# $CH_4$ mitigation: what can we learn from atmospheric measurements

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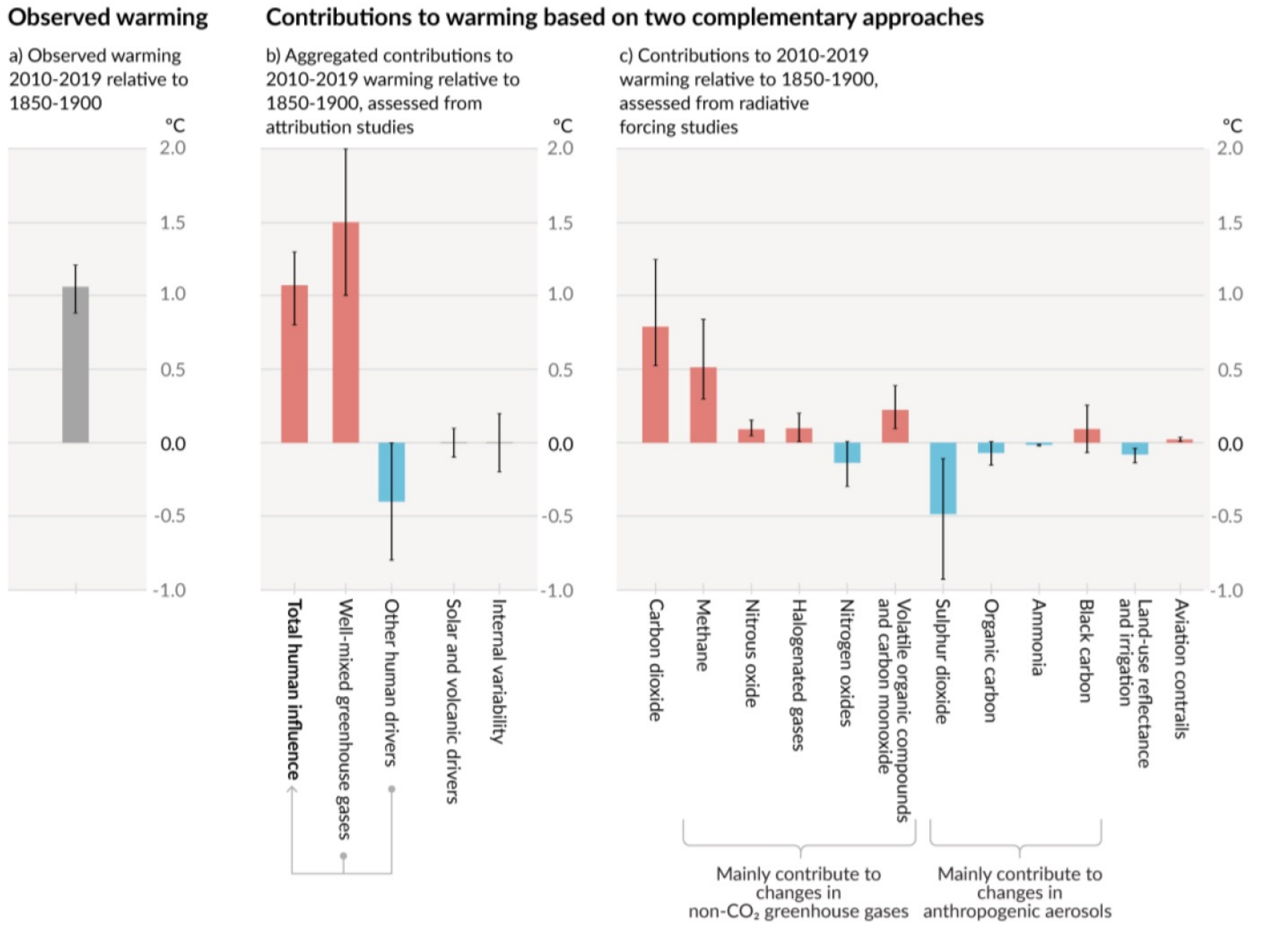
# Observed warming is driven by emissions from human activities, with greenhouse gas warming partly masked by aerosol cooling

*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.

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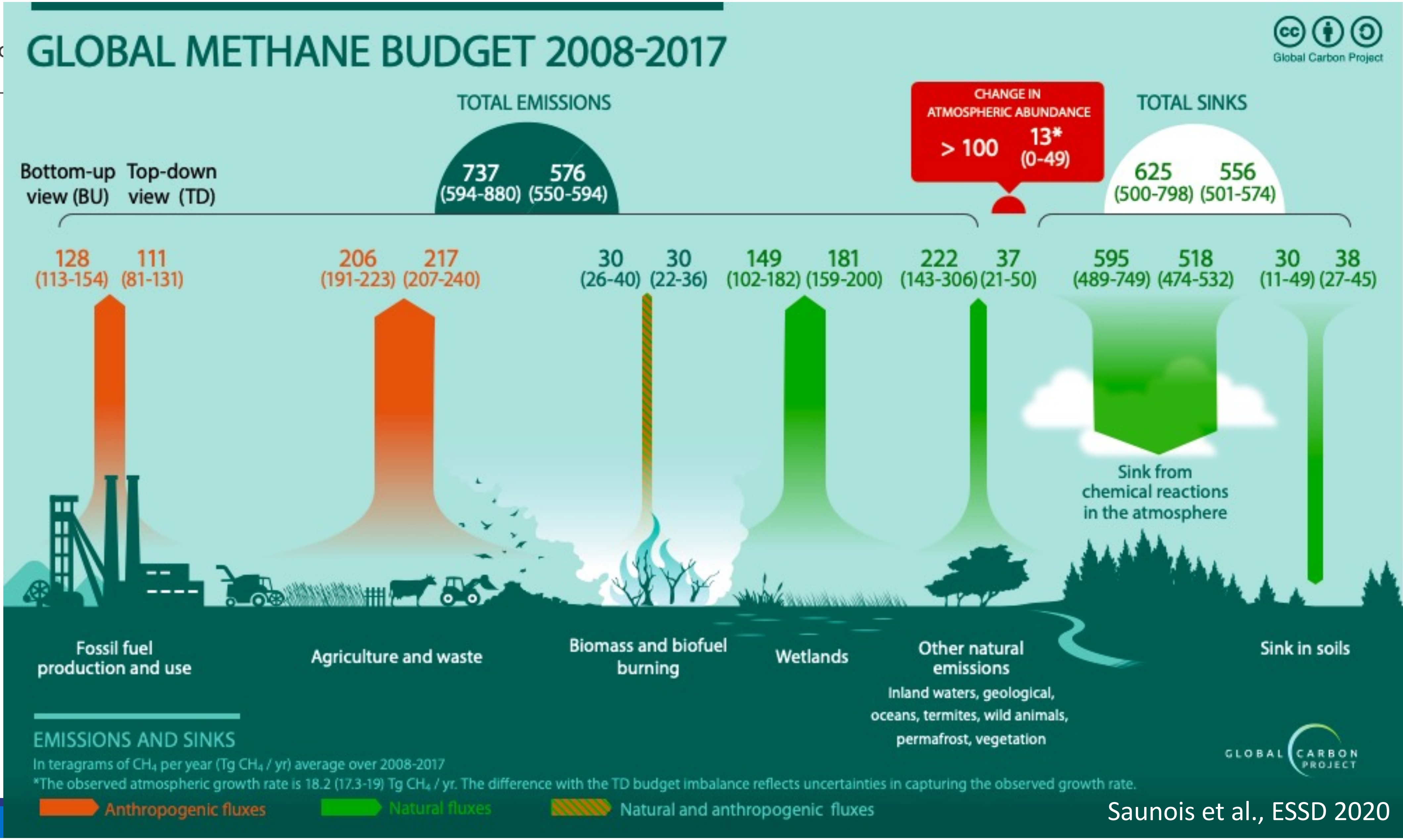
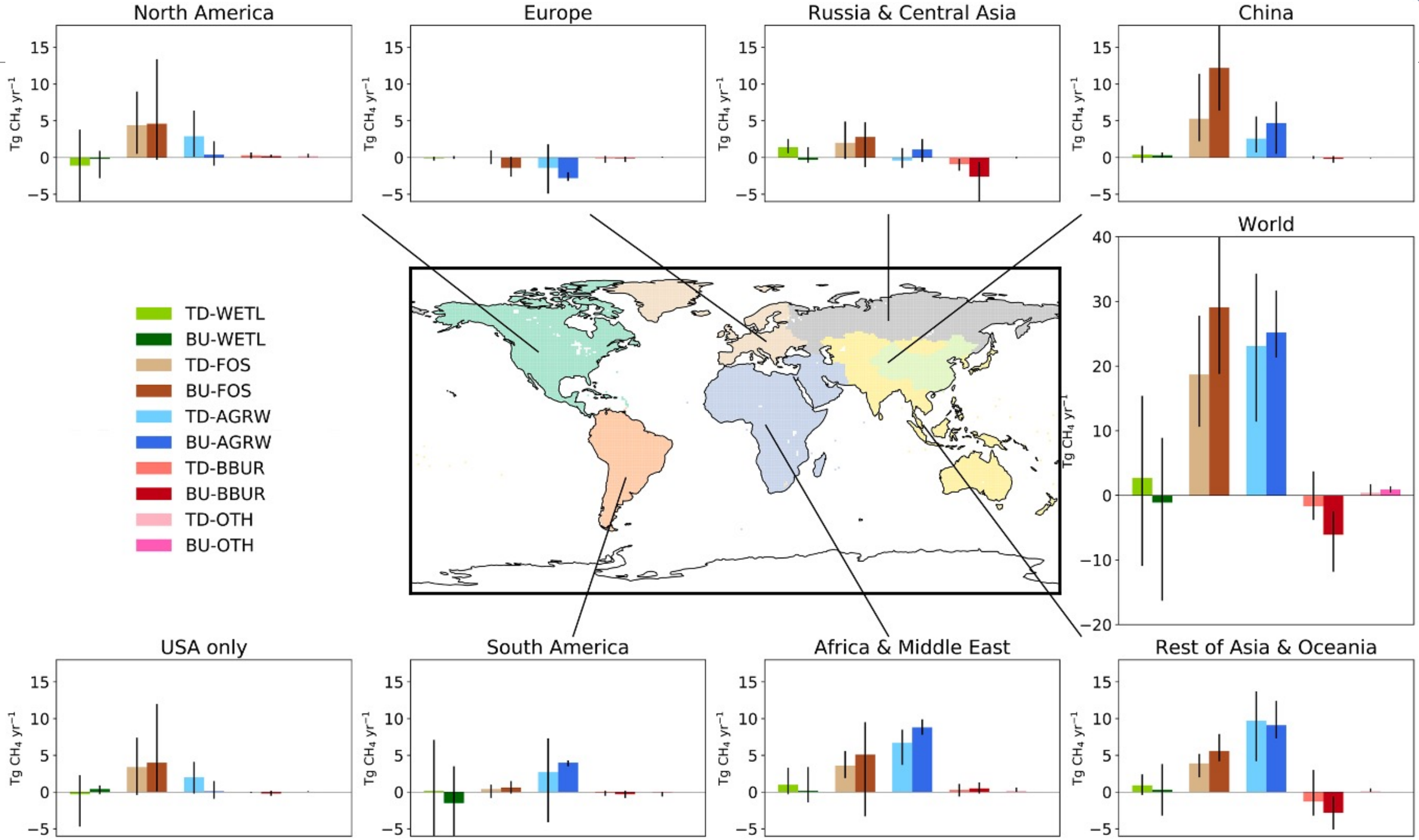
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP



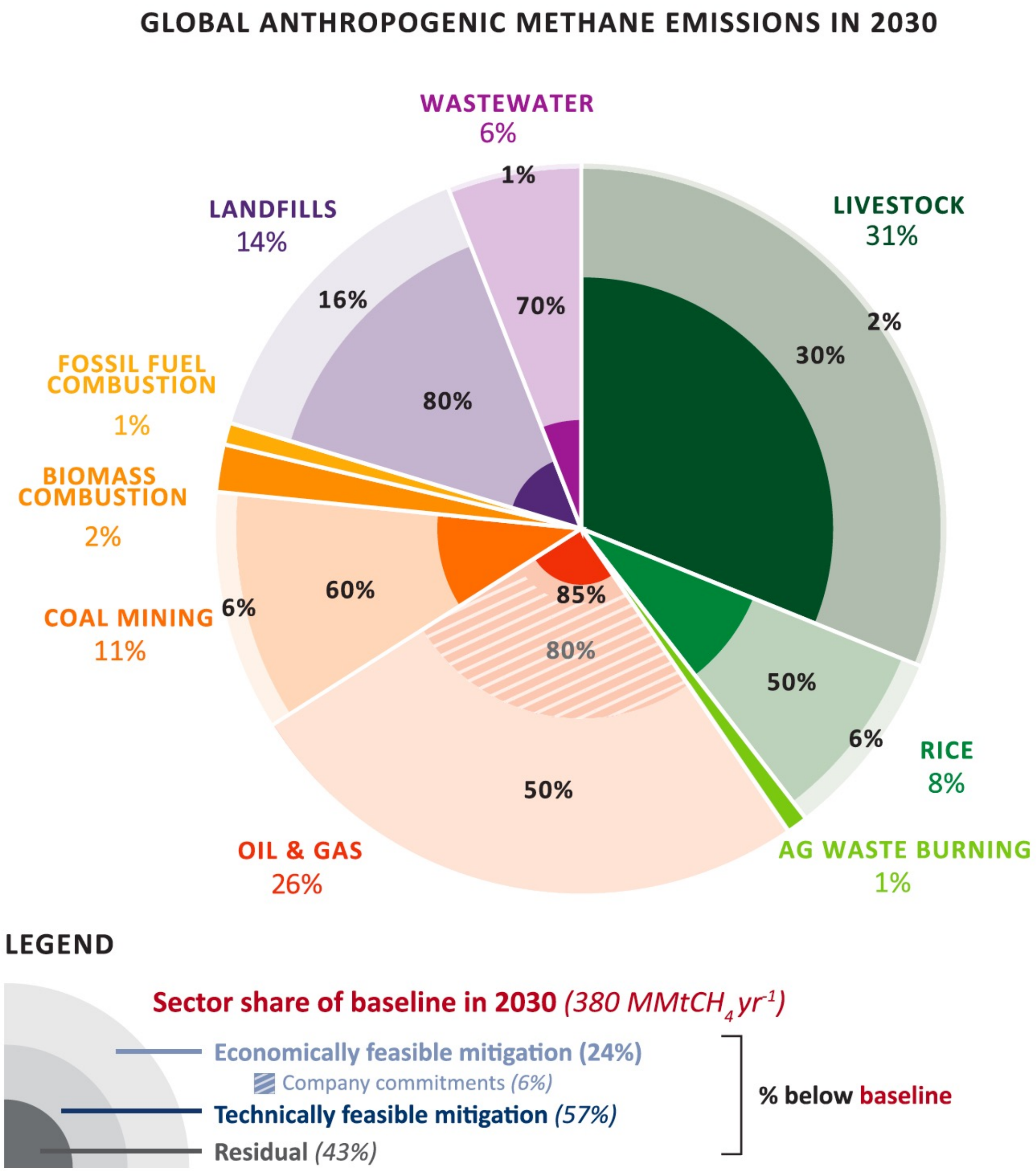

Saunois et al., ESSD 2020

# Fossil fuel and agriculture drive global methane increase




*Jackson et al., ERL 2020*

# Sector by sector potential for emission reduction

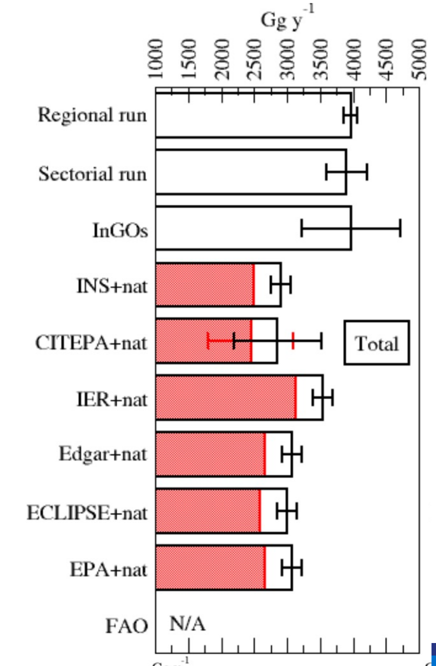


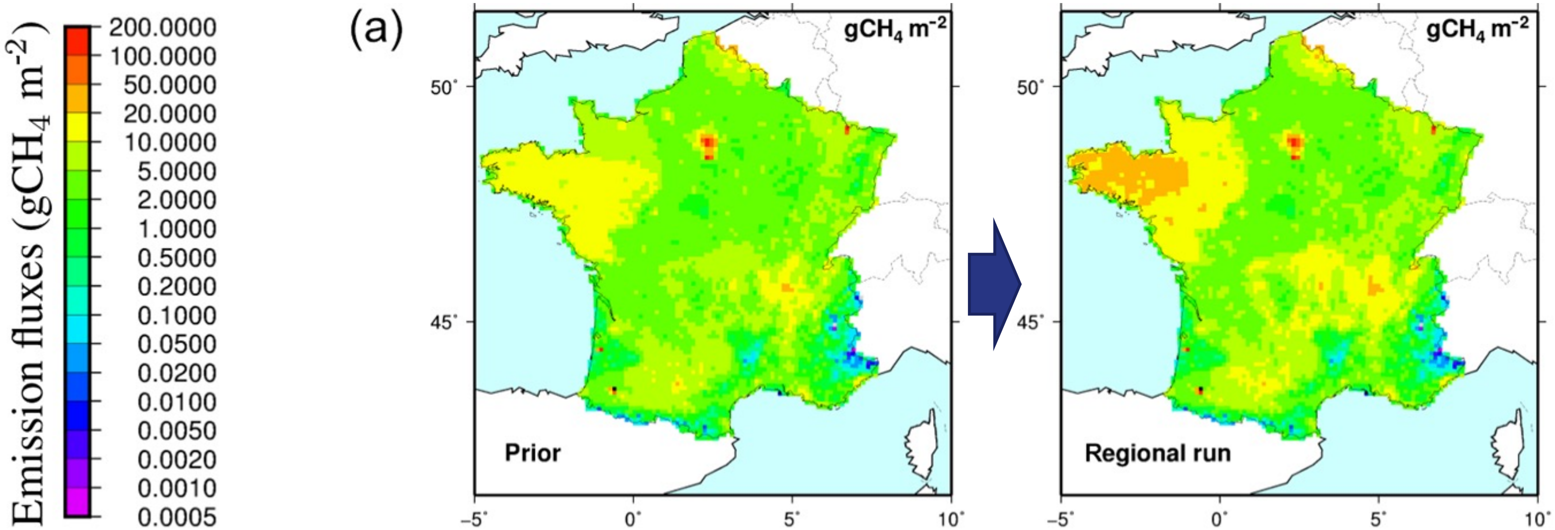

Ocko et al., ERL 2021

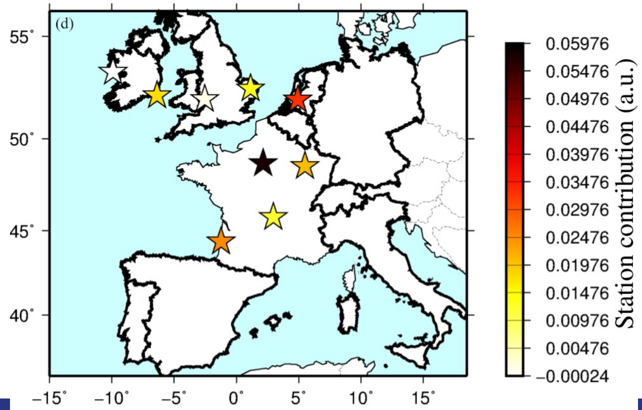
## Confronting national inventories to long term atmospheric measurements

*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

- 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.


Environmental Science & Technology
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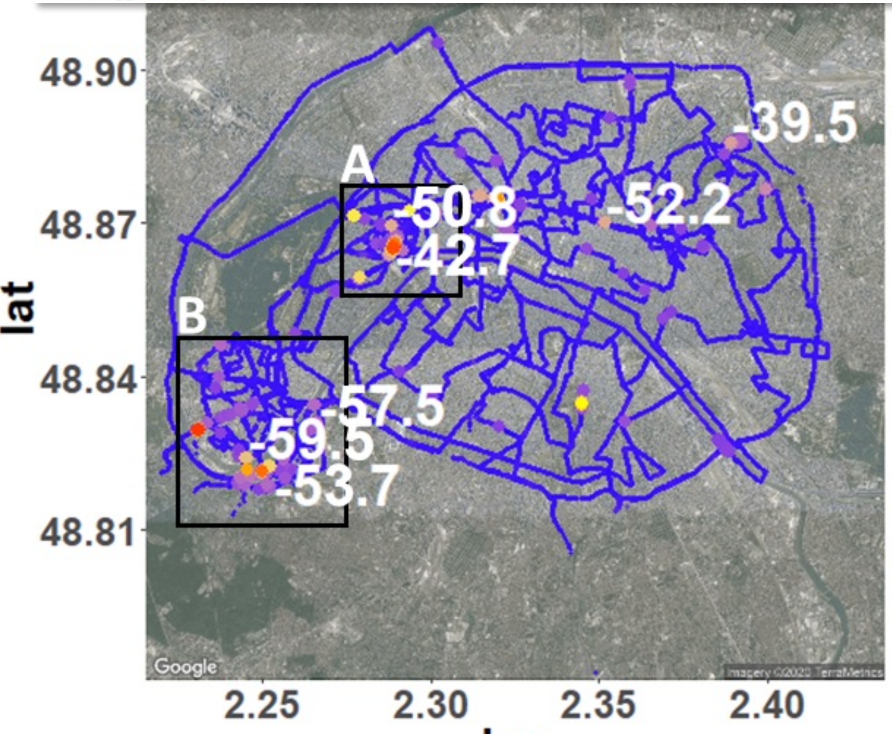
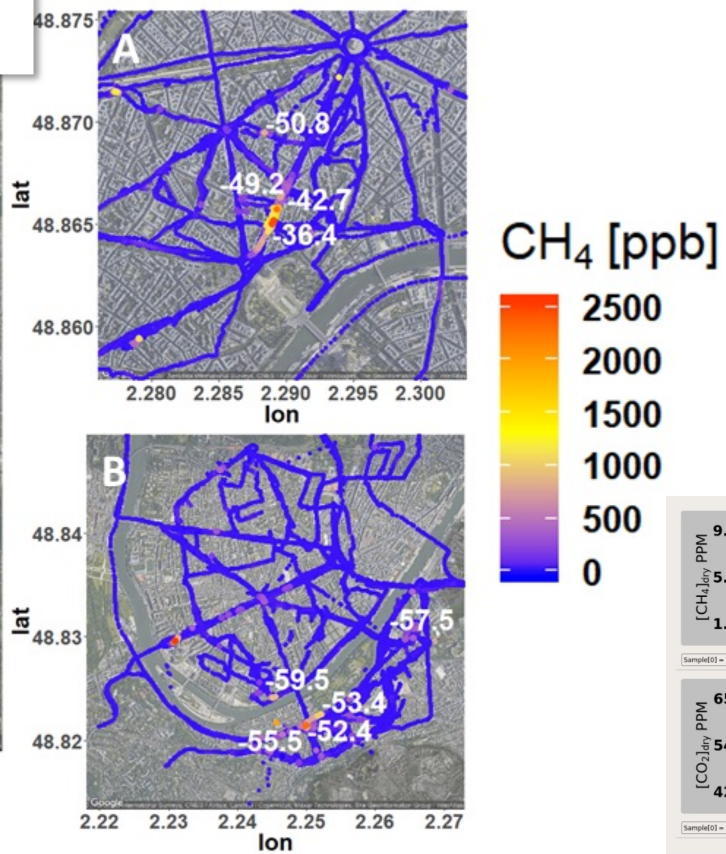
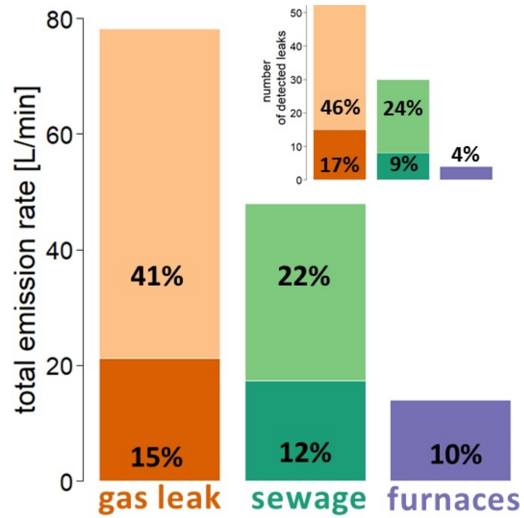
Article

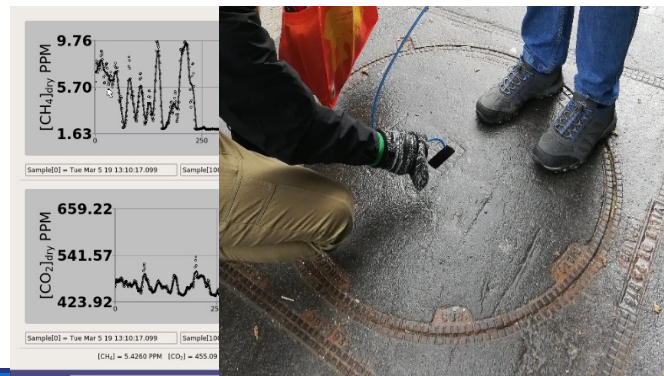
**Mapping Urban Methane Sources in Paris, France**

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



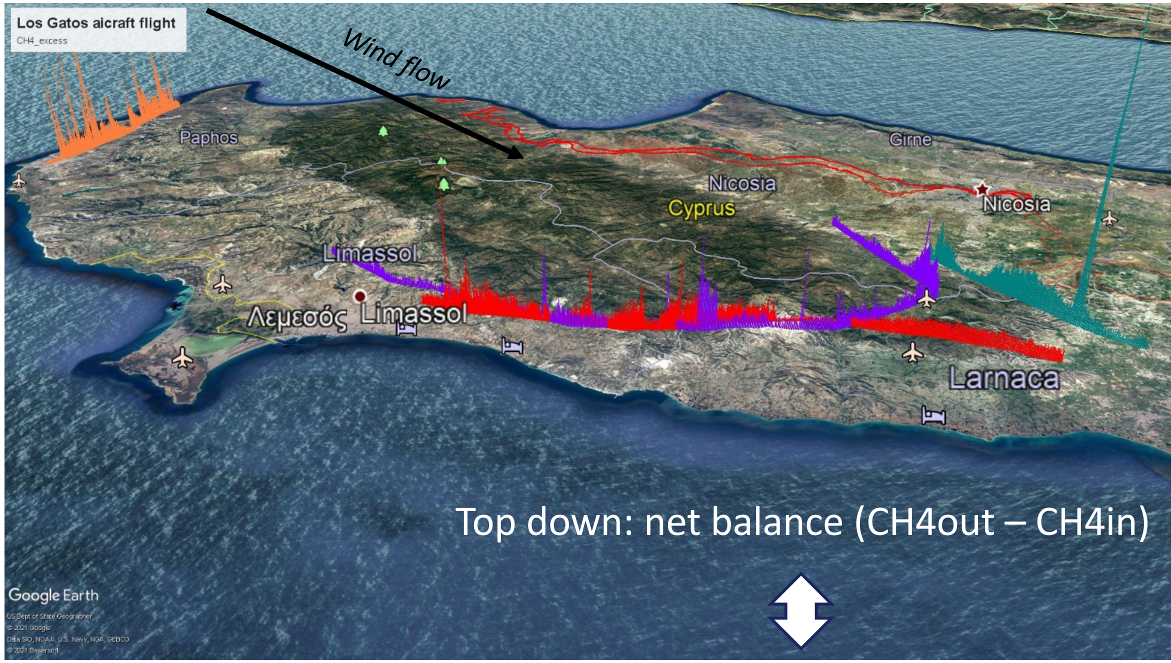




*Defratyka et al., EST 2021*

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




Top down: net balance (CH4out – CH4in)

Bottom up: statististics site by site (landfill, farms…)

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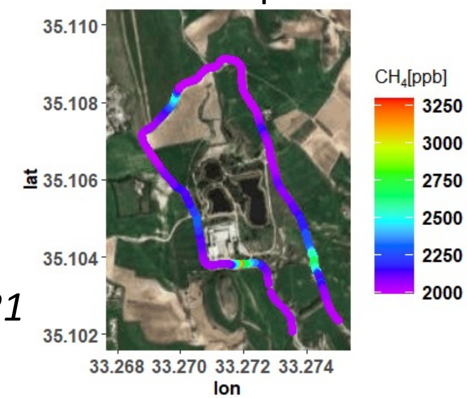


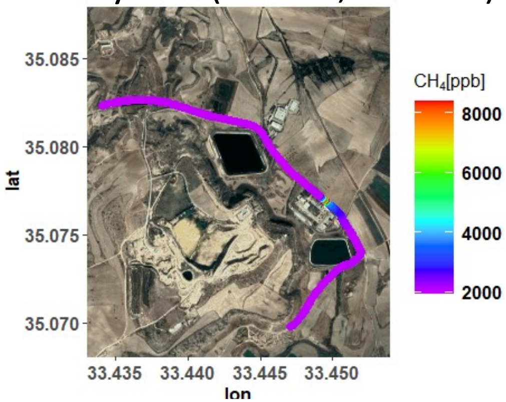


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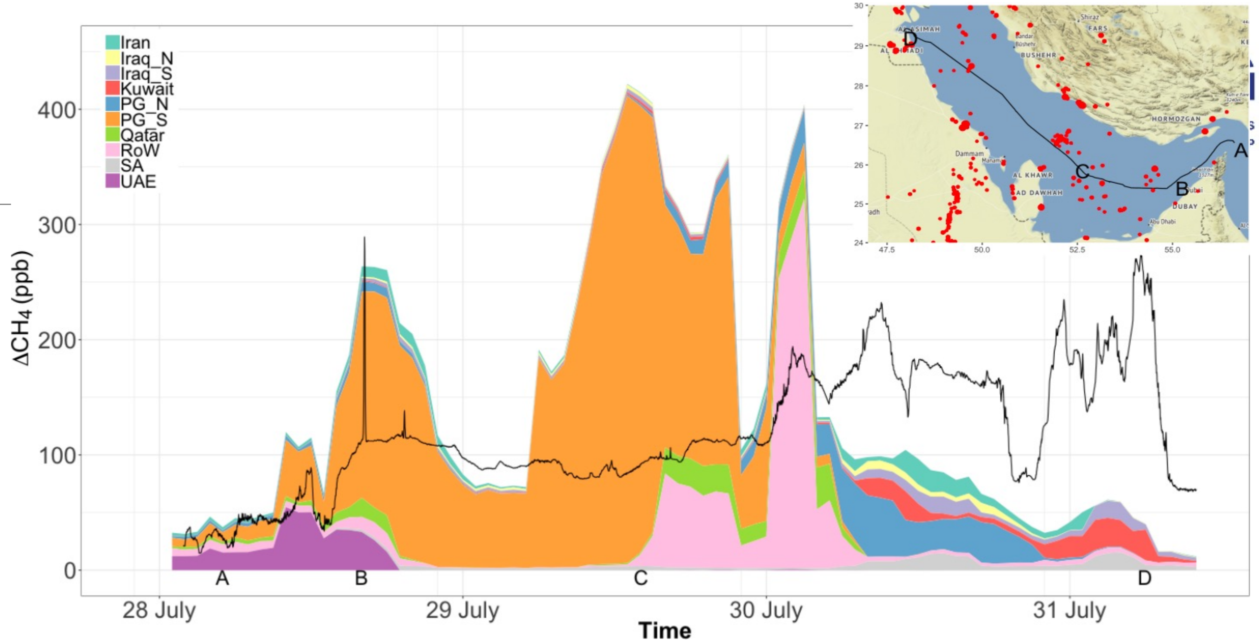
*Liu et al IGAC 2021*

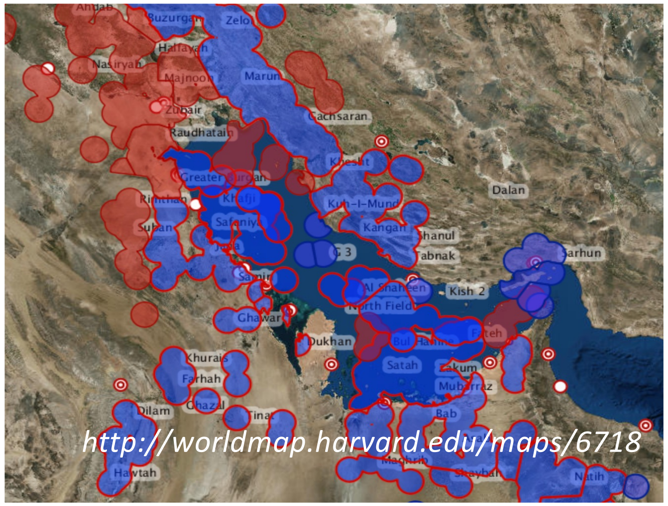

# Oil and gas $CH_4$ emissions in the Middle East: the AQABA campaign

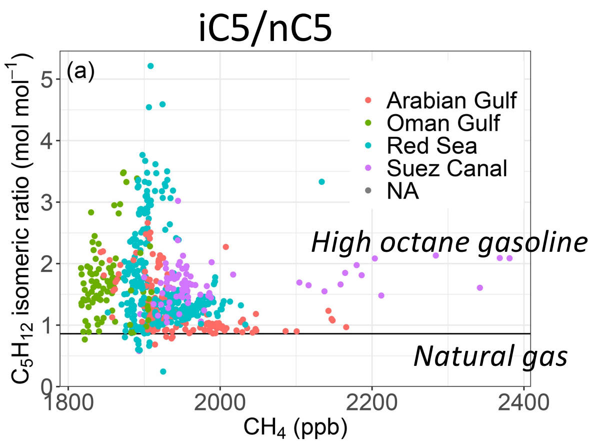
*Paris et al., ACP 2021*

- 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

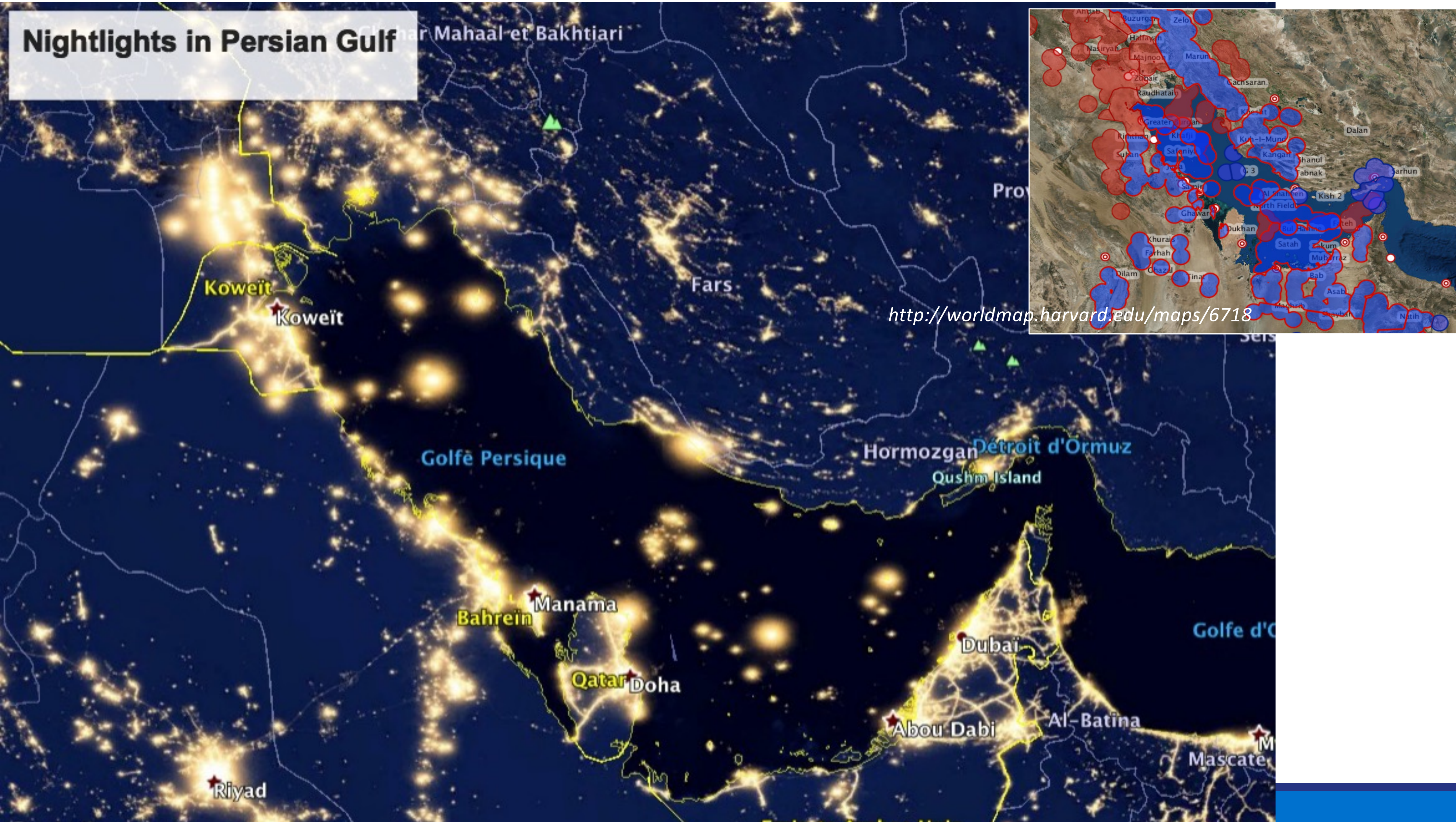






# Nightlights in Persian Gulf




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