AERONET 30

Comprehensive monitoring of variability in the composition of climate-active pollutants in the atmosphere of the mountainous region of Central Asia

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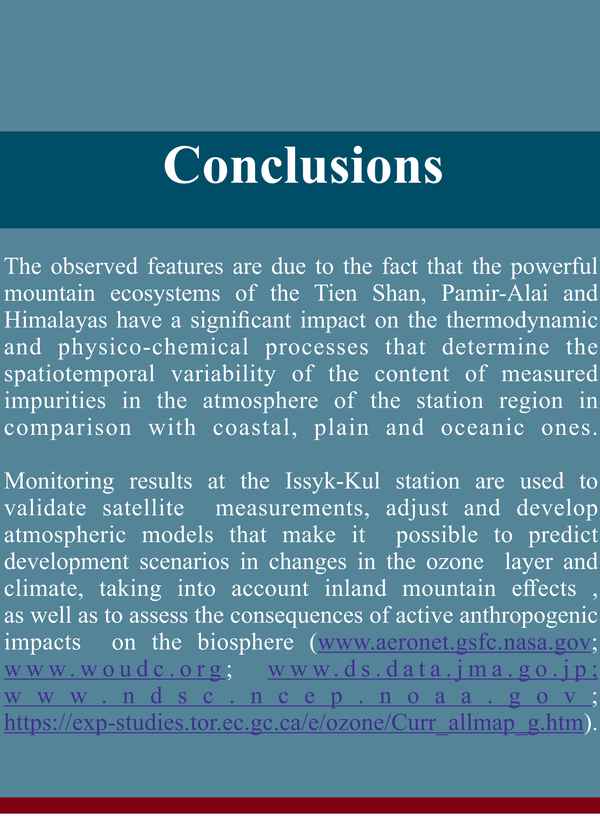
Introduction

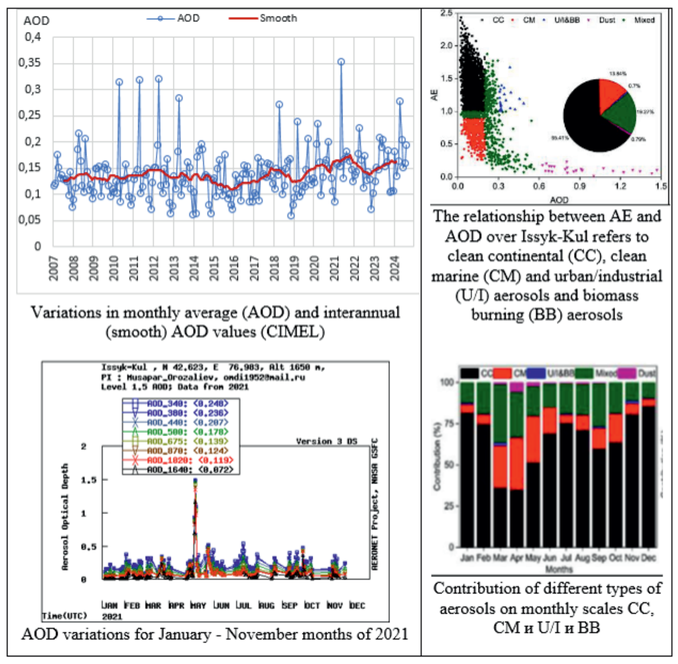
More than 43 years of monitoring of trace atmospheric impurities at the high-mountain stations “Issyk-Kul” (in AERONET, GAW network) and “Issyk-Kul OMD” made it possible to determine features in interannual variations and trends in aerosols, ozone and other gases content in the atmosphere over Central Asian mountainous region in conditions of rapidly changing solar, geophysical processes and anthropogenic load. The observed features are due to powerful impact of the mountain ecosystems of Tien Shan, Pamir-Alai and Himalayas on the thermodynamic, physical, and chemical processes determining the spatiotemporal variability of measured impurities in the atmosphere of the region in comparison with coastal, plain and oceanic ones. The aerosol optical depth was calculated from measured atmospheric transparency from 1984 to 2009. Since 2007 measurements of the aerosols optical characteristics have been carried out with an automatic radiometer CIMEL, CE 318N-V8S5-M9. Measurements of total O3, SO2, NO2, CO2, H2O from 1980 to 2021 were carried out with special spectrophotometric installations, since 2021, O3, SO2, NO2 measurements have been carried out using the Brewer MkIV spectrophotometer. The monitoring results are used to validate satellite measurements, adjust and develop atmospheric models, taking into account continental mountain effects, and assess active anthropogenic impacts on the biosphere.



Deviations TO (Δ = -31%) Issyk-Kul OMD (42°62 N,76°98 E, 1640 m asl)

Results

Since 2007, measurements of the optical characteristics of aerosols have been carried out with an automatic radiometer CIMEL, CE 318N-V8S5-M9.



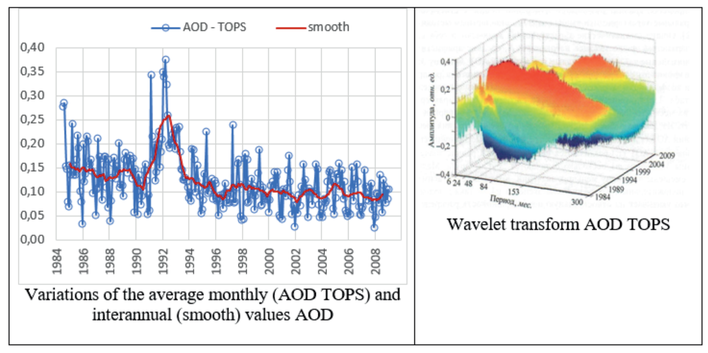
Variations in monthly average (AOD) and interannual (smooth) AOD values (CIMEL)

The relationship between AE and AOD over Issyk-Kul refers to clean continental (CC), clean marine (CM) and urban/industrial (U/I) aerosols and biomass burning (BB) aerosols

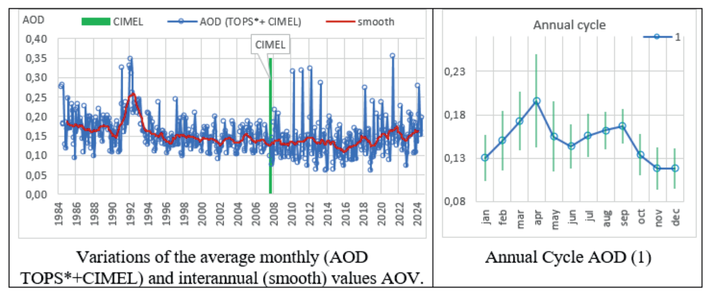
AOD variations for January - November months of 2021

Contribution of different types of aerosols on monthly scales CC, CM и U/I и BB

The aerosol optical depth was calculated from the measured atmospheric transparency from 1984 to 2009.



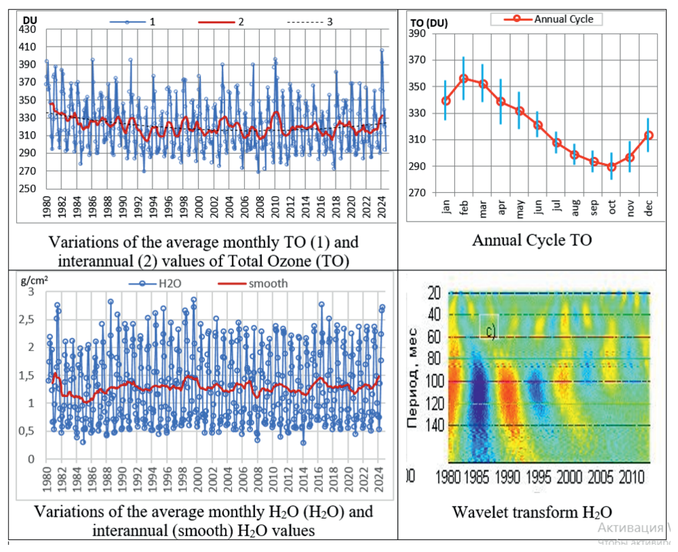
Variations of the average monthly (AOD TOPS) and interannual (smooth) values AOD



Variations of the average monthly (AOD TOPS*+CIMEL) and interannual (smooth) values AOV.

Annual Cycle AOD (1)

Measurements of the total content of O3, SO2, NO2, CO2, H2O from 1980 to 2021 were carried out with special spectrophotometric installations, and since 2021, measurements of O3, SO2, NO2 have been carried out using a Brewer MkIV network spectrophotometer

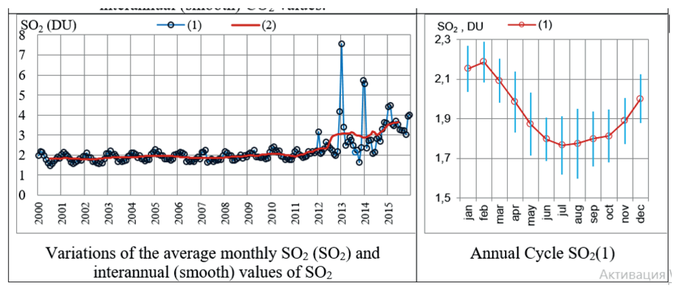


Variations of the average monthly TO (1) and interannual (2) values of Total Ozone (TO)

Annual Cycle TO

Variations of the average monthly H_2O (H_2O) and interannual (smooth) H_2O values

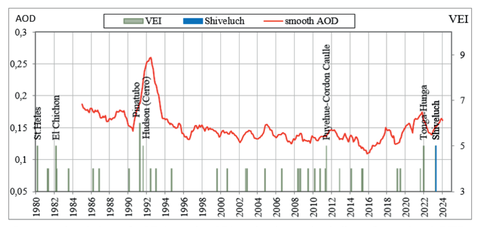
Wavelet transform H_2O



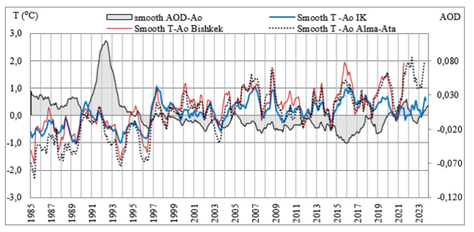
Variations of the average monthly SO_2 (SO_2) and interannual (smooth) values of SO_2

Annual Cycle SO_2(1)

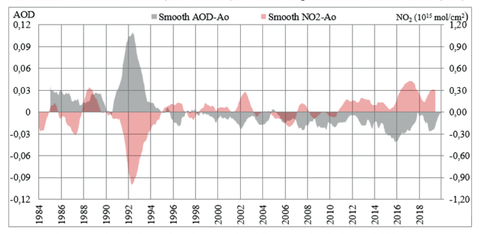
Long-term (more than 43 years) monitoring of trace atmospheric impurities at the high-mountain stations “Issyk-Kul” (in the AERONET, GAW network) and “Issyk-Kul OMD” allowed us to determine some features in interannual variations and trends in the content of aerosols, ozone (O3) and other gases (SO2, NO2, CO2, H2O) in the atmosphere over the mountainous region of Central Asia under conditions of rapidly changing solar-geophysical processes and anthropogenic load



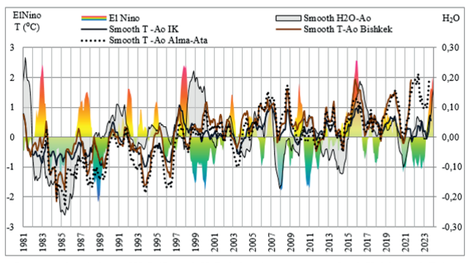
Interannual variations of AOD (smooth AOD) , volcanic eruption indices of more than 3 (VEI)



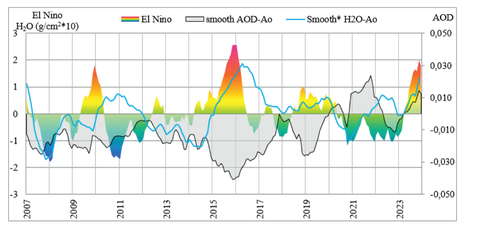
Interannual variations of AOD (smooth AOD-Ao) and temperature at Issyk-Kul (smooth T -Ao IK), Bishkek (smooth T-Ao Bishkek) and Alma-Ata (smooth T-Ao Alma-Ata) stations



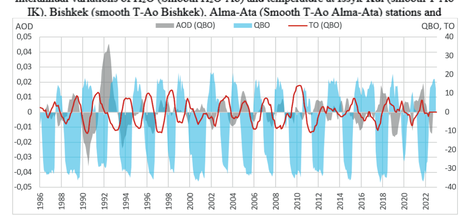
Interannual variations of AOD (smooth AOD-Ao) and NO_2 (smooth NO_2-Ao)



Interannual variations of H_2O (Smooth H_2O-Ao) and temperature at Issyk-Kul (smooth T-Ao IK), Bishkek (smooth T-Ao Bishkek), Alma-Ata (Smooth T-Ao Alma-Ata) stations and



Interannual variations of AOD (smooth AOD-Ao) and H_2O (Smooth* H_2O-Ao) measured at Issyk-Kul station and variations of the El Nino index



Quasi-two-year oscillation over Issyk-Kul: AOD (AOD QBO), Total Ozone (TO QBO) and Quasi biennial oscillation of equatorial wind (QBO 20hPaN)

Conclusions

The observed features are due to the fact that the powerful mountain ecosystems of the Tien Shan, Pamir-Alai and Himalayas have a significant impact on the thermodynamic and physico-chemical processes that determine the spatiotemporal variability of the content of measured impurities in the atmosphere of the station region in comparison with coastal, plain and oceanic ones.

Monitoring results at the Issyk-Kul station are used to validate satellite measurements, adjust and develop atmospheric models that make it possible to predict development scenarios in changes in the ozone layer and climate, taking into account inland mountain effects, as well as to assess the consequences of active anthropogenic impacts on the biosphere (www.aeronet.gsfc.nasa.gov; www.woudc.org; www.ds.data.jma.go.jp; www.ndsc.ncep.noaa.gov; https://exp-studies.tor.ec.gc.ca/e/ozone/Curr_allmap_g.htm).

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