Trends in ozone-depleting substances and the ODGI

Chlorofluorocarbons
Halons
Chlorinated and Brominated chemicals

Hydrochlorofluorocarbons

Hydrofluorocarbons

Support personnel
Station personnel

Air sampling at South Pole
**Observing** global changes:
With global sampling networks, custom instrumentation, high-accuracy standardization, analysis of air trapped in glacial snow

**Guiding** ozone layer recovery & monitoring compliance:

**Understanding** the underlying causes of observed global changes:
NOAA halocarbon surface sampling network
NOAA halocarbon surface sampling network

- **CFC-12**
  - BRW
  - NWR
  - MLO
  - SMO
  - SPO

- **CFC-11**

- **CCl₄**

- **Halon 1211**
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**Guiding ozone layer recovery & monitoring compliance:**

*Is the Montreal Protocol working? Is ozone recovery proceeding as expected? When will halogen levels return to 1980 levels?*

**Understanding the underlying causes of observed global changes:**
Is the Montreal Protocol working? Most ODSs are decreasing, replacements (HCFCs) are increasing.
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**Summarizing trends for all ODSs:** Effective Equivalent Chlorine (EECl)

Global EECl $[\text{Cl} + (\text{Br} \times 60)]^*f$

Down 11% from peak!!
Effective Equivalent Stratospheric Chlorine Projections (WMO, 2007)
For mid-latitudes

The Ozone Depleting Gas Index

ODGI_{2007} = 73

The Ozone Depleting Gas Index

1980 level

ESRL Data
A1 (WMO 2006)
EESC in1980
Past Data

NOAA/ESRL
Over Antarctica it will take longer for EESC to return to 1980 levels (Newman et al., 2006)
Measuring Atmospheric Halocarbon Trends at NOAA/ESRL
Ozone-depleting substances and substitute chemicals

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How are banks affecting ODS emissions and abundances?

**Understanding the underlying causes of observed global changes:**
Refining future projections with observations

Data: NOAA & AGAGE
Refining future projections with observations

Implications:
- Larger Bank?
- Unaccounted production?
- Slower recovery?

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**Understanding** the underlying causes of observed global changes:
Recent changes in global HCFC mixing ratios and growth rates

As of 2004 (WMO 2007)
Recent changes in global HCFC mixing ratios and growth rates

Accelerated growth rates after 2004 for the 3 abundant HCFCs, but not for HFCs.

Cl from HCFCs:
- in 2004: +5.9 ppt/yr
- in 2007: +9 ppt/yr
Emissions derived from global changes compared to recent WMO(2007) scenario Ab projection…

Substantial emission increases recently!
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HCFC Emissions (GWP-weighted)
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How are CH$_3$Br abundances influenced by exemptions & non-regulated use?

**Understanding** the underlying causes of observed global changes:
Atmospheric Observations of CH$_3$Br*

- Despite large natural sources, CH$_3$Br has declined globally nearly every year since production decreases began (1999).

- Northern Hemisphere declines are twice those in the SH.

- Despite exemptions and non-regulated consumption, overall the decline has been faster than expected.

- Observations allow an estimate of the [Anthropogenic/Total]$_{1997}$ source fraction: 30 (20-40)%.

*Updated Montzka, et al. (2003)
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Will halogen levels overall continue to decline (short vs long-lived drivers)?

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**Understanding the underlying causes of observed global changes:**

*Related to sources:*
Quantifying sources on global *and* national scales.
Quantifying other gases (VSLS) and other processes (ocean, land, biosphere).
Regional-Scale Measurements

Aircraft profiles
Surface Stations
Tall Towers

Regular ongoing aircraft profile sampling and ~daily flask samples at non-remote, tall tower locations…
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**Related to sinks:**
Assessing abundance and variability of atmospheric hydroxyl radical (OH)
Assessing the magnitude of land sinks on continental scales.
$\text{CH}_3\text{CCl}_3 \text{ from the NOAA surface flask network}$

- **Mixing Ratio (ppt)**
- **(NH - SH) / mean**

- **Northern Hemisphere**
- **Southern Hemisphere**
- **(NH - SH)/mean**

Data showing the decrease in $\text{CH}_3\text{CCl}_3$ levels over time in both hemispheres.
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