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Nanosatellites: The next big chapter in atmospheric tomography?

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Nanosatellite technology opens up new possibilities for Earth observation. We expect that in the next decade large satellite constellations will arise with hundred, up to thousand satellites in low Earth orbit. While most constellations will be dedicated to internet of things and global communication, a larger number of satellites will be also equipped with rather low-cost sensors, such as GNSS receivers, suited for monitoring of the Earth's atmosphere. However, future evolution of atmospheric science leans not only on densified observing systems but also on new, more complex analysis methods. In this respect, tomographic principles provide a unique opportunity for sensor fusion and therefore, contribute to a better understanding of the specific sensor characteristics and to exploit their full potential for sensing the three-dimensional atmospheric state. One difficulty in performing the conversion of integral measurements into three-dimensional images is that the signal ray path is not a straight line but rather dependent on the object properties along the signal path. Another challenge is related to the limited number of radio sources and detectors with respect to the size of the object of interest. Therefore, the inverse problem is either solved linearly or iterative non-linear. In this chapter, the individual solving techniques for the tomographic problem are presented, including strategies for removing deficiencies of the ill-posed problem by using truncated singular value decomposition and L-curve technique. Applied to dense nanosatellite formations, a new quality in the reconstruction of the 3D water vapor distribution is obtained, which has the potential for leading to further advances in atmospheric science.