EGU22-10817 Session GI2.3

Effects of stemflow on radiocesium infiltration into the forest soil

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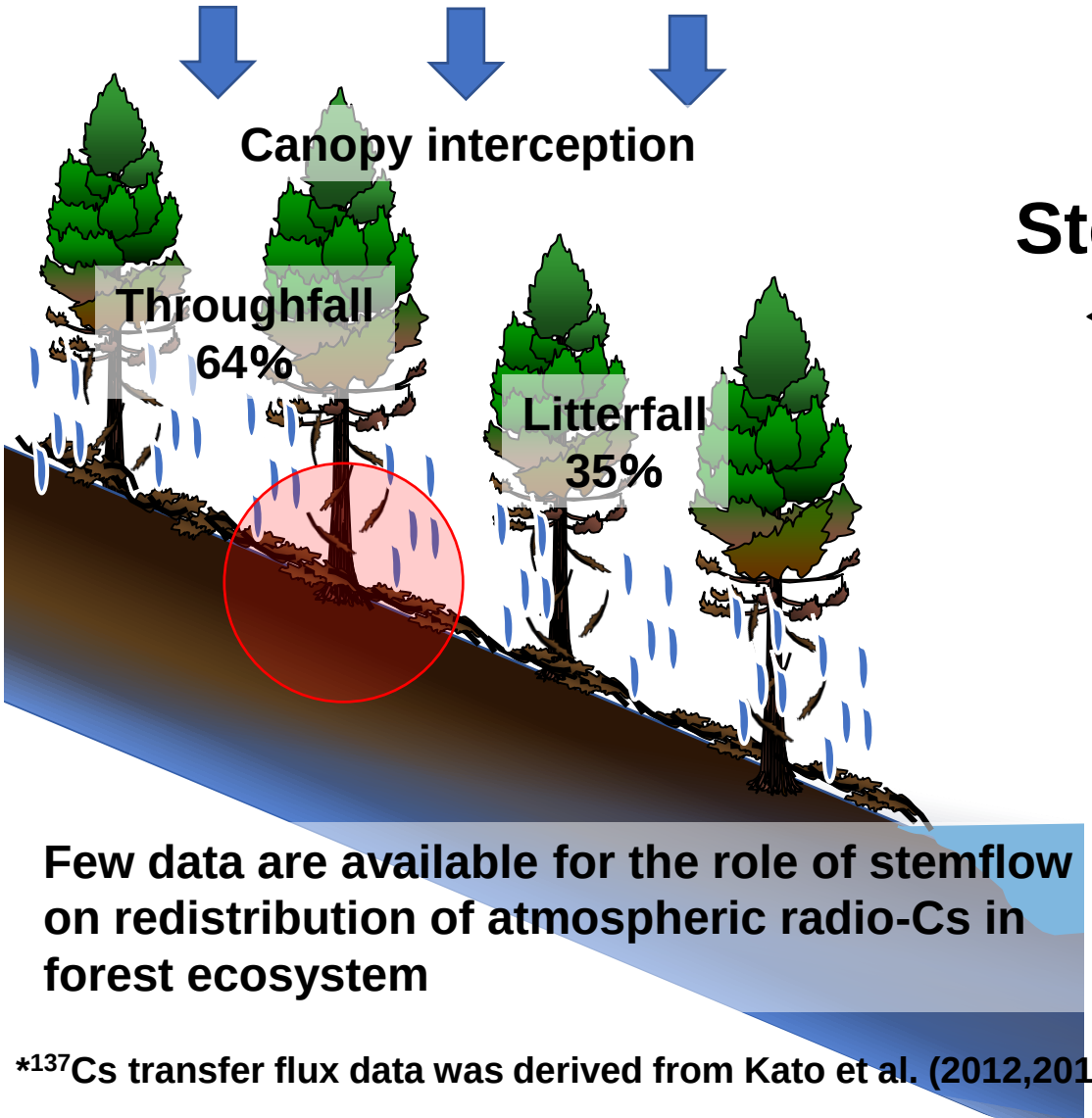
Background: Role of Stemflow on Water Redistribution and Material Transport

Japanese Cedar stand: Evergreen conifer

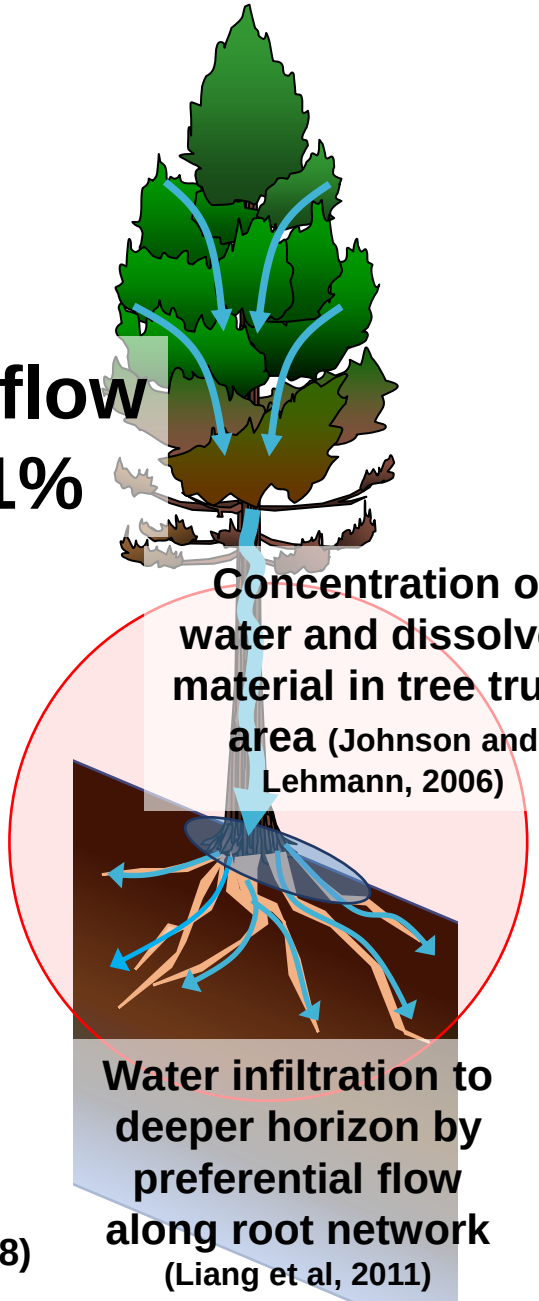
Fukushima accident-derived radio-Cs fallout



Few data are available for the role of stemflow on redistribution of atmospheric radio-Cs in forest ecosystem

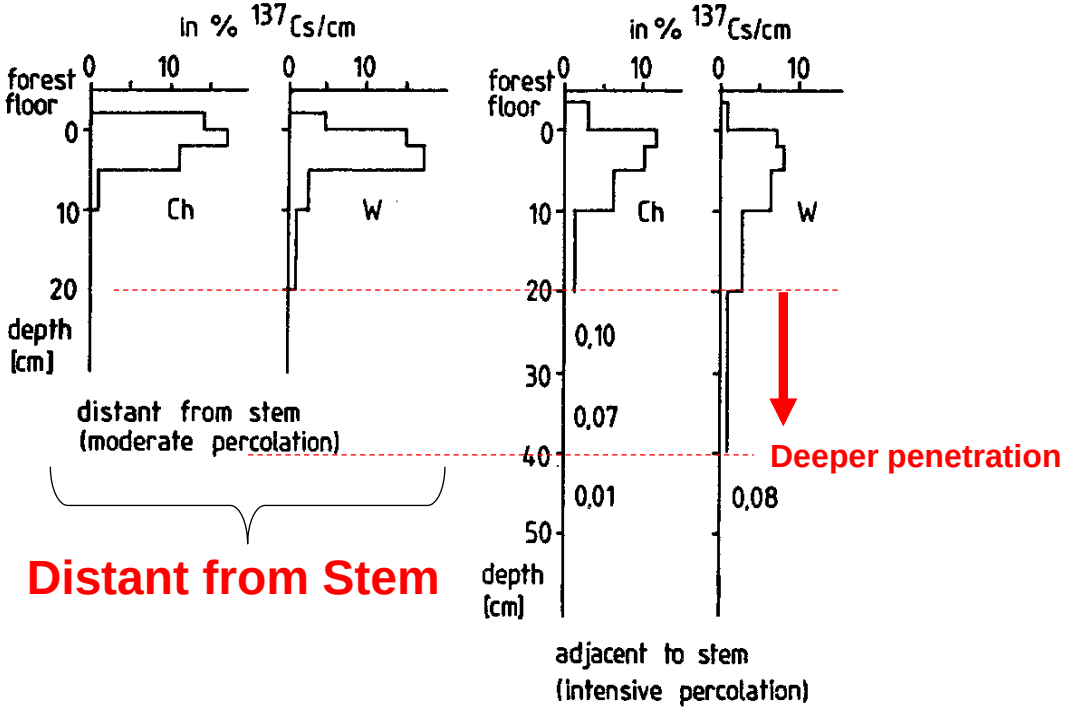
*^{137}Cs transfer flux data was derived from Kato et al. (2012,2017, 2018)

Stemflow
< 1%

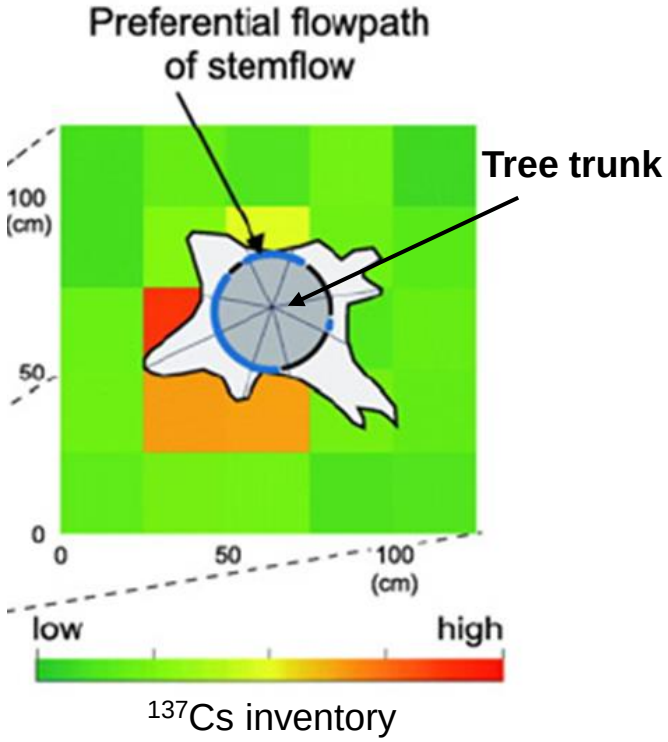


Background: Role of Stemflow on Water Redistribution and Material Transport

- **Forester and Schimmack (1992)**
  "Höglwald" Beech Forest stand
  (southern Bavaria, Germany)
  Soil sampling experiment



- **Imamura et al (2017)**
  Japanese Konara Oak stand
  (Tsukuba, Ibaraki, Japan)
  Soil sampling
  and dye tracer experiment



These previous studies provide evidence that stemflow influences the transport of radio-Cs into the soil layer. **However, the relationship between rainwater and radio-Cs infiltration at the base of tree trunks needs to be clarified by hydrological methods.**

Purpose of This Study

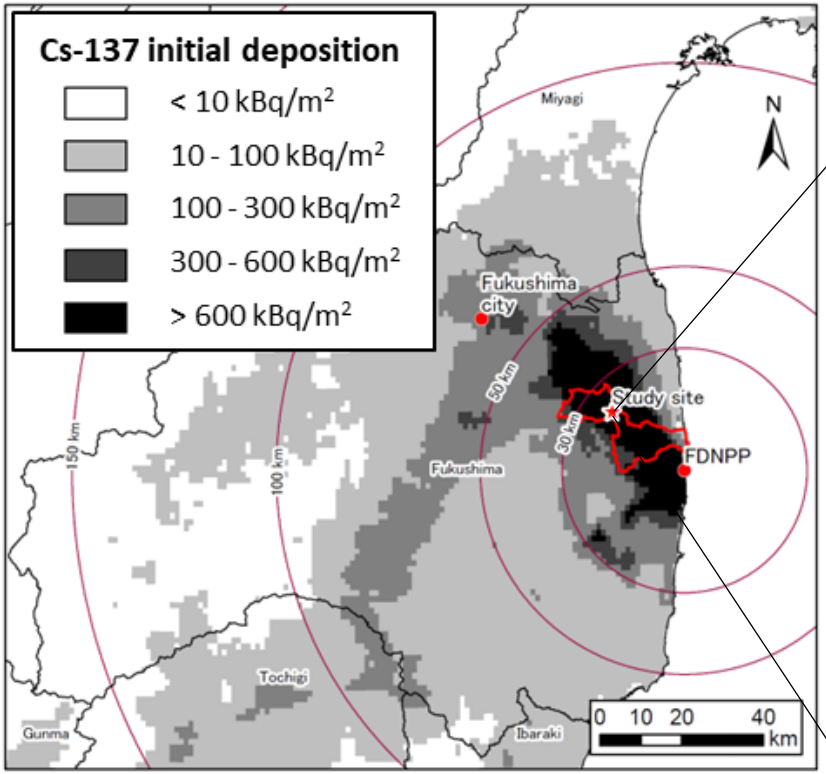
This study aimed to quantify the effect of stemflow on radio-Cs infiltration into forest soil.

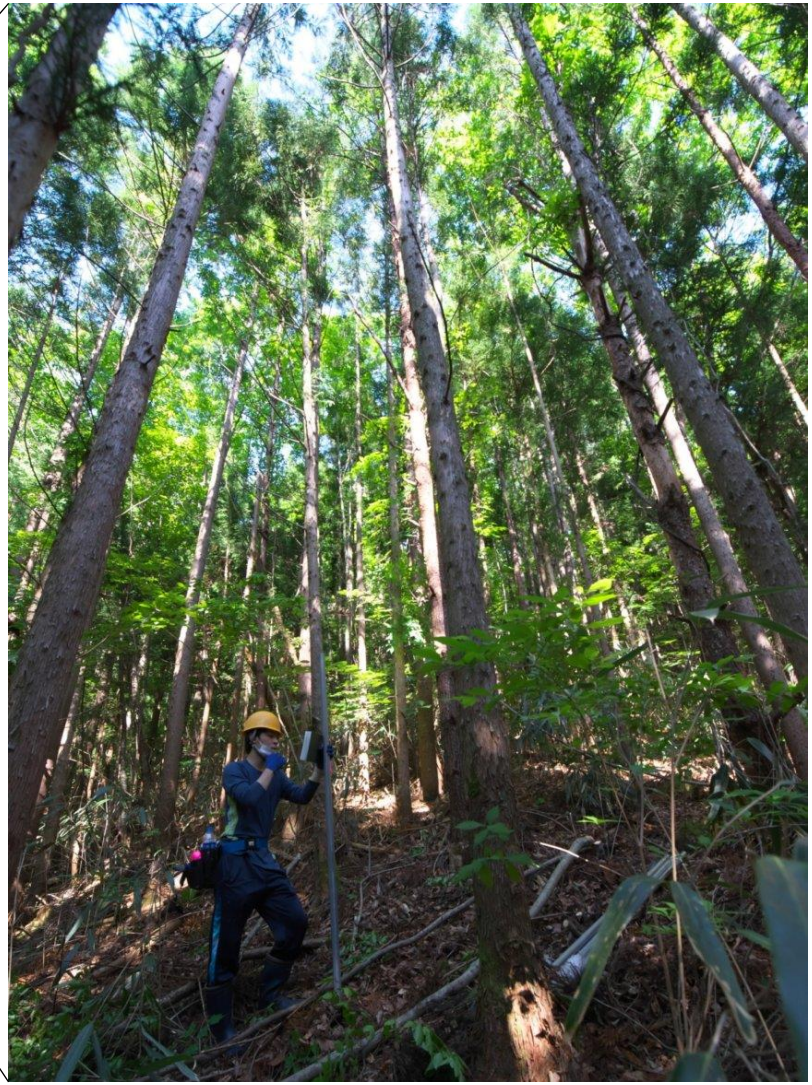
In addition to hydrological observations of canopy water balance, soil infiltration water was collected adjacent to the tree stem (AtS) and at a distance from the stem (DfS). Finally, rainwater and radiocesium fluxes in soil infiltration water were compared between AtS and DfS.

Methodology: Study site description

The study site is located in Namie-town, 20 km northwest of the Fukushima Dai-ichi Nuclear Power Plant.

The site is highly contaminated by the fallout of the Fukushima accident, accumulating initial ^{137}Cs fallout of 4227 kBq/m^2.





Japanese cedar stand

Stand density : 2500 tree/ha

Mean DBH: 16.7± 6.1 cm

Tree height: 18 m

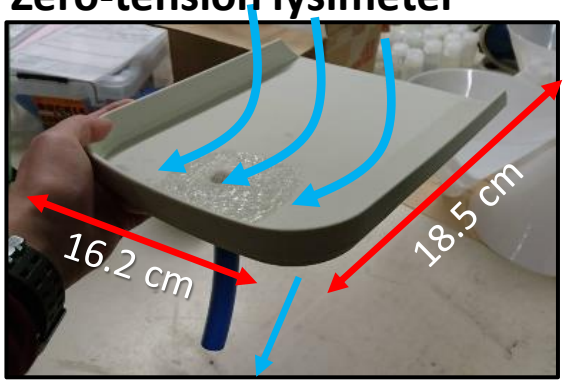
Annual precipitation: 1442 mm

Methodology: Experimental setting for Experiment-1

Experiment-1: Comparison of water and radio-Cs flux at two locations (Adjacent to stem vs Distant from stem)

- Measurement of soil infiltration water flux by using a zero-tension lysimeter.
- The lysimeters were installed at two depths; 5-cm and 20-cm.
- Analysis of dissolved ^{137}Cs concentration in soil water (< 0.45µm).

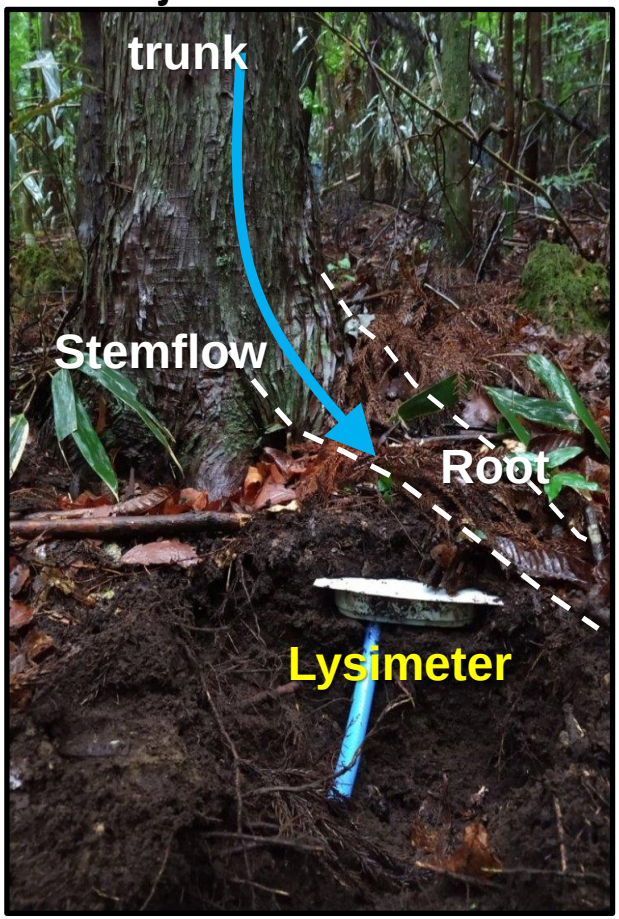
Zero-tension lysimeter



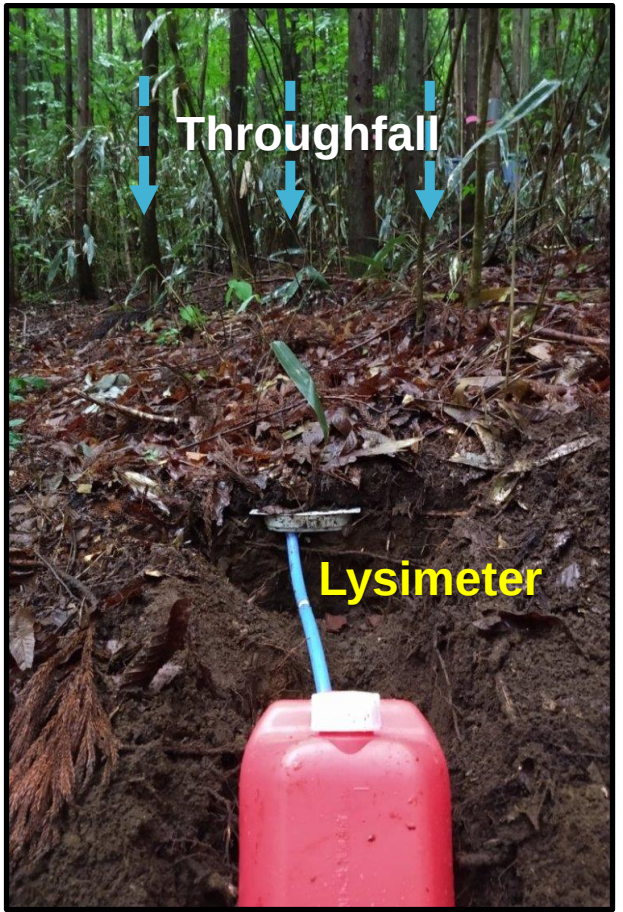
3 locations and 2 depth for each location.
In total, 6 zero-tension lysimeter dataset for AfS and DfS, respectively.

The radio-Cs in filtered water (0.45µm) was defined as “dissolved Cs”

AtS: Adjacent to Stem



DfS: Distant from Stem



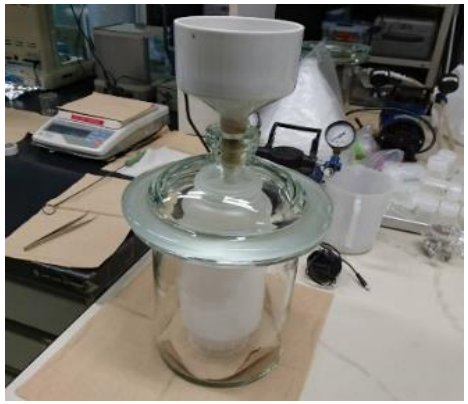
Methodology: Experimental setting for Experiment-2

Experiment-2:

Measurement of water and radio-Cs flux after interception of stemflow (Adjacent to stem vs Distant from stem)

- Stemflow input was prohibited.
- Changes in water and radio-Cs flux before and after the stemflow-interception were compared.

Filtering water samples using a 0.45μm membrane filter.

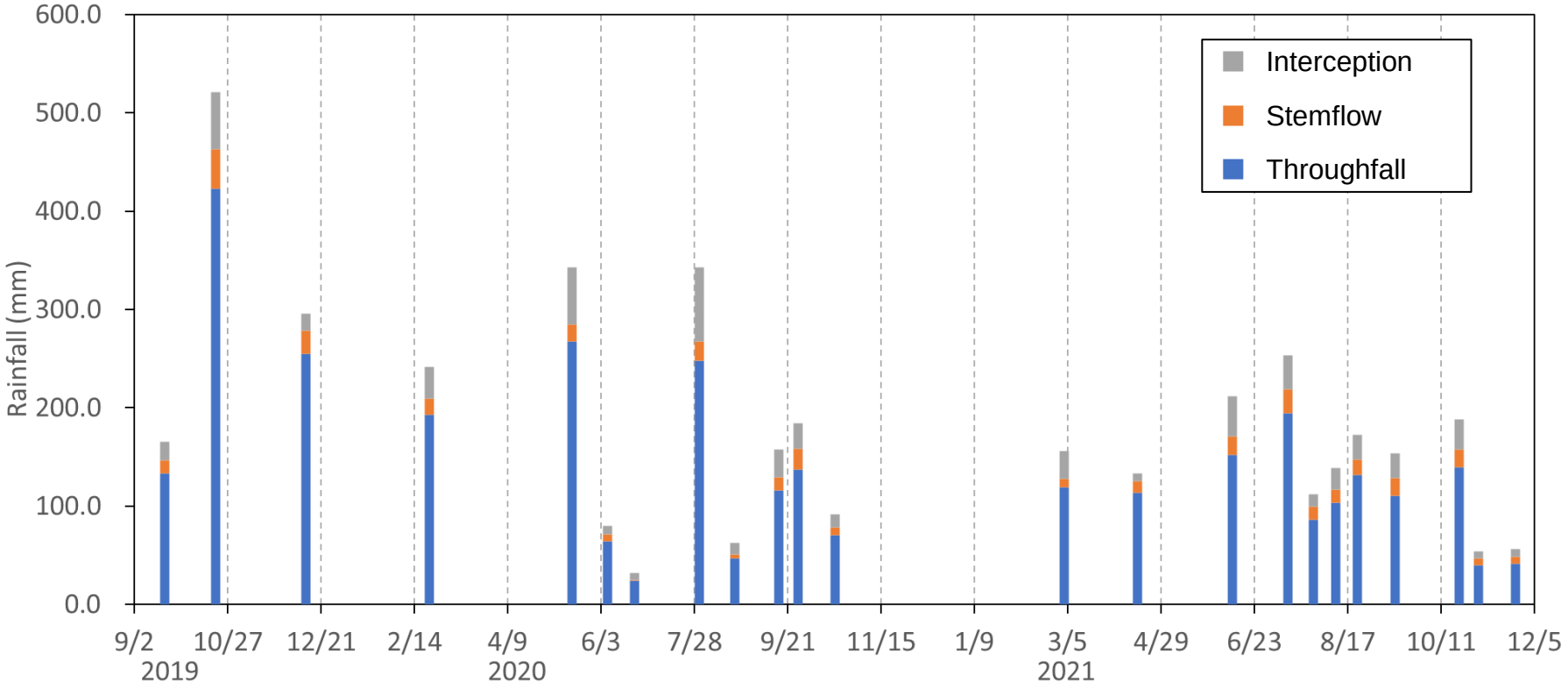


Detection of ^{137}Cs by using a Ge gamma-ray detector (661 keV).

AtS: Distant from Stem

Results and Discussion: Analysis results of Experiment 1

■ **Rainfall characteristics during the observation period (2019~2021)**

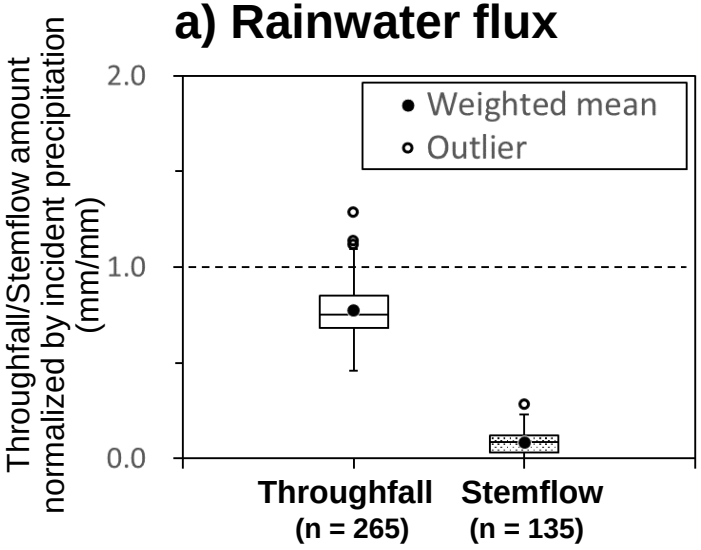


- **In total 23 rainfall events were observed during the 3-y monitoring period.**
- **Incident precipitation (4146 mm) was partitioned into Throughfall (TF: 77.4%), Stemflow (8.0 %), and Interception (14.6%)**

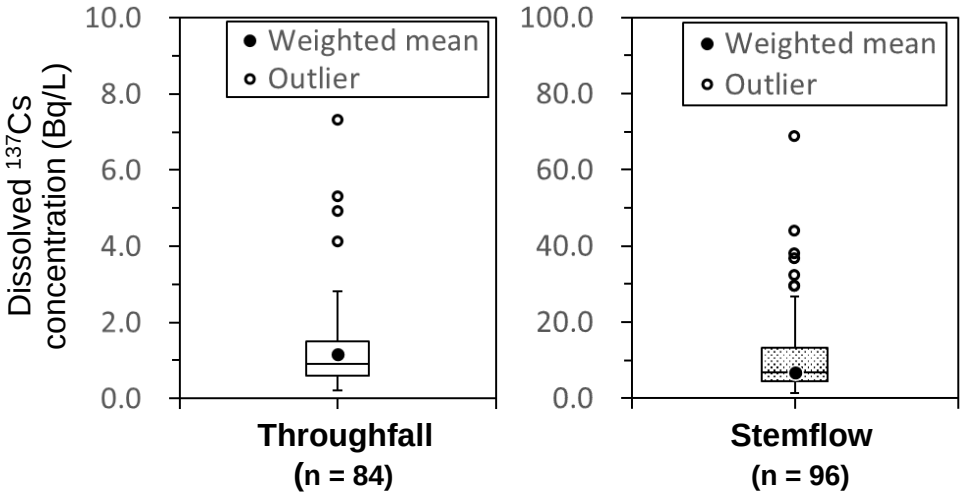
Results and Discussion: Analysis results of Experiment 1

■ Rainfall characteristics during the observation period (2019~2021)

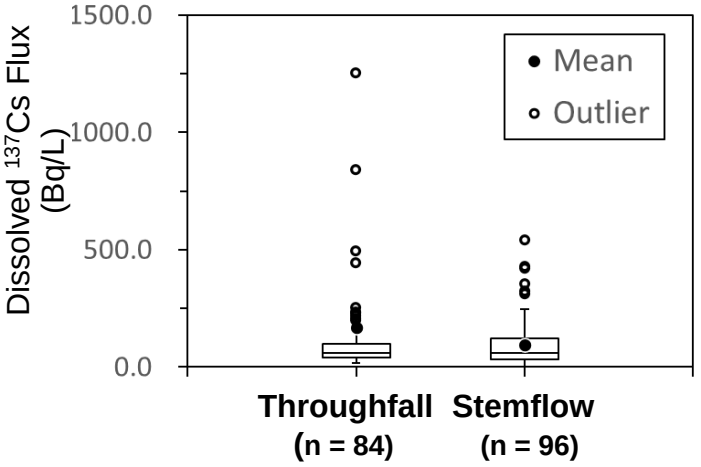
a) Rainwater flux



b) Dissolved ^{137}Cs concentration



c) Dissolved ^{137}Cs flux



Rainwater flux **Throughfall >> Stemflow**

Dissolved ^{137}Cs conc.
Throughfall << Stemflow

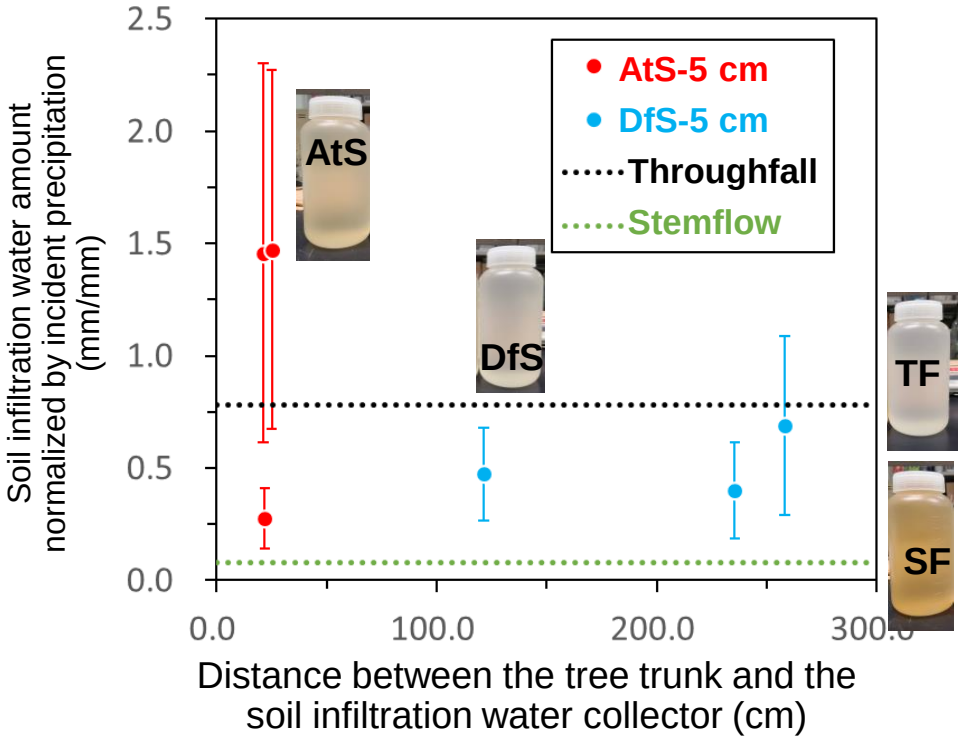
Dissolved ^{137}Cs flux
Throughfall = Stemflow

*^{137}Cs flux for stemflow was calculated based on the canopy projection area.

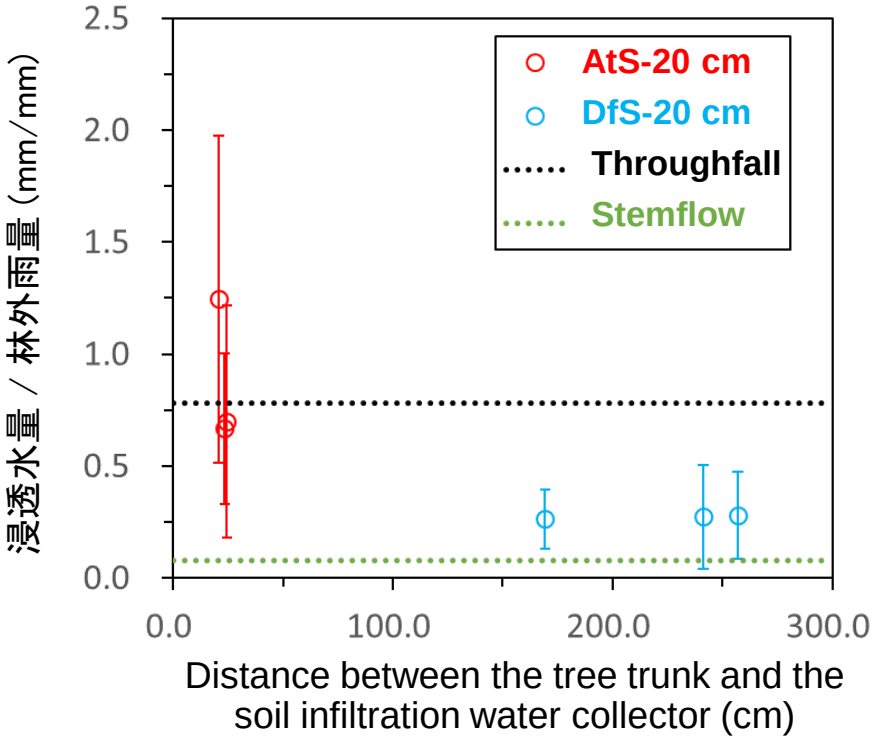
Results and Discussion: Analysis results of Experiment 1

■ **Comparison of Soil infiltration water fluxes at AtS and DfS.**

a) Soil infiltration water at **5-cm depth**



b) Soil infiltration water at **20-cm depth**

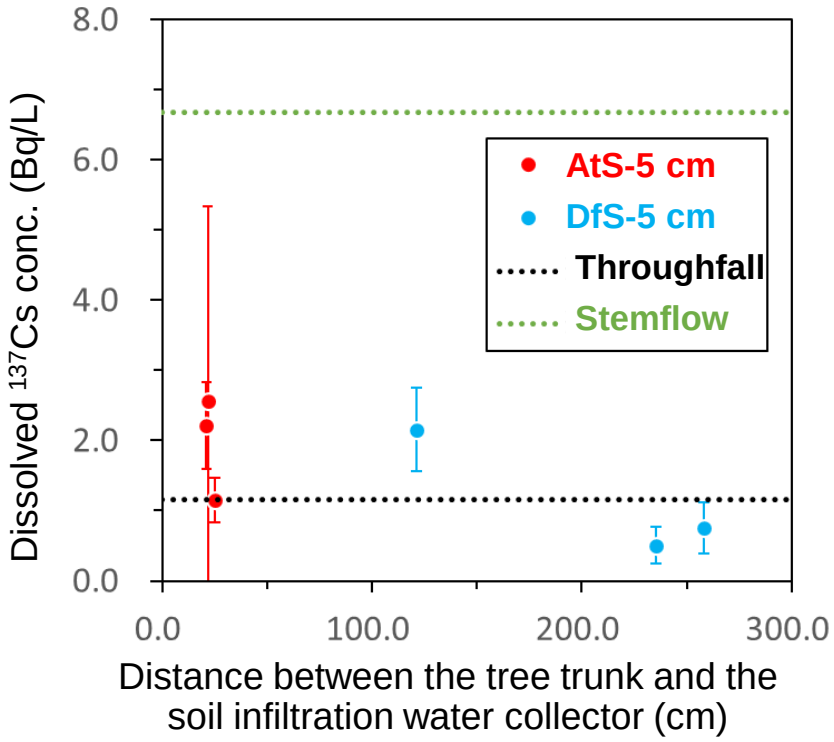


- **AtS (Adjacent to Stem) showed 2.2 – 3.2 times greater soil water infiltration flux than DfS (Distant from Stem).**
- **Assuming stemflow infiltrate into the soil within the 10-cm radius area of stem, soil infiltration water flux increase up to 3 times greater than throughfall .**

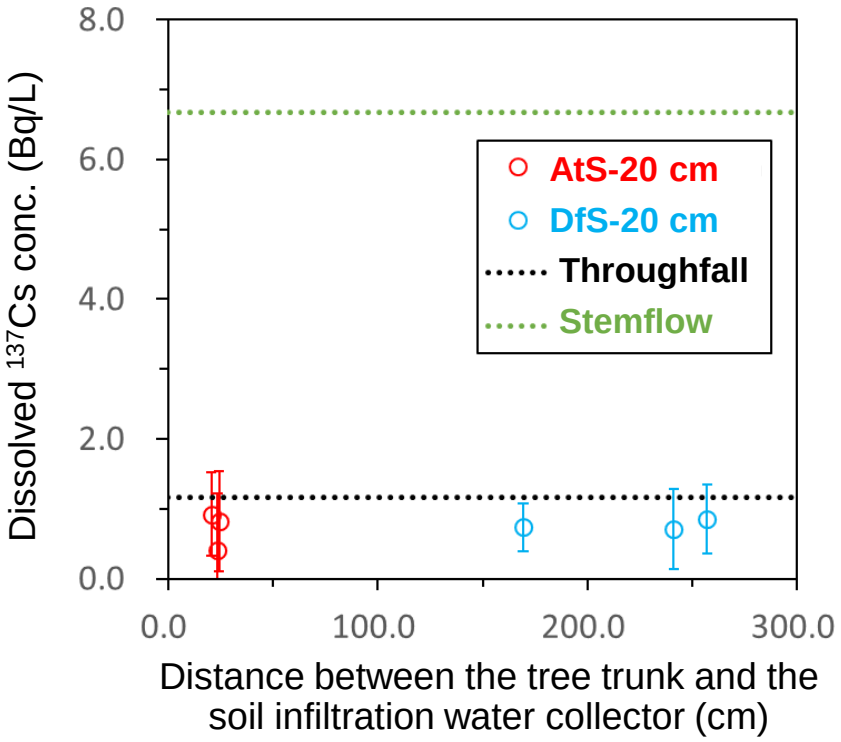
Results and Discussion: Analysis results of Experiment 1

■ **Comparison of Dissolved ^{137}Cs concentration in soil infiltration water**

a) Soil infiltration water at **5-cm depth**



b) Soil infiltration water at **20-cm depth**

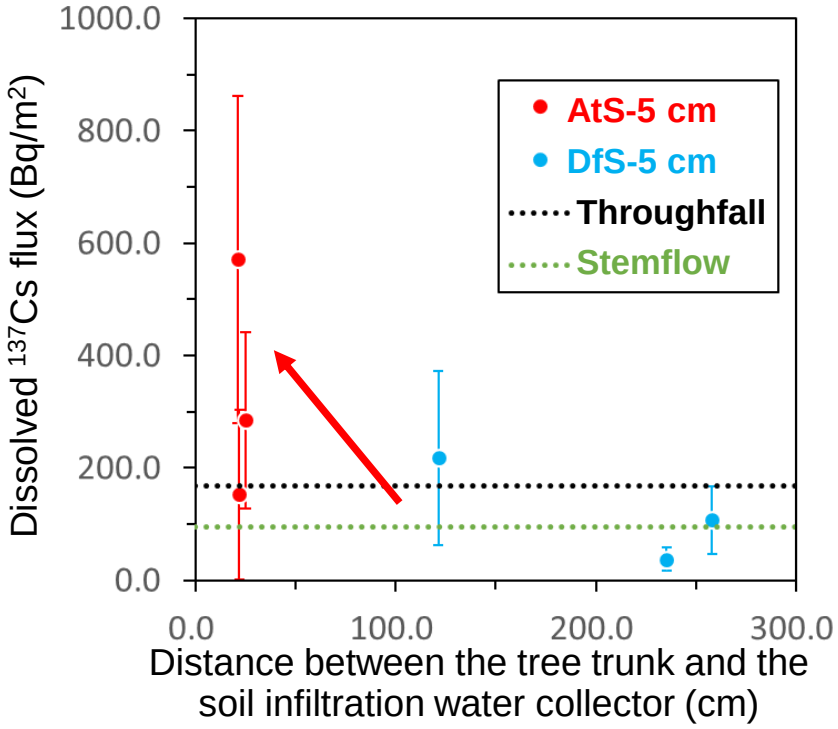


- **AtS (Adjacent to Stem) showed 1.7 times greater dissolved ^{137}Cs concentration in soil infiltration water than DfS (Distant from Stem).**
- **The dissolved ^{137}Cs in stemflow may be absorbed by surface soil during water infiltration through soil profile.**
- **Difference in the dissolved ^{137}Cs conc. of 20-cm depth soil infiltration water was not significant between AtS and DfS .**

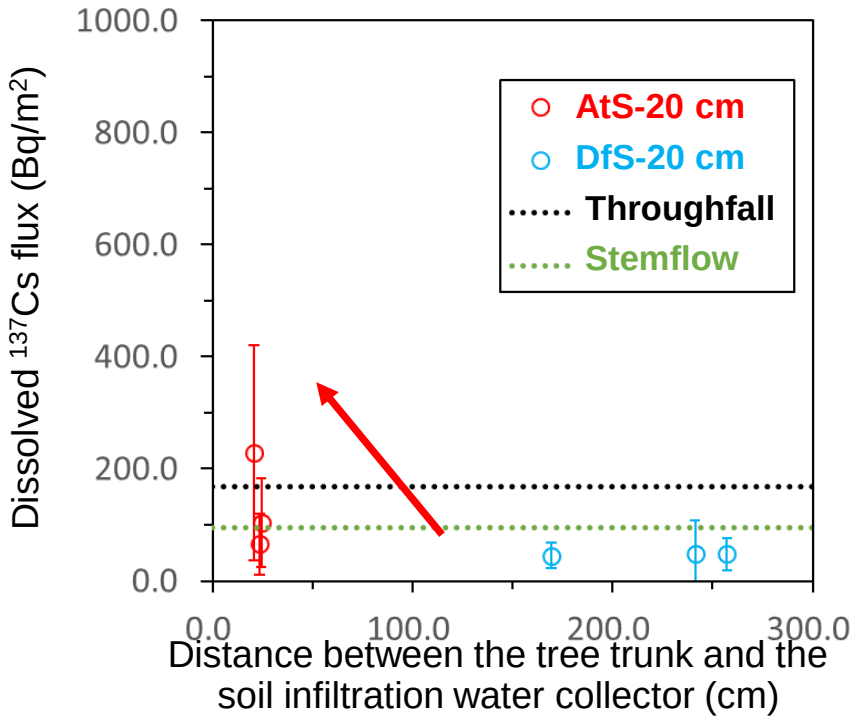
Results and Discussion: Analysis results of Experiment 1

■ **Comparison of Dissolved ^{137}Cs flux via soil infiltration water**

a) Soil infiltration water at **5-cm depth**



b) Soil infiltration water at **20-cm depth**



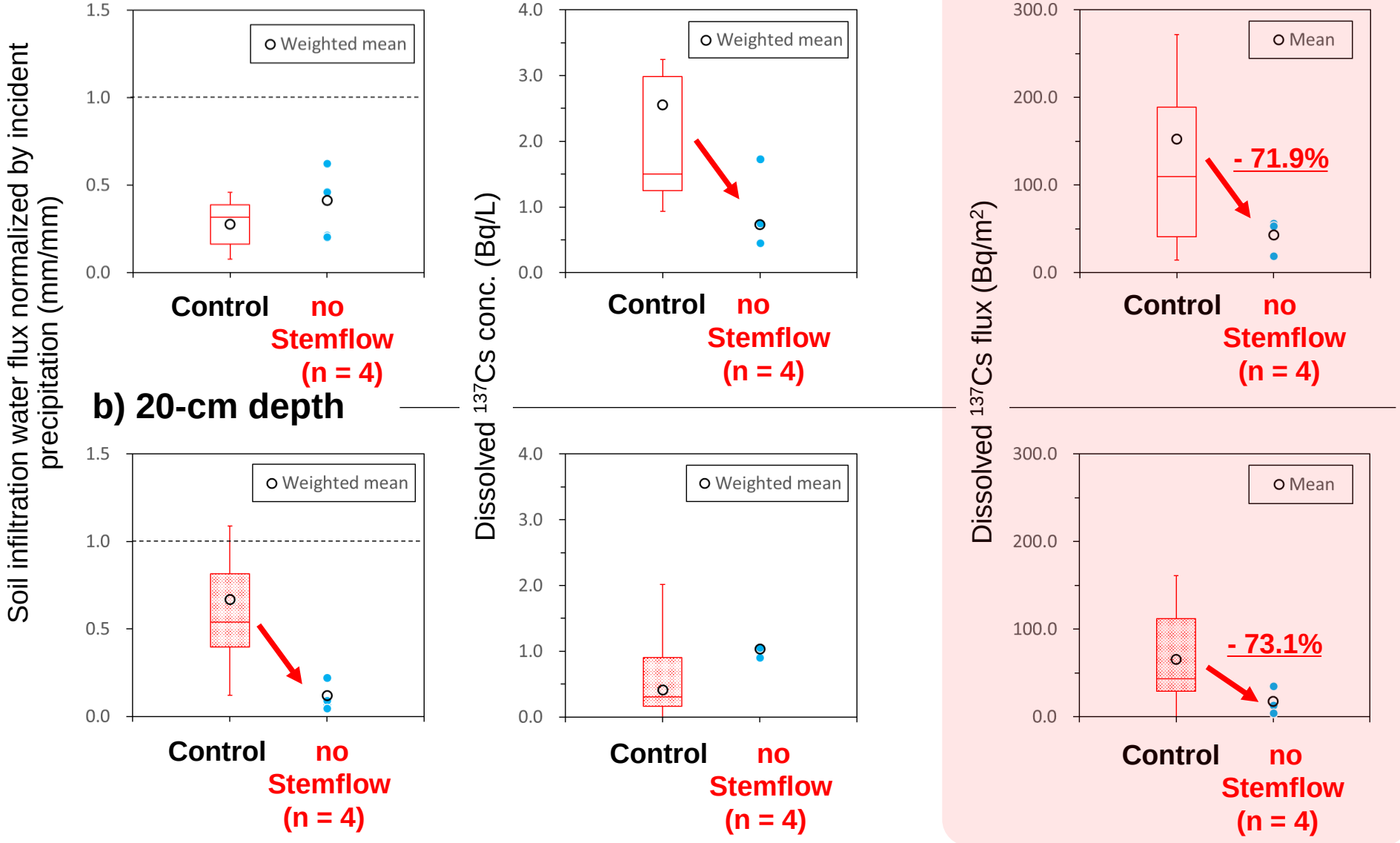
➢ **AtS (Adjacent to Stem) showed 3.0 – 3.4 times greater dissolved ^{137}Cs flux via soil infiltration water than DfS (Distant from Stem).**

Results and Discussion: Analysis results of Experiment 2

■ **Comparison of Dissolved ^{137}Cs flux via soil infiltration water**

a) 5-cm depth

b) 20-cm depth



Summary:

- We conducted field experiment to examine the role of stemflow on radio-Cs infiltration flux into forest soil.
- **Results of Experiment-1**

  AtS (Adjacent-to-Stem) exhibited

  >2.2-3.2 times greater soil infiltration water flux

  >1.7 times greater dissolved ^{137}Cs conc.

  ↓ * at 5-cm depth, but no significant for 20-cm depth

  Consequently, 3.0-3.4 times greater dissolved ^{137}Cs flux

  ***both 5-cm and 20-cm depth**
- **Results of Experiment-2**

  As a result of stemflow interception,

  >Soil infiltration water flux decreased approx. 70% for 20-cm depth

  >Dissolved ^{137}Cs conc. decreased approx. 70% for 5-cm depth

  ↓

  Consequently, dissolved ^{137}Cs flux decreased 71.9-73.1%.

This study indicated that stemflow increased water and radio-Cs inflow flux within the basal area of tree stem and encouraged infiltration to deeper soil horizon (> 20-cm depth).