NSF OCE - 1034746: Collaborative Research: A Novel Tracer Approach to Estimate the Atmospheric Input of Trace Elements into the Global Ocean
Award Amount: $429,272
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Atmospheric input into the global ocean constitutes an important budgetary component of numerous chemical species and plays a key role in controlling biogeochemical processes in the ocean. Assessment of this input is difficult however because measurements of deposition rates to the ocean, particularly in remote areas, are rare and susceptible to problems of temporal and spatial variability. While the collection and analysis of aerosol samples is somewhat routine, the chemical concentration data collected from ship board or land-based aerosol samplers in and of themselves cannot yield the deposition flux of trace elements; a method is required to transform concentration measurements into flux. The ability to derive the atmospheric flux of ^{7}Be from its ocean inventory provides a key linkage between the atmospheric concentration of chemical species and their deposition to the ocean. We have demonstrated that estimates of the atmospheric flux of trace elements (TEs) can be made by multiplying the ocean inventory of ^{7}Be x [TE/^{7}Be] ratio in bulk aerosols. Flux estimates for trace elements made by the ^{7}Be ocean inventory method were comparable to fluxes derived from rain samples collected on the island of Bermuda (see Table below).

The situation at Bermuda allowed such testing to be made, where ocean-based methods can be calibrated by convenient land locations. Our results suggest that this method would be useful for remote areas where fixed sampling stations do not exist; that is, the majority of the global ocean.

Sampling for ^{7}Be aboard the R/V Atlantic explorer

***Comparison of collection-based and ^{7}Be method annual TEI Atmospheric Deposition Fluxes (μmol $m^{-2}y^{-1}$). Three significant figures are shown for convenience.**

Year 1 data; July 2011-June 2012

	Mn	Fe	Co	Ni	Cu	Zn	Cd	Pb
^{7}Be method	30.2	1570	0.944	14.7	38.2	28.1	0.157	1.64
Measured Wet deposition	14.0	414	0.283	1.75	3.98	9.90	0.035	0.540
Calculated Dry deposition (V_d=1.16 cm s^{-1})	9.93	496	0.308	5.12	11.9	10.4	0.056	0.623
Total (wet+dry) / ^{7}Be method	79%	58%	63%	47%	42%	72%	58%	71%

Year 2 data; July 2012-June 2013

	Mn	Fe	Co	Ni	Cu	Zn	Cd	Pb
^{7}Be method	38.0	1790	0.860	10.3	22.0	29.6	0.096	1.60
Measured Wet deposition	13.7	175	0.265	4.96	7.63	21.2	0.073	0.520
Calculated Dry deposition (V_d=1.16 cm s^{-1})	12.6	563	0.279	3.55	8.08	11.1	0.038	0.575
Total (wet+dry) / ^{7}Be method	69%	41%	63%	83%	71%	109%	116%	68%

24 month weighted average; July 2011-June 2013

	Mn	Fe	Co	Ni	Cu	Zn	Cd	Pb
^{7}Be method	34.1	1680	0.902	12.5	30.1	28.9	0.127	1.62
Measured Wet deposition	14.1	308	0.274	3.61	6.09	16.4	0.056	0.540
Reported Wet Deposition (Kim et al., 1999)	7.5-10	130-250		1.4-6.0	1.6-16	21-28	0.2-0.8	0.3-7.0
Calculated Dry deposition (V_d=1.16 cm s^{-1})	11.2	529	0.293	4.34	9.98	10.8	0.047	0.599
Reported Dry Deposition (Arimoto et al., 2003)		1100				3		
Total (wet+dry) / ^{7}Be method	74%	50%	63%	64%	53%	94%	81%	70%

*Kadko D., W. M. Landing, and R. U. Shelley (2015) A novel tracer technique to quantify the atmospheric flux of trace elements to remote ocean regions. Journ. Geophy. Res. Oceans, 119, doi:10.1002/2014JC010314.