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**Long-term observations of halogenated trace gases at Jungfraujoch for estimating global and regional emission trends**

Since the 1930s, halogenated gases have been used in a wide spectrum of anthropogenic applications, from foam blowing over fire retardant to refrigerant. Different generations of halogenated gases have contributed to environmental problems (stratospheric ozone depletion, global warming) and, as such, their emissive production and use has been targeted by various international treaties (Montreal Proto-col and its amendments, Kyoto Protocol, Paris Agreement). Long-term atmospheric observations and atmospheric models are the core validation tools for confirming/checking compliance with agreed-upon phase-out and phase-down scenarios.

Since 2000, Empa carries out continuous, in-situ measurements of more than 50 halogenated trace gases at Jungfraujoch as part of the global AGAGE network (Advanced Global Atmospheric Gases Ex-periment). Combining these observations with global scale transport and chemistry models, it is possi-ble to derive global emission trends of most of these long-lived compounds. For most of the ozone depleting substances (chlorofluorocarbons, hydrochlorofluorocarbons, halons) estimated emissions trends confirm compliance with the Montreal protocol. However, discrepancies for others serve as a warning system and point to where additional efforts for emission reductions are needed. Similarly, global trends of compounds targeted solely for their large global warming potential (hydrofluorocar-bons), show first indications of the more recent regulation efforts.

In addition to global scale studies and because the site is frequently impacted by regional pollution events, Jungfraujoch observations can be used to estimate spatially resolved emissions from Switzer-land and across Europe. Swiss national total emissions are routinely estimated by a tracer-ratio method and provided as part of the national inventory report to UNFCCC. At the regional scale, atmospheric transport models are applied to provide the link between observations and emissions. In the last two decades, these transport models have evolved from a relatively coarse grid resolution, barely suitable for representing high-Alpine observations, to a kilometer-scale resolution, allowing emission estimates on increasingly finer scales.