Nighttime dissolution in a temperate coastal ocean ecosystem increases under acidification: Supplementary material

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Abbreviations

A_T	Total alkalinity
C_T	Dissolved Inorganic Carbon
G_{net}	Net community calcification
P_{net}	Net community production
Ω_{arag}	Aragonite saturation state
PAR	Photosynthetically active radiation
PAR_{mm}	Michaelis-Menten function of PAR
T_f	Gaussian function of temperature
F_{CO2}	Air-sea flux of CO_2
ρ	Sea water density
d	Mean tide pool depth

Collinearity between explanatory variables

Table S1. Variance Inflation factors (VIFs) for the potential explanatory variables in each tide pool during the day.

	PAR_{mm}	P_{net}	T_f	Ω_{arag}
Pool 1	5.48	2.00	4.32	1.28
Pool 2	2.49	1.22	1.64	2.15
Pool 3	6.45	2.25	5.04	4.00
Pool 4	3.07	2.69	2.11	2.26

Table S2. Variance Inflation factors (VIFs) for the potential explanatory variables in each tide pool during the night.

	P_{net}	T_f	Ω_{arag}
Pool 1	1.55	1.52	2.15
Pool 2	2.12	1.21	2.34
Pool 3	1.97	1.72	2.53
Pool 4	1.58	1.61	2.03

Table S3. Pearson correlation coefficients between explanatory variables in each tide pool during the day.

		PAR_{mm}	P_{net}	T_f	Ω_{arag}
Pool 1	PAR_{mm}	1			
	P_{net}	0.70	1		
	T_f	0.87	0.58	1	
	Ω_{arag}	0.43	0.29	0.46	1
Pool 2	PAR_{mm}	1			
	P_{net}	-0.09	1		
	T_f	0.58	0.18	1	
	Ω_{arag}	0.70	-0.29	0.37	1
Pool 3	PAR_{mm}	1			
	P_{net}	0.40	1		
	T_f	0.88	0.33	1	
	Ω_{arag}	0.71	-0.15	0.71	1
Pool 4	PAR_{mm}	1			
	P_{net}	0.53	1		
	T_f	0.37	0.71	1	
	Ω_{arag}	0.61	-0.03	-0.12	1

Table S4. Pearson correlation coefficients between explanatory variables in each tide pool during the night.

		P_{net}	T_f	Ω_{arag}
Pool 1	P_{net}	1		
	T_f	-0.09	1	
	Ω_{arag}	-0.55	0.53	1
Pool 2	P_{net}	1		
	T_f	-0.02	1	
	Ω_{arag}	-0.70	0.31	1
Pool 3	P_{net}	1		
	T_f	0.09	1	
	Ω_{arag}	-0.57	0.48	1
Pool 4	P_{net}	1		
	T_f	0.12	1	
	Ω_{arag}	-0.46	0.48	1

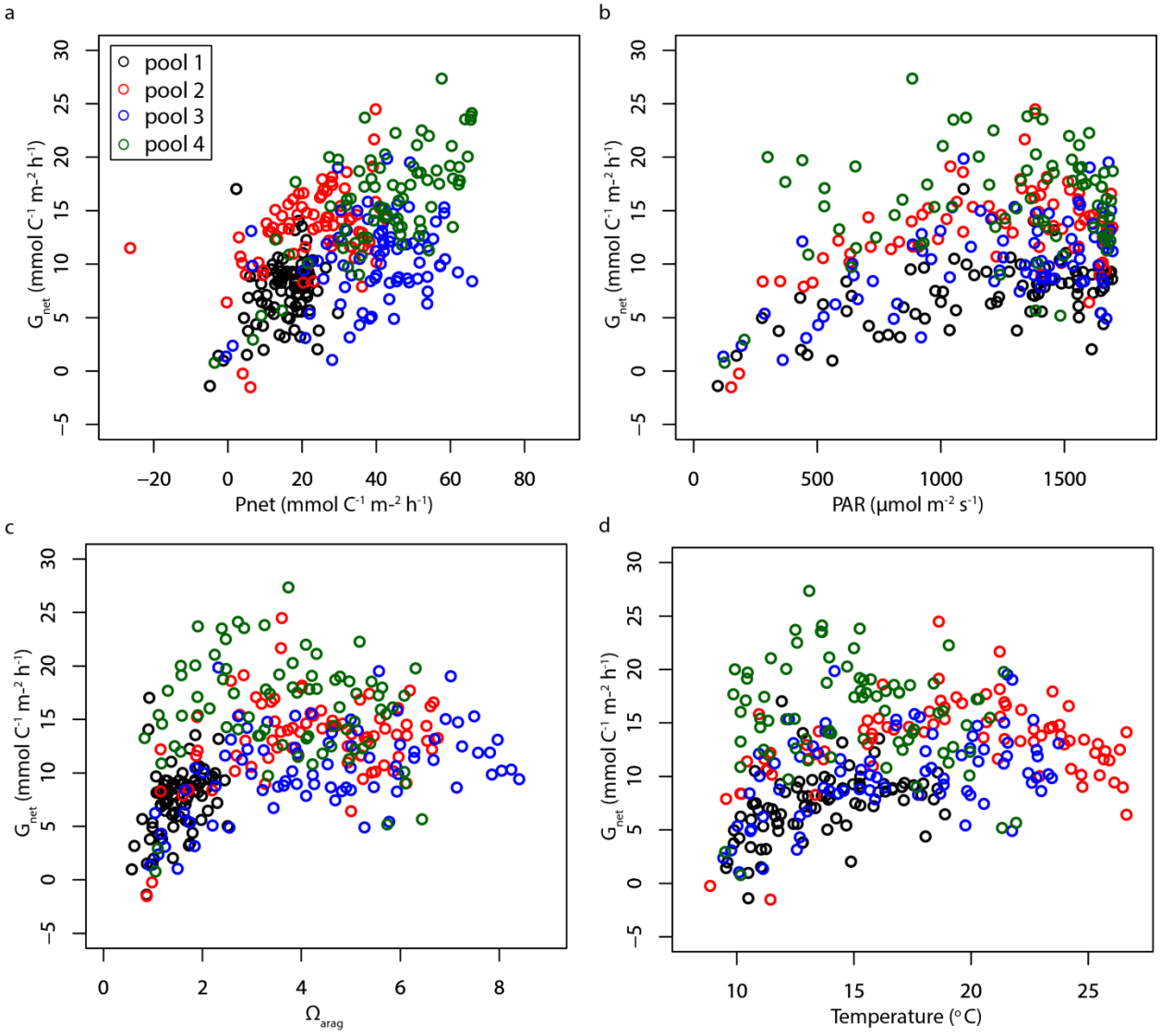

Figure S1. G_{net} (mmol C^{-1} m^{-2} h^{-1}) against a, P_{net} (mmol C^{-1} m^{-2} h^{-1}), b, Photosynthetically Active Radiation (µmol m^{-2} s^{-1}), c, Aragonite saturation state (Ω_{arag}) and d, Temperature (°C) in each of the tide pools during the day.

Nutrients

The concentration of NO_2^- + NO_3^- is found to generally decrease between the first and last bottle samples on a given sample day (daylight hours; Fig. S2). Although this may be representative of net community nutrient NO_2^- + NO_3^- uptake, the magnitude of changes are orders of magnitude lower than changes in ΔA_T and therefore any corresponding net community release of anions[1,2,3] would have negligible influence on G_{net}. The rate of change of NH_3 + NH_4^+ concentration between first and last daily bottle samples is shown to be highly variable (Fig. S2). However measured $\Delta(NH_3 + NH_4^+)$ explains none of the variance in ΔA_T (Fig. S3). As such, sporadic high concentrations are interpreted as a consequence of local animal excretion and not a result of net community uptake. The release of H^+ associated with the latter would have had a strong influence on measured A_T[1,2,3]. We therefore conclude that ΔA_T is primarily driven by community calcification. Nutrient concentrations were not measured for nighttime samples.

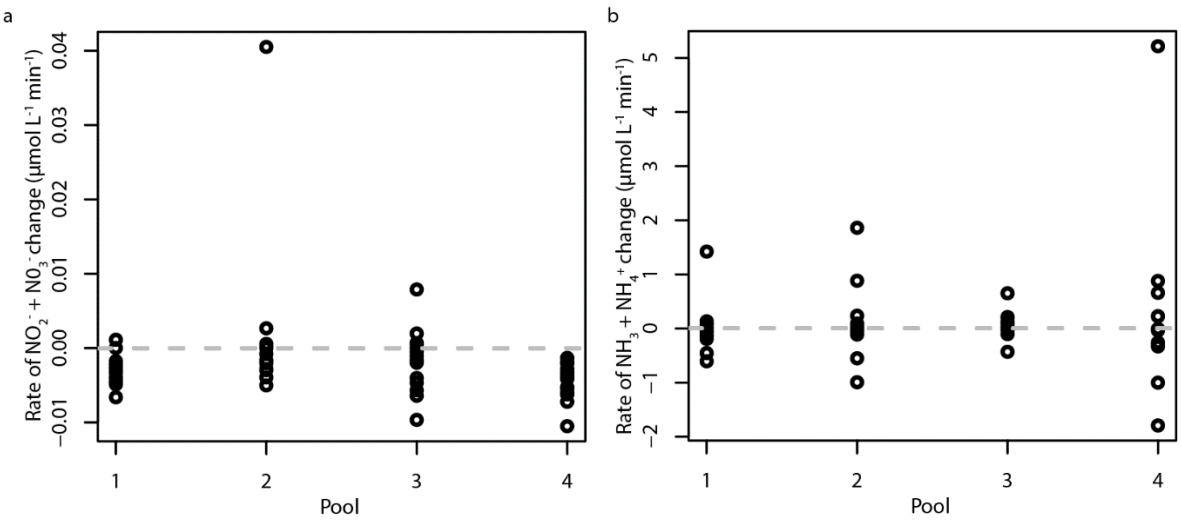

Figure S2. Rate of a, NO_2^- + NO_3^- and b, NH_3 + NH_4^+ concentration change between first and last daily sampling times in each tide pool (µmol L^{-1} min^{-1}). All samples were taken during the daytime.

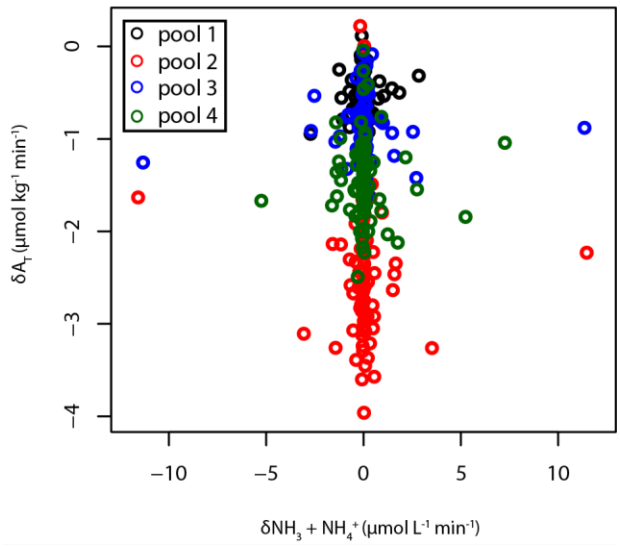

Figure S3. δNH_3 + NH_4^+ (µmol L^{-1} min^{-1}) against δA_T (µmol kg^{-1} min^{-1}) in each tide pool. There is no significant relationship between δNH_3 + NH_4^+ and δA_T in any of the tide pools.

PAR and temperature functions

Michaelis-Menten coefficients		
Pool	K_m	V_{max}
1	1019.7±487.0	14.16±3.00
2	402.7±123.9	18.23±1.44
3	815.3±361.2	17.83±3.08
4	147.4±71.9	18.29±1.18

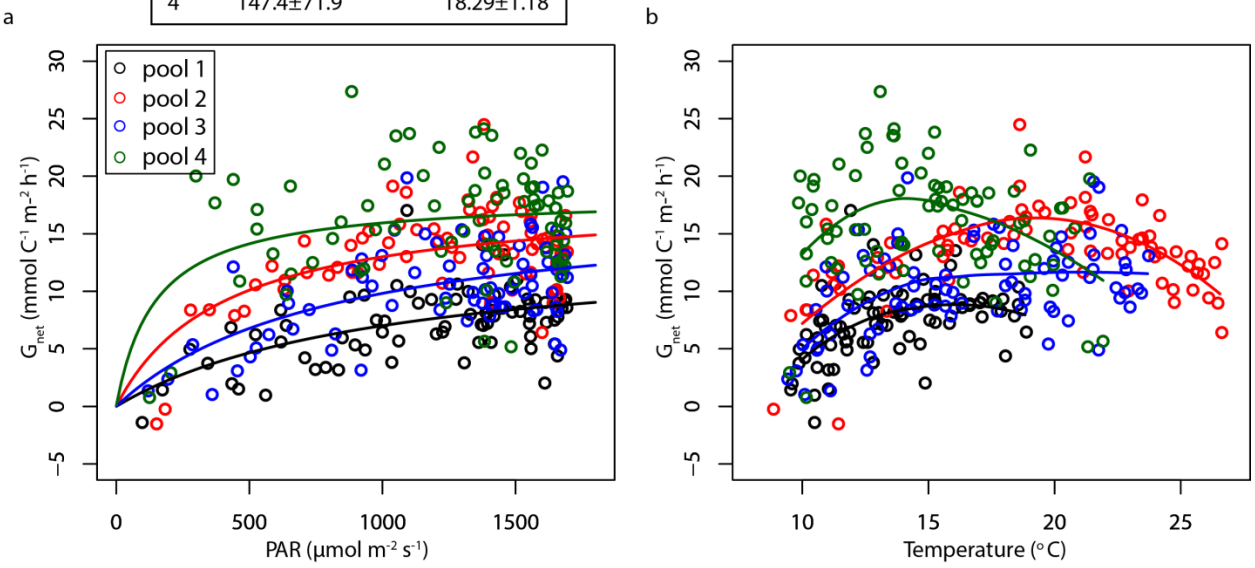

Figure S4. G_{net} (mmol C^{-1} m^{-2} h^{-1}) against a, PAR (µmol m^{-2} s^{-1}) and b, temperature (°C) in each of the tide pools. Michaelis-Menten and Gaussian functions are derived for G_{net}-PAR and G_{net}-temperature relationships respectively. Michaelis-Menten ($V=V_{max}[S]/(K_m+ [S])$) coefficients with associated standard errors are given however as the Gaussian temperature functions are produced using locally weighted regression methods (LOESS)[4] they cannot be represented by a simple mathematical equation.

Alkalinity-dissolved inorganic carbon relationships

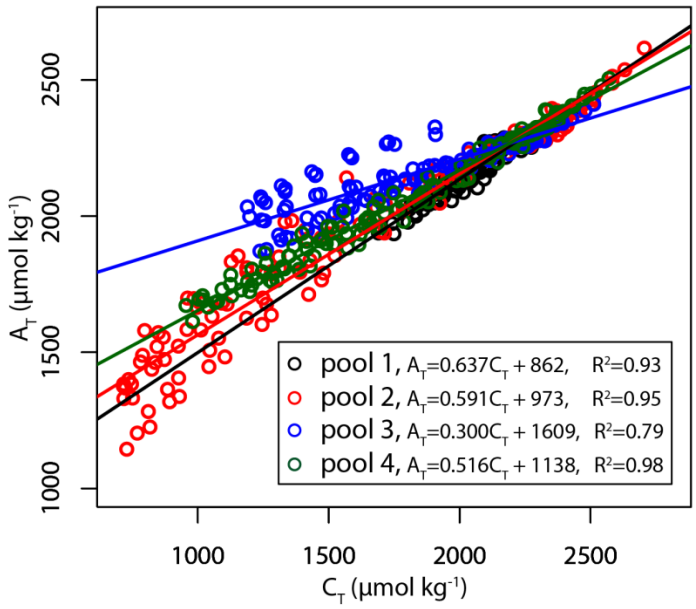

Figure S5. Total least squares regressions between alkalinity (A_T) and dissolved inorganic carbon (C_T) in each of the tide pools.

Nighttime community calcification against P_{net} and temperature

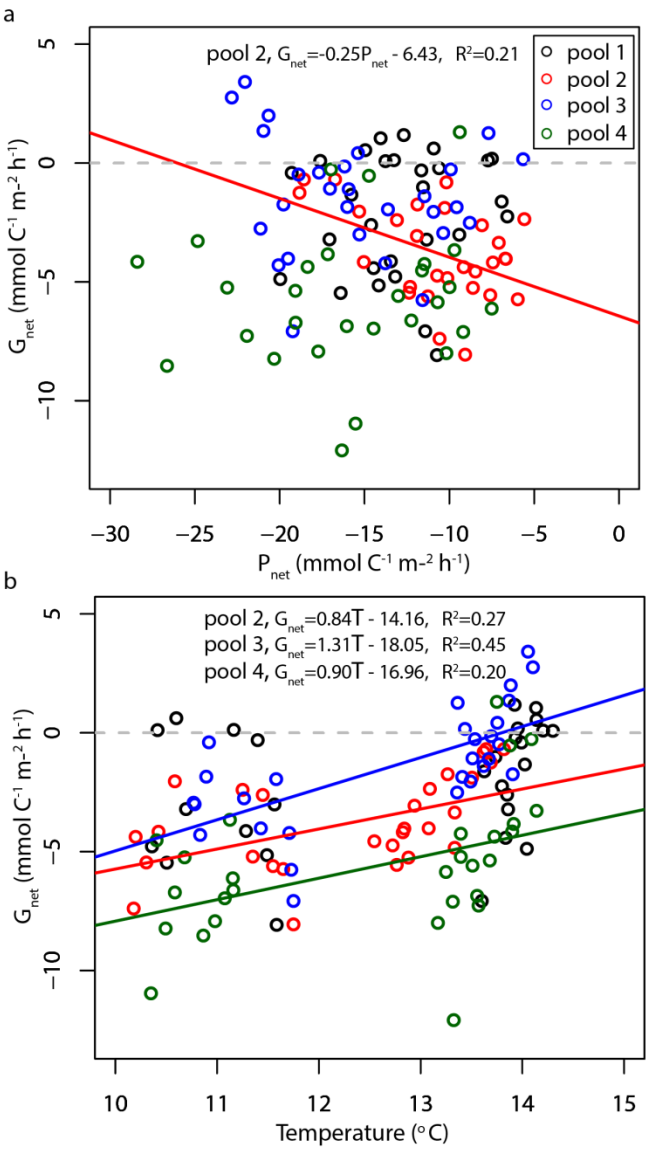

Figure S6. Nighttime G_{net} (mmol C^{-1} m^{-2} h^{-1}) against a, P_{net} (mmol C^{-1} m^{-2} h^{-1}), and b, Temperature (°C) in each of the tide pools. Regression lines of variables significant at the $p<0.05$ level are shown. Dashed grey lines show the separation between net community calcification and net community dissolution.

References

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