

Wind Modelling through Meso-Micro Coupling Method with Thermal Stability Effects

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Intro

Coastal wind farms thrive on the reliable and robust sea breezes, ensuring high energy yield. The mesoscale-microscale coupling method (MMC) combines mesoscale models and the micro-scale model to improve the wind modelling on the complex terrain (Fig 1).

Methods

In Meteodyn WT, the MMC method utilizes the statistic wind profiles from mesoscale model not only for the initial and boundary conditions but also as forces within the computational domain to maintain statistical meso-scale wind profiles (Fig 2). The Monin-Obukhov length (L) obtained from the mesoscale data is used to choose thermal stability classes[1].

Results

- As shown in Fig 3, MMC method demonstrates improvements in horizontal extrapolation. The thermal stability conditions play the important role in the simulations.
- Meteodyn WT provides the wind map on the complex terrain (Fig 4).

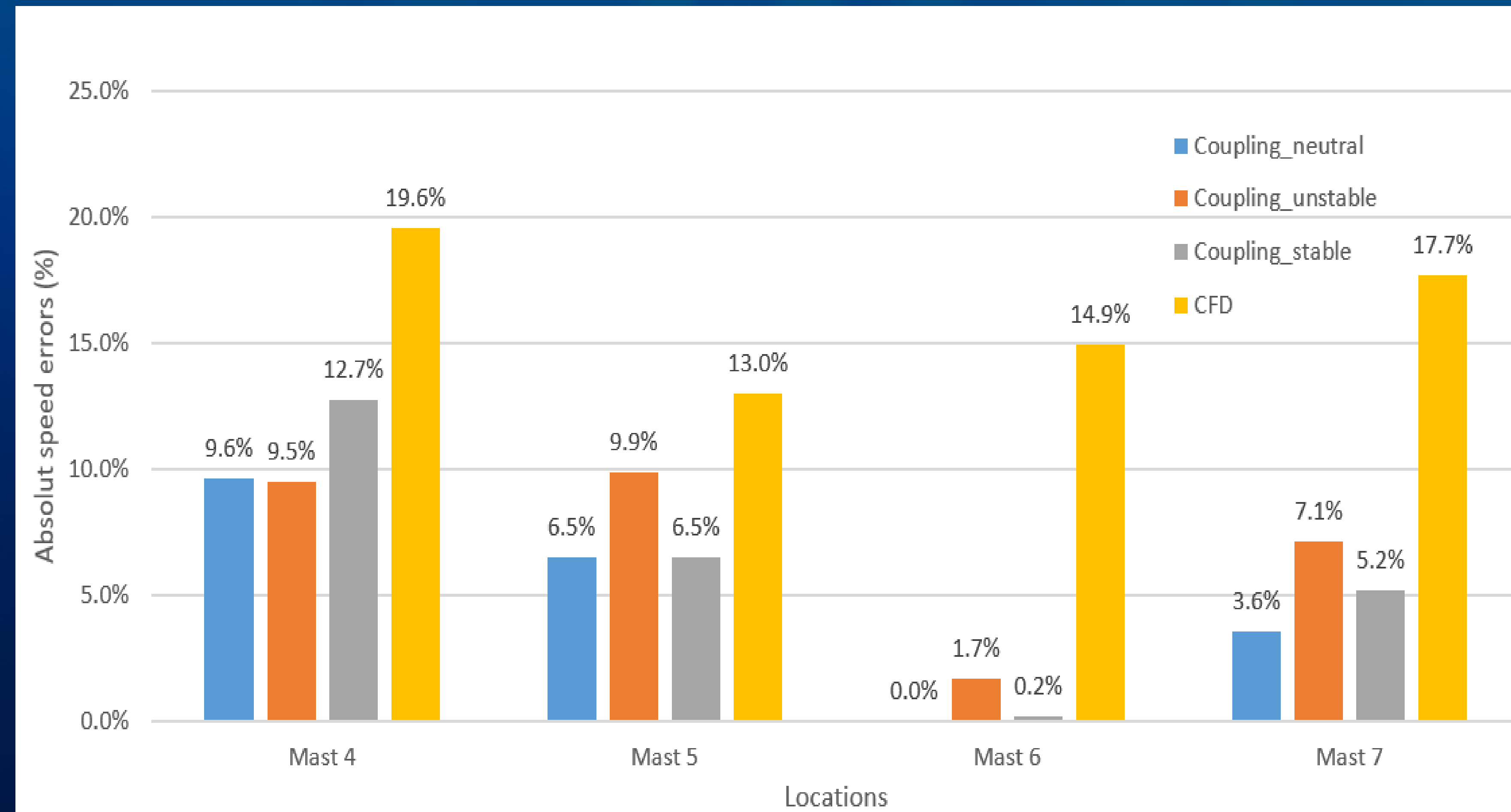


Fig 3. Errors of wind speed

In the coastal region, the MMC method enhances wind distribution compared to conventional CFD method reliant on a single reference.



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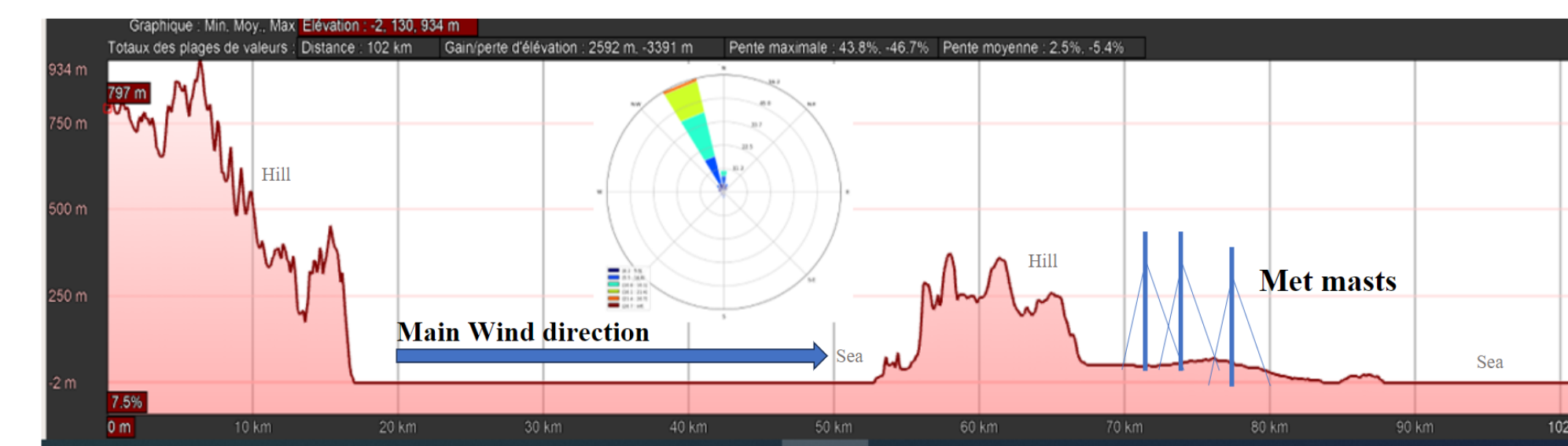


Fig1. Site elevation profile

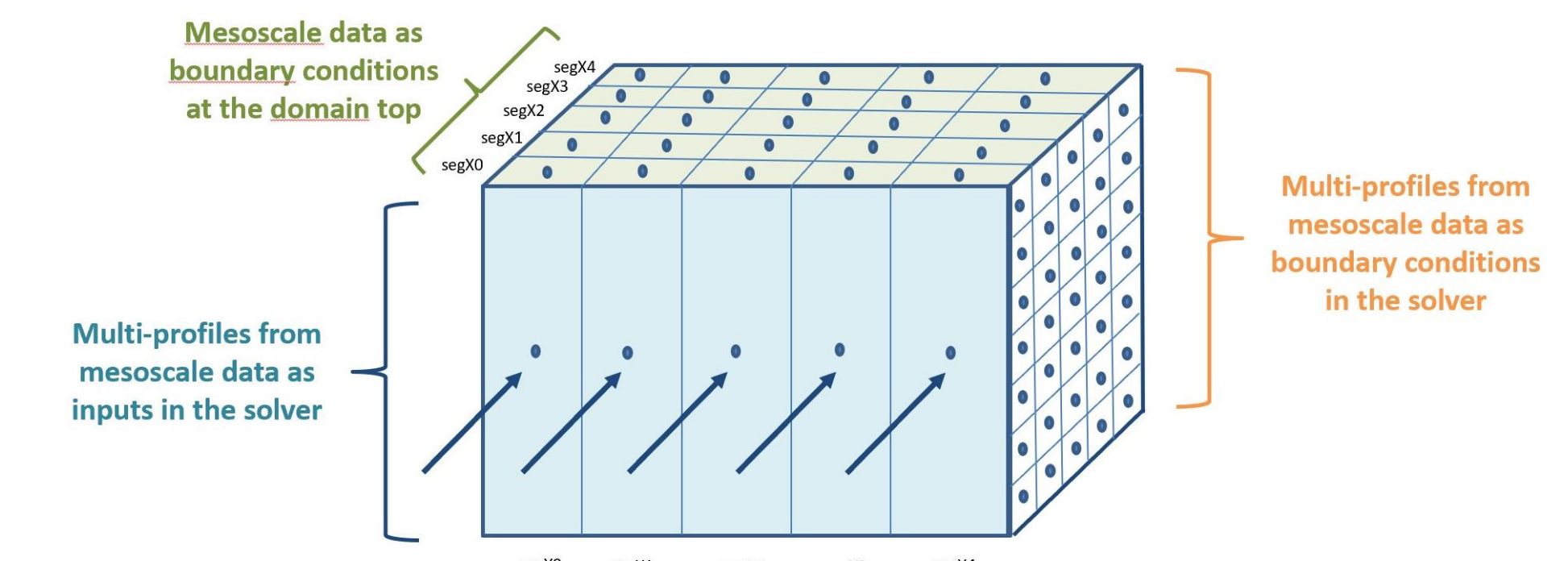


Fig 2. MMC method

Occurrence of each condition for main direction

Condition	Criteria	Occurrence
Instable	$1/L < -0.02$	8%
Neutral	$-0.02 \leq 1/L \leq 0.02$	82%
Stable	$1/L > 0.02$	10%

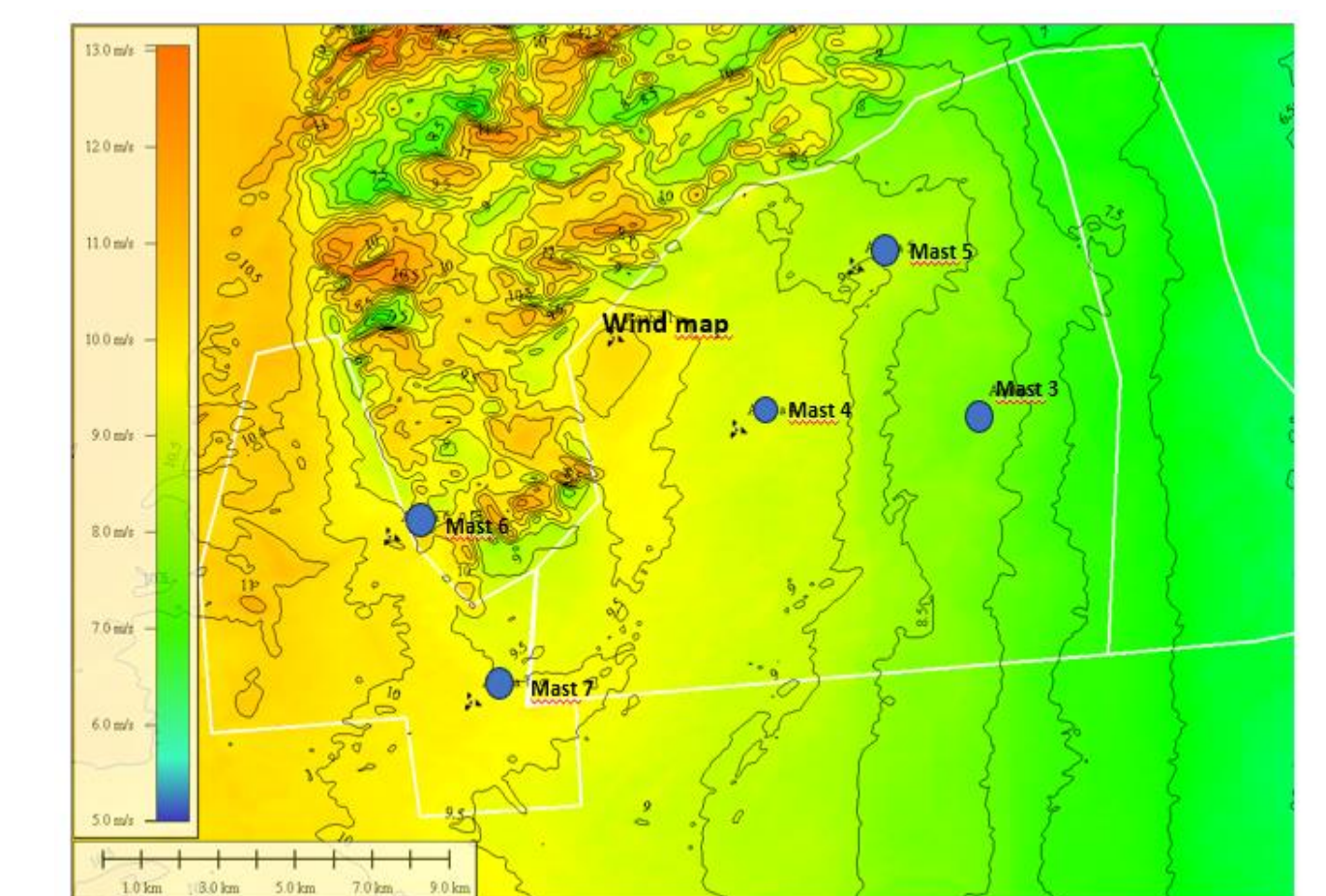


Fig 4. Wind map (25m resolution)

References

[1] Atmospheric Stratification Determinations at Complex Wooded Site, Ru LI, Edouard Leonard, WindEurope2023 Copenhagen.

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