Comparison of the daily direct irradiance and sunshine duration

Kalju Eerme

Tartu Observatory, Estonia

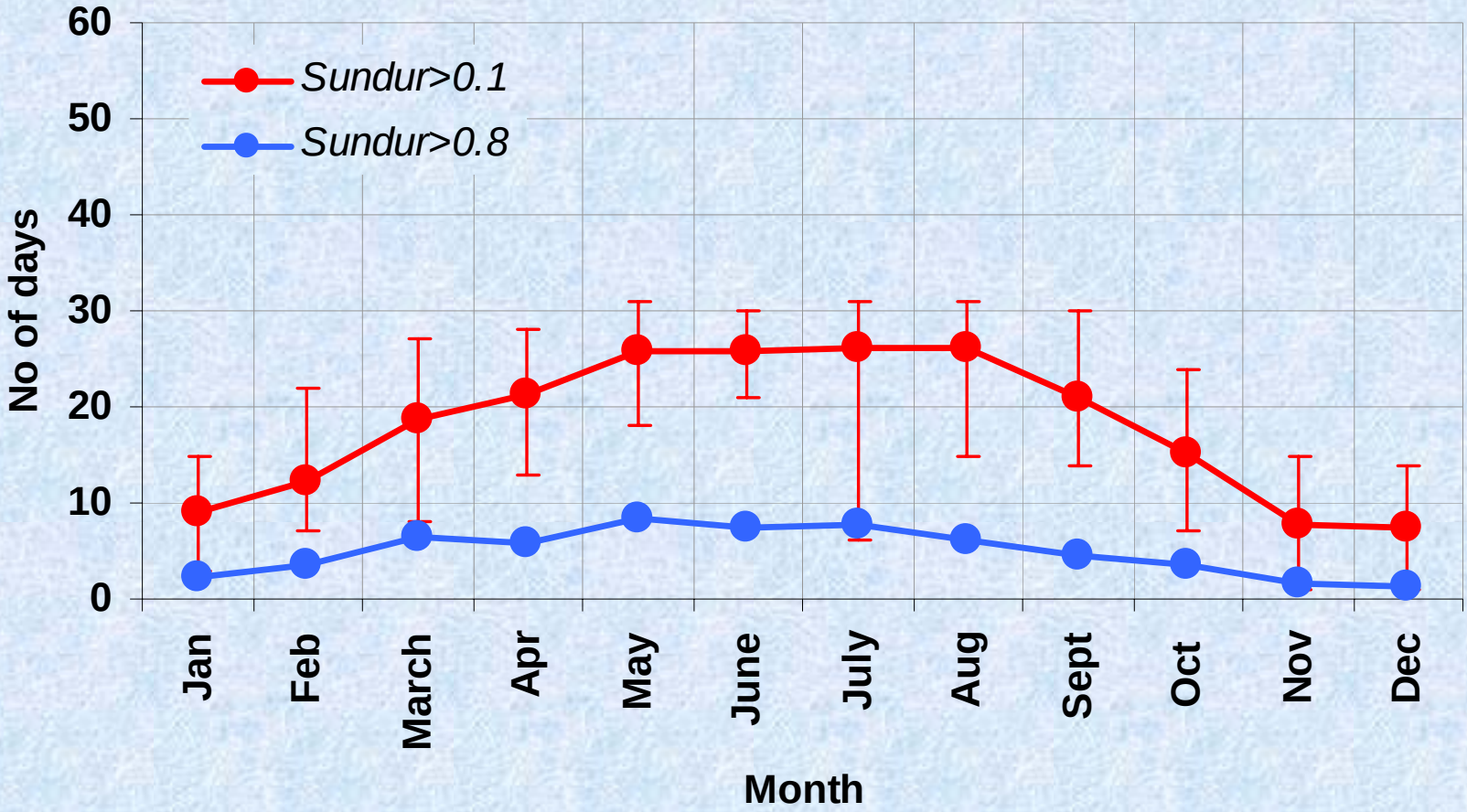
Content of presentation

- The daily sums on sunshine duration and direct irradiance measured at Tartu-Tõravere meteorological station in 1967-2008 studied
- How much differ the daily relative sunshine duration and daily relative sum of direct irradiance due to the daily variations of cloud amount?
- Study on monthly basis

Daily relative sum of direct irradiance and relative sunshine duration

- Both as the ratios relative to the value of corresponding normal cloudless day I'/I'_{clear} and $Sundur/Sundur_{clear}$
- The first expresses the daily amount of direct irradiance energy and the second the daily total time of sunhine
- The both ratios and their ratio were calculated
- Zero and infinite values excluded, also those corresponding to $Sundur/Sundur_{clear} < 0.1$

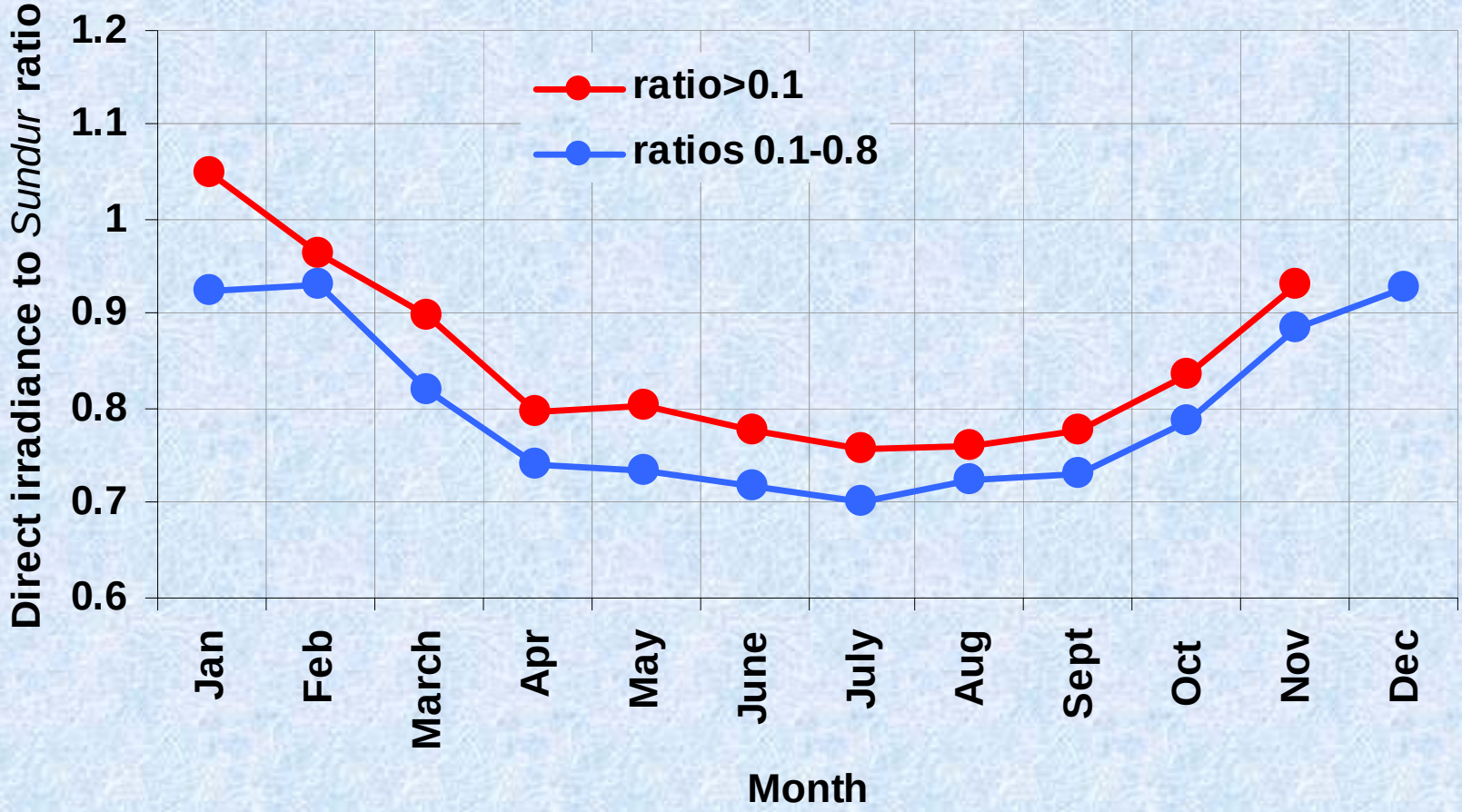
Monthly numbers of days *Sundur*/*Sundur*$_{clear}$ above 0.1 and between 0.1- 0.8



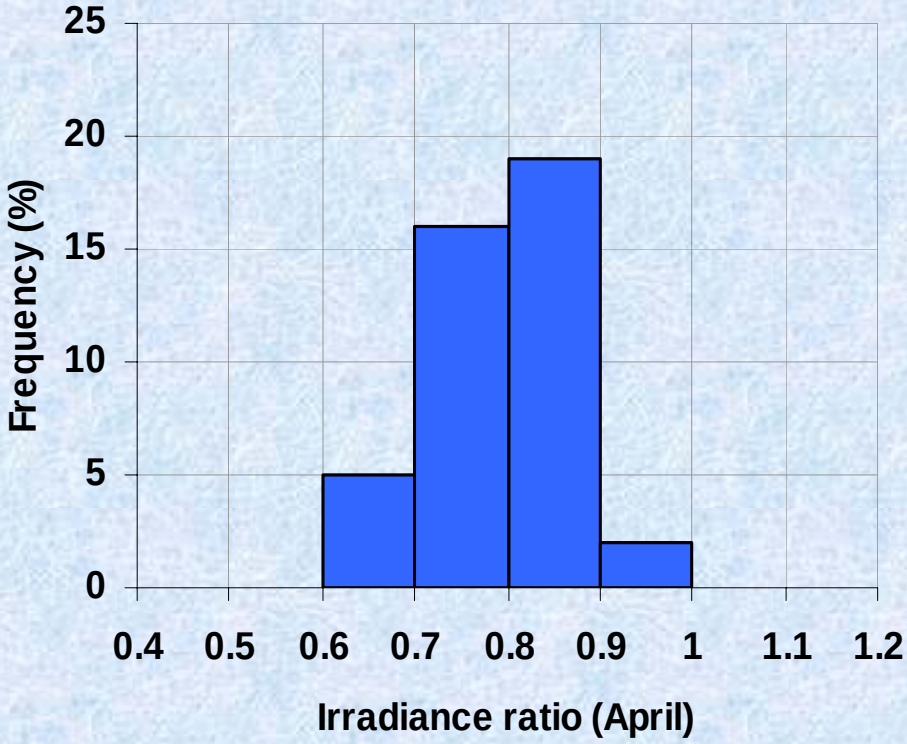
Results

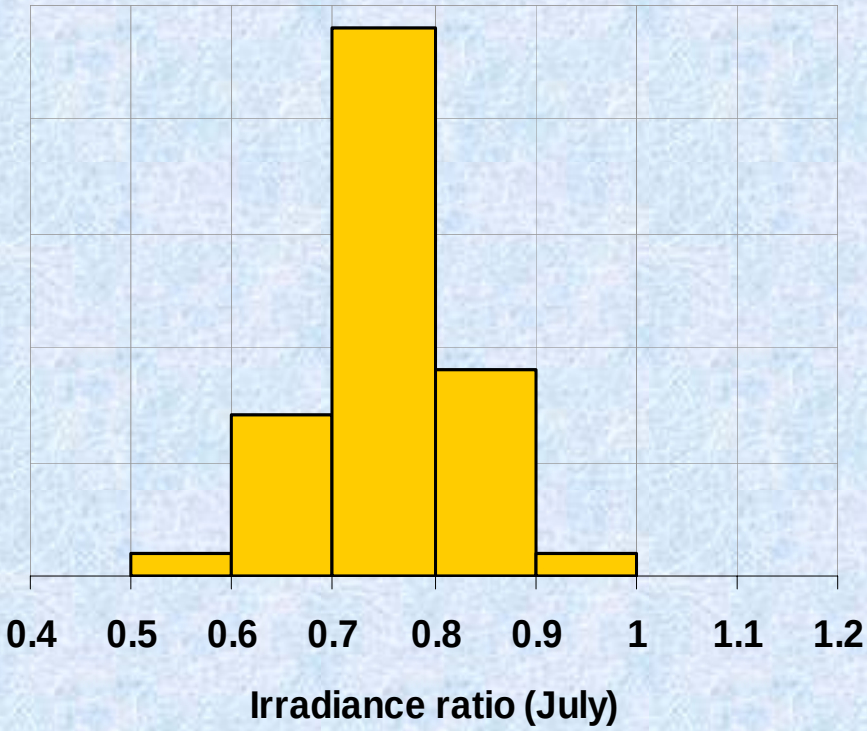
- Data for 1967-2008 treated (still part of them)
- For $Sundur/Sundur_{clear} < 0.1$ the ratio varied in the range 0.2 to 5. Further excluded
- For $Sundur/Sundur_{clear} > 0.8$ the values of ratio close to 1. Mean value March to September around 0.90, in winter slightly above 1
- For $0.1 < Sundur/Sundur_{clear} < 0.8$ the ratios smaller, mean in March to September 0.73 (annual values 0.69-0.79), in winter close to 1

Monthly mean values of the ratio I'/I'_{clear} to $Sundur/Sundur_{clear}$



Examples of yearly distribution of the monthly mean of the ratio





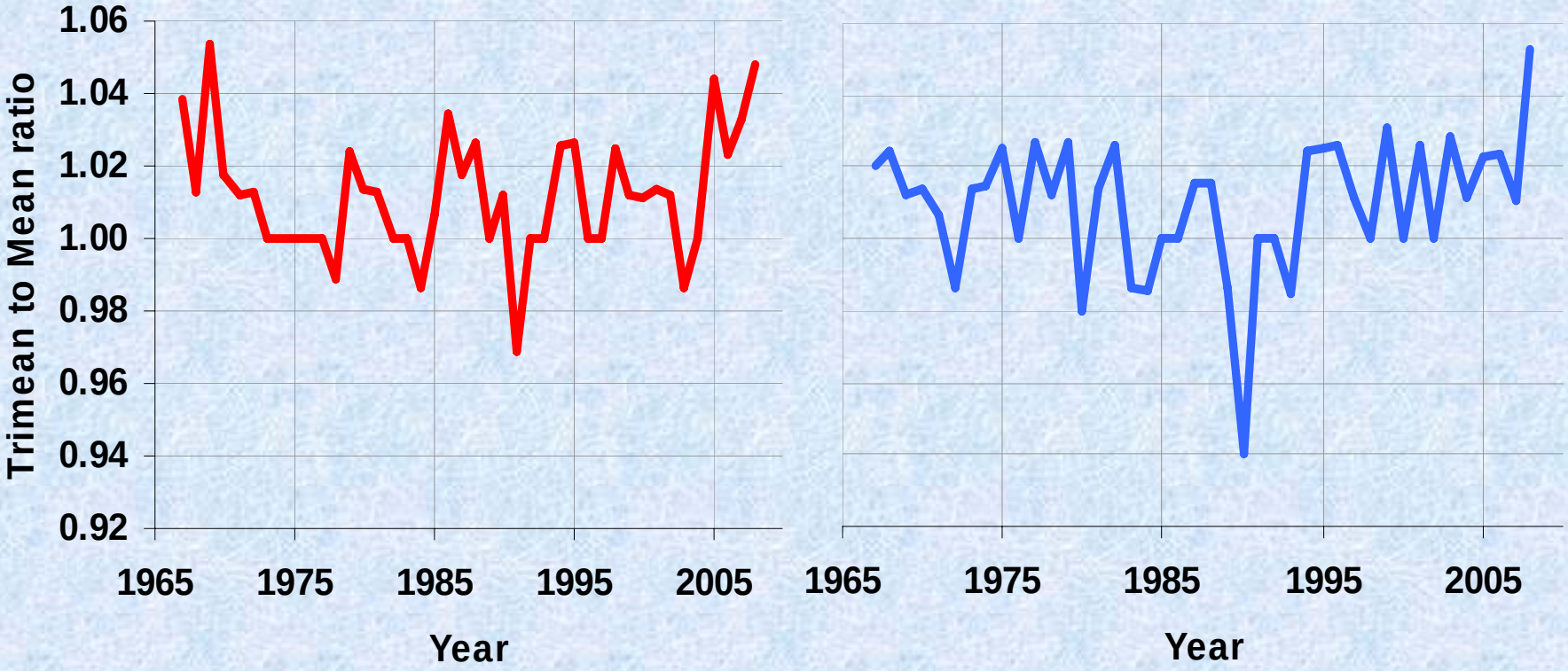
Numerical summary measures in Exploratory Data Analysis (EDA)

- The goal of EDA to get insight into the processes behind the numerical data
- The numerical summaries of location, spread and symmetry
- Summary measures must be robust (nonsensitive to the variations in distribution) and resistant (nonsensitive to extreme values)
- Conventional mean is not the best measure of location

More robust summary measures

- Median
- Quartiles based measures
- Trimean (trimmed median)
- Trimean = $(q_{0.25} + 2q_{0.5} + q_{0.75})/4$
- Spread measures instead StD
- Interquartile range IQR = $q_{0.75} - q_{0.25}$
- Median Abs. Deviation MAD = median$|x_i - q_{0.5}|$

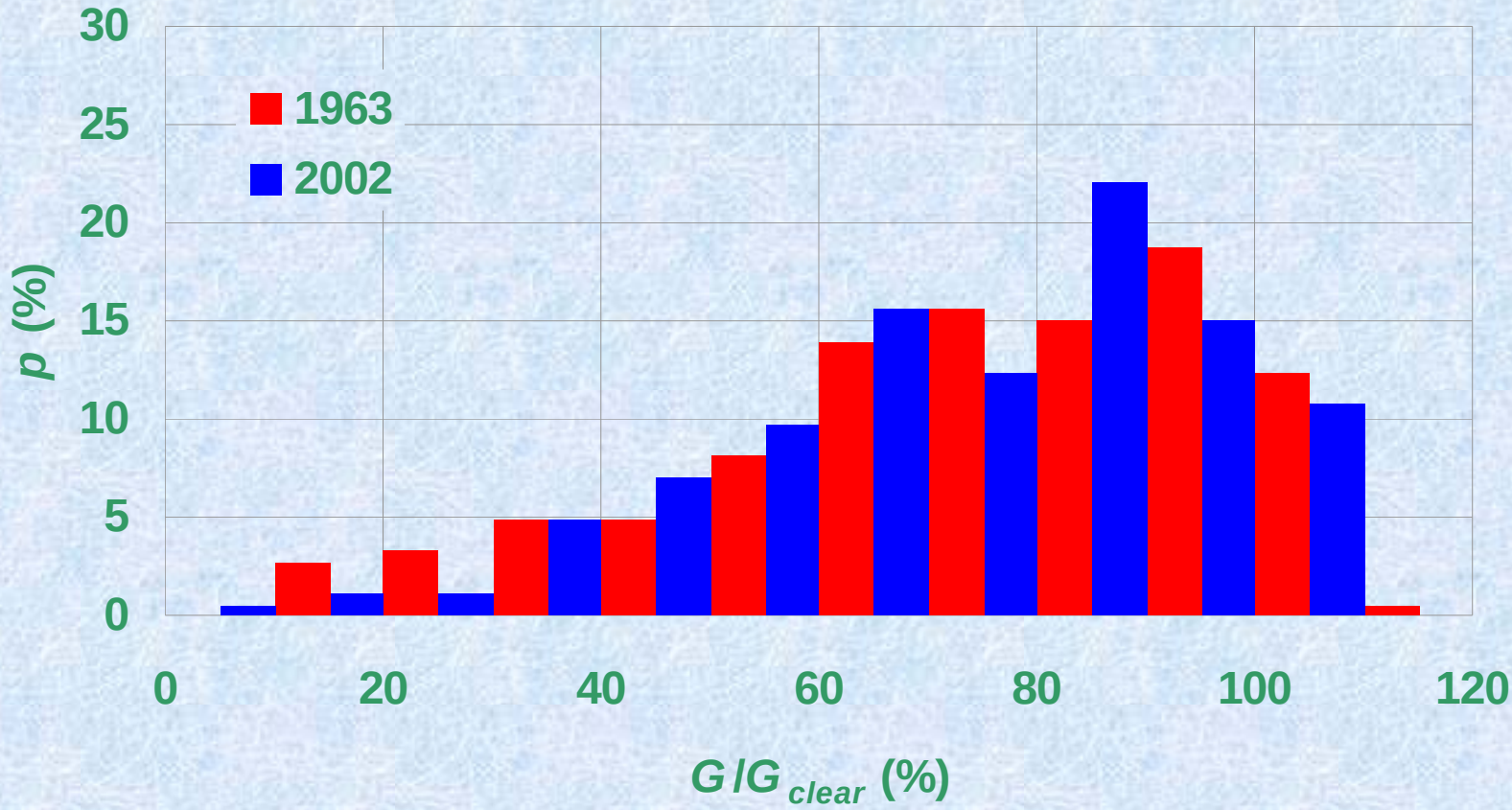
Trimean to mean of the ratios in May-June and July-August



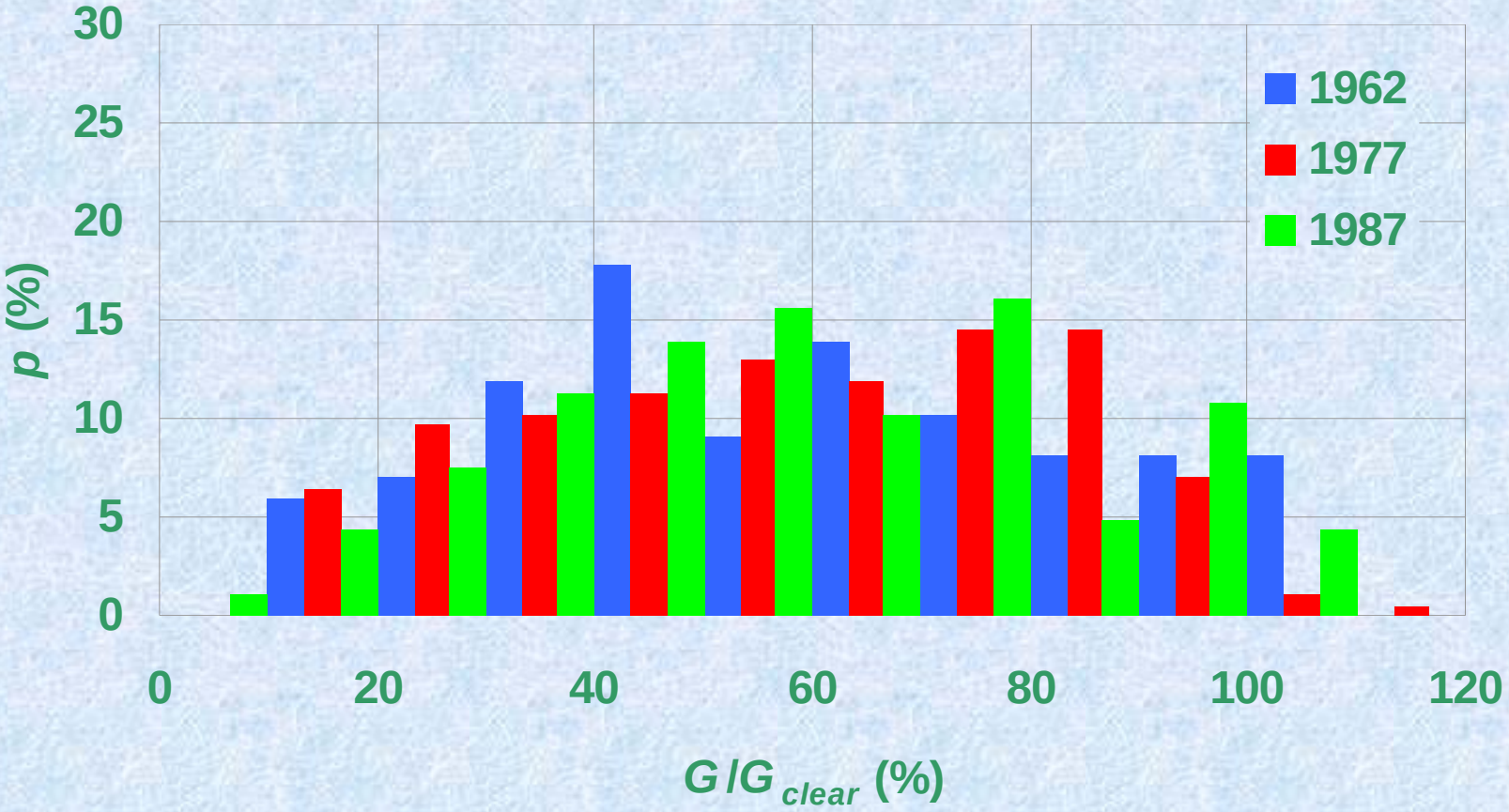
Comparison of mean, median and trimean for some other quantities used as proxy in UV reconstruction

- Daily relative sum of broadband global irradiance
- Winter, summer half-year and autumnal values are compared for 1955-2008
- Considering the trimean as most robust measure the conventional mean overestimates the Q/Q_{clear} during the dark half-year and underestimates during the bright half-year
- Mean/trimean ratio in winter 1.05 (0.96-1.18) in autumn 1.09 (0.99-1.25) and in summer 0.975 (0.94-1.02)

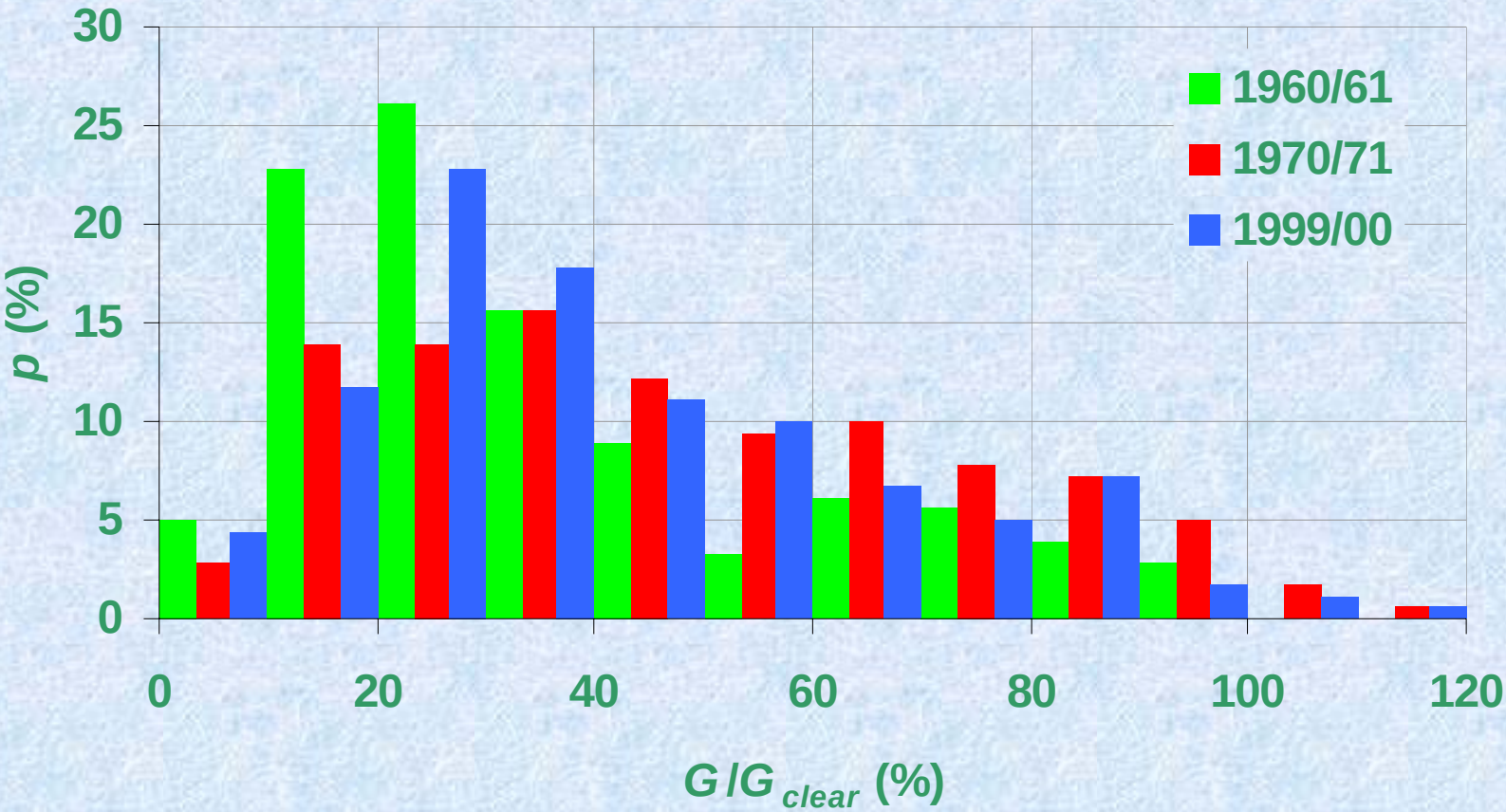
G/G_{clear} PDF in most fine-weather summer half-years



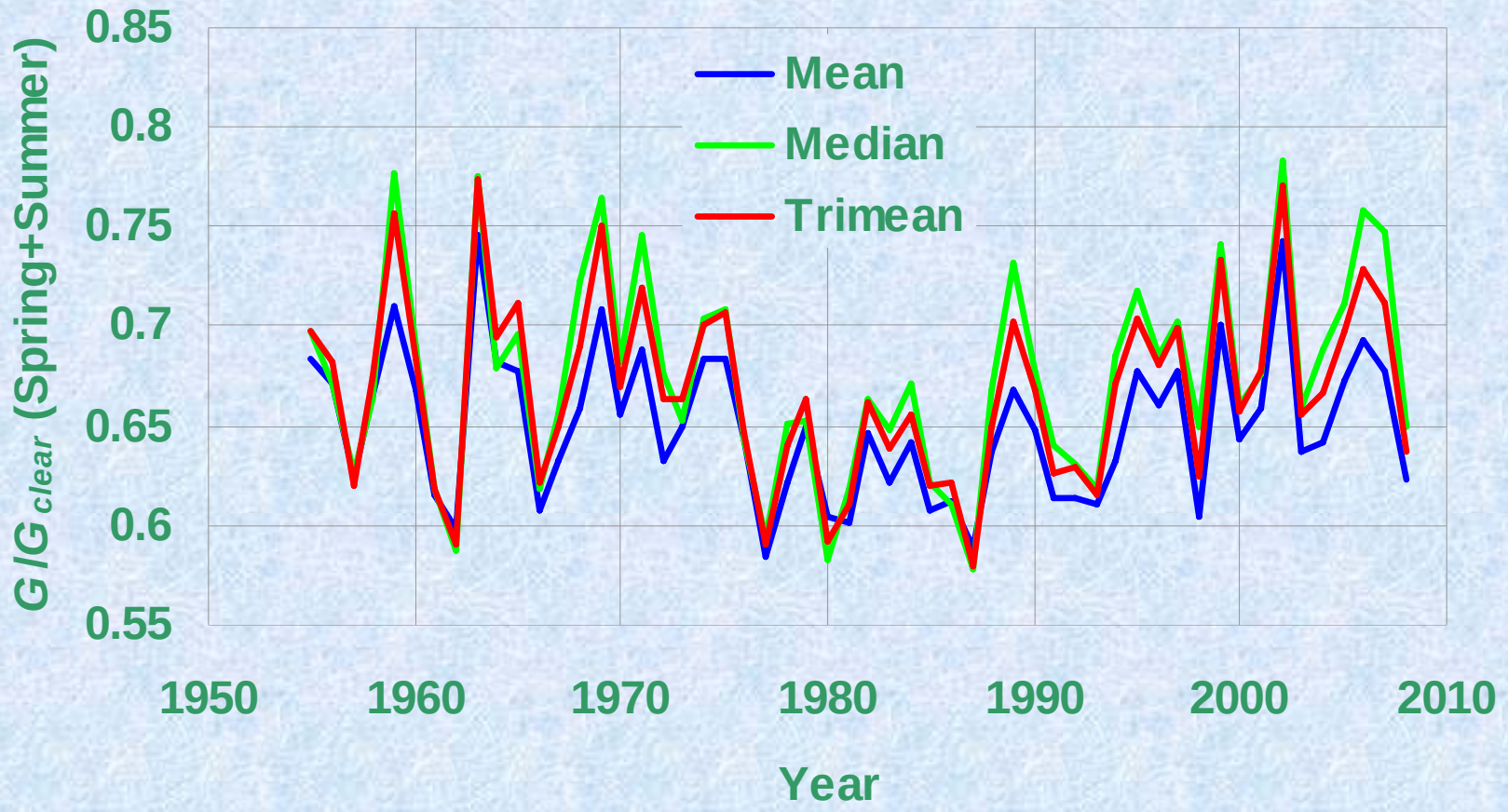
G/G_{clear} PDF in most cloudy summer half-years



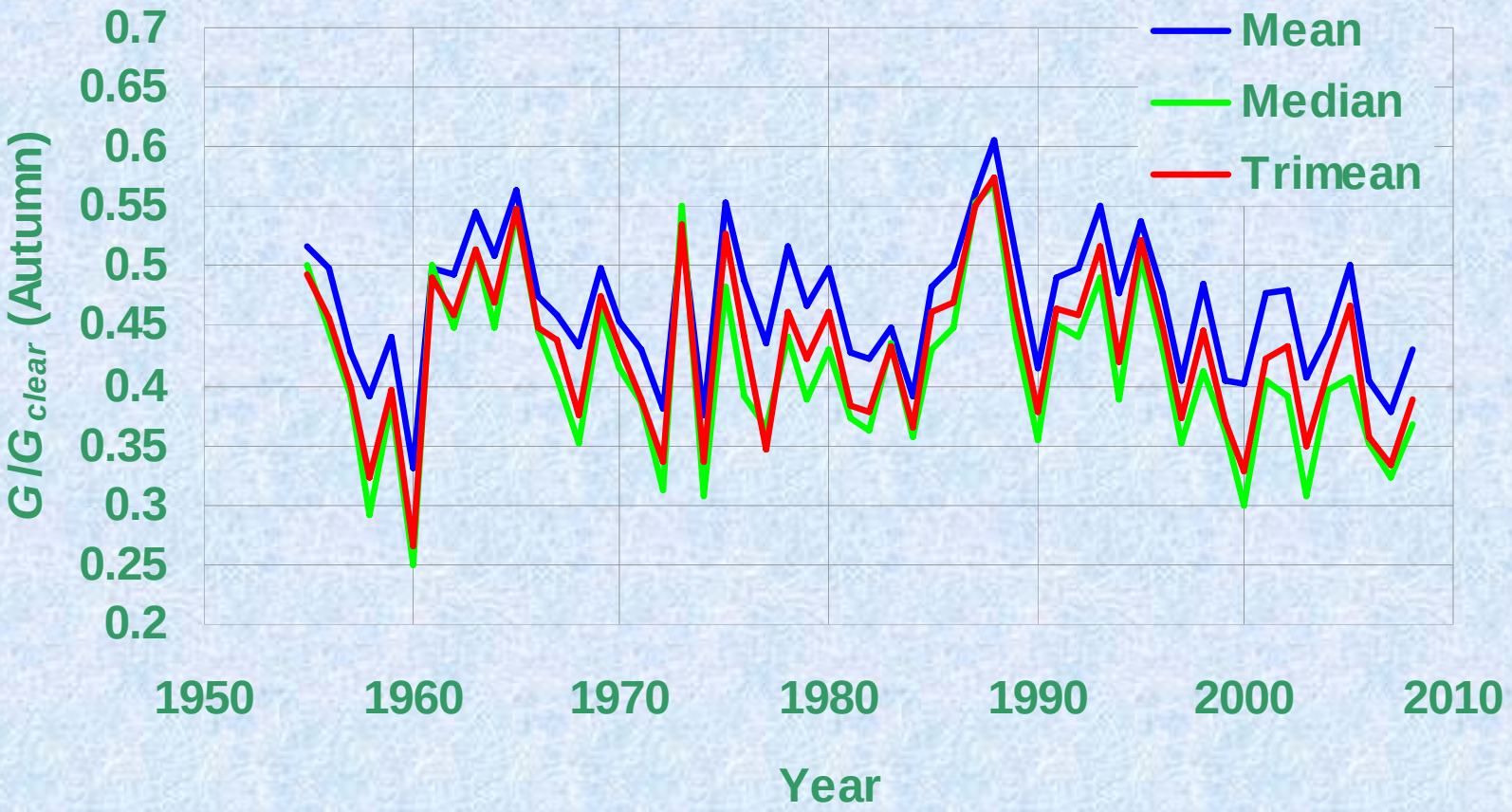
G/G_{clear} PDF in most cloudy winter half-years



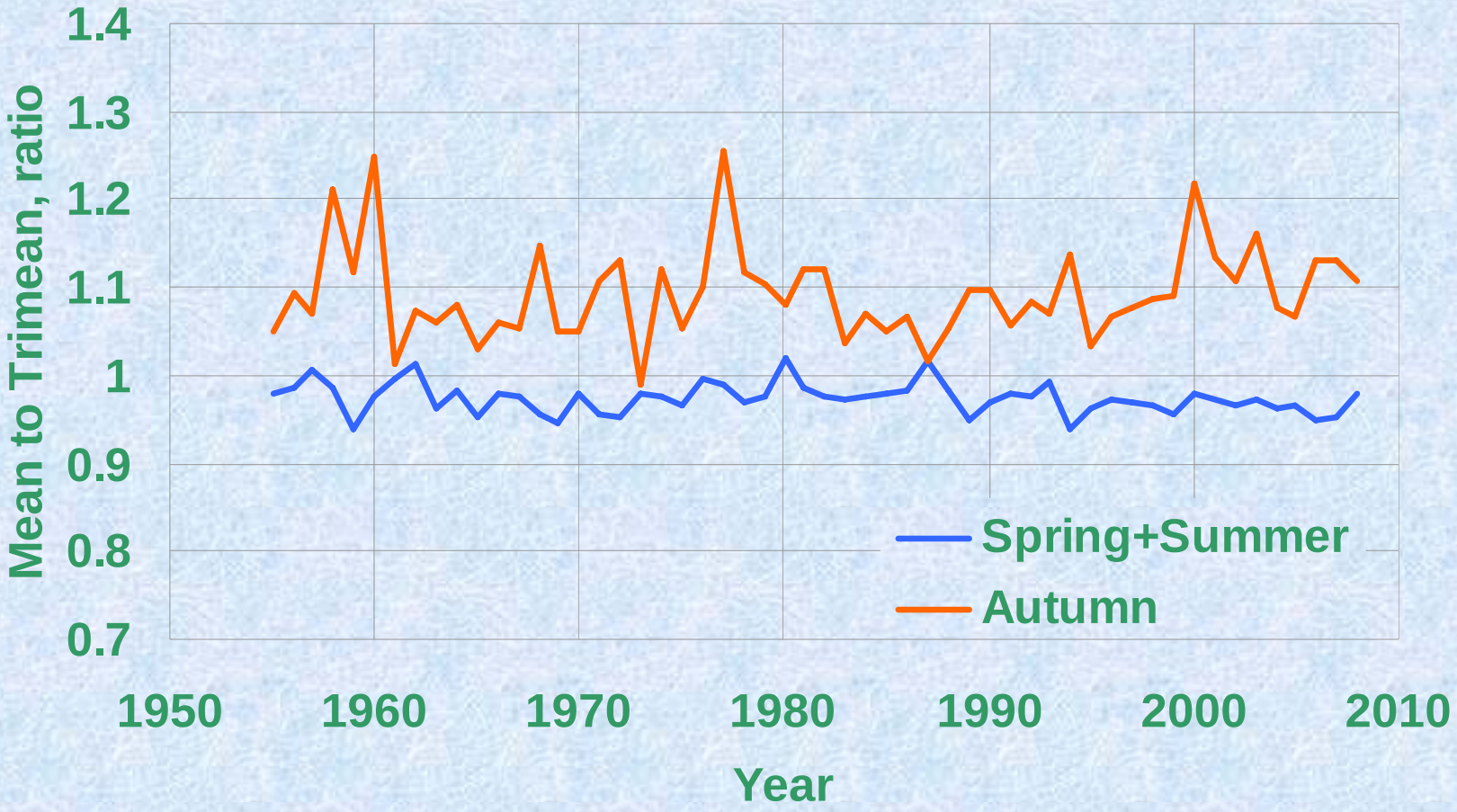
Mean, median and trimean of spring+summer G/G_{clear} in 1955-2008



Mean, median and trimean of autumnal G/G_{clear} in 1955-2008



Mean/trimean ratios



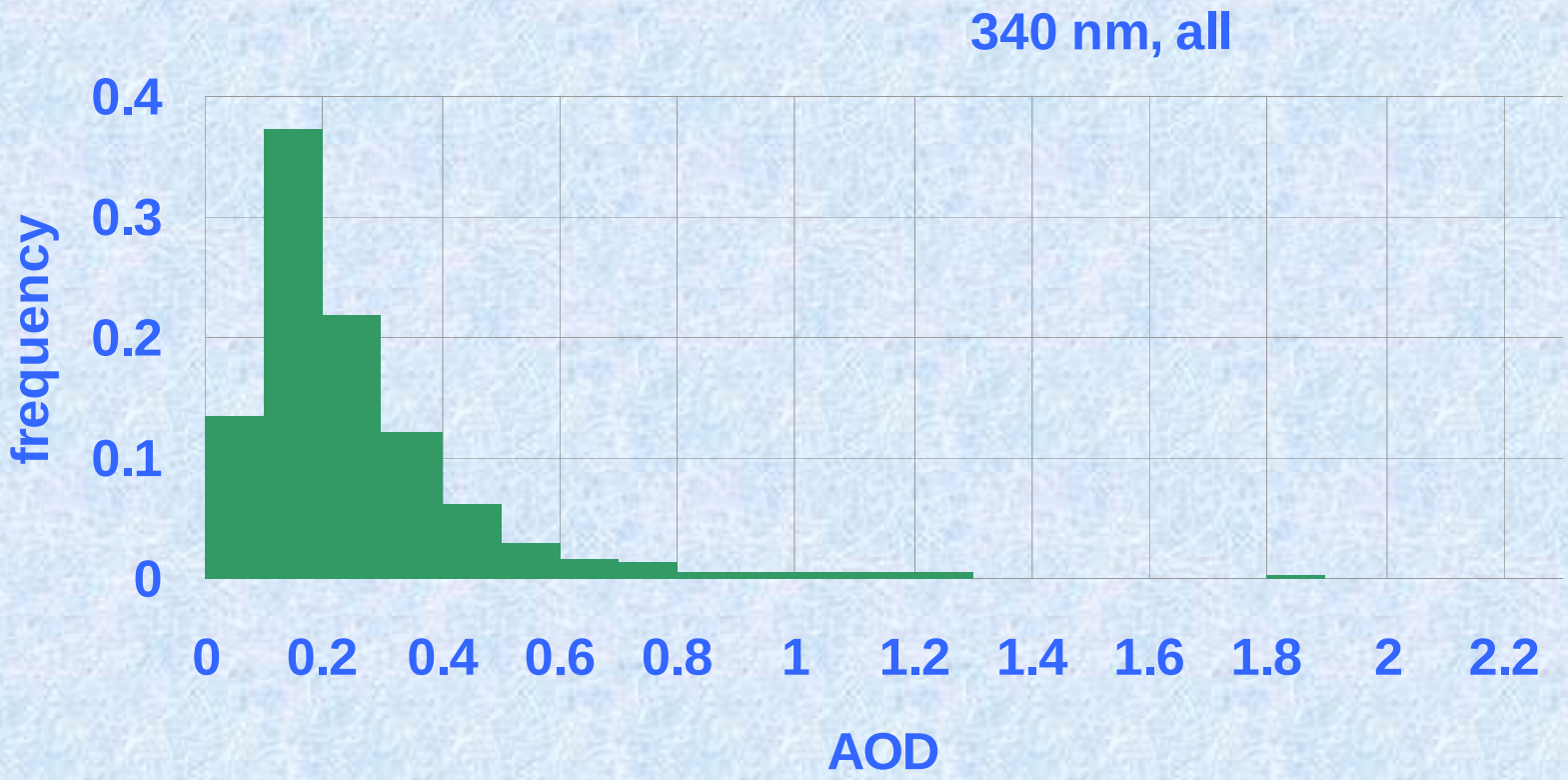
Aerosol optical depth

- AERONET data 2002-2008 for Tõravere (58º16’N, 26º28’) used. About 900 values

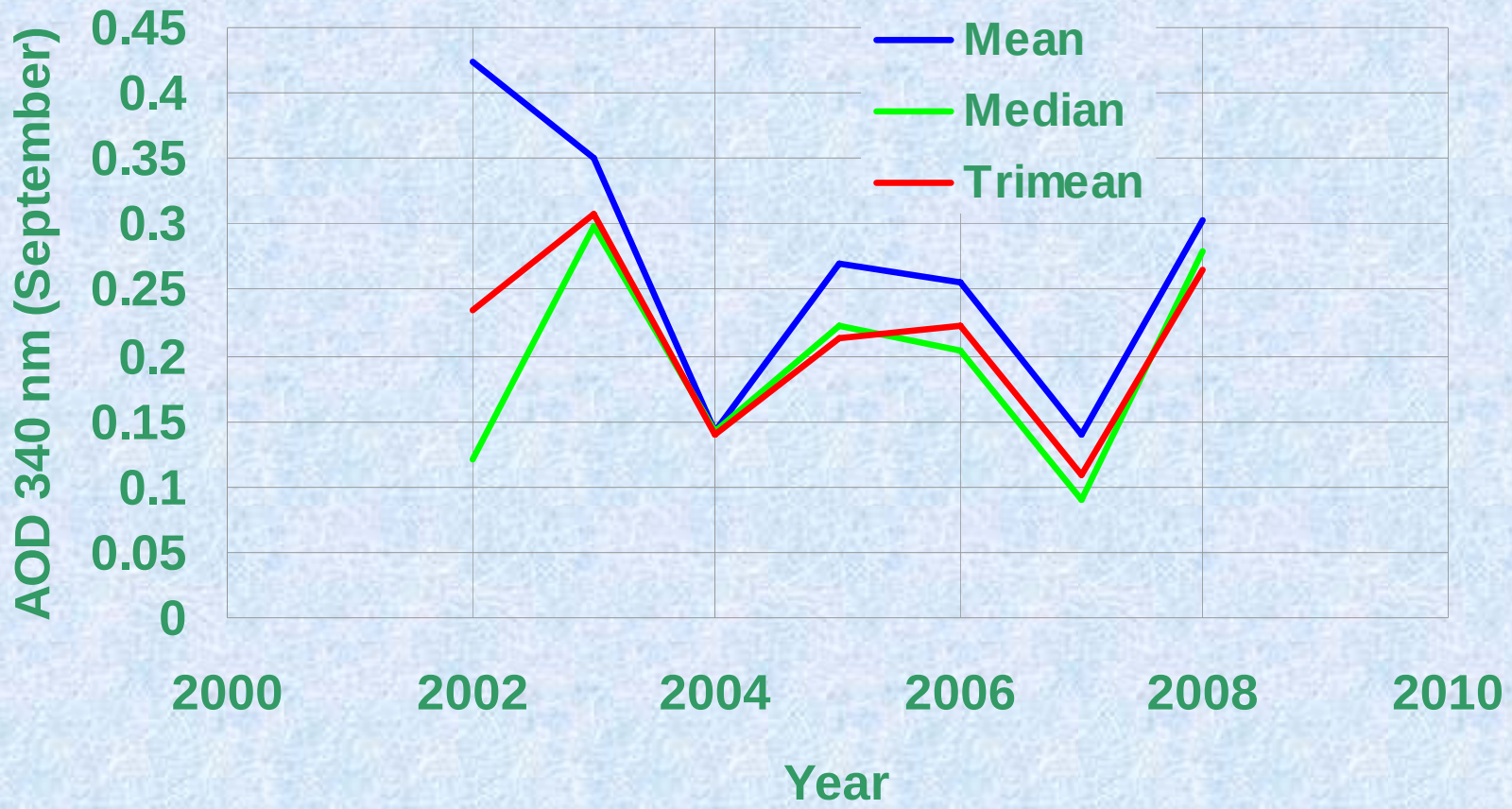
	Mean	Median	Trimean	Mode
340 nm	0.261	0.198	0.21	0.153
500 nm	0.165	0.12	0.129	0.113

- Monthly distributions vary strongly. The biases larger for larger spreads

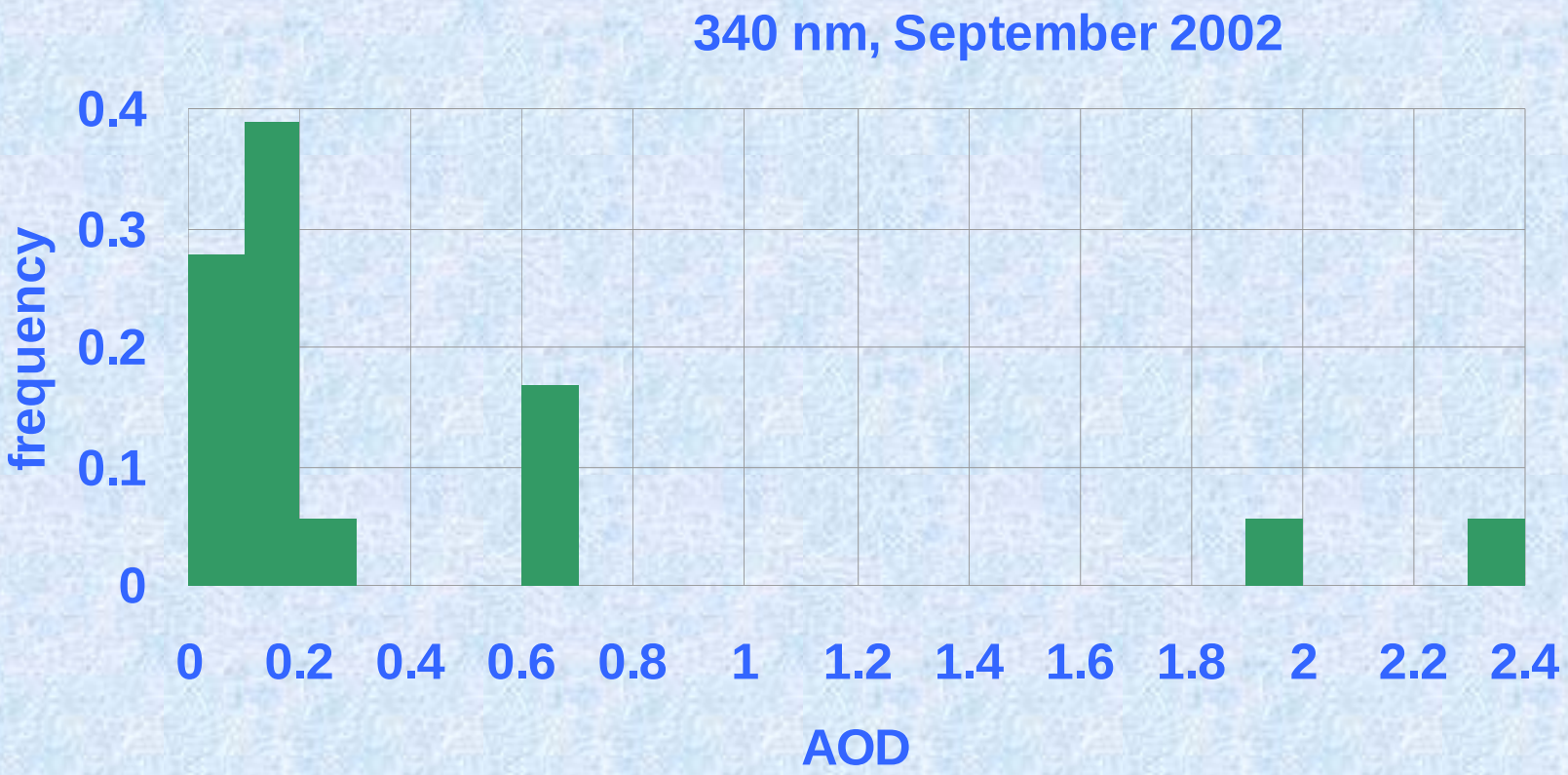
AOD all data histogram



Mean, median and trimean of monthly AOD



Monthly AOD histogram



Total ozone

- The monthly satellite data since used
- The Mean/Trimean ratio

  within ±1% **65.5 %**

  within ± 2% **95.5 %**

  more than 2% **4.5 %**

- For the I'/I'_{clear} and $Sundur/Sundur_{clear}$ ratio also all three measures agree well