Radon222 as an additional source of atmospheric ionization in simulations of the chemical-climate model SOCOLv2

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MOTIVATION

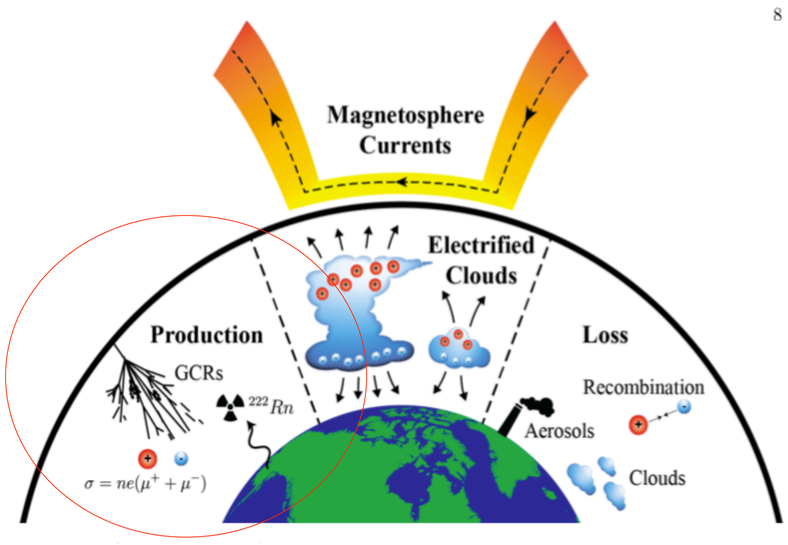


Figure 1. A representation of the major physical mechanisms that drive the electrical processes by Lucas [2010]

The main aim of this research is a introduction of the radon ionization to CCM SOCOLv2 for studying and understanding of the physical processes involved in the the impact of GEC through variability of conductivity on climate and ozone layer driven by different anthropogenic and natural forcing agents. Also this research is a part of the COST WG3 activity http://www.atmospheric--electricity--net.eu.

THE PROCESSES THAT IONIZE AIR

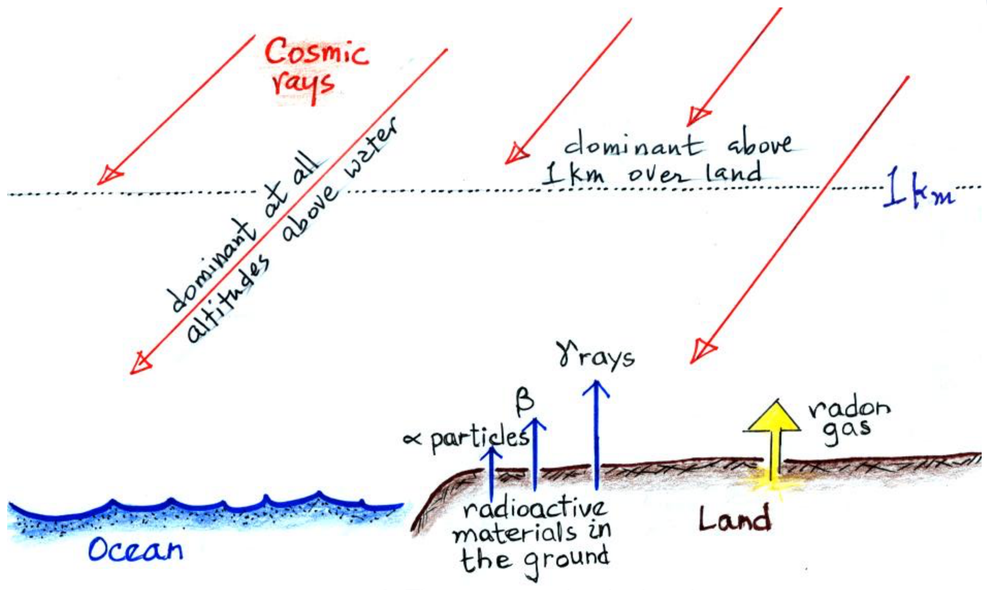


Figure 2. The processes that ionize air

emission type	range of travel	ionization rate [ip/(cm^3 sec)]
alpha particles	only a few cm above the ground	not well known
beta particles	a few meters above the ground	0.1 to 10
gamma rays	100s of meters above the ground	1 to 6
radon	depends on atmospheric conditions	1 to 20 at 1-2 m above ground
cosmic rays	1 to 2 ip/(cm^3 sec) near the ground	

Table 1. A typical ionization rates, ip - ion pairs. ["The Earth's Electrical Environment," National Academy of Sciences, 1986]

HOW IT WORKS?

- ✓ First of all, we add radon as a tracer to the CCM SOCOLv2;
- ✓ Secondly, we obtain and install radon emission and decay data;

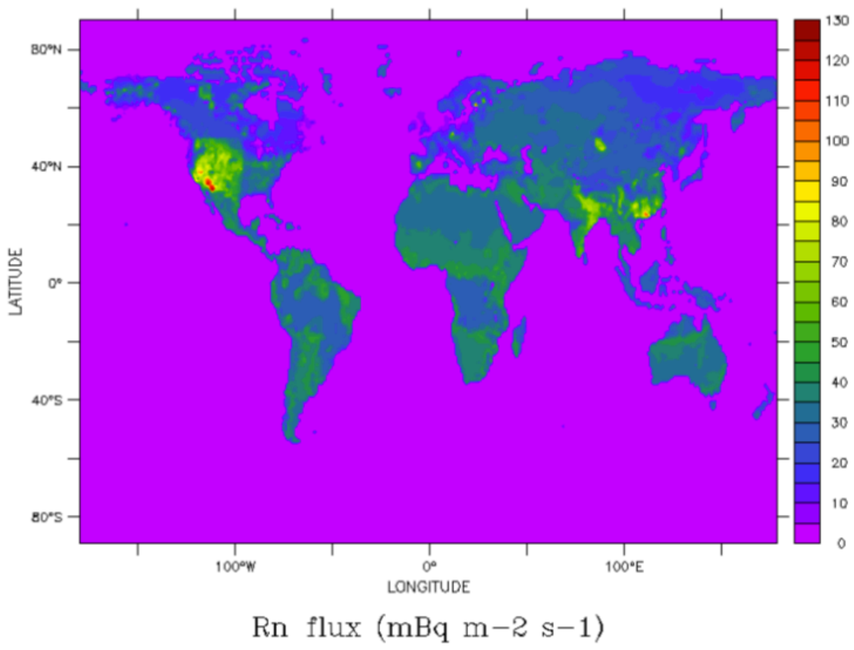
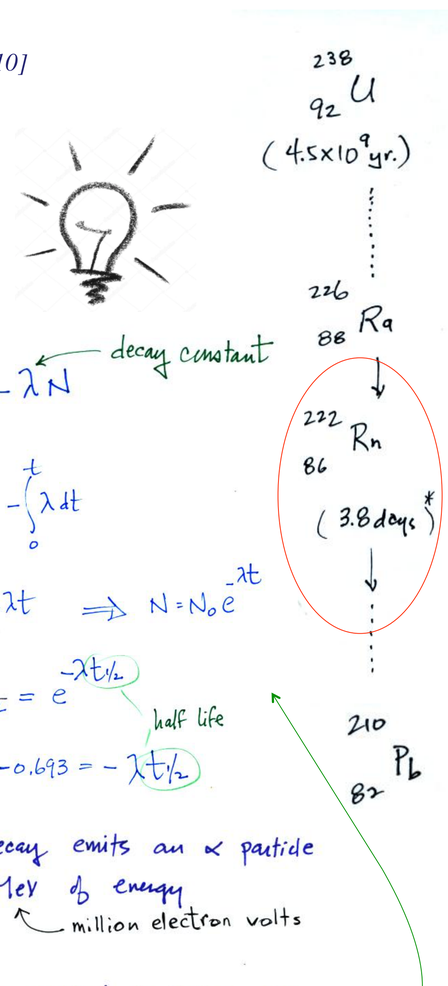


Figure 3. A global map of radon emissions for July by Schery and Wasiolek [1998].



A digitazed map was used as a source emission of radon in the SOCOLv2 model.

- ✓ After, we calculate the mass mixing ratio and the ionization rates by radon (described by the following equation).

CCM SOCOLv2

- ✓ The CCM SOCOL is a combination of a modified version of the MA-ECHAM4 and the CTM MEZON [M. Schraner et al., 2008].
- ✓ The model has 39 levels in a hybrid sigma-pressure coordinate system spanning the model atmosphere from the surface to 0.01 hPa (≈80 km). A geographical grid spacing of about 3.75◦.
- ✓ The model includes 41 chemical species of the oxygen, hydrogen, nitrogen, carbon, chlorine and bromine groups, which are determined by 118 gas-phase reactions, 33 photolysis reactions and 16 heterogeneous reactions in/on aqueous sulphuric acid aerosols, water ice and nitric acid trihydrate (NAT).

RESULTS AND CONCLUSIONS

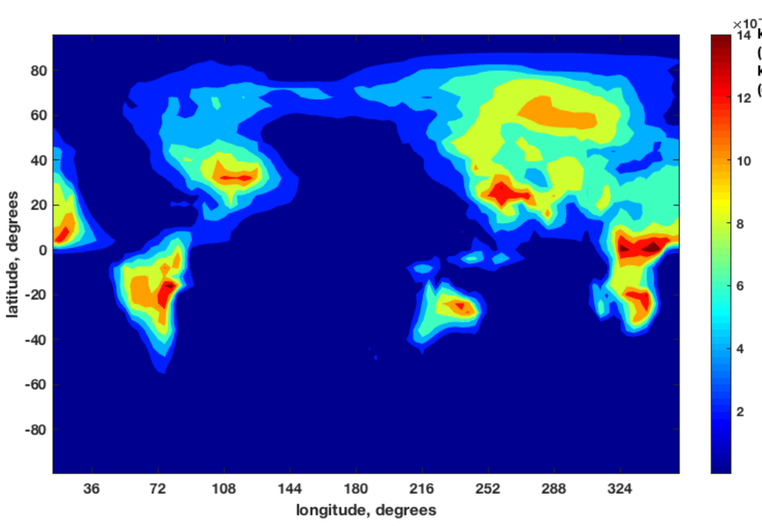


Fig. 4. Radon mass mixing ratio in the lowest model level

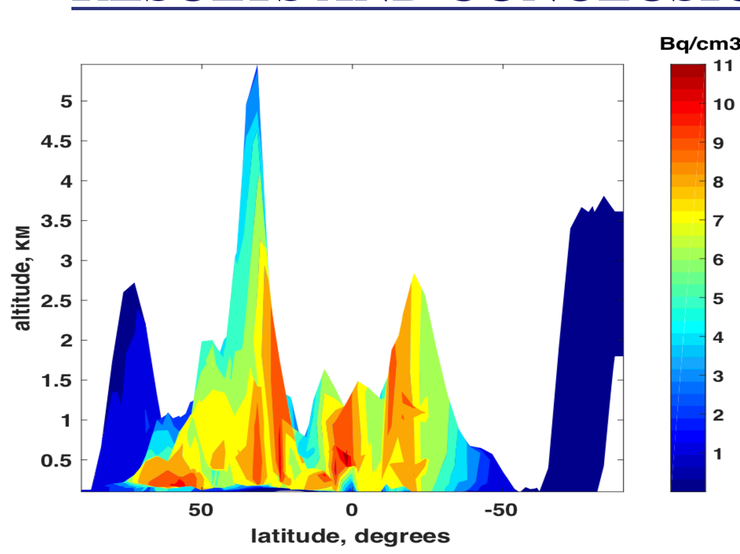


Fig. 5. Simulated zonal mean ionization rates induced by Rn222

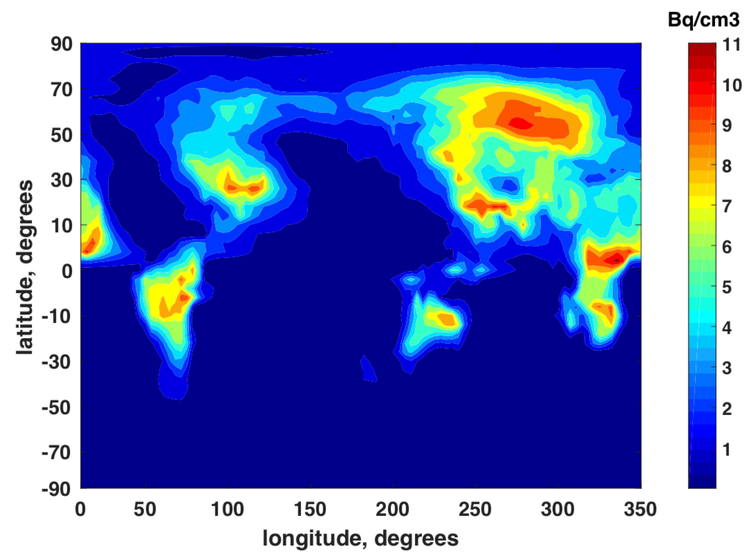


Fig. 6. Simulated monthly mean near-surface ionization rate induced by Rn222

* The radon-related ionization rates in boreal winter due to increased atmospheric stability leads to seasonal mean as high as 20 Bqcm−3s. In the middle- and low- latitude continental areas the zonal mean of radon-induced ionization rate is up to 30 Bqcm−3 on 2000 m elevation.
* In Russia and Canada strong radon-related ionization often occurs in winter at low temperature, which provides favorable condition for the ion induced aerosol nucleation.
* Obtained results show that the global model SOCOLv2 can reliably reproduce the variations of atmospheric radon concentrations, such as it follows from comparisons of our results with the results of global models ECHAM5 and WACCM [4].

REFERENCE

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