

Colockum Tarps Wildfire: June 30, 2013

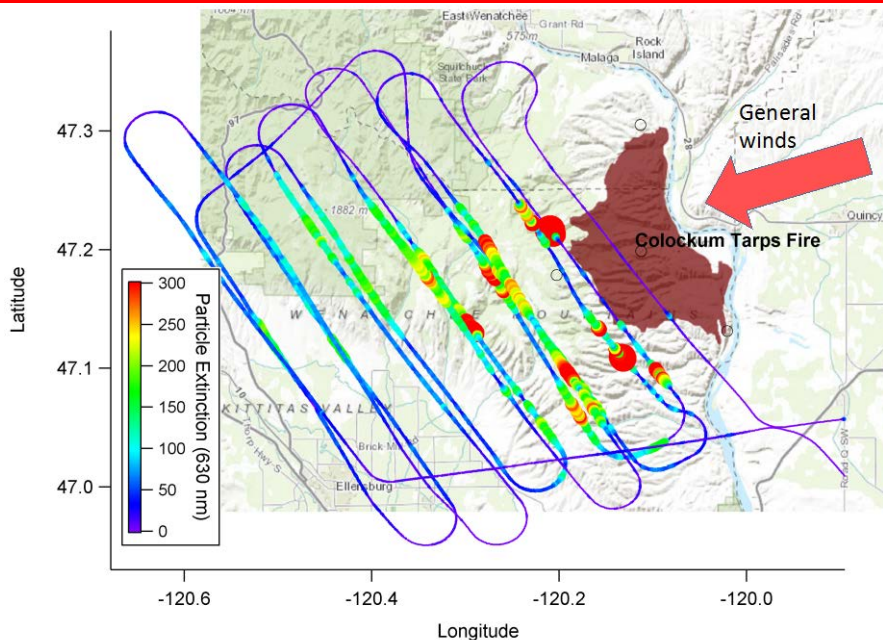
Fire Information Report for Colockum Tarps

Wildland Fire Incident
Report Date: 05-AUG-13

Burnt Area: 80,400 Acres
Location: Chelan County, WA (Malaga)
Cause: Under Investigation
Incident Team Type: IMT Type 2
Team Leader: Gales
Containment Status: 60% contained
Expected Containment: Unknown
Fuels: Also 2(Timber Grass Understory) and 9 (Hardwood Litter) High 5800000.00 749PRIM

Fire report information is based on the Incident Status Summary (ICS-209) database. Additional information for current large incidents is available via the [Incident Management Situation Report \(IMSR\)](#) provided by the [National Interagency Coordination Center](#).

Discrepancies between the fire acreage displayed on the large incident location map and the acreage reported in the ICS-209 are subject to the currency of ICS-209 information reported above (please note the report date). The USDA Forest Service Remote Sensing Applications Center is not responsible for the accuracy of this information.



Orthogonal transects roughly represent 30-minutes of aging starting from 0 hours over the fire (B_{ext}: A. Freedman)



ASU: TEM Sampler

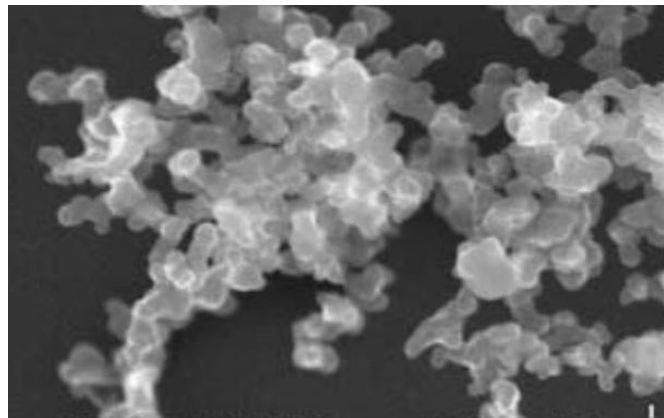


Lacy-Carbon grid
One collection/transect



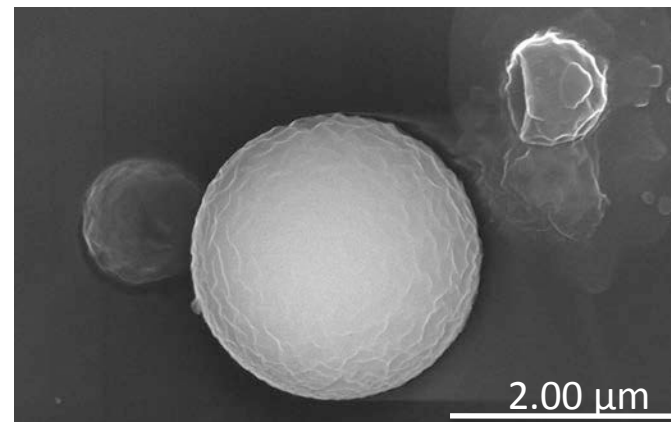
Types of Spherical Carbonaceous Solids

Ns-soot



Li, Pósfai, Hobbs, Buseck (JGR 2003)

Tar balls (BrC particles)



Li, Pósfai, Hobbs, Buseck (JGR 2003)

Tar Balls (TBs)

- Organic particles distinguished by shape, composition, high viscosity, lack of crystallinity, and possibly refractory character
- Uniquely recognized through electron microscopy; overlooked by other measurement (?)
- Size Range: 100 – 300 nm
- Can contain up to 10 mol % of non-carbon elements, mainly H, O, S
- Are one of the major identified components of brown carbon (BrC) (e.g., Andreae & Geléncser 2006)
- Refractive Index
 - $RI_{TB} = 1.27 - 0.27i$ (Alexander et al. 2008) & $RI_{TB} = 1.84 - 0.21i$ (Hoffer et al., 2015)
 - $RI_{TB} = 1.56 - 0.02i$ (Hand et al., 2005)
 - $RI_{TB} = 1.75 - 0.002i$ (Chakrabarty et al., 2010)

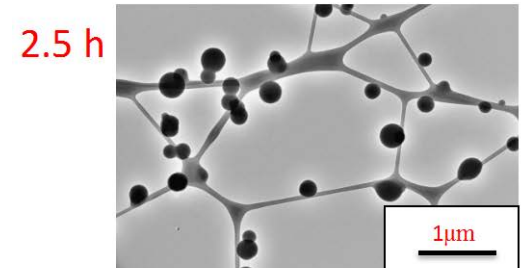
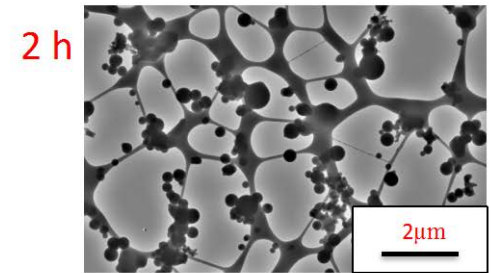
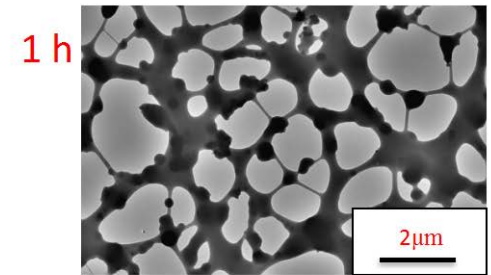
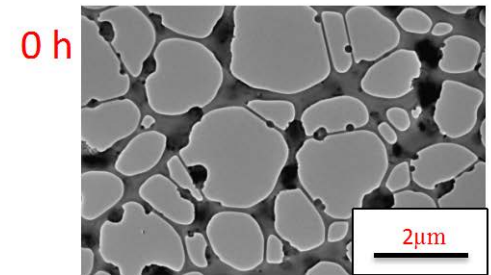
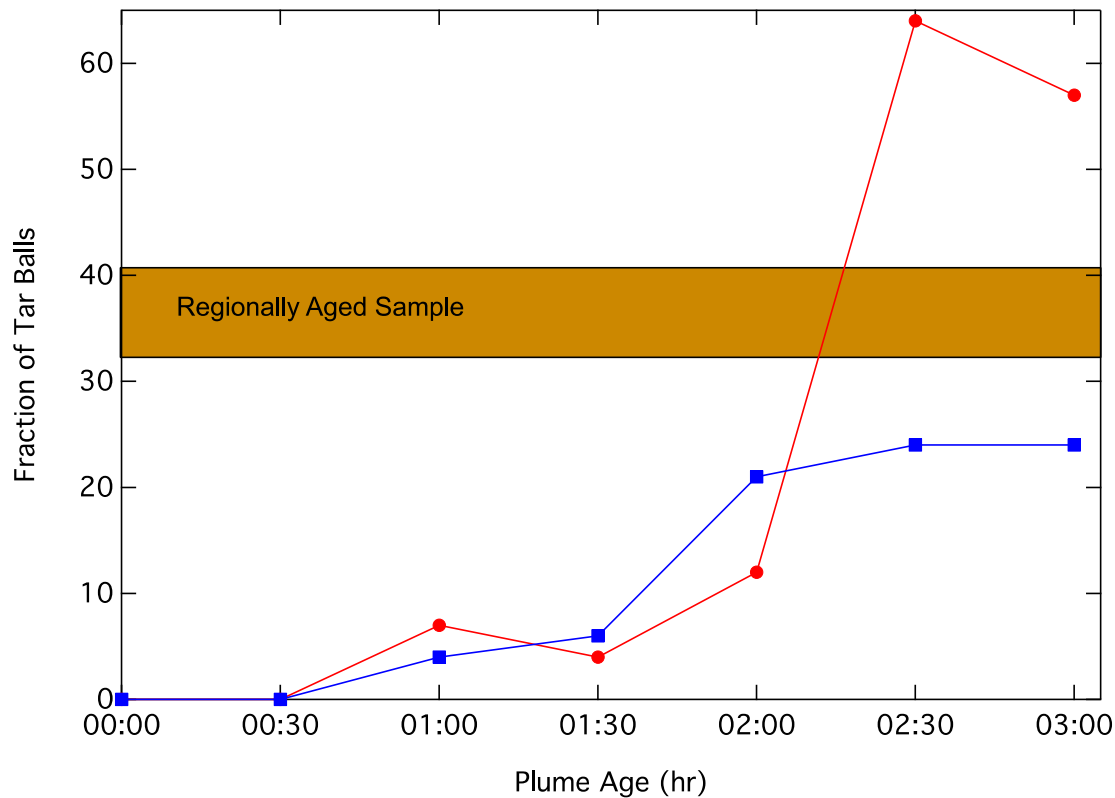
100x

Evolution of Tar Balls

Lingering uncertainty about TB Formation mechanism

- Primary: rapid heating of primary plant emissions
- Secondary: oxidation/photolysis of POA

BBOP data shows increase in TBs number as a function of plume age



TB Fraction in a Wildfire Plume

Conclusive detection of TBs is still limited to electron microscopy (e.g., TEM)
Several TEM studies have reported very high TB fractions (>50%)

However:

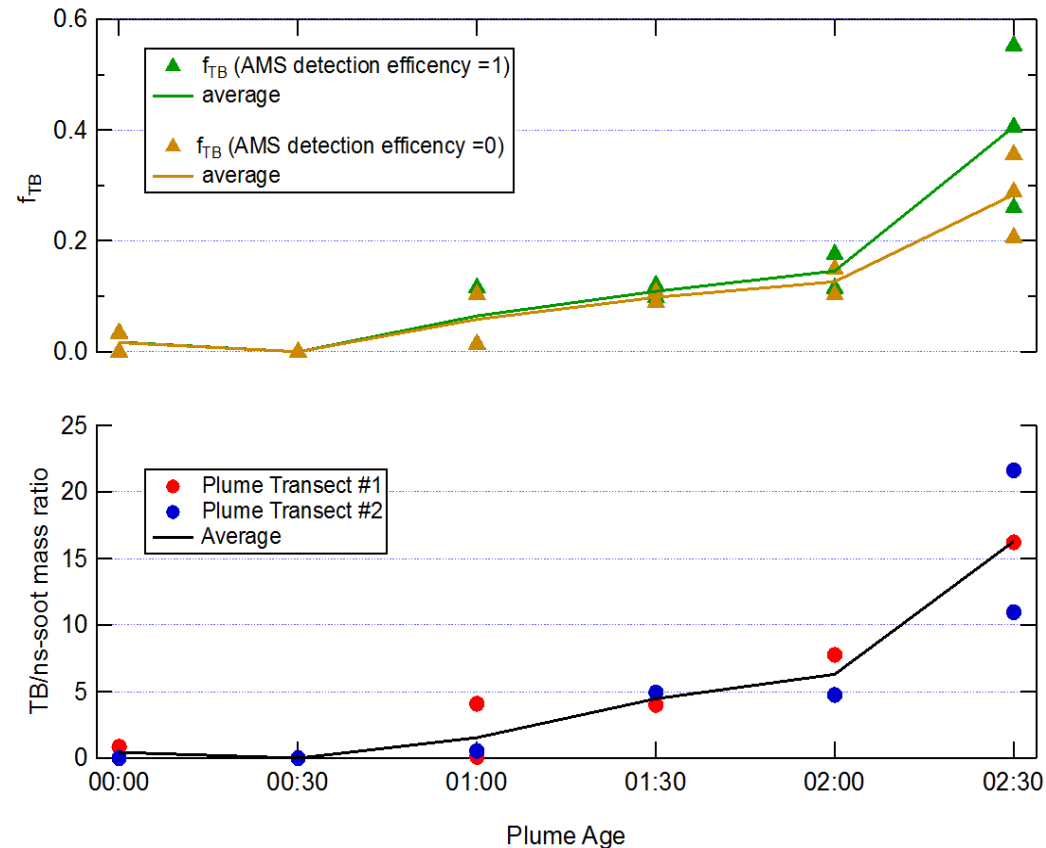
Loss of volatile material can occur during storage and electron beam interrogation
TEM-derived TB fractions overestimate the true contribution of TBs

Combine TEM, AMS, and SP2 to provide estimate the TB mass fraction in the plume

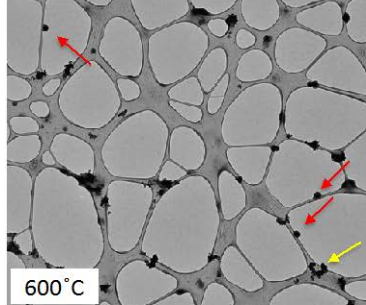
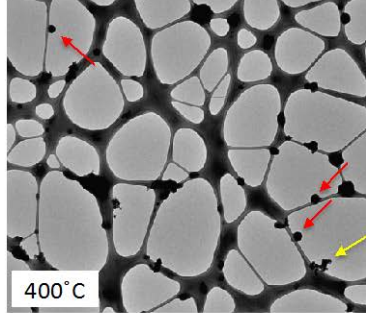
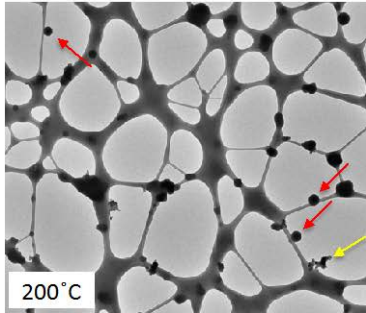
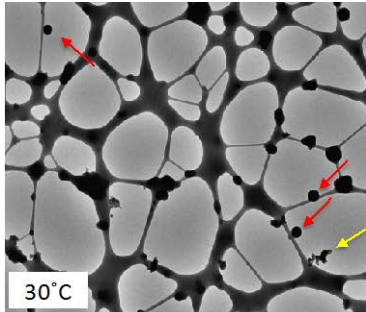
- TEM provides: μ_{TB} , $\mu_{ns-soot}$
- AMS provides: μ_{org} , μ_{inorg}
- SP2 provides: μ_{rBC}

rBC (SP2) = soot (TEM)

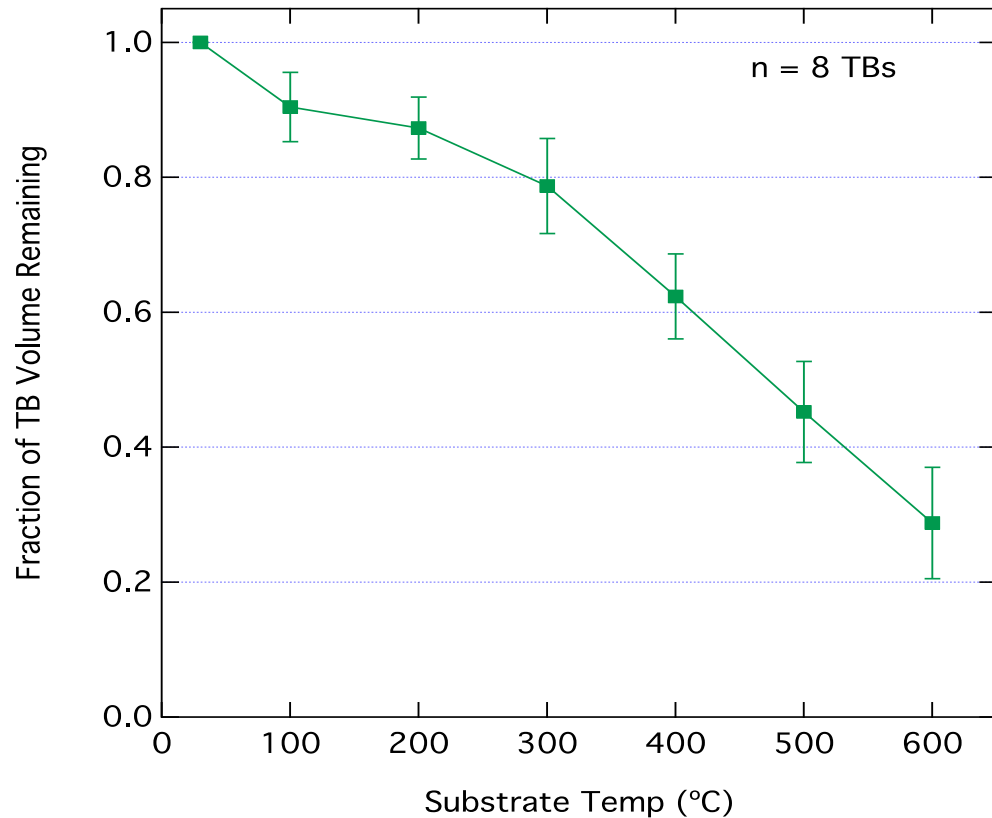
First report of TB mass fraction, f_{TB}



Thermal Robustness of Tar Balls



Thermal experiments suggest that TBs may not be detected by AMS



Take Home Messages

Tar balls are observed to increase in number fraction as a function of plume age

- TB formation proceeds through a secondary process.
- First time that high-temporal-resolution data has documented this formation.
- Growth in TBs means increase of an absorbing component in the plume – contrary to commonly observed increase in SSA

TB mass fraction estimated in plume

- Combining the ratio of TB mass to ns-soot mass derived from TEM with rBC mass fraction (from SP2 & AMS), the mass fraction of TBs in plume is estimated to be ~ 0.30 .
- First time the mass fraction of TBs in a smoke plume has been estimated.

Thermal Robustness of TBs

- Heating experiments reveal that TBs exhibit a degree of thermal robustness (refractory character)
- Implications to AMS detection efficiency (600°C) must be understood.

Likely that biomass burn inventory is underestimated due to the difficulty of measuring TBs.

- BBOP derived TB mass fractions suggests this underreporting could be 25-30%
- Help in closing the top-down/bottom-up discrepancy (2-4x; see Kaiser et al., 2012)