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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 are 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 us to describe the vertical distribution of clouds to better understand the impact of clouds and surface temperature in the Mediterranean continent, which may allow to extend the period of study and to better understand the link between clouds and surface temperature. In this study, we are evaluating our tools and estimating the sampling bias in order to know which scale we can consider with these tools. We are also considering clouds’ distribution of the particularly warm winter of 2007.

GOCCP (GCM Oriented Calipso Cloud Product)

- Active measurements
- Vertical structure of clouds (40 levels)
- Products comparable to GCM data

WRF-MedCorDEX simulations

We use a WRF simulation performed in the framework of MELD-CORDEX (downscaling of ERA-interim reanalyses) that covers the Mediterranean domain, over the period 1989-2011.

- horizontal resolution: 20km
- 28 vertical levels, outputs every 3 hours (See poster Bastin Tuesday topic 7 for further details)

2 problems:
- Two different samplings due to spatial and temporal resolutions (Fig. 3)
- WRF outputs generate mixing ratios of ice, snow and liquid clouds (WSM5 scheme): what to do with the lidar signal (SR) => lidar simulator

A. Calipo Sampling evaluation

Comparison of simulated cloud fraction (bottom) and SR (right) between satellite sampling (WRF profiles corresponding to GOCCP measurement) and WRF sampling (one profile per day at each grid point)

B. Model evaluation

Comparison of SR histograms (left) and vertical cloud distribution (right) between observations and WRF simulations (40km sampling).

Case study: Winter 2007

- At 1st order, the mean seasonal temperature over Europe is largely explained by the frequency of weather regimes during the concerned season (Palmer,1999).
- But Piyou (2007) showed that the exceptional warm fall/winter of 2007 (Fig. 9) was not driven by changes in mid flow situations.

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 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

References and acknowledgments

References:

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