H33E-1374

Beryllium-7 Wet Deposition in Open Precipitation and Canopy Throughfall

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Introduction

Beryllium-7 has been of recent interest in estimating short-term erosion and sediment fingerprinting (Walling 2012). However, with few exceptions (e.g. Kaste 2011), little is known about vegetation interception or deposition under a tree canopy. As a part of our sediment fingerprinting studies in the Christina River Basin Critical Zone Observatory, we investigate the following questions:

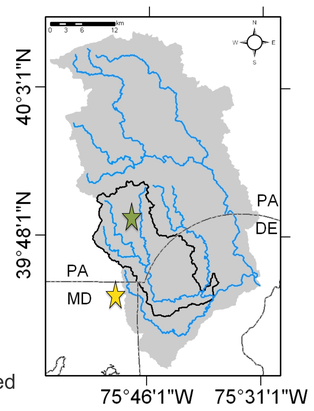
1. What is the variation in 7Be wet deposition between events in different seasons?

2. Does the presence of a tree canopy change the wet deposition that would reach the land surface?

Study Location

Christina River Basin Critical Zone Observatory

- Total area: 1440 km^2
- 3 main tributaries – Brandywine River (842 km^2), Red Clay Creek (140 km^2), White Clay Creek (277 km^2)
- Centuries-old anthropogenic footprint of urban and agricultural land use
- Samples collected in two locations within the CRB CZO: White Clay Creek – Boulton Run and the Fair Hill NRMA



White Clay Creek – Boulton Run
- 8 hectare, first-order catchment, majority forested with some agriculture
- Forest ~ 60 years old, with caonopy dominated by yellow poplar (*Liriodendron tulipifera*) with American beech (*Fagus grandifolia*)

Fair Hill Natural Resources Management Area
- 12 hectare forested catchment
- Stand density of 225 trees/ha, a stand basal area of 36.8 m2/ha, a mean dbh of 40.8 cm, and a mean tree height of 27.8 m.
- The forest canopy is comprised of *Liriodendron tulipifera* L. (yellow poplar) , *Fagus grandifolia* Ehrh. (American Beech), *Acer rubrum* L. (red maple), and *Quercus alba* L. (white oak). The dominant canopy trees are approximately 80-100 years old and have a leaf area index (LAI) of 5.3 m2/ m2.

Methods

Field Sample Collection
- Open precipitation and canopy throughfall samples collected during 9 events from August 2011 through October 2012 at each of the two sites.
- Shallow soil cores (5 cm diameter X 15 cm length) were collected twice at each site. On one occasion, the overlying vegetation and/or duff layer was also collected.

Open precipitation collection at White Clay Creek

Throughfall collection at White Clay Creek (left) and Fair Hill (right)

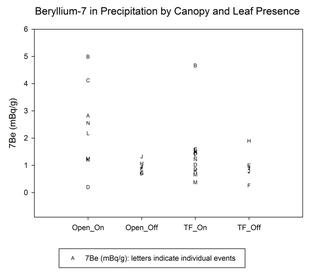
Shallow soil core collection at Fair Hill

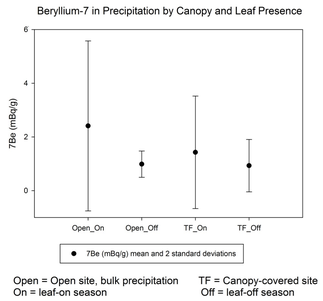
Isotope Extraction and Analysis

1. Prior to extraction, a spike of stable Beryllium (^{9}Be as $BeSO_4$) was added to the sample.
2. ^{7}Be was extracted from precipitation using ion exchange resins (Komura et. al. 2006).
3. Supernatant was removed, reserving an aliquot for checking recovery of the spike via ICP MS, and resins were prepared for gamma ray spectroscopy on HPGe planar-style detectors at the University of Delaware.
4. Each sample was analyzed for 24-48 hours.
5. Sample activity was corrected for recovery rate, based on the analysis of our ^{9}Be spike, and adjusted to reflect activity on day of collection.

Findings

Beryllium-7 within storms and across seasons

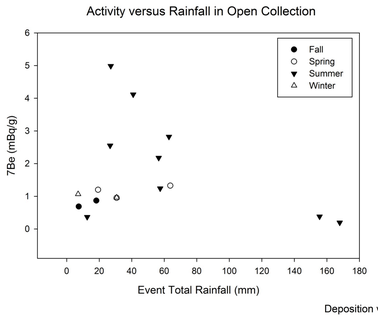


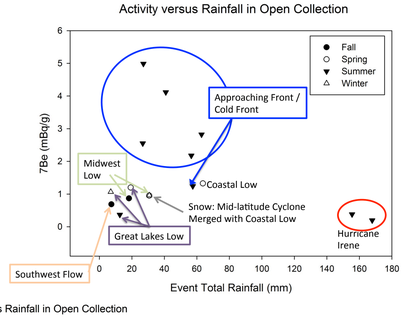


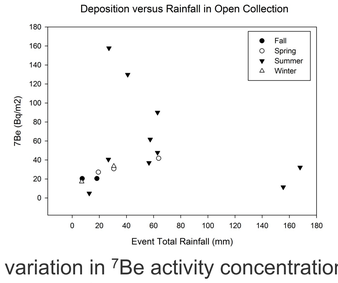
Open = Open site, bulk precipitation
On = leaf-on season

TF = Canopy-covered site
Off = leaf-off season

- Difference between leaf on and leaf off seasons is statistically significant (alpha=0.05)
- Wide variation in activity concentration between different events during the leaf on (spring and summer season).
- Some individual events show difference with canopy presence, but others do not.

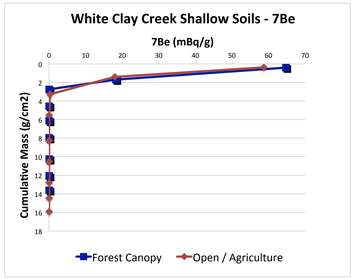


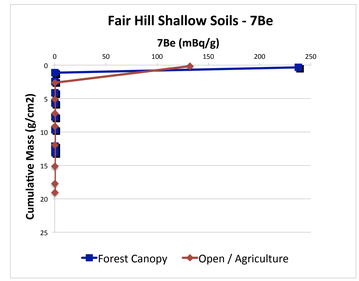




- Storm type explain the variation in ^{7}Be activity concentration versus total rain, particularly during summer events.
  - Storms associated with approaching fronts and cold fronts have higher ^{7}Be activity concentration than lows originating from the Great Lakes and Midwest.
  - Hurricane Irene had very low ^{7}Be activity concentration and high event total rainfall.
- For more on storm types and total throughfall precipitation in the Fair Hill Nature Preserve see poster: Siegert et al. (H33E-1378), in this session.

Shallow Soil Cores





Total 7Be Inventory (Bq/cm2)	
White Clay Creek - Open	0.676
White Clay Creek - Forest	0.833
Fair Hill - Open	0.356
Fair Hill - Forest	1.381

- At both locations, the total ^{7}Be activity in the forest core is greater than that in the open core.
- The majority of the ^{7}Be activity is held in the grass vegetation in the open sites, duff layer in the forest, and in the O-horizon of the soil (53% at White Clay Creek and 100% at Fair Hill).

Conclusions

- ^{7}Be total deposition varies by season, with generally higher deposition in the summer. The differences in activity concentration are statistically significant.
- Activity concentration in throughfall tends to be lower and less variable than in open precipitation, but these differences are not significant.
- Vegetation, particularly ground vegetation, intercepts ^{7}Be.

Applications for Sediment Fingerprinting
- Activities differ under forest canopy from nearby open sites with grass cover. In both cases, they are higher under the forest canopy, despite lower activity concentration in throughfall and less total volume of throughfall than open precipitation.
- When collecting fingerprinting source materials, the O-horizon must be collected.

Citations

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Acknowledgements

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