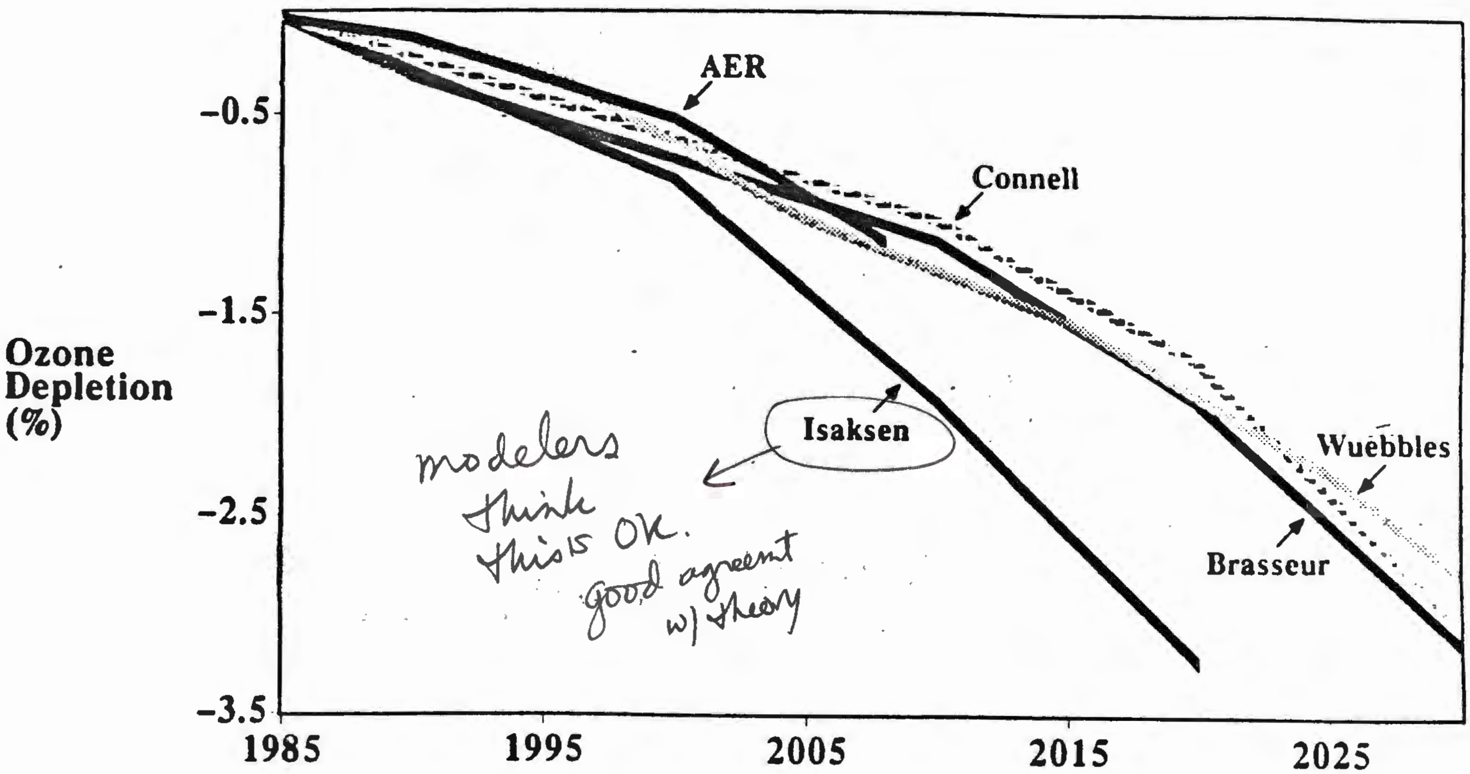
Collection: Masterman, Vicki: Files
Folder Title: Stratospheric Ozone V (4 of 12)
Box: 2

EXHIBIT 5-46

Model Comparison for Coupled Perturbation Scenario



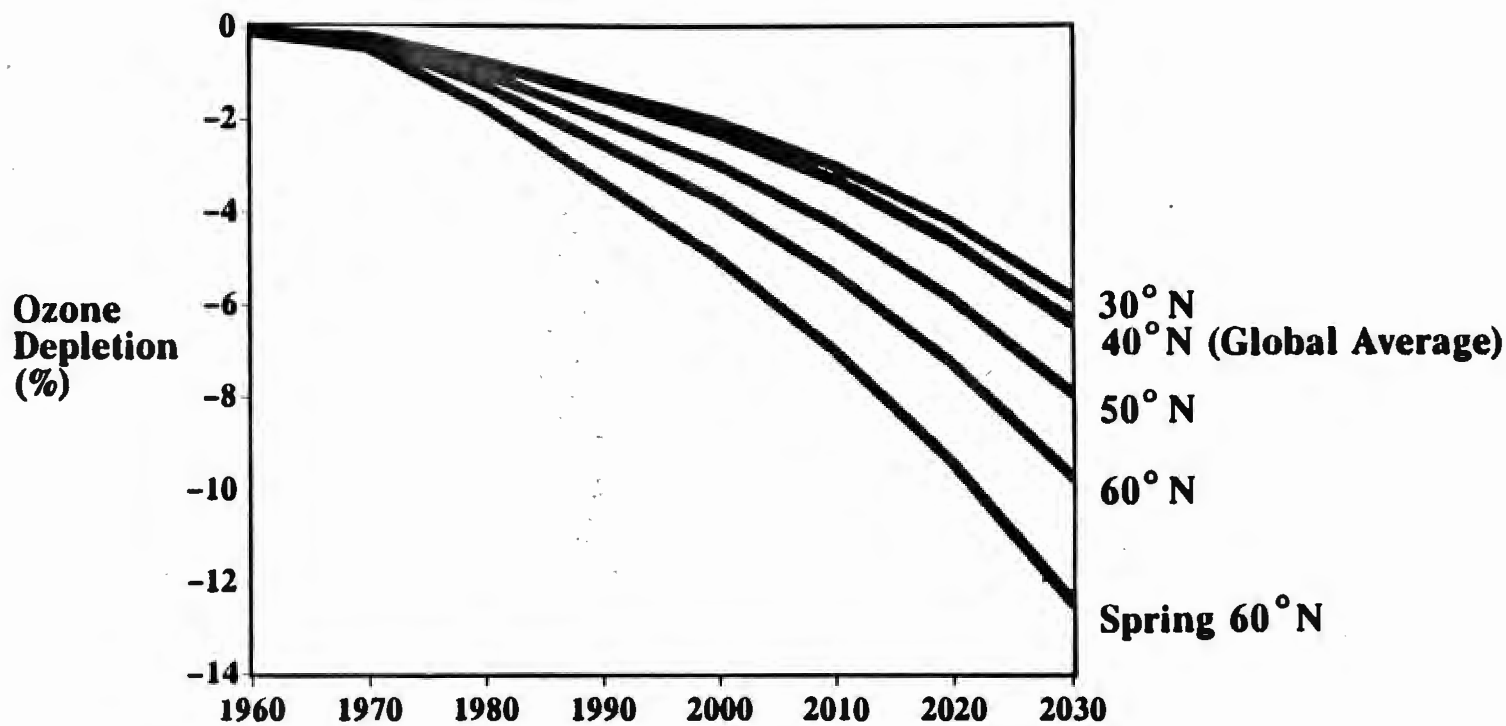
Global average change in total column ozone as calculated by several modeling groups for a common scenario of:

Compound	Growth Rate (% per year)
CFCs	3.0 (emissions)
CH4	1.0 (concentrations)
N2O	0.25 (concentrations)
CO2	~0.60 (concentrations)

Results shown for 2-D models of Isaksen and AER, 1-D models of Brasseur and Wuebbles, and Connell's parameterization of the LLNL 1-D model.

Source: Chemical Manufacturers Association, (1986); World Meterorological Organization, (1986); Connel, (1986); Brasseur and DeRudder, (1986); and Isaksen and Stordal, (1986).

DEPLETION VARIES WITH LATITUDE



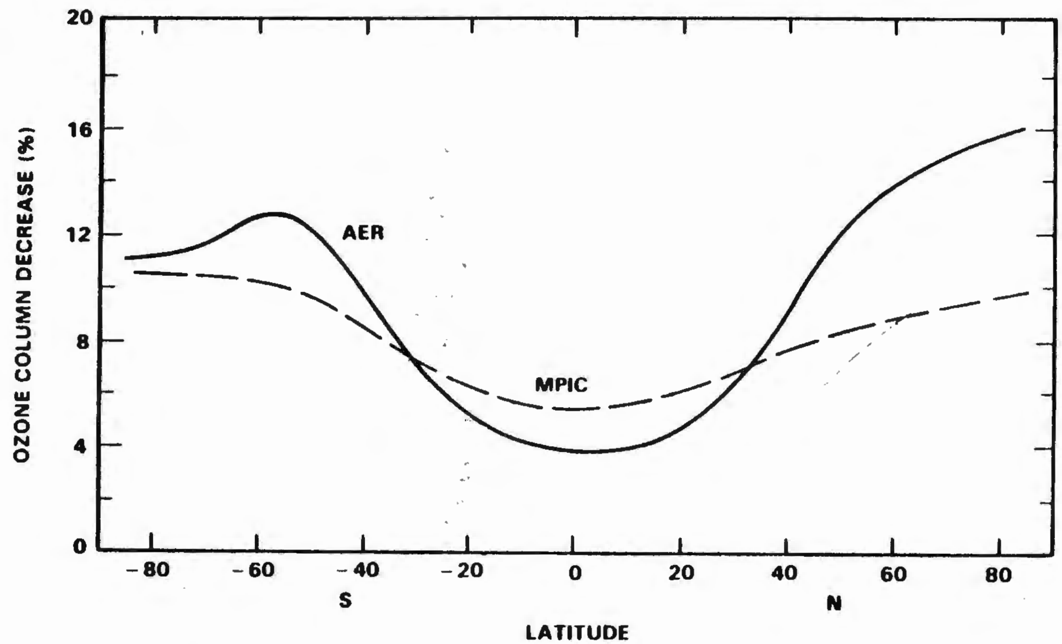
Growth Rates

CFCs: 3% CO_2: 0.6%

CH_4: 1% N_2O: 0.25%

Source: Isaksen (1986) "Ozone Perturbations Studies in a Two-Dimensional Model with Temperature Feedback in the Stratosphere Included," UNEP Workshop

TWO DIMENSIONAL MODELS VARY IN LATITUDINAL DEPLETION

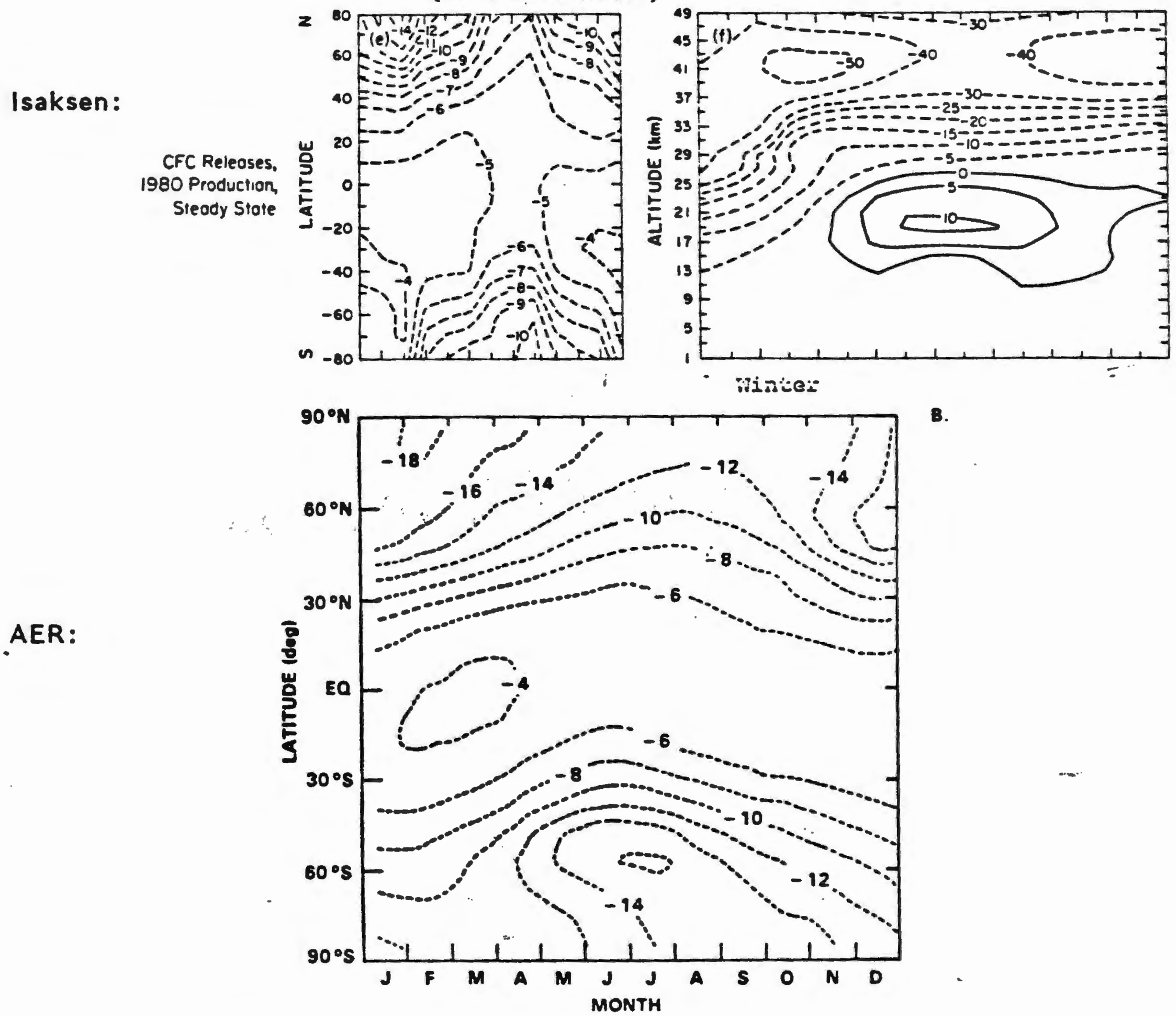


The effect of type of atmospheric dynamics used in two-dimensional models on the latitudinal variation of calculated ozone-column reduction (April). The increase of Cl_x is about 7 ppbv in each case: AER model, scenario S2A; MPIC model, scenario SMA.

Source: **WMO Assessment (1986)**

EXHIBIT 5-15

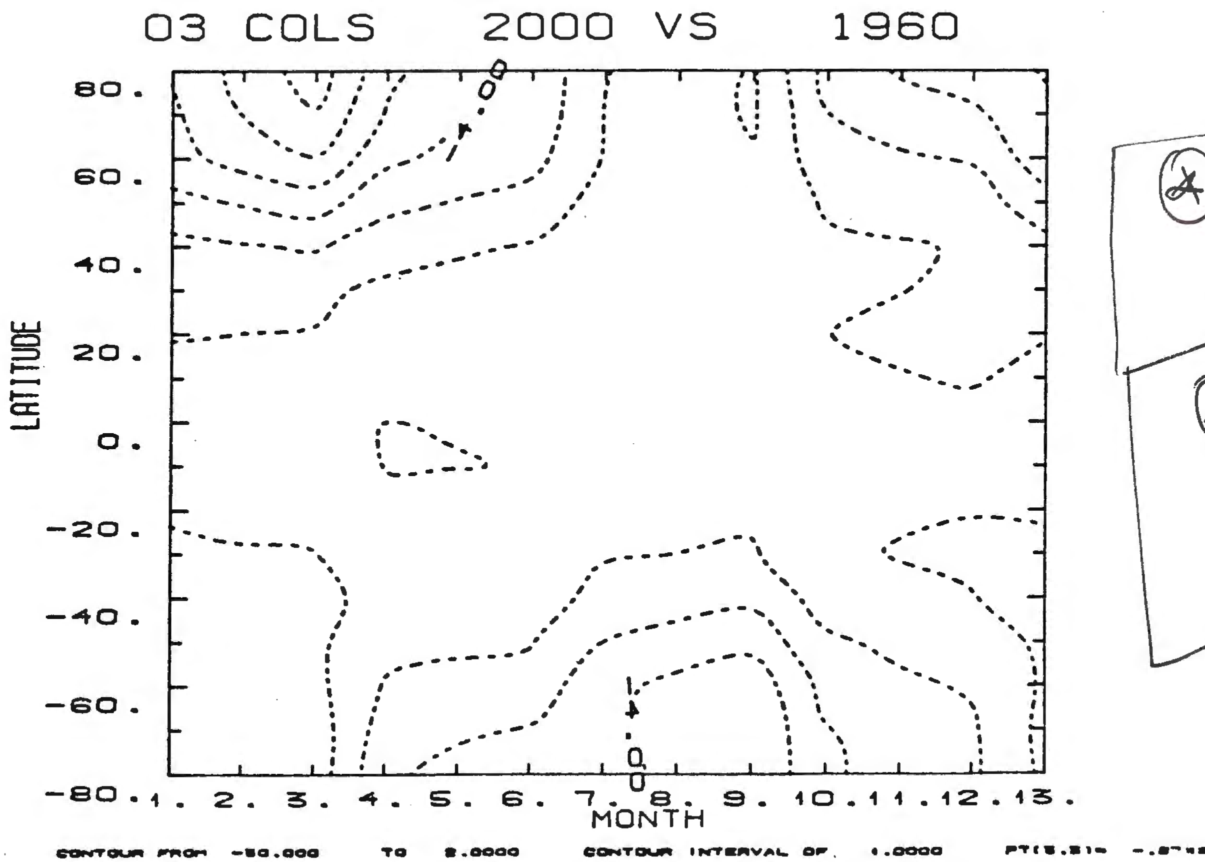
Ozone Depletion by Latitude and Season for CLx Increase of ~6.0 ppv (IS 2-D Model) (AER 2-D Model)



Results from IS 2-D model, for an increase in Clx from 1.0 ppbv to 7.2 ppbv. The bottom panel depicts changes of 1.3 to 8.2 ppbv Clx for the AER 2-D model. Both panels show change in the total ozone column as a function of latitude and time of the year.

Source: Isaksen and Stordal (1986a); WMO (1986).

2-D Analysis of Protocol
(Isaksen model)



(*) worse in No & So latitudes

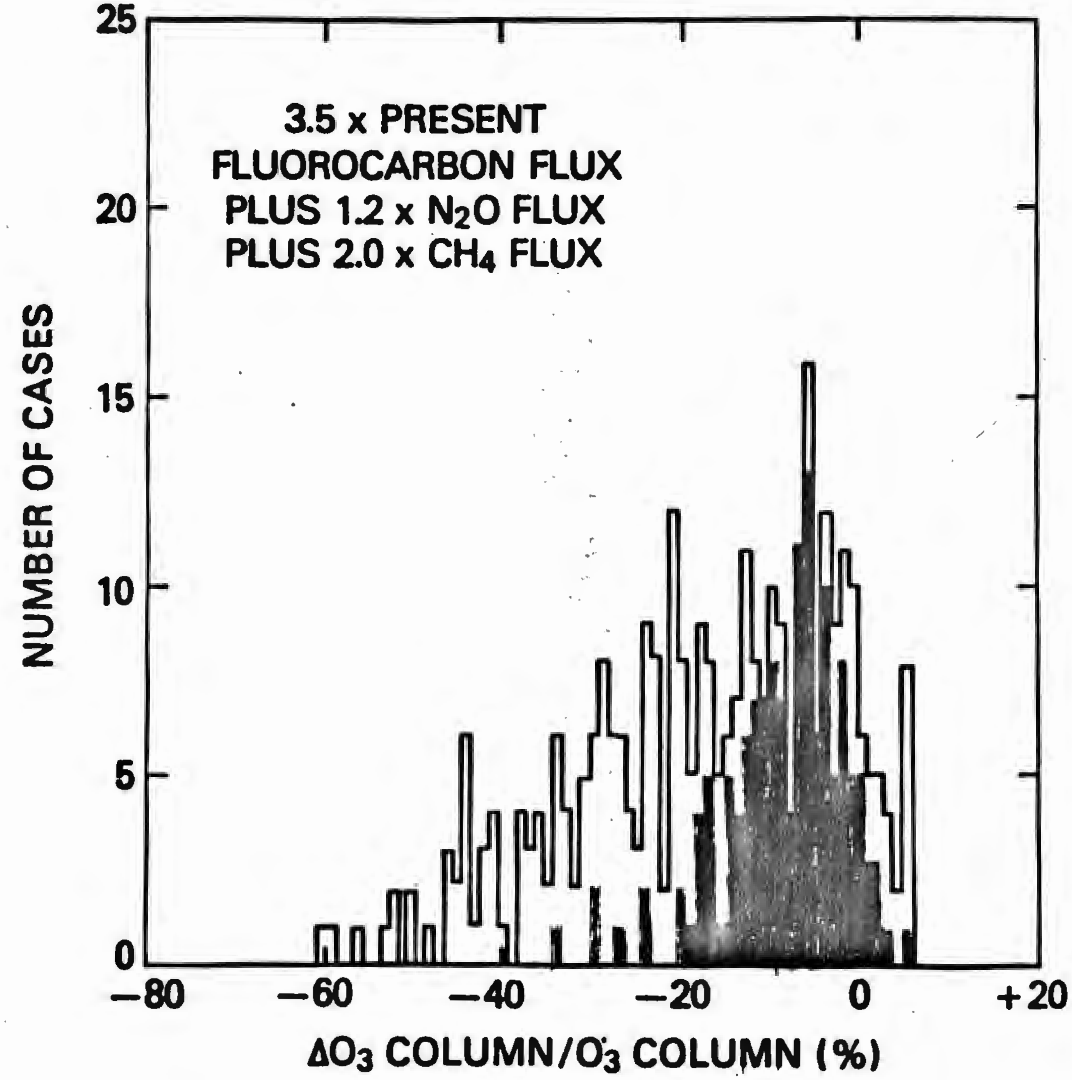
(*) worse in springtime

Assumptions:

Freeze of CFCs in 1986
25% CFC cutback from 1996 to 2000
Halon 1301 and 1211 eliminated in 1986
Methane growth 1% per year
Nitrous oxide growth 0.25% per year
Carbon dioxide growth 0.5% per year

1-D MONTE CARLO RESULTS

OZONE DEPLETION FOR 3.5 times PRESENT CFC FLUX

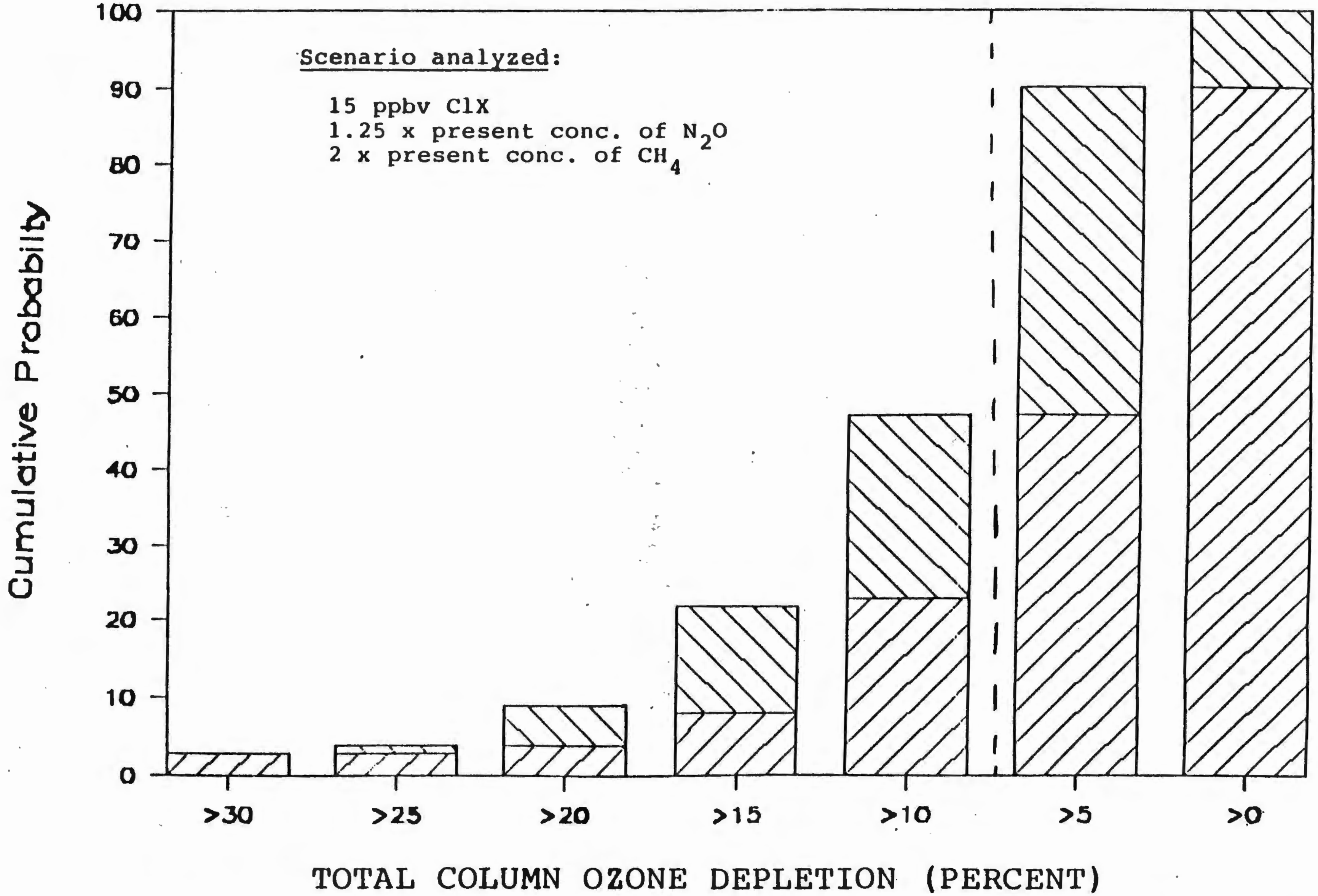


Impt. chart for uncertanties

SOURCE: STOLARSKI AND DOUGLASS (1985)

Shaded area shows where modeled concentrations fall within range of measurements.

MONTE CARLO ANALYSIS WITH THE LLNL 1-D MODEL



SOURCE: Adopted from K.E. Grant et al. (1986) "Monte Carlo Uncertainty Analysis of Stratospheric Ozone in Ambient and Perturbed Atmospheres", LLNL.

EXHIBIT E-4

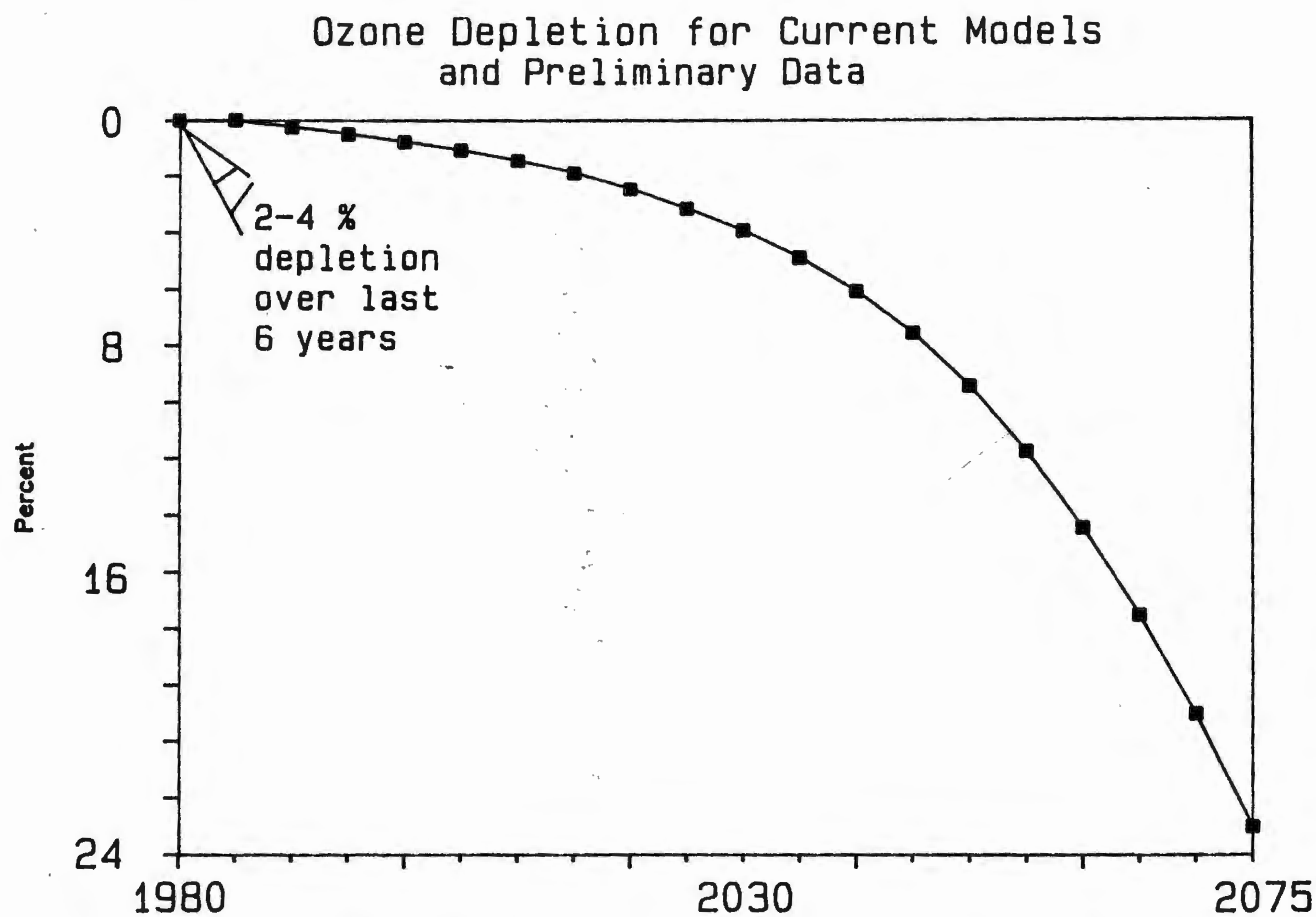
EXAMPLE OZONE-DEPLETION SCALING FACTORS*

Ozone Depletion (percent)	Scaling Factors Low	Scaling Factors High
≤15.0	0.4	2.0
≥20.0	0.5	1.8

* These factors represent the 10th and 90th fractile estimates from a lognormal distribution of uncertainty developed from values reported in: Stolarski, R.S., and A.R. Douglass (1986), Sensitivity of an Atmospheric Photochemistry Model to Chlorine Perturbation Including Consideration of Uncertainty Propagation, Draft Report to the U.S. Environmental Protection Agency, Washington, D.C.

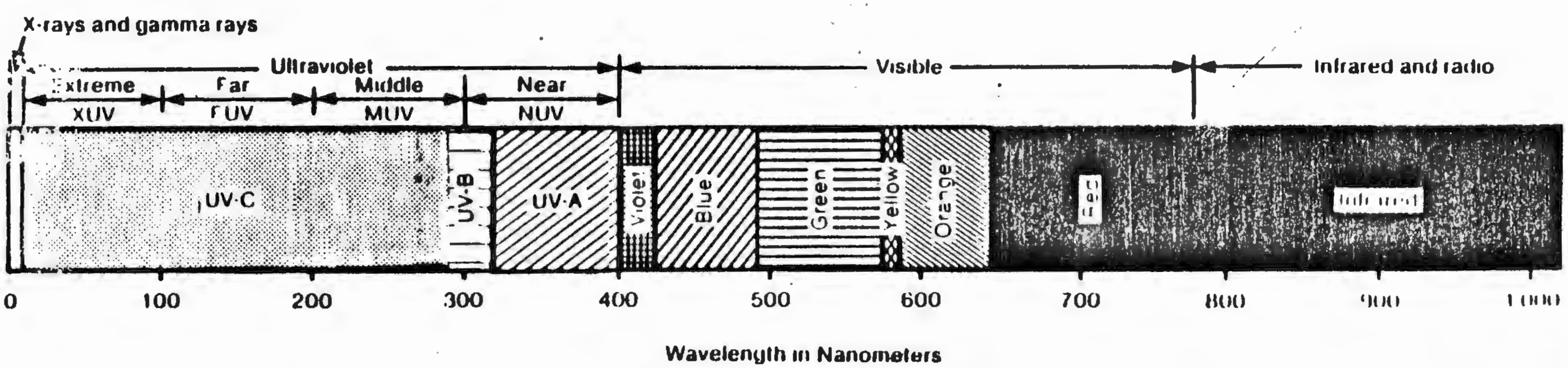
ANALYSIS OF RISKS

Implications of Developing Information

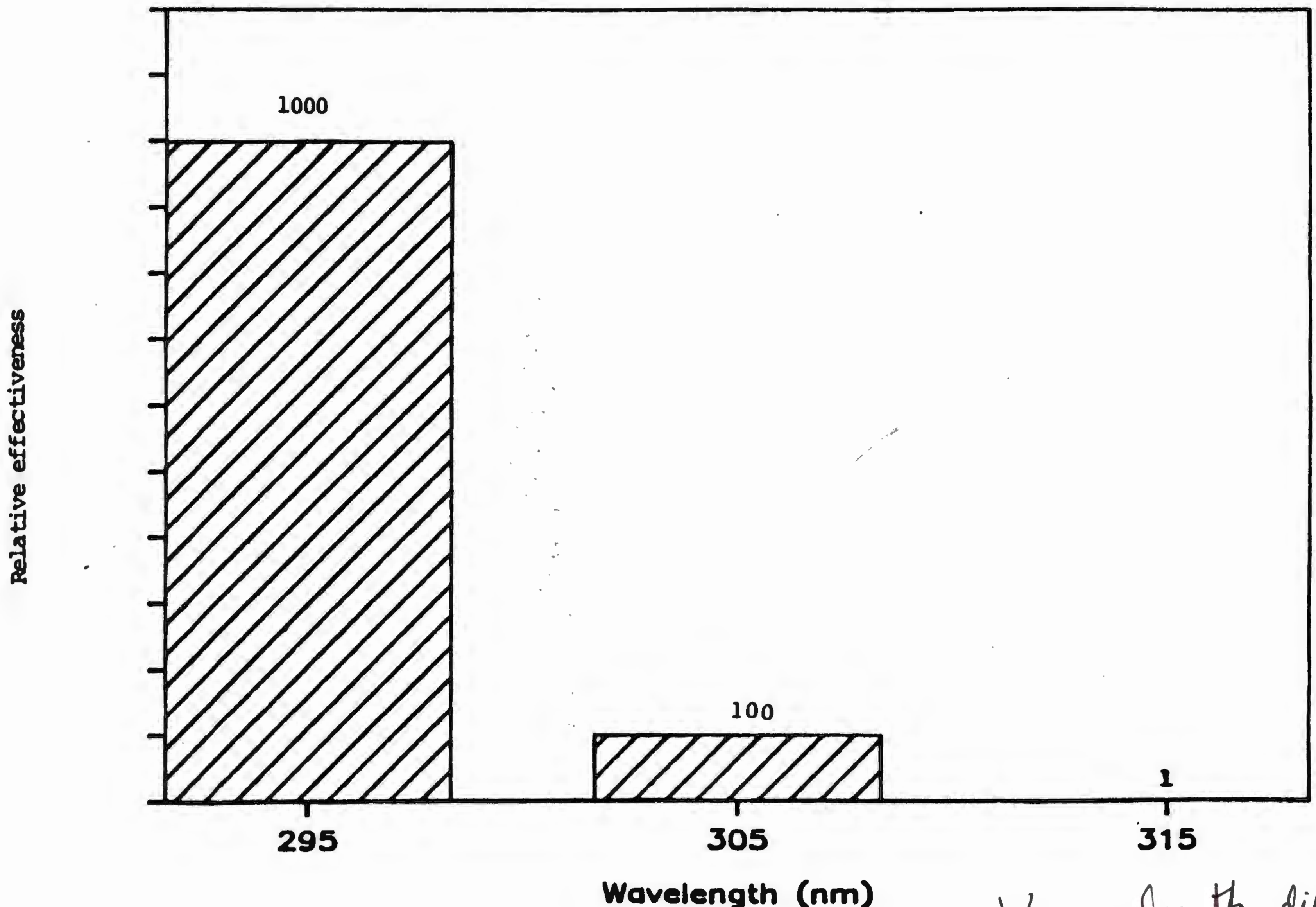


If recent decreases in ozone prove correct and are related to CFCs, current models would be substantially underpredicting future changes in ozone.

THE ELECTROMAGNETIC SPECTRUM



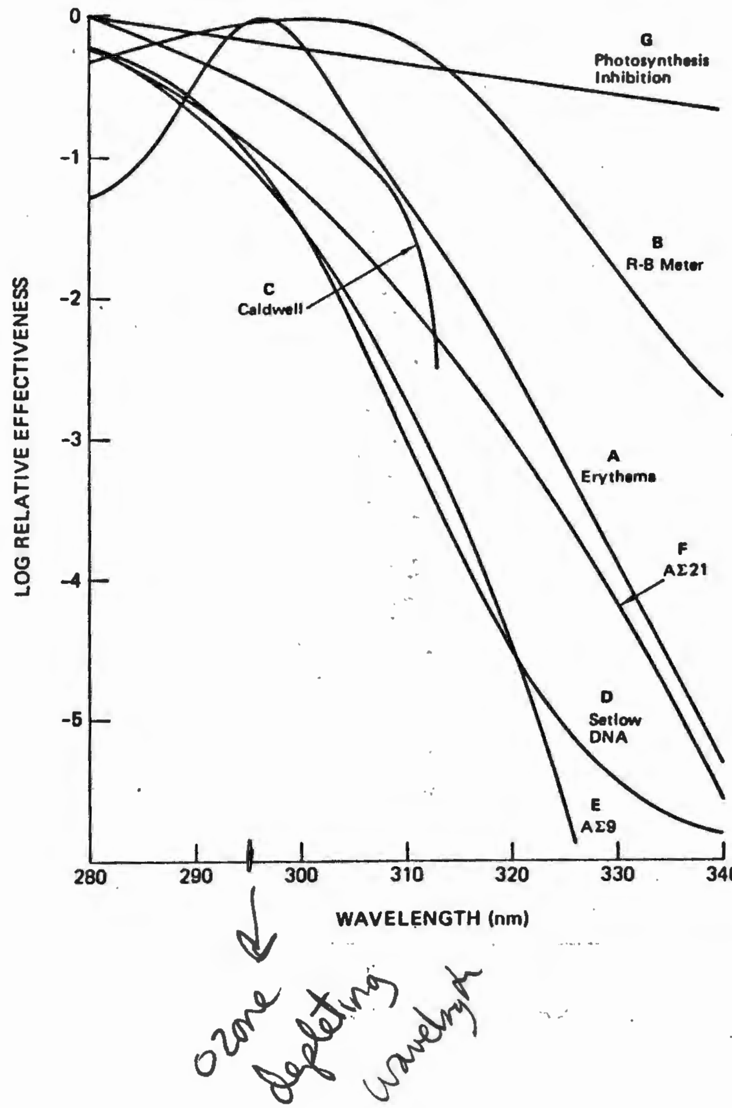
Relative Damage to DNA



Source: Setlow (1974)

☆ b/c wavelength diff not get 1% ozone depletion = 1% damage.

ACTION SPECTRA



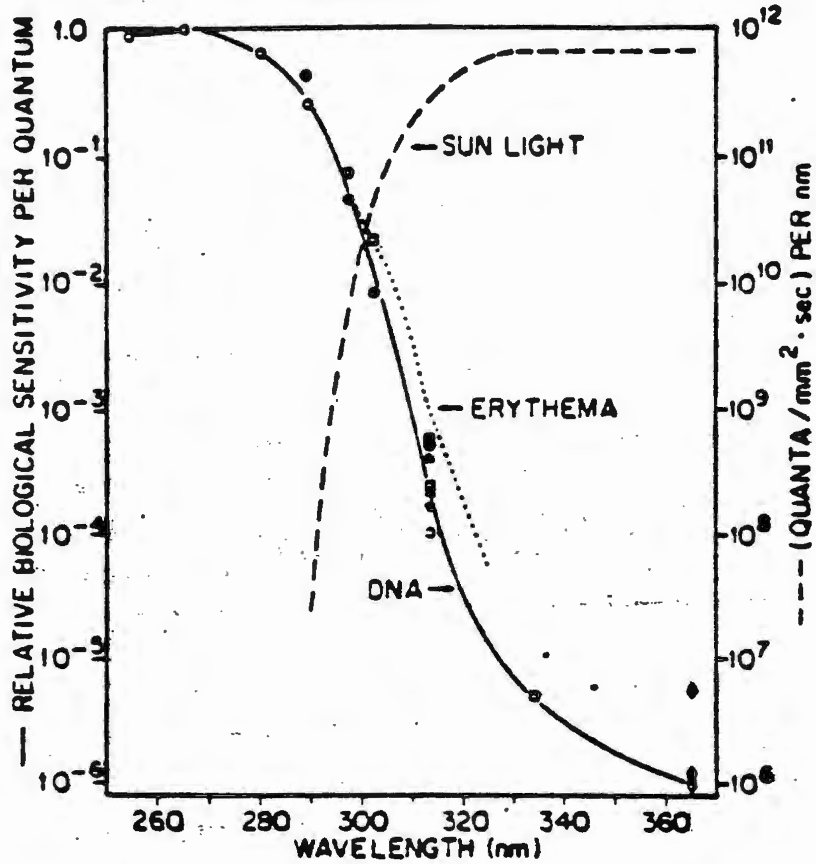


FIGURE 2-4

AVERAGE DNA ACTION SPECTRUM

Source: Setlow 1974.

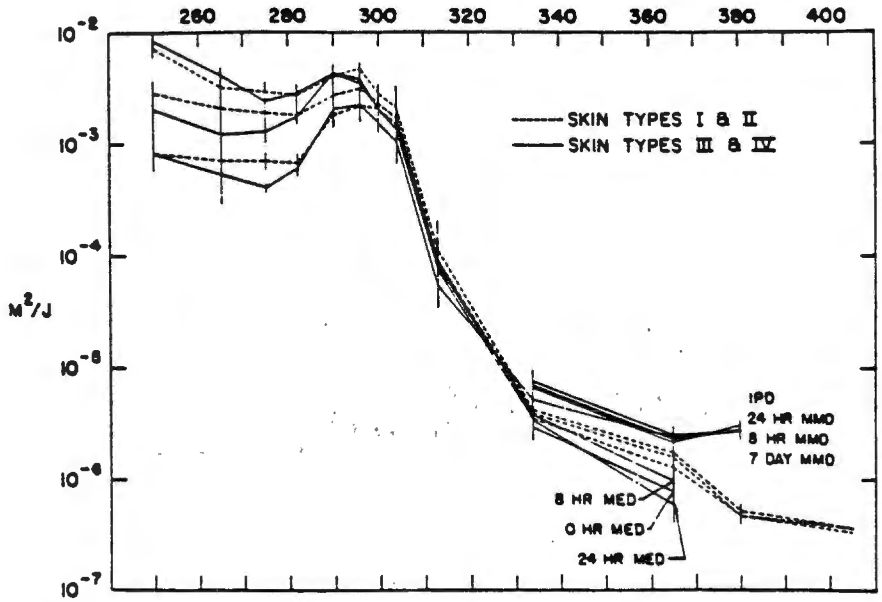


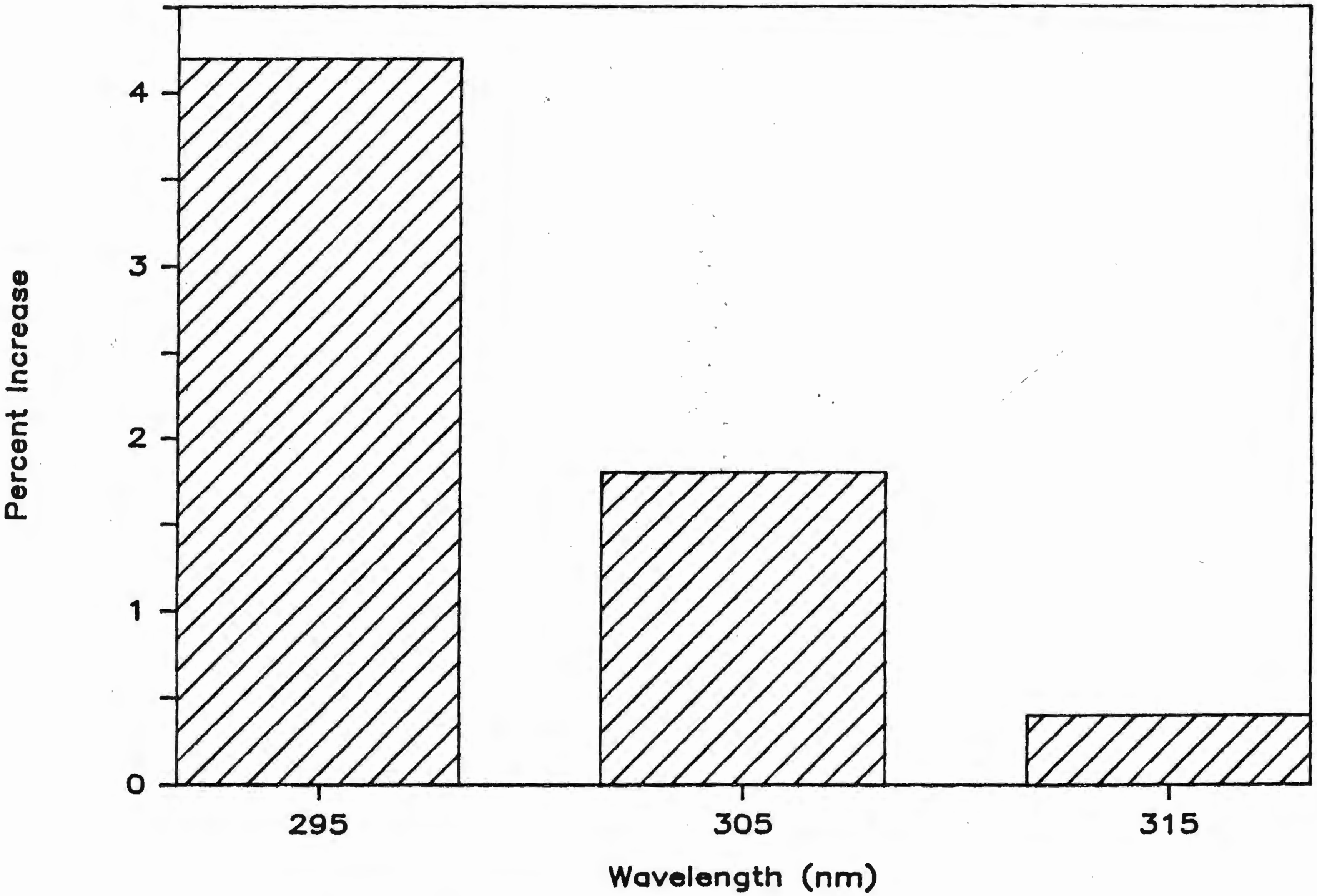
FIGURE 2-5

ACTION SPECTRA FOR ERYTHEMA AND MELANOGENESIS

Source: Gange et al. 1986.

Increases in UV from 1% Ozone Depletion

in Talahassee, Florida



Source: NASA UV model estimates

– 1% depletion in Florida is worse than 1% depletion in Mpls. b/c it's off a bigger base.

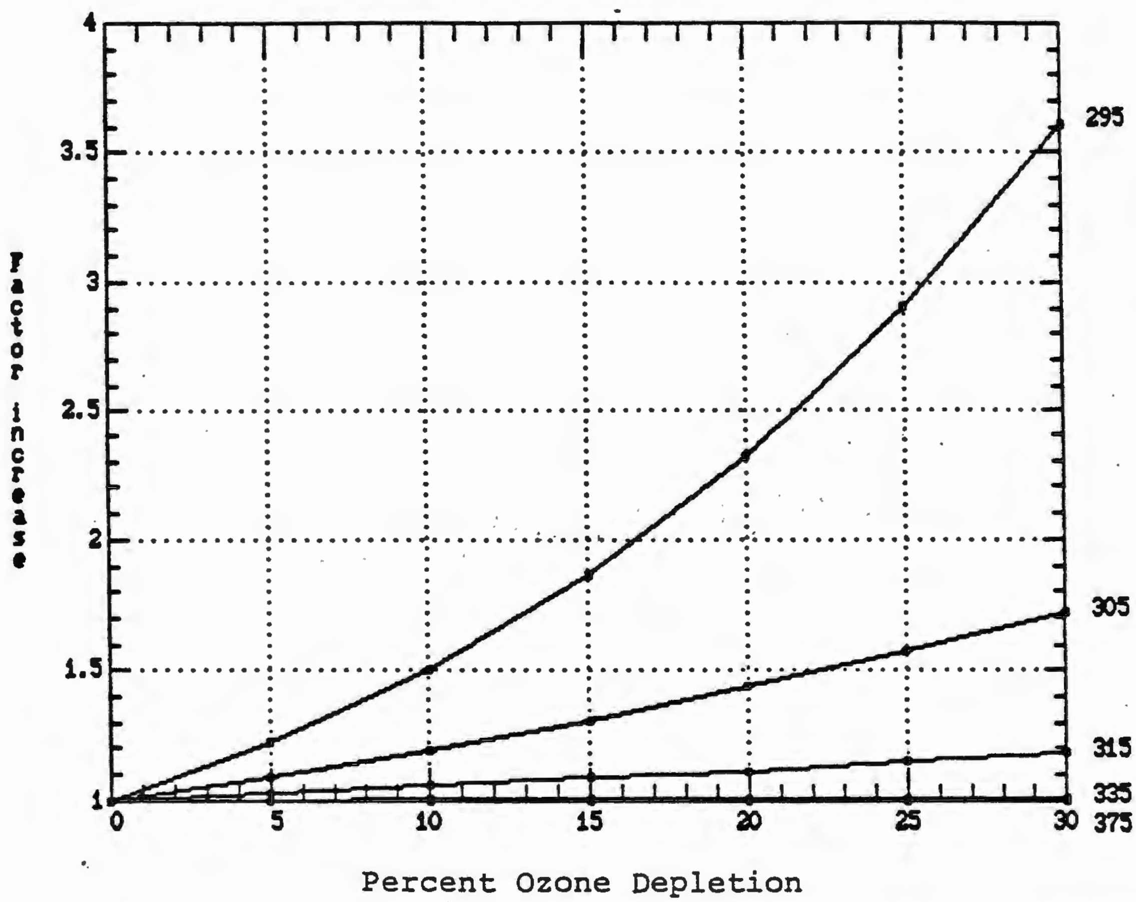


FIGURE 2-16

MINNEAPOLIS: TOTAL YEARLY FLUX VS. OZONE DEPLETION

EXHIBIT F-7

Cities Used to Evaluate Changes in UV Flux for the Three Regions of the U.S.

REGION 1: NORTH	REGION 2: MIDDLE	REGION 3: SOUTH
New York	Chicago	Los Angeles
Detroit	Philadelphia	San Diego
Milwaukee	Baltimore	Houston
Boston	San Francisco	Dallas/Fort Worth
Seattle	Washington	Phoenix
Minneapolis	Denver	New Orleans
Portland	Salt Lake City	Miami
Buffalo	Kansas City	Atlanta

EXHIBIT F-8

States Includes in the Three Regions of the U.S.

REGION 1: NORTH	REGION 2: MIDDLE	REGION 3: SOUTH
Alaska	California (N) a/	Alabama
Connecticut	Colorado	Arizona
Idaho	Delaware	Arkansas
Maine	District of Columbia	California (S) a/
Massachusetts	Illinois	Florida
Michigan	Indiana	Georgia
Minnesota	Iowa	Hawaii
Montana	Kansas	Louisiana
New Hampshire	Kentucky	Mississippi
New York	Maryland	New Mexico
North Dakota	Missouri	South Carolina
Oregon	Nebraska	Texas
Rhode Island	Nevada	
South Dakota	New Jersey	
Vermont	North Carolina	
Washington	Ohio	
Wisconsin	Oklahoma	
	Pennsylvania	
	Tennessee	
	Utah	
	Virginia	
	West Virginia	
	Wyoming	
Latitude = 43.3 N	Latitude = 39.1 N	Latitude = 31.8 N

a/ California is divided in half, one half being included in the Middle Region, and one half included in the South Region.

Source: Latitude estimates based on population centroids for each state from the 1980 U.S. census, Master Area Reference File #2, Geography Section, U.S. Bureau of Census, Department of Commerce.

EXHIBIT F-9

Percent Change in UV as a Function of Change in Ozone Abundance for Three U.S. Regions
(DNA Action Spectrum)

OZONE DEPLETION (%)	CHANGE IN UV (%) North	Middle	South
-10	-17.3	-17.2	-16.7
-5	-9.3	-9.1	-8.9
-2	-3.8	-3.8	-3.8
0	0.0	0.0	0.0
2	4.2	4.3	4.2
5	10.8	10.6	10.5
10	22.9	22.8	22.2
20	53.8	53.2	51.0
30	96.0	94.8	90.4

Source: Based on analyses using the UV Model developed by Serafino and Frederick (1986).

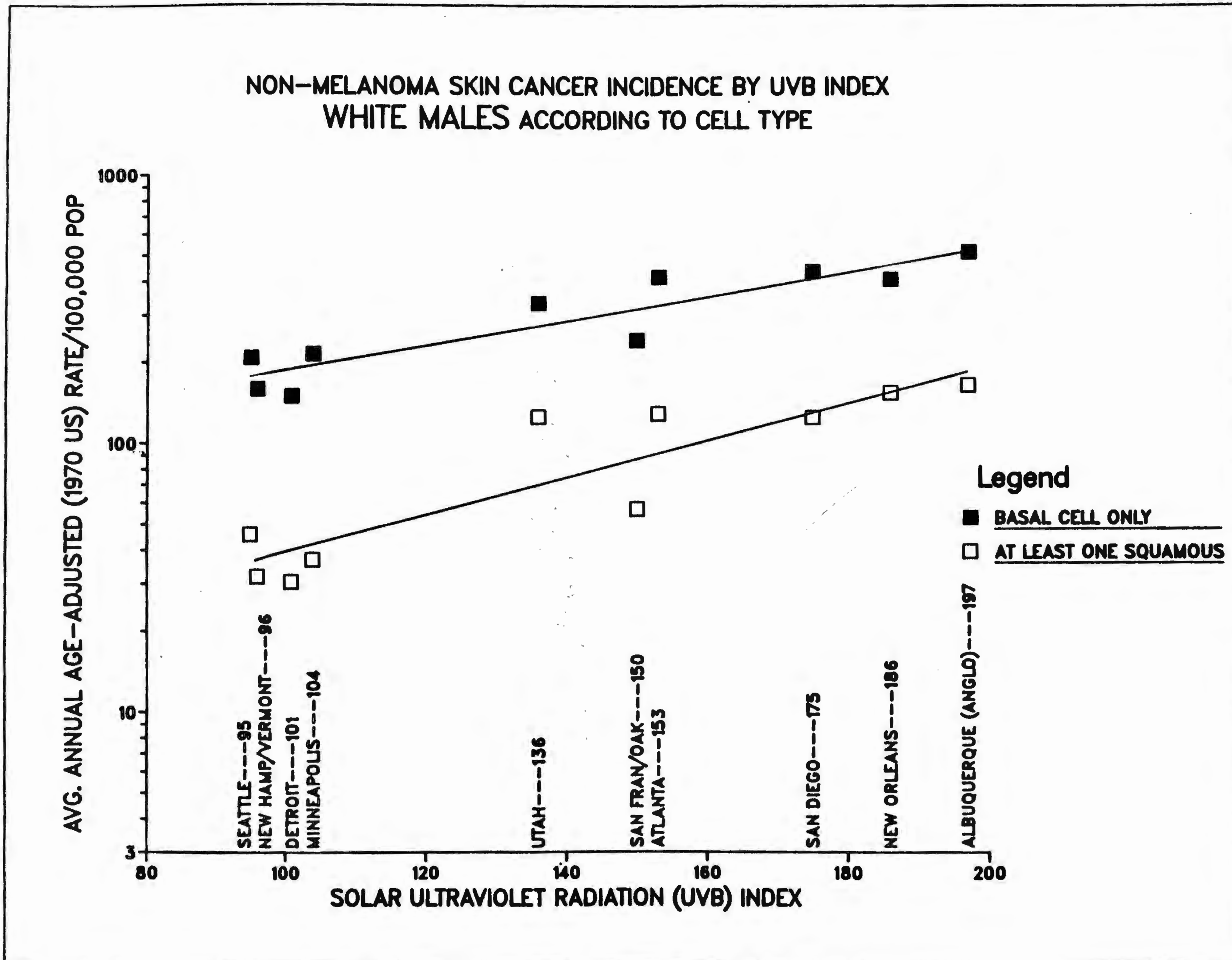
EXHIBIT F-14

Baseline Prevalence of Senile Cataracts
(Rate per 100,000)

	AGE				
	≤54*	55-64	65-74	75-84	85+
Male	0.0	4,300	16,000	40,900	40,900
Female	0.0	4,700	19,300	48,900	48,900

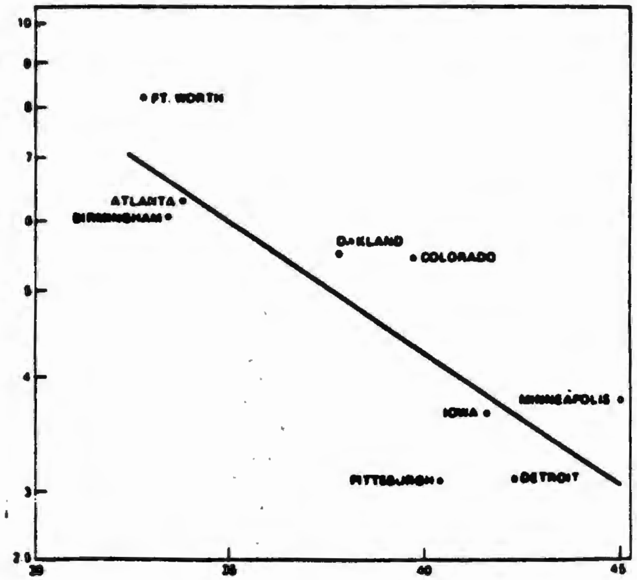
* Prevalence for individuals under 54 years of age assumed to be zero.

Source: Leske C.L. and R.D. Sperduto (1983), "The Epidemiology of Senile Cataracts: A Review," American Journal of Epidemiology, Vol. 118, No. 2, pp. 152-165.


NON-MELANOMA SKIN CANCER INCIDENCE BY UVB INDEX
WHITE MALES ACCORDING TO CELL TYPE
AVG. ANNUAL AGE-ADJUSTED (1970 US) RATE/100,000 POP
1000
100
10
3
80
100
120
140
160
180
200
SOLAR ULTRAVIOLET RADIATION (UVB) INDEX
SEATTLE---95
NEW HAMP/VERMONT---96
DETROIT---101
MINNEAPOLIS---104
UTAH---136
SAN FRAN/OAK---150
ATLANTA---153
SAN DIEGO---175
NEW ORLEANS---186
ALBUQUERQUE (ANGLO)---197
Legend
BASAL CELL ONLY
AT LEAST ONE SQUAMOUS

MELANOMA INCIDENCE VERSUS LATITUDE

Rate Per 100,000



Degrees North

Age–Adjusted Rate for White Males

Source: Scotto and Fears, National Cancer Institute, 1975

EXHIBIT F-16

Coefficients Relating Percent Change in UV to Percent Change in Incidence

(For use with the DNA Action Spectrum -- Whites only)

	Low a/	Middle	High b/
NON-MELANOMA SKIN CANCER			
Squamous			
Male	1.42	2.03	2.64
Female	1.47	2.22	2.98
Basal			
Male	0.932	1.29	1.65
Female	0.316	0.739	1.16
MELANOMA SKIN CANCER			
Face, Head and Neck			
Male	0.661	0.846	1.029
Female	0.798	1.019	1.236
Trunk and Lower Extremities			
Male	0.421	0.651	0.875
Female	0.341	0.522	0.700

a/ Middle value minus one standard error.

b/ Middle value plus one standard error.

Sources: Melanoma coefficients derived from Scotto and Fears (in press). Non-melanoma coefficients presented in Chapter 7.

Issues being addressed

* population ages (held fixed now)

* baseline rate out of equilibrium

  -- rise in all cohorts

  -- appears to be levelling out
     (prediction therefore possible)

EXHIBIT F-18

Coefficients Relating Percent Change in Senile Cataract Prevalence for a One Percent Change in UV (all races)

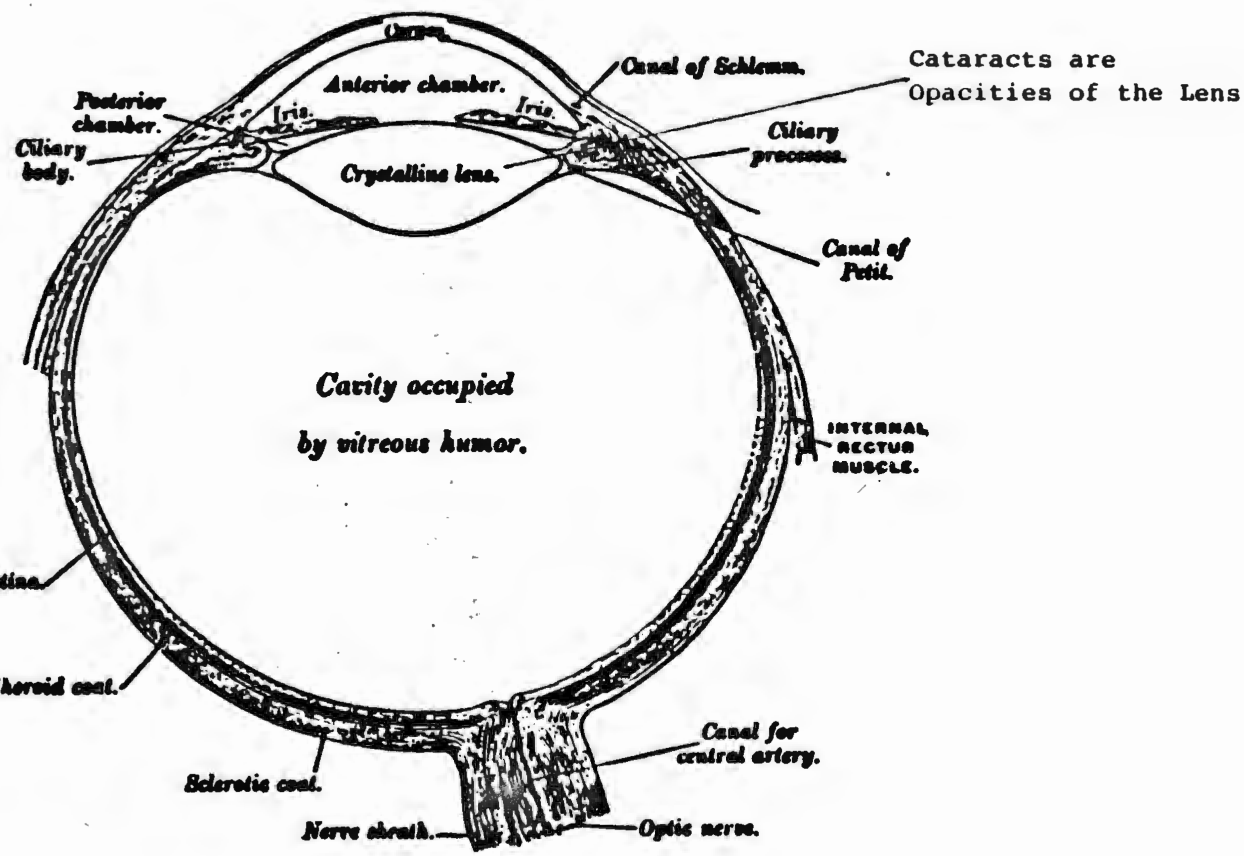
	Low a/	Middle	High b/
Males and Females	0.171	0.311	0.419

a/ Middle estimate minus one standard error.

b/ Middle estimate plus one standard error.

Source: Derived from Hiller, R., R. Sperduto, and F. Ederer (1983), "Epidemiologic Associations with Cataract in the 1971-1972 National Health and Nutrition Examination Survey," American Journal of Epidemiology, Vol. 118, No. 2, pp. 239-248.

A HORIZONTAL SECTION OF THE EYEBALL



SOURCE: GRAY'S ANATOMY. 1974

Cataracts

Magnitude of the Problem

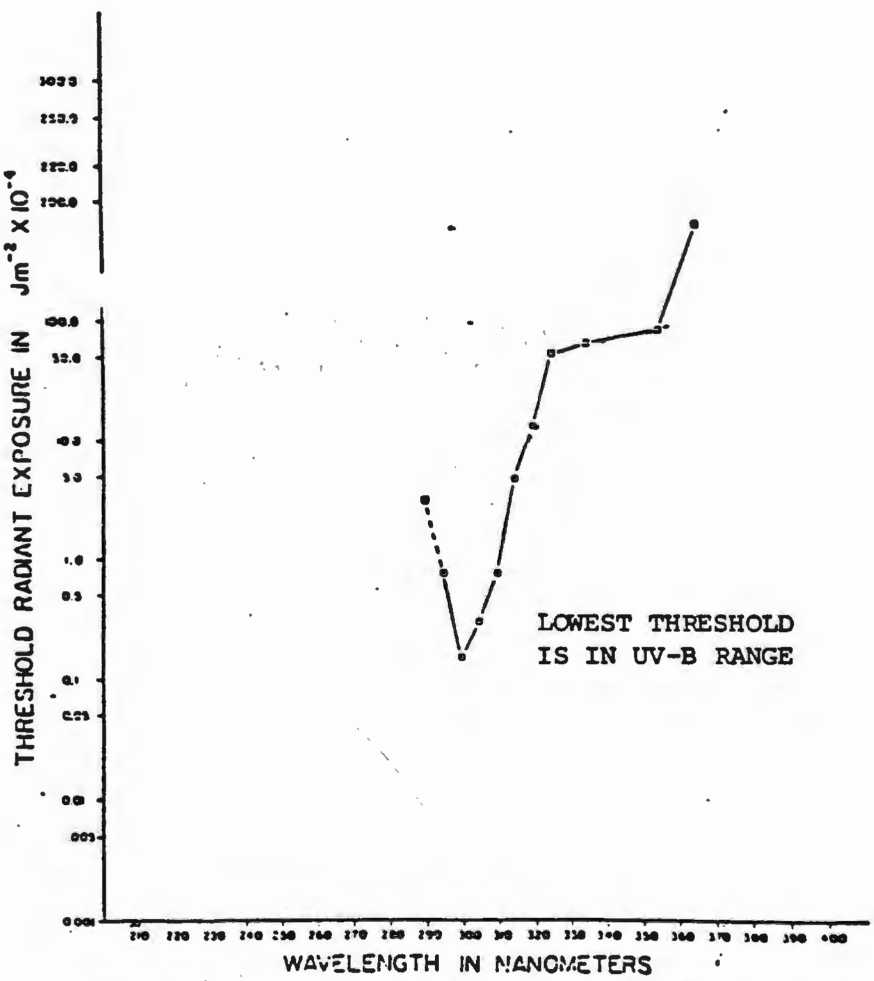
Trends in estimating aged population and cataract rates

Population	Year	Cataract	
100%	1980	100%	
115%	2000	175%	Industrialized areas
170%	2000	230%	Developing areas

From Maitchouk (1985)

- **Worldwide senile cataract is responsible for significant visual impairment in 30 to 45 million people – of these perhaps 12 to 15 million are blind.**
- **Current treatment rates are not keeping pace with current incidence rates – thus the problem will continue to grow.**

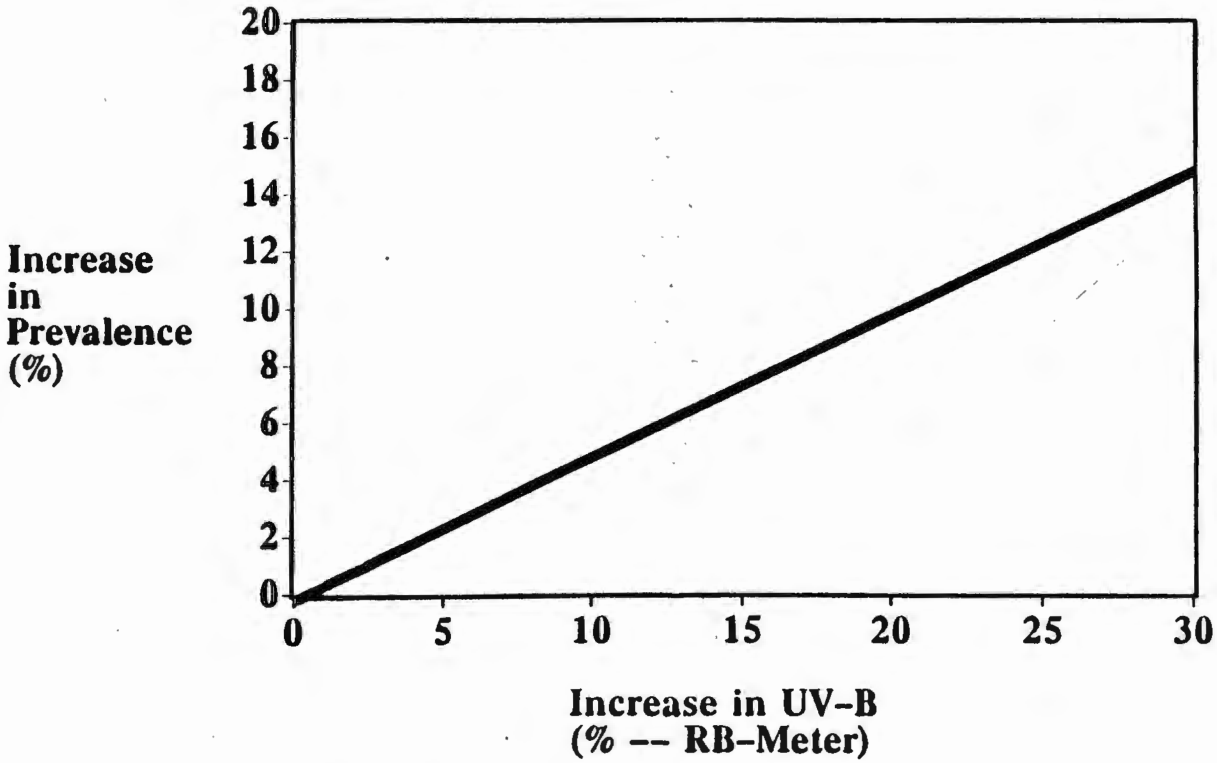
Animal experiments show that UV-B can induce cataracts



Ultraviolet action spectrum for cataracts in the rabbit in wavelength range from 290 to 370mm

Source: Pitts (1981)

THE PREVALENCE OF SENILE CATARACTS CORRELATES WITH UV-B
(Relationship for a Person of Age 60)



Source: Based on Hiller (1983)
Analysis of NHANES Data

EXHIBIT F-14

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(Rate per 100,000)

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* Prevalence for individuals under 54 years of age assumed to be zero.

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	Low a/	Middle	High b/
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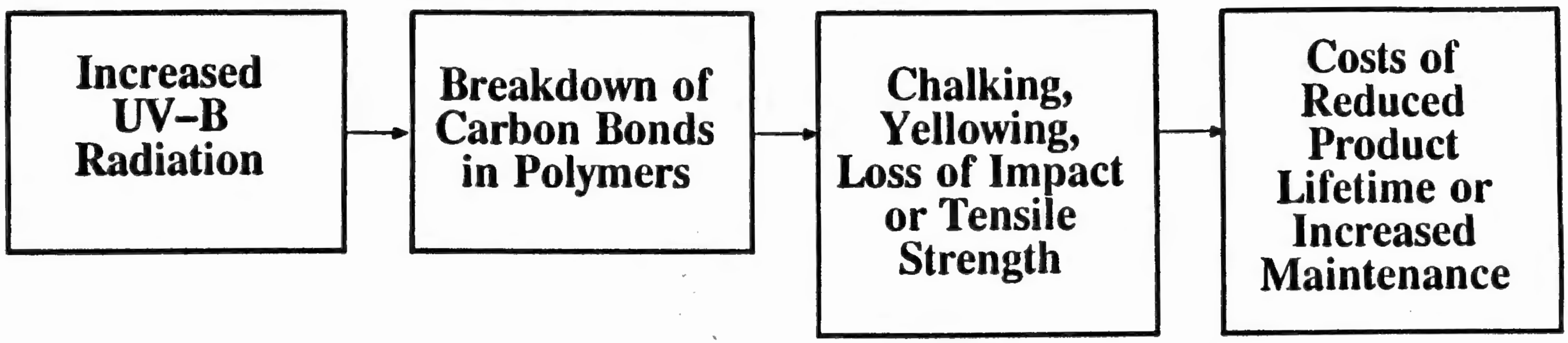
a/ Middle estimate minus one standard error.

b/ Middle estimate plus one standard error.

Source: Derived from Hiller, R., R. Sperduto, and F. Ederer (1983), "Epidemiologic Associations with Cataract in the 1971-1972 National Health and Nutrition Examination Survey," American Journal of Epidemiology, Vol. 118, No. 2, pp. 239-248.

UV–B AND ACCELERATED WEATHERING OF POLYMERS

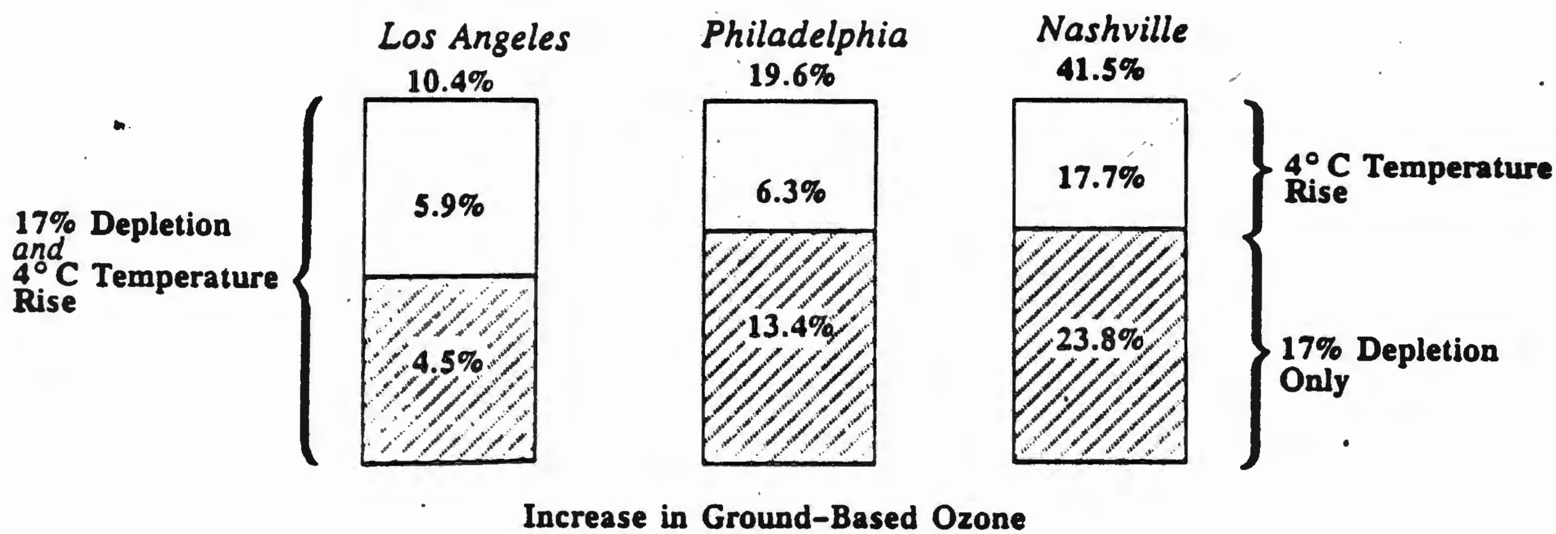


Case Study: **PVCs Used Outdoors in Siding and Window Frames**

Assumes: **Use of Stabilizers to Offset losses**
Ozone Depletion Based on Mid–Range Cases

Costs: **Cumulative Costs of $4.7 Billion in U.S. (1984–2075)**

GLOBAL WARMING WOULD EXACERBATE EFFECTS OF DEPLETION ON GROUND-BASED OZONE



Source: Whitten (1986)

PREDICTED HYDROGEN PEROXIDE INCREASE -- OXIDANT AND ACID RAIN PRECURSOR

15% Depletion ⇒ 30x Increase

1. **Being Tested in Smog Chambers**
2. **Would Tend to Increase Acid Precipitation**
3. **Important Oxidant**

Research in Early Stages

SOURCE: WHITTEN (1986)

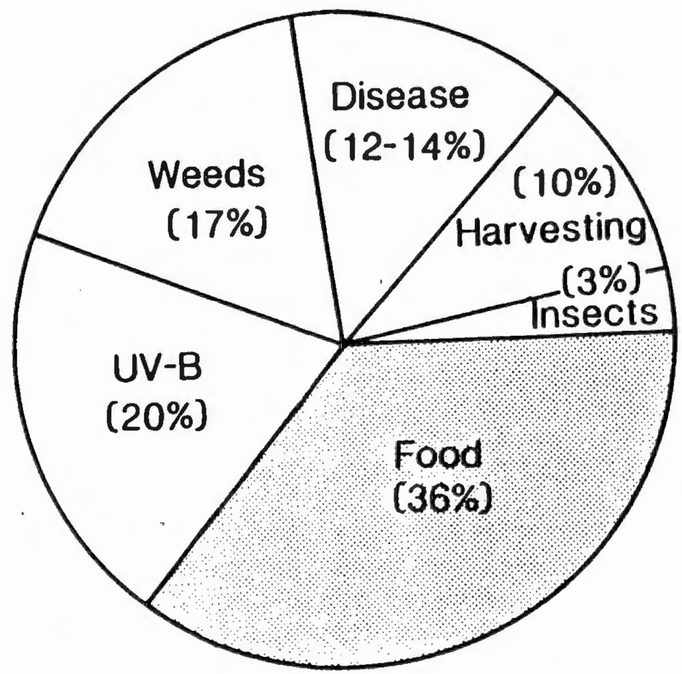
SUMMARY OF UV EFFECTS ON SOYBEAN YIELD ON SENSITIVE CULTIVARS AND QUALITY

20% OZONE DEPLETION

YEAR	% CHANGE IN YIELD	% CHANGE IN SEED QUALITY		
		PROTEINS	OILS	
1981	-25			
1982	-23	-5	-2	
1983	+6	-4	+1	(Drought years)
1984	-7	0	-2	(Drought years)
1985	-20	0	0	

SOURCE: Teramura, in Effects of Changes in Stratospheric Ozone and Global Climate, August (1986).

1/3 OF CULTIVARS ARE NOT SENSITIVE TO UV-B



Current sources of soybean crop losses in the United States in relation to anticipated losses due to a 25% ozone depletion.

SOURCE: Teramura (1986), "The Potential Consequences of Ozone Depletion upon Global Agriculture", in U.S. EPA/UNEP, Effects of Changes in Stratospheric Ozone and Global Climate. Volume 2: Stratospheric Ozone, U.S. EPA, Washington, DC.

Economic Impact of Reduced Yields due to UV-B

DRI Agriculture Model

* Standard tool used by Pesticides Office

* Will be used to simulate soybean yield losses

* Econometric formulation

  -- forecasts changes in prices and quantities
  -- traces effects through agricultural and other sectors

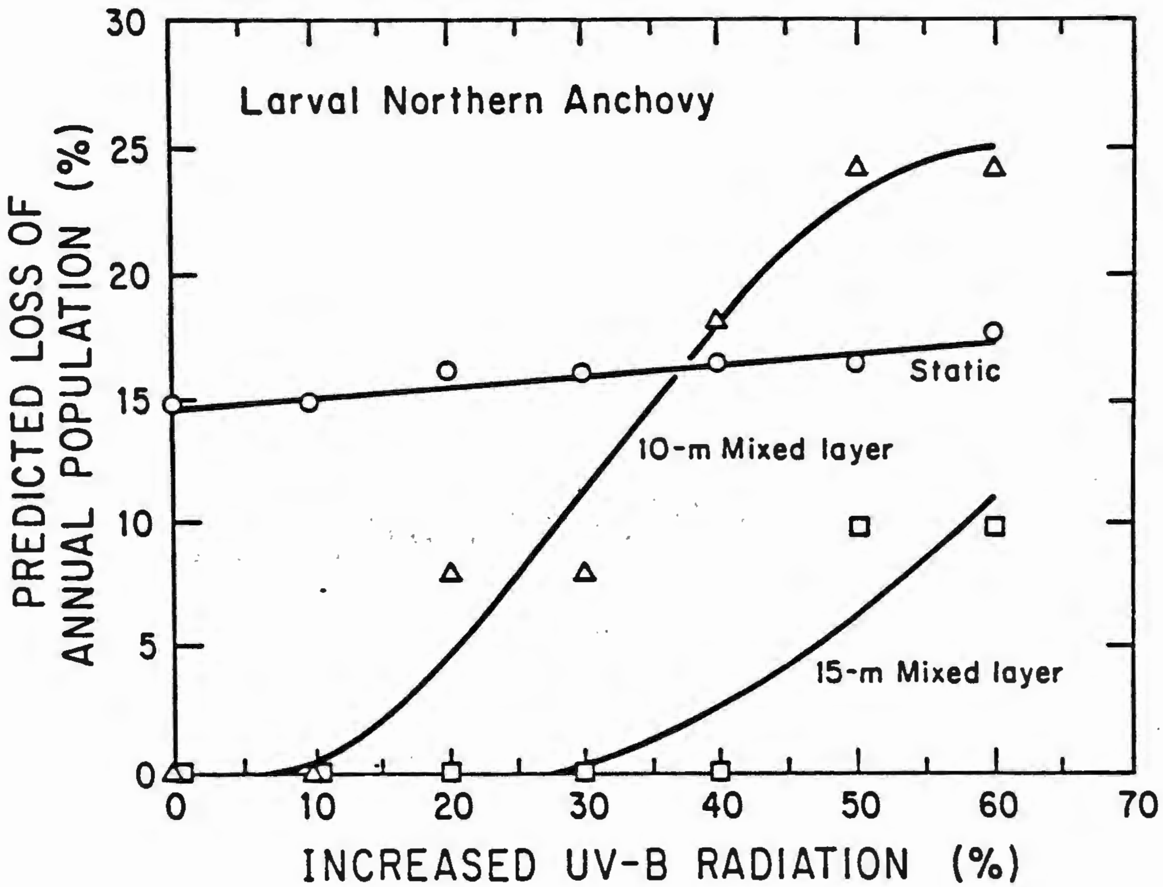
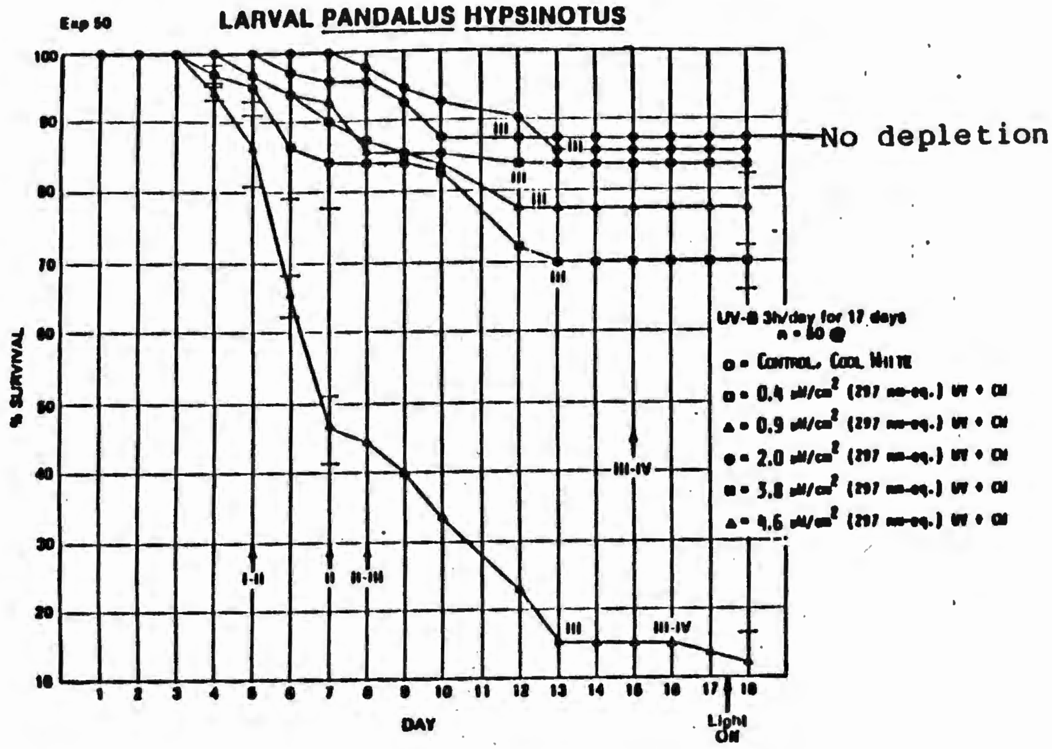


Figure 3. Effect of increased levels of solar UV-B radiation on the predicted loss of larval Northern Anchovy from annual populations, considering the dose/dose-rate threshold and the vertical mixing models (based on data of Hunter, Kaupp, and Taylor 1981, 1982).

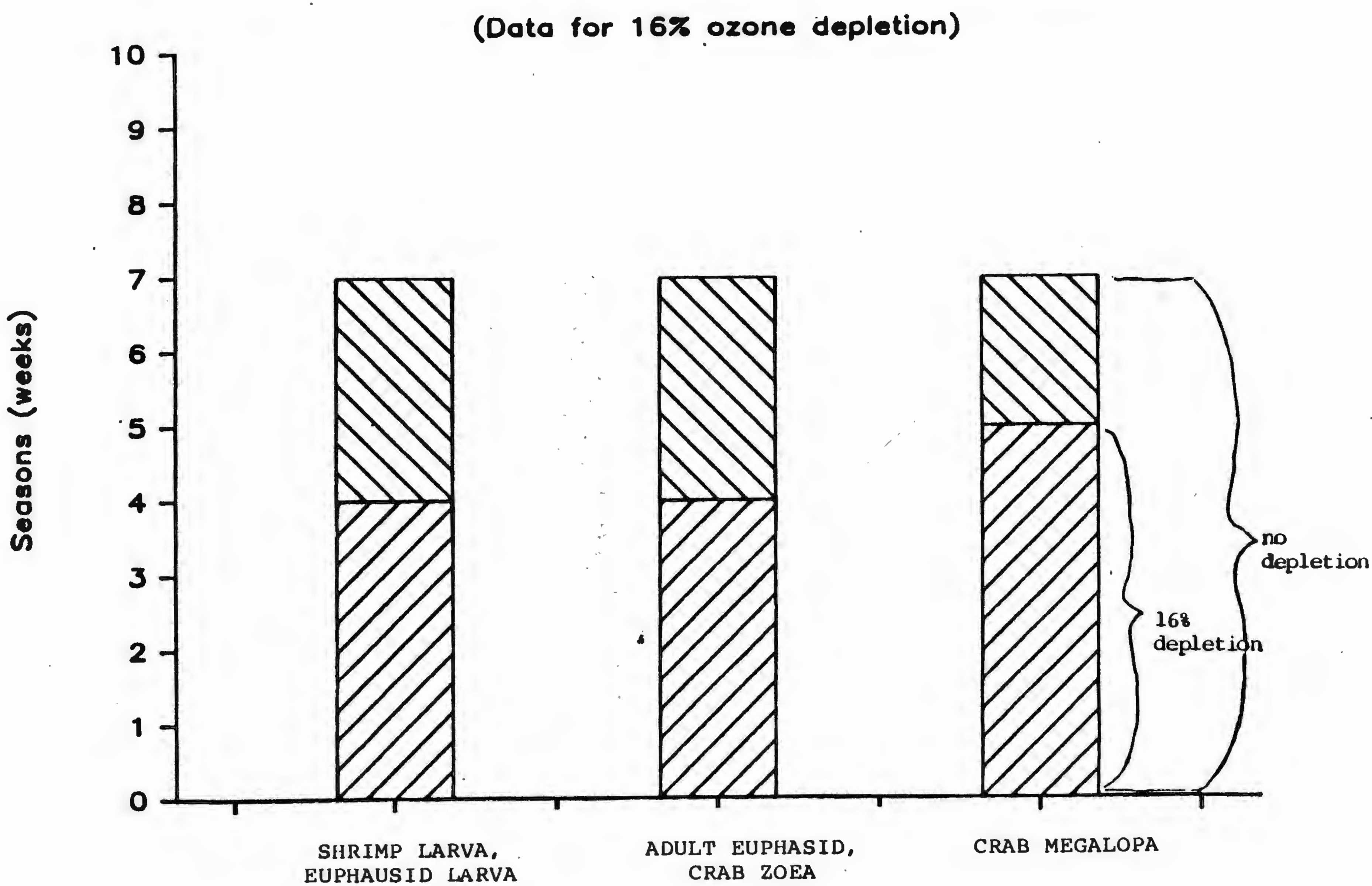
UV CUTS SURVIVAL RATES OF AQUATIC ORGANISMS



Percent survival from birth through 18 days of larval *Pandalus hypsinotus*, at six levels of UV-B radiation. Temperature 9.4-11.1° C. Roman numerals indicate larval stages. Capped vertical lines represent 95% confidence limits of five replicates (from Damkaer et al. 1980).

SOURCE: DAMKAER AND DEY (1984)

UV SHORTENS AQUATIC BREEDING SEASONS

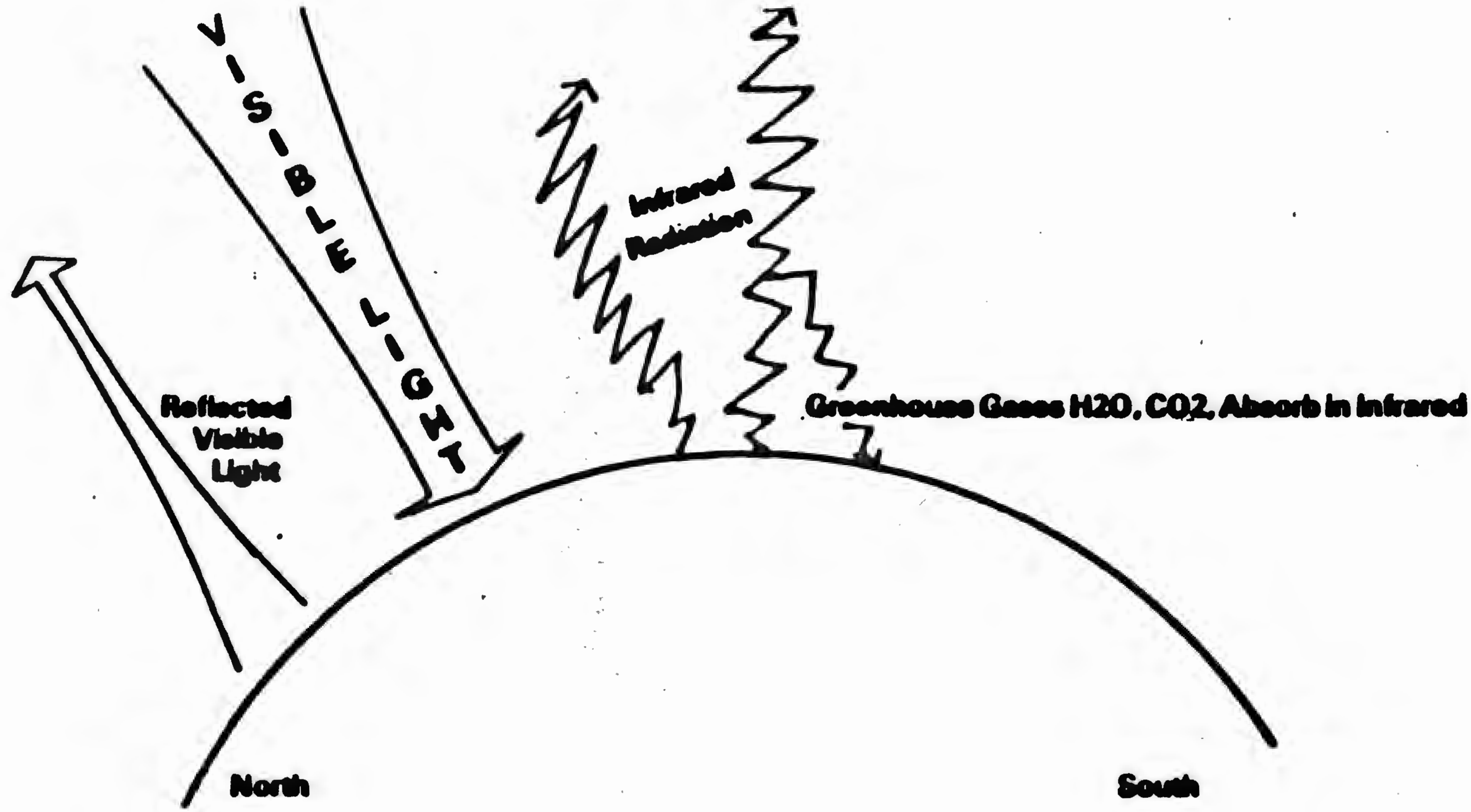


Adapted from Damkear et al.,1984.

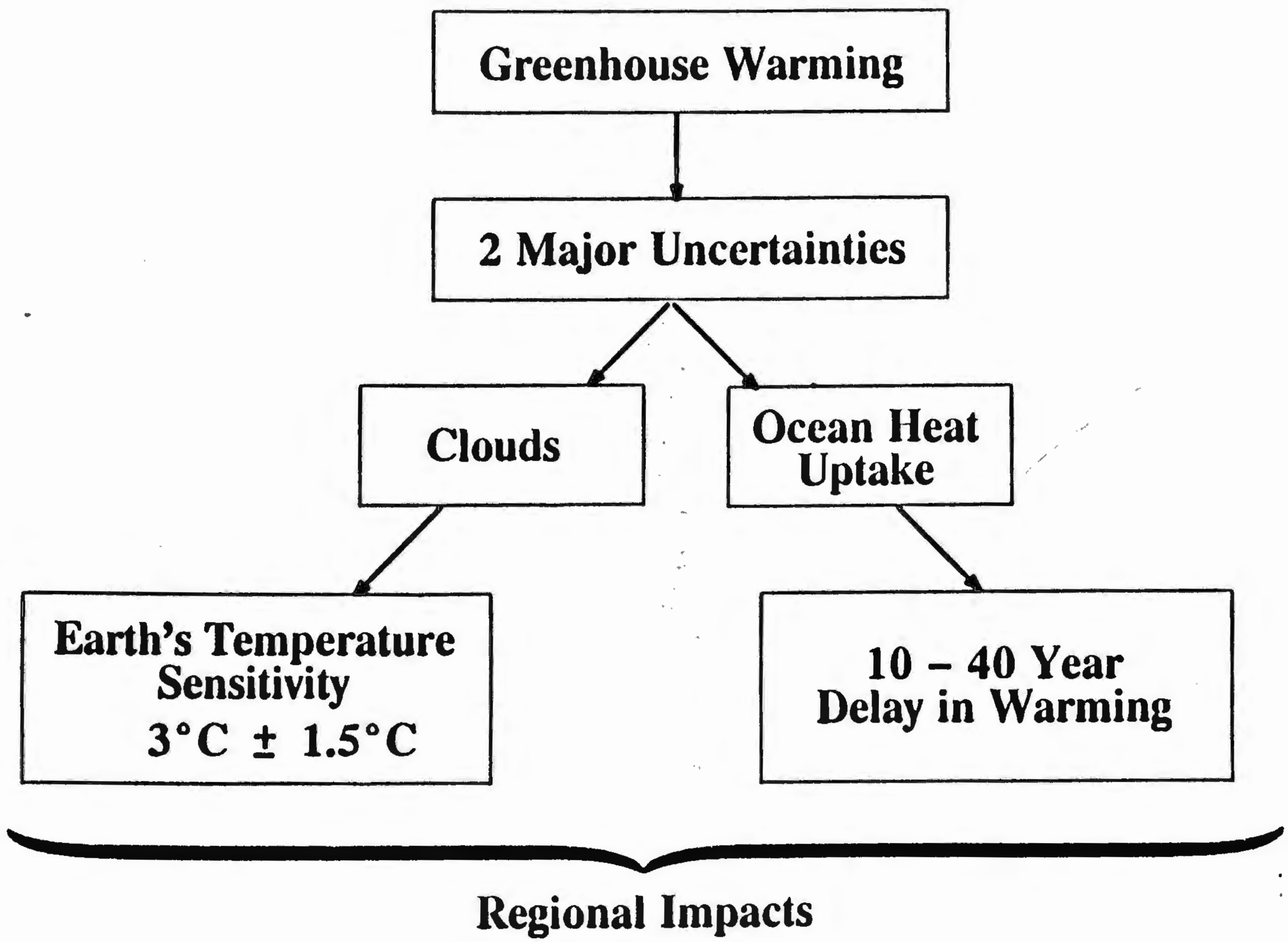
LINKAGES BETWEEN OZONE AND CLIMATE

Trace Gas	Effects on ozone	Effects on climate
CFCs	Leads to depletion	Greenhouse gas
Carbon dioxide	Slows down depletion	Greenhouse gas
Methane	Adds to ozone levels	Greenhouse gas
Nitrous oxide	Depletes ozone; sink for chlorine	Greenhouse gas

EARTH'S TEMPERATURE IS RAISED BY EXISTING GREENHOUSE GASES



GREENHOUSE WARMING



ALL MAJOR ASSESSMENTS CONCLUDE THAT SUBSTANTIAL GLOBAL WARMING WILL OCCUR

- NAS 1979 -- "WE ESTIMATE THE MOST PROBABLE GLOBAL WARMING FOR A DOUBLING OF CO_2 TO BE NEAR 3°C WITH A PROBABLE ERROR OF ±1.5°C

  WE HAVE TRIED BUT HAVE BEEN UNABLE TO FIND ANY OVERLOOKED OR UNDERESTIMATED PHYSICAL EFFECT THAT COULD REDUCE THE CURRENTLY ESTIMATED GLOBAL WARMING TO NEGLIGIBLE PROPORTIONS. IT APPEARS THAT THE WARMING WILL EVENTUALLY OCCUR..."

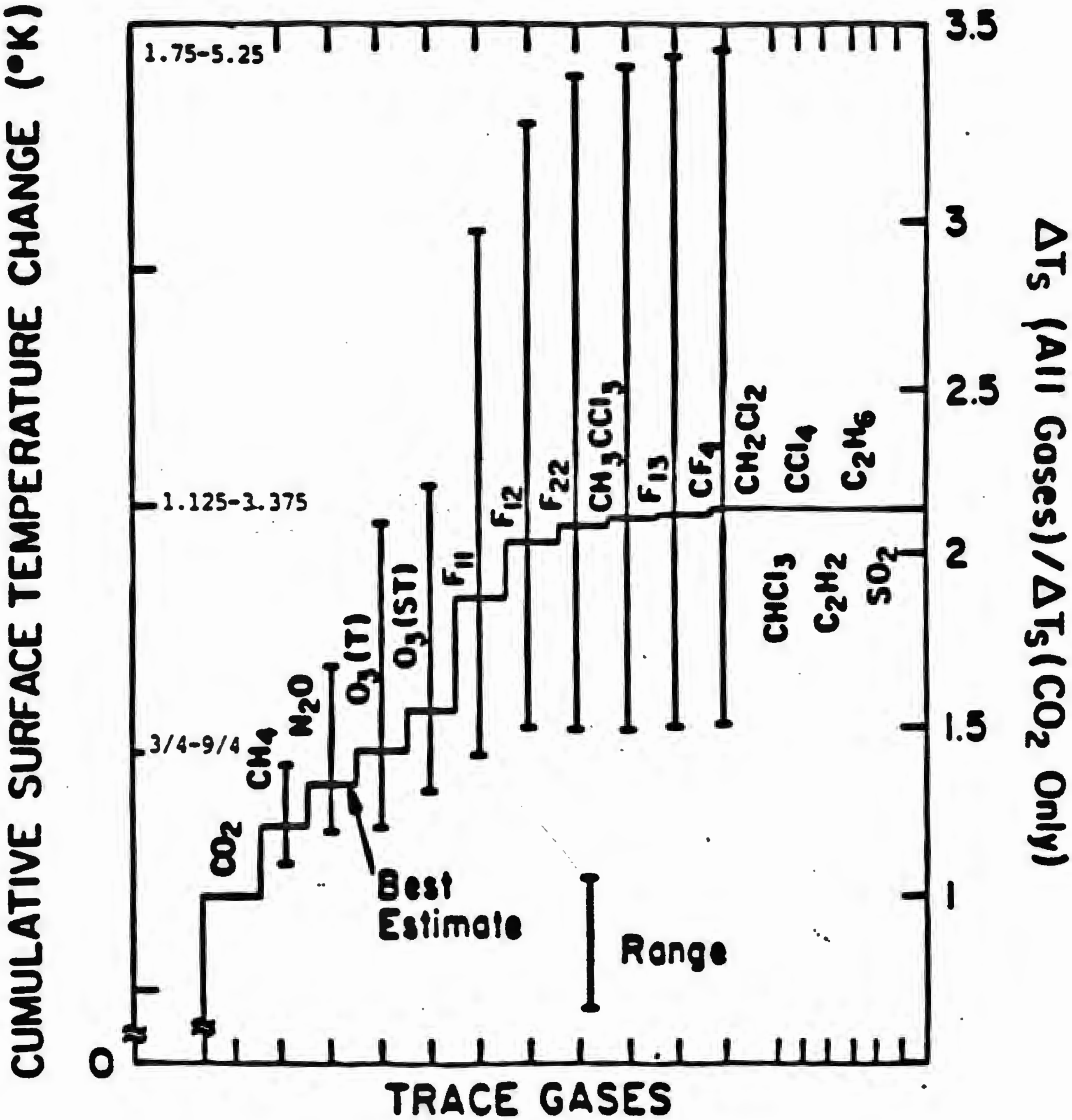
- NAS 1982 -- "THE PRESENT STUDY HAS NOT FOUND ANY NEW RESULTS THAT NECESSITATE SUBSTANTIAL REVISION OF THE CONCLUSIONS OF THE (1979) REPORT."

- NAS 1983 -- "FROM CLIMATE MODEL SIMULATIONS OF INCREASED CO_2 WE CONCLUDE WITH CONSIDERABLE CONFIDENCE THAT THERE WOULD BE A GLOBAL MEAN TEMPERATURE INCREASE."

- VILLACH (UNEP, WMO, ICSU) 1985 -- "IF PRESENT TRENDS CONTINUE, THE COMBINED CONCENTRATIONS OF ATMOSPHERIC CO_2 AND OTHER GREENHOUSE GASES WOULD BE EQUIVALENT TO A DOUBLING OF CO_2 FROM PRE-INDUSTRIAL LEVELS BY POSSIBLY AS EARLY AS THE 2030S.

  ... THE GREENHOUSE GASES ARE LIKELY TO BE THE MOST IMPORTANT CAUSE OF CLIMATE CHANGE OVER THE NEXT CENTURY.

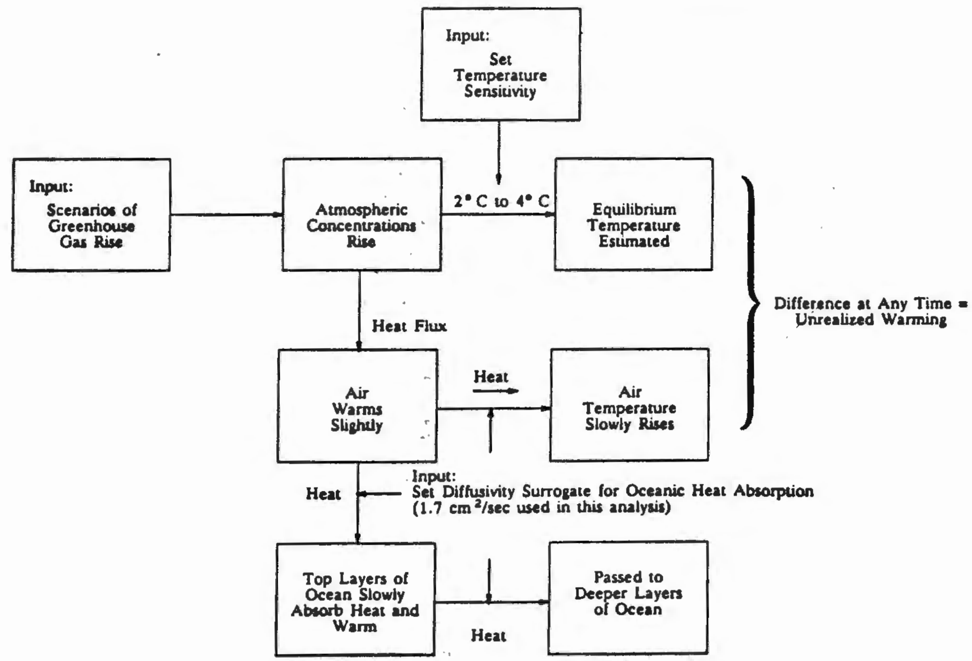
CUMULATIVE SURFACE WARMING FOR ADOPTED TRACE GAS SCENARIO
(Period: Fifty Years from 1980 Levels)



Ramanathan, V., et al., 1985. "Trace Gas Trends and Their Potential Role in Climate Change," Journal of Geophysical Research.

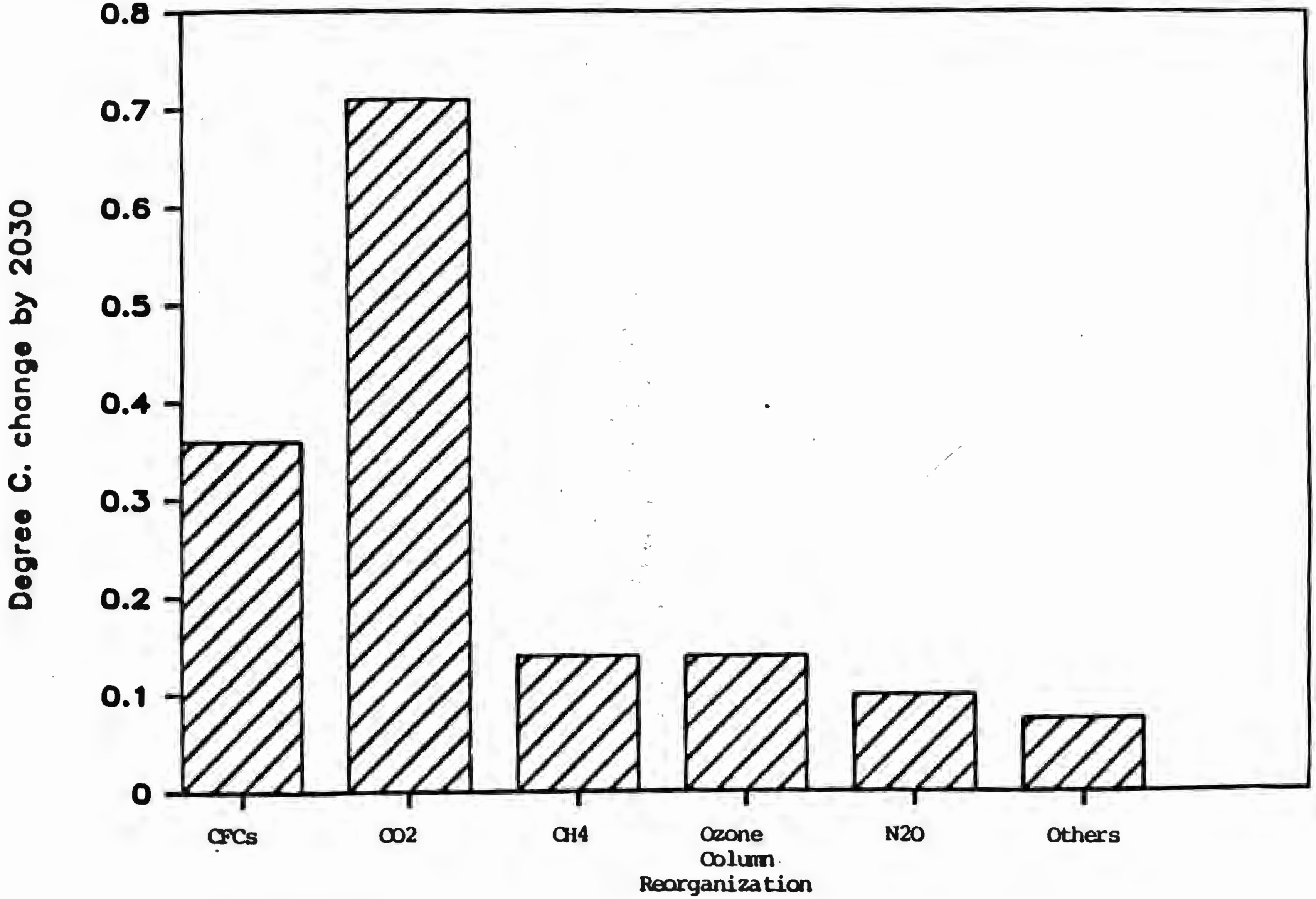
FIGURE 3

TEMPERATURE CHANGE: LACIS MODEL OF EQUILIBRIUM RESPONSE AND TRANSIENT RESPONSE

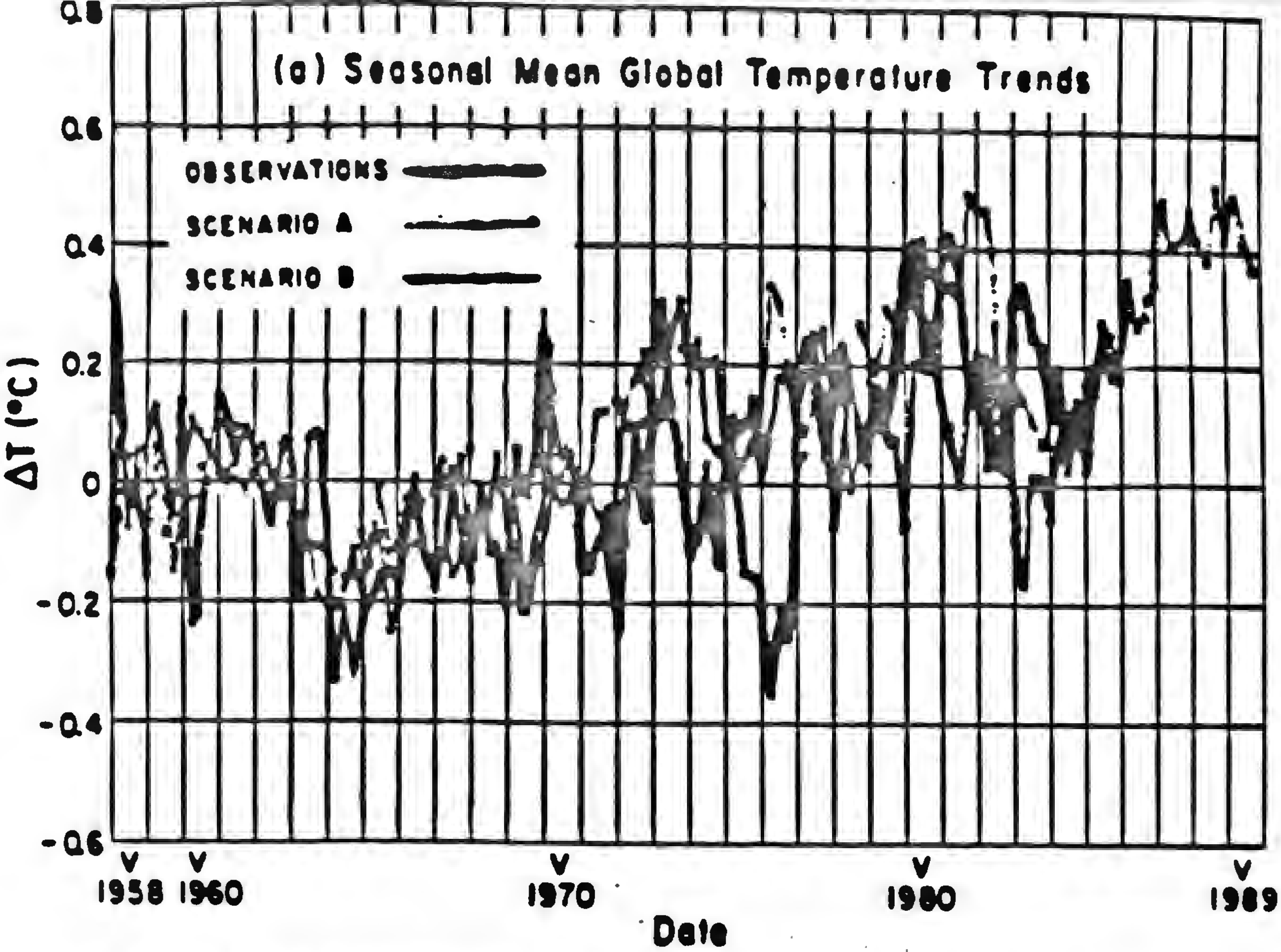


One Estimate of Relative Contribution

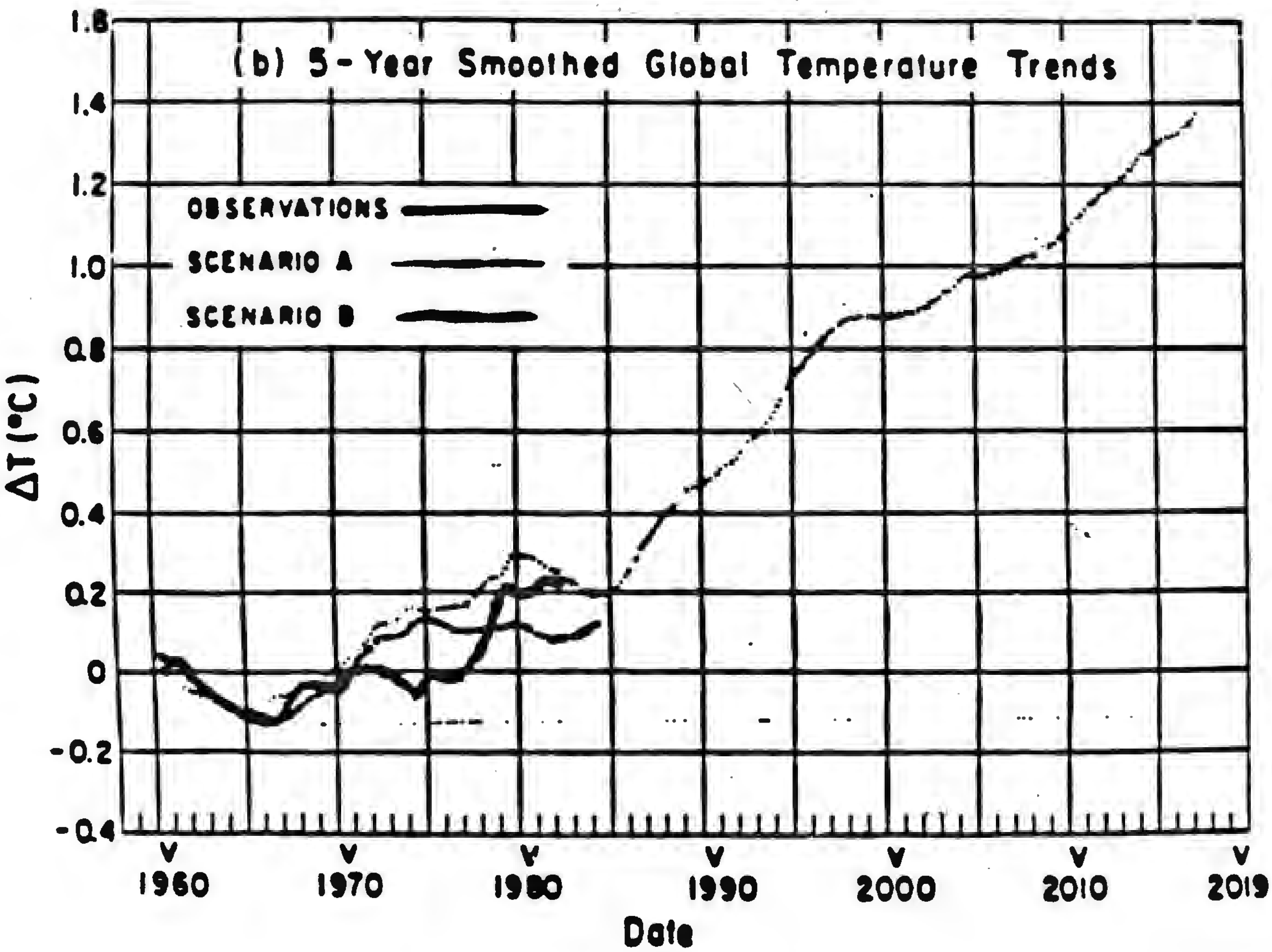
of Trace Gases to Greenhouse Warming



SOURCE: Ramanathan et al (1985).

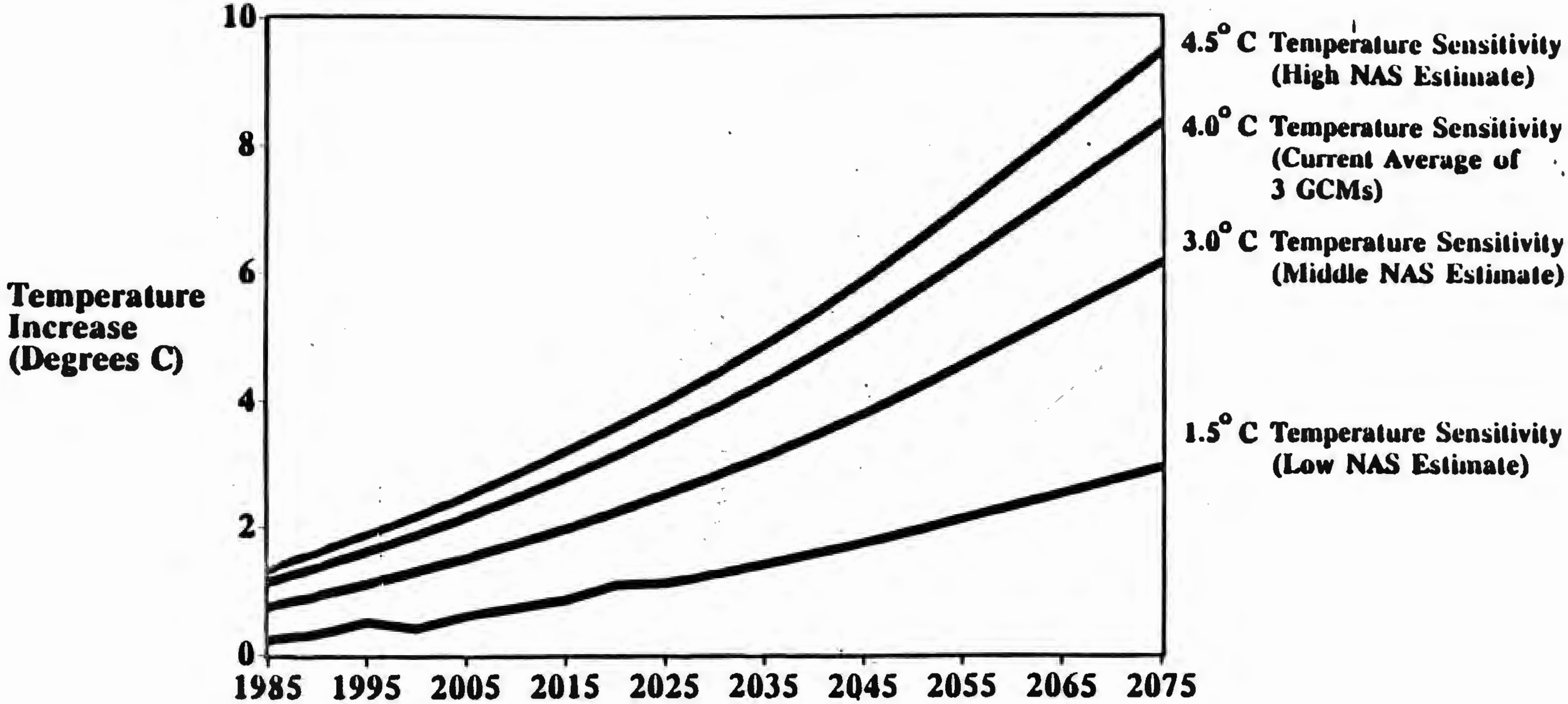


(a) Seasonal Mean Global Temperature Trends
OBSERVATIONS
SCENARIO A
SCENARIO B
ΔT (°C)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
1958
1960
1970
1980
1989
Date



(b) 5-Year Smoothed Global Temperature Trends
OBSERVATIONS
SCENARIO A
SCENARIO B
ΔT (°C)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
-0.2
-0.4
1960
1970
1980
1990
2000
2010
2019
Date

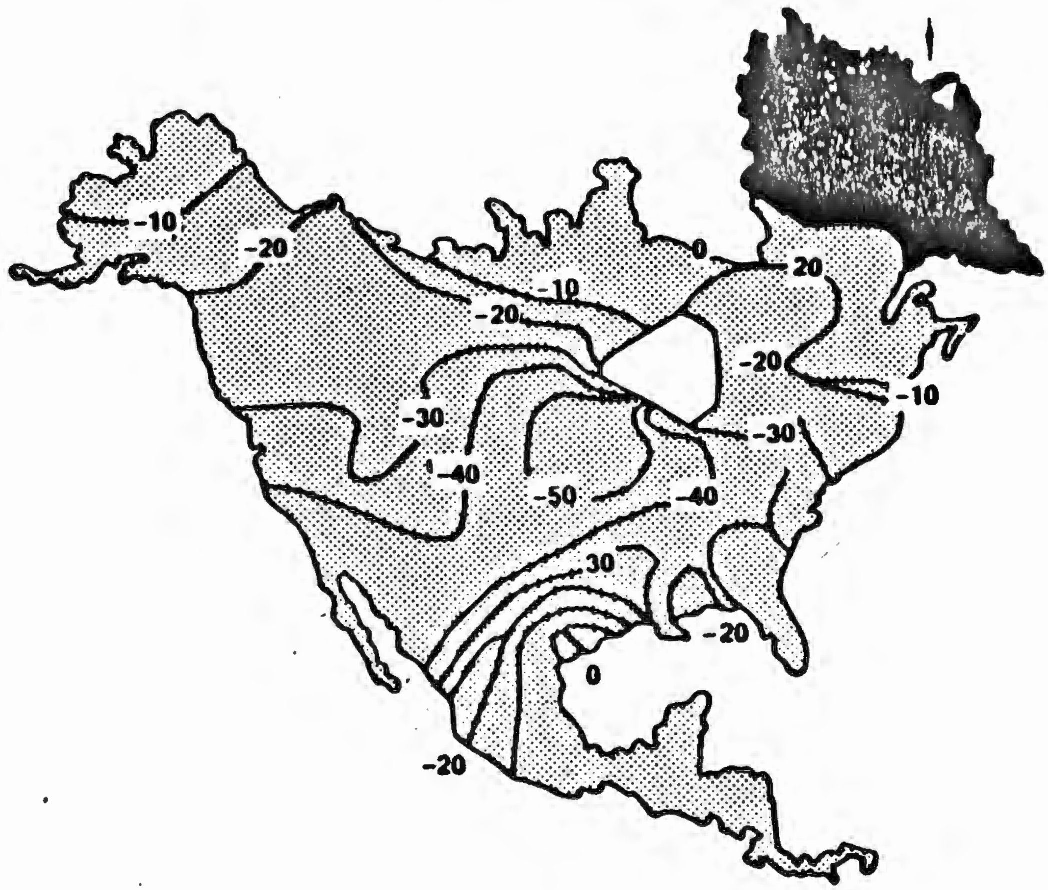
EQUILIBRIUM TEMPERATURE RISE: CENTRAL CASE



Source: Based on 1-D Box Model of the Atmosphere and Oceans

**** DO NOT CITE OR QUOTE ****

POTENTIAL CHANGE IN SOIL MOISTURE IN RESPONSE TO A DOUBLING OF CO_2 (Continued)



CO_2–induced change in soil moisture expressed as a percentage of soil moisture obtained from the normal CO_2 experiment.

Reference: S. Manabe and R.T. Wetherald, Geophysical Fluid Dynamics Laboratory/NOAA, Princeton University, Princeton, N.J.