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Spatiotemporal variations of methane during the Wenchuan Ms8.0 earthquake from satellite observations

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The great Wenchuan Ms8.0 earthquake, on May 12, 2008, was one of the worst continental earthquake events to have struck China in recent decades, and it killed more than ten thousand people in several cities along the western Sichuan basin. It is a new type of earthquake that deserves further study. The variation in soil gas concentration serves as a useful tool for monitoring earthquakes. Some people have speculated that thermal abnormalities before earthquakes are related to the release of CH4. They always pay attention to the total column of CH4. However, the same column concentration might correspond to this distinct vertical structure.

The focus of this study is to examine the spatiotemporal variation of CH4 in the mid-upper troposphere during the Wenchuan earthquake (12 May, 2008) using AIRS retrieval data and to discuss the mechanism of the methane anomaly. Three indices were proposed and used for analysis: the Absolute Local Index of Change of the Environment (ALICE), the Vertical Concentration Gradient (Gradient), and the Successive Differential Value (Diff). Our results show that the methane concentration increased significantly in 2008, with an average increase of $5.12*10^{-8}$, compared to the average increase of $1.18*10^{-8}$ in the previous five years. The Alice and Diff indices can be used to identify methane concentration anomalies. The two indices showed that the methane concentration distribution before and after the earthquake broke the distribution features of the background field. As the earthquake approached, areas of high methane concentration gradually converged towards the west side of the epicenter from both ends of the Longmenshan fault zone. Moreover, a large anomalous area was centered at the epicenter eight days before the earthquake occurred, and a trend of strengthening, weakening and strengthening appeared over time. The Gradient index showed that the vertical direction obviously increased before the main earthquake, and the value was positive. The gradient value is negative during coseismic or postseismic events. The gradient index reflects the gas emission characteristics to some extent. We also determined that the methane release was connected with the deep crust-mantle stress state, as well as microfracture generation and expansion.