

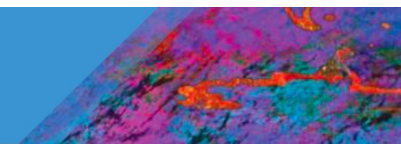


CH₄ mitigation: what can we learn from atmospheric measurements

JEAN-DANIEL PARIS

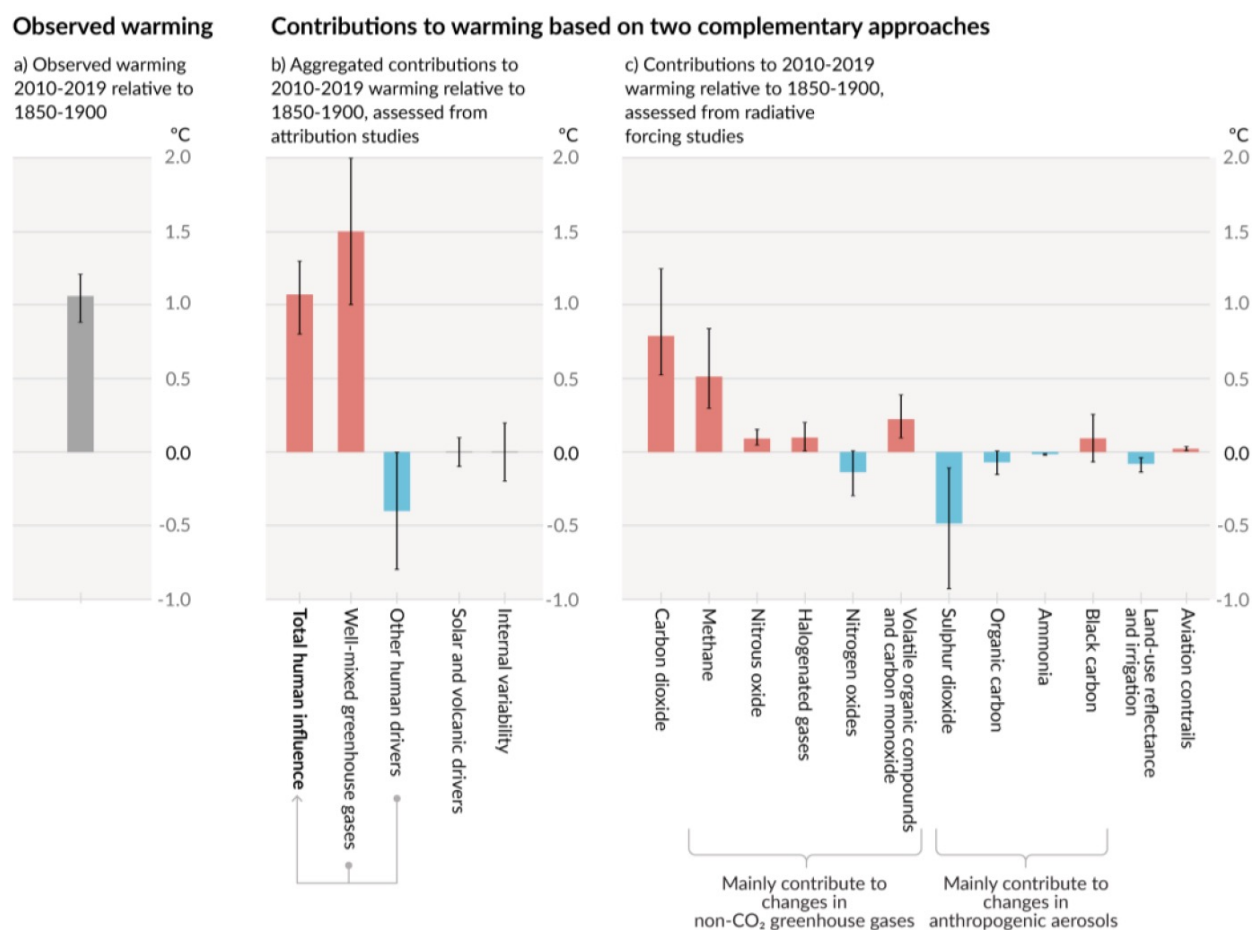
LSCE, CEA, SACLAY, FRANCE

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Observed warming is driven by emissions from human activities, with greenhouse gas warming partly masked by aerosol cooling

Figure SPM.2





[Credit: Evgeny Nelmin | Unsplash]



To limit global warming, strong, rapid, and sustained reductions in CO₂, methane, and other greenhouse gases are necessary.

This would not only reduce the consequences of climate change but also improve air quality.

ipcc

INTERGOVERNMENTAL PANEL ON climate change



GLOBAL METHANE BUDGET 2008-2017



TOTAL EMISSIONS

Bottom-up view (BU) Top-down view (TD)

737 (594-880) 576 (550-594)

CHANGE IN
ATMOSPHERIC ABUNDANCE
> 100 13* (0-49)

TOTAL SINKS

625 (500-798) 556 (501-574)

128 (113-154) 111 (81-131)

206 (191-223) 217 (207-240)

30 (26-40) 30 (22-36)

149 (102-182) 181 (159-200)

222 (143-306) 37 (21-50)

595 (489-749) 518 (474-532)

30 (11-49) 38 (27-45)

Fossil fuel production and use

Agriculture and waste

Biomass and biofuel burning

Wetlands

Other natural emissions

Inland waters, geological, oceans, termites, wild animals, permafrost, vegetation

Sink in soils

Sink from chemical reactions in the atmosphere

EMISSIONS AND SINKS

In teragrams of CH₄ per year (Tg CH₄ / yr) average over 2008-2017

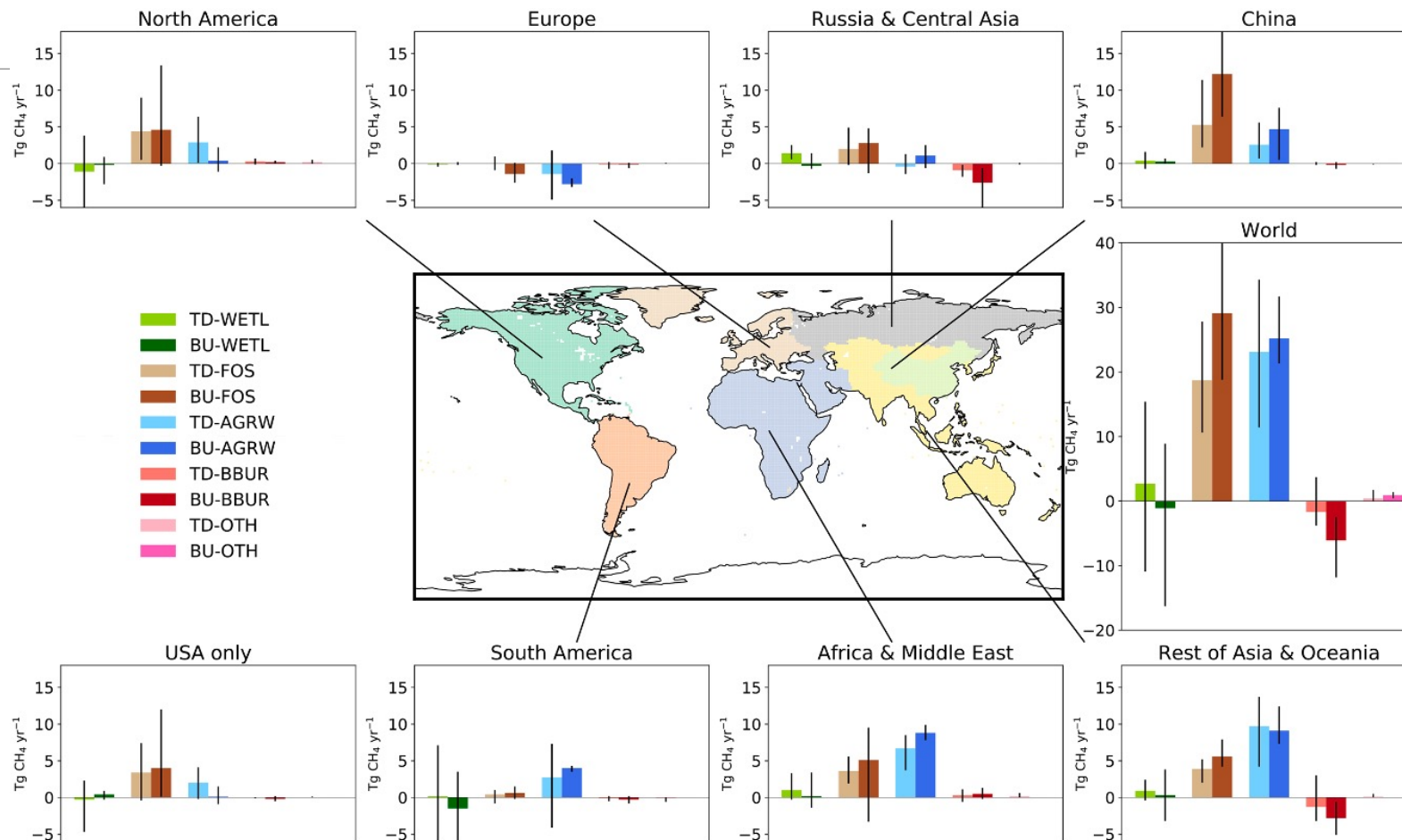
*The observed atmospheric growth rate is 18.2 (17.3-19) Tg CH₄ / yr. The difference with the TD budget imbalance reflects uncertainties in capturing the observed growth rate.

Anthropogenic fluxes Natural fluxes Natural and anthropogenic fluxes



Saunois et al., ESSD 2020

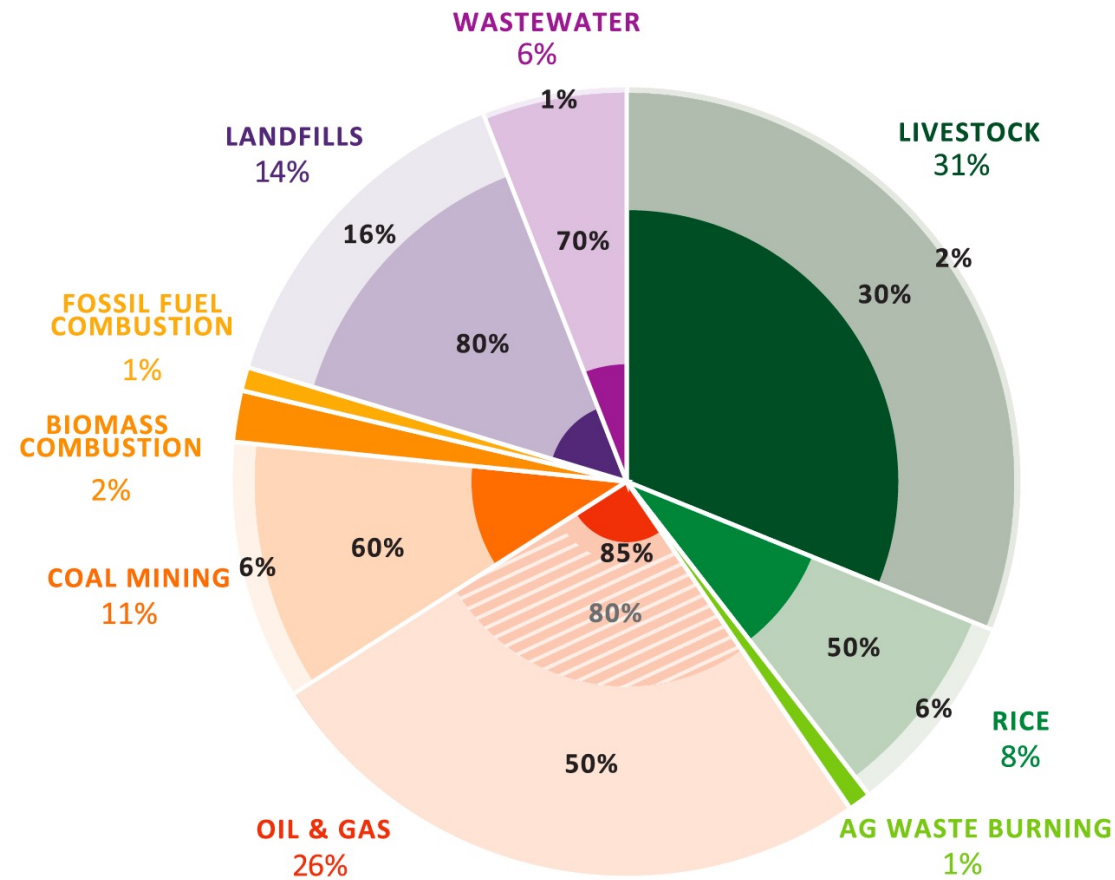
Fossil fuel and agriculture drive global methane increase



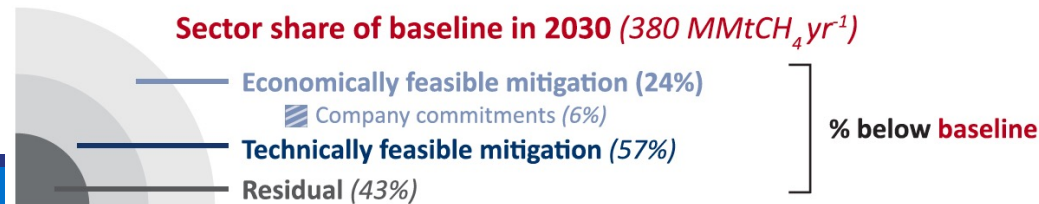
Jackson et al., ERL 2020

GLOBAL ANTHROPOGENIC METHANE EMISSIONS IN 2030

Sector by sector
potential for
emission
reduction



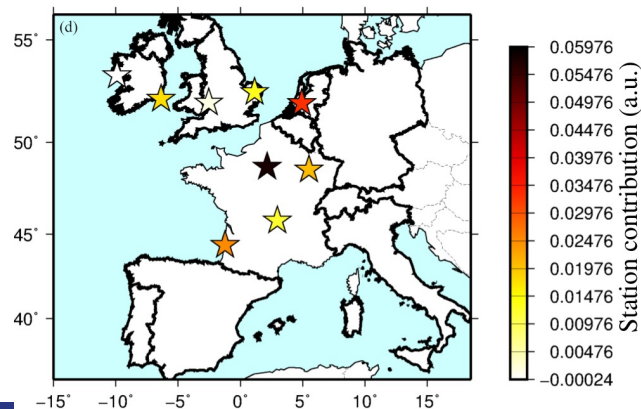
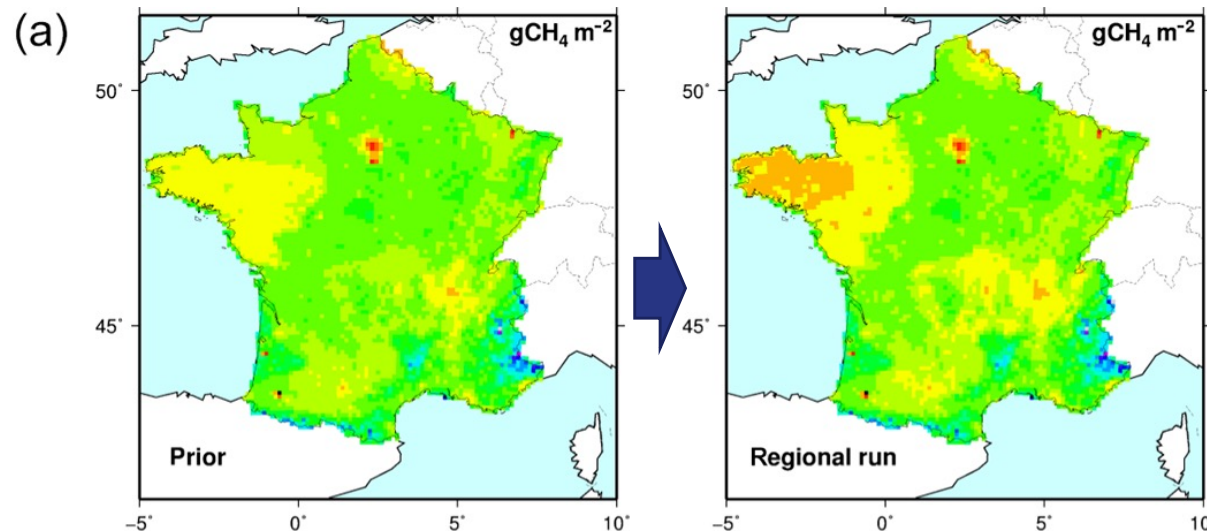
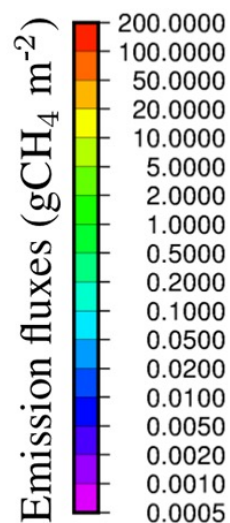
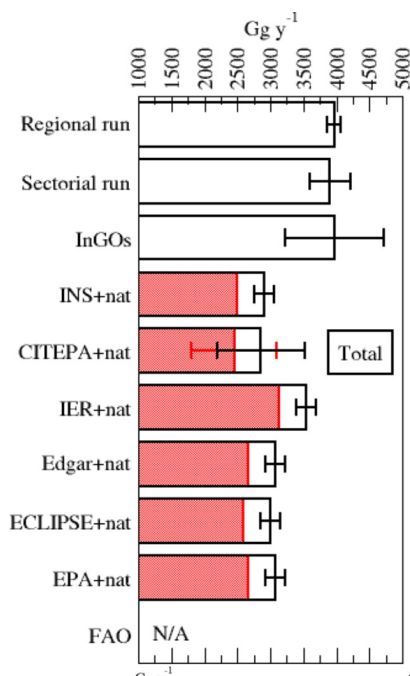
LEGEND



Confronting national inventories to long term atmospheric measurements

Pison et al., ACP 2018

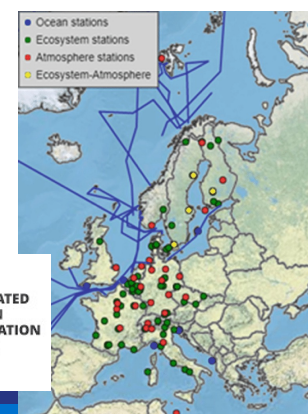
Mapping CH₄ emissions
in France –
incrementing from pre-
existing inventories



Mobilizes a transnational
monitoring network – in Europe
this is ICOS, a European Research
Infrastructure

ICOS

INTEGRATED
CARBON
OBSERVATION
SYSTEM



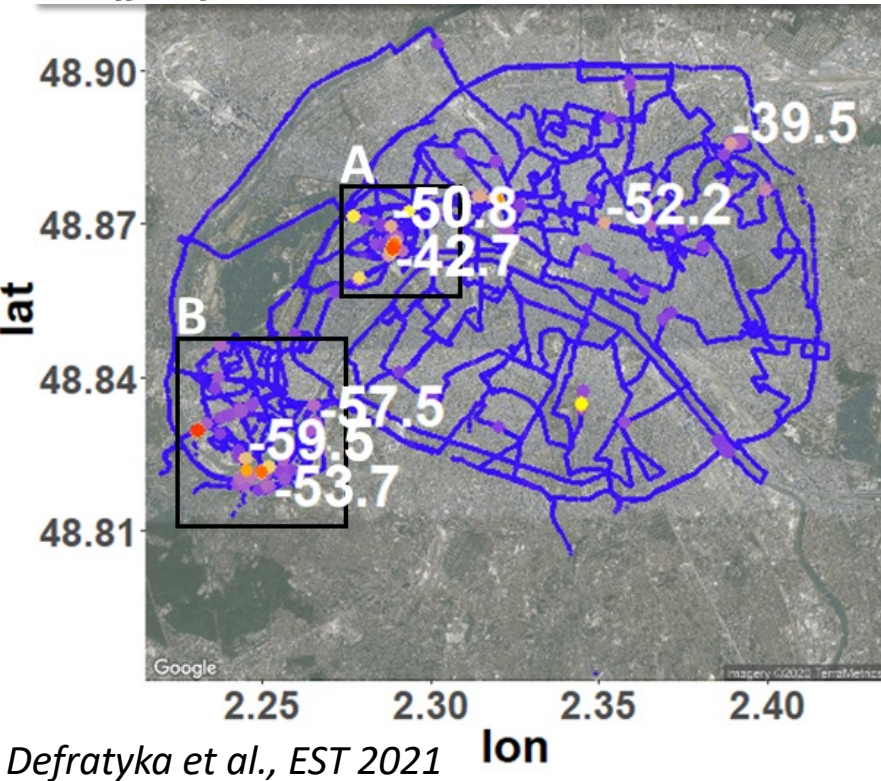
Mapping methane sources in Paris



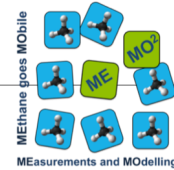
pubs.acs.org/est

Mapping Urban Methane Sources in Paris, France

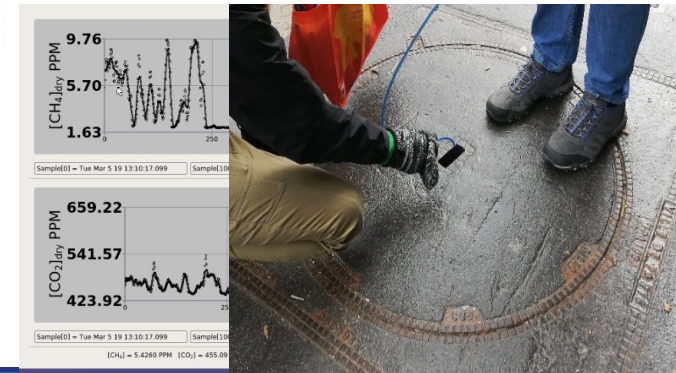
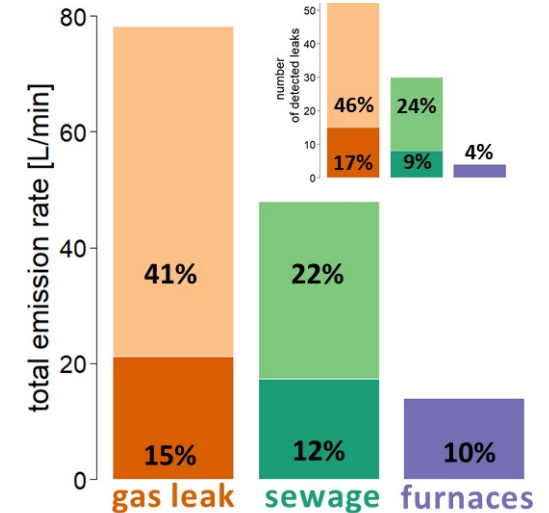
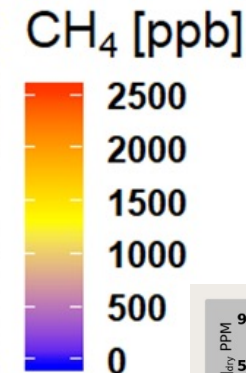
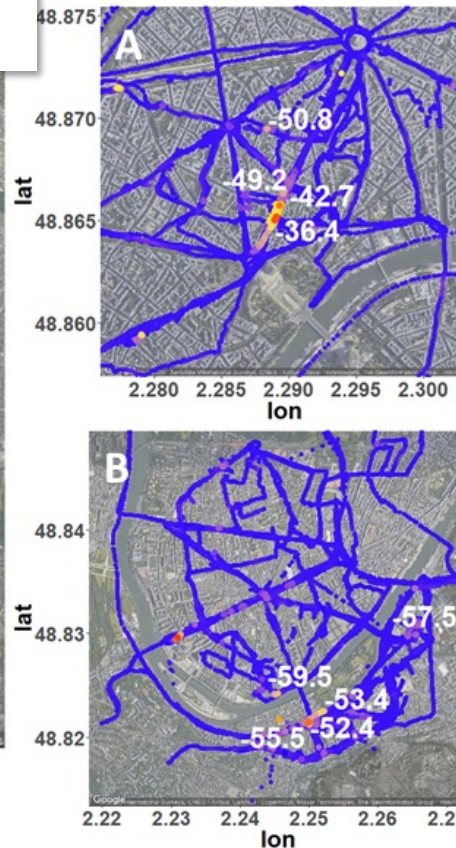
Sara M. Defratyka,* Jean-Daniel Paris, Camille Yver-Kwok, Julianne M. Fernandez, Piotr Korben, and Philippe Bousquet



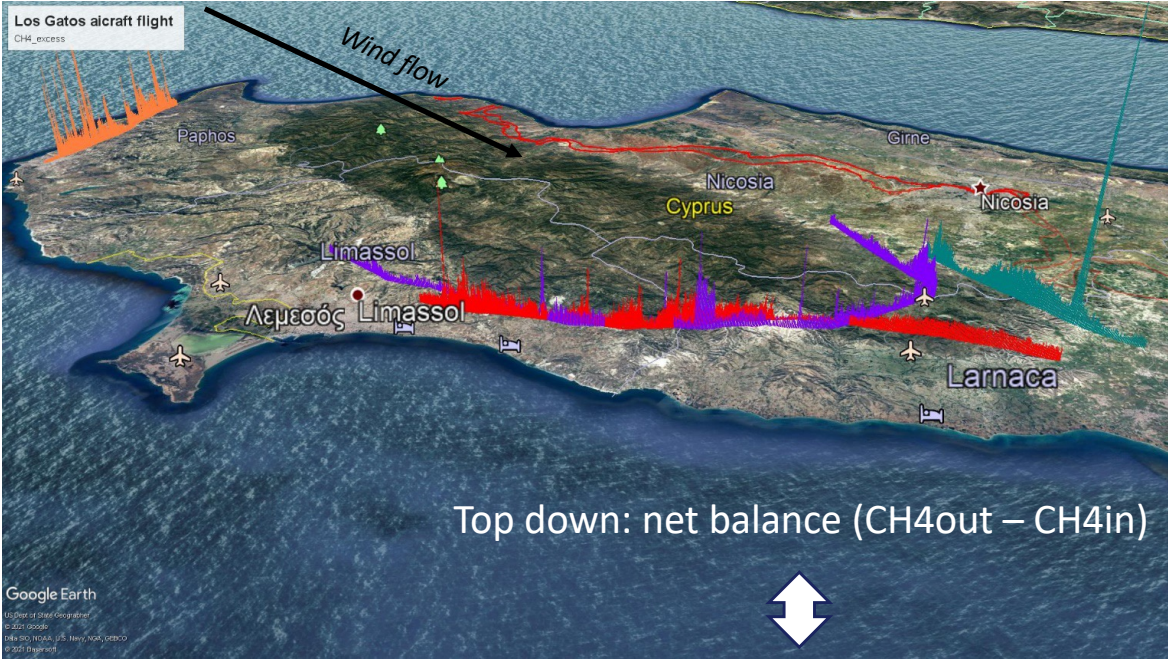
Defratyka et al., EST 2021



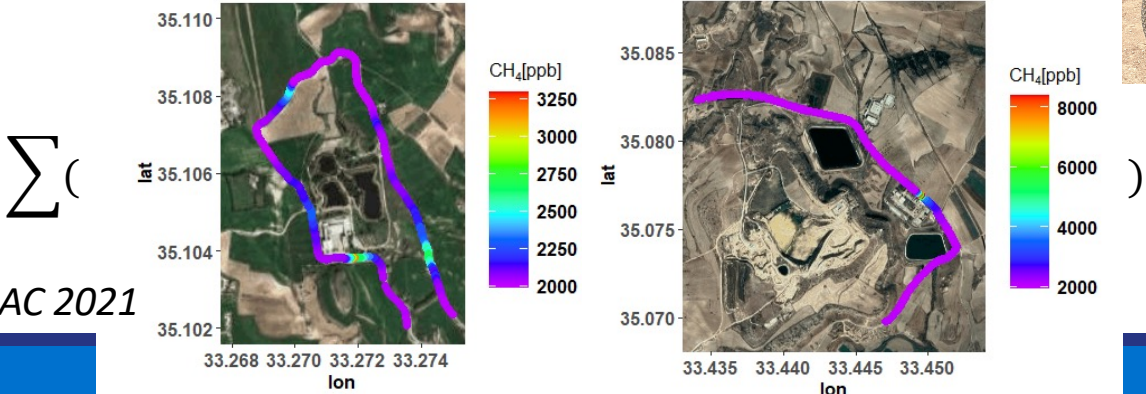
- Driving 720km in Paris and suburbs with in-situ optical analyzers
- Peak-based approach + isotopic signatures + hand-held sensor
- Identification of previously unquantified sources in Paris : sewage, furnaces
- Paris is in the lower range of known cities CH_4 emission intensity
- But Paris CH_4 represents mitigation options.



Desaggregating methane emissions at the country scale – the case of Cyprus



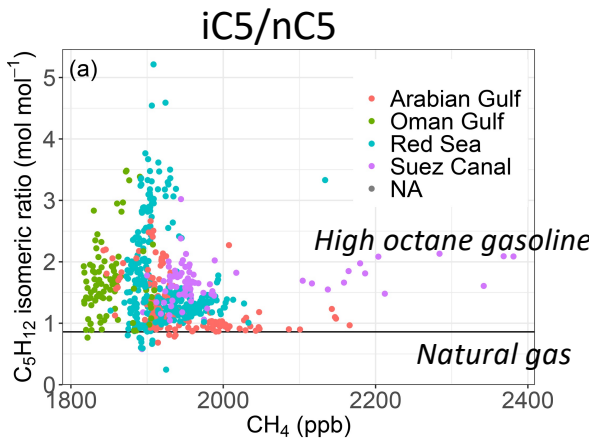
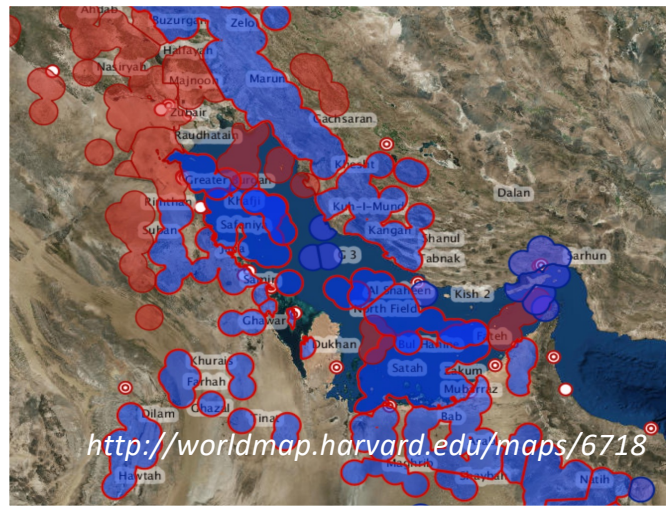
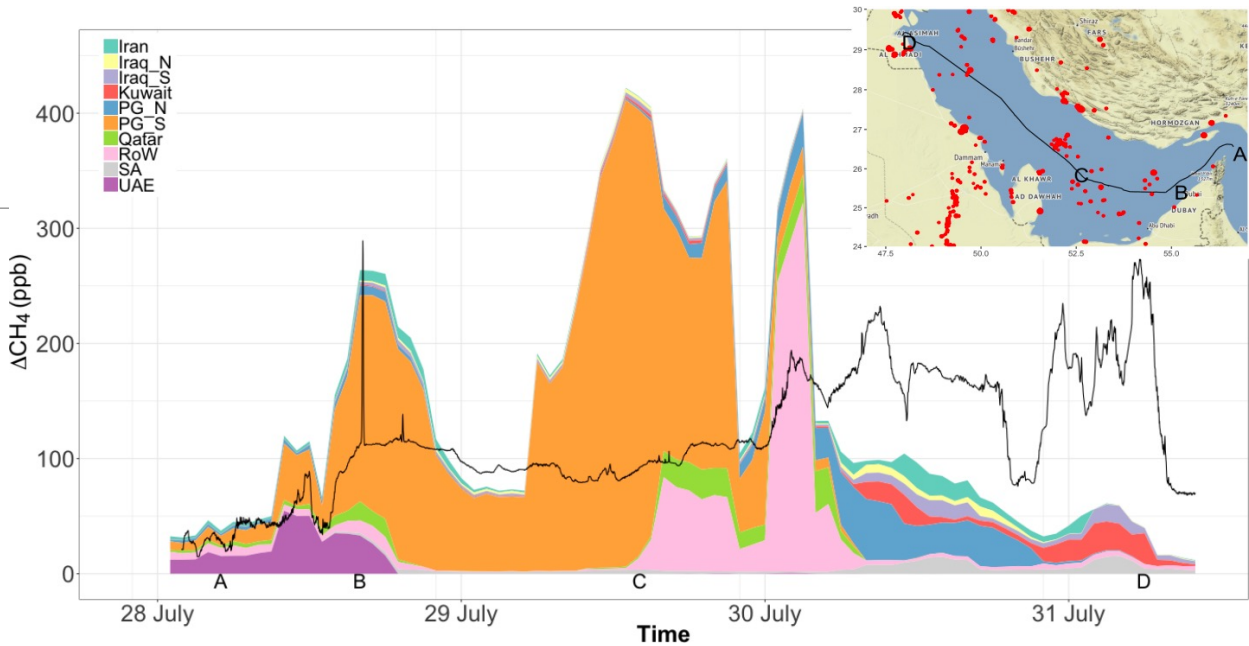
Bottom up: statistics site by site (landfill, farms...)



Oil and gas CH₄ emissions in the Middle East: the AQABA campaign

Paris et al., ACP 2021

- Shipborne in situ measurements of CH₄ and VOCs
- Southern Arabian Gulf emissions overestimated (x4-7)
- Northern Arabian Gulf emissions underestimated (/2)
- Oil and gas emissions quantified from C₂-C₆ alkanes + atmospheric modelling



Nightlights in Persian Gulf

Koweït

Fars

Golfé Persique

Hormozgan

Detroit d'Ormuz

Qushm Island

Bahrein

Manama

Qatar

Doha

Dubai

Abou Dabi

Al-Batina

Mascate

Riyad

<http://worldmap.harvard.edu/maps/6718>

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