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Beyond AOD - A team science initiative

Quantify vertically-resolved aerosol absorption

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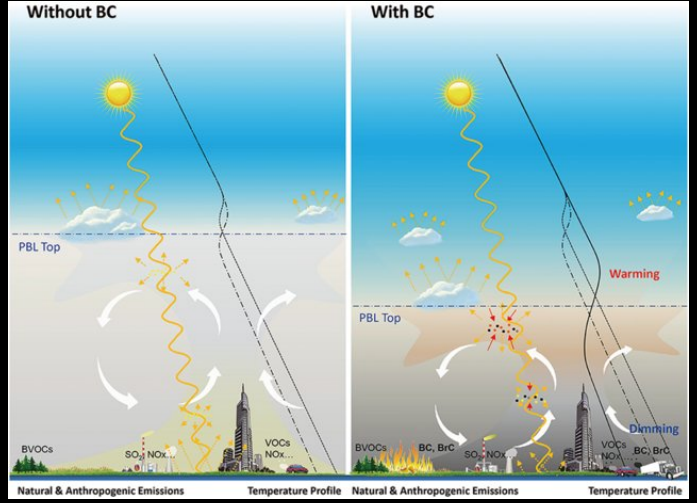
Relevance of Absorbing AOD

To help answer climate science questions, we need to

- improve process understanding/parametrization to advance models
  - Emission, Transformation, Redistribution, and Removal
  - PBL processes and Air Quality
  - Indirect radiative forcing:
    - Heating/Cooling
    - Atmospheric dynamics (stability)
    - Cloud formation
    - Planetary Albedo
- perform observations of absorbing AOD profiles
  - Direct radiative forcing

Black Carbon "*is 2nd most important human emission in terms of its climate forcing*" after CO_2, and that "*, largely due to lack of knowledge about cloud interactions with both black carbon and co-emitted organic carbon*". Bond et al. [2013]



Li, Zhanqing, et al., 2017

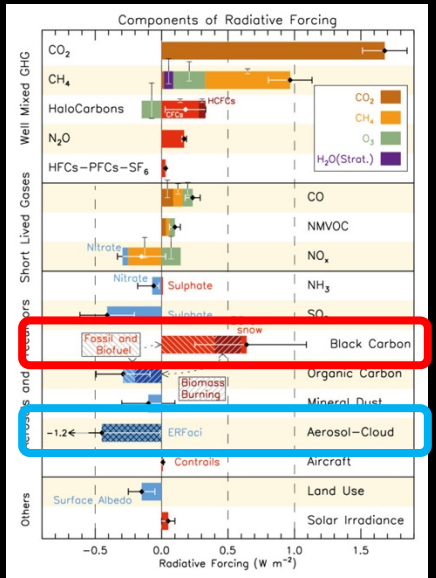
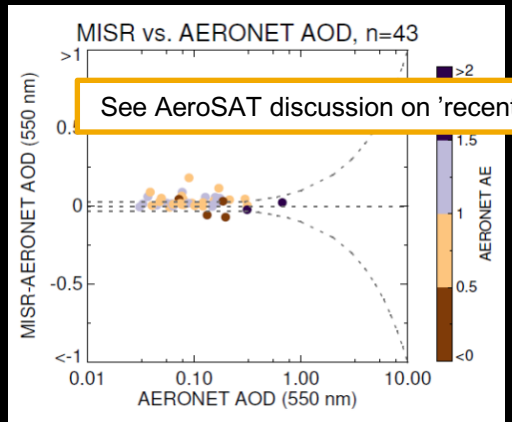
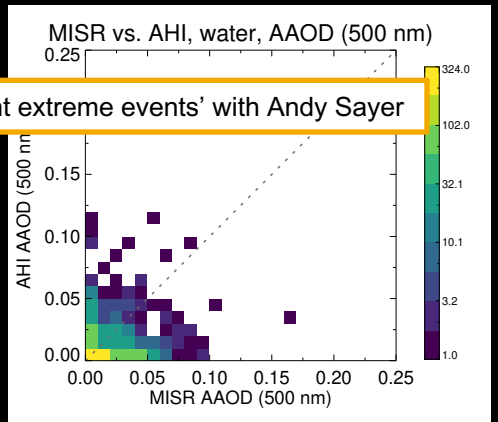


Figure 8.17, IPPC, AR5 Climate Change 2013: The Physical Science Basis

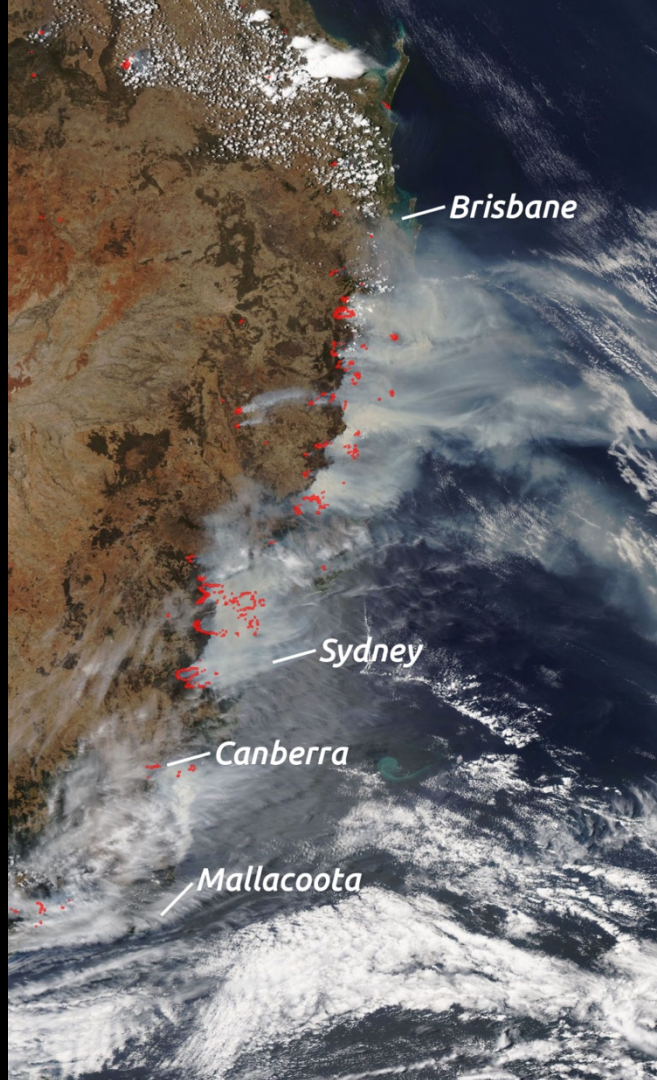
Motivation

- Spent 30 years on AOD and aerosol size
- I propose to concentrate our efforts now '*beyond AOD*'
- AAOD is important and dominates the direct aerosol radiative forcing (DARF) uncertainty [IPCC 2013; Loeb and Su, 2010]
- Room for improvements for current and future observations

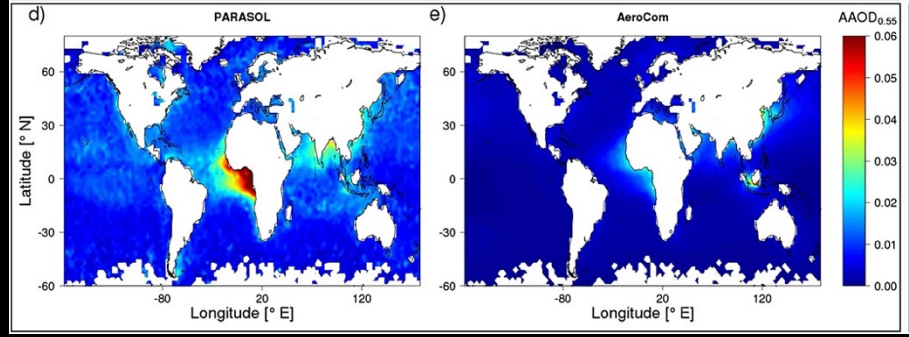


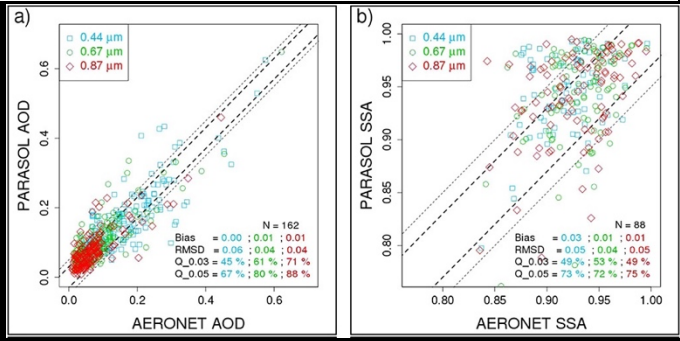


See AeroSAT discussion on 'recent extreme events' with Andy Sayer



Challenge





Lacagnina et al. 2015

- Current satellite instruments and retrievals have very low skill for quantifying aerosol absorption
- Current lidars provide curtains and imagers lack sensitivity to vertical profile.
- Combined retrievals of polarimeters, lidars and spectrometers are in their infancy.
  'Classic' EOS-area retrievals are still being improved.
- Lack of lidar measurements between CALIPSO and ACCP
- Lack of optical/microphysical statistics derived from in-situ observation

Opportunities

- Rich data records (satellite and airborne/ground-based remote and in-situ)
- Next Generation
  - Experts
  - Observations (MAIA, EarthCARE, PACE, METOP/EPS-SG, Sentinel-5, SBG, and ACCP)
  - Innovative Retrieval Approaches
    - Joint spatiotemporal surface-atmosphere retrievals (GRASP, MAIAC)
    - Spectral gaseous absorption for aerosol profiling (A-band)
    - Combined retrievals: LEO+GEO, Lidar+Polarimeter+Spectrometer
    - Improved microphysical/optical aerosol property information
    - Advanced statistical tools
      - Optimal Estimation
      - AI/ML techniques
      - Varimax-rotated principal component analysis

Team Science Initiative to achieve breakthroughs and make a difference!

Goal: **As international collaborative community, let's move '*beyond AOD*' towards aerosol absorption profile observations to help address key climate science questions.**

Proposed Objectives:

1. Build a collaborative, diverse and innovative community to advance remote sensing of absorbing aerosol.
2. Develop consensus on how to best quantify aerosol absorption from space using novel combinations of observations and innovative retrieval methods.
3. Write proposals for feasibility and sensitivity studies.
4. Work on papers to create funding and maybe even new mission and instrument opportunities.

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