Production of organic species by lightning in Titan's atmosphere

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Titan's nitrogen-dominated atmosphere contains various hydrocarbons and nitriles produced mainly by charged-particle chemistry and photochemistry in the upper atmosphere. Most of them condense at the cold trap near the tropopause, so the troposphere is considered to harbour little minor species as compared to the upper atmosphere. However, lightning may provide an important energy source for the neutral chemistry in the troposphere. While lightning could not been detected on Titan by remote sensing so far, recent observations of extensive methane clouds and theoretical modelling suggest the likelihood of some lightning in the lower 20 km of Titan's atmosphere. The cosmic-ray ionisation and the midly reducing condition give rise to an enhanced number density of free electrons down to the surface. Once extensive methane clouds develop in supersaturated atmosphere, these electrons can rapidly charge the methane cloud and may induce cloud-to-ground lightning strokes. Among others, acetylene, ethylene and hydrogen cyanide can be produced by lightning, as shown in laboratory experiments. While these species are unlikely to affect the stratospheric chemistry, it may have an impact on the organic chemistry and microphysics in the lower troposphere and at the surface.

Geochemical study of cold seeps on the seafloor off Kumano in Nankai Trough

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Interstitial waters collected in 18 push cores from surface sediments (up to 30 cm) inside and outside of dense biological communities on the seafloor off Kumano in the Nankai Trough were analysed for CH_4, ΣCO_2, $\delta^{13}C_{CH4}$, $\delta^{13}C_{CO2}$, chloride, sulfate, δD_{H2O} and $\delta^{18}O_{H2O}$. Chemical and isotopic compositions taken within bacterial mat of Low-Chloride Anomaly (LCA) site indicate that fluids characterized by CH_4- and ΣCO_2-enrichment, chloride and sulfate depletion, and low δD_{H2O} and $\delta^{18}O_{H2O}$ value compared with bottom seawater are discharging from the sea bottom. Extremely high methane concentration in pore fluids at the LCA site is more than 600 μmol/kg, a value that is 5 orders of magnitude greater than bottom seawater. We estimated that the pristine hydrogen and oxygen isotopic composition of the fresh water would be --35±9‰SMOW and –3.7±0.9‰SMOW, respectively, implying that land-derived groundwater may be a plausible source for the low-Cl^- fluid. Distribution of chloride concentration illustrates the enormous spatial and horizontal variability of low-Cl fluids, suggesting that ascending velocities of the low-Cl fluids are highly variable even within an area of 30 cm. Results from steady state models applied to the chloride distribution in the pore fluids yield the estimated maximum values of fluid flow velocities in the range of 0.5-1.5 m/yr, comparable to the previously reported values within the bacterial mats in the Nankai Trough accretionary wedge.