Table S1. Number of Arctic Skuas tracks by population and year. 'Years tracked' represent the time between two breeding periods.

Colony	Population	Years tracked	No. of tracks
Fugloy	Faroe Islands	2016/17	21
Fugloy	Faroe Islands	2017/18	6
Brensholmen and Slettnes	Norway	2011/12	6
Brensholmen and Slettnes	Norway	2012/13	6
Brensholmen and Slettnes	Norway	2013/14	3
Brensholmen and Slettnes	Norway	2014/15	27
Brensholmen and Slettnes	Norway	2015/16	28
Brensholmen and Slettnes	Norway	2016/17	16
Brensholmen and Slettnes	Norway	2017/18	13
Brensholmen and Slettnes	Norway	2018/19	3
Rousay and Fair Isle	Scotland	2017/18	6
Rousay and Fair Isle	Scotland	2018/19	6
Rousay and Fair Isle	Scotland	2019/20	2
Kongsfjorden	Svalbard	2009/10	13
Kongsfjorden	Svalbard	2010/11	13
Kongsfjorden	Svalbard	2011/12	17
Kongsfjorden	Svalbard	2012/13	12
Kongsfjorden	Svalbard	2013/14	4
Kongsfjorden	Svalbard	2014/15	6
Kongsfjorden	Svalbard	2015/16	6
Kongsfjorden	Svalbard	2016/17	13
Kongsfjorden	Svalbard	2017/18	7
Kongsfjorden	Svalbard	2018/19	7

Table S2. Number of deployments, of 175 in total, of each geolocator type on individual Arctic Skuas by population. Some individuals tracked over multiple years had new geolocators deployed on subsequent recapture, whilst a small number of geolocators were deployed on new birds once retrieved.

Geolocator type		Faroe Islands	Norway	Scotland	Svalbard	Total
Migrate Technology	C250	25	53	0	19	97
	C65/C65s	0	1	10	1	12
British Antarctic Survey	mk13	0	0	0	14	14
	mk15	0	6	0	17	23
	mk9	0	0	0	11	11
Biotrack	mk3006	0	9	0	9	18

Table S3. Number of tracks per geolocator wet/dry recording mode and per population.

Population	3 seconds every 5 minutes	3 seconds every 10 minutes	Every 6 seconds and recorded on change of state	No wet/dry data collected	Total
Scotland	0	10	0	4	14
Faroe Islands	0	15	12	0	27
Norway	4	23	73	2	102
Svalbard	0	74	0	24	98
Total	4	122	85	30	241

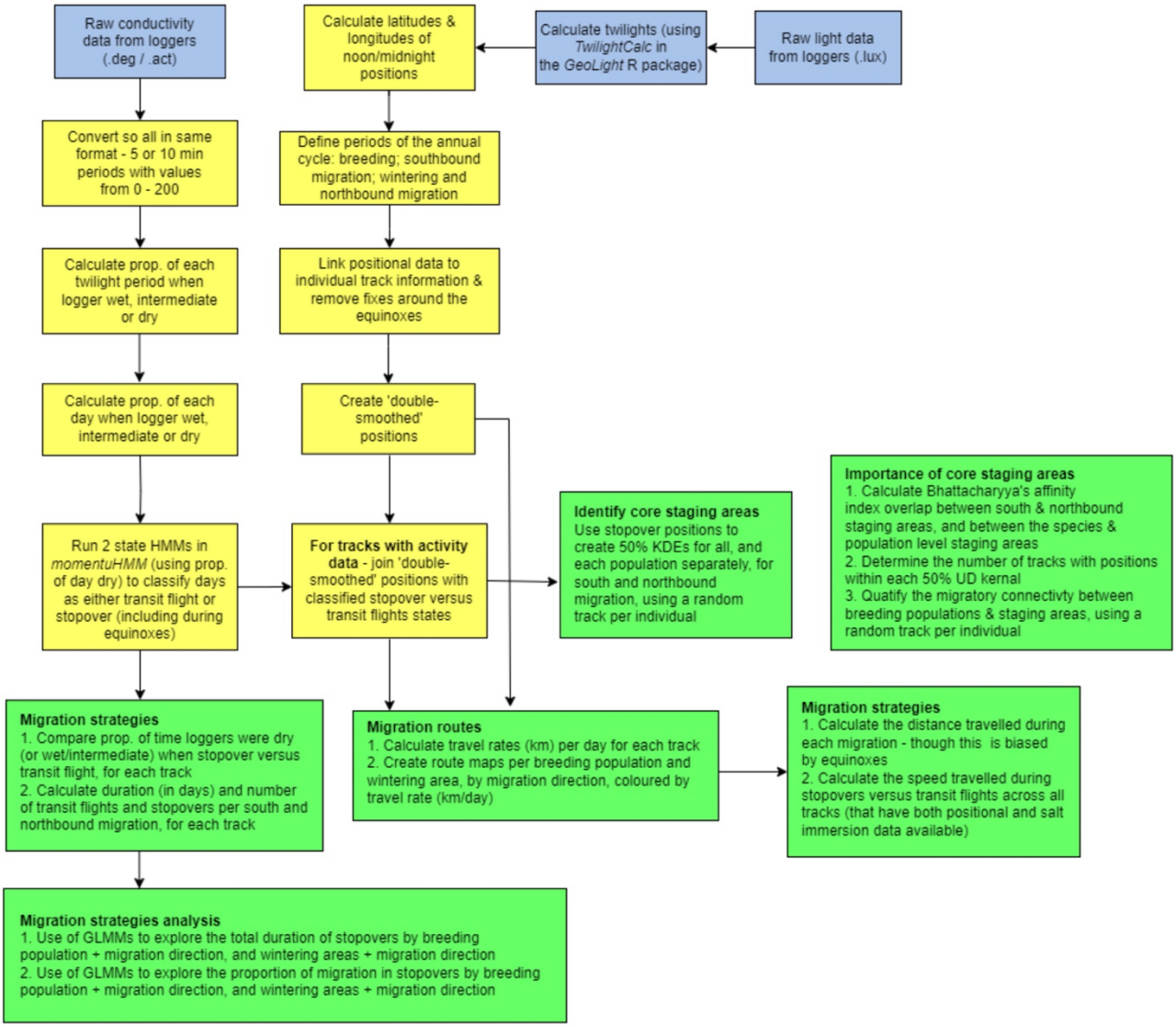


Figure S1. Flow chart showing how the data from the geolocators was processed and analysed. Blue boxes represent input data, yellow boxes refer to processing steps and green boxes to analytical steps.

Table S4. Proportion of tracks and mean proportion of migration duration, by breeding population, that overlapped with the equinoxes during south and northbound migration.

		Southbound		Northbound	
Population	Tracks	Proportion of tracks	Mean proportion of migration	Proportion of tracks	Mean proportion of migration
Svalbard	98	0.90	0.44	0.00	0.00
Norway	102	0.89	0.60	0.44	0.31
Faroe Islands	27	0.59	0.48	0.56	0.46
Scotland	14	0.79	0.51	0.71	0.36

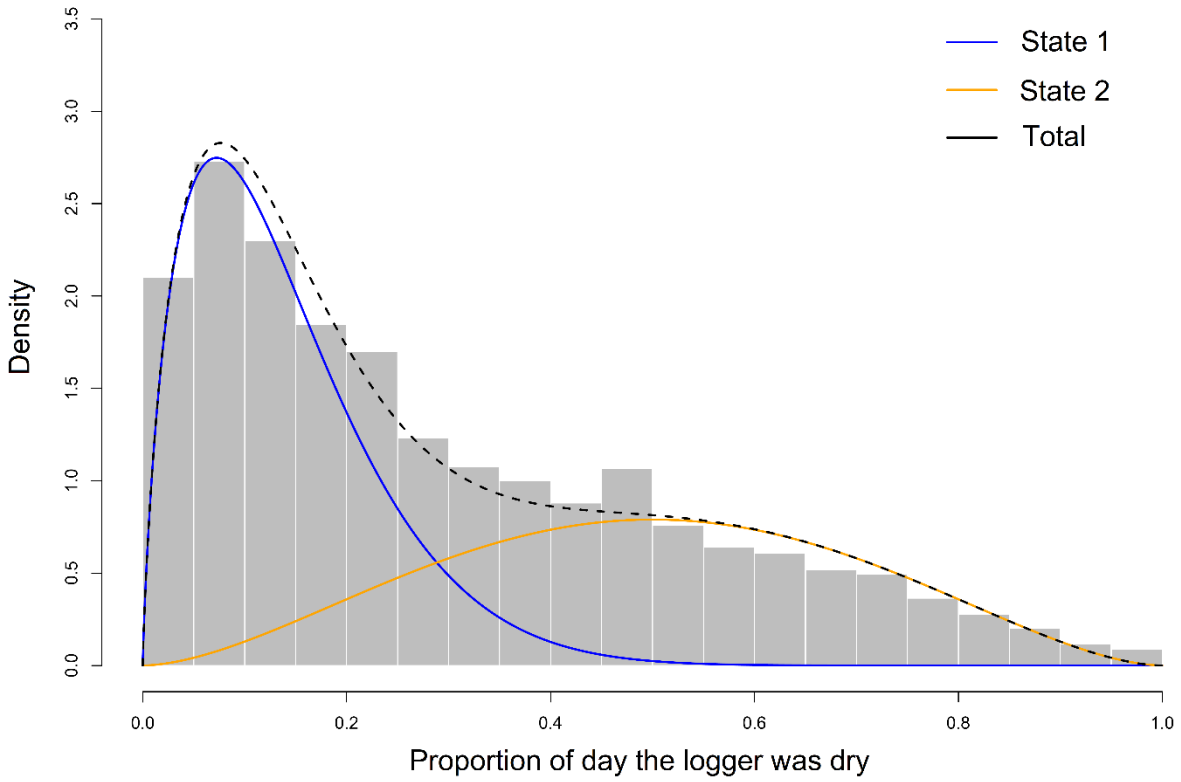


Figure S2. Classification output from the two-state Hidden Markov model (HMM) with a single data stream, the proportion of each day that was dry. Positions classified as State 1 were considered at stopovers, associated with days where a lower proportion of the day was recorded as dry. Positions classified as State 2 were considered on transit flights, associated with days where a greater proportion of the day was dry. Density on the y-axis refers to the likelihood that an individual is in that state at a given point.

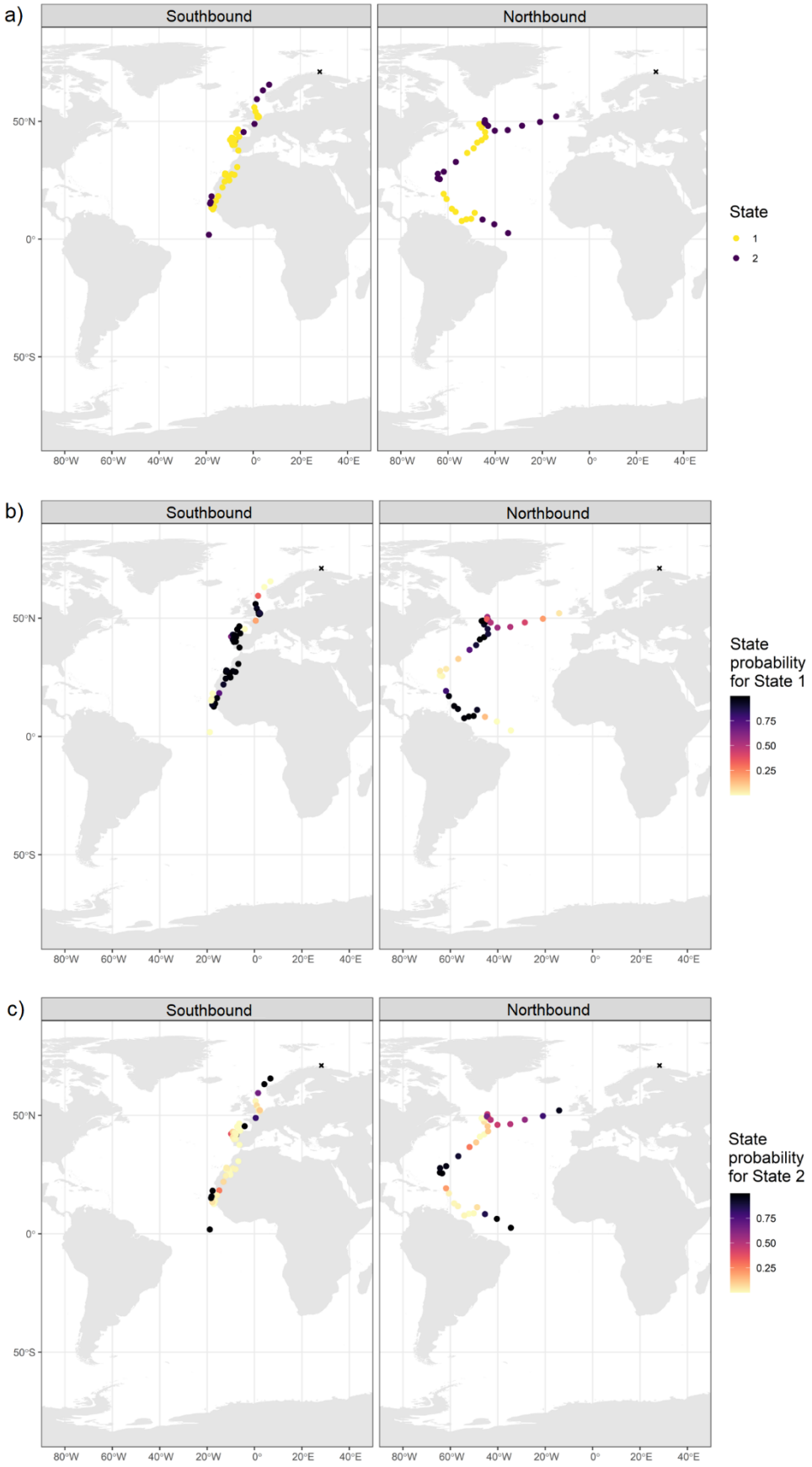
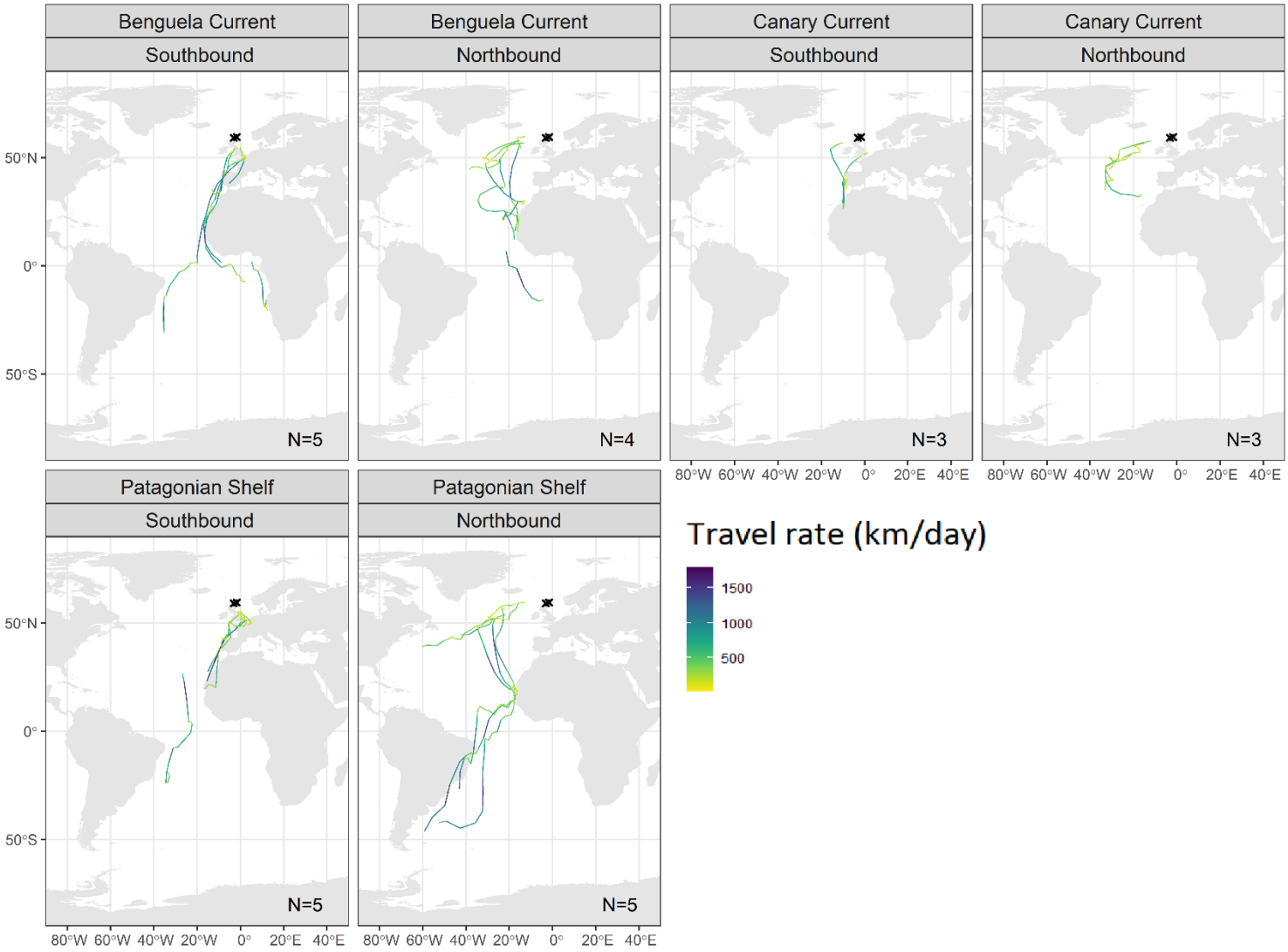
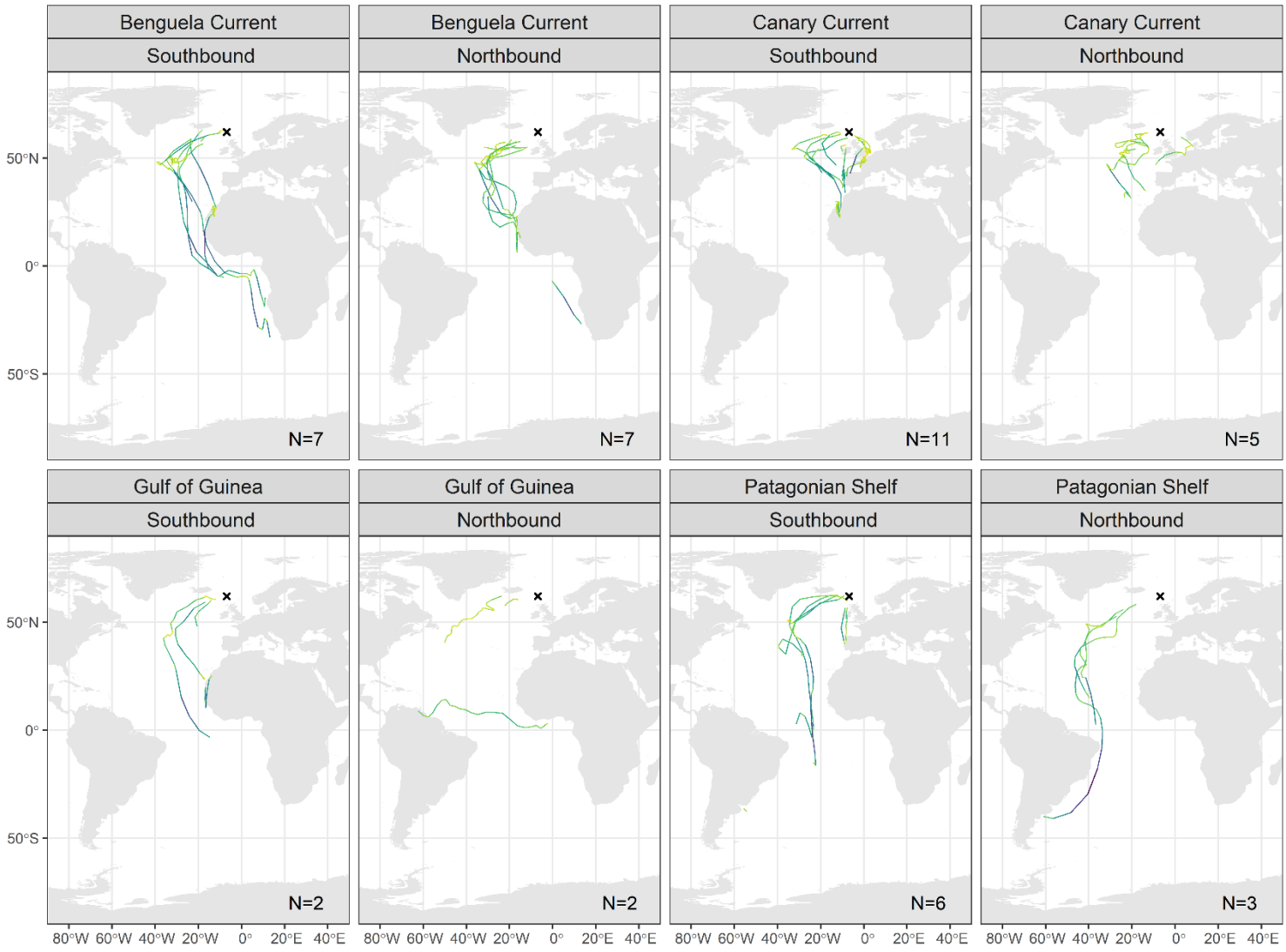


Figure S3. Example track from an Arctic Skua from Norway showing the double smoothed' positions, during south and northbound migration, by a) state (State 1: stopovers. State 2: transit flight); b) the probability of each position being assigned as State 1; and c) the probability of each position being assigned as State 2.

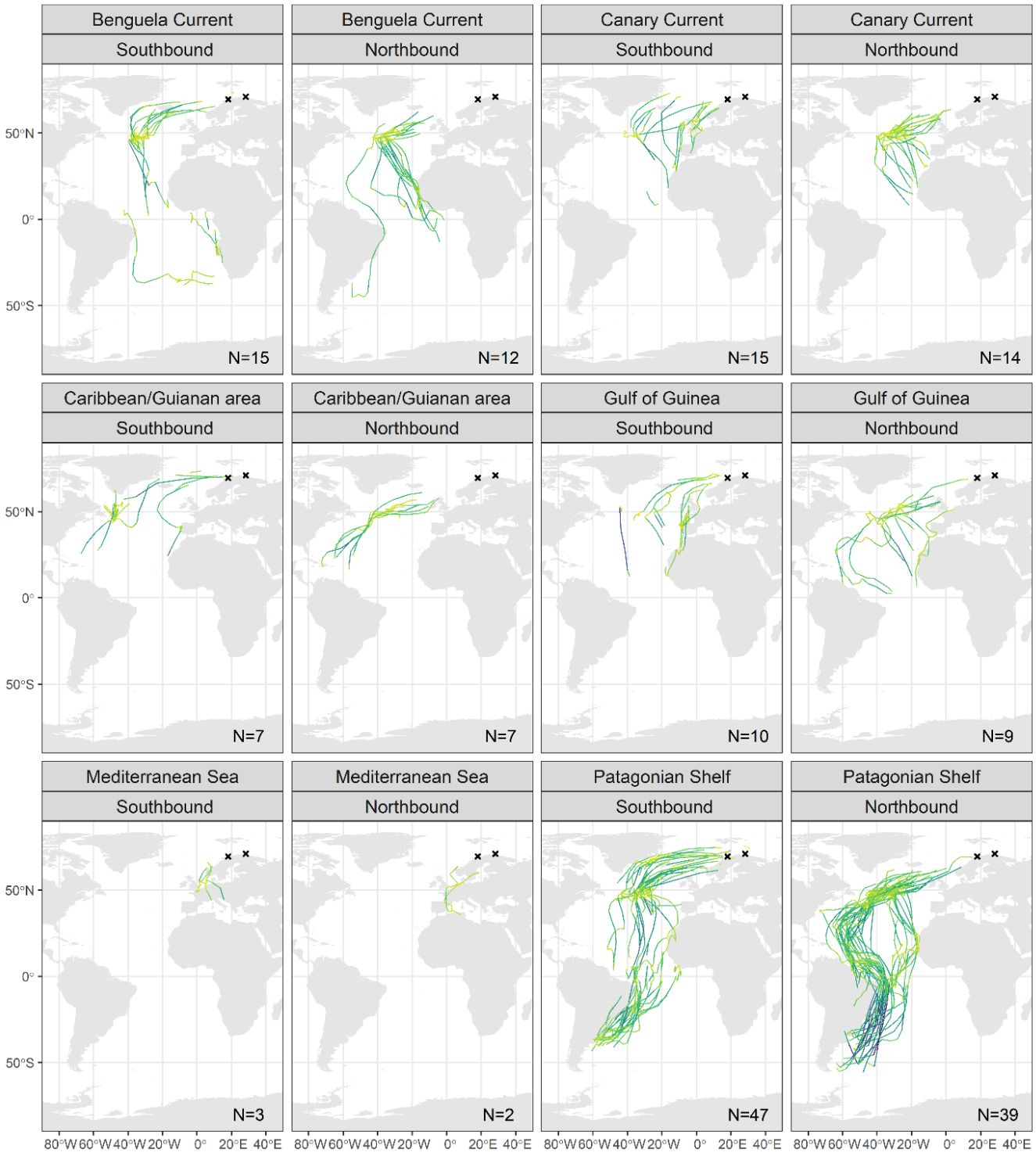
a) Scotland


Benguela Current
Southbound
N=5
Benguela Current
Northbound
N=4
Canary Current
Southbound
N=3
Canary Current
Northbound
N=3
Patagonian Shelf
Southbound
N=5
Patagonian Shelf
Northbound
N=5
50°N
0°
50°S
80°W 60°W 40°W 20°W 0° 20°E 40°E
Travel rate (km/day)
1500
1000
500

b) Faroe Islands



c) Norway


Benguela Current
Southbound
N=15
Benguela Current
Northbound
N=12
Canary Current
Southbound
N=15
Canary Current
Northbound
N=14
Caribbean/Guianan area
Southbound
N=7
Caribbean/Guianan area
Northbound
N=7
Gulf of Guinea
Southbound
N=10
Gulf of Guinea
Northbound
N=9
Mediterranean Sea
Southbound
N=3
Mediterranean Sea
Northbound
N=2
Patagonian Shelf
Southbound
N=47
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Northbound
N=39
50°N
0°
50°S
80°W 60°W 40°W 20°W 0° 20°E 40°E

d) Svalbard

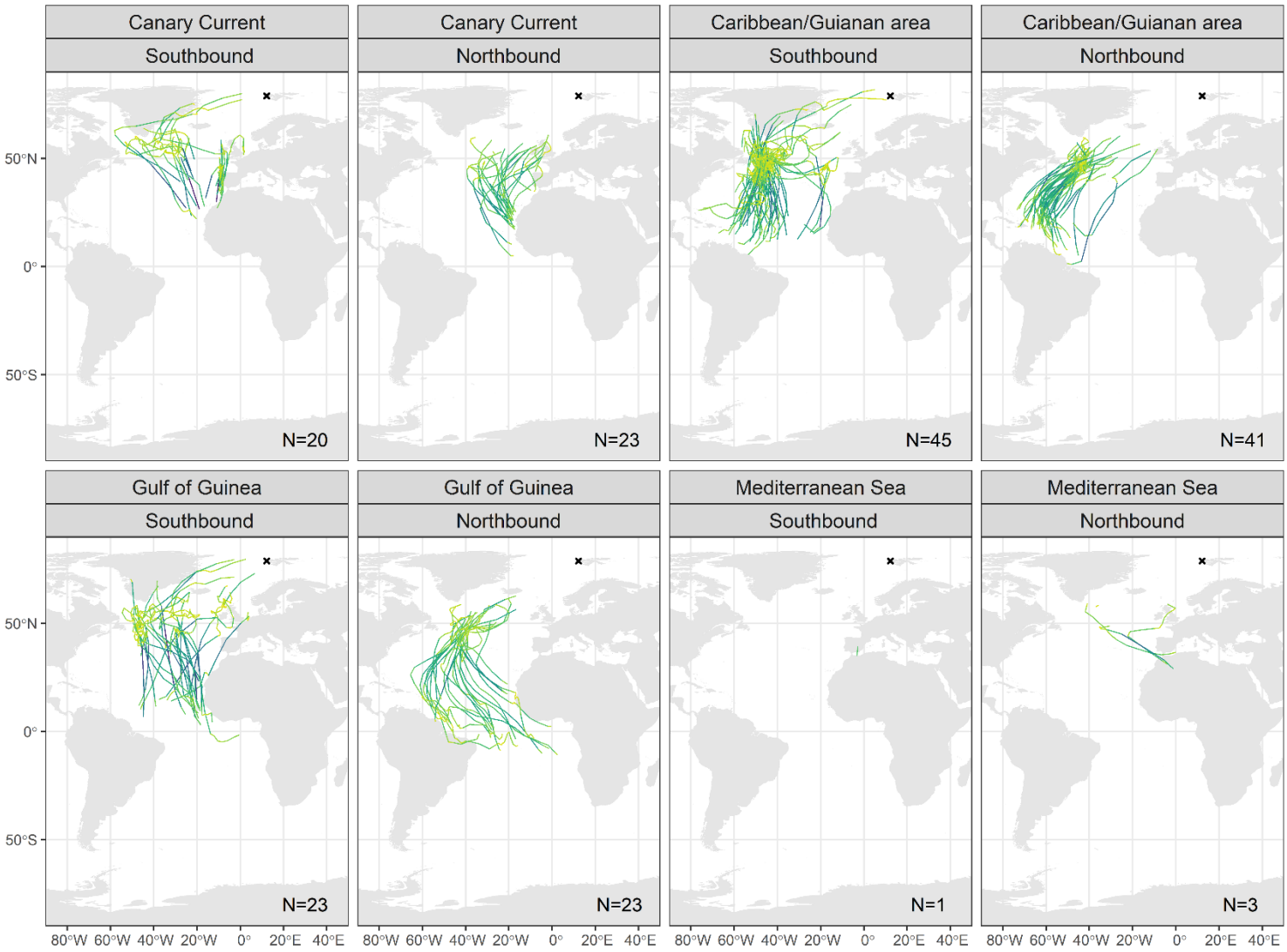


Figure S4. Smoothed migration routes of Arctic Skuas from a) Scotland, b) the Faroe Islands, c) Norway and d) Svalbard during southbound and northbound migration, split by wintering area. The travel rate (km/day) of sections of tracks are shown to indicate areas where skuas were likely flying straight through (high rates of travel: dark green to purple) compared to those where individuals were foraging or resting on the water (low rates of travel: yellow to light green). Crosses depicts breeding colonies. N refers to number of tracks displayed for each migration period and wintering area. To visually identify areas that individuals migrated straight over (potentially indicating areas with lower productivity/foraging opportunities, Alerstam, 2009) compared to areas where individuals travelled more slowly and stopped to forage/rest, we calculated travel rates per day by measuring the daily distance travelled between double smoothed positions, using the *disthaversine* function in the *Geosphere* R package (Hijmans 2019).

Text S1. Among population and year consistency in core staging areas

The extent of Bhattacharyya's Affinity (BA) between the population specific 50% UD kernels and the overall species-level 50% UD kernels varied by season, with higher BA in north than southbound migration (southbound: 0.45 ±SD 0.27; northbound: 0.77 ± 0.13; Figure 2, Table S5).

Data on Arctic Skua migrations were obtained over multiple years, however we pooled the data across years to create the overall species-level UD kernel. To check whether the skuas were consistent in their core staging areas across years at the population level we created UD kernels for Svalbard and Norway for all years where at least 10 individuals were tracked. BA overlap between year-specific core 50% UD kernels were compared to the core 50% UD kernel for all years combined, for the Svalbard and Norway populations separately. For both Norway and Svalbard, there was high BA between the year-specific core UD kernels and the core UD kernel for each population of all years combined, across both migrations (Table S6, Figures S5 and S6).

Table S5. Bhattacharyya's Affinity (BA) in core staging area 50% utilisation distributions, based on positions classified as stopover locations, compared among populations and to all tracks from the four populations combined, for south and northbound migration.

	Faroe Islands	Norway	Scotland	Svalbard
Southbound				
All tracks	0.32	0.64	0.14	0.70
Faroe Islands		0.44	0.32	0.00
Norway			0.40	0.26
Scotland				0.00
Svalbard				
Northbound				
All tracks	0.78	0.94	0.70	0.64
Faroe Islands		0.72	0.86	0.30
Norway			0.62	0.62
Scotland				0.22
Svalbard				

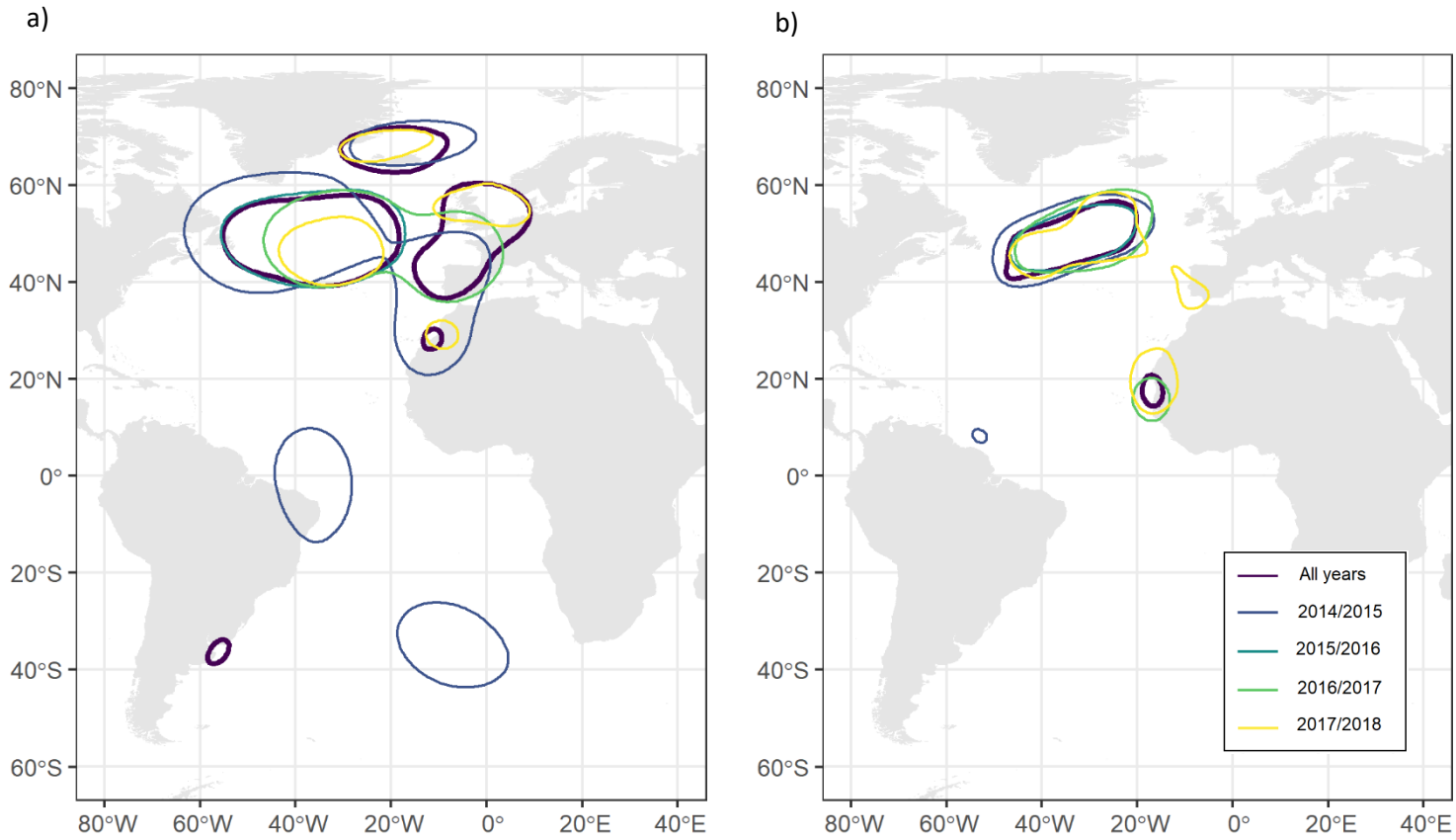
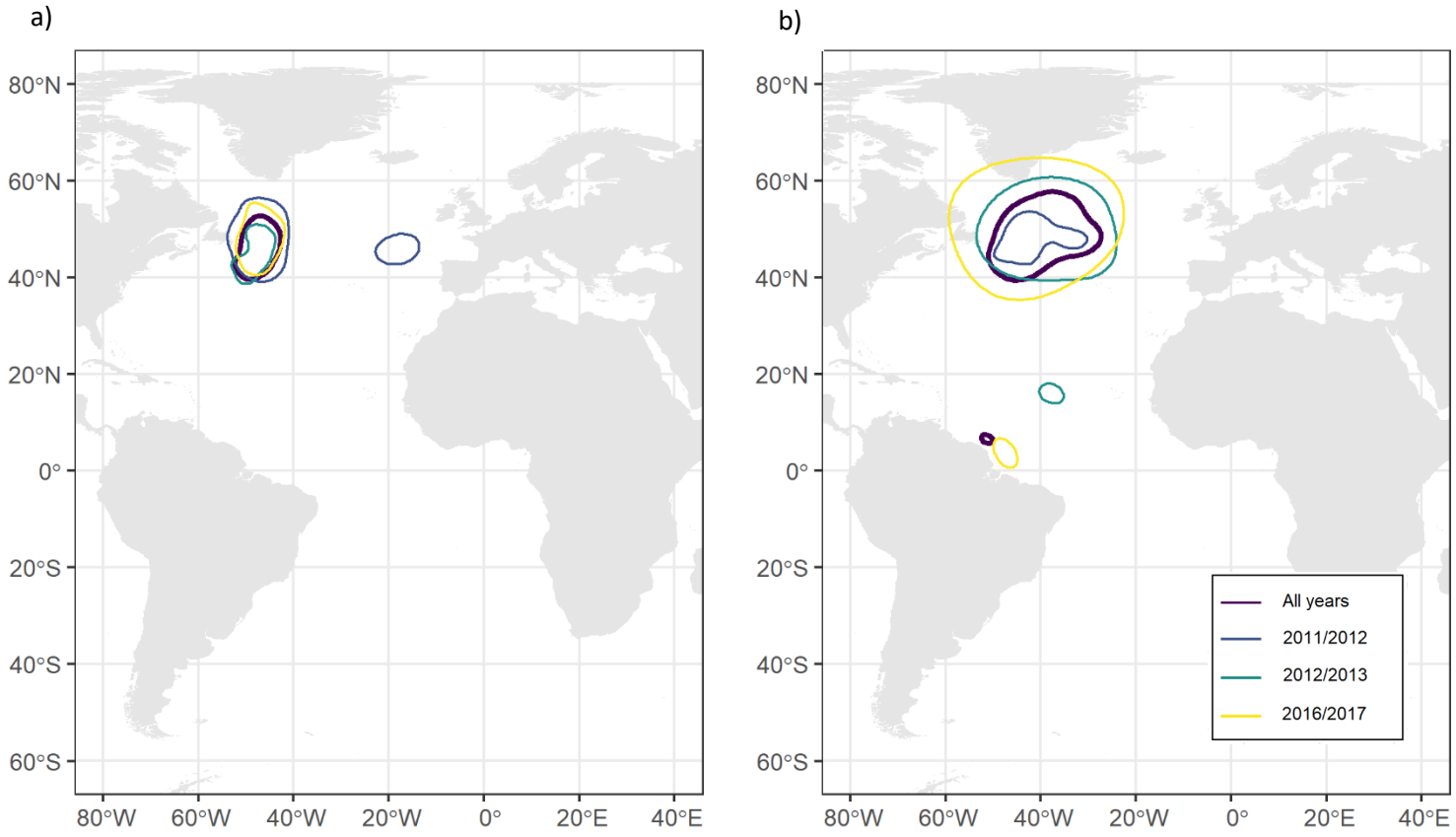


Figure S5. Norway core 50% utilisation distribution (UD) for all tracks and years (N =102), for a) south and b) northbound migration, based on positions classified as stopover locations, compared to the 50% core UDs for individuals tracked during 2014/2015 (N = 26); 2015/2016 (N = 26); 2016/2017 (N = 16); and 2017/2018 (N = 12).

Figure S6. Svalbard core 50% utilisation distribution (UD) for all tracks and years (N =98), for a) south and b)



northbound migration, based on positions classified as stopover locations, compared to the 50% core UDs for individuals tracked during 2011/2012 (N = 17); 2012/2013 (N = 12); and 2016/2017 (N = 13).

Table S6. The extent of overlap measured using Bhattacharyya's affinity (BA), between the population level 50% utilisation distribution (UD), based on positions classified as stopover locations, compared for all years combined and each year with more than 10 tracks was relatively high for both north and southbound migration, for a) Norway and b) Svalbard. Maximum BA value is 0.5.

a) Norway	2014/15	2015/16	2016/17	2017/18
No. of tracks	26	26	16	12
Southbound	0.54	0.82	0.80	0.72
Northbound	0.84	0.92	0.82	0.74

b) Svalbard	2011/12	2012/13	2016/17
No. of tracks	17	12	13
Southbound	0.72	0.86	0.88
Northbound	0.76	0.80	0.68

Table S7. Estimated mean (± SD) number, duration and total duration (days) of transit flights and stopovers (Figure S1) taken by individual Arctic Skuas, during southbound and northbound migration, split by breeding population, ordered from the highest to lowest latitude.

Breeding area	Svalbard		Norway		Faroe Islands		Scotland	
Activity	Transit flights	Stopovers	Transit flights	Stopovers	Transit flights	Stopovers	Transit flights	Stopovers
Southbound migration								
Number	2.73 (± 1.09)	1.96 (± 1.04)	2.80 (± 1.08)	2.38 (± 1.14)	2.37 (± 1.08)	2.05 (± 0.86)	2.50 (± 1.72)	2.63 (± 1.6)
Duration (days)	5.04 (± 3.48)	14.30 (± 16.3)	7.78 (± 6.82)	9.79 (± 10.4)	7.19 (± 6.93)	9.35 (± 10.1)	8.00 (± 8.45)	8.36 (± 6.76)
Total duration (days)	13.76 (± 4.50)	27.93 (± 20.43)	21.81 (± 10.97)	23.27 (± 15.53)	17.04 (± 10.54)	19.14 (± 14.81)	20.00 (± 13.58)	22.00 (± 12.35)
Distance (km)[1]	8230 (± 1069)		11629 (± 3440)		8595 (± 3732)		9911 (± 3193)	
Northbound migration								
Number	1.45 (± 0.65)	1.32 (± 0.62)	2.67 (± 0.92)	2.01 (± 0.92)	2.15 (± 0.88)	1.85 (± 0.81)	2.00 (± 0.87)	1.88 (± 0.83)
Duration (days)	4.81 (± 2.83)	7.27 (± 3.78)	5.81 (± 4.65)	9.62 (± 6.49)	7.16 (± 6.09)	10.90 (± 7.72)	7.89 (± 7.04)	9.27 (± 6.54)
Total duration (days)	6.97 (± 3.36)	9.60 (± 5.11)	15.49 (± 7.45)	19.36 (± 9.08)	15.40 (± 8.34)	20.25 (± 12.87)	15.78 (± 8.73)	17.38 (± 7.91)
Distance (km)[1]	9083 (± 2690)		16117 (± 6059)		11478 (± 5980)		14269 (± 5793)	

[1]For each track, we calculated the great circle distance travelled during southbound and northbound migration from the breeding colony to the wintering area, including the direct line distance between the last and first location either side of the equinoxes, using the *disthaversine* function in the *Geosphere* R package (Hijmans 2019) on the double smoothed positions. Distances only provide a broad indication of the actual distances travelled by individuals given the error around raw geolocator positional fixes and due to the gaps around the equinoxes.

Table S8. Estimated mean (± SD) number, duration and total duration (days) of transit flights and stopovers (Figure S1) taken by individual Arctic Skuas, during southbound and northbound migration, split by wintering location, ordered from closest to furthest distance from the breeding populations.

Wintering area	Mediterranean Sea		Canary Current		Caribbean region		Gulf of Guinea		Benguela Current		Patagonian Shelf	
Southbound migration												
Activity	Migrant flights	Stopovers	Migrant flights	Stopovers	Migrant flights	Stopovers	Migrant flights	Stopovers	Migrant flights	Stopovers	Migrant flights	Stopovers
Number	2.17 (± 0.75)	1.80 (± 0.84)	2.04 (± 0.88)	1.63 (± 0.79)	2.84 (± 1.25)	1.93 (± 1.24)	2.42 (± 0.76)	1.80 (± 0.48)	3.04 (± 1.27)	2.63 (± 1.13)	3.24 (± 1.00)	2.87 (± 1.08)
Duration (days)	4.23 (± 3.09)	8.67 (± 10.85)	4.77 (± 3.56)	9.94 (± 10.00)	5.01 (± 3.29)	19.20 (± 20.06)	5.71 (± 4.50)	14.13 (± 15.41)	9.33 (± 8.14)	8.40 (± 5.57)	8.49 (± 7.34)	7.59 (± 4.83)
Total Duration (days)	9.17 (± 6.18)	15.60 (± 11.44)	9.74 (± 5.43)	16.21 (± 11.69)	14.21 (± 4.21)	37.00 (± 23.80)	13.81 (± 6.68)	25.43 (± 19.18)	28.36 (± 7.19)	22.04 (± 12.66)	27.47 (± 7.37)	21.78 (± 9.63)
Distance (km)[1]	4193 (± 561)		6432 (± 1417)		8432 (± 464)		9055 (± 766)		11296 (± 902)		14400 (± 851)	
Northbound migration												
Number	1.75 (± 0.50)	1.75 (± 0.50)	1.82 (± 0.80)	1.37 (± 0.72)	1.43 (± 0.61)	1.29 (± 0.53)	2.07 (± 0.87)	1.63 (± 0.84)	2.55 (± 0.74)	2.14 (± 0.65)	2.84 (± 1.07)	2.28 (± 0.96)
Duration (days)	3.14 (± 1.68)	7.86 (± 4.91)	4.23 (± 2.93)	10.95 (± 8.26)	4.10 (± 2.40)	8.75 (± 6.08)	5.14 (± 3.23)	11.14 (± 7.50)	9.32 (± 8.14)	8.40 (± 5.57)	7.18 (± 6.02)	7.78 (± 5.16)
Total Duration (days)	5.50 (± 1.73)	13.75 (± 4.57)	7.71 (± 3.87)	14.97 (± 9.74)	5.86 (± 2.82)	11.29 (± 9.65)	10.67 (± 5.28)	18.15 (± 12.65)	18.59 (± 5.32)	20.38 (± 6.74)	20.37 (± 5.76)	17.72 (± 7.62)
Distance (km)[1]	6422 (± 1765)		7145 (± 2097)		8804 (± 1926)		12152 (± 2743)		15506 (± 3667)		20748 (± 3449)	

[1]For each track, we calculated the great circle distance travelled during southbound and northbound migration from the breeding colony to the wintering area, including the direct line distance between the last and first location either side of the equinoxes, using the *disthaversine* function in the *Geosphere* R package (Hijmans 2019) on the double smoothed positions. Distances only provide a broad indication of the actual distances travelled by individuals given the error around raw geolocator positional fixes and due to the gaps around the equinoxes.

Table S9. The number and proportion (in parenthesis) of individuals (which had tracks with saltwater immersion data and migratory timing details[1]) that had any stopover / any positions (stopovers and transit flights) within each core staging area (50% Kernel utilisation distributions) for all populations during both the south and northbound migration (Figure 1). The staging area codes match those in Figure 1 and 2. A proportion of individuals (southbound: 0.19; northbound: 0.06) were not recorded in the core staging areas likely due to missing data around the equinoxes, whilst some individuals visited more than one staging area during a migration period. In addition, 13 individuals during southbound migration (Scotland – 3, Faroe Islands – 7; Norway – 1, Svalbard – 2) and two individuals during northbound migration (both from Svalbard) had no positions assigned as stopovers by the HMM. Therefore, the sum of individuals associated with staging areas differs to the total number of individuals.

Staging area	Area (km^2)	Centroid longitude	Centroid latitude	Faroe Islands	Norway	Scotland	Svalbard	Total
Southbound								
S1	3110000	-41.20891	48.79675	7 / 12 (0.30 / 0.52)	26 / 28 (0.50 / 0.54)	0 / 0 (0.00 / 0.00)	27 / 30 (0.79 / 0.88)	60 / 70 (0.50 / 0.59)
S2	424000	-0.15663	52.48757	3 / 3 (0.13 / 0.13)	6 / 6 (0.12 / 0.12)	4 / 6 (0.40 / 0.60)	2 / 2 (0.06 / 0.06)	15 / 17 (0.13 / 0.14)
S3	269000	-8.00167	43.44456	3 / 7 (0.13 / 0.30)	5 / 8 (0.10 / 0.15)	4 / 6 (0.40 / 0.60)	3 / 4 (0.09 / 0.12)	15 / 25 (0.13 / 0.21)
None	NA	NA	NA	4 / 4 (0.17 / 0.17)	16 / 14 (0.31 / 0.27)	1 / 3 (0.10 / 0.30)	2 / 2 (0.06 / 0.06)	23 / 23 (0.19 / 0.19)
Total individuals	-	-	-	23	52	10	34	119
Northbound								
N1	3140000	-32.78015	49.94371	14 / 14 (0.82 / 0.82)	49 / 50 (0.94 / 0.96)	4 / 8 (0.50 / 1.00)	28 / 35 (0.80 / 1.00)	95 / 107 (0.85 / 0.96)
N2	121000	-16.95215	17.20552	3 / 3 (0.18 / 0.18)	8 / 8 (0.15 / 0.15)	3 / 4 (0.38 / 0.50)	1 / 1 (0.03 / 0.03)	15 / 16 (0.13 / 0.14)
None	NA	NA	NA	3 / 3 (0.18 / 0.18)	3 / 2 (0.06 / 0.04)	1 / 0 (0.13 / 0.00)	5 / 2 (0.14 / 0.06)	12 / 7 (0.11 / 0.06)
Total individuals	-	-	-	17	52	8	35	112

[1]To identify the core staging areas using the 50% UDs we could only use fixes identified as stopovers outside the equinoxes where we also had positional data (Figure S1). Therefore, the use of the core staging areas, and number of individuals using each, is likely to be an underestimation as we were unable to use the more reliable longitude of tracks to estimate which additional individuals used this staging area during the equinox given it covers a large area of the mid-Atlantic.

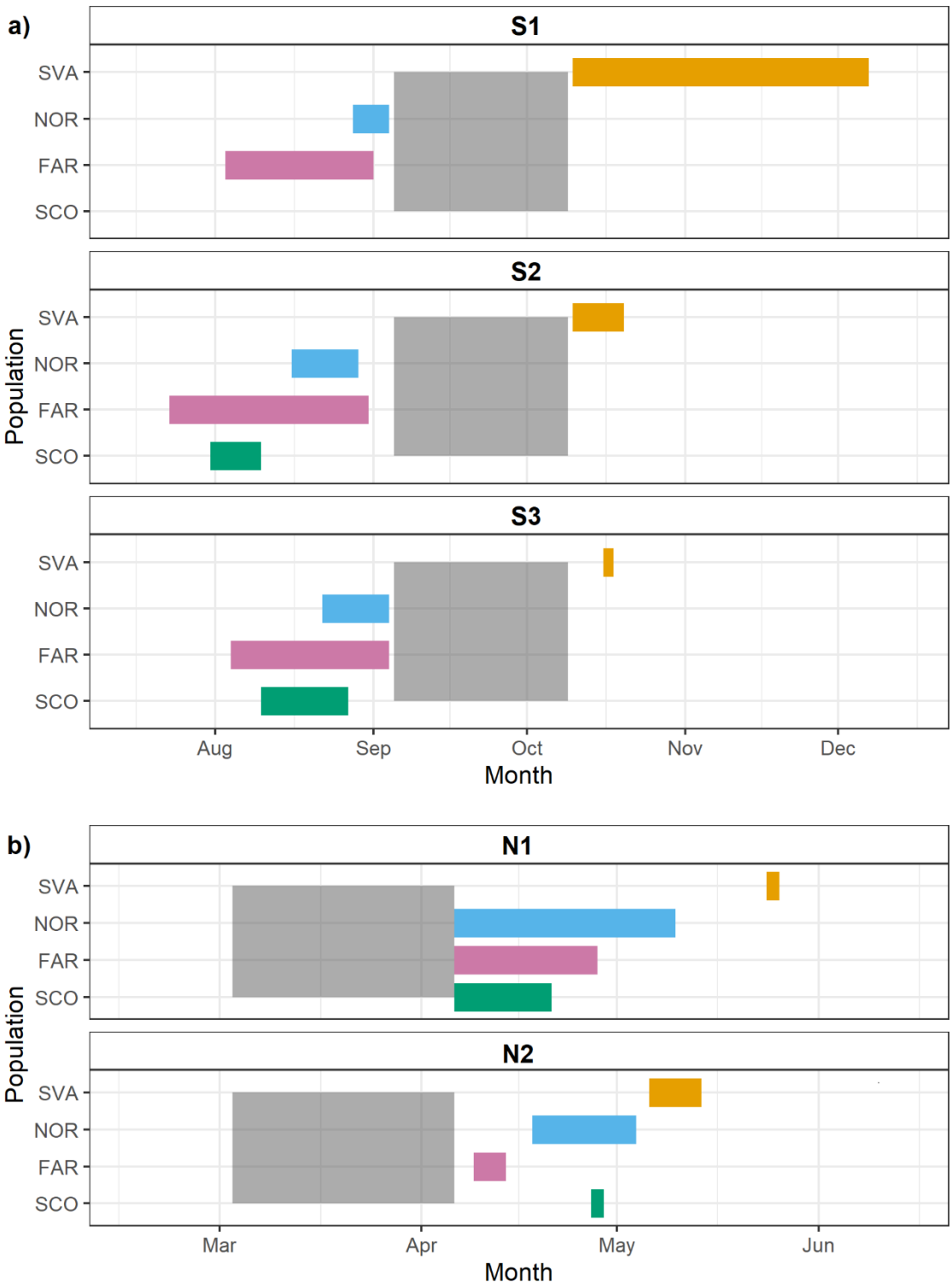


Figure S7. The first arrival date and last departure date of individuals to each staging area during a) southbound and b) northbound migration from each breeding population: Svalbard (yellow), Norway (blue), the Faroe Islands (purple) and Scotland (green). The grey boxes cover the 17 days either side of the equinoxes (20 March and 22 September) where we lack positional data. Staging areas are labelled S1, S2, S3 and S4 for southbound migration and N1 and N2 for northbound migration (see Figure 1 and 2).

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