OZONE!

Good up high
Bad nearby
Stratospheric

Tropospheric
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• We’ll study health effects in the spring.
• Chemically much more active than $\text{O}_2$
• Beneficial uses:
  – Purify water
  – Sterilize air
  – Bleaching certain foods (flour)
Reminder about formation

\[ \text{O}_2 + \text{UV light} \rightarrow 2\text{O} \]

\[ 2\text{O} + 2\text{O}_2 \rightarrow 2\text{O}_3 \]
Why we care
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• What’s causing the damage to the layer?
Amazing CFC’s

• Easily liquified!
• Relatively inert!
• Non-toxic!
• Non-combustible!

• Coolants, propellants, used in making styrofoam, industrial solvents
• Because of inertness, diffuse slowly, unchanged into stratosphere
• Troposphere:
  – Thinnest layer, 80% mass, almost all H$_2$O
  – .04 ppm O$_3$
• Stratosphere: 10 ppm O$_3$
Why is ozone *thinning* seasonal?

During sunless winter, polar stratospheric clouds (PSC’s) form within vortex

This special cloud surface is ideal for “chlorine reserve compounds” (CFC’s, HCl, ClONO$_2$)
Main Reactions

$\text{CF}_2\text{Cl}_2 + \text{uv light} \rightarrow \text{cleaves Cl}$

$\text{Cl} + \text{O}_3 \rightarrow \text{ClO} + \text{O}_2$

$\text{ClO} + \text{O} \rightarrow \text{Cl} + \text{O}_2$
• Catalyst - alters the rate of a reaction without permanently being altered by that reaction, and so can react over and over again.

• One molecule of chlorine can potentially degrade over 100,000 molecules of ozone before it is removed from the stratosphere or becomes part of an inactive compound.
Timeline

- Mid-70’s recognized problem
- 1978 U.S. banned use of CFC’s
- 1987 Montreal Protocol banned product internationally
- But CFC’s are stable, insoluble in H₂O, so may be 2070 before ozone completely restored IF no additional threats are introduced.