Atmosphere-Land Dynamics of Mercury in a Forest Landscape of the Adirondack Region of New York

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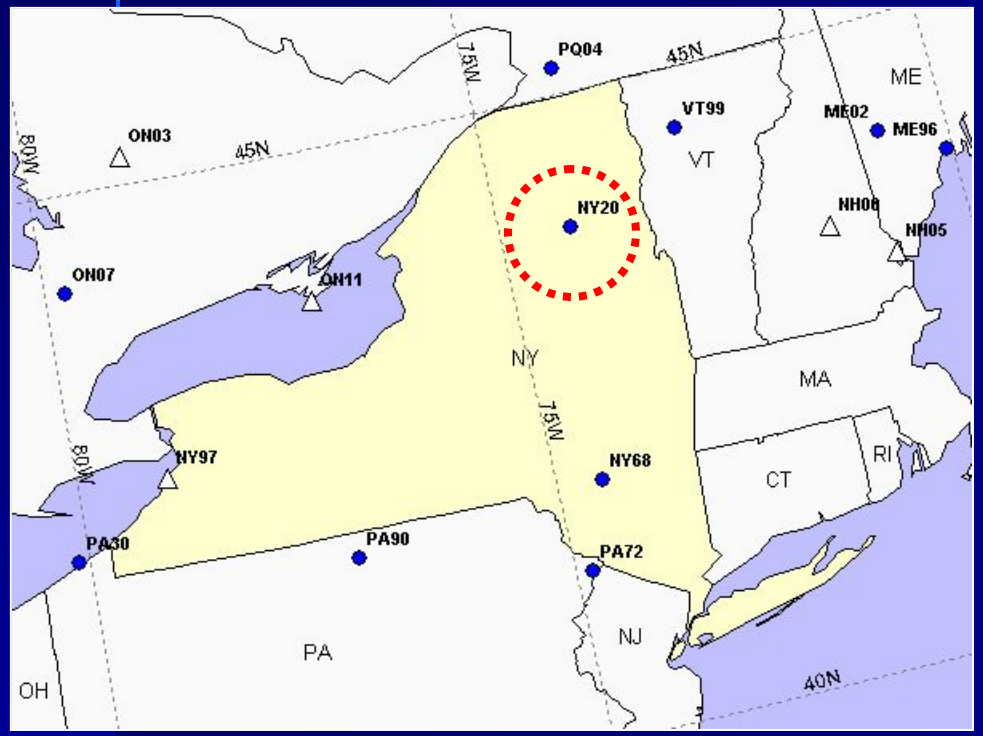
Sources of Support

National Science Foundation
US Environmental Protection Agency
New York State Energy Research and Development Authority

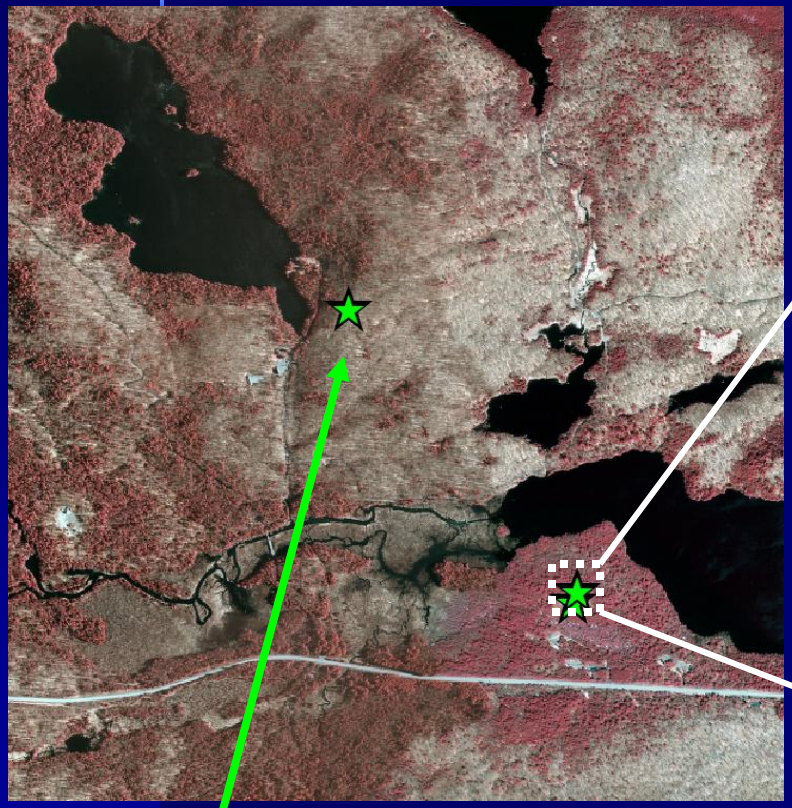
Outline

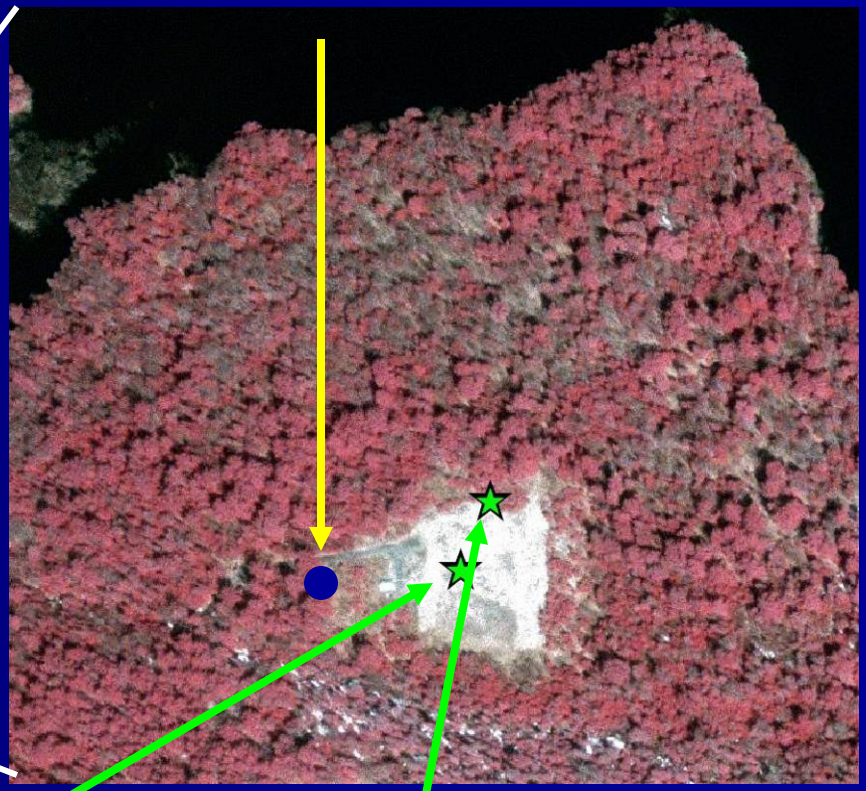
- Background and site description
- Forms of Hg in the atmosphere
- Hg inputs – wet deposition and throughfall
- Foliar Hg
- Soil Hg emissions
- Stream losses and mass balance

Huntington Wildlife Forest Newcomb, NY



- MDN monitoring NY20 station
- U.S. EPA CASTNET
- Latitude: 43.9731
- Longitude: -74.2231
- Elevation: 500m





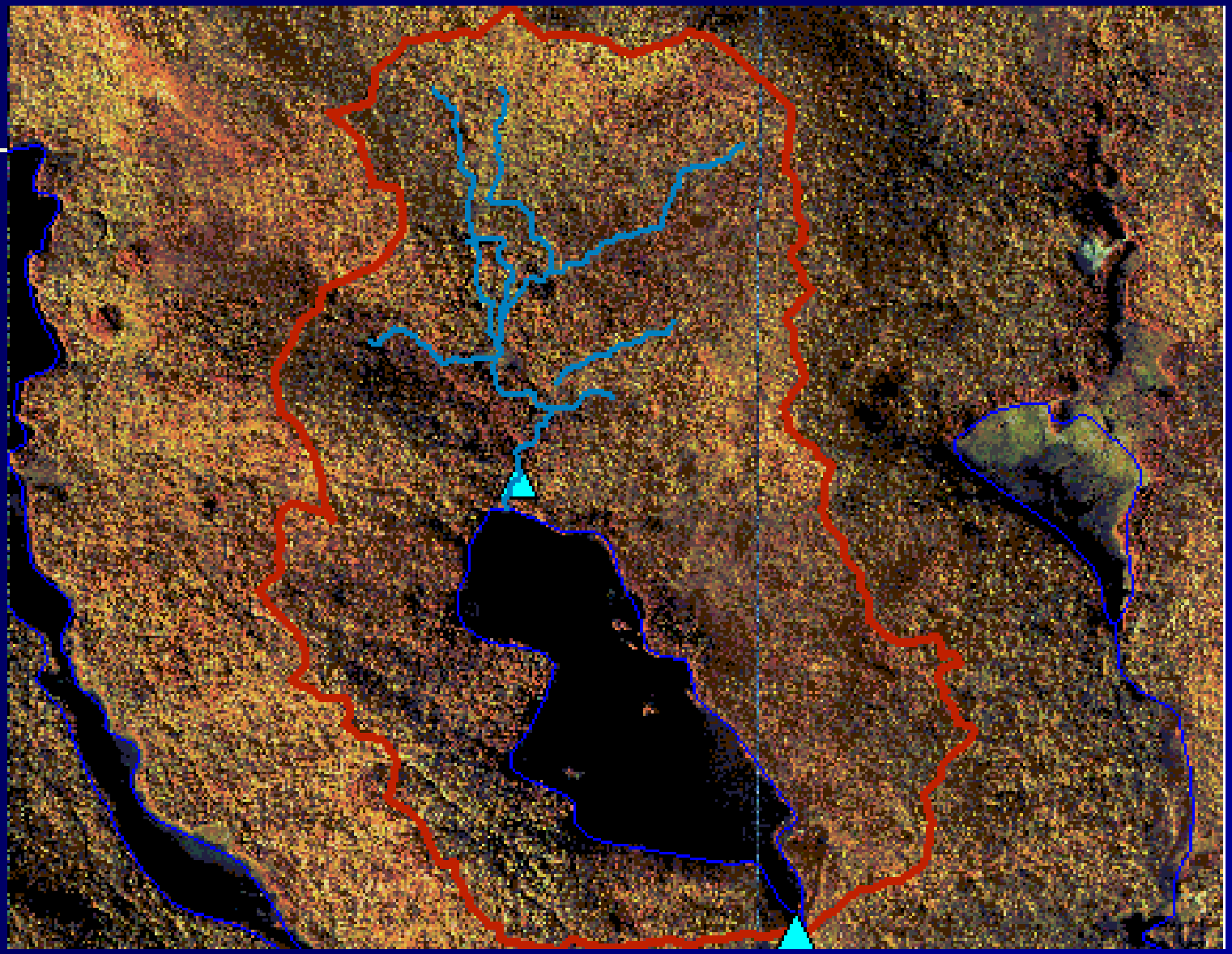
Ambient air

Deciduous throughfall
& Emission

Wet deposition

Coniferous throughfall
& Emission

Arbutus Lake Watershed-352 ha



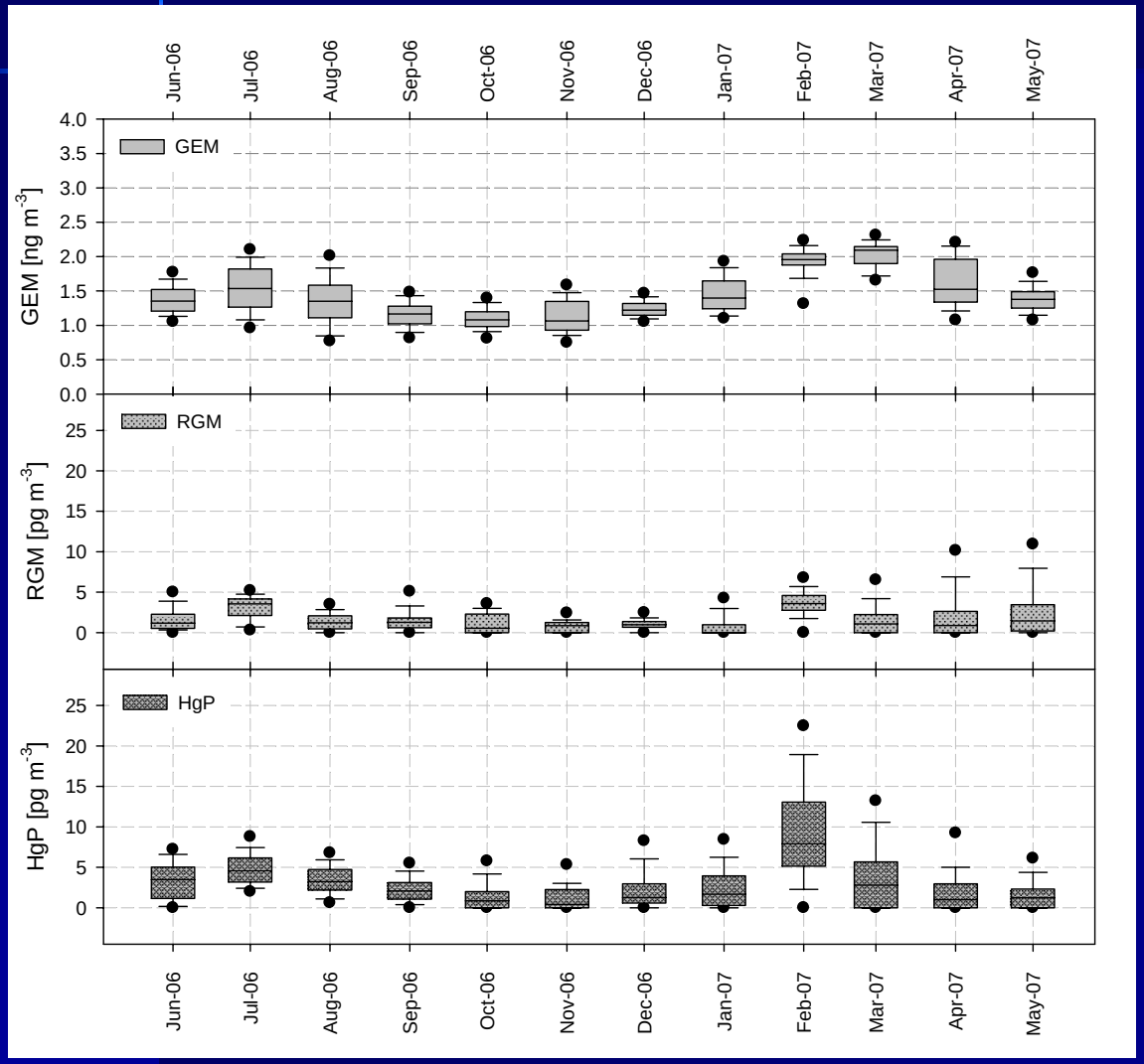
Atmospheric Hg

- **Sampling Method**
  - June 2006 ~ May 2007
  - Tekran automated Hg species system (Tekran model 2537A, 1130, and 1135)
- **Analytical Method**
  - CVAFS

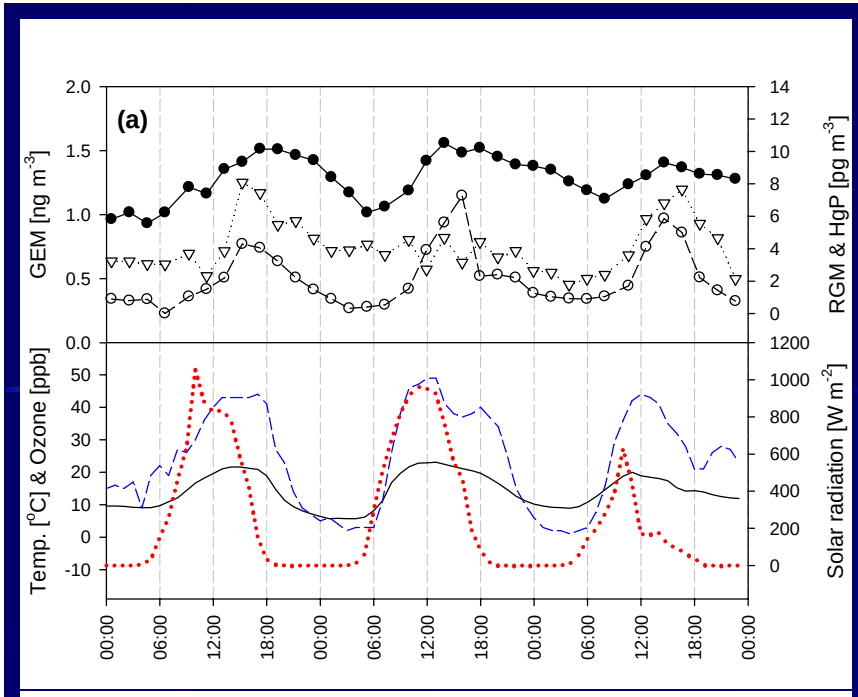
Overall Concentrations

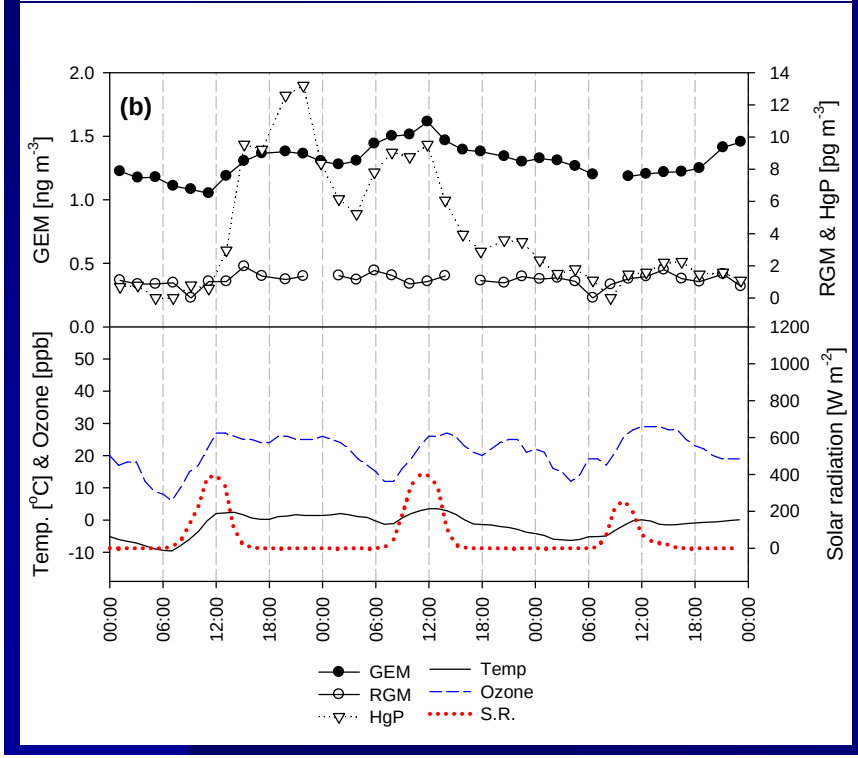
	GEM (ng/m^3)	RGM (pg/m^3)	HgP (pg/m^3)	RGM/TGM (%)	HgP/TM (%)
Mean	**1.39**	**1.77**	**3.22**	**0.12**	**0.22**
S. E.	0.01	0.04	0.07	0.00	0.00
Median	1.31	1.19	2.35	0.09	0.17
S.D.	0.36	2.20	3.73	0.15	0.22
Minimum	0.51	< MDL	< MDL	0.00	0.00
Maximum	2.52	45.44	53.98	3.45	3.02
N	3147	3136	3137	3147	3147

Monthly Variations of Hg



- Highest in winter and summer
- Lowest in fall



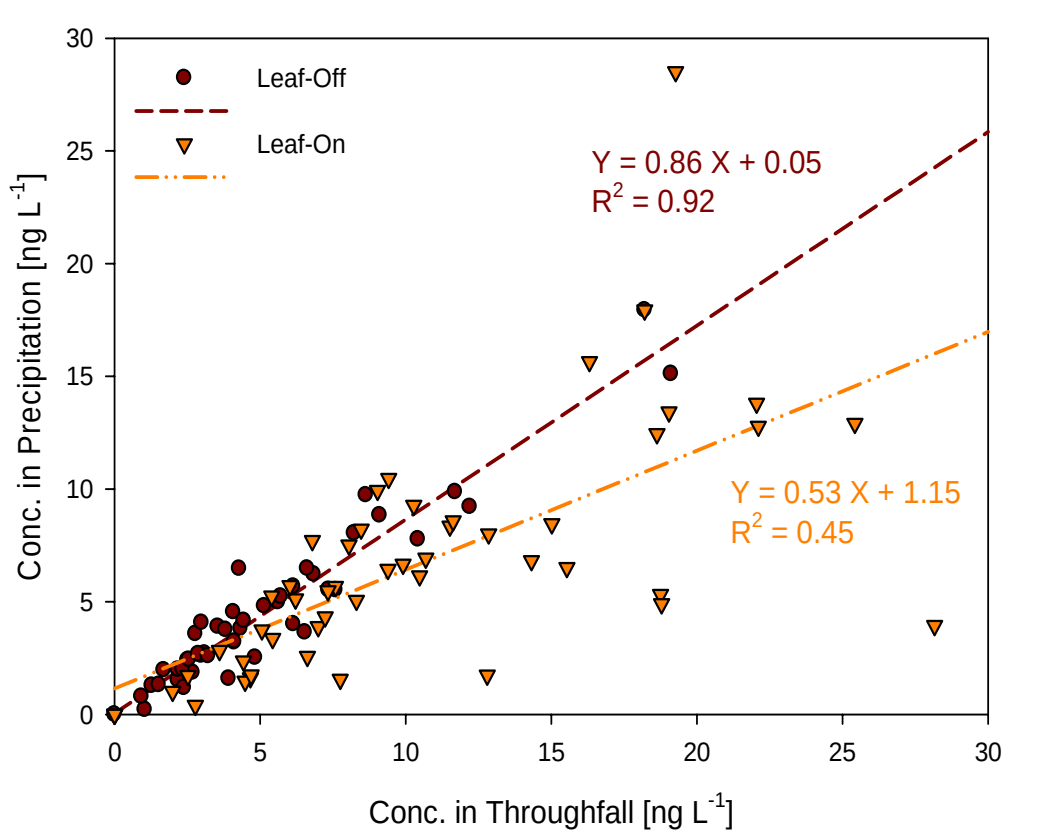


Diurnal Patterns

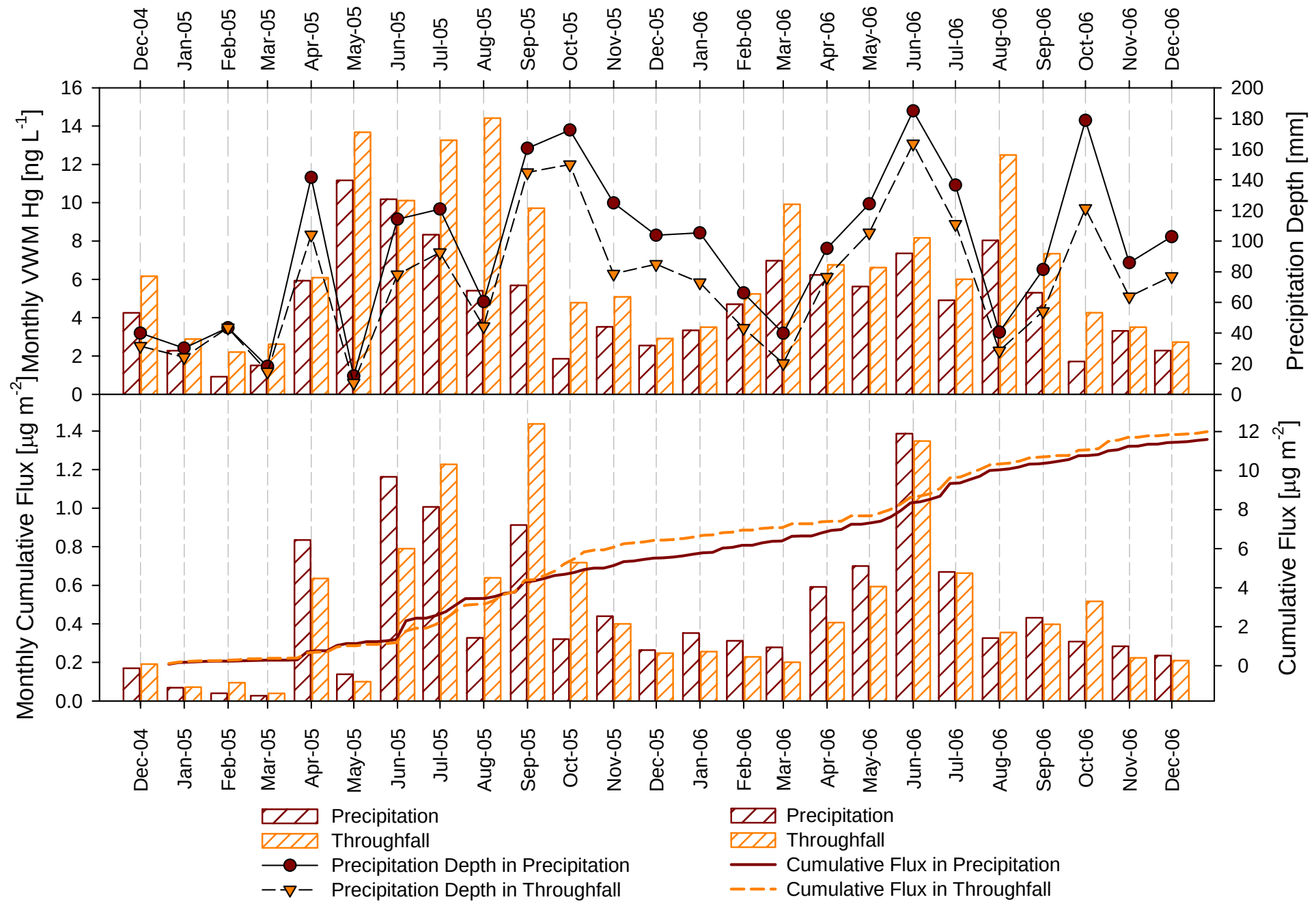
- **Forest Canopy**
  - Photoreaction
  - Air-foliar exchange
  - Hg emission from the forest floor
- **Warm seasons (all species)**
  - Significant diurnal patterns
- **Winter**
  - Weak diurnal patterns

Wet Deposition & Throughfall

Hg Concentrations

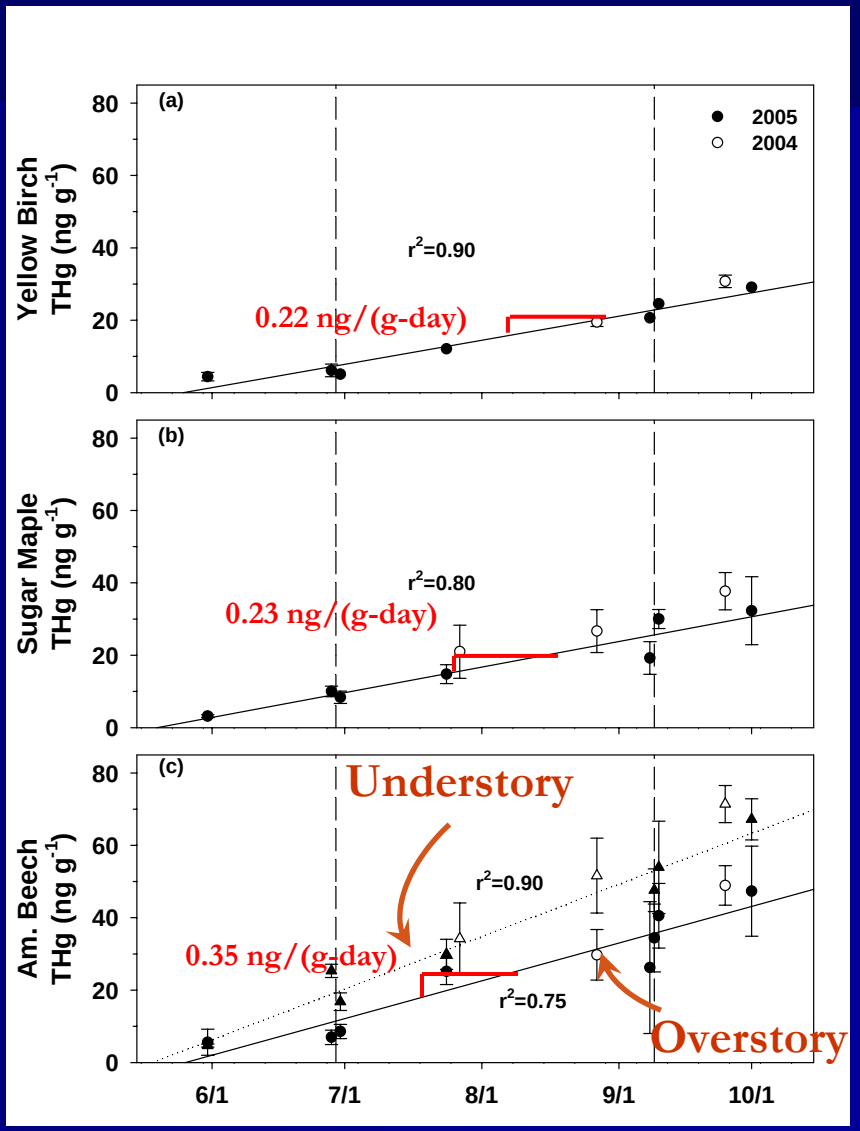


- **Leaf-on**
  - Throughfall > precipitation
  - 2 times higher (slope=0.53)
- **Leaf-off**
  - Throughfall > precipitation
  - Slightly higher (slope=0.86)
- **Precipitation quantity**
  - Throughfall 80% precipitation


Monthly VWM Hg [ng L-1]
Precipitation Depth [mm]
Monthly Cumulative Flux [µg m-2]
Cumulative Flux [µg m-2]
Dec-04
Jan-05
Feb-05
Mar-05
Apr-05
May-05
Jun-05
Jul-05
Aug-05
Sep-05
Oct-05
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Oct-06
Nov-06
Dec-06
Precipitation
Throughfall
Precipitation Depth in Precipitation
Precipitation Depth in Throughfall
Precipitation
Throughfall
Cumulative Flux in Precipitation
Cumulative Flux in Throughfall

Leaf Tissue

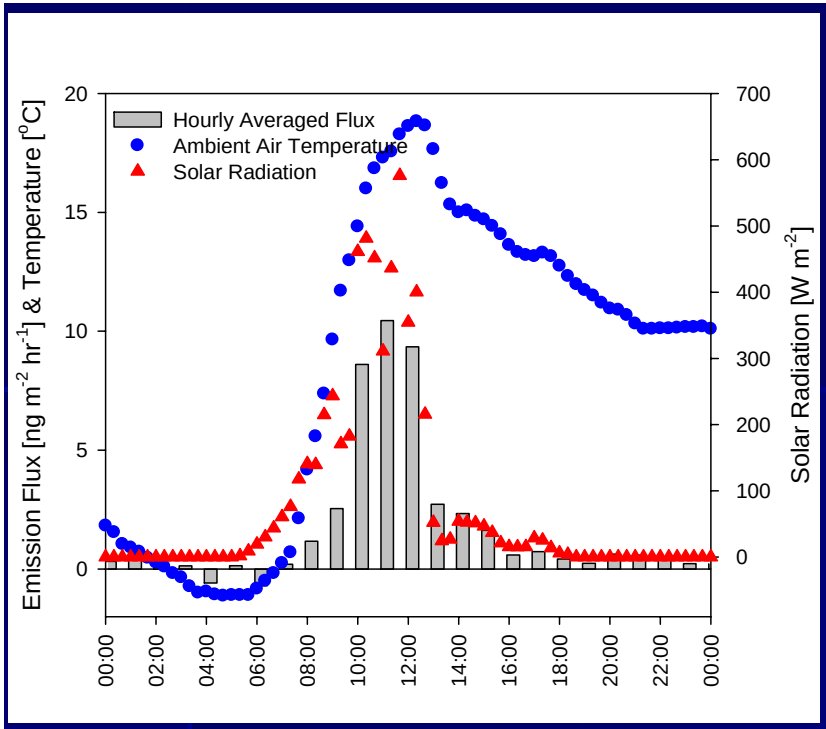
- **THg increase**
  - ~10x increase
  - Beech > Birch, Maple
- **Understory beech**
  - 42% higher

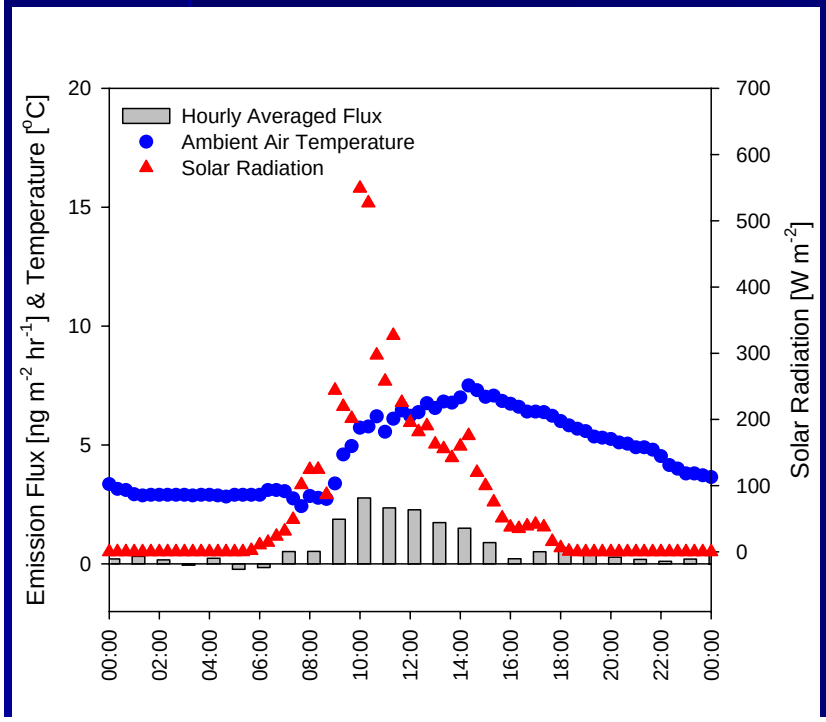


Soil Evasion

Dynamic Flux Chamber

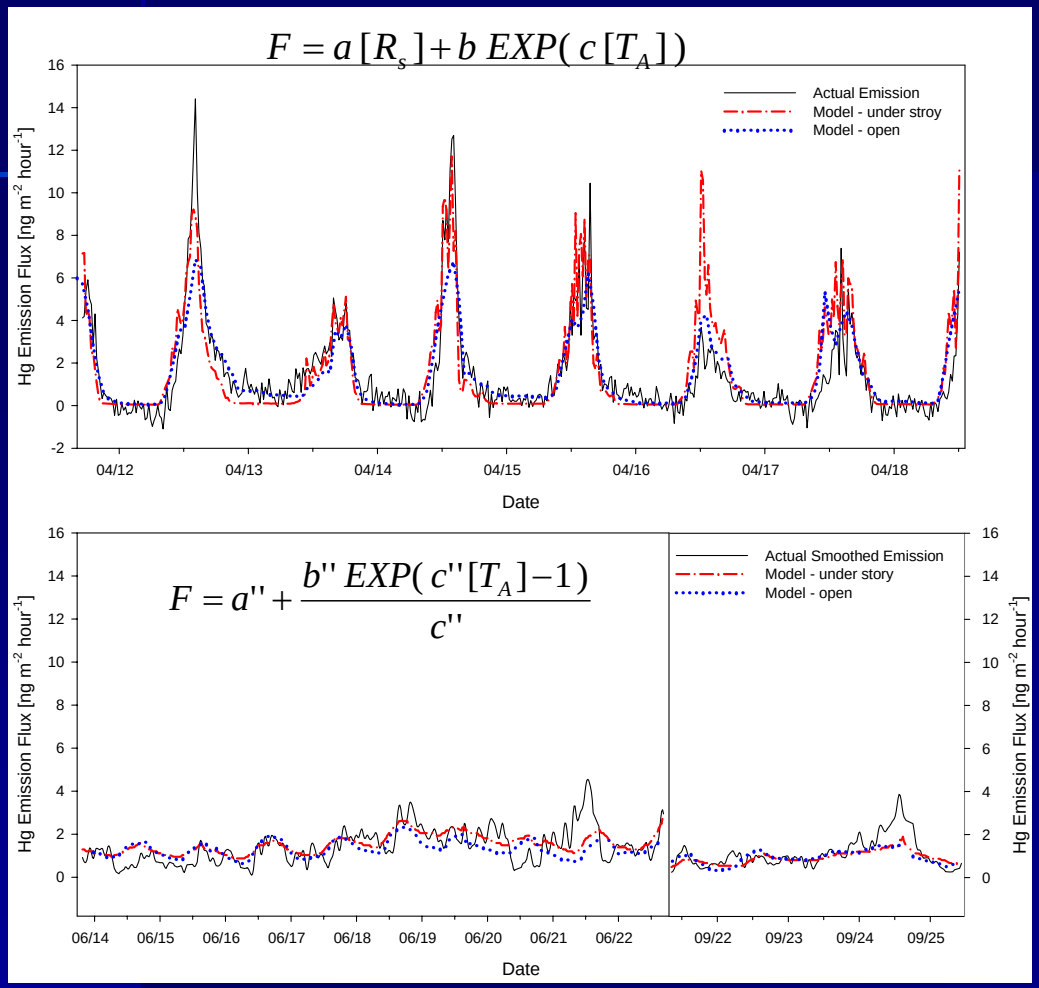
DFC operation system for measuring Hg emission flux from soils





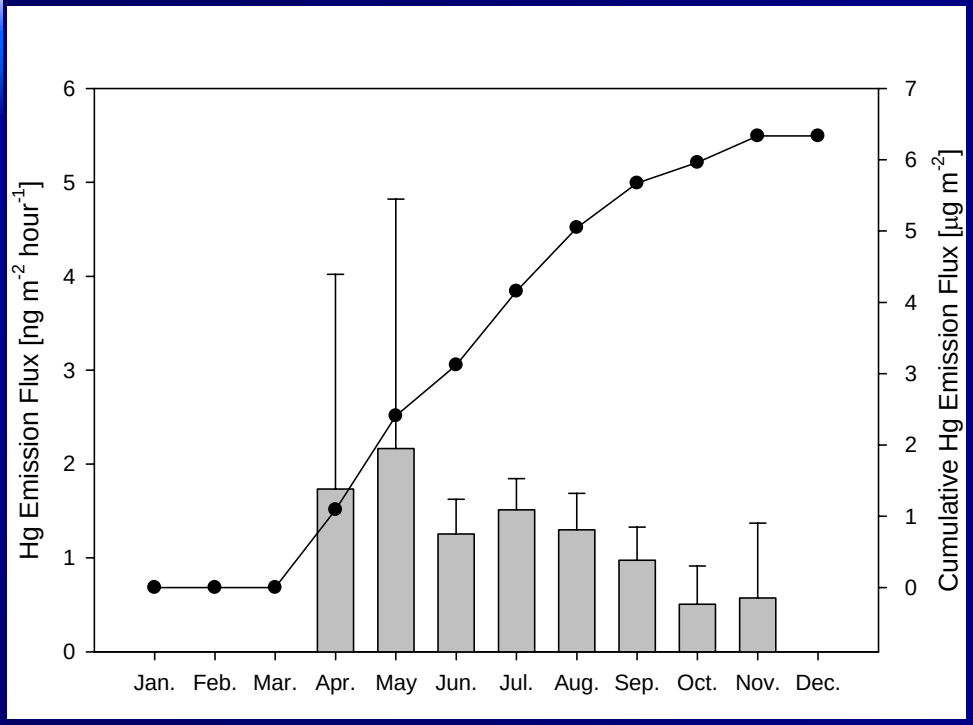
Leaf-off Periods

- Diurnal pattern
- Highly dependent on solar radiation and air temperature
- Most soil Hg is Hg^{2+}. How is Hg reduced?



- **Leaf – off**
  - F = Hg Emission Flux
  - R_S = Solar Radiation
  - T_A = Air Temp.
  - *a* (0.0068), *b* (0.075), *c* (0.169)
- **Leaf – on**
  - F = Hg Emission Flux
  - T_A = Air Temp.
  - *a''* (0.108), *b''* (0.0718), *c''* (8.14E-10)

Yearly Estimation

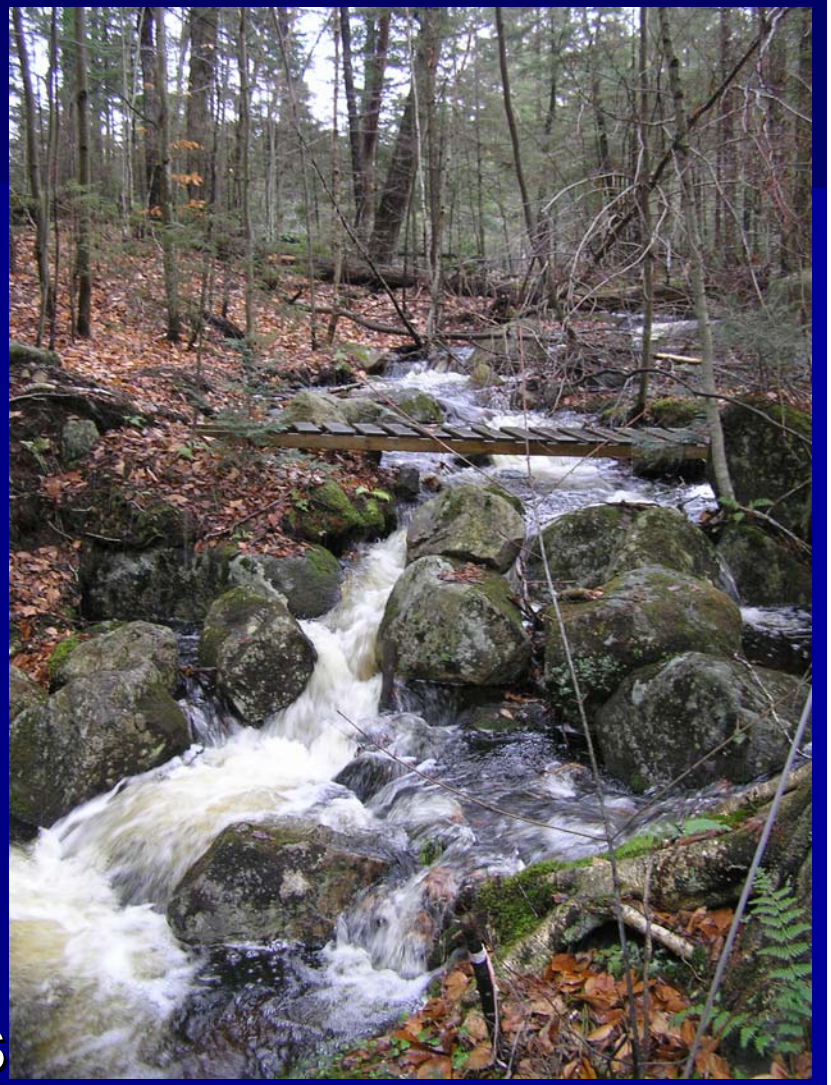


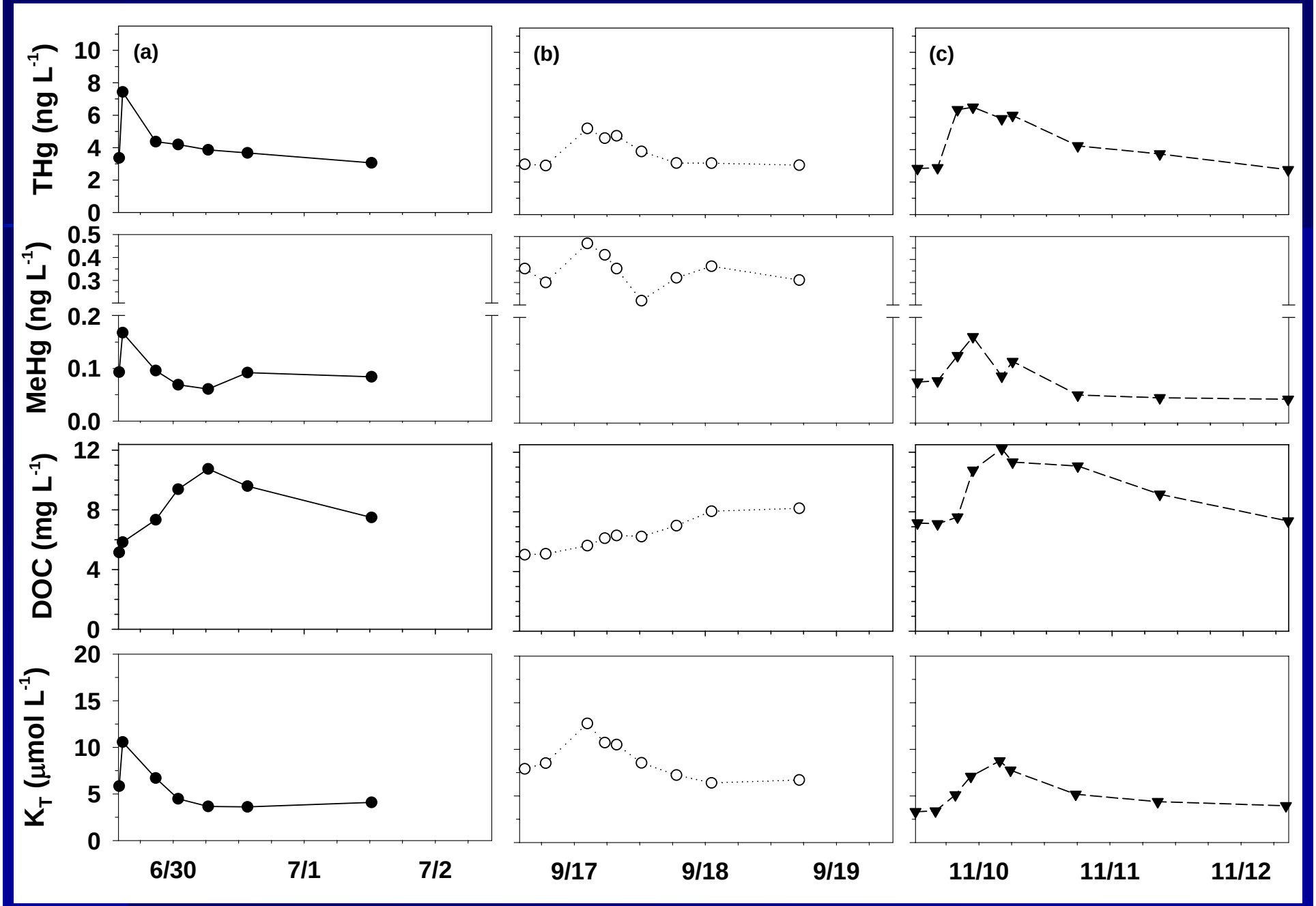
- **Assuming**
  - Zero emissions during snow cover
  - Zero emissions during rain events between 8 AM and 8 PM.
  - Leaf-on period is from May to Oct.

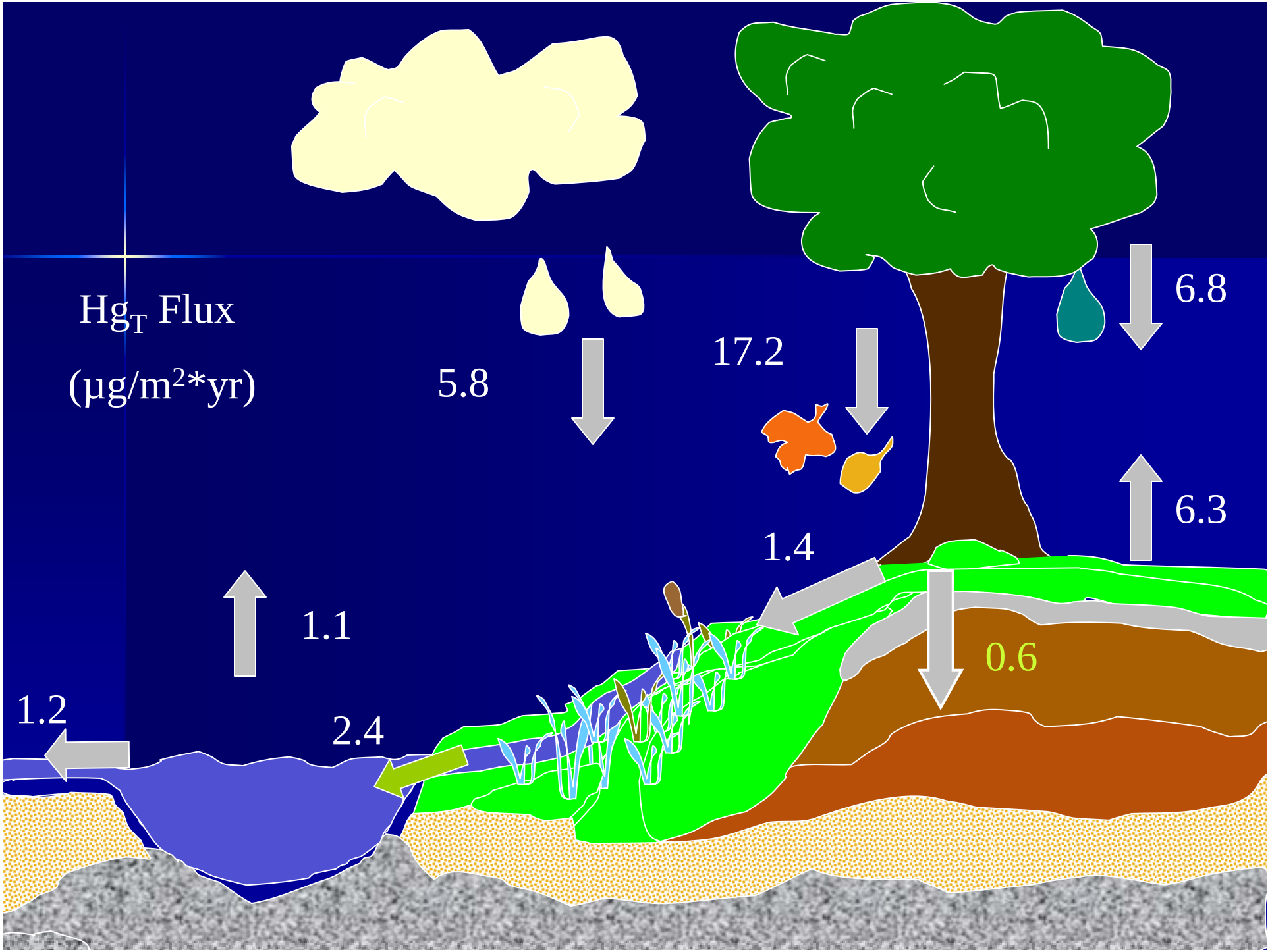
Cumulative estimated Hg emission flux is 6.3 $\mu g\ m^{-2}\ year^{-1}$

Stream Flux

- Discharge driven flux
- “New” vs. “Old” Hg
- Limited particulate contribution (~25%)
- Wetlands are important in the supply of Hg species




(a)
(b)
(c)
THg (ng L-1)
MeHg (ng L-1)
DOC (mg L-1)
KT (µmol L-1)
6/30
7/1
7/2
9/17
9/18
9/19
11/10
11/11
11/12


Hg_T Flux
(µg/m²*yr)
5.8
17.2
6.8
6.3
1.4
1.1
0.6
1.2
2.4

Conclusions

- Concentrations of atmospheric Hg species are dynamic at this remote forest site
- Hg inputs and soil emissions are important pathways
  - litterfall is the most important input
  - throughfall ≅ emissions
- High flow events result in elevated Hg loss
- Soil and lake are net sinks of Hg inputs