Westchester Wind Project
2022 Radar and Acoustic Monitoring

Prepared for:

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1.0 Introduction

Natural Forces Developments LP (Natural Forces) retained Ausenco Engineering Inc. (Ausenco) (formally known as Hemmera), to conduct spring and fall radar and acoustic monitoring of nocturnal migrating birds at the Westchester Wind Project (the Project) in 2021 and 2022. The Project is located approximately 63 kilometers (km) northwest (NW) of the Town of Truro, Nova Scotia (NS).

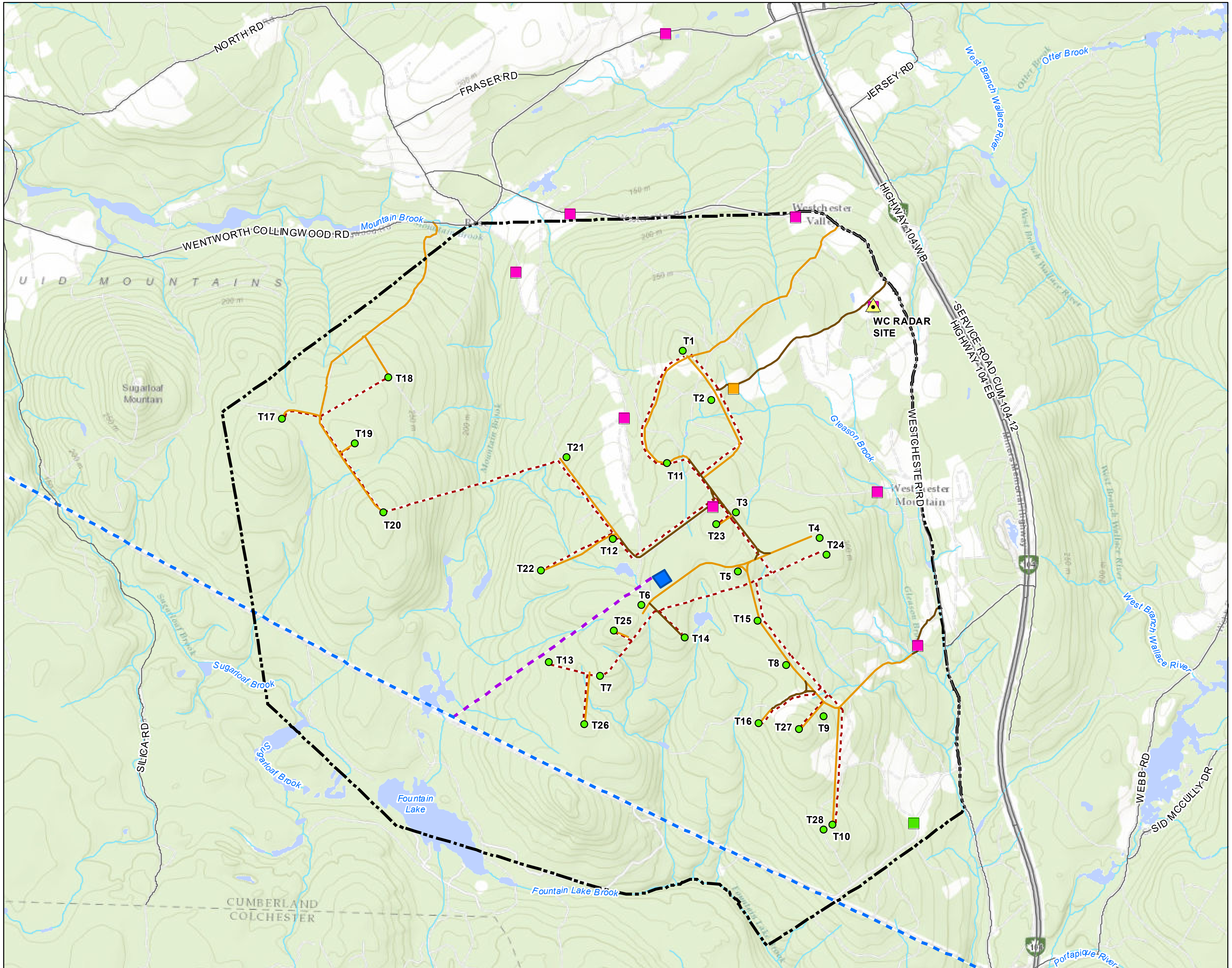
The *Guide to Preparing an EA Registration Document for Wind Power Projects in Nova Scotia* (Nova Scotia Government 2021) specifies that avian radar studies are required for projects that include turbines greater than 150 m in height. Also, the Canadian Wildlife Service's (CWS) *Wind Energy & Birds Environmental Assessment Guidance Update* (Environment and Climate Change Canada 2022), created in April 2022, specifies that migratory avian radar and acoustic studies be completed for projects that include turbines greater than 150 m in height. Given that the Project turbine will have a maximum total height greater than 150 m, Natural Forces consulted with the CWS and Nova Scotia Environment (NSE) regarding the development and implementation of an avian radar and acoustics study.

Ausenco, in partnership with Dr. Phil Taylor of Tabanid Consulting and Acadia University, completed spring and fall avian radar and acoustic monitoring at the Project in 2021. In February 2022, Natural Forces submitted an Environmental Registration Document to the Environmental Assessment Branch for Nova Scotia Environment and Climate Change for approval. On April 14, 2022, the Ministers Decision Letter was issued. The letter determined that the Registration Document provided was insufficient to make a decision, and that additional information was required.

This report provides a summary of the additional avian migration information collected during the spring and fall migration seasons of 2022.

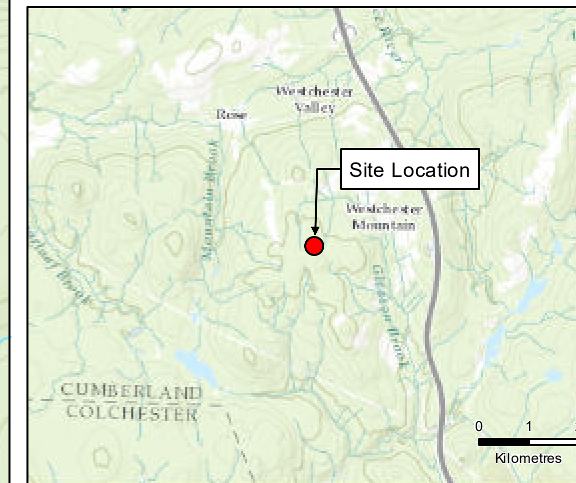
1.1 Project Details

Natural Forces is proposing 28 potential turbine locations for the Project but will only develop up to 12 turbine locations. The turbines will range in size from 4.2 to 6.2 megawatts (MW) each, with the total Project nameplate capacity bring up to 75 MW. The final turbine model has not been selected for the Project. The range in turbine specifications being considered include a hub height between 100 and 131 meters (m), rotor diameter between 138 and 170 m, for a total turbine height (i.e., tip of blade) between 170 and 200 m above ground level (agl). The potential rotor swept area (RSA) of the turbines will range from 20 to 200 m.



Natural Forces
Westchester Mountain Wind Project

Project Area



Legend

- Audio Sensor Location (Spring & Fall)
- Audio Sensor Location (Spring)
- Audio Sensor Location (Fall)
- Radar Location
- Turbine Location
- Collector Line
- Existing Road
- New Road
- Existing Transmission Line
- Project Transmission Line
- Road
- Watercourse
- Local Assessment Area
- Substation
- Waterbody

Notes

1. Natural Forces is proposing 16 potential turbine locations for the Project, but will only develop up to 12 turbine locations.
2. All mapped features are approximate and should be used for discussion purposes only.
3. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Contains information licensed under the Open Government Licence(s) - Nova Scotia
- Aerial Image: ESRI World Topographic Map
- Inset Basemap: ESRI World Topographic Map

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105712-01	Production Date: Dec 13, 2022	Figure 1

Ausenco natural forces

2.0 Methods

The following section provides a summary of the methodology used to collect and analyse the radar and acoustic data during spring and fall, 2022.

2.1 Radar Monitoring

The location of the radar was chosen based on access to the Project area, site security and clear sight lines. The radar was deployed within the northern portion of the Project area (See Figure 1.1), approximately 1,500 m from the nearest proposed turbine.

The radar system used in 2022 was the same unit used at the Project during the fall 2021 migration season. This radar system has been used in the past to assess migratory bird movements at proposed wind energy projects in NS and New Brunswick (NB) (e.g., Burchill Wind Project [Taylor et al. 2020], Benjamins Mill Wind Project [Hemmera 2021]) and has been proven to provide an adequate representation of bird passage rates and heights. The radar monitoring system was initially developed through federal (i.e., CWS) grant funding and has been improved upon through multiple iterations over the past 15+ years. The approach used has been implemented on no fewer than 4 wind energy projects in NB and 6 energy projects in NS, along with two successful Master of Science degrees and presented in peer reviewed scientific publications.

The radar used was a Furuno (Camas, Washington, USA) 1962 BB marine radar operating in the microwave X-band (9410 ± 30 Megahertz (MHz), 25 kilowatt (kW)) with a 6-foot XN13A open-array antenna (with a beam width of approximately 22° in the horizontal plane and approximately 1.35° in the vertical plane). The radar was mounted on a custom support framework in a vertical orientation to monitor the altitude of targets and was run in short pulse mode (2100 pulses per second) at 24 revolutions per minute (rpm).

Prior to deployment, the radar was calibrated while in a horizontal orientation using targets at a known distance. The radar signal was digitized at 4.5 m range resolution with an azimuth resolution of 1.35° using a DSPNOR ScanStreamer (Bergen, Norway). Data were saved on external hard drives and later analyzed using Cognitive Marine Tracker (CMT) radar analysis software, from the Cognitive Radar Corporation (Waterloo, Ontario).

During the spring season, radar data were collected from April 5 to June 6. During this 62-day monitoring period, the radar functioned properly for 56 nights (approximately 90% of the spring monitoring period).

During the fall season, radar data were collected from July 8 to November 30, 2022. During the 145-day monitoring period, the radar functioned properly for 132 nights (approximately 91% of the monitoring period). The majority of the interruption in data collect was due to hurricane Fiona. In anticipation of the arrival of the hurricane the radar was removed from the elevated stand and secured. While the radar equipment was not damaged in the storm, power outages and intermittent cellular coverage following the storm caused gaps in radar data collection.

Acoustic data were collected throughout the spring and fall seasons (see **Section 2.2**); however, to facilitate the timing of this report, fall acoustic data included in this report extends only until November 1, 2022.

2.1.1 Radar Data Processing

Targets were extracted over background noise if they were at least 6 pixels in size, and the sensitivity to detect targets over the threshold in the CMT software (Pfa setting) was set at 0.02. These settings allowed for weak targets at long range to be identified over background noise, but also were sensitive enough to pick up insects at short range and birds at the edge of the radar beam. To filter out insects and birds on the periphery of the beam at close range, the peak power of the radar return for each target ("peak_val setting") was used and corrected for range, since returned power decreases with range to the fourth power ("scaled intensity"). The numbers of targets in five-minute intervals across the entire season were then correlated with acoustic data, to determine a threshold above which we could be more confident targets were primarily birds. The correlation between acoustic and radar detections plateaued at a scaled intensity of 18, so targets below that threshold were removed from the analysis.

Radar data was visually inspected to determine periods of rain, which were excluded from analysis. Targets below 70 m agl were also eliminated because they are contaminated by ground clutter.

Targets were then extracted from individual "columns" of air starting at a distance along the ground between 300 m and 320 m from the radar. This approach allows for smaller birds to be detected at high altitudes, while sampling low altitudes horizontally from the radar.

2.2 Acoustic Monitoring

A network of acoustic sensors (Audiomoths™) were placed throughout the Project area, with one placed at the radar unit, and 9 throughout the project area (See Figure 1.1). This distribution of sensors allows for sampling of nocturnal migrants throughout the Project area. The sensors were placed a minimum of approximately 500 m apart to reduce the potential for duplicate sampling of airspace.

The sensors were programmed to begin recording approximately one hour before the end of evening civil twilight and finish recording one hour after the beginning of morning civil twilight and placed in open areas with a clear view of the sky. The sensors were checked approximately every 30 days to replace batteries and download data onto an external hard drive. The detection range of each recording unit is estimated to be up to approximately 100 m for nocturnal flight calls (NFCs) of migratory birds (primarily passerines). Civil twilight was calculated using the suncalc package in R (v 0.5.1; Thieurmel & Elmarchraoui 2022).

2.2.1 Acoustic Data Processing

All acoustic data were either sampled or resampled to 22 kilohertz (kHz) (encompassing the frequency range where most NFCs occur), then subset to encompass only the period of time between the end of evening civil twilight and the beginning of morning civil twilight. It is during this period that birds make NFCs while actively migrating (Evans 2005).

All acoustic files were processed using a custom-built artificial intelligence (AI) NFC detection model developed by Dr. Kitzes' laboratory at the University of Pittsburgh using Open Sound Scape python package. The model was trained using NFCs originally identified by John Kearney of John F. Kearney & Associates (see a summary of these data at nocturnalflightcalls.com).

The NFC model assigns a 'score' to each species group, which is then related to the probability that a specific acoustic detection actually is that species group. NFCs detected by the model were sampled for validation. Each NFC was assigned to one of 3 categories related to the time of night, either ‘Dusk’, ‘Dawn’ or ‘Night’. NFCs categorized as ‘Dusk’ and ‘Dawn’ were detected during 30 min from the beginning or end of the civil twilight period, respectively. For validation, up to 100 NFCs were randomly selected (scores > 2; weighted by score) from the Dusk/Dawn period, and up to 200 calls from the Night period. These calls were visually assessed (by examining a spectrogram) and/or listened to by an expert (Tabanid Consulting Ltd) to verify the identity of the call or call group.

For species with more than 300 calls with scores >2, a statistical model was fit to assess the remaining calls. A binomial model, with the response being valid/not valid was fit to model score and time of night and season. These models were then used to predict the probability that any given call was of a given species or species group.

For plotting and analysis, all NFCs were selected that had been validated, or (for those with >300 calls) had predicted probabilities of greater than 85%. The 85% value was chosen to provide a balance between false classifications and false negatives (i.e., overlooking calls that are truly there). Where applicable, classified calls were further assessed (by visually inspecting additional spectrograms) to check that the false positive rate was near 15%.

Given the few NFCs recorded during the spring, all calls identified by the model (above a score of '2') were validated and were used for analysis. For Canada warbler (*Cardellina canadensis*) all NFCs that were above the 85% threshold for inclusion were visually or acoustically assessed. Similarly, because the AI model works less well with thrush (*Turdidae*) calls, all Thrush calls were manually validated with a score of ‘2’ or greater and included those in the known detections.

2.3 Data Analysis

All analyses were conducted in Rstudio (V. 2021.09.02) running program R (R Statistical Core team; V 4.0.4) and python V.3.8.

2.3.1 Visualization Patterns

All radar and acoustic detections were plotted to visually explore the patterns of bird movement at the site in conjunction with wind direction and strength at the ground level and aloft. Analysis within this report is restricted to a summary of those observations.

Nights from both the spring and fall migration seasons were selected for focus within this report. Nights were selected with many radar targets, many acoustic detections, or that showed different patterns of bird behaviour at the site compared to other nights.

The full set of visualizations for the radar data for the spring and fall are presented in **Appendix A** and **Appendix B**, respectively.

2.3.2 Radar Analysis

The primary objective of the radar study was to describe the general patterns of migrating birds at the Project site through visualizations, and statistically assess how the number of targets observed below 200 m in altitude relate to those above 200 m, and how the total number of targets observed relate to particular weather variables of interest.

Two response variables were derived from the compiled radar data. The first was the number of targets detected in each hourly period (excluding rain) across all nights. The second was the ratio of the number of targets detected below and above 200 m in altitude. That ratio is positively related to the proportion of targets flying beneath 200 m but does not represent the actual proportion, since the probability of detecting targets decreases with increasing altitude due to changes in the shape and size of the radar beam, and the size of the targets. As such, this ratio overestimates the proportion of targets observed at lower altitudes to some unknown extent. Regardless, the ratio serves as a useful indicator to determine under which conditions and times more targets are flying at relatively lower altitudes.

Weather data (wind speed and direction, pressure, temperature, and humidity) were acquired from the National Centers for Environmental Prediction (NCEP) (https://www.weather.gov/ncep/) and downloaded via the RNCEP package in program R (R Statistical Core Team V 4.0.4) and interpolated to an hourly value at the location using an approach identical to that employed in the function NECP.interp. For this report, wind data from ~700 m altitude were used.

The effect of weather (tailwind assistance, barometric pressure, change in barometric pressure and humidity) on a) the log of the number of targets detected and b) the proportion of targets below 200 m (relative to above 200 m) was modelled using generalized linear models. Model support was assessed using Akaike's Information Criterion (package MuMIn; Barton 2012).

The relationship between targets aloft and weather is complex and nonlinear, and as such, statistical models of such relationships can be difficult to interpret. Therefore, simple models were fit to show the dominant relationships between the two response variables described above and the weather variables. Furthermore, since relationships between wind speed, wind direction and the number of birds aloft can also be complex, a 'tailwind assistance' variable was used to provide a measure of how much the wind would assist a given bird flying in a specific direction. It is known that nocturnal migrants fly with positive tailwind assistance (Peckford and Taylor 2008). Tailwind assistance was calculated assuming migrants are flying in a direction of 45 degrees during spring and 225 degrees in the fall. Therefore, for example in the spring, if the wind was flowing from the direction of 45 degrees, then the birds' tailwind assistance would be negative (a headwind); if the wind was flowing towards 45 degrees, the birds' tailwind assistance would be positive. The strength of the assistance is a function of both the direction of the wind, and its speed.

In addition to the weather variables described above, terms were fit for time of night (categorized into 'sunset', 'sunrise' and 'middle' of the night, with 'sunset' being 90 minutes after the end of evening civil twilight, 'sunrise' being 90 minutes before the beginning of morning civil twilight, and 'middle' representing the remainder of the night). Civil twilight was calculated using the suncalc package in R (v.0.5.1; Thieumel & Elmarchraoui 2022). This variable help assess how total numbers differed at migratory initiation (sunset), cessation (sunrise) and during the night.

The R package 'tidyverse' (Wickham et al. 2019) was used for data manipulation and visualization and the function 'glmer' in package 'lme4' (Bates et al. 2015) was used for statistical modelling. In all cases, mixed effects models were fit, with the day of the year as a random effect. Treating day as a random effect allows the model to account for additional variation in counts that is not fully captured by the weather or timing variables. Models of the total counts were fitted with a 'poisson' family (i.e., the relationship between the response and the predictor variables was on a log scale) and measure of the proportions were filled using a 'binomial' family, which transforms the response using a log-odds ratio. Model fits were assessed by examining residual plots.

2.3.3 Acoustic Analysis

As outlined in **Section 2.2.1**, acoustic data were processed to identify NFCs, primarily by passerines. **Table 2.1** shows the NFC categories for the species and species groups used by the model.

Table 2.1 Nocturnal Flight Call Species and Species Groups

Species / Species Group	Potential Species[(a)]
· Cup-Sparrows	· Chipping Sparrow · Field Sparrow · American Tree Sparrow
· Fox / Song Sparrow Complex	· Fox Sparrow · Song Sparrow
· Zeep	· Bay-breasted Warbler · Blackburnian Warbler · Blackpoll Warbler · Cape May Warbler · Magnolia Warbler · Northern Waterthrush · Yellow Warbler
· Single-banded down sweep	· Pine Warbler · Northern Parula · Yellow-throated Warbler (very rare to call) · Prairie Warbler (very rare to call)
· Double-up	· Black-throated Green Warbler · Tennessee Warbler · Nashville Warbler · Orange-crowned Warbler
· Thrush – Group 1	· Hermit Thrush · American Robin · Grey-cheeked Thrush (rare) · Bicknell's Thrush (rare) · Eastern Bluebird (rare) · Wood Thrush (rare)
· Thrush – Group 2	· Swainson's Thrush · Veery · Rose-breasted Grosbeak (rarely calls) · Scarlet Tanager (rare)
· Full Species	Sparrows: · White-throated sparrow · Savannah Sparrow Warblers: · American Redstart · Black-and-white Warbler

Species / Species Group	Potential Species[(a)]
	· Black-throated Blue Warbler · **Canada Warbler** · Chestnut-sided Warbler · Common Yellowthroat · Mourning Warbler · Ovenbird · Palm Warbler · Yellow-rumped Warbler Other: · **Common Nighthawk** · American Woodcock Poorly detected/classified: · Wilson's Warbler · Red-breasted Nuthatch · Pine Siskin · Golden-crowned Kinglet

(a) Species in bold represent Species at Risk

Following the analysis, the NFCs identified covered a broad range of warbler, sparrow and thrush species found in the region, and are listed below. For auditory and visual examples of these calls, visit nocturnalflightcalls.com.

- "Zeep"
- "Cup Sparrow" (cupsp)
- "Double-Up" (dubup)
- "Single-banded down sweep" (sbds)
- "Fox Sparrow / Song Sparrow" (fssp)
- "Thrushes" (thrushes)
- American Redstart (amre)
- Black and White Warbler (baww)
- Black-throated Blue Warbler (btbw)
- Canada Warbler (cawa)
- Common Yellowthroat (coye)
- Chestnut-sided Warbler (cswa)
- Mourning Warbler (mowa)
- Ovenbird (oven)
- Yellow-rumped Warbler (yrwa)
- Savannah Sparrow (savs)
- White-throated Sparrow (wtsp)

3.0 Results

The results presented below are limited to data collected during the 2022 spring and fall migration seasons.

3.1 Spring Migration

3.1.1 Nocturnal Migration Patterns

Some level of active migration was observed on most nights monitored. Most of the migration activity was observed across 5 nights (May 4, May 14, May18, May 23, and May 26). We have chosen to focus the spring analysis on these select nights along with May 19 which had high levels of audio detections. The entire dataset of nights for the spring season can be found in the Appendix A.

Figure 3.1 shows the change in radar target density across the spring season, along with a distribution of density above and below 200 m. The majority of radar detections during the peak nights occurred at altitudes greater than 200 m. Only on May 23 were more than 1,000 targets detected below 200 m on a single night.

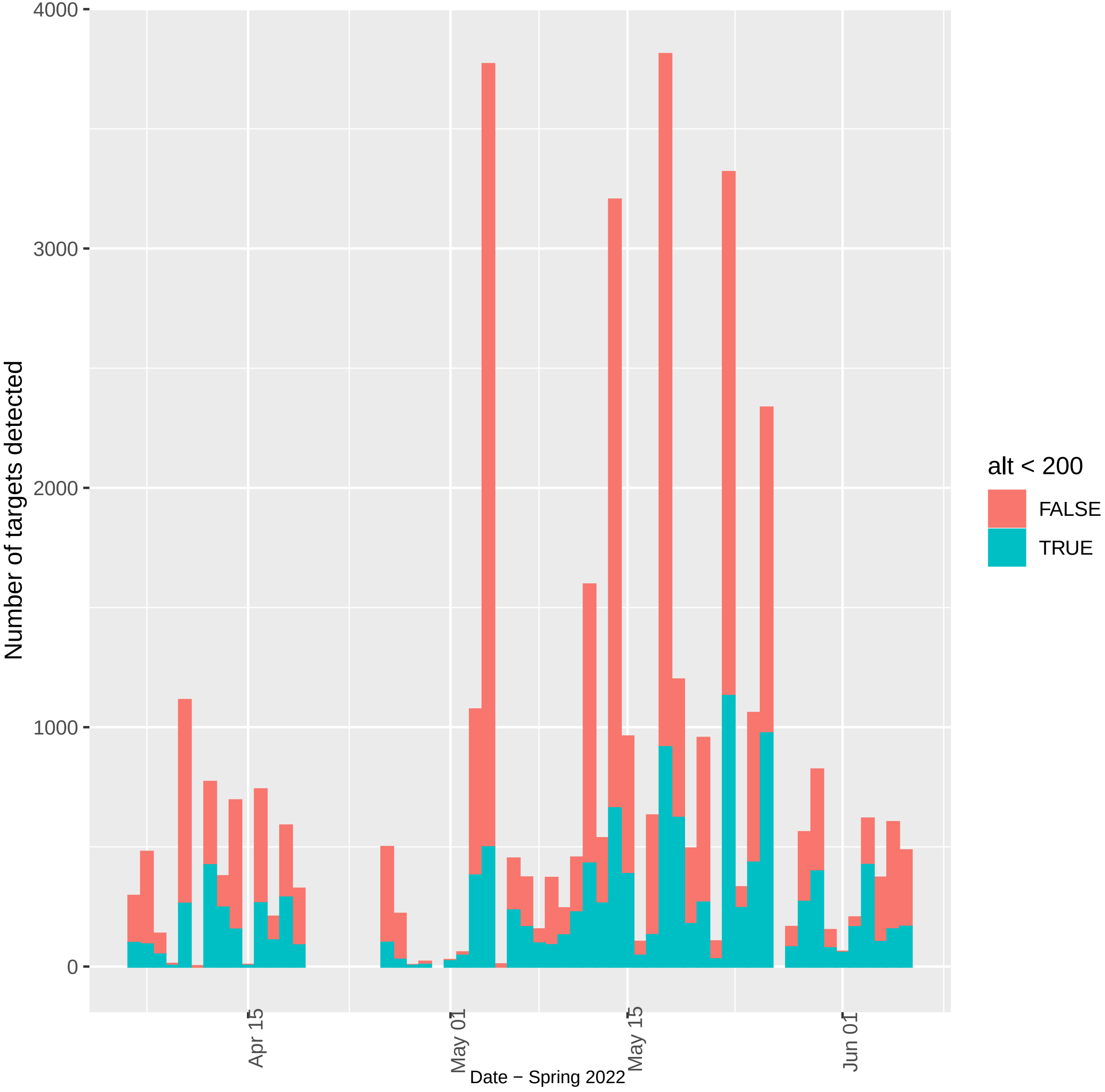

Figure 3.1 Seasonal Change in Radar Detections by Altitude – Spring 2022

Figure 3.2 shows the altitudinal, seasonal, and within night distribution of radar targets for select nights in the spring. The nights selected had either many radar targets, many acoustic detections, or that showed different patterns of bird behaviour at the site compared to other nights. Each plot within **Figure 3.2** is a separate night, with the beginning and end of civil twilight indicated by the vertical green and yellow lines, respectively. Date and time are on the x-axis and altitude is on the y-axis. Hexagonal points are radar detections divided into time and altitude bins and are scaled from light grey (few detections) through dark purple, blue, green to yellow (many detections). Wind direction and strength aloft (~700 m) for each hour are displayed at the top of each plot via a red arrow. Red lines represent the approximate altitudinal range of the RSA.

Acoustic detections (a single NFC) are red points along the base of each plot. Note that acoustic detections are more frequent when the radar shows targets at lower altitudes (see May 18 and May 23), which is likely a function of the detection range of each recording unit. It should also be noted that calling frequency is known to not be constant and some species migrate without calling (e.g., vireos and flycatchers; Smith et al. 2014), so the number of radar targets will not always correlate with the number of acoustic detections (see May 14 approximately 4 hours after sunset).

3.1.2 Altitudinal distribution of radar targets

Across all nights, most targets observed were at lower altitudes with the number of targets generally decreased with increasing altitude (**Figure 3.3**). This decline is partly due to an actual decrease in the number of birds, but also reflects the declining probability of detecting birds at more distant ranges. It is difficult to separate the effects of these two variables. The red line shown in **Figure 3.3** represents the maximum potential height of the turbines.

Figure 3.5 shows the density of radar detections by altitude for only the 6 selected nights. The red line indicates the maximum height of the turbines.

The pattern of radar targets by altitude varied across nights. On the nights with the largest movements of migration (May 4, May 14, and May 18) (see **Figure 3.1**) targets were observed to be primarily at higher elevations (e.g., 400 m or greater) (**Figure 3.4**). On nights when migration was less intense, but still elevated compared to most nights (May 23 and May 26) the peak altitude band was below 200 m, but large numbers of targets were still observed above the RSA.

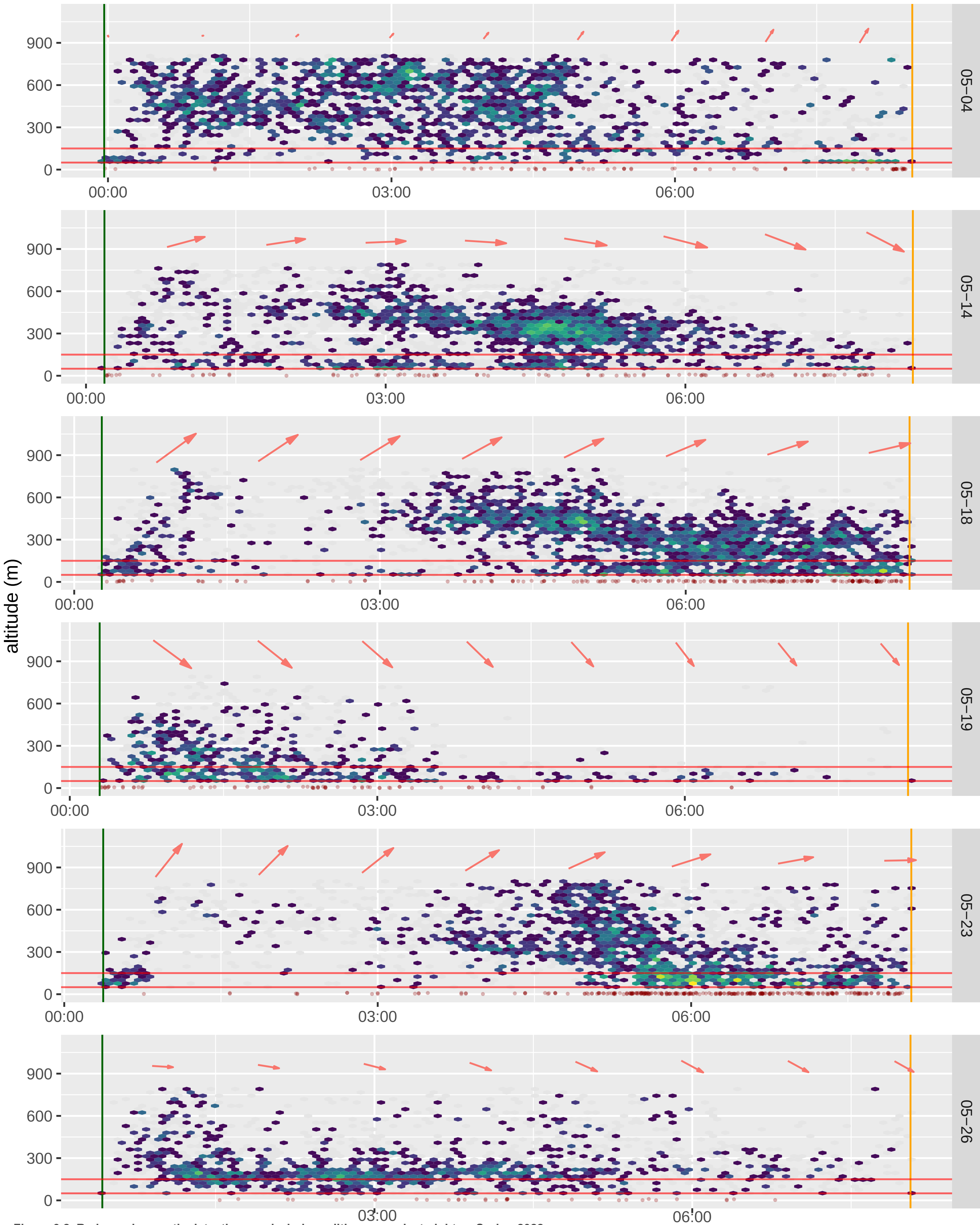

Figure 3.2 Radar and acoustic detections and wind conditions on select nights – Spring 2022

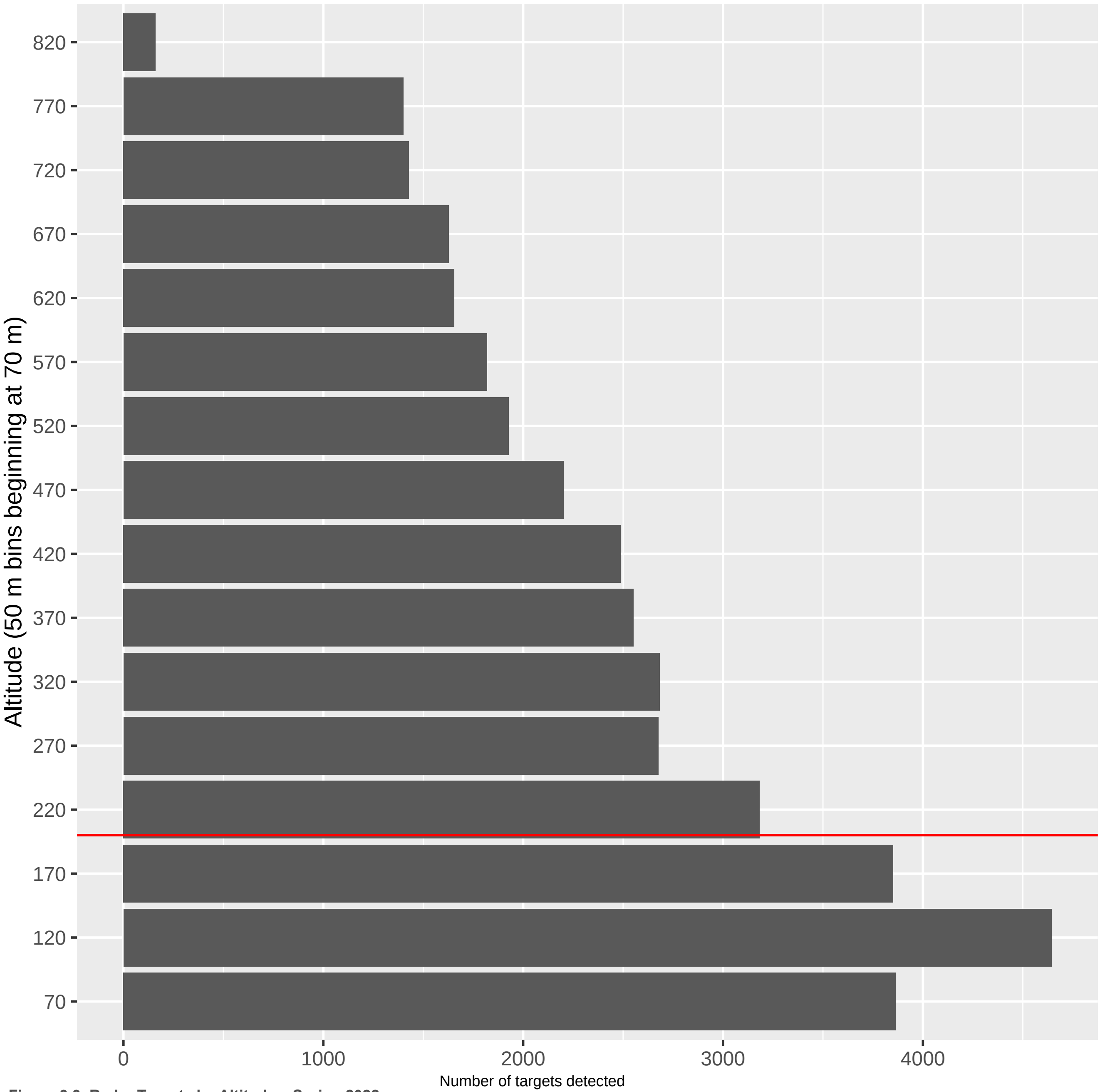

Figure 3.3 Radar Targets by Altitude – Spring 2022

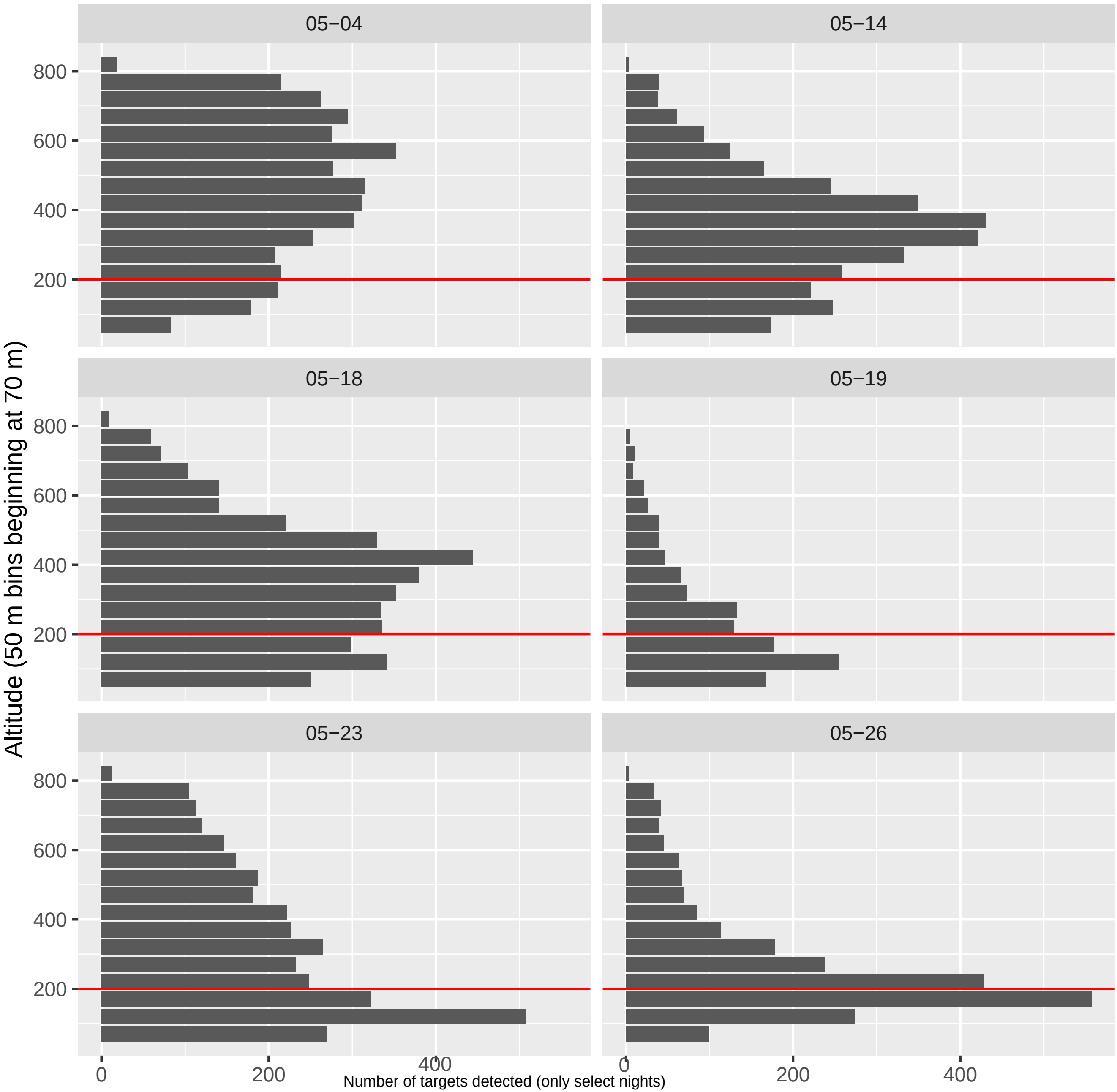

Figure 3.4 Radar Targets by Altitude for Select Nights – Spring 2022

3.1.3 Statistical Analysis of Spring Radar Data

Statistical models provided evidence that the total number of birds per hour was related to tailwind assistance (at 'surface'), time of night (sunset, sunrise, and middle of the night) and weather (temperature, surface pressure and relative humidity). The most important differences are summarized in **Figure 3.5** and **Figure 3.6** can be attributed to different behaviours through the night. The radar detected numerous targets immediately after the initiation of migration (take-off after sunset) and during the middle of the night (continued migration), and fewer in the morning. That the period immediately before dawn sees many fewer targets may reflect that birds are either not landing within the Project area following migration or they are consistently ending their migration flights early in the night.

Within Figure 3.5 each point represents the number of targets in hourly bins, classified by time periods (panels) and month (colours). Tailwind speeds are plotted along the x-axis in km per hour with negative and positive values representing tailwind assistance. To improve data visualization, the total number of targets is represented on the y-axis by taking the log base 10 of the number of targets in hourly bins. The lines are regressions for each group, showing a positive relationship during the middle of the night across the entire season. This means that the number of targets detected is low in strong headwinds (negative tailwind assistance) and increases as tailwind strength increases (**Figure 3.5**). This follows a general pattern that birds prefer to migrate with tailwinds or very light headwinds (e.g., Peckford 2006).

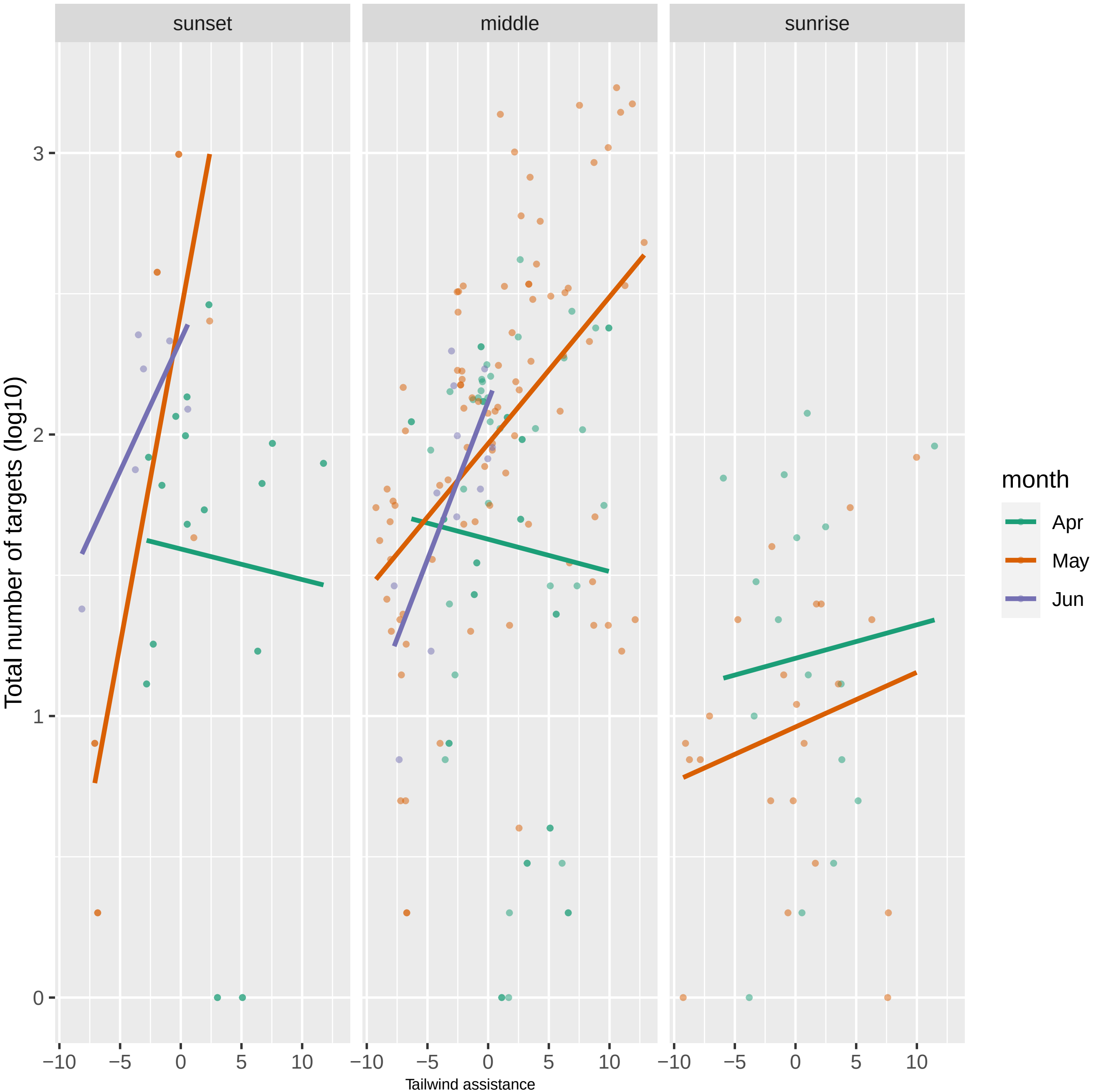

Figure 3.5 Relationship between Tailwind Assistance on Total Number of Targets across Time of Night and Month – Spring 2022

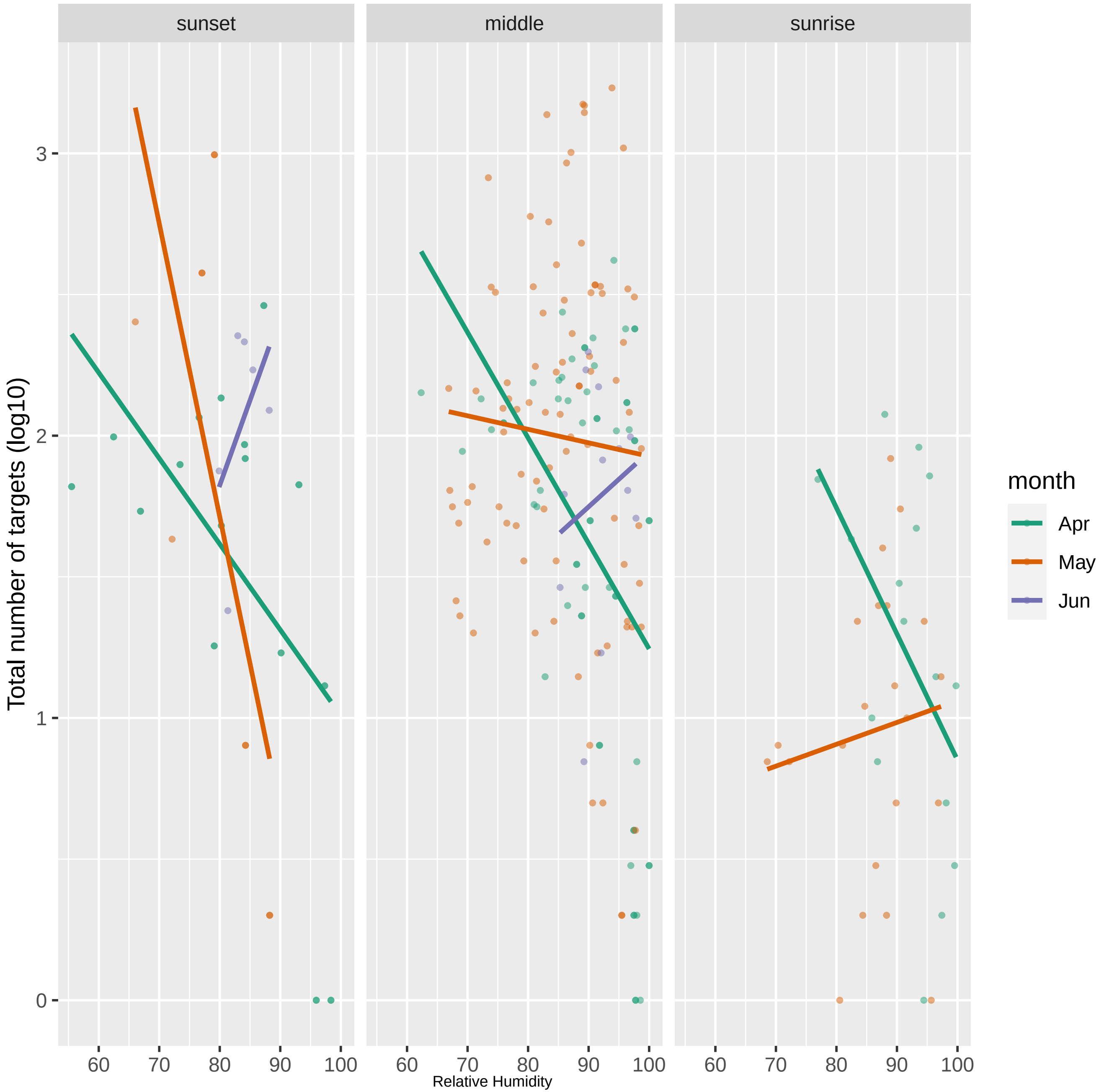

Figure 3.6 Relationship between Relative Humidity on Total Number of Targets across Time of Night and Months – Spring 2022

The symbology of **Figure 3.6** is the same as **Figure 3.5,** above. However, **Figure 3.6** shows the relationship with targets detected and relative humidity. Generally, throughout the season, the number of targets detected decreased as relative humidity increased. This relationship was strongest during the early part of the season (April 2022) and weakened as the season progressed.

Relative number of birds at lower altitudes

The index of the proportion of targets flying at low altitudes demonstrates the proportion of targets below a given altitude (i.e., 200 m) in relation to what is detected above that altitude. The index was related to the overall number of migrants, along with all timing and weather variables.

In **Figure 3.7**, each dot represents the number of birds detected below 200 m divided by the total number of birds observed in each hourly bin classified by time of night. The lines are smoothed relationships between the index, and the total number of targets are presented on a log scale.

The primary finding expressed in **Figure 3.7** is that on nights when large numbers of targets were detected, and during the middle part of the night, there tended to be fewer of those targets at lower altitudes. This same pattern is also illustrated in **Figure 3.4.**

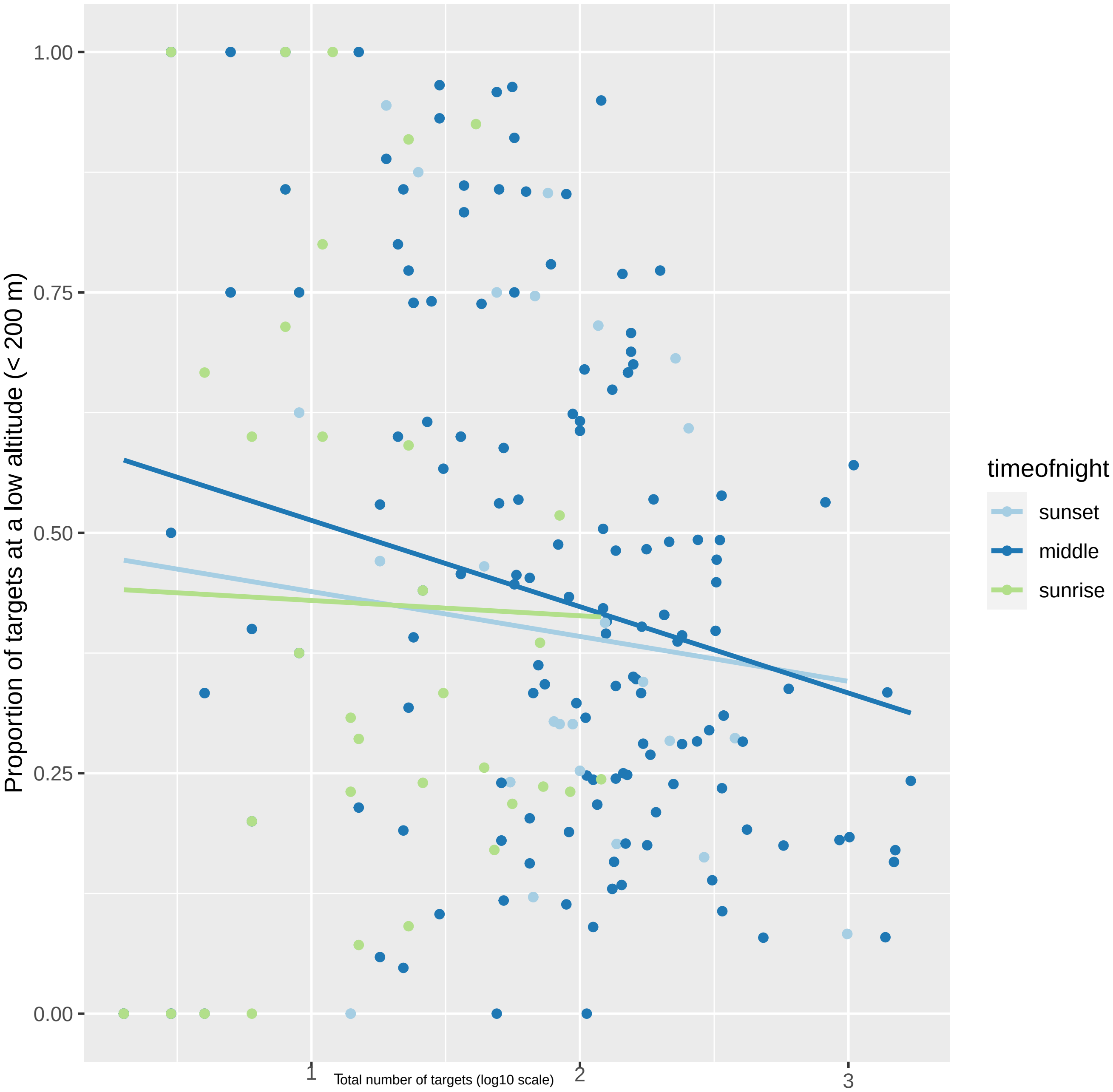

Figure 3.7 Proportion of Targets at Low Altitude in Comparison to Total Number of Targets across Time of Night – Spring 2022.

3.1.4 Nocturnal Flight Call Detections

Flight calls were analyzed and grouped into one of 17 species groups with the majority being warblers (63%), followed by sparrows (37%). The most common species / species group observed was ovenbird, followed by white-throated sparrow, which comprised 42% of the total detections (**Table 3.2**).

Table 3.2 Nocturnal Flight Call Detections by Species and Species Group

Species / Species Group[(a)(b)]	Total Number of Calls Detected	Proportion of Calls Detected
Ovenbird	713	22.6
White-throated Sparrow	605	19.2
Zeep	565	17.9
Savannah Sparrow	469	14.9
American Redstart	396	12.5
Double Up	121	3.8
Fox Sparrow / Song Sparrow	77	2.4
Black and White Warbler	76	2.4
Single Banded Down Sweep	44	1.4
Common Yellowthroat	27	0.9
Common Nighthawk	18	0.6
Canada Warbler	15	0.5
Mourning Warbler	11	0.3
Cup Sparrow	8	0.3
Black-throated Blue Warbler	6	0.2
Thrush 2	4	0.1
Chestnut-sided Warbler	3	<0.1
Total	**3,158**	**100**

(a) "Zeep" species groups includes bay-breasted warbler, blackburnian warbler, blackpoll warbler, Cape May warbler, magnolia warbler, northern waterthrush and yellow warbler; "Cup Sparrow" species group includes chipping sparrow, field sparrow and American tree sparrow; "Double Up" species group includes black-throated green warbler, Tennessee warbler, Nashville warbler and orange crowned warbler; "Single Banded Down Sweep" species includes pine warbler, northern parula, yellow-throated warbler, and prairie warbler; "Thrush 2" includes Swainson's Thrush, Veery, Rose-breasted Grosbeak and Scarlet Tanager.

(b) Species in bold represent Species at Risk.

Figure 3.8 shows the distribution of acoustic detections by species across the entire spring season. Timing of species detections are as expected with most warblers detected during the mid- to late-May, and sparrows detected throughout much of May. Very few NFCs were detected during April.

The majority of the sparrows were detected prior to May 15 (with a peak on May 2), and most warbler NFCs were concentrated in late May (**Figure 3.8)**. Nightjar and thrush detections were sparce and generally occurred in late May.

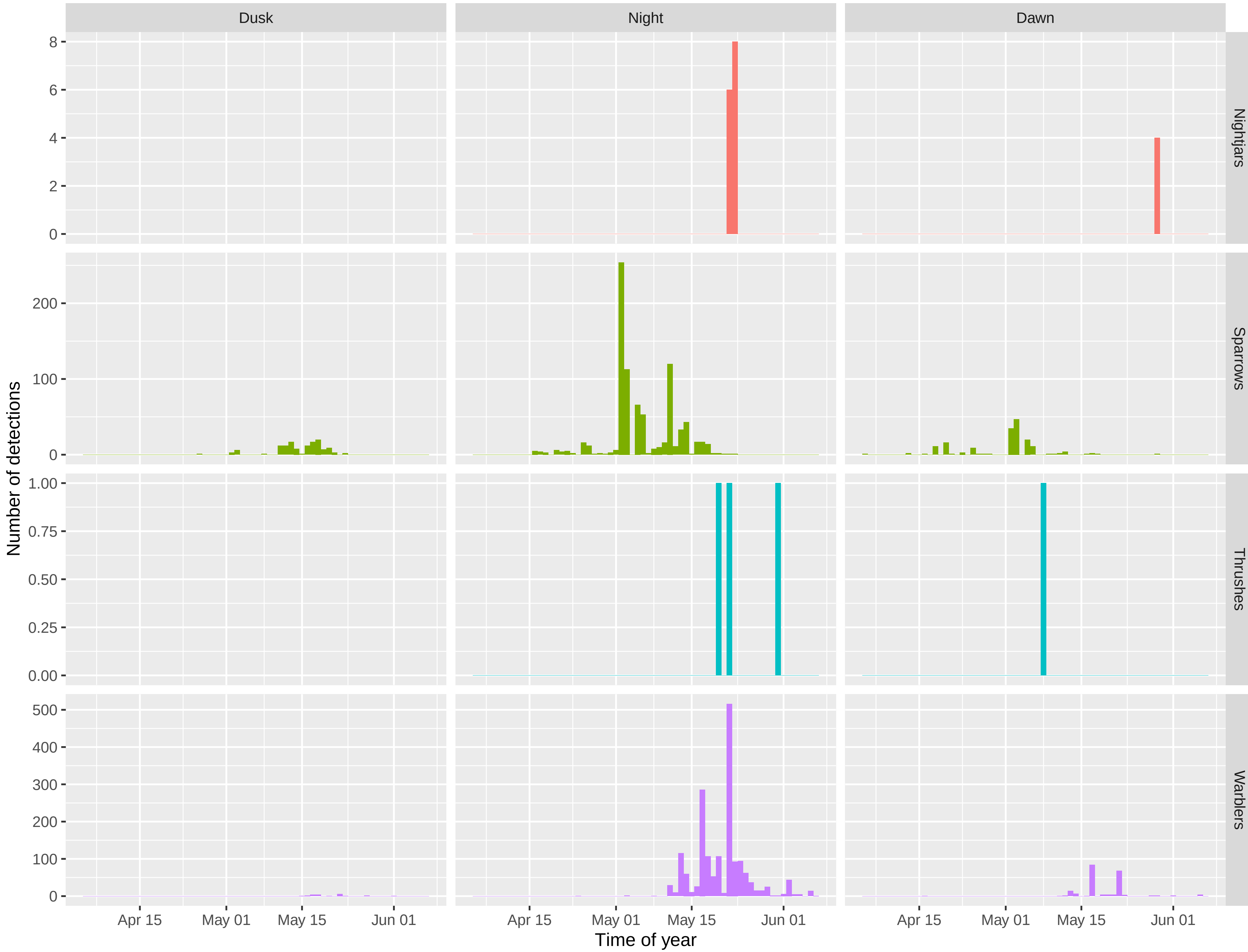

Figure 3.8 Proportion of Targets at Low Altitude in Comparison to Total Number of Targets across Time of Night – Spring 2022.

Figure 3.9 shows the distribution of acoustic detections by species of sparrows (green), warblers (purple), thrushes (blue) and nightjars (orange) across the entire spring season. The number of detections shown in **Figure 3.9** is the total number of calls detected for that group on that night; also note that the scale differs between groups. Timing of species detections are as expected with most sparrows detected early to mid-May and warblers concentrated in mid to late-May.

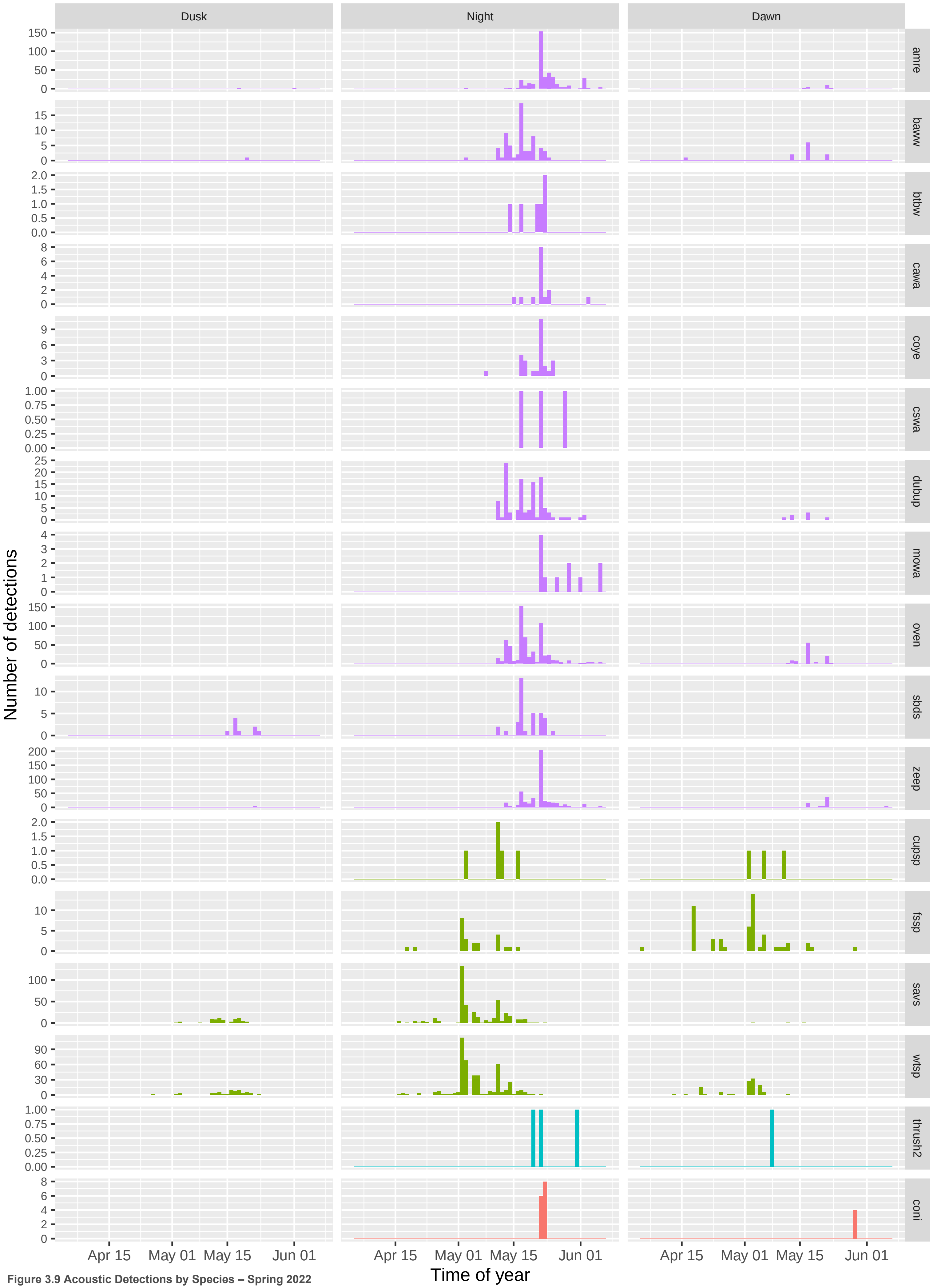

Figure 3.9 Acoustic Detections by Species – Spring 2022

Figure 3.10 shows the occurrence of NFCs detected by time of night during the spring migration season. Sparrows were the only species group detected in April, and were generally observed throughout the night. Thrushes and nightjars (i.e., Common nighthawk [*Chordeiles minor*]) were only detected during May, and were generally detected near dawn. The number of warbler NFCs were concentrated in May, and generally increased as time to sunrise decreased.

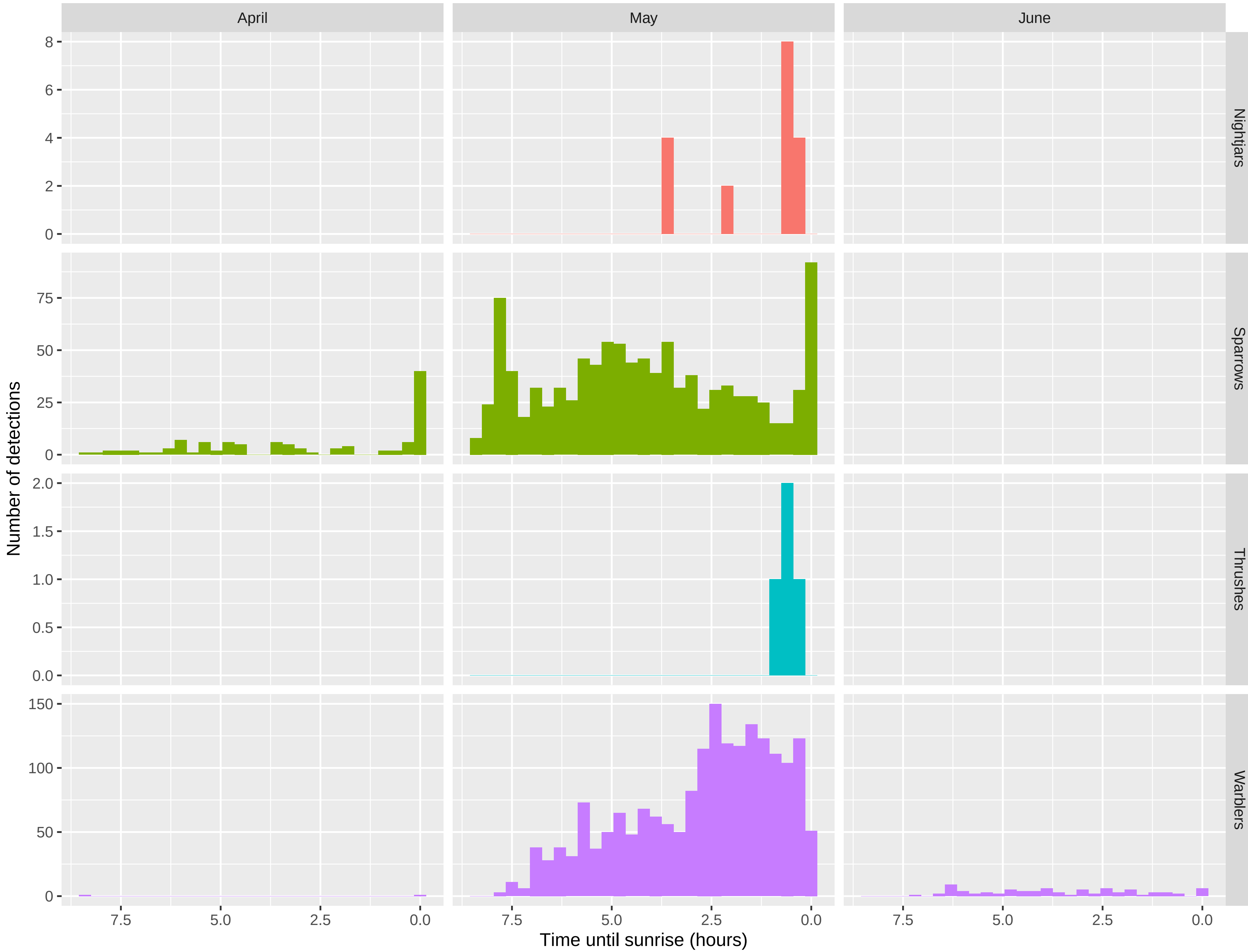

Figure 3.10 Nocturnal Flight Calls by Time until Sunrise – Spring 2022

3.2 Fall Migration

3.2.1 Nocturnal Migration Patterns

Figure 3.11 shows the change in radar target density across the fall season, along with a distribution of density above and below 200 m (labeled as “High” and “Low” in **Figure 3.11**). As with the spring migration season, active migration was observed on most nights monitored. Generally, migration intensity increased from the start of monitoring until mid/late September, after which the number of targets detected per night decreased (**Figure 3.11**).

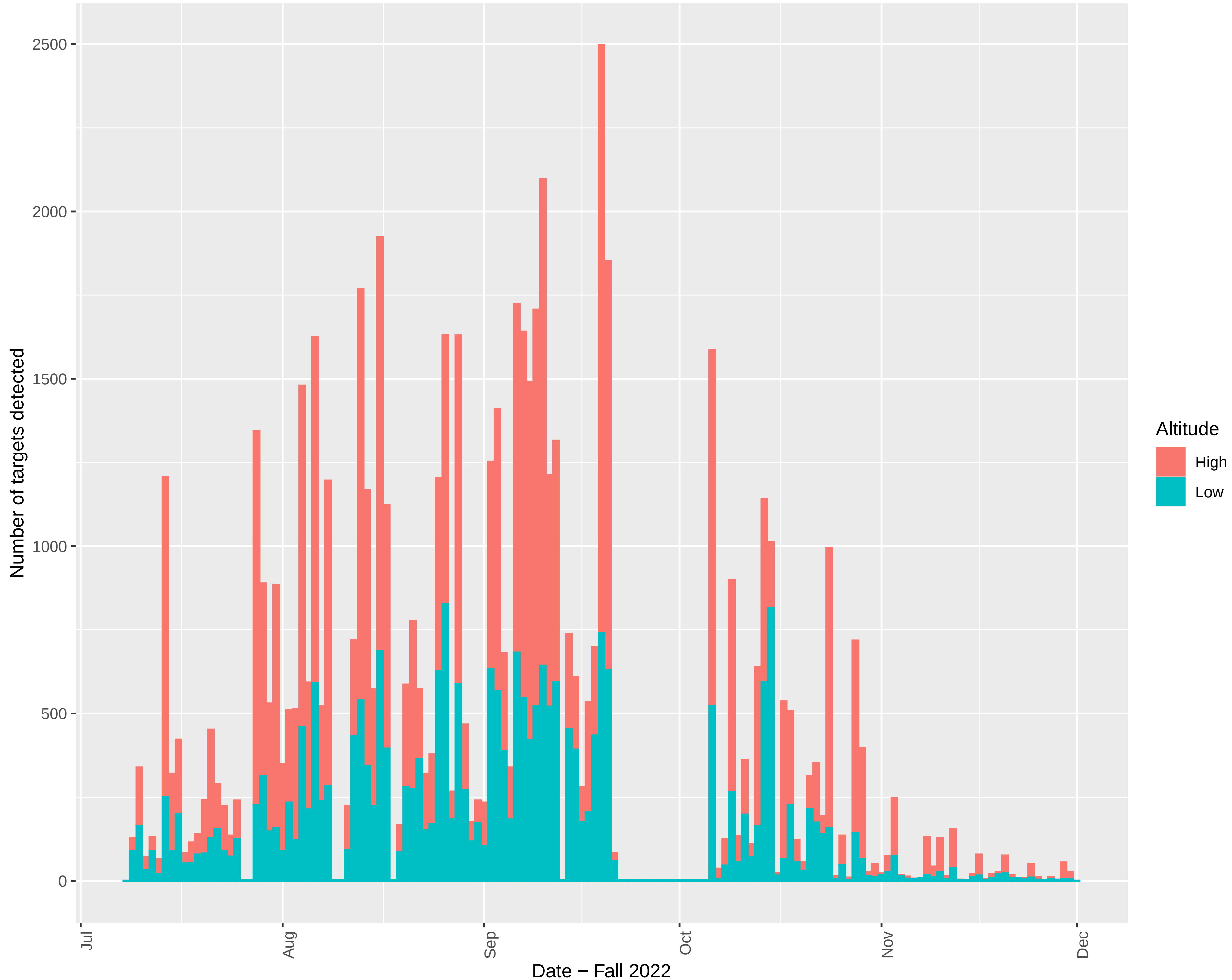

Figure 3.11 Nocturnal Flight Calls by Time until Sunrise – Spring 2022

Eight nights during the fall were selected for further focus (see Appendix B for the complete fall dataset). The 8 nights selected have either many radar targets, many acoustic detections, or show different patterns of bird behaviour at the site compared to other nights (**Figure 3.12**). Each plot within **Figure 3.12** shows the altitudinal distribution of radar targets for each select night in the fall in relation to wind speed, direction and precipitation. The beginning and end of civil twilight indicated by the vertical green and yellow lines, respectively. Date and time are on the x-axis and altitude is on the y-axis. Hexagonal points are radar detections divided into time and altitude bins and are scaled from light grey (few detections) through dark purple, blue, green to yellow (many detections). Wind direction and strength aloft (700 m) for each hour are displayed at the top of each plot via a red arrow. Light blue boxes represent precipitation events where raindrops could not be distinguished from birds. Red lines represent the approximate altitudinal range of the RSA. Acoustic detections (a single NFC) are red points along the base of each plot. The entire dataset of nights for the fall season can be found in the **Appendix B**.

During most nights represented in **Figure 3.12** there was a northerly wind direction. However, October 24 shows a somewhat atypical pattern with high density migration when winds are strong and from the south – which resulted in many targets at low altitude (i.e., less than 200 m). August 14 shows a night where rain began during the middle of the night, and a large number of targets were observed close to the ground just before the rain began. October 6 is also a night were rain occurred during the night. Targets detected between the rain periods were lower than before the rains began (**Figure 3.12**).

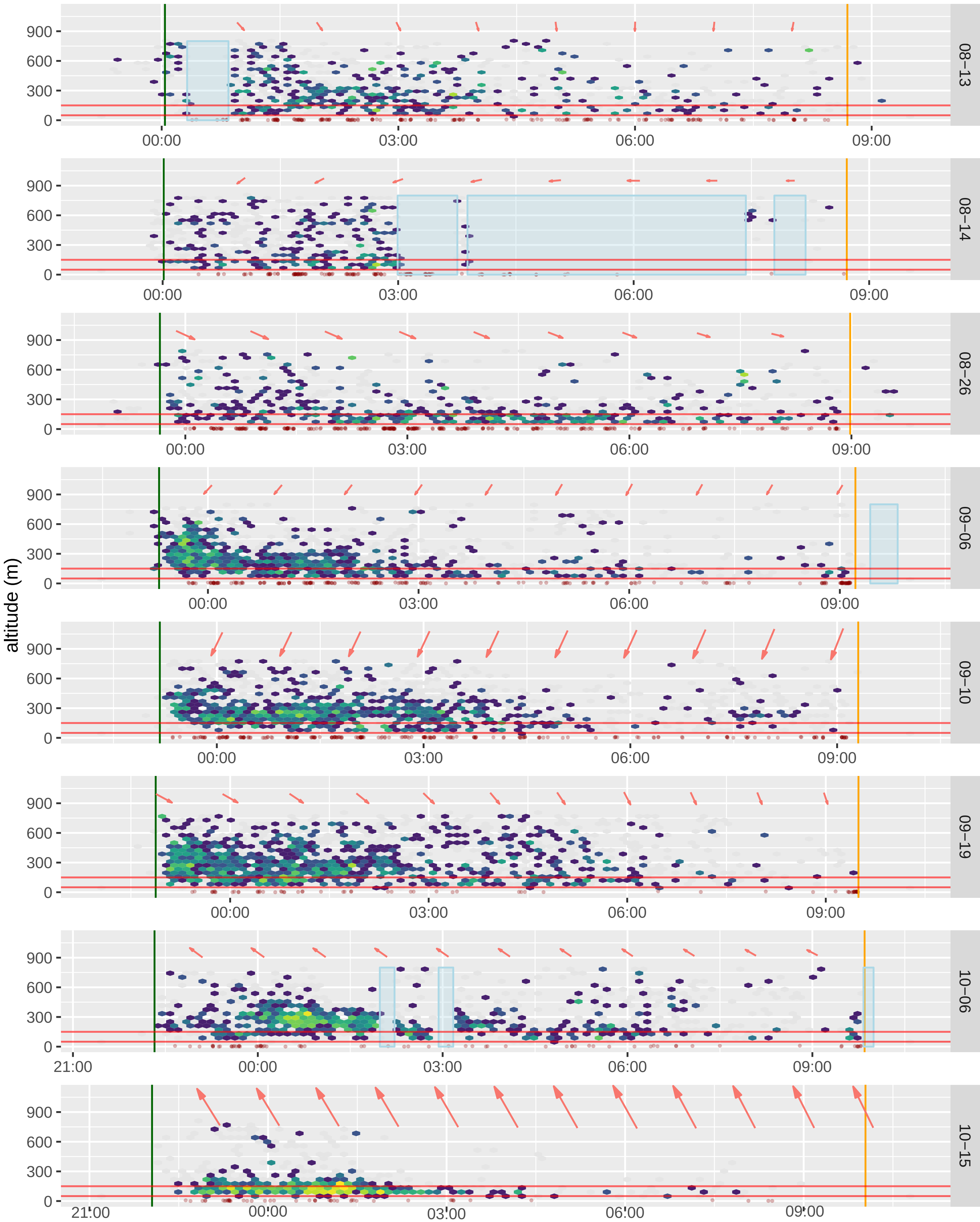

Figure 3.12 Radar Targets by Altitude for Select Nights – Fall 2022

3.2.2 Altitudinal Distribution of Radar Targets

When viewing all radar detections combined during the fall season the altitudinal band with the most detections is between 120 and 170 m. Across all nights, a somewhat uniform decline in targets detected per 50 m altitudinal band between approximately 220 and 800 m (**Figure 3.13**) is observed. This decline is due in part due to the declining probability of detecting birds at more distant ranges, and potentially, to an actual decrease in the number of birds at increased altitudes. However, it is difficult to separate the effects of these two variables. The red line shown in **Figure 3.13** represents the maximum potential height of the turbines.

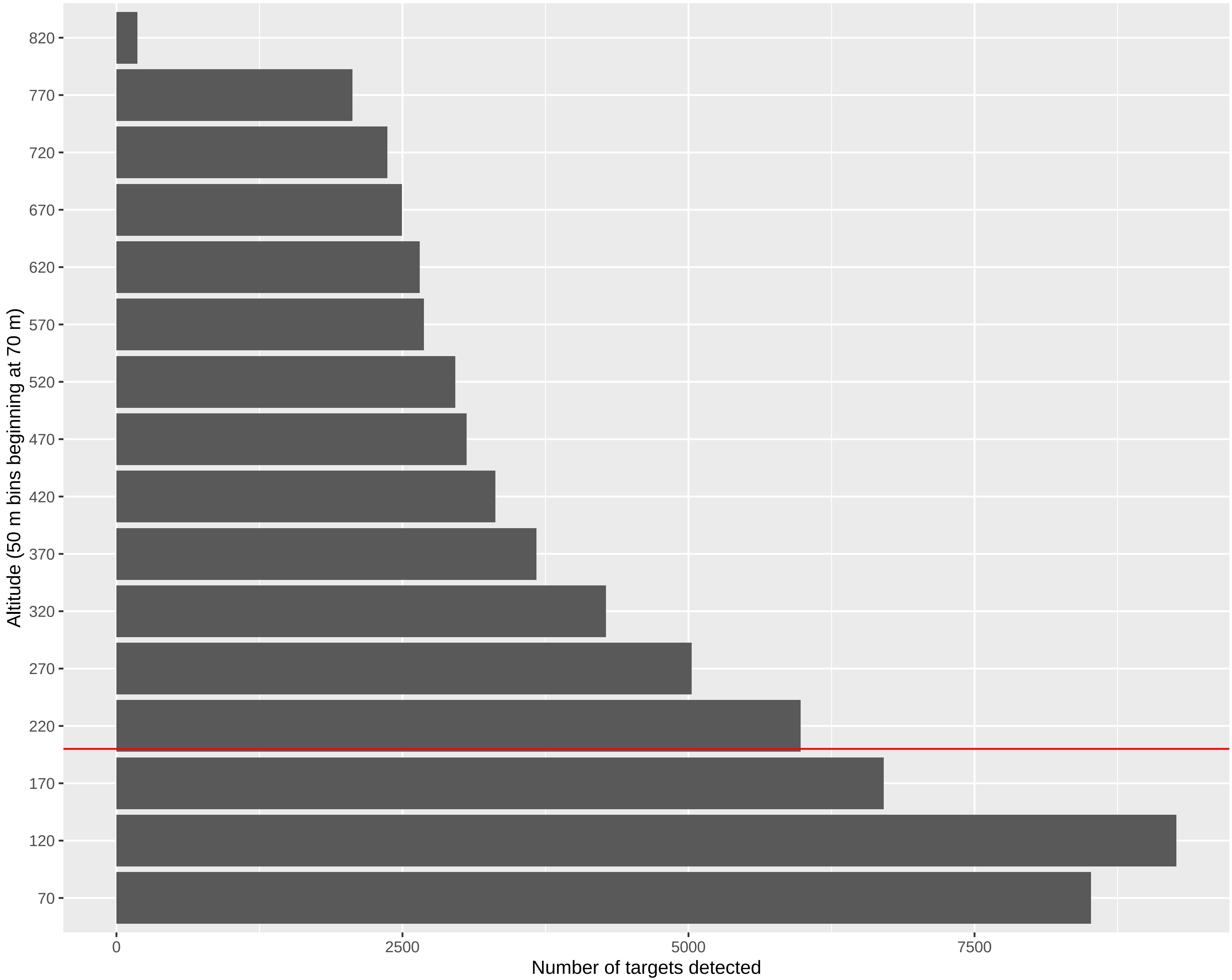

Figure 3.13 Radar Targets by Altitude - Fall 2022

Figure 3.14 shows the density of radar detections by altitude for only the selected nights discussed above. The red line indicates the maximum height of the turbines. The pattern of radar targets by altitude for these nights show different patterns, but many nights have most activity at approximately the top of the RSA (i.e., 200 m).

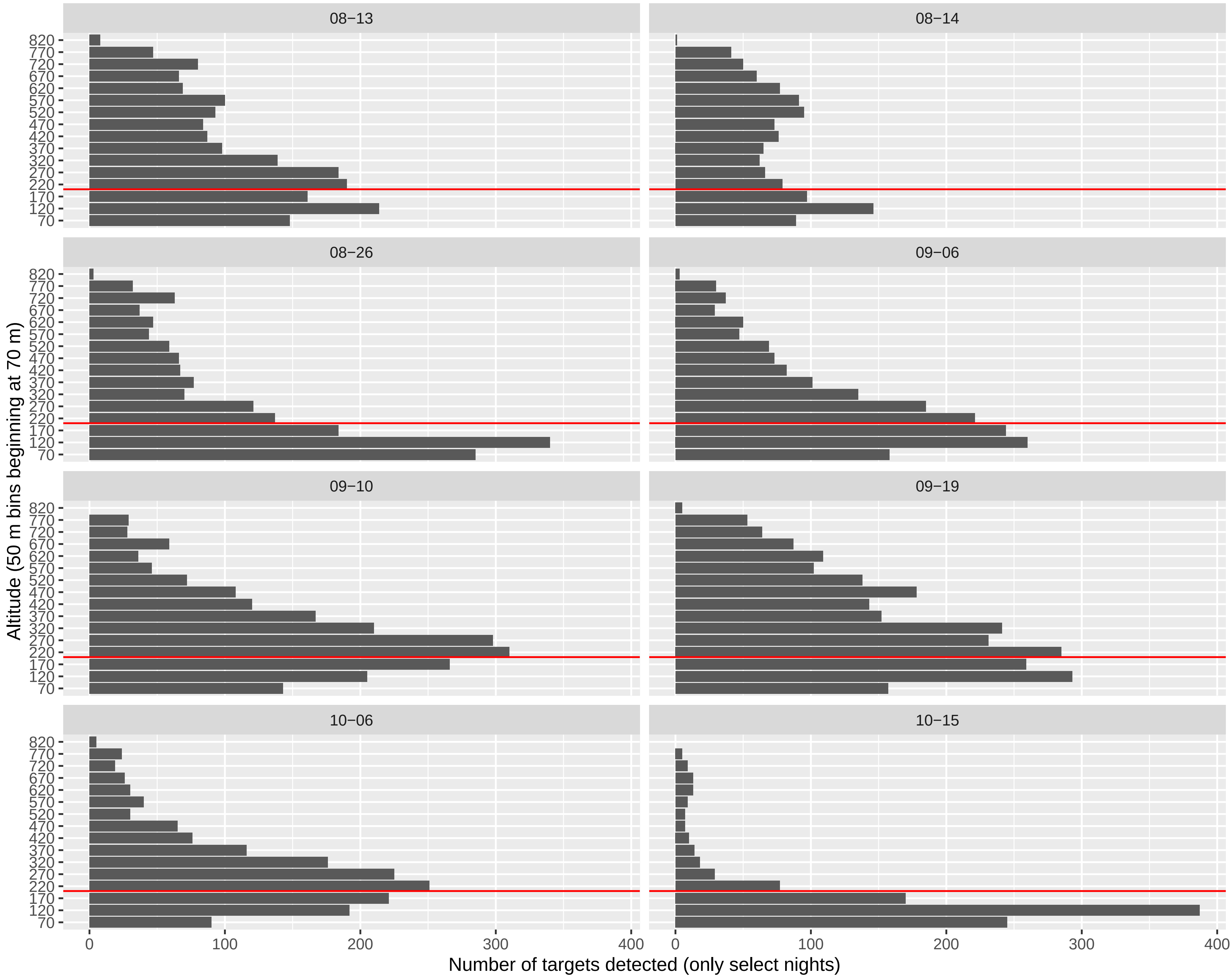

Figure 3.14 Radar Targets by Altitude for Select Nights - Fall 2022

3.2.3 Statistical Analysis of Radar Data

The same statistical models completed for the spring migration, described in **Section 3.1.3**, were completed for the fall data. The same trends observed during the spring, were seen during the fall, with increased targets detected during increased tailwind assistance (**Figure 3.15**) and fewer targets detected during increased relative humidity (i.e., increase precipitation) (**Figure 3.16**). See **Section 3.1.3** for a description of the symbology presented in the plots below.

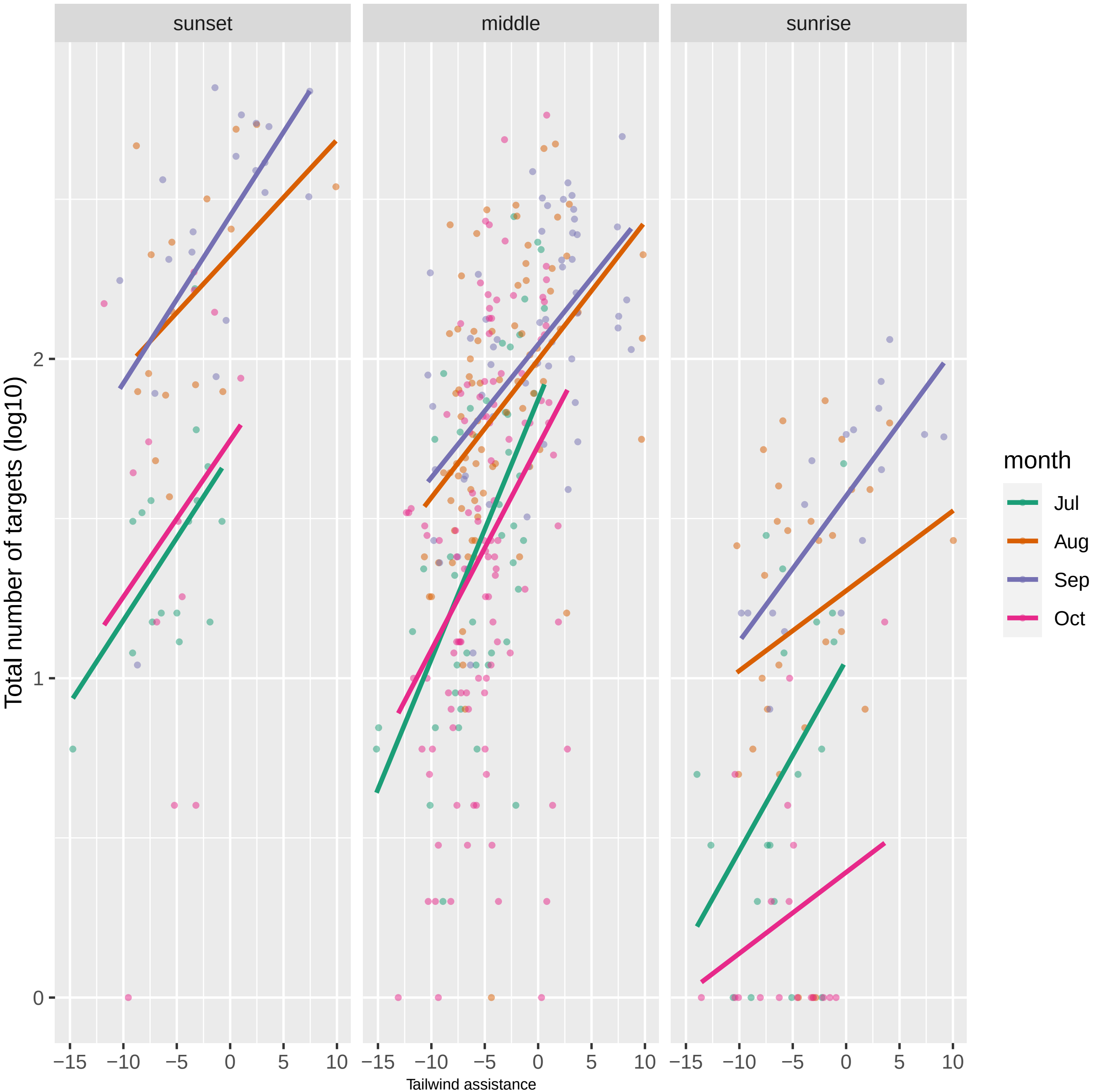

Figure 3.15 Relationship Between Tailwind Assistance on Total Number of Targets across Time of Night and Month – Fall 2022

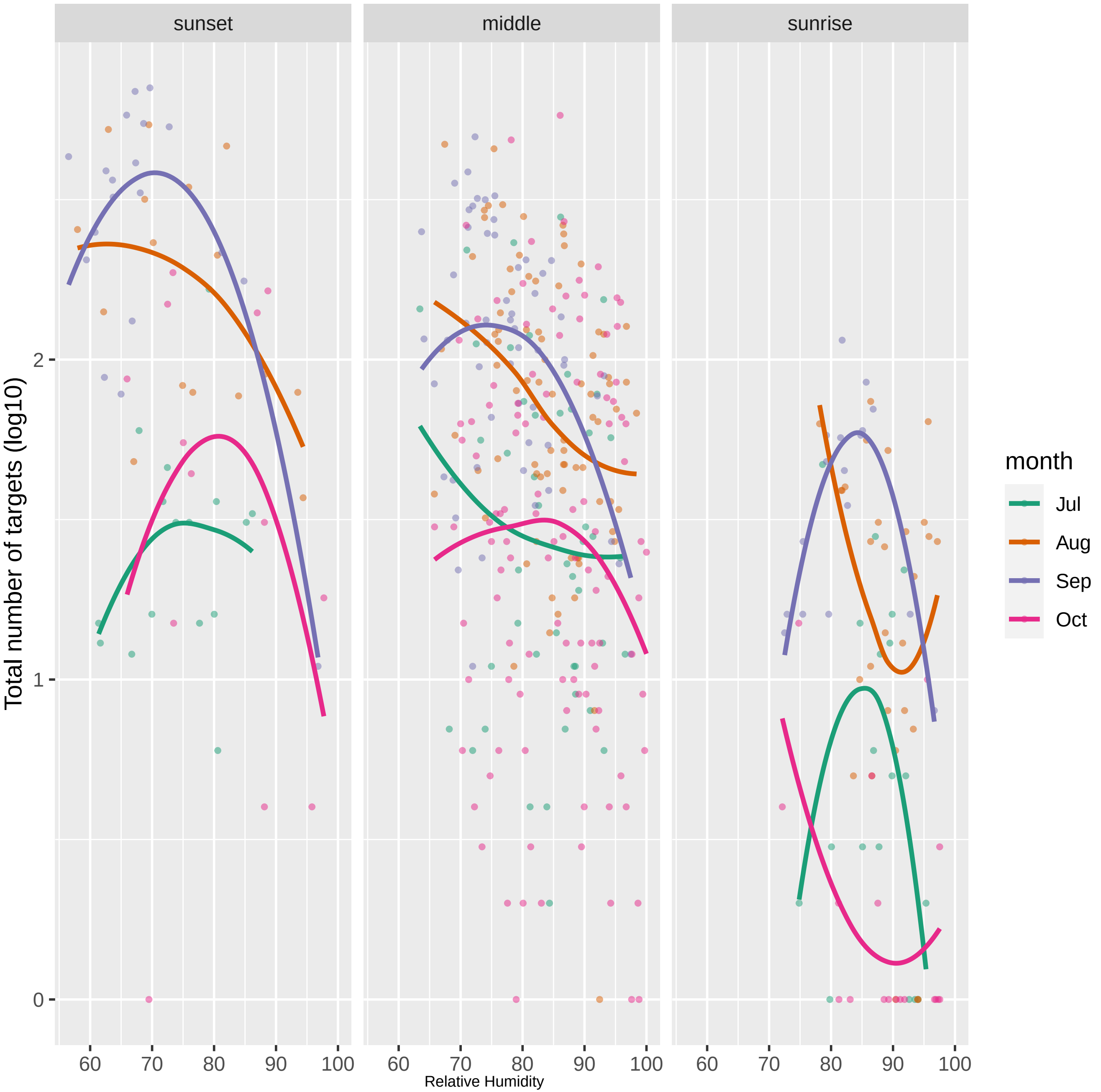

Figure 3.16 Relationship between Relative Humidity on Total Number of Targets across Time of Night and Months – Fall 2022

Relative number of birds at lower altitudes

Figure 3.17 shows the relationship between the total number of targets aloft, compared to the proportion of those targets below 200 m. This analysis is the same as completed in the spring and shown in **Figure 3.7.** In **Figure 3.17**, each dot represents the number of birds detected below 200 m divided by the total number of birds observed in each hourly bin classified by time of night. The lines are smoothed relationships between the index, and the total number of targets are presented on a log scale.

During the middle part of the night (i.e., the bulk of active migration) there is a constant relationship between the two variables. Meaning, that the proportion of targets below 200 m is consistent, irrespective of the total number of targets detected each night. This pattern is different then what was observed during the spring (**Figure 3.7**).

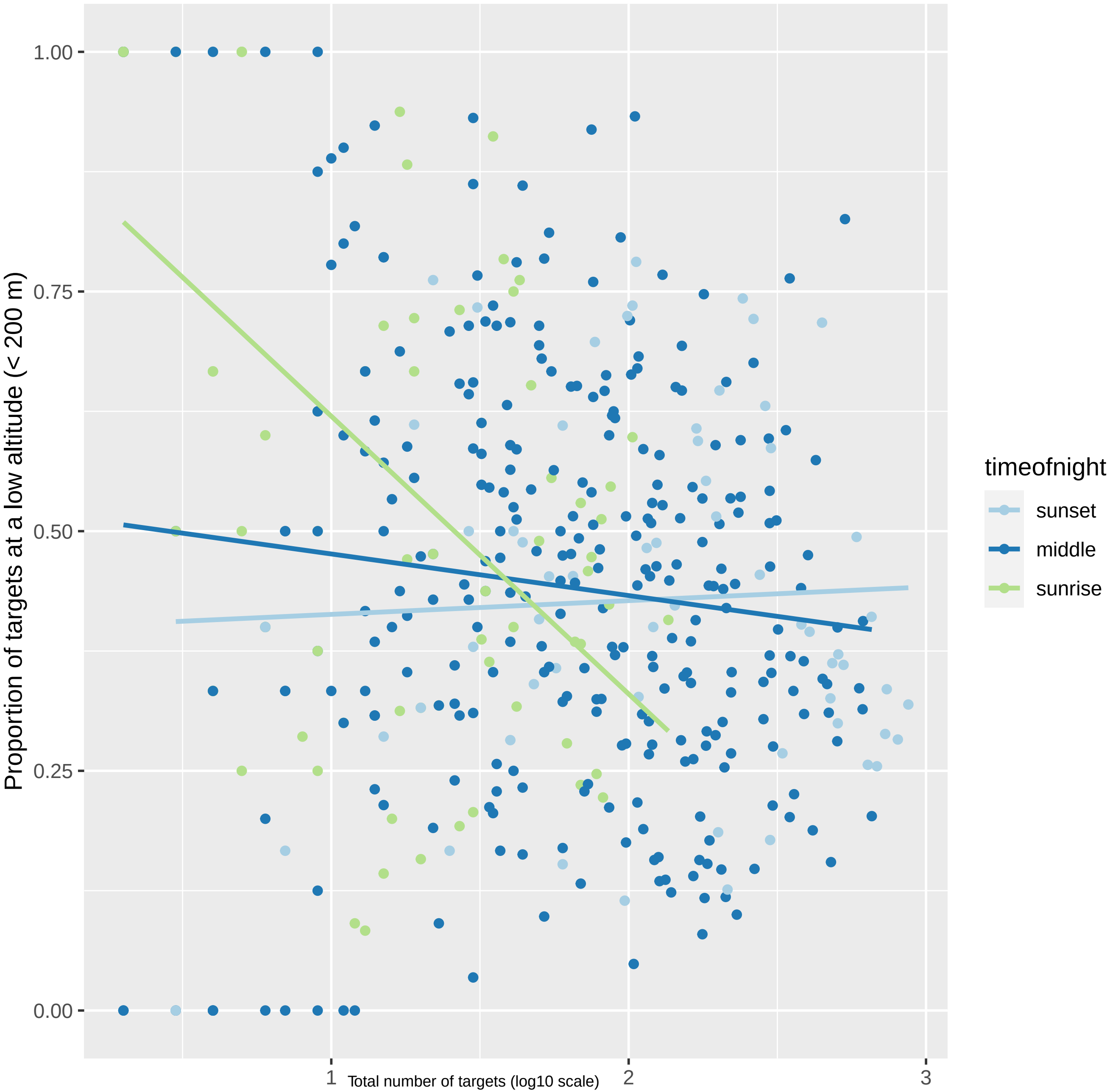

Figure 3.17 Proportion of Targets at Low Altitude in Comparison to Total Number of Targets across Time of Night – Fall 2022

3.2.4 Nocturnal Flight Call Detections

Flight calls were analyzed and grouped into one of 18 species groups. Warblers comprised the majority (81%) of NFCs detected during the fall season. The most common species / species group observed were “zeeps” and ovenbirds which comprised 49% of the total detections (**Table 3.3**).

Table 3.3 Nocturnal Flight Call Detections by Species and Species Group

Species / Species Group[(a)(b)]	Total Number of Calls Detected	Proportion of Calls Detected
Zeep	4,275	31.5
Ovenbird	2,375	17.5
Savannah Sparrow	1,931	14.2
Double Up	1,422	10.5
American Redstart	1,357	10
Black and White Warbler	804	5.9
White-throated Sparrow	363	2.7
Fox/Song Sparrow	174	1.3
Common Yellowthroat	164	1.2
Mourning Warbler	160	1.2
Single Banded Down Sweep	152	1.1
Thrush 2	111	0.8
Canada Warbler	97	0.7
Black-throated Blue Warbler	89	0.7
Chestnut-sided Warbler	62	0.5
Common Nighthawk	25	0.2
Cup Sparrow	18	0.1
Thrush 1	1	<0.1
Total	13,580	100.0%

(a) “Zeep” species groups includes bay-breasted warbler, blackburnian warbler, blackpoll warbler, Cape May warbler, magnolia warbler, northern waterthrush and yellow warbler; “Cup Sparrow” species group includes chipping sparrow, field sparrow and American tree sparrow; “Double Up” species group includes black-throated green warbler, Tennessee warbler, Nashville warbler and orange crowned warbler; “Single Banded Down Sweep” species includes pine warbler, northern parula, yellow-throated warbler, and prairie warbler; “Thrush 1” includes Hermit Thrush, Gray-cheeked Thrush; “Thrush 2” includes Swainson’s Thrush, Veery, Rose-breasted Grosbeak and Scarlet Tanager.

(b) Species in italic represent Species at Risk.

Fewer NFCs were detected at the beginning and end of the monitoring period, indicating that the entirety of the migration season was captured. Also, nearly all warbler NFCs were detected during the middle portion of the night (i.e., not during Dusk or Dawn) which suggests that most NFCs detected represent migrants passing over the Project area, and not individuals that were stopping over (**Figure 3.18**).

Thrushes were primarily detected from late august through to mid-September. Many thrush calls were also detected at Dawn when individuals typically call as they descend from migratory flight. This was observed on three mornings from September 1 to 15 (**Figure 3.18**).

Sparrows, representing approximately 18% of the NFCs, were detected largely from September through mid-October. Similar to warblers, most sparrows were observed during the middle part of the night (**Figure 3.18**). However, considerably more were detected near Dawn and may represent individuals calling from the ground. which were predominantly savannah sparrows.

Common Nighthawk were observed only during the early part of the migration season and near dawn (**Figure 3.18**). As such, it is assumed that these common nighthawk calls are from individuals breeding in the area. Common nighthawk are known to call frequently during dawn and dusk (Brigham et al. 2020); therefore, the NFCs detected likely represent few individuals calling repeatedly near the acoustic sensors.

The number of detections shown in **Figure 3.18** is the total number of calls detected for that group on that night; also note that the scale differs between species.

Figure 3.19 shows the distribution of acoustic detections by species group for: warblers (purple), sparrows (green), thrushes (blue) and common nighthawk (orange) across the entire fall season. The number of detections shown in **Figure 3.19** is the total number of calls detected for that group on that night; also note that the scale differs between species.

Figure 3.18 Nocturnal Flight Call Detections by Species Group and Time of Year - Fall 2022

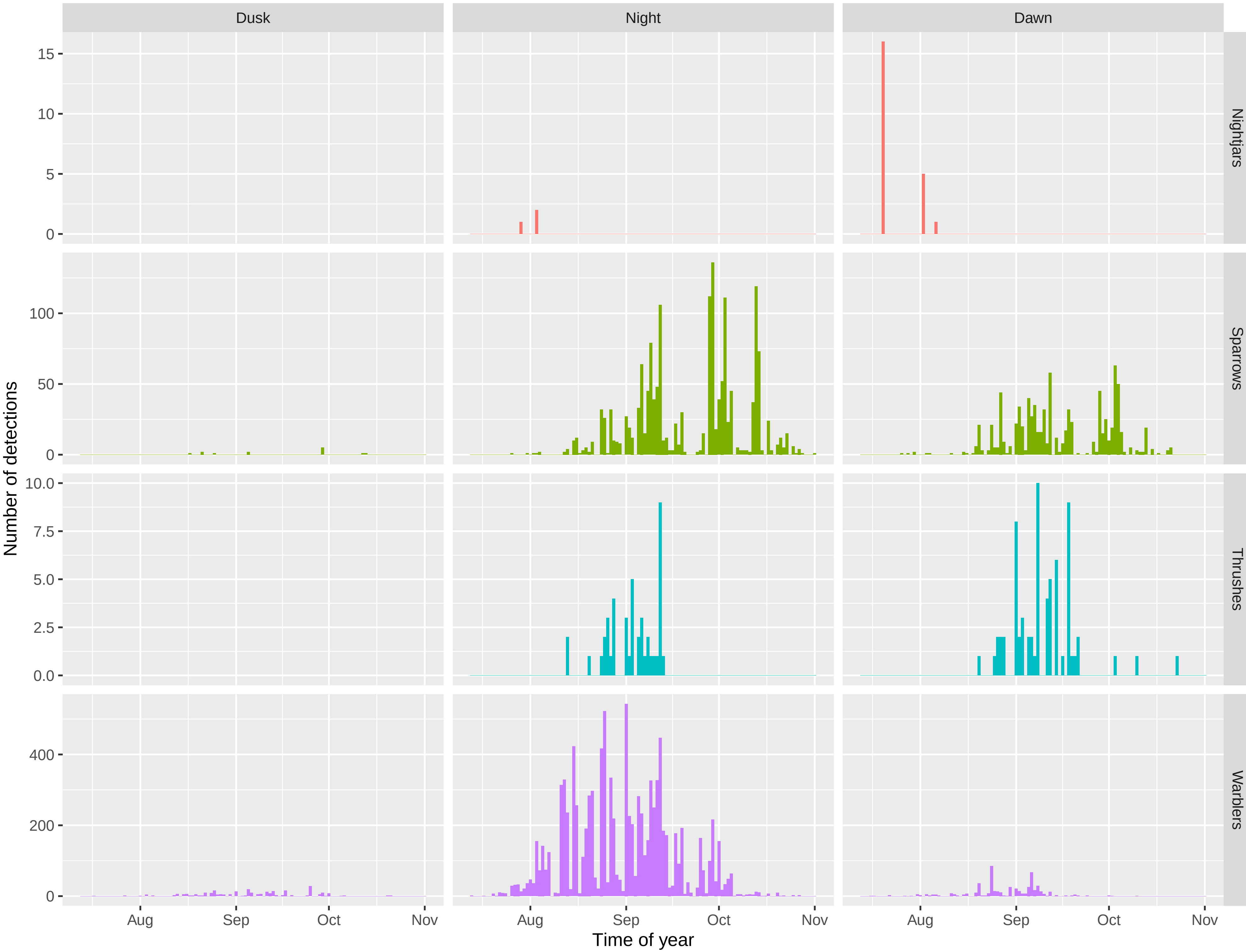

Figure 3.18 Nocturnal Flight Call Detections by Species Group and Time of Year - Fall 2022

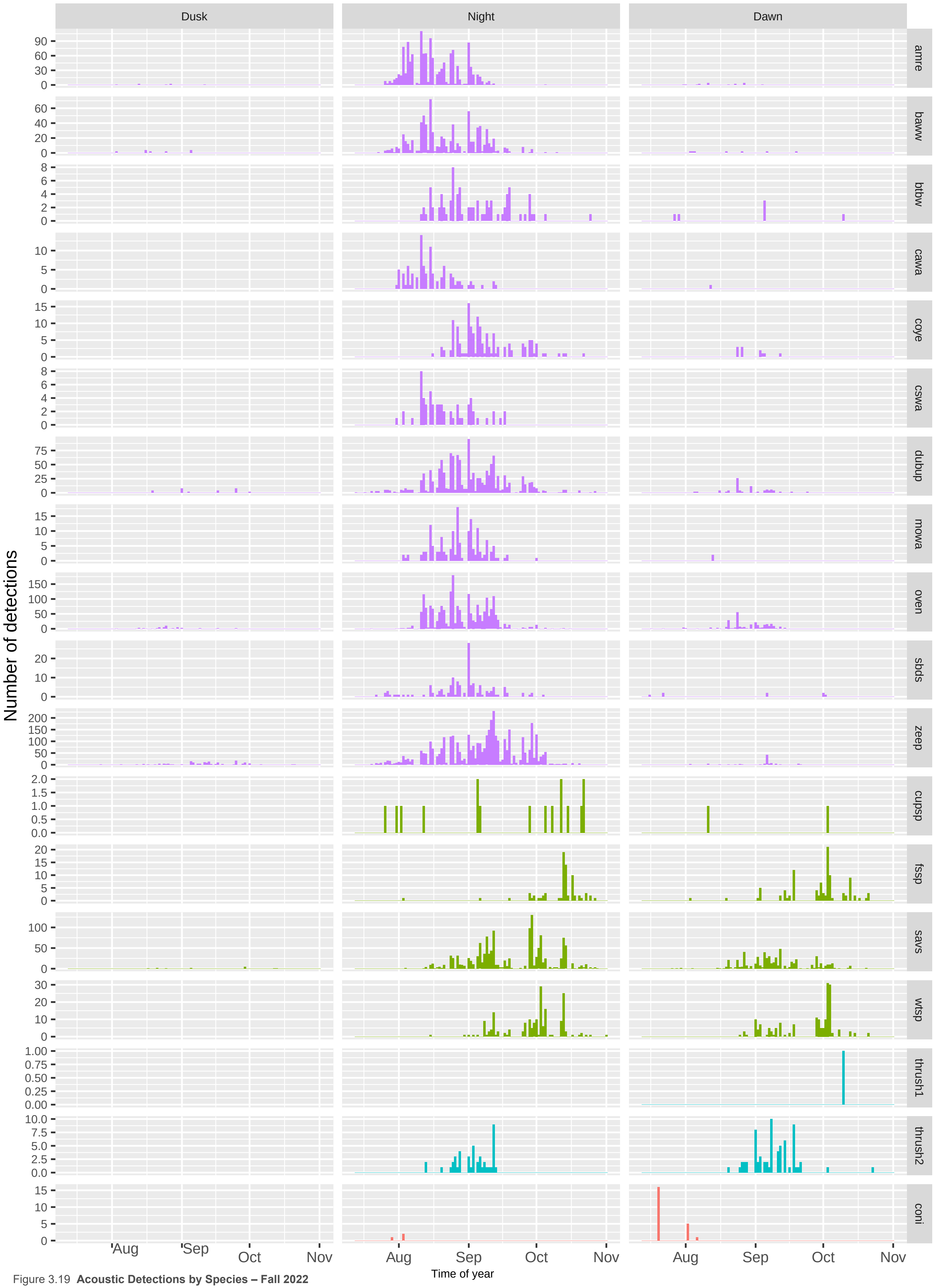

Figure 3.19 **Acoustic Detections by Species – Fall 2022**

Figure 3.20 shows the occurrence of NFCs detected by time of night during the fall migration season. Common Nighthawk (likely breeding individuals) were active primarily at dawn. While sparrows and thrushes were detected throughout the night, the majority were also detected near dawn. As shown in **Figure 3.18**, most warblers were detected during the middle part of the night, representing individuals in active migration.

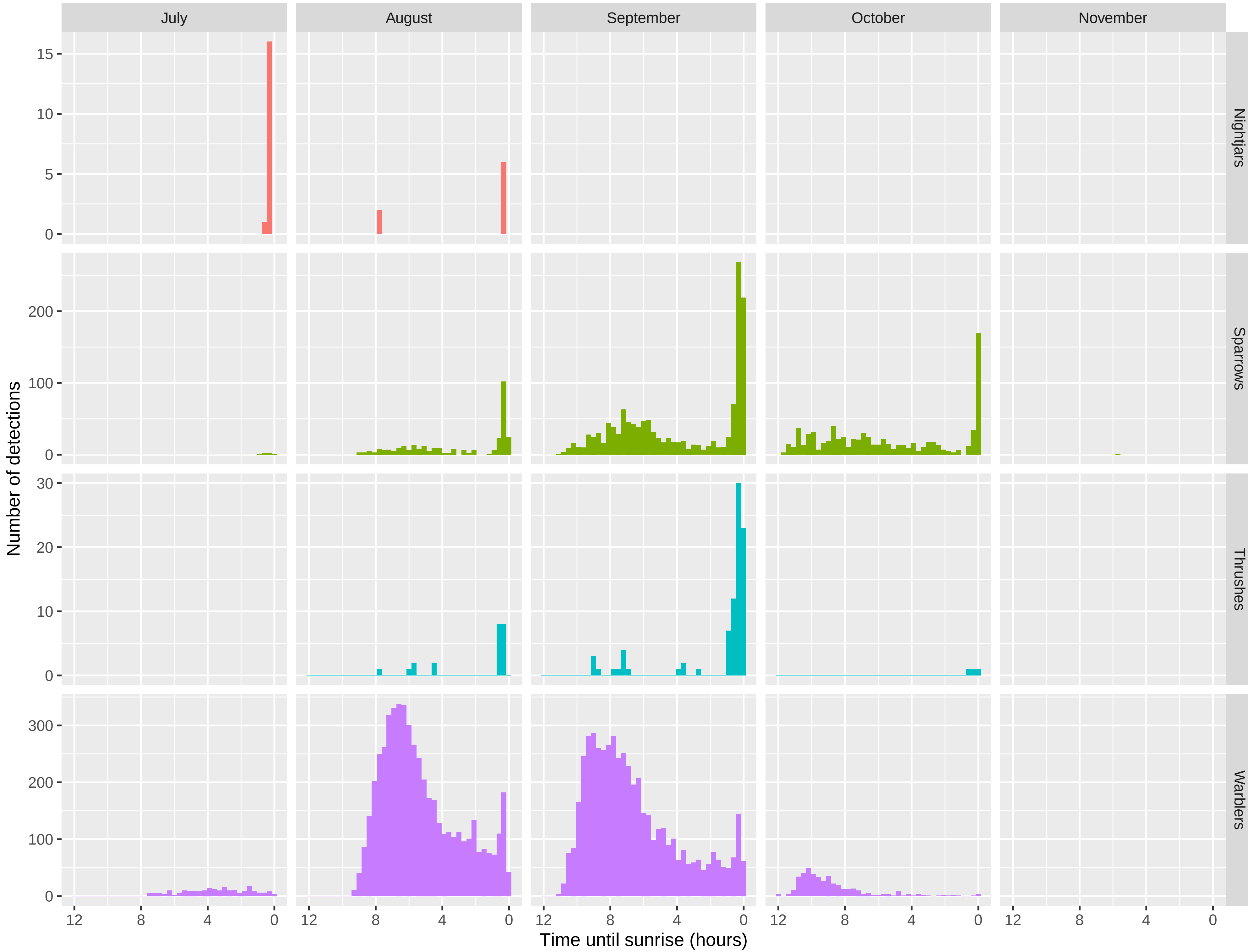

Figure 3.20 Nocturnal Flight Calls by Time until Sunrise – Fall 2022

4.0 Summary

Radar and acoustic monitoring were completed at the Project area during the spring and fall 2022 migration seasons with radar data collected within approximately 1,500 m of the nearest proposed turbine and acoustic data obtained through a network of sensors located across the Project area.

Radar monitoring was nearly continuous throughout the spring (April 5 to June 6) and fall (July 8 to November 30) seasons. Acoustic monitoring was conducted continuously through both seasons, however acoustic data included within this report extends only until November 1 in order to meet the reporting timelines. Given that very few radar targets were detected in November, it is assumed that very few NFCs occurred in November as well. Considering these dates, and when examining the number of detections observed across this time period, the entire spring and fall nocturnal migration seasons were monitored at the site. As is typically seen on similar studies in Nova Scotia, the intensity and duration of the spring migration season is much less compared to the fall.

Targets were detected at heights throughout the area sampled (i.e., between 70 m and approximately 800 m). However, given that the probability of detecting small birds decreases as distance from the radar increases, the decrease in number of detections of birds higher than 400 m is likely a combination of fewer birds aloft and a decreased detectability.

When examining the nights with the largest numbers of targets (i.e., when most of the migration occurred), most of the targets tend to be at approximately the top of the RSA (i.e., 200 m). Based on experience completing similar studies across the Atlantic region, often during peak nights of migration, the density of targets is generally at a higher altitude, approximately 400 m.

When examining differences in detections within nights, most radar and acoustic activity was observed during the middle portion of the night. While some unknown percentage of migrants are likely stopping over at the Project area, given the consistency in distribution of activity within nights the data suggest that a large proportion of migrants are not utilizing the area for staging during migration. However, it should be noted that it is possible that migrants are landing earlier in the night.

Most activity was observed when favourable tailwinds were present and with little to no precipitation. These findings are typical to other radar and acoustic studies completed in Nova Scotia (e.g., Peckford and Taylor, 2008; Hemmera 2021).

The composition of the species detected via acoustic sensors were consistent with the range of species known to migrate into and through Nova Scotia in the spring and fall. The timing of those species was also as expected, with most warblers detected between mid to late May and August to early September, and sparrows observed throughout May and September through October; very few NFCs were detected at the beginning and end of each season, indicating that entirety of each season was monitored.

4.1 Species at Risk

While common nighthawk (listed as *Threatened* under the Nova Scotia *Endangered Species Act* (NSESA) and the federal *Species at Risk Act* (SARA)) were detected during the spring and fall migration seasons, the majority of the calls detected are believed to be from local individuals rather than active migrants. Given this species is active at night and calls frequently, the number of calls detected do not provide an accurate representation of the number of individuals at the site, but rather confirms their presence within the Project area.

Canada warblers (listed as endangered under the Nova Scotia *Endangered Species Act* and threatened under the federal *Species at Risk Act*) were detected via NFCs during the spring on May 18, May 21 and May 23, and during the fall throughout much of August. Canada warblers were also observed during the in-person visual 2021 spring (3 individuals; May 21 and 26, 2021) and fall (2 individuals; August 25, 2021) migration surveys completed by Dillon Consulting Ltd. (Natural Forces Developments LP 2022). Based on detections via the acoustic sensors and observations made in-person, the period when Canada warblers migrate through the Project area appears limited to the last week of May in the spring and August in the fall. Given that Canada warbler NFCs are distinct and detectable from other species, it is assumed that most, or all, Canada warbler NFCs captured by the sensors were identified. Of the 112 Canada warbler calls detected, only 1 was at dusk or dawn, suggesting that the majority of this species are flying over the site during nocturnal migration.

4.2 Assessment of Risk

The assessment of collision risk by migratory birds with turbines using radar and acoustic data are difficult and have not been proven to be that effective. In general, mortality associated with windfarms is thought to be low, relative to the effects of other human infrastructure (Zimmerling et al. 2013). While risk may be correlated with volume of migration, without multiple, standardized radar/acoustic studies conducted across a broader region (i.e., across Nova Scotia), it is difficult to make definitive statements about whether the volume of migrants at any particular site is more or less than what might be expected elsewhere.

Risk of migratory bird collisions is also hypothesized to be increased when birds are landing within a project area or if large numbers of birds are “forced” to fly lower due to weather variables such as fog. As indicated above, it appears from the data that large numbers of birds are not using the Project area as a stopover site. However, because during the peak nights of migration the relative density of migration was highest near the top end of the RSA, there is a potential for a proportion of migrants to be at risk of collision during migration.

4.3 Comparison with 2021 Results

In 2021, Ausenco completed radar and acoustic monitoring at the Project site using the same approach taken in 2022 (see Hemmera 2022) apart from spring and fall 2022 seasons consisting of a longer monitoring period, and the use of a shorter-range radar in the spring of 2021.

In 2021, spring monitoring occurred from May 4 through June 6. In 2022 monitoring was initiated on April 5 and continued until June 6. While some level of migration were observed across the 2022 monitoring period, peaks in migration activity were not detected by the radar (and little to no NFCs were detected) in April, suggesting that large migratory movements were not missed in the 2021 assessment.

The radar unit used during the 2021 spring season had a shorter range compared to the radar unit used in the fall of 2021 and the spring/fall of 2022 (i.e., the fall 2021 and spring/fall 2022 radars were the same). As a result of this difference, we observed more targets at higher altitudes during the spring of 2022 compared to 2021. During the 2021 spring season, nights with peak migration showed most targets were observed within the RSA of the turbines, this was not observed for the peak nights in 2022 when the longer-range radar was used. Within the Hemmera 2021 report, it was postulated that the detection limitations of the radar during the spring may give the impression that more birds are flying at lower altitudes at a select set of nights while migration is in fact occurring at higher altitudes, outside of the detection range of the radar. Results from the spring 2022 season appear to support this hypothesis.

Fall monitoring was initiated earlier and extended later into the 2022 season compared to 2021. While some moderately sized movements of migrants were detected in July and early August of 2022, very little activity was observed in November.

As discussed in the 2021 annual report, reasons for the observation of migratory activity within the RSA was hypothesized to be either movements of local birds, topographical conditions at the Project area, or a function of the detection range of the radar. Based on 2022 data, it is unlikely that the targets are local bird movements (as confirmed via NFCs) or a function of the radar detection range. Therefore, a possible explanation for the pattern of targets may be that as migrants approach the general area of the Cobequid mountains they do not increase their altitude above ground level in response to the increased elevation in the general area (i.e., approximately 300 m above sea level). If the relative increased topography in the general area is the reason for migratory activity to be approximately 200 m, this pattern of migration would be expected to be observed across the Cobequid region. However, this explanation is speculative given that there are no other publicly available radar or acoustic migratory data in the region, and a regional assessment of migration would likely be needed to answer the question more fully.

Acoustic analysis techniques improved from 2021. In 2021 only information on the movement patterns of warblers and sparrows were available, while in 2022 information on several individual species and species groups are provided. The 2022 data revealed the presence of two species at risk (Section 4.2) and provided more information on thrushes in the Project area.

4.4 Limitations

The following are limitations related to the data collected that should be considered when drawing conclusions from the data presented within this report.

Radar Data

Radar data can provide a good understanding of nocturnal avian migration trends at proposed wind energy project sites. However, there are limitations to how the data are collected and can be interpreted, such as:

- While it is assumed that most targets are migratory birds, some proportion of targets may be from insects, bats, clutter and or precipitation
- Species identification using radar alone is not possible
- As distance from the radar increases, the detection probability of small (i.e., passerine sized) targets decreases. Because we know migration density decreases with increased altitude, the interplay between detection probability and migrant behaviour is difficult to measure.
- Detections at very low altitudes (i.e., below 70 m) is difficult to capture in most onshore wind energy sites due to topography and tree cover which cause clutter in the radar signal.

Acoustic Data

While NFC calling rates provide a good representation of migratory activity (e.g., species present, trends in activity), there are many factors that influence calling rates; several of which are:

- Microphone sensitivity (detection rates may change based on weather, background noise, vegetation cover, and technology)
- Time of year (it is unknown how migratory urgency may impact calling rates)
- Time of night (calling rates may be higher during the early portion of the night to entice stopovers to initiate migratory flight, or in the morning, when individuals are choosing to land for the day). How this influences detection rates is poorly understood. ,
- Weather conditions (it is unknown how weather conditions may impact calling rates)
- Density of migrants (it is unknown if calling rates increase or decrease with increased migrant density)
- Species composition (while it is known that not all species call, the calling frequency is known for many species that do produce NFCs).

5.0 Closure

This work was performed in accordance with the Purchase Order between Hemmera Envirochem Inc. (Hemmera), a wholly owned subsidiary of Ausenco Engineering Canada Inc. (Ausenco), and Natural Forces Developments LP, dated February 24, 2022 (Contract). This report has been prepared by Hemmera, based on fieldwork conducted by Hemmera, for the sole benefit and use by Natural Forces Developments LP. In performing this work, Hemmera has relied in good faith on information provided by others and has assumed that the information provided by those individuals is both complete and accurate. This work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and Project terms of reference; further, the findings are time sensitive and are considered valid only at the time the report was produced. The conclusions and recommendations contained in this report are based upon the applicable guidelines, regulations, and legislation existing at the time the report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

We sincerely appreciate the opportunity to have assisted you with this Project and if there are any questions, please do not hesitate to contact the undersigned.

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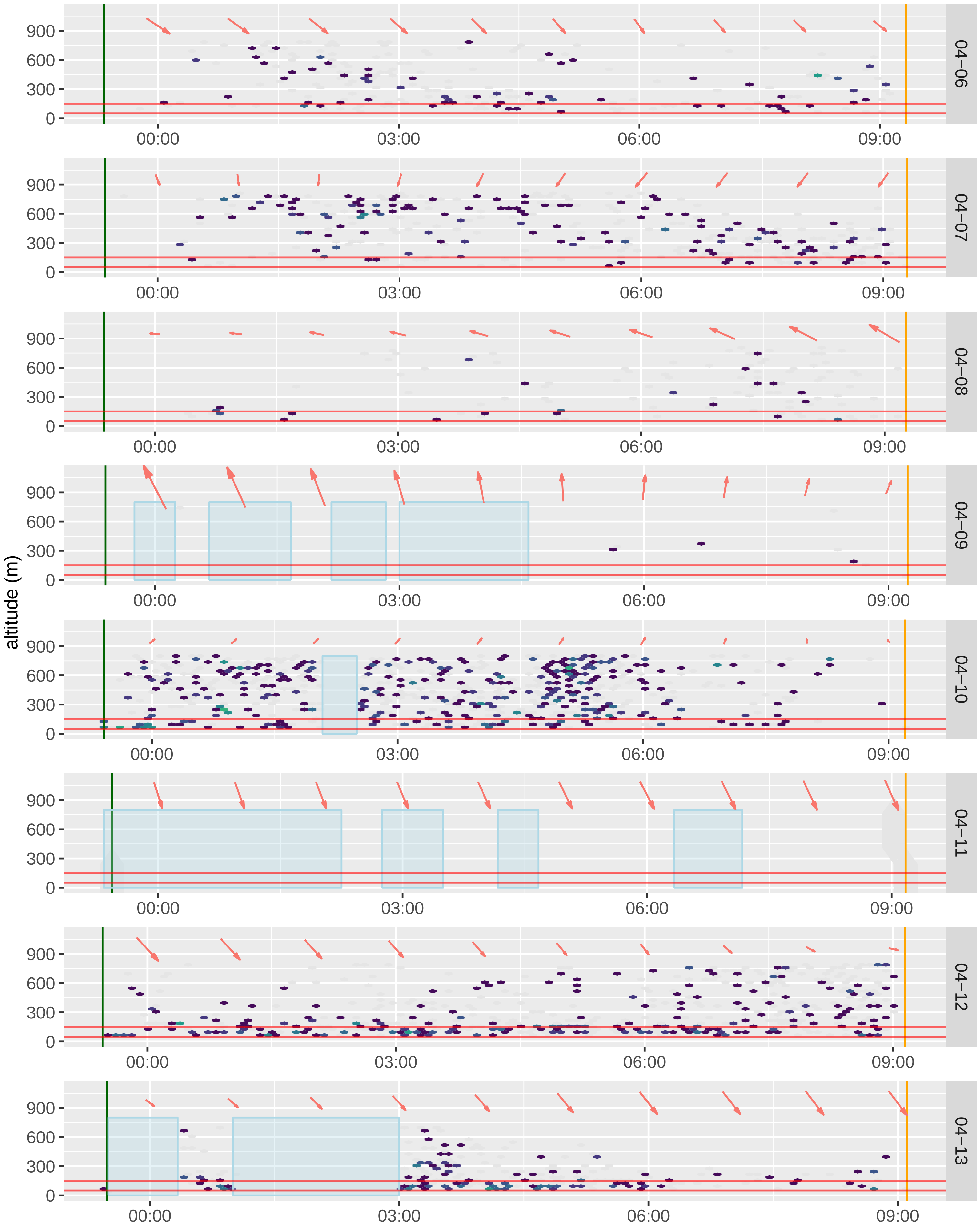
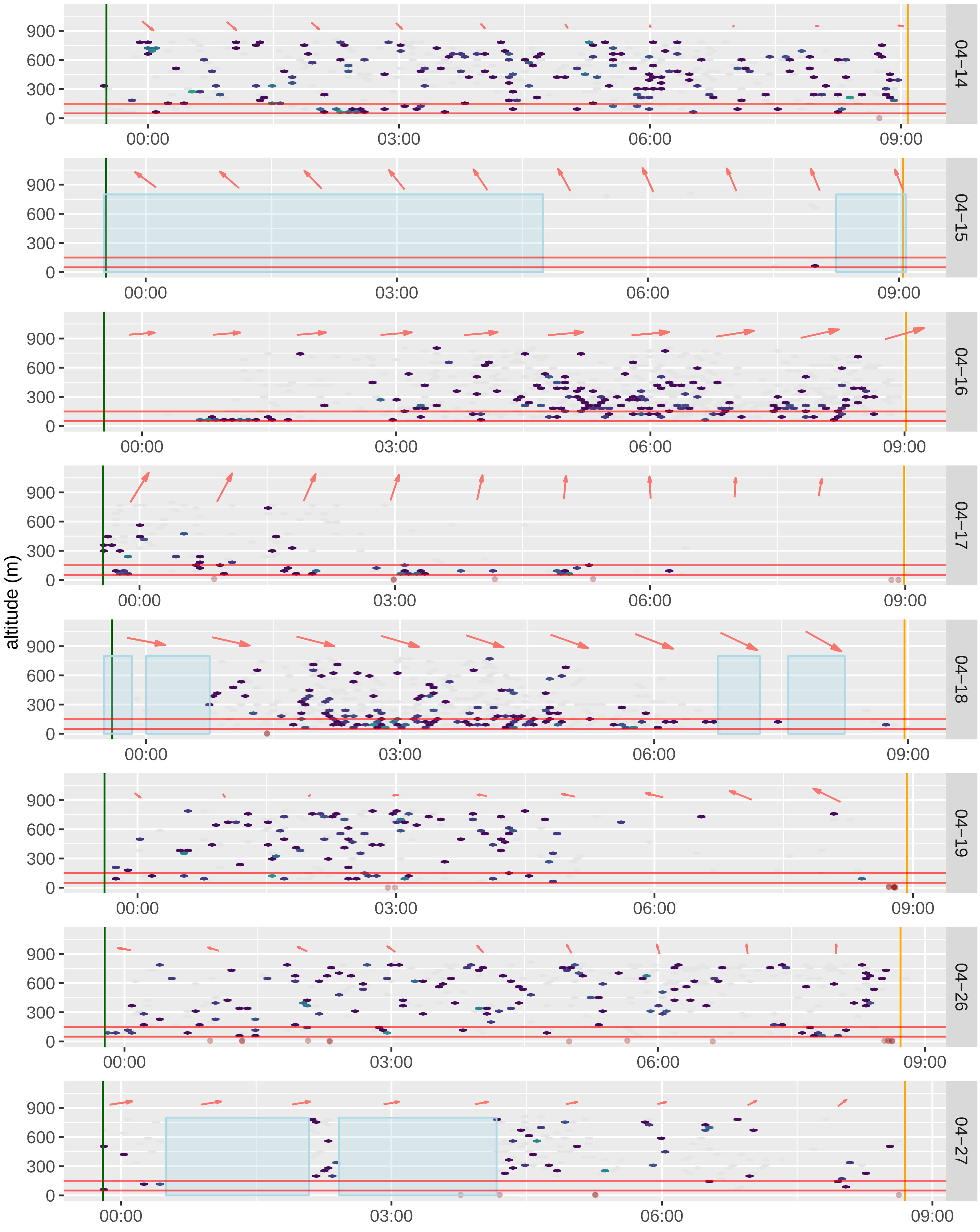
Appendix A
Complete Spring Radar Data

OVERVIEW

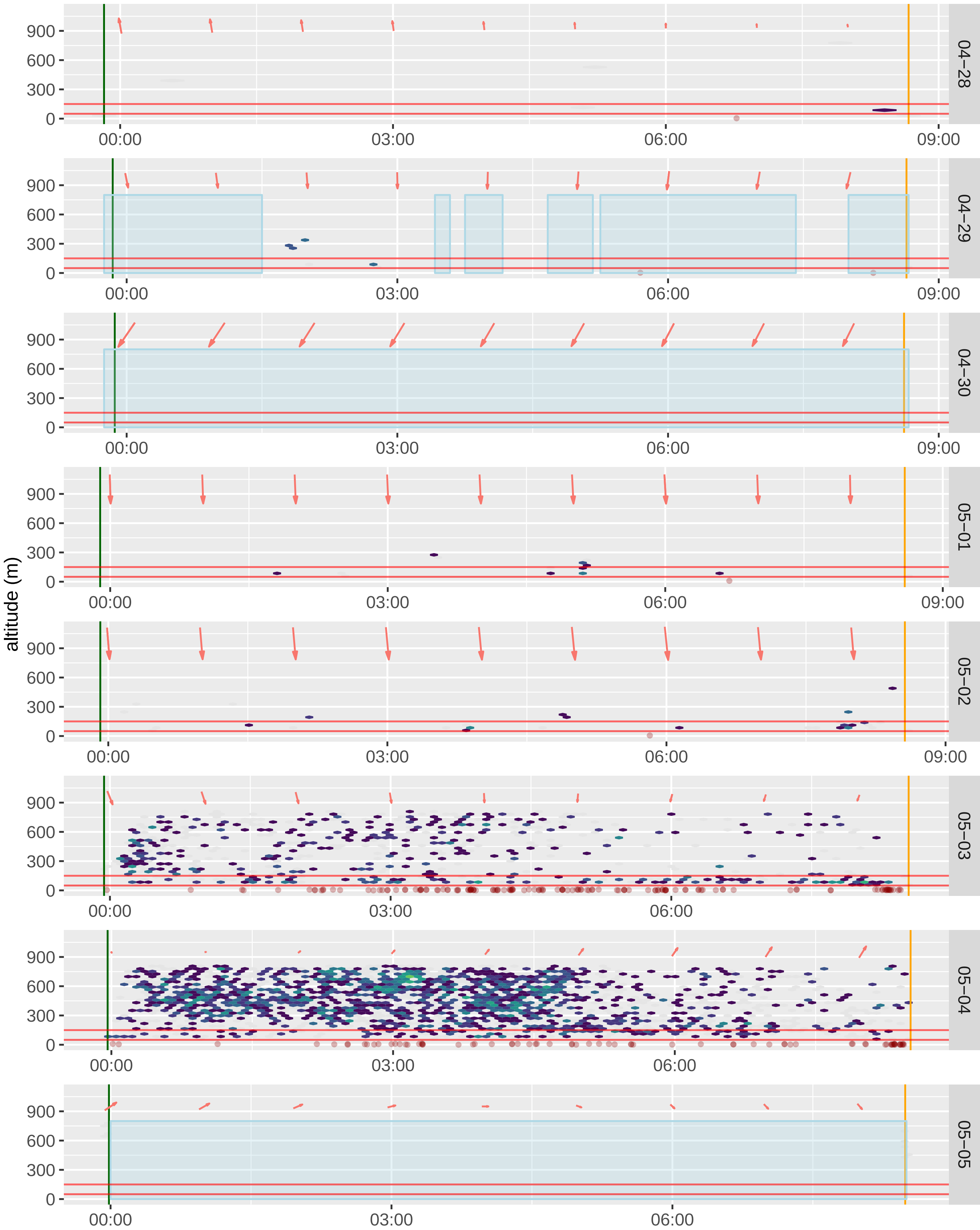
The following plots provide the radar and acoustic detections and wind conditions on all nights monitoring at the Project in spring 2022. Each plot is a separate night, with the beginning and end of civil twilight indicated by the vertical green and yellow lines, respectively. Date and time are on the x-axis and altitude is on the y-axis. Hexagonal points are radar detections divided into time and altitude bins and are scaled from light grey (few detections) through dark purple to yellow (many detections). Acoustic detections (a single NFC) are red points along the base of each plot (These have not been processed, and so on some nights may be contaminated by insects, raindrops or other noise). Wind direction and strength at approximately 700 m (red arrow) for each hour are displayed at the top of each plot. The blue box represents a period of rain when we were unable to distinguish between raindrops and bird detections. Red lines represent the approximate altitudinal range of the rotor sweep area.

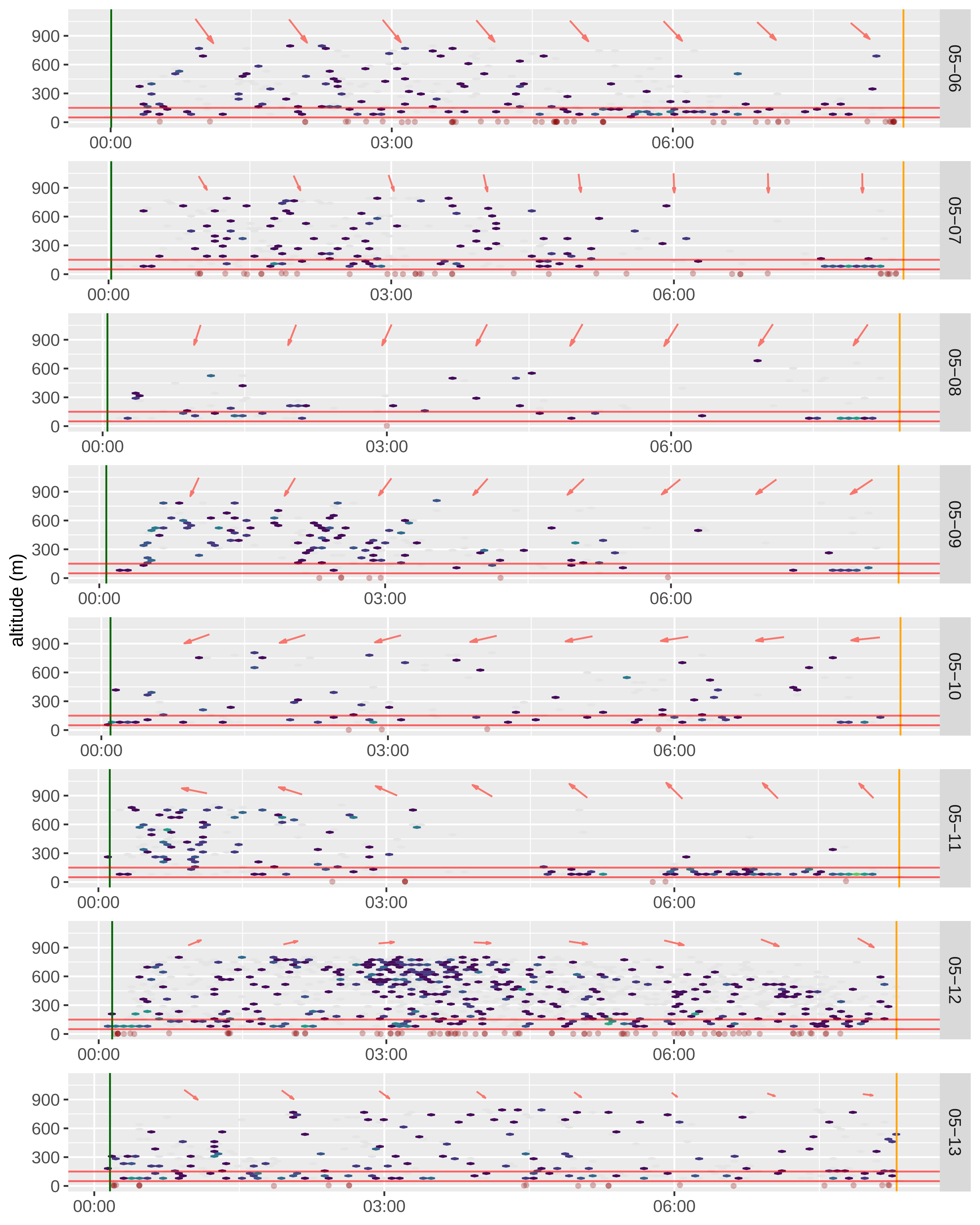


altitude (m)
900
600
300
0
00:00
03:00
06:00
09:00
04−06
04−07
04−08
04−09
04−10
04−11
04−12
04−13

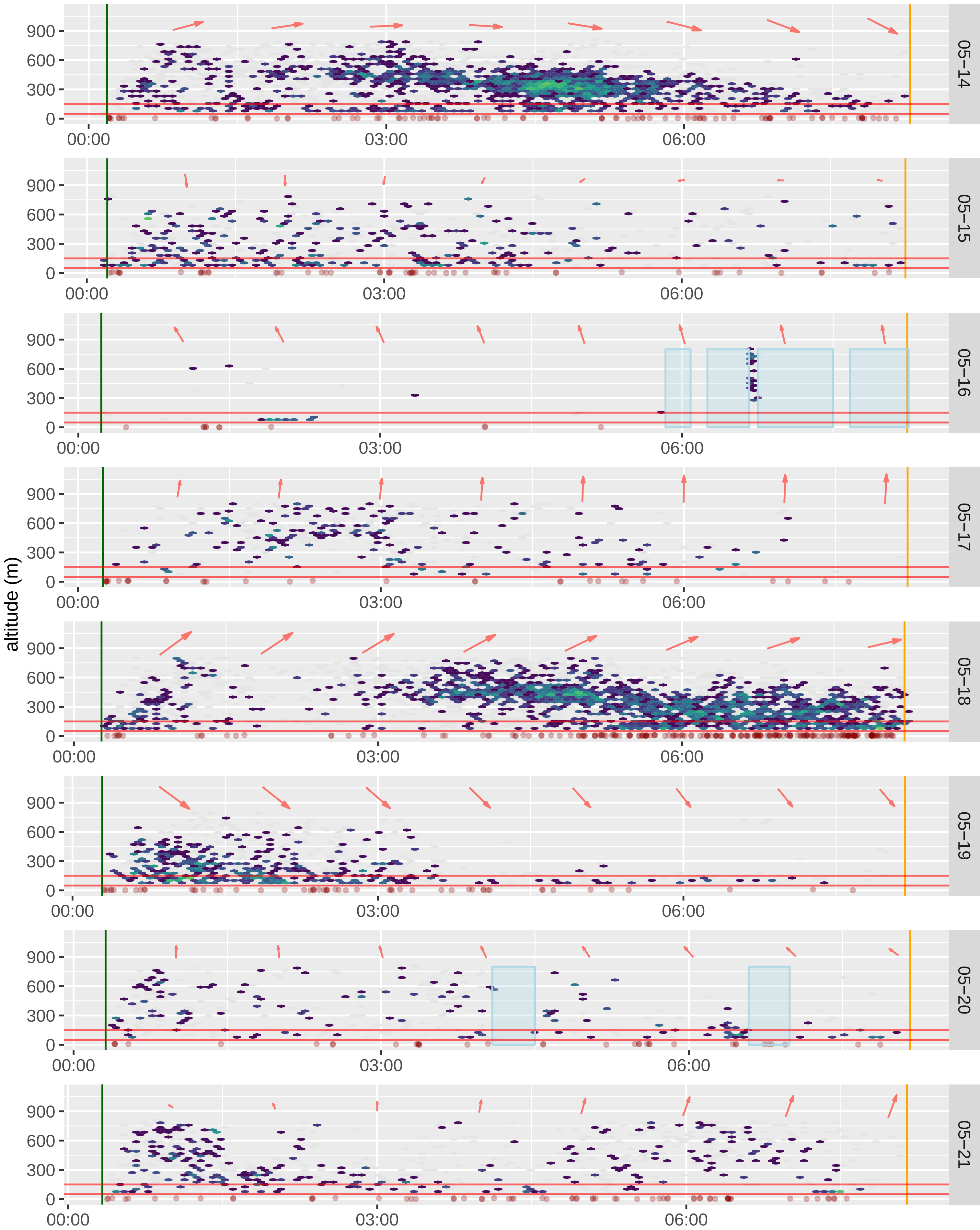


altitude (m)
04−14
04−15
04−16
04−17
04−18
04−19
04−26
04−27
0
300
600
900
00:00
03:00
06:00
09:00

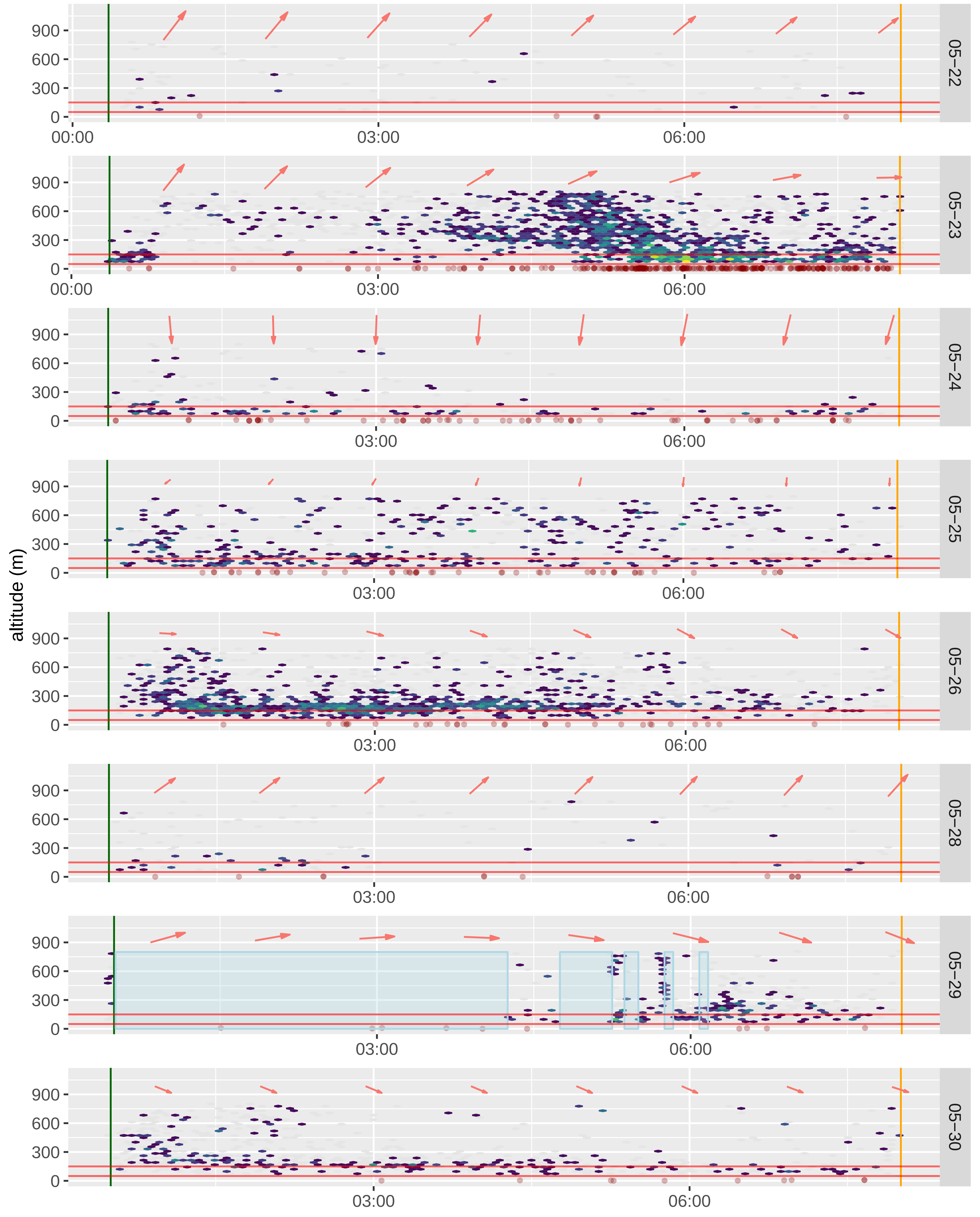

altitude (m)
0
300
600
900
00:00
03:00
06:00
09:00
04−28
04−29
04−30
05−01
05−02
05−03
05−04
05−05



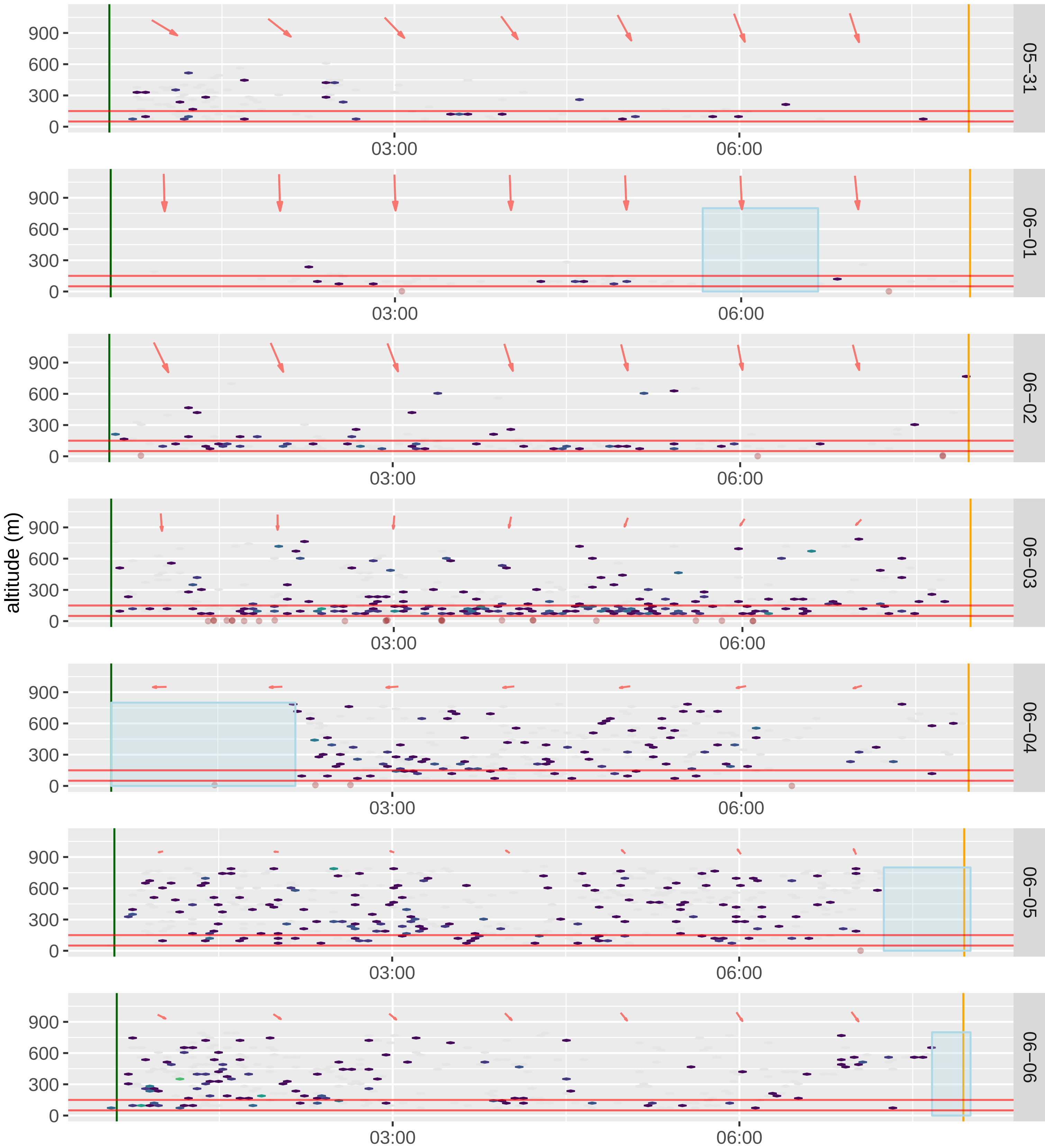
altitude (m)
900
600
300
0
00:00
03:00
06:00
05–06
05–07
05–08
05–09
05–10
05–11
05–12
05–13



altitude (m)
0
300
600
900
00:00
03:00
06:00
05−14
05−15
05−16
05−17
05−18
05−19
05−20
05−21



altitude (m)
05−22
05−23
05−24
05−25
05−26
05−28
05−29
05−30
00:00
03:00
06:00
0
300
600
900

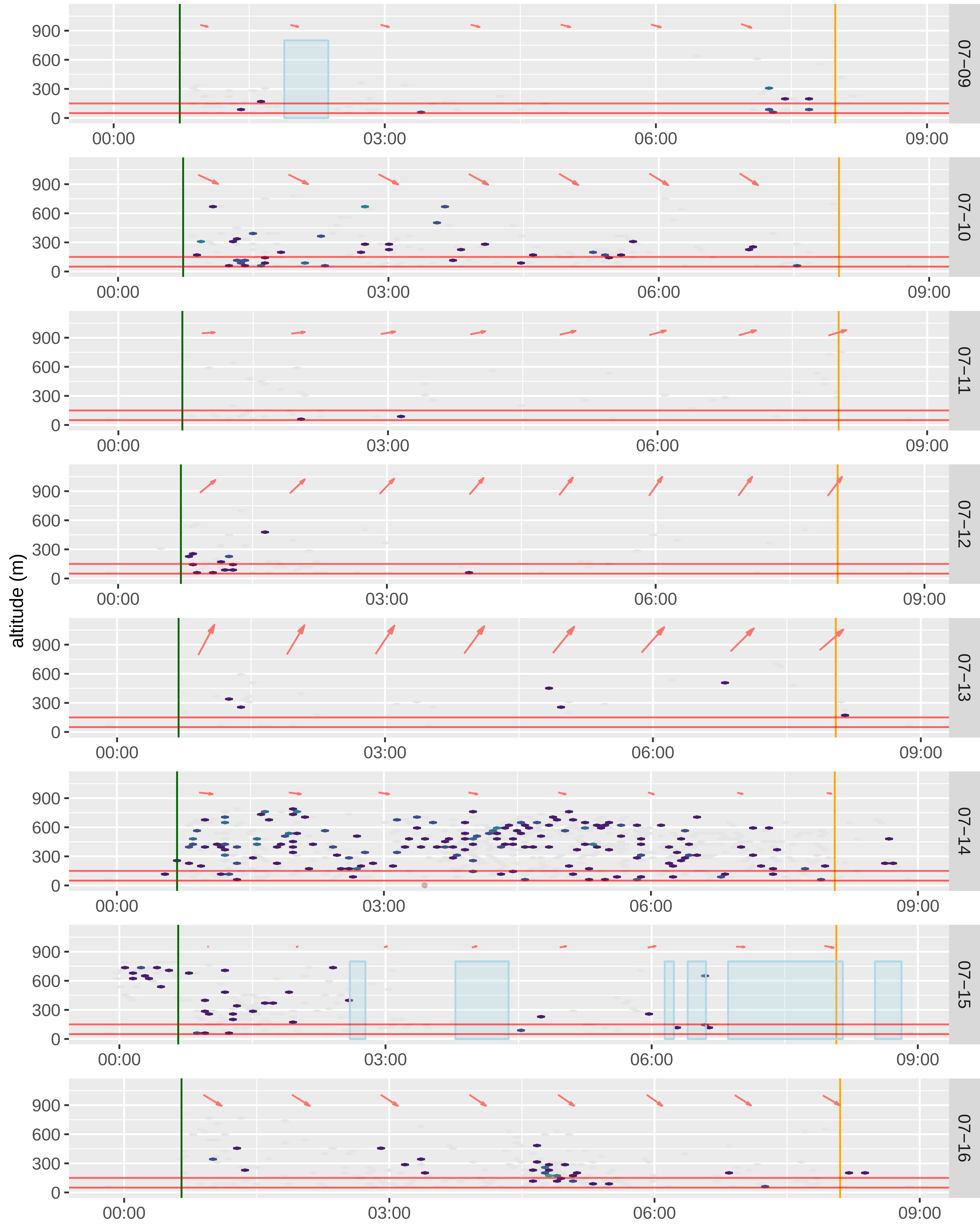


altitude (m)
900
600
300
0
03:00
06:00
05−31
06−01
06−02
06−03
06−04
06−05
06−06

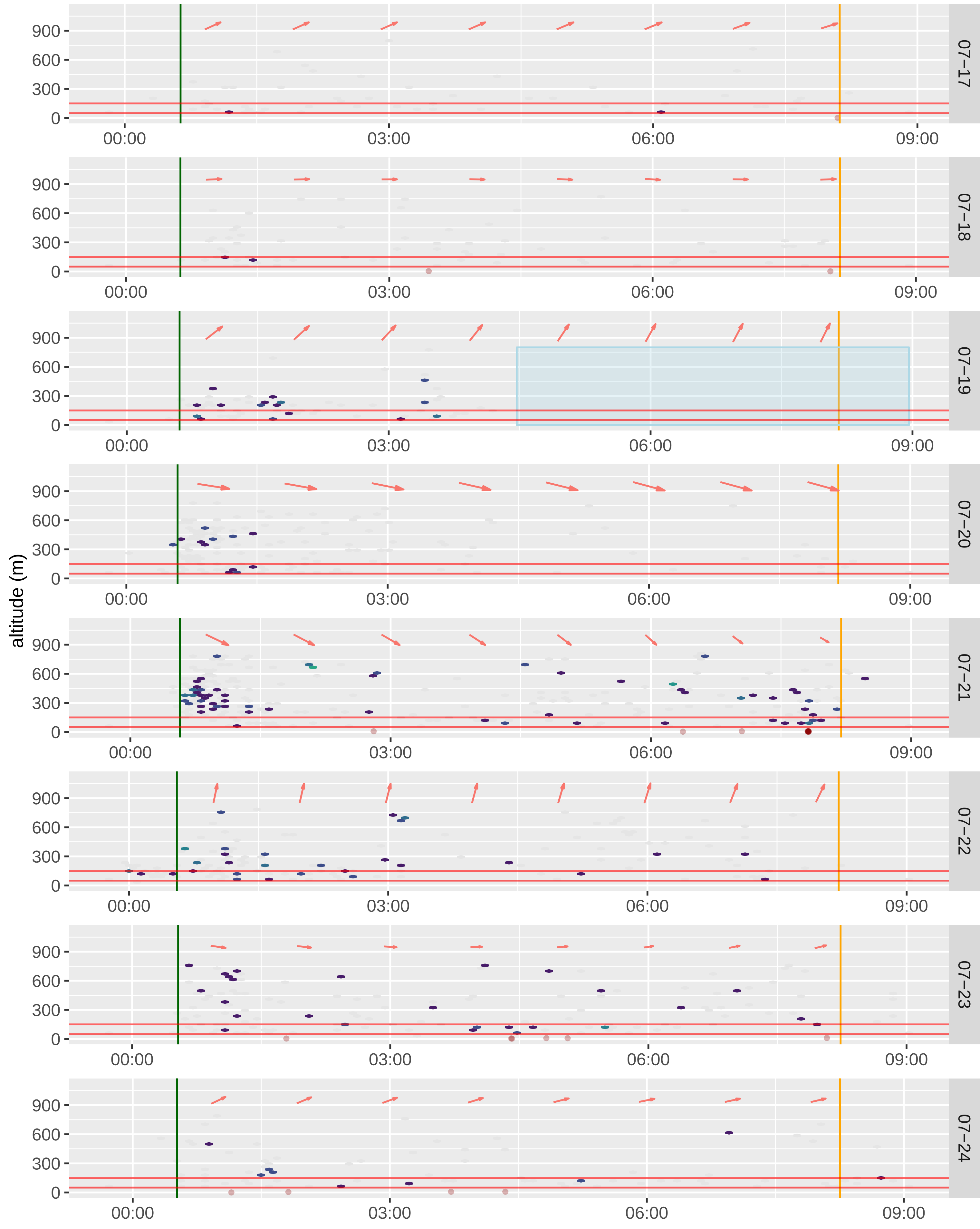
Appendix B
Complete Fall Radar Data

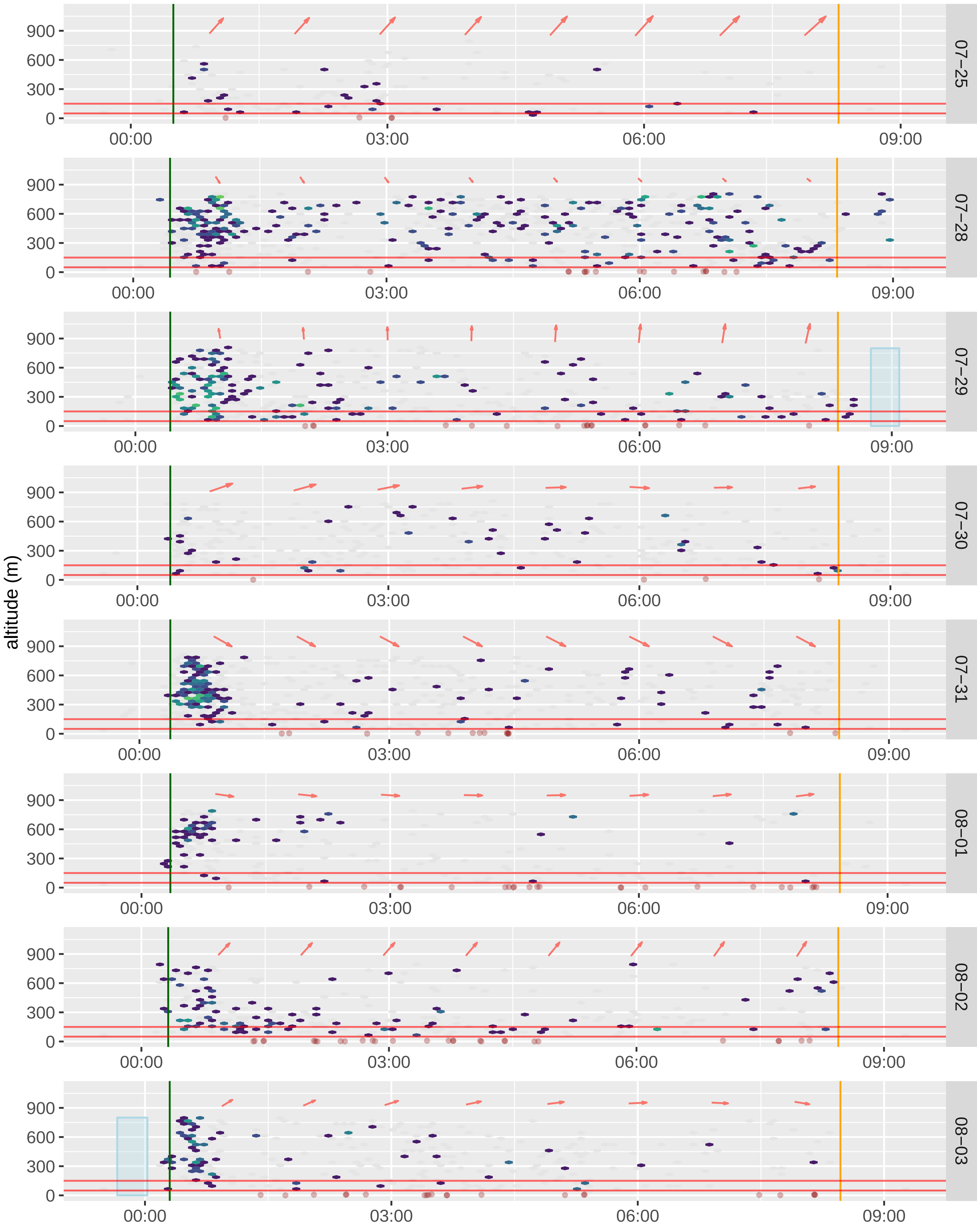
OVERVIEW

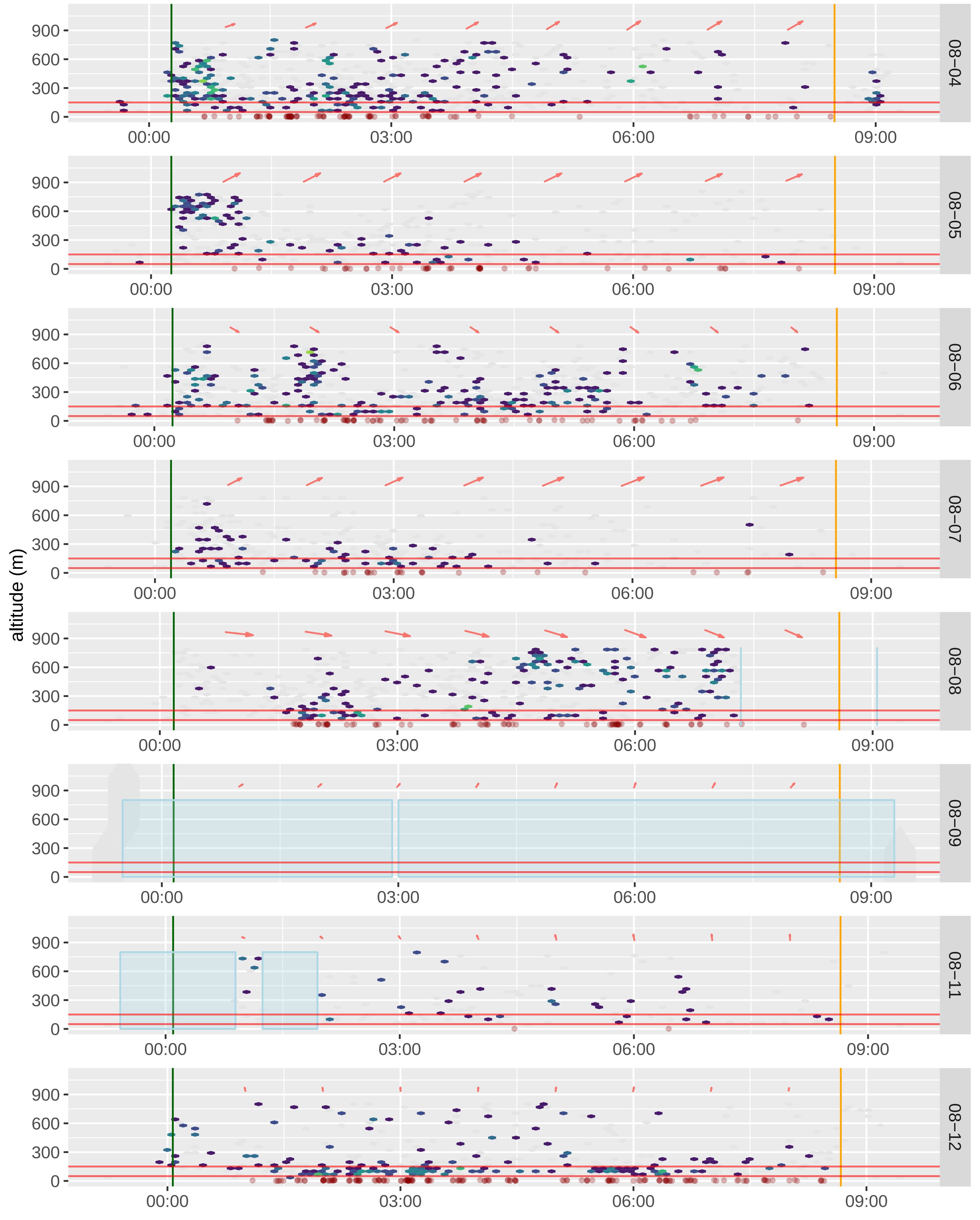
The following plots provide the radar and acoustic detections and wind conditions on all nights monitoring at the Project in fall 2022. Each plot is a separate night, with the beginning and end of civil twilight indicated by the vertical green and yellow lines, respectively. Date and time are on the x-axis and altitude is on the y-axis. Hexagonal points are radar detections divided into time and altitude bins and are scaled from light grey (few detections) through dark purple to yellow (many detections). Acoustic detections (a single NFC) are red points along the base of each plot (These have not been processed, and so on some nights may be contaminated by insects, raindrops or other noise). Wind direction and strength at approximately 700 m (red arrow) for each hour are displayed at the top of each plot. The blue box represents a period of rain when we were unable to distinguish between raindrops and bird detections. Red lines represent the approximate altitudinal range of the rotor sweep area.



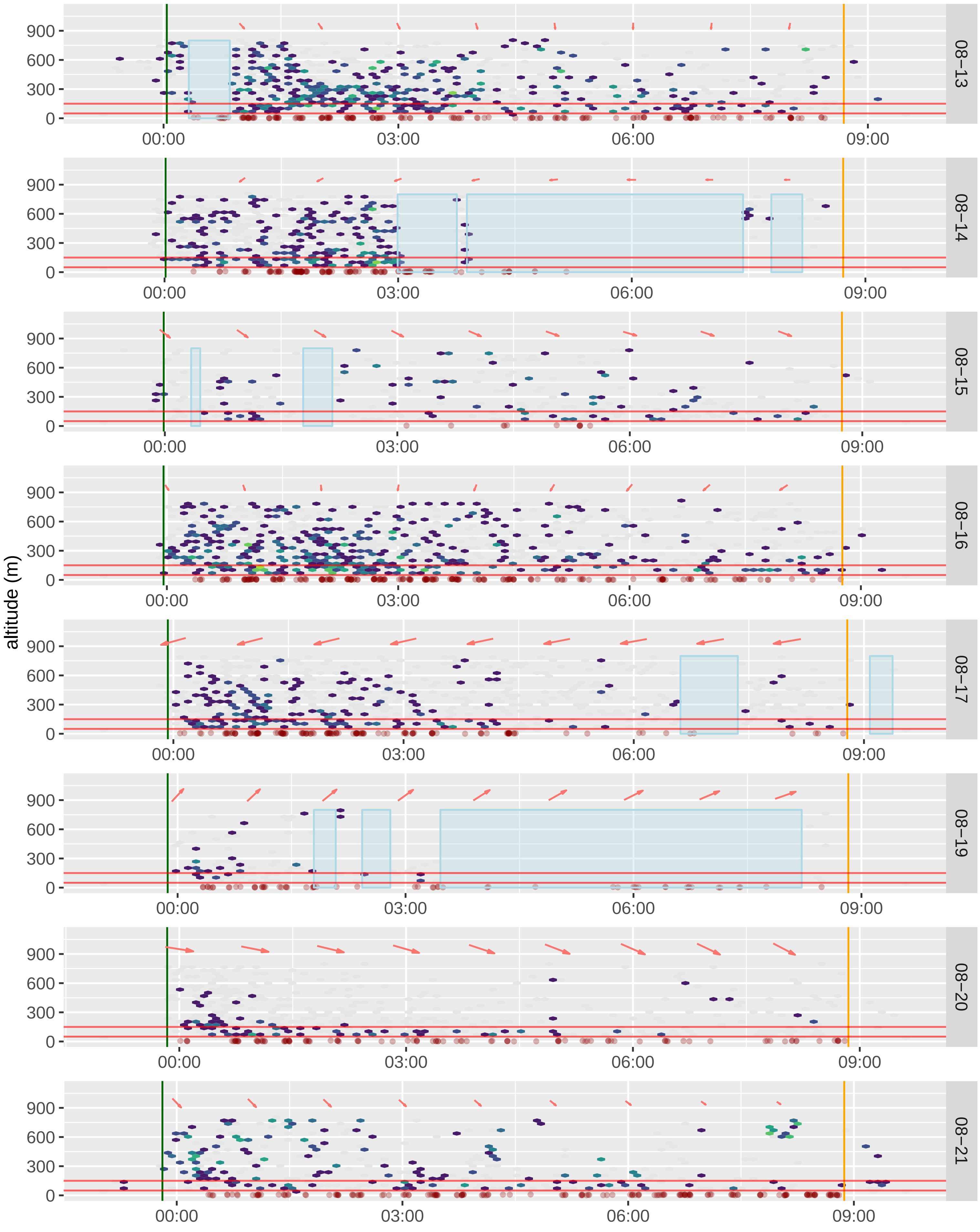
altitude (m)
0
300
600
900
00:00
03:00
06:00
09:00
07−09
07−10
07−11
07−12
07−13
07−14
07−15
07−16


altitude (m)
900
600
300
0
00:00
03:00
06:00
09:00
07−17
07−18
07−19
07−20
07−21
07−22
07−23
07−24

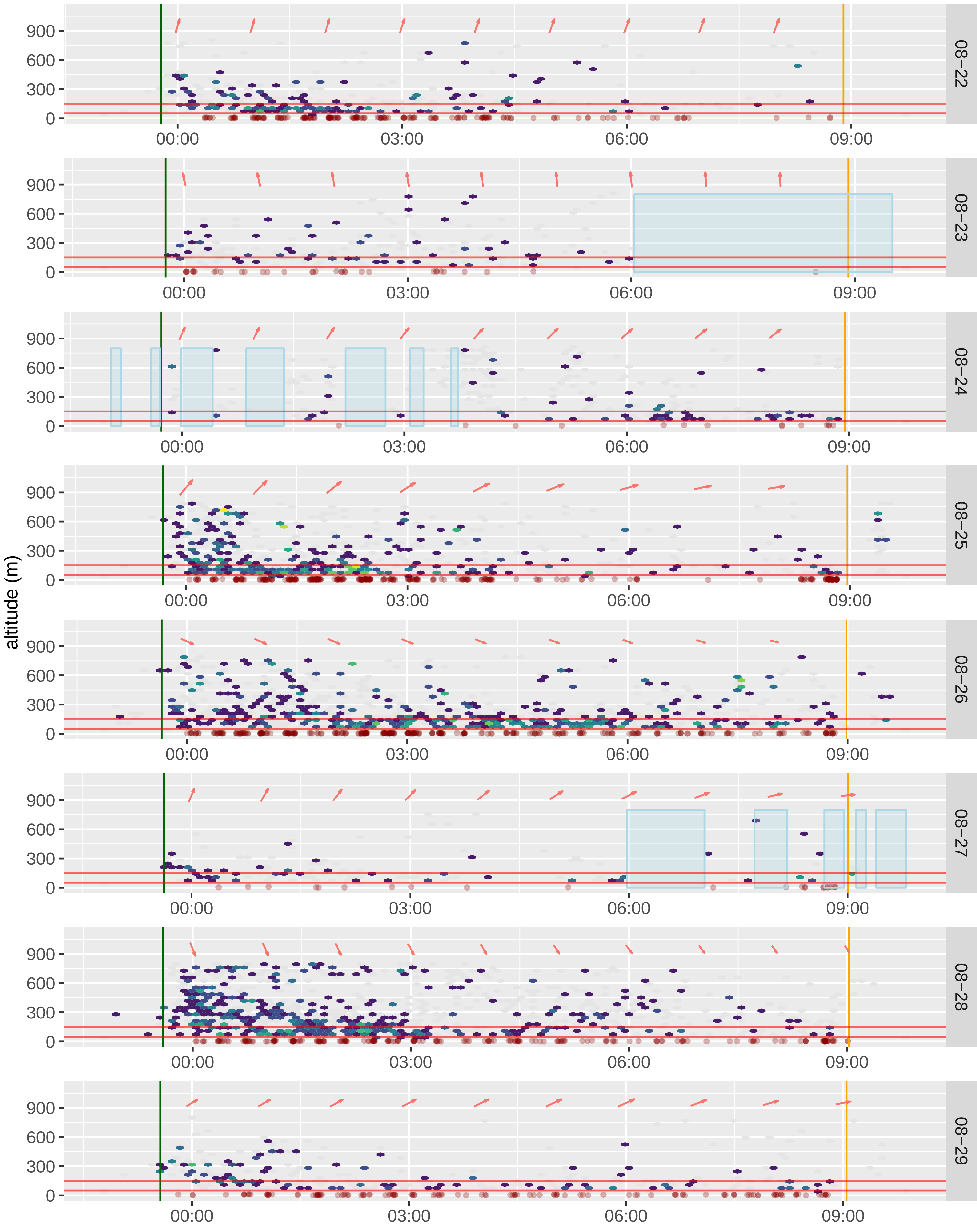

altitude (m)
0
300
600
900
00:00
03:00
06:00
09:00
07−25
07−28
07−29
07−30
07−31
08−01
08−02
08−03



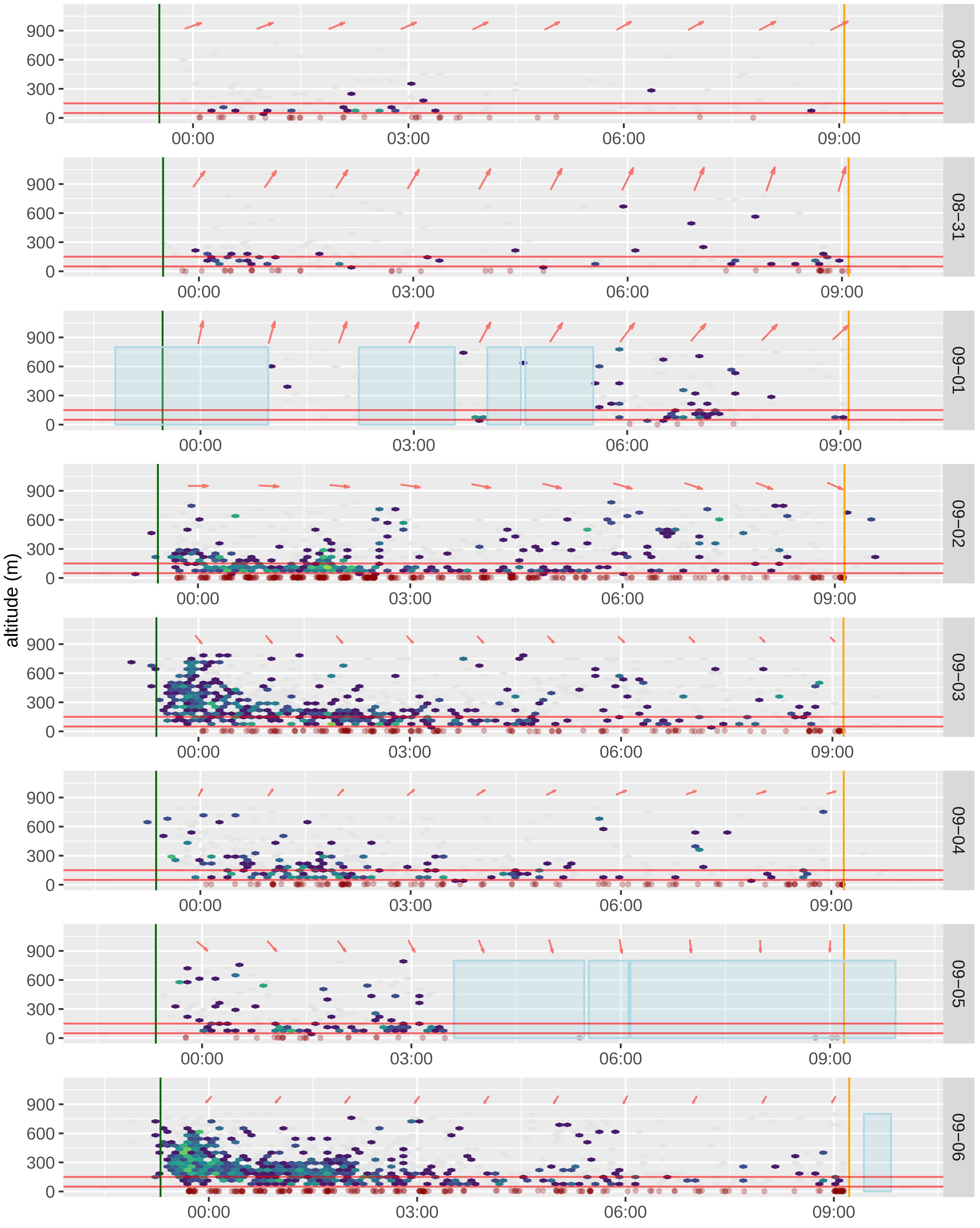
altitude (m)
0
300
600
900
00:00
03:00
06:00
09:00
08−04
08−05
08−06
08−07
08−08
08−09
08−11
08−12



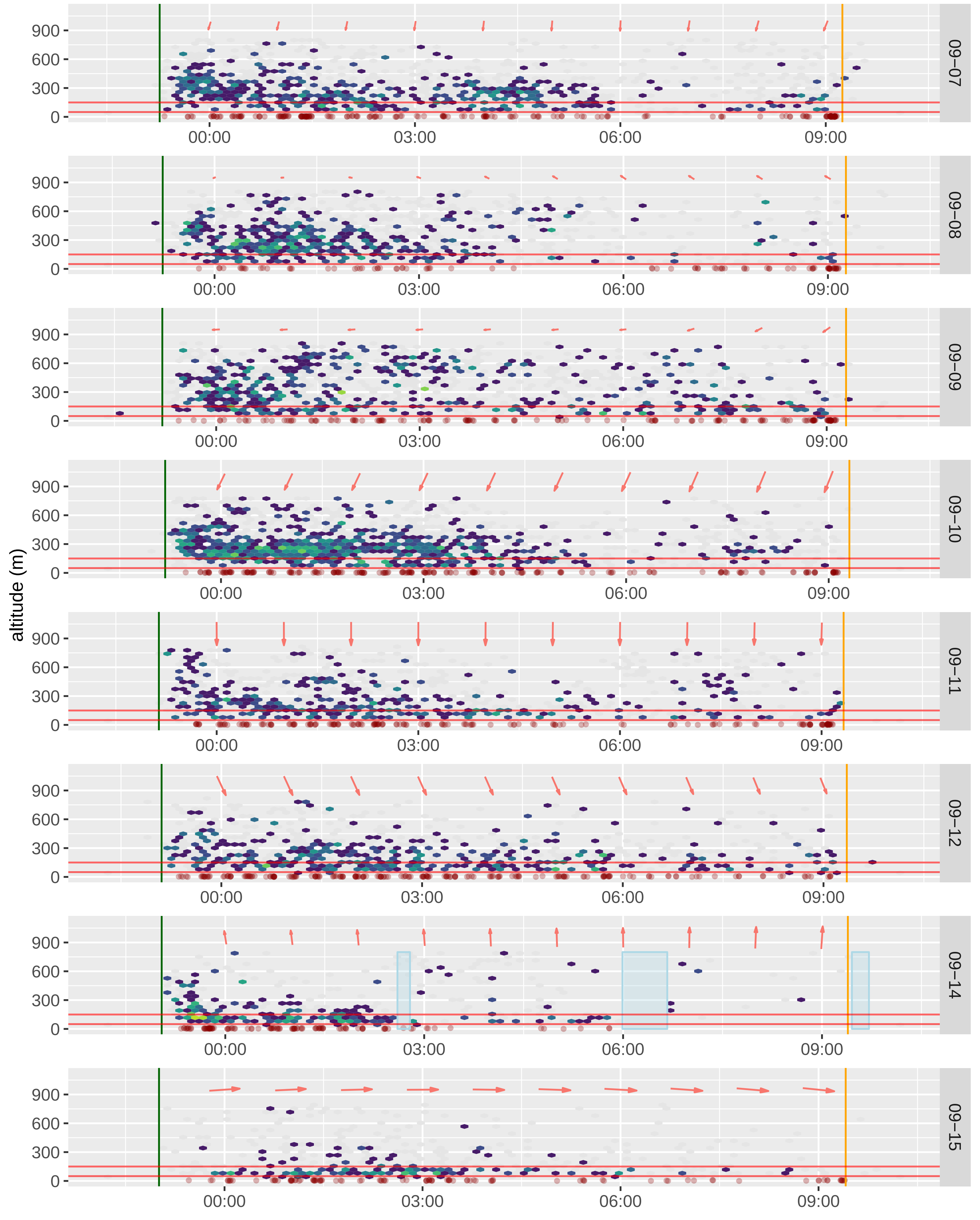
altitude (m)
08–13
08–14
08–15
08–16
08–17
08–19
08–20
08–21
0
300
600
900
00:00
03:00
06:00
09:00

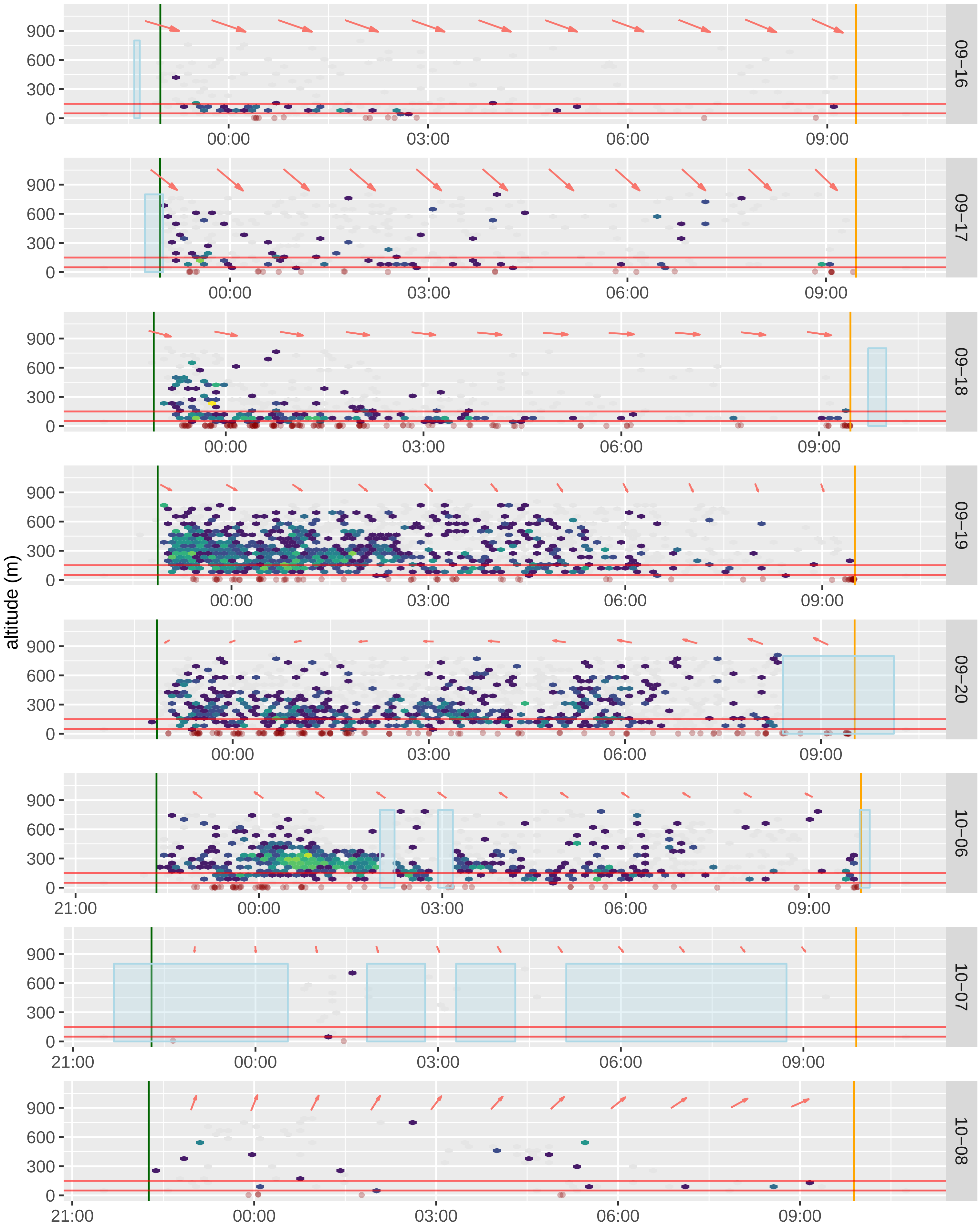


altitude (m)
0
300
600
900
00:00
03:00
06:00
09:00
08−22
08−23
08−24
08−25
08−26
08−27
08−28
08−29

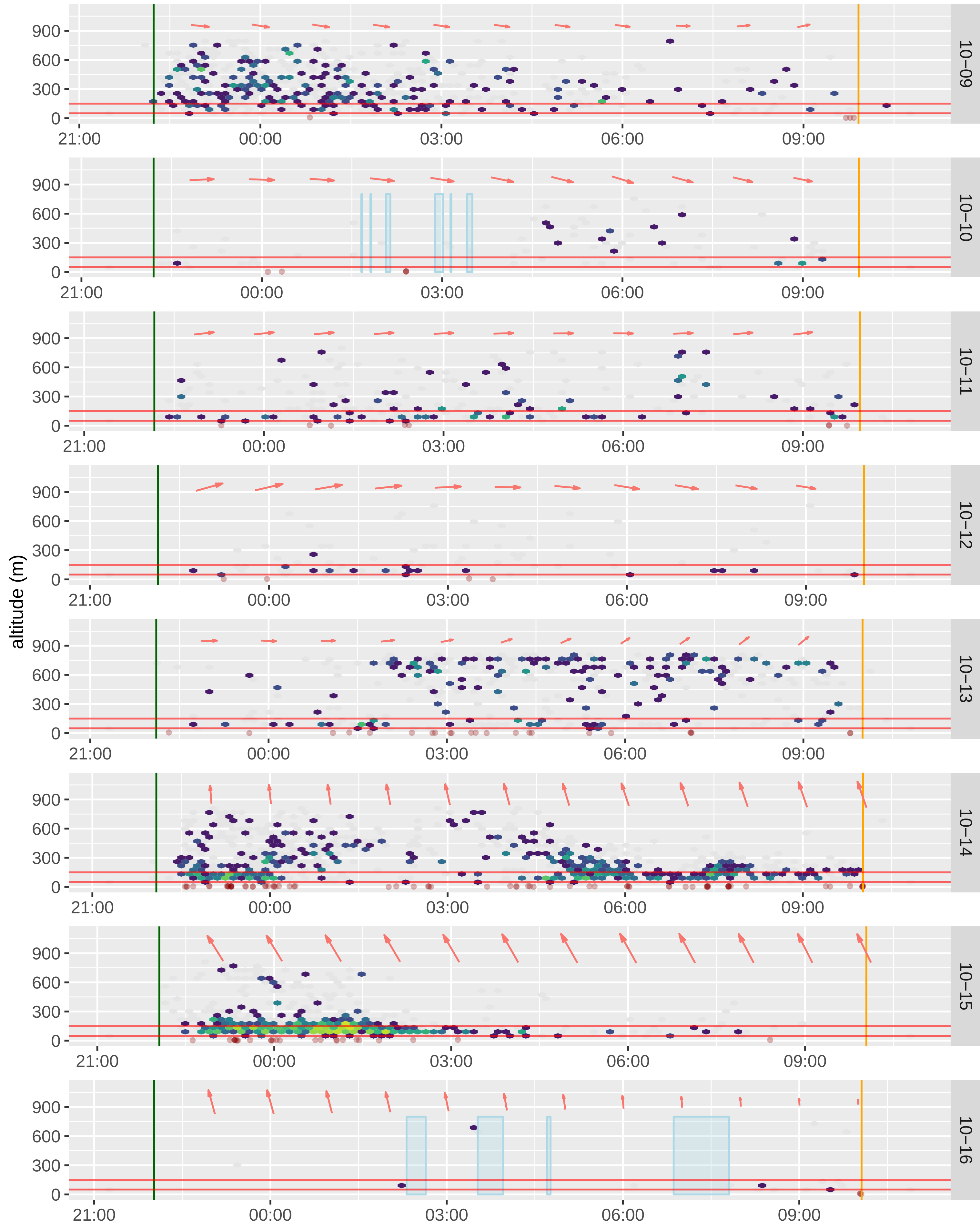


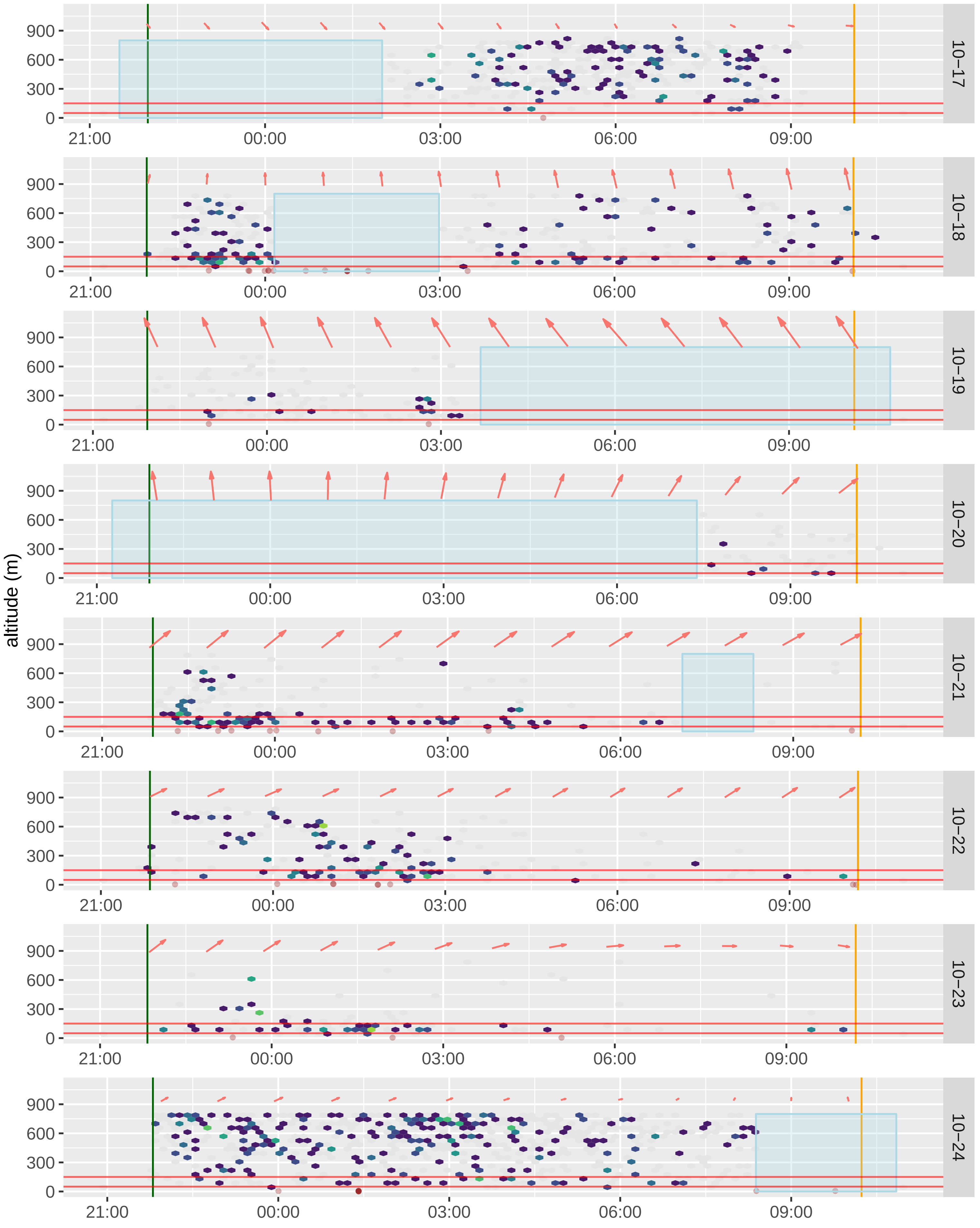
altitude (m)
0
300
600
900
00:00
03:00
06:00
09:00
08−30
08−31
09−01
09−02
09−03
09−04
09−05
09−06

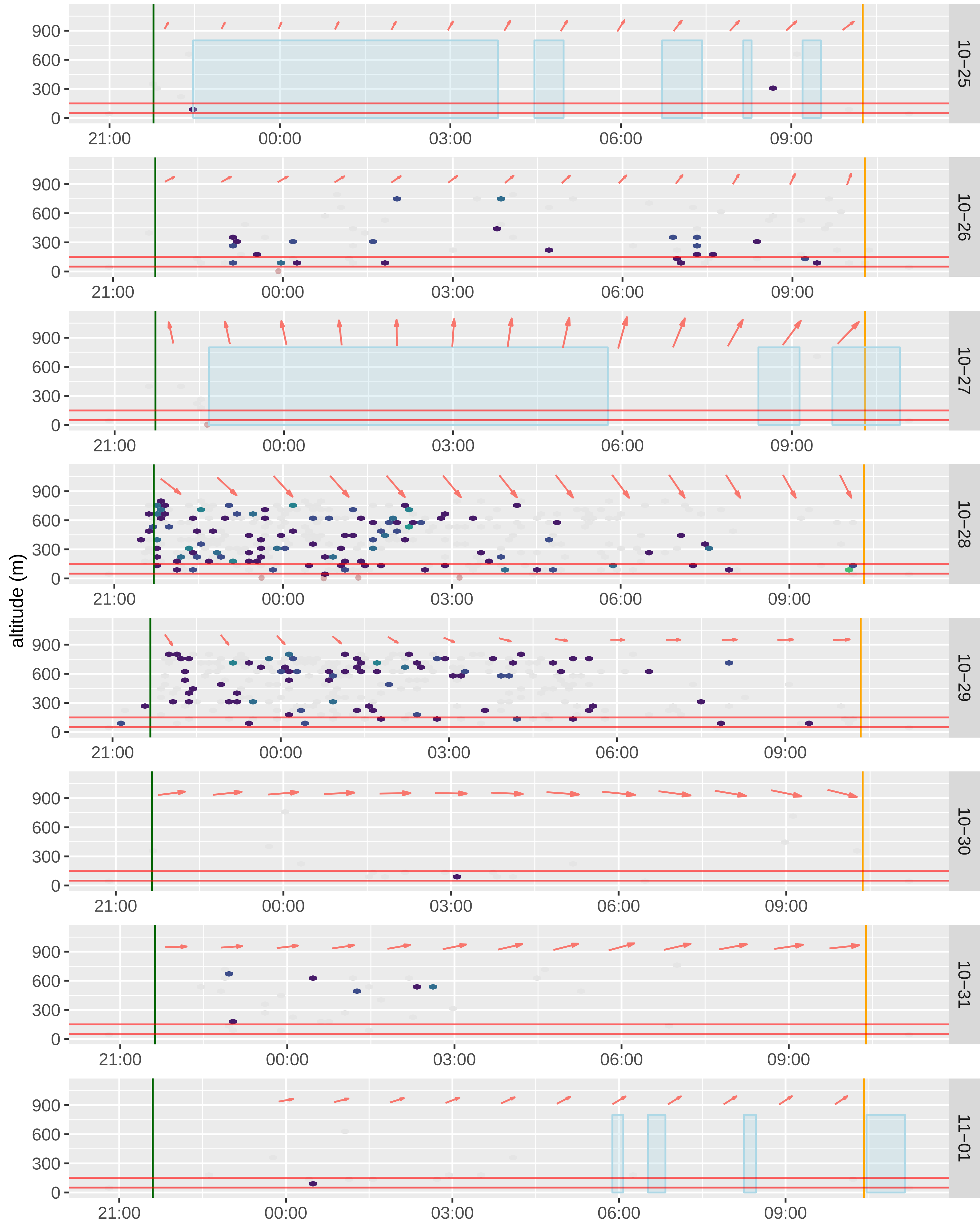

altitude (m)
0
300
600
900
00:00
03:00
06:00
09:00
09–07
09–08
09–09
09–10
09–11
09–12
09–14
09–15



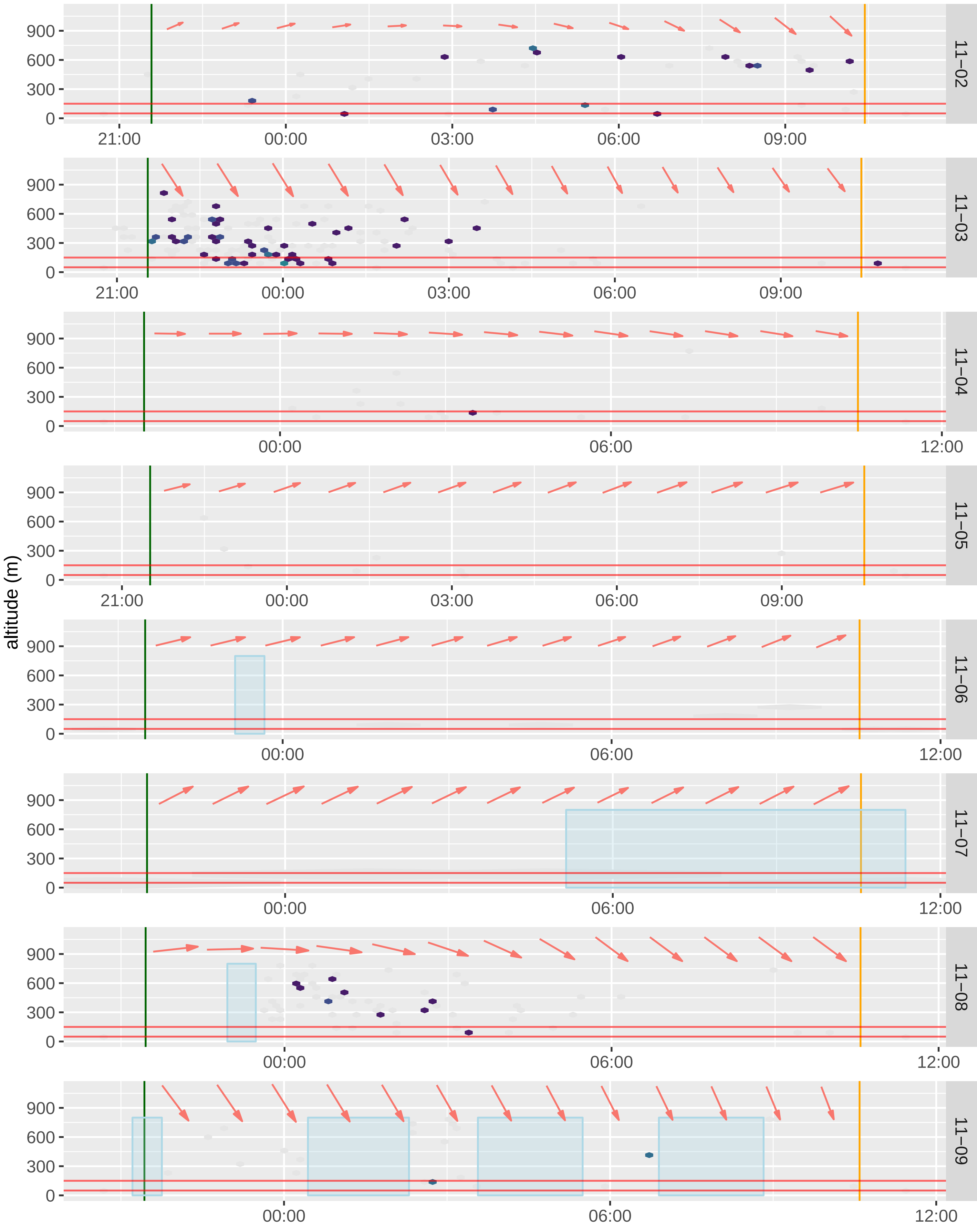
altitude (m)
0
300
600
900
21:00
00:00
03:00
06:00
09:00
09–16
09–17
09–18
09–19
09–20
10–06
10–07
10–08


altitude (m)
900
600
300
0
21:00
00:00
03:00
06:00
09:00
10–09
10–10
10–11
10–12
10–13
10–14
10–15
10–16

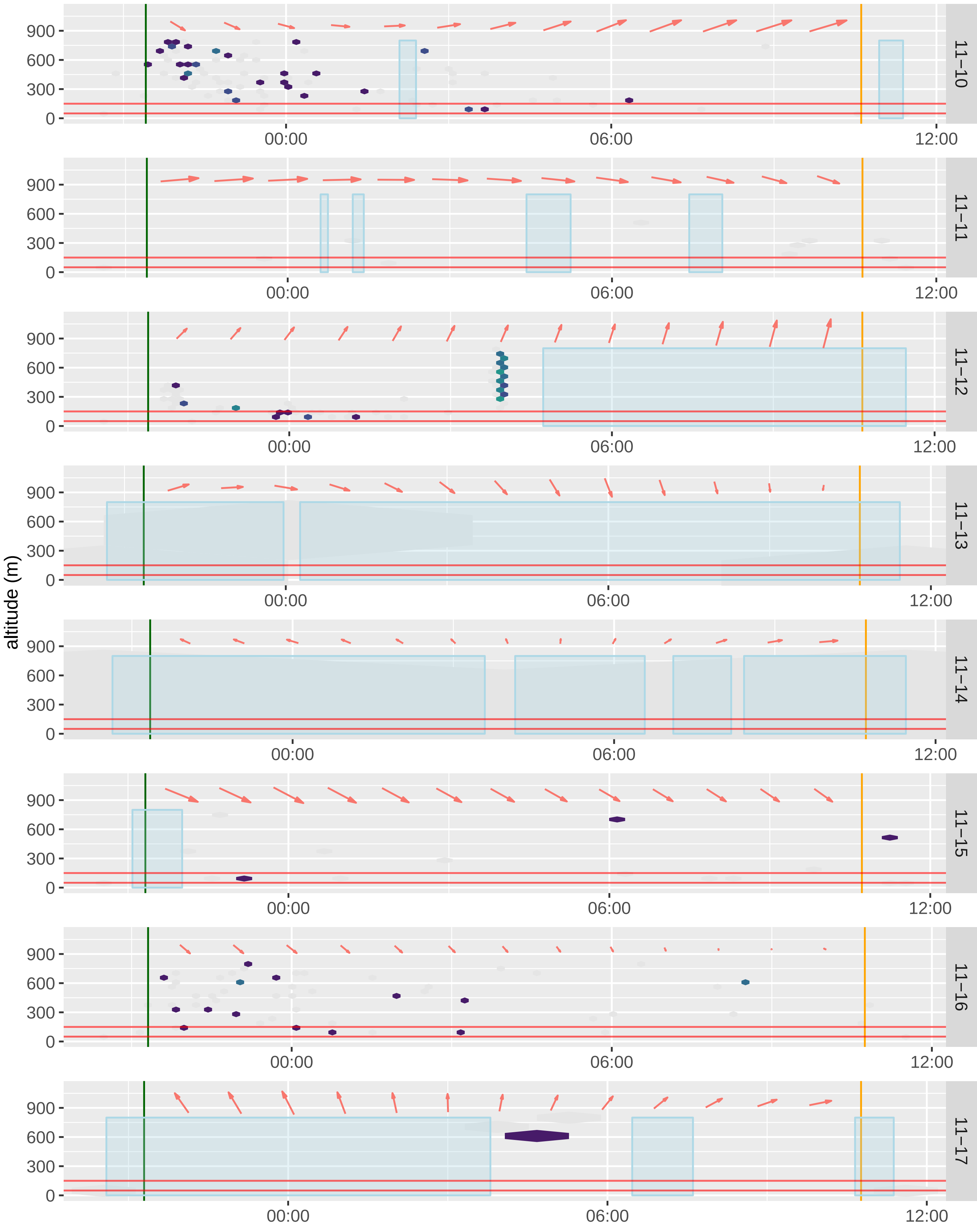

altitude (m)
900
600
300
0
21:00
00:00
03:00
06:00
09:00
10–17
10–18
10–19
10–20
10–21
10–22
10–23
10–24

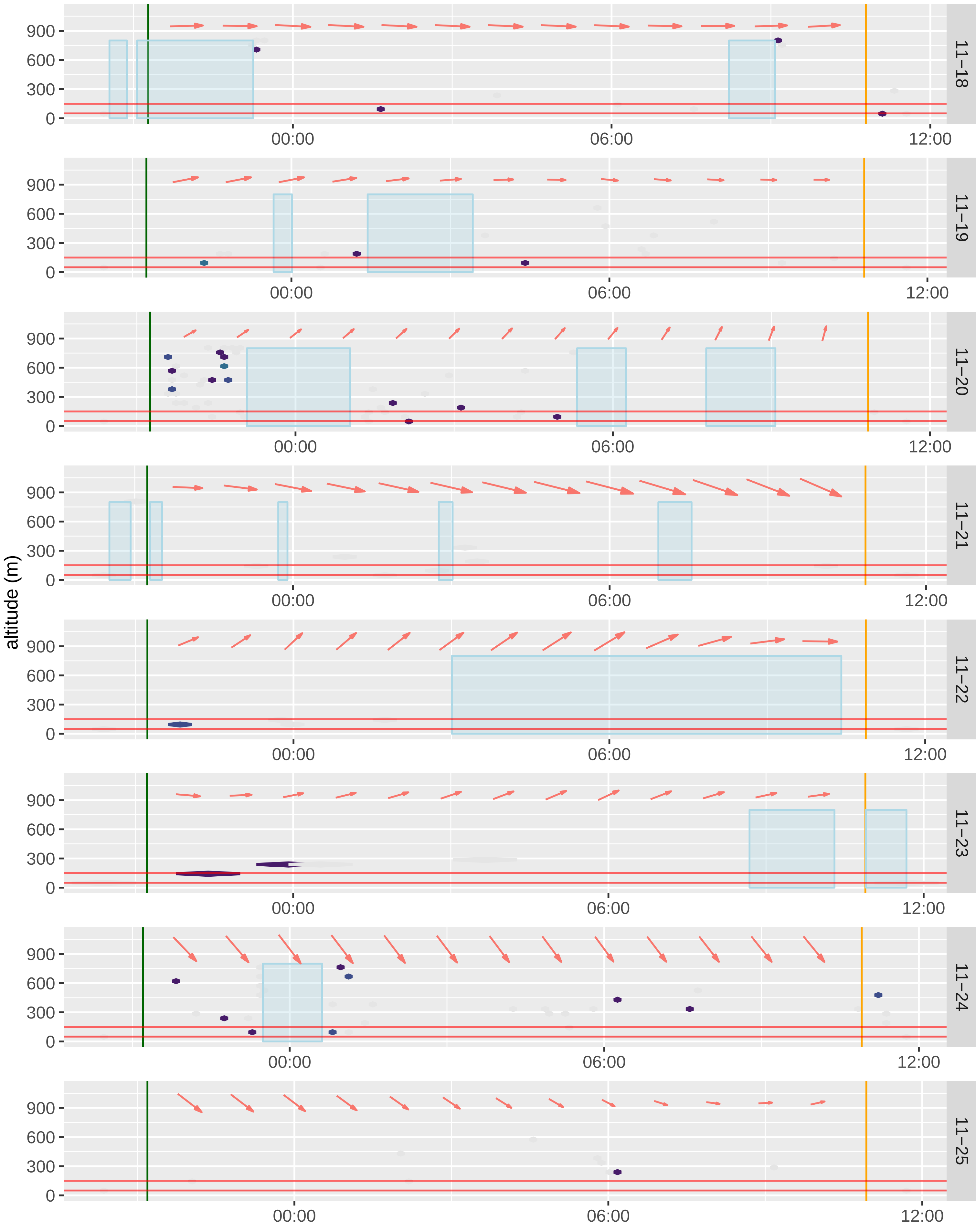


altitude (m)
0
300
600
900
21:00
00:00
03:00
06:00
09:00
10−25
10−26
10−27
10−28
10−29
10−30
10−31
11−01

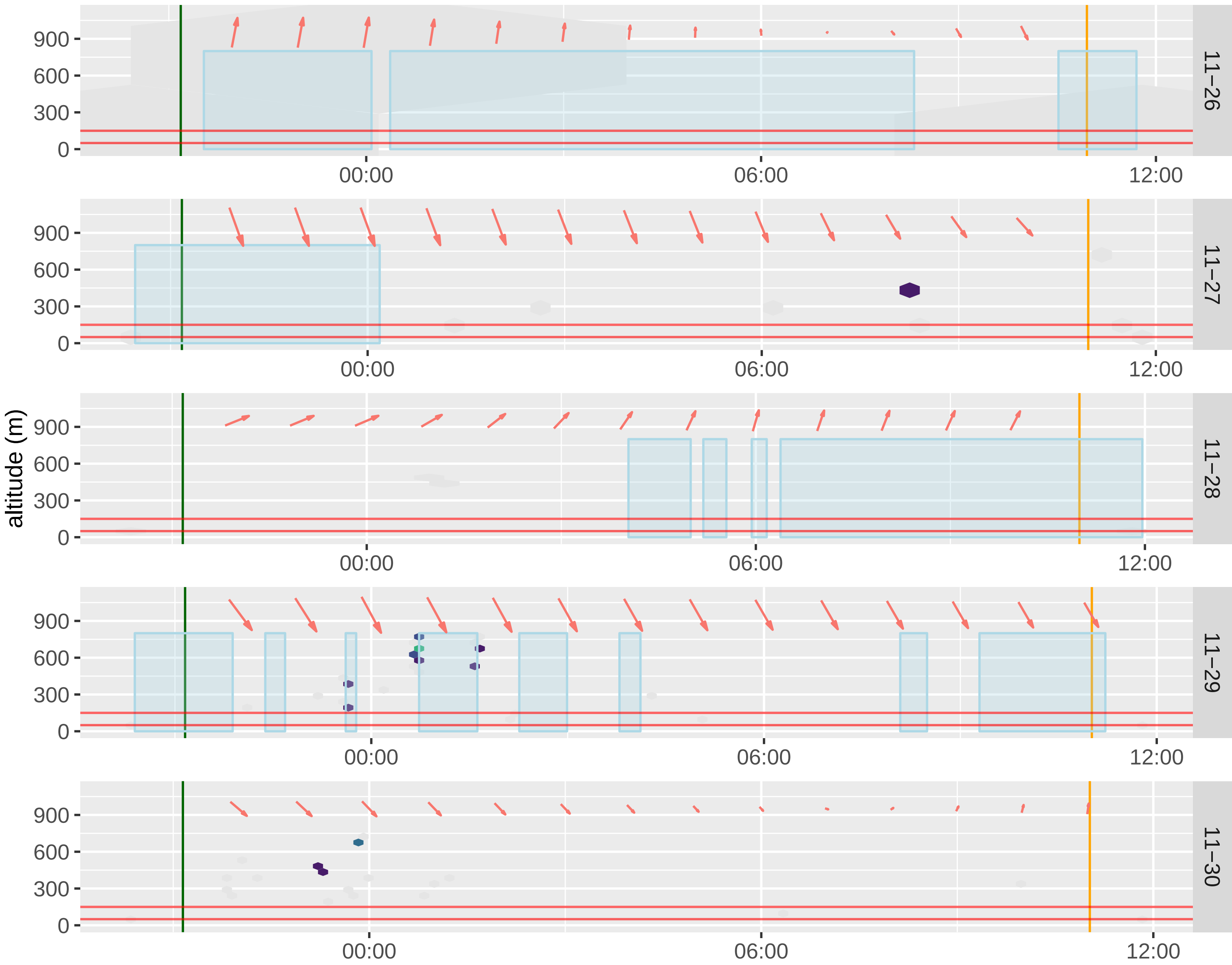


altitude (m)
11−02
11−03
11−04
11−05
11−06
11−07
11−08
11−09
0
300
600
900
21:00
00:00
03:00
06:00
09:00
12:00


altitude (m)
900
600
300
0
00:00
06:00
12:00
11–10
11–11
11–12
11–13
11–14
11–15
11–16
11–17



altitude (m)
0
300
600
900
00:00
06:00
12:00
11−18
11−19
11−20
11−21
11−22
11−23
11−24
11−25



altitude (m)
900
600
300
0
00:00
06:00
12:00
11−26
11−27
11−28
11−29
11−30

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