Supplementary Material

Impact of Physics Parameterizations on High-Resolution Air Quality Simulations over the Paris Region

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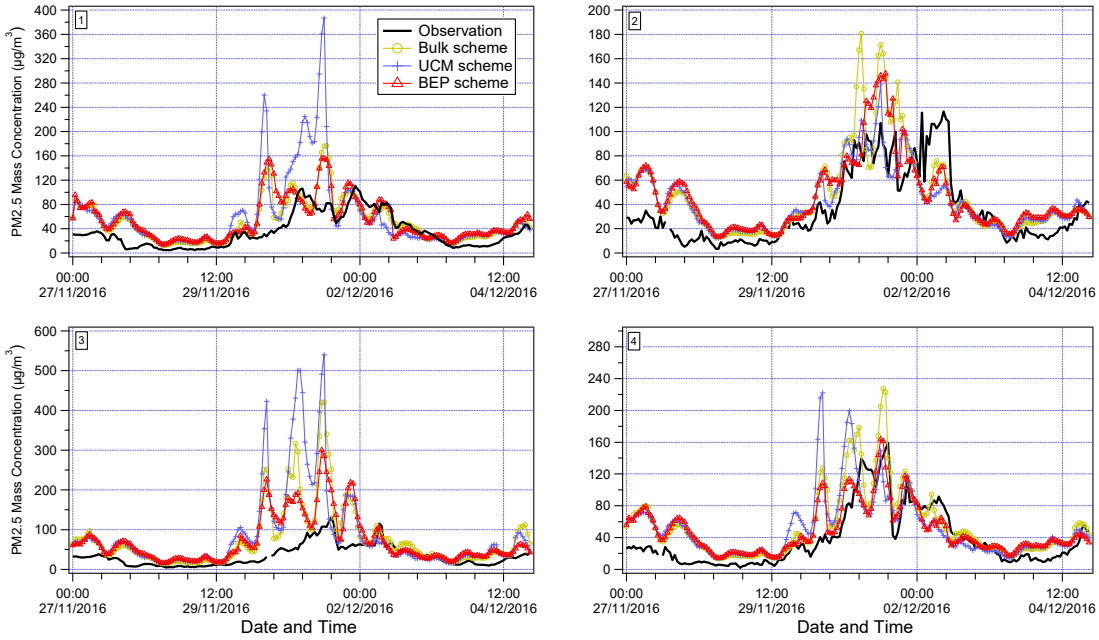
List.S1. Name list of WRF model

Table.S1. The urban parameters for the urban canopy model

Parameters	*URBAN-PAM1*	*URBAN-PAM2*
Buliding height	12 m	16.3 m
Roof width	3.75 m	25 m
Road width	11.25 m	16.6 m
Urban area ratio for a grid	0.95	0.95
Vegetation area ratio for a grid	0.95	0.95
Diurnal maximum of anthropogenic heat flux	50 w m^{-2}	50 w m^{-2}



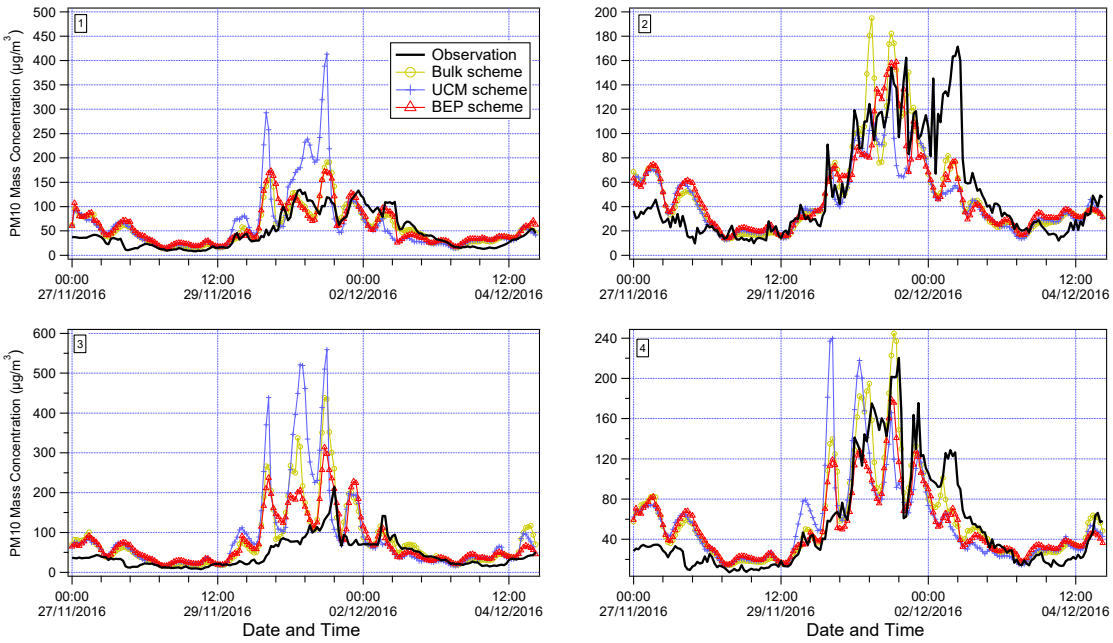
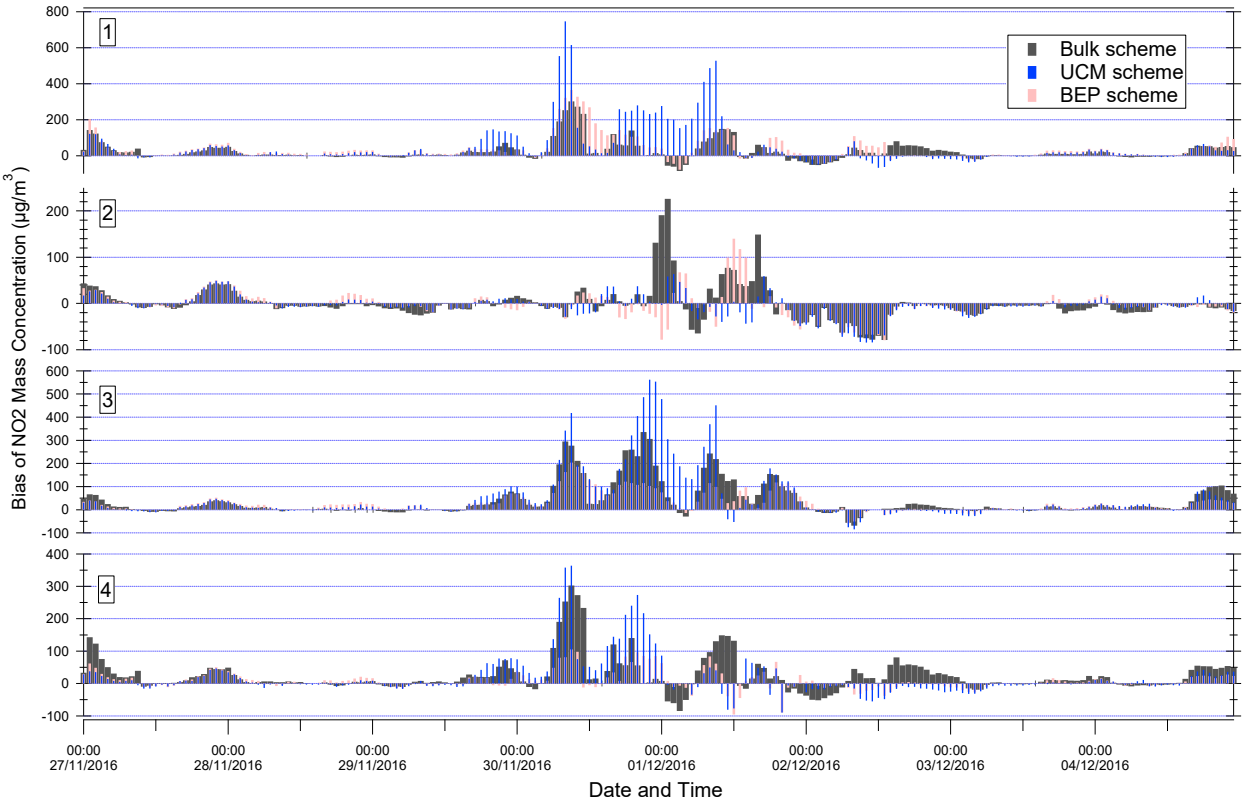
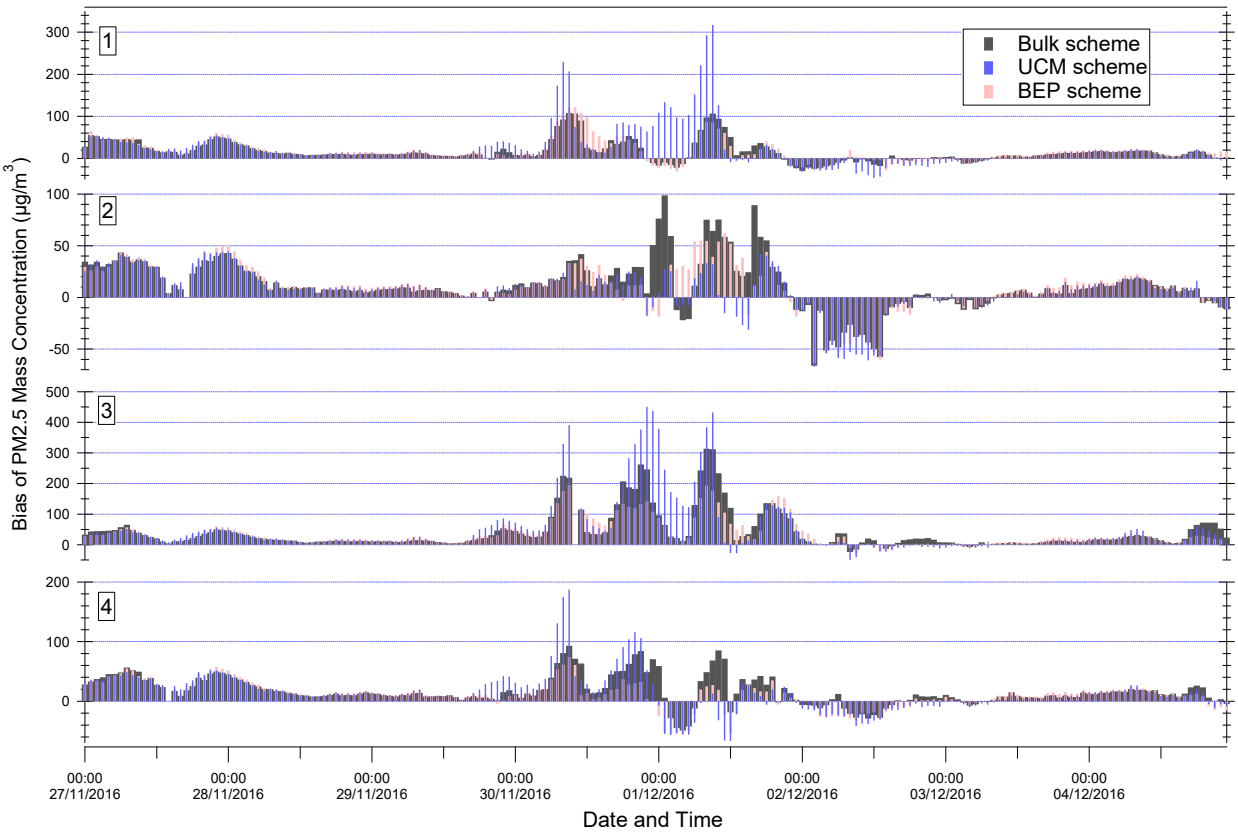


Figure S1. Time series of $PM_{2.5}$, PM_{10} mass concentrations (μg m^{-3}): No1, 2, 3, 4 represent station FR04002, FR04034, FR04143, FR04156, respectively.




Bulk scheme
UCM scheme
BEP scheme
1
2
3
4
Bias of PM2.5 Mass Concentration (μg/m3)
300
200
100
0
100
50
0
-50
500
400
300
200
100
0
200
100
0
00:00
27/11/2016
00:00
28/11/2016
00:00
29/11/2016
00:00
30/11/2016
00:00
01/12/2016
00:00
02/12/2016
00:00
03/12/2016
00:00
04/12/2016
Date and Time

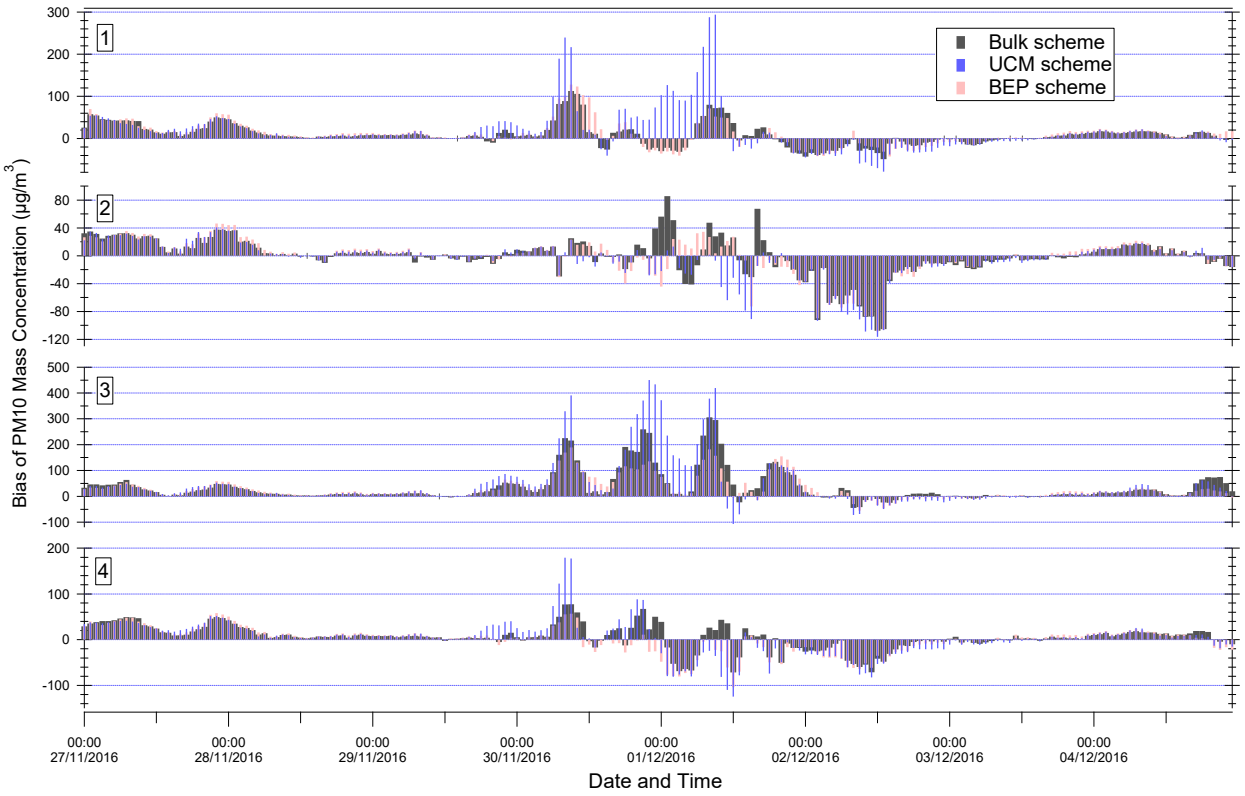


Figure S2. Time series of bias of NO_2, $PM_{2.5}$, PM_{10} mass concentrations: No1, 2, 3, 4 represent station FR002, FR034, FR143, FR156, respectively.

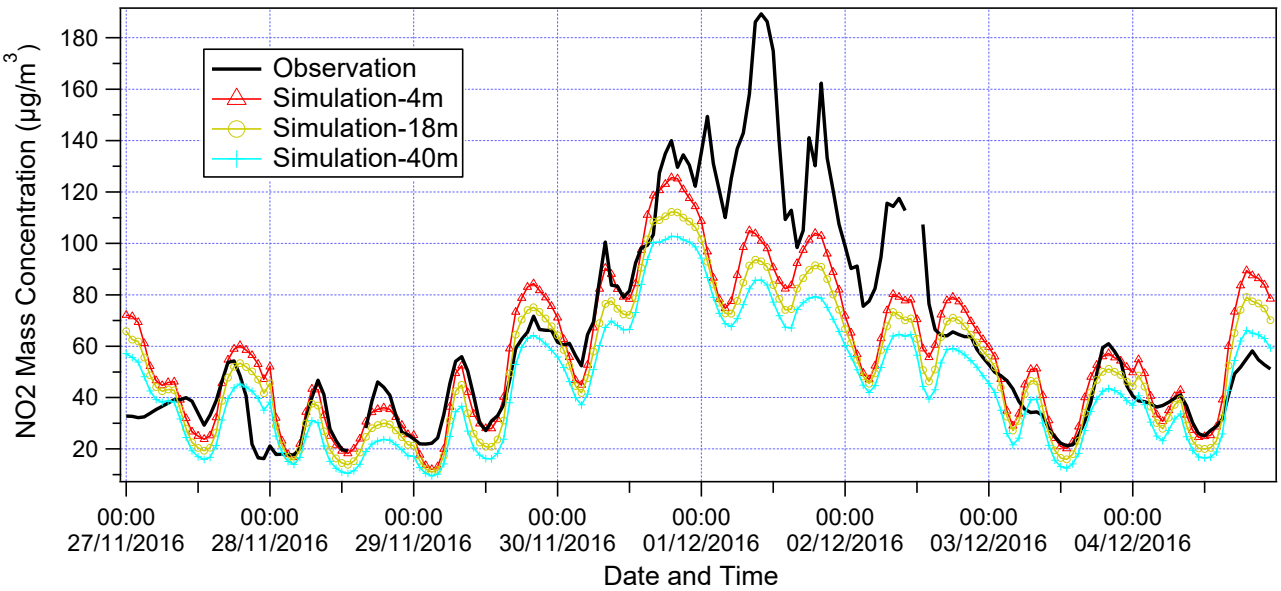
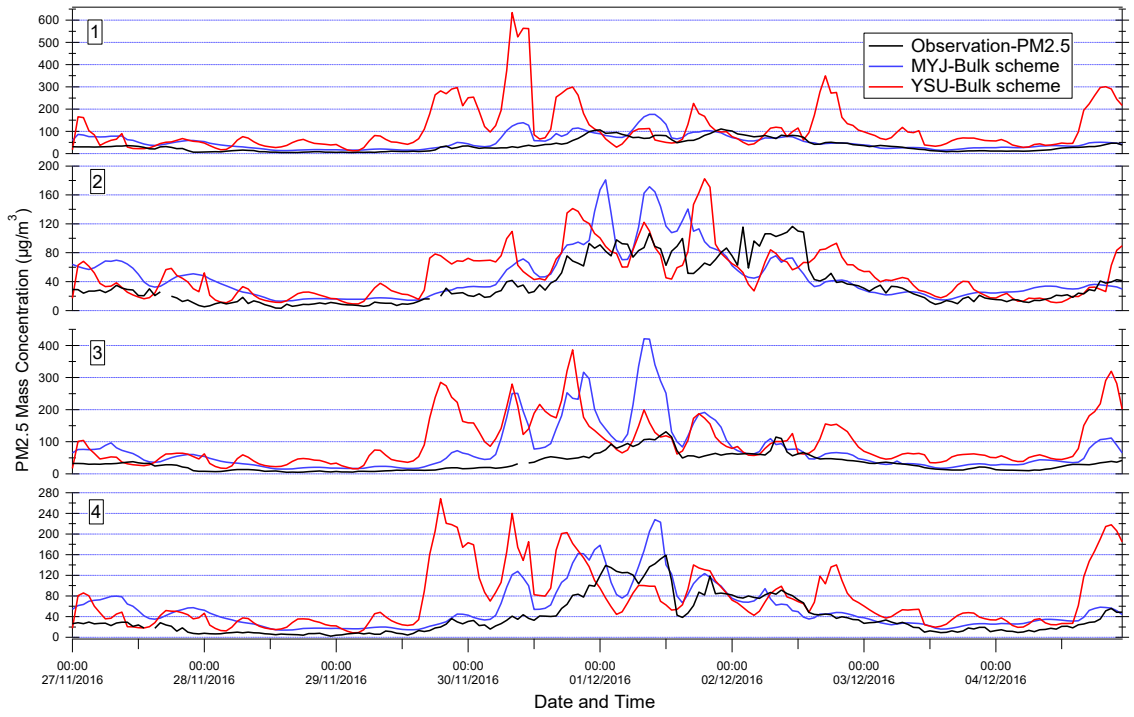
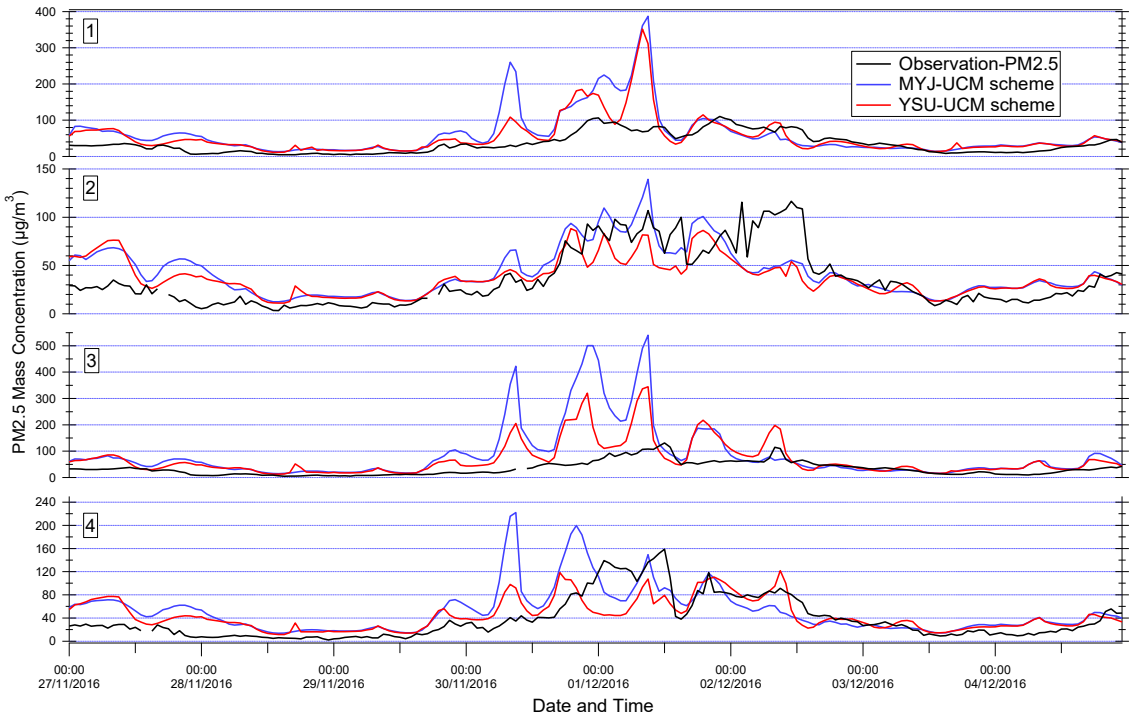


Figure S3. Time series between observed and modelled NO_2 with the first height of about 4 m, 18m and 40 m, respectively. Both observation and simulations are the average of Station FR04002, FR04034, FR04143, FR04156, respectively.





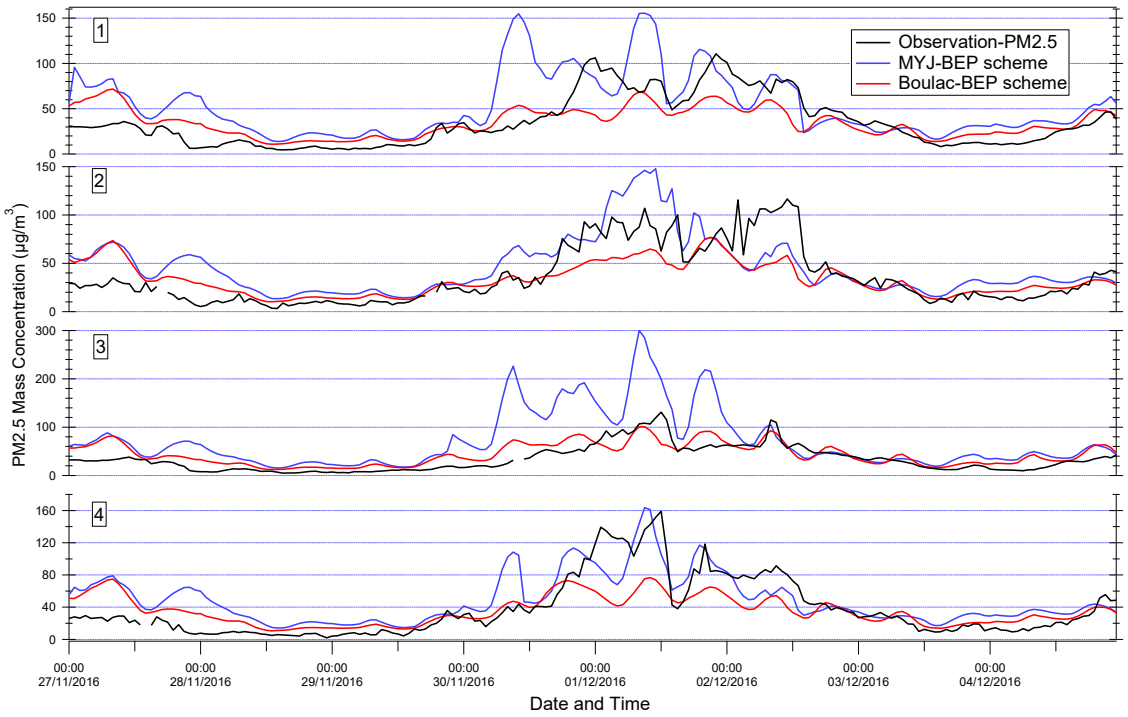
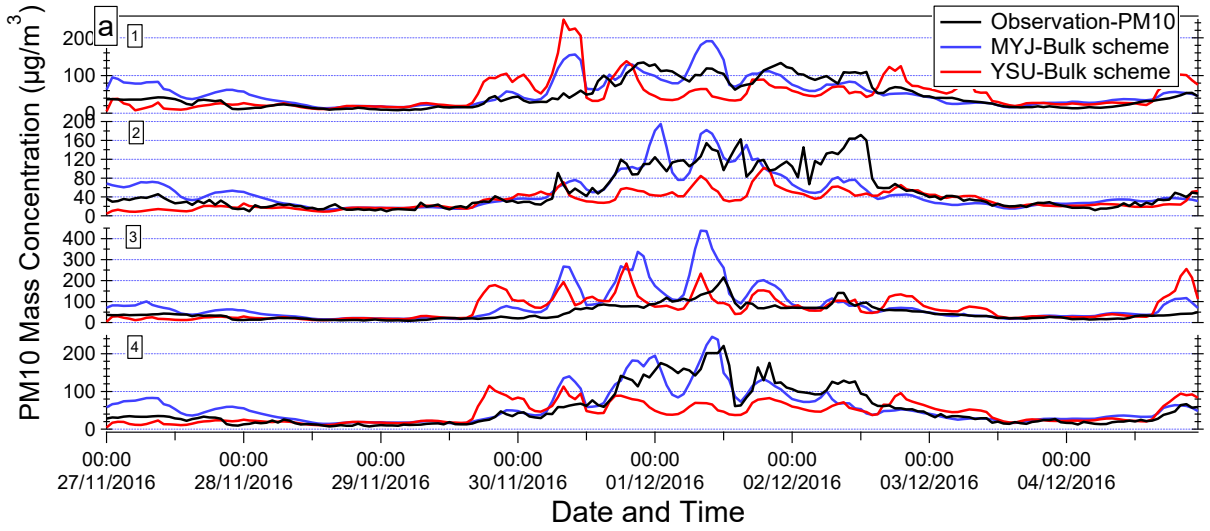
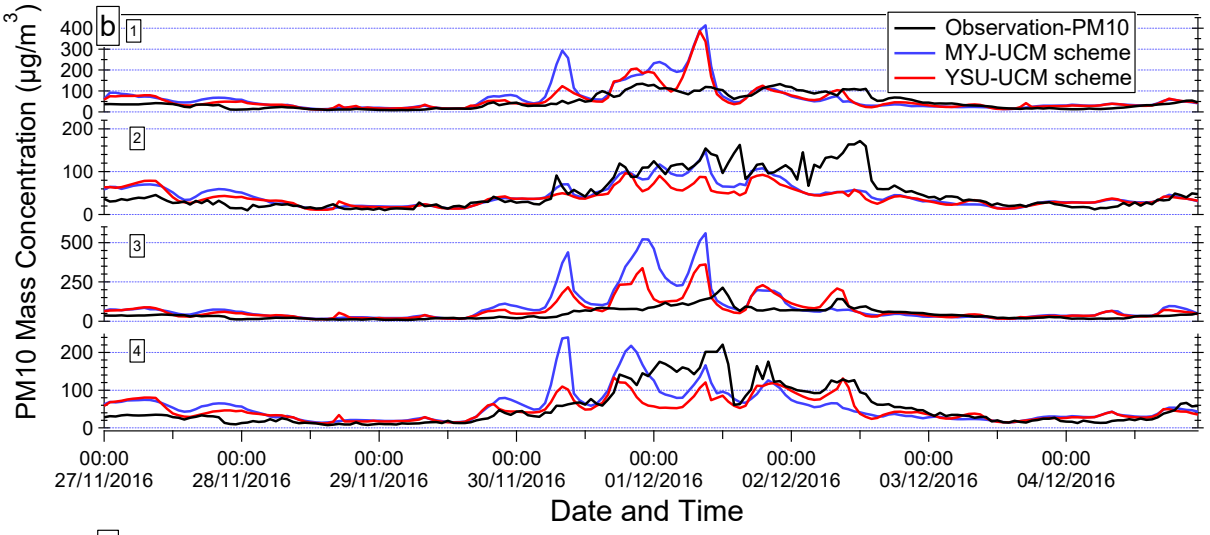


Figure S4. Time series between observed and modelled $PM_{2.5}$: a, b and c represent each PBL schemes coupled with each urban canopy schemes respectively; 1, 2, 3, and 4 represent Station FR04002, FR04034, FR04143, FR04156,, respectively


a
Observation-PM10
MYJ-Bulk scheme
YSU-Bulk scheme
PM10 Mass Concentration (μg/m3)
Date and Time
00:00 27/11/2016
00:00 28/11/2016
00:00 29/11/2016
00:00 30/11/2016
00:00 01/12/2016
00:00 02/12/2016
00:00 03/12/2016
00:00 04/12/2016


b
Observation-PM10
MYJ-UCM scheme
YSU-UCM scheme
PM10 Mass Concentration (μg/m3)
Date and Time
00:00 27/11/2016
00:00 28/11/2016
00:00 29/11/2016
00:00 30/11/2016
00:00 01/12/2016
00:00 02/12/2016
00:00 03/12/2016
00:00 04/12/2016

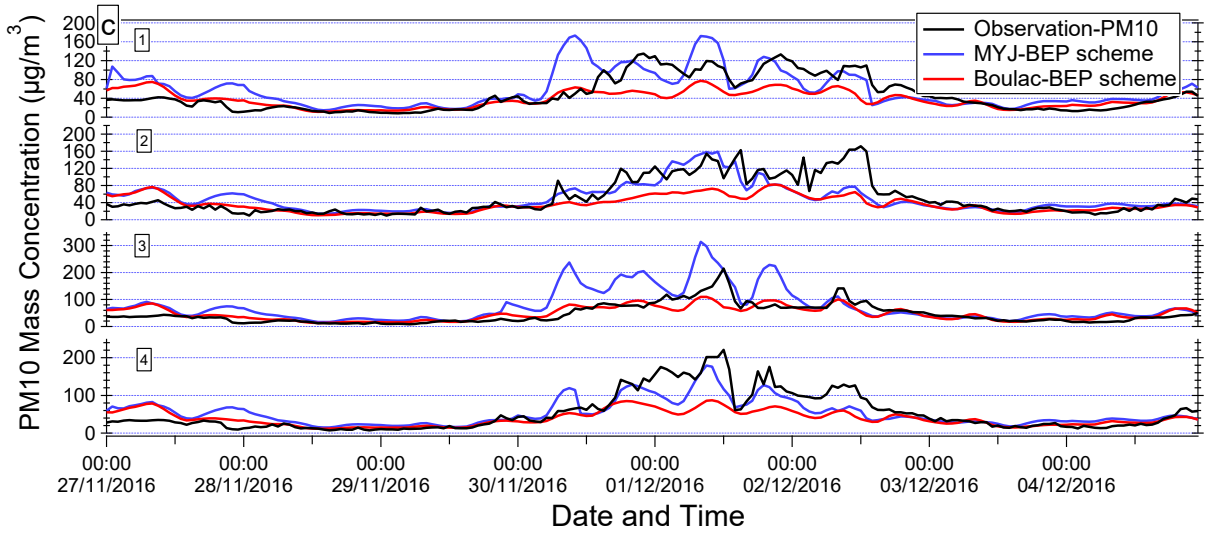

c
Observation-PM10
MYJ-BEP scheme
Boulac-BEP scheme
PM10 Mass Concentration (μg/m3)
Date and Time
00:00 27/11/2016
00:00 28/11/2016
00:00 29/11/2016
00:00 30/11/2016
00:00 01/12/2016
00:00 02/12/2016
00:00 03/12/2016
00:00 04/12/2016

Figure S5. Time series between observed and modelled PM_{10}: a, b and c represent each PBL schemes coupled with each urban canopy schemes respectively; 1, 2, 3, and 4 represent Station FR04002, FR04034, FR04143, FR04156,, respectively.

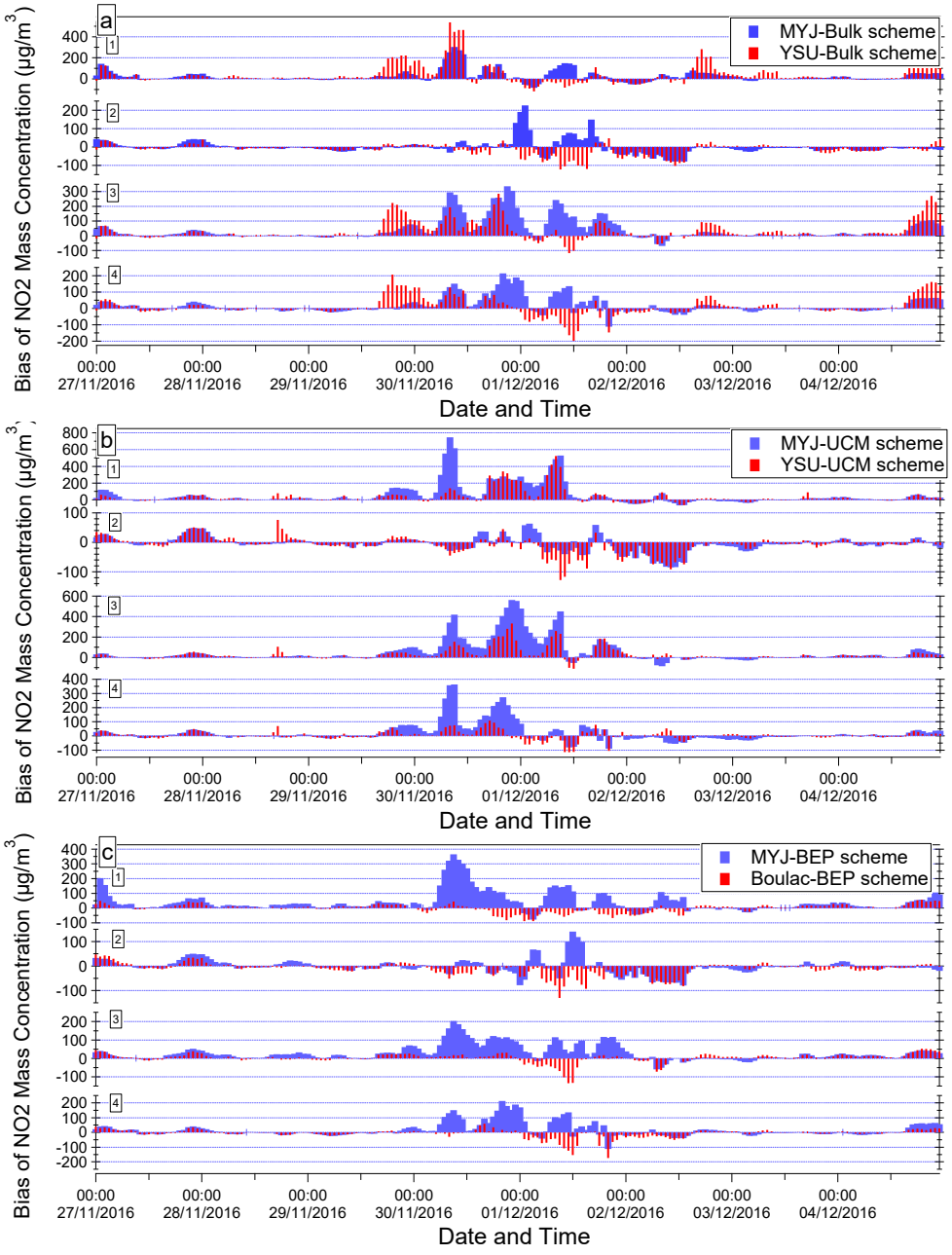


Figure S6. Time series of bias between observed and modelled NO_2: a, b and c represent each PBL schemes coupled with each urban canopy schemes respectively; 1, 2, 3, and 4 represent Station FR04002, FR04034, FR04143, FR04156, respectively.

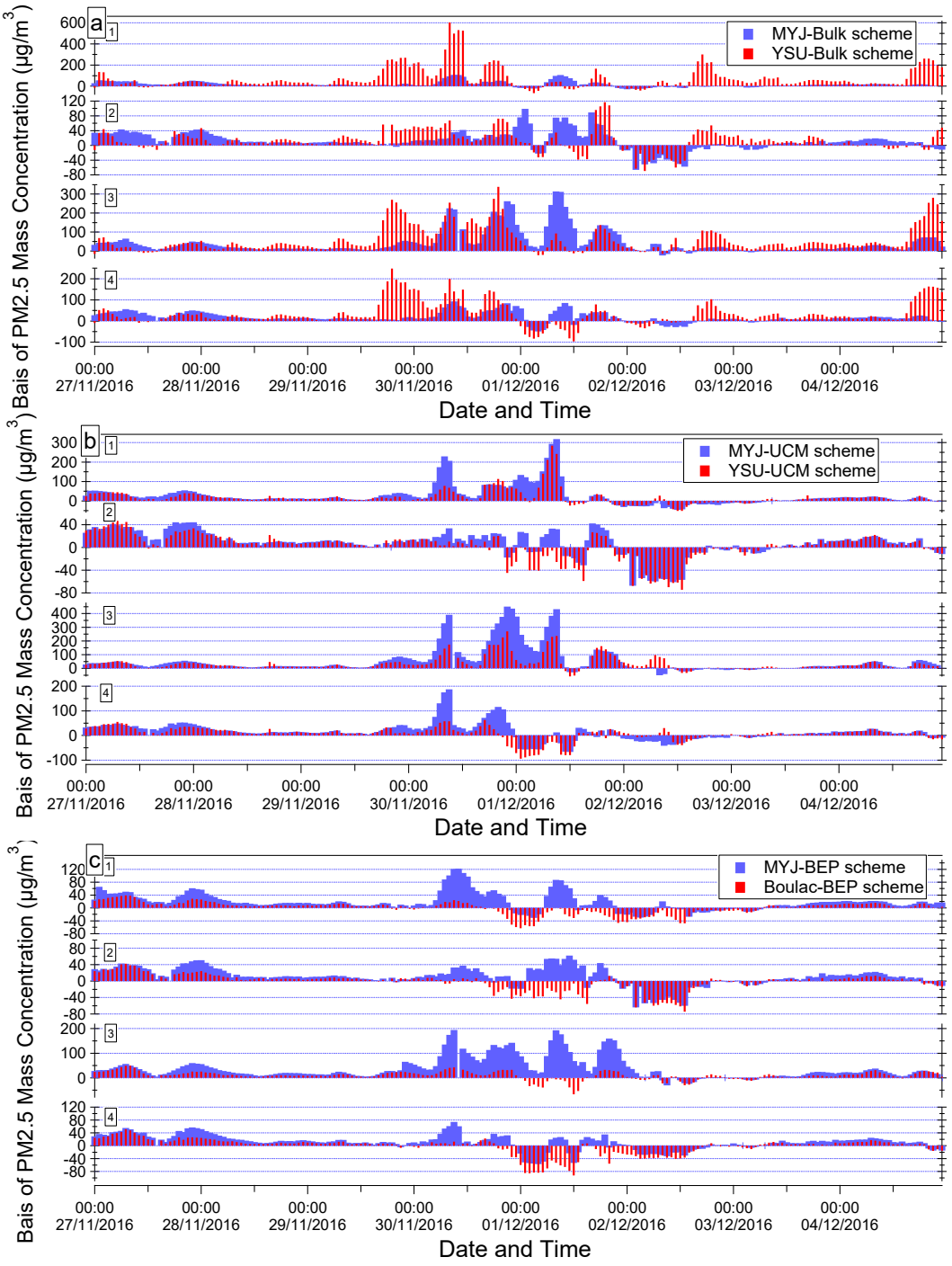


Figure S7. Time series of bias between observed and modelled $PM_{2.5}$: a, b and c represent each PBL schemes coupled with each urban canopy schemes respectively; 1, 2, 3, and 4 represent Station FR04002, FR04034, FR04143, FR04156,respectively.

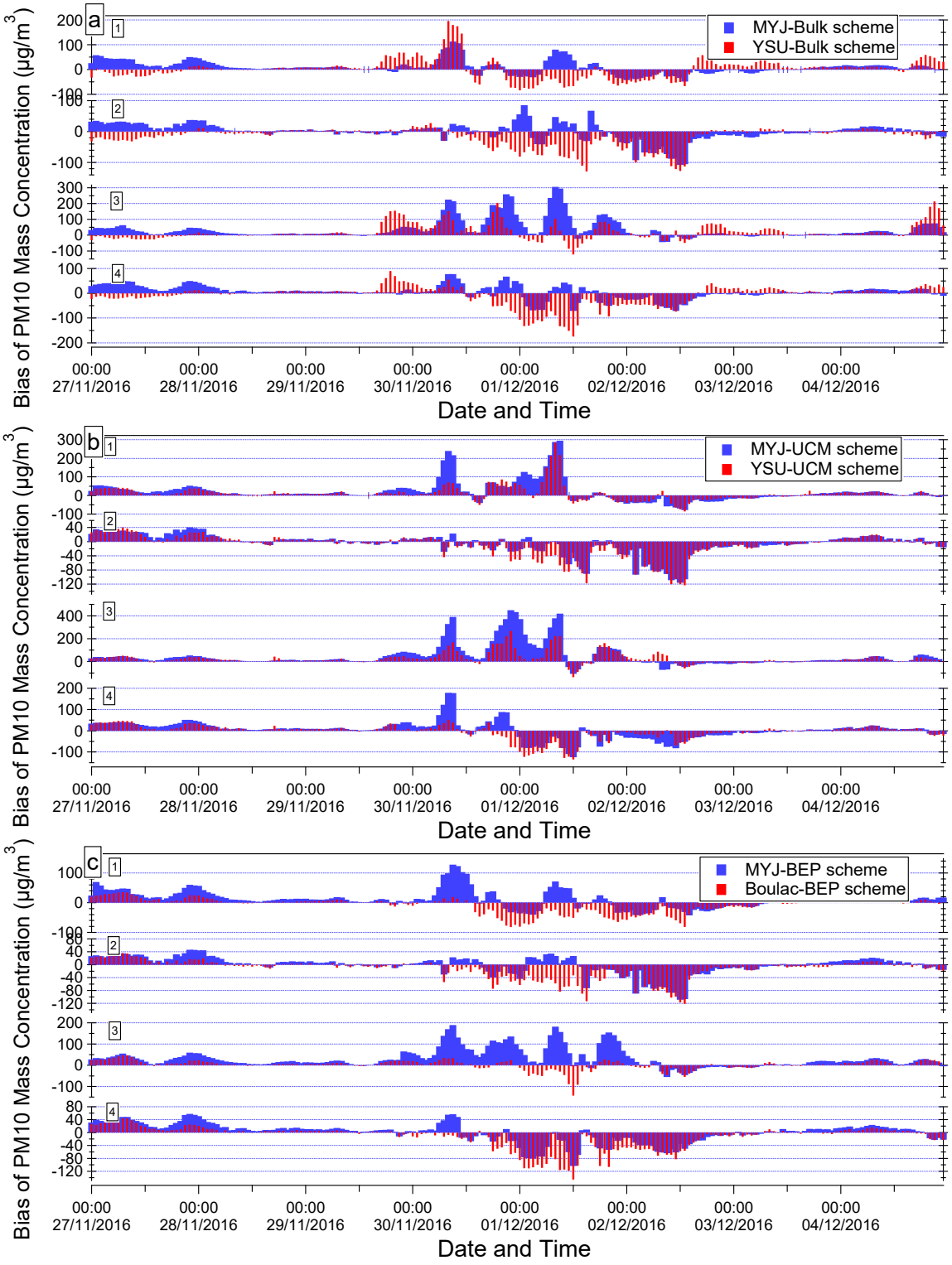


Figure S8. Time series of bias between observed and modelled PM_{10}: a, b and c represent each PBL schemes coupled with each urban canopy schemes respectively; 1, 2, 3, and 4 represent Station FR04002, FR04034, FR04143, FR04156,respectively.

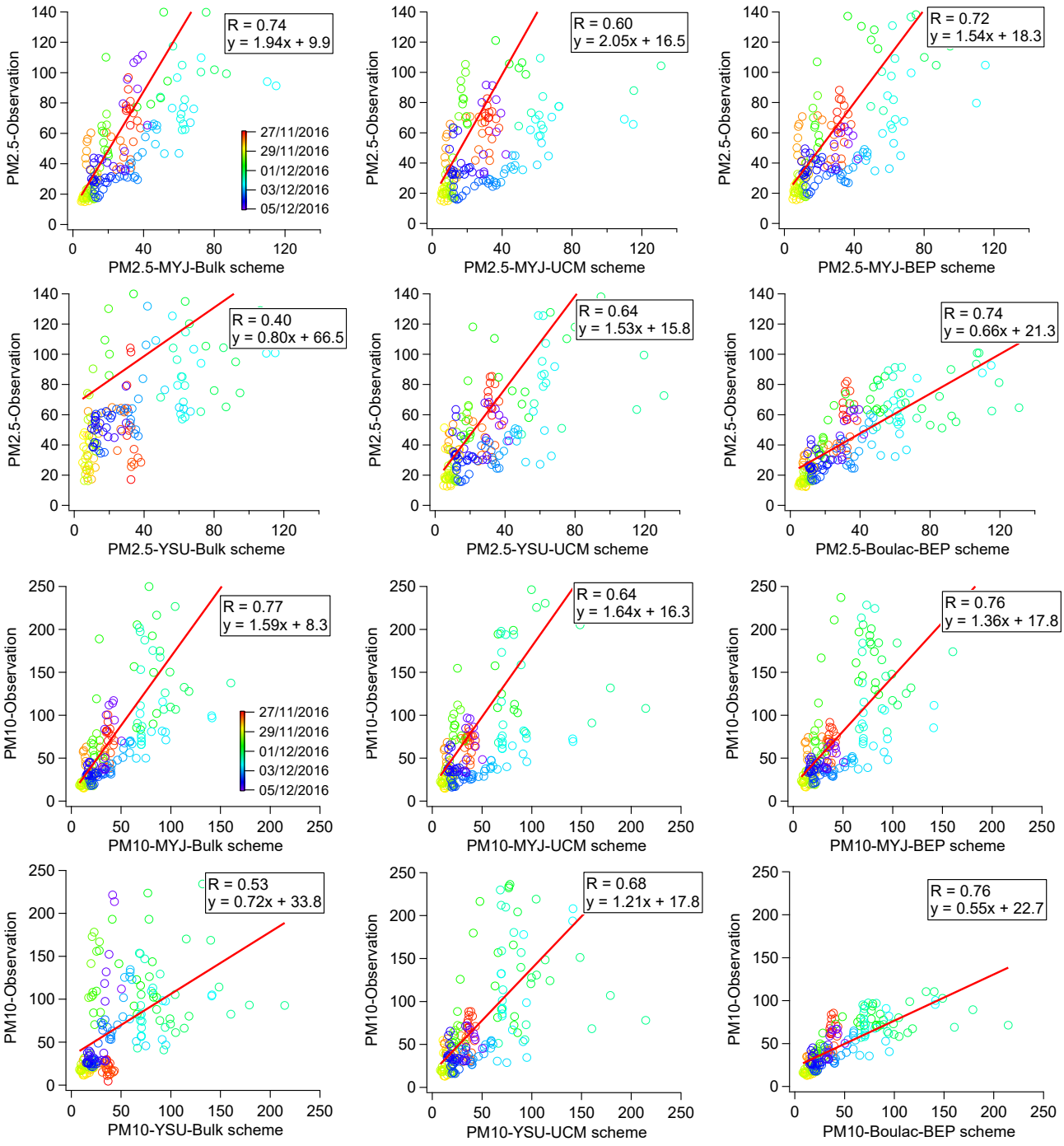


Figure. S9. Liner fit between observed and modelled $PM_{2.5}$ and PM_{10}

List.S1. Name list of WRF model

```
&time_control
run_days                            = 0,
run_hours                           = 24,
run_minutes                         = 0,
run_seconds                         = 0,
start_year                          = _Y1_, _Y1_, _Y1_,_Y1_,
start_month                         = _M1_, _M1_, _M1_,_M1_,
start_day                           = _D1_, _D1_, _D1_,_D1_,
start_hour                          = 00,   00,   00,   00,
start_minute                        = 00,   00,   00,   00,
start_second                        = 00,   00,   00,   00,
end_year                            = _Y2_, _Y2_, _Y2_,_Y2_,
end_month                           = _M2_, _M2_, _M2_,_M2_,
end_day                             = _D2_, _D2_, _D2_,_D2_,
end_hour                            = 00,   00,   00,   00,
end_minute                          = 00,   00,   00,   00,
end_second                          = 00,   00,   00,   00,
interval_seconds                    = 21600
input_from_file                     = .true.,.true.,.true.,.true.,
history_interval                    = 60,   60,   60,   60,
frames_per_outfile                  = 1000, 1000, 1000, 1000,
restart                             = ._THIS_RST_.,
restart_interval                    = 1440,
write_hist_at_0h_rst                = ._THIS_RST_.,
io_form_history                     = 2
io_form_restart                     = 102
io_form_input                       = 2
io_form_boundary                    = 2
debug_level                         = 0
use_netcdf_classic                  = .true.

&domains
time_step                           = 60,
time_step_fract_num                 = 0,
time_step_fract_den                 = 1,
max_dom                             = 2,
s_we                                = 1,    1,     1,    1,
e_we                                = 106,  118,   115,  85,
s_sn                                = 1,    1,     1,    1,
e_sn                                = 91,   115,   103,  79,
s_vert                              = 1,    1,     1,    1,
e_vert                              = 53,   53,    53,   53,
p_top_requested                     = 5000,
num_metgrid_levels                  = 32,
num_metgrid_soil_levels             = 4,
dx                                  = 45000, 15000, 5000, 1666.6667,
```

```
dy                          = 45000, 15000, 5000, 1666.6667,
grid_id                      = 1,     2,     3,     4,
parent_id                    = 1,     1,     2,     3,
i_parent_start               = 1,     24,    39,    44,
j_parent_start               = 1,     20,    66,    38,
parent_grid_ratio            = 1,     3,     3,     3,
parent_time_step_ratio       = 1,     3,     3,     3,
feedback                     = 1,
smooth_option                = 0,
eta_levels                   = 1.,  0.9995, 0.999,  0.9985, 0.9975,
                            0.996230185,   0.9949736,   0.993716955,   0.992334723,
                            0.990814209,  0.989141703,  0.987301886,  0.98527813,
                            0.983051956, 0.980603218, 0.977909565, 0.974946558,
                            0.971687257, 0.968101978, 0.964158237, 0.959820092,
                            0.955048144,  0.949799001,  0.94402492,  0.937673509,
                            0.930686891,  0.923001587, 0.914547801,  0.905248582,
                            0.895019472, 0.883767486, 0.871390283, 0.857775331,
                            0.842798889,  0.826324821,  0.80820334,  0.788269699,
                            0.7663427,   0.742223024,   0.715691328,   0.68650645,
                            0.65440315,  0.619089544,  0.580244482,  0.537514985,
                            0.49051252,  0.438809812,  0.381936818,  0.319376528,
                            0.250560224,  0.17486228,  0.0915945247, 0.0000,

/
&physics
mp_physics                   = 6,     6,     6,     6,
ra_lw_physics                = 4,     4,     4,     4,
ra_sw_physics                = 4,     4,     4,     4,
radt                         = 30,    30,    30,    30,
bldt                         = 0,     0,     0,     0,
cu_physics                   = 1,     1,     1,     0,
cudt                         = 5,     5,     5,     5,
isfflx                       = 1,
ifsnow                       = 1,
icloud                       = 1,
surface_input_source         = 3,
num_soil_layers              = 4,
num_land_cat                 = 21,
maxiens                      = 1,
maxens                       = 3,
maxens2                      = 3,
maxens3                      = 16,
ensdim                       = 144,
sf_sfclay_physics            = 2,     2,     2,     2,
sf_surface_physics           = 2,     2,     2,     2,
sf_urban_physics             = ( 0 for Bulk; 1 for UCM; 2 for BEP)
bl_pbl_physics               = ( 1 for YSU; 2 for MYJ; 8 for Boulac)
num_urban_layers             = 6400
```

```
/
&fdda
 grid_fdda                  = 1,   1,  0,   0,
 gfdda_inname                = "wrffdda_d<domain>",
 gfdda_end_h                 = 10000,  10000,  255,  255,
 gfdda_interval_m            = 360,  360,  360,  360,
 io_form_gfdda               = 2,
 fgdt                       = 1,   1,   1,  1,
 if_no_pbl_nudging_uv        = 0,   0,   0,  0,
 if_no_pbl_nudging_t         = 0,   0,   0,  0,
 if_no_pbl_nudging_q         = 0,   0,   0,  0,
 if_zfac_uv                  = 1,   1,   1,  1,
 k_zfac_uv                   = 12,  12,  12, 12,
 if_zfac_t                   = 1,   1,   1,  1,
 k_zfac_t                    = 12,  12,  12, 12,
 if_zfac_q                   = 1,   1,   1,  1,
 k_zfac_q                    = 12,  12,  12, 12,
 if_zfac_ph                  = 1,   1,   1,  1,
 k_zfac_ph                   = 12,  12,  12, 12,
 guv                        = 0.0003, 0.0003, 0.0003, 0.0003,
 gt                         = 0.0003, 0.0003, 0.0003, 0.0003,
 gq                         = 0.0003, 0.0003, 0.0003, 0.0003,
 gph                        = 0.0003, 0.0003, 0.0003, 0.0003,
 xwavenum                    = 5,   5,   5,  5,
 ywavenum                    = 5,   5,   5,  5,
 if_ramping                  = 0,
 dtramp_min                  = 60.0,
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&dynamics
w_damping                    = 1,
rk_ord                      = 3,
diff_opt                    = 1,      1,      1,       2,
km_opt                      = 4,      4,      4,       2,
diff_6th_opt                = 2,      2,      2,       2,
diff_6th_factor             = 0.12,   0.12,   0.12,    0.12,
base_temp                   = 290,
damp_opt                    = 1,
zdamp                      = 5000.,  5000.,  5000.,   5000.,
dampcoef                    = 0.01,    0.01,    0.01,     0.01,
khdif                      = 0,      0,      0,       0,
kvdif                      = 0,      0,      0,       0,
smdiv = 0.1, 0.1, 0.1,
 emdiv = 0.01, 0.01, 0.01,
 epssm = 0.1, 0.1, 0.1,
non_hydrostatic              = .true., .true., .true., .true.,
moist_adv_opt               = 1,      1,      1,       2,
scalar_adv_opt              = 1,      1,      1,       2,
tke_adv_opt                 = 1,      1,      1,       2,
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time_step_sound                 = 4,      4,      4,   4,
 h_mom_adv_order                  = 5,      5,      5,   5,
 v_mom_adv_order                  = 3,      3,      3,   3,
 h_sca_adv_order                  = 5,      5,      5,   5,
 v_sca_adv_order                  = 3,      3,      3,   3,

/

&bdy_control
spec_bdy_width                   = 5,
spec_zone                      = 1,
relax_zone                     = 4,
specified                       = .true., .false., .false., .false.,
nested                         = .false., .true., .true.,  .true.,
/

&grib2
&namelist_quilt
nio_tasks_per_group = 0,
nio_groups = 1,
```