Mercury flux along the central meridional North Pacific from the GEOTRACES GP15 cruise

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Introduction

1 Human activity has substantially increased the amount of mercury (Hg) in the biosphere, and particularly methylmercury (MeHg), the most bioaccumulative form in the surface ocean[1] which supports most of the seafood consumed by humans and drives the related health impacts.[2]

2 Air-sea exchange of Hg is a critical part of the global Hg cycle as wet and dry deposition are the dominant sources of Hg to the ocean, accounting for 70% or more of the inputs, and gas exchange is the dominant sink, being about 90% of the outputs from the ocean.[3]

3 Few high-resolution measurements of Hg^0 are presently available for constraining global and regional flux estimates. Comparison of data between these cruises' data for air-sea exchange of Hg is critically important for understanding spatial and temporal drivers of net Hg^0 evasion.

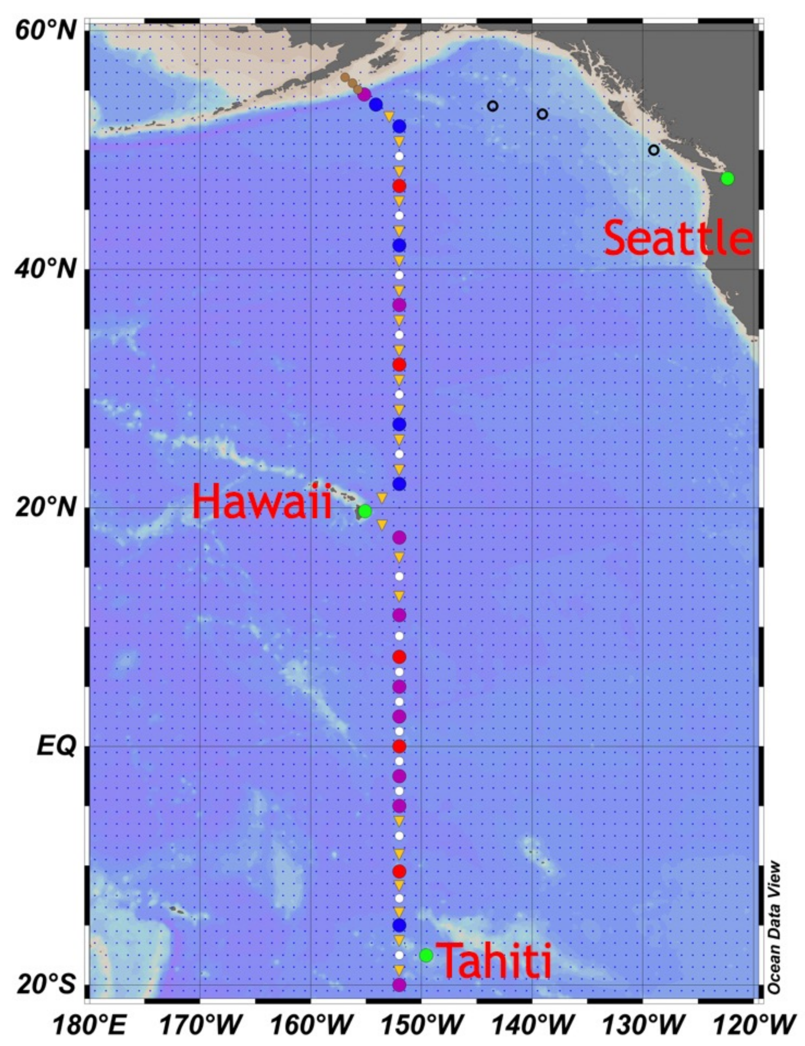

Fig. 1 Cruise information of US GEOTRACES Meridional Transect – GP15, from Seattle to Tahiti(port stop in Hilo, Hawaii) on R/V Roger Revelle.

Methods

1. Mercury speciation in atmosphere. We used the Tekran modules 2537/1130/1135 for the determination of Hg^0, RGHg (reactive gaseous Hg) and Hg^P (particulate Hg), respectively in the atmosphere.

2. Air-sea exchange flux for Hg^0. An equilibrator allows bubbled air to reach equilibrium with the dissolved element Hg (DHg^0) in the seawater. The air was then subsampled and its concentration was quantified by using the Tekran 2537 with 5-minute resolution.[5]

3. Rain Collection. Rainfall was collected using an automated collector and analyzed for Hg and MeHg.

4. Multiple and linear regression analysis. To identify the relationships between continuously measured Hg^0 flux and environmental factors, statistical models have been used. The environmental factors include wind speed, surface temperature, surface salinity, silica, nitrate, phosphate, fluorescence and upwelling index, which can be back calculated from the ^7Be profile.[6]

Results & Discussion

1 Mercury speciation in atmosphere.

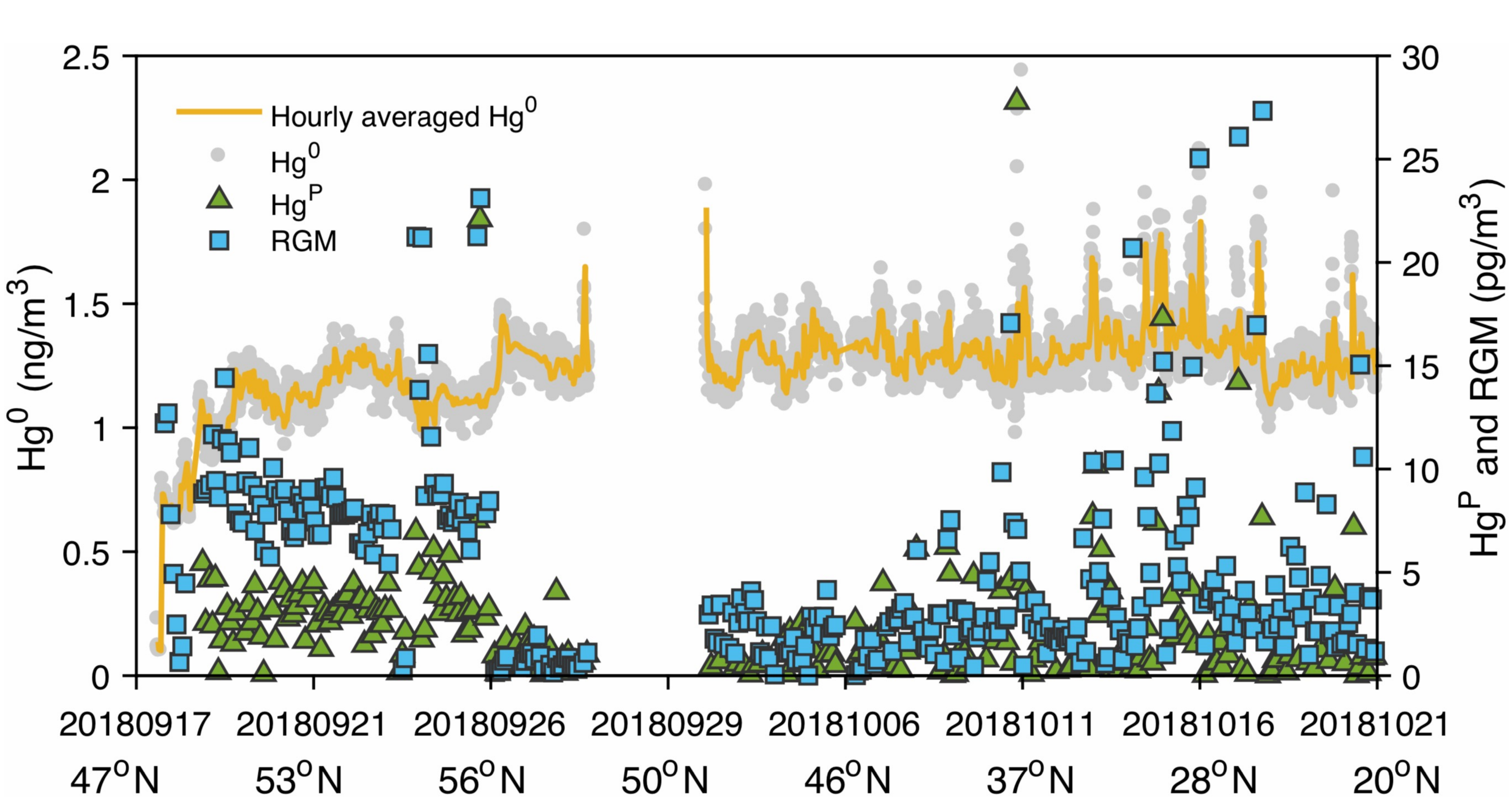

Fig. 2 Mercury speciation in atmosphere during the GP15 cruise - whole view of GP15 cruise.

Results & Discussion

2 Fig. 3 shows the relationship between the Hg^0 flux and the upwelling index for GP15 cruise. Generally, the flux is higher when the upwelling index is higher.

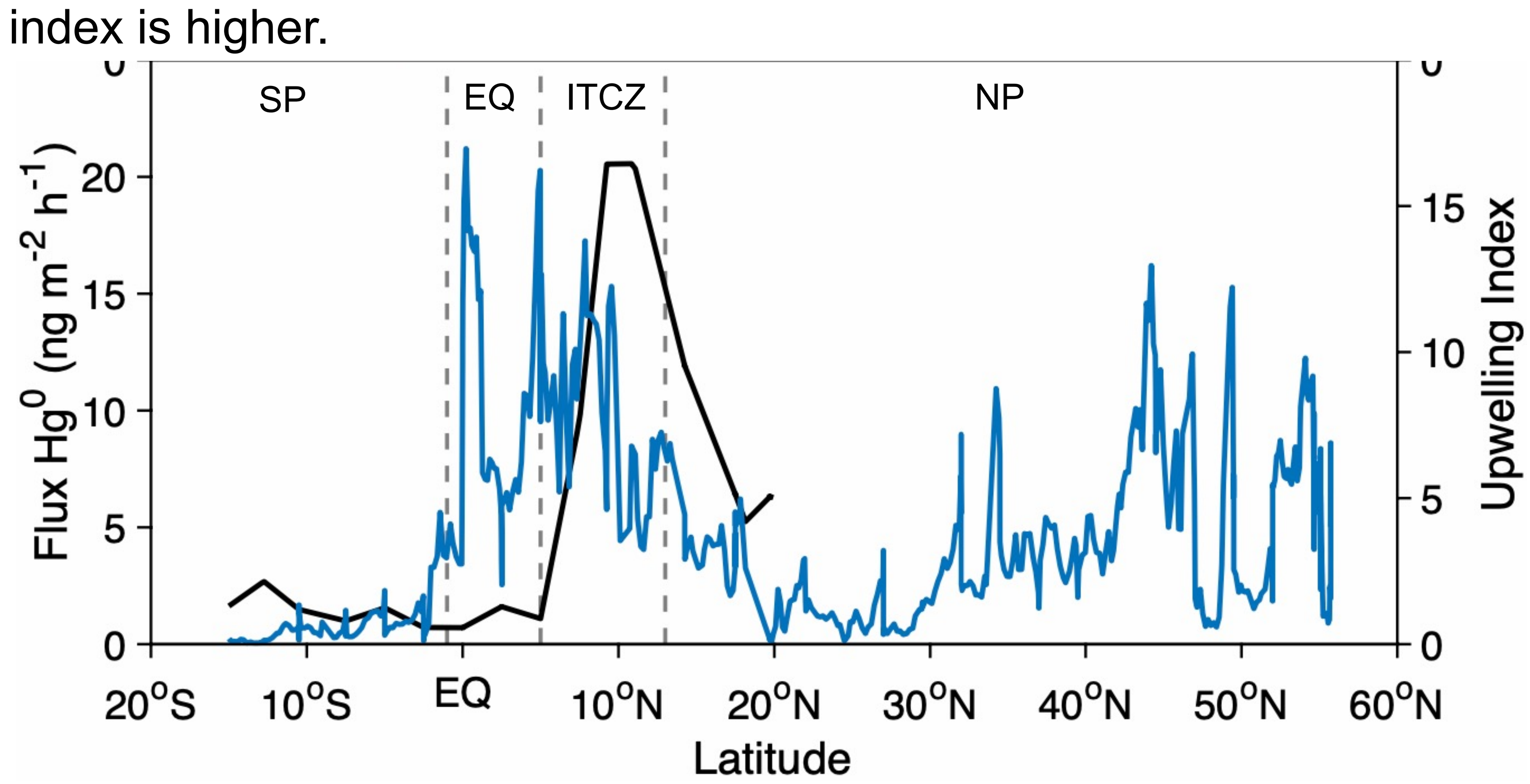

Fig. 3 GP15 in 2018 Fall in the Pacific Ocean. Latitudinal variability in the measured Hg^0 evasion (blue) and calculated upwelling index[6] (black) on the GP15. The transects are divided into four regions - North Pacific (NP), Intertropical Convergence Zone (ITCZ), Equator (EQ) and South Pacific (SP).

3 Multiple and linear regression modeling (Fig. 4 and Table 1) showed that several different environmental factors were important within the cruise and varied among the different regions. For both cruises, surface dissolved Hg^0 and wind speed are both the main drivers of the flux. For GP15, several environmental factors show the strongest influence for driving the evasion. For example, in the ITCZ, flux is mostly affected by the upwelling. However, for METZYME, the influence from upwelling is not significant.

GP15 (2018 Fall)

Whole	NP	ITCZ	EQ	SP	
0.38	0.13	0.32	0.91	0.84	Dissolved Hg^0
0.13	-0.08		0.47		Air Hg
0.61	0.76	0.79	0.67	0.51	WindSpeed
-0.18	-0.37	0.44	-0.54	-0.60	Temp
-0.19	-0.30	-0.37	0.51	-0.55	Salinity
		0.57	-0.47	-0.47	Upwelling
0.11	0.20		0.51		Silica
0.25	0.31	-0.55	0.49	0.48	Phosphate
0.20	0.25	-0.36	0.48	0.41	Nitrate

$p < 0.05$
- $R \geq 0.50$
- $0.25 \leq R < 0.50$
- $0 \leq R < 0.25$
- $-0.25 \leq R < 0$
- $-0.50 \leq R < -0.25$
- $R < -0.50$

Fig. 4 Heat maps for linear correlation coefficient between Hg^0 evasion and other environmental factors for the NP, ITCZ, EQ and SP regions, for the GP15 and METZYME cruises. The color represents the different range of correlation coefficients ($p < 0.05$).

Multiple linear regression analysis for GP15

	Best model fit	R^2	n
ITCZ	Wind + Temp - Sal + Upwelling - P - N	0.91	59
EQ	Wind - Temp + Sal - Upwelling + Si + P + N	0.77	45
SP	Wind - Temp - Sal - Upwelling + P + N	0.59	90

Notes: Wind, Temp, Sal, Si, P and N represents wind speed, temperature, salinity, silica, phosphate and nitrate.

Table 1 Results of multiple linear regression analysis for GP15 cruises for different regions (all significant results at the $p < 0.05$ level are shown).

Reference & Acknowledgements

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