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Understanding Nighttime Methane Concentrations at the Amazon Tall Tower Observatory (ATTO)

Santiago Botia (1), Christoph Gerbig (1), Julia Marshall (1), Gilberto Fisch (2), Otavio Acevedo (3), Cleo Quaresma (4), and Jost Lavric (1)

(1) Max Planck Institute for Biogeochemistry, Jena, Germany, (2) Institute of Aeronautics and Space, São José dos Campos, Brazil, (3) Federal University of Santa Maria, Santa Maria, Brazil, (4) Federal Institute of Education, Science and Technology, Belém, Brazil

The most important individual source of methane globally is wetlands, which in the Amazon rainforest are abundant. Wetland emissions in the Amazon represent 15% of the global wetland emissions. Therefore, understanding the main drivers of methane emissions in this region is vital to constrain its global variability. At the Amazon Tall Tower Observatory (ATTO), an unprecedented 6-year record of methane concentrations at half-hourly intervals provides a unique opportunity to understand methane variability at different temporal scales. Methane concentrations show a seasonal pattern at all five measurement levels, with a peak during the dry season. Interestingly, the maximum values are found at the highest measurement inlet (80m). Our data record shows that for some years this dry season peak is mainly driven by a nighttime methane enhancement at the highest level when the nocturnal boundary layer is under stable conditions and there is almost a complete absence of vertical mixing. In order to understand what is driving these nighttime methane enhancement events, we performed a detailed observational analysis of the dependence on wind direction, atmospheric stability and estimated nocturnal boundary layer height for a subset of nights of November 2015. In addition, we performed high-spatial-resolution WRF-GHG simulations to validate that methane could be accumulated in the valleys close to ATTO. Our results indicate that for some nights, high methane concentrations, in some cases above 1900 ppb, coincided with low turbulence intensity, weak wind speeds and very shallow nocturnal boundary layer. Furthermore, our WRF-Chem simulations corroborate that methane is accumulated in the valleys around the site, suggesting a possible source of these nighttime methane enhancement events.