When the fjords take a breath: Influence of wind forcing and Ekman dynamics on deep ventilation in the North Patagonian fjords

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Table S1. Hydrographic and wind-driven forcing conditions during grouped ventilated periods at 170 m depth in Guafo Mouth (2016–2024). Values correspond to the period means of dissolved oxygen (DO, µmol L⁻¹), conservative temperature (CT, °C), absolute salinity (SA, g kg⁻¹), and potential density anomaly (σ_0, kg m⁻³). Ventilation intensity is quantified as ΔAOU (µmol L⁻¹), defined as the decrease in apparent oxygen utilization (AOU) from the onset of each period to its minimum value. Wind forcing is represented by meridional wind stress (Ty, N m⁻²), Ekman pumping velocity (W_E, m d⁻¹), total Ekman forcing (Ek total, m³ s⁻¹ m⁻¹), and its anomaly relative to the annual mean (ΔEk total, m³ s⁻¹ m⁻¹). Positive Ek total values indicate upwelling-favourable conditions, whereas negative values indicate downwelling-dominated forcing.

ID	DO (µmol L⁻¹)	ΔAOU (µmol L⁻¹)	CT (°C)	SA (g kg⁻¹)	σ (kg m⁻³)	τy (N m⁻²)	W_E (m d⁻¹)	**Ek total (m³ s⁻¹ m⁻¹)**	ΔEk total (m³ s⁻¹ m⁻¹)
1	172.002	87.084	9.710	34.061	26.146	−0.058	−0.139	**−0.639**	−0.356
2	208.150	68.882	10.385	34.108	26.069	−0.146	−0.484	**−1.689**	−1.080
3	170.018	3.247	7.358	34.503	26.851	−0.012	0.137	**−0.034**	0.575
4	144.934	8.967	8.024	34.488	26.742	−0.012	0.047	**−0.087**	0.357
5	141.351	34.856	8.999	34.359	26.492	−0.044	−0.059	**−0.458**	−0.014
6	141.698	45.304	10.126	34.082	26.093	−0.055	−0.185	**−0.641**	−0.260
7	125.674	32.500	9.078	34.217	26.370	−0.034	−0.011	**−0.335**	0.047
8	139.052	20.783	8.588	33.103	25.580	−0.022	0.037	**−0.194**	0.199
9	131.249	10.732	9.521	34.181	26.270	−0.067	−0.116	**−0.714**	−0.338
10	148.787	26.932	7.776	34.435	26.737	−0.010	0.092	**−0.047**	0.329
11	131.585	7.789	8.153	34.262	26.547	0.020	0.088	0.246	0.601
12	143.810	37.207	9.421	34.101	26.224	−0.045	0.049	**−0.407**	−0.052
13	134.203	19.600	8.610	34.359	26.553	−0.022	0.059	**−0.179**	0.176
14	135.296	53.748	10.234	34.086	26.077	−0.080	−0.322	**−0.964**	−0.455
15	122.576	16.432	8.591	34.426	26.608	−0.046	−0.037	**−0.470**	0.039
16	121.919	27.300	8.913	34.175	26.362	−0.040	−0.029	**−0.405**	−0.052

Table S2. Characteristics of the ventilation pulses identified in the dissolved oxygen time series at ~170 m depth in the Guafo Mouth mooring. For each pulse, the table includes the start date, duration (Days), minimum apparent oxygen utilization (AOU_{min}), and maximum dissolved oxygen concentration (DO_{max}). Hydrographic conditions are represented by the initial and final conservative temperature (CT_{ini}, CT_{fin}) and absolute salinity (SA_{ini}, SA_{fin}), together with their net changes during the pulse (ΔCT and ΔSA). Wind forcing is described by the total Ekman transport during the 5 d preceding the pulse (Ek_{total} 5dpre) and during the pulse itself (Ek_{total} during), as well as their difference (ΔEk_{total}). The last column (Period context) indicates whether the pulse occurred within an identified ventilated period or outside ventilated periods.

Pulse ID	Start date	Days	AOU_{min}	DO_{max}	CT_{ini}	CT_{fin}	ΔCT	SA_{ini}	SA_{fin}	ΔSA	Ek_{total} 5dpre	Ek_{total} (during)	Period Context
1	19-06-16	2	144.110	140.087	9.676	9.949	0.273	34.271	34.152	−0.119	−0.189	0.096	outside
2	22-07-16	2	126.047	158.285	9.732	9.963	0.231	34.154	34.037	−0.117	−1.658	0.577	P1
3	02-08-16	2	75.888	206.739	10.130	10.281	0.151	33.930	33.902	−0.028	−2.333	−1.933	P1
4	12-08-16	3	92.879	190.455	9.871	10.161	0.290	34.118	33.920	−0.198	−1.594	−1.505	P1
5	02-09-16	2	81.133	202.544	10.084	10.144	0.060	33.883	33.796	−0.086	−1.205	0.410	P1
6	06-09-16	2	67.153	216.122	10.114	10.229	0.115	33.902	33.734	−0.168	0.255	−1.552	P1
7	03-10-16	2	98.380	187.888	9.362	9.656	0.295	34.147	34.020	−0.127	−0.295	−0.690	P1
8	23-10-16	4	102.526	183.782	9.145	9.639	0.494	34.231	34.055	−0.176	0.205	0.060	P1
9	08-08-17	6	70.210	209.240	9.624	10.431	0.807	34.489	34.147	−0.342	−2.005	−3.285	P2
10	18-08-17	11	40.432	239.414	9.992	10.667	0.675	34.336	33.834	−0.502	−1.214	−2.292	P2
11	04-09-17	4	34.642	246.572	10.407	10.486	0.079	34.093	34.004	−0.089	−2.009	−1.801	P2
12	10-09-18	4	154.303	133.509	9.328	9.334	0.005	34.409	34.269	−0.140	−1.126	−0.424	outside
13	31-12-18	2	188.184	100.673	8.956	9.141	0.185	34.472	34.359	−0.113	−0.531	−0.390	outside
14	25-03-19	4	174.931	117.710	8.974	8.660	-0.314	34.075	34.013	−0.062	−0.201	0.402	outside
15	02-06-19	6	180.162	105.664	9.292	9.654	0.361	34.589	34.257	−0.332	−0.799	−1.712	outside
16	16-07-19	4	116.232	169.965	9.856	10.308	0.452	34.274	33.964	−0.310	−2.931	−0.907	P6
17	07-09-19	2	141.625	146.941	9.307	9.254	−0.054	34.207	34.139	−0.068	0.669	−0.497	P7
18	29-09-19	2	167.350	129.896	8.624	8.693	0.068	34.098	34.034	−0.064	−0.240	−0.838	P7
19	23-03-20	3	198.272	90.114	9.052	9.216	0.164	34.516	34.355	−0.160	−1.265	−1.482	outside
20	24-07-20	6	142.317	145.193	9.903	10.136	0.233	33.793	33.568	−0.226	0.194	−0.077	outside

21	06-08-20	4	129.566	154.068	9.973	10.333	0.360	33.435	33.216	−0.220	−2.052	−0.850	outside
22	11-08-20	2	116.962	167.390	10.149	10.185	0.036	33.330	33.315	−0.015	−0.459	−0.184	outside
23	23-05-21	5	195.963	92.316	9.162	9.236	0.073	34.468	34.277	−0.192	−1.996	−1.045	outside
24	12-07-22	2	151.141	147.237	9.175	9.307	0.132	34.222	34.087	−0.135	−2.786	−1.343	P12
25	15-07-22	5	119.529	167.998	9.290	9.502	0.212	34.099	33.940	−0.159	−1.033	−1.284	P12
26	12-08-22	4	154.743	135.836	9.621	9.665	0.044	34.463	34.242	−0.222	−0.861	−1.750	outside
27	13-09-22	2	157.984	132.408	8.789	8.894	0.105	34.467	34.383	−0.084	−0.100	−3.082	outside
28	24-06-23	2	185.564	97.969	9.910	10.012	0.102	34.375	34.295	−0.080	−0.920	−0.945	outside
29	07-07-23	2	156.823	126.219	9.722	10.144	0.422	34.285	34.128	−0.157	−1.667	0.352	P14
30	15-07-23	2	138.729	143.296	10.226	10.307	0.080	34.136	34.140	0.004	−0.853	0.526	P14
31	23-07-23	2	130.902	150.934	10.235	10.341	0.106	34.257	34.130	−0.127	−1.242	−0.755	P14
32	01-08-23	2	124.409	158.650	9.799	10.201	0.402	34.126	33.936	−0.190	−2.327	−0.891	P14
33	29-08-23	5	110.829	171.178	10.254	10.392	0.137	34.076	33.878	−0.198	−1.479	−2.058	P14
34	30-09-23	2	141.940	142.507	9.615	9.932	0.317	34.235	34.074	−0.161	−0.287	0.041	outside
35	03-07-24	2	145.495	139.215	9.445	9.882	0.437	34.099	34.100	0.001	−0.331	0.149	outside

Table S3. Statistical significance of explanatory variables for the variability of oxygen, obtained by applying a sequential ANOVA (type I) to a generalized linear model (GLM) with a logit link function for the residual negative binomial distribution. (A) Bold values indicate significant effects ($p < 0.05$).

Predictive variables	df	Deviance	Residual df	Residual Deviance	p > ($\|X^2\|$)	ED (%)
Null, Oxygen			2625	4145.3		
Salinity	1	343.80	2624	3801.5	**<0.01**	**22.8**
Temperature	1	9.73	2623	3791.8	0.001	0.6
Density	1	1155.10	2622	2636.7	**<0.01**	**76.6**
Total Ekman	1	0.14	2621	2636.5	0.705	0.0

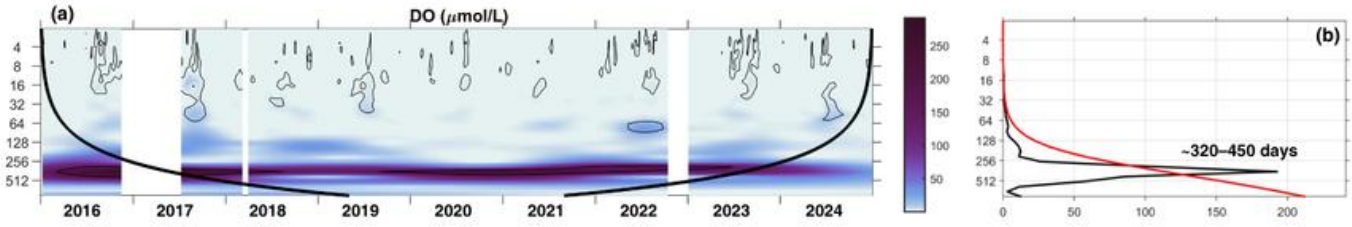

Figure S1. Continuous Morlet wavelet power spectrum of unfiltered dissolved oxygen (DO) at ~170 m depth. (a) Time–period distribution of the normalized wavelet power. Significant regions at the 95 % confidence level (black contours) are concentrated in the low-frequency band between ~320 and 450 d, indicating a dominance of interannual variability. The thick black curve denotes the cone of influence. (b) The global wavelet spectrum (black line) and corresponding 95 % significance level (red line), highlighting the spectral peak within the annual-to-interannual range.

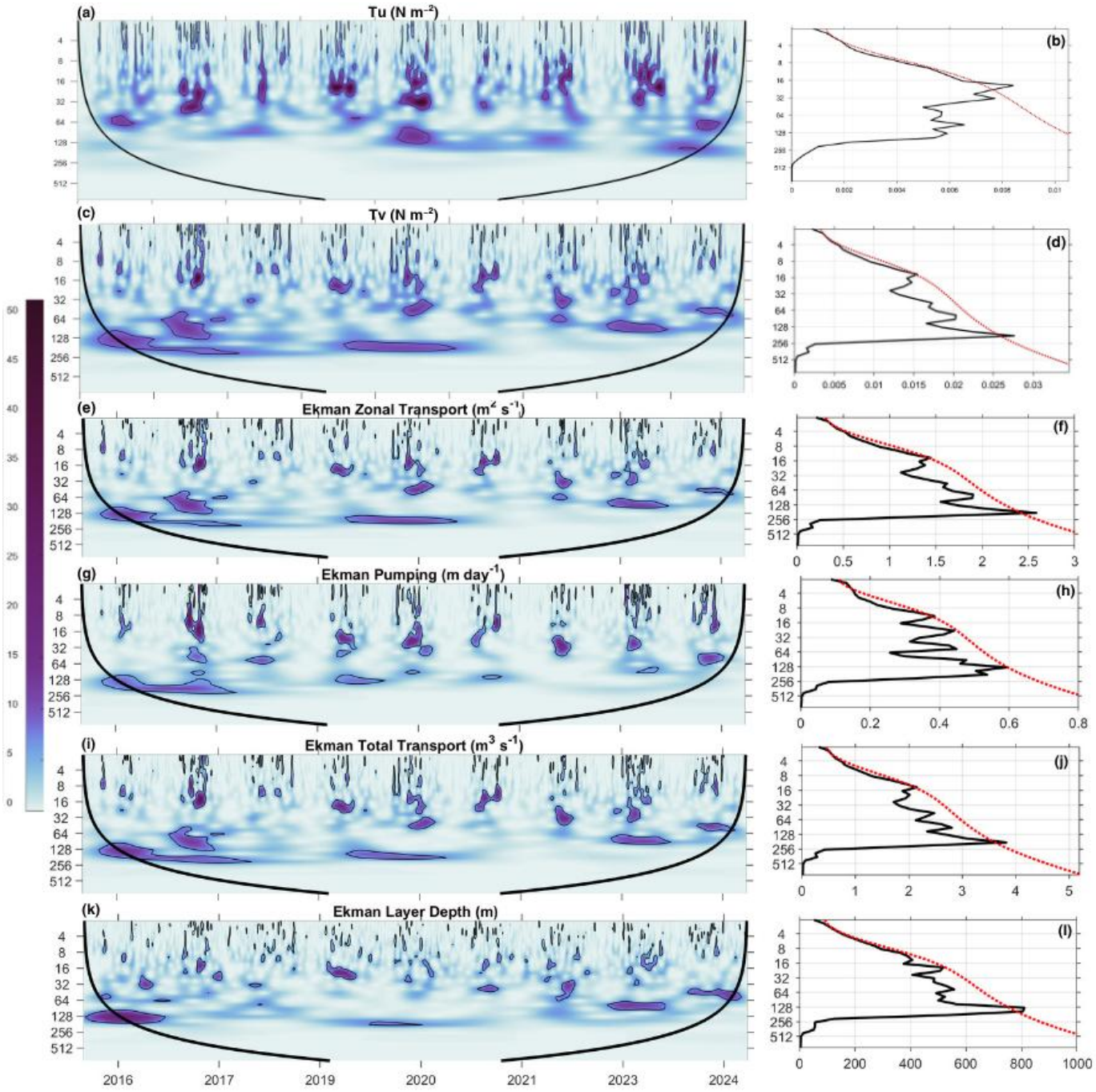

Figure S2. Wavelet coherence between high-pass filtered dissolved oxygen (DO) and wind-derived forcing variables (cutoff period: 250 d). Panels show the coherence between DO and (a) zonal wind stress (τu), (b) meridional wind stress (τv), (c) zonal Ekman transport (Ue), (d) Ekman pumping (W_E), (e) total Ekman transport (Ek_total), and (f) Ekman layer depth (D_E). Shading indicates coherence magnitude (0–1), and black contours denote the 95 % confidence level against a red-noise background. The thick black curve represents the cone of influence. Significant coherence is primarily concentrated within the synoptic and intraseasonal timescales.