IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Faire avancer la sûreté nucléaire

Rayonnement Cosmique et Radioprotection dans l'aviation civile et les activités spatiales

04/07/2023
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Découverte du Rayonnement cosmique

↗ Viktor Hess en 1911 et 1912

- Le physicien autrichien V. Hess a effectué une série d'ascensions à bord d'un ballon à hydrogène afin de mesurer le rayonnement dans l'atmosphère. Il cherchait la source des rayonnements ionisants qui s'enregistraient sur un électroscope - la théorie dominante était que les rayonnements provenaient des roches de la Terre. Le rayonnement cosmique provient de l'espace et du soleil.

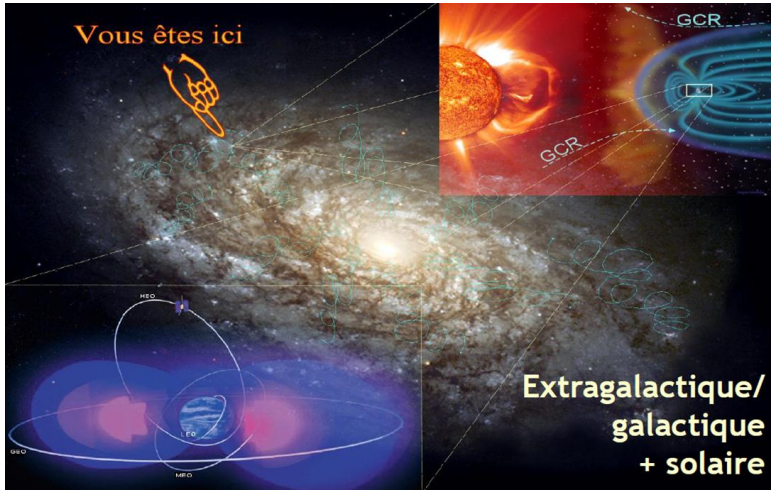
- Prix Nobel en 1936

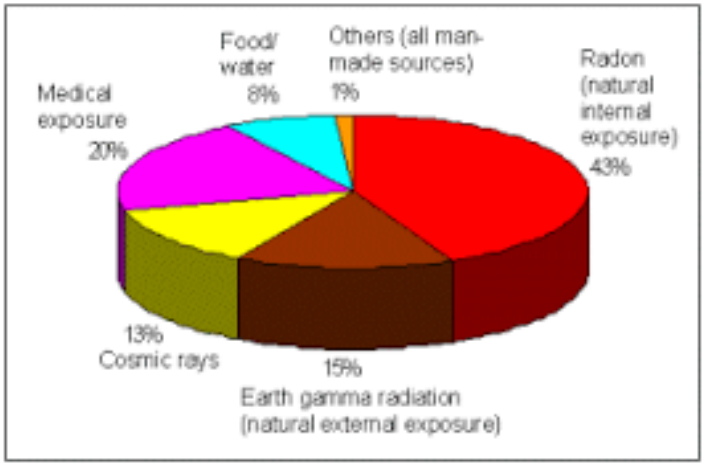
L'espace est radioactif!

Introduction

↗ Qu'est ce le rayonnement cosmique?

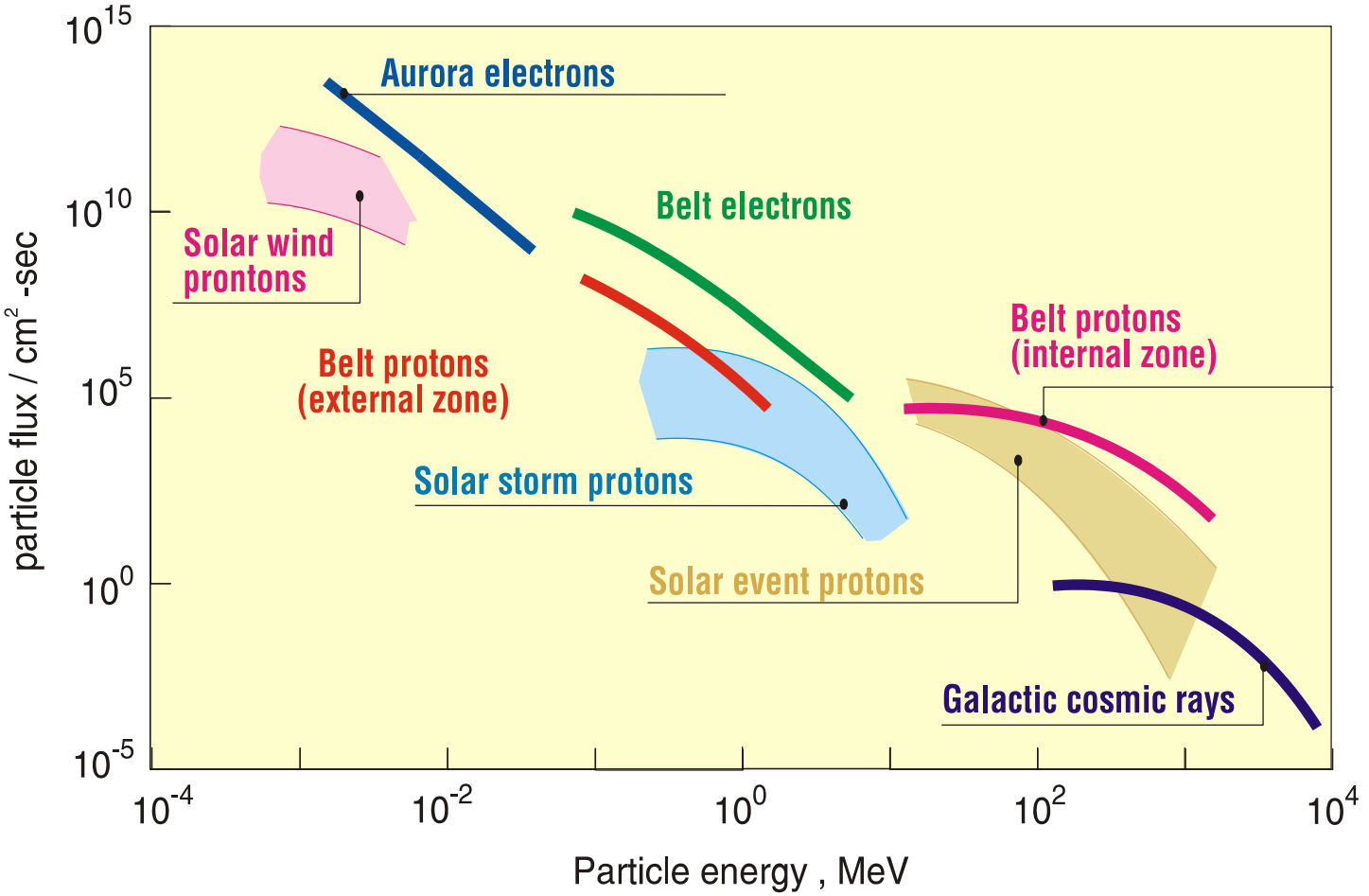
- Origine Galactique et extra Galactique et Solaire
- Nous sommes tous exposés au RC!
- RC représente 1/7 de notre exposition au rayonnement naturelle





Crédit: OMS

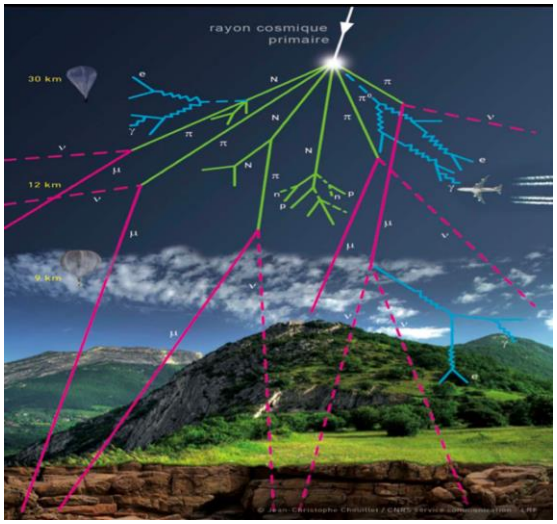
Energie du RC

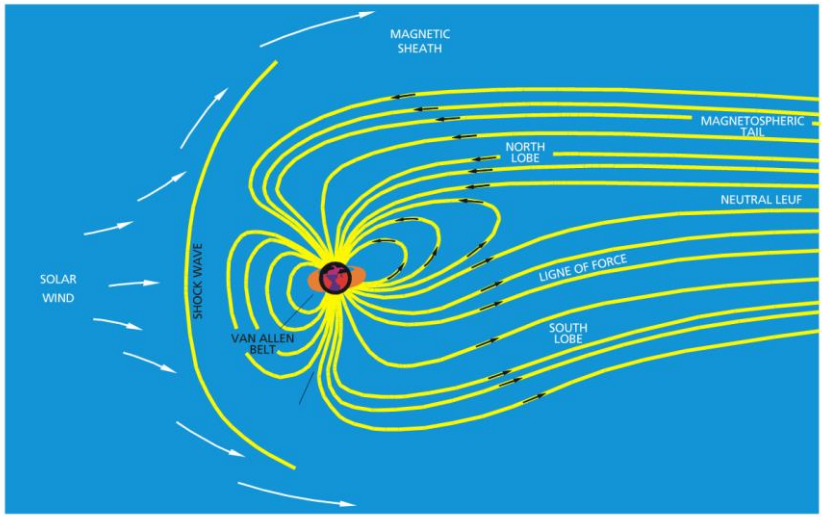


Protection contre le CR

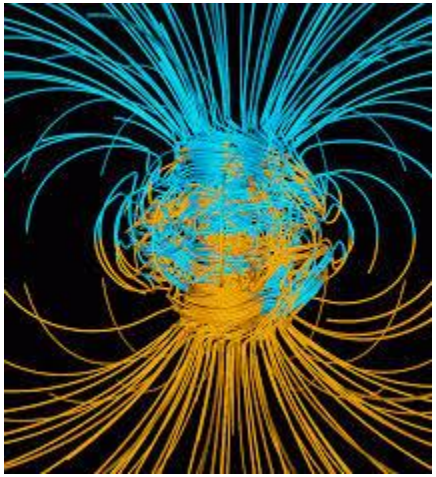
↗ 3 barrières de protection

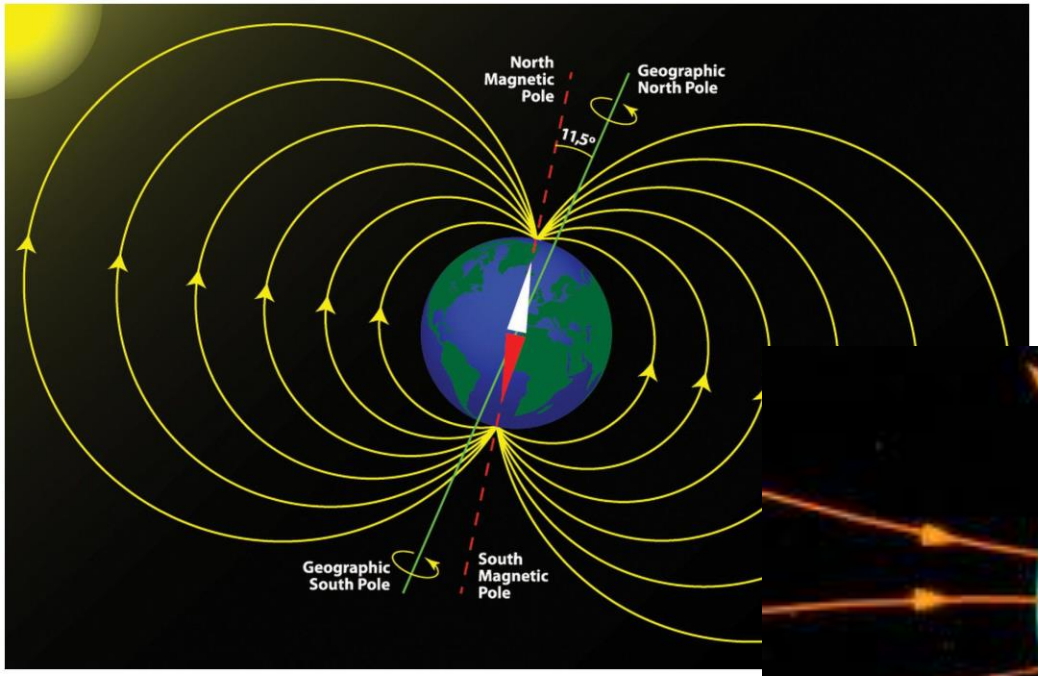
- Champ magnétique interplanétaire
- Magnétosphère terrestre
- Atmosphère

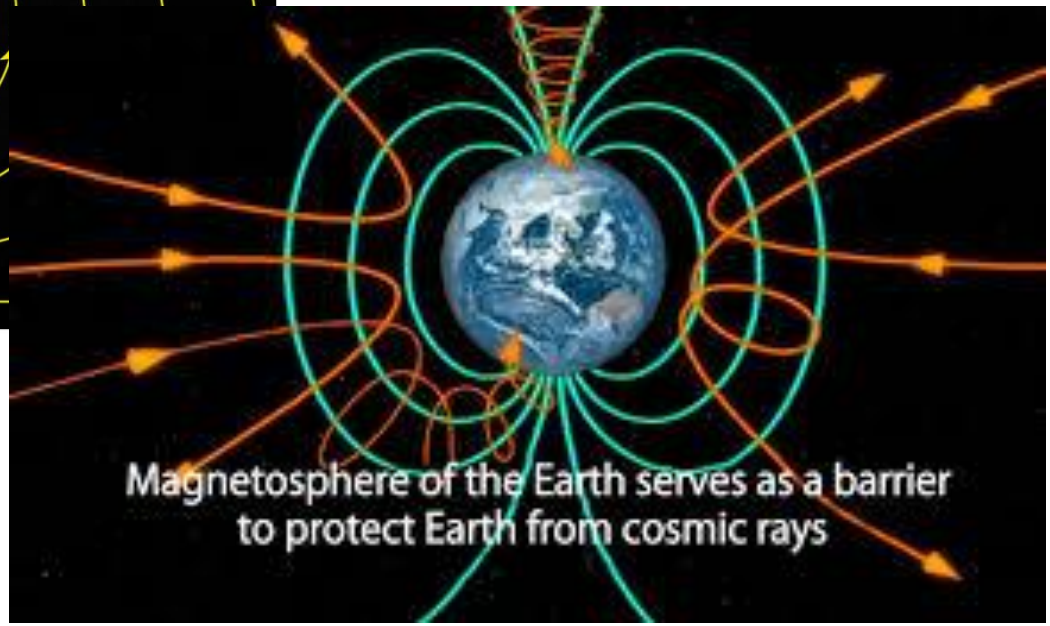




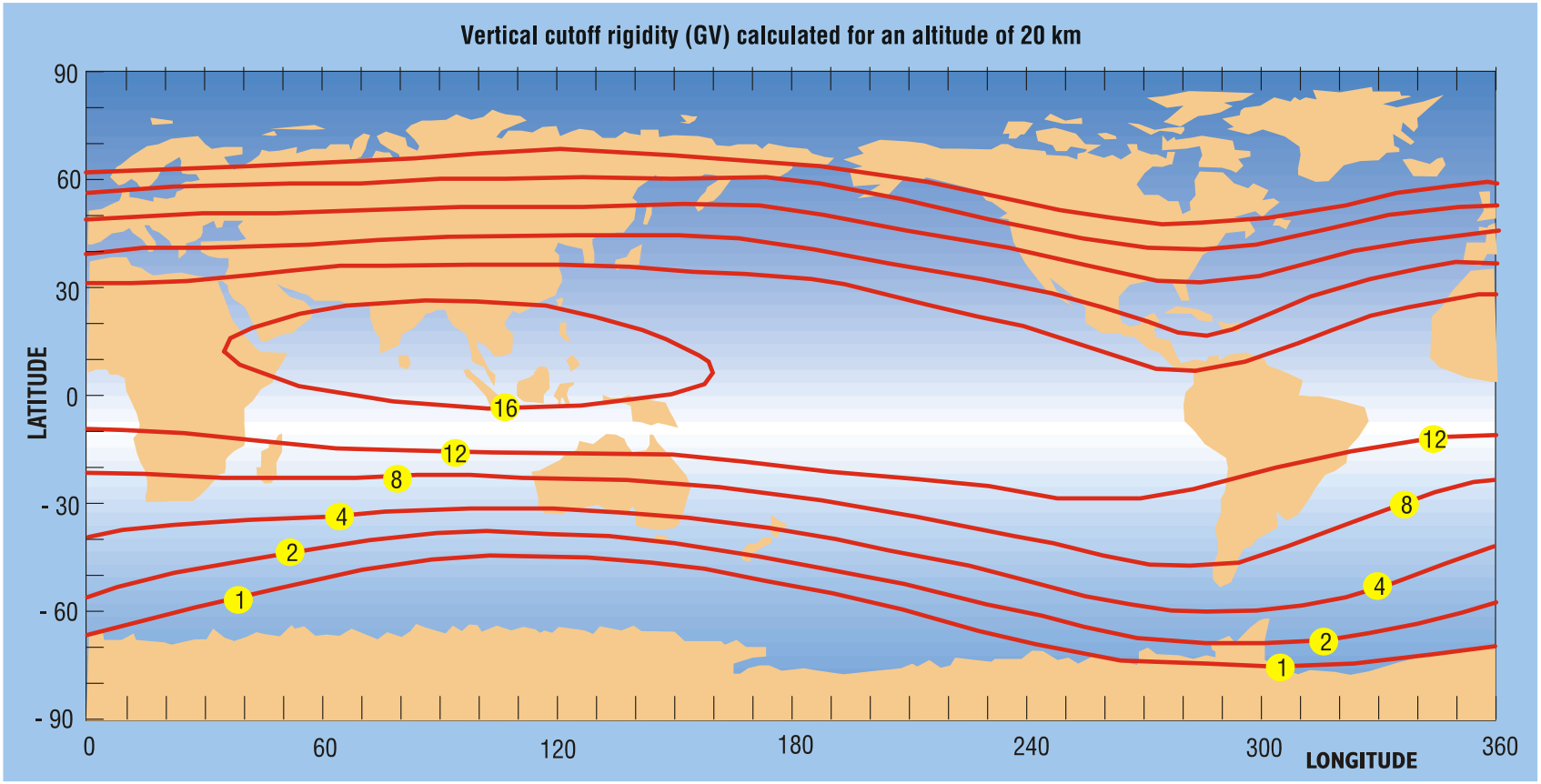
La magnétosphère



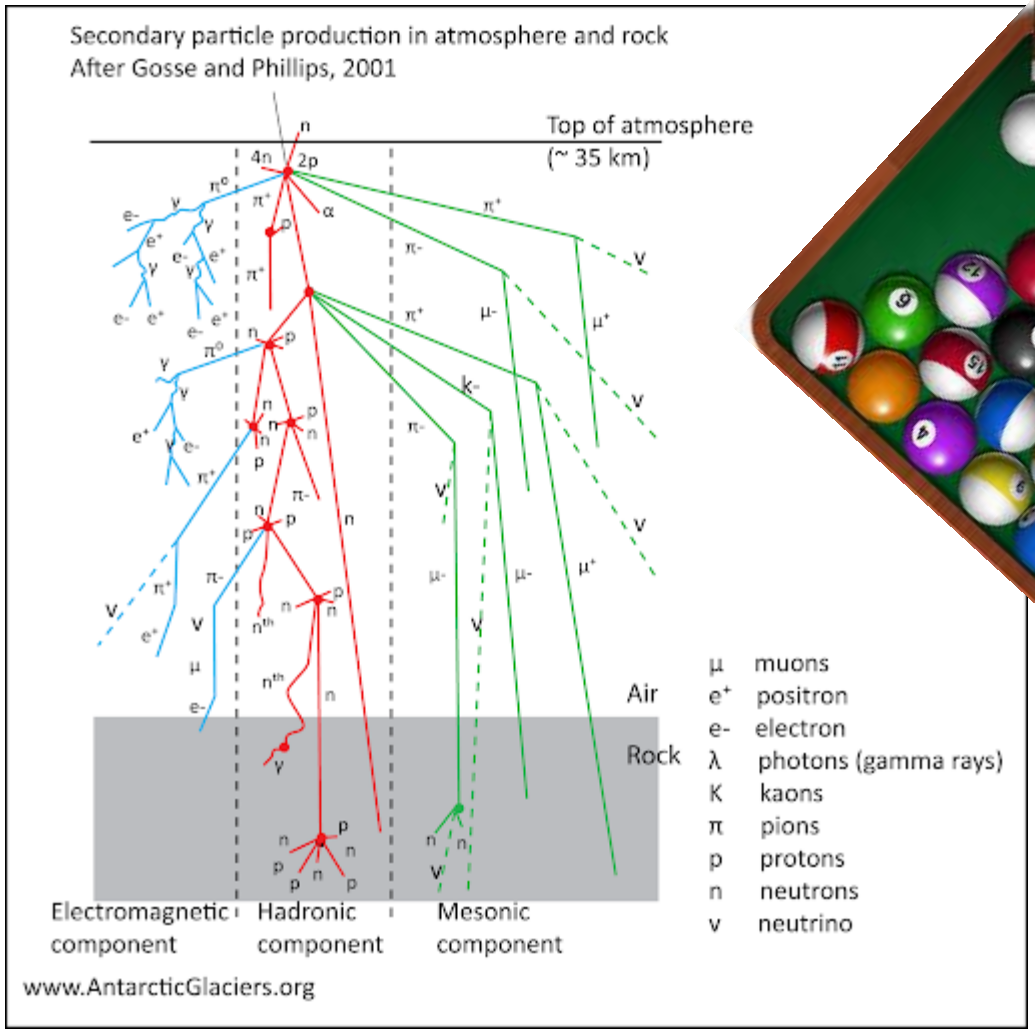


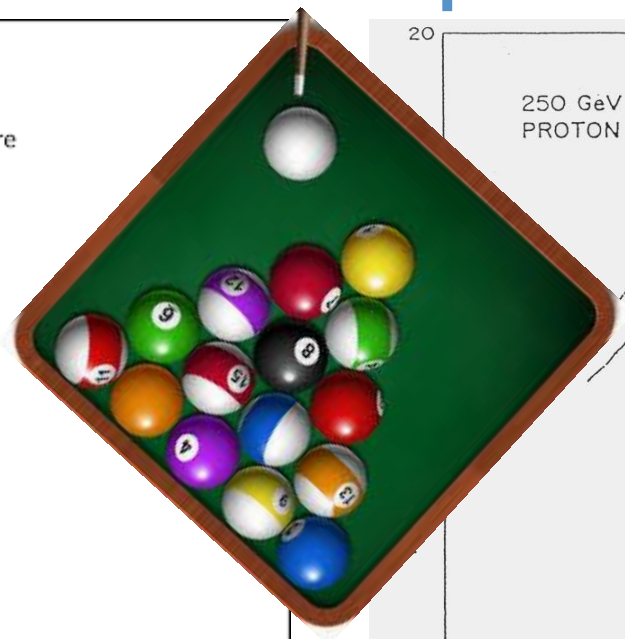


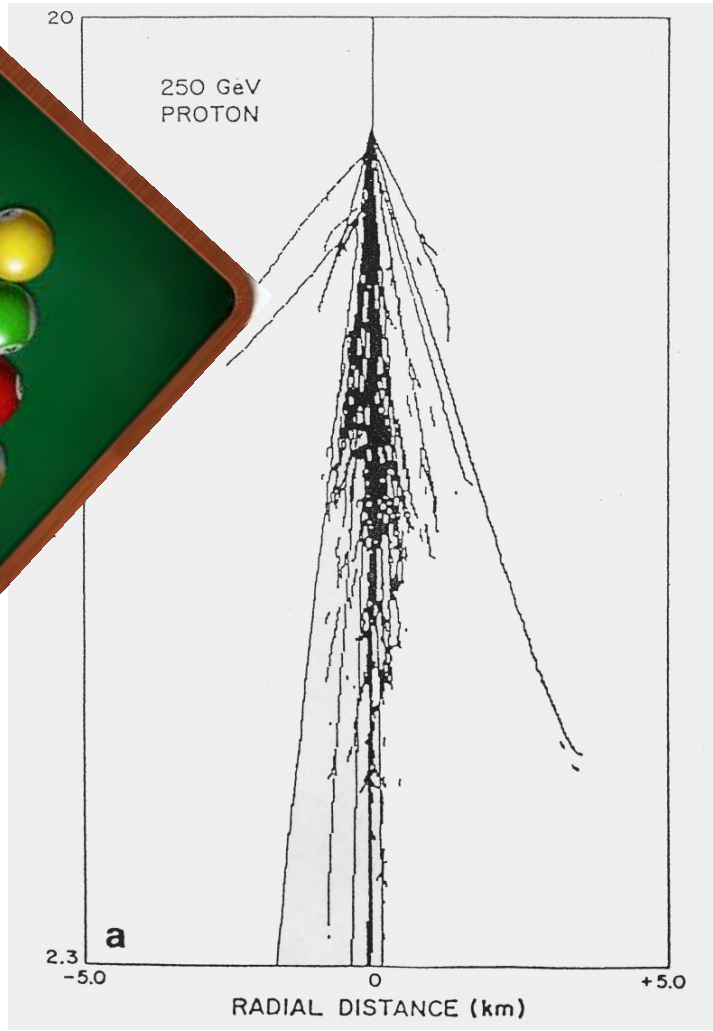
Rigidité magnétique



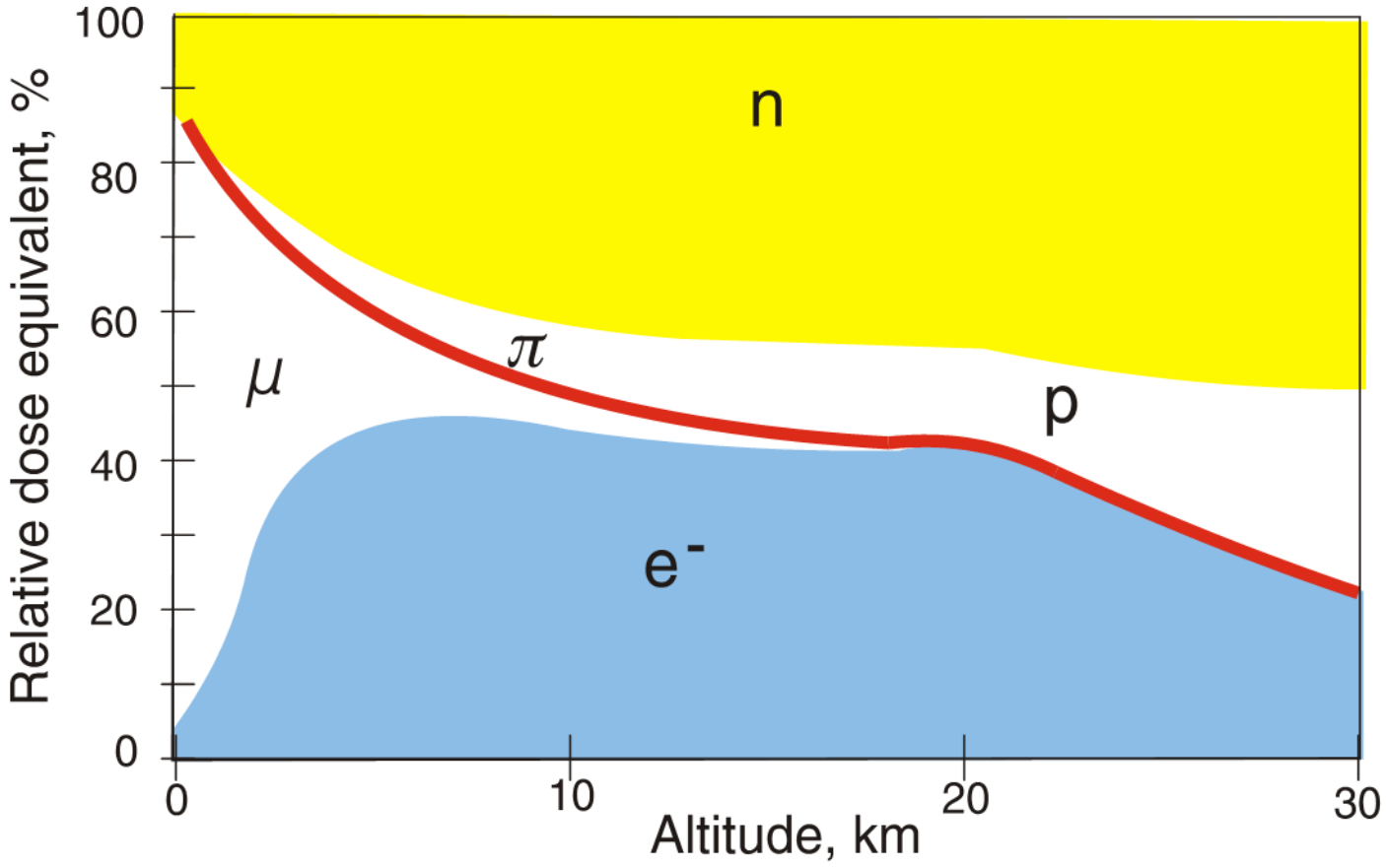
Interaction dans l'atmosphère



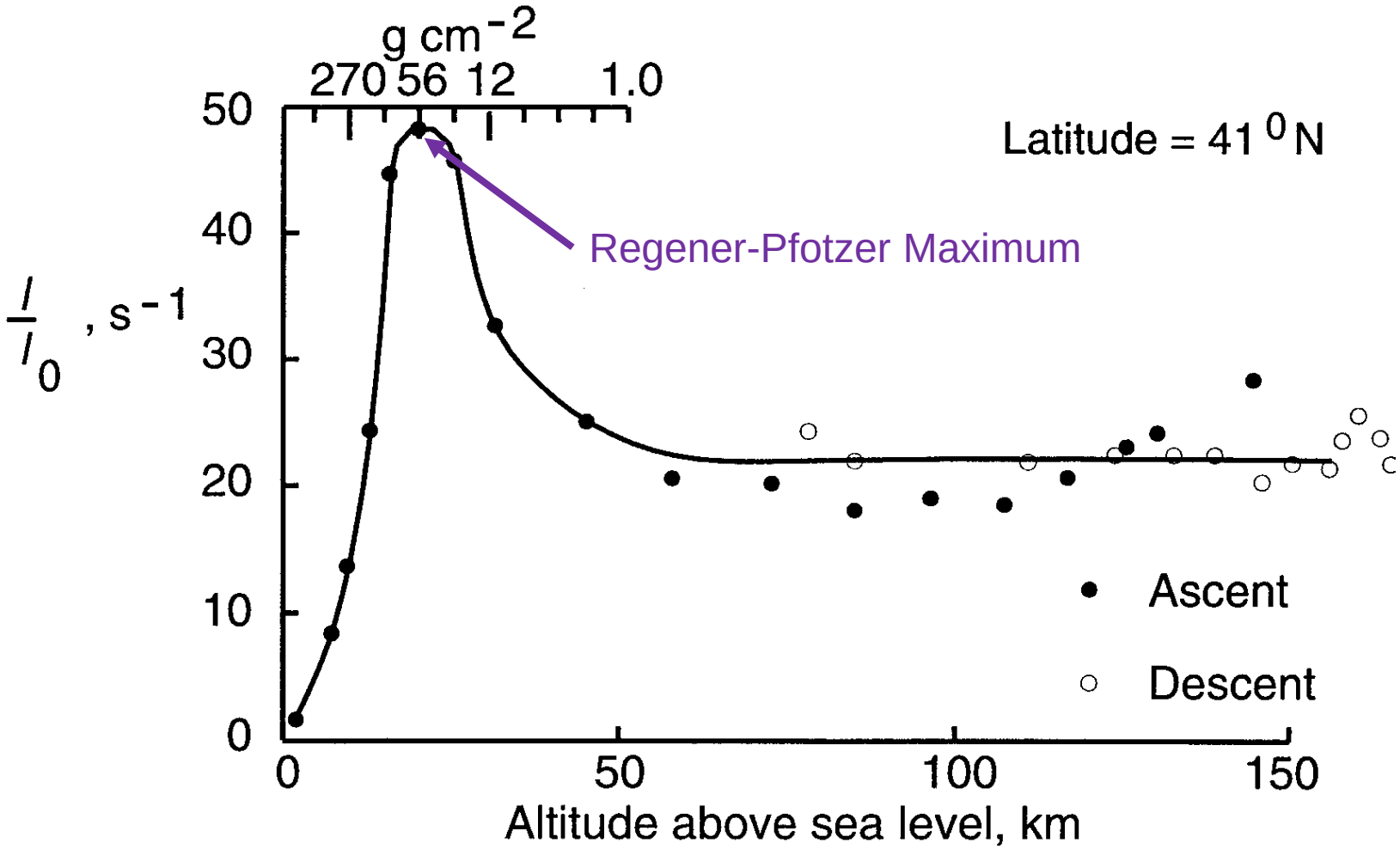




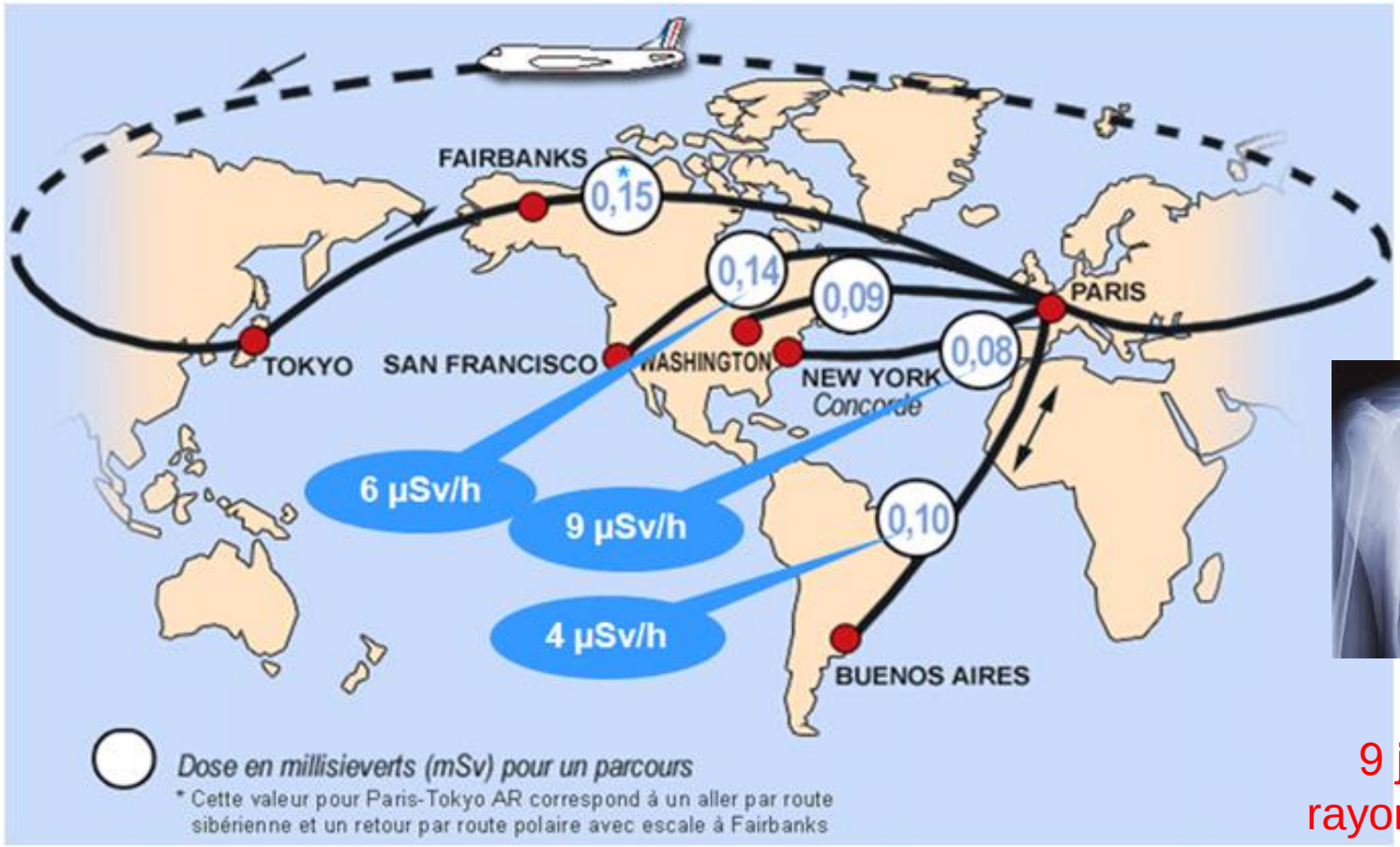
Interaction dans l'atmosphère



Interaction dans l'atmosphère

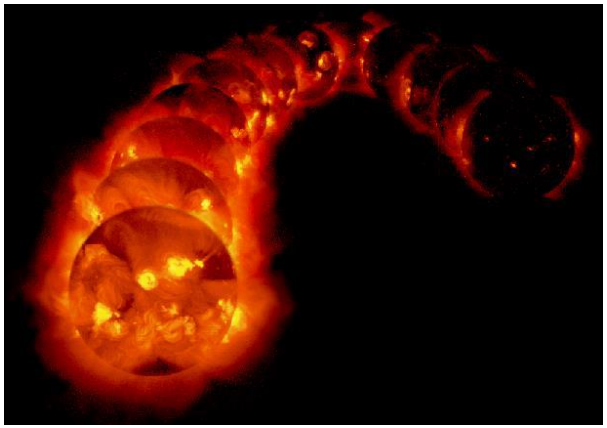


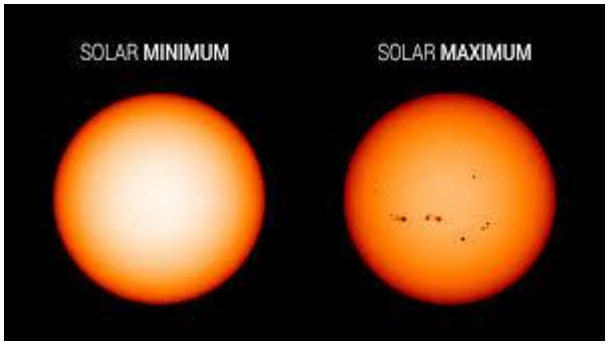
Exposition au RC en vol

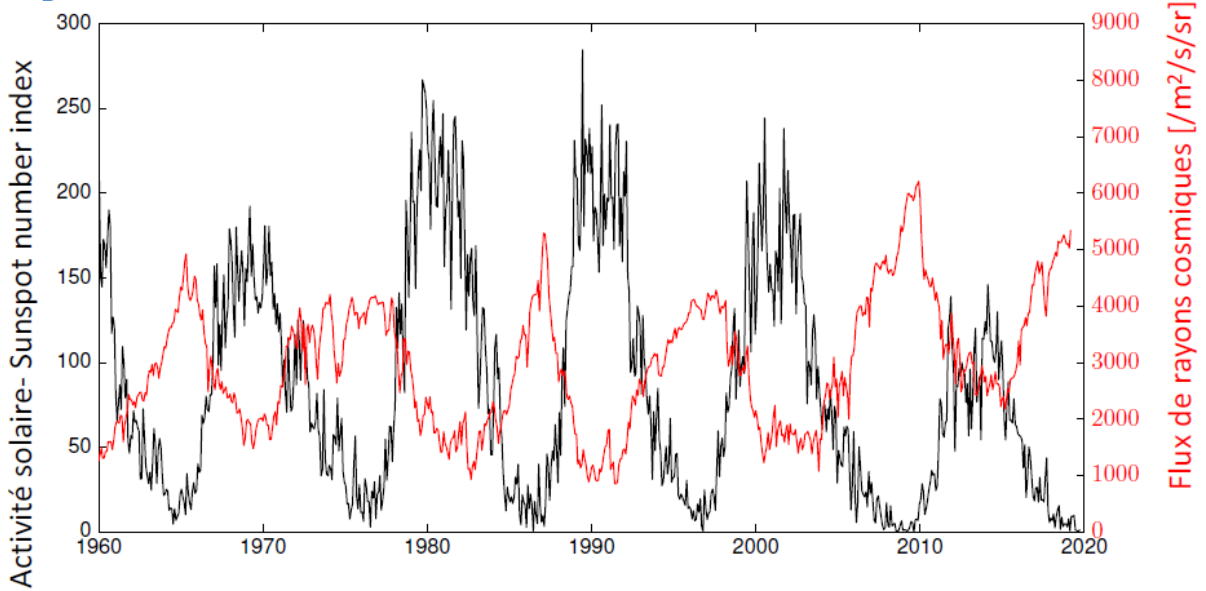


0,06 mSv
9 jours d'expo au rayonnement naturelle

Modulation du RC galactique avec e cycle solaire

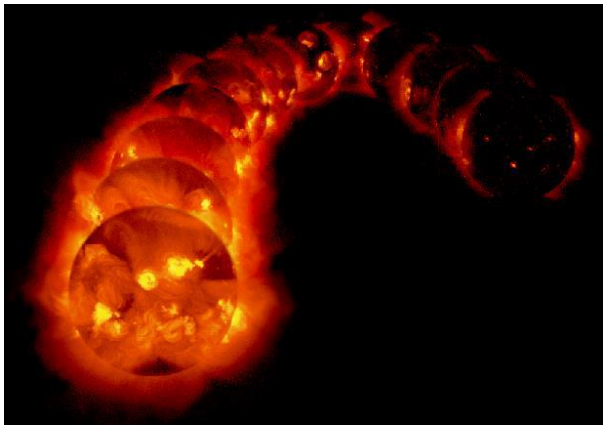


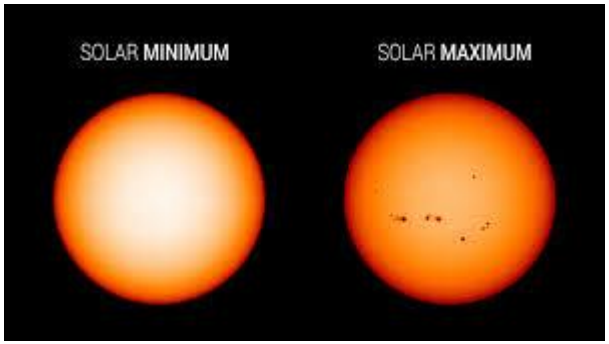


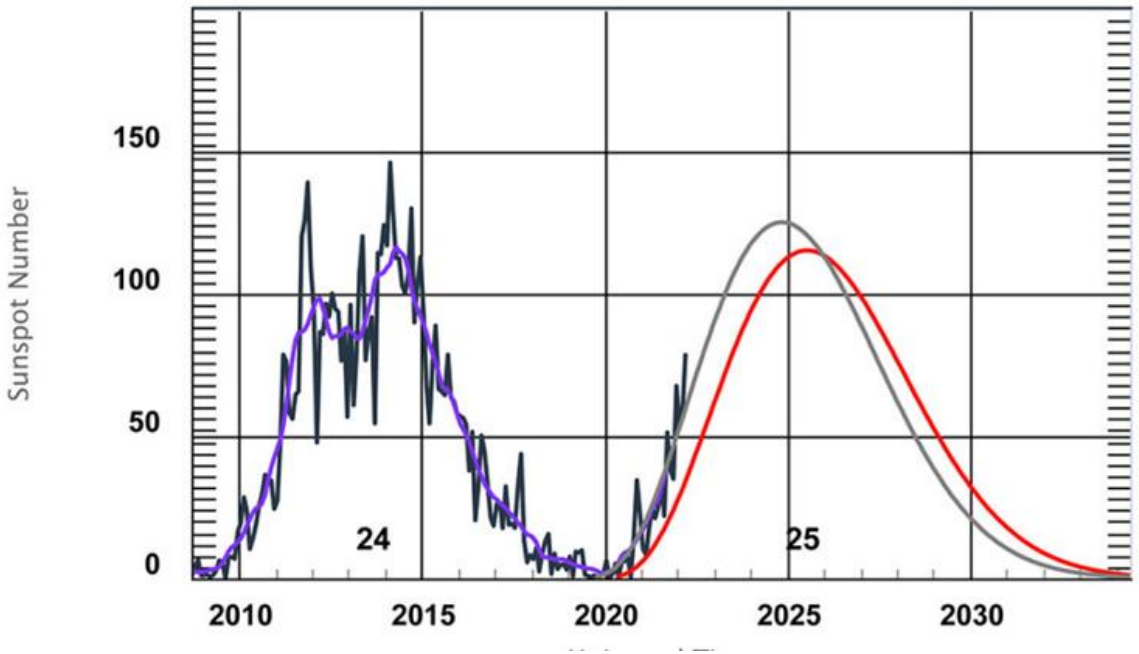


Modulation du flux de rayon cosmique dans l'espace proche de la terre calculé à partir de mesure de
moniteur de neutron sur terre et des données satellite.

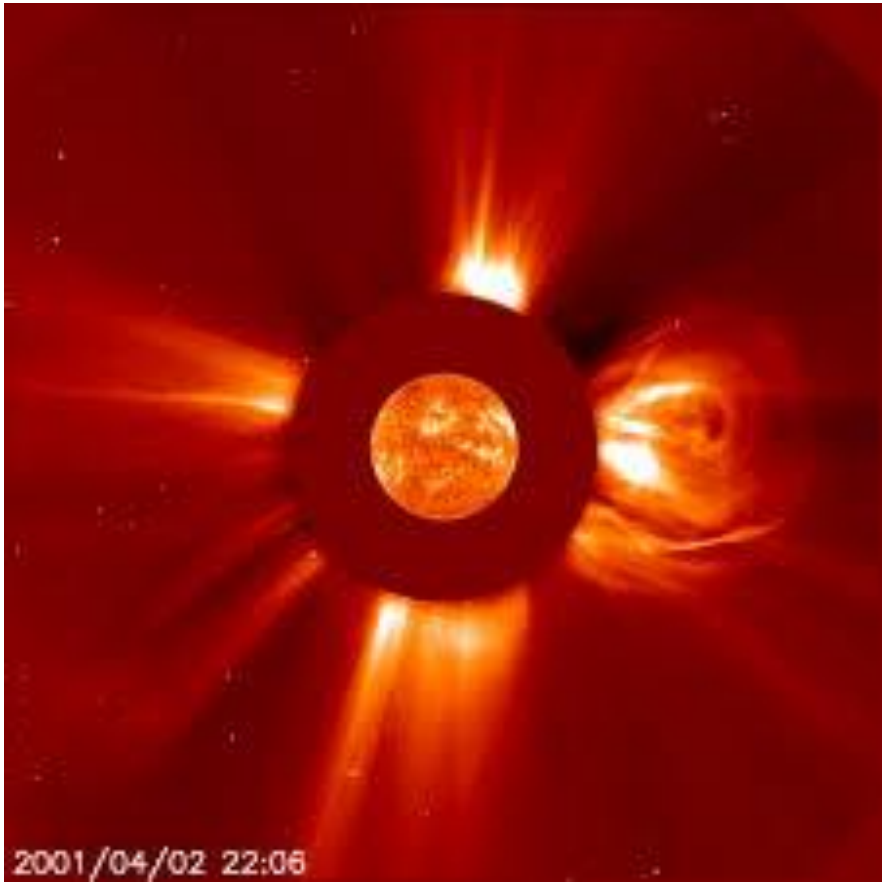
Modulation du RC galactique avec e cycle solaire





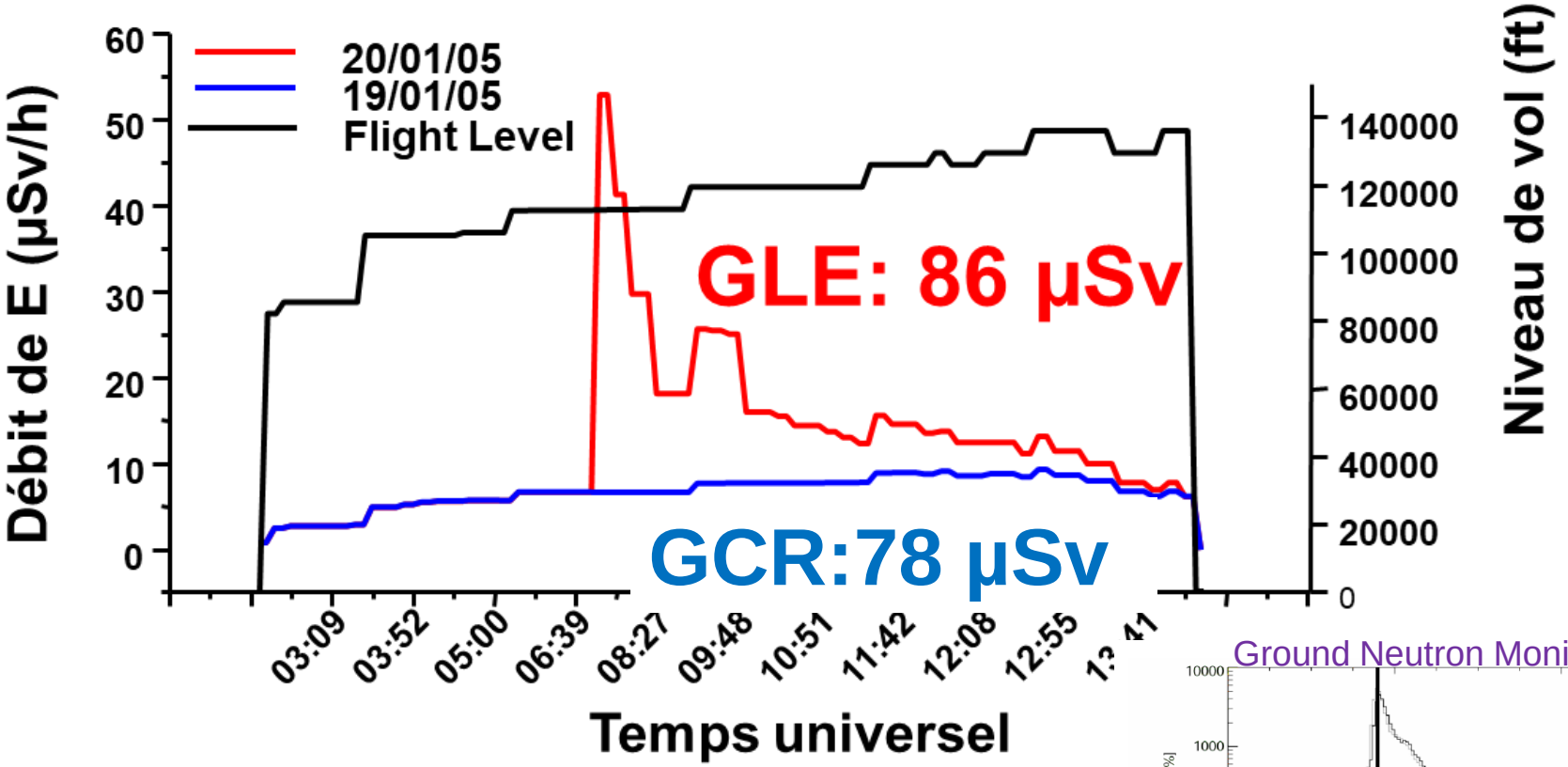


Eruptions solaires



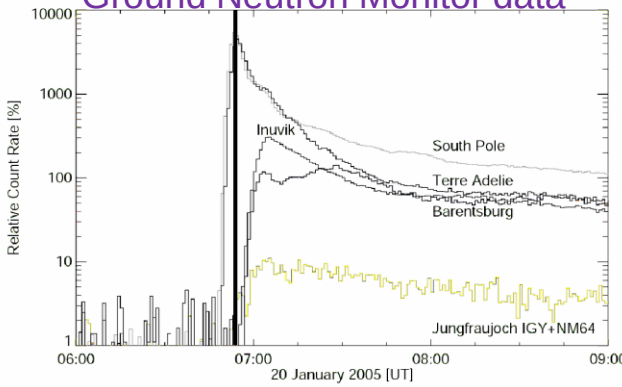
https://www.youtube.com/watch?v=oHHSSJDJ4oo&list=RDCMUCsXVk37bltHxD1rDPwtNM8Q&index=1

Impact aux altitude vol

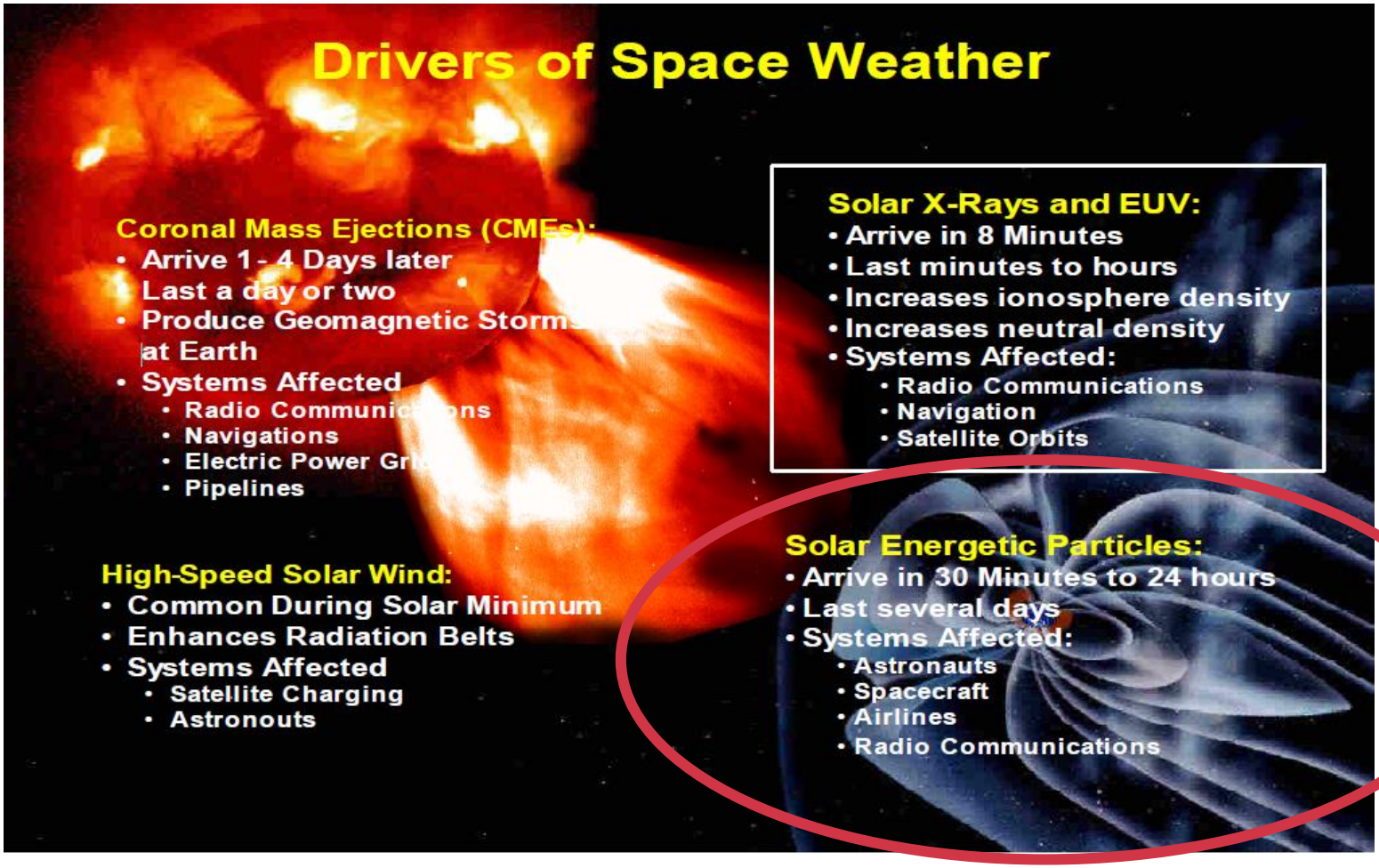


GLE: Ground Level Event

Ground Neutron Monitor data

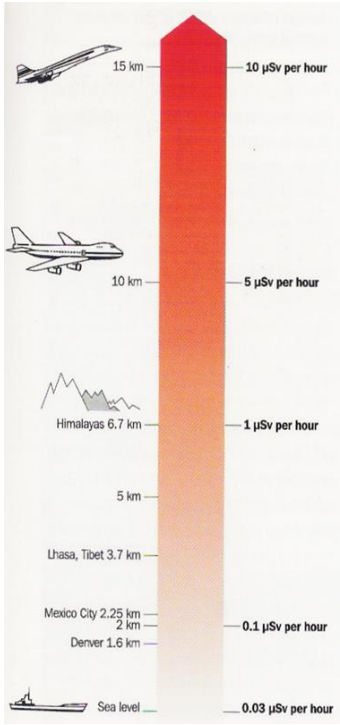


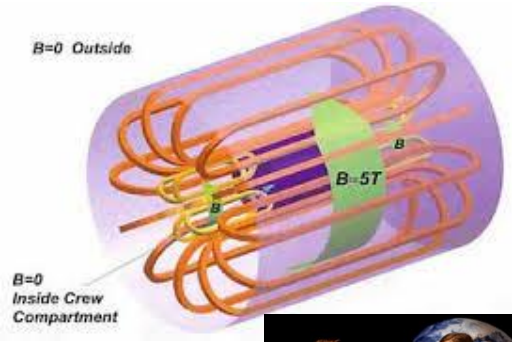
« Space weather »



Problématique santé

- Niveau du sol : contribution mineure
- Altitude de vol : en moyenne, le personnel navigant est la population de travailleurs la plus exposée (mais la dose maximale est d'environ 6 mSv/an).
- LEO : sous contrôle (0,2-0,7 mSv/j)
- Station lunaire (1,4 mSv/j)
- Mission spatiale (hors magnétosphère) : le RC est un problème critique pour la survie de l'équipage (SEP) et reste l'une des principales limitations des voyages spatiaux; les solutions sont encore à l'étude.





Réglementation pour l'exposition des PN

Council directive 96/29Euratom

Article 42, Protection of air crew

« Each Member State shall make arrangements for undertakings operating aircraft to take account of exposure to cosmic radiation of air crew who are liable to be subject to exposure ***more than 1 mSv per year****. The undertakings shall take appropriate measures, in particular:*

- ***to assess the exposure of the crew concerned****,*

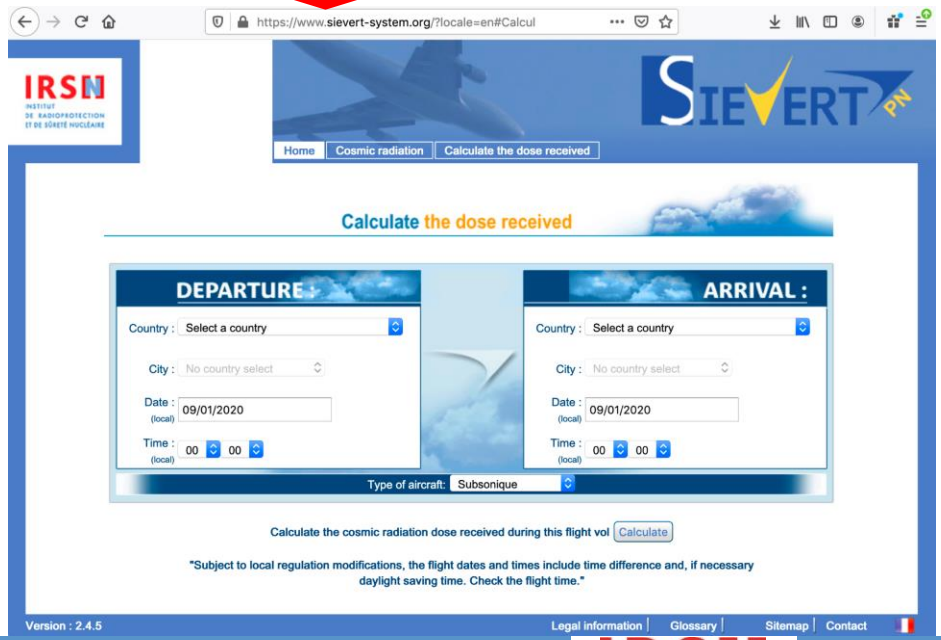
- ***to take into account the assessed exposure when organizing working schedules with a view to reducing the doses of highly exposed aicrew****,*

- to inform the workers concerned of the health risks their work involves,

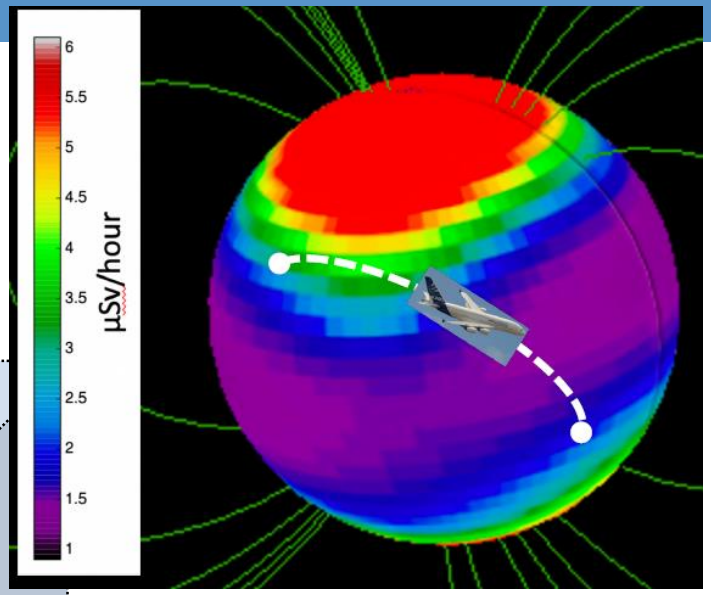
- to apply Article 10 to female air crew. »

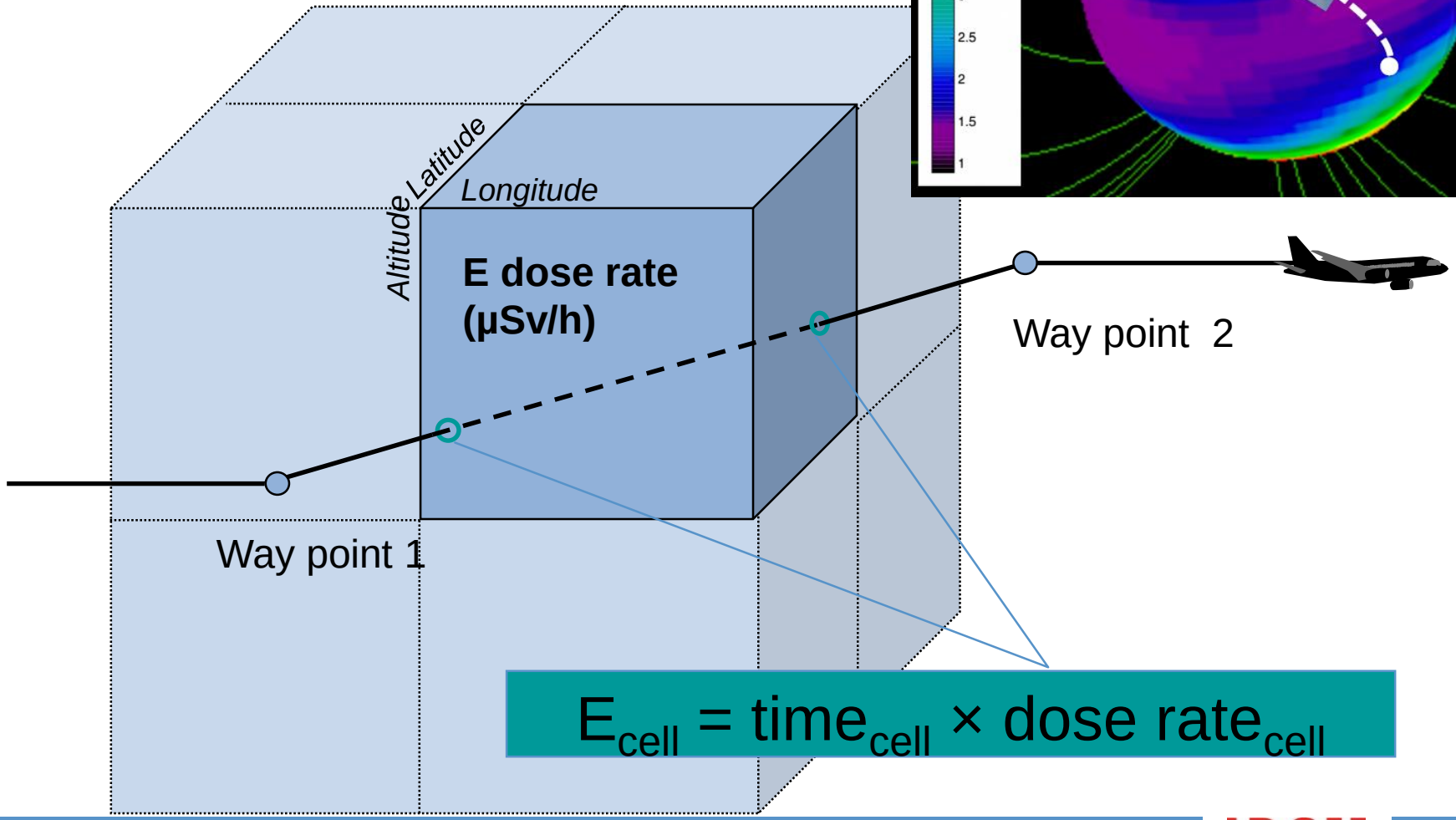
Estimation des expositions

- Pas de dosimètres, uniquement calcul
- Estimation mensuelle
- Galactique et éruptions (modèle SiGLE)
- Prédiction des doses sur 18 mois



Evaluation par calcul

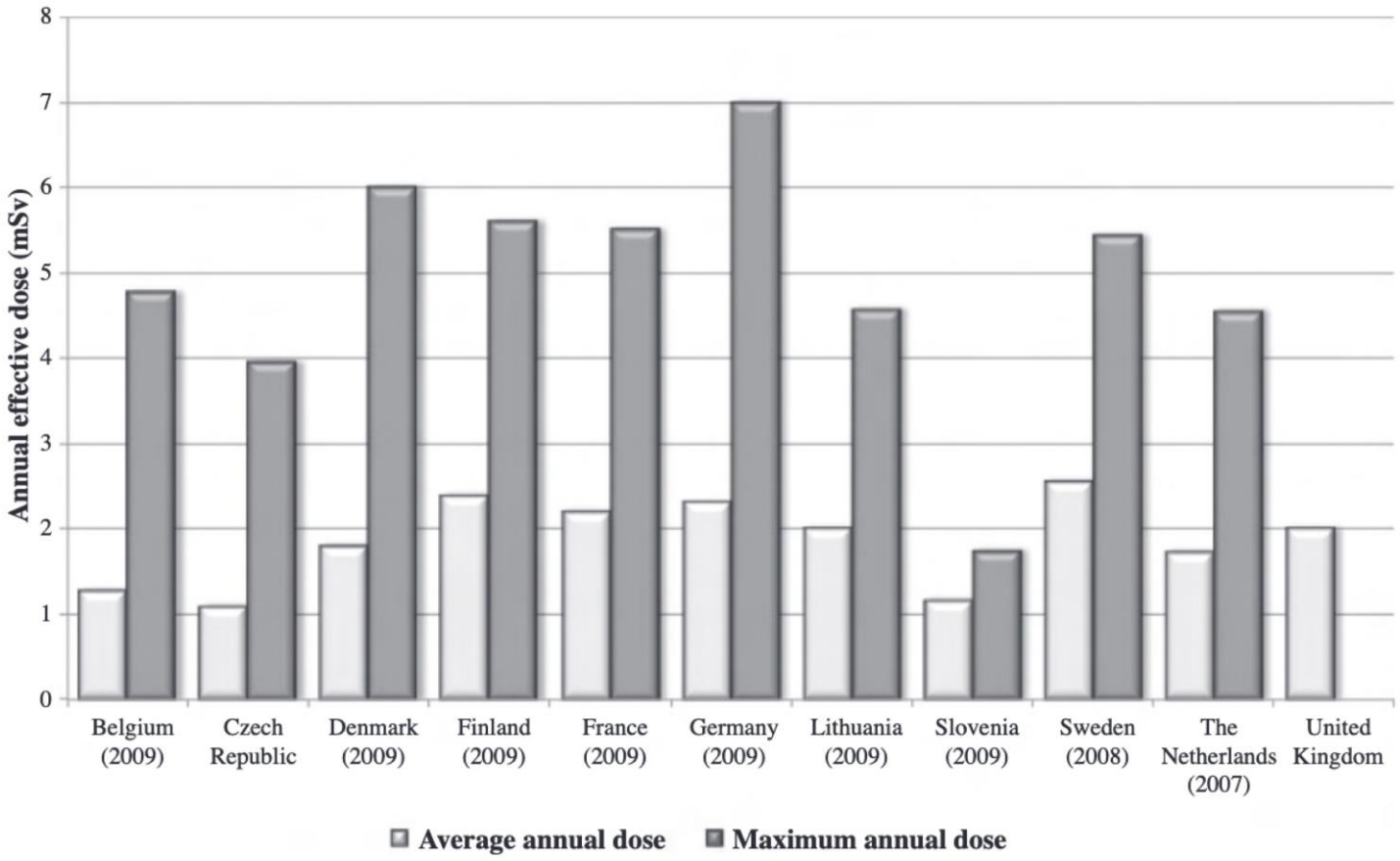




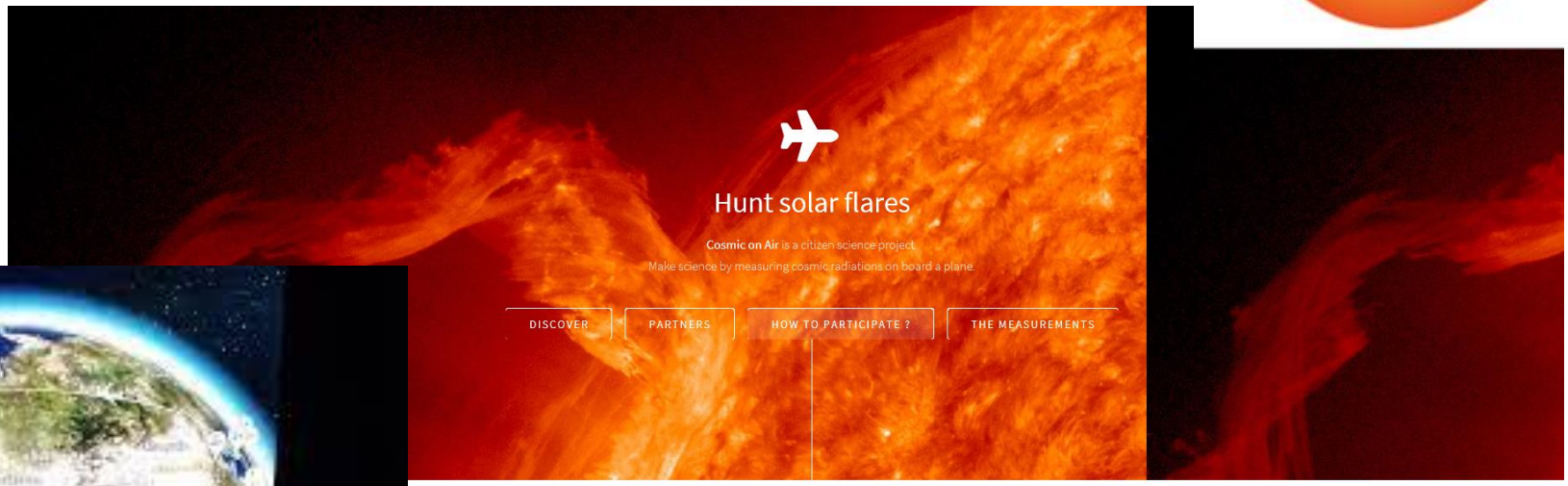
$$E_{cell} = time_{cell} \times dose\ rate_{cell}$$

Validation des calculs

Exposition des PN en Europe



Projet de science citoyenne



The Cosmic on Air project

The Cosmic on Air project is a citizen science project which aims to collect measurements of dose rate carried out on board airplane by the public to organize and make them available to the scientific community, in particular those which could be carried out during solar flares. These phenomena can significantly increase dose rates at flight altitudes. Eruptions are sporadic phenomena and those with a significant effect are rare. Very few measurements made on board aircraft are available, which limits the understanding of these phenomena in the atmosphere.

Understand more

www.cosmic-on-air.com