Monitoring sensible heat flux over urban areas in a high-altitude city using Large Aperture Scintillometer and Eddy Covariance

Introduction

Urbanization leads to modifications of surface energy balance which governs the momentum, heat and mass transfer between urban canopy layer and the atmosphere, thus impacts dynamic processes in the urban ABL and ultimately influence the local, regional and even global climate. It is essential to obtain accurate urban ABL observations to enhance our understanding of land-atmosphere interaction process over the urban area and help to improve the prediction ability of numerical model. However, up to now, there are rarely observations in high latitude cities. This study took place in Lhasa, which is the administrative capital of the Tibet Autonomous Region of China. With an average altitude of 3650 m, Lhasa is one of the highest cities in the world. Over recent years it has experienced tremendous growth. From 2000 to 2015, its resident population increased from 0.47 million to 0.9 million and the number of tourists increased from 0.6 million to 20 million per year. It has a cool semi-arid climate. Sensible heat flux observations are achieved by a combination of one eddy-covariance (EC) system and one Large Aperture Scintillometer (LAS). The EC system consists of a sonic anemometer (CSAT3) and an open-path infrared gas analyzer (LI-7500), which was installed on the office building at a height of 25.1 m above ground level (a.g.l.). At the same site, meteorological instruments were installed, including a four-component radiometer (CNR4), an open-path infrared gas analyzer (LI-7500), a tipping bucket rain gauge (TB4MM), an ultrasonic anemometer (CSAT3), a wind sensor (AWCr40), a temperature/humidity probe (HMP155A), a wind monitor (Met One-0348) and a tipping bucket rain gauge (TB4MM). EC data were logged at 1Hz, and all meteorological data were sampled at 5s interval and averaged to 30 min (CR3000). High frequency EC data were processed to 3min statistics using EddyPro (LI-COR) following conventional procedures, including spike removal, time lag compensation, coordinate rotation, sonic temperature correction, frequency response correction, and density fluctuation correction (WPL). The LAS transmitter and receiver (BLS450) were mounted on two buildings at 37.1 m a.g.l. and 76.5 m a.g.l., respectively with a path length of 2.82 km. The transmitter correction (WPL). The LAS transmitter and receiver (BLS450) were mounted on two buildings at 37.1 m a.g.l. and 76.5 m a.g.l., respectively with a path length of 2.82 km. The transmitter correction (WPL). The LAS transmitter and receiver (BLS450) were mounted on two buildings at 37.1 m a.g.l. and 76.5 m a.g.l., respectively with a path length of 2.82 km. The transmitter correction (WPL). The LAS transmitter and receiver (BLS450) were mounted on two buildings at 37.1 m a.g.l. and 76.5 m a.g.l., respectively with a path length of 2.82 km. The transmitter correction (WPL). The LAS transmitter and receiver (BLS450) were mounted on two buildings at 37.1 m a.g.l. and 76.5 m a.g.l., respectively with a path length of 2.82 km. The transmitter correction (WPL). The LAS transmitter and receiver (BLS450) were mounted on two buildings at 37.1 m a.g.l. and 76.5 m a.g.l., respectively with a path length of 2.82 km. The transmitter correction (WPL). The LAS transmitter and receiver (BLS450) were mounted on two buildings at 37.1 m a.g.l. and 76.5 m a.g.l., respectively with a path length of 2.82 km. The transmitter correction (WPL). The LAS transmitter and receiver (BLS450) were mounted on two buildings at 37.1 m a.g.l. and 76.5 m a.g.l., respectively with a path length of 2.82 km. The transmitter correction (WPL). The LAS transmitter and receiver (BLS450) were mounted on two buildings at 37.1 m a.g.l. and 76.5 m a.g.l., respectively with a path length of 2.82 km. The transmitter...