

Supporting Information for "How rain shapes cloud-scale dynamics and mass flux in the trades"

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1. Figures S1 to S8

Introduction This Supplementary material presents seasonal variability of the cloud life cycle (Figure **S1**), extended plots binned by cloud top height for non-precipitating clouds (Figure **S2**), sensitivity tests of the composite cloud (Figures **S3** to **S6**) and controls of the mass flux separating non-precipitating (Figure **S7**) and precipitating clouds (Figure **S8**).

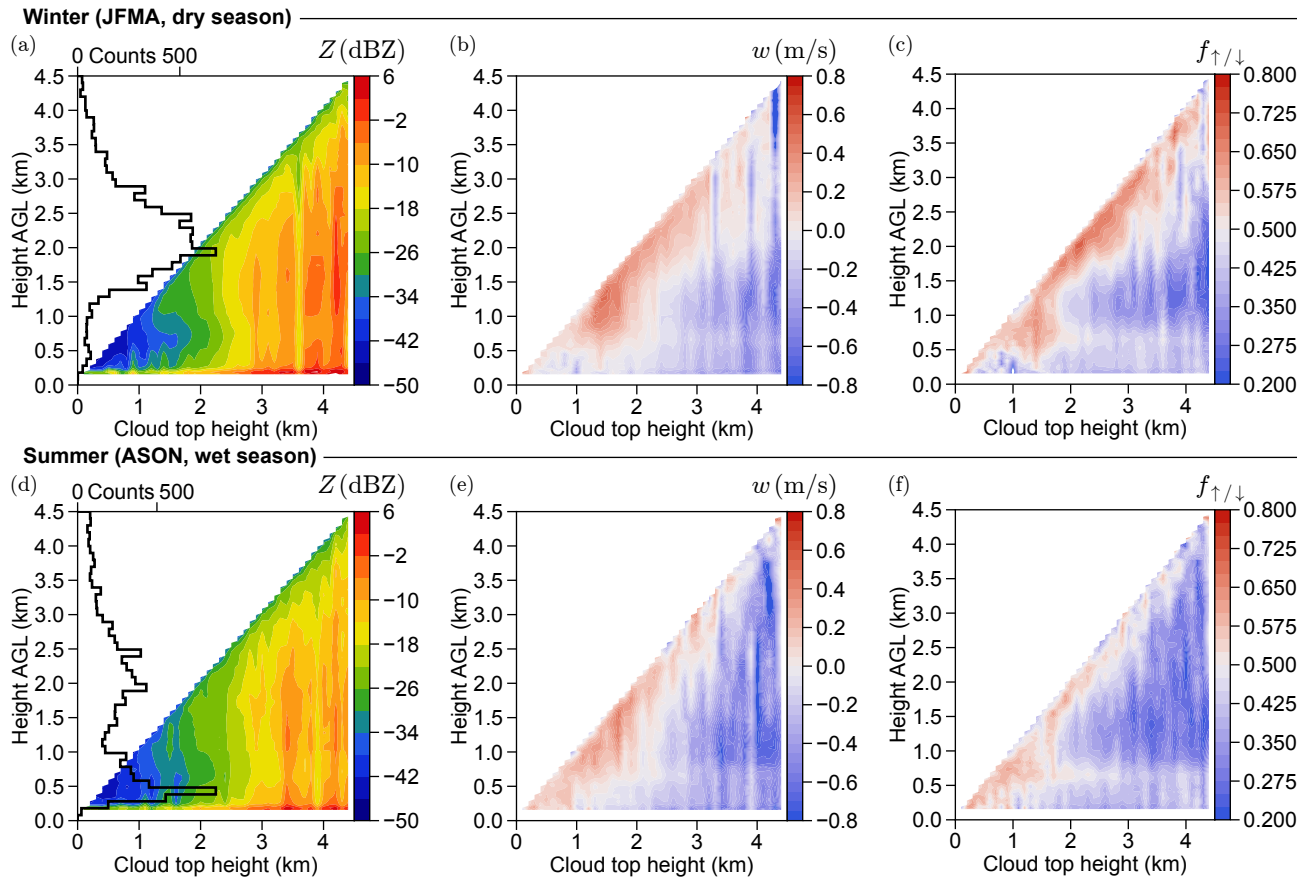


Figure S1. Seasonal variability of the average vertical profiles of precipitating clouds binned by cloud top height. Top row (a-c): winter (JFMA, dry season), bottom row (d-f): summer (ASON, wet season). (a, d) Average reflectivity Z . Solid black line: histogram of cloud top height. (b, e) Average in-cloud vertical velocity w . (c, f) Average relative updraft-to-downdraft fraction $f_{\uparrow/\downarrow}$.

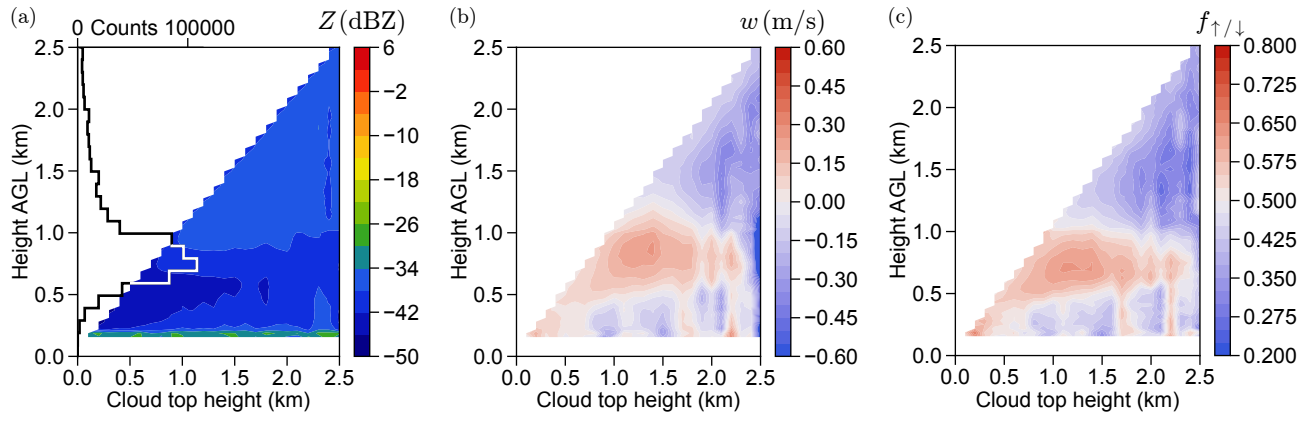


Figure S2. Average vertical profiles of non-precipitating clouds binned by cloud top height. (a) Average reflectivity Z . Solid black line: histogram of cloud top height. (b) Average in-cloud vertical velocity w . (c) Average relative updraft-to-downdraft fraction $f_{\uparrow/\downarrow}$.

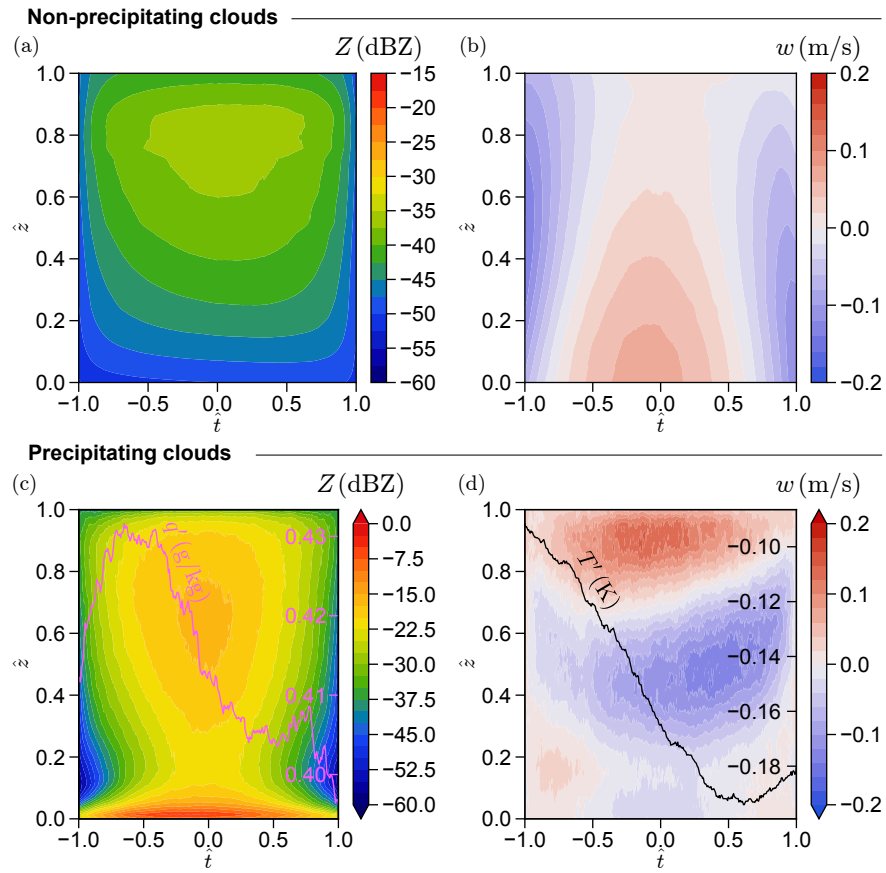


Figure S3. Composite medians of non-precipitating (top row) and precipitating (bottom row) clouds and the associated surface meteorology anomalies with regards to their daily averages. Velocities include clear air pixels around the clouds (see text). Non-precipitating clouds: (a) Reflectivity Z . (b) Vertical velocity w . Precipitating clouds: (c) Reflectivity Z . Solid pink line: specific humidity anomaly q' . (d) Vertical velocity w . Solid black line: temperature anomaly T' . The coordinates are normalized with regards to the lowest range gate and cloud top for the height \hat{z} and the cloud start and end for the time \hat{t} . The wind direction is from right to left.

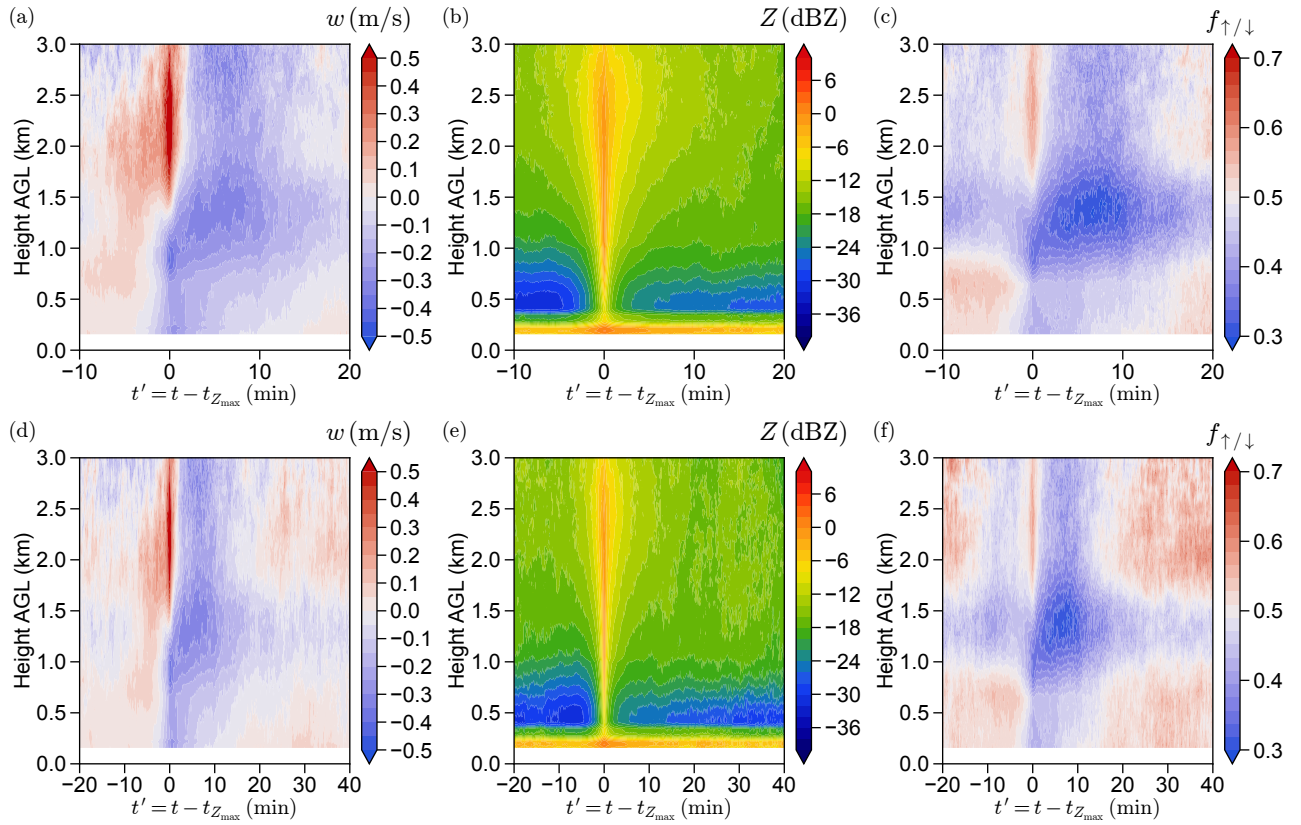


Figure S4. Composite means of precipitating clouds and the associated surface meteorology anomalies with regards to their daily averages. Velocities include clear air pixels around the clouds (see text). Top row is zoomed in around $t' \in [-10, 20]$ min for easier comparison with the plots in reduced units in the main text. (a, d) Reflectivity Z . (b, e) Vertical velocity w . (c, f) Relative updraft-to-downdraft fraction $f_{\uparrow/\downarrow}$. The time coordinate is centered as $t' = t - t_{Z_{\max}}$ so that the times of maximum reflectivity all line up together. The wind direction is from right to left.

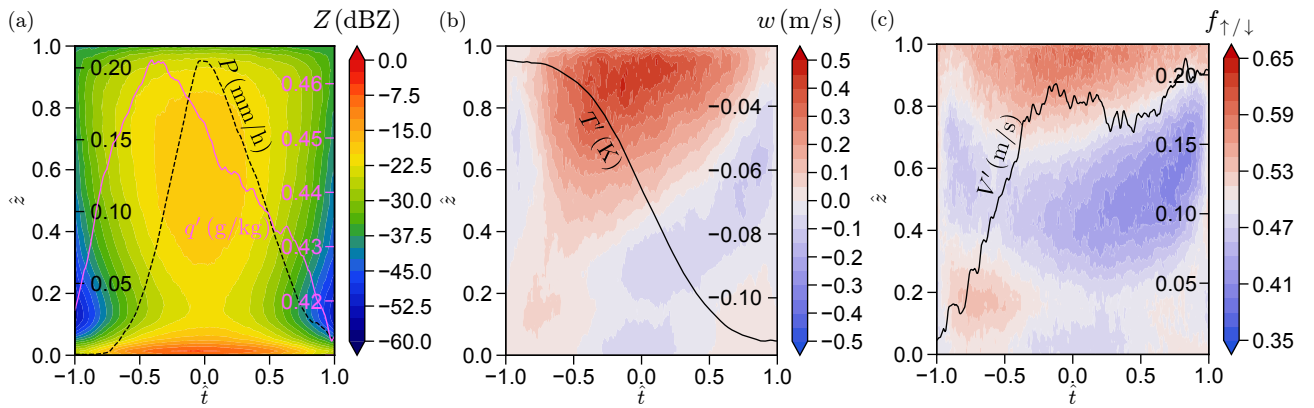


Figure S5. Composite means of precipitating clouds shorter than 20 min and the associated surface meteorology anomalies with regards to their daily averages. Velocities include clear air pixels around the clouds (see text). (a) Reflectivity Z . Dashed black line: precipitation rate. Solid pink line: specific humidity anomaly q' . (b) Vertical velocity w . Solid black line: temperature anomaly T' . (c) Relative updraft-to-downdraft fraction $f_{\uparrow/\downarrow}$. Solid black line: wind magnitude anomaly V' . The coordinates are normalized with regards to the lowest range gate and cloud top for the height \hat{z} and the cloud start and end for the time \hat{t} . The wind direction is from right to left.

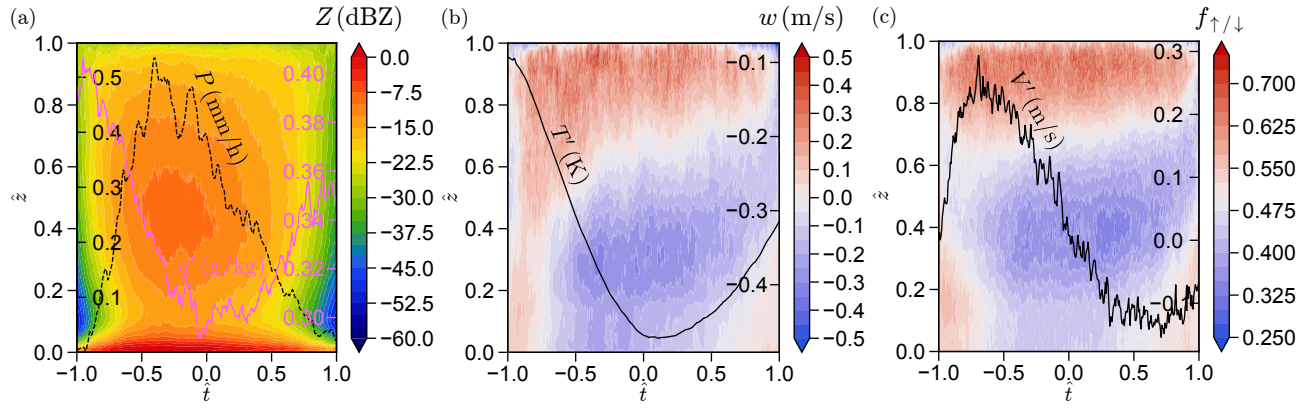


Figure S6. Composite means of precipitating clouds longer than 20 min and the associated surface meteorology anomalies with regards to their daily averages. Velocities include clear air pixels around the clouds (see text). (a) Reflectivity Z . Dashed black line: precipitation rate. Solid pink line: specific humidity anomaly q' . (b) Vertical velocity w . Solid black line: temperature anomaly T' . (c) Relative updraft-to-downdraft fraction $f_{\uparrow/\downarrow}$. Solid black line: wind magnitude anomaly V' . The coordinates are normalized with regards to the lowest range gate and cloud top for the height \hat{z} and the cloud start and end for the time \hat{t} . The wind direction is from right to left.

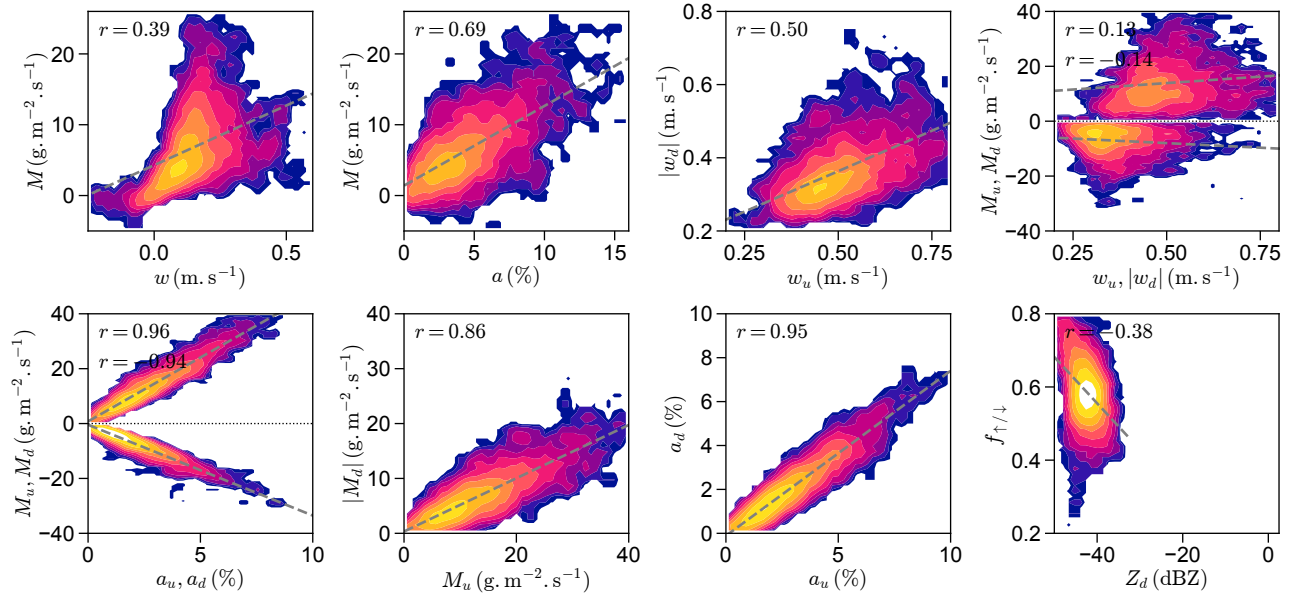


Figure S7. Controls of the cloud base mass fluxes for non-precipitating clouds only. All variables are taken as their 600 to 900 m average. Relationships are plotted as joint density plots in logarithmic scale for readability. Dashed gray lines and r values report the ordinary linear regression on the underlying data. (a) Cloud base mass flux as a function of the cloud base vertical velocity. (b) Mass flux as a function of the cloud fraction. (c) Mass flux as a function of the cloud base vertical velocity. (d) Mass flux as a function of the cloud fraction. (e) Upwards velocity as a function of the downwards velocity. (f) Upward [resp. downward] mass flux as a function of the upward [resp. downward] velocity. (g) Upward [resp. downward] mass flux as a function of the upward [resp. downward] motion fraction. (h) Downward mass flux as a function of the upward mass flux. (i) Downward motion fraction as a function of the upward motion fraction. (j) Relative up-to-downdraft fraction as a function of the cloud base reflectivity.

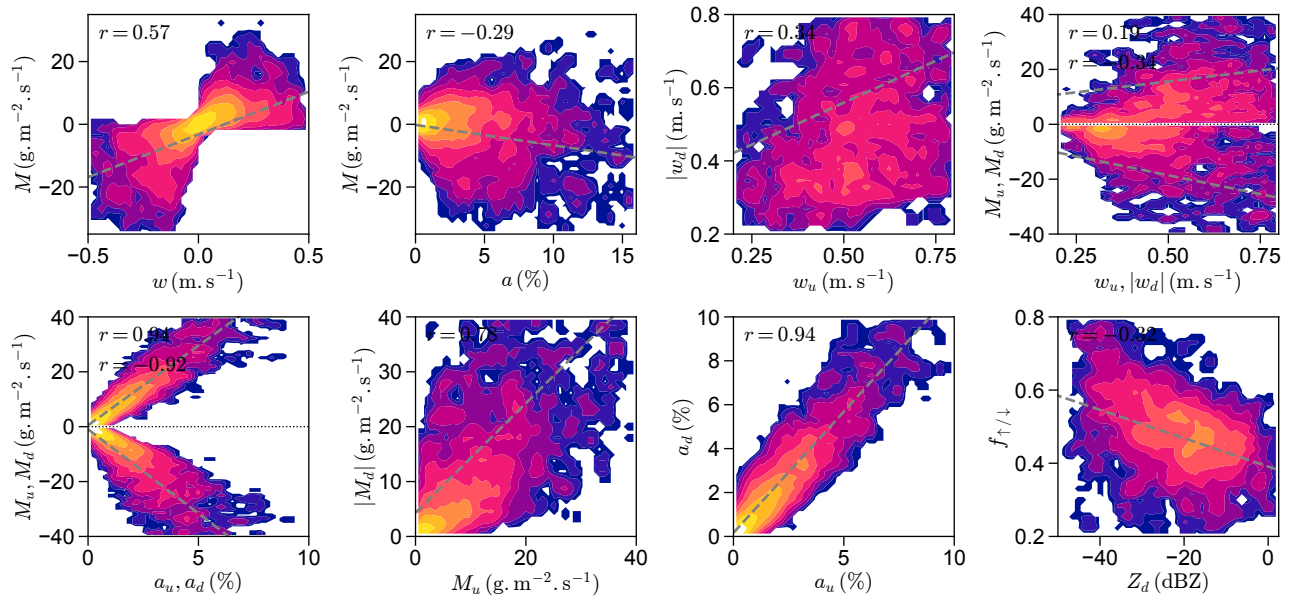


Figure S8. Controls of the cloud base mass fluxes for precipitating clouds only. All variables are taken as their 600 to 900 m average. Relationships are plotted as joint density plots in logarithmic scale for readability. Dashed gray lines and r values report the ordinary linear regression on the underlying data. ((a) Cloud base mass flux as a function of the cloud base vertical velocity. (b) Mass flux as a function of the cloud fraction. (c) Mass flux as a function of the cloud base vertical velocity. (d) Mass flux as a function of the cloud fraction. (e) Upwards velocity as a function of the downwards velocity. (f) Upward [resp. downward] mass flux as a function of the upward [resp. downward] velocity. (g) Upward [resp. downward] mass flux as a function of the upward [resp. downward] motion fraction. (h) Downward mass flux as a function of the upward mass flux. (i) Downward motion fraction as a function of the upward motion fraction. (j) Relative up-to-downdraft fraction as a function of the cloud base reflectivity.