Variability of aerosol optical parameters at the stations of the Southern and Northern polar regions (SPR and NPR) in the first decade of the XXI century

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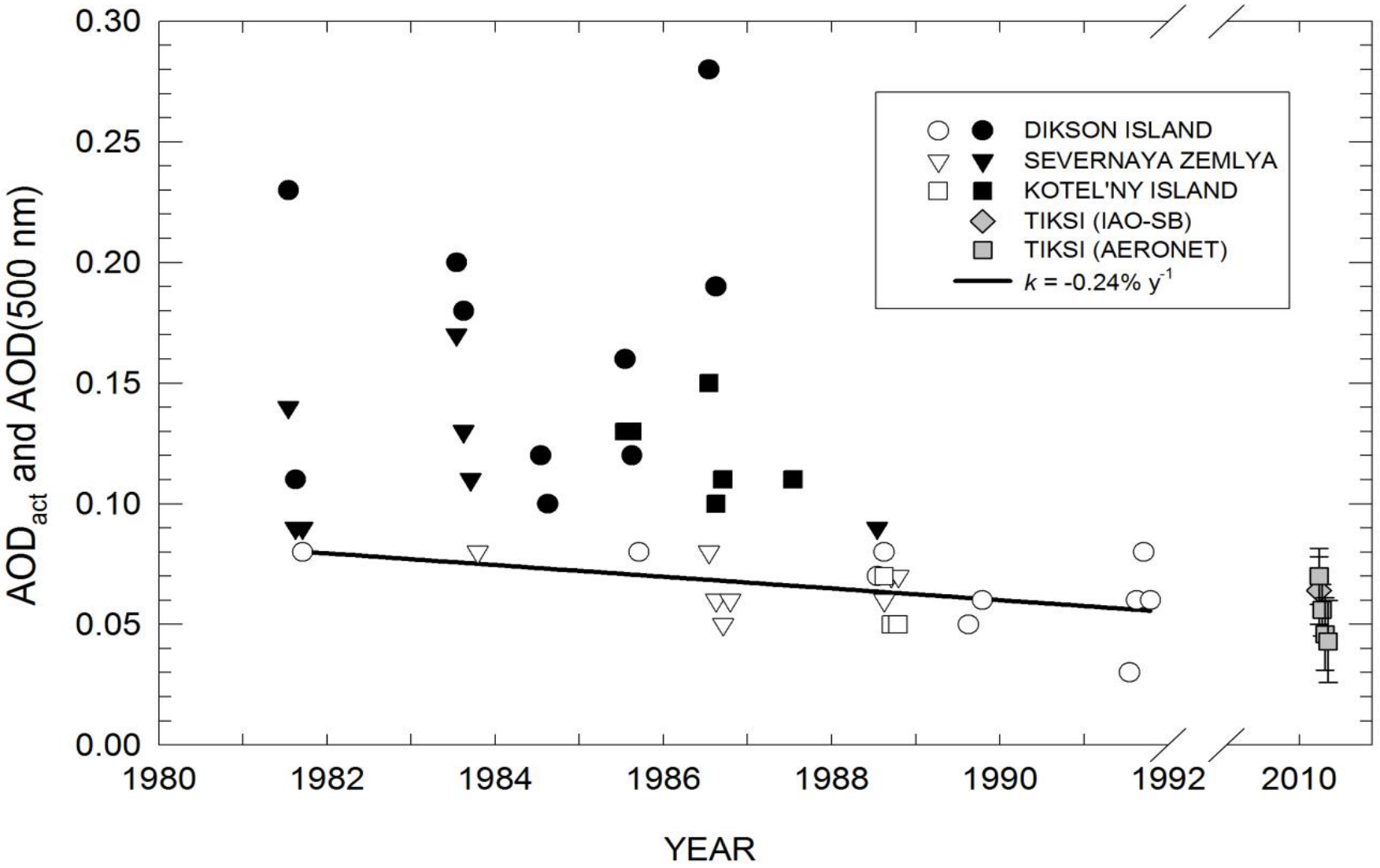
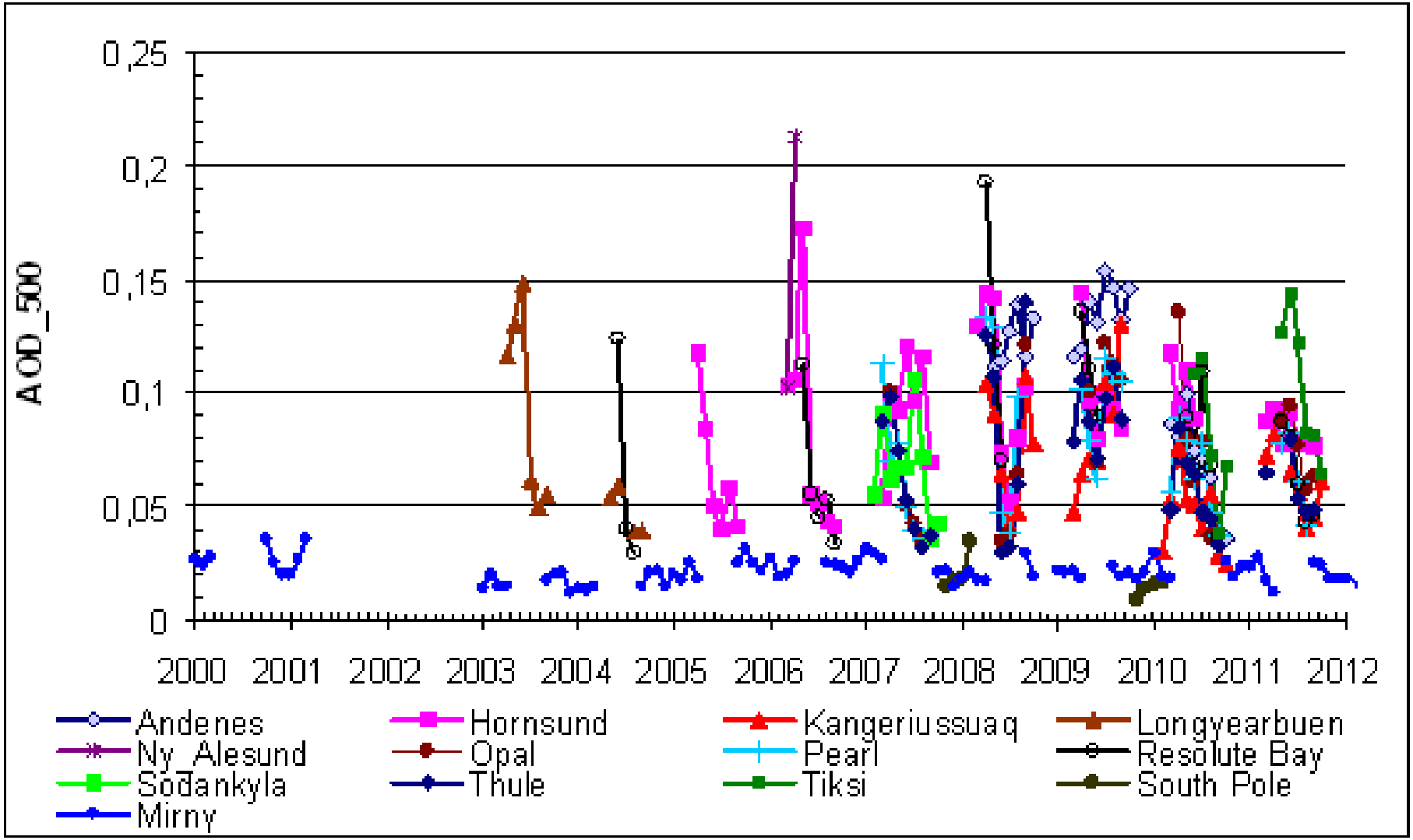
- In this report we present some results of observations of aerosol optical depth and atmospheric turbidity obtained in the Arctic and Antarctic stations AERONET and Russian polar stations in the first decade of the 21st century.

Long-term variability of AOD in Russian Arctic

(C. Tomasi et al., 2012. Atmospheric Environment, 52 (2012) 29-47 doi:10.1016/j.atmosenv. 2012.02.055)

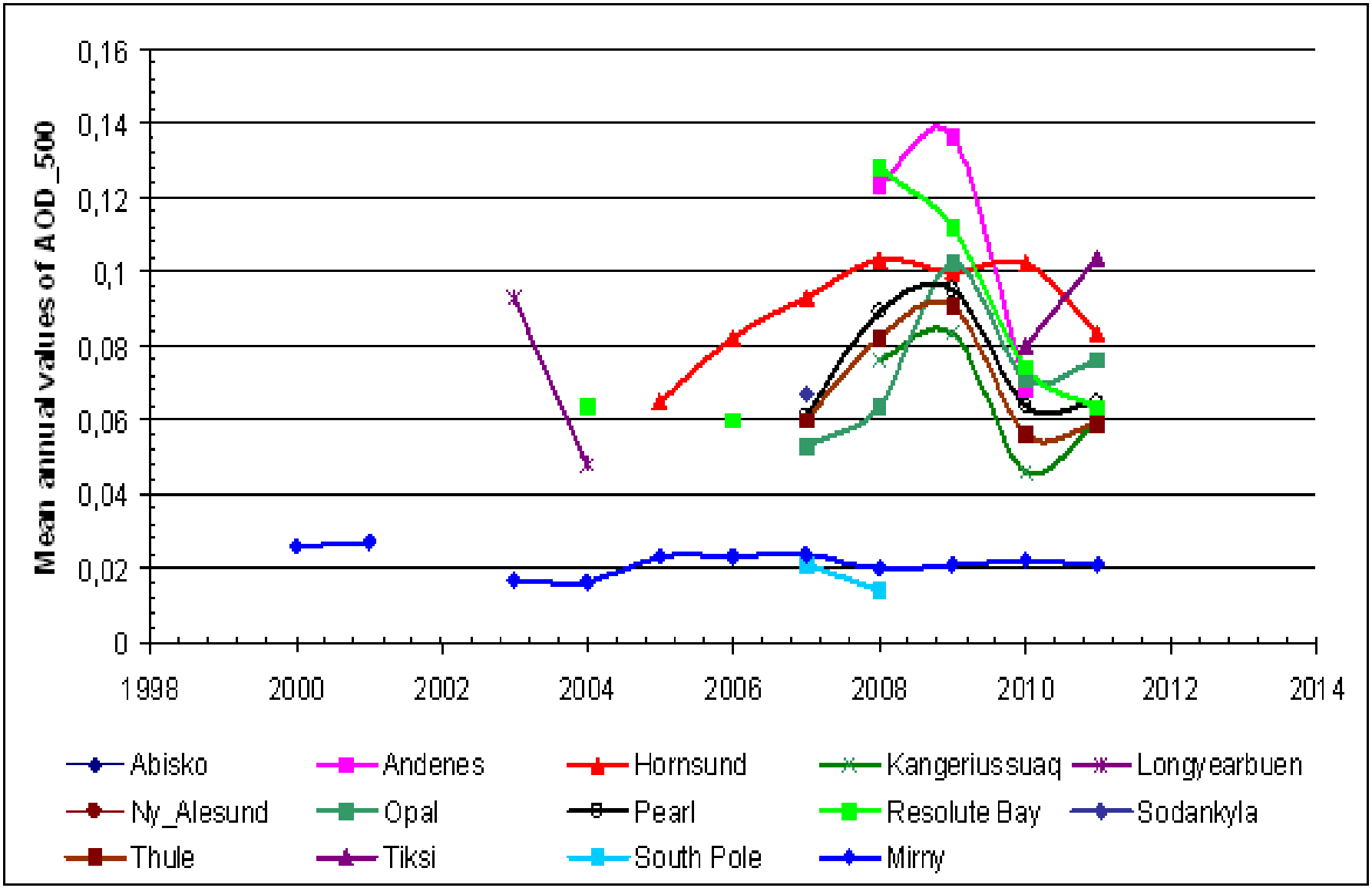


Variability of monthly mean values of AOD_500 at the Arctic AERONET stations and Antarctic stations Mirny and South Pole



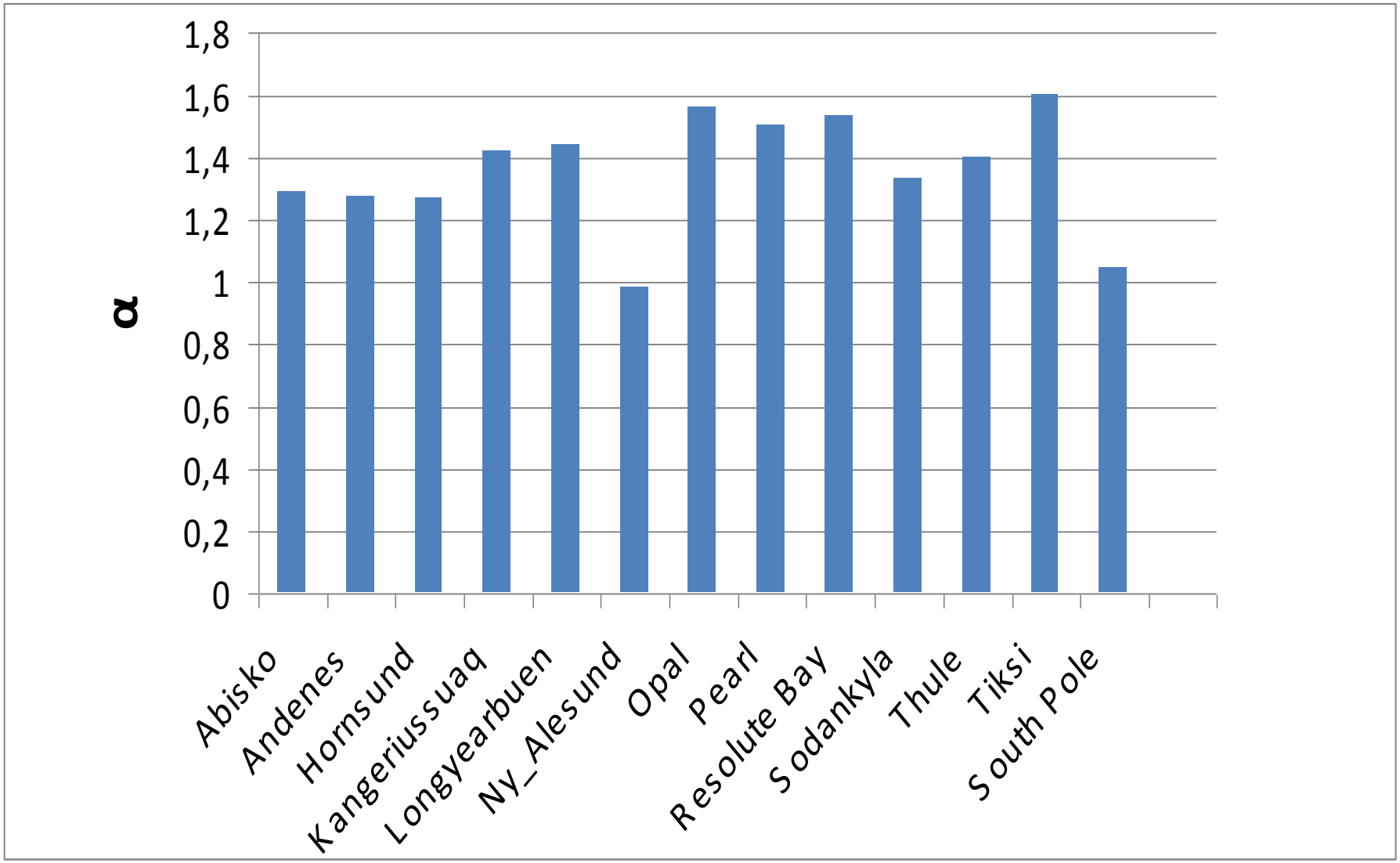
- The monthly mean values of AOD(500) don't exceed 0.05 at the Antarctic stations and 0.25 at the Arctic stations. Statistically significant trends have not been identified.

Variability of annual mean values of AOD(500) at the Arctic AERONET stations and Antarctic stations Mirny and South Pole



- All Arctic stations showed an increase AOD(500) in 2009. Reasons for this are not clear, since the main volcanic eruptions (Sarychev volcano?, June 12, 2009) and forest fires in Russia occurred later. Most likely this phenomenon is connected with processes of the atmospheric circulation in 2009. At the Antarctic stations AOD(500) changes have not been identified in 2009.

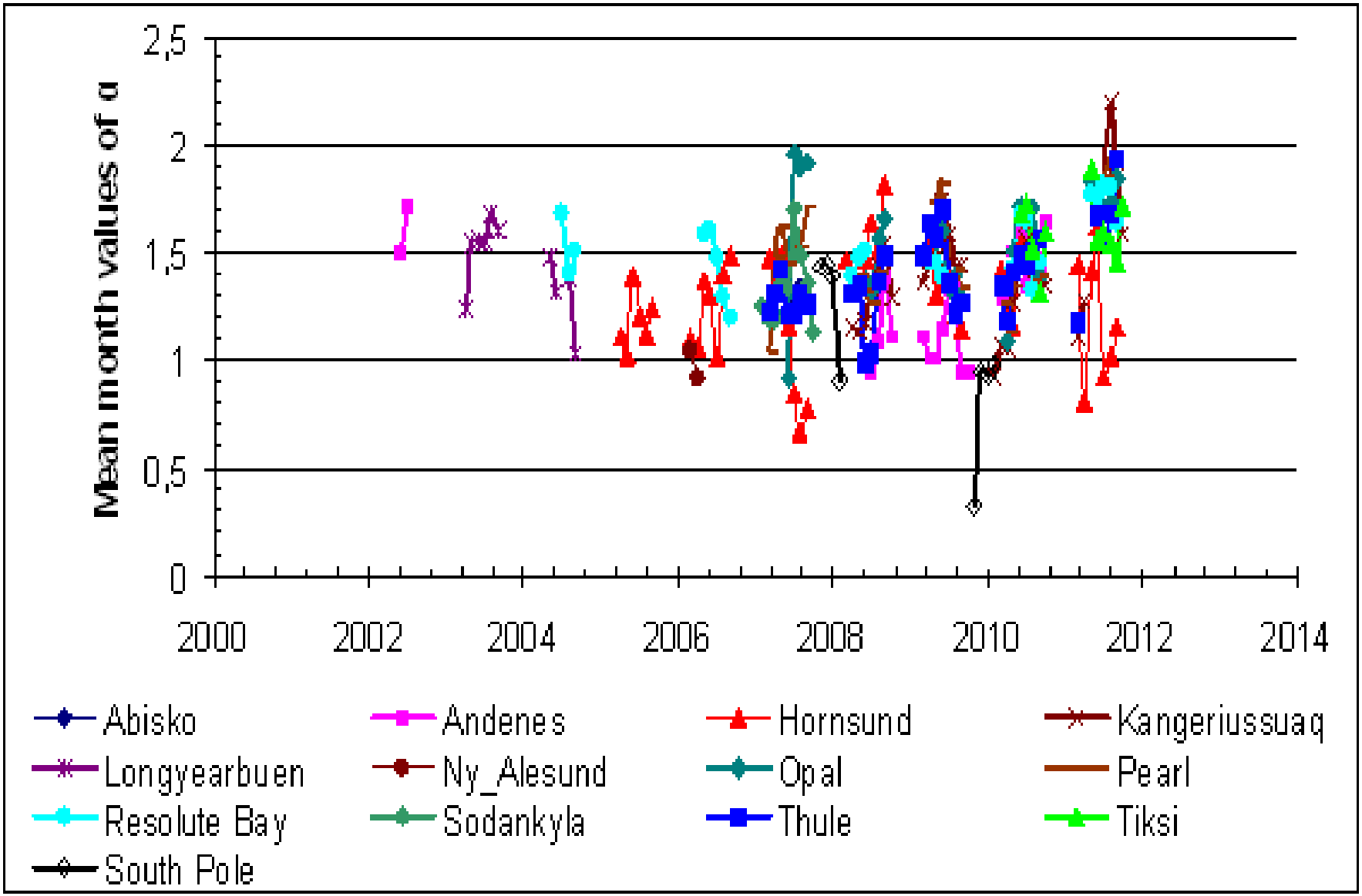
Mean values of the Ångström exponent α at the Arctic AERONET stations and South Pole in 2002-2011



- Mean values of the Ångström parameter α vary from 0.98 (Ny-Alesund) till 1.59 (Tiksi). Thus, the average value of α by Ångström (α=1.3) falls in the middle of this range.

- Next slide demonstrates that from 2002 to 2006 we can see a reduction of the mean monthly values of α, and after 2006 a gradual increase of α begins.

Variability of monthly mean values of α for 2002 – 2011



At Russian actinometrical stations the parameter named total optical depth (TOD) is used to characterize the turbidity/transparency of the atmosphere (so called “apparent transmission”. Bodhaine *et al. 1989*)

TOD is defined by the formula (Radionov, 1994):

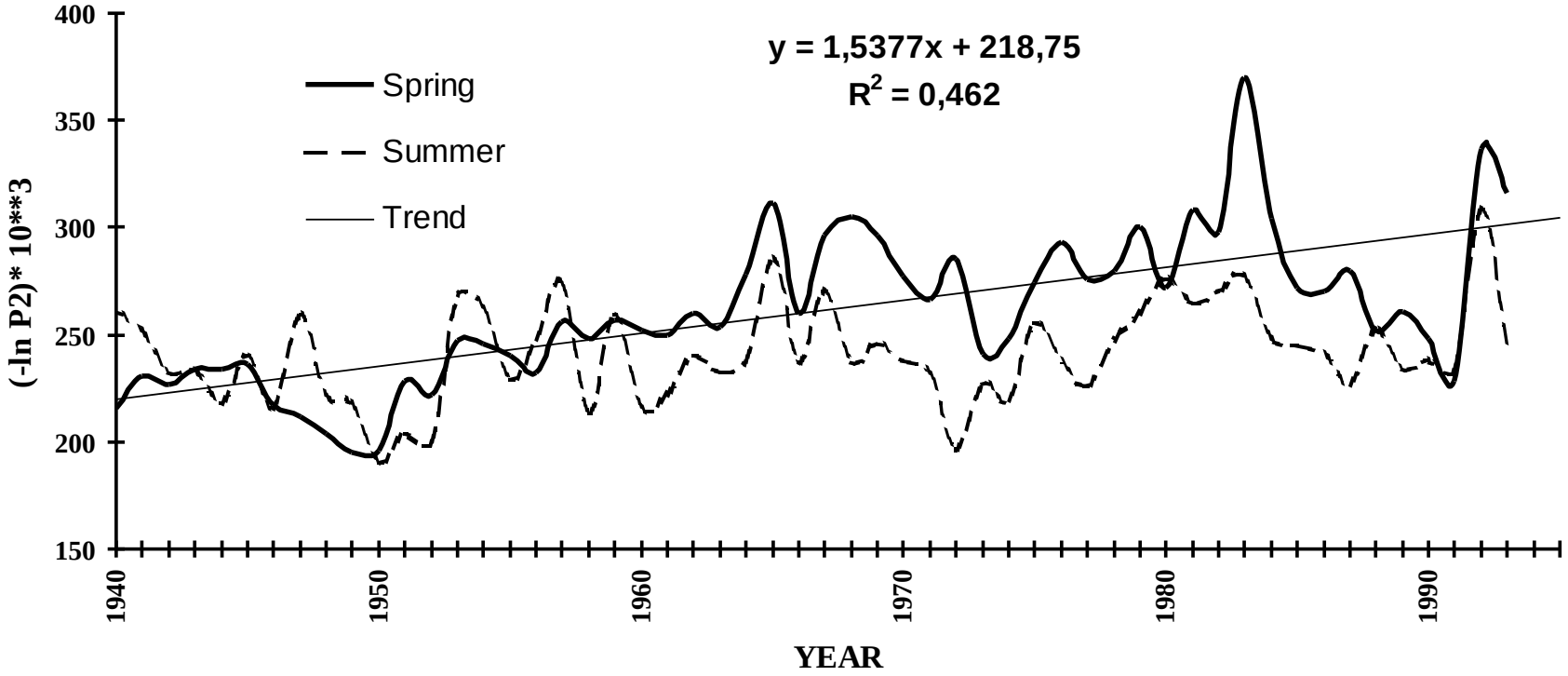
$$\mathbf{TOD = -\,(\sin h + 0.204)\cdot \ln\,(S(h) / S_{\odot})/1.41}$$

where

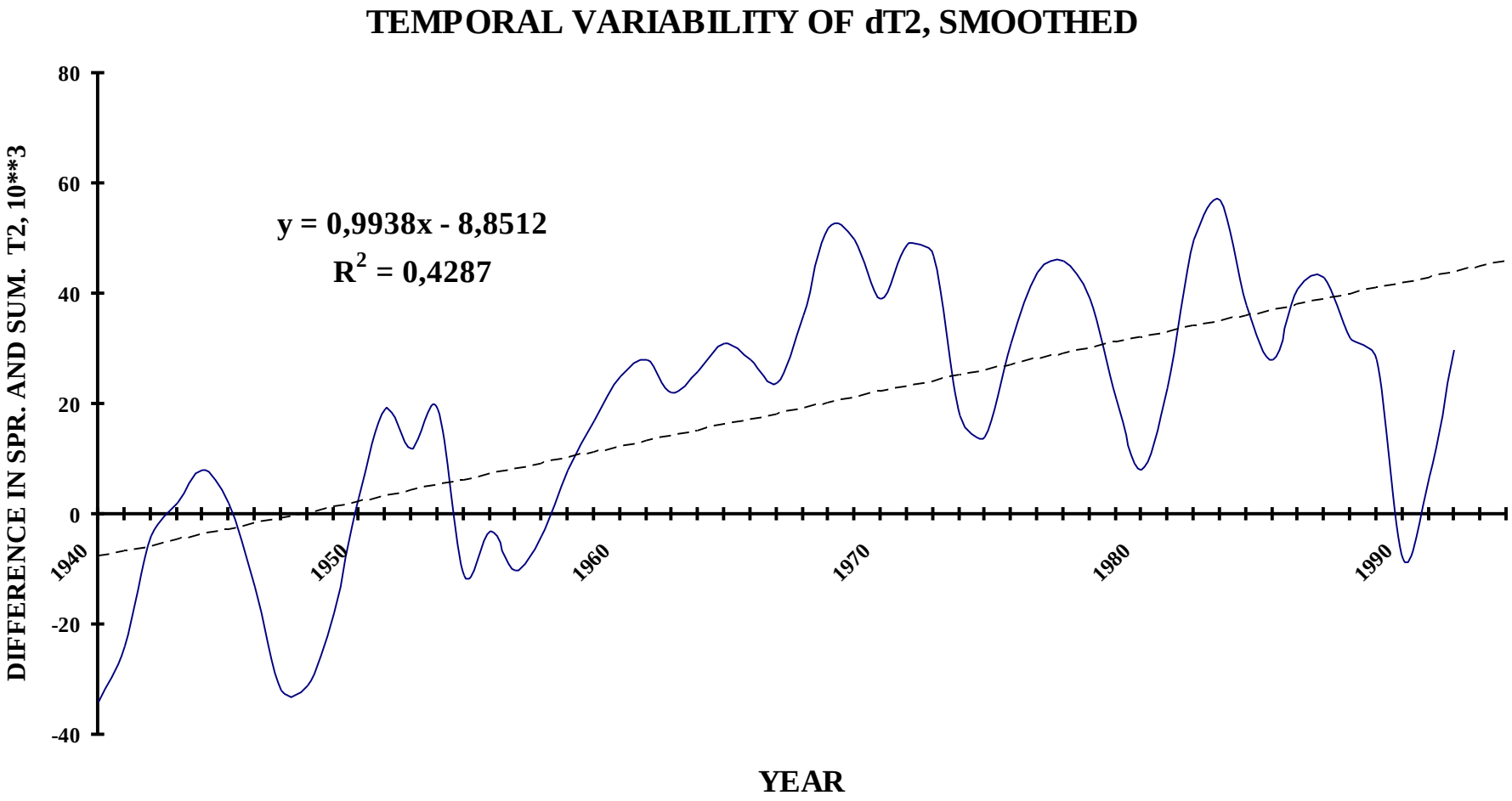
- S(h) - the measured direct solar radiation (kW/m^2) at Sun elevation h reduced to the average Sun-Earth distance;
- $S_{\odot}$ – direct solar radiation on the top border of the atmosphere.

The TOD represents optical depth of the atmosphere for direct solar radiation in a range of lengths of waves $\Delta\lambda$ = 0.3–4 mkm. Its variations are defined mainly by changes of atmospheric water vapour and aerosol content.

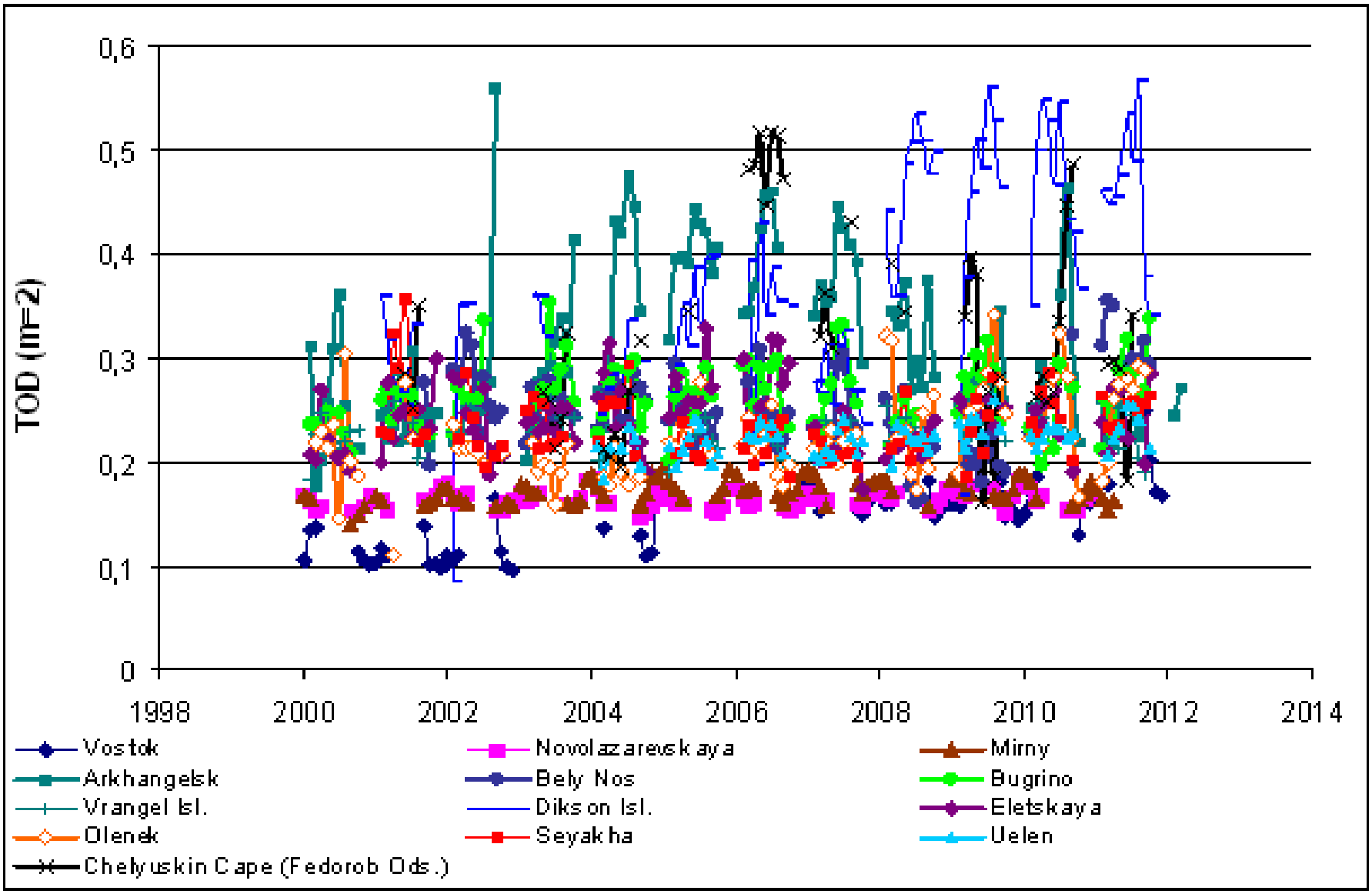
Long-term variability of atmospheric turbidity at Dixon Is.



Long-term variability of difference of spring and summer values of atmospheric turbidity at Dixon Is.



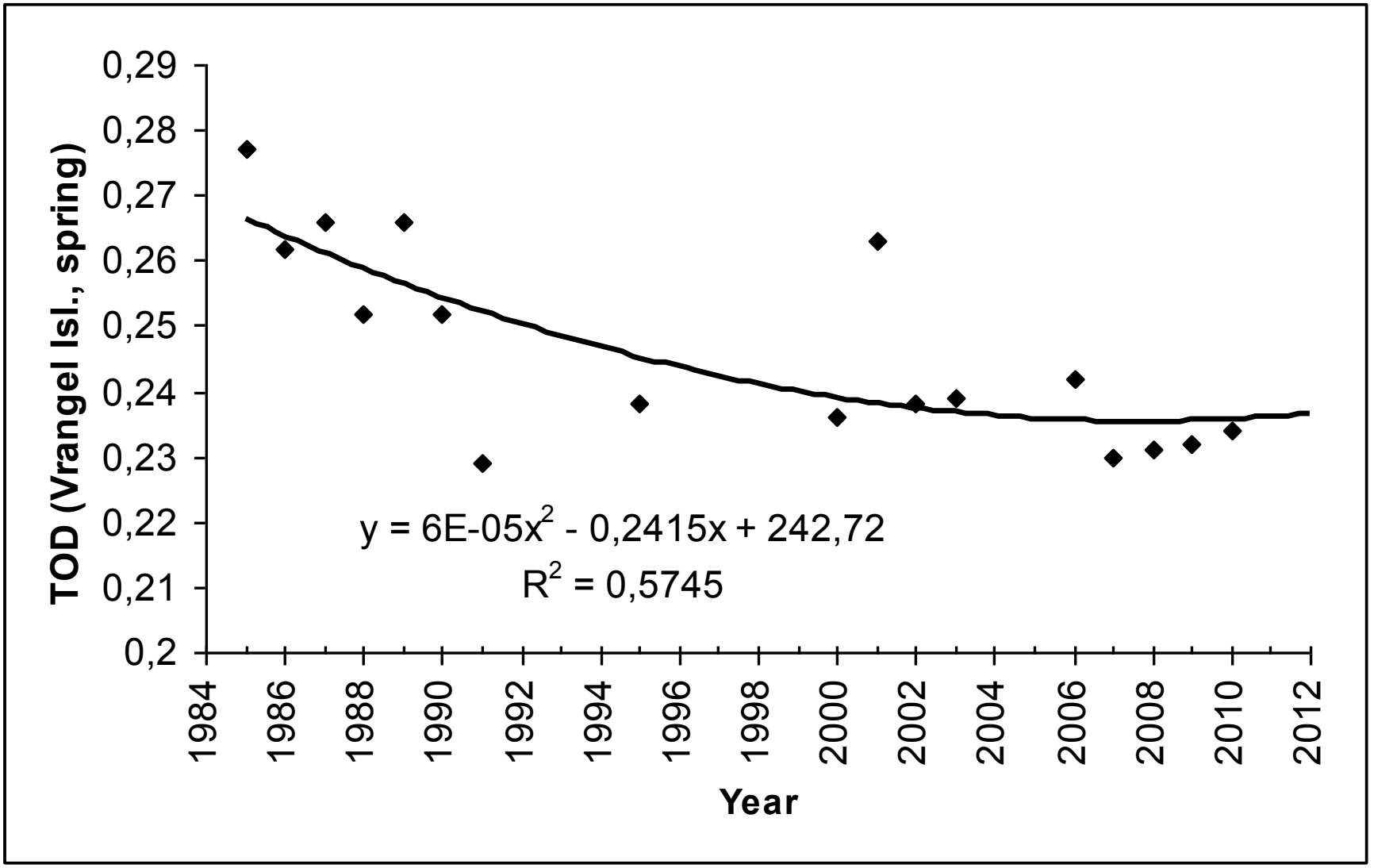
Variability of mean monthly values of the total optical depth at the Arctic and Antarctic Russian stations



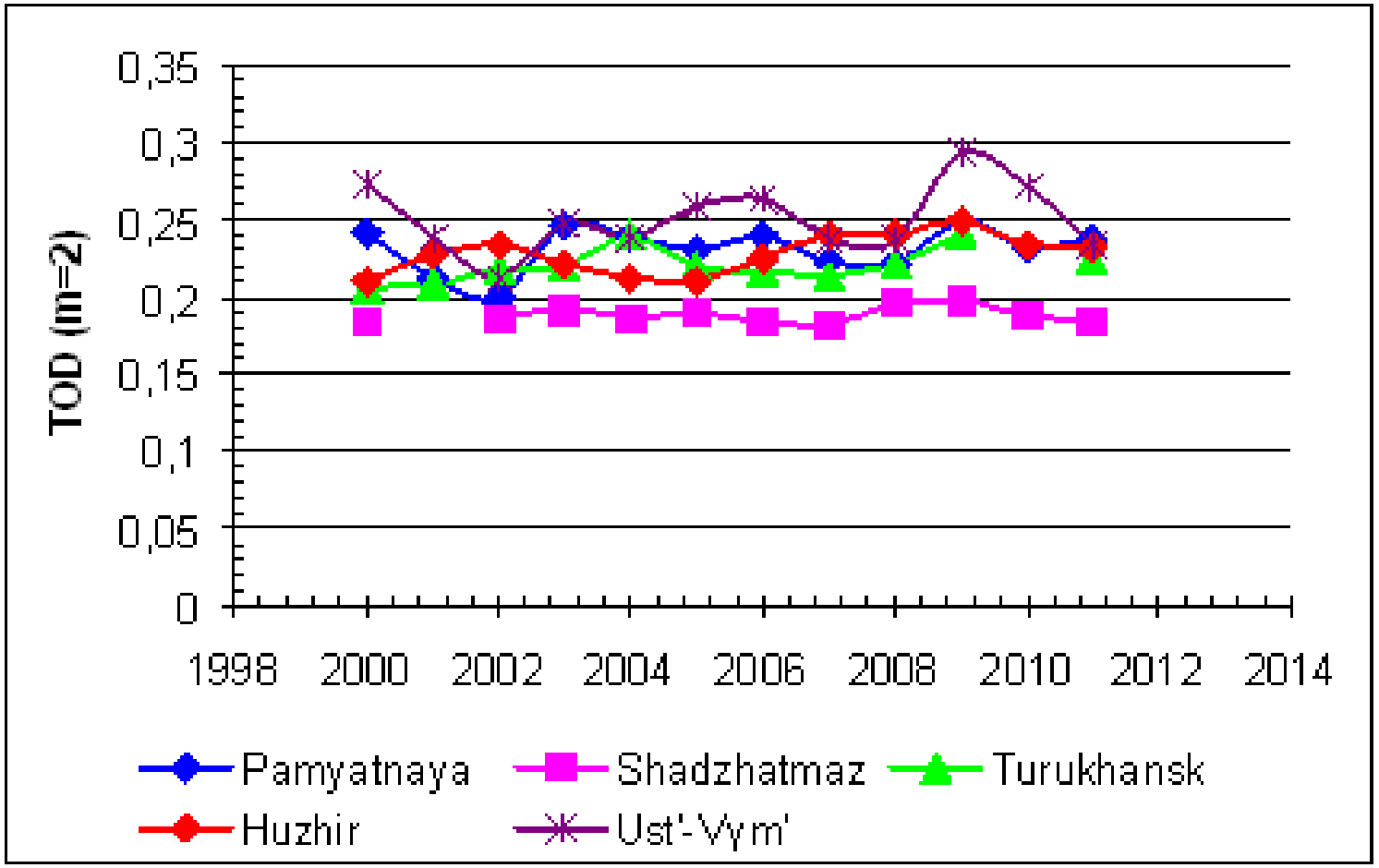
- The mean monthly values of TOD don't exceed 0.2 at the Antarctic stations. At the Arctic stations these values don't exceed 0.4. Monthly means TOD exceeding 0.4, registered only at three Arctic Russian stations. These are Arkhangelsk and two stations of the Taimyr Peninsula – Dikson Isl. (beginning from 2008) and Chelyuskin Cape (in 2006).

- Arkhangelsk is an urban station, which shows the effect of anthropogenic pollution. The reasons which have caused increase TOD on Dickson Isl. and Chelyuskin Cape, are established now.

Variability of TOD at Vrangel Island in spring (March – May)



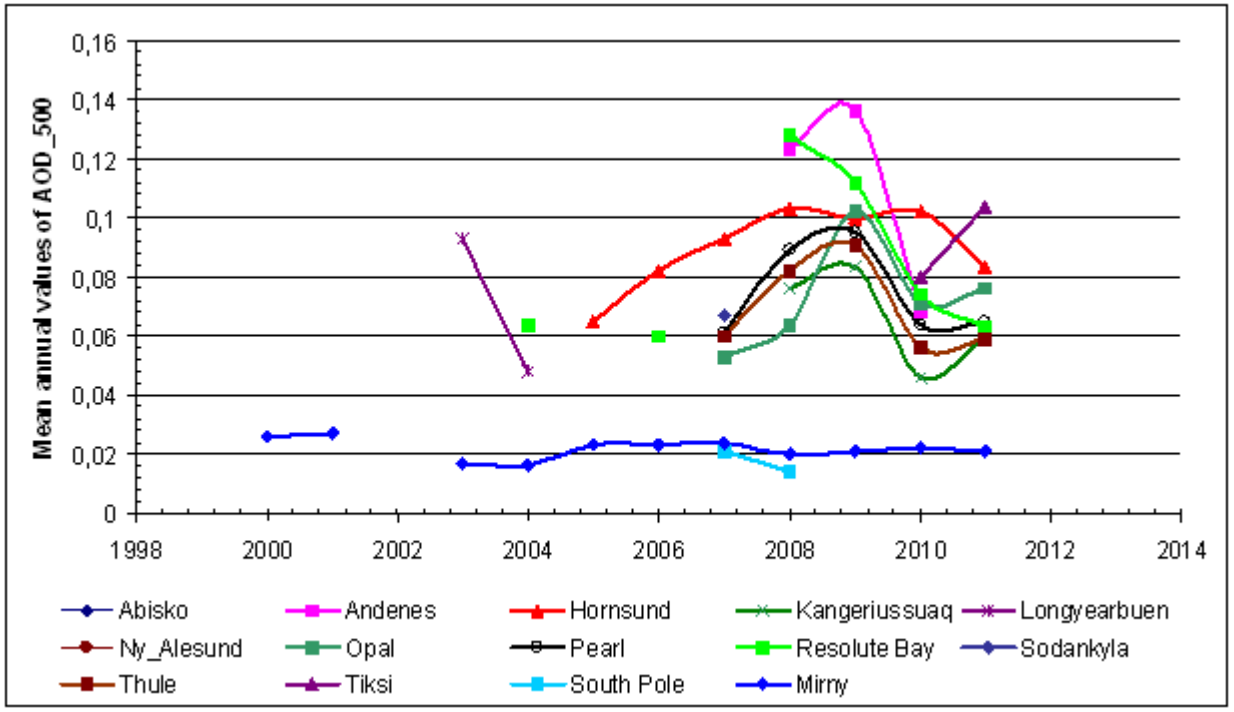
Variability of annual mean values of TOD at the Russian background monitoring stations located in moderate latitudes



Turukhansk (65,8° N, 87,9° E.), Ust’-Vym’ (62,2° N, 50,1° E), Pamyatnaya (56,0° N, 65,7° E), Huzhir (53,2° N, 107,3° E), Shatzhatmaz (43,7° N, 42,7° E).

The bottom curve characterizes variability of mean annual values at the mountain station Shadzhatmaz located in the North Caucasus at height of 2070 m.

It should be noted that, at the station Ust'-Vym' (62.2° N) recorded an increase of TOD in 2009 (as well as AOD(500) on the slide 6).



- **Conclusions**

- The monthly mean values of AOD(500) don't exceed 0.05 at the Antarctic stations and 0.25 at the Arctic stations.

- At the AERONET stations the Ångström exponent α changed in the range of 0.98 to 1.59 in 2002-2011.

- The slight decrease of the mean monthly values of selectivity parameter α is observed from 2002 to 2006, and after 2006 a gradual increase of α began.

- At the Russian Antarctic stations the mean monthly values of the TOD ≤ 0.2. At the Arctic Russian stations these values < 0.4 except for three stations, namely, Arkhangelsk, Dikson Isl., and Chelyuskin Cape, where monthly means TOD ≥ 0.4.

- The parallel observations of the AOD(500) and TOD at Mirny station in Antarctic, found that the AOD(500) is an average of 12% of the TOD.

- During the first decade 21st century statistically significant trends for the AOD(500) and TOD are not registered at the Arctic, Antarctic and mid-latitude stations.

- In 2009, an increase of AOD(500) was observed at the Arctic stations. The same increase of TOD in 2009, was noted at the northern mid-latitude station Ust'-Vym'.

Thank you for your attention