

Relationship between surface and air temperatures over Hong Kong on a winter night

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A cloud-free Advanced Spaceborne Thermal Emission Sensor (ASTER) thermal image of urban and rural areas of Hong Kong was obtained on a winter night with a well developed heat island, accompanied by a 148km-long vehicle traverse of air temperatures. This study demonstrates a methodology for the creation of an air temperature image using a night-time Advanced Spaceborne Thermal Emission Sensor (ASTER) image of Surface Temperature in conjunction with an 'in situ' mobile air temperature survey. An $R^2=0.78$ was obtained between satellite surface temperature and mobile air temperature when data for rural and urban areas were analysed separately and this was lower than the R^2 obtained for the whole study area. The methodology can provide an accurate distribution of air temperatures over a whole city and can be used to characterize the urban heat island at the image time.

Further observations from the image and ground data may be used to address theories of heat island formation including the roles of city structure, city size and advection. For example, previous studies stress the importance of city structure, including building density and height (Goldreich 1985) and the sky view factor (SVF) (Eliasson, 1992) in nocturnal heat loss. On the other hand Stoll and Brazell (1992) and Spronken-Smith and Oke (1998) observe that although the thermal properties of surfaces and their radiative geometry are dominant factors in heat island formation, the correlation between the surface and air is affected by advection from adjacent land uses, especially in complex areas. Furthermore the advection model by Summers (1964) suggest that distance from the rural boundary is an important influence on heat island intensity. Although the data indicate that temperature gradients in both air and surface temperatures can be related to land cover changes, as well as built density, the most extensive urban area of Kowloon is substantially warmer than smaller towns of similar structure in the New Territories. This suggests that city size as well as urban structure is an important factor in determining the magnitude of the urban heat island.