Supplementary materials:

A meteorological overview of the ORACLES (ObseRvations of Aerosols above CLouds and their intEractionS) campaign over the southeast Atlantic during 2016-2018: Part 2 – daily and synoptic characteristics

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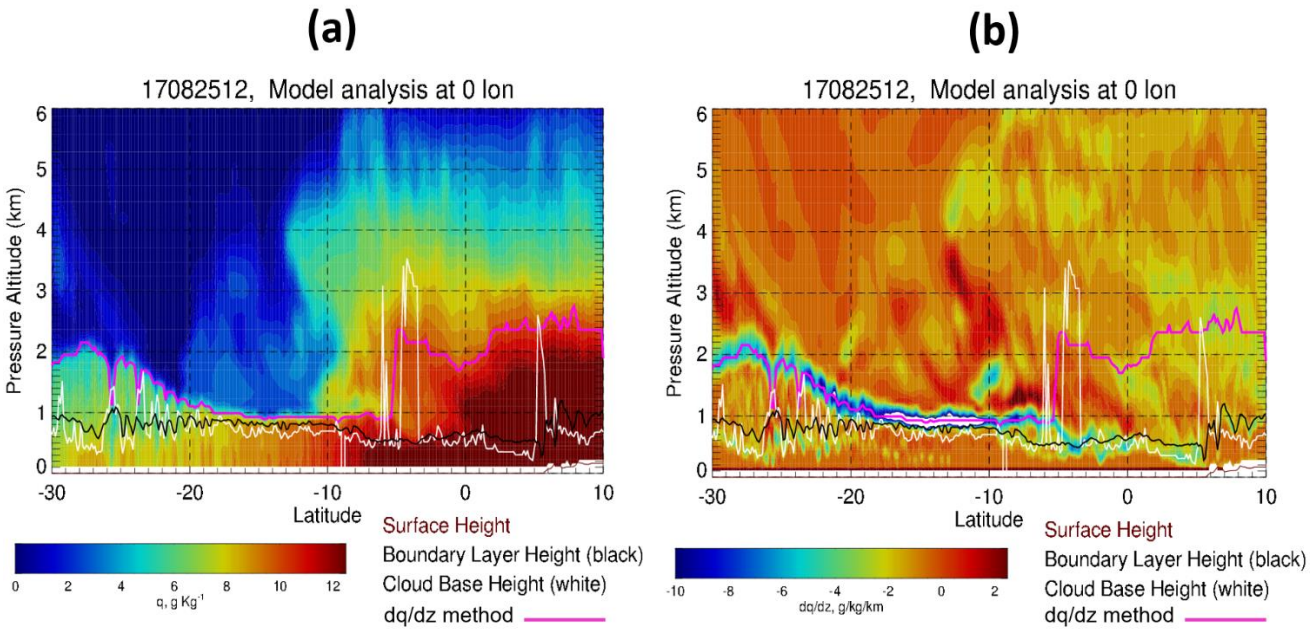


Figure S1. Map of (a) specific humidity (*q*, g kg^{-1}) and (b) vertical gradient of *q* (d*q*/dz, g kg^{-1} km^{-1}) overlaid by ERA5 boundary layer height (BLH) (Richardson number method, black line) and decoupled cloud BLH developed in this study (d*q*/dz method, magenta line) at 12:00 UTC 25 August 2017. Note that ERA5 BLH is referred to "Bulk Richardson number method" because it is estimated using bulk Richardson number (ERA5 data description document). The surface height (brown line) and cloud base height (white line) are also plotted.

Note: The plots demonstrate that 1) the bulk Richardson number method (black line) and the maximum vertical gradient of *q* (d*q*/dz method; the detail methodology is shown in section 2.2 in the main manuscript) agree well over the SE Atlantic Ocean 5–20° S at 0° E, but 2) it (black line) underestimates BLH over the convective (moist) region (*q*> 10g kg^{-1}) and most of the ocean except for 5–20° S at 0° E compared to the d*q*/dz method. ECMWF model-level data is shown here, but similar results are obtained using the pressure level data.

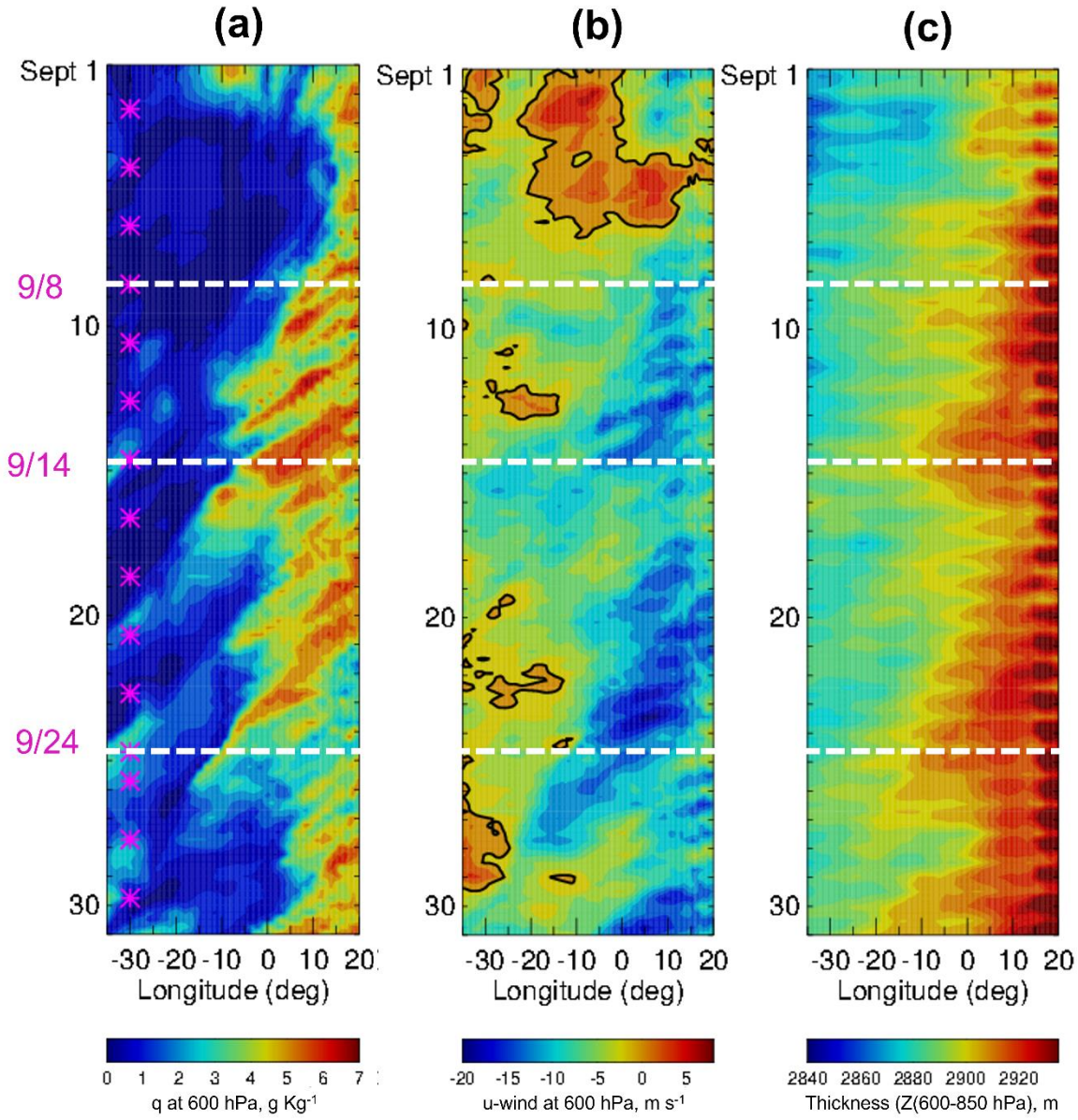


Figure S2. (a-c) Longitude-time cross-section of 6 hourly (a) 600 hPa specific humidity (*q*, g kg^{-1}), (b) 600 hPa zonal wind (shading, m s^{-1}), (c) thickness (geopotential height difference (600-850 hPa); high values over a South African plateau represents the heat low, m) averaged over 8-10° S during September 2016. The white dashed lines indicate the flight days investigated further in this study, and the asterisks represent the flight days during September 2016 deployment. The black contour in (b) represents 0 value of zonal wind.

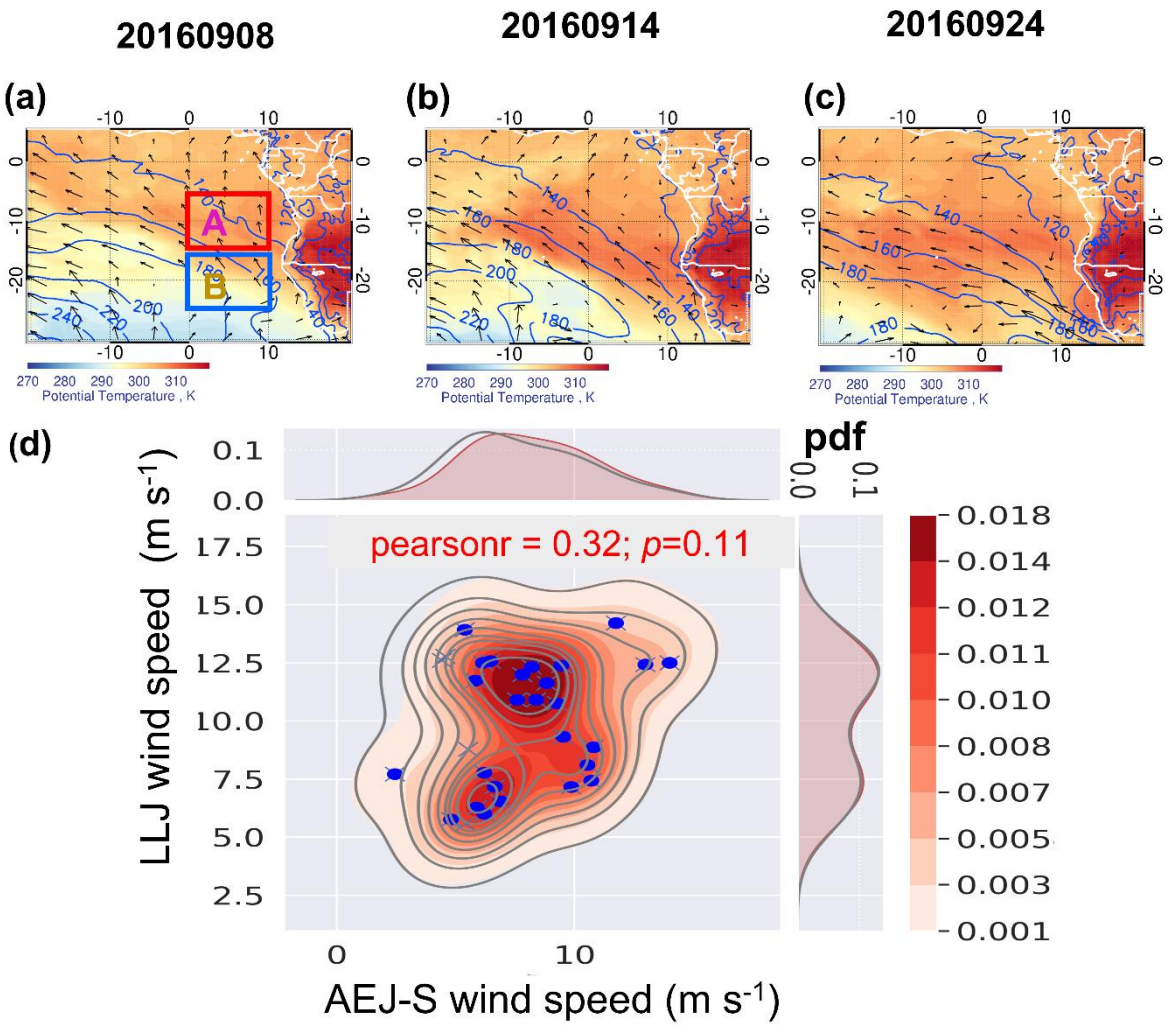


Figure S3. Map of (a–c) 850 hPa potential temperature (θ; shading, K) and 925 hPa horizontal winds (vectors, m s^{-1}) overlaid by 1000 hPa geopotential height (Z, blue contour, m) at 12:00 UTC 8, 14, and 24 September 2016. (d) 2-D joint pdf of the daily AEJ-S wind speed averaged over region A (0–10° E, 5–15° S) and LLJ wind speed averaged over region B (0–10° E, 15–25° S) marked in (a) (correlation is obtained for 5–30 September 2016 (blue dots) when the AEJ-S develops). The marginal plot shows their normalized pdf for the whole month (gray) and the days during the month when AEJ-S develops (red), respectively.

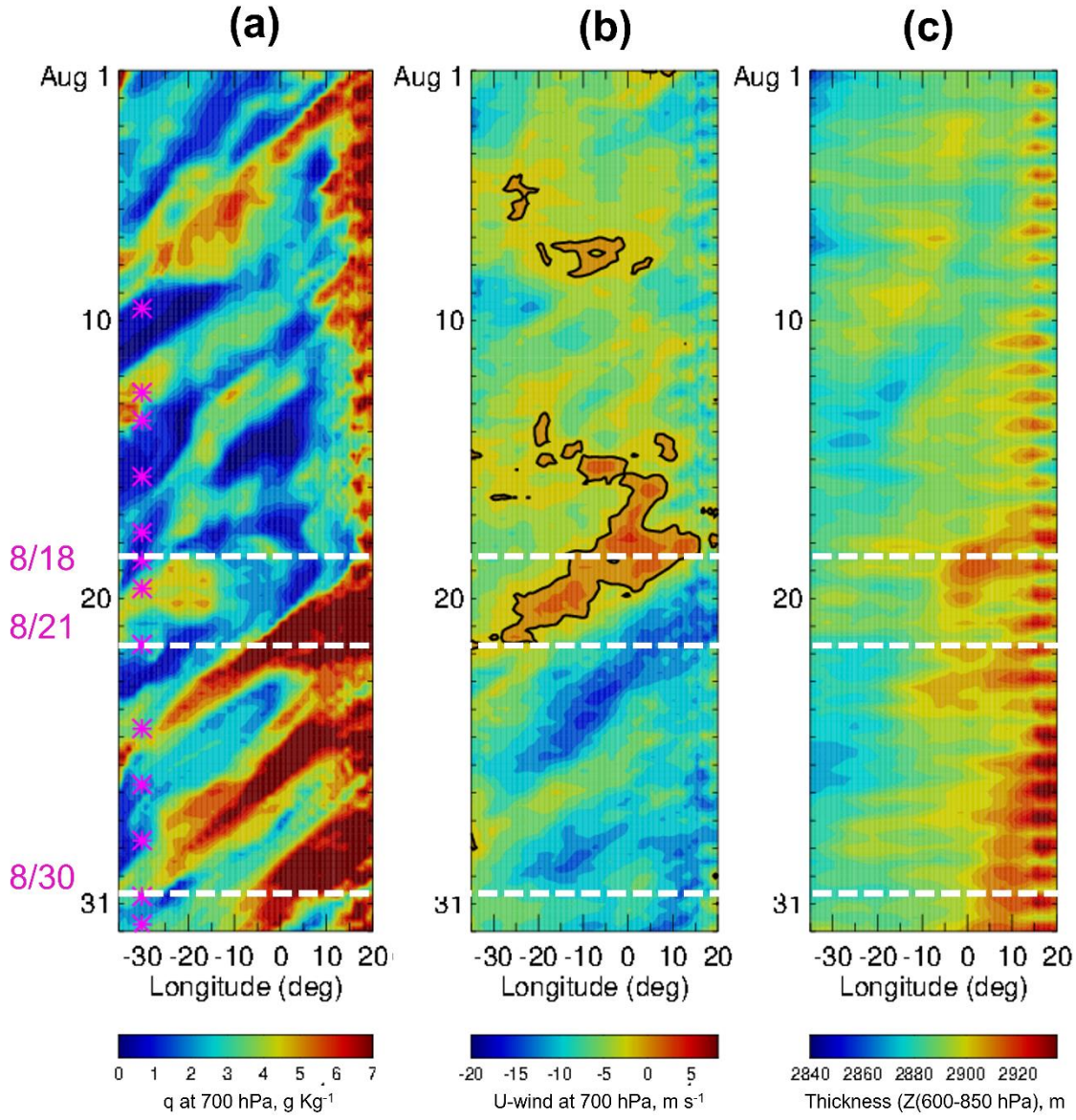


Figure S4. Longitude-time cross-section of 6 hourly (a) 700 hPa specific humidity (*q*, g kg^{-1}), (b) 700 hPa zonal wind (shading, m s^{-1}), (c) thickness (geopotential height difference (600-850 hPa); high values over a South African plateau represents the heat low, m) averaged over 5–7° S during August 2017. The white dashed lines indicate the flight days investigated further in this study, and the asterisks represent the flight days during August 2017 deployment. The black contour in (b) represents 0 value of zonal wind.

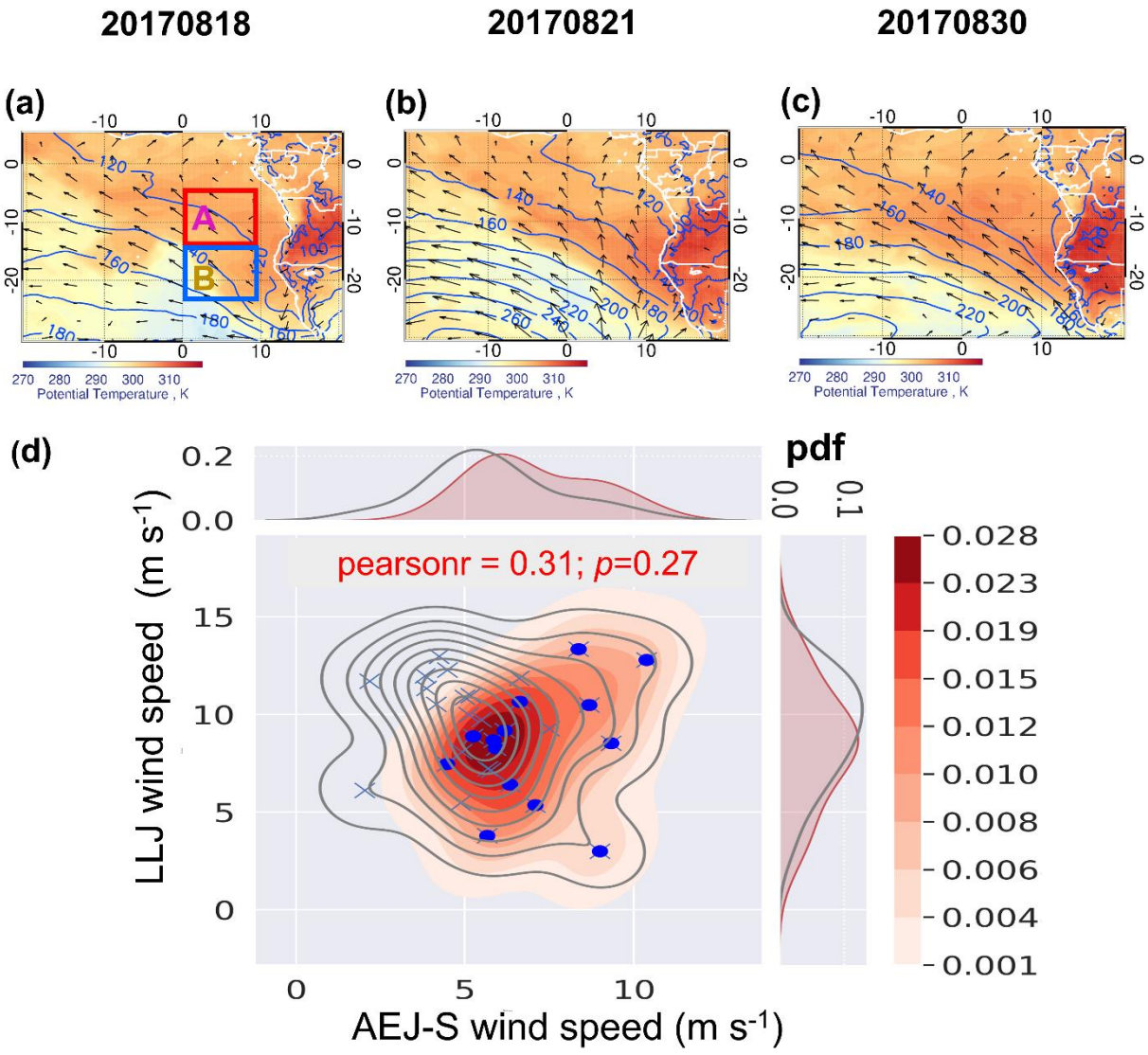


Figure S5. Map of (a–c) 850 hPa potential temperature (θ; shading, K) and 925 hPa horizontal winds (vectors, m s^{-1}) overlaid by 1000 hPa geopotential height (Z) (blue contour, m) at 12:00 UTC 18, 21, and 30 August 2017. (d) 2-D joint pdf of the daily AEJ-S wind speed averaged over region A (0–10° E, 5–15° S) and the LLJ wind speed averaged over region B (0–10° E, 15–25° S) marked in (a) (correlation is obtained for 18 – 31 August 2017 (blue dots) when the AEJ-S develops). The marginal plot shows their normalized pdf for the whole month (gray) and the days during the month when AEJ-S develops (red), respectively.

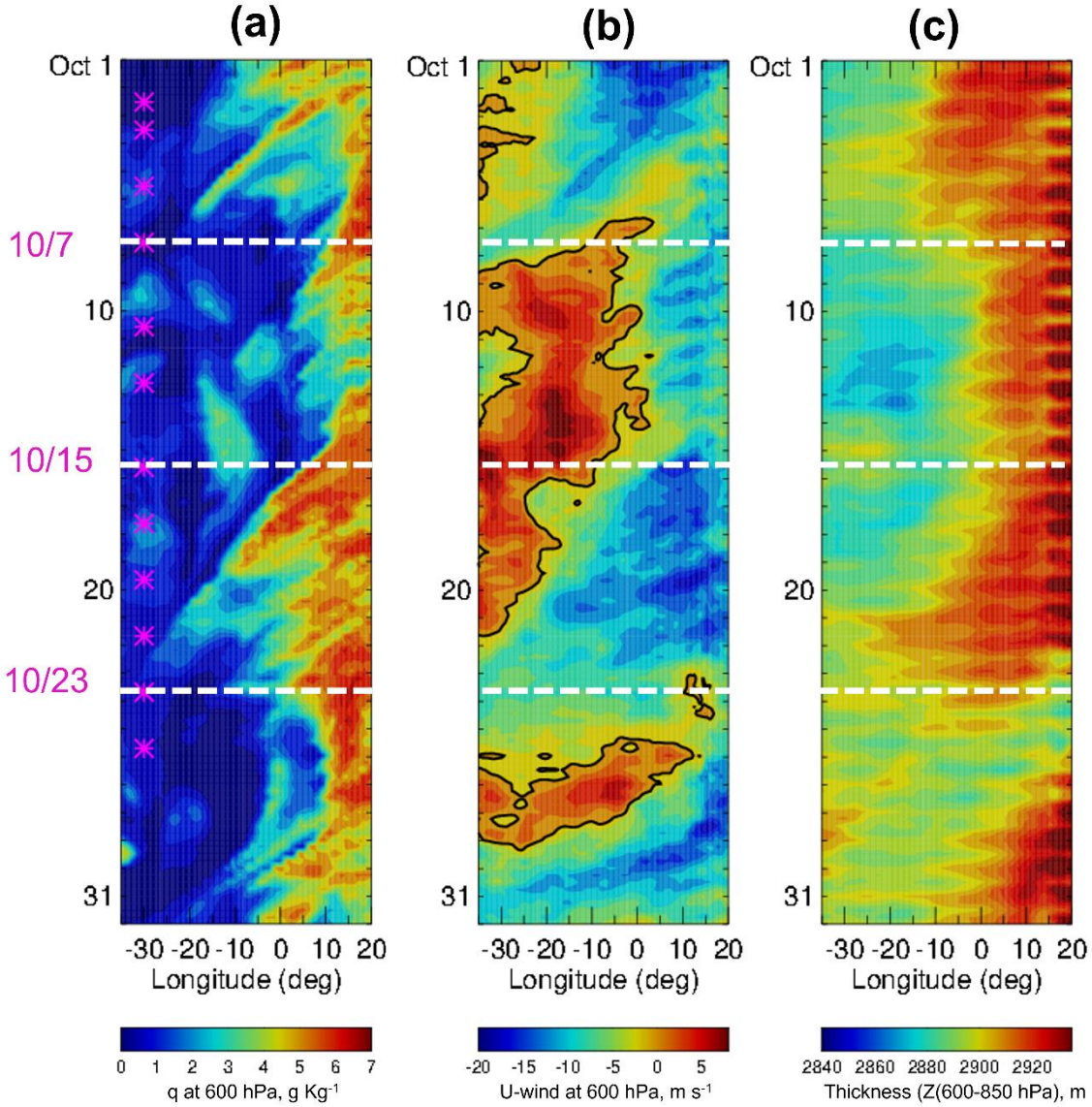


Figure S6. Longitude-time cross-section of 6 hourly (a) 600 hPa specific humidity (*q*, g kg^{-1}), (b) 600 hPa zonal wind (shading, m s^{-1}), (c) thickness (geopotential height difference (600-850 hPa); high values over a South African plateau represents the heat low, m) averaged over 8–10° S during October 2018. The white dashed lines indicate the flight days investigated further in this study, and the asterisks represent the flight days during October 2018 deployment. The black contour in (b) represents 0 value of zonal wind.

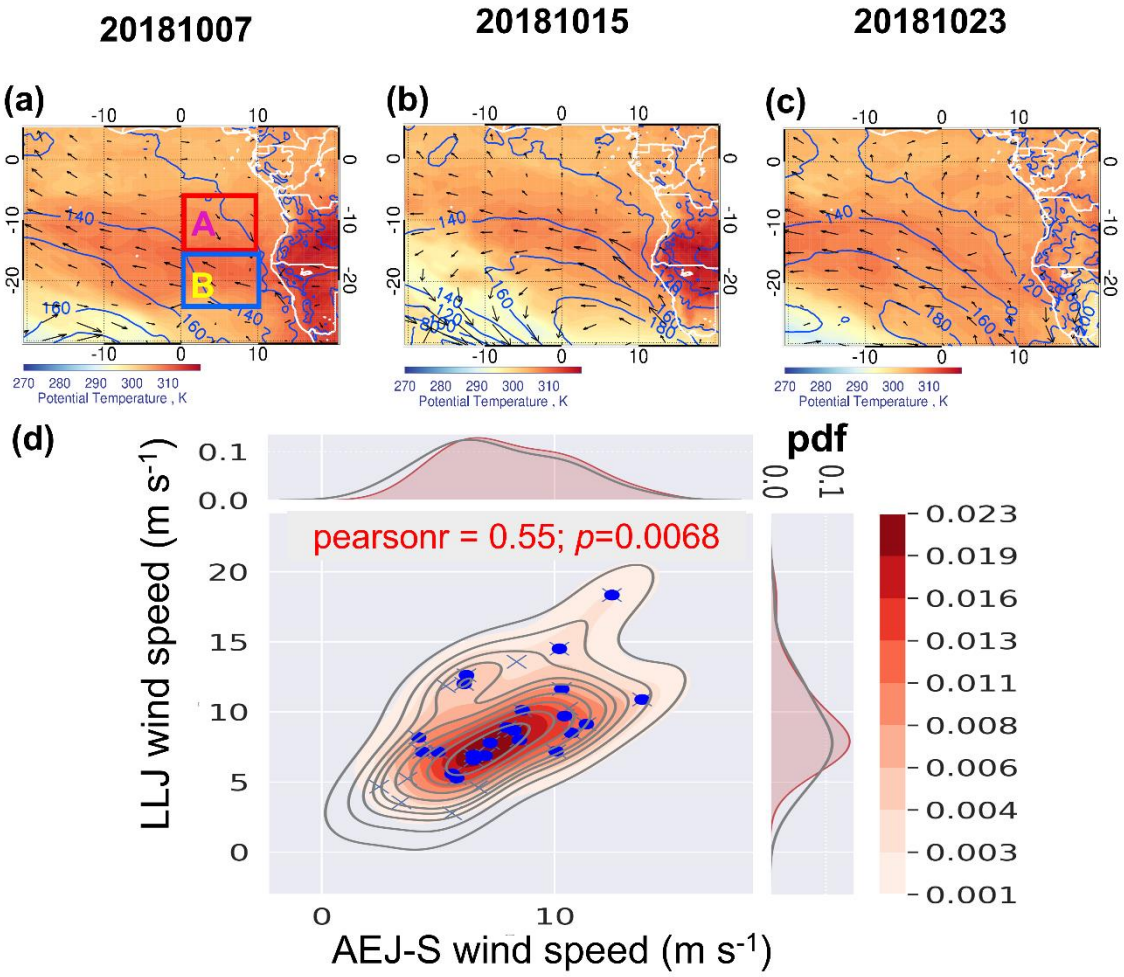


Figure S7. Map of (a–c) 850 hPa potential temperature (θ; shading, K) and 925 hPa horizontal winds (vectors, m s^{-1}) overlaid by 1000 hPa geopotential height (Z) (blue contour, m) at 12:00 UTC 7, 15, and 23 October 2018. (d) 2-D joint pdf of the daily AEJ-S wind speed averaged over region A (0–10° E, 5–15° S) and the LLJ wind speed averaged over region B (0–10° E, 15–25° S) marked in (a) (correlation is obtained for 1–24 October 2018 (blue dots) when the AEJ-S develops). The marginal plot shows their normalized pdf for the whole month (gray) and the days during the month when AEJ-S develops (red), respectively.

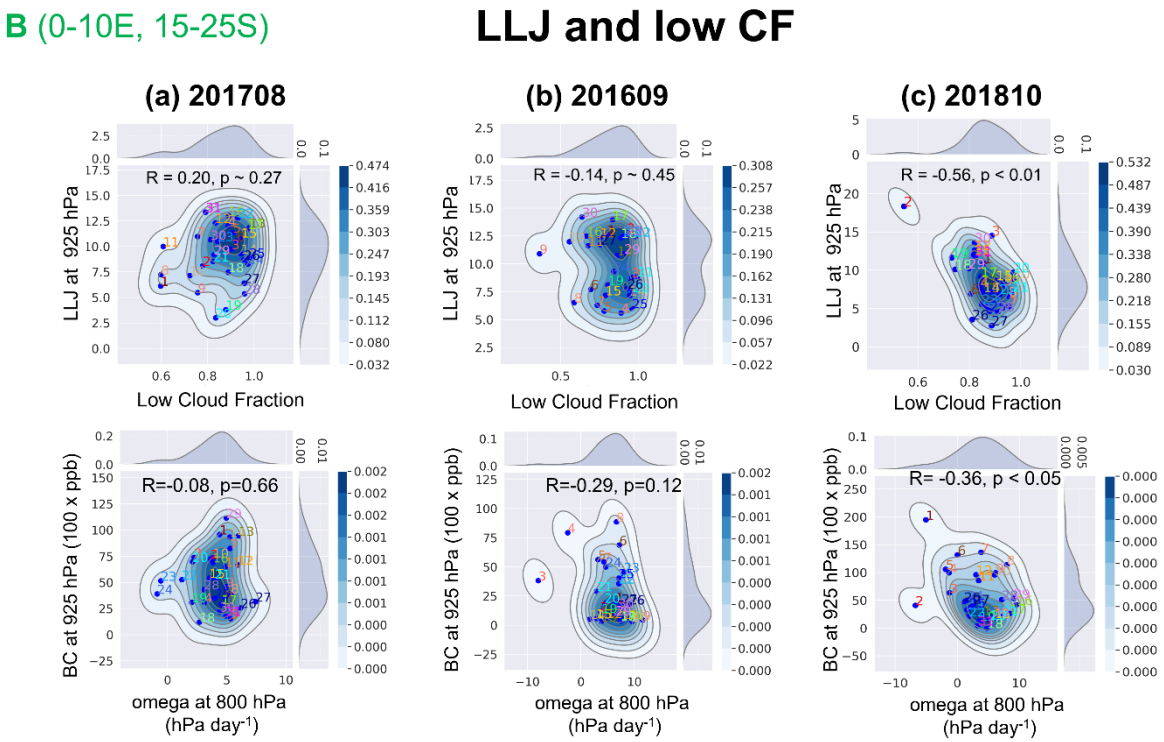


Figure S8. The 2-d density plot of (top) 925 hPa low-level jet (LLJ) and low-cloud fraction (low-CF) and (bottom) 925 hPa LLJ and 800 hPa vertical velocity (omega, positive value represents subsidence) during (a) August 2017, (b) September 2016, and (c) October 2018.

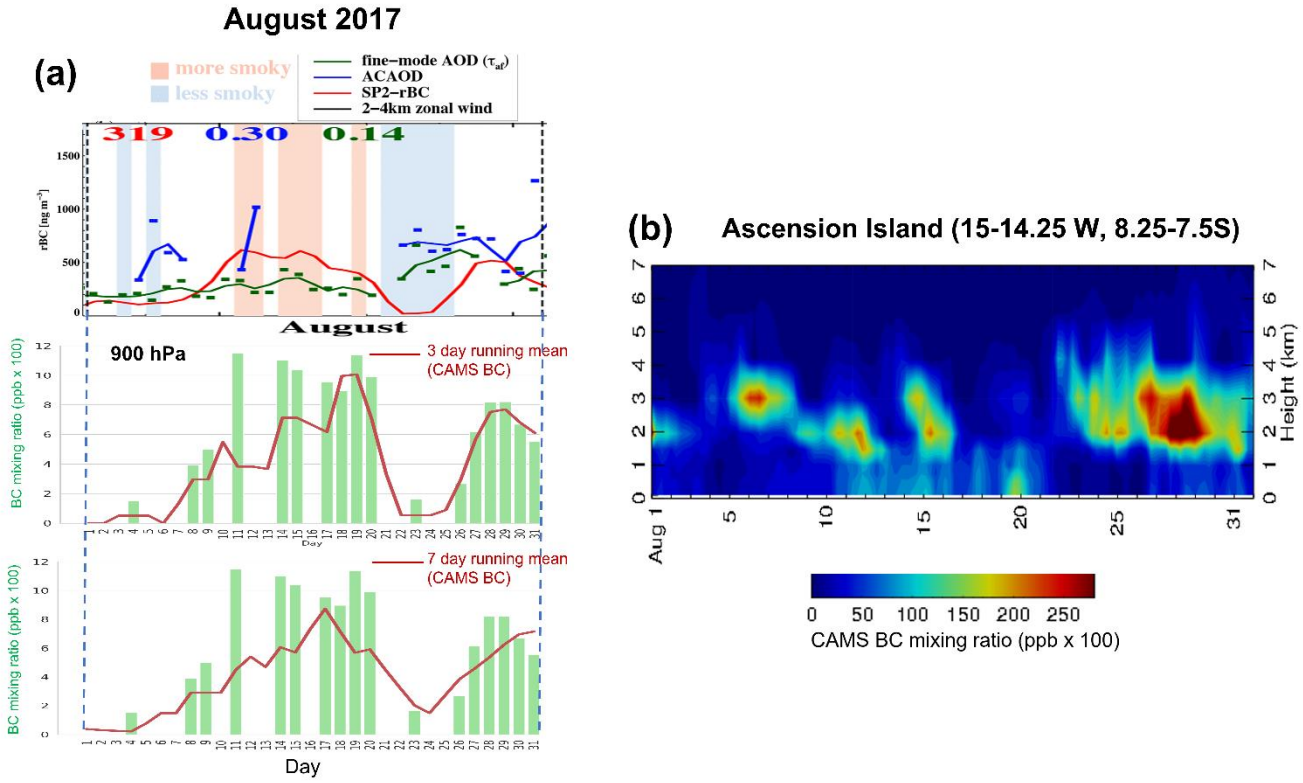


Figure S9. (a) (top) observed daily refractory BC (rBC) mass concentration over Ascension Island in August 2017, adapted from Zhang and Zuidema (2021). *Red line*: 3day running mean of the data. (Middle and bottom) 900 hPa CAMS BC (*red lines*: 3 day and 7 day running mean of daily averaged BC mixing ratio) over Ascension Island in August 2017. (b) Time-height cross section of BC averaged over Ascension Island (15W-14.25W, 8.25S-7.5S) in August 2017. The 1000 ng m^{-3} is equivalent to 1 ppb.

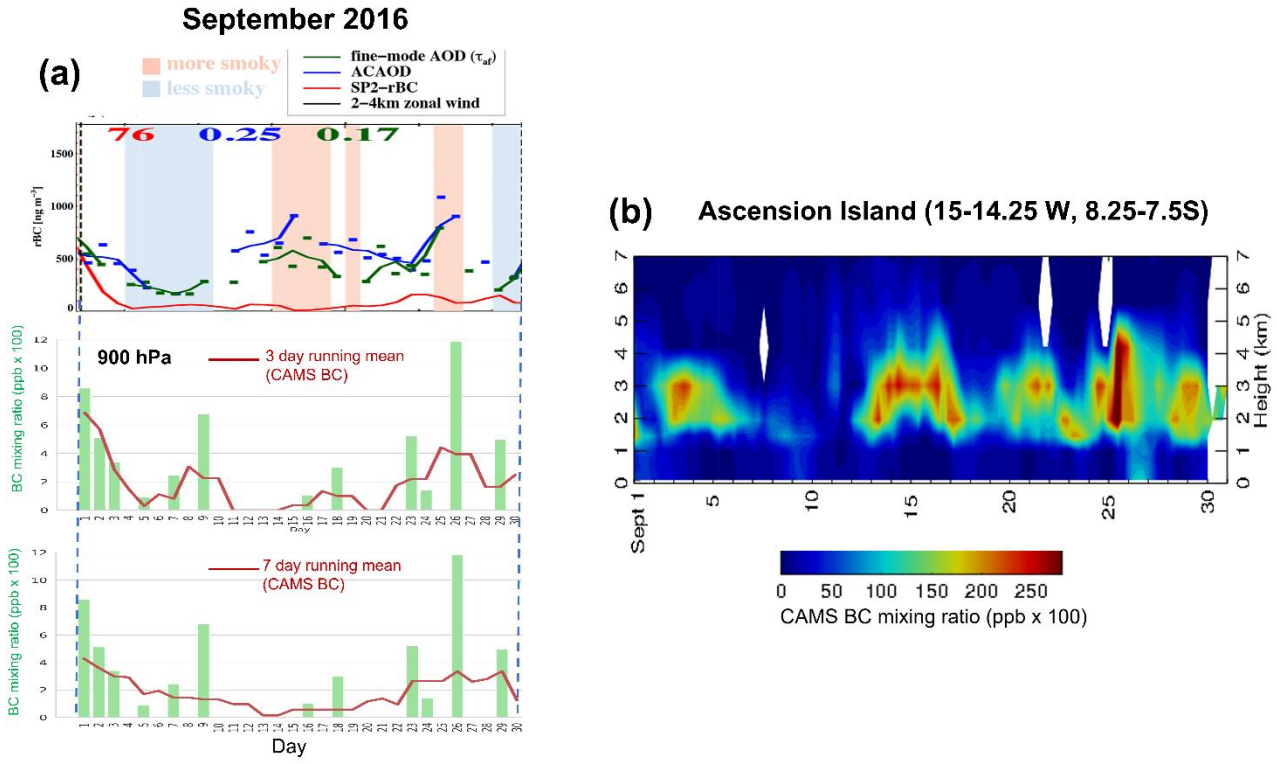


Figure S10. (a) (top) observed daily refractory BC (rBC) mass concentration over Ascension Island in September 2016, adapted from Zhang and Zuidema (2021). *Red line*: 3day running mean of the data. (Middle and bottom) 900 hPa CAMS BC (*red lines*: 3 day and 7 day running mean of daily averaged BC mixing ratio) over Ascension Island in September 2016. (b) Time-height cross section of BC averaged over Ascension Island (15° W-14.25° W, 8.25° S-7.5° S) in September 2016. The 1000 ng m^{-3} is equivalent to 1 ppb. The white area in (b) represents the missing values.

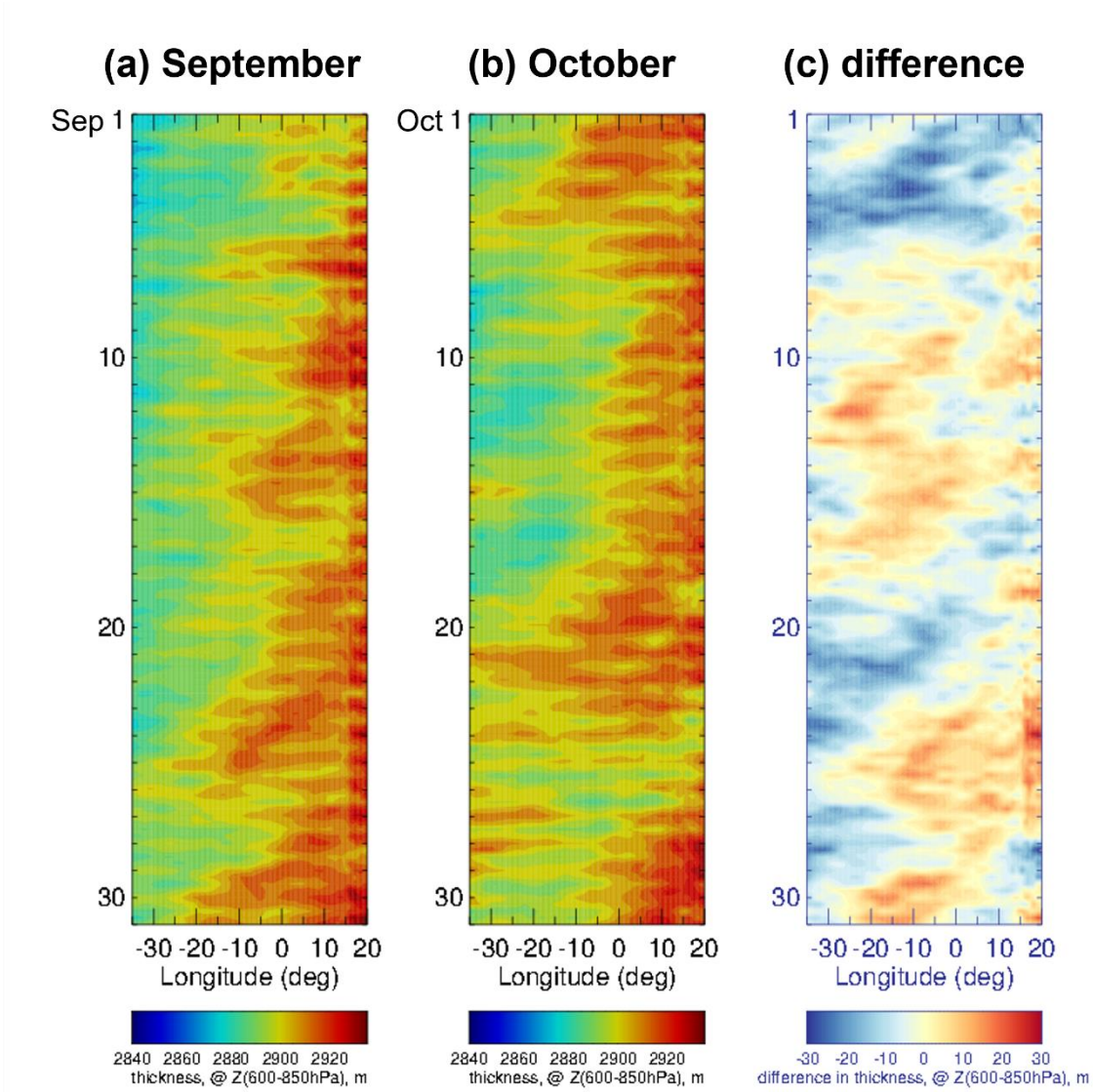


Figure S11. Longitude-time cross-section (Hovmöller diagram) of the 6-hourly thickness (geopotential height difference (600-850 hPa); high values over a South African plateau represents the heat low, m) averaged over 8-10° S during (a) September 2016, (b) October 2018, and (c) their difference. The red (blue) color in (c) represents the stronger (weaker) heat low in September 2016 than in October 2018.

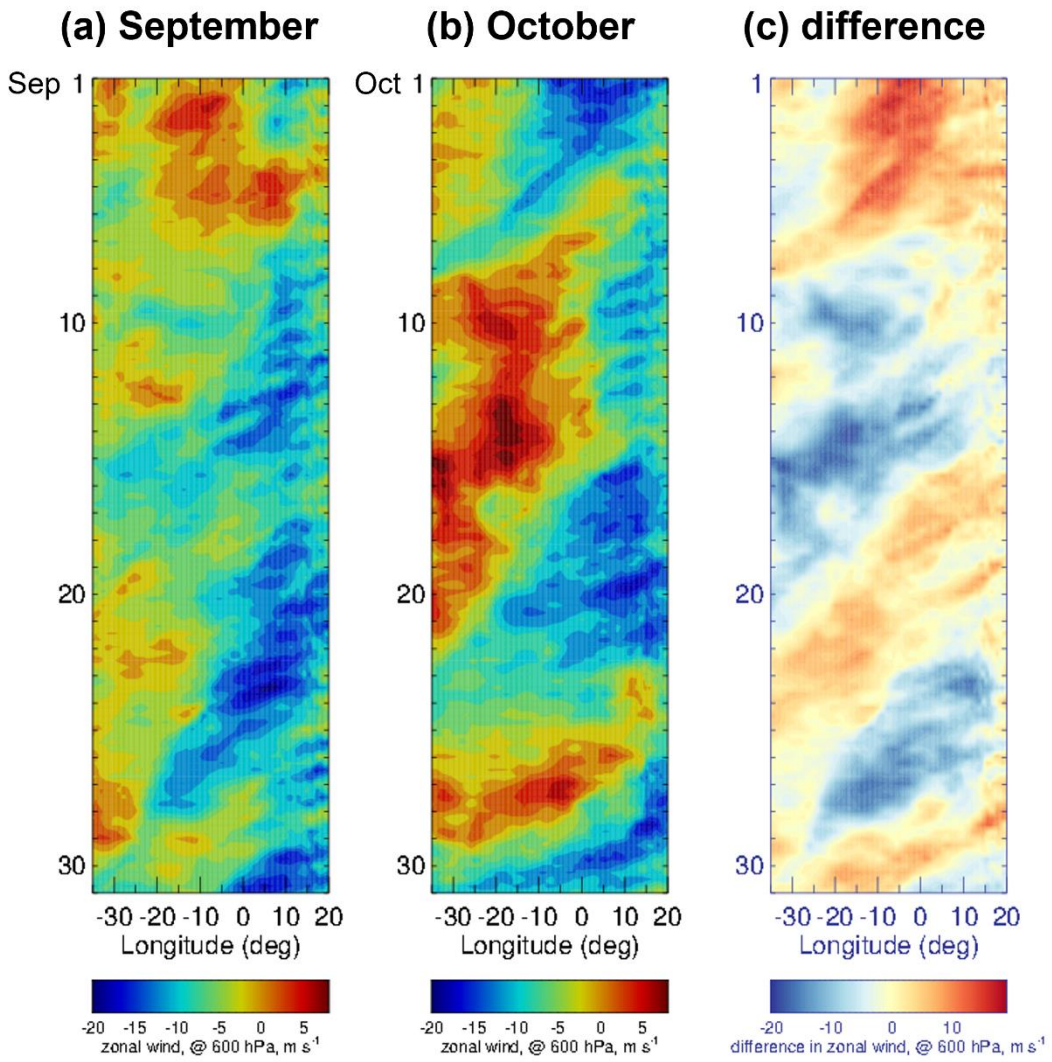
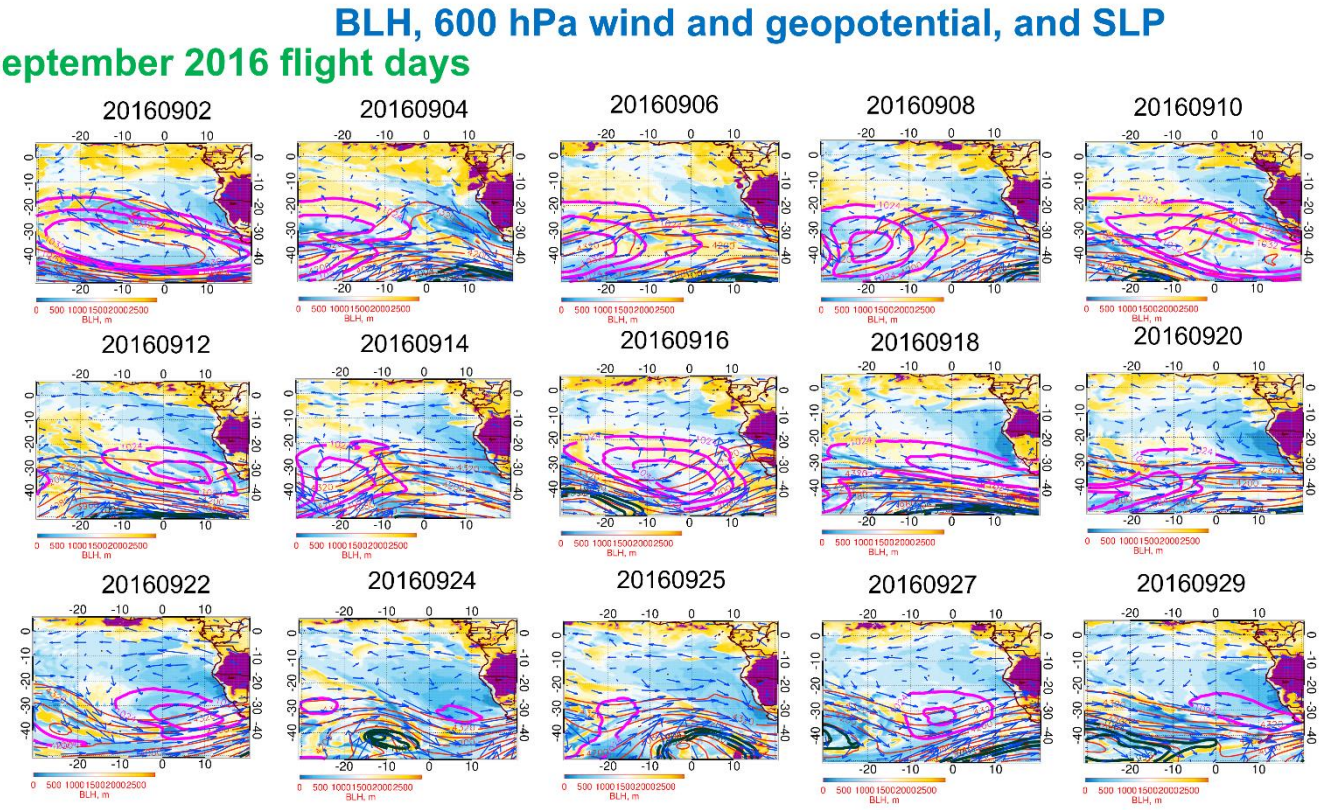


Figure S12. Longitude-time cross-section (Hovmöller diagram) of 6-hourly 600 hPa zonal wind (shading, m s^{-1}) averaged over 8-10° S during (a) September 2016, (b) October 2018, and (c) their difference. The red (blue) color in (c) represents the weaker (stronger) 600 hPa zonal easterly wind in September 2016 than in October 2018.



115 **Figure S13. Map of BLH (shading, m) overlaid by 600 hPa horizontal winds (vectors, m s^{-1}), 600 hPa geopotential height (red lines, m), and sea level pressure (SLP; dark green (low-pressure: 996, 1000, 1004), and magenta (high-pressure: 1024, 1028, 1032), hPa) at 12:00 UTC on flight days in September 2016. The purple shading over the land refers to BLH higher than 3250 m.**

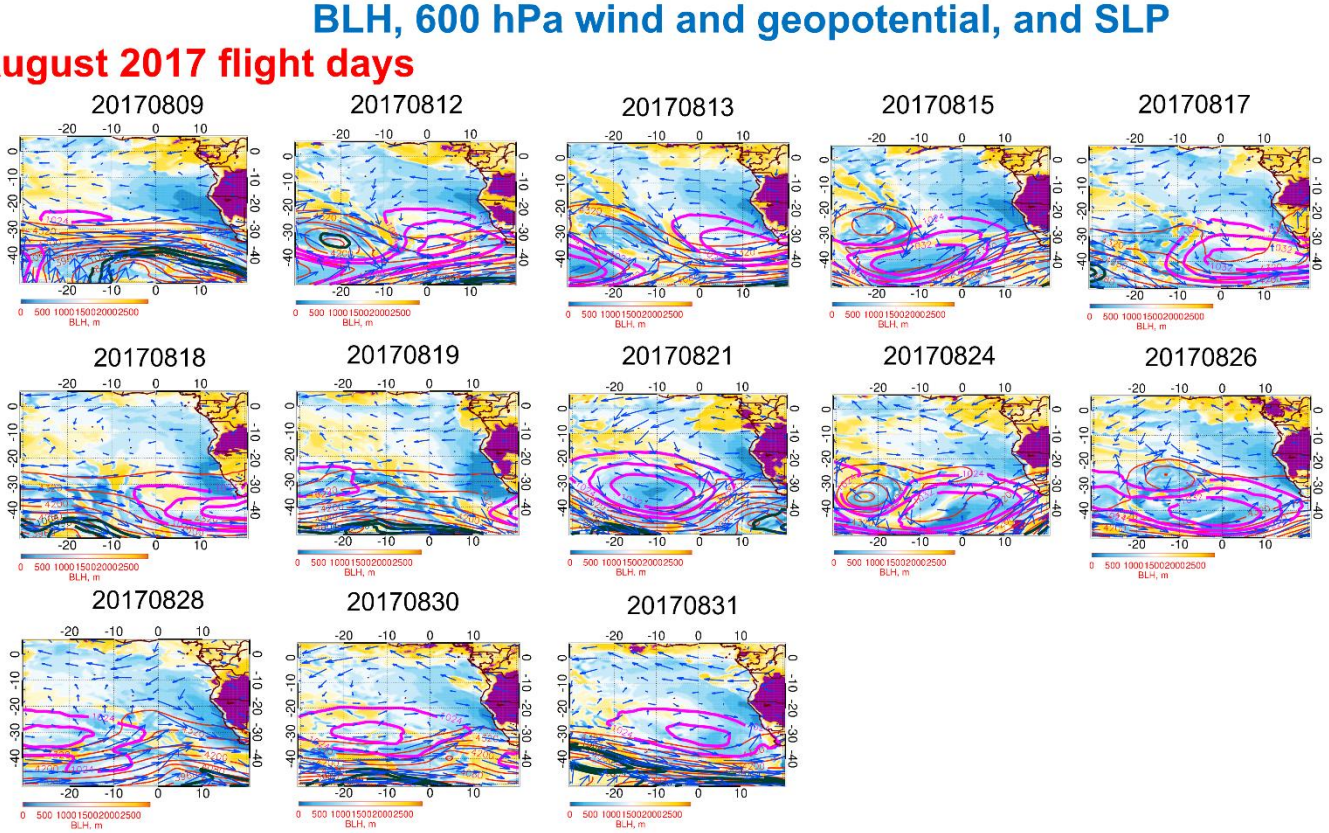


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Figure S14. Map of BLH (shading, m) overlaid by 600 hPa horizontal winds (vectors, m s^{-1}), 600 hPa geopotential height (red lines, m), and sea level pressure (SLP; dark green (low-pressure: 996, 1000, 1004), and magenta (high-pressure: 1024, 1028, 1032), hPa) at 12:00 UTC on flight days in August 2017. The purple shading over the land refers to BLH higher than 3250 m.

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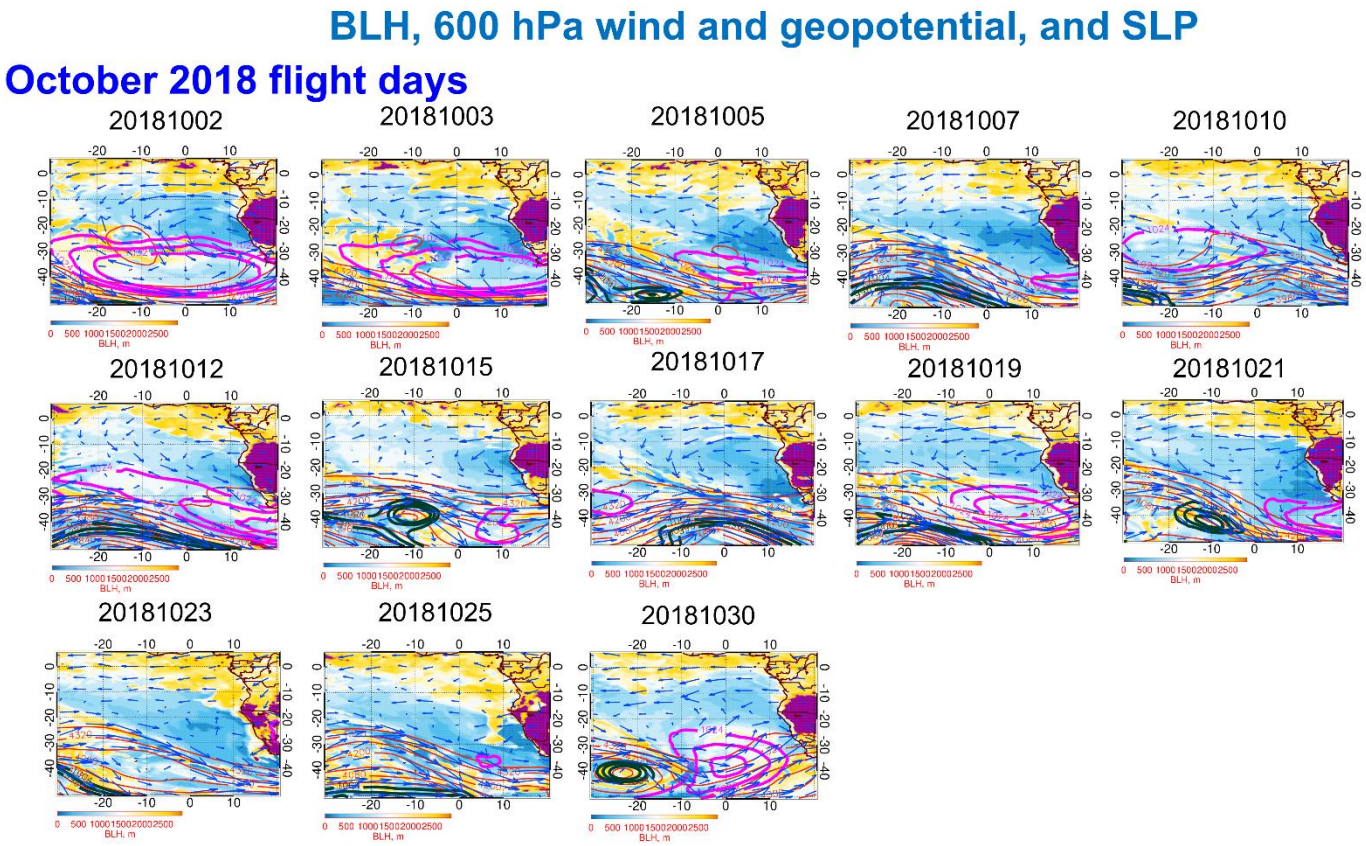

Figure S15. Map of BLH (shading, m) overlaid by 600 hPa horizontal winds (vectors, m s^{-1}), 600 hPa geopotential height (red lines, m), and sea level pressure (SLP; dark green (low-pressure: 996, 1000, 1004), and magenta (high-pressure: 1024, 1028, 1032), hPa) at 12:00 UTC on flight days in October 2018. The purple shading over the land refers to BLH higher than 3250 m.