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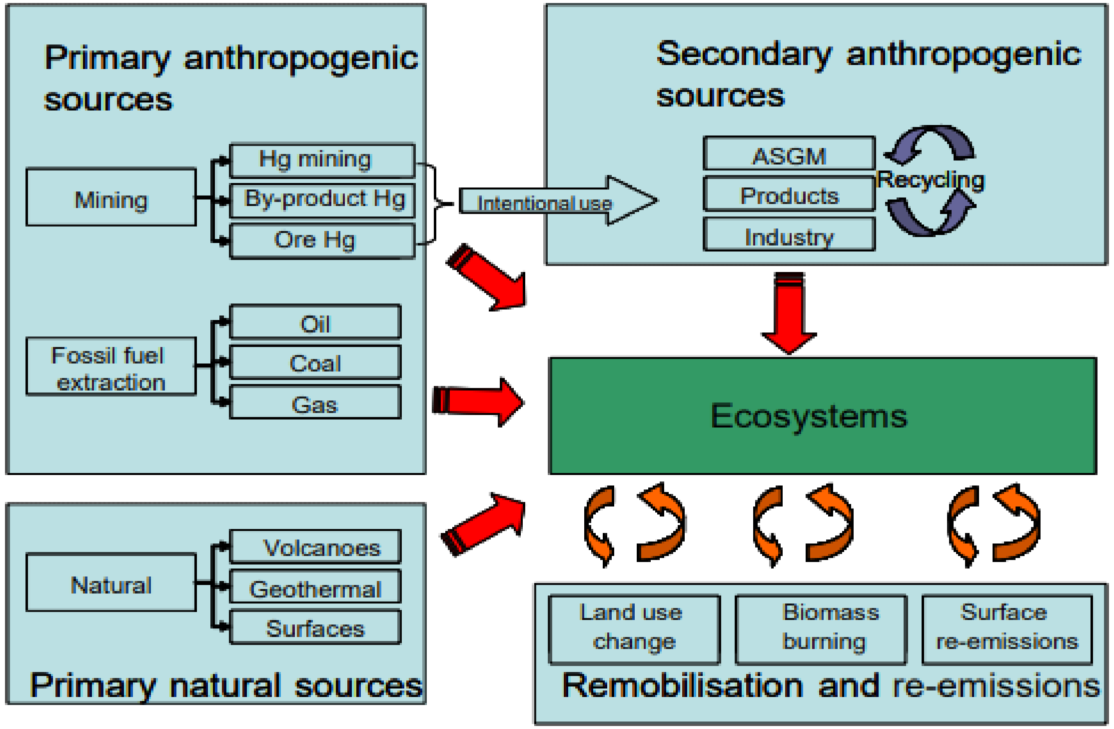
Jacopo Cabassi

Venturi S, Randazzo A, Santi R, Maioli G, Capecchiacci F, Nisi B, Meloni F, Tassi F, Rappuoli D, Vaselli O

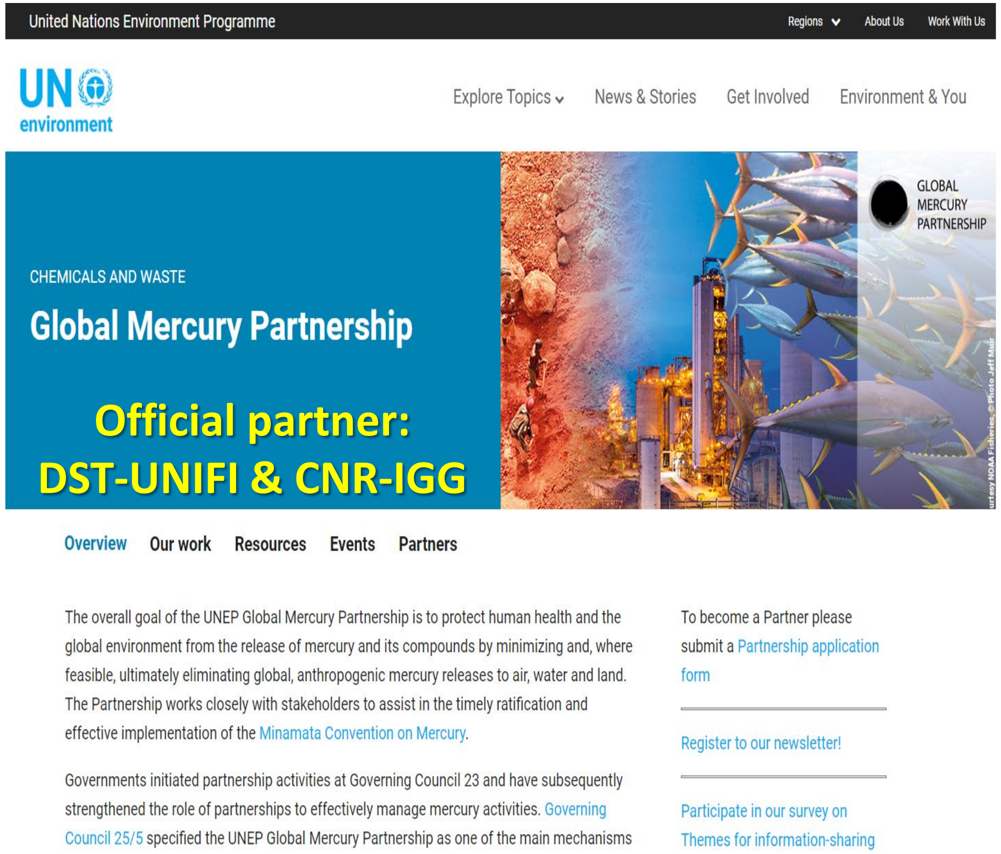
Gaseous elemental mercury (GEM) in Florence (central Italy): measurements at point stations and comparison with other gaseous pollutants



Mercury is emitted in the atmosphere as elemental vapour (Hg^0 or GEM, i.e. gaseous elemental mercury) from different sources, including earth's surface natural degassing and re-evaporation of previously deposited mercury, and past and present anthropogenic activities

The urban environment is not an exception, being characterized and affected by possible local-sourced emissions (e.g. related to municipal waste, motor vehicles and fossil fuel combustion, urban surfaces, industrial activities, and biomass combustion) and by non-point sources of Hg, which, although extremely difficult to identify, can be relevant

A strong need to inventory emissions and improve monitoring



GLOBAL MERCURY ASSESSMENT 2018

KEY FINDINGS

UN environment

KEY FINDING 1

A new global inventory of mercury emissions to air from anthropogenic sources in 2015 quantifies global emissions from 17 key sectors at about 2220 tonnes.

There are also smaller anthropogenic sources that it is not yet possible to quantify in the detailed global inventory. Total emissions from these additional sources are evaluated to total of the order of tens to hundreds of tonnes per year. They would therefore not significantly change the total global emissions inventory but may be of local or regional significance.

KEY FINDING 2

Estimated global anthropogenic emissions of mercury to the atmosphere for 2015 are approximately 20% higher than they were in updated estimates for 2010.

Continuing action to reduce emissions has resulted in modest decreases in emissions in North America and the European Union. Increased economic activity, notably in Asia, and the use and disposal of mercury-added products appears to have more than offset any efforts to reduce mercury emissions.

KEY FINDING 3

Emissions patterns in 2015 are very similar to those in 2010.

The majority of the 2015 emissions occur in Asia (49%; primarily East and South-east Asia) followed by South America (18%) and Sub-Saharan Africa (16%). Emissions associated with artisanal and small-scale gold mining account for almost 38% of the global total and are the major contributor to the emissions from South America and Sub-Saharan Africa. In other regions, emissions associated with energy production and industrial emissions predominate.

KEY FINDING 4

Stationary combustion of fossil fuels and biomass is responsible for about 24% of the estimated global emissions, primarily from coal burning (21%).

Main industrial sectors remain non-ferrous metal production (15% of the global inventory), cement production (11%) and ferrous metal production (2%). Emissions from waste that includes mercury-added products comprise about 7% of the 2015 global inventory.

KEY FINDING 5

Human activities have increased total atmospheric mercury concentrations by about 450% above natural levels.

This increase includes the effects of mercury emitted from human sources in the past which is still circulating in the biosphere, known as legacy mercury. Historical emissions up to the end of the 19th century, mainly from gold, silver, and mercury (cinnabar) mining and refining in the Americas, contributed more to the present-day anthropogenic mercury in soils and the oceans than all 20th century industrial sources combined. The presence of legacy mercury and the potential for climate change to influence its remobilization complicates our ability to assess potential future changes.

MINAMATA CONVENTION ON MERCURY

The UN Minamata Convention on Mercury stipulated that emissions from all types of relevant sources must be monitored and inventoried, as well as the state of knowledge on the different sources and distribution mechanisms of mercury must be implemented through research and monitoring programmes

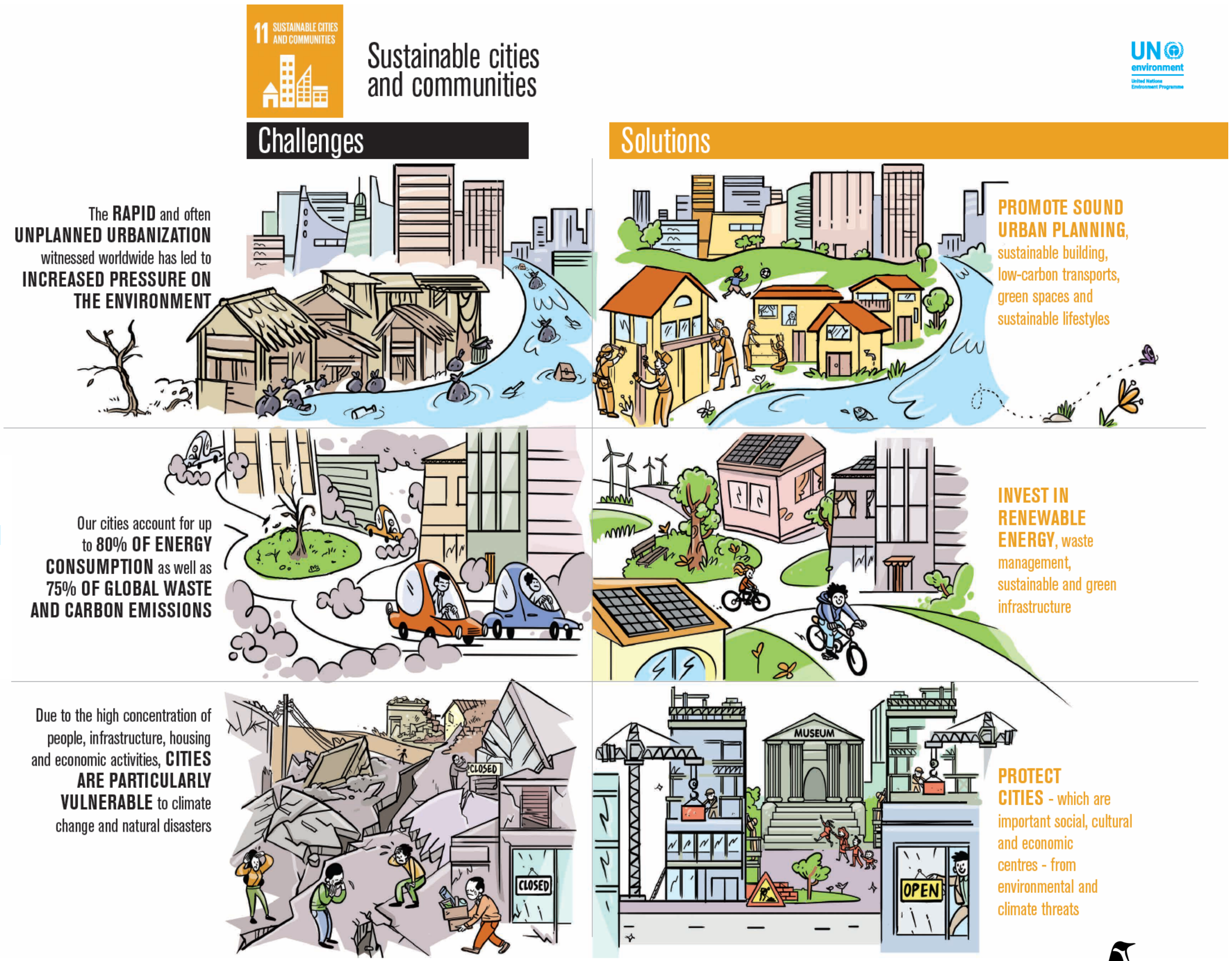
Why study an urban context?

globalgoals.org

REDUCE THE ENVIRONMENTAL IMPACT OF CITIES

By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.

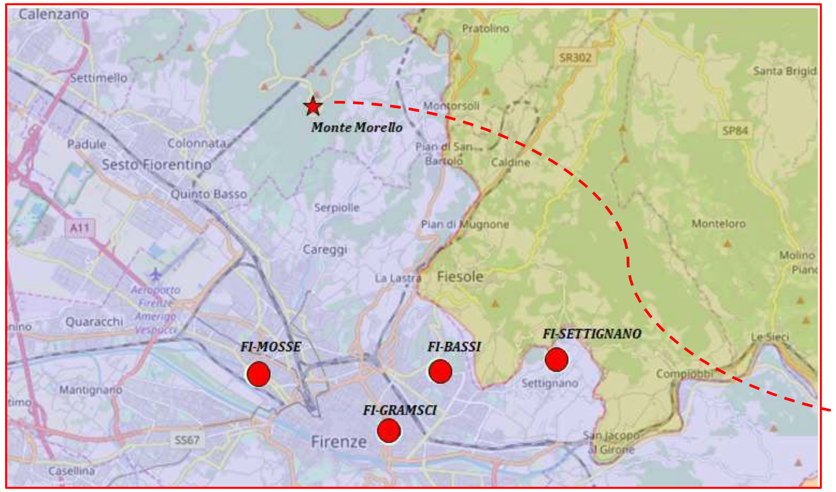
In this context, quantifying the presence of mercury in urban air and investigating and deciphering its behavior under different environmental conditions is pivotal



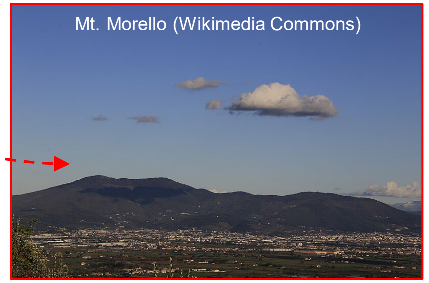
GEM measurements through a Lumex® RA-915M instrument were for the first time performed in different areas of Florence (central Italy) at selected fixed monitoring points and in combination with CO_2 and CH_4 (including carbon isotopes)

Lumex® RA-915M: portable Zeeman-effect atomic absorption spectrometer with high-frequency modulated light polarization
GEM dynamic reading range: 2-30,000 ng/m^3

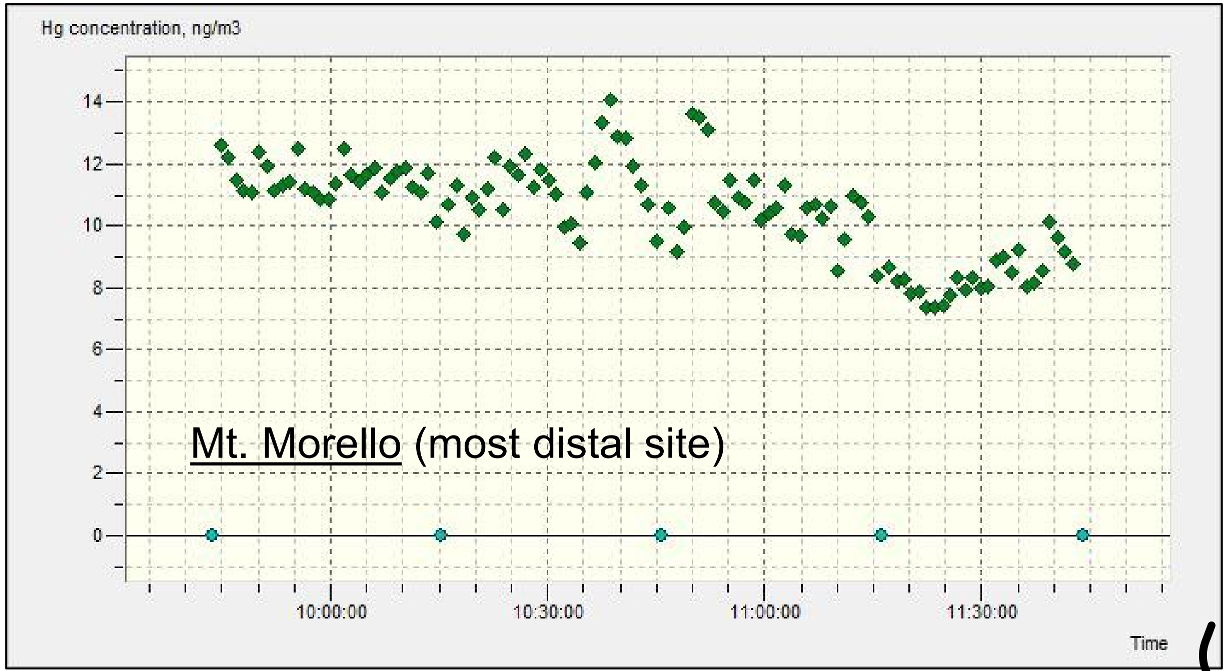
Picarro® G2201-i Analyzer: cavity ring-down spectroscopy for CO_2 and CH_4
CO_2: from air concentration up to 2000 ppm
CH_4: High Precision (1.8 – 12 ppm) & High Range (up to 1000 ppm)

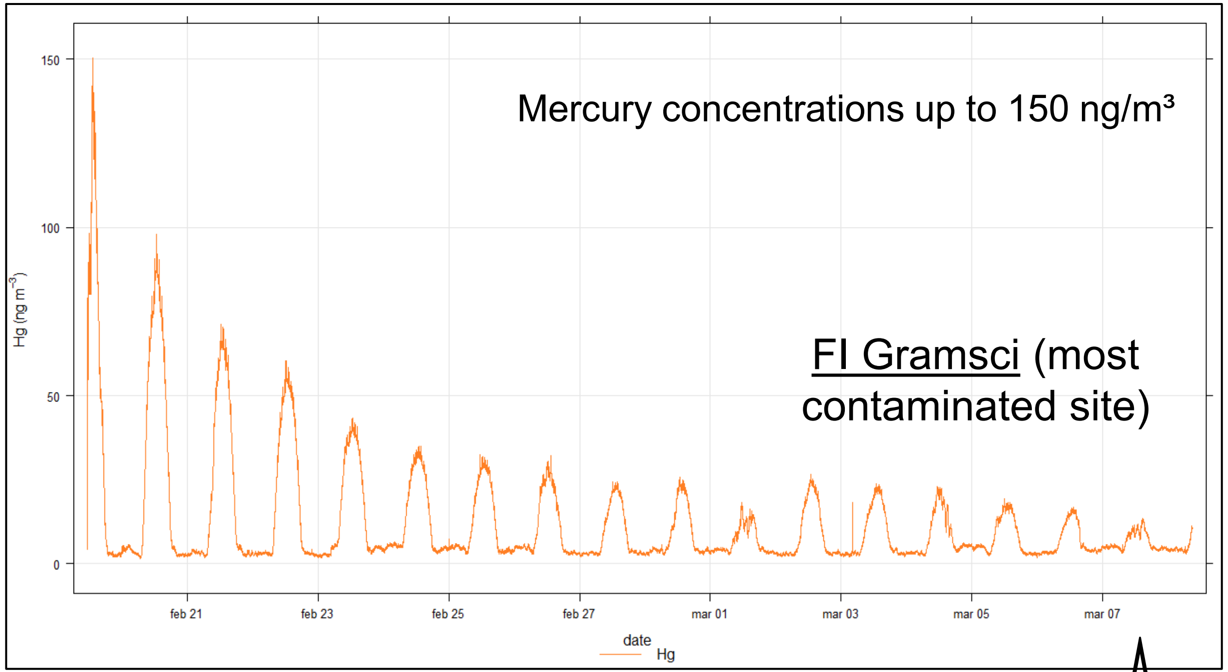


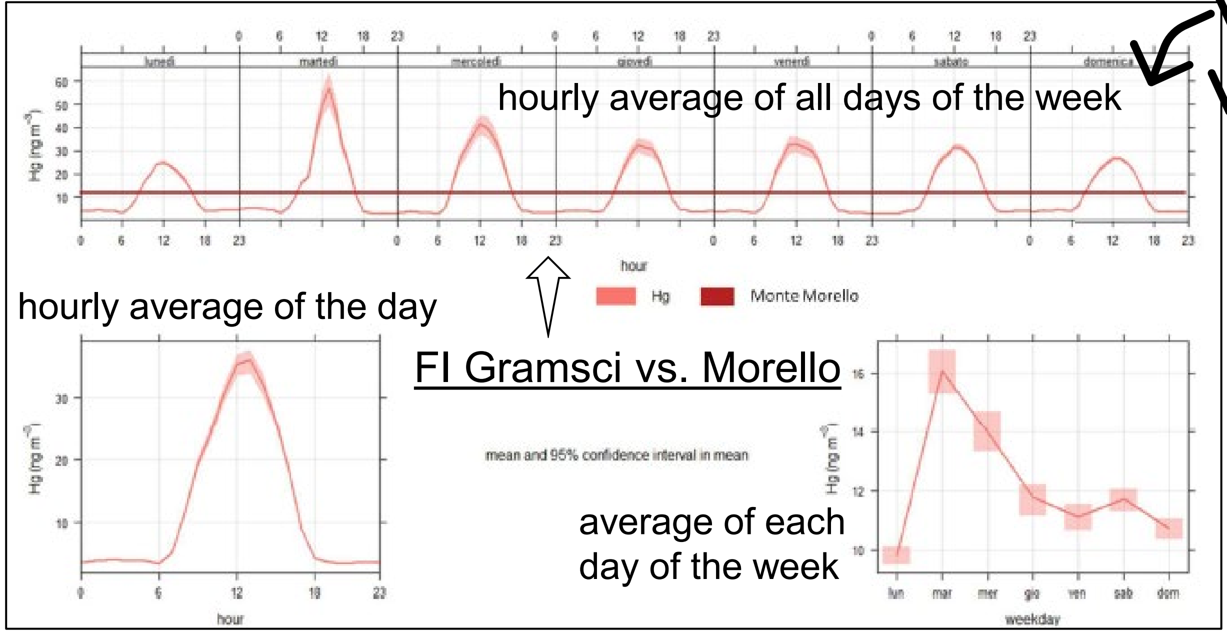
ARPAT monitoring stations: FI-SETTIGNANO, FI-GRAMSCI, FI-BASSI & FI-MOSSE


Mt. Morello (Wikimedia Commons)

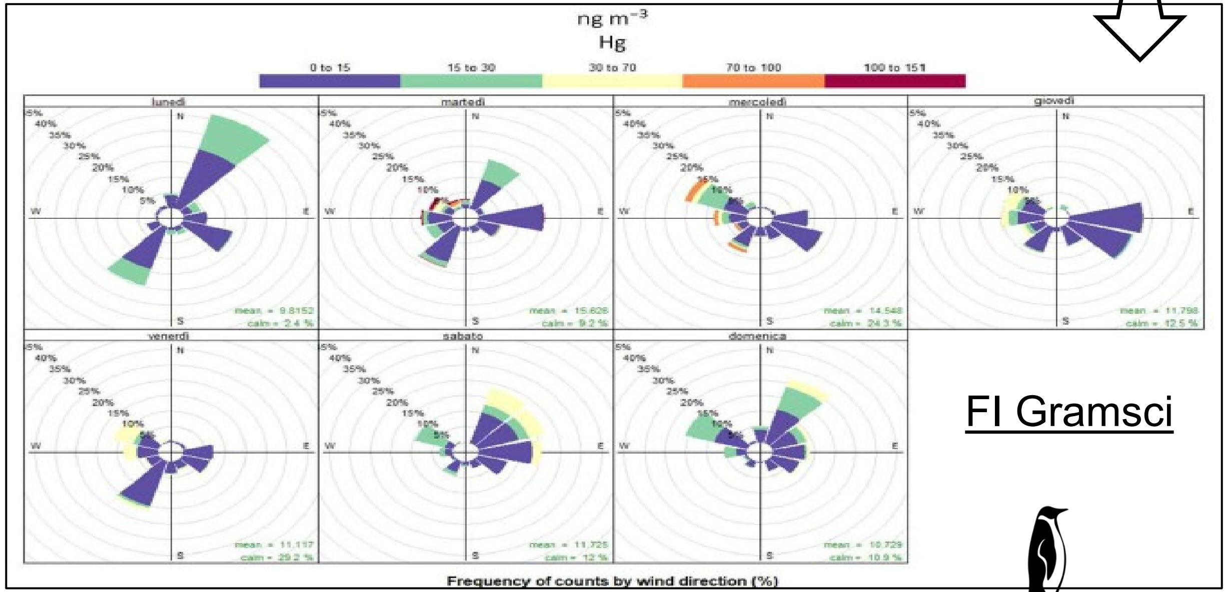

Florence (Wikimedia Commons)





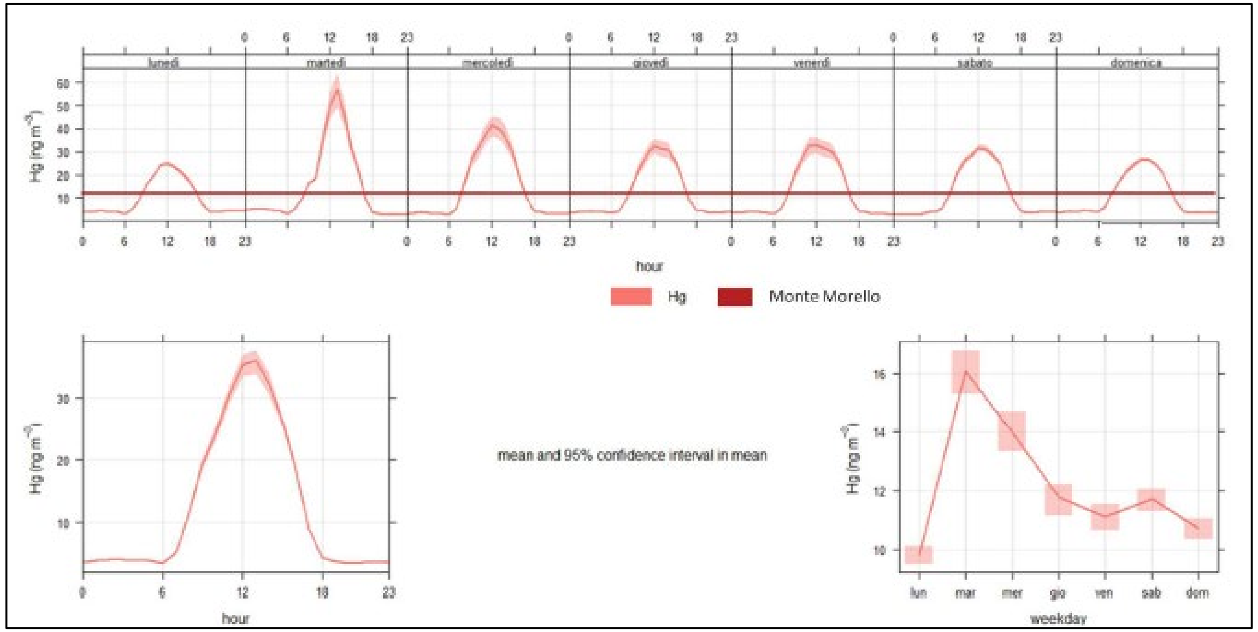


Pollution rose: graph that relates different ranges of Hg values to wind directions and provides information on the percentage frequency with which a given range is present

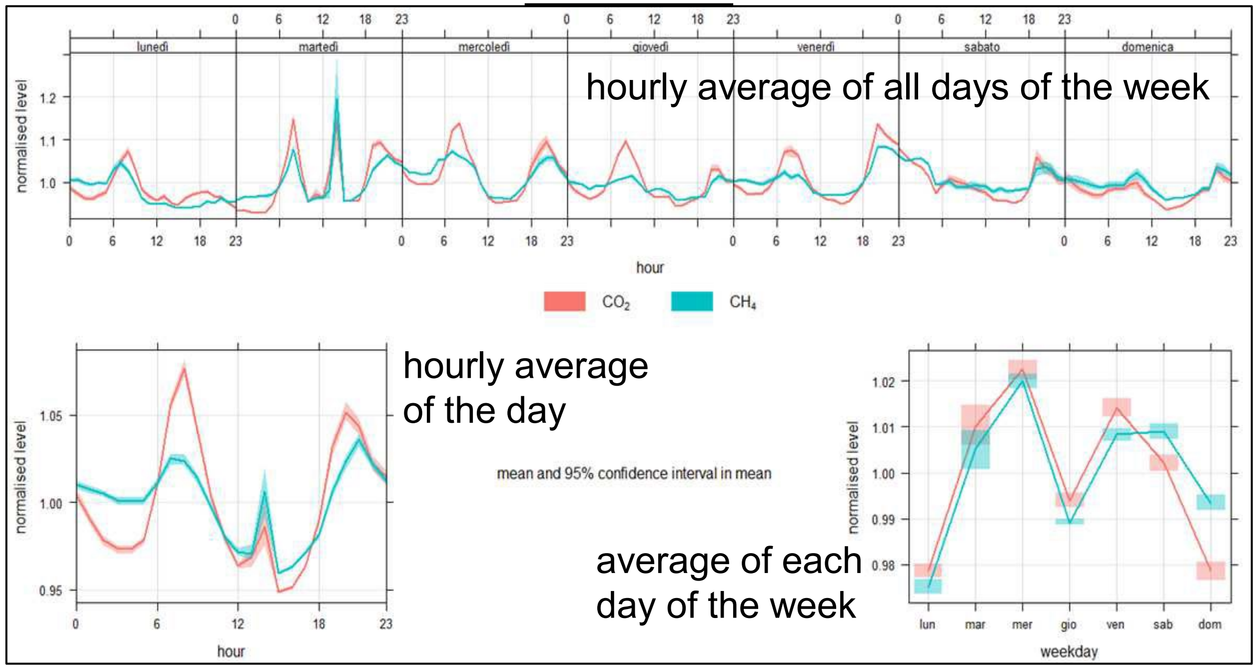


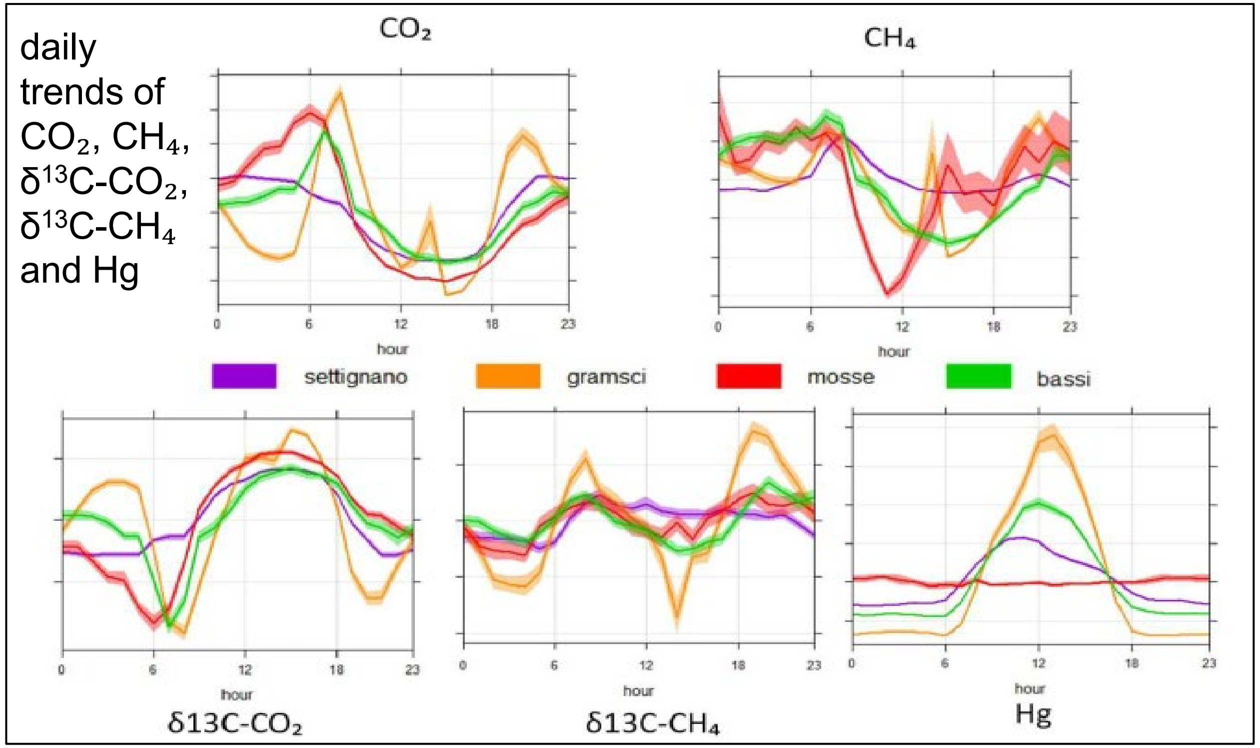
Maioli, 2019

normalization by dividing each component by its average value



FI Gramsci





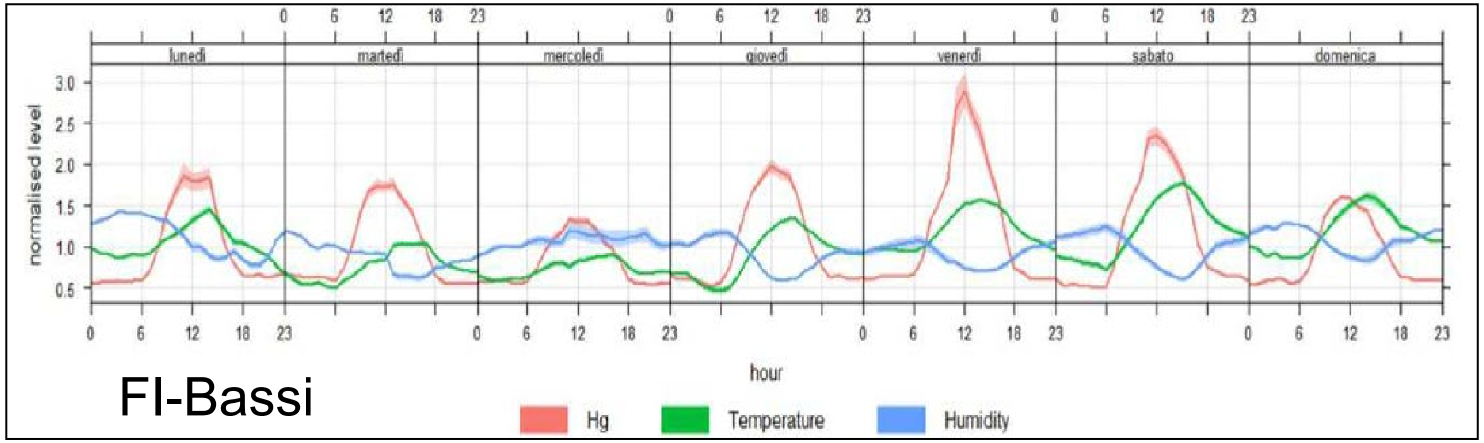
Various GHGs sources/processes: vehicular exhaust emissions, domestic heating (CO_2), leakage from underground pipeline network, biogenic emissions from urban waterways (CH_4) + air boundary layer movement

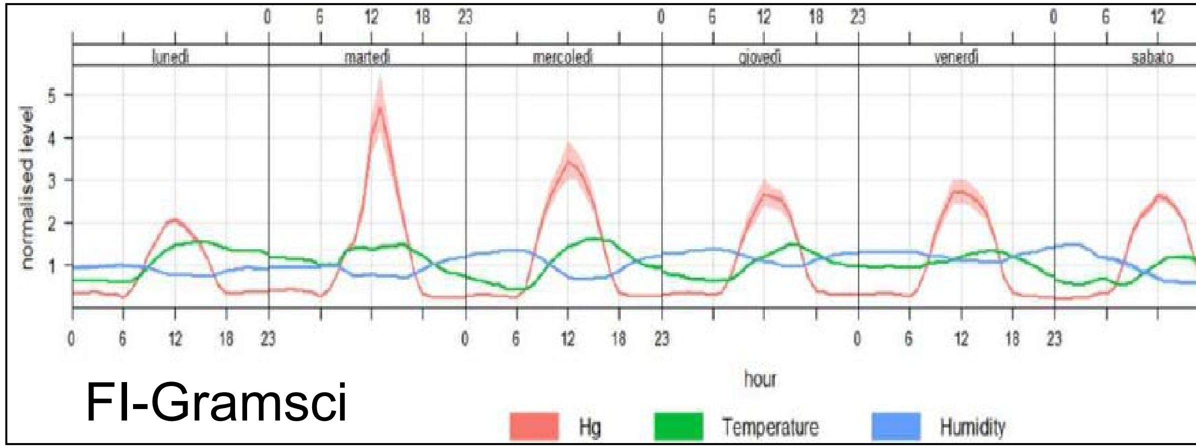
GEM averages are characterized by a completely different trend with respect to those of CO_2 and CH_4, implying that their emission source(s) and/or behavior in the atmosphere is/are not the same

Maioli, 2019

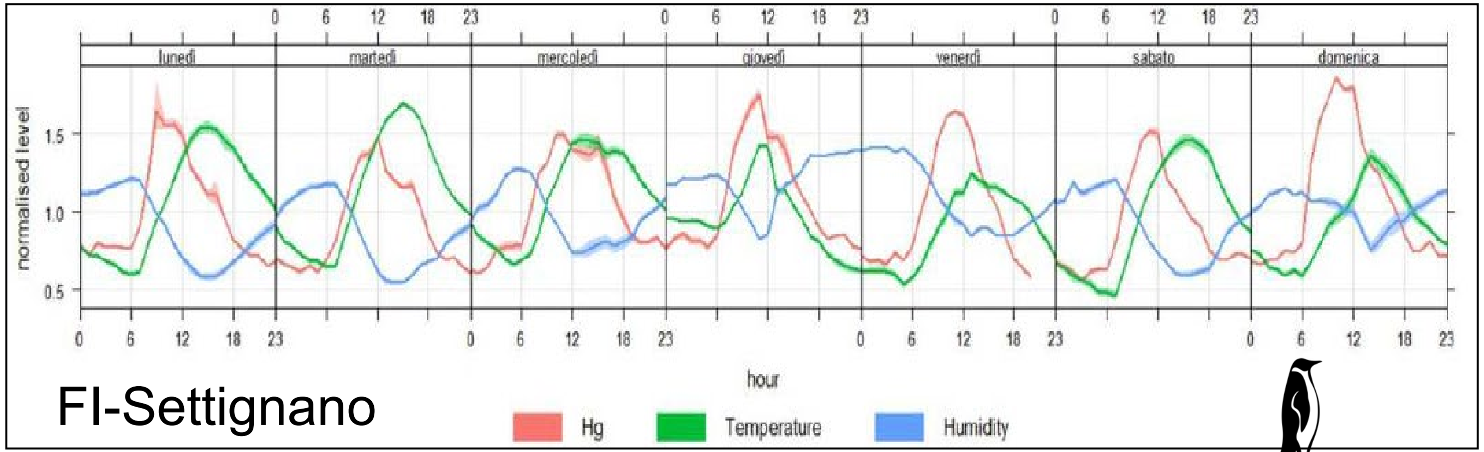
Some considerations:

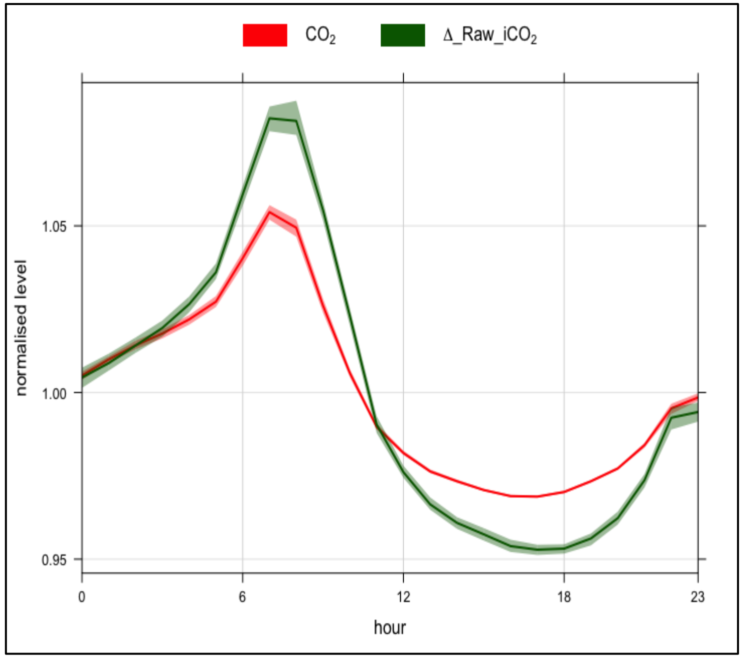
- GEM evident peaks at midday, so traffic seems to influence Hg contents to a minor extent (no link between concentrations and traffic peak hours)
- Direct correlation of Hg peaks with temperature and inverse correlation with humidity: photochemical processes during the day influence mercury emissions
- Solar radiation, which peaks in the middle hours of the day, induces the photoreduction of Hg^{2+} to Hg^{0}
- Solar radiation has a direct influence on air temperature and indirect on humidity, so their correlations with Hg reflect that of Hg and solar radiation
- FI-Mosse: extremely irregular trend. Sampling in the latter part of April, increase in temperatures with possible increase in the height of the mixing layer, resulting in dilution of Hg during daylight hours, no correlation between Hg, temperature and humidity, as well as lower average Hg values

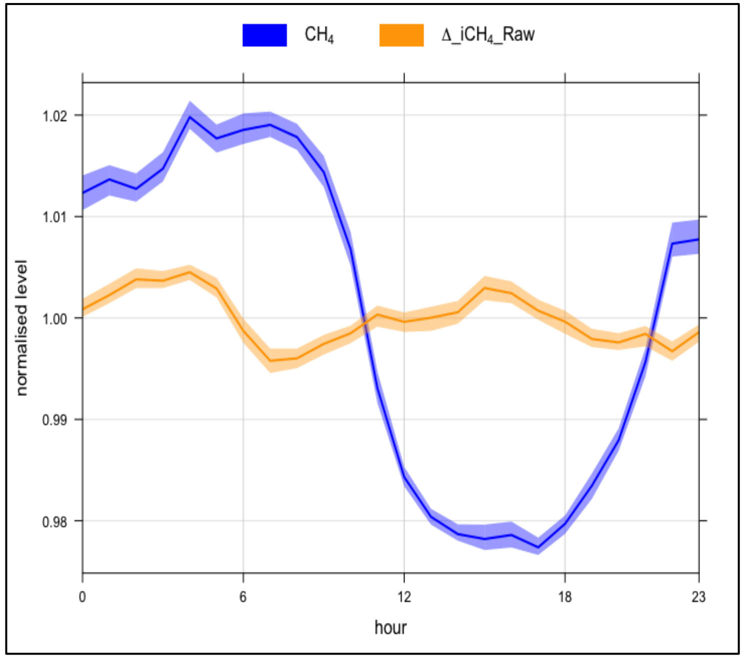




Maioli, 2019

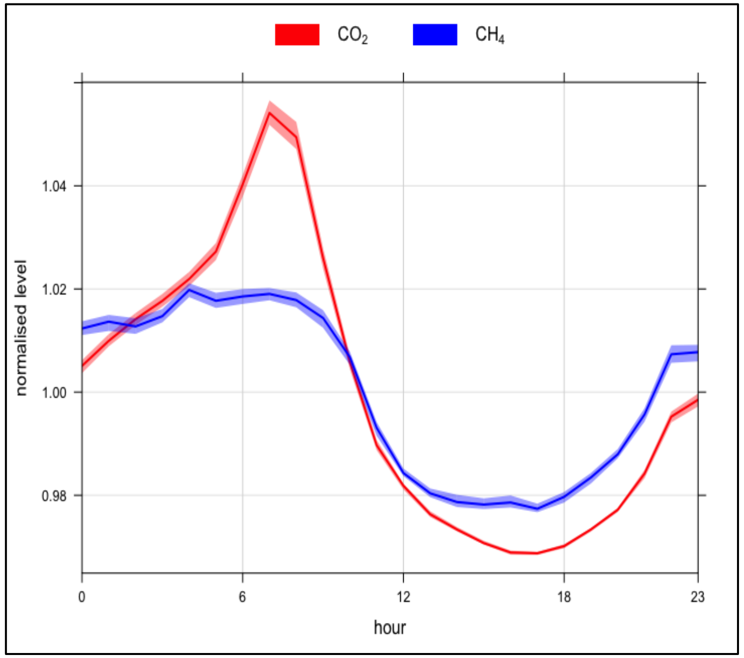


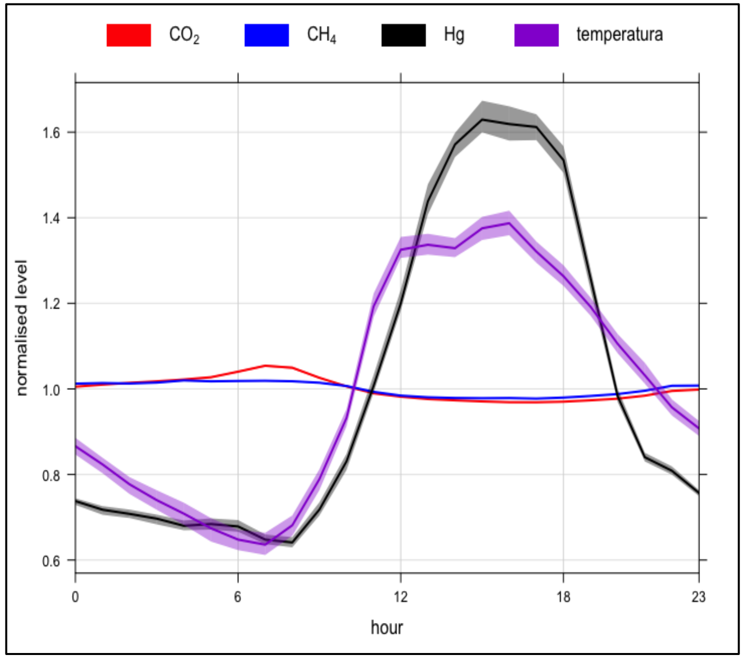


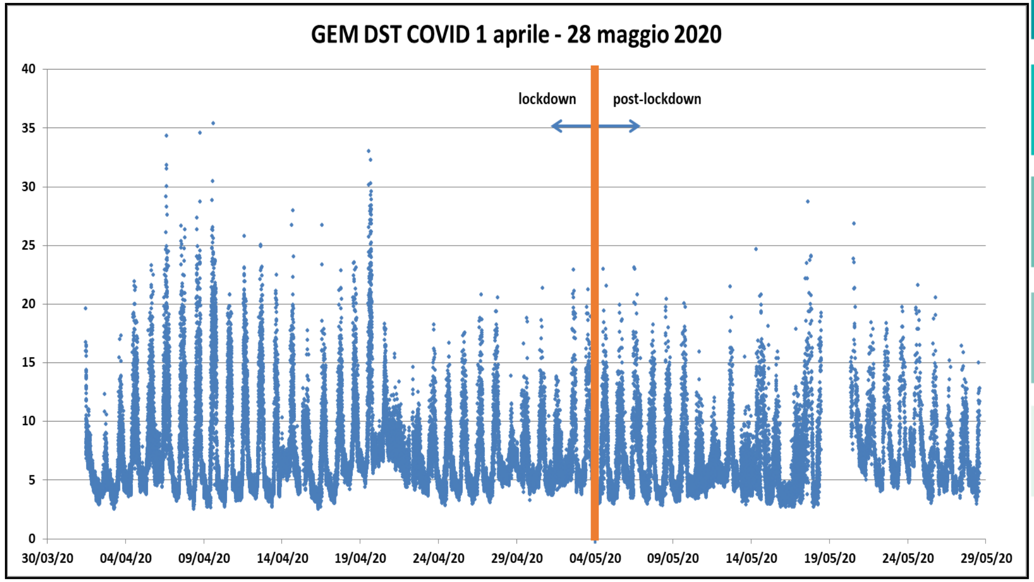


The same happens at fixed points other than the ARPAT monitoring network

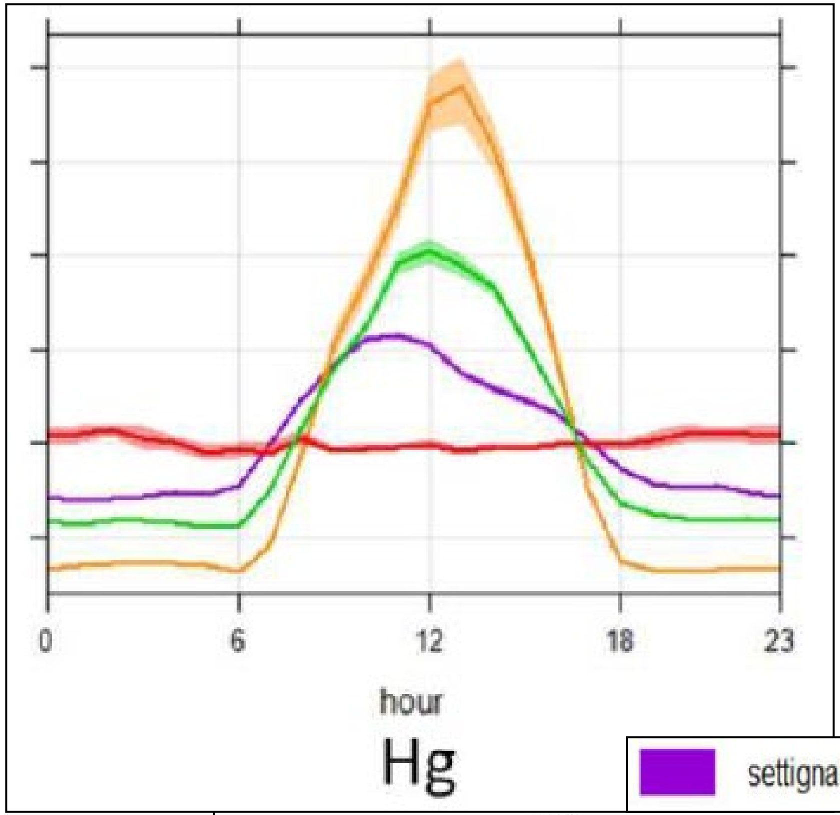
Covid pandemic did not produce a substantial change between syn- and post-lockdown GEM concentrations







FI-DST Santi, 2020

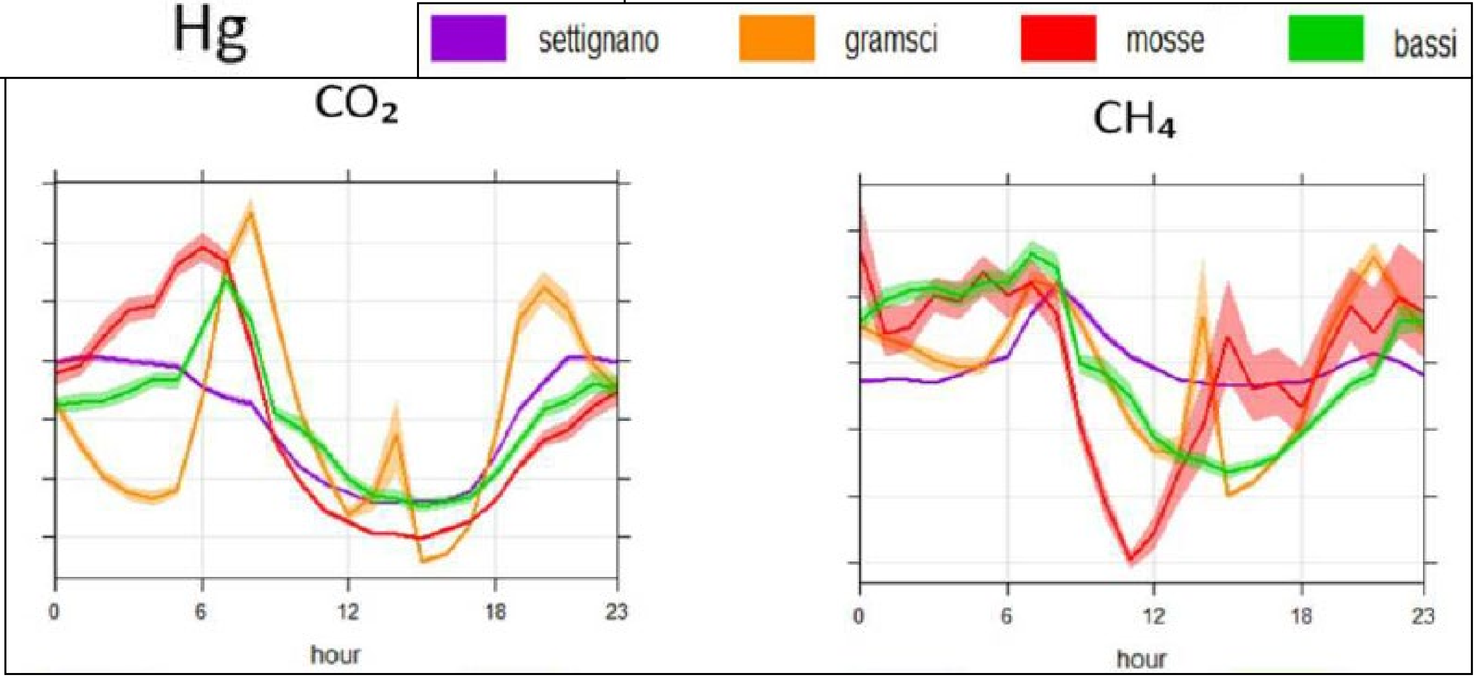


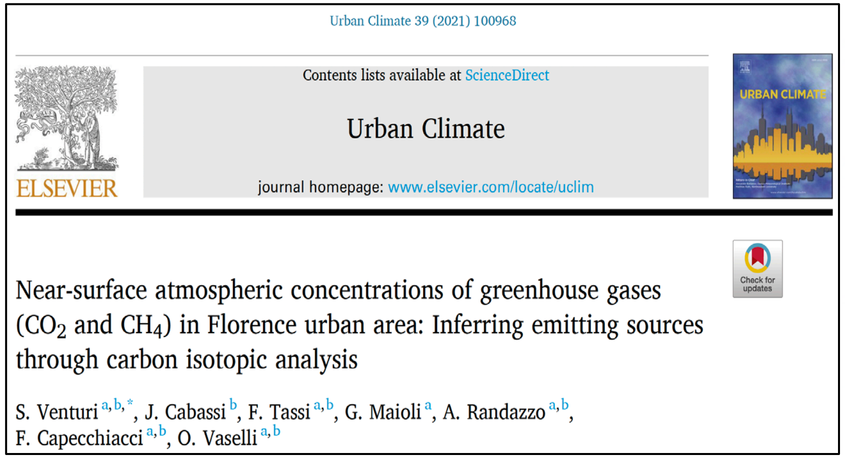
Remarks:

Hg presented a significant increase in the central hours of the day and showed a direct correlation with temperature and an inverse correlation with relative humidity because of Hg dependence on solar radiation, which causes photochemical reactions that reduce and mobilize previously deposited Hg^{2+}

Nevertheless, vehicular traffic (at its highest during peak hours), i.e. one of the main factor regulating GHGs dynamics (as well as to a lesser extent domestic heating), likely had an influence on Hg too, since the measurement stations were characterized by different concentrations in agreement with the traffic intensity and/or the presence of anthropogenic emissions

GHGs




Urban Climate 39 (2021) 100968

Contents lists available at ScienceDirect

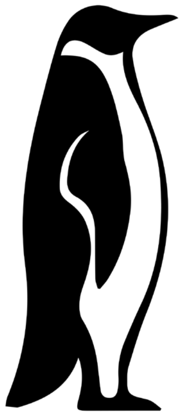
Urban Climate

journal homepage: www.elsevier.com/locate/uclim

ELSEVIER

Near-surface atmospheric concentrations of greenhouse gases (CO_2 and CH_4) in Florence urban area: Inferring emitting sources through carbon isotopic analysis

S. Venturi[a,b,*], J. Cabassi[b], F. Tassi[a,b], G. Maioli[a], A. Randazzo[a,b], F. Capecchiacci[a,b], O. Vaselli[a,b]



Remarks and future:

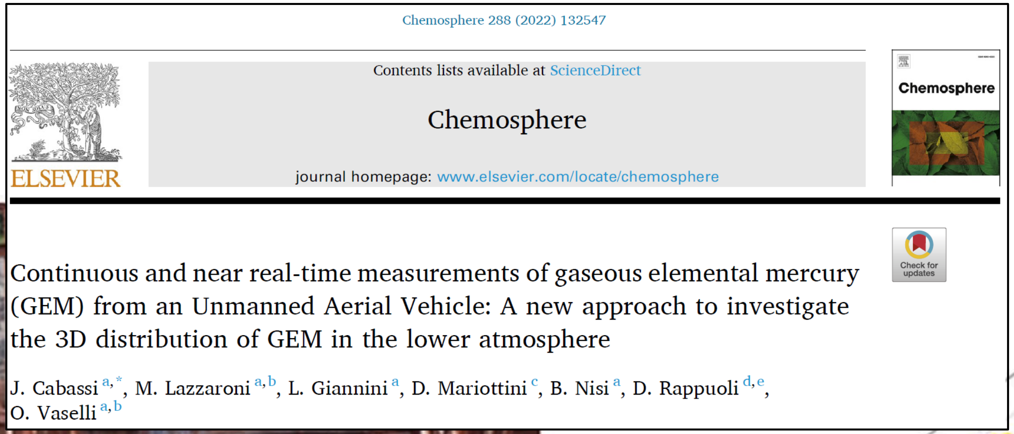
The results of this study clearly highlighted the potentiality of implementing traditional urban air quality monitoring networks with GEM-dedicated instrumentation in order to improve our understanding of Hg concentrations, distribution and sources in urban areas and anthropogenic environments

GEM comparison with other gaseous pollutants is also a useful tool

Looking ahead...

- coupling of GEM and particulate matter measurements via low-cost stations, in both fixed points and along transects across Florence (also with CO_2 and CH_4)
- possible use of the Lumex+drone combination in selected sites to achieve a GEM 3D distribution map…

A new approach…


Chemosphere 288 (2022) 132547

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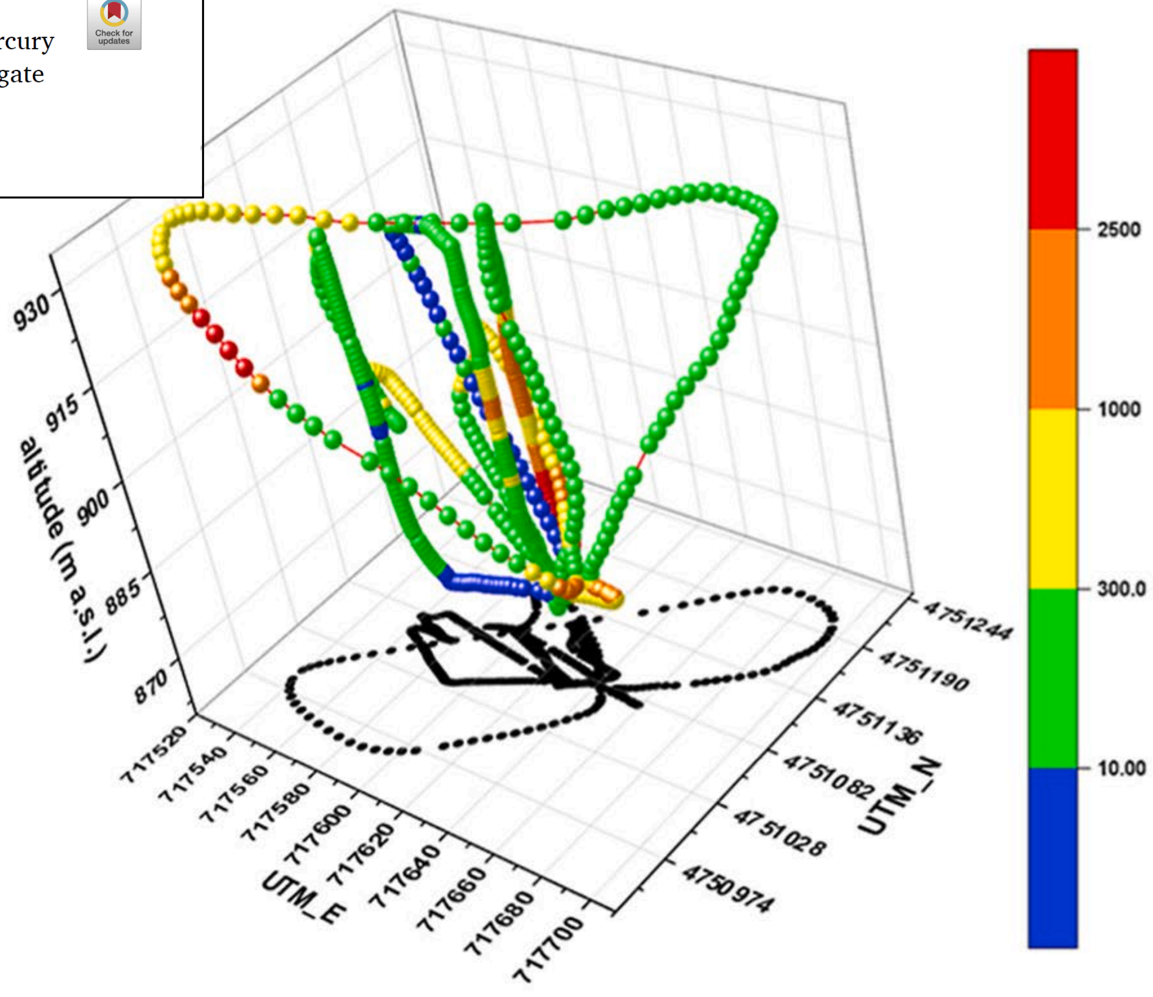
Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere

Continuous and near real-time measurements of gaseous elemental mercury (GEM) from an Unmanned Aerial Vehicle: A new approach to investigate the 3D distribution of GEM in the lower atmosphere

J. Cabassi [a,*], M. Lazzaroni [a,b], L. Giannini [a], D. Mariottini [c], B. Nisi [a], D. Rappuoli [d,e], O. Vaselli [a,b]

Lumex + UAV



3D distribution of GEM

THANKS FOR YOUR ATTENTION

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Cabassi J [1], Venturi S [2], Randazzo A [2], Santi R [2], Maioli G [2], Capecchiacci F [2], Nisi B [1], Meloni F [2], Tassi F [2], Rappuoli D [3], Vaselli O [2]

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