

Figure Harmony's TIR observation geometry



**Faculty of Civil Engineering and Geosciences**

**Geoscience and Remote Sensing**

**Master of Science Project release date: June 2023**

**Themes: Earth Observation and Clouds**

**Cloud-top motion vectors and height retrieval with the multiple-view Harmony TIR payload.**

* The observed brightness temperature does not correspond to the surface of the cloud (insofar a cloud surface can be defined), but to some effective position somewhere inside the cloud. It is therefore important to consider this penetration in the interpretation and validation of the results.

**Students profile**

The candidate should have an interest in Earth Observation. The work involves working with (simulated) data sets and the develoment of algorithms, which requires some interest in (Python) coding.

Being involved in the Harmony mission implies also some exposure to ESA, KNMI and other institutions involved in the mission across Europe

**Information:**

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For students of Applied Earth Sciences, Aerospace Engineering, Electrical Engineering, Mathematics or Computer Science

**Context**

Recently, ESA has selected the Harmony mission as its 10th Earth Explorer. One of the key aspects of the mission is the study of air-sea interactions. This will be done combining data provided by two types of payloads:

i. The multi-static radar payload will be used to provide high resolution estimates of surface winds, surface ocean currents, and ocean wave spectra.

ii. A multi-view thermal infrared payload will be used to retrieve sea surface temperature and/or cloud-top motion vectors (CMV) and heights (CTH).

This MSc project will focus on this latest aspect. As illustrated in the figure, multiply simultaneous observations of clouds from different directions allow the exploitation of the parallax effect to estimate their position in 3-D space. Repeated views with the same geometry allow to estimate the displacement of the clouds between the views and, hence, the cloud motion vector. The principles of CMV and CTH retrieval were demonstrated during previous preparatory studies, but still leaving many problems unsolved and room for improvement.

**Research Questions/Topics:**

* What is the best approach/algorithm to estimate the offset (disparity) in the position of the cloud field for a pair of images, considering that the clouds look different when viewed from different directions or at different times. During the preparatory phases promising results were obtained using readily available dense optical flow methods. The performance of different algorithms and the optimal settings for a given algorithm probably depend on the type of cloud field.
* How to combine the offsets estimated from the different pairs to perform a joint estimation of the cloud-top position and 3-D motion vector, and to provide a characterization of the cloud dynamics. This involves treating the problem as a point-cloud problem rather than a pure image processing problem.