Remote Sensing of Global Ocean Surface Phosphate
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Surface Phosphate (DIP) Variation
Dissolved inorganic phosphate (DIP) is one of the major bio-limiting nutrients.
We lack either autonomous or remote sensing approaches to consistently estimate variation in DIP.

Approach:
Mechanistically link axes of variation to satellite inputs
1st Axis, Latitudinal
Physical ocean properties
• SST, PAR, SSS
2nd Axis, Tropical upwelling
Particle optical properties
• Rrs, b0, a, chlor-a, poc, pic, plankton size fraction
• Nano-, pico-, micro-plankton
3rd Axis, Subtropical gyres
Iron stress
• Fe stress, AOT, dust deposition
4th Axis, Polar Oceans
Upwelling indicators
• wind stress, taux, tauy, curl,sla

GLODAP2 PO₄ ocf observations.
High = red, Low = blue.

Neural Network with Satellite Predictors
We test which combination of satellite inputs leads to the best prediction of surface [DIP].

SST alone covered 55% of global variation, but networks with NPP, SSS, and Dust Deposition captured gyre and equatorial upwelling regional gradients.

Artificial neural network models describe complex nonlinear response and interactions between remote sensing observations and [DIP].

Global Distribution DIPsat

Fit to DIP Observations
Including database of high sensitivity DIP measurements improves prediction at lowest concentrations.

Conclusions
- We predict 73% of the variation in surface ocean phosphate concentration using remote sensing inputs to a neural network model.
- The response of predicted phosphate to remote sensing inputs matches our mechanistic understanding of phosphate sources and sinks.
- Sea surface salinity and dust deposition improve accuracy of low phosphate levels among subtropical gyres.
- The influence of ice melt and land induced circulation changes may not be well captured in this model.

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References