Supplementary Material

Table S1: Sensitivity tests to the parameterization of gas transfer velocity, the variability of the mole fraction of CO_2 in the atmosphere, and the calcification processes on the annual CO_2 air-sea flux estimate.

Sensitivity tests		**Annual air-sea flux (mol C m^{-2} yr^{-1})**
Sensitivity to the parameterizations of gas transfer velocity, type of the parametrization	**Parameterizations of gas transfer velocity**	
Quadratic wind dependency	Wanninkhof (1992) used in the standard run	0.47
	Wanninkhof (2014)	0.37
Hybrid wind dependency	Liss and Merlivat (1986)	0.25
	Nightingale et al. (2000)	0.35
	Wanninkhof et al. (2009)	0.34
Cubic wind dependency	Wanninkhof and McGillis (1999)	0.60
Including explicit bubbles parametrizations	Woolf (1997)	0.55
	Stanley et al. (2009)	0.55
	Liang et al. (2013)	0.42
	Mean (SD)	0.43 (0.12)
Sensitivity to the mole fraction of CO_2 in the atmosphere	**Added value to the mole fraction used in the standard run**	
	-3 ppm	0.33
	+3 ppm	0.61
	Mean (SD)	0.47 (0.20)
Sensitivity to $CaCO_3$ production	**Added term to Eq. 1**	
	Based on mean [minimum - maximum] PIC:POC ratio and NCP	0.29 [0.36,- 0.20]
	Based on Lajaunie-Salla et al. (2021)	0.40
	Mean (SD)	0.35 (0.08)

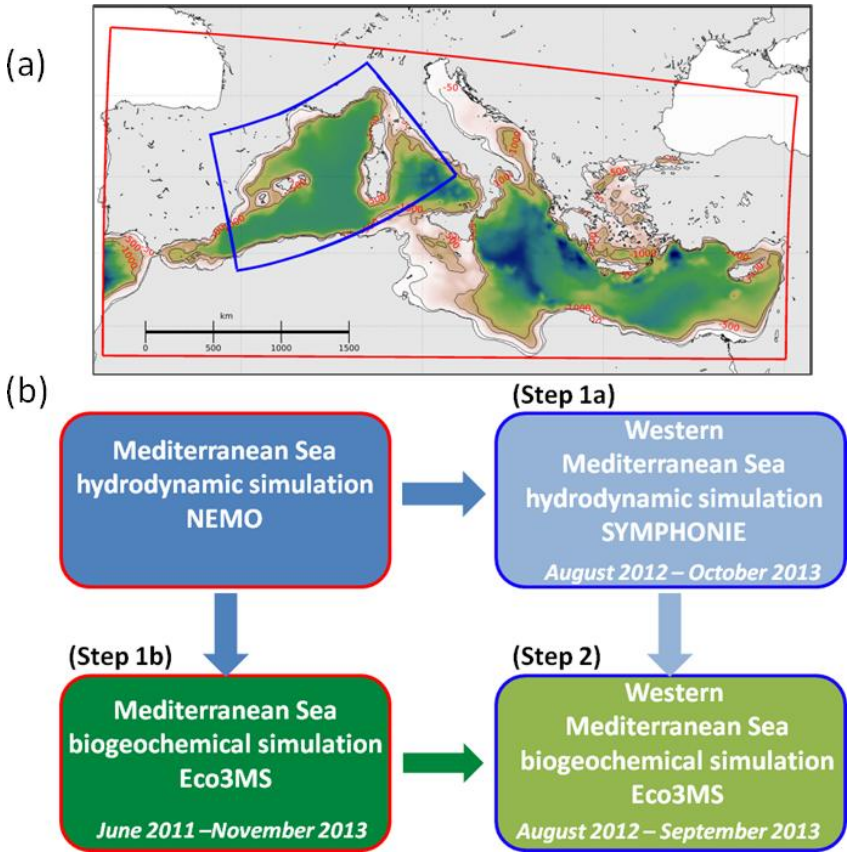

Figure S1: Domain and bathymetry (m) of (a) the forcing coupled NEMO-Eco3MS Mediterranean model (red contour) and of the coupled SYMPHONIE-Eco3MS western sub-basin model (blue contour). (b) Scheme of the downscaling strategy from the Mediterranean Sea to the western sub-basin.

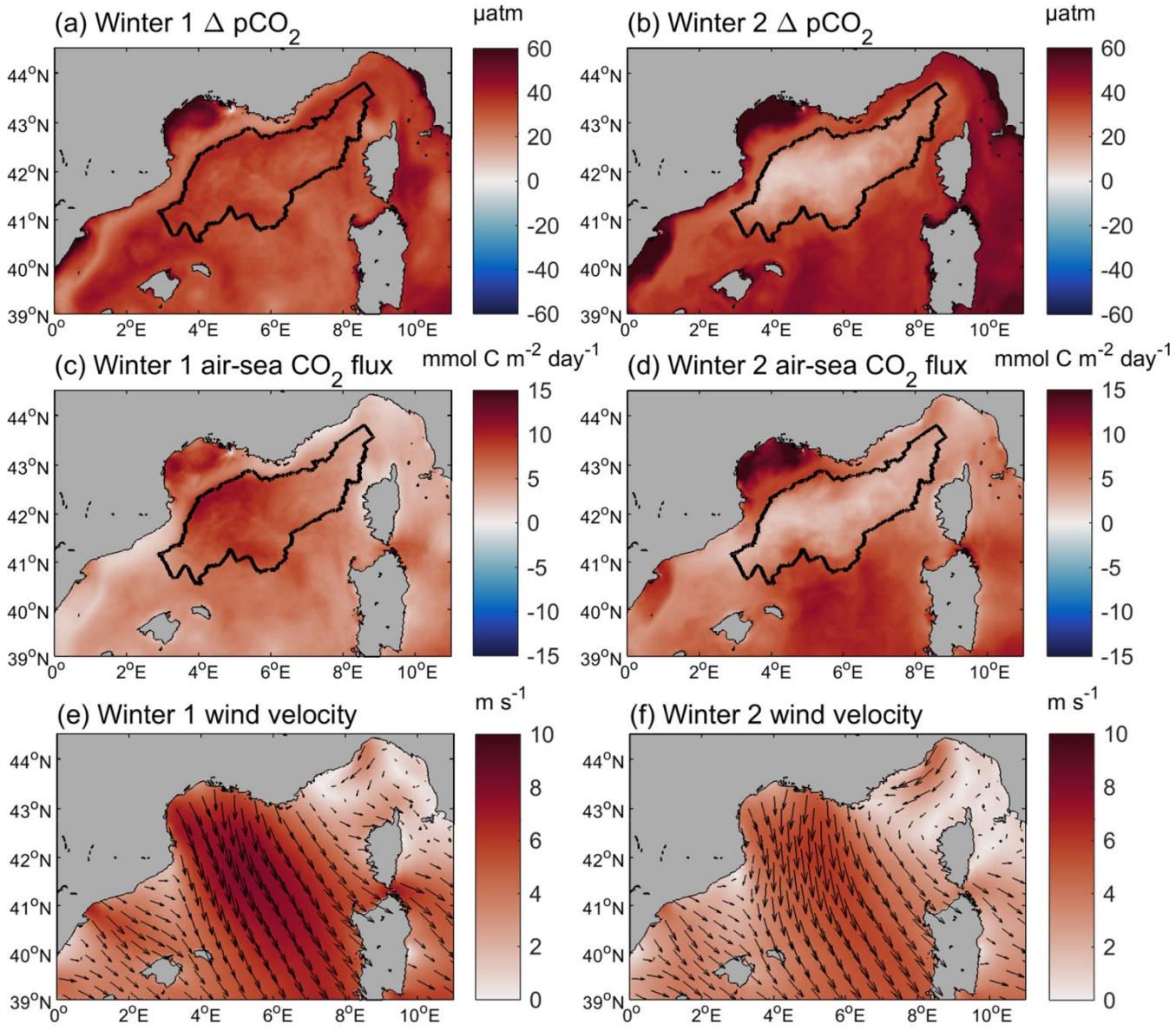

Figure S2: (a,b) pCO_2 difference ($pCO_{2,atm}$ - $pCO_{2,sea}$, in µatm), (c,d) air-to-sea CO_2 flux (mmol C m^{-2} day^{-1}) and (e,f) wind velocity (m s^{-1}), averaged over winter 1 (28 November-15 January) and winter 2 (16 January-23 March) sub-periods. The black line indicates the limit of the deep convection area.