CNRM, UMR 3589

SOUTENANCE DE THESE CNRM

lundi 14 février 2022 à 09h30

TOWARDS FOG FORECAST IMPROVEMENT THROUGH THE INSTRUMENTAL SYNERGY OF CLOUD RADARS AND MICROWAVE RADIOMETERS

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en salle Taillefer et en visioconférence

Code bj = https://bluejeans.com/111007881/5617

Résumé

Fog- the reduction in visibility at the surface due to water droplets or ice crystals- can cause significant disruption to transportation, resulting in both human and economic costs. However, fog is badly predicted by even modern high resolution numerical weather prediction (NWP) models. One way in which fog forecasting may be improved is through more accurate initial model conditions.
A new generation of 95 GHz cloud radars, presents the possibility of observing fog properties that could be assimilated to improve initial conditions of NWP models.
A common data assimilation strategy for new instruments is to perform an intermediate step by making a retrieval of the atmospheric variables from the observations, before then attempting to assimilate these retrieved variables into a NWP model.
The retrieval of LWC profiles from radar reflectivity alone is an under-determined problem, something which ground-based microwave radiometer observations can help to constrain. In fact, ground-based microwave radiometers are sensitive to vertical profiles of the vertically integrated value of LWC, the liquid water path (LWP) but also to temperature and humidity, which are also key variables to determine the saturation capability of the fog layer. The main aim of this thesis is thus to optimally combine cloud radar and microwave radiometer observations in a synergistic retrieval algorithm, in order to obtain physically consistent retrievals of temperature, humidity and LWC profiles during fog conditions which when assimilated into a NWP model, could result in improved fog forecasts.
To that end, a one dimensional variational data assimilation scheme (1D-Var) has been chosen to combine the cloud radar and microwave radiometer observations with short-term-forecasts from the NWP model AROME.

Firstly, to prepare for the 1D-Var retrievals, an error analysis is conducted on the AROME model during fog events at the SIRTA observation site near Paris. Significant spatio-temporal fog prediction errors were found, which led to a correction method, termed the most resembling profile (MRP) method, for the selection of more appropriate model profiles to be used in the 1D-Var retrievals.
Secondly, developments to the 1D-Var algorithm which allow the retrieval of temperature, humidity and LWC together are presented. The algorithm is firstly tested on a synthetic dataset in order to evaluate the developed algorithm in idealised conditions. It is then tested with real data from the recent field campaign SOFOG-3D, carried out with the use of LWC measurements made from a tethered balloon platform. The capability of the algorithm to retrieve LWC, temperature and humidity profiles during fog conditions with a good accuracy is demonstrated.
The potential improvements to fog forecasts through improved initial model conditions are then discussed alongside future developments which could further improve retrieval accuracy of the developed algorithm.

Composition de Jury

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