Virtual discussion forum for the expansion of the global network of ODSs, HFCs, and other compounds of interest to the Montreal Protocol

16 March 2022, 21:00-24:00 UTC

The discovery in 2018 of an unexpected increase of CFC-11 emissions by Montzka et al.[1] exposed the limitations of both reporting and the observation networks for quantifying regional emissions of ozone depleting substances (ODSs). These unexpected CFC-11 emissions were initially detected via global measurements, and the locations of only about half of these emissions could be identified and quantified based on then-existing monitoring station locations [Rigby et al.[2]]. The limited existing measurement sites meant possible emissions from many parts of the world could neither be identified nor quantified.

The purpose of this 3-hour on-line forum is to discuss ideas and present information on the development of an improved monitoring network to identify and quantify emissions of Montreal Protocol gases (ODSs and HFCs) from additional regions of the globe. In particular, the workshop is focused on:

1) Understanding sources of emissions: past production and consumption, the evolution of banks, and accuracy of bottom-up emissions,
2) The future evolution of ODSs, hydrofluorocarbons (HFCs), and other compounds of importance to the Montreal Protocol,
3) Observational systems and techniques including standards and the metrology of these measurement systems,
4) Siting and development of new stations for improving regional coverage of Montreal Protocol gases (ODSs and HFCs).

Registration: (WebEx):
https://unep.webex.com/unep/onstage/g.php?MTID=e7750f78b49a06cc94563dea40bc4e026

Agenda (3 hours in duration)

1. *Introduction (10 minutes)*

   Meeting Goals – Cornelius Rhein (EU), Sophia Mylona (UNEP Ozone Secretariat)

   Background Material – A. R. Ravishankara (Colorado State U.)

2. *Where has most production & consumption occurred? Current status and banks? (20 minutes)*

   Bayesian Modeling of Halocarbon Banks

   Megan Lickley (MIT)

   This talk will present a Bayesian probabilistic banks model, previously published to quantify CFC-11, 12 and 113 banks and their emissions, that incorporates the widest range of constraints to date. This model has been extended to the suite of banked chemicals regulated under the Montreal Protocol (HCFC-22, HCFC -141b, and HCFC-142b, halon-1211, and

[1] Montzka, S. A. et al. An unexpected and persistent increase in global emissions of ozone-depleting CFC-11. Nature 557, 413 (2018).
[2] Rigby, M., et al., Increase in CFC-11 emissions from eastern China based on atmospheric observations, Nature, 569, 546 (2019)

halon-1301, and CFC-11, CFC-12, CFC-113, CFC-114 and CFC-115). This work shows that banks are very likely larger than previous international assessments suggest, and identifies the largest banks by chemical and equipment type. Finally, I will discuss reasons for discrepancies between this work and previous methods and discuss opportunities for improved modeling.

Bottom-up Modeling of Emissions

Helen Walter-Terrinoni (AHRI)

[TBD]

3. *Where will future production of ODSs and HFCs occur? (20 minutes)*

Modelling long-term HFC emissions with mitigation potential and costs – GAINS model methodology

Pallav Purohit (IIASA)

The emissions of hydrofluorocarbons (HFCs) have increased significantly in the past two decades, primarily as a result of the phaseout of ozone depleting substances under the Montreal Protocol and the use of HFCs as their replacements. While HFCs do not deplete ozone, many are potent greenhouse gases and as such subject to global phase-down under the Kigali Amendment to the Montreal Protocol. We present the GAINS (Greenhouse gas - Air pollution Interactions and Synergies) methodology for estimating current and future HFC emissions, their abatement potentials, and costs for replacement with alternative synthetic and natural substances, all at the resolution of 14 source sectors identified for 180 countries and regions, which can be aggregated to produce global estimates. Models like GAINS can be used to assess the extent of future demand for HFCs and the expected geographical distribution of emissions and costs under alternative abatement pathways. GAINS is however not modelling the global trade of HFCs and how markets affect the regional allocation of HFC production.

Can Trade Inform Consumption of Montreal Protocol Gases?

Smriti Kumble (Rocky Mountain Institute)

Montreal Protocol gases are not always consumed where they are produced, but are traded internationally. Using HFCs as an example, we analyzed publicly-reported commodity trade data from 2017-2019 to track imports and estimate consumption in developing countries. This approach can be extended to other MP gases and longer time frames, and could provide an additional source of data for modeling future emissions.

4. *What are the principal measurement techniques? Costs? (30 minutes)*

In-Situ High Frequency Measurements

Martin Vollmer (Empa)

A brief overview will be given of the state-of-the art measurement techniques and focus on high-frequency measurements for ODSs and halogenated GHGs. The largest in-situ measurement network is currently that of AGAGE (Advanced Global Atmospheric Gases Experiment) using Medusa-GCMS technique. The sites deliver 2-hourly measurements thereby contributing to a global assessment of trends and gradients, and delivering high-resolution information for regional emissions estimates within the footprints of the station. Costs of instruments, continuous operations are touched on, as well as new potential commercial instrument options.

Flask Measurements for Regional Emission Quantification

Stephen Montzka (NOAA)

A multi-site flask-sampling network has enabled estimates U.S. emissions of long-lived trace gases on regional scales since 2008. Flask sampling for deriving regional emissions with atmospheric measurements provides some advantages over on-site instrumentation that are related to flexibility, costs, resource commitments, on-the-ground personnel requirements, site-to-site data consistency, and instrument maintenance. Low-cost flask sampling approaches can provide initial surveys of emissions regionally, whereas additional resources can sustain automated sampling at higher frequencies (1 to 2 flasks/day is routine). This presentation will include a discussion of these different approaches for providing regional emission estimates and identify some considerations that may assist Parties in assessing how best to fill gaps in the existing global trace-gas measurement network.

Calibration, Standards, and Metrology

Bradley Hall (NOAA)

Maintaining high-quality standards for calibration is essential for detecting trends and gradients in atmospheric mixing ratios. A few organizations maintain calibration scales for a number of ozone-depleting substances and related gases, and have experience collecting whole air that can be used for reference. Close collaborations between observing networks along with co-located sampling at some sites have been beneficial, and collaborations with National Metrology Institutes may help fill gaps in calibration scale development. Current practices and future challenges with respect to calibration will be discussed.

5. *Where could we best locate new stations to monitor these ODSs and HFCs? Sampling frequencies? Meteorology? (20 minutes)*

Selecting New Observing Locations

Ron Prinn (MIT)

A method for selecting new observing locations using bottom-up estimations of the spatial distribution of potential emissions and computation of the emission sensitivities (footprints) of potential observing sites is presented. For bottom-up emissions, a machine learning model (ML) is trained using annual global VIIRS nighttime light radiance and socio-economic datasets as inputs, and top-down emission estimates of CFC-11 in eastern China as the ground truth. The ML model suggests that south China, India, Malaysia, Eastern Europe, Turkey, Mexico, and Brazil are more likely to have unreported emissions. Based on this, potential candidates for new observing sites are selected, and their footprints by season using the NAME Lagrangian model are computed. The ability of potential surface sites to constrain emissions can be significantly affected by regional climatology (e.g., Asian monsoon) and regional topography (e.g., surrounding high mountains). For high-spatial resolution emission estimations, the need for sampling frequencies that resolve regional pollution events is discussed.

An Exploration of Measurement Site Location and Sampling Frequency for Emissions Estimates

Luke Western (U. Bristol & NOAA)

This talk will present results from an idealized modelling study on the impact of measurement frequency and sampling period on uncertainties in emissions derived using inverse modelling. An increased measurement frequency gives diminishing returns when trying to reduce emissions uncertainty. The pros and cons of site placement (e.g., distance from sources, elevation) will be discussed in the context of emissions quantification using inverse modelling.

6. *Q&A and Discussion – Paul Newman (NASA) (70 minutes*)