Guo et al.: **Ångström exponent errors prevent accurate visibility measurement**, Atmos. Meas. Tech. Discuss. https://doi.org/10.5194/amt-2020-415, in review, 2020.

Review

General

The paper presents theoretical background of visibility measurements and points out systematic errors in essentially all visibility measurements. The theoretical background of the errors is pointed out on lines 34 – 64 of the discussion paper. The explanation is convincing, I really learned new things in reading it. It is obvious that there are systematic errors in visibility measurements worldwide. The topic is definitely important, not only to the scientific community but also to a wider audience: visibility measurements for instance at airports, harbours and at sea are relevant to practically everybody.

The paper is important and basically well written and I can recommend publishing it in AMT.
However, before that I wish you would do some modifications.

First, I can see in your Fig. 2 that there were bimodal size distributions in your simulations already but you did not really pay any attention to it. Bimodality of size distributions have a strong effect on the Ångström exponent, see, e.g.,
Schuster, G. L., Dubovik, O., and Holben, B. N.: Angstrom Exponent and Bimodal Aerosol Size Distributions, J. Geophys. Res., 111, D07207, https://doi.org/10.1029/2005JD006328, 2006.
There are a lot of references in that paper and there are a lot of refs to it that discuss this matter. Among other things it shows that the Ångström exponent often varies with wavelength. And with the ratio of coarse and fine particles. How do these affect your results?

Detailed comments

L40 “Obviously, WMO believes ...”. WMO is not a person, it cannot believe anything. Rewrite.

L42 “Ångström indicated the spectral dependence of visibility as early as 1929 (Ångström, 1929) …”.
I was wondering, whether Ångström really wrote about visibility and acquired a copy of the original paper. I was right. There is not even the word “visibility” in the whole paper. There is the wavelength dependency of absorption and transmittance and the derivation of the exponent that was later called the Ångström exponent. So, transmittance depends on the Ångström exponent and visibility depends on transmittance according to your Eq. (1). Your Eq. (2) follows from these but it is not given by Ångström (1929).

L59 “.. opinion of the WMO …”. again, WMO is not a person, it does not have opinions. Rewrite.

L95-98 “The relationship between the hygroscopic growth factor (GF) and refractive index (m) of mixed particles can be expressed by Eq. (7), where m_A and m_w represent the refractive indices of dry aerosol particles and water particles”

$$m = \frac{m_a + m_w(GF - 1)}{GF} \qquad (7)$$

The Eq. (7) is strange, I have never seen it in this form. First, what do you mean with ”water particles”? Does it mean humid particles or pure water droplets? Further, GF is generally defined as the ratio of humid and dry particle diameters. So let me develop this further:

$$m = \frac{m_a + m_w(GF - 1)}{GF};\quad GF = \frac{D_{p,humid}}{D_{p,dry}} \Rightarrow m = \frac{m_a + m_w\left(GF - 1\right)}{GF} = \frac{D_{p,dry}}{D_{p,humid}} m_a + \left(\frac{D_{p,humid} - D_{p,dry}}{D_{p,humid}}\right) m_w$$

This is definitely not a volume-weighted average of refractive indices of m_a and m_w. So, how was Eq. (7) derived? If it was used like it is written now then you should correct it and repeat your simulations with a corrected one.