**Climate Impacts of Biomass Burning (BB) Emissions and Black Carbon (BC) Aerosol**

- **Biomass Burning**: Large source of Carbon to the atmosphere
  - Particles: Black Carbon (BC), Organic Carbon (OC), Brown Carbon (light-absorbing in the visible and UV)
  - Gases: CO, CO₂
  - Largest BC source globally

- **BB is the largest source of BC globally**
  - BC: most light absorbing particle in the visible region
  - 6-9 Tg/yr with up to ~0.6 W m⁻² warming - (IPCC, 5AR)
  - 2nd most important in global warming, most uncertain, underestimated
  - Expected to increase in the future due to increased drought and extreme events

- **BC directly warms the atmosphere, OC cools**
  - Mixtures in BB with complex climate impacts (indirect effects: clouds, precipitation)
  - BB emissions age in time – changing properties of the aerosol (physical, optical, chemical)
  - BC from BB has enhanced absorption due to coatings
  - (S. Liu, GRL, 2014; D. Liu, Nat Geo, 2017)

**Layered Atlantic Smoke Interactions with Clouds (LASIC) Campaign**

- **Southern Africa**: Largest BB source
  - Fuels: Land clearing wood and grassland fires
  - BB Season peaks from June – November

- **LASIC Measurements**
  - Ascension Island is in the Southern Atlantic Ocean
  - June 2016 – October 2017
  - Sample 2 Southern African BB Seasons
  - PI: Paquita Zuidema

- **AMF1 Aerosol Observing System (AOS) and Mobile AOS (MAOS)**: In situ aerosol measurements at the surface
  - Particulate: number, size, optical properties, Black Carbon (BC) content, non-refractory chemical composition, hygroscopicity and water uptake
  - Trace Gas: Nitrogen Oxides, Combustion tracers (CO, SO₂), Ozone, Volatile Organic Compounds (VOCs)

- **Biomass Burning**
  - Largest plumes of the season arrive at ASI in **August 2016**
  - Submicron number concentration of \(~1000 \text{#/cc}\)
  - Absorption Coefficients reach 30 Mm⁻¹

- **Back trajectory analysis** - (A. Adebiyi, Q J Roy Meteor Soc, 2016)
  - Southern African sources (e.g., Namibia, Angola) with ~1 week atmospheric transportation time
  - Active fires from August 6 – 17 (MODIS / VIIRS) show numerous fires across the region

- **Non-refractory submicron aerosol mass is dominated by Organics (OA) in August during the peak BB season**
  - Preliminary PMF analysis of the OA (not shown) indicates the OA to be aged/oxidized with minimal fresh BB (BBOA) similar to previous (aged BB) from Mt. Bachelor, CA
  - (S. Zhou et al., ACP, 2017)

- **SEM Images of 4 Types of BC in BB**
  - China et al., Nat. Commun., 2013

- **Comparison with Laboratory BB and US Wildfires**
  - Laboratory BB data (shown in color based on OC Mass Ratio)
    - Sampled flaming to smoldering conditions with a large range of fuels, including African grasses
    - Dominant trend for near-field emissions, optical properties of the aerosol depend on fire conditions
    - (S. Liu et al., GRL, 2014)
  - Ambient BB from SW US Forest Fires
    - **Las Conchas** and **Whitewater Baldy** in New Mexico
    - Aged from < 1 day to < 4 days
    - Preliminary LASIC BB plumes (aged ~1 week)
      - Lower SSA and AAE than SW US BB plumes
      - BC not observed by AMF1 AOS

- AMF1 AOS and MAOS LASIC 2016 Preliminary Results
  - Submicron bulk chemical aerosol
    - OA and rBC dominate the submicron mass and have similar mass concentrations with OA/rBC ~ 1 in the plumes

- Aerosol Optical Properties
  - Absorption Angstrom Exponent (AAE)
    - Values ~1 indicate most of the absorbance is from BC
    - Higher observed values could indicate BrC
    - (Saleh R. et al., Nat Geo, 2014)

- Single Scatter Albedo (SSA; not shown)
  - Values ≤0.85 indicate a mixture (internal/external)
  - Lower in the plumes (higher BC fraction)
  - Is the fuel (likely grasses/savannas) more flaming?
  - High BC per total aerosol mass