Aircrew exposure to cosmic rays

- Challenges and management -

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Content

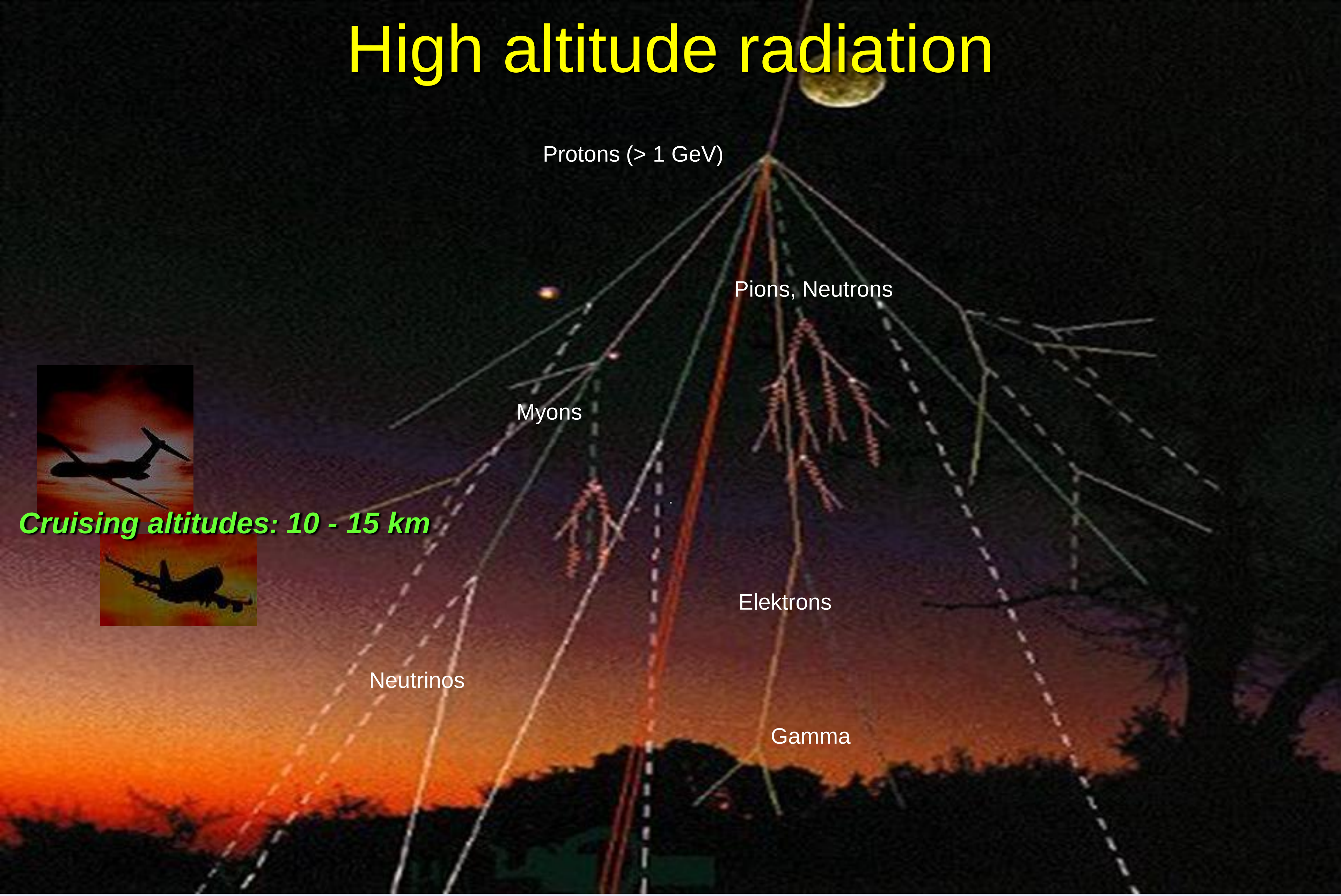
Cosmic radiation as existing exposure

Physical, economical and social impacts

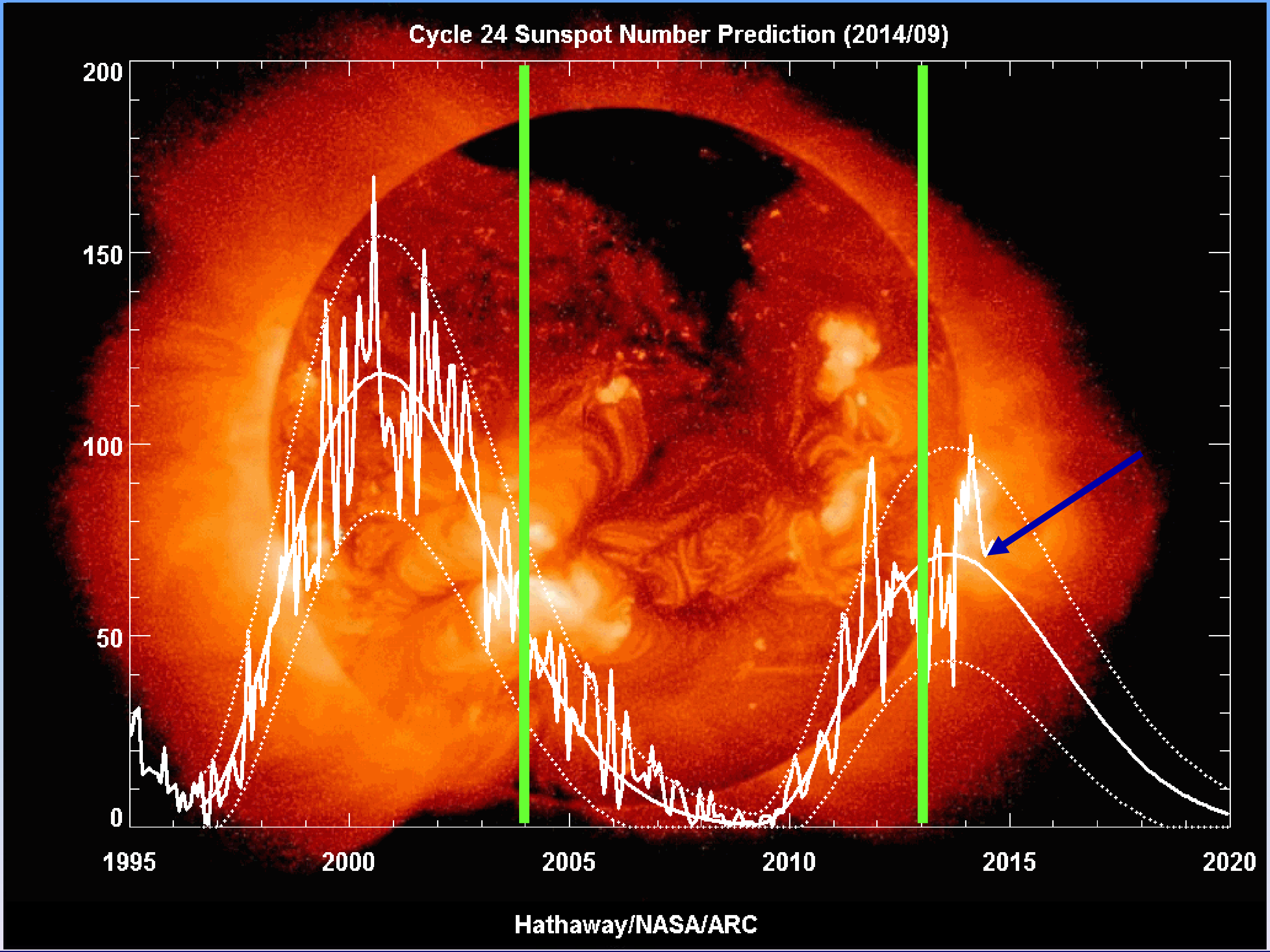
Aviation and optimization

Globalisation and future challenges

High altitude radiation

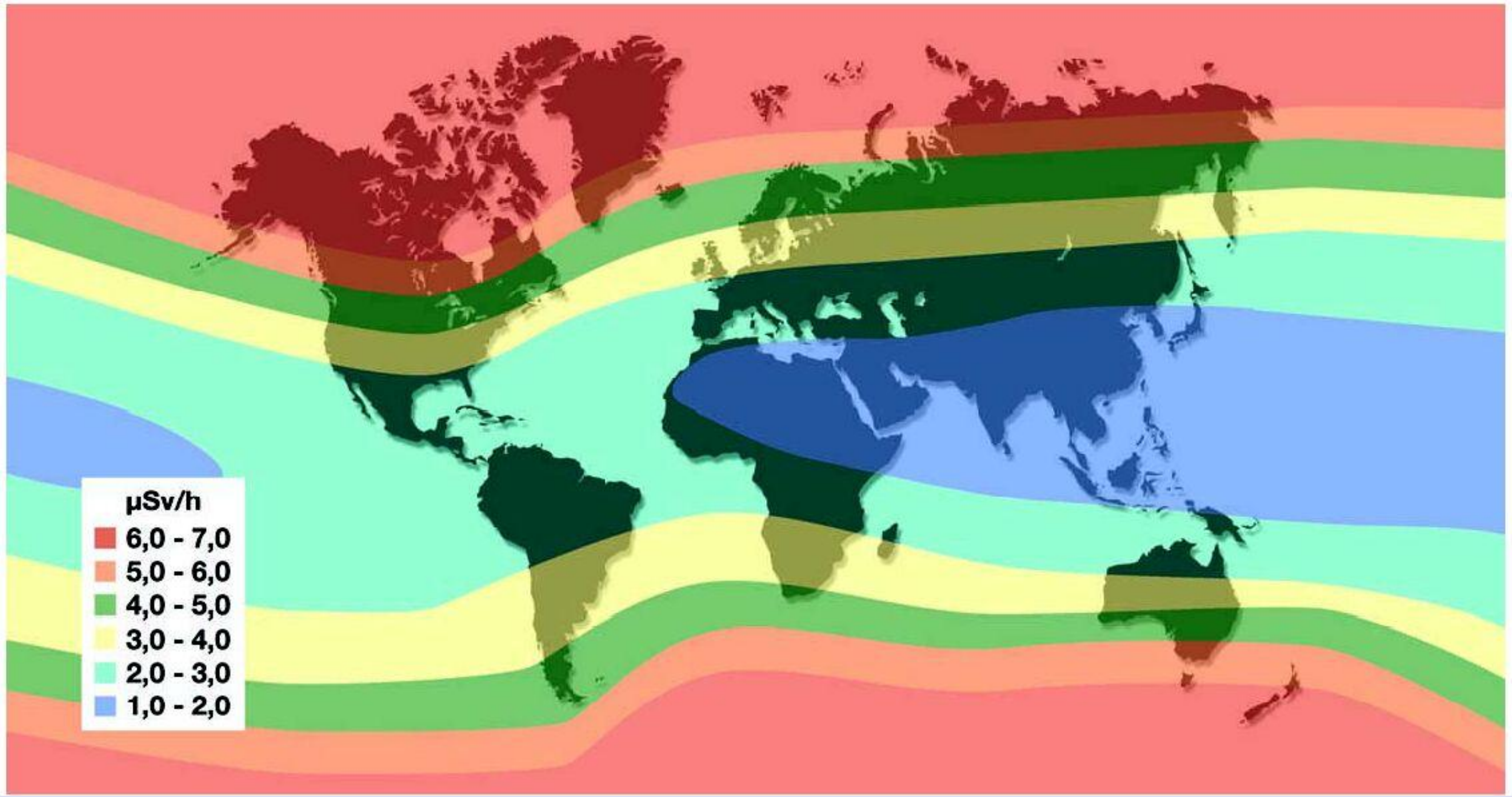


Solar activity in solar cycle 23 and 24



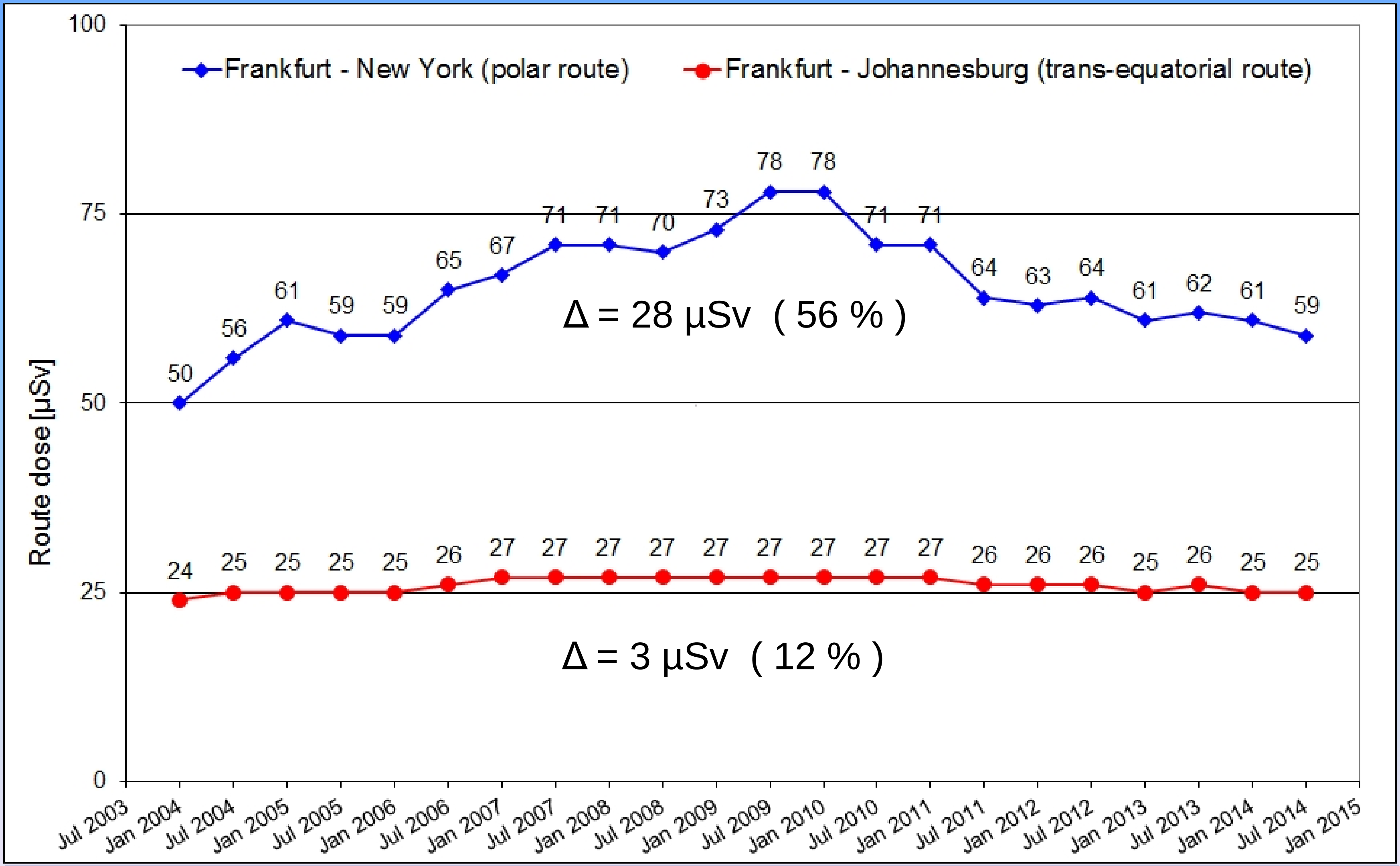
Geo-magnetic shielding of cosmic ray

Ambient dose rate by latitude and longitude in 11 km altitude, Dec. 2002



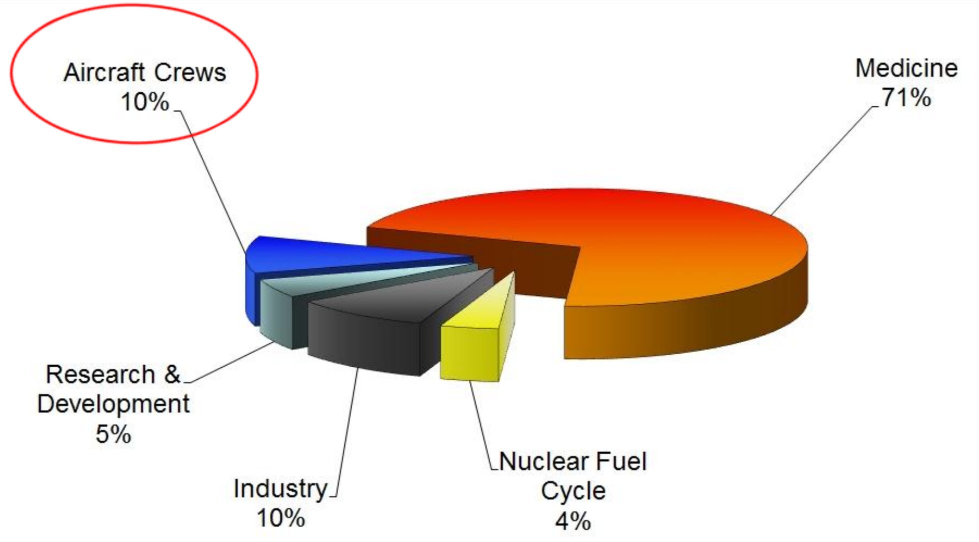
Change of route doses 2004 – 2014

(solar cycles 23 / 24, FRA - JFK, FRA - JHB, Epcard Net 5.4.3)

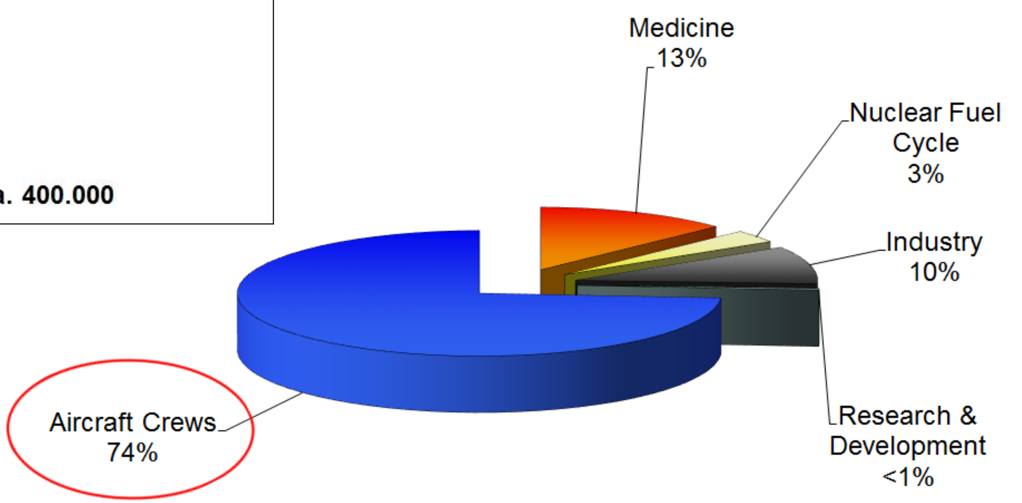


Radiation exposed workers

Monitored workers and collective doses in Germany, 2012



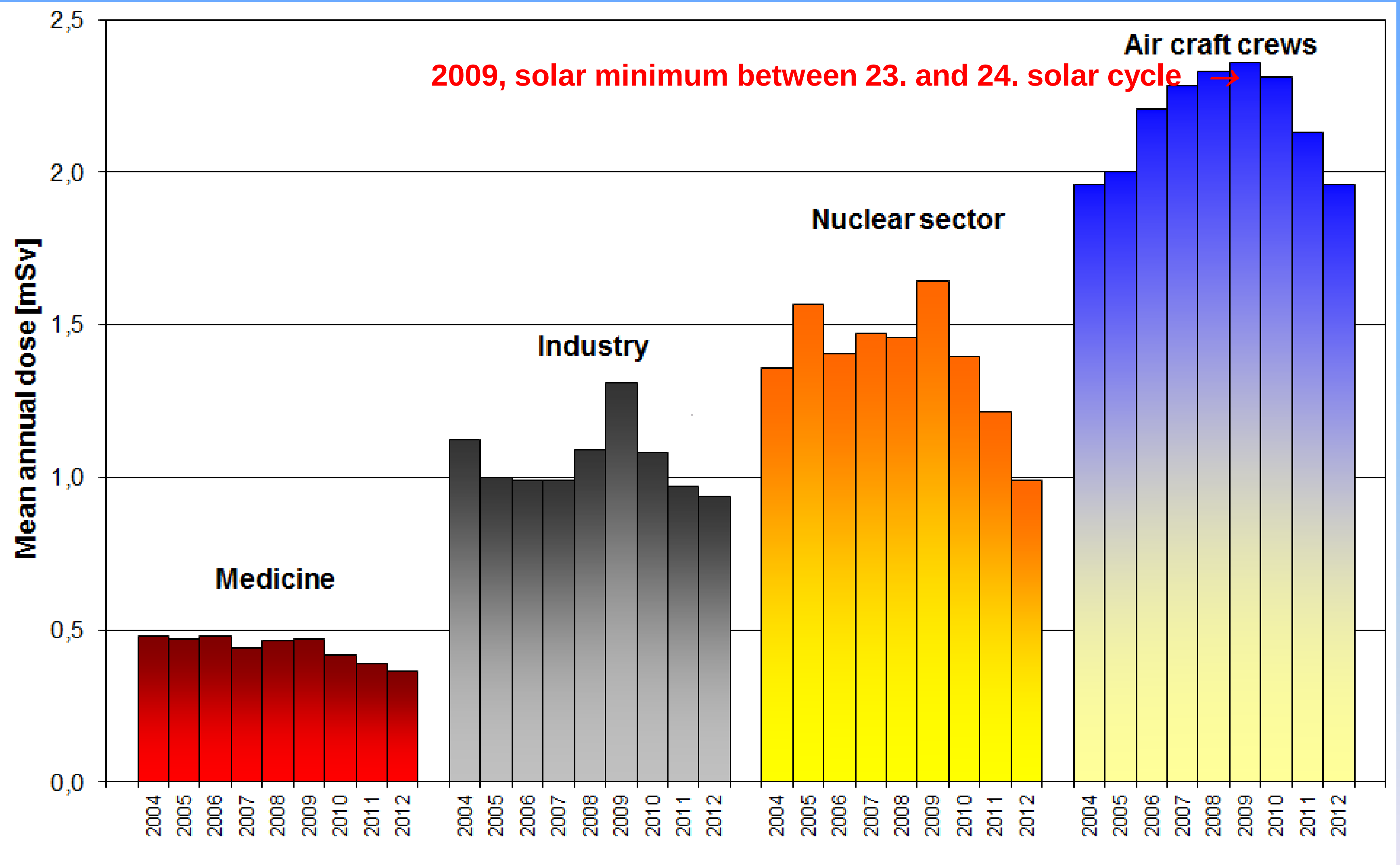
Radiation exposed workers in Germany (2012): ca. 400.000



Collective dose of radiation exposed workers in Germany (2012): 106 pers.-Sv

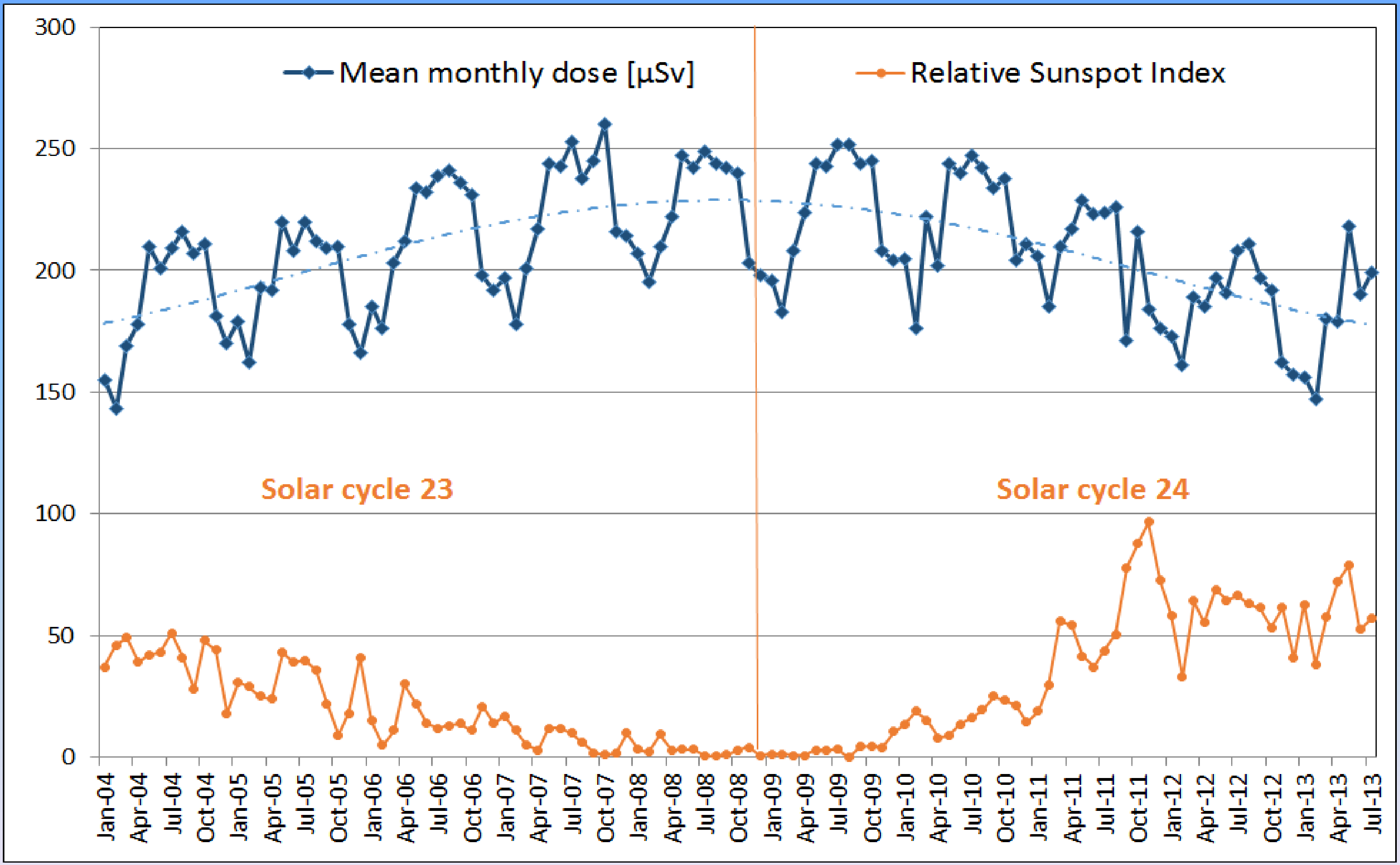
Mean annual dose in work sectors

Monitored persons with measurable doses, Germany 2004 - 2012



Monthly doses of aircraft crews

Germany, Dec. 2003 – June 2013

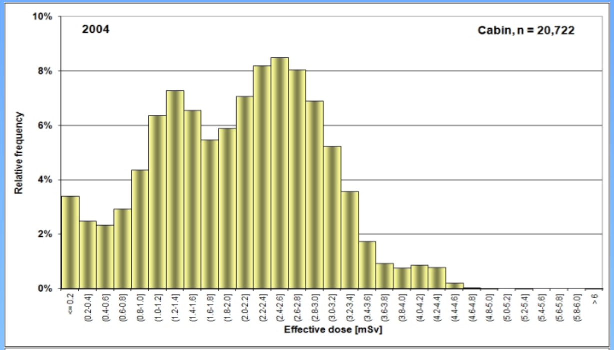


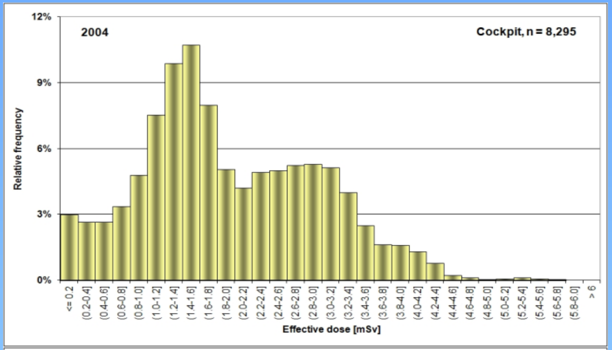
Frequency distribution of doses

German aircraft personnel, 2004 – 2009 - 2014

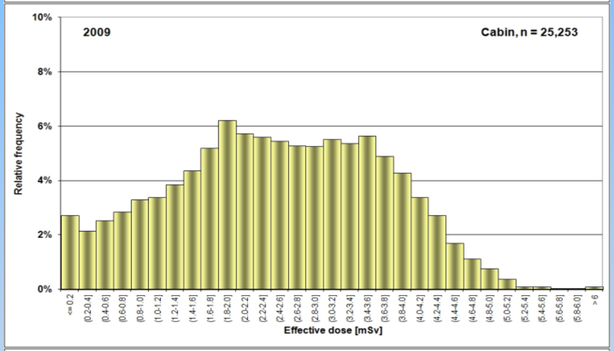
Flight attendants

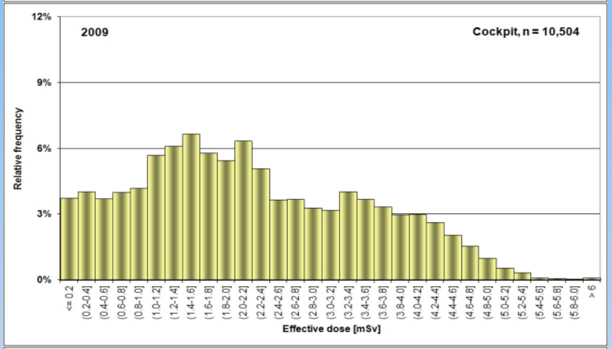
Pilots



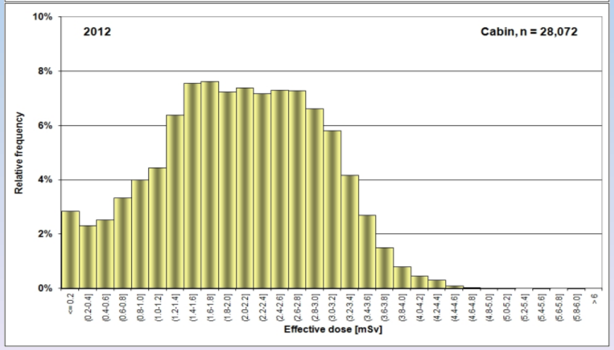


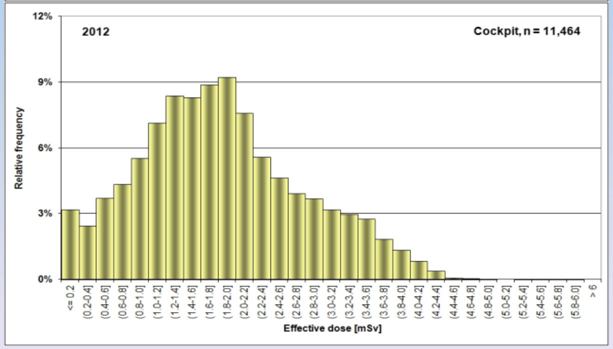
2004





2009





2012

Typology of air crew members

Female flight attendants by age and dose, Germany, 2004

Alter / Dosis [mSv]	0.1 - 0.5	0.6 - 1.0	1.1 - 1.5	1.6 - 2.0	2.1 - 2.5	2.6 - 3.0	3.1 - 3.5	> 3.5	Summe
<= 25	***275***	175	331	248	360	322	180	***286***	2.177
26 - 30	227	308	547	452	804	***722***	***398***	***244***	3.702
31 - 35	261	***417***	576	424	640	606	259	85	3.268
36 - 40	261	***474***	***875***	***641***	711	509	227	28	3.726
41 - 45	85	211	***570***	***453***	404	324	97	8	2.152
> 45	47	111	255	***263***	299	***306***	122	9	1.412
Summe	1.156	1.696	3.154	2.481	3.218	2.789	1.283	660	16.437

Holm-Bonferroni test at multiple α–level: $p < 0.05$, 0.01, 0.001

RP problems in aviation

Protection principle	Application to aviation	Practical consequences
Distance	lower cruising altitude	- more fuel consumption, - higher cost, - more environmental burden.
Shielding	at fuselage protective clothes cruising along lower latitudes	- not feasible (weight), ineffective (energy), - ineffective, not acceptable, - not applicable, - ineffective: longer routes → more radiation exposure, - (see above).
Time	less block hours	- more part time personnel, - economically not acceptable

Optimization by work planning

- Allocation of personnel to route-mix

- Multi-type employment of pilots:
  long-haul / short-haul mix within aircraft families

Problems: Goal conflicts (flight attendants), costs

Optimization by flight planning

Calculation programs for cost-optimized flight routes:

Optimization criteria:

Fuel consumption, flight time ***+ route dose***

Problem: costs

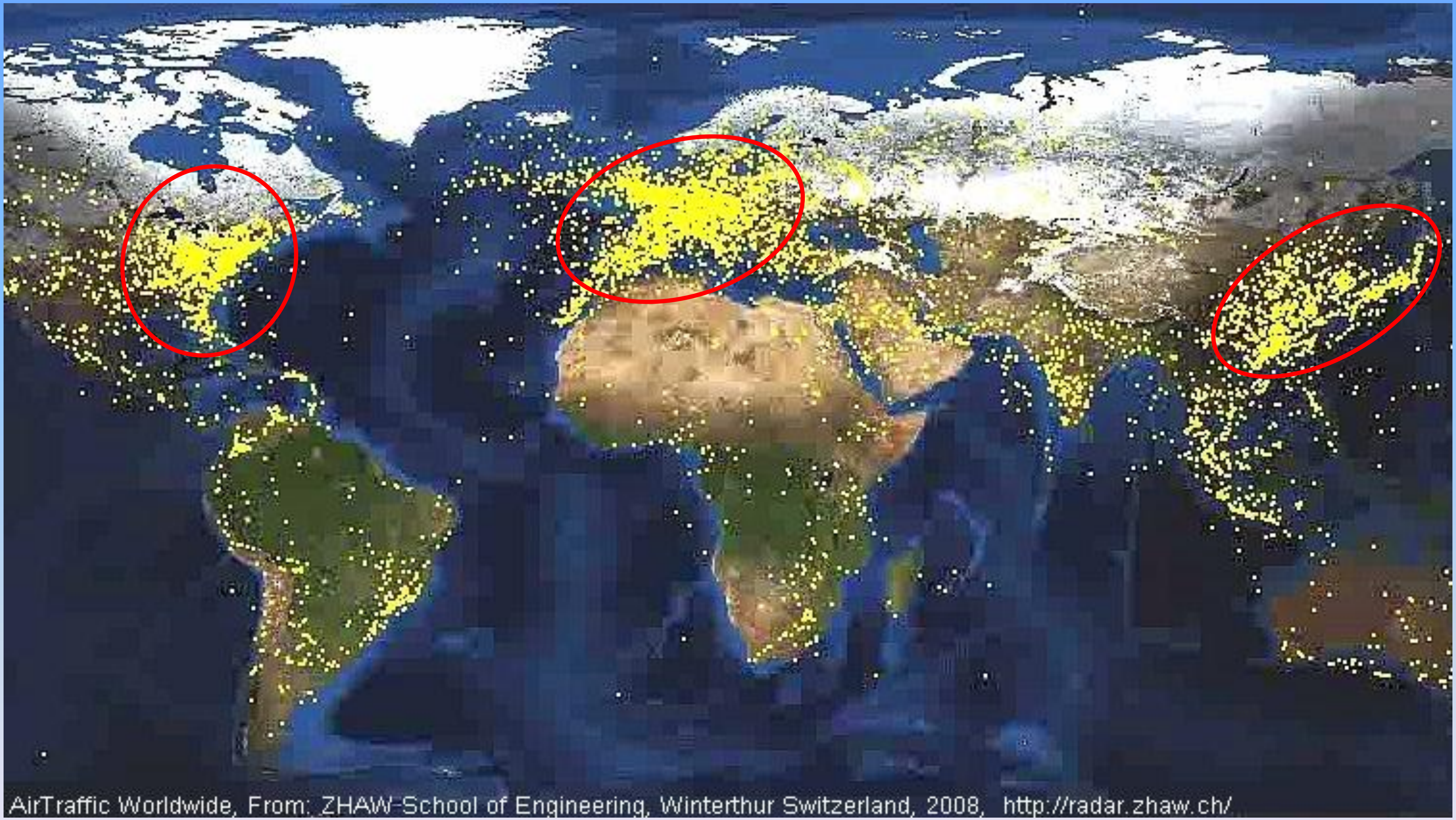
Optimization en route

RP policy of IFALPA*

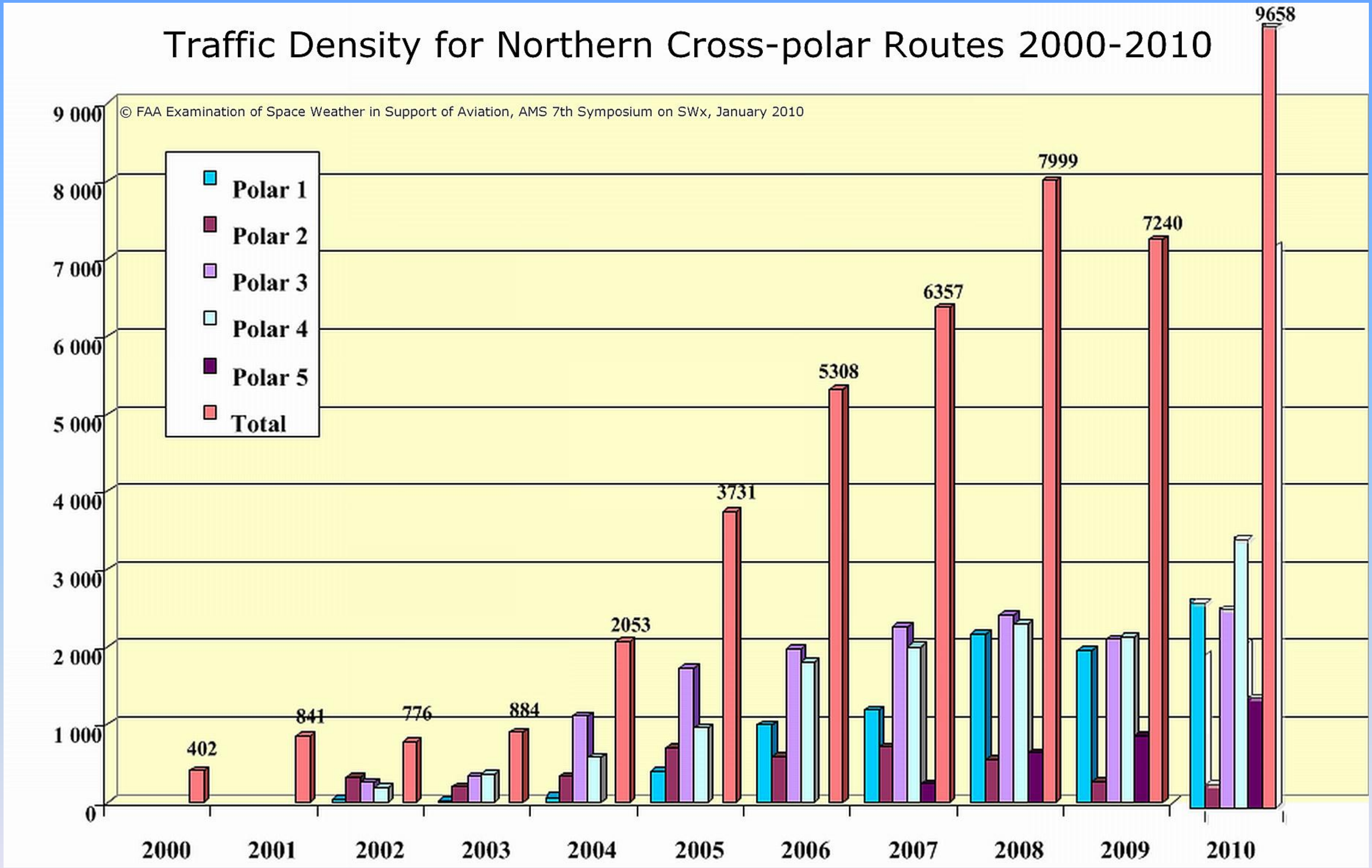
- Avoid flying above optimum flight level
- Avoid last step climb
- Avoid intermediate step climbs with following descent
- Cruise at lower flight level with true air speed of originally planned higher flight level (at least for the later part of flights)
- Act on ambient dose rate (on board dosemeter)

*) International Federation of Air Line Pilots' Associations

Global airspace at 12:00 GMT



Going global - via North Pole



Future challenges

- Development of new ultra-long-range aircraft
  (> 15.000 km, altitude 43.000 ft.)

- Longer non-stop flights
  (> 15 h, e.g. Singapore – New York)

- Increase of long-haul route doses: by 30 - 50 %
  (estimation by VC Cockpit, Germany)

How to manage?

- RP in aviation on international level
- Co-operation with national and international stakeholders, in particular pilot organisations
- Seek for synergy effects between radiation protection, flight safety and airline business needs.

Thank you!

Quelle: http://www.lens-flare.de/flugzeug-zwischen-wolken-5655.htm