Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2016-499-AC1, 2016

Atmospheric Chemistry and Physics Discussions
Open Access

Interactive comment on "Application of a new scheme of cloud base droplet nucleation in a Spectral (bin) Microphysics cloud model: sensitivity to aerosol concentrations" *by* E. Ilotoviz and A. Khain

E. Ilotoviz and A. Khain

alexander.khain@mail.huji.ac.il

Received and published: 27 September 2016

We express our gratitude to Referee for the valuable comments and remarks.

Anonymous Referee #1

1. C. The paper relay heavily on the theoretical work presented in Pinsky 2012 and previous works. It would be nice to have this paper on a more "standalone mode". A summary of the main assumptions and derivations would make it much useful.

(R) We added more details in description of the approach in Section 2 (model description). A short derivation of the basic equation for supersaturation maximum is presented in new Appendix.

2. C. On the same note, throughout the paper the validation of the new scheme (NA) should be better explained. When the results are compared to a one D model – is it a parcel model? When the authors state that the results of the NA are "much better" they should explain more on how they reached this conclusion.

(R) We used the parcel model to calculate supersaturation maximum and concentration using CCN distribution and vertical velocity at the cloud base as in the HUCM simulations. New Fig 2 shows that New Approach produces the values of supersaturation and droplet concentrations much closer to "exact" values obtained by the parcel model than to the values obtained in ST.

3. (C) Does the model with the new scheme assigns Smax as the supersaturation for all of the gridbox near cloud base? If yes wouldn't it results in an overestimation of the activation? If not please explain why? (R) The values of Smax are calculated at all grid points that we assume to be associated to cloud base (the first grid point from below at which). Some overestimation is possible in case of very high concentration as it is shown by Pinsky et al. (2012), but this error is substantially lower than in case Standard Approach is used.

4) (C) Is this parameterization done only for the gridbox near (above) cloud base? If yes how does the LCL is found? How sensitive is it to the location of the theoretical LCL within the gridbox? Say that in one case the theoretical LCL is toward the upper part of the gridbox, wouldn't it make more sense to assign the Smax parameter to the gridbox above? How sensitive it is to such details?

(R) We determine the model cloud base in the way described in the response above. In this approach, the grid point is slightly above the theoretical LCL, because we use condition . At the same time, the calculations performed according to Pinsky et al. (2012) show that the level where is located, i.e. from about 20 m (for high CCN concentration) to about 60 m (for low CCM concentration) is higher than the LCL. The estimations show, therefore, that the level where is quite close to the model cloud base level. Accordingly, the droplet concentration determined at is assigned to the corresponding grid point at the model cloud base. We believe that the fact that we assign the droplet concentration calculated at the point of Smax to the lower model level, where ,does not lead to serious errors.

5) (C) Smax and N (number of activated droplets) are coupled. Smax depends on N and N (or r(critical for activation)) on Smax. Could the authors explain how they solve them both and it the analytical parametrization? I guess one equation is eq. 3 but another equation is needed.

(R) Detailed explanations are added in Section 2.

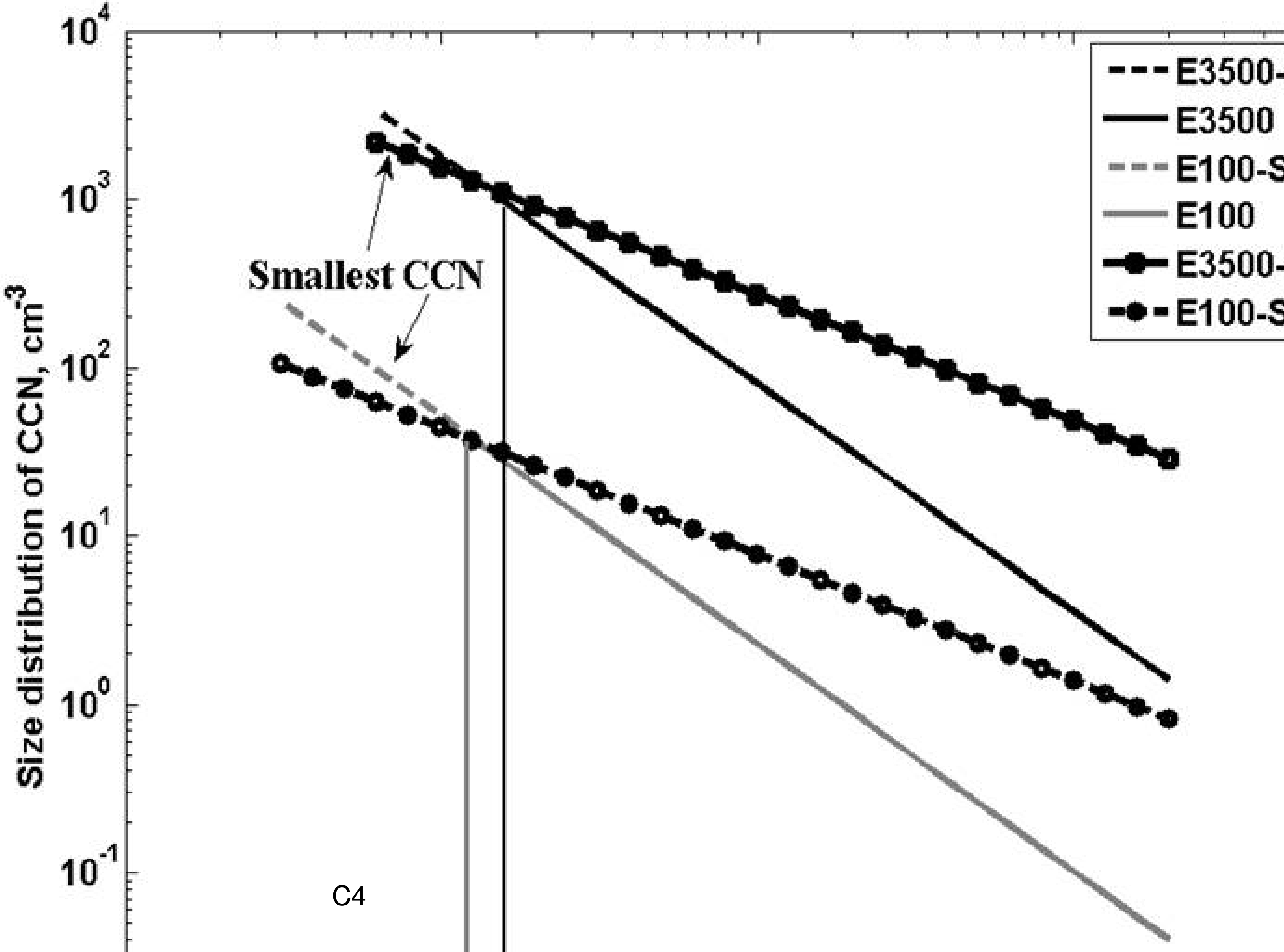
Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/acp-2016-499/acp-2016-499-AC1-supplement.pdf

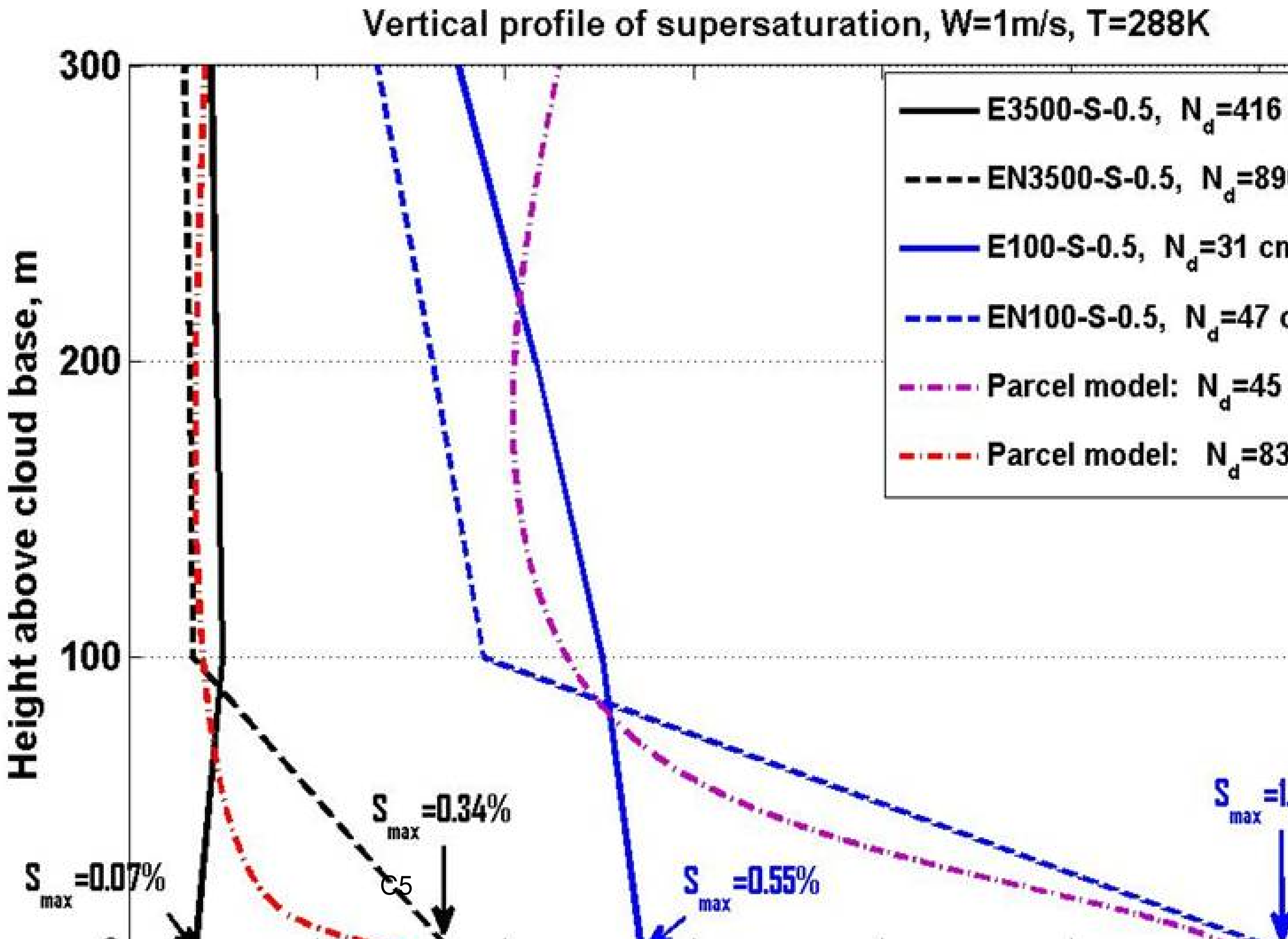
---

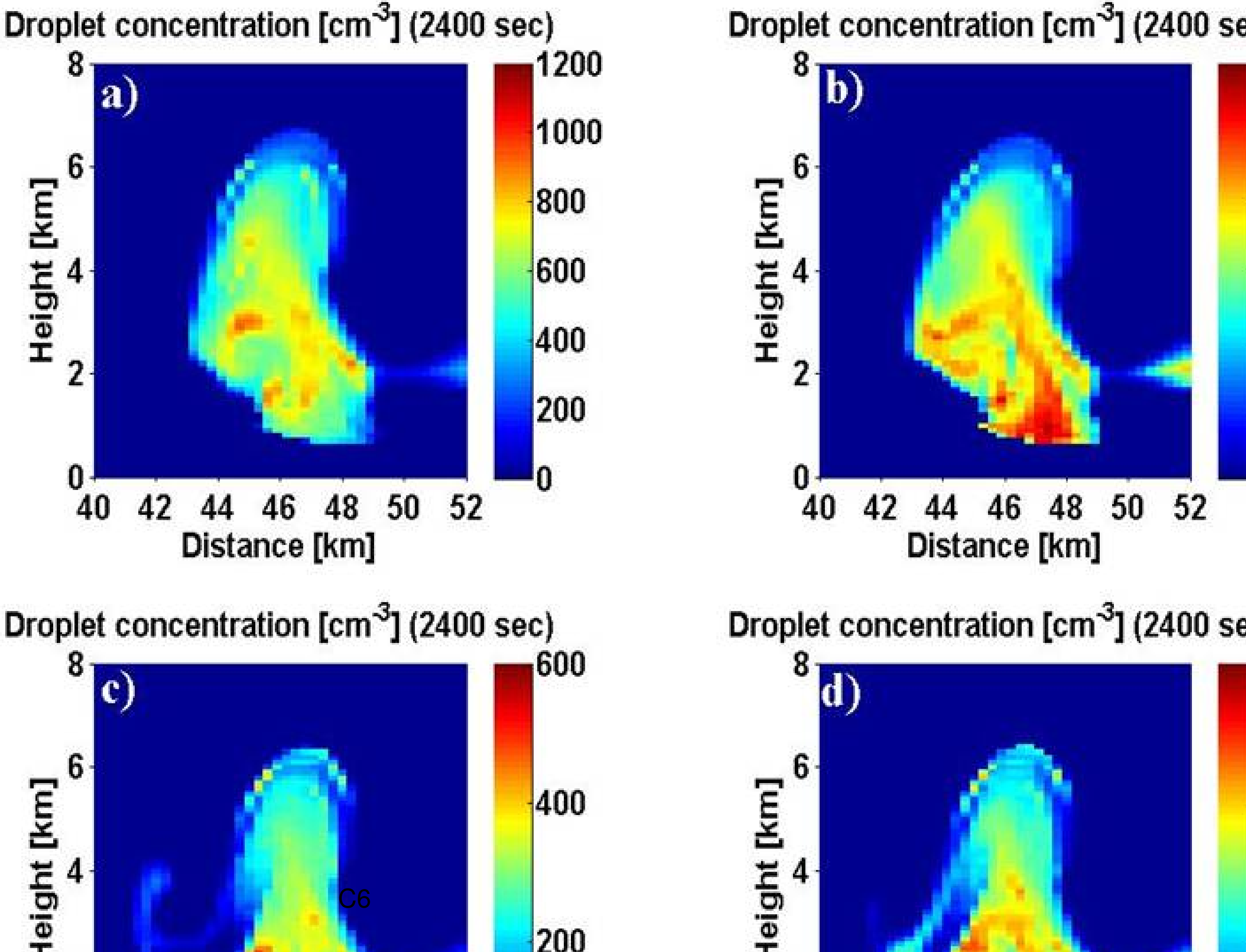
Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-499, 2016.

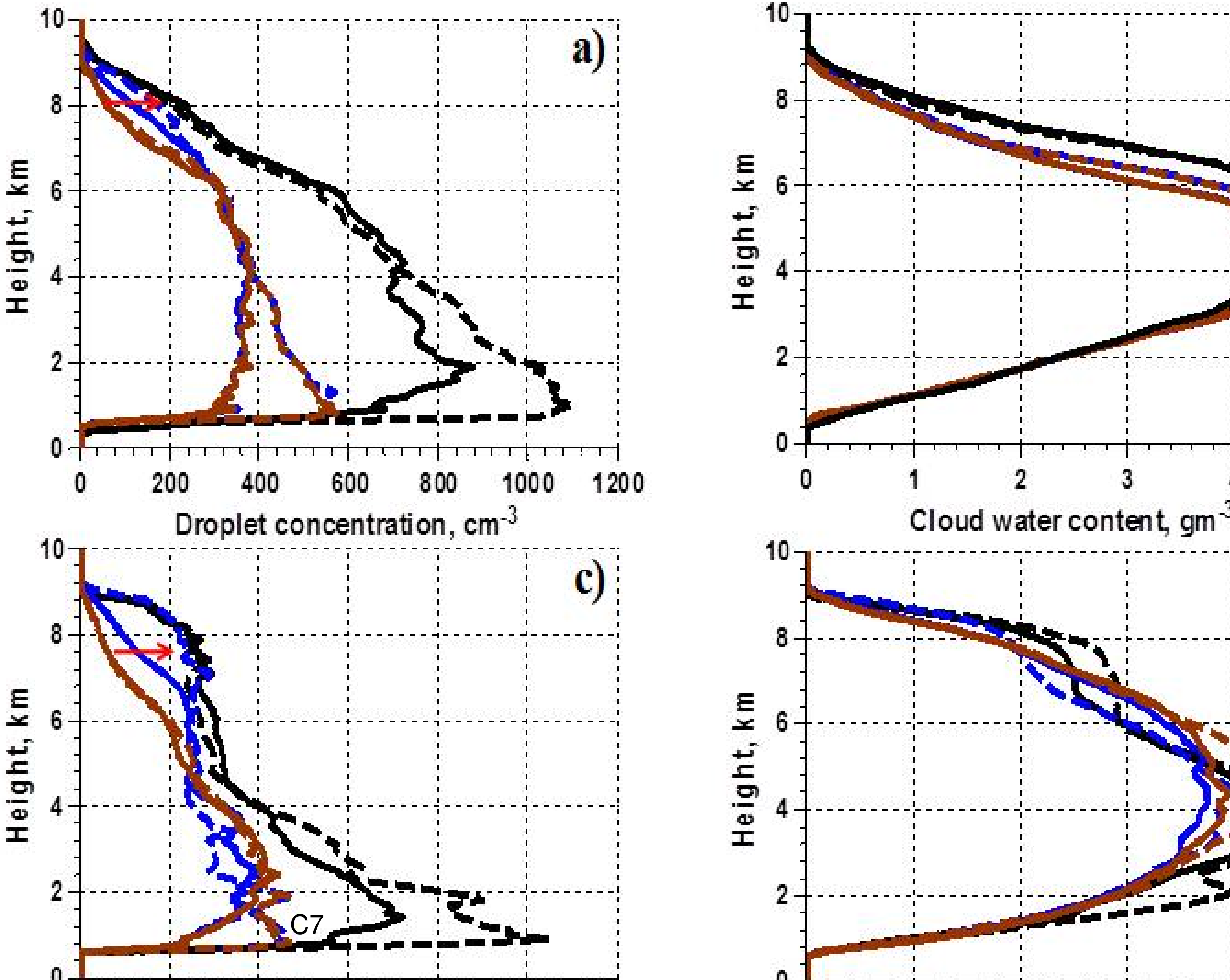
Printer-friendly version

Discussion paper

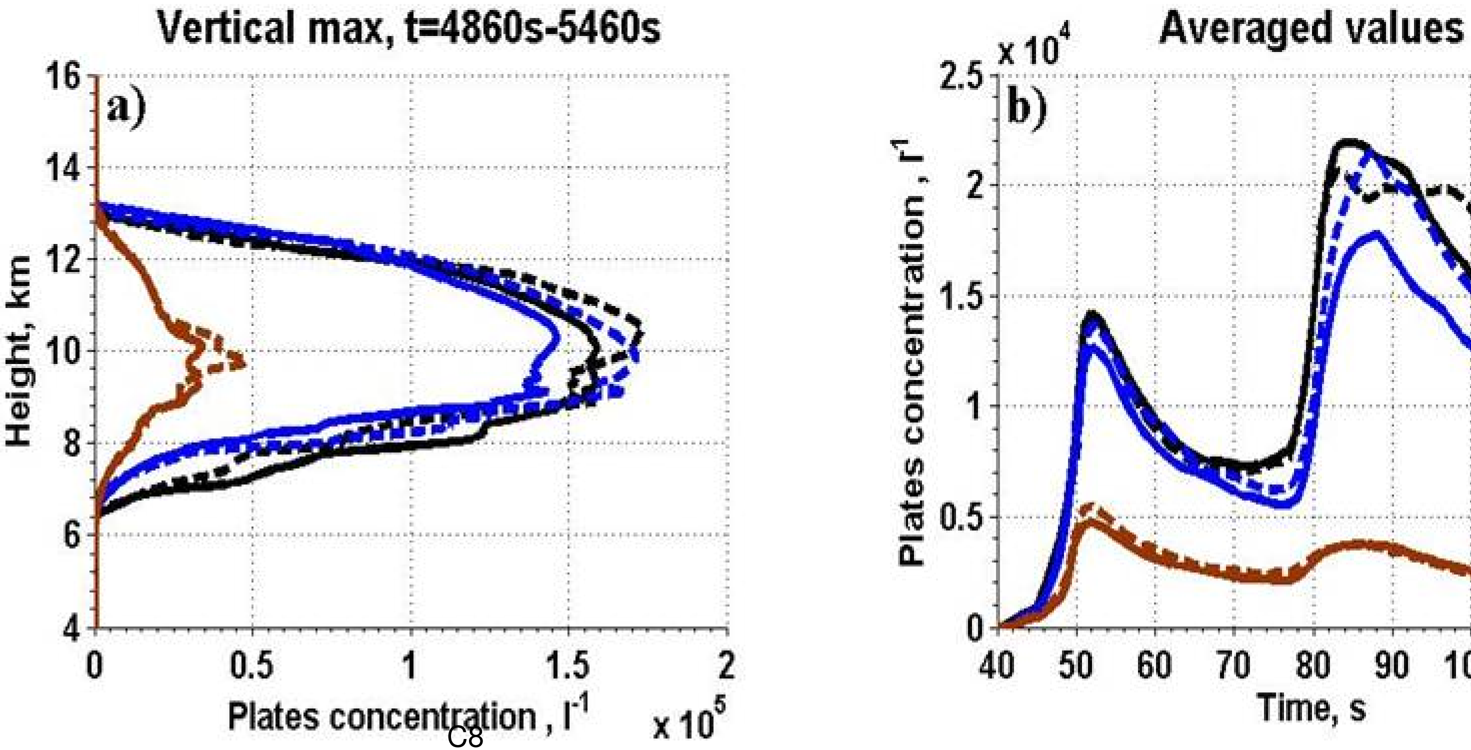

Size distribution of CCN, cm^{-3}
10^4
10^3
10^2
10^1
10^0
10^{-1}
Smallest CCN
E3500
E100
C4


Vertical profile of supersaturation, W=1m/s, T=288K
Height above cloud base, m
300
200
100
E3500-S-0.5, N_d=416
EN3500-S-0.5, N_d=89
E100-S-0.5, N_d=31 cn
EN100-S-0.5, N_d=47 c
Parcel model: N_d=45
Parcel model: N_d=83
S_max=0.34%
S_max=0.07%
S_max=0.55%
C5

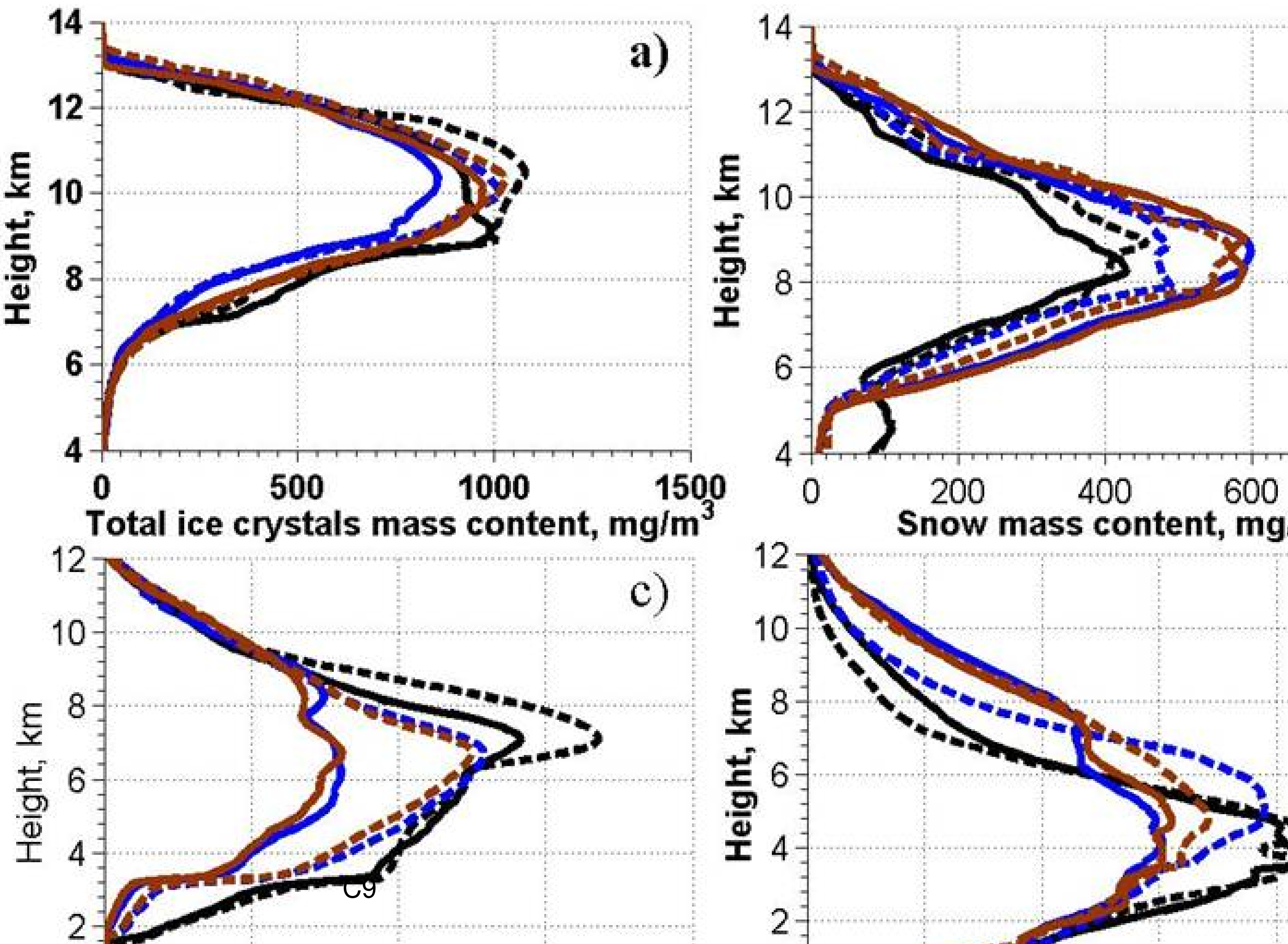

Droplet concentration [cm-3] (2400 sec)
a)
Height [km]
Distance [km]
Droplet concentration [cm-3] (2400 se
b)
Height [km]
Distance [km]
Droplet concentration [cm-3] (2400 sec)
c)
Height [km]
Droplet concentration [cm-3] (2400 se
d)
Height [km]

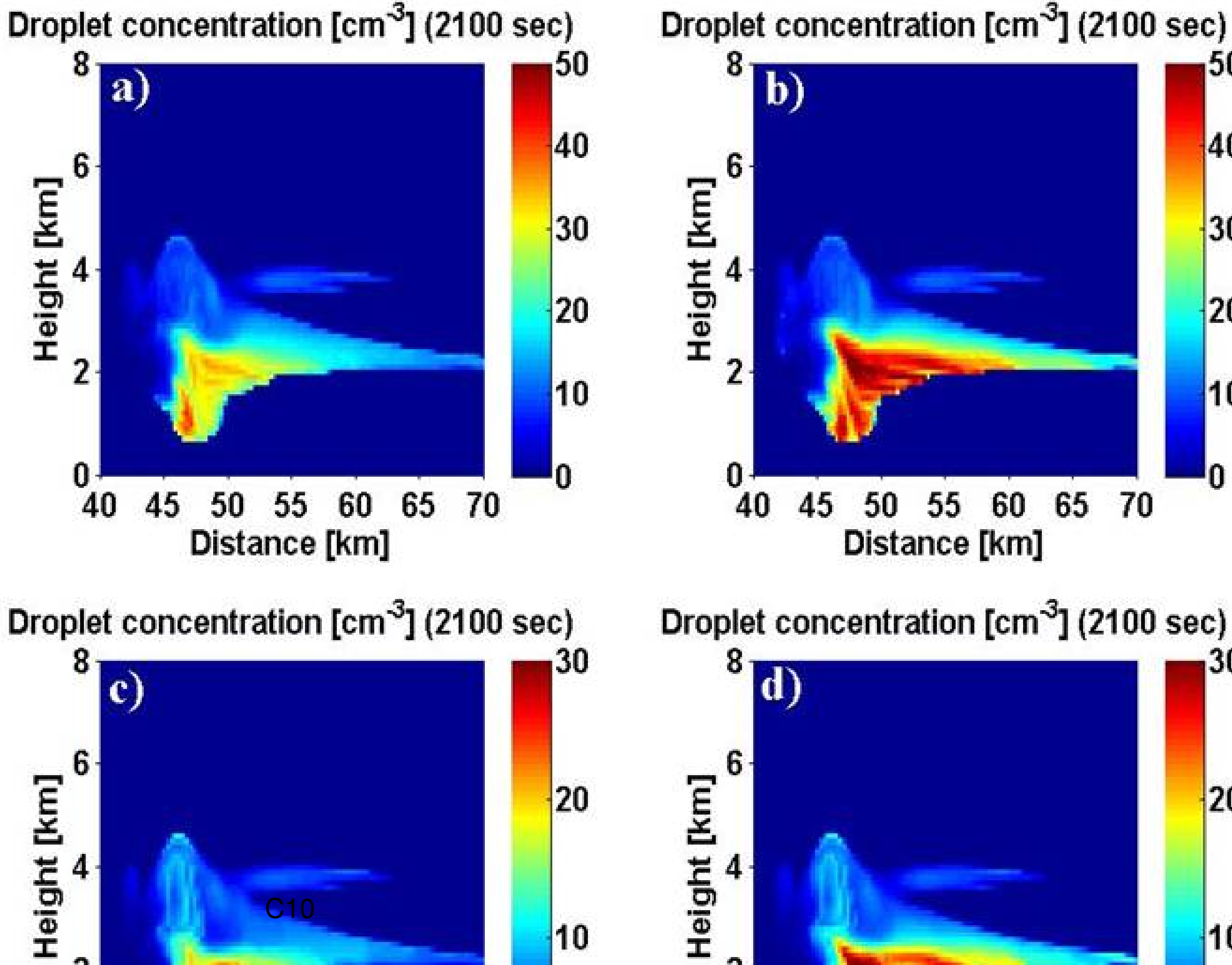


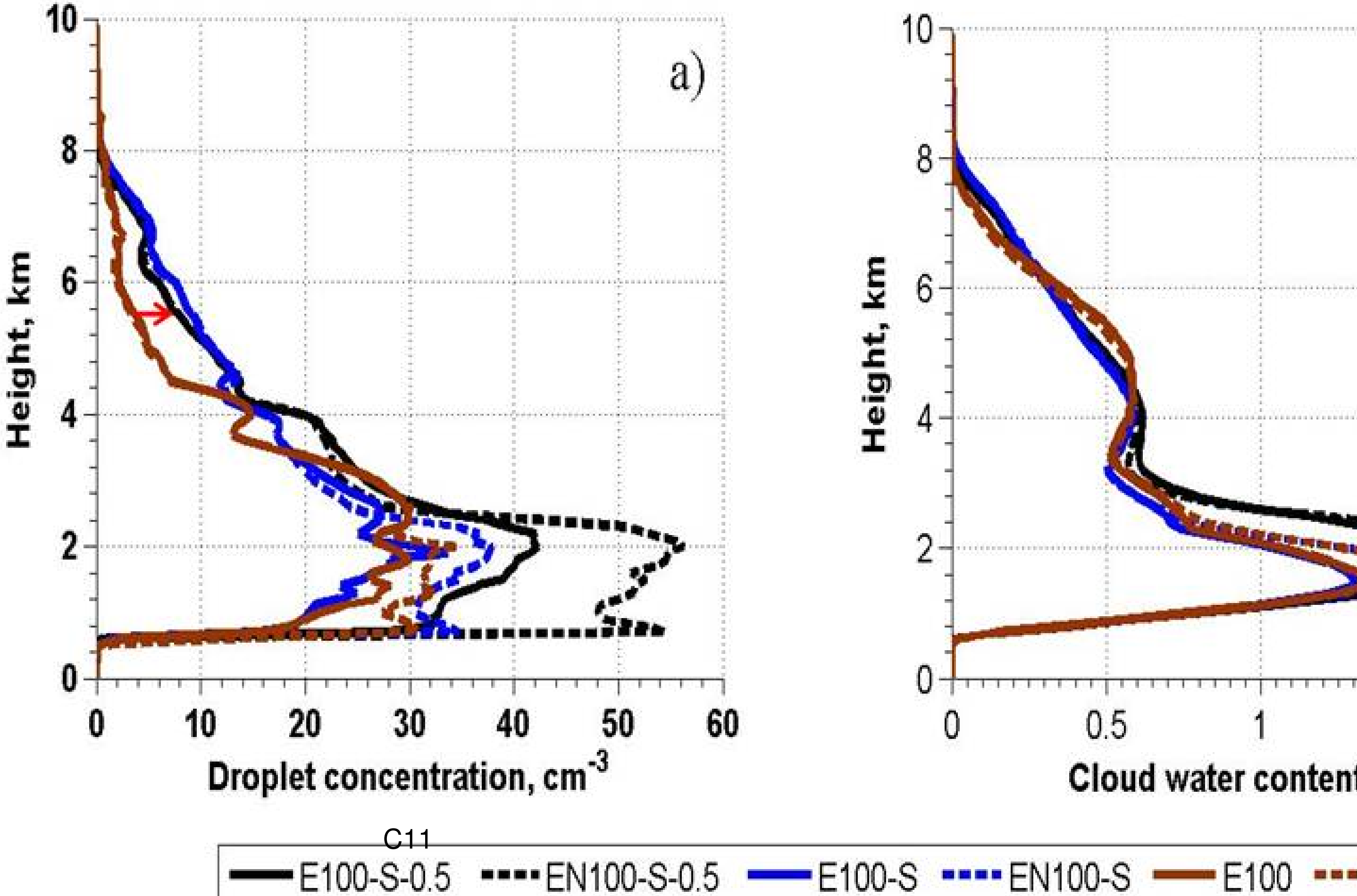
a)
c)
C7
Height, km
Height, km
Height, km
Height, km
10
8
6
4
2
0
0
200
400
600
800
1000
1200
Droplet concentration, cm-3
0
1
2
3
Cloud water content, gm



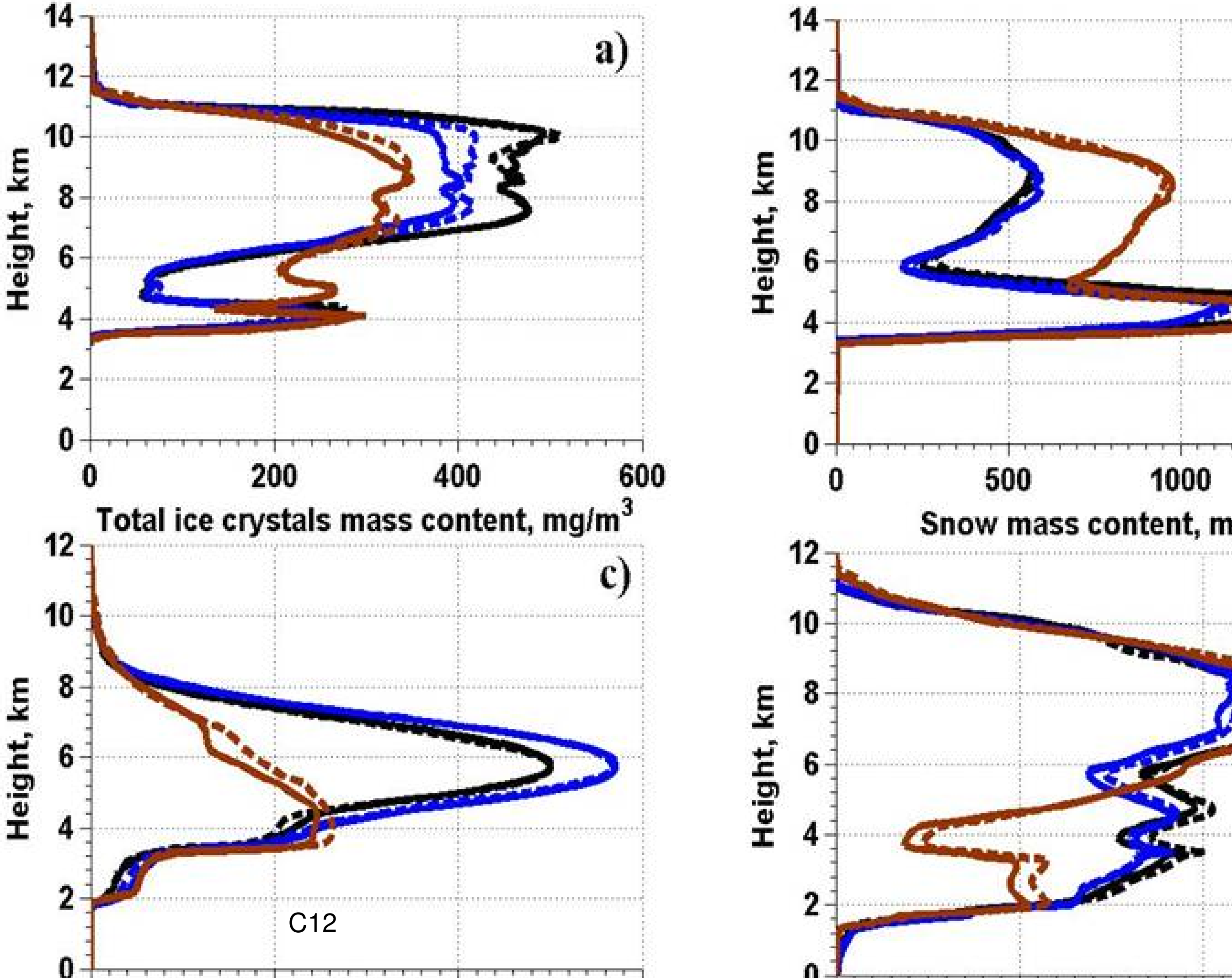
Vertical max, t=4860s-5460s
a)
Height, km
Plates concentration , l-1
x 10^5
Averaged values
x 10^4
b)
Plates concentration , l-1
Time, s


a)
Height, km
Total ice crystals mass content, mg/m3
Height, km
c)
Height, km
Height, km


Droplet concentration [cm-3] (2100 sec)
a)
b)
c)
d)
Height [km]
Distance [km]
0 2 4 6 8
40 45 50 55 60 65 70
0 10 20 30 40 50
10 20 30



a)
Height, km
Droplet concentration, cm^{-3}
Cloud water content
E100-S-0.5
EN100-S-0.5
E100-S
EN100-S
E100


a)
Height, km
Total ice crystals mass content, mg/m3
Snow mass content, m
c)
0
200
400
600
500
1000
14
12
10
8
6
4
2

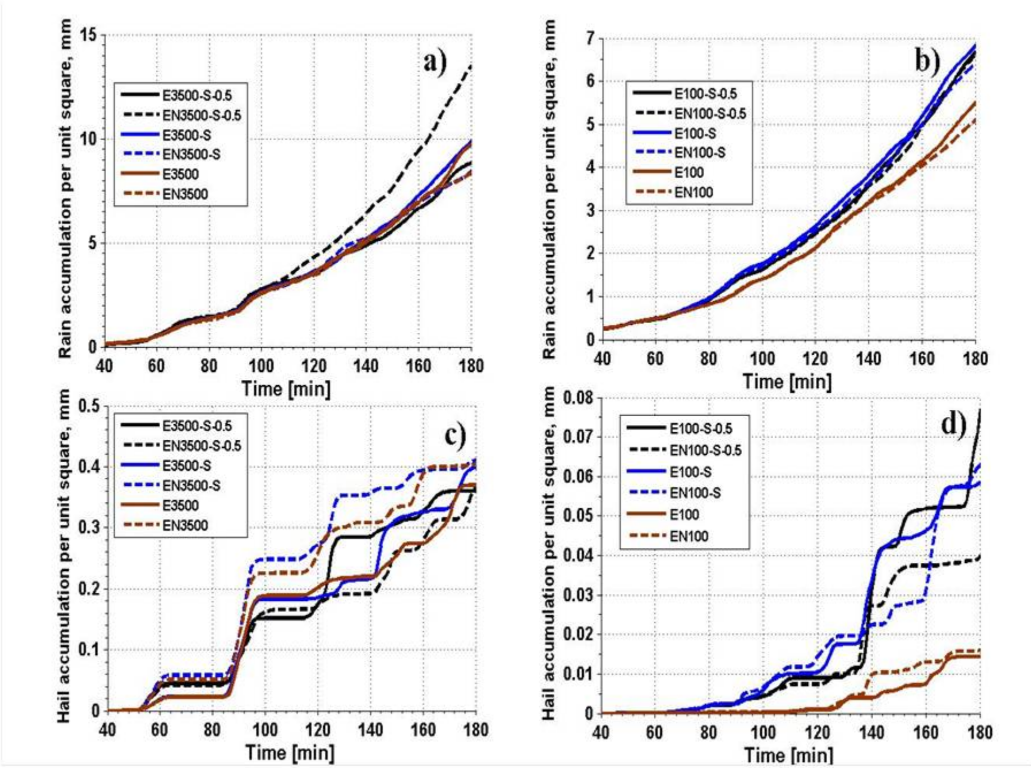


Fig. 10. Time dependencies of (a) accumulated rain at surface for polluted and (b) for clean. Accumulated hail at the surface for polluted (c) and for clean (d) in different simulations in polluted cases.