A Comparison of Measured and Calculated Light Scattering During the MAGIC Field Campaign

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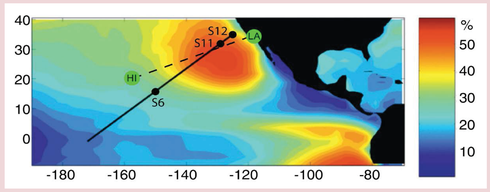
MAGIC

The goal ofthe MAGIC field campaign, which occurred from Sept, 2012 to Oct, 2013, was to investigate the stratocumulus-to-cumulus transition that occurs from east to west in this region.



Annual June-July-August low-level cloud cover, with MAGIC route, GPCI transect, and CGILS points (from Teixeira et al., J. Clim., 2011)

MAGIC was sponsored and operated by the U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Climate Research Facility, which deployed the Second ARM Mobile Facility (AMF2) aboard the Horizon Lines cargo container vessel Spirit as it made repeated voyages between Los Angeles and Honolulu, yielding nearly 35 excursions through this transition during nearly 200 days at sea.

It all happens here

Light-Scattering Closure

MAGIC aerosol properties measured: size distributions from D=55-1000 nm with the UHSAS (Ultra-High Sensitivity Aerosol Spectrometer), and light-scattering coefficients at λ = 450, 550, & 700 nm (blue, green, & red) with the nephelometer.

Both of these measurements were taken using an impactor with either a D=1 μm or a D=10 μm cutoff.

The light-scattering coefficients measured with the nephelometer are compared with those calculated using the size distribution measured by the UHSAS. There will be some uncertainties in such as comparison, as relative humidities of the two instruments were different.

For more information, contact
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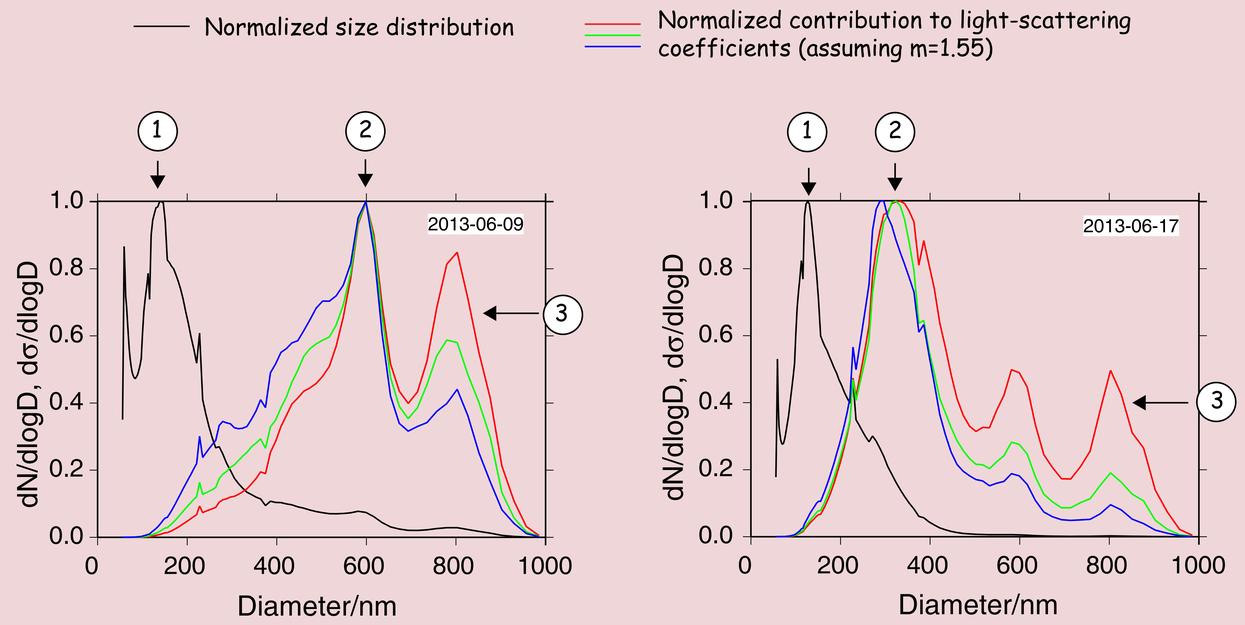
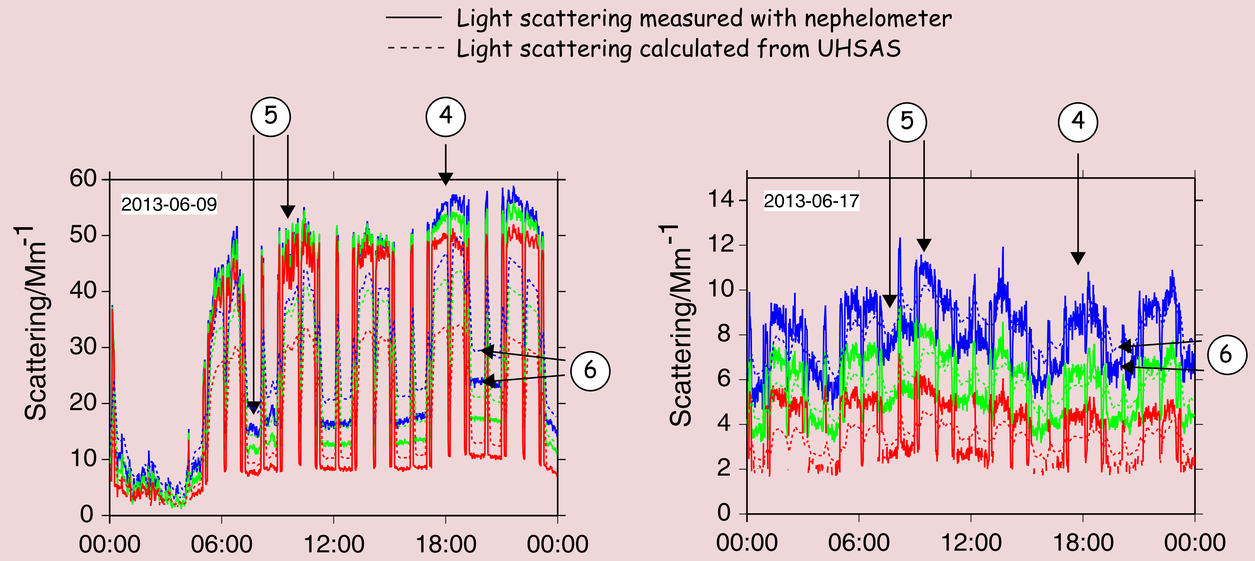
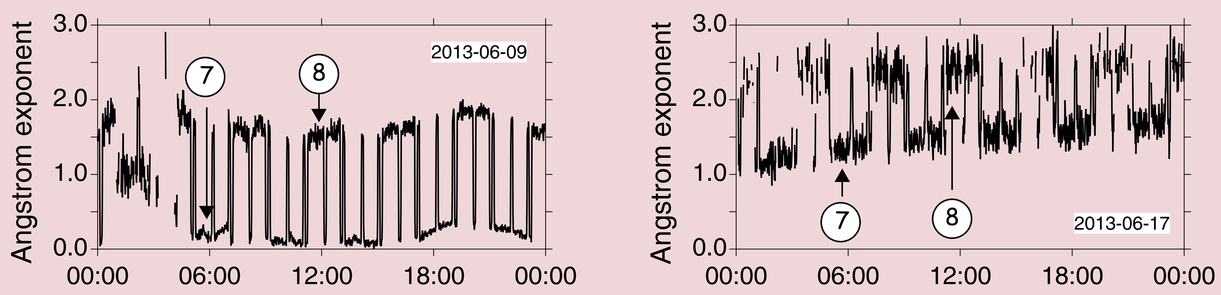
Websites with MAGIC information:
www.arm.gov/campaigns/amf2012magic
www.bnl.gov/envsci/ARM/MAGIC/
www.rmrco.com/cruise/magic/

A Comparison of Two Days: 2013-06-09 and 2013-06-17

Winds on 2013-06-09 were much stronger (~12 m/s) than those on 2013-06-17 (5-7 m/s).







Observations

1. The size distribution peaks near D=140 nm on 2013-06-09 and near D=125 nm on 2013-06-17.
2. The contribution to the light scattering peaks near D=600 nm on 2013-06-09 and near D=300 nm on 2013-06-17.
3. There is a much greater contribution to light scattering from larger particles on 2013-06-09 than on 2013-06-17.
4. There is much more scattering on 2013-06-09 than on 2013-06-17.
5. There is much more scattering for D<10 μm than for D<1 μm, and this effect is more pronounced on 2013-06-09. Additionally, the wavelength dependence of scattering is much less on 2013-06-09 than on 2013-06-17.
6. There is fair agreement between the light scattering calculated from the size distribution and that measured, for D<1 μm cutoff.
7. The Angstrom exponent å for D<10 μm is near 0 on 2013-06-09, implying that most of the scattering is from large particles; on 2013-06-17 å is >1 for this size range.
8. The Angstrom exponent å for D<1 μm is near 1.5 on 2013-06-09 and near 2.5 on 2013-06-17.

Note

Larger particles can have a large contribution to light scattering, even at low concentrations: σ(1000 nm)/σ(150 nm) ~ 850 (for λ=550 nm).

Conclusions

Particles with D > 1 μm (not measured by the UHSAS), likely sea salt particles, can provide the dominant contribution to the scattering.

The scattering coefficient on 2013-06-09 is much greater than that on 2013-06-17 because the higher winds generated more sea salt.

The calculated and measured light scattering differ, even when both are from the D=1 μm cutoff, because the impactor is inherently not sharp.

The calculated scattering at D=1 μm and D=10 μm cutoffs differs, even though the UHSAS detects only particles with D<1 μm, because the impactor cutoff is inherently not sharp.

The Angstrom exponent on 2013-06-09 with the D=10 μm cutoff is near zero, implying large particles, likely sea salt particles generated by the higher winds, dominate the light scattering.

WE THANK HORIZON LINES AND THE CAPTAIN & CREW OF THE SPIRIT FOR THEIR HOSPITALITY AND SUPPORT!