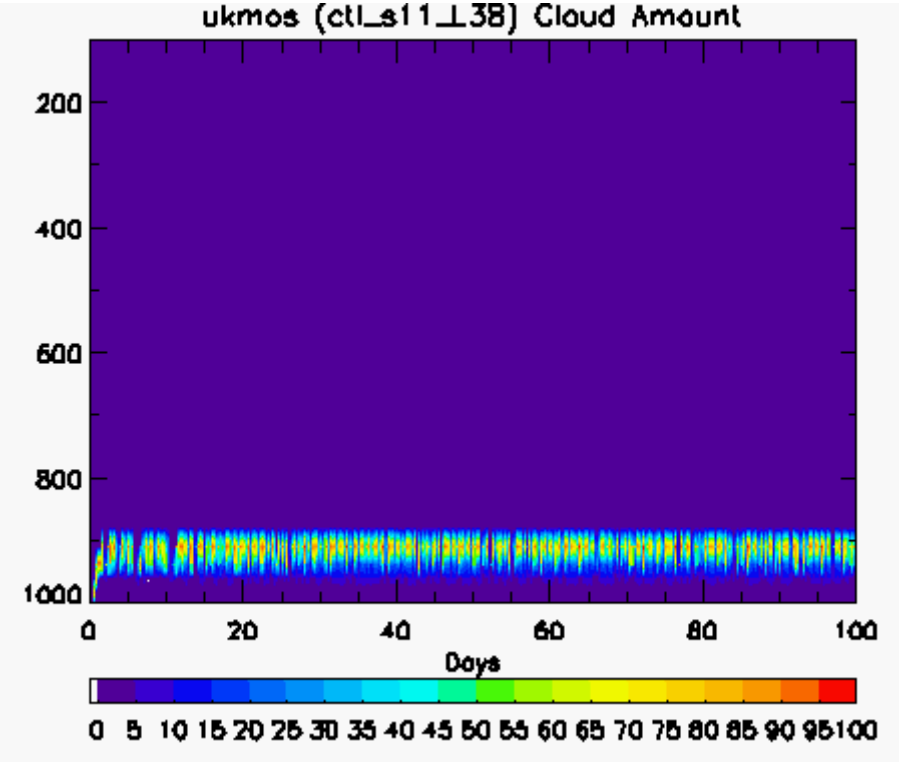


p2k

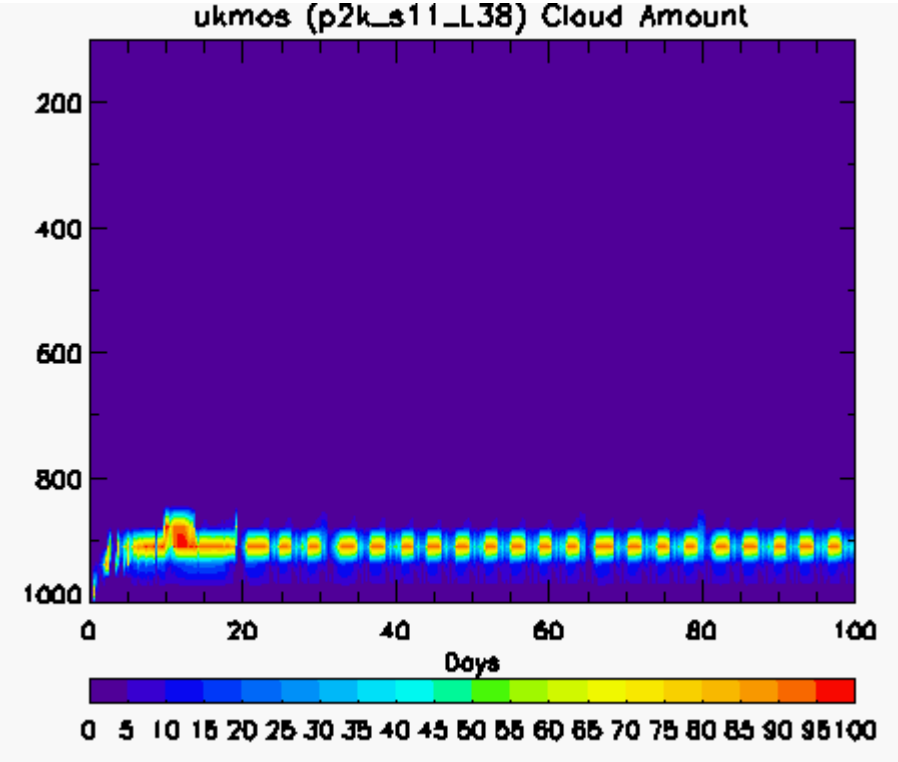


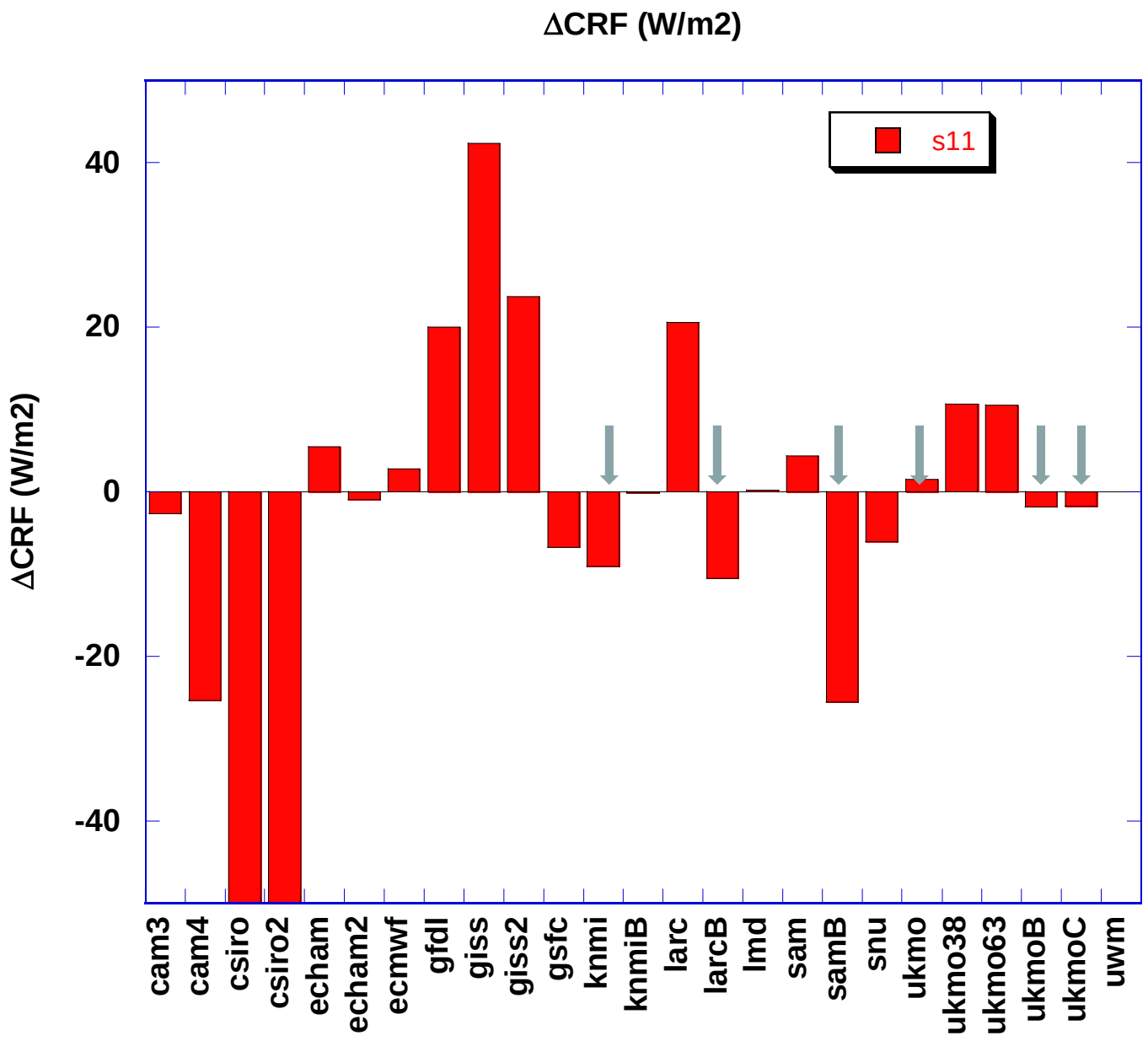
Positive Feedback in UKMO L38

ctl

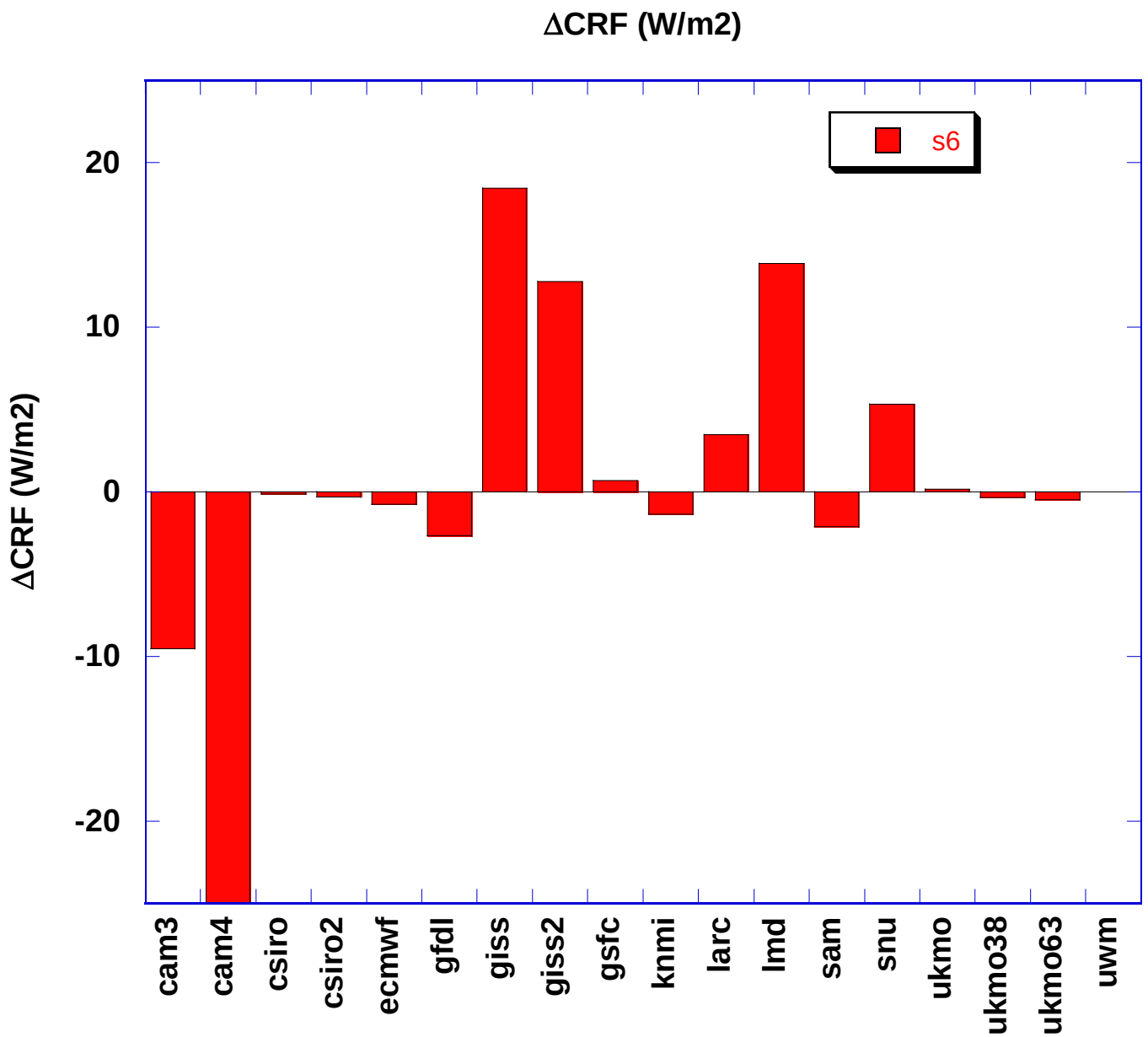


p2k



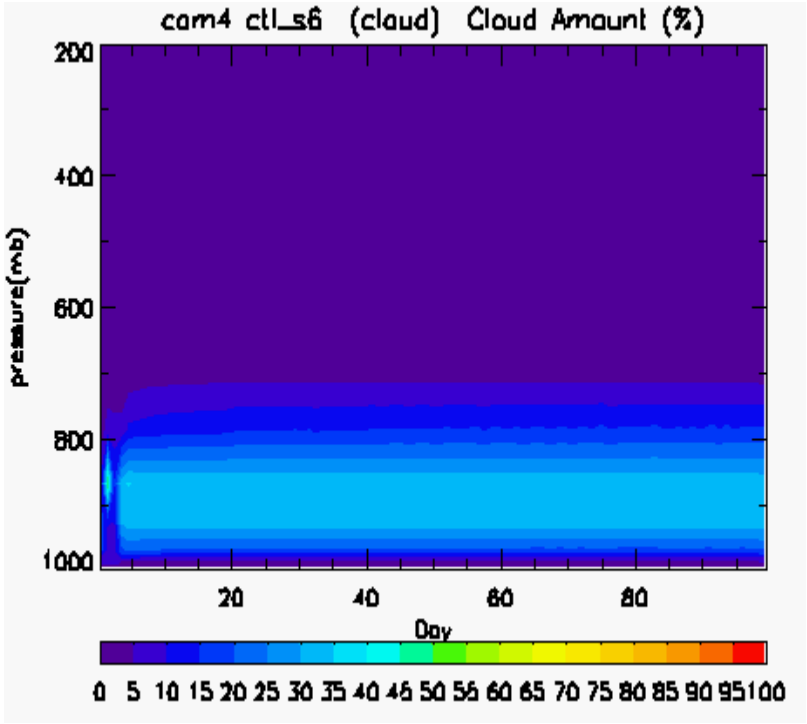

ΔCRF (W/m2)
ΔCRF (W/m2)
40
20
0
-20
-40
s11
cam3
cam4
csiro
csiro2
echam
echam2
ecmwf
gfdl
giss
giss2
gsfc
knmi
knmiB
larc
larcB
lmd
sam
samB
snu
ukmo
ukmo38
ukmo63
ukmoB
ukmoC
uwm

S6

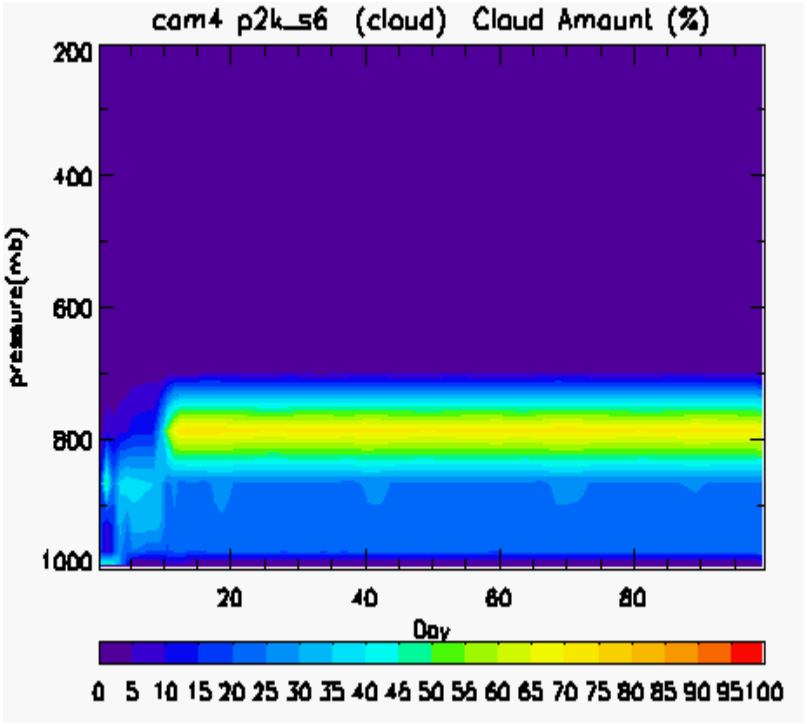

ΔCRF (W/m2)
ΔCRF (W/m2)
20
10
0
-10
-20
s6
cam3
cam4
csiro
csiro2
ecmwf
gfdl
giss
giss2
gsfc
knmi
larc
lmd
sam
snu
ukmo
ukmo38
ukmo63
uwm

Negative Feedback in CAM4

ctl



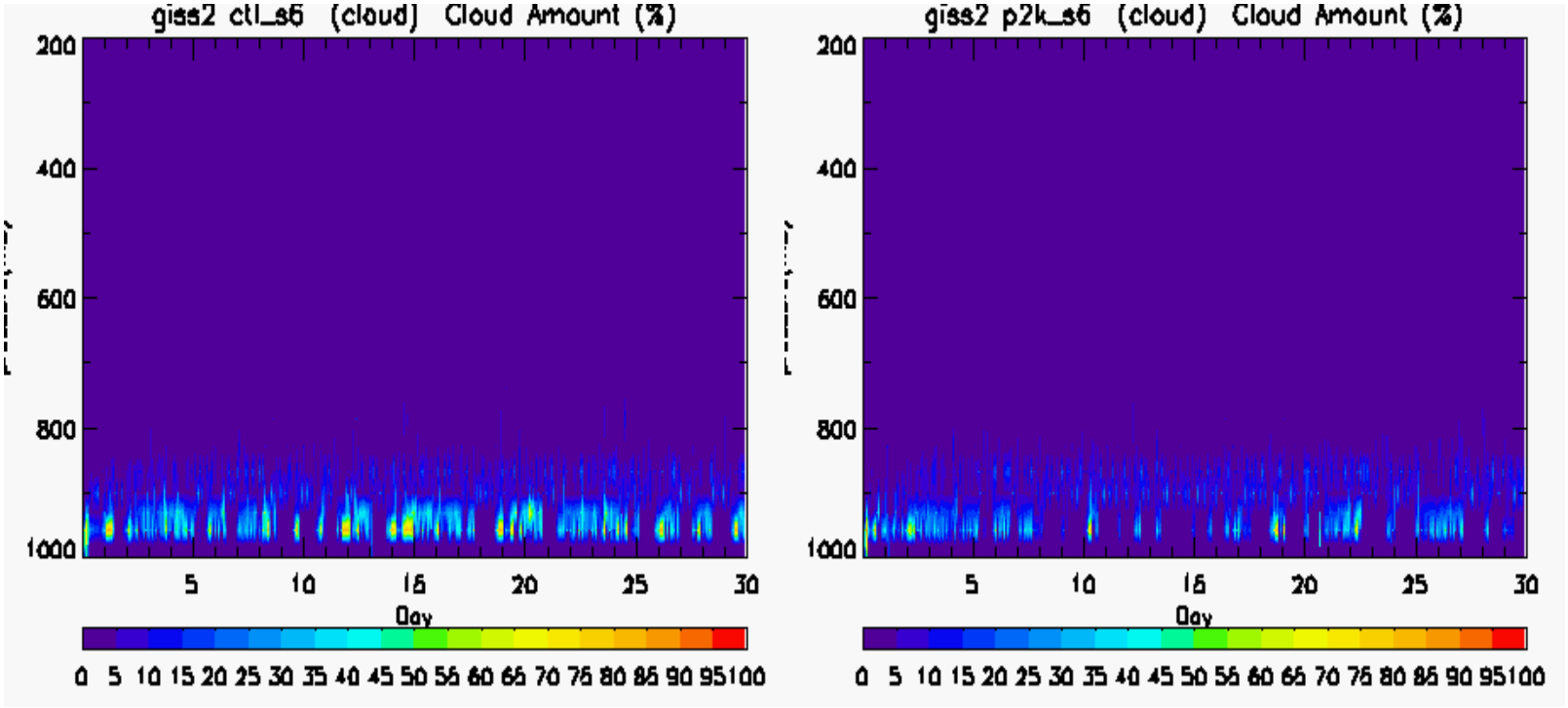
p2k

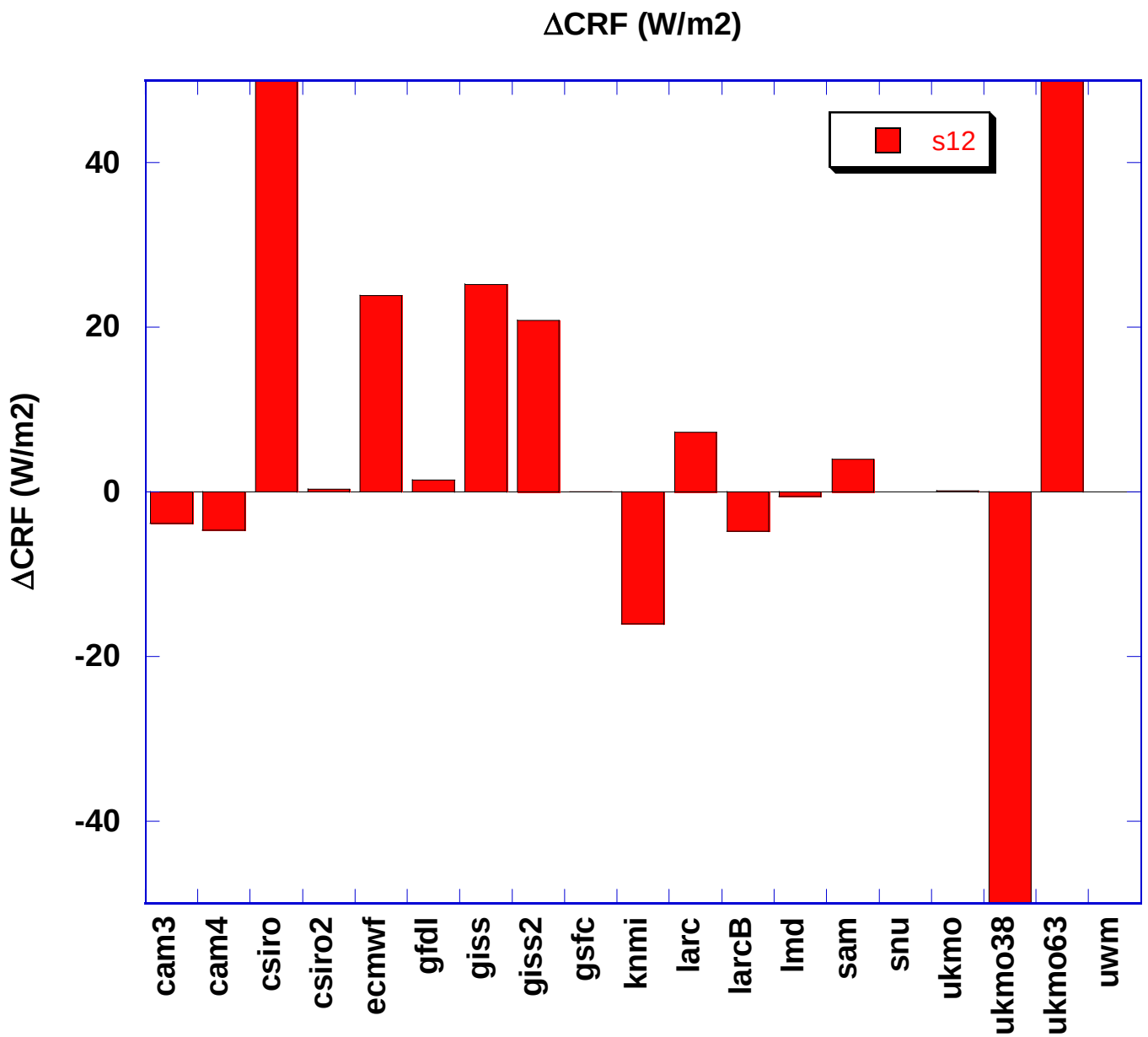


Positive Feedback in GISS

ctl

p2k

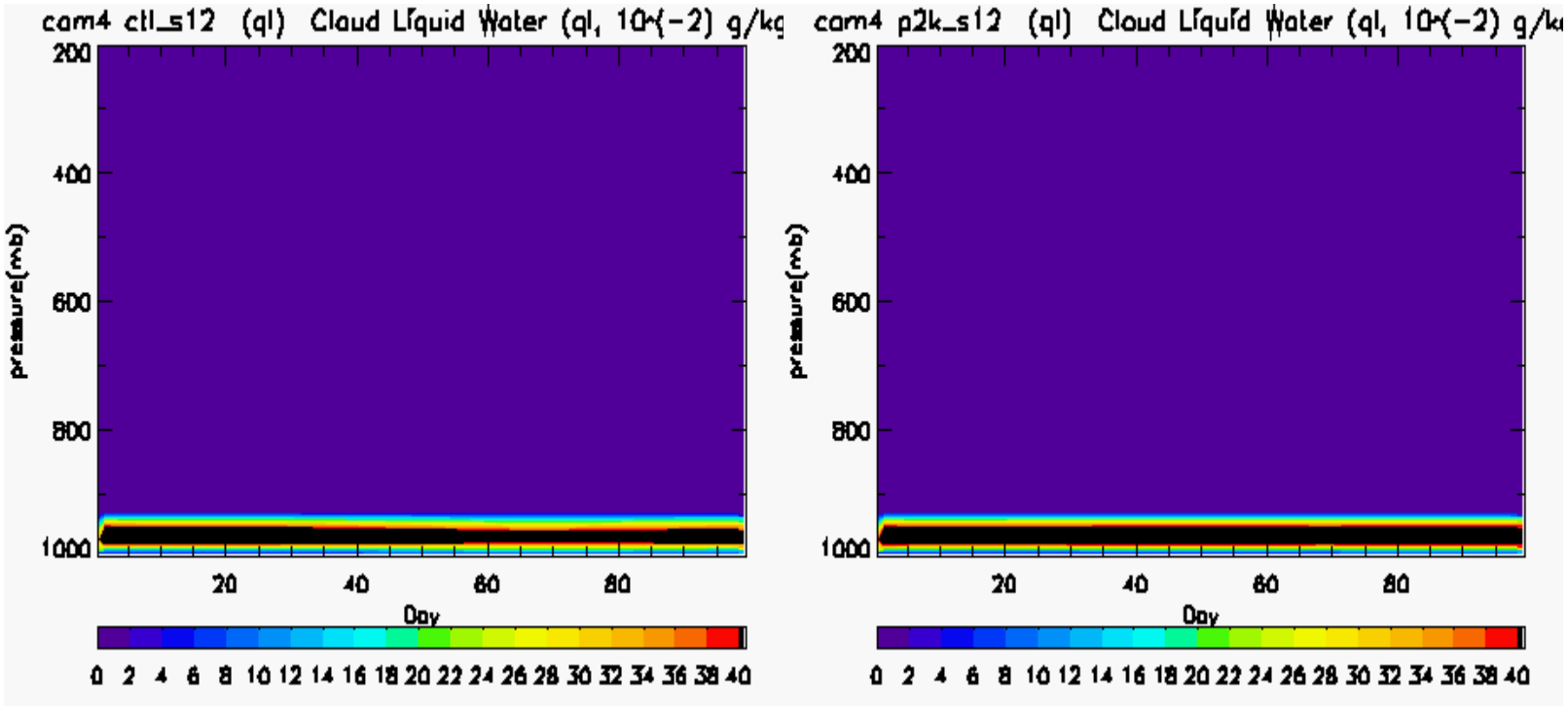



ΔCRF (W/m2)
ΔCRF (W/m2)
40
20
0
-20
-40
s12
cam3
cam4
csiro
csiro2
ecmwf
gfdl
giss
giss2
gsfc
knmi
larc
larcB
lmd
sam
snu
ukmo
ukmo38
ukmo63
uwm

Negative Feedback in CAM4

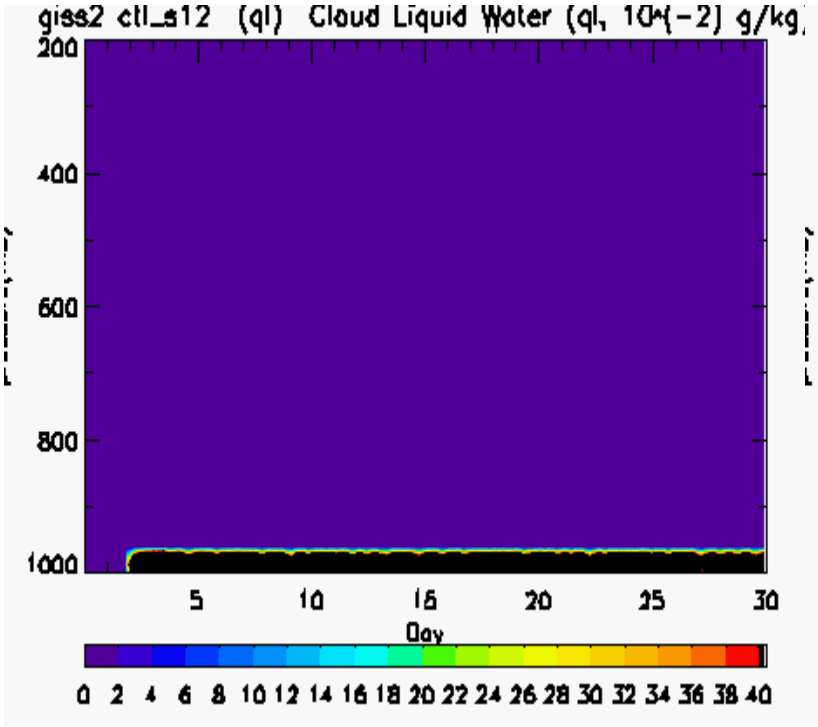
ctl

p2k

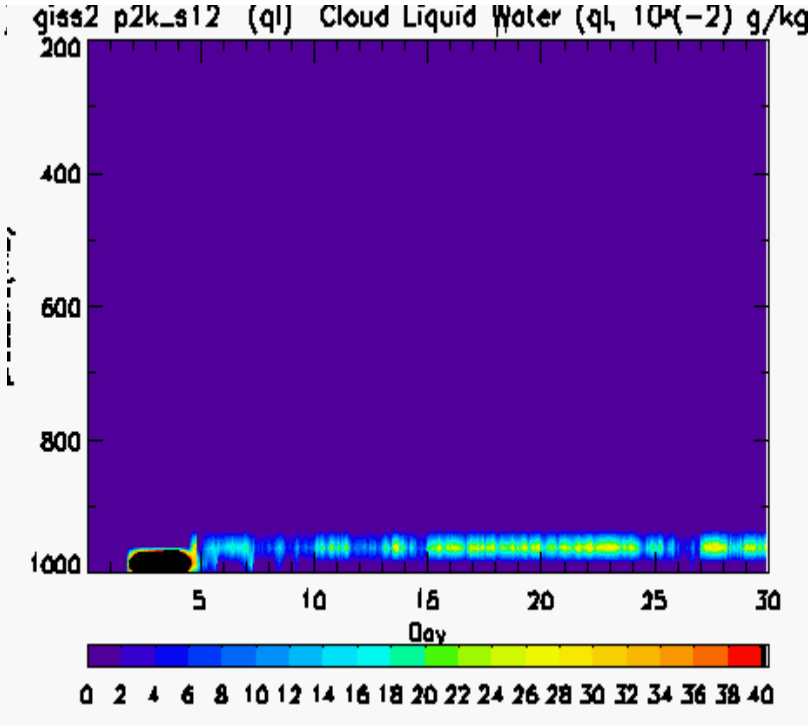


Positive Feedback in GISS

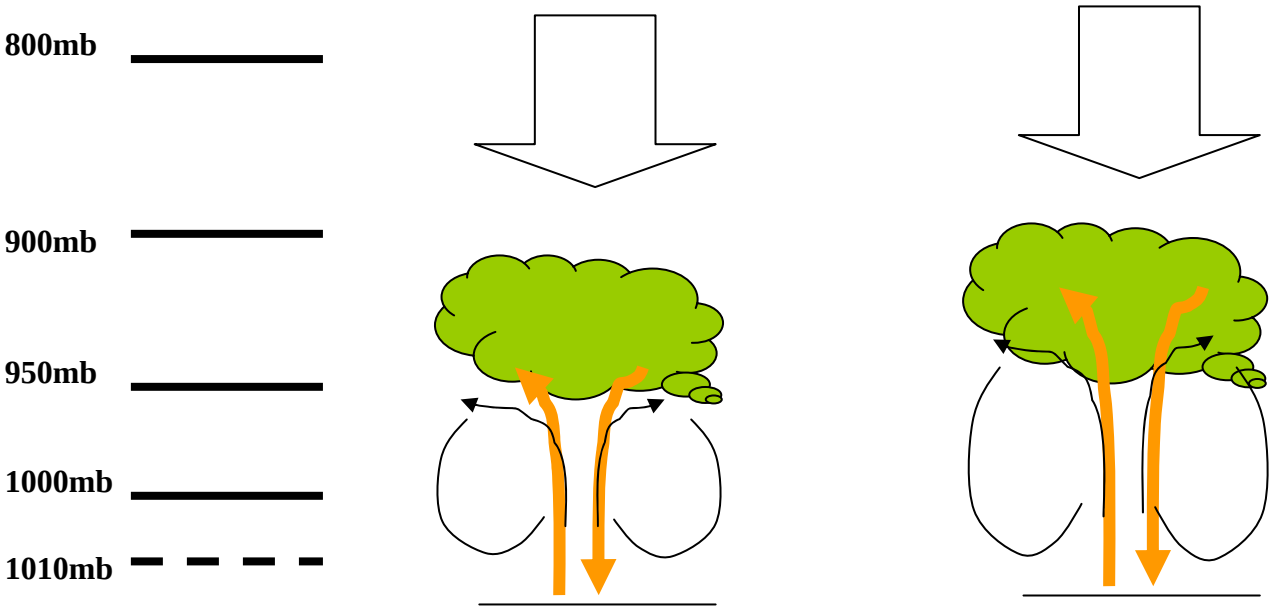
ctl



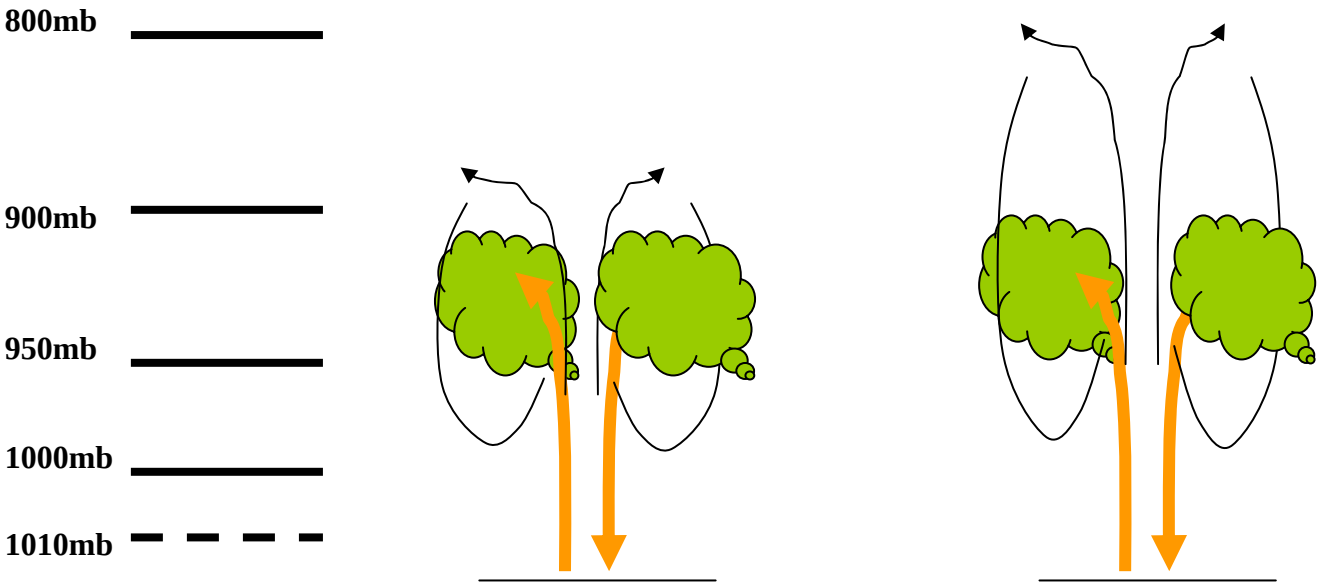
p2k



Negative feedbacks



Positive feedbacks
(Explicit cloud top entrainment mixing)



Summary

1.The SCMs simulated a wide range of low clouds and cloud feedbacks at all three locations

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

first for cloud distribution in control climate, and then for cloud feedback

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)

Papers for incremental steps

Revised Simulation Results Analyzed for BAMS

Future

SCM S11 (S6 and S12)

LES S11 and sensitivities

http://atmgcm.msrc.sunysb.edu/cfmips

SCM: Next Steps

1. Connection with GCMs
    - Diurnal Variation
    - Transient Forcing
    - Different locations
    - 4K perturbation
    - 4XCO2

2. Connection with LES

3. Connection with Observations
    - Seasonal
    - Interannual

LES: Next Steps

1. Standardized Runs

2. Convergence for S11 with SAM

3. Convergence among models
   DYCOMS

4. Sensitivity