Diplomarbeitspräsentation

FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

# Ocean Surface Generation and Rendering

Masterstudium:

Visual Computing

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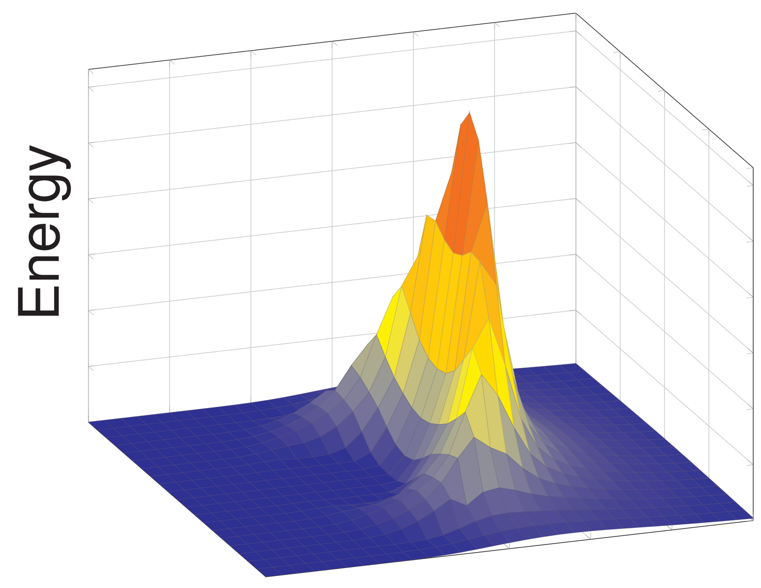
## Introduction

**Motivation**: For computer graphics to reproduce the diverse appearance of ocean surfaces represents a sophisticated problem. First, the ocean is huge and may be visible all the way to the horizon. Second, the ocean surface is dynamic and therefore needs to be updated constantly with the passage of time. Third, the optics of water are intricate.

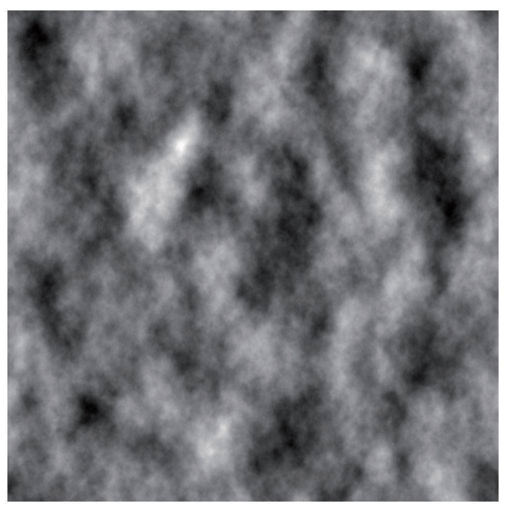
**Problem Statement**: In this thesis we seek to generate, animate, and render the surface of the open ocean in real time. We combine the seminal work by Tessendorf [4] with real-time rendering algorithms which have been tailored specifically to the open ocean [1, 2, 3]. For realism as well as variety we employ wave spectrum models from oceanographic research.

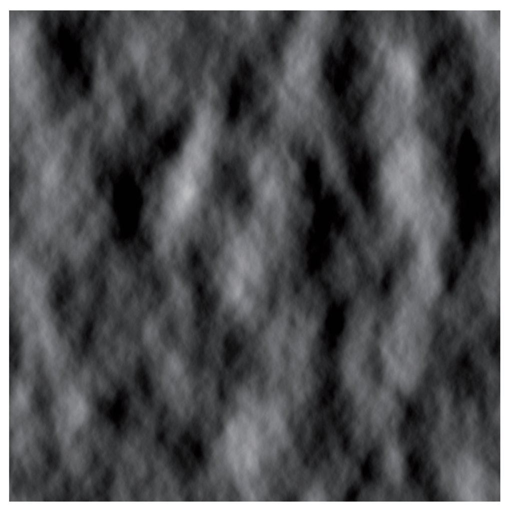
## Ocean Surface Generation

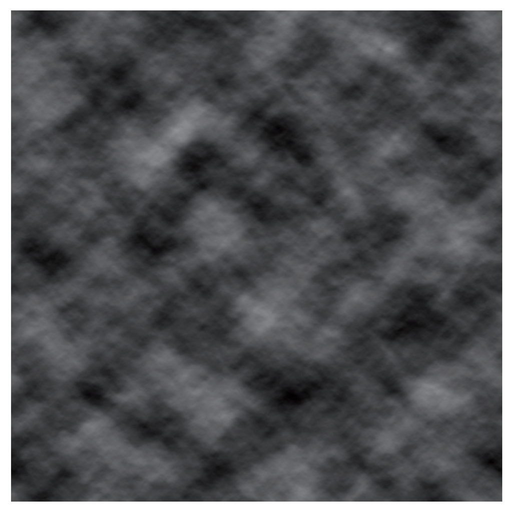
The **wave spectrum** represents the sea as wave energy in Fourier space. The only parameters are wind speed and distance from shore. To obtain more varied seas, from calm ones to highly agitated ones, we employ not just one, but four well-established wave spectrum models.




Given the wave spectrum, we **synthesize** all data for rendering: wave heights, horizontal displacements, and all the respective first order partial derivatives. To improve performance, the wave heights and the horizontal displacements may be generated at a lower resolution than their respective derivatives.

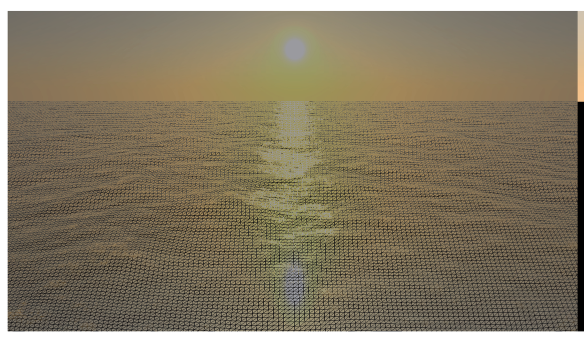

Heights

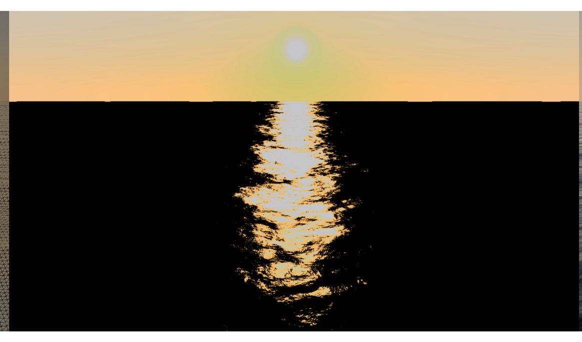

Displacement $X$

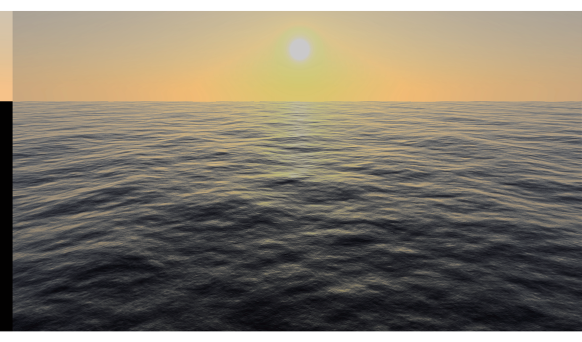

Displacement $Z$

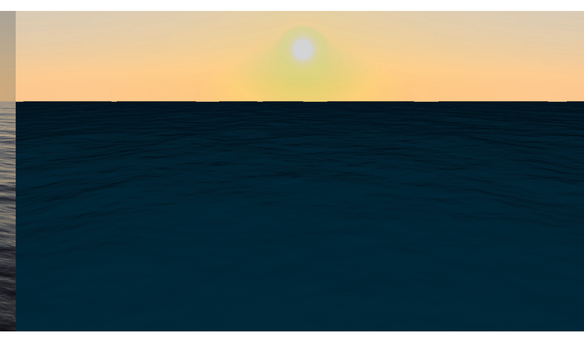
## Ocean Surface Rendering

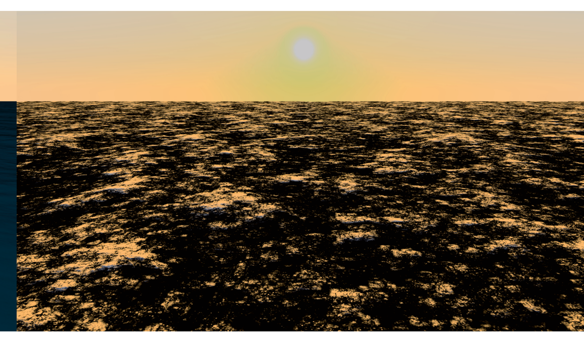
With wave heights and horizontal displacements at hand, we are able to render the animated ocean surface geometry. Moreover, based on the first order partial derivatives of the wave heights, we compute the reflected sun light, the reflected sky light, and the light refracted from the water. Additionally, based on the first order partial derivatives of the horizontal displacements, we compute the light reflected by whitecap foam. Last, by combining all lighting terms, we obtain the final result.

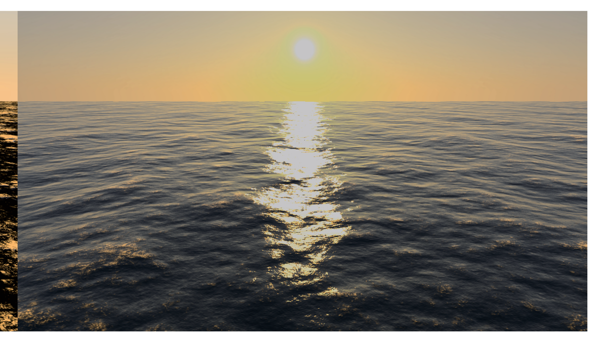

Surface geometry


Reflected sun light


Reflected sky light

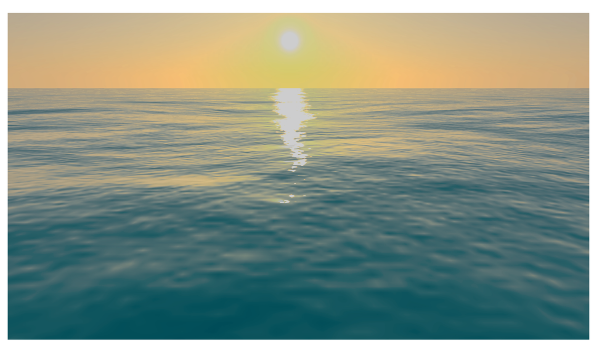

Refracted light

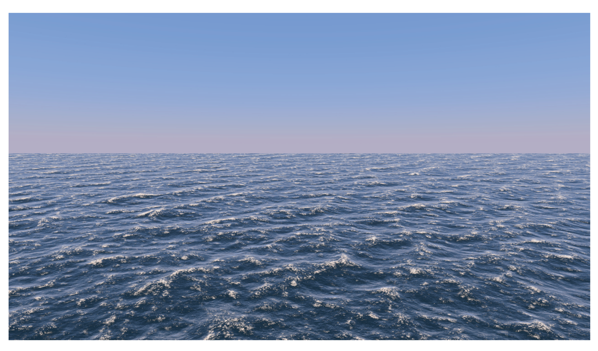

Whitecap foam


Final result

## Results

- Generate and render the animated ocean surface in real time
- Seamless transition between close-ups and panoramas
- Supports a large variety of seas
- User controlled balance between model detail and performance


Close-up of the sunset over a serene sea


Panorama of a highly agitated sea


Large, sharp-crested waves

## References

[1] Eric Bruneton, Fabrice Neyret, and Nicolas Holzschuch.
Real-time realistic ocean lighting using seamless transitions from geometry to brdf.
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[3] Claes Johanson.
Real-time water rendering - introducing the projected grid concept.
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[4] Jerry Tessendorf.
Simulating ocean water.
In *SIGGRAPH course notes*. ACM, 1999.

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