

Global Observation System for Mercury

- a GEO Flagship -



GLOBAL OBSERVATION SYSTEM FOR MERCURY

Lead: Nicola Pirrone

Focus: To provide EO data and products to support policy makers and stakeholders in evaluating cost-effective strategies for reducing the impact of mercury contamination on human health and ecosystems

Platform: GEOSS

URL: www.gos4m.org



Scope

It is aimed to support all interested parties and the UN Environment in the implementation of the **Minamata Convention** by providing a **Knowledge Hub on Mercury** designed to **assess the effectiveness of measures** that Parties may consider for reducing the mercury level in the environment and its impact on human health.

UN
environment



MINAMATA
CONVENTION
ON MERCURY



Objectives

- **Enhance integration of in-situ and satellite observations** to better understand the transport and deposition patterns of **Hg** at continental and global scales and identify/explain hotspots;
- Provide **global comparable monitoring data** for Hg and other key parameters needed for data analytics and modeling purposes;
- Support the **development of new cost-effective equipment/sensors** to lower investment and management costs of monitoring networks/programs;
- **Enhance the geographical coverage** of in-situ global monitoring;
- **Foster the validation of regional and global scale models** for policy scenario analysis including the evaluation of associated costs;
- **Facilitate actions toward a full interoperability** of data, models and knowledge.

Members

[HOME](#) / [Members](#)

Members that have signed the [Membership Agreement](#)

Name	Acronym	Country
Biodiversity Research Institute	BRI	USA
Environment and Climate Change Canada – Atmospheric Mercury Monitoring	ECCC-AMM	Canada
Finnish Meteorological Institute	FMI	Finland
Géosciences Environment Toulouse	GET	France
Helmholtz Centre for Materials and Coastal Research	HZG	Germany
Institut "Jozef Stefan"	JSI	Slovenia
Institut des Géosciences de l'Environnement	IGE	France
Institut Français de Recherche pour l'Exploitation de la Mer	IFREMER	France
Institute of Geochemistry, Chinese Academy of Sciences	IG, CAS	China
Instituto de Investigaciones en Biodiversidad y Medioambiente	INIBIOMA-CONICET	Argentina
Limnological Institute Siberian Branch Russian Academy of Sciences	LIN SB RAS	Russia
Littoral Environnement et Sociétés	LIENSs	France
Lumex-marketing LLC	LUMEX	Russia
Mediterranean Institute of Oceanography	MIO	France
South African Weather Service	SAWS	South Africa
Tsinghua University	TU	China
U.S. National Atmospheric Deposition Program	NADP	USA
Université de Pau et des Pays de l'Adour	IPREM	France
University of York	UoY	United Kingdom
CNR-Institute of Atmospheric Pollution Research	CNR-IRA	Italy

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Search

GOS4M DATA

GOS4M DATA CATALOG

GOS4M MIRROR PORTAL

GOS4M KNOWLEDGE HUB

HERMES DSS

GOS4M NETWORK



Global Observation System for Mercury

GOS4M



October 2, 2020

News

Italy ratified the Minamata Convention on Mercury

The Italian Senate ratified the Minamata Convention on Mercury (DDL S. 1171 (<http://www.senato.it/leg/18/BGT/Schede/Ddliter/51523.htm>). The ratification of the Minamata Convention by the Italian Parliament is very much welcomed by the scientists of the Institute on Atmospheric Pollution of the CNR (CNR-IIA) who in the last 20 years have coordinated important research projects funded by the European [...]



September 30, 2020

News

GOS4M Virtual Kick-off Workshop

The kick-off workshop of the GOS4M GEO Flagship will be held online on October 7 and 8. The virtual kick-off workshop will convene major scientific experts on mercury monitoring and will be opened by Monika Stankiewicz, Executive Secretary of the Minamata Convention on Mercury and Gilberto Camara, Director of the GEO Secretariat. The workshop will officially [...]



December 13, 2019

News

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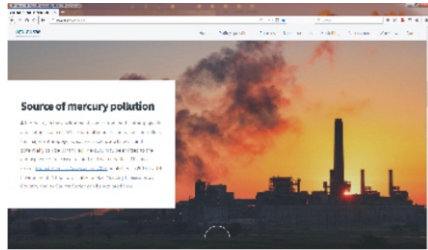
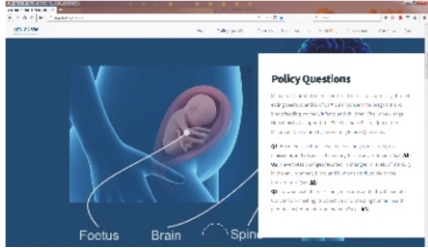
[GOS4M NETWORK](#)



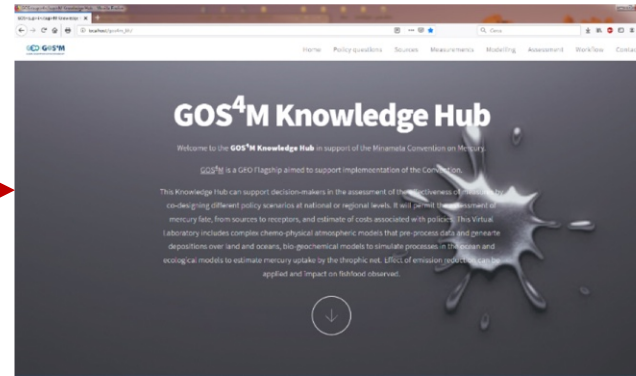
GOS4M Knowledge Hub

(conceptual framework)

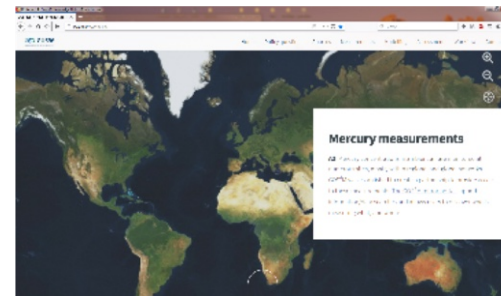
Policy questions



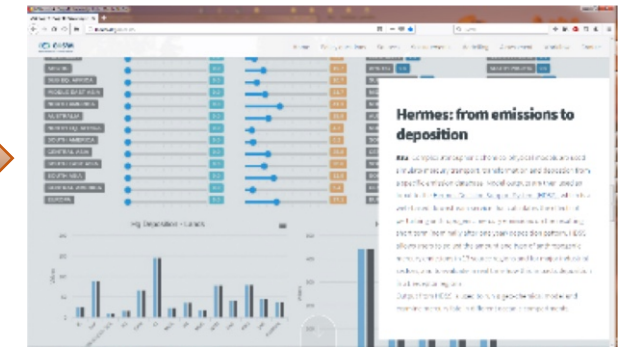
Co-design Policy Scenarios



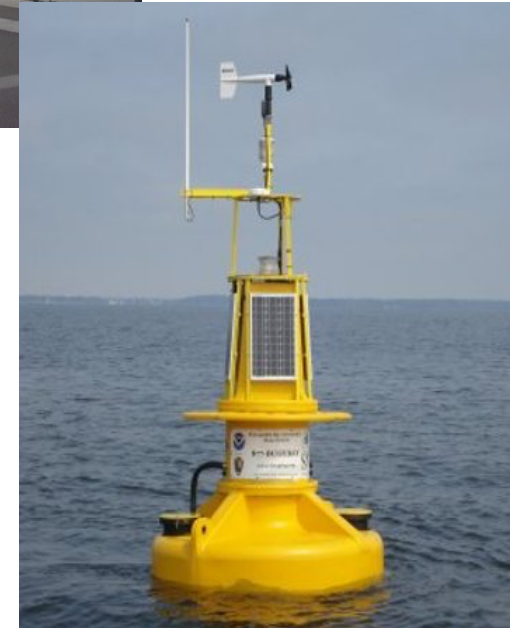
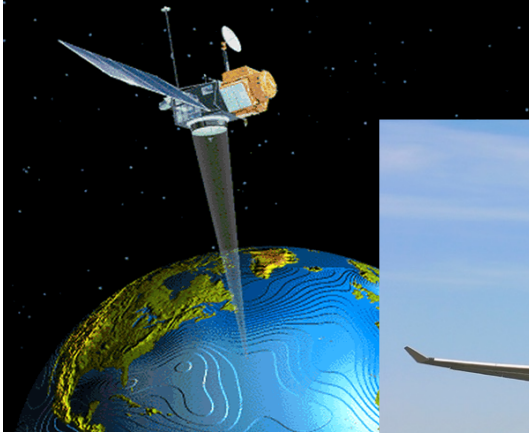
EOs data sets



Policy scenarios assessment



EOs for Hg studies are provided by different platforms



Satellite sensors for Hg models

Satellite(s)	Data repository	Parameters
GOME, SCIAMACHY, GOME2/METOP-A	ESA	O3, NO2, BrO, H2O, SO2, CH2O, HNO3, ClO, ClONO2, HCl, CH4, OCIO, NO, NO3, CO, CO2, N2O, surface UV, solar activity
MLS (EOS-Aura)	CEOS Database	BrO, CH3Cl, CH3CN, CH3OH, ClO, CO, H2O, HCl, HCN, HNO3, HO2, HOCl, N2O, O3, OH, SO2, ClONO2, CH4, Temp., RH
ACE-FTS	CEOS Database	CH4, CO2, CO, CFC-11, CFC-12, NO, NO2, HNO3, HCl, ClONO2, C2H2, C2H6, HCFC-22, N2O5, SF6, O3, Temp.
IASI	CEOS Database	CH4, CO2, CO, N2O
S5P (starts September 2017)	ESA	O3, NO2, SO2, CO, CH4, CH2O,
AIRS	CEOS Database	CH4, CO2, CO
GACM	CEOS Database	CO, N2O, HNO3, ClO, SO2, NO2, CH2O
GEMS	CEOS Database	NO2, SO2
Geo-Cape	CEOS Database	NO2, SO2, CH2O
HiRDLS	CEOS Database	CH4, F11, F12, NO2, N2O, HNO3, ClONO2, N2O5, Temp.
IKFS	CEOS Database	CH4, Temp., cloud type, cover, liquid water
LM	CEOS Database	NO, NO2
OMI	CEOS Database	CH4
OSIRIS	CEOS Database	NO2, BrO
PCW PHEOS	CEOS Database	CH4, CO2, CO, NO2, HNO3, BrO, PAN, temp., O3 profile
SAGE-III	CEOS Database	NO2, OCIO, temp., O3 profile
SMR	CEOS Database	CO, N2O, HNO3, ClO, temp., O3 profile
TANSO-FTS	CEOS Database	CH4, CO2, HDO, ozone profile, chlorophyll fluorescence, atmospheric pressure

Vertical Profiles and Validation of **satellite vs. in-situ measurements** relevant to model the Hg fate in the global environment

Parameters provided by Satellites and Aircraft campaigns:

- 25 chemical parameters
- 17 aircraft and 27 satellites
- Covering 20 years (1998-2017)

Source: by Ralf Ebinghaus and Danilo Custodio, iGOSP project

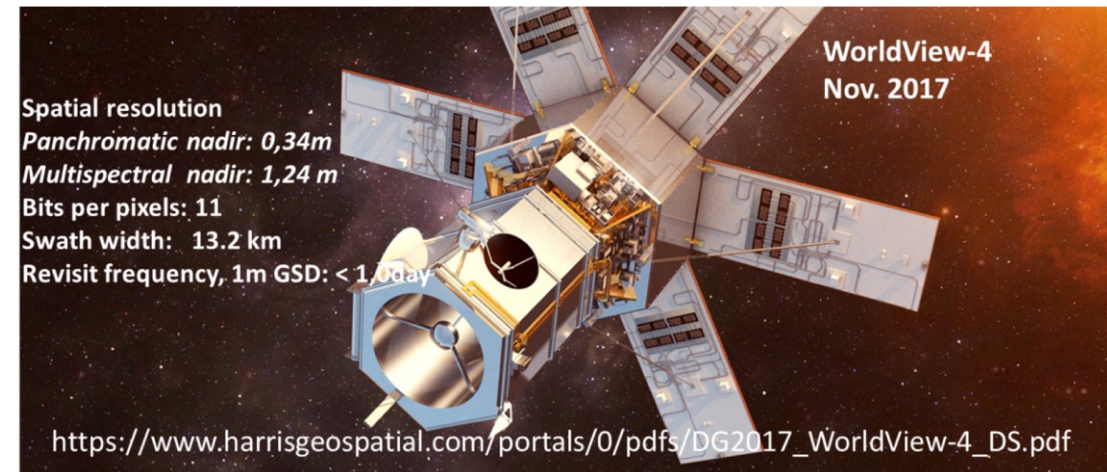


Chemical parameters	Measured by satellites	Measured by aircrafts
BrO	7	2
CO	15	14
CO2	10	9
CH3OH	1	1
CH3CN	1	1
CH4	17	8
H2O	3	4
NO2	17	9
N2O	9	5
NO	3	10
O3	5	15
SO2	9	10
SF6	1	1
HO2	1	4
OH	1	4
HNO3	9	3
PAN	1	1
HCl	3	1
HNO4	1	1
CH2O	9	2
CFC	3	1
CH3Cl	1	1
HCFC	1	1
C2H6	1	1
C2H2	1	1

Satellite sensors for ASGM

(Artisanal Small Scale Gold Mining)

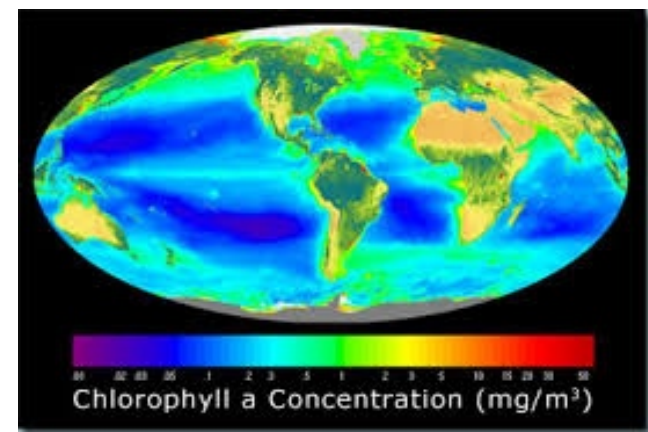
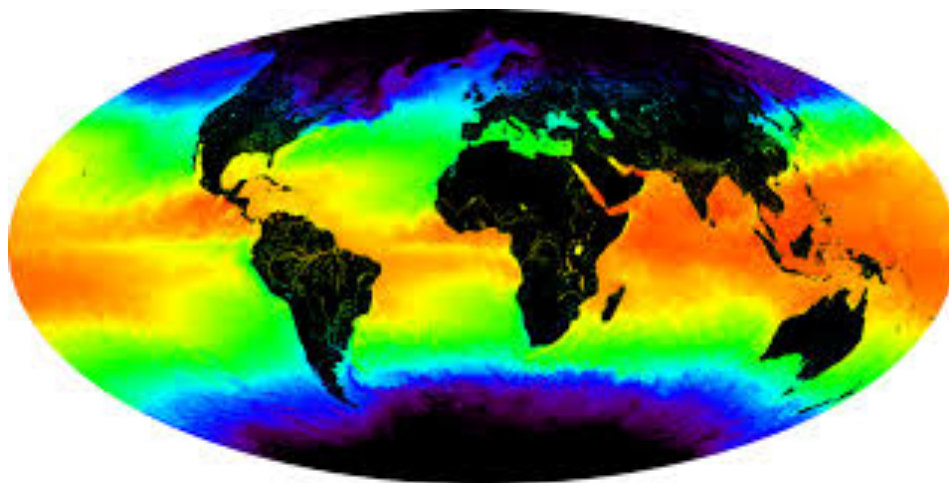
a) Change detection to identify ASGM (place)



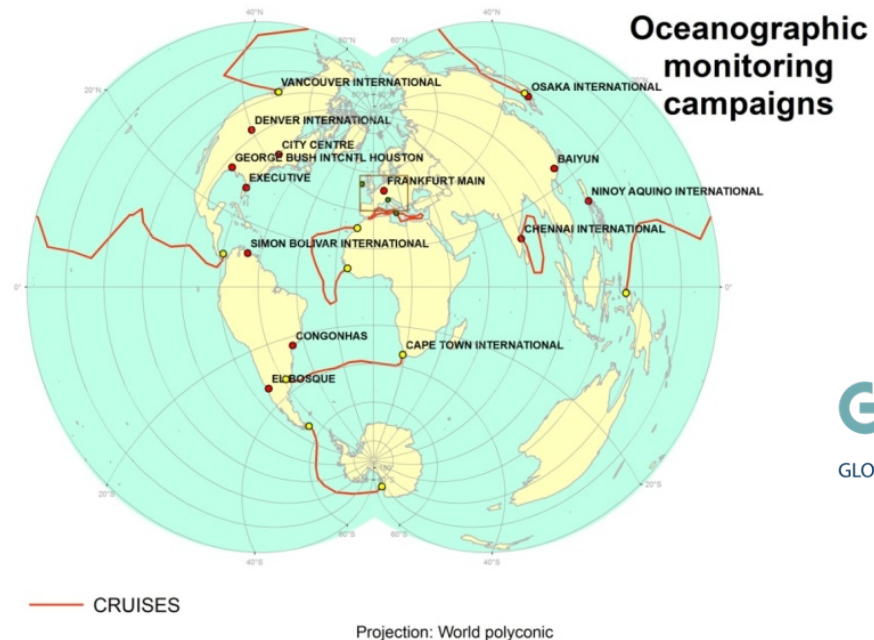
	Type	Sensor on-board
Land cover (LC) and Land Cover Changes (LCC)	Medium-high free imagery	Landsat and Sentinel-2
	Very-High spatial Resolution (VHR) satellite	WorldView constellations
Area with extensive cloud coverage	integrated use of active	Sentinel-1
	passive sensors	Sentinel-2

Satellite sensors for Sea parameters

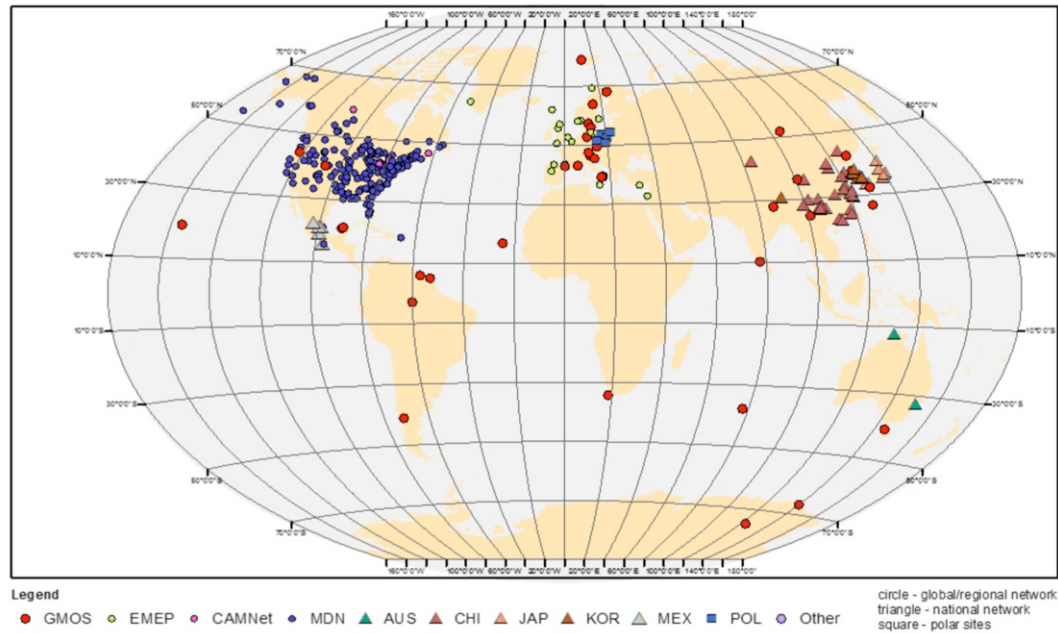
Parameters	
Ocean chlorophyll concentration	ETM+, MISR, MODIS, GOCI, VIIRS, OLI, GSA (1), MERSI-2, SGLI, OLCI
Dissolved organic matter	MODIS, OLCI, MERSI-2, SGLI
Ocean suspended sediment concentration	MODIS, OLCI, MERSI-2, SGLI, OLCI, CZI
Sea surface temperature	MODIS, AIRS, AMSR-E, SEVIRI, Imager, Sounder, AVHRR/3, HIRS/4, IASI, VIIRS, MSU-GS, ...



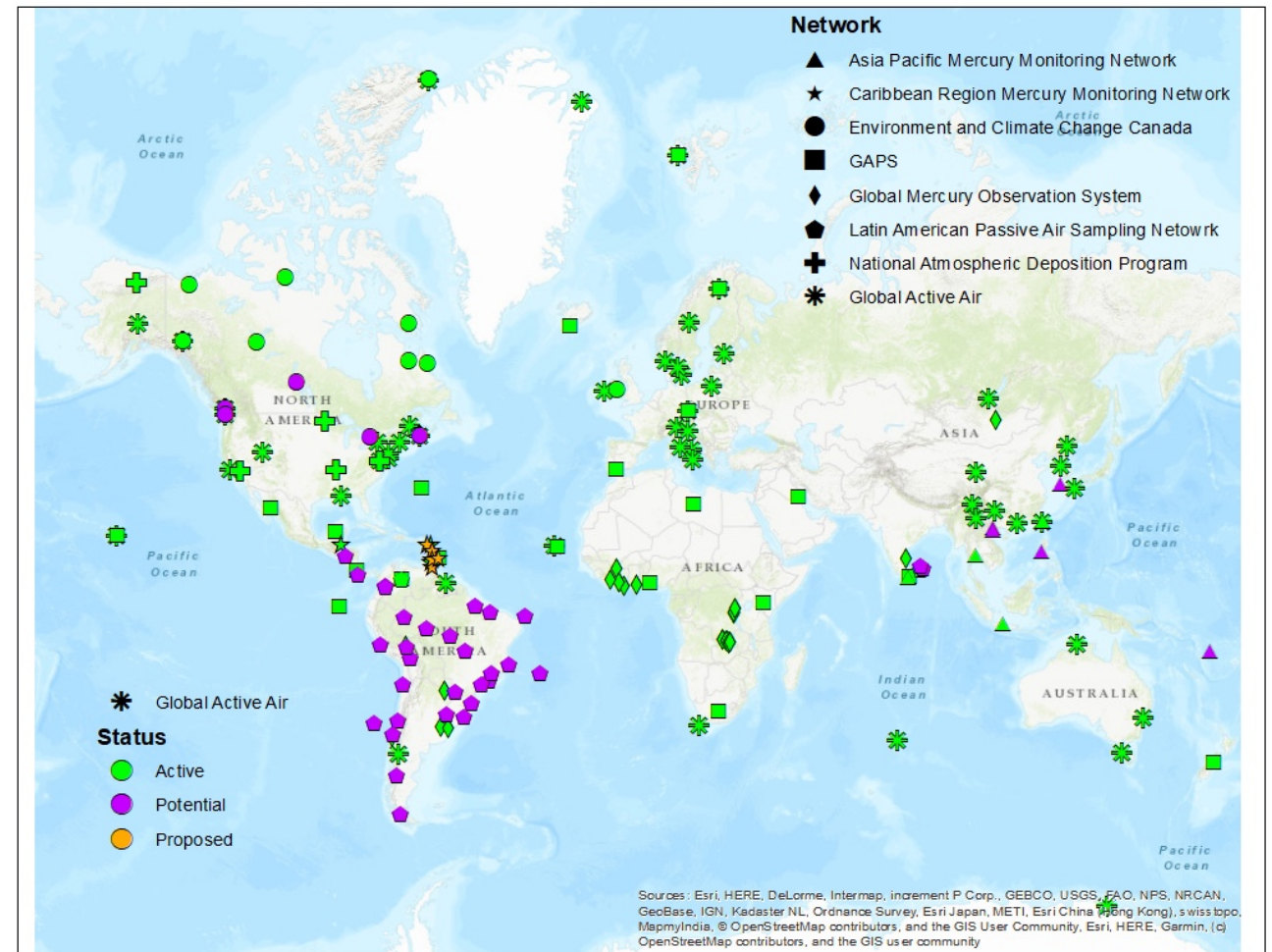
GMOS: Oceanographic campaigns



Global Coverage of in-situ Hg monitoring

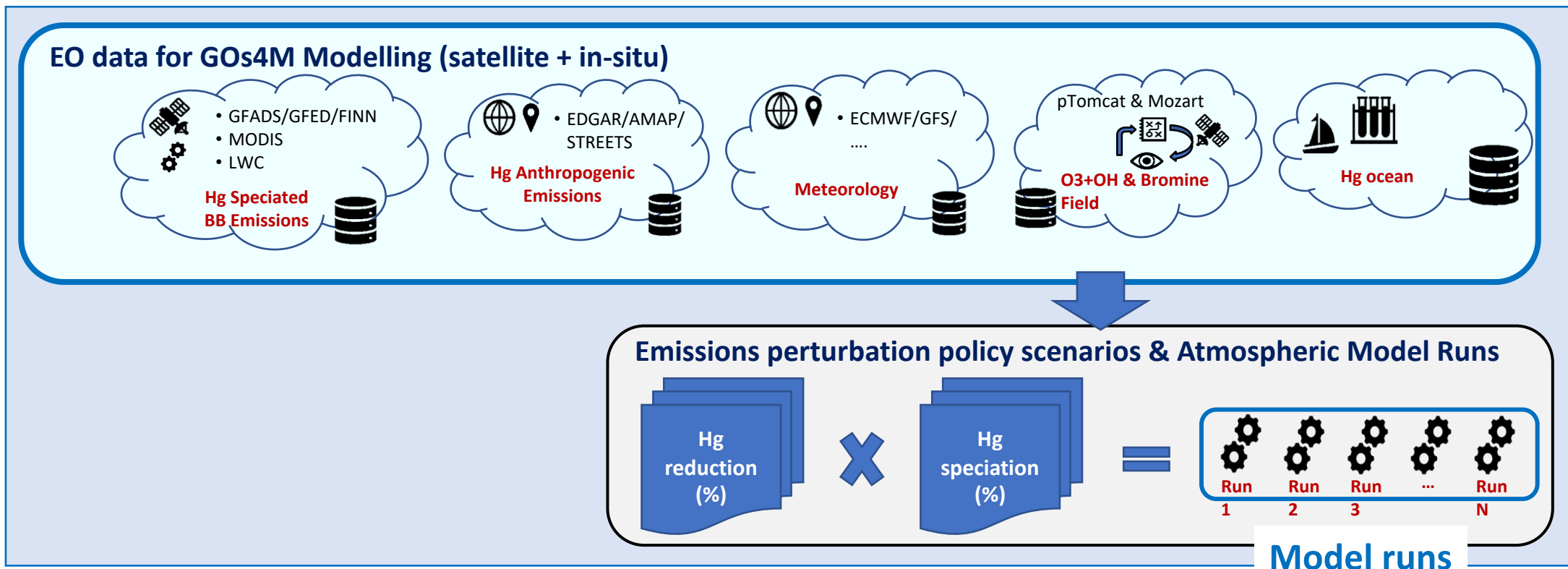


Source: Fig.1 of "Levels of Mercury in Air". Chapter-3, GMA-2019 for COP3

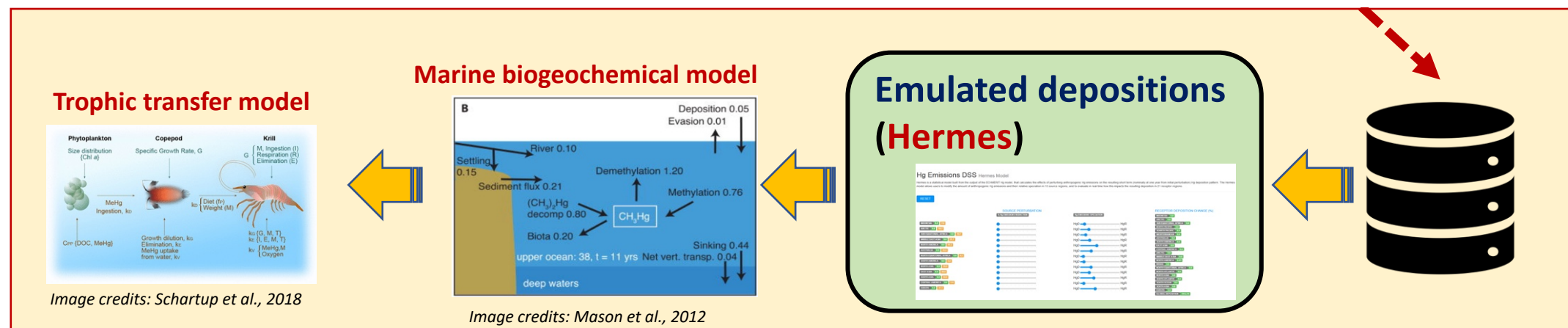


Source: Revised Fig.1 of "Levels of Mercury in Air". Chapter-3, GMA-2019 for COP3 (by A. Steffen)

Pre-processing



Post-processing



Workflow

Example

-50%

- Europe
- North America
- East Asia

ANTHROPOGENIC EMISSION PERTURBATION

It is possible to reduce Hg Anthropogenic emission from 12 source region

CURRENT GLOBAL DEPOSITION 1912.79 Show Map

% Hg EMISSIONS REDUCTION



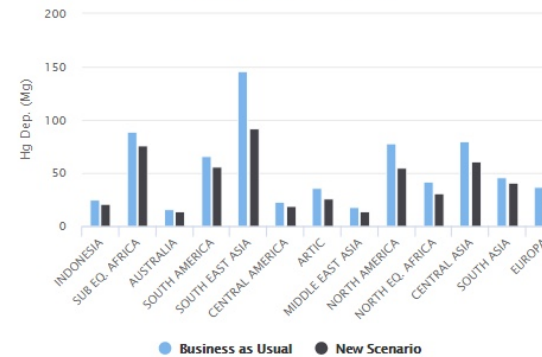
DEPOSITION CHANGES

The inputs are passed in near-real time to the statistical engine that calculates the change (%) on Hg deposition due to the selected emission reductions. If a reduction is not statistically significant (95% confidence interval) the deposition change is shown in blue. If reduction is significant for a given receptor the value is displayed in green. (De Simone et al., 2017)

GLOBAL DEPOSITION SCENARIO 1492.08

LAND (%)		OCEAN (%)	
INDONESIA (SEA)	-17.99	NORTH PACIFIC	-25.01
ARCTIC (ARC)	-26.48	SOUTH PACIFIC	-15.69
SUB EQ. AFRICA (SAF)	-15.39	MEDITERRANEAN	-31.82
MIDDLE EAST ASIA (MDE)	-21.93	INDIAN	-15.76
NORTH AMERICA (NAM)	-29.95	NORTH ATLANTIC	-25.43
AUSTRALIA (PAN)	-13.09	SOUTH ATLANTIC	-14.92
NORTH EQ. AFRICA (NAF)	-25.28	SOUTH OCEAN	-14.28
SOUTH AMERICA (SAM)	-15.22	ANTARCTIC (ANT)	-14.06
CENTRAL ASIA (CIS)	-23.06	GLOBAL OCEANS	-20.41
EAST ASIA (EAS)	-37.05	Biogeochemical response Oceans at 10 years -17.59	
SOUTH ASIA (SAS)	-10.61		
CENTRAL AMERICA (MCA)	-20.16		
EUROPA (EUR)	-37.11		

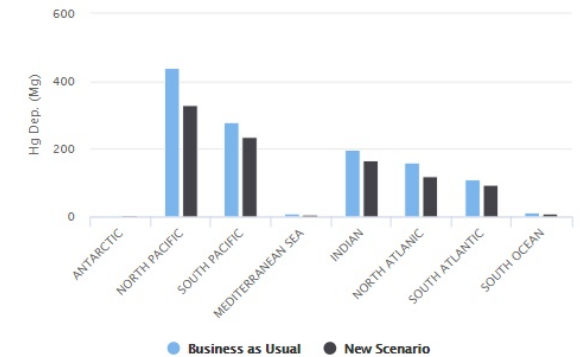
Hg Deposition - Lands



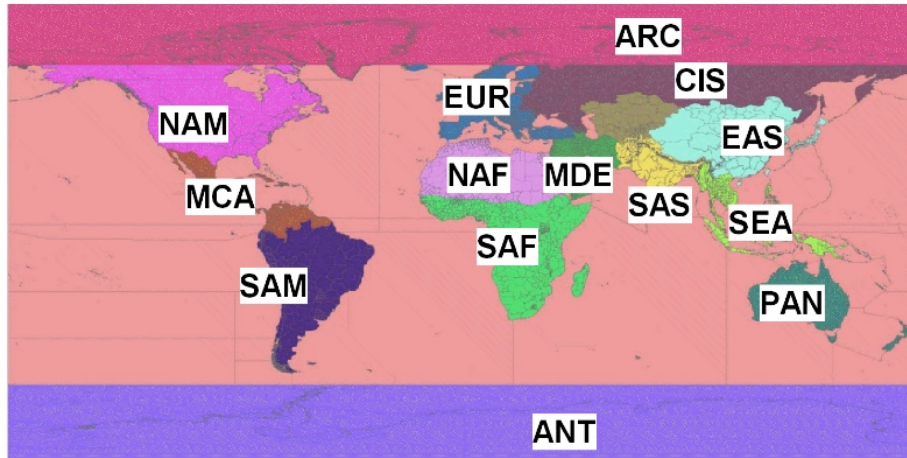
% of reduction is shown

blue = not significant
green = significant

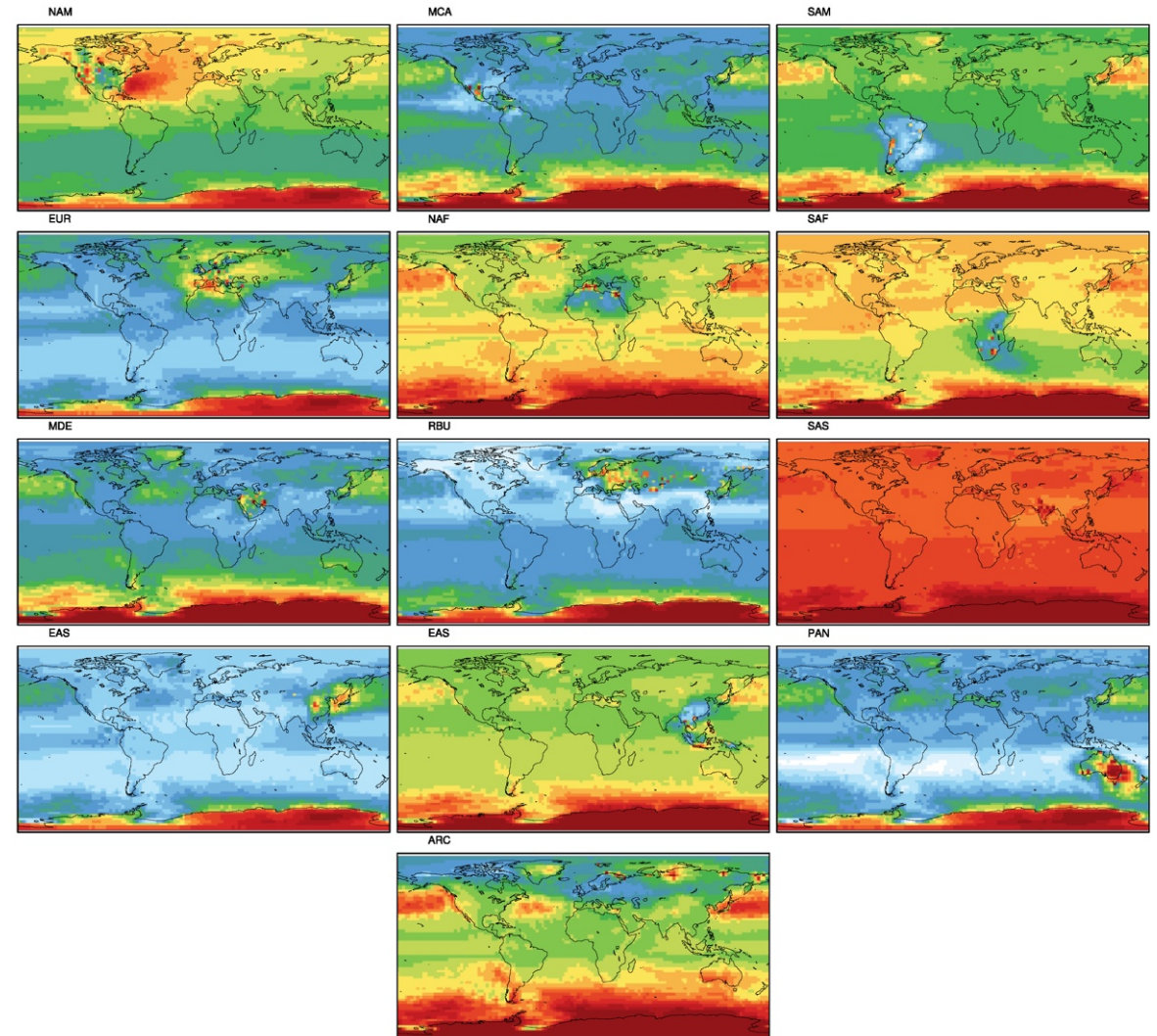
Hg Deposition - Oceans



Tagging Hg from regions & sources



Tagging Hg species emitted from regions and industrial sector allows multiple experiments in one single model run

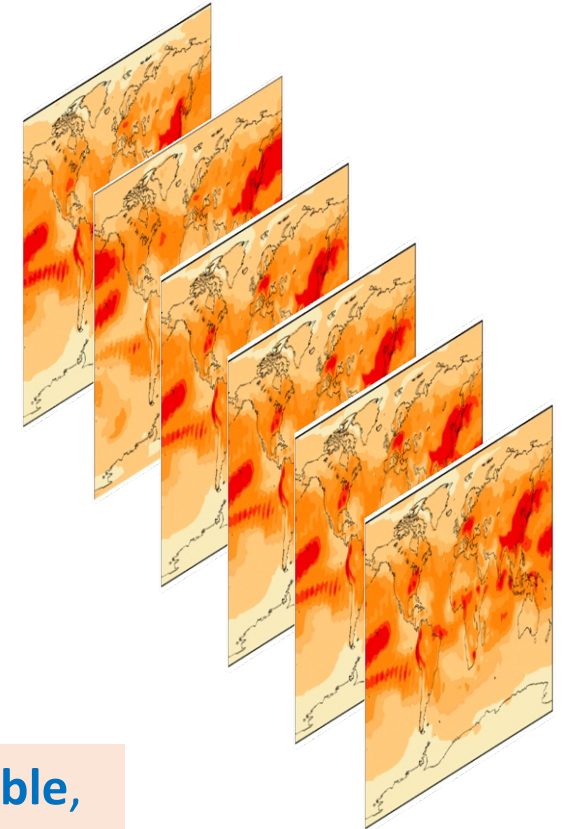
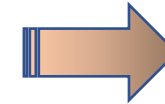
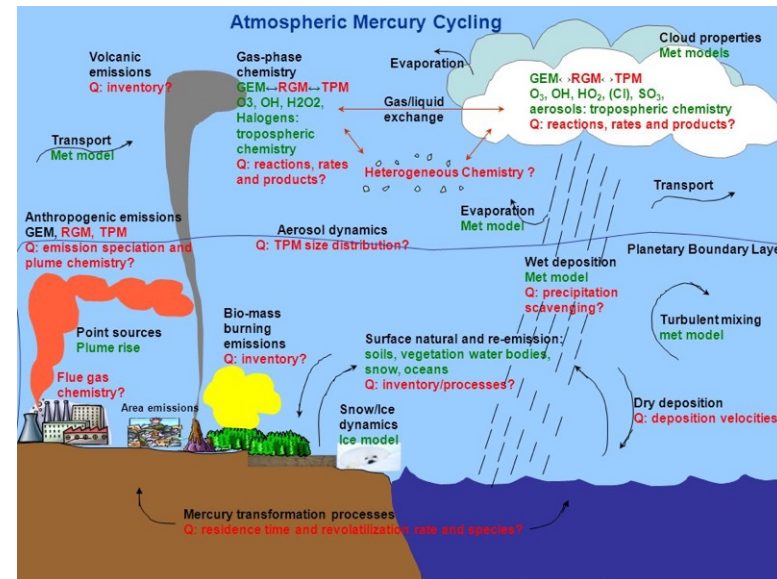
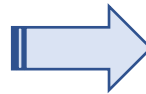
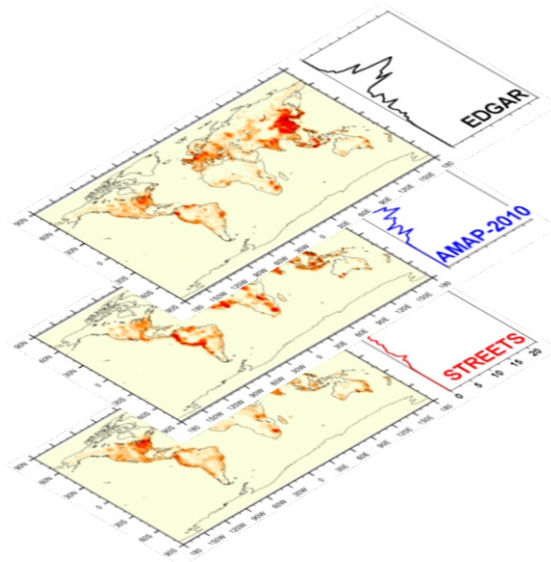


How to deal with uncertainty in CTMs

Emission Inventories:
EDGAR, AMAP, ...

Atmospheric processes
taking place in the Hg Cycle

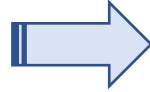
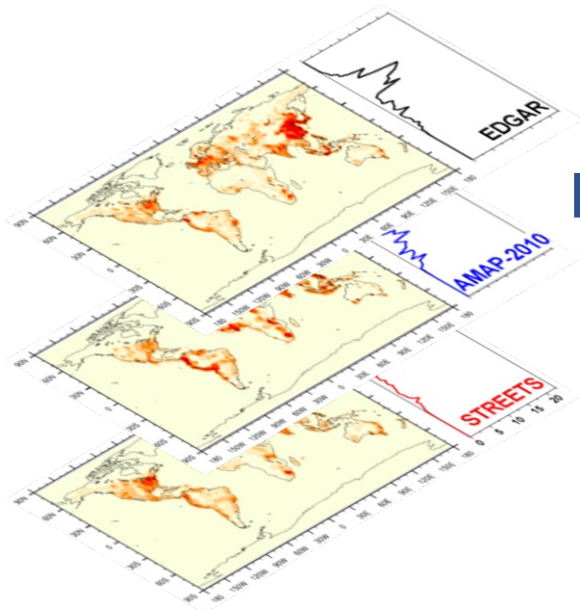
Ensemble of Hg
deposition patterns



Combining input with processes' uncertainty to obtain an **ensemble**,
and therefore the **statistics of model outputs**

Ensemble of Atmospheric Hg Global Models

Emission Inventories:
EDGAR, AMAP, ...

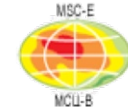


ECH^{MER}IT

Global EMEP Multi-media
Modeling System (**GLEMOS**)

GEOS-Chem

Global/Regional Atmospheric
Heavy Metals Model (**GRAHM**)

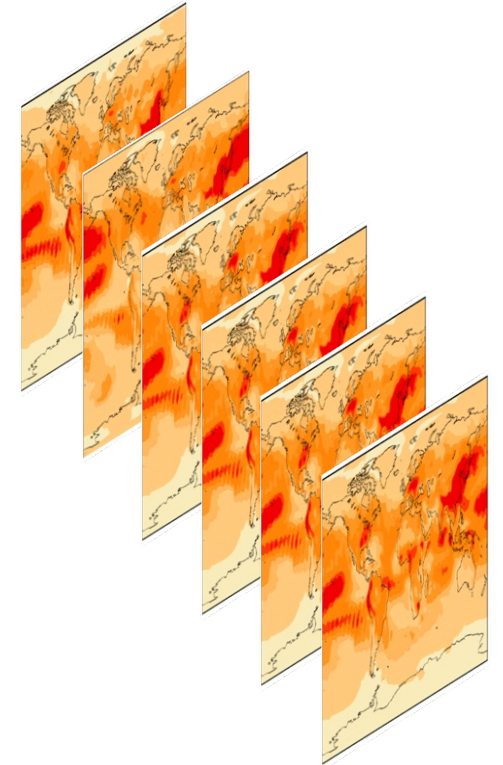
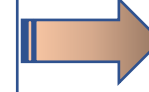


MSC-E



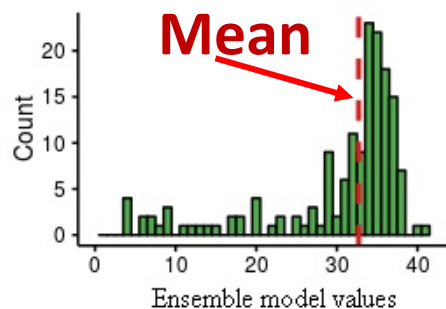
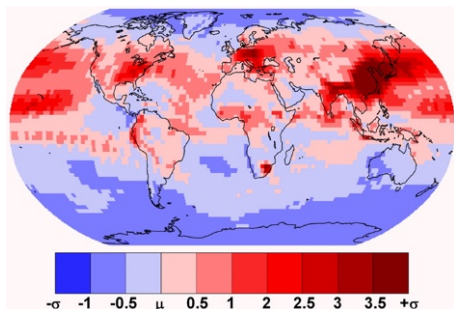
Environment and
Climate Change Canada
Environnement et
Changement climatique Canada

Models' Outputs for
Emission Scenarios



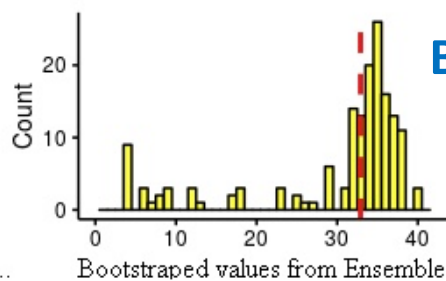
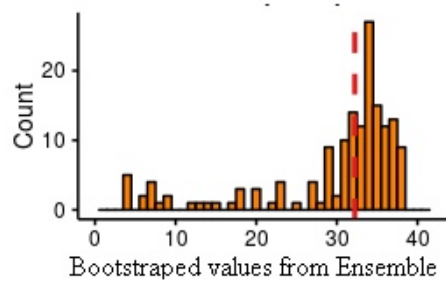
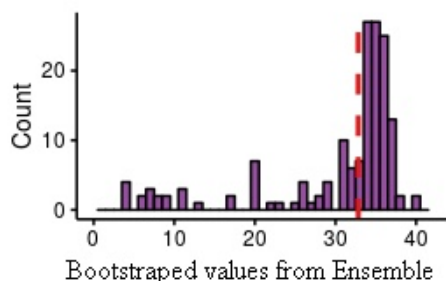
Bootstrap technique

Limitation on model runs is by-passed with bootstrap technique



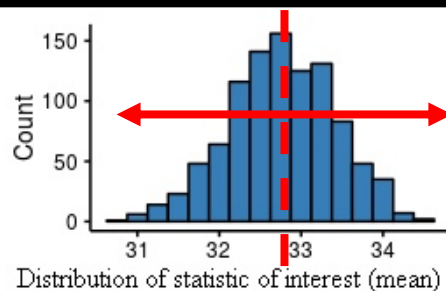
Distribution of Hg deposition values across the model ensemble

B
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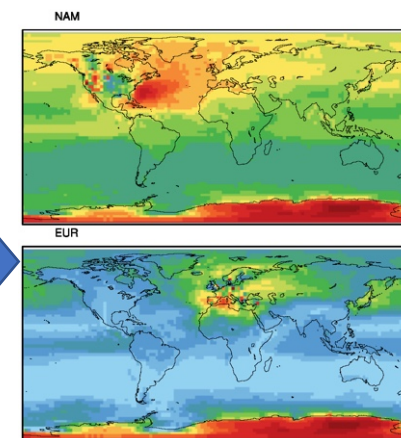
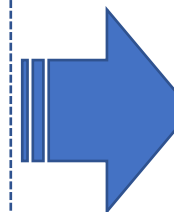
Bootstrapped samples, i.e. 10000

Distribution of means across the bootstrapped samples



Mean & CI (95%)

Allows the calculation of robust statistics and relative Confidence Intervals



$$\text{NCIAM (\%)} = 100 * \text{CI}(95\%) / \text{Mean}$$

What was accomplished so far

- **Promoted the federation of existing in-situ monitoring networks and programs** to share data and knowledge.
- **Since 2016** a number of meetings have been held in order to build the partnership. **Meetings** were organized with representatives of monitoring networks, PI of projects & programs, UNEP, GEO Initiatives, among others.
- **A web portal** (www.gos4m.org) was prepared for outreach and dissemination purposes.
- **A partnership agreement** was prepared with contributions of several interested parties (i.e., USEPA, Env. Canada, GEO SEC)
- The GOS4M partnership agreement **has been signed** by a number of parties.
- **Several** EU, national and international **projects** have been contributing to GOS4M activities carried out so far.

What was accomplished so far, *..cont'd*

- **GOS4M & GMOS** contributed to the **UNEP-GEF pilot project** with CNR and WHO for the global monitoring plan for Hg in air and HBM.
- **GEO Ministerial 2019:** GOS4M was one of the selected EU user-oriented showcase.
- **GOS4M:** is one of the Pilots (P1) of the Showcase “Health Surveillance” in E-Shape.
- **GOS4M** contributed to the **GMA-2018 for COP3**.
- **GOS4M** was presented in **COP2 and COP3**.

What was accomplished so far, ..*cont'd*

- ERA-PLANET/ iGOSP / **GOS4M** provided contribution to the ad-hoc group on EE of the MC.
- **GOS4M** is part of the MercOx and GMOS-Train (H2020).
- **GOS4M** is part of UNEP F&T and cooperate with several countries in expanding the global coverage of in-situ monitoring networks with PASs.

Resources Mobilization

- ✓ + National/international funding of all GOS4M Members will be provided on the GOS4M portal
- ✓ **ERA-PLANET/iGOSP** (H2020-689443) (CNR, CNRS, FMI, HZG, IJS,)
- ✓ **ERA-PLANET/iCUPE** (H2020-689443) (FMI, HEL, CNR, CNRS, HZG, ...)
- ✓ **E-shape** (H2020-820852) (ARMINES, CNR, CNRS, FMI, HZG,)
- ✓ **GMOS-Train** (H2020-860497) (IJS, IFREMER, CNR, CNRS, HZG, MIT,...)
- ✓ **Merc-OX** (H2020) (IJS, CNR,)
- ✓ **EIRENE ESFRI RI** (H2020 - **under evaluation**) (MU, CNR, CNRS, IJS,...)
- ✓ **INFRAIA** (H2020 - **under evaluation**) (MU, CNR, CNRS, IJS,...)
- ✓ **I-SEED** (H2020 – approved / **under negotiation**) (IIT, CNR, SSA, Wageningen Univ.,...)



e-shape

EuroGEOS Showcases: Applications Powered by Europe



Planned activity (2020-2021)

(to be agreed at the first joint SC and SAB meeting)

- ✓ Consolidate the **Governing structure and responsibilities (DAY-2)**
- ✓ **Enlarge the partnership.**
- ✓ Enhance **dissemination activity** in policy & scientific meetings.
- ✓ Promote **intercomparison of QA/QC methods** and on-line products.
- ✓ **Continue cooperation with UNEP and MCM and other Intern. Org.:** Webinars have been planned for the Minamata Online Week (16-20 Nov. 2020).
- ✓ **Promote intercomparison of biogeochemical models** to estimate Hg in marine biota.
- ✓ **Contribute to the COP4 of the MCM** - in Bali, Indonesia in 2021.
- ✓ **Contribute to ICMGP 2021 in South Africa.**

Thanks