SEASONAL CHANGES OF METHANE ABSORPTION IN THE SATURN ATMOSPHERE. A. P. Vidmachenko, Main Astronomical Observatory of National Academy of Sciences of Ukraine, Str. Ak. Zabolotnogo, 27, Kyiv, 03680, vida@mao.kiev.ua

Introduction: Saturn's equator has a significant tilting (26°44′) to the orbital plane. Thus, during rotation around the sun (29.45 years), it is characterized by the difference in the solar energy influx to the different latitudes of more than 10 times [23-25]. Winter's hemisphere is in the polar night, and in the ring's shadow. Moreover ring reduces up to 70% of solar radiation, increasing the seasonal contrast in the flow of energy from the sun to the planet. Because of the elliptical orbit, and that Saturn is in perigee at summer in the south, its southern hemisphere receives 15-25% more energy than the northern. All this affects the physical and optical properties of clouds and haze, as well as the atmosphere vertical structure in different latitudes [7, 13]. Changing seasonal solar influx strongly affects the higher levels of the atmosphere, where the radiation generated in the ultraviolet and infrared spectrum. It is here clearly visible changes in the reflectance and emission properties of Saturn [1-4, 22] associated with the seasonal changes in the solar energy. Stay planet in orbit at the time of the equinox is the best for the study of differences in atmospheric characteristics of the northern and southern hemispheres. In recent years it was in 1966, 1980, 1995 and 2009.

Latitudinal variation of methane absorption: According to the observations in 1966, an asymmetry in the level of absorption of methane between the southern and northern hemispheres [10] observed (Fig.) From the observations in 1965-1971 [8, 11, 12, 15, 16, 26], the lowest absorption is observed in the equatorial belt. With the increasing of latitude methane absorption increases and reaches its maximum value at latitude 20-40° in both hemispheres. On the northern temperate latitudes absorption by 15-20% higher than in the southern. From 1970 to 1978, the methane absorption in the atmosphere has increased significantly. Reduces the absorption in the southern hemisphere began again in 1979 [26]. During equinox 1980 methane absorption in the equatorial region was minimal, in the southern tropical and polar regions - was stronger than in the northern hemisphere by 5% in 619 nm, 10-20% in the 725 nm and 20-40% in the 792 nm (Fig.) [13, 22-26]. That is, a large absorption was in the hemisphere, which for the past ten years before the equinox, the sun is stronger irradiated. After 1980 the change in methane absorption between the northern and southern hemispheres was the opposite of what it was before. [18] Ring began to close the southern hemisphere of Saturn. In 1985-1989 in the northern part of the equatorial region the methane absorption was minimal; at latitude 30-60° absorption varies little, and somewhat reduced at the pole [9].

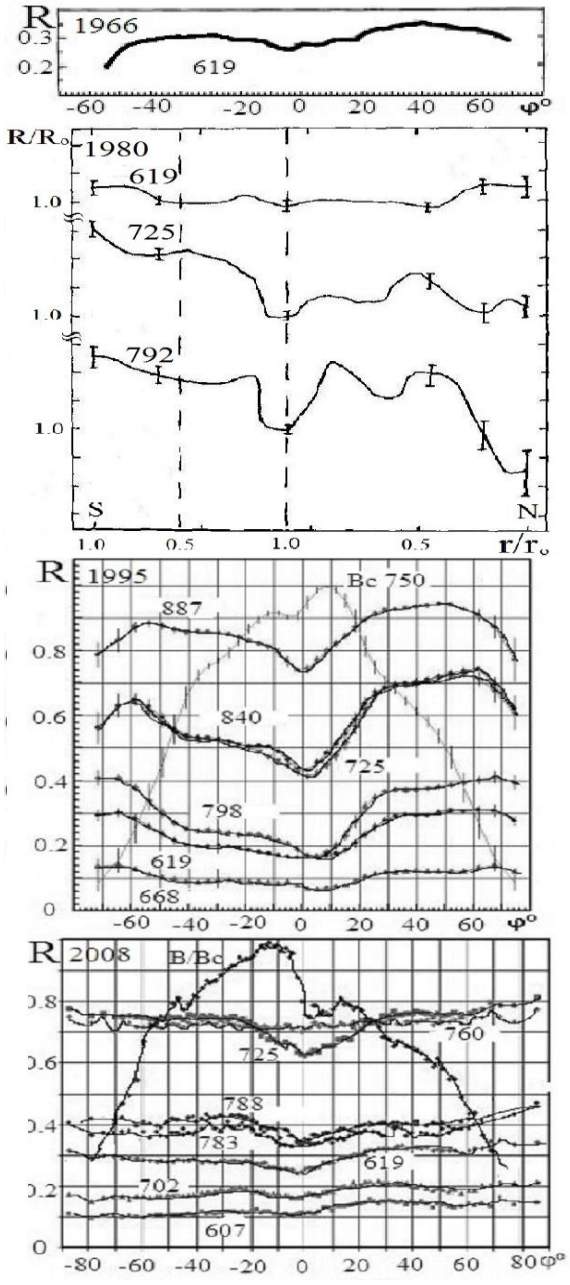

Fig. Latitudinal variations of depth R bands in the absorption of methane on Saturn's disk: 29/11/1966 [16], 19/09/1995 [19], in December 2008 [17] by measuring the spectra; variations of normalized absorbance values R/Ro in the methane absorption bands from observations in 1980 [22, 24].

Observations in 1995 showed that the latitudinal distribution of methane absorption is asymmetrical with respect to the Saturn's equator. The lowest absorption was in the equatorial belt and so it was in all years irrespective of season. From 1995 to 2009 there was an increase of methane bands depth in the southern temperate zone of Saturn [17-19]. In contrast to the pronounced asymmetry of absorption in the southern and northern hemisphere in 1995, at the equinox in 2009 the difference in absorption between the hemispheres at middle latitudes is virtually nonexistent (Fig.). An absorption band (as well as in 1995) show a very slight increasing in the northern hemisphere.

It is known that in 1966-1980 and 1995-2009 Saturn approaches the Sun at a minimum distance of 9 AU as for ring opening. Therefore, the summer southern hemisphere at the equinox must accumulate more energy from the sun than in the previous half-periods of the northern hemisphere before the equinoxes in 1966 and 1995, when summer was in the northern hemisphere at the maximum distance from the Sun of 10 AU. Due to the large influx of 15-25% of the solar energy to the summer southern hemisphere after the equinox in 1966 and 1995, there is an ammonians cloud evaporated, decreasing their volume density [5, 20, 21]. The decrease in the scattering coefficient in the clouds and haze resulted in an increase of the methane absorption by increasing the absorption of the optical path due to multiple scattering in the cloud cover.

It was assumed that the latitudinal distribution of methane absorption in the 2009 Equinox will be asymmetric to what was observed in 1966, 1995 and similar to what it was in 1980. But it did not happen (Fig.) In the northern hemisphere, the absorption is not reduced, although in the southern hemisphere, it increased significantly. The maximum of methane absorption for 10 years before the equinox in 1966 and 1995, was in the northern hemisphere, which is illuminated by the sun. In equinox 1980 [13, 22, 24, 26] change in methane absorption with latitude was the opposite of what it was in equinox 1966 and 1995. Thus, in all previous Saturn equinox, the maximum of methane absorption was in hemisphere temperate latitudes of which almost 14 years were exposed to the sun. In the opposite hemisphere always observed minimal methane absorption [24, 26].

In 2009 equinox, as expected, the absorption in the southern hemisphere increased significantly. However, in the northern hemisphere expected reductions absorption - was not. Although all physical and orbital characteristics of Saturn's equinox in 1980 and 2009, almost repeated, but the response was very different. Thus, there was no formation of high ammonians clouds in the part of the atmosphere, which has just come out from under the ring to direct insolation. Ammonia could not turn to ice. And ammonians clouds stayed deep in a "hot" atmosphere. Images of Saturn obtained by "Cassini" also showed [6] a significant weakening of convective processes [14] in the atmosphere. This influenced the bulk density of the clouds, the clouds stayed below, and the optical thickness of the haze above the clouds increased. All of this has led to an increase in methane absorption, which is formed in the process of multiple scattering in clouds and haze.

But why is observed a difference in the latitudinal variations in methane absorption at the equinox in 1980 and 2009? See later in the *LPS XXXXVI Abstract 1052***.**

References:

[1] Bezard B. et al. (1984) Icarus, 60, 274-288.

[2] Cess R.D. et al. (1981) Icarus, 46, 249-255.

[3] Cochran A. L. and Cochran W. D. (1981) Icarus, 48, 488-495.

[4] Conrath B. J. and Pirraglia J. A. (1983) Icarus, 53, 286-292.

[5] Drossart P.et al. (1989) TVPJS, NASA-SP-494, 344-362.

[6] Fletcher L. N. et al. (2010) Icarus, 208, 337-352.

[7] Gallis L.V. and Nealy J.E. (1978) GRL, 5, 249-252.

[8] Irvine W. M. et al. (1968) AJ, 73, 251-264.

[9] Karkoshka E. and Tomasko M. G. (1992) Icarus, 97, 161-181.

[10] Marin M. (1968) J. Observ., 51, 179-191,

[11] Owen T. (1969) Icarus, 19, 355-364.

[12] Price M.J. and Franz O.G. (1980) Icarus, 44, 657-667.

[13] Steklov A. F. et al. (1983) Sov. Astron. Let., 9, 135-136.

[14] Stone P. H. (1973) Space Scien. Rev., 14, 444-459.

[15] Teifel V. G. (1975) Solar Syst. Res., 9, 57.

[16] Teifel V. G. et al. (1969) 40th IAU Symp. 375-383.

[17] Tejfel V. G. et al. (2010) Astron. Tsirk., 1573, 1-2.

[18] Tejfel V. G. at al. (2008) LPS XXXIX, 1530.

[19] Tejfel V.G. (1969) JAS, 26, 854-859.

[20] Temma T. et al. (2005) Icarus, 175, 464– 489.

[21] Tomasko M. G. et al. (1984) Saturn (A85–33976 15– 91), 150– 194.

[22] Vidmachenko A. P. (1984) Astrom. Astrof., 51, 56–62.

[23] Vidmachenko A. P. (1985) KPCB, 1, 12-15.

[24] Vid'Machenko A. P. (1999) KPCB, 15, 320 - 331.

[25] Vid'Machenko A. P. (1987) KPCB, 3, 10-12.

[26] West R. A. et al. (1982) Icarus, 51, 51-64.