Aerosol Absorption Measurements Inter-Comparison

IOP planning discussion

Objective

Promote better understanding of the advantages and limitations, specifically with respect to measurement uncertainty, of different approaches to in situ aerosol light absorption measurements.

Outcome

Report accuracy and precision for instruments used to measure aerosol optical properties.

Provide a basis of determination for investment in and deployment of particular instruments for continuous, long-term operation at ARM-like fixed sites.

Goals for this discussion

- Why?
- What?
- Where?

Aerosol Absorption Measurements Inter-Comparison

- Why?

what are the most important questions to answer with this IOP

- What?

what minimum set of instruments is required to answer those questions

- Where?

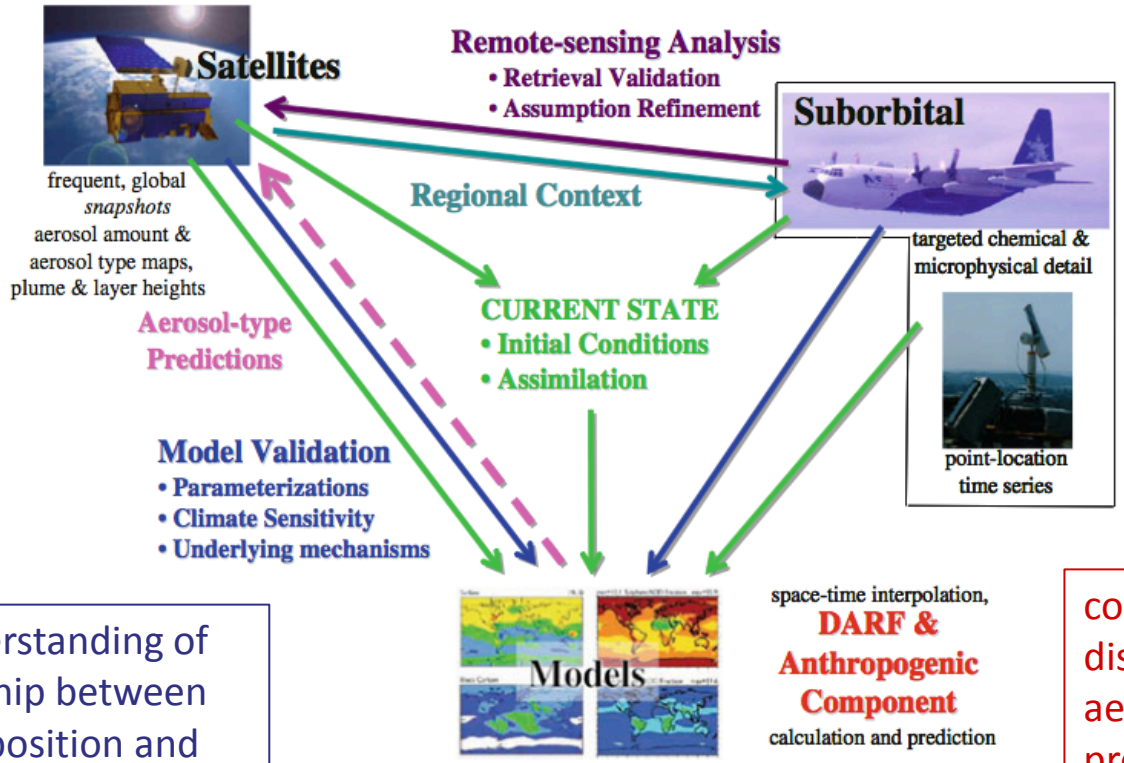
what is the most feasible location that will provide the conditions necessary to answer those questions

Aerosol Absorption Measurements Inter-Comparison

Role of in situ measurements in constraining aerosol radiative forcing

Kahn 2012,
Surv. Geophys

only direct measurement of the absorption contribution to light extinction (remote sensing requires assumptions) – used to evaluate remote sensing retrievals

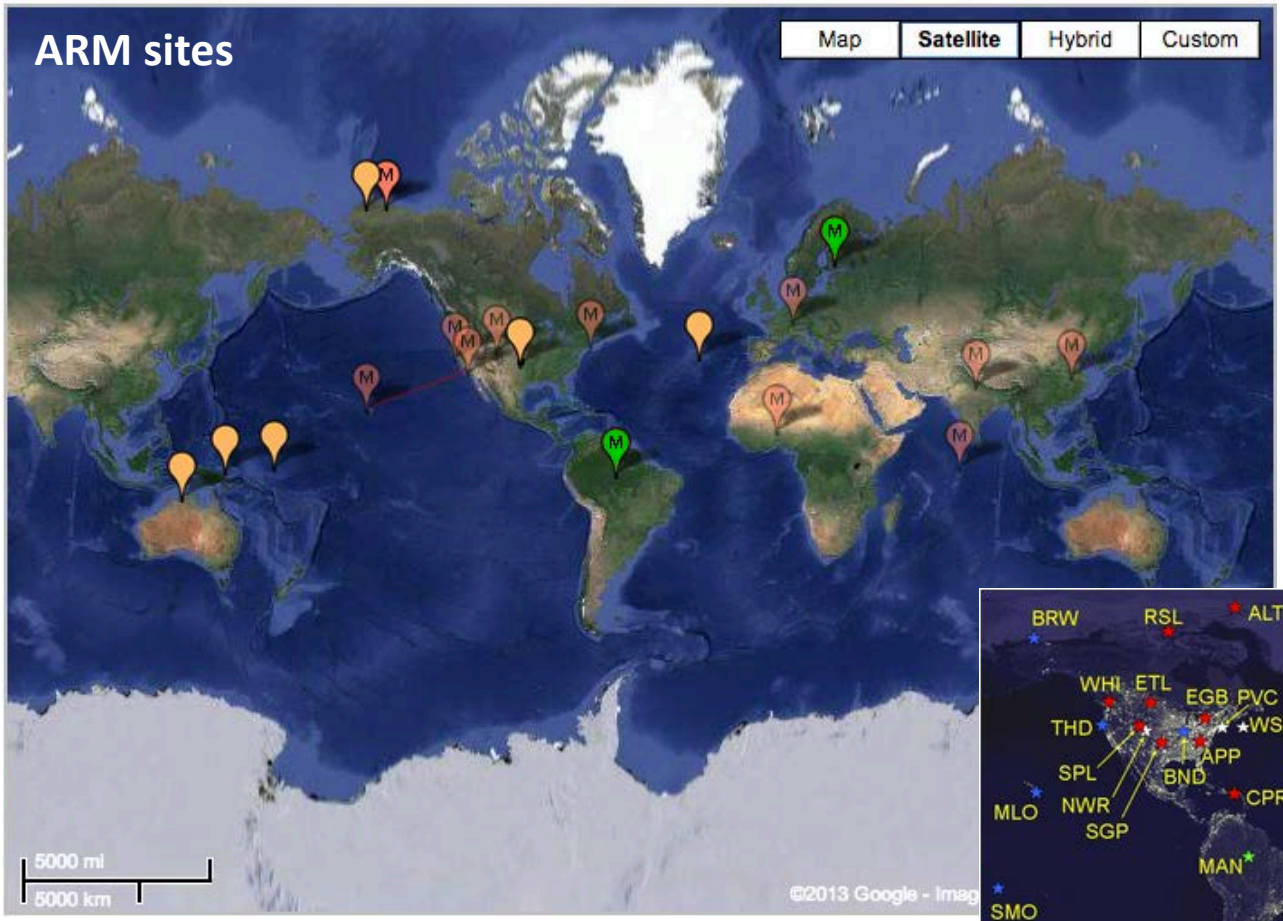


provide understanding of the relationship between aerosol composition and mixing state and the resulting optical properties

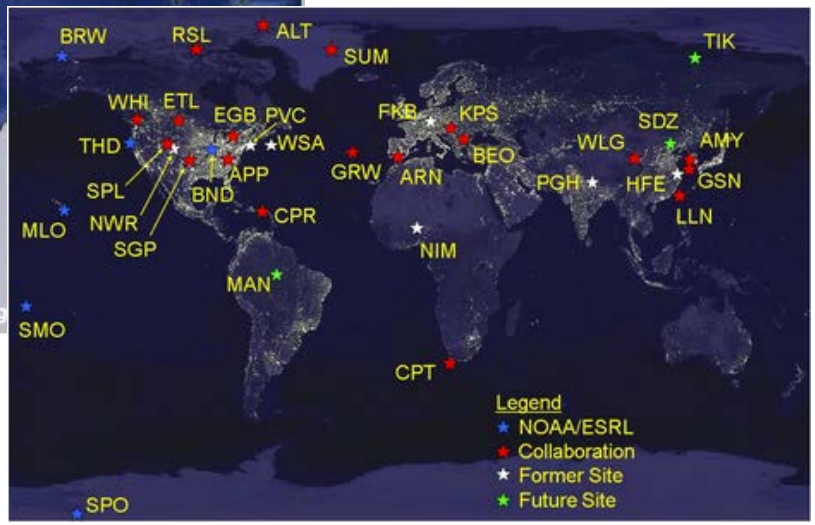
constraining globally-distributed climatology of aerosol climate-forcing properties

Aerosol Absorption Measurements Inter-Comparison

Filter-based absorption measurements are a major player



NOAA/GAW networks

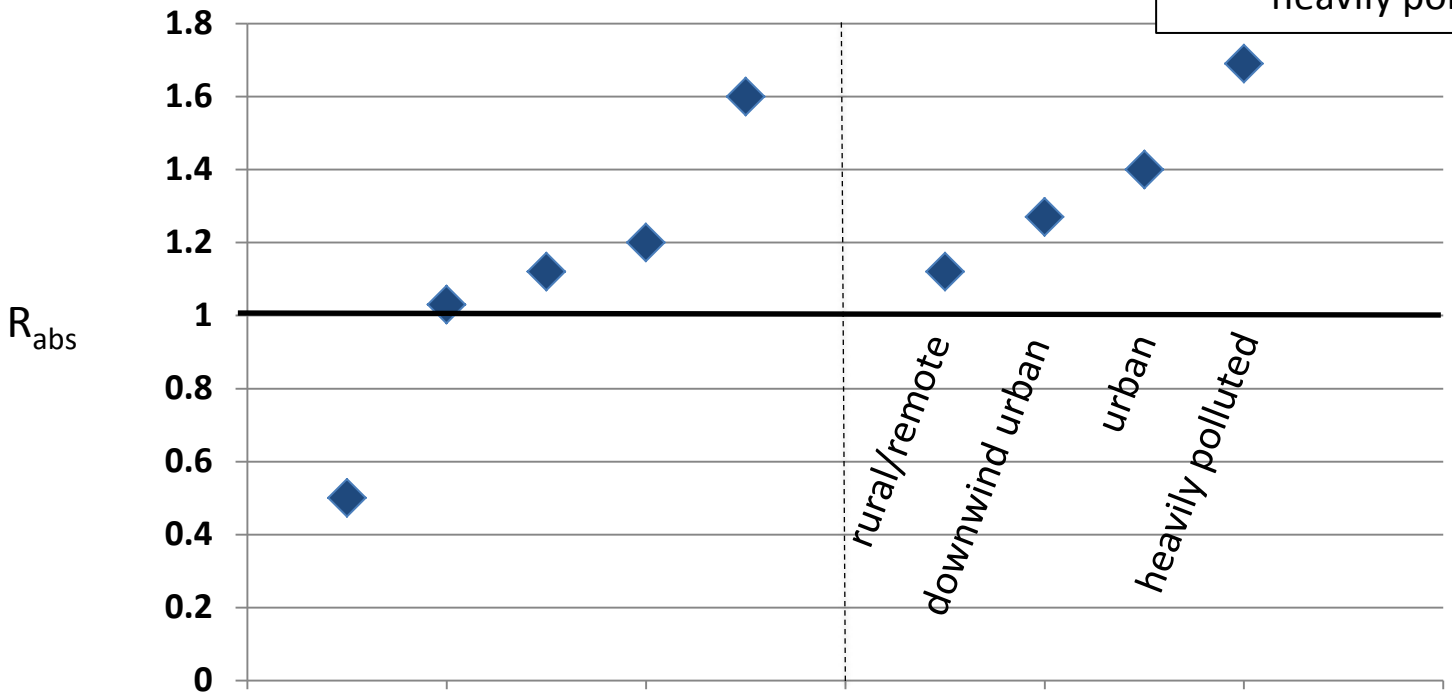


Aerosol Absorption Measurements Inter-Comparison

Consistency in measurement approaches is lacking

OA mass (μg m^{-3})
- rural/remote = 0-2.5
- downwind urban = 2.5-5.0
- urban = 5.0-12.5
- heavily polluted = >12.5

$R_{abs} = \sigma_{abs}$ filter/σ_{abs} ref



Lack et al. 2008

Aerosol Absorption Measurements Inter-Comparison

Scope

- priority is to address in situ aerosol absorption measurement
- intent is to keep this a ground-based exercise

Campaign Funding Levels and Review Structure*:

< $25K IMB reviewed

< $100K IMB reviewed with community endorsement

> $100K mail out peer review

> $300K reviewed by ARM Science Board

*general guidelines

Aerosol Absorption Measurements Inter-Comparison

Defining (Refining) Why

- Under what conditions do in situ filter-based, difference, and direct measurements of aerosol absorption disagree?
- Is the accuracy in these measurements sufficient to address aerosol climate-forcing problems?
- Can calibration or correction factors be developed/improved for filter-based aerosol absorption measurements?
- Do these measurement approaches allow for defining relationships between aerosol absorption optical properties, aerosol chemical composition, and column radiative fluxes?

Aerosol Absorption Measurements Inter-Comparison

Deciding What

- What geophysical parameters are most important to evaluate?
  - light absorption coefficient
    - range of wavelengths
    - absorption angstrom exponent

- With what accuracy do we need to measure these parameters?
  - sensitivity studies
  - do we actually understand the reported uncertainty of these instruments? (can we explain accuracy, precision, resolution?)

- At what temporal resolution do we need to sample these parameters?

- What ancillary information or set of measurements is required to answer the established science questions?
  - passive remote sensing
  - active remote sensing
  - airborne measurements

Aerosol Absorption Measurements Inter-Comparison

Determining Where

- What conditions are required to answer the established science questions?
  - range in aerosol loading
  - range in aerosol composition
  - range in relative humidity

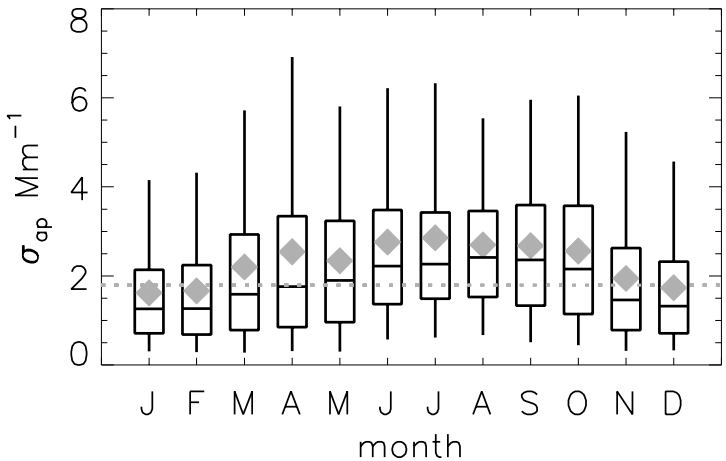
- Can this work be accomplished at an existing ARM fixed-site? (requiring far fewer resources)

Aerosol Absorption Measurements Inter-Comparison

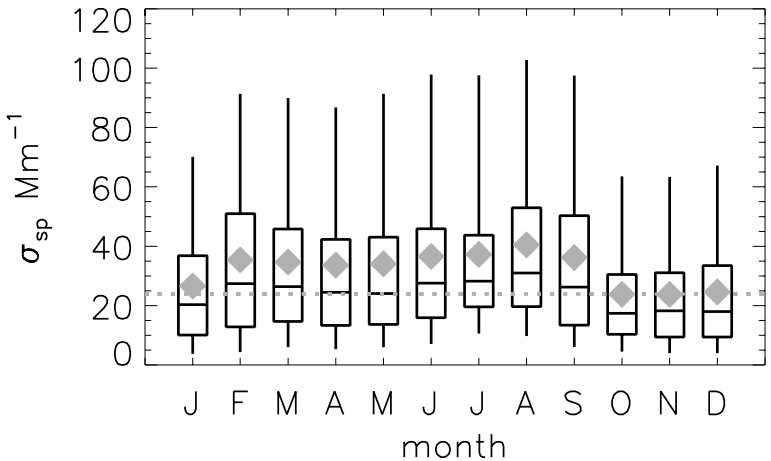
Defining (Refining) Where

SGP: 1996-2012

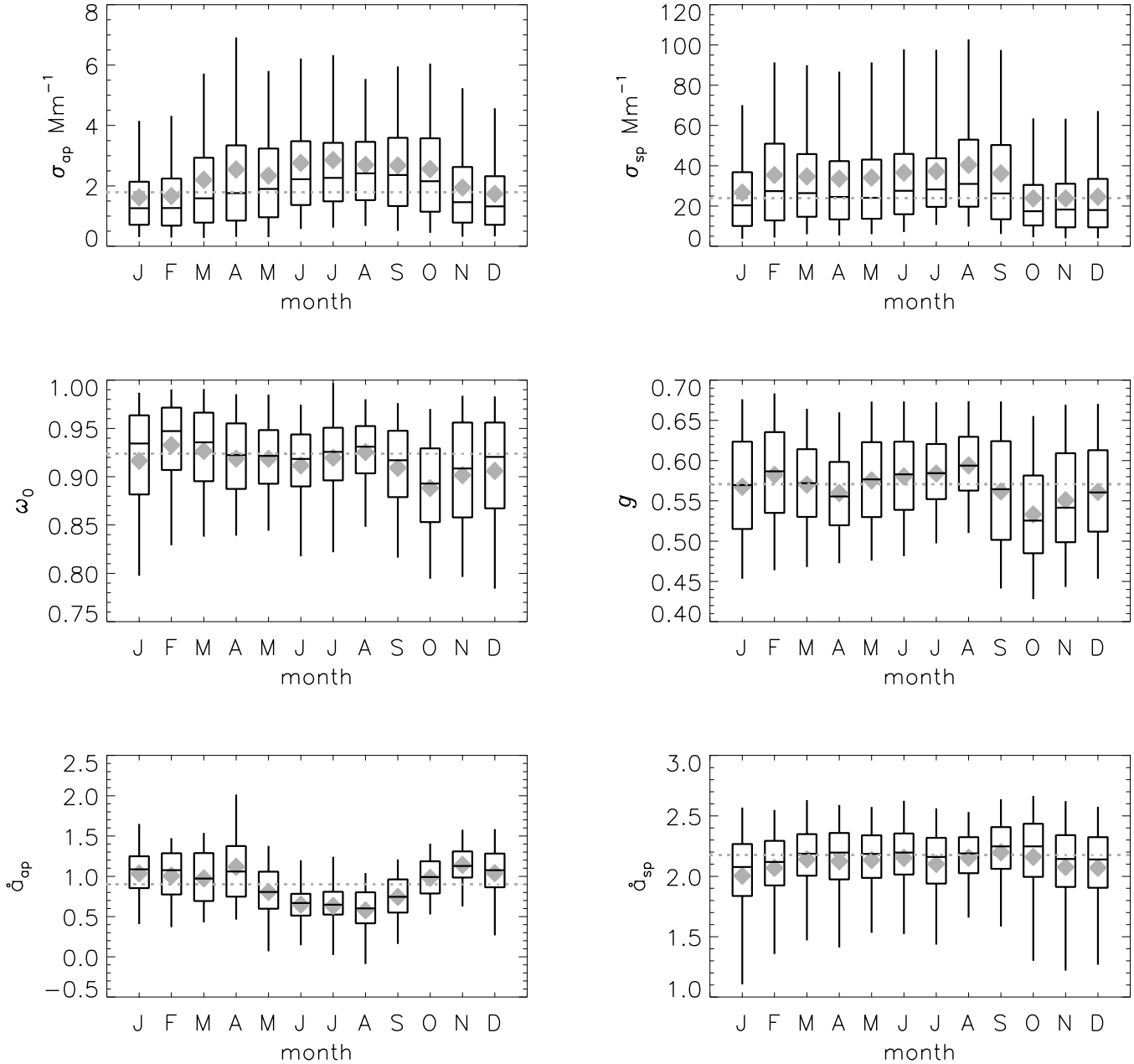
PSAP Absorption



Neph Scattering



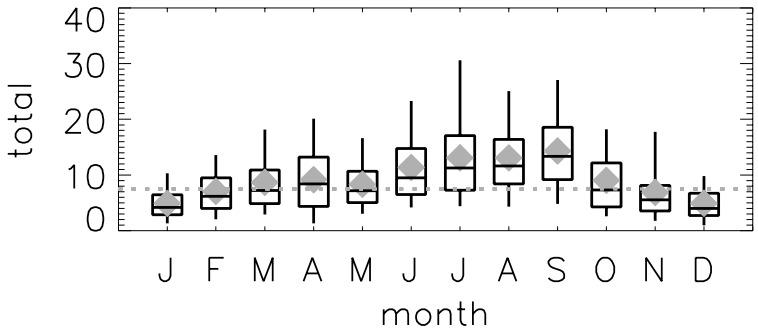
SGP: 1996-2012

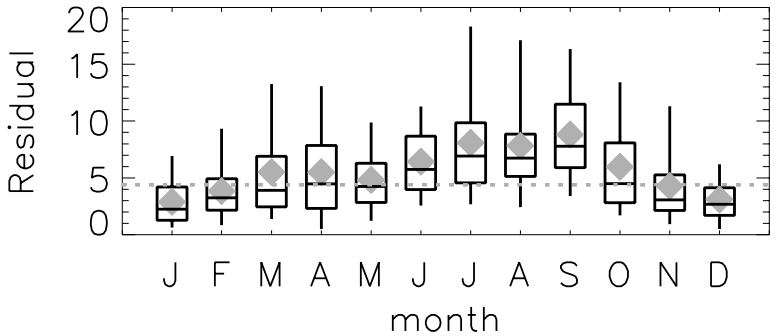


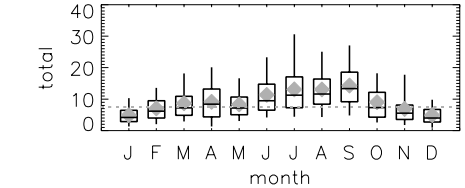
Aerosol Absorption Measurements Inter-Comparison

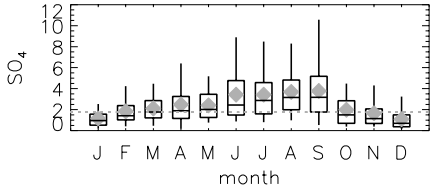
Defining (Refining) Where

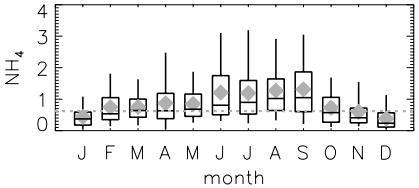
SGP: 1998-2006

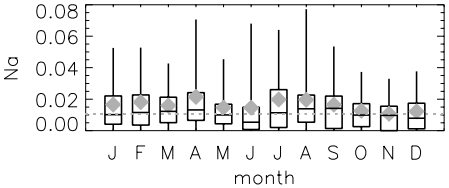


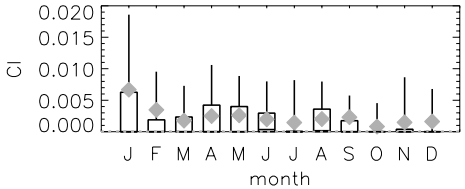


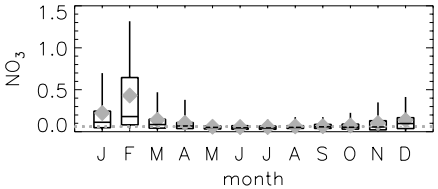


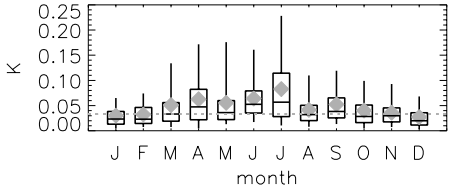


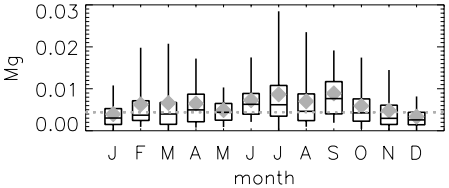


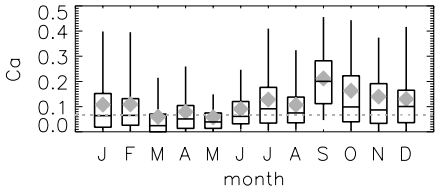


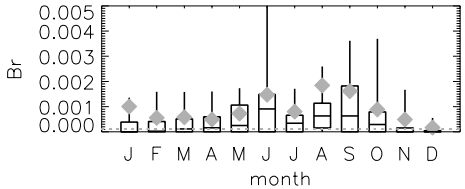


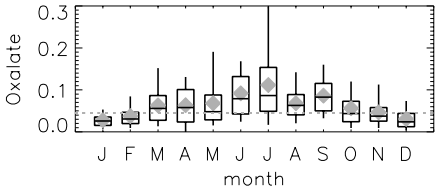


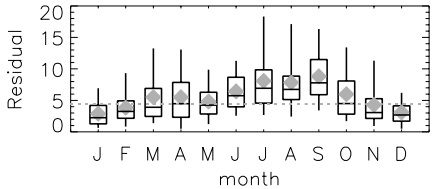












Aerosol Observing System: Mobile Facilities

AMF-1

AOS
CPC (10-3000 nm)
CCN 100 (single column)
Dry neph – 3 λ
Wet neph – 3 λ (40-80%)
PSAP – 3 λ (and/or CLAP)

Non-AOS aerosol relevant
CIMEL Sun photometer
MFRSR
MPL
SAS-he
SAS-ze
AERI

AMF-2
Marine-capable

AOS
CPC (10-3000 nm)
CCN 100 (single column)
HTDMA
Dry neph – 3 λ
Wet neph – 3 λ (40-80%)
PSAP – 3 λ

Non-AOS aerosol relevant
MPL
HSRL

For land use only:
CIMEL Sun photometer
MFRSR

MAOS

MAOS-A (optical)
CPC (10-3000 nm)
CPC (2.5-3000 nm)
UHSAS (50 nm – 1 µm)
CCN 200 (dual column)
Dry neph – 3 λ
Wet neph – 3 λ (40-80%)
PSAP – 3 λ
Aethalometer – 7 λ
PASS-3

MAOS-C (chemical)
PILS
PTRMS
ACSM
SP2
CO, O3, SO2, NOx