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Effect "negative viscosity" as possible mechanism of ozone hole are formed above Antarctica at last quarter of XX century

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One of the possible mechanisms of the ozone hole formation over Antarctica can be a meridional transport of ozone deficit by the mesoscale vortexes generated by perturbations in the stratospheric circumpolar vortex. This transport can occur against the global ozone gradient in the polar stratosphere.
An assessment of the value and sign of the macro-turbulent exchange coefficient provides understanding of the intensity and direction of large-scale vortex diffusion in the framework of the equations of heat, moisture and momentum transfer. The local viscosity can be negative at this since the turbulent viscosity, heat conductivity and diffusion coefficients characterize already not the physical properties of fluids and gases but the statistical properties of their turbulent motions. According to the definition of Viktor Starr (1968), “negative viscosity” leads to the impulse transfer against a zonal gradient. So, the small-scale energy passes to zonal energy and in the equations of transfer of the conservative properties of the atmosphere (temperature, humidity, ozone, etc.), the transfer can be against the average zonal gradient. To estimate macro-turbulent exchange coefficients, we shall use a procedure, which is similar by structure to the procedure, which is used for reduction of the non-linear Burger’s equation to the linear equation of heat conductivity.
Whereas in 1980, one mainly observes the positive values of meridional turbulent exchange coefficient, but to 1988 and especially in 2003, these values within the stratospheric vortex are predominantly negative. The growth of the negative value of the meridional transfer coefficient simultaneously with the increased area and the “depth” of the ozone hole allow us to interpret the development of the ozone hole in terms of the mechanism of “negative” viscosity, responsible for transfer of kinetic energy by smaller-scale vortexes towards large-scale perturbations enhancing thus the intensity of the stratospheric circumpolar vortex. Correspondingly, ozone in this process is transferred against the latitudinal gradient of its distribution, creating the ozone deficit within the stratospheric vortex and its maximum at the periphery. One of the peculiarities of the ozone hole in Antarctica is presence of the maximum ozone value at the periphery of the ozone hole. There is an impression that the ozone maximum and minimum over Antarctica are formed by one mechanism within the circumpolar stratospheric vortex over the South Pole. The mechanism of the “negative viscosity” quite fits in principle this role.
Calculations showed that exactly in spring (in September in the South Polar Area) values of meridional turbulent exchange coefficient achieve their maximum negative values. In the process of occurrence of the ozone hole and its development beginning from 1982, the scale of the stratospheric circumpolar vortex in the South Polar Area decreases with a simultaneous increase of the vortex intensity (“depth”). The latter seems to contribute to appearance of the ‘negative viscosity” effect, when ozone is transported from the stratospheric vortex to its external boundary, creating the ozone deficit inside the vortex and its excess at the periphery of the circumpolar vortex. A decrease of the vortex scale can be caused by a combined impact of natural multiyear fluctuations of the general circulation (for example, a 40-year period) and a continuously increasing anthropogenic impact.