Resum de Tesi Doctoral

UNIVERSITAT POLITÈCNICA DE CATALUNYA
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Escola de Doctorat

DNI/NIE/Passaport	
Nom i cognoms	ROBERT FRANKLIN BANKS
Títol de la tesi	Assessment of planetary boundary-layer schemes with advanced remote sensing instruments and air quality modelling
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(Mínim 1 i màxim 4, podeu veure els codis a http://doctorat.upc.edu/gestio-academica/impresos/tesi-matricula-i-diposit/codis-unesco)

Resum de la tesi de 4000 caràcters màxim (si supera els 4000 es tallarà automàticament)

Urban air pollution is of major concern in Spain and also throughout Europe and globally with numerous effects on human health and ecosystems. Since air quality (AQ) is predominantly a problem for human health and the environment, the lowest levels of the atmosphere are the most important to investigate, mainly the planetary boundary-layer (PBL). Atmospheric variables (i.e. temperature, humidity, winds) in the PBL are critically important as inputs for accurate simulations in AQ models. From a modeling standpoint PBL height can be extremely difficult to compute accurately due to the fact that boundary layer processes occur at smaller geographical scales than mesoscale meteorological models can resolve. To that end, atmospheric models make use of parameterizations to represent the boundary layer structure in the lower atmosphere.
This Ph.D. thesis evaluates the sensitivity of high-resolution AQ simulations from the CALIOPE AQ forecast system (www.bsc.es/caliope) in the distribution of gaseous photochemical pollutants using different PBL schemes in the Weather Research and Forecasting (WRF) model. The project is separated into three main activities.
First, was an evaluation of available methods for estimating PBL height from lidar measurements based on data from the Barcelona multiwavelength Raman lidar, a member site of the European Aerosol Research Lidar Network (EARLINET). Lidar-estimated PBL heights were compared with those obtained from radiosoundings. It was found that a time-adaptive extended Kalman filter (EKF) technique provided lidar estimates closest (coefficient of determination = 0.96) to values estimated with radiosoundings. The 13-yr average PBL height was 1.28 ± 0.4 km with the EKF method, which is similar to previous studies.
In the second activity, eight PBL schemes from the WRF model were evaluated as compared to observations over Barcelona and Athens. Instrumentation included two lidars, and numerous radiosondes and surface meteorological stations. Data from Athens was collected during the 39-day HygrA-CD field campaign, which took place in summer 2014. In both studies it was generally found that non-local PBL schemes perform better. For example, the non-local asymmetric convective model version 2 (ACM2) scheme showed coefficient of determination values of 0.33 and 0.15, for the Barcelona and Athens studies, respectively. WRF model simulations with the ACM2 scheme only slightly under-estimated PBL heights in Athens during Etesians events, with a mean bias around 0.11 km.
In the final activity, four WRF PBL schemes were sensitivity-tested with model simulations from the CALIOPE AQ forecast system, as compared with surface observations from ground AQ stations and lidar data from the Barcelona micropulse lidar (MPL), a new station in the NASA Micropulse Lidar Network (MPLNET). It was found that WRF model-simulated PBL height and surface meteorology can largely impact the simulations of air pollution variables (ozone, nitrogen dioxide, particulate matter less than 10 microns). CMAQ model simulations coupled to WRF with the ACM2 and Bougeault–Lacarrère (BouLac) PBL schemes performed the best for surface ozone concentrations at rural background stations, with correlation values of 0.82 and 0.79 compared to surface AQ observations, respectively. In addition, spatial analysis of the CMAQ model simulations showed the lowest biases using the ACM2 and BouLac schemes.
The outcome from this project is a deeper understanding of the sensitivity of AQ simulations to model PBL schemes, which may result in more accurate operational AQ forecasts.

Lloc: BARCELONA

Data: 15/2/16

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