Review of Esteve et al, ACPD 2011

This paper investigates the consistency between aerosol optical depths and optical properties derived from AERONET against those derived from aircraft in-situ properties. A series of analyses are made, mainly using linear regression either forced through the 0:0 point or not.

General Comments:

The main strength of the paper is that it uses data from an aircraft that makes routine measurements near to an AERONET site and so is able to assess the results in a more climatological manner than specific targeted flights which are only able to provide snapshot evidence of agreement/disagreement.

The main weakness of the paper is that while the aircraft is equipped with standard nephelometers and aethelometers, the detailed measurements available from e.g. OPCs, aerosol mass spectrometers for aerosol chemistry etc are not available owing to payload constraints. That said, I do think that the measurements are useful and interesting and the authors do a reasonable job of presenting their results in a reasonably unbiased way. They could go a little further in postulating where the problems in reconciling the AODs come from given that they are sampling only a section of the atmosphere, rather that the full atmospheric column. The problem with the volatility of ammonium nitrate is glossed over and should also be mentioned.

Specific comments:

Abstract:
L 13. Given that L2.0 AERONET data comparisons against the aircraft data are limited to 1 point, the SSA conclusion must be removed. Figure 3 must also be removed as scatter plots with 1 point on them are not relevant or informative.

Introduction:
Para 1: Given our current understanding of aerosol direct radiative forcing and WMGHGs (IPCC, 2007), it is not correct to same that they are the same magnitude. The aerosol direct effect has been assessed as -0.50±0.4Wm-2 (IPCC, 2007, Chapter 2), while the radiative forcing from well mixed greenhouse gases is assessed as +2.63±0.26Wm-2 (IPCC, Chapter 2). Please tone this down.

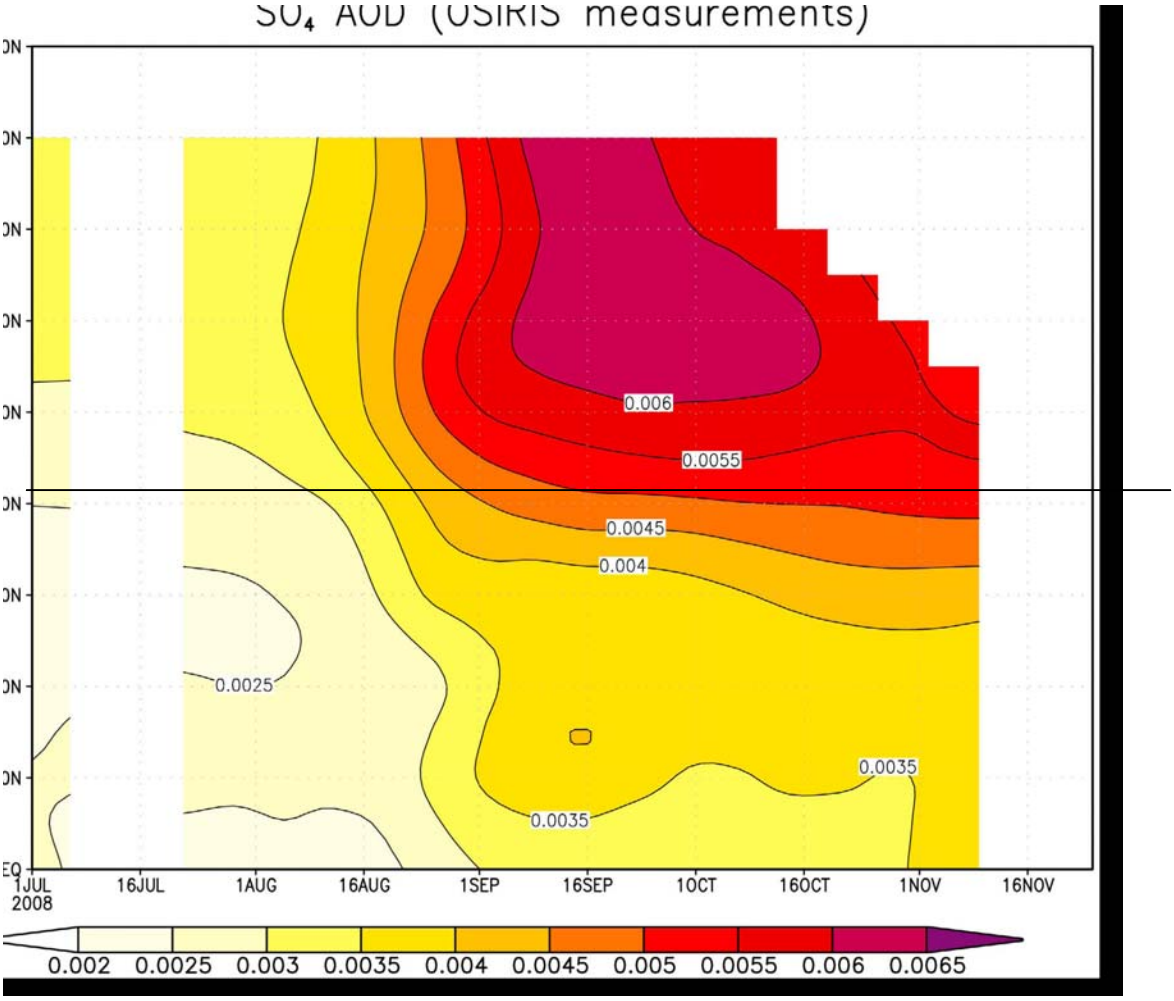
P29005, L6. These simple estimates of the direct radiative forcing are only relevant for cloud-fee skies. Insert ‘cloud-free sky’ before ‘direct aerosol radiative forcing’

L15. Sentence is too long. however -> However

P29006, L 3. AOD is a wavelength dependent quantity, suggest inserting a subscript lambda after AOD, i.e. AOD_{λ}

P29007, L 13. Having a heater upstream of the nephelometers will certainly reduce the relative humidity. However, it may also cause volatalisation of some aerosol particles, particularly nitrate …..

P 29008, L 5. I note that the flights were performed between June 2006-October 2008. Kasatochi erupted on 7-8 August 2008 injecting ~ 1.5TgSO2 into the stratosphere (Kravitz et al., 2010). The dynamical evolution of the plume was such that the plume would have reached Illinois quite shortly after (mid-August). Here's a figure from Kravitz et al, with a line at 40N. You'll see a measured AOD of around 0.005 (at 750nm) on a zonal average. However, the AOD will be many times (factor of 10-100 greater) this in the centre of the plume just subsequent to the eruption :-



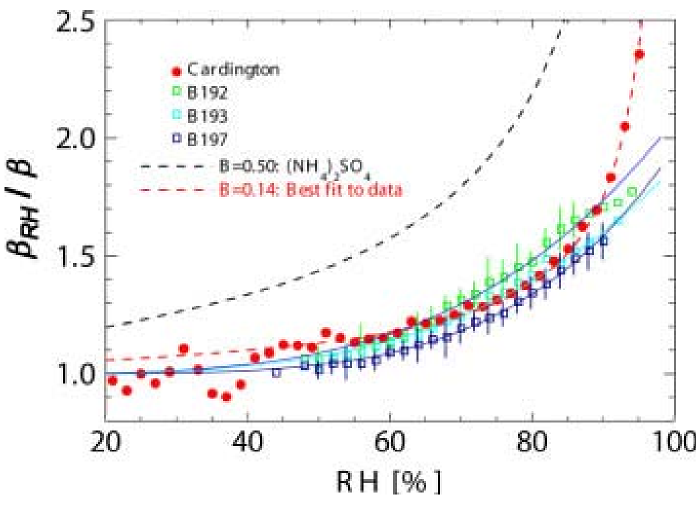
Fortunately you should have missed the majority of the impacts of the plume. It would be worth noting that the time period that you've chosen is pretty much outside the period of significant volcanic stratospheric AOD as this as one of the possibilities that you raise is aerosol above the maximum flight level of the aircraft.

P29008. L5 – L17. Are you sure that you were flying on flight levels? There is a technicality here that aircraft at low levels tend to fly on QNH rather than the standard atmosphere and 1013hPa surface pressue. If you are really flying on flight levels throughout then amore detail is required. Why? Because your dz determined from your pitot static tube pressure will be a function of the surface pressure.

For example, if the 'real' pressure adjusted to ASL is 1030hPa rather than 1013 then you'll actually be flying at 1117m rather than 1000m (hydrostatic approximation with an assumed scale height of 7km) – you'll have to add about 10% or so onto the dz. This is potentially a source of error/bias in your calculations owing to you integrating your scattering (product of scattering * dz) if you are really flying flight levels as you suggest in your manuscript. Clarification is required.

P29011, L 8-17. Fig 3 should be removed as it is unnecessary.

Section 4.1. I agree that there are possibly some problems related to relative humidity models etc. Having had a look at the hygroscopic growth factors from Figure 10, it is interesting to note that the Koloutsou-Vakakis et al (2001) parameterisation is strikingly similar to other measurements using tandem nephelometers. Haywood et al (2008, QJRMS) use airborne and surface based systems over the UK. The airborne system (green, light blue and dark blue) gives growth factors of around 1.4, 1.5, and 1.7 at RHs of 80, 85, and 90% RH, which seems strikingly similar to those shown in Figure 10. This study could be referred to give extra support to the K-V measurements. The real problem of non-linearity in the f(RH) versus RH comes when you get above 90%. At these high RHs, the ground based system (nephelometer combined with a visiometer) start to increase rapidly.



P29014, L 29. Only 59% of the particle mass is SO4 or VOC. Going back to the V-K et al paper, here is another 7% identified as nitrate. This could cause some trouble as the nitrate/ammonia/water is pretty unstable, particular at high temperatures. Heating prior to the nephelometer is likely to dissociate ammonium nitrate back to gas phase nitric acid and ammonia. If the V-K paper is representative, you could lose 7% of your aerosol anion mass (more aerosol total mass) simply by volatalising your nitrate. I think that this potential problem should be emphasised in the discussion, particularly as there is an author for both studies on the author list:

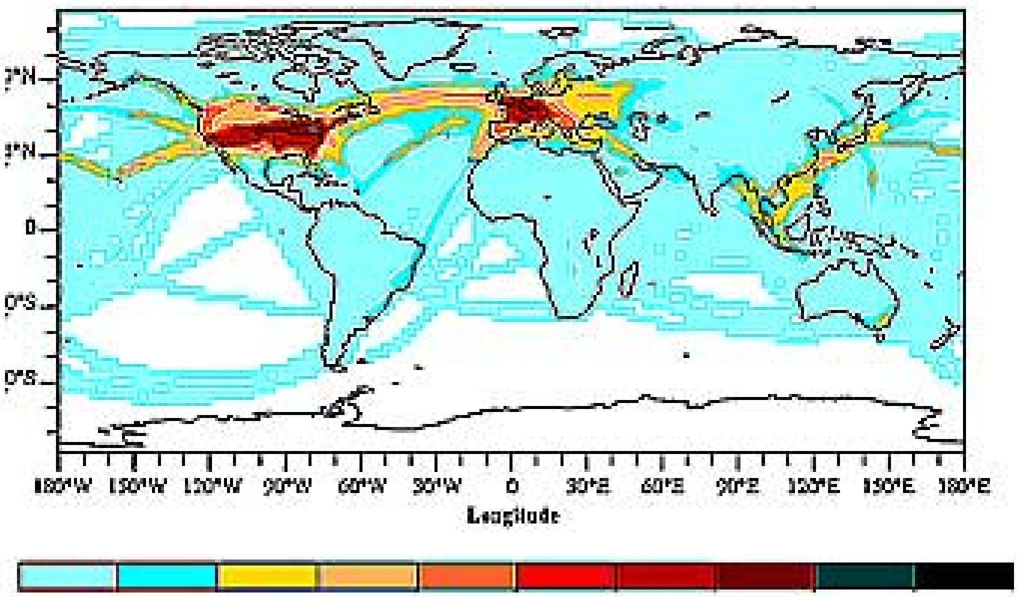
Bergin et al (1997), Evaporation of Ammonium Nitrate Aerosol in a Heated Nephelometer: Implications for Field Measurements

P29017, L1: Typo ‘phygroscopicity arameterizations’.

Section 4.2. It is troubling that the AAO measures 10-20% less scattering than measurements made at the ground. Generally, I’d believe ground based measurements more than aircraft measurements which are notoriously difficult to make accurately. If there is a discrepancy of this magnitude, this could pretty much explain the discrepancy between the AERONET and the AAO measurements. This again could be pointing the finger at nitrates being volatalised in the AAO nephelometer.

Section 4.3. The point made earlier about the aircraft operating on Flight Levels needs to be addressed.

Section 4.5. One thing to note here is that the site is under an are with extremely high air traffic. Infact – this plot from IPCC suggests it is in an area which is a global maximum (IPCC, 1999, see below). This means that there will be significant aircraft emissions over the site at cruise altitude. This is also an area where contrails and contrail induced cirrus are very prevalent. Could the discrepancy be caused by the SKYRAD and AERONET methods including very disperse thin sub-visible contrail cirrus? The optical depth offset of ~0.05 and the AERONET detection of more large particles (Fig 2, 4,5) might be related to this. Are the cloud screening algorithms really going to be able to detect and reject sub-visible cirrus with a visible optical depth of 0.05?



Section 4.9. I don't think that anything can be inferred about the SSA given the paucity of the data.

Conclusions. I'd like to see some more acknowledgement of the potential role of nitrate aerosol (e.g. Bergin et al. 1997), the role of stratospheric aerosol (Kravitz et al 2010, but also perhaps Solomon et al, Science, 2011, below), and the fact that the site is one of the potential hot-spots for sub-visual cirrus induced by aircraft . SSA should not be compared against given you've only 1 data point.

It would be very useful too if the authors could suggest what additional measurements (either from the surface or from the aircraft) would be necessary for better determining the reasons behind the discrepancies.