

**Вариации оптической и инфракрасной
прозрачности атмосферы Земли
под действием космических лучей и изменение
термодинамических параметров атмосферы**

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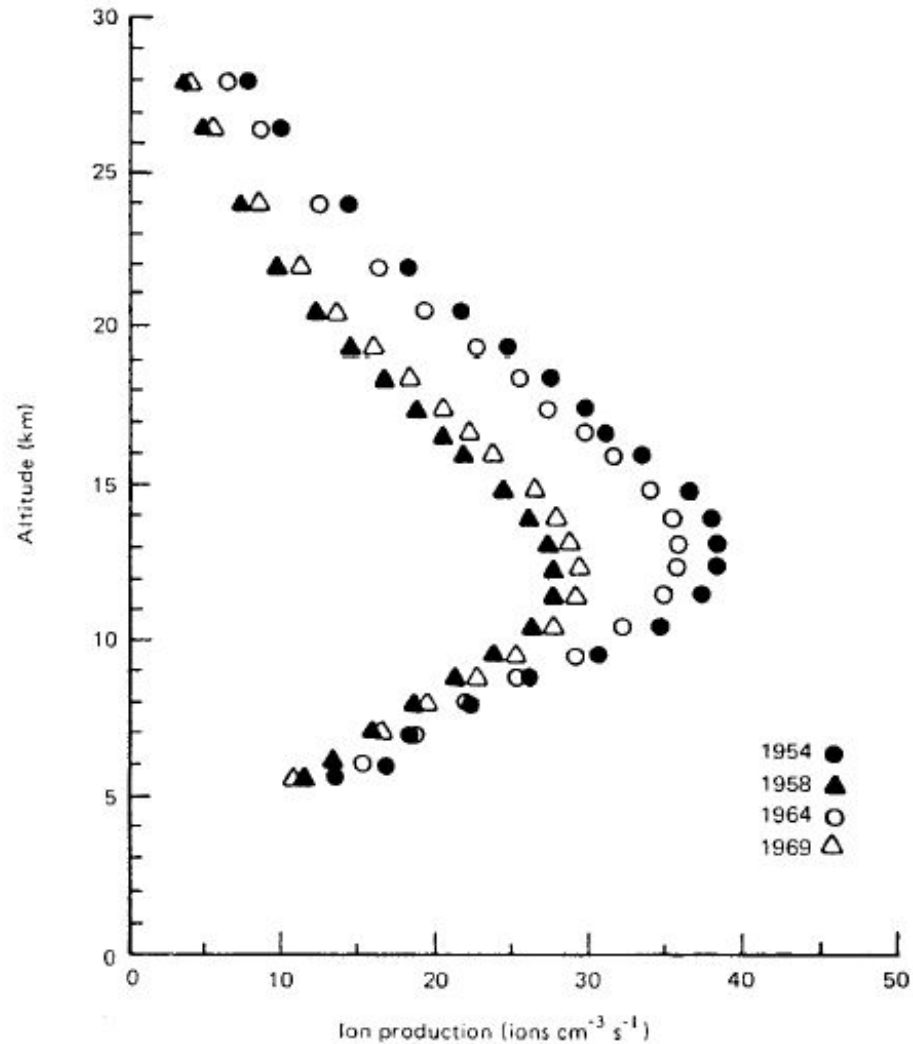
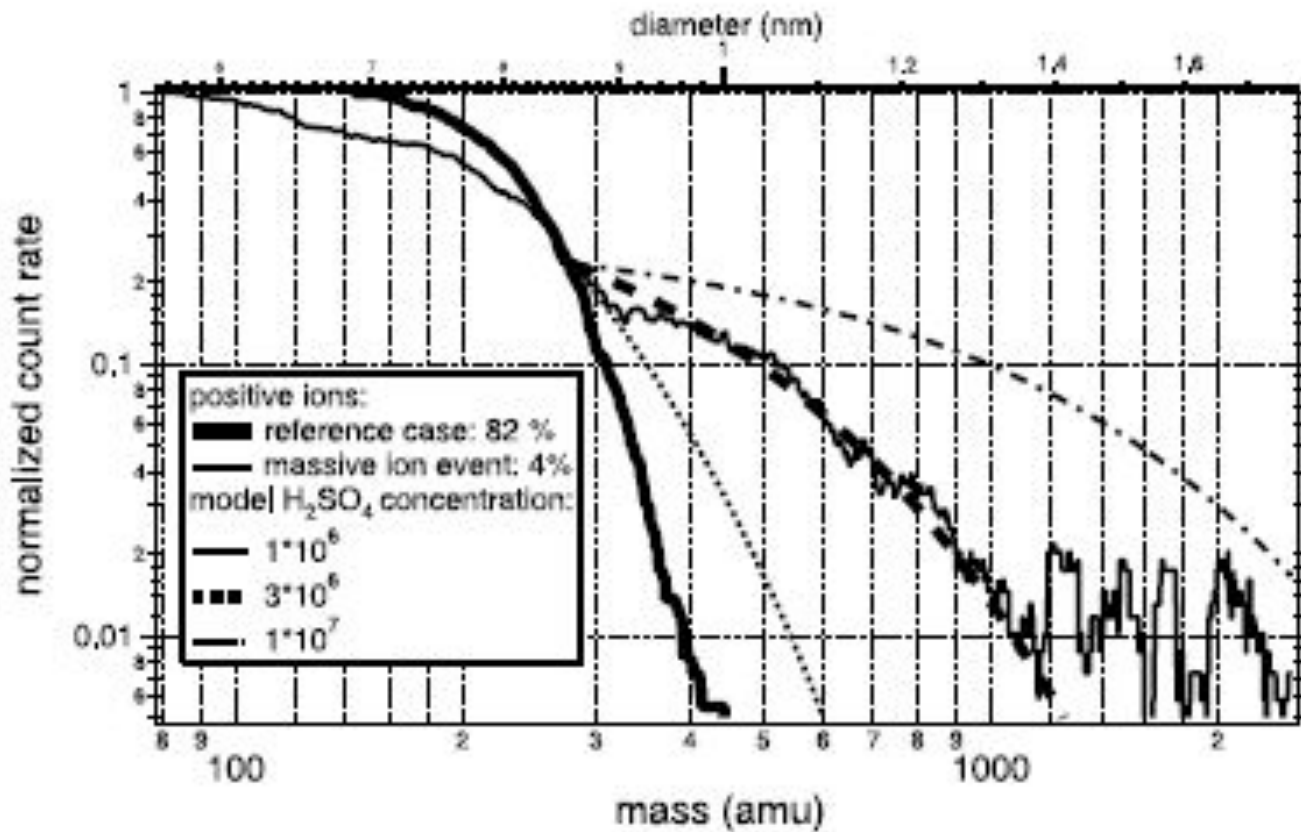


Figure 3. Variability over a solar cycle in the vertical profiles of Ion pair production over Thule, which is situated at a high magnetic latitude (adapted from Neher, 1971). Due to geomagnetic shielding, the levels of ionisation are reduced at lower latitudes, but essential features in the vertical profile are similar.



High-Pass-Mode (HPM) mass spectra of positive ions, obtained by mass spectrometric measurements in the upper troposphere and additionally 3 modeled spectra for H₂SO₄ concentrations of 1*10⁶, 3*10⁶ and 1*10⁷ cm⁻³. Spectrum 1: Reference case, ions up to an m of 400 are present. Spectrum 2: Massive ion event, ions up to a m of 2500 are present (S. Eichkorn et al, 2002)

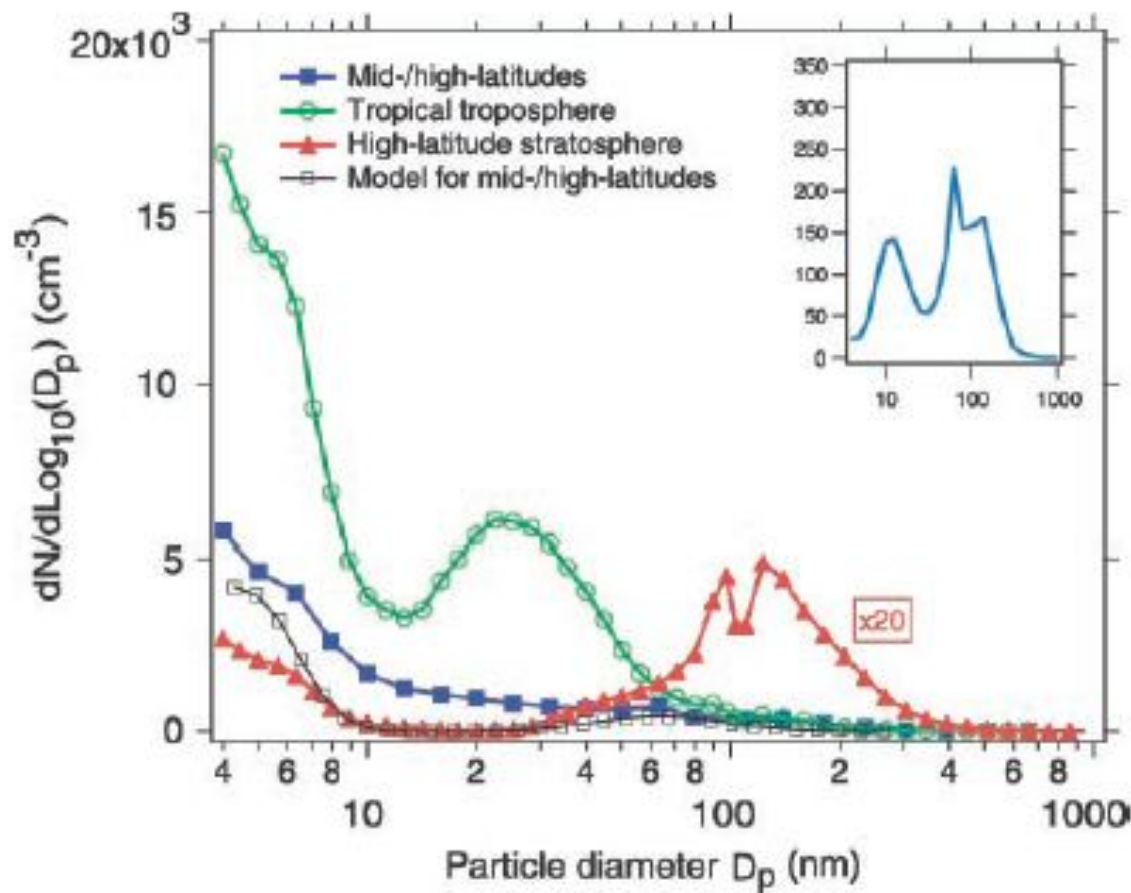


Fig. Mean size distributions for cases satisfying the criteria for recent new particle formation: mid- and high-latitude UT/LS (7 to 13 km), tropical troposphere (7 to 17km) and high-latitude stratosphere (17 to 21km). Results from a simulation of the IIN model after 2-day nucleation evolution are shown for a comparison with the mid- and high-latitude UT/LS case. The model uses \sim 80% of the measured peak noontime PH_2SO_4 and the other average conditions observed for samples showing the feature of new particle formation (table S1). (**Inset**) The average size distribution at the mid- and high latitudes for samples showing no recent particle formation. (*Lee et al, 2003*)

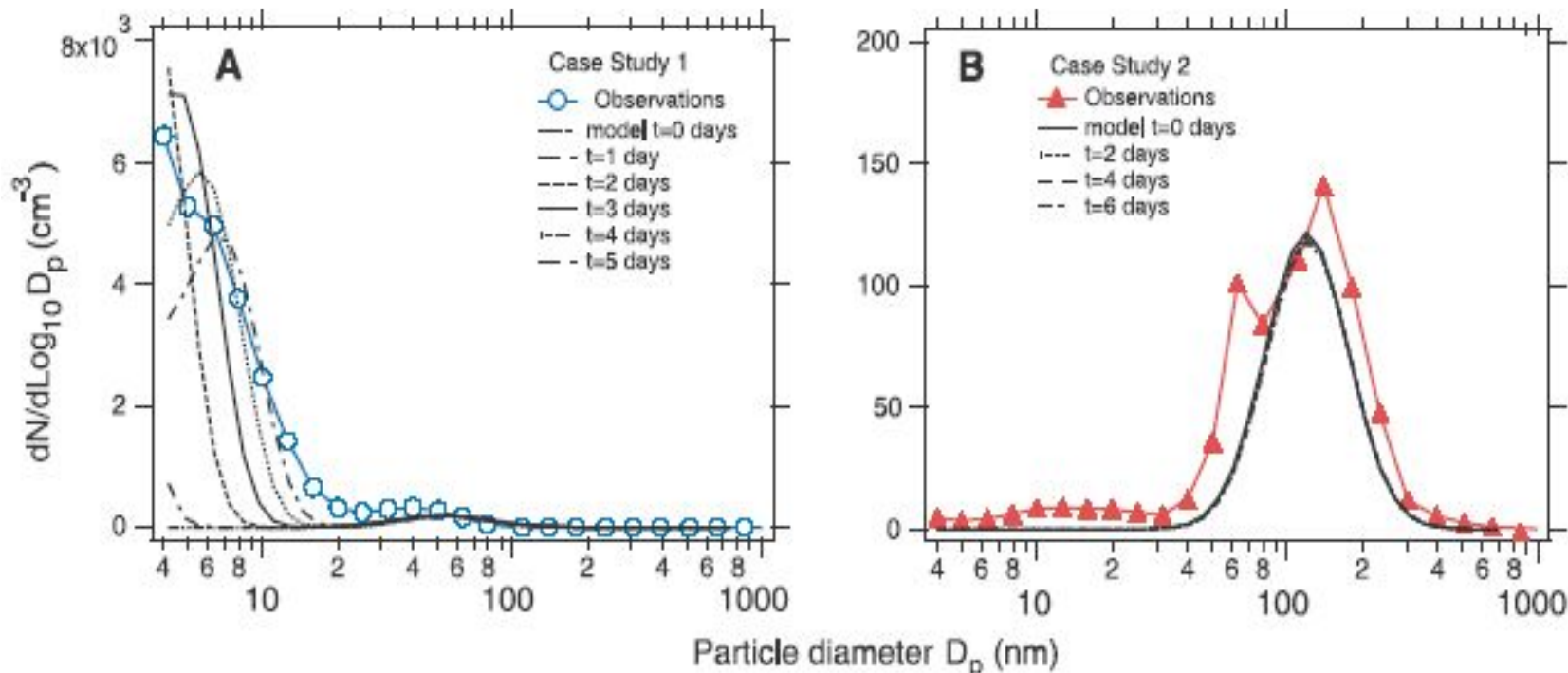


Fig.2. Comparison of measured and simulated particle-size distributions for two cases: high and low ultrafine particle production. **(A)** Particle number-size distributions measured over 18 minutes on 25 January 2000 at 11.2 km, latitudes from 59°N to 60°N, and longitudes from 4°E to 6°E (blue circles). Particle size distributions as a function of time as simulated by the IIN model (black curves). The model uses a peak noontime $P_{\text{H}_2\text{SO}_4}$ of $300 \text{ cm}^{-3} \text{ s}^{-1}$, corresponding to $[\text{OH}]$ of two-thirds of the measured value and a fractional sun exposure of 0.25. Other input parameters, including a background particle mode, were as measured in flight (table S1). The $[\text{H}_2\text{SO}_4]$ derived from the model is $\sim 1 \cdot 10^6 \text{ cm}^{-3}$. **(B)** Particle-size distributions measured over a 12-minute period on 10 December 1999 at 12.5 km, latitudes from 67°N to 70°N, and longitudes from 19°E to 22°E (red triangles). Particle-size distributions as a function of time as simulated by the IIN model, initialized with parameters measured aboard the aircraft (table S1), (black curves).

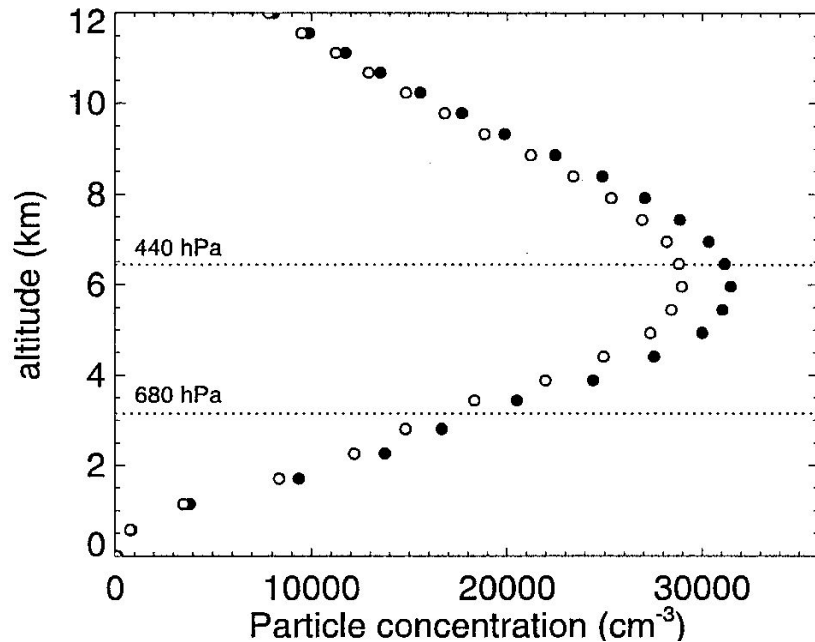
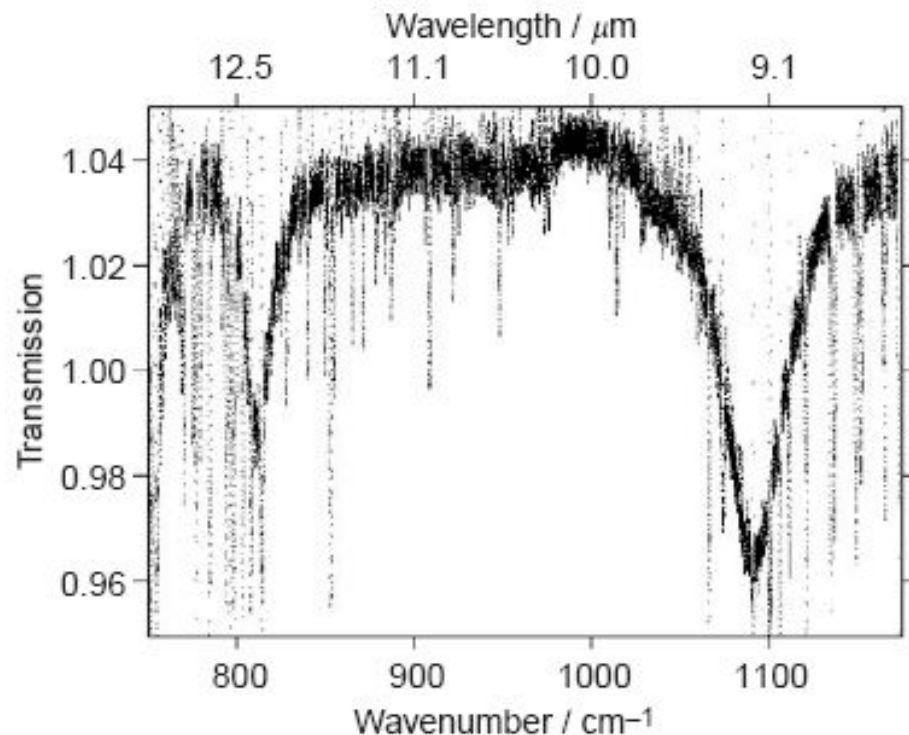


Fig. Concentration of particles of aerosol larger than 3 nm in diameter, formed during 3 hours

Fig. IR spectrum with enhanced ionisation divided by spectrum from ambient background ionisation, showing areas of enhanced absorption at 12.3 and 9.1 mm (810 and 1095cm^{-1}). The absorption at 13 mm is due to CO_2 . Absorption bands, likely to be from molecular cluster-ions can be seen at 12.3 and 9.2 mm (815 and 1090cm^{-1}) (Aplin and McPheat, 2005)



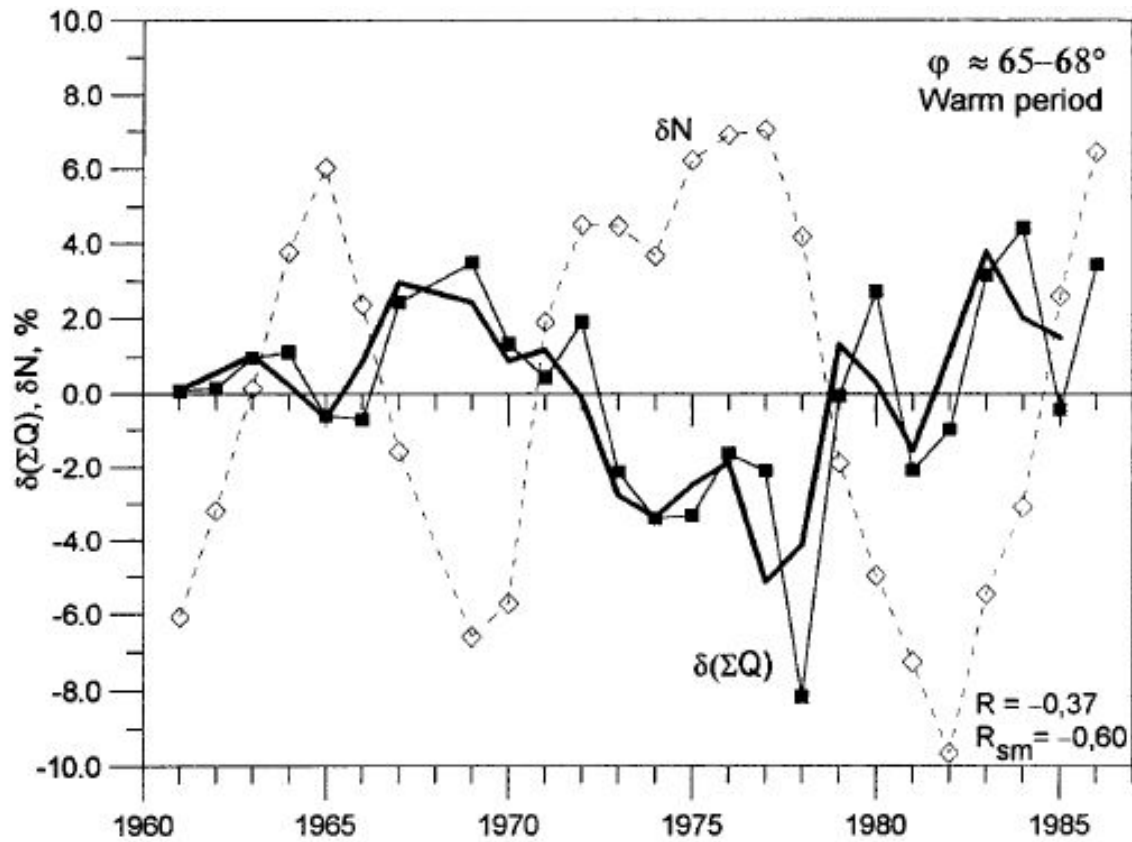
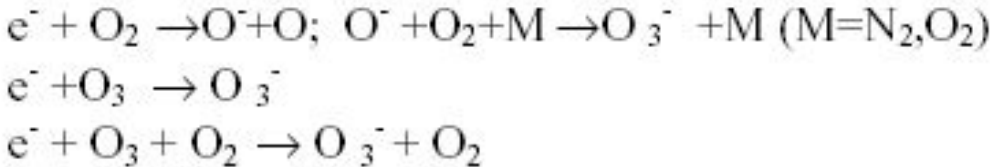


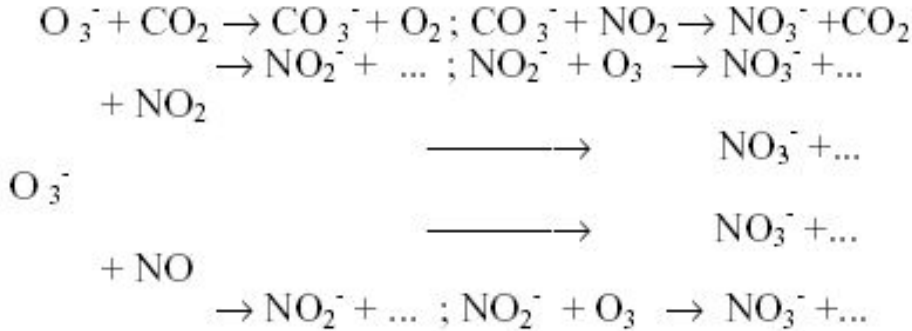
Fig. Long-term variations of the solar radiation input $\delta(\Sigma Q)$ in the geographic latitudinal belt $65 \pm 68^\circ$ (thin line) and of GCR intensity δN (dashed line); the thick line displays the 2-yr running average of $\delta(\Sigma Q)$ S.V. Veretenenko*, M.I. Pudovkin, 1999.

It is possible to separate two steps in the process of generation of NO_3^- ion (G.A.M. Dreschhoffl, ..., I.V. Koudriavtsev et al, 1999).

At first step the capture of electron by oxygen and nitrogen molecules and origination of O_3^- takes place



At second step the interaction between ion O_3^- and molecules NO_x takes place. This interaction leads to the origination of the ions NO_3^- and molecules CO_2 .



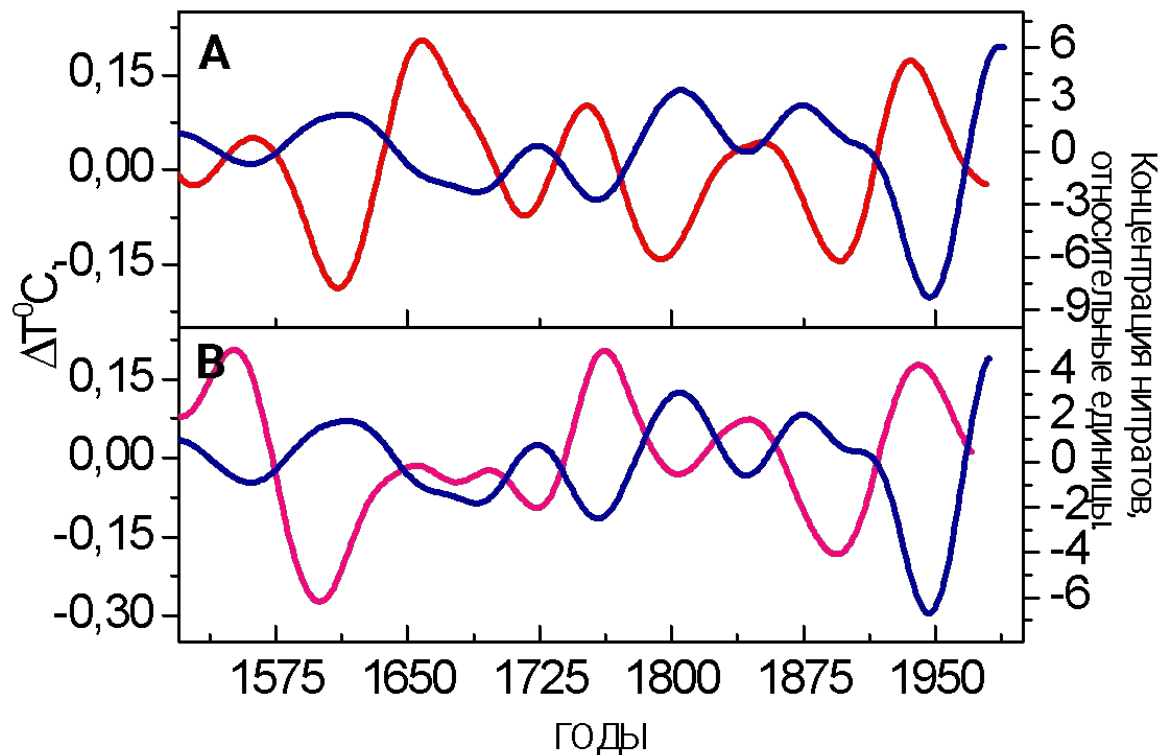


Рис. Временные серии взйвлетно-фильтрованные в полосе 55-147 лет (использован базис МНАТ).

А– кривая 1 – Н1, кривая 2 - июльская температура в континентальной части северной Фенноскандии [Lindholm and Eronen, 2000]; В – кривая 1 – Н1, кривая 2 - средняя температура сезона вегетации в приморской части северной Фенноскандии [Briffa et al., 1992];

(Огурцов, 2002)

ОСНОВНЫЕ УРАВНЕНИЯ

$$\frac{dW}{dz} = \alpha_1 \rho (1 + \delta_1) W \quad ; \quad \frac{dA}{dz} = \alpha_2 \rho (1 + \delta_2) (A - fE) \quad ; \quad \frac{dB}{dz} = \alpha_2 \rho (1 + \delta_2) (fE - B)$$

$$dQ = (\alpha_1 \rho (1 + \delta_1) W + \alpha_2 \rho (1 + \delta_2) A + \alpha_2 \rho (1 + \delta_2) B - 2\alpha_2 \rho (1 + \delta_2) fE + \left(\frac{d}{dz} \lambda \frac{dT}{dz} \right)) dz$$

где W - поток солнечного коротковолнового (видимого) излучения;

A, B - потоки инфракрасного излучения, распространяющиеся вниз и вверх; α_1, α_2 - коэффициенты поглощения видимого и инфракрасного излучения в атмосфере, без учета дополнительного поглощения, вызванного влиянием КЛ; δ_1, δ_2 - описывает дополнительное поглощение видимого и инфракрасного излучения, вызванное влиянием КЛ; $E = \sigma T^4$, σ - постоянная Стефана-Больцмана; T - температура воздуха; коэффициент $f < 1$ показывает, на сколько длинноволновое излучение атмосферы меньше чем излучение абсолютно черного тела.

$$\delta_1 = \frac{\delta_{10}}{\sqrt{2\pi}\sigma_1} \exp(-(\tau_v - \tau_{v0})^2 / (2\sigma_1^2))$$

$$\delta_2 = \frac{\delta_{20}}{\sqrt{2\pi}\sigma_2} \exp(-(\tau - \tau_0)^2 / (2\sigma_2^2))$$

$$\tau_v = \int_z^{\infty} \alpha_1 \rho(h) dh$$

$$\tau(z) = \int_z^{\infty} \alpha_2 \rho(h) dh$$

$$\sigma_1 = \beta \sigma \quad ; \quad \tau_{v0} = \beta \tau_0 \quad ; \quad \text{т.е. } \tau_v = \beta \tau \quad ; \quad \tau(0) = 3.78 \quad , \quad \beta = \alpha_1 / \alpha_2 = 0.2$$

1) Долговременные вариации прозрачности и распределения температуры в атмосфере.
 $dQ = 0$

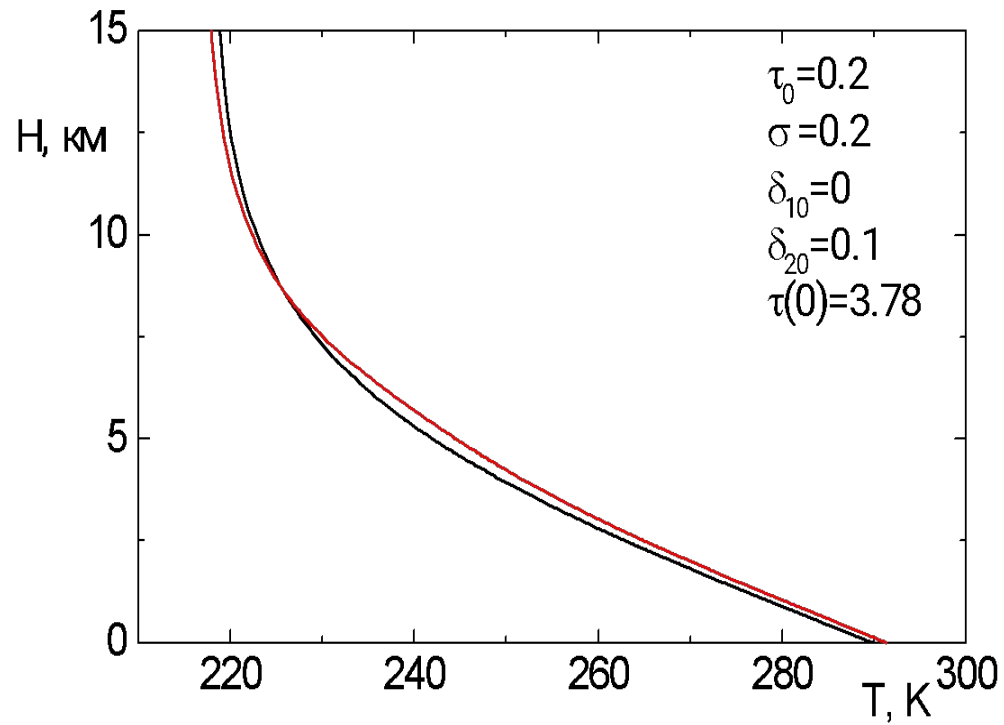
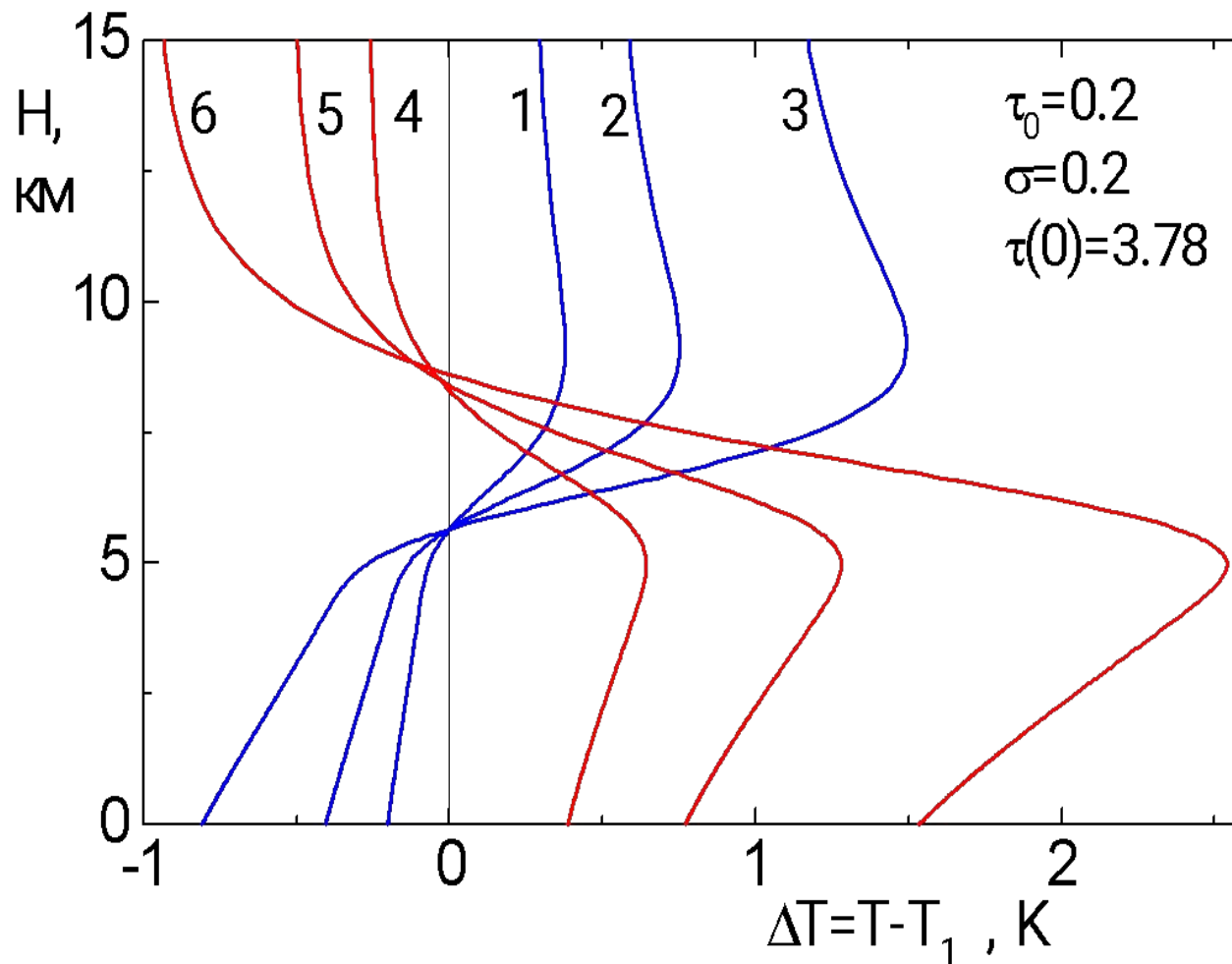


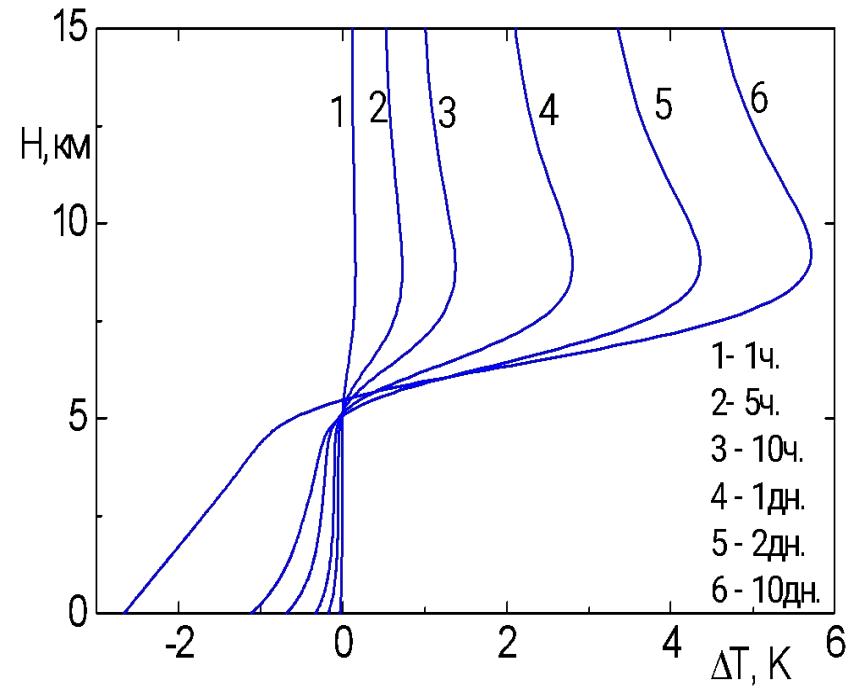
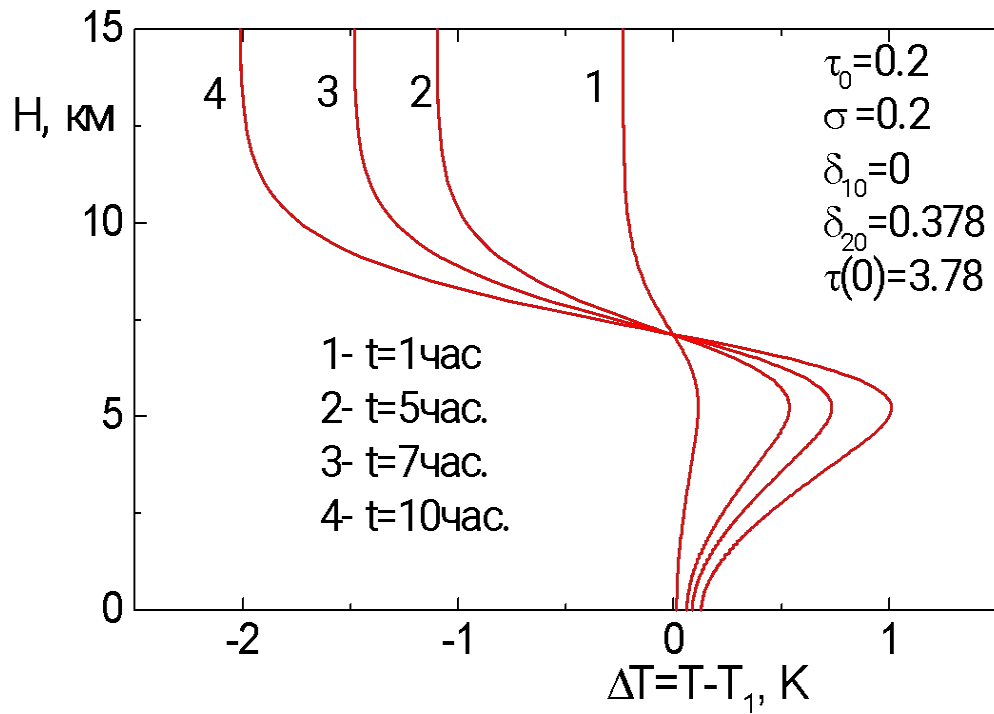
Рис. Распределение температуры в атмосфере

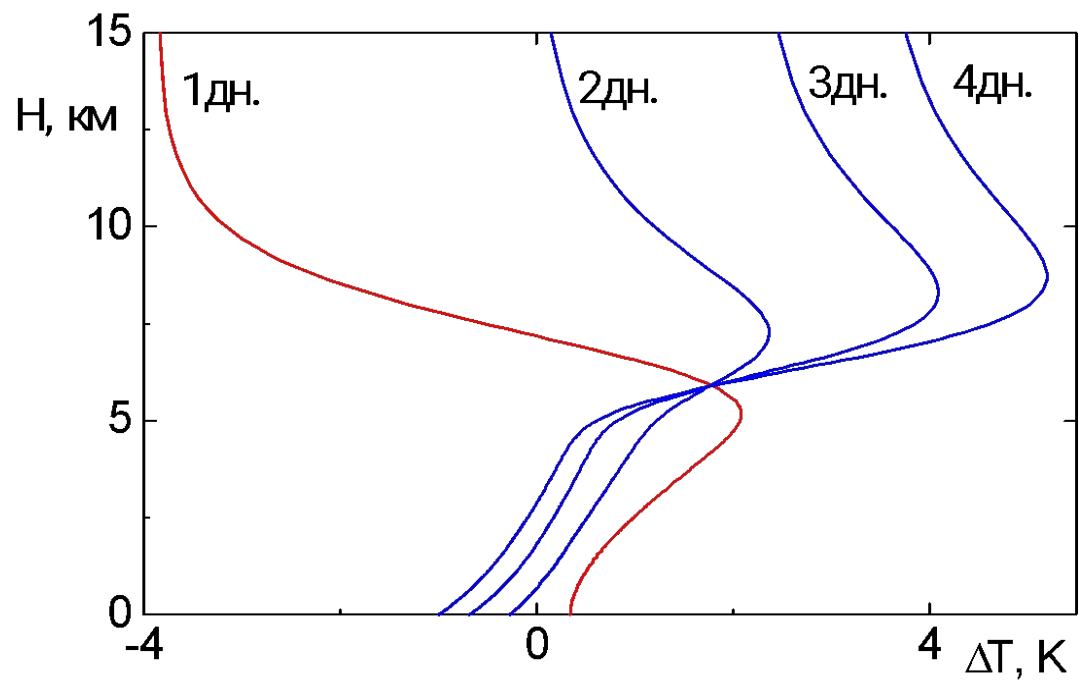
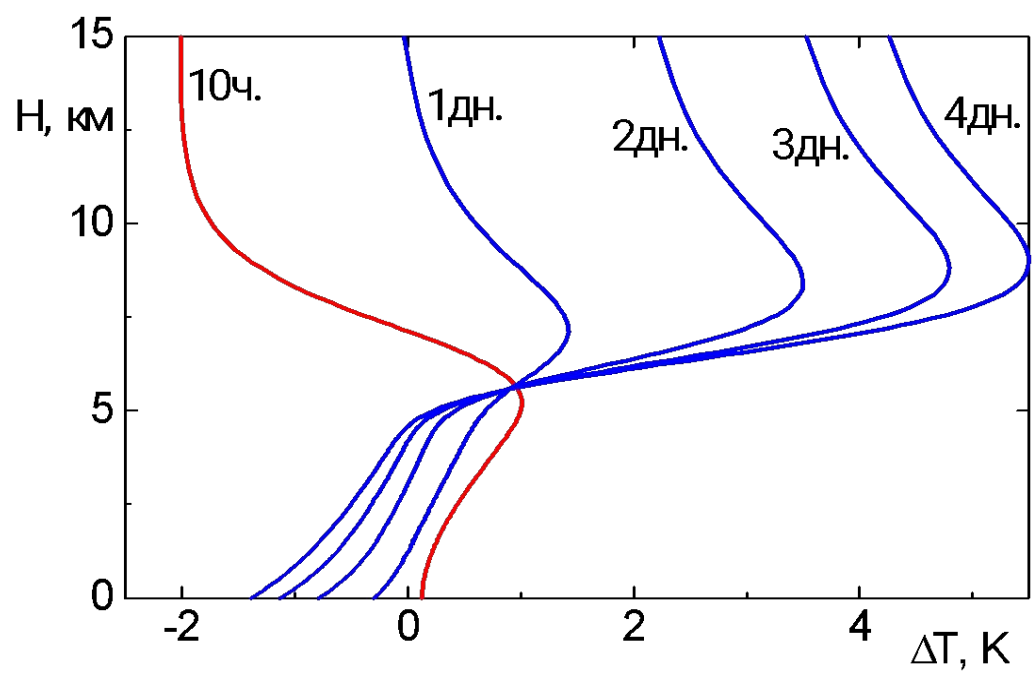


Изменение температуры $\Delta T = T - T_1$ для различных значений поглощающего слоя:

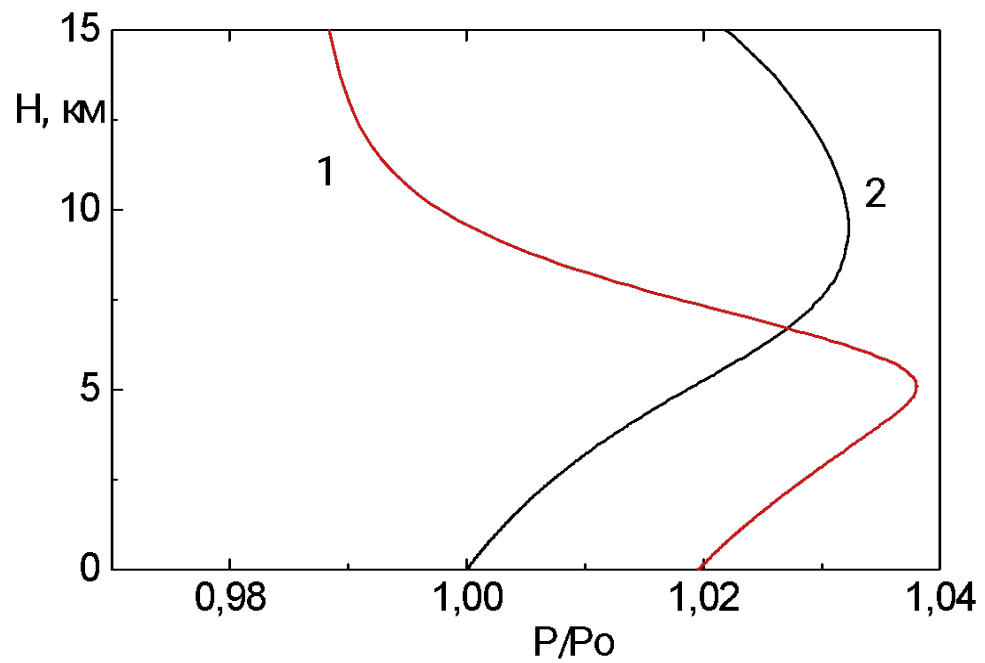
1 $-\delta_1 = 0,005$; $\delta_2 = 0$; 2 $-\delta_1 = 0,01$; $\delta_2 = 0$; 3 $-\delta_1 = 0,02$; $\delta_2 = 0$;
 4 $-\delta_1 = 0$; $\delta_2 = 0,025$; 5 $-\delta_1 = 0$; $\delta_2 = 0,05$; 6 $-\delta_1 = 0$; $\delta_2 = 0,1$

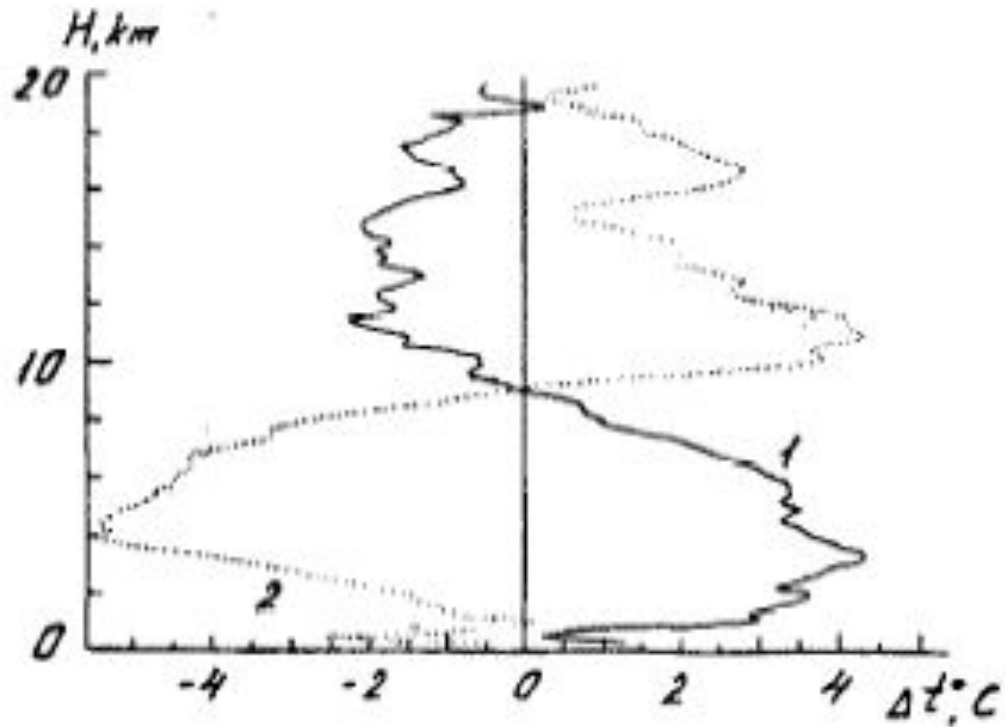
Кратковременные вариации прозрачности и распределения температуры в атмосфере





Вариации атмосферного давления





Variations of the mean temperature profiles for the anticyclonic conditions before the SCR burst:
1 - on the key day ($t=0$): 2 - on the third day ($t=+3$). (M. I. Pudovkin et al, 1996).

MARSH AND SVENSMARK

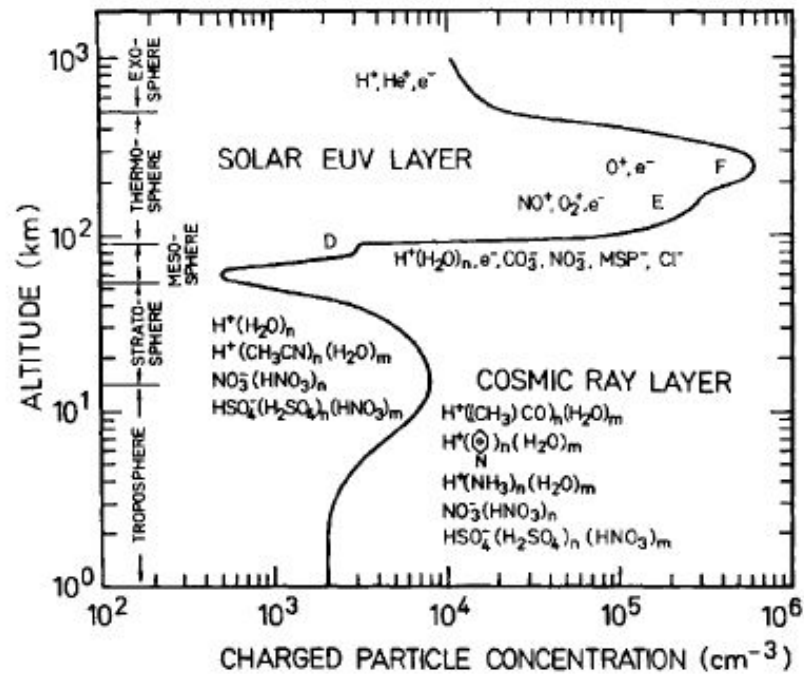


Figure 8. Vertical Profile of ionisation density in the atmosphere. Included are the major ion species at various altitudes (adapted from Viggiano and Arnold, 1995).

$$dQ = \frac{C_v \rho_e dT}{dt} dz$$

