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LETTER TO THE EDITOR

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Overestimation of China's marshland CH_4 release

Worldwide, China is home to the fourth largest combined area of natural wetlands, including lakes, rivers, marshland, offshore wetlands, and coastal wetlands (Niu et al., 2012). A recent study (Xiao, Deng, Dong-Gill, Huang, & Tian, 2019), named X2019 hereafter, provided a synthesis of its carbon budget. Indeed, most of the estimations in the study have advanced our knowledge, for example, suggesting China's fresh waters are a significant CH_4 emitter (Li et al., 2018).

However, in terms of marshland CH_4 release, the largest single CH_4 source among the various wetland types, the study estimated a budget of 11.2 Tg CH_4-C/year, which is four times larger than other recent estimations (Figure 1a; Table S1; Li et al., 2015; Wei & Wang, 2016; 2017). However, based on our experience of observing and simulating CH_4 emissions from natural wetlands, as well as evidence in the literature, we suggest the results to be an overestimation of the CH_4 release from China's marshlands, and suspect that there might be two reasons why: an overestimation of the extent of China's marshlands and an overestimation of the CH_4 emission rates from the Tibetan Plateau (TP; Figure 1b).

With respect to the marshland extent, X2019 used an extent of 21.7 M ha in their study, and the source of this figure was the *Second* National Wetland Resource Survey, 2009–2013 (SFA, 2015—SFA2015 for short), whose finding in this regard was much higher than that of previous studies (Figure 1c; Table S2). For example, the marshland extent in SFA2015 was 2.64 times greater than that the result of Niu et al. (2012), which was only 8.9 M ha. Specifically, the result of Niu et al. (2012) showed high spatiotemporal consistency among different years (Figures S1 and S2; Wei & Wang, 2016). At least three pieces of evidence imply an overestimation of China's marshland extent in SFA2015: (a) The *First* National Wetland Resource Survey reported 13.7 M ha of marshland in China (1995–2003; Table S2; Lei & Zhang, 2005), suggesting an unlikely increase in marshland extent of 58.4% during less than a decade if SFA2015 is to be believed. (b) On the TP, all previous studies report a higher lacustrine extent than marshland extent (Figure S3), consistent with our own 20 years of field observation. However, SFA2015 reported extents of 4.8 and 10.0 M ha for lakes and marshland on the TP, respectively. (c) In northeast China, SFA2015 reported an extent of only 0.5 M ha for rice paddies, although rice paddies have reached a coverage exceeding 5.4 M ha, according to the Ministry of Agriculture of China (2016), indicating they may have been wrongly classified as marshland in that region.

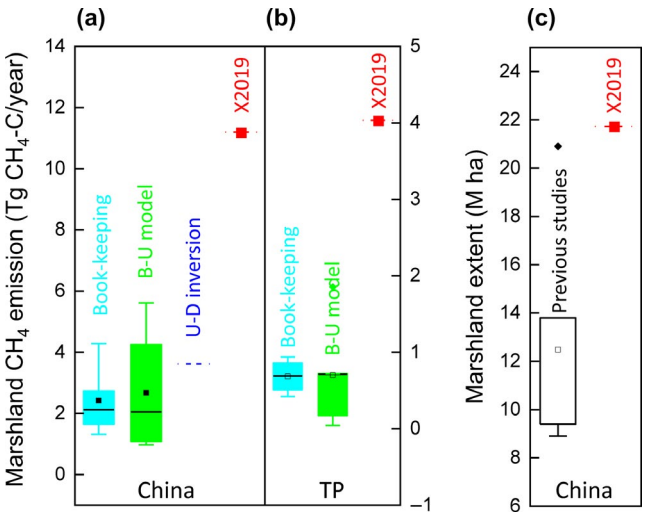

FIGURE 1 (a, b) Comparison between results on the magnitude of marshland CH_4 release from book-keeping surveys, bottom-up (B–U) simulations and up-down (U–D) inversions, with those from X2019, for (a) the whole of China and (b) Tibetan Plateau. (c) Comparison between the extent of China's marshlands reported in previous studies (Wei & Wang, 2016) and that of X2019

In terms of the second reason, that is, overestimation of the CH_4 emission rates from the TP, the CH_4 emission rate of 0.69 Mg CH_4-C ha^{-1} $year^{-1}$ reported by X2019 is much higher than estimations in other recent studies in China (<0.3 Mg CH_4-C ha^{-1} $year^{-1}$; Li et al., 2015; Wei & Wang, 2016, 2017), especially on the TP (<0.2 Mg CH_4-C ha^{-1} $year^{-1}$). On average, the altitude of the TP exceeds 4,000 m, meaning the climate is colder than that of temperate and boreal regions (Figure 2a). Marshland on the TP has experienced an expansion by roughly 10% since the 2000s because of increasing precipitation and glacial melt (Figure 2b). With a proportion of 40%, the TP dominates existing marshland in China (Niu et al., 2012), indicating a significant role when estimating the CH_4 release from China's marshland. Notably, however, marshlands below 4,000 m emit far higher quantities of CH_4 than their counterparts at higher latitudes (Figure 2c). And more importantly, most 'marshes' of the TP are actually 'wet meadows' (78%; Wei et al., 2015), especially where their situation exceeds 4,000 m, with a hummock–hollow landscape (Figure S4)—the hummocks emit much less CH_4, or even absorb CH_4 (Wei et al., 2015), resulting in a much lower CH_4 emission rate in these environs. The above evidence suggests their spatial differences cannot be overlooked. However, 8 of 11 observations on the TP in X2019 were located below 4,000 m, which explains what we suggest to be an overestimation of the CH_4 emissions in this region.

Based on the evidence outlined above, we suggest that X2019 may have overestimated the CH_4 release because of an overestimation of both marshland extent and CH_4 emission rates. The *potential* overestimation of marshland extent may also have affected the

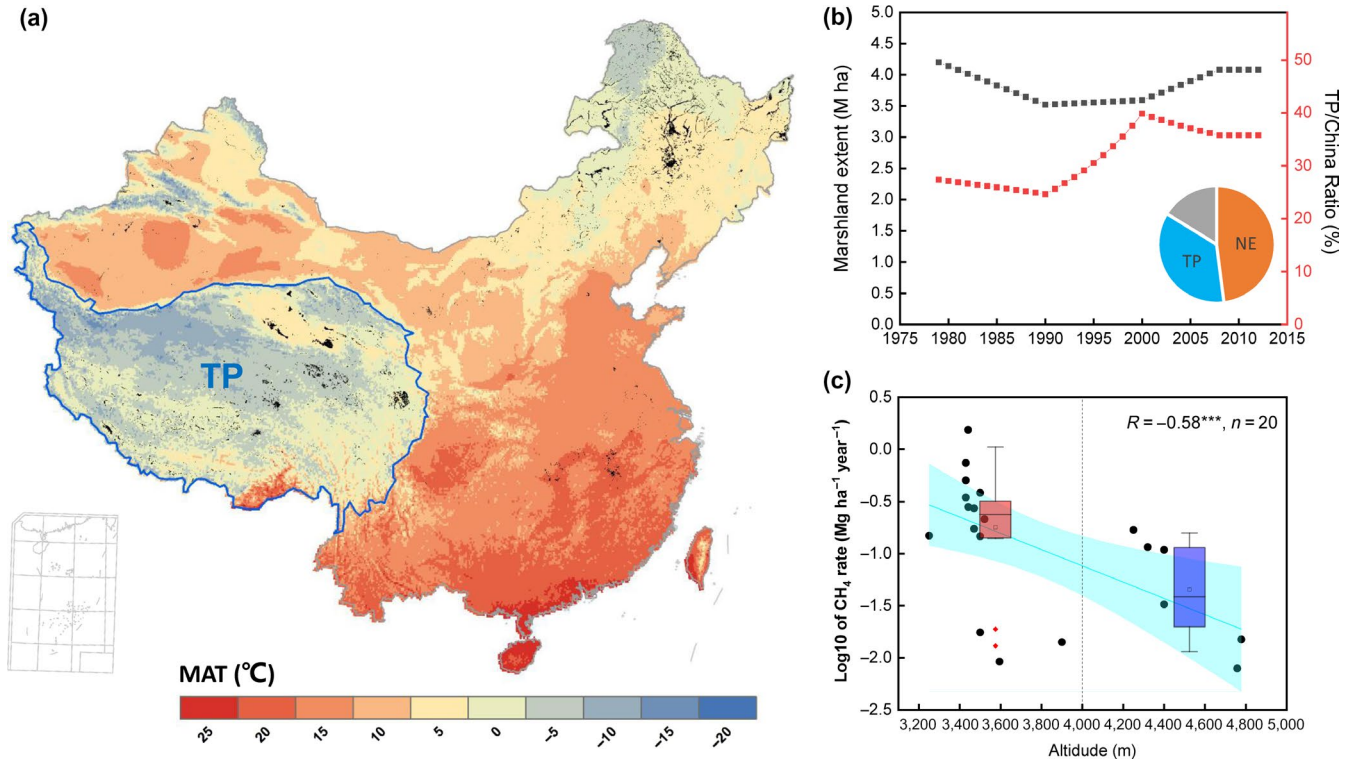

FIGURE 2 (a) Mean annual temperature (MAT) and the marshlands of China and the Tibetan Plateau (TP), indicated by black dots. (b) Temporal variation in marshland extent on the TP and its contribution to China's marshland extent (NE = northeast China). (c) Variation in CH_4 emission rates on the TP. Note: the vertical bar is the log10 of the CH_4 emission rates

estimation of its carbon storage. Furthermore, book-keeping surveys are not the best choice for estimating CH_4 emissions, especially for a large country like China, because of the significant difference regarding the CH_4 emission rates due to spatial heterogeneity of both abiotic factors (such as altitude, soil texture, hydrology, and climate) and biotic factors (such as vegetation and organic carbon) of marshland. Thus, we hope future national estimation studies will improve by employing process-based models that have already taken these factors into consideration.

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