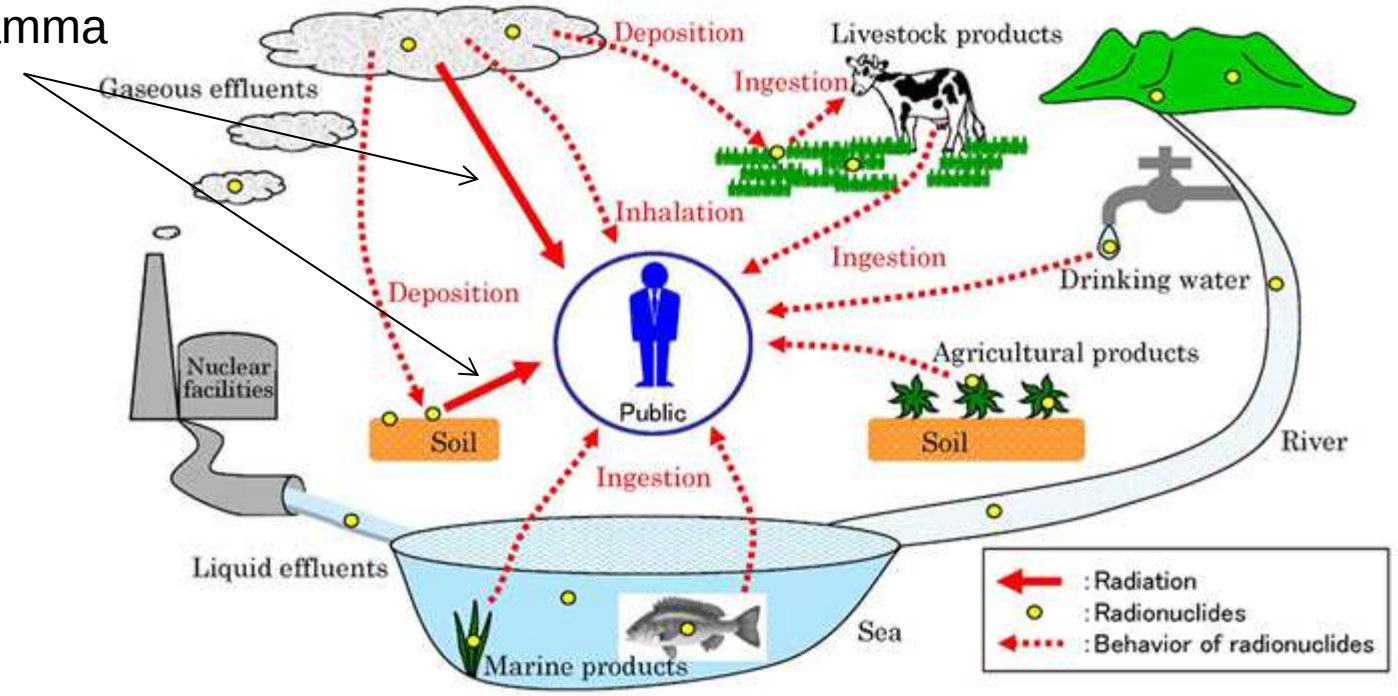
Nuclear sources – radioactivity considerations

Questions? Write delia.arnold-arias@zamg.ac.at

Radioactivity considerations

- Exposure pathways and why ATM is important

RN of concern: gamma emitters



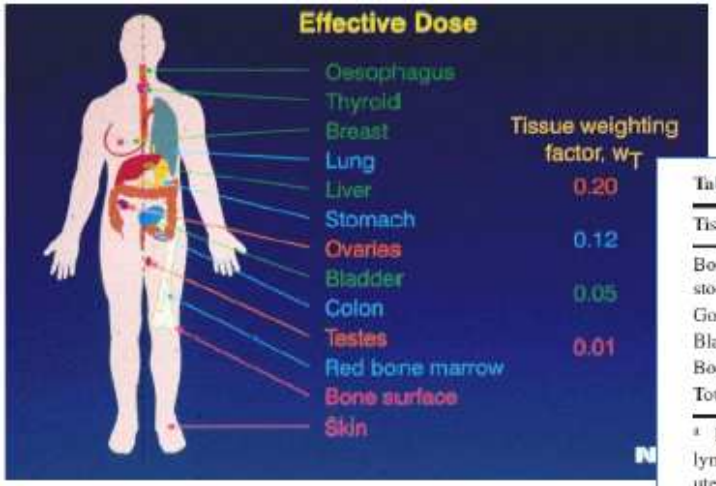
http://www.jaea.go.jp/english/04/ntokai/houkan/houkan_02.html

Radioactivity considerations

- From concentrations to doses? (ICRP Pub 74)

$$E = \sum_{T} w_T \sum_{R} w_R D_{T,R}$$

Depending on radiation type



2007 recommendations of ICRP

Table 3. Recommended tissue weighting factors.

Tissue	Tissue weighting factor, w_T	Sum of w_T values
Bone-marrow (red), colon, lung, stomach, breast, remainder tissues[a]	0.12	0.72
Gonads	0.08	0.08
Bladder, oesophagus, liver, thyroid	0.04	0.16
Bone surface, brain, salivary glands, skin	0.01	0.04
Total		1.00

[a] Remainder tissues: Adrenals, extrathoracic (ET) region, gall bladder, heart, kidneys, lymphatic nodes, muscle, oral mucosa, pancreas, prostate (♂), small intestine, spleen, thymus, uterus/cervix (♀).

D (ambient concentration, intake factor (inhalation rate, location), time of exposure, counter measures, age, gender, deposition…)

Examples of (simplified – assuming semi-infinite cloud) calculations:

DOSE in Sv = Cloudshine coefficient (Sv m^3 Bq^{-1} s^{-1}) X Concentration of radioactivity in the air (Bq m^{-3}) X duration over which this concentration is encountered (s)

DOSE RATE in Sv hr^{-1} = Cloudshine coefficient (Sv m^3 Bq^{-1} s^{-1}) X Concentration of radioactivity in the air (Bq/m^3) X 3600 s / hour

Radioactivity considerations

- From concentrations to doses? (ICRP Pub 74)

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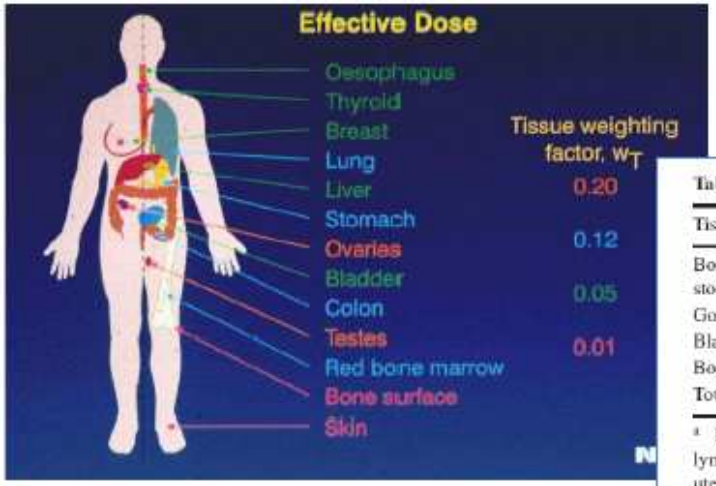

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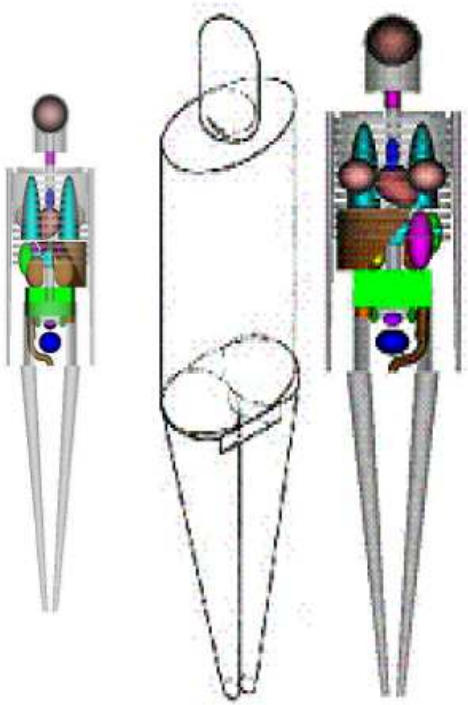
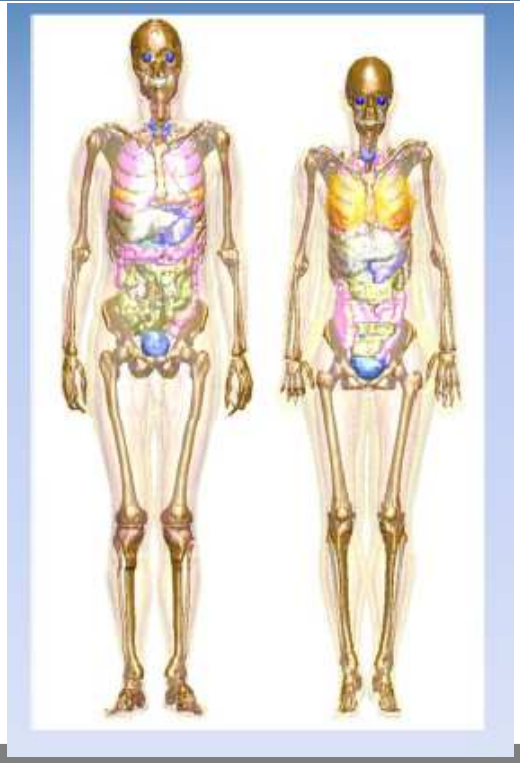


Dose coefficients based on Adam and Eva phantoms and MC simulations



Radioactivity considerations

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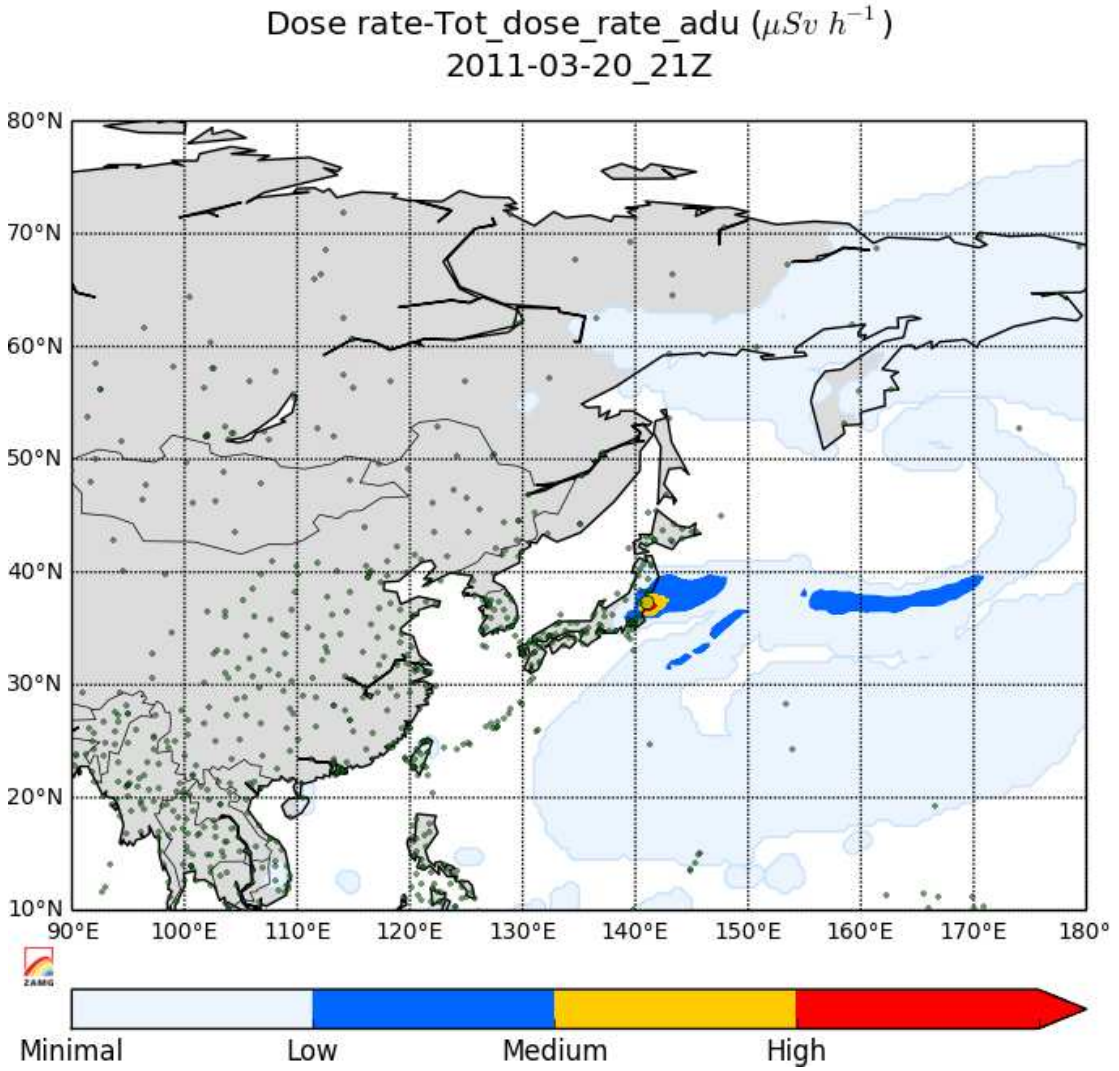


Radioactivity considerations

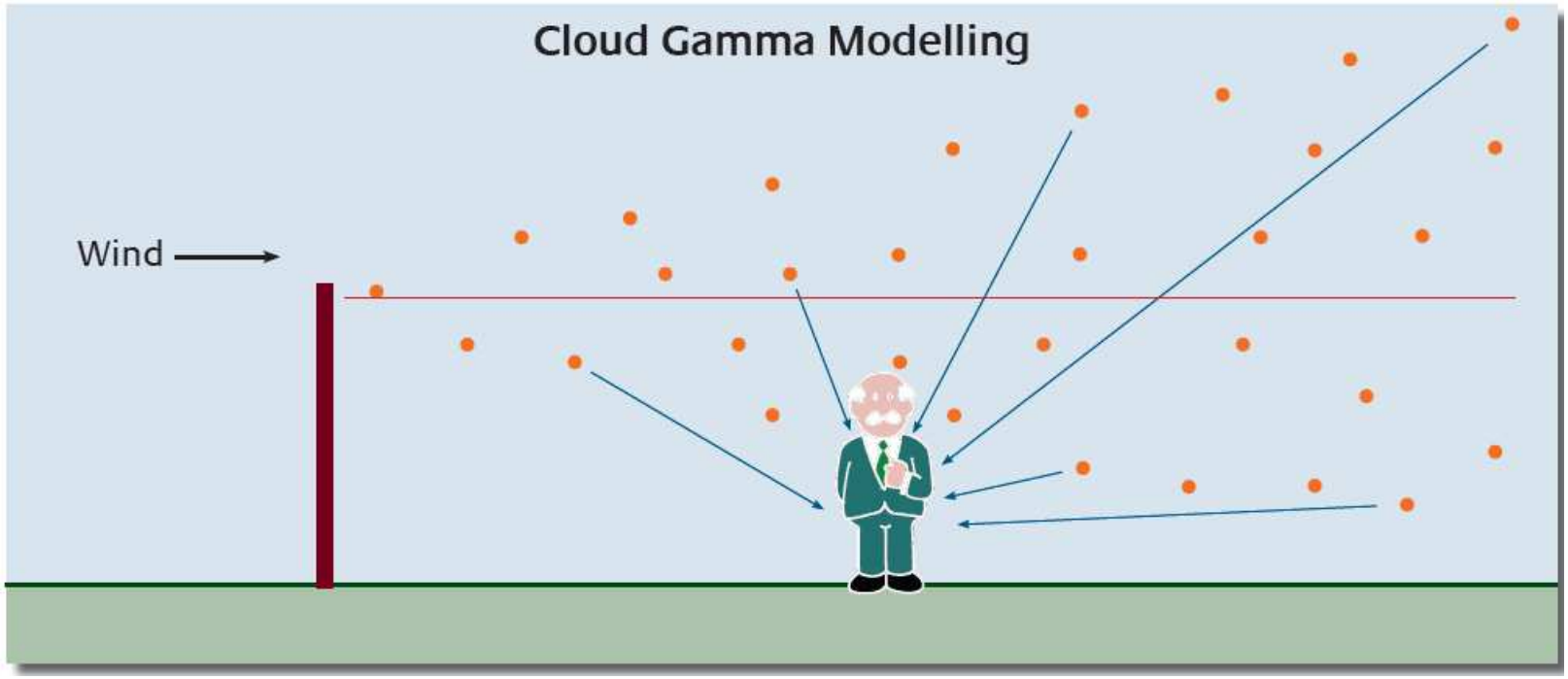
Type of limit	Occupational	Public
Effective dose	**20 mSv per year**, averaged over defined periods of 5 years and not exceeding 50 mSv in any single year	**1 mSv in a year**, or exceptionally more in a single year provided that the average over 5 years does not exceed 1 mSv per year
Annual equivalent dose in:		
Lens of the eye	150 mSv	15 mSv
Skin [2,3]	500 mSv	50 mSv
Hands and feet	500 mSv	-

- a chest x-ray: 0.2 mSv
- a scan: up to 10 mSv
- a (return) transatlantic flight = 0.04 mSv.

On average person in Ireland gets about 4000uSv/year just from natural sources (http://www.epa.ie/radiation/radexp/exposure/#.VL9CQMnJKWw)

Radioactivity considerations

Careful with approximations!



Bedwell et al. (NAME III) – non-well mixed cloud or proximity to the source

What about decay chains? Considerations on the half-lives and changes of species need to be made