Thermochemical Kinetics of CO, NH_3, and PH_3 Transport Tracer Molecules in the Atmospheres of Solar System and Extrasolar Giant Planets

DAVID L. HUESTIS, [1] GREGORY P. SMITH[1], and DONALD HILDENBRAND[1]
[1]*SRI International, Menlo Park, CA USA*

In the atmospheres of extrasolar and solar system giant planets, chemical kinetics matters. The composition of a volume of gas depends not only on chemistry occurring where it is, but also on how it got there. The giant planets in our own solar system still have much to teach us about what we will be observing on extrasolar giant planets and how to interpret what we observe.

Some molecules, such as CO, C_2H_2, C_2H_6, PH_3, and NH_3, can function as tracer molecules, providing remotely observable signatures of vertical transport. They are often observed at pressures and temperatures where they are not the expected thermochemical equilibrium form, which implies transport from other regions of the atmosphere. The critical questions are the time scales of chemical interconvertion compared to those of vertical transport.

PH_3 and NH_3 especially have complicated thermochemistry and chemical kinetics that, until recently, have been poorly understood. Based on analysis of recent literature, we have identified new chemical mechanisms for interconverting NH_3 and N_2 and for interconverting PH_3 and NH_4-H_2PO_4. We will also review of the chemistry of the CO to CH_4 transformation.

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