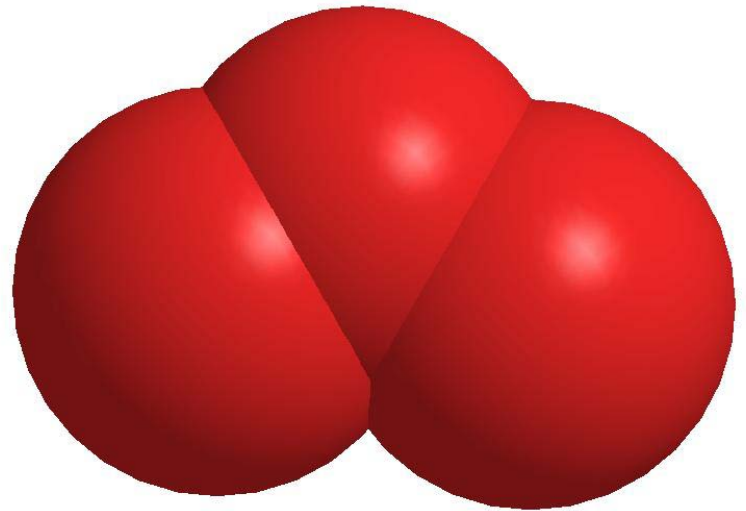


# Ozone Depletion

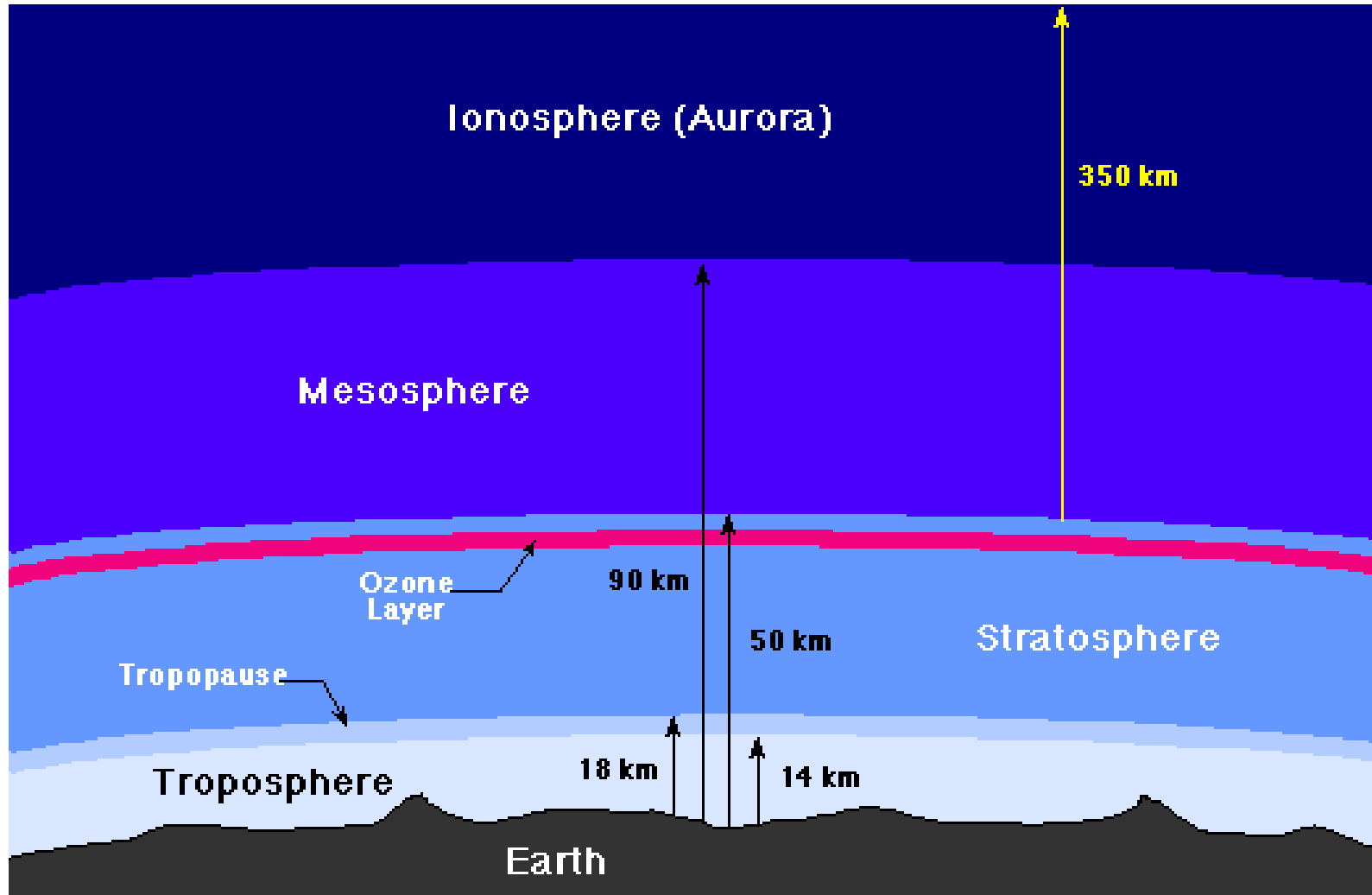


# 1a. What is Ozone?

- Ozone ( $O_3$ ) is a triatomic molecule of oxygen. The form of oxygen we breathe ( $O_2$ ) is diatomic. At ground level  $O_3$  is undesirable, but it plays a protective role in the earth's stratosphere.



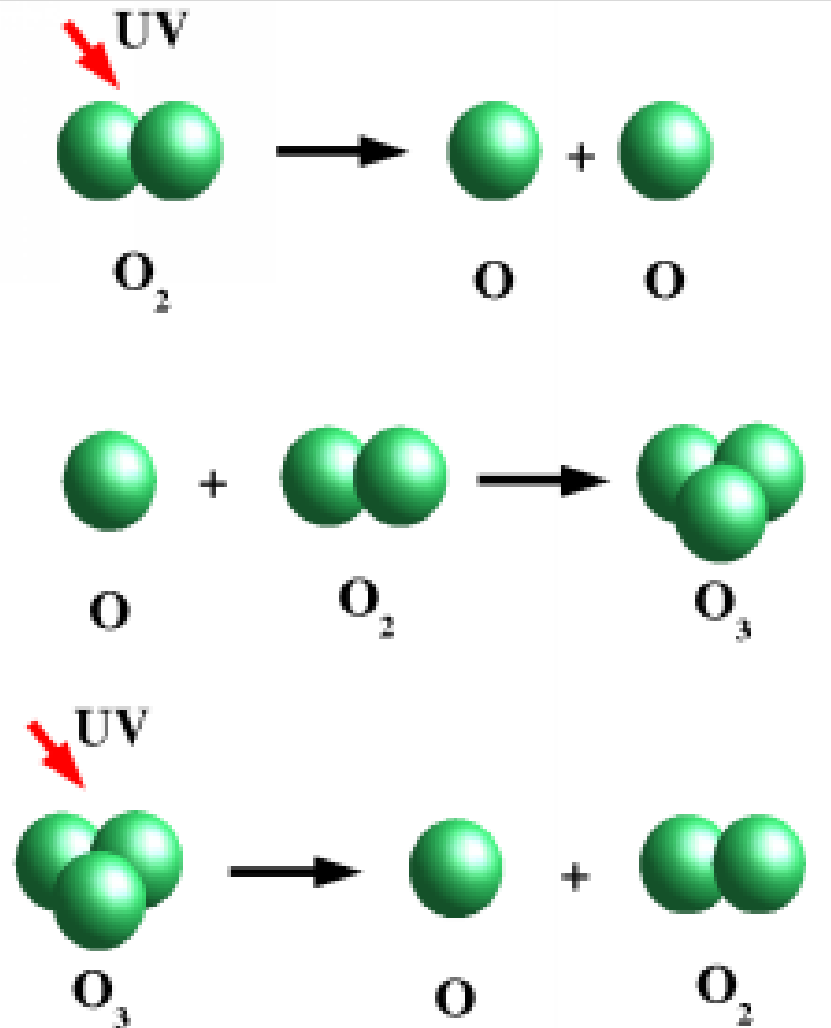
# 1b. Where is Ozone Found?



## 2. Why Ozone is Essential

- $O_3 + uv \rightarrow O_2 + O + \text{heat}$

Ozone converts harmful ultraviolet rays into harmless heat.



# Forms Of Ultraviolet

UVA(400–315 X10<sup>-9</sup> m )  
*Not absorbed by ozone.*



99% of UV which reaches earth's surface; least harmful form, but can contribute to the aging of skin, DNA damage and possibly skin cancer.

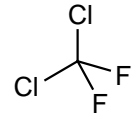
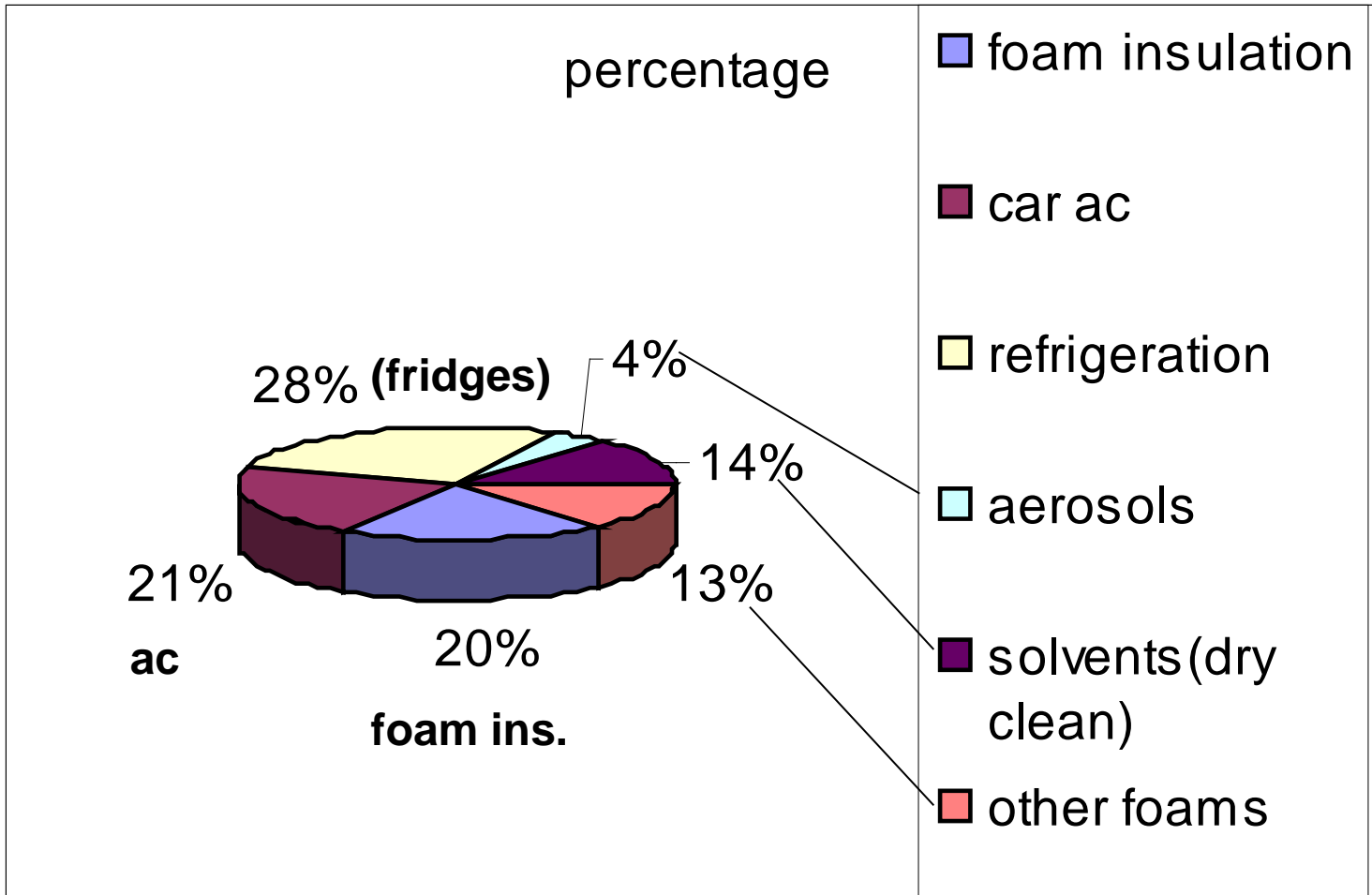
UVB(315–280 X10<sup>-9</sup> m)  
A fair amount is absorbed by ozone.

Leads to formation of vitamin D but can also cause skin cancer

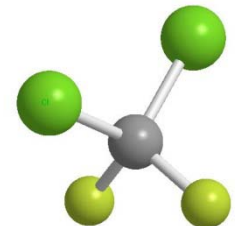
UVC(<280 X10<sup>-9</sup> m )

Extremely dangerous.  
All absorbed by O<sub>2</sub> and O<sub>3</sub>

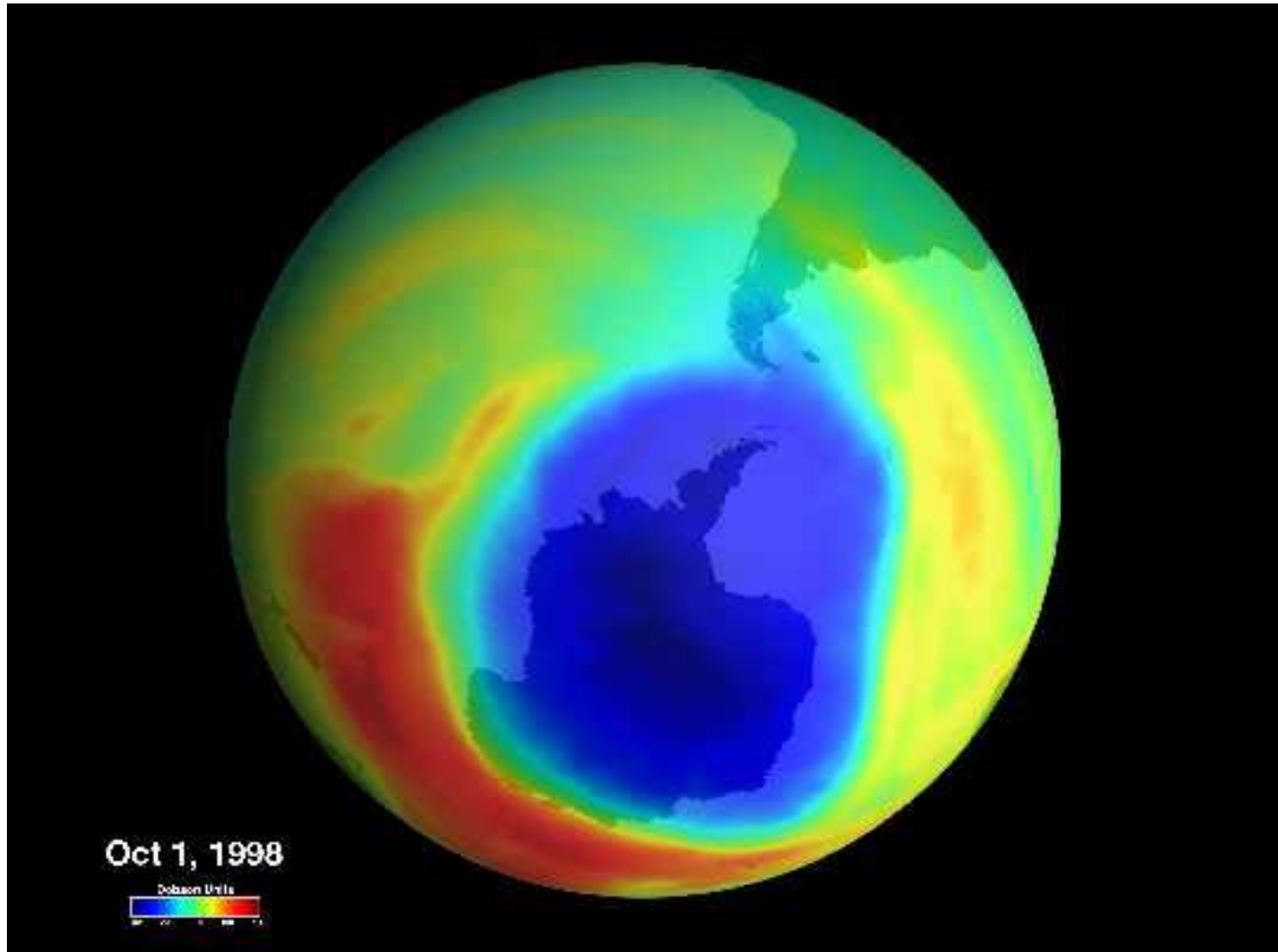
# 3. What Threatens Ozone?



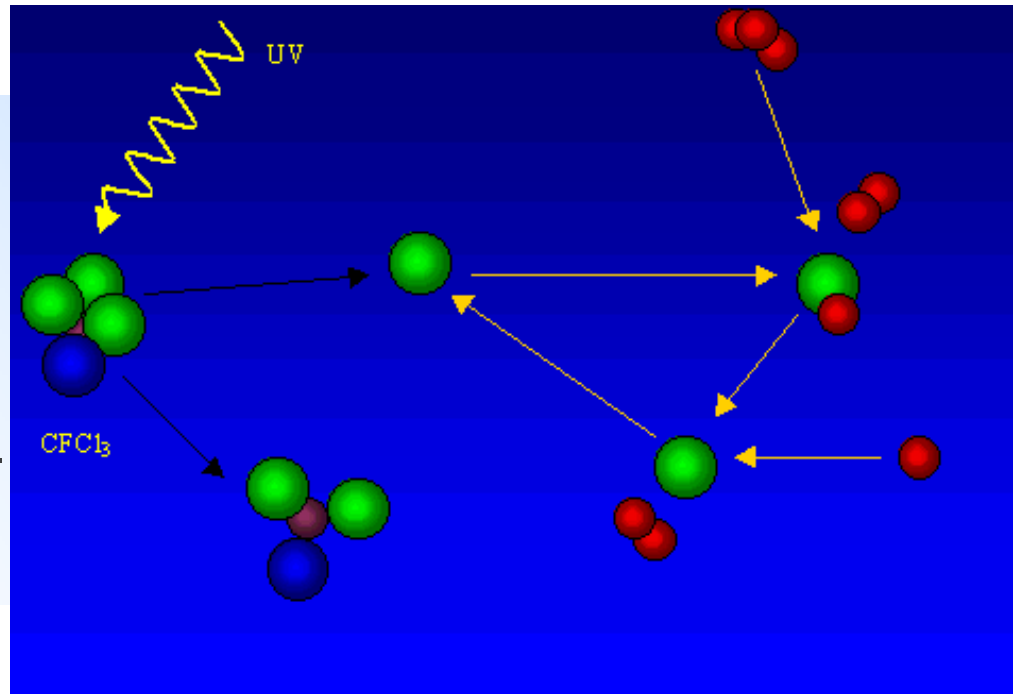
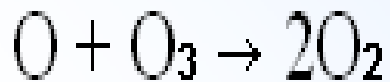
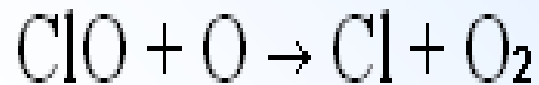
**Freon-12**  
( $\text{CCl}_2\text{F}_2$ ,  
an  
example  
of a **CFC**)



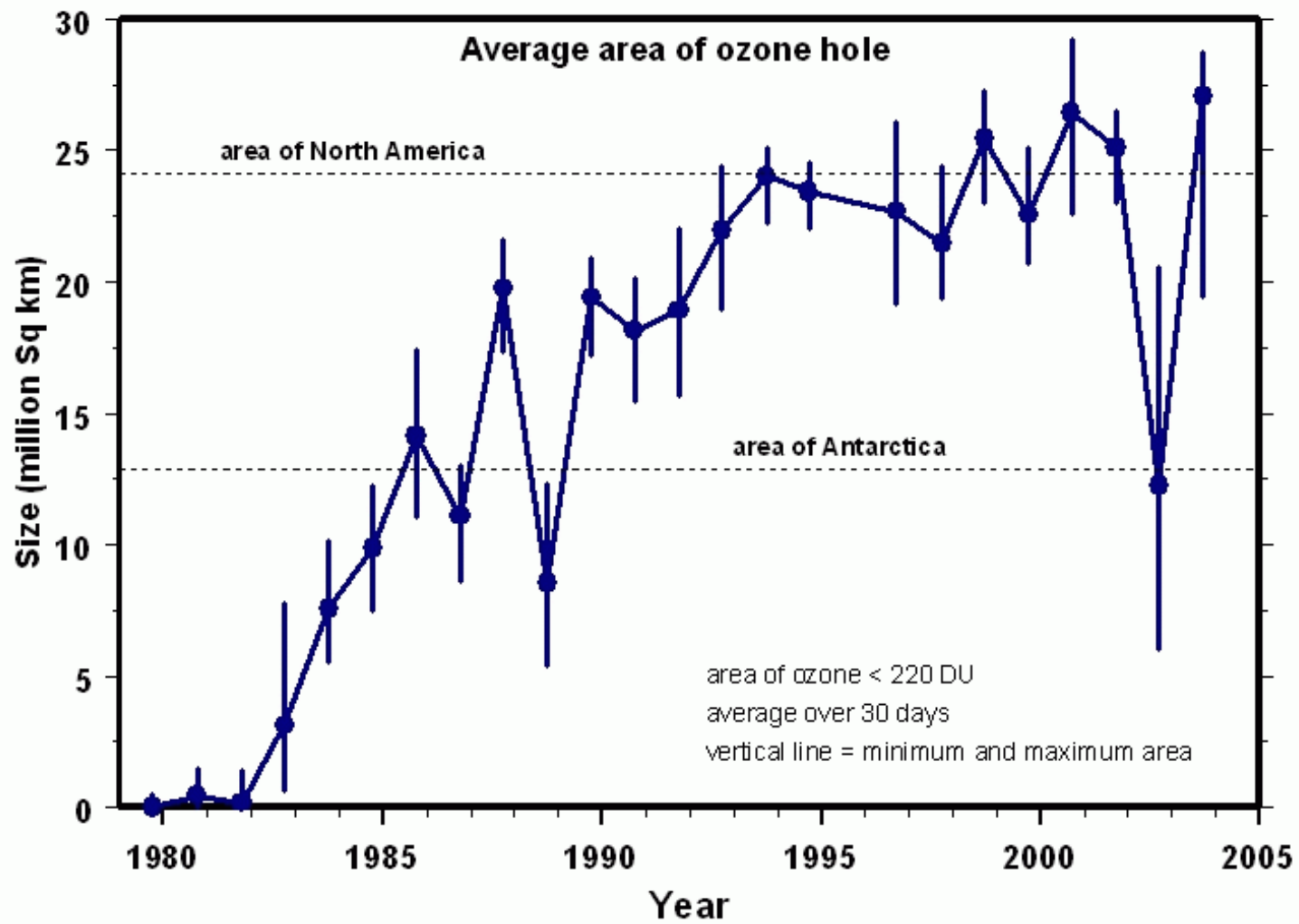
# The Ozone Hole Above Antarctica



### 3. What Threatens Ozone? (continued)

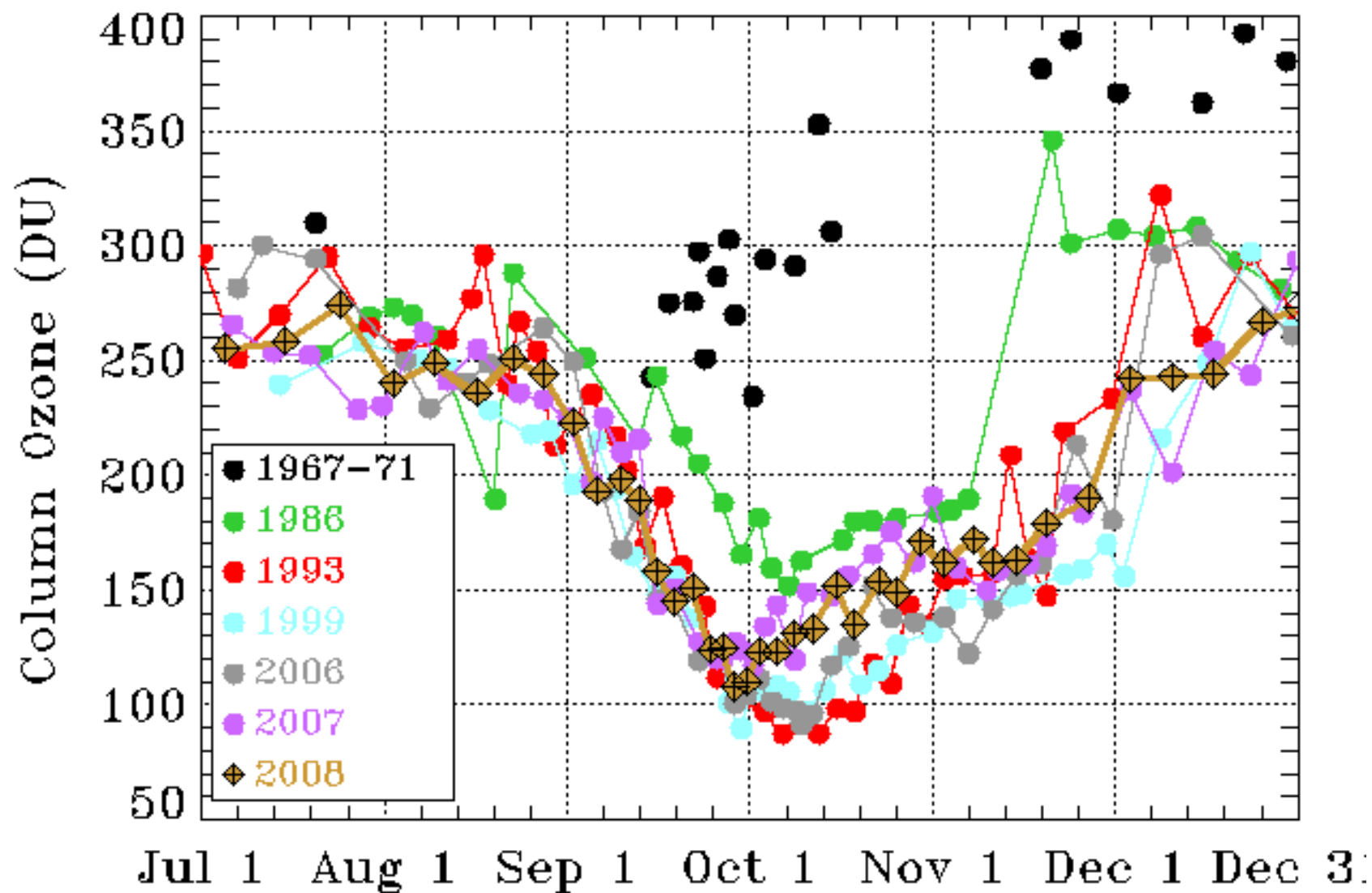






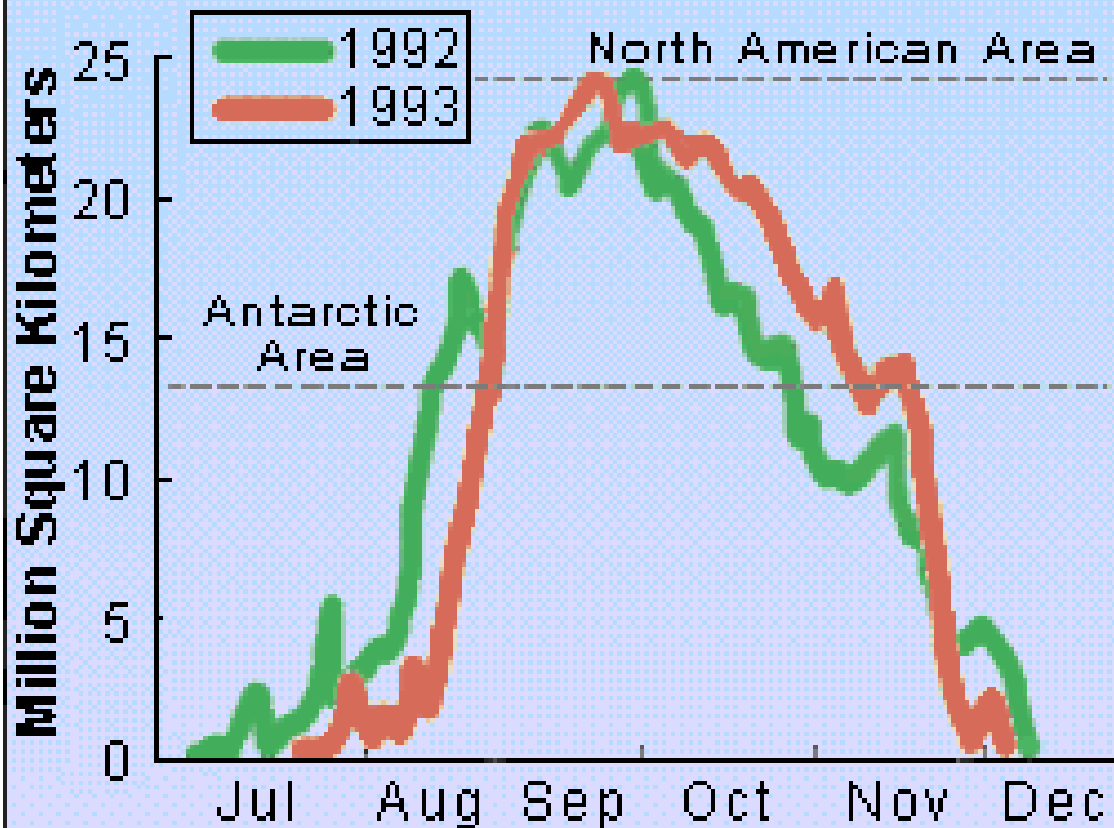
# SOUTH POLE OZONESONDES

## Total Column Ozone



# Ozone Hole Area

(<220 DU; 40°-90° S)



NASA

# 4. Effects of Thinner Ozone Layer



## 4. Effects of Thinner Ozone Layer



- A 45 year-old-woman noted darkening of a pigmented lesion on the left leg. Histology revealed a superficial spreading melanoma with a Breslow index of 0.28mm. The scar was reexcised with a 1 cm margin.



A 60-year-old man with a history of extensive sun exposure was referred by his primary care physician for evaluation of a changing mole on the left side of his neck for a few months. Skin biopsy revealed malignant melanoma.

**TABLE 19-1.4. Reflection of Light (300 nm) Off Various Ground Surfaces**

Ground surfaces	Per cent reflection
Fresh snow	85.0
Dry dune sand	17.0
Water: up to an angle of 60° from the perpendicular (beyond 60° reflection increases nearly to 100% at 90°)	5.0
Sandy turf	2.5
Grass	2.5





# What to Look for in Sunscreen

- **UVB protection:** Padimate O, Homosalate, Octisalate (octyl salicylate), Octinoxate (octyl methoxycinnamate)
- **UVA protection:** Avobenzone
- **UVA/UVB protection:** Octocrylene, titanium dioxide, zinc oxide, Mexoryl (ecamsule)
- <http://en.wikipedia.org/wiki/Ultraviolet>



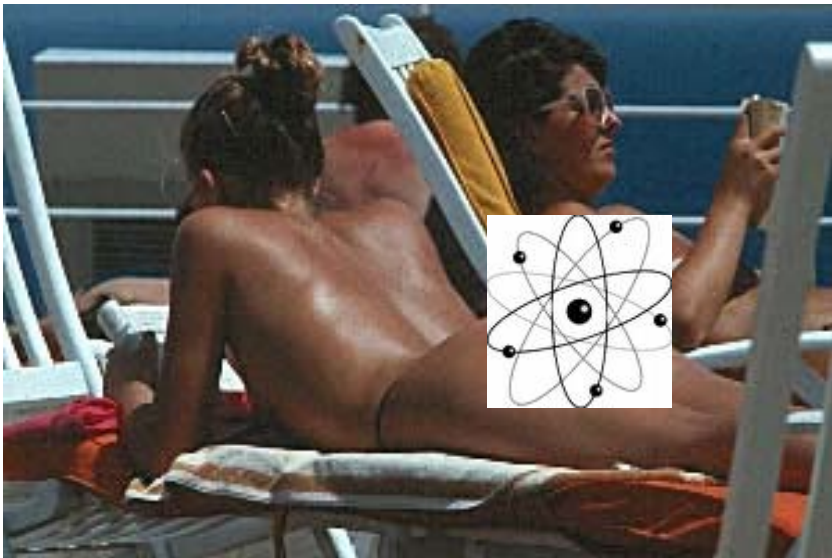
# Hats Provide Protection



# Zinc oxide (complete protection)



# Other Effects of UV Damage



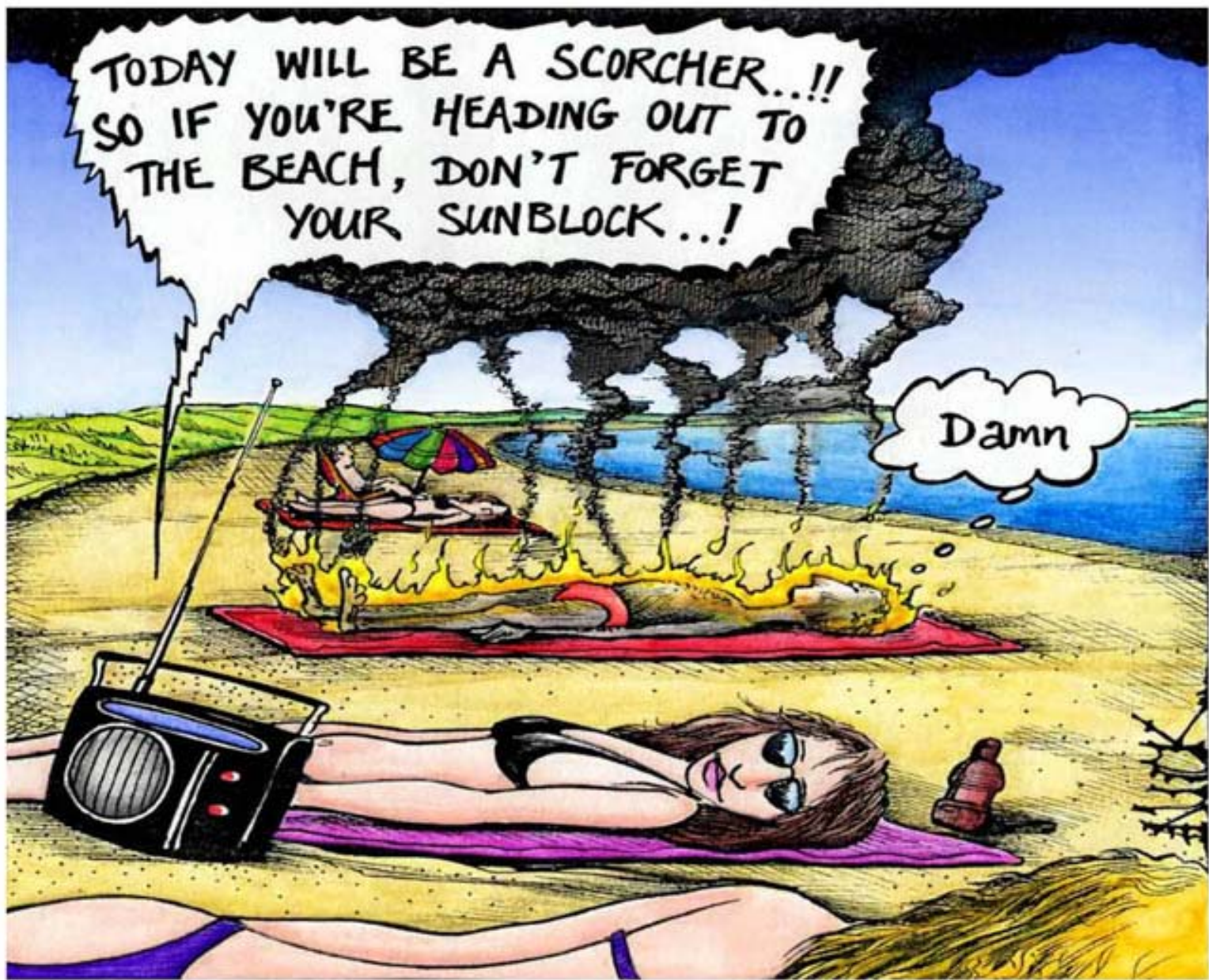
**BEFORE**



**AFTER**

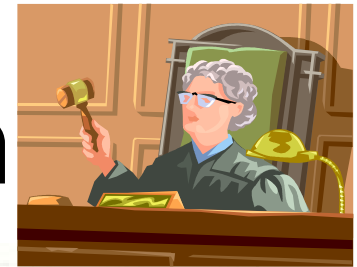
TODAY WILL BE A SCORCHER...!!  
SO IF YOU'RE HEADING OUT TO  
THE BEACH, DON'T FORGET  
YOUR SUNBLOCK...!

Damn



# 5. Fixing the Problem

ozone depletion potential (ODP).



Compound	Formula	ODP	Atmospheric lifetime (years)
CFC-11	$\text{CFCl}_3$	1.0	60
CFC-12	$\text{CF}_2\text{Cl}_2$	1.0	120
CFC-113	$\text{CF}_2\text{ClCF}_2\text{Cl}$	0.8	90
CFC-114	<del><math>\text{CF}_2\text{ClCF}_2\text{Cl}</math></del> $\text{CClF}_2\text{CClF}_2$	0.6-0.8	200
Halon-1211	<del><math>\text{CF}_2\text{Br}_2\text{Cl}</math></del> $\text{CF}_2\text{CClBr}$	2.2-3.5	25
Halon-1301	$\text{CBrF}_3$	7.8-16	80-110
Halon-2402	$\text{C}_2\text{F}_4\text{Br}_2$	5.0-6.2	23-28
HCFC-22	<del><math>\text{CHF}_3\text{Cl}</math></del> $\text{CHClF}_2$	0.04-0.06	15-20
HCFC-123	<del><math>\text{CF}_2\text{CHCl}_2</math></del> $\text{CHCl}_2\text{CF}_3$	0.02-0.16	1-2
HCFC-141b	$\text{CH}_3\text{CFCl}_2$	0.03-0.11	6-11
HCFC-124	$\text{CF}_3\text{CHCl}$	0.016-0.024	5-10

Montreal protocol(1987): most countries agreed to ban all CFC's by the year 2000

# 5. Fixing the Problem

- $\text{Cl} + \text{C}_2\text{H}_6(50\ 000\ \text{tons}) \rightarrow \text{HCl} + \text{C}_2\text{H}_5$



Expensive solution

# A better way

- Use refrigerants that do not release chlorine
- Maintain the ban on CFC's