Tropical forest CH_4: from flux chambers to micrometeorological tower measurements

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Field experiment

Fieldsite ZF2 (INPA-LBA), primary forest :

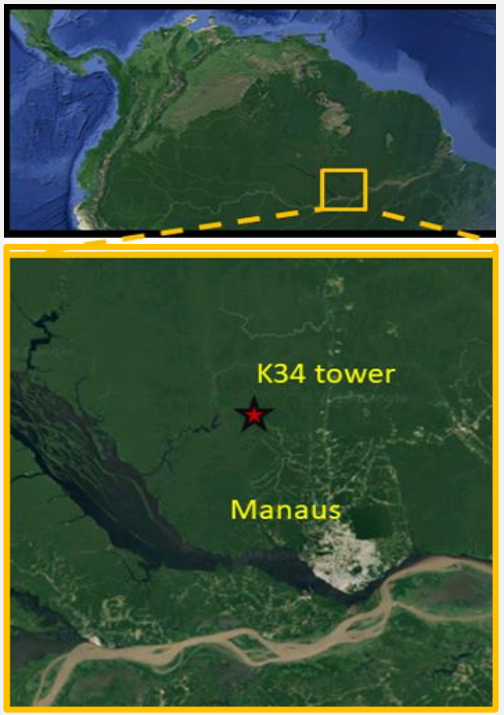
- Hilly terrain, with plateaus, slopes, campinaranas (forest on white sand) and valleys (inundated after strong rain events)
- On plateau, K34 tower (50 m), running since 1999:
  - EC CO_2 measurements
  - Meteorological measurements

Since October 2018, at K34 tower:

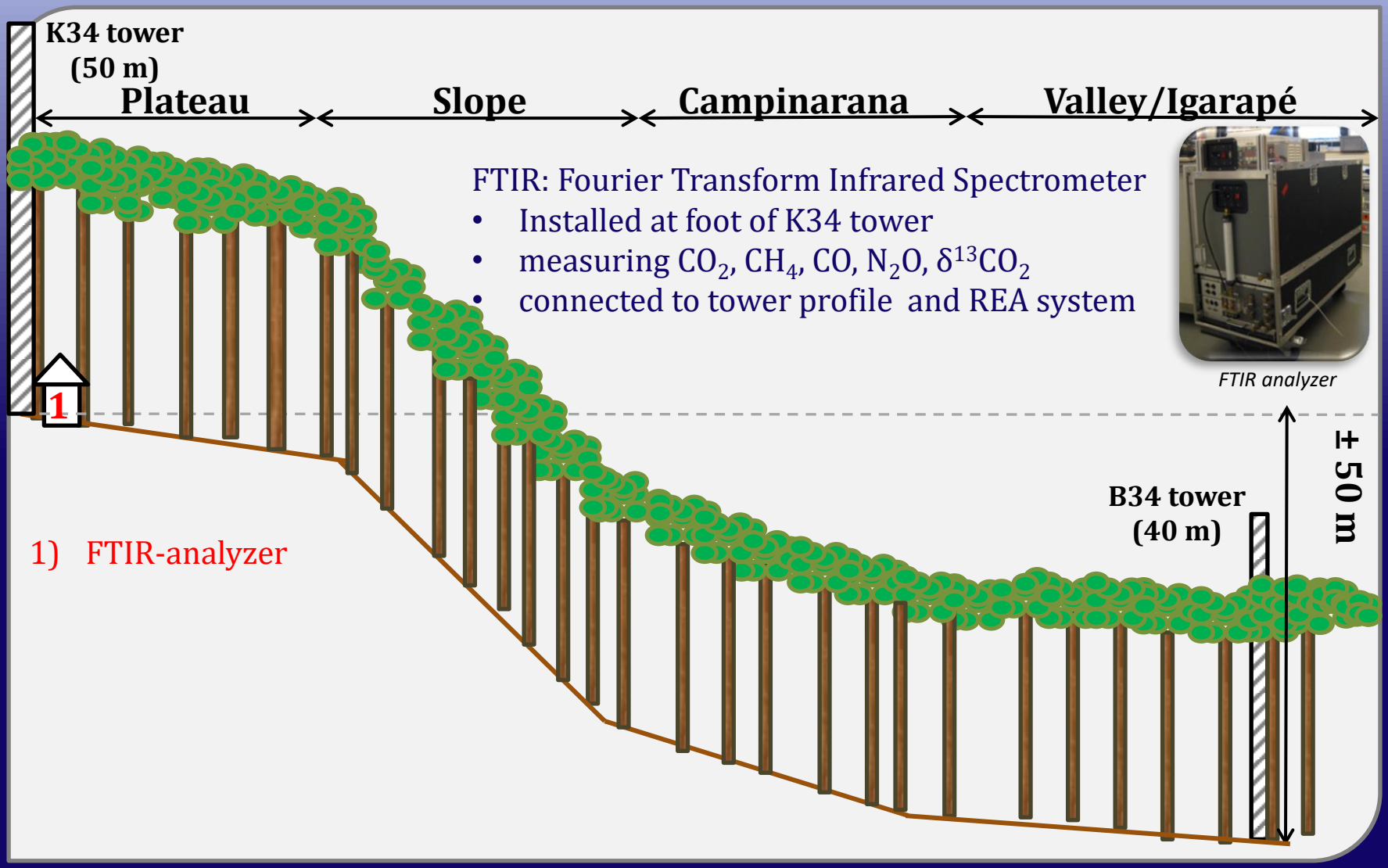
- Ecotech Spectronus FTIR-analyzer (Griffith et al., 2012)
- measuring CO_2, CH_4, CO, N_2O, $\delta^{13}CO_2$
- FTIR analyzer connected to:
  - Relaxed Eddy Accumulation (REA)
  - Tower profile measurements

Since March 2019, around K34 tower:

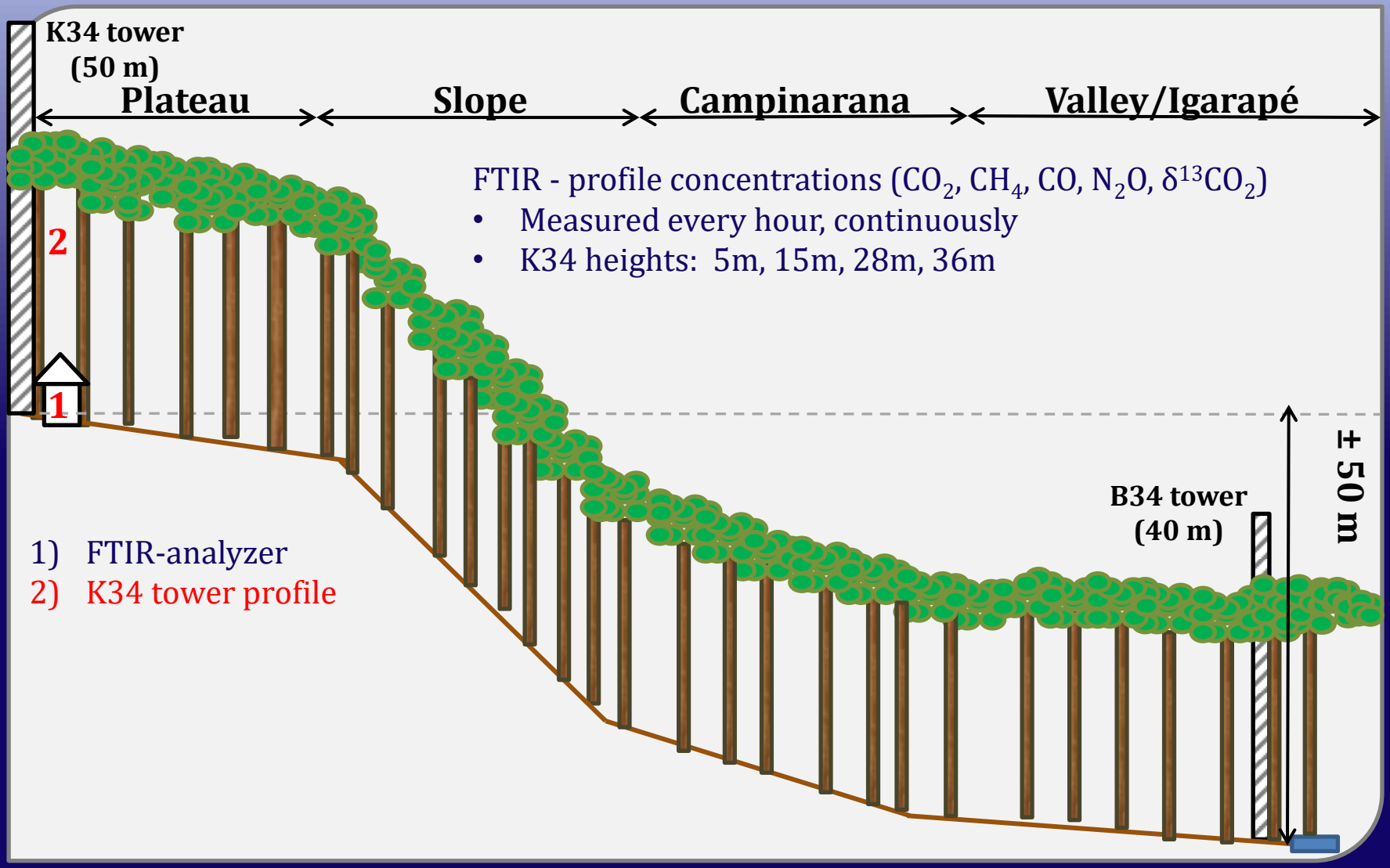
- 3 intensive measurement campaigns
- Los Gatos Ultraportable Analyzer (CO_2 & CH_4):
  - Flux measurements of soil, tree and water
  - Nighttime valley concentration measurement



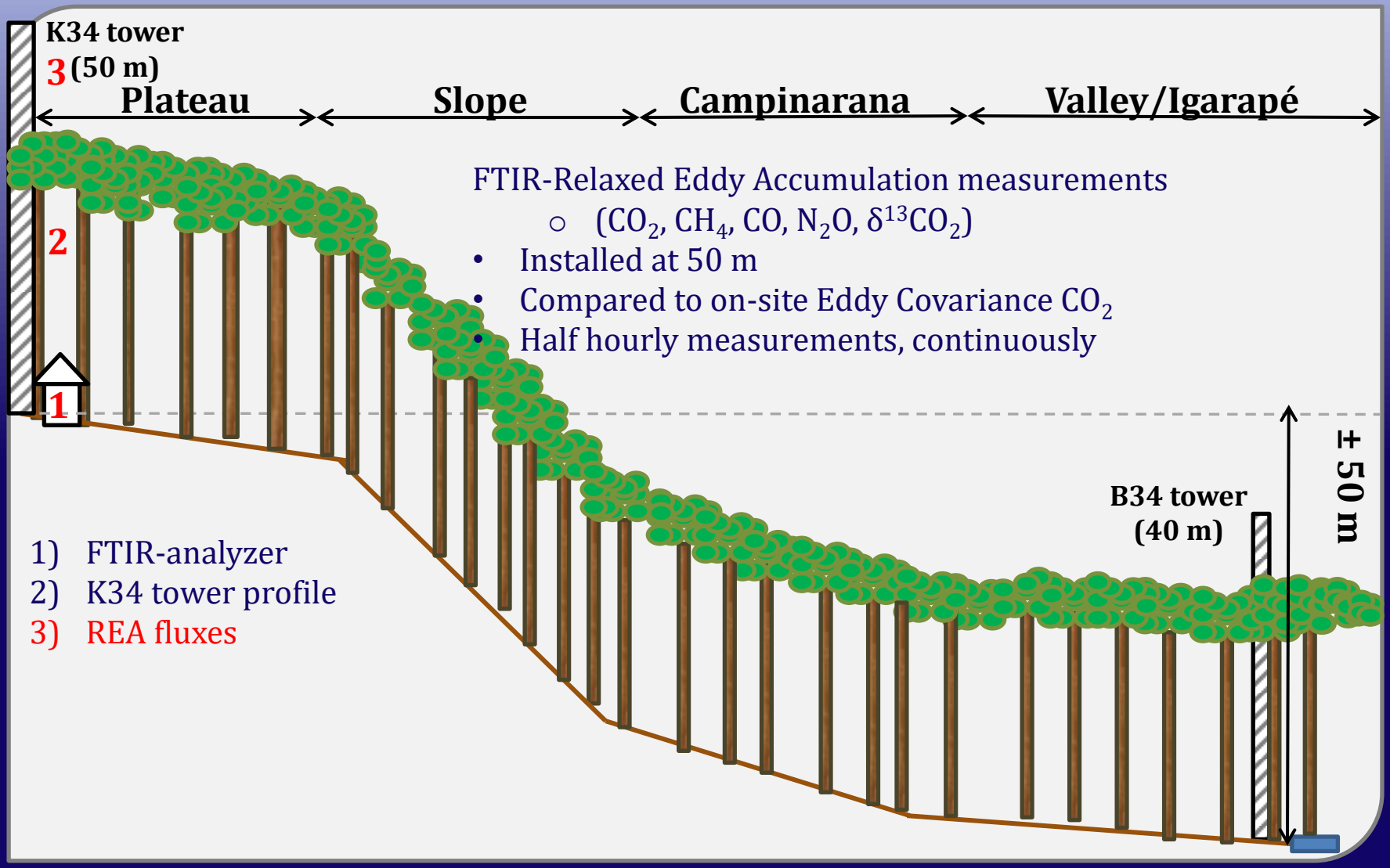
Field experiment



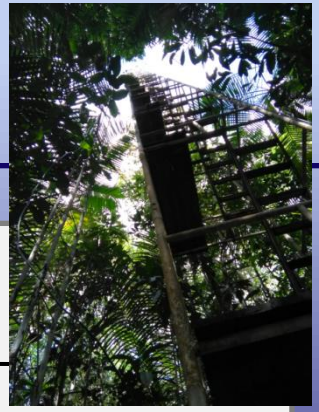
Field experiment



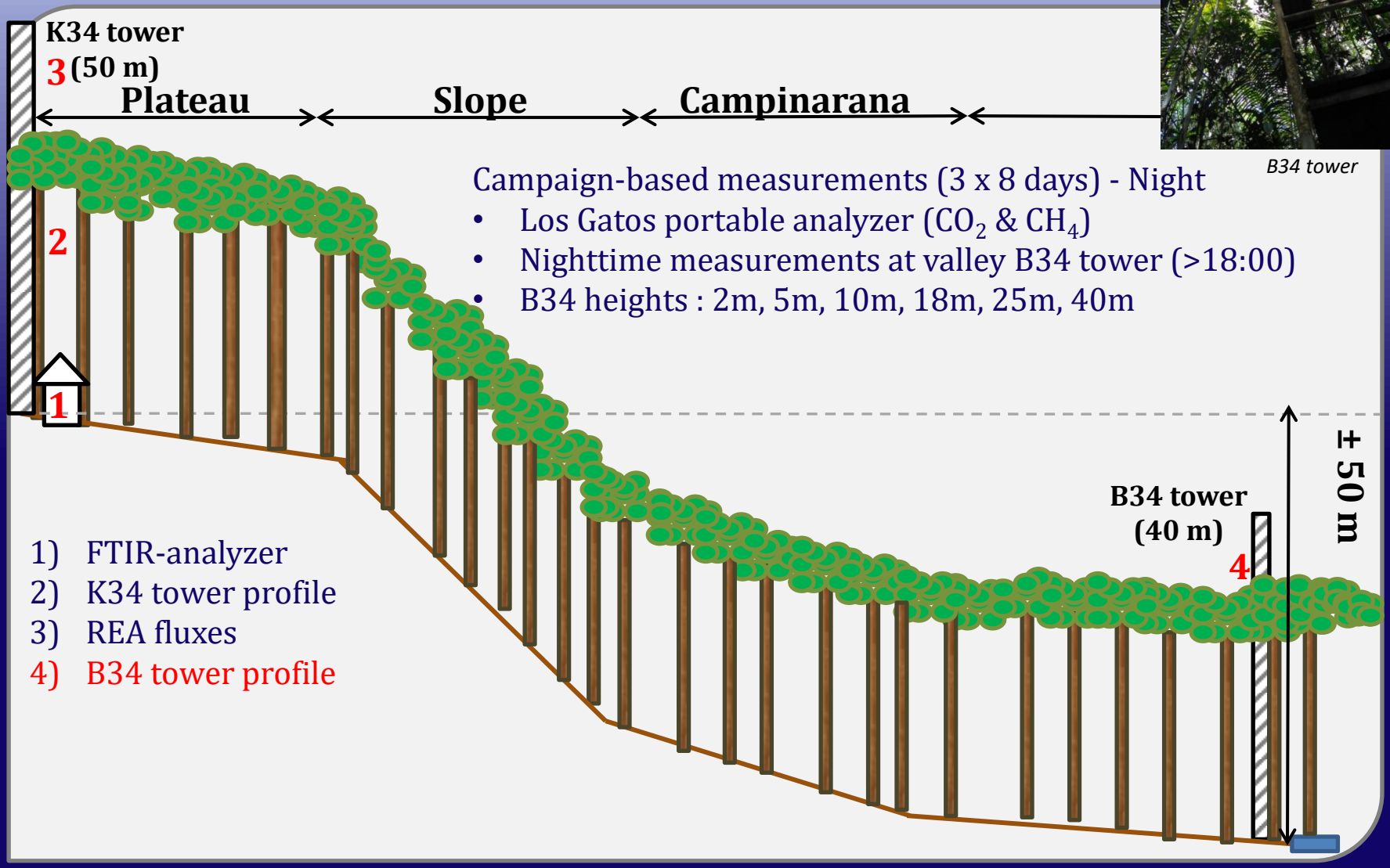
Field experiment



Field experiment



B34 tower

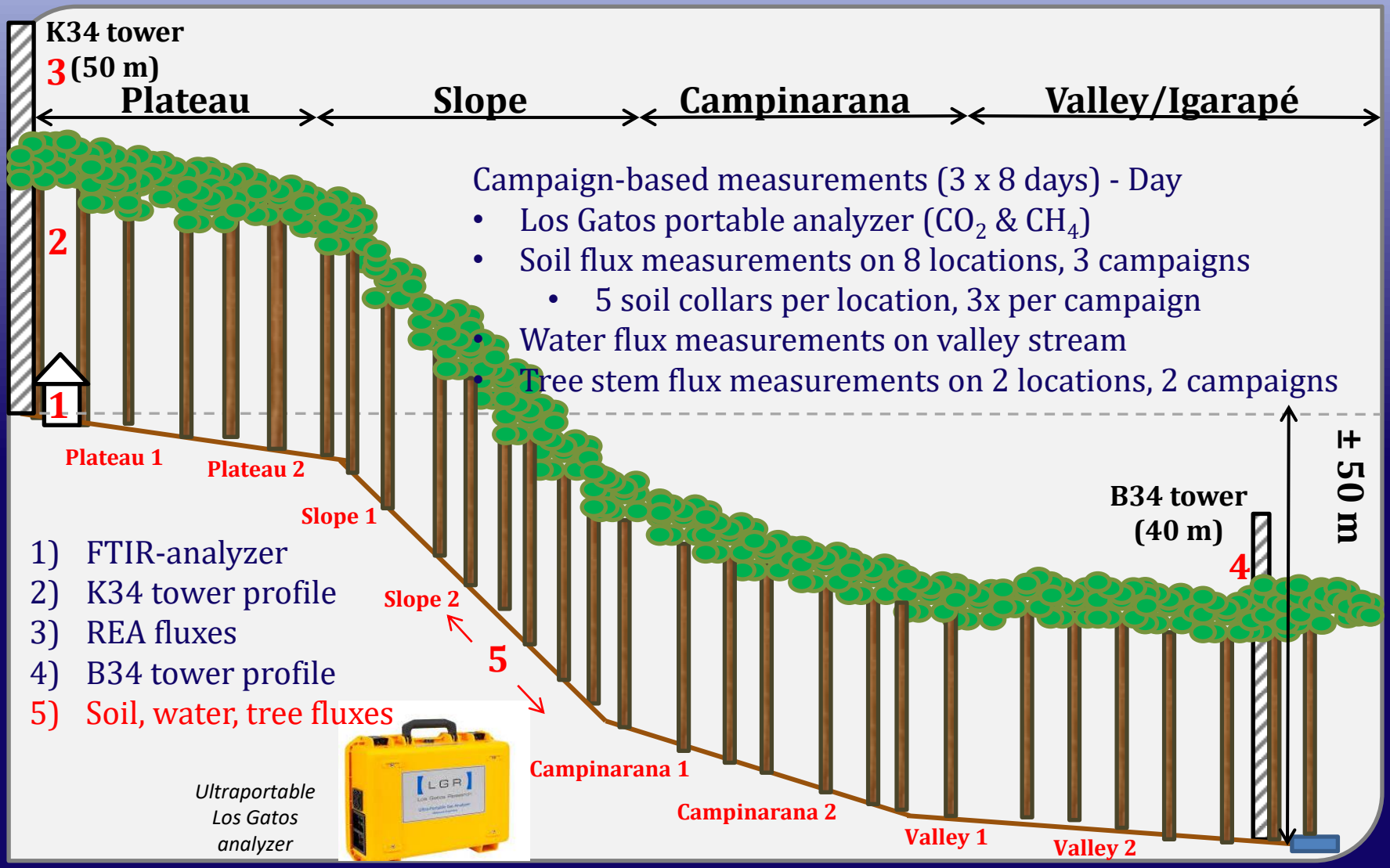


Campaign-based measurements (3 x 8 days) - Night

- Los Gatos portable analyzer (CO_2 & CH_4)
- Nighttime measurements at valley B34 tower (>18:00)
- B34 heights : 2m, 5m, 10m, 18m, 25m, 40m

1) FTIR-analyzer
2) K34 tower profile
3) REA fluxes
4) B34 tower profile

Field experiment



Campaign-based measurements (3 x 8 days) - Day

- Los Gatos portable analyzer (CO_2 & CH_4)
- Soil flux measurements on 8 locations, 3 campaigns
  - 5 soil collars per location, 3x per campaign
- Water flux measurements on valley stream
- Tree stem flux measurements on 2 locations, 2 campaigns

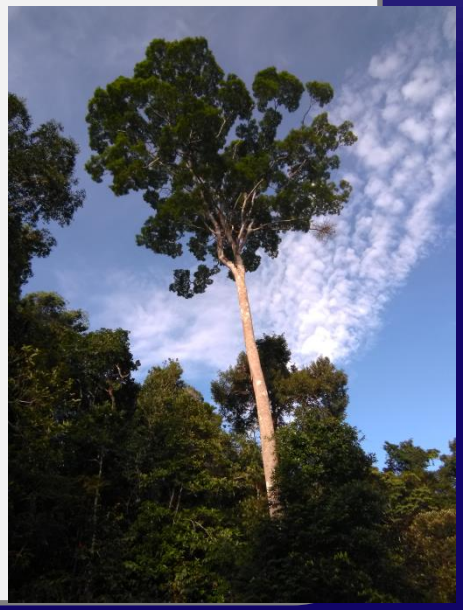
1) FTIR-analyzer
2) K34 tower profile
3) REA fluxes
4) B34 tower profile
5) Soil, water, tree fluxes

Ultraportable Los Gatos analyzer

Results

The following slides will show a selection of preliminary data on:

- Soil flux measurements
- K34 tower concentration data (plateau)- general patterns
- K34 tower concentration data (plateau)
  - Emission estimate based on tower concentration data
- B34 tower concentration data (valley)
  - Emission estimate based on tower concentration data



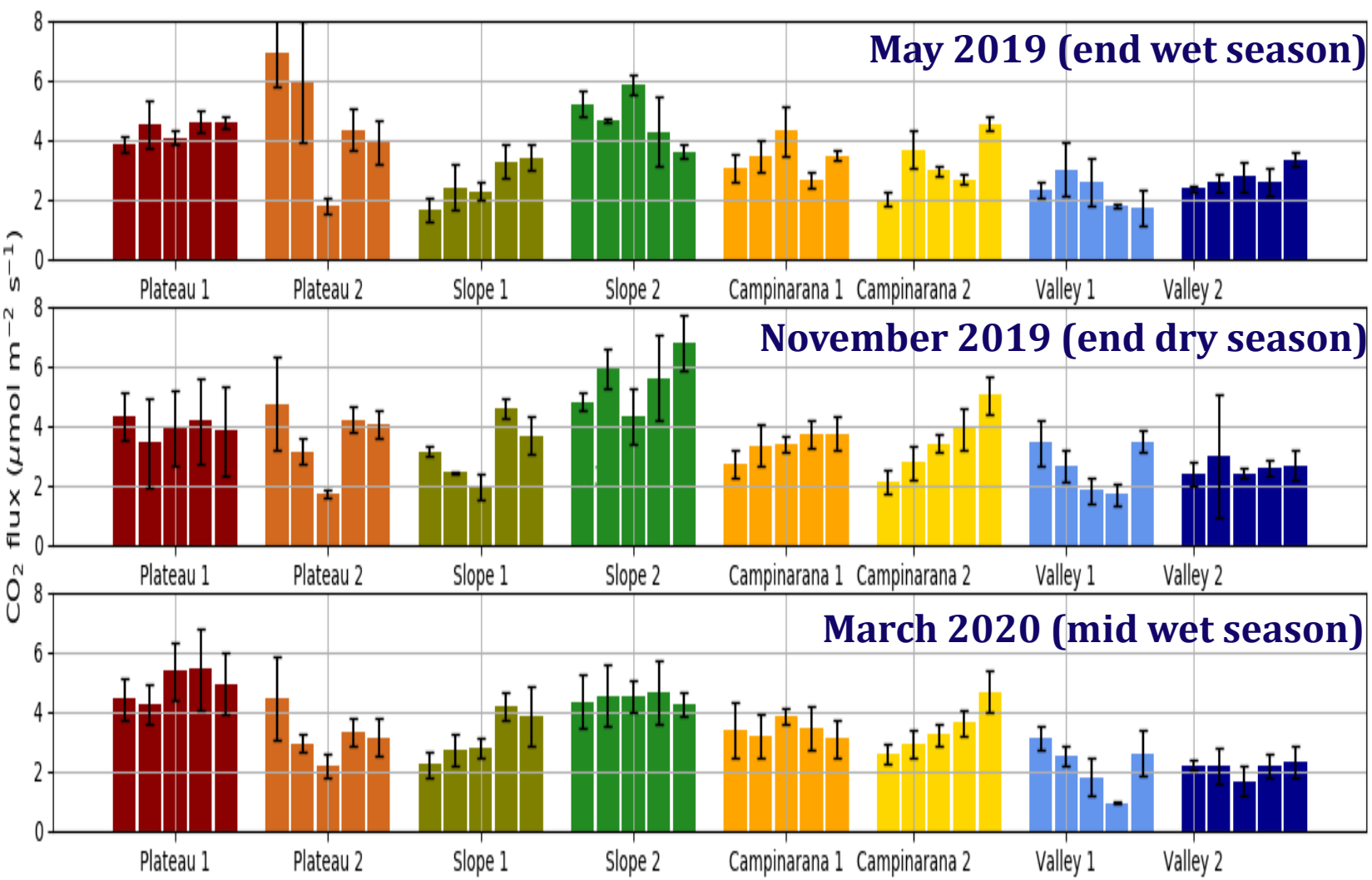
Results

Soil flux measurements

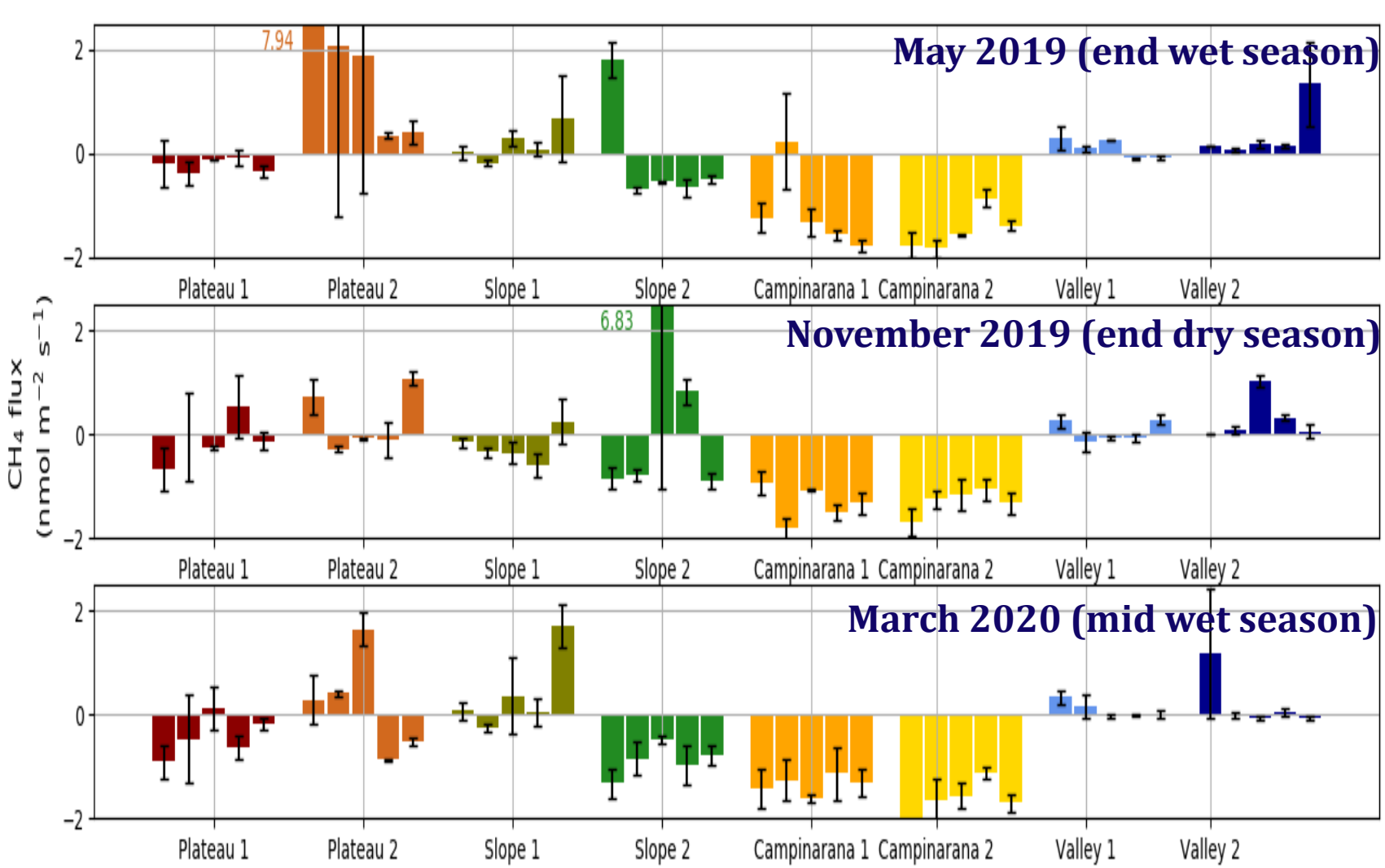
- Three campaigns (wet season, dry season, wet season)
- Closed static chamber measurements
- 40 soil collars (5 soil collars on 8 locations)
- CO_2 and CH_4 fluxes
- Additional measurement of T and soil moisture
- Measured 3 times per campaign
  - Shown fluxes are mean of 3 measurements
  - Shown standard deviation is standard deviation of 3 measurements

Soil collar with temperature sensor

Soil flux measurements: CO_2



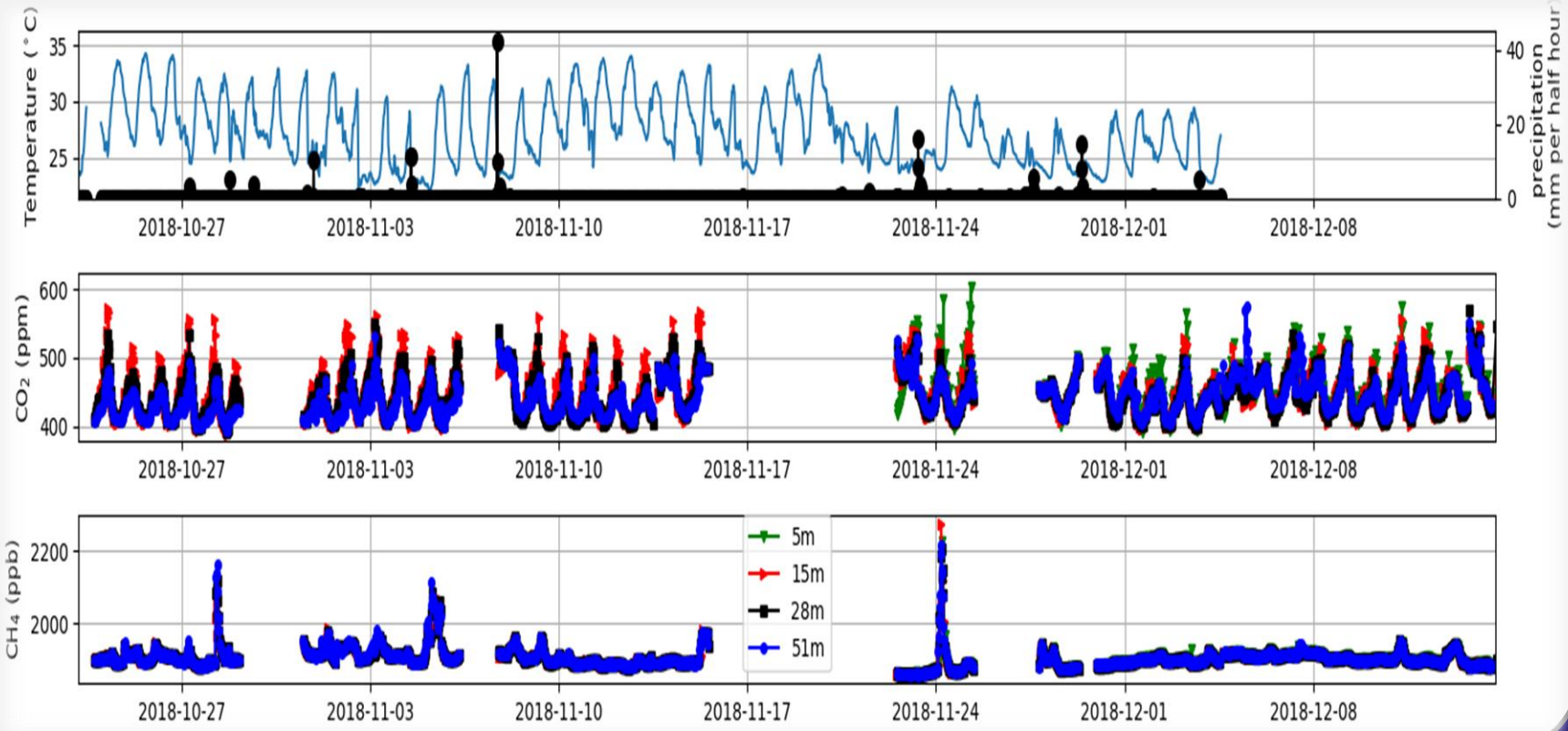
Soil flux measurements: CH_4



Plateau K34 tower: general patterns

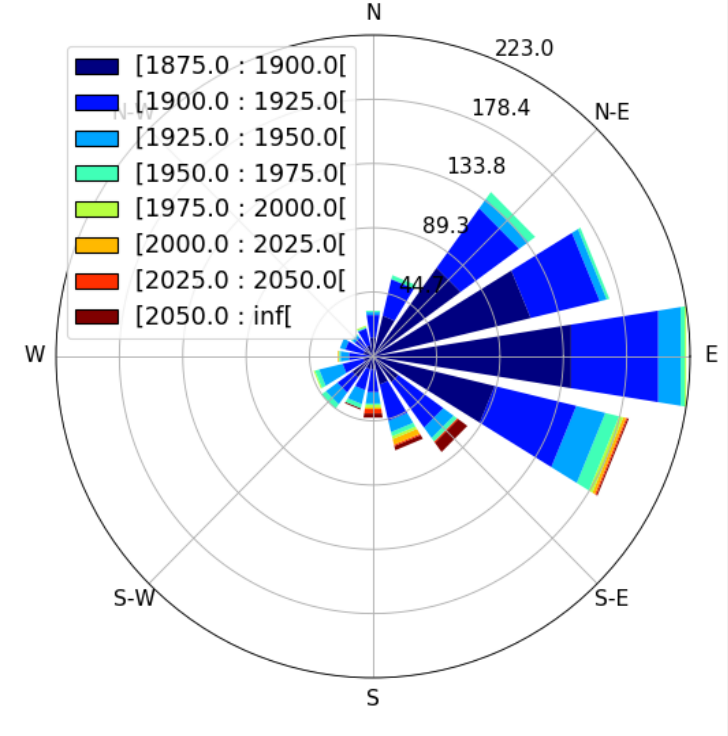
Concentration data from October-December 2018:

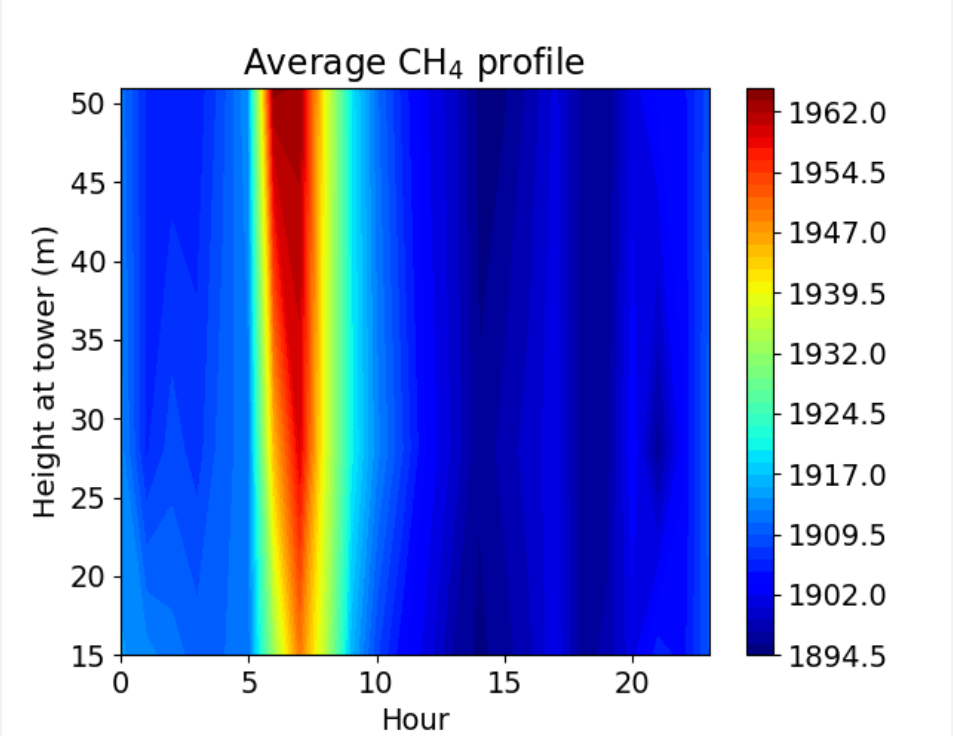
- High CH_4 peaks are observed, up to 2200 ppb
- Peaks seem not to correlate to rain or temperature patterns
- Peaks sometimes coincide with CO peaks (not shown), indicating anthropogenic origin



Plateau K34 tower: general patterns

- Peaks usually occur when wind was southeast with moderate wind speed (± 1-2 m s^{-1})
- The CH_4 concentration profile indicates that the CH_4 concentration peaks first 'arrive' at the higher levels before reaching the lower levels

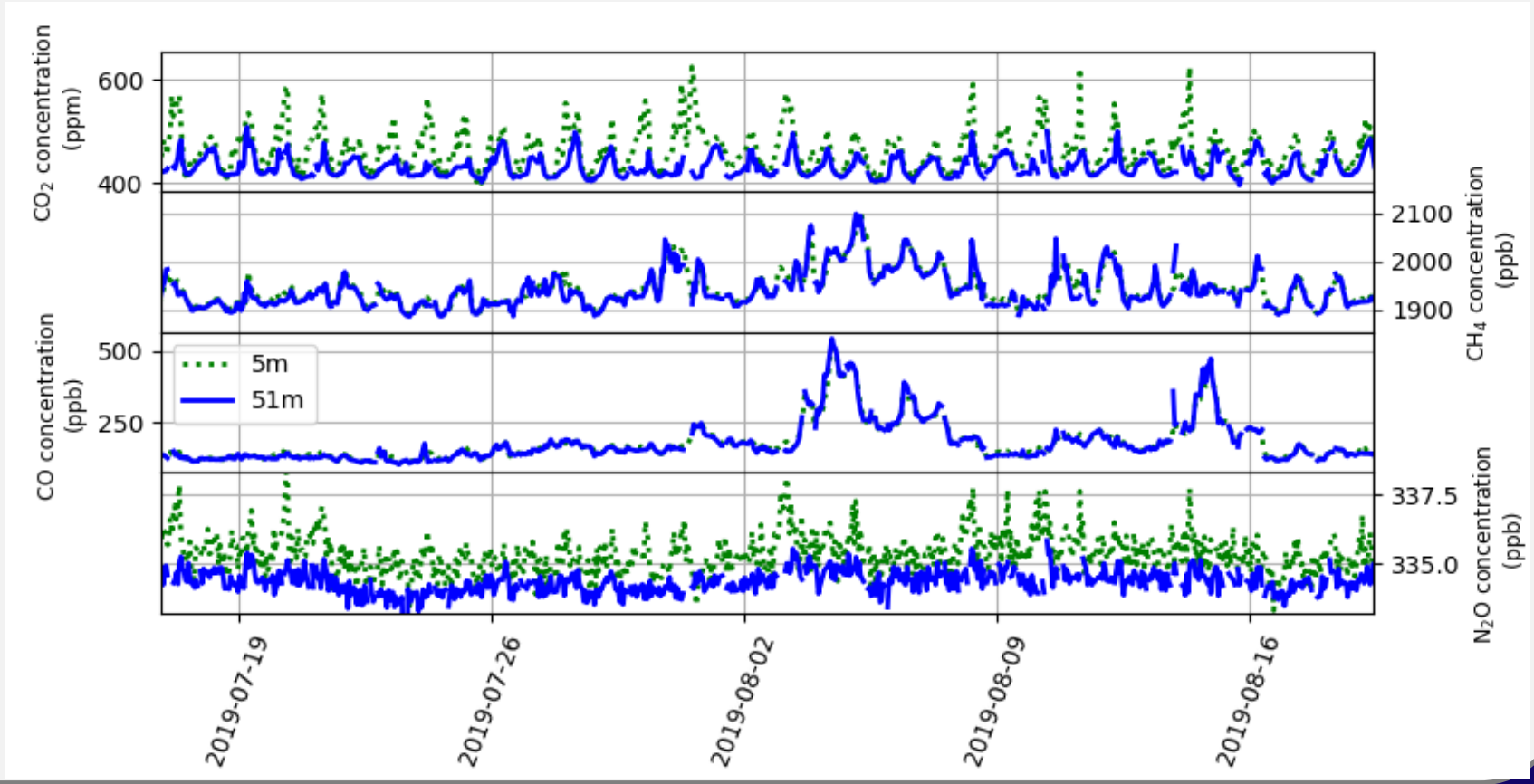




Plateau K34 tower: general patterns

Concentration data from July-August 2019:

- Amazon forest fires from August 2019 are visible in CO concentration data
- Small but consistent positive N_2O gradient observed, indicating N_2O emissions



CH_4 profile: emission estimates

- CH_4 concentration profiles were measured at K34 (plateau, continuously) and B34 (valley, campaign based)
- The method as described by Carmo et al. (2006) was used to estimate CH_4 fluxes:

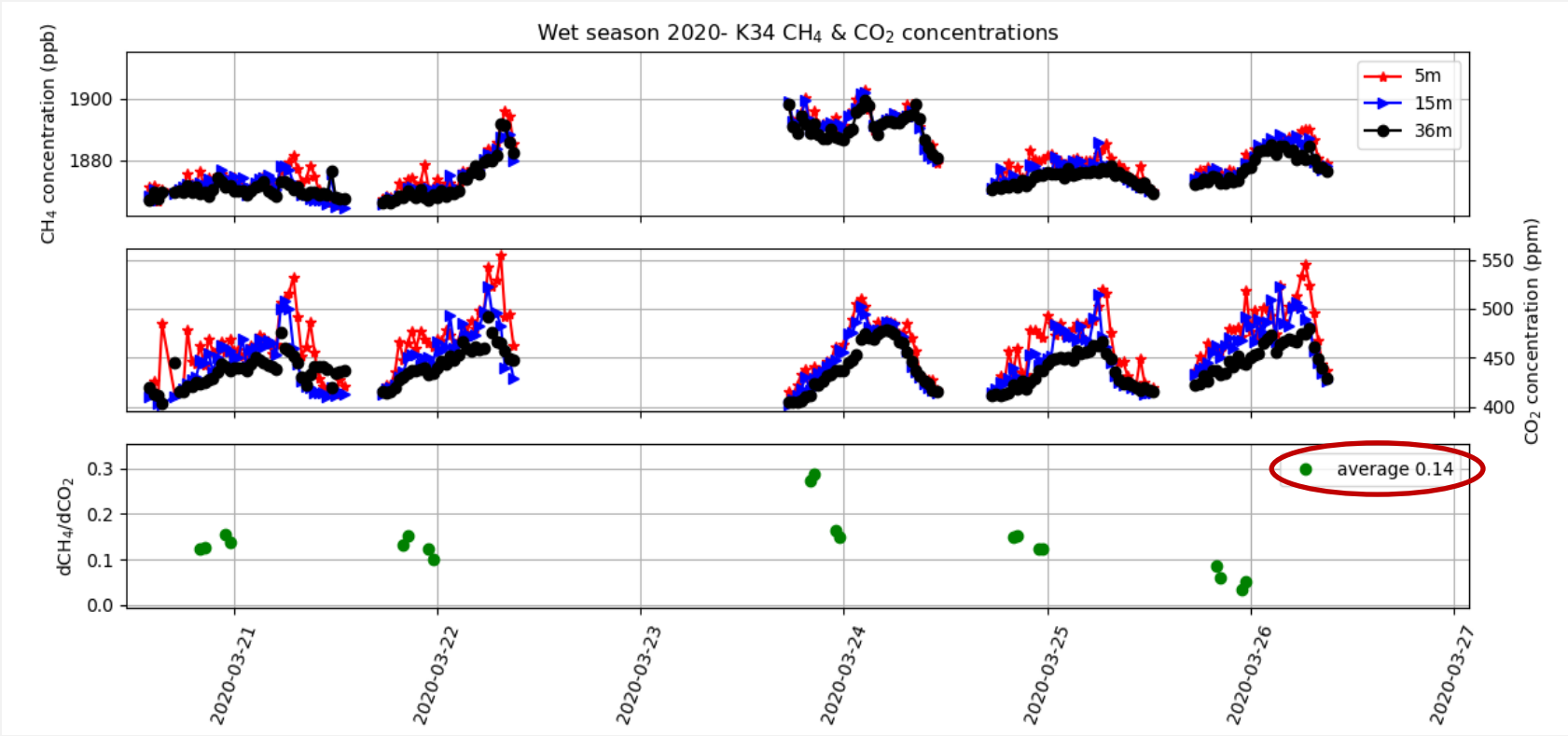
- $$P_{CH4} = \rho J_{soil} \frac{d[CH4]}{d[CO2]}$$

Wherein

- dCH_4 and dCO_2 is the nighttime 3h-average vertical concentration gradient at 20h (20:00-23:00) and 23h (23:00-2:00)
- Jsoil is the soil CO_2 flux (based on soil chamber fluxes)
- ρ is the ratio ecosystem-soil fluxes, set at 2.4 (value for Amazon rainforest , Chamber et al., 2004)

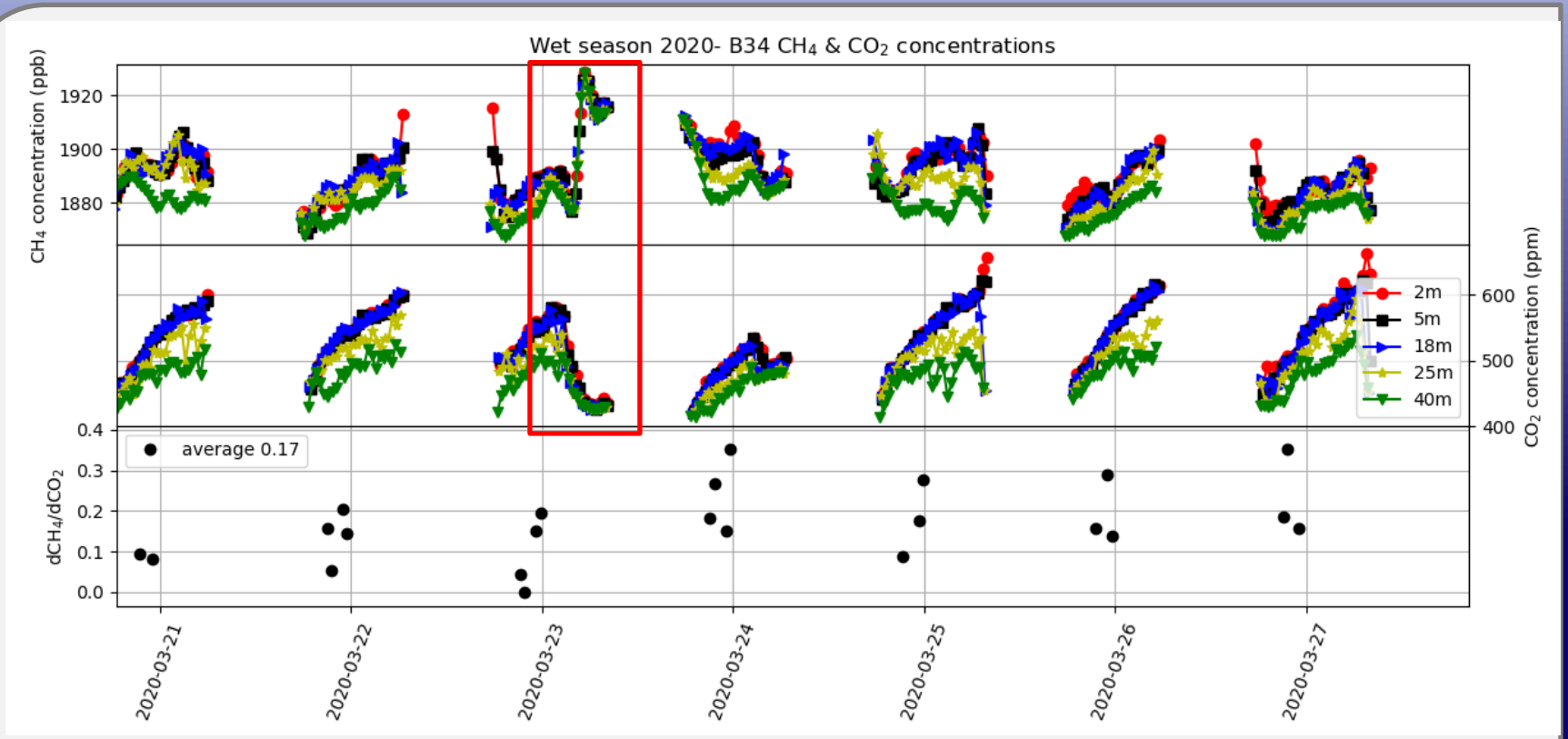
- For the K34 tower, the concentration difference between 5 and 36 m was taken
- For the B34 tower, the concentration difference between 5 and 25 m was taken

K34-plateau CH_4 profile: emission estimates



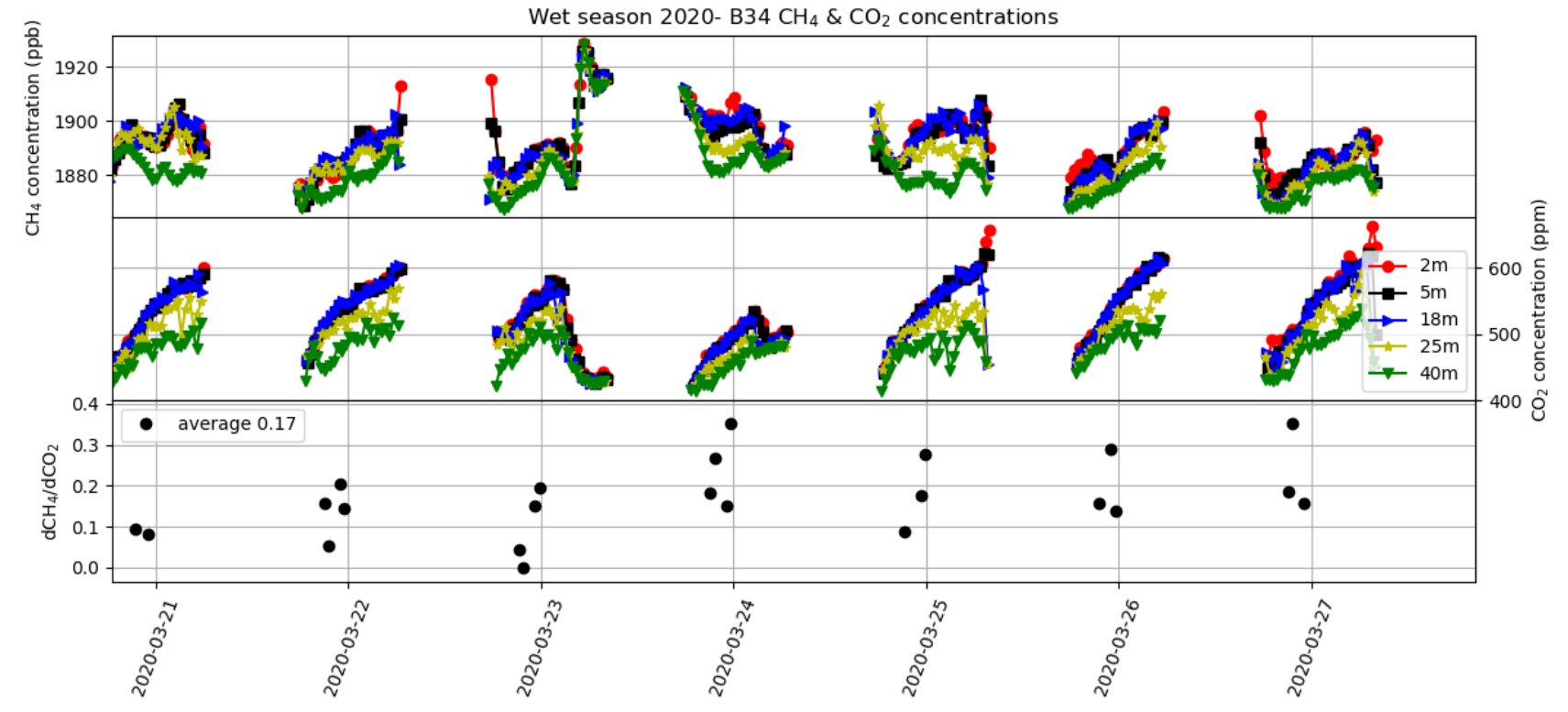
- Average dCH_4/dCO_2 = 0,14
- Jsoil = 4,0 umol m^{-2} s^{-1} (averaged plateau 1 & 2- March 2020)
- ρ = 2,4
- **Estimated CH_4 flux = 1,3 nmol m^{-2} s^{-1}**

B34-valley CH_4 profile: emission estimates



- On 23 March 2020, peak of CH_4 passing by, while CO_2 concentrations dropped. Unfortunately, no measurements of plateau of that night are available.
- In general, clear difference between 25 and 40 m (above canopy) and other heights

B34-valley CH_4 profile: emission estimates



- Average dCH_4/dCO_2 = 0,17
- Jsoil = 2,2 umol m^{-2} s^{-1} (averaged valley 1 & 2- March 2020)
- ρ = 2,4
- **Estimated CH_4 flux = 0,9 nmol m^{-2} s^{-1}**

Preliminary conclusions and outlook

- Chamber measurements show that plateau, slope and campinarana soils are generally taking up CH_4, and that valley soils show minor CH_4 emissions;
- However, preliminary profile analyses indicate a small overal ecosystem emission of CH_4 ($\sim$ 1 nmol m^{-2} s^{-1});
- Similar flux magnitudes were observed before at same fieldsite by Querino et al. (2011);
- Tower profile and Relaxed Eddy Accumulation data still need to be processed further, so that a general ecosystem CH_4 flux estimate can be given.

For questions or suggestions, I would be happy to be in contact!
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