Expanding Geostationary Atmospheric Composition Satellite Constellation: Towards Global Coverage

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Ali Omar, NASA

and the White Paper Team

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Outline of White Paper and this Presentation

01 **At the beginning**
Genesis of this activity

02 **The Volunteer Team**
Orgs/Disciplines/Regions

03 **The Problem**
Geostationary Solution

04 **Gaps in Observations**
The case for a Geo-Belt Constellation

05 **Ground Measurements**
Strengthening and standardizing

06 **Closing high latitude gaps**
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07 **Benefits**
Integrated Observations Modeling, Forecasting, Transport

08 **After the White Paper**
Continue efforts to inform, build capacity and explore opportunities

GENESIS

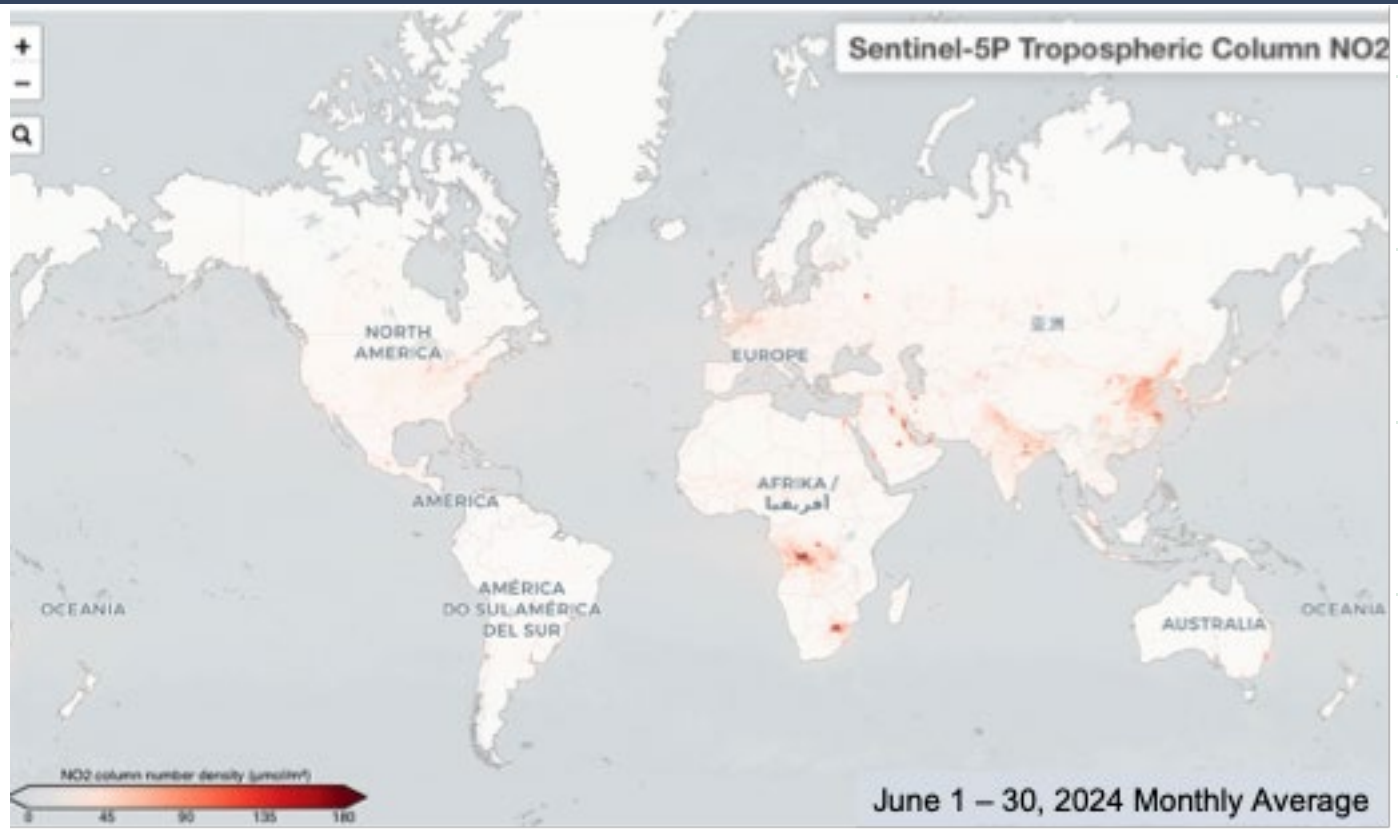
- In 2024, CEOS AC-VC commissioned a new White Paper
- The initial goal was to complement GEMS, TEMPO, and Sentinel-4 with global air quality and greenhouse gas observations
- A dedicated team has been meeting bi-weekly to draft the document
- The initial plan was presented at the October 2025 CEOS SIT Meeting
- Following this meeting, the scope was reduced to focus exclusively on air quality

A finalized White Paper will be ready for the **2026 SIT Fall meeting** for review by the Principals.

White Paper Authors

Ali Omar, Emma Knowland, Barry Lefer
NASA
James Hannigan, Pieternel Levelt, Shima Shams, Helen Worden
National Center for Atmospheric Research (NCAR)
Owen Cooper, Shobha Kondragunta
National Oceanic and Atmospheric Administration (NOAA)
Ana Andries
Surrey University, UK
Paulo Artaxo
University of Sao Paolo, Brazil
Sara Basart
World Meteorological Organization (WMO)
Dominika Cyzewska
European Org. for the Exploitation of Meteorol. Satellites (EUMETSAT)
Arlindo daSilva
Asticou-Earth Systems LLC USA)
Sebastian Diez
Universidad del Desarrollo, Chile
Sheldon Drobot, Dennis Nicks
BAE Aerospace, USA
Richard Eckman
University of Maryland, College Park
Omar Emam
Intospass, UK
Betsy Farris
University of Colorado
Jonathan E Hickman
NASA GISS (Columbia University)
Eloise Marais
University College London
Dylan Millet
University of Minnesota
Ray Nassar, Christopher Sioris
Environment and Climate Change Canada (ECCC)
Marloes Penning DeVries
University of Twente, Netherlands
Rob Ryan
University of Melbourne, Australia
Raid M Suleiman
Harvard-Smithsonian Astronomical Observatory
Ben Veihelman
European Space Agency (ESA)
Karn Vohra
University of Birmingham, UK
Jun Wang
University of Iowa

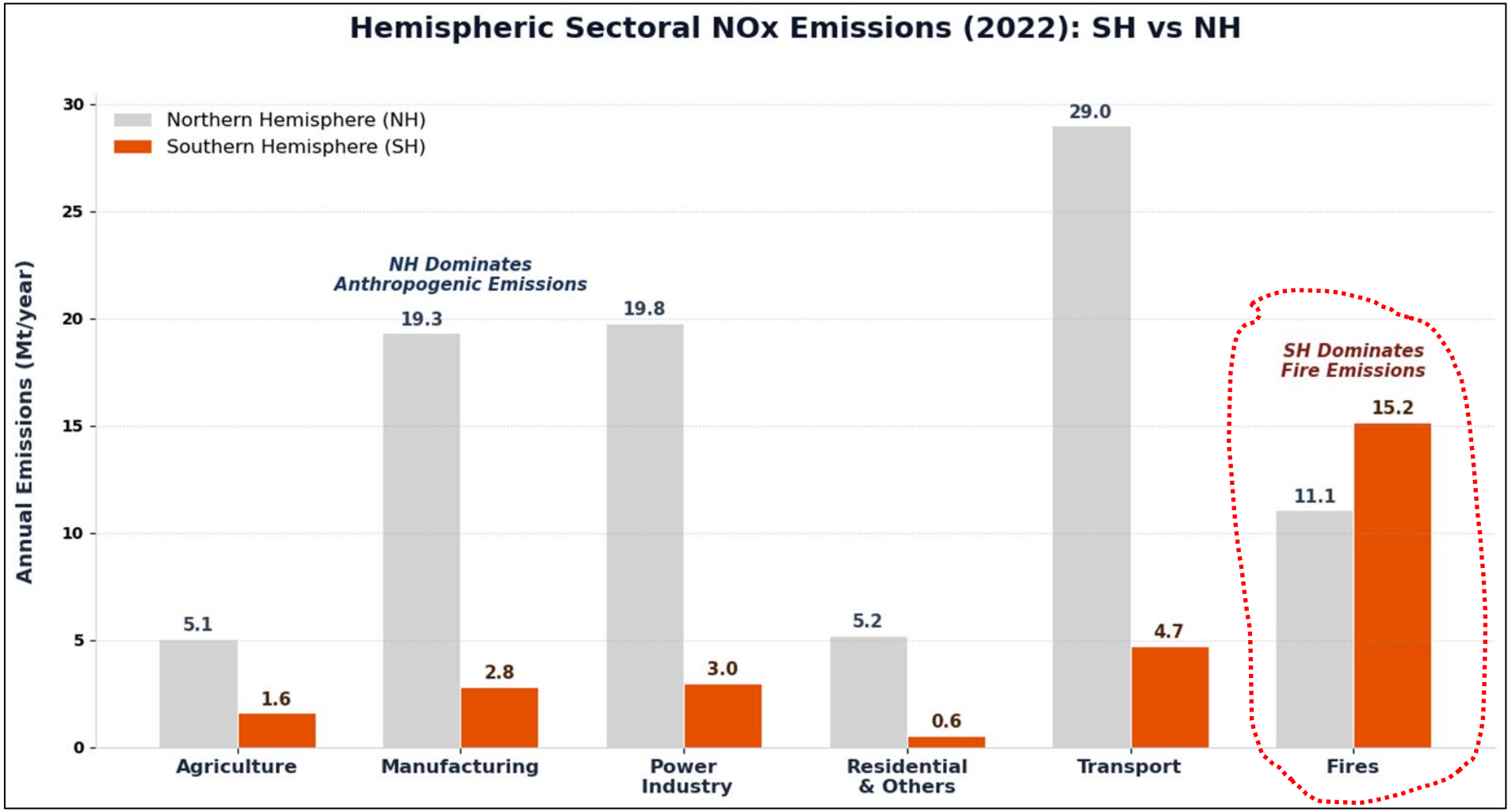
The Challenge – Addressing the Gap in Observations



Tropospheric Nitrogen dioxide (NO_2) column concentration retrieved by Sentinel 5P for the month of June 2024. High column densities (denoted by bright red colors) over the South Africa are associated with high power plant and industrial emissions in the region. Elevated column densities over south equatorial Africa are associated with dry season biomass burning activity

- Human activities drive rapid atmospheric changes.
- The fast pace of change requires hourly observations.
- These shifts directly impact air quality and human health.
- Accurate measurements are vital to guide actions and evaluate the success of current strategies

No_x Emissions : A tale of two hemispheres

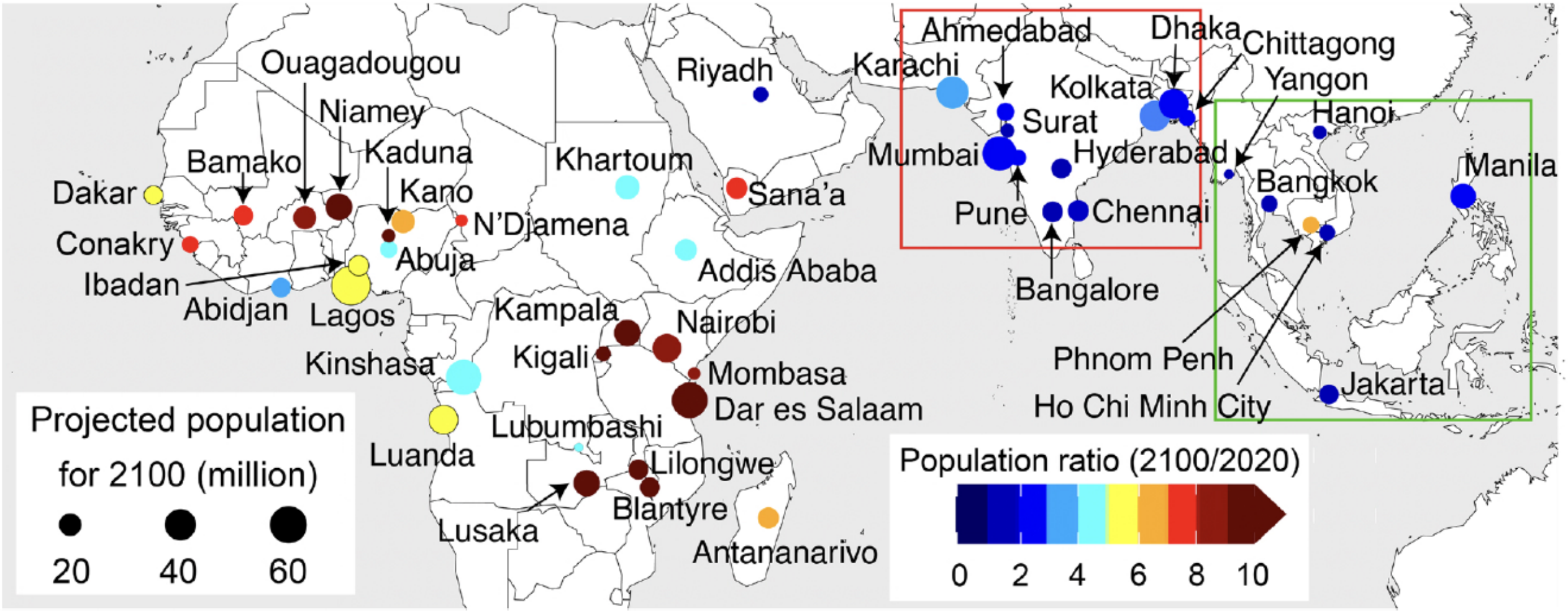


NH - NOx emissions from different source sectors are higher than fire emissions in the NH

SH - fire emissions are are the main source of NOx

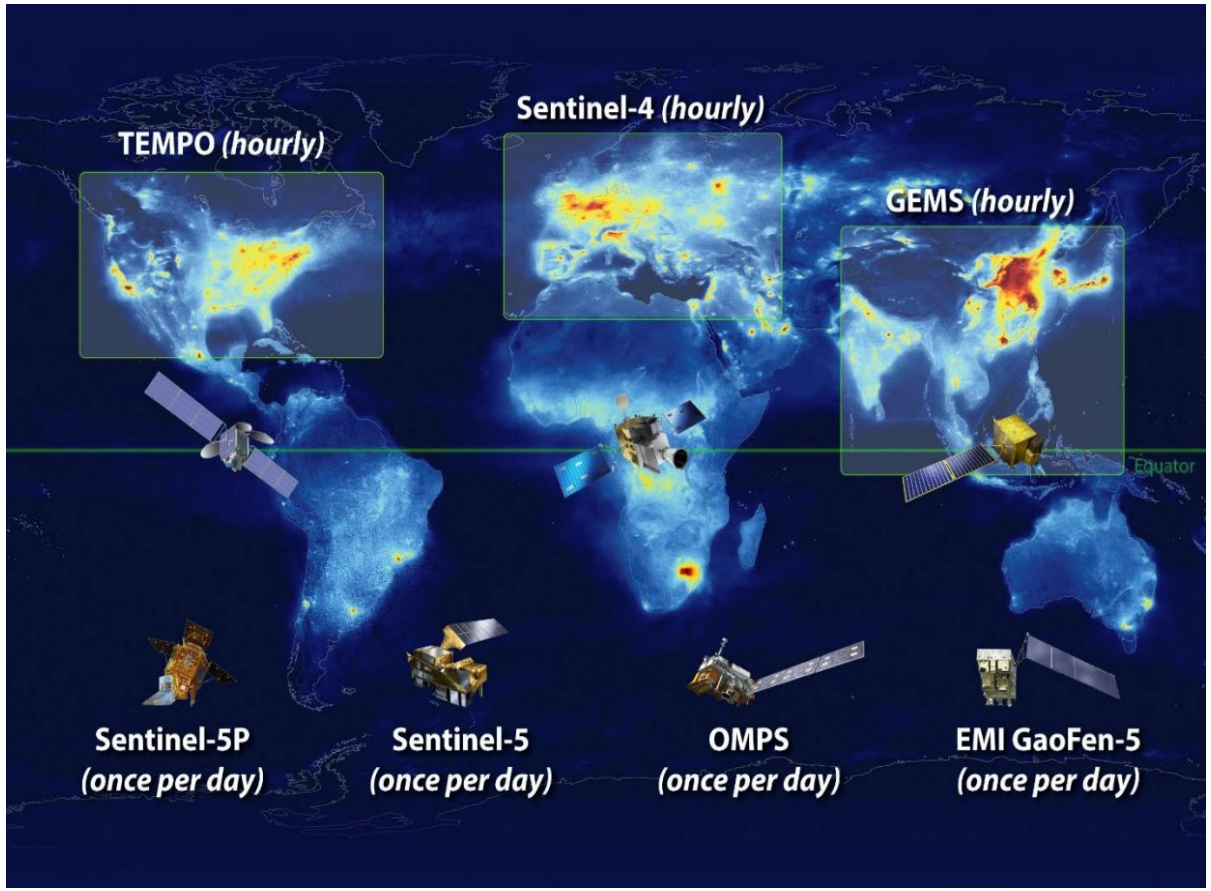
Source: EDGAR database.

Projected population growth for the fastest-growing cities in the tropics (25°S to 25°N) by 2100



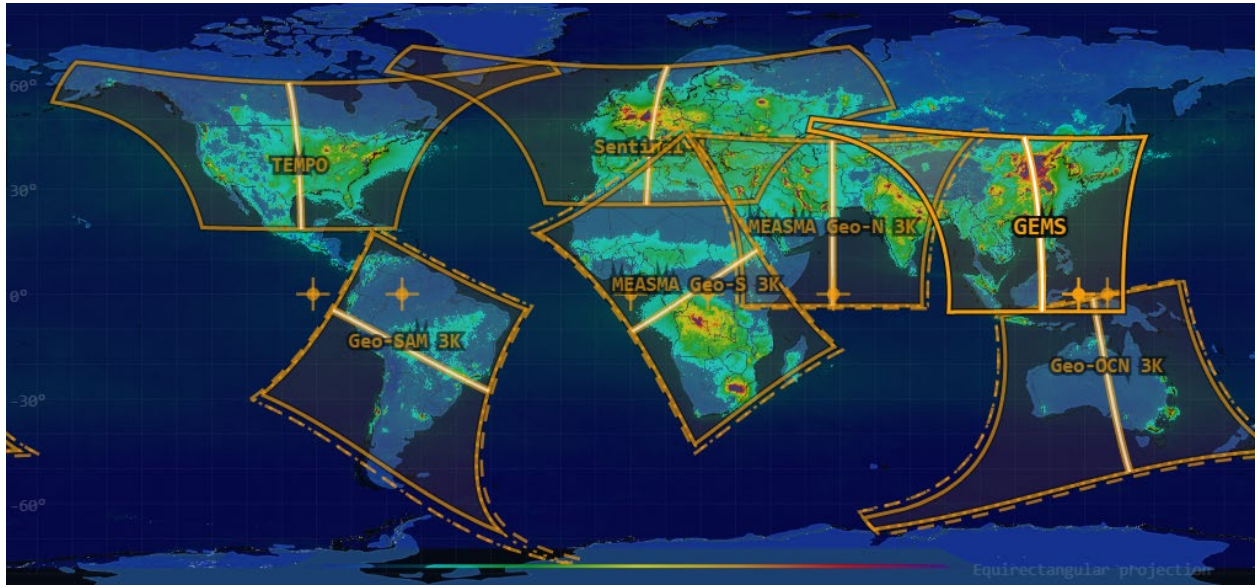
Source: Vohra et al. (2022)

The Current Landscape



- The CEOS Atmospheric Composition Virtual Constellation (AC-VC) partners provide valuable data
- Gaps remain in observing diurnal cycles, rapidly changing events, and specific pollutants in the SH and populated NH regions
- Polar-orbiting satellites offer global coverage, but limited temporal resolution

Closing the Gap: The Global Geostationary Satellite Solution (Geo-Belt)



- Four new geostationary satellites identified to cover the gaps
- Continuous, wide-area coverage over currently undermonitored regions
- Complementing and enhancing existing constellation
- Significant ownership and participation at the regional level to build capacity
- Leverage the Analysis Ready Data (ARD) concepts for Geo

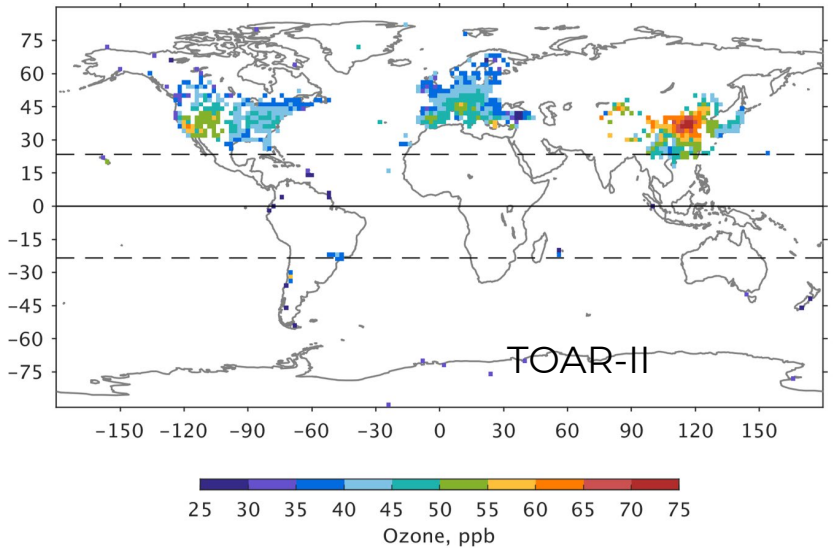
The benefits of investing in geostationary atmospheric composition monitoring extend far beyond the science. By improving our ability to predict and respond to environmental challenges, we can realize significant economic savings in areas such as healthcare, agriculture, and resource management.

Strengthening Ground-Based Measurements for Calibration/Validation

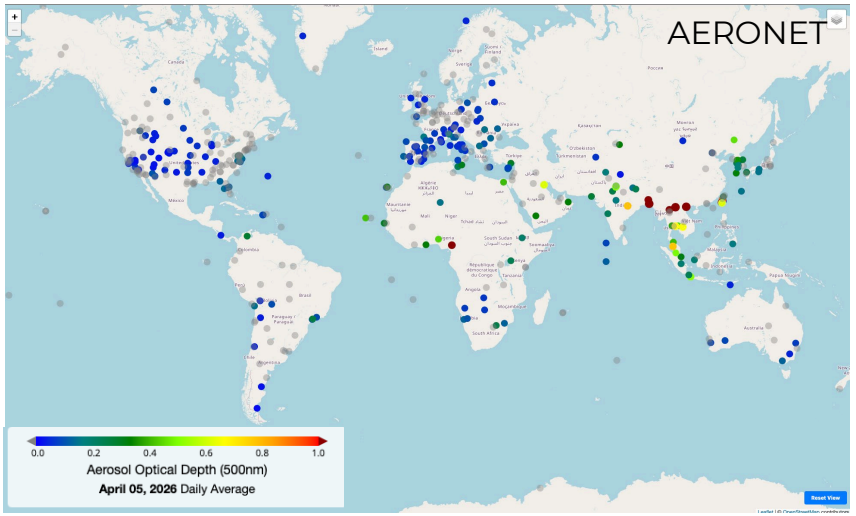
- Leverage existing ground-based networks (e.g., AERONET, Pandonia, NDACC).
- Establish strategically located collection of instruments at relevant sites
- Focus on comprehensive instrumentation and local capacity building.
- Engage diaspora scientists to reach local institutions (e.g., AMS Townhall Jan 2025) in developing countries

The disparity in atmospheric composition ground-based measurements around the globe creates an issue, as unmonitored regions are often disproportionately impacted by pollution but lack the resources to monitor and mitigate the impacts effectively.

Ground Stations for Monitoring Ozone, Nitrogen dioxide, and Particulate Matter



- All available surface ozone (O_3) observations from the Tropospheric Ozone Assessment Report (TOAR). Note that Ozone monitors exist in Australia but are not yet in the open-access TOAR-II database (Szopa et al., 2026)
- Pandonia Global Network (PGN) – Trace gases NO_2, O_3, HCHO, etc
- AERONET – Optical Depth (proxy for PM)



Strengths

Uniform and standardized

- Algorithms /data processing
- Instrument operating routines
- Quality control

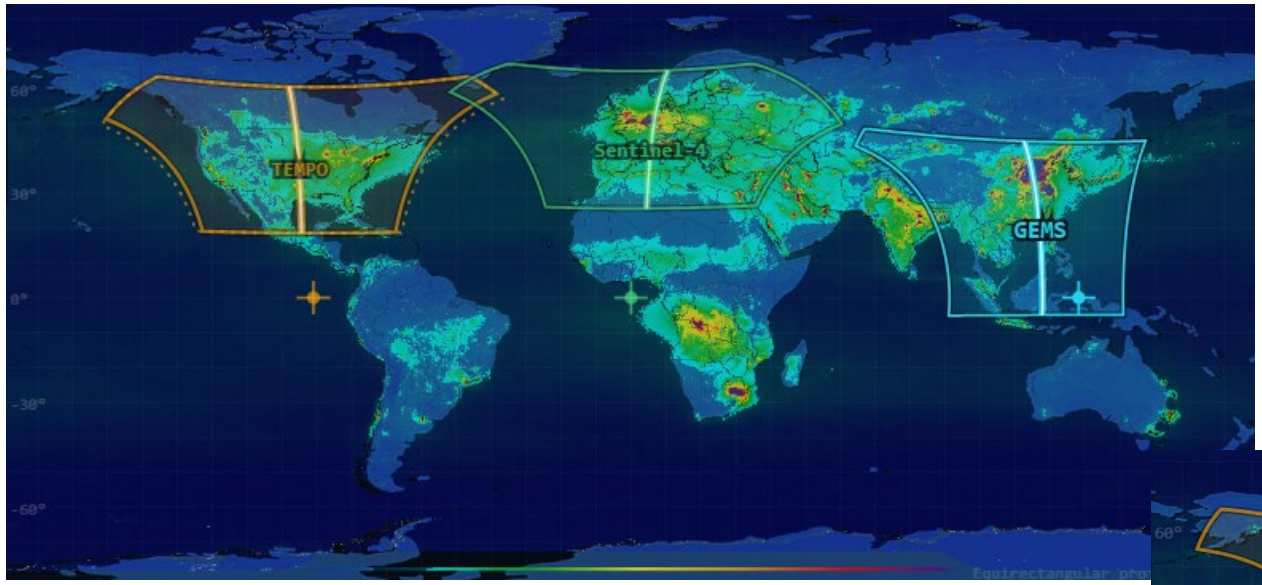
Real-time data processing

Data archiving

Geostationary observations will provide data in regions not covered by ground networks

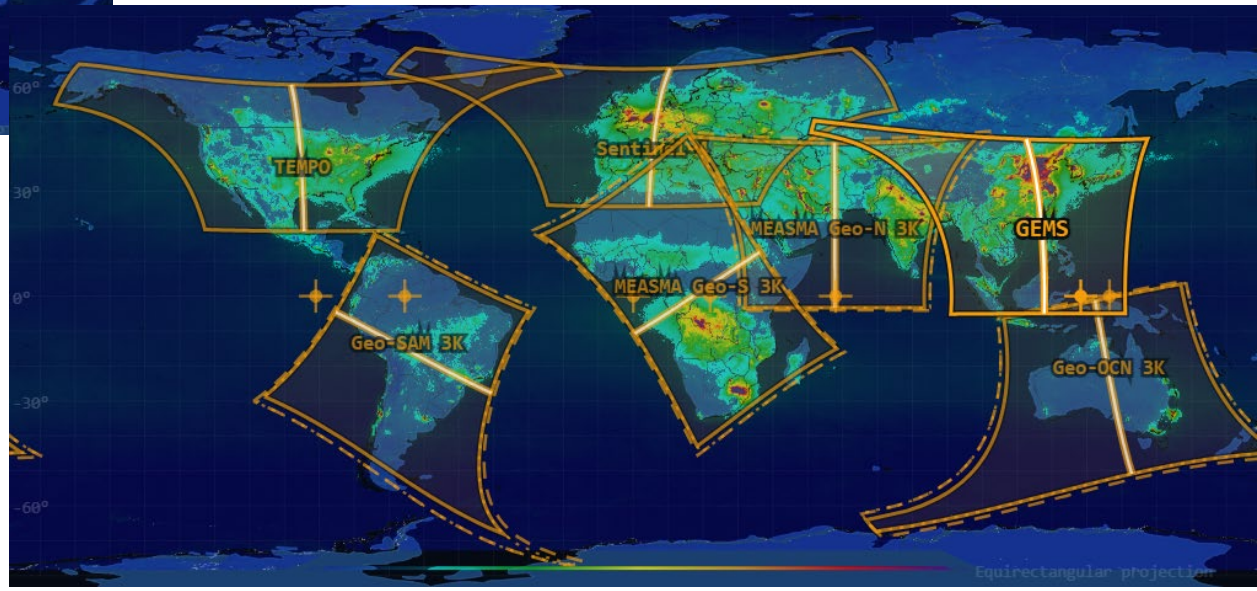
Geo-Belt Constellation – Notional Maps

GeoAQ Constellation – TEMPO, Sentinel-4, GEMS

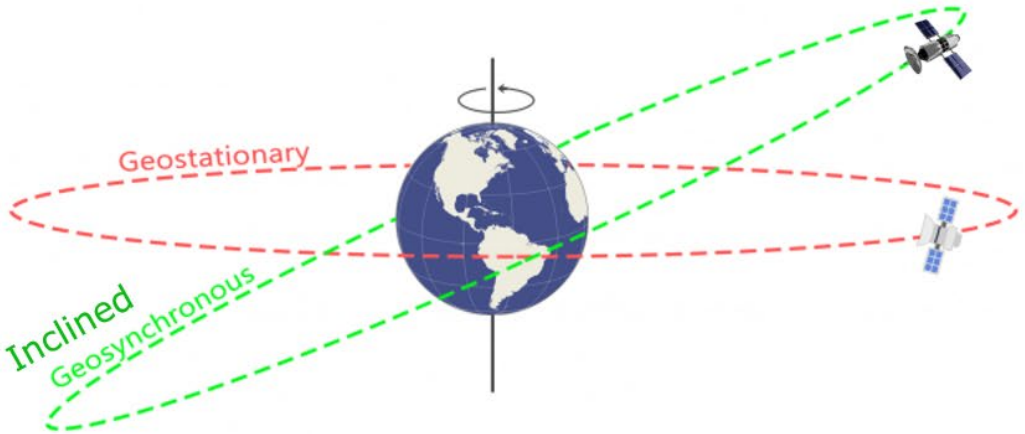


High latitudes are not covered the the Geostationary Platforms

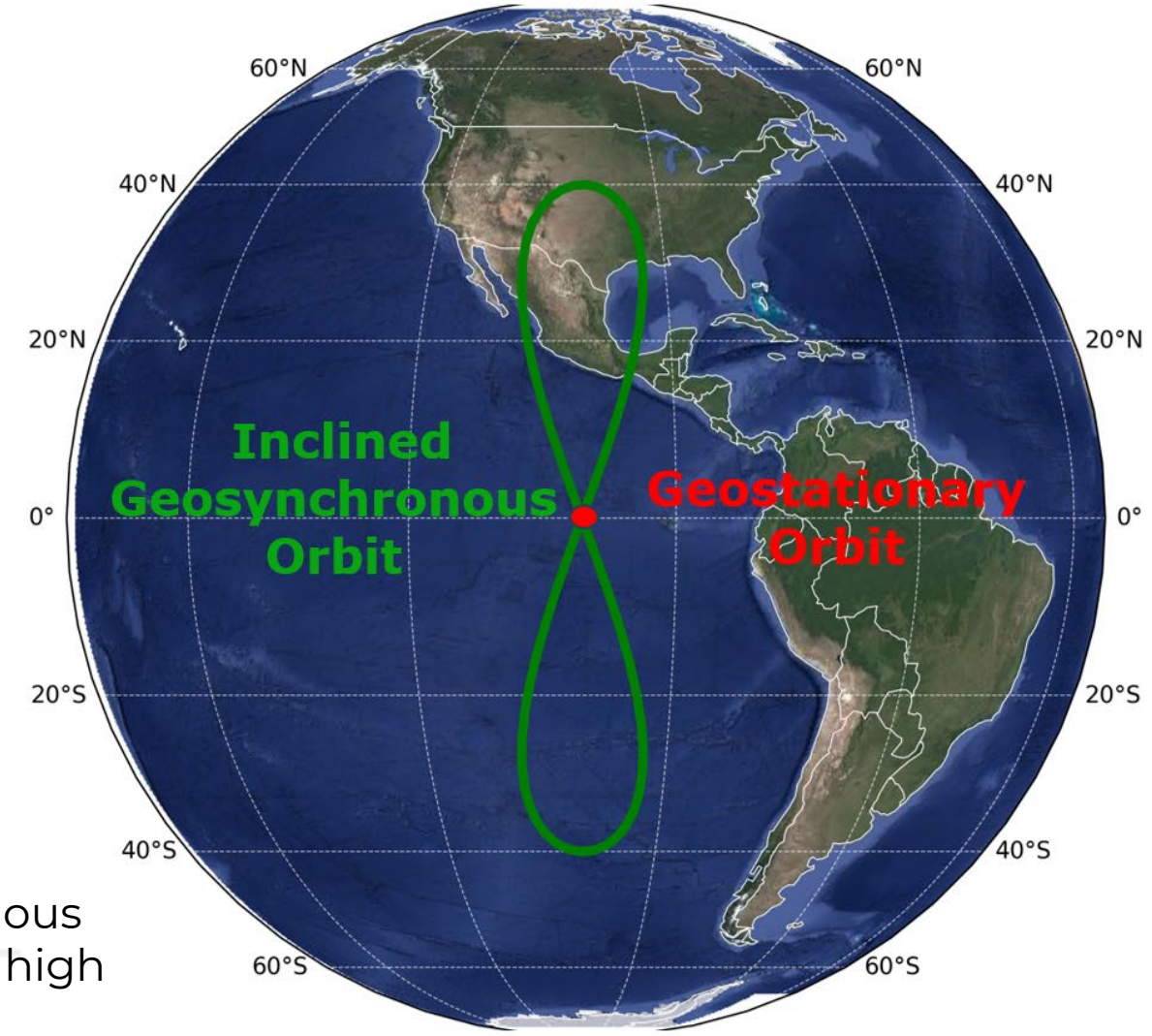
Geo-Belt Constellation : GeoAQ Constellation +4



Inclined Geosynchronous Orbits (IGOs)



Altitude = 35,786 km

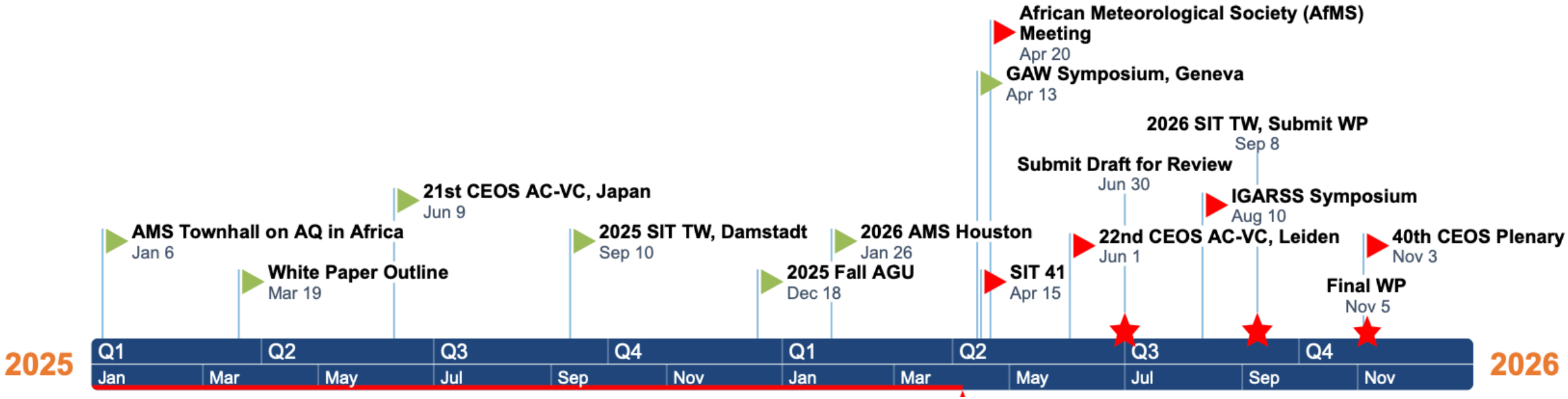


ECCC has proposed the use of Inclined Geosynchronous Orbits (IGOs) to observe under monitored regions at high northern latitudes

Summary and Path Forward: Towards Global Air Quality Coverage

- **The Critical Observational Gap:** Rapid urbanization in the Tropics drives fast-paced atmospheric changes, yet these vulnerable regions lack the continuous, diurnal air quality monitoring needed to protect public health.
- **Limitations of LEO Architectures:** Polar-orbiting satellites provide baseline global coverage but miss rapid, hourly pollution events and unique Southern Hemisphere emission profiles (e.g., intense wildfires).
- **The "Geo-Belt" Solution:** Adding four new geostationary satellites to the existing NH constellation will afford continuous, hourly coverage over South America, Africa, the Middle East/India, and Oceania.
- **Addressing High-Latitude Blind Spots:** Inclined Geosynchronous Orbits (IGOs) offer a targeted, highly effective solution to monitor critical high-latitude environments, completing the global picture.
- **Strengthening Ground-Based Synergies:** Satellite expansion anchored by standardized ground networks (e.g., AERONET, Pandonia, TOAR) to ensure robust calibration, validation, and local capacity building.
- **Delivering Actionable Benefits:** Analysis Ready Data (ARD) improves predictive modeling, supports epidemiological research, and drives significant economic savings in healthcare and resource management.
- **Path Forward:** Initiated by the CEOS AC-VC, this collaborative white paper provides the **roadmap for this global expansion,** with final principal review slated for the Fall 2026 SIT meeting.

Schedule



AQ Community Review WhitePaper — Jul 1 - Aug 14

Prepare Draft Final White Paper — Aug 17 - Sep 3

★ Major Milestone/Deliverable

Backup slides