

Development of a Plan for Global Monitoring of Human Exposure to and Environmental Concentration of Mercury

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Side Event

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Objectives

Enhanced understanding of mercury concentrations in ambient air through the strengthening of the Global Monitoring Observation System (GMOS) and the development of the complementary passive air sampling (PAS) network for ambient air concentrations

Activities

- ✓ Establish a **monitoring network to collect atmospheric samples by developing Passive Air Samplers (PAS)** to complement the GMOS monitoring program.
- ✓ **Conduct a pilot testing of PAS** for one year at new sites and at selected reference GMOS sites.
- ✓ In cooperation with UN Environment, WHO and other interested parties **to draft a proposal for developing a worldwide air monitoring plan**, including existing active sites/networks and sites with PASs.



Equipment installed at all GMOS sites



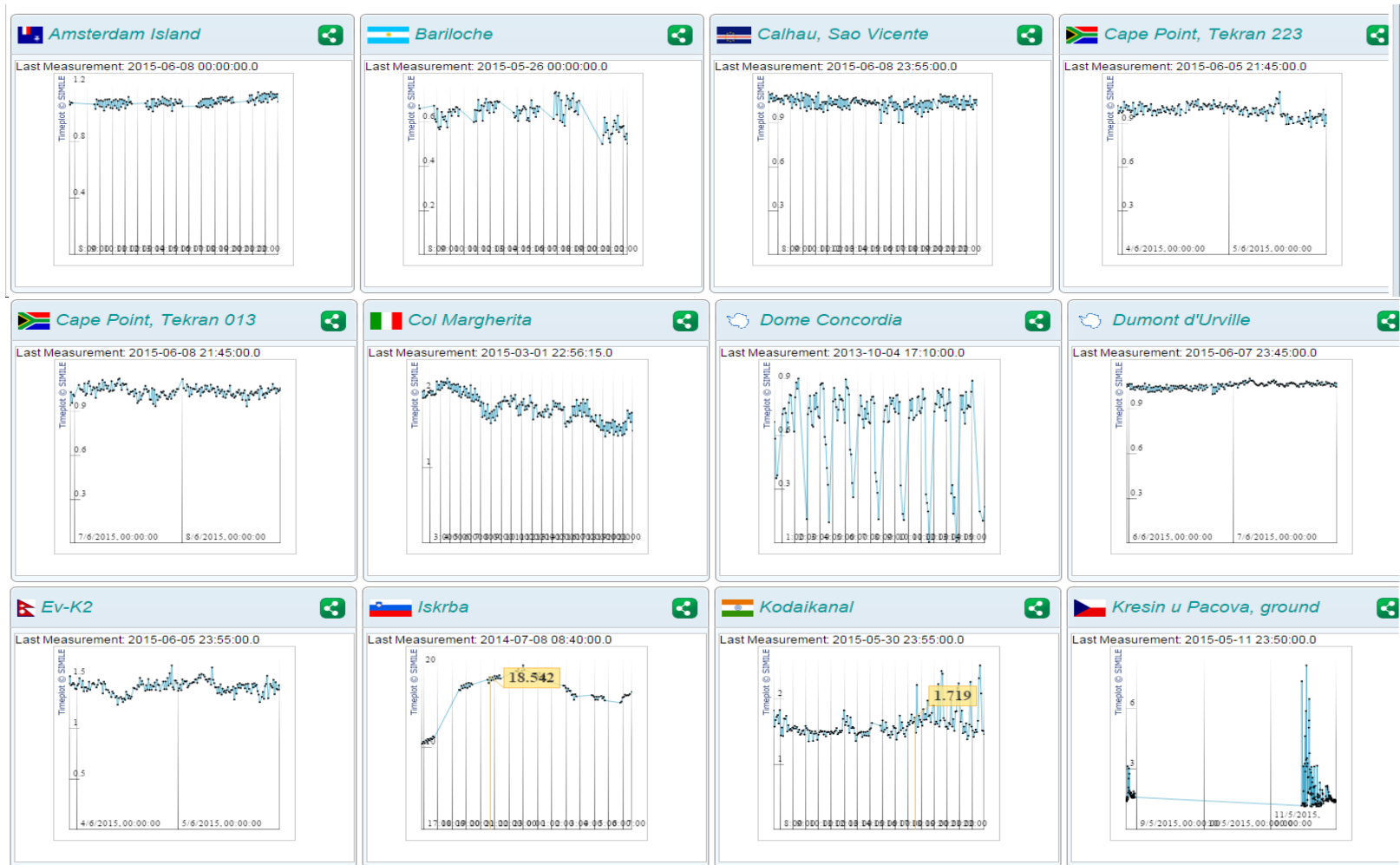
- SOPs for Hg
- To ensure high quality, comparable global atmospheric Hg measurements at all GMOS sites

TGM/GEM: Tekran 2537 or Lumex RA 915 AM

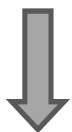
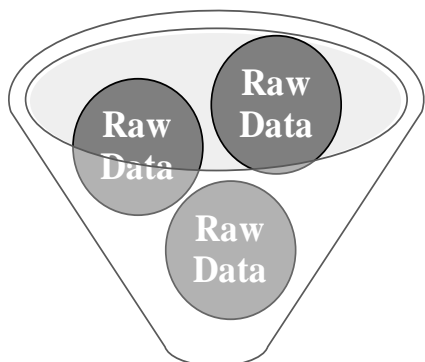


Speciated Hg: Tekran 2537/1130/1135

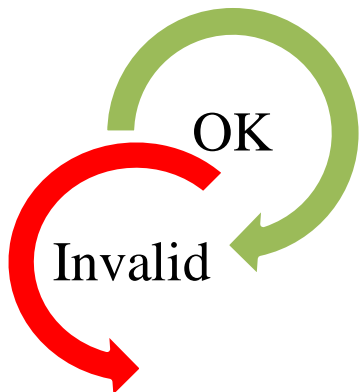
GMOS - Near real-time data from monitoring stations



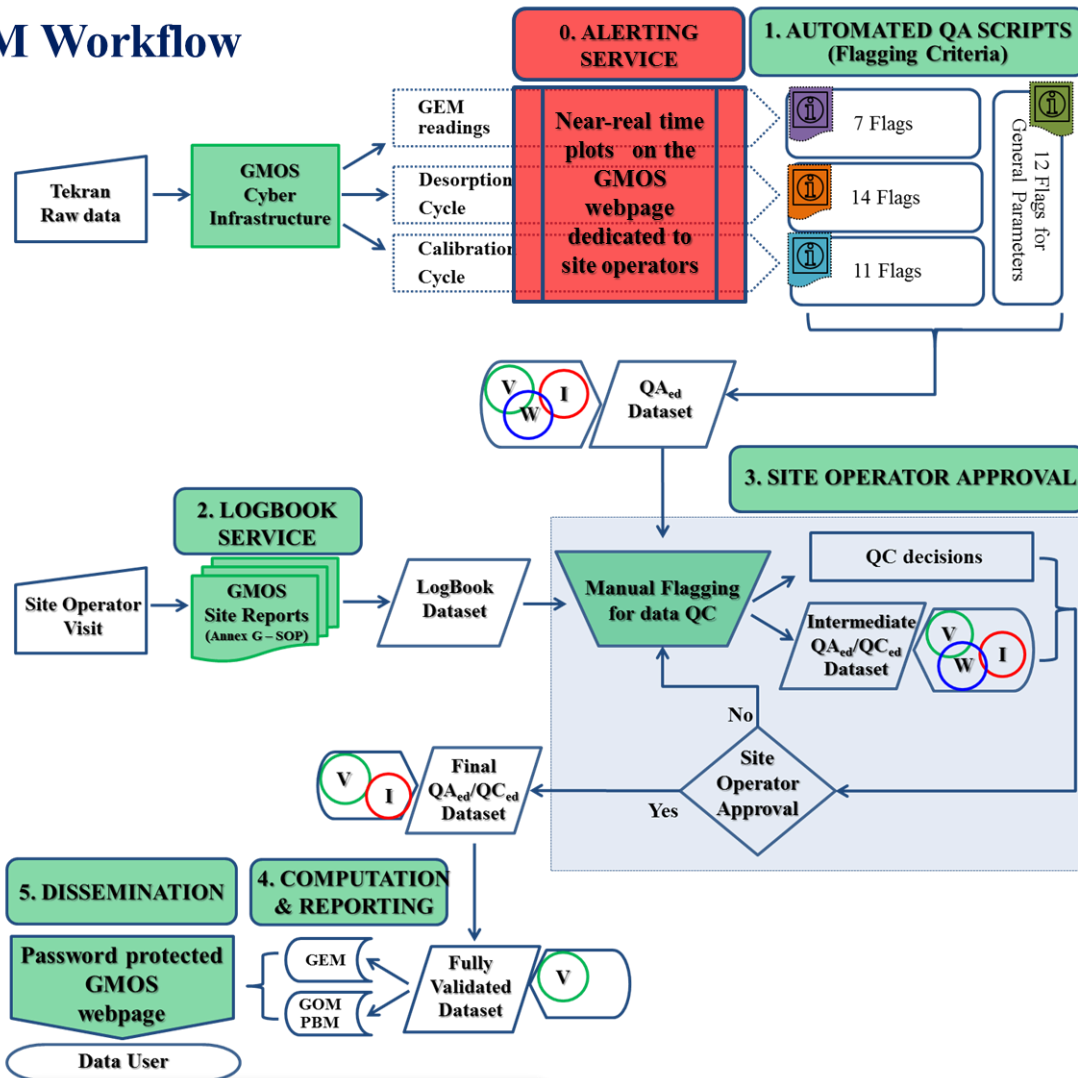
GDQM - GMOS Data Quality Management System



Flagging Criteria



❖ G-DQM Workflow



Management of a large data sets

QA and QC of Measurements

GMOS – Spatial Data Infrastructure



Ground-based (historical)



Tropospheric (historical + current)



Oceanographic
(historical + current)



Ground-based near real-time



Emissions inventories



Marine biota

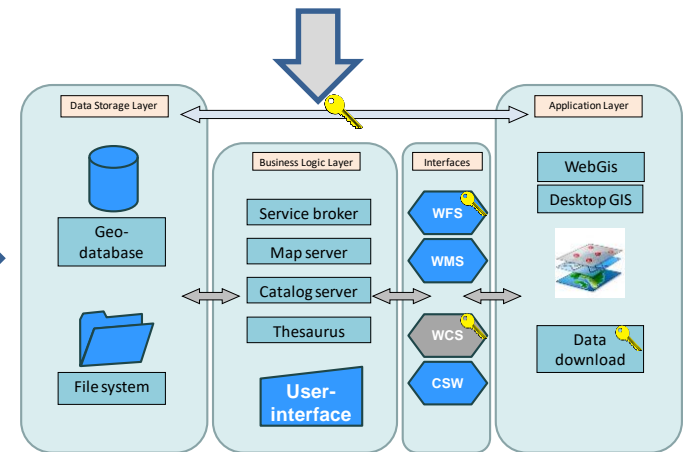
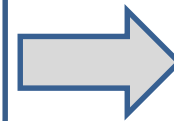
Humans



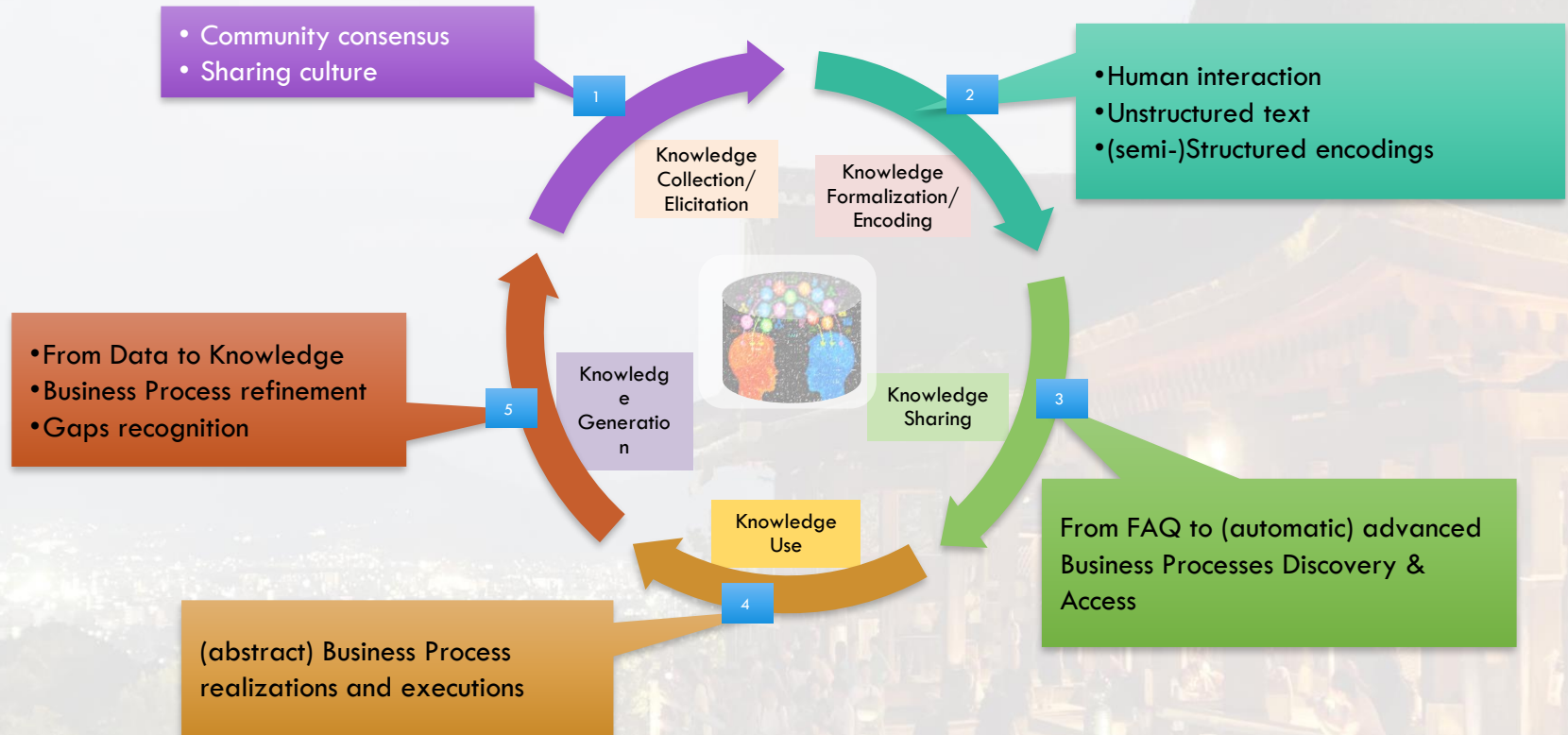
Mosses & Lichens



Validated atmospheric
Model outputs

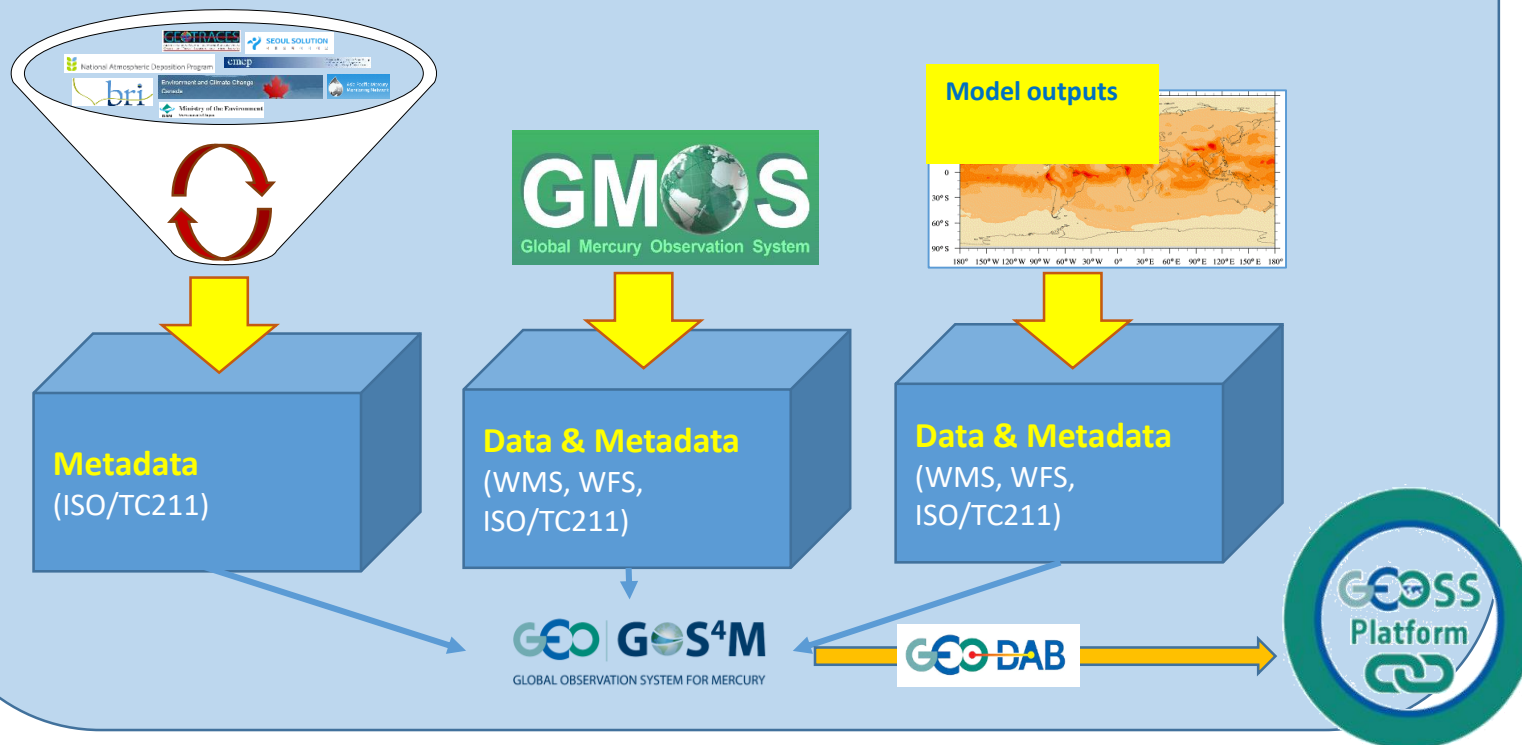


The Knowledge Lifecycle → Minamata Knowledge Platform



Minamata Knowledge Platform

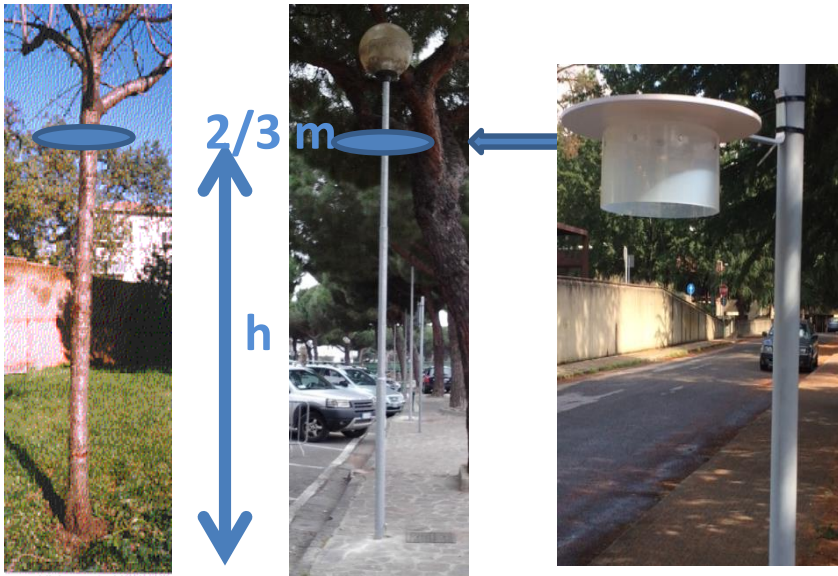
- Information catalog (metadata creation)
- Algorithms and models documentation



Why to use PASs for Global Hg Monitoring

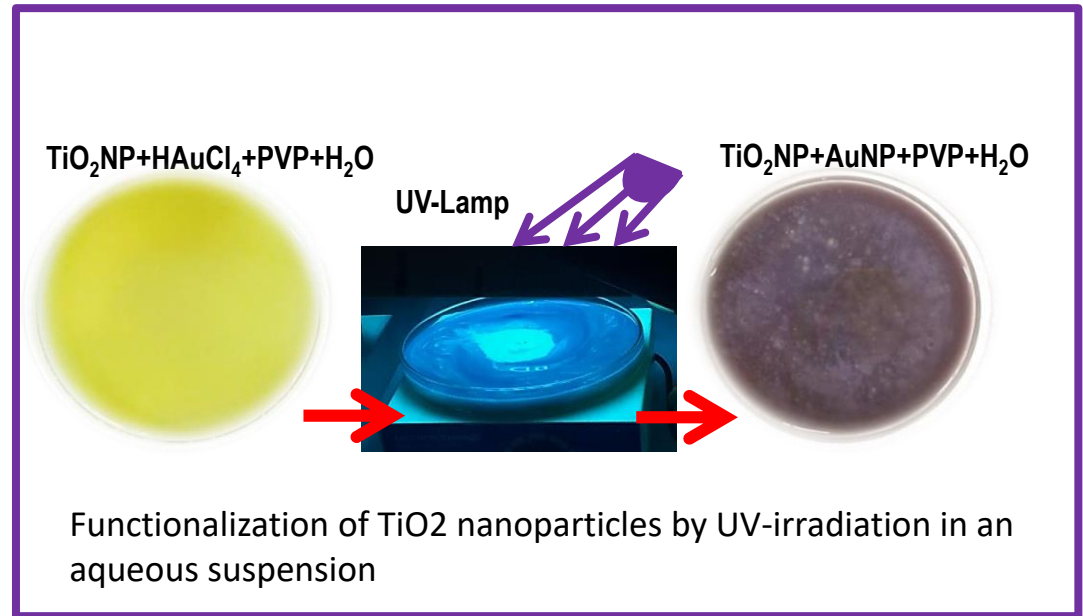
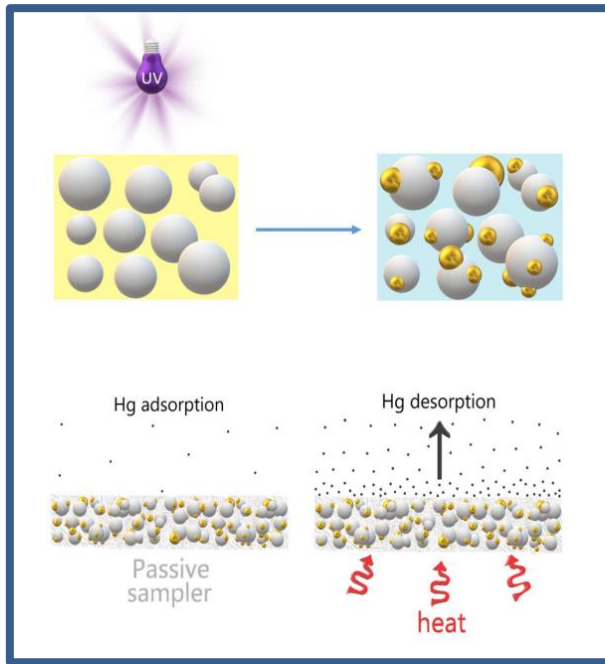
PASs are an effective alternative for conventional air quality monitoring to support exposure and health effects studies, given its simplicity and low cost

PASs are capable of providing comparable performance to active samplers in terms of sensitivity and reproducibility



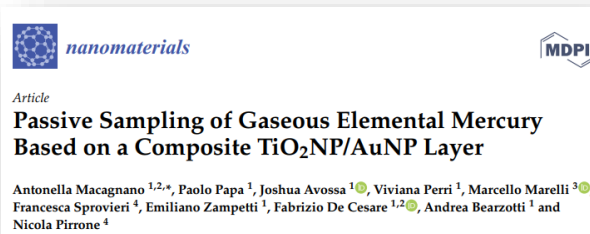
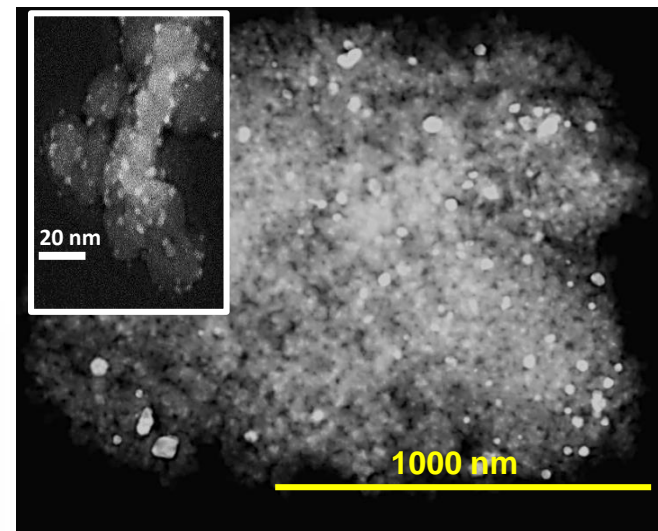
Typical deployment of PASs in the field

Design and preparation of the nanomaterial for CNR-IIA PASs

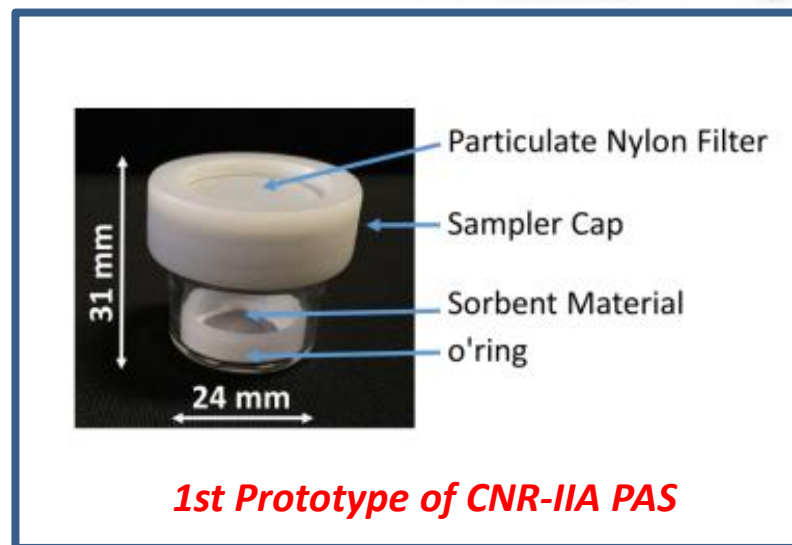
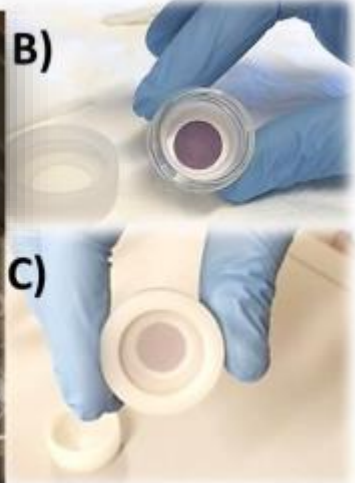
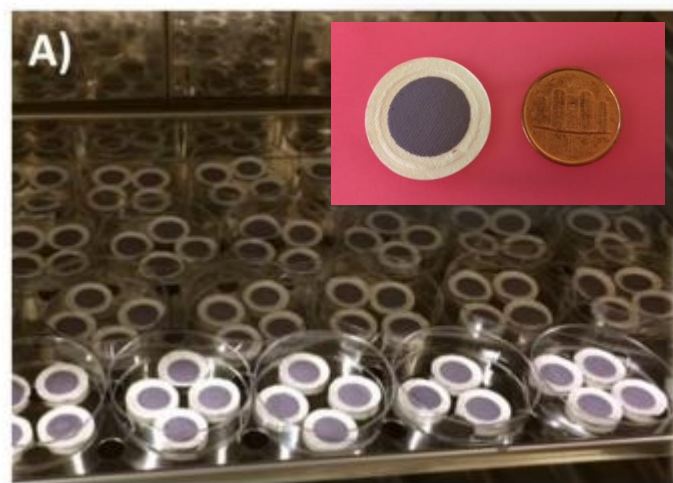
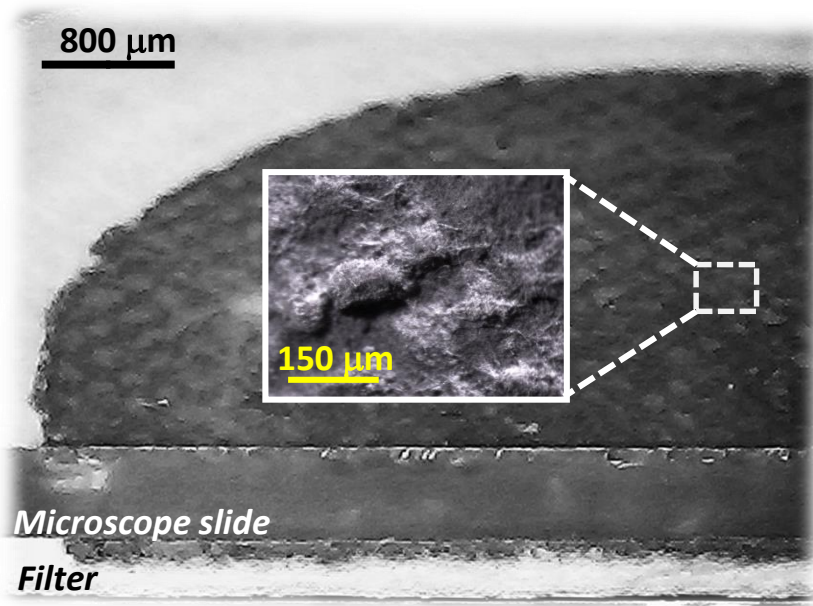
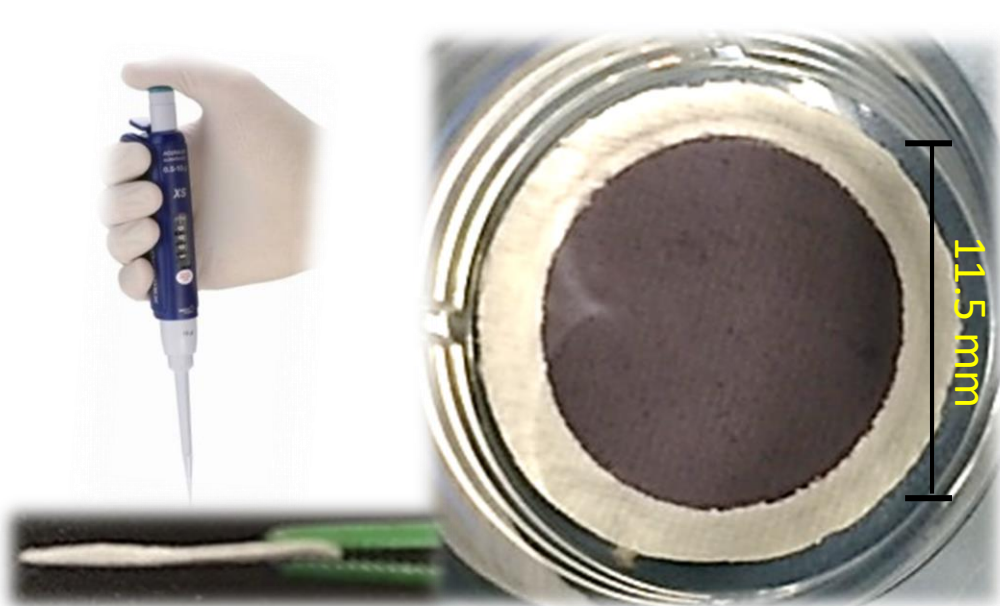


Representative STEM micrographs of an Au/TiO₂ anatase sample at low magnification—AuNPs (gold nanoparticles) appear brighter over the greyish support- and at higher magnification (*inset*)

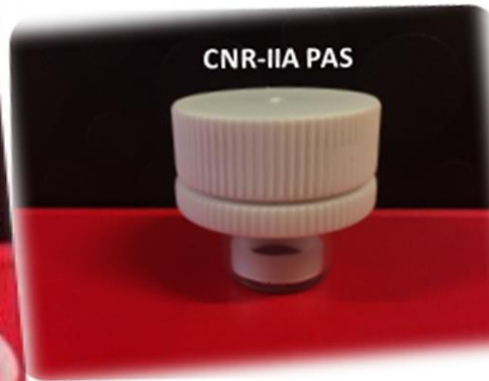
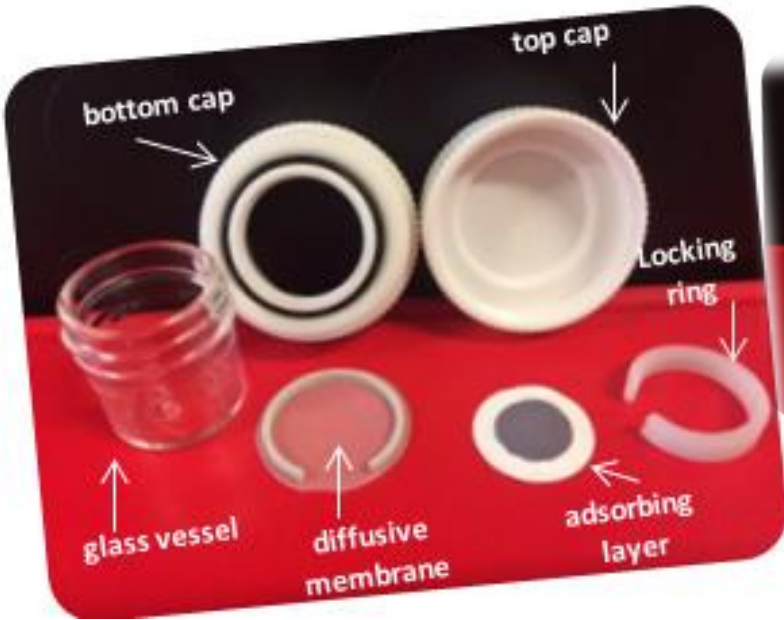
They consisted of an adsorbent layer made of titania nanoparticles (TiO₂NPs, ≤25nm diameter) finely decorated with gold nanoparticles. The TiO₂NPs functionalization occurred for the photocatalytic properties of titania-anatase when UV-irradiated in an aqueous solution containing HAuClO₄.



PAS nanoparticle film preparation

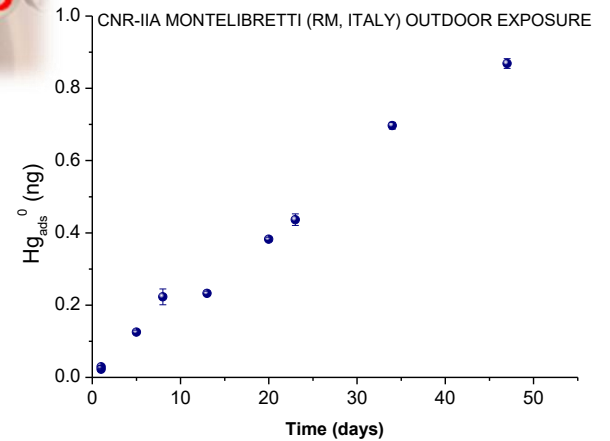


CNR-IIA Hg Passive Air Samplers (PASs)



OUTDOOR

Hg⁰ adsorption through 47 days

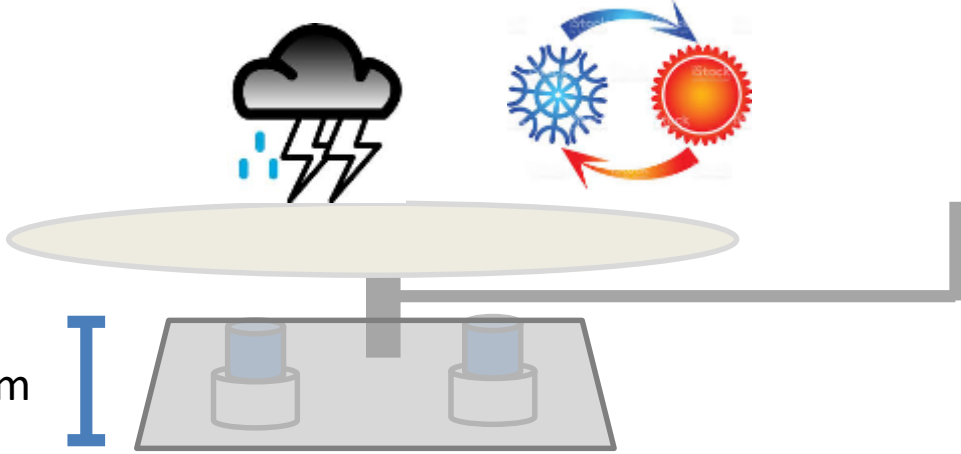


Shelter design for housing the PASs

The shelter comprises N. 8 labelled slots to host up to 8 PASs (A-A, B-B, C-C, and Blanks1 and 2).



3 cm



The shelter should be tied to a pole by a plastic clamp at about **2-3 meters above ground.**



Procedures for PASs

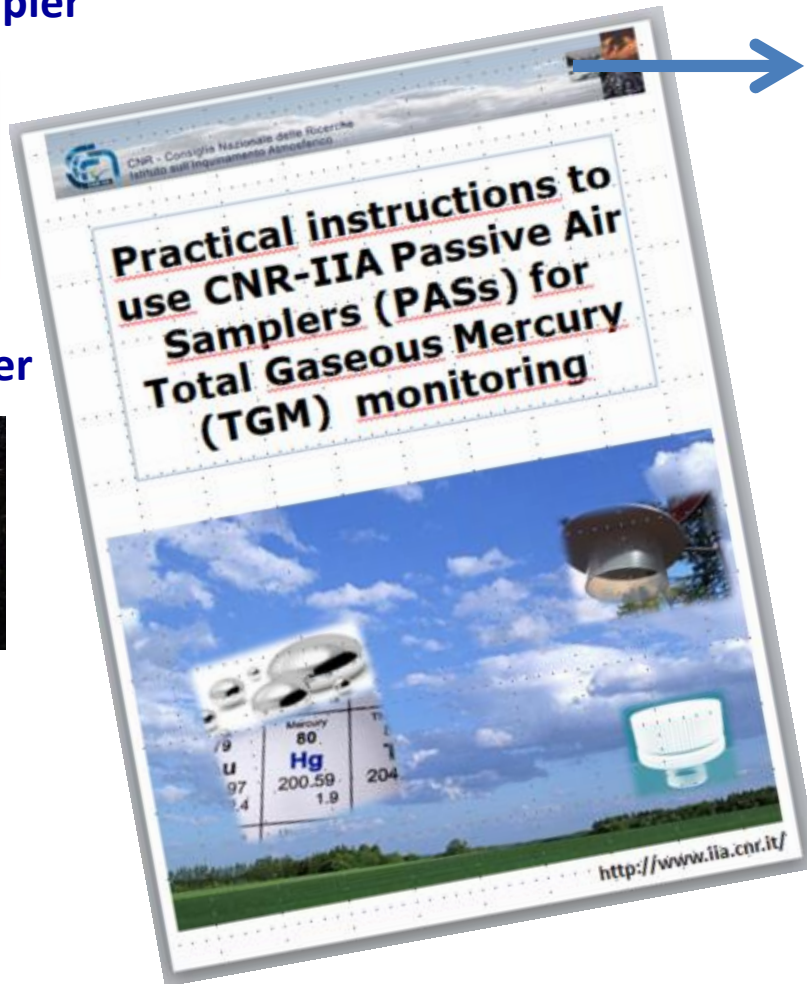
CNR-IIA axial sampler



CNR-IIA PAS holder



PAS storage



Passive Sampling Materials

- Each box comprises **N. 1 shelter** and **N. 1 complete passive sampling set**.
- Each **sampling set** includes **up to N. 6 bags**, labeled with sequential numbers, holding the samplers required for a 6-week monitoring campaign.
- Specifically each bag contains a well defined couples of samplers individually kept under vacuum:
 - **Bag 1:** N. 4 couples of under vacuum (u.v.) passive samplers (A1-A2, B1-B2, C1-C2, Blank 1-Blank2)
 - **Bag 2:** N. 1 couple of u.v. passive samplers (A3-A4)
 - **Bag 3:** N. 2 couple of u.v. passive samplers (A5-A6, B3-B4)
 - **Bag 4:** N. 1 couple of u.v. passive samplers (A7-A8)
 - **Bag 5:** N. 2 couple of u.v. passive samplers (A9-A10, B5-B6)
 - **Bag 6:** N. 1 couple of u.v. passive samplers (A11-A12)

'Video – Practical instructions for Mercury Passive Sampling'
<http://www.iaa.cnr.it/progetto-unep-gef/>

Materials for each PAS sampling campaign



Each passive sampler is kept in a vacuum bag which includes:

- ***N.4 self-locking clear plastic bags;***
- ***N.1 sealed glass vessel (PASs);***
- ***N.1 open-cap mounting a diffusive barrier***

Removal, Packaging, Storage and Transportation



001#01A07ITA

Survey of UNEP-GEF Monitoring Sites
Please answer the following questions (by filling in the blank spaces) as much detail as possible. The information you provide will be used to determine the sampling points which are possible for your site and to provide for specific work your assessors. Thank you for your time and cooperation!

Personnel Information

Name of person completing this survey: _____
Institution name: _____
Please contact person: _____
Small address for primary contact person: _____
Type of personnel: _____

Site Details

Site name: _____
Site number (if known check): _____
Site type (i.e., urban, industrial, semi-urban etc. - please check): _____
Latitude: _____ Longitude: _____

General Site Characteristics

In a few brief sentences please describe the presence of the station, vegetation cover on the station, existing buildings and other nearby structures, etc.
Does your site represent a city?

Storage (T: 4°C)

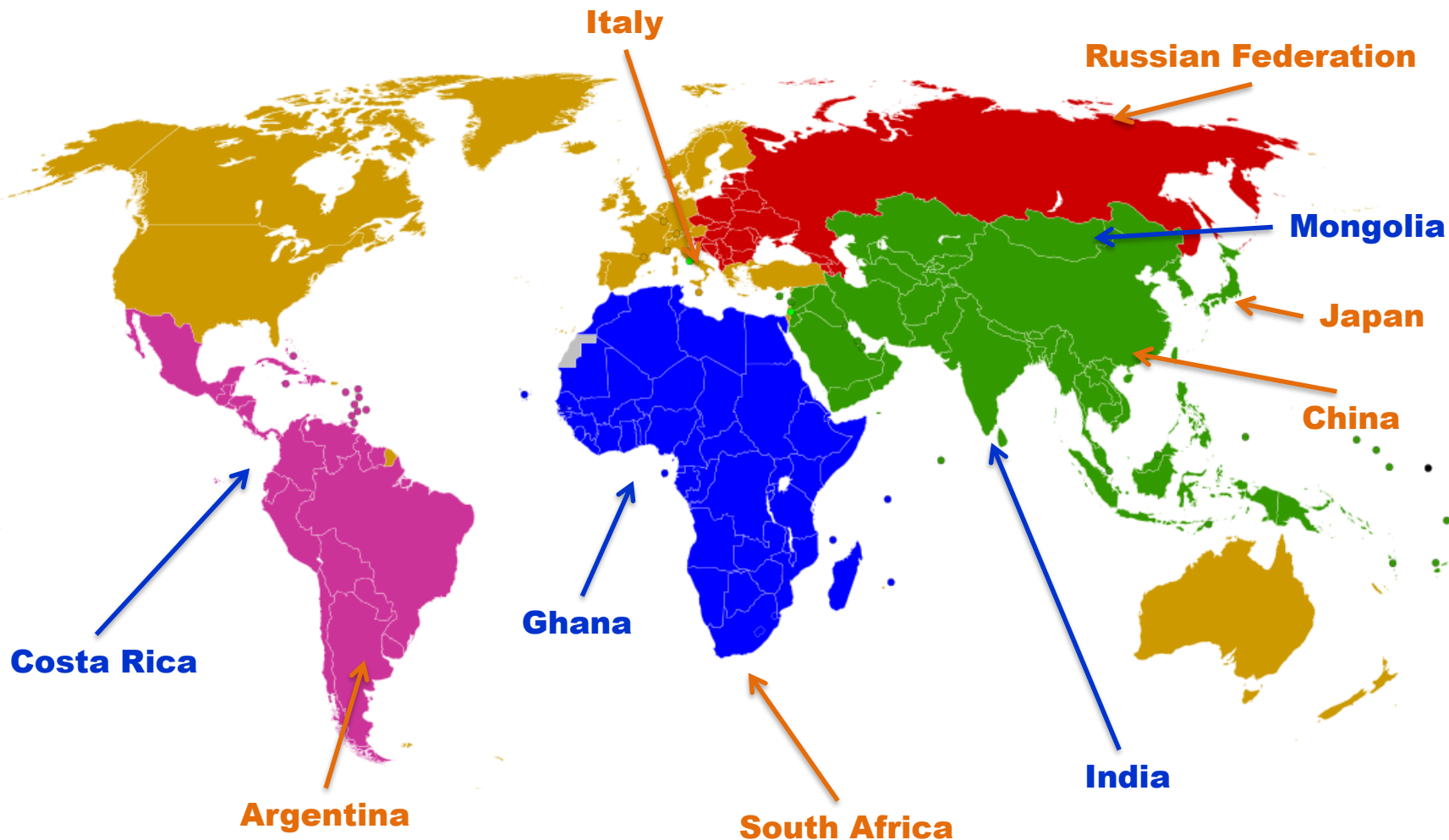


Monitoring Strategy

The selected **sites where located in 10 different countries** that are part of **all UN regions** which include:

- Asia-Pacific
 - African
 - Eastern European,
 - Latin America and Caribbean Countries - GRULAC
 - Western European and Others Group - WEOG
-
- ✓ PASs distributed and utilized at least at 6 sites.
 - ✓ At least 4 locations for co-exposure of active and passive air samplers
 - ✓ At least **3 master sites established** that deliver results for simultaneous capture of Hg **using active and PASs.**
 - ✓ Regarding the UN regions, there is a reference that "it is attempted to cover all UN regions" and that the report presenting PASs data covers at least 3 developing country regions.

Selected 10 Air Sampling Sites



- *Blue sites – Only Passive sampling*
- *Orange sites – co-locate PAS and Active Sampling*

Selection of monitoring sites

from GMOS & WHO networks

GMOS – Selected sites

Background

- Monte Curcio (Italy)
- Bariloche (Argentina)
- Cape Point (Sud Africa)
- Cape Hedo (Japan)
- China (*Mt. Ailao, *substituted site)
- Russian Federation (*Listvyanka - substituted site)

WHO- Selected sites

Polluted Sites

Ghana

Mongolia

India

Costa Rica

All GMOS sites are located in background locations in order to obtain measurements that are representative of a large region (important for trends analysis)



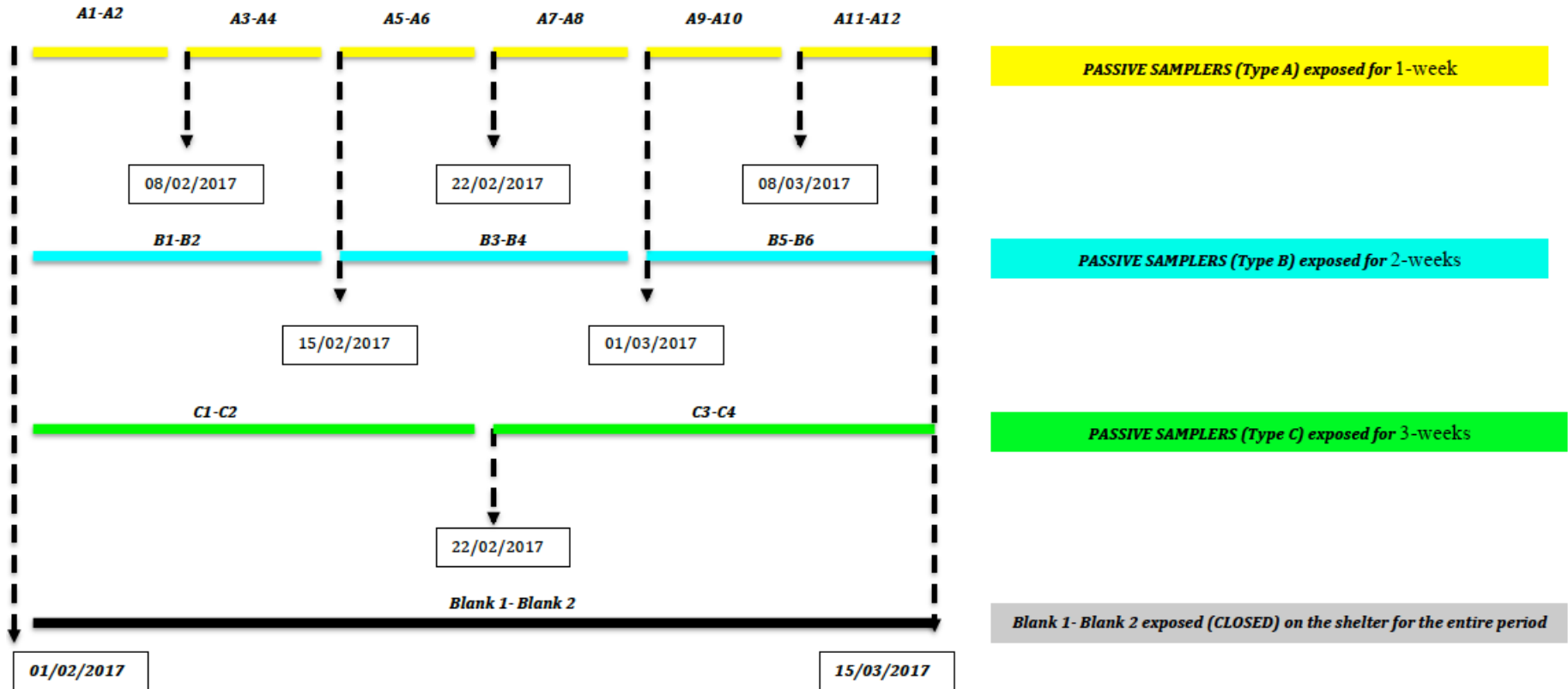
Some sites for co-monitoring have been located at polluted sites affected by local/regional Hg emissions

Hg Monitoring Program

Three Sampling Campaigns have been performed during three different seasons to account for different meteorological conditions



Hg Monitoring Program: Sampling schemes at polluted sites

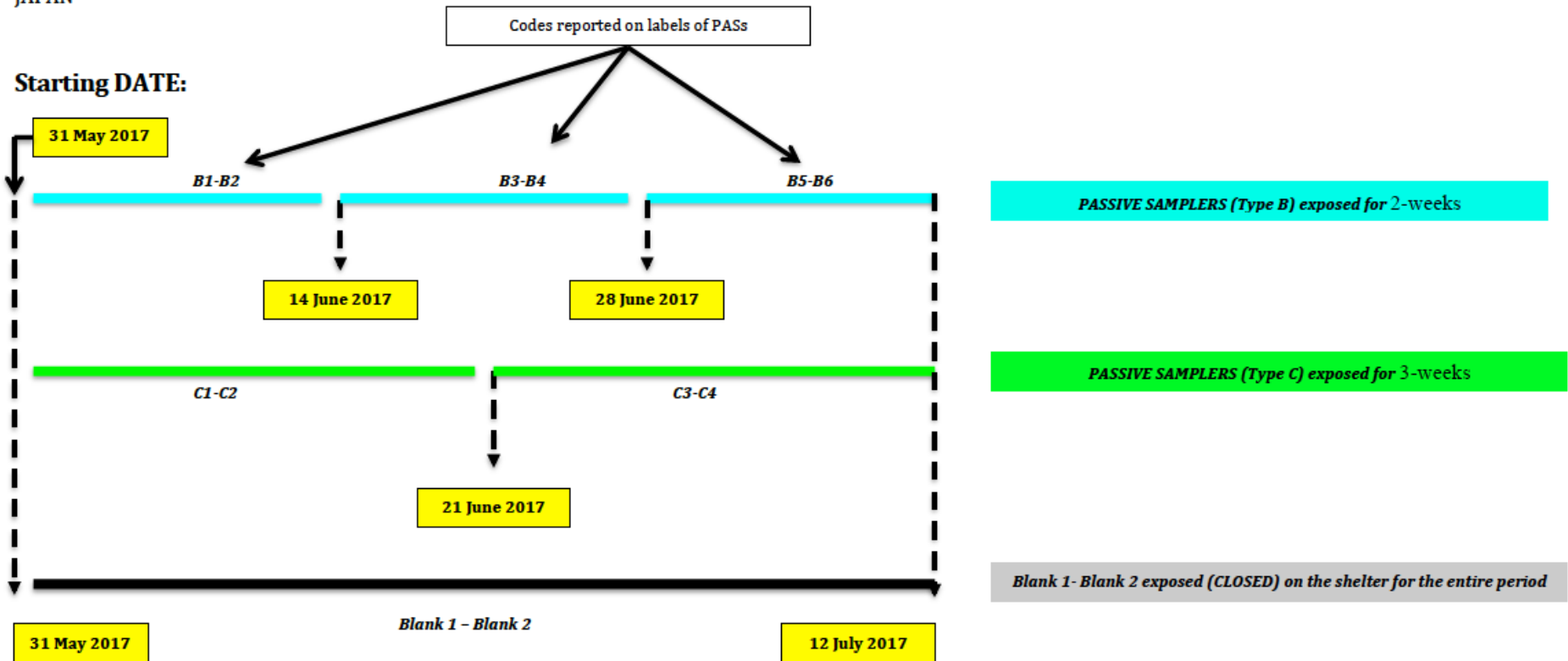


Sampling scheme adopted for sites in Ghana, Mongolia, India and Costa Rica

PASs have been exposed for 1, 2 and 3 weeks in parallel

Hg Monitoring Program: Sampling schemes at background GMOS sites

MONTE CURCIO
ARGENTINA
SOUTH AFRICA
JAPAN

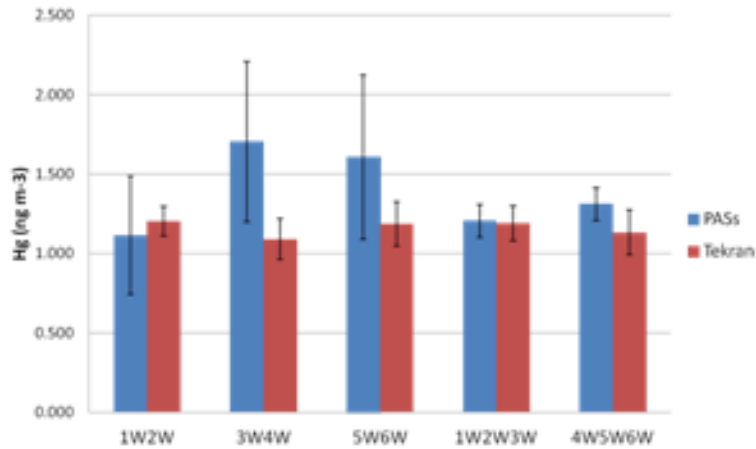


Sampling scheme adopted for sites in Italy, Argentina, South Africa, Japan, China and Russian Fed.

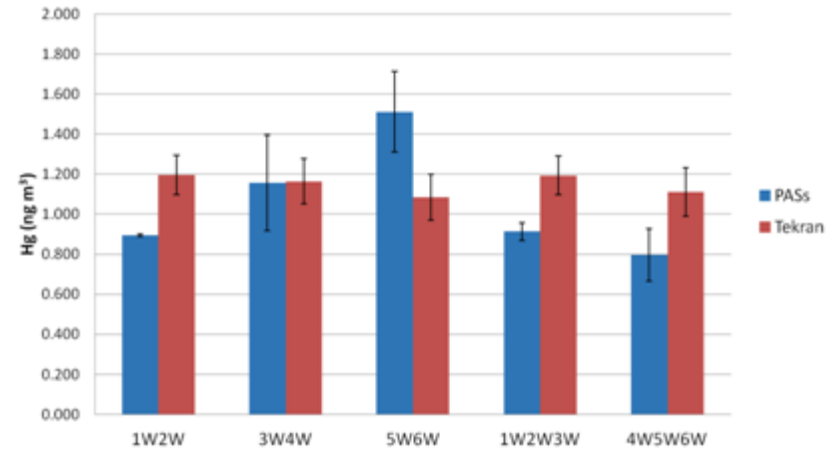
PASs have been exposed for 2 and 3 weeks in parallel

1st & 2nd sampling campaigns: comparison at Mt. Curcio Site (Italy)

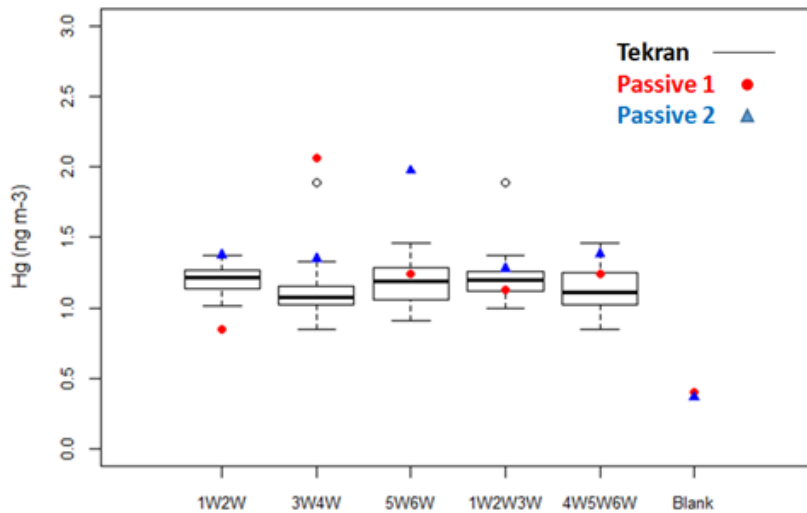
MCU-1° Campaign



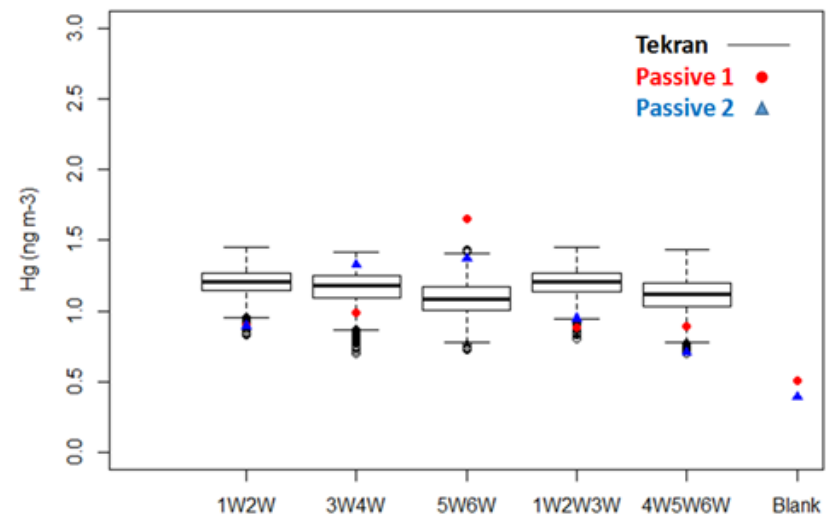
MCU - 2° Campaign



MCU - 1st Campaign

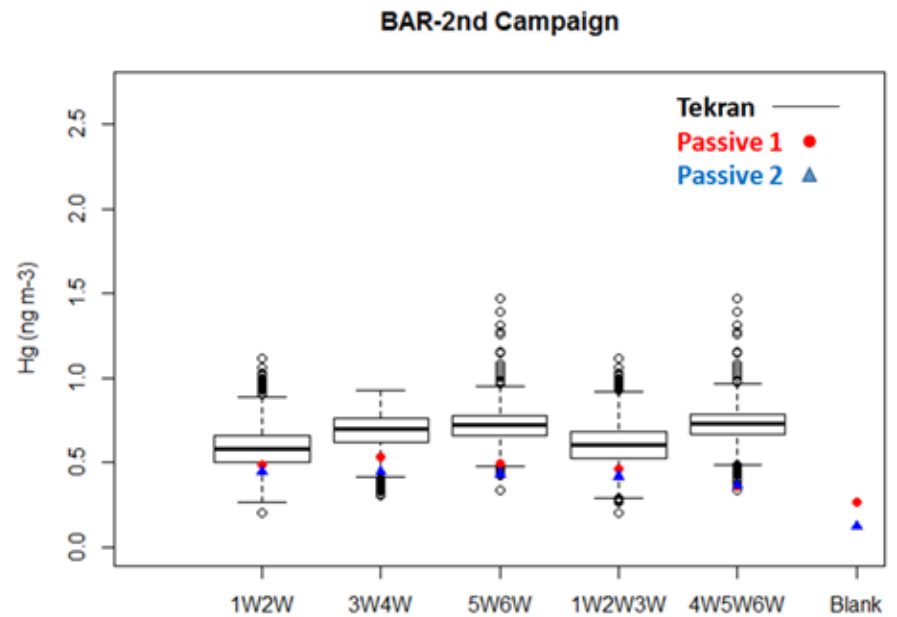
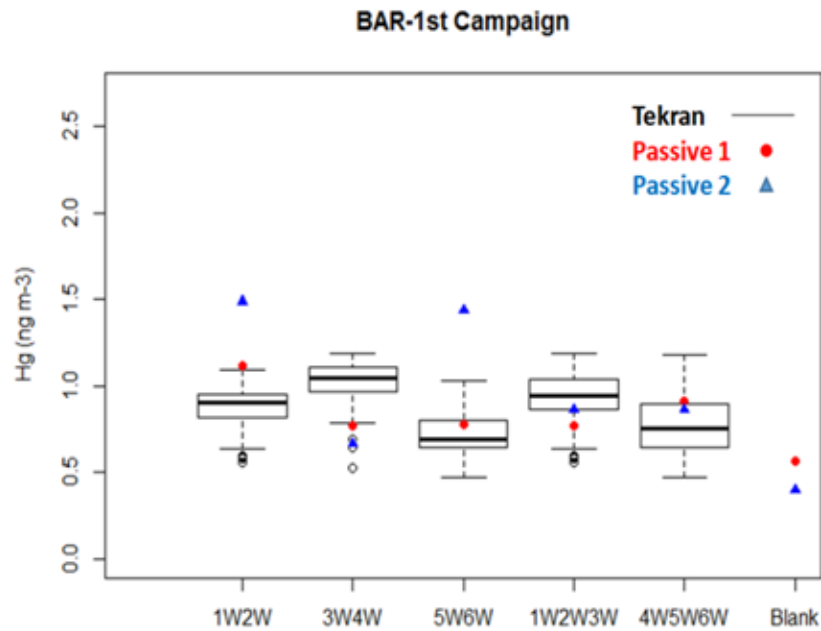
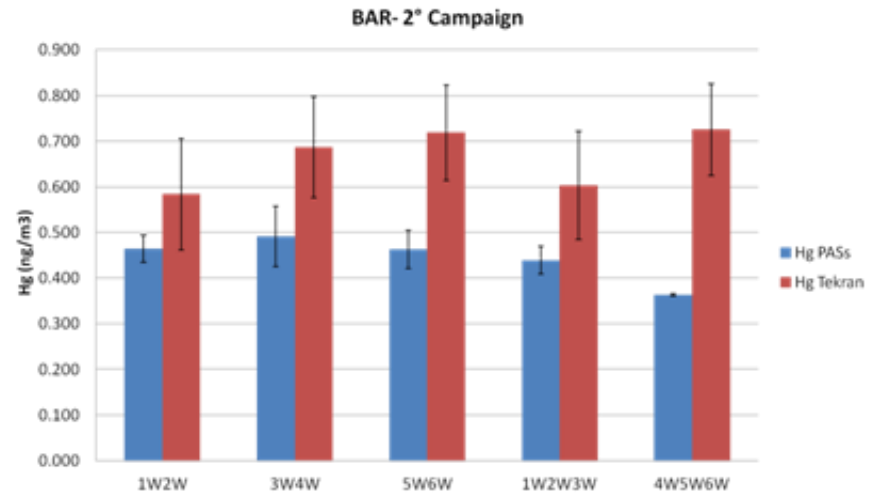
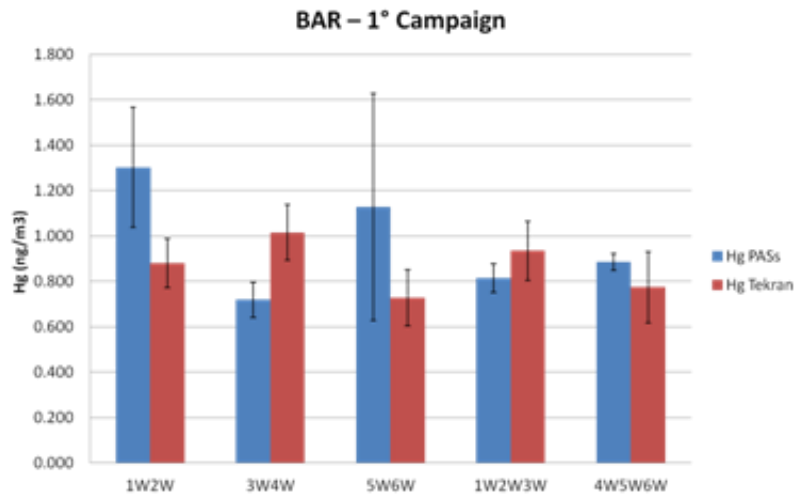


MCU-2nd Campaign



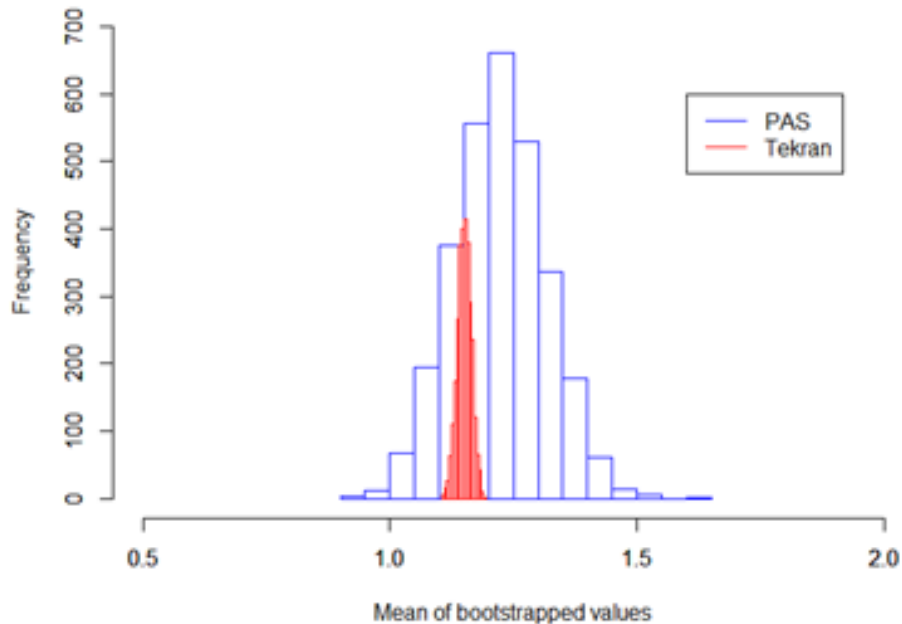
Comparison between the Hg Tekran data distribution, represented by boxplots, and the Hg data concentrations from each single co-exposed PAS, data points in blue/red, obtained during the 1st and 2nd campaign at **Mt. Curcio station**.

1st & 2nd sampling campaigns: comparison at Bariloche Site (Argentina)

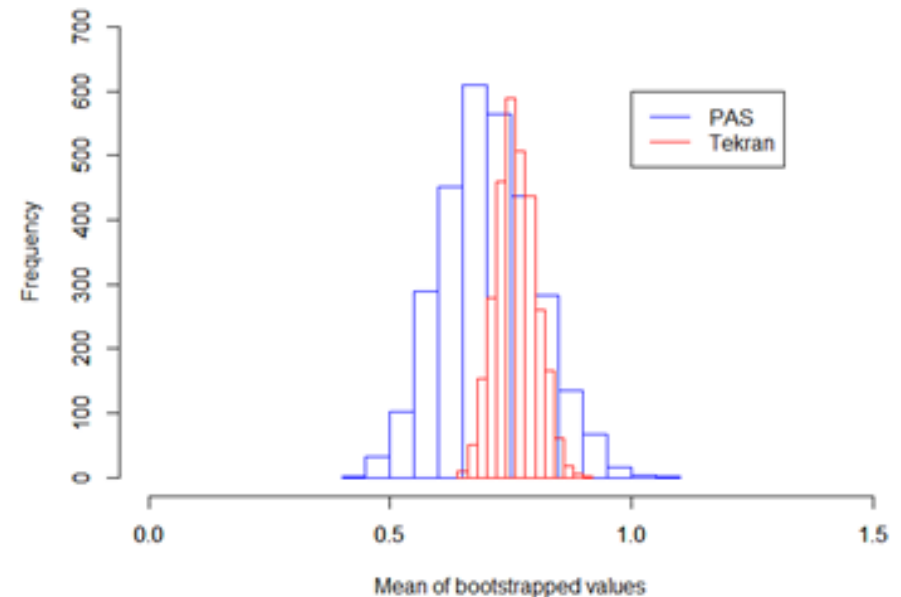


1st & 2nd sampling campaigns: Hg means distribution of bootstrapped values from PAS and Tekran data at GMOS sites

Bootstrap PAS-Tekran Mean 1-2° camp - MCU



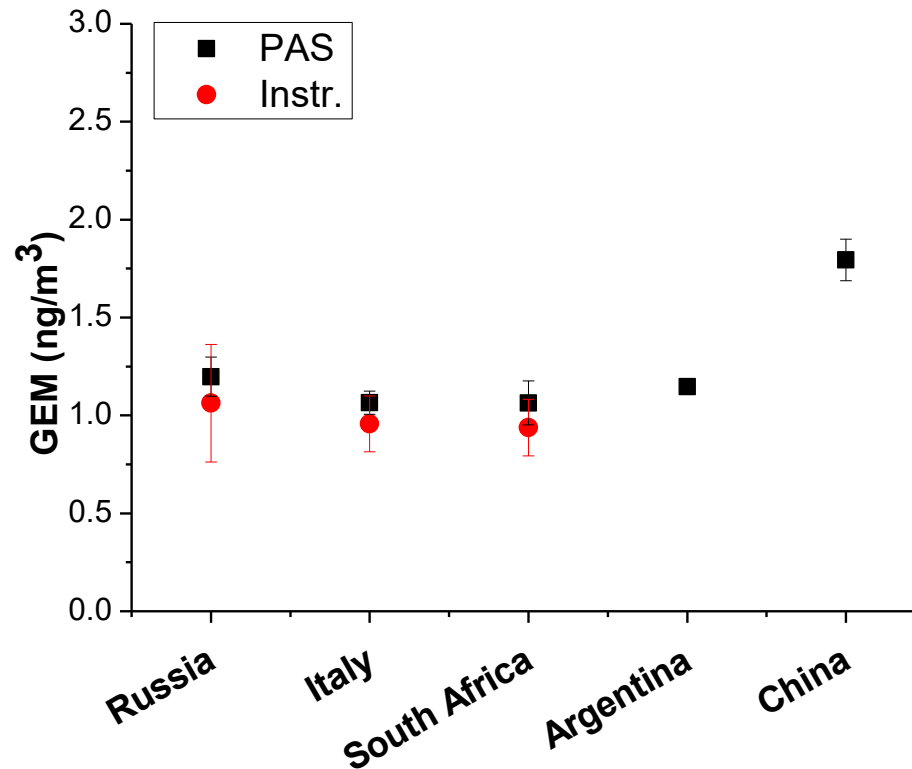
Bootstrap PAS-Tekran Mean 1-2° camp - BAR



The bootstrapping analysis highlighted that the distribution of Hg PAS data was generally with a broader range than the Tekran distribution.

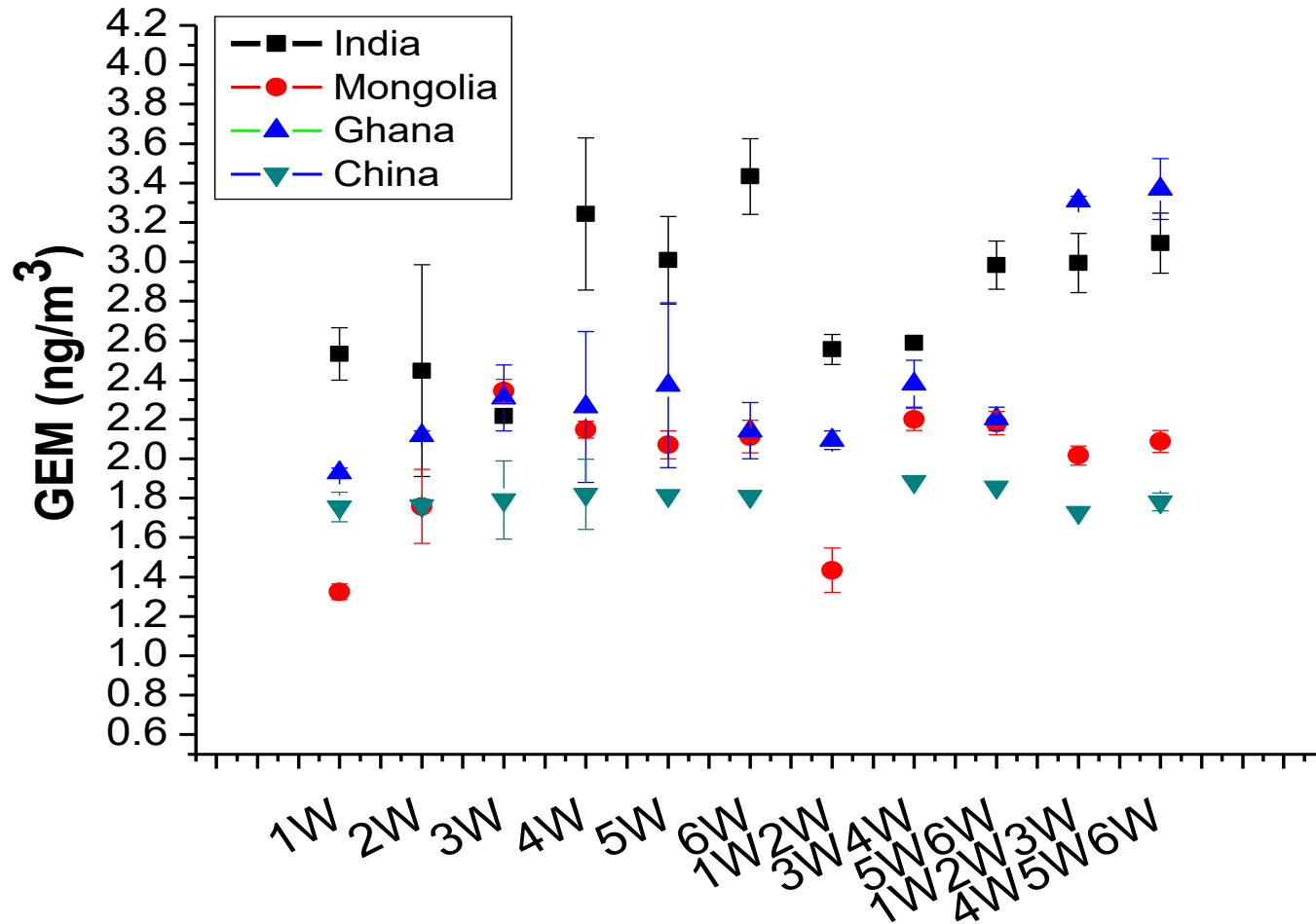
3rd Sampling Campaign:

comparison of PASs vs. Tekran/Lumex at the GMOS sites



- PAS values result within SD of instrumental data
- PAS could give infoes when electrical troubles happened on the equipment

3rd Sampling Campaign: PASs conc. at the five WHO sites



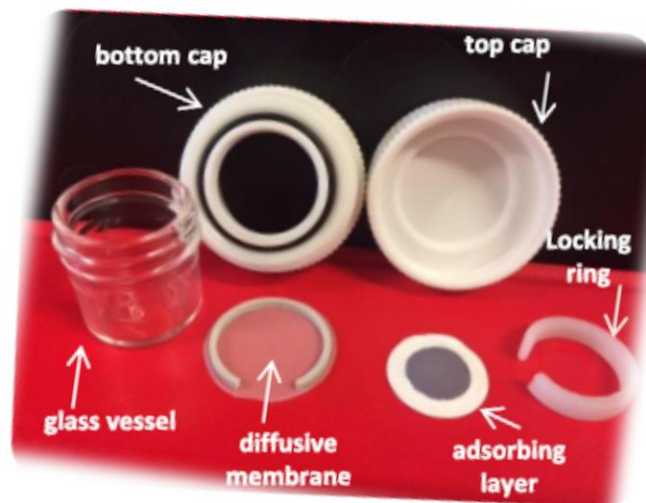
Future activities within ERA-PLANET and GEO Flagship GOS4M

- ✓ Promote an intercomparison among different PAS
- ✓ To contribute to fill geographical gaps of GMOS by adding new sites with PAS
- ✓ To cooperate with UN Environment, MC SEC and all Nations to develop the GMP having as basis existing monitoring networks
- ✓ To contribute to the EE assessment planned for the 2023

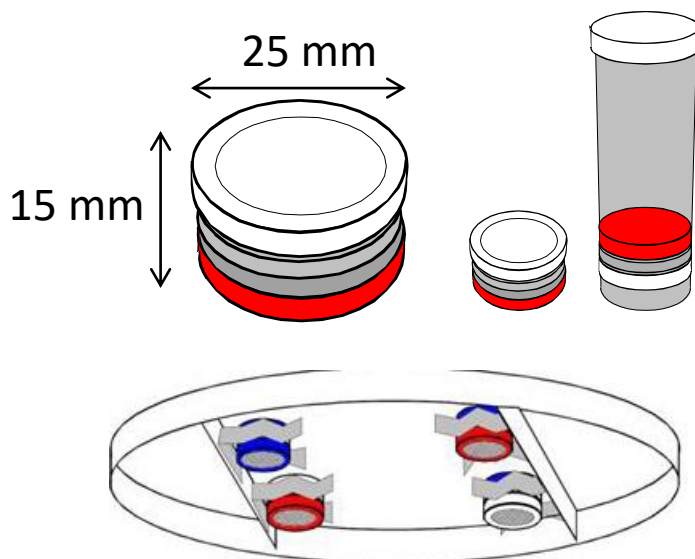
Intercomparison exercise with developed Hg PASs in the framework of IGOSP/ ERA-PLANET



Env. Canada + Univ. Toronto



CNR-IIA PAS



Selected sites for Hg PASs from GAPS & MONET networks

	No	Country	Site	Description	Lat	Lon	Altitude	Network
South America	1	Colombia	Manizales	Remote	5.0758	-75.4366	2670	GAPS
	2	Ecuador	Quito	Urban	-0.25	-78.5833	1658	GAPS
	3	Argentina	Salta	Remote	-25.0851	-66.126	===	GAPS
	4	Argentina	Rio Gallegos	Rural	-51.6473	-69.207	18	GAPS
South Asia	5	Indonesia	Bukit Kototabang	===	0.2	100.32	864	GAPS
	6	Malaysia	Danum Valley	===	4.9813	117.8436	426	GAPS
	7	Philippines	Manila	Urban	14.6519	121.06888	74	GAPS
Africa	8	Uganda	Bukasa Island	===	-0.41	32.48	1151	GAPS
	9	South Africa	De Aar	Rural	-30.6650	23.9930	1287	GAPS
	10	Ghana	Abetefi	===	6.6833	-0.75	594	MONET
	11	Nigeria	Sheda	Suburban	8.881	7.062167	229	MONET
	12	Congo	Brazzaville	Urban	-4.2812	15.24364	298	MONET
	13	Morocco	Morocco Observatory	===	33.925	-6.758	===	MONET
	14	Ethiopia	Asela	Urban	7.95	39.11667	2327	MONET
	15	Kuwait	Abdaly	===	29.9788	47.70633	52	GAPS
New Zealand	16	New Zealand	Temple Basin, Arth	===	-42.9088	171.5747	1345	GAPS

South America: Hg & POPs sites

GAPS Network



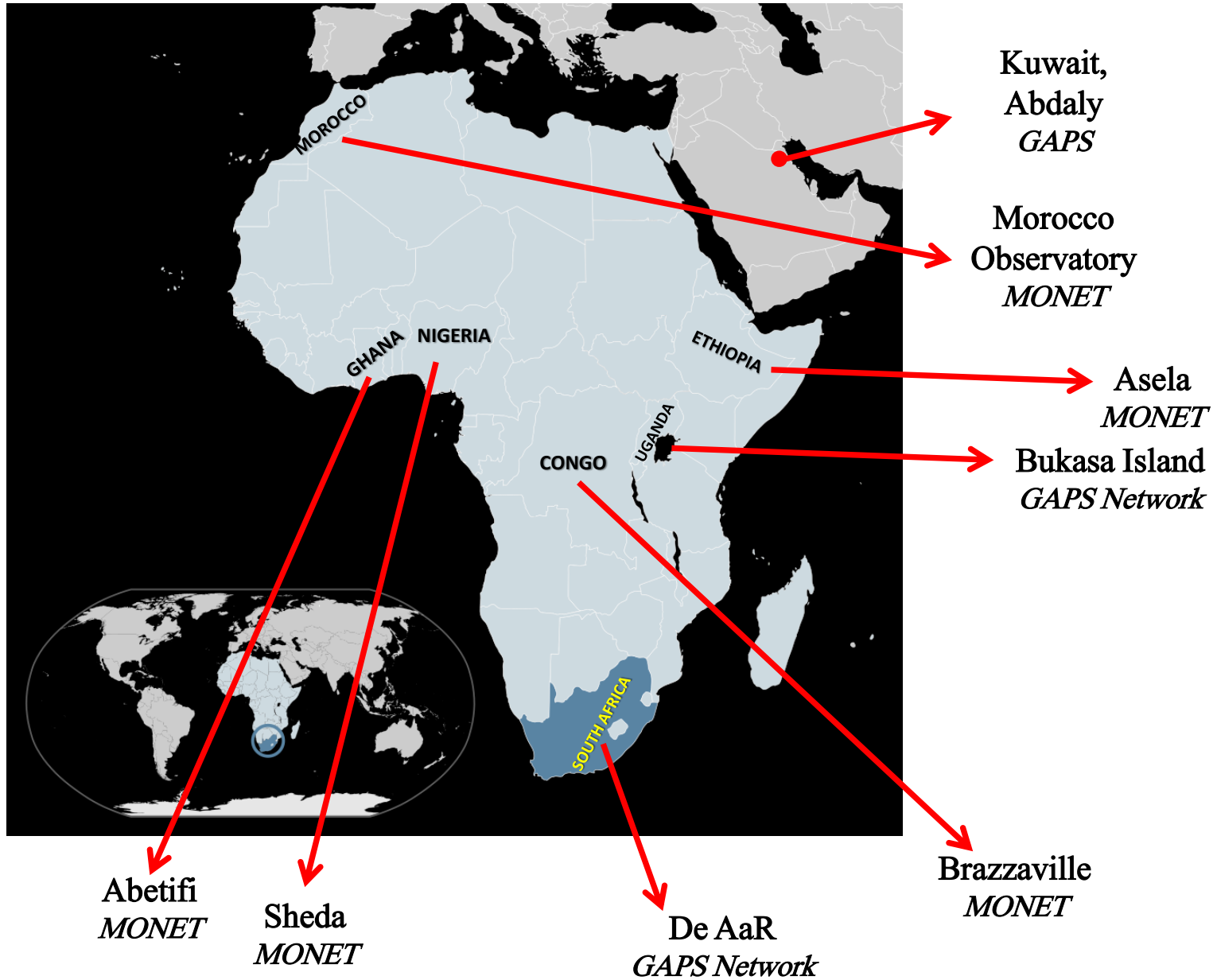
Argentina also claims a portion of Antarctica; all claims in Antarctica are in abeyance under the terms of the Antarctic Treaty effective in 1961.

Ecuador Travel Advice

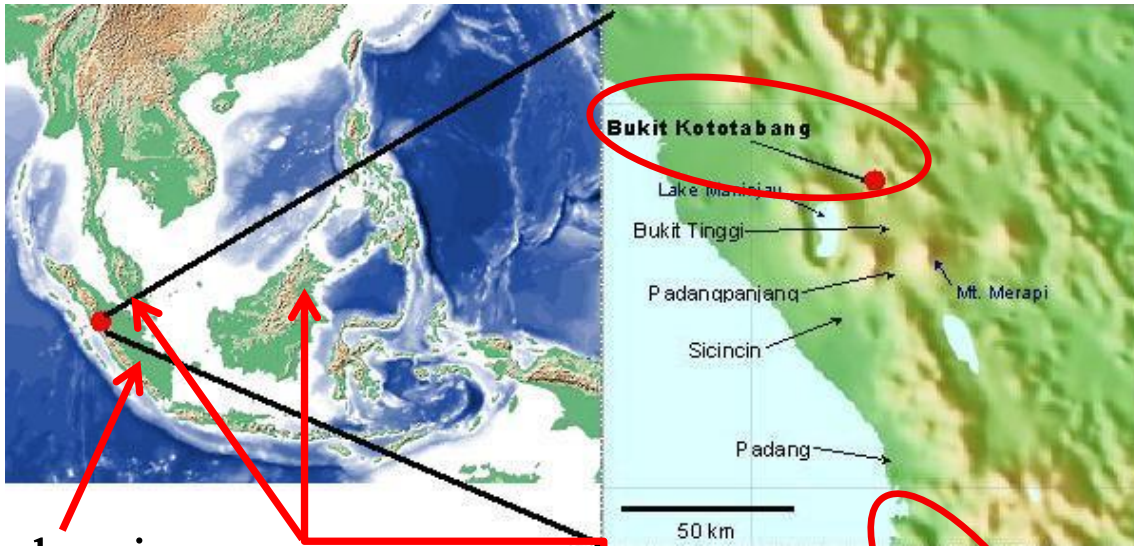
- Do not travel
- Reconsider your need to travel
- Exercise a high degree of caution

Legend:
 - International boundary
 - Administrative boundary
 - National capital
 - Administrative centre
 - Other point of interest
 - Mountain/plateau

Africa: Hg & POPs sites GAPS & MONET Networks



South ASIA: Hg & POPs sites GAPS Network

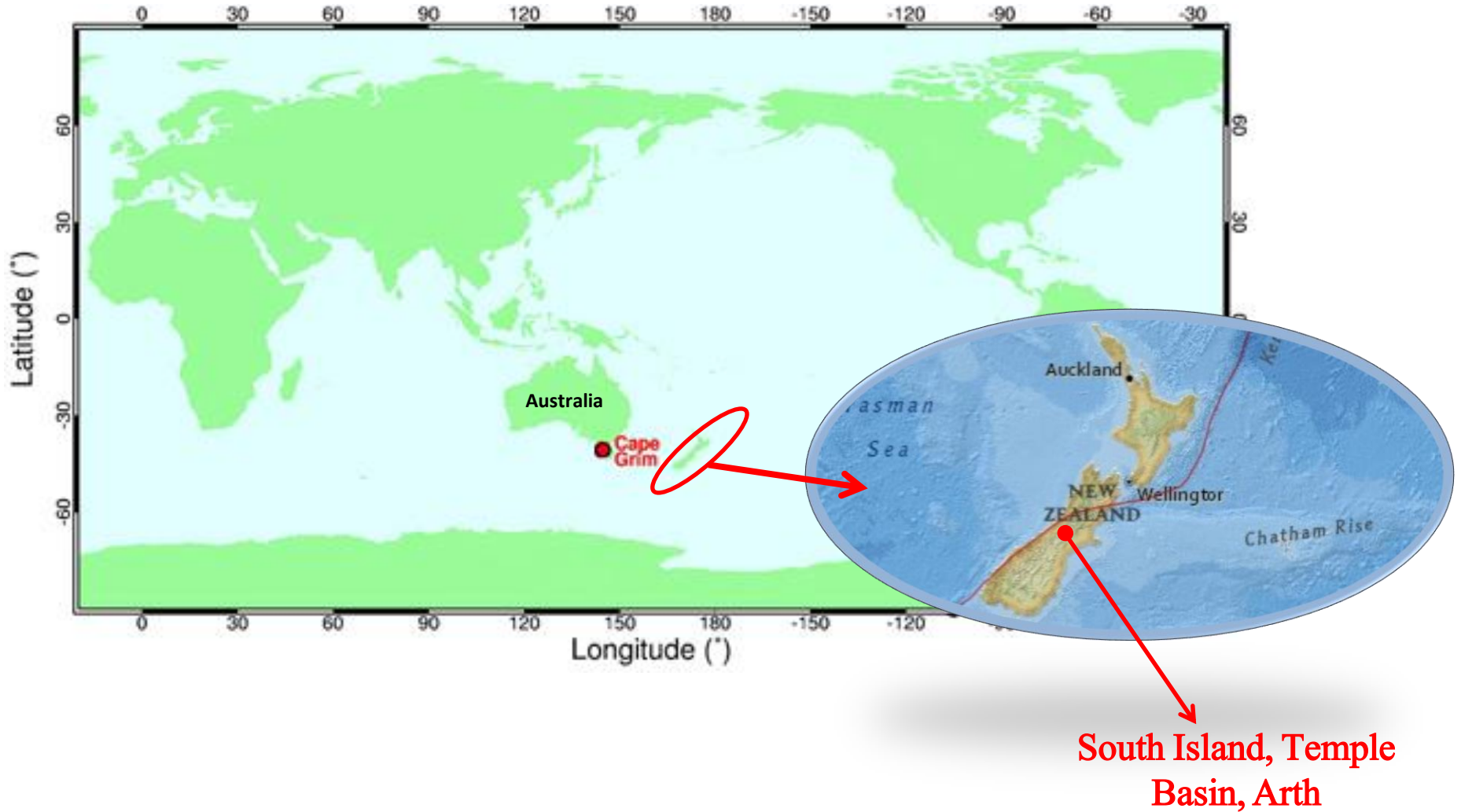


Indonesia

Malaysia



New Zealand: Hg & POPs monitoring site GAPS Network



Cote d'Ivoire: Hg Passive Air Sampling Sites



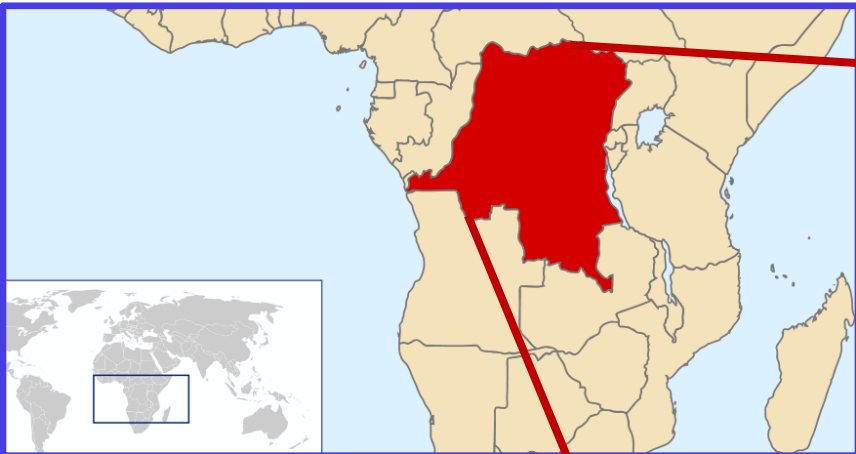
N.	Site	Altitude	Lat.	Lon.	Description
1	ENS Abidjan	44	5°20'30"N	3°59'06"W	urban area
2	Lamto (Lamto Ecological Research Station)	50-100	6°09'39"N	5°37'31"W	nature conservation and research
3	Bonikro (Divo)		6°14'39"N	5°26'41"W	industrial and artisanal gold mine
4	Kanankono (Tingrela)		10°21'02"N	6°14'34"W	industrial and artisanal gold mine
5	Zouan-Hounien	263	6°55'16"N	8°12'17"W	industrial and artisanal gold mine

Responsible:

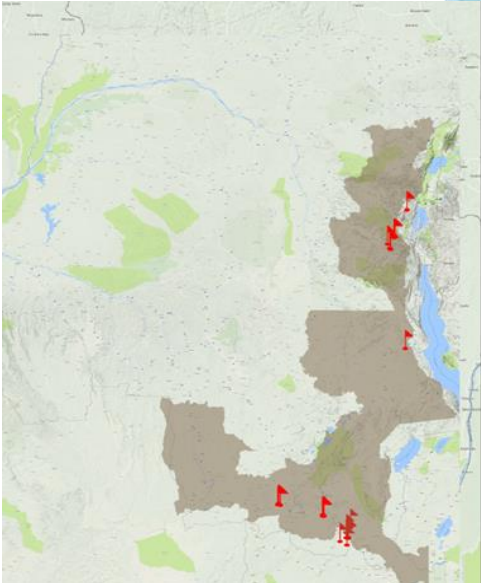
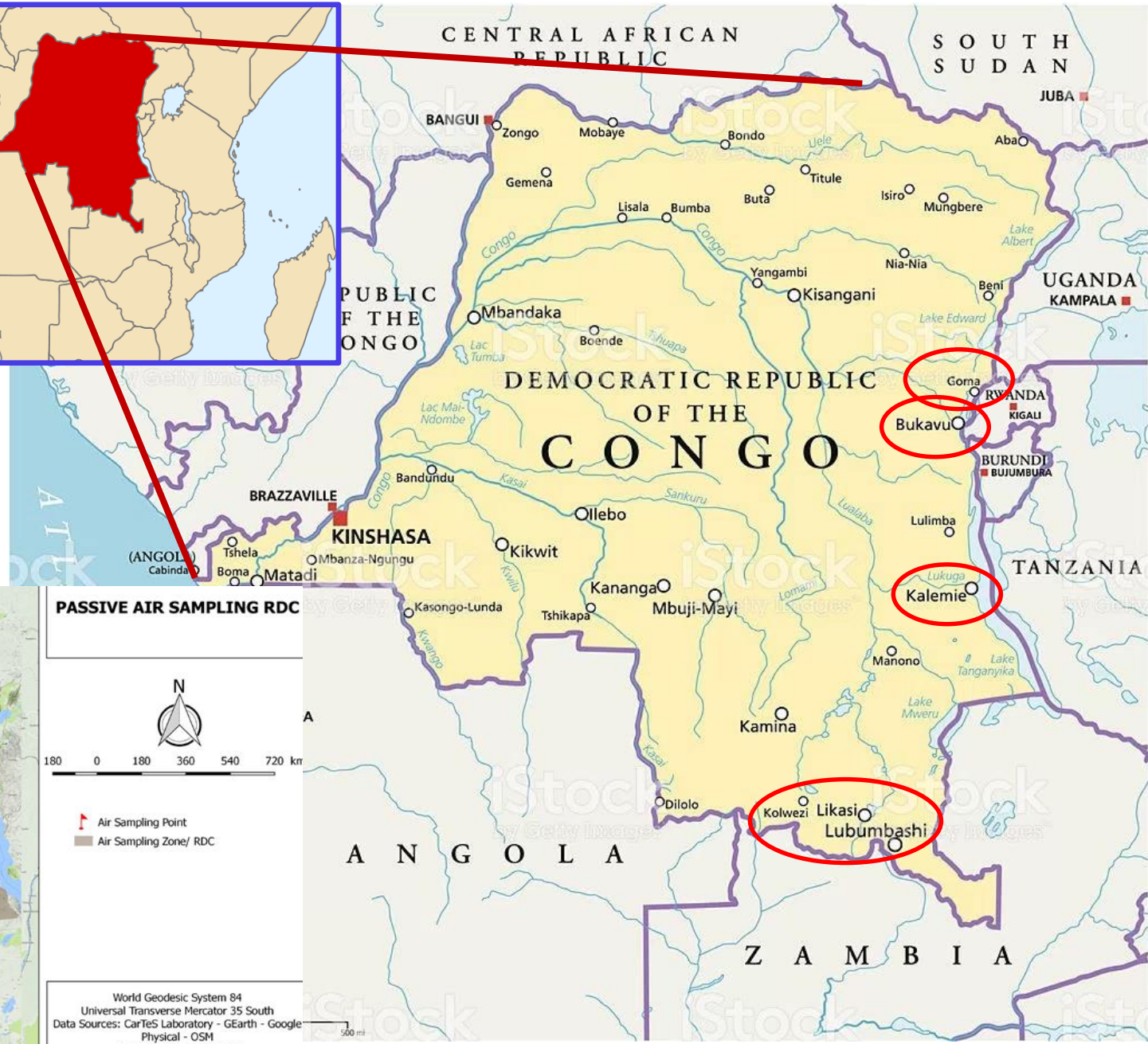
Mariame Coulibaly, Univ. of Abidjan
(University Felix Houphouet-Boigny);

Koffi Marcellin Yao, Center for
Oceanographic Research in Abidjan;

CONGO: Hg Passive Air Sampling Sites



Resp. :
Merimée Kalumba



PASSIVE AIR SAMPLING RDC

N

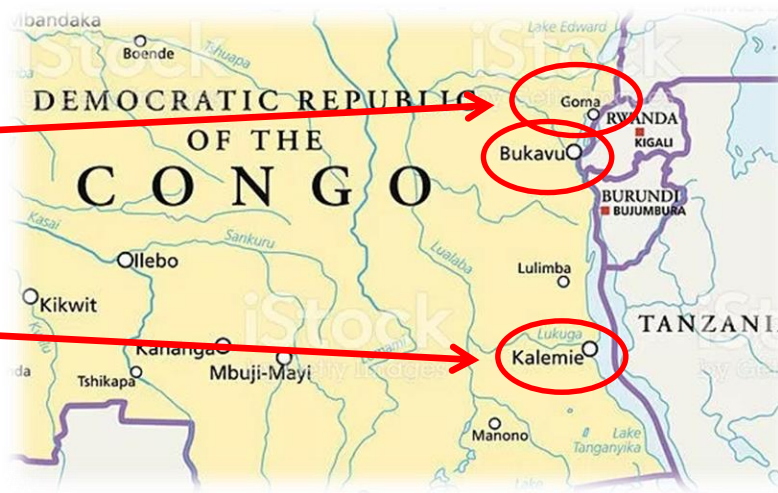
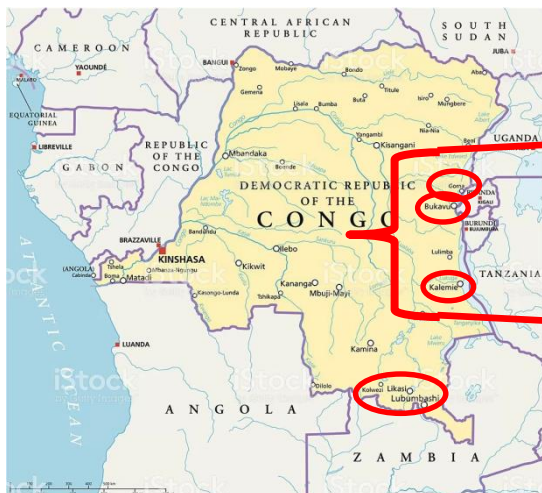
180 0 180 360 540 720 km

Air Sampling Point

Air Sampling Zone/ RDC

World Geodesic System 84
Universal Transverse Mercator 35 South
Data Sources: CarTeS Laboratory - GEarth - Google
Physical - OSM
CarTeS-Laboratory©2018

CONGO: Hg Passive Air Sampling Sites



Sites names :	Latitude	Longitude	Altitude	Sites characteristics.
Goma				
Goma PAS 1	-1.668311°	29.238610°	1534	Remote
Goma PAS 2	-1.652568°	29.239960°	1563	Urban

Sites names :	Latitude	Longitude	Altitude	Sites characteristics.
Bukavu				
S KIVU PAS 1	-2.483799°	28.860452°	1467	Urbain
S KIVU PAS 2	-2.515948°	28.853115°	1557	Urbain (La botte)
S KIVU PAS 3	-2.496849°	28.879038°	1496	Urbain
S KIVU PAS 4	-2.876692°	28.746745°	2365	ASGM Tw 1
S KIVU PAS 5	-2.848977°	28.749335°	2121	ASGM Tw 2
S KIVU PAS 6	-2.846637°	28.730259°	1982	ASGM Tw 3
S KIVU PAS 7	-2.836549°	28.725784°	1820	ASM Tw 4
S KIVU PAS 8	-2.837489°	28.722271°	1773	ASGM Tw 5
S KIVU PAS 9	-2.707108°	28.655001°	1629	Rural Wal 1

Sites names :	Latitude	Longitude	Altitude	Sites characteristics.
Kalemie				
Kalemie PAS 1	-5.911801°	29.190816°	774	Urbain (rond-point kisebwe)

CONGO: Hg Passive Air Sampling Sites

Sites names :	Latitude	Longitude	Altitude	Sites characteristics.
Kolwezi				
Kolwezi PAS 1	-10.6862	25.4492	1410	Urban
Kolwezi PAS 2	-10.616977°	25.390887°	1456	Rural
Kolwezi PAS 3	-10.667072°	25.438341°	1403	Péri-urbain
Kolwezi PAS 4	-10.668061°	25.364580°	1413	Péri-urbain

Sites names :	Latitude	Longitude	Altitude	Sites characteristics.
Likasi				
Likasi PAS 1	-11.002042°	26.705330°	1310	Péri-urbain
Likasi PAS 2	-11.019653°	26.733196°	1273	Urbain
Likasi PAS 3	-11.010987°	26.750054°	1305	Urbain
Likasi PAS 4	-11.004870°	26.756594°	1289	urbain industriel
Likasi PAS 5	-10.962541°	26.722178°	1284	péri-urbain kikula
Likasi PAS 6	-10.988726°	26.737779°	1291	Urbain

Sites names	Latitude	Longitude	Altitude	Sites characteristics.
Lubumbashi				
LUB PAS 1	-11.680864°	27.486421°	1257	Urban
LUB PAS 2	-11.674296°	27.465796°	1249	Urban
LUB PAS 3	-11.676168°	27.455910°	1260	Remote Baya
LUB PAS 4	-11.882156°	27.441227°	1282	Urban
LUB PAS 5	-11.6614	27.4171	1271	Rural
LUB PAS 6	-11.352592°	27.549136°	1238	Remote
LUB PAS 7	-11.512845°	27.427485°	1377	Remote
LUB PAS 8	-11.774419°	27.234989°	1340	Urban (GCM)
LUB PAS 9	-11.644971°	27.488785°	1282	Urban

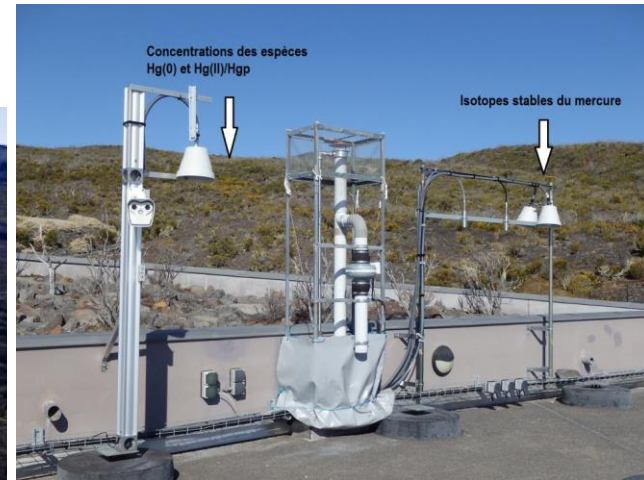
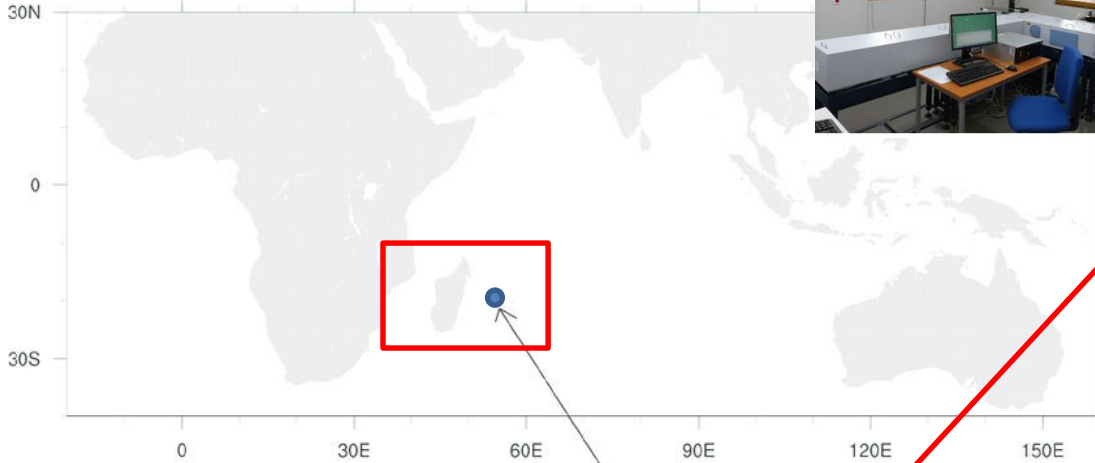
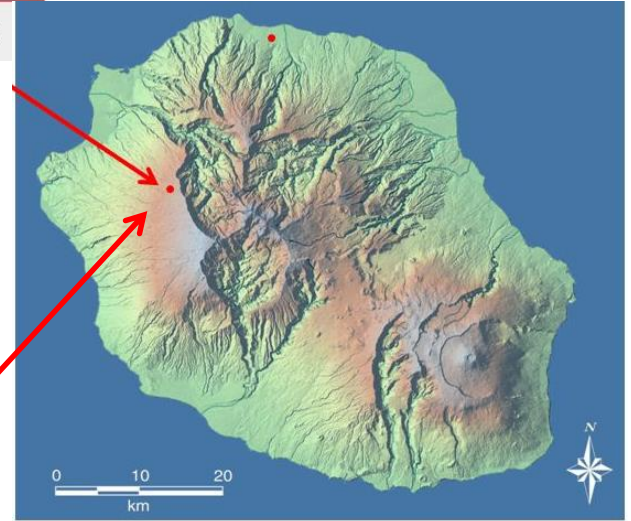


Reunion Island

Aurelien Dommergue, J. Sonke,
O. Magand
CNRS – Univ Grenoble Alpes

New atmospheric observations
in the Southern Hemisphere
Maido Observatory of la Réunion
(21°S, 2200 m)

Maido Observatory (2200 m)



Hg Sites in India

Resp. Sci.: K. Jayanarayanan, CORAL, IIT Kharagpur, India



4 Site: Indian Institute of Technology (IIT)
Kharagpur, West Bengal (Rural site)

5 Site: Campus in **Kolkata**, West Bengal
(Urban Site)

Resp. Sci.: Prof. Ramesh Ramacandram

1 Site: **Kodaicanal** (high elevation; 2133m asl), Mountain site;

2 Site: **Andaman Islands** (on Mount Harriet National Park, 383m asl), Marine site;

3 Site: **Chennai**, Coastal-Urban Site;





Station Information (name, code, coordinates):

Gunn Point (GPT)

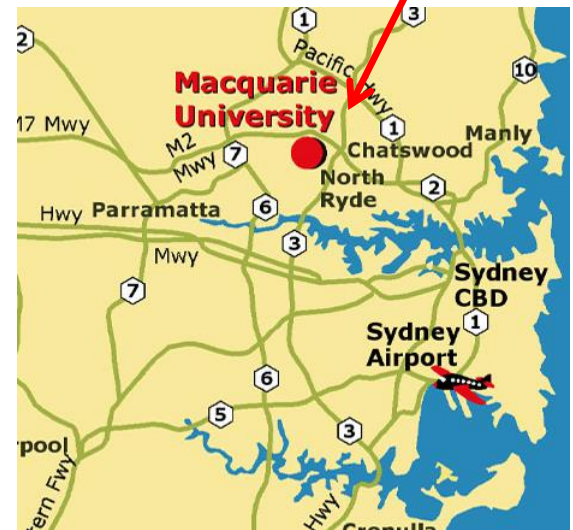
Latitude: 12°14'56.87"S
Longitude: 131° 2'40.83"E
Elevation: 25 m. asl

Glenville (GVL)

Latitude: 32°28'39.29"S
Longitude: 151° 6'6.10"E
Elevation: 85m asl (from DEM, to be confirmed)

Macquarie University Weather Station (MQU)

Latitude: 33°45'55.1"S
Longitude: 151° 7'3.2"E
Elevation: 66.8m asl





Gunn Point



Glenville

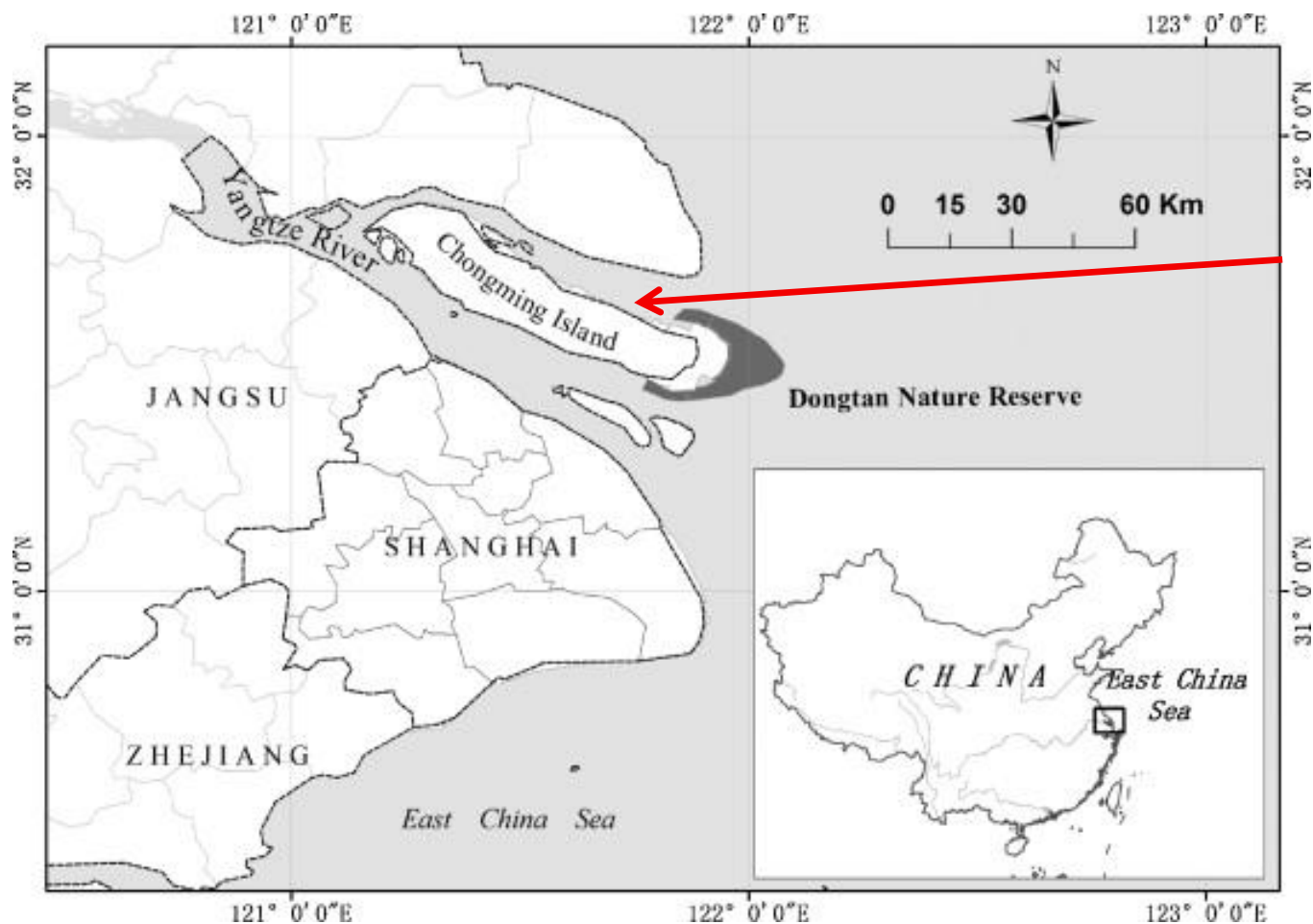


Macquarie Univ. Weather Station



Hg Monitoring in China

Resp. Scientist: Prof. Shuxiao Wang, Tsinghua Univ., Beijing



No.6 sites (tbd) in Chongming Island

Thank you

