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Using regional simulations and spatial lidar to study regional cloud variability

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Context
This work aims to study the clouds’ role on regional climate variability. At first order, European climate is driven by large scale circulations. However, clouds, known to have two major radiative effects impacting the surface’s temperature: the greenhouse effect and the mask effect. These effects are strongly dependent on macrophysical and microphysical properties of clouds. It is then necessary to consider the vertical distribution of clouds to better understand their impact on regional climate.

Since June 2006, A-train observations are available and allow the description of this vertical distribution of clouds and additional properties from satellite imagers. The main aim of this study is to separate the long-term climatic variability from the short term variability and to understand the role of clouds in the European climate.

Tools

A. CALIPSO observations

1. Comparison of simulated cloud fraction (bottom) and SR (right) between satellite sampling (WRF profiles corresponding to CALIPSO measurement) and WRF sampling (one profile per day at each grid point)
2. Light overestimation of high clouds in winter and underestimation in summer (2% with the CALIPSO sampling)

B. Model evaluation

1. Comparison of SR histograms (left) and vertical cloud distribution (right) between observation and WRF sampling (daily mean)

Case study: Winter 2007

From observations (Fig. 11), over the 6 available years, spatially averaged cloud fraction without weather regime separation doesn’t show a special signal for winter 2007 (the strong signal for year 2010 is due to persistence of NAO weather regime).

But from simulations, WRF is 0.1 longer period, a west-east temperature anomaly structure is found (Fig. 12) with 40% less clouds over central Europe (where maximum of temperature anomaly is observed, fig. 9) and 40% more clouds over western Mediterranean sea and Europe.

Conclusion and perspectives

- CALIPSO sampling: insignificant bias over the 7 years but not enough tracks over a season to study interannual variability or anomaly at 20 km resolution (max 6 profiles by grid points) -Model overestimates high clouds and therefore more profiles are attenuated. It leads to less clouds detection - Study with ground based lidar shows that this simulation actually underestimates low clouds in summer but not in winter over continent. However, the radiative impact of these differences should be evaluated.

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