



2023 – 2025  
1.5 M€ (EU) + 0.3 M€ (CH)  
16 partners in 10 countries  
[kadi-project.eu](http://kadi-project.eu)

## GAW Kenya

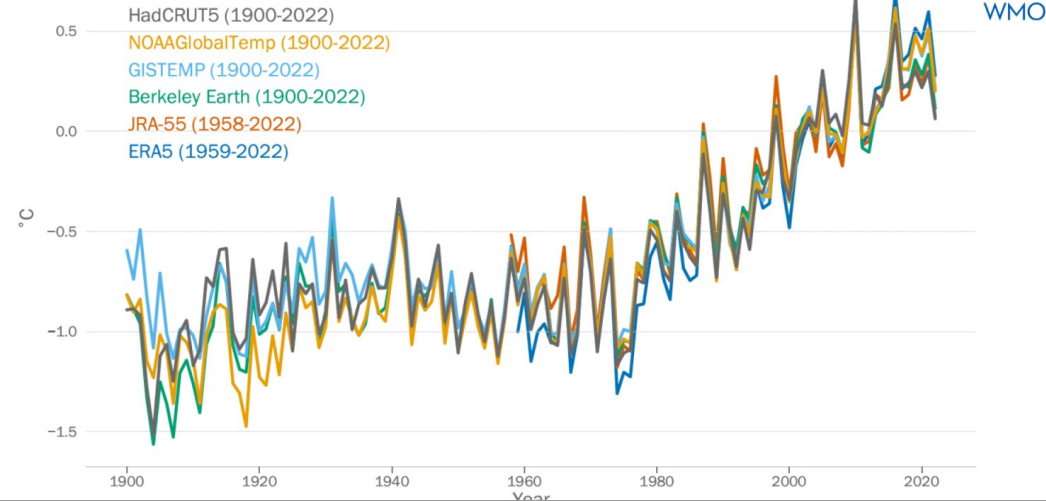
30 years of  
success, challenges and  
opportunities

Jörg Klausen

Federal Office for Meteorology and Climatology MeteoSwiss, Switzerland

# Weather and climate change are significant risks for Africa

## Africa Annual Temperature



Temperature difference in °C with respect to the 1991–2020 climatological period for Africa (WMO Regional Association I) from 1900 to 2022, based on six datasets – WMO-No. 1330, <https://wmo.int/publication-series/state-of-climate-africa-2022>



“Given Africa’s high exposure, fragility and low adaptive capacity, the **effects of climate change** are expected to

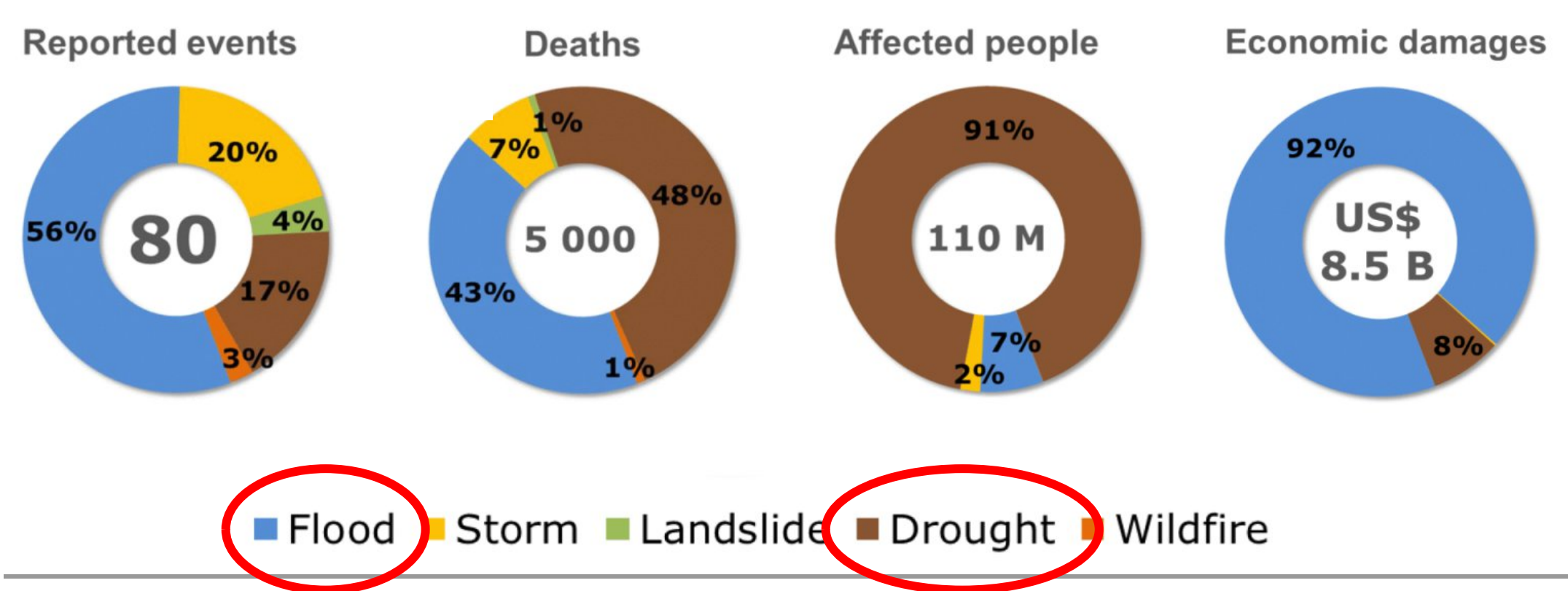
**be felt more severely.** People’s health, peace, prosperity, infrastructure, and other economic activities across many sectors in Africa are exposed to significant risks associated with climate change” – H.E.

Ambassador Josefa Leonel Correia Sacko, Commissioner for Agriculture, Rural Development, Blue Economy and Sustainable Environment at the African Union Commission

WMO-No. 1330, <https://wmo.int/publication-series/state-of-climate-africa-2022>

# Weather and climate change incur a heavy toll on Africa

2022



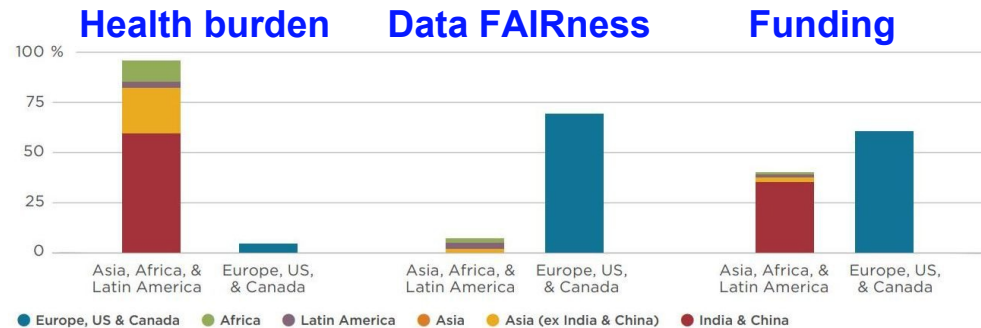
Weather-, climate- and water-related disasters in Africa in 2022. Note: The economic damages of some disaster occurrences are not presented in the figure due to data unavailability. – WMO-No. 1330, <https://wmo.int/publication-series/state-of-climate-africa-2022> Source: EM-DAT, Data as of June 2023

# Poor air quality affects millions of people in Africa

**600'000**  
deaths/year in Africa  
are associated to poor air quality

Source: UNEP, <https://www.unep.org/news-and-stories/story/air-pollution-africas-invisible-silent-killer-1>

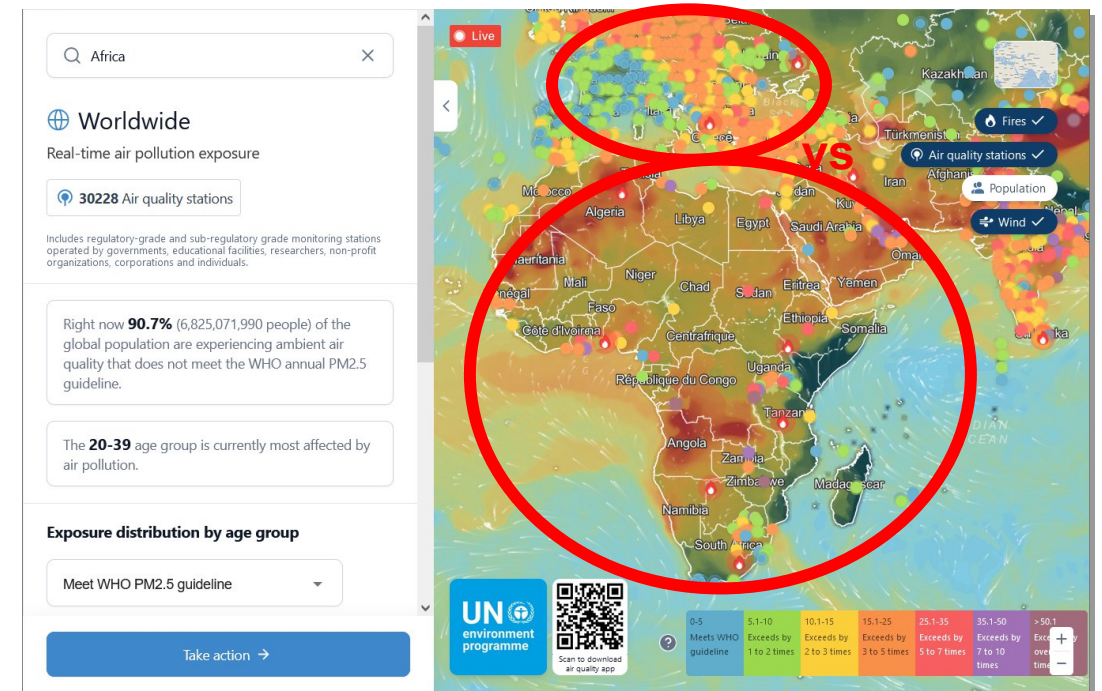
... and under-funded



Sources: \*Air Quality Life Index Annual Report 2023, \*\*OpenAQ 2022, "Open Air Quality Data: The global landscape"; \*\*\*Clean Air Fund, 2022, "The State of Global Air Quality Funding"

[https://epic.uchicago.edu/wp-content/uploads/2023/12/Fig-1.1\\_AQ-Report\\_1-e1701962024826.jpg](https://epic.uchicago.edu/wp-content/uploads/2023/12/Fig-1.1_AQ-Report_1-e1701962024826.jpg)

... and Africa is notoriously under-sampled



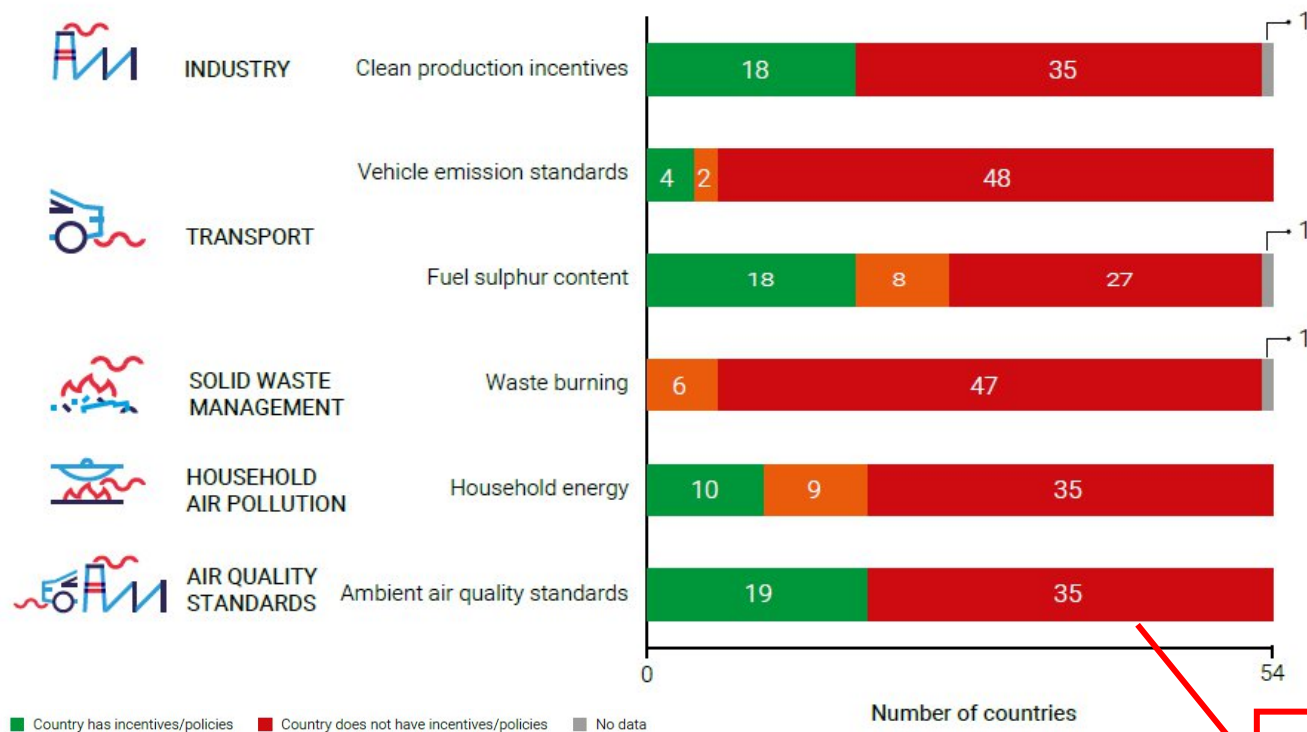
Source: <https://www.iqair.com/unep> (accessed: 2024-09-06T10:17Z)



# 2021 State of key actions to improving air quality

Figure 1. Progress towards adoption of key actions that can significantly improve air quality

Where is the Africa region in taking action to improve air quality?



Source: [https://wedocs.unep.org/bitstream/handle/20.500.11822/36696/AAQA\\_ES.pdf](https://wedocs.unep.org/bitstream/handle/20.500.11822/36696/AAQA_ES.pdf)

Positive signs for policy change and more action do exist ...



‘Regulatory’ is the keyword here!

No incentives / policy

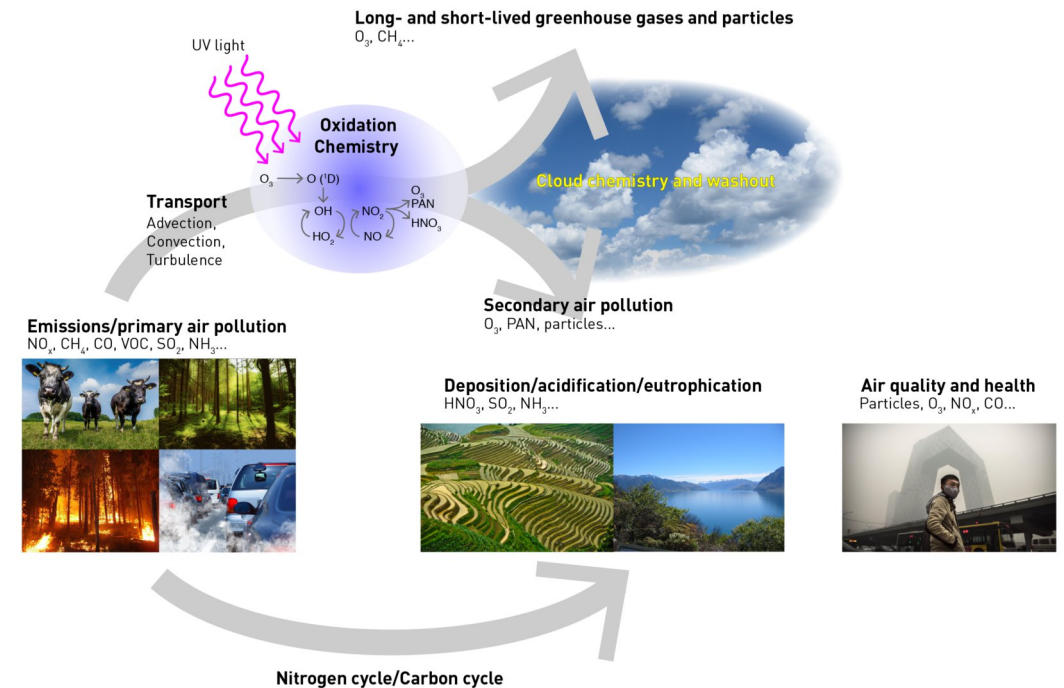


# Atmospheric composition matters!

- Climate
  - Greenhouse gases, aerosols
- Air quality and Health
  - Aerosols
  - Reactive gases incl. ozone
- Weather
  - Water vapor feedback of climate change
  - Stratospheric ozone controlling UV, stratospheric temperature
- Terrestrial ecosystems and food production
  - Aerosols
  - Reactive gases incl. ozone

☾ We can only manage what we can measure!

## Physical and chemical processes that control the composition of the atmosphere



# GAW Kenya

30 years of success,  
challenges and opportunities

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**KENYA  
METEOROLOGICAL  
DEPARTMENT**



Materials Science and Technology



**Global Monitoring Laboratory**  
Earth System Research Laboratories

WMO Global Atmosphere Watch  
World data centres on  
- Aerosols (GAW-WDCA)  
- Reactive Gases (GAW-WDCRG)

# International Context and Objectives



The mission of GAW is to

- Reduce environmental risks to society and meet the requirements of environmental conventions
  - United Nations Framework Convention on Climate Change (UNFCCC)
  - Vienna Convention for the Protection of the Ozone Layer
  - Convention on Long-Range Transboundary Air Pollution (CLRTAP)
- Strengthen capabilities to predict climate, weather and air quality
- Contribute to scientific assessments in support of environmental policy.



NASA program started in 1998

- To fill gaps in global observing network
- For satellite validation
- Trend analysis of ozone layer recovery
- UTLS dynamics and ozone exchange



# It's all about people!

- Syprose Nyadida, Francis Mutuku, Joseph Mukola, David Njiru, Mathew Mutuku (KMD)
- Christoph Zellweger, Martin Steinbacher, Stephan Henne (Empa)
- Benjamin Brem, Günter Wehrle (PSI)
- Many more colleagues of a 30-year journey ...

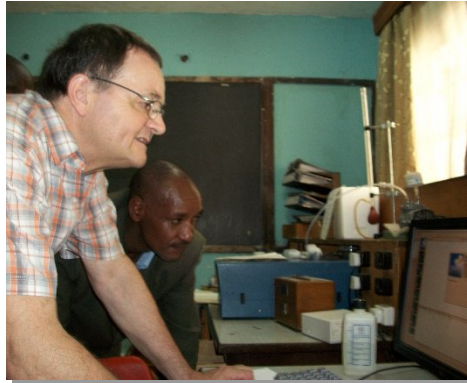


Top left to right: Wilson Kimani, John Nguo, Bruno Hoegger, Wolfgang Junkermann, Gilbert Levrat, Joseph Mukola, Zablon Shilenje, John Aseyo, Bertrand Calpini, Martin Oloo

Bottom left to right: Annet Nyaga, Gonzague Romanens, Jacques Grandjean, Kennedy Thiong'o, John Mutai, Constance Okuku, John Rotich, Getrude Muriuki, Stella, William Ayoma



# GAW Kenya: Nairobi and Mount Kenya



The station was visited by Amb. Valentin Zellweger @SwissEmbassyKE to learn about the importance of longterm observations as key inputs for accurate climate models and thus the development of [#earlywarningsystems](#) for climatic extremes affecting agriculture and food security 3/5



12:08 · 21.10.2023 from Earth · 491 Views

1994

2002

**GAW Kenya**

2015

2024



Today, Ambassador Valentin Zellweger visited the @MeteoKenya together with a delegation from #MeteoSuisse. An occasion to celebrate a great example of the close & successful partnership between 🇨🇭 and 🇰🇪 that now spans almost 30 years.



5:22 pm · 9 Sep 2021 from Nairobi, Kenya · Twitter for iPhone







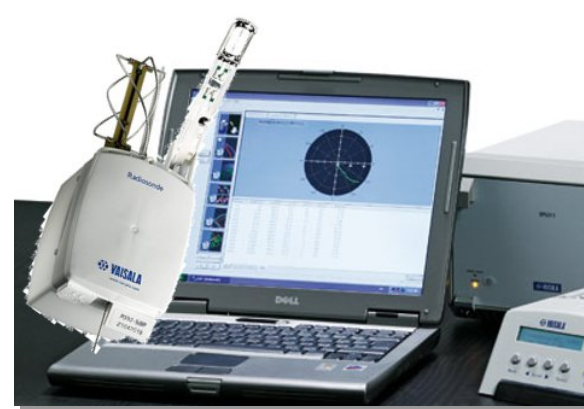
# Regional GAW Station Nairobi (NRB)

## Focus

- Ozone (total, profile, surface)

## History

- 1984: Dobson 018 at Nairobi University
- 1998: Start of ozone soundings
- 2002: Dobson 018 failed
- 2005: Dobson 018 at NRB after repair
- 2010: RS80 ozone sounding
- 2012: Surface ozone at NRB
- 2012: Ozone calibration bench at NRB
- 2019: Brewer 071 at NRB
- 2021: RS41 ozone sounding



Today, Ambassador Valentin Zellweger visited the [@MeteoKenya](#) together with a delegation from [#MeteoSuisse](#). An occasion to celebrate a great example of the close & successful partnership between  and  that now spans almost 30 years.



5:22 pm · 9 Sep 2021 from Nairobi, Kenya · Twitter for iPhone

**MeteoSwiss**

**New**

Aerosols and  
particulate matter





# Nairobi part of the NASA SHADOZ

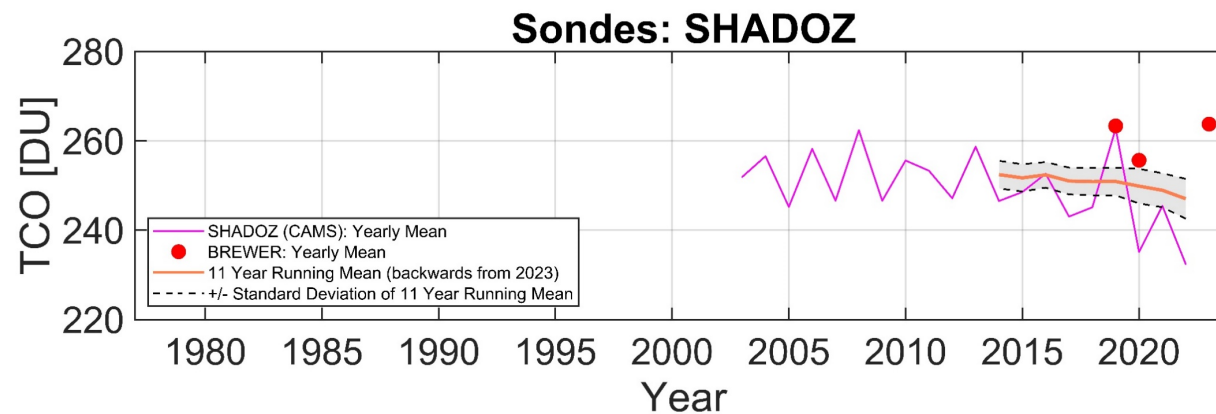
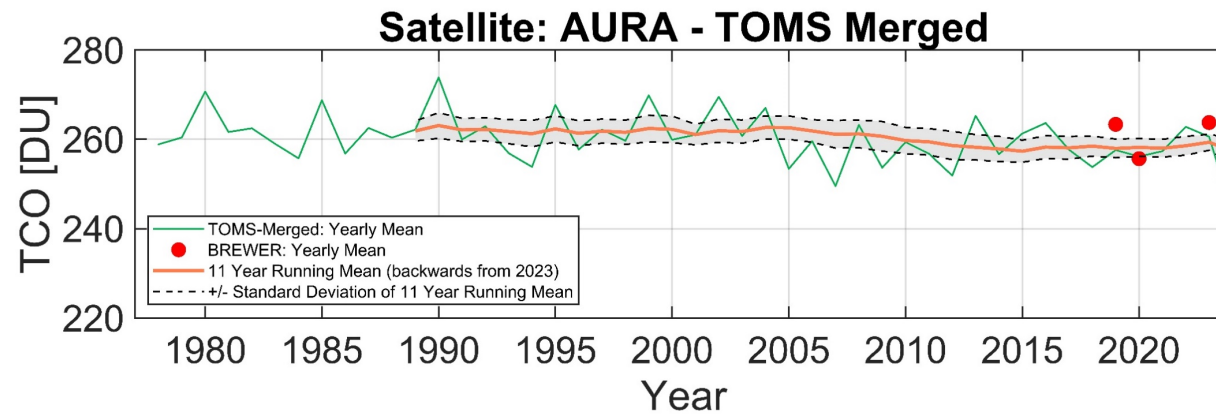
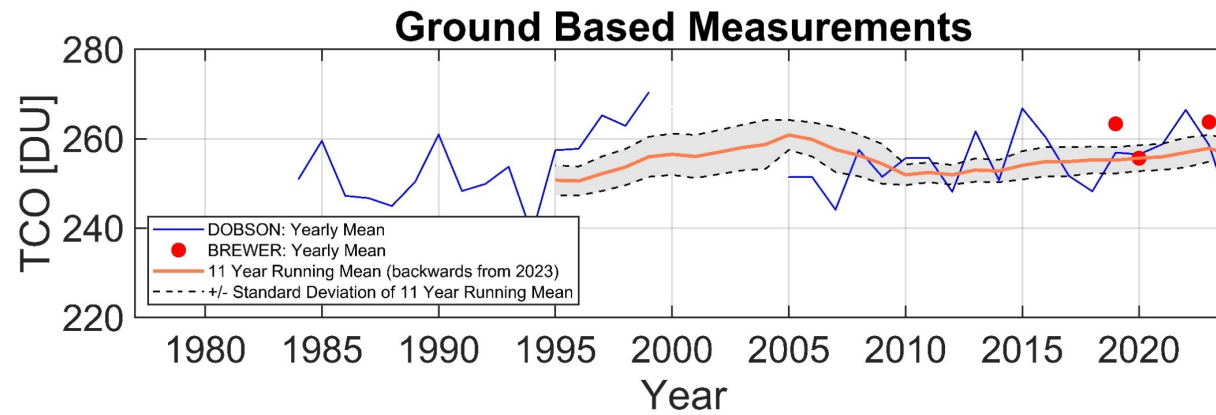
Southern Hemisphere ADditional Ozonesondes initiative

promote quality ozone profile measurements in the southern hemisphere  
to calibrate the satellite ozone retrievals



**MeteoSwiss**

# GAW Nairobi



Today, Ambassador Valentin Zellweger visited the @MeteoKenya together with a delegation from #MeteoSuisse. An occasion to celebrate a great example of the close & successful partnership between 🇨🇰 and 🇨🇭 that now spans almost 30 years.



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# Global GAW Station Mount Kenya

## Focus

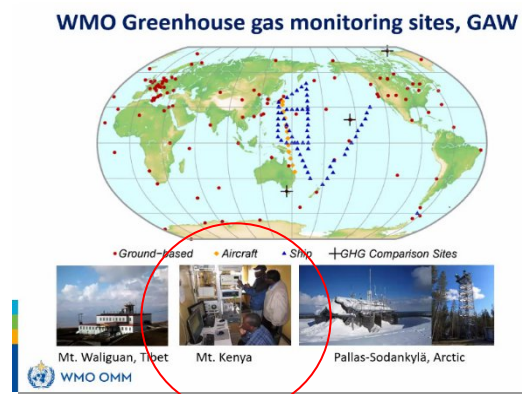
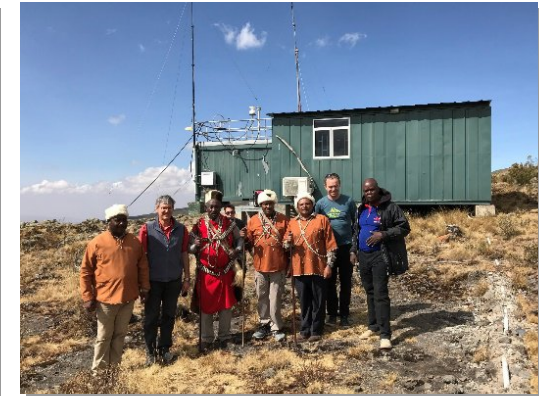
- Surface ozone, CO, greenhouse gases, aerosols

## History

- 1994-1998: Site recognition and build-up
- 2001: Support through Empa, MeteoSwiss
- 2006-2007: 1<sup>st</sup> attempt to establish GHG measurements, renewal of meteo
- 2016-2018: Renewal of powerline, aerosol optical properties with PSI
- 2020: Renewal of GHG measurements
- 2021: WMO SG Petteri Taalas mentions station in context of G3W.



Bruno Hoegger, Gilbert Levrat,  
Wolfgang Junckermann, Wilson Kimani, ...



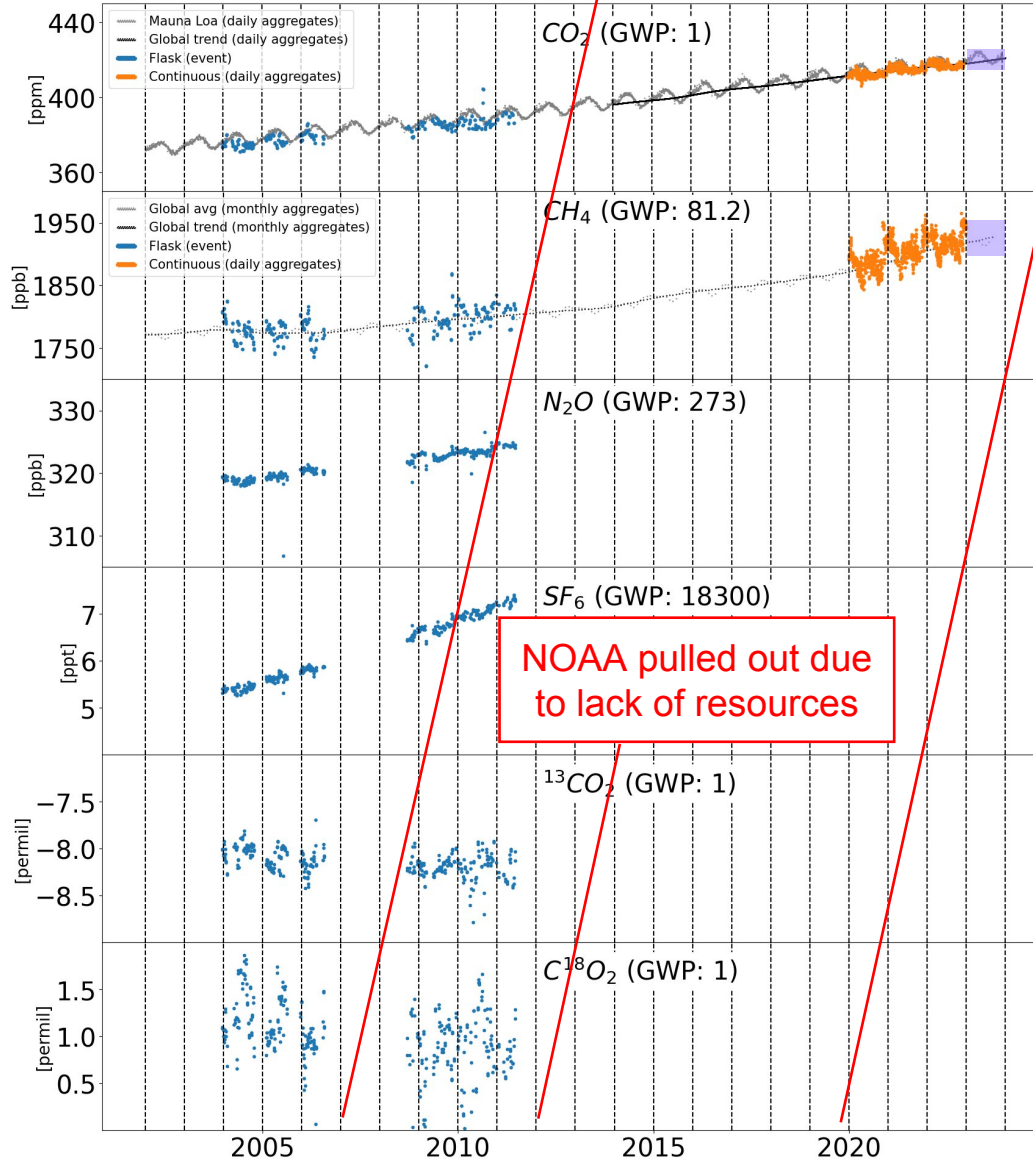




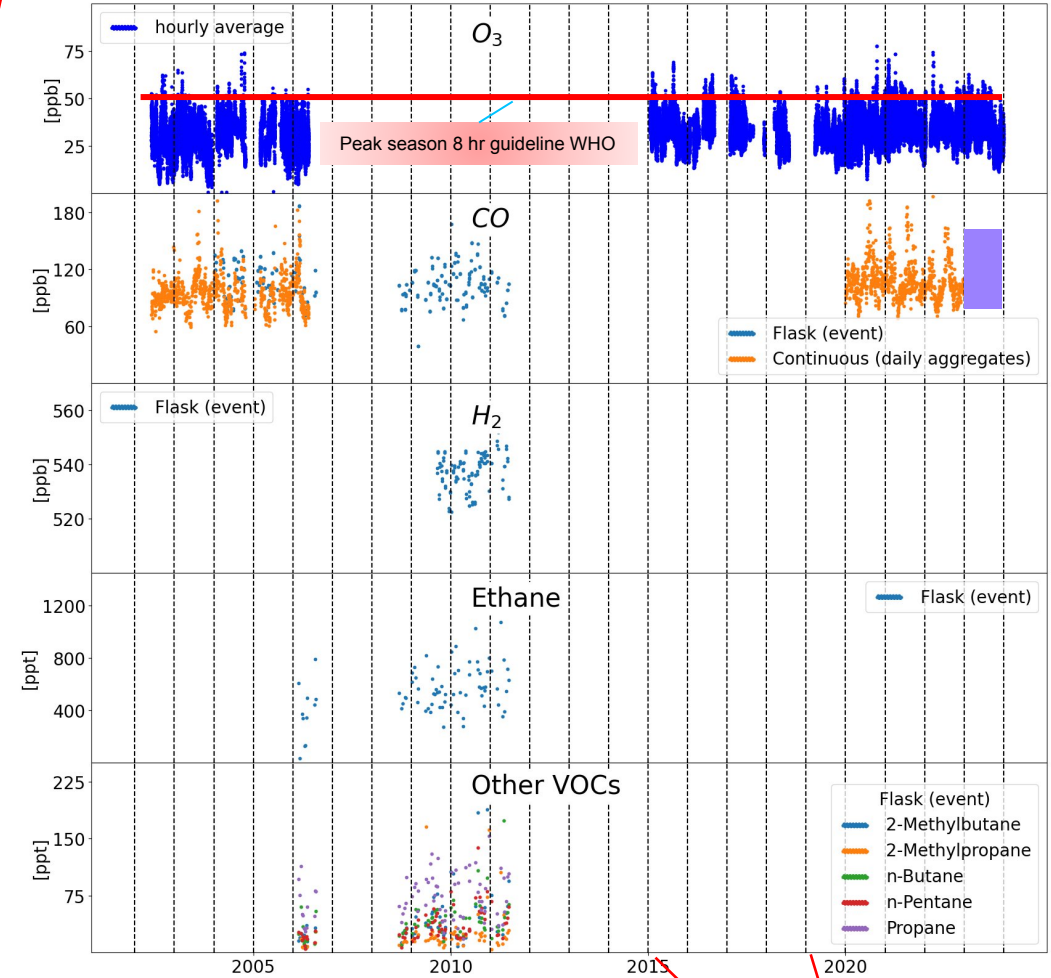
# Trace gases

MeteoSwiss/Empa  
launched 1<sup>st</sup> Picarro  
analyzer ... failed

MeteoSwiss/Empa  
launched 2<sup>nd</sup> Picarro  
analyzer ... failed



NOAA pulled out due  
to lack of resources



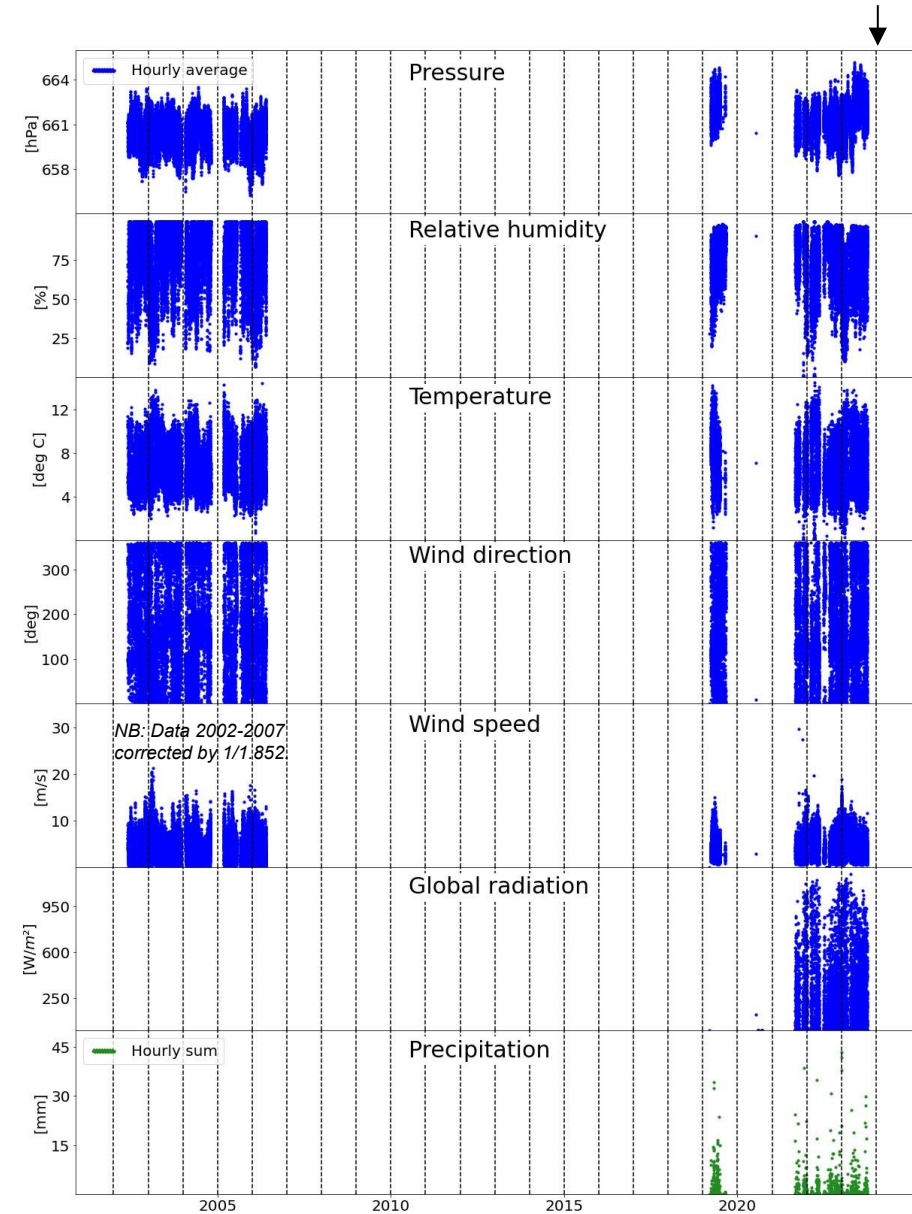
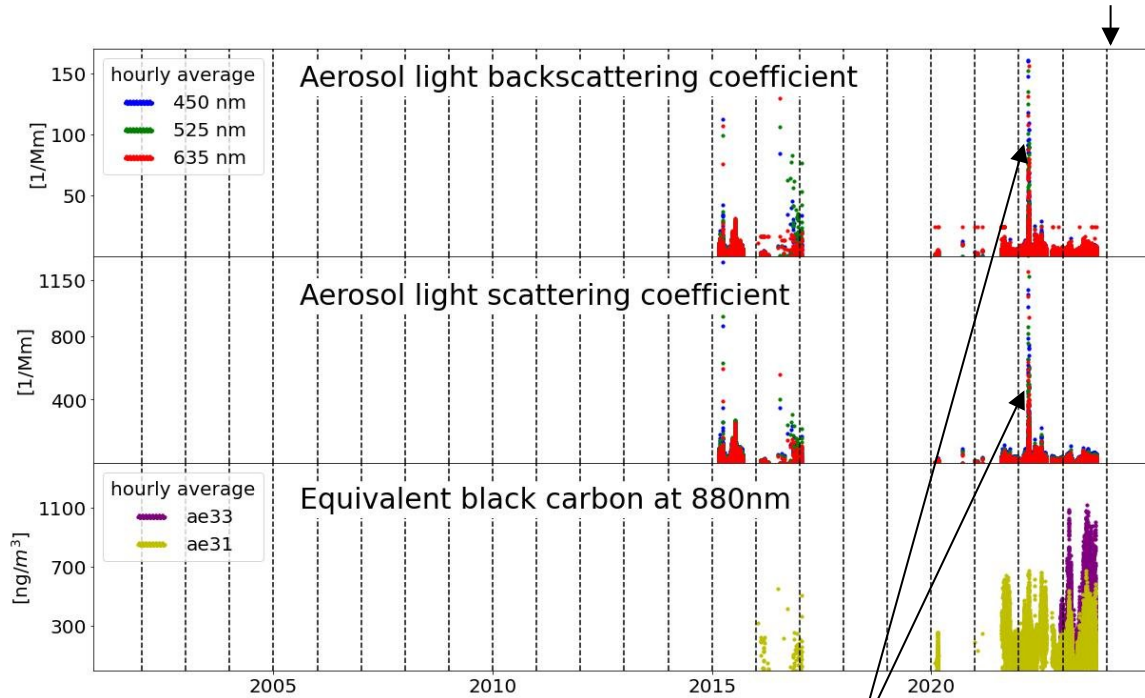
Power line  
issues

Power line renewed

UPS renewed



# Aerosols and meteorology

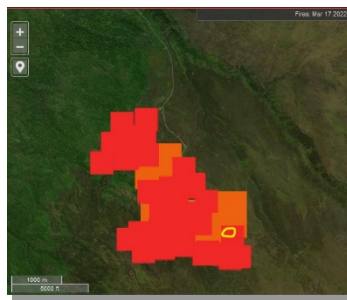


Njiru David Murithi  
Forwarded

13:33

Hi all. The are reports of fire at the mountain. Teams have been mobilized to stop the fire from engulfing the old Moses Camp. We pray that it does not spread to the power line or worse to our station. Photo taken from the Sirmon Gate.  
More will follow wn we get them 🙏🙏🙏

13:37







# Long-term observations need commitment

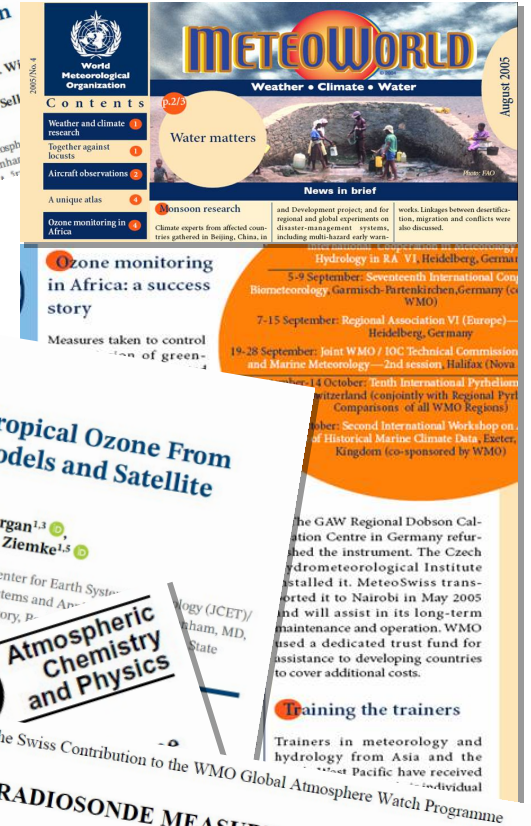
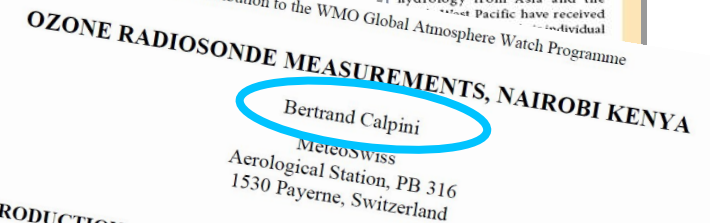
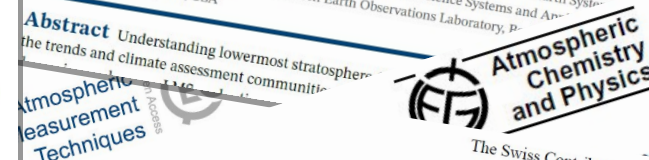
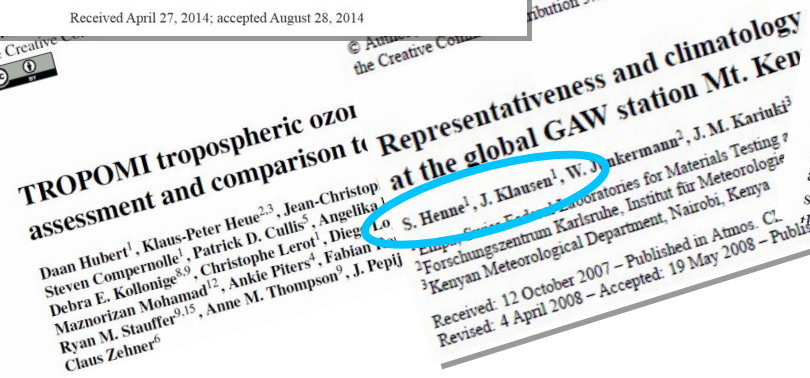
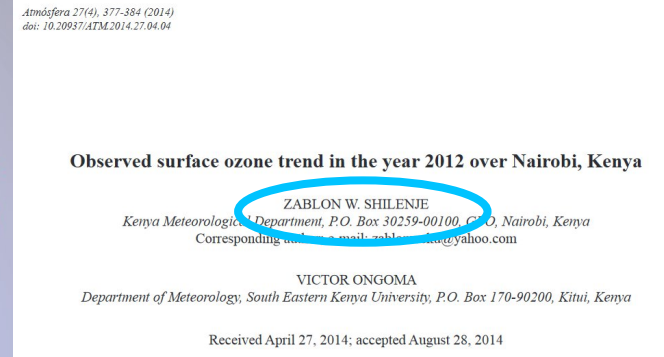
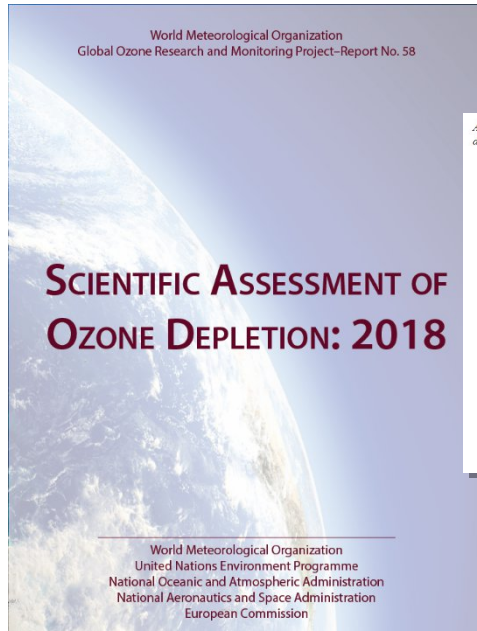
- Basic infrastructure maintenance
  - Preventive and corrective instrument maintenance
  - Calibration of instruments
  - Life-cycle replacement of instrumentation
  - Continuous QA/QC
  - Scientific exploitation of data
  - Training of operators and technicians
- à **Improved data quality**
- à **Improved (scientific/societal) services**





# Opportunity for science

- Numerous papers and technical reports, conference proceedings
- Foundation for MSc theses and other studies by KMD colleagues!





# CAMS model validation



KENYA  
METEOROLOGICAL  
DEPARTMENT

Empa  
Materials Science and Technology



Federal Office of Meteorology and  
Climatology MeteoSwiss

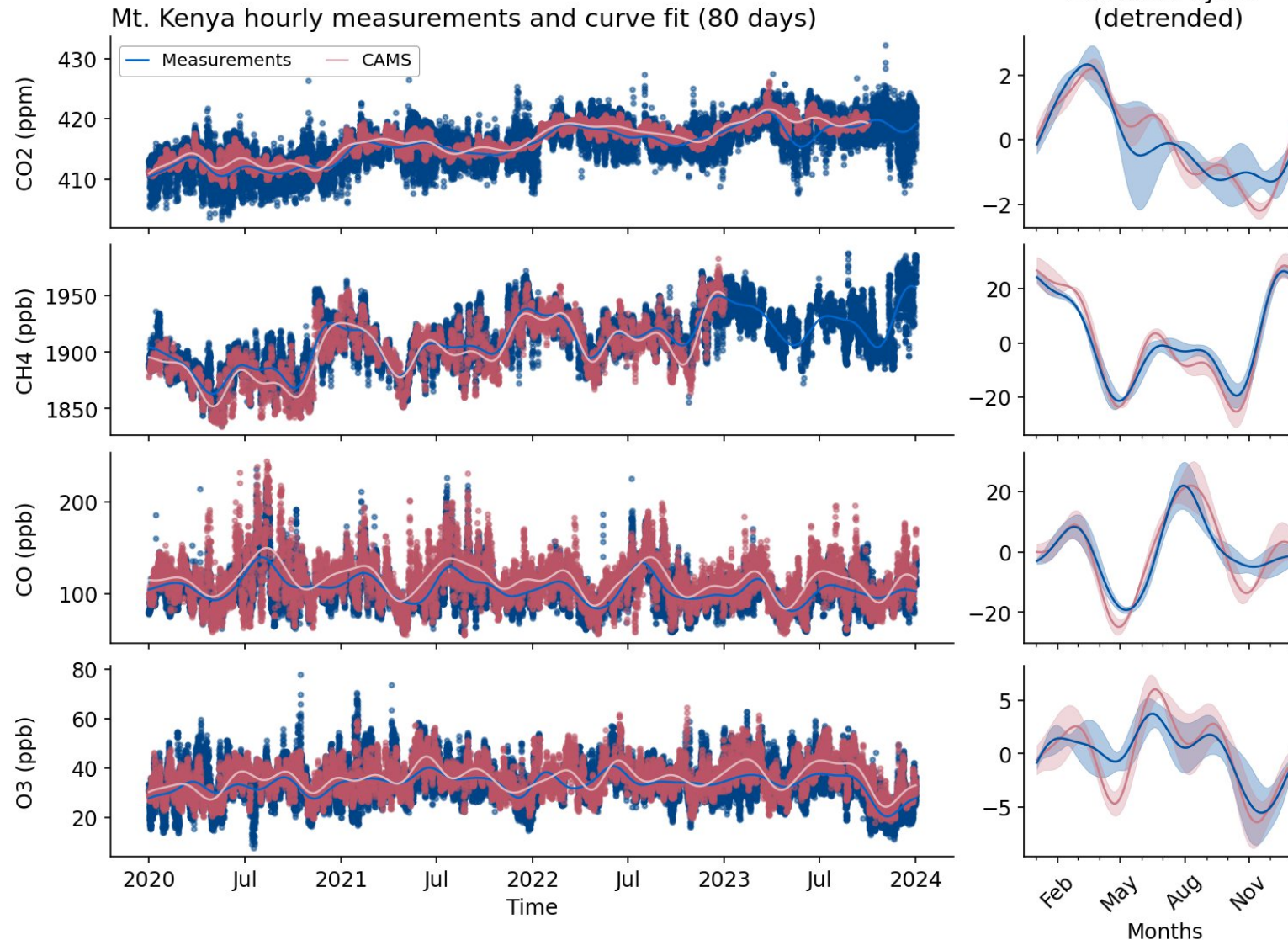


Copernicus  
Europe's eyes on Earth

Atmosphere  
Monitoring Service

IMPLEMENTED BY  
ECMWF

Seasonal cycle  
(detrended)



Excellent value of long-term observations for model and satellite validation.

☾ Many more science and services opportunities exist





# Impact

- Data are used in **global science**, e.g., SHADOZ, GAW
  - improve understanding of climate change, ozone layer recovery
  - ground truth for satellite validation
  - WMO/UNEP Ozone Assessment
- Data can be used for **global services**, e.g.,
  - CAMS
  - Global Greenhouse Gas Watch
  - National GHG Reporting under UNFCCC
- **Kenyan society**
  - Professional opportunities for local staff
  - Technology transfer and training opportunities for higher education
  - Raised awareness in the Kenyan population, improved policy decisions
- **Global societies**
  - Investments in Africa have a political dimension > developing scientific and economic capacity > increasing political stability > lowering need for migration > ...

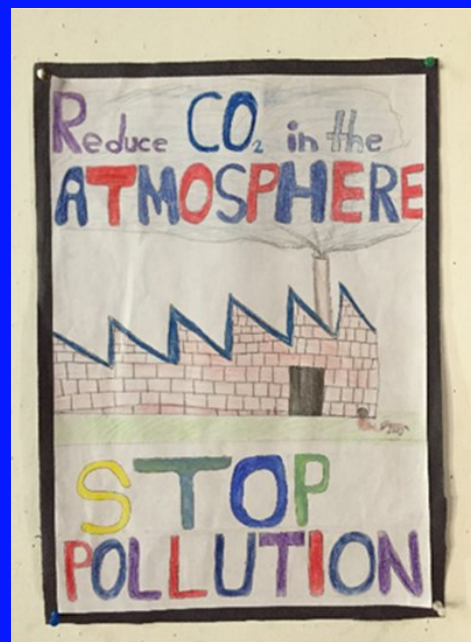
# Challenges, conclusions and lessons learned

- **Long-term surface-based measurements** are needed for understanding atmospheric and ecosystem behaviour in the tropics, and they are **invaluable complements to satellite observations**.
  - ☾ To resource them is a perennial struggle!
- **Capacity development** and knowledge transfer has to be **continuous**, often **multi-decadal**, and **equitable** to address requirements and secure sustainable operations
  - ☾ academic education often too theoretical, lack of practical experience
  - ☾ impermeable barrier wrt to technical vs data/science-related tasks between operators/meteorologists (never touch an instrument/data) and technicians (never touch data)
  - ☾ to get young talent and to keep them engaged is a recurring challenge!
- **Open data sharing increases the usefulness of observations**
  - ☾ National regulations and revenue models must change!

## Challenges, conclusions and lessons learned (cont'd)

- KMD/Kenya has shown commitment to GAW, but the organization is not ready to take on full ownership even after 30 years
  - ☾ requires a compulsory mandate for engagement in air quality (?)
  - ☾ need for additional financial/human resources at department level to maintain infrastructure and access to station
  - ☾ improve hand-over when rotating staff to avoid loss of existing scientific and engineering capacity
- One single foreign partner (i.e., Switzerland) is a high-risk and cannot be the long-term perspective
  - ☾ Capacity needs to improve within the country
- Engage more stakeholders in operations and scientific exploitation, develop a “community-of-practice”
  - ☾ Please step forward and seize the opportunity!! Anyone?

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joerg.klausen@meteoswiss.ch



Kids' posters seen at Giraffe Center, Nairobi, 2017



KADI, Knowledge and climate services from an African observation and Data research Infrastructure, has received funding from the European Union's Horizon Europe Programme and from the State Secretariat for Education, Research, and Innovation SERI under grant agreement No 101058525.