MERCUDA

Real-time GPU-based marine scene simulation

Background

- 15 years of Research & Technology for the french MoD (PEA)
- GPGPU arrived in 2007
- First development of a GPU-based sea surface demonstrator with impressive speed-up compared to the CPU version
- 18 months of internal R&D around GPGPU and sea surface modeling and rendering (visible and IR)
- 2 major DGA founding for the EM version
- For 1 year, we have been working on a more complete version with the addition of 3D objects (boats, coasts, …)

Main goal

- **Provide real-time, realistic simulations of sea scenes**

- **Applications:**
  - **Search And Rescue : finding a small signature object in the clutter**
  - **Mission preparation, training**
  - **Situation awareness**
  - **Design and development of marine survey systems**
  - **Asymmetrical terrorist threats**
  - **Illegal fishing**
  - **Smuggling**
  - **Piracy**
  - **Environmental disaster**

Technical overview

➢ Characteristics:

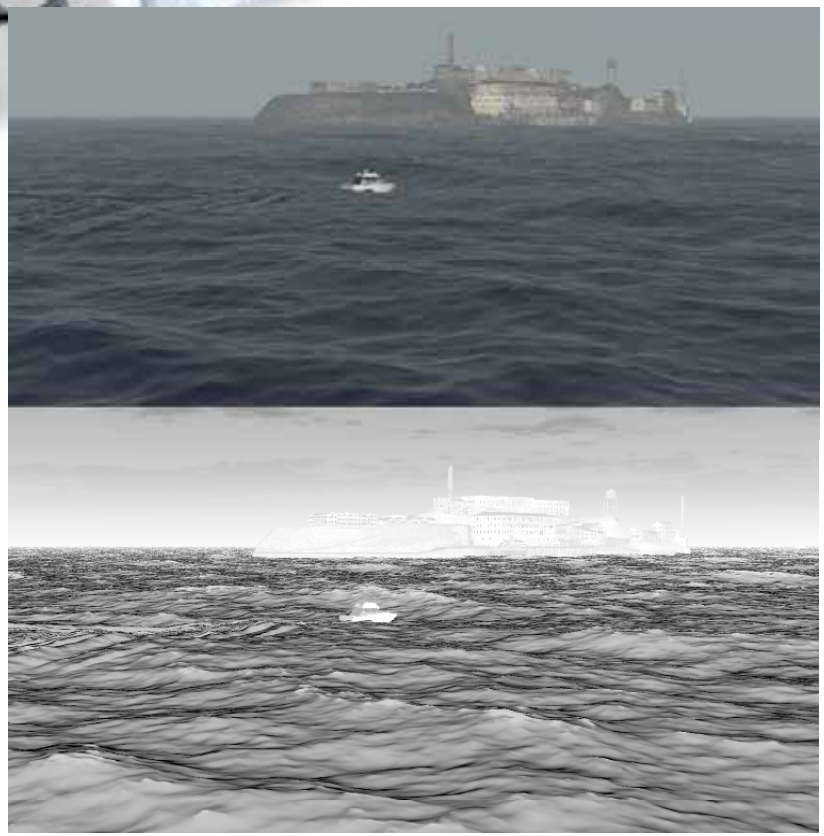
- Multi-band model (visible, IR2, IR3, radar X band)
- Multi-resolution model (10x10 cm² in a detailed zone, 60x60 km² wide-area)
- Real-time thanks to GPU computing
- 3D animated scene : sea surface, boats and coasts
- Fully configurable model (scenario, weather)
- Simulated sky integration (visible, IR) : SKYGEN© product

➢ Modeled phenomena:

- Surface simulated through sea spectrum calculation (wind speed, swell) with non-linearity producing horizontal movements (orbital speed)
- Breaking waves (spikes) and white caps
- Shadows
- Grazing angles
- Ship wakes

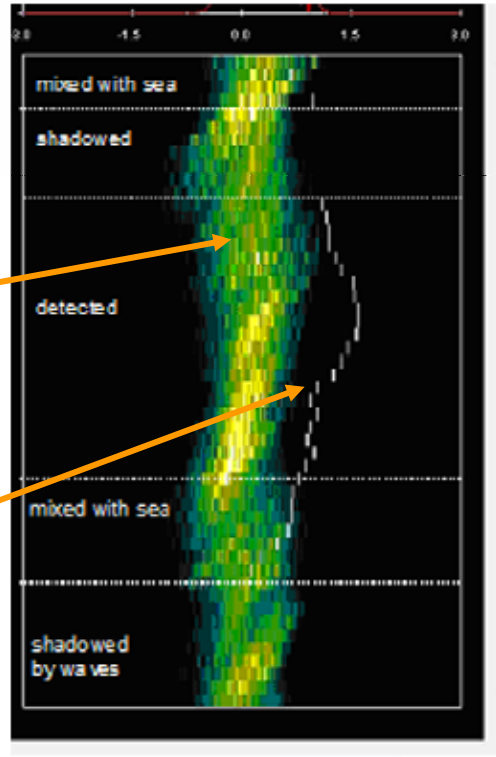
Results

Simultaneous Visible & IR modes



Radar mode

Doppler calculation



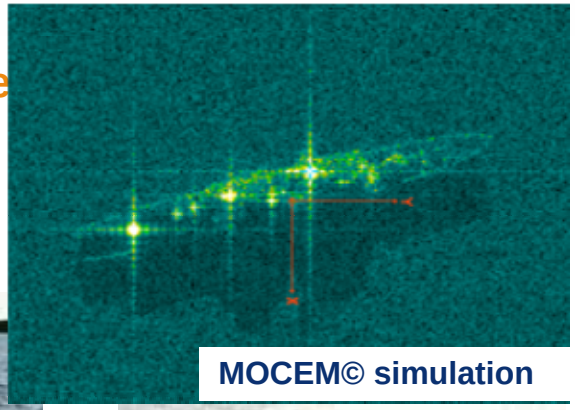
Sea clutter

Boat signature (SER)

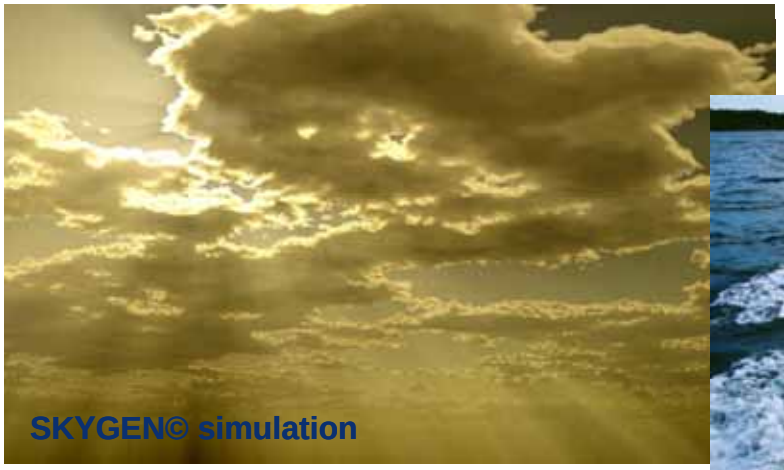
The sea surface model was developed with the expertise of IFREMER
Radar model was funded by DGA / MRIS

Ongoing development

- Improvement to ship attitudes and interaction with the sea surface (wakes, bow wave)
- Integration of multi-scattering points radar signature
- Calculation of dynamic sky background
- Integration with RADTHERM (thermal model)
- Integration with WRF (Weather Research and Forecasting mode
- Integration with EM rain clutter simulation

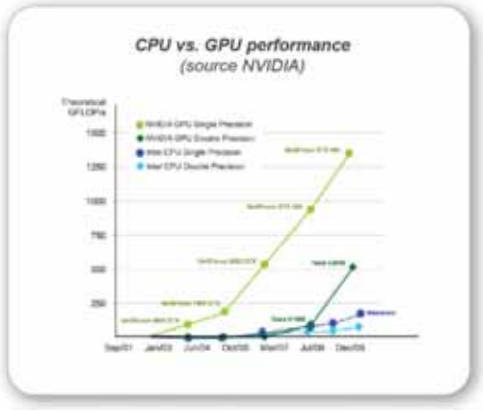


MOCEM© simulation



SKYGEN© simulation

Benefits of GPGPU



- **GPU performances are twice better every 18 months**
  - Allows to compute :
    - More complex and accurate algorithms
    - Get rid of statistical simplifications
    - Reach / keep real-time capabilities
  - Allows to plan new use of simulation like :
    - Training software physically qualified
    - Sensor performances evaluation (hardware-in-the-loop simulation)
    - Decision-support
    - Analyze of relatively unknown phenomena
- **More and more tools, libraries available**
  - Allows to develop faster
  - Fast and powerful integration between computation and rendering (OpenGL/Direct3D and shaders + CUDA/OpenCL)
- **Low investment**
  - GPU is not expensive
  - GPU can be found in any computer
  - Short learning period : C-based language
  - Standard solution : OpenCL

Demo

http://www.youtube.com/watch?v=sf6EVn2Zgk4