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## Investigation of the effects of humidity and volatile coatings on the photothermal interferometry signal

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- Carbonaceous the aerosols (CA) affect health, visibility and atmosphere climate
- Carbonaceous particles are difficult to detect specifically, especially in mixed aerosols
- Established measurements light **O**T



measured as a periodic phase shift change in the interferometer.

Speed of Light

<u>.</u> Why

nteresting?

absorption by CA are performed ex situ (i.e. particles are deposited into filters)

These methods suffer from large systematic errors caused by the modification of particle properties due to deposition of particles into the filter

- In situ absorption measurements are free of these artefacts
- We are currently working on a PTI instrument for the measurement of CA
- Using the PTI technique allows the correction of measurement artefacts, for example light absorption by gases, by incorporating a reference path without CA
- As the measurement is non-resonant, it is possible to extract extra information about the CA from the shape of the heating curves (see below)

gases

to

occurring

significantly

measurements



Air

Temperature

PTI

**Above:** Interferometer design for the PTI experiment. BS is a beamsplitter and DM a dichroic mirror.





Refractive Index

Experiment

The gases must either be removed before the measurement or the light absorption of the gas measured without the CA particles

can

light

- As the gases absorb light, they can be used to calibrate the instrument response
- Absorption features of gases are very specific, i.e. there is a large wavelength dependence to the absorption magnitude
- As these absorption magnitudes are well known, PTI has the potential for primary calibration with a gas standard



Above: Absorption data for a range of light absorbing gases calculated for 1 ppm of gas. The data is averaged over a 1 nm interval to approximate the spectral bandwidth of the heating laser.

532 and 1064 nm. Ovals show the ambient typical concentrations of the respective species. The presence of absorbing gases can lead to measurement artefacts the in of determination equivalent BC mass, but also present an opportunity for the calibration of the PTI.



Phase Shift

in the

Interferometer

latent heat and

S

Volatile



Left: Ambient CA particles often have volatile coatings, which evaporate when the temperature of the particle rises and recondense when the particle cools.



Heating cycle and expected phase shift ----- Uncoated particle Coated particle Heating Cooling Heating the



surrounding gas. This effect could possibly be PTI measured in measurements by examining the heating and cooling rates at high light intensities.



vel

Cooling

100 150 150 200 Time (s/50000) Time (s/50000)

Heating cooling different and cycles for Above: concentrations of soot generated by spark discharge. Each curve represents a 1 second average of the respective cycle and is baseline corrected to argon. The deviation from linearity is caused by heat flowing out of the sensing region.

- Conclusions
- In situ absorption measurements of CA can be affected by artefacts arising from light absorption by gases and the evaporation of volatiles
- The gas absorption artefact can be mitigated by careful experimental design
- The shape of the time resolved PTI signal can be used to determine
- the influence of volatile coatings in *in situ* absorption measurements

HITRANonline database, www.hitran.org, accessed eference 29.06.2017; J. A. Davidson et al., JGR, **93**, D6, 7105 (1988); J. B. Burkholder and R. K. M Talukdar, Geophys. Res. Lett., **21**, 7, 581 (1994)

