Supplementary Material

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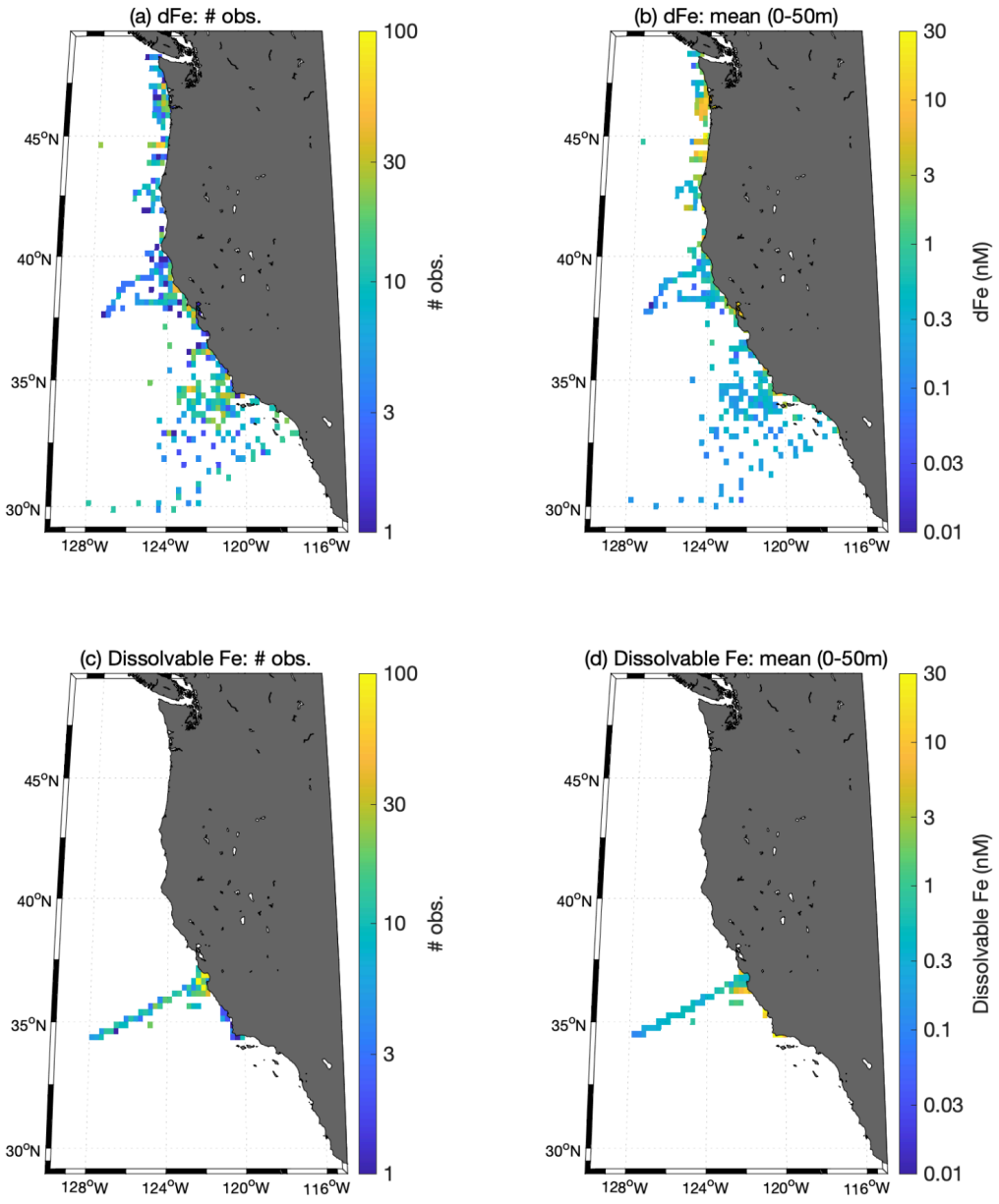

Figure S1. Fe dataset from the U.S. West Coast. (a) Number of truly dissolved Fe measurements for all depth levels within spatial cells of 0.25◦x 0.25◦horizontal resolution. (b) Mean truly dissolved Fe concentration (nM) in the 0-50 m depth range, averaged over the 0.25◦x 0.25◦cells

shown in (a). (c) Number of dissolvable Fe measurements for all depth levels within spatial cells of 0.25◦x 0.25◦horizontal resolution. (d) Mean dissolvable Fe concentration (nM) in the 0-50 m depth range, averaged over the 0.25◦x 0.25◦cells shown in (c).

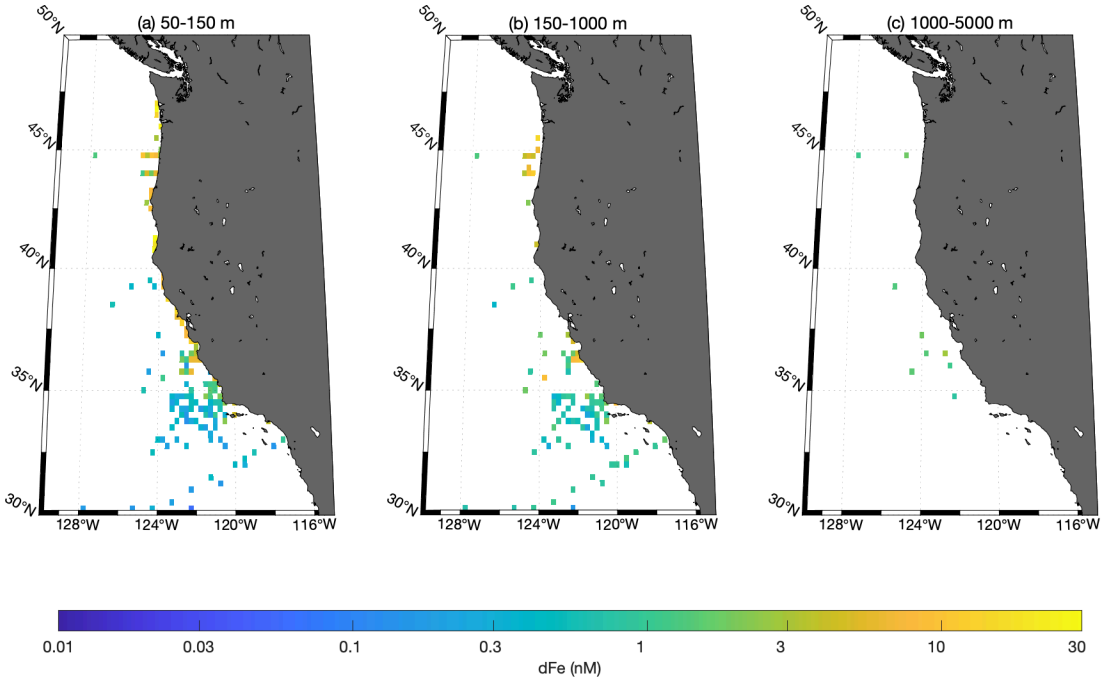

Figure S2. Dissolved iron dataset from the U.S. West Coast. Mean dFe concentration (nM) in the (a) 50-150 m; (b) 150-1000 m; and (c) 1000 - 5000 m depth range, averaged over the 0.25 degree x 0.25 degree cells.

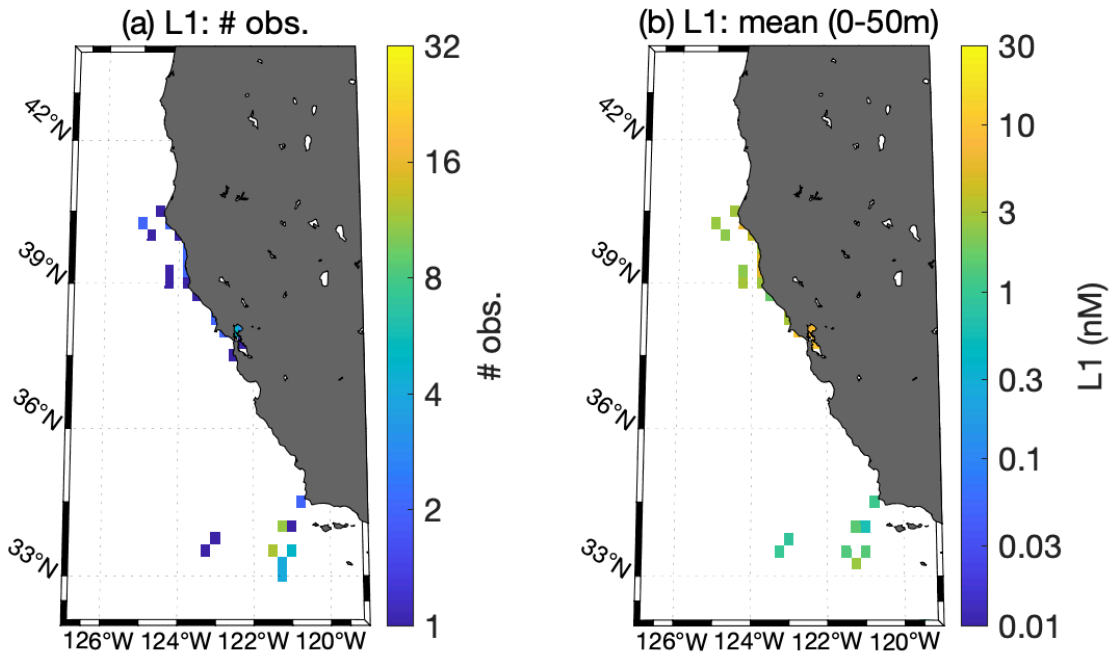

Figure S3. Ligand L1 dataset from the US West Coast. (a) Number of L1 measurements within spatial cells of 0.25 degree x 0.25 degree horizontal resolution. (b) Mean L1 concentration (nM) in the 0-50 m depth range, averaged over the 0.25 degree x 0.25 degree cells shown in (a).

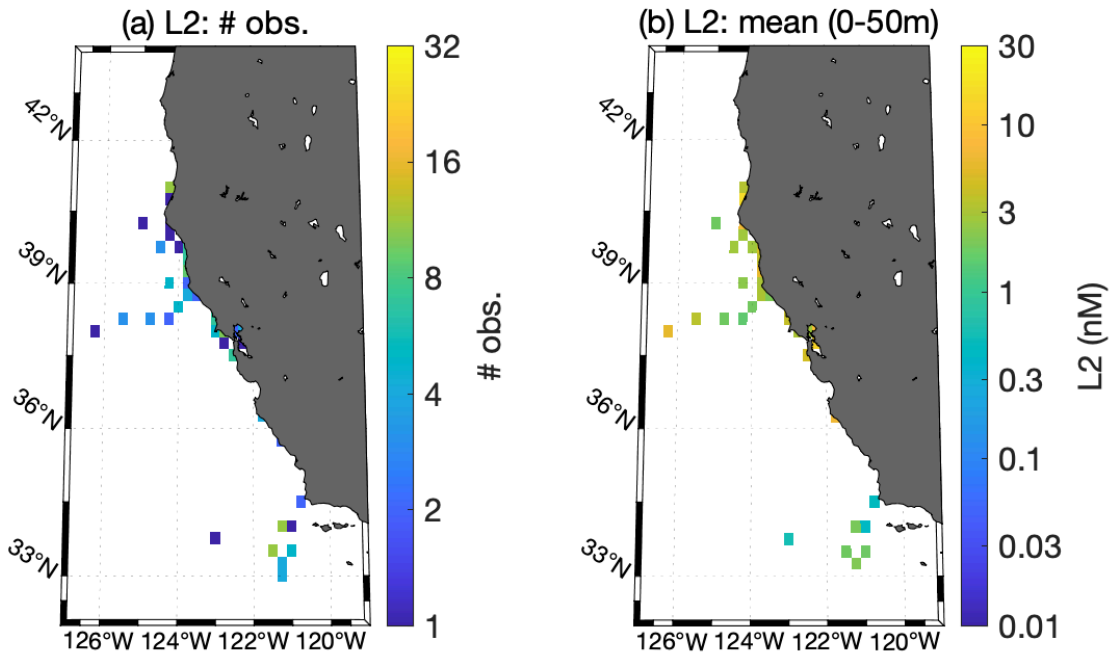

Figure S4. Ligand L2 dataset from the US West Coast. (a) Number of L2 measurements within spatial cells of 0.25 degree x 0.25 degree horizontal resolution. (b) Mean L2 concentration (nM) in the 0-50 m depth range, averaged over the 0.25 degree x 0.25 degree cells shown in (a).

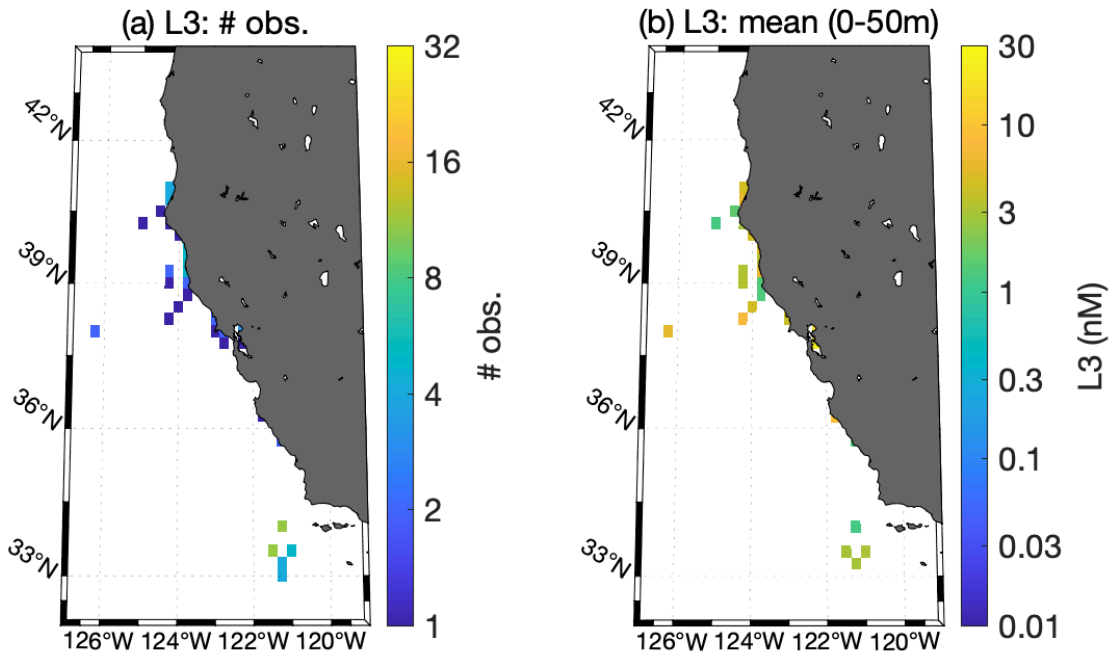

Figure S5. Ligand L3 dataset from the US West Coast. (a) Number of L3 measurements within spatial cells of 0.25 degree x 0.25 degree horizontal resolution. (b) Mean L3 concentration (nM) in the 0-50 m depth range, averaged over the 0.25 degree x 0.25 degree cells shown in (a).

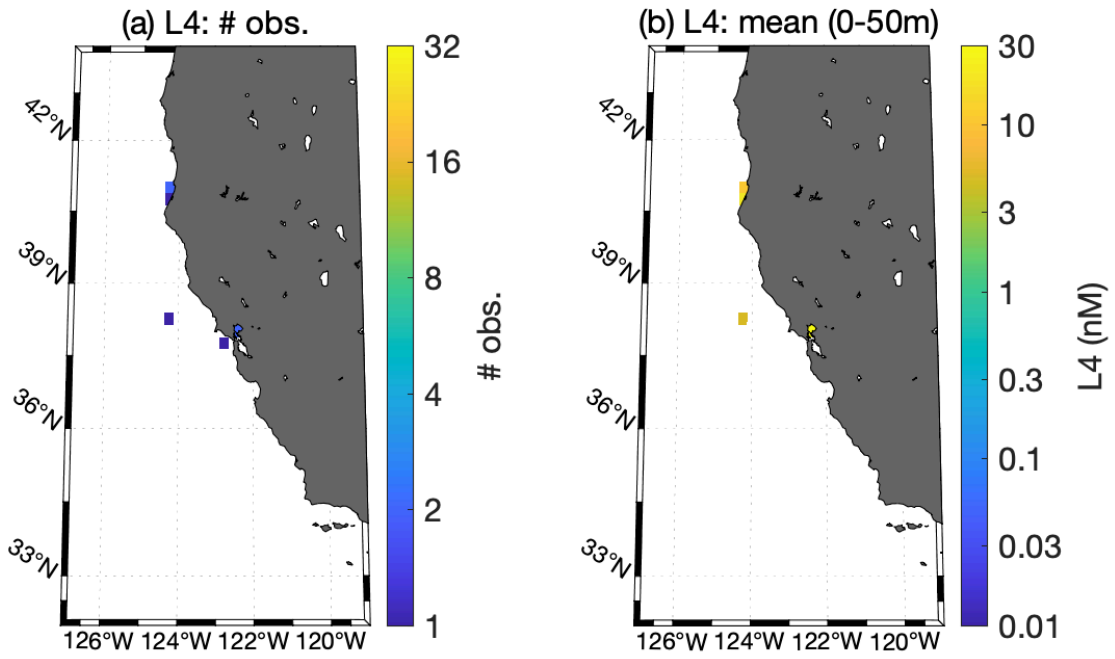

Figure S6. Ligand L4 dataset from the US West Coast. (a) Number of L4 measurements within spatial cells of 0.25 degree x 0.25 degree horizontal resolution. (b) Mean L4 concentration (nM) in the 0-50 m depth range, averaged over the 0.25 degree x 0.25 degree cells shown in (a).

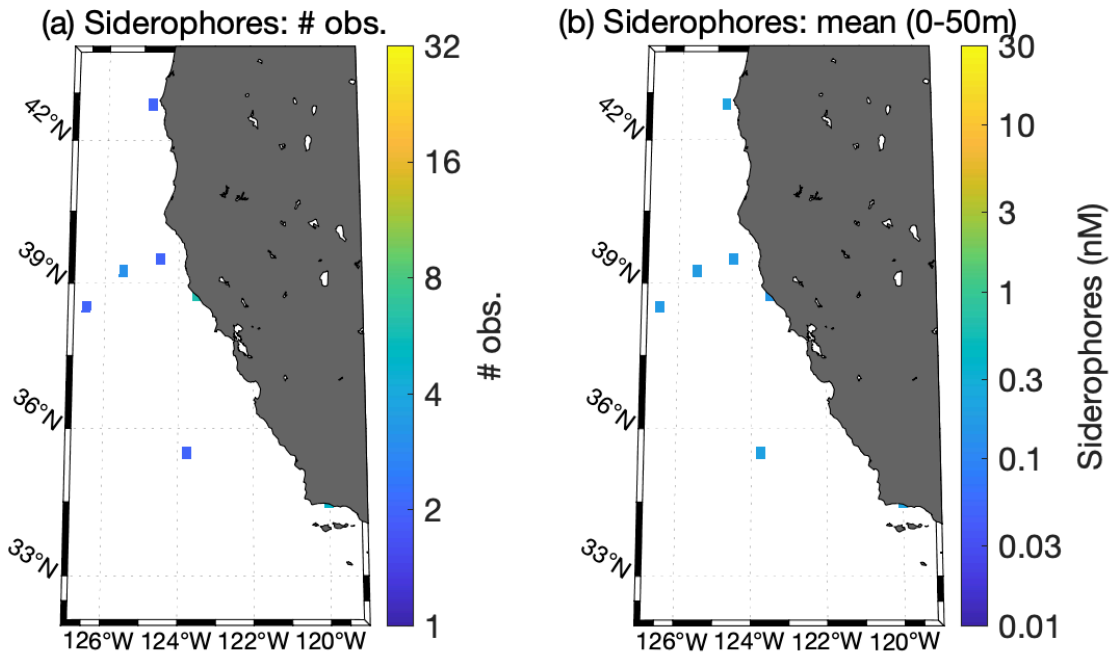

Figure S7. Siderophores dataset from the US West Coast. (a) Number of Siderophores measurements within spatial cells of 0.25 degree x 0.25 degree horizontal resolution. (b) Mean Siderophores concentration (nM) in the 0-50 m depth range, averaged over the 0.25 degree x 0.25 degree cells shown in (a).

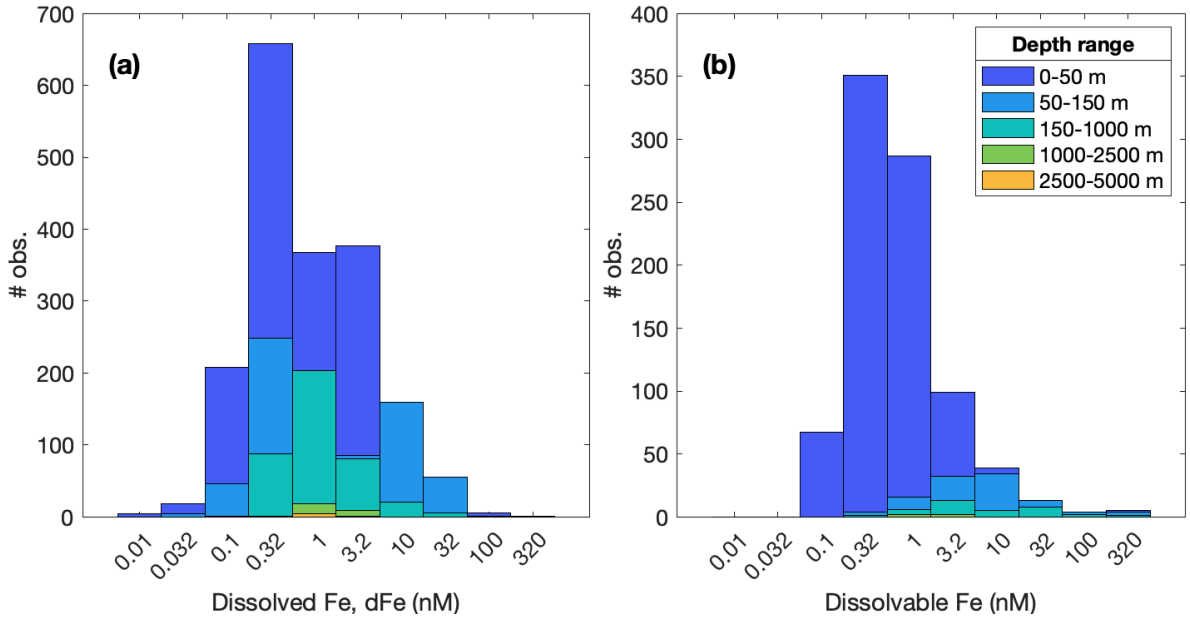

Figure S8. Histograms showing the number of measurements as a function of concentrations for (a) truly dissolved Fe (nM) and for (b) dissolvable Fe (nM), based on the data compilation. Colors show different depth ranges.

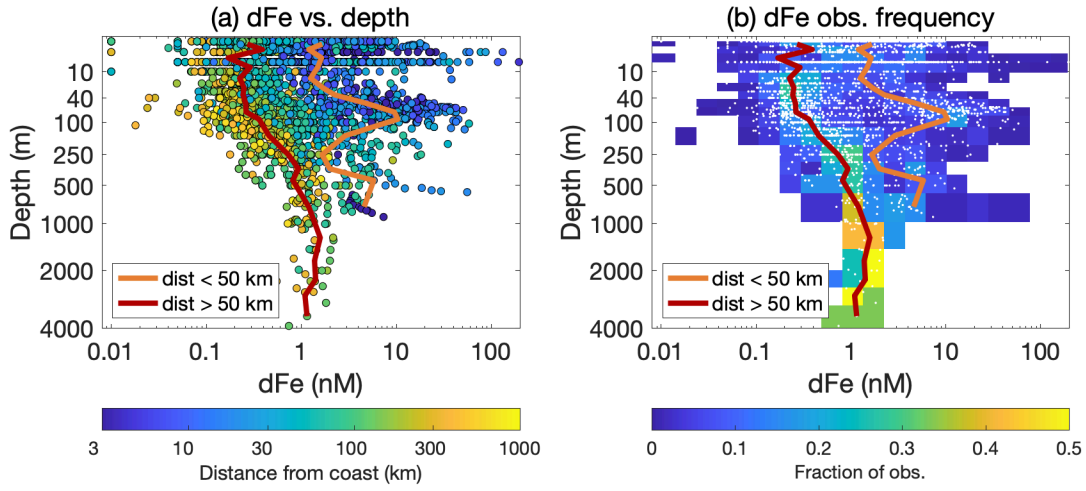

Figure S9. a) Vertical profile of truly dissolved Fe (nM) measurements along the US West Coast. Each dot represents a measurement, with colors showing the distance from shore (km). Solid orange and red lines show the median truly dFe for nearshore (< 50 km) and offshore (> 50 km) measurements, respectively. (b) Density distribution of truly dFe samples as a function of depth. Background colors show the probability distribution of truly dFe measurements at each depth, calculated as the fraction of measurements with a given concentration in each depth layer. White dots show individual measurements; solid orange and red lines the median truly dFe for nearshore (< 50 km) and offshore (> 50 km) measurements, respectively.

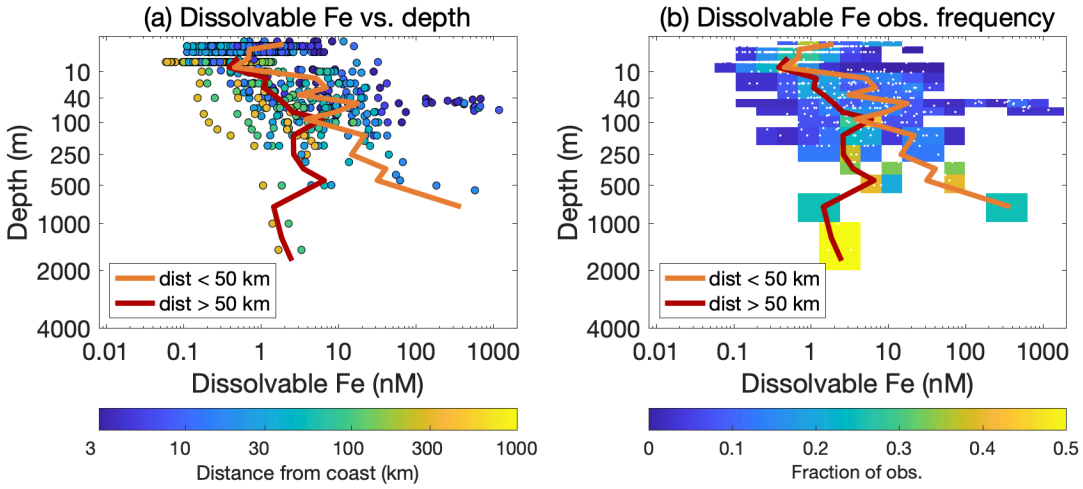

Figure S10. a) Vertical profile of dissolvable Fe (nM) measurements along the US West Coast. Each dot represents a measurement, with colors showing the distance from shore (km). Solid orange and red lines show the median dissolvable Fe for nearshore (< 50 km) and offshore (> 50 km) measurements, respectively. (b) Density distribution of dissolvable Fe samples as a function of depth. Background colors show the probability distribution of dissolvable Fe measurements at each depth, calculated as the fraction of measurements with a given concentration in each depth layer. White dots show individual measurements; solid orange and red lines the median dissolvable Fe for nearshore (< 50 km) and offshore (> 50 km) measurements, respectively.

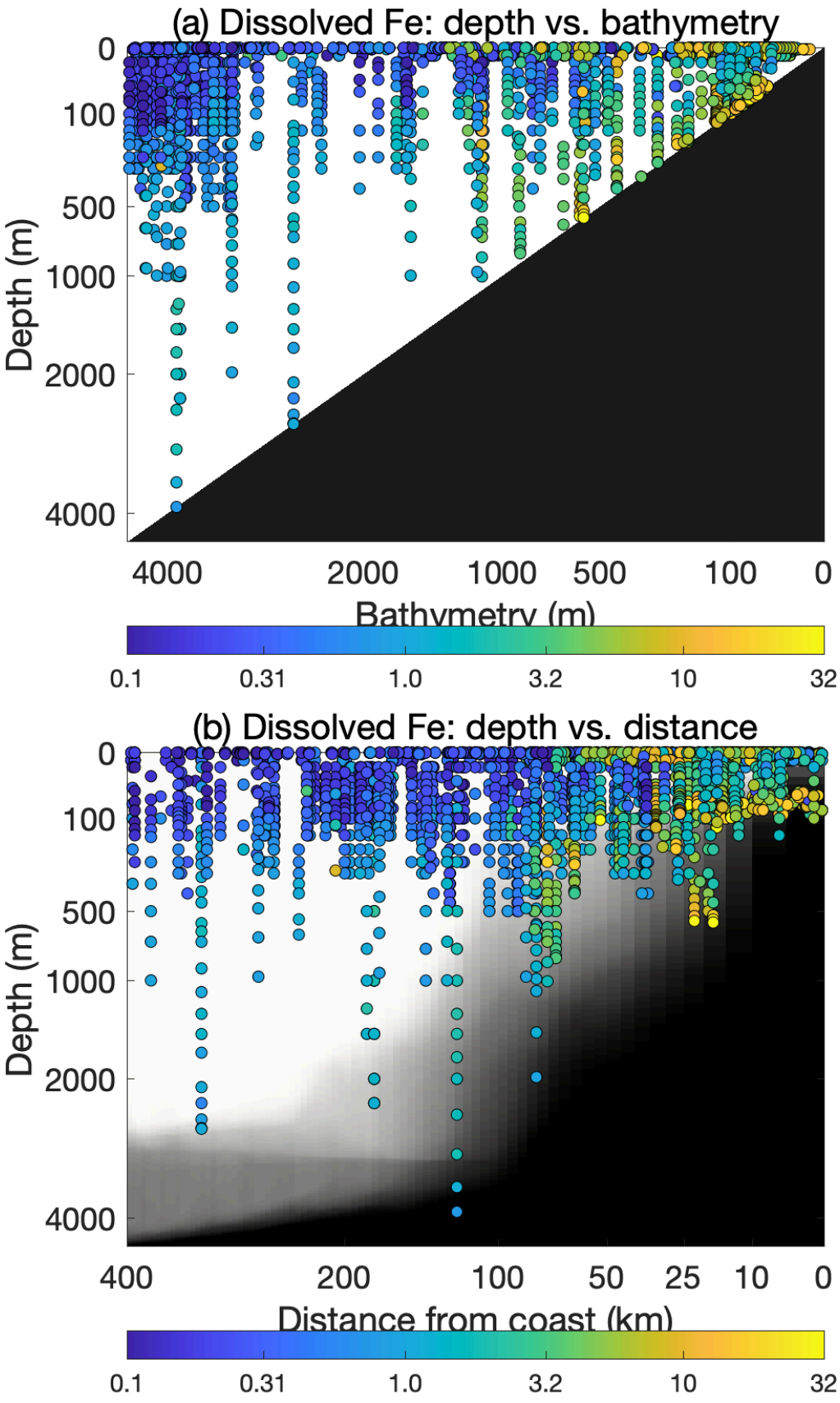
(a) Dissolved Fe: depth vs. bathymetry
Depth (m)
0
100
500
1000
2000
4000
4000
2000
1000
500
100
0
Bathymetry (m)
0.1
0.31
1.0
3.2
10
32
(b) Dissolved Fe: depth vs. distance
Depth (m)
0
100
500
1000
2000
4000
400
200
100
50
25
10
0
Distance from coast (km)
0.1
0.31
1.0
3.2
10
32

Figure S11: Truly dFe (nM) distribution along the US West Coast continental margin as a function of (a) seafloor depth (m) and (b) distance from shore (km). Seafloor depth is derived from the ETOPO bathymetry database at 15” resolution. In (a), black shading indicates locations below the seafloor. In (b), grayscale shading shows a histogram of bottom depths, calculated as the proportion of water column vs. seafloor at each distance bin, ranging from 100% water column (white) to 100% below seafloor (black)

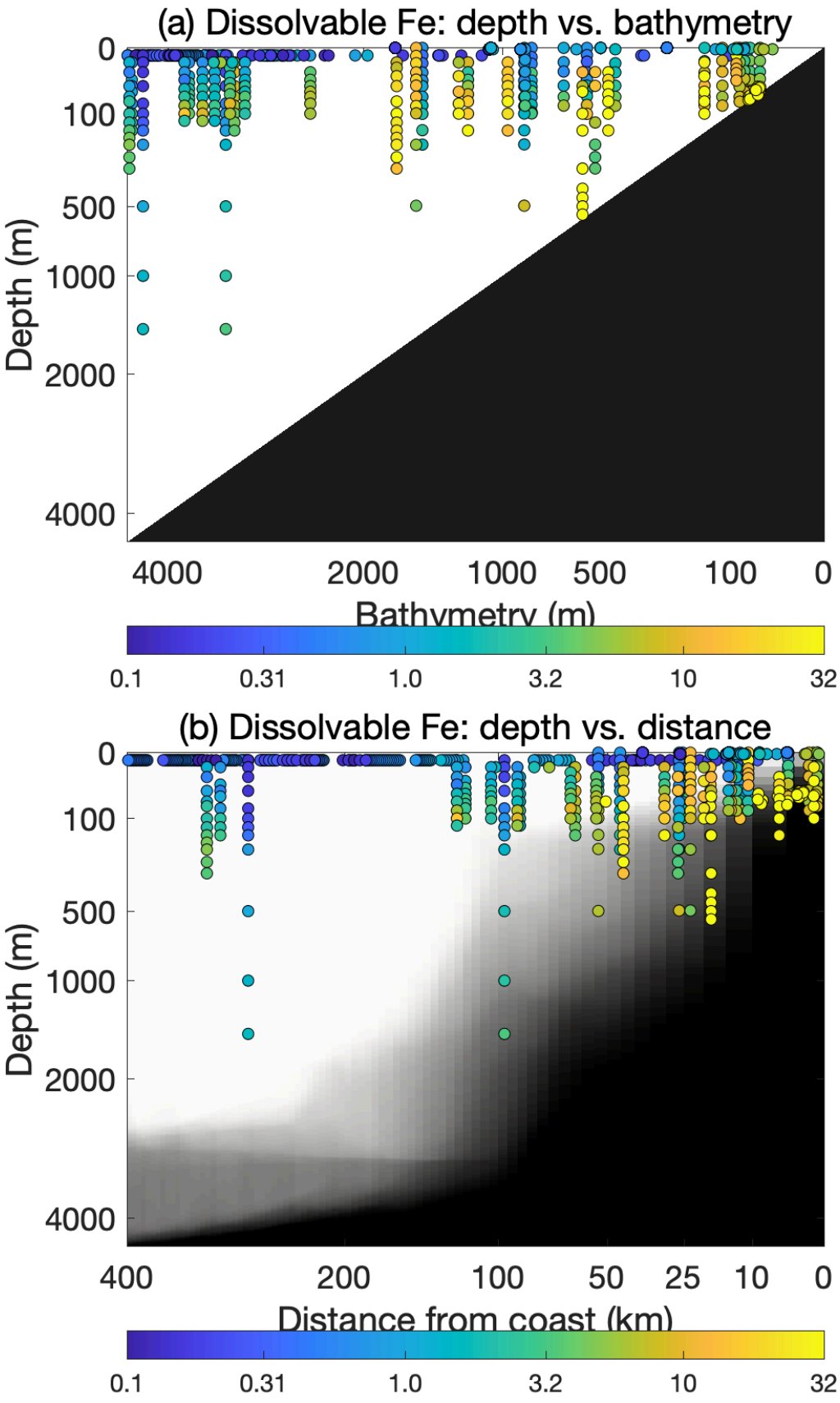
(a) Dissolvable Fe: depth vs. bathymetry
Depth (m)
0
100
500
1000
2000
4000
4000
2000
1000
500
100
0
Bathymetry (m)
0.1
0.31
1.0
3.2
10
32
(b) Dissolvable Fe: depth vs. distance
Depth (m)
0
100
500
1000
2000
4000
400
200
100
50
25
10
0
Distance from coast (km)
0.1
0.31
1.0
3.2
10
32

Figure S12. Dissolvable Fe (nM) distribution along the US West Coast continental margin as a function of (a) seafloor depth (m) and (b) distance from shore (km). Seafloor depth is derived from the ETOPO bathymetry database at 15” resolution. In (a), black shading indicates locations below the seafloor. In (b), grayscale shading shows a histogram of bottom depths, calculated as the proportion of water column vs. seafloor at each distance bin, ranging from 100% water column (white) to 100% below seafloor (black)

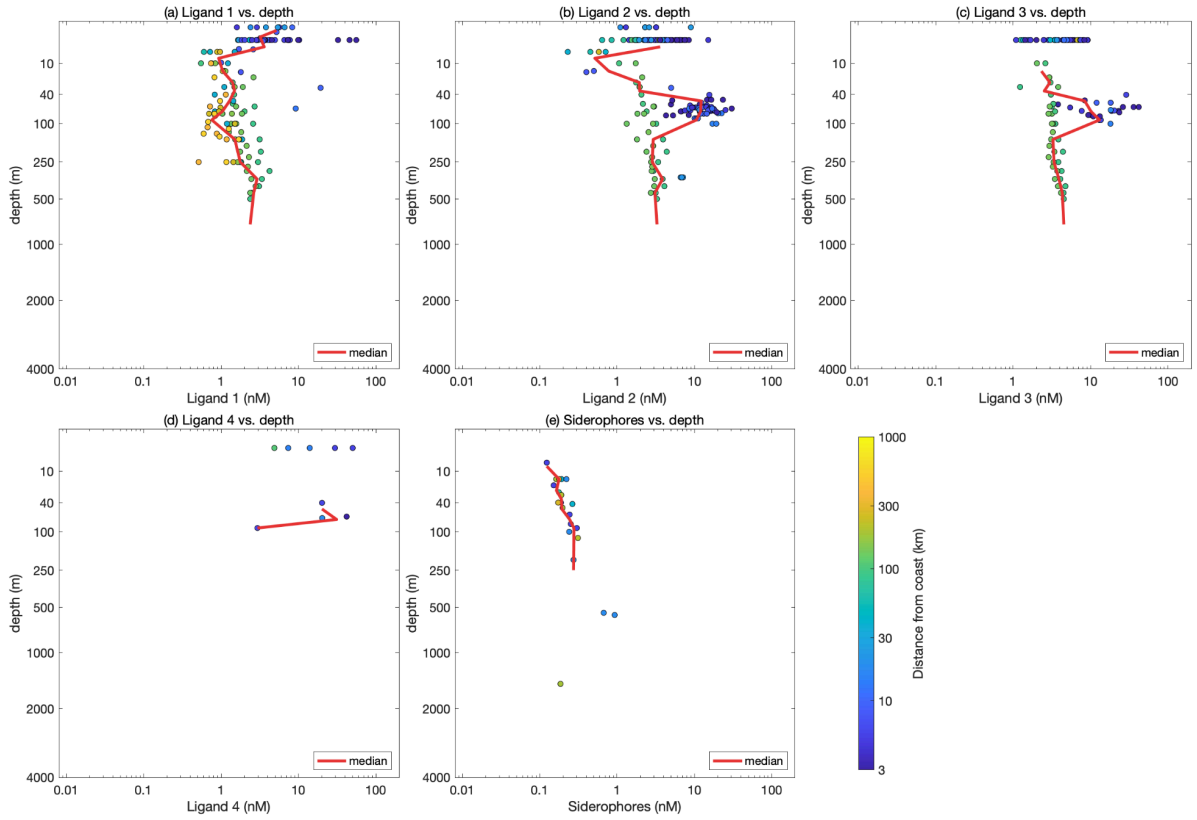

Figure S13. (a) Vertical profile of (a) L1, (b) L2, (c) L3, (d) L4, (e) Siderophores (nM) along the US West Coast. Each dot represents a measurement, with colors showing the distance from shore (km). Red lines show the median ligand concentrations.

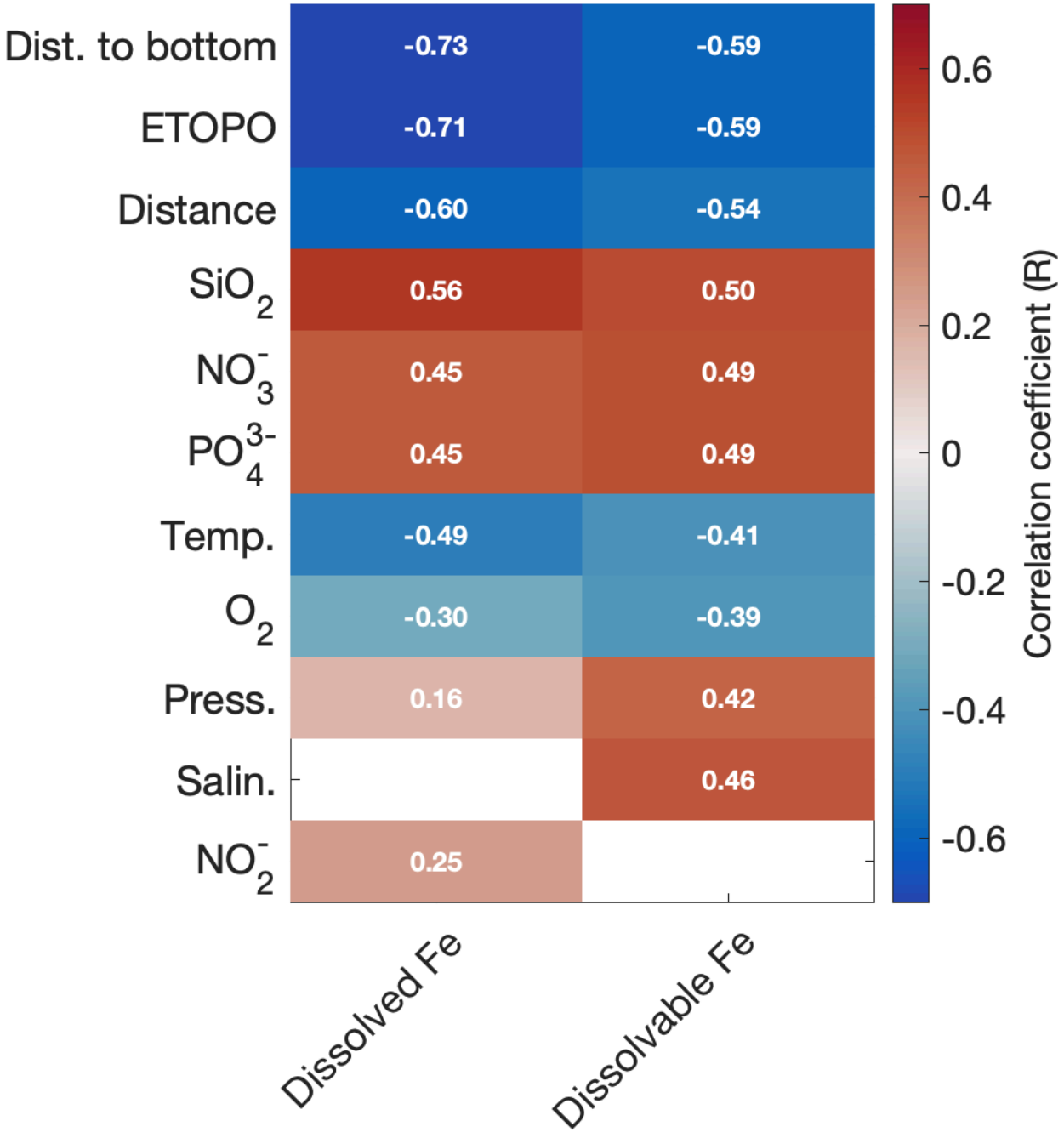

Figure S14. Correlation coefficients between dissolvable Fe (nM) and other co-located environmental variables. Co-location was performed by averaging all variables onto a horizontal grid with a resolution of 0.25◦x0.25◦(see Figure 1), and does not consider the time of year of the observations. Log-transformations of all variables were taken before calculating the correlations. Only correlations significant at $p<0.01$ are shown.

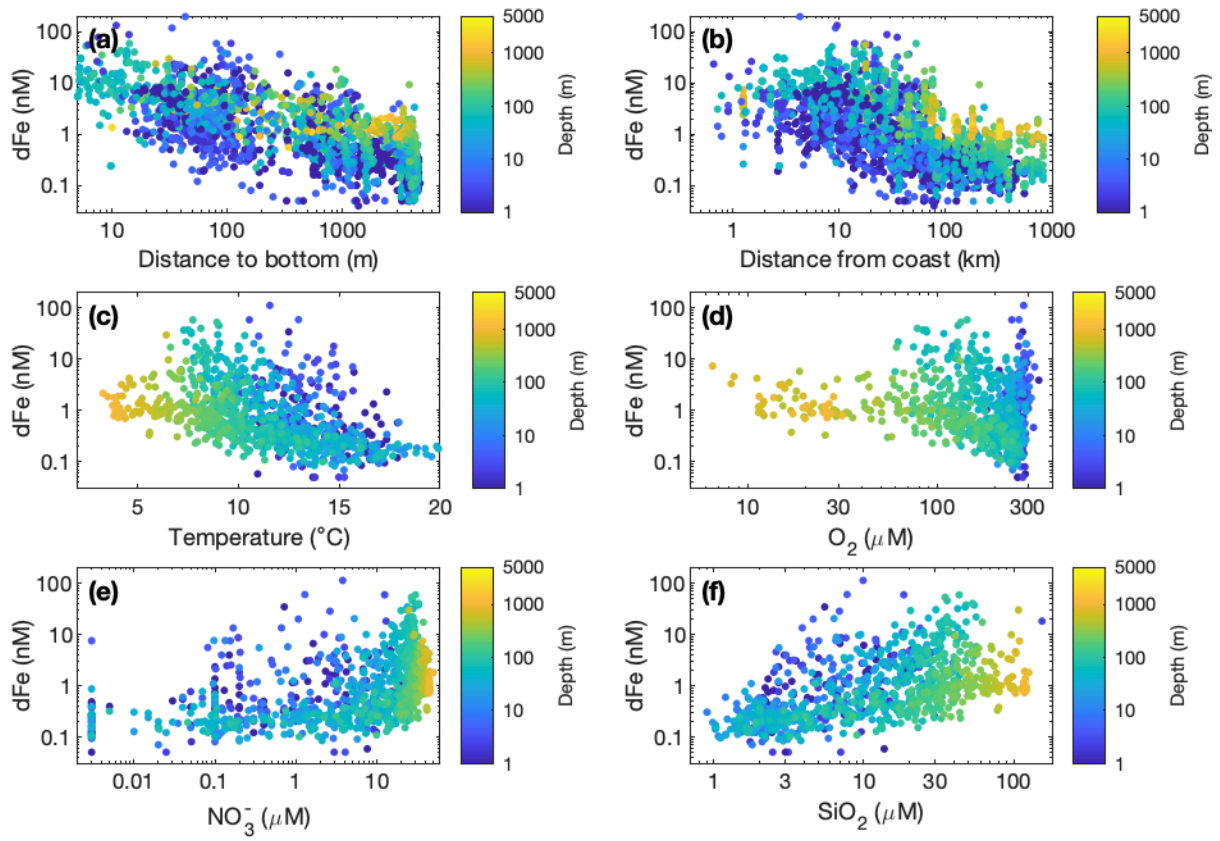

Figure S15. Relationship between truly dissolved Fe concentrations (nM) and co-located environmental vari-ables along the US West Coast. Co-location was performed by mapping all variables onto a three-dimensional grid with a horizontal resolution of 0.25◦and 32 unevenly spaced vertical levels (see Figure 1), at monthly climatological resolution, irrespective of the year of the measurements. Colors show depth (m).

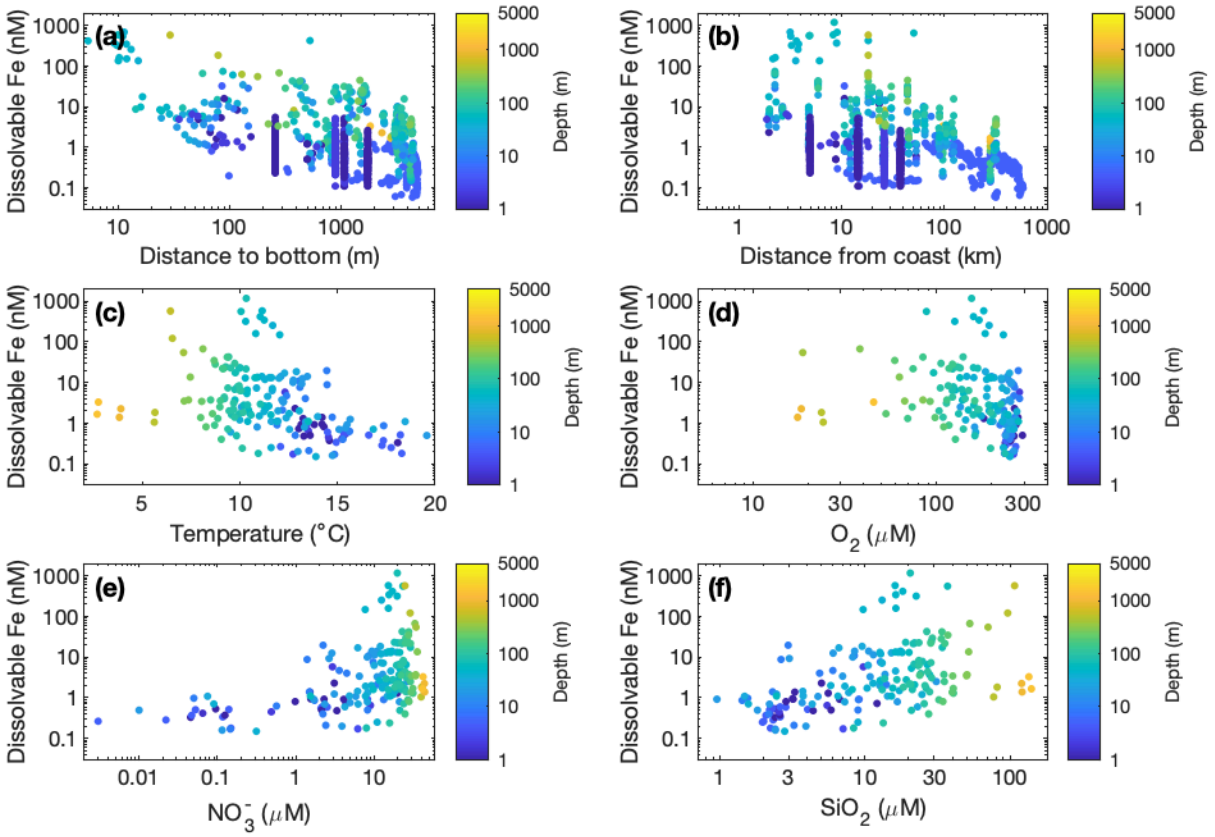

Figure S16. Relationship between dissolvable Fe concentrations (nM) and co-located environmental vari-ables along the US West Coast. Co-location was performed by mapping all variables onto a three-dimensional grid with a horizontal resolution of 0.25◦and 32 unevenly spaced vertical levels (see Figure 1), at monthly climatological resolution, irrespective of the year of the measurements. Colors show depth (m).

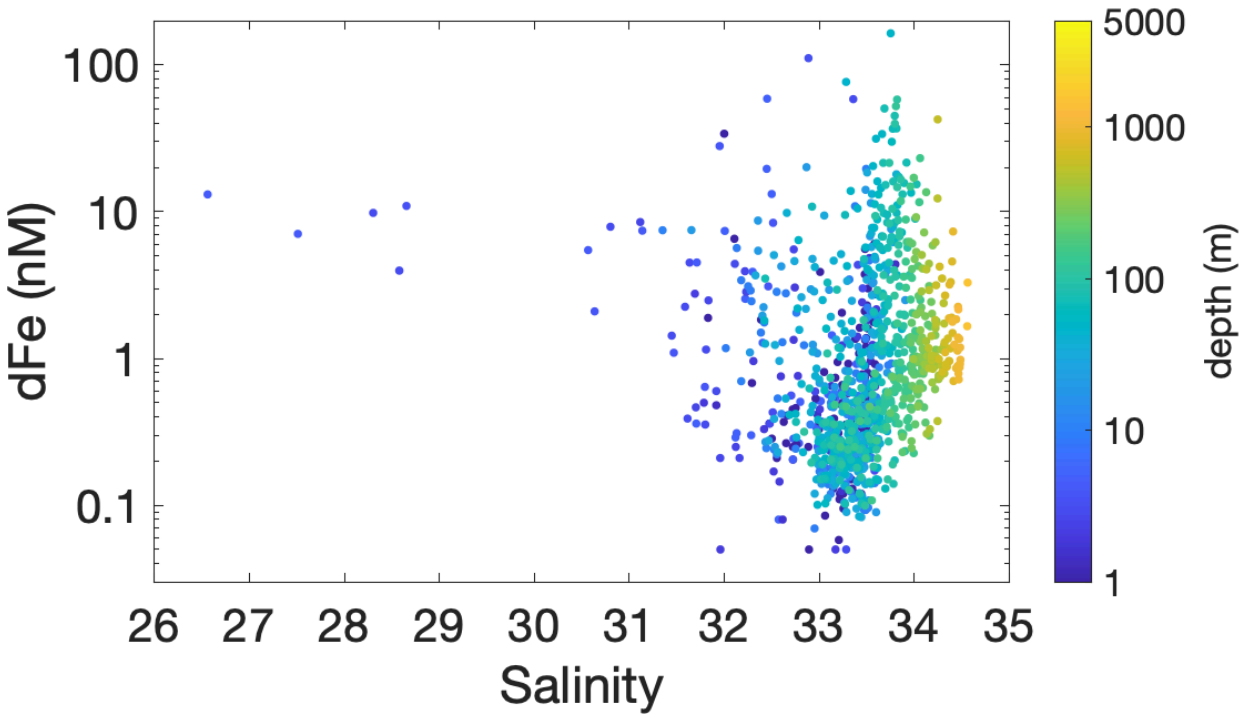

Figure S17: Relationship between dFe concentrations (nM) and co-located salinity along the US West Coast. Co-location was performed by mapping all variables onto a three-dimensional grid with a horizontal resolution of 0.25◦and 32 unevenly spaced vertical levels (see Figure 1), at monthly climatological resolution, irrespective of the year of the measurements. Colors show depth (m).

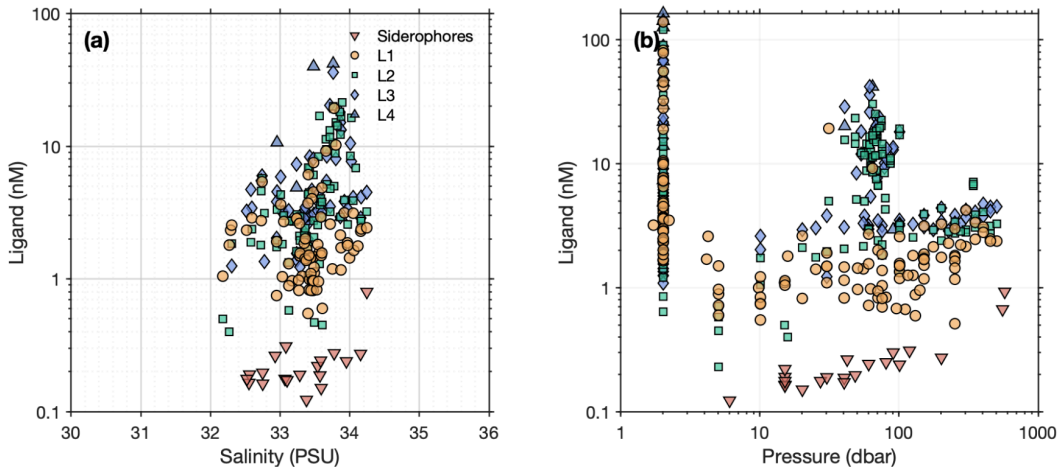

Figure S18: Relationship between ligand concentrations (nM) and co-located salinity (a) and pressure (b) along the US West Coast. Co-location was performed by mapping all variables onto a three-dimensional grid with a horizontal resolution of 0.25◦and 32 unevenly spaced vertical levels (see Figure 1), at monthly climatological resolution, irrespective of the year of the measurements. Colors show depth (m). Different colored symbols represent different types of ligands (Siderophores, L1, L2, L3, and L4 - see the legend and section 2).

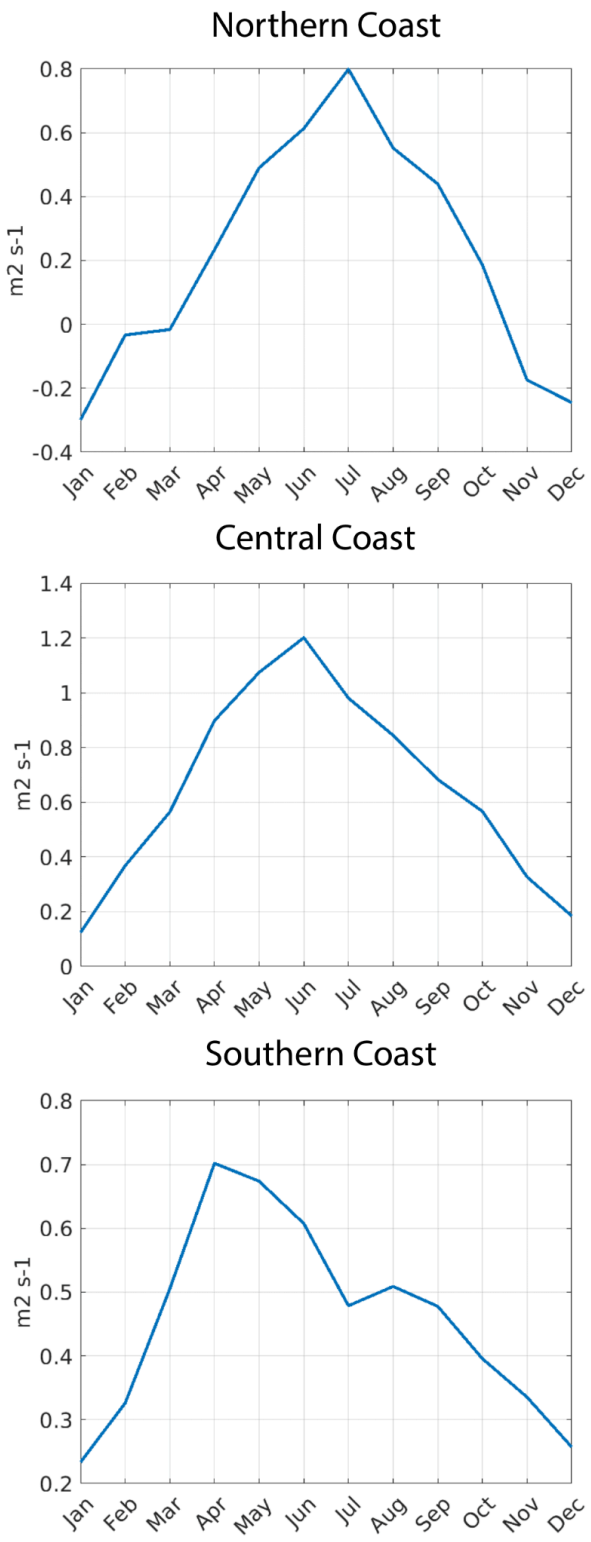

Figure S19: Monthly climatology of the Coastal Upwelling Transport Index (CUTI: vertical volume transport - m^2/s) averaged over the period 1988- 2025 along the (a) Northern USWC, (b) Central USWC, and (c) Southern USWC.

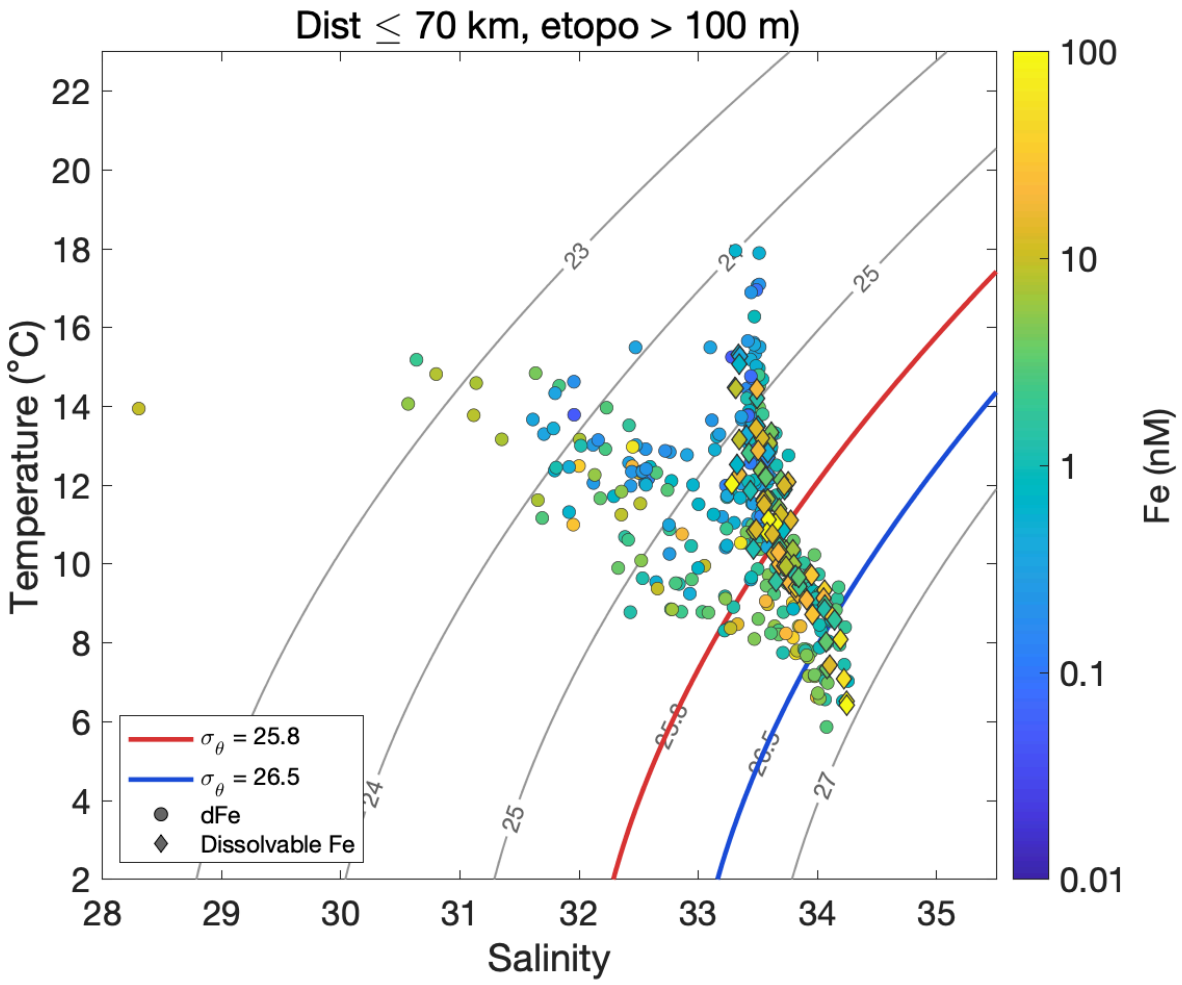

Figure 20. Temperature-salinity (T-S) diagram of truly dissolved Fe (circles) and dissolvable Fe (diamonds) concentrations (nM, color scale) from coastal stations of the U.S. West Coast compilation within 70 km of the coast and off the continental shelf (bottom depth >100 m). Both Fe types are colored on a shared $\log_{10}$ scale. Gray contours show potential density anomaly (σθ, kg m^{-3}). The red and blue lines highlight the σθ = 25.8 and σθ = 26.5 isopycnals, respectively, which bracket the core density range of the California Undercurrent (CUC) as defined by Bograd et al. (2019).

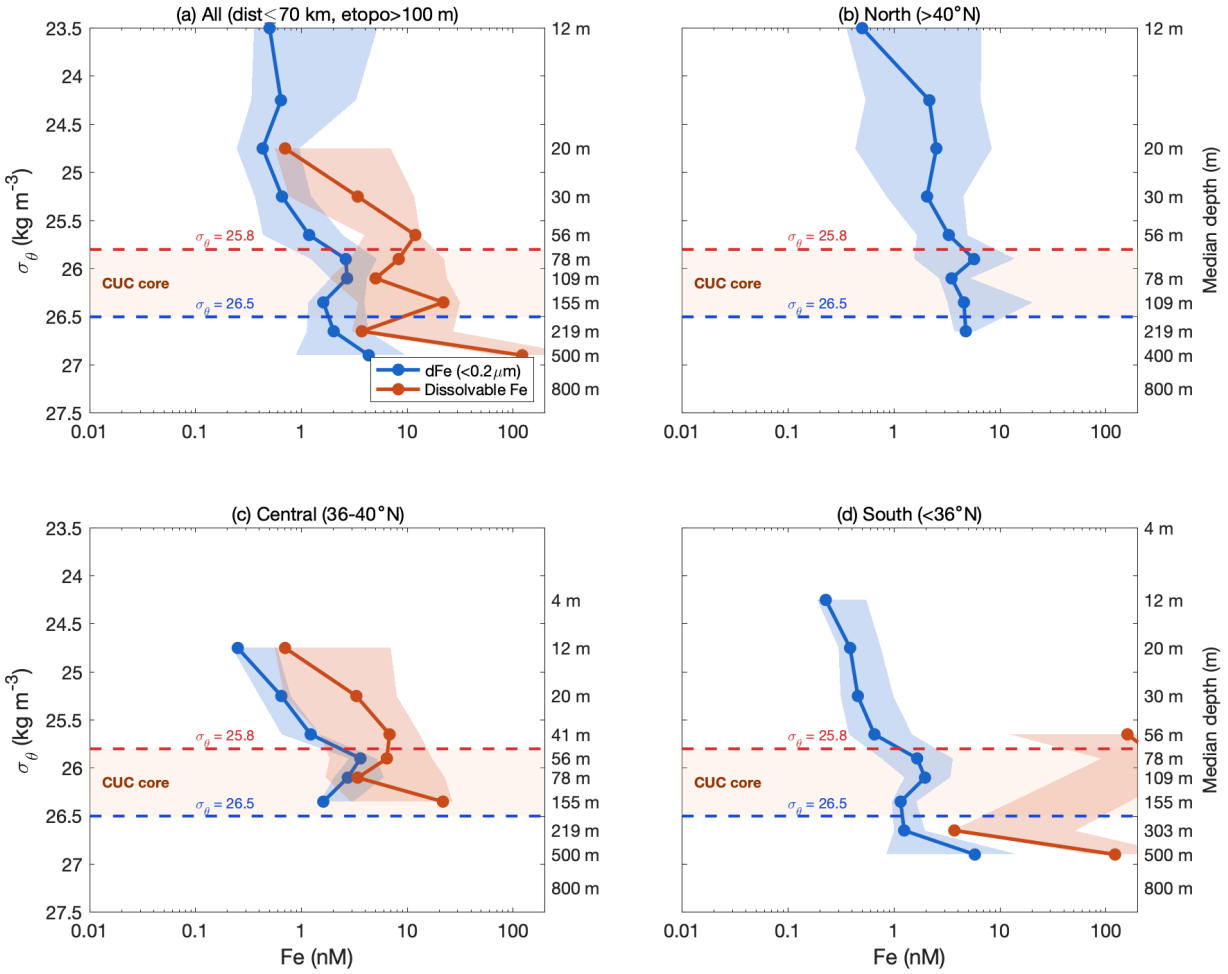

Figure S21. Median truly dissolved Fe (blue) and dissolvable Fe (orange) concentrations (nM) as a function of potential density anomaly (σ_θ, kg m⁻³) for (a) the full U.S. West Coast coastal domain and three latitudinal subregions: (b) North (>40°N), (c) Central (36–40°N), and (d) South (<36°N). All panels are restricted to coastal stations within 70 km of the coast and off the continental shelf (bottom depth >100 m). Lines show the median concentration within each density bin and shaded envelopes show the interquartile range (25th–75th percentile). The right-hand axis shows the median depth (m) corresponding to each density bin. The red and blue dashed lines mark σ_θ = 25.8 and σ_θ = 26.5 kg m⁻³, respectively, which bracket the core density range of the California Undercurrent (CUC; shaded orange band) following Bograd et al. (2019) and Zaba et al. (2021).

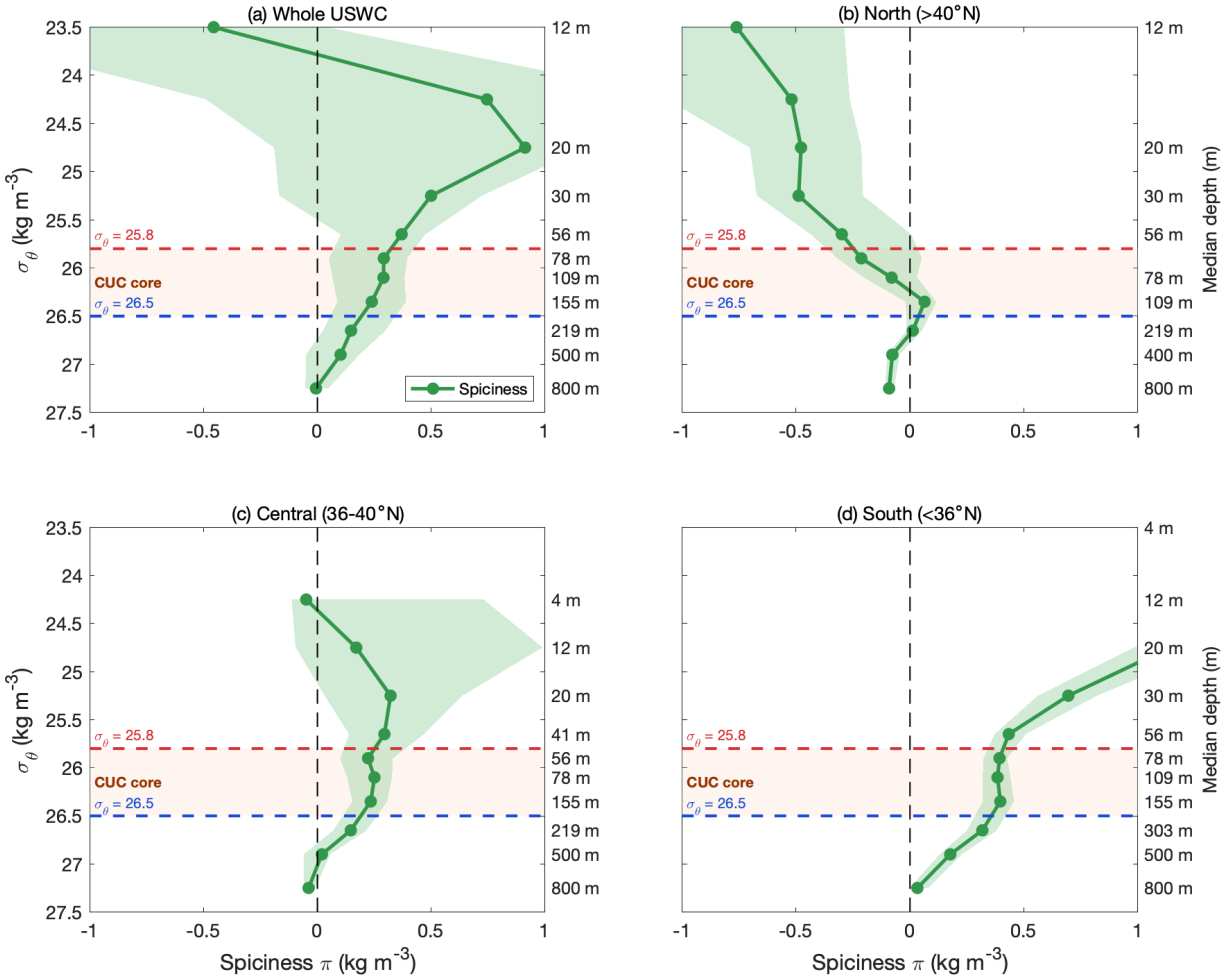

Figure S22: Vertical distribution of spiciness (π, kg m⁻³) as a function of potential density (σ_θ, kg m⁻³) for **(a)** the whole U.S. West Coast (USWC) domain and the **(b)** North (>40°N), **(c)** Central (36–40°N), and **(d)** South (<36°N) subregions. Green circles and lines show the median spiciness in each σ_θ bin (bin edges as in Fig. S21); shading shows the 25th–75th percentile range. The right-hand axis in each panel gives the median observed depth (m) corresponding to each σ_θ bin. The dashed black vertical line marks π = 0. The shaded orange band and red/blue dashed horizontal lines mark the core density layer of the California Undercurrent (CUC; σ_θ = 25.8–26.5 kg m⁻³), following the isopycnal framework of Bograd et al. (2019). Data are restricted to off-shelf, near-coastal grid cells (0 < distance-to-coast ≤ 70 km; bottom depth [ETOPO] > 100 m) to isolate the CUC pathway from broader shelf and open-ocean variability.

Spiciness was computed from gridded median temperature and salinity fields using TEOS-10 conservative temperature and absolute salinity following McDougall and Krzysik (2015).

Tables

Table S1. Data sources for the dFe and ligand compilation, along with information on the measurement methods, the type of dFe and ligands measured, and sample treatments as described in the original studies (Please see those studies for more information).

Data Sources	Period and Region Covers	Measurement methods	Iron (and Ligand if any) Measurement Type	Sample Treatments
1. Landing and Bruland, 1987 (The contrasting biogeochemistry of iron and manganese in the Pacific Ocean);	1978-1980; 124W and 36N	Samples were collected in 30 L, Teflon-lined, General Oceanics Go-Flo bottles.	Dissolved and particulate Fe. dFe are all Fe species passing through a 0.3µm filter.	All dissolved samples were acidified to a pH <2 with 4mL of sub-boiling quartz distilled 6M HCl per liter of sample and stored in pre-cleaned conventional polyethylene (CPE) bottles. The filters bearing suspended particulates were rinsed with 15 mL of pH 8.5 Q-H20, folded, and stored frozen.
2. Martin and Gordon, 1988 (Northeast Pacific iron distributions in relation to phytoplankton productivity);	1984; ~ 122W-128W and 35N	Seawater was collected using Teflon-coated 30-l Go-flo bottles suspended on a nonmetallic Kevlar line.	Dissolved and particulate Fe. The samples were filtered through tared acid-washed 142 mm, 0.4 µm Nuclepore (R) filters mounted in Teflon sandwiches.	dFe were pre-concentrated using Chelex-100 ion exchange at pH 6 and/or APDC/DDDC-chloroform organic extraction.
3. Johnson et al., 2001 (The annual cycle of iron and the biological response in central California coastal waters);	1999-2004; ~ 122W and 36N	Seawater was collected for Fe analysis at a depth of 1 to 2 m with a Teflon pumping system and samples were stored overnight at <5 degrees C	Dissolved and dissolvable Fe were determined by flow injection analysis with chemiluminescence detection. dFe were passed through a 0.45µm filter.	Dissolvable Fe samples were acidified to pH 3 with ultrapure acid and analyzed after 1 minute. dFe samples were acidified to pH 3 for analysis.
4. MBARI California-Hawaii 2001 cruise Data Johnson et al., 2003 (Surface ocean-lower atmosphere interactions in the Northeast Pacific Ocean Gyre: Aerosols, iron, and the ecosystem response);	2001; ~ 122W-158W and 21N-36N	Seawater for metal analyses was subsampled from the towed pumping system flow at ~ 6 mL/min with a peristaltic pump. Fe concentrations were determined using modifications of the Flow Injection Analysis.	Dissolved and dissolvable Fe. dFe were filtered onto 0.45 µm, 142-mm-diameter polycarbonate (Nuclepore) filters. Dissolvable Fe were defined as a portion of the weak acid leachable particulate Fe. Leachable Fe concentrations were less than 10% of the dissolved concentration.	Seawater for each metal analysis was passed through a high capacity, acid cleaned 20 µm filter (Alltech, Timberline metal-free) and then adjusted to the appropriate pH in line. For dissolvable iron measurements, the subsample stream merged with a stream of 0.15 N double distilled HCl, which produced a sample pH of 3.3 ± 0.2.
5. Chase et al., 2002 (Iron, nutrient, and phytoplankton distributions in	2002; ~ 122W and 36N	When the ship was underway at 10 knots, a continuous stream of near-surface, trace metal clean seawater was	dFe: unfiltered, non acidified sample stream.	The sample stream was neither filtered nor acidified before injection. A flow injection system was used for analyzing discrete samples for Fe.

Oregon coastal waters);		obtained for iron and nitrate analyses using a brass “fish” towed over the side of the ship. Profile samples for Fe analysis were collected in acid-leached high-density polypropylene bottles from Niskin bottles modified for trace metal sampling by acid leaching, replacing inner springs with C flex tubing, and viton o-rings with fluorosilicone O rings.		
6. Fitzwater et al., 2003 (Iron, nutrient and phytoplankton biomass relationships in upwelled waters of the California coastal system);	2000; ~ 122W and 37N	Surface samples were collected from a towed ‘‘fish’’ suspended by a boom approximately 5m off the portside of the ship. Sample water for dissolvable Fe measurements was then drawn off an in-line tee using a small peristaltic pump.	Dissolvable and particulate Fe. Dissolvable Fe is operationally defined as the Fe(III) detected after seawater is held at pH ~3 for 1 min. This detected Fe(III) would include inorganic Fe(III), organically bound Fe(III) released by the acid addition and Fe(III) leached off of particles.	The sample was acidified in line to a pH of 3–3.4 prior to pre-concentration on a column of 8-hydroxyquinoline.
7. Firme et al., 2003 (Spatial and temporal variability in phytoplankton iron limitation along the California coast and consequences for Si, N, and C biogeochemistry);	1999; ~ 120W-124W and 34N-38N	Near-surface water (5–10 m) was collected for the incubation experiments using an acid-washed all-teflon Osmonic Bruiser diaphragm pump system. dFe concentrations were measured by flow injection analysis or by cathodic stripping voltammetry methods.	Seawater samples for total dFe measurements were 0.2 μm -filtered	Water samples were homogenized in a 50-l acid-washed carboy using trace metal clean techniques, and dispensed into acid-washed 1 l polycarbonate bottles. dFe samples were acidified to pH 1.7 -- 1.8, and microwaved prior to analysis.
8. Chase et al., 2005 (Manganese and iron distributions off central California influenced by upwelling and shelf width);	2002; ~ 121W-122W and 36N	Near-surface (~2 m) seawater for trace metal analysis was continuously pumped into a class-100 flow bench in the main shipboard laboratory through acid-cleaned polyethylene tubing attached to a towed fish. Vertical profile samples for Fe analysis were collected in 2.5 L bottles with Teflon coated interior surfaces (Ocean Test Equipment) mounted	Dissolvable Fe: defined as the Fe species passed through a 20 μm filter and were acidified inline to pH 3.4 for 1 minute prior to analysis.	Fe samples were passed through a 20 μm filter and were acidified inline to pH 3.4 for 1 minute prior to analysis.

		in a small Rosette modified for trace metal work. Fe (Fe(III)) was measured by Flow Injection Analysis (FIA) with chemiluminescence detection.		
9. Hurst and Bruland, 2003 (The effects of the San Francisco Bay plume on trace metal and nutrient distributions in the Gulf of the Farallones);	July 1999; February 2003; and and June 2004;	Samples were collected with a clean surface pump system. Analyte concentrations in particulate (Al, P, Mn, Fe, Co, Cu, Zn, Cd, and Pb) and dissolved trace metal (Mn, Fe, Co, Cu, Zn, and Cd) fractions were prepared and measured using a Thermo-Electron Element 1 magnetic sector HR-ICP-MS with a PFA Teflon™ spray chamber and PFA-ST nebulizer (Elemental Scientific). Columbia River estuary samples and the BBL sample from outside San Francisco Bay were collected using 30 L Teflon™ coated GO Flo™ bottles (General Oceanics) attached to Kevlar™ hydroline.	The soluble fractions were operationally defined by the 0.03 µm nominal pore size; thus, the colloidal trace element concentrations were estimated by taking the difference between measured values in the 0.4 and 0.03 µm filtrates.	The extraction of the leachable trace element fraction from the frozen PCTE filters was performed by delivering 2 mL of 25% quartz-distilled acetic acid (QHAc) into a 7 mL vial and allowing contact with the folded filter for 2 h at room temperature. The leachate and rinses of the filter were removed, placed into an acid-cleaned quartz beaker and heated to dryness. The resulting residue was redissolved in 1 M QHNO3. Each filter and the associated refractory particulate material was then microwave-bomb digested with 2 mL of concentrated quartz-distilled nitric acid (QHNO3) and 50 µL of concentrated trace metal grade HF in PTFE Teflon™ bombs (Savillex, Minnetonka, MN). The final digest solution was diluted to yield a 1 M HNO3 matrix solution.
10. Buck et al., 2007 (Dissolved iron speciation in two distinct river plumes and an estuary: Implications for riverine iron supply)	June and July 2024; Columbia River estuary and San Francisco Bay outflow	Surface samples from the Columbia River and San Francisco Bay plume systems, including shallow (to 20 m) vertical profiles through the Columbia River plume, were collected with a clean surface pump "sipper" system.	All Fe speciation and total dissolved Fe samples were filtered through acid-cleaned 0.45-/mi pore size Teflon™ membrane polypropylene capsule filters (Calyx™, MSI).. Total dissolved Fe concentrations were measured using two comparable methods: adsorptive cathodic stripping voltammetry (ACSV) and FIA.	For both methods, samples were acidified to pH 1.8 with 4 mL L1 6 mol L"1 Q-HC1 following collection and filtration.
11. Lohan and Bruland, 2008 (Elevated Fe(II) and dFe in Hypoxic Shelf Waters off Oregon and Washington: An Enhanced	2005-2008; ~ 124W and 45N-47N	dFe(II) and Fe(III) concentrations were immediately determined onboard ship in samples from the bottom boundary layer along the mid shelf off the coast of	dFe are Fe species passed through a 0.4 µm filter	Samples were acidified with sub-boiled quartz distilled HCl pH 1.8 to inhibit further Fe(II) oxidation. Fe(III) was determined immediately (within ~5 min) using flow injection analysis. Samples were then analyzed for total dFe by adding hydrogen peroxide to oxidize all Fe(II)

Source of Iron to Coastal Upwelling Regimes);		Washington and Oregon during both upwelling and downwelling conditions. Samples were collected with 8 L Teflon coated GO-Flo bottles (General Oceanics) attached to a Kevlar hydroline.		present in the sample; Fe(II) was determined by the difference between total dFe and Fe(III).
12. Elrod et al., 2008 (A long-term, high-resolution record of surface water iron concentrations in the upwelling-driven central California);	1999-2005; ~ 122W and 36N	Samples for dissolved and dissolvable Fe were collected using a surface pumping system employing trace metal clean techniques or were collected from acid washed Niskin bottles mounted on the remotely operated vehicle. The concentrations of dFe (DFe < 0.50 µm) and dissolvable Fe (DVBLFe, unfiltered, leached at pH 3.2 for ~3 min) were determined by flow injection analysis with chemiluminescence detection.	Dissolved and dissolvable Fe. dFe is defined as the Fe species passed through a 0.50 µm filter. Dissolvable Fe is defined as Fe leached from particles at pH 3.2.	
13. Severmann et al., 2010 (The continental shelf benthic iron flux and its isotope composition);	2007; 124W and 40N-43N	Benthic incubation chambers	dFe samples were filtered through 0.45µm filters.	dFe samples samples were acidified to pH 1.7 with purified HCl.
14. King and Barbeau, 2011 (CalCOFI program) (Dissolved iron and macronutrient distributions in the southern California Current System);	2002-2006; ~ 117W - 124W and 29 N - 35N	Profiles for dFe analysis were collected using GO Flo bottles (General Oceanics) attached to a synthetic line (New England Ropes) with a coated lead ballast and lowered using a trace metal clean hydraulic winch. dFe was measured using an FeLume flow injection analysis system with an Fe(II) sulfite reduction chemiluminescent flow injection analysis method.	The operationally defined dFe fraction was collected by either vacuum filtering or in‐line filtering samples through acid‐cleaned 0.4 µm pore size, 47 mm diameter polycarbonate membrane filters	dFe in acidified seawater samples is reduced to Fe(II) with 2 µM sulfite for 12 h, buffered in line with 2 M ammonium acetate (~90% sample/ 10% buffer) to pH ~6 and Fe(II) is pre-concentrated on a column filled with nitriloacetic acid resin. Fe(II) is then eluted and oxidized when mixed with a pH > 9.5 luminol‐ammonia buffer.
15. John et al., 2012 (The flux of iron and iron isotopes from San Pedro Basin sediments);	2008-2010; 118W-119W and ~ 33N-34N	Samples from the Santa Barbara Basin were collected using the US Geotraces trace-metal clean rosette equipped with Teflon-coated Niskin bottles, and filtered	dFe, measured by Niskin bottle and passed through 0.45 µm filter	Fe was extracted from pH 2 seawater onto an NTA-resin in a batch extraction process, then Fe was eluted from the NTA resin in 10% HCl and further purified by anion exchange chromatography.

		through an Osmonics Teflon filter capsule with a nominal pore size of 0.45 µm.		
16. King et al., 2011 (Quasi-Lagrangian drifter studies of iron speciation and cycling off Point Conception, California)	May 2006 and April 2007 Point Conception, California	Trace metal clean seawater samples from the mixed-layer were collected using either a custom-made trace metal clean Teflon pumping system via Teflon tubing connected to an air-driven diaphragm pump (Cole-Parmer), or GO Flo bottles (General Oceanics) attached to a synthetic line (New England Ropes) tripped with lead messengers coated with epoxy-based paint (General Oceanics). Seawater	Operationally defined dissolved seawater fractions were collected by vacuum filtering (< 500 mm Hg) samples through acid-cleaned 0.4 µm polycarbonate track-etched membrane filters (Millipore) on a Teflon filtration rig (Savillex) An established competitive ligand exchange-adsorptiv e cathodic stripping voltammetry (CLE-ACSV) method was used to measure the organic complexation of dFe.	Dissolved Fe samples were stored in acid-cleaned 250 mL low density polyethylene (LDPE; Nalgene) bottles — each bottle was rinsed with the filtrate, filled, and acidified to pH ~1.8 by adding ultrapure HCl to a final concentration of 0.025 M. Dissolved Fe speciation samples were collected in acid-cleaned 500 mL fluorinated polyethylene (FLPE; Nalgene) bottles that were filled with ultrapure water (>18MΩ cm-1; Milli-Q, Millipore) to condition for at least two weeks prior to rinsing and filling with samples. All samples were frozen at −20 °C and returned to the lab for analysis.
17. Biller et al., 2013 (Coastal iron and nitrate distributions during the spring and summer upwelling season in the central California Current upwelling regime);	2010-2011; 120W-124W and 35N-40N	Vertical profiles and BBL samples for trace metals were obtained using 8L Teflon™ coated GO-Flo™ bottles (General Oceanics) deployed on a Kevlar™ hydroline. Sample bottles were rinsed four times with samples prior to filling.	Samples for dFe collected along the surface transects as well as from the GO-Flo™ bottles for vertical profiles and BBL samples were filtered using 0.2 µm pore size Acropak 200 capsule filters. With this filter pore size, the dFe data here includes both colloidal and truly soluble Fe.	Samples for post-cruise multi-element analysis were acidified to pH ~ 1.7 with 4 mL of ~6 Ns ub-boiled quartz distilled HCl per liter of seawater, and samples for shipboard Fe analysis were acidified with 2mL of 6 NQ-HCl per liter of seawater (pH~2) and allowed to sit for at least 2h prior to analysis.
18. Bundy et al., 2014 (Distinct pools of dissolved iron-binding ligands in the surface and benthic boundary layer of the California Current);	2010-2011; ~ 121W-126W and 35 - 40N	Trace metal clean samples from the BBL in May 2010 and August 2011 were collected using Teflon-coated 8 liter GO-Flo bottles (General Oceanics) suspended on a Kevlar line and triggered with Teflon messengers. dFe totals were determined shipboard using flow injection analysis. dFe organic	dFe concentrations and four ligand classes defined by their conditional stability constant (binding strength). All dissolved samples were filtered through Acropak 200 capsule filters (0.2 µm).	Samples were acidified to pH 2 immediately after collection using quartz-distilled HCl and were allowed to sit for 2 h before analysis.

		speciation was measured using electrochemical methods (CLE-ACSV) with salicylaldoxime as the competing ligand, using multiple analytical windows.		
19. Bundy et al., 2015 (Iron-binding ligands and humic substances in the San Francisco Bay estuary and estuarine-influenced shelf regions of coastal California);	2011; 121W-124W and 37N-40N	DFe and dFe-binding ligand samples were collected using trace metal clean Teflon tubing and a Teflon diaphragm pump connected to an air compressor. Organic dFe-binding ligands were analyzed using a multiple analytical window (MAW) adaptation of traditional competitive ligand exchange adsorptive cathodic stripping voltammetry (CLE-ACSV) methods. The added competitive ligand is salicylaldoxime.	dFe samples were filtered in-line with acid-cleaned 0.45 µm Osmonics cartridge filters after 1 L of water had been passed through the tubing and filter.	dFe samples were stored at room temperature in 250 mL acid-cleaned low density polyethylene bottles at pH 1.8.
20. Bundy et al., 2016 (CCE-LTER program) (Iron-Binding Ligands in the Southern California Current System: Mechanistic Studies);	2011; ~ 121W and 32N-33N	All trace-metal clean samples were collected either using single Teflon-coated 12 L GO-Flo bottles mounted directly on non-metallic hydroline or 5 L X-Niskin bottles mounted on a powder-coated rosette deployed on non-metallic hydroline . The analysis of dFe-binding ligands was completed by competitive ligand exchange-adsorptive cathodic stripping voltammetry (CLE-ACSV) using multiple analytical windows (MAWs). Salicylaldoxime as the competing ligand.	dFe samples were filtered in-line with a 0.2 µm Acropak-200 filter. Three ligand classes defined by their conditional stability constant (binding strength).	Filtered samples for dFe analysis were placed in 250 mL low-density polyethylene bottles, acidified to pH 1.8 (Optima HCl) and stored for at least 3 months until analysis in the lab.
21. Boiteau et al., 2018 (Patterns of iron and siderophore distributions across the California Current System);	2014; ~ 120W - 126W and 34.3N - 42.87N	Water samples (20 L) for ligand analysis were collected using a trace metal clean GeoFish sampling system or PTFE coated GO-Flo bottles deployed on a Kevlar hydroline. Ligands were quantified and identified using	Total ligand concentrations, Fe-ligand complex, and siderophores	For ligand analyses, samples were filtered through 0.2 µm polyethersulfone capsule filters into polycarbonate carboys then pumped through resin columns at 15 mL min−1 using a peristaltic pump and platinum-cured silicone tubing.

		recently developed methods based on liquid chromatography with inductively coupled plasma mass spectrometry and electrospray ionization mass spectrometry.		
22. Hogle et al., 2018 (Pervasive iron limitation at subsurface chlorophyll maxima of the California Current)	July 2007 119.5W - 123.5W and ~ 29.8N - 31.1N	As in **King and Barbeau, 2011 - see 14.**	As in **King and Barbeau, 2011 - see 14.** An established competitive ligand exchange-adsorptive cathodic stripping voltammetry (CLE-ACSV) method was used to measure the organic complexation of dFe.	As in **King and Barbeau, 2011 - see 14.**
23. Till et al., 2019 (The iron limitation mosaic in the California Current System: Factors Governing Fe availability in the shelf/near-shelf region);	2014; ~ 121W-127W and 35N-42N	dFe samples were obtained from a valve in the Teflon line.	dFe samples were filtered through a 0.2 µm polysulfone membrane AcroPak-200 capsule filter into low-density polyethylene bottles that had been rigorously cleaned as in the GEOTRACES cookbook.	Sample bottles for Fe were stored in weak (pH ~ 2) trace metal grade HCl and rinsed three times with sample before filling. Fe samples were acidified to pH ~ 2 with quartz-distilled HCl and let sit for at least an hour before analysis.
24. Kelly et al., 2021 Trace metal and black carbon data in seawater samples taken in southern California during the 2017 Thomas Fire;	2017; 119W and 34N	Surface seawater samples (~2 m depth) were collected using a polytetrafluorethylene (PTFE) Saint Gobain Furon™ bellows pump with low-density polyethylene (LDPE) tubing. Samples were collected following trace metal clean protocols at sea.	Dissolved samples were filtered in-line with a detachable 0.2 µm polyethersulfone membrane (Pall Acropak™ 1500 capsule filter) and collected in either 50 mL centrifuge tubes or 20 L cubitainers.	Filtered (<0.2 µm) Fe samples were acidified to pH 2 using HCl directly after the cruise and stored for ~2 months.
25. Abdala et al., 2022 (Examining ecological succession of diatoms in California Current System cyclonic mesoscale eddies);	2014; ~ 123W-127W and 37N-42N	A trace metal clean surface tow-fish system was used to collect water from 3–5 m depth at roughly 1-h intervals (n = 20 samples total) while the ship was underway (traveling at ~ 10 knots).	dFe analyses were filtered through an acid-cleaned, seawater-flushed 0.2 µm Acropak filter capsule	Seawater samples were acidified at sea to pH 1.7 using quartz-distilled HCl and stored in acid cleaned LDPE bottles for at least 2 months. Prior to analysis, acidified seawater was buffered to pH 6 and dFe was pre-concentrated onto Nobias-chelate PA1 resin and then eluted off the column using quartz-distilled HNO3. The eluent was then analyzed using a Thermo-Element high resolution XR ICP-MS, which was run in counting mode.

26. Evans et al., 2023 (The role of seasonal hypoxia and benthic boundary layer exchange on iron redox cycling on the Oregon shelf);	2021; ~ 124W - 125W and 43N-46N	Fe samples were collected primarily using 5 liter Teflon-coated external spring Niskin-type bottles with a stand-alone trace metal clean rosette.	Fe samples were filtered using Pall Gelman Supor 0.45 µm polyethersulfone filters Fe(II) was measured via chemiluminescence with luminol, consisting of a continuous 2 mL/min flow of sample and luminol solution at a 1 : 1 ratio into a FeLume system	Total dFe samples were collected into 500-mL low-density polyethylene bottles. Within 1 month of collection, these samples were acidified to a pH of approximately 1.7 by adding 1 mL of hydrochloric acid per 500 mL of seawater. Samples were analyzed after 6–12 months of storage. Samples were prepared in triplicate using the sea FAST-pico offline method, where 10 mL of acidified sample was added to a Nobias resin chelation column then eluted with ultrapure, distilled 5% nitric acid for a final volume of 0.5 mL.
27. Forsch et al., 2023 (Iron Limitation and Biogeochemical Effects in Southern California Current Coastal Upwelling Filaments);	2019; ~ 120W - 125W and 34N - 36N	Trace metal clean samples for dFe and total dissolvable Fe (TDFe) were sampled from Teflon-coated X-Niskin bottles on a powder-coated rosette, deployed on a coated hydrowire (Kevlar line)	The Fe samples were handled in a Class 100 trace metal clean van and filtered in-line using acid-washed Teflon tubing and acid-washed 0.2 µm.	Acropak-200 capsule filters pressurized by filtered air. Filtered samples were acidified to pH 1.8 with HCl (Optima Grade, VWR) and stored in 250 mL acid-clean low-density polyethylene bottles for on-shore analysis using flow-injection analysis with chemiluminescence.
28. Floback et al., (in press.) Iron supply from the Oregon margin to the ocean dominated by hypoxia-dependent particles	2021; ~ 124W-128W and 44N	Samples for dissolved metals were collected using 5 L Teflon coated external spring Niskin-type bottles (Ocean Test Equipment) with a trace metal clean rosette (Sea-Bird Electronics). Fe concentrations are quantified utilizing a Finnegan Element 2 (Thermo Scientific) Inductively Coupled Plasma-Mass Spectrometer (ICP-MS) and Apex desolvation system in medium resolution.	dFe samples were filtered using acid washed 0.45 um filters (Supor) into acid washed 500 mL low density polyethylene (LDPE) bottles.	Samples were filtered using acid washed 0.45 um filters (Supor) into acid washed 500 mL low density polyethylene (LDPE) bottles. Within one month of collection, samples were acidified to a pH of ~1.7 utilizing 1 mL of hydrochloric acid (Optima, Fisher Scientific) per 500 mL of seawater.
29. Till et al., (in prep)	Measurements were collected along the Oregon and Northern California coast during the Phytoplankton UPwelling Cycle (PUPCYCLE II) expedition, onboard the R/V Sally Ride from 27 May to 11 June 2023.	Samples for iron analysis were collected with a rosette of Teflon-coated OTE bottles during a separate cast directly after the daily sampling cast. After recovery, OTE bottles were taken directly to a trace metal-clean sampling van where they were pressurized with filtered compressed air. Surface samples (~3 m depth) were also collected	All samples were passed through pre-cleaned 0.2 micrometer Supor membrane AcroPak capsule filters into trace metal cleaned bottles (Cutter et al., 2017).	Samples were acidified to pH 1.8 with optima HCl and analyzed post-cruise with a flow injection analysis method (Lohan et al., 2006) with modifications as in Biller et al. (2013).

		with a tow-fish system plumbed into the trace metal van, as in Bruland et al. (2005).		

Tables

Table S2. Data sources for measurements of temperature, salinity, nutrients, oxygen and chlorophyll-a in the USWC, which include a range of regional programs (CalCOFI, CCE-LTER), local surveys, time series stations, and individual research cruises

	Data sources
1.	Global Ocean Data Analysis Project version 2 (GLODAPv2) (Olsen et al., 2019)
2.	Ocean Carbon and Acidification Data System compilation (Jiang et al., 2023)
3.	California Cooperative Oceanic Fisheries Investigations (CalCOFI) (King & Barbeau, 2011)
4.	Monterey Bay Aquarium Research Institute (MBARI) (Ren et al., 2018)
5.	California Current Ecosystem Long Term Ecological Research (CCE-LTER, (Hsieh et al., 2005 and Wolfe et al., 2023)
6.	Santa Barbara Coastal Long Term Ecological Research (SB-LTER)
7.	Plumes and Blooms (Catlett et al., 2021)
8.	NOAA Harmful Algal Blooms program (NOAA-HABs) (Sandoval-Belma et al., 2023)
9.	GLOBEC Northeast Pacific program (GLOBEC-NE) (Lorenzo et al., 2015)
10.	Salish Sea Cruises (Alin et al., 2021)
11.	Newport Line (Harvey et al., 2020)
12.	San Pedro Ocean Time-series (Fuhrman et al., 2006)
13.	Santa Monica Bay Observatory timeseries (Leinweber and Gruber, 2013)
14.	PESCAR24 cruise (Devol et al., 2017)
15.	New Horizon GoCal cruises (Beman and Popp., 2012)