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FCT FACULDADE DE CIÊNCIAS E TECNOLOGIA UNIVERSIDADE NOVA DE LISBOA

DEPARTAMENTO DE INFORMÁTICA

HPCMOX3D ocean colour simulations

CENTER FOR INFORMATICS AND INFORMATION TECHNOLOGIES

COMPUTING SYSTEMS / ASC Team

CENTRIA

A joint effort with Prof. José Cardoso e Cunha (CITI) and Dr. Davide D'Alimonte (CENTRIA)

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Dr. Kajiyama has been a CITI member since 2008, working on HPC research in close collaboration with multidsciplinary partners in the application domain of satellite ocean colour.

Objectives

This project aims to develop new high-performance computing (HPC) modules on the basis of an existing parallel Monte Carlo (MC) ocean colour (OC) radiative transfer code, hereafter MOX, developed by a multidisciplinary team of researchers in the CITI and CENTRIA centres. From the applicative perspective, the project addresses a MOX extension for three-dimensional (3D) simulations with a view to specific OC studies on uncertainty assessments of field above-water radiometry. From a Computer Science point of view, the present work provides technical support for large-scale OC computer experiments through improved efficiency and flexibility of MOX simulations challenged by different sources of uncertainty affecting the code performance and product accuracy.

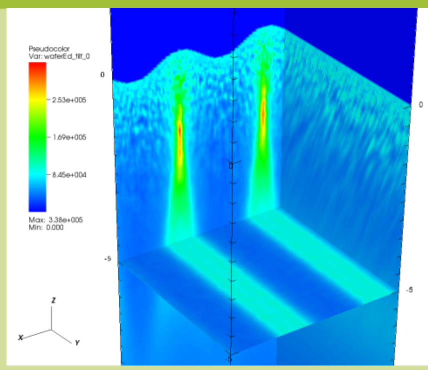

Fig. 1: Example of MC simulation results in 3D, showing the effects of light focusing due to surface waves.

Methodology

MOX is extended to compute light distributions within and above a column of seawater at high spatial resolution in an extended 3D domain (Fig. 1). New MC elements are introduced to account for light polarization induced by: a) scattering in the atmosphere (due to both air molecules and aerosol); and b) reflection and transmittance at the air-water interface in the presence of sea-surface waves (Fig. 2). Increased computational loads in 3D simulations with the additional MC elements for polarization effects are addressed by developing new performance optimization and job scheduling methods based on HPC and machine learning techniques. Application studies based on large-scale 3D MOX simulations are conducted using HPC facilities including the Milipeia cluster (Univ. Coimbra).

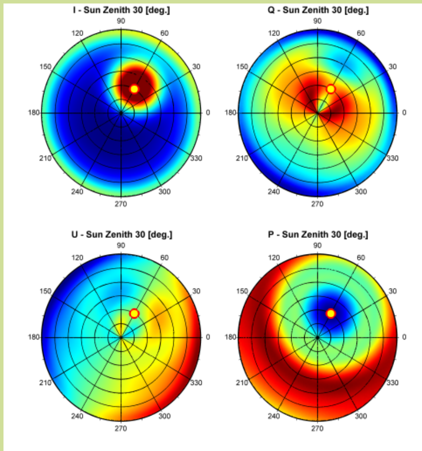

Fig. 2: MC sky radiance modelling: simulated Stokes components I, Q and U, as well as the degree of polarization P = $(Q^2 + U^2)^{1/2}$ / I.

Expected Results

Outcomes of this project are relevant to *in situ* above-water radiometry for the validation of satellite OC data products in current and future satellite marine observation programs, including the MERIS and OLCI missions of the European Space Agency (ESA). The most relevant example is the OC component of Aerosol Robotic Network (AERONET-OC), which specifically supports long-term cross-site OC validation measurements by means of autonomous above-water radiometer systems (Fig. 3). MOX 3D simulations with the extended capability to model polarization effects are foreseen to support a theoretical quantification of uncertainty budgets due to sun and sky glints induced by sea-surface waves affecting AERONET-OC above-water radiometric observations.

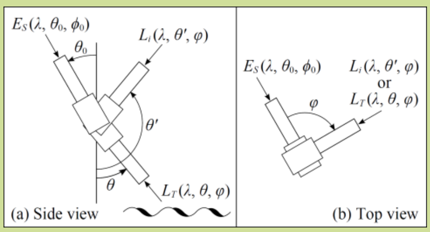

Fig. 3: Measurement geometry of AERONET-OC above-water radiometer systems, configured with sun zenith angle θ_0, sun azimuth angle ϕ_0, viewing angles θ and $\theta'=180°-\theta$, and relative azimuth angle φ with respect to ϕ_0.

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