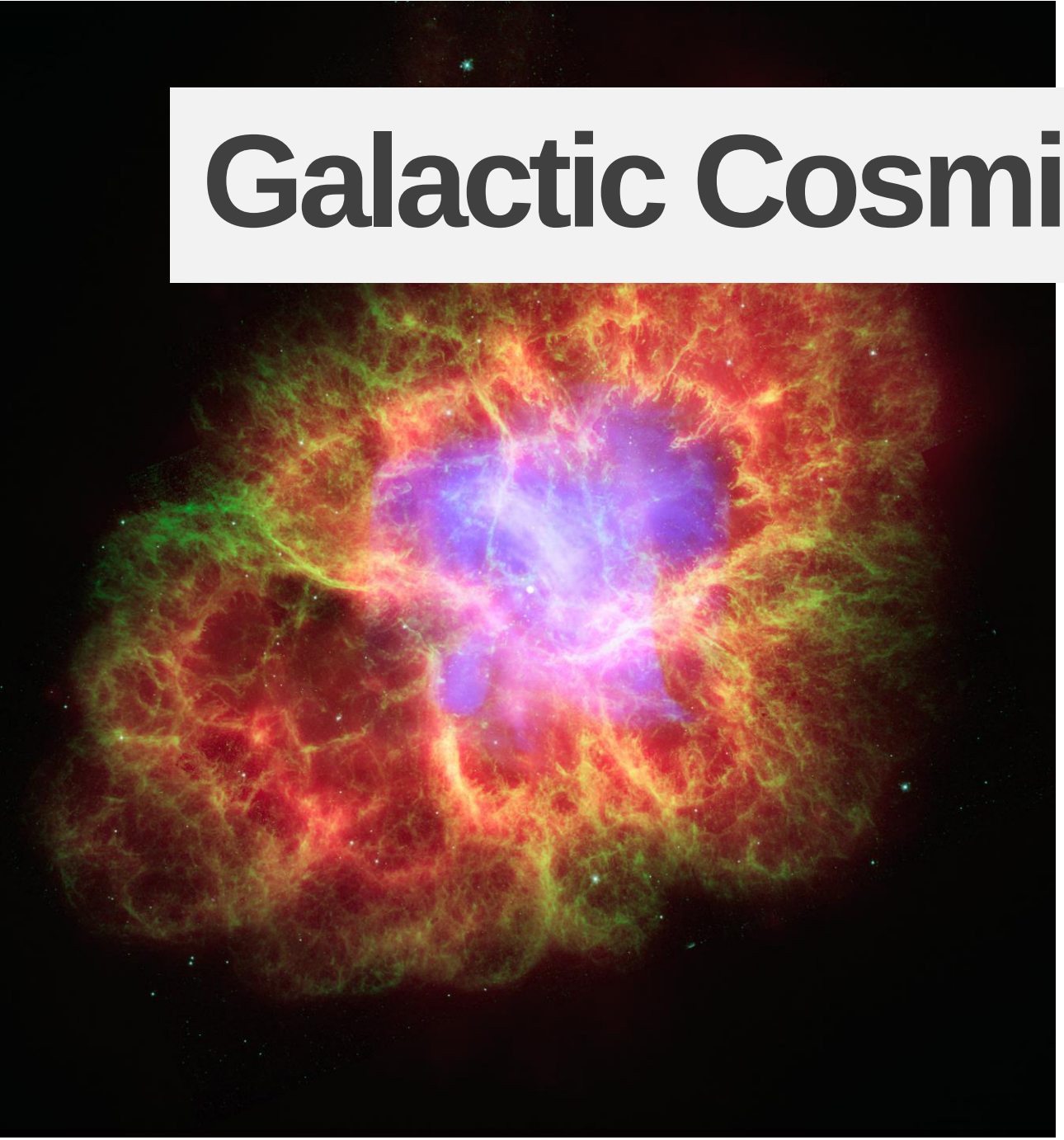
Radiation Risks at Altitude

PCAIRE
crew radiation monitoring

Galactic Cosmic radiation (GCR)



- GCR originates outside of our solar system from exploding stars, or Supernovas
- Highly energetic particles are ejected at almost the speed of light and make their way to our solar system and to Earth
- These particles are highly ionizing

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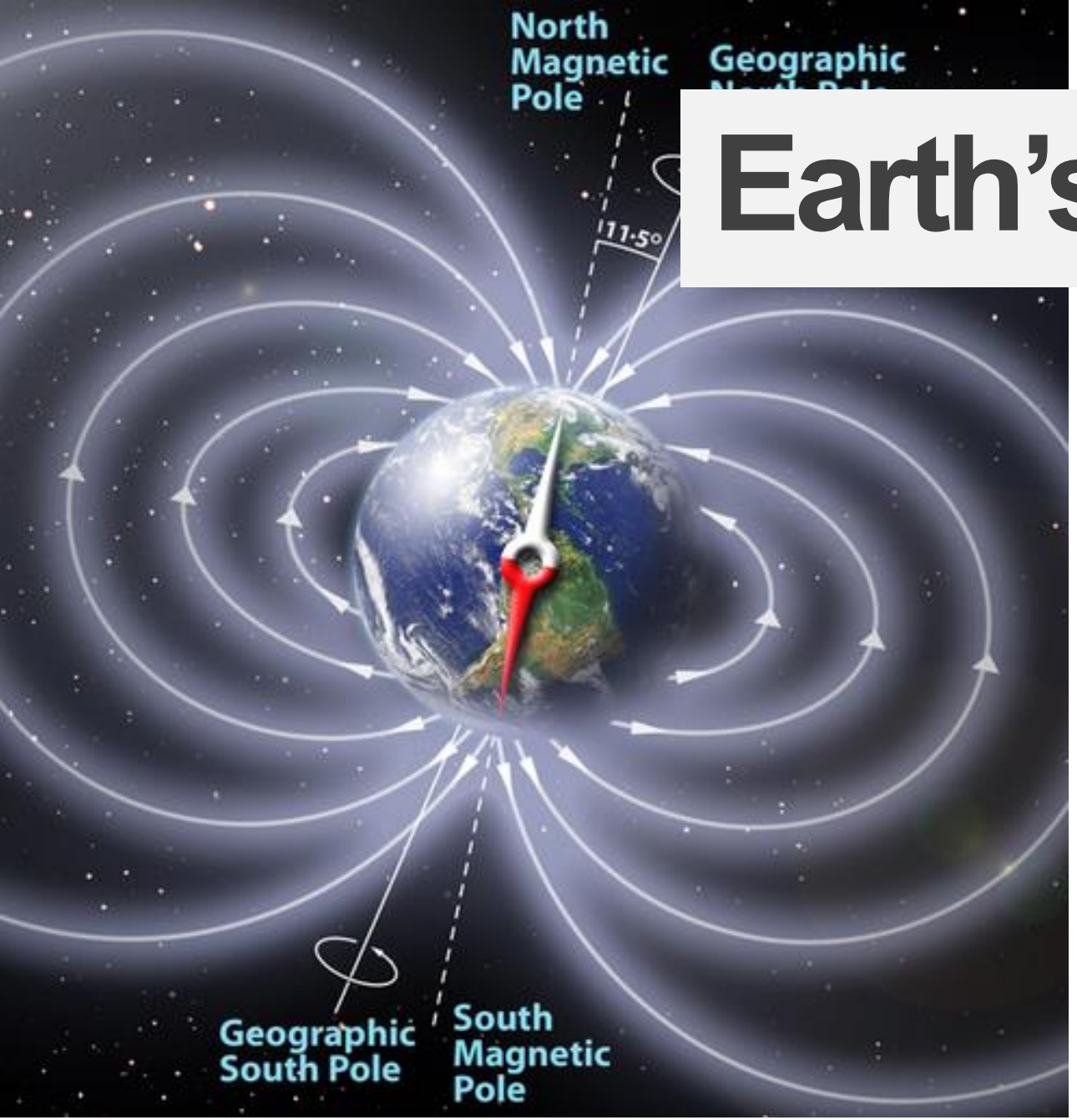
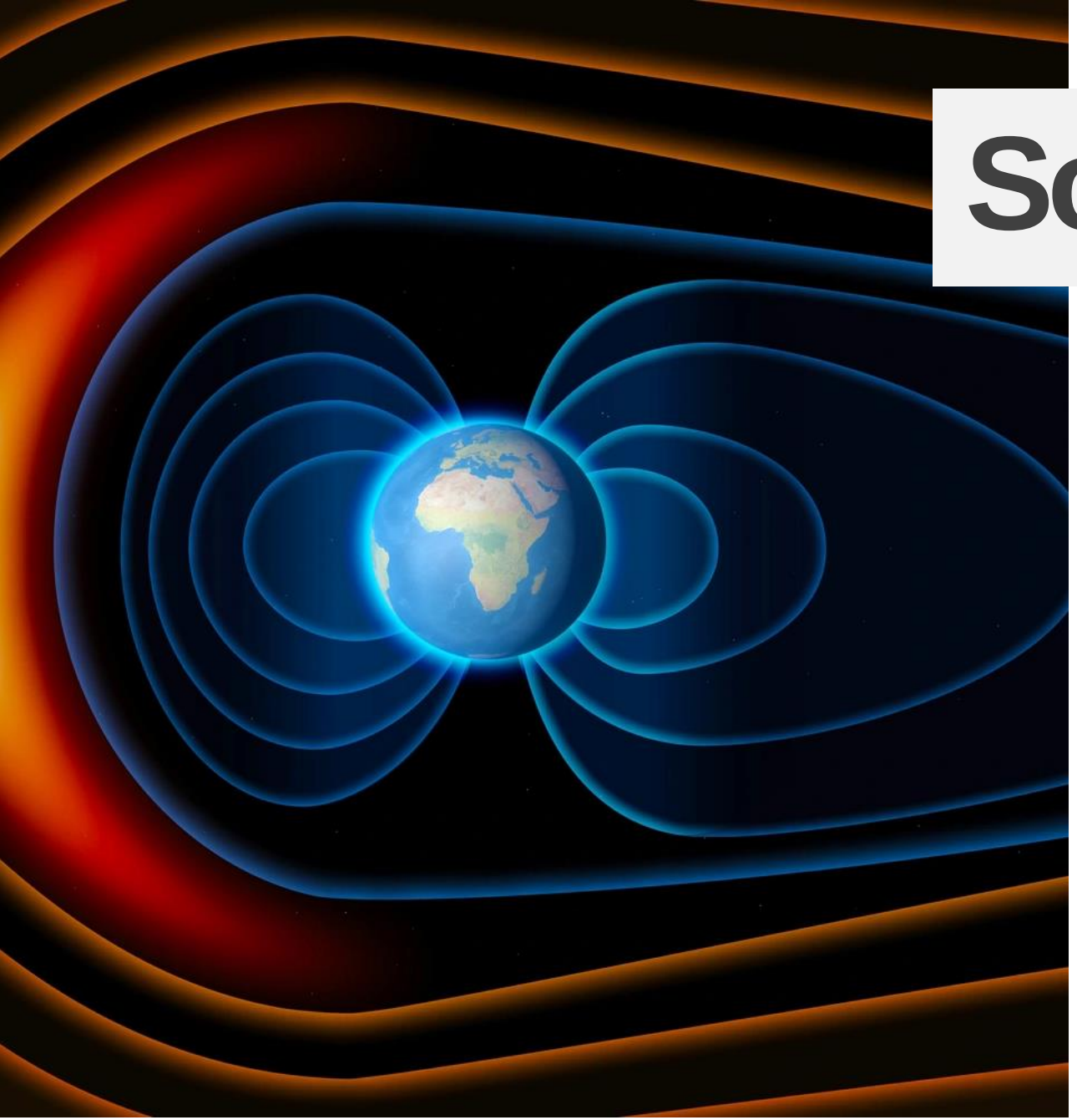


Earth's magnetic shield

- The incoming particles are deflected and dispersed by the Earth's magnetic field, making the intensity of cosmic radiation at aircraft levels ~3 times greater at the Poles than at the Equator
- Cosmic radiation is prevalent at jet altitudes, and it is approximately one hundred times greater than detected at sea level



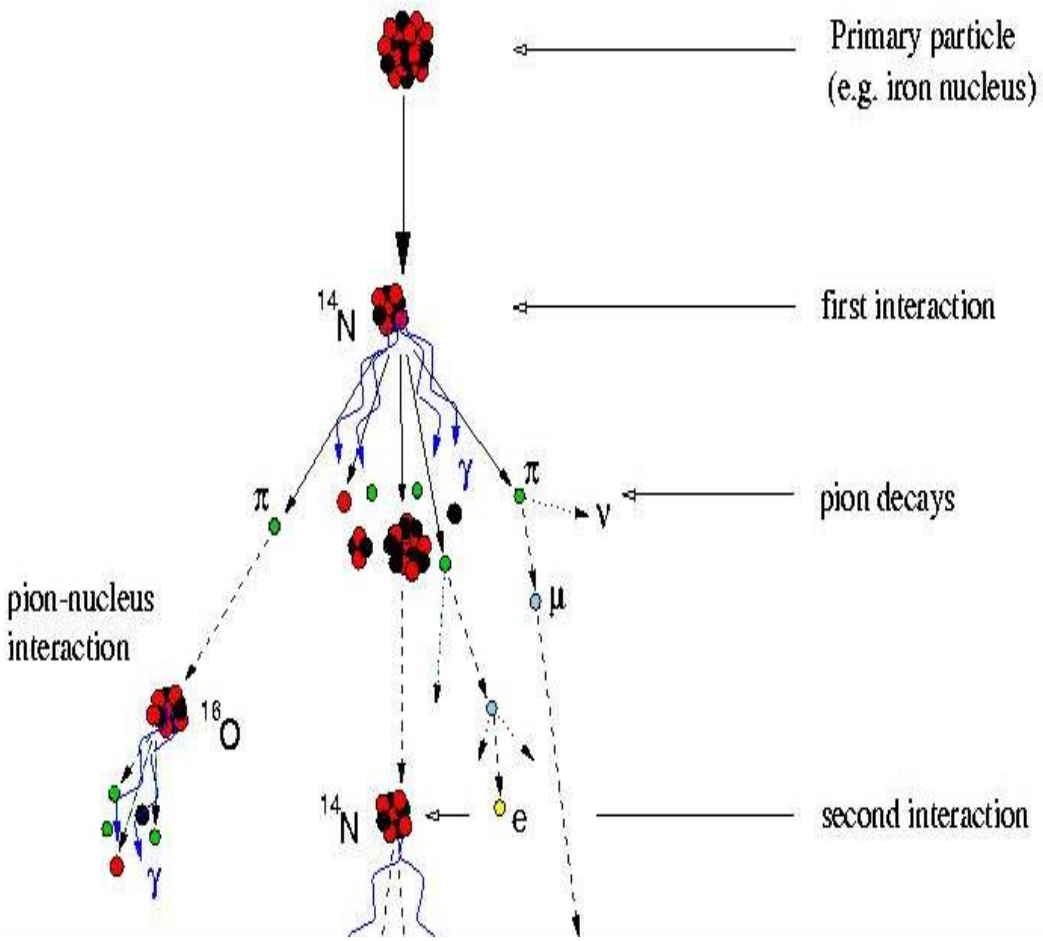
Solar contribution

- Our sun also ejects radioactive particles in a stream. As this stream is directed around our magnetic shield it acts as a further ‘shield’ to the incoming galactic radiation particles
- The intensity of the suns ejections varies on a 11-year solar cycle.
- Large solar particle events can penetrate the Earth’s magnetic shield and our atmosphere. Luckily, these large solar storms only happen every 10 to 50 years.

Earth’s atmosphere

- The particles that can penetrate our atmosphere collide with water and other particles which disintegrate into particle showers
- These cascades are comprised of different particles types as it penetrates our atmosphere.
- This complex spectrum of particles cannot be measured by normal detectors and dosimeters used in other radiation fields on Earth

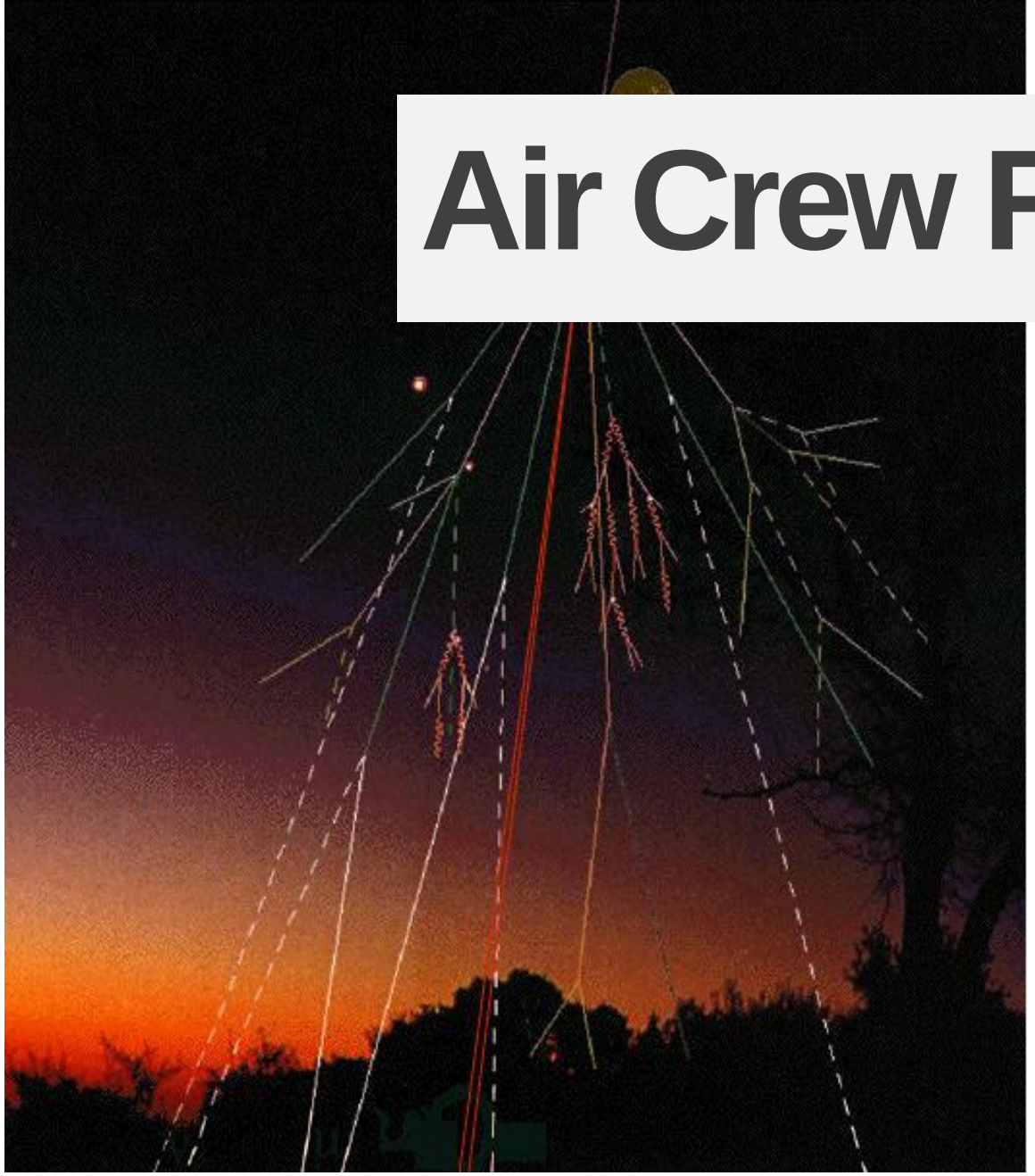
Particle showers



- The particle showers reduce in intensity as they penetrate further into our atmosphere
- This leads to higher radiation levels at higher altitudes

Radiation Terminology

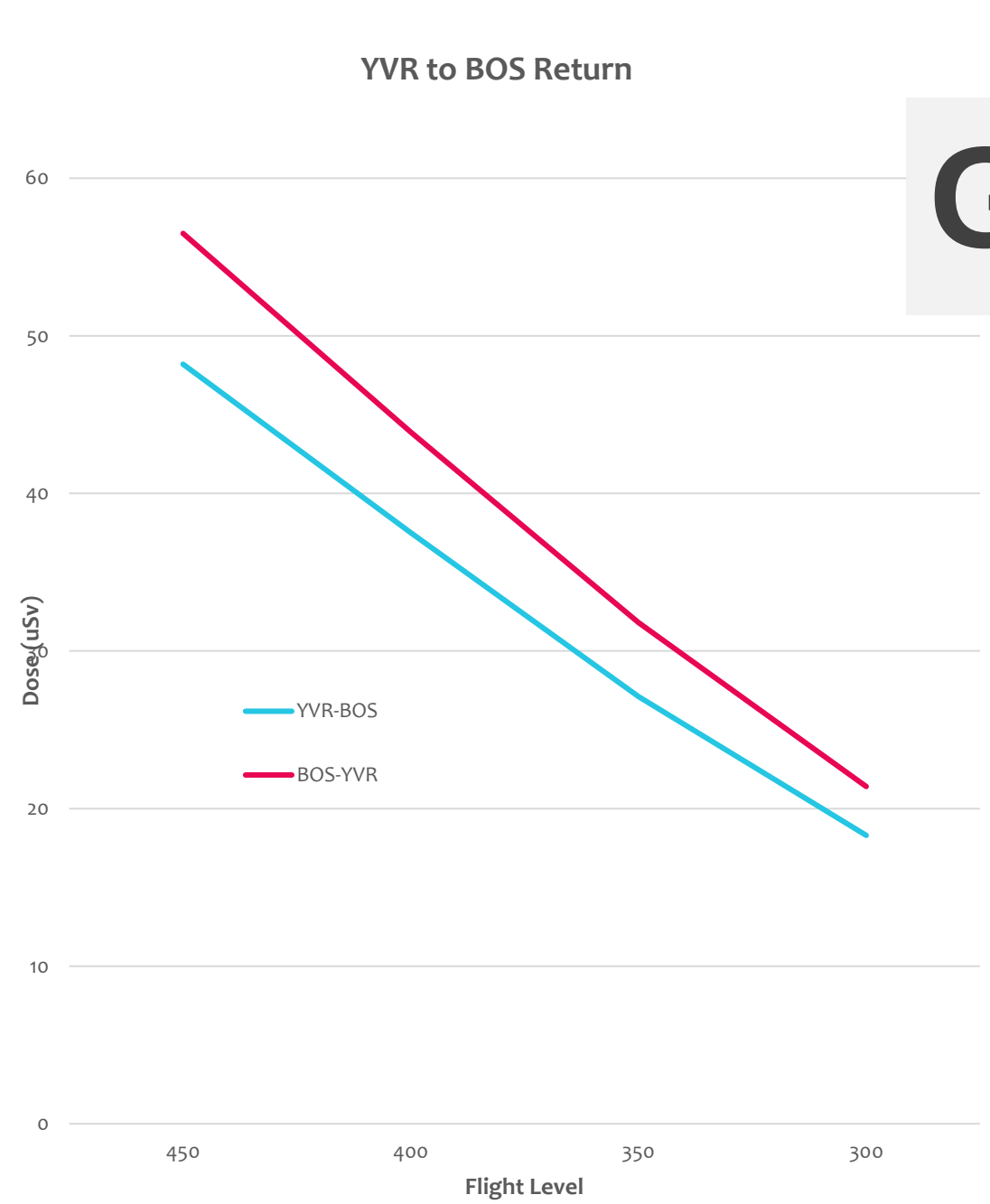
- The amount of radiation a body absorbs is referred to as Dose.
- In SI units, this dose is measured in Sieverts. The actual dose received is normally stated in millisieverts (mSv) or micro sieverts (μSv) as a Sievert is a very large amount of energy
- Flight doses are in the 5-75 μSv/flight range, leading to yearly doses from 1-8 mSv/y for aircrew and some frequent fliers



Air Crew Radiation Exposure

- GCR (Galactic Cosmic radiation) levels are increased at higher altitudes due to the shielding provided by our atmosphere
- GCR increased at the poles, due to the shape of our magnetic shield (rigidity). Equatorial region is the lowest level of GCRs.
- GCR levels vary with the 11-year solar cycle
- Radiation levels can be increased at altitudes infrequently due to large solar particle events

GCR exposure levels



- A return flight from Vancouver (YVR) to Boston (BOS) – June 2024
- 36% increase in dose between 35,000 and 45,000 ft (FL 350 and 450)
- 40% increase in dose between 30,000 and 45,000 ft (FL 300 and 450)

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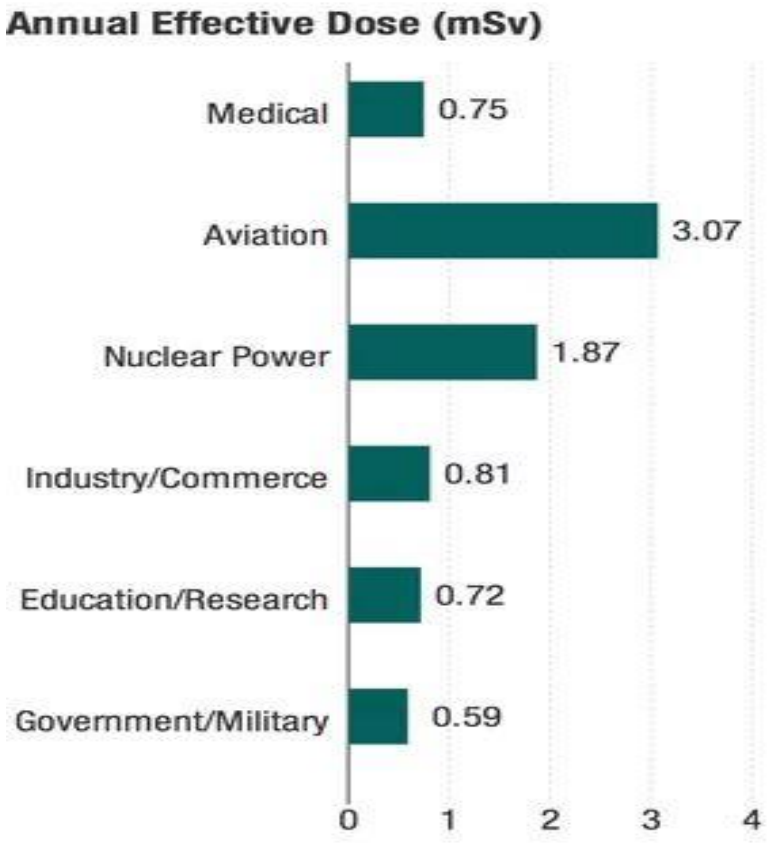
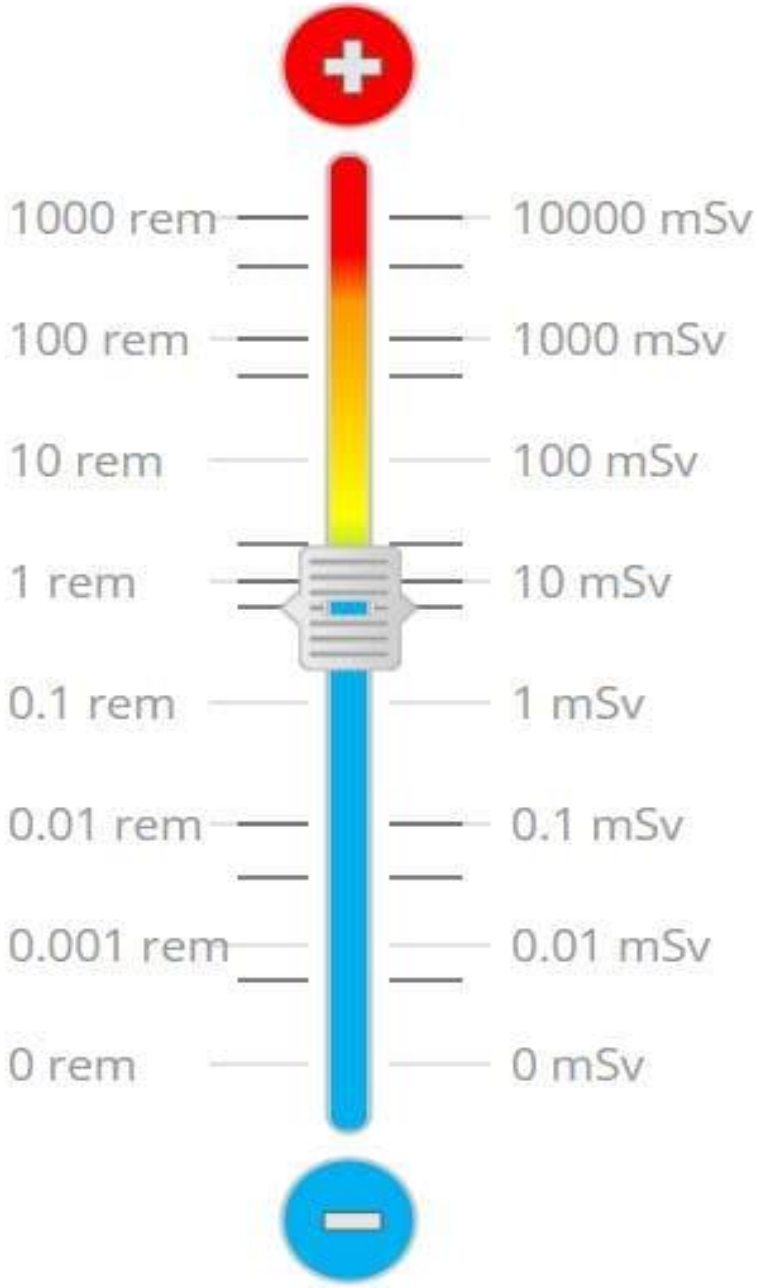
Air Crew Radiation Exposure



- Studies based on actual measurements over the last 20 years specifically demonstrate that aircrew are the highest exposed occupation
- Terrestrial nuclear workers in all countries are mandated to utilize expensive and professional dose monitoring programs
- Aircrew are mandated to monitor doses in Europe. Most countries do not require any data collected for aircrew
- The risk per Sievert is the same for terrestrial nuclear workers and aircrew

Data from the National Council on Radiation Protection and Measurements show the average annual effective dose for workers in various fields. Aviation doses are estimated based on flight routes and altitudes.

National Council on Radiation Protection and Measurements. Ionizing radiation exposure of the population of the United States. Bethesda, MD: NCRP; Report No. 160; 2009.



Actual Risk

- Health Canada study in 2023 indicates that the probability in our lifetime of developing cancer is approximately 43%.
- ICRP and EPA state that a dose of 6 mSv in one year increases the lifetime risk of cancer by approximately 0.03%
- So, risk to Aircrew (and all occupationally exposed people) is VERY LOW
- Pregnant aircrew have an increased rationale for effective monitoring

Levels and Limits

- Most national/international regulators and governing bodies recommend monitoring for aircrew that are exposed to greater than 1 mSv/y due to occupational exposure (i.e., not background)
- These bodies also recommend a yearly exposure limit of 6 mSv/y
- Pregnant flight crew have a ICRP recommended limit of 1 mSv/y
- These levels of exposure are common for aircrew that fly more than 400 hours per year at altitudes greater than 25,000 ft

The PCAire Application

- PCAire has been developed to be a practical tool for assessing and monitoring aircrew exposure
- PCAire is based on actual measurements on worldwide flights
- PCAire works directly with airline's requirements to meet regulatory requirements or proactive disclosure
- PCAire is an ISO quality data-based system developed as a commercial platform
- PCAire has the most accurate outputs of any GCR estimation code
- PCAire has been certified for use in the European Union, Canada, Australia, Israel and other countries

What We Do

PCAIRE is a semi-empirical computer program allowing airlines to estimate their crew radiation dose on any flight. The PCAire system can:

- Interface with any flight planning and crew scheduling software to calculate flight doses
- Provide individual crew reports, yearly and monthly reports, as well as advisories for crew members who accumulate high doses
- Provide monthly update e-mails to every crew each month and provide an airline specific web site where crew can review and forecast doses in advance using the PCAire planning tool

About Us

- Since 2004, PCAire has processed over 12 million flights and monitored more than 100,000 aircrew members worldwide.
- PCAire has developed complex algorithms that can accurately estimate radiation levels during jet aircraft flights
- PCAire is one the only fully certified and peer reviewed code in the world – providing accuracy based on actual inflight measurements
- PCAire follows strict guidelines to ensure personal data is protected and information is tracked and transmitted professionally, as within the nuclear industry

Thank You

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