DICE case: results of LMDZ SCM forced by surface fluxes (stage 1b)

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LMDZ SCM is run with 70 levels, timestep=450 sec.
Version used for part of CMIP5 runs : **IPSL-CM5B**
Described in Hourdin et al., Climate Dynamics 2012

Boundary layer : TKE (Mellor & Yamada, 1974)
Thermal plume mass flux (Hourdin et al. 2002)

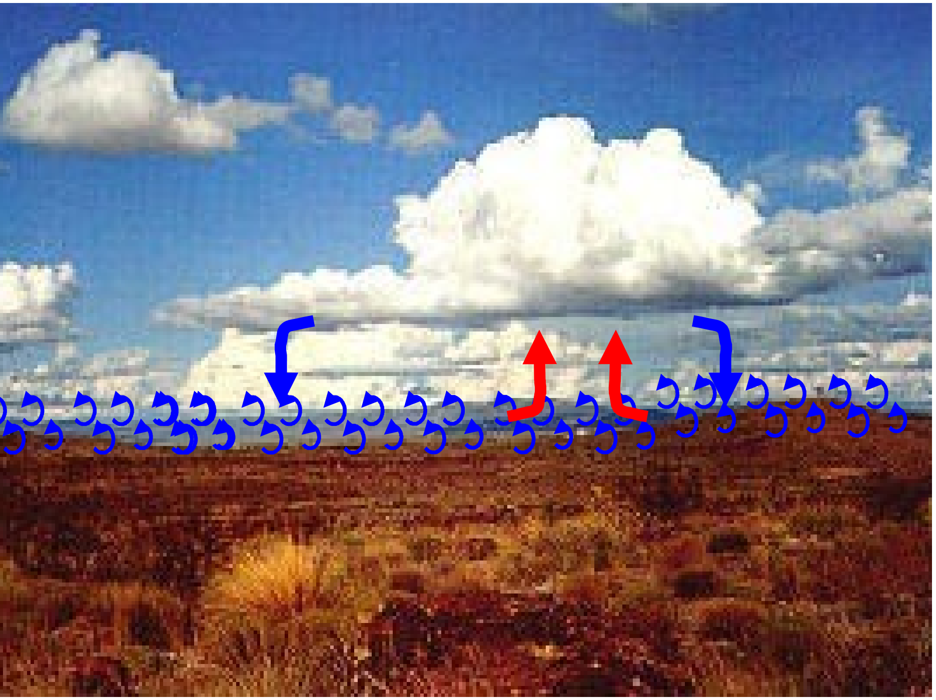
Shallow convection : Thermal plume mass flux from ground
(Rio & Hourdin 2008, Rio et al. 2010)

Deep convection : Emanuel (93)
+ wakes (Grandpeix et al. 2010)

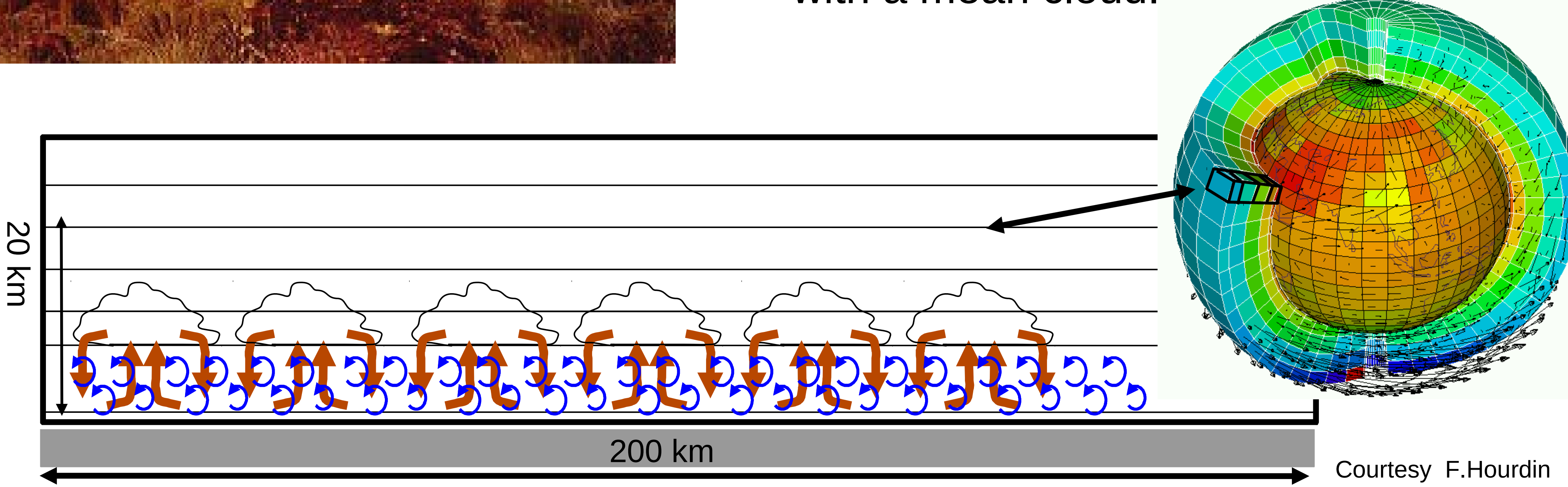
Clouds : Statistic: lognormal law for large scale
and bi-gaussian for shallow cumulus
(Jam et al, 2013)

Thermal plume model

Isotropic small scale turbulence -> turbulent mixing



Thermal plume model :
mass flux parameterization
which separates each atomospheric
column in two parts :
ascending air from the surface
and descending air around.
We represente a mean plume
with a mean cloud.



Courtesy F.Hourdin

Since april 2013 : « stabilized » version

+ Asymptotic mixing length imposed (100m) in Yamada scheme

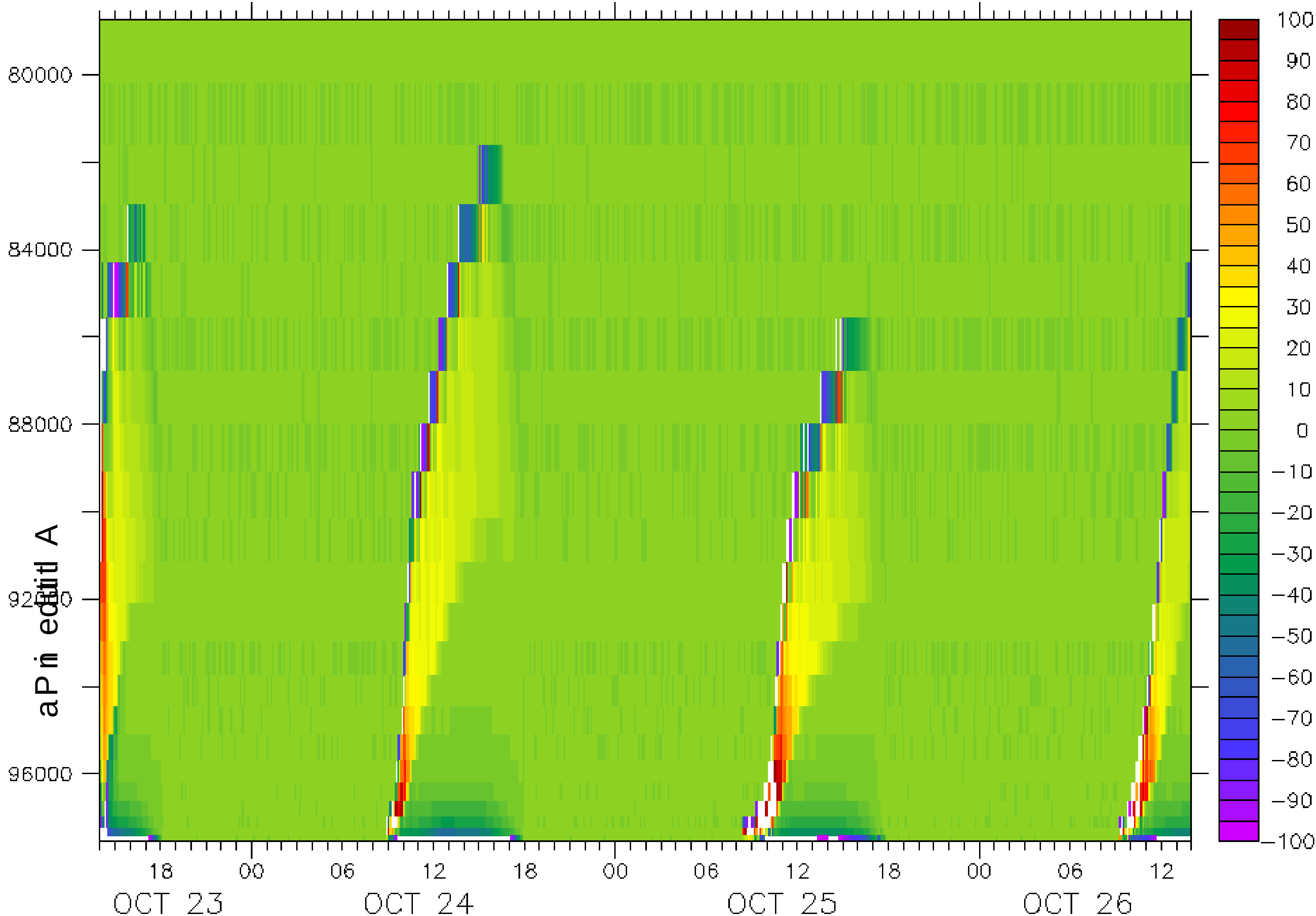
+ Subsidence around thermal plume : computation of advection becomes implicite

Some details about forcings

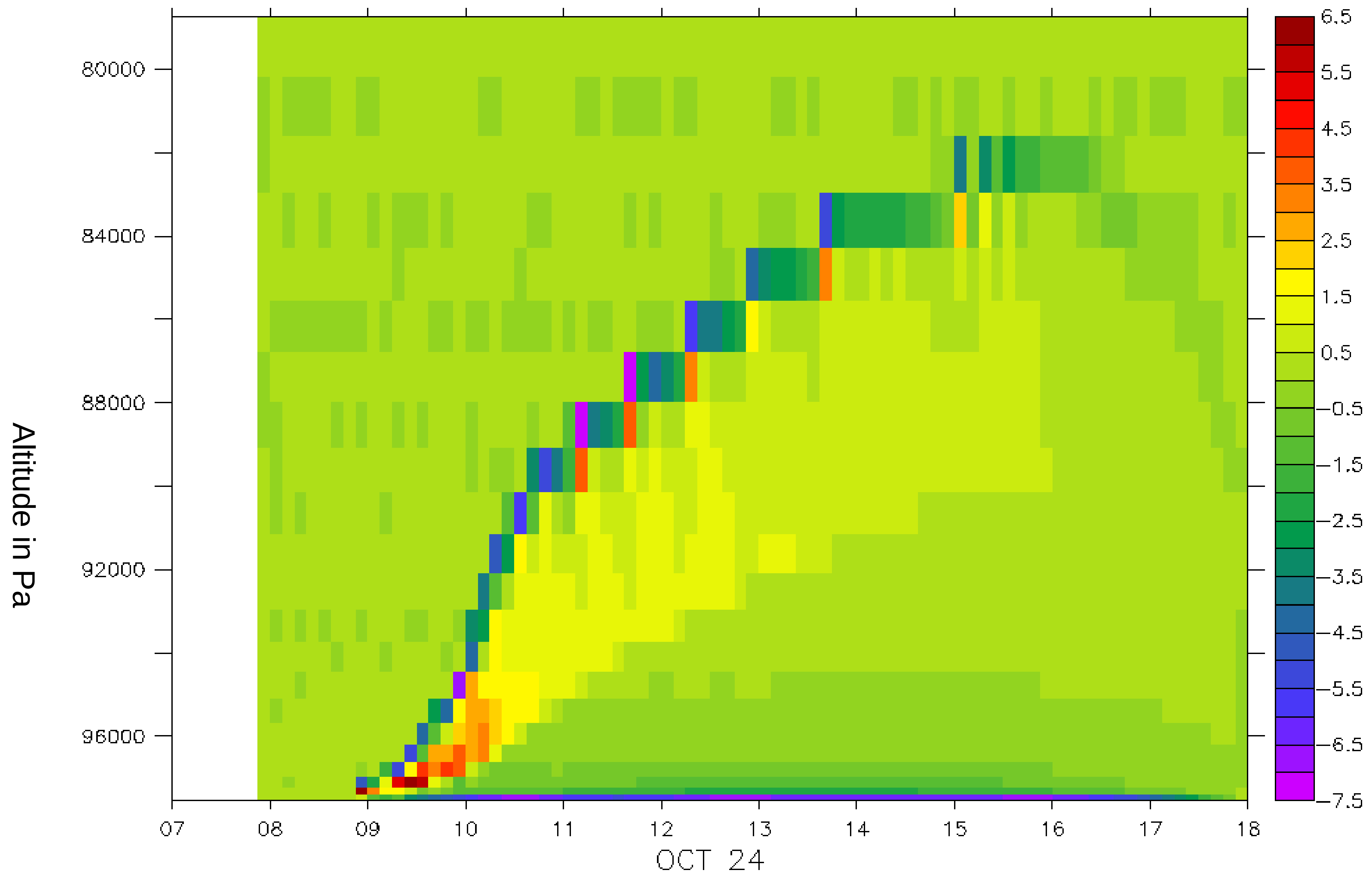
- Latent and sensible heat fluxes are imposed

- To generate LWUP flux, we run the radiative scheme and impose the observed skin temperature (Tg)

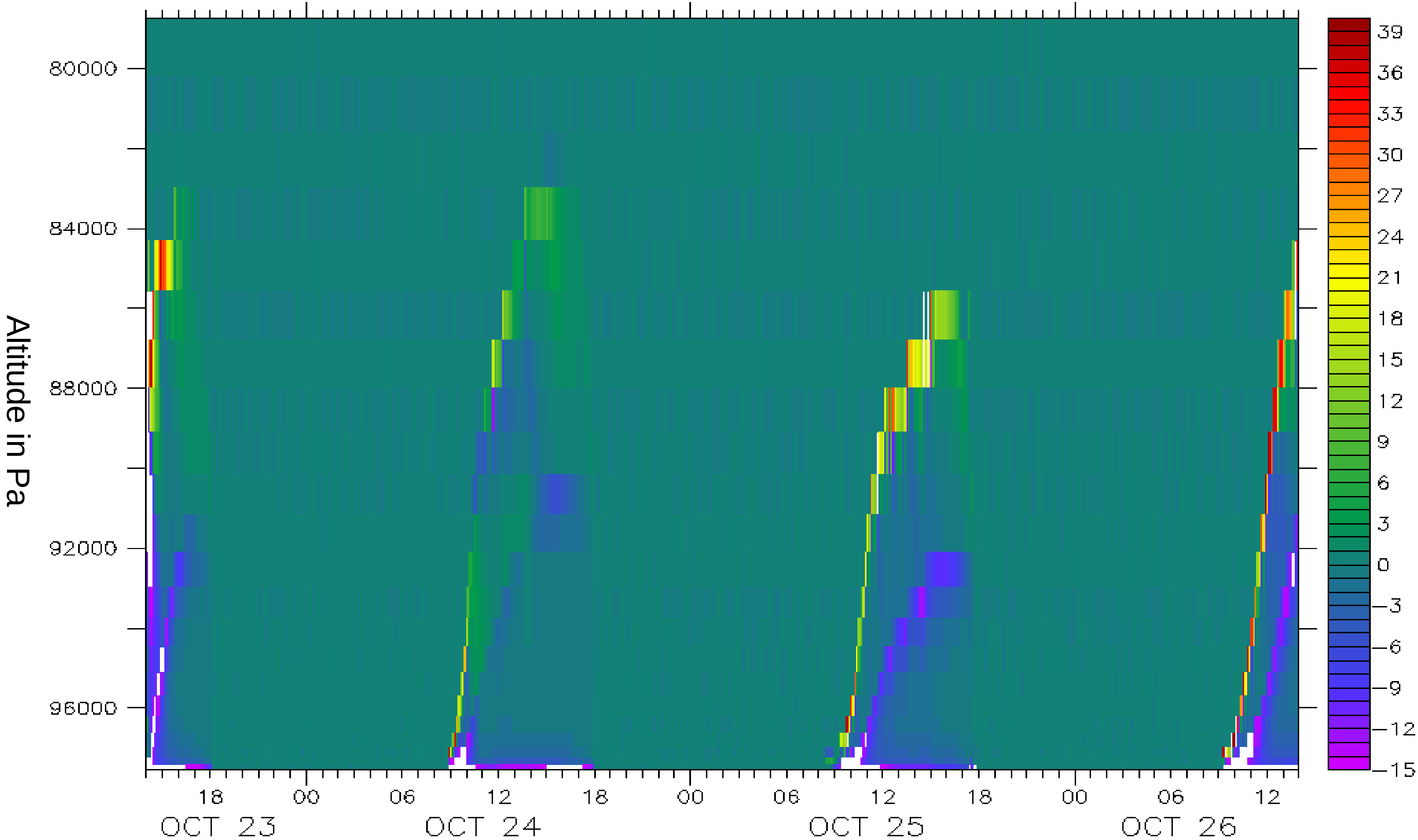
- We combine observed u* with the model windspeed to calculate surface momentum drag coefficient



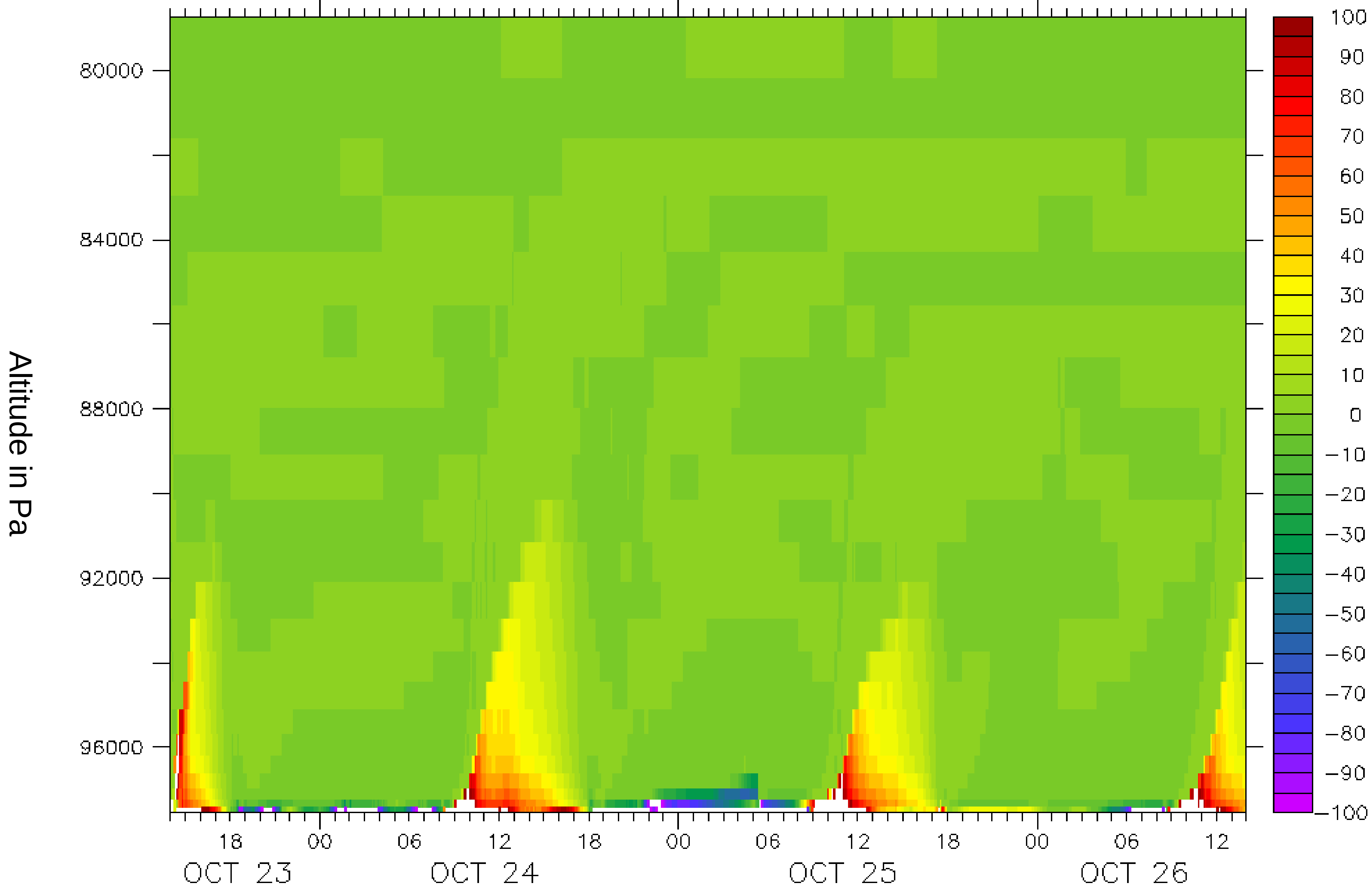
Temperature tendency due to thermal plume scheme (K/day)



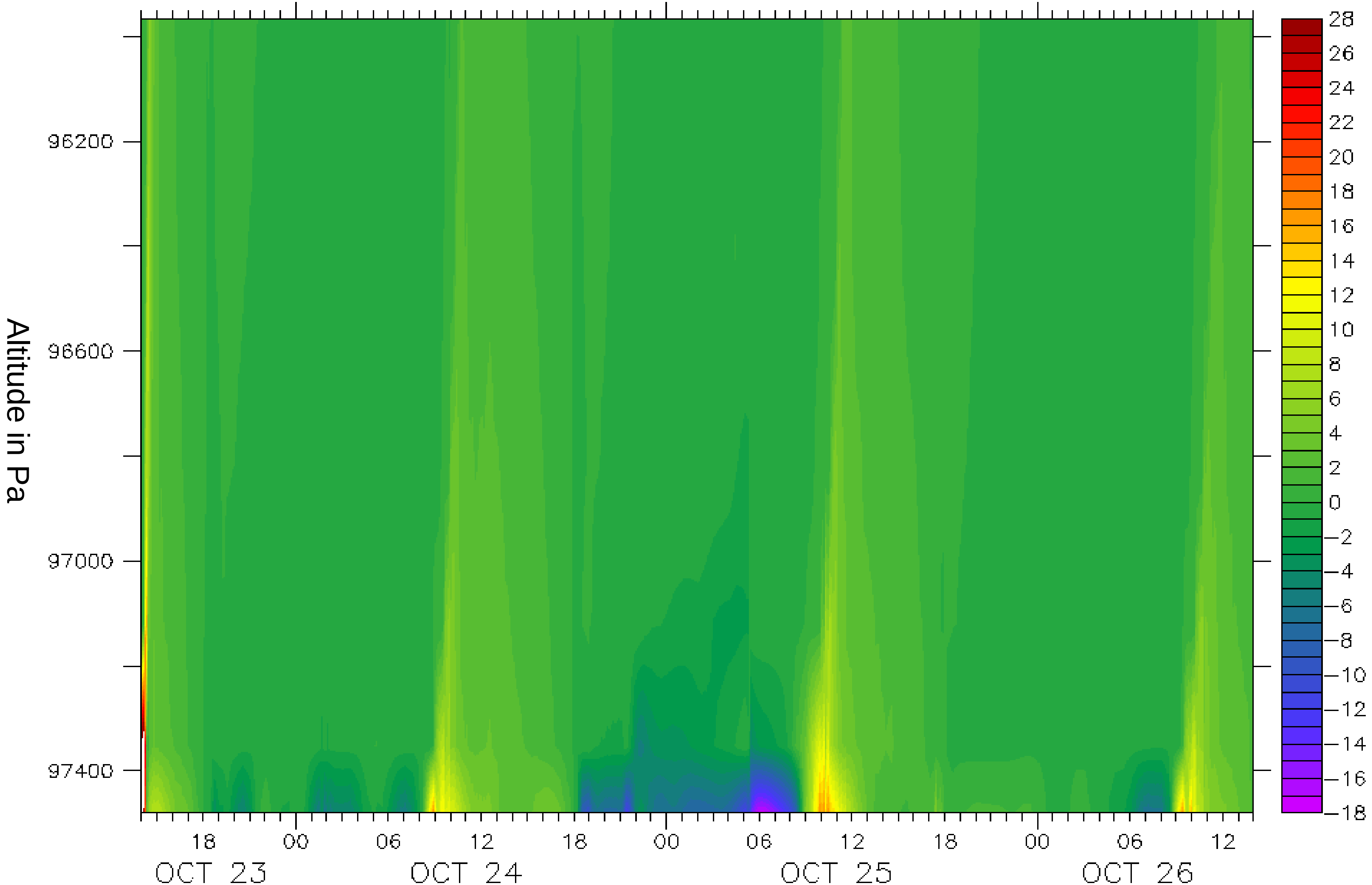
Detail of temperature tendency due to thermal plume scheme (K/hour)



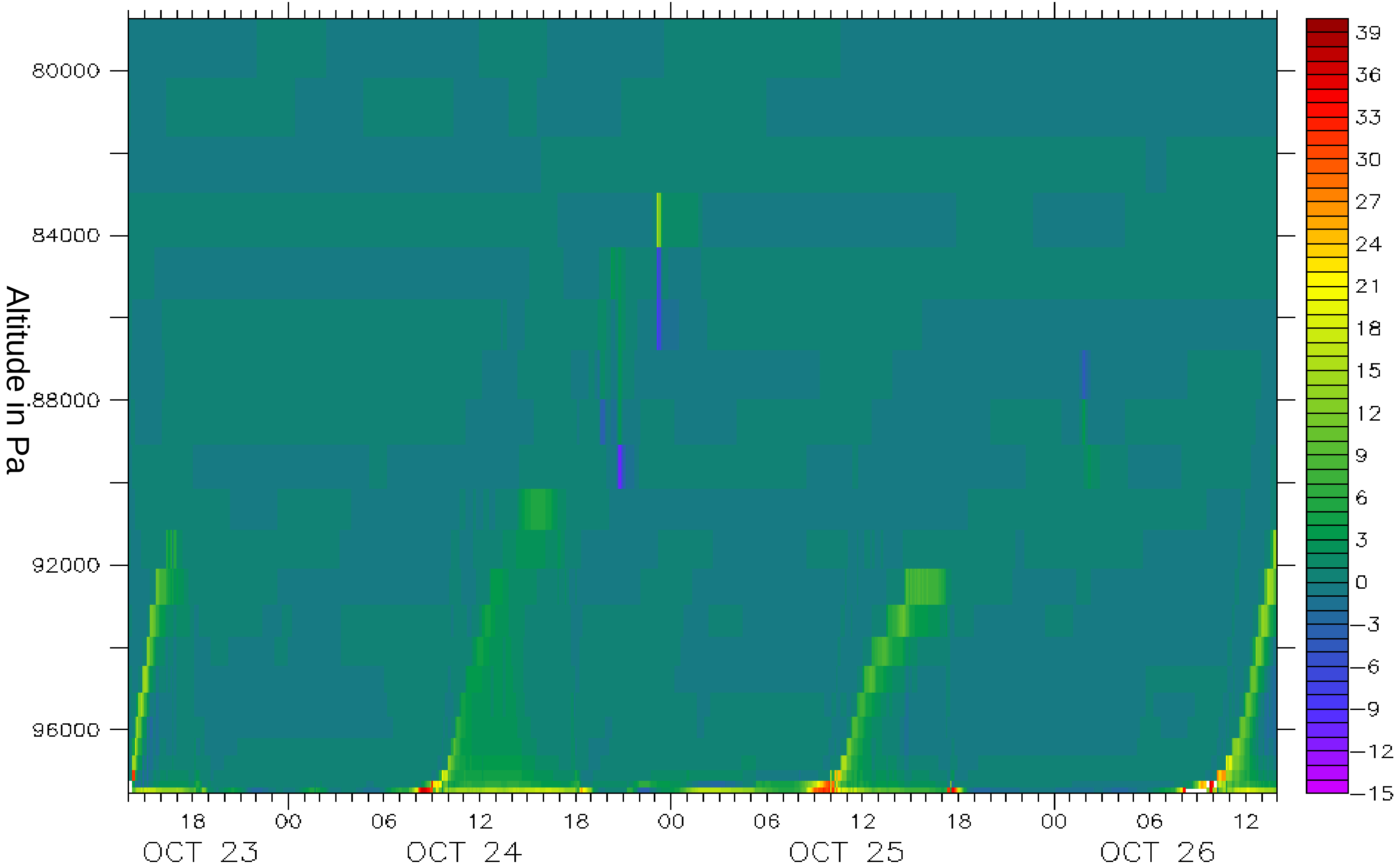
Q tendency due to thermal plume scheme (g/kg/day)



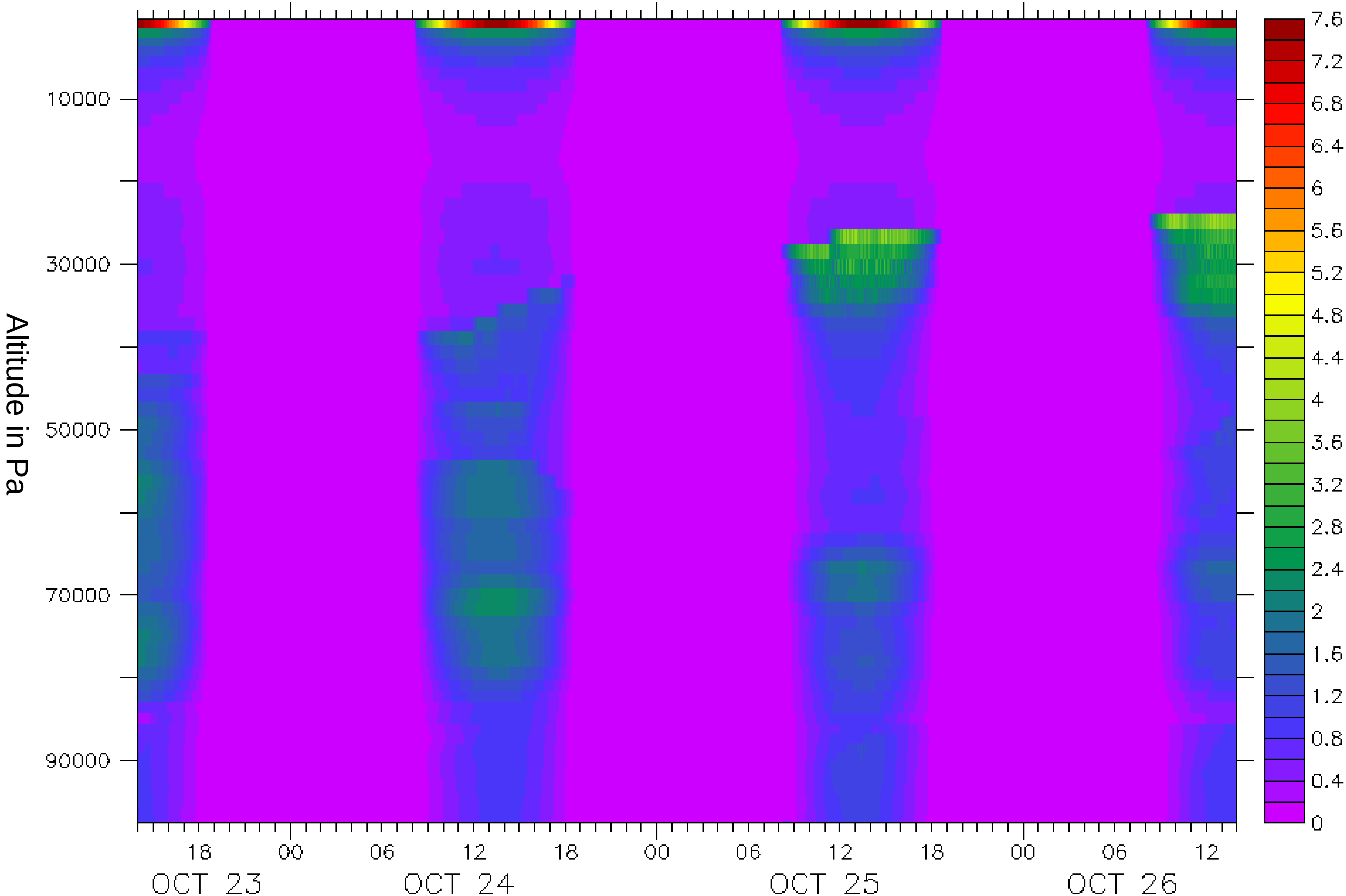
Temperature tendency due to vertical diffusion scheme (K/day)



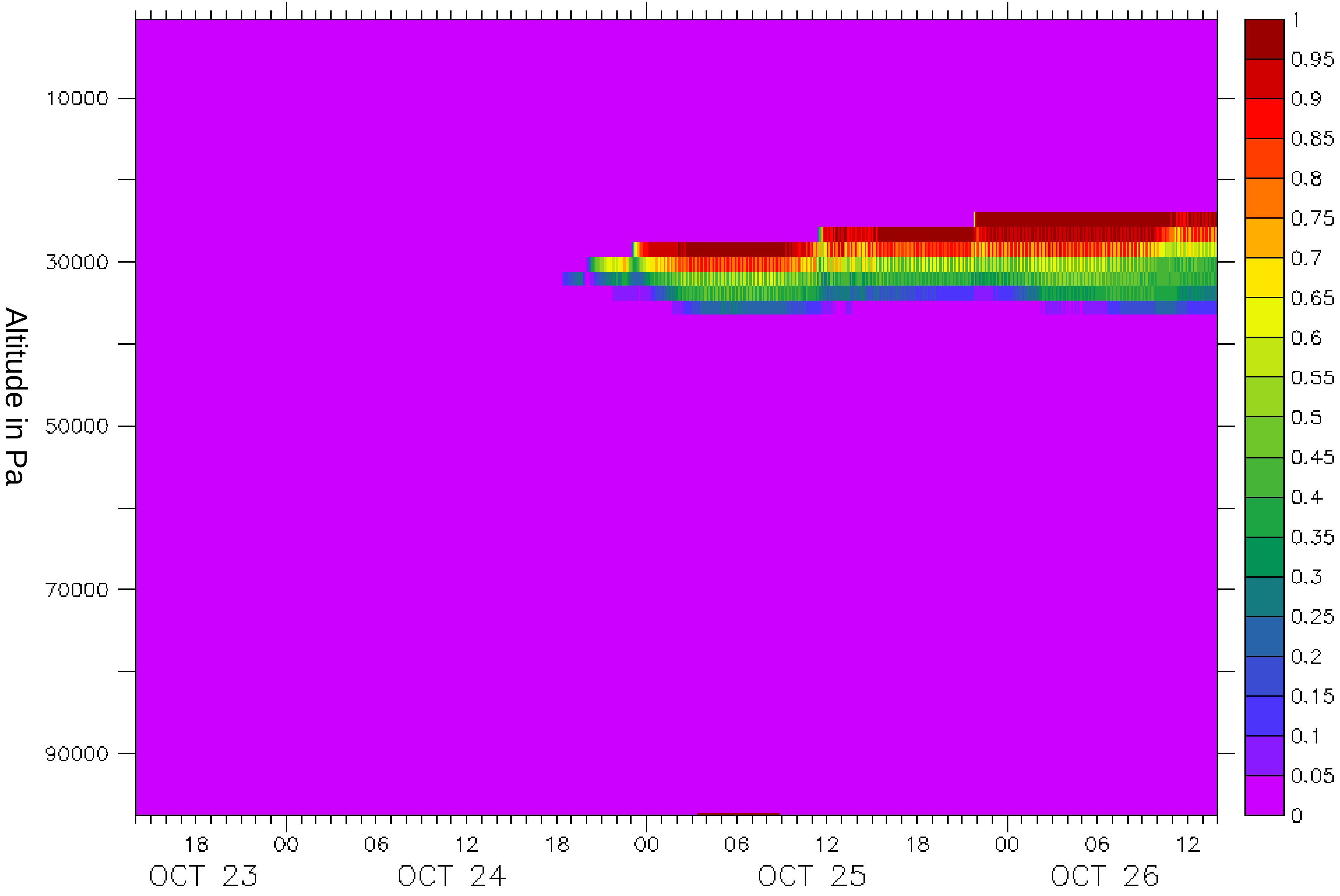
Detail of temperature tendency due to vertical diffusion (K/hour)



Q tendency due to vertical diffusion scheme (g/kg/day)

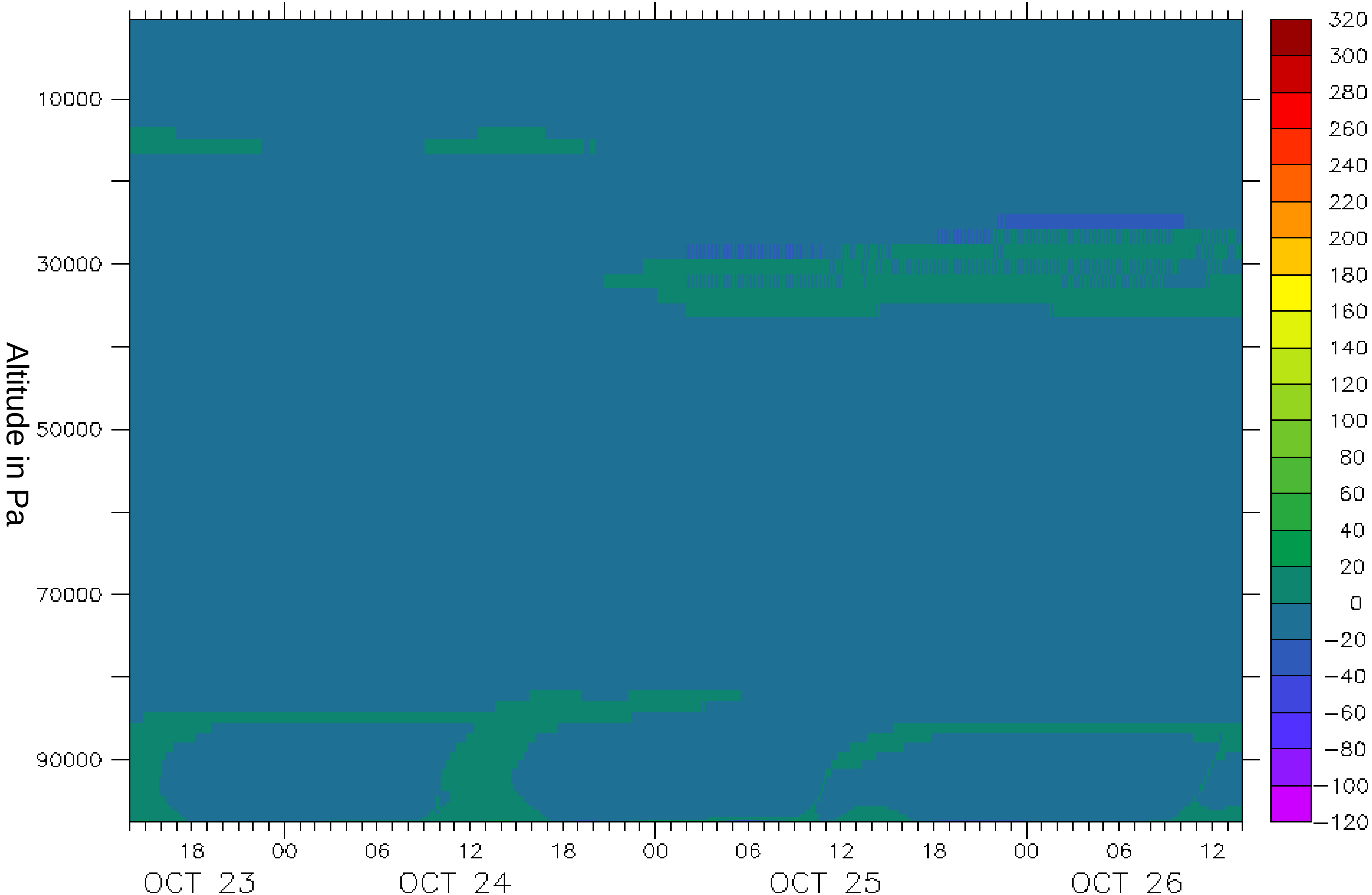


Temperature tendency due to SW radiation scheme (K/day)

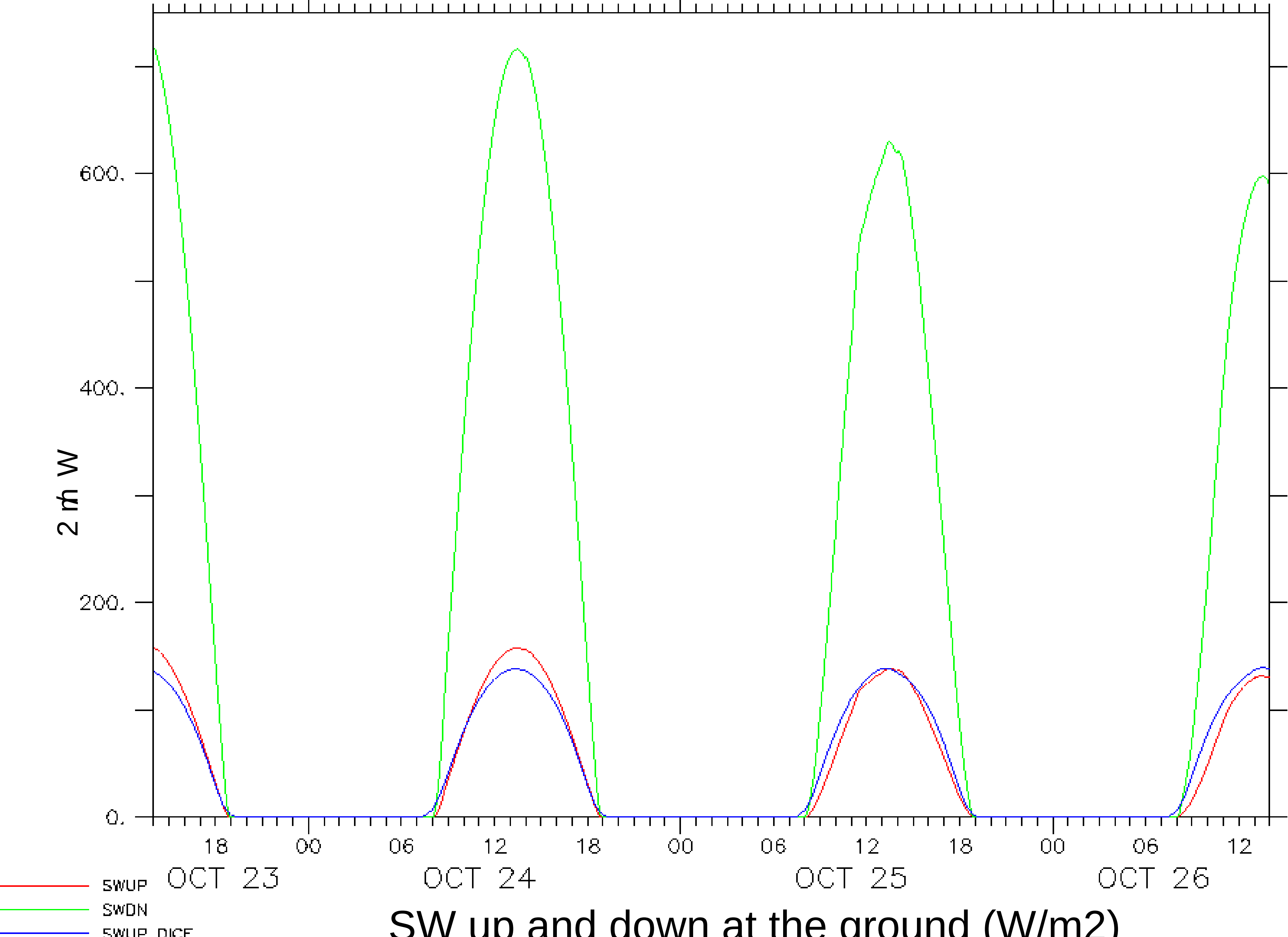


Altitude in Pa
10000
30000
50000
70000
90000
18
00
06
12
18
00
06
12
18
00
06
12
OCT 23
OCT 24
OCT 25
OCT 26
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0

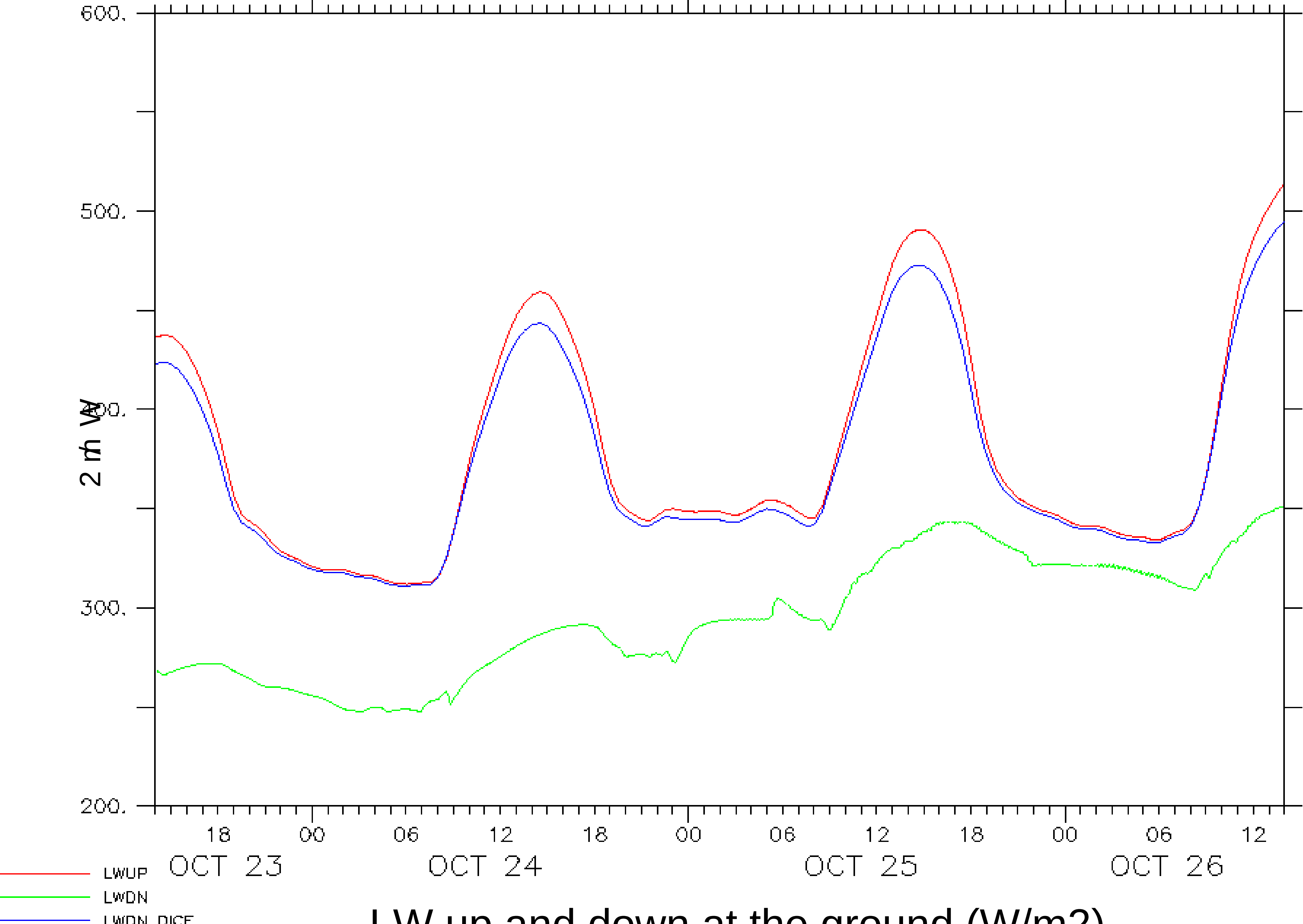
Cloud cover



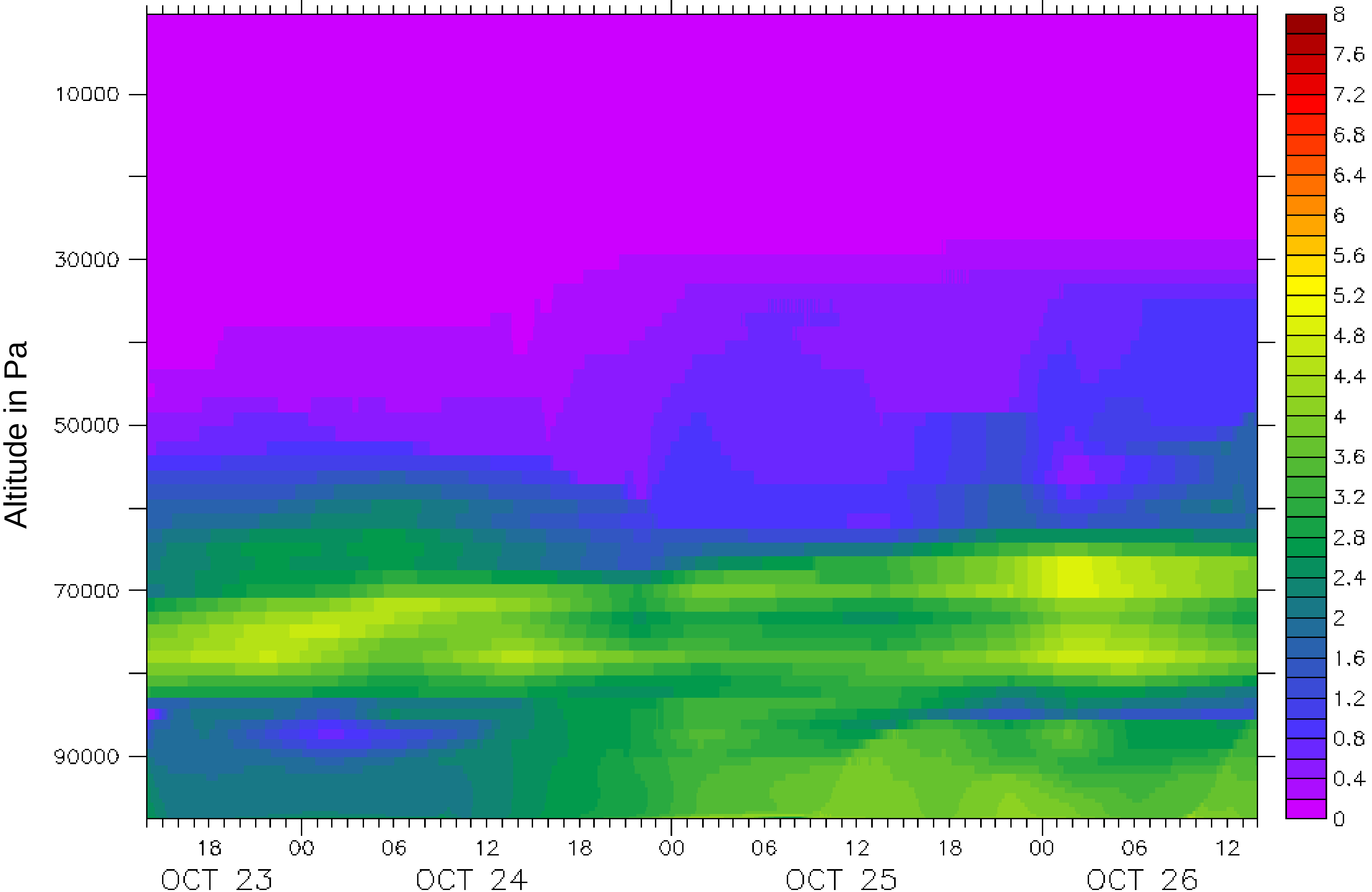
Temperature tendency due to LW radiation scheme (K/day)



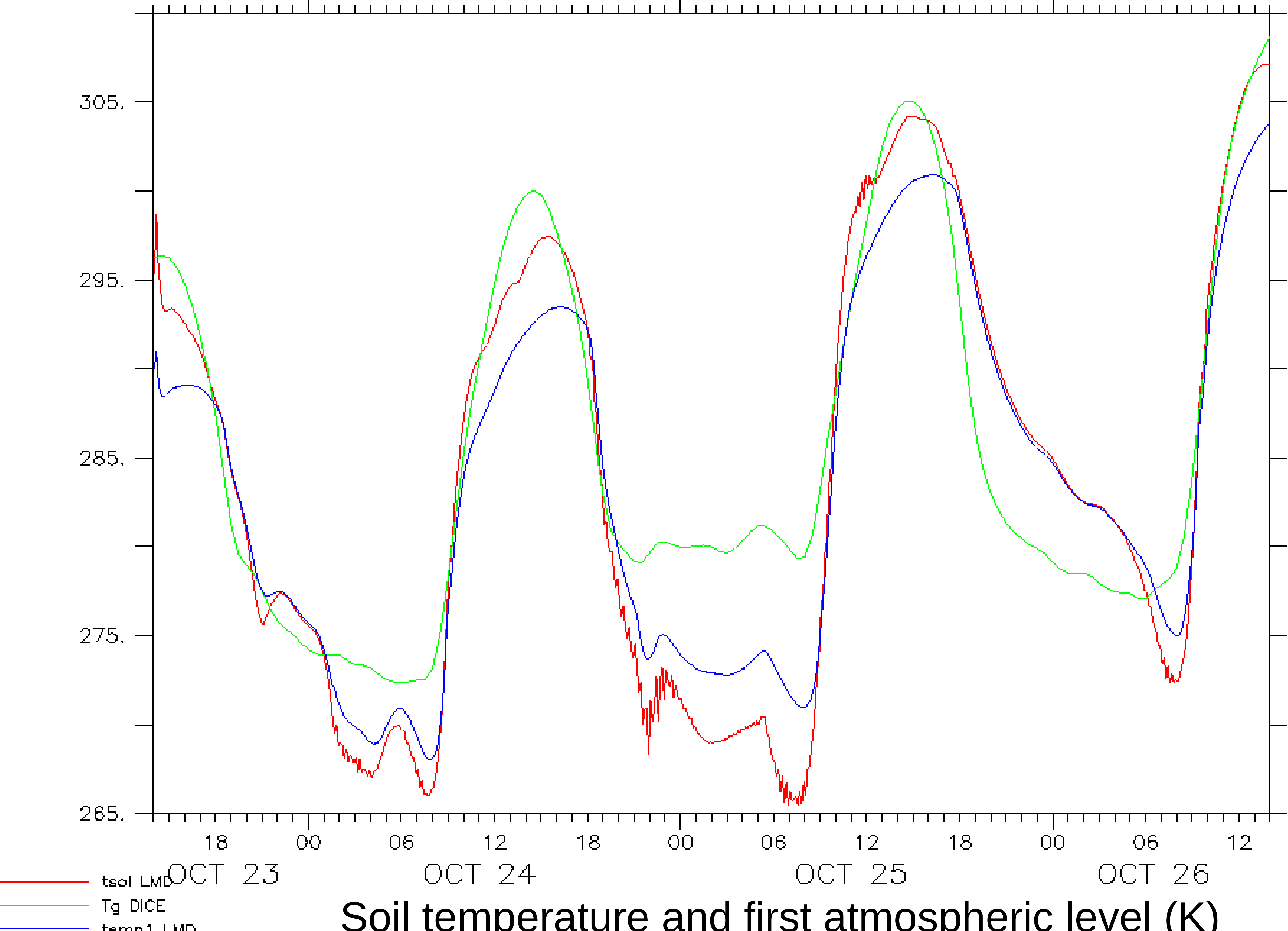
SW up and down at the ground (W/m2)



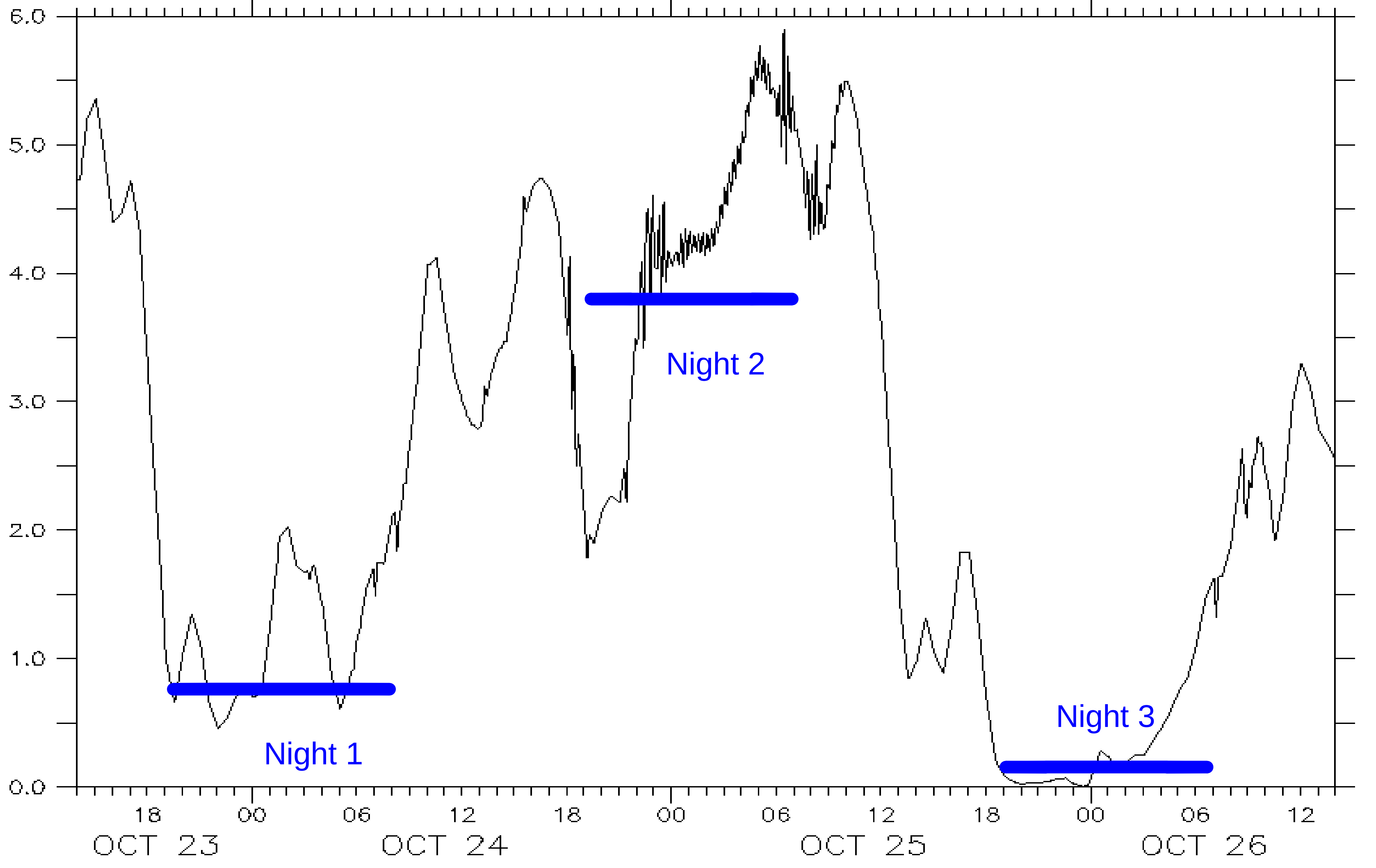
LW up and down at the ground (W/m2)



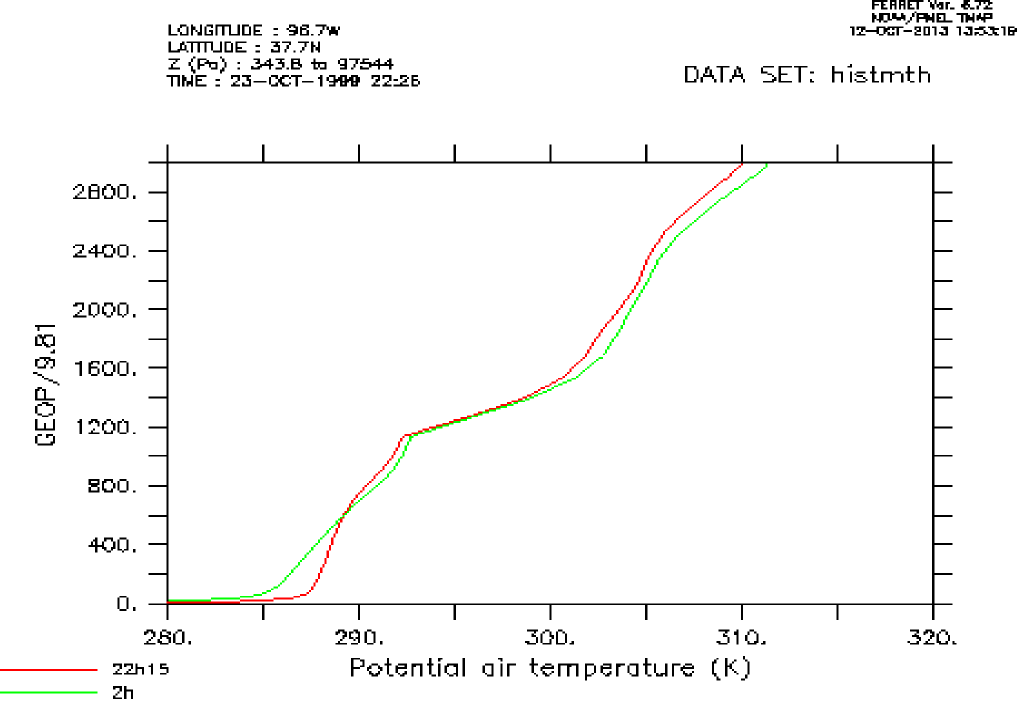
Water vapor (g/kg)



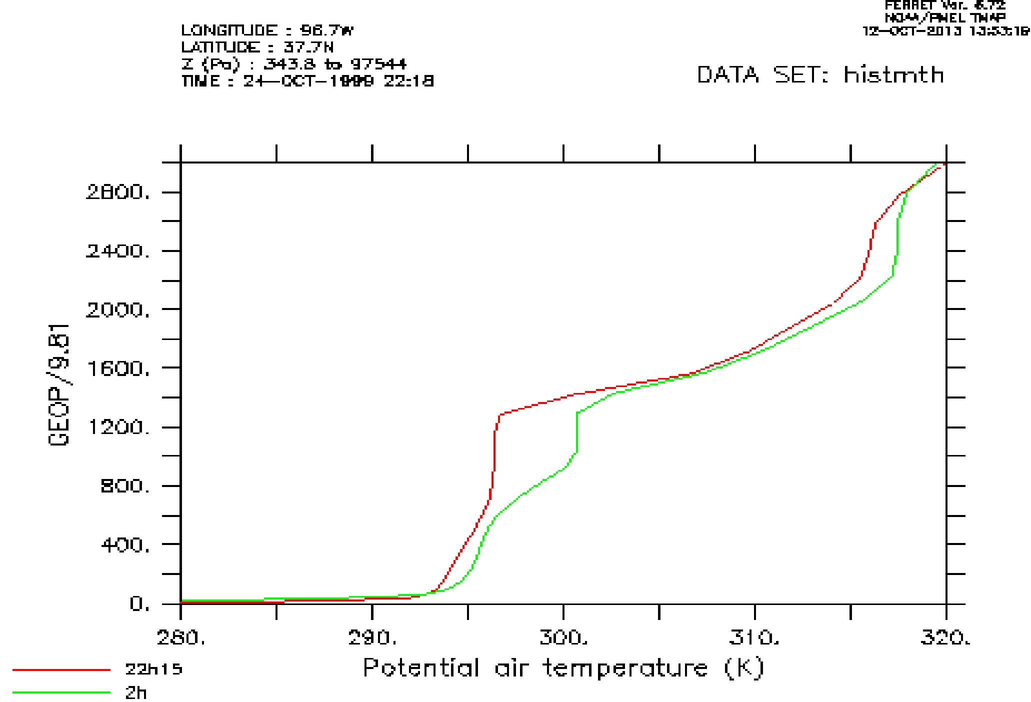
Soil temperature and first atmospheric level (K)



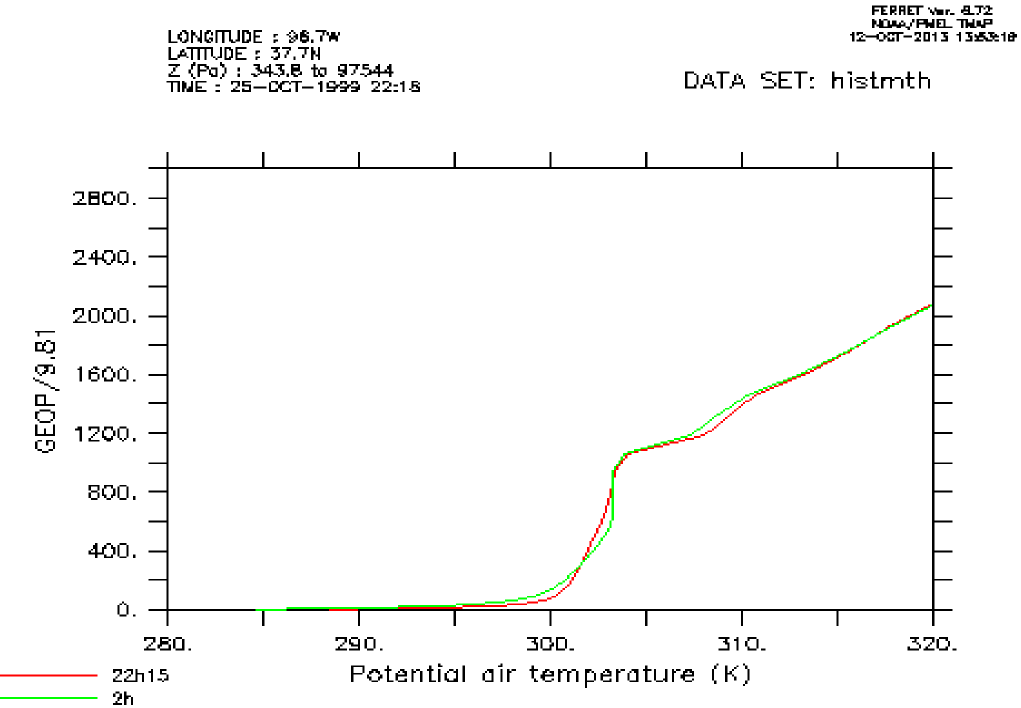
10m wind speed (m/s)



theta(K) 23−24 night

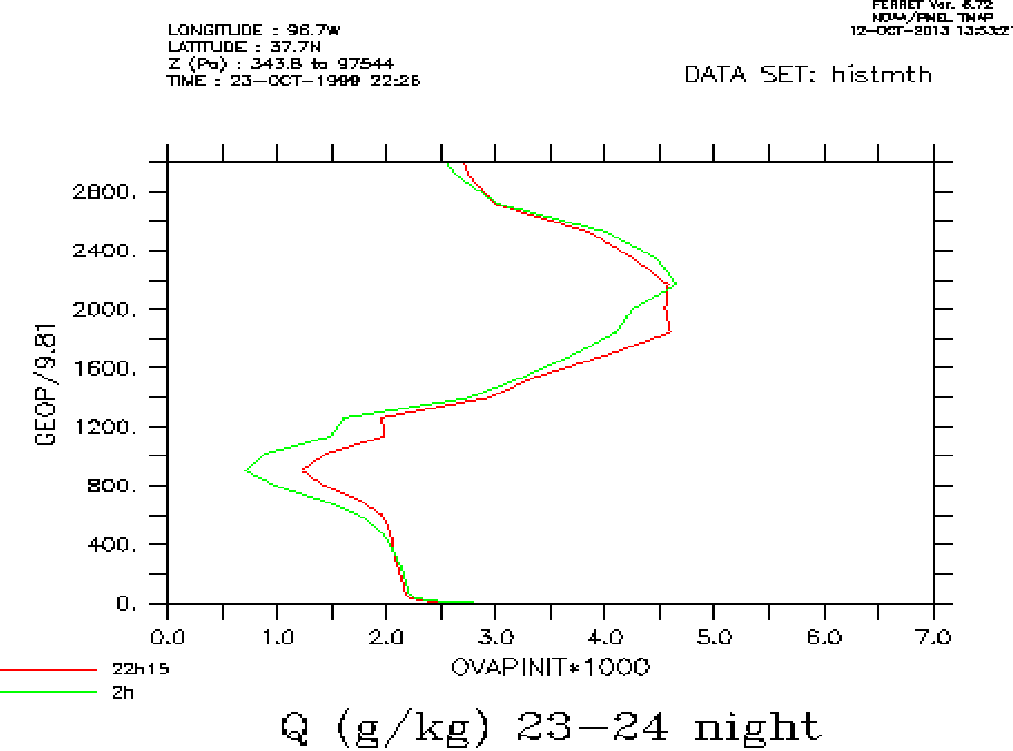


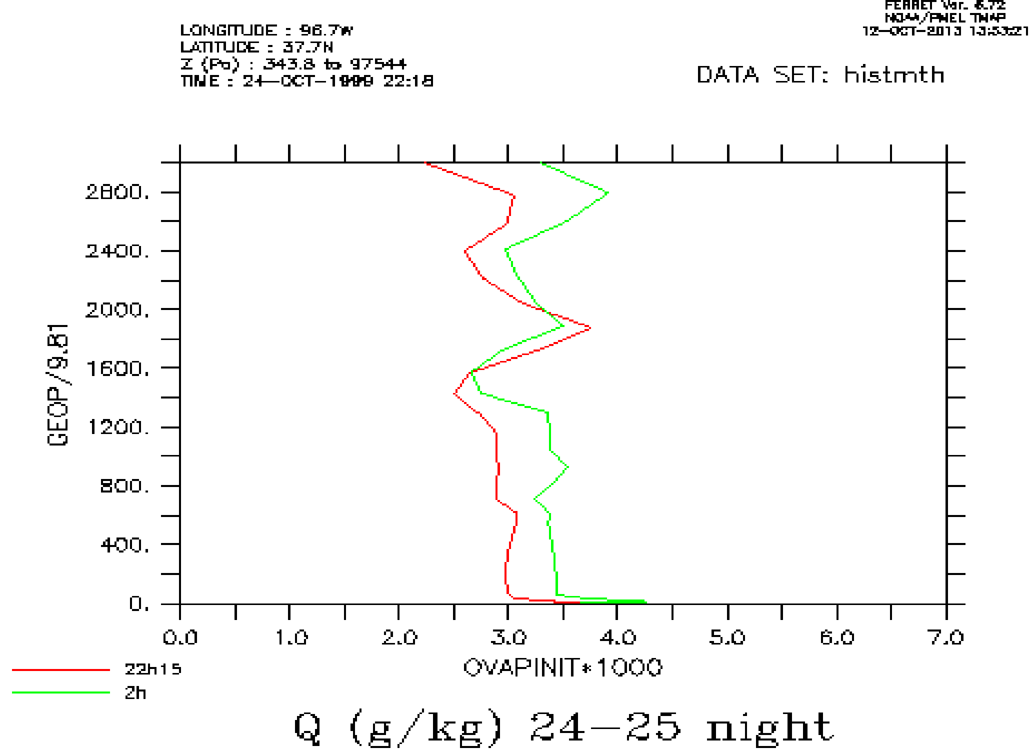
theta(K) 24−25 night

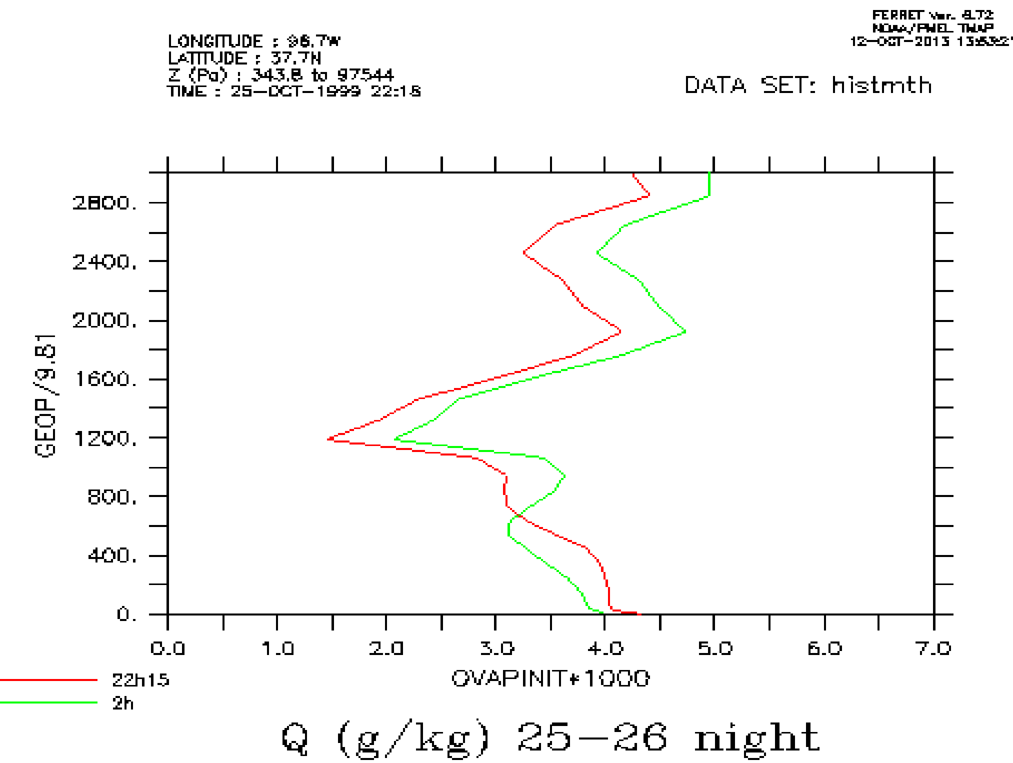


theta(K) 25−26 night

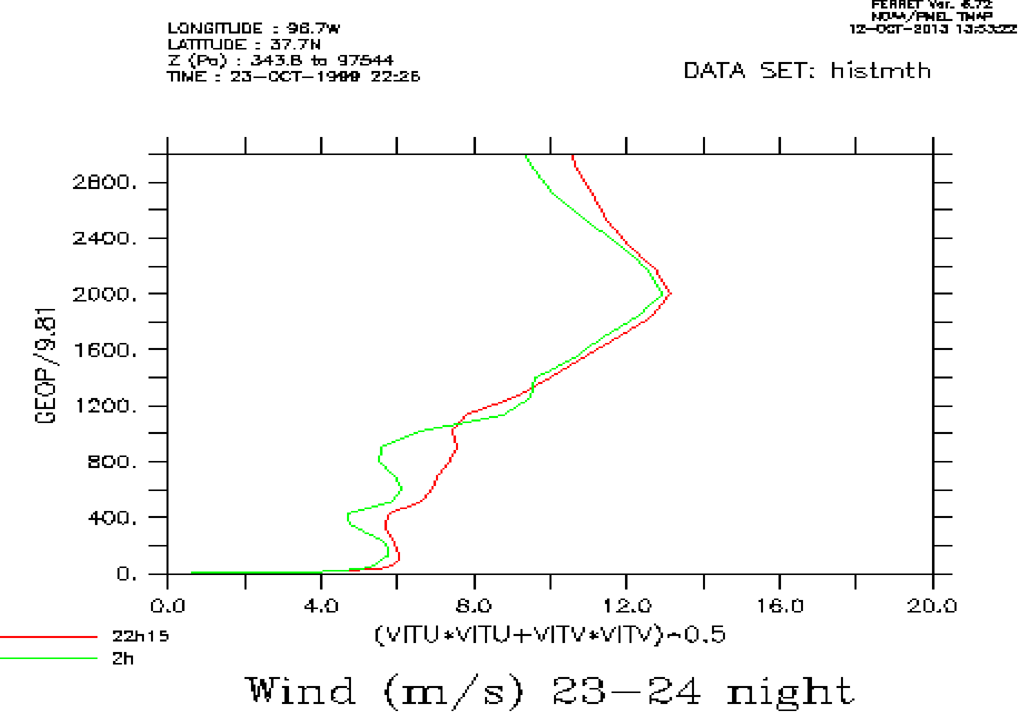
Theta profils during the 3 nights at 22h and 2h (K)

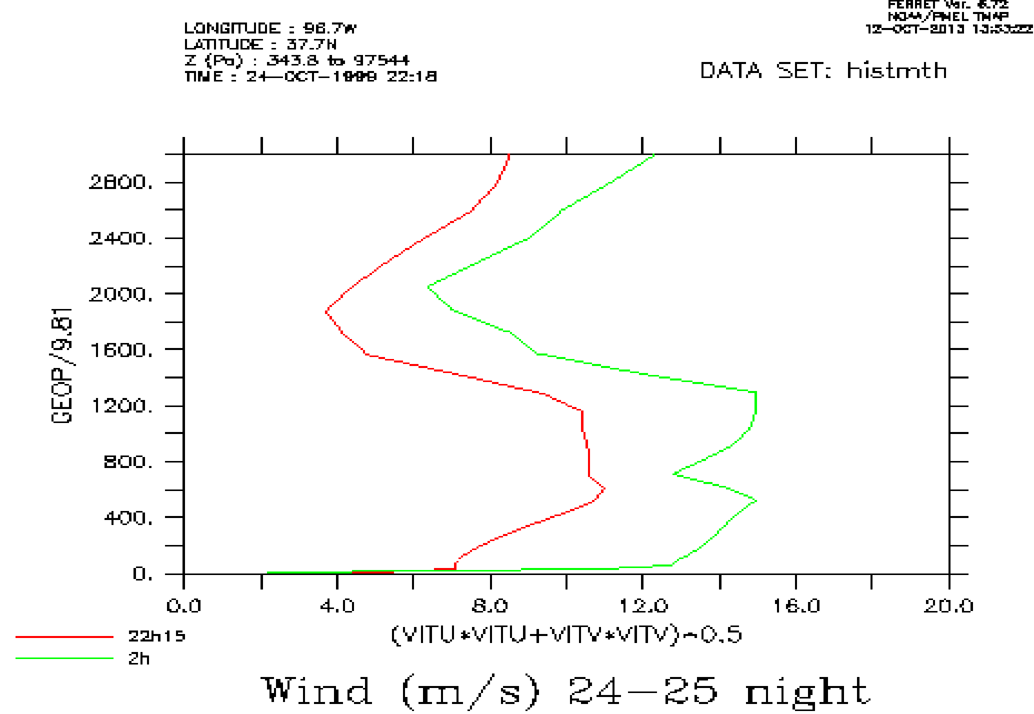


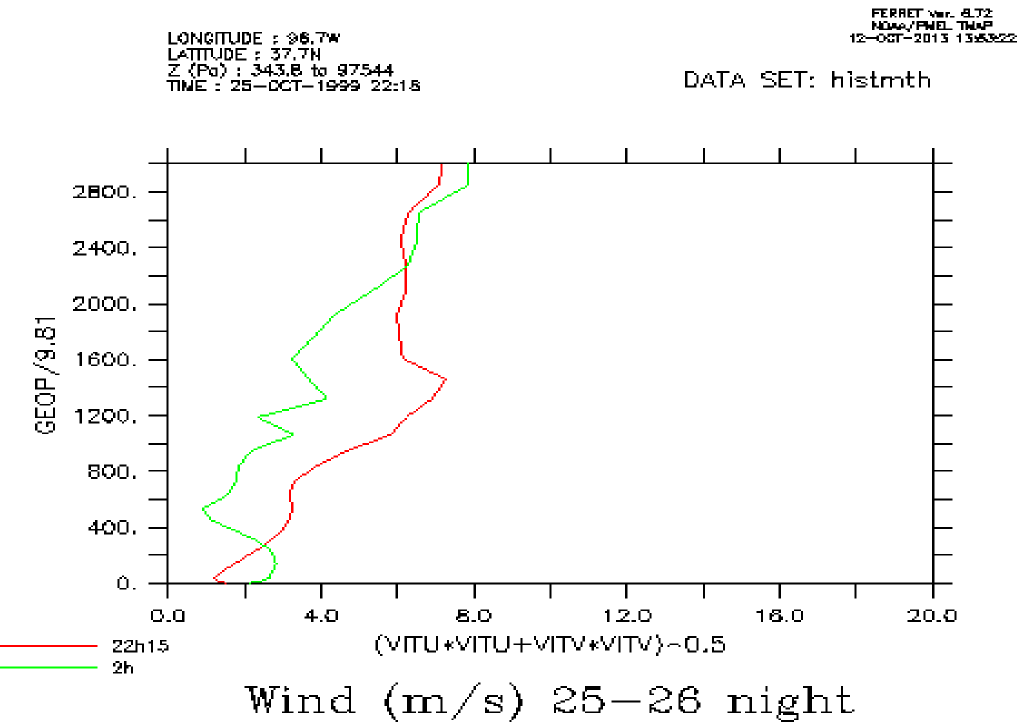




Qv profils during the 3 nights at 22h and 2h (g/kg)







Wind speed profils during the 3 nights at 22h and 2h (m/s)

Heat drag coefficient to low ?

Instability functions F_m and F_h for $R_{i0}>0$ (Louis et al., 1982):

$F_m = 1/1+2bR_{i0}\ (1+dR_{i0})^{-1/2}$

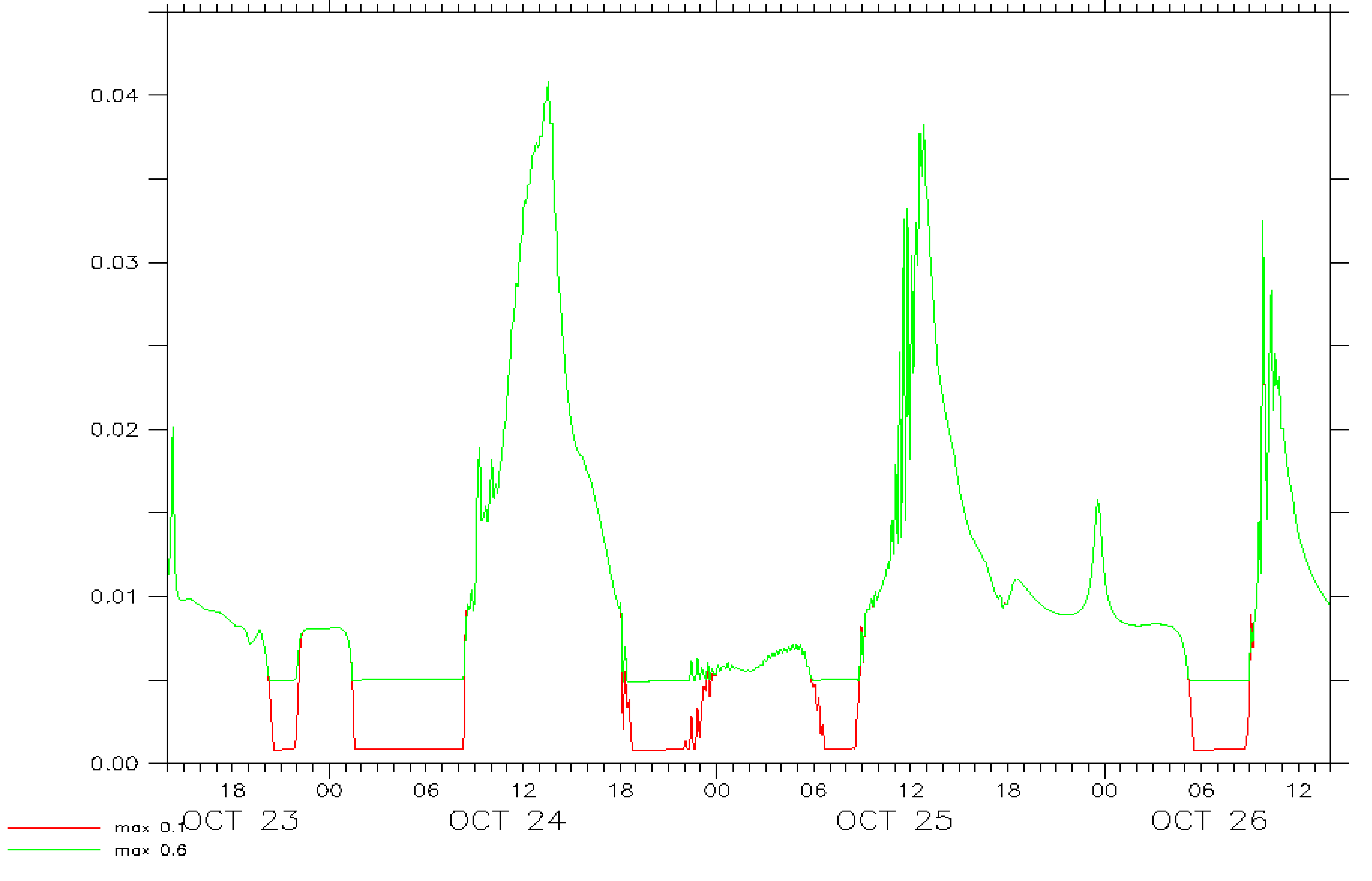
$F_h = 1/1+3bR_{i0}\ (1+dR_{i0})^{1/2}$

Where b=c=d=5

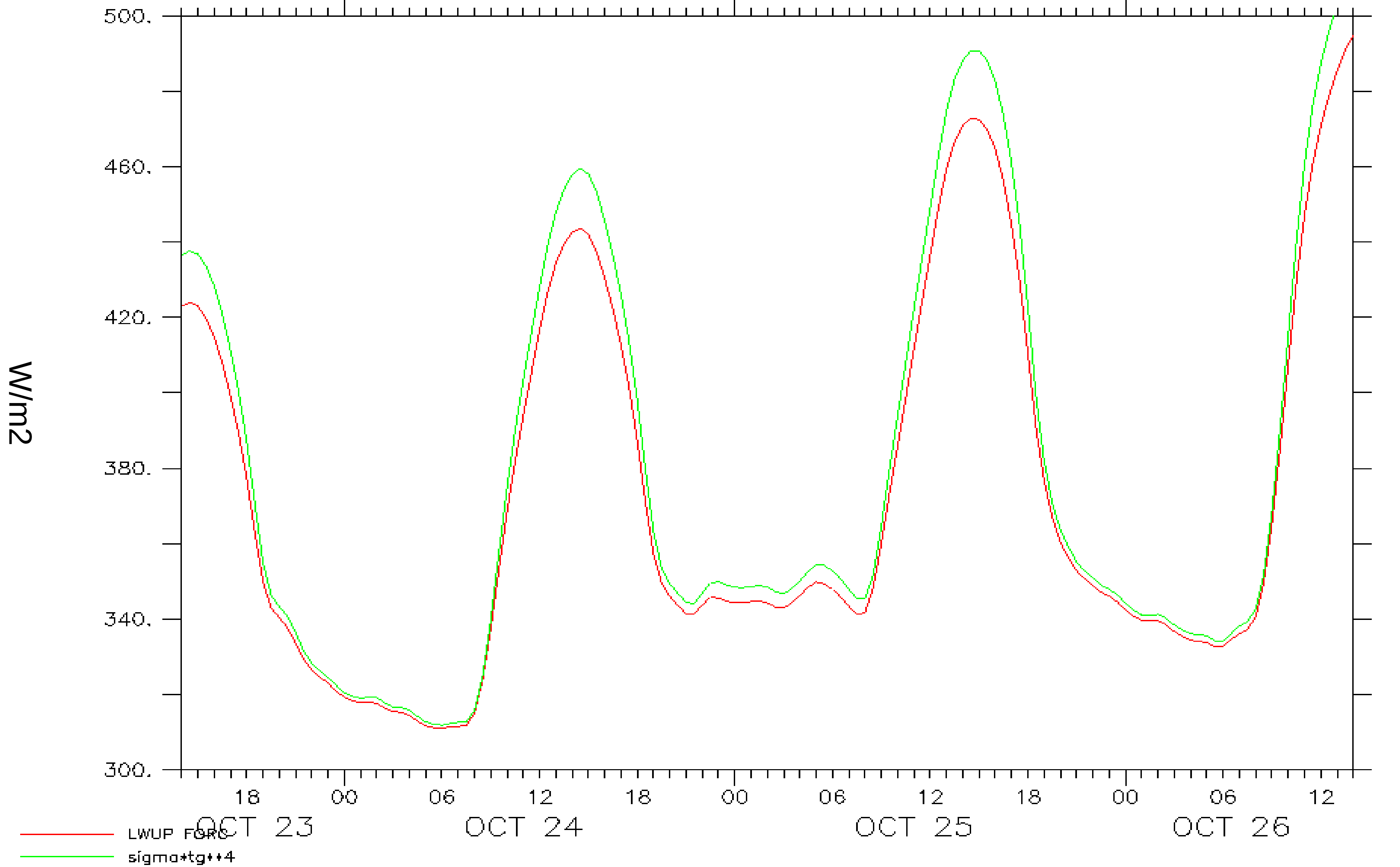
In LMDZ:

$F_m = \max\ (F_m, 0.1)$ --> 0.6

$F_h = \max\ (F_h, 0.1)$ --> 0.6



Sensitivity tests for heat drag coefficient

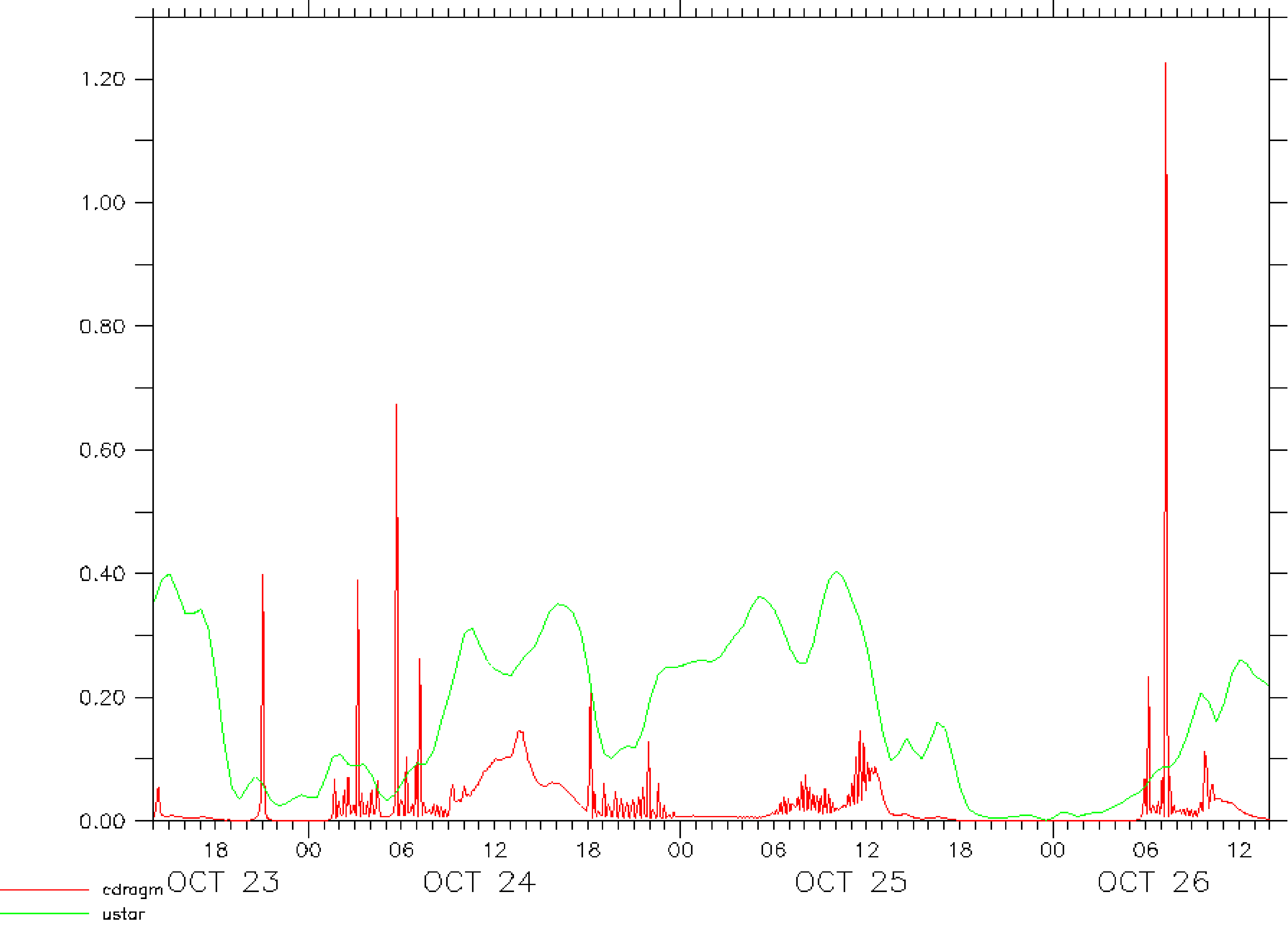


Why LWUP is not equal to $\sigma * T_g^4$?

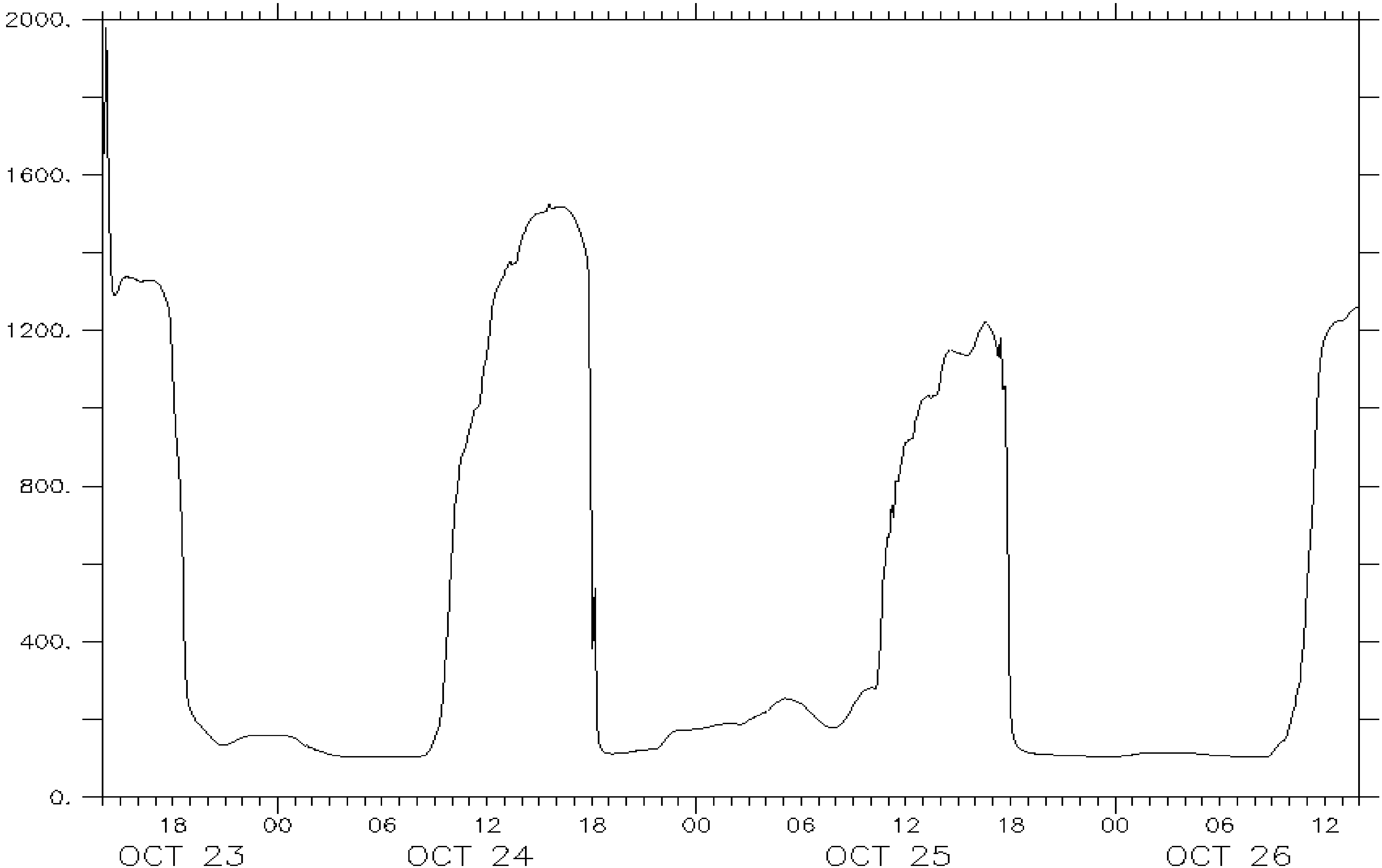
Conclusion:

Some extra work to do for a better representation of very stable boundary layers !

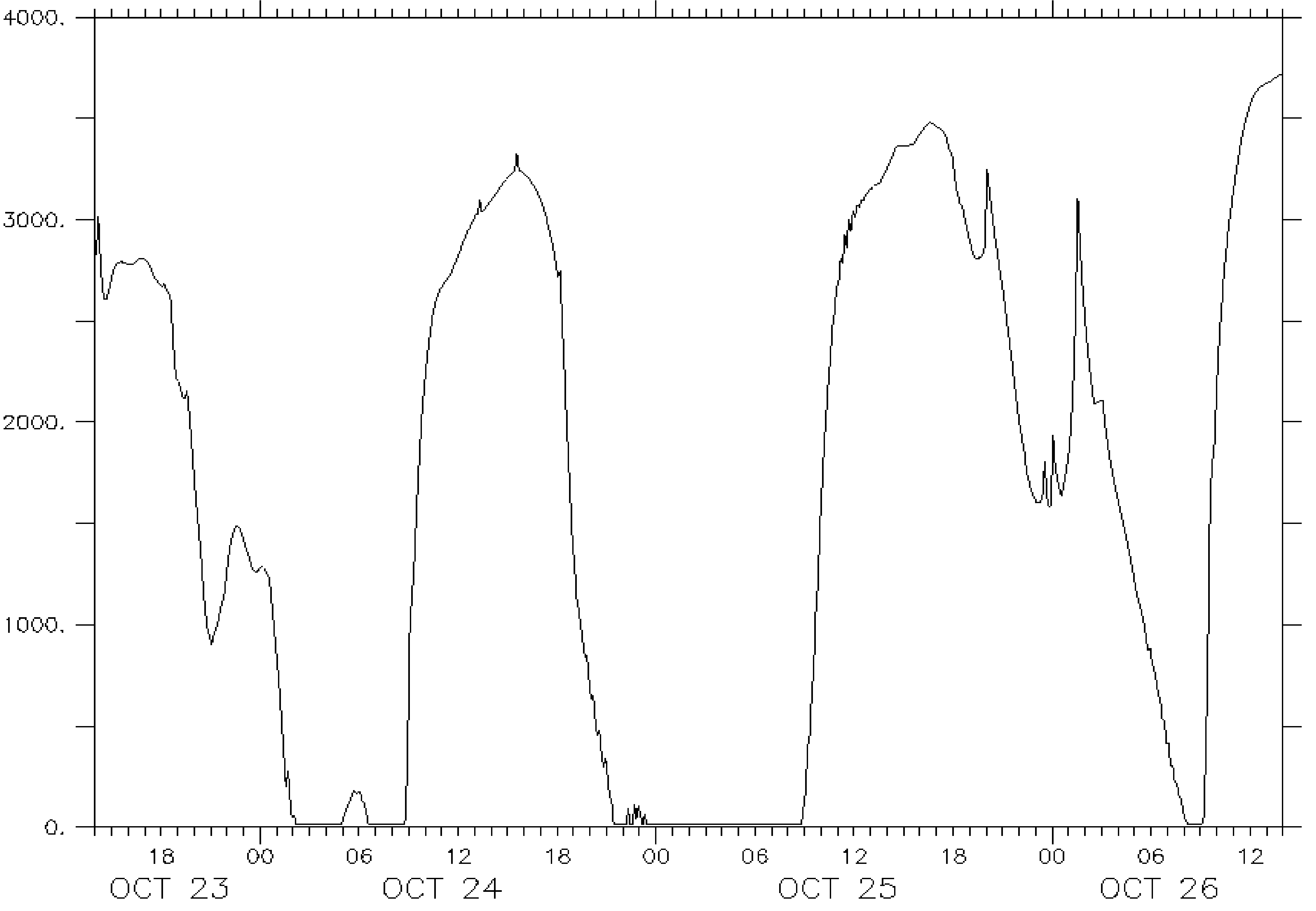
Thank you for your attention !



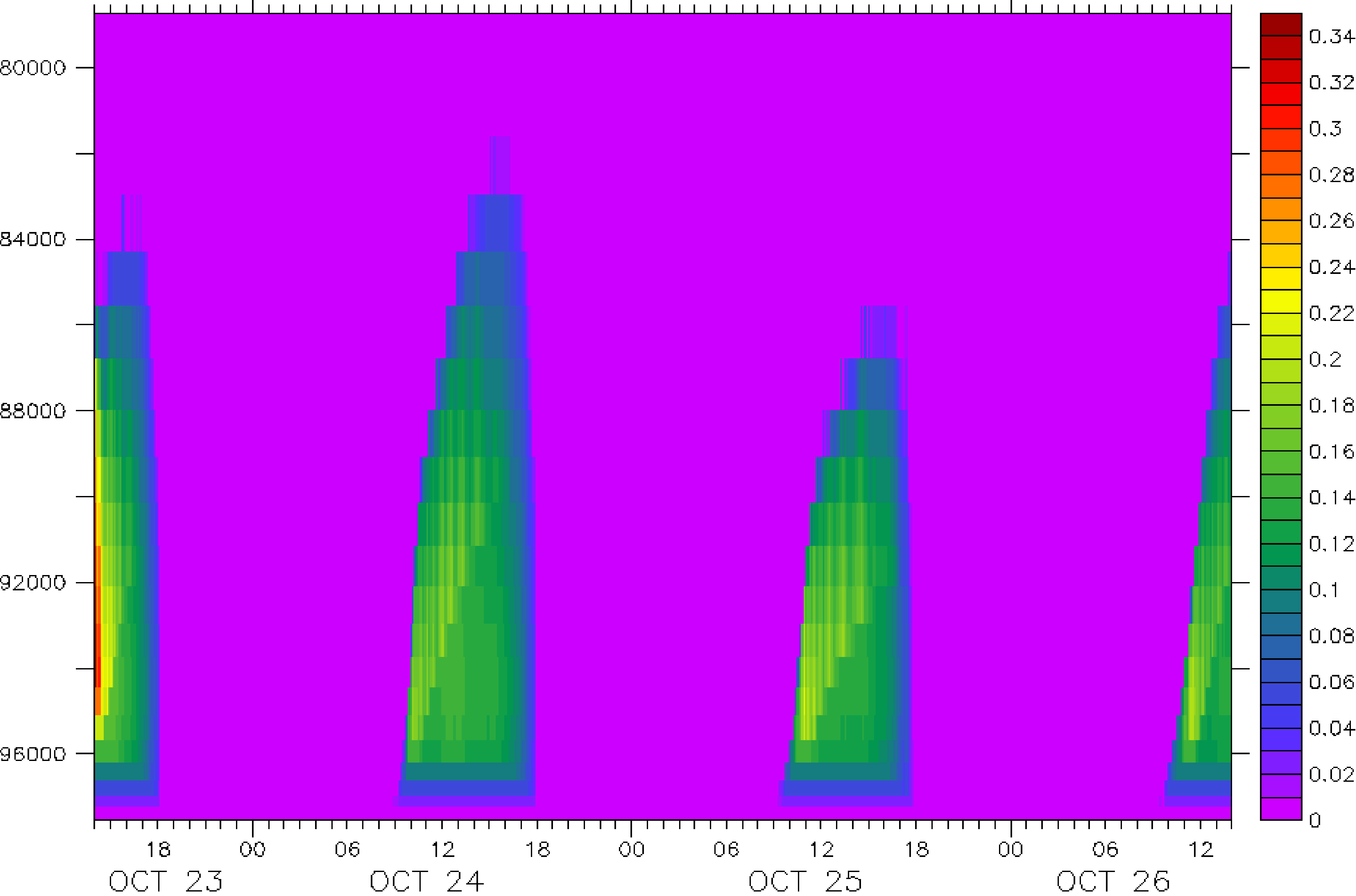
1.20
1.00
0.80
0.60
0.40
0.20
0.00
18
00
06
12
18
00
06
12
18
00
06
12
OCT 23
OCT 24
OCT 25
OCT 26
cdragm
ustar



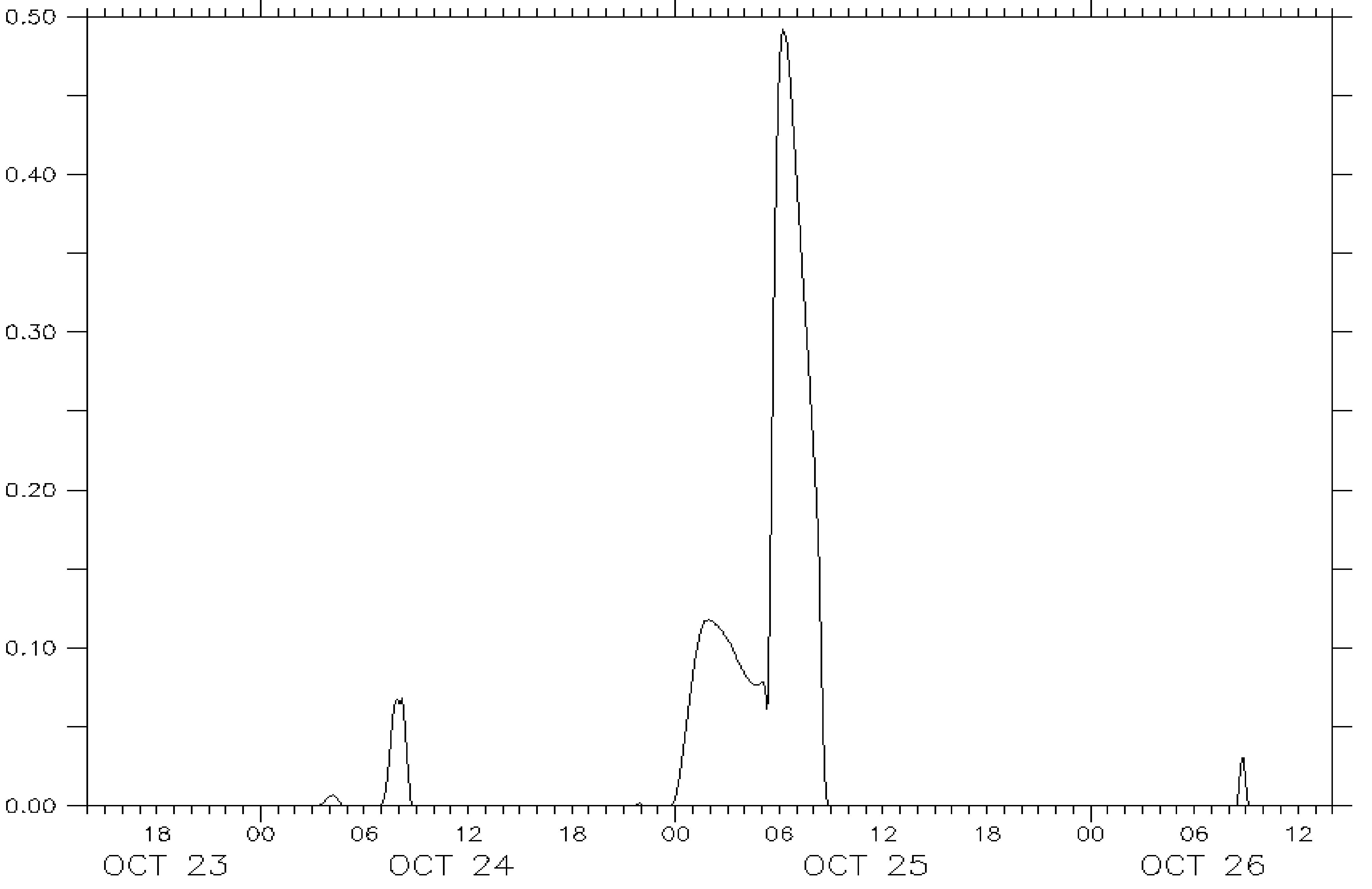
Boundary Layer height (m)



Level of condensation (m)



EDMF mass flux (kg/m2/s)



Precipitation (mm/day)