Derivation of methane surface emission from atmospheric methane balance

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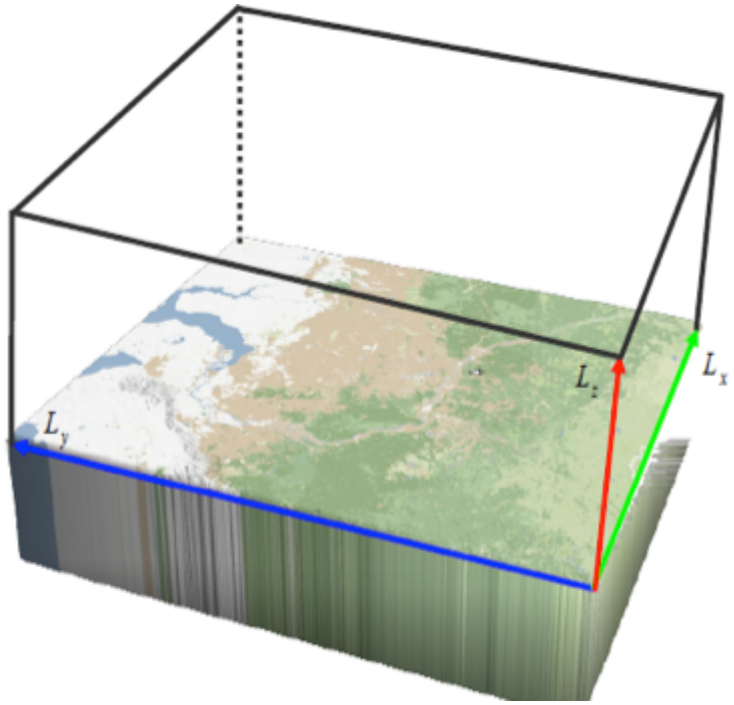
Methodology

In the method total concentration of methane inside the domain will be calculated as a volume integral of methane concentration from the MACC reanalysis, consequently, the advective and turbulent fluxes of methane through domain boundaries will be calculated based on a grid steps of the meteorological data. The methane sink due to oxidation in the atmosphere of the investigated domain will be taken from MACC reanalysis. Calculation domain is 1200 by 1200 km, resolution being 1.125°.



Mathematical formulation

$$\frac{\partial}{\partial t}\tilde{C} + \iint \left((uC)_{x=L_x} - (uC)_{x=0}\right) dydz + \iint \left((vC)_{y=L_y} - (vC)_{y=0}\right) dxdz = \widetilde{CD} - \widetilde{R_{ox}} + \iint \left(\left(k_x \frac{\partial C}{\partial x}\right)_{x=L_x} - \left(k_x \frac{\partial C}{\partial x}\right)_{x=0}\right) dydz + \iint \left(\left(k_y \frac{\partial C}{\partial y}\right)_{y=L_y} - \left(k_y \frac{\partial C}{\partial y}\right)_{y=0}\right) dxdz + \iint \left(\left(k_z \frac{\partial C}{\partial z}\right)_{z=L_z} - \left(k_z \frac{\partial C}{\partial z}\right)_{z=0}\right) dxdy$$

Mathematical formulation

$$\tilde{f} = \iiint f dx dy dz,$$

$$D = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z}$$

$$K_{m,x} = (k * \Delta)^2 |def| \sqrt{1 - Ri}$$

$$Ri = \frac{\frac{g}{\theta}\frac{\partial \theta}{\partial z}}{def^2}; \Delta = max(\Delta x, \Delta y, \Delta z); def^2 = \left(\frac{\partial u}{\partial z}\right)^2 + \left(\frac{\partial v}{\partial z}\right)^2$$

$$R_{ox} = K[CH_4][OH]\ ;\quad K = K_0 exp(T_{const}/T)$$

$$\Delta z_{i+1/2} = -\frac{(P_{i+1} - P_i)(T_i + T_{i+1})R}{(P_{i+1} + P_i)g}$$

Thank you for attention!

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