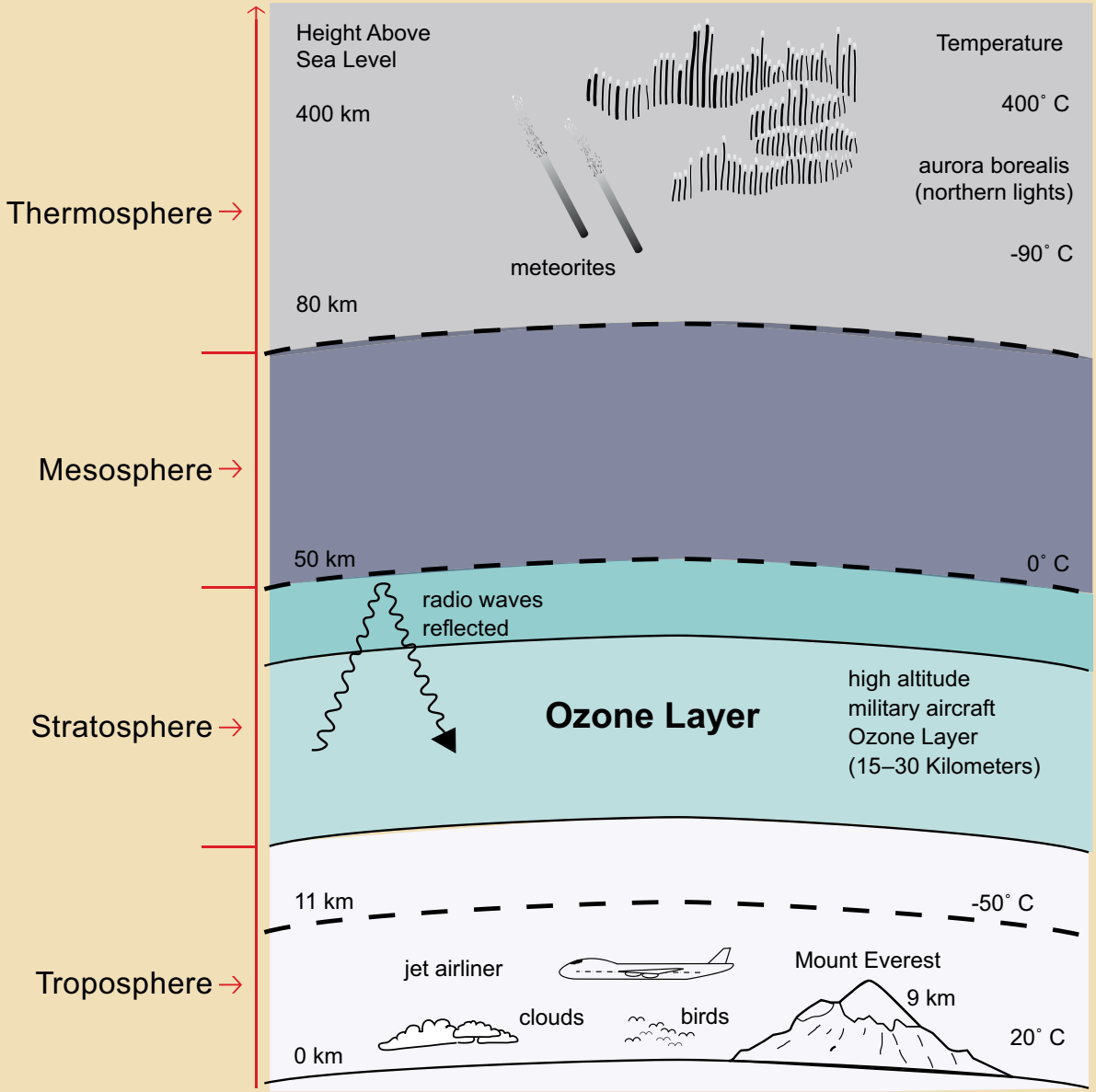
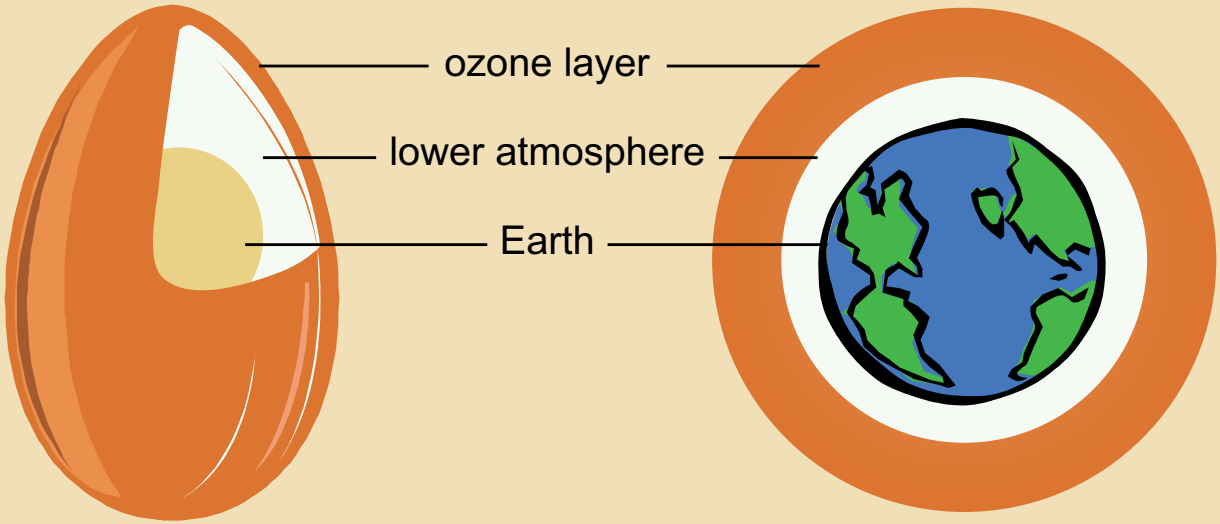
VA #1 UV Overexposure: Sunburn

VA #2 Where in Earth's Atmosphere Is the Ozone Layer?

This is the atmosphere profile averaged over the year and over Earth.

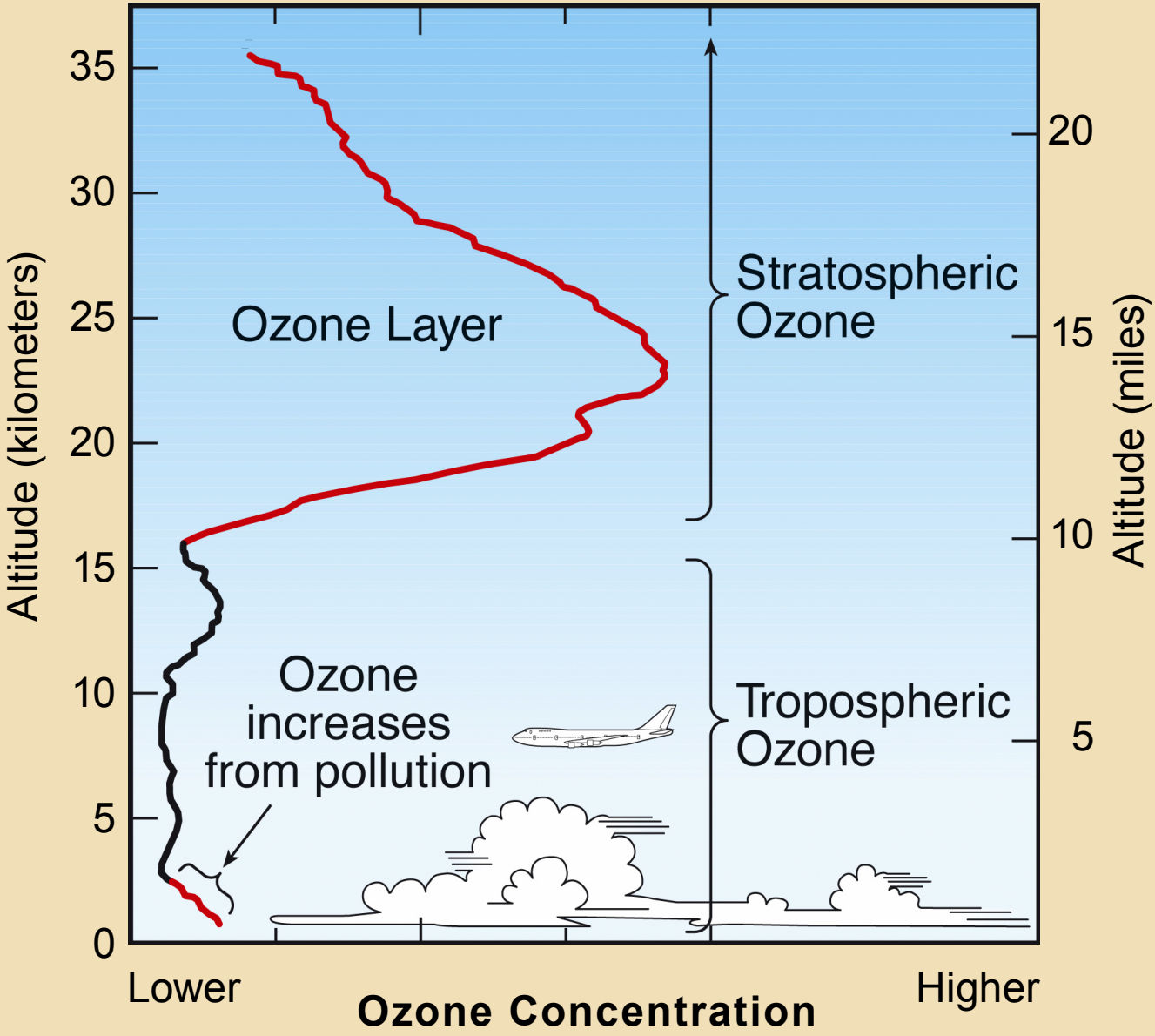


VA #3 Model of the Ozone Layer



VA #4 Los Angeles Smog

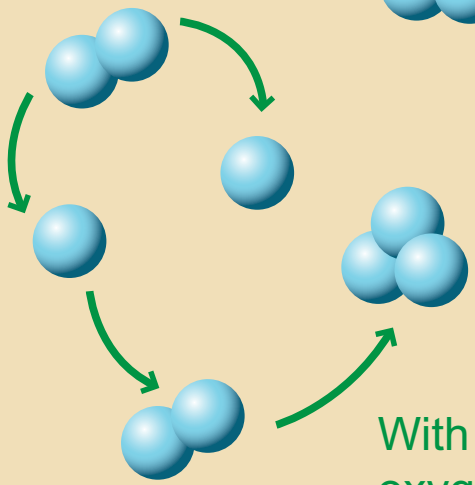
VA #5 Ozone in the Atmosphere



VA #6 Natural Oxygen–Ozone Cycle

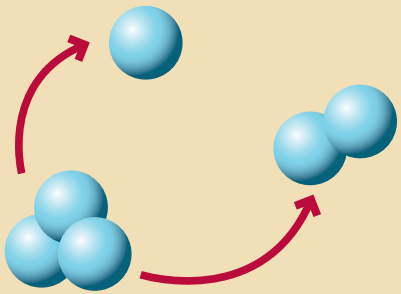
Ozone Production

The oxygen molecule is split by radiation.



With UV energy, oxygen atom bonds with oxygen molecule to form ozone.

Ozone Destruction



The ozone molecule is split by radiation.

= Oxygen Atom

VA #7 Ozone Layer Connection

Phytoplankton

Damage to DNA causes reduced populations and/or altered species composition and may result in:

- Changes to the marine food web
- → Loss of local fisheries
- → Changes to ecosystem
- → Loss of global fisheries
- → Food shortage
- → Increased hunger/starvation
- → Increased cost for food

Ozone Layer Depletion

Crops

Damage to DNA causes reduced crop production, may result in:

- The need for more crop acreage
- → Less native vegetation
- → Reduced biodiversity
- → More soil erosion
- Increased costs for growing food
- → Increased cost for food
- Global food shortage
- Land competition from other demands—housing, natural areas

Human Communities

Overall, the effects of UV radiation on human health (eyes, immune system, skin) will cause an increased demand for more medical services. With aging and ever-increasing populations, demand for medical services will out weigh supply. Personal and governmental costs for health care will increase.

Cataracts & eye damage may result in:

- Demand for more community services
- → Increased taxes
- Need for more doctors to perform surgery
- → Tax already short supply of health care services
- Personal loss of freedom and movement

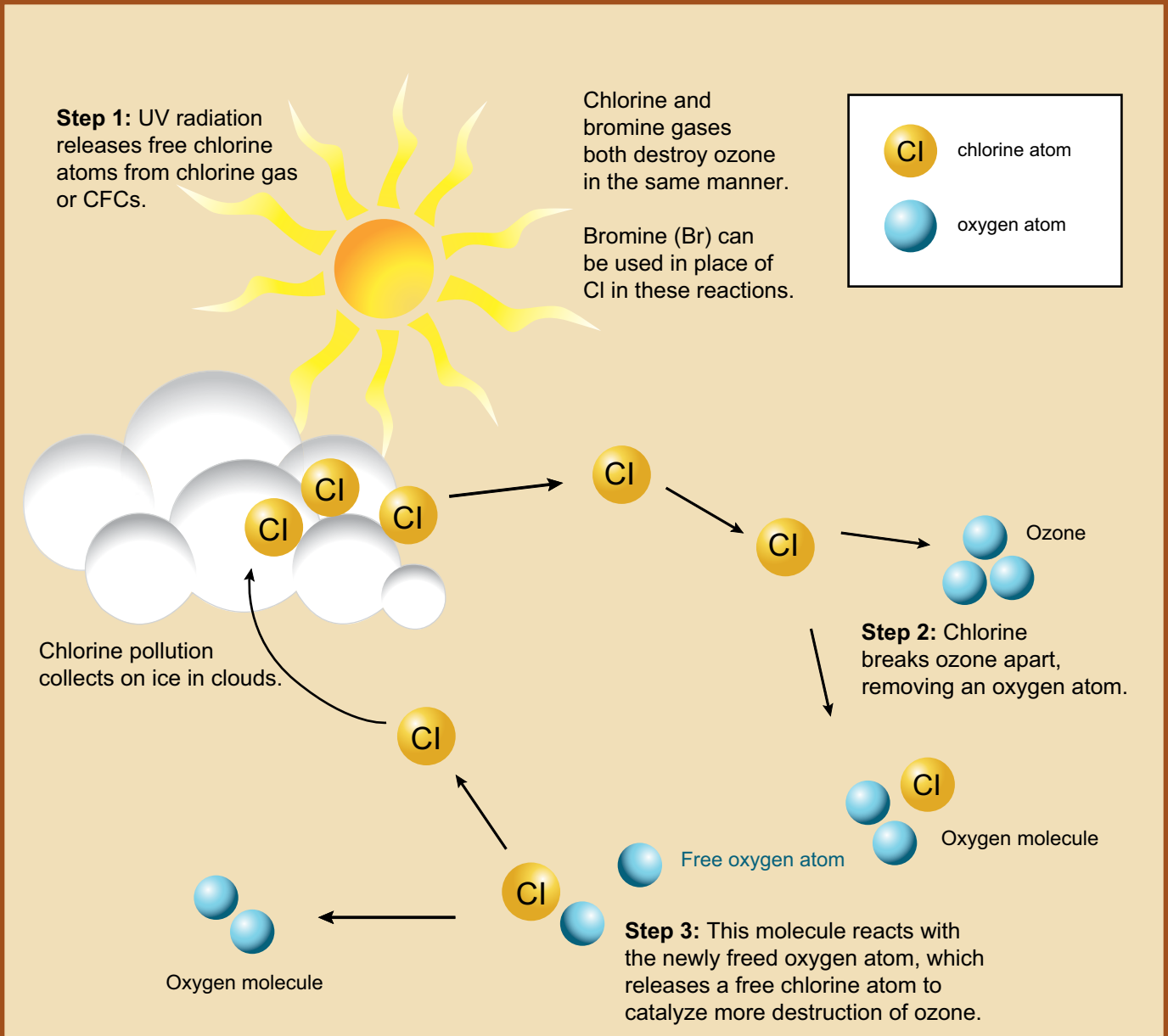
Weakened immune system may result in:

- More diseases → increased spreading of diseases
- Vaccine failure → more infectious diseases
- Return of plagues on a global level
- Increase in auto-immune diseases (HIV, arthritis, diabetes, MS)

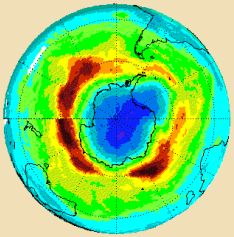
Skin Damage (DNA) may result in:

- Skin cancer → death is worst-case scenario
- Painful, costly treatment
- Premature aging/wrinkles → Self-esteem issues
- Increased demand for cosmetic treatments

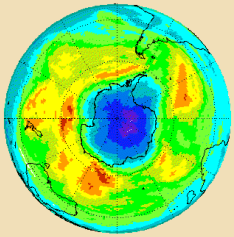
VA #8 Ozone Destruction Process



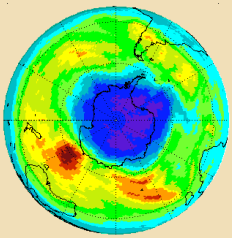
VA #9 Antarctic Ozone Hole Timeline



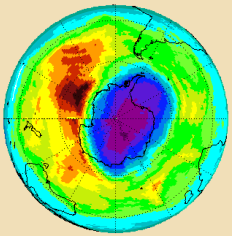
Oct., 1980
3.27 million square miles



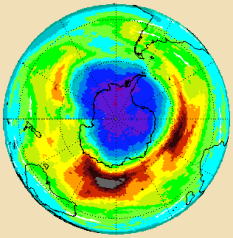
Oct., 1982
10.8 msm



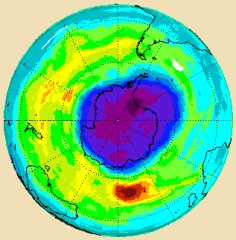
Sept, 1984
14.65 msm



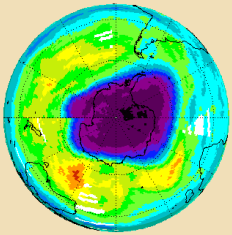
Oct, 1986
14.37 msm



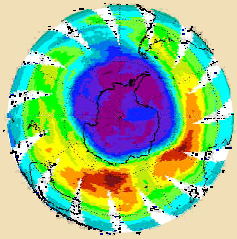
Sept., 1988
13.76 msm



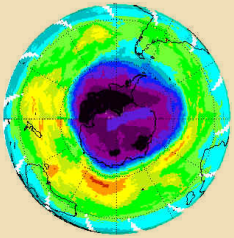
Sept., 1990
21.05 msm



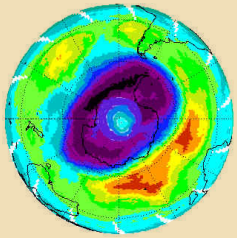
Sept, 1992
24.90 msm



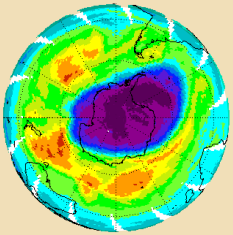
Sept, 1996
26.96 msm



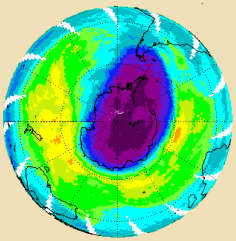
Sept., 1998
28.21 msm



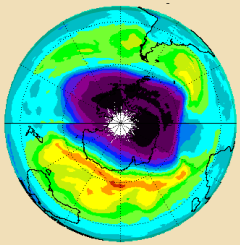
Sept, 2000
30.31 msm



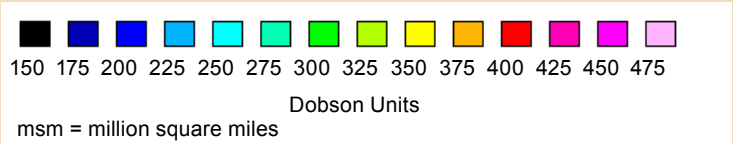
Sept, 2002
21.74 msm



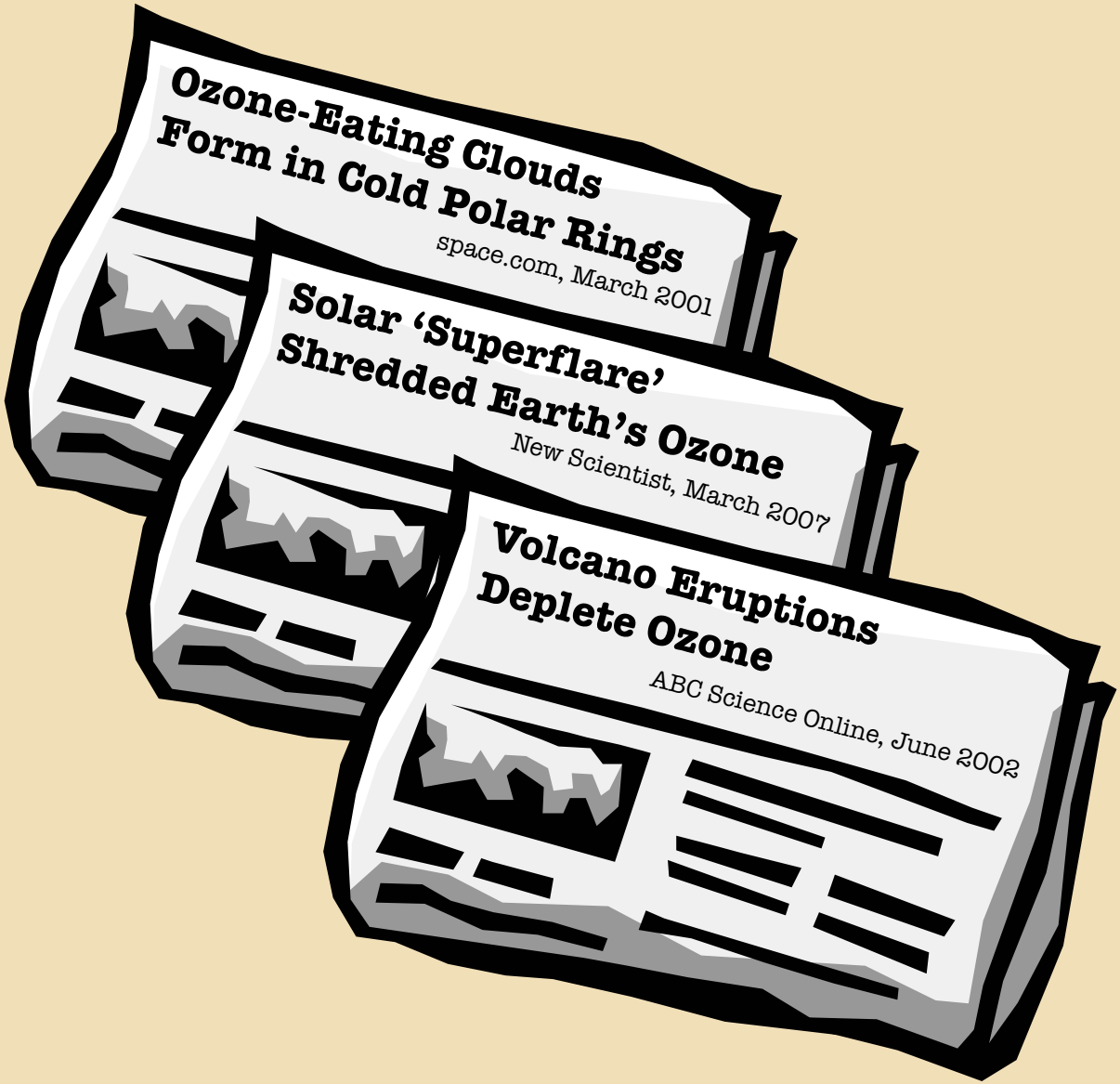
Sept, 2004
22.76 msm



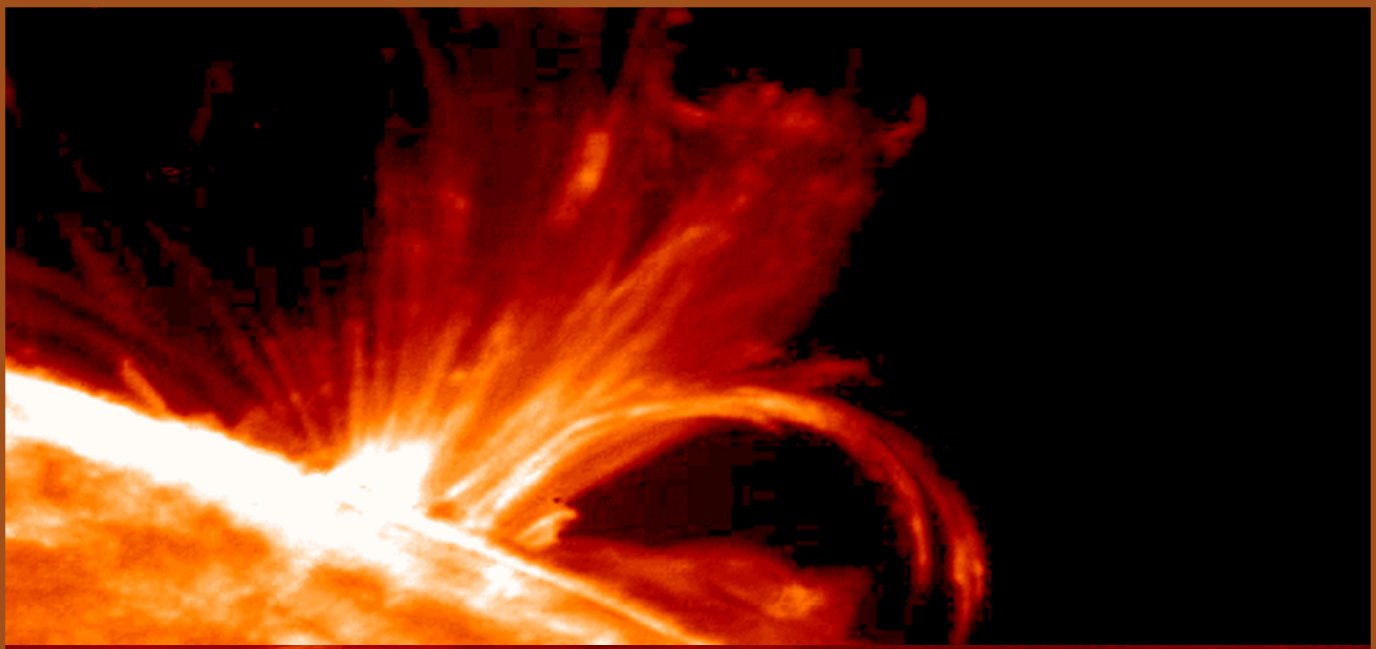
Oct., 2006
29.5 msm

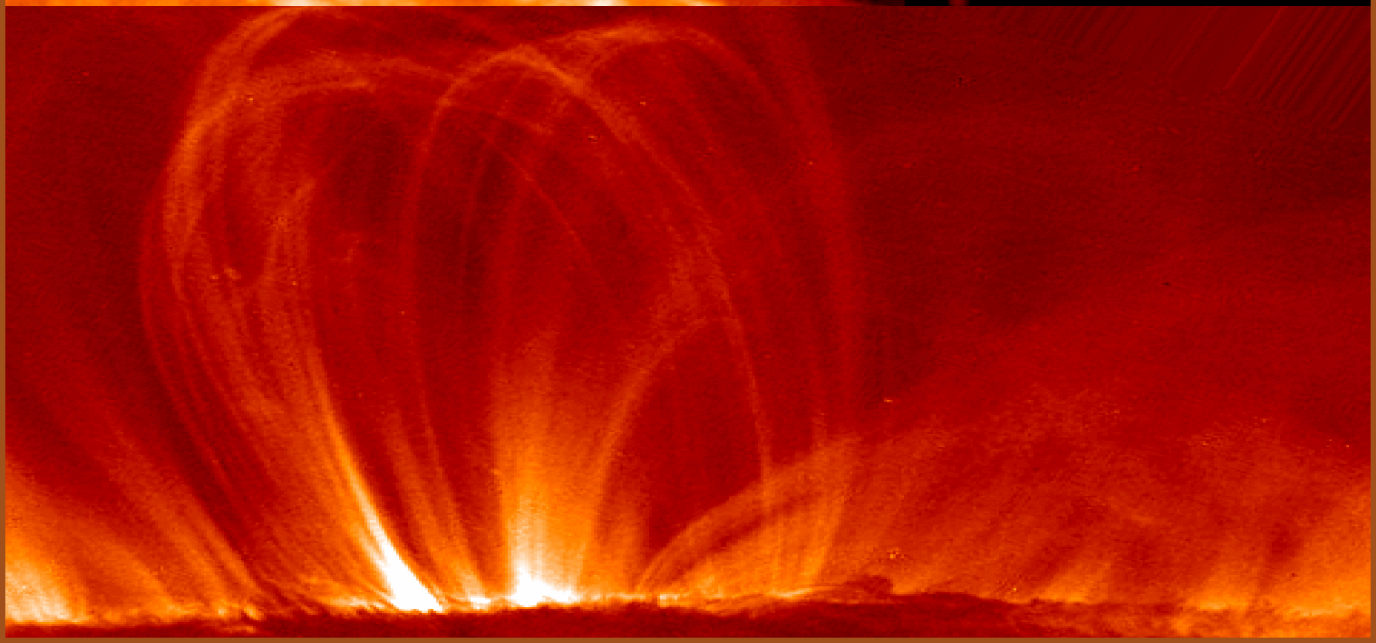


VA #10 Headlines about the Ozone Layer



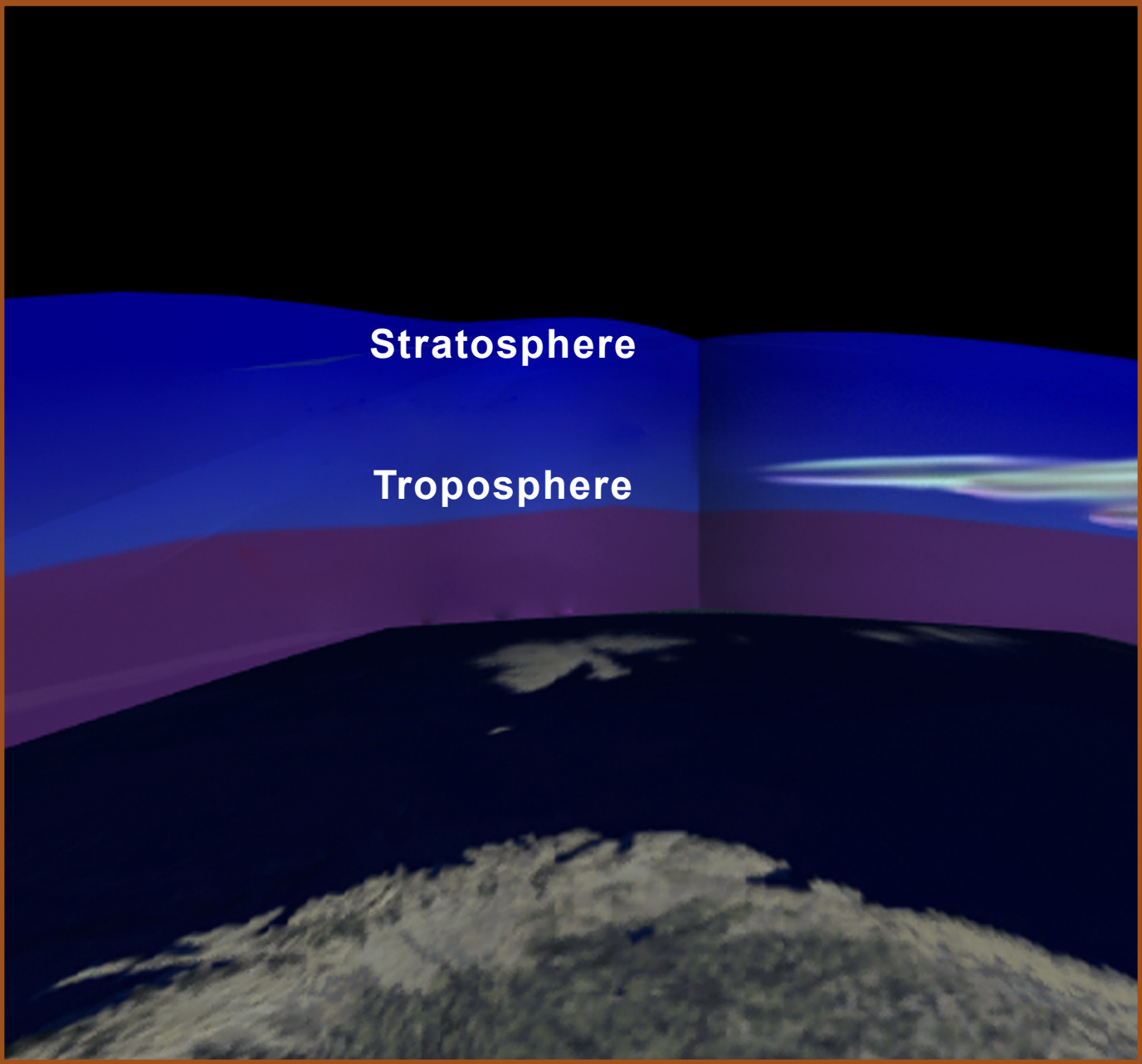
VA #11 Solar Flares



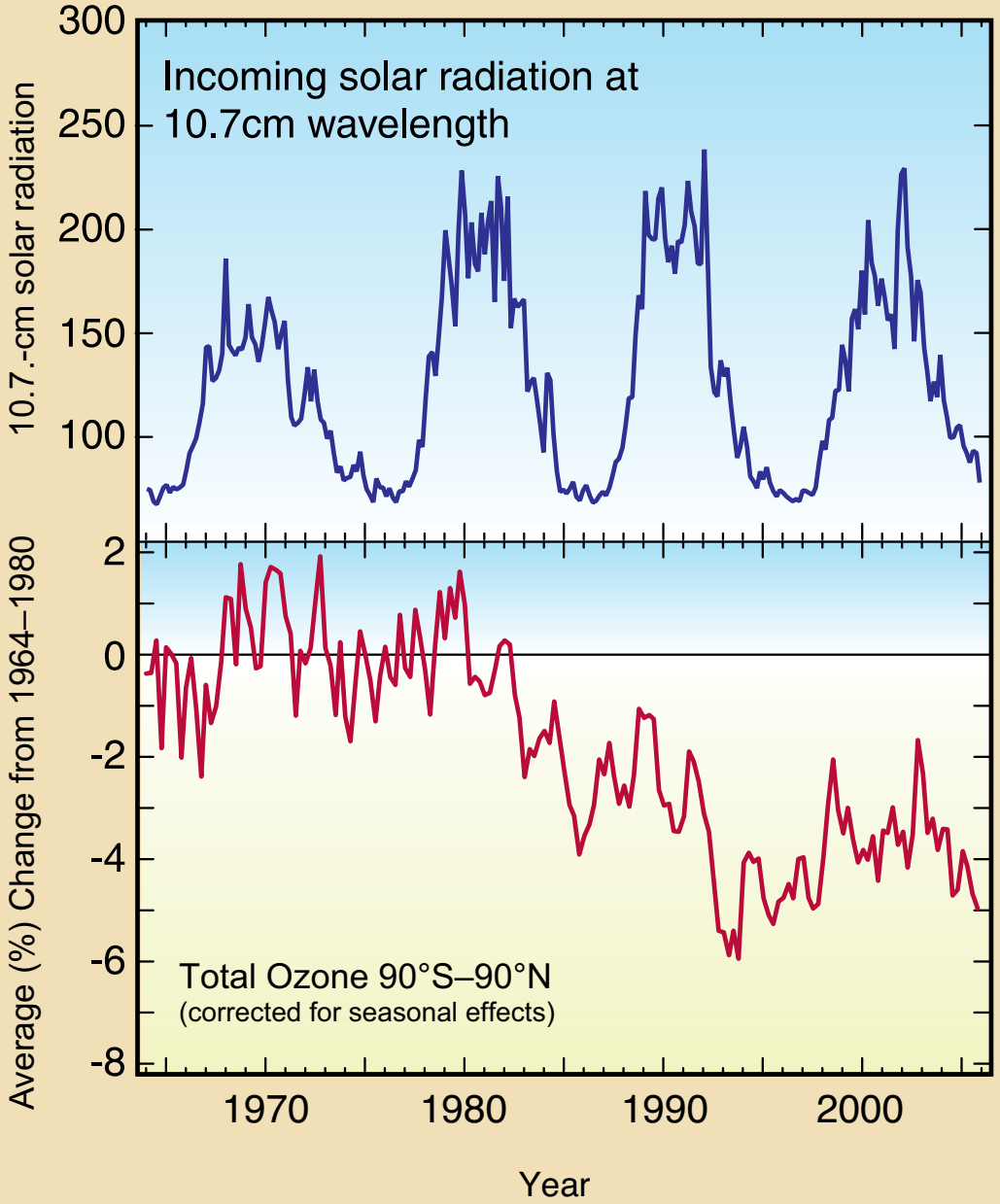


VA #12 Volcanic Eruptions

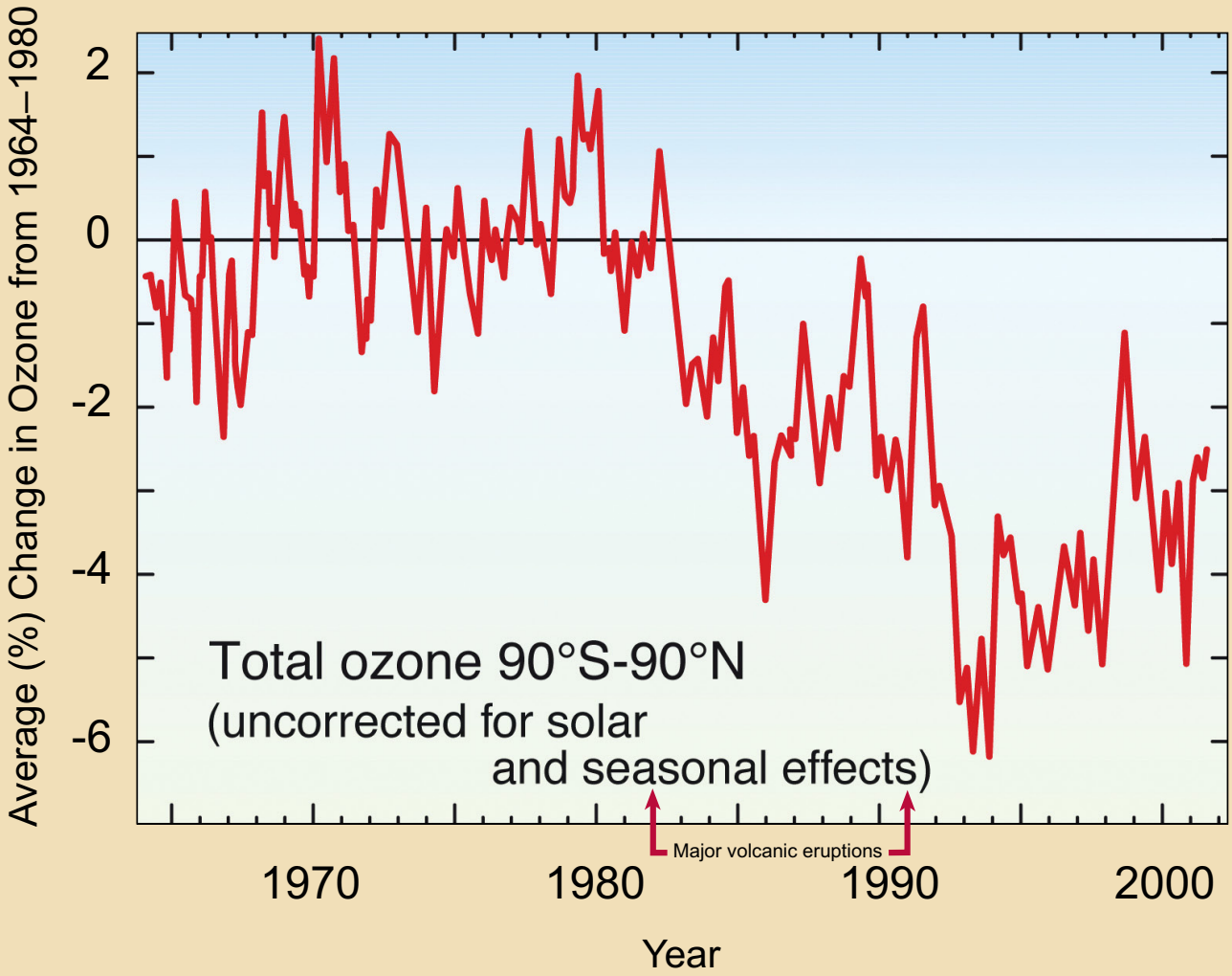
VA #13 Stratospheric Polar Clouds and the Ozone Layer



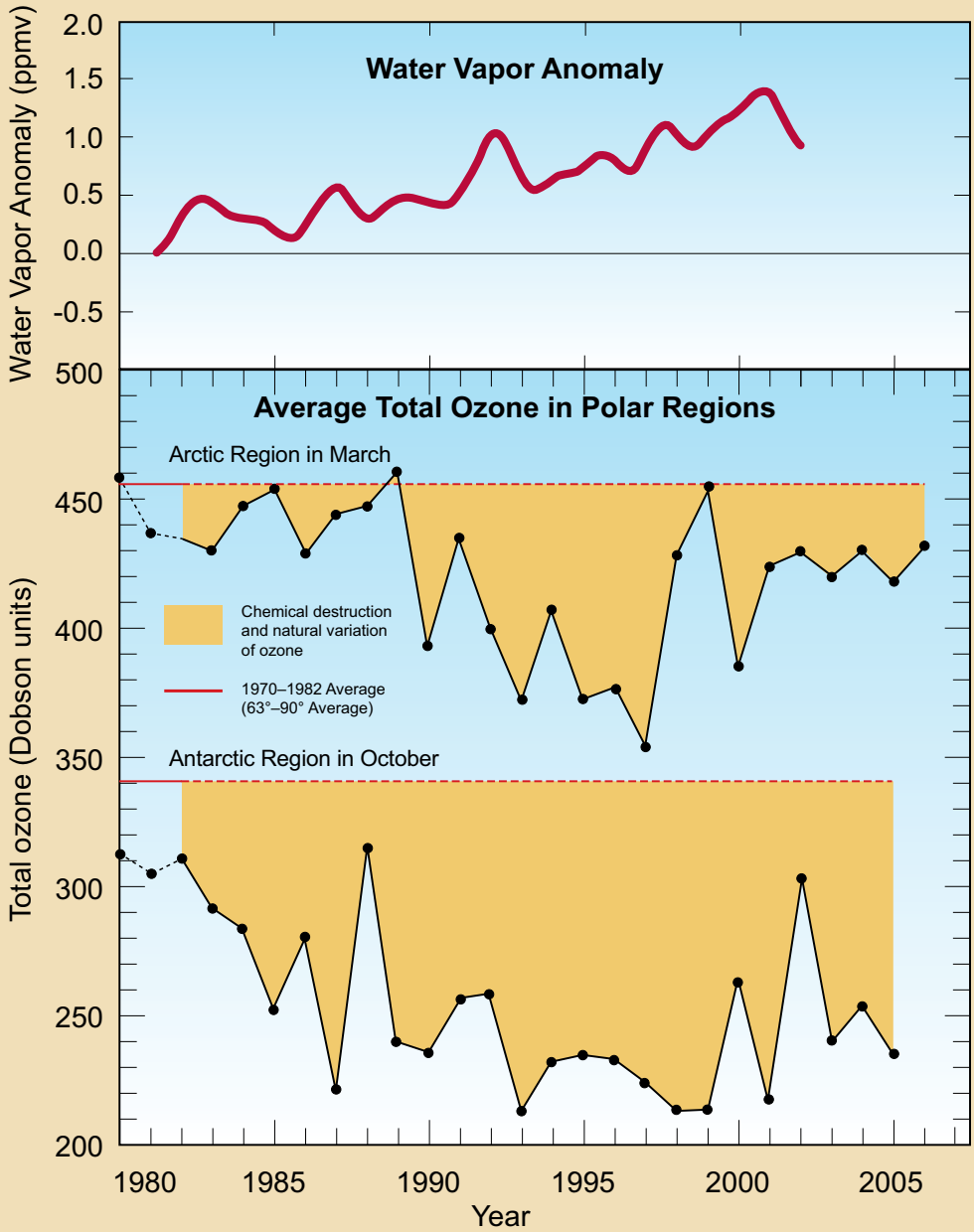
VA #14 Comparing Solar Flares to Ozone Levels



VA #15 Comparing Volcanic Eruptions to Ozone Levels



VA #16 Comparing Stratospheric Clouds to Ozone Levels



VA #17 Which Can You Live Without?

VA #18 Sources of Chlorine and Bromine Gas Emissions

Human Activities		
Product/Source	Chemicals Involved	Catalyst in Ozone Destruction
Air Conditioning		
Foams		
Aerosol sprays (spray paint, hair spray, cooking spray)		
Metered Dose Inhalers		
Refrigeration and coolants		
Solvents		
Fire Extinguishers		
Pesticides		
Natural Conditions		
Source	Chemicals Involved	Catalyst in Ozone Destruction
Volcanic Eruptions		
Solar Flares		0000
Stratospheric Polar Clouds		

VA #19 Periodic Table of Elements

Halogens

Periodic Table of the Elements

1A	2A	3B	4B	5B	6B	7B	8B			1B	2B	3A	4A	5A	6A	7A	8A
1 **H** 1.00794 Hydrogen																	2 **He** 4.002602 Helium
3 **Li** 6.341 Lithium	4 **Be** 9.012182 Beryllium											5 **B** 10.811 Boron	6 **C** 12.0107 Carbon	7 **N** 14.0067 Nitrogen	8 **O** 15.9994 Oxygen	9 **F** 18.9984032 Fluorine	10 **Ne** 20.1797 Neon
11 **Na** 22.989769 Sodium	12 **Mg** 24.3050 Magnesium											13 **Al** 26.9815386 Aluminum	14 **Si** 28.0855 Silicon	15 **P** 30.973762 Phosphorus	16 **S** 32.065 Sulfur	17 **Cl** 35.453 Chlorine	18 **Ar** 39.948 Argon
19 **K** 39.0983 Potassium	20 **Ca** 40.078 Calcium	21 **Sc** 44.955912 Scandium	22 **Ti** 47.867 Titanium	23 **V** 50.9415 Vanadium	24 **Cr** 51.9961 Chromium	25 **Mn** 54.938045 Manganese	26 **Fe** 55.845 Iron	27 **Co** 58.933195 Cobalt	28 **Ni** 58.6934 Nickel	29 **Cu** 63.546 Copper	30 **Zn** 65.38 Zinc	31 **Ga** 69.723 Gallium	32 **Ge** 72.64 Germanium	33 **As** 74.92160 Arsenic	34 **Se** 78.96 Selenium	35 **Br** 79.904 Bromine	36 **Kr** 83.798 Krypton
37 **Rb** 85.4678 Rubidium	38 **Sr** 87.62 Strontium	39 **Y** 88.90585 Yttrium	40 **Zr** 91.224 Zirconium	41 **Nb** 92.90638 Niobium	42 **Mo** 95.96 Molybdenum	43 **Tc** [98] Technetium	44 **Ru** 101.07 Ruthenium	45 **Rh** 102.90550 Rhodium	46 **Pd** 106.42 Palladium	47 **Ag** 107.8682 Silver	48 **Cd** 112.411 Cadmium	49 **In** 114.818 Indium	50 **Sn** 118.710 Tin	51 **Sb** 121.760 Antimony	52 **Te** 127.60 Tellurium	53 **I** 126.90447 Iodine	54 **Xe** 131.293 Xenon
55 **Cs** 132.9054519 Cesium	56 **Ba** 137.327 Barium	57-71 Lanthanides	72 **Hf** 178.49 Hafnium	73 **Ta** 180.94788 Tantalum	74 **W** 183.84 Tungsten	75 **Re** 186.207 Rhenium	76 **Os** 190.23 Osmium	77 **Ir** 192.217 Iridium	78 **Pt** 195.084 Platinum	79 **Au** 196.966569 Gold	80 **Hg** 200.59 Mercury	81 **Tl** 204.3833 Thallium	82 **Pb** 207.2 Lead	83 **Bi** 208.98040 Bismuth	84 **Po** [209] Polonium	85 **At** [210] Astatine	86 **Rn** [222] Radon
87 **Fr** [223] Francium	88 **Ra** [226] Radium	89-103 Actinides	104 **Rf** [267] Rutherfordium	105 **Db** [268] Dubnium	106 **Sg** [271] Seaborgium	107 **Bh** [272] Bohrium	108 **Hs** [270] Hassium	109 **Mt** [276] Meitnerium	110 **Ds** [281] Darmstadtium	111 **Rg** [280] Roentgenium	112 **Uub** [285] Ununbium	113 **Uut** [284] Ununtrium	114 **Uuq** [289] Ununquadium	115 **Uup** [288] Ununpentium	116 **Uuh** [293] Ununhexium	117 **Uus** [294] Ununseptium	118 **Uuo** [294] Ununoctium

Lanthanides	57 **La** 138.90547 Lanthanum	58 **Ce** 140.116 Cerium	59 **Pr** 140.90765 Praseodymium	60 **Nd** 144.242 Neodymium	61 **Pm** [145] Promethium	62 **Sm** 150.36 Samarium	63 **Eu** 151.964 Europium	64 **Gd** 157.25 Gadolinium	65 **Tb** 158.92535 Terbium	66 **Dy** 162.500 Dysprosium	67 **Ho** 164.93032 Holmium	68 **Er** 167.259 Erbium	69 **Tm** 168.93421 Thulium	70 **Yb** 173.054 Ytterbium	71 **Lu** 174.9668 Lutetium
Actinides	89 **Ac** [227] Actinium	90 **Th** 232.03806 Thorium	91 **Pa** 231.03588 Protactinium	92 **U** 238.02891 Uranium	93 **Np** [237] Neptunium	94 **Pu** [244] Plutonium	95 **Am** [243] Americium	96 **Cm** [247] Curium	97 **Bk** [247] Berkelium	98 **Cf** [251] Californium	99 **Es** [252] Einsteinium	100 **Fm** [257] Fermium	101 **Md** [258] Mendelevium	102 **No** [259] Nobelium	103 **Lr** [262] Lawrencium

Alkali Metals	Alkaline Earth	Basic Metal	Halogen	Noble Gas	Non Metal	Rare Earth	Semi Metal	Transition Metal

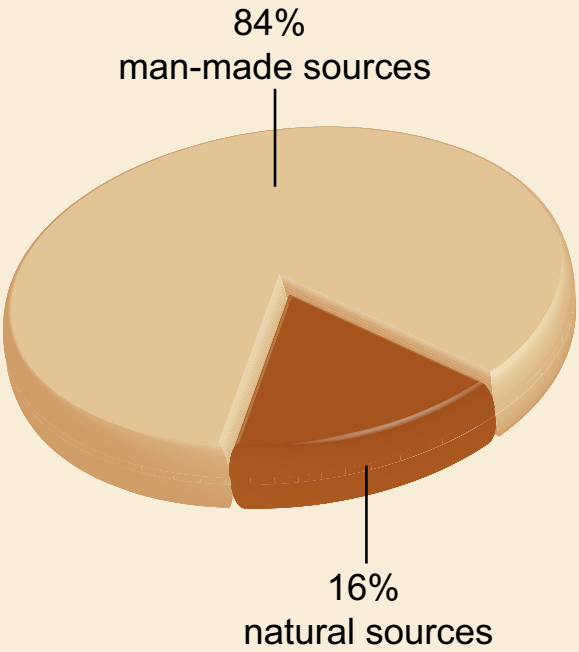
VA #20 Miracle Products' ODP

Man–made Products	Gas Emissions	Ozone-Depleting Potential (ODP)
Chlorine		
Air conditioning, coolants, foams, aerosol sprays, metered-dose inhalers, refrigeration	CFC-11	1.0
	CFC-12	1.0
	CFC-13	1.0
	HCFCs	0.02–0.12
	Carbon tetrachloride-CCl_4	0.73
Solvents	Methyl chloroform-CH_3CCl_3	0.12
Refrigeration	Methyl chloride-CH_3Cl	0.02
Bromine		
Fire retardants and fire extinguishers	Halon-1301	16.0
	Halon-1211	7.1
Pesticides	Methyl bromide-CH_3Br	0.51
Natural Sources	**Gas Emissions**	**Ozone-Depleting Potential (ODP)**
Chlorine		
Emissions from volcanic eruptions	Hydrogen chloride	Uncertain

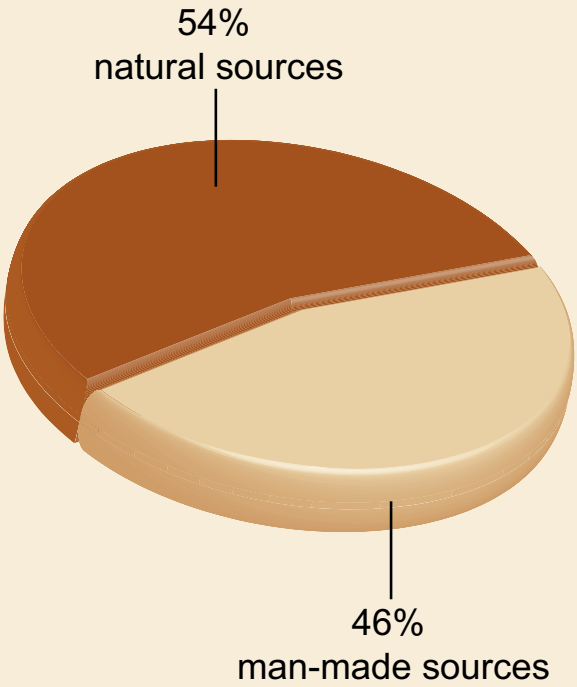
VA #21 Stratospheric Gas Sources

Primary Sources of Chlorine and Bromine Gasses for the Stratosphere in 2004

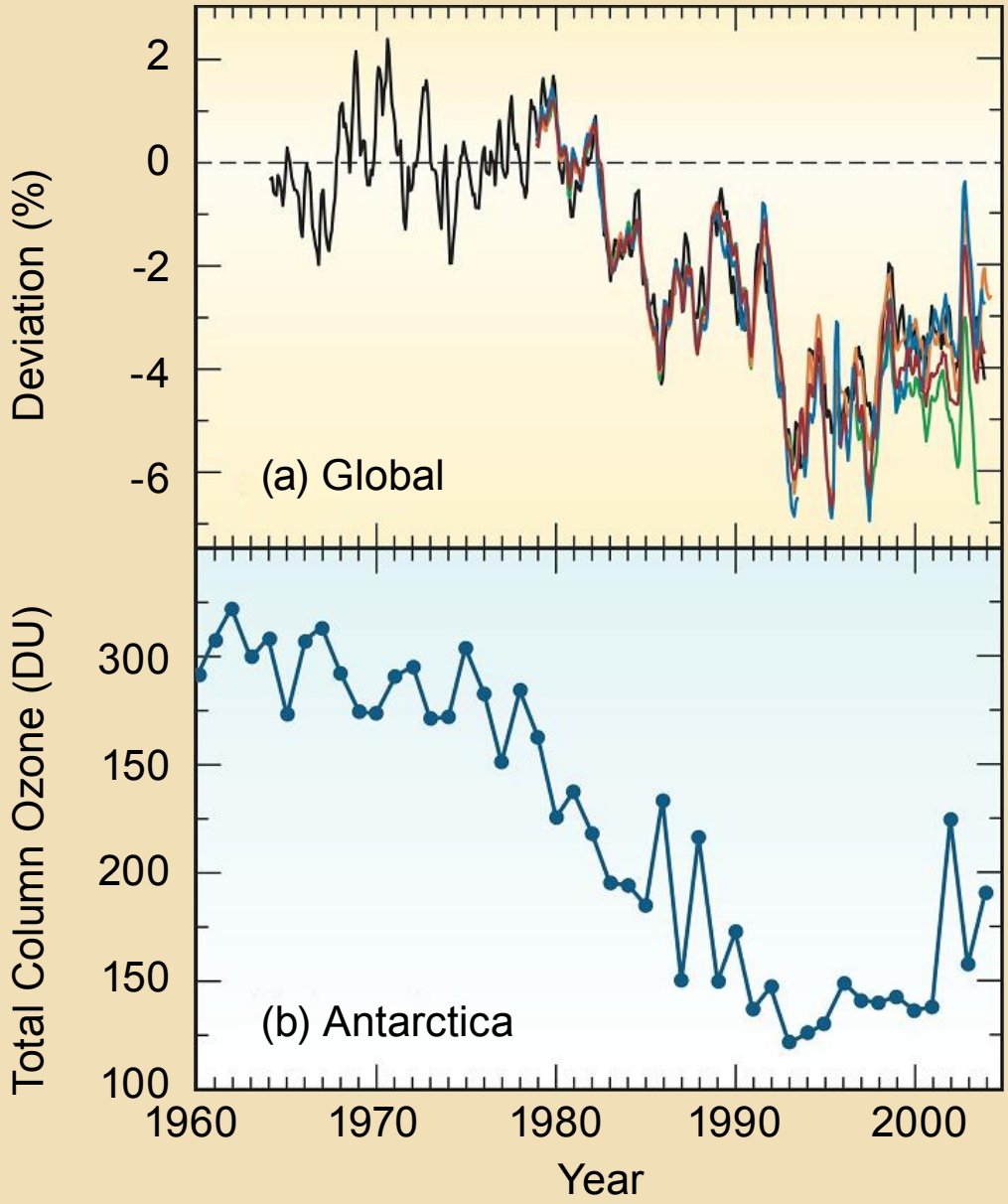
Chlorine Gasses
Total chlorine amount
= 3390 parts per trillion



Bromine Gasses
Total bromine amount
= 21.2 parts per trillion

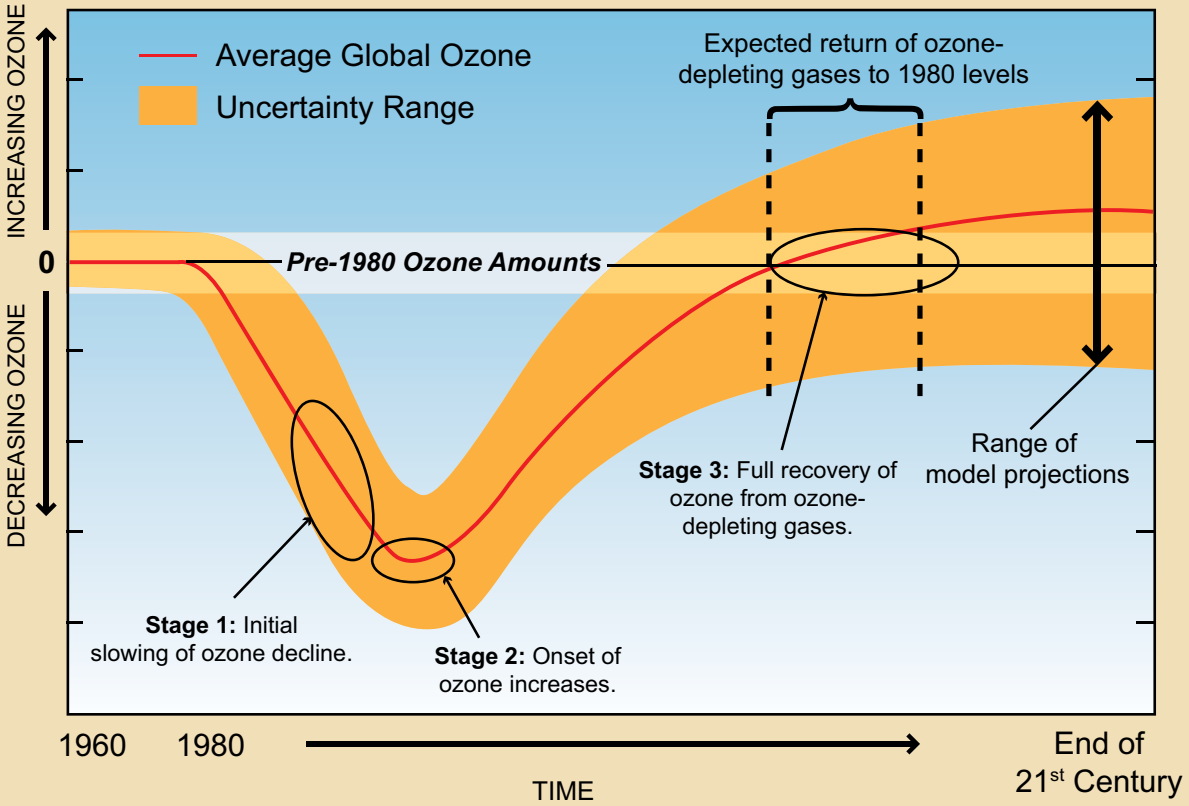


VA #22 Changes to the Ozone Layer



VA #23 Projected Recovery Stages of Global Ozone

Global Ozone Change from Pre-1980 Values



The timeline for recovery identifies three stages. The large uncertainty range illustrates natural ozone variability in the past and potential uncertainties in global model projections of future ozone amounts.

Source: http://www.esrl.noaa.gov/csd/assessments/2006/chapters/twentyquestions.pdf