

A low-cost, open-path water vapor analyzer for Eddy Covariance Measurement of EvapoTranspiration (ECMET)

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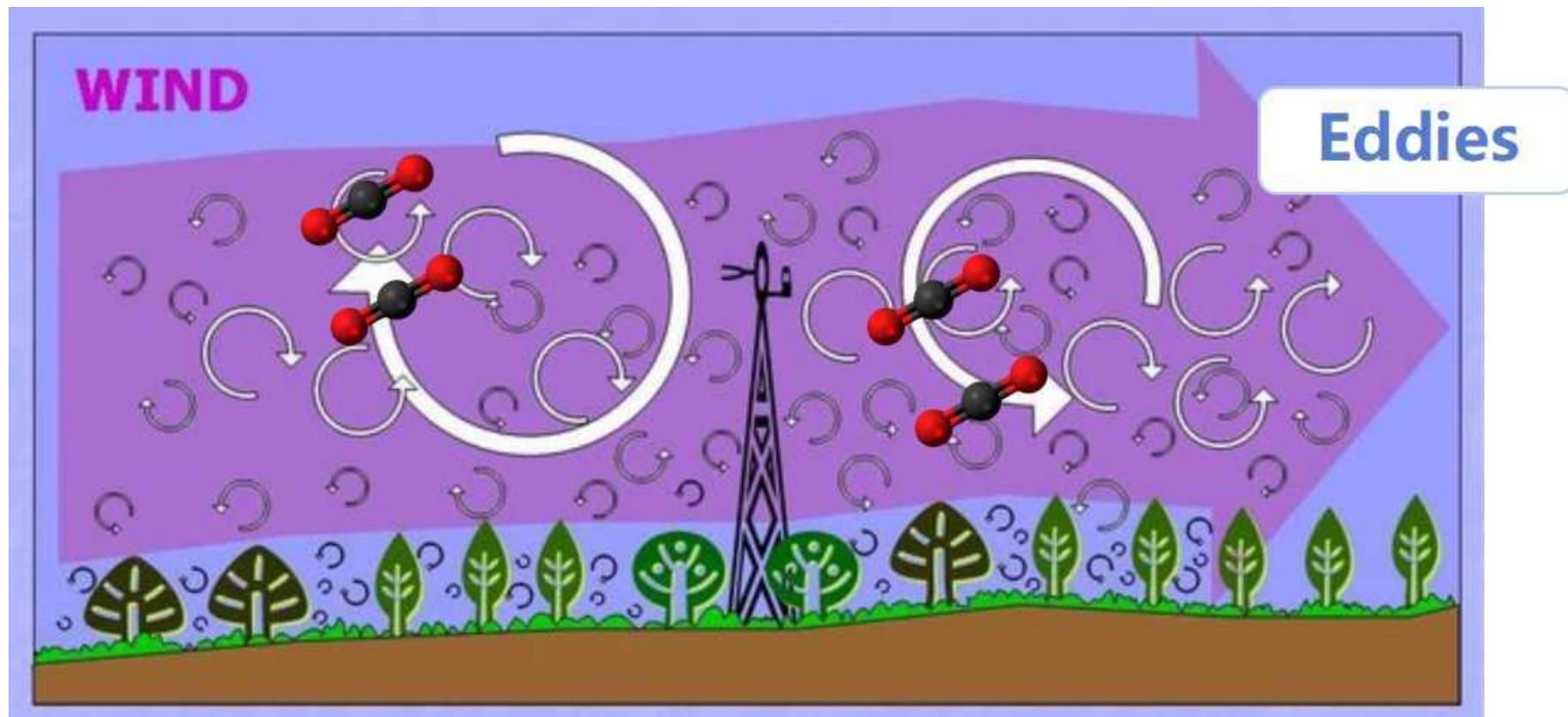
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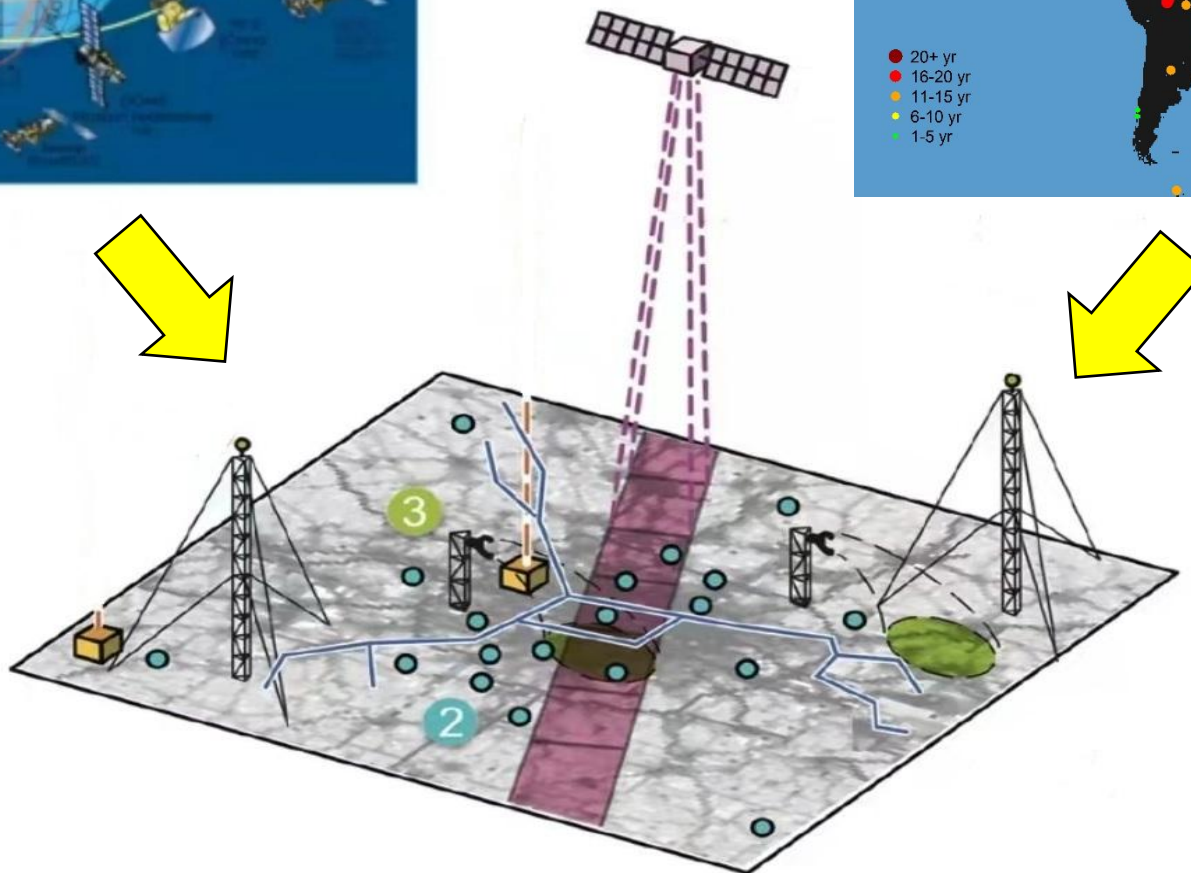
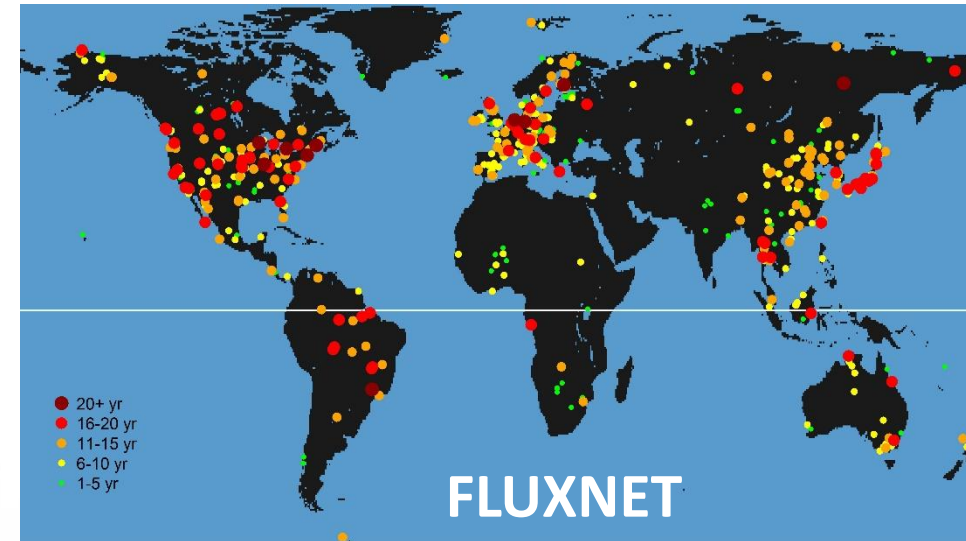
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HS6.6
Remotely-sensed evapotranspiration (RS-ET)

Eddy Covariance measurement of ET flux (ECMET)

- Wind is made up of small turbulence, or eddies
- Sum up the vertical contributions of H_2O /energy from all the eddies





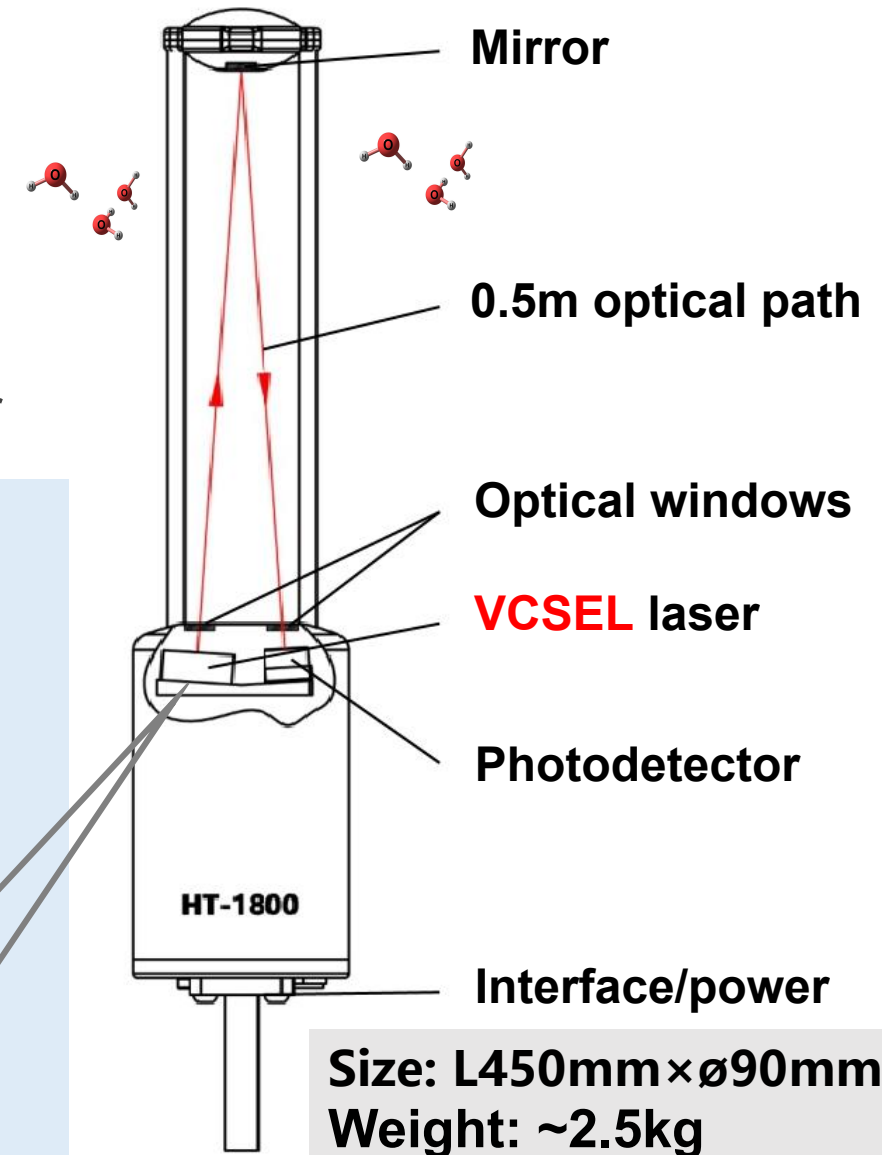
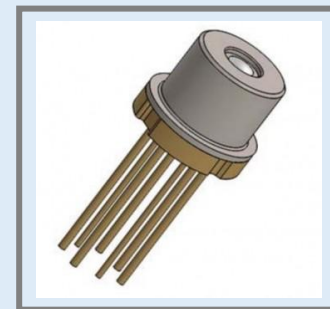
- Ground-based ECMET measurement for remote-ET verification
- Need low cost ECMET solutions

Solution: VCSEL-based fast H₂O analyzer

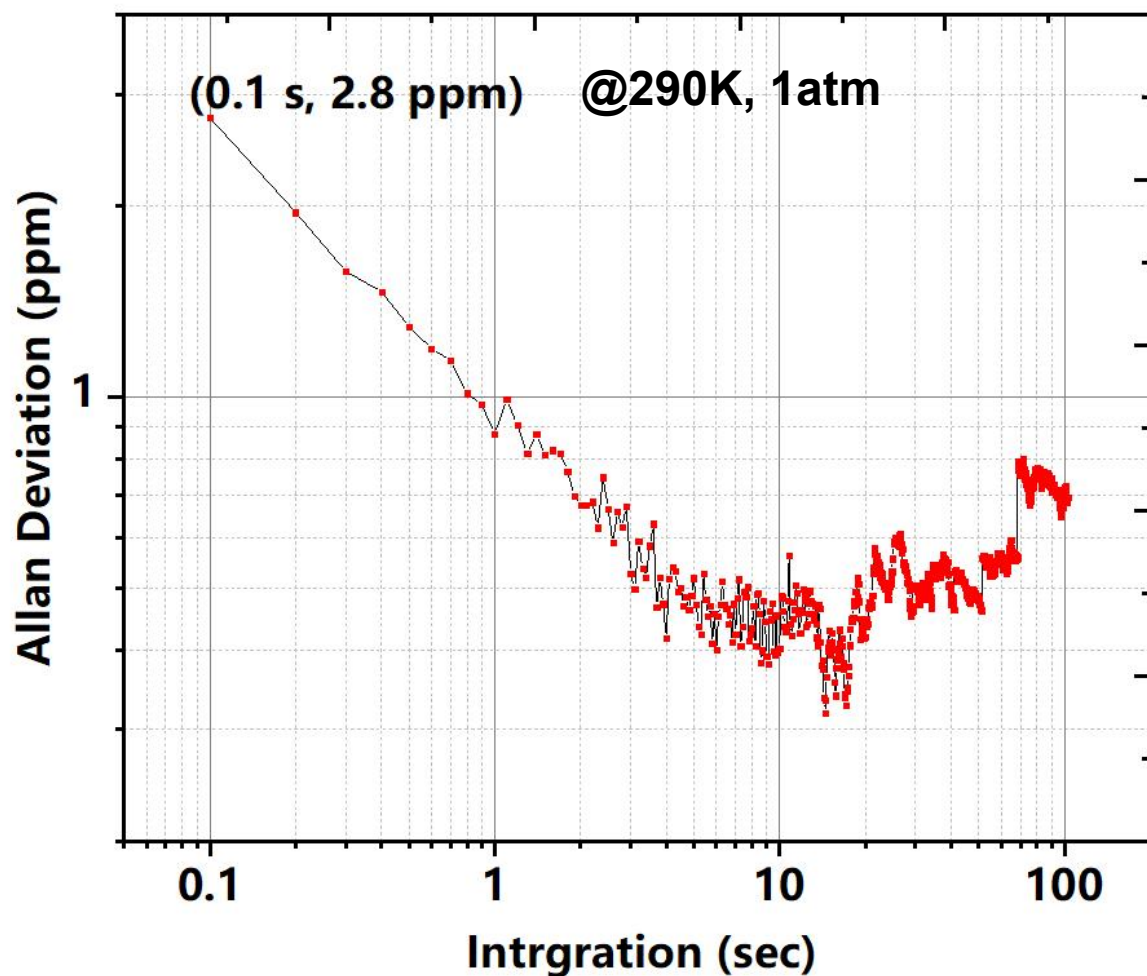
- Strong 1392nm H₂O line --> high sensitivity
- Distinct absorption lines --> high selectivity
- Open-path --> Fast response, no sampling delay/loss
- No gas sampling pump and pretreatment --> low power

Advantages of VCSEL H₂O sensor

- VCSEL is **cheaper** when manufacture in quantity (e.g. IT industry)
- **Eye safe** (Class I laser)
- Require **less operating power** (<100mW)
- Smaller package(sensor) size



Analyzer sensitivity



Allan Deviation analysis following Werle *et al.* (1993)

Specification

Measurement range	0 ~ 60 mmol/mol
Sampling rate	20Hz / 10Hz / 1Hz
Atm. Pressure range	70 ~ 110 kPa
Temp. range	-20 ~ 50 °C
Comm. port	RS-232
Supply Power	10 W (typical)
Env. grade	IP67

Key features

- No consumables
- Lower cost
- Portable
- Easy maintain



Comparison with two commercially available water vapor analyzers for ET flux measurements

- **Site info.:**
Wheat field at Suzhou, Jiangsu
From 29/Apr/22 to 17/May/22
- **ET flux system 1:**
HT1800 H₂O analyzer (HealthyPhoton®);
uSonic-3 MP sonic anemometer (METEK®)
- **ET flux system 2:**
LI-7500 H₂O analyzer (LICOR®)
CSAT-3A sonic anemometer (CSI®)
- **ET flux system 3:**
EC-150 H₂O analyzer (CSI®)
CSAT-3A sonic anemometer (CSI®)



- **Site info.:**

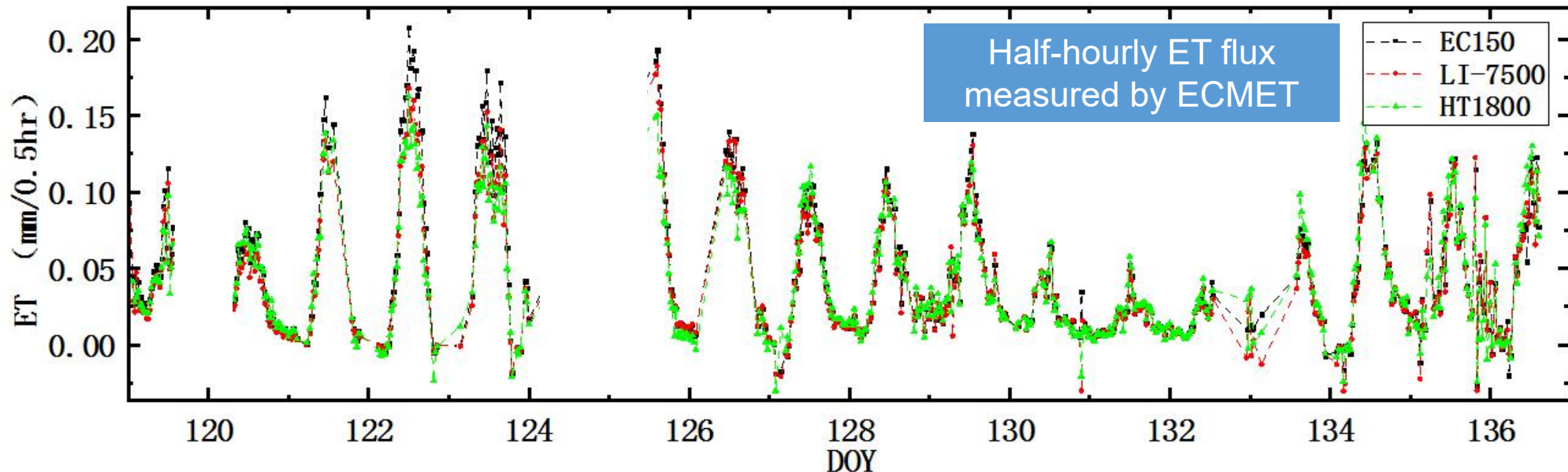
Wheat field at Suzhou, Jiangsu

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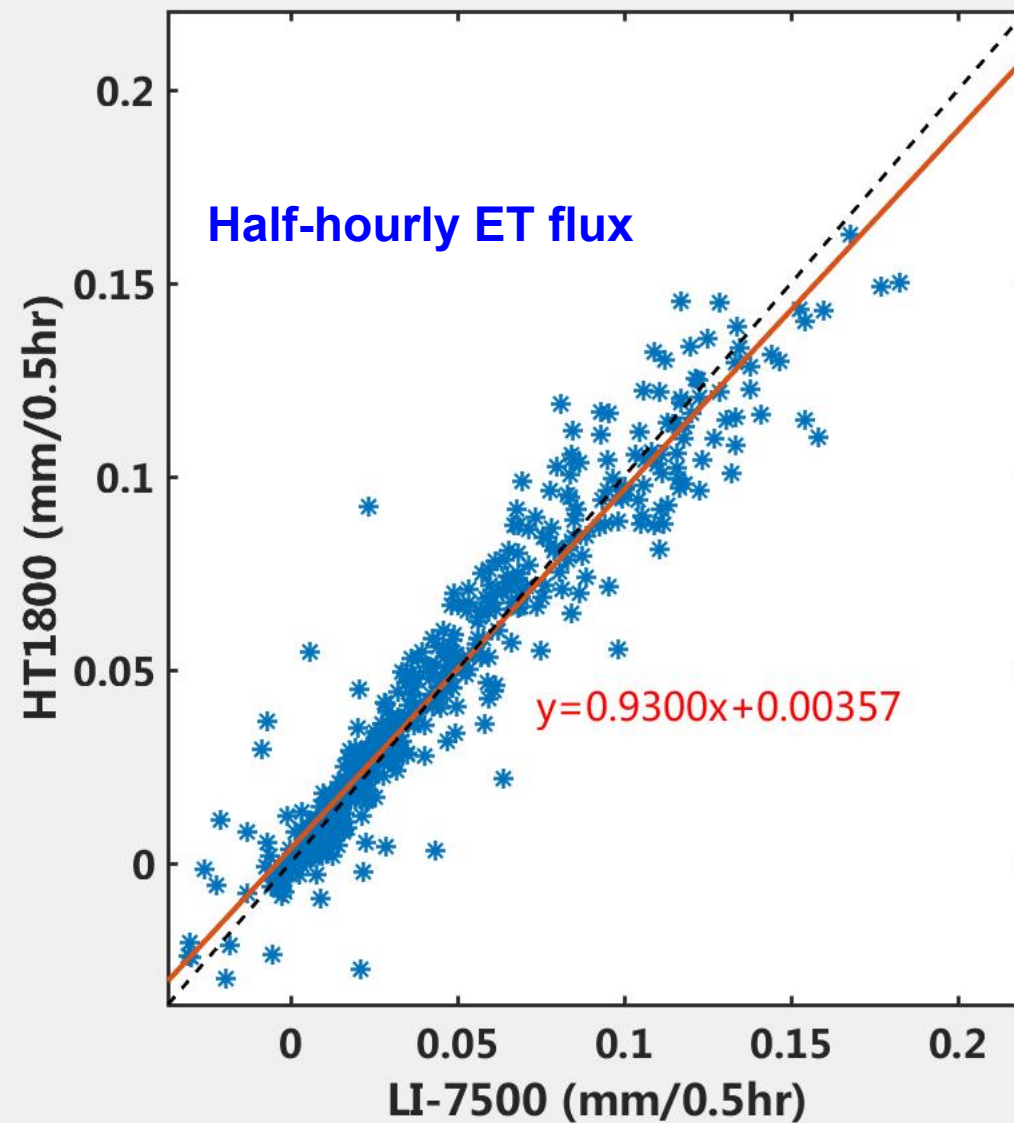
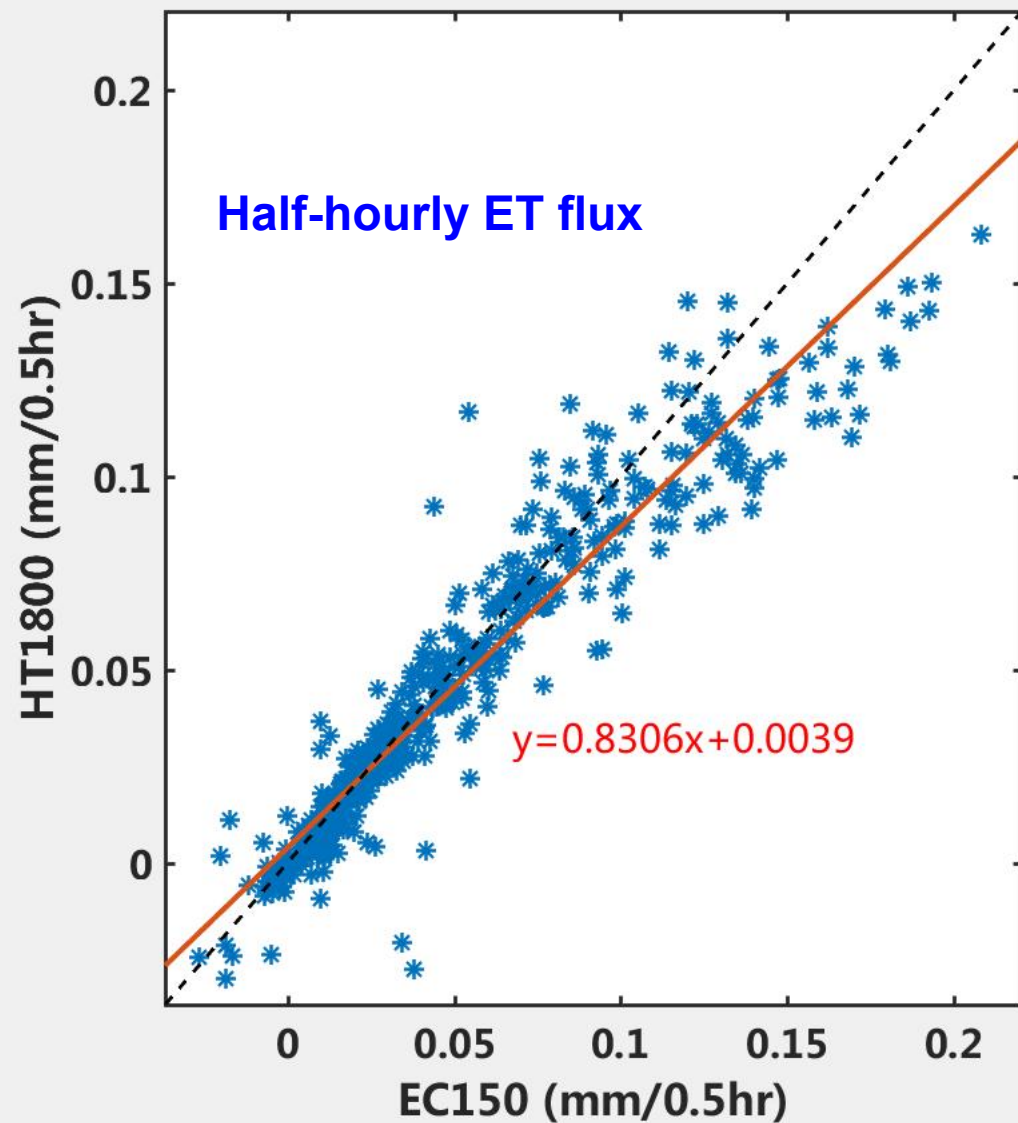
- **ET flux system 1:**

HT1800 H₂O analyzer (HealthyPhoton®);

uSonic-3 MP sonic anemometer (METEK®)



ET flux comparison



- An **eddy covariance system** equipped with an **open-path VCSEL H₂O analyzer** (**HT1800, HealthyPhoton Co. Ltd.**) was deployed to measure the ET fluxes **continuously** with a 100m~1000m footprint scale.
- HT1800 showed **comparable ET estimates** with two widely-used H₂O analyzers for ET flux systems.
- Future work includes **satellite data verification**, and using machine learning with ECMET to **improve the performance of the empirical ET models** (e.g. Penman method).

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Thank you for watching! Please contact us by
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