Assessing the Climatic Representativeness of a Global Network of Methane Flux Towers in Wetlands

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Introduction

- CH_4 is a greenhouse gas, more potent than CO_2.[1]
- In the past three decades, there have been periods of increasing atmospheric CH_4, however it is poorly understood why these changes are happening.[2]
- Wetlands are the largest natural sources of CH_4 but remains an uncertain source.[3]
- Eddy-flux towers measure wetland emissions at the ecosystem scale.
- A global network of tower (FLUXNET–CH_4) allows us to estimate global flux, but their geographic distribution has some 'blind spots'

Figure 1: Retrieving data from a flux tower located at Eden's Landing

Research Question: How representative is the methane flux tower network of the world's climatic conditions?

Data & Method

- Use 44 towers located in wetlands or rice crops.
- Use 11 climatic variables gridded globally, representing long-term averages 2000-2017: Precipitation, Long/Shortwave Radiation, Pressure, Specific Humidity & Temperature: Annual Average, Monthly Average, Max of Warmest Month, Min of Coldest Month, Average of Warmest Quarter, Average of Coldest Quarter
- Mask variables to areas of >2.5% wetland fraction.
- Extract climatic variables at tower point locations.
- Evaluate the similarity (i.e. Euclidean distance) of every pixel on the map to the network of towers.
- Use statistical tests, scripted in R, to evaluate distributions. Analyses inspired by Kumar et al. 2016. [4]

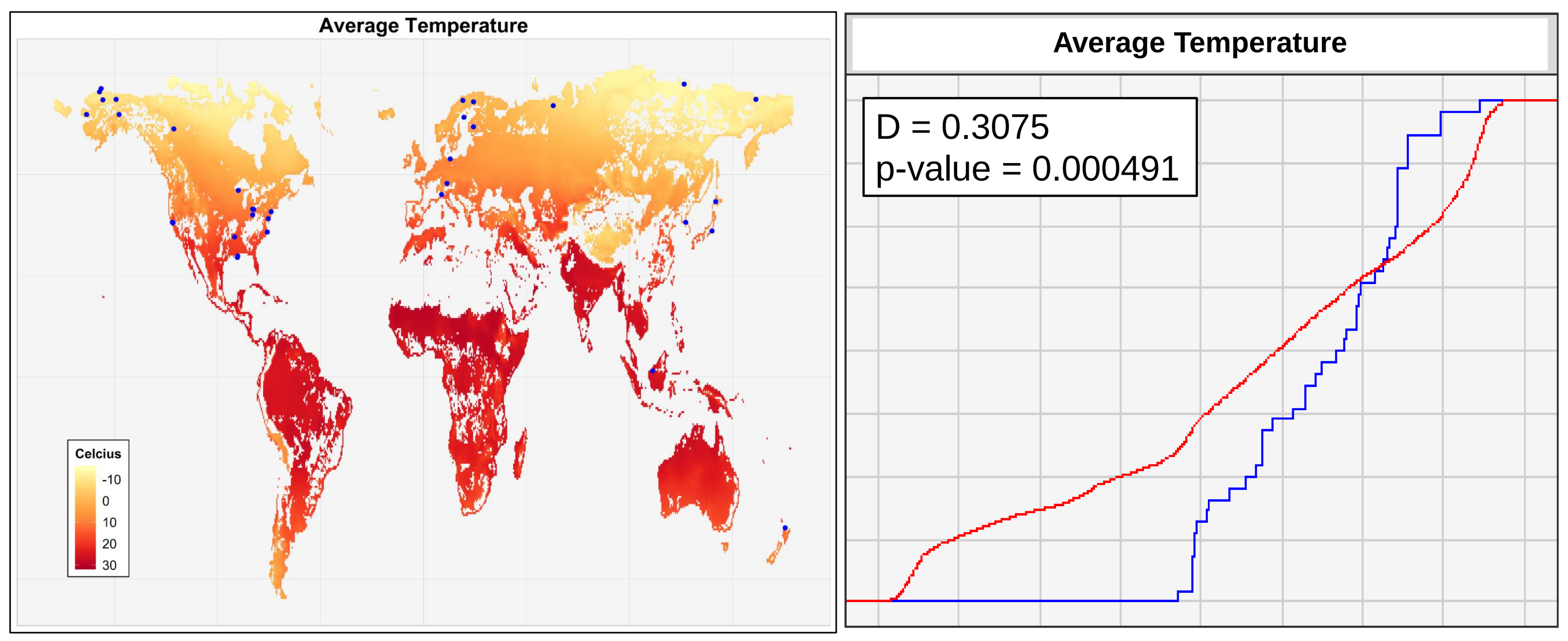

Figure 2: Left – Global average temperature (2010 – 2017), Each blue dot represents a tower in the network. Right – Two sample KS test of the average temperature data. Blue is tower data while red is global data.

Analysis & Results

- We tested whether the distribution of towers is representative of the world across 11 climatic variables.
- Our first analysis was univariate or a single climatic variable at a time: Kolmogorov–Smirnov (KS) test (Figure 2).
- We found that our network of towers is not statistically representative of the world baseline for any of our individual climatic variables.
- Later analyses were multivariate, consisting of all the climatic variables at once (Figure 3).

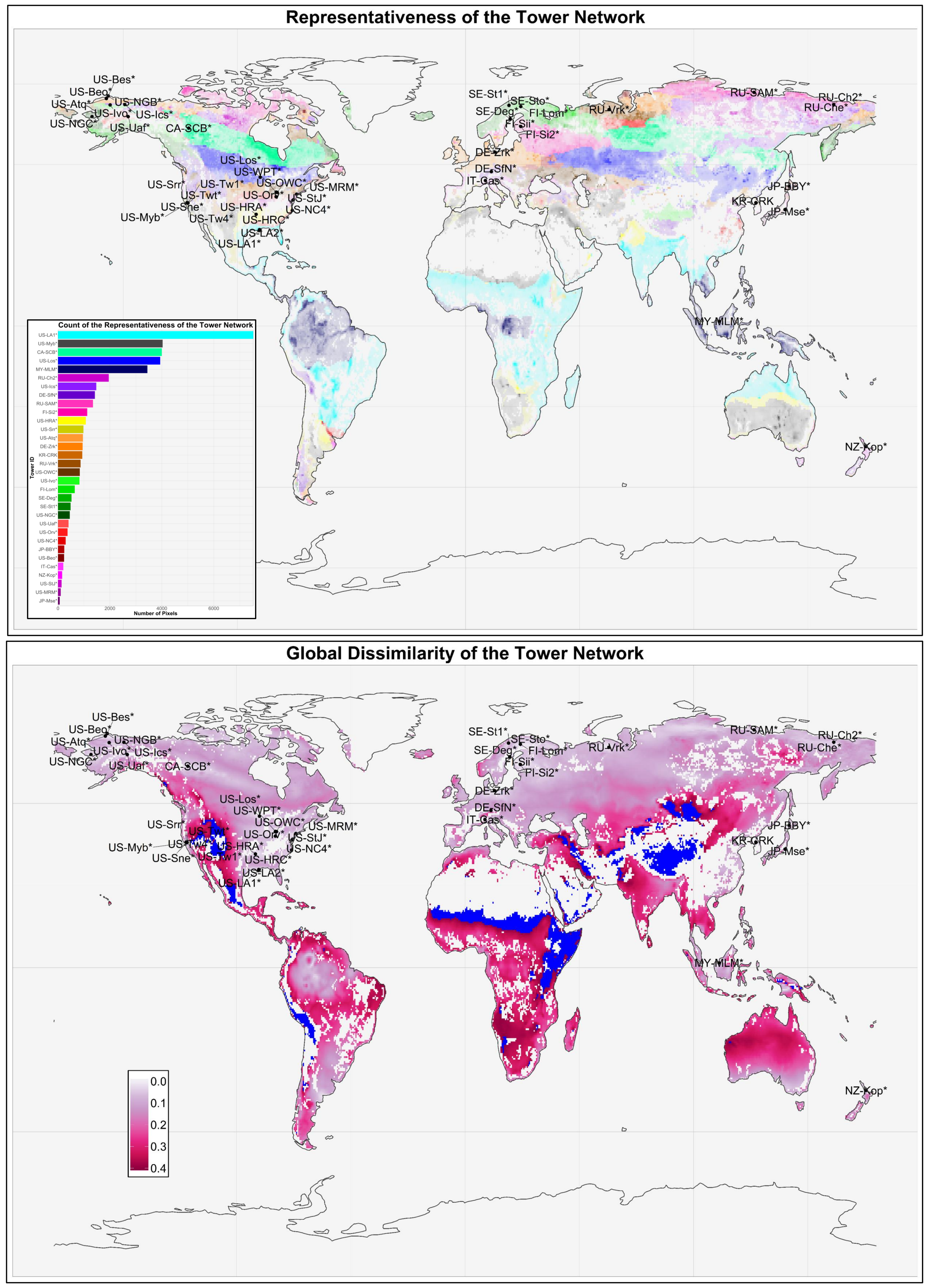

Figure 3: Top – Division of the land mass into their most similar tower. Large portions of the land surface are closest to towers US-LA1* and US-Myb*. Top Inset – Histogram of the number of pixels in the world represented by a tower. Bottom – Global dissimilarity to the current flux tower network. The highlighted blues areas indicated areas that have global dissimilarity greater than 40%.

Results (Cont'd)

- We then calculated the climatic similarity of the entire world's to our network of towers (Figure 4).
- Large areas in the tropics and mountainous regions show large dissimilarity to our network of towers (Figure 3).
- We then evaluated the representativeness of the methane flux towers not yet included in our network through non-metric multidimensional scaling (NMDS).
- Plot the flux towers in a 2-dimensional NMDS plot that shows the climatic distance between sites (Figure 4).
- Distinct cluster of towers seen in the NMDS plot indicate towers that could improve the network representativeness.

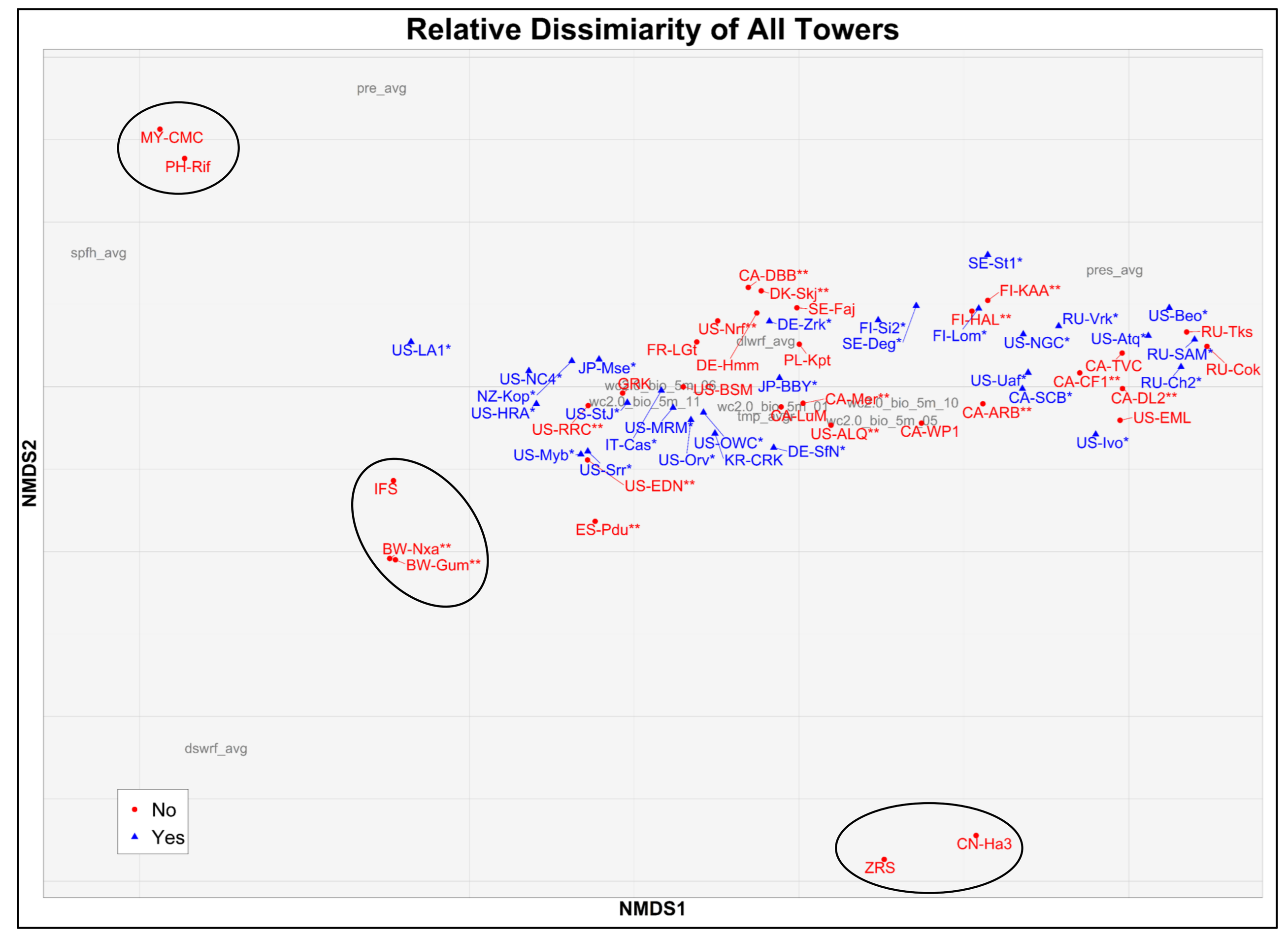

Figure 4: NMDS of all the towers, red are towers we don't have data from, blue is towers that we have obtained data from.

Conclusion

- The current network of methane towers has gaps in the tropics.
- The selective addition of towers in the tropics and mountainous regions would improve the representativeness of network.
- Our measure of climatic-distance is useful in identifying areas where new towers should be installed to fill our current 'blind spots.“
- The expanded network will help understand the contribution of wetland fluxes to the increase in atmospheric methane.

References

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[3] Turetsky, M. R., Kotowska, A., Bubier, J., Dise, N. B., Crill, P., Hornibrook, E. R., . . . Wilmking, M. (2014, April 28). A synthesis of methane emissions from 71 northern, temperate, and subtropical wetlands. Retrieved from https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.12580
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