RELATIVE CONTRIBUTION OF INTERNAL VS. EXTERNAL SOURCES OF PHOSPHATE TO THE SURFACE MIXED LAYER IN THE P-DEPLETED MEDITERRANEAN SEA

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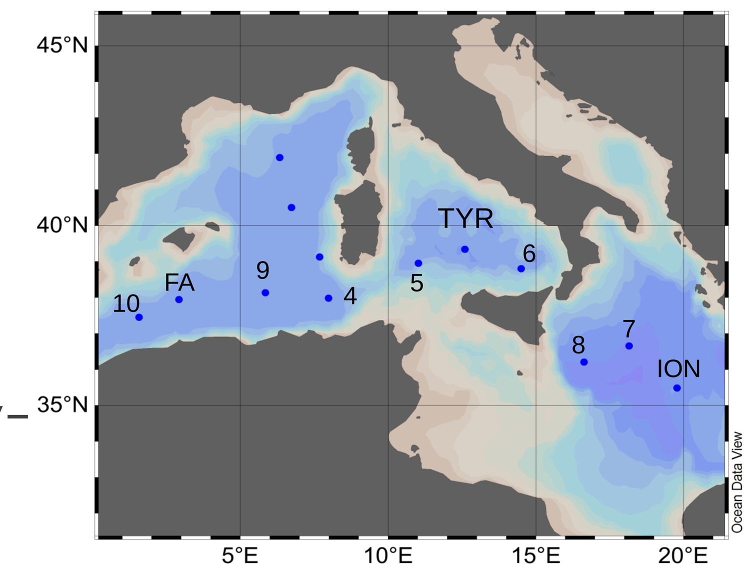
SUMMARY

- First cross-basin simultaneous measurements of nanomolar phosphate concentration, atmospheric deposition and alkaline phosphatase activity in the P-depleted Mediterranean Sea
- Diapycnal fluxes supplied between 0 and 0.03 µmol P m^{-2} d^{-1} to the surface mixed layer.
- Atmospheric deposition supplied between 0.07 and 1.92 µmol P m^{-2} d^{-1} to the surface mixed layer.
- Neither diapycnal fluxes nor atmospheric deposition are sufficient to satisfy the estimated P demand in upper waters.
- DOP hydrolysis supplied between 6.8 and 235.8 µmol P m^{-2} d^{-1} to the surface mixed layer. Large variability in the contribution of DOP hydrolysis to estimated P requirements.



PEACETIME CRUISE

The PEACETIME oceanographic cruise took place onboard the R/V 'Pourquoi Pas?' in the Western/Central Mediterranean Sea in May–June, 2017. The purpose of this expedition was to study critical processes induced by atmospheric deposition, in particular Saharan dust, occurring at the air-sea interface in the Mediterranean Sea.

DATA AND CALCULATIONS

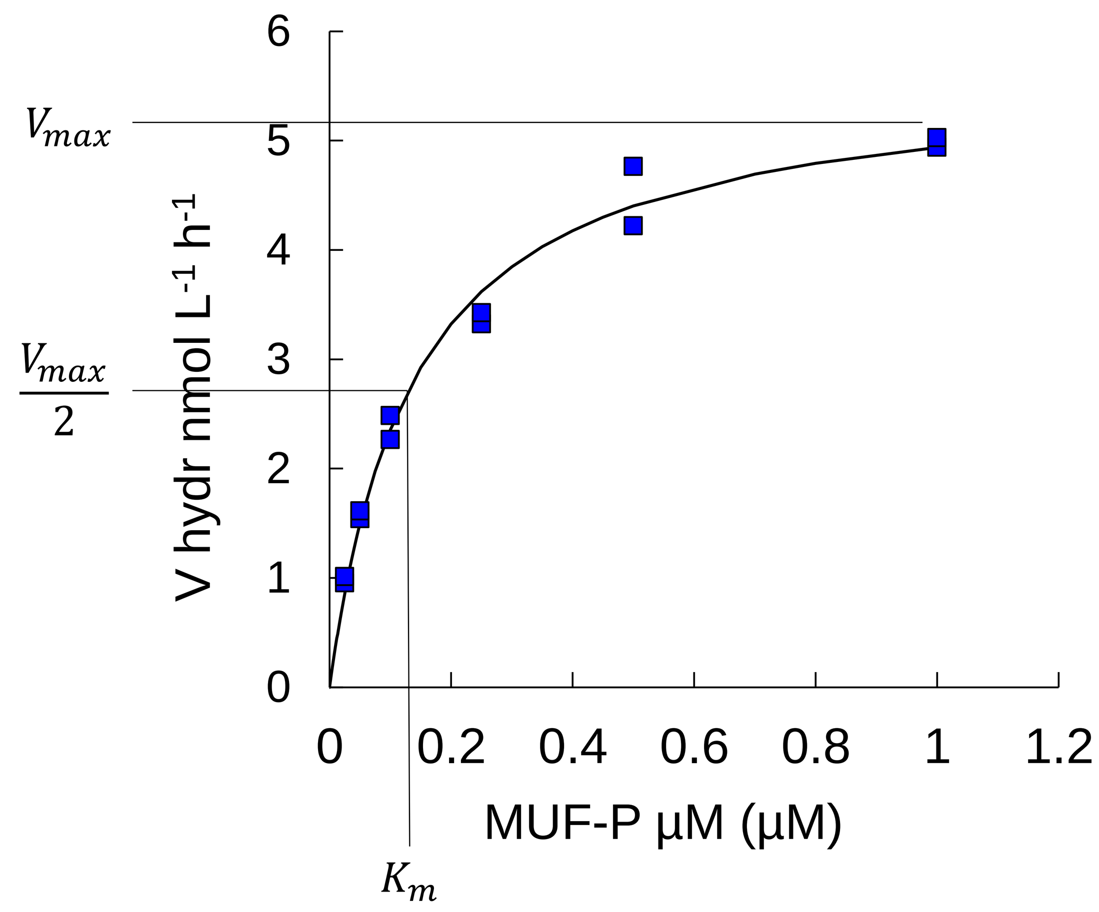
❖ **DIAPYCNAL FLUXES**: Fick's Law: $F = -K_z \frac{\partial C}{\partial z}$

- Kz (vertical diffusion coefficient) obtained from each station from a run of the SYMPHONIE model at the scale of the Mediterranean basin initialized in 2011
- ∂C/∂z (PO_4^{3-} concentration gradient) estimated as the slope (±SD) of the linear regression of PO_4^{3-} vs. depth in each layer.
- PO_4^{3-} concentration: molybdenum blue method using 2 m LWCC (DL = 1 nM).

❖ **ATMOSPHERIC FLUXES**: Free-contamination aerosols sampling operated all along the cruise. Two rains collected during FA and ION stations. Dry deposition fluxes estimated from P concentration in aerosols using deposition velocity of 1 cm s^{-1}. Wet deposition fluxes issued from rainwater P concentration. P analyses carried out by HR-ICP-MS directly for rainwater and after acid digestion for aerosol filters.

❖ **IN SITU DOP HYDROLYSIS FLUXES** $= \frac{V_{max} + [APDOP]}{K_m + [APDOP]}$

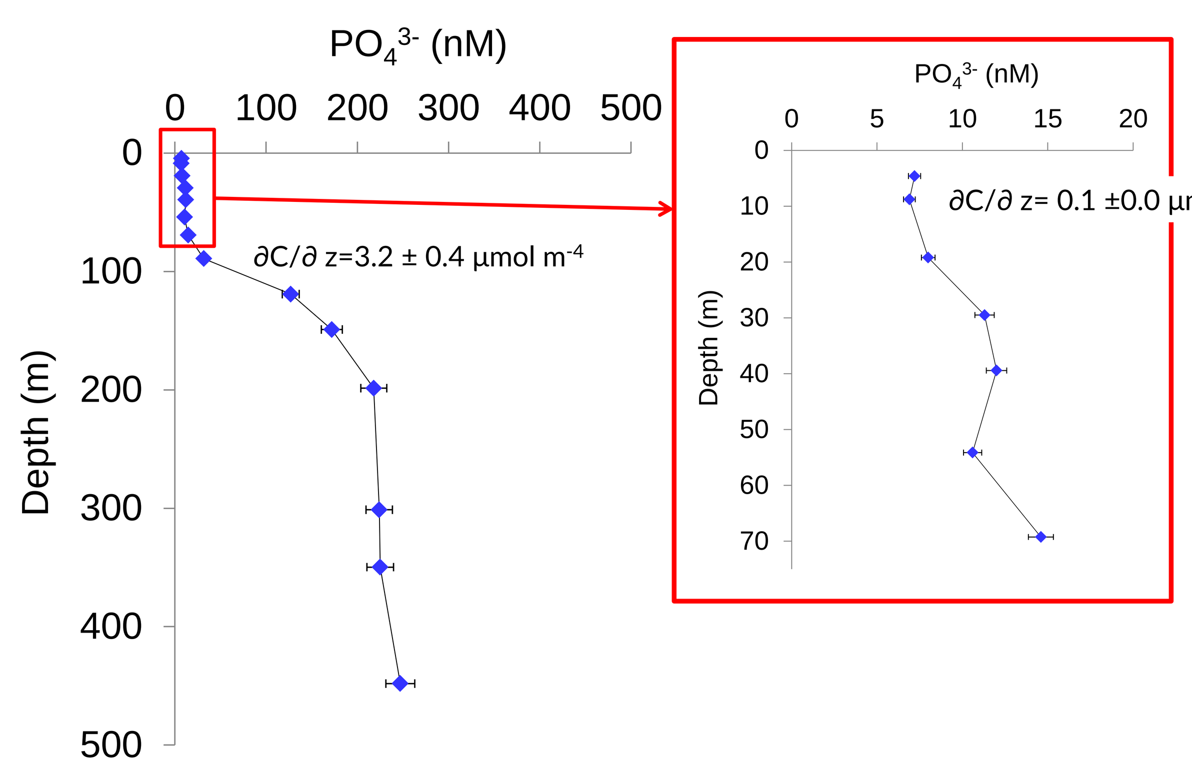
- V_{max}, K_m derived from Michaelis Menten fitting of MUF-P concentration kinetics.
- [APDOP]: DOP fraction potentially available to alkaline phosphatase, derived from DOP data and assuming an AP-hydrolysable fraction of 27 ± 10 % (Djaoudi et al. 2017)



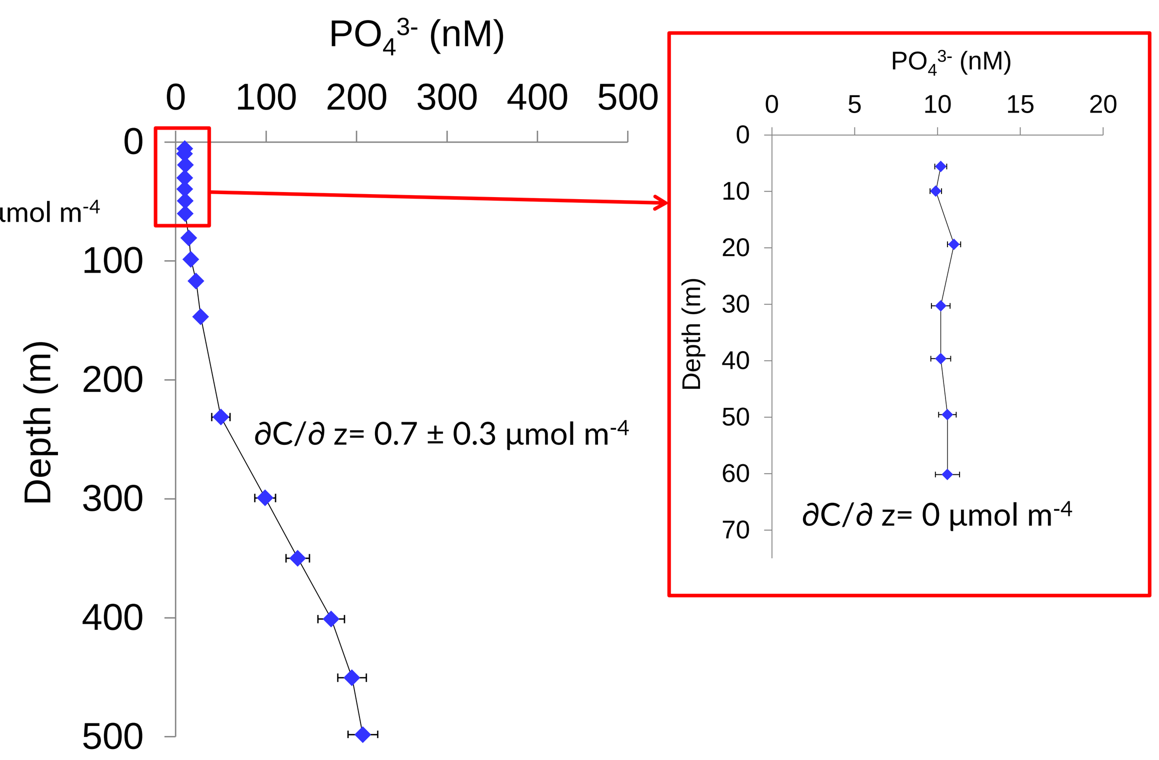
Example of Michaelis Menten fitting of MUF-P concentration kinetics and graphical representation of Vmax and Km. ION STATION, 5 m depth.

PHOSPHATE VERTICAL PROFILES: TWO EXAMPLES AT TYR AND ION STATIONS

TYR STATION



ION STATION

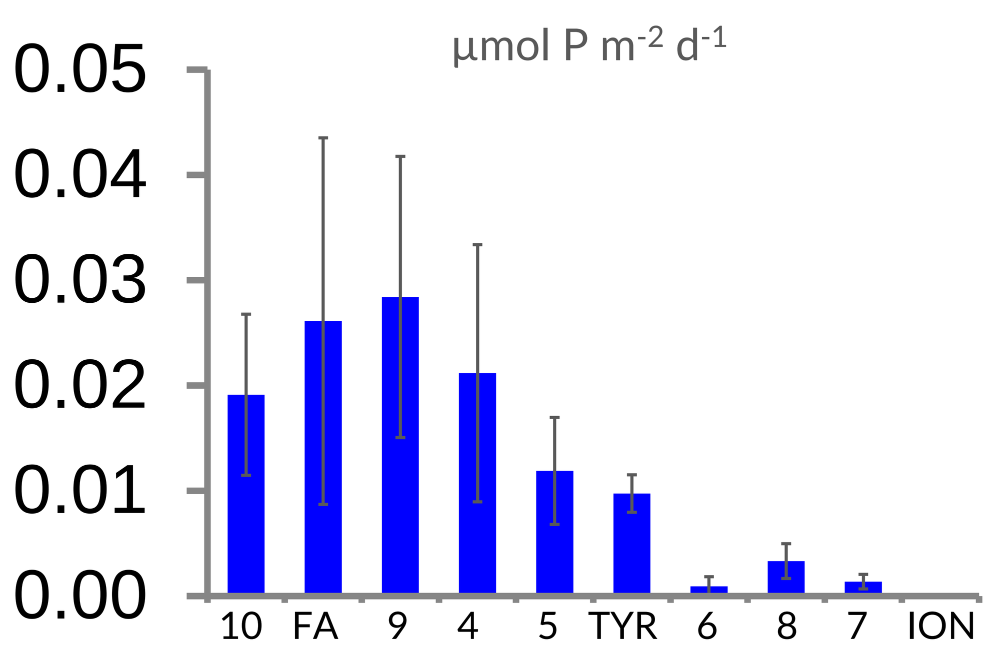


❖ Two distinct layers: a phosphate depleted layer (PDL), from the surface to the top of the phosphacline and a phosphate repleted layer (PRL), across the phosphacline to the base of the euphotic zone.

❖ Low but significant phosphate dC/dz in the PDL → diapycnal fluxes reaching the surface mixed layer (in all stations excepting ION).

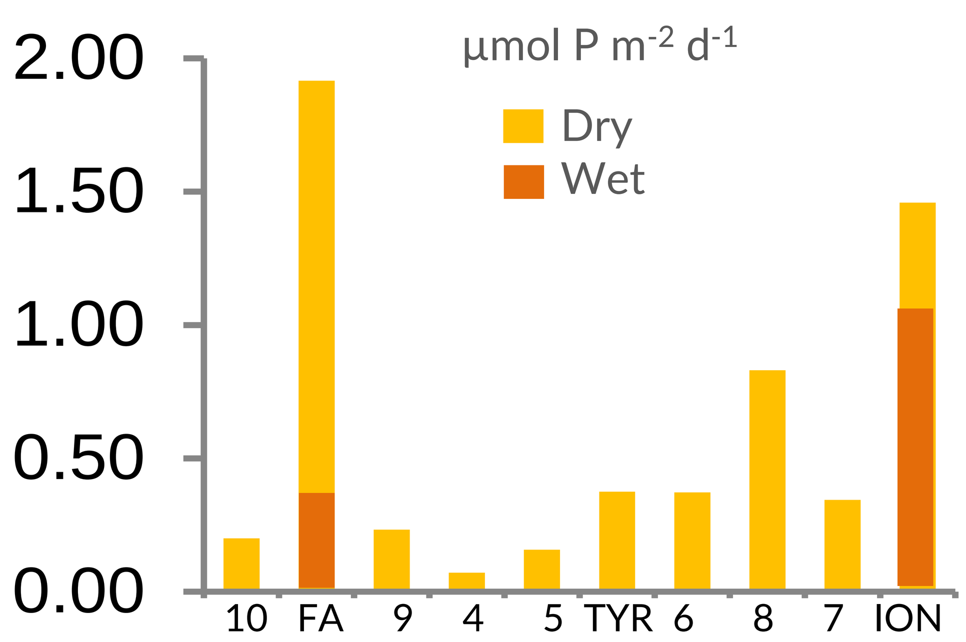
LONGITUDINAL VARIABILITY OF PHOSPHATE FLUXES TO THE SURFACE MIXED LAYER

DIAPYCNAL FLUXES

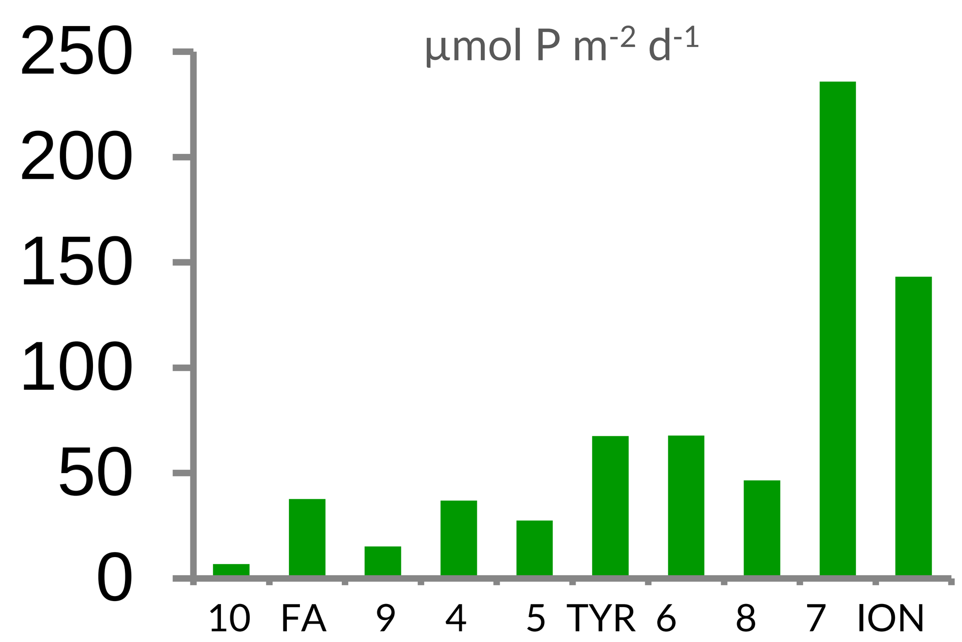


Decreasing west to east gradient

ATMOSPHERIC FLUXES

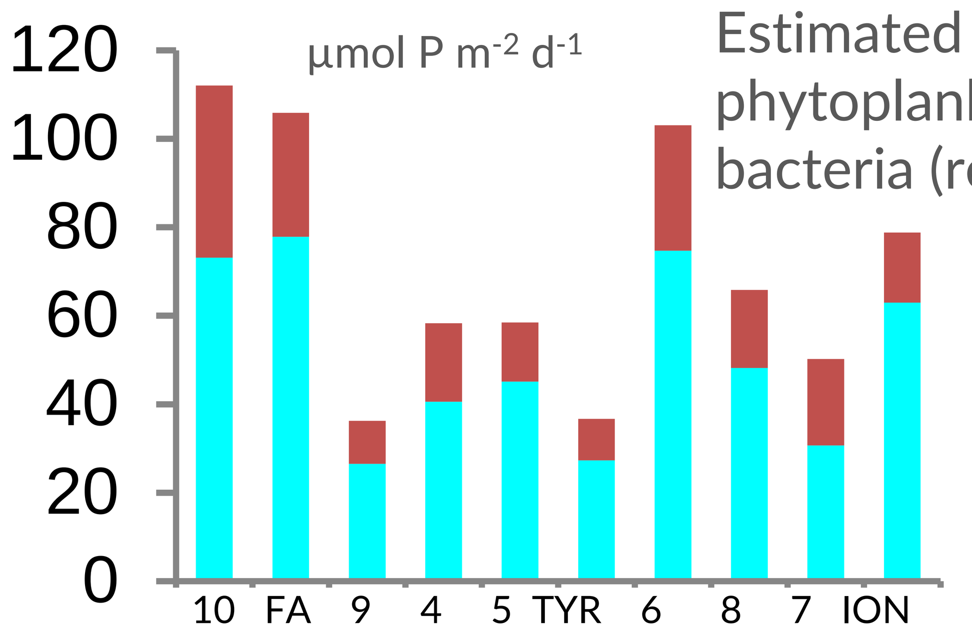


DOP HYDROLYSIS FLUXES



Increasing west to east gradient

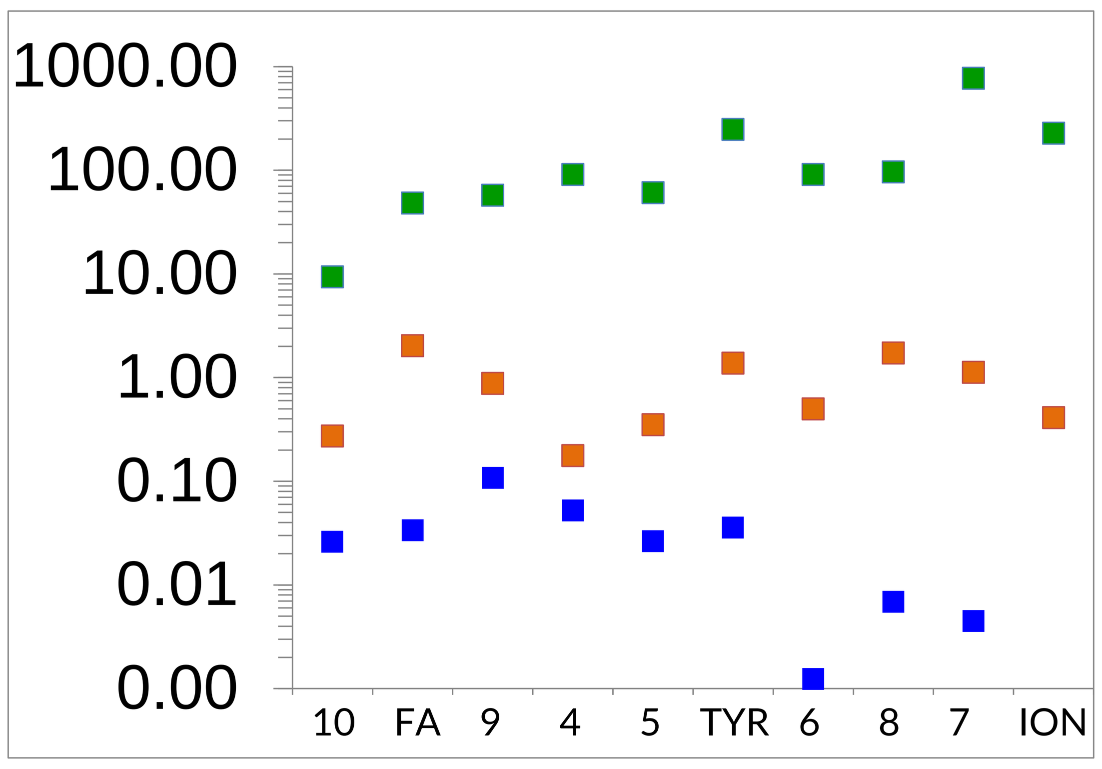
ANALYSIS OF EXTERNAL VS. INTERNAL SOURCES CONTRIBUTING TO PHOSPHATE REQUIREMENTS IN THE SURFACE MIXED LAYER



Estimated P requirements from phytoplankton (blue) and heterotrophic bacteria (red) in the surface mixed layer

External sources are not sufficient to satisfy the estimated P requirements in the surface mixed layer (0.2-2% contribution).

P supply is dominated by **internal sources** (DOP hydrolysis). Large range of contribution to P requirements from not sufficient (9% in st. 10) to largely exceeding (760% in st. 7)



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