Climate and atmospheric deposition drive the variability and long-term trend of dissolved organic carbon flux in the conterminous United States

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Introduction
The lateral flux of dissolved organic carbon (DOC) from soils to inland waters and ultimately to the ocean represents a fundamental component of the global carbon cycle.

DOC Production
1. Incomplete decomposition of soil organic carbon.
2. Production of vegetation root exudates.
3. Washout of organic compounds in throughfall.

Objective
To estimate the delivery and potential fates of DOC flux from terrestrial through aquatic ecosystems to the ocean, we developed an empirical terrestrial-aquatic DOC fluxes model (TAF-DOC). TAF-DOC incorporates various environmental factors (e.g., meteorology, sulfur, and nitrogen deposition).

Model Structure
Input Data
- Temperature
- Precipitation
- Sulfur Deposition
- Nitrogen Deposition
- Landscape
- Elevation

SOC
SOC Pool
WSM
DOC
WFS
FOM
DOCE
Outgassing
Watershed
Sediment

Model Application
TAF-DOC was applied to estimate spatial-temporal dynamics of DOC flux and potential fates across the conterminous United States during the 1985 to 2018 time period.

Results and Conclusions

The estimated DOC loading from terrestrial to aquatic ecosystems in the conterminous United States was 33.5 ± 2.2 TgC per year in the period of 1985-2018. The estimated DOC flux from soils to inland waters of these 2110 watersheds ranged from 0.1 to 25.7 gC/m² per year with a mean of 4.4 gC/m² per year.

Figures

Figure 1. An example of the DOC flux within a watershed.

Figure 2. Structure and workflow of the empirical terrestrial-aquatic DOC fluxes model. SOC is the soil organic carbon, and DOCM is the DOC can be moved from soils to inland waters. DOCE is the DOC exported from the watershed. DOCE is the DOC exported to the ocean. WSM is the Watershed Soil DOC Module. WFS is the Watershed DOC Fluxes Module. FOM is the Flux to the Ocean Module.

Figure 3. The annual DOC flux.

Figure 4. The DOC budget in the United States.

Figure 5. The contribution of each watershed to the DOC export from the conterminous United States to oceans in the period of 1985-2018. The estimated DOC flux from soils to inland waters of these 2110 watersheds ranged from 0.1 to 25.7 gC/m² per year with a mean of 4.4 gC/m² per year.

Figure 6. The time series of normalized DOC flux anomaly from terrestrial to aquatic ecosystems (N [DOC Anomaly]), temperature anomaly (N [T Anomaly]), precipitation anomaly (N [P Anomaly]), sulfur deposition anomaly (N [S Anomaly]), and nitrogen deposition (N [N Anomaly]) anomaly in the period of 1985-2018 (a). The linear relationship between N [DOC Anomaly] and N [P Anomaly] (b). The linear relationship between N [DOC Anomaly] and N [S Anomaly] (c).

Conclusions
1) Precipitation is the dominant driver for interannual DOC dynamics.
2) The longer-term trend of DOC flux is strongly controlled by the rate of sulfur deposition.

Reference