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Quality Assessment of the Cobel-Isba Numerical Forecast System of Fog and Low Clouds

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Abstract—Short-term forecasting of fog is a difficult issue which can have a large societal impact. Fog appears in the surface boundary layer and is driven by the interactions between land surface and the lower layers of the atmosphere. These interactions are still not well parameterized in current operational NWP models, and a new methodology based on local observations, an adaptive assimilation scheme and a local numerical model is tested.The proposed numerical forecast method of foggy conditions has been run during three years at Paris-CdG international airport. This test over a long-time period allows an in-depth evaluation of the forecast quality.This study demonstrates that detailed 1-D models, including detailed physical parameterizations and high vertical resolution, can reasonably represent the major features of the life cycle of fog (onset, development and dissipation) up to +6 h. The error on the forecast onset and burn-off time is typically 1 h. The major weakness of the methodology is related to the evolution of low clouds (stratus lowering). Even if the occurrence of fog is well forecasted, the value of the horizontal visibility is only crudely forecasted. Improvements in the microphysical parameterization and in the translation algorithm converting NWP prognostic variables into a corresponding horizontal visibility seems necessary to accurately forecast the value of the visibility.

Key words: Numerical prediction, fog, short term forecast.

1. Introduction

Air-traffic safety and operational efficiency depend heavily upon accurate and timely forecasts of fog and low clouds. Adverse visibility conditions can strongly reduce the efficiency of terminal area traffic flow. For example, at Paris - Charles de Gaulle international airport (Paris-CdG), the landings and departures are reduced by a factor of 2 in foggy conditions (so called *Low Visibility Procedures* (LVP), defined by Air Traffic Control authorities (ATC) and corresponding to visibility < 600 m or ceiling < 200 ft -about 60 m). The occurrence of poor visibility conditions restricting the flow of air traffic in major airport terminals is one of the main causes of aircraft delays. Accurate anticipation of the onset and cessation of LVP conditions allows for air-traffic managers to effectively regulate traffic and to optimize the use of airport capacity.

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Land surface and boundary layer processes play a fundamental role in the life cycle of a fog layer. These effects are still not well parameterized in current operational numerical weather prediction (NWP) models. Moreover, horizontal and vertical resolution of the current NWP models are larger than the corresponding characteristic fog scales (TARDIF, 2007). Consequently, fog and low clouds that are predominantly driven by local influences are poorly forecast by current NWP models. Single-column models are able to overcome these deficiencies, despite the poor estimate of horizontal heterogeneities. Several 1-D models have been used to study fog layers (e.g., MUSSON-GENON, 1986; DUYNKERKE, 1991; BERGOT and GUÉDALIA, 1994). Moreover, 1-D models are currently used in real time to forecast fog at the local scale (CLARK, 2002, 2006; TERRADELLAS and CANO, 2003; TERRADELLAS *et al.*, 2005; HERZEGH *et al.*, 2003). These feasibility studies have demonstrated the capabilities of local numerical models for short-term forecasting. Moreover, it is obvious that an important component for success is the capacity to initialize at their best, the local numerical model using specific observations and a local adaptive assimilation scheme (BERGOT *et al.*, 2005). The methodology tested in this article is based on Cobel-Isba numerical prediction system operationally used at Paris-CdG airport to forecast LVP conditions.

The objective of the work presented here is to evaluate the performance of the Cobel-Isba numerical prediction system used at Paris-CdG airport over a period of three years. This evaluation aims to better identify the strengths and weaknesses of the system, and facilitate an optimal use of Cobel-Isba forecast products. A brief description of the numerical method, including local assimilation and Cobel-Isba numerical model, is presented in section 2. The quality of the forecast of LVP conditions at Paris-CdG is detailed in section 3. Finally, recommendations and the limitation of this kind of local numerical modelling are outlined in section 4.

2. Numerical Forecast System

a. Cobel-Isba Numerical Model

The atmospheric model used in this study is the high resolution 1-D Cobel (Code de Brouillard à l'échelle locale) model. This column model was developed in collaboration between the Laboratoire d'Aérologie (Université Paul Sabatier/ C.N.R.S., France), Université du Québec a Montréal (U.Q.A.M., Canada) and Centre National de Recherches Météorologiques (GAME-CNRM/CNRS, France). A detailed description can be found in BERGOT (1993), BERGOT and GUÉDALIA (1994), and only a brief description will be given hereafter.

The model equations are classically derived from the Boussinesq hypothesis, under the assumption of horizontal homogeneity. However, spatial heterogeneities are treated as an external mesoscale forcing and are evaluated from the Météo-France operational NWP model Aladin (model grid box of about 10 km). These mesoscale