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Deep learning applied to sea surface semantic segmentation: Filtering sunglint from aerial imagery

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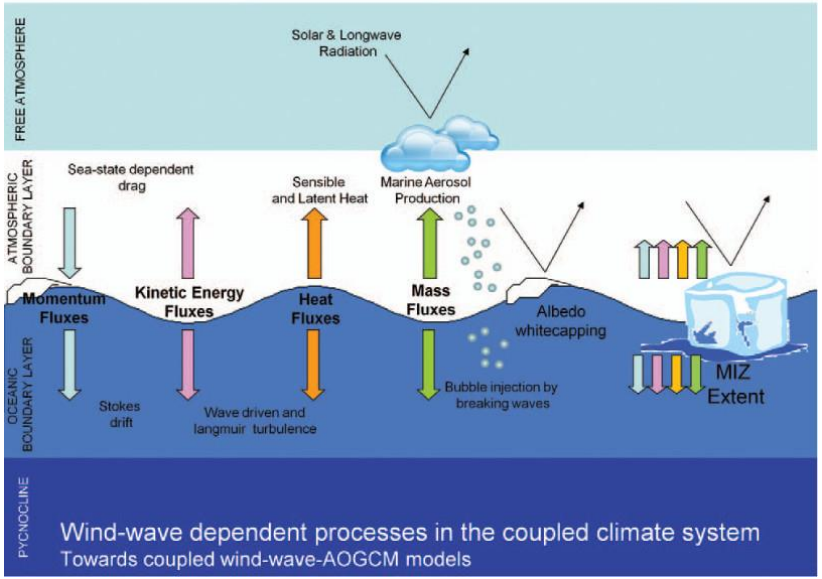
The importance of waves in climate

Exchanges between oceans and the atmosphere involve fifteen times as much carbon as human activities emit by burning fossil fuels, and are crucial in regulating temperature of the planet.



Cavaleri et al 2012

The importance of waves in climate

Emissions

Exchanges

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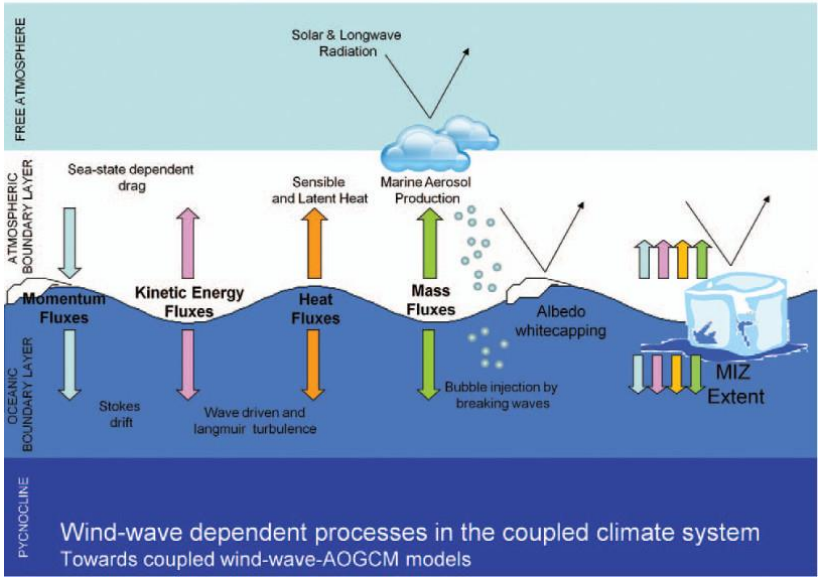
As water waves serve as a boundary between the ocean and the atmosphere, the understanding of wave processes is key to better model our changing climate

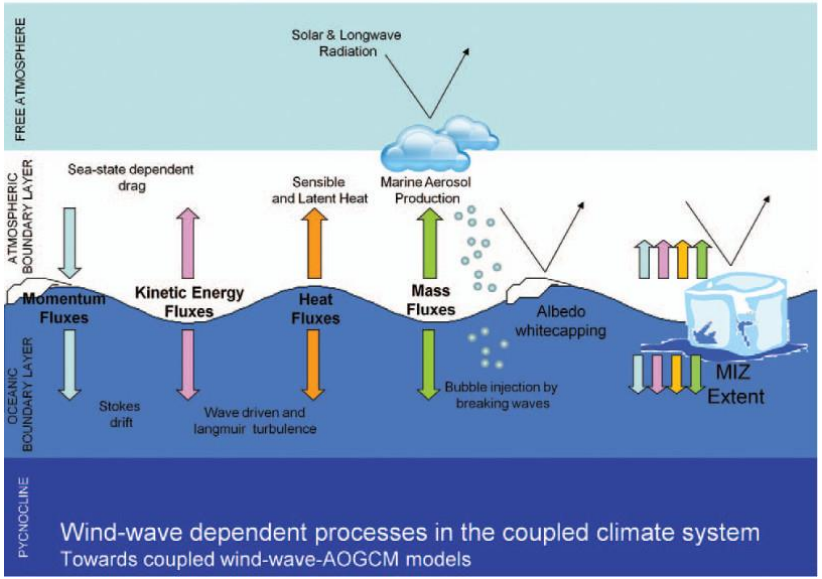


Cavaleri et al 2012

The importance of waves in climate

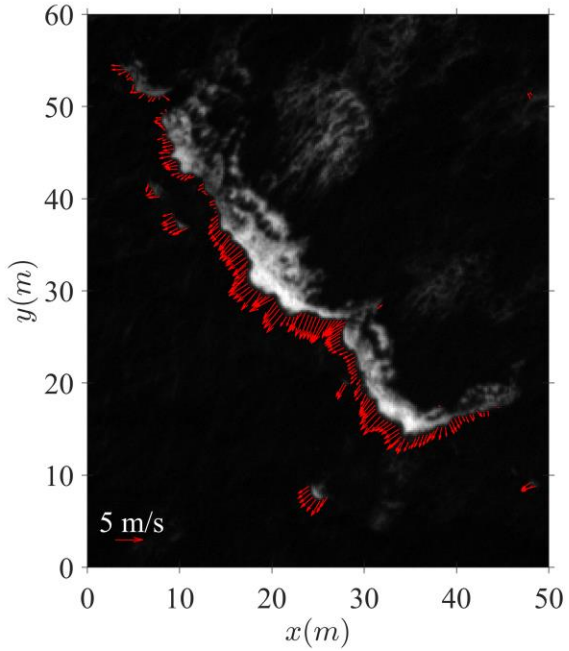
Wave breaking in particular is crucial in developing better understanding of the exchange of momentum, heat, and gas fluxes between the ocean and the atmosphere.

It was also shown to significantly increase albedo and aerosol concentrations (through generation of whitecaps and sea spray), the key variables in climate models.



Cavaleri et al 2012

Wave breaking statistics



A common way to determine properties of breaking waves, is to analyze percentage of whitecap (foam due to breaking) coverage of the sea surface.

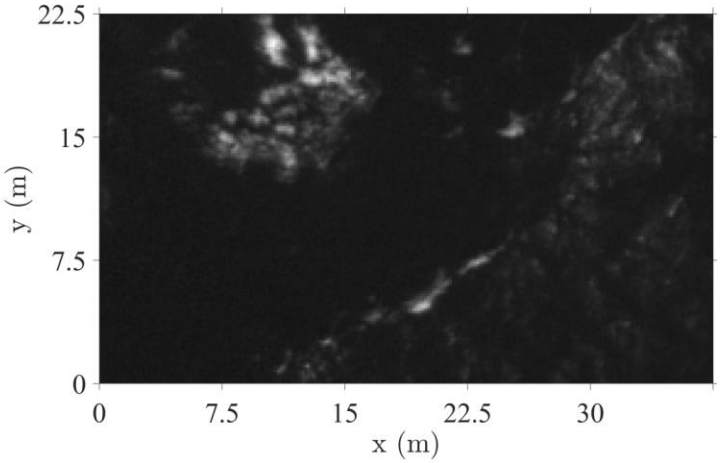
Following the approach of Phillips 1985, wave breaking can be analyzed in terms of length (and associated speeds) of actively breaking waves.

This approach enables for determination of many relevant properties (e.g. momentum).

Issue – sunglint

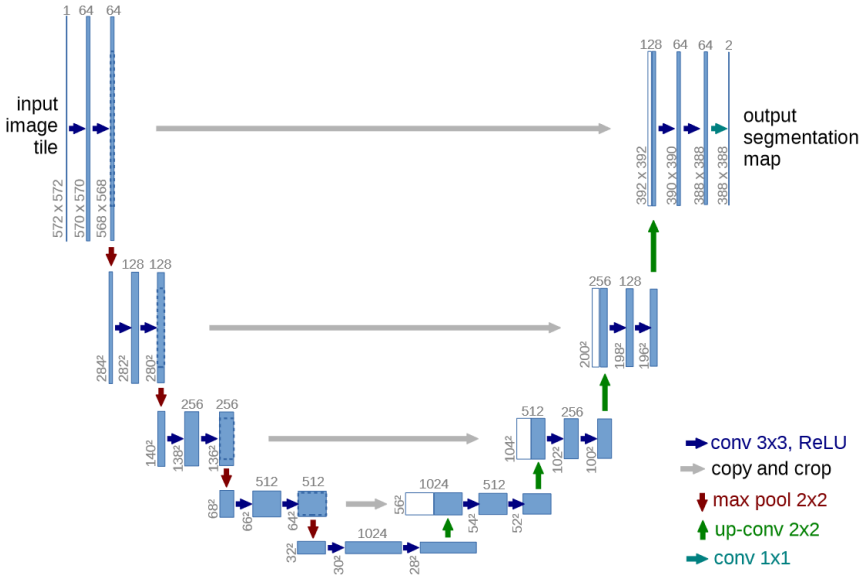
Note that the previous example was taken in near-perfect lighting conditions. Often, the images will be polluted with sunglint.

This can drastically affect the model output!



It is difficult to explicitly define algorithm that will differentiate between whitecaps and sunglint in various cases. Therefore, the use of deep learning segmentation model is proposed.

Machine learning background

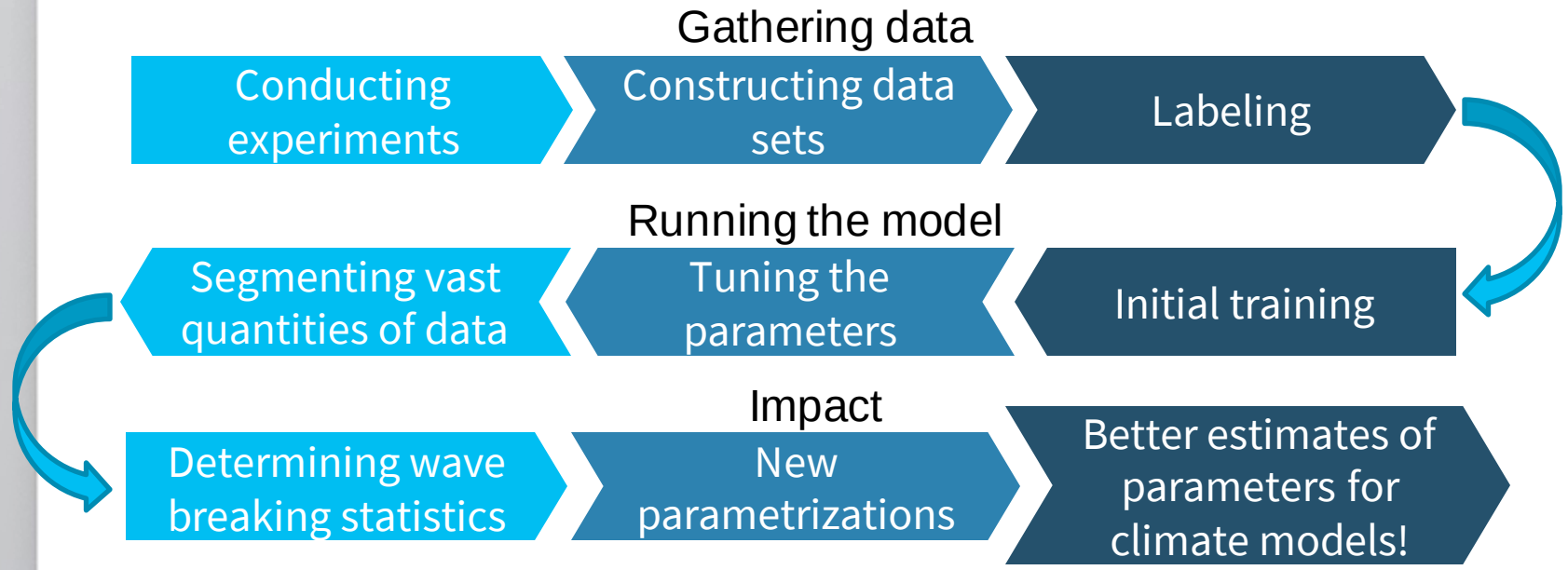


Ronnenberger et al 2015

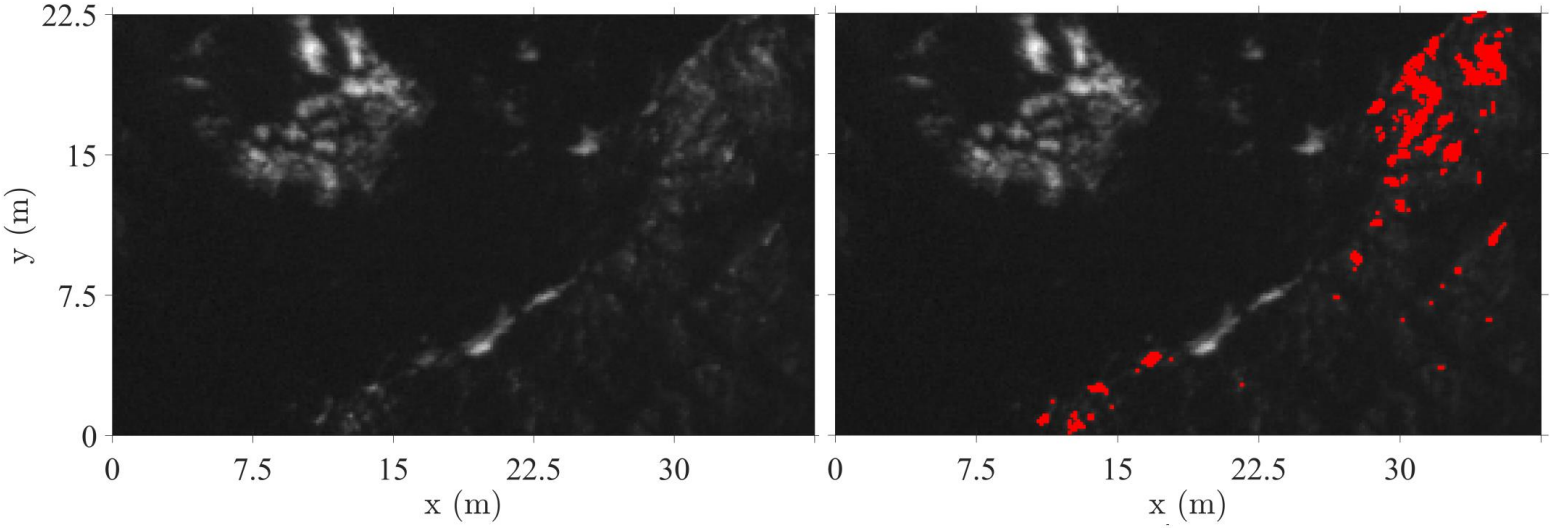
The problem under consideration requires highly accurate model architecture, with the ability to segment images at pixel level.

Due to these reasons, the use of UNet model originally developed for pixel biomedical image segmentation, is proposed.

Proposed workflow



Example of (manual) segmentation



References

L. Cavaleri, B. Fox-Kemper, M. Hemer – "Wind waves in the coupled climate system" – Bulletin of the American Meteorological Society, 2012

O.M. Phillips - "Spectral and statistical properties of the equilibrium range in wind-generated gravity waves" - Journal of Fluid Mechanics, 1985

O. Ronneberger, P. Fischer, T. Brox - "U-Net: Convolutional Networks for Biomedical Image Segmentation" - arXiv, 2015