**Refrigerant Column, August 2024**

# R23 Emissions on the Rise

*By Björn Palm*

Most readers of *Cooling & Heat Pumps* are familiar with the **Montreal Protocol**, a landmark international agreement that successfully limited emissions of ozone-depleting substances. Fewer may realize that the Protocol also has a **Kigali Amendment**, which sets out a phase-down schedule for powerful greenhouse gases—much like the EU's own F-gas Regulation.

What is less well known is that the Montreal Protocol involves **annual meetings** to review compliance and, if needed, adopt new measures. These sessions are hosted by UNEP's Ozone Secretariat and bring together scientists, policymakers, and industry representatives. I attended this year's meeting as a delegate for the **International Institute of Refrigeration**.

Among the many reports presented, one stood out: the continuing rise in **R23 emissions**.

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## R23 – A Small Refrigerant with a Big Climate Impact

R23 ($CHF_3$) is a low-temperature refrigerant no longer in use in Sweden and largely phased out elsewhere due to its extreme **global warming potential (GWP100 = 14,700)**. Because of this, it is closely tracked by UNEP's Ozone Secretariat.

Yet despite reduction efforts, atmospheric concentrations of R23 continue to climb (see Fig. 1). If the current trend persists, levels will **double by 2027 compared to 2005**. Although it is a relatively uncommon refrigerant, R23 accounts for around **15% of the total radiative forcing** of all HFCs combined. With an atmospheric lifetime of **228 years**, even immediate elimination of emissions would leave its footprint for centuries.

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## Where Does It Come From?

There are several potential sources:

- **Atmospheric breakdown of other HFCs and HFOs**: Possible, but estimated to explain only about **3% of annual R23 emissions**.
- **By-product of R22 production**: A far more likely culprit. R22 is still manufactured in China and many developing countries. It is well established that R23 forms as a by-product. In theory, this R23 should either be recycled back into the process or destroyed (e.g., by high-temperature incineration).

Two methods are used to estimate emissions: reported figures from known sources, and atmospheric monitoring worldwide. Until 2014, the numbers matched reasonably well. Since then, however, the gap has grown sharply (see Fig. 2).

The report presented in Montreal suggests that **R22 production is the driver** behind the unexplained rise, pointing specifically to "unknown sources in eastern China." Measurements show higher concentrations there than elsewhere. Intriguingly, the difference between reported emissions and measured atmospheric values closely matches the volume of R23 that China reports as "destroyed."

The **Chinese delegation**, for its part, pushed back. They argued that:

- Higher concentrations are unsurprising given that a major share of the world's refrigerant production is located in China.
- Equivalent high-resolution measurements have not been carried out near factories in other producing countries, such as India, the USA, or Russia.

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## Lessons for Europe – and Beyond

For me, the conclusion is clear: **Europe must accelerate its shift to natural refrigerants**. By demanding systems based on $CO_2$, hydrocarbons, and other natural options, we can push global manufacturers to recognize that these technologies deliver excellent performance with manageable risks.

Encouragingly, the trend is already visible. At **Chillventa 2024**, some **30 manufacturers of propane heat pumps** exhibited—more than 20 of them from Asia. Clearly, EU policy is influencing markets well beyond Europe's borders.

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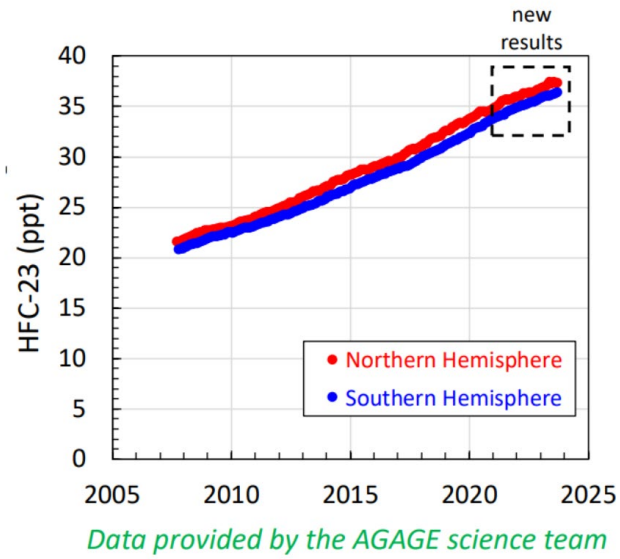


**Fig. 1.** Atmospheric concentration of R23

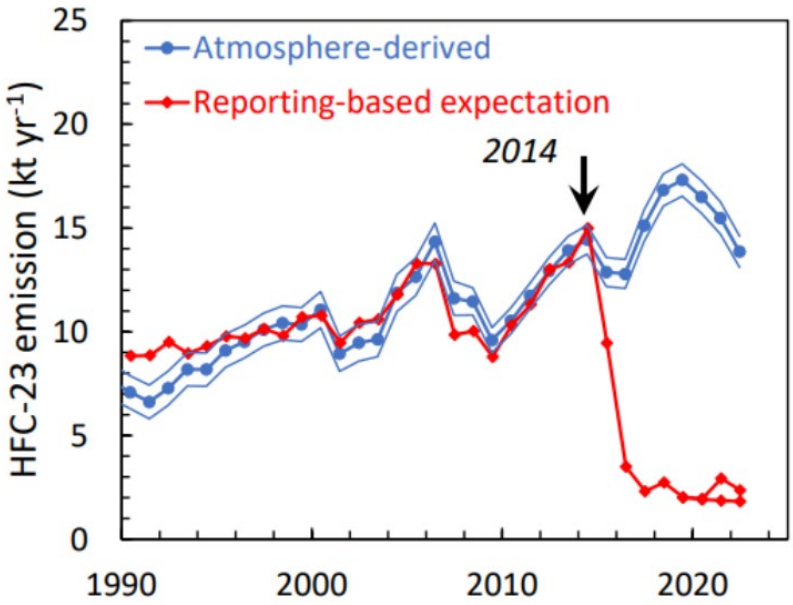


**Fig. 2.** R23 emissions estimated by two different methods

**Source:**
(1) UNEP Ozone Secretariat – Thirty-Sixth Meeting of the Parties: Pre-session documents