Review of Egusphere-2024-1180:

The authors present a novel method for retrieving cloud fraction from multi-angle polarized measurements that observe both cloud-bow and oceanic sun-glint. The novel contribution of this work is especially in the utilization of the polarized sun-glint signal to retrieve a resolution-independent measure of cloud fraction. The manuscript is well-written and acts as a demonstration of the key physical dependencies of the retrieval, using a combination of 1D RT and simple 3D RT simulations. This work can form the basis for the potential development and more widespread validation of an operational algorithm.
For this version, I have three comments for which I recommend minor revisions to the manuscript.

First, the method relies on the presence of unambiguous liquid within the field of view. This becomes increasingly unlikely when combining multi-angle observations at coarse-resolution as is done here. Naturally, the final effect of undetected ice will depend on the details of the cloud-top phase algorithm that is utilized. I don't think that a detailed emulation of the role of the cloud-top phase algorithm in filtering errors is necessary for this work. However, no phase determination algorithm will be perfect. So, this study should also perform a similar sensitivity study using 1D RT on the effect of the presence of overlying optically thin ice layers (e.g., cirrus) on the retrieval.

Second, the utility of this product for testing scientific hypotheses relies on its algorithmic stability. While threshold-based, pixel-by-pixel cloud masks provide an unstable estimate of the cloud fraction when the cloud size distribution changes, they can be designed to be invariant to solar-viewing geometry. On the other hand, the method developed here depends on the cloud fraction in the sun-glint view, which will change in viewing zenith angle with solar zenith angle. The cloud fraction at an oblique view is not the same as the vertically projected cloud fraction that is used as a model diagnostic, for example. For a polar-orbiting satellite this difference will introduce a regionally and seasonally varying bias in the apparent vertically projected cloud fraction. The magnitude of this bias is one of the foremost controls on the utility of this proposed method. This concept should be discussed within the text, with a recommendation that this effect should be evaluated in further studies.

It appears the 3D RT simulations are at a single SZA of 50 degrees, which is associated with an overestimation of cloud fraction. The magnitude of the SZA-dependence of the retrieval will depend strongly on the realism of the cloud geometry. The 3D RT simulations utilize relatively large horizontal-to-vertical aspect ratios (5:1), when compared with typical cumulus, which might be more on the order of 2:1 or 1:1. Therefore, I don't see it as strictly necessary to quantify this with the simplified cloud fields presented here (though I would welcome it if the authors choose to also include 3D RT results for SZA=15 to contrast). However, it is very important to describe the concept so that readers can understand all of the expected behavior of the technique.

Third, I believe the value of the specMACS analysis is to validate the cloud fraction derived from the coarse-resolution polarization method. However, at the moment, there is just an intercomparison of two cloud masks. Based on figure 16, the pixel-by-pixel cloud mask is missing a lot of cloud, which makes its use as a reference for assessing cloud fraction not as helpful. As stated in the text, the pixel-by-pixel cloud mask is designed to identify candidates for microphysical retrievals, leading to a tendency to be cloud-conservative, rather than being designed to optimally estimate cloud fraction. Fig. 18 may therefore be underestimating the presence of a more significant underestimate by the new cloud fraction estimate.

Given the relatively small number of data-points selected for the comparison, there is not really a need to compromise accuracy by utilizing an automatic Otsu thresholding method. I recommend that the thresholds be tuned by hand to each scene to ensure that all cloud is included. This way ambiguities such as mentioned in Line 441-442 can be avoided.