Supporting Information for ”Realism of Lagrangian large eddy simulations driven by renalysis meteorology: Tracking a pocket of open cells under a biomass burning aerosol layer”
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Contents of this file
1. Supplemental Figures S1 to S12
2. Figures 1 to 10 of the main text in original resolution

Additional Supporting Information (Files uploaded separately)
1. Animation A1, showing the cloud evolution seen by satellite and in the simulations
Figure S1. Aerosol number at the outset of the simulations on 3 September 2017, 14:45:00 UTC (fractional day of year d = 245.61458) on the (a) green, (b) blue, and (c) red trajectories.
Figure S2. Meteosat Second Generation (MSG) Spinning Enhanced Visible and Infrared Imager (SEVIRI) imagery, with domain of simulation $G_1$, to scale, at 16:45:00 UTC. The trajectory of the simulation intersects with the path of CLARIFY flight C052 at this time. Magenta indicates flight C052 profile P7 (16:27:49 – 16:36:33 UTC). Yellow indicates the C052 flight profiles P1-P7 (5 September 2017, 15h44m10s – 16h39m41s UTC). Light gray indicates the profile P1, which provided biomass burning aerosol concentrations in the free troposphere. See also Abel et al. (2020).
Figure S3. Cloud effective radius ($r_{\text{eff}}$) and optical depth ($\tau$) in the simulations along the green (a, b), blue (c, d), and red (e, f) trajectory. MODIS retrievals at the trajectory locations are shown in yellow/black. MODIS samples data from locations with $r_{\text{eff}} \leq 30 \mu m$. The simulated $r_{\text{eff}}$ and $\tau$ were sampled over locations where $\tau \geq 1$ and where $r_{\text{eff}} \leq 30 \mu m$. Gray shading indicates nighttime. The simulations are listed in Table 1 of the main text.
Figure S4. Cloud liquid water (a) and cloud drop number (b) collected by the CDP instrument along the segment of the CLARIFY flight C052 shown in Fig. S3. Magenta indicates the C052 profile P7 (16:27:49 - 16:36:33 UTC). Yellow indicates the C052 flight profiles P1–P7 (5 September 2017, 15h44m10s–16h39m41s UTC). See Abel et al. (2020) for details.
Figure S5. Vertical profiles in simulation $G_0$ (green), with a biomass burning layer in the free troposphere, and simulation $G_1$ (yellow), without a biomass burning layer. (a) Aerosol number mixing ratio at the outset of the simulations on 3 September 2017, 14:45:00 UTC (fractional day of year $d = 245.61458$). (b) aerosol number concentration, (c) water vapor mixing ratio, and (d) temperature on 5 September 2017, 16h45m00s UTC (fractional day of year $d = 247.69792$), and in-situ measurements from CLARIFY flight C052. CLARIFY C052 profile P7 (5 September 2017, 16:27:49 – 16:36:33 UTC, magenta) is located at the intercept of the simulation trajectory and the CLARIFY C052 flight path. CLARIFY flight C052 profile P1 (5 September 2017, 15h25m18s – 15h50m53s, gray) is located upstream along the flight path. The location of the simulation domain, the CLARIFY flight C052 path and its profile P1 and P7 are shown in Fig. S2.
Figure S6. Time series in simulation G₀ (yellow, without a biomass burning layer above the inversion) and simulation G₁ (green, with a biomass burning layer above the inversion). Gray shading indicates nighttime.
Figure S7. Time series in simulation G₁ using bin cloud microphysics (green) and simulation G₂ using bulk cloud microphysics (dark green). Gray shading indicates nighttime.
Figure S8. Time series in simulation B₁ using bin cloud microphysics (blue) and simulation B₂ using bulk cloud microphysics (dark blue). Gray shading indicates nighttime.
Figure S9. Time series in simulation $R_1$ using bin cloud microphysics (red) and simulation $R_2$ using bulk cloud microphysics (dark red). Gray shading indicates nighttime.

Legend:
- Aerosol (boundary layer)
- Cloud fraction
- Cloud drops (boundary layer)
- Rain drops (boundary layer)
- Cloud optical depth
- Rain optical depth
- Cloud water path
- Rain water path
- Aerosol (boundary layer)
- Cloud drops (boundary layer)
- Surface precipitation
- Inversion height
Figure S10. Domain mean profiles of water vapor (a, b) and temperature (c, d) in simulation G_2 (dark green, dotted), G_3 (aquamarine, dashed), and G_4 (beige, solid), on (a, c) 4 September 2017, 12h00m00s UTC (d = 246.50000) and (b, d) 5 September 2017, 16h45m00s UTC (d = 247.69800), at the intercept of the simulation trajectory with the path of CLARIFY flight C052, with observations from the location of the intercept (CLARIFY flight C052 profile P7, 5 September 2017, 16:27:49 – 16:36:33 UTC, magenta).
Figure S11. Same as Fig. S10, focusing on the altitude range 0–150 m.
Figure S12. Domain mean profiles of west-east (a, b) and south-north (c, d) wind speed in simulation G2 (dark green, dotted), G3 (aquamarine, dashed), and G4 (beige, solid), on (a, c) 4 September 2017, 12h00m00s UTC (d = 246.50000) and (b, d) 5 September 2017, 16h45m00s UTC (d = 247.69800) with ERA5 values at the ERA5 model levels (black dots).
Figures in the main text in original resolution
Figure 1. Meteosat Second Generation (MSG) Spinning Enhanced Visible and Infrared Imager (SEVIRI) imagery, with simulation domains on the green, blue, and red trajectory, to scale.
Figure 2. Optical depth of liquid water in simulation G₁, green trajectory (a-d), B₁, blue trajectory (e-h), and R₁, red trajectory (i-l), at the times and locations shown in Fig. 1.
Figure 3. Time series in the simulations $G_1$ (green), $B_1$ (blue), and $R_1$ (red). Gray shading indicates nighttime.
Figure 4. Cloud drop effective radius ($r_{\text{eff}}$) and optical depth ($\tau$) in the simulations along the green (a, b), blue (c, d), and red (e, f) trajectory. SEVIRI retrievals at the trajectory locations are shown in magenta (ORAC, Thomas et al., 2009) and black (Peers et al., 2019, 2021), with squares representing the mean and whiskers the lower and upper standard deviation. Simulations are listed in Table 1. Gray shading indicates nighttime.
Figure 5. Domain mean profiles in simulation G₁ (green) on 5 September 2017, 16h45m00s UTC, ERA5 profiles (black), interpolated to the vertical grid of the simulations, on 5 September 2017, 16h32m30s UTC, and in-situ measurements from CLARIFY flight C052. CLARIFY C052 profile P7 (5 September 2017, 16:27:49 – 16:36:33 UTC, magenta) is located at the intercept of the simulation trajectory and the CLARIFY C052 flight path. CLARIFY flight C052 profile P1 (5 September 2017, 15h25m18s – 15h50m33s, gray) is located upstream along the flight path. The location of the simulation domain, the CLARIFY flight C052 path and its profile P1 and P7 are shown in Fig. S2).
Figure 6. Cloud properties (a, b, c) and frequency of occurrence of cloud and rain water (d). Simulation G1 (green) is shown on 5 September 2017, 16h45m00s UTC, at the intercept of the simulation trajectory with the path of CLARIFY flight C052. Measurements at the intercept (magenta) were taken during the C052 flight profile P7 (5 September 2017, 16:27:49 – 16:36:33 UTC). Measurements from C052 flight profiles P1–P7 (median and interquartile range, yellow/black dots with whiskers) represent a longer flight segment, extending upstream of the intercept (5 September 2017, 15h44m10s – 16h39m41s UTC). CLARIFY flight C052 profiles P1–P7 mean cloud (gray) and rain (black) fractions are shown in panel d. The location of the simulation domain at the intercept with CLARIFY flight C052, and locations of the profiles P1–P7 are shown in Fig. S2.
Figure 7. Same as Fig. 6 but rain properties.
Figure 8. Hydrometeor mass distribution, averaged over the last 12h (d = 247.2 to 247.7), in simulation G₁ (green) using bin microphysics, and simulation G₂ (dark green) using bulk microphysics, in the center of the boundary layer (solid) and at the surface (dotted).
Figure 9. Vertical profiles, averaged over the last 12 h (d = 247.2 to 247.7) of simulation $G_1$ (green) using bin microphysics, and simulation $G_2$ (dark green) using bulk microphysics.
Figure 10. Time series in simulation $G_2$ (dark green), $G_3$ (aquamarine), and $G_4$ (beige). Gray shading indicates nighttime.