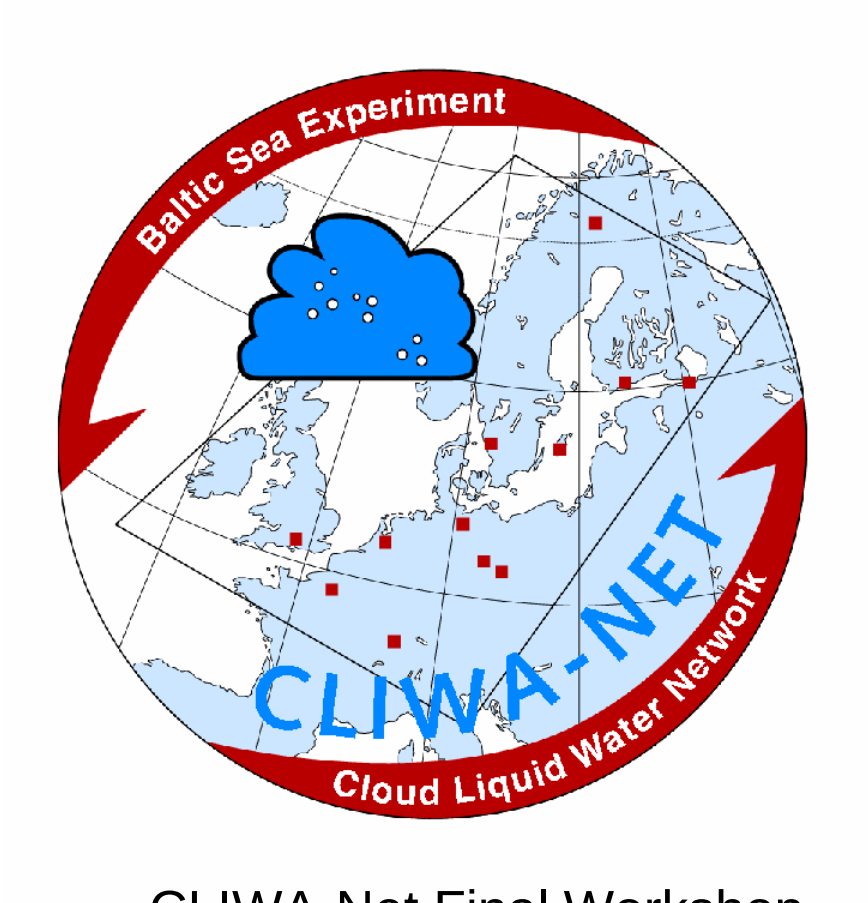
Evaluation of I) the model predicted vertical distribution of liquid water content and II) model simulated brightness temperatures

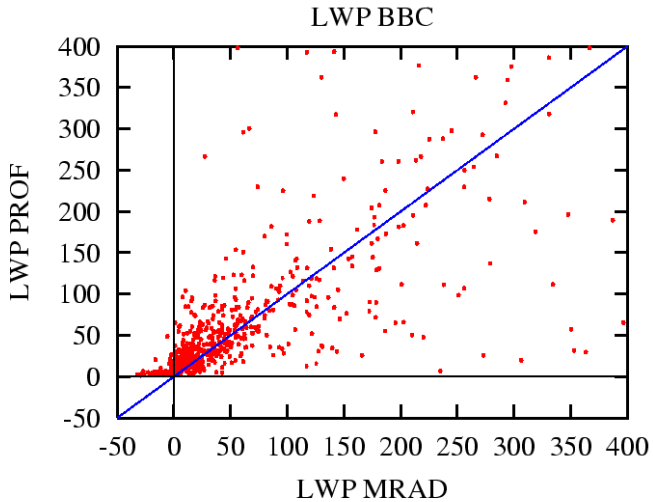
Erik van Meijgaard, KNMI, De Bilt, The Netherlands

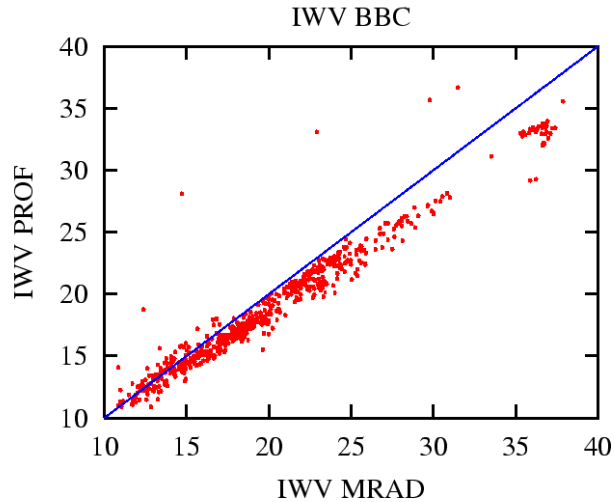


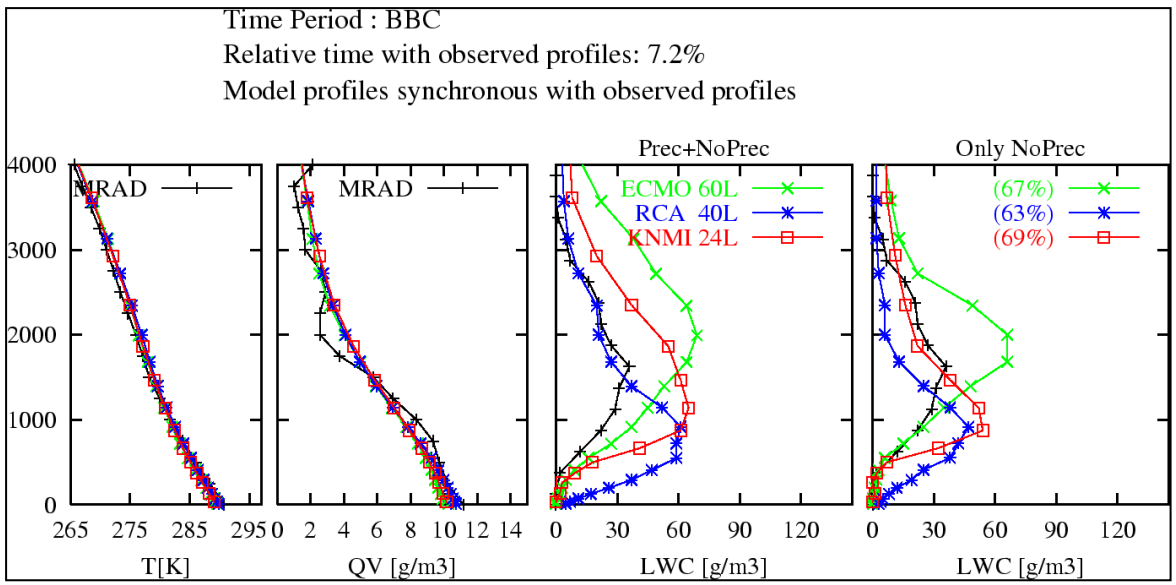
CLIWA-Net Final Workshop,
Madrid, 17 December 2002

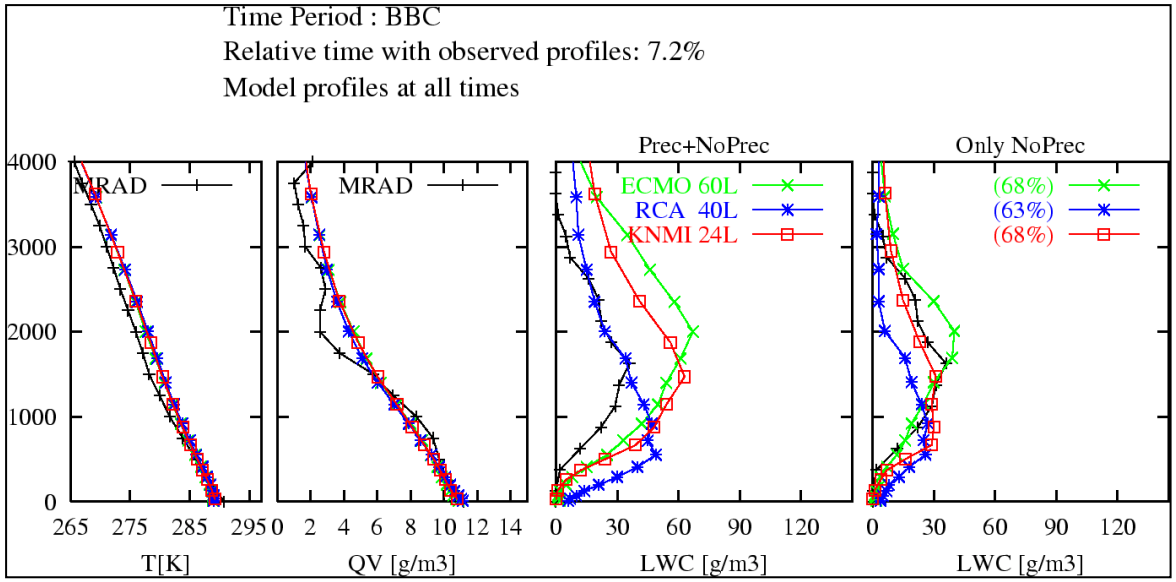
Model predicted vertical distribution of cloud liquid water

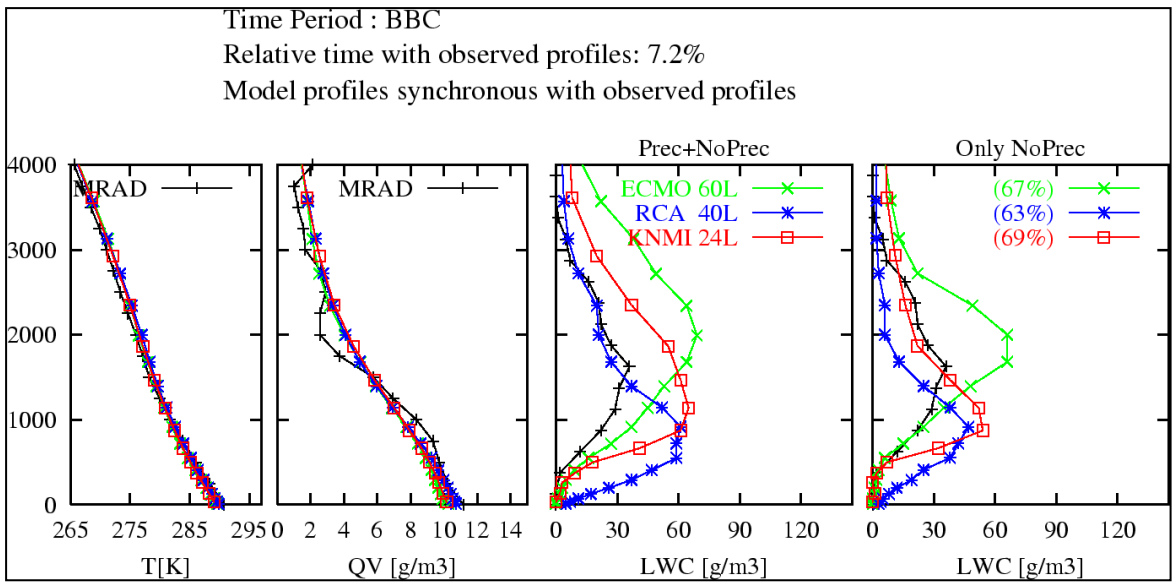
Time Period : BBC ; Relative time with observed profiles: 7.2%



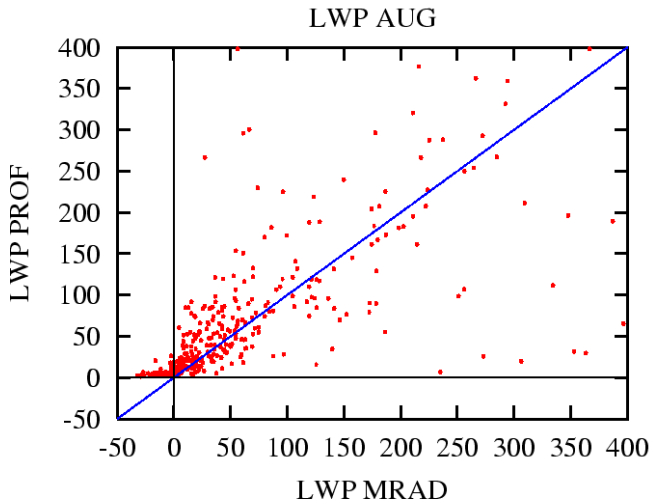


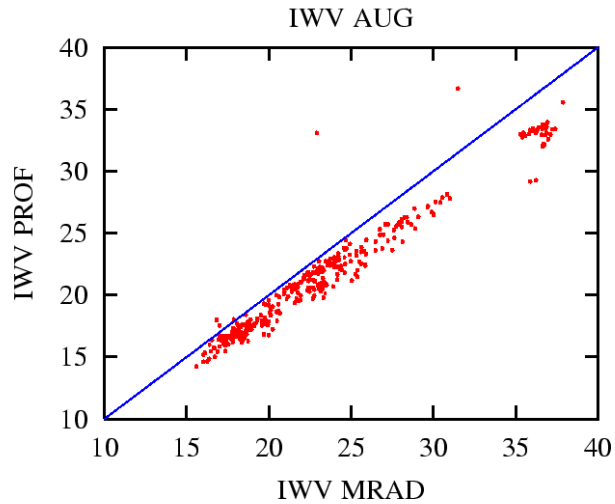


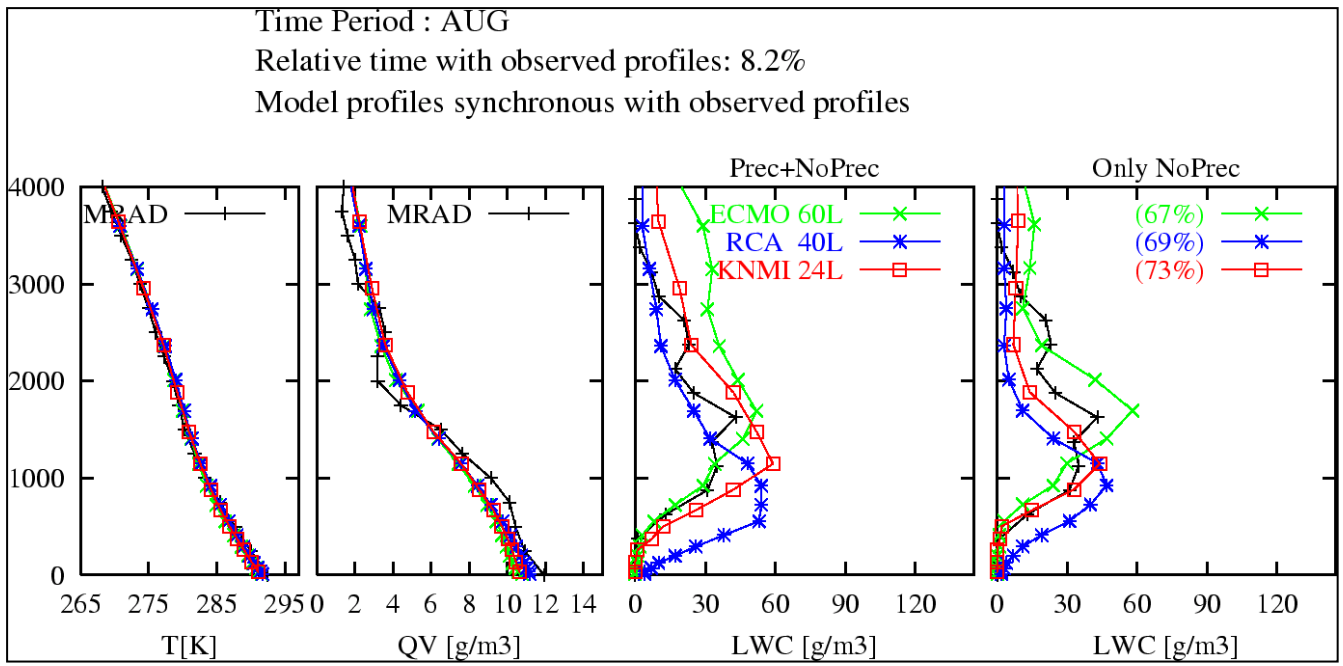

Time Period : BBC
Relative time with observed profiles: 7.2%
Model profiles at all times
Prec+NoPrec
Only NoPrec
MRAD
MRAD
ECMO 60L
RCA 40L
KNMI 24L
(68%)
(63%)
(68%)
4000
3000
2000
1000
0
265 275 285 295
0 2 4 6 8 10 12 14
0 30 60 90 120
0 30 60 90 120
T[K]
QV [g/m3]
LWC [g/m3]
LWC [g/m3]


Time Period : BBC
Relative time with observed profiles: 7.2%
Model profiles synchronous with observed profiles
Prec+NoPrec
Only NoPrec
MRAD
MRAD
ECMO 60L
RCA 40L
KNMI 24L
(67%)
(63%)
(69%)
4000
3000
2000
1000
0
265 275 285 295
0 2 4 6 8 10 12 14
0 30 60 90 120
0 30 60 90 120
T[K]
QV [g/m3]
LWC [g/m3]
LWC [g/m3]

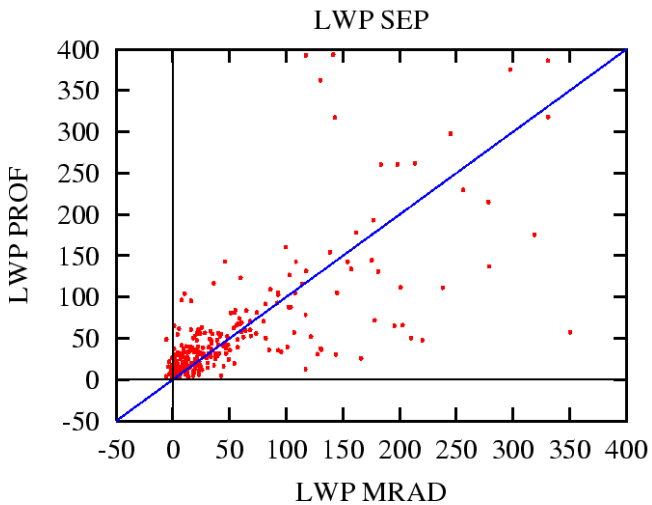
Time Period : AUG ; Relative time with observed profiles: 8.2%

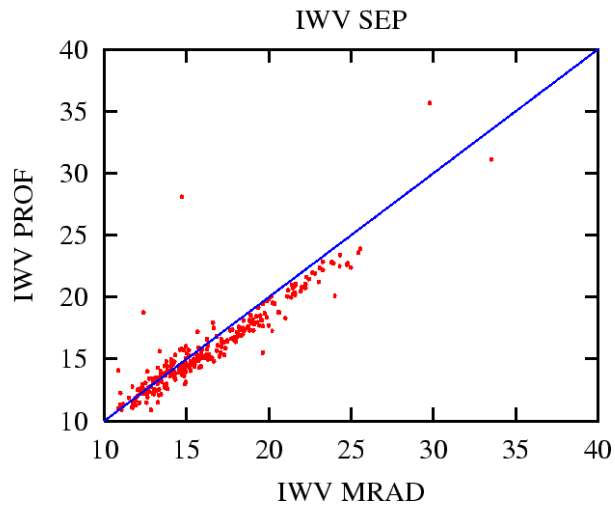


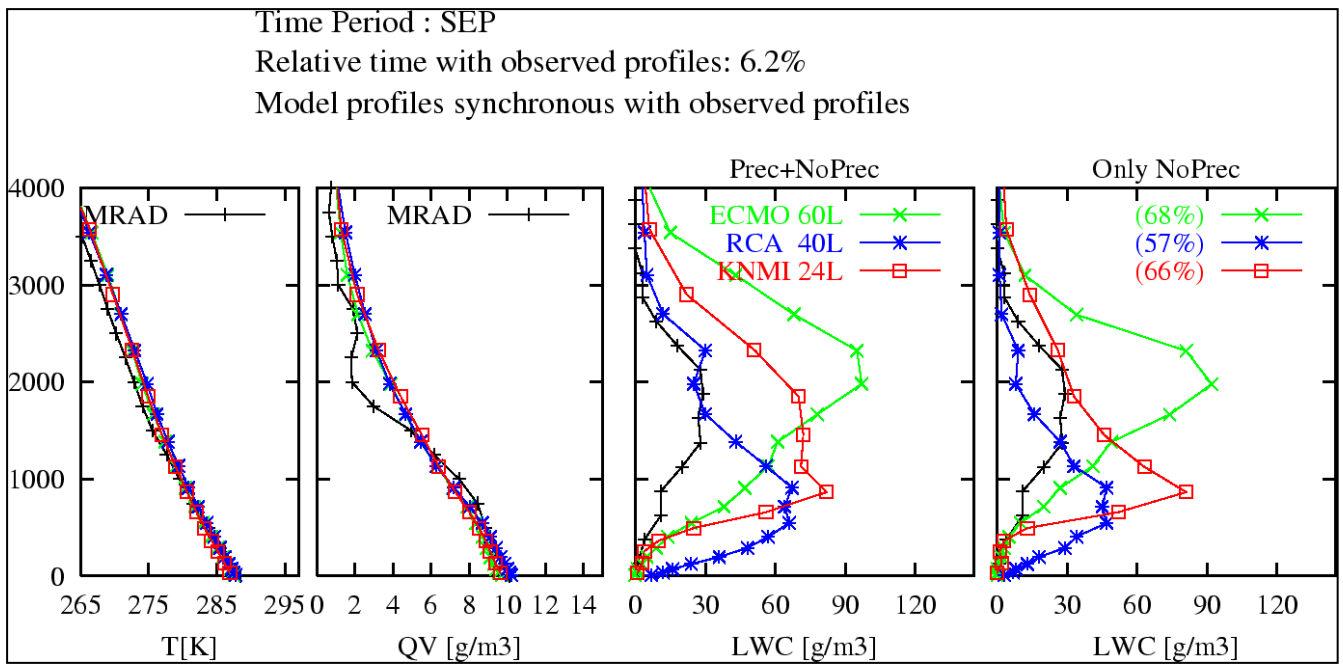




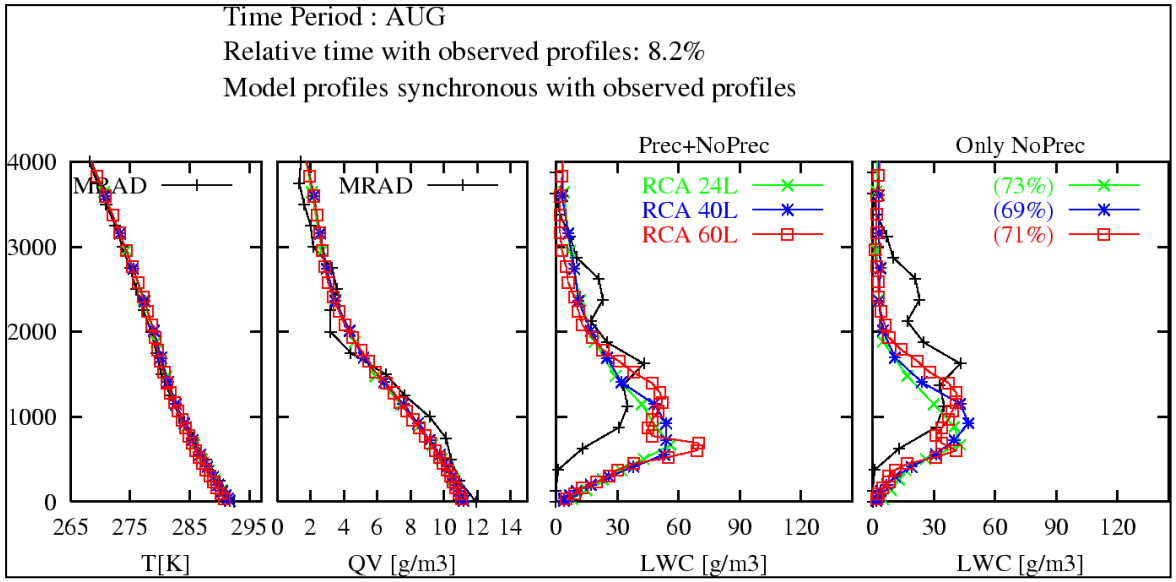
Time Period : SEP ; Relative time with observed profiles: 6.2%

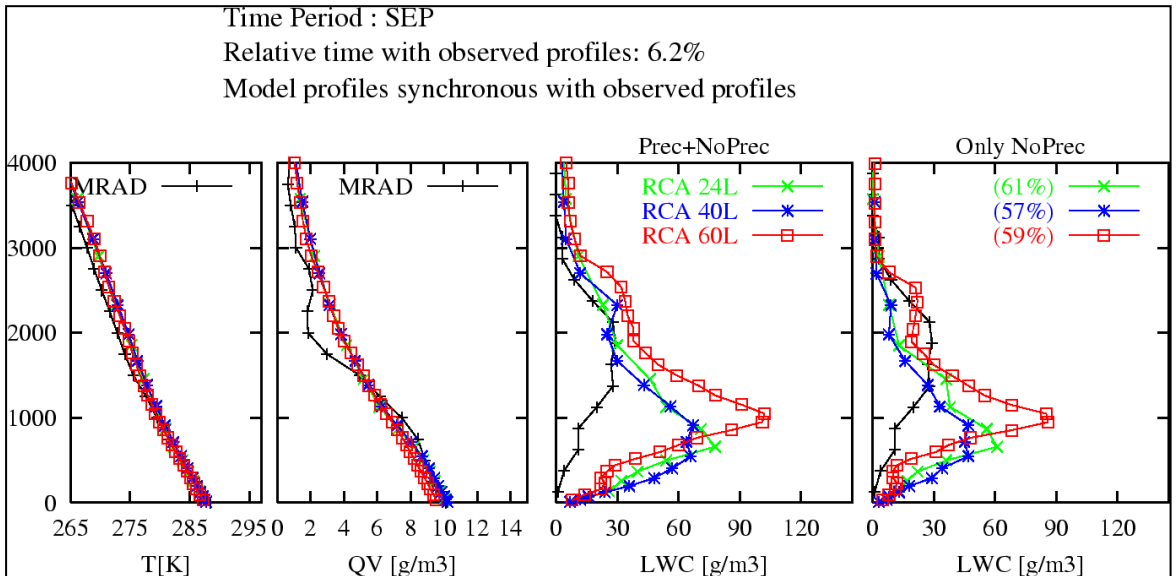






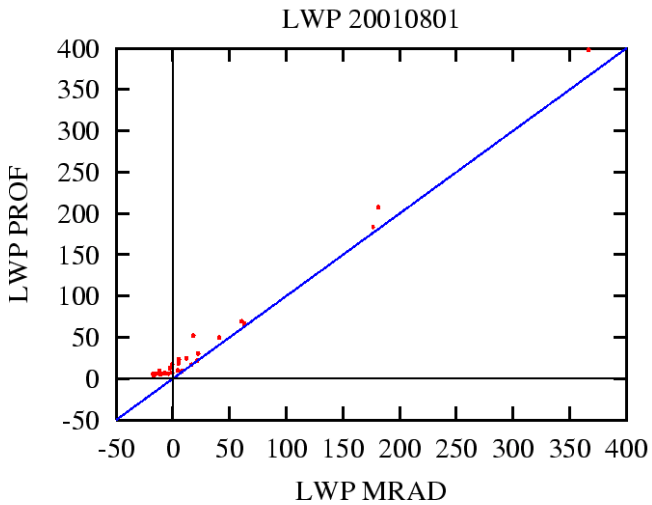
RCA model: 24L, 40L, 60L

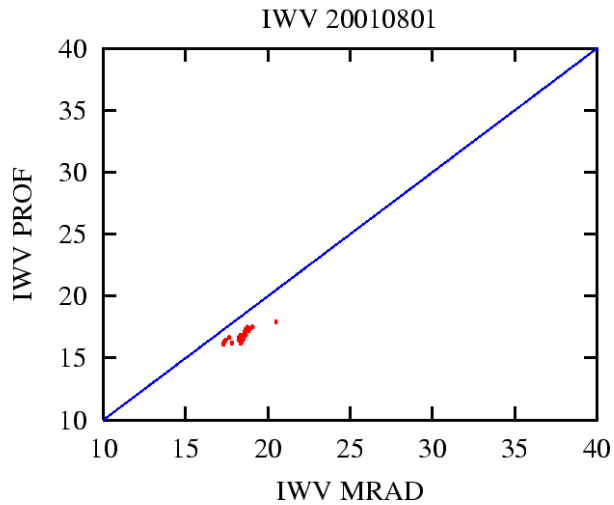


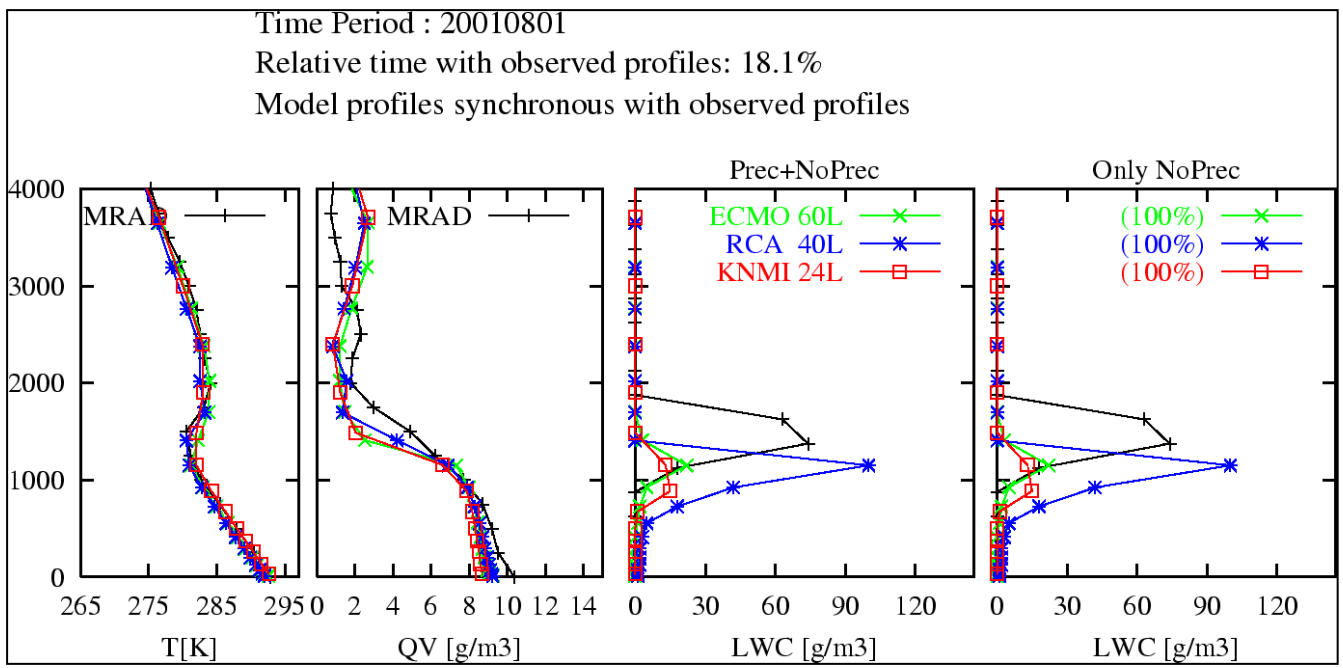


1 August 2001

Time Period : 20010801 ; Relative time with observed profiles: 18.1%

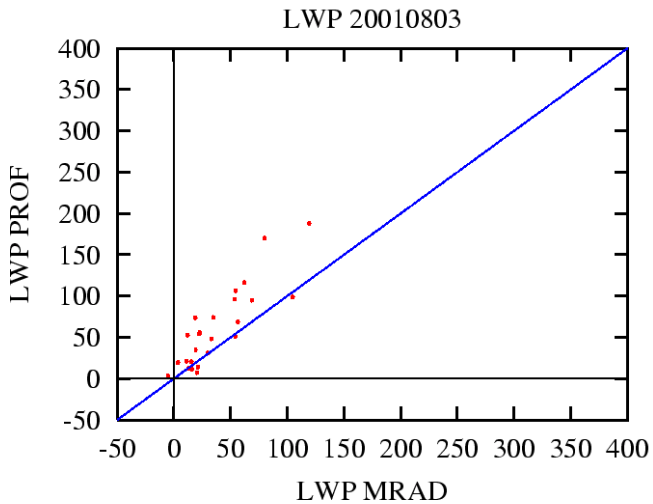


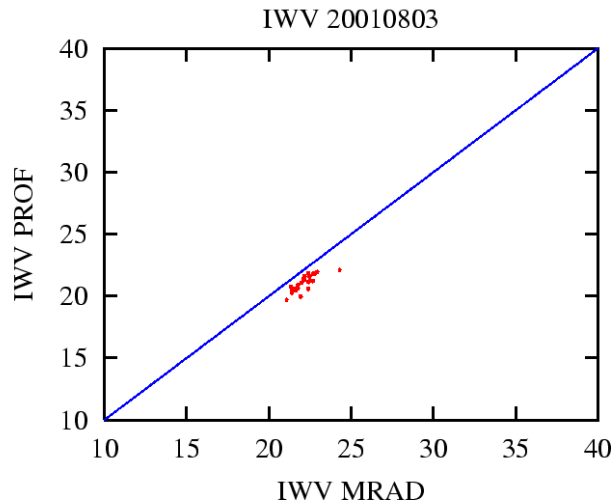


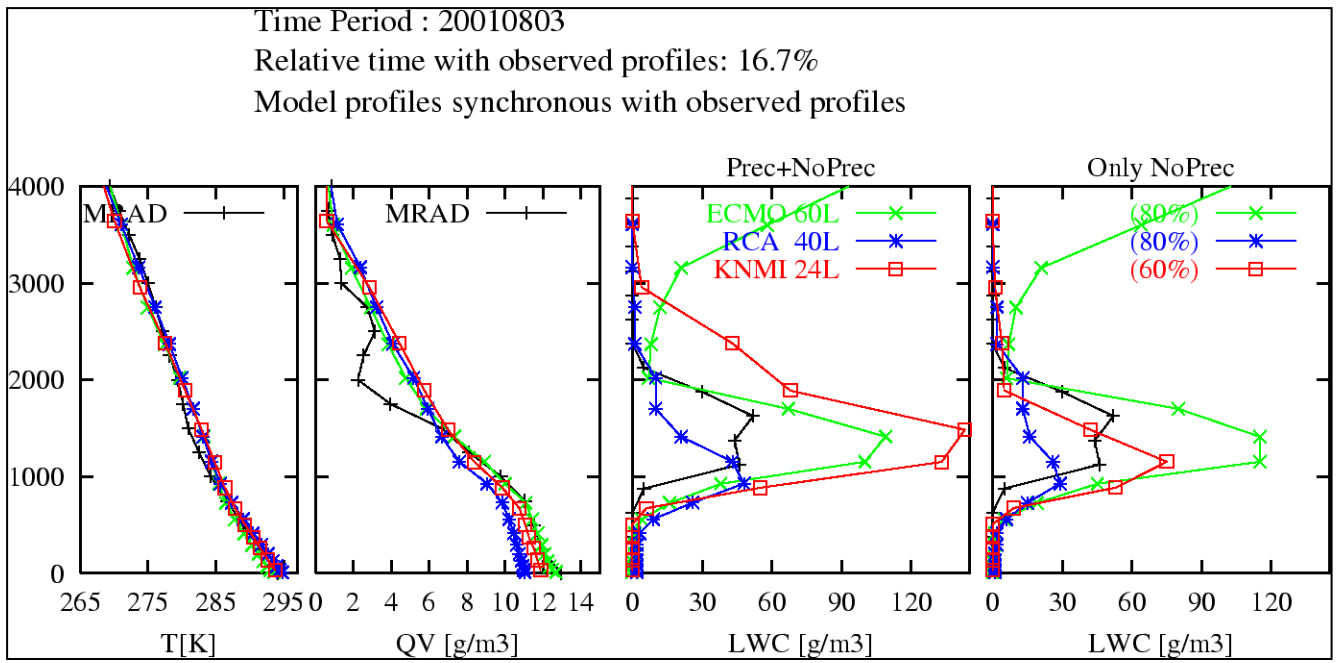


3 August 2001

Time Period : 20010803 ; Relative time with observed profiles: 16.7%

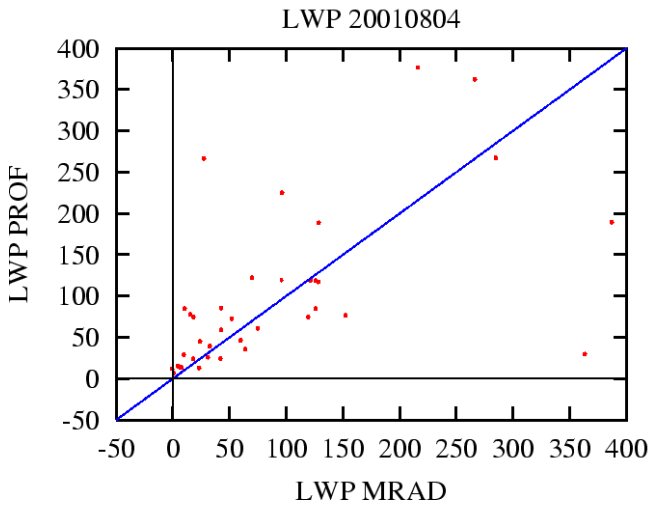


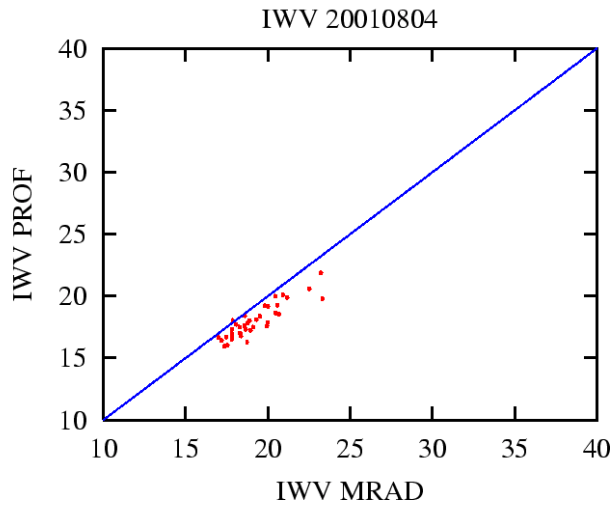


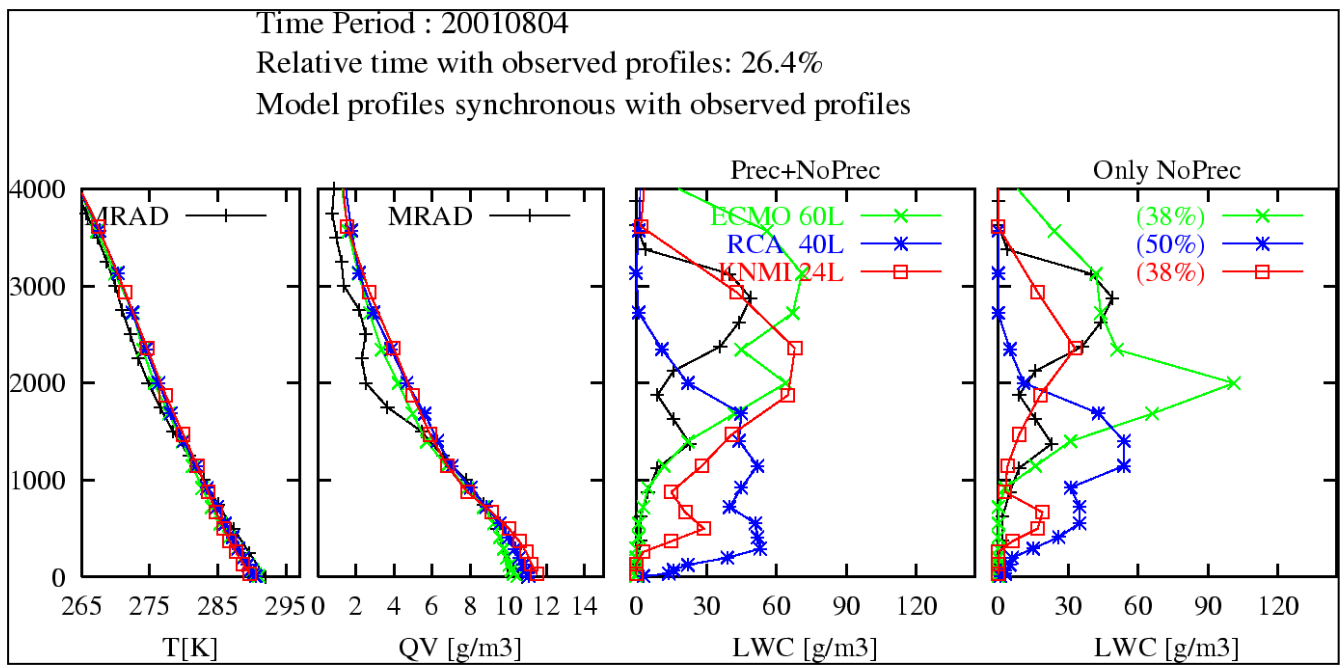


4 August 2001

Time Period : 20010804 ; Relative time with observed profiles: 26.4%

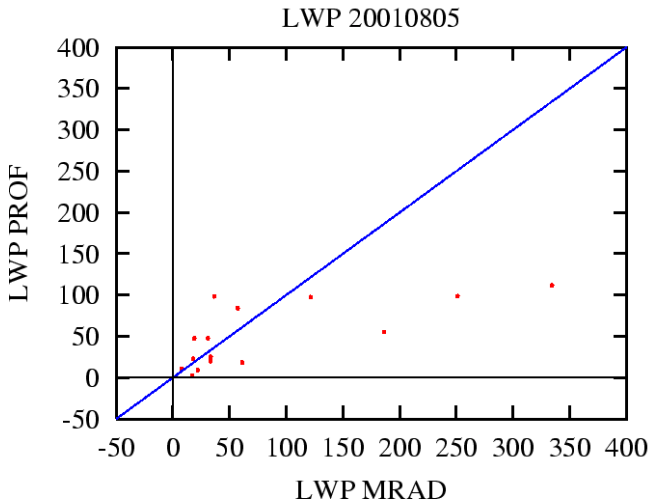


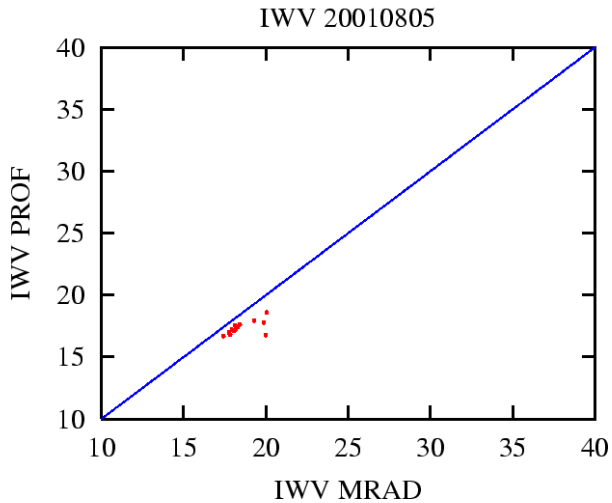


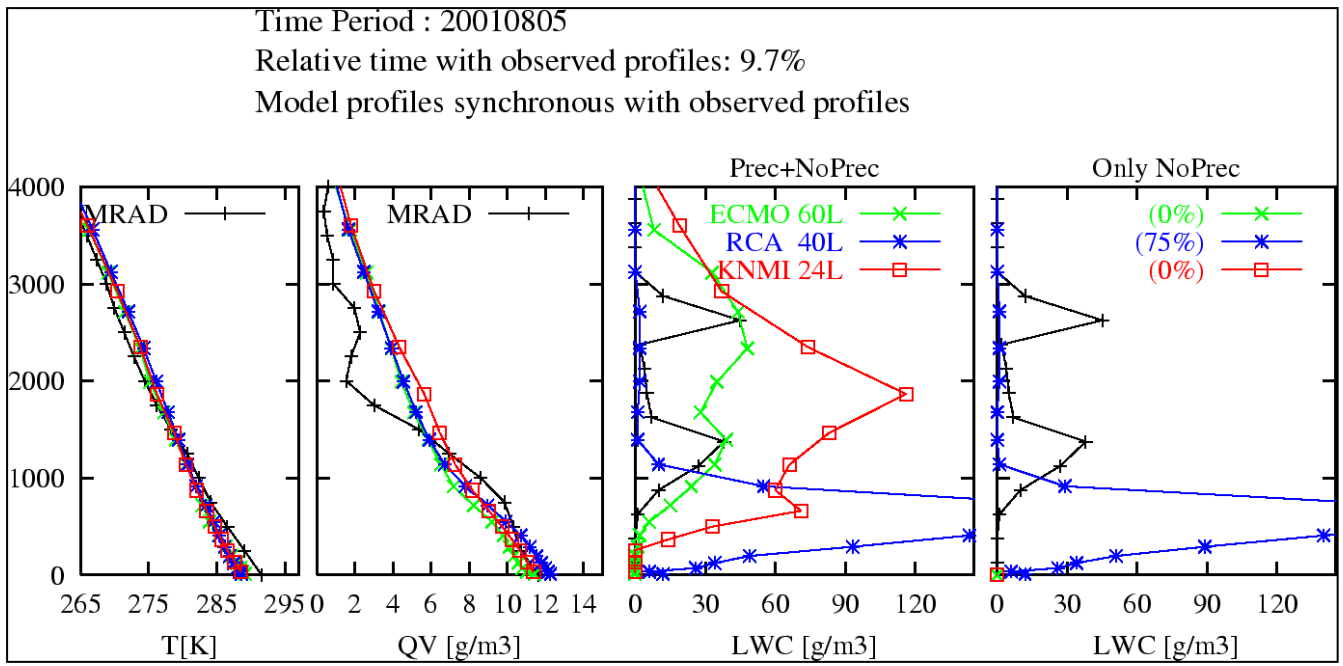


5 August 2001

Time Period : 20010805 ; Relative time with observed profiles: 9.7%

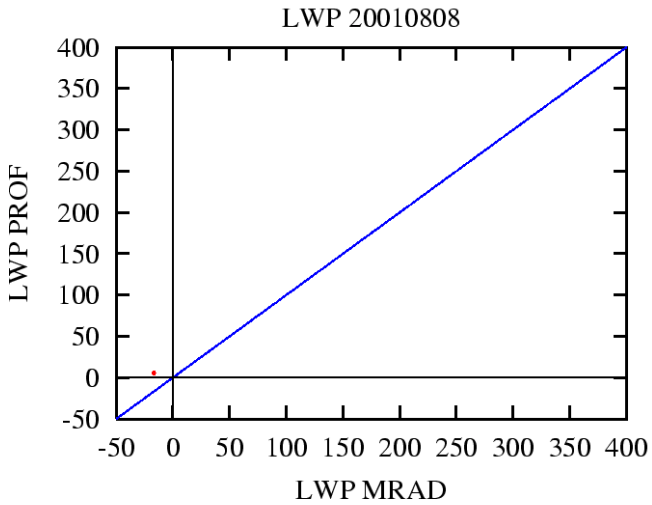


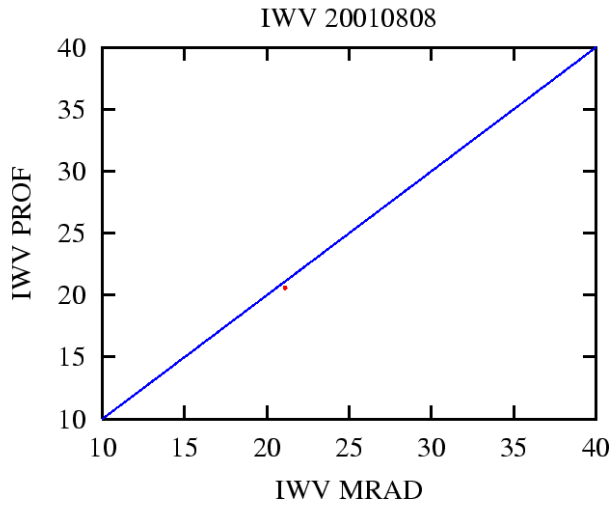


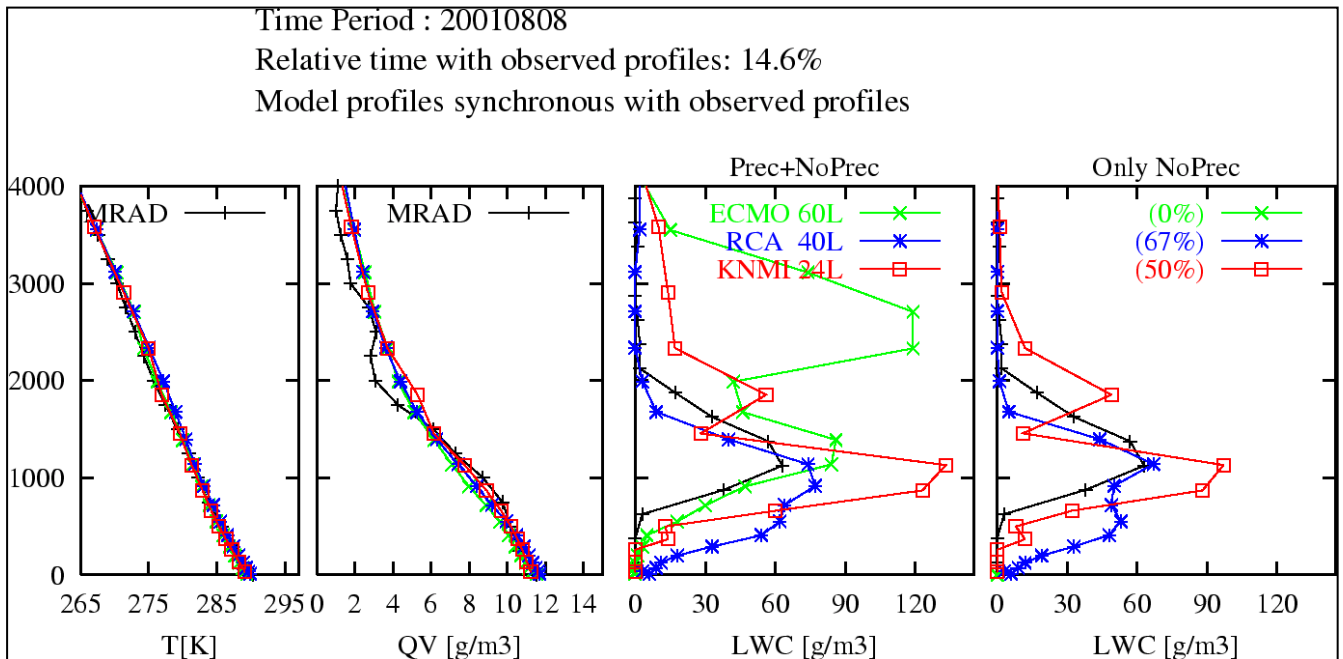


8 August 2001

Time Period : 20010808 ; Relative time with observed profiles: 14.6%

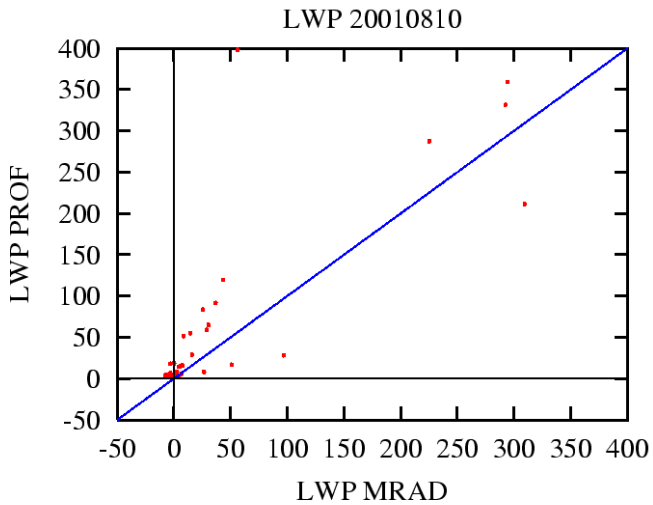


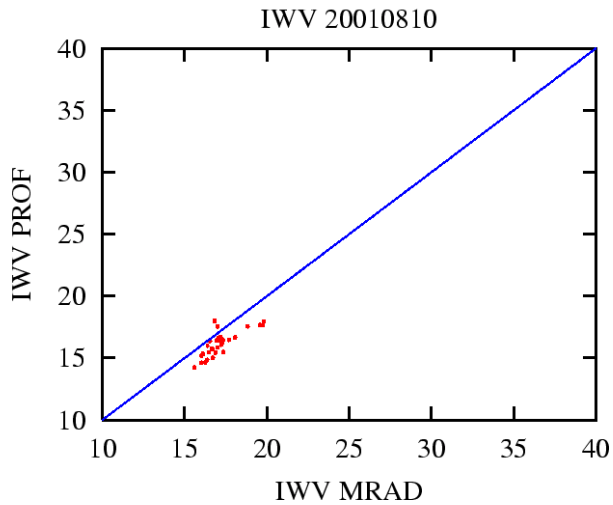


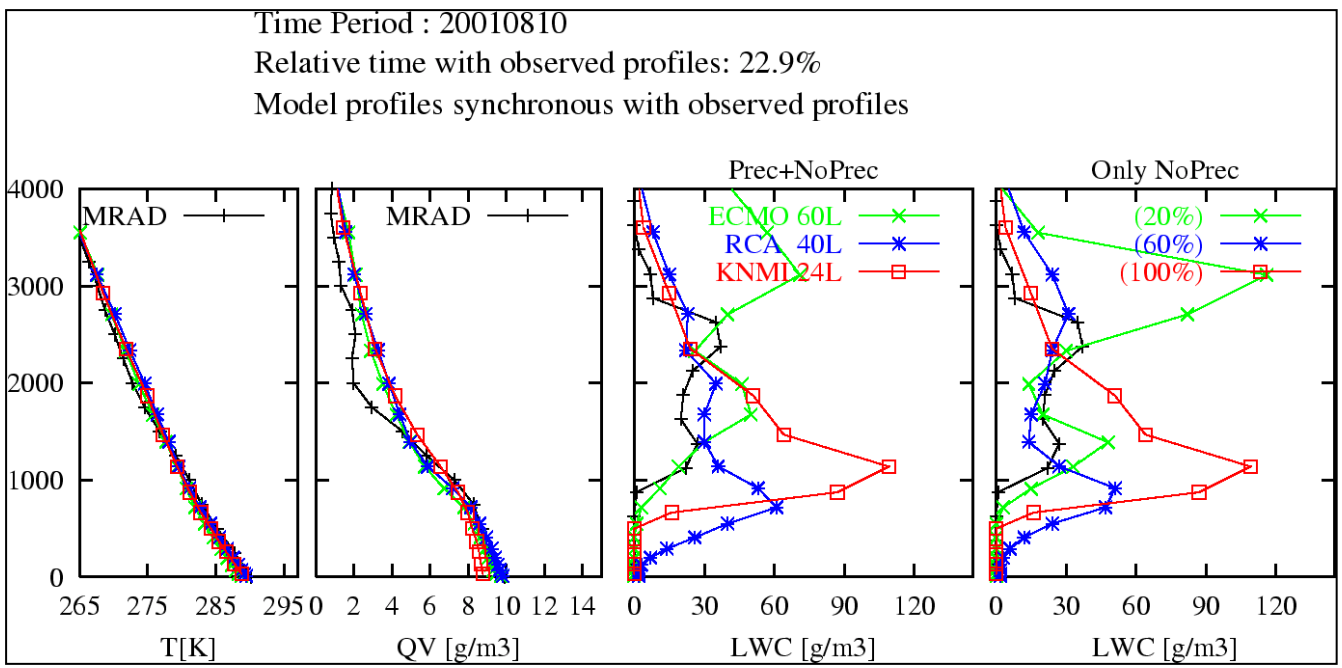


10 August 2001

Time Period : 20010810 ; Relative time with observed profiles: 22.9%

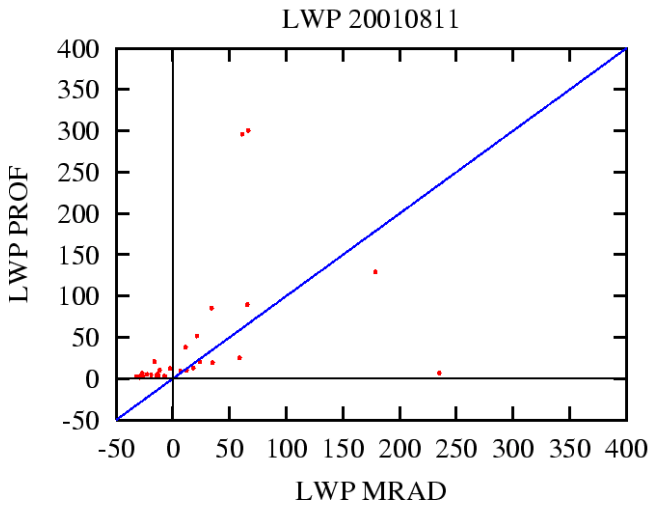


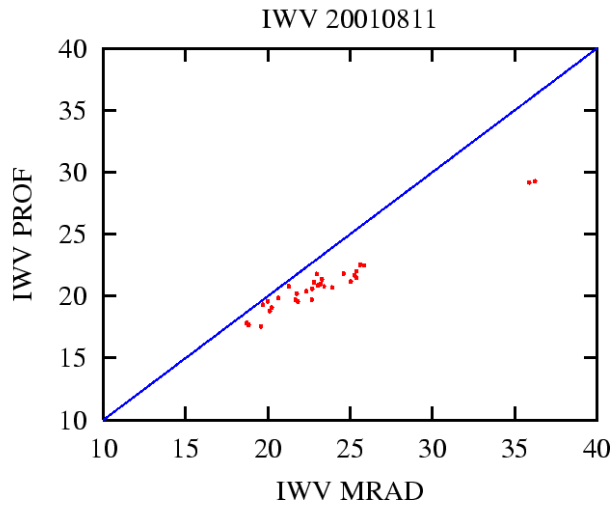


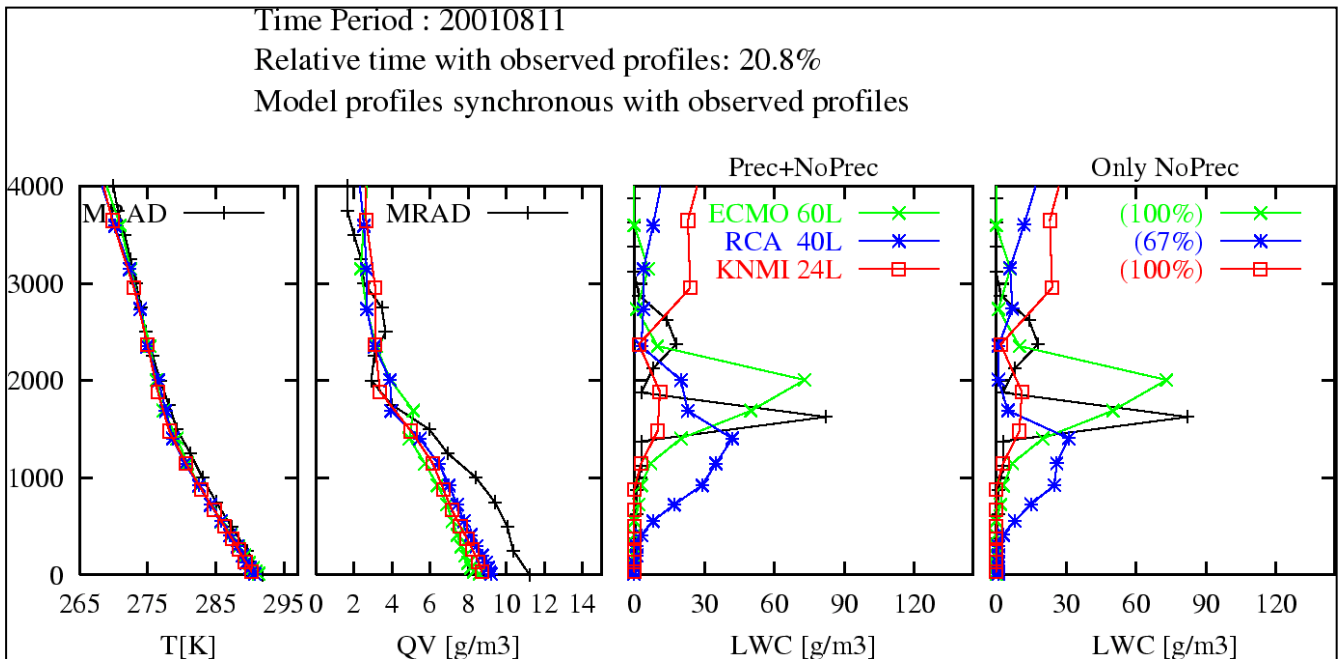


11August 2001

Time Period : 20010811 ; Relative time with observed profiles: 20.8%

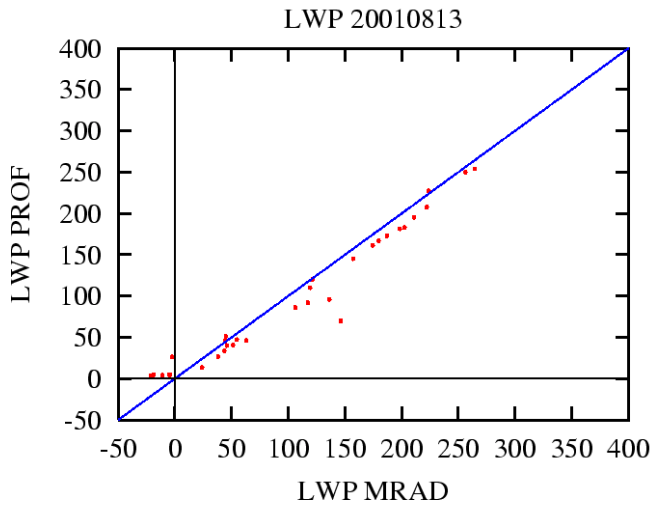


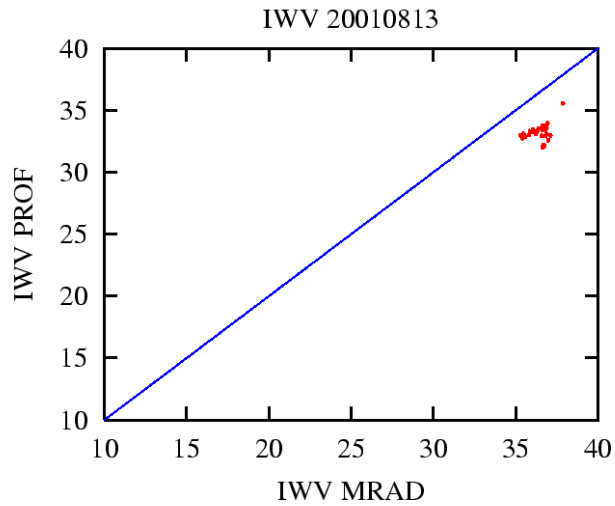


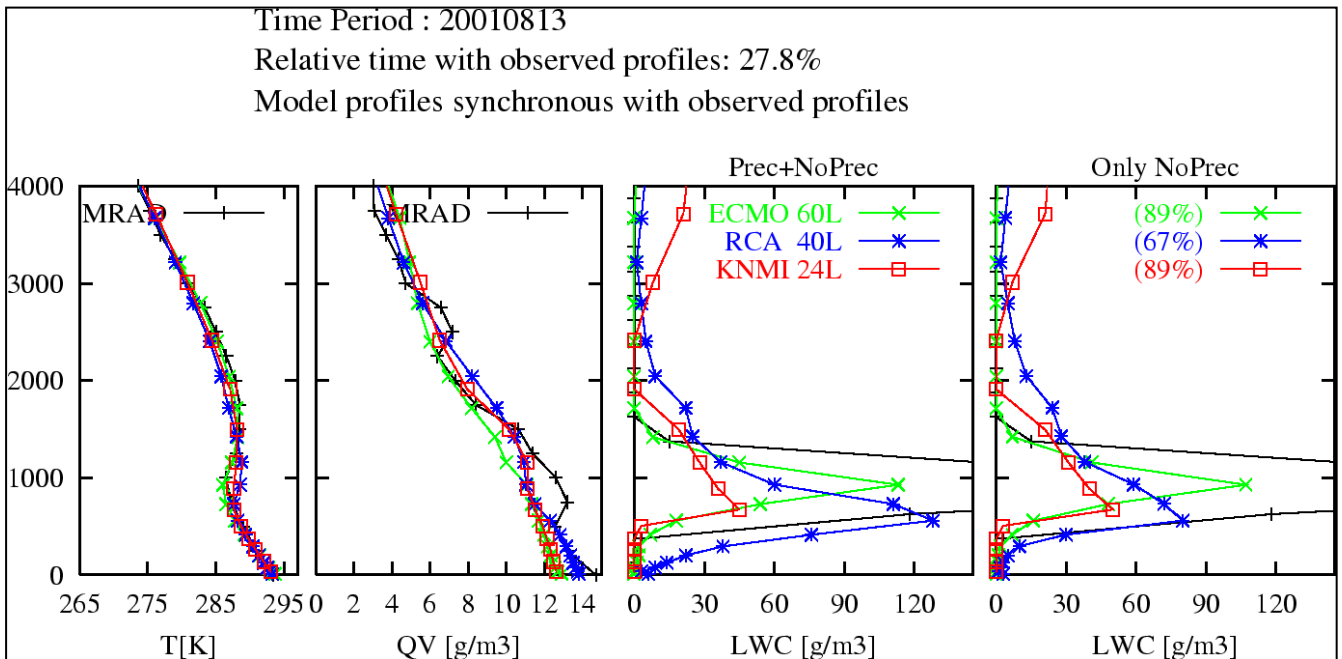


13 August 2001

Time Period : 20010813 ; Relative time with observed profiles: 27.8%

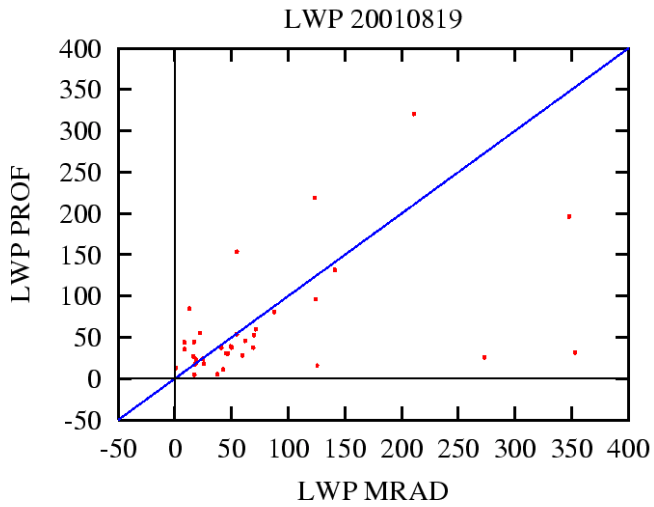


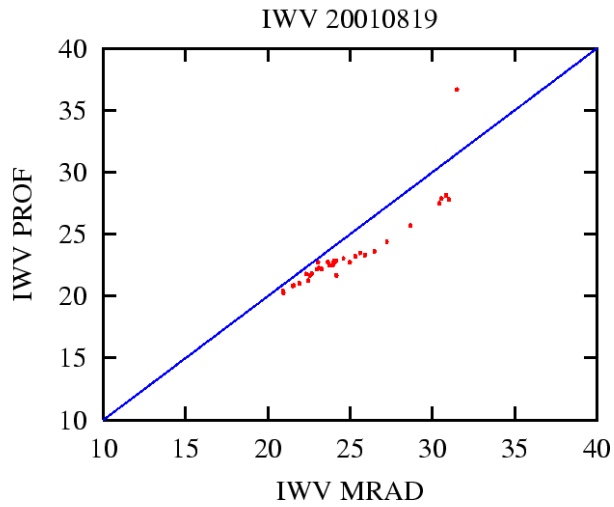


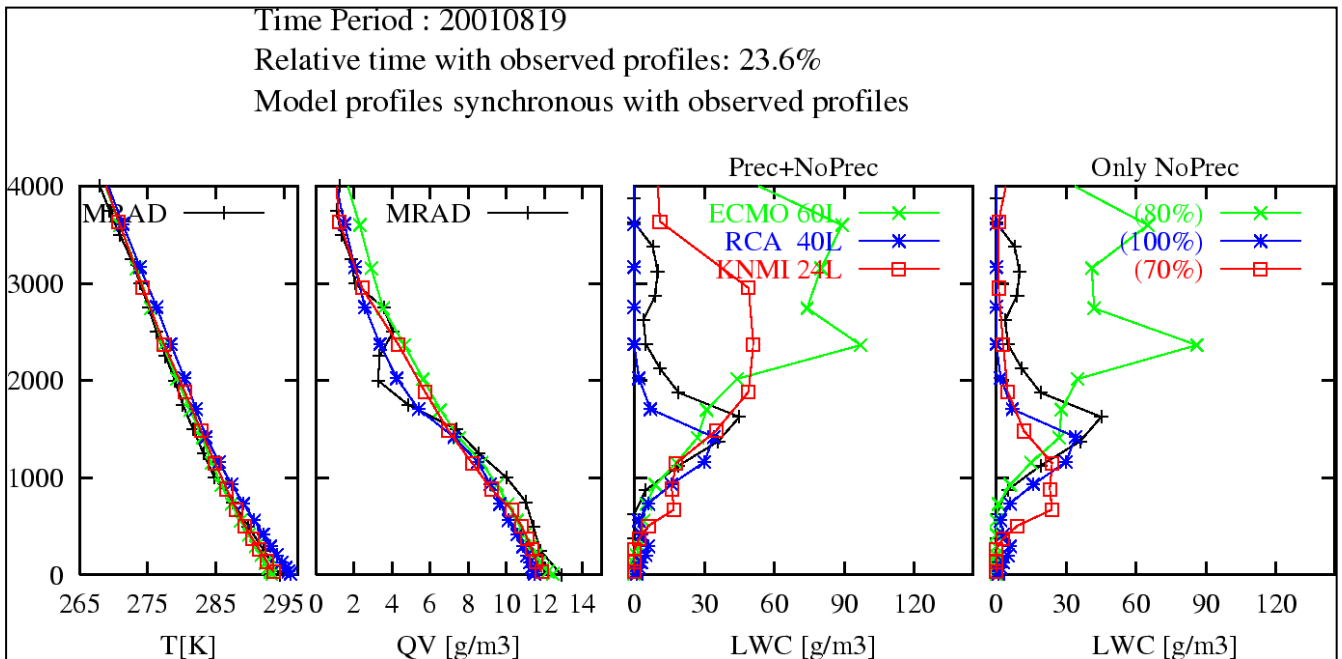


19 August 2001

Time Period : 20010819 ; Relative time with observed profiles: 23.6%

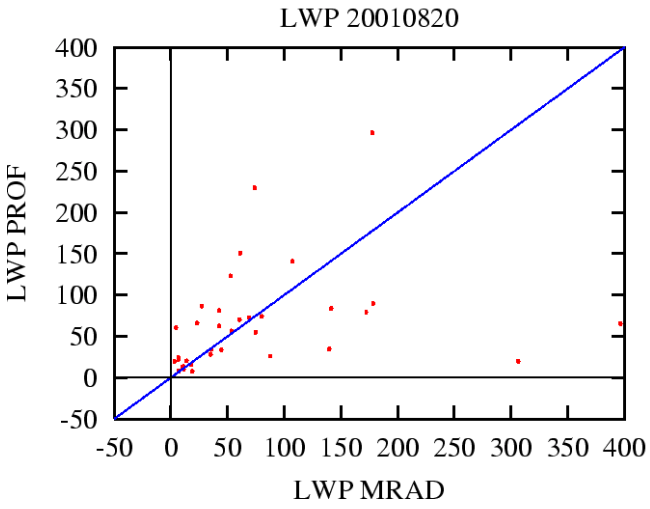


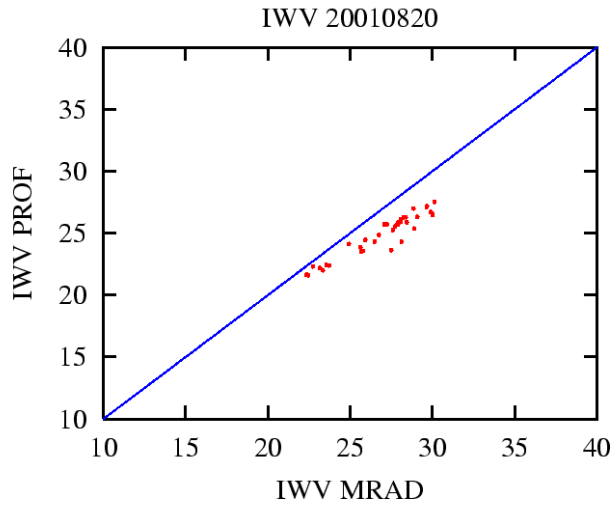


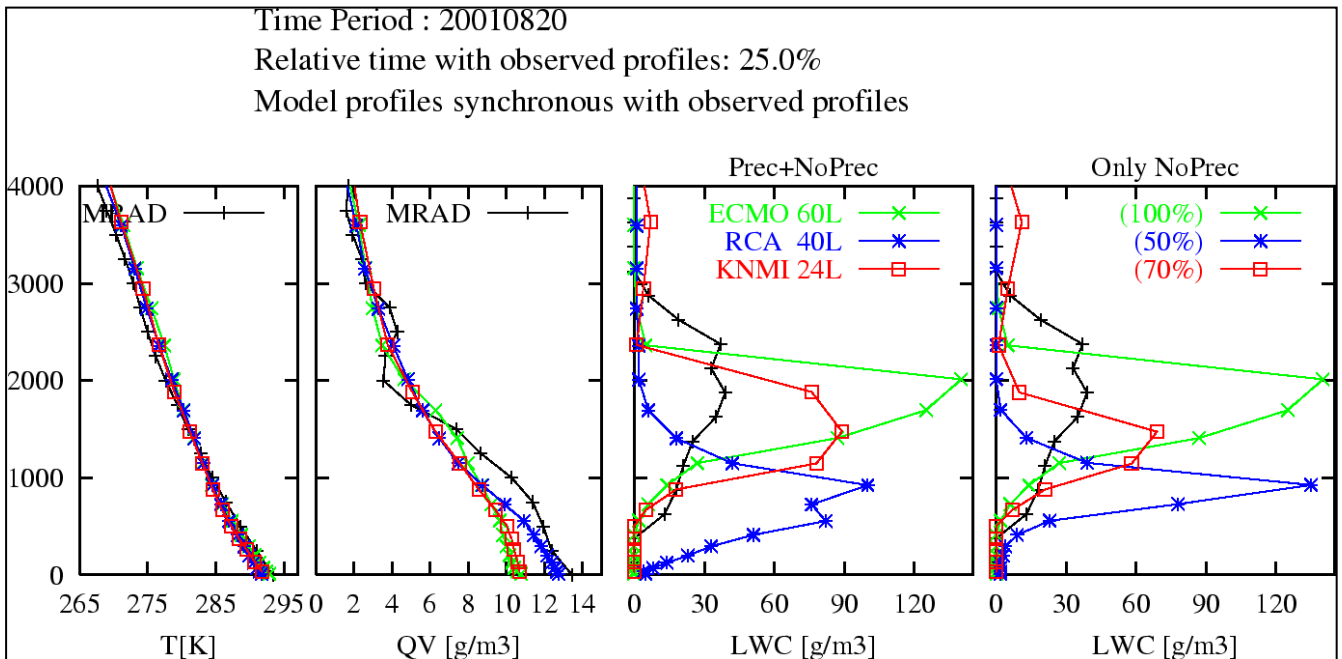


20 August 2001

Time Period : 20010820 ; Relative time with observed profiles: 25.0%

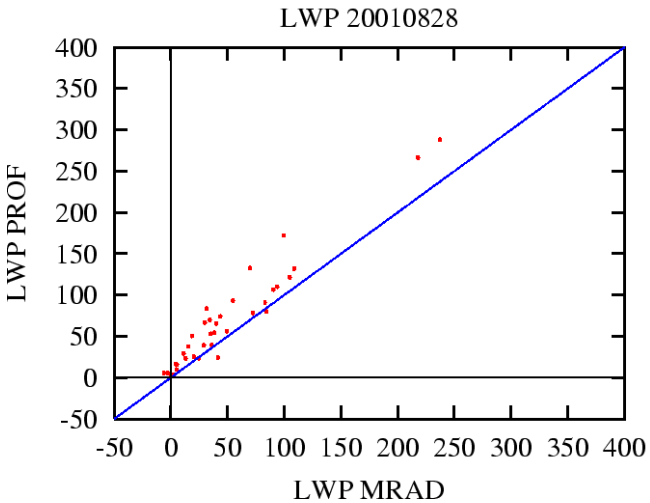


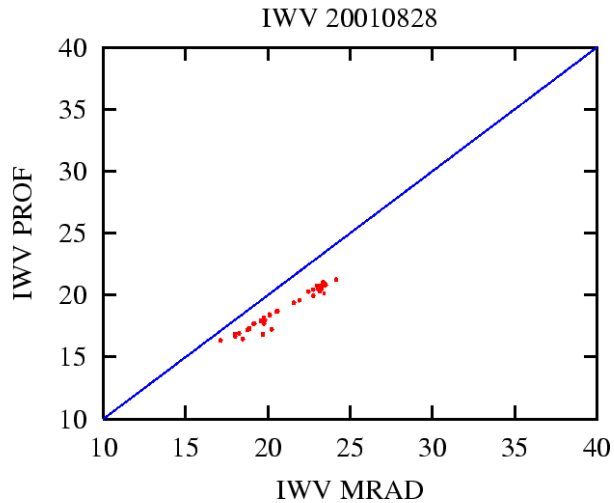


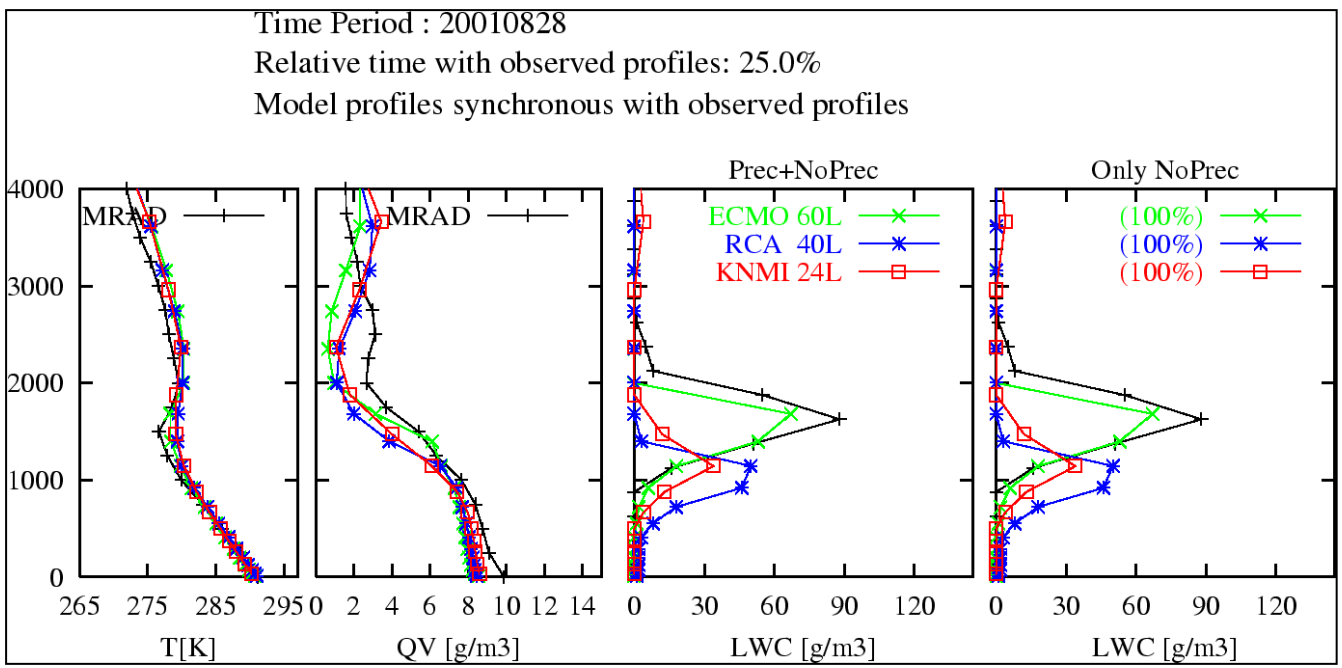


28 August 2001

Time Period : 20010828 ; Relative time with observed profiles: 25.0%

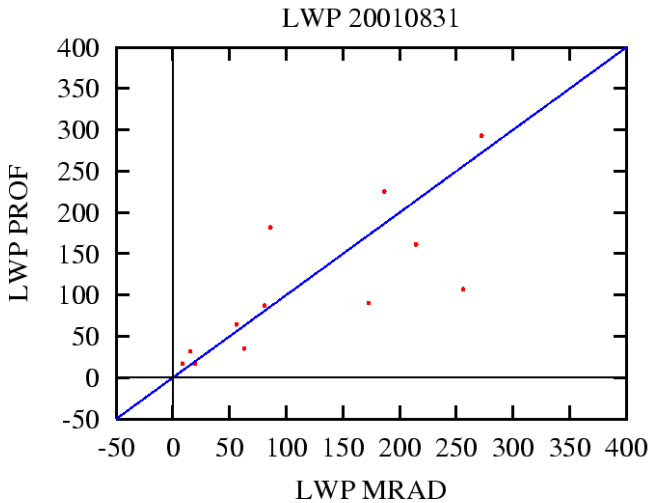


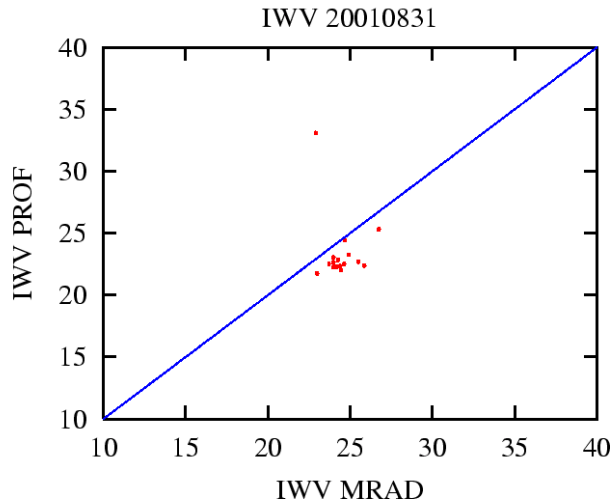


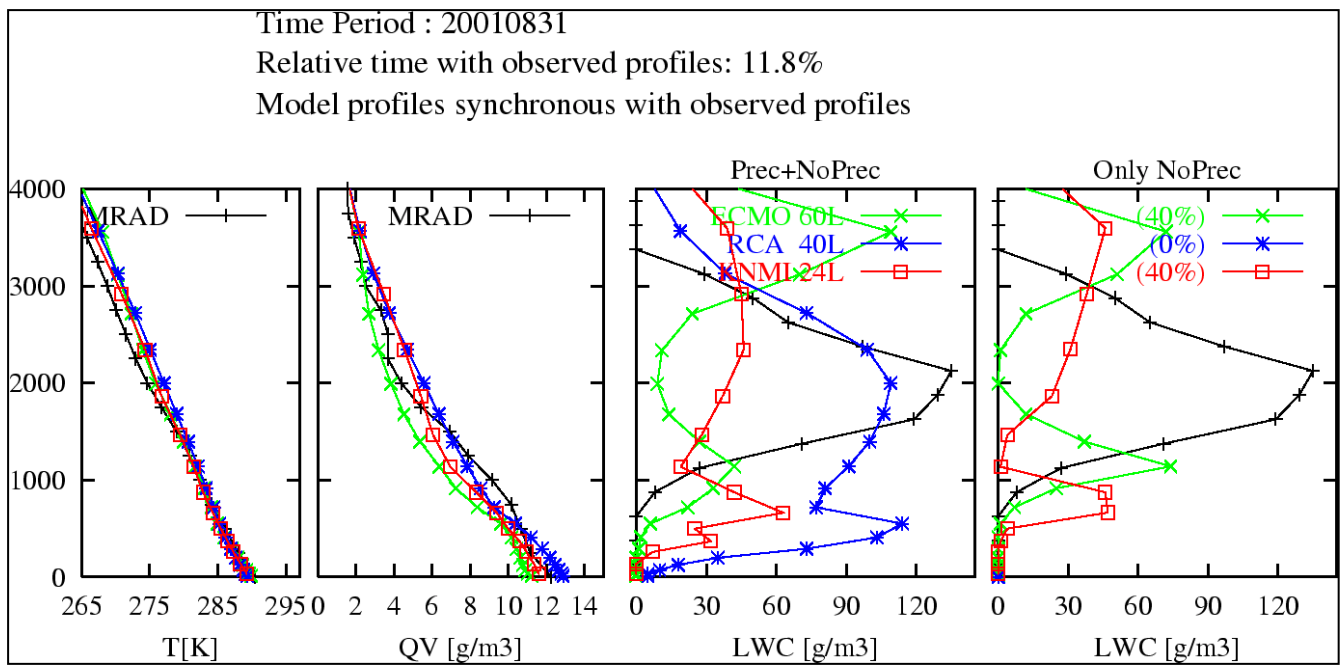


31 August 2001

Time Period : 20010831 ; Relative time with observed profiles: 11.8%

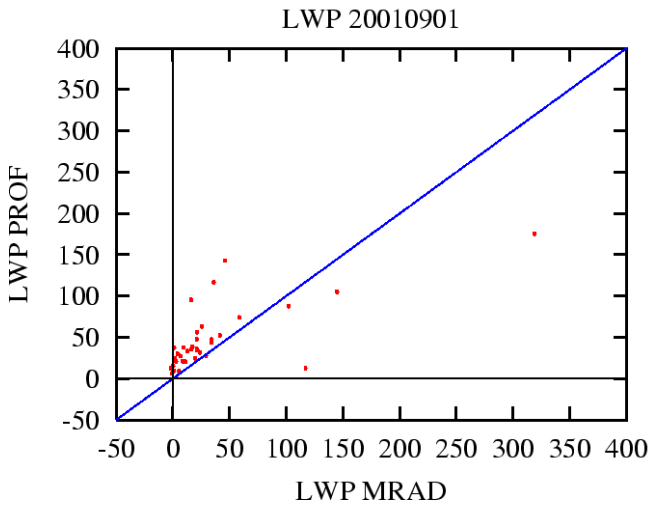


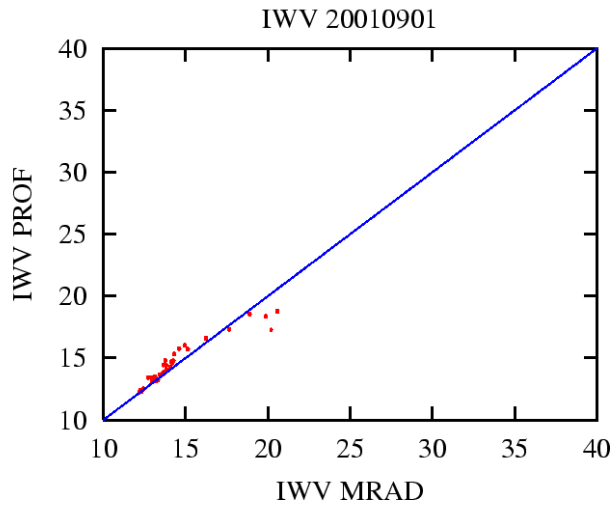


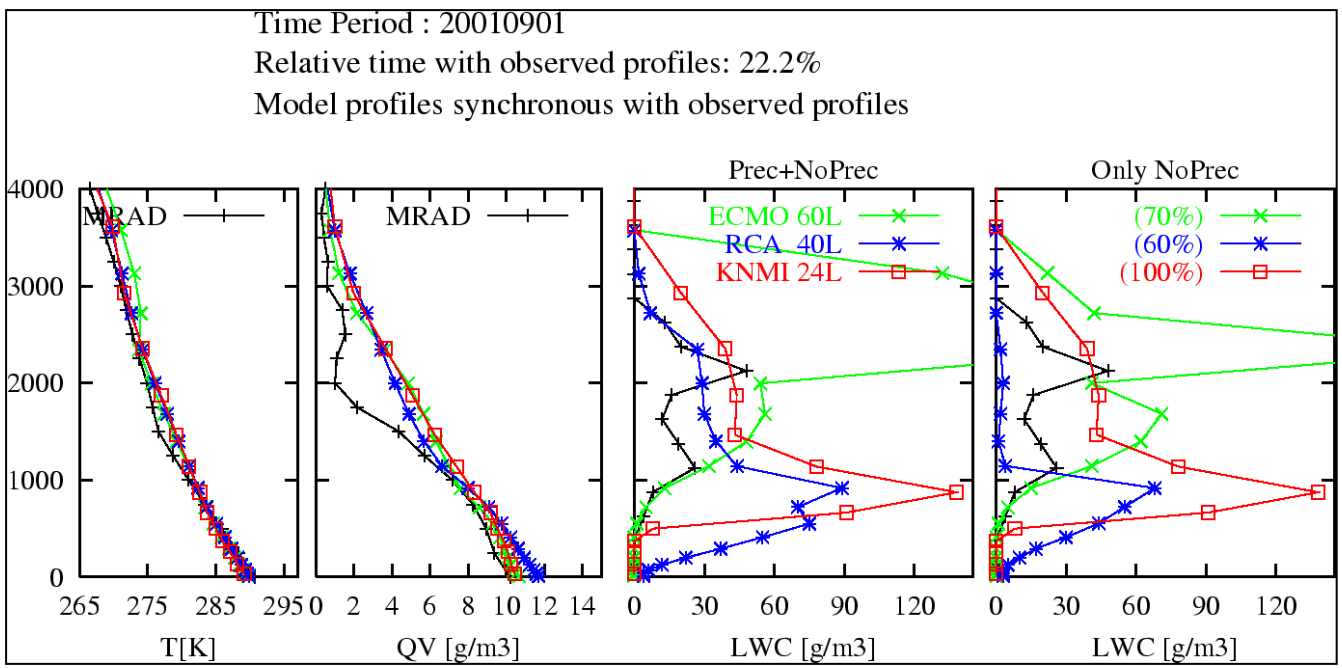


1 September 2001

Time Period : 20010901 ; Relative time with observed profiles: 22.2%

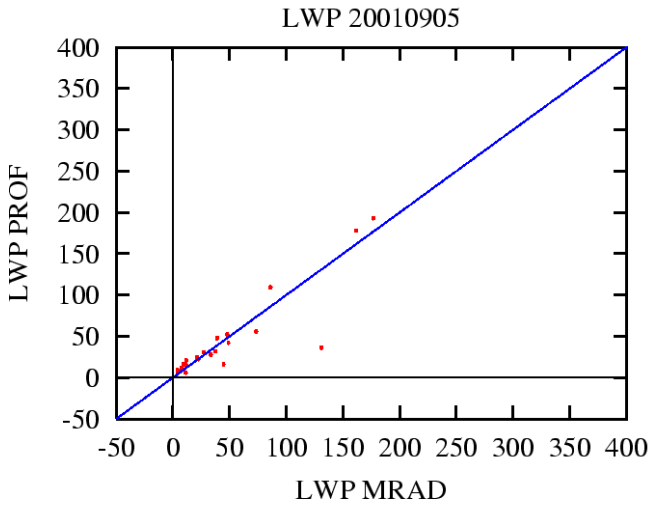


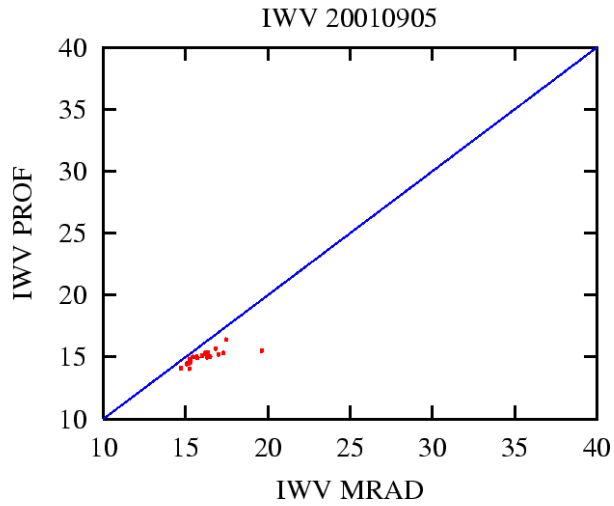


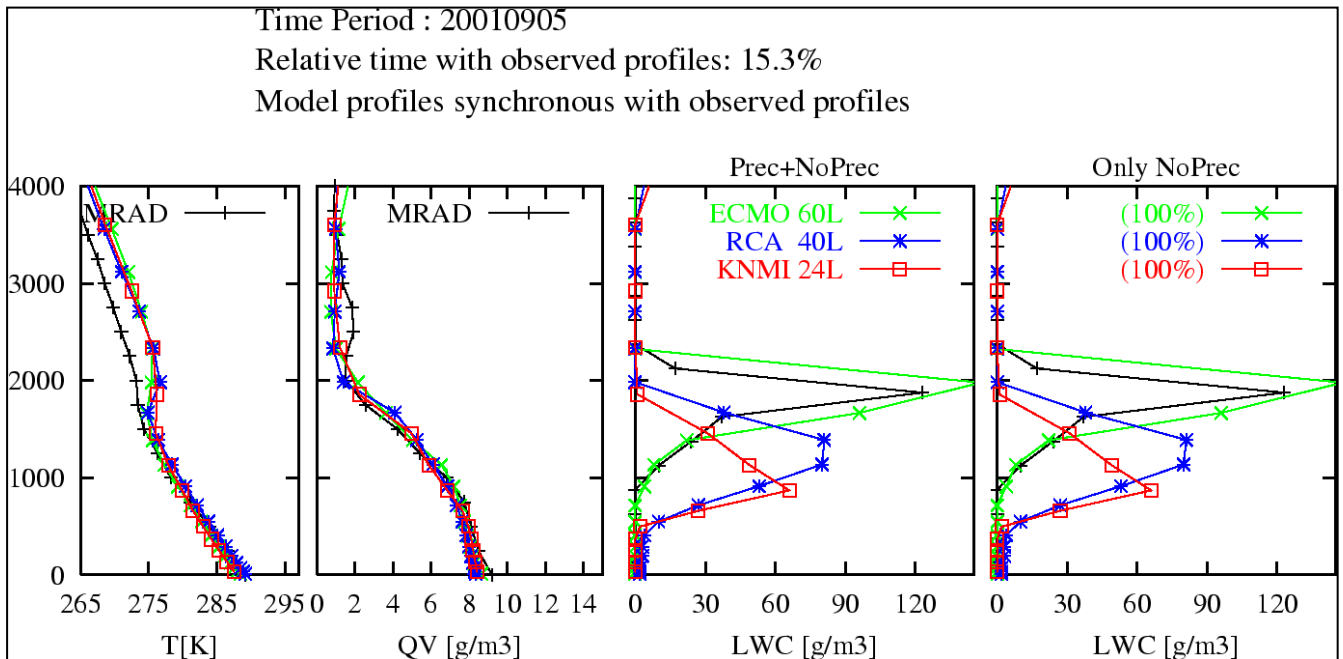


5 September 2001

Time Period : 20010905 ; Relative time with observed profiles: 15.3%

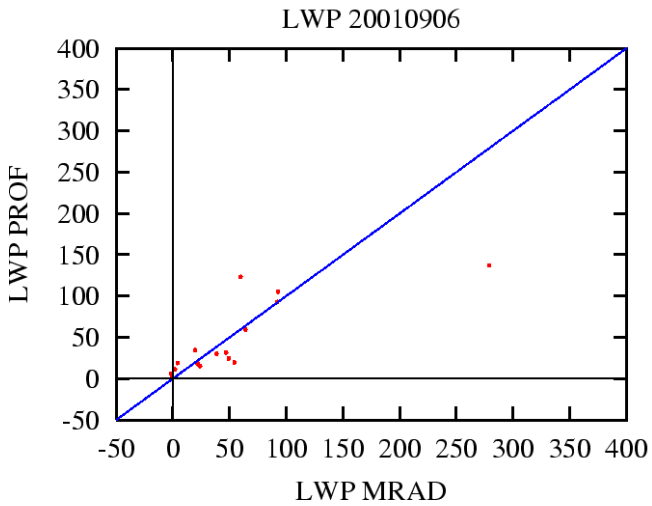


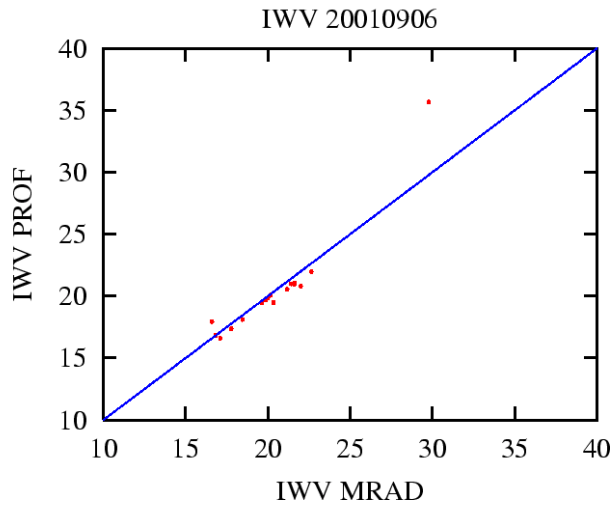


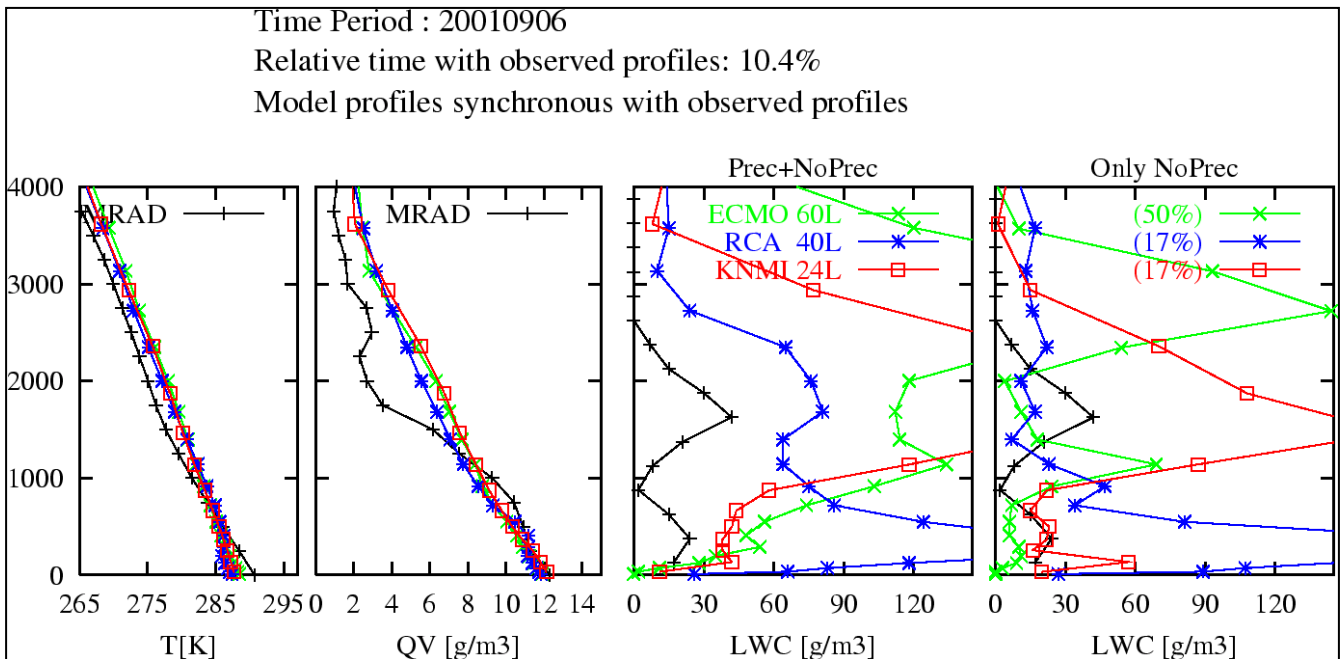


6 September 2001

Time Period : 20010906 ; Relative time with observed profiles: 10.4%

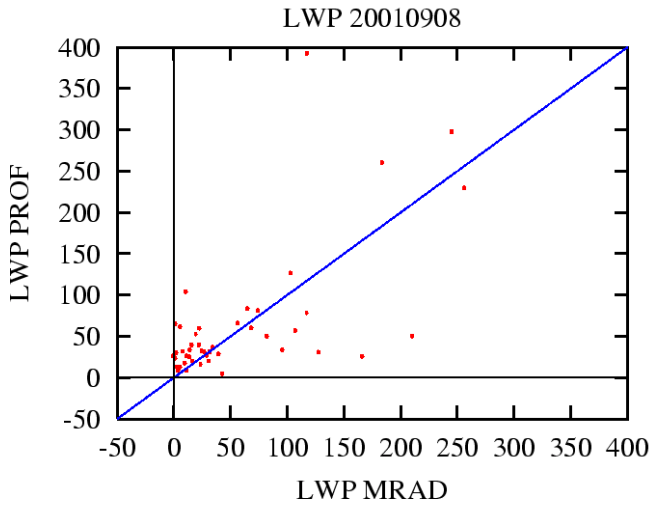


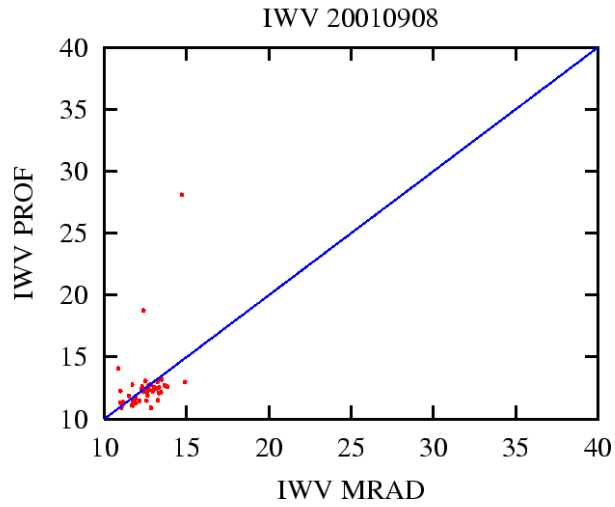


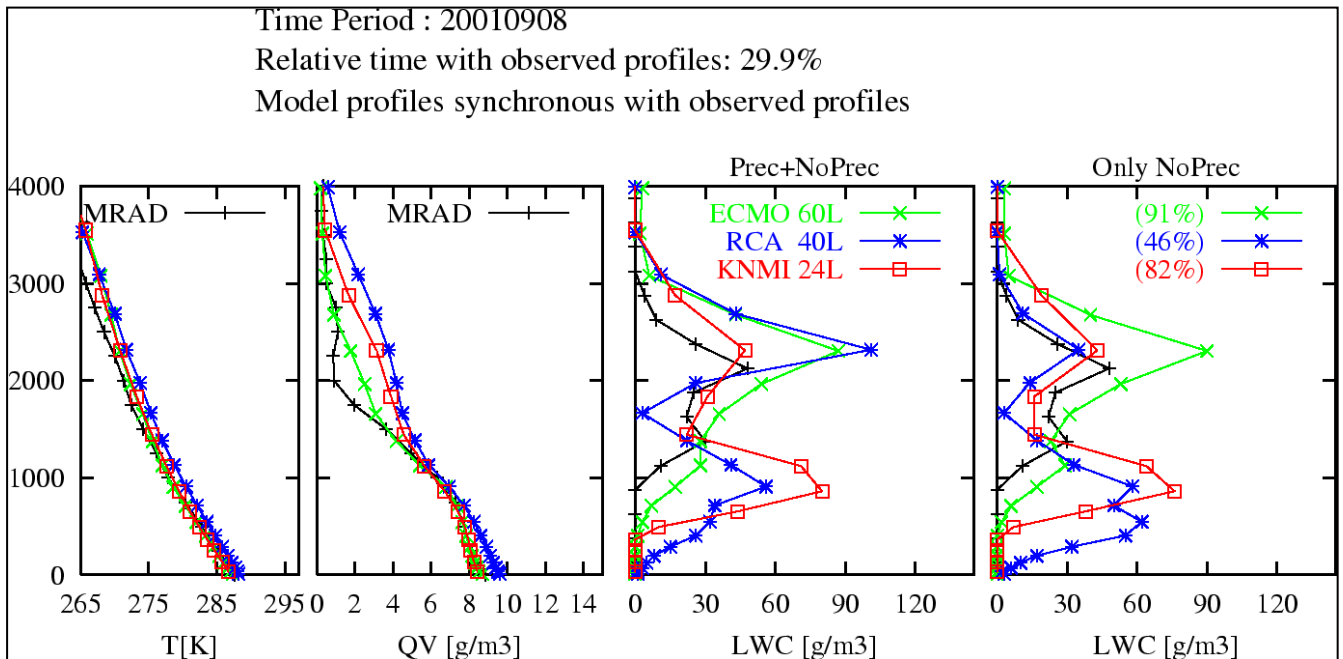


8 September 2001

Time Period : 20010908 ; Relative time with observed profiles: 29.9%

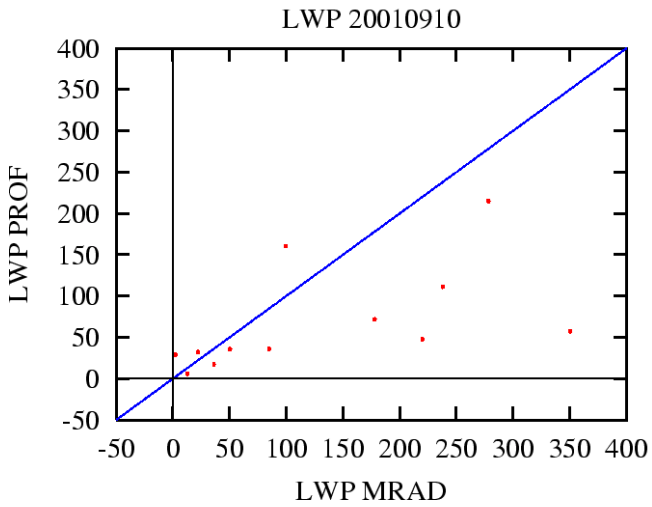


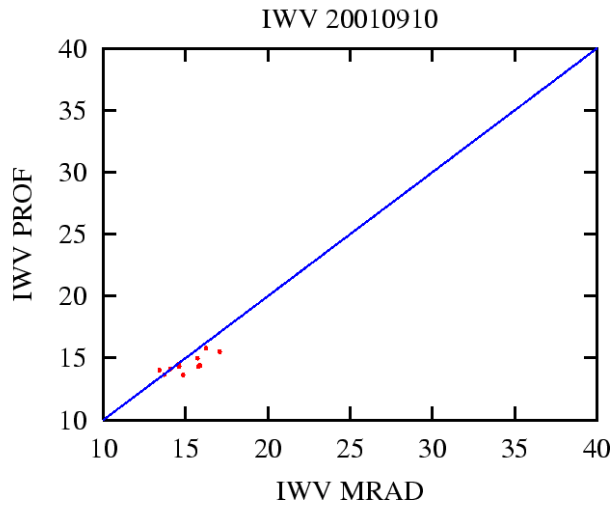


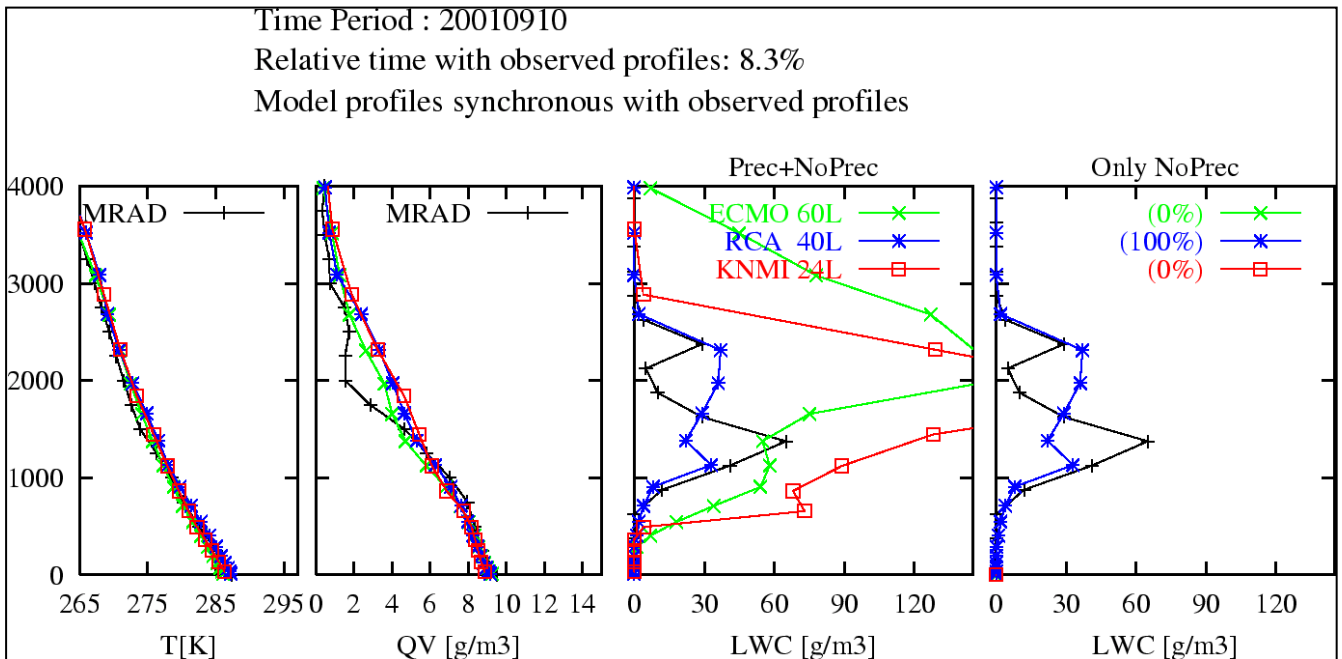


10 September 2001

Time Period : 20010910 ; Relative time with observed profiles: 8.3%

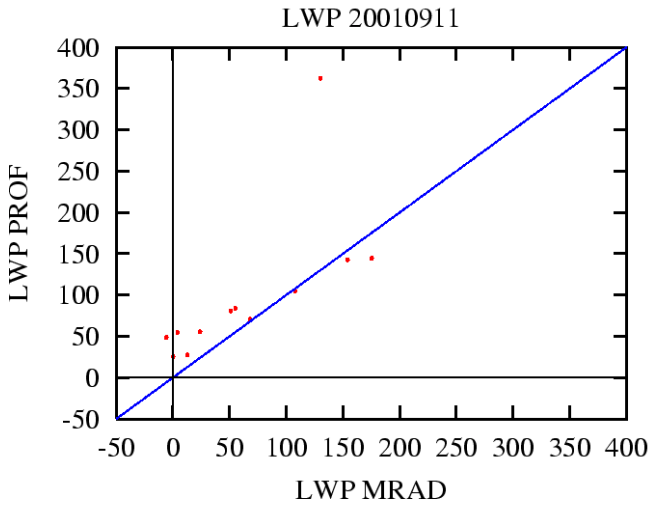


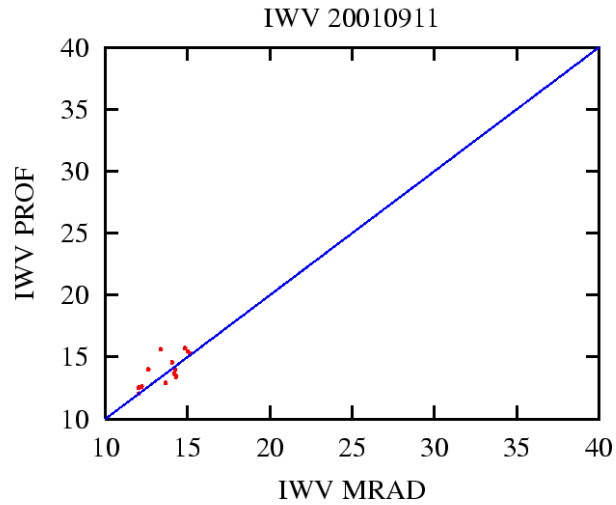


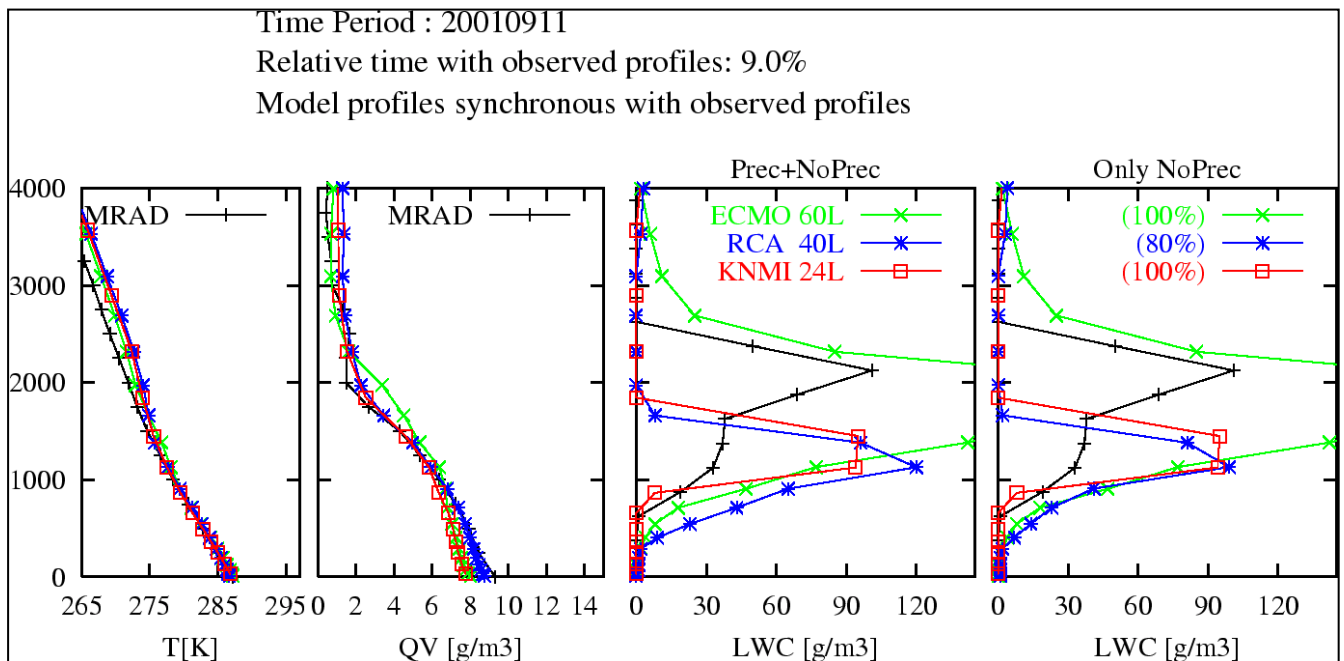


11 September 2001

Time Period : 20010911 ; Relative time with observed profiles: 9.0%

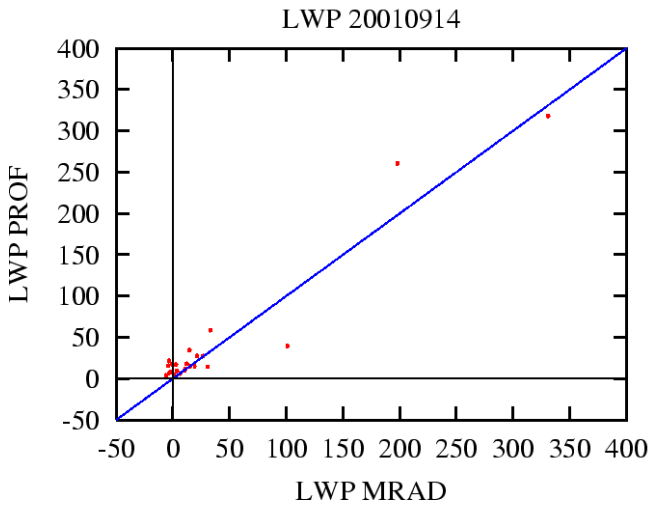


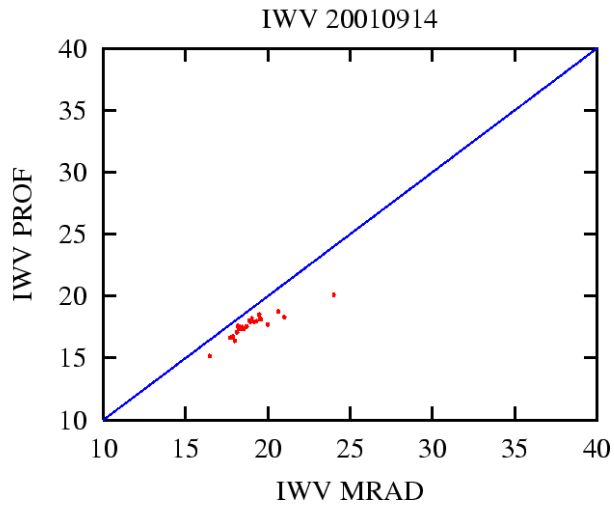


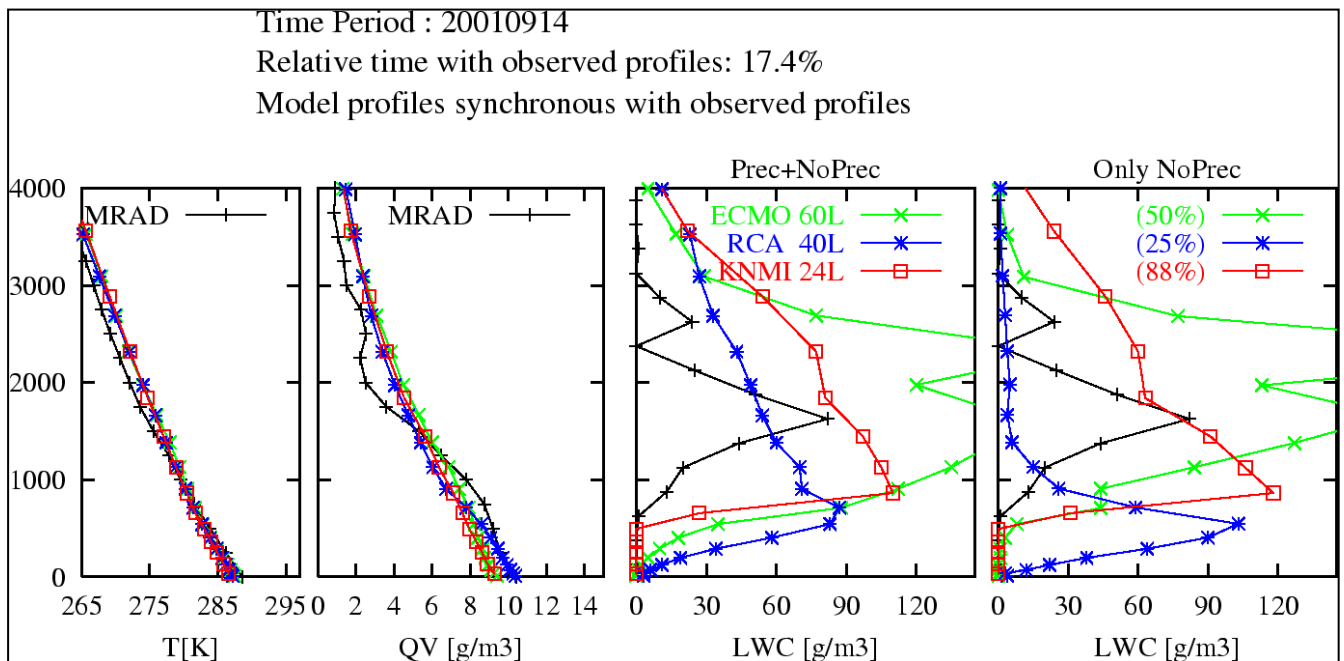


14 September 2001

Time Period : 20010914 ; Relative time with observed profiles: 17.4%

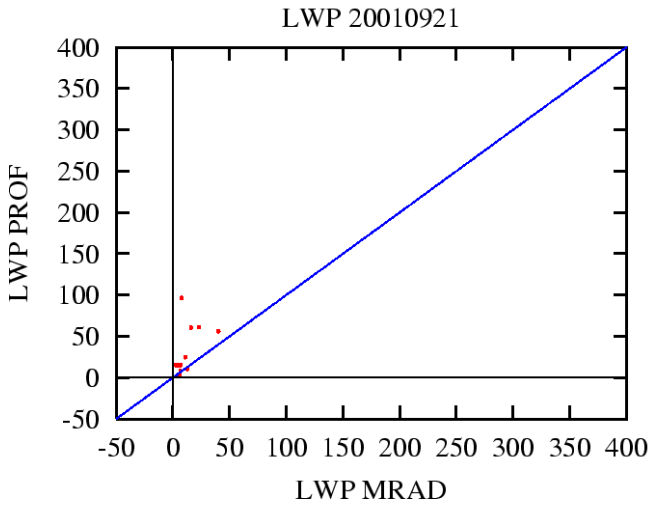


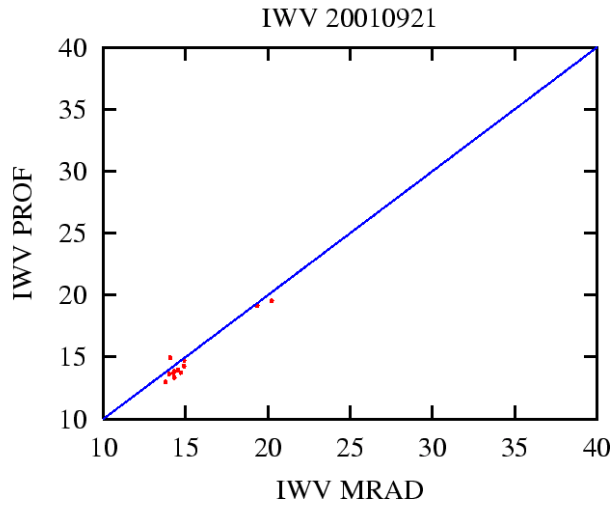


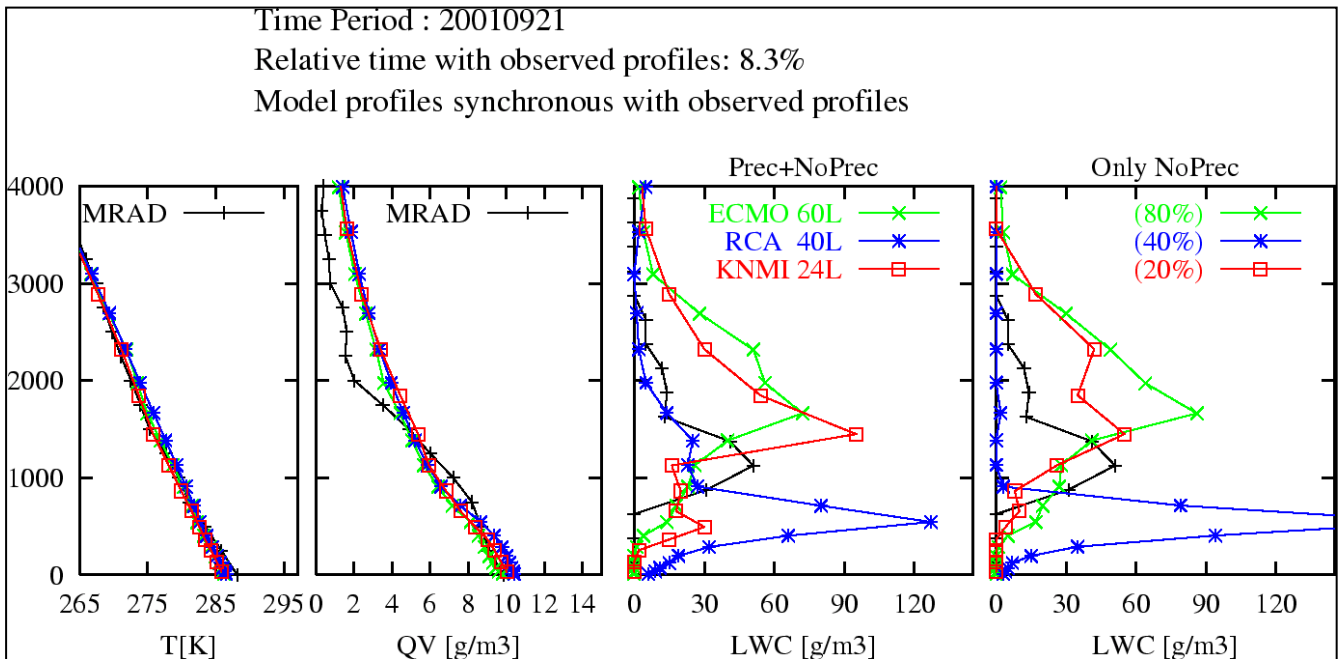


21 September 2001

Time Period : 20010921 ; Relative time with observed profiles: 8.3%

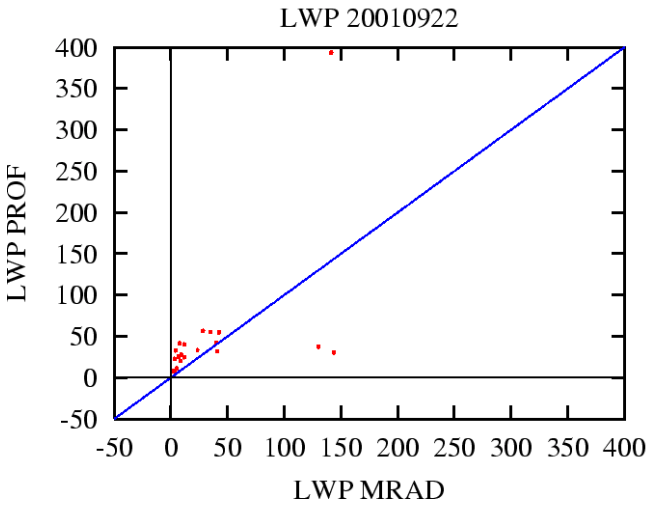


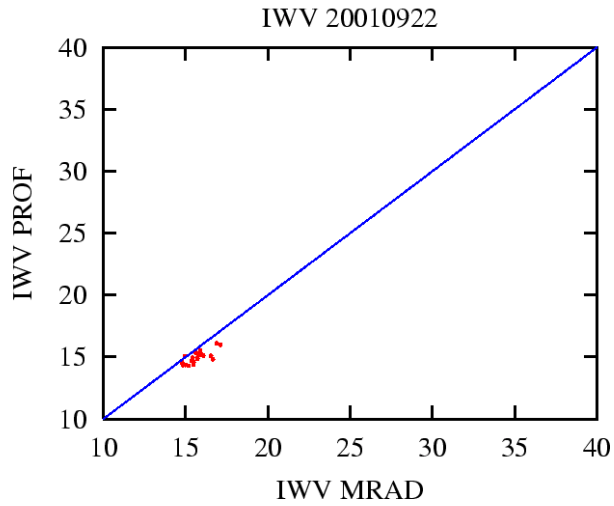


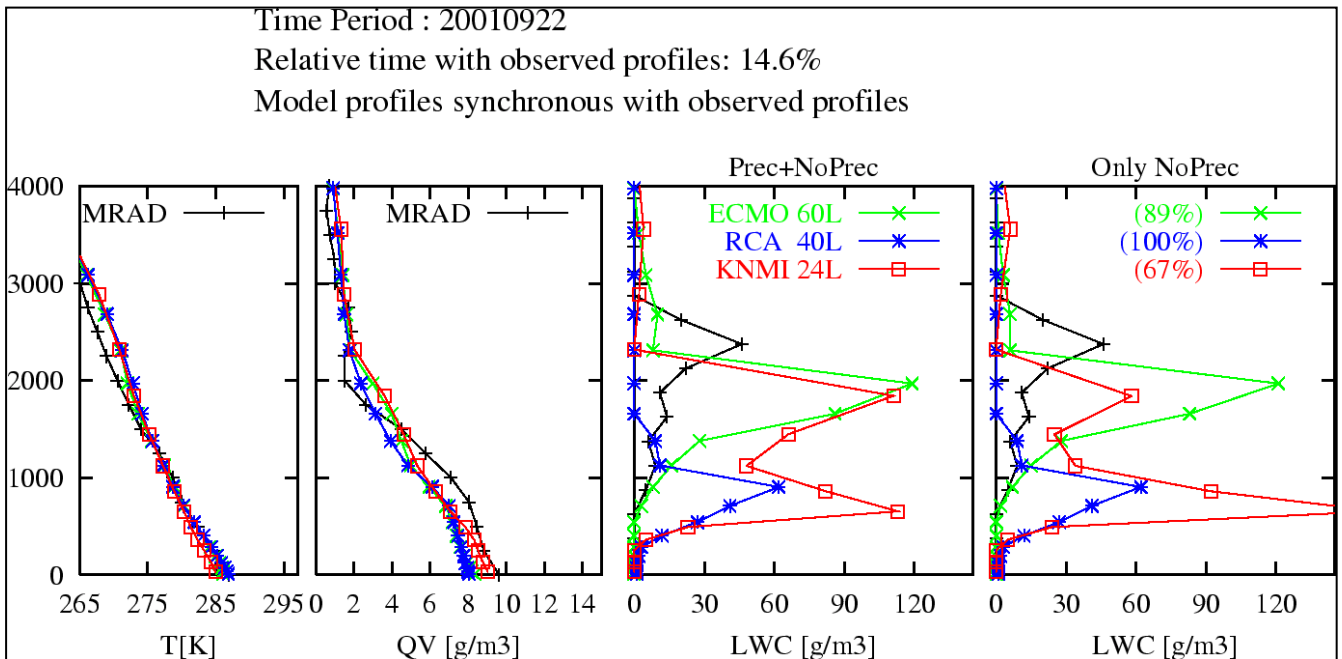


22 September 2001

Time Period : 20010922 ; Relative time with observed profiles: 14.6%

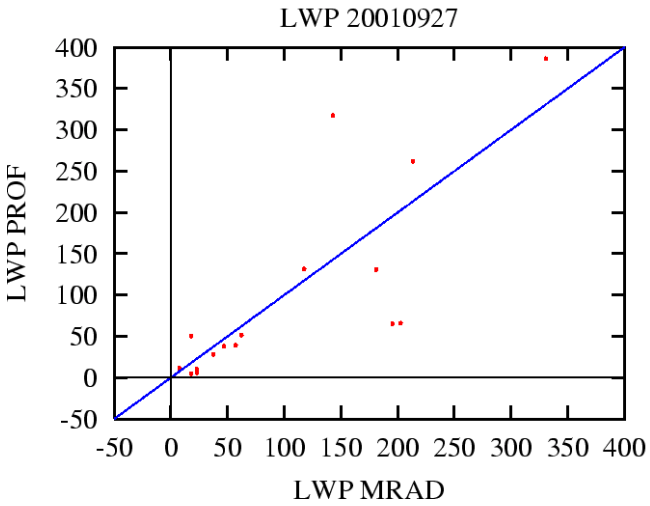


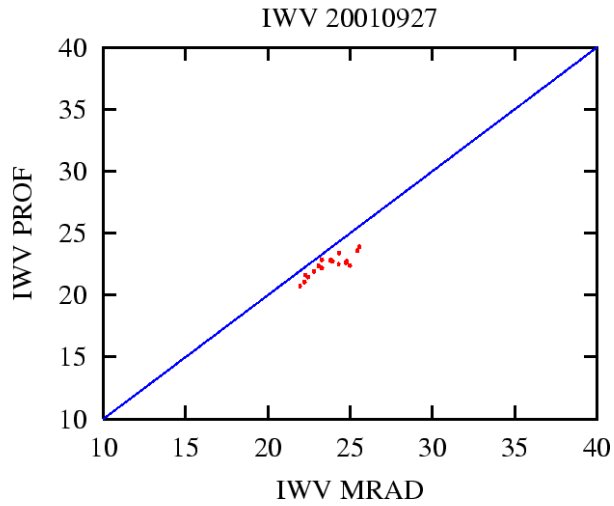


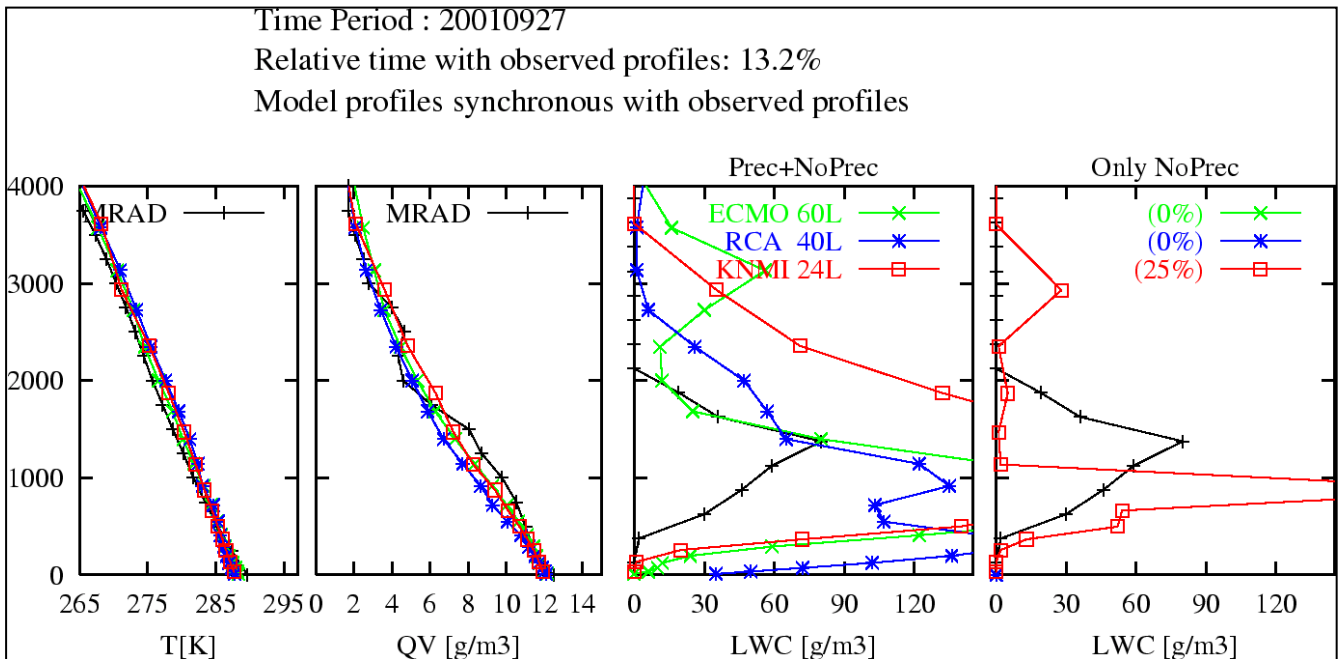


27 September 2001

Time Period : 20010927 ; Relative time with observed profiles: 13.2%

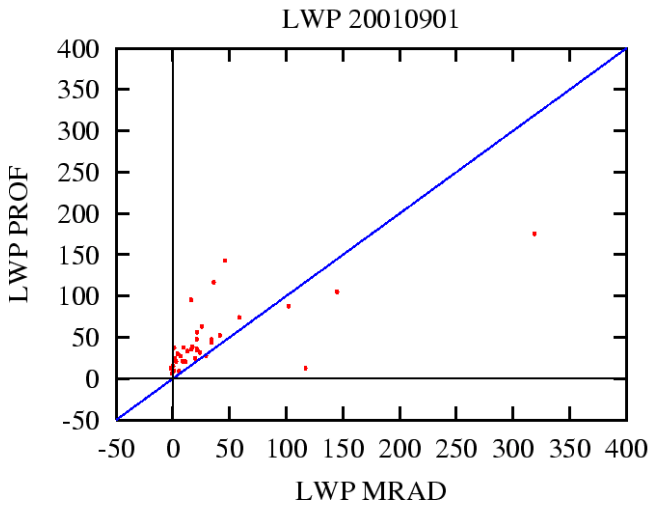


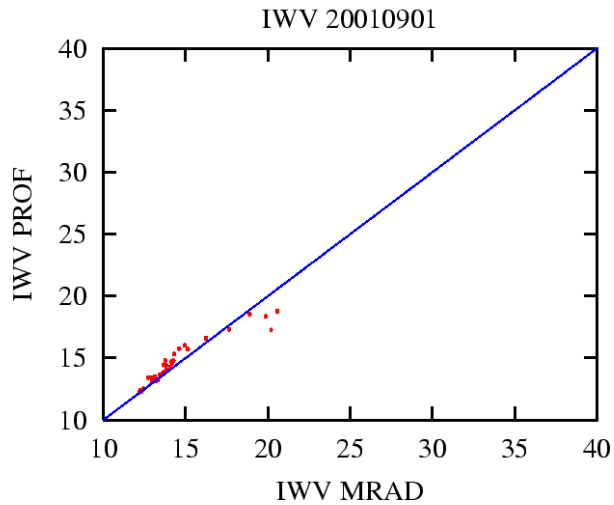


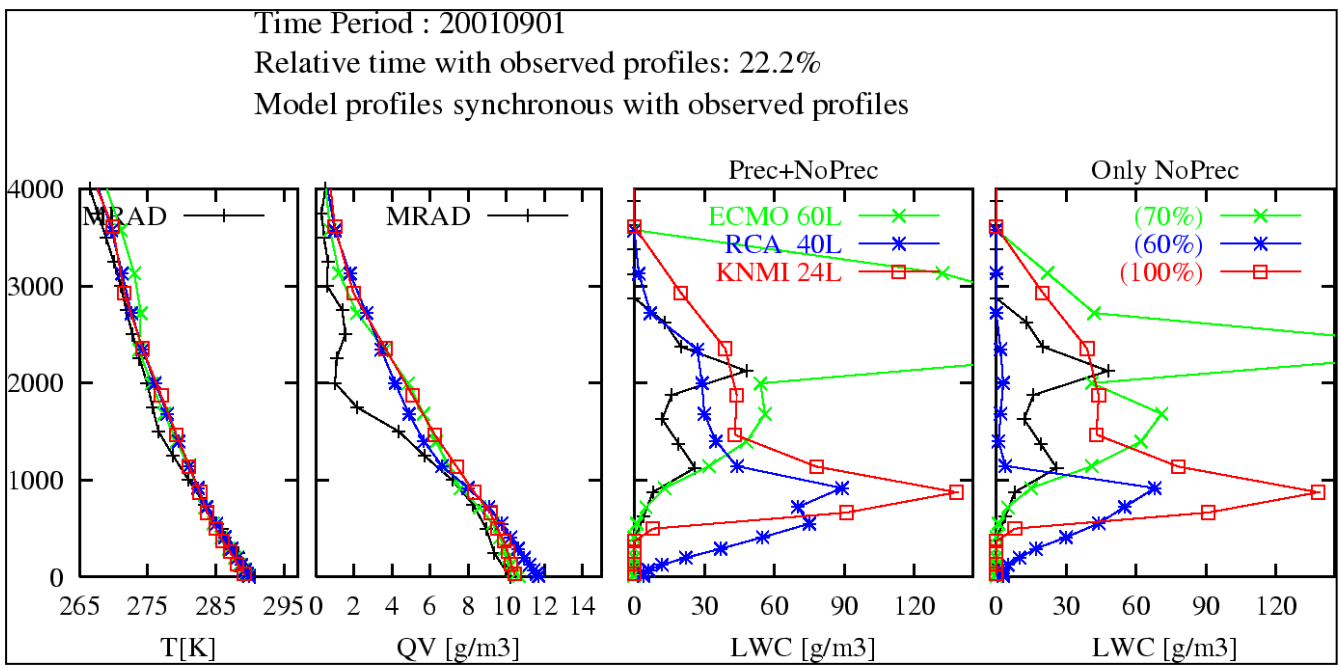


1 September 2001

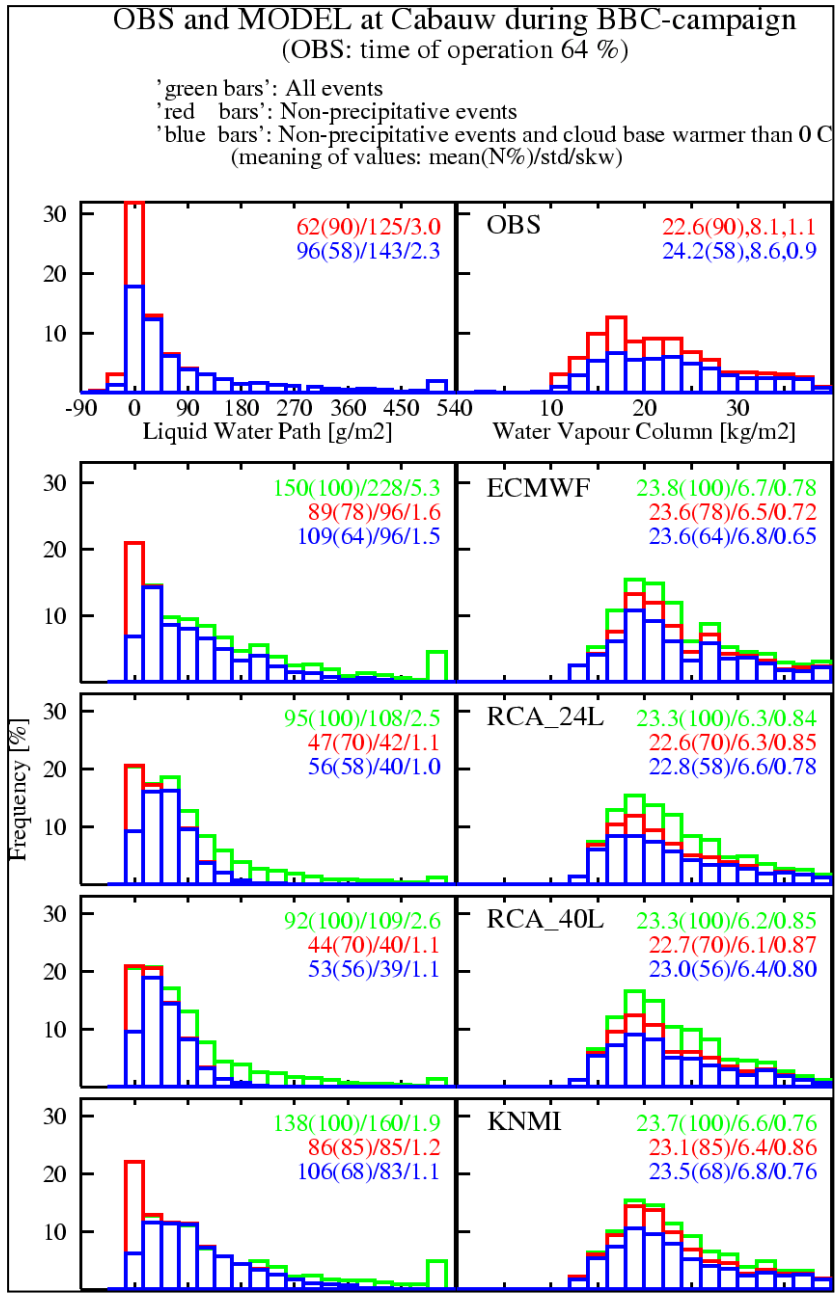
Time Period : 20010901 ; Relative time with observed profiles: 22.2%

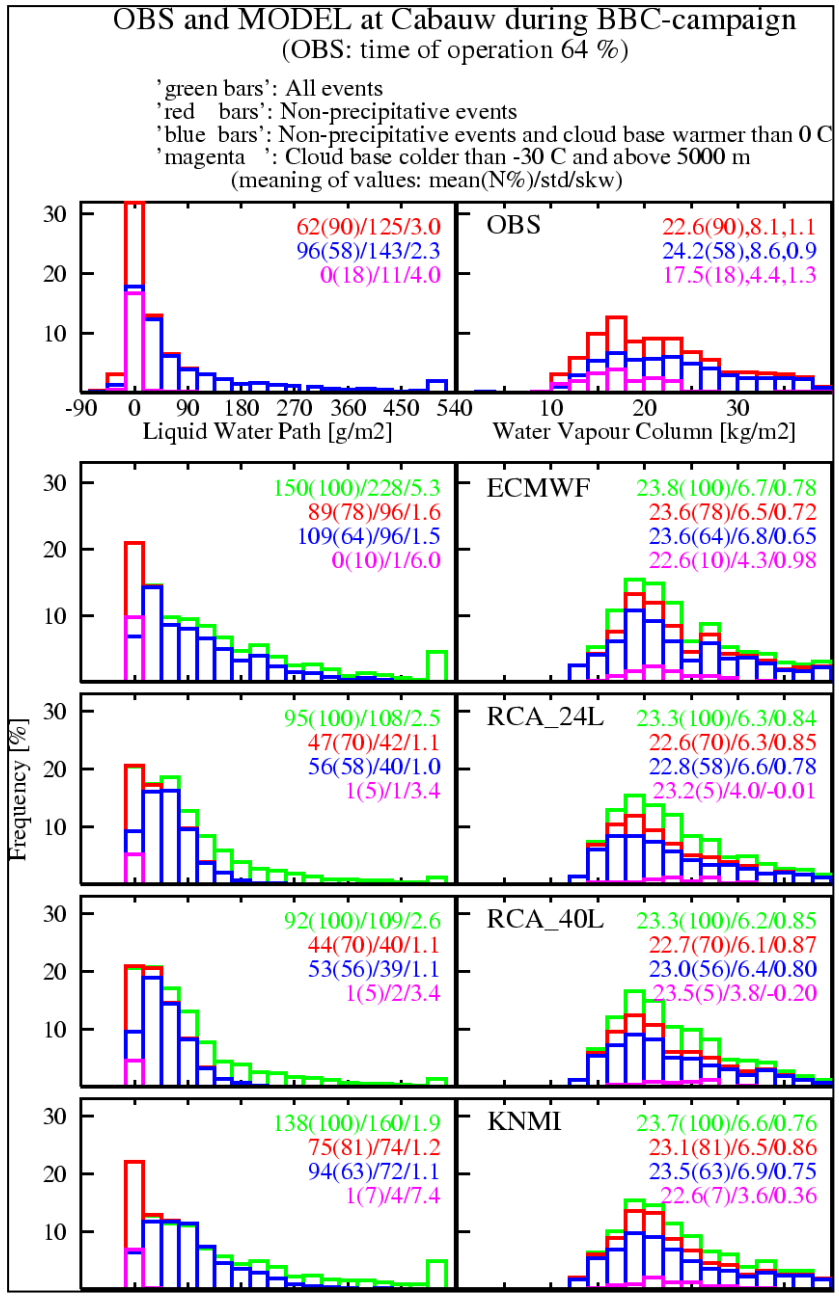






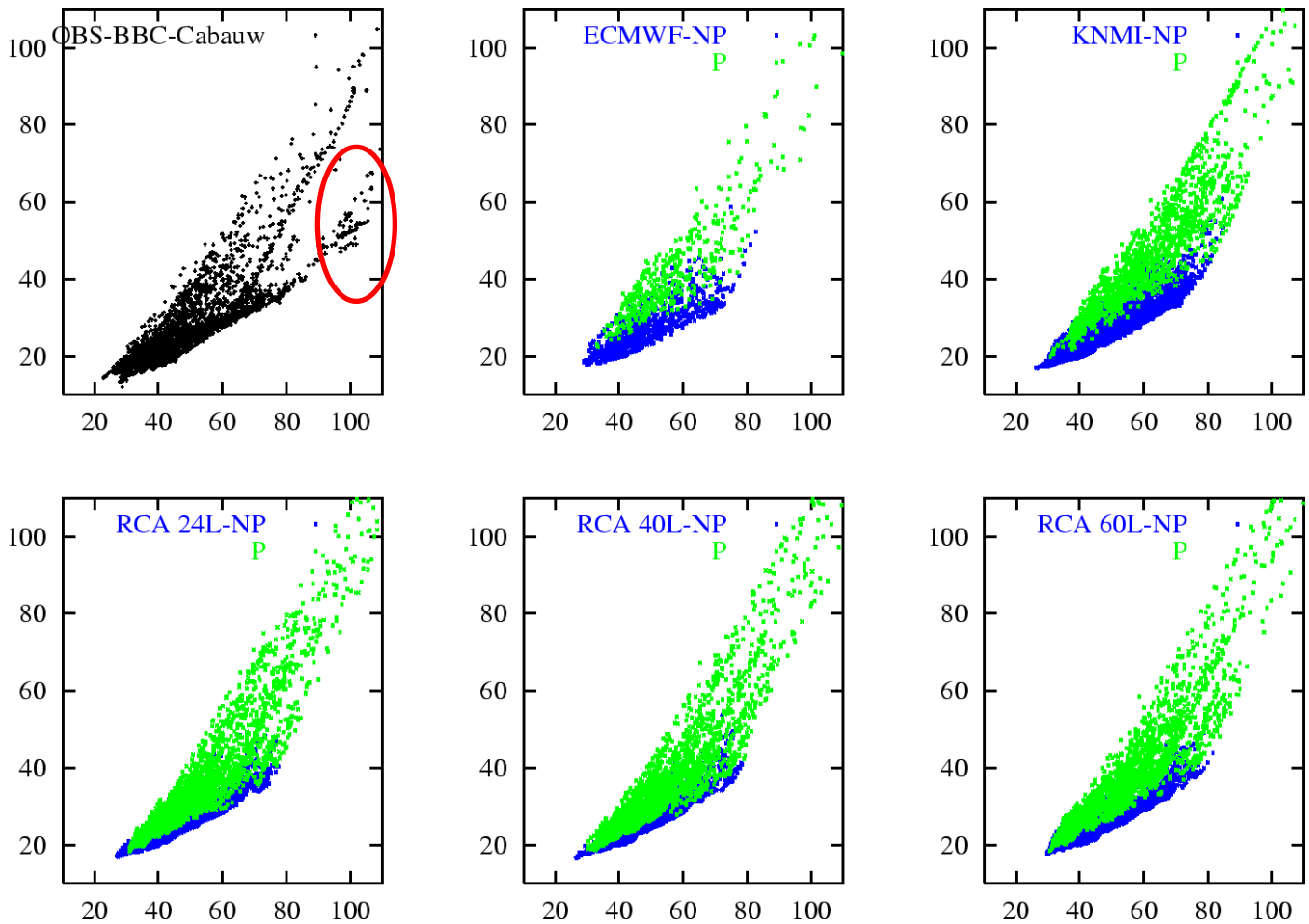
Simulation of brightness temperatures with Liebe 1993 algorithm

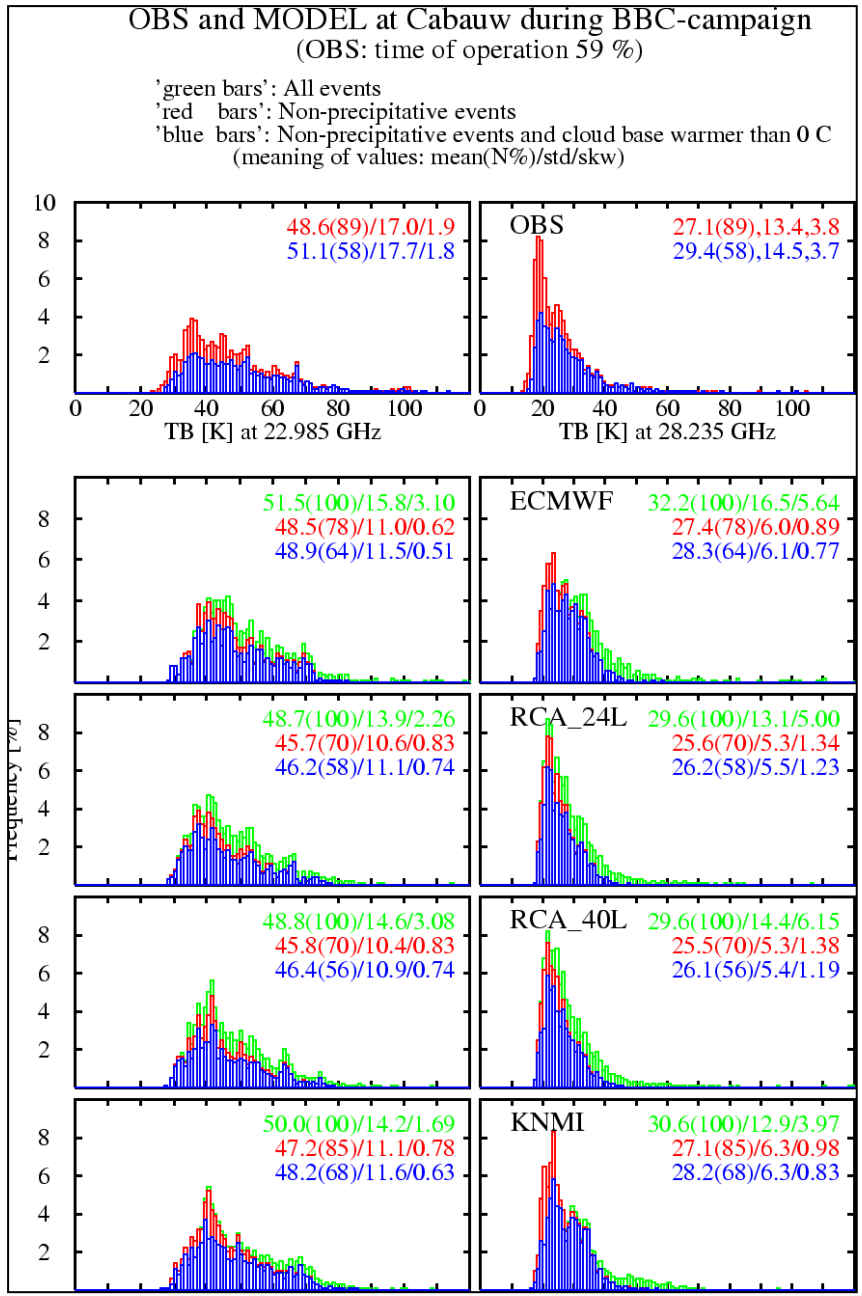

OBS and MODEL at Cabauw during BBC-campaign
(OBS: time of operation 64 %)
'green bars': All events
'red bars': Non-precipitative events
'blue bars': Non-precipitative events and cloud base warmer than 0 C
(meaning of values: mean(N%)/std/skw)
62(90)/125/3.0
96(58)/143/2.3
OBS
22.6(90),8.1,1.1
24.2(58),8.6,0.9
Liquid Water Path [g/m2]
Water Vapour Column [kg/m2]
150(100)/228/5.3
89(78)/96/1.6
109(64)/96/1.5
ECMWF
23.8(100)/6.7/0.78
23.6(78)/6.5/0.72
23.6(64)/6.8/0.65
95(100)/108/2.5
47(70)/42/1.1
56(58)/40/1.0
RCA_24L
23.3(100)/6.3/0.84
22.6(70)/6.3/0.85
22.8(58)/6.6/0.78
92(100)/109/2.6
44(70)/40/1.1
53(56)/39/1.1
RCA_40L
23.3(100)/6.2/0.85
22.7(70)/6.1/0.87
23.0(56)/6.4/0.80
138(100)/160/1.9
86(85)/85/1.2
106(68)/83/1.1
KNMI
23.7(100)/6.6/0.76
23.1(85)/6.4/0.86
23.5(68)/6.8/0.76
Frequency [%]

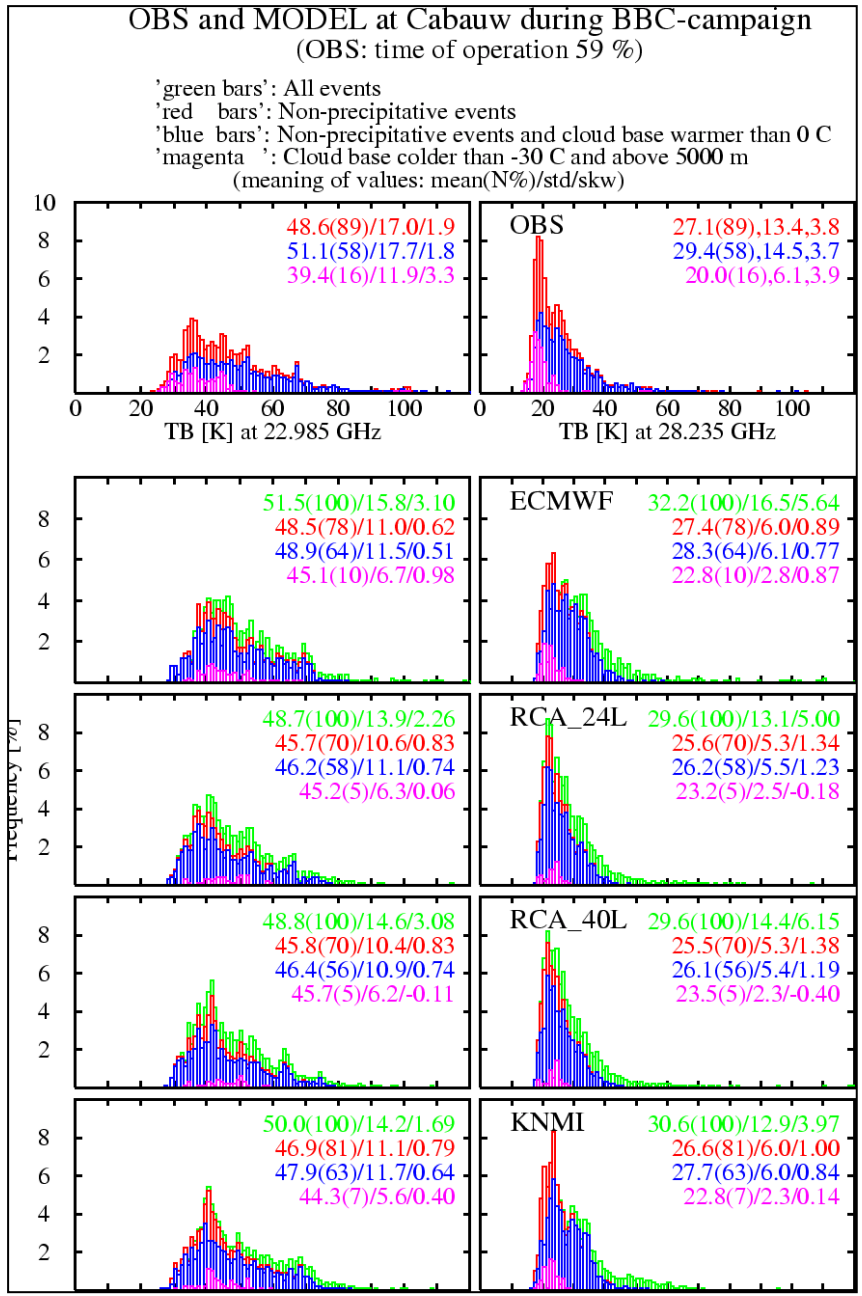

OBS and MODEL at Cabauw during BBC-campaign
(OBS: time of operation 64 %)
'green bars': All events
'red bars': Non-precipitative events
'blue bars': Non-precipitative events and cloud base warmer than 0 C
'magenta ': Cloud base colder than -30 C and above 5000 m
(meaning of values: mean(N%)/std/skw)
62(90)/125/3.0
96(58)/143/2.3
0(18)/11/4.0
OBS
22.6(90),8.1,1.1
24.2(58),8.6,0.9
17.5(18),4.4,1.3
Liquid Water Path [g/m2]
Water Vapour Column [kg/m2]
150(100)/228/5.3
89(78)/96/1.6
109(64)/96/1.5
0(10)/1/6.0
ECMWF
23.8(100)/6.7/0.78
23.6(78)/6.5/0.72
23.6(64)/6.8/0.65
22.6(10)/4.3/0.98
95(100)/108/2.5
47(70)/42/1.1
56(58)/40/1.0
1(5)/1/3.4
RCA_24L
23.3(100)/6.3/0.84
22.6(70)/6.3/0.85
22.8(58)/6.6/0.78
23.2(5)/4.0/-0.01
92(100)/109/2.6
44(70)/40/1.1
53(56)/39/1.1
1(5)/2/3.4
RCA_40L
23.3(100)/6.2/0.85
22.7(70)/6.1/0.87
23.0(56)/6.4/0.80
23.5(5)/3.8/-0.20
138(100)/160/1.9
75(81)/74/1.2
94(63)/72/1.1
1(7)/4/7.4
KNMI
23.7(100)/6.6/0.76
23.1(81)/6.5/0.86
23.5(63)/6.9/0.75
22.6(7)/3.6/0.36
Frequency [%]

Horizontal axis: TB1 (22.985 GHz)

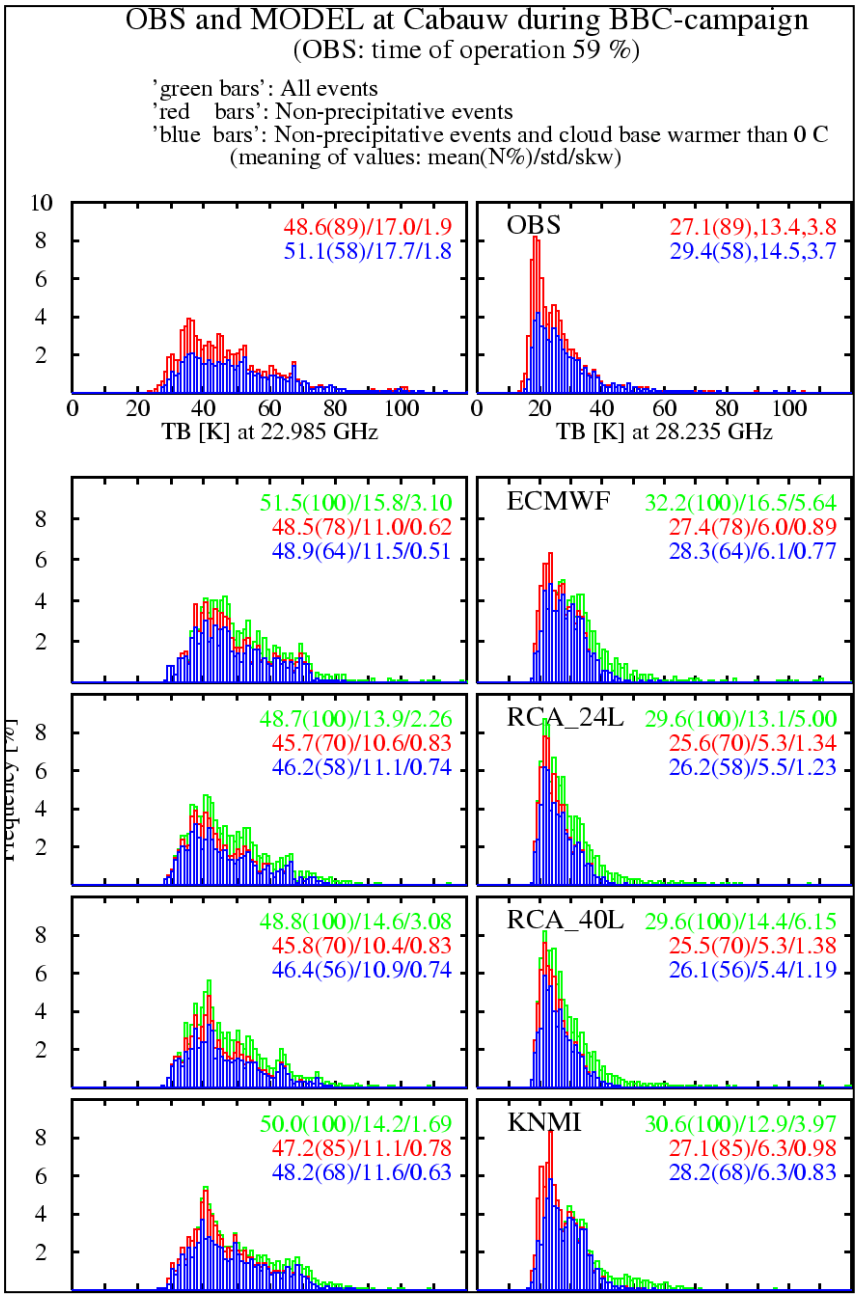
Vertical axis: TB2 (28.235 GHz)

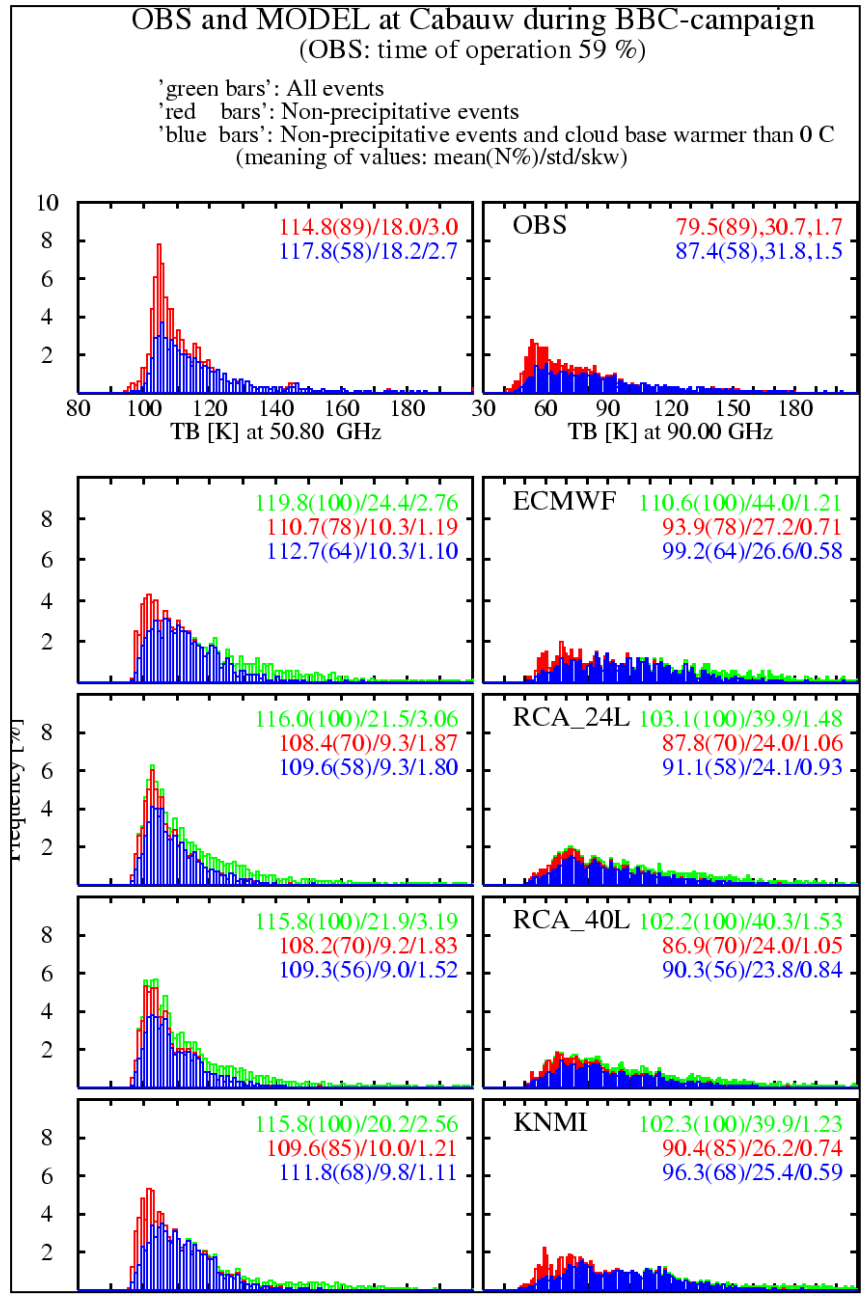



OBS and MODEL at Cabauw during BBC-campaign
(OBS: time of operation 59 %)
'green bars': All events
'red bars': Non-precipitative events
'blue bars': Non-precipitative events and cloud base warmer than 0 C
(meaning of values: mean(N%)/std/skw)
48.6(89)/17.0/1.9
51.1(58)/17.7/1.8
OBS
27.1(89),13.4,3.8
29.4(58),14.5,3.7
TB [K] at 22.985 GHz
TB [K] at 28.235 GHz
51.5(100)/15.8/3.10
48.5(78)/11.0/0.62
48.9(64)/11.5/0.51
ECMWF
32.2(100)/16.5/5.64
27.4(78)/6.0/0.89
28.3(64)/6.1/0.77
48.7(100)/13.9/2.26
45.7(70)/10.6/0.83
46.2(58)/11.1/0.74
RCA_24L
29.6(100)/13.1/5.00
25.6(70)/5.3/1.34
26.2(58)/5.5/1.23
48.8(100)/14.6/3.08
45.8(70)/10.4/0.83
46.4(56)/10.9/0.74
RCA_40L
29.6(100)/14.4/6.15
25.5(70)/5.3/1.38
26.1(56)/5.4/1.19
50.0(100)/14.2/1.69
47.2(85)/11.1/0.78
48.2(68)/11.6/0.63
KNMI
30.6(100)/12.9/3.97
27.1(85)/6.3/0.98
28.2(68)/6.3/0.83
Frequency (%)


OBS and MODEL at Cabauw during BBC-campaign
(OBS: time of operation 59 %)
'green bars': All events
'red bars': Non-precipitative events
'blue bars': Non-precipitative events and cloud base warmer than 0 C
'magenta ': Cloud base colder than -30 C and above 5000 m
(meaning of values: mean(N%)/std/skw)
48.6(89)/17.0/1.9
51.1(58)/17.7/1.8
39.4(16)/11.9/3.3
OBS
27.1(89),13.4,3.8
29.4(58),14.5,3.7
20.0(16),6.1,3.9
TB [K] at 22.985 GHz
TB [K] at 28.235 GHz
51.5(100)/15.8/3.10
48.5(78)/11.0/0.62
48.9(64)/11.5/0.51
45.1(10)/6.7/0.98
ECMWF
32.2(100)/16.5/5.64
27.4(78)/6.0/0.89
28.3(64)/6.1/0.77
22.8(10)/2.8/0.87
48.7(100)/13.9/2.26
45.7(70)/10.6/0.83
46.2(58)/11.1/0.74
45.2(5)/6.3/0.06
RCA_24L
29.6(100)/13.1/5.00
25.6(70)/5.3/1.34
26.2(58)/5.5/1.23
23.2(5)/2.5/-0.18
48.8(100)/14.6/3.08
45.8(70)/10.4/0.83
46.4(56)/10.9/0.74
45.7(5)/6.2/-0.11
RCA_40L
29.6(100)/14.4/6.15
25.5(70)/5.3/1.38
26.1(56)/5.4/1.19
23.5(5)/2.3/-0.40
50.0(100)/14.2/1.69
46.9(81)/11.1/0.79
47.9(63)/11.7/0.64
44.3(7)/5.6/0.40
KNMI
30.6(100)/12.9/3.97
26.6(81)/6.0/1.00
27.7(63)/6.0/0.84
22.8(7)/2.3/0.14
Frequency (%)

22.985 Ghz 28.235 Ghz 50.80 Ghz 90.00 Ghz





Conclusions

- Averaged over the whole BBC campaign the models put maximum in LWC (liquid water content) at different altitudes. When model events with precipitation are ignored, maximum values in LWC compare reasonably well with those inferred from measurements.