



WEATHER CLIMATE WATER  
TEMPS CLIMAT EAU

# Global Atmosphere Watch (GAW) Programme

and how its activities are contributing with climate research

Sara Basart

*Scientific Officer  
Science and Innovation*

*On behalf of GAW: Greg Carmichael (Chair) and WMO-GAW team*

*WRCP Meeting, Brussels, 11 May 2023*



**WMO OMM**

World Meteorological Organization  
Organisation météorologique mondiale



# Global Atmosphere Watch (GAW)

*Research Enabling Atmospheric Composition Services*

*Advance and enhance science, services and infrastructure related to atmospheric composition, and support policies for society through applied research aimed at improving the understanding of the roles of aerosols, reactive gases, stratospheric ozone and greenhouse gases and their interactions in the Earth System.*

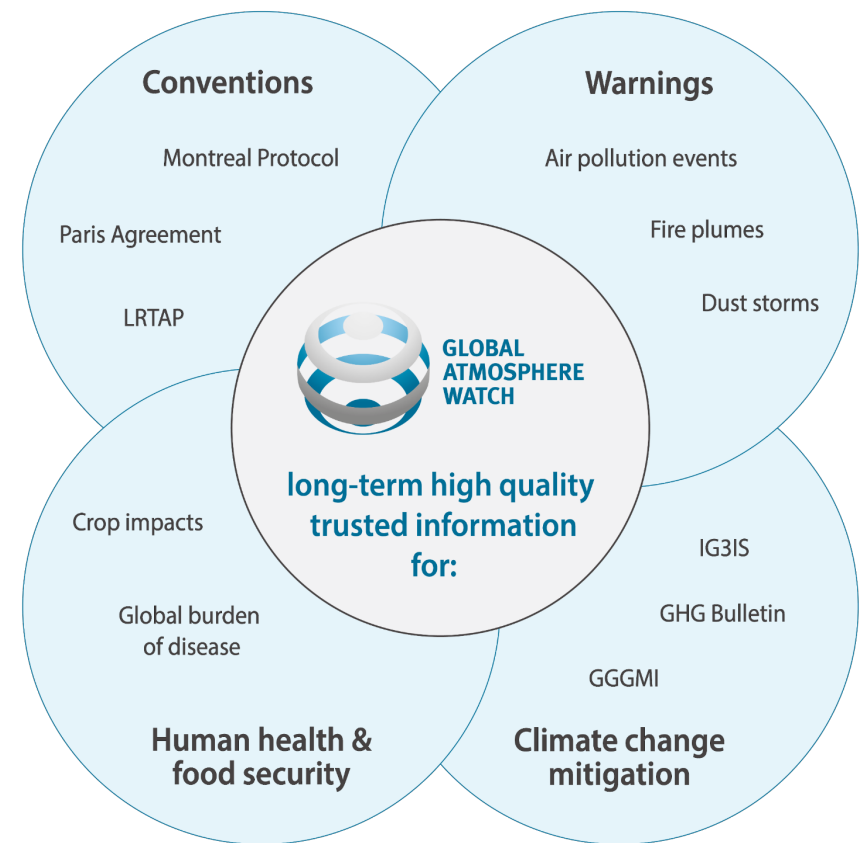
**Drivers: Global societal needs**





# Global Atmosphere Watch (GAW)

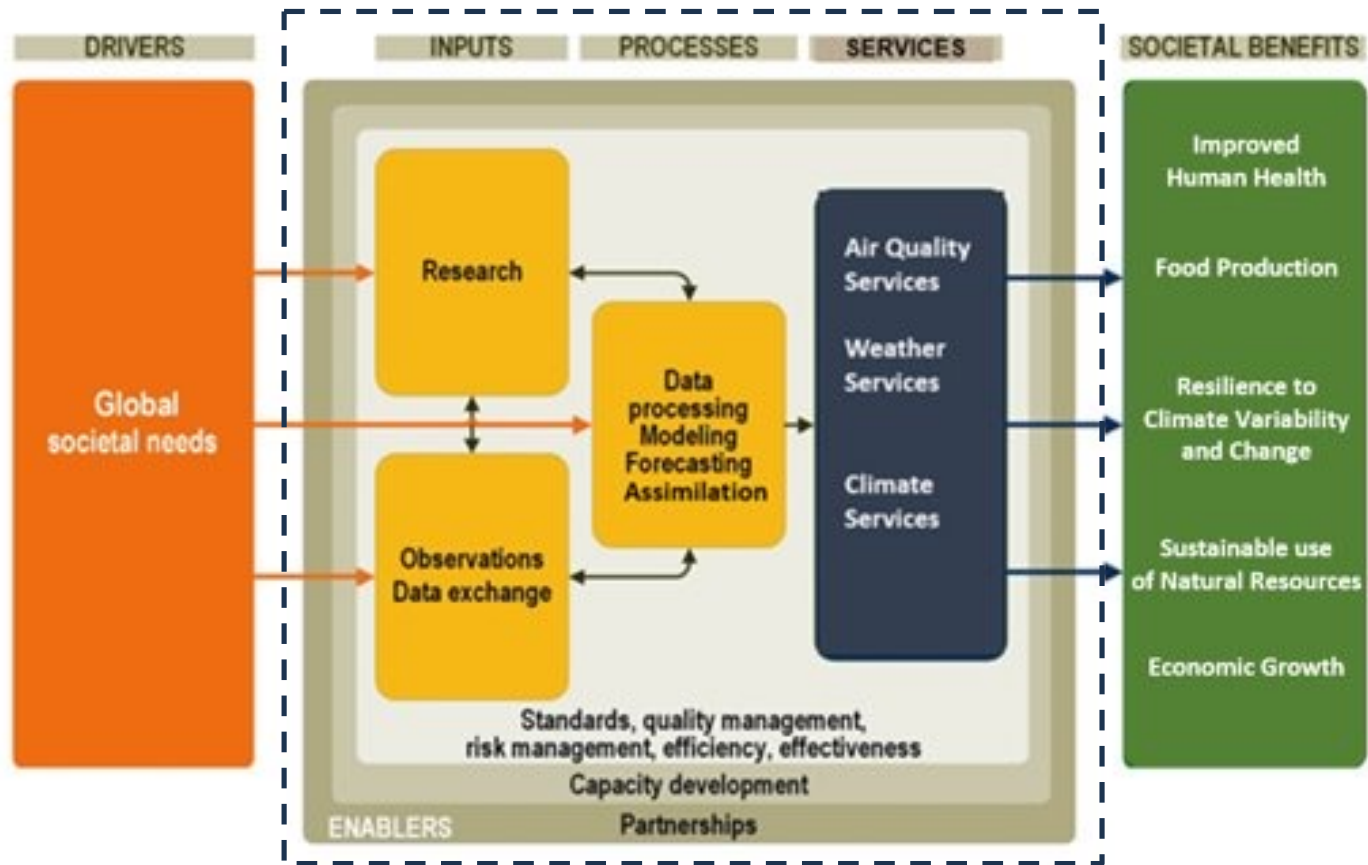
- *Based on partnerships involving contributors from **100 countries** (including many contributions from research community)*
- *Maintains and applies **long-term systematic** observations of the chemical composition and related physical characteristics of the atmosphere*
  - Emphasizes **quality assurance and quality control**
- *Delivers integrated products and services of relevance to society.*





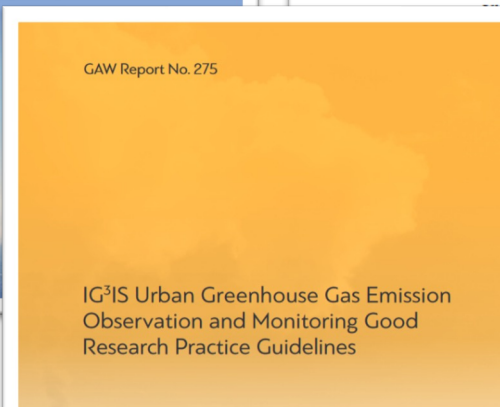
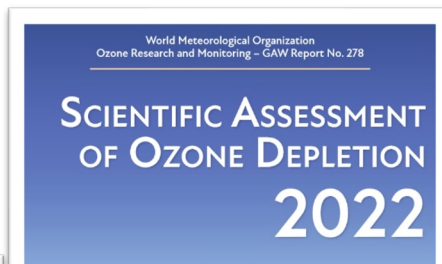
# Global Atmosphere Watch (GAW)

*Achieving a comprehensive atmospheric composition observing and analysis infrastructure by closely linking operations and research*





# GAW Achievements



Atmos. Chem. Phys., 22, 4615–4703, 2022  
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Atmospheric Chemistry and Physics  
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EGU

Review article

## Advances in air quality research – current and emerging challenges

Ranjet S. Sokhi<sup>1</sup>, Nicolas Moussiopoulos<sup>2</sup>, Alexander Baklanov<sup>3</sup>, John Bartzis<sup>4</sup>, Isabelle Coll<sup>5</sup>, Sandro Finardi<sup>6</sup>, Rainer Friedrich<sup>7</sup>, Camilla Geels<sup>8</sup>, Tiia Grönholm<sup>9</sup>, Tomas Halenka<sup>10</sup>, Matthias Ketzel<sup>8</sup>, Androniki Maragkidou<sup>9</sup>, Volker Matthias<sup>11</sup>, Jana Moldanova<sup>12</sup>, Leonidas Ntziachristos<sup>2</sup>, Klaus Schäfer<sup>13</sup>, Peter Suppan<sup>14</sup>, George Tsegas<sup>2</sup>, Greg Carmichael<sup>15</sup>, te Franco<sup>16</sup>, Steve Hanna<sup>17</sup>, Jukka-Pekka Jalkanen<sup>9</sup>, Guus J. M. Velders<sup>18,19</sup>, and Jaakko Kukkonen<sup>9,1</sup>



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Perspective

## Improving Estimates of Sulfur, Nitrogen, and Ozone Total Deposition through Multi-Model and Measurement-Model Fusion Approaches

Joshua S. Fu,\* Gregory R. Carmichael,\* Frank Dentener,\* Wenche Aas, Camilla Andersson, Leonard A. Barrie, Amanda Cole, Corinne Galy-Lacaux, Jeffrey Geddes, Syuichi Itahashi, Maria Kanakidou, Lorenzo Labrador, Fabien Paulot, Donna Schwede, Jiani Tan, and Robert Vet

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Article Documentation

Submission Information

Article Type: Research Article

# Global Atmospheric Composition Observations: The Heart of Vital Climate and Environmental Action

Gregory R. Carmichael, Oksana Tarasova, Øystein Hov, Leonard Barrie, and James H. Butler

**Overview of global airborne dust in 2021**  
The spatial distribution of the global surface concentration of mineral dust in 2021 (Figure 1) and its anomaly relative to climatologically mean values (1981–2010) (Figure 2) were derived based on the dust products from the Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2) (Goreau et al., 2017). This is the latest atmospheric reanalysis version for the modern satellite era produced by the NASA Global Modeling and Assimilation Office (GMAO). Spatially, the estimated peak annual mean dust surface

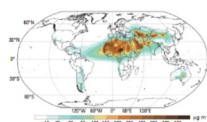


Figure 1. Annual mean surface concentration of mineral dust ( $\mu\text{g m}^{-3}$ ) in 2021 based on the NASA MERRA-2 reanalysis

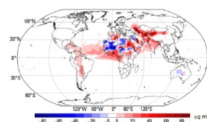


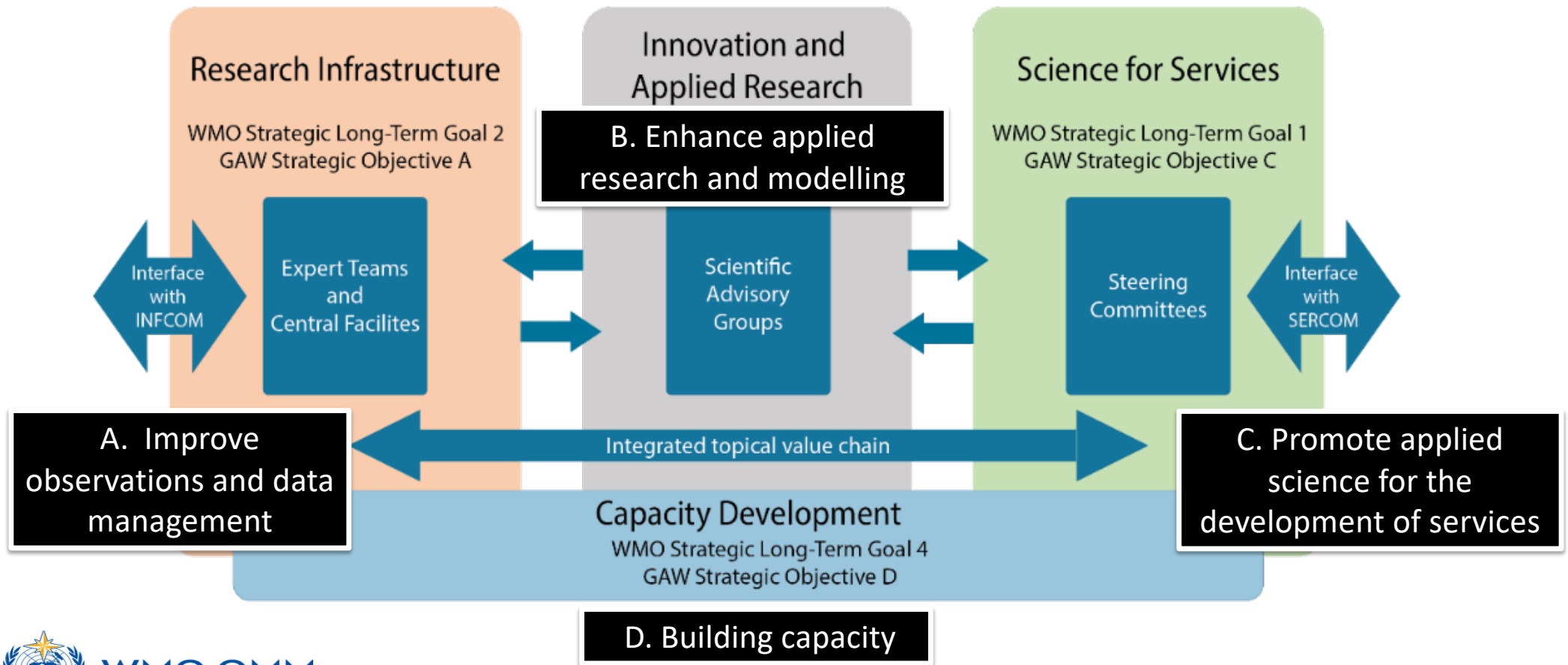
Figure 2. Anomaly of the annual mean surface dust concentration in 2021 relative to the 1981–2010 mean, based on the NASA MERRA-2 reanalysis

within precipitation, or dry deposition on vegetation, soil, crop production. Current global scale maps of atmospheric deposition are mainly based on chemical transport model



# GAW SIP 2024-2027 Strategic Objectives

*Aligned explicitly with new WMO strategic plan*

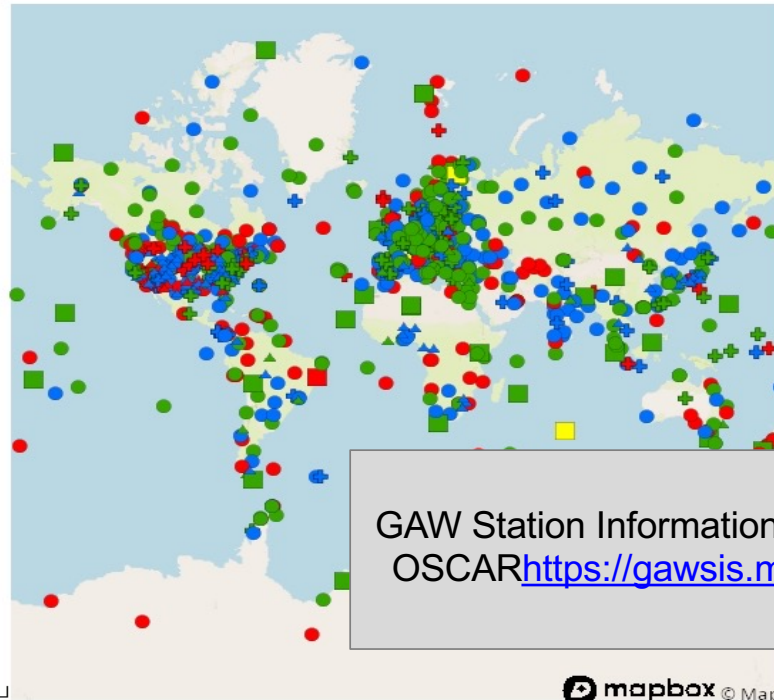




# GAW: Observational (research) Infrastructure

*Strengthen the atmospheric composition measurement and data infrastructure and contribute to **understanding trends and variability and extremes.***

- More than 200 parameters
- Intercomparisons
- Measurement guidelines
- World Data Centers



Filling gaps:  
LCS and satellites

GAW Station Information System (**GAWSIS**) part of OSCAR <https://gawsis.meteoswiss.ch/GAWSIS/#/>



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra  
  
Swiss Confederation  
  
Federal Department of Home Affairs FDHA  
Federal Office of Meteorology and Climatology MeteoSwiss

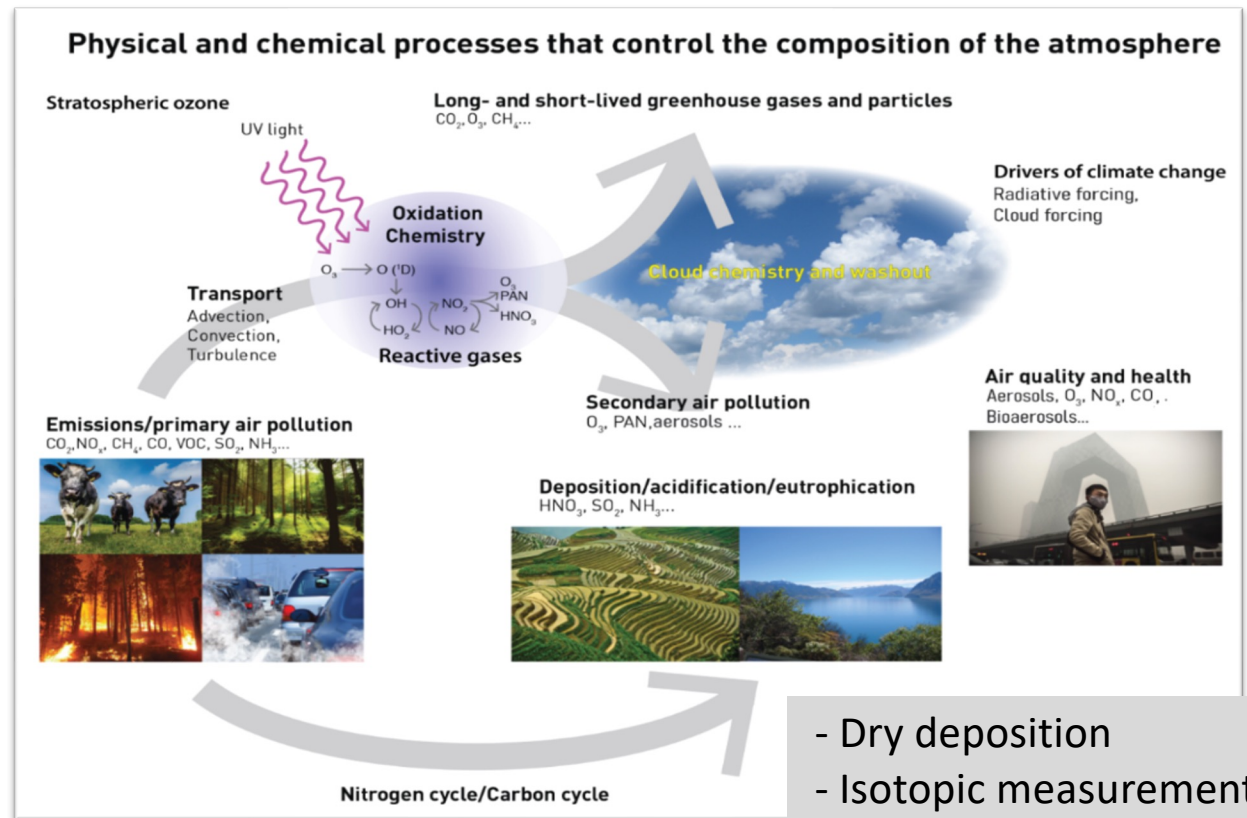
mapbox © Mapbox © WMO © OpenStreetMap

- |                       |                    |   |
|-----------------------|--------------------|---|
| Global                | Operational        | ● |
| Regional              | Partly operational | ● |
| Contributing networks | Non-reporting      | ▲ |
| Local                 | Closed             | ★ |
| Other networks        | Planned            | + |
|                       | Pre-operational    | ● |
|                       | Stand-by           | ● |



# GAW: Innovation and Applied Research

*Improve predictive capabilities and analysis through applied research aimed at advancing the understanding of the roles and fate of aerosols, reactive gases, stratospheric ozone and greenhouse gases and their interactions in the Earth System.*



- Dry deposition
- Isotopic measurements
- **AC climate interactions**
- Inverse modeling

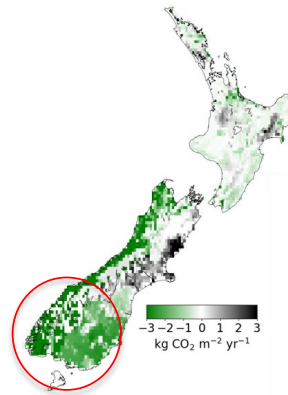
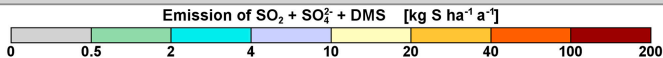
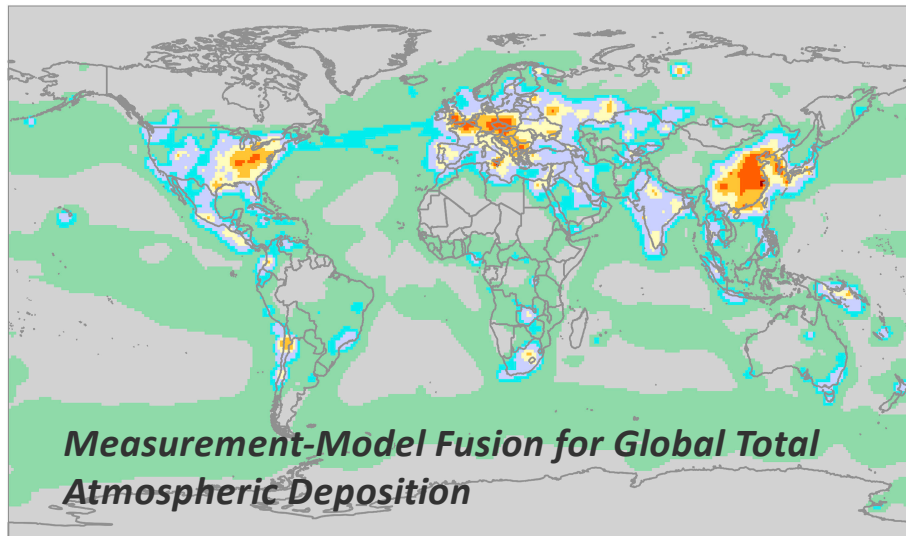




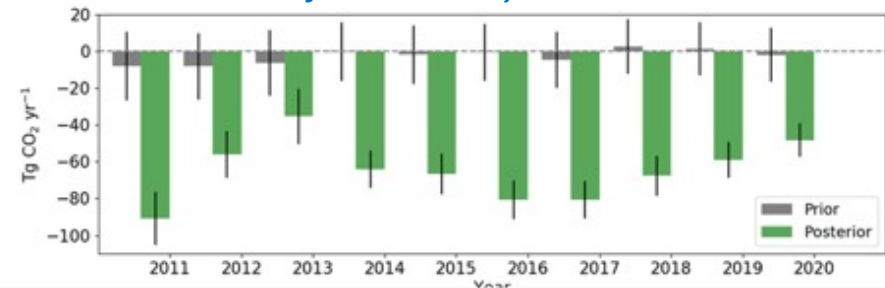
# GAW: Science for Services

*Advance the application of atmospheric composition information in support of policies and conventions, and expand societal services related to air quality, human and ecosystem health, **climate change** and food production.*

## Deposition to ecosystems and crops + climate action



*Integrated Global Greenhouse Gas Information System*



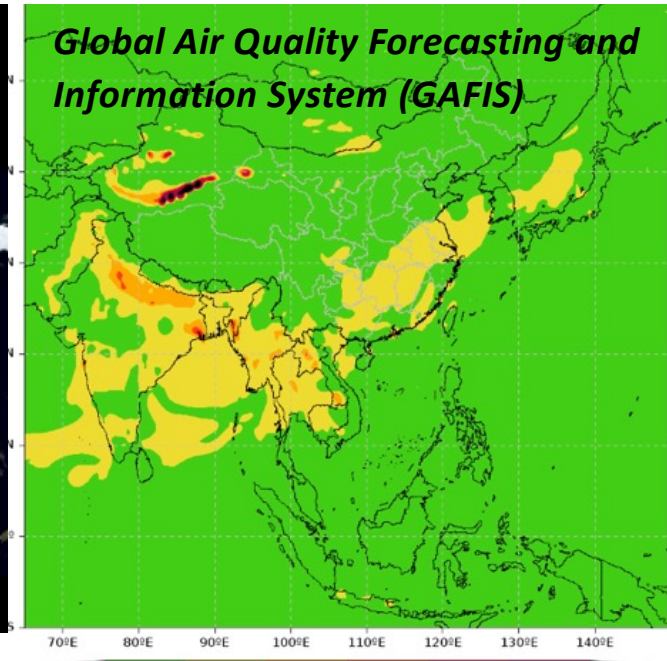
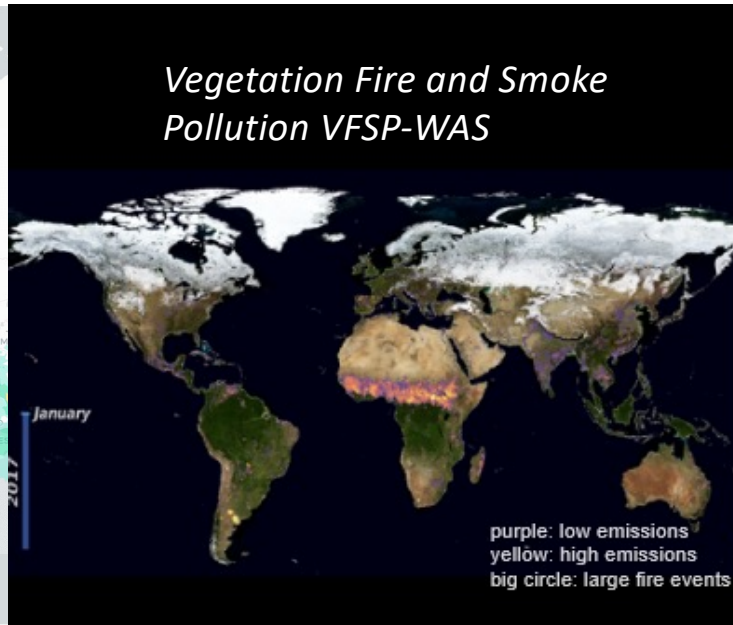
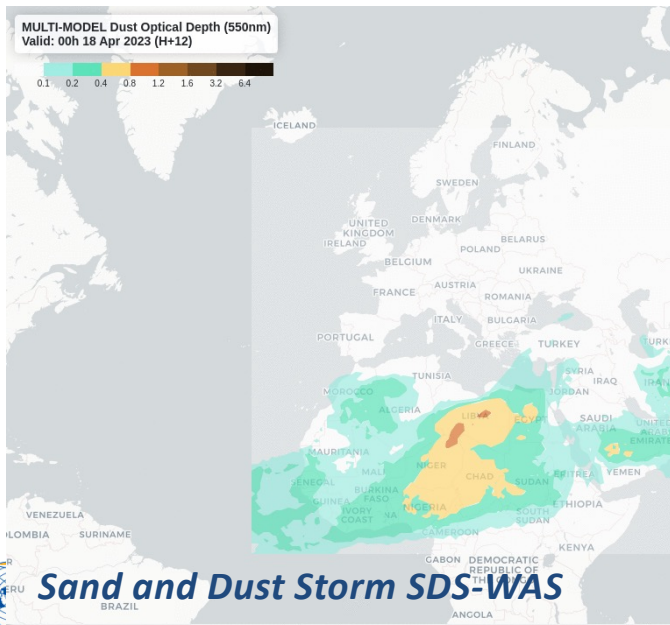
*Aotearoa New Zealand's terrestrial carbon uptake*



# GAW: Science for Services

*Advance the application of atmospheric composition information in support of policies and conventions, and expand societal services related to air quality, human and ecosystem health, **climate change** and food production.*

## Warnings and Air Quality Services Model intercomparisons





## GAW: Capacity Building

*Enhance capacity throughout the GAW programme and promote the use of atmospheric composition information.*

- *Advocate for the importance of GAW observations, products and services and develop capacity across all levels: from leaders to the youngest.*
- *Extend training capabilities in the regions.*
- *Intensify the use of modern communication technologies to complement in-person and on-site training.*
- *Join forces for capacity building, within WMO, within the UN Organizations and beyond UN.*





## GAW and WRCRP connections

### ***Chemistry and Climate***

*Ozone Depletion*

*Carbon cycle*

*Aerosol optical properties – Direct Radiative Forcing*

- *Dust Mineralogy and its role in Climate*
  - *EC-EARTH, ERC FRAGMENT links with NASA EMIT*

*Aerosol-cloud-interactions*

*Ocean Geochemistry – Deposition*

- *GESAMP and DOMOS*



**Earth System Modelling  
and Observations (ESMO)  
Coupled Modelling (WGCM)**

We looking for enhancinin collaboration  
and promote more synergies between us



**Thanks for your attentions**

**<https://community.wmo.int/en/activity-areas/gaw>**

**Sara Basart (sbasart@wmo.int)**

**WMO OMM**

**World Meteorological Organization**

**Organisation météorologique mondiale**