



Supplement of

High sensitivity of simulated fog properties to parameterized aerosol activation in case studies from ParisFog

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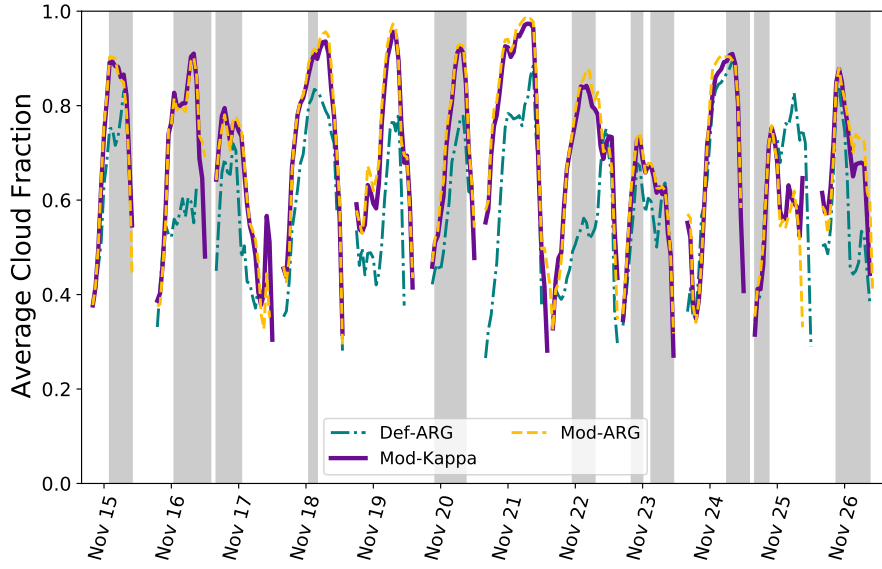


Figure S1: Timeseries of average cloud fraction (at the surface) from the 500 m resolution model for simulations Def-ARG, Mod-ARG and Mod-Kappa (only from the foggy gridboxes). Foggy periods in the observations are shown in shaded grey. Tick marks on the x-axis are at midnight UTC time.

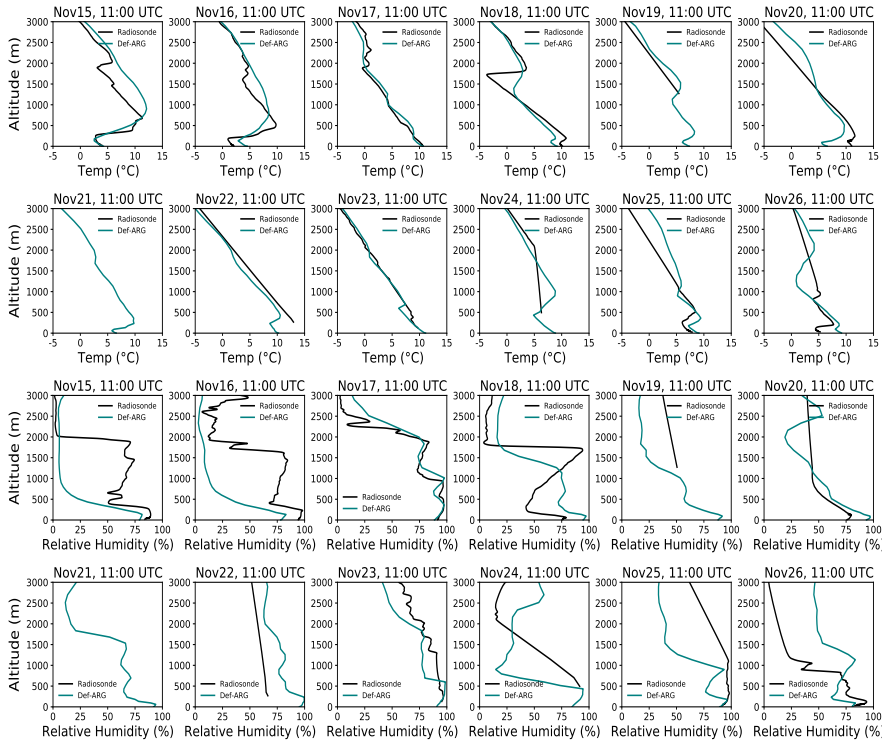


Figure S2: Temperature and relative humidity vertical profiles from our 500 m grid resolution Def-ARG simulation at 11:00 UTC each day, compared with the radiosonde data.

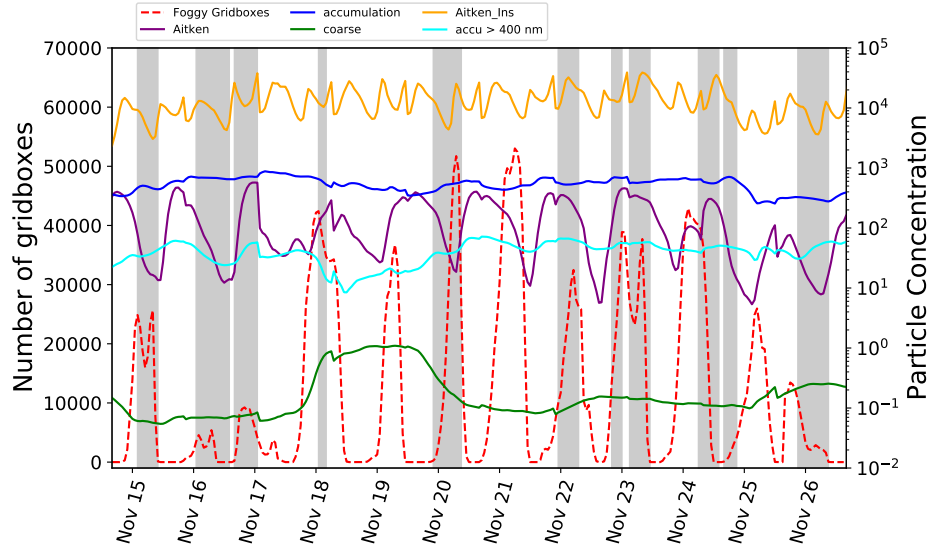


Figure S3: Timeseries of number of foggy gridboxes (Left Y axis) and particle number concentrations (Right Y axis) in the 500 m-resolution Def-ARG simulation. We demonstrate the domain mean number concentration of Aitken (soluble and insoluble), accumulation (total and > 400 nm diameter), and coarse mode aerosols simulated in the model at 5 m altitude. Observed foggy periods are shown by grey shaded area.

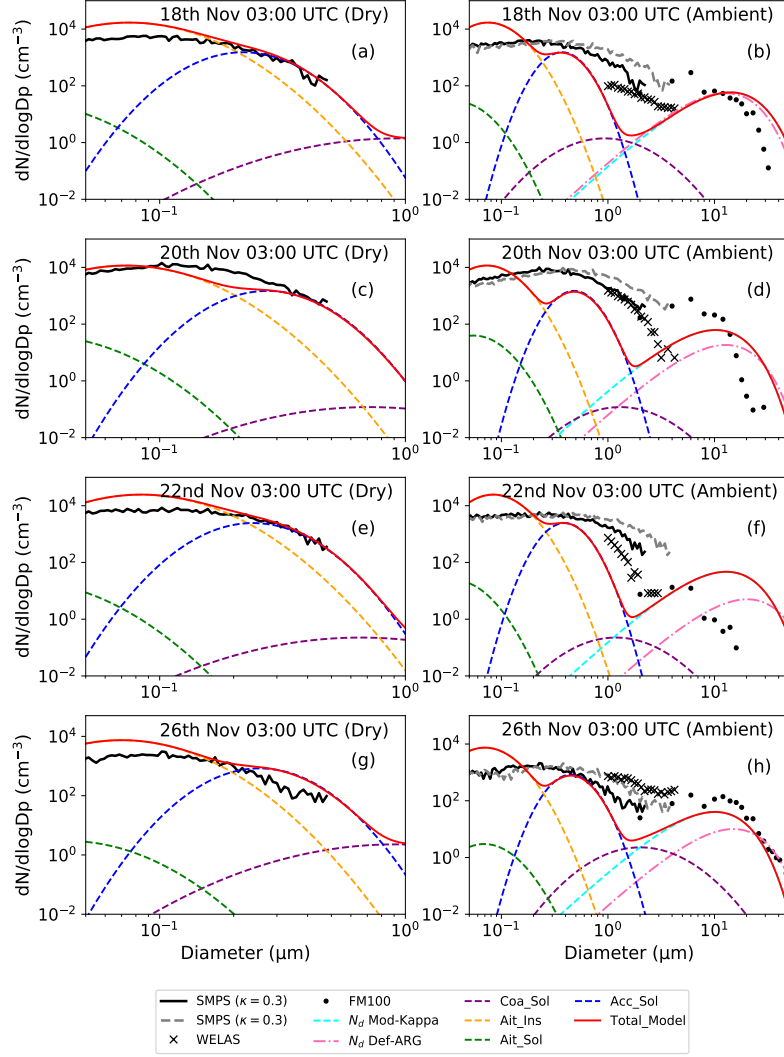


Figure S4: Dry and ambient aerosol size distribution on 18, 20, 22 and 26 November at 03:00 UTC from observations and the Mod-Kappa simulation. Only foggy grid cells are shown. The dry size distribution is measured by the SMPS only, while the WELAS and fog monitor (FM) observed the size distribution at ambient relative humidity. For this ambient size distribution, we also converted dry particle concentration data from the SMPS to ambient using κ -Köhler theory assuming a kappa value of 0.1 (and 0.3) and 100% relative humidity. The red line shows simulated total dry and ambient-humidity particle size distributions, while the dashed lines show the different aerosol and droplet modes. We also show the droplet size distribution from the Def-ARG simulation.

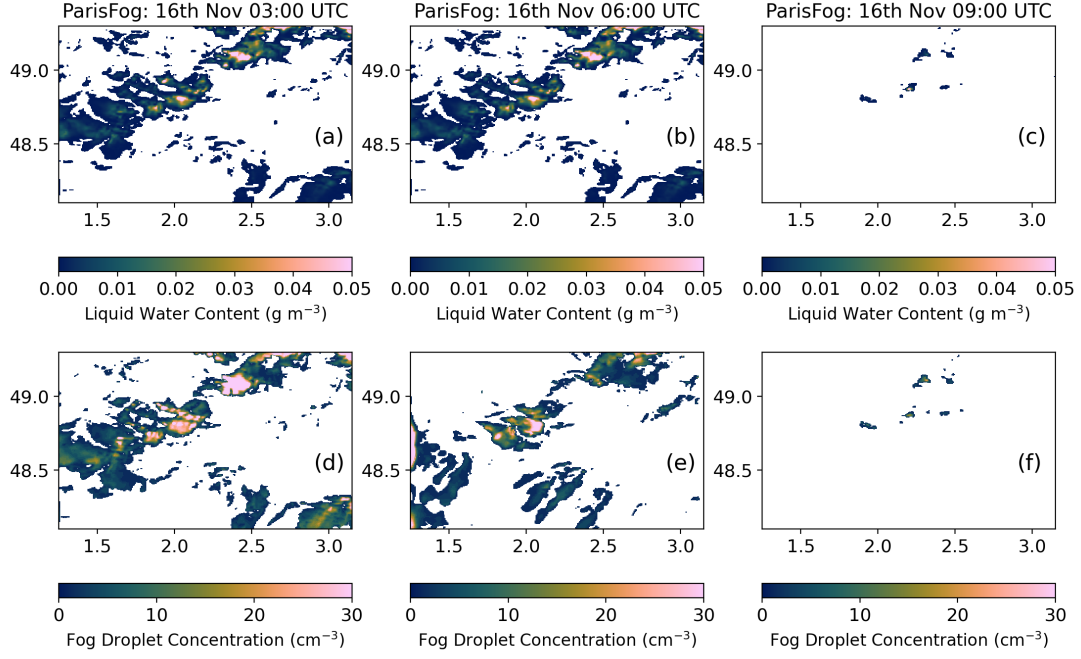


Figure S5: Spatial distribution of grid-mean liquid water content (top panel) and fog droplet number concentrations (bottom panel) at different times on 16th Nov from the 500 m resolution Def-ARG simulation at 5 m altitude.

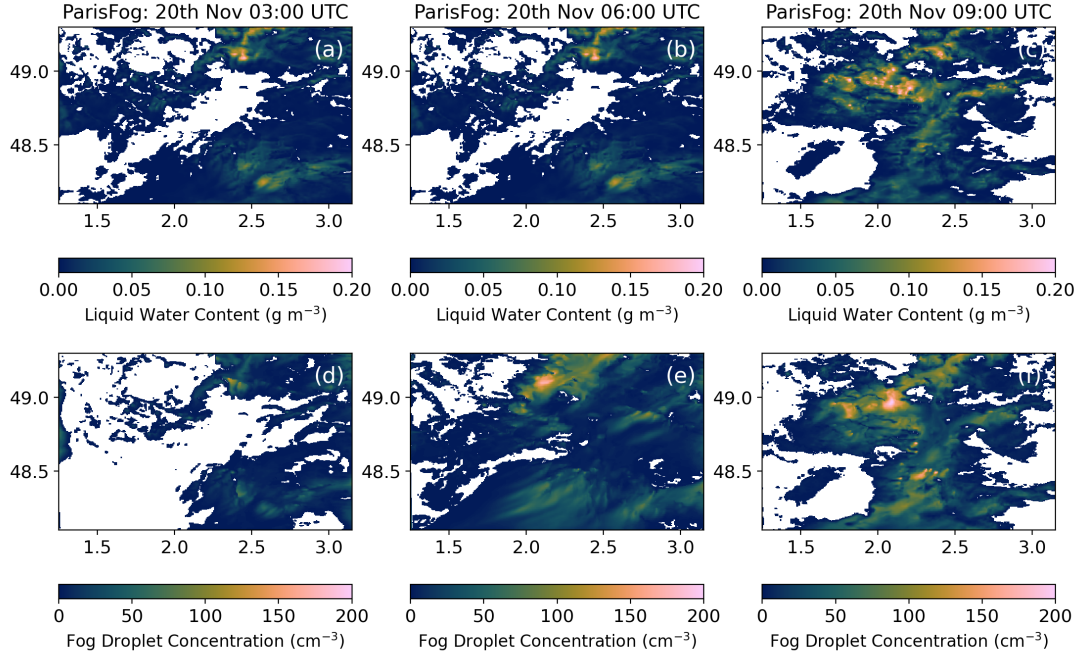


Figure S6: Spatial distribution of grid-mean liquid water content (top panel) and fog droplet number concentrations (bottom panel) at different times on 20th Nov from the 500 m resolution Def-ARG simulation at 5 m altitude.

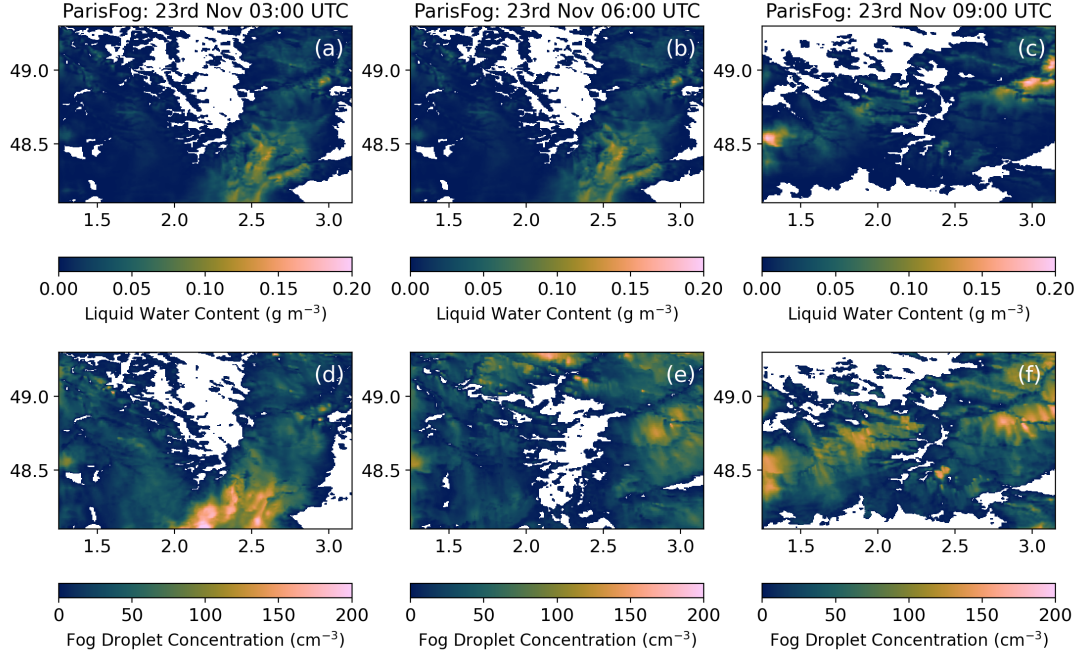


Figure S7: Spatial distribution of grid-mean liquid water content (top panel) and fog droplet number concentrations (bottom panel) at different times on 23rd Nov from the 500 m resolution Def-ARG simulation at 5 m altitude.

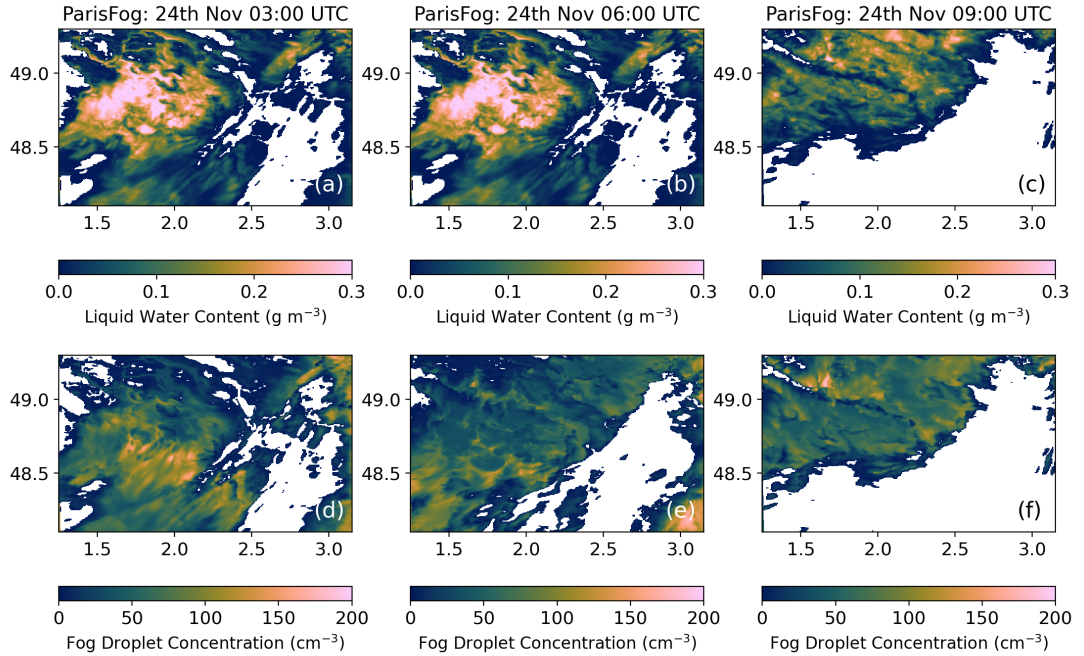


Figure S8: Spatial distribution of grid-mean liquid water content (top panel) and fog droplet number concentrations (bottom panel) at different times on 24th Nov from the 500 m resolution Def-ARG simulation at 5 m altitude.

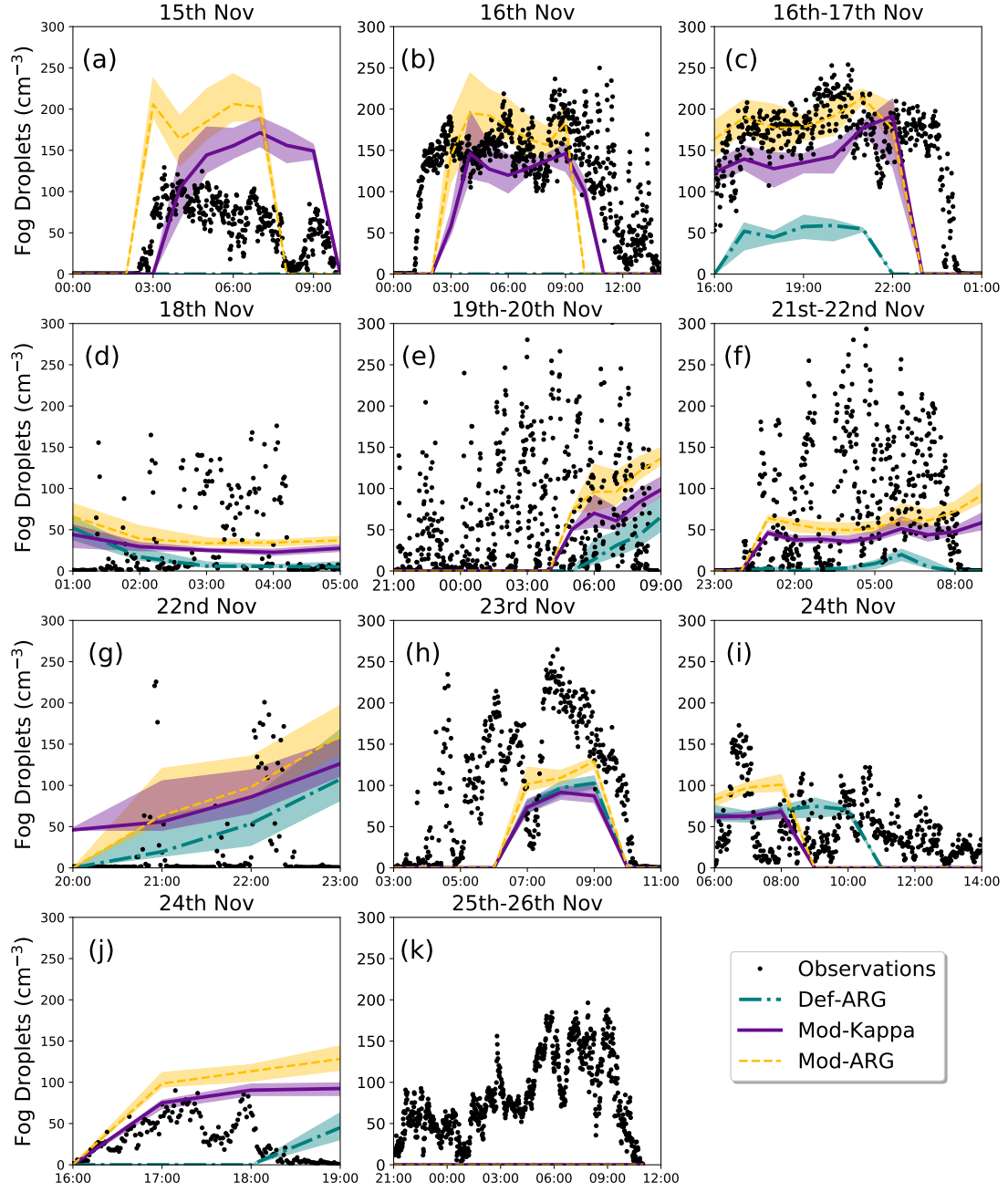


Figure S9: Variation of N_d as a function of time (UTC) for different fog events in the 500 m resolution regional simulations. Here we have used 20×20 gridboxes around SIRTa to calculate median and interquartile ranges. Subplots (a-k) compare all the simulations with the observations for the different fog cases. The solid (and dashed) lines and shaded regions represent the median and interquartile range from foggy gridboxes.

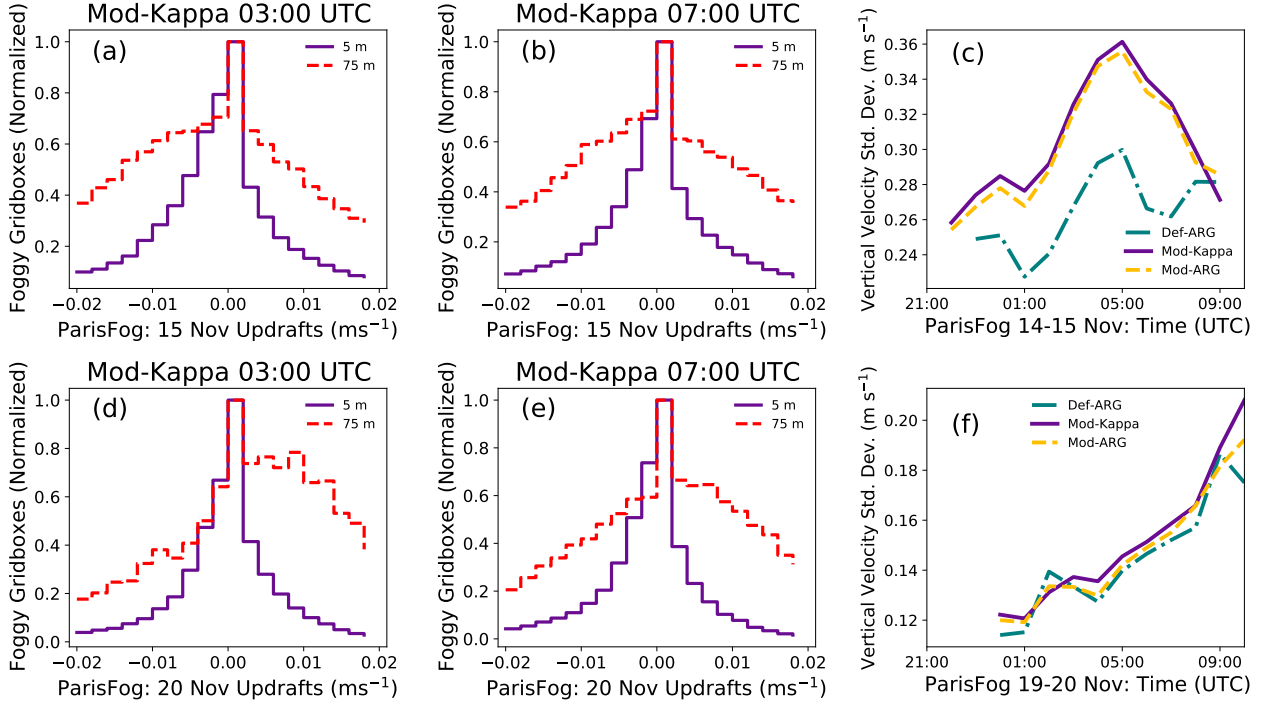


Figure S10: Histogram of updrafts at 5 m and 75 m altitude for two ParisFog cases at (a,d) 03:00 and (b,e) 07:00 UTC from the Mod-Kappa simulation. These panels show resolved updraft speeds, while the right panels (c,f) show the simulated standard deviation (σ_w) of unresolved sub-grid updrafts (the square root of the diagnosed unresolved subgrid updraft variance) from Def-ARG, Mod-ARG and Mod-Kappa simulations for the same fog cases at the surface. These results are from foggy gridboxes only.

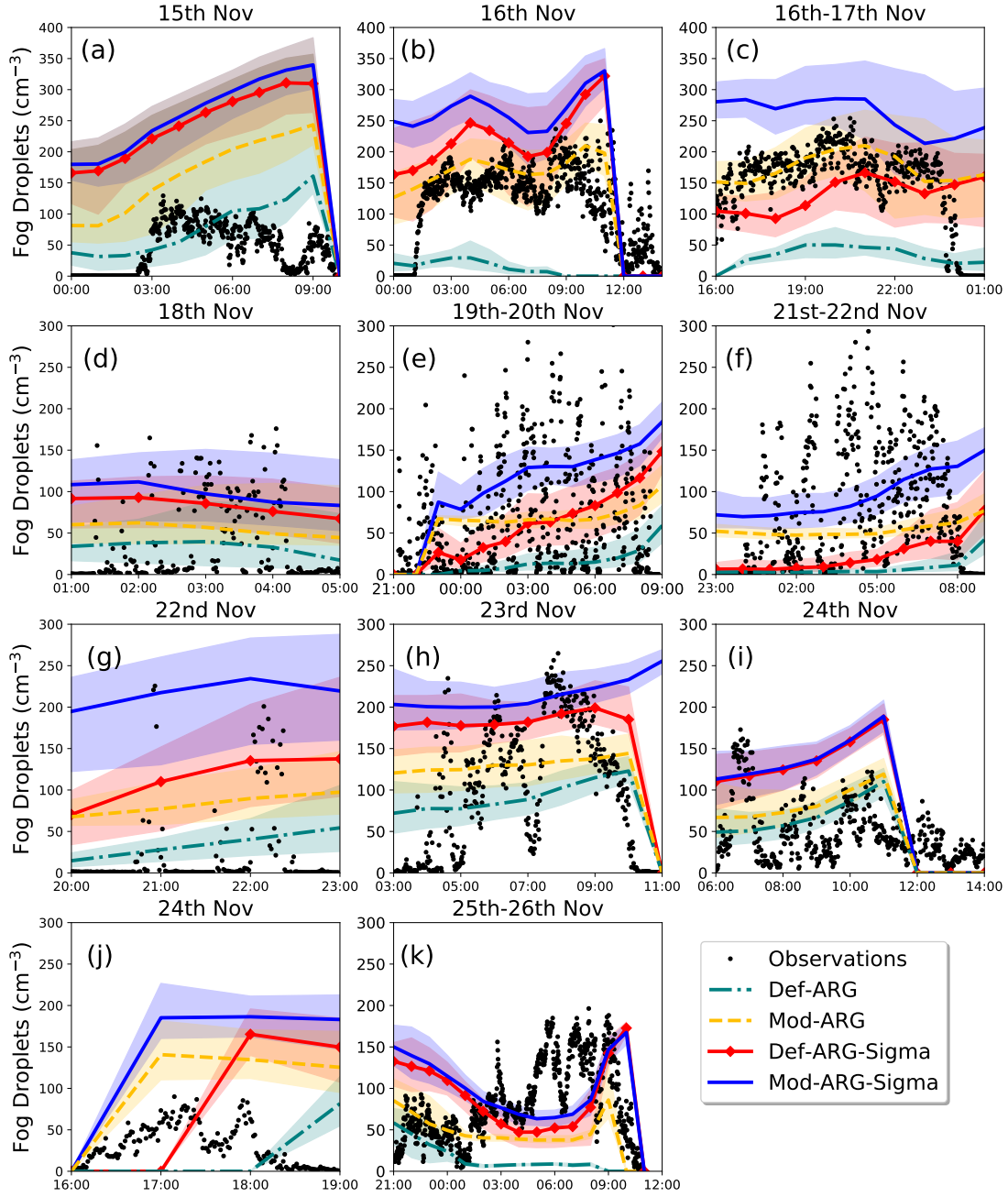


Figure S11: Variation of N_d as a function of time (UTC) for all the fog events in the 500 m resolution regional simulations, compared to observations from the fog monitor. We show results from Def-ARG, Mod-ARG, and corresponding simulations (Def-ARG-Sigma and Mod-ARG-Sigma), in which a sub-grid component is introduced to the updraft speed used in the aerosol activation scheme. In simulations Def-ARG-Sigma and Mod-ARG-Sigma, the updraft for activation is $w_{act} = w + c\sigma_{wsub}$, where σ_{wsub} is the width of updraft distribution (the square root of the diagnosed sub-grid vertical velocity variance), and the prefactor c is set to 0.2. w_{act} and w are the activation updraft and resolved (grid-scale) updraft respectively. In Supplement Figure S1 of the companion paper, we show that σ_{wsub} at the surface is overestimated by a factor of 5 for the LANFEX fog case we study (for which we have a turbulent kinetic energy dataset). However, for these ParisFog cases the prefactor is not motivated by model evaluation (we believe the simulated σ_{wsub} is closer to observations of vertical velocity variance), and so the prefactor is an ad-hoc tuning. The solid (and dashed) lines and shaded regions represent the median and interquartile range from foggy gridboxes.

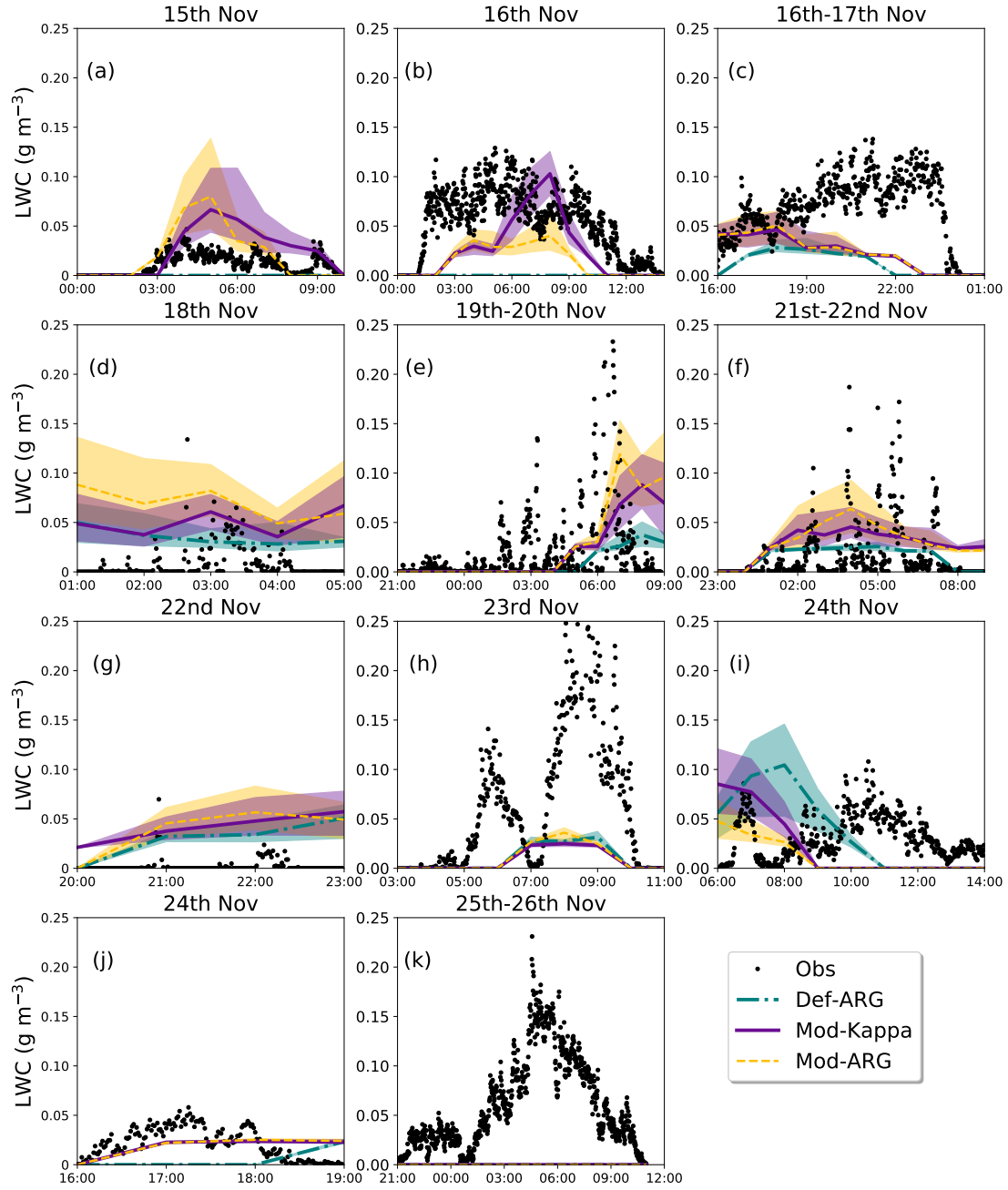


Figure S12: Variation of LWC as a function of time (UTC) is shown here for different fog events in the 500 m resolution regional model. Here we have used 20×20 boxes gridboxes around SIRTA to calculate median and interquartile ranges. Subplots (a-k) compare all the simulations with the observations for the different fog cases. The solid (and dashed) lines and shaded regions represent the median and interquartile range from foggy gridboxes.

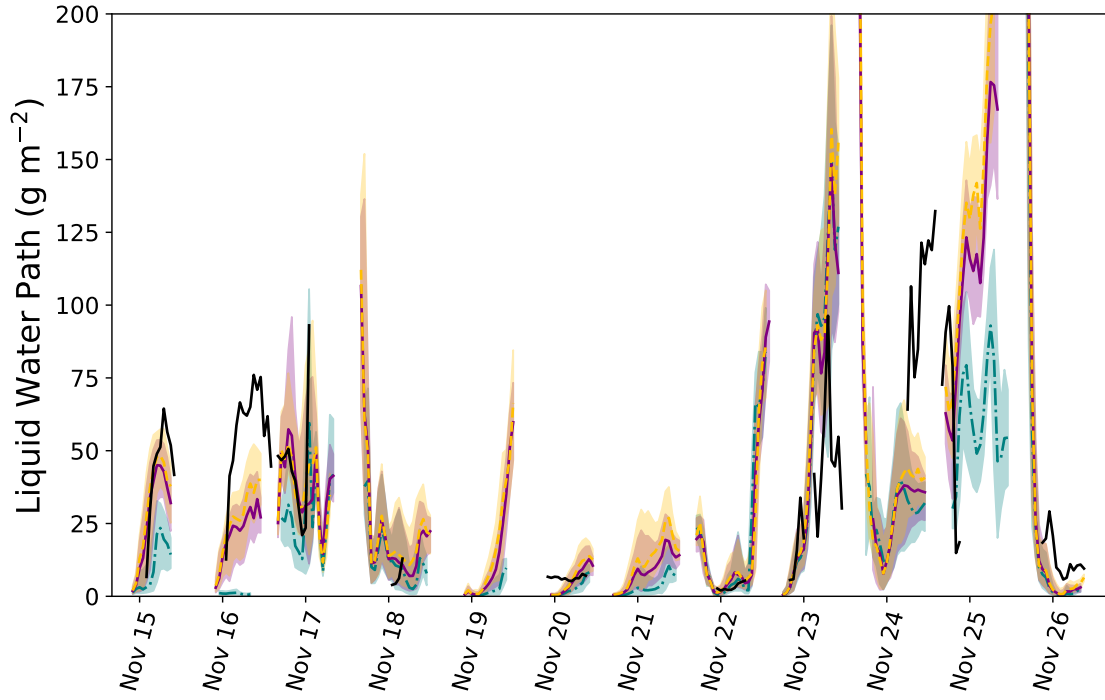


Figure S13: Time series of Liquid Water Path during the ParisFog cases for simulations Def-ARG, Mod-ARG, and Mod-Kappa from the 500 m model.

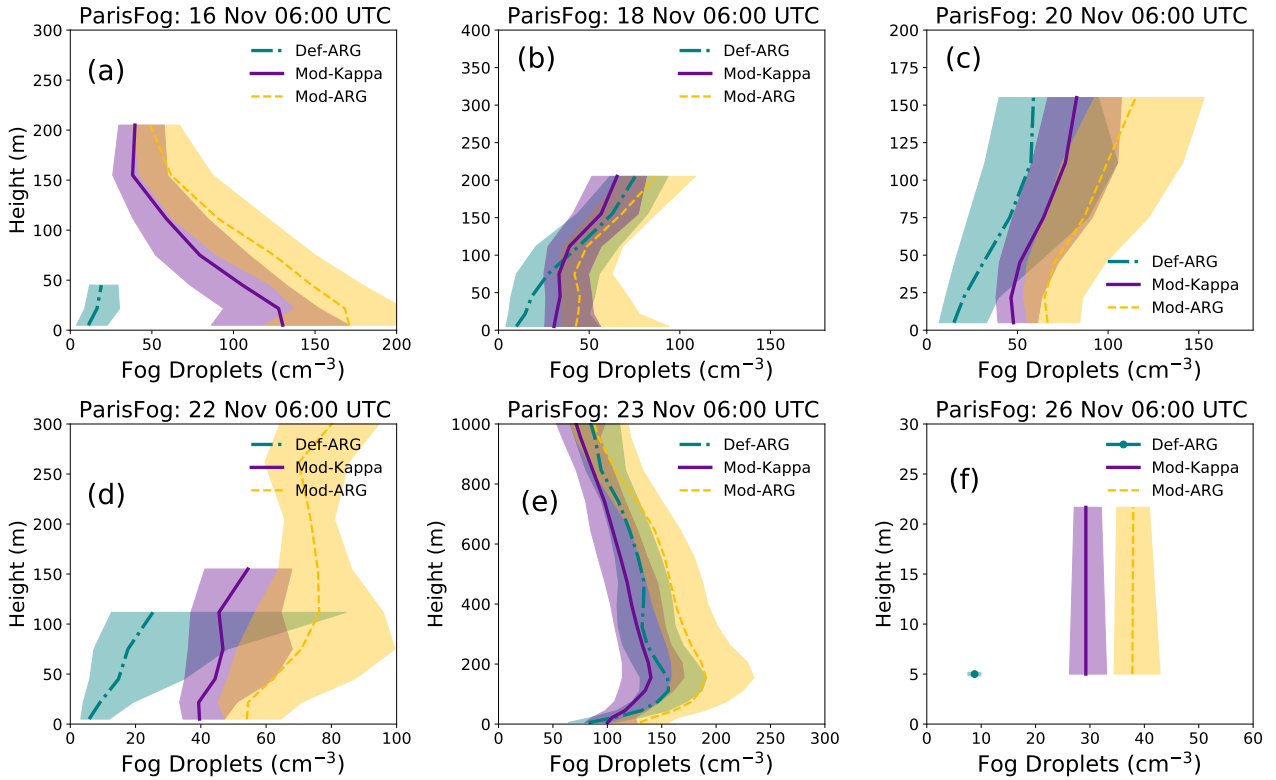


Figure S14: Variation of simulated droplet N_d in the 500 m-resolution model as a function of height for different fog events. Note the different y axis limits between subfigures. The solid and dashed lines represent the median values, and the shaded regions represent the interquartile ranges over foggy gridboxes. The solid and dashed lines represent the median values, and the shaded regions represent the interquartile ranges over the foggy gridboxes. We have picked columns that are entirely foggy till our threshold of 1000 gridboxes.

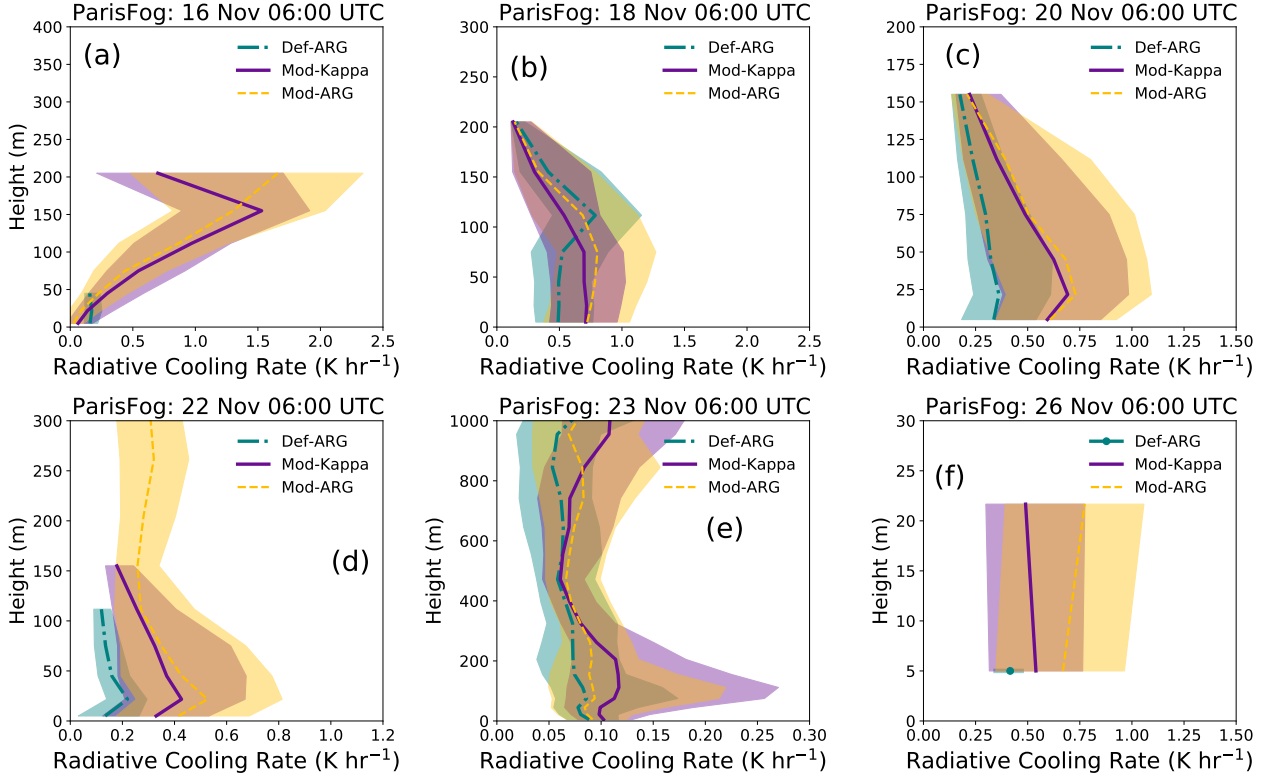


Figure S15: Variation of simulated radiative cooling rates in the 500 m-resolution model as a function of height for different fog events. Note the different y axis limits between subfigures. The solid and dashed lines represent the median values, and the shaded regions represent the interquartile ranges over foggy gridboxes. The solid and dashed lines represent the median values, and the shaded regions represent the interquartile ranges over the foggy gridboxes. We have picked columns that are entirely foggy till our threshold of 1000 gridboxes.

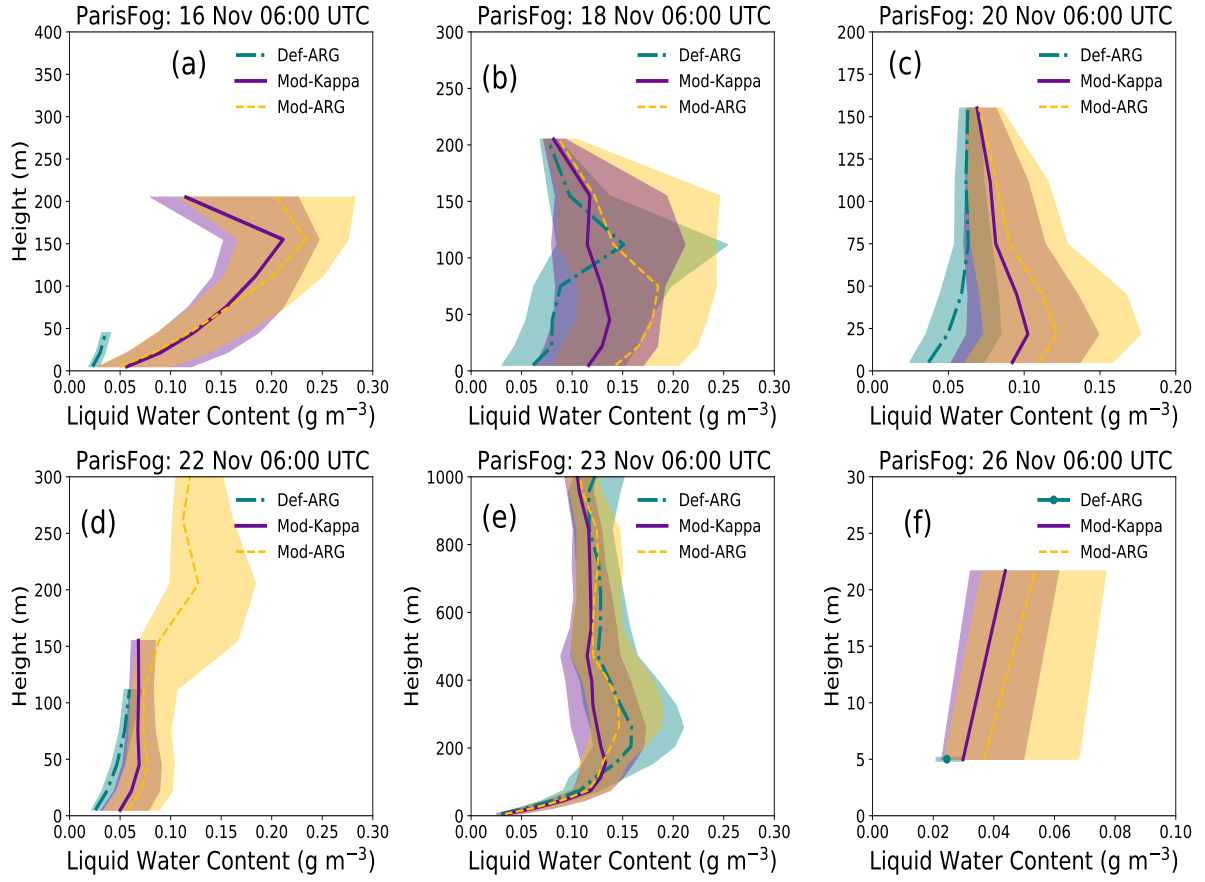


Figure S16: Variation of simulated LWC in the 500 m-resolution model as a function of height for different fog events. Note the different y axis limits between subfigures. The solid and dashed lines represent the median values, and the shaded regions represent the interquartile ranges over foggy gridboxes. The solid and dashed lines represent the median values, and the shaded regions represent the interquartile ranges over the foggy gridboxes. We have picked columns that are entirely foggy till our threshold of 1000 gridboxes.

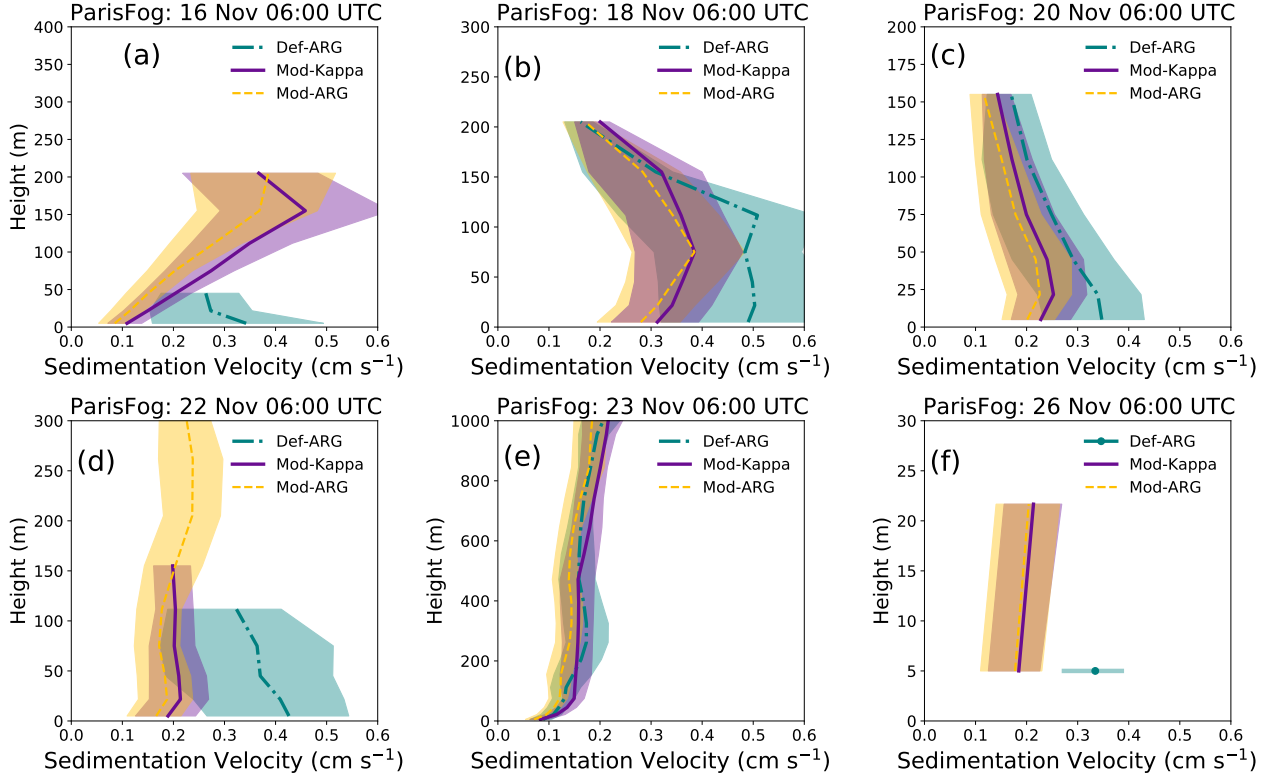


Figure S17: Variation of simulated droplet sedimentation velocity in the 500 m-resolution model as a function of height for different fog events. Note the different y axis limits between subfigures. The solid and dashed lines represent the median values, and the shaded regions represent the interquartile ranges over foggy gridboxes. The solid and dashed lines represent the median values, and the shaded regions represent the interquartile ranges over the foggy gridboxes. We have picked columns that are entirely foggy till our threshold of 1000 gridboxes.

Table S1: Normalized Mean Bias Factor (NMBF) for N_d for different simulations (500 m model) for all fog cases.

Fog Case	Def-ARG	Mod-ARG	Mod-Kappa
Nov 15 02:30	0.74	2.69	1.97
Nov 16 01:10	-9.01	0.23	-0.06
Nov 16 16:00	-3.31	0.25	-0.05
Nov 18 01:30	0.08	0.82	0.34
Nov 19 22:00	-5.18	-0.41	-0.96
Nov 21 23:50	-7.08	-0.19	-0.64
Nov 22 20:50	0.68	3.06	2.23
Nov 23 03:25	0.08	0.31	0.02
Nov 24 06:20	0.06	0.27	-0.17
Nov 24 16:10	-0.15	3.28	2.05
Nov 25 21:40	-4.09	-0.69	-1.52

Table S2: Normalized Mean Error Factor (NMEF) for N_d across different simulations (500 m model) for all fog cases.

Fog Case	Def-ARG	Mod-ARG	Mod-Kappa
Nov 15 02:30	1.02	2.74	2.02
Nov 16 01:10	9.25	0.38	0.33
Nov 16 16:00	3.45	0.31	0.33
Nov 18 01:30	0.70	1.00	0.89
Nov 19 22:00	5.83	1.00	1.42
Nov 21 23:50	8.07	0.85	1.24
Nov 22 20:50	0.89	3.06	2.23
Nov 23 03:25	0.56	0.60	0.56
Nov 24 06:20	0.71	0.84	0.64
Nov 24 16:10	2.10	3.46	2.23
Nov 25 21:40	4.46	1.01	1.78