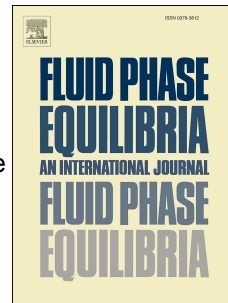


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Multiphase-equilibria analysis: Application in modeling the atmospheric and lacustrine chemical systems of Saturn's moon Titan

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## Multiphase-equilibria analysis: application in modeling the atmospheric and lacustrine chemical systems of Saturn's moon Titan

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Abstract

Titan's lower atmosphere has condensed phases in equilibrium with it. It is well known that there is a liquid phase in lakes and liquid condensates in the lower troposphere that are part of the liquid cycle in Titan's system. This work analyzes further the phase equilibria using CRYOCHEM equation of state by accounting for solid phases that can exist at the extremely cold conditions on Titan, as well as the possibility of a second liquid phase in the deep lakes, all within the ternary system nitrogen-methane-ethane. Titan's fluid exhibits rich variation of phases that allow us to show multiphase equilibria in full action. The multiphase equilibria covered in this work are two-phase (vapor-liquid, liquid-liquid, solid-liquid, solid-vapor, solid-solid), three-phase (vapor-liquid-liquid, vapor-liquid-solid, vapor-solid-solid, liquid-liquid-solid), and four-phase equilibria (solid-liquid-liquid-vapor); issues associated with the unphysical phases in the calculations are also discussed. The results of multiphase-equilibria analysis describe new understandings about Titan's surface, troposphere, and subsurface lake liquids, as described in the conclusions.

Keywords: multiphase equilibria; solid solutions; equation of state; Titan

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