Estimations of ozone and aerosol particle fluxes in Central Amazonia through vertical profiling

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Aerosol and trace gas fluxes are fundamental to quantify sources and sinks of the atmospheric components. In this work, we aim to estimate particle and ozone fluxes and understand the **vertical transport mechanisms** over the Amazon Forest.

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1

Measurements were conducted at the 325 m-tall **ATTO tower** (2.13°S, 59.00°W, 134 m.a.s.l.), in the Central Amazon region in Brazil.

A **sonic anemometer** located on the tower, 127 m above ground, measured micrometeorological parameters.

Aerosol and ozone instrumentation were mounted on a **robotic lift (RoLi)**, which allowed for continuous vertical profiling on the tower (*Fig. 1*) over **4 campaigns** and **6209 profiles** (Brill et al., 2026).

Figure 1: *RoLi lift and instrument box on the ATTO tower.*

2

$$F_\chi = -D\left[\frac{\partial \rho_\chi}{\partial z}\right]_H$$

$$D = \frac{k(H-d)u_*}{\Phi}$$

The turbulent fluxes were estimated by the **flux-gradient method**, connecting the vertical profiles with transport mechanisms.

$k \approx 0.4$ (von Karman constant)
$H = 127$ m (meas. height)
$d \approx 33.4$ m (displacement height)

u_* (friction velocity)
Φ (stability correction function)

3

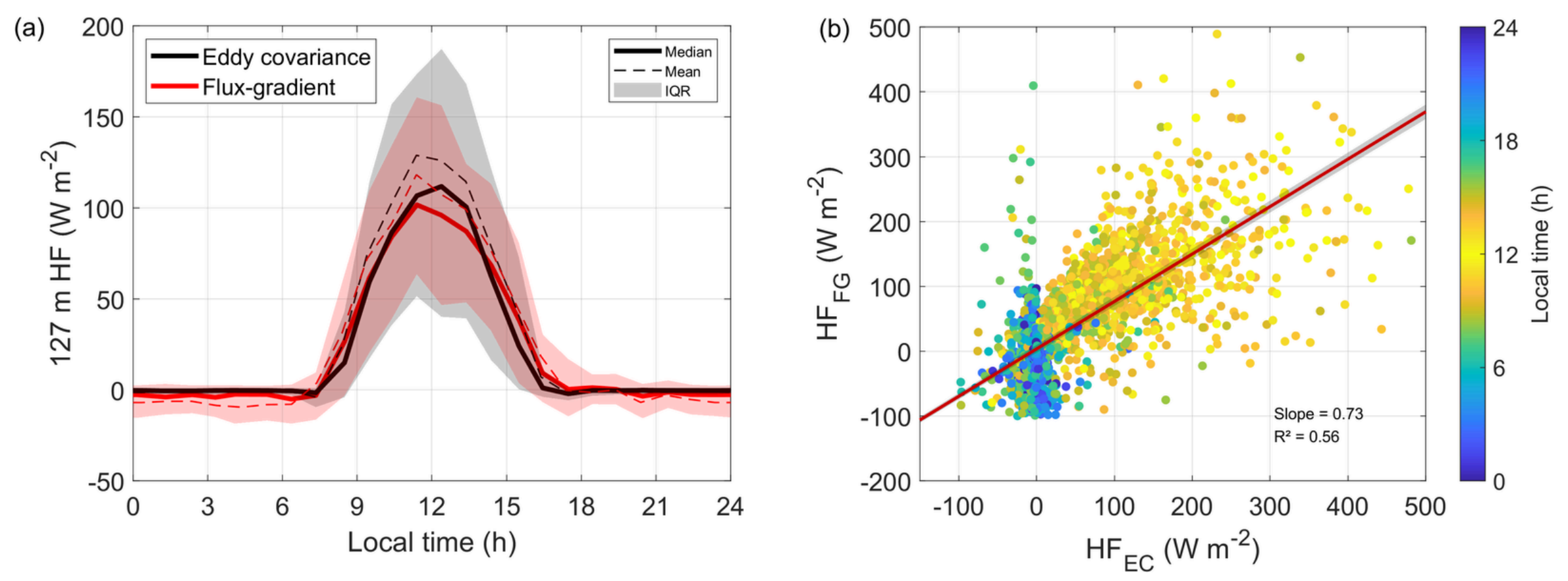


Figure 2: *Comparison between EC and FG estimated sensible heat flux for all RoLi campaigns.*

The agreement between eddy covariance (EC) and flux-gradient (FG) estimated heat fluxes is **strong when considering averages over multiple profiles**. Point-by-point comparison is less precise. Aerosol fluxes can also be estimated by both techniques.

4

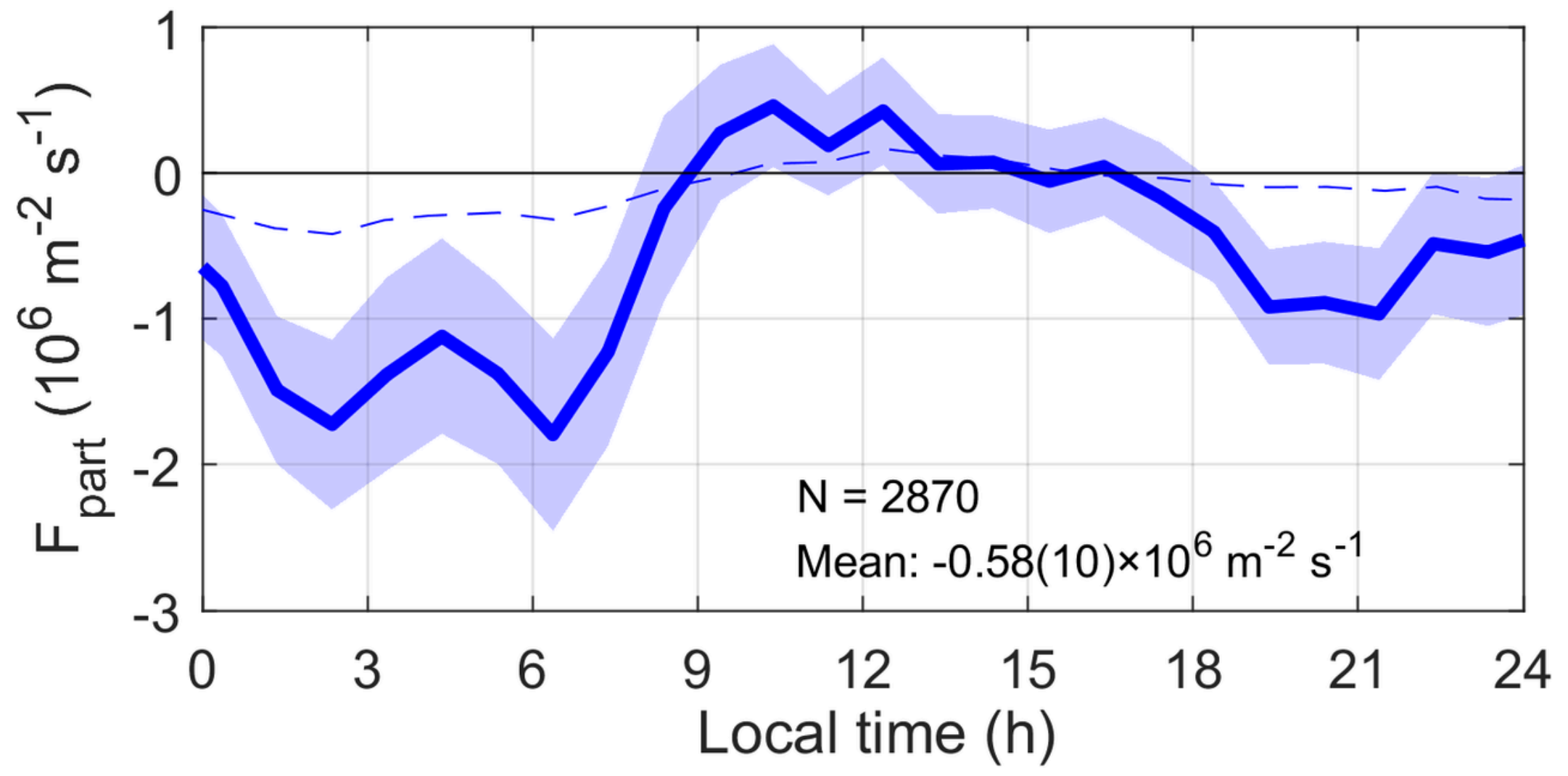


Figure 3: *Diurnal cycle of the 127 m particle flux in the wet season. Smoothed with a 3-points moving average.*

Slight predominance of **downward fluxes (55%)**, mainly at night (60%), indicating deposition. The results are very noisy and sensitive to outliers, however a **seasonal trend** is also apparent, with the dry season showing larger fluctuations.

During rain events, the **turbulent flux does not explain the increase** in ozone concentration, accounting for only 12% of the total effect. This, indicates that the downdraft is the dominant process.

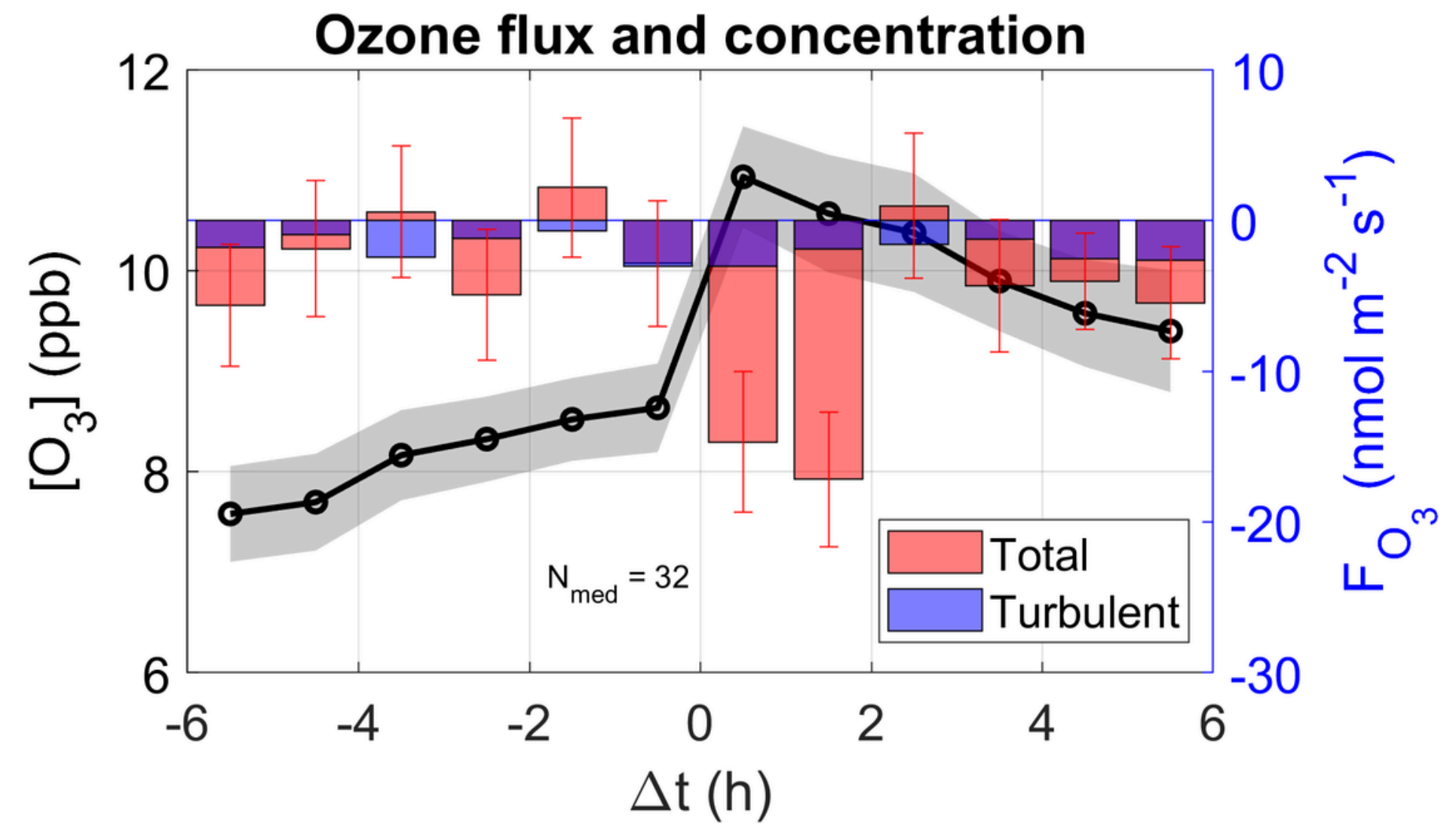
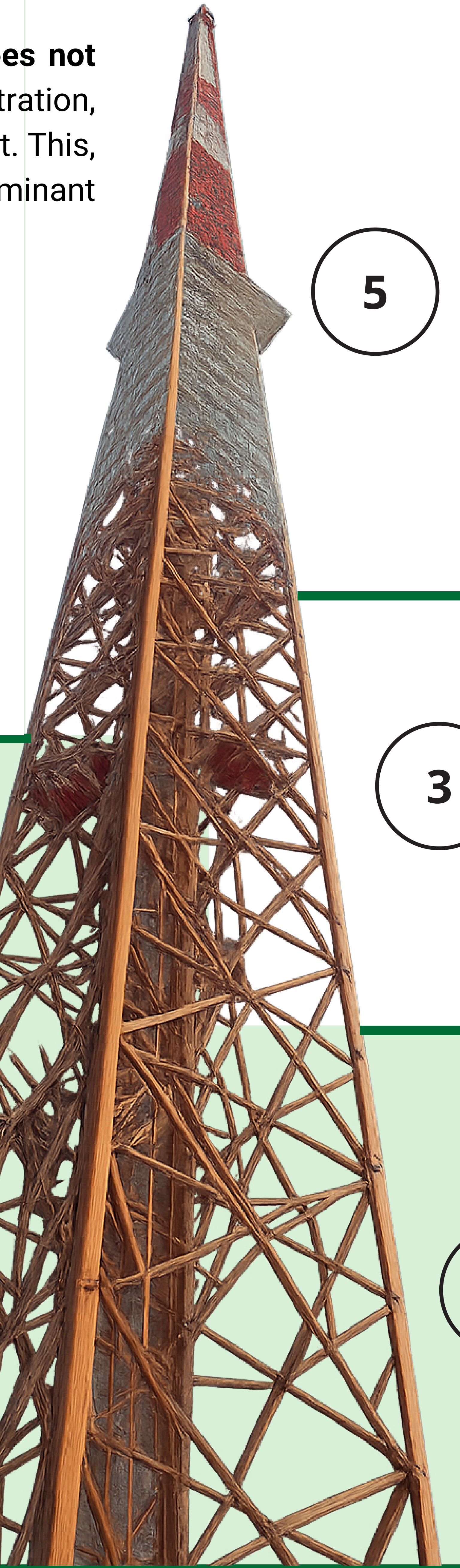


Figure 4: *Rain-normalized 127 m ozone concentration (black), and turbulent and total fluxes (blue and red bars, respectively) over the wet season RoLi profiles.*



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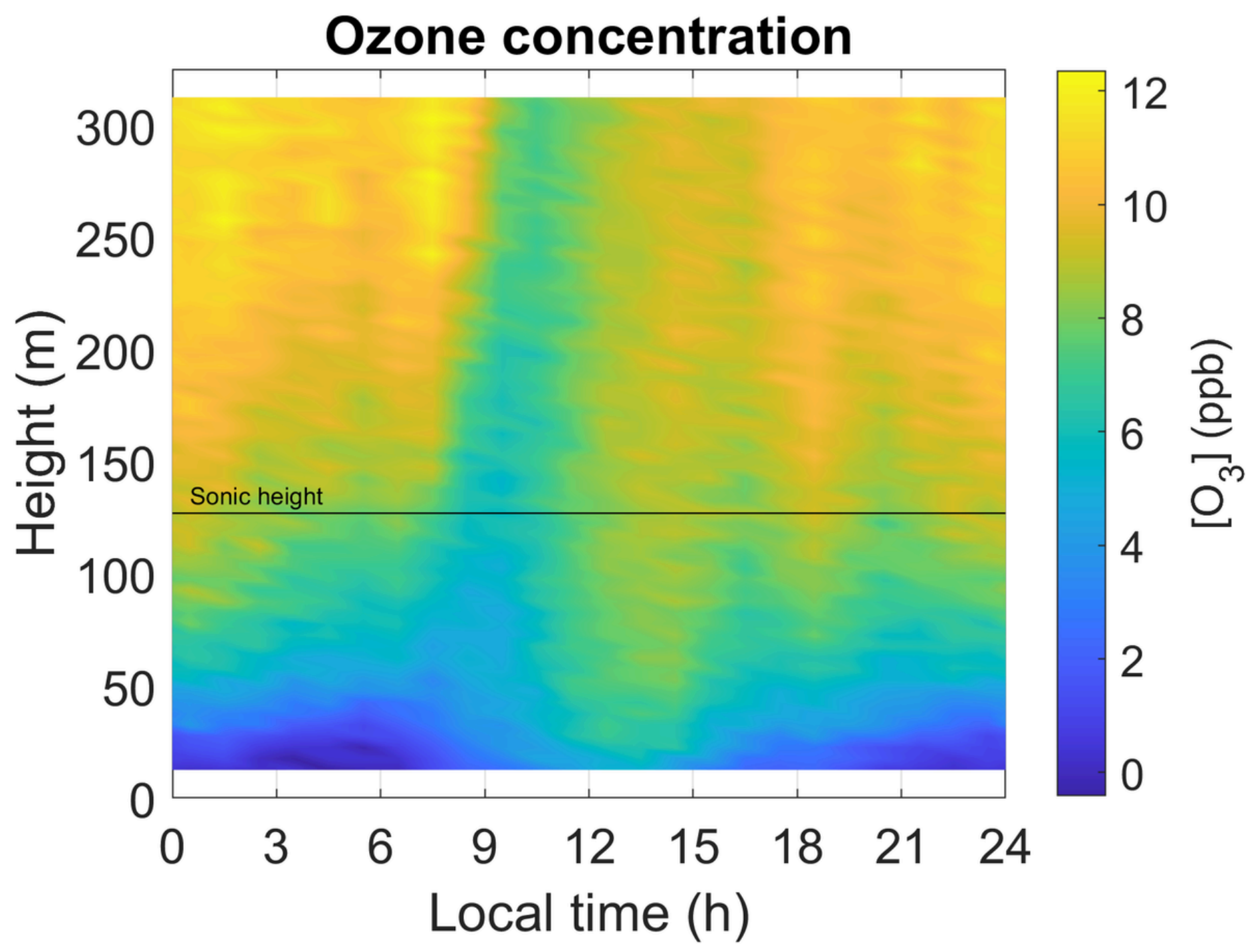

Figure 5: *Diurnal cycle of the vertical profile of the ozone concentration during the wet season campaigns.*

Evidences of turbulent mixing in the early morning were found, with and average growing velocity of **6 cm/s**. Furthermore, previously trapped air from the stable layer can affect concentrations above due to physical mixing and chemical reactions.

TAKE-AWAY MESSAGES

Boundary layer dynamics and particle emission/formation dictate the aerosol and ozone concentrations at the lower troposphere. Turbulent motion is mostly dominant, except during rain events.