

Continuous Atmospheric Monitoring Activities in Japan

The 8th APMMN workshop in 2019

Jakarta, Indonesia

Objectives

- ◆ Monitor current levels of mercury and other heavy metals in air, particles, and precipitation;
- ◆ Obtain useful information on the long-range transportation of trace elements in Asia-Pacific region;
- ◆ Develop monitoring methodologies;
- ◆ Contribute to the international efforts in atmospheric monitoring

Japanese Atmospheric Mercury Monitoring Network

● NIMD

● MOEJ

Fukuoka

Minamata
(Only TGM)

Oga, Akita
(MOEJ)

Cape Hedo

**(MOEJ and
NIES)**

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* TGM = GEM + GOM

- NIMD
- MOEJ

Fukuoka
Hirado
Minamata



Oga, Akita
(MOEJ)

Omaezaki

Minami-Awaji

From June 2017 to July 2019

Cape Hedo
(MOEJ and NIES)

Continuous Atmospheric Mercury / Wet Deposition Monitoring in the Background Area of Japan

- Cape Hedo
- Oga Peninsula

Measurement Items, Sampling, and Analytical Method

Component	Measurement items		Sampling and analytical methods	site
Atmosphere	Mercury	Mercury speciation (GEM, GOM, PBM)	Continuous measurement with Tekran® mercury speciation system	Cape Hedo, Oga
	Particulate matter	Pb, Cd, Cu, Zn, As, Cr, V, Ni, Se, Sb, Ba, Co, Mn, Sn, Te, Tl, Be, Al, Fe, Ca, Na, K, Mg	7 days continuous sampling by the low-volume sampler and analyzed by ICP/MS	Cape Hedo
Precipitation	Hg		Sampling by the automatic wet-only sampler and analyzed by CVAAS (EPA method 1631, Revision E)	Cape Hedo, Oga

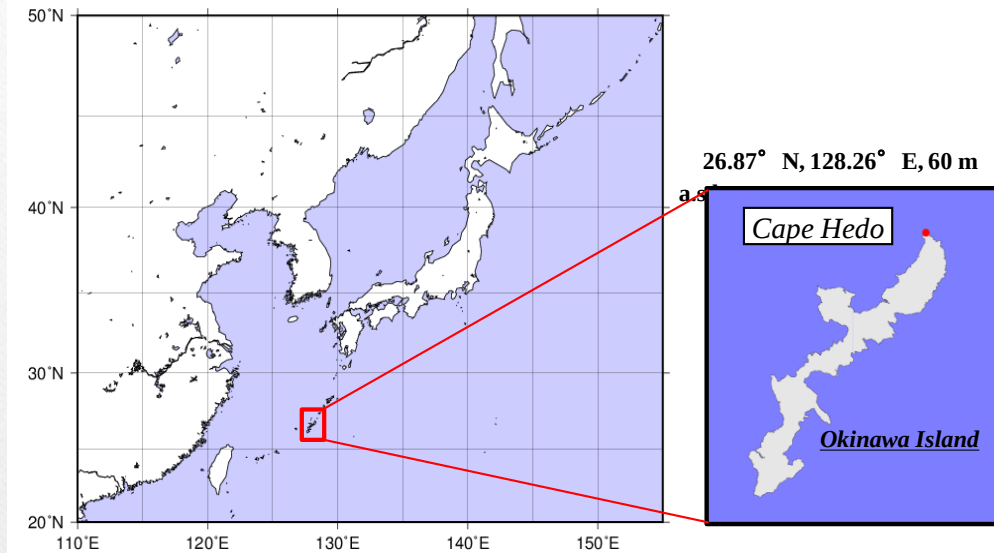
GEM: Gaseous Elementary Mercury

GOM: Gaseous Oxidized Mercury

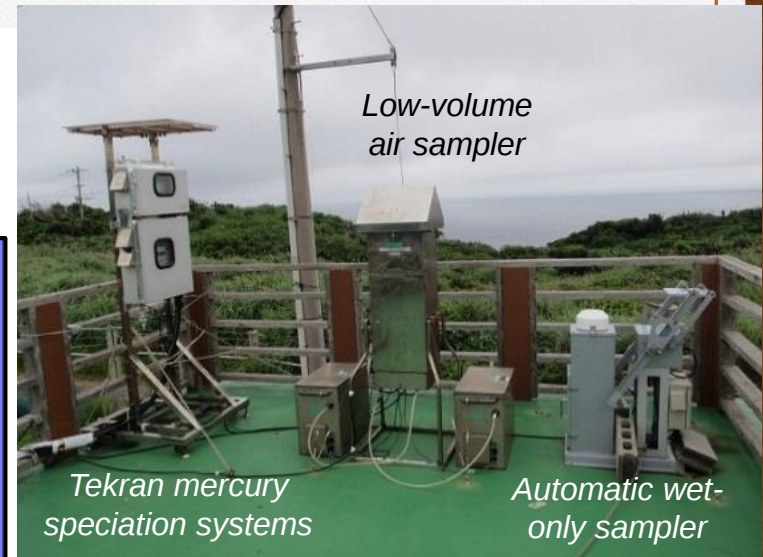
PBM: Particle-Bound Mercury

CVAAS: Cold Vapor-Atomic Absorption Spectrometry

Cape Hedo Atmosphere and Aerosol Monitoring Station (CHAAMS)

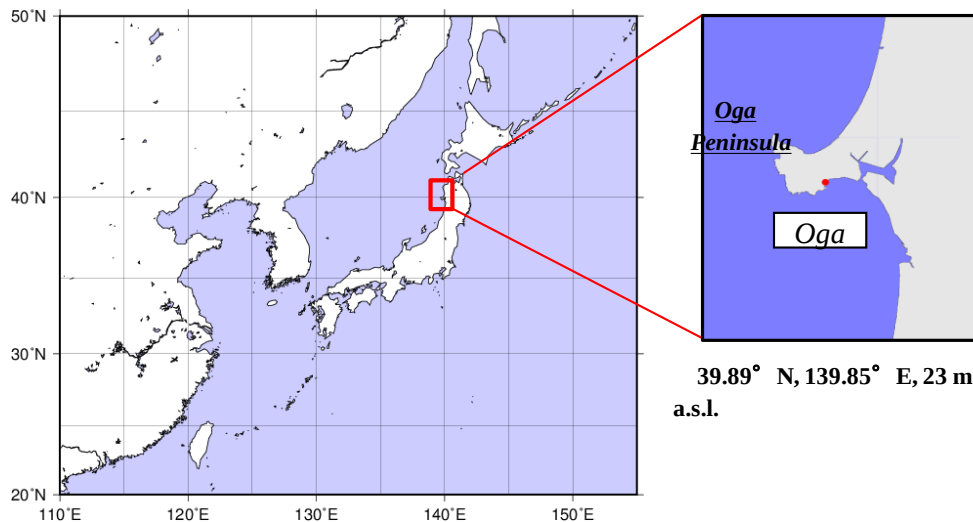


*: CHAAMS operated by
National Institute for
Environment Studies (NIES)

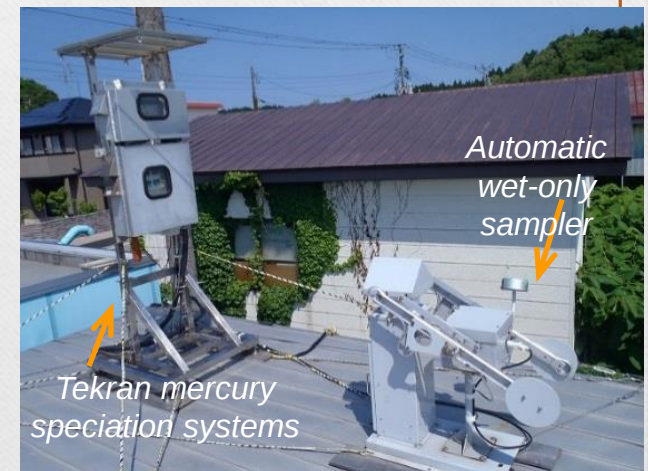


Tekran mercury speciation
analyzer and other heavy metals
monitoring systems

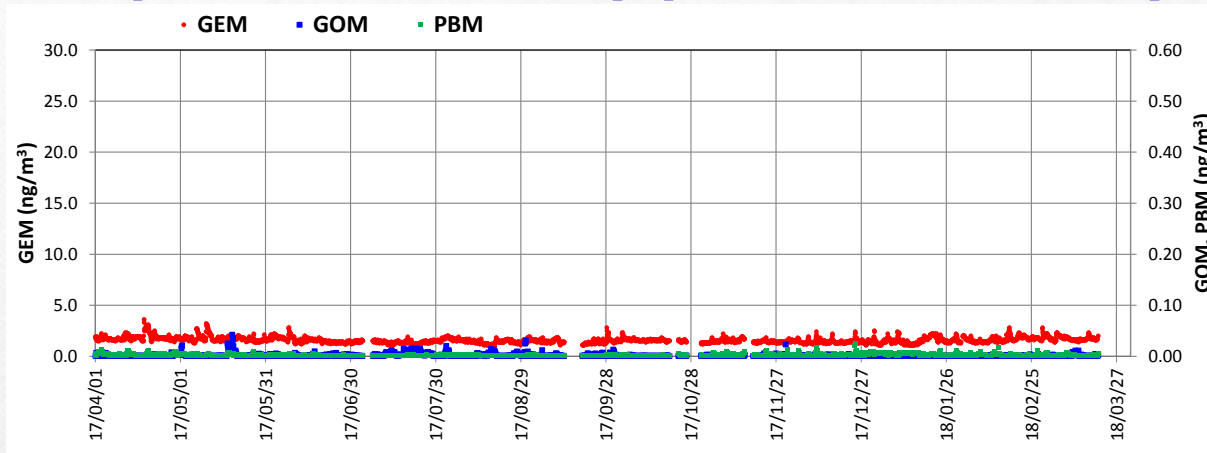
Mercury Monitoring Station in Oga Peninsula



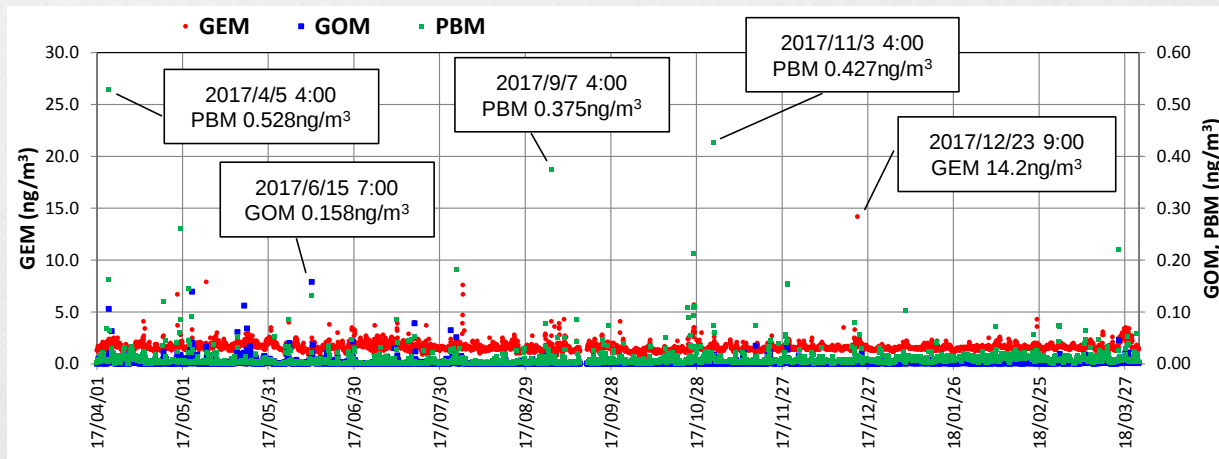
To strengthen the capacity of the mercury-observation network in Japan, a new observation site was set up at Oga city, Akita Prefecture, in September 2014.



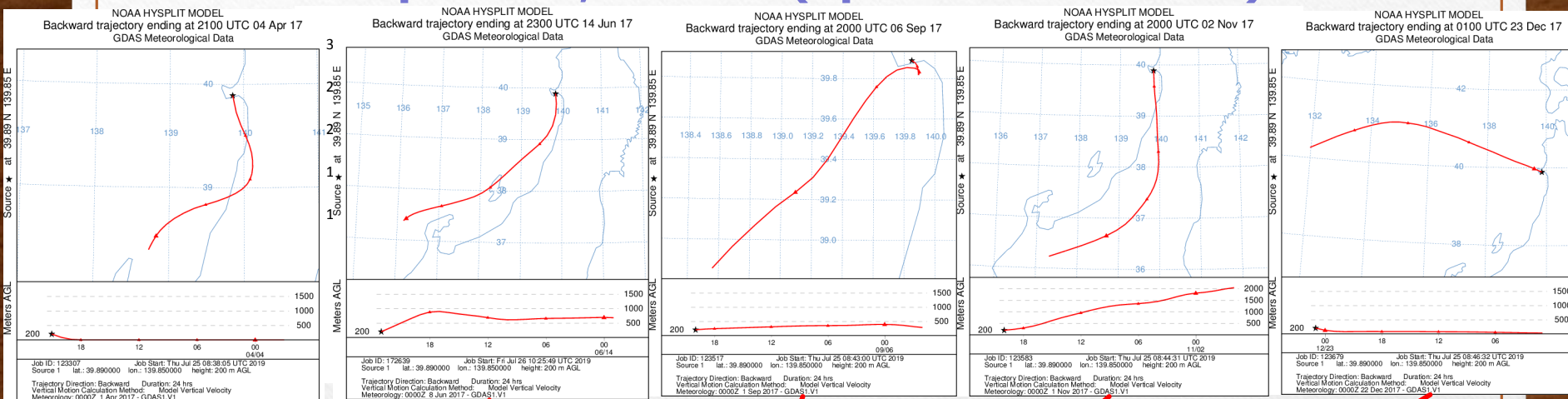
Observations of Mercury Species Cape Hedo, FY2017 (Apr 2017-Mar 2018)



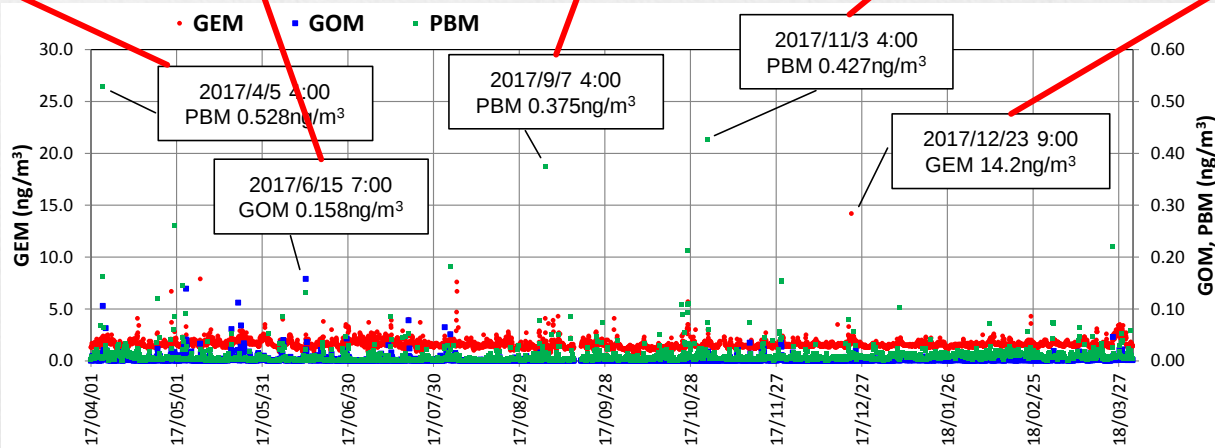
Oga, FY2017 (Apr 2017-Mar 2018)



Observations of Mercury Species Cape Hedo, FY2017 (Apr 2017-Mar 2018)

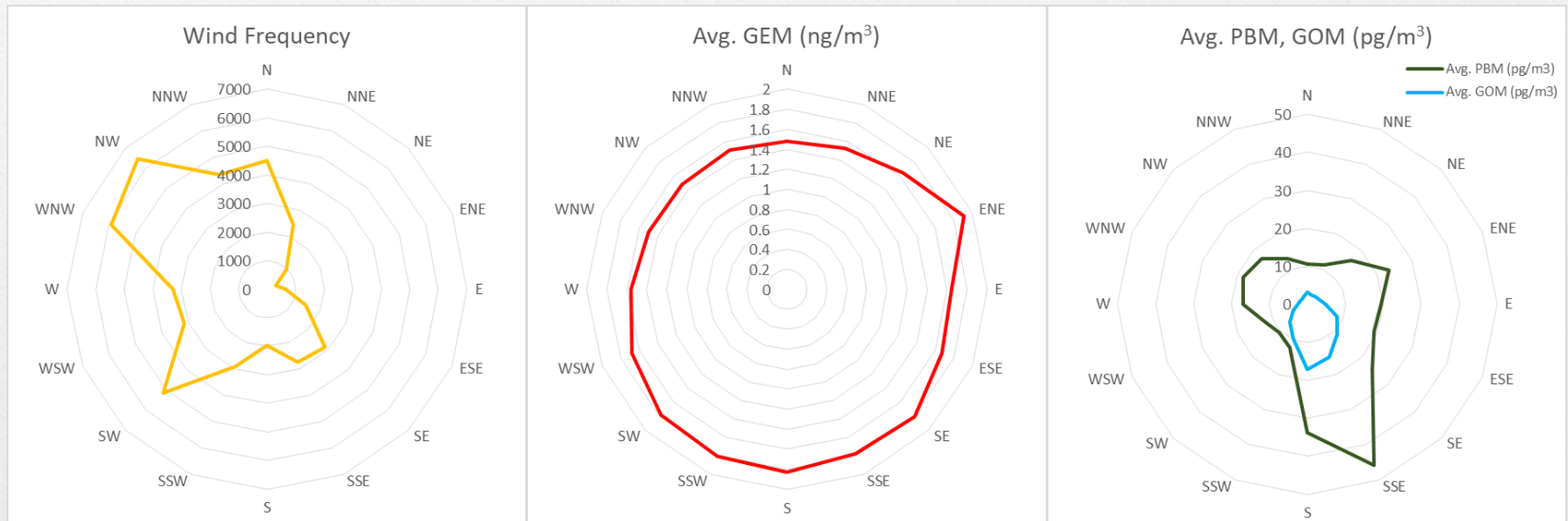


Oga, FY2017 (Apr 2017-Mar 2018)



Observations of Mercury Species

Wind and Atmospheric Mercury in Oga, FY2017



Observations of Mercury Species

Monthly Variations of GEM

Cape Hedo, FY2017 (Apr 2017-Mar 2018) Unit: ng/m³

FY2017	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mean	1.8	1.7	1.6	1.4	1.5	1.4	1.6	1.5	1.4	1.5	1.7	1.8
Median	1.7	1.7	1.5	1.4	1.5	1.4	1.5	1.4	1.4	1.5	1.6	1.7
Min	1.4	1.3	1.2	1.0	1.0	1.1	1.2	1.2	1.1	1.1	1.3	1.4
Max	3.6	3.2	2.8	1.9	2.0	2.8	2.3	2.2	2.5	2.4	2.8	2.9
Standard Deviation	0.3	0.3	0.3	0.1	0.2	0.2	0.1	0.1	0.2	0.3	0.3	0.2
Samples (Hours)	464	471	465	422	464	366	352	416	458	463	421	472

Oga, FY2017 (Apr 2017-Mar 2018) Unit: ng/m³

FY2017	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mean	1.7	1.8	1.6	1.7	1.6	1.6	1.4	1.5	1.6	1.5	1.6	1.8
Median	1.6	1.7	1.5	1.7	1.5	1.5	1.3	1.5	1.5	1.5	1.6	1.6
Min	1.2	1.3	0.7	0.7	1.0	0.8	0.7	1.1	1.3	1.2	1.2	1.2
Max	6.7	7.9	4.0	4.0	7.6	4.3	5.7	3.0	14.2	2.3	4.3	3.5
Standard Deviation	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.2	0.6	0.2	0.3	0.4
Samples (Hours)	449	479	462	481	475	430	479	435	477	478	434	480

Observations of Mercury Species

Monthly Variations of GOM and PBM

Cape Hedo, FY2017 (Apr 2017-Mar 2018) Unit: ng/m³

	FY2017	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
GOM	Mean	0.002	0.003	0.002	0.004	0.003	0.002	<0.001	0.001	0.001	<0.001	<0.001	0.002
	Min	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Max	0.008	0.042	0.010	0.015	0.031	0.013	0.005	0.023	0.004	0.005	0.005	0.011
PBM	Mean	0.003	0.002	0.001	0.001	0.001	<0.001	0.001	0.002	0.003	0.004	0.002	0.002
	Min	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
	Max	0.014	0.010	0.006	0.004	0.004	0.004	0.006	0.012	0.025	0.011	0.017	0.007

Oga, FY2017 (Apr 2017-Mar 2018) Unit: ng/m³

	FY2017	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
GOM	Mean	0.004	0.006	0.004	0.002	0.002	0.001	<0.001	0.003	0.001	0.002	0.002	0.004
	Min	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Max	0.106	0.139	0.158	0.078	0.065	0.016	0.006	0.036	0.019	0.008	0.005	0.046
PBM	Mean	0.015	0.006	0.005	0.004	0.005	0.009	0.010	0.012	0.008	0.010	0.013	0.013
	Min	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.001	0.002	<0.001
	Max	0.528	0.145	0.131	0.085	0.181	0.375	0.212	0.427	0.079	0.103	0.071	0.221

Observations of Mercury Species

Annual Variations of GEM

Cape Hedo

	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017
Mean	1.9	2.1	2.0	1.7	1.7	1.6	1.7	1.6
Median	1.8	2.0	1.9	1.6	1.7	1.6	1.6	1.5
Min	1.2	1.1	1.3	0.9	1.2	1.0	1.2	1.0
Max	6.0	4.7	7.3	4.8	3.9	3.4	3.5	3.6
Standard Deviation	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3

Oga

Statistics
Hourly Mean of GEM
Unit: ng/m³

FY2014	FY2015	FY2016	FY2017
1.6	1.6	1.6	1.6
1.6	1.6	1.6	1.5
0.9	0.7	0.7	0.7
6.7	21.8	20.2	14.2
0.4	0.4	0.5	0.4

*Fiscal Year in Japan: April to Next March
(e.g. FY2017: Apr 2017-Mar 2018)

Observations of Mercury Species

Annual Variations of GOM, PBM

Statistics
Hourly Mean
Unit: ng/m³

Cape Hedo

Oga

GOM									GOM			
	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2014	FY2015	FY2016	FY2017
Mean	0.002	0.002	0.001	0.002	0.002	0.001	0.002	0.002	0.002	0.003	0.002	0.003
Min	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Max	0.058	0.044	0.024	0.039	0.047	0.044	0.046	0.042	0.048	0.152	0.165	0.158

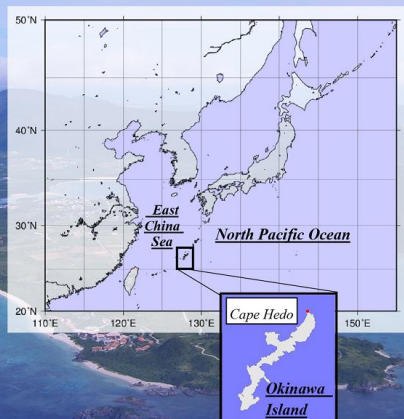
PBM									PBM			
	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2014	FY2015	FY2016	FY2017
Mean	0.002	0.002	0.002	0.004	0.004	0.002	0.003	0.002	0.009	0.009	0.011	0.009
Min	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Max	0.048	0.041	0.027	0.071	0.044	0.020	0.030	0.025	0.144	0.557	0.234	0.528

*Fiscal Year in Japan: April to Next March
(e.g. FY2017: Apr 2017-Mar 2018)



atmosphere

IMPACT
FACTOR
2.046



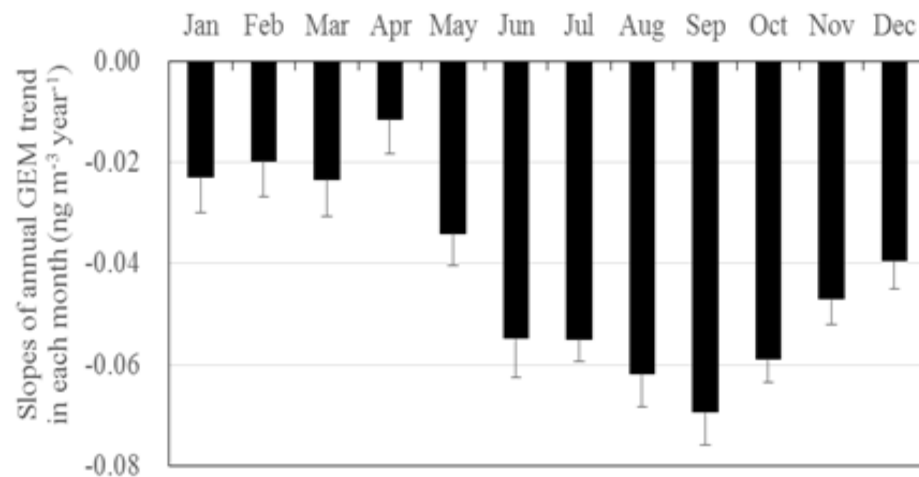
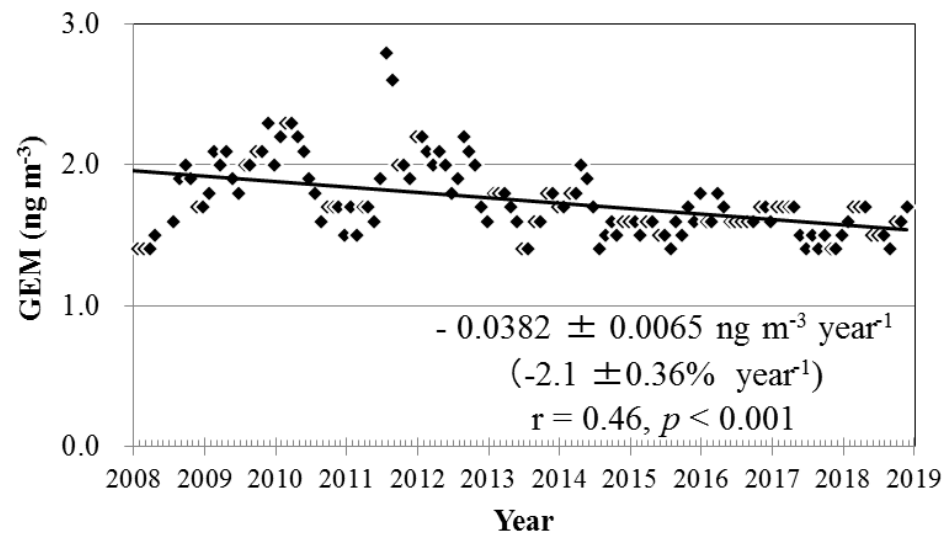
Long-Term Observation of Atmospheric Speciated Mercury during 2007–2018 at Cape Hedo, Okinawa, Japan

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Atmosphere **2019**, *10*(7), 362;
<https://doi.org/10.3390/atmos10070362>



Observations of Precipitation Mercury Concentration in Precipitation (Annual Mean)

◆Cape Hedo

Unit: ng/L

FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
3.4	3.1	2.4	3.0	1.9	2.2	1.4	2.0	4.3

↑ Previous Analytical Procedure

Improved Analytical Procedure →

FY2016	FY2017
6.6	4.8

◆Oga

Unit: ng/L

Previous Analytical Procedure →

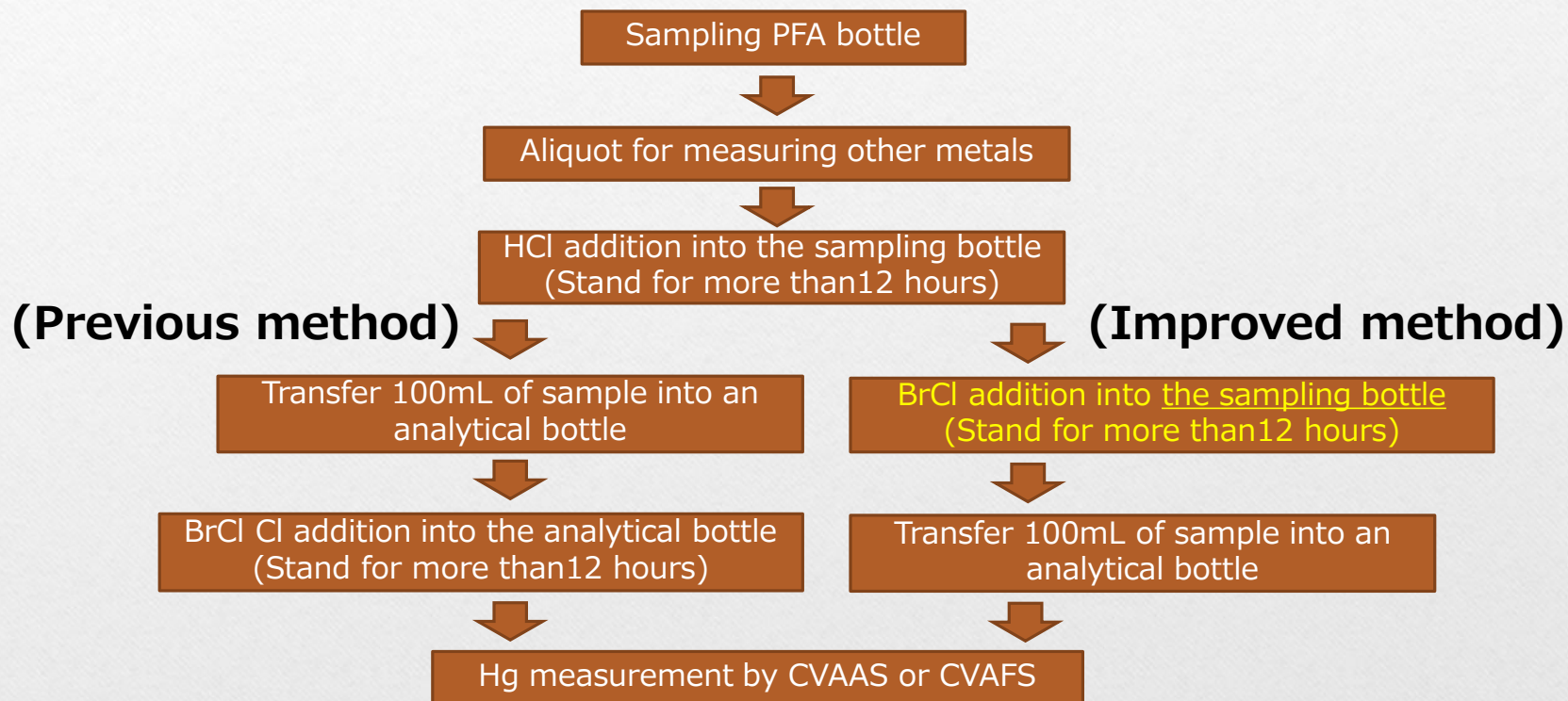
FY2014	FY2015	FY2016
2.5	2.9	4.7

Improved Analytical Procedure →

FY2016	FY2017
6.3	5.7

Observations of Precipitation

Improve the analytical procedure



Observations of Precipitation Mercury Concentration in Precipitation (Annual Mean at other sites)

Fiscal year	Minamata		Hirado		Fukuoka		Omaezaki		Kashiwazaki		Minami-Awaji	
	Hg Conc. (ng/L)	Rainfall (mm)	Hg Conc. (ng/L)	Rainfall (mm)	Hg Conc. (ng/L)	Rainfall (mm)	Hg Conc. (ng/L)	Rainfall (mm)	Hg Conc. (ng/L)	Rainfall (mm)	Hg Conc. (ng/L)	Rainfall (mm)
FY 2009	5.6	1677										
FY 2010	<u>Jun. 2011 Restart</u>		<u>Jun. 2011 Start</u>									
FY 2011	6.3 *	2528	5.8 *	2187								
FY 2012	6.8	2212	6.7	2109	<u>Jun. 2013 Start</u>							
FY 2013	7.8	1653	7.4	2062	7.6 *	1786	<u>Dec. 2013 Start</u>		<u>Jul. 2013 Start</u>			
FY 2014	9.0	1876	7.4	1968	8.1	1410	6.5	1865	6.7 **	2863		
FY 2015	8.9	2436	6.8	2269	8.2	1845	7.2	2165	5.1	2517		
FY 2016	6.6	2611	5.5	2652	7.5	2034	6.2	1834	6.2	2356	<u>Jun 2017 Start</u>	
FY 2017	6.9	1963	6.5	1685	8.0	1337	5.3	1668	<u>Mar. 2017 End</u>		7.8 *	939
FY 2018	5.8	2191	8.3	1734	10.4	1291	7.2	1764			9.8	1338
FY 2019											<u>Jul. 2019 End</u>	

* The VWM values from June to next March (For 10 months)

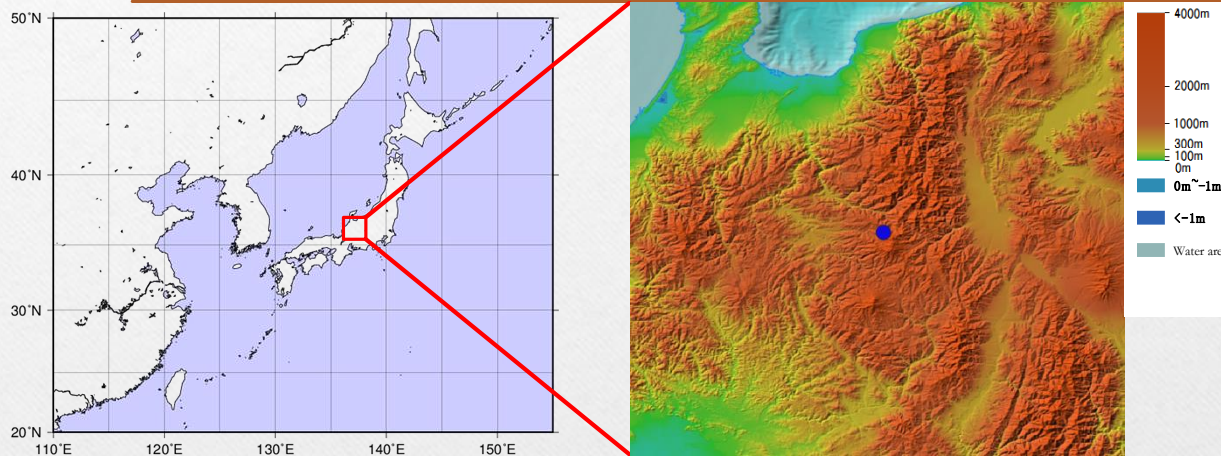
** The VWM values from July to next March (For 9 months)

New Activities

- Continuous Atmospheric Mercury Monitoring in High Altitude
- Monitoring of Atmospheric Mercury in Large Particle Matter

Atmospheric Mercury Monitoring on High-Altitude Site

- Norikura Monitoring Station (36.17 N, 137.52E, 1950m a.s.l.)



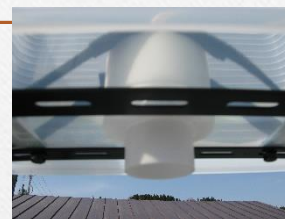
Source: Geospatial Information Authority of Japan
(<https://maps.gsi.go.jp/development/ichiran.html>)

*: Data of sea area is edited by the documents of
Hydrographic and Oceanographic Department,
Japan Coast Guard



To obtain the information of the concentration of GOM in high altitude atmosphere, continuous mercury speciation monitoring is begun in the mountains in the central area of Japan Main Island.

Monitoring of Mercury in Large Particle Matter of Atmosphere



PBM by Tekran 1135 is measured in the particle smaller than $2.5\mu\text{m}$. To obtain the information of mercury in larger particle ($>2.5\mu\text{m}$), the sampling and analysis of particle matter using a filter-pack is conducted in continuous mercury monitoring site (Cape Hedo and Oga)

Thank you!

For more information:

<https://www.env.go.jp/en/chemi/mercury/bms2017.html>