Aircraft Crew Exposures in Germany from 2004 – 2009

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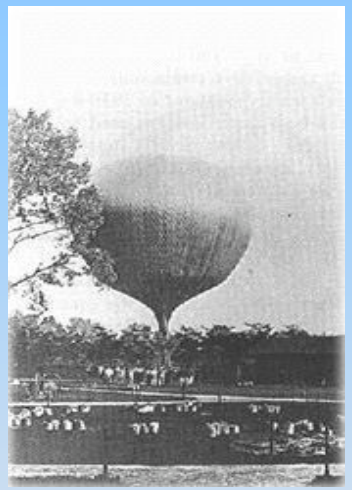
Cosmic radiation as existing exposure

Discovery of cosmic radiation



Victor Hess
1883 - 1964
Nobel price 1936

High altitude radiation

Cruising altitudes: 10 - 15 km

Protons (> 1 GeV)

Pions, Neutrons

Myons

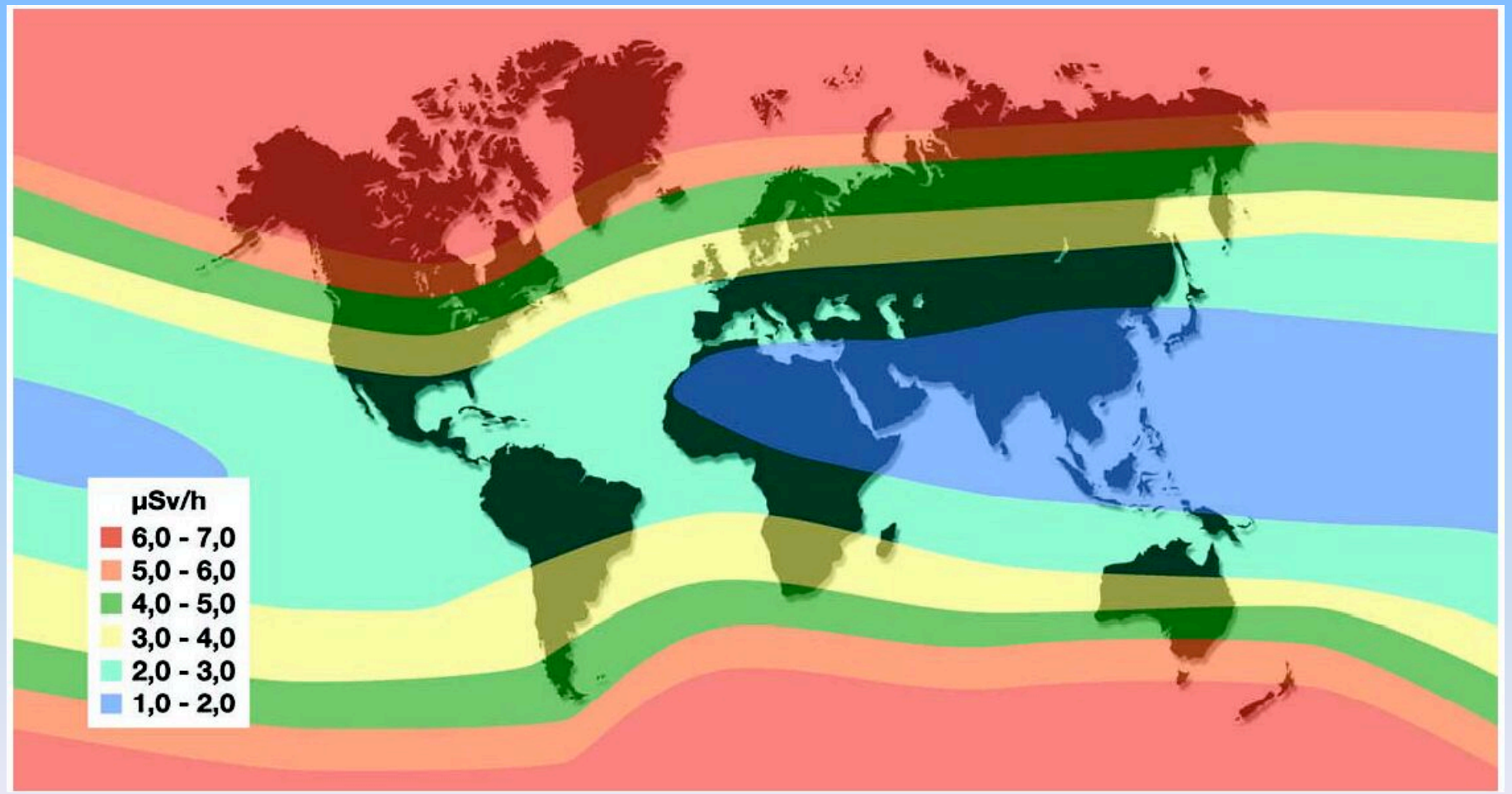
Elektrons

Neutrinos

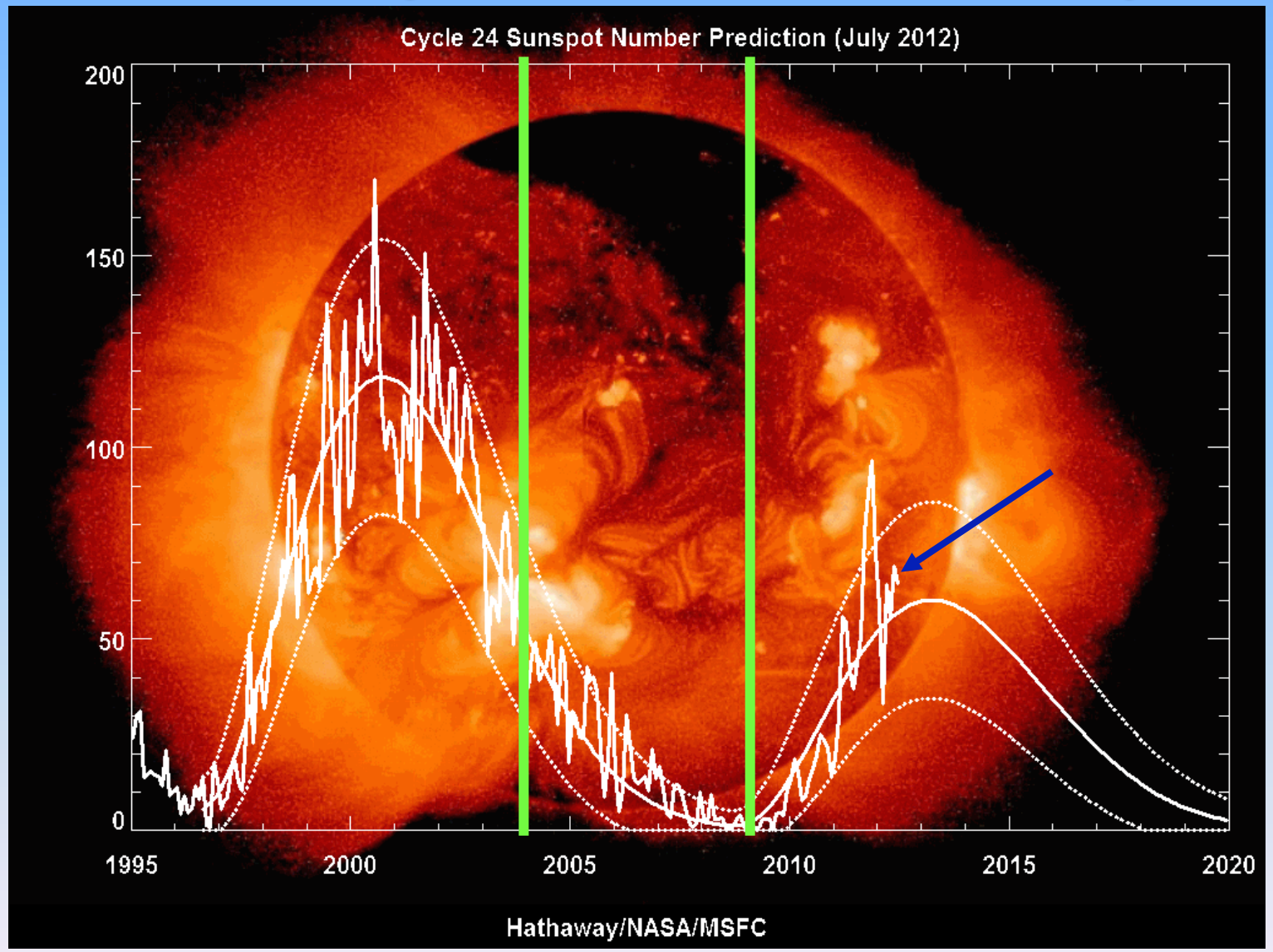
Gamma

Geo-magnetic shielding of cosmic ray

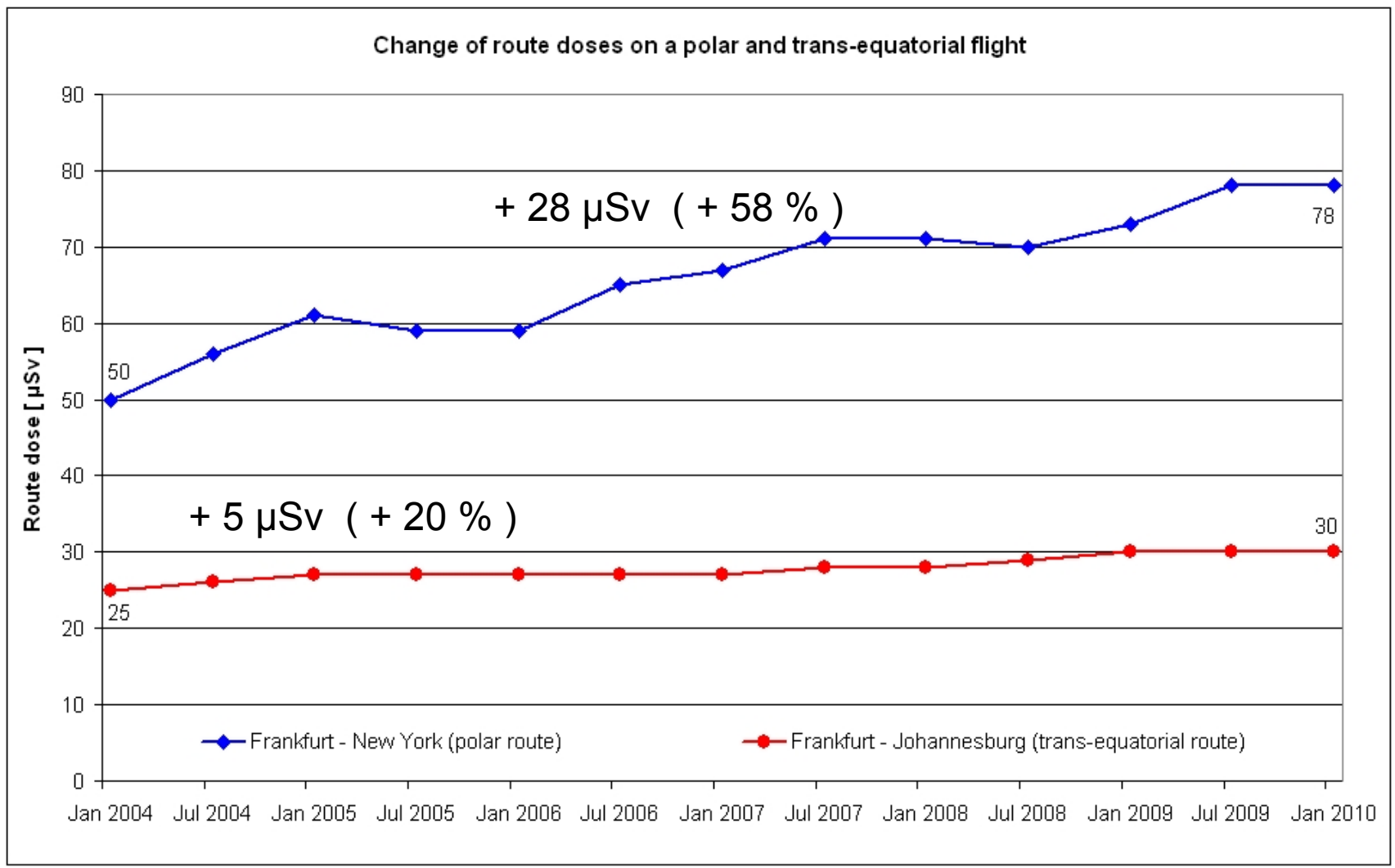
Ambient dose rate by latitude and longitude in 11 km altitude, Dec. 2002



Solar cycle and solar activity



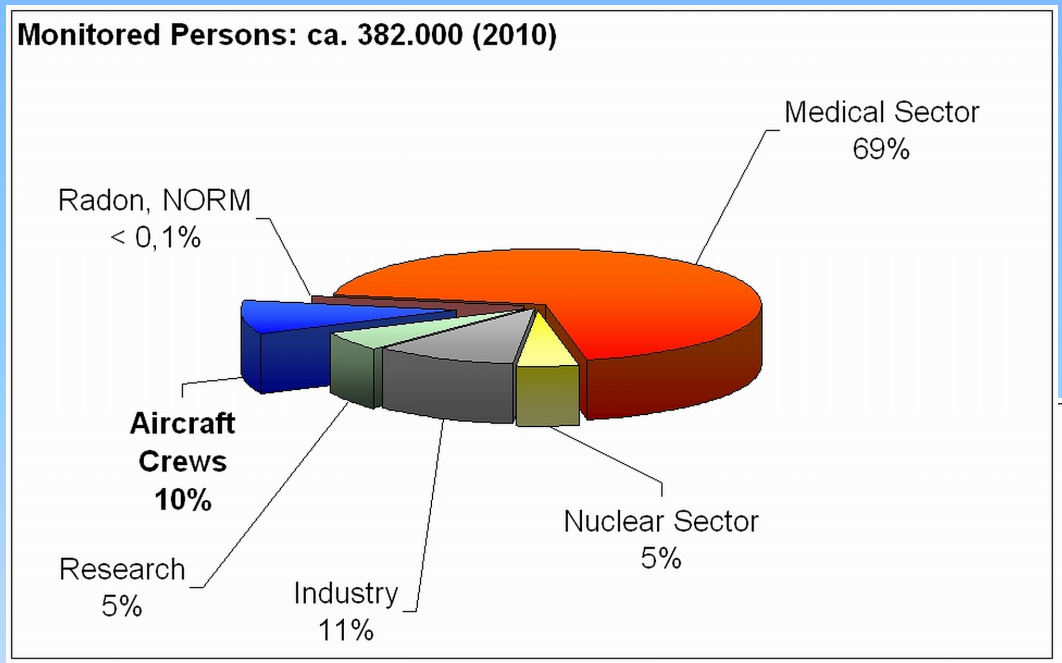
Increase of route doses 2004 - 2009

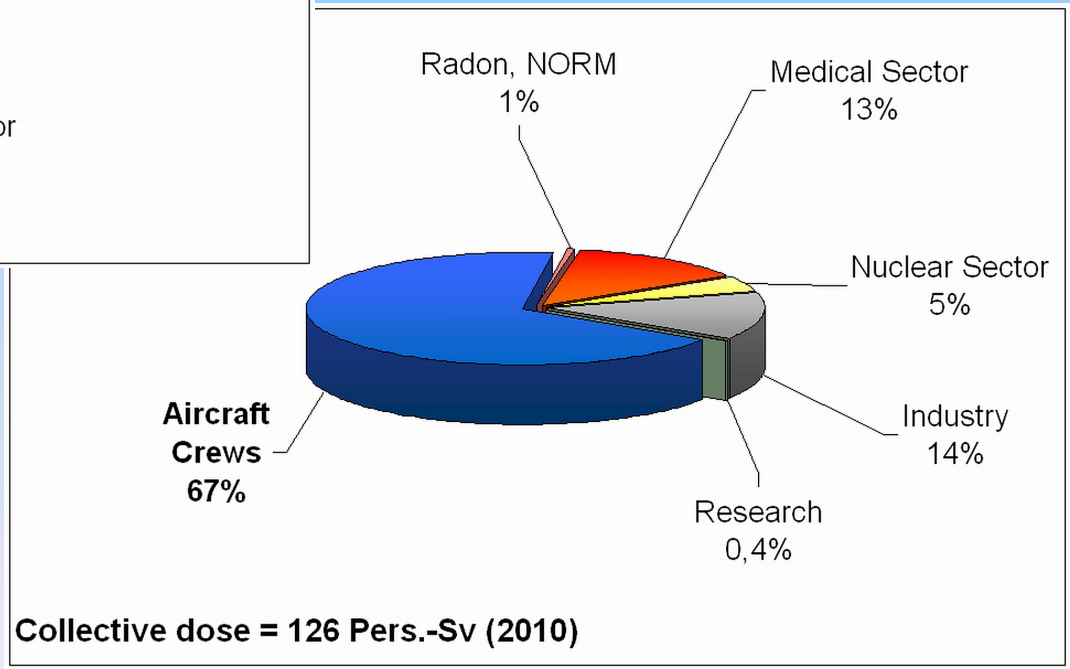


Radiation exposure of German aircraft crews

Radiation exposed work sectors

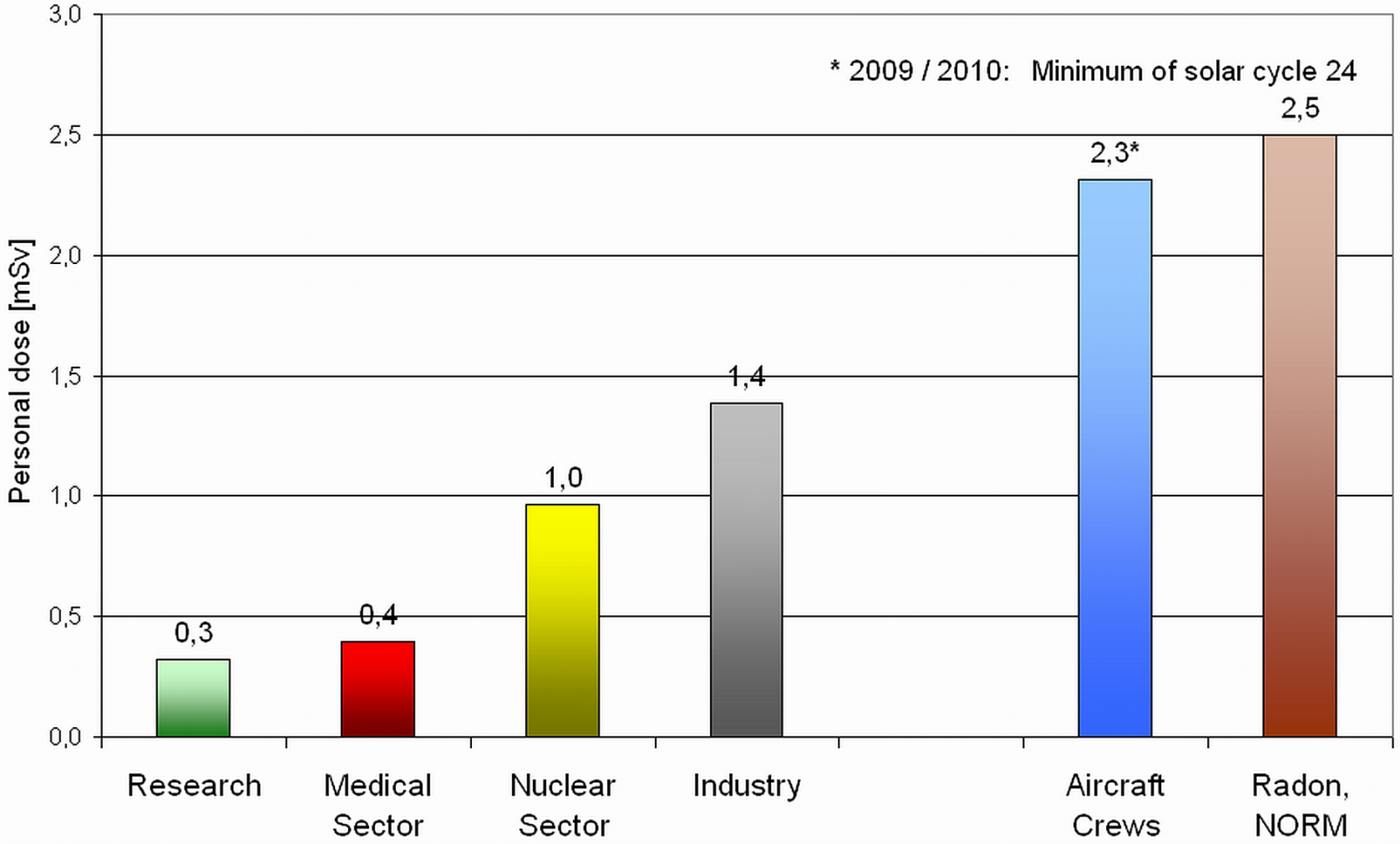
Monitored workers and collective doses in Germany, 2010





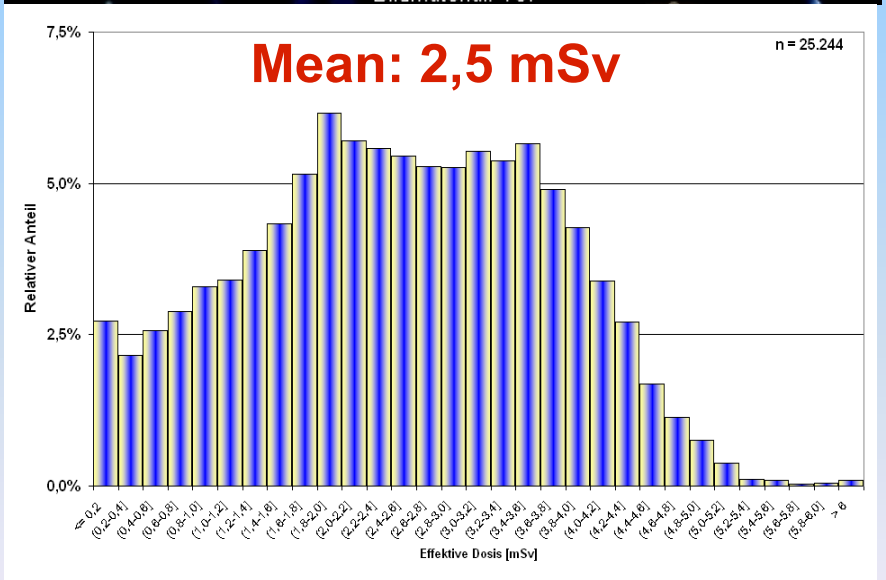
Mean annual dose in work sectors

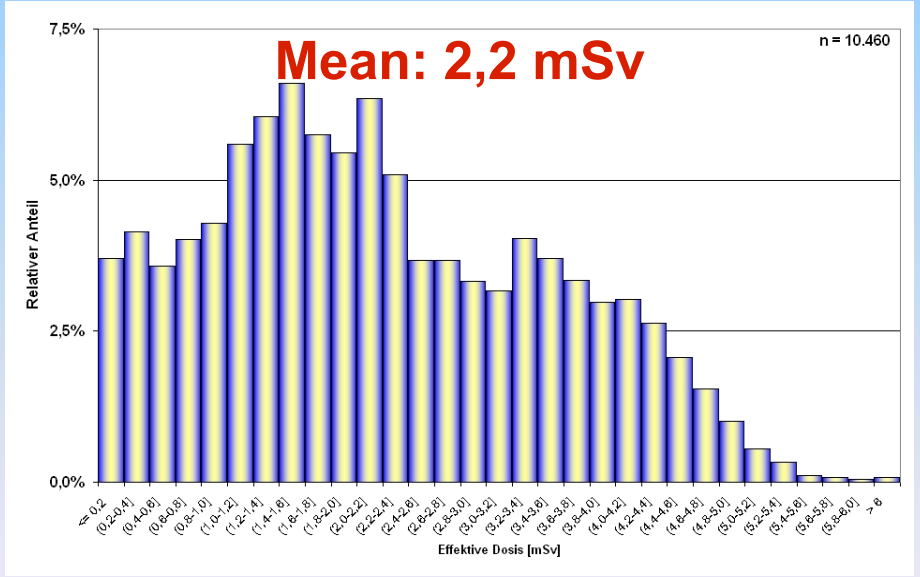
Monitored persons with measurable doses, Germany 2010



Frequency distribution of dose

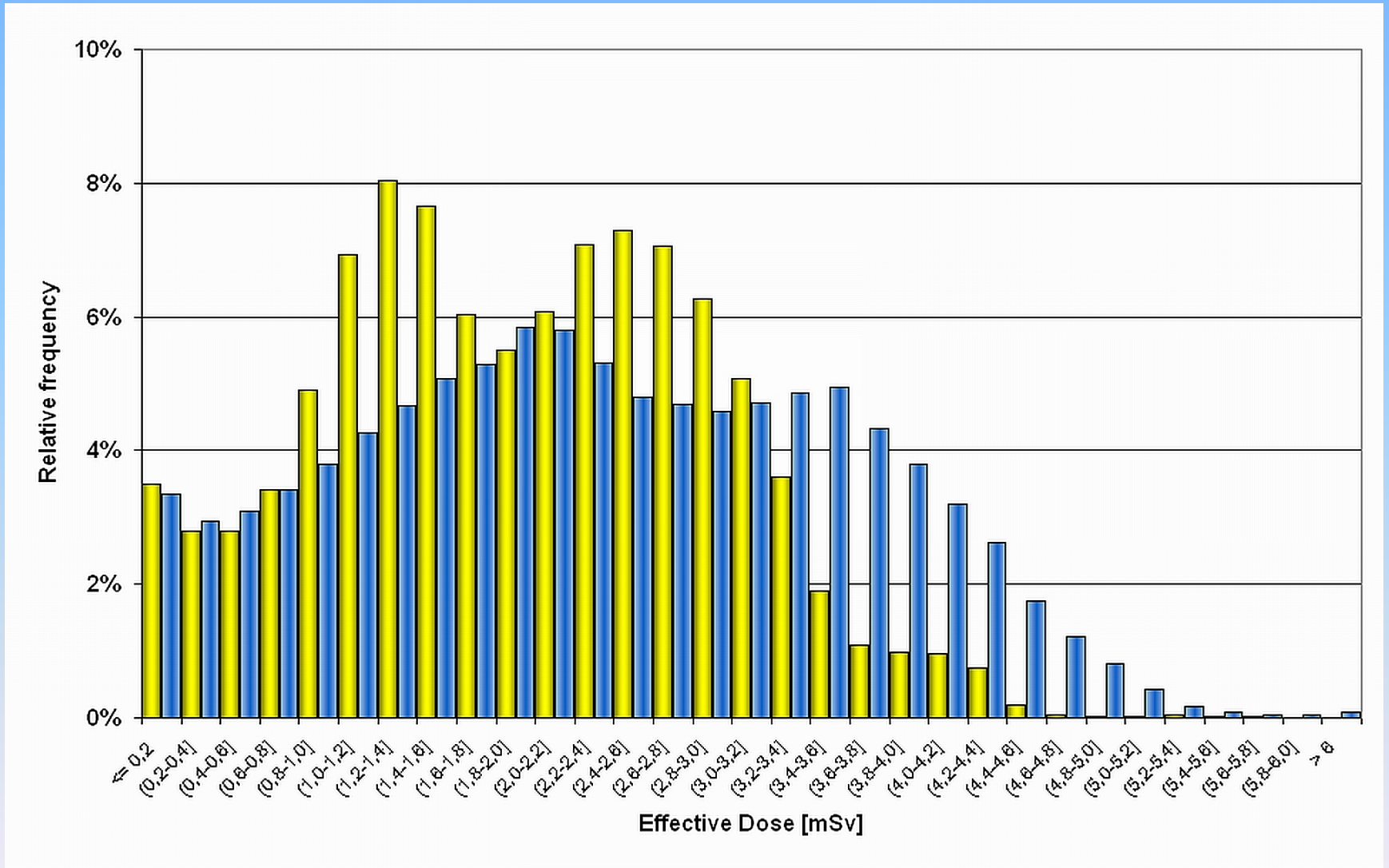
Cabin and cockpit personnel, Germany, 2009





Frequency distribution change

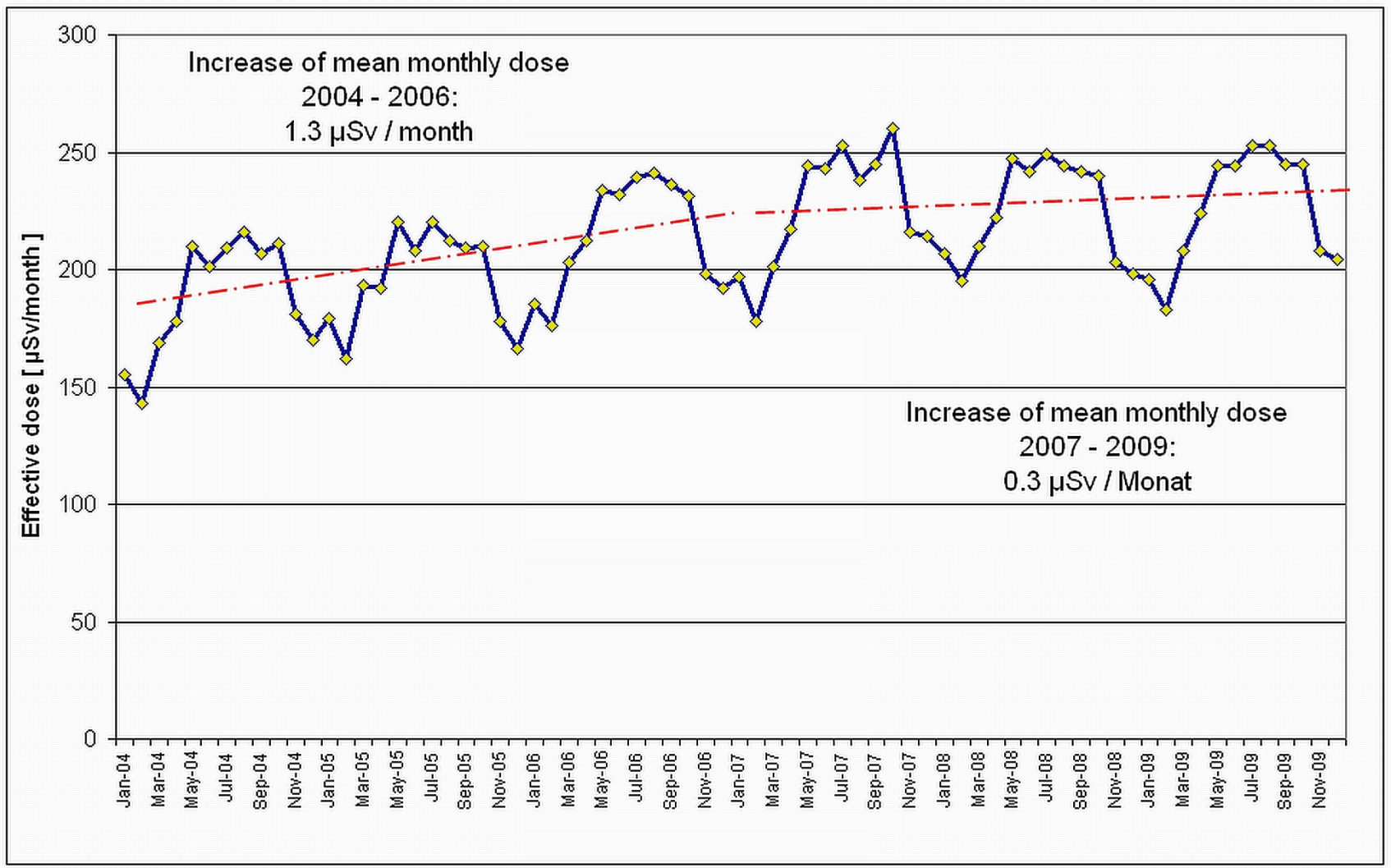
All aircraft crews, Germany, 2004 vs. 2009



Bundesamt für Strahlenschutz

Trend of average monthly dose

All aircraft crews, Germany, 2004 - 2009

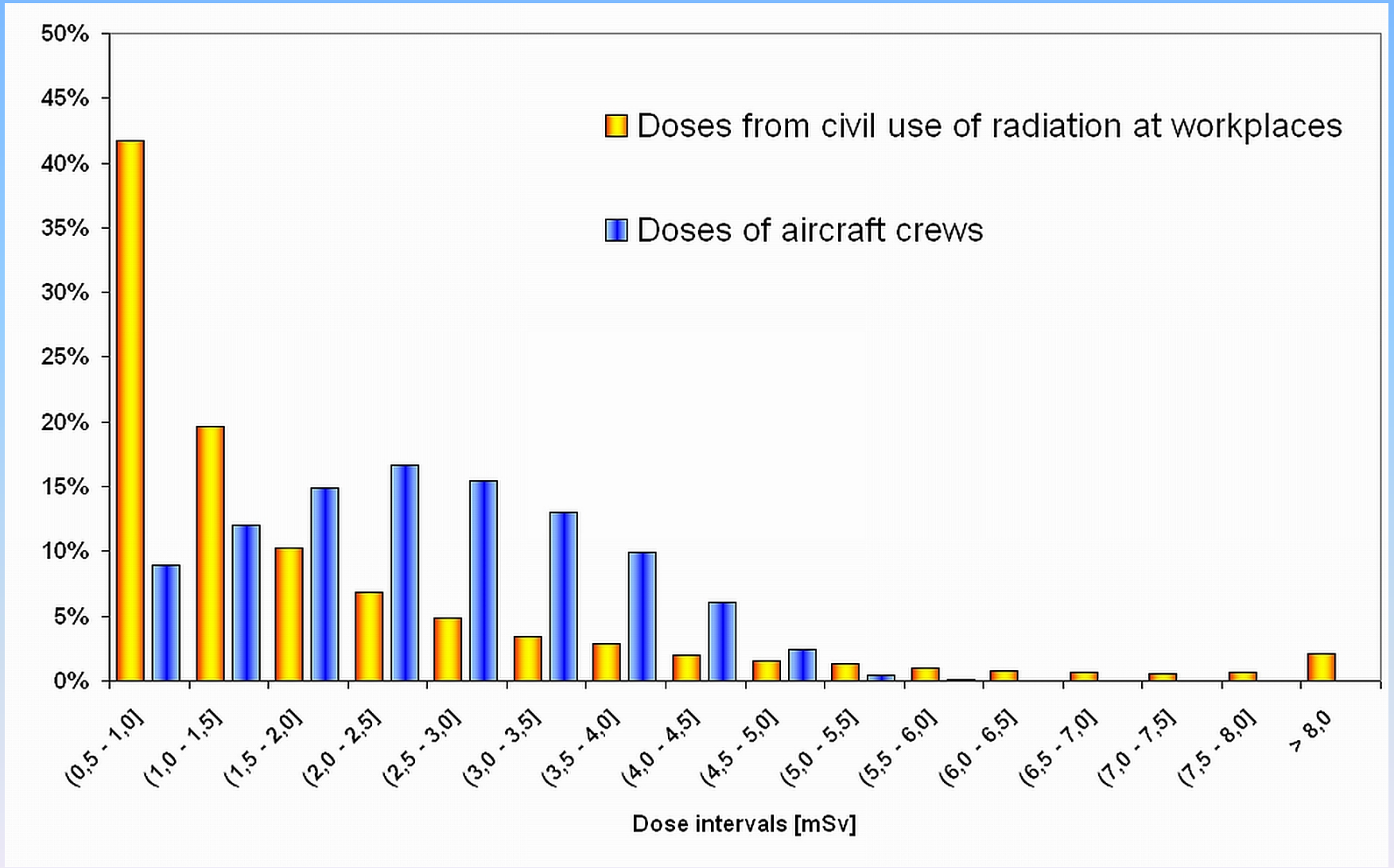


Aviation and optimization

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

ALARA and frequency distributions of dose



Optimization by flight planning

Calculation programs for cost-optimized flight routes:

Target criteria:

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

Optimization by work planning

- Allocation of personnel to route-mix

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

Optimization en route

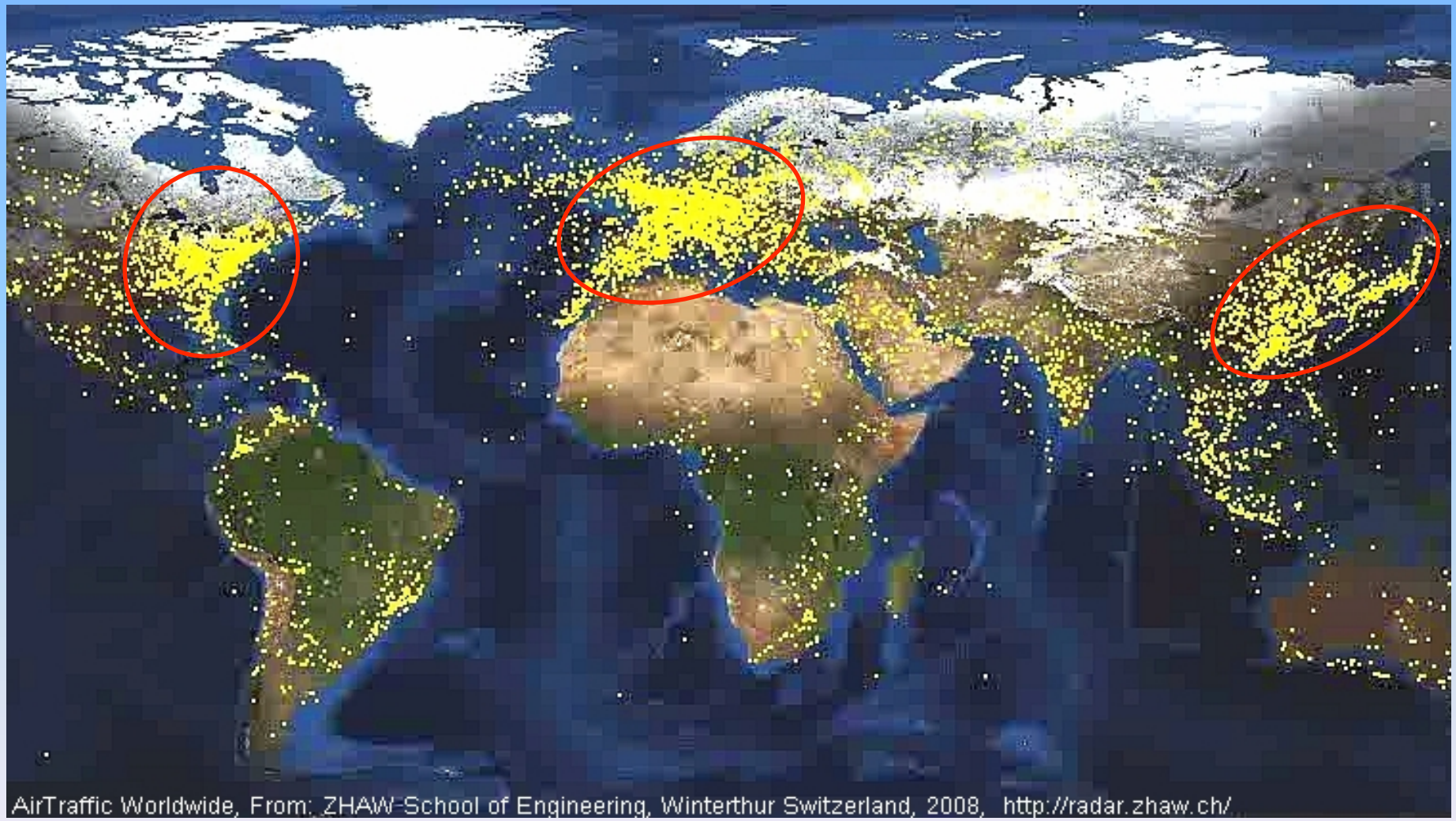
RP policy of IFALPA*

- 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)

*) International Federation of Air Line Pilots' Associations

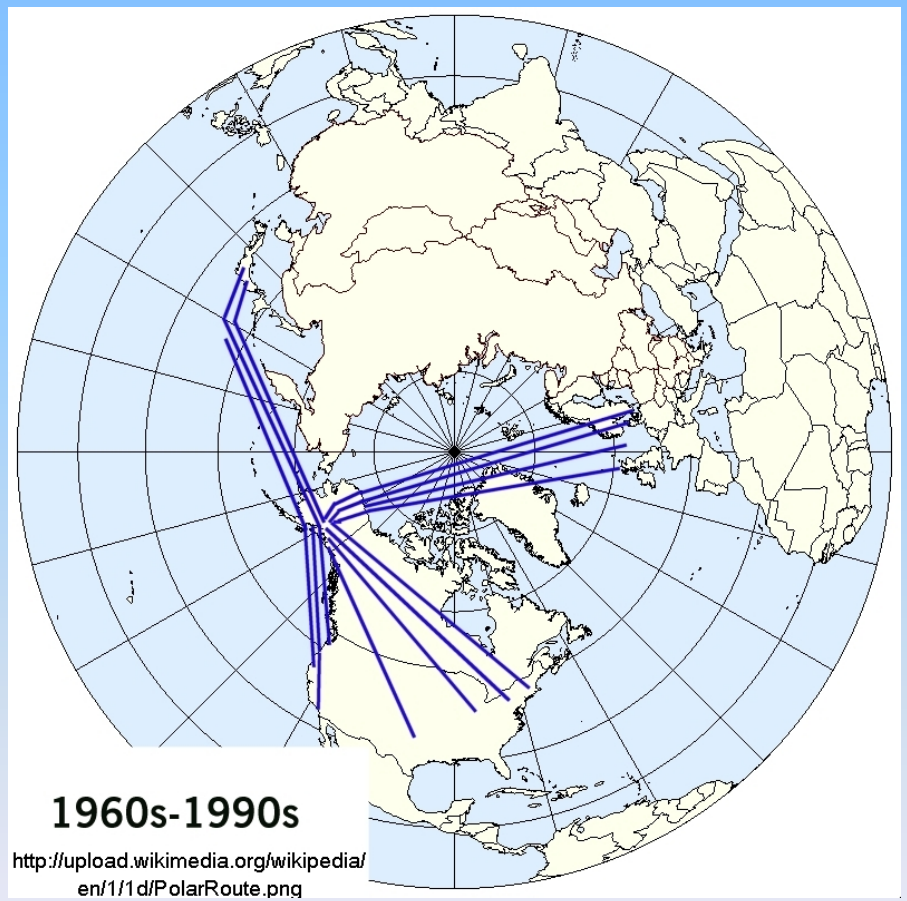
Globalisation and future challenges

Global airspace at 12:00 GMT



Flight routes in polar region

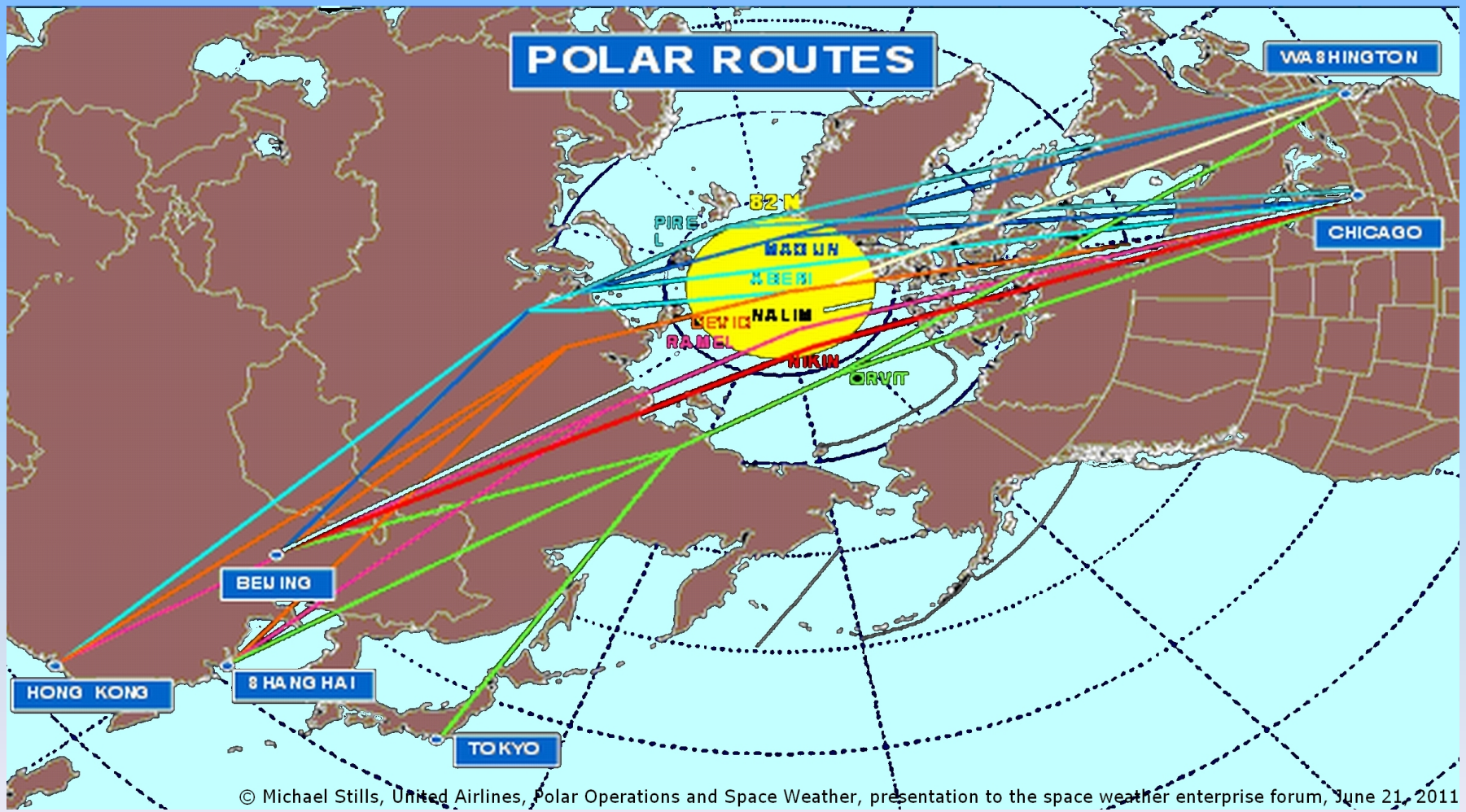
< 2000 “Old Europe”



> 2000 “New Global Player”

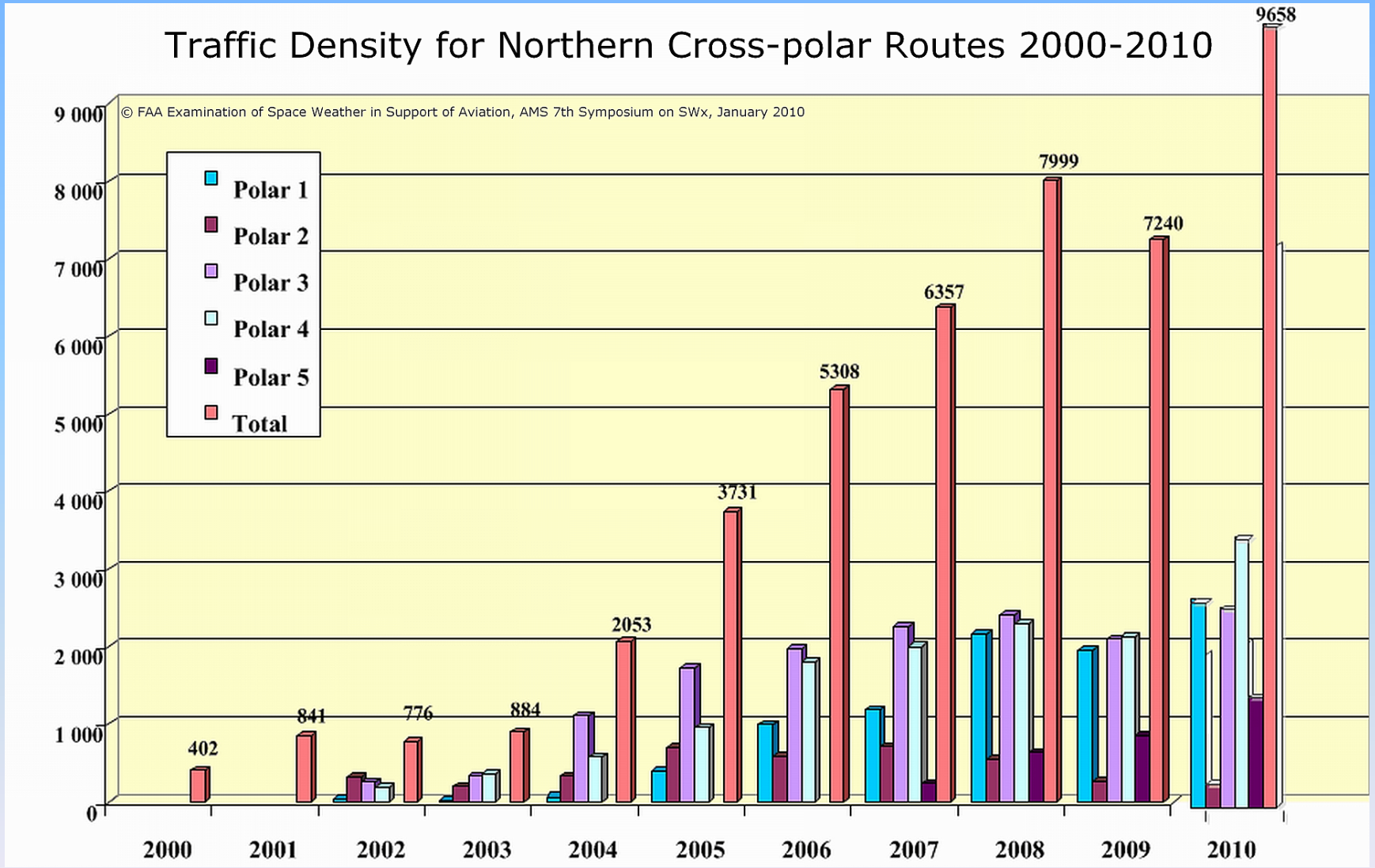
Flight routes in polar region (cont.)

Far East - North America



© Michael Stills, United Airlines, Polar Operations and Space Weather, presentation to the space weather enterprise forum, June 21, 2011

Going global - via North Pole



Future challenges

- Development of new long-range aircraft
- 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)

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