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南极中山站至Dome A考察断面近地层湍流参数特征

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Characteristics of near surface turbulent parameters along the traverse route from Zhongshan Station to Dome A, East Antarctica

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摘要 利用南极中山站至Dome A考察断面上3个自动气象站2005~2007年的观测资料和2008年夏季在中山站附近冰盖获取的湍流观测资料,应用空气动力学方法和涡动相关法计算分析了中山站至Dome A断面上近地层各种湍流参数(感热通量,潜热通量,湍流温度、湿度和速度尺度,地表粗糙度,大气稳定度及动量输送系数)的季节变化、日变化及其空间分布规律.结果表明:感热和潜热均具有明显的季节变化和夏季日变化特征.夏季,近地层大气向雪冰表面输送的感热通量由沿岸中山站的-4.2 W/m^{2}降至高原缓坡区EAGLE的-0.3 W/m^2,至内陆高原Dome A则已转变为由雪冰表面向大气输送感热,约5.5 W/m^2;潜热通量由沿岸的16.8 W/m^{2}向内陆高原快速减小至Dome A的1.2 W/m^2;地表粗糙度、动量输送系数和地表摩擦速度均由冰盖陡坡区(强下降风区)向沿岸和内陆高原快速减小,最小值出现在Dome A,这与风速的变化特征相一致,表明南极内陆冰盖的地表动力学参数与风速密切相关.该结果对改进气候模式中南极地区的边界层参数化方案具有重要的参考意义.

关键词: 南极冰盖 湍流通量 湍流参数 涡动相关法 空气动力学法

Abstract: Based on the data from Zhongshan Station (eddy covariance measurements) and three Automatic Weather Stations deployed along the traverse route from Zhongshan Station to Dome-A, East Antarctica, and using aerodynamics method and eddy-correlation technique, we analyzed the seasonal and diurnal variation of the near surface turbulent parameters (sensible/latent heat fluxes, turbulent scales of temperature, specific humidity and wind speed, surface roughness length, atmospheric stability and momentum transfer coefficient), as well as their spatial distribution patterns. The results showed that sensible/latent heat fluxes display obvious annual variation and summer diurnal cycle. In summer, the near-surface air transfers heat to snow/ice in sensible heat flux form (except Dome A) and receives latent heat flux from snow/ice surface. Sensible (Latent) heat flux increases (decreases) with the increasing elevation and distance from the coast, from -4.2 (16.8) W/m^2 at Zhongshan to 5.5 (1.2) W/m^2 at Dome-A (the summit of the East Antarctic ice sheet). The spatial distribution patterns of surface roughness length, momentum transfer coefficient and friction velocity in summer are similar with wind speed, increasing southward from the East Antarctic coast into the interior escarpment region (strong katabatic wind zone), and then weakening gradually inland. It indicates that these surface dynamical parameters of the Antarctic ice sheet are closely related with wind speed. The results have an important reference value on improving the boundary layer parameterization scheme in Antarctic climate simulation.

Keywords: Antarctica ice sheet Turbulent fluxes Turbulent parameters Eddy-correlation technique Aerodynamics method

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