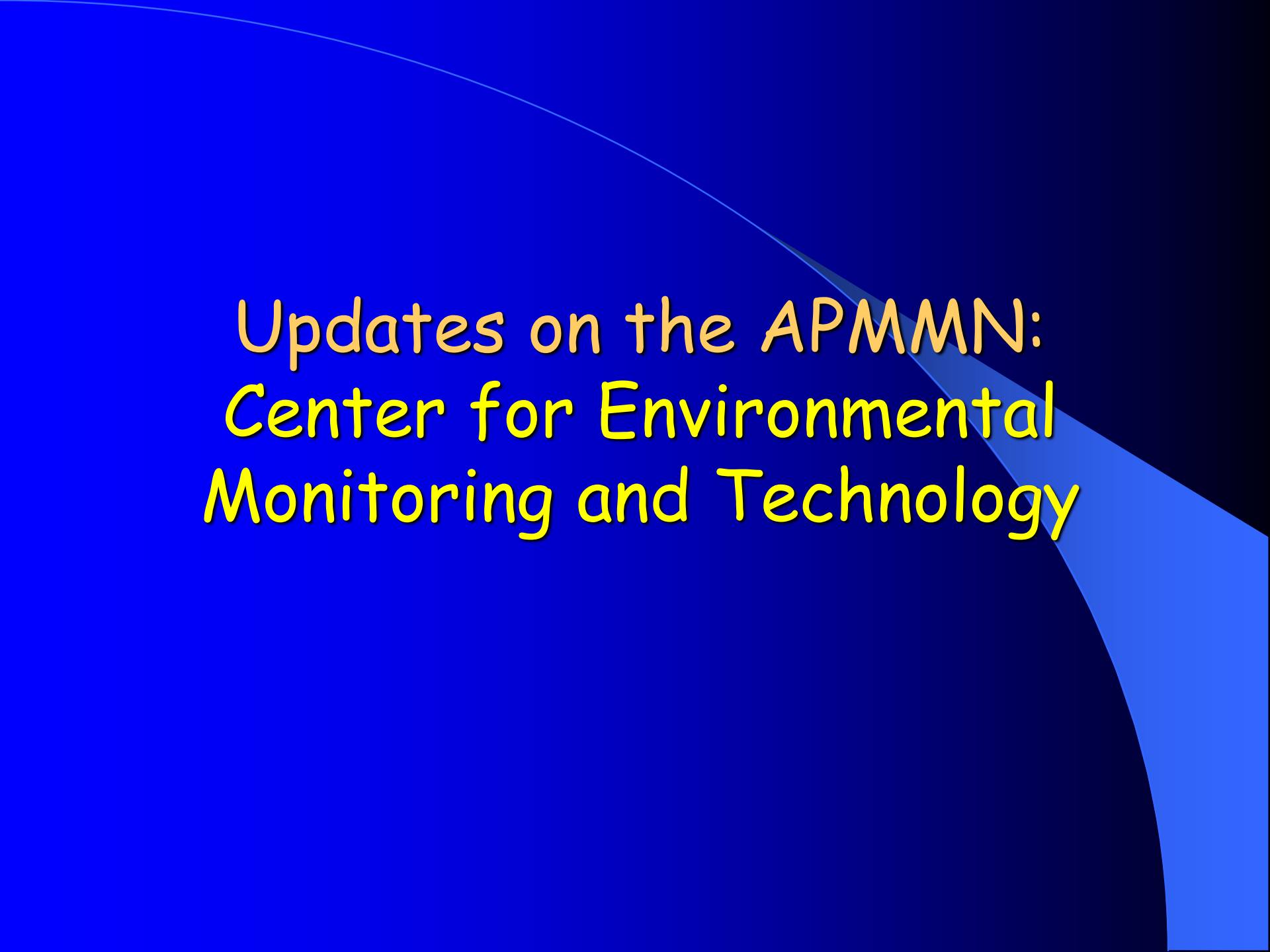


Update on the APMMN and Progress on Wet Deposition Sample Analysis

Guey-Rong Sheu

**Department of Atmospheric Sciences
National Central University
Taiwan**

The background is a solid blue gradient. A thin, light blue curved line starts from the top left and arcs across the upper half of the slide. On the right side, there is a darker blue triangular shape pointing towards the center.

Updates on the APMMN: Center for Environmental Monitoring and Technology

Background

- Taiwan EPA, USEPA and NADP have been working closely since 2012 to establish a collaborative Asia-Pacific Mercury Monitoring Network.



Background

- NCU Hg Lab serves as the center for ultra-trace level Hg analysis and training
 - To help analyze rainwater samples, and to train researchers from other Asian countries for capacity building of ultra-trace level Hg sampling and analysis
 - However, lab space and analytical equipment are limited
 - Establishment of the **Center for Environmental Monitoring and Technology** in 2016
 - Administrative offices and lab expansion to support the operation of Asia-Pacific Mercury Monitoring Network

Center for Environmental Monitoring and Technology

國立中央大學導覽圖

NCU Campus Map

Administrative area

Guest house

便捷指引

Teaching & Research

- 汽車停車場
Vehicle Parking
- 機車停車場
Motorcycle Parking
- 公車站
Bus Stop
- 安心腳踏車
Green Bike
- 餐廳
Restaurant
- 郵局
Post Office
- 自動提款機
ATM
- 商店
Store
- 廁所
Toilet
- 緊急電話
Emergency Call Box
- 自動體外心臟電擊去脈器
Automated External Defibrillator

- 1 行政大樓
Administrative Building
- 2 教務大樓
Academic Building
- 3 中正圖書館 (舊館)
Zhong Zheng Library (Old Library)
- 4 中正圖書館 (新館)
Zhong Zheng Library (New Library)
- 5 計算中心
Computer Center
- 6 國際事務
International Student Affairs
- 7 創新及創業服務
Innovation & Entrepreneurship Center
- 8 體育館
Gymnasium
- 9 校史館
History Museum
- 10 107藝文館
107 Art House Cinema
- 11 人文社會科學大樓
Humanities & Social Sciences Building
- 12 人文社會科學大樓
Humanities & Social Sciences Building
- 13 科學教育館
Science Education Center
- 14 科學教育館
Science Education Center
- 15 語言中心
Language Center
- 16 宿舍服務中心
Student Dormitory Service Center

往 觀音、桃園高鐵站

To Guan-yin, High Speed Rail Taoyuan Station

往 中壢、中山高

To Zhong-li, National Highway No.1

Lab

行政服務

Administration & Services

- 1 行政大樓
Administrative Building
- 2 教務大樓
Academic Building
- 3 中正圖書館 (舊館)
Zhong Zheng Library (Old Library)
- 4 中正圖書館 (新館)
Zhong Zheng Library (New Library)
- 5 計算中心
Computer Center
- 6 國際事務
International Student Affairs
- 7 創新及創業服務
Innovation & Entrepreneurship Center
- 8 體育館
Gymnasium
- 9 校史館
History Museum
- 10 107藝文館
107 Art House Cinema

教學研究

Teaching & Research

- 11 文學院大樓
College of Liberal Arts Building #1
- 12 文學院大樓
College of Liberal Arts Building #2
- 13 人文社會科學大樓 (文學學院辦公大樓)
College of Liberal Arts Building #3
- 14 科學教育館
Science Education Center
- 15 科學教育館
Science Education Center
- 16 科學教育館
Science Education Center
- 17 科學教育館
Science Education Center
- 18 科學教育館
Science Education Center
- 19 科學教育館
Science Education Center
- 20 科學教育館
Science Education Center

休閒生活

Sport & Recreation

- 41 體育館
Gymnasium
- 42 游泳池
Swimming Pool
- 43 網球場
Tennis Court
- 44 網球場
Tennis Court
- 45 網球場
Tennis Court
- 46 網球場
Tennis Court
- 47 網球場
Tennis Court
- 48 網球場
Tennis Court
- 49 網球場
Tennis Court
- 50 網球場
Tennis Court

宿舍

Dormitory

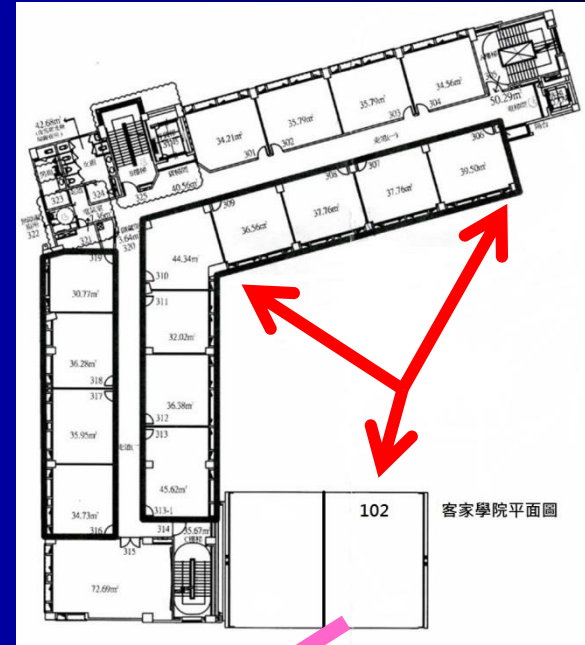
- 60 國際學生宿舍
International Student Dormitory
- 61 學生宿舍
Student Dormitory
- 62 學生宿舍
Student Dormitory
- 63 學生宿舍
Student Dormitory
- 64 學生宿舍
Student Dormitory
- 65 學生宿舍
Student Dormitory
- 66 學生宿舍
Student Dormitory
- 67 學生宿舍
Student Dormitory
- 68 學生宿舍
Student Dormitory
- 69 學生宿舍
Student Dormitory

其他單位

Other Units

- 81 附屬機構
Affiliated Institutions
- 82 附屬機構
Affiliated Institutions
- 83 附屬機構
Affiliated Institutions
- 84 附屬機構
Affiliated Institutions
- 85 附屬機構
Affiliated Institutions
- 86 附屬機構
Affiliated Institutions
- 87 附屬機構
Affiliated Institutions
- 88 附屬機構
Affiliated Institutions
- 89 附屬機構
Affiliated Institutions
- 90 附屬機構
Affiliated Institutions

Administrative Area: Hakka Studies Building



Administrative Area: Hakka Studies Building



3rd floor
offices and
meeting
rooms



Meeting room



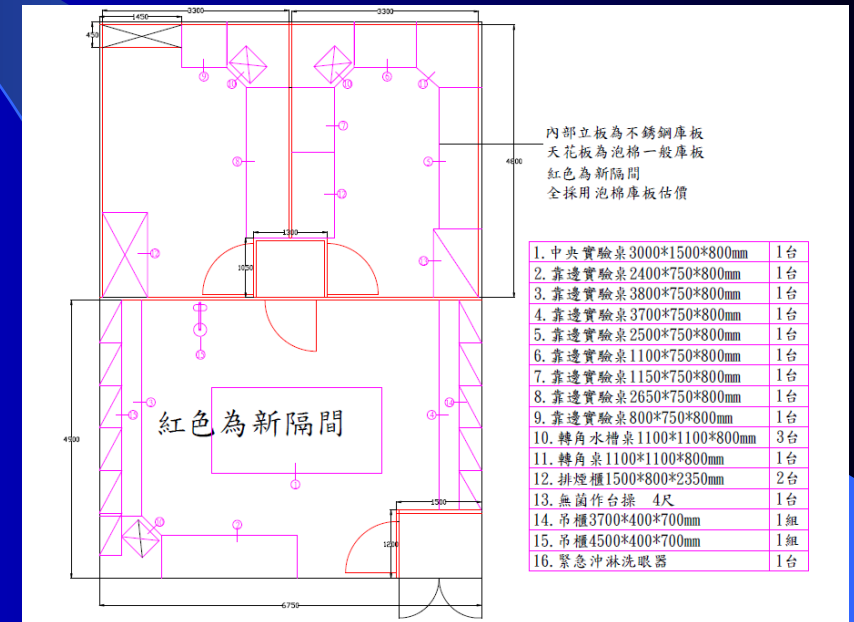
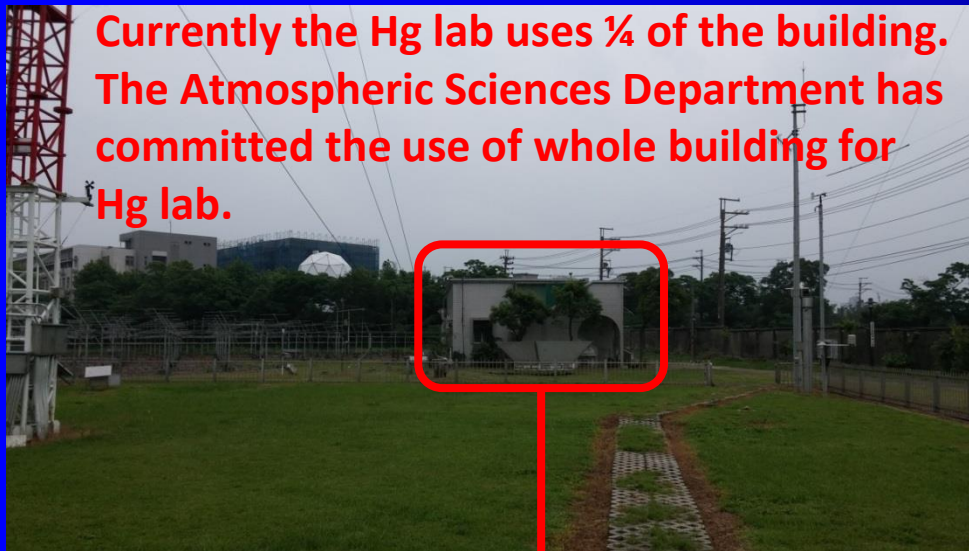
Visitor's office



Staff's office

Lab Space and Equipment Expansion

Currently the Hg lab uses $\frac{1}{4}$ of the building. The Atmospheric Sciences Department has committed the use of whole building for Hg lab.



Lab Space and Equipment Expansion



Guest House on NCU Campus

- All double rooms with three room sizes: 17.8 m², 22.4 m², and 36.4 m².

Type	General Price	Discount Price
17.8 m ²	NT 1100/D	NT 550/D
22.4 m ²	NT 1200/D	NT 600/D
36.4 m ²	NT 1800/D	NT 900/D



Progress on Wet Deposition Sample Analysis

Commonly Used Units for Trace and Ultra Trace Components

<i>Name of concentration unit</i>	<i>Part per thousand</i>	<i>Part per million</i>	<i>Part per billion</i>	<i>Part per trillion</i>	<i>Part per quadrillion</i>	<i>Part per quintillion</i>	<i>Part per sextillion</i>
Volume/volume concentration	vpth (ppth v/v)	vpm (ppm v/v)	vpb (ppb v/v)	vpt (ppt v/v)	vpq (ppq v/v)	vpq _{ui} (ppq _{ui} v/v)	vps (pps v/v)
Mass-mass concentration	ppth	ppm	ppb	ppt	ppq	ppq _{ui}	pps
Percentage (%)	10 ⁻¹	10 ⁻⁴	10 ⁻⁷	10 ⁻¹⁰	10 ⁻¹³	10 ⁻¹⁶	10 ⁻¹⁹
Amount of analyte in 1 g sample	1 milligram (1 mg)	1 microgram (1 µg)	1 nanogram (1 ng)	1 picogram (1 pg)	1 femtogram (1 fg)	1 attogram (1 ag)	1 zeptogram (1 zg)

Concentration of major ions in rainwater.

Concentration of Hg and MeHg in rainwater and ambient air.

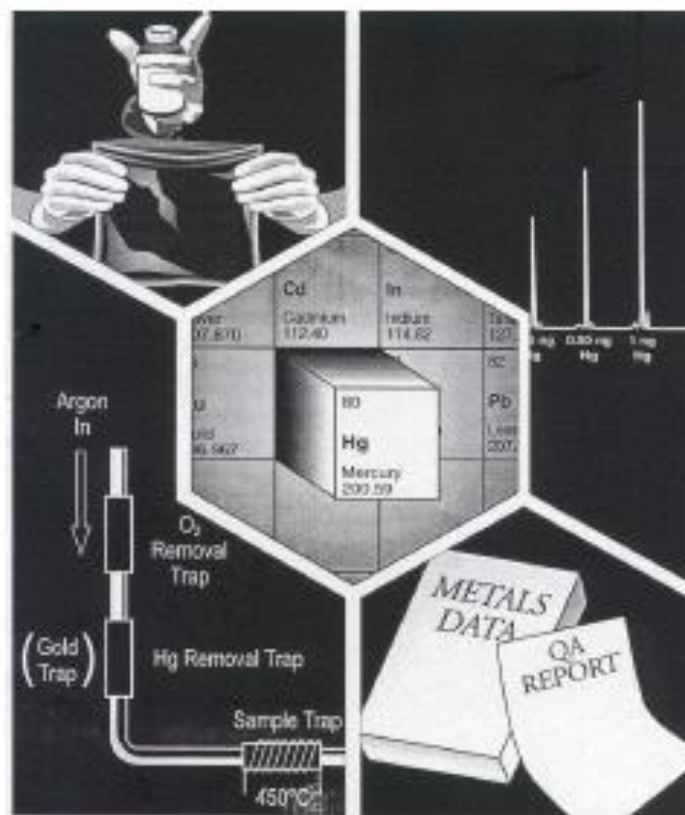
Analytical Methods and Detection Levels

Method Source	Method Number	Media Name	Instrumentation	Detection level
EPA-NERL	245.1	WATER	CVAA	0.2 ug/L
EPA-NERL	245.2	WATER	CVAA	0.2 ug/L
EPA-OSW	7470A	VARIOUS	CVAA	0.2 ug/L
USGS	I-2462	WATER	CVAA	0.1 ug/L
USGS	I-1462	WATER	CVAA	0.5 ug/L
USGS	I-5462	OTHER	CVAA	0.5 ug/L
USGS	I-7462	WATER	CVAA	0.5 ug/L
USGS	I-3462	WATER	CVAA	0.5 ug/L
NOAA_NST	131.01	ANIMAL TISSUE	CVAA	0.012 ug/L
NOAA_NST	131	SOIL/SEDIMENT	CVAA	0.012 ug/L
EPA-EAD	1631	WATER	CVAFS	0.0002 ug/L
EPA-OSW	6010 C	VARIOUS	ICP-AES	17 ug/L
EPA-NERL	200.7	WATER	ICP-AES	7 ug/L
EPA-NERL	200.8	WATER	ICP-MS	0.2 ug/L
ASTM	D6502	WATER	XRF	1 ug/L

CVAFS: Cold Vapor Atomic Fluorescence Spectrometry

Method 1631, Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry

August 2002



Rainwater Hg Analysis

- Total Hg is quantified by dual amalgamation CVAFS after BrCl oxidation, $\text{NH}_2\text{OH}\cdot\text{HCl}$ neutralization, and SnCl_2 reduction.



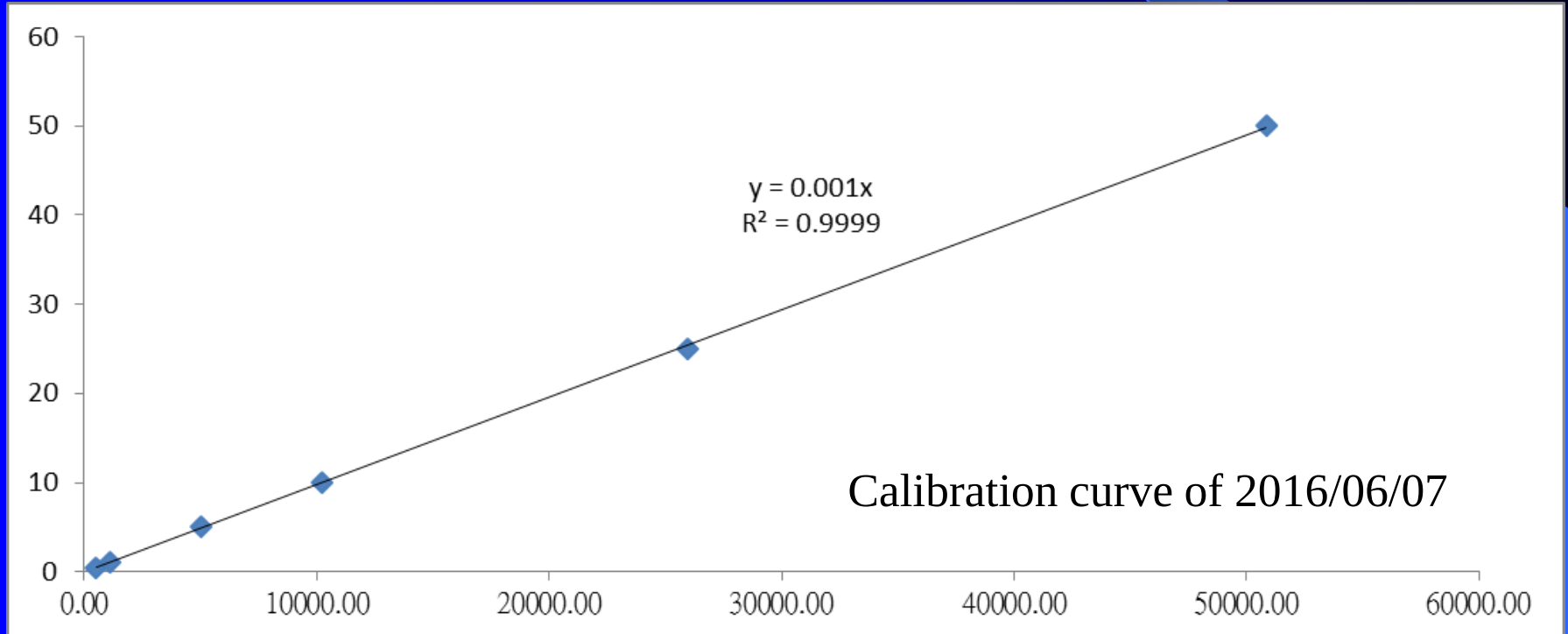
QA/QC: Method Detection Limit

The detection limit and minimum level of quantitation in this Method usually are dependent on the level of interferences rather than instrument limitations. The method detection limit (MDL; 40 CFR 136, Appendix B) for Hg has been determined to be 0.2 ng/L when no interferences are present. The minimum level of quantitation (ML) has been established as 0.5 ng/L. An MDL as low as 0.05 ng/L can be achieved for low Hg samples by using a larger sample volume, a lower BrCl level (0.2%), and extra caution in sample handling.

MDL of my lab is 0.16 ng/L

QA/QC: Calibration Curve

R^2 of calibration curve > 0.999



QA/QC: Blanks of 2015

	Frequency	Mean (ng L ⁻¹)	Min. (ng L ⁻¹)	Max. (ng L ⁻¹)	1631 rev. E
System blank	39/39	0.04	0.00	0.21	< 0.5 ng L ⁻¹
Bottle blank	38/39	0.07	0.00	0.6	< 0.5 ng L ⁻¹

QA/QC: Duplicate Analysis and Matrix Spike

	Results of 2015
Duplicate analysis	0.0% - 3.8%
Matrix spike recovery	98.5 – 109.8%

Acceptance Criteria	Section	Limit (%)
Initial Precision and Recovery (IPR)	9.2.2	
Precision (RSD)	9.2.2.3	21
Recovery (X)	9.2.2.3	79-121
Ongoing Precision and Recovery (OPR)	9.5.2	77-123
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	9.3	
Recovery	9.3.4	71-125
Relative Percent Difference (RPD)	9.3.5	24

QA/QC: Percent Recovery of CRM

ORMS-5

Elevated mercury in river water

ORMS-5 is a river water spiked with inorganic mercury. The material is packaged in 50 ml glass ampoules stabilized with 0.5% BrCl.

Table 1: Certified quantity value for ORMS-5

Element	pg/g
Hg	26.2 ± 1.3

QA/QC: Percent Recovery of CRM

	Frequency	Recovery(%)
Before 2015/11	9	87.6 ±4.1
After 2015/11	6	101.2±4.7

Precision and Recovery for Reagent Water, Fresh Water, Marine Water, and Effluent Water
Using Method 1631

Matrix	*Mean Recovery (%)	*Precision (% RSD)
Reagent Water	98.0	5.6
Fresh Water (Filtered)	90.4	8.3
Marine Water (Filtered)	92.3	4.7
Marine Water (Unfiltered)	88.9	5.0
Secondary Effluent (Filtered)	90.7	3.0
Secondary Effluent (Unfiltered)	92.8	4.5

*Mean percent recoveries and RSDs are based on expected Hg concentrations.

Rainwater Samples Received and Analyzed

Site	Number of Samples
Indonesia	9
Korea-GIST	3
Korea-NIER	9
Thailand	48
Vietnam	19

Some samples recently received from Korea-GIST and Thailand are not analyzed yet.

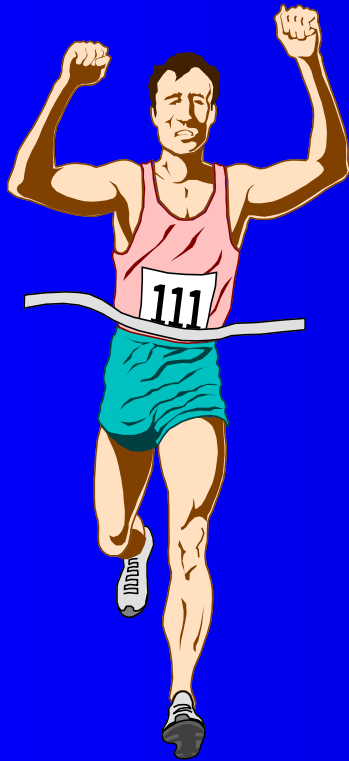
Data Summary of Analyzed Samples

Number of Samples	Min. Hg Conc. (ng/L)	Max. Hg Conc. (ng/L)
88	0.88	147.1

Summary of Rainwater Hg Conc. Worldwide

Location	Site characteristic	VWM conc. (ng L ⁻¹)	References
12 sites in Taiwan	Various	7.3-12.1	Lin et al., 2016
Equatorial Pacific Ocean	Open ocean	2.9	Mason et al., 1992
North Pacific Ocean	Open ocean	14.3	Laurier et al., 2003
Bermuda	Island	4.7	Gichuki and Mason, 2014
Long Marine Lab, CA, USA	Coastal (Pacific)	6.0	Steding and Flegal, 2002
Monterey Bay, CA, USA	Coastal (Pacific)	5.8	Conaway et al., 2010
CBL, MD, USA	Coastal (Atlantic)	11.4-15.0	Mason et al., 2000
Nam Co, China	High elevation	4.8	Huang et al., 2012
Mt. Leigong, China	Mountain	4.0	Fu et al., 2010
Chuncheon, Korea	Rural	8.8	Ahn et al., 2011
Pensacola, FL, USA	Urban/suburb	17.3	Landing et al., 2010
4 sites in Xiamen, China	Urban/suburb	11.4-14.0	Xu et al., 2014
Seoul, Korea	Urban	10.1-16.3	Seo et al., 2012
Nanjing, China (9 months)	Urban	52.9	Zhu et al., 2014
Chongqing, China	Urban	30.7	Wang et al., 2012
Moffett Field, CA, USA	Urban	11.6	Steding and Flegal, 2002
EMEP (2013)	Various	2.6-12.5	EMEP, 2015
107 sites in USA (MDN/NADP)	Various	1.6-25.8	NADP 2014 Annual Summary
10 sites in Japan (estimate)	Various	5.2-9.5	Sakata and Marumoto, 2005
10 sites in UK	Various	1.6-5.1	Rowland et al., 2010
2 sites in South Africa	Various	10.6-15.8	Gichuki and Mason, 2013
2 sites in Mexico	Various	7.9-8.2	Hansen and Gay, 2013

**THANK
you!**



Contact:
grsheu@atm.ncu.edu.tw