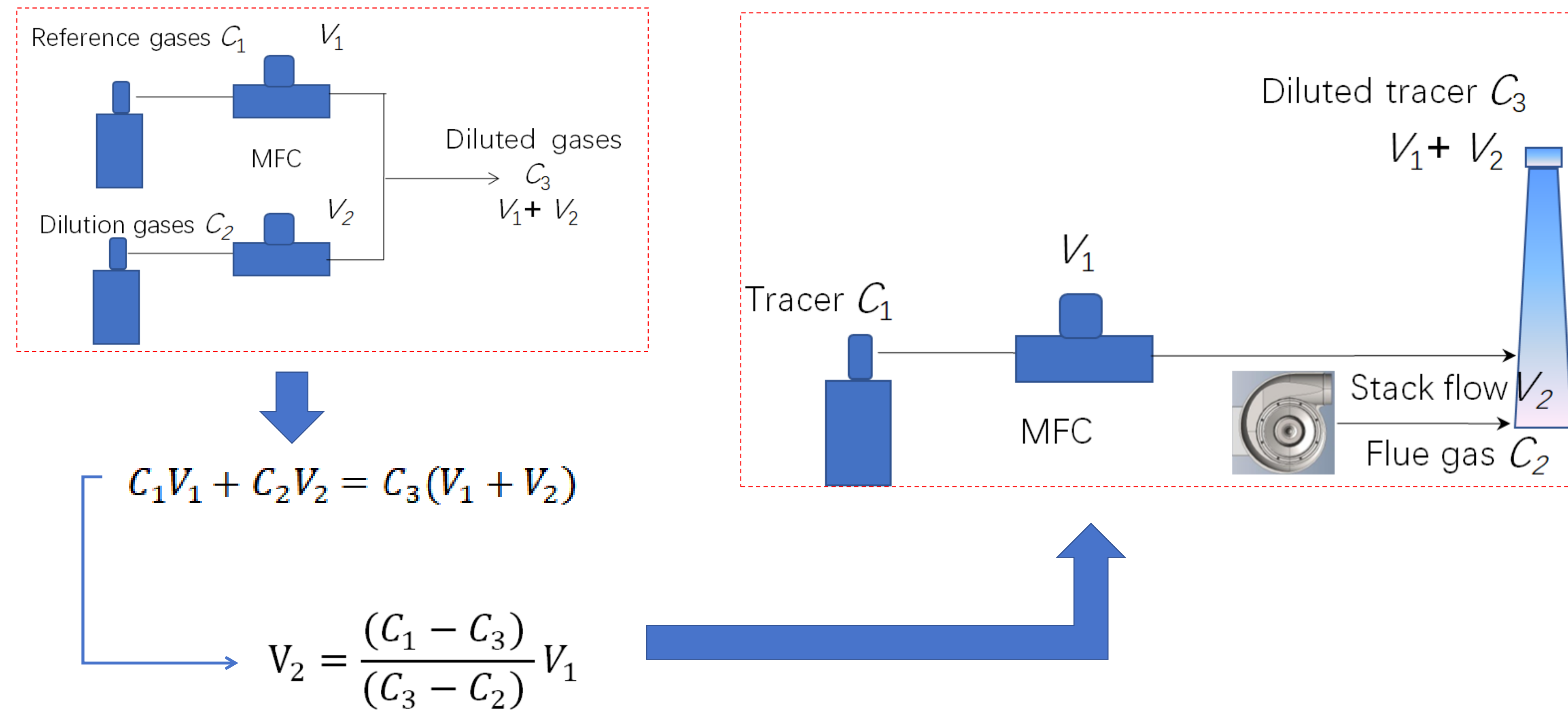


Title: In-situ Quantification of Carbon Emissions from a Power Plant Using the Tracer Gas Dilution Method

1.Introduction

- CO₂ emissions from stack accounts for more than 50% of all greenhouse gas emissions in China.
- Large discrepancy between **Fuel based method** and **Continuous Emission Monitoring based method**.
- Difficulty for **turbulent flow** measurement in stack, due to asymmetric or skewed velocity distributions.
- Tracer gas dilution** (TGD) method, also known as the chemical method, could be a promising solution.



2.Methods

1.Continuous Emission Monitoring based method

$$\text{CO}_2 \text{ emissions} = \text{Concentration} \times \text{Flow}$$

NDIR



Humidified
Gas reference materials

S-type Pitot Tube



Upper level standard

2. Tracer gas dilution(TGD) method

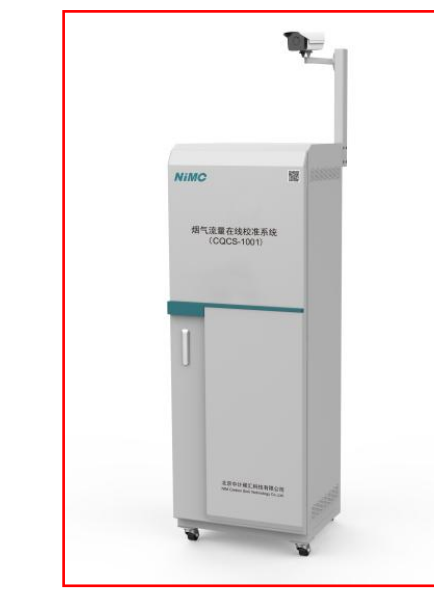
$$\text{CO}_2 \text{ emissions} = \text{Concentration} \times \text{Flow}$$

NDIR



Humidified
Gas reference materials

TGD



Tracer gas reference
& MFC

3. Unmanned Aerial Vehicle based method

$$\text{CO}_2 \text{ emissions} = \oint [\Delta\text{CO}_2 \times \rho_{\text{air}} \times \text{Wind Speed} \times dS]$$

Airborne
OA-ICOS

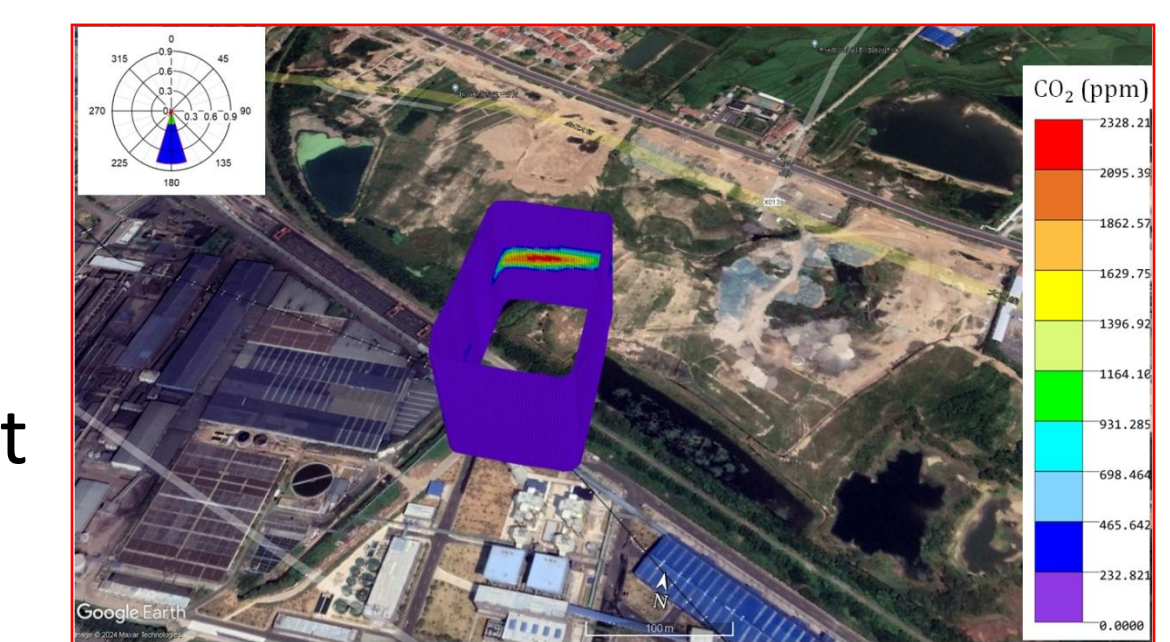
T

P

Ultrasonic
anemometer

GPS

Box
Flight



Divergence
Theorem

4. Fuel based method

$$\text{CO}_2 \text{ emissions} = \text{Coal consumption rate} \times \text{Carbon content}$$

Belt scale

Inhomogeneity?

Elemental analyzer



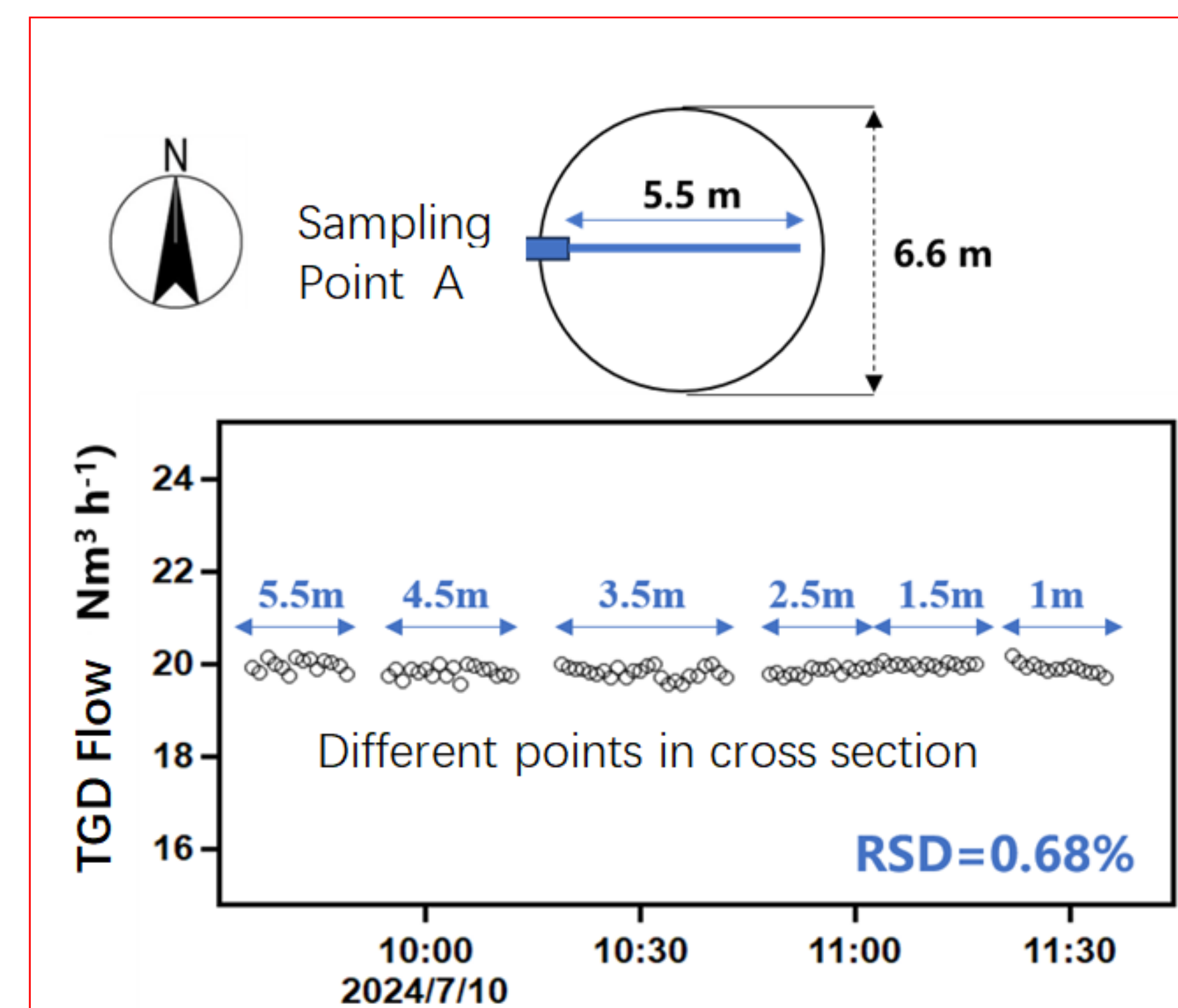
Captive chain



Coal reference materials

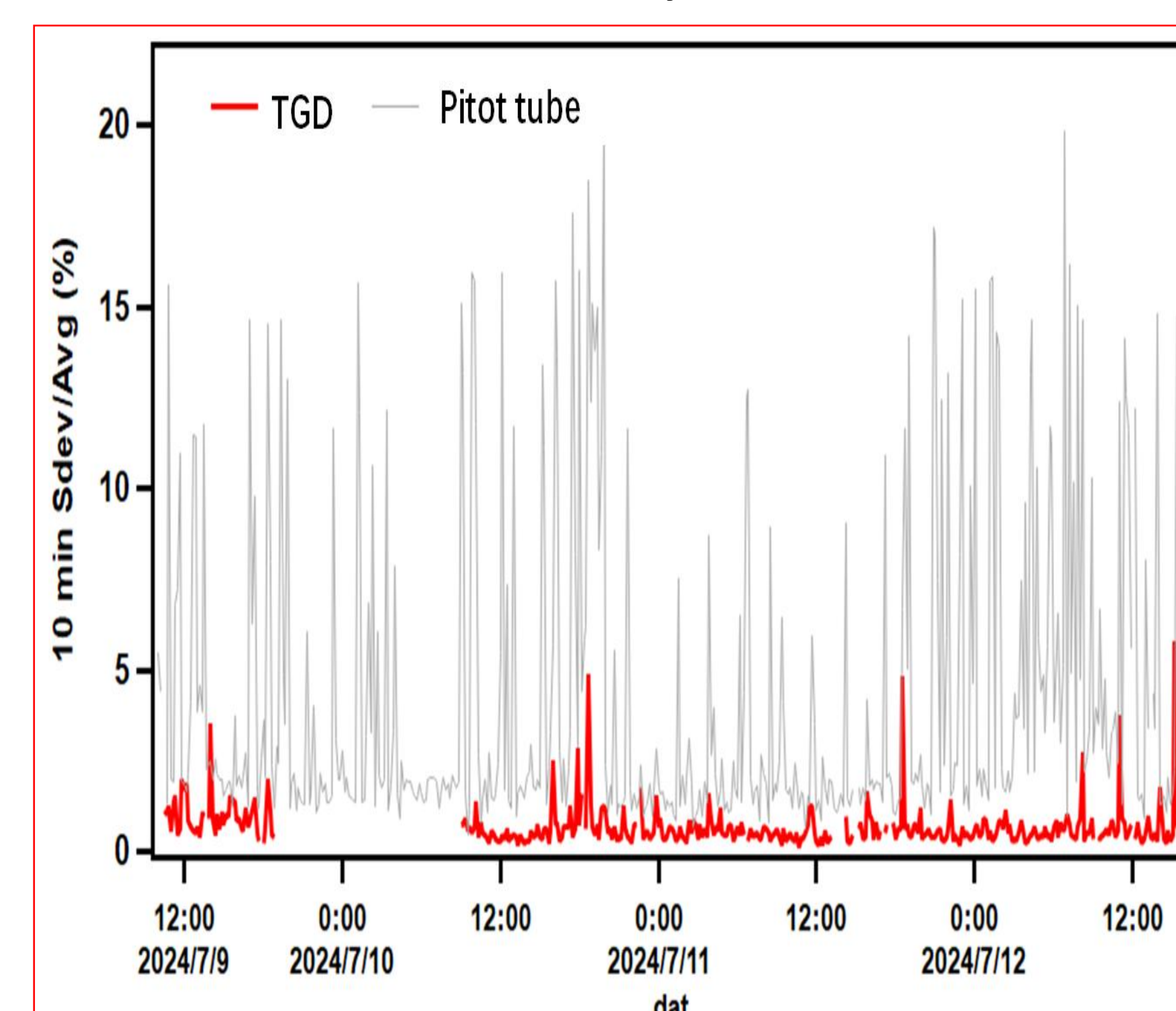
3.Results And Analysis

1.Tracer Concentration distribution in stack



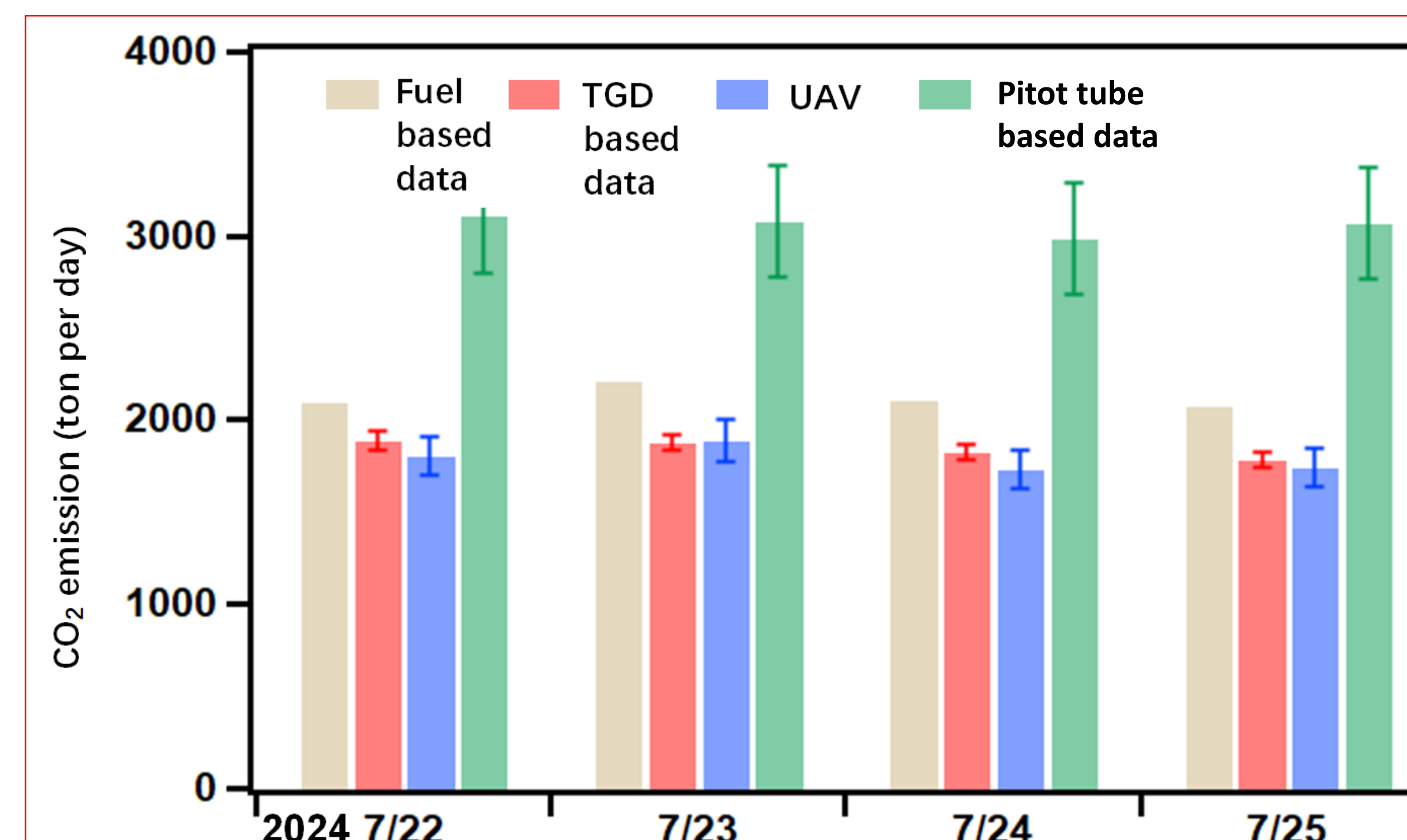
The uncertainty contribution of tracer inhomogeneity is less than 0.68%

2. The exhaust flow by TGD and Pitot tube



The RSD of flow by TGD is much smaller

3. Differences among 4 different methods



The average daily emissions rate:
Pitot tube > Fuel based > TGD data > UAV data

4.Conclusion

- Tracer gas dilution(TGD) method is insensitive to the asymmetric flow distribution in ducts, thus providing a good method in reducing the uncertainty of stack emissions .
- In this case study, the relative expanded uncertainty of the volume flow measurement using the TGD method was less than 2.5%.
- The distribution of tracer concentration and the prerequisites for a homogenous mixture in flue gas should be further clarified.
- The accurate quantified stationary emission could be used as a standard releasing source for the verification of other methods.