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Shortwave Array Spectroradiometer

Instrument Status Update
and
Measurement and Model Closure

ASR Aerosol Lifecycle Working Group
Radiative Impact and Drivers of the Aerosol-Cloud Continuum
Connor J. Flynn, Sept 13, 2011

P Kiedron, J Michalsky: NOAA

J Barnard, D Hopkins, A Mendoza, D Nelson, R Norheim : PNNL

E Mlawer, M Alvarado : AER

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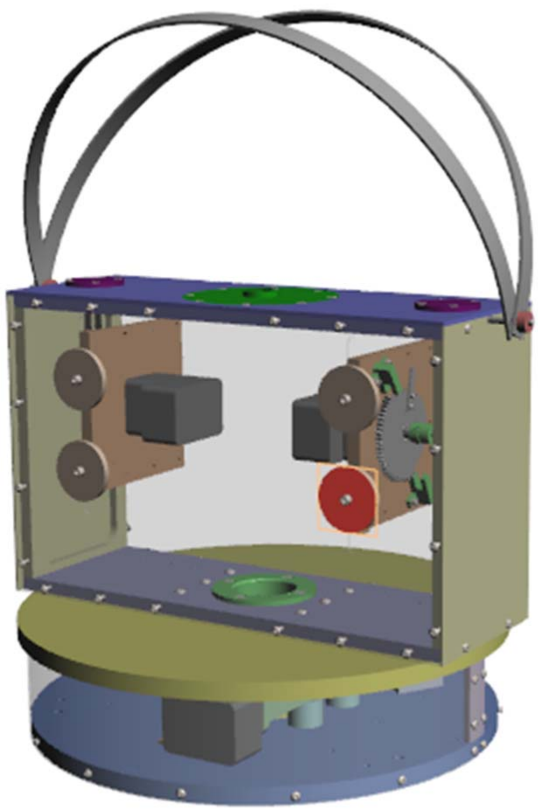
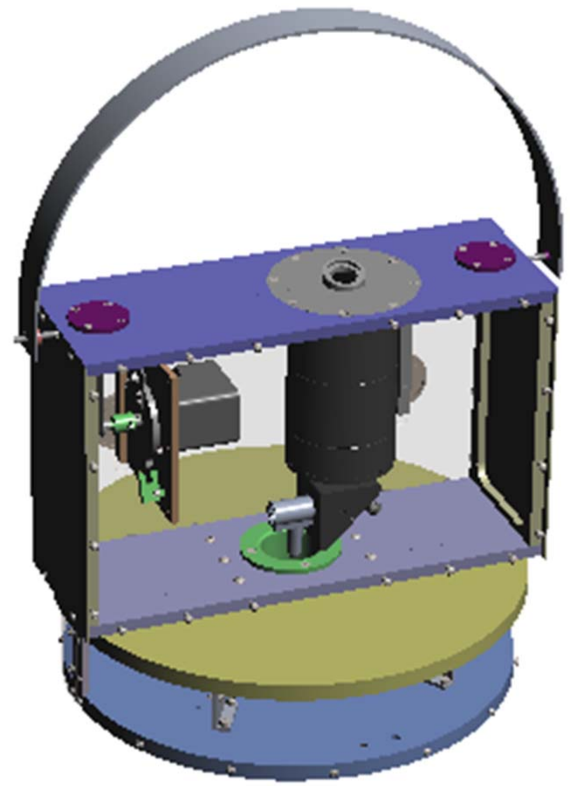
Shortwave Array Spectroradiometers: SAS-Ze and SAS-He

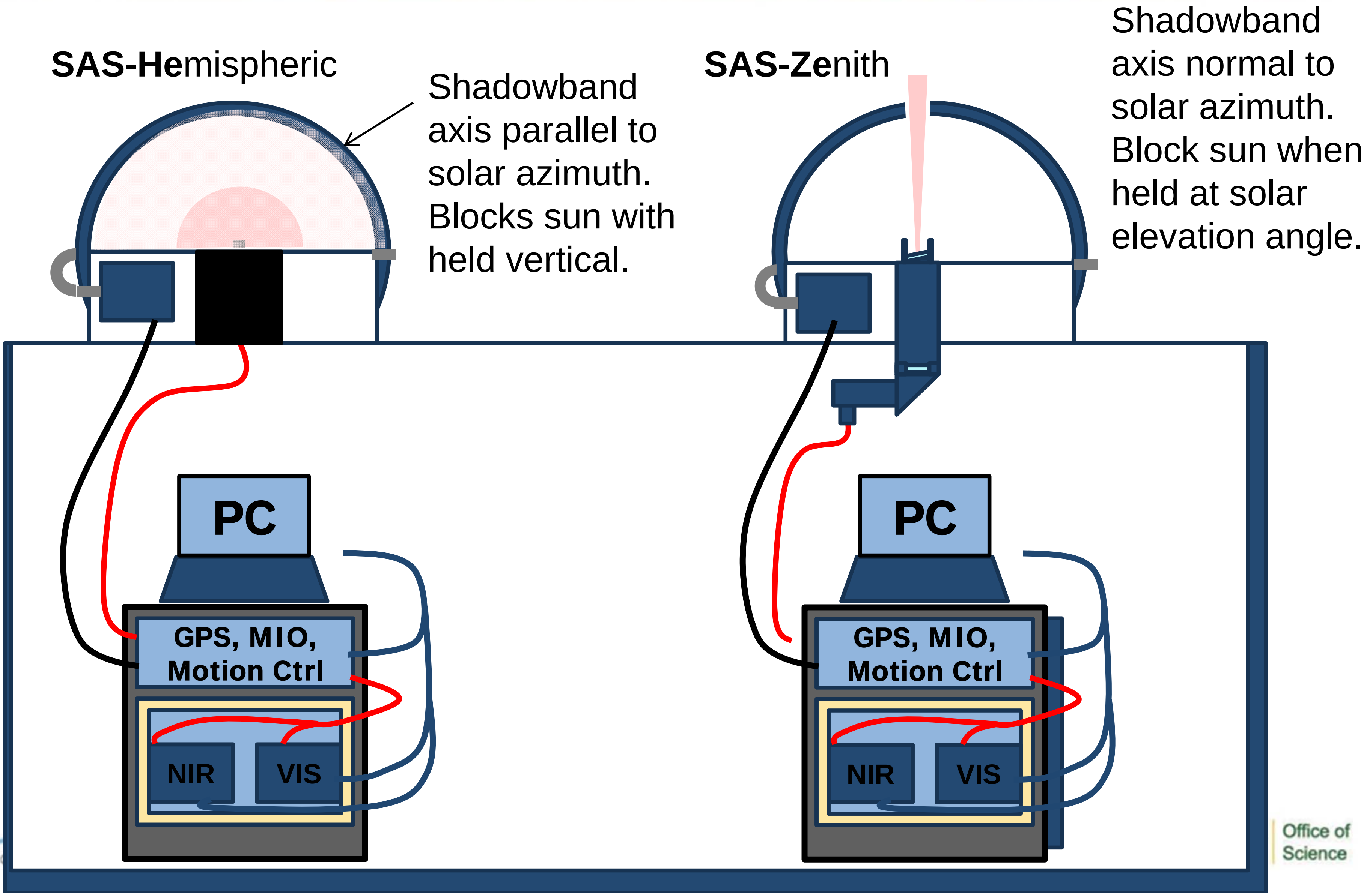
SAS-Hemispheric



SAS-Zenith



Shortwave Array Spectroradiometer Suite: SAS-Ze and SAS-He



Equivalent Spectrometers for both SAS–Ze and SAS–He

Silicon CCD for UV/VIS:

- ~350-1100 nm
- 1.6 nm FWHM resolution
- 0.5-0.6 nm pixel spacing

InGaAs array for NIR

- ~970-1700 nm
- 6 nm FWHM
- 3-4 nm pixel spacing

But very measurement modes:

SAS-Ze:

- Band nearly stationary
- Sky radiances
- 1-sec

SAS-He:

- Multiple band positions
- Direct & diffuse irradiances,
- Slew over solar disk
- ~60 sec, can be faster

SAS systems deployed at SGP





- SAS's installed March 2011
- SWS reinstalled June, shortly after -Ze azimuth drive failed April
  - **Baffle installed but pol effects noted**
- SAS-He signal dropping June 24.
- SAS-He undulation late July
- SAS-Ze drive replaced Aug 17.
- Condensation issue in chiller identified, resolved <u>last week</u>.

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SAS systems deployed in India

- Arrived in June, systems assembled.
- No acceptable location on the ground.
- Sky stand not ready despite valiant efforts of Indian contractors.
- Monsoon commences with constant rain
- SAS systems reinstalled, aligned and operating as of Sept. 7. Thanks Carlos!

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Definitive SW spectral data set effectively starts Sept 2011

Down-welling irradiance:

Cimel, MFRSR, NIMFR, RSS, SAS-He

Down-welling zenith radiance:

Cimel, NFOV2, SWS, SAS-Ze

Up-welling irradiance:

Only MFR (Do we have this in India?)

(SGP ONLY) (AMF1 ONLY)

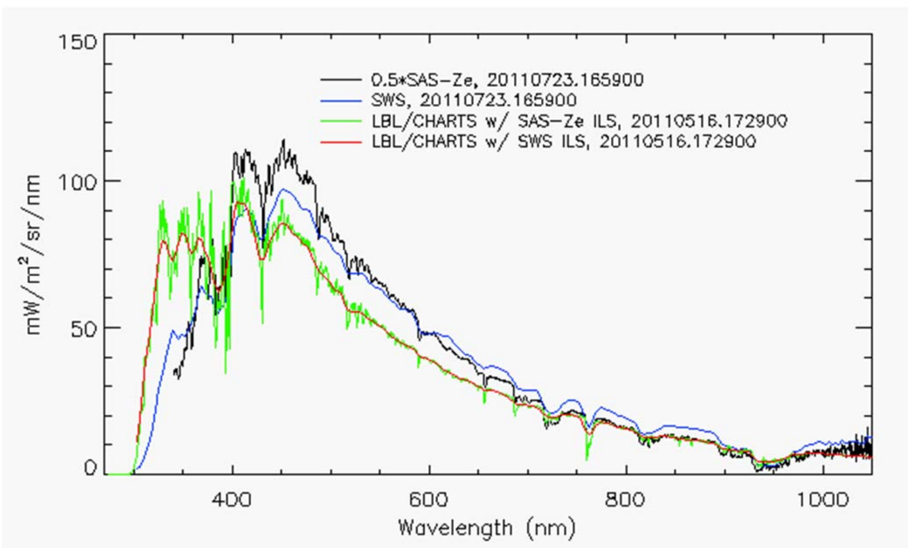
Definitive set effectively starts Sept 2011, but we couldn't wait

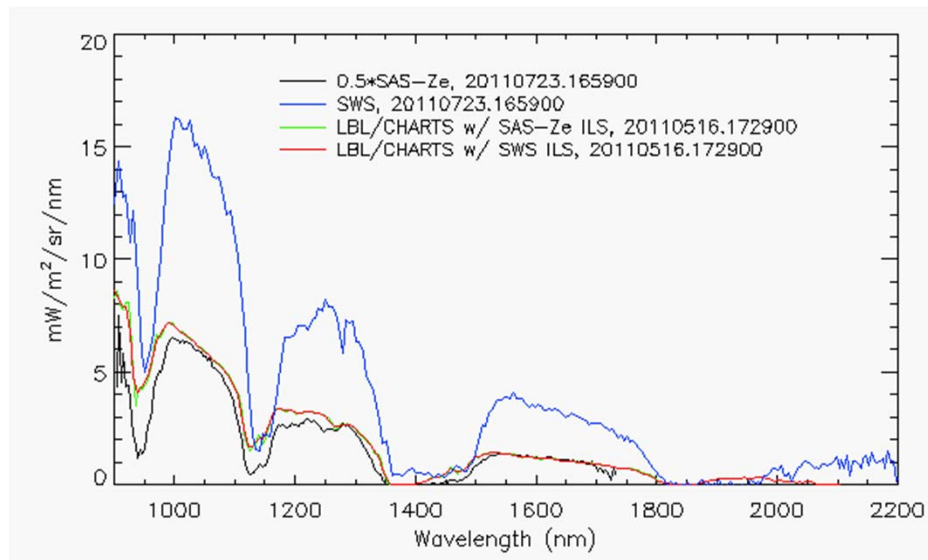
To exercise the frame work for radiation closure, Eli Mlawer, Matt Alvarado, and I examined radiation closure at the surface using nominal spectral calibrations from the SAS-Ze and SWS.

Included MFSR-derived AOD, SSA, g and Mergesonde for atm state.

Agreement between the shape of the measured and modeled clear sky zenith radiance is much better than before.

Highlights critical need for solid head-to-head calibration.





SAS-He: Hemispheric Irradiance

Band positions:

1. Dark
2. TH
3. SA
4. Slew A-B
5. SB
6. BK
7. Repeat CCW
8. Re-zero band

Repeat …

Extracting irradiance components:

A. Subtract darks from all.
B. Take mean (SA+SB)/2
C. Dirh_raw = A – BK
D. Dirh = cos_corr*Dirh_raw
E. Dif_raw = TH – DirH
F. Dif = dif_cos_cor*Dif_raw
G. TH = Dirh + Dif
H. Dir_norm = Dirh/cos(sza)
I. Apply spectral response

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Future SAS VAPs

- Standard Langley for pixels free of strong absorbers (water vapor, oxygen)
- AOD, ang(λ), SSA, g, N(r), n*, cloud fraction
- Modified Langley for remaining pixels.
- Gas-phase retrievals, PWV, O_3, and maybe NO_2, CO_2
- MFSRS-type cloud OD, r_{eff} retrieval
- PCA Noise-filter

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Column absorption closure through size distributed props.

- Establish degree of agreement with column integrated particle properties retrieved from sun photometry, and the size distributions and size-resolved growth functions measured at the surface.
- Basic: perfectly mixed boundary layer and simply extrapolate the size-resolved aerosol population at the surface properties up through to the vertical column up to the top of the mixing layer, humidifying the surface number density distribution with g(RH) according to a measured RH profile. Compare to the column-integrated quantities from radiometry. This is almost what the Aerosol Best Estimate does with the optical properties, except the projection to particle space provides the potential to infer vertical absorption distribution or at least boundary layer and elevated layer contributions.
- A more sophisticated approach would involve "dehumidifying" the vertical lidar extinction profile with the inverse of the AOS f(RH) curve, and then using this dry extinction profile to weight the surface aerosol properties before humidifying with the vertical RH profile. This may help overcome challenges previously observed in by additionally constraining the vertical profile of aerosols, putting the particulate properties under scrutiny.
- To the extent that skill is demonstrated within the well-mixed BL, this presents the opportunity to infer properties of elevated aerosols as the extrapolated surface properties and the total column when elevated aerosols are indicated, for example by lidar.