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PROJET DE FIN D'ETUDES

INGENIEURS DE L'ECOLE NATIONALE DE LA METEOROLOGIE

FICHE DE PROPOSITION DE SUJET

Titre du sujet proposé : Model intercomparison between the ICON and AROME for fog cases around Payerne

Organisme ou service proposant le sujet :

Federal Office of Meteorology and Climatology MeteoSwiss
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Le stage présente-t-il un caractère de confidentialité ? : NON

Le stage peut-il être effectué à distance ? : OUI en cas de contraintes sanitaires fortes (confinement), mais une présence sur les sites de Toulouse et Zurich serait préférable

1) Description du sujet – livrables attendus

Most operational numerical weather prediction (NWP) centres list errors in fog forecasting amongst their top model problems, with the requirement for improvement considered as high-priority. The key customer driving this is the aviation sector, with about 50% of weather related delays at busy airports being due to low visibility events. Despite many improvements in recent years in high-resolution NWP models, fog remains a difficult forecasting challenge (Bergot and Koracin, 2021).

An intercomparison experiment among different NWP models in the field of fog and low clouds forecast was carried out for Paris-CdG in 2005 (Bergot et al, 2007). This intercomparison experiment has proved that most of NWP models can simulate the major features of the fog cycle. However, a high sensibility to the physical parameterisations and vertical resolution has been found.

Since 2005, NWP models have greatly improved, particularly the spatial resolution: AROME 1.3 km in France and ICON 1km in Switerland. The main goal of this intercomparison between AROME and ICON is to identify the capabilities of these models to forecast fog accurately, and

an attempt will be made to identify the main reasons behind the differences among these models. The effect of the vertical resolution and the effect of surface deposition of fog droplets on the fog prediction will particularly be examined. Our intention is not to show that one NWP model is better than the other but rather to identify inacurracies in the key processes driving the fog layer (Westerhuis et al., 2020).
For the intercomparison between AROME and ICON, Payerne and its surroundings constitute the target area. Payerne is located between agricultural lands and urbanised areas with mostly flat terrain or gently rolling hills. This area is representative for a classical airport area.
MeteoSwiss operates many instruments at Payerne which provide detailed observations of the atmosphere in the lower atmosphere : Radiosoundings, microwave radiometers, ceilometers, a Raman lidar, wind lidars, radar wind profilers, and many more. These observations will permit to identify model deficiencies in turbulence processes, surface processes or in the low cloud life cycle.
The concept of process diagrams has demonstrated to be very fruitful to analyze fog (Bergot and Lestringant, 2019). It allows a good illustration of the spread of fog during the chaotic phase. Only 50% of fog cases evolved into deep and optically thick fog, associated with saturated adiabatic temperature profiles. The other 50% remained shallow and optically thin, associated with thermally stable layer near the ground (Price et al., 2018).
Shallow and deep fogs are thus quite different and identifying if fog becomes deep is clearly an important forecast goal. This transition between shallow and mature fog will be explored with the concept of process diagrams.

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J. Appl. Meteorol. Climatol., 46, 504–521, https://doi.org/10.1175/JAM2475.1, 2007.
-Bergot T, Lestringant R. :
On the Predictability of Radiation Fog Formation in a Mesoscale Model: A Case Study in Heterogeneous Terrain.
Atmosphere. 2019; 10(4):165. https://doi.org/10.3390/atmos10040165
-Bergot T, Koracin D. :
Observation, Simulation and Predictability of Fog: Review and Perspectives.
Atmosphere. 2021; 12(2):235. https://doi.org/10.3390/atmos12020235
-Westerhuis S, Fuhrer O,Cermak J, Eugster W. :
Identifying the key challenges for fog and low stratus forecasting in complex terrain.
Q.J.R. Meteorol. Soc., 2020;146:3347–3367. https://doi.org/10.1002/qj.3849
-Price, J., Lane, S., Boutle, I., Smith, D., Bergot, T., Lac, C., Duconge, L., McGregor, J., Kerr-Munslow, A., Pickering, M. :
LANFEX: A field and modeling study to improve our understanding and forecasting of radiation fog.
Bull. Am. Meteorol. Soc., 2018, 99, 2061–2077, https://doi.org/10.1175/BAMS-D-16-0299.1

2) <u>lieu du stage, durée ou période</u>

The student will begin in DESR/CNRM (Toulouse). During this period in Toulouse, the student will become familiar with the physical processes governing the fog life cycle, the process diagram concept and the French AROME NWP.
Afterwards, the student will conthinue his/her work in Zurich at MeteoSwiss. She/he will discover the Swiss ICON NWP model and the observational super-site at Payerne.