WMO INTER-REGIONAL CLIPS TRAINING WORKSHOP ON URBAN CLIMATOLOGY

Pune, India, 6 -10 September 2010

Course Description

Meteorological properties vary significantly in urban environments. The course is presented over five days and comprises a series of lectures complemented by practical exercises. Here we present an overview of the course structure focussing on the lectures, which will take place on during the morning period. The exercises take place after lunch.

1. Introduction

These lectures outline the scope of urban climatology and its relevance to the design and planning of cities.

(a) *Urban Weather & Climate:* This lecture introduces the workshop by presenting the urban effect on the atmosphere at all scales. It presents the history of urban climate studies and focuses on major developments in the field. In particular it outlines methodological and conceptual developments.

(b) *Urban scales & urban effects:* The urban effect is scale dependent and this is a consistent theme during the workshop. Understanding the structure of the urban atmosphere plays a significant role in developing observational/modelling studies and interpreting their results.

(c) *Urban form & urban function:* The urban effect is fundamentally an outcome of the interaction between the atmosphere and the underlying urban surface, which is distinguished in its physical character and its emissions of heat, moisture and materials from the non-urban surface. This lecture examines the nature of the urban 'surface'.

The exercises that will accompany this component will focus on the acquisition of urban data relevant to urban climate studies. These data include available datasets on urban land-use and land-cover and the potential for creating urban databases from surveys and existing maps.

2. Urban Effects (Observations)

These lectures examine the evidence for the urban effect based upon observations. Much of our knowledge of the urban effect is acquired from experiments conducted in urban areas

and the purpose of these lectures is to outline the major effects of urban areas on climate parameters.

(a) *Airflow:* The urban surface is characterised by its uneven roughness which retards the flow of air across the city. Between the ground and approximately twice the height of buildings, the airflow is highly turbulent and difficult to characterise. Airflow patterns affect the exchange of energy, of gases and of materials. This lecture describes the airflow effect.
(b) *Temperature & Humidity:* One of the most distinguishable features of the urban climate is its effect on air temperature, producing an 'urban heat island' (UHI). However, this effect is not simple and incorporates many different types of UHIs. This lecture outlines the types of UHI and their characteristics.
(c) *Precipitation & Evaporation:* The urban effect on precipitation, both within the urban area and beyond, is a matter of ongoing research using satellite and radar information coupled with ground-based observations. The lecture will present current evidence for this effect.
(d) *Urban measurements:* Conventional meteorological measurements are not possible in urban settings. Thus, different guidelines need to be followed if useful information is to be collected. This lecture presents guidelines for measuring different parameters within the urban setting – critical to this process is the creation of metadata describing the site to support the meteorological data.

The exercises here will focus on the links between conventional measurements and those obtained in urban areas. Obtaining useful information from urban databases is critical in making this link. Guidelines for making observations in urban areas are explored.

3. Urban effects (Process)

These lectures are devoted to the exchange processes that regulate the urban effect and how these may be altered through design decisions. These aspects of the programme would have been alluded to in the above lectures but are the focus of these sessions.

(a) *Urban energy budget:* This accounts for the exchanges of energy at the surface of the earth and how these are modified in the urban environment. The impact of materials and urban geometry on the natural energy fluxes and the contribution of anthropogenic heat are discussed.
(b) *Urban water budget:* The replacement of natural surfaces with materials that are mostly impervious has a large impact on the hydrology of urban areas. This is a topic that deserves its own workshop. Here attention is drawn to the overall impact of urban areas on the water balance, particularly as it relates to the energy budget.
(c) *Urban design:* Decisions on the nature of the urban environment (e.g. use of materials, placement of buildings, etc.) are responsible for altering the processes above and generating the urban climate effect. Here, attention is drawn to the links between the physical geography of the city and its impact.

The exercises to complement this component focus on the nature of urban areas and how they impact on the energy and water budgets at different scales.

4. Urban climate methods

This session is focussed on the methods employed to understand the urban effect on climate (and vice versa). Attention is paid to numerical models at different scales and their capacity for including urban parameters.

(a) *Urban modelling (Micro-scale):* This lecture presents the options for examining the urban effect at the micro-scale ('urban neighbourhoods') using models of varying complexity.

(b) *Urban modelling (≥Meso-scale):* This incorporates a number of different models used for climatological and meteorological (e.g. weather forecasting) purposes. Many of these models have a lengthy history of use and are being continuously improved by incorporating urban land-cover parameters to capture urban effects.

(c) *Climate change and cities:* Global climate models do not currently include urban parameterisation schemes. Nevertheless, establishing the impact of climate change on cities is of paramount importance to address issues of risk, vulnerability and adaptation strategies. This lecture examines the role of urban areas in climate change projections and the impact of these projections on cities.

The focus in the exercises should be on urban models of varying sophistication. In the case of climate change, the core issues for each city may be different and require distinct approaches. Some examples of city-based climate change management schemes will be discussed.

5. Urban impacts

The primary purpose of improved urban climate knowledge is to apply this knowledge for the benefit of urban citizens. This component looks at the impact of the urban effect on human climates in particular and the potential for urban planning and design to incorporate climate information. While air quality concerns are addressed in many city management schemes, other health issues are not considered at this scale.

(a) *Human comfort & health:* This lecture introduces the topic of the human thermal climate and the notion of (dis)comfort. These concepts have a long history in the study of indoor climates however they have only recently been applied to outdoor situations.

(b) *Heat warning systems:* Concerns for extreme heat events and the public health consequences has resulted in the development of heat warning systems at city scales that incorporate meteorology, bioclimate and behaviour.

(c) *Architecture, urban design and climate:* The final lecture attempts to bring together the themes discussed over the week, in particular the opportunity for design at urban scales to address climate stresses.

The associated exercises will look at urban thermal comfort in the urban environment and explore the role of urban design in moderating environmental stresses.