

## Ozone nightmare: A lucky escape?

Atoms of bromine (Br) are **45 times** more efficient than chlorine (Cl) at destroying ozone.

"... if the chemical industry had developed organobromine compounds [halons] instead of CFCs... then without any preparedness, we would have been faced with a catastrophic ozone hole everywhere and in all seasons ...  
Noting that nobody had given any thought to the atmospheric consequences of the release of Cl or Br before 1974, I can only conclude that mankind has been extremely lucky." **Paul Crutzen, Nobel Prize acceptance speech, 1995**

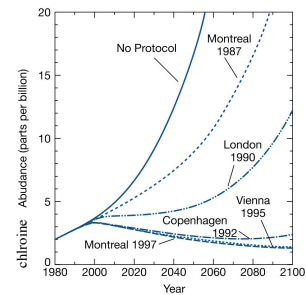
(The 1995 Nobel Prize in Chemistry was shared between Paul Crutzen, Mario Molina, and Sherwood Rowland for their work on ozone chemistry)

## Halting ozone depletion

**Montreal Protocol (1987)** with various amendments replaced CFCs with ozone-friendly chemicals.

Graph: when will stratospheric chlorine get back down to pre-1980 levels?

After about 2050



Kump, Fig 17-14

**Freon substitutes:**

HCFCs - vulnerable to chemical removal in troposphere

HFCs - contain no chlorine

## Lessons from the ozone experience

- **Earth is a coupled system:**
  - >> actions can have unanticipated consequences
  - >> these can be sudden and dramatic
- Be careful of anything that has a long atmospheric lifetime
- Vigilant monitoring is good even if it doesn't seem interesting  
We caught the ozone hole this way.
- High-tech monitoring systems can screw up. Good to have someone actually looking at the data.
- Dramatic events drive public policy far more than theoretical predictions.
- **A successful model for coping with global change: International scientific assessments and international treaties based on them.**

## Ozone misinformation & ignorance

1990s - *Wall Street Journal*, *Washington Post*, *Washington Times*, *Omni* (a science/science fiction mag) question ozone hole despite abundant evidence known to all atmospheric chemists. Why?

Journalists pick up misinformation spread in books by Dixy Lee Ray and Rush Limbaugh.

This propagates through the media, copy-cat style

## Dobson: seasonal difference

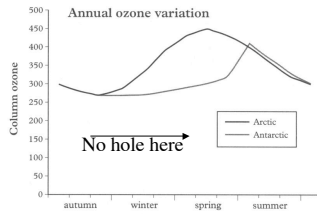


Figure 2.1 The 'Southern anomaly' in annual ozone variation.

Dixy Lee Ray incorrectly says that this early data showed an ozone hole: it did not.

Dobson:  
Attributes  
seasonal  
difference to  
different  
stratospheric  
circulation in  
southern vs.  
northern  
hemisphere

## Cl comes from CFCs

Nature 379, 526 – 529 (1996); doi:10.1038/379526a0

Satellite confirmation of the dominance of chlorofluorocarbons in the global stratospheric chlorine budget

James M. Russell III, Mingzhao Luo, Ralph J. Cicerone & Lance E. Deaver

OBSERVED increases in concentrations of chlorine in the stratosphere have been widely implicated in the depletion of lower-stratospheric ozone over the past two decades. The present concentration of stratospheric chlorine is more than five times that expected from known natural 'background' emissions from the oceans and biomass burning, and the balance has been estimated to be dominantly anthropogenic in origin, primarily due to the breakdown products of chlorofluorocarbons (CFCs). But despite the wealth of scientific data linking chlorofluorocarbon emissions to the observed chlorine increases, the political sensitivity of the ozone-depletion issue has generated a re-examination of the evidence. Here we report a four-year global time series of satellite observations of hydrogen chloride (HCl) and hydrogen fluoride (HF) in the stratosphere, which shows conclusively that chlorofluorocarbon releases—rather than other anthropogenic or natural emissions—are responsible for the recent global increases in stratospheric chlorine concentrations. Moreover, all but a few per cent of observed stratospheric chlorine amounts can be accounted for by known natural and anthropogenic tropospheric emissions. Altogether, these results implicate the chlorofluorocarbons beyond reasonable doubt as dominating ozone depletion in the lower stratosphere.

## Dixy's 1958 ozone hole? Nope.

### Antarctic Total Ozone in 1958

Paul A. Newman

The Antarctic ozone hole results from catalytic destruction of ozone by chlorine radicals. The hole develops in August, reaches its full depth in early October, and is gone by early December of each year. Extremely low total ozone measurements were made at the Antarctic Dumont d'Urville station in 1958. These measurements were derived from spectrographic plates of the blue sky, the moon, and two stars. These Dumont plate data are inconsistent with 1958 Dobson spectrophotometer ozone measurements, inconsistent with present-day Antarctic observations, and inconsistent with meteorological and theoretical information. There is no credible evidence for an ozone hole in 1958.

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French 1958 data show a random scatter

i.e., data with no accuracy or repeatability, e.g. jumps 130 DU in one day (April 18-19)

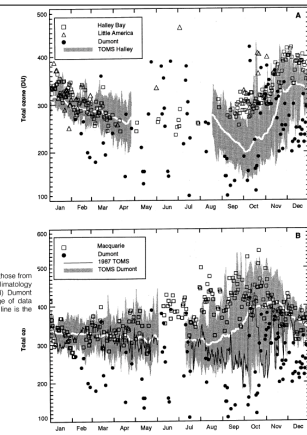


Fig. 2. Time series of total ozone. Comparison of values from Dumont d'Urville (●) with those from (A) Halley Bay (□) and Lata Amara (△) and (B) Maguire Island (□). The TOMS climatology (shaded values) was developed from satellite overpasses of (A) Halley Bay and (B) Dumont between November 1978 and January 1992. The grey shading represents the range of data (minimum and maximum values) for each day over the 13 years, and the thick white line is the average total ozone value at each site.

Rejected by WMO as useless, unreliable data.

## The Japanese data

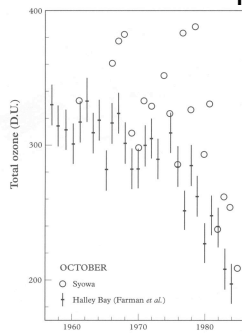


Figure 6.2 Comparison of Halley Bay and Syowa data for springtime ozone. Reproduced from S. Chubachi & R. Kajiwara, *Geophys. Res. Lett.*, (1986) 13, 1197. © 1986, American Geophysical Union.

Note:  
 Uncertainty bars on  
 Halley Bay data (+/-15 DU)  
 No bars on Japanese data; also  
 Japanese data miss several  
 seasons.

Halley Bay is 76 S, whereas  
 Syowa is -69 S (further  
 out in ozone hole/ vortex)  
 accounts for some of the difference

## Roots of ozone misinformation

Dixy Lee Ray cites virtually no "primary sources", i.e. scientific peer-reviewed publications. Those cited are distorted when cited (e.g. Dobson, Japanese group) or background material (Rowland).

Rush Limbaugh notes Dixy Lee Ray as his source in his bestseller *The Way Things Ought to Be* that claims there is no ozone hole.

Dixy Lee Ray cites Rogelio Maduro frequently as her source

Rogelio Maduro is a writer (not a scientist) and associate editor of *21st Century Science & Technology* published by supporters of politician Lyndon LaRouche (who was convicted of fraud and tax evasion and sentenced to 15 years in jail in 1985)