Evidence for biomass burning-forced dimming in Southern Africa

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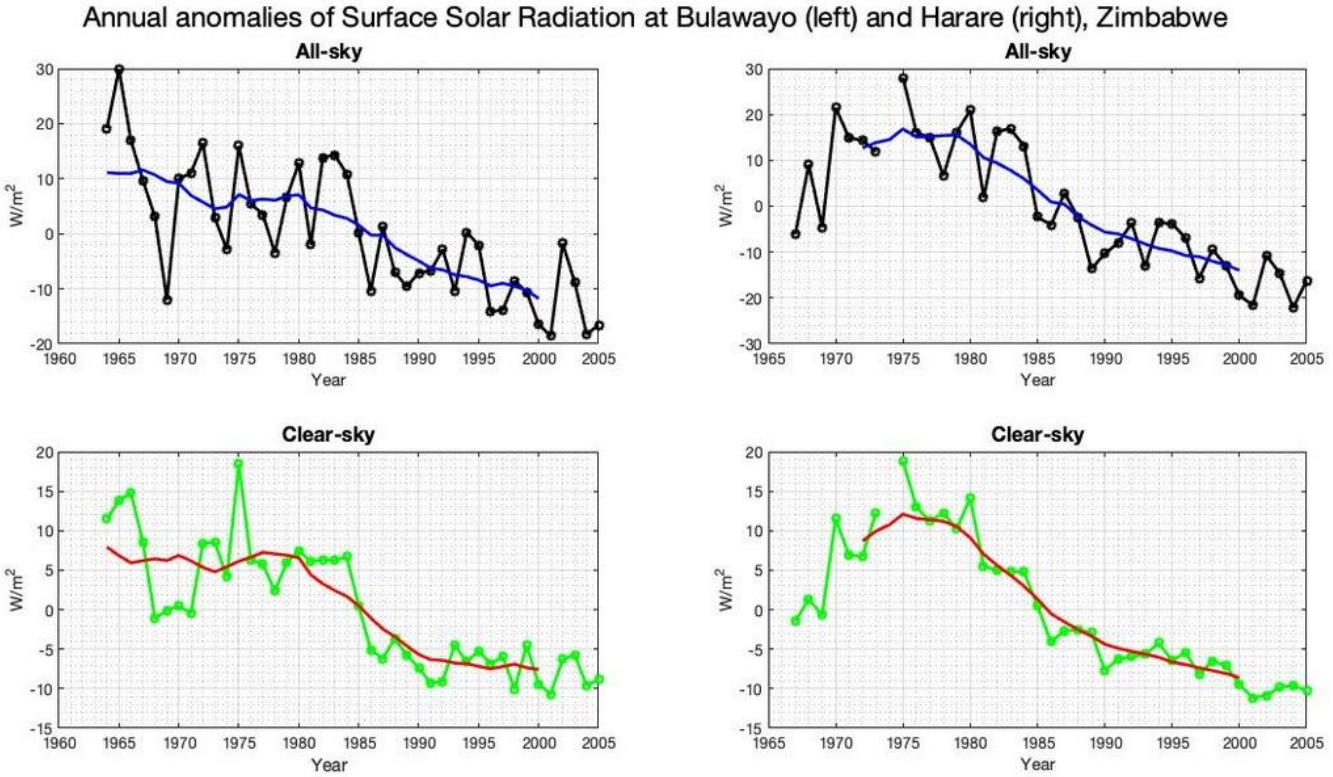
Stations and data

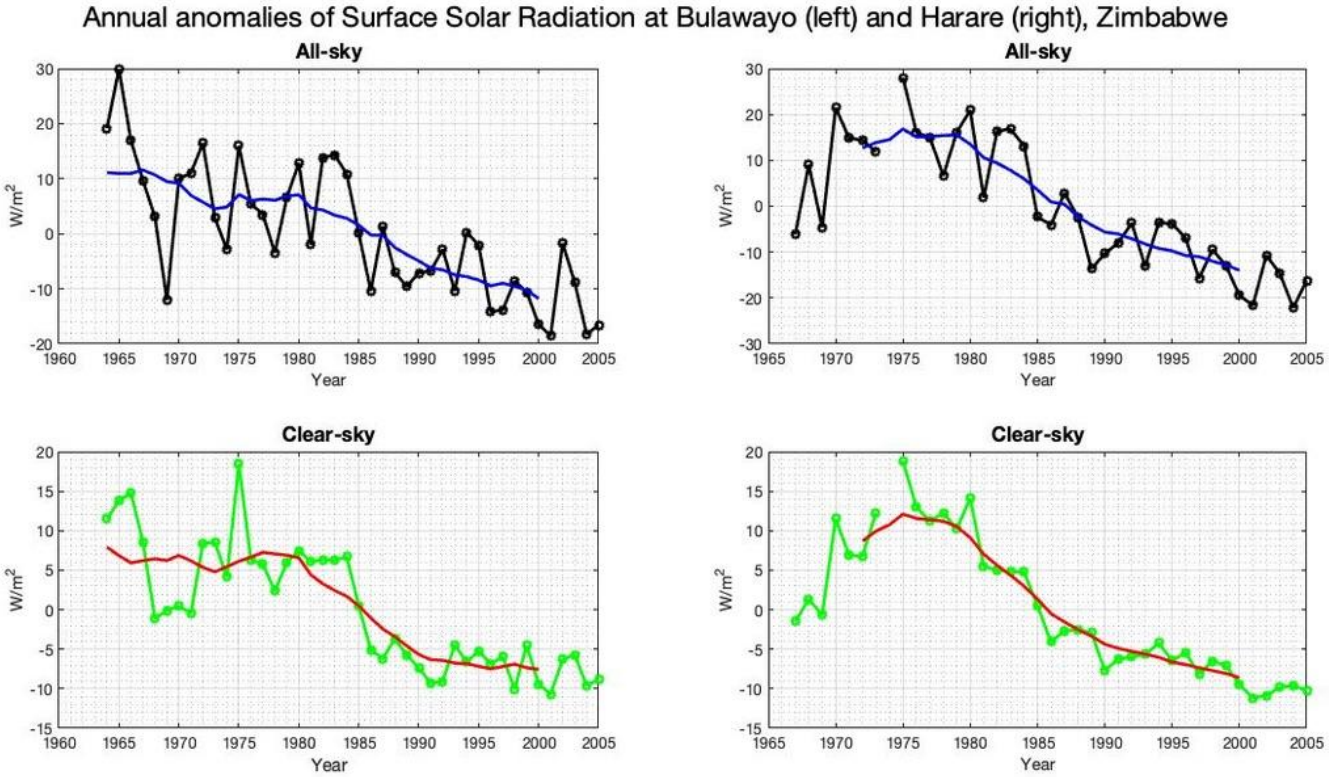
- Surface solar radiation from Bulawayo (1964-2005) and Harare (1967-2005), Zimbabwe.
- Clear-sky SSR derived with method by Ferreira Correa et al. (2022) [Submitted to Earth and Space Science].
- Cloud and water vapour data (1979-2019) from ERA5 reanalysis.

Persistent Dimming in Bulawayo and Harare, Zimbabwe



Persistent Dimming in Bulawayo and Harare, Zimbabwe

-6.63 W/m^2 per decade



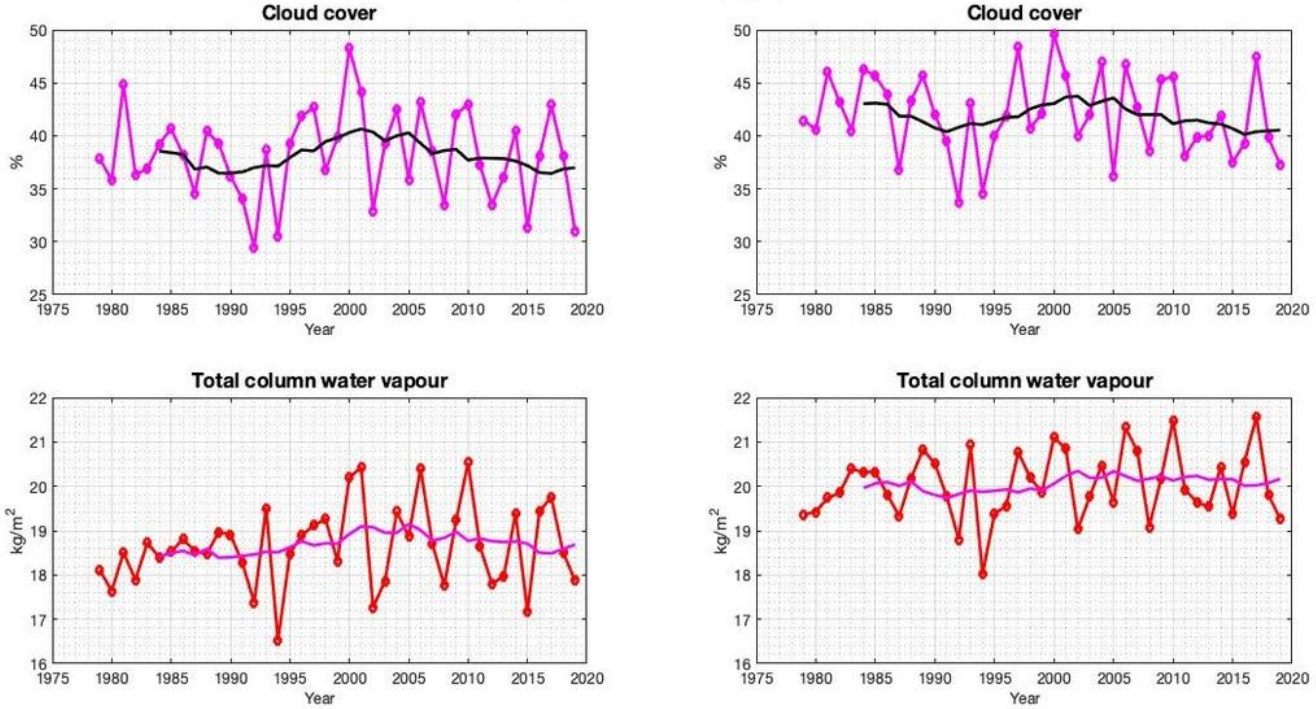
-12.38 W/m^2 per decade

-7.66 W/m^2 per decade

-12.80 W/m^2 per decade

Cloud cover and water vapour trends from ERA5 reanalysis

Annual cloud cover and total column water vapour means from ERA5
at Bulawayo (left) and Harare (right), Zimbabwe

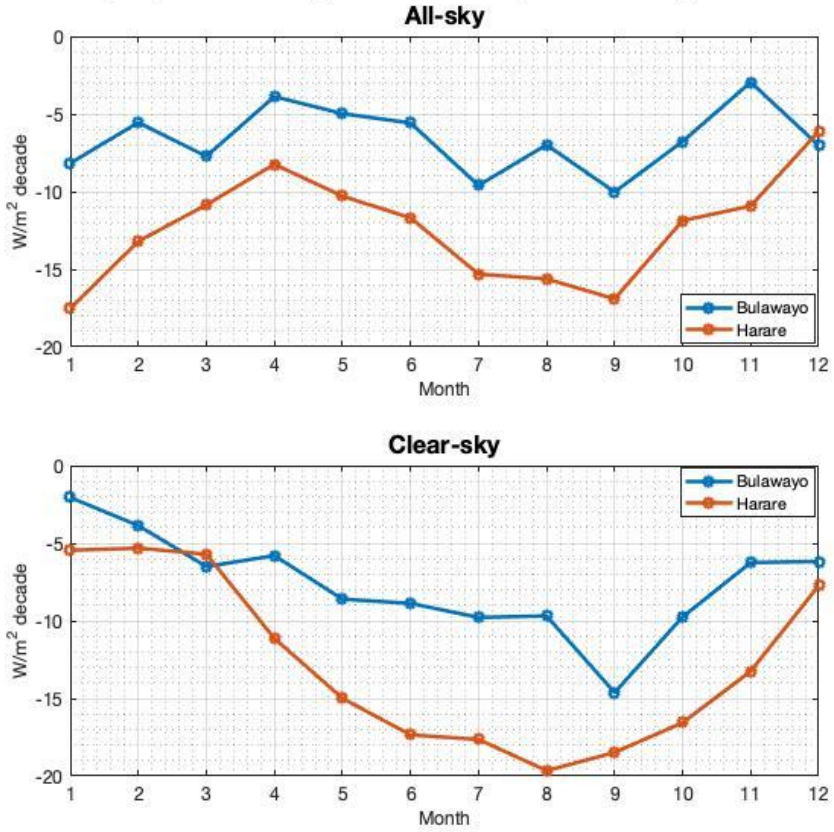


Cloud cover and water vapour trends from ERA5 reanalysis

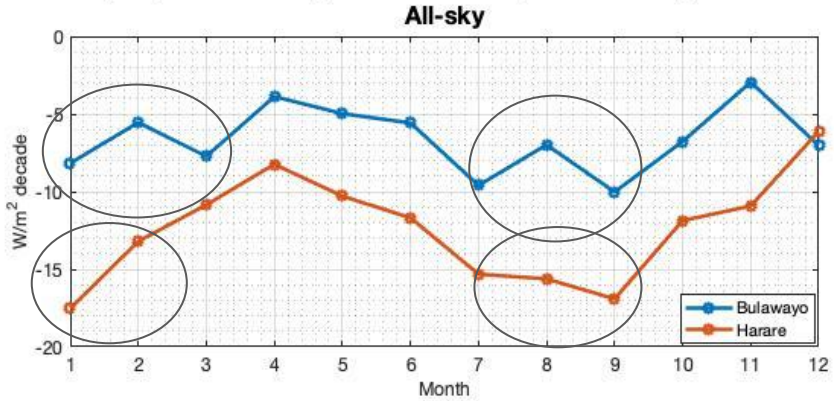
Cloudiness			
	Absolute trend per decade	Relative trend per decade	Period
Bulawayo	-4.02%	-10.53%	1979-1990
	4.24%	11.11%	1991-2000
	-2.21%	-5.79%	2002-2019
Harare	-4.19%	-10.0%	1979-1991
	3.13%	7.46%	1992-2002
	-1.92%	-4.98%	2003-2019

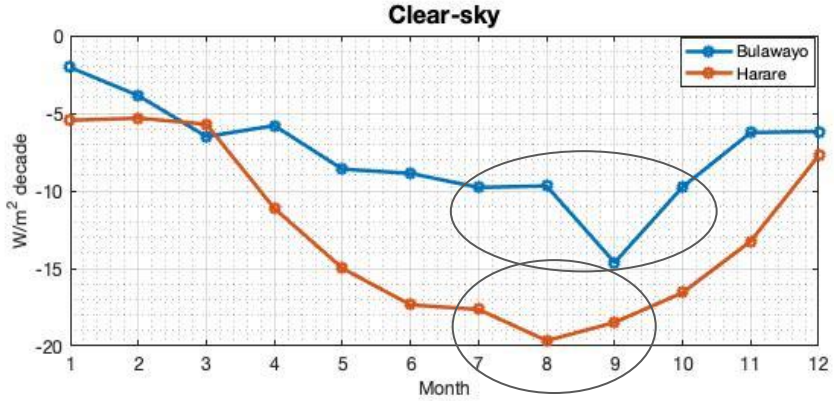
Water vapour			
	Absolute trend per decade	Relative trend per decade	Period
Bulawayo	0.18 kg/m^2	0.97%	1979-1999
	-0.27 kg/m^2	-1.45%	2000-2019
Harare	0.08 kg/m^2	0.40%	1979-2019

Monthly relative SSR trends in
Bulawayo (1964-2005) and Harare (1967-2005), Zimbabwe

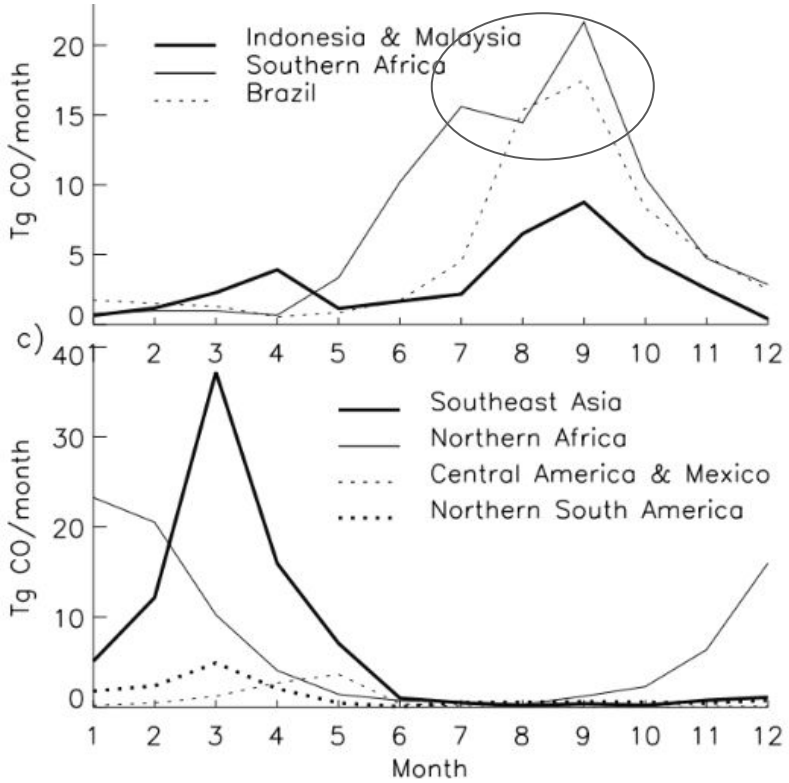


Monthly relative SSR trends in
Bulawayo (1964-2005) and Harare (1967-2005), Zimbabwe





Average biomass burning rate and AOD trends



Adapted from Duncan et al., 2003

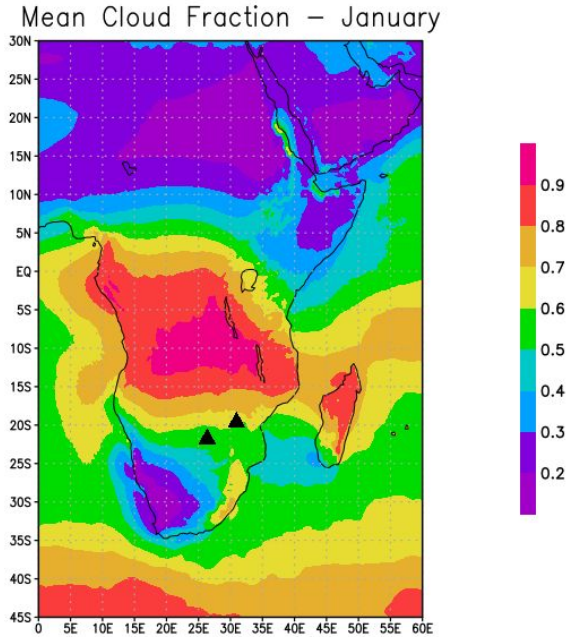
- Southern Africa:
  - Higher biomass burning rates between July and September (Duncan et al., 2003)
  - Positive trend in AOD [1980-2006] (Streets et al., 2009)

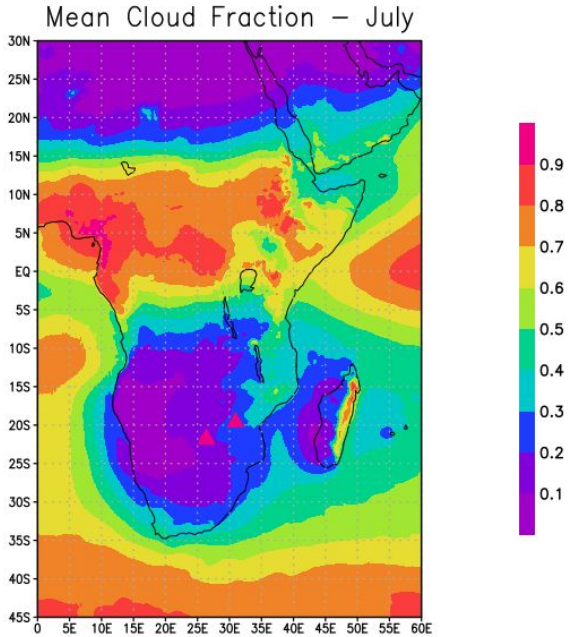
Summary and conclusions

- Persistent dimming in all-sky SSR at both stations, was followed by similar (in sign and magnitude) dimming in clear-sky SSR
- No significant water vapour or cloud cover changes that could justify such trends were observed within the period
- Monthly relative trends in all-sky: strong dimming in January and from July to September
- Monthly relative trends in clear-sky: strong dimming from July to September
- January: biomass burning aerosols transport from lower latitudes and high cloudiness.
- July to September: low cloudiness and high biomass burning emissions in Southern Africa.
- **Observed dimming most associated with biomass burning emissions.**

Appendix

Mean cloud fraction from ERA5





AOD trends (Streets et al., 2009)

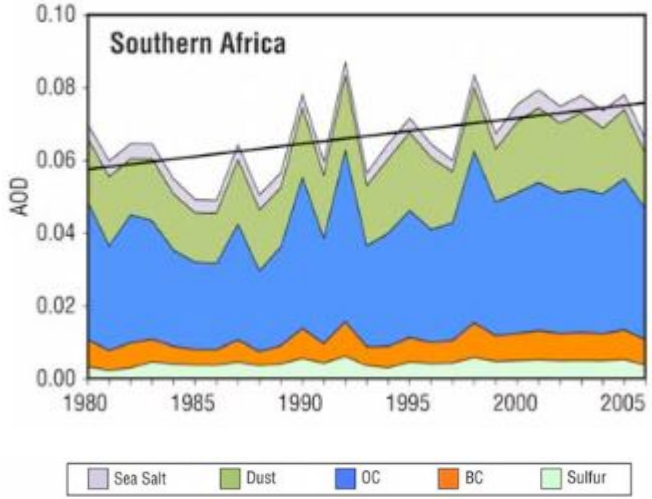


Figure 4. Estimated AOD trends for natural aerosols in each region, 1980–2006.

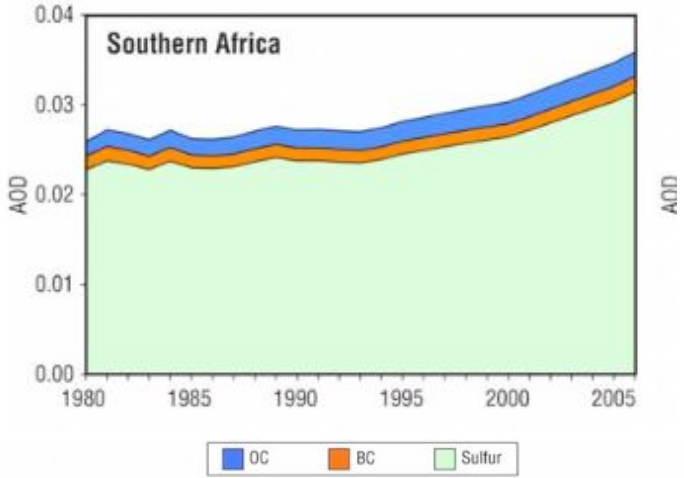


Figure 5. Estimated AOD trends for anthropogenic aerosols in each region, 1980–2006.