Preliminary results of surface flux estimates of N_2O and CH_4 using observations at the Cabauw tower

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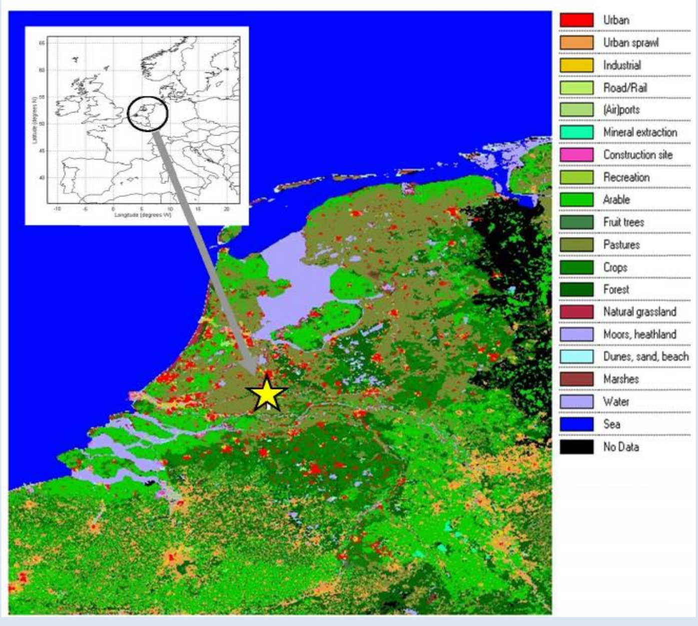
Introduction

The atmospheric concentrations of N_2O and CH_4 has been increasing in the past decades.



- surrounded by complex sources of greenhouse gases
- the concentration footprint is relatively large

Fig.1 The location of Cabauw tower and land use map

For a better understanding of the budget of N_2O and CH_4, this study aims to exploit the long-term continuous observations as well as meteorological parameters at the Cabauw tower to infer the surface fluxes of N_2O and CH_4 on a local to regional scale.

Methodology

Surface flux = Storage flux + Turbulent flux

❖ **Storage flux**- derived by the concentration gradients between 20, 60, 120, 200 m

$$F_{Stor} = \int_0^{Z_r} \frac{1}{V_m} \cdot \frac{\partial \bar{c}}{\partial t} dz = \int_0^{Z_r} \frac{\rho_{Air}}{M_{Air}} \cdot \frac{\partial \bar{c}}{\partial t} dz$$

≅ the sum of each trapezoidal area[1]

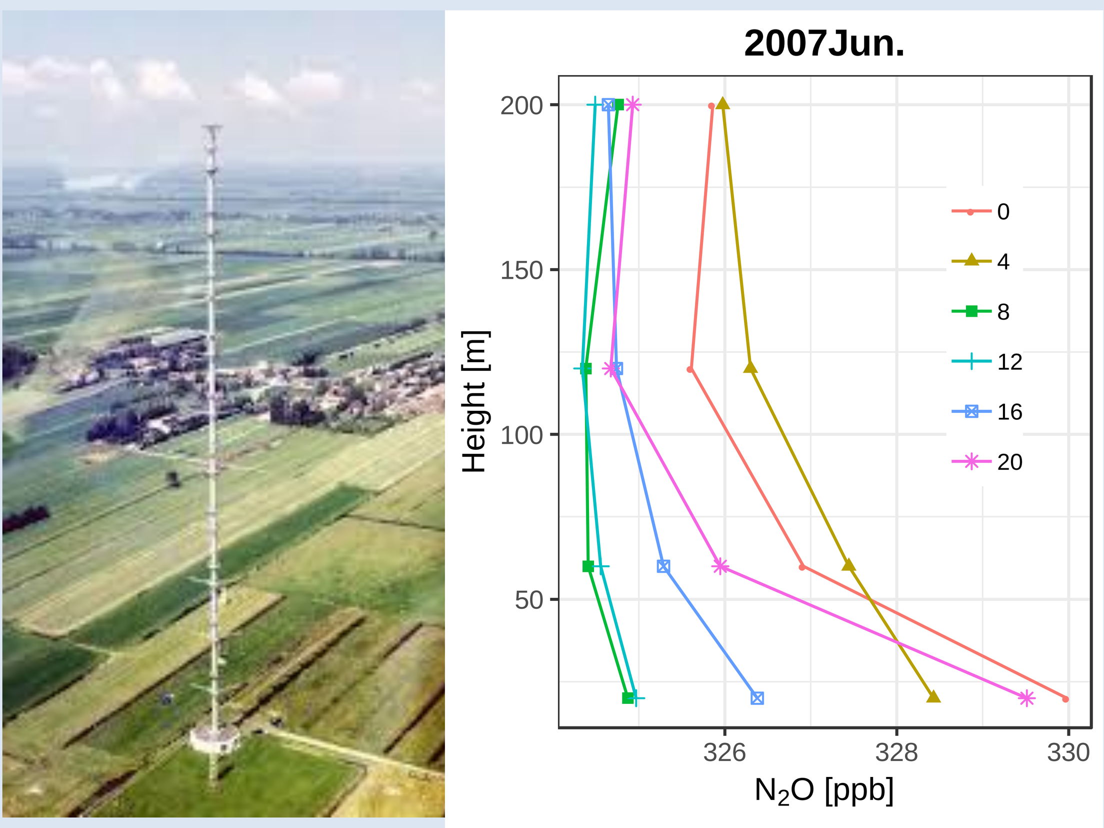


Fig.2 The vertical concentration profile

❖ **Turbulent flux**- the modified Bowen ratio methods

The same eddy diffusivity for gas, heat and water vapor[2]

$$F_{Eddy} = \frac{1}{V_m} . \overline{w'c'}(Z_r) = \frac{H}{C_p M_{Air}} \cdot \frac{\partial c}{\partial T_{pot}}$$

1 **Used meteorological parameters:**

- H: sensible heat flux [W/m^2]
- P_h: Air pressure profile [Pa]
- T_h: Air temperature profile [K]

2 **Used constants:**

- C_p: specific heat capacity of air at constant pressure [1.005 J/g/K]
- M_{Air}: molar weight of air [28.96 g/mol]
- R: gas constant [8.31 J/K/mol]

References

[1] Winderlich J et al., 2014. Inferences from CO2 and CH4 concentration profiles at the Zotino Tall Tower Observatory (ZOTTO) on regional summertime ecosystem fluxes. *Biogeosciences*, *11*(7), pp.2055-2068.

[2] Businger J, 1986. Evaluation of the accuracy with which dry deposition can be measured with current micrometeorological techniques. *Journal of Climate and Applied Meteorology*, *25*(8), pp.1100-1124.

Acknowledgements

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Results- 1. Concentrations

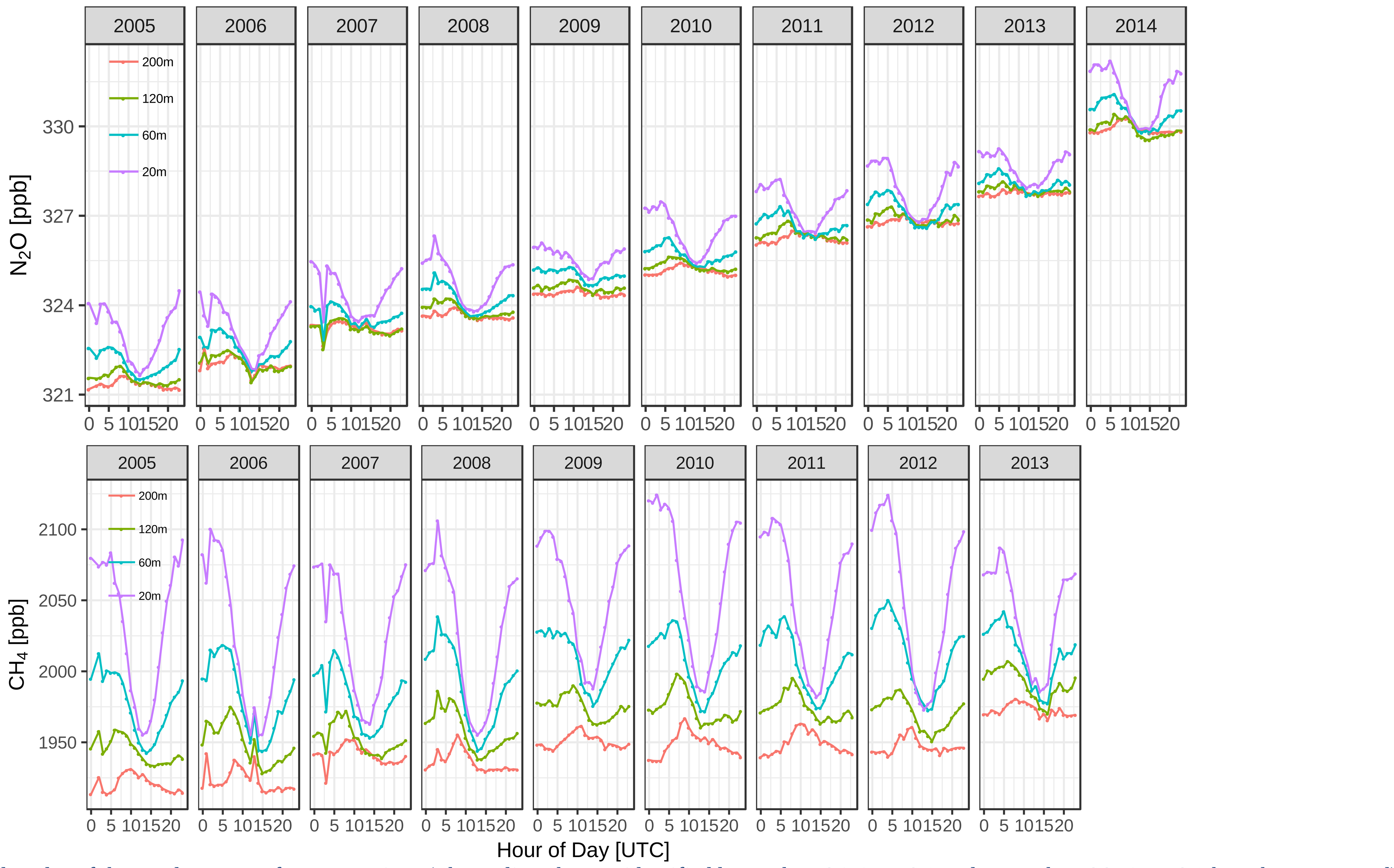

Fig.3 The diurnal cycles of the yearly means of concentrations (The outliers that are identified lower than Q1-1.5*IQR and upper than Q3+1.5*IQR have been removed)

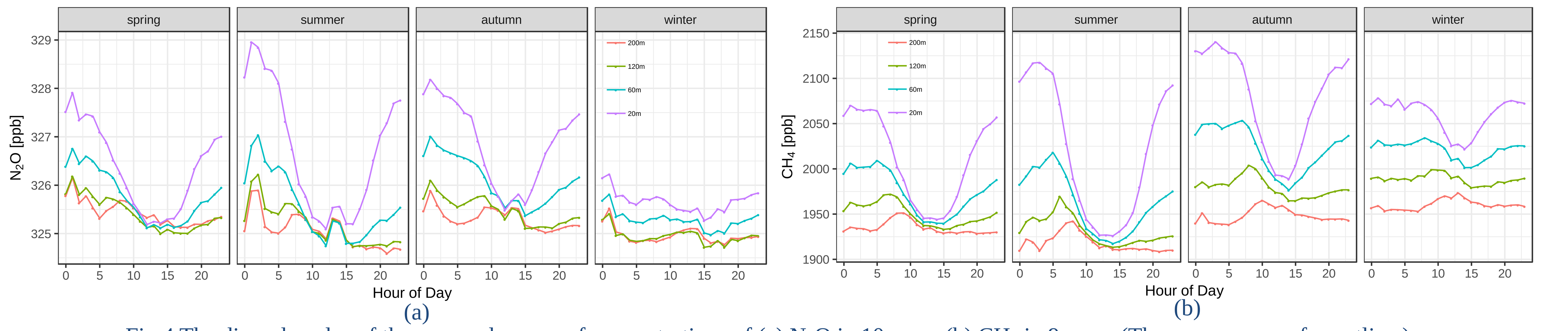

Fig.4 The diurnal cycles of the seasonal means of concentrations of (a) N_2O in 10 years (b) CH_4 in 9 years (The same process for outliers)

Conclusions

1. The diurnal patterns of vertical profile concentrations of N_2O and CH_4 measured at Cabauw show common features probably due to the change of nocturnal boundary layer heights and the co-location of the sources.
   - A The N_2O concentration shows a clear increasing trend during 2005-2014 but CH_4 does not.
   - B The diurnal cycles of N_2O show more seasonal variability than CH_4.
2. This method can potentially give a good estimate of the surface flux of N_2O and CH_4 during nighttime.

Results- 2. The flux

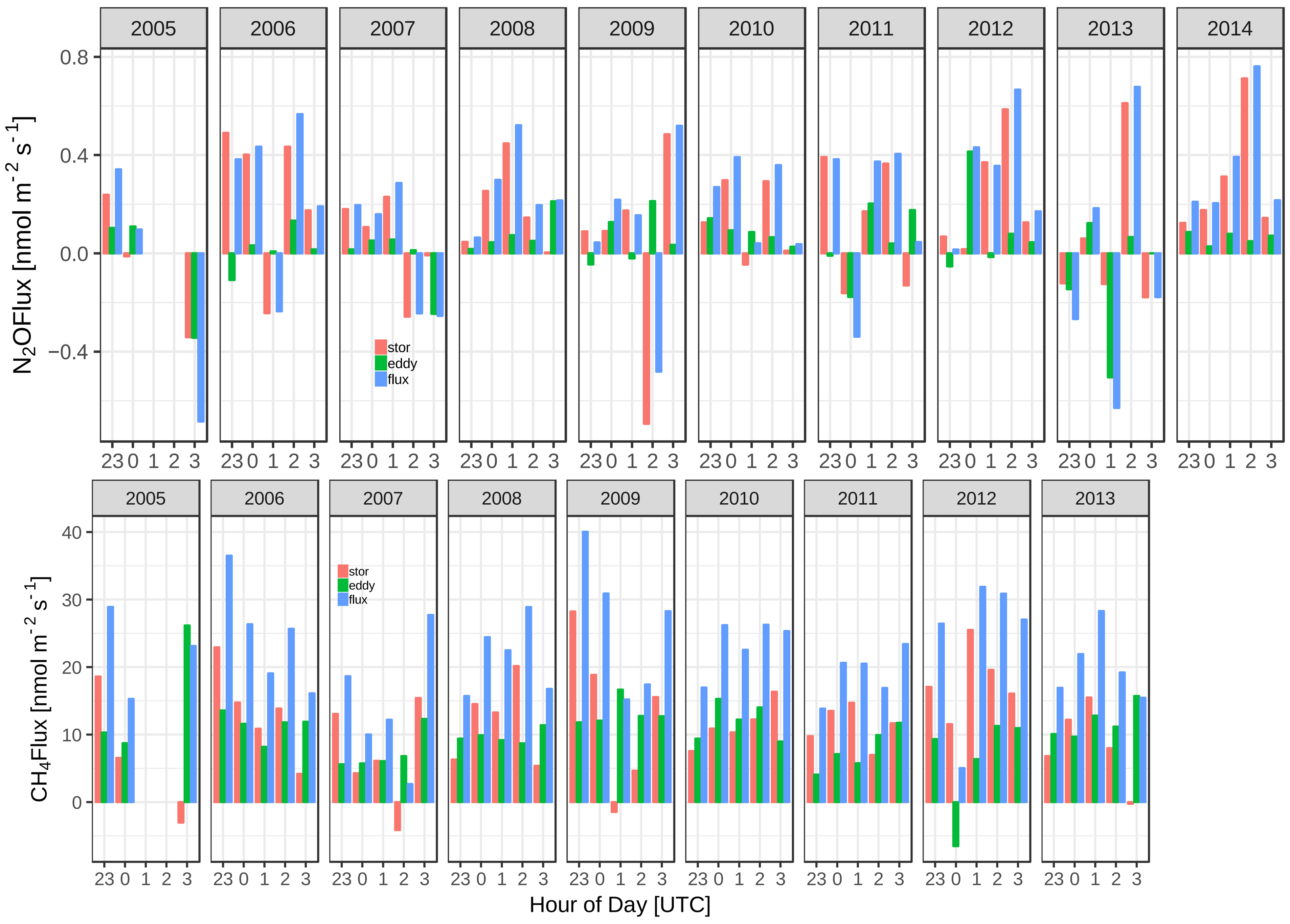

Fig.5 The diurnal cycles of the yearly means of the flux (The outliers in the heat, pressure and temperature that are identified lower than Q1-1.5*IQR and upper than Q3+1.5*IQR have been removed)

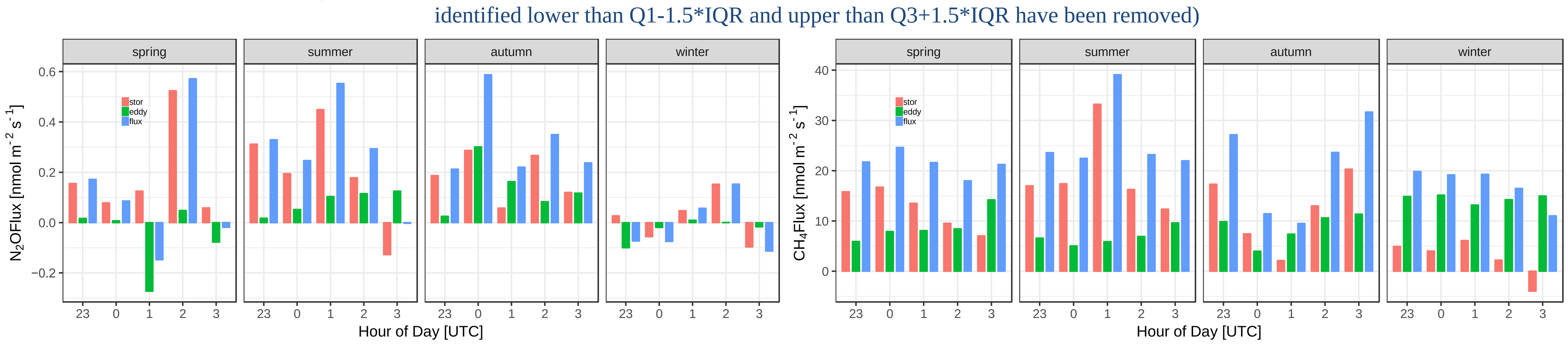

Fig.6 The diurnal cycles of the seasonal means of the flux of (a) N_2O in 10 years (b) CH_4 in 9 years (The same process for the outliers)

Note: Spring: March-April Summer: June-August Autumn: September-November Winner: December-February.