GAW's Measurement-Model Fusion for Global Total Atmospheric Deposition (MMF-GTAD) Initiative



WMO OMM

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MMF-GTAD Initiative Steering Committee

Task Force on Measurements and Modelling Meeting
11-13 May 2020

MMF-GTAD Steering Committee

- Amanda Cole, Environment and Climate Change Canada, Canada
- Joshua Fu, University of Tennessee, USA
- Lorenzo Labrador, GAW Secretariat
- Wenche Aas, NILU Norwegian Institute for Air Research, Norway
- Camilla Andersson, Swedish Meteorological and Hydrological Institute,
 Sweden
- Leonard Barrie, Stockholm University & The Cyprus Institute
- Frank Dentener, European Commission
- Corinne Galy-Lacaux, CNRS, France
- Jeffrey Geddes, Boston University, USA
- Maria Kanakidou, University of Crete, Greece
- Donna Schwede, US Environmental Protection Agency, USA
- Fabien Paulot, NOAA, USA

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Robert Vet, Retired from ECCC, Canada



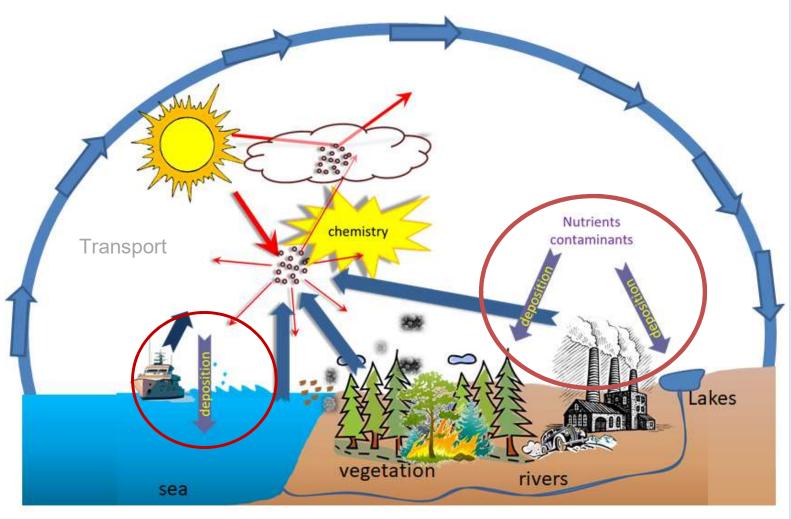
Outline

- Motivation and background
- > Stakeholder/user communities
- Long- and short-term plans





Atmospheric deposition is a key component of the Earth System



Important loss process for airborne pollutants, therefore critical term for concentrations

Input to land and aquatic ecosystems

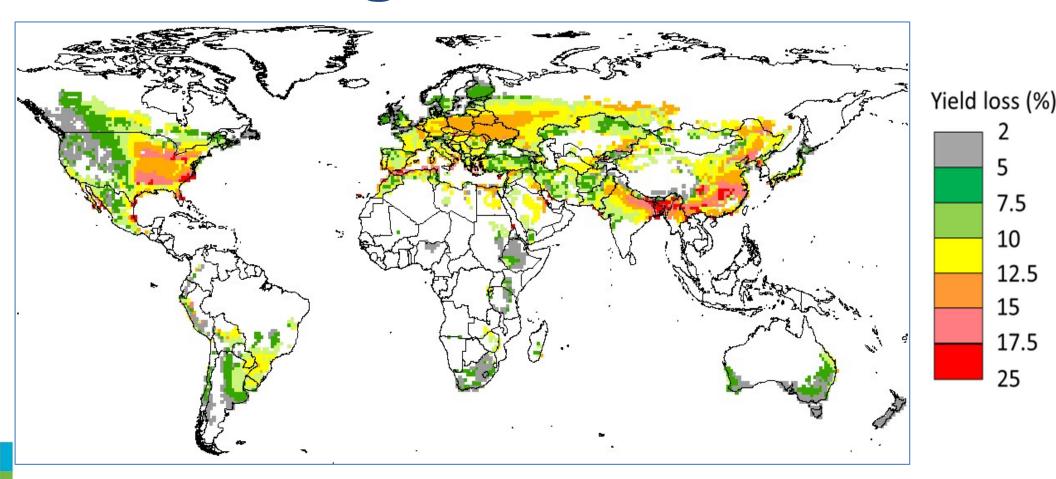
Short-term and cumulative effects

Indirect effects, e.g. links to carbon sequestration



Impact of ozone deposition on agriculture



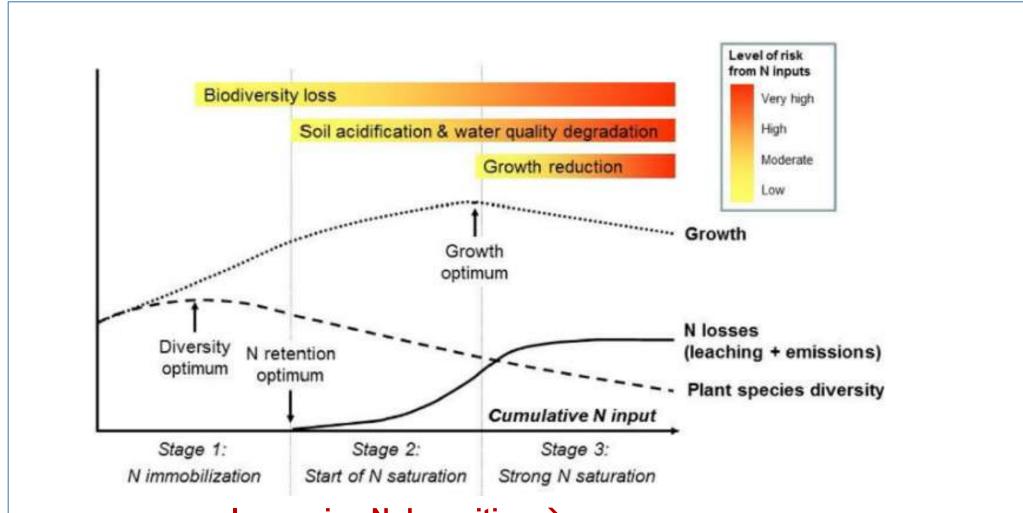


Wheat yield loss due to ozone deposition onto plant stomata (from Mills et al., 2018) **Estimated financial losses:** 14-26 billion US\$ yr⁻¹ (van Dingenen et al., 2009)



Nitrogen saturation effects on ecosystems





Increasing N deposition →



MMF-GTAD and **SDGs**



Figure 1.1 How air pollution relates to the UN Sustainable Development Goals



Reducing air pollution can help families become healthier, save on medical expenses, and improve productivity.



Power generation, industry and transportation are large contributors to air pollution. A new focus on decreasing energy consumption and on improving sustainable and public transportation could progressively reduce pollution.



Air pollution can cause crop damage and affect food quality and security.

e.g. O_3



Urban areas significantly contribute to air pollution. Making cities sustainable could progressively improve the air quality.

e.g. O₃ NO₂ PM_{2.5}



Air pollution poses a major threat to human health. It is linked to respiratory infection and cardiovascular disease. It causes increases in population morbidity and mortality.

e.g. $O_3 NO_2 PM_{25}$



Chemicals released into the air increase air pollution and contribute to harmful effects on human health. Responsible production and consumption could help to reduce these harmful chemicals.



Pollutants such as sulfur dioxide (SO₂) and nitrogen oxides (NO_x) from open fires and the combustion of fossil fuels mix with precipitation causing harmful acid rain that can compromise water quality.

e.g. SO₂ NH₃ NO_x



Combustion of fossil fuels plays a key role in the process of climate change, which places food, air and water supplies at risk, and poses a major threat to human health.



Electricity from renewable energy rather than fossil fuels offers significant public health benefits through a reduction in air pollution.



Deposition of air pollutants on water may negatively affect its quality and life under water, It can lead to eutrophication and acidification of fresh water bodies, and accumulation of toxic metals and Persistent Organic Pollutants (POPs) in fresh and marine waters.

e.g. NH₃ NO_x DON SO₂



Air pollution impacts on health, crop and forest yields, ecosystems, the climate and the built environment, with consequences for productivity and economic growth. Ambient and indoor air pollution also has negative effects on the working environment and its safety.



Emissions from combustion of fossil fuels mixed with precipitation cause acid rains that pose a major threat to forests and ecosystems.

e.g. NH₃ NO_x DON SO₂



SDG Graphic: EEA, 2017 after UNICEF 2016



MMF-GTAD: rationale

In order to assess the impacts of deposition on the environment and the UN Sustainable Development Goals, there is a need for 'best possible' atmospheric deposition maps produced operationally on a global scale. For this we propose using "Measurement-Model Fusion"

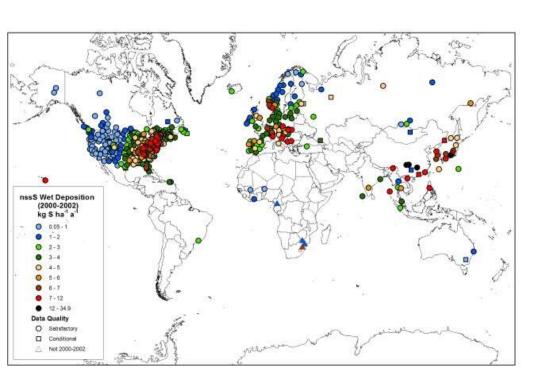


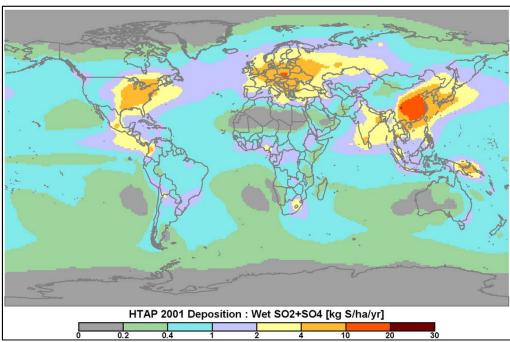
Global measurement-model comparison of atmospheric deposition



Measurement (2000-2002)

Model (2001 Ensemble Mean)



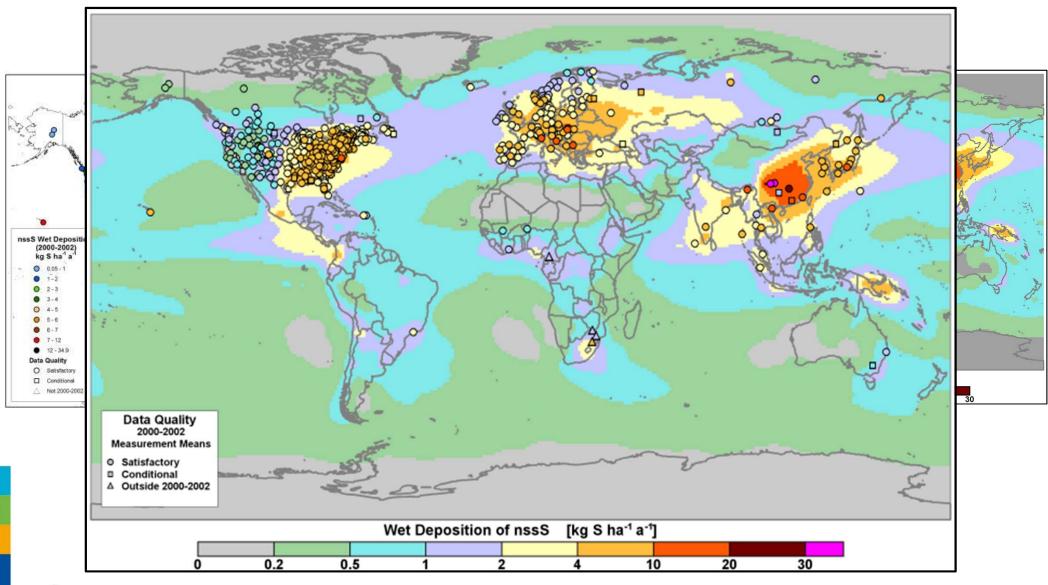


Vet et al. 2014. A global assessment of precipitation chemistry and deposition of sulfur, nitrogen, sea salt, base cations, organic acids, acidity and pH, and phosphorous, *Atmospheric Environment*, 93: 3-100.



Global measurement-model comparison of atmospheric deposition

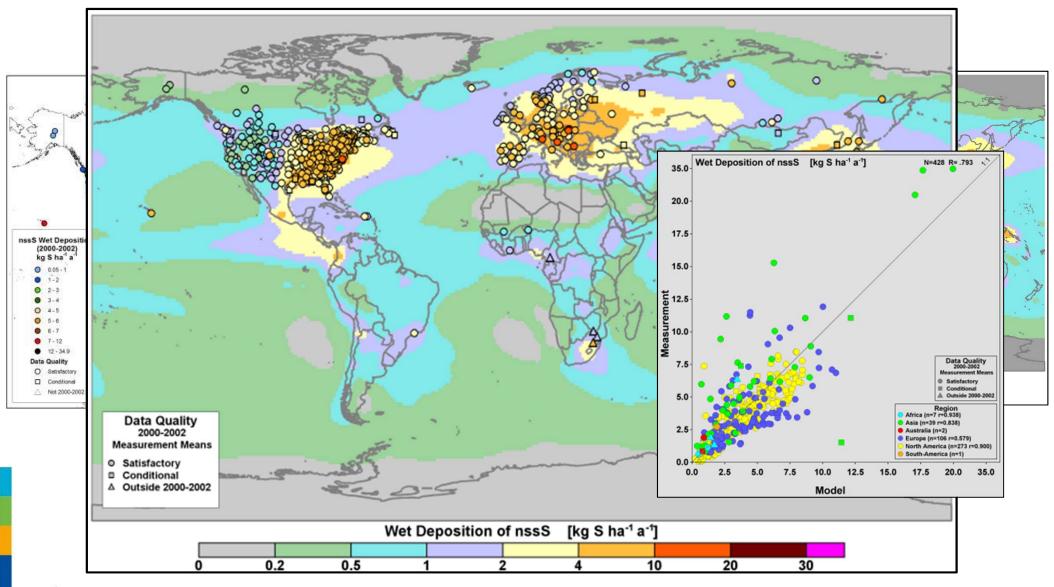






Global measurement-model comparison of atmospheric deposition



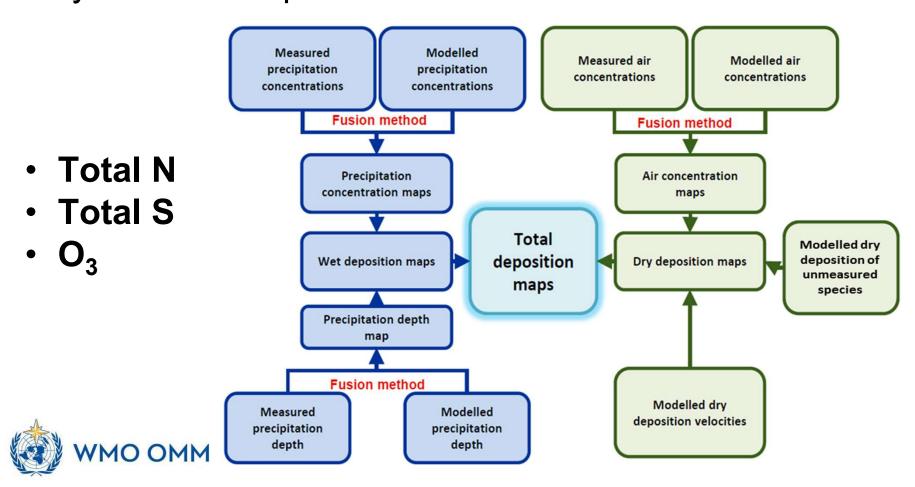






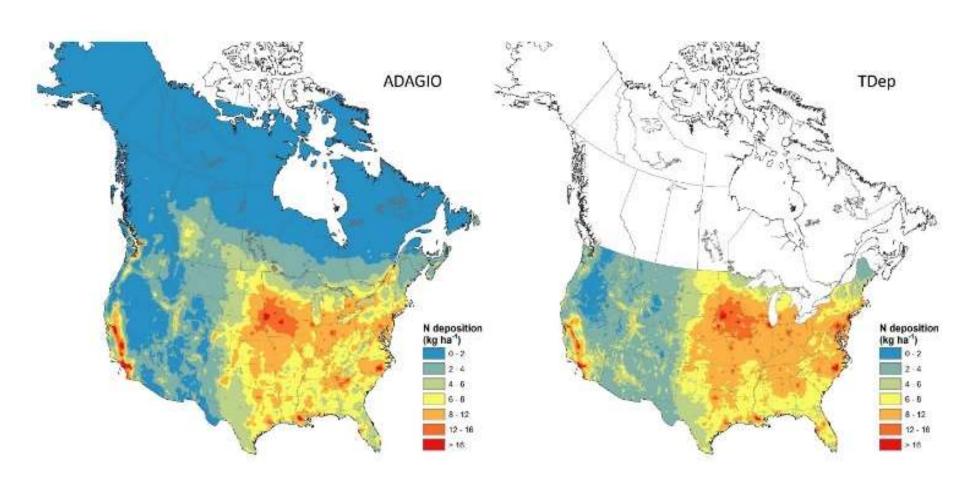
MMF-GTAD: methodology

 MMF brings together best-available data and modelling results on precipitation chemistry, precipitation depth, air concentrations and dry deposition velocities to estimate wet, dry and total deposition



Regional MMF maps: ADAGIO and TDep, N deposition





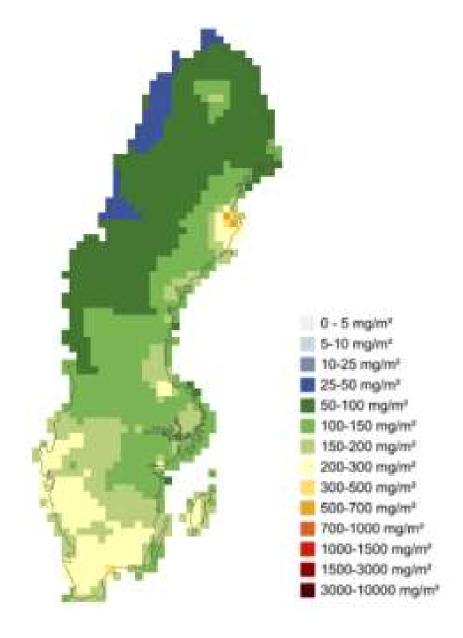
Adapted from Schwede, D., A. S. Cole, R. Vet, G. Lear. Ongoing US-Canada collaborations on nitrogen and sulfur deposition, Environmental Management, June 2019.







2017 sulfur deposition in Sweden produced by the Swedish Meteorological and Hydrological Institute (adapted from Leung et al., 2019).





MMF-GTAD products - potential users



MMF-GTAD a Science for Services Initiative

Vision: stakeholders will be able to access high-resolution, high-quality, global-scale maps of total atmospheric deposition to meet societal needs as they relate to the environment and global sustainable development.



MMF-GTAD near- and midterm activities



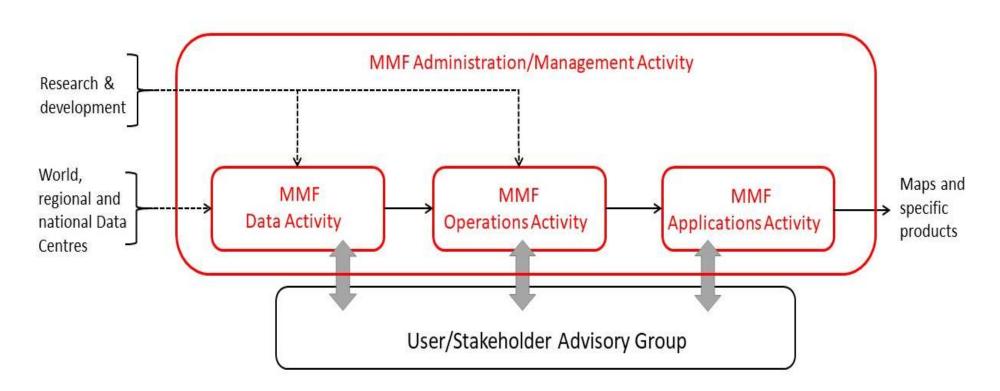
- Drafting of the project's Implementation Plan
- Publication of overview/motivation paper
- Single year global maps method development and proof of concept
- European map for regional detail
- Data harmonization strategy
- Establishment of the operational MMF-GTAD mapping system in 3 years, provided sufficient resources become available.

MMF-GTAD Project - further steps

- Establish a Resource Mobilisation Strategy for finding funds to support the near-term and mid-term Implementation Plan activities
- Establish a **method for engaging** stakeholders, end-users, and partners in the Project, e.g., a Stakeholder Advisory Group
- Use evolving scientific research and development to upgrade and improve the MMF-GTAD system, methods and products.



MMF-GTAD project - Working (a) arrangements



Conceptual diagram of the MMF-GTAD Project mapping system.





Many thanks for your attention!

https://public.wmo.int/en/resources/bulletin/measure ment-model-fusion-global-total-atmospheric-depositionwmo-initiative



Back up slides



Identified potential users of MMF-GTAD products

Ecosystems

- UN Convention for Biological Diversity (Strategic Plan for Biodiversity and Aichi Target 8, Biodiversity Indicators Partnership)
- United Nations Environment Programme (UNEP)
- International Nitrogen Management System (INMS)
- Intergovernmental Science-Policy on Biodiversity and Ecosystem Services (IPBES)
- National and regional regulatory bodies responsible for ecosystem conservation

Sustainable Agriculture and Forestry

- United Nations Food and Agriculture Organization (FAO)
- United Nations World Food Programme
- Global Partnership on Nutrient Management
- International Nitrogen Initiative (INI)
- A plethora of institutional and NGO stakeholders working on sustainable agriculture, but lacking data and knowledge on the role of deposition

Climate, Health, Water



Identified potential users of MMF-GTAD products

Ecosystems, Sustainable Agriculture and Forestry......

Climate

- United Nations Framework Convention on Climate Change (UNFCCC) and Paris Agreement
- Intergovernmental Panel on Climate Change (IPCC)
- UN Environment Programme (UNEP)
- Climate and Clean Air Coalition
- A range of institutional and NGO's working on climate change, but lacking data and knowledge on the role of deposition

Health

- World Health Organization (WHO): Air Quality Guidelines, Global Burden of Disease Assessment, Global Platform on Air Quality and Health
- National and regional regulatory bodies responsible for human health and air quality

Water

Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
 *International Maritime Organisation .