Studying Air Pollution and Climate Change on the African Continent

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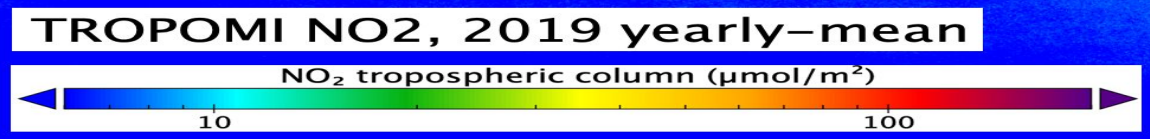
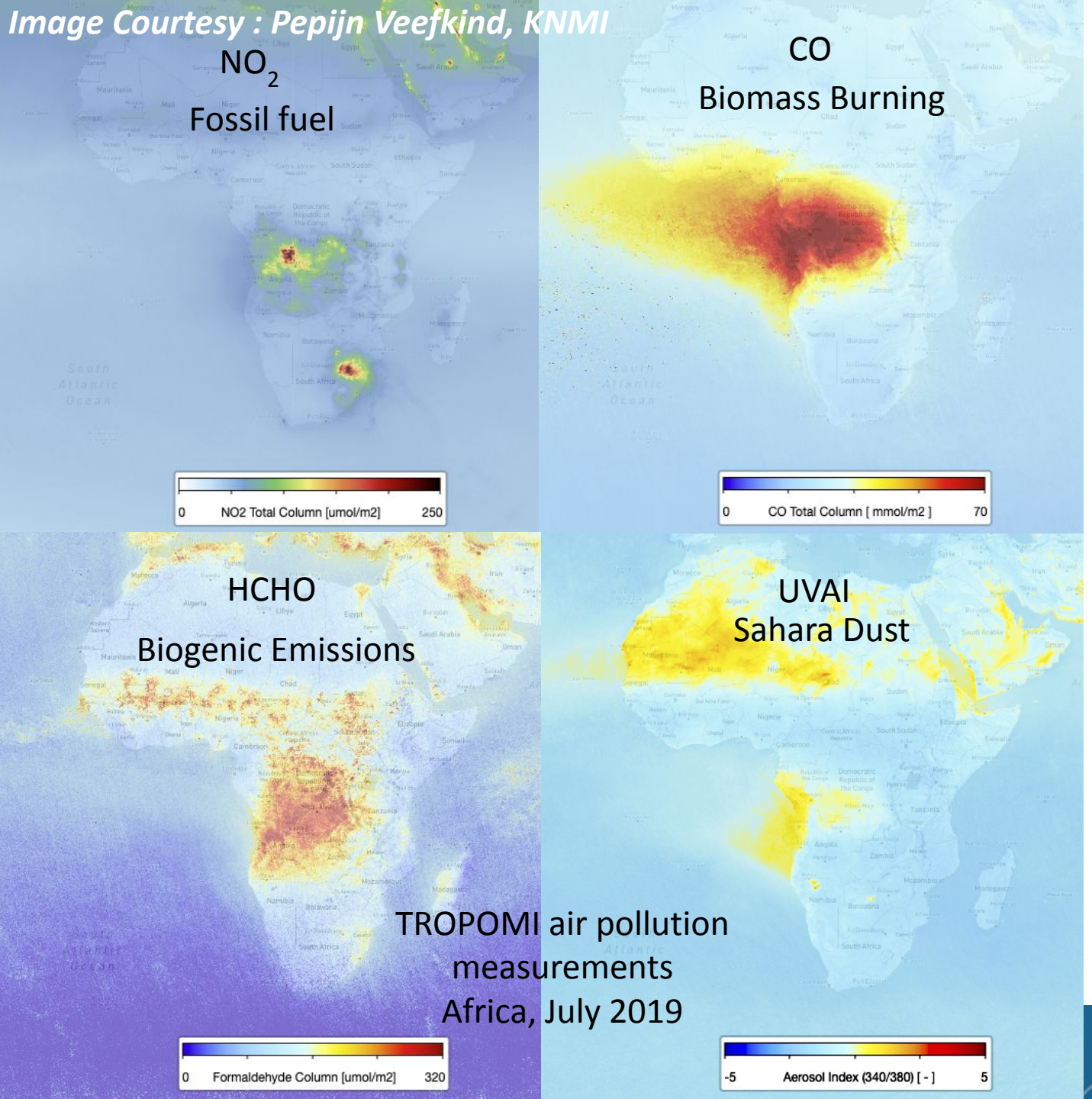
EGU, Vienna, 2024

Courtesy, Henk Eskes, KNMI



Prof. Dr. Pieternel Levelt, NCAR ACOM Director
OMI Principal Investigator (NASA Eos Aura)
TROPOMI scientific initiator (ESA sentinel-5 precursor)
KNMI, TU Delft

Image Courtesy : Pepijn Veefkind, KNMI



TROPOMI air pollution measurements Africa, July 2019

Africa

Population is expected to double in 2050 (2.5 billion) and triple in 2100 (3.8 billion)

4th industrial revolution: will lead to huge increase in air pollutants and greenhouse gases

All pollution sources are present in Africa:

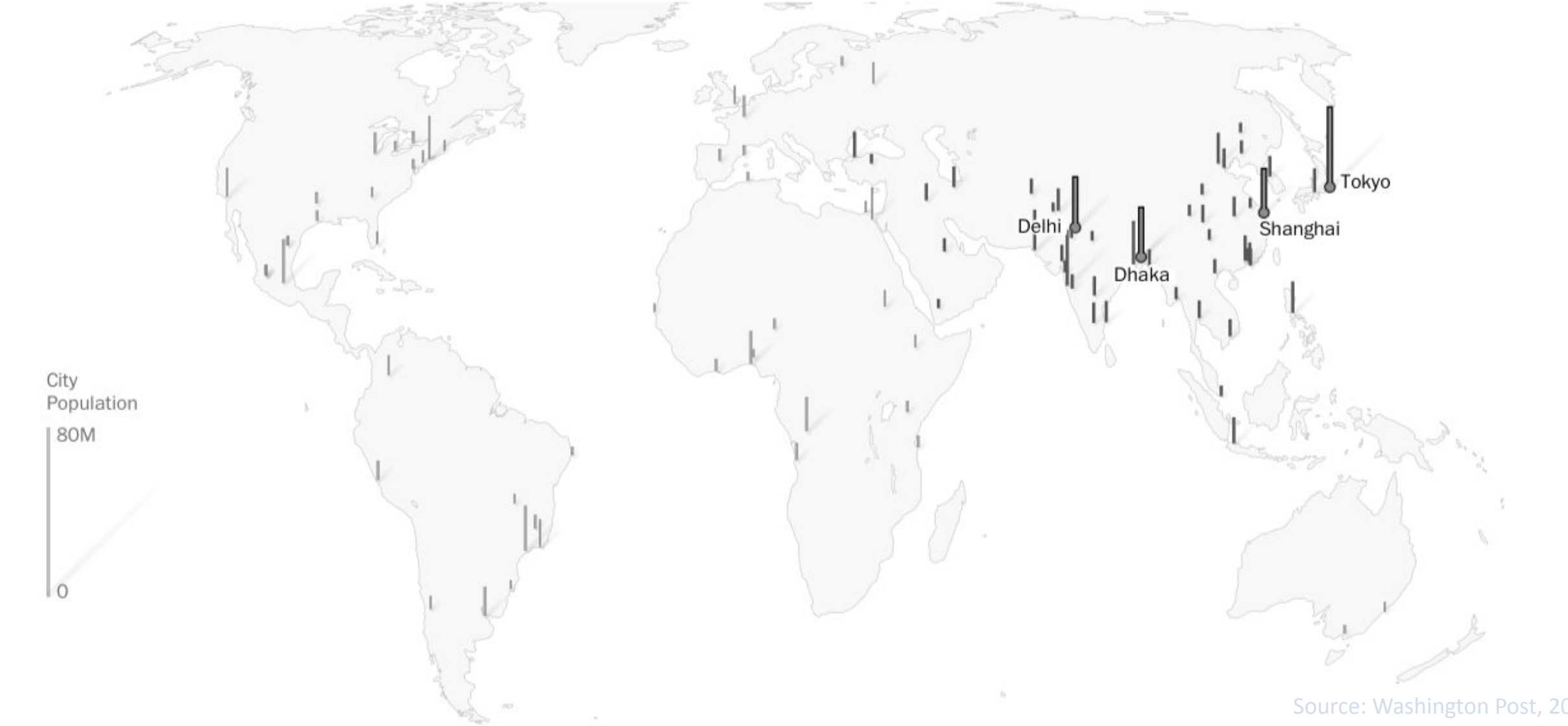
- NO2 – fossil fuel combustion
- CO – biomass burning
- HCHO – Biogenic Emissions
- UVAI – Sahara Dust

There is a lack of groundbased measurements over Africa

There is a lack of emission estimates over Africa

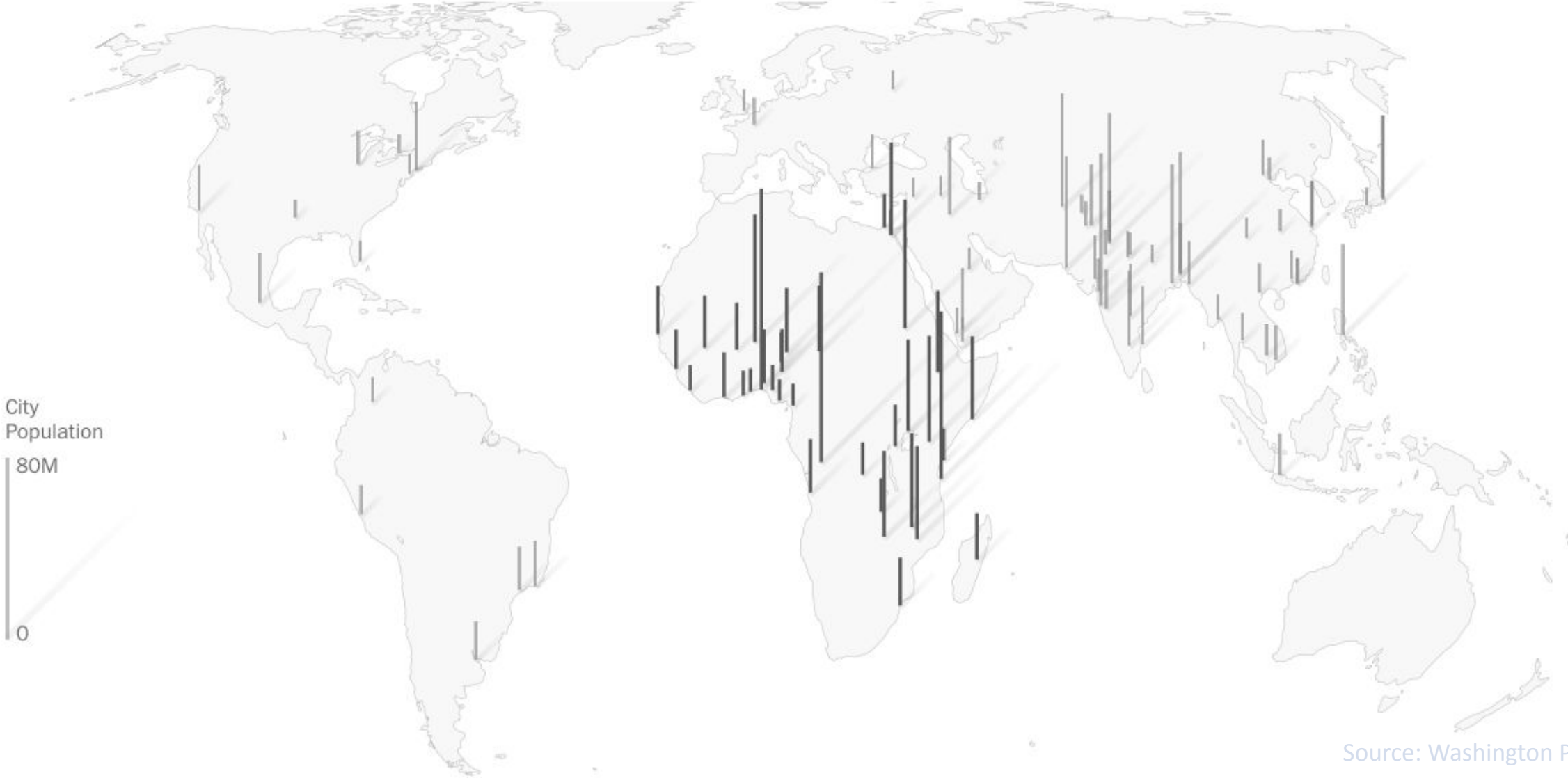
There is an urgent need for new capability for air quality management for health and environment

100 Largest Megacities 2025



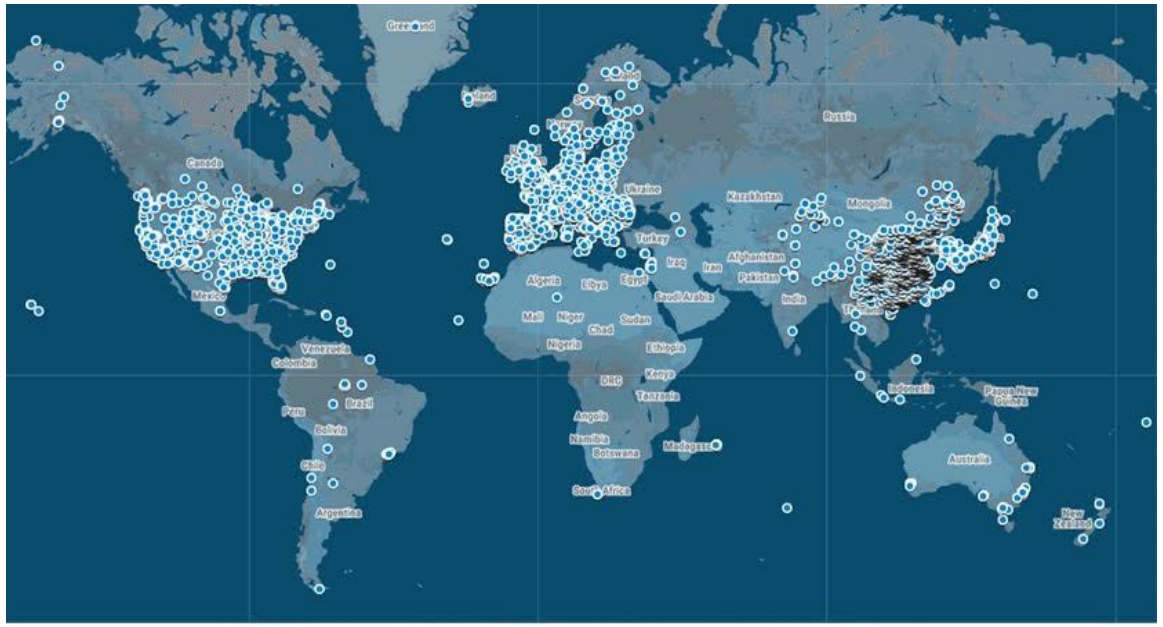
Source: Washington Post, 2021

100 Largest Megacities 2100

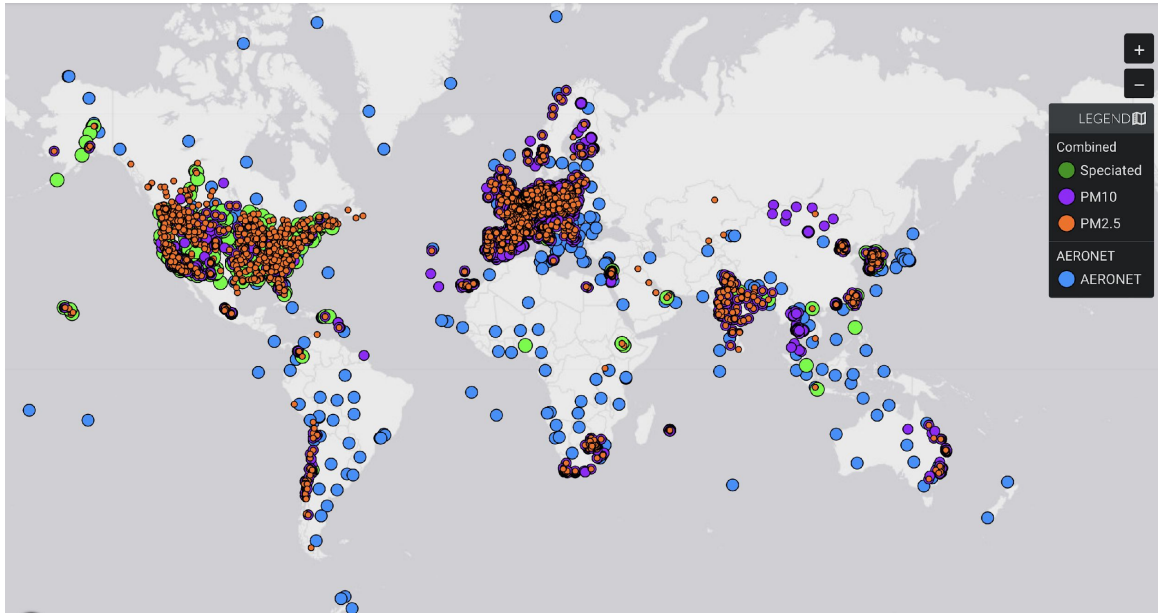


Source: Washington Post, 2021

Severe Lack of reliable ground based observations in the Global South

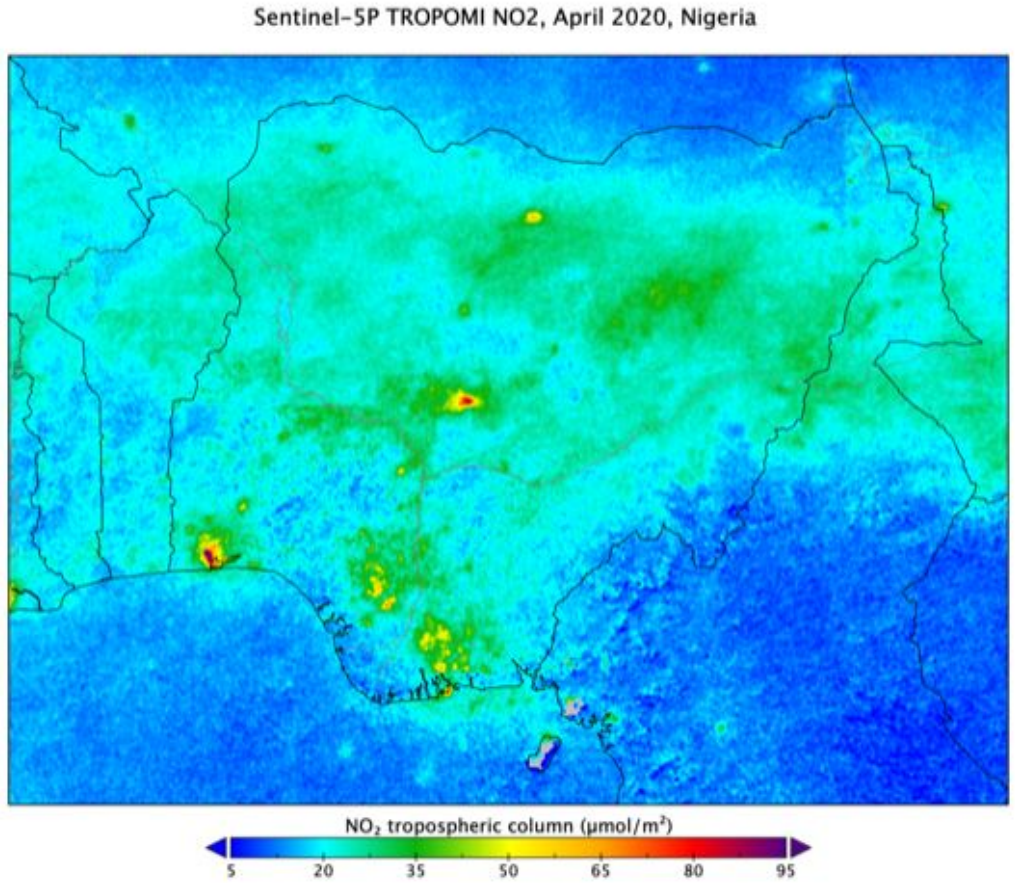


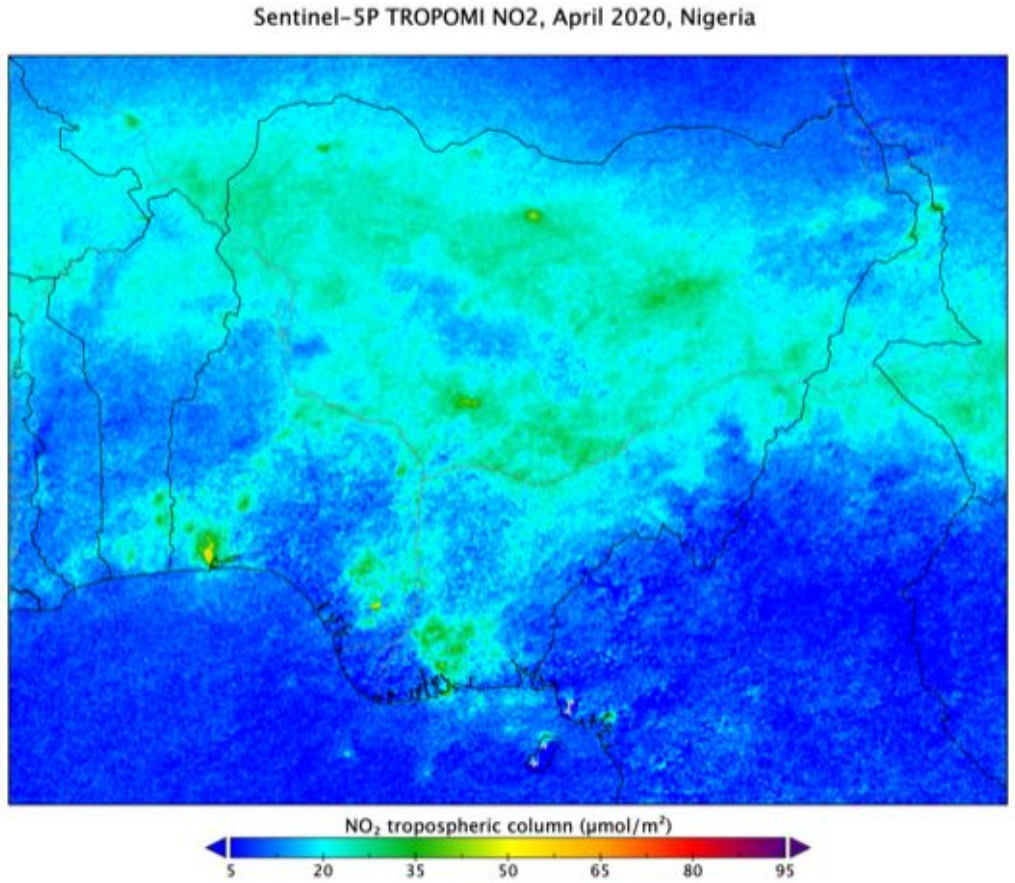
Ozone Monitoring sites
(TOAR and Open AQ)



Aerosol Surface Monitoring sites
(MAIA Data Visualization Tool)

TROPOMI NO_2 measurements over Africa: **COVID lockdown**





TROPOMI NO2 yearly mean 2019

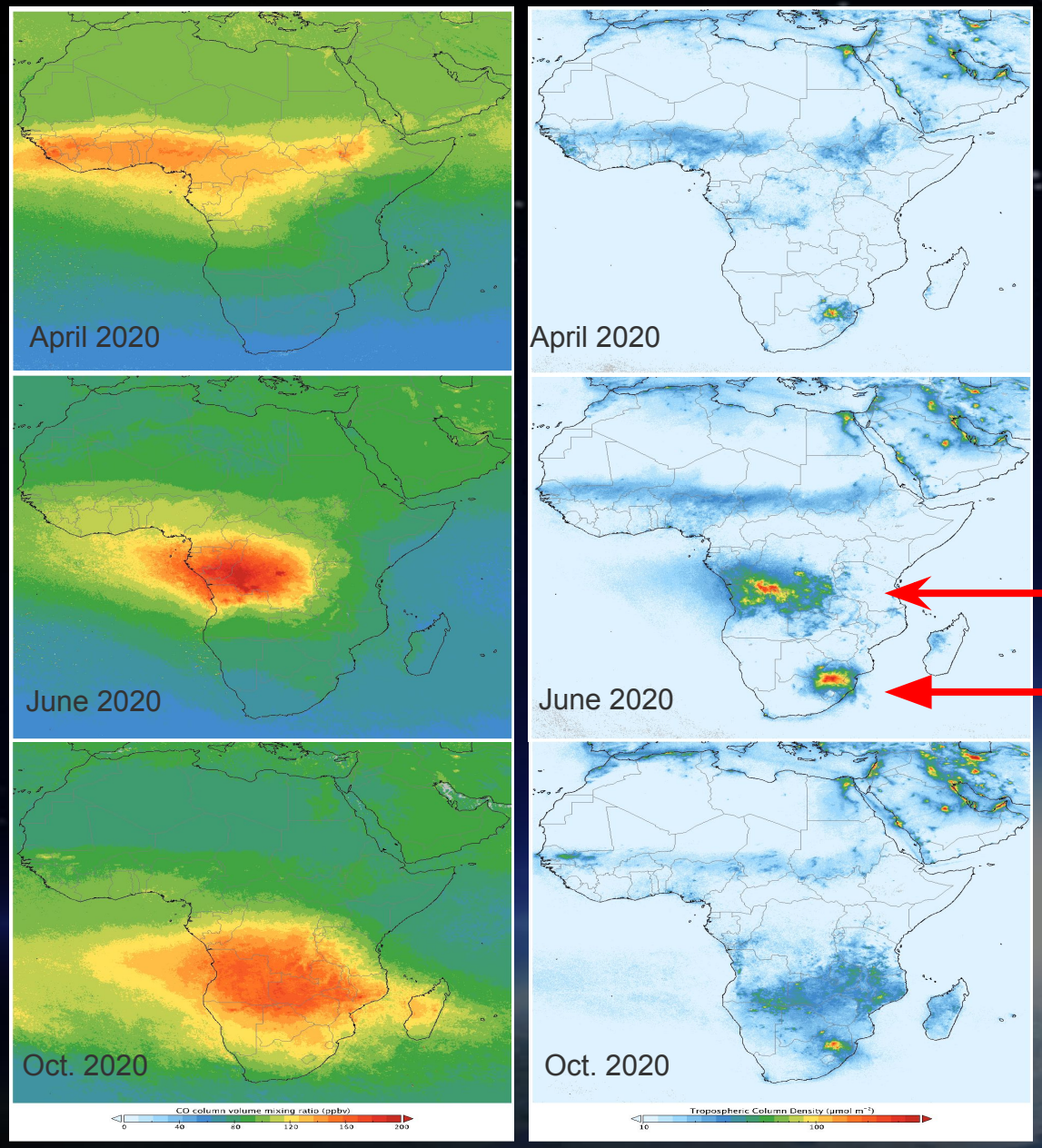
Nigeria,TROPOMI NO_2 , April 2019

Nigeria, TROPOMI NO_2 , April 2020

Courtesy: ***Henk Eskes, KNMI***

CO

NO_2



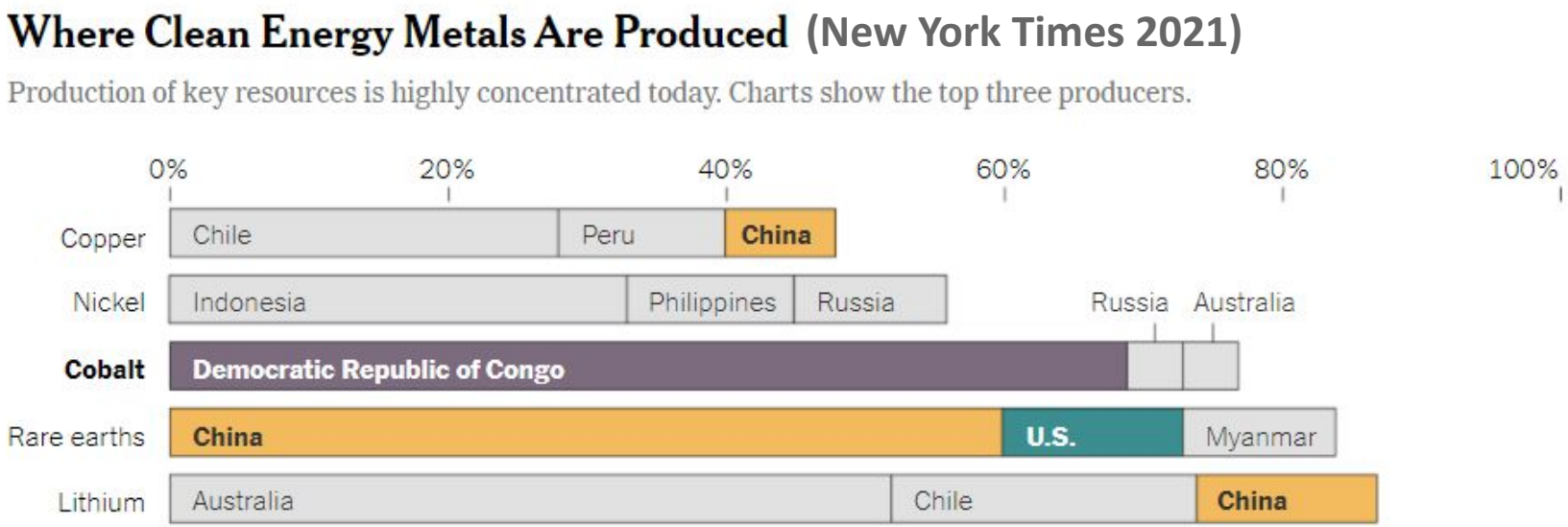
Biomass Burning over Africa as measured by TROPOMI CO and NO_2

Biomass burning in tropical Africa

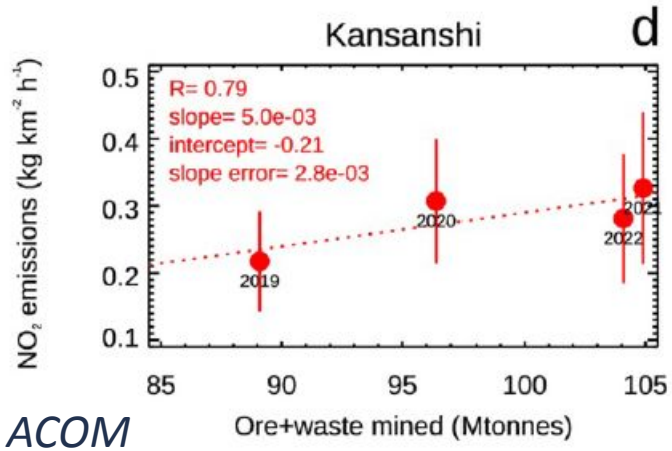
Power plants near Johannesburg

Pepijn Veefkind, KNMI

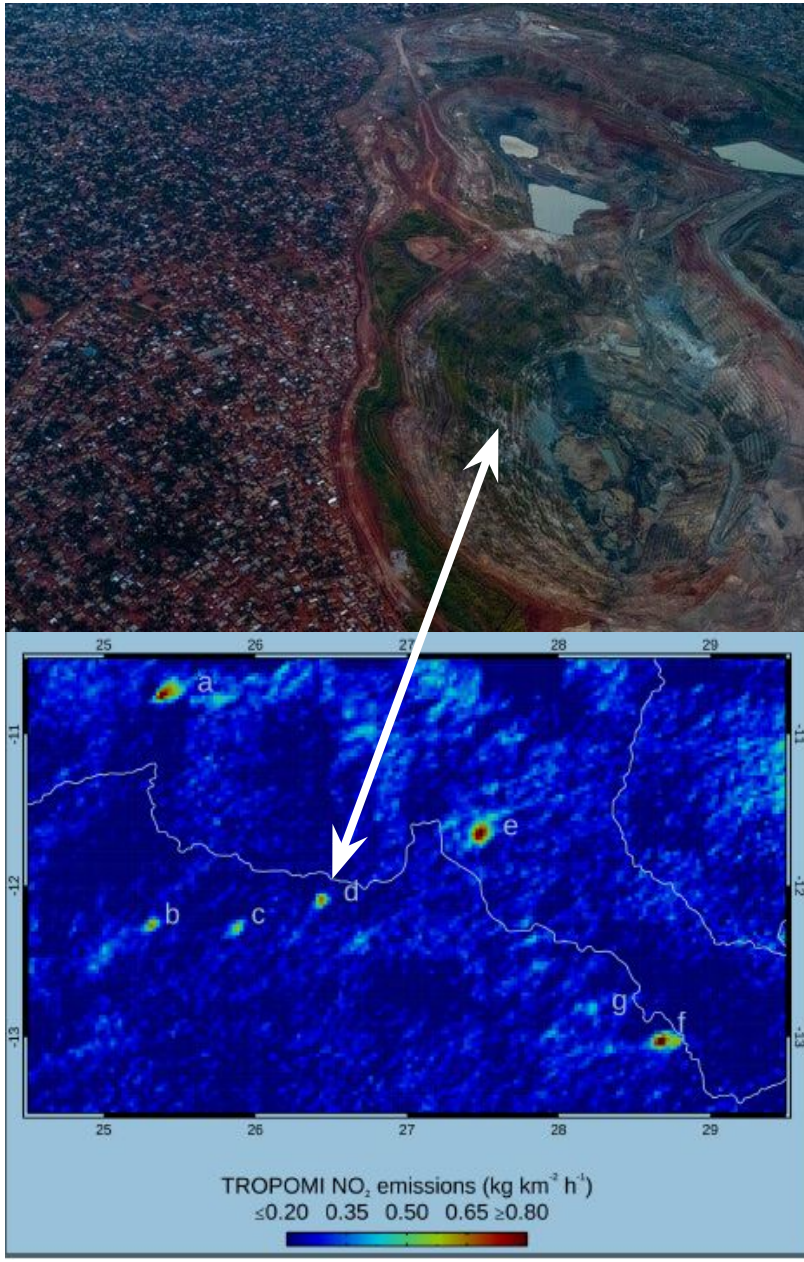
Emissions from metal mining in Africa



NOx Emissions follow Production



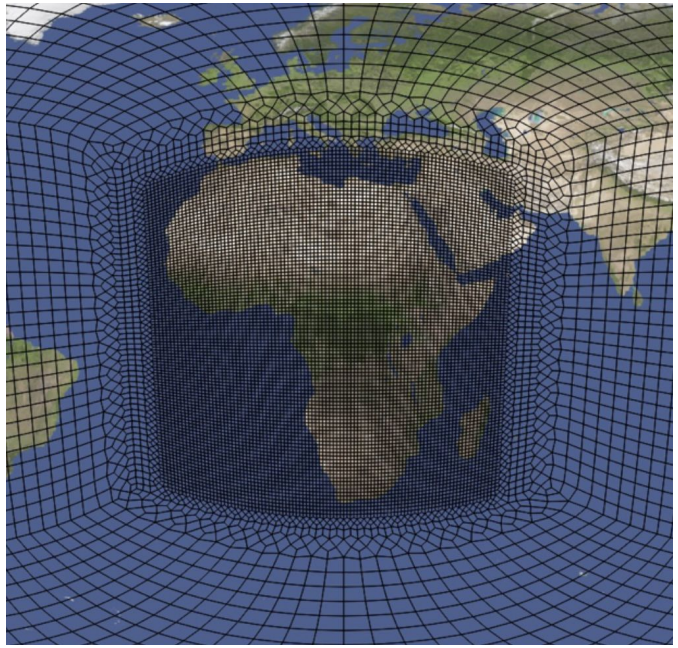
Martinez-Alonso et al., JGR 2023, NCAR ACOM



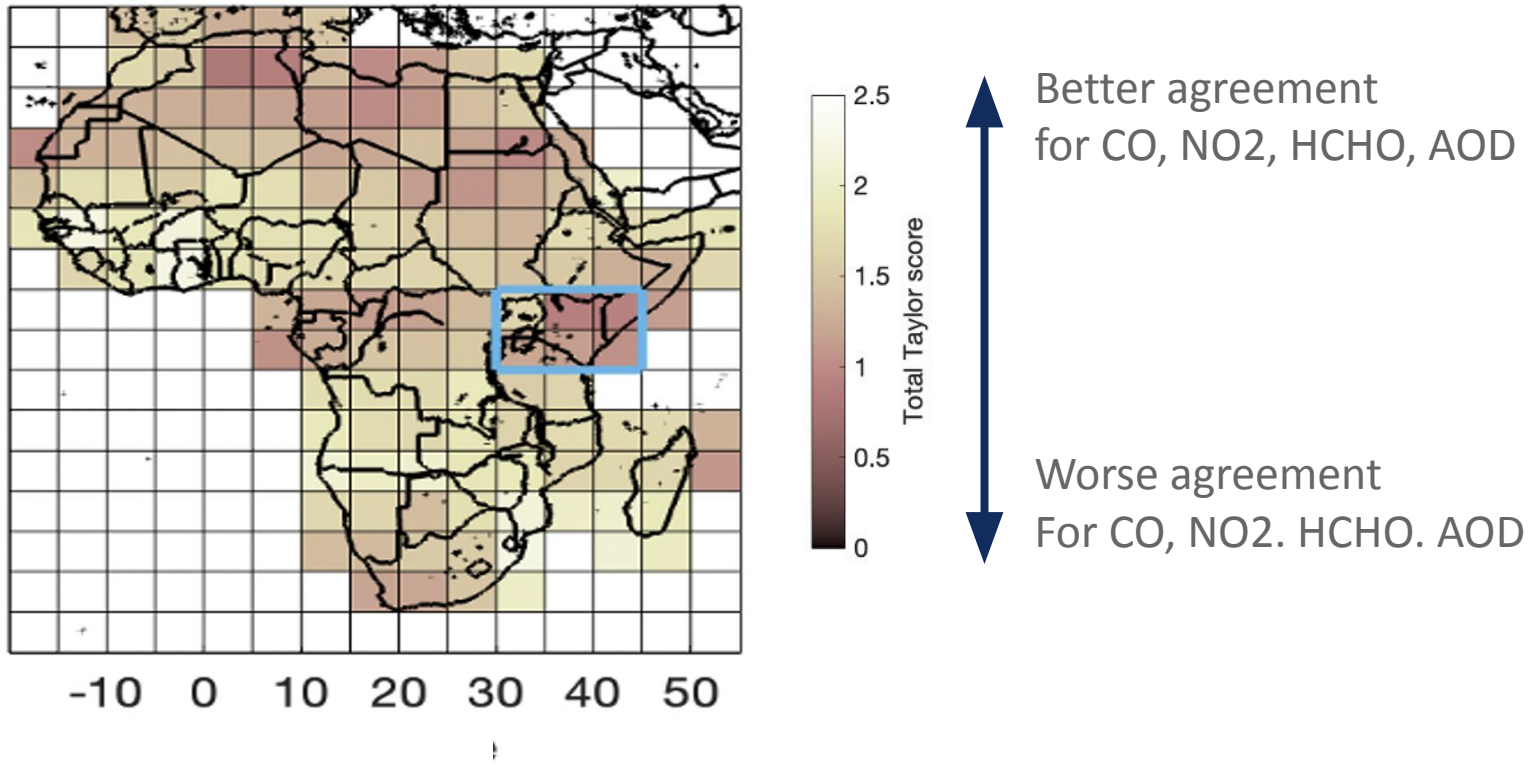
Air Quality Modelling over Africa using MUSICA

- We quantify model-satellite discrepancies over Africa with MUSICAv0.
- The highlighted East Africa region has the largest model-satellite discrepancies.
- A field campaign there can help understand model-satellite discrepancies and improve model predictability.

MUSICAv0 grid for Africa:

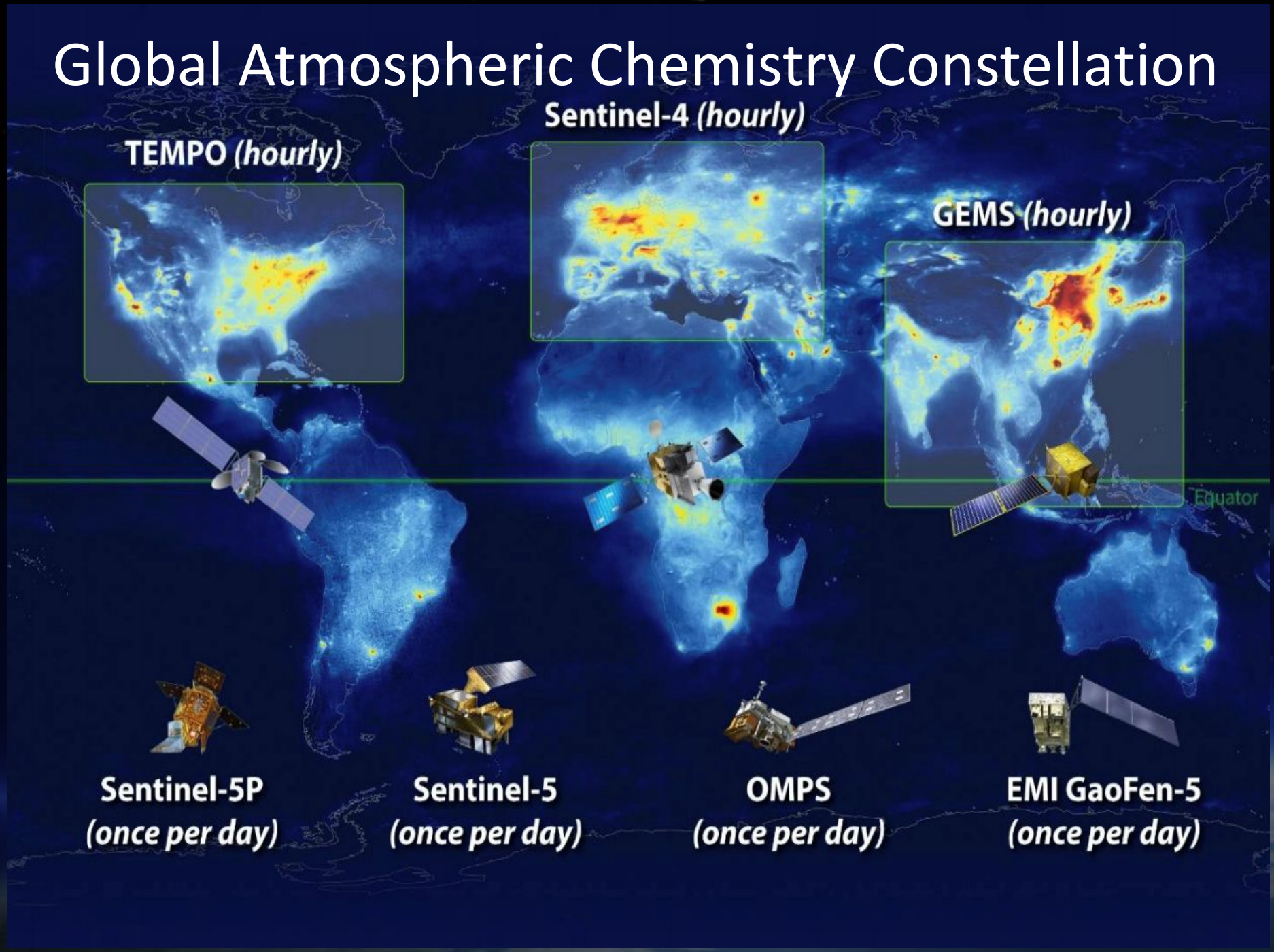


MUSICA-satellite discrepancies:



Wenfu Tang et al., GMD 2023, NCAR ACOM

Global Atmospheric Chemistry Constellation



TROPOMI

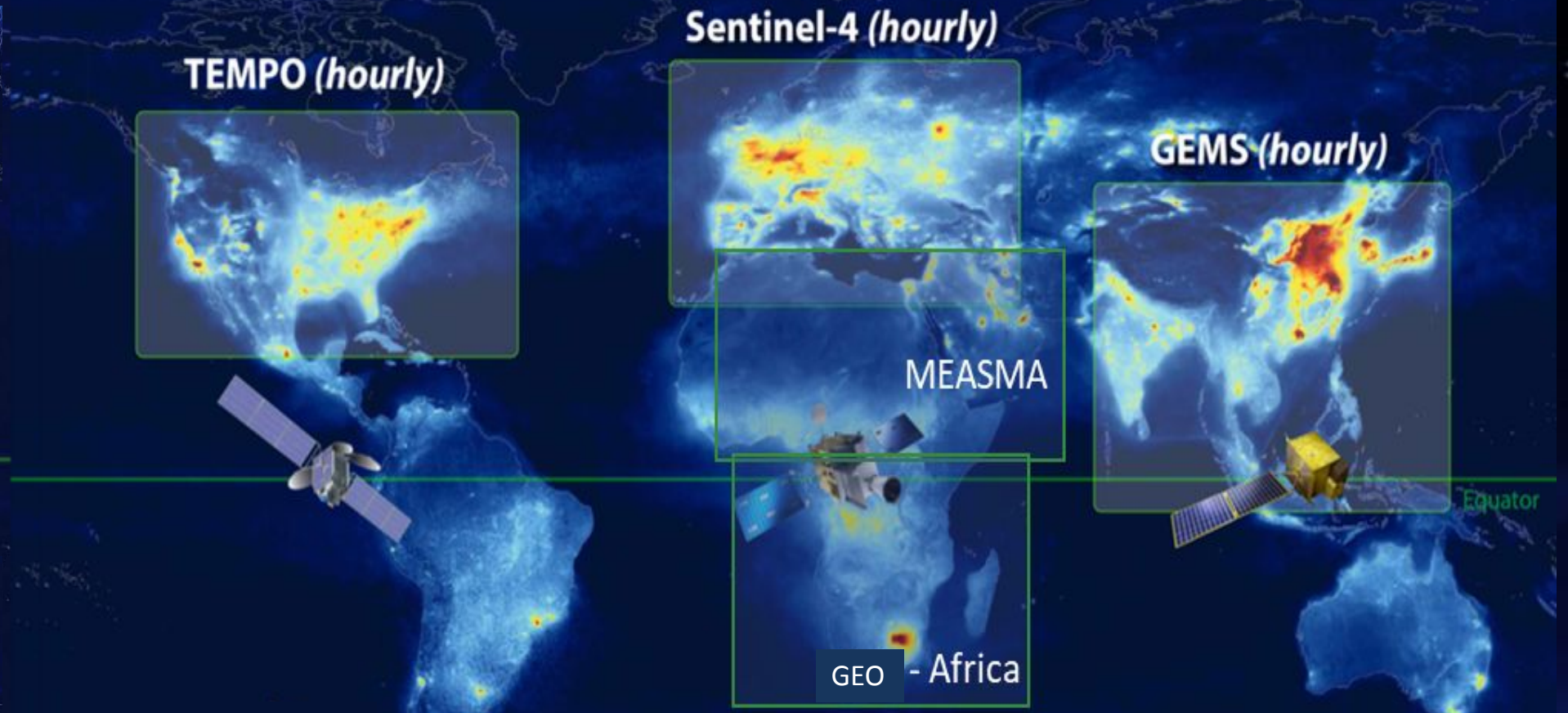
Global Atmospheric Chemistry Constellation

Sentinel-5P
(once per day)

Sentinel-5
(once per day)

OMPS
(once per day)

EMI GaoFen-5
(once per day)



TROPOMI

Field of Regard for MEASMA: GEO over Middle East and North Africa

NSF | NCAR Operated by UCAR

Current activities in the international space community

- There are 2 initiatives for GEO's to measure over Africa initiated by Ball Aerospace and scientists:
  - Measma (Omar Emam , Raid Suleiman et al)
  - Africa GEO (Pieternel Levelt et al)

  Currently we are trying to form science teams with a focus to have scientists from the regions these instruments are going to measure
- AGU 2023:
  - Townhall Meet at AGU with leaders in the field and cross disciplinary
  - Papers at AGU, one from Levelt, one from Ball Aerospace, in different sessions
- EGU 2024 :
  - Oral presentation in the AQ constellation session (Levelt)
- GEOXO meeting May 6-8, 2024 in Washington DC
- OMI-TROPOMI Science Team Meeting June 3-6 2024 at NCAR-ACOM (also TEMPO, GEMS, GEO over the Global South)
- TEMPO-GEMS science team meeting in August 2024 in Hawaii
- CEOS will take initiative to write the scientific concept paper for the need of GEOs over the Global South
- Ball Aerospace Corporate talks to private funders and foundations etc, aim to get funding end of 2024 c

Summary Africa

UCAR/NCAR initiative 'Accelerating environmental sustainability solutions in Africa: a UCAR initiative', Workshop at NCAR, Boulder CO, (Wenfu Tang et al – March 21-22, 2024)

Population is expected to triple in 2100 (now 1.1 billion, becomes 3.8 billion)
4th industrial revolution: huge increase in air pollutants & green house gases

5 workshops on Africa last years:

- Advancing air quality and carbon science in Africa (Ben Gaubert, NCAR ACOM– March 2021)
- Lorentz Workshop ' The power of TROPOMI to bridge Science and Policy' (Pieternel Levelt and Marleen Dekker KNMI& Leiden Univ- April 2022)
- Workshop on a pilot design for air quality in Africa(Solomon Bililing – June 2022)
- Workshop on AQ in Africa , in Kigali - Africa (Solomon Bililing et al – Jan 2023)

IGAC: Long standing tradition with Africa subgroup, including scientists from Africa

NCAR & KNMI could contribute: Ground based monitoring, modelling, flight campaigns, laboratory , satellite observations

Investigate Potential for GEOstationary satellite over the Global South and Africa, working on a GEO Science Team with USA and African scientist representation, several science meetings focused on GEO capability.