GEOSCIENCES HELP TO PROTECT HUMAN HEALTH: ESTIMATION OF ADSORBED RADIATION DOSES WHILE FLIGHT JOURNEYS AS IMPORTANT STEP TO RADIATION RISK ASSESSMENT

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Natural and artificial sources of radiation dose for general population (collective effective dose equivalent - to 2000 man-Sv or 2000 mkSv/hour for human)

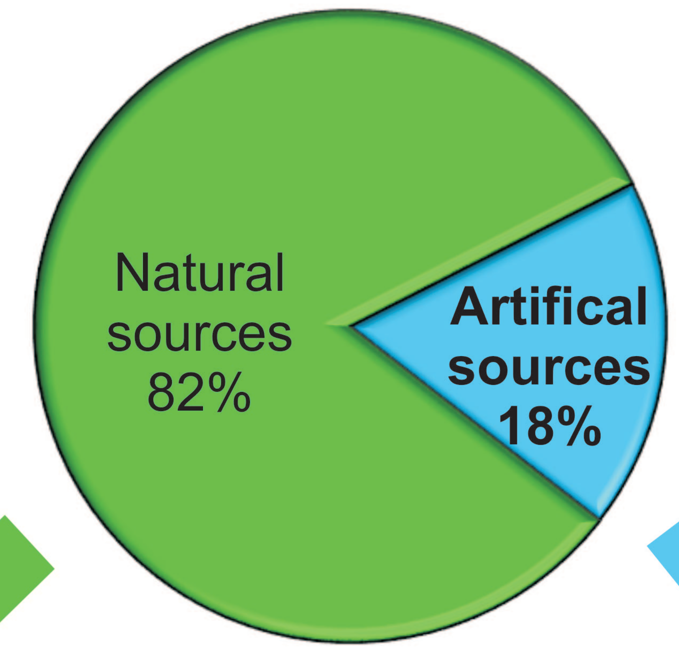

Chart 1

Natural components of radiation dose to general population

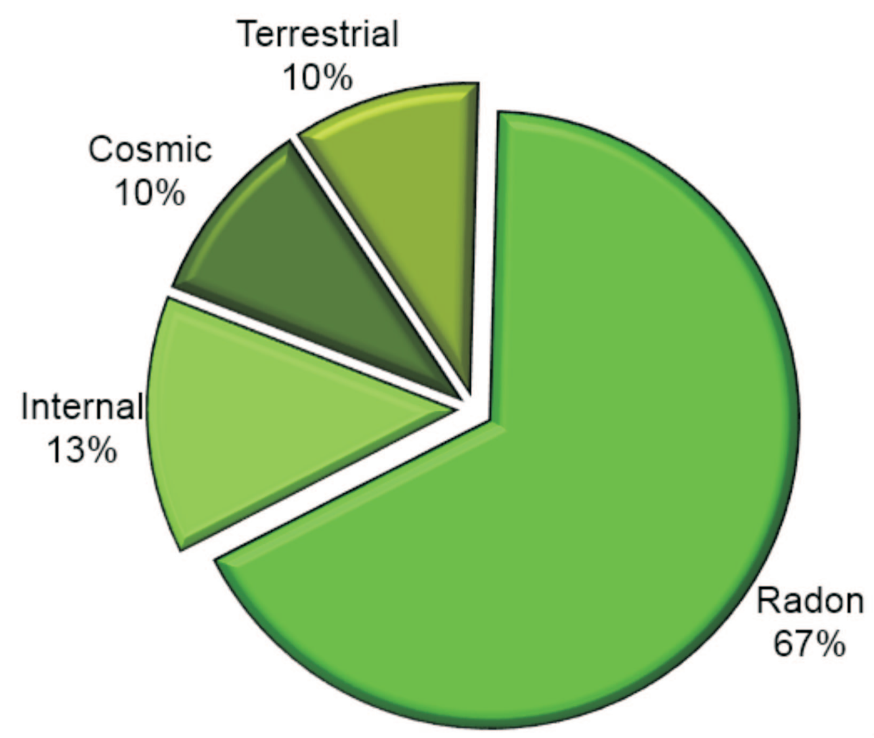

Chart 2

Artificial components of radiation dose to general population

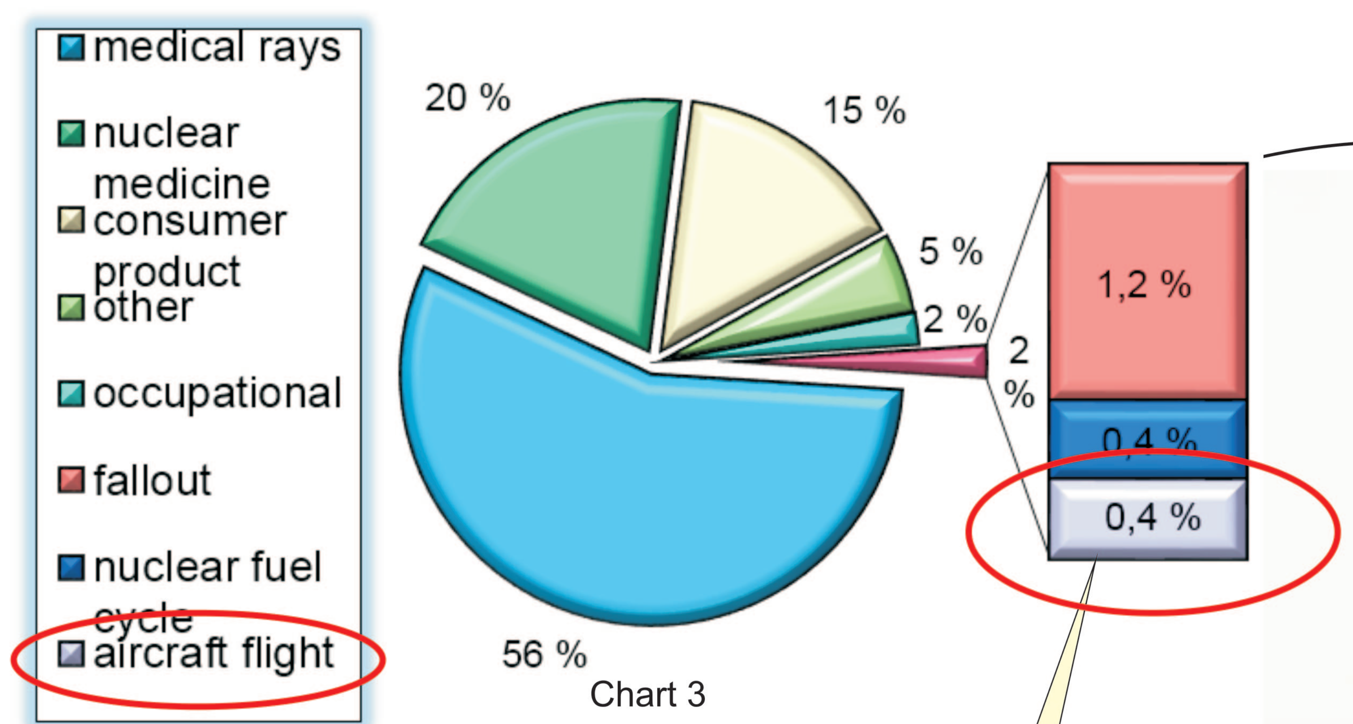

Chart 3

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Bekman, I.N. Radon: Enemy, Doctor, Assistant// Lections - 25p

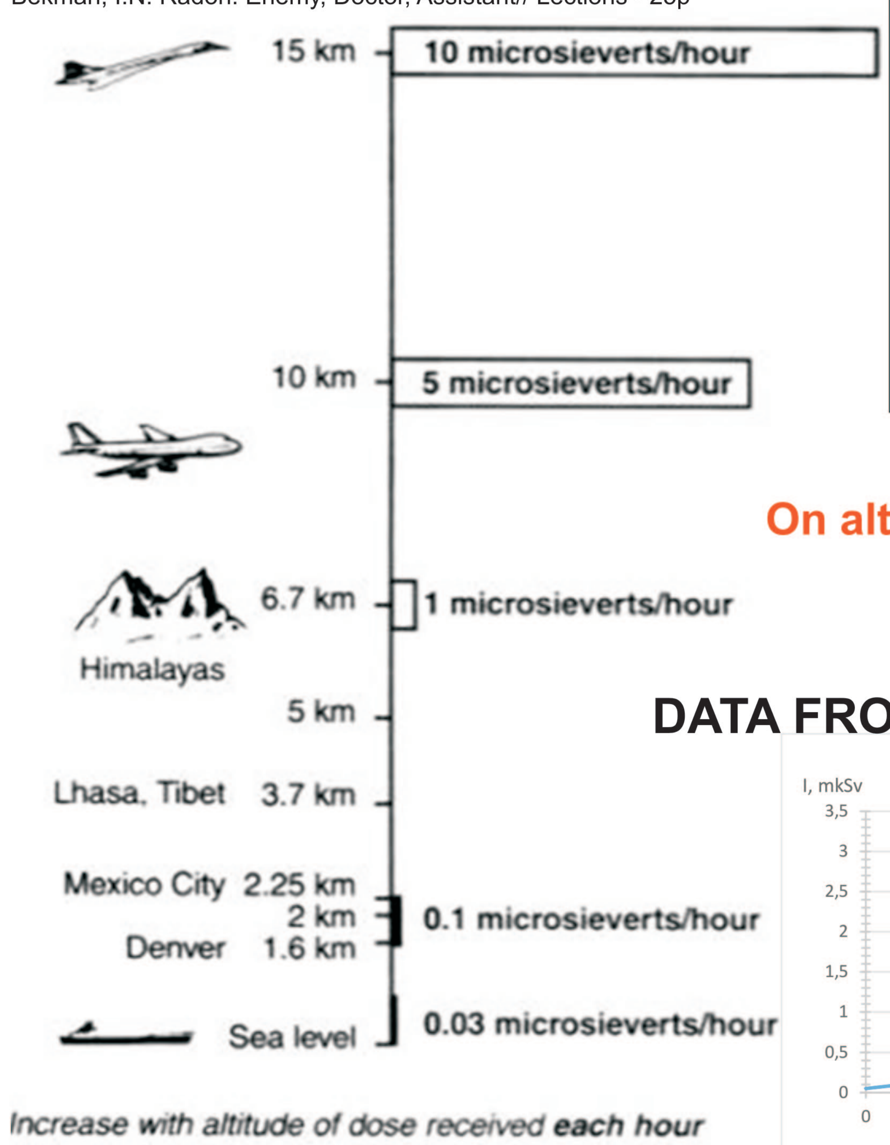

Fig.4 Dependence of radiation doses from altitude

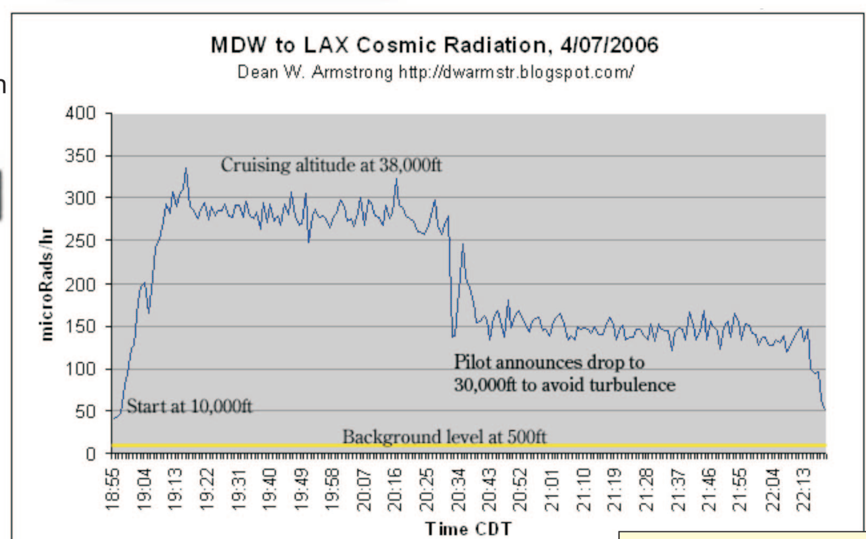

Chart 4

On altitude12-20 km over sea level adsorbed dose is 5-13 mkSv per hour

Should we do risk assessment of radiation level while flight journeys ?

DATA FROM PERSONAL DOSIMETER

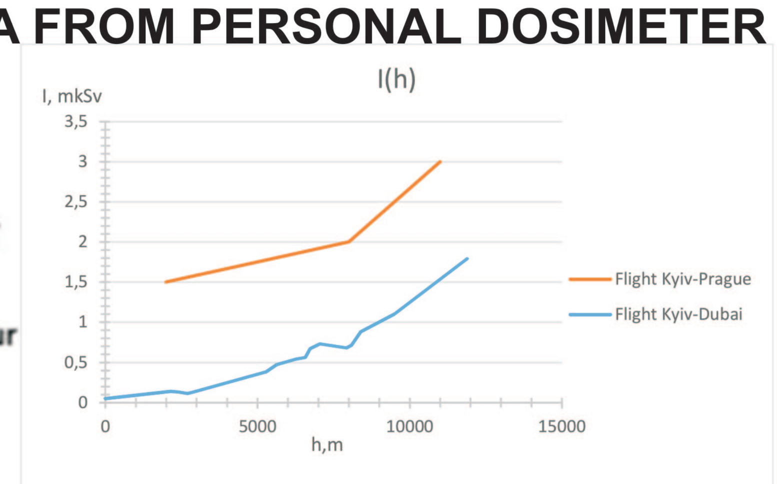

Chart 5 Authors' measurements of radiation during flight journeys.

Collective dose per year during flight journeys may be compared with dose from nuclear fuel cycle BUT ! ! !

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Fig.1 Space

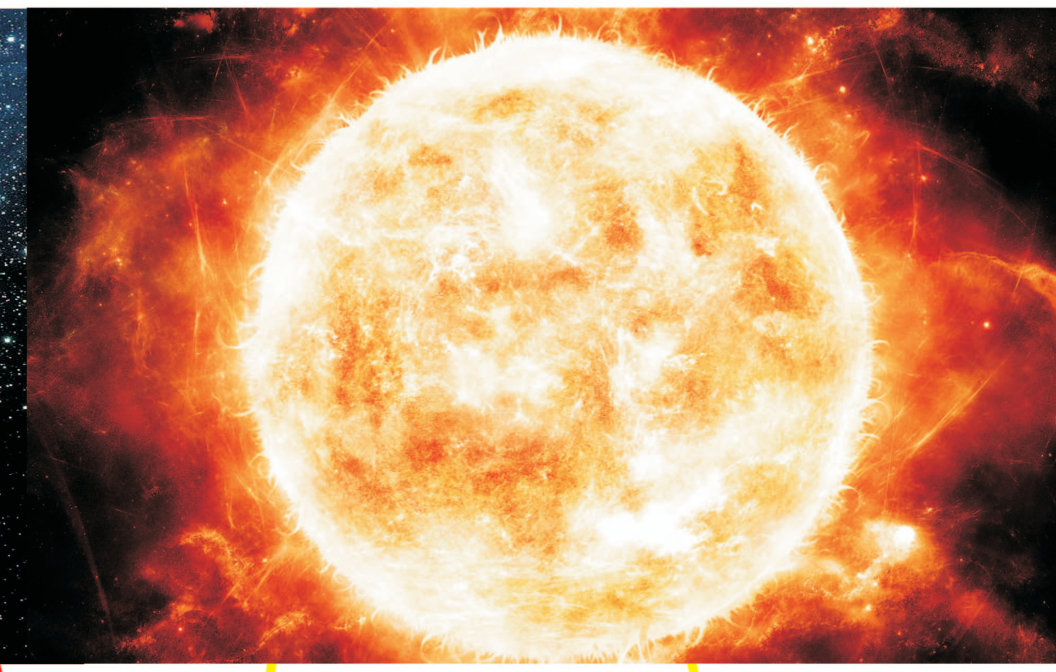


Fig.2 The Sun

Amount of solar radiation in dependence from longitude of the Earth

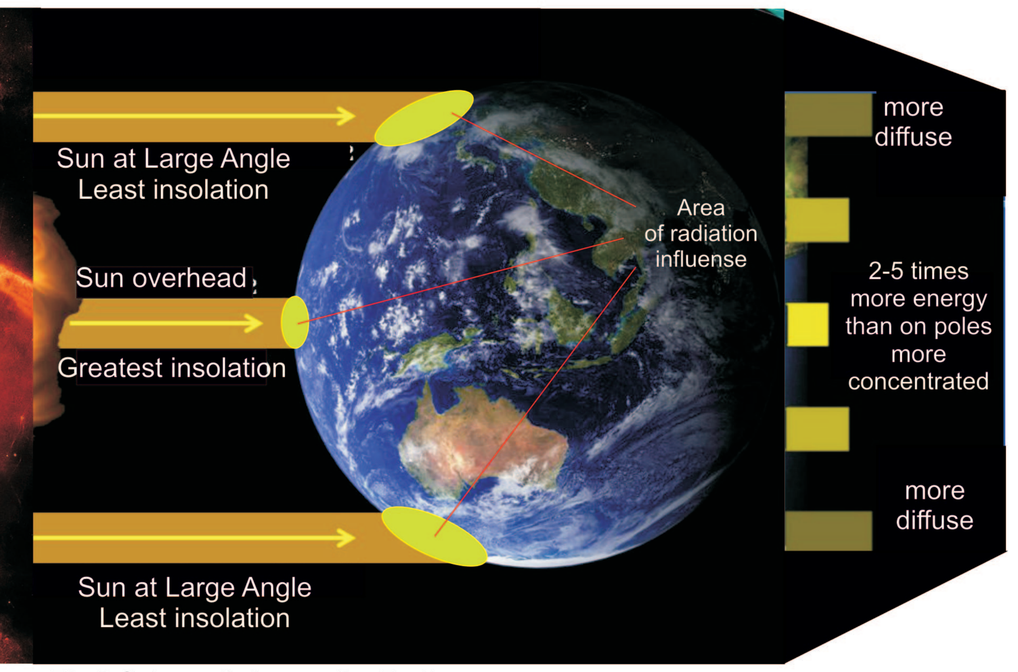
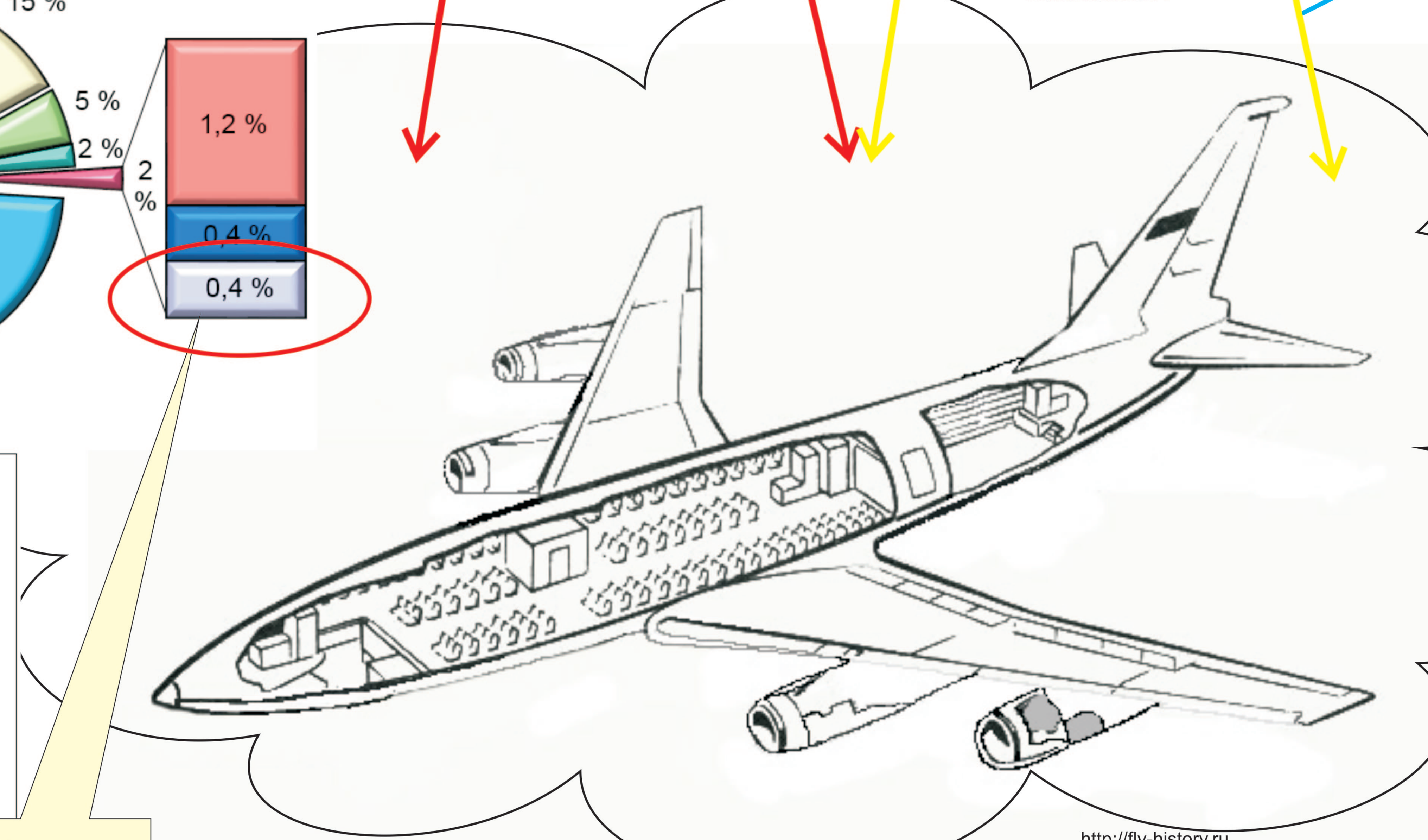


Fig.3 Solar radiation on the Earth

COSMIC RAYS high-energy charged particles E from 0,1 to 50 MeV

SOLAR RADIATION the electromagnetic and corpuscular radiation



http://fly-history.ru

Pic.4 Model of aircraft

Our investigations show, that radiation doses could be dangerous for people, who spend more than 800 hours per year in flight on height from 10 km and in periods of normal solar activity. Also passengers and flight crew can adsorb more doses while journeys during more active solar radiation (solar storms, highest solar activity during the day).

Special algorithm for radiation evaluation is proposed, in which altitude, duration of flight, geographical position, meteorological conditions and solar activity variations are taken into consideration.

Solar radiation not stable during the year. In different seasons different parts of the Earth are irradiated not equally.

ALGORITHM FOR RADIATION EVALUATION

DISTRIBUTION OF DIRECT SOLAR RADIATION

$$Q_\varphi = \frac{2S_0}{R^2} P^m \left[t \sin\varphi \sin\delta + \frac{\Pi}{2\pi} \cos n\varphi \cos\delta \sin\left(\frac{2\pi}{\Pi} t\right) \right]$$

DISTRIBUTION OF DIRECT SOLAR RADIATION AS A FUNCTION OF CLOUDNESS FACTOR (a, n, b)

$$Q_c = Q_0 \left(1 - an - bn^2\right)$$

DISTRIBUTION OF TOTAL DIRECT SOLAR RADIATION AS A FUNCTION OF LATITUDE (φ)

$$Q_d = \frac{I_0 \Pi}{\pi} \cos\varphi$$

DISTRIBUTION OF TOTAL SOLAR RADIATION DURING THE DAY (t_1 - time of sunrise; t_2 - time of maximum solar activity; t_3 - time of sunset)

$$Q_{inc}(t) = \begin{cases} 0, \; 0 \le t \le t_1, \\ Q_{\max} \sin^p \left[\frac{\pi (t - t_1)}{t_1} \right], & t_1 \le t \le t_2, \\ Q_{\max} \sin^q \left[\frac{\pi (t - t_2)}{t_2} \right], & t_2 \le t \le t_3, \\ 0, \; t_3 \le t \le 24, \end{cases}$$

ADSORBED DOSES FROM SOLAR RADIATION

$$R = 1{,}4 \left[K_{dr} e^{(-0.51+0.386h)} + (K_{df} + K_{rf})(0.0013 + 0.033 \ln H)(1 - 0.01 a_c) I_{rc} \right] \quad \delta \le 5^\circ$$
$$R = 1{,}4 \left[K_{dr} e^{(18.81/h-0.235)} + (K_{df} + K_{rf})(0.0013 + 0.033 \ln H)(1 - 0.01 a_c) I_{rc} \right] \quad \delta > 5^\circ$$

ADSORBED DOSES FROM SOURCES OF RADIATION WITH HETEROGENOUS PARAMETERS (cosmic radiation)

$$P_\gamma = \frac{q \times 3.7 \times 10^7 \times 2\pi \times \sum_i E_{\gamma_i} n_i \mu'_{e,i} d \times 1.6 \times 10^{-6} \times 3600}{0.144} \left[\frac{P}{год} \right]$$

CONCLUSIONS

According to the shown results **FLIGHT JOURNEYS ARE SAFE** for people, who spend less than 800 hours per year in flight on height from 8000 m above Earth surface and fly while stable solar activity. **BUT** flight journeys **COULD BE DANGEROUS FOR HEALTH** if human spend more than 800 hours per year in flight on height from 8000 m above Earth surface and if some-times fly while increased solar activity (solar storms, annual and diurnal periods of highest solar radiation).

Proposed steps of **RADIATION COMPONENTS EVALUATION** will allow to predict amount of possible adsorbed doses for passengers and crew while flight journeys and **PREVENT OVERRADIATION OF PEOPLE**. Unfortunately there is not enough available for authors precise information about components to create working algorithms for exact predictions

Dependence of solar radiation from period of the year

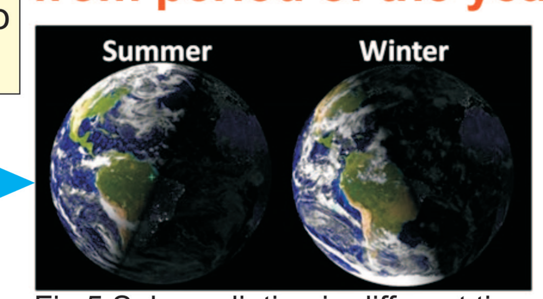


Fig.5 Solar radiation in different time of year

Dependence of solar radiation from period of the day

City	longitude	MJ/m^2
Kyiv	52°	629
Dubai	25°	1123

Table 1 Solar energy dependence from longitude
Solar radiation and radiation balance data // St.Petersburg - 2009

On Chart 5 it is shown that solar radiation is higher during flight Kyiv-Prague than during flight Kyiv-Dubai, but according to the information on table 1, it should be vice versa. That effect occur, because flight Kyiv-Prague was during the period higher solar activity - midday and flight Kyiv-Dubai was during the evening - lower solar activity. That example shows, that **period of the day is more influential factor on amount of radiation, than longitude.**

Acknowledgements

Bekman, I.N. Radon: Enemy, Doctor, Assistant// Lections
Radiation: doses, effects, risks [1990] // Moscow
Solar radiation and radiation balance data (the world network) January - March 2006 [2009]// St.Petersburg
http://fly-history.ru
http://NCRPonline.orgaa