The ozone layer and its repercussion in live beings

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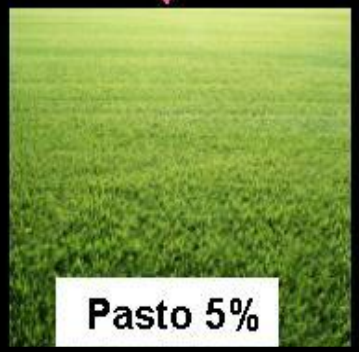
AUMENTAN LA IRRADIACION

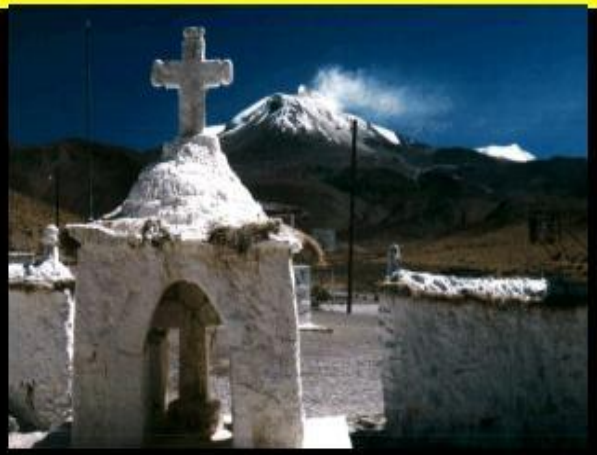
Superficies reflectantes



Altura

0 m RUV 7,2 KJ/m^2

Por cada 1.000 m RUV aumenta un 22 %

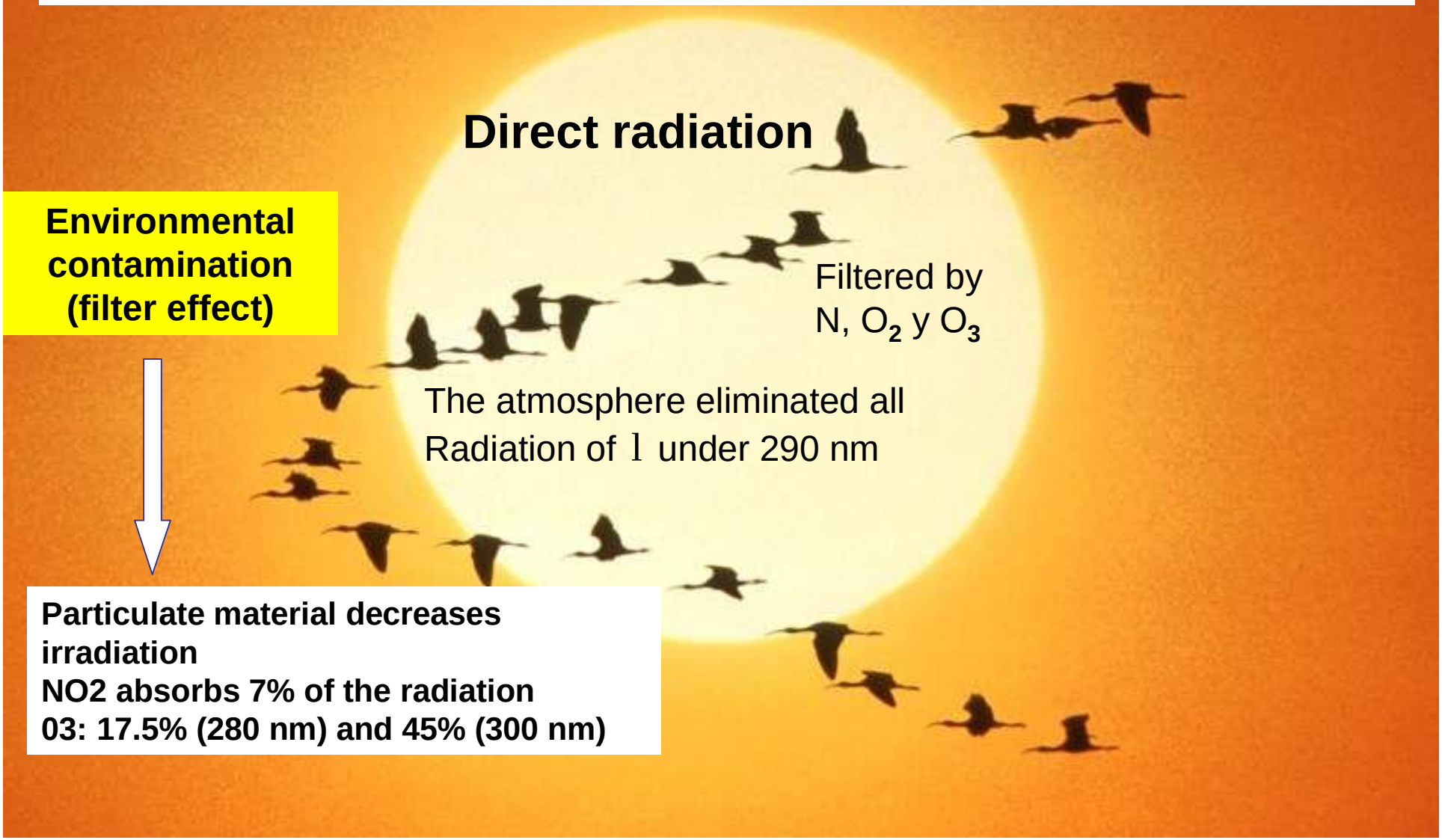


2.470 m RUV 11,6

4.321 m RUV 14.9

SOLAR ENERGY

The irradiates 56x1026 calories per minute. In summer, the energy is 70% higher than in winter (excentrical earth orbit). The earth receives 3.7x1021 calories per day (100,000 times the hydrogen bomb or 100 times what is consumed by humans in one year).

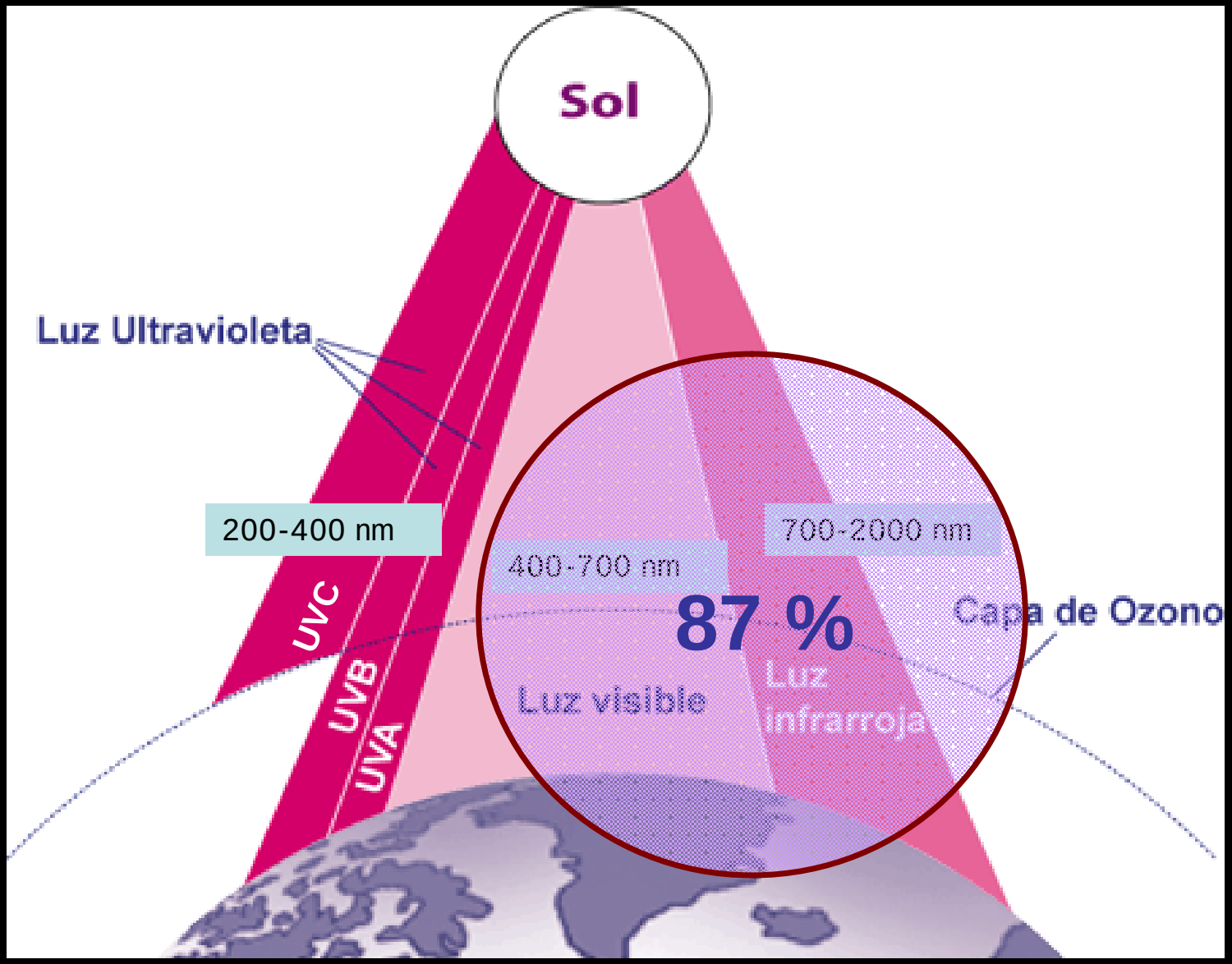


Environmental contamination (filter effect)

Particulate material decreases irradiation
NO2 absorbs 7% of the radiation
03: 17.5% (280 nm) and 45% (300 nm)

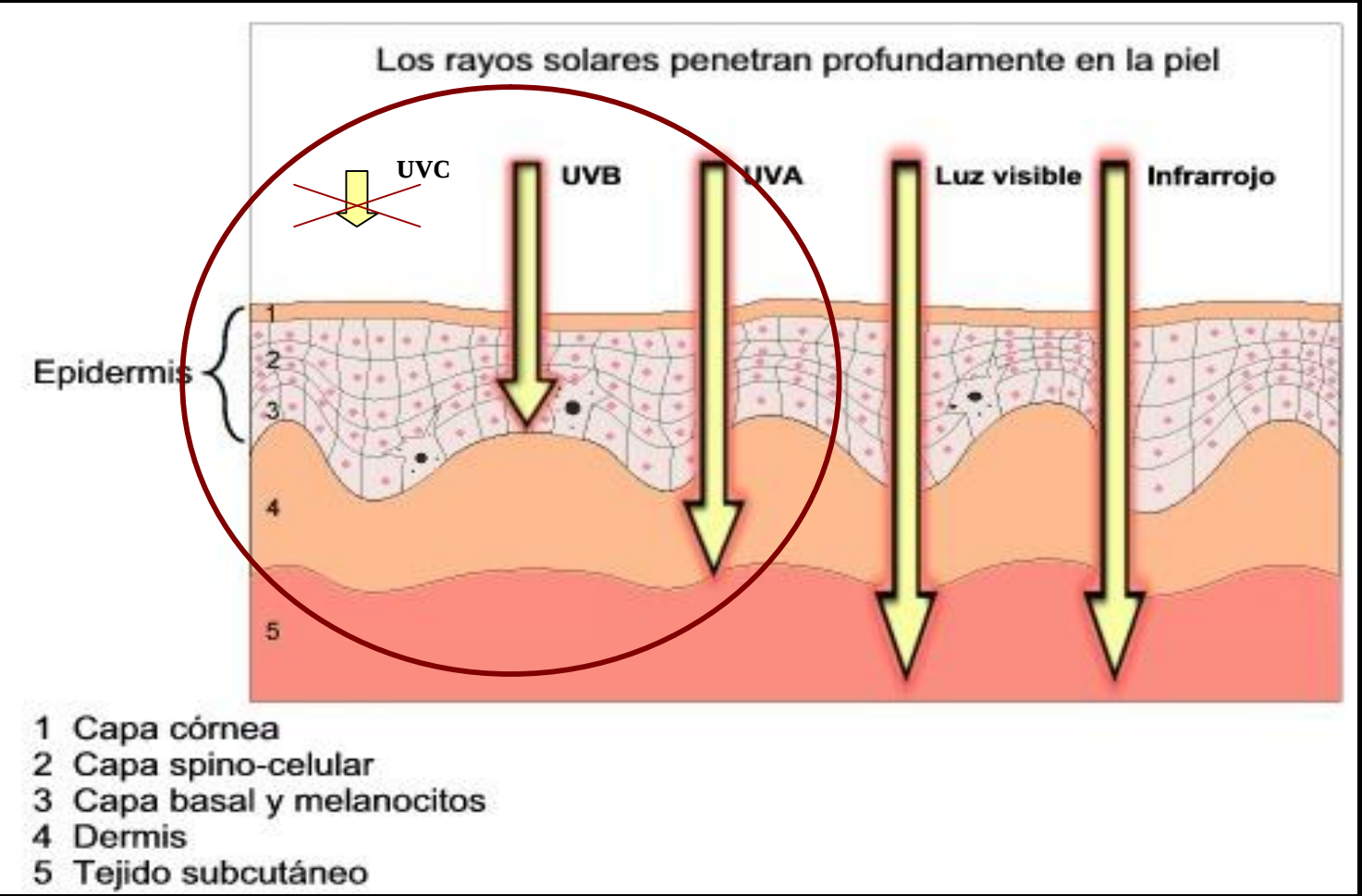
Sun UV radiation

Due to its deepness of penetration, is capable of producing great damages because of its intense photochemical activity



Rouzaud F, Kadekaro AL, Abdel-Malek Z, Hearing V. MC1R and the response of melanocytes to ultraviolet radiation.
Mut Res 2005;(571):133-152.

RUV



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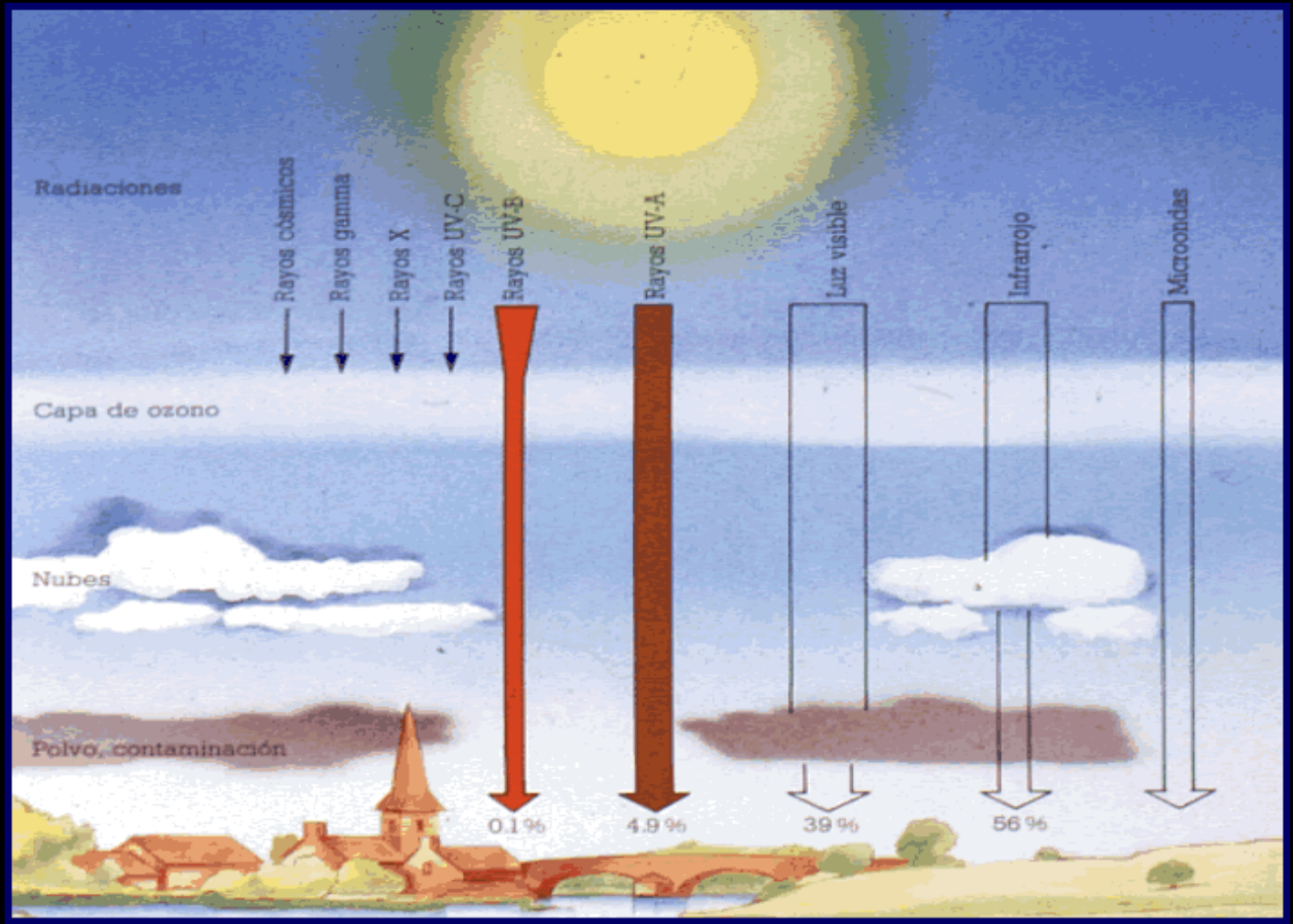
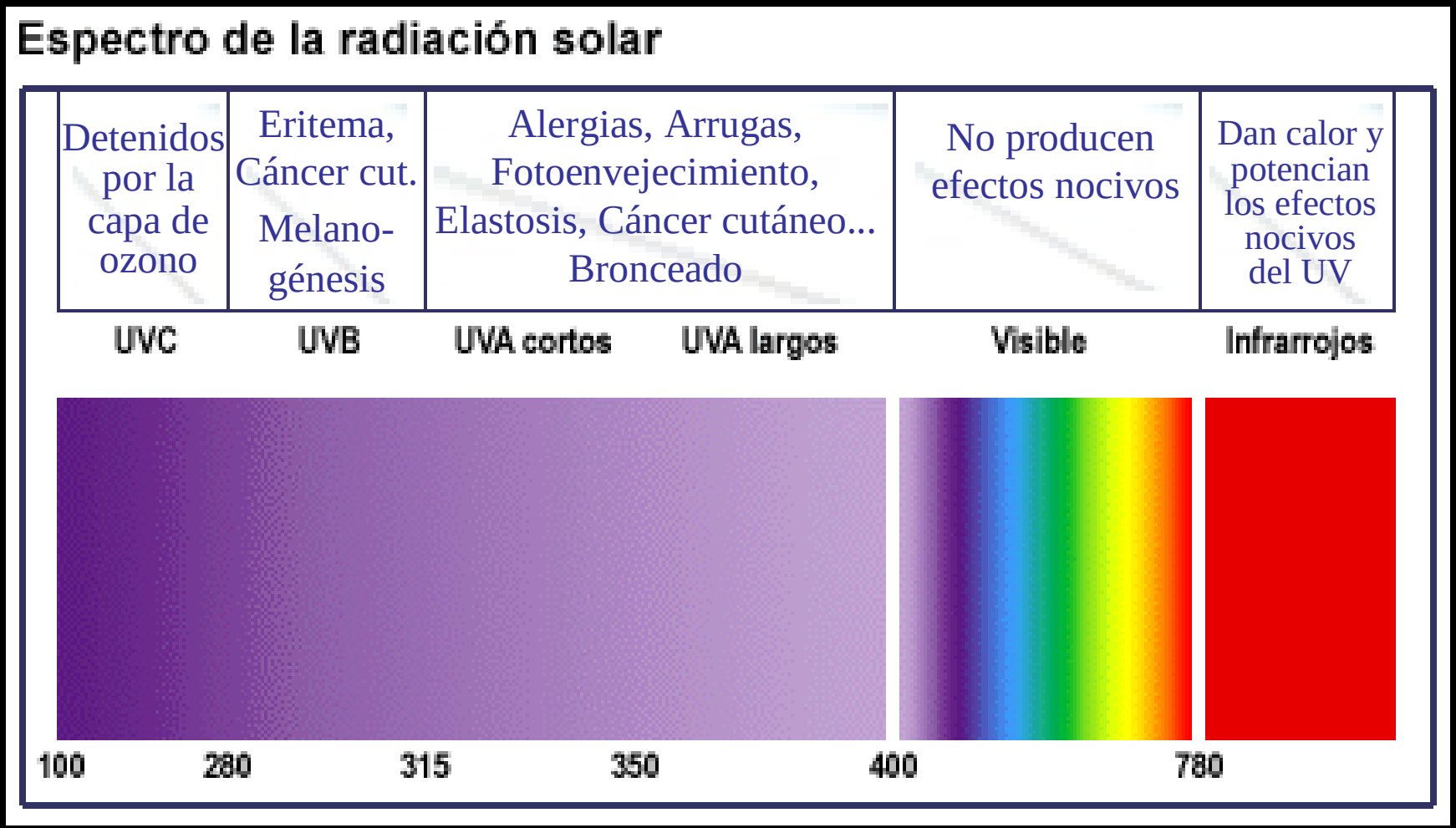
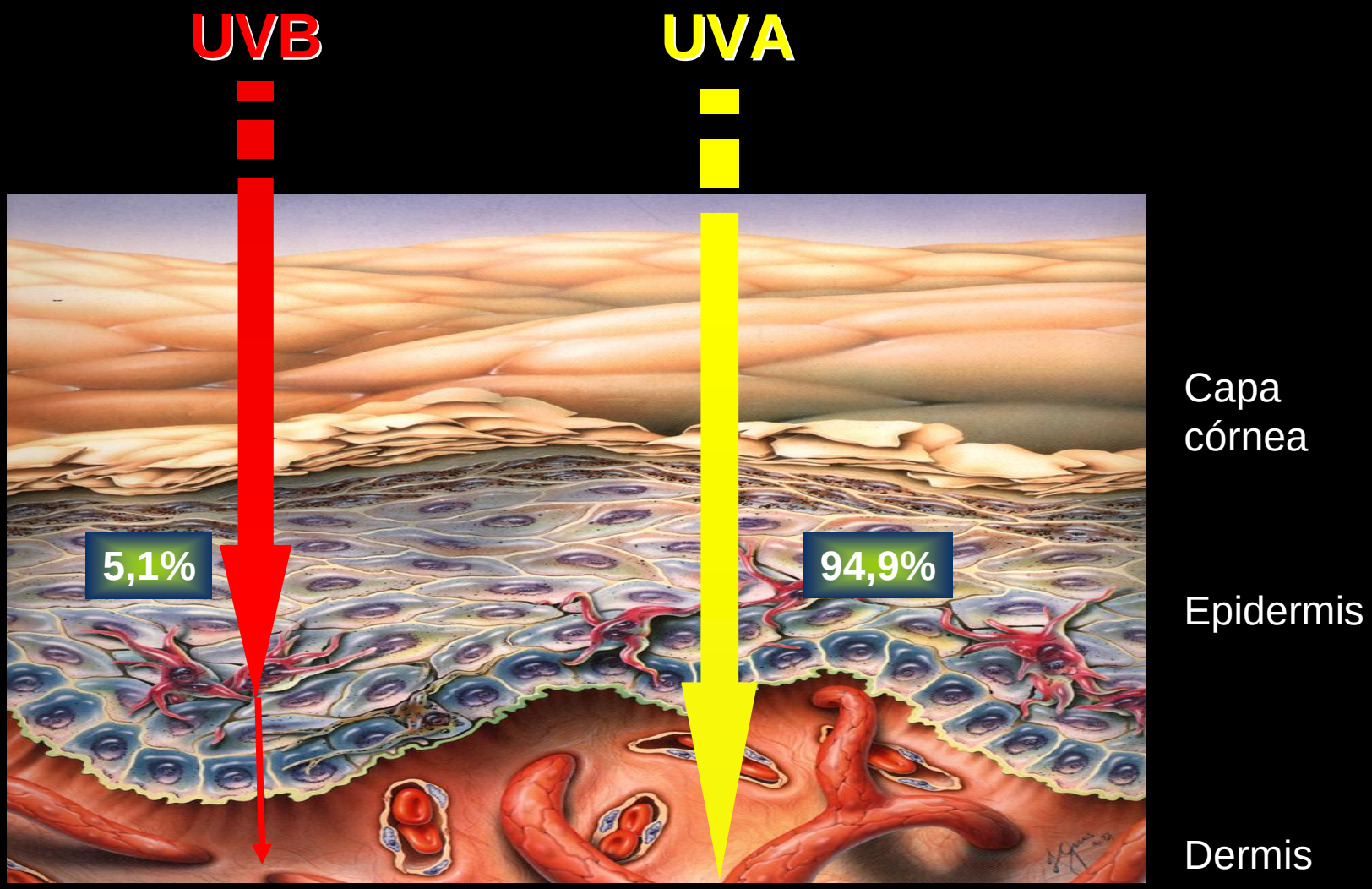
Radiación Solar



Radiación Solar



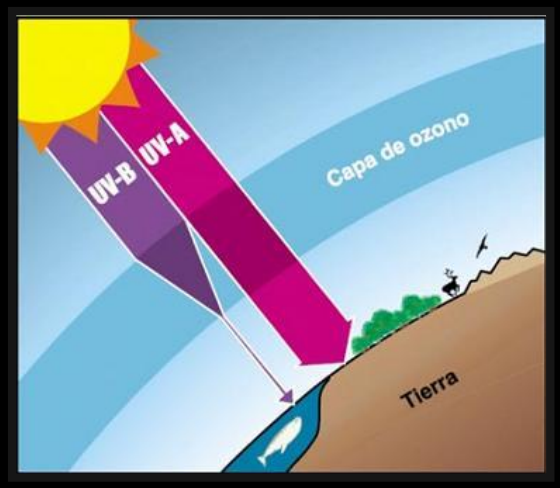
RUV



Al menos 18 veces más UVA que UVB

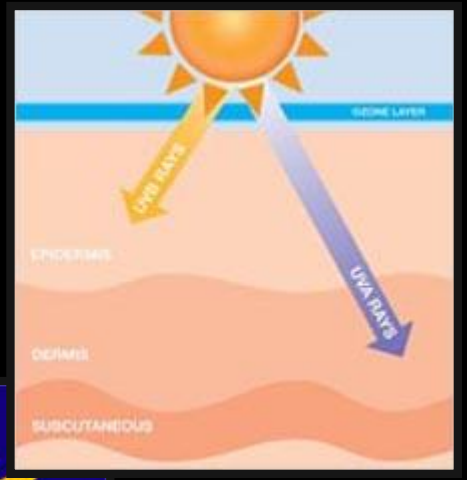
UVA

- 95% of the radiation that gets to the skin
- Energy 20 times larger than UVB
- Reach the dermis
- Are present every day
- Remain until nightfall
- Traverse clouds and glass



UVB

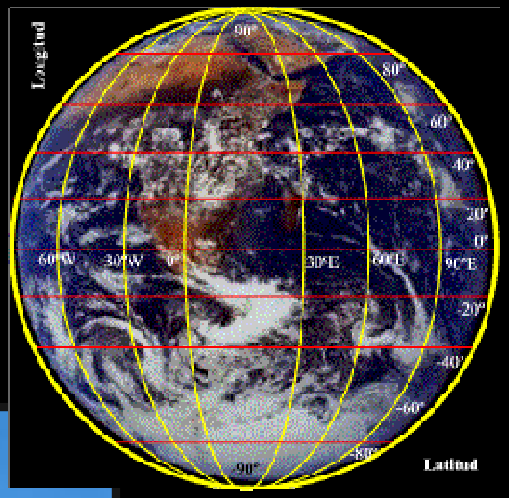
- 5% of the radiation that gets to the skin
- Energy 20 times lower than UVA
- Reach the epidermis
- Increase in summer and decrease in winter
- Are present from 11 to 18 hrs
- Do not traverse clouds or glass



External factors

Intensity of sunlight

- Latitud y altitud
- Estaciones
- Hora del día
- Transmisión
- Reflexión



Frequency of exposure

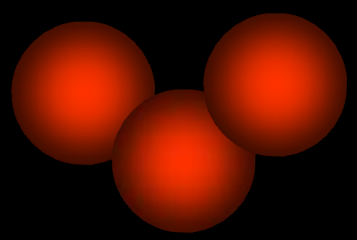
Frequency in time

OZONO

Ozone is a relatively simple molecule composed by three oxygen atoms

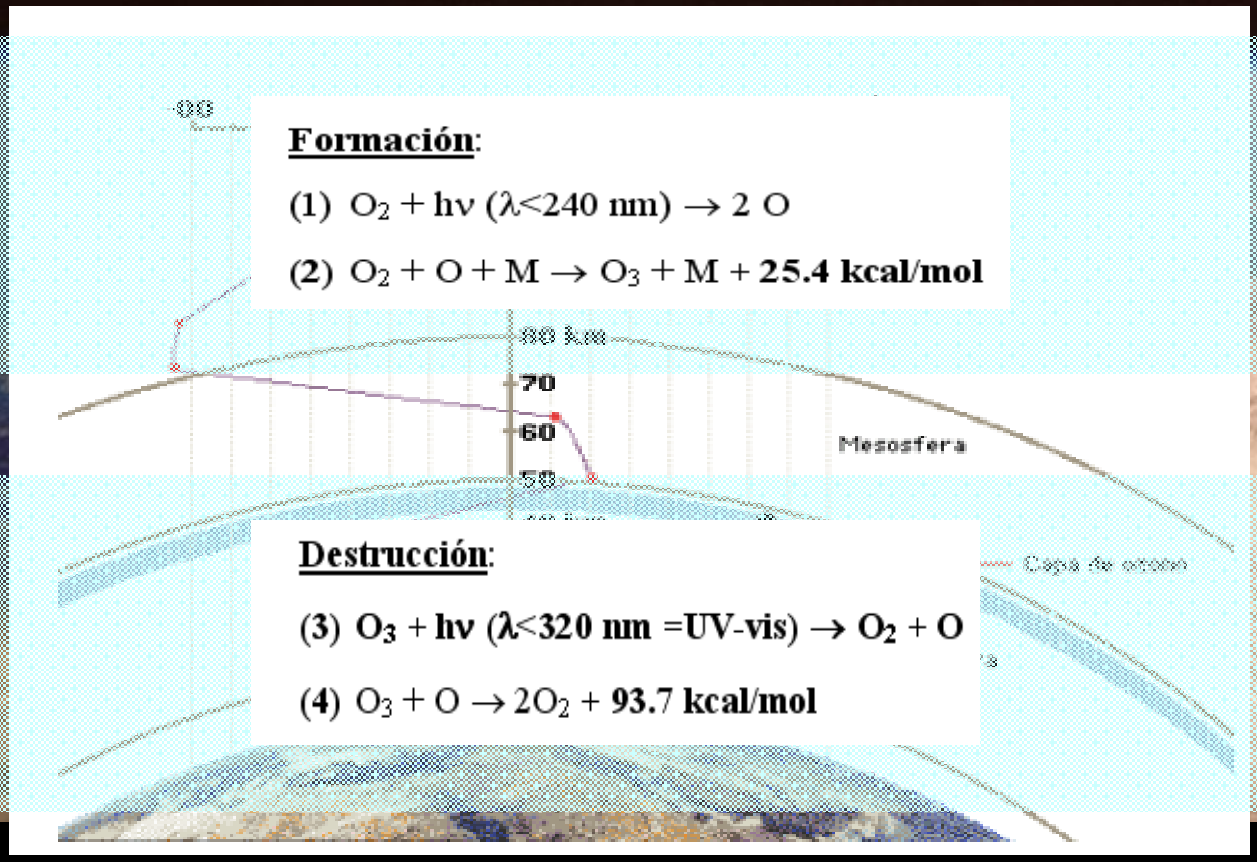
It is a reactive substance which in high concentrations “in low atmosphere” produces respiratory damage.

At higher altitudes, where 90% of the ozone in our planet is concentrated, it performs an important job by absorbing ultraviolet radiation.



$\Rightarrow$ O_3

Relationship OZONO – Ultraviolet light



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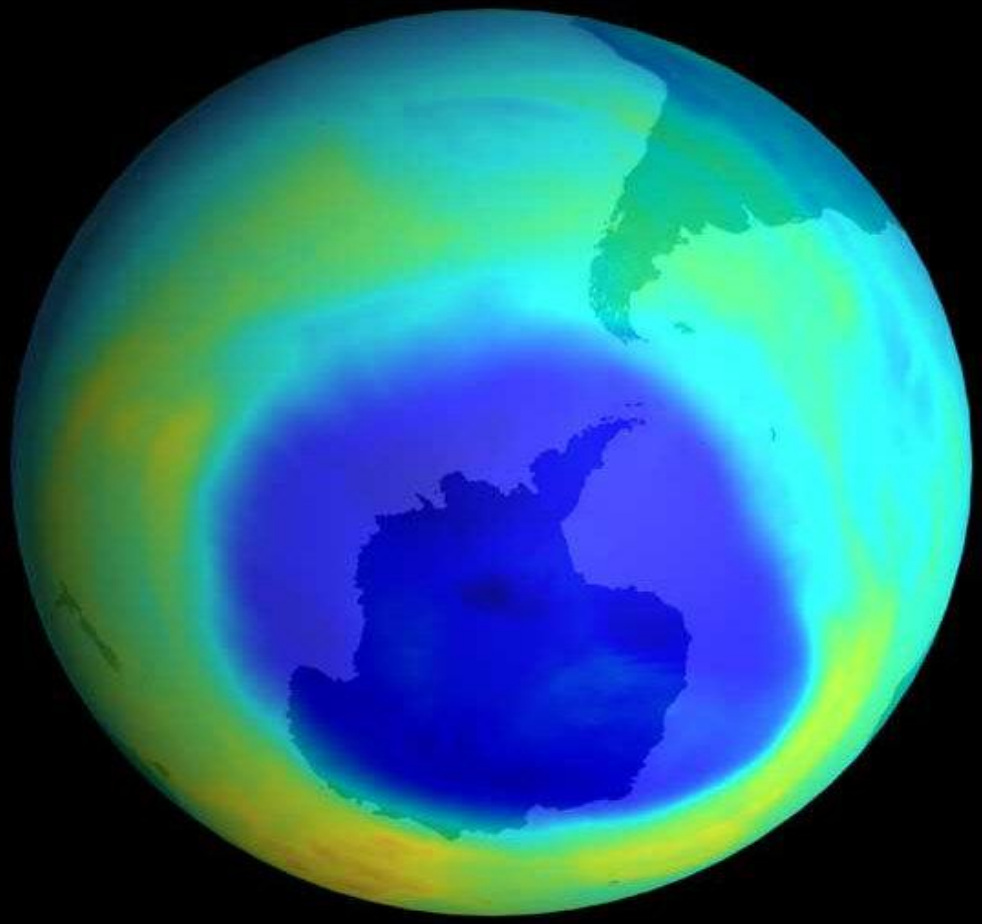
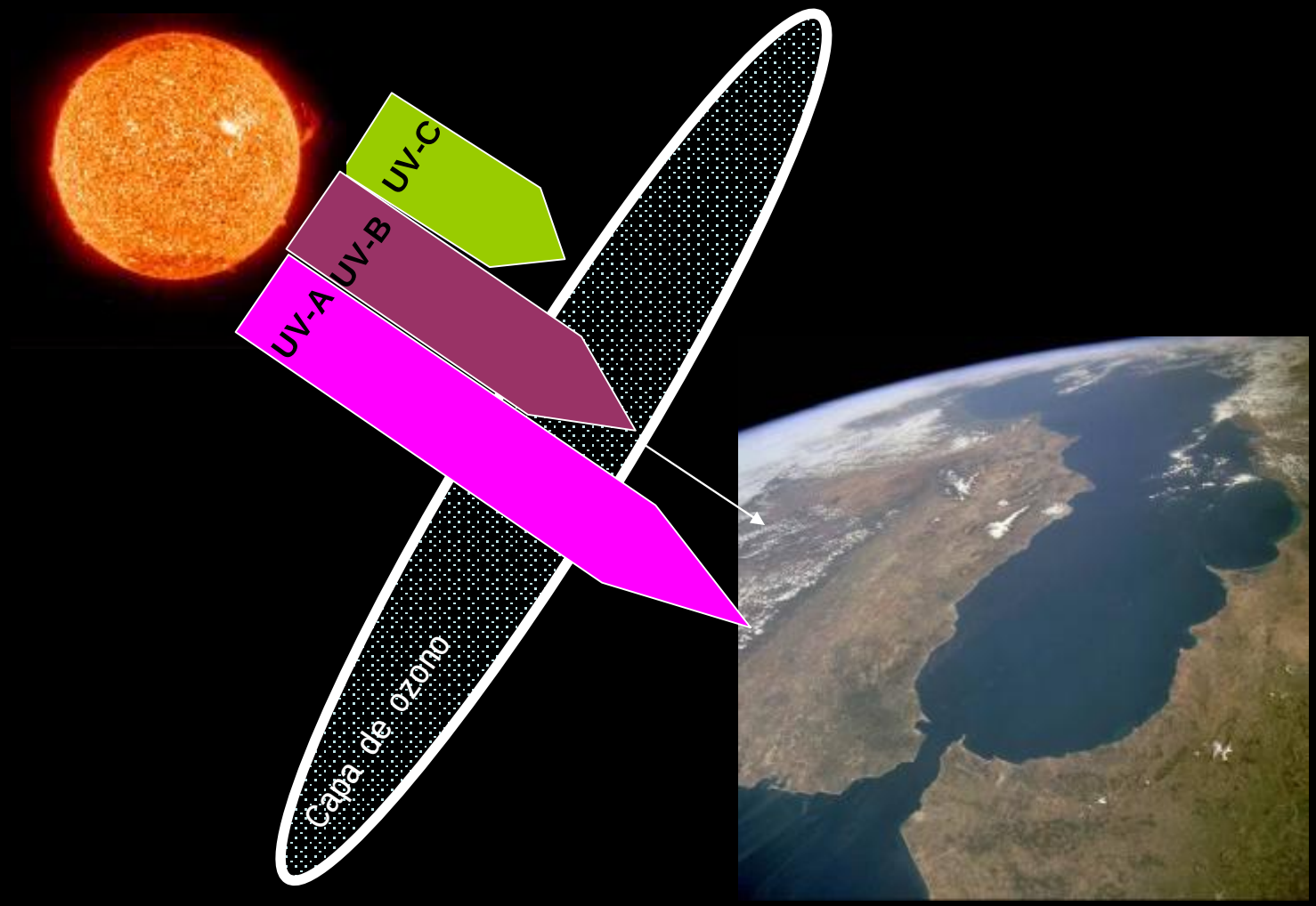
Relationship OZONO – Ultraviolet light



The shorter the UV wave length, the greater the damage it causes More easily absorbed by the ozone layer

Protocolo de Montreal 1987- *Asamblea General de Naciones Unidas-, Día Internacional de la Preservación de la Capa de Ozono 1994*

Relationship OZONO – Ultraviolet light



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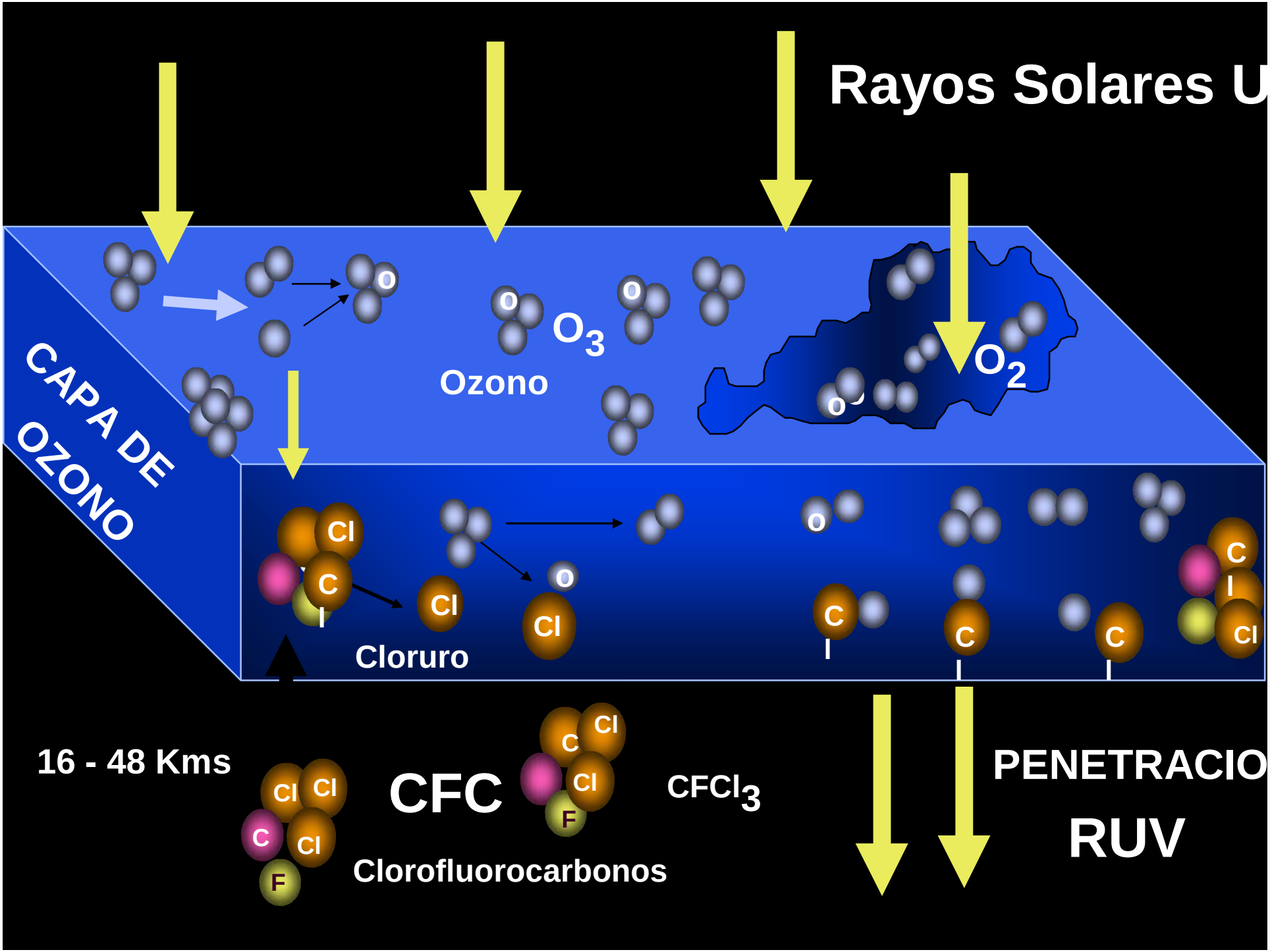
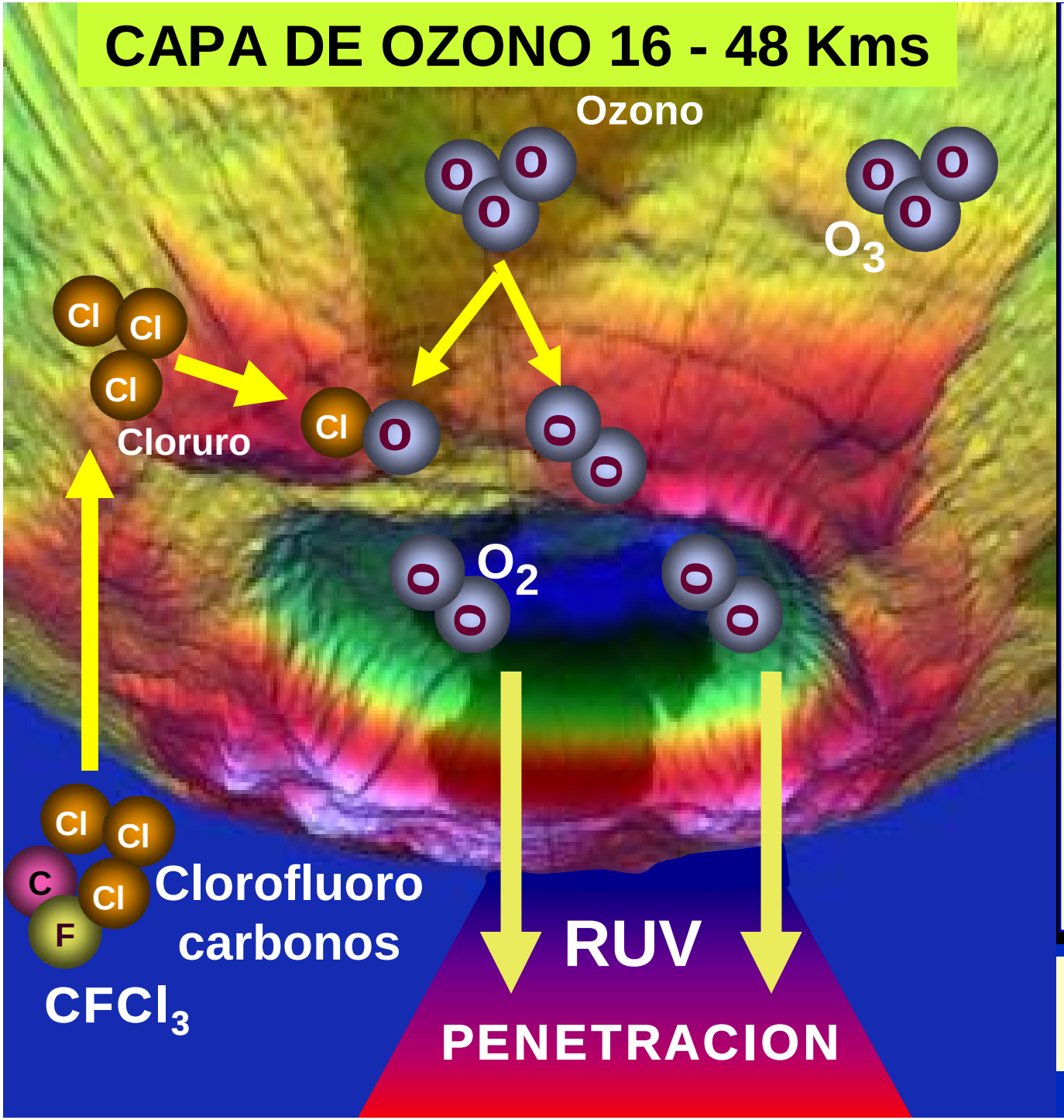

Rayos Solares U
CAPA DE OZONO
O
O
O
O_3
Ozono
O
O_2
Cl
C
Cl
Cl
O
O
Cloruro
C
C
C
C
Cl
16 - 48 Kms
Cl
Cl
C
Cl
F
CFC
C
Cl
Cl
F
$CFCl_3$
Clorofluorocarbonos
PENETRACIO
RUV



RADIACION l(nm)

infrared light

Away	
10.000	
Close	
1.000	

visible light

Red	700
Orange	620
Green	530
Blue	470
Violet	400

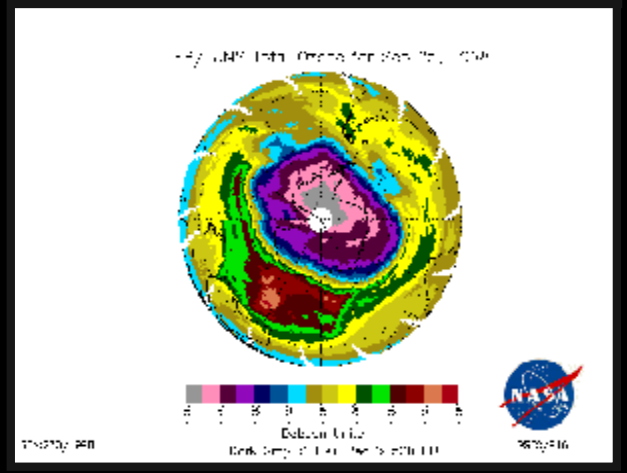
Ultraviolet light

UV-A 1	340-400
UV-A 2	315-340
UV-B	280-315
UV-C	<280

El Ozono estratosférico filtra RUV-B (280-320nm).

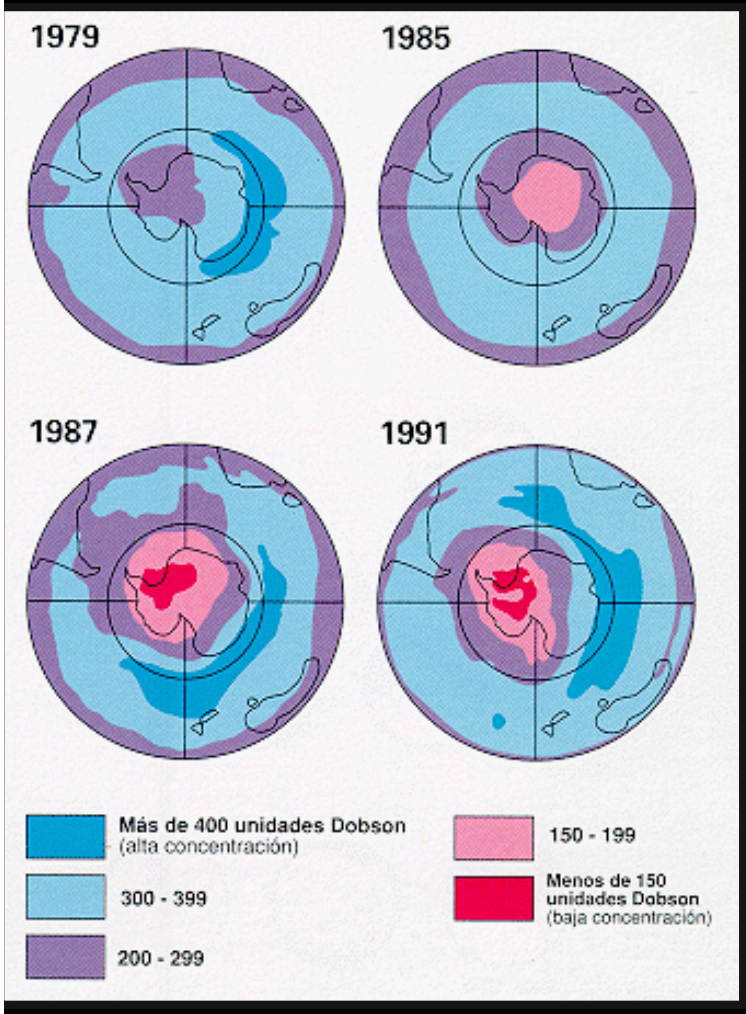
The hole in the Antarctica

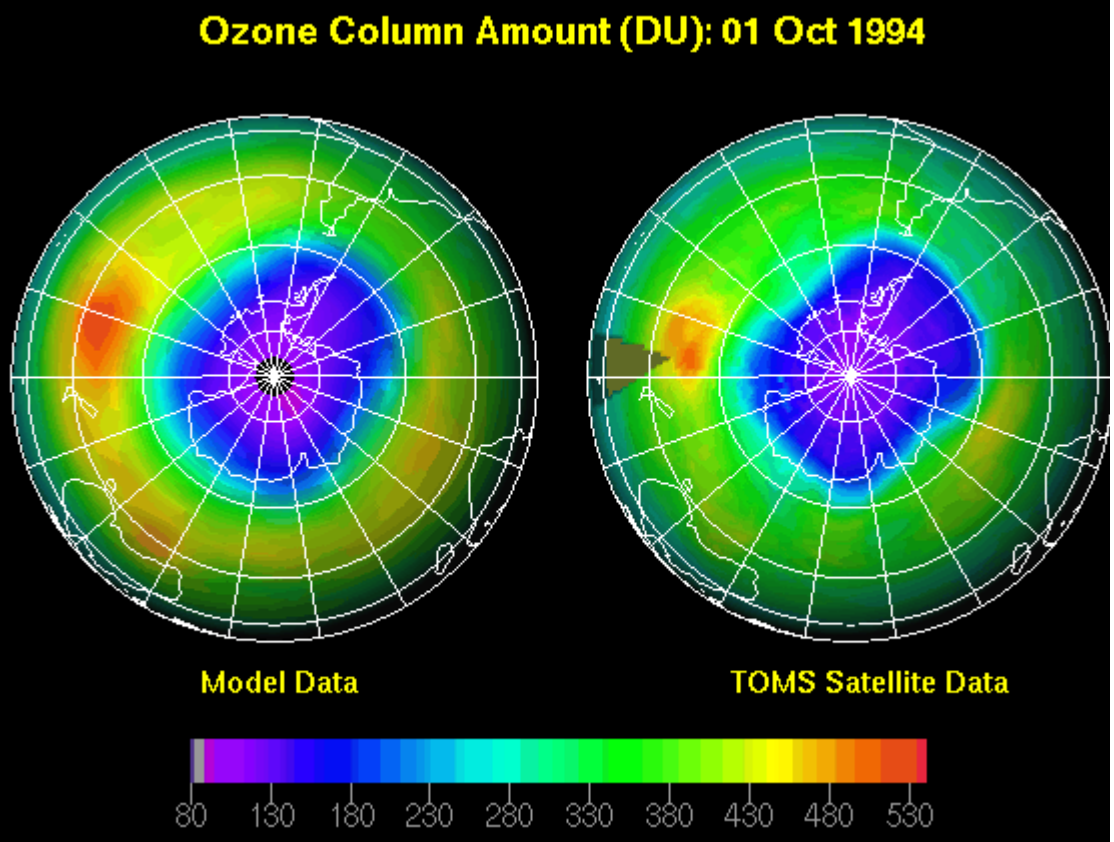
- It has been demonstrated that the CFCs are the main cause of the ozone destruction
- Each southern spring a “hole” opens in the ozone layer over the Antarctica, as large as the United States and as deep as Mount Everest
- This hole has grown almost every year. Since 1979 it appears every year except in 1988.



Zander R, Mahieu E, Demoulin P, Duchatelet P, Roland G, Servais C, De Mazière M, Reimann S, Rinsland CP. Our changing atmosphere: evidence based on long-term infrared solar observations at the Jungfraujoch since 1950. Sci Total Environ 2008;391(2-3):184-95.

The hole in the Antarctica





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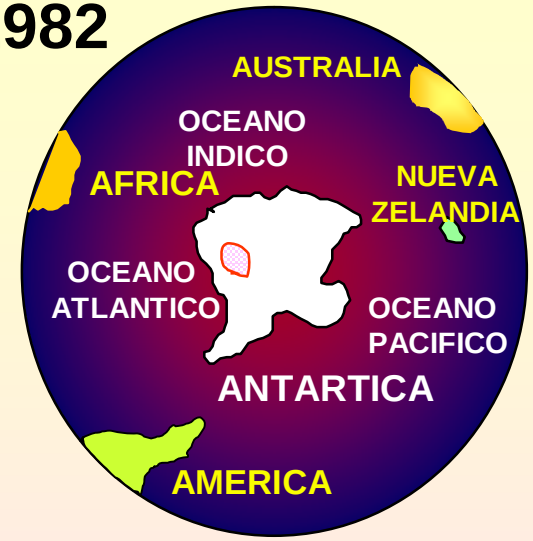
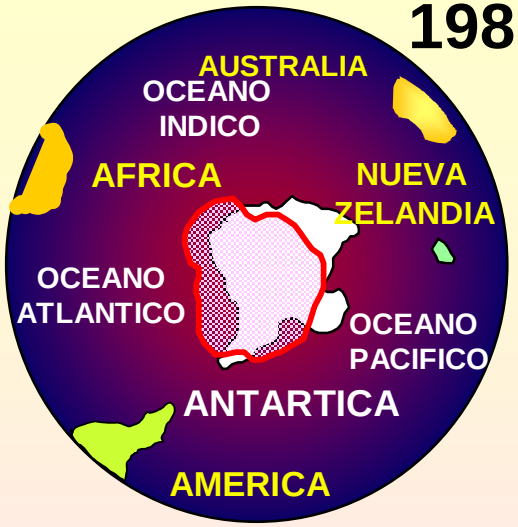
Ozone "Hole"

1982

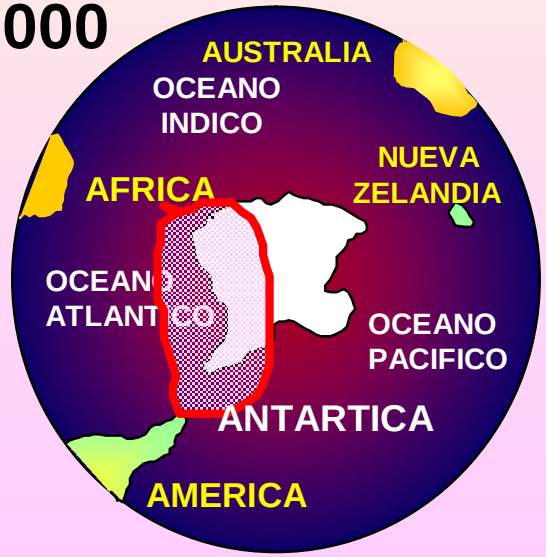


1987

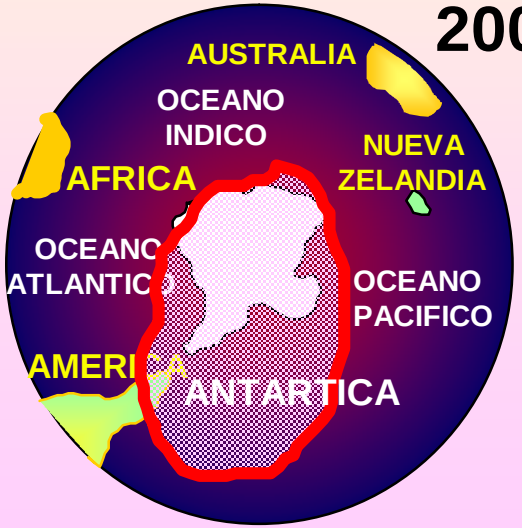


Since two decades ago
It occurs in the Antarctica, the southern extreme of Argentine and Chile, a spring decrease of low ozone (200 U. Dobson de O3) and an increase of UV-B Radiation (de 2,4 KJ/m^2 a 5,2 KJ/m^2)

2000

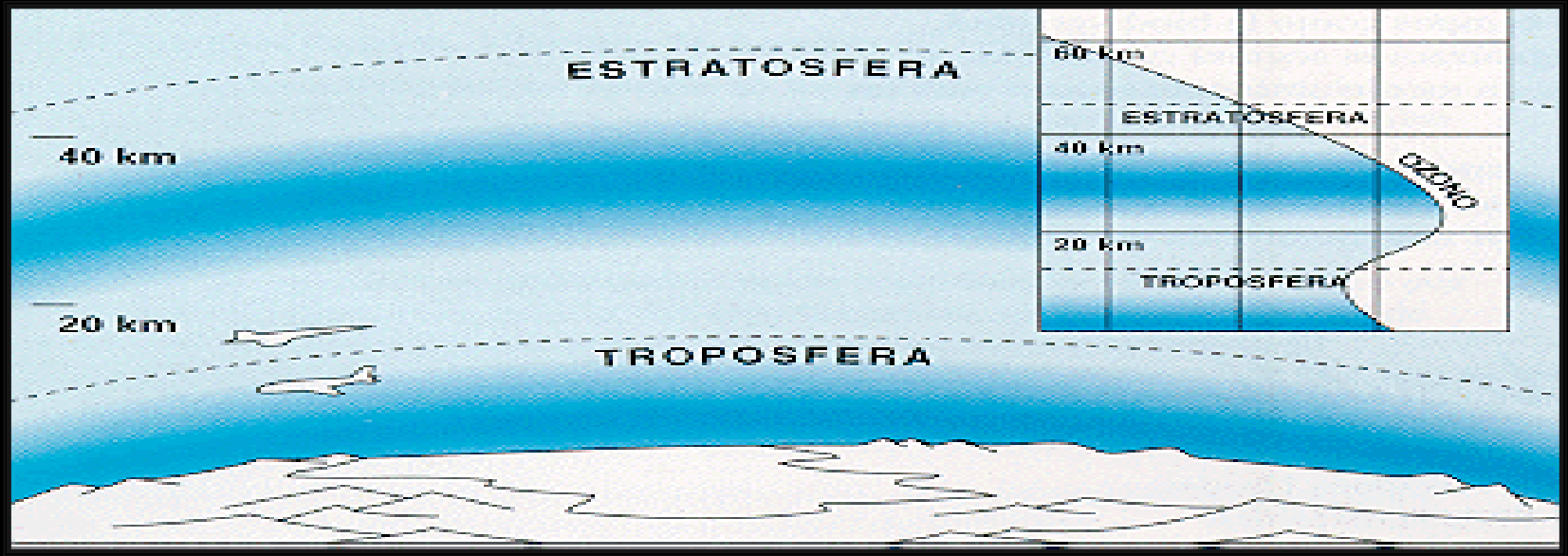


2007



Damage of the ozone layer

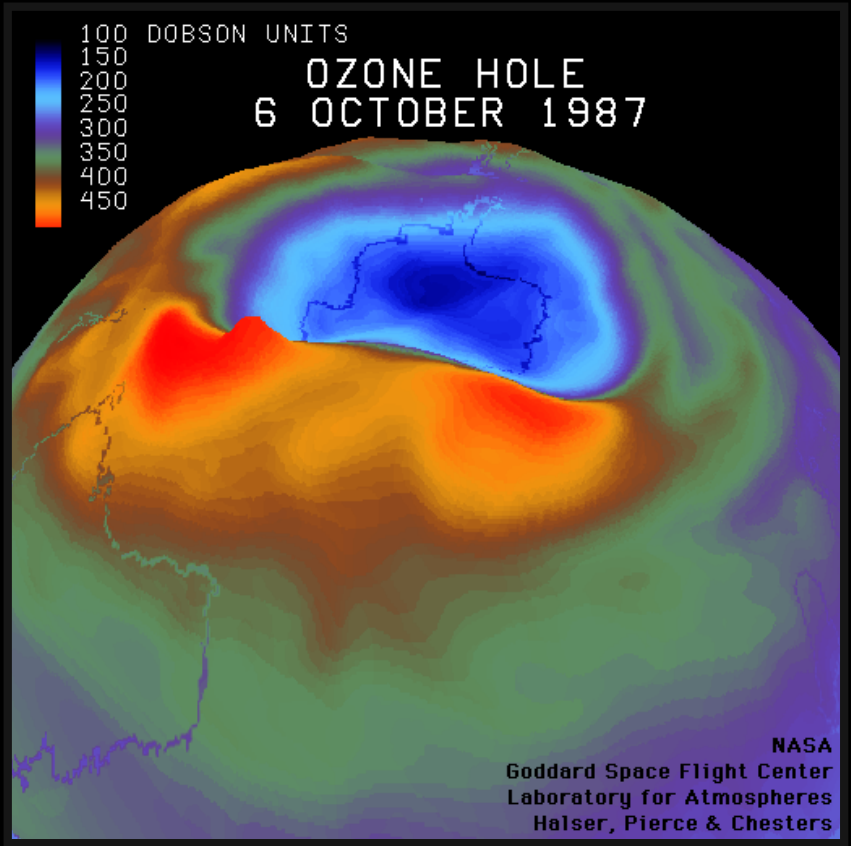
The Fragile Shield



Ozone forms a fragile shield, apparently immaterial, but very effective. It is so scattered over the 35 Km of thickness of the stratosphere that if it were compressed it would forma a layer around the Earth no thicker than a shoe sole

Zander R, Mahieu E, Demoulin P, Duchatelet P, Roland G, Servais C, De Mazière M, Reimann S, Rinsland CP. Our changing atmosphere: evidence based on long-term infrared solar observations at the Jungfraujoch since 1950. Sci Total Environ 2008;391(2-3):184-95.

The destruction of the ozone layer is one of the most severe environmental problems that we face today. It could be responsible for millions of skin cancer cases at a worldwide level and damage of farm production



PHYSICAL MEASUREMENT TECHNIQUES

Wide wave equipments

They measure total UV radiation (filter systems)

Robertson- Berger Radiometer measures total radiation erythema associated

Spectroradiometers

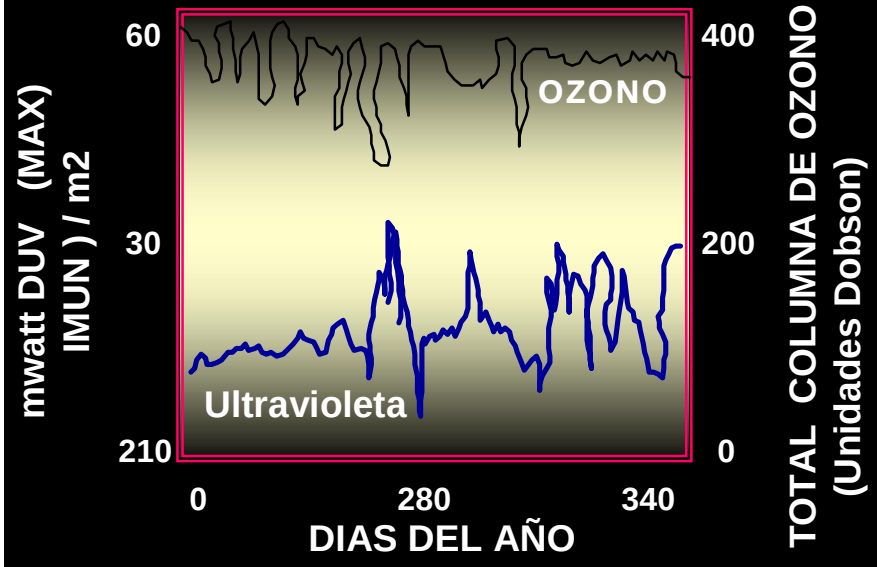
Brewer Spectrometer: measures ozone

Biospherical Instruments (SUV-100A): measures total irradiation (direct and diffuse light)

Measurement of Environmental UV-B radiation

Espectroradiómetro Brewer

Biometro UV de Luz solar 501



REDUCTION OF THE OZONE LAYER

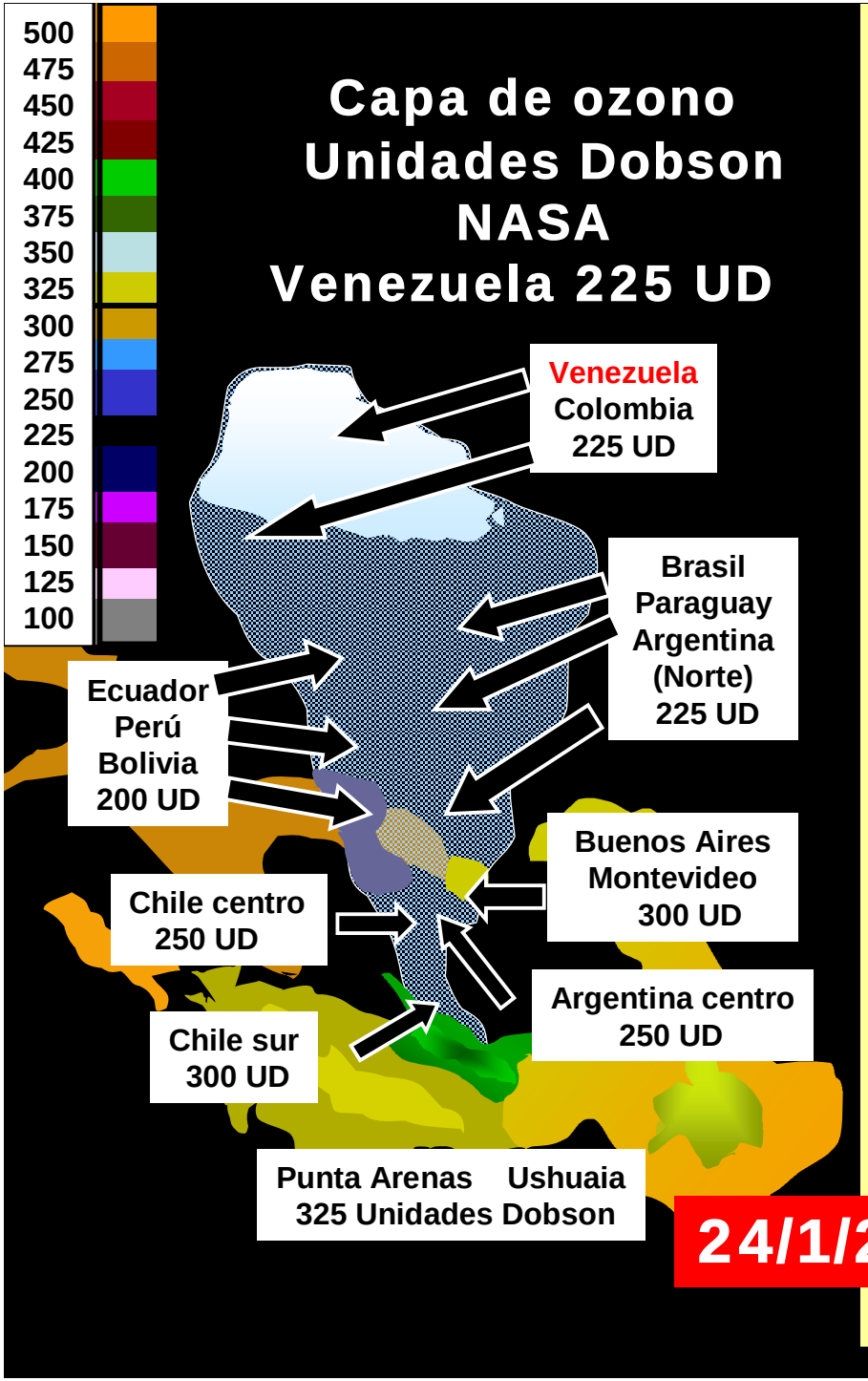
Causative factors:

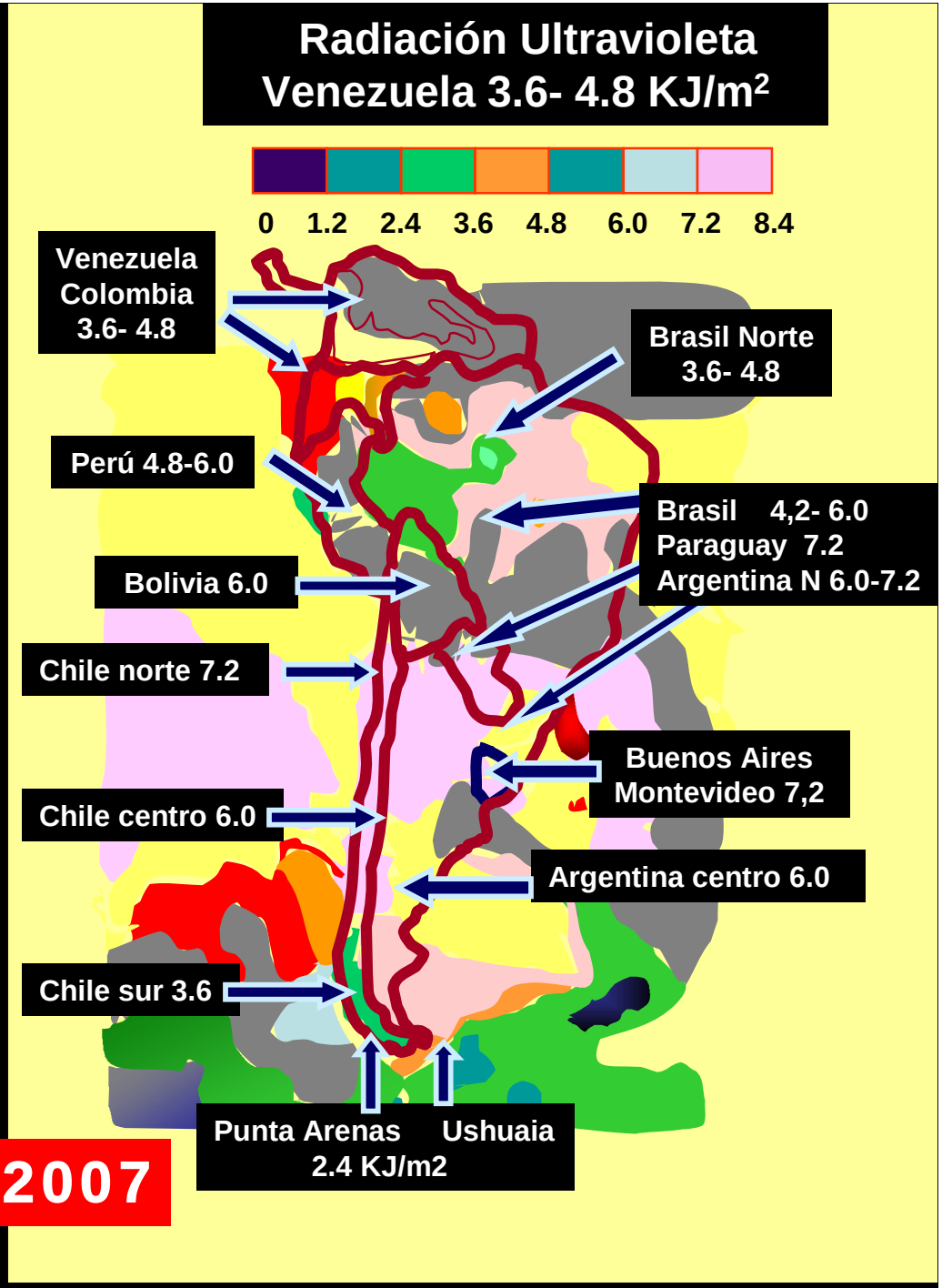
Chlorofluorocarbons

- Supersonic flights
- Use of nitrogenated fertilizers
- Thermonuclear explosions

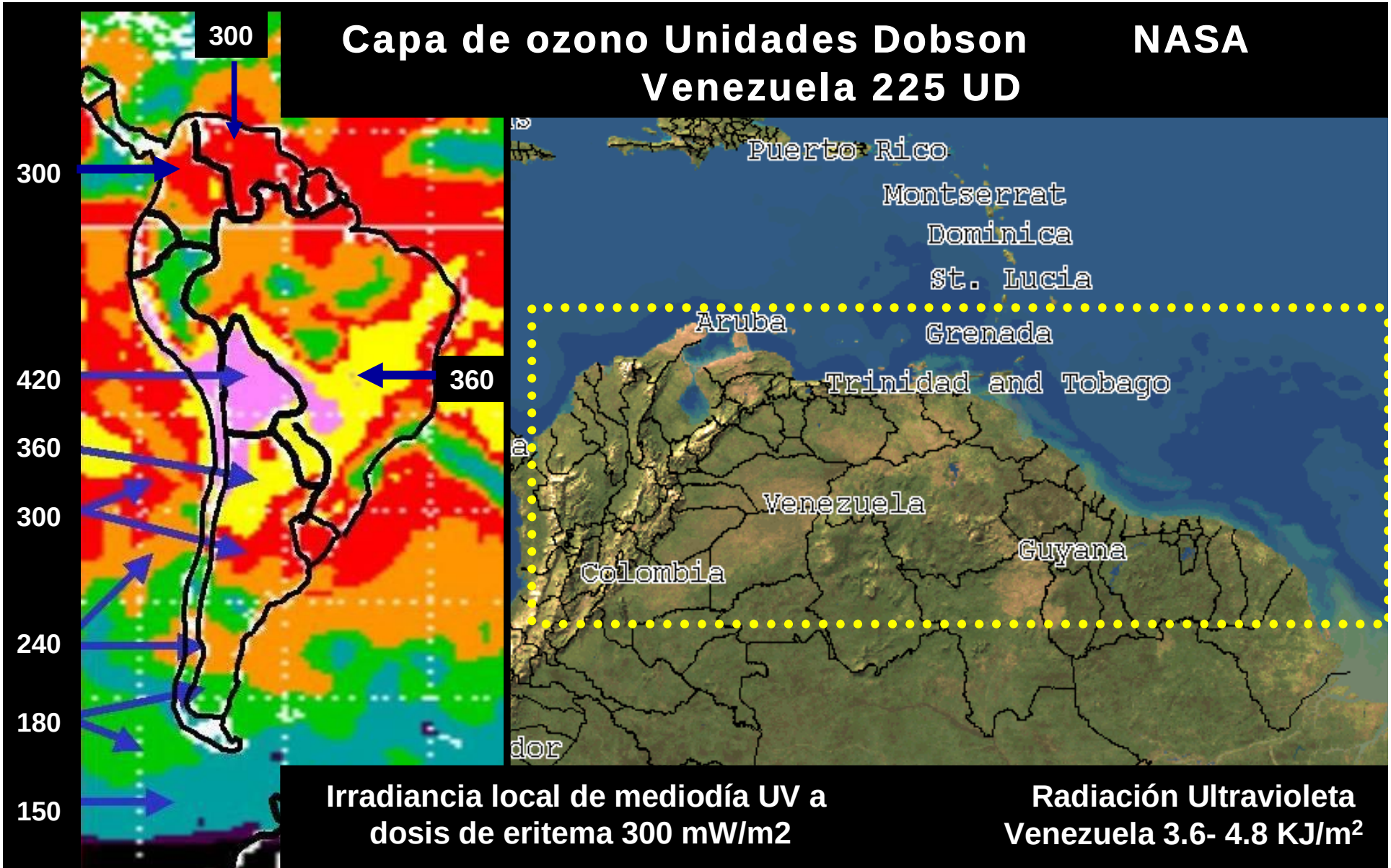
- The magnitude of the reduction varies with the latitude and season of the year

- The decrease of the density of the stratospheric Ozone layer is greater in the regions nearer to the Antarctica


500
475
450
425
400
375
350
325
300
275
250
225
200
175
150
125
100
Capa de ozono
Unidades Dobson
NASA
Venezuela 225 UD
Venezuela
Colombia
225 UD
Brasil
Paraguay
Argentina
(Norte)
225 UD
Ecuador
Perú
Bolivia
200 UD
Buenos Aires
Montevideo
300 UD
Chile centro
250 UD
Argentina centro
250 UD
Chile sur
300 UD
Punta Arenas Ushuaia
325 Unidades Dobson
24/1/2007

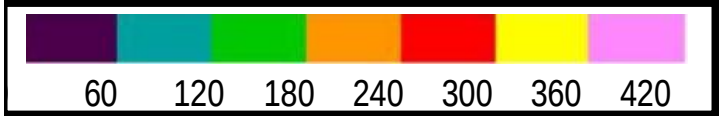

Radiación Ultravioleta
Venezuela 3.6- 4.8 KJ/m2
0 1.2 2.4 3.6 4.8 6.0 7.2 8.4
Venezuela
Colombia
3.6- 4.8
Brasil Norte
3.6- 4.8
Perú 4.8-6.0
Brasil 4,2- 6.0
Paraguay 7.2
Argentina N 6.0-7.2
Bolivia 6.0
Chile norte 7.2
Buenos Aires
Montevideo 7,2
Chile centro 6.0
Argentina centro 6.0
Chile sur 3.6
Punta Arenas Ushuaia
2.4 KJ/m2

Capa de ozono Unidades Dobson NASA
Venezuela 225 UD



Irradiancia local de mediodía UV a dosis de eritema 300 mW/m2

Radiación Ultravioleta Venezuela 3.6- 4.8 KJ/m^2

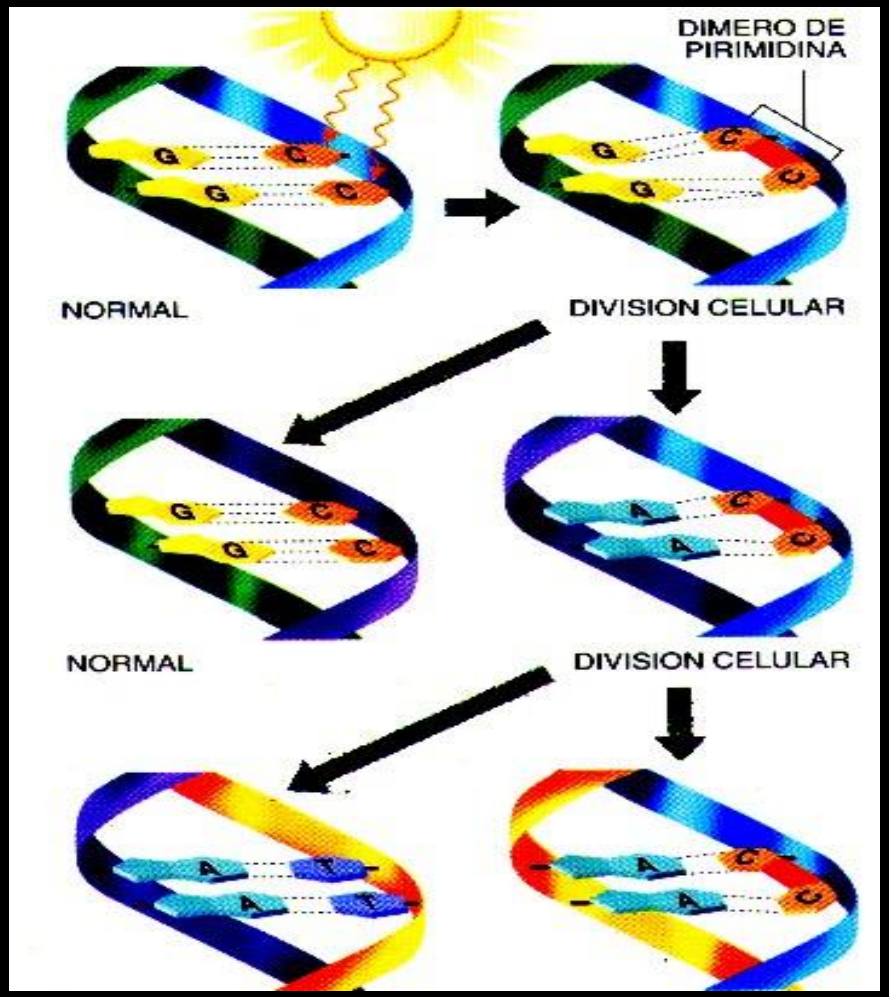


24 Enero 2007

How are we affected by UV radiation?

- It contributes to skin cancer
- It alters the immunological system
- It produces eye damage such as cataracts
- More severe sunburn and photoaging
- It increases the risk of allergic and phototoxic dermatitis
- It activates certain bacteria and viruses
- It reduces harvest yields
- It reduces the yield of the fishing industry

Norval M, Cullen AP, de Gruijl FR, Longstreth J, Takizawa Y, Lucas RM, Noonan FP, van der Leun JC. The effects on human health from stratospheric ozone depletion and its interactions with climate change. Photochem Photobiol Sci 2007;6(3):232-51.


DIMERO DE PIRIMIDINA
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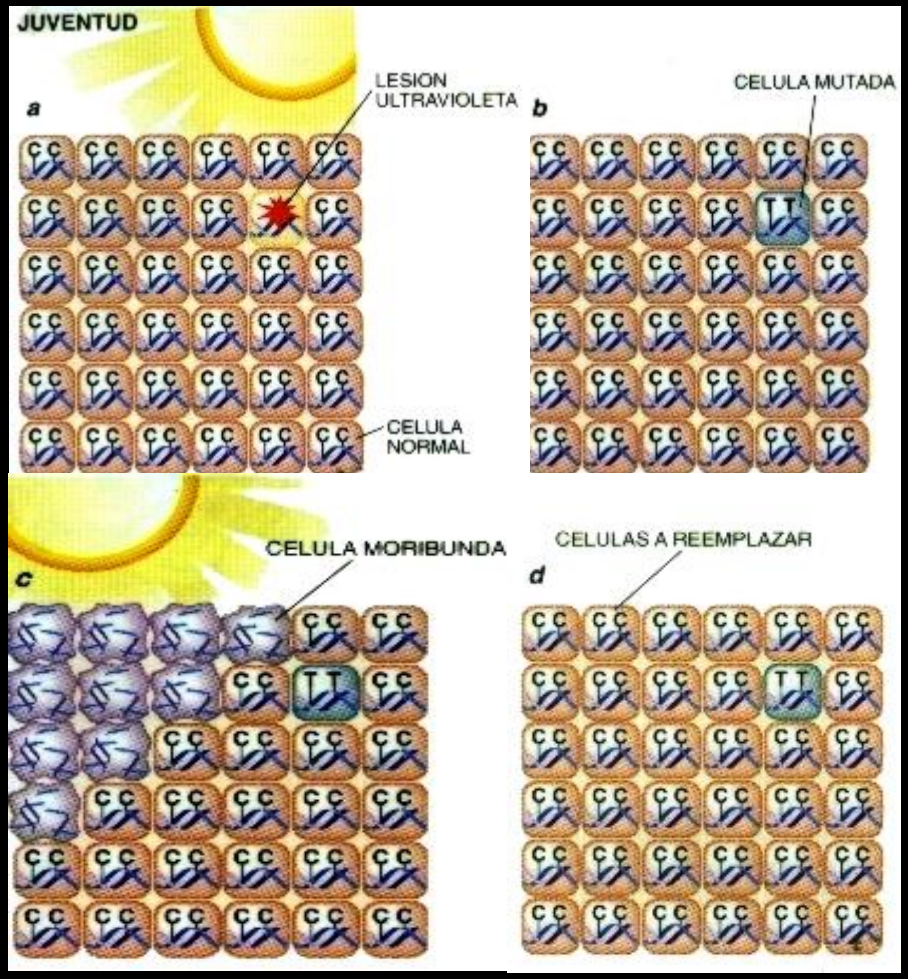
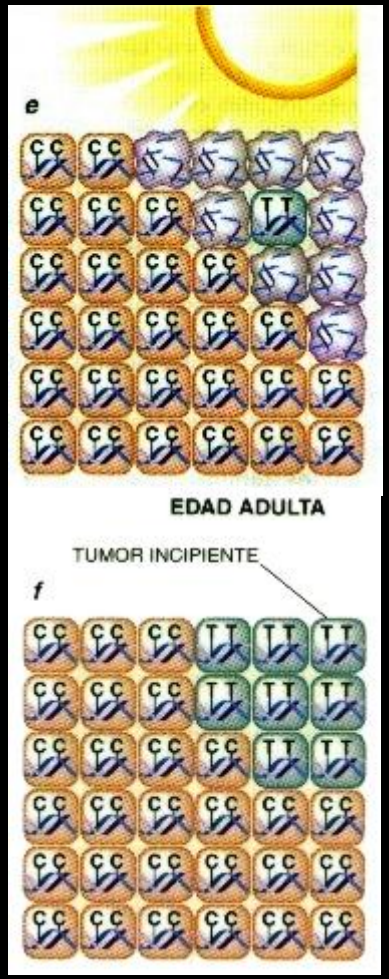
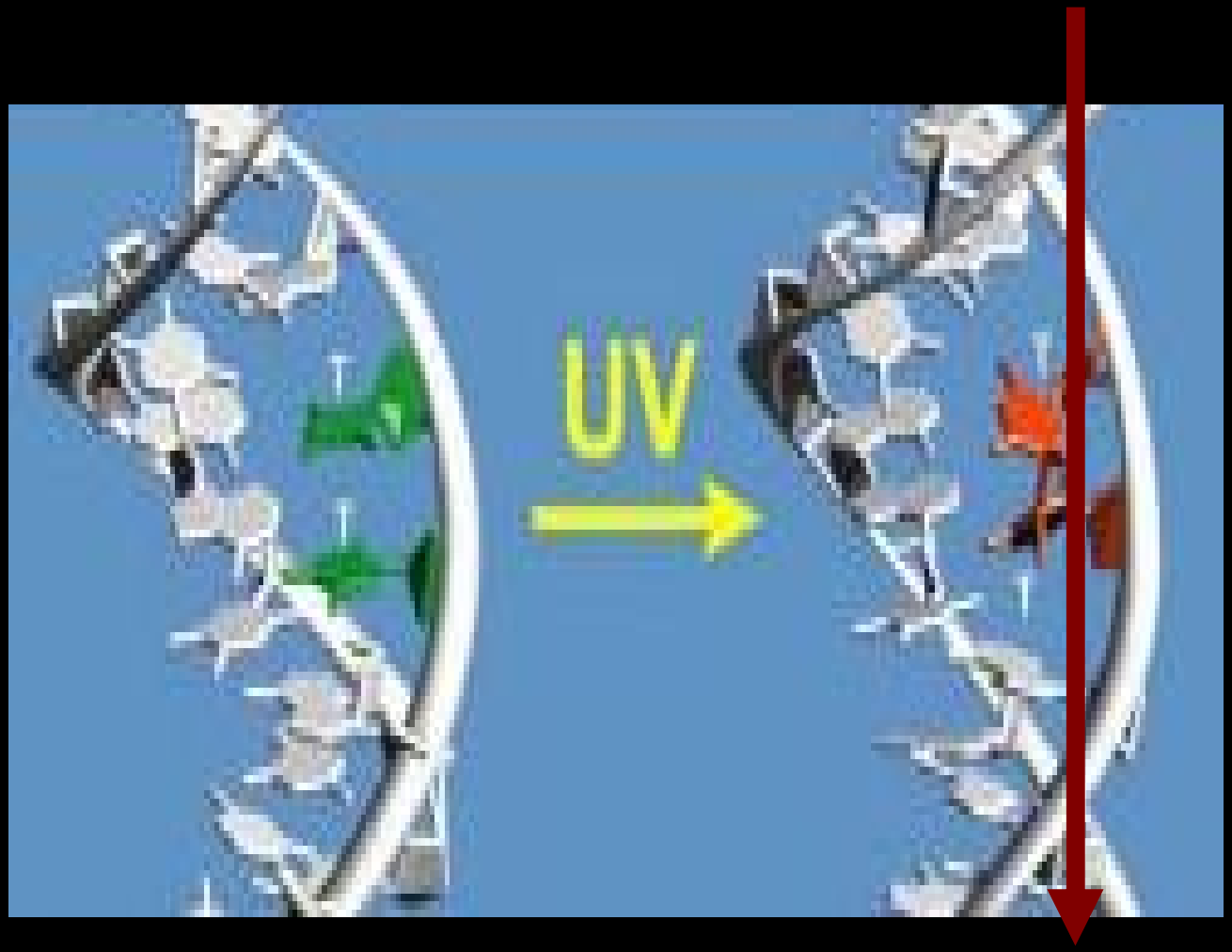
NORMAL
DIVISION CELULAR

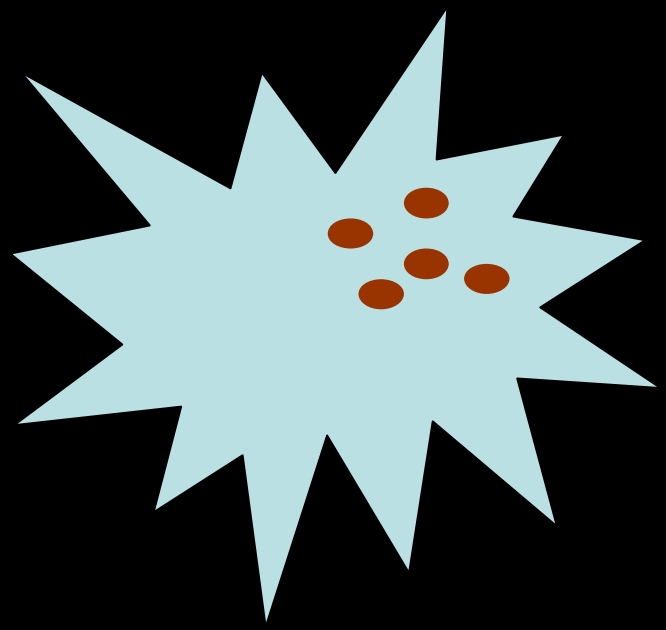

JUVENTUD
a
LESION ULTRAVIOLETA
CELULA NORMAL
b
CELULA MUTADA
c
CELULA MORIBUNDA
d
CELULAS A REEMPLAZAR


e
EDAD ADULTA
TUMOR INCIPIENTE
f



Kohler B, et al. New Look at DNA hints at origin of ultraviolet damage. Nature; 2005.

MELANINE AND ITS PHOTOPROTECTIVE ROLE



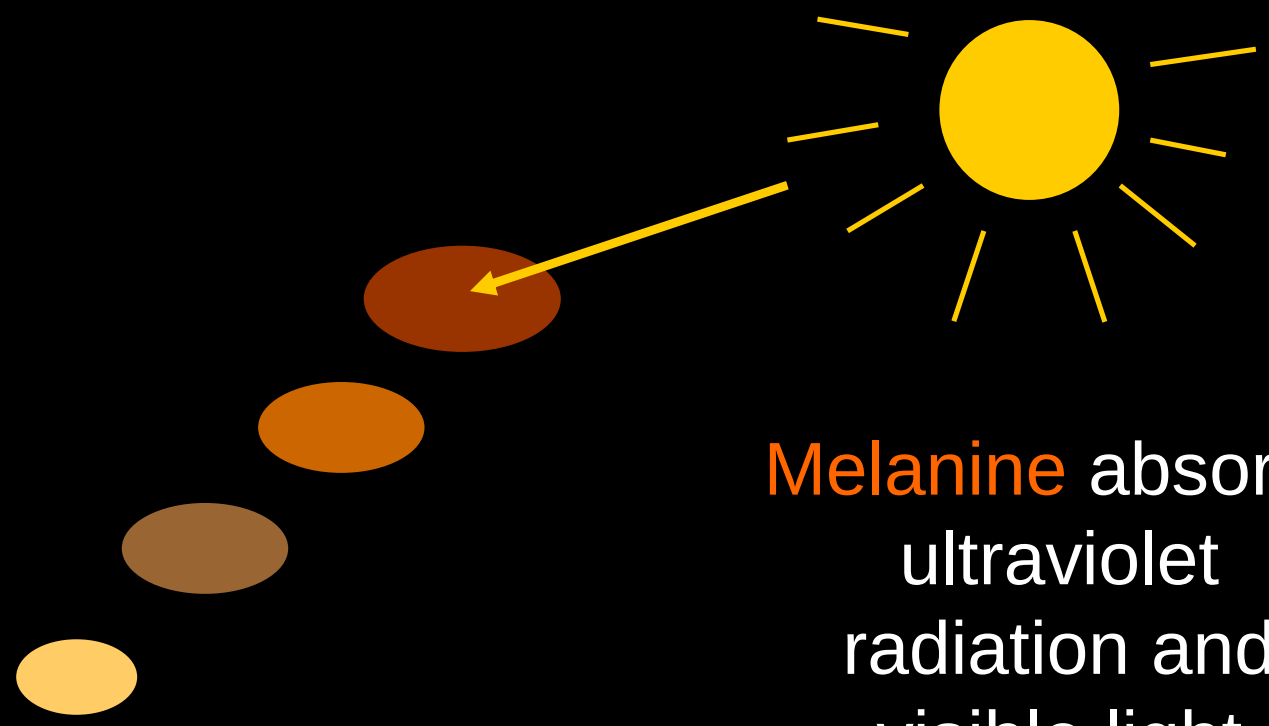
El melanosoma,

Si comparamos la piel pigmentada con la que está intensamente pigmentada:

- Más melanina
- Mayor diámetro
- Melanosomas dispersos
- Degradación lenta

Szabo G, Gerald A, Pathak M,Fitzpatrick T. Racial differences in the fate of melanosomes in human epidermis.
Nature 1969;(198): 1081-1082.

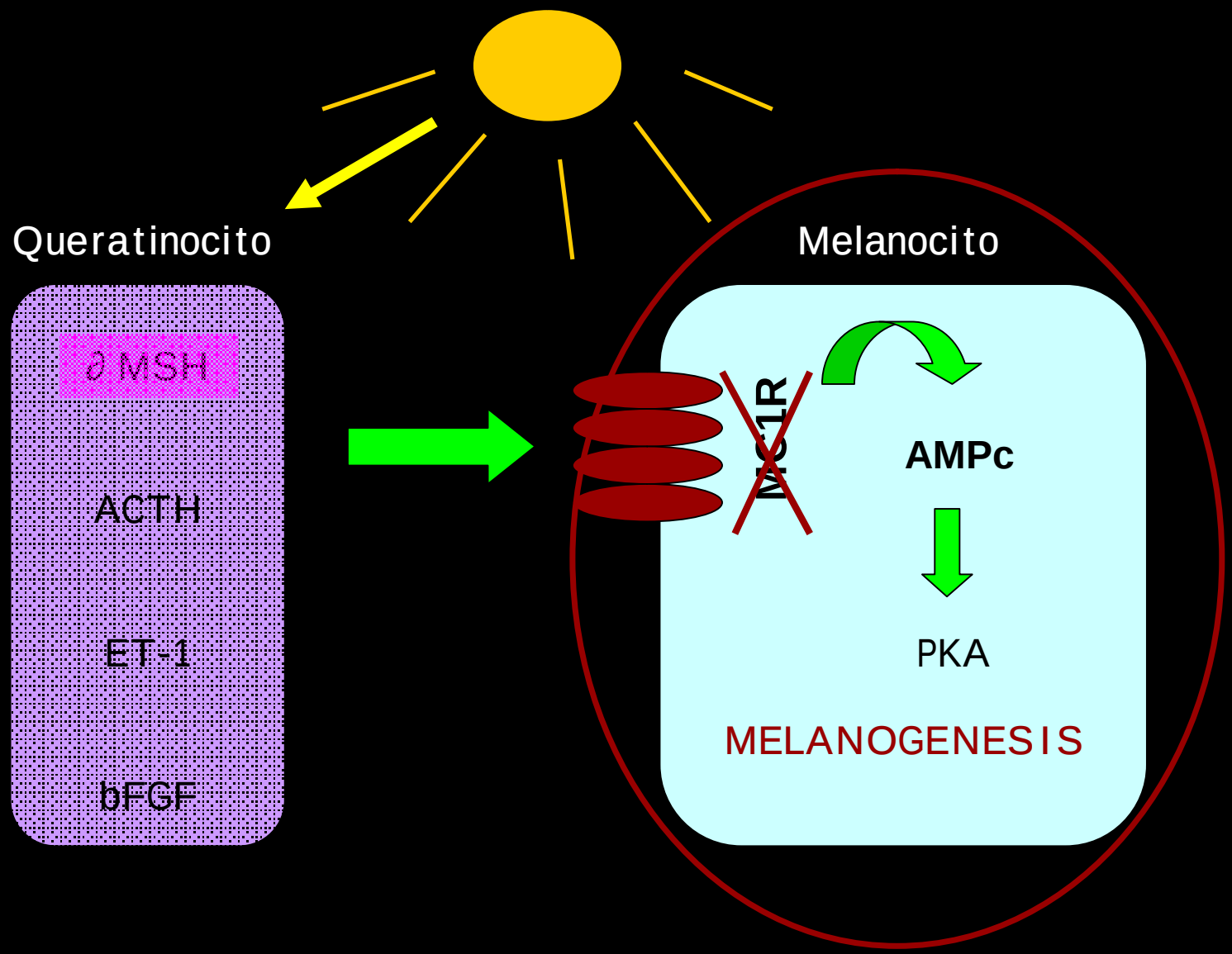
MELANINE AND ITS PHOTOPROTECTIVE ROLE



Melanine absorbs ultraviolet radiation and visible light

Rouzaud F, Kadekaro AL, Abdel-Malek Z, Hearing V. MC1R and the response of melanocytes to ultraviolet
radiation. Mut Res 2005;(571):133-152.

RESPUESTA DE LOS MELANOCITOS Y QUERATINOCITOS FRENTE A LA UV



David Fisher del Dana-Farber Cancer Institute y John D'Orazio de University Of Kentucky College of Medicine en Lexington.

It has been determined that p53 apart from repairing the DNA damage produced by UV, controls the initiation of the suntan process cascade

Barsh G, Attardi L. A Healthy tan? N Engl J 2007;356:2208-9.
Fisher D, Cui R, Windlund H, Feige E, Lin J, Wilensky D, et al.Central role of p53 in the suntan response and
Pathologic Hyperpigmentation. Cell 2007;128:853-64.

OZONE & UV

EFECTOS DE LAS RADIACIONES UV

Earth ecosystems

- **Plants: Varied effects**
  - Alfalfa develops resistance to RUV DNA damage (adaptation)
  - Decreases soy production

- **Insects: they can see radiations between 300 and 400 nm**
  - UV reflected by plants attracts pollinating insects
  - Butterflies use this mechanism for their pairing
  - Bees and other insects use UV light to localize sun position and orient themselves in their flights

OZONE & UV

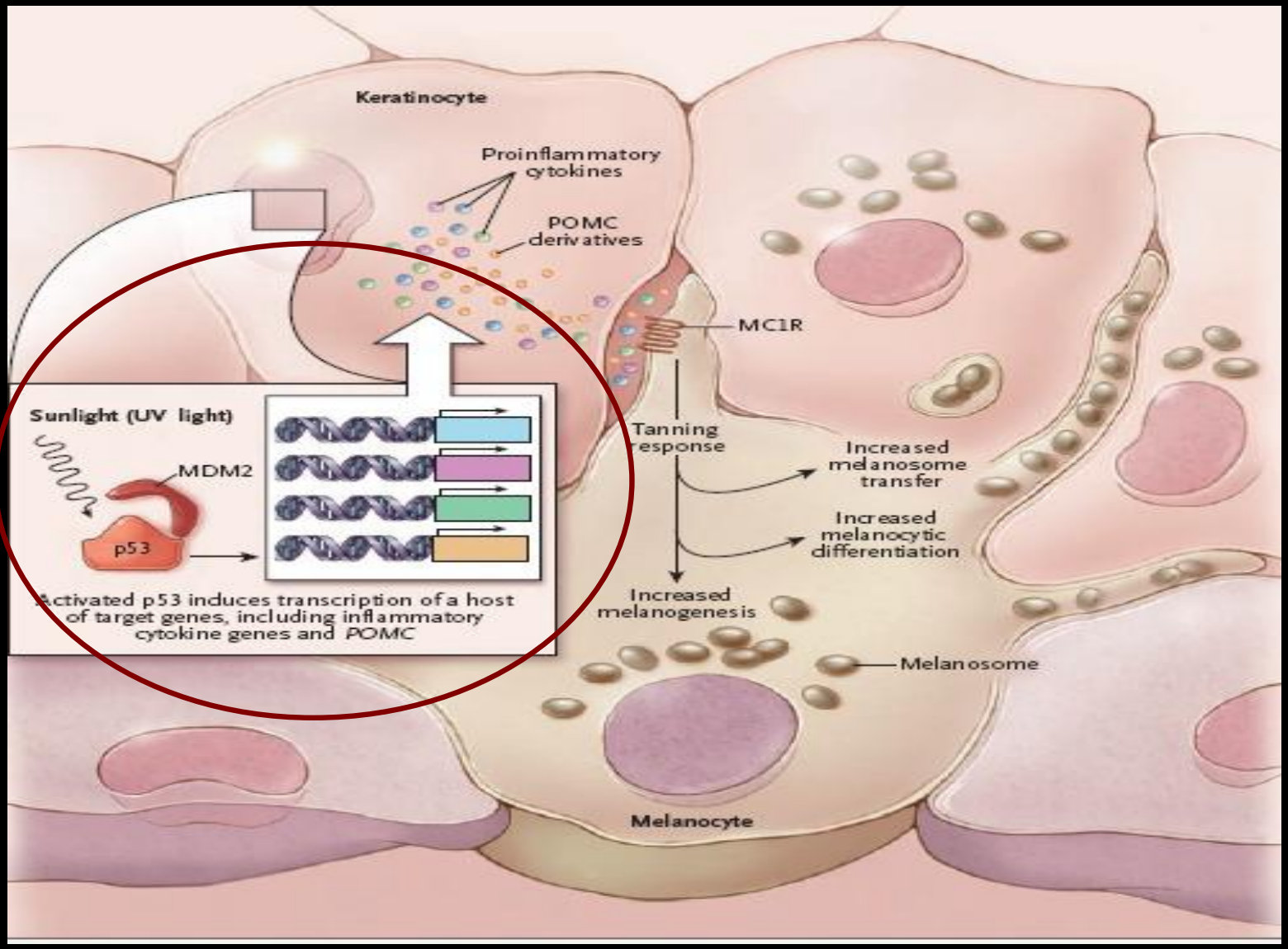
EFECTOS DE LAS RADIACIONES UV

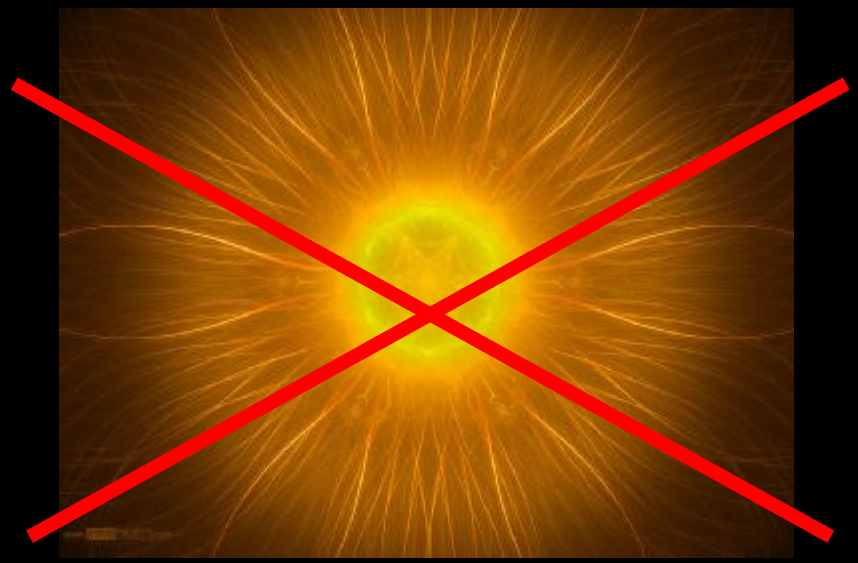
Aquatic systems

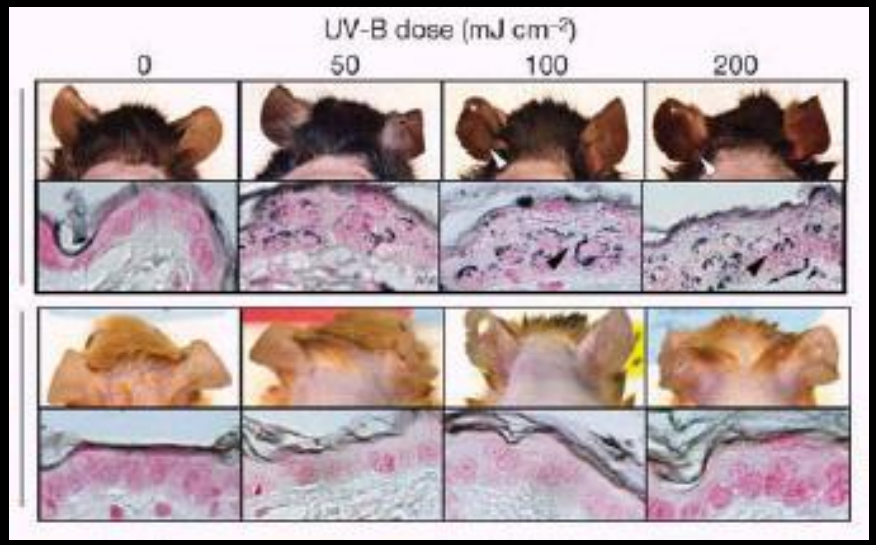
Phytoplankton

- **This is the largest Earth ecosystem**
- **It produces 60% of the oxygen and absorbs 50% of the marine CO_2**
- **RUV increase decreases phytoplankton, which provokes a decrease of fishing yields**

GLOBAL WARMING


Keratinocyte
Proinflammatory cytokines
POMC derivatives
MC1R
Sunlight (UV light)
MDM2
p53
Activated p53 induces transcription of a host of target genes, including inflammatory cytokine genes and POMC
Tanning response
Increased melanosome transfer
Increased melanocytic differentiation
Increased melanogenesis
Melanosome
Melanocyte

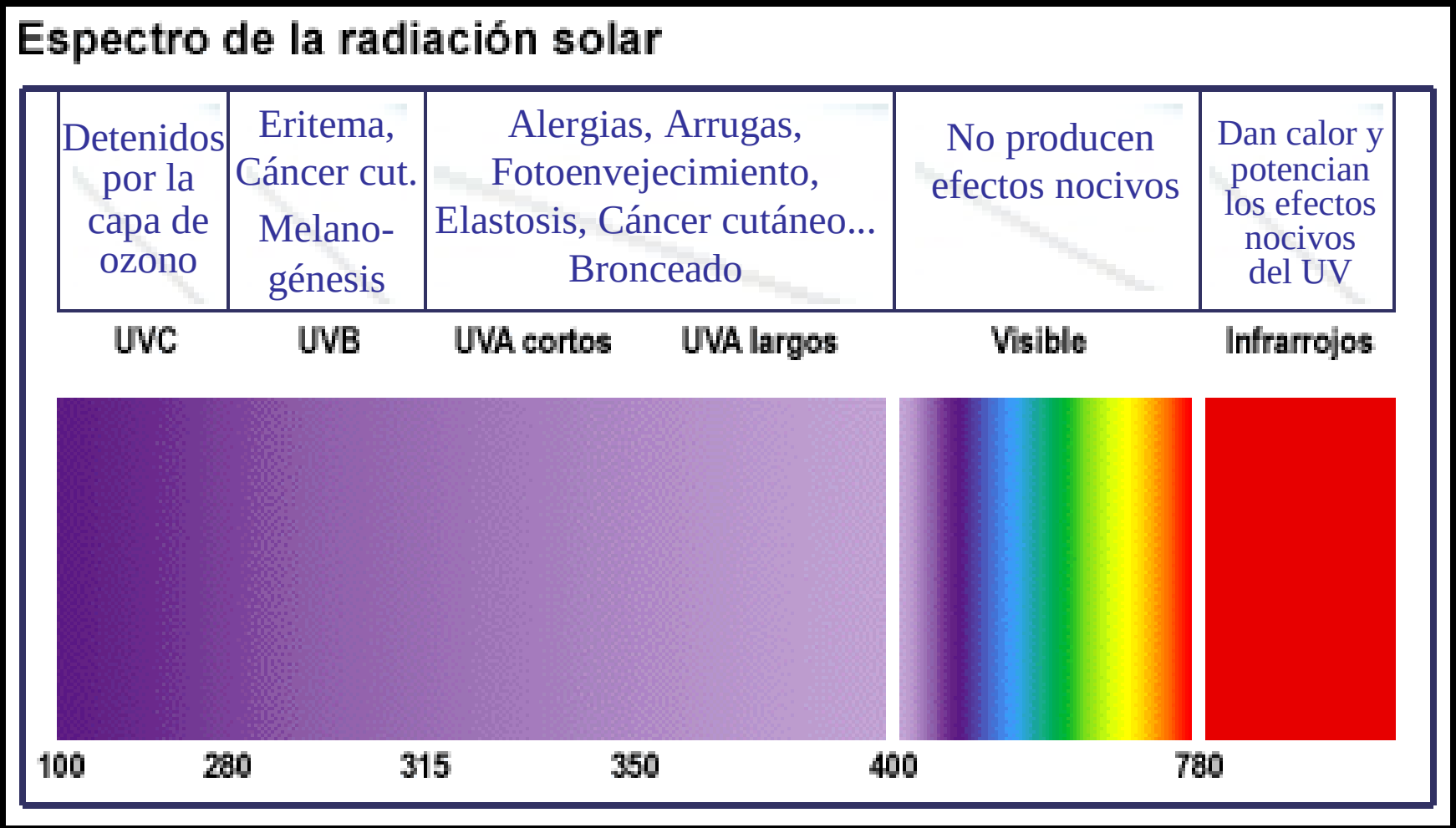




Mutación de MC1R

QUEMABAN SIN BRONCEARSE

Radiación Solar



RADIACIÓN SOLAR

Efectos clínicos: Piel- Ojos -Inmunidad

	UVB	UVA	Visible
1.- Sintesis de Vitamina D3	+	+	-
2.- Pigmentación	+	++	-
3.- Quemadura solar	++	+	-
4.- Pigmentación tardía	++	+	-
5.- Fototoxicidad	+	+	+
6.- Fotoalergia	-	++	-
7.- Inmunomodulación	+	+	-
8.- Reacción hiperplástica	+	+	-
9.- Fotoenvejecimiento	+	+	+
10.- Carcinogénesis	++	+	-

Efectos Benéficos

1. Síntesis vitamina D
2. Bienestar psíquico
3. Regulación ritmo circadiano

UVA

1.- Representa el 90%-95% de la radiación UV solar.
2.- Penetra más en la piel y atraviesa vidrios de ventanas.
3.- Induce más inmunosupresión que eritema.
4.- Activa stress oxidativo (fotoinmunosupresor).

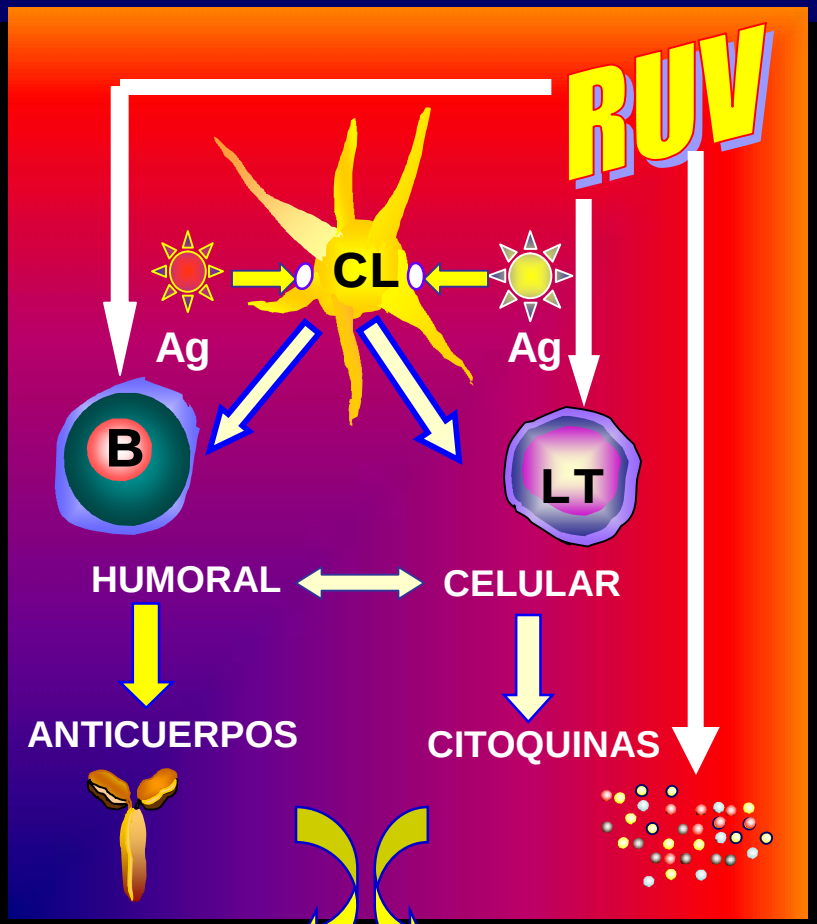
Schwarz A y cols.Nat Cell Biol 2000; 4: 26-31.
Young AR, Walker ST. Exp Dermatol 2002: 11(Suppl. 1) : 17-19.

EFECTOS DE LA RUV EN LA INMUNIDAD

INFECCIONES

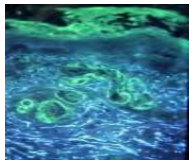
Linfocitos B

Linfocitos T



TIPO I
Inmediata
IgE

TIPO II
Citotóxica
IgG, ADCC



TIPO III
Complejos
IgG-C

TIPO IV
Retardada
Th1

TIPO V
Granuloma
LTh1 o Th2

ALTERACION DE LA INMUNIDAD

INMUNO DEFICIENCIA

HIPERSENSIBILIDAD ALERGIAS

1.- Gniadecki R y cols. Cell Mol Biol (Noisy-le-grand) 2000 Feb;46(1):121-7
2.- Hofmann-y cols. J Invest Dermatol 2004;723: 781-787

RUV: EFECTOS INMUNODERMATOLOGICOS

1.- REACCIONES ALERGICAS : Fármacos, Vegetales,etc.
2.- UV Y DERMATOSIS INMUNOLOGICAS (Vitiligo, Psoriasis)
3.- INFECCIONES
4.- AUTOINMUNIDAD
5.- ALTERACION DE LA INMUNIDAD CONTRA EL CANCER

FOTOALERGIA A VEGETALES : FITO FOTODERMATITIS

Dermitis de foto contacto por Ruda

INMUNIDAD Y RADIACION UV Y CANCER

1.- La dosis inmunosupresora de UV es menor que la requerida para provocar cáncer cutáneo.

2.- La RUV disminuye inmunidad celular al dañar a las células de Langerhans.

3.- Puede afectar a las enfermedades infecciosas y a los programas de vacunación.

4.- Menor rechazo a tumores malignos.

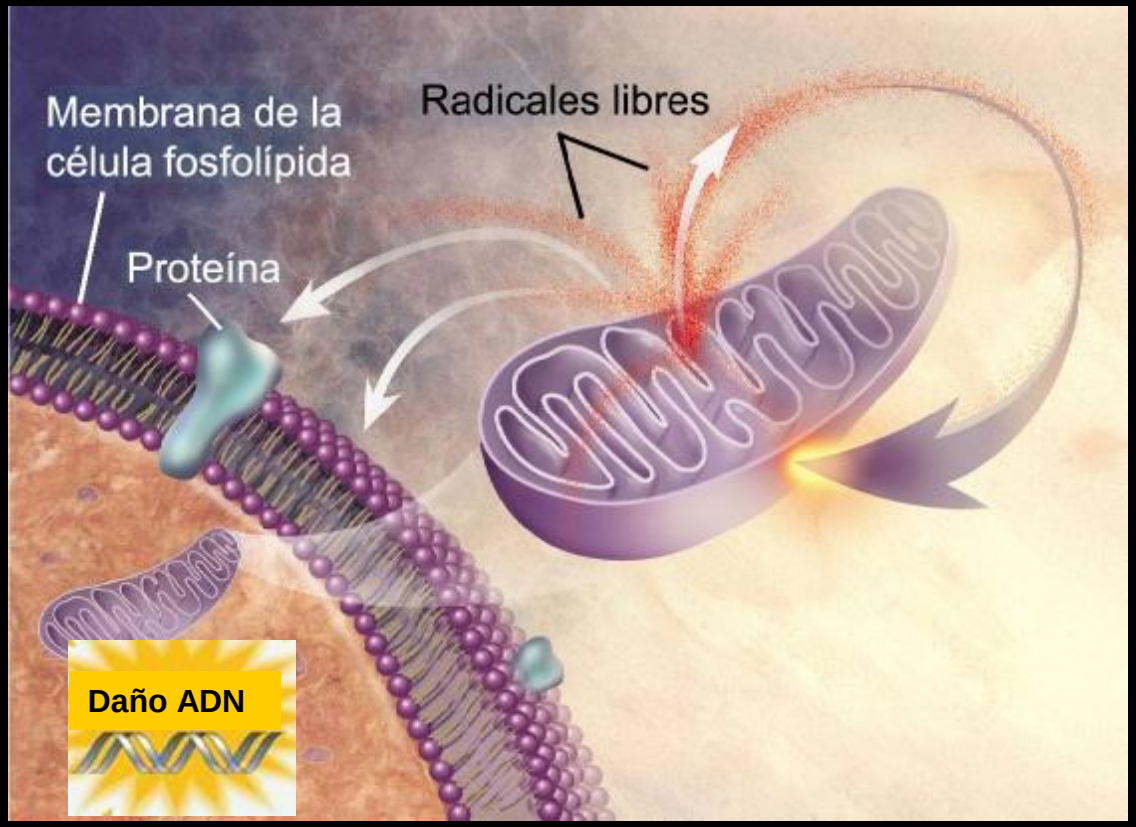
Carcinoma Basocelular

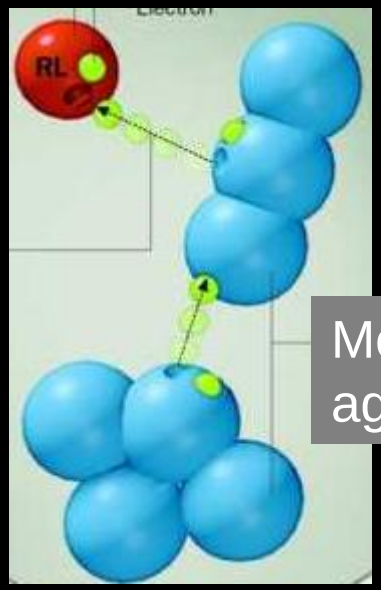
Carcinoma Espinocelular

1.- Kelvin D. J. Y cols. J Lueko Biol, 1993, 54:604
2.- Moodycliffe AM y cols. Nat Immunol 2000;1: 521-525.

Other UV Radiation effects

Oxidative Stress

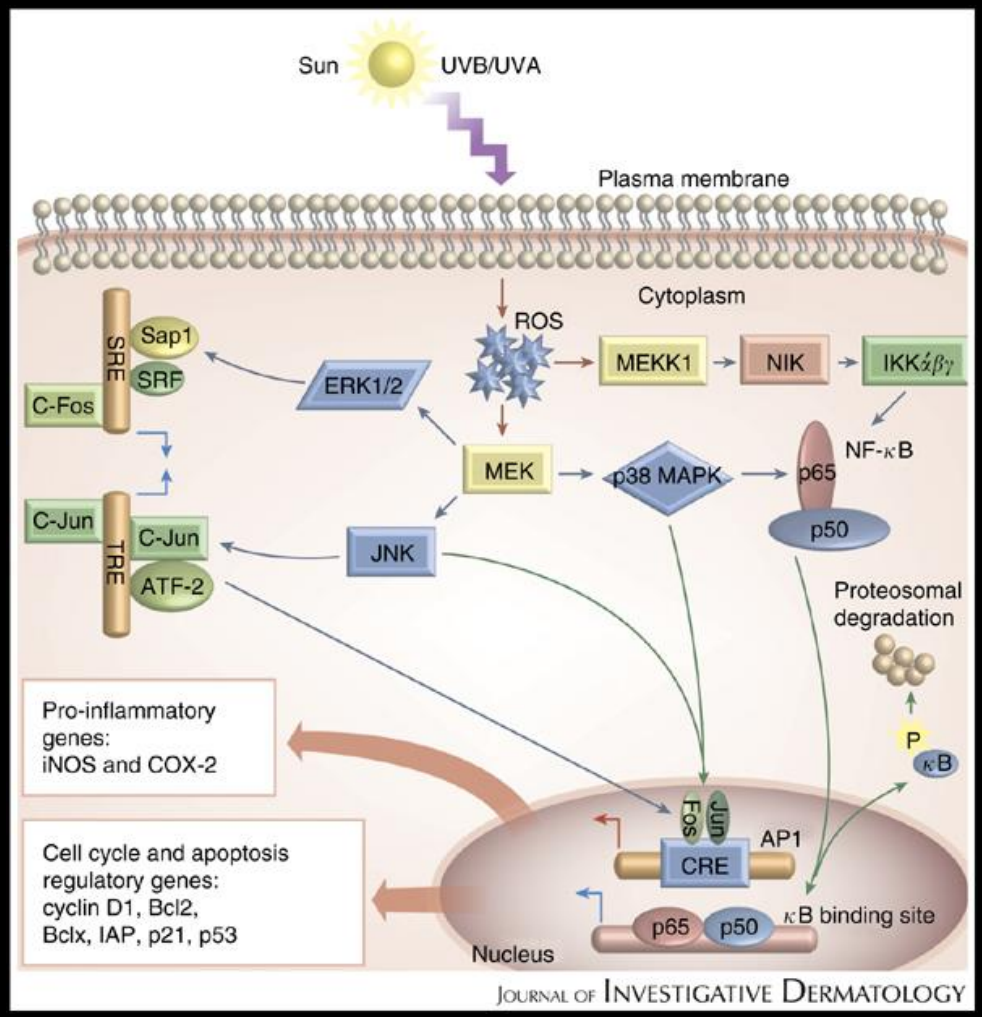




Cáncer de piel

Fotoenvejecimiento

Estrés oxidativo inducido por UV en la piel



RL (ROS) → Cascade of intracellular signals

Effects:
Production of pro-inflammatory substances
Alteration of cell regulation and apoptosis signals
Carcinogenesis

FORSKOLIN

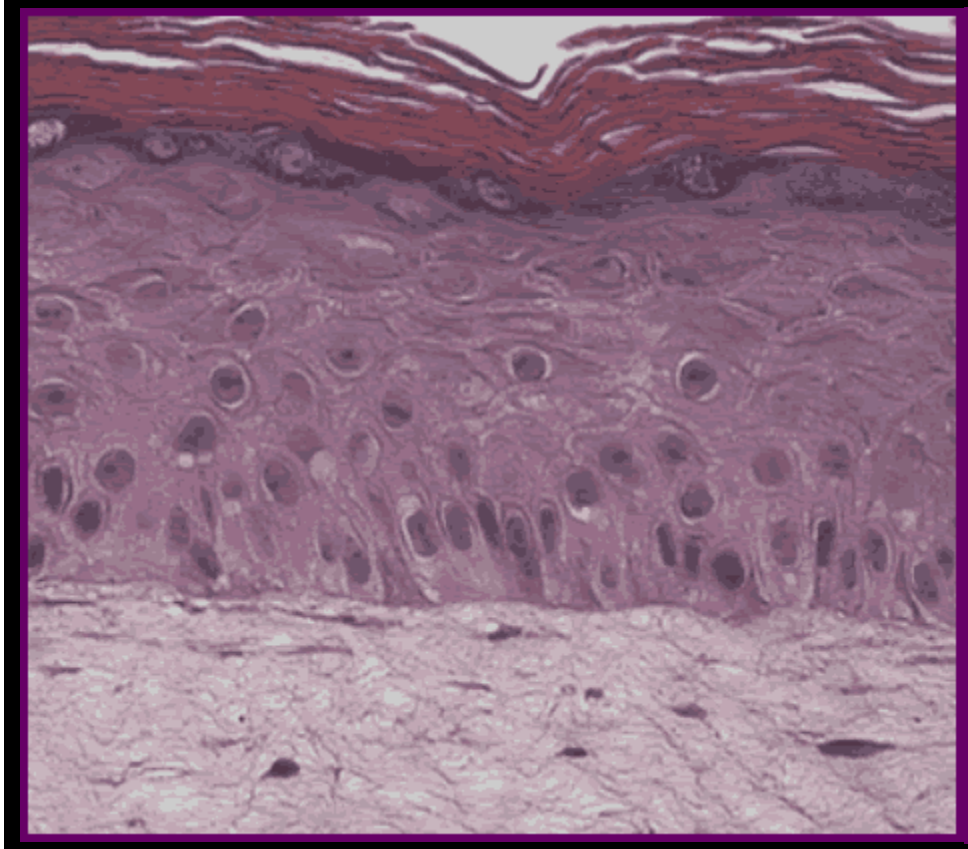
Activation of the suntan machinery

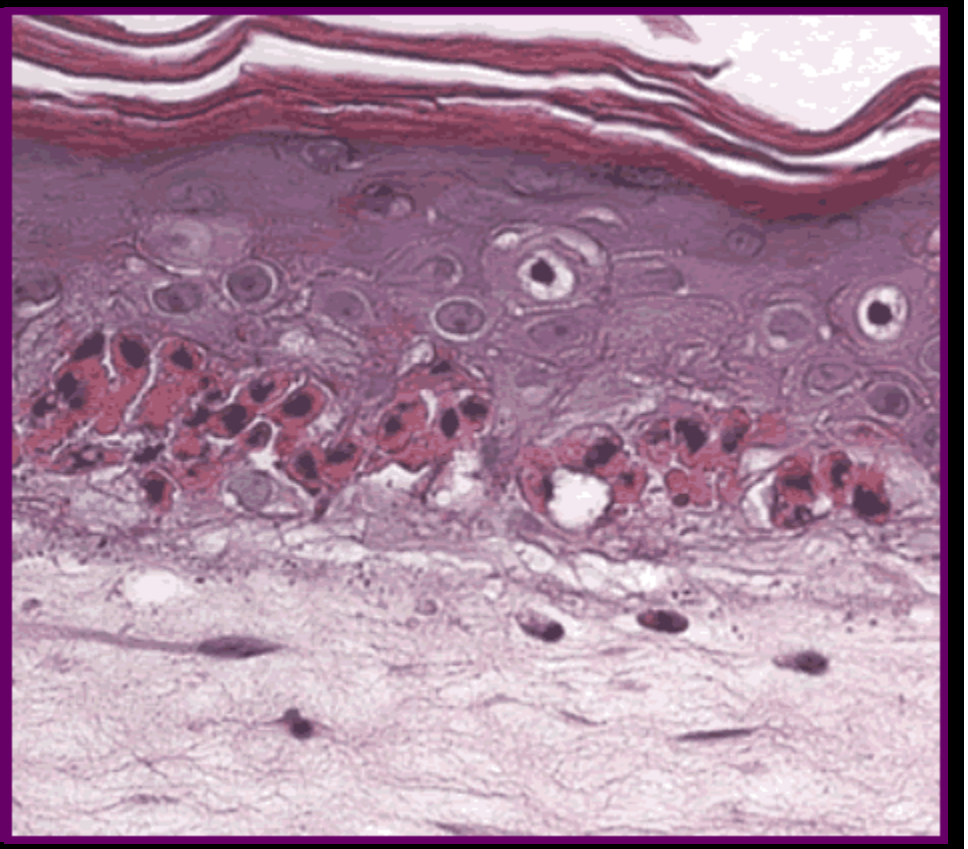
↑ AMPc

Mutation MC1R

FOTOTIPOS

La Importancia de la Fotoprotección





Piel no irradiada **Piel irradiada con UV**

Marrot L, Meunier JR. Skin DNA photodamage and its biological consequences.
J Am Acad Dermatol 2008;58(5):139-48

MED Y FOTOTIPOS

Un MED se define como la más baja exposición que produce una percepción mínima rojiza.

FOTOTIPOS DE PIEL		
Fototipos	Reacción de la piel	Dosis J/m2
I	Siempre se queman, nunca se broncean	0,5
II	Siempre se queman, se broncean ligeramente	1,0
III	A veces se queman, siempre se broncean	1,5
IV	Nunca se queman, siempre se broncean	2,0
V	Piel moderadamente pigmentada	2,5
VI	Negros	3,0

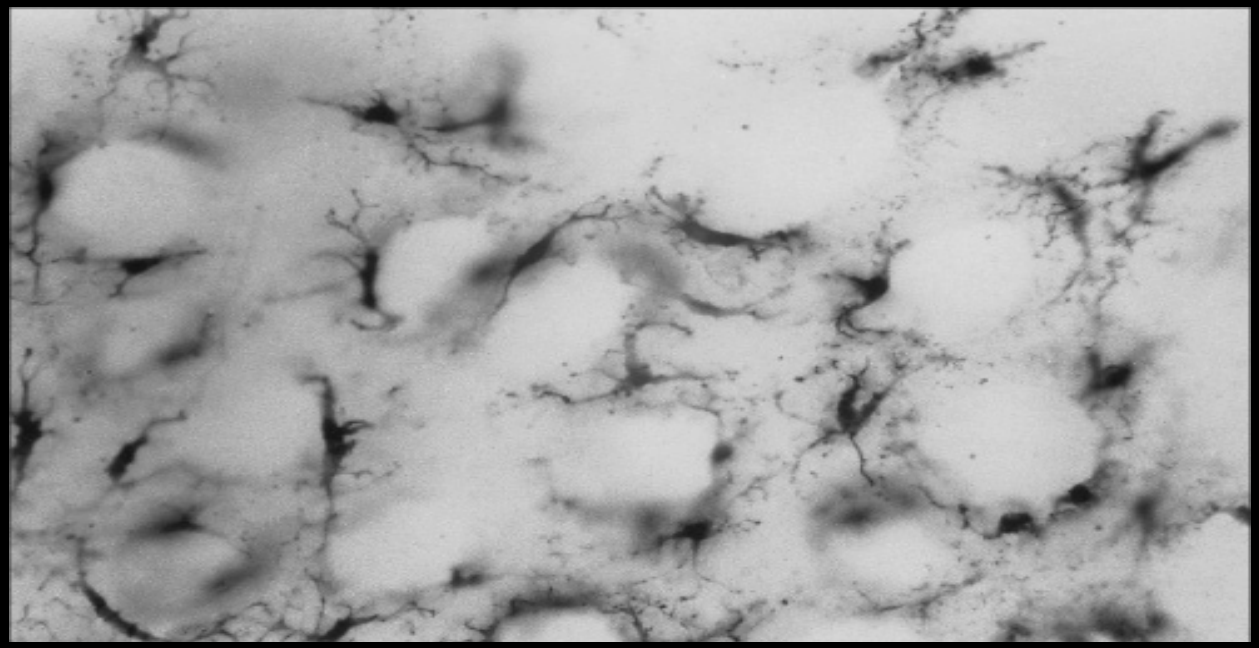
MED Y FOTOTIPOS

Fototipos	Tiempo de exposición
I	10 minutos
II	15 a 20 minutos
III	30 minutos
IV	30 a 45 minutos
V	60 minutos
VI	> 60 minutos

MED Y FOTOTIPOS

SENSIBLES AL SOL	TOLERANTES AL SOL
I al III	IV al VI

LA MELANINA Y SU ROL FOTOPROTECTOR



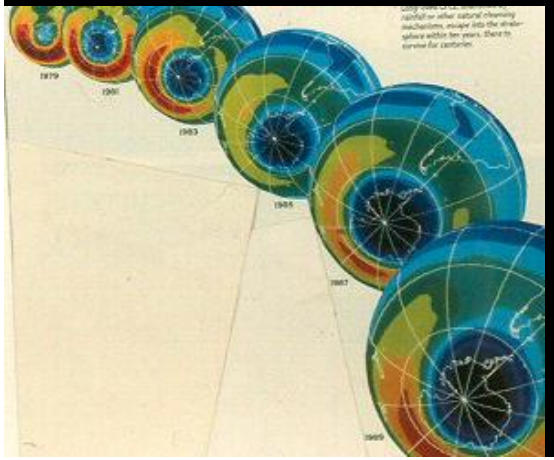
The main determinant of skin color is melanocyte activity

Kollias N, Sayre R, Zeise L, Chedekel M. Photoprotection by melanin. J Photochem Photobiol 1991;(9):135-160.

Cáncer de piel
Capa de Ozono

- Reducción 2% en 20 años
- Por c/1% reducción:

↑ **UVB 2%**
↑ **CBC 3%**
↑ **CEC 6%**
↑ **MM 1-1.5%**



¿Por que Fotoprotección? RUV y Carcinogénesis

Melanoma Maligno invasor

Riesgo de vida de desarrollar… (USA)

- **Niño nacido 1935** → **1/1500**
- **Niño nacido 1980** → **1/250**
- **Niño nacido 1990** → **1/120**
- **Niño nacido 2000** → **1/90**
- **Niño nacido 2001** → **1/71**

Rigel DS Photoprotection 21st century perspective. Br J Dermatol. 2002 146 34 37

Rigel DS, et al. MM … in the 21st century. CA Cancer J Clin 200 50 215 36

GLOBAL WARMING

Muito Obrigado

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