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Supplementary material

Supplement

Table S1. Results of the sensitivity analysis performed to test if distributions of potential departure locations differed when the back-trajectory model was run with the wind data from different pressure levels (850 hPa, 925 hPa and 1000 hPa). Earth mover's distance (EMD) is used to compare distributions calculated with the wind data from different pressure levels. Identical distributions have EMD value of 0. The largest differences are generally between simulations at 1000mb and 850mb.

Day + N	Pressure level	925	1000	Day +N	Pressure level	925	1000
	850	0.0021	0.0025		**850**	0.0024	0.3980
02/10/2007 N=7599	**925**	-	0	**11/03/2009 N=6913**	**925**	-	0.2386
	850	0.1771	0.1029		**850**	0.0005	0.2393
10/10/2007 N=11454	**925**	-	0.0022	**12/03/2009 N=1765**	**925**	-	0.1560
	850	0.0755	0.1631		**850**	0.0589	0.0943
12/10/2007 N=8735	**925**	-	0.1384	**14/03/2009 N=1922**	**925**	-	0.0750
	850	0.0720	0.4216		**850**	0.2888	0.3437
13/10/2007 N=15373	**925**	-	0.2128	**15/03/2009 N=39821**	**925**	-	0.2262
	850	0	0.0061		**850**	0.0460	0.2185
19/10/2007 N=11739	**925**	-	0.0736	**16/03/2009 N=4289**	**925**	-	0.2053
	850	0.0008	0.3539		**850**	0.0091	0.3443
21/10/2007 N=12752	**925**	-	0.2166	**14/03/2010 N=6241**	**925**	-	0.3699
	850	0.1499	0.4855		**850**	0.3282	0.5508
14/03/2008 N=11687	**925**	-	0.2519	**16/03/2010 N=10529**	**925**	-	0.0834
	850	0.2506	0.4171		**850**	0	0.1459
27/03/2008 N=19029	**925**	-	0.0062	**17/03/2010 N=9093**	**925**	-	0.1028
	850	0.0183	0.0080		**850**	-0.0022	0.01497
22/04/2008 N=2660	**925**	-	0.0039	**21/03/2010 N=19045**	**925**	-	0.1323
	850	0.0040	0.0661		**850**	-0.0093	0.6129
29/10/2008 N=20306	**925**	-	0.0080	**22/03/2010 N=2819**	**925**	-	0.6608
	850	0.0027	0.0004		**850**	0.1007	-0.0021
30/10/2008 N=46729	**925**	-	0	**26/03/2010 N=5424**	**925**	-	0.0089

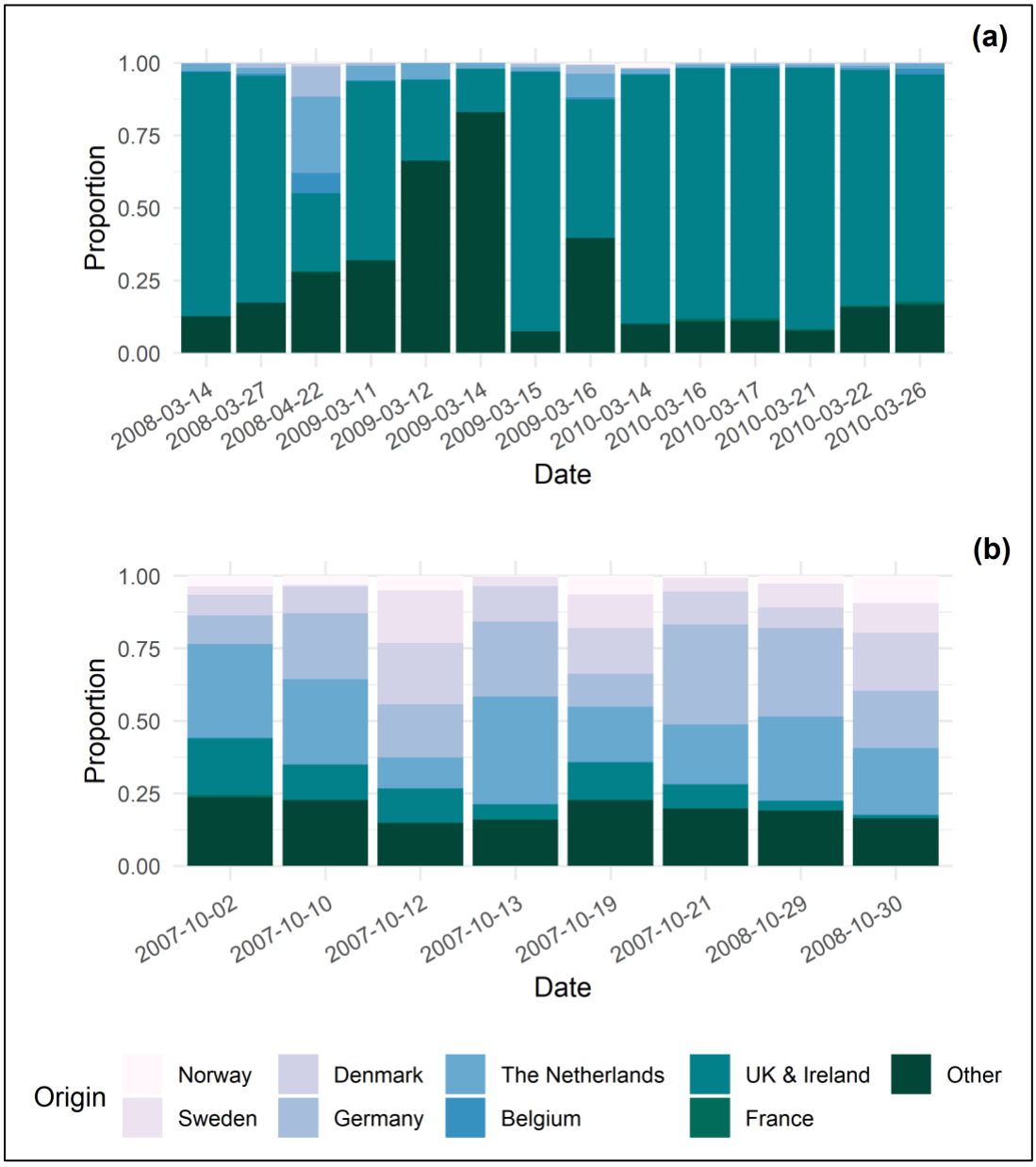

Figure S1. The daily proportion of trajectories tracked back to potential departure locations in the spring (a) and autumn (b) migratory seasons

While figure 4 shows the potential departure areas aggregated for all nights of intense migration, the spatial distribution of departure locations does differ among nights. Figure S2 shows daily distributions of potential departure locations of birds for two nights of intense migration in spring (Figure S2a and S2b) and autumn (Figure S2c and S2d). To demonstrate differences among nights, we intentionally selected two nights in which we observe some deviations from the seasonal pattern (Figure S2a and S2c) and two nights that reflect the seasonal distribution of intense migration (Figure S2b and S2d).

On 22/04/2008 ~50% of the trajectories were tracked back to Belgium and France (Figure S2a, bar plot). Trajectories estimated to originate from these two countries had a heading towards north and north-east. The distribution of headings on this night was multi-modal with a mean of 65.08° (*r=0.3*) (Figure S2a, rose plot; Table S2), while the mean wind direction was 285.12° (*r=0.81*). The resulting departure locations were quite dispersed (Figure S2a). Figure S2b shows the individual trajectories in the night of 15/03/2009 which was the most intense spring migration night during this study (*N=39821*). Approximately 80% of the trajectories on this night were tracked back to the southern UK and Ireland (Figure S2b, bar plot) with a mean heading of 90.44° (*r =0.84*), which corresponds with seasonal patterns (Figure S2b, rose plot; Table S2). On this night, winds were supporting with a mean wind direction of 107.62° (*r=0.89*).

On 30/10/2008 we see the arrival of birds that come from Norway and cross the North Sea from north to south (Figure S2c), which is not something we commonly observed in autumn (Figure 4b). Moreover, this night was also the night with the highest number of migrants for the autumn season (*N=46729*). The mean heading of the trajectories was 225.88° (*r=0.84*) and the mean wind direction was 209.47 (*r=0.89*), corresponding with the seasonal patterns. Migration patterns on 13/10/2007 reflect the general pattern observed for intense migration in autumn (Figure S2c). The mean heading was 219.05° (*R=0.85*) (Figure S2c, rose plot; Table S2) and birds mainly departed from the Netherlands and Germany (Figure S2c, bar plot). Even though sidewinds prevailed with a mean direction of 349.44°, the mean wind speed (4.25 m/s), was the lowest for all nights (Table S2). Summary statistics of the individual nights of intense migration is available in Table S2.

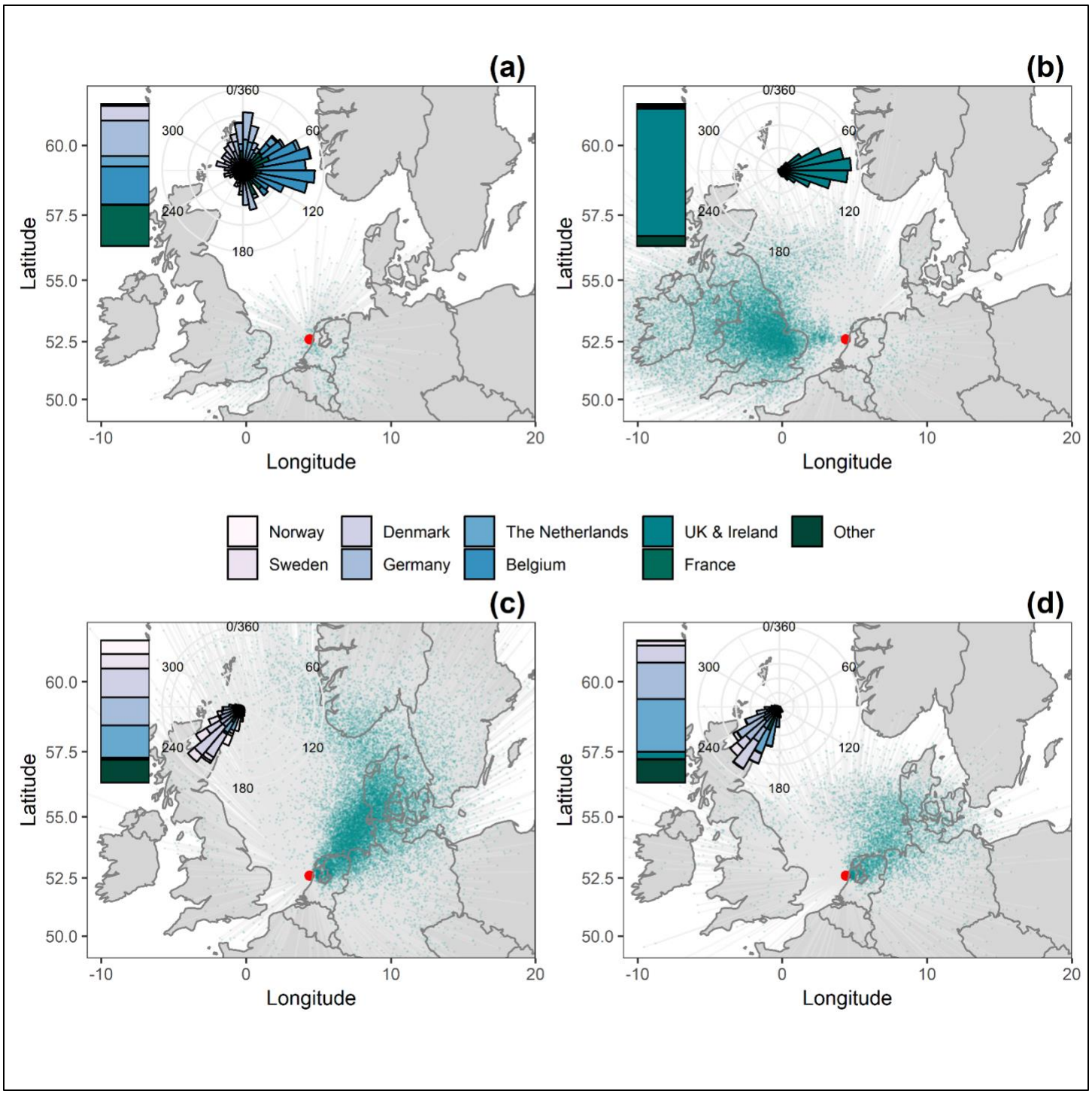

Figure S2. Simulated trajectories (silver lines) and departure locations (blue-green dots) on 22nd of April 2008 (a), 15th of March 2009 (b), 30th of October 2008 (c) and 13th of October 2007 (c). The red dot on a map represents the radar location. Bar in the upper left corner of each plot shows the proportion of trajectory origins, while the rose plot provides the distribution of headings on each respective night.

Table S2. Summary statistics of the trajectories at the potential departure locations on individual days. For directional data means are circular means and angular deviation (AD) is presented instead of SD. Value of mean resultant length R closer to 1 indicates higher concentration in directions (Jammalamadaka and SenGupta 2001, Kutil 2012). Dates shown in Figure S2 are highlighted.

Date	N	Track direction (degrees)		Groundspeed (m/s)		Heading (degrees)		Airspeed		Wind direction (degrees)		Wind speed (m/s)		Wind assistance (m/s)	
		Mean	R	Mean	SD	Mean	R	Mean	SD	Mean	R	Mean	SD	Mean	SD
02/10/2007	7599	192.6	0.6	18.6	4.1	190.0	0.6	17.4	3.7	245.8	0.3	4.3	2.1	0.8	3.1
10/10/2007	11454	203.0	0.7	17.3	3.9	221.2	0.6	14.9	3.5	162.5	0.7	5.8	2.8	1.4	2.7
12/10/2007	8735	214.7	0.7	20.6	5.4	227.3	0.6	15.6	3.9	190.5	0.7	8.0	2.9	4.1	4.6
13/10/2007	15373	222.3	0.7	16.6	3.8	219.0	0.8	17.9	3.3	349.4	0.6	4.2	2.3	-1.6	2.9
19/10/2007	11739	199.7	0.7	19.1	4.5	211.1	0.6	15.1	4.4	178.8	0.7	6.7	3.1	3.2	3.6
21/10/2007	12752	229.0	0.6	18.7	5.2	213.2	0.6	16.4	4.1	297.6	0.7	6.8	2.4	1.3	4.5
14/03/2008	11687	100.6	0.8	20.4	4.3	114.5	0.8	17.7	3.4	49.2	0.8	6.4	2.1	1.9	3.0
27/03/2008	19029	104.4	0.8	16.3	3.8	110.2	0.8	14.6	3.2	80.6	0.6	4.6	1.8	1.3	3.1
22/04/2008	2660	4.5	0.1	15.2	5.5	65.0	0.3	14.9	5.0	285.1	0.8	7.5	3.2	-0.9	5.6
29/10/2008	20306	231.0	0.7	16.2	6.2	234.8	0.8	18.9	4.1	43.2	0.6	6.0	4.6	-3.5	5.1
30/10/2008	46729	220.6	0.8	20.7	5.4	225.8	0.8	15.7	3.9	209.4	0.8	6.3	3.9	4.3	3.1
11/03/2009	6913	95.8	0.7	20.2	5.3	117.1	0.6	14.3	4.8	73.3	0.9	10.2	2.0	4.1	5.3
12/03/2009	1765	89.3	0.7	22.6	5.6	53.8	0.6	13.7	4.4	111.3	1.0	15.1	1.3	5.3	8.4
14/03/2009	1922	82.2	0.8	23.2	6.0	38.0	0.7	16.5	5.1	121.5	1.0	16.3	1.8	1.5	8.5
15/03/2009	39821	89.5	0.8	22.3	5.3	90.4	0.8	18.7	3.9	107.6	0.7	6.1	3.3	2.9	3.5
16/03/2009	4289	96.9	0.5	17.5	4.7	102.3	0.4	13.1	4.4	92.9	0.8	7.1	3.3	3.6	4.7
14/03/2010	6241	86.8	0.8	20.8	5.7	58.0	0.7	18.0	4.1	144.4	0.9	10.3	3.3	0.4	6.1
16/03/2010	10529	76.1	0.8	20.6	5.1	101.4	0.8	15.4	4.0	37.1	0.9	9.8	2.5	3.2	4.4
17/03/2010	9093	74.1	0.9	20.5	4.7	100.5	0.7	13.5	4.5	48.7	0.9	11.6	2.3	4.2	5.1
21/03/2010	19045	84.2	0.9	22.3	4.8	105.4	0.8	16.8	3.9	50.5	0.9	9.8	3.2	3.5	3.7
22/03/2010	2819	86.2	0.8	25.7	5.8	103.1	0.7	16.6	4.7	68.2	0.9	13.1	3.5	6.8	6.5
26/03/2010	5424	73.0	0.8	25.3	7.4	102.3	0.7	17.8	4.7	35.0	0.9	14.0	4.0	4.3	7.9