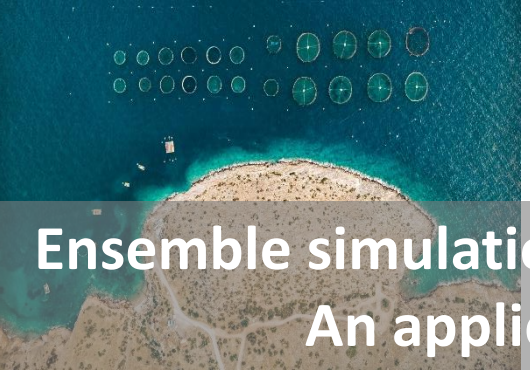

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Ensemble simulation of seawater temperature and its seasonal variations in vertical gradient - An application to aquaculture operations in Southern Aegean Sea, Greece

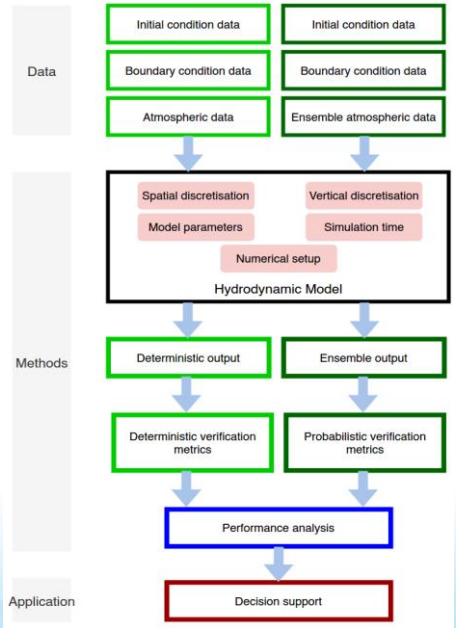
Background

Accurate prediction of **seawater temperature** (SWT) plays an important role in the decision making of **aquaculture** activities. SWT controls fish growth rate, feeding rate, and disease outbreaks. **Coastal numerical models** can predict SWT. Those predictions are affected by uncertainties induced among others by the uncertainties of the input data. In this study, we assess the uncertainty in SWT both in spatial scale and in the vertical gradient arising from the **atmospheric forcing functions** such as wind speed, air temperature, dew point temperature and cloud cover. **Ensemble method** of probabilistic prediction is employed for this purpose. Study is conducted for Southern Aegean Sea of **Greece**.

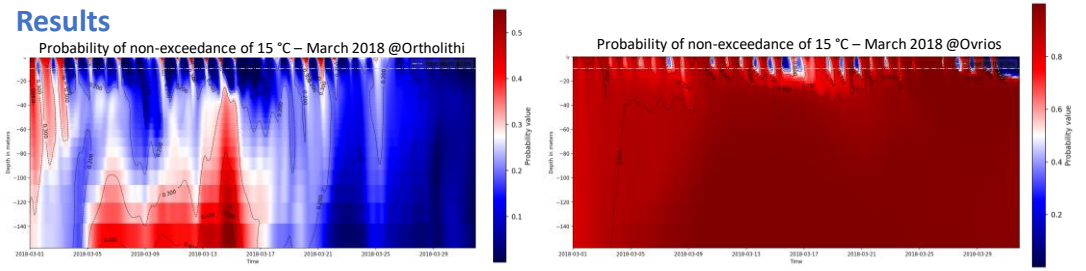
Methodology

Steps are depicted in the flowchart

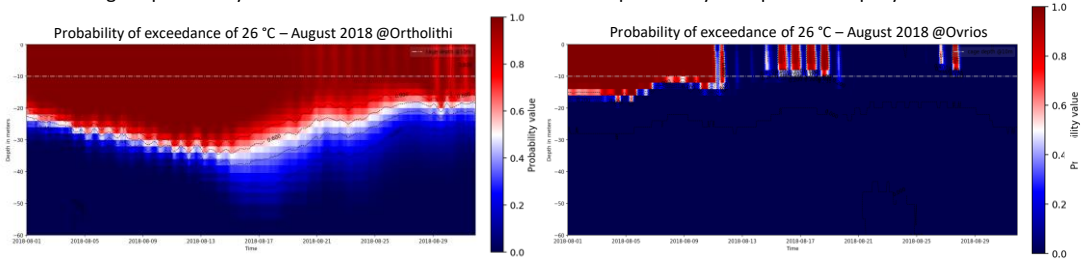
- The Coastal hydrodynamic model is developed using **Delft 3D flexible mesh** modelling tool. A uniform grid size of ~1 km is used.
- For the ensemble predictions, 10 members of atmospheric forcing fields with four variables in each are provided to the hydrodynamic model as input for generating 10 member SWT predictions.
- Simulations are performed for 3 years, from 2016 to 2018.
- Uncertainty analysis in predicted SWT is conducted at two aquaculture farm locations (Orthollithi and Ovrios) considering an upper thermal limit of 26 °C and lower thermal limit of 15 °C for Sea bream species.
- March and August are considered for analysis as winter and summer months respectively.



Results



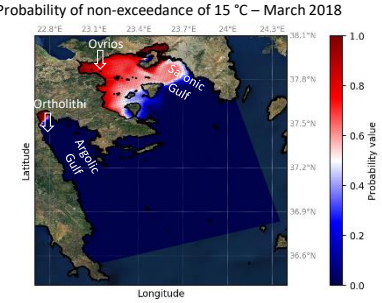
During March, at Orthollithi we see mixed SWT with discontinuous probability of non-exceedance of 15 °C; at Ovrios, there are higher probability for the same thermal limit with minor low probability disruptions in top layer.



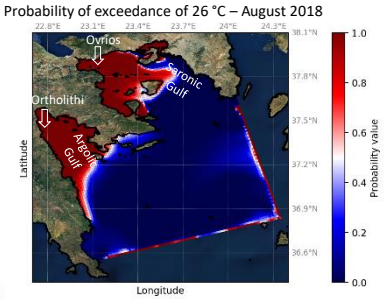
During August, stratifications are observed in the SWT; At Orthollithi high probability of exceedance of 26 °C is seen up to 20-30 m depth; At Ovrios high probability is seen up to 25 m is disrupted with low probability of exceedance.

Conclusions and Recommendations

- Mixed SWT in winter in both stations; Ovrios at higher risk of lower thermal limit; Adapt winter diet or change feed ratio
- Orthollithi at higher risk of upper thermal limit; flexible depth of fish cage is recommendable
- Spatial uncertainty information is useful in site selection of new farm installation
- Only uncertainty from atmospheric forces are considered; Other sources such as parametric uncertainties need to be evaluated
- SWT model result could be used to yield bio-economic model; fish growth and farm economy will be predictable



Saronic gulf show higher probability of non-exceedance of 15 °C than Argolic gulf.



Both gulf areas show a higher probability of exceedance of 26 °C.
Open sea beyond the gulfs shown consistently low probability for both thermal limits.

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