Coupling CALIOP observations and regional simulations at 20km resolution: is that a good candidate to study cloud variability at the regional scale?

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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 temperature: the greenhouse effect, and the albedo 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 and of other microphysical properties. However, the sampling is limited. To determine small scale variability, we complete these observations, we use a regional climate model which may allow to extend the period of study and to better understand the link between clouds and surface temperature.

In this study we address the ability of our tools to study impact of clouds on European climate at a resolution suitable to take into account the complex terrain of this area. Seasonal and inter annual clouds variability is presented for observations and simulations. We also evaluate the amplitude of clouds variability in the simulations and the uncertainties linked to the satellite sampling.

### B. Effect of satellite under sampling

**Evaluation of CALIPSO sampling using the WRF+GOCSP simulations**

- Comparison between Sat. sampling and WRF sampling for cloud fraction
- CF<sub>WRF</sub> - CALIPSO = WRF profiles where/when there is CALIPSO measurement
- CF<sub>WRF</sub> 2006-2011 = one profile per night at each grid point

**C.1 Model evaluation: seasonal variability**

- Overestimation of high clouds in the model (Fig. 6)
- Overestimation of high cloud vertical depth (although less optically thick clouds (Fig. 7) > more profiles are fully attenuated under 7 km <- less low clouds detected by SR threshold

**C.2 Model evaluation: inter annual variability**

- Underestimation of low clouds, especially in summer > need complementary analyses
- WRF simulations underestimate low clouds: the result is amplified with lidar simulator
- Low cloud detection (amplified by the use of lidar simulator and overestimation of high clouds) at specific levels. The sampling effect on CF estimation is significant when studying the interannual variability: The vertical distribution at high levels is modified and the amplitude is reduced in high clouds in summer. It is different when only considering 3 layers (high, mid and low clouds): instead of detailed vertical distribution?

### D.1 Discussion #1

The sampling effect on CF estimation is significant when studying the interannual variability: The vertical distribution at high levels is modified and the amplitude is reduced in high clouds in summer. It is different when only considering 3 layers (high, mid and low clouds): instead of detailed vertical distribution?