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Statistical analysis of mesoscale eddy activity in the Lofoten Basin of the Norwegian Sea

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Introduction

We apply an automatic eddies' identification method to detect and track mesoscale eddies in the Lofoten Basin (LB) for the period 1993-2017. After identification we exclude tracks of eddies with a lifetime of less than 35 days (99% eddies) in order to exclude the vortices associated with synoptic variability, as well as errors that could arise due to the small discreteness of satellite measurements in the study basin. Thus there were found only 120 CEs and 210 ACEs to study. All the tracks tracks were divided onto 4 groups according to location of eddy genesis and dissipation: Group 1 - Eddies born and dissipated in area 1; group 2 - Eddies born and dissipated in area 2; group 3 - Eddies born in area 2 and dissipated in area 1; group 4 - Eddies born in area 1 and dissipated in area 2. We analyzed variability and evolution of different eddies' parameters

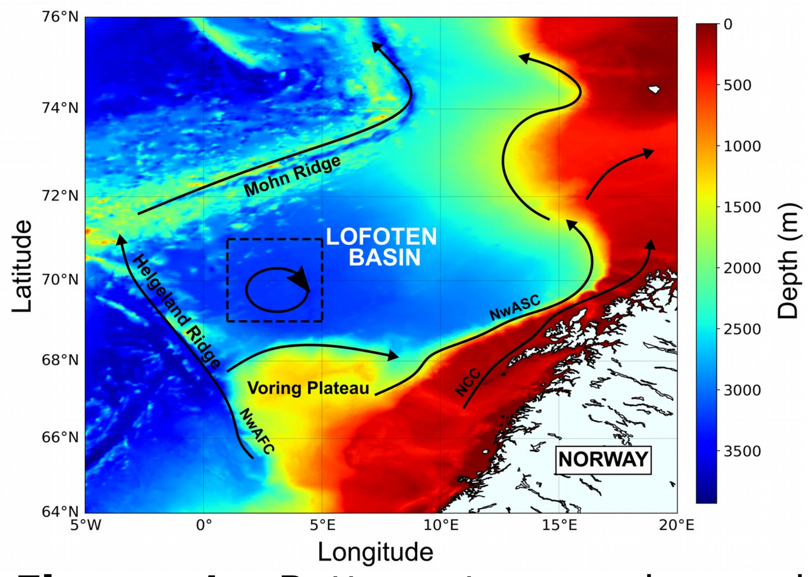


Figure 1. Bottom topography and general circulation of the study region. Area 1 – inside dotted line square (Lofoten Vortex). Area 2 - outside it.

Materials and methods

- High resolution (0.25° x 0.25° grid) AVISO altimetry data of sea level anomalies for the 25 years from 1993 to 2017.
- An open-source code for automatic identification and tracking of eddies developed by Faghmous et al. (2015) on the altimetry data for the detection and tracking of mesoscale eddies.

Tracks divided onto groups

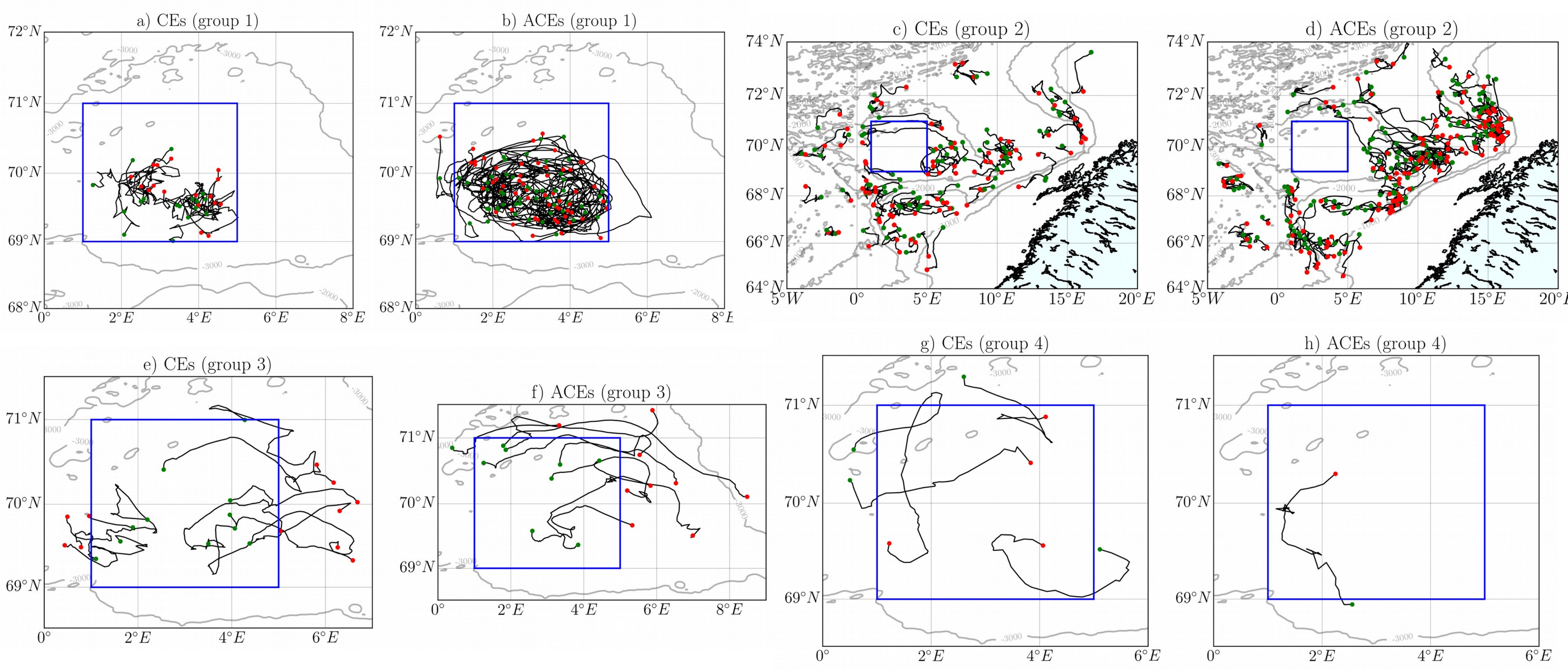


Figure 5. Tracks of mesoscale eddies; red dots show the location of eddy generation, and the green dots indicate the location of eddy decay.

Evolution of eddies' properties

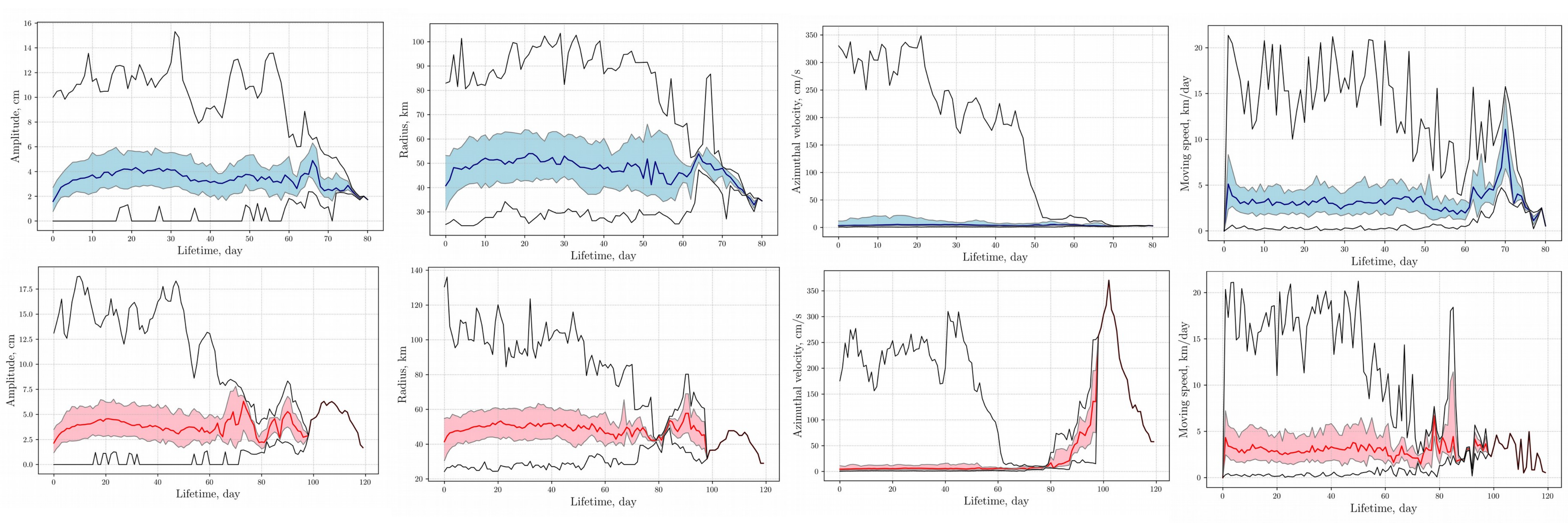


Figure 6. Variability of group 1 eddies' parameters depending on their lifetime (CEs – blue, ACEs – Red). Colored areas correspond the variability of 25%–75%. Thick color lines indicate medians, and thin black lines show minima and maxima.

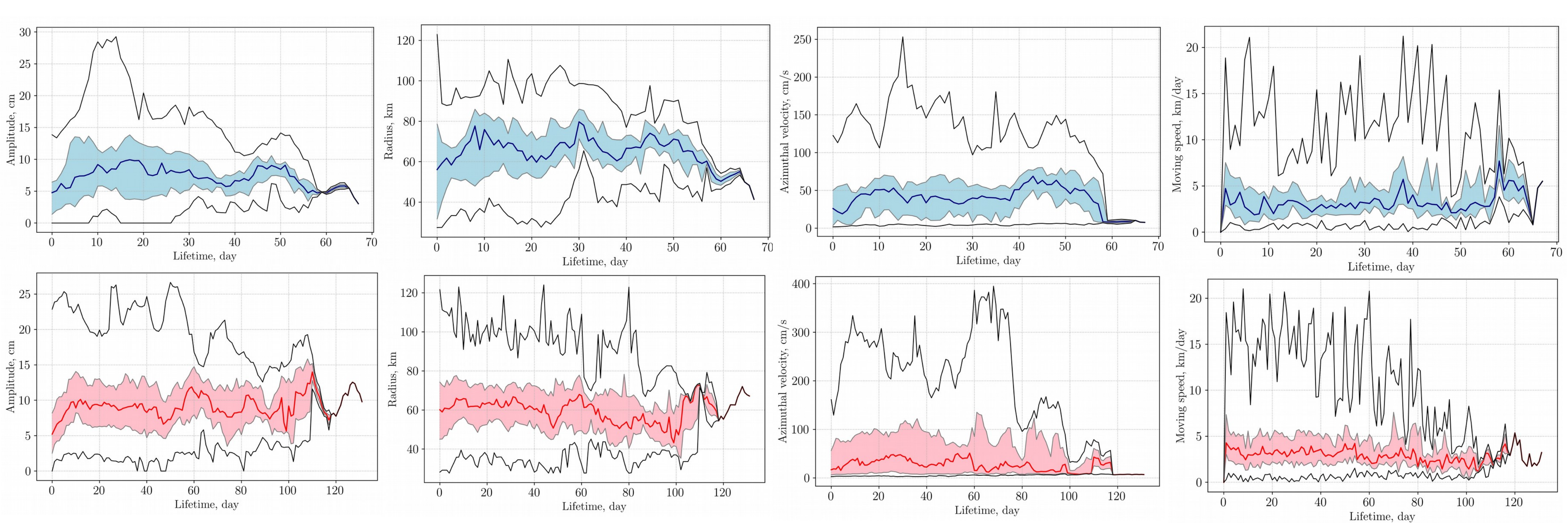


Figure 7. Variability of group 2 eddies' parameters depending on their lifetime (CEs – blue, ACEs – Red). Colored areas correspond the variability of 25%–75%. Thick color lines indicate medians, and thin black lines show minima and maxima.

Eddies' statistics

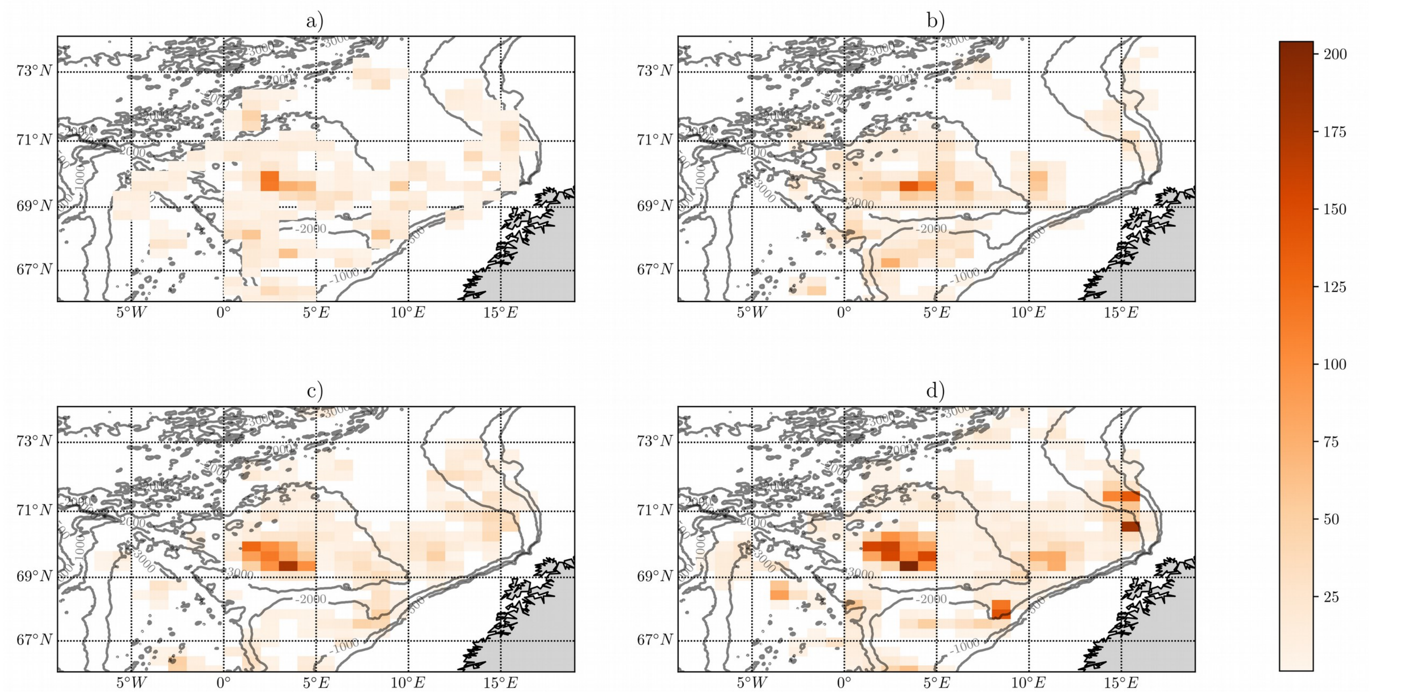


Figure 2. Total number of occurrences of mesoscale eddies in every 1° longitude and 0.38° latitude bins in the LB for CEs: (a) – winter period, (b) – summer period; and ACEs (c) – winter period, (d) – summer period. Thin grey lines are isobaths.

Table 1
Statistical parameters of CEs and ACEs in the LB for the period 1993-2017

Parameter	Type of the eddies	Statistical parameter				
		Mean	Median	STD	Min	Max
Radius, (km)	CEs	55.0	53.3	15.8	24.3	122.9
	ACEs	55.1	53.0	15.6	24.3	136.2
Amplitude, (cm)	CEs	5.2	4.2	3.5	1.0	29.3
	ACEs	6.2	5.0	4.3	1.0	26.6
Azimuthal vel., (cm/s)	CEs	28.2	6.2	46.6	0.5	348.6
	ACEs	32.3	7.7	54.0	0.6	395.1
Lifetime, (days)	CEs	46.4	43.0	10.2	35.0	80.0
	ACEs	50.8	46.0	16.6	35.0	131.0
Moving speed, (km/day)	CEs	4.0	3.1	3.2	0.0	21.4
	ACEs	4.0	3.1	3.1	0.0	21.2

Variability of size's parameter

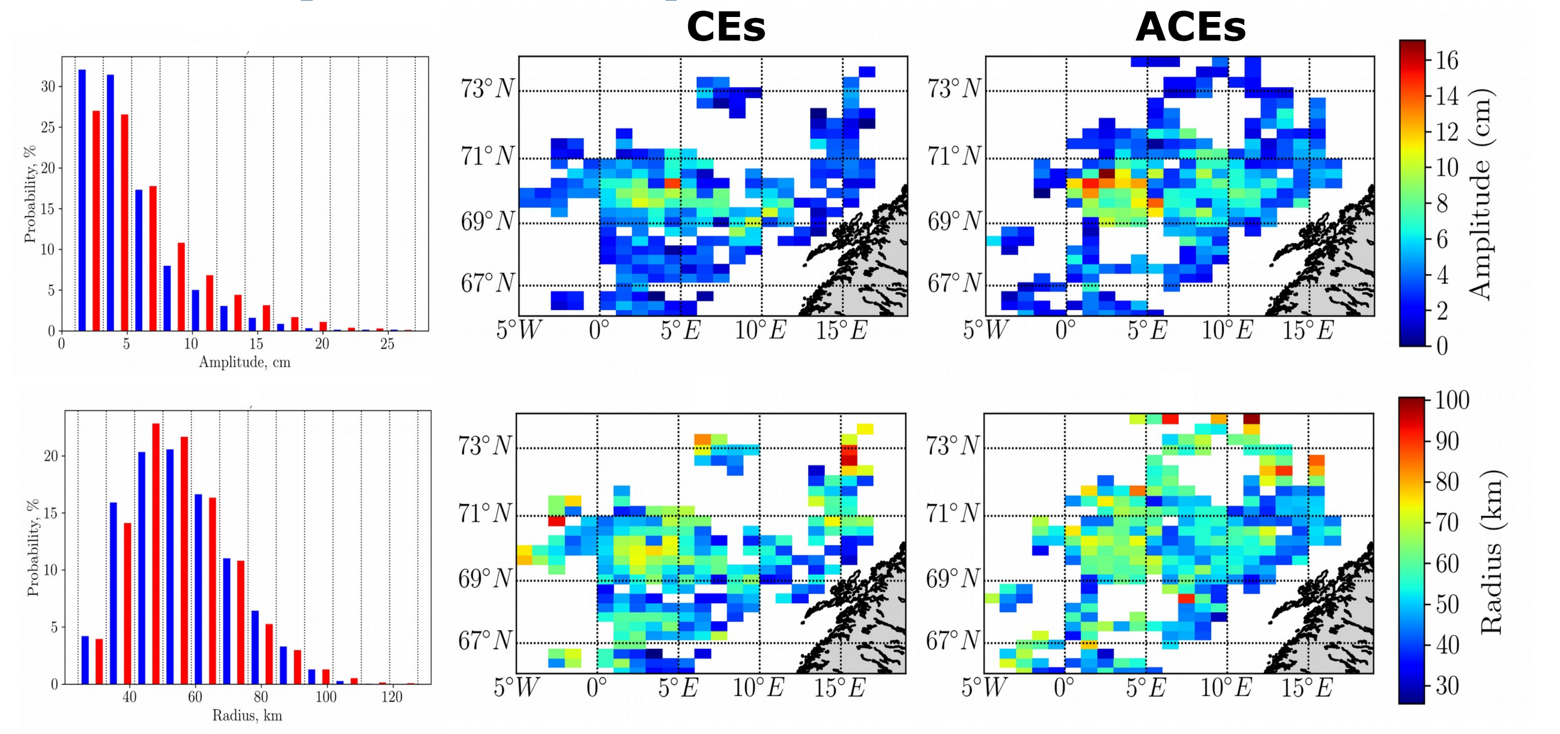


Figure 3 . Left panel is Empirical Distribution Functions. Midle and right are spatial distribution of mean values.

Variability of kinetic parameters

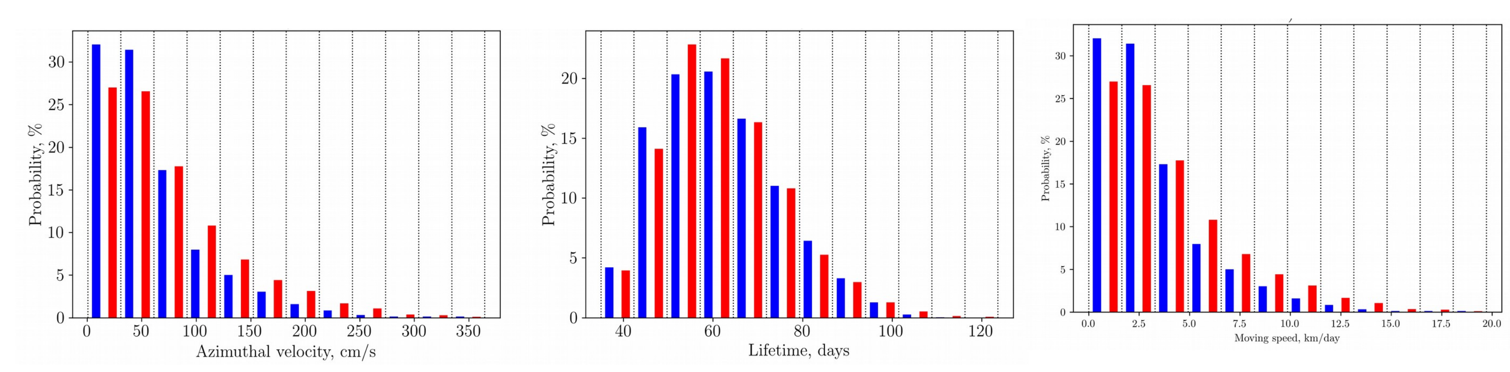
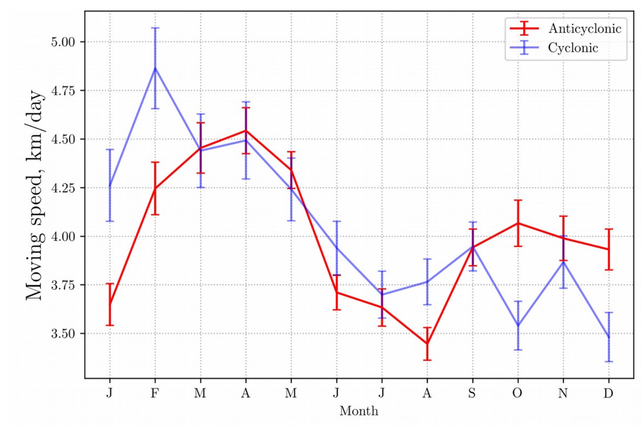


Figure 4. Top panel is Empirical Distribution Functions. Bottom graphs are interannual variability with the standard error (b) for CEs (blue) and ACEs (red) in the LB for the period 1993-2017



Conclusions

We found out three distinct areas of eddy formation in the frontal zone of the NwASC, from where eddies shift to the north-west, forming three main trajectories. The temporal variability of the characteristics of eddies on tracks reveals differences between the two groups of eddies reflected different genesis. Eddies in the LB have a more pronounced variability during life and possess characteristics of a larger scale than at the periphery of the Norwegian Current. The average speed of movement of eddies on tracks has a pronounced seasonal variation when the maxima of the speeds of movement of both types of eddies appear in winter (February-April).