Studying the conversion energy on different geometry configuration of current power turbines site

Eduardo De Paula Kirinus, Wiliam Correa Marques, Bruno De Castro Pezzato, Vanice Rodrigues Poester

Universidade Federal do Rio Grande, Brasil

ekirinus@gmail.com || www.lansd.furg.br

Introduction

- " Inexhaustible";
- Reduce the emission of CO_2;
- Reduce the dependance of fossile fuels;
- Constantly enhance of existing technologies.

Study Area

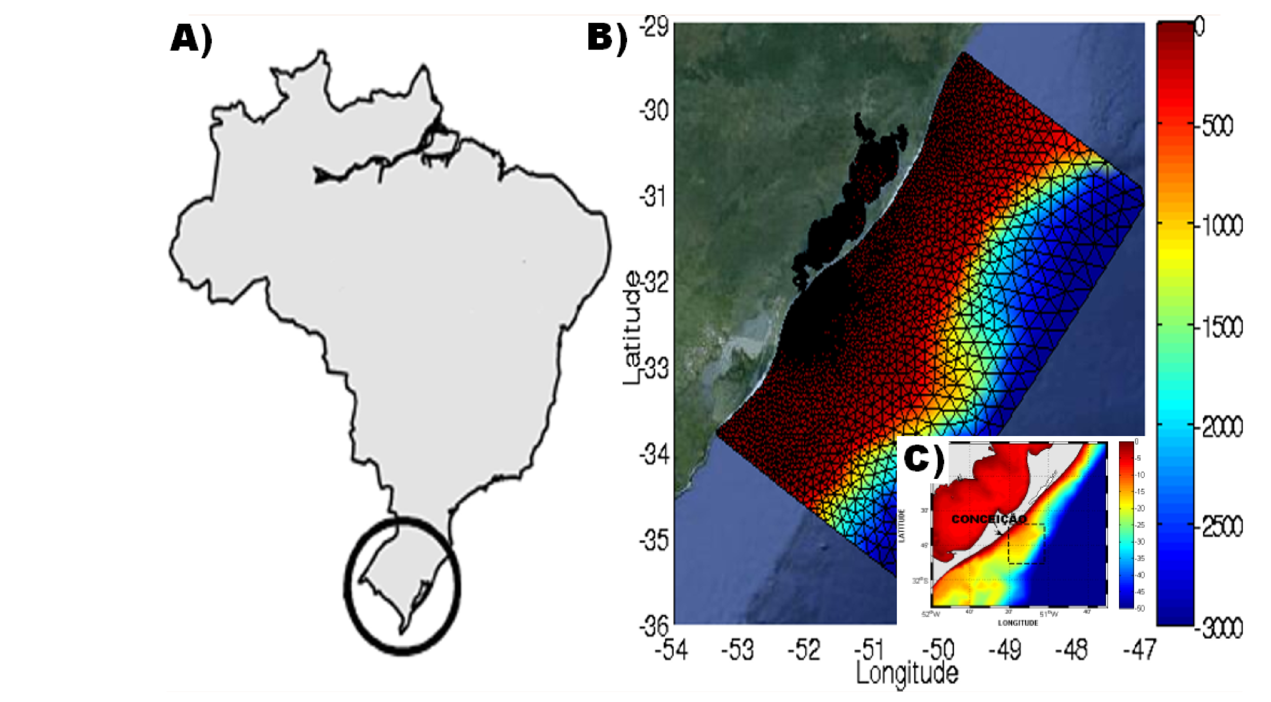

Fig.1: Study Area. Southern Brazilian Shelf, with maximum depth around 3.000m. In detail the studied area, near the Conceição.

Methodology

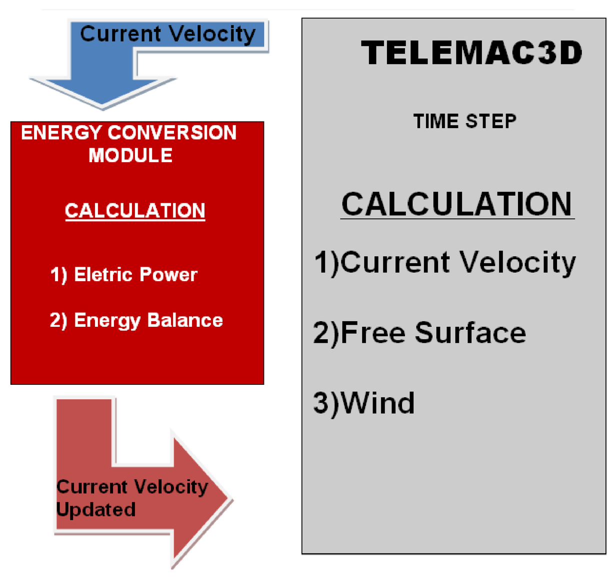

Fig.2: Fluxogram of the interactions between the TELEMAC3D and the energy module.

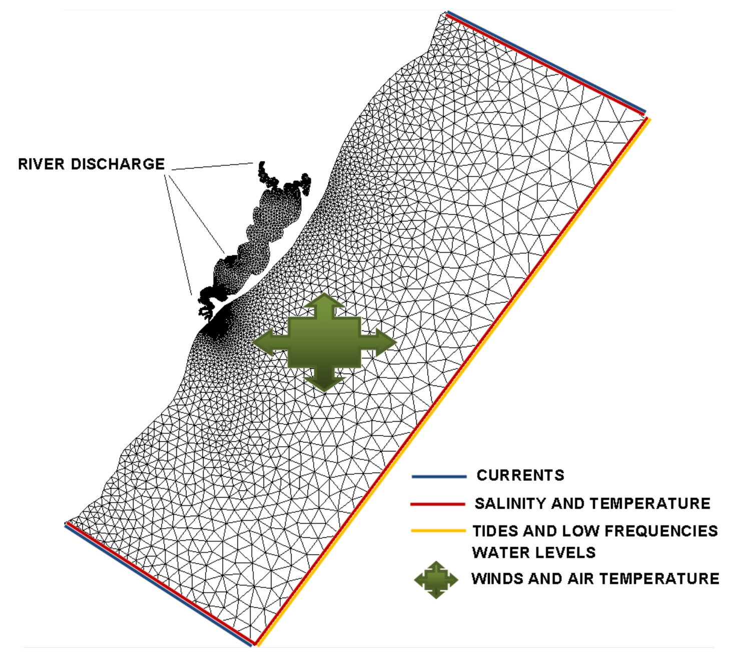

Fig.3: The finite elements mesh highlighting the liquid and surface boundaries conditions for the TELEMAC3D model.

The TELEMAC3D model solves the Navier-Stokes equations by considering local variations in the free surface of the fluid, neglecting density variations in the mass conservation equation and considering the hydrostatic pressure and Boussinesq approximations. It relies on the sigma coordinate system to follow the surface and lower boundaries for vertical discretization.

→ Water discharge (National Agency of Waters - ANA)
→ Velocities (U and V) (Ocean Circulation and Climate Advanced Model - OCCAM)
→ Winds and Air Temperature (Reanalysis - NOAA
→ Tides (Fes - Aviso)

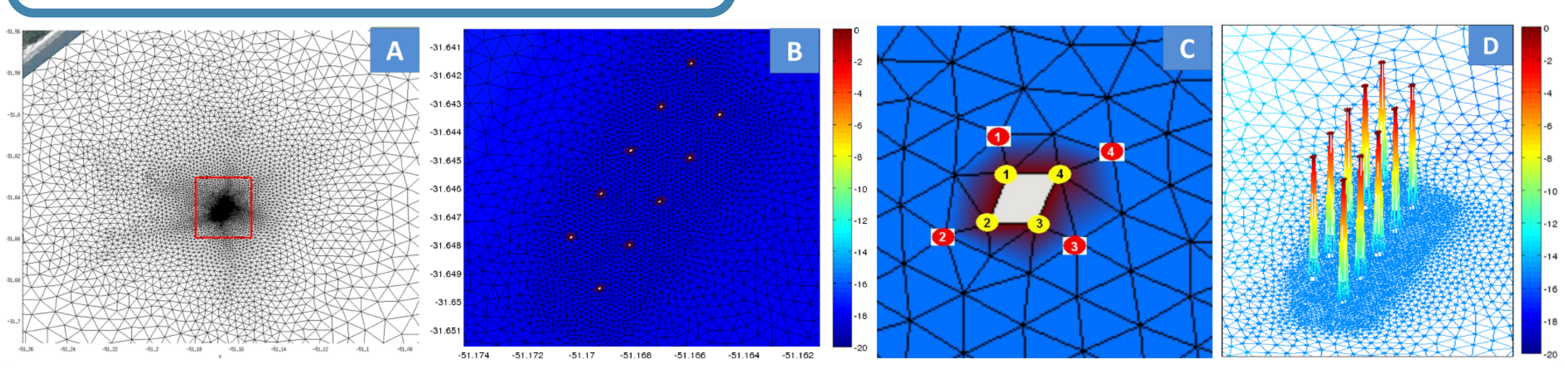

Fig.4: Region of the turbines on the study area. (A) Numerical grid with high degree of refine on the interest region. (B) Converters farm with 10 turbines represented with 2 arrays. (C) Scheme showing the interactions between the energy conversion module and the turbines. The red bullets represent the nodes where the velocity is acquired for the energy conversion module, while the yellow bullet represent the turbine node. (D) Conversion structures represented in a three dimensional shape. The depth of this site is around 18m.

Results

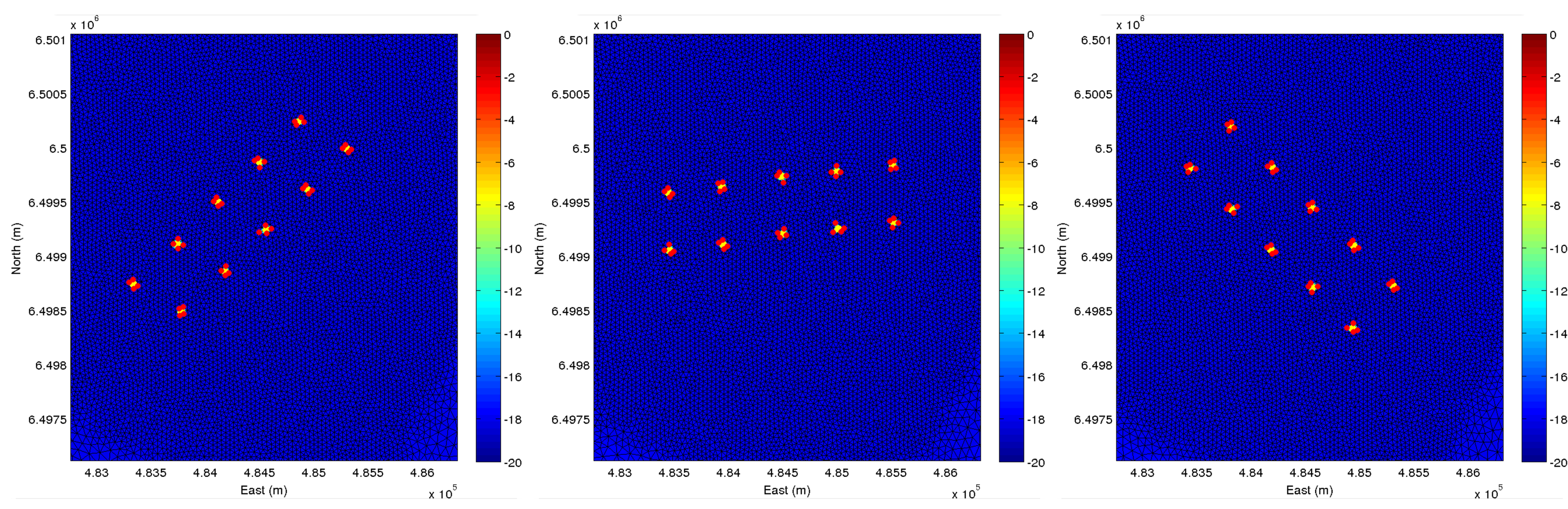

Fig.5: Three turbine farm geometries with 10 turbines were tested. (A) Parallel to the coastline (I); (B) 45º to the coastline (II); (C) 90º to the coastline (III).

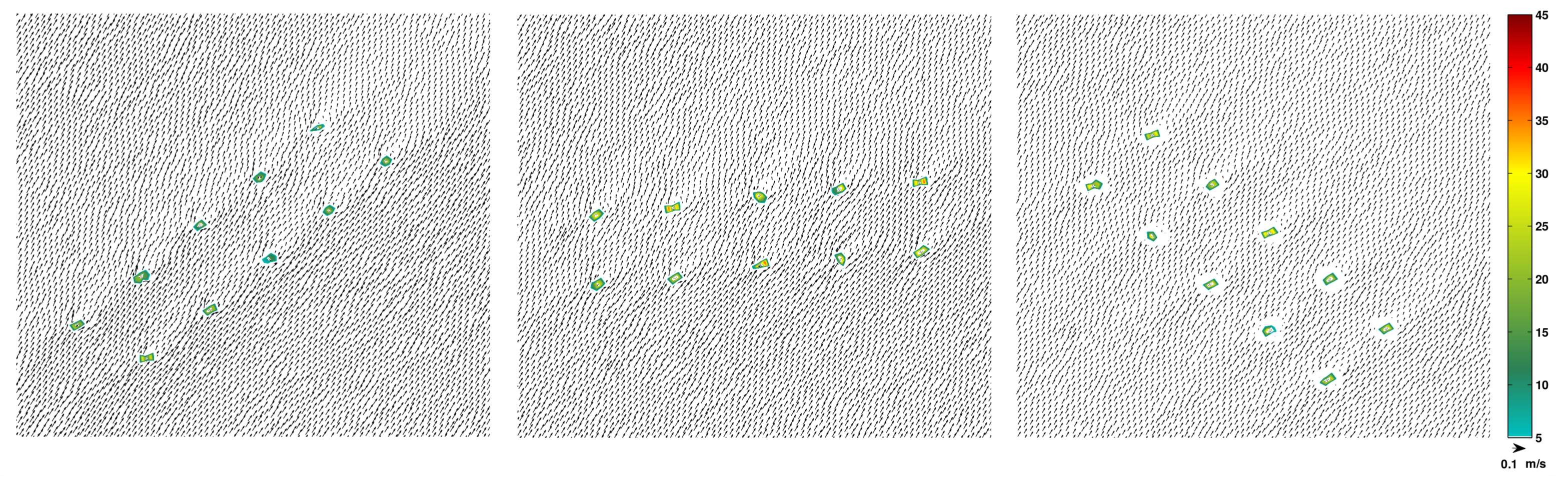

Fig.6: Residual velocities and the mean power (kW) generated for the turbines as isolines.

Table I: Comparison between the studied scenarios.

	Scenario		
Power	I	II	III
Minimum (kW)	0	0	0
Average (kW)	23,93	33,12	30,49
Standard Dev. (kW)	36,56	44,12	44,65
Integrated (MW)	14,36	19,87	18,29
Frequency	I	II	III
<25 kW (%)	68,66	59,5	65
25-40 kW (%)	13,33	11,16	10,33
> 40 kW (%)	18	29,33	24,66

Conclusions

The Southern Brazilian Shelf is highly dynamic and constantly influenced by cycling winds (North-East/South-West) and the wind-driven coastal currents. This condition makes the usage of marine current turbines viable. From this work we can conclude that with this scenario comparison approach, the 45^o alignment show enhanced power generation against the others scenarios. However, longer simulations shall be performed in order to proper evaluate the power generation during an entire year time due to the constant cycling winds.

Acknowledgements

The authors are grateful to the Agência Nacional do Petróleo - ANP for the fellowship regarding the Programa de Recursos Humanos (PRH-27), the Fundação de Amparo à Pesquisa do Estado do Rio Grande do Sul (FAPERGS) and to the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for sponsoring this research under contracts: 179912-3, 456292/2013-6 and 305885/2013-8