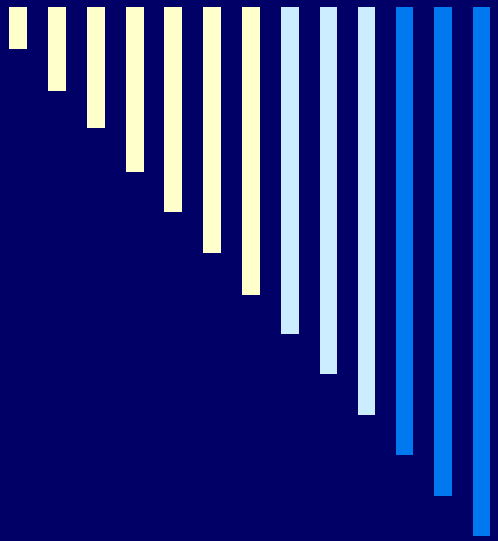

Gaseous mercury flux measurements over a hardwood forest

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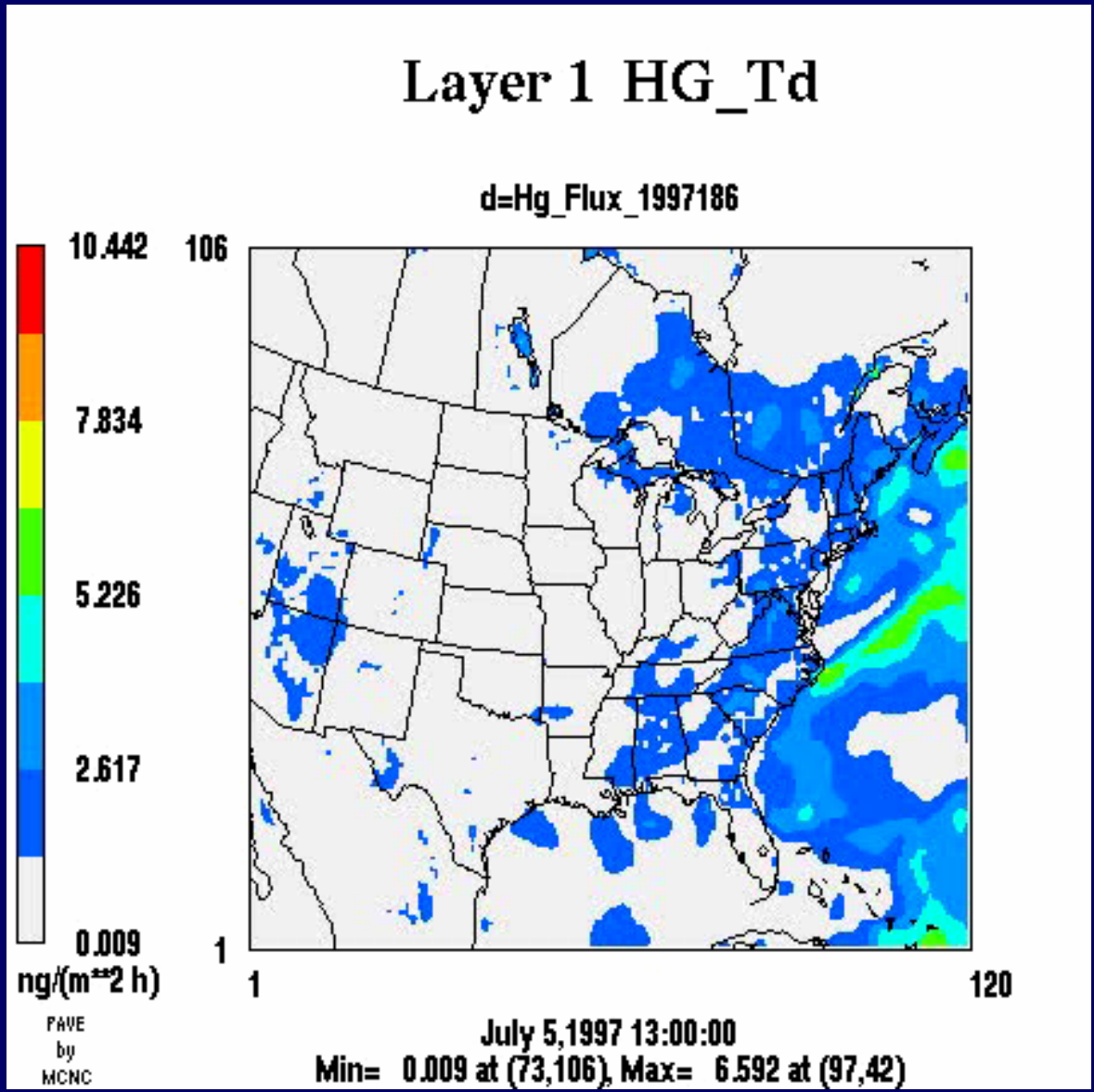
Outline

- Mercury Surface Interface Model (HgSIM) of natural mercury emissions
- Measurements for verification of HgSIM
  - Measurement system
  - Mercury flux measurement results
- Summary and implication for future modeling work

Mercury Surface Interface Model (HgSIM)

- Developed to provide natural emissions to air quality models
  - Previous natural emissions estimations were of the same magnitude as anthropogenic emissions
- Emission algorithms were adapted from literature for air-vegetative, air-soil, and air-water emissions
- Simulates hourly gridded natural elemental mercury emissions

Emission Results from HgSim



Relaxed Eddy Accumulation (REA) mercury flux measurements

Site Description

- Measurements taken on at a tower in Coventry, Connecticut
- Measurement height was 1.2 canopy heights
  - 25 meters
- Forest composition
  - Transition between upland oak and lowland red maple

Site Description

Mercury Air Pollution Research Project

Field Research Site

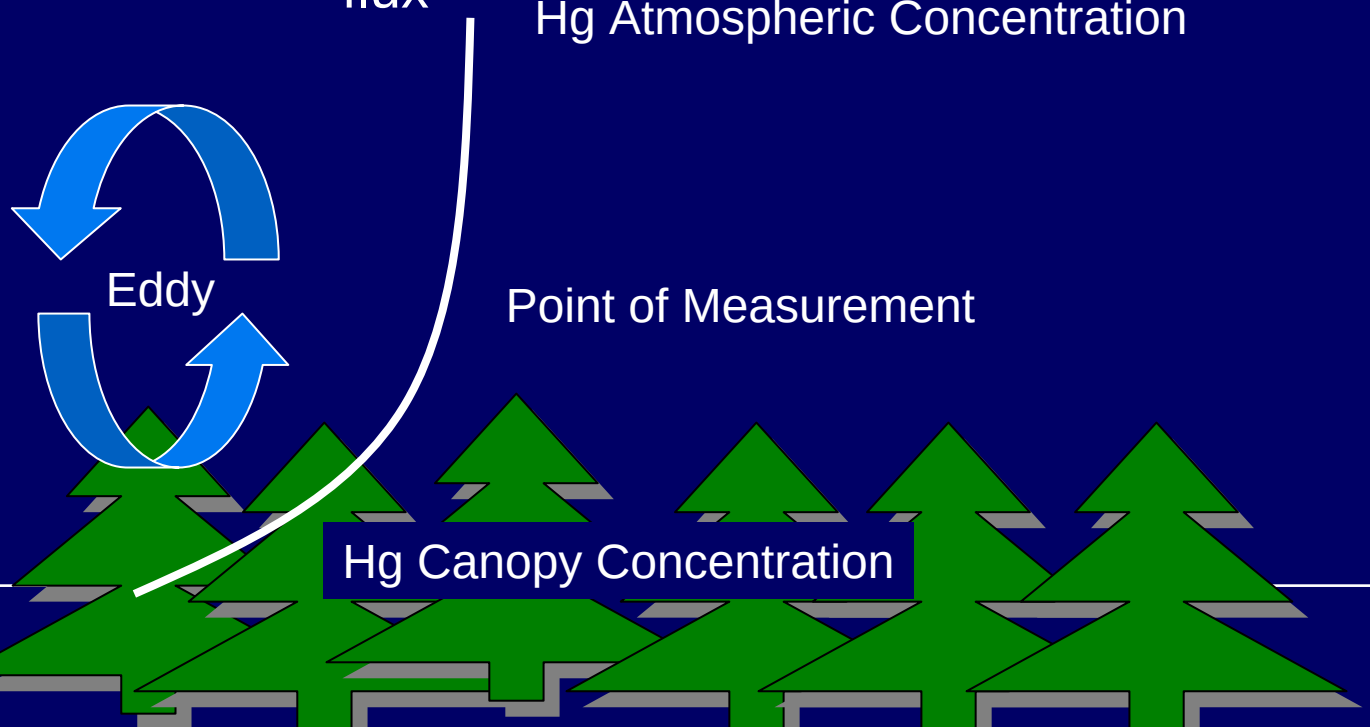
Walk up tower for Hg flux measurements

Hg Flux Measurement Technique

- Relaxed Eddy Accumulation (REA) technique was used
- Similar to widely used eddy covariance technique
  - But allows for the use of a slow response mercury concentration measurement
- Single point measurement
  - Less tubing, simpler design, etc.

Relaxed eddy accumulation

- UCONN's relaxed eddy accumulation system
  - REA measurements of Hg and H_2O fluxes
  - Independent eddy covariance measurement of H_2O flux



REA Equation

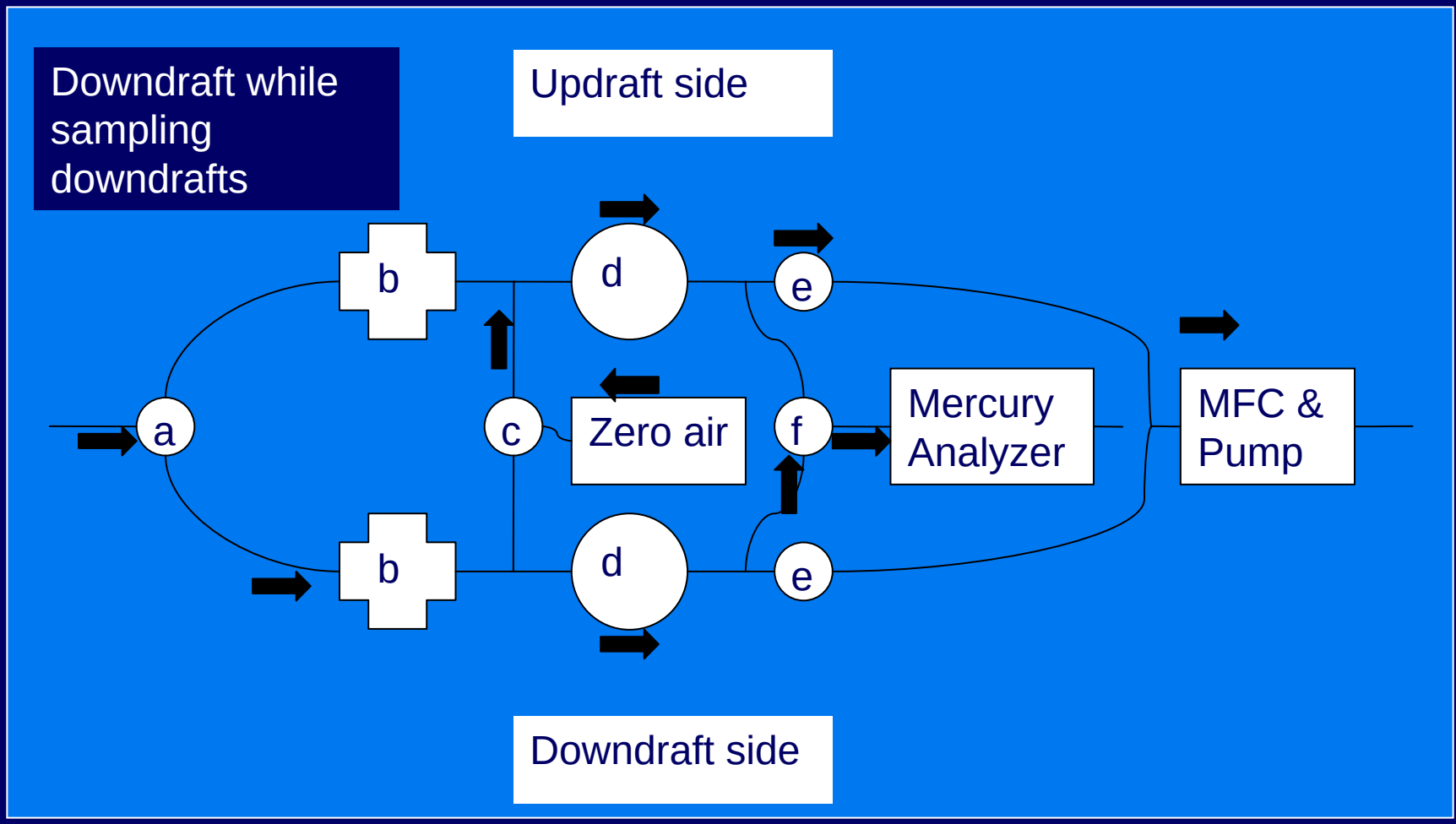
- Flux is measured by sampling the up- and downdraft mercury concentrations and a fast response 3-D anemometer
- Calibrated using the temperature in up- and downdrafts

$$F_{Hg} = \beta \sigma_w (C_{up} - C_{down})$$

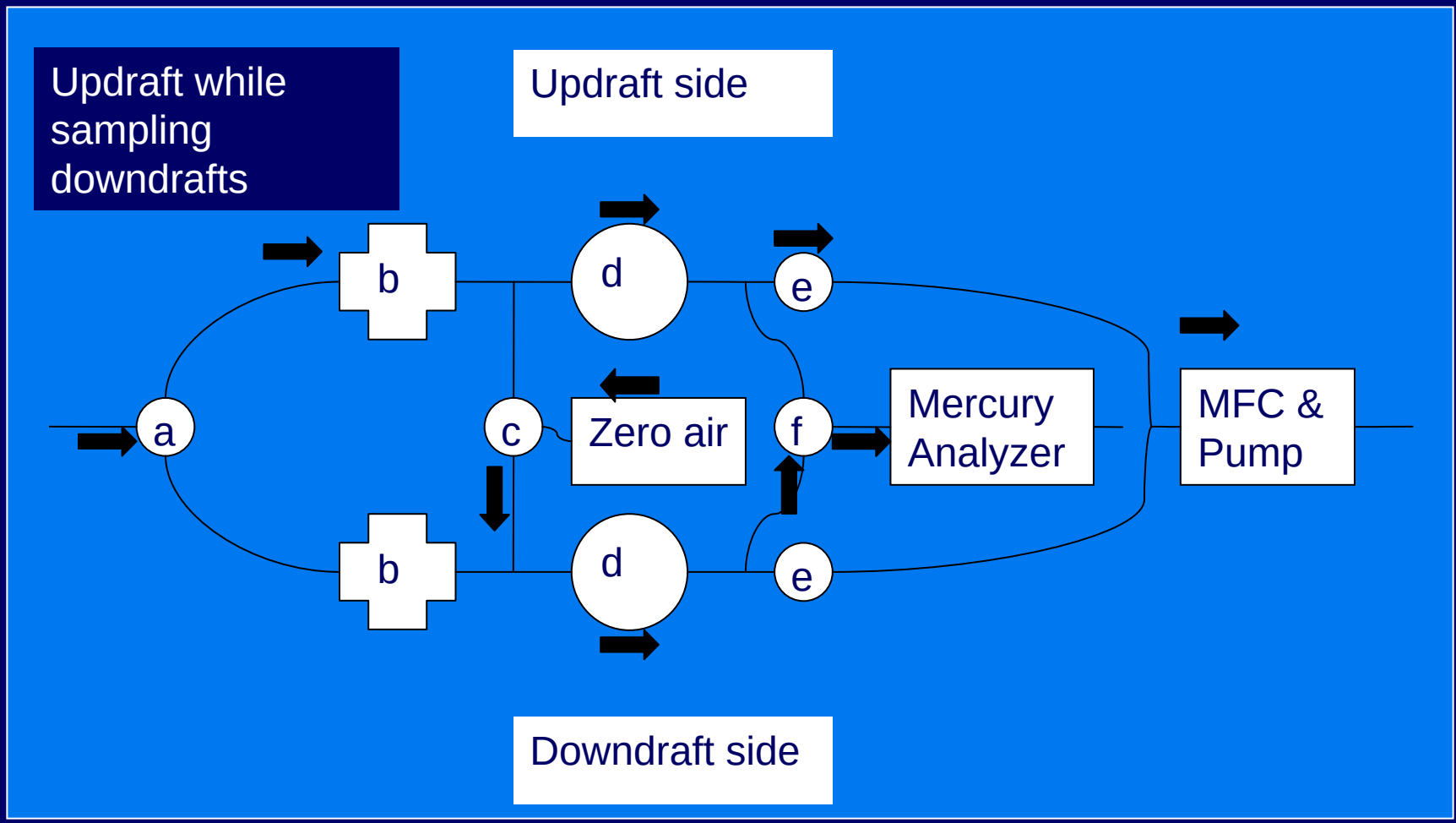
UConn’s REA system

REA System

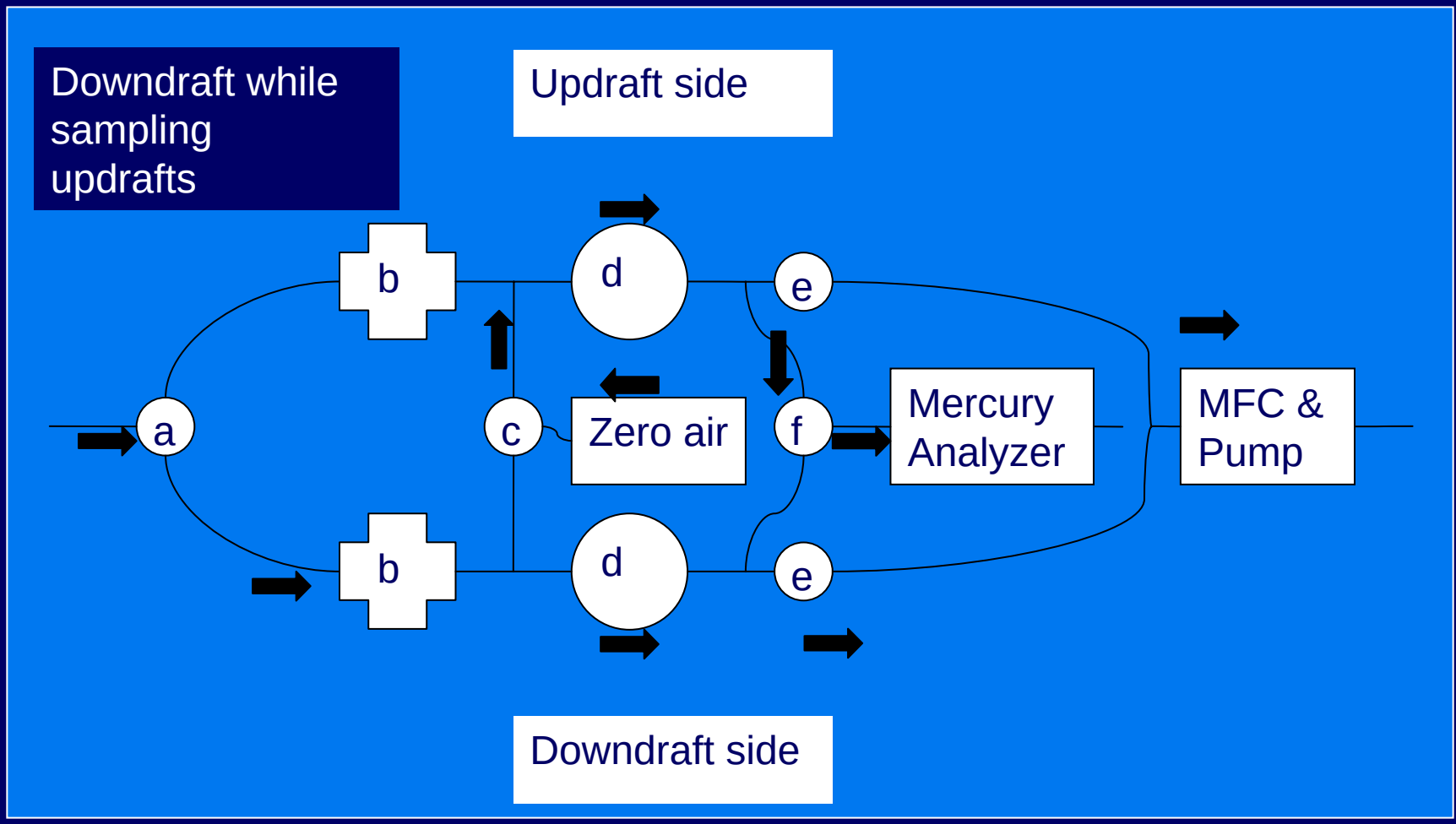
REA schematic



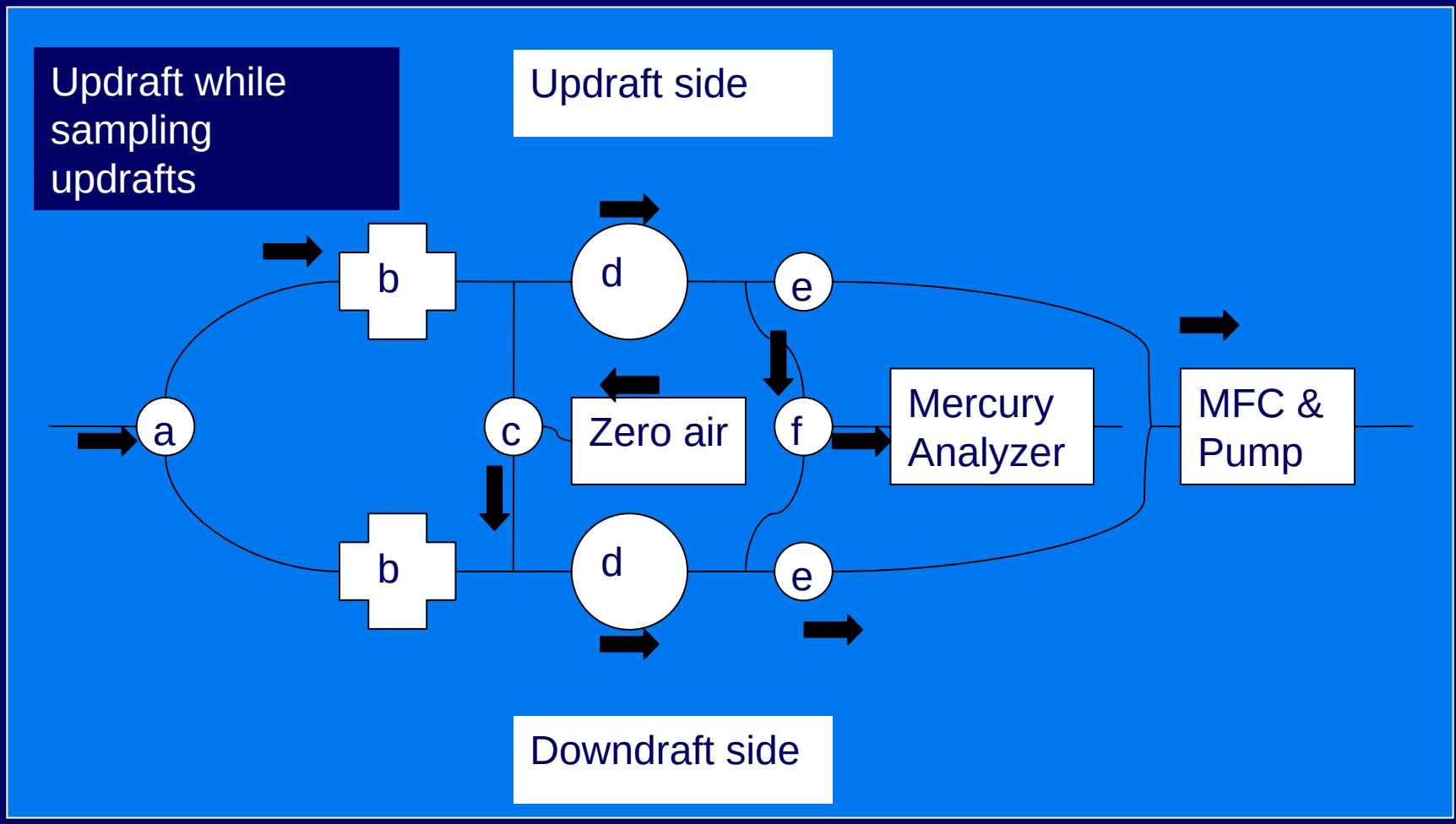
REA schematic



REA schematic



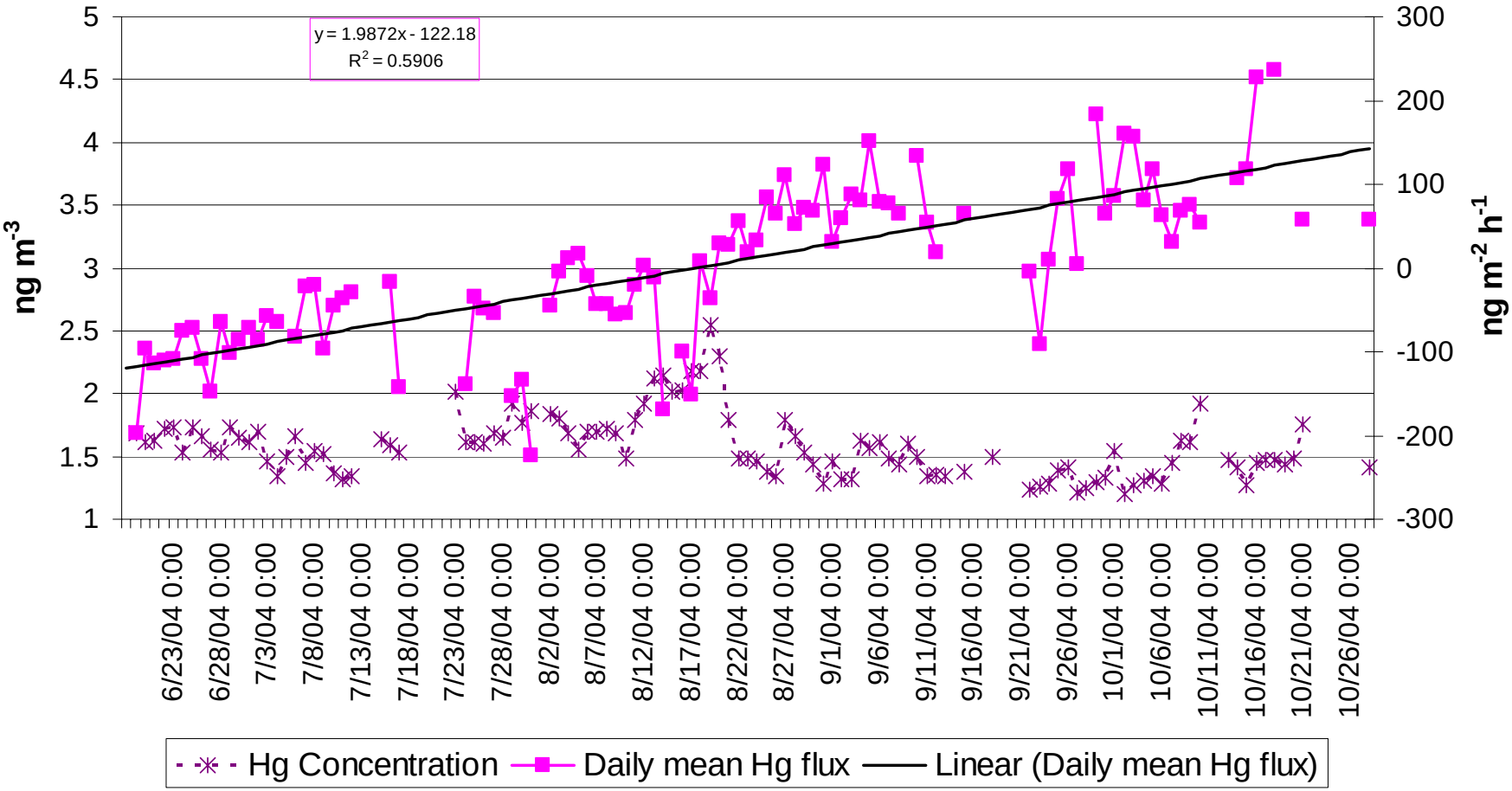
REA schematic



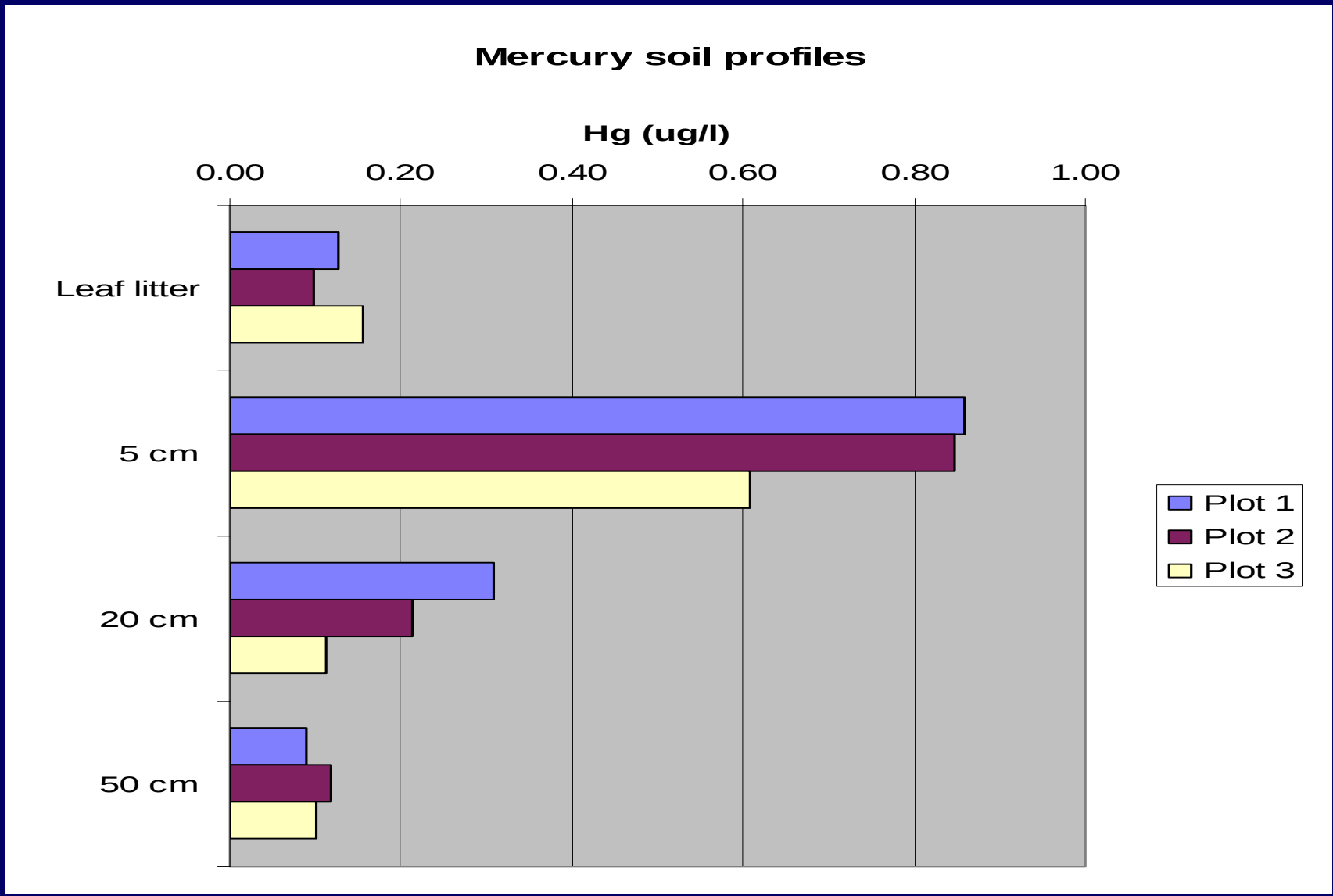
Measurement results

- Growing season atmosphere-forest mercury exchange
- Co-located mercury sampling of environmental media at the flux site
  - Soil, leaves, ground water, wet deposition, atmospheric concentrations

Mercury Flux Measurements



Mercury soil concentrations



Seasonal Mercury Flux Measurements

- Hourly total gaseous mercury flux measurements were taken for a year
- During the winter the forest acted as sink
  - Evasion dominated only during periods of snow melt
- The average growing season gaseous flux showed little or no net deposition or evasion of mercury

Seasonal Mercury Flux Measurements

- Growing season fluxes were dynamic with an increasing trend in the flux from leaf out to senescence
  - Deposition dominated from leaf out until mid August
  - Evasion dominated from mid August to complete senescence
- Evasion leveled off in late August

Fall Leaf off Mercury Flux Measurements

- Fall mercury fluxes were event dominated
- Evasion was dominate during strong wind events
- Deposition was dominate during cool wet periods

Conclusions

- The mercury cycle is seasonally dynamic
- The trend in the growing season flux parallels that of the leaf concentrations
- Winter, spring, and fall fluxes appear to be functions of events
  - Snow melt, snow fall, wind, rain fall etc.
- The study sight is a weak sink annually
- Mercury accumulates in the soil organic matter

Preliminary Model Comparison

- HgSIM was developed from measurements taken from mid to late summer
- HgSIM agrees with mid summer fluxes best
- Mechanisms may be different than modeled
- Leaf litter fall is a large input into the soil system

Hypothesized Flux Mechanisms

- Leaves act as a dynamic exchange surface for atmospheric mercury
- Mercury in soil-water solution is taken up by the vegetation
- Soil mercury concentrations are closely tied to organic matter
- Soil solid, soil-water, vegetation, and atmospheric concentrations are interlinked via fluxes between the different media

Publications

- Bash, Miller, Meyer, Bresnahan, 2004, Northeast United States and Southeast Canada natural mercury emissions estimated with a surface emission model, Atmospheric Environment 38 5683-5692
- Bash, Bresnahan, Miller (submitted) A conceptual compartmentalized dynamic surface interface model for atmosphere-surface exchange of mercury, Journal of Applied Meteorology, NOAA/EPA Golden Jubilee special issue

Thank You

- Thanks to:
- The Connecticut River Airshed Watershed Consortium (CRAWC)
- The University of Connecticut Agriculture Experiment Station
- Questions?

The Mercury Budget

Component	Mean concentration	Annual flux
Litter	30.64 ng/g	-11.49 ug/m2
Soil 5 cm	0.1 ug/L	
Soil 20 cm	0.8 ug/L	
Soil 50 cm	0.2 ug/L	
Rain	8 ng/L*	-10 ug/m2*
Snow	0.9 ng/L	
Ground Water	0.93 ng/L	
Air	1.58 ng/m3	
Growing Season Surface-Air Flux		13.75 ug/m2