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Incorporating ALADIN/Aeolus lidar observations into a climate record of cloud profile

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Clouds play an important role in the energy budget of our planet, and their response to climate warming is the largest source of uncertainty for model-based estimates of climate sensitivity and evolution. Understanding the Earth's energy budget requires knowing the cloud coverage, its vertical distributions and optical properties. Predicting how the Earth climate will evolve requires understanding how these cloud variables respond to climate warming. Documenting how the cloud’s detailed vertical structure evolves on a global scale over the long-term is a necessary step towards understanding and predicting the cloud’s response to climate warming.

Satellite observations have been providing a continuous survey of clouds over the whole globe. Infrared sounders have been observing our planet since 1979. Despite an excellent daily coverage and daytime/nighttime observation capability, the height uncertainty of the cloud products retrieved from the observations performed by these space-borne instruments is large. This precludes the retrieval of the cloud’s vertical profile with the accuracy needed for climate relevant processes and feedback analysis. This drawback does not exist for active sounders, which measure the altitude-resolved profiles of backscattered radiation with an accuracy on the order of 1−100 meters.

All active instruments share the same measuring principle – a short pulse of laser or radar electromagnetic radiation is sent to the atmosphere and the time-resolved backscatter signal is collected by the telescope and is registered in one or several receiver channels. However, the wavelength, pulse energy, pulse repetition frequency (PRF), telescope diameter, orbit, detector, or optical filtering are not the same for any pair of instruments. These parameters define the active instruments’ capability of detecting atmospheric aerosols and/or clouds for a given atmospheric situation and observation conditions (day, night, averaging distance). In merging different satellite data, the difficulty is to build a multi-lidar record accurate enough to constrain predictions of how cloud evolve as climate warms.

In this work, we discuss the approach to merging the measurements performed by the relatively young space-borne lidar ALADIN/Aeolus, which has been orbiting the Earth since August 2018 and operating at 355nm wavelength with the measurements performed since 2006 by CALIPSO lidar, which is operating at 532nm and is near the end of its life-time.

The approach consists of:

(a) developing a cloud layer detection method for ALADIN measurements, which complies with CALIPSO cloud layer detection;

(b) comparing/validating the resulting cloud ALADIN product with the well-established CALIOP/CALIPSO cloud data set;

(c) developing an algorithm for merging the CALIOP and ALADIN cloud datasets;

(d) applying the merging algorithm to CALIOP and ALADIN data and build a continuous cloud profile record;

(e) adapting this approach to future missions (e.g. ATLID/EarthCare).

In the presentation, we show the results of preliminary analysis performed for the first two steps and discuss the future development of this approach.