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Numerical modeling of transport of biomass burning emissions on South America

Saulo Ribeiro de Freitas
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Our research efforts have addressed theoretical and numerical modeling of sources emissions and transport processes of trace gases and aerosols emitted by biomass burning on the central of Brazil and Amazon basin. For this effort we coupled an Eulerian transport model with the mesoscale atmospheric model RAMS (Regional Atmospheric Modeling System).

The development work can be described as follows:

(1) We tested the capability of RAMS to simulate the planetary boundary layer and convective systems on the Amazon basin during the dry season. Observed data from RBLE1 experiment, ECMWF and NCEP reanalysis were used as initial and boundary conditions. Comparison between simulations using only ECMWF and NCEP data were done and the results were compared with RBLE1 and AVHRR observations.

2) We improved a source emission parameterization of biomass burning emissions using remote and local observations. Comparison with Earth Probe TOMS aerosol index product, GOES-8 ASADA albedo from UW-Madison/CIMSS and with climatological source emission for carbon monoxide had pointed out the usefulness of the sources emissions parameterization.

3) The convective transport of trace gases by a mesoscale convective system (MCS) in the Amazon basin is explicitly modeled through a numerical simulation with high spatial resolution. The study is carried out using the atmospheric model RAMS (Regional Atmospheric Modeling System). The model configuration was configured with 3 grids with horizontal resolution of 50, 10 and 2.5 km. We used data from Trace_A Experiment (1992) in order to compare the model results to the observed carbon monoxide in the high troposphere transported by a MCS that took place in the Amazon basin (Sep. 26, 1992).

4) We introduced into RAMS a more complex cumulus scheme developed by Dr. George Grell based on an approach of Arakawa and Schubert. This implementation still has some work to be done, but preliminary results have shown several improvements in terms of the location where convection is activated and the intensity of the vertical mass flux. Some efforts will be put in order to couple a convective transport of tracers to this scheme.

Oral presented at: **LBA-Ecology Open Meeting.** Atlanta, February 12-14, 2001

Numerical simulation of planetary boundary layer and convective systems on Amazon basin during dry season

Numerical simulation of planetary boundary layer (PBL) development and deep and moist convective systems on Amazon basin using the Regional Atmospheric Modeling System (RAMS) is presented. The study was carried on for the period of TRACE-A experiment. ECMWF and NCEP reanalysis were used to supply initial and boundary conditions. Comparison of the reanalysis data with radiosondes showed that both models have much more moisture in PBL and troposphere than observation, causing the model RAMS simulate a PBL with stratocumulus that does not appears on observations and convective systems on wrong space and time. Simulations of PBL development on forest and savanna areas are showed using both reanalysis and are compared with RBLE1 observations. For simulation of a mesoscale convective system that took place over Central Brazil on September 26, 1992, the effects of using different reanalysis assimilated by RAMS with several time scales of nudging process are showed. The Fig. 1 shows some thermodynamic profiles simulated and observed on forest. Figs. 2 and 3 show the energy budget simulated with ECMWF data and compare with the observation of RBLE1 experiment.

Oral presented at: **LBA-Ecology Open Meeting.** Atlanta, February 12-14, 2001

Regional numerical modeling of transport of biomass burning emissions on South America

A study about the atmospheric transport of biomass burning emissions in the Amazon and the Central of Brazil is presented. This study is carried out throught a numerical simulation of the atmospheric motions using the atmospheric model RAMS (Regional Atmospheric Modeling System). In this method the mass conservation equation is resolved for CO_2, CO and particulate material PM2.5. A model of gases and particles sources emissions is introduced, associated with biomass burning in tropical forest and savanna. The sources are spatially and temporally distributed and daily assimilated, according to the biomass burning spots defined by remote sensing. The advection, in a resolved scale, and turbulent transport, in a sub-grid scale, are resolved using RAMS model parameterizations. A transport sub-grid parameterization, associated to wet and deep circulation not explicitly resolved by the model, due its low spatial resolution, is introduced. Sinks, associated with generic process of removal/transformation of gases/particles, are parameterized and introduced in the mass conservation equation. The methodology is applied to a case study on August and September 1999. Comparison with Earth Probe TOMS aerosol index product, GOES-8 ASADA albedo from UW-Madison/CIMSS and with climatological source emission for CO are made to point out the usefulness of sources emissions parameterization presented here. The Figure 4 shows a comparison between the simulated distribuition of aerosol PM2.5 with the TOMS aerosol index product on September 01, 1999.

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Explicitly Modeling the Vertical Transport of Biomass Burning Emissions by a Mesoscale Convective System on Amazon Basin

The convective transport of trace gases by a mesoscale convective system (MCS) on Amazon basin is explicitly modeled through a numerical simulation with high spatial resolution. The study is carried out using the atmospheric model RAMS (Regional Atmospheric Modeling System). The model configuration was set up with 3 grids with horizontal resolution of 50, 10 and 2.5 km. The resolution of the finer grid should permit the model resolve the main eddies associated with deep convection activity, simulating the transport of pollutants from planetary boundary layer (PBL) to high troposphere. The case study is related to a MCS that took place on September 26, 1992 on Amazon basin, where the PBL was polluted by biomass burning emissions on the previous days. The atmospheric simulations were carried out using ECMWF reanalysis for initial and boundary condition. The initial condition for carbon monoxide (CO) in PBL was defined using profiles obtained by an instrumented aircraft of the TRACE-A experiment and the remote-sensing product 'aerosol index' of TOMS. The simulated thermodynamic and CO vertical profiles inside the MCS and at environment are presented, as well the role of updrafts and downdrafts at the vertical transport of pollutants. Comparison between the CO measured by aircraft at the MCS anvil and modeled is shown. Also are discussed the main information resulting from high resolution experiments that might be helpful in order to parameterize the convective transport at low spatial resolution models. Fig. 5 shows tracer and thermodynamic profiles inside of updfrat at simulations with resolution of 2.5 km. Figs. 6 and 7 shows the same profiles that are 'resolved' at resolutions of 10 and 50 km.

New cumulus scheme based on Arakawa and Schubert's approach

The Fig. 8 shows a comparison between the traditional cumulus scheme of RAMS based on Kuo's approach and the new one developed by Dr. George Grell. The two upper pictures compare the simulated parameterized convective precipitation. With the Grell scheme there is much more precipitation (and at different places) than that simulated by Kuo scheme. The two lower pictures show the vertical velocity and the convective heating rate for both schemes. The high resolution simulations indicate the Grell scheme is more realistic than the Kuo scheme.

RAMS Simulations with NCEP and ECMWF

Reserva Jaru (62W 10S) 2100Z24sep1992

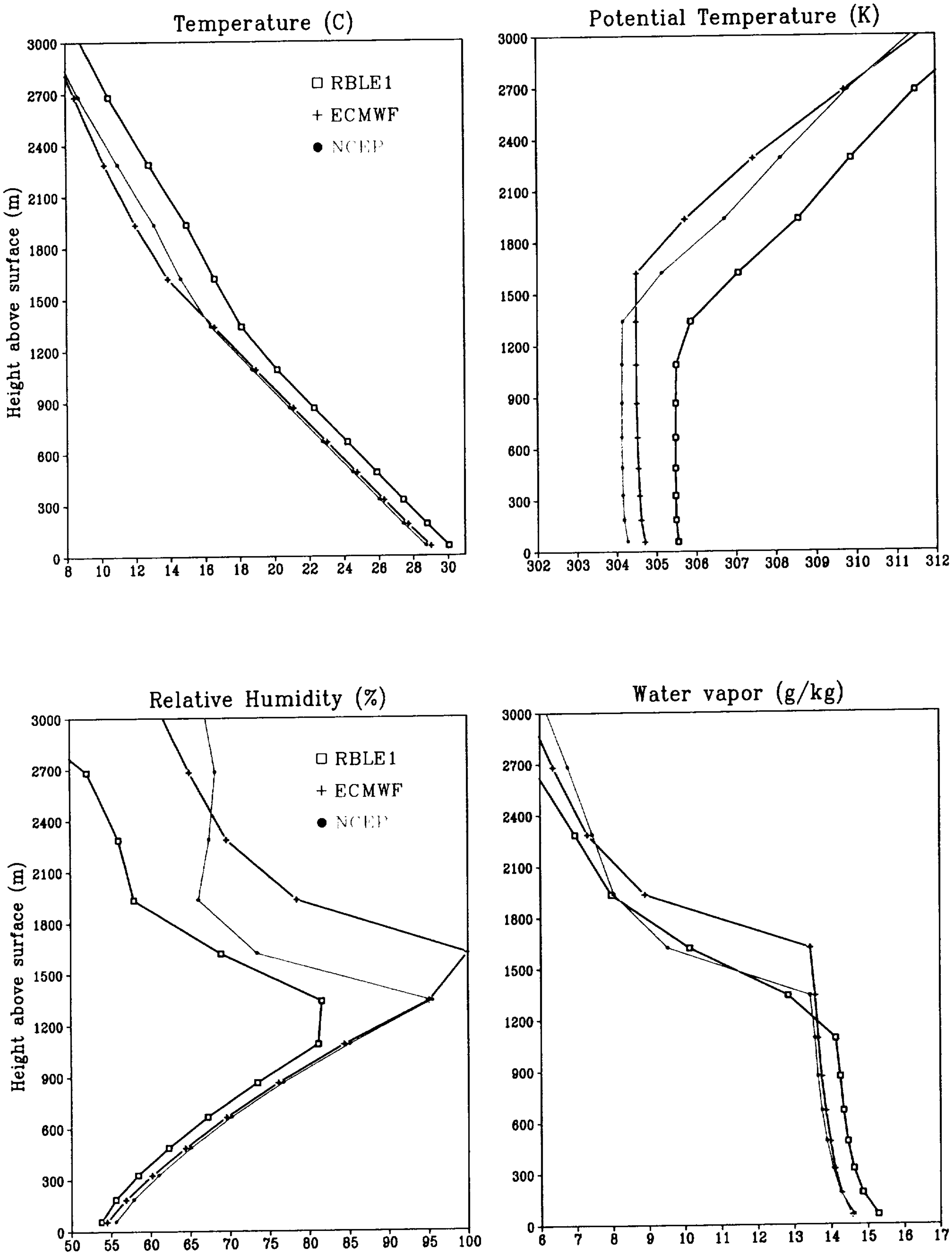
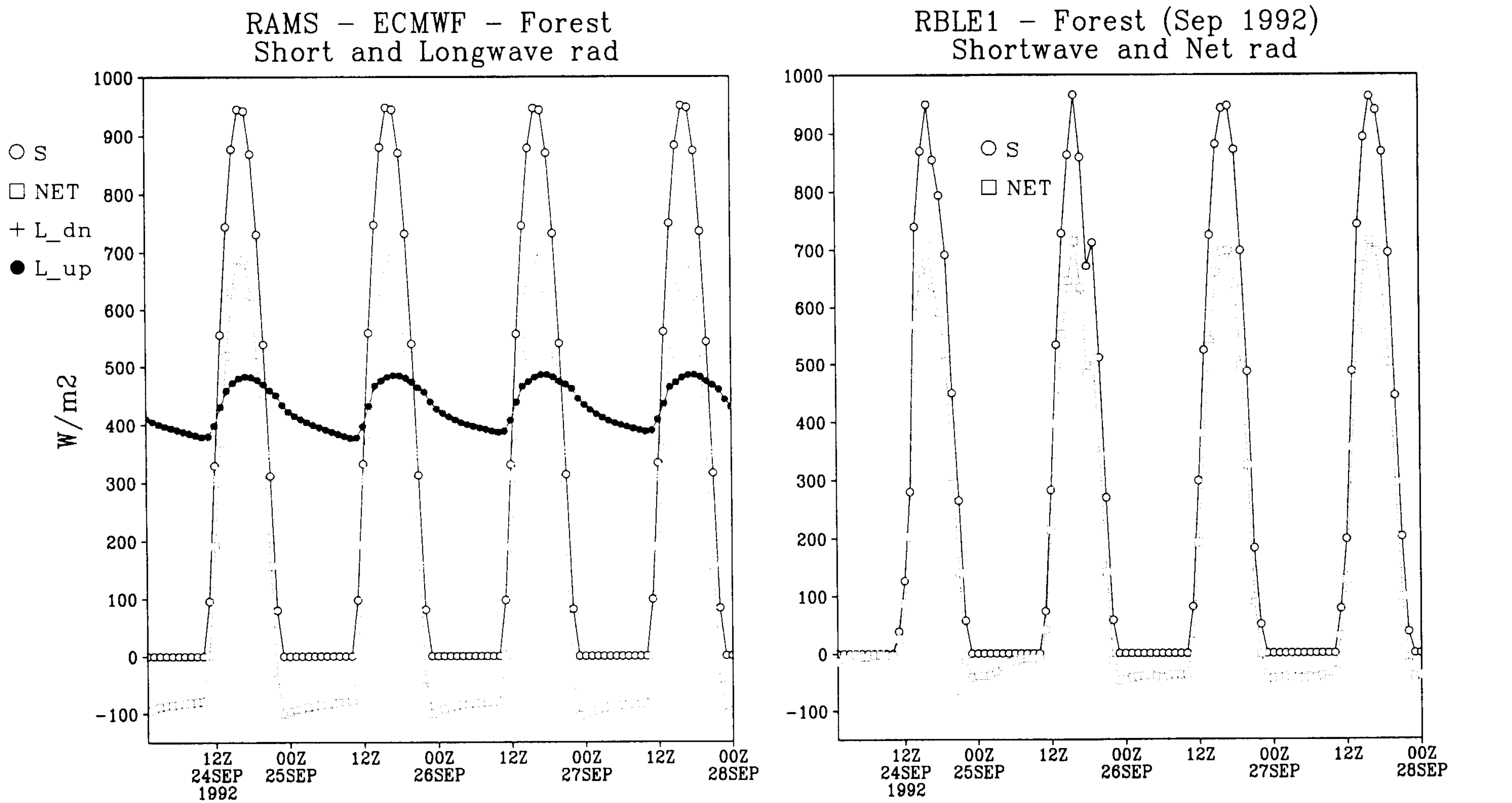
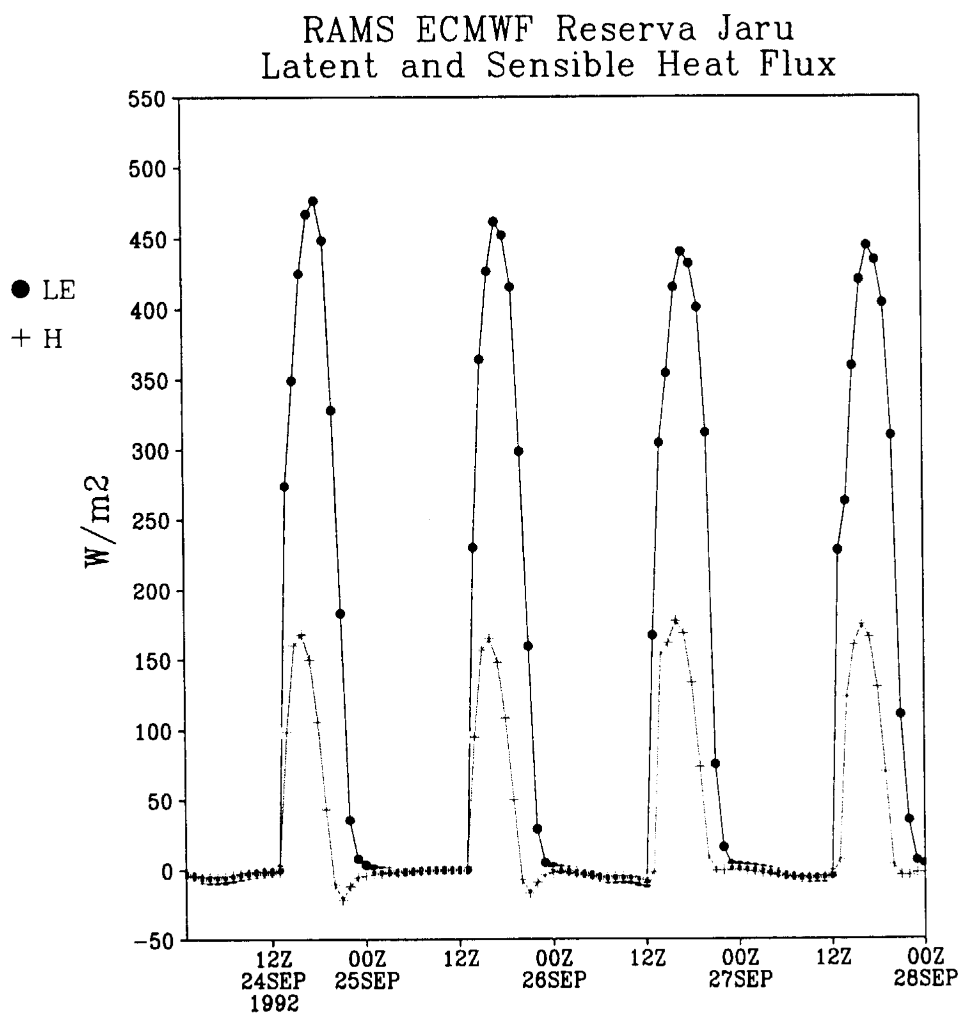


Fig 1



RAMS - ECMWF - Forest
Short and Longwave rad
S
NET
L_dn
L_up
W/m2
1000
900
800
700
600
500
400
300
200
100
0
-100
12Z 24SEP 1992
00Z 25SEP
12Z
00Z 26SEP
12Z
00Z 27SEP
12Z
00Z 28SEP
RBLE1 - Forest (Sep 1992)
Shortwave and Net rad
S
NET

Fig 2


RAMS ECMWF Reserva Jaru
Latent and Sensible Heat Flux
LE
H
W/m2
550
500
450
400
350
300
250
200
150
100
50
0
-50
12Z 24SEP 1992
00Z 25SEP
12Z
00Z 26SEP
12Z
00Z 27SEP
12Z
00Z 28SEP

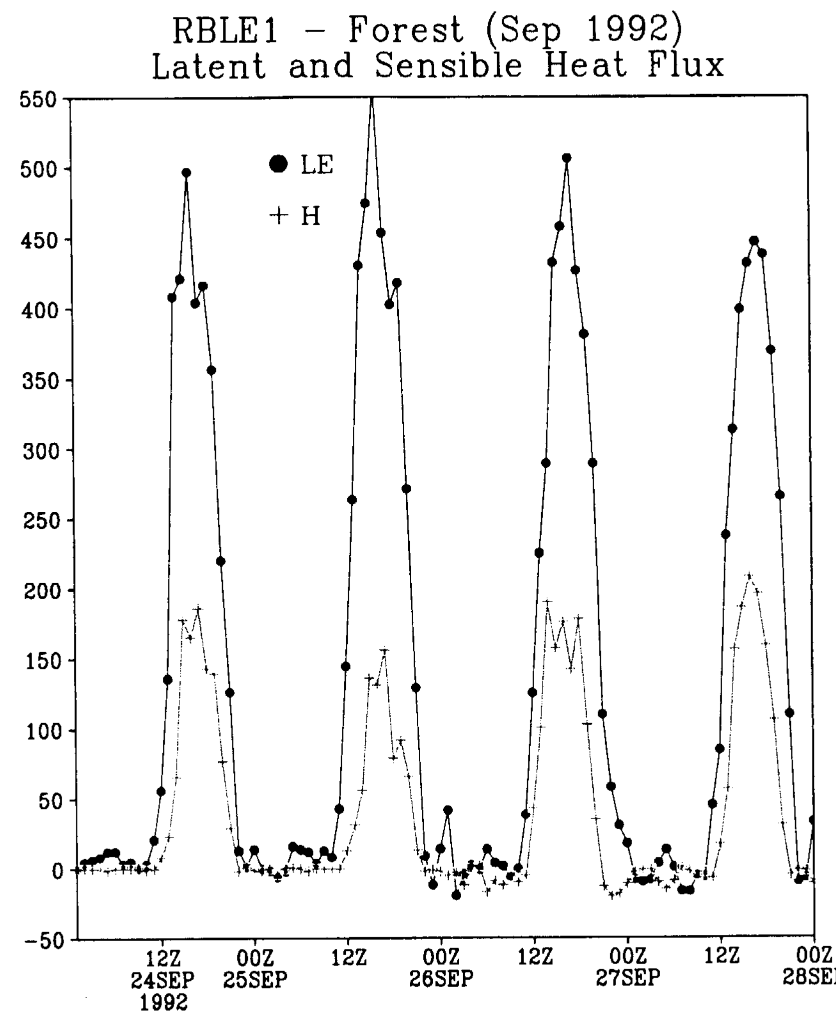
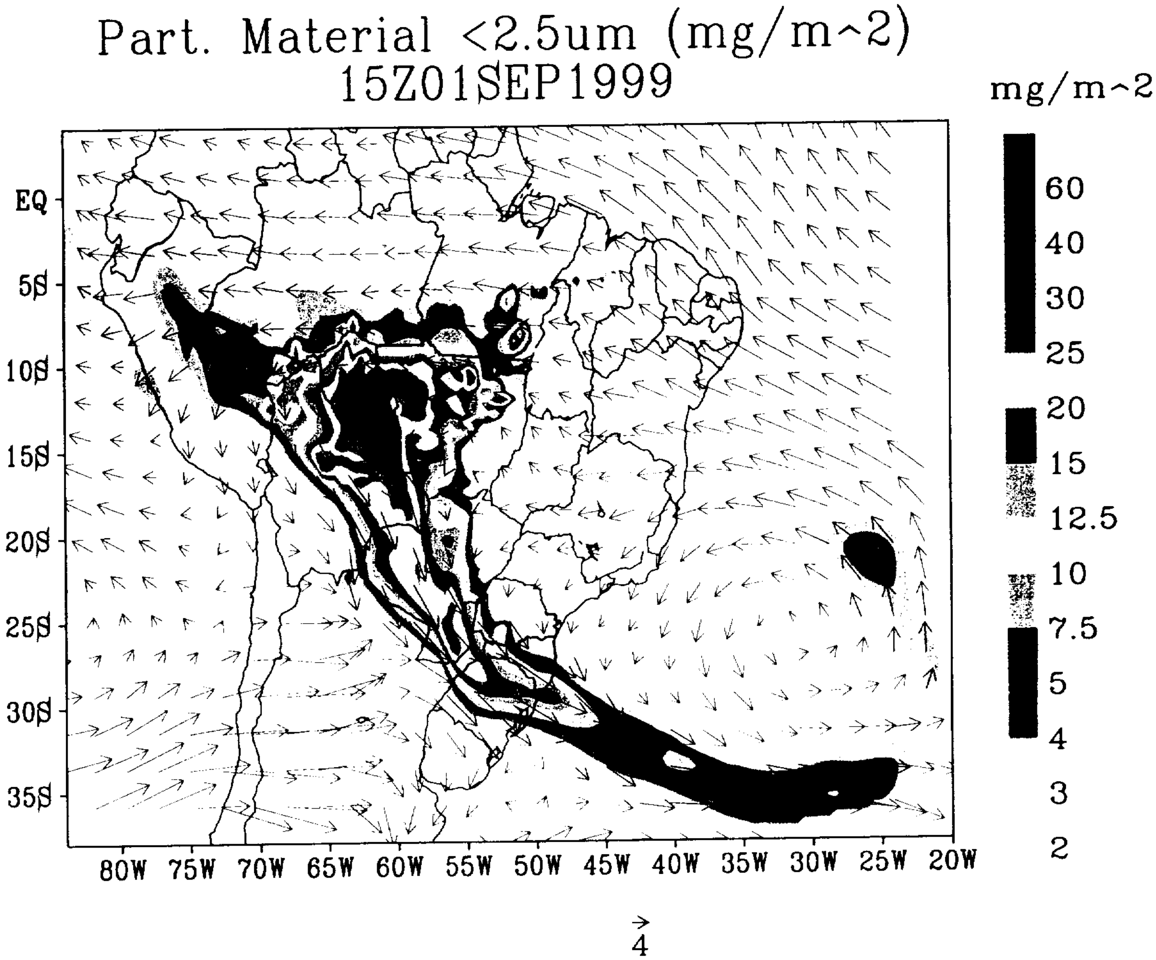

RBLE1 - Forest (Sep 1992)
Latent and Sensible Heat Flux
LE
H
550
500
450
400
350
300
250
200
150
100
50
0
-50
12Z 24SEP 1992
00Z 25SEP
12Z
00Z 26SEP
12Z
00Z 27SEP
12Z
00Z 28SEP

fig 3


Part. Material <2.5um (mg/m^2)
15Z01SEP1999
mg/m^2
60
40
30
25
20
15
12.5
10
7.5
5
4
3
2
EQ
5S
10S
15S
20S
25S
30S
35S
80W 75W 70W 65W 60W 55W 50W 45W 40W 35W 30W 25W 20W
4

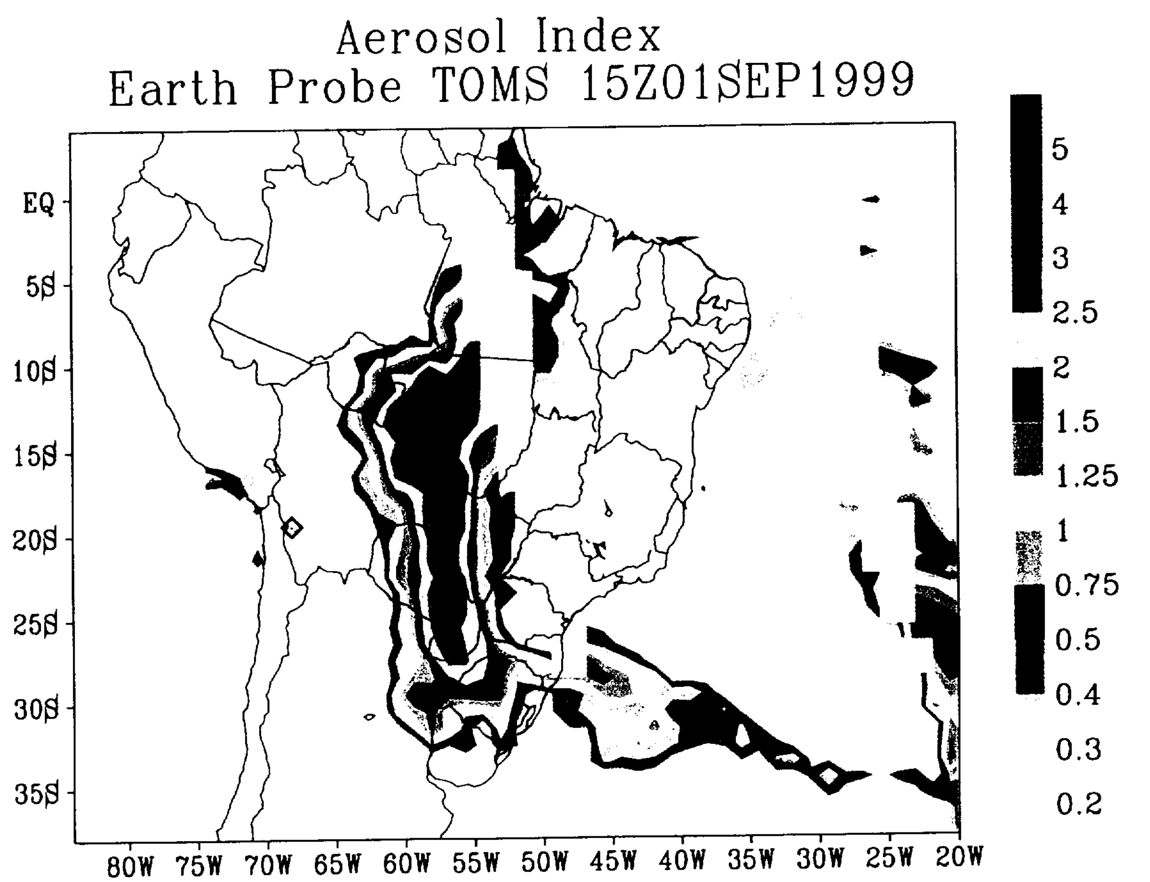
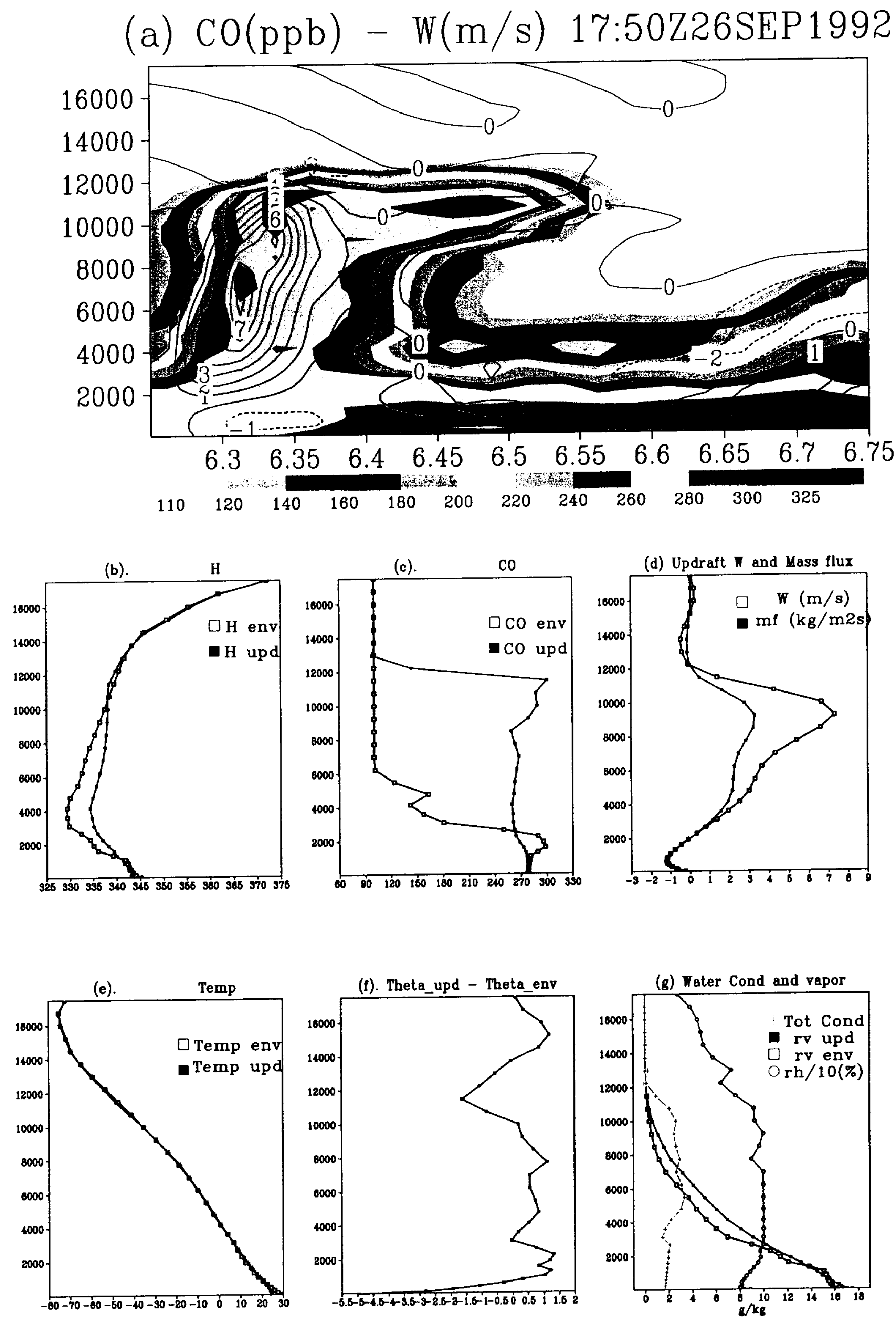

Aerosol Index
Earth Probe TOMS 15Z01SEP1999
5
4
3
2.5
2
1.5
1.25
1
0.75
0.5
0.4
0.3
0.2
EQ
5S
10S
15S
20S
25S
30S
35S
80W 75W 70W 65W 60W 55W 50W 45W 40W 35W 30W 25W 20W

fig 4



(a) CO(ppb) - W(m/s) 17:50Z26SEP1992
16000
14000
12000
10000
8000
6000
4000
2000
6.3
6.35
6.4
6.45
6.5
6.55
6.6
6.65
6.7
6.75
110
120
140
160
180
200
220
240
260
280
300
325
(b). H
H env
H upd
(c). CO
CO env
CO upd
(d) Updraft W and Mass flux
W (m/s)
mf (kg/m2s)
(e). Temp
Temp env
Temp upd
(f). Theta_upd - Theta_env
(g) Water Cond and vapor
Tot Cond
rv upd
rv env
rh/10(%)
g/kg

fig 5

Grid 2 - resolution 10 x 10 km

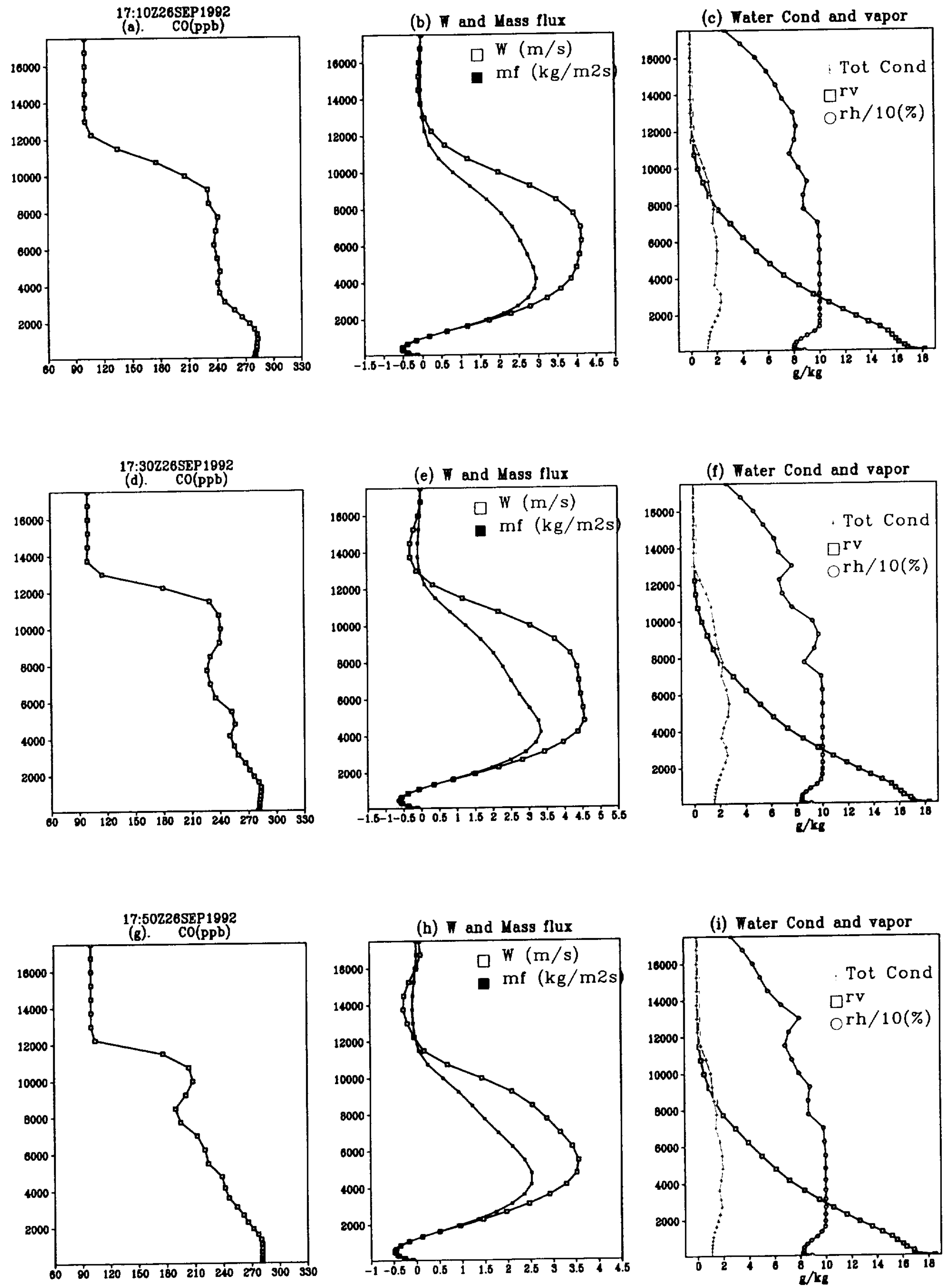


Fig 6

Grid 1 – resolution 50 x 50 km

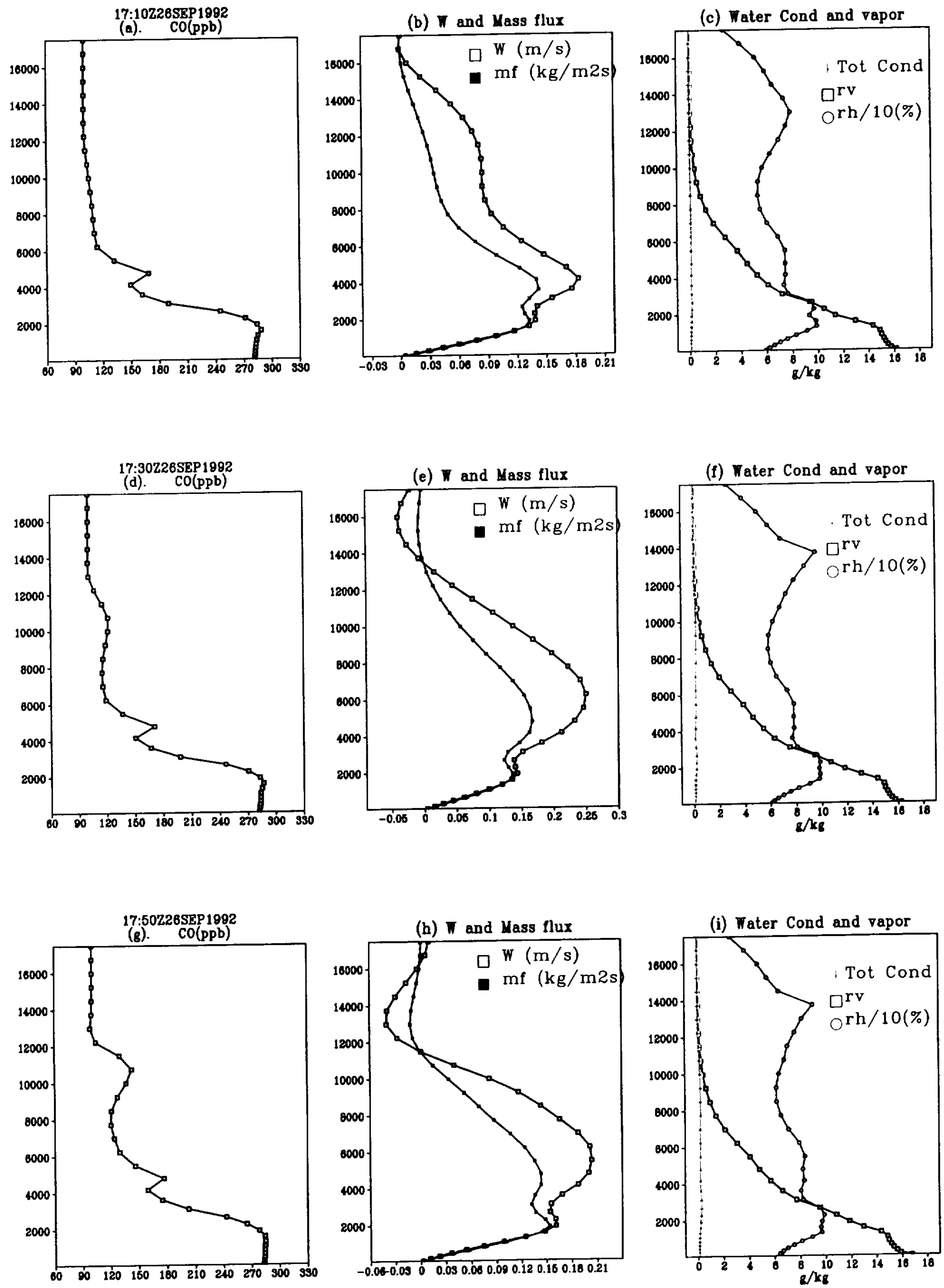


fig 7

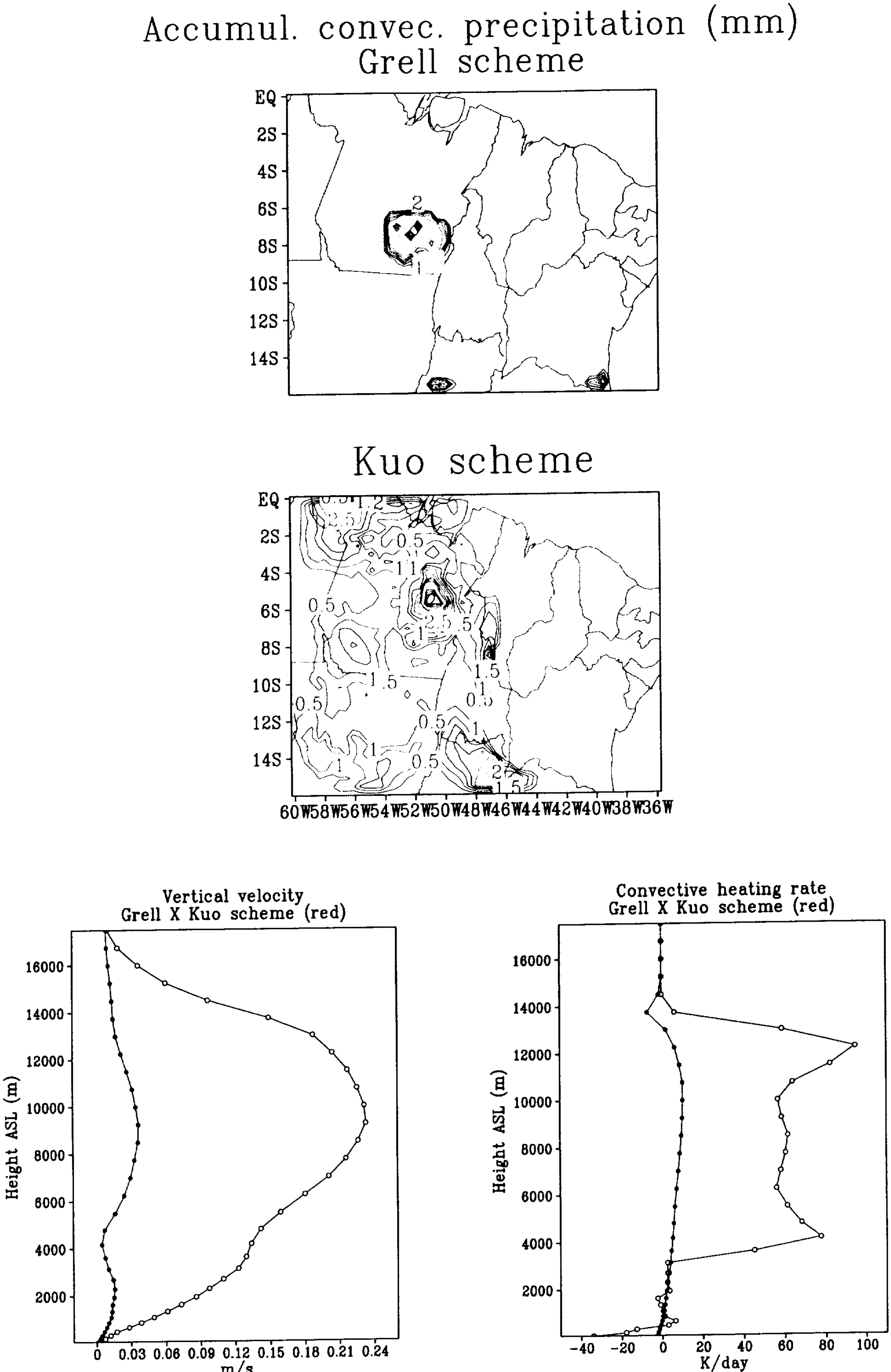

Accumul. convec. precipitation (mm)
Grell scheme
EQ
2S
4S
6S
8S
10S
12S
14S
Kuo scheme
60W58W56W54W52W50W48W46W44W42W40W38W36W
Vertical velocity
Grell X Kuo scheme (red)
Height ASL (m)
m/s
Convective heating rate
Grell X Kuo scheme (red)
K/day

Fig 8