Energy and Environment

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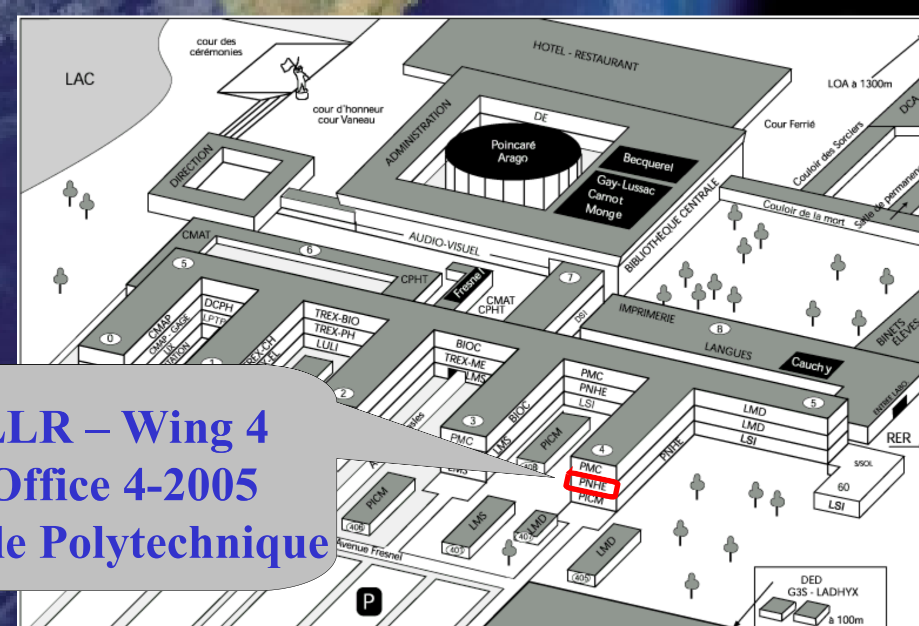
PC1 – Orders of magnitude



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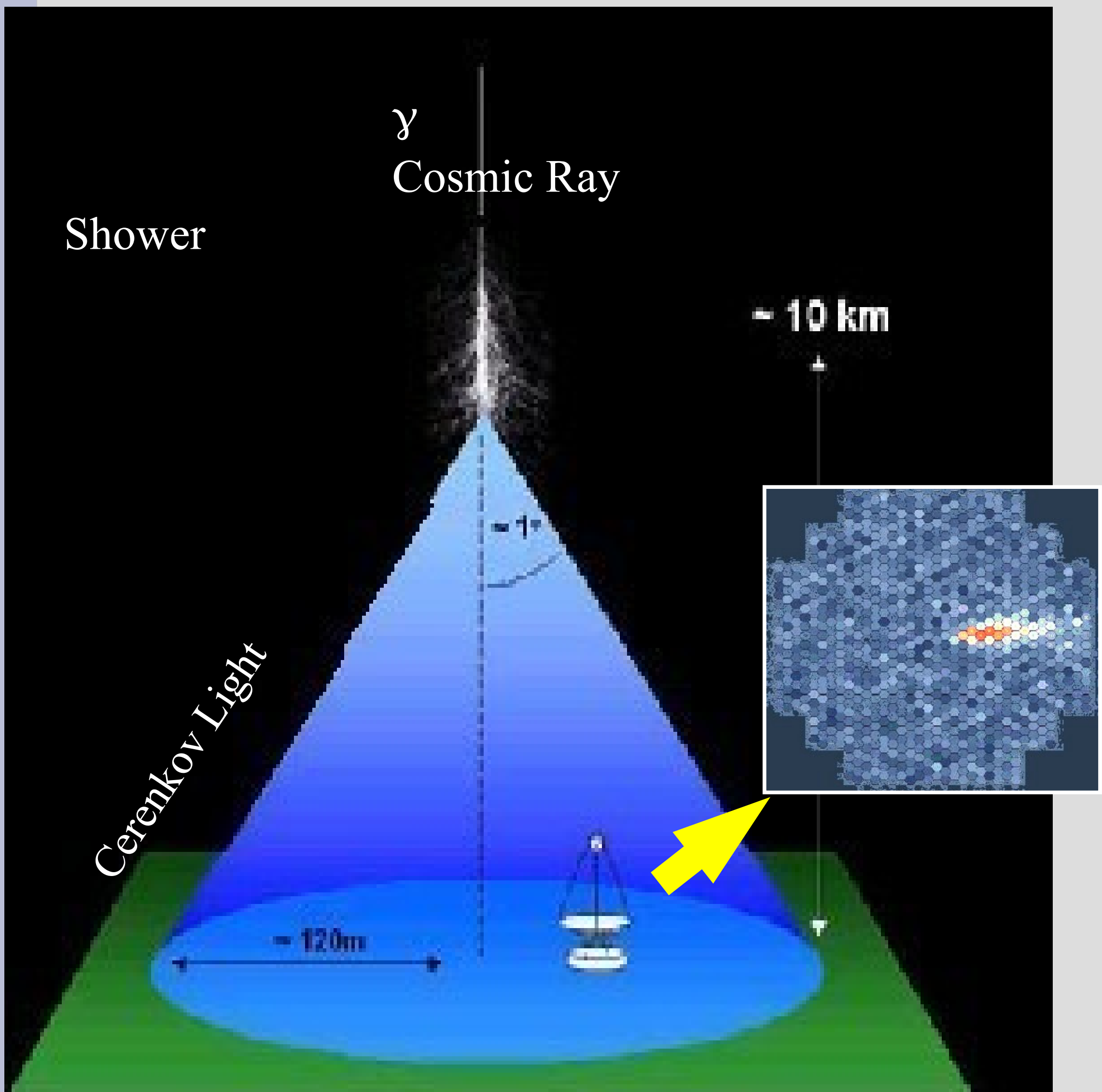
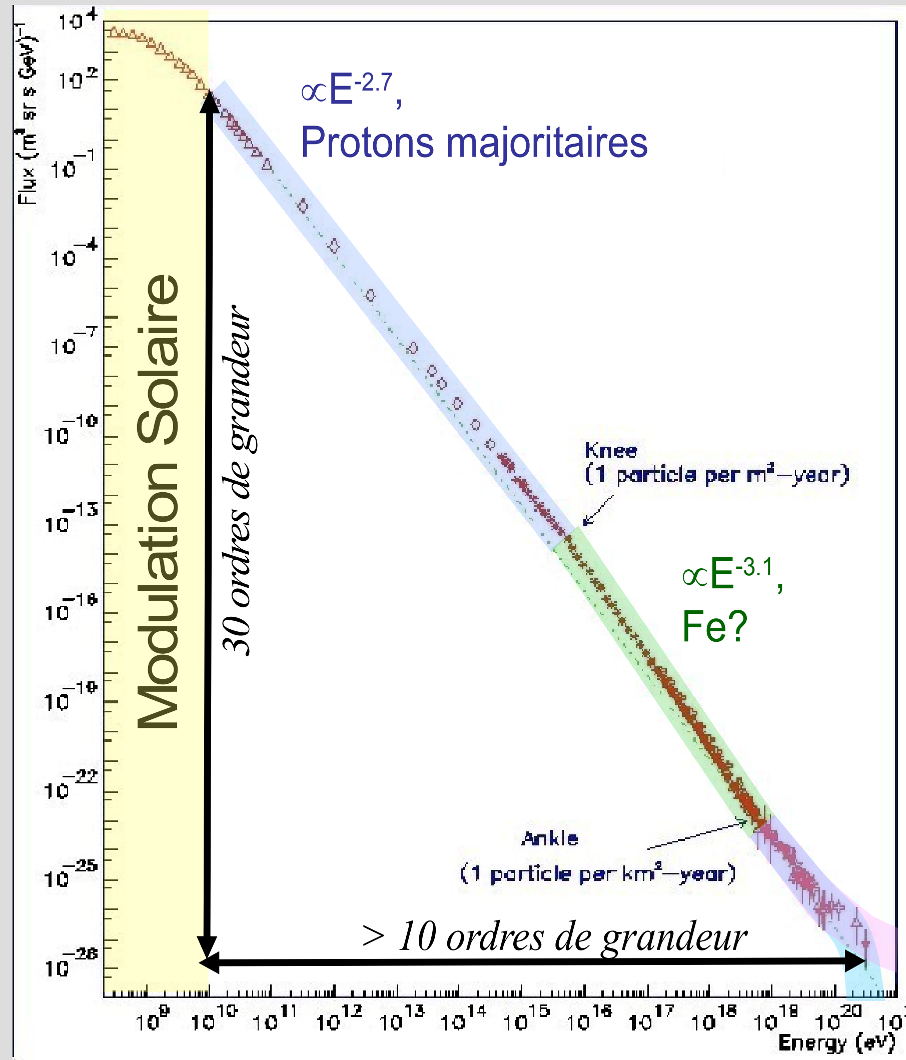
HESS and cosmic rays





Human

- Energy Budget?

Body Area

Body surface area - Wikipedia, the free encyclopedia - Mozilla Firefox

Fichier Édition Affichage Historique Marque-pages Outils Aide

Sea ice | Body surface area - ...

https://en.wikipedia.org/wiki/Body_surface

Rechercher

Calculation [edit]

Various calculations have been published to arrive at the BSA without direct measurement. In the following formulae, BSA is in m^2, W is mass in kg, and H is height in cm.

The most widely used is the Du Bois formula,[4][5] which has been shown to be equally as effective in estimating body fat in obese and non-obese patients, something the Body mass index fails to do.[6]

$$BSA = 0.007184 \times W^{0.425} \times H^{0.725}$$

A commonly used and simple one is the Mosteller formula:[7]

$$BSA = \sqrt{\frac{W \times H}{3600}} = 0.016667 \times W^{0.5} \times H^{0.5}$$ or even simpler : $BSA = \sqrt{W \times H}/60$ or if Ht is height in m : $BSA = \sqrt{W \times Ht}/6$

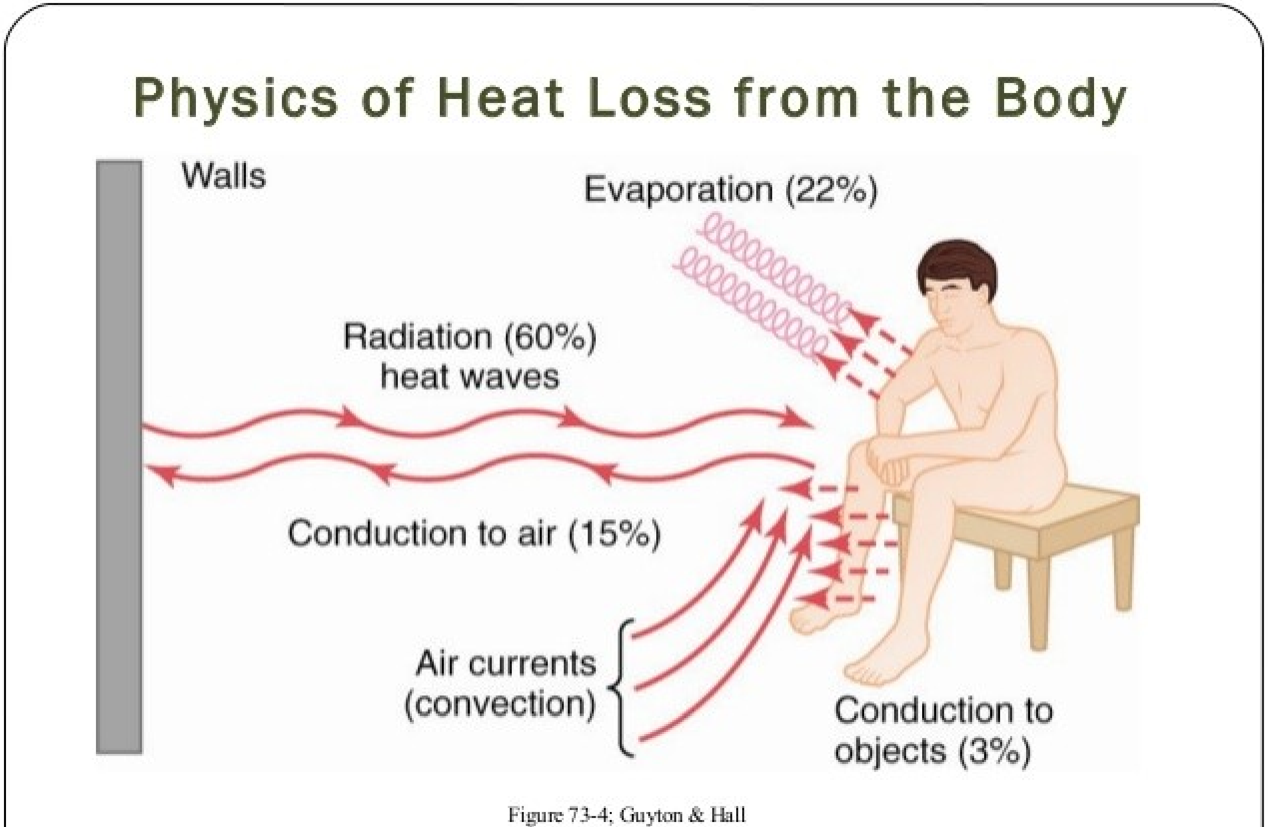
Other formulas for BSA in m^2 include:

Haycock[8]	$0.024265 \times W^{0.5378} \times H^{0.3964}$
Gehan and George[9]	$0.0235 \times W^{0.51456} \times H^{0.42246}$
Boyd [10][11]	$0.0003207 \times \text{weight(g)}^{(0.7285-0.0188 \log_{10} \text{weight(g)})} \times H^{0.3}$
or equivalently	$0.03330 \times W^{(0.6157-0.0188 \log_{10} W)} \times H^{0.3}$
Fujimoto[12]	$0.008883 \times W^{0.444} \times H^{0.663}$
Takahira[12]	$0.007241 \times W^{0.425} \times H^{0.725}$
Shuter and Aslani[13]	$0.00949 \times W^{0.441} \times H^{0.655}$
Schlich[14]	$0.000975482 \times W^{0.46} \times H^{1.08}$ (women)
	$0.000579479 \times W^{0.38} \times H^{1.24}$ (men)

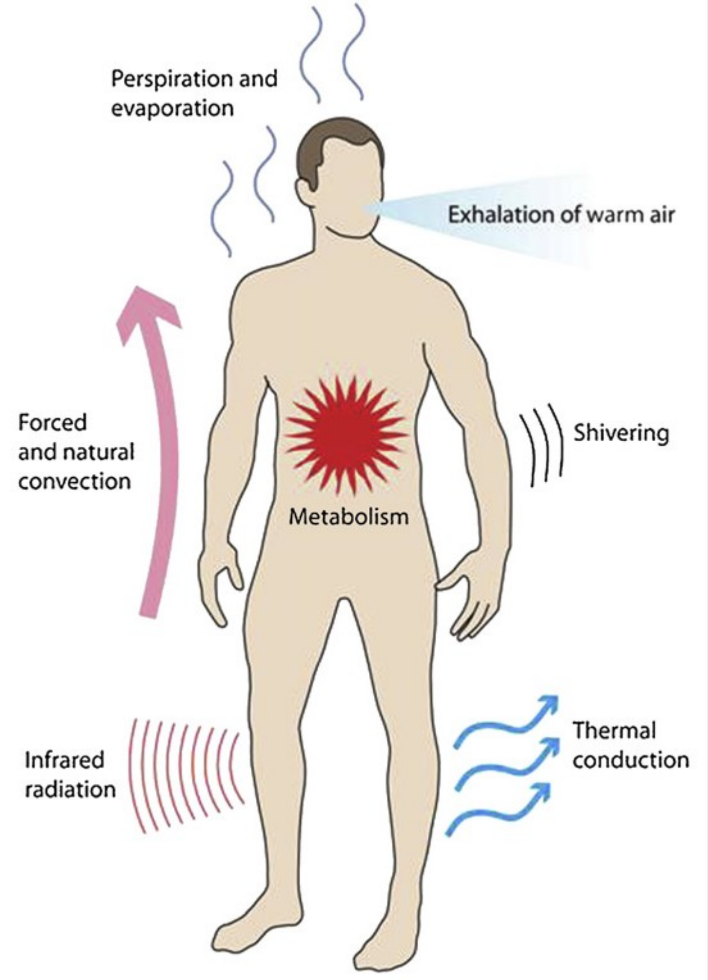
A weight-based formula was proposed by Costeff and recently validated for the pediatric age group that does not include a square root, making it easier to use. It is [4Wkg+7]/[90+Wkg].[15][16]

Average values [edit]

Thermal Balance



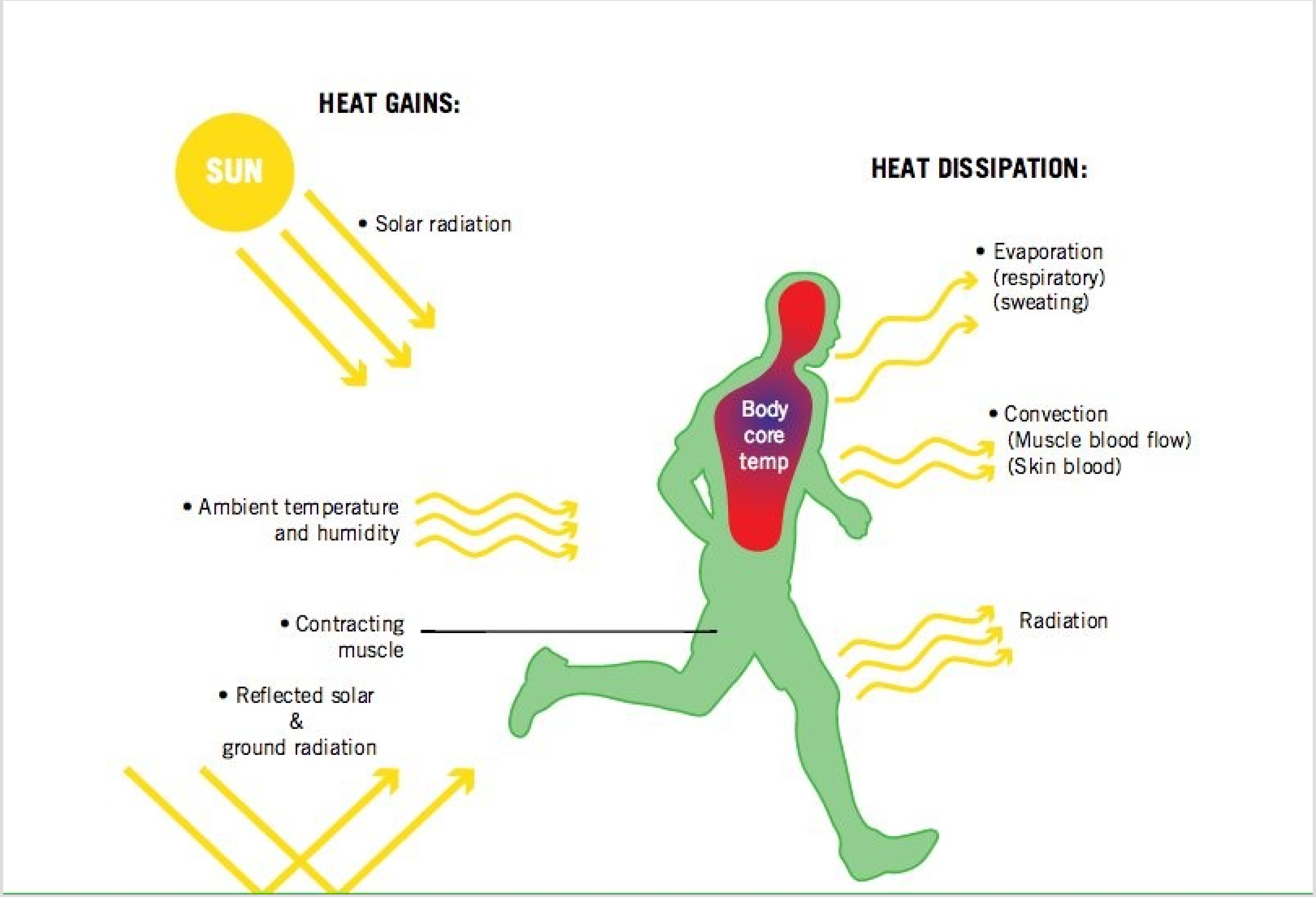
Mechanisms of heat loss from the body



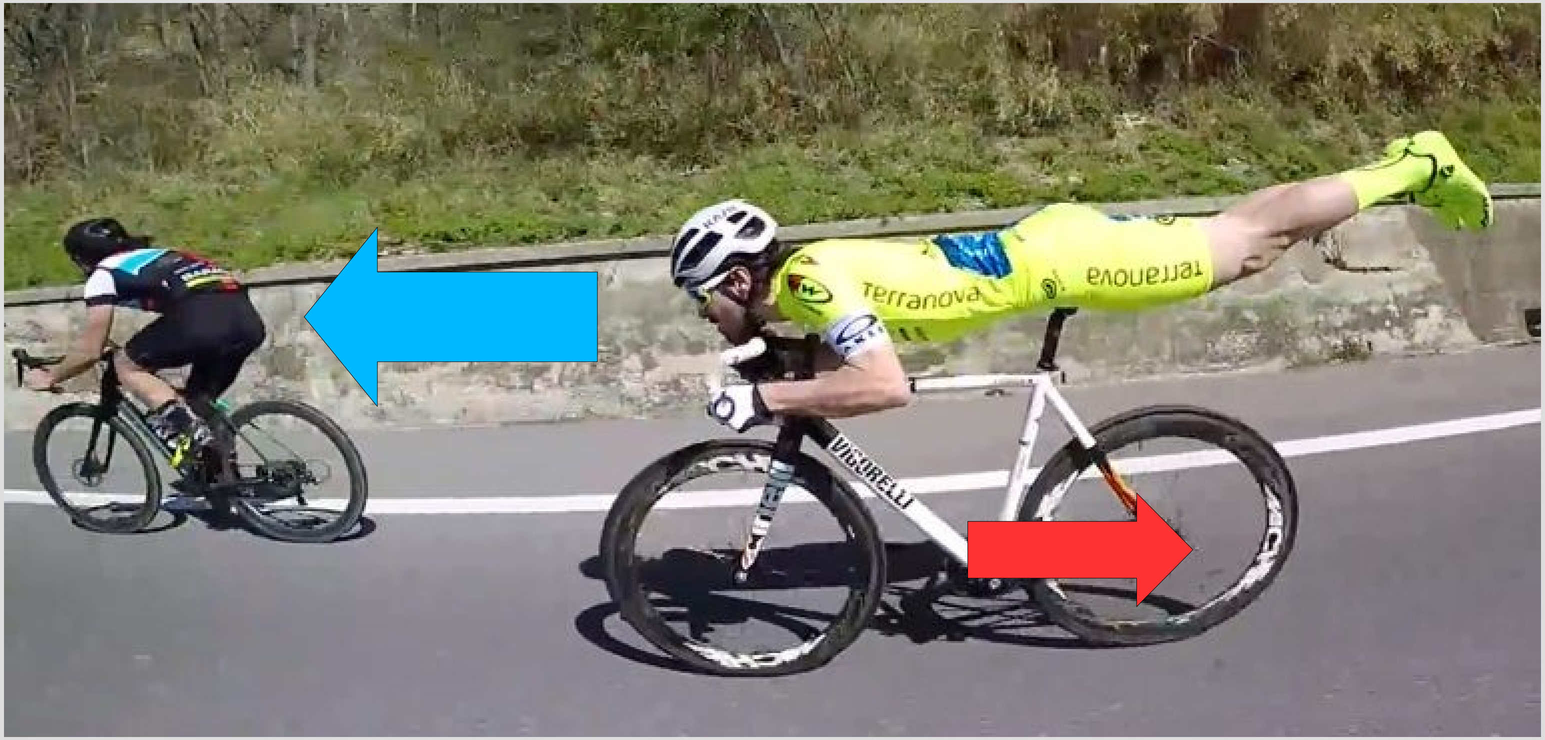
Climbing stairs

Sweating?

Body Balance



Biker



- Friction power?

Semi-trailer

- 36 tons, from 0 to 90 km/hr in 1 minute
- Power?

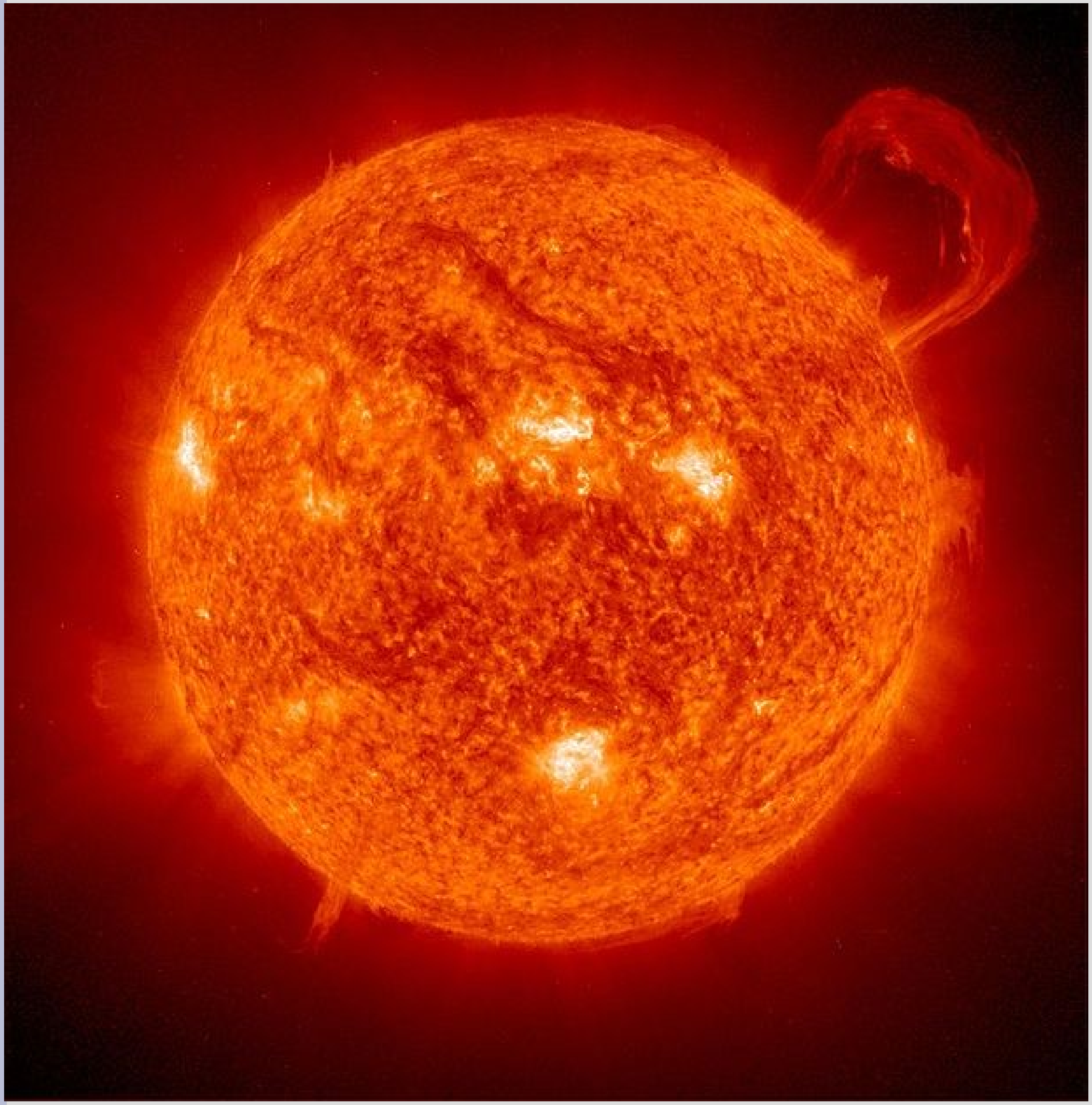
Wind Turbine

- Wind power going through the turbine?

3 Gorges Dam

- Typical power?

Sun

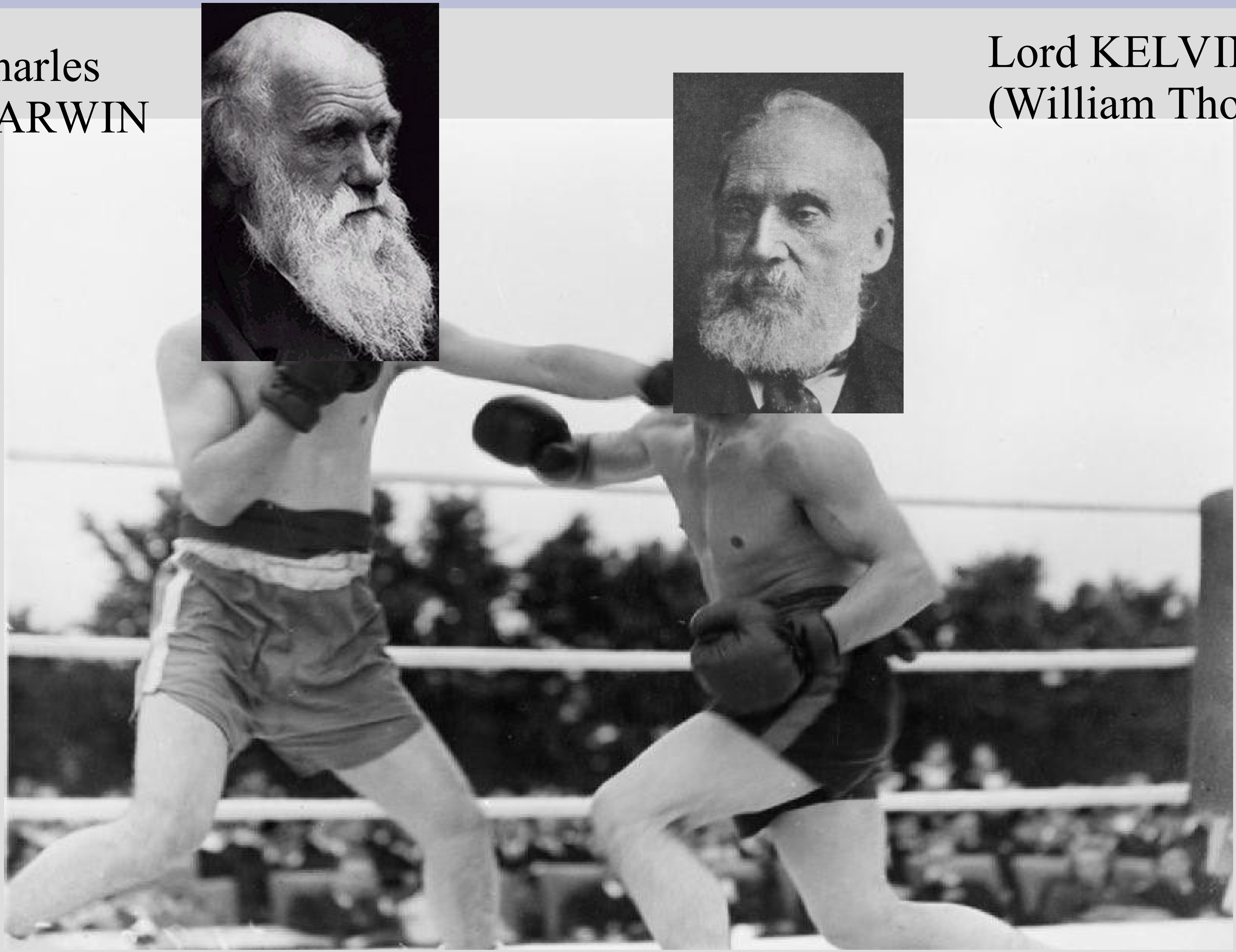


- 74% H, 24% He
- 4 10^6 tons converted every second
- temperature
  - centre: 15 10^6 K
  - surface: 5800 K
- density
  - centre: 150 g/cm^3
  - surface: ~10^{-2} g/cm^3

The debate on the age of the earth and sun

Charles
DARWIN

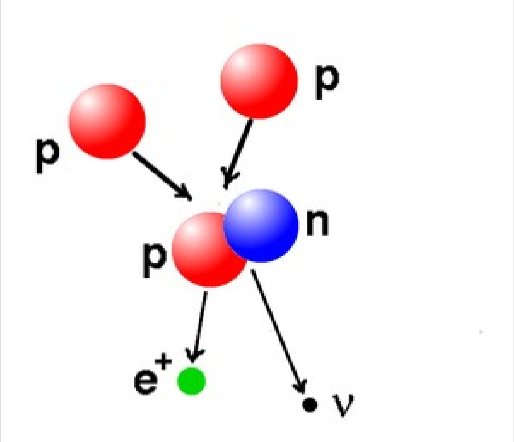
Lord KELVIN
(William Thomson)



Nuclear reactions in the sun

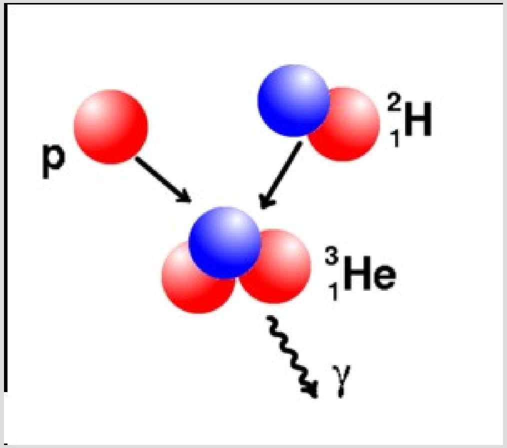
Proton-proton chain - Appraisal: $\mathbf{4p \rightarrow {}^4He + e^+ + \nu_e + 26MeV}$

1)



Deuterium Formation
(Slow Interaction, slow: 10^{10} year)
Releases 0.42 MeV (positron and neutrino)

2)

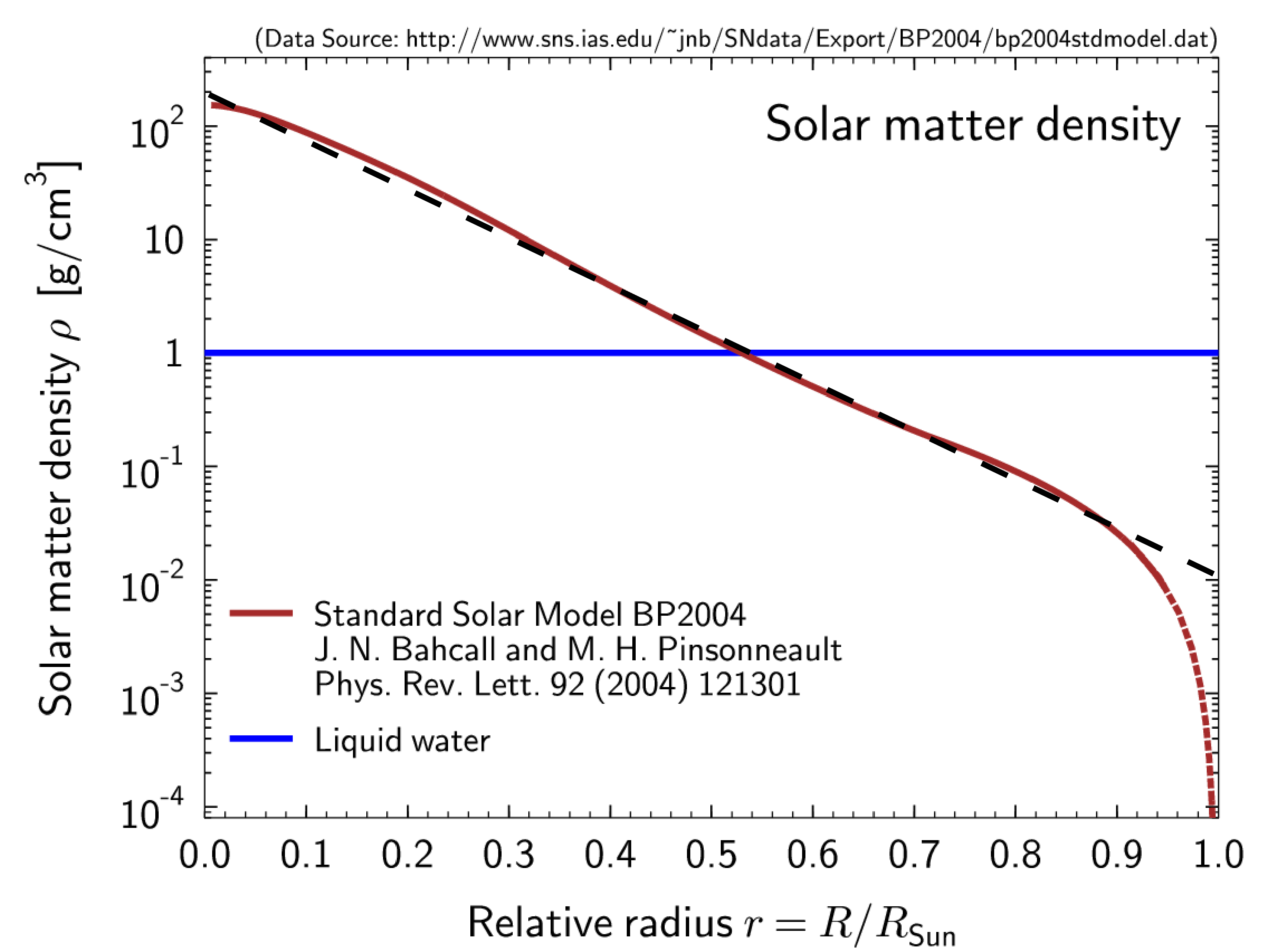


Deuterium-proton Fusion,
Releases 5,49 MeV (photon)

3) Fusion ^3He gives ^4He: reaction PP1/PP2/PP3
PP1: $^3He + ^3He \rightarrow ^4He + ^1H + ^1H + 12{,}86$ MeV

**CNO reactions sometimes require higher energies,
but contribute less than 1% of the radiated power of the sun.**

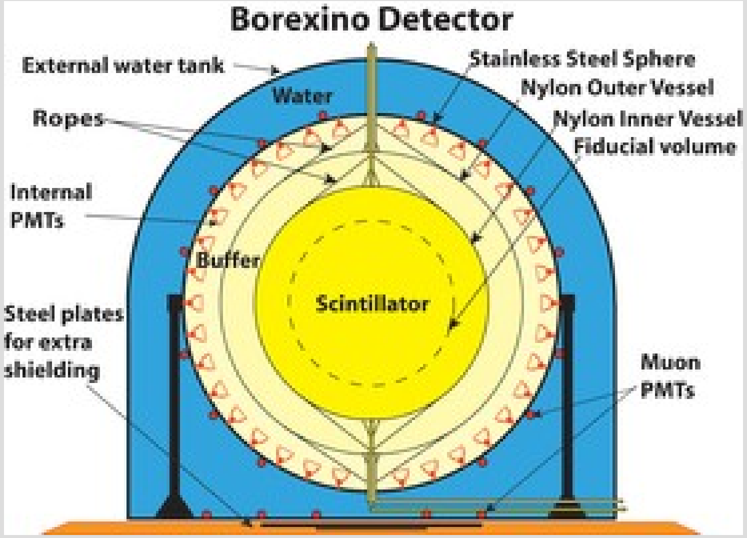
Sun density profile



Our current understanding

- The thermal power of the sun is produced by chains of fusion reactions. (1930)
- Created photons take millions of years to come out of the sun.
- The created neutrinos leave almost instantaneously.
- Neutrinos from the CNO cycle were first observed in 1970
- We just observed neutrinos from the pp cycle in 2014

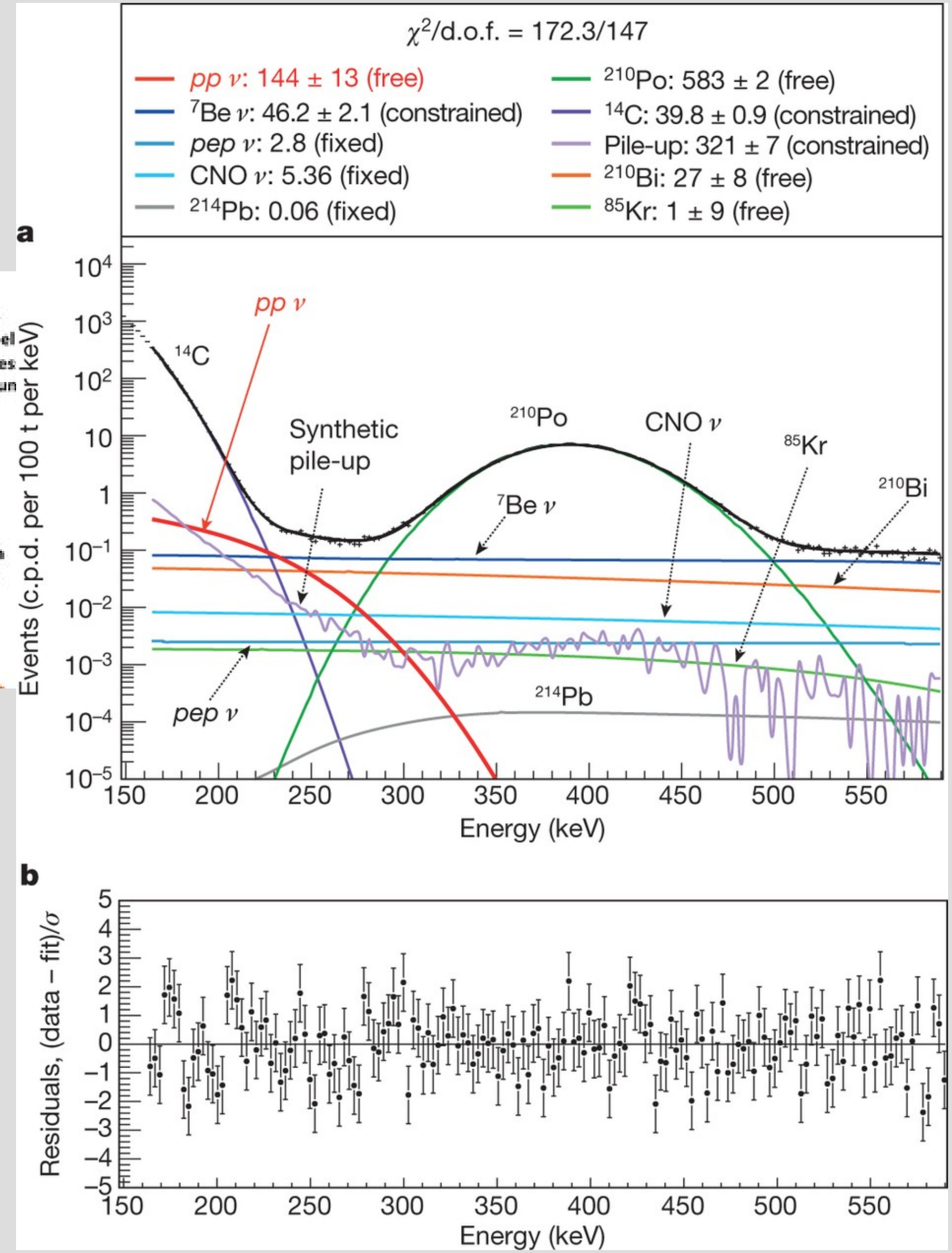
  Neutrinos from the primary proton–proton fusion process in the Sun
  Borexino CollaborationNature 512, 383–386 (28 August 2014)

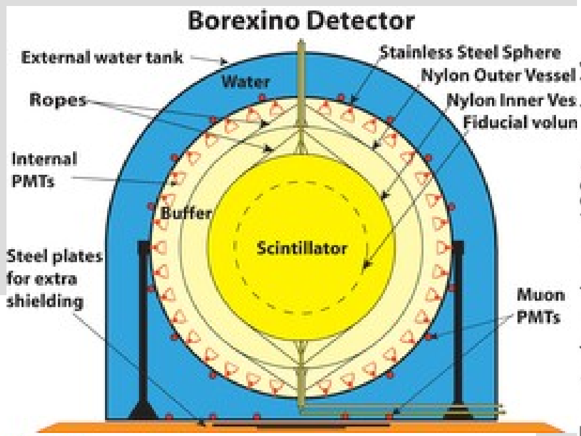


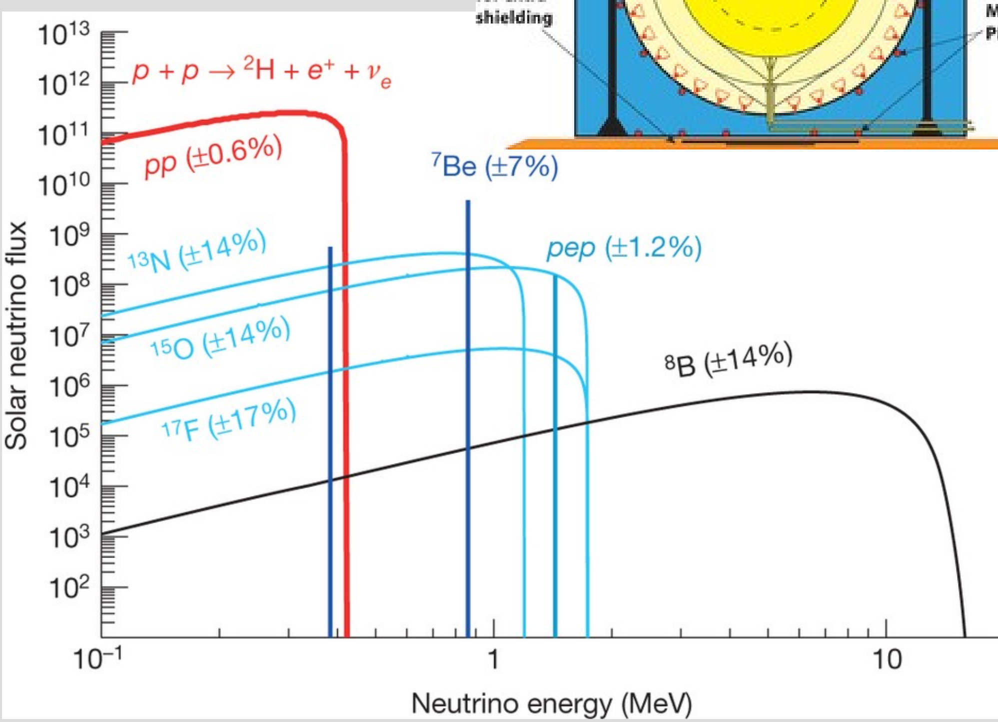
Neutrinos from the initial fusion reaction

BOREXINO collaboration observed neutrinos from the initial reaction

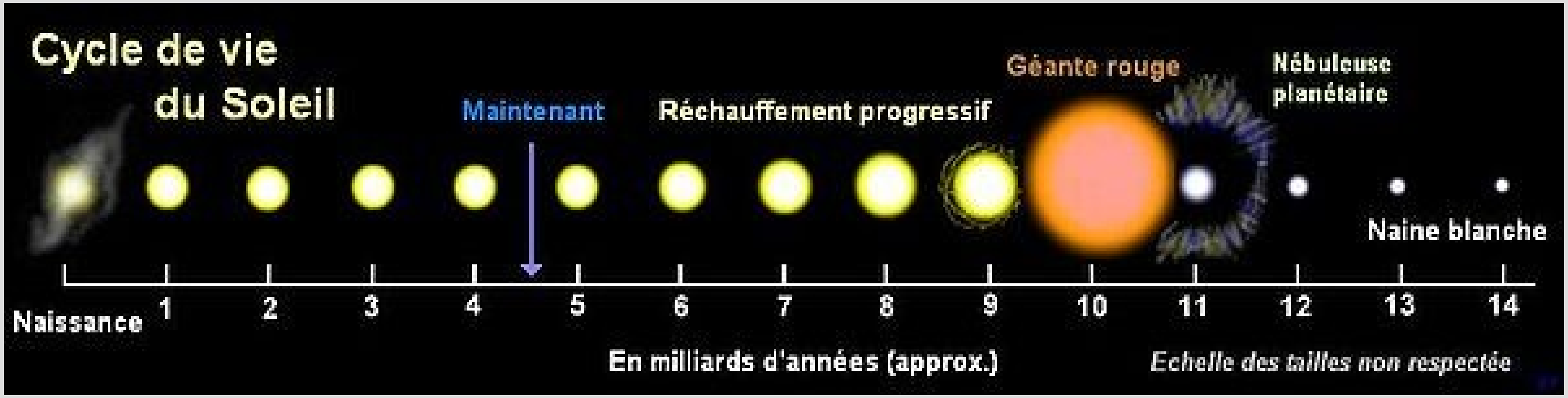
$$\mathbf{p+p \rightarrow D^{+} + e^{+} + \nu_{e} + 0.42MeV}$$







Evolution of the sun



- Current Age: 4.7 Gyr
- During 7.6 Gyr: gradual increase in the fusion rate (7% / Gyr)
- Then contraction of the heart, increased heart temperature and expansion of the envelope (Red Giant).
- Fusion of helium (10^8 K) into Carbon and Oxygen, 200 Myr
- Collapse of the heart (white dwarf) and expulsion of the outer layers

Photosynthesis - Quantum Yield

- Quantum Yield: number of O_2 produced for one absorbed photon
- ~ 10%

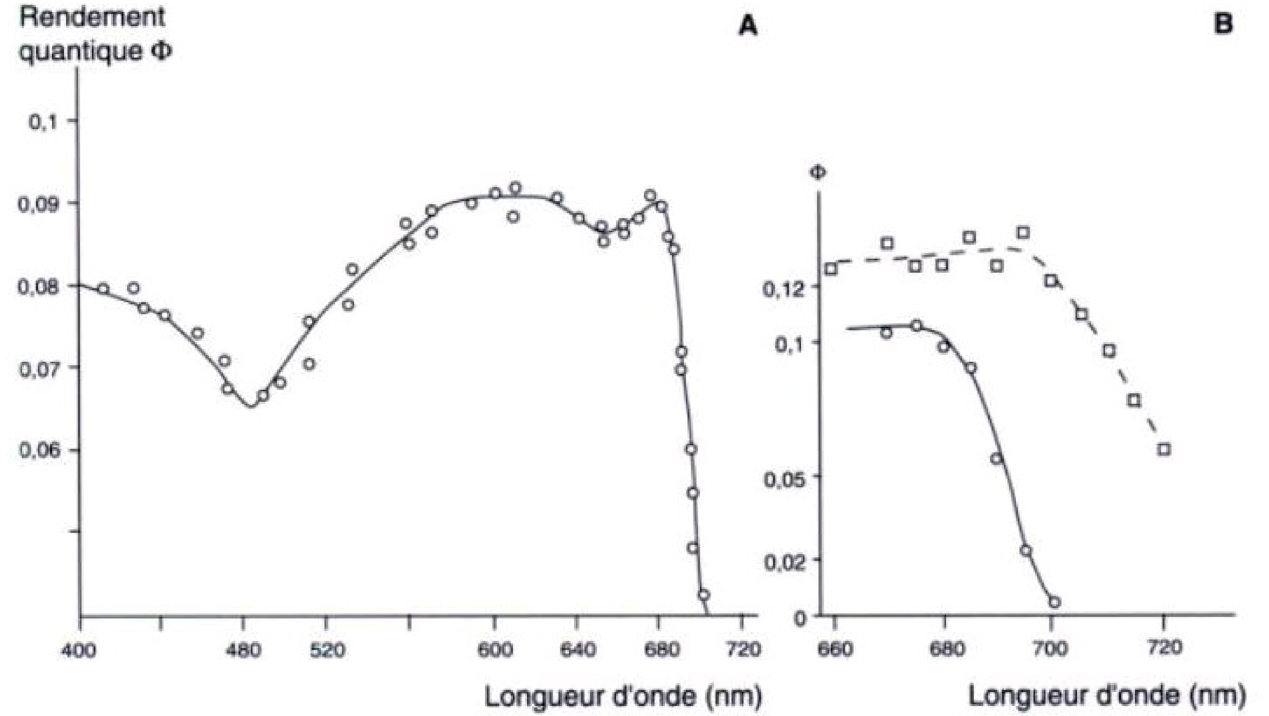
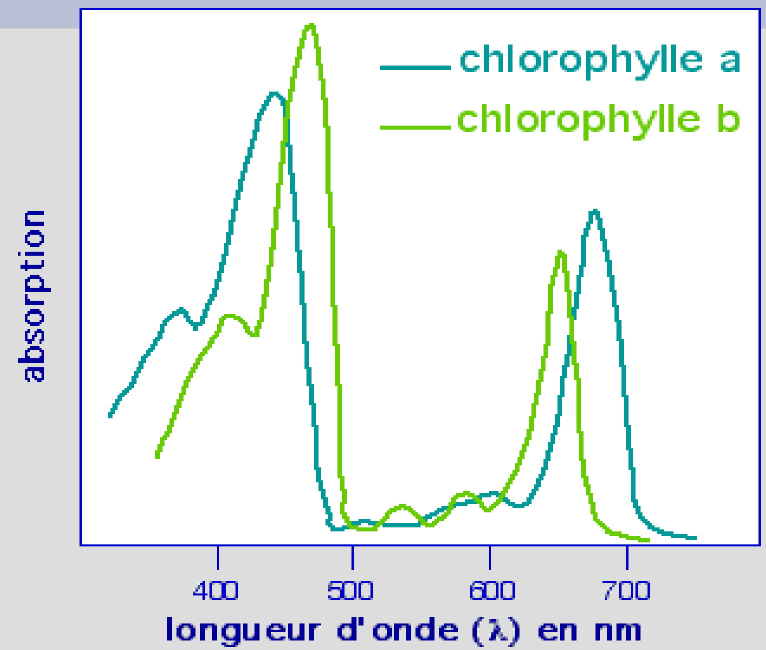


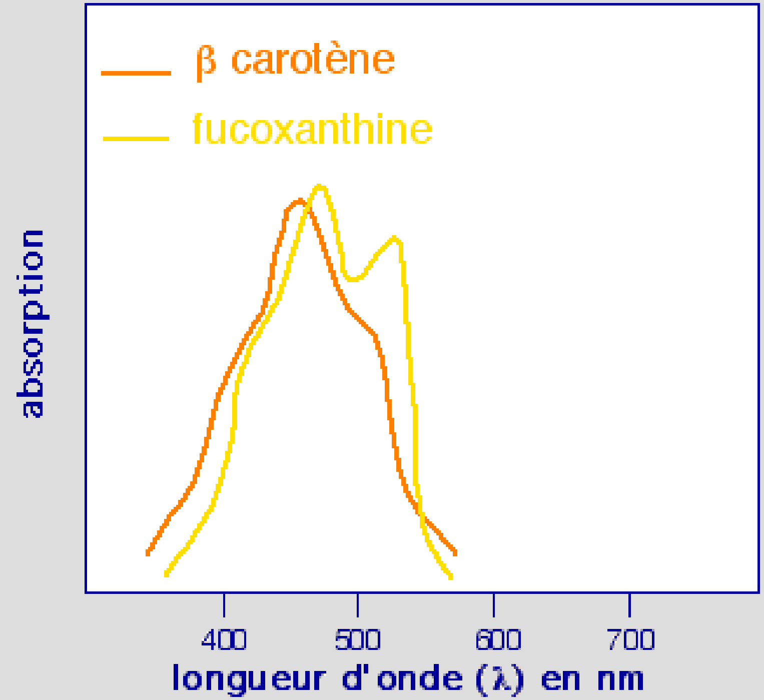
Figure 9.3. Variation du rendement quantique pour l'émission d'oxygène en fonction de la longueur d'onde de la lumière incidente chez *Chlorella*, d'après les expériences classiques d'Emerson *et al.* (1943 et 1957). **A.** L'illumination est réalisée avec différentes lumières monochromatiques de faible intensité conduisant à une faible activité photosynthétique, à flux lumineux isoquantiques. L'activité photosynthétique se situe en dessous du point de compensation ; aussi, la vitesse d'émission d'oxygène est déterminée en tenant compte de la vitesse de consommation d'oxygène due à l'*activité respiratoire*, mesurée dans les périodes d'obscurité alternant avec les illuminations. **B.** Expérience identique réalisée dans la région des radiations rouges du spectre en lumière monochromatique (——) puis en lumière bichromatique (- - - -) : addition aux différentes lumières monochromatiques d'une lumière de faible intensité de 644 nm.

Absorption spectra

- Absorption spectrum of chlorophyll:
  - maximum in the red and blue, the leaves are green!



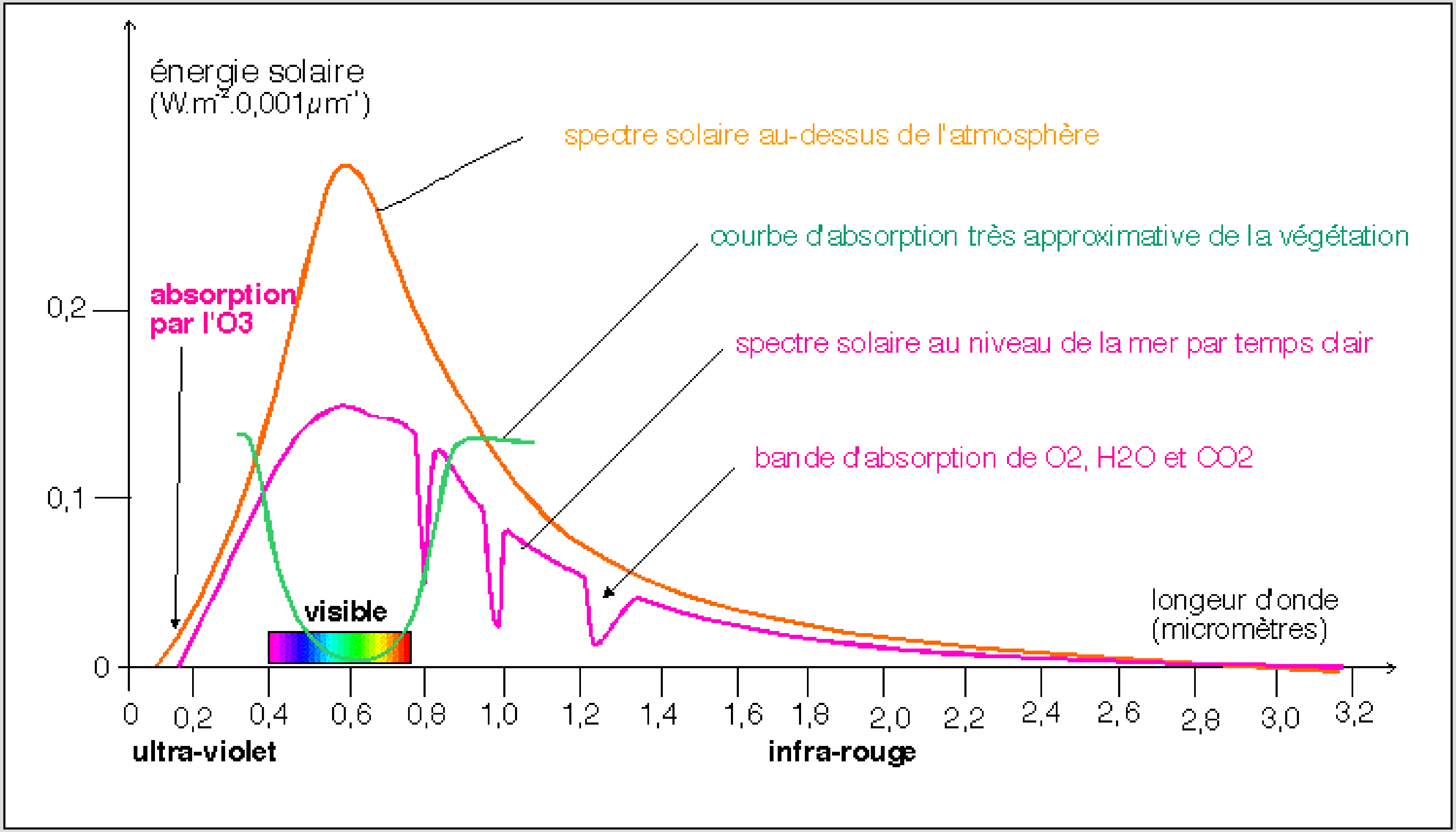
- Carotene absorbs in the blue and some in the green.



Photosynthesis - Absorption

- Absorption spectrum of plants

→ Loss of a factor ~ 3



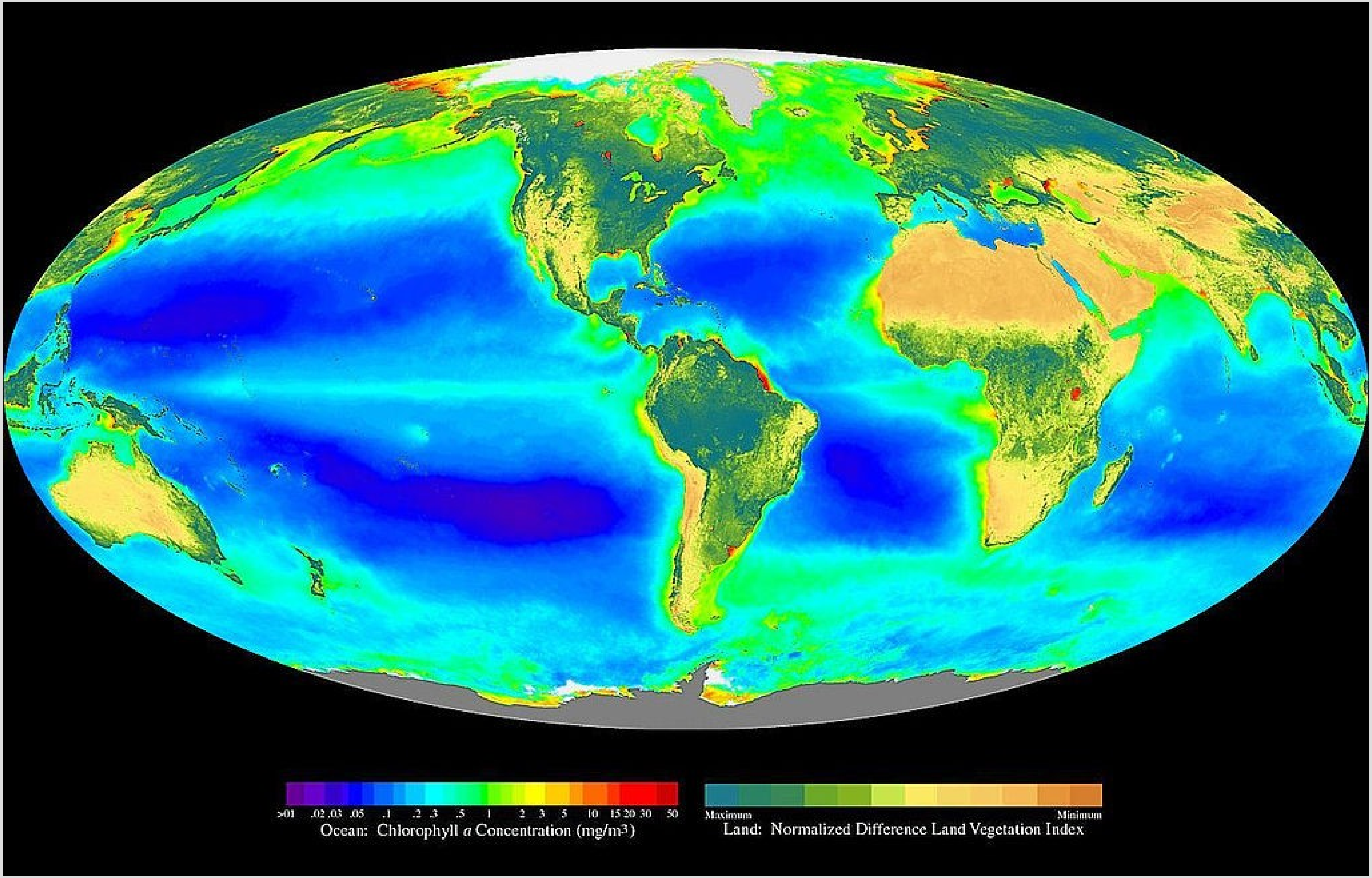
Photosynthesis - Net Yield

- Quantum yield ~ 10%
- Absorption spectrum ~ 30%
- Plant respiration, various losses ~ 50%
- Seasonality of plant growth

↓

- Final Yield : ~1%
- 346 W/m^2 at the top of the atmosphere,
  < 200 W/m^2 on the ground
- Net production: ~2 W/m^2
- How many Toe per hectare per year?

Photo-synthetic activity



Current biomass Productions

- Co-products (current estimates)
  - Harvestable straws (20%) 5.2 Mt dm
  - Sons 1.2 Mt dm
  - Beet pulp 1.4 Mt dm

competition with livestock

- Energy crops
  - Sorghum biomass, triticale 10 à 15 t dm/ha.year
  - Miscanthus, switchgrass 15 à 25 t dm/ha.year
  - Short Rotation Coppice 10 à 12 t dm/ha.year

Competition with the area

- Forest Production
  - Wood: current organic growth : 10^3 Mm^3/year
  - Annual harvest 59 Mm^3/year of which 21 Mm^3/year timber

(dm = dry matter)