Impact of climate models on biosphere dose estimations

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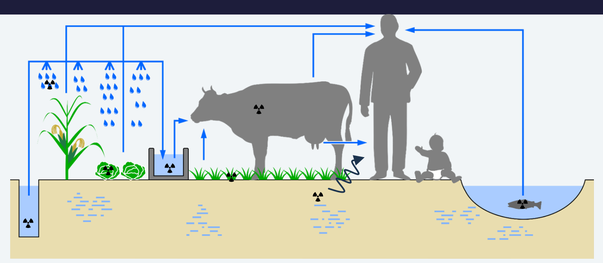
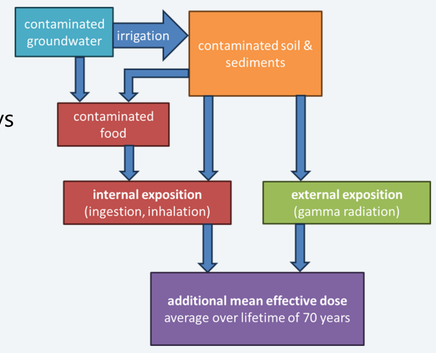
Motivation



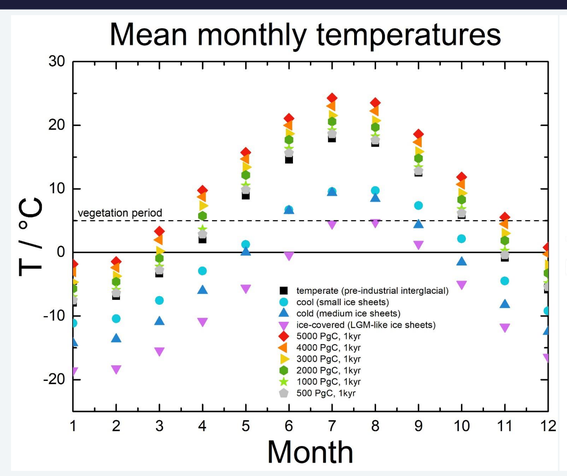


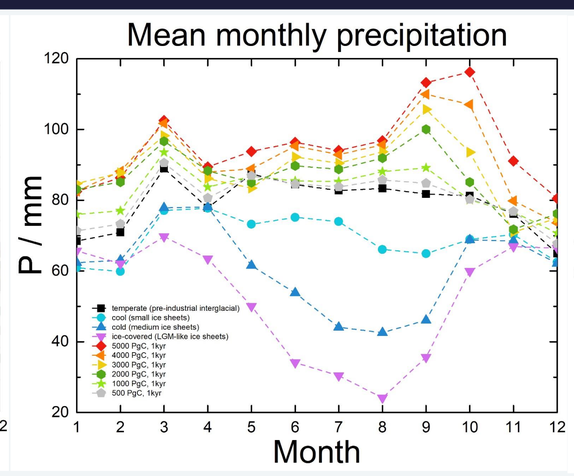
- Dose calculation required by EndlSiAnfV § 7
- Exposure pathways given by BASE (2022) [1]
- Final repository & biosphere exposed to different climates (evaluation period: 10^6 yr)
- Irrigation deficit governed by climatic conditions (temperature, precipitation, humidity)
- Radionuclides: agricultural irrigation (groundwater) crucial pathway into biosphere
- Activity concentration in food and environmental media affect radiation dose

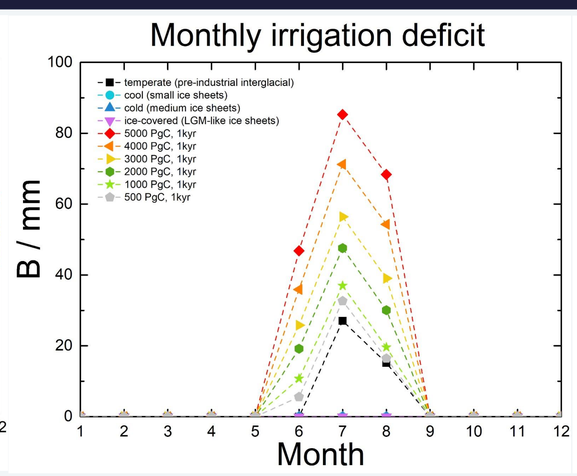
Methods

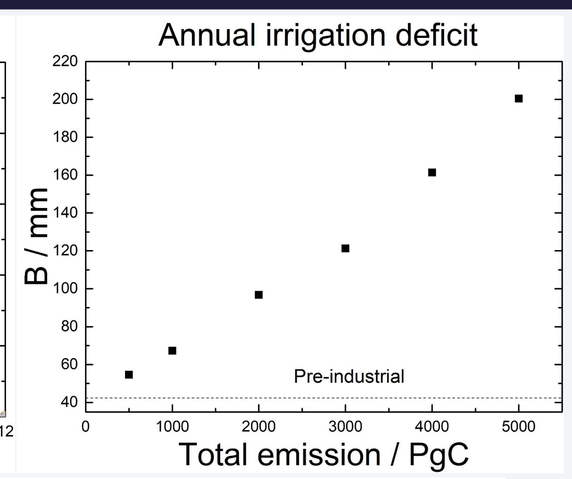
- Equilibrium and transient CLIMBER-X modeling (PIK)
- Reference: temperate climate (pre-industrial interglacial)
- Distinct states: cool, cold, ice-covered
- Active anthropocene: six carbon emission scenarios, sampled 1 kyr after present
- Radiation dose estimation in accordance with BASE (2022) [1]
- External & internal exposure pathways
- Geosphere not considered → dose conversion factors (DCF)
- Steady lifestyle, agricultural and dietary habits assumed → comparable conditions

Results and discussion

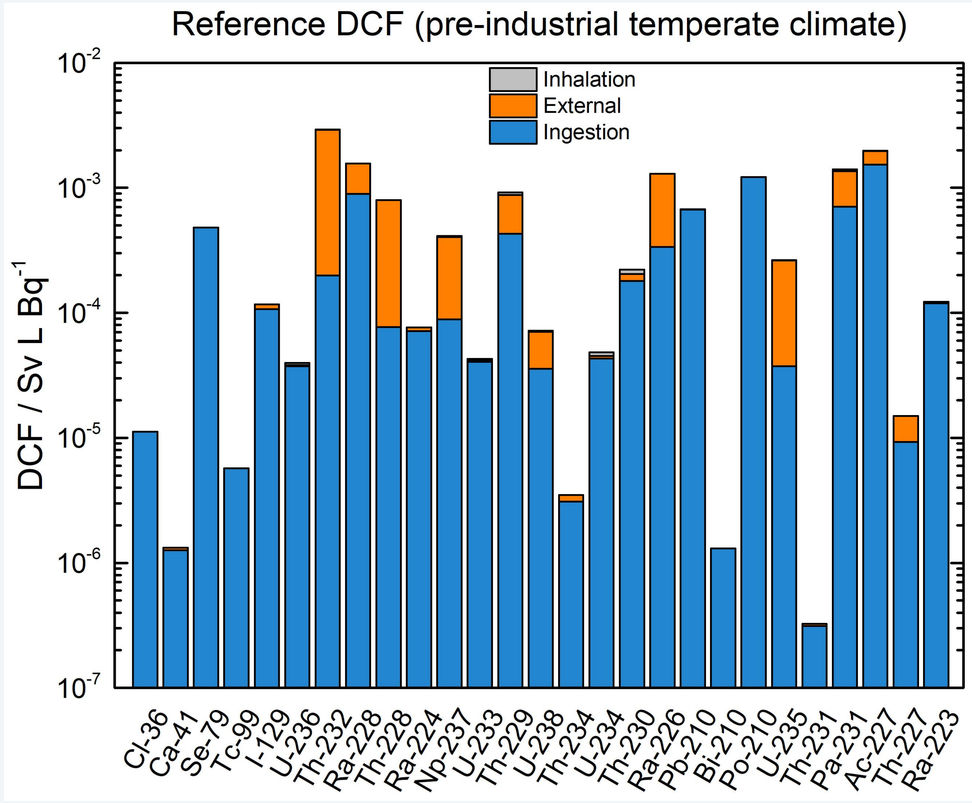




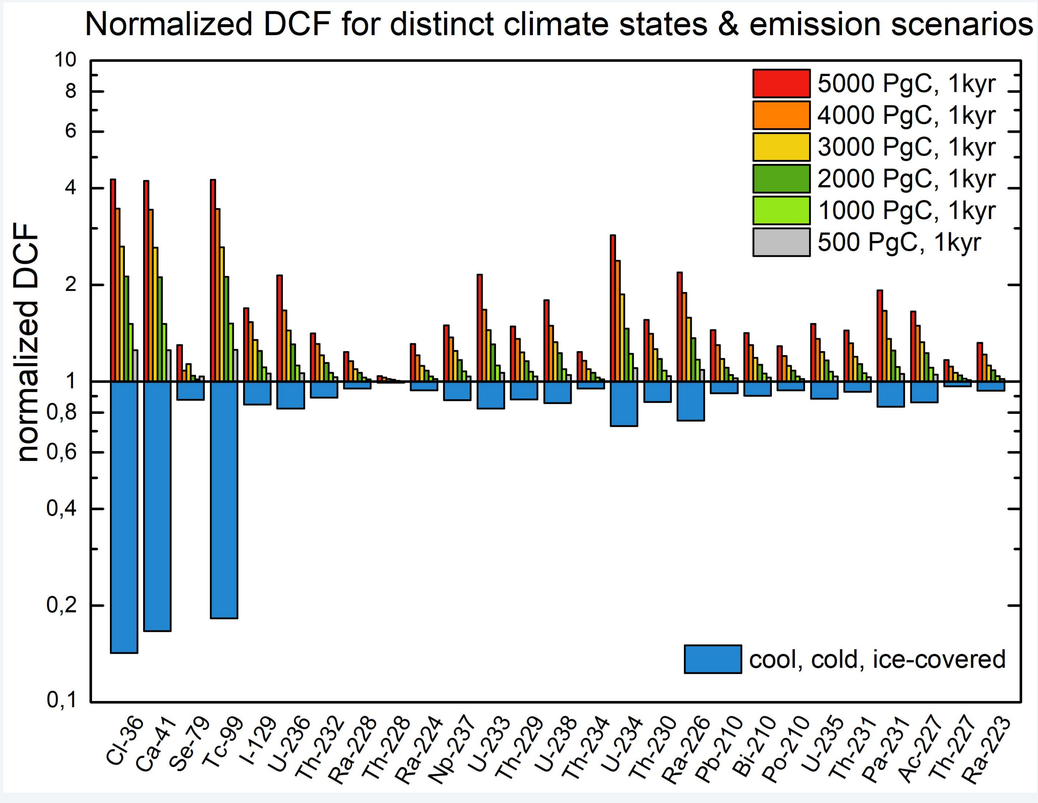




Reference DCF (pre-industrial temperate climate)



Normalized DCF for distinct climate states & emission scenarios



- Elevated DCF for all radionuclides and all carbon emission scenarios compared to pre-industrial temperate climate due to increased irrigation demands
- Irrigation deficit and DCF increase with total carbon emission for almost all considered radionuclides
- Exception: Se-79, different dose-dominant ingestion pathways for emission scenarios
- Irrigation deficit increases up to a factor of 5, DCF increase up to a factor of 4 (Cl-36, Ca-41, Tc-99, 5000 PgC after 1 kyr)
- Colder climate states: no irrigation deficit, indistinguishable in terms of dose estimation, reduction of DCF up to one order of magnitude

Summary and outlook

- Climatic conditions can lead to an increase or decrease of the estimated radiation dose in the biosphere depending on the irrigation deficit
- Results are an important input for the consideration of alternative climate states according to BASE (2022) [1]
- Further insights require coupled geosphere transport and dose calculations
- Climate-dependent parametrization of biosphere model allows for adaptation of transfer processes as well as lifestyle, agricultural, and dietary habits

Financed by Bundesgesellschaft für Endlagerung mbH (BGE);
Research contract: STAFuE-21-4-Klei

Literature

[1] Bundesamt für die Sicherheit der nuklearen Entsorgung (2022): Berechnungsgrundlage für die Dosisabschätzung bei der Endlagerung von hochradioaktiven Abfällen. Berlin.

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