

Figure S1: Example of a back-tracked parcel starting at the location of the HALO aircraft during flight AC18. This parcel started at 2014-09-28 20:34:53 UTC and was traced back in time in one-hour steps up to 120 hours, as shown in the time color scale on the right. The solid gray line is the full flight AC18 track.

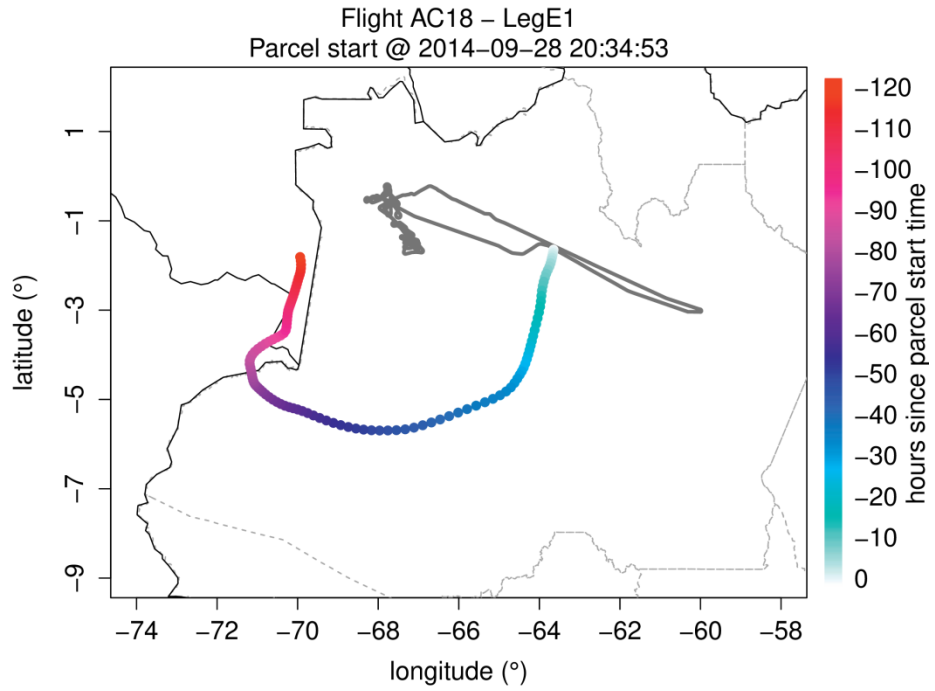


Figure S2: Examples of snapshots of the back-tracked parcel shown in Figure S1 matched in time to the closest GOES-13 infrared brightness temperature ( $T_b$ ). Color dots are the same ones as in Figure S1, representing the position and backward time (in hours). Here the snapshots are zoomed in a  $3^\circ \times 3^\circ$  box centered at the parcel location at the time shown on the top the snapshots. Dashed boxes show the  $1^\circ \times 1^\circ$  box centered in the back-tracked parcel within which we looked up the minimum  $T_b$ . This value is shown at the left corner of each snapshot as well as the parcel altitude and GOES-13 infrared (IR) time.

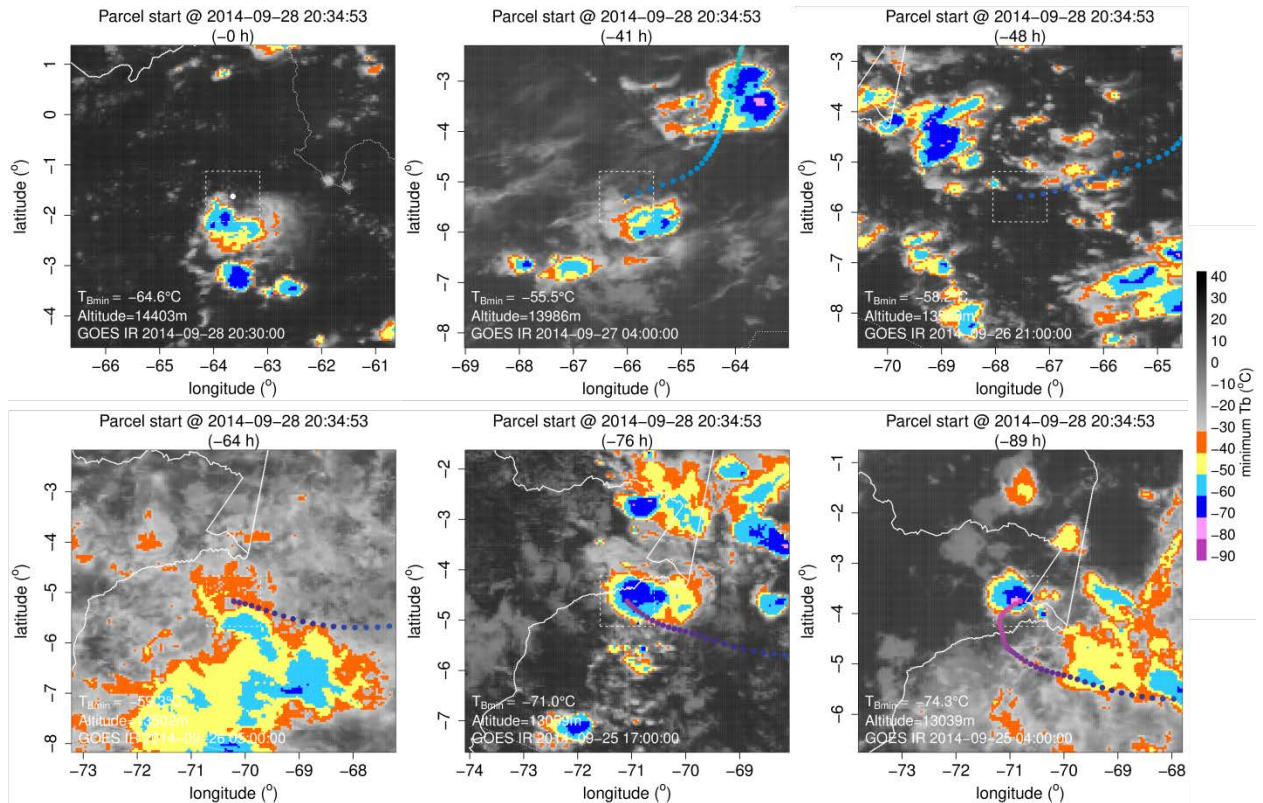


Figure S3: Summary of the back-tracked parcel positions (as in Fig. S1) with the minimum  $T_b$  tracked as shown in the snapshot examples of Figure S2. Here the back-track parcel position is colored with the value of minimum  $T_b$  found in the  $1^\circ \times 1^\circ$  box.

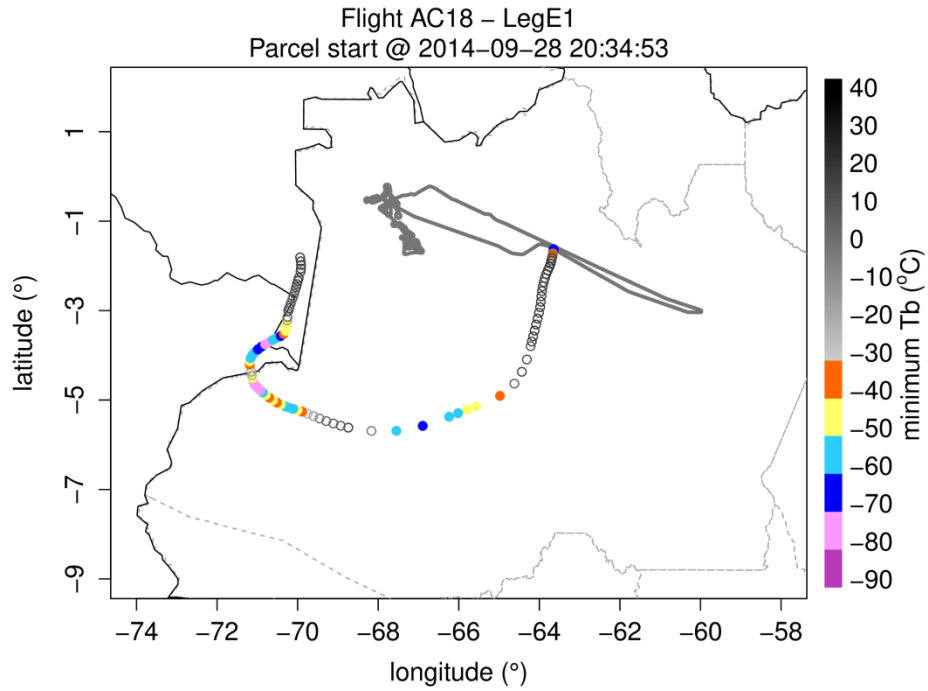


Figure S4. Mean vertical profiles of temperature, relative humidity and potential temperature ( $\theta$ ) from radiosoundings at Manacapuru.

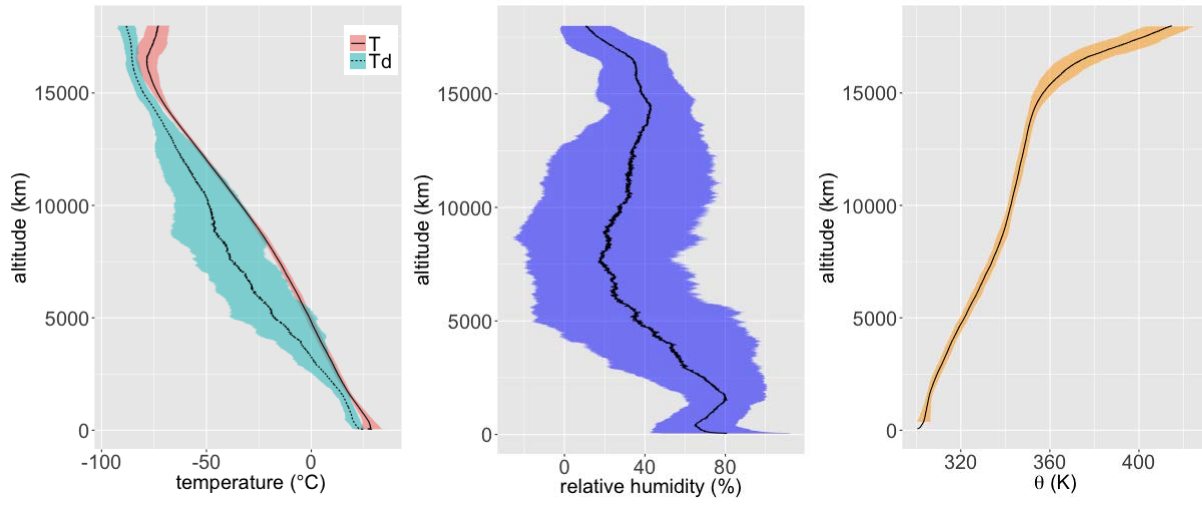
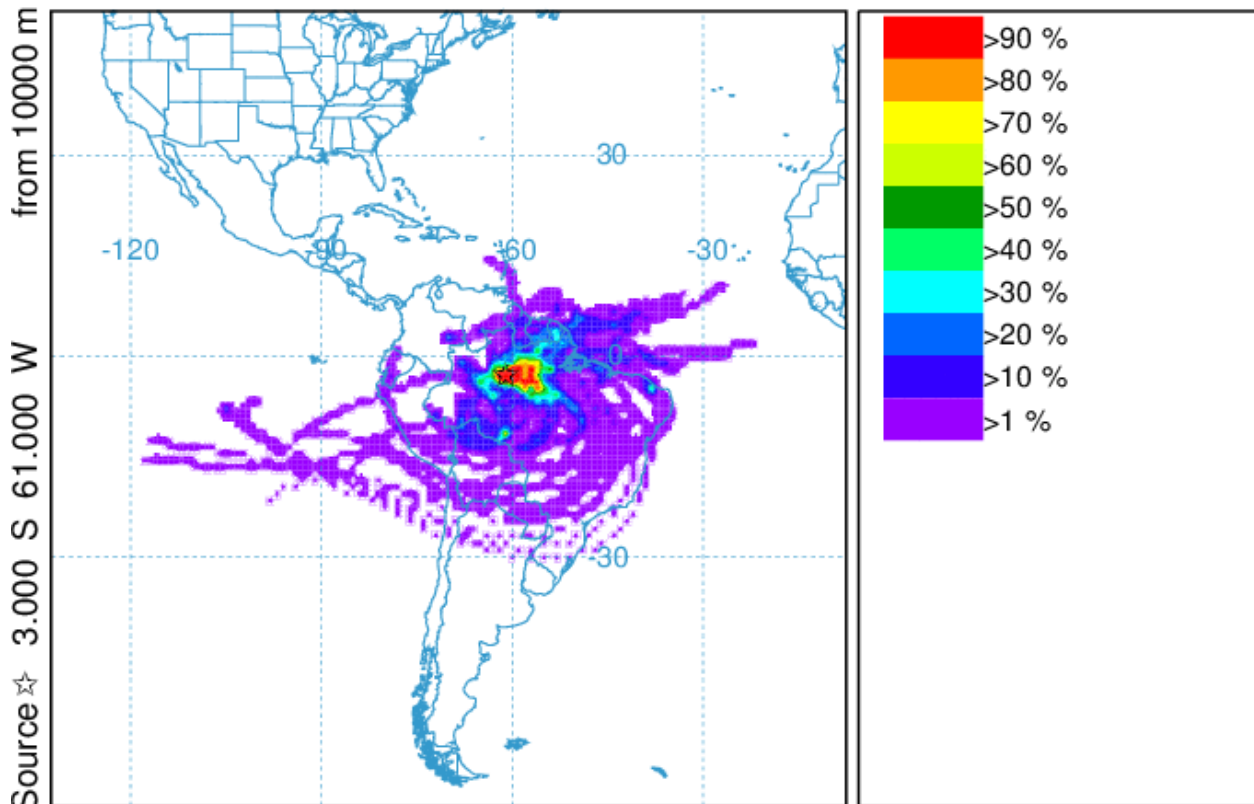


Figure S5: Trajectory statistics based on 120-hour backtrajectory calculations for September 2014, initialized at Manaus at an elevation of 10 km.

### NOAA HYSPLIT MODEL - TRAJECTORY FREQUENCIES

# endpts per grid sq./# trajectories (%) 0 m and 99999 m  
Integrated from 2100 30 Sep to 0900 27 Aug 14 (UTC) [backward]  
Freq Calculation started at 0000 00 00 (UTC)



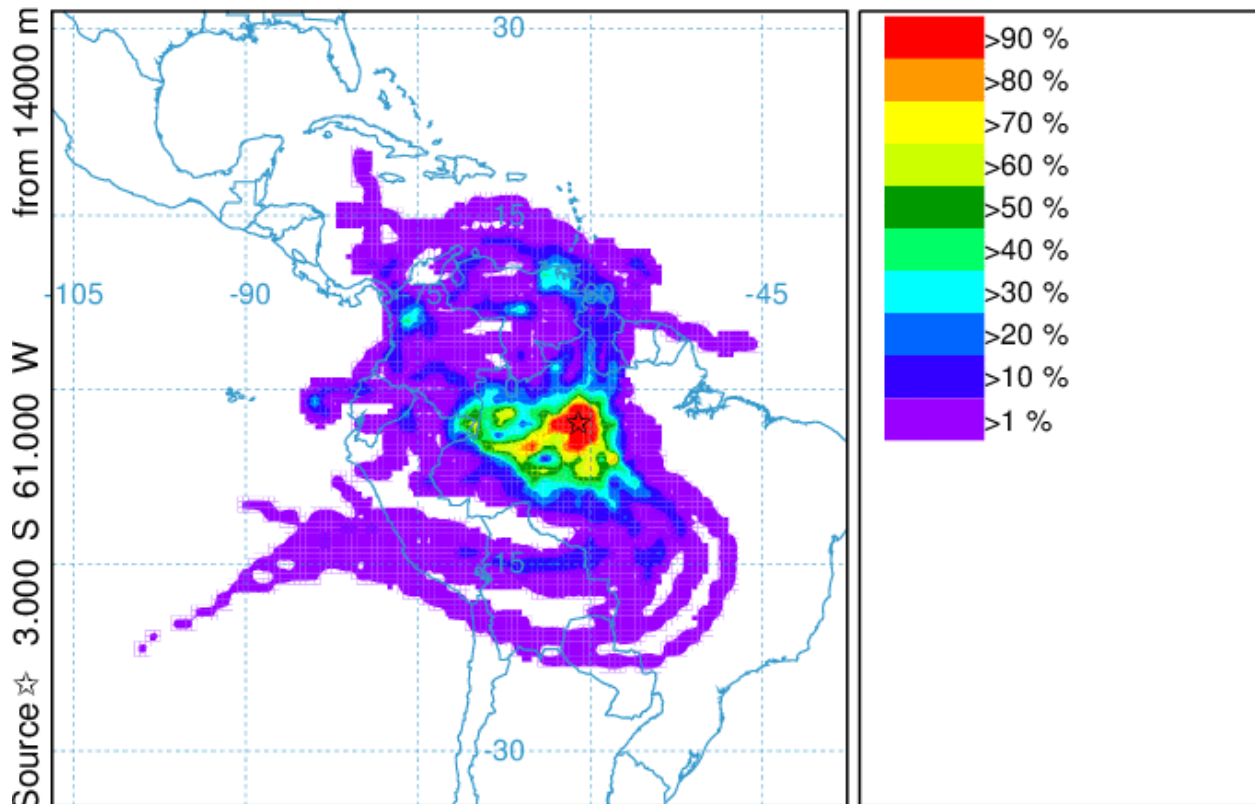
#### METEOROLOGICAL DATA

Job ID: 113173 Job Start: Wed Jan 11 22:11:28 UTC 2017  
Source 1 lat.: -3.000000 lon.: -61.000000 height: 10000 m AMSL  
Initial trajectory started: 2100Z 30 Sep 14  
Direction of trajectories: Backward Trajectory Duration: 120 hrs  
Frequency grid resolution: 1.0 x 1.0 degrees  
Endpoint output frequency: 60 per hour  
Number of trajectories used for this calculation: 60  
Meteorology: 0000Z 29 Sep 2014 - GDAS1

Figure S6: Trajectory statistics based on 120-hour backtrajectory calculations for September 2014, initialized at Manaus at an elevation of 14 km.

### NOAA HYSPLIT MODEL - TRAJECTORY FREQUENCIES

# endpts per grid sq./# trajectories (%) 0 m and 99999 m  
Integrated from 2100 30 Sep to 0900 27 Aug 14 (UTC) [backward]  
Freq Calculation started at 0000 00 00 (UTC)



#### METEOROLOGICAL DATA

Job ID: 113224 Job Start: Wed Jan 11 22:18:03 UTC 2017  
Source 1 lat.: -3.000000 lon.: -61.000000 height: 14000 m AMSL  
Initial trajectory started: 2100Z 30 Sep 14  
Direction of trajectories: Backward Trajectory Duration: 120 hrs  
Frequency grid resolution: 1.0 x 1.0 degrees  
Endpoint output frequency: 60 per hour  
Number of trajectories used for this calculation: 60  
Meteorology: 0000Z 29 Sep 2014 - GDAS1