On-board cloud radar project to characterize the role of marine micro-organisms emissions on the atmospheric properties of clouds

Sea2Cloud

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Scientific context

VOLDORAD-3 is a W-band Doppler radar (wavelength 3.2 mm) dedicated to the study of volcanic plumes to characterize their ash load and dynamic processes. Funded by the Interdisciplinary Mission of the CNRS (DEFI - 'Instrumentation aux limites') and LabEx ClerVolc, this radar was developed in collaboration with the LATMOS, based on the cloud radar BASTA (Delanoë et al., 2016). The new cloud radar is also shared at atmospheric measurement campaigns for the characterization of clouds.

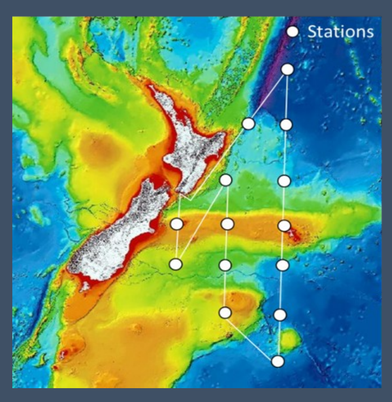
It will participate, in synergy with other instruments aboard the ship Tangaroa, to Sea2Cloud 2020 offshore campaign off New Zealand. This mission aims to characterize the role of marine microorganism emissions on the atmospheric properties of clouds that are poorly represented in models in this region of the world.

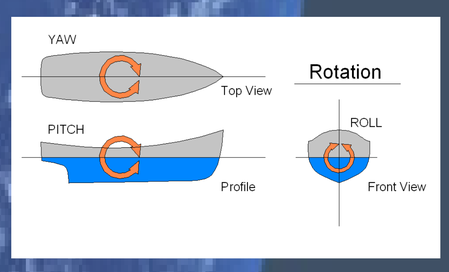
https://www.europeandissemination.eu/sea2cloud-by-karine-sellegri-2/2704

Aboard the R/V Tangaroa

Embarking the cloud radar for the Sea2Cloud offshore campaign reveals specific technological challenges related to the marinization of the material:
- choice of the location on board
- consideration of corrosion and potential vibrations

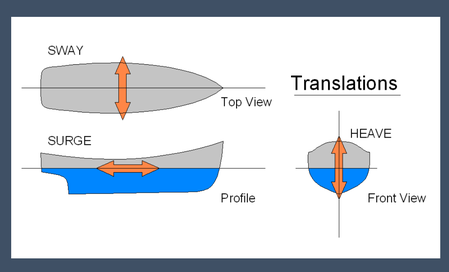
Dynamic position
(location, speed, heading)





Yaw, Roll, Pitch

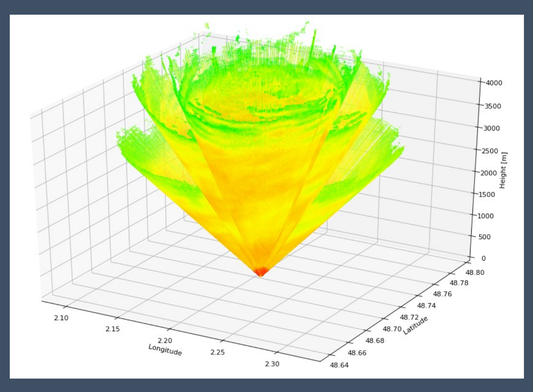
Sway, Surge, Heave



The cloud radar

Initially, this cloud radar was implemented to obtain vertical profiles in reflectivity and radial velocity to characterize the density of thin clouds, fogs, associated hydrometeors. In order to reconstruct horizontal velocity fields, this radar has been equipped with an active positioning system (SPID Elektronik) allowing the azimuth and elevation of the atmosphere to be scanned.

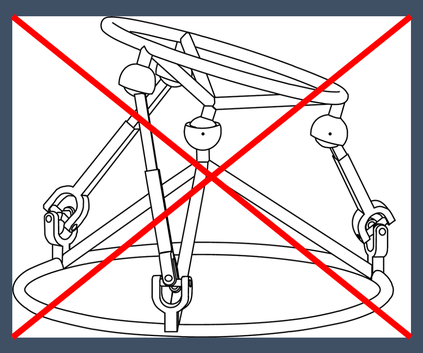
http://spid.net.pl/en/ras-hr-2/



multi-elevations VAD

Scanning the atmosphere in different directions allows to reconstruct both 3D fields of volcanic plumes but also clouds, fog and low rainfall (Range Height Indicator, RHI or Plan Position Indicator, PPI) but also to reconstruct their dynamics (Velocity Azimuth Display, VAD).

Attitude compensation



The installation of a stabilized platform represents a cost equivalent to the price of the radar itself. This solution is discarded.

We will use the spatial references provided continuously by the on board instruments , ie:

Gyroscope

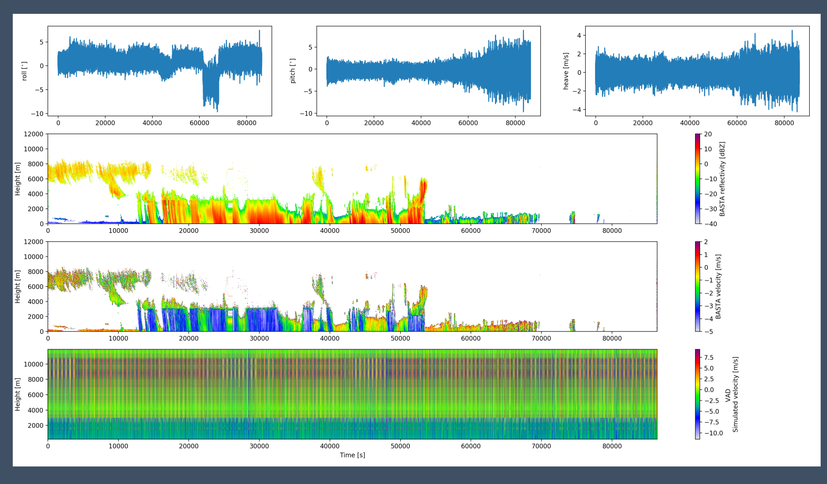
Differential GPS

Motion Reference Unit

https://www.niwa.co.nz/vessels/rv-tangaroa/specifications-and-principal-features

VAD simulation

Example of reflectivity and Doppler velocity measurements collected by a Basta cloud radar during the 2018 SOCRATES campaign in the Southern Ocean aboard the Australian Research Vessel, Investigator.
The measurements given by the motion reference unit show the ship's movements (pitch, roll, heave) in a geographical area similar to our future expedition.
We obtain a simulation of a VAD with a constant horizontal wind and a speed of hydrometeors corresponding to ice and rain.



Conclusion

We propose to use the VAD technique compensated by the constant quantization of the ship's attitude.

We will restore the vertical speed of hydrometeors and their horizontal velocity above the place of acquisition every 90 seconds or so.

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Reference : Delanoë J. et al., 2016. BASTA, a 95 GHz FM-CW Doppler radar for cloud and fog studies. J. Atm. Ocean. Tech. 33, 1023-1038.