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Determinants of calcite flux in planktonic foraminifera on seasonal and interannual time scales

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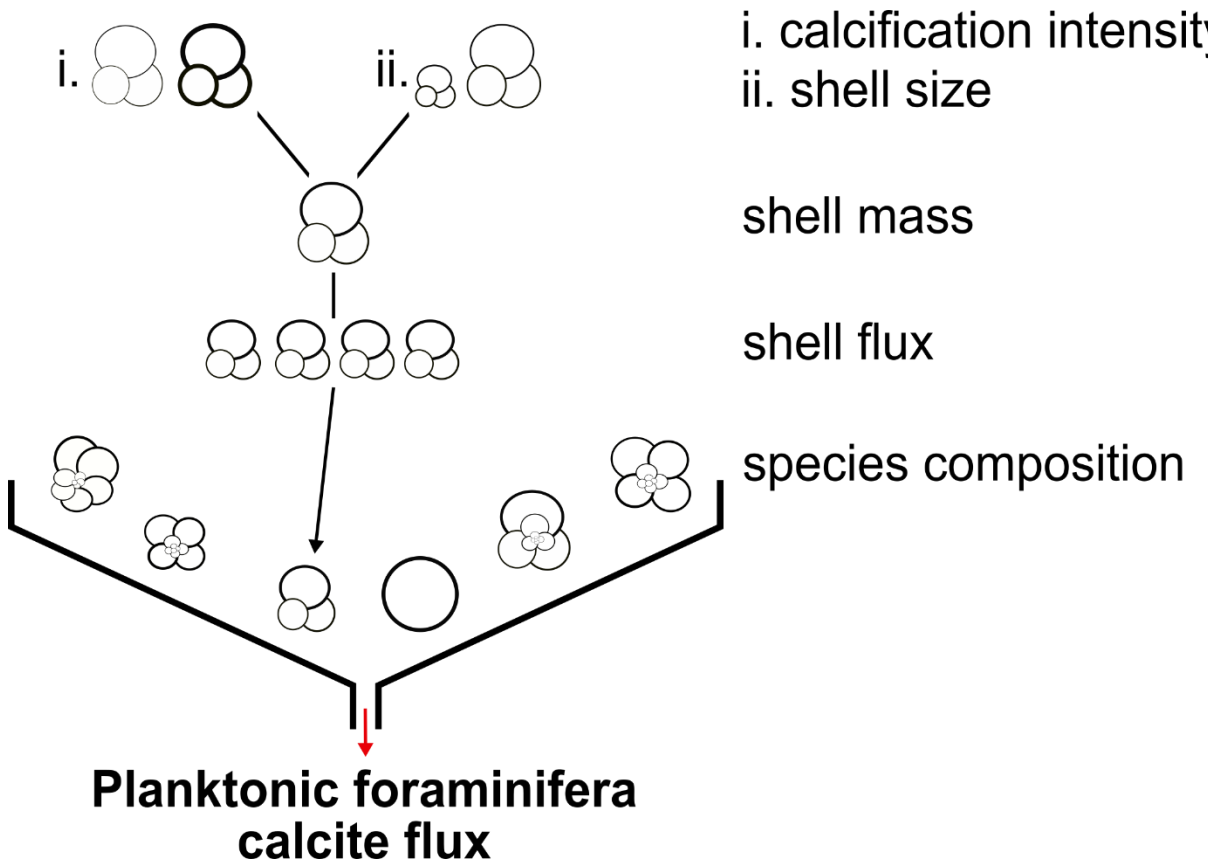
Fig. 1: Schematic representation of factors determining the planktonic foraminifera calcite flux:



Objective: disentangle to what degree foraminifera calcite flux variability on intra- and inter-annual time scales is due to variability in species-specific shell fluxes and shell masses (size and calcification intenstiy)

Tab. 1: Cap Blanc time series

Deployment	Lat (° N)	Long (° W)	Water depth (m)	Deployment depth (m)	Sampling start	Sampling end	Number of samples
Cap Blanc -3 upper	21°08.3 °N	20°40.3 °W	4094	730	08.04.1990	30.04.1991	18
CaB Blanc-18 upper	21°16.9 °N	20°48.1 °W	4168	1222	25.03.2007	05.04.2008	20

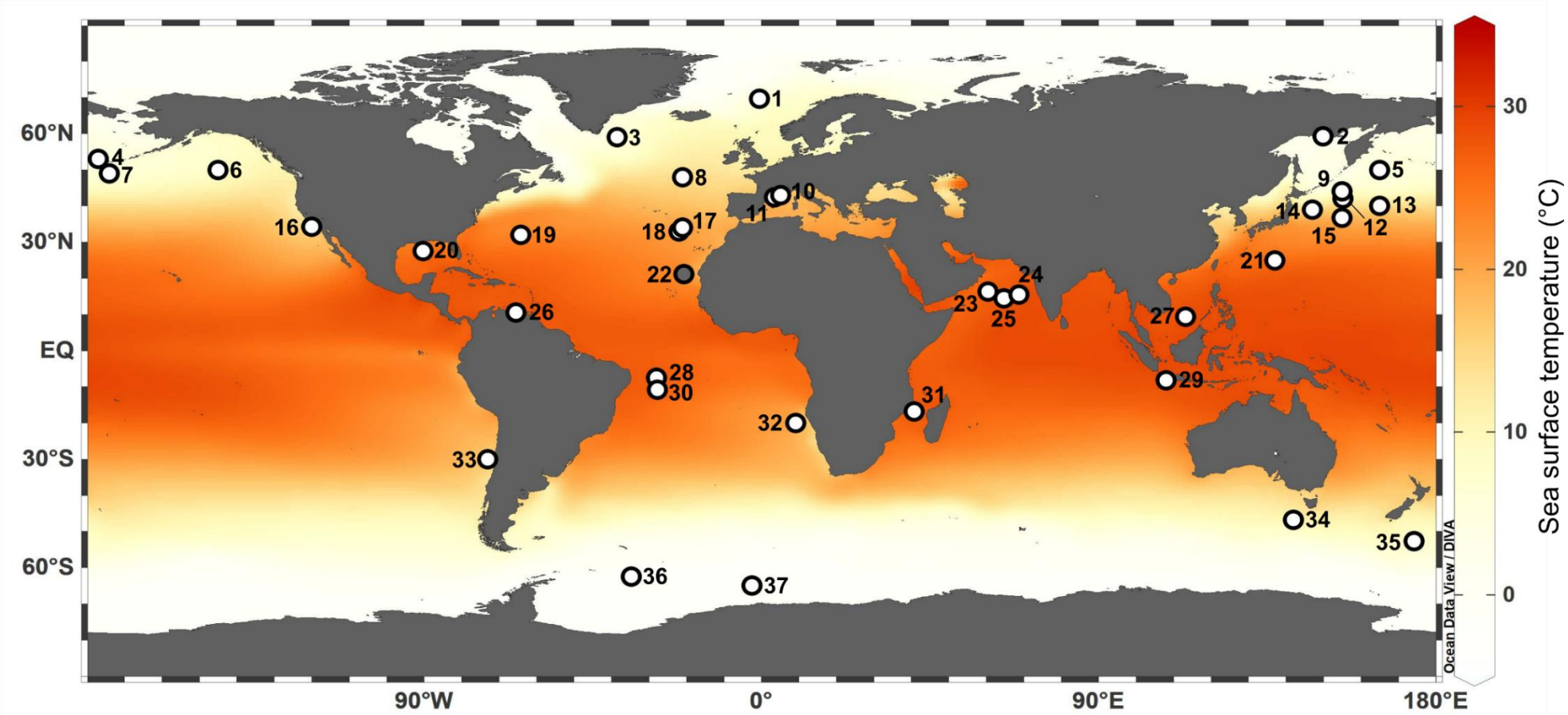


Fig. 2: Position of sediment trap mooring off Cap Blanc (22, grey symbol) used in this study, and the location of sediment trap time series discussed (Jonkers and Kučera, 2015)

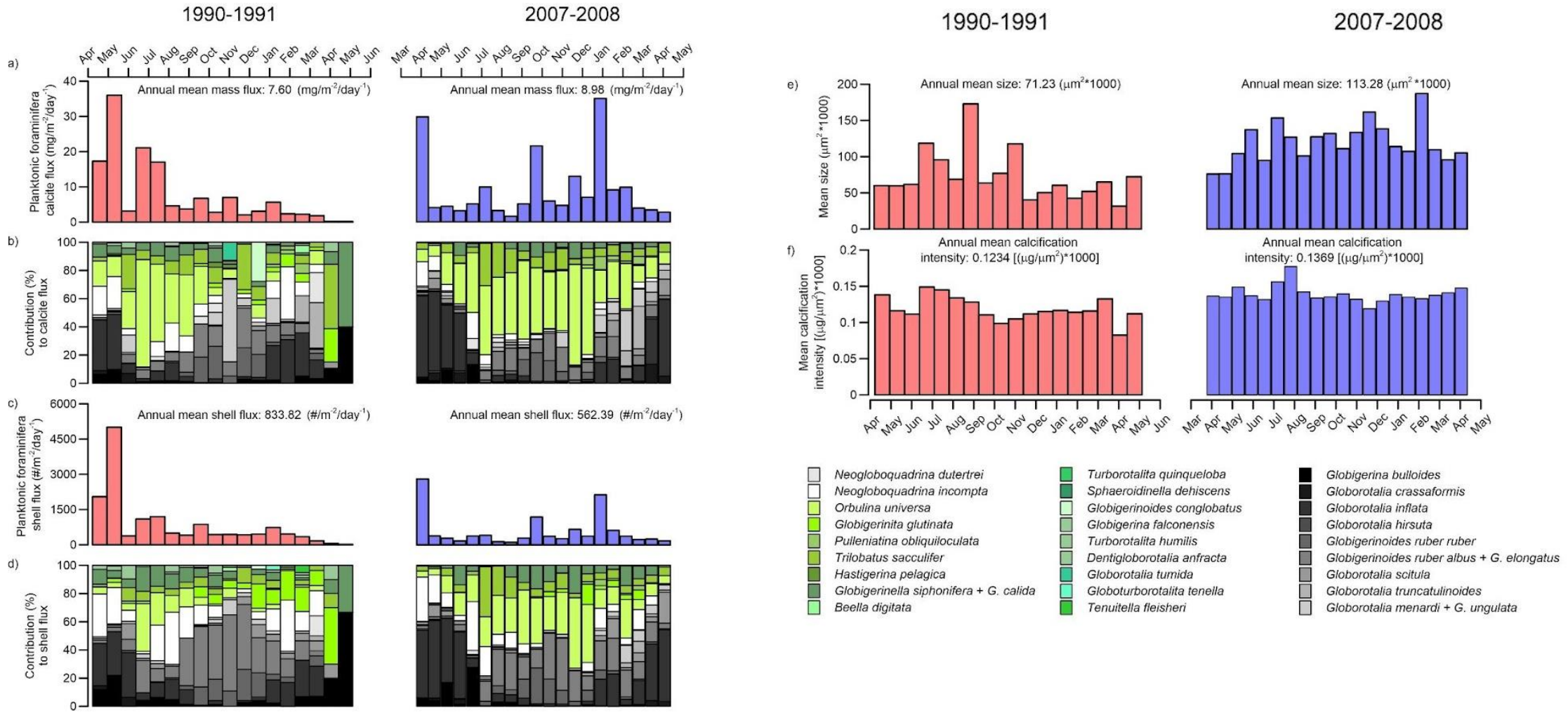


Fig. 3: The Cap Blanc planktonic foraminifera time series. A: total planktonic foraminifera shell flux; B: contribution of the individual species to the total shell flux; C: total planktonic foraminifera calcite flux; D: contribution of the individual species to the total calcite flux; E: mean shell size and F: mean calcification intensity. Colours in A, C, E and F denote different years and in B and D the individual species. Individual species contributed differently to the shell and calcite fluxes, indicating that shell mass is not equal among different species.

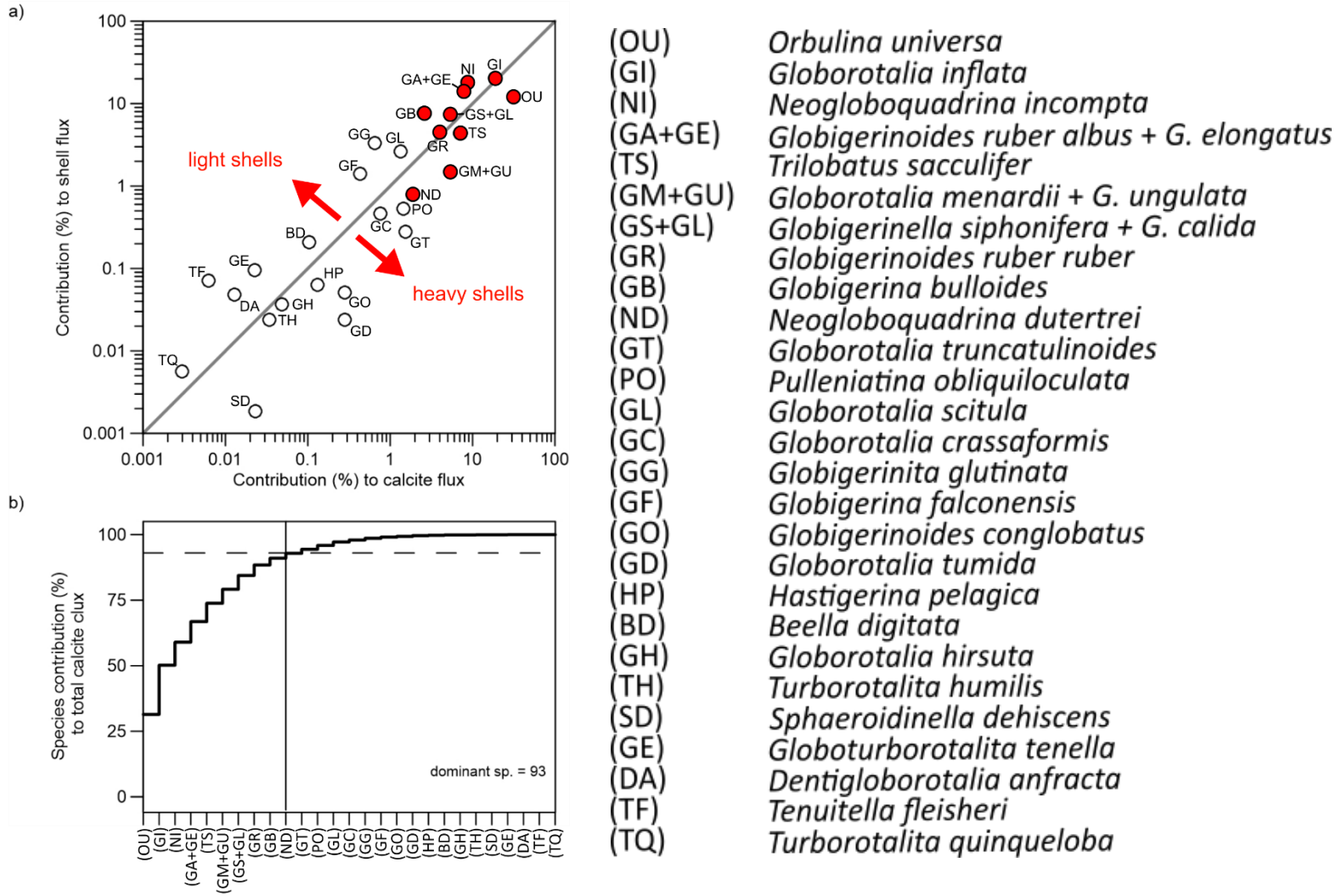


Fig. 4: Relationship between the species shell flux and calcite flux. Black line denotes the 1:1 relationship that allows to distinguish between lightly and heavily calcified species. The ten most abundant species (red filled symbols in A) in the two time series combined account for more than 91% of the planktonic foraminifera shell flux and more than 92% of the calcite flux (B).

Intra-annual (seasonal) variability and predictability of planktonic foraminifera calcite flux

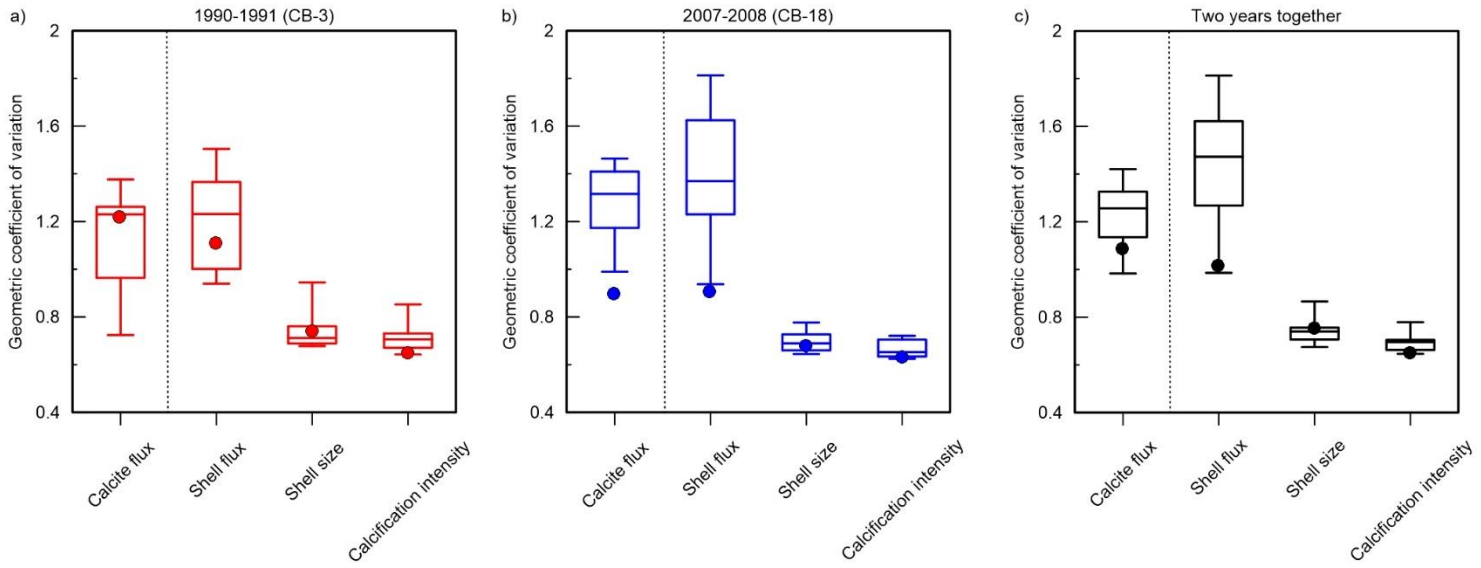


Fig. 5: Variance of planktonic foraminifera calcite flux, shell flux, mean size and mean calcification intensity among the ten most abundant and heaviest species, expressed as geometric coefficient of variation, plotted for 1990-1991 (red) and 2007-2008 (blue) and for both time series together (black). Filled circles show the variation in the same parameters for all foraminifera. In all cases the variance in the calcite flux was only matched by variance in the shell flux and shell size and calcification intensity varied much less, suggesting that shell flux variability dominates variability in calcite flux

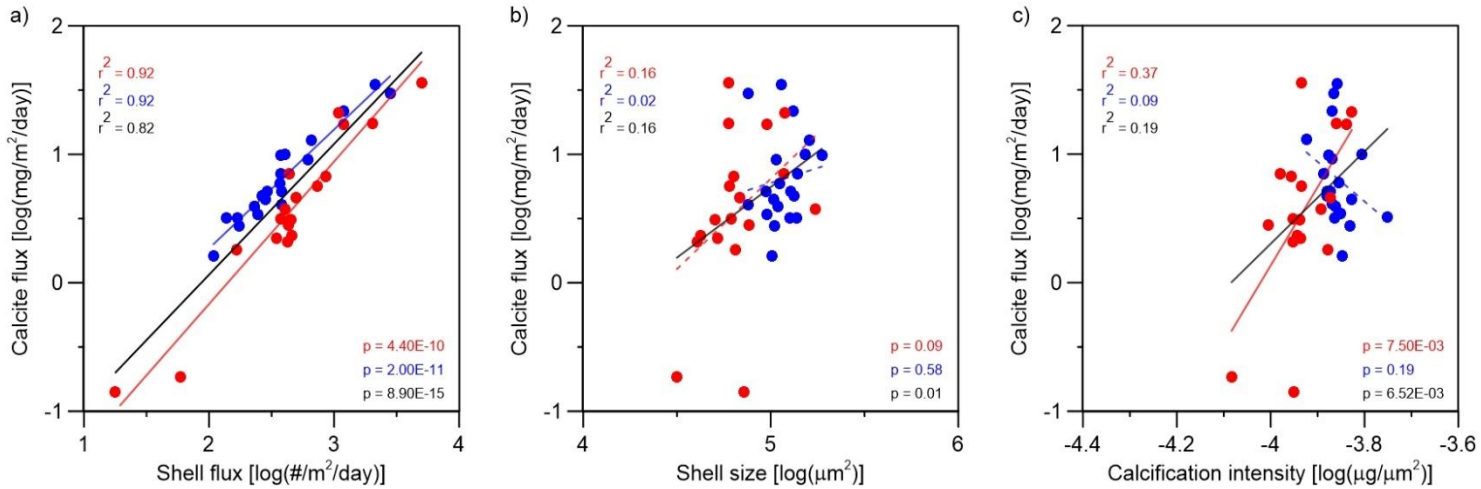


Fig. 6: Predictors of foraminifera calcite flux. Linear regression between the planktonic foraminifera calcite flux, shell flux, mean shell size and mean calcification intensity (weight/size), shown separately for the 1990-1991 (red) and 2007-2008 (blue) time-series as well as for both years together (black). On the intra-annual time scales, planktonic foraminifera calcite flux correlates best with the shell flux

Inter-annual (between the years) variability and predictability of planktonic foraminifera calcite flux

A markedly different pictures emerges when inter-annual variability is assessed:

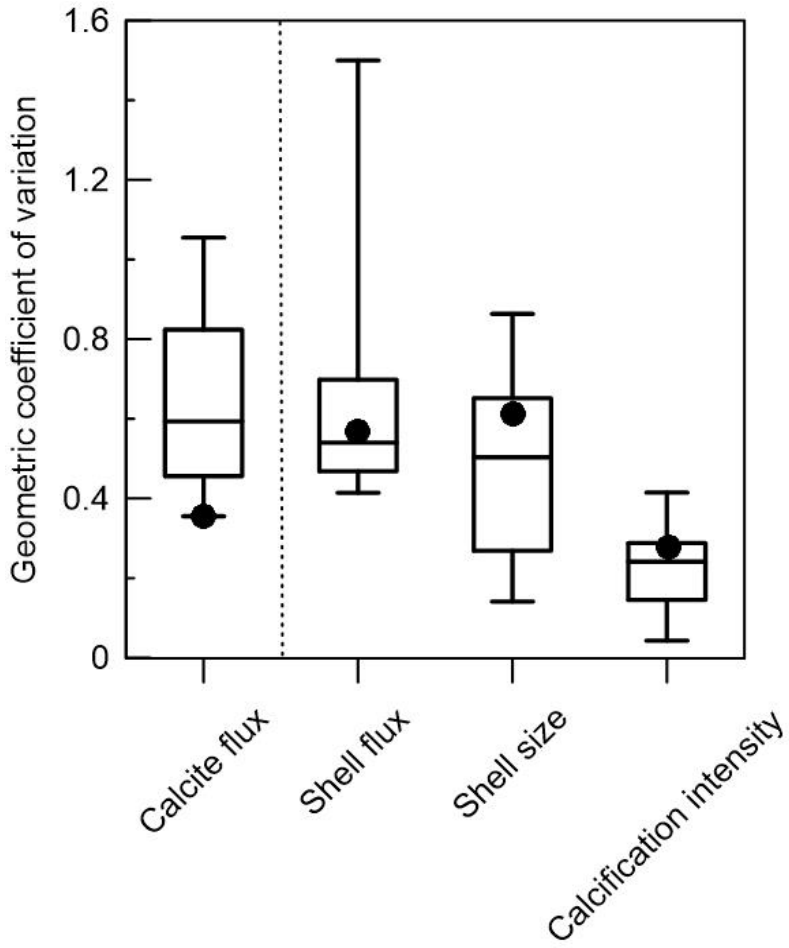
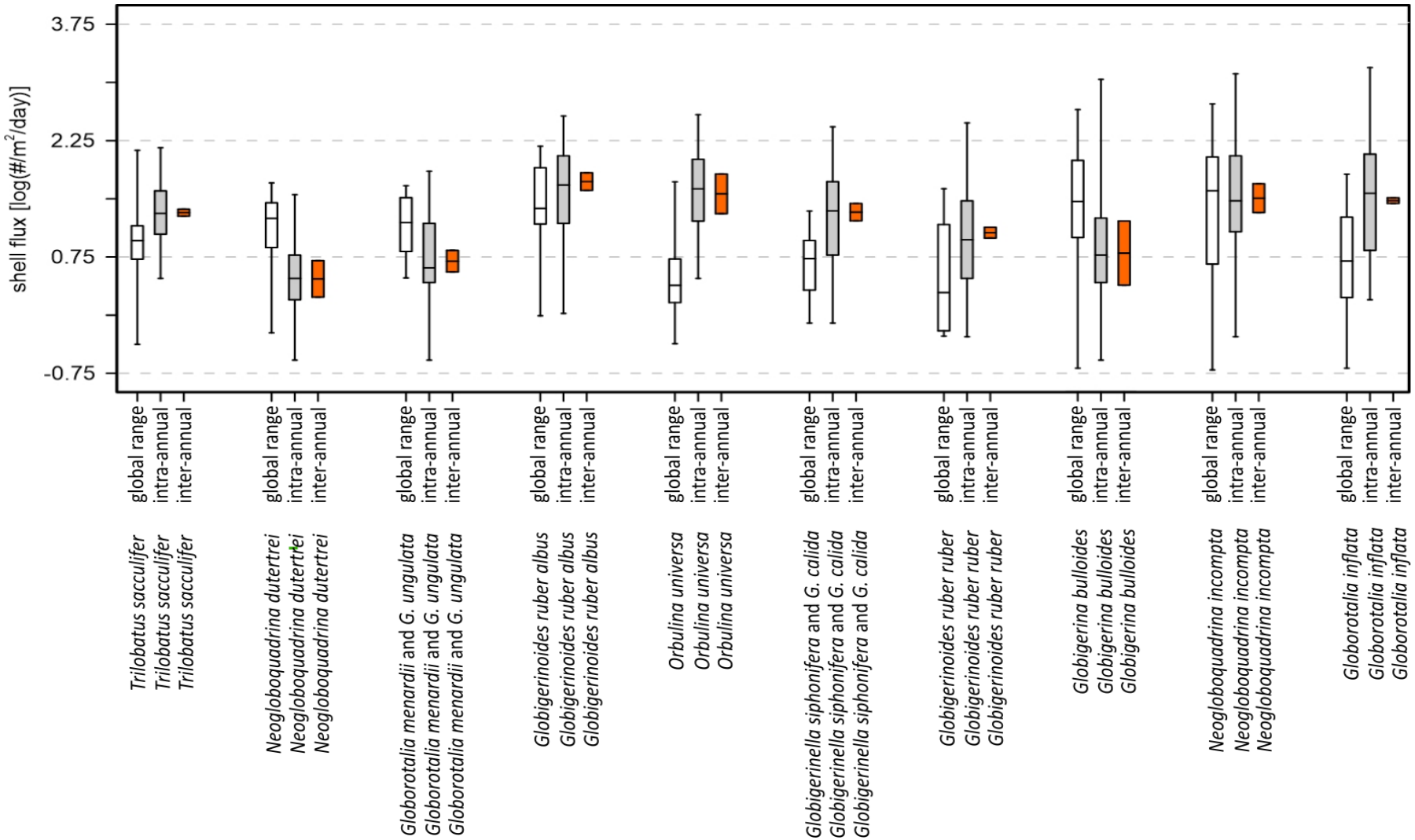


Fig. 7: Inter-annual differences in calcite flux, shell flux, mean size and mean calcification intensity. Statistics are shown only for the ten dominant species, but filled circles indicate the values calculated for all foraminifera. Inter-annual variability is smaller for all parameters and both shell flux and shell size vary at a comparable magnitude with calcite flux.

Fig. 8: For most species the observed intra-annual variability (with grey) at Cap Blanc shows a range that is comparable to global variability (with white) in annual mean fluxes, suggesting that the insights from the Cap Blanc time series can be extrapolated to in space. The comparison also shows that inter-annual variability (with orange) is comparably low, thus rendering its prediction more difficult



Tab.2: Evaluating intra- and inter-annual changes in planktonic foraminifera calcite flux

		assuming constant size [μm^2] and calcification intensity [$\mu g/\mu m^2$]	assuming constant size [μm^2] but variable calcification intensity [$\mu g/\mu m^2$]	assuming variable size [μm^2] but constant calcification intensity [$\mu g/\mu m^2$]	assuming constant shell flux [$\#/m^2/d^{-1}$] and calcification intensity [$\mu g/\mu m^2$] but variable size [μm^2]
Intra-annual	RMSE	4.95 [$mg/m^2/d^{-1}$]	4.08 [$mg/m^2/d^{-1}$]	1.56 [$mg/m^2/d^{-1}$]	
	NRMSE (%)	**14**	11	4	
Inter-annual	RMSE	2.26 [$mg/m^2/d^{-1}$]	1.86 [$mg/m^2/d^{-1}$]	0.53 [$mg/m^2/d^{-1}$]	1.21 [$mg/m^2/d^{-1}$]
	NRMSE (%)	164	135	**44**	83

- global estimate of planktonic foraminifera calcite flux at one time, shell flux is the most relevant predictor (14 % root mean square error normalized to range; NRMSE)
- a prediction of the temporal evolution of the calcite flux will also require estimates of changes in shell size and calcification intensity

References

Jonkers, L. & Kučera, M. (2015) Global analysis of seasonality in the shell flux of extant planktonic Foraminifera. *Biogeosciences*, 12, 2207-2226.

Locarnini, R.A., Mishonov, A.V., Baranova, O.K., Boyer, T.P., Zweng, M.M., Garcia, H.E., Reagan, J.R., Seidov, D., Weathers, K.W., Paver, C.R. & V., S. (2019) World Ocean Atlas 2018. 1: Temperature, 52.

Schlitzer, R. (2019). Ocean Data View. Retrieved from https://odv.awi.de.

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Thank you for your attention!

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