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Supplement of

Isoprene emissions track the seasonal cycle of canopy temperature, not primary production: evidence from remote sensing

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Supporting online material

Reference isoprene emission model

Following Arneth et al. (2007) and Niinemets et al. (1999), the monthly isoprene emission rate I_{REF} in the reference model was modelled in LPJ as:

$$I_{REF}=\sum_{i=1}^{pfts}\varepsilon_i \frac{c_{i,370\,ppm}}{87c_i} GPP_i \exp\left[0.1\left(T_{CAN-PFT}-30^o C\right)\right]$$

where summation is over the plant functional types (PFTs), ε_i is the fraction of photosynthetic electrons used for isoprene synthesis under standard conditions (constant through the seasonal cycle), $c_{i,}$ is the CO_2 concentration inside the leaf, $c_{i,\ 370ppm}$ is the leaf-internal concentration corresponding to an ambient CO_2 concentration of 370 ppm and GPP_i is the gross primary production. Both c_i and $c_{i,\ 370ppm}$ are for non-water stressed conditions.

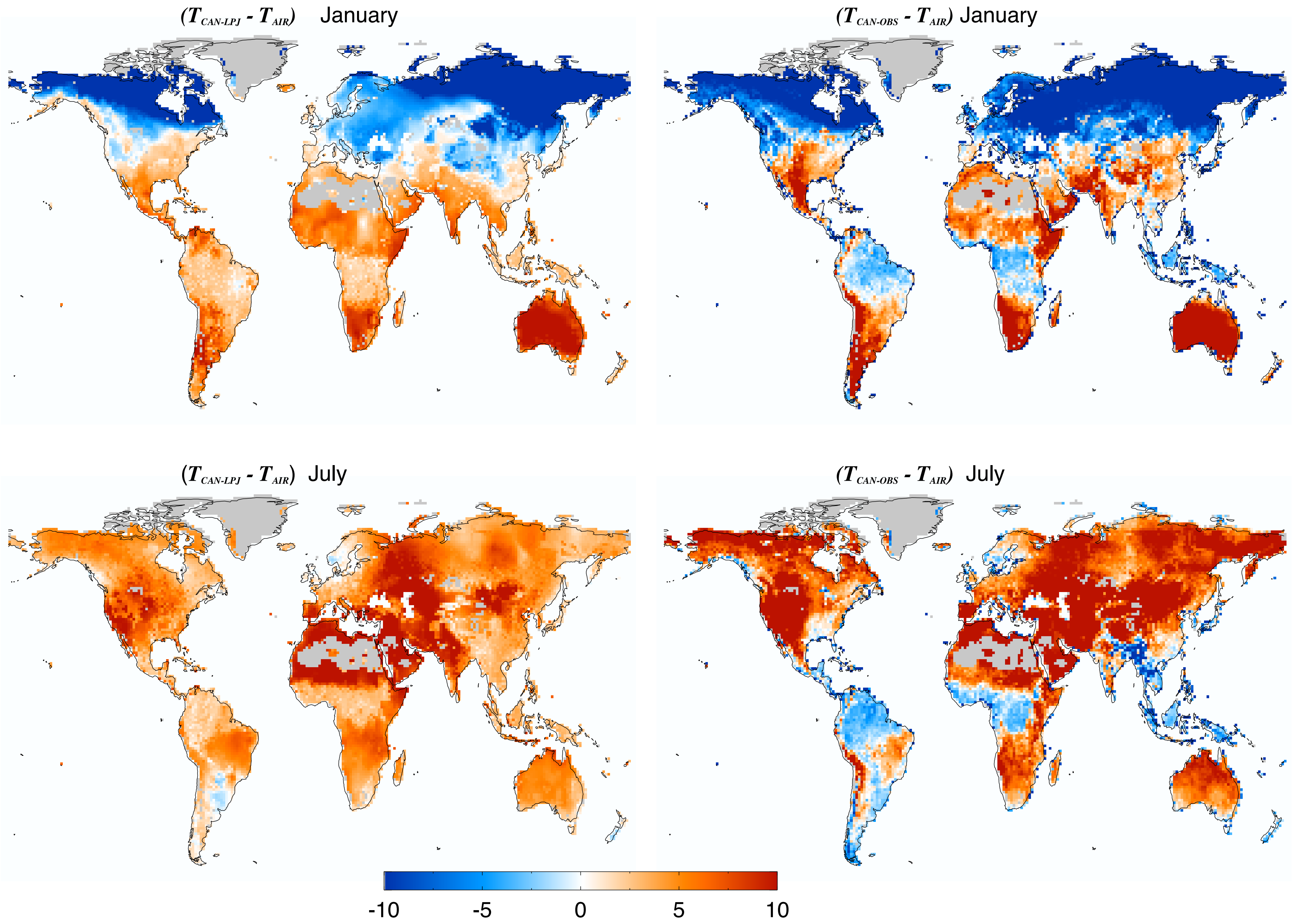
We used Guenther et al.'s (2006) values of the ε_i factors, with modifications from Millet et al., 2008, to derive values of the fraction of photosynthetic electrons diverted to isoprene production at standard temperature, ε, as follows: $\varepsilon = 0.0085$ for tropical broadleaved trees, 0.1070 for other broadleaved trees, 0.0303 for needle-leaved evergreen trees, 0.0106 for needleleaved summergreen trees, and 0.0076 for C_3 and C_4 grasses and other non-woody plants. Note that the effect of these different (and approximate) values on the modelled seasonal cycle of isoprene emission was slight, working only through differences in the phenology of different PFTs. This version of LPJ does not separate diffuse and direct radiation fractions, whose share in the total radiation received by the canopy may have an impact on photosynthesis rates in dense canopies (Alton, 2008).

Error analysis

In only three regions was $r(T_{AIR})$ greater than $r(T_{CAN-OBS})$ or $r(T_{CAN-LPJ})$: Aus2, San2 and Nord. Of those regions, only in the Nord region were the air-temperature correlations more than 0.07 greater than the canopy-temperature correlations. Nord was also one of the few sites in which $r(T_{CAN-OBS}) < 0.78$. In the other two sites with $r(T_{CAN-OBS}) <0.78$ (Con1 and Con2), both canopy temperature measures were better predictors of formaldehyde concentration than I_{REF}, GPP and T_{AIR}. These regions had the smallest seasonal temperature range (1.5°C, not shown) of all the regions examined and yet the P value for formaldehyde versus $T_{CAN-OBS}$ was 0.03, implying that the formaldehyde signal is influenced by $T_{CAN-OBS}$ with better than 95% confidence. It is not clear why the predictive capability of canopy temperatures failed in Nordeste. This region had a fairly large temperature range (11°C in MODIS), the offset of the surface temperatures from the satellite data showed no bias towards large or small values, and similar biomes (Ivory Coast) were well modelled by the canopy temperatures. Unlike in other regions, where the 1-2 month shift in the maxima and minima of the canopy temperatures relative to air temperature improved the correlation with formaldehyde, in Nordeste, this timing shift degraded the correlation. Yet both the observed and the modelled surface temperatures showed the same shift.

Supporting Material Figure Captions

Figure S1. Differences between temperature fields (^{o}C) for January and July 2002. Calculated canopy temperature *minus* air temperature (left, $T_{CAN-LPJ}-T_{AIR}$); MODIS 2m surface temperature *minus* air temperature (right, $T_{CAN-OBS}-T_{AIR}$).


(T_CAN-LPJ - T_AIR) January
(T_CAN-OBS - T_AIR) January
(T_CAN-LPJ - T_AIR) July
(T_CAN-OBS - T_AIR) July
-10
-5
0
5
10