

Offshore Wind and Wave Energy Assessment in the Hellenic Seas



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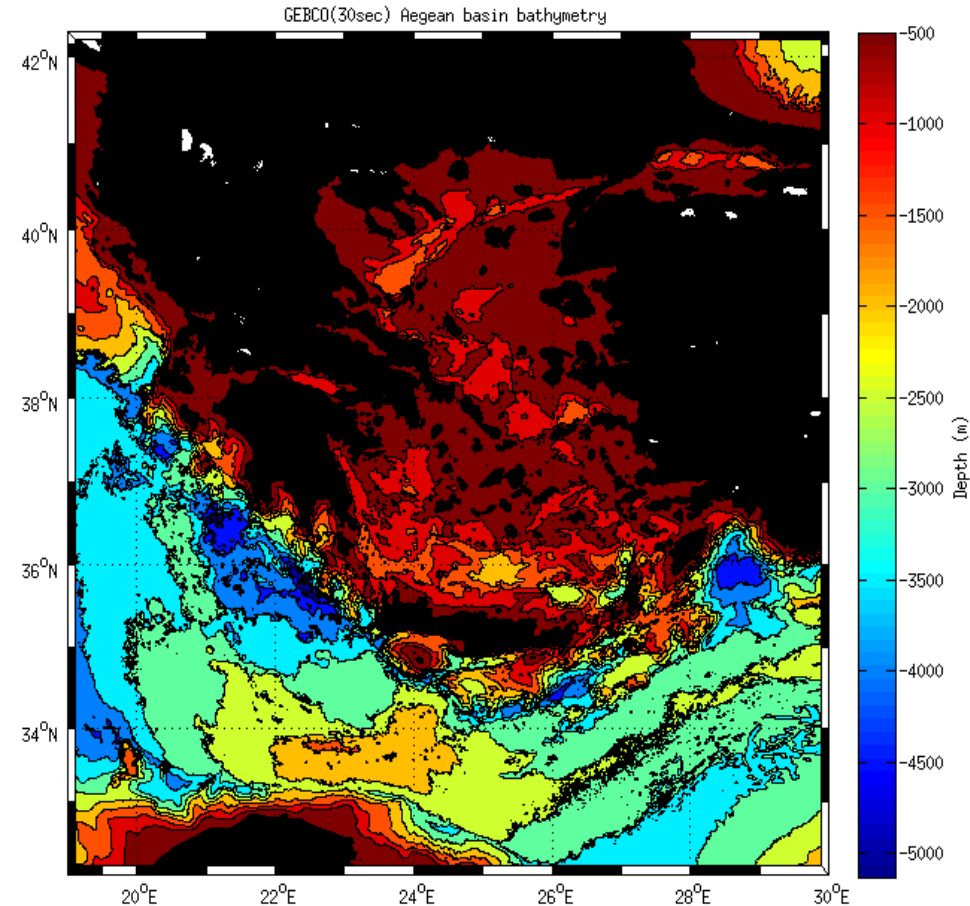


KAPÉ
CRES

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Contents

- Overview and novel analysis of the available data bases
- Estimation of the offshore wind and wave energy potential
- Study the long-term variability of the potential offshore energy production
- Use of gridded bathymetry (EMODnet, Gebco) data sets and ecology parameters



GEBCO 30 arc-second interval grid

Wind and Wave Data Bases



- SKIRON-Eta, 1995–2009, 0.1° x 0.1°, 3h
- ECMWF, Era-Interim, 1979–2011, 0.25° x 0.25°, 6h
- Satellite Data NOAA Blended Sea Winds, 1979–2011, 0.25° x 0.25°, 6h

- Wave and Wind Atlas of the Hellenic Seas: WAM-Cycle 4, 0.1° x 0.1°, 3h, 10yr period
- ECMWF, Era-Interim Reanalysis, 1979–2013, 0.125°x0.125°, 6h



In situ observations (HCMR buoy network)

Data Analysis

Wind Speed

- Estimation of mean values in different temporal scales
- Long-term variability analysis (STD, MAV, IAV)

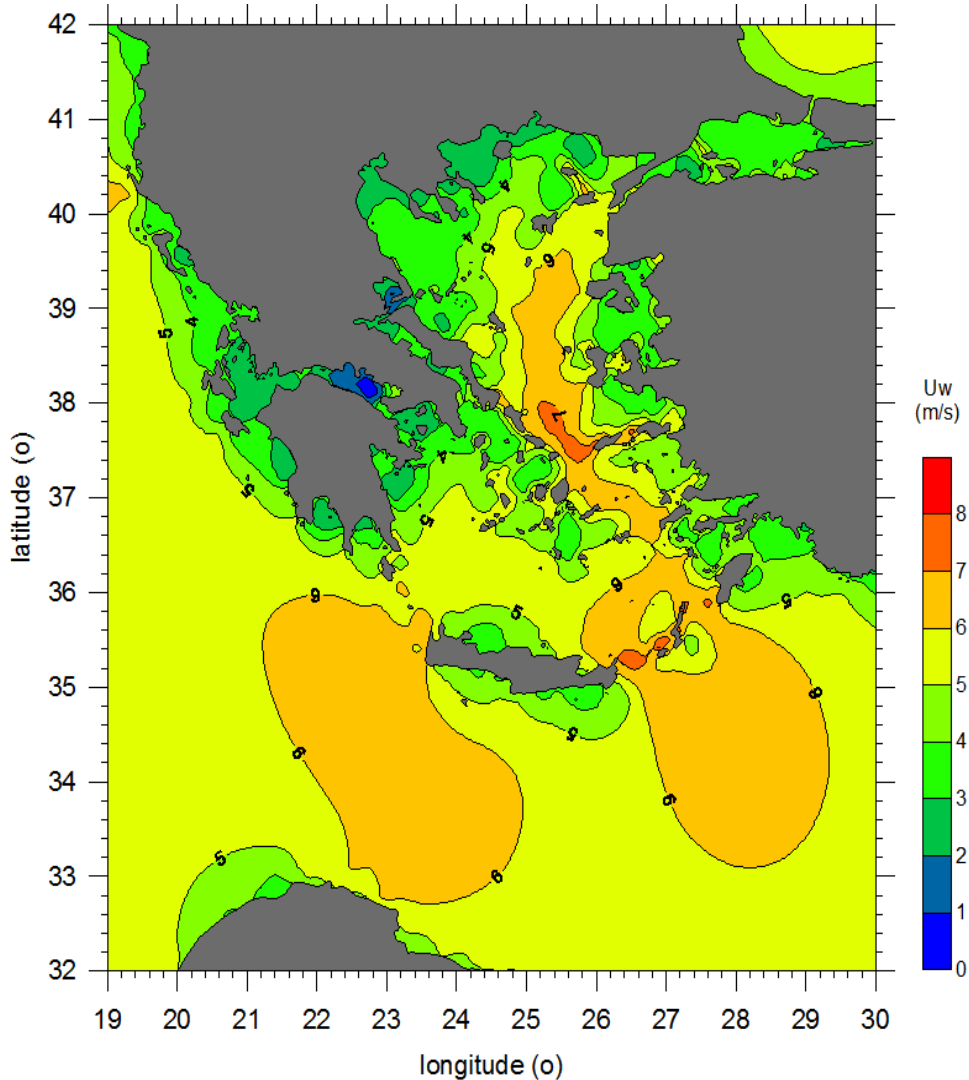
Wind Direction

- Mean direction
- Directional variance
- Most probable wind direction

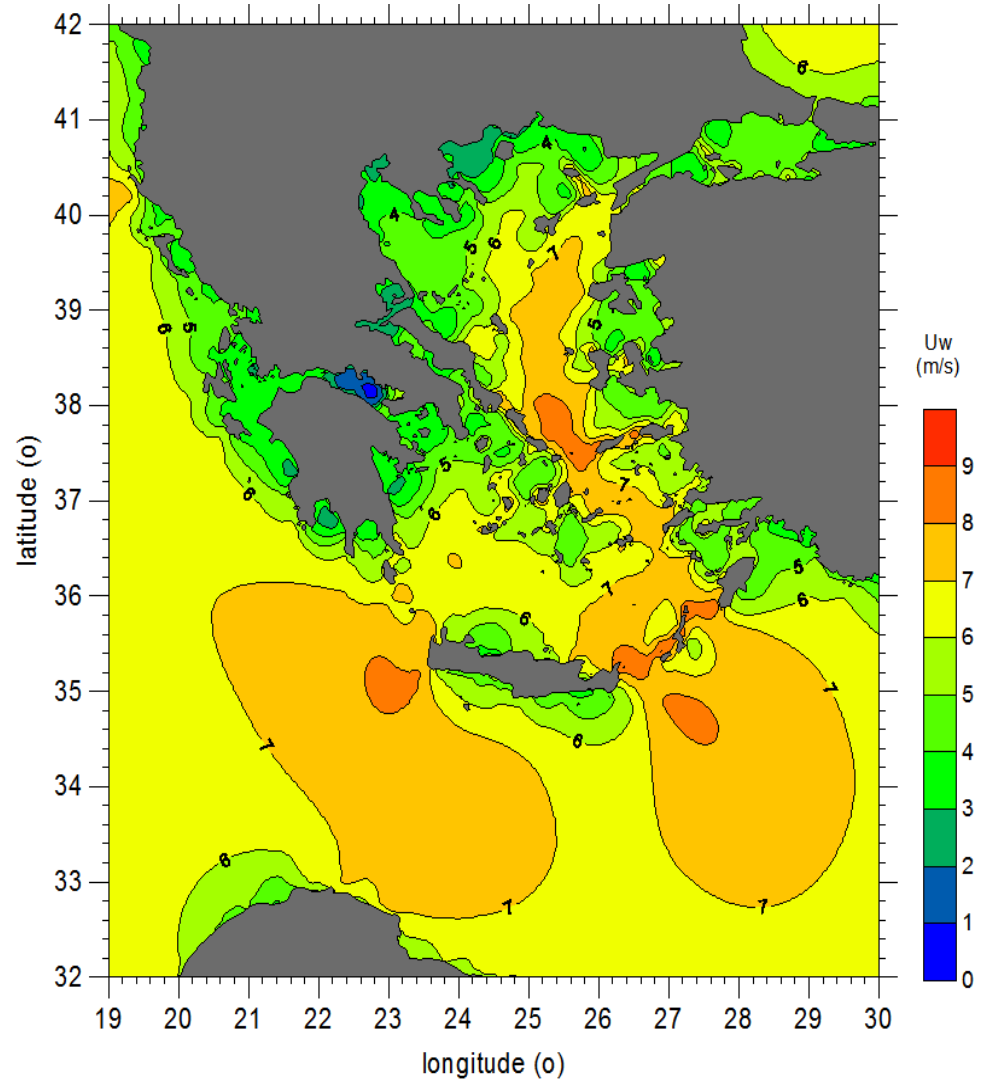
Wave Data

- Significant wave height (H_s)
- Wave direction (Θ_w)
- Wave period (T_p, T_e)

SKIRON Eta – Wind Speed

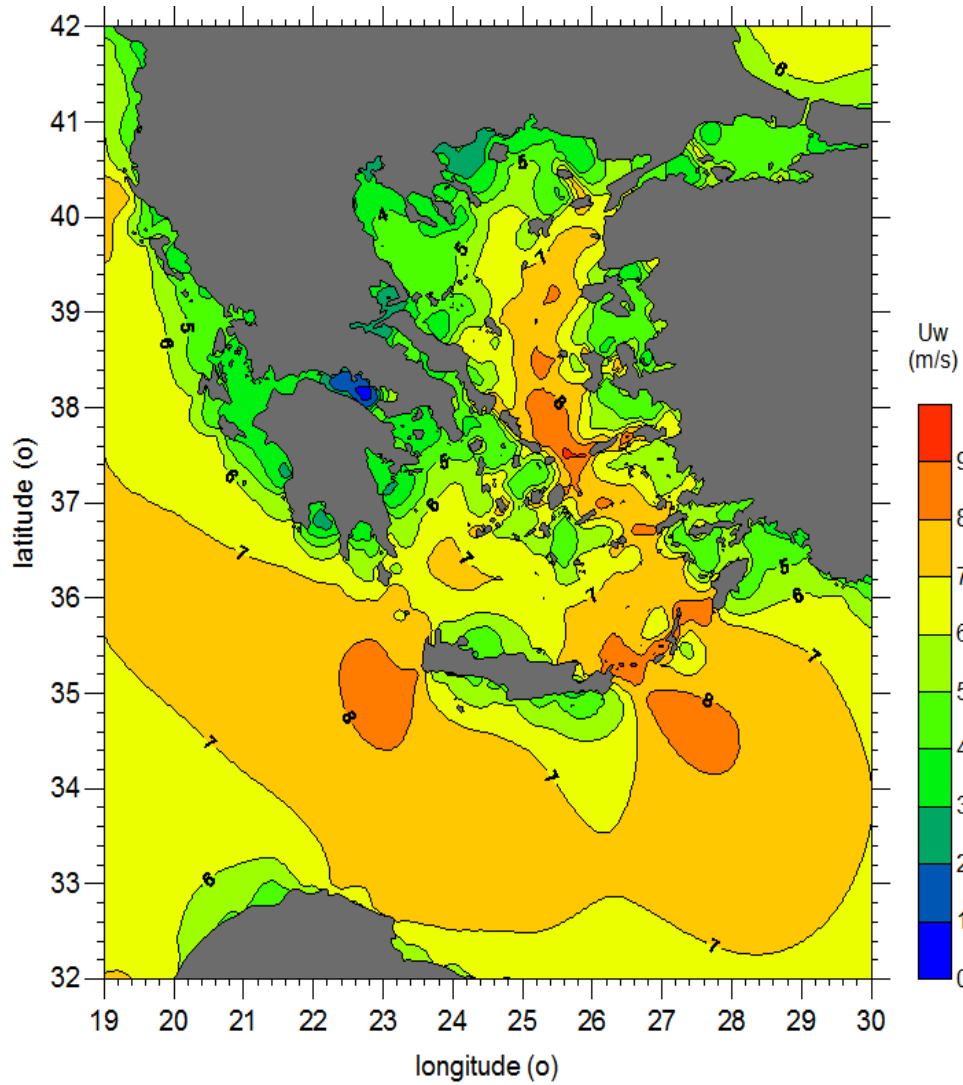


10m

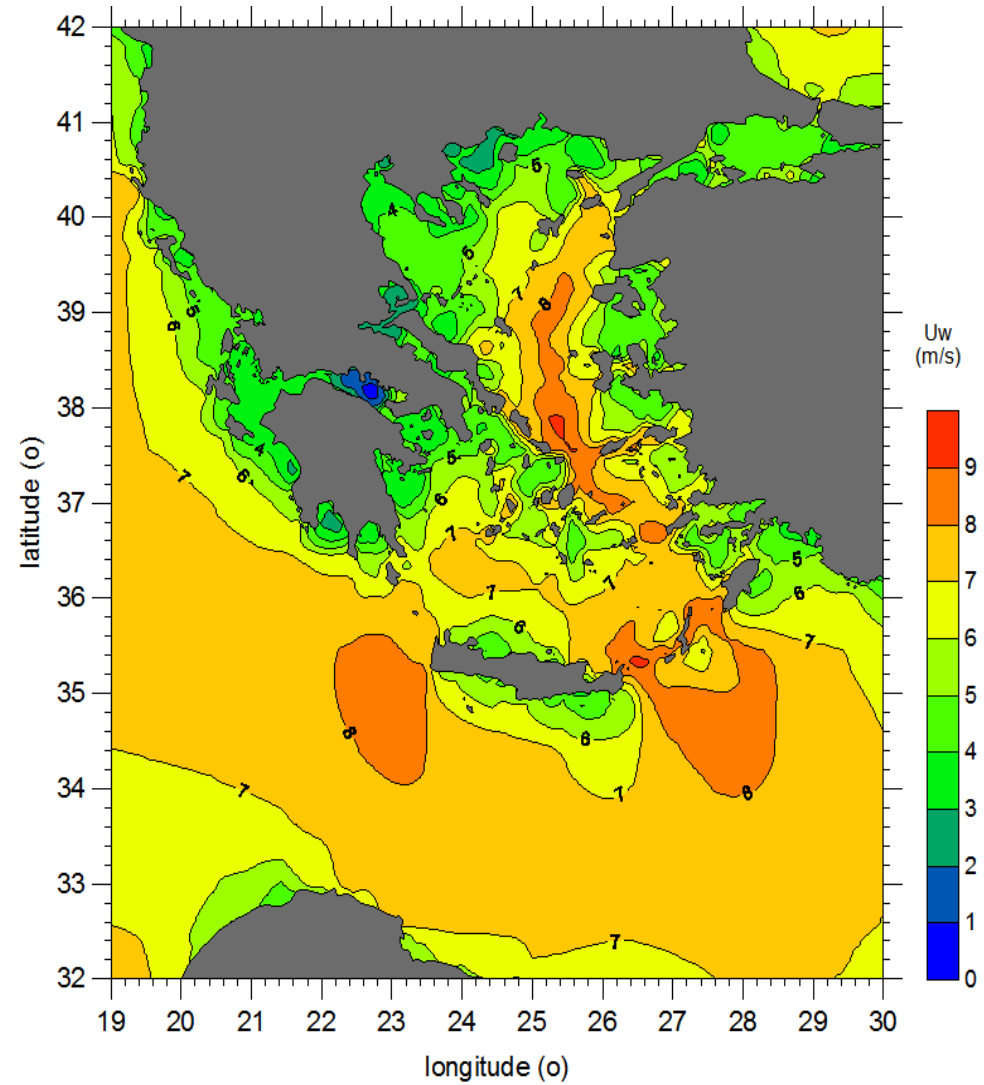


60m

Wind Speed

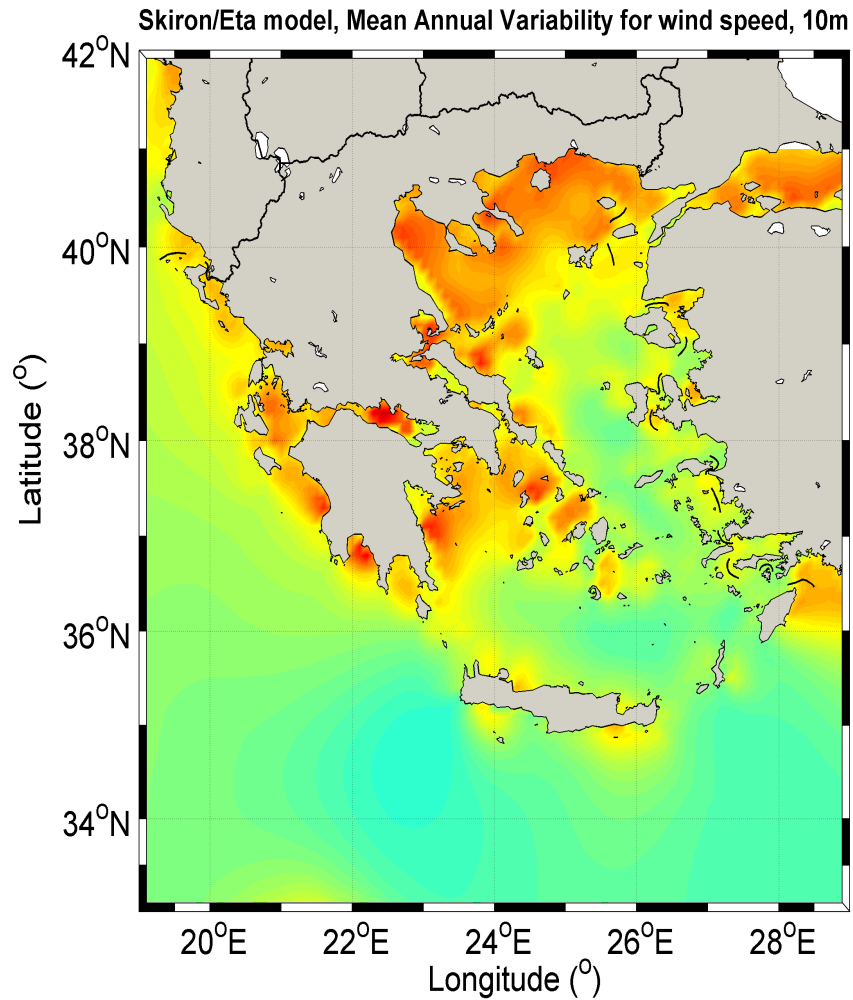


80m

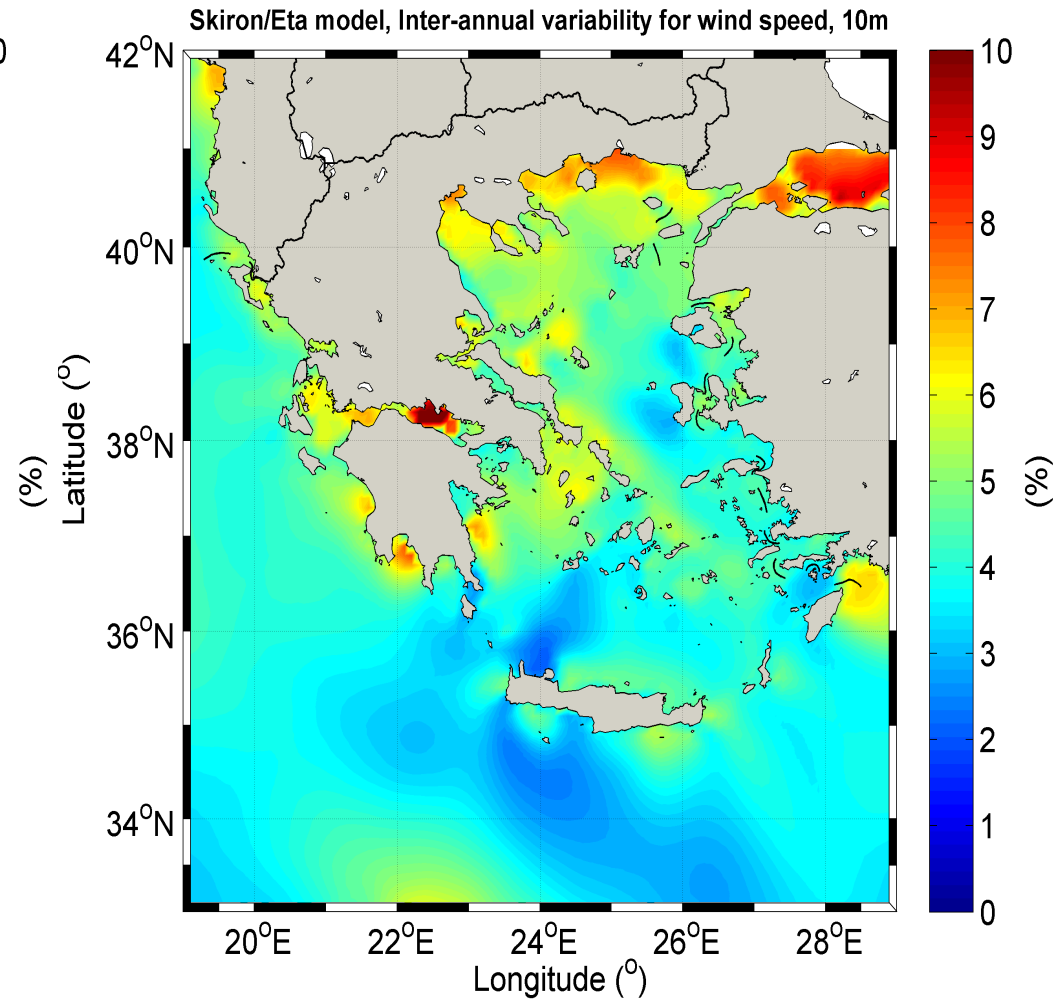


100m

SKIRON Eta Wind Speed Variability



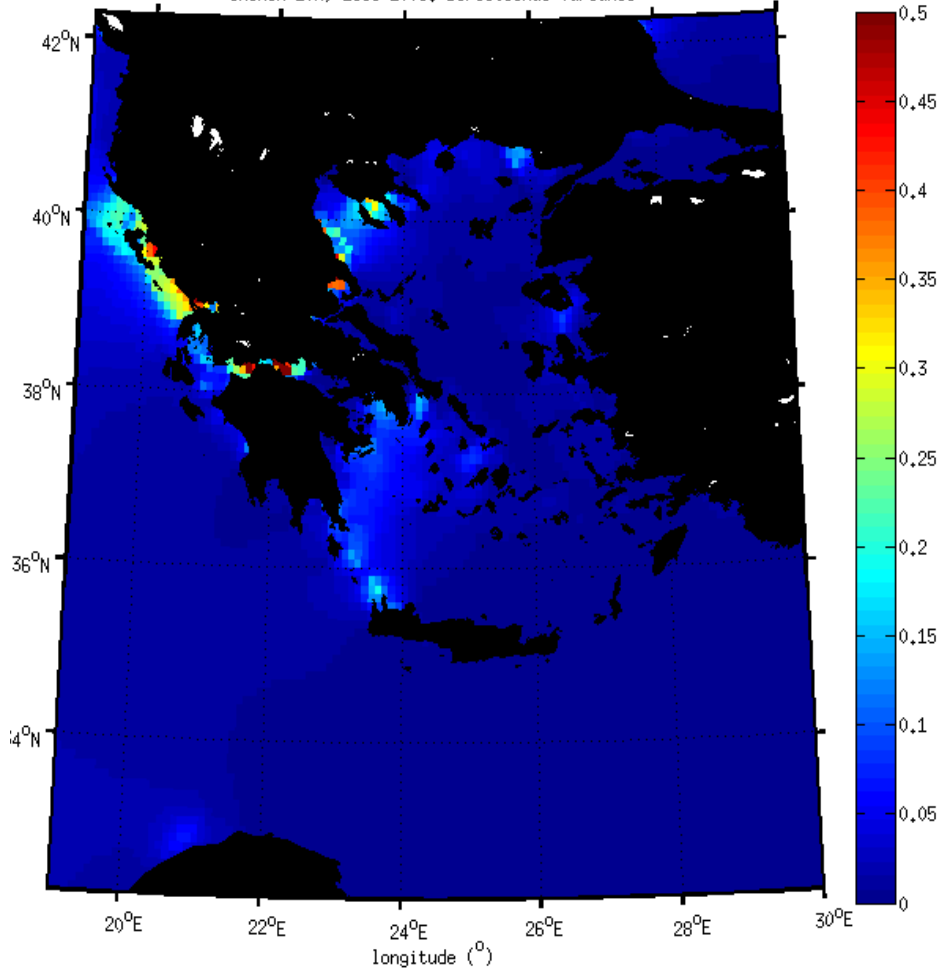
Skiron Eta: Mean annual variability



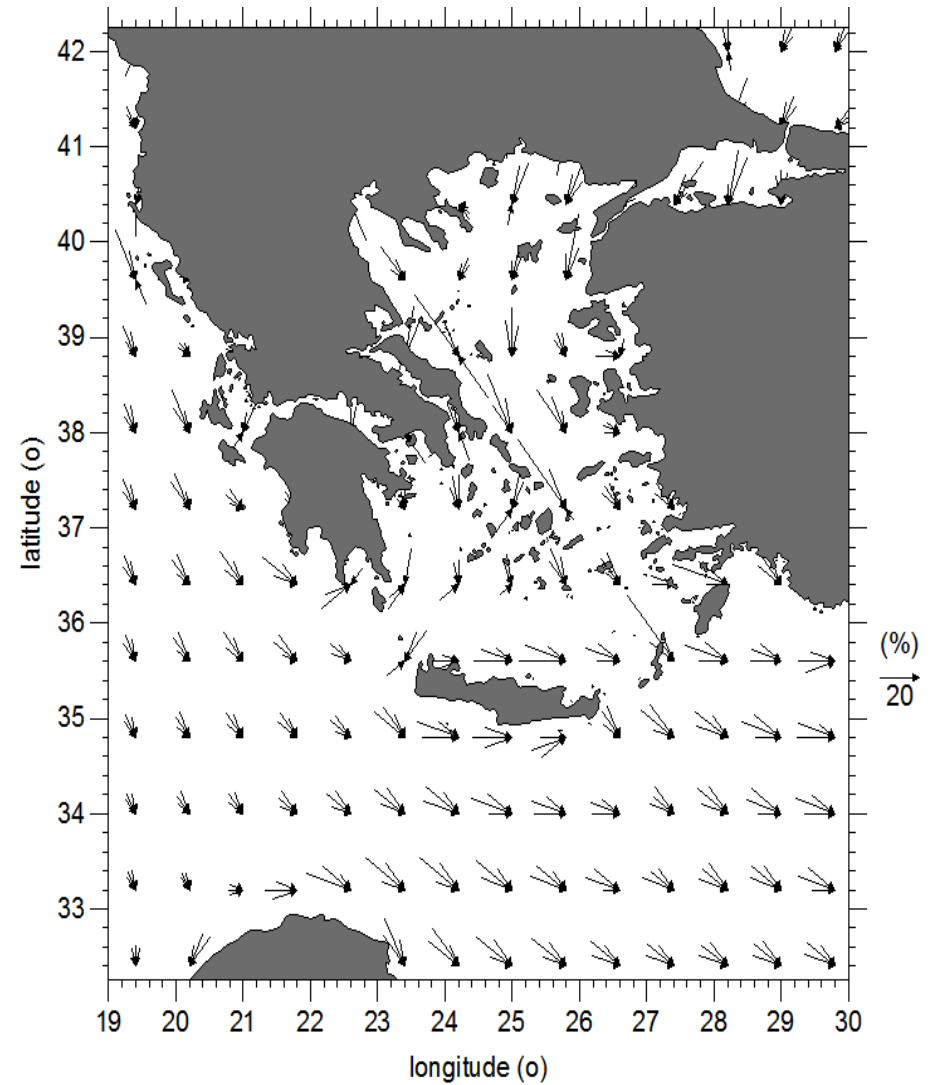
Skiron Eta: Inter-annual variability

SKIRON Eta: Annual Wind Direction 10m

SKIRON ETA, 1995-2009: Directional Variance

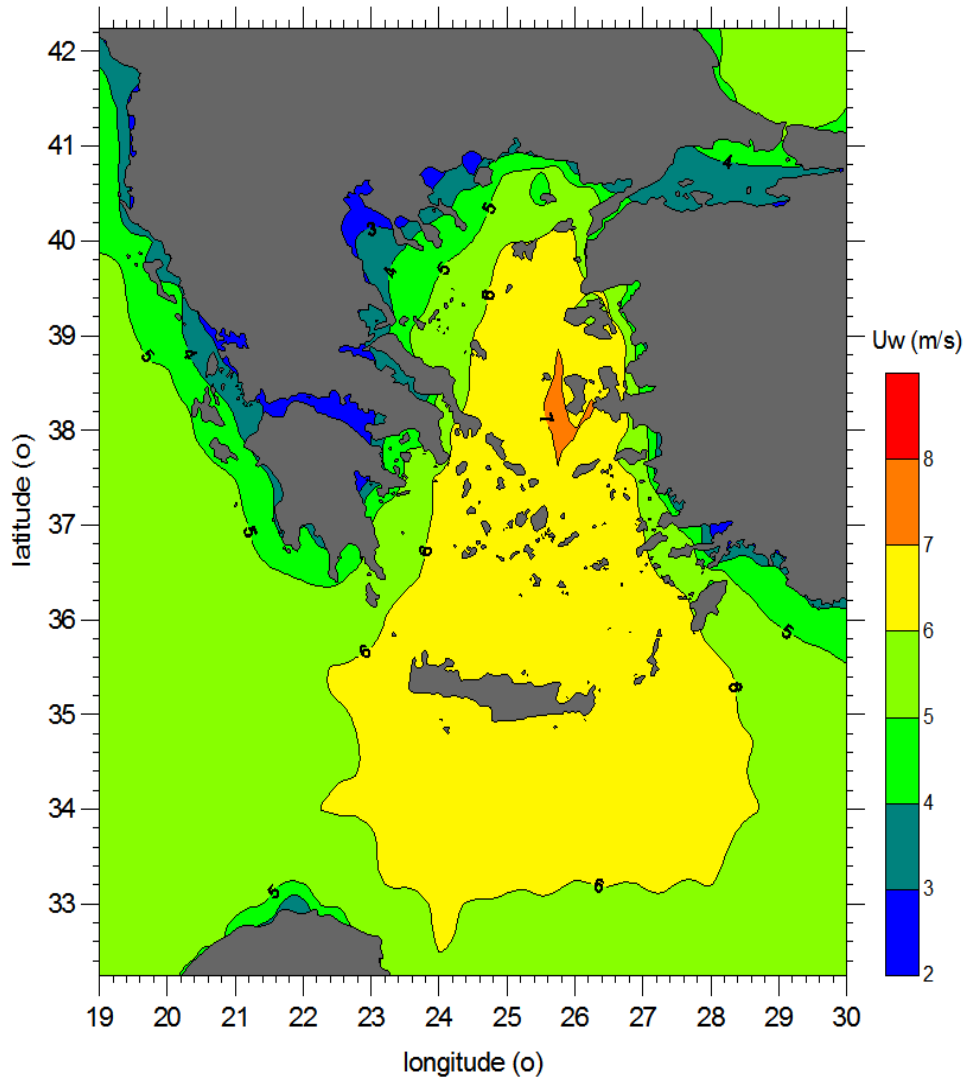


Mean annual wind direction variance

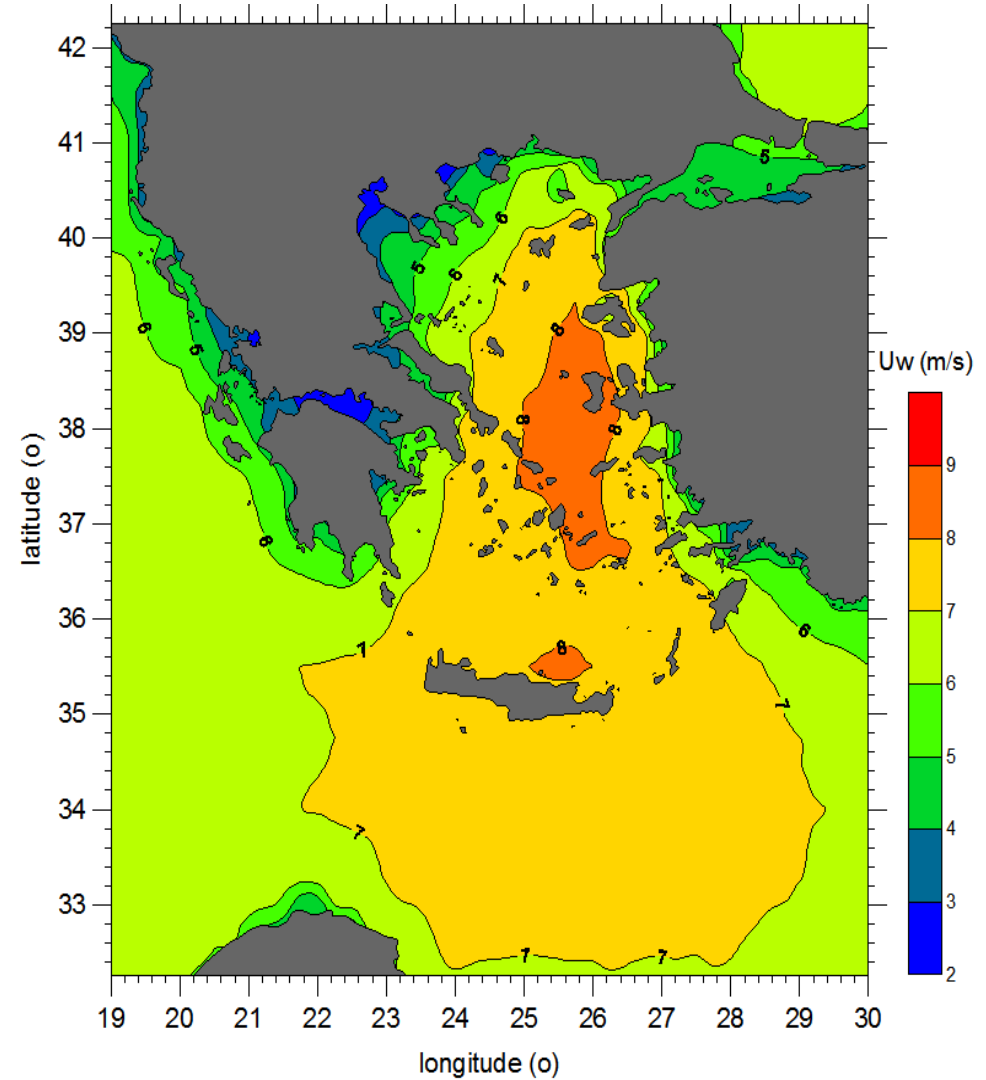


3 most probable annual wind directions

Era Interim Reanalysis Wind Speed

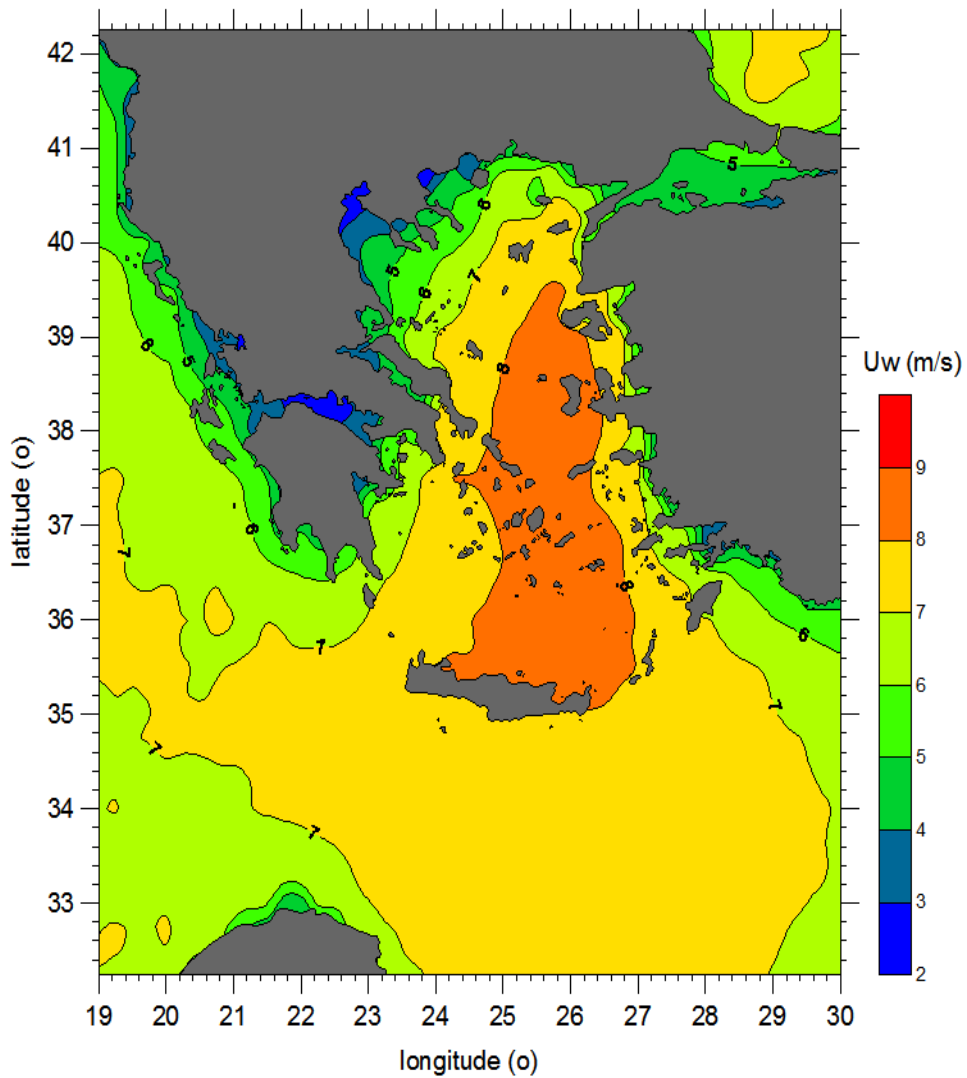


10m

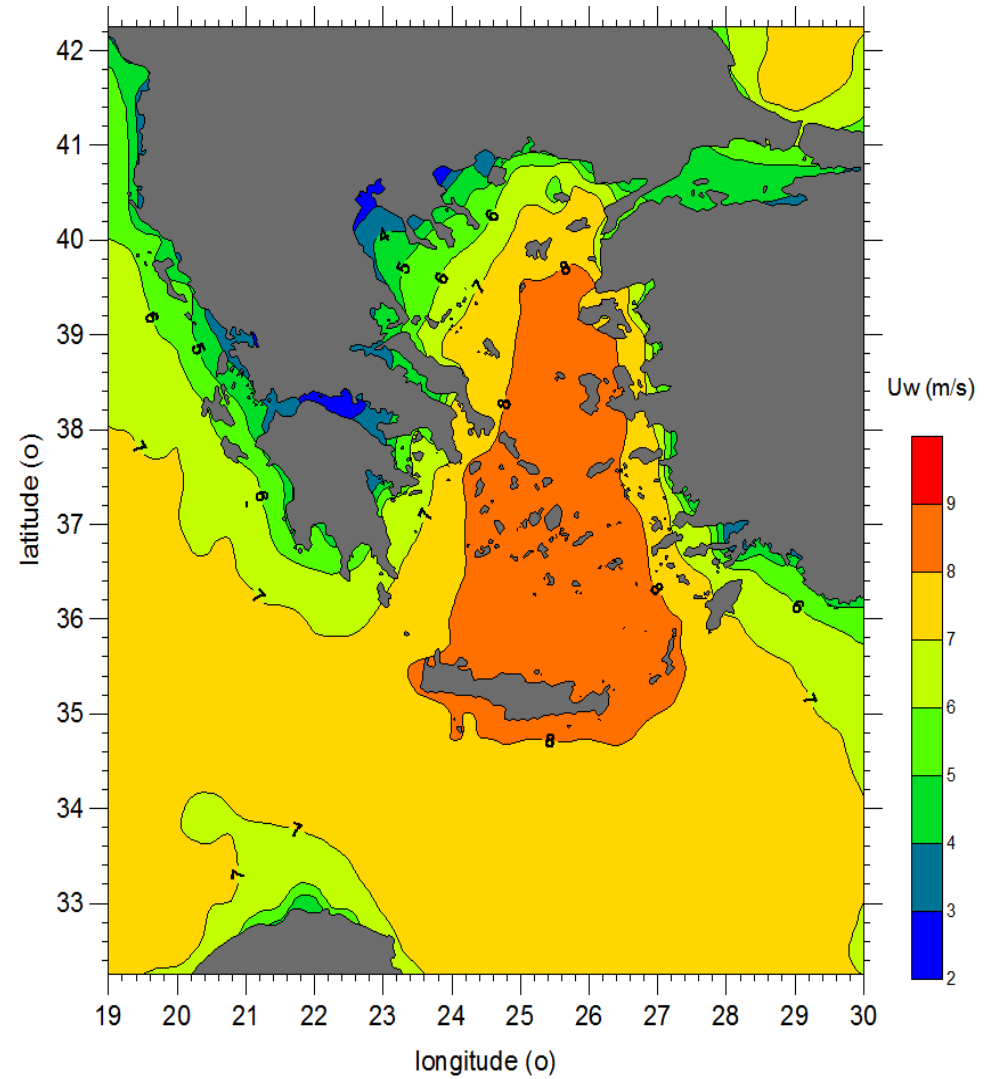


60m

Era Interim Wind Speed



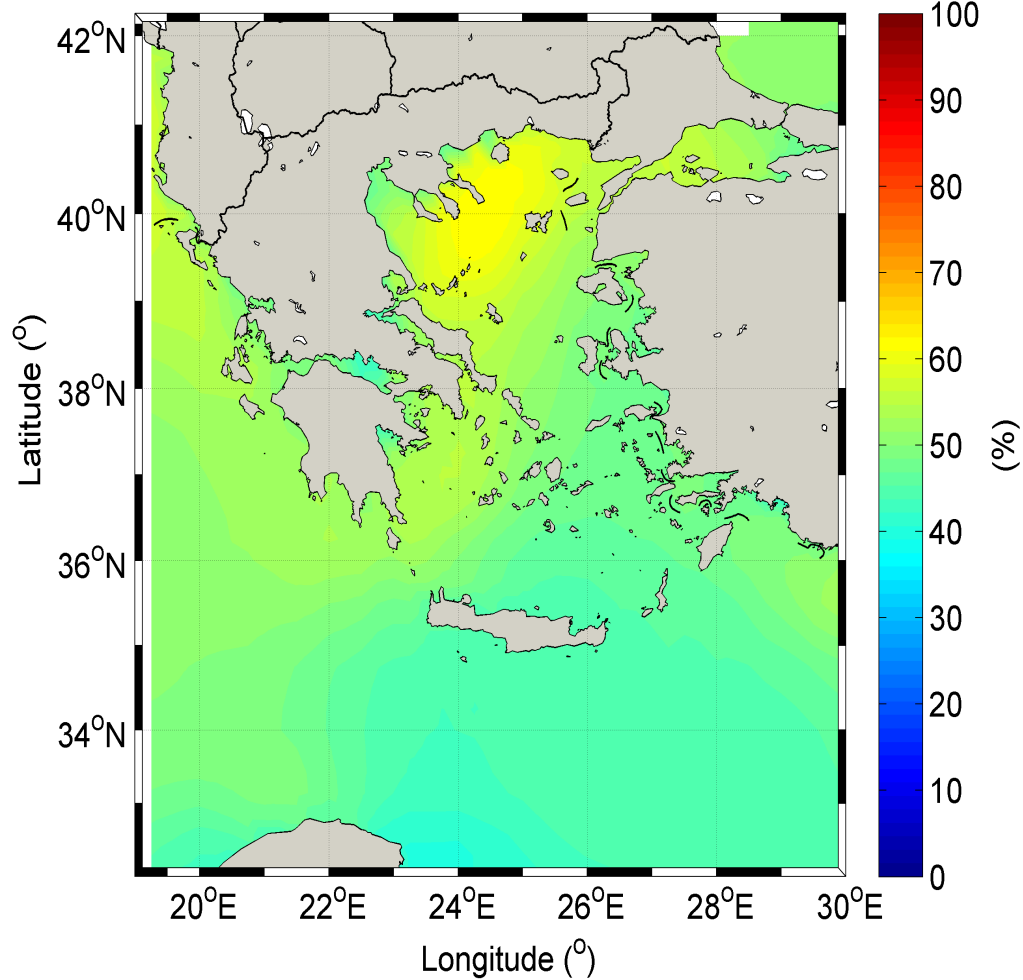
80m



100m

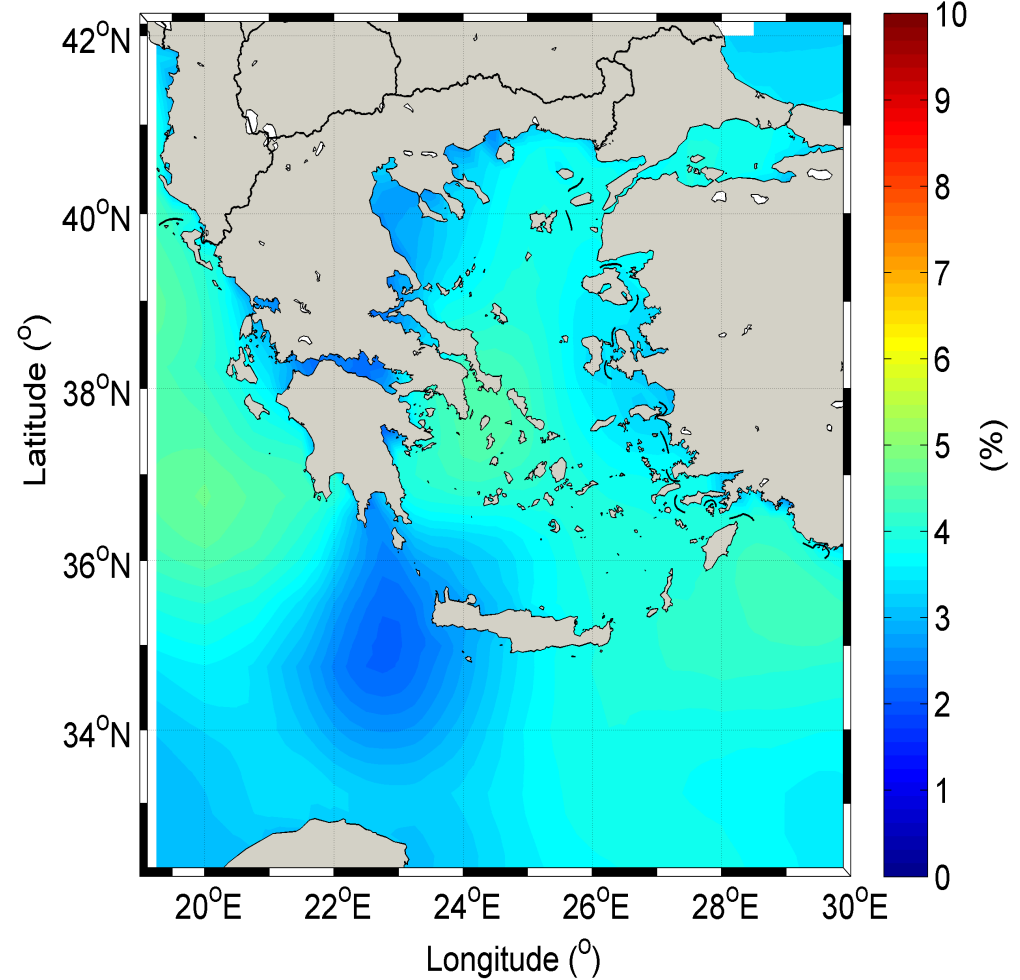
Era Interim Wind Speed Variability

ECMWF, 1979-2011: Mean Annual Variability for wind speed, 10m



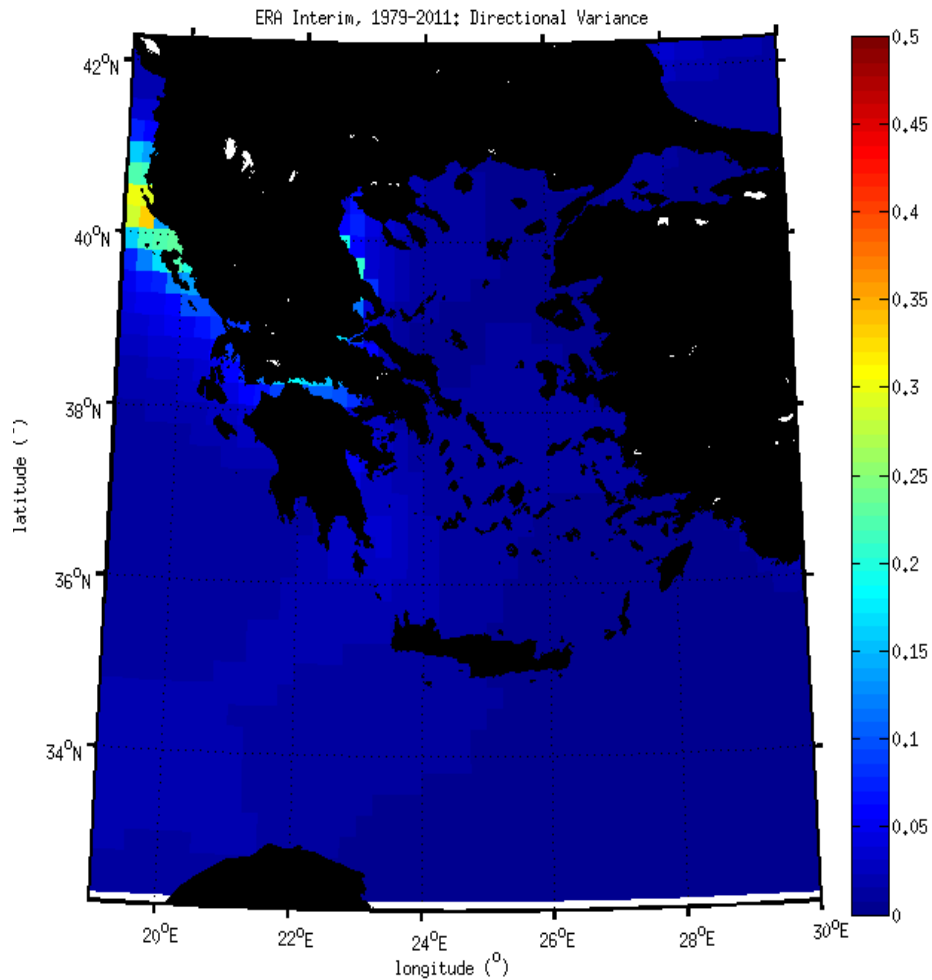
Era Interim: Mean annual variability

ECMWF, 1979-2011: Inter-annual variability for wind speed, 10m

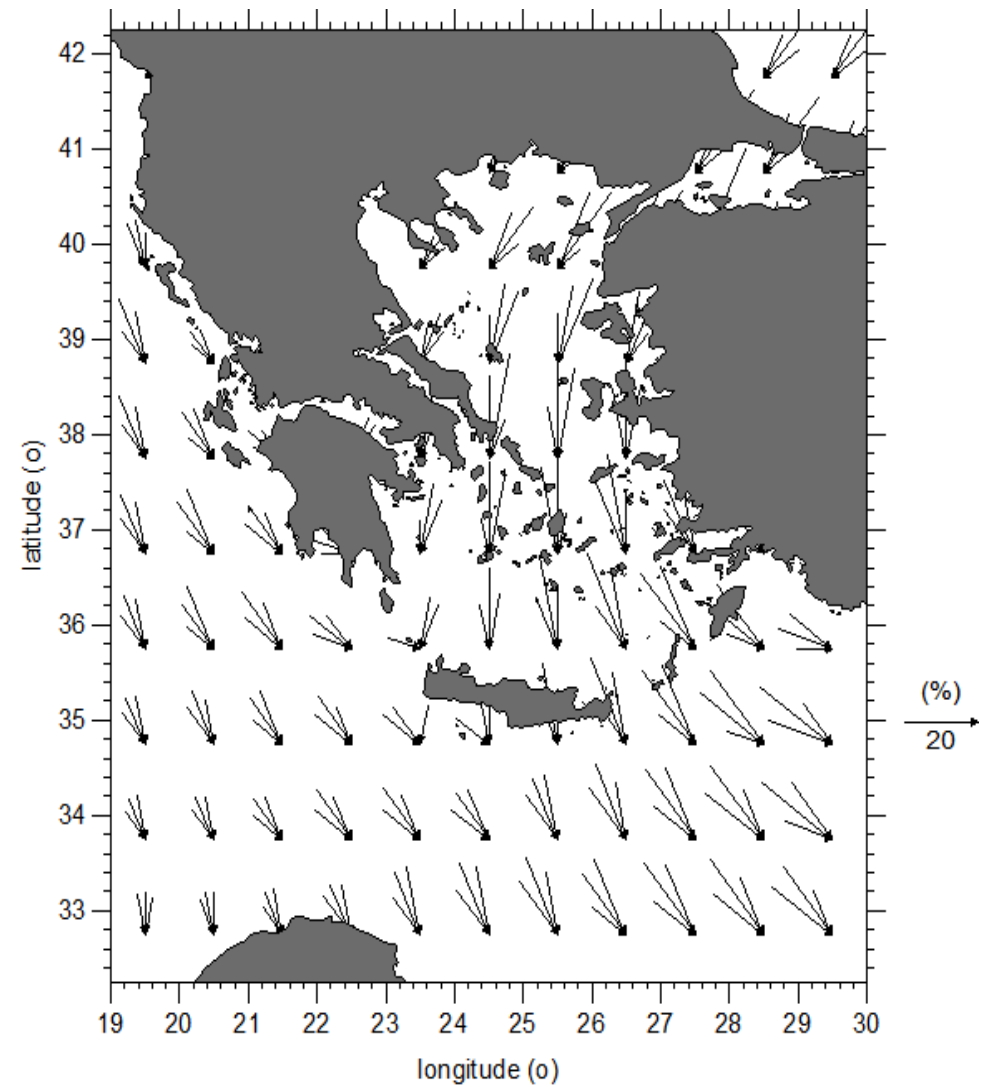


Era Interim: Inter-annual variability

Era Interim: Annual Wind Direction 10m

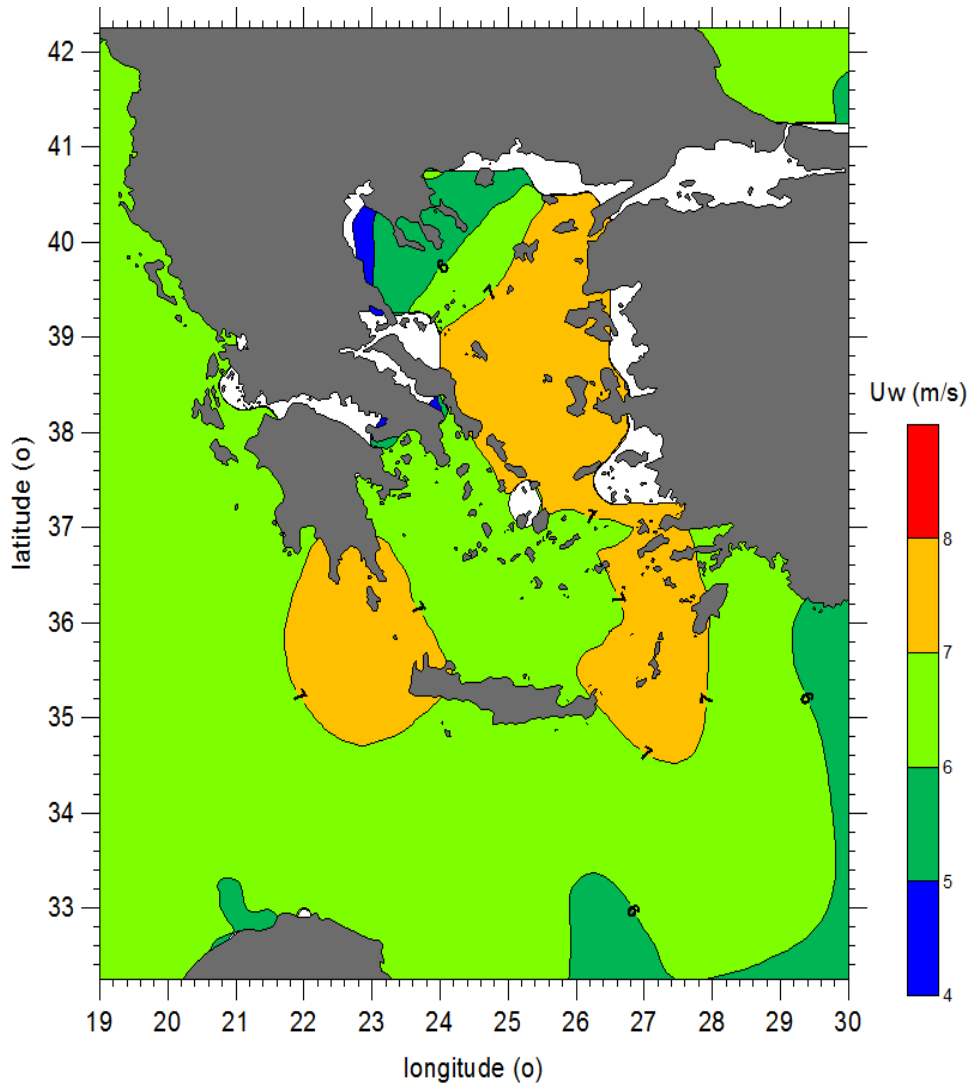


Mean annual wind direction variance

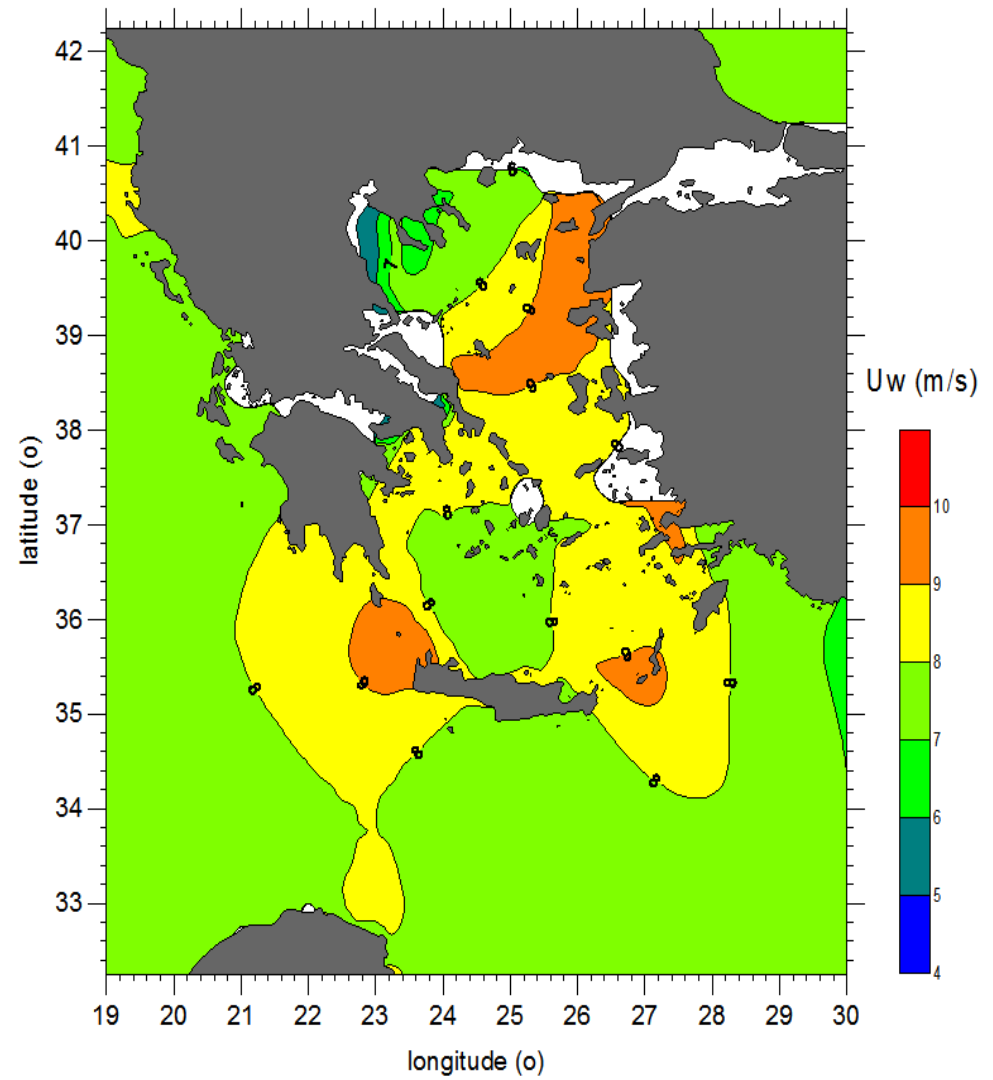


3 most probable annual wind directions

NBSW Satellite Data - Wind Speed

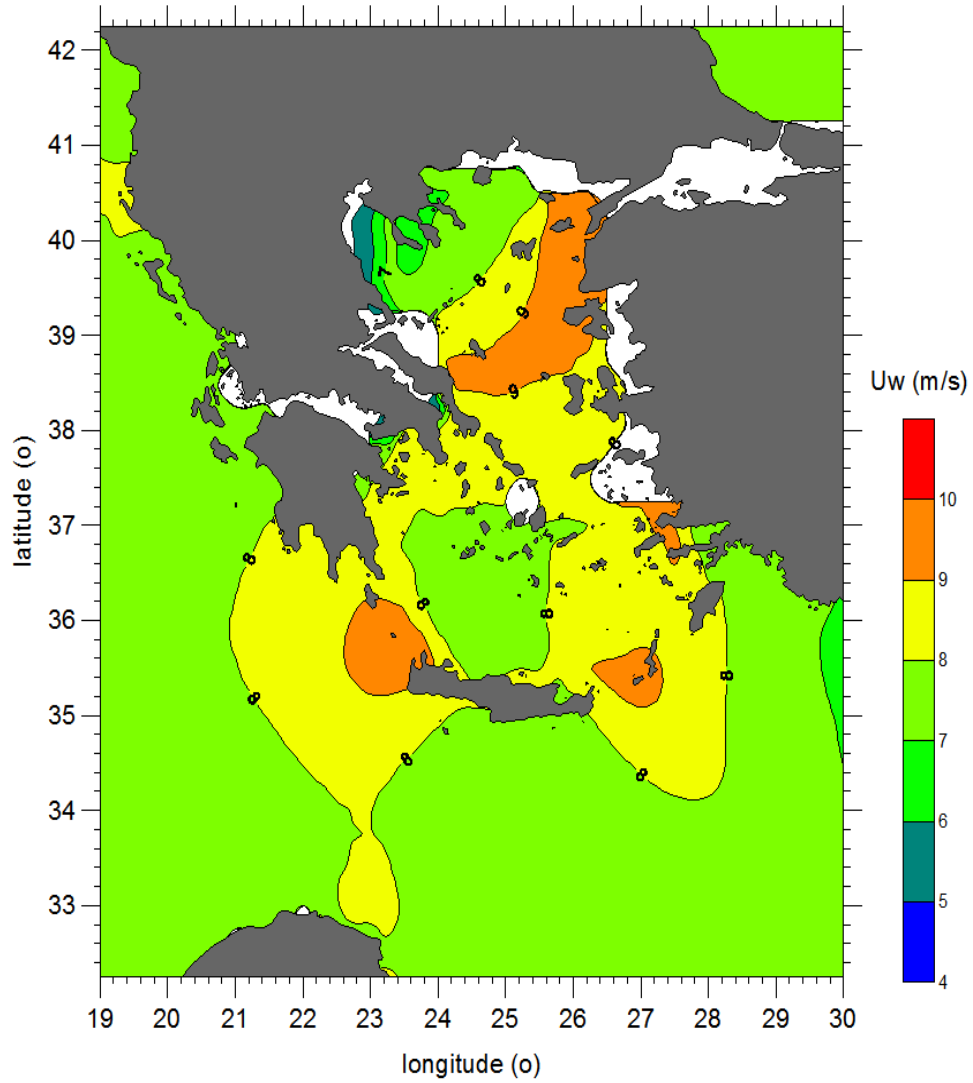


10m

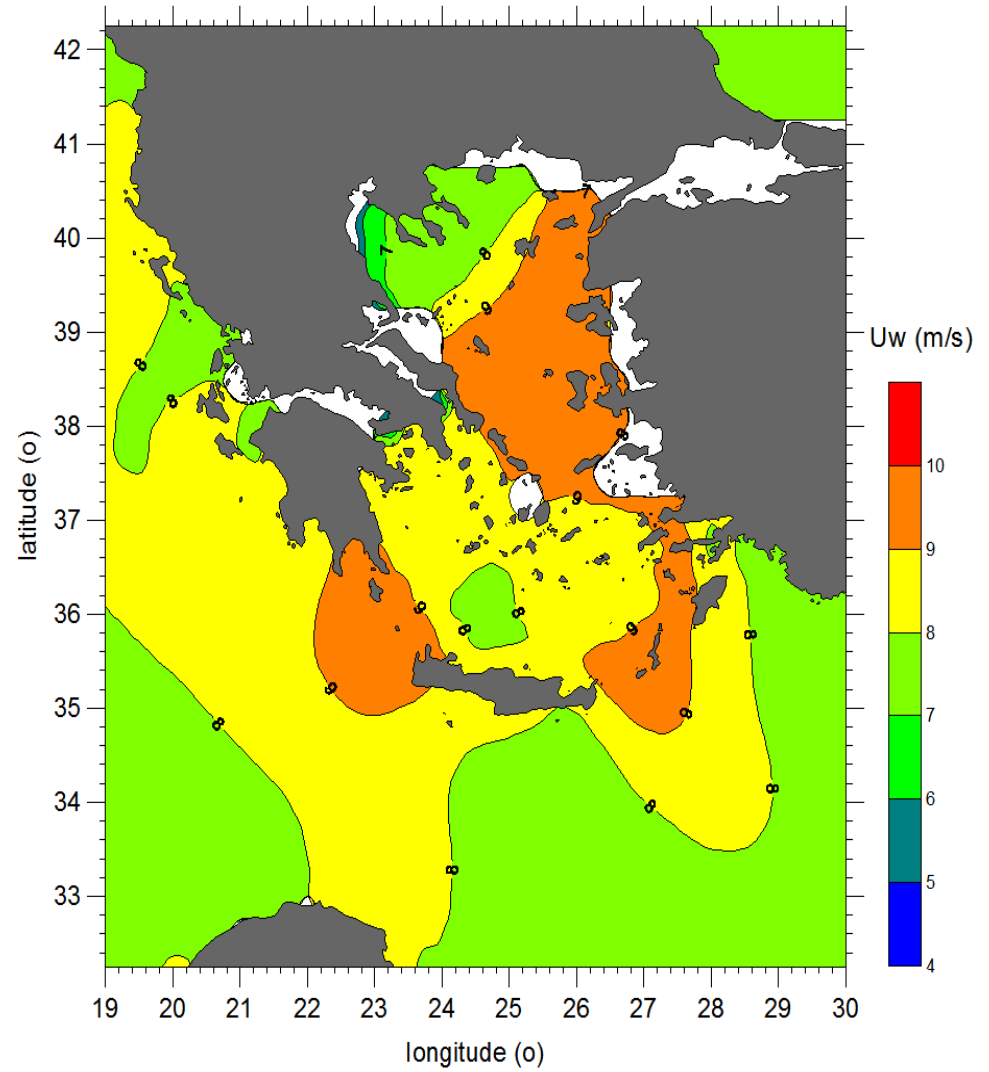


60m

NBSW - Wind Speed

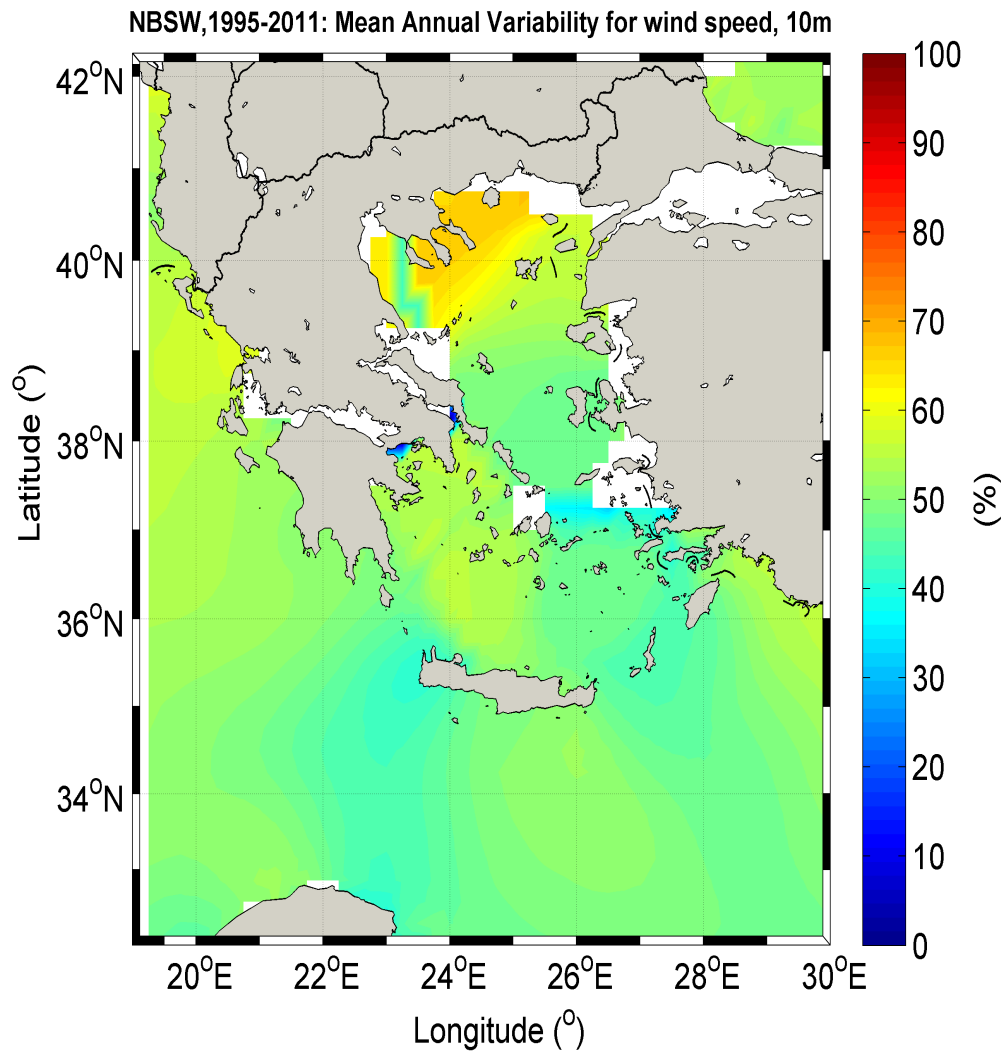


80m

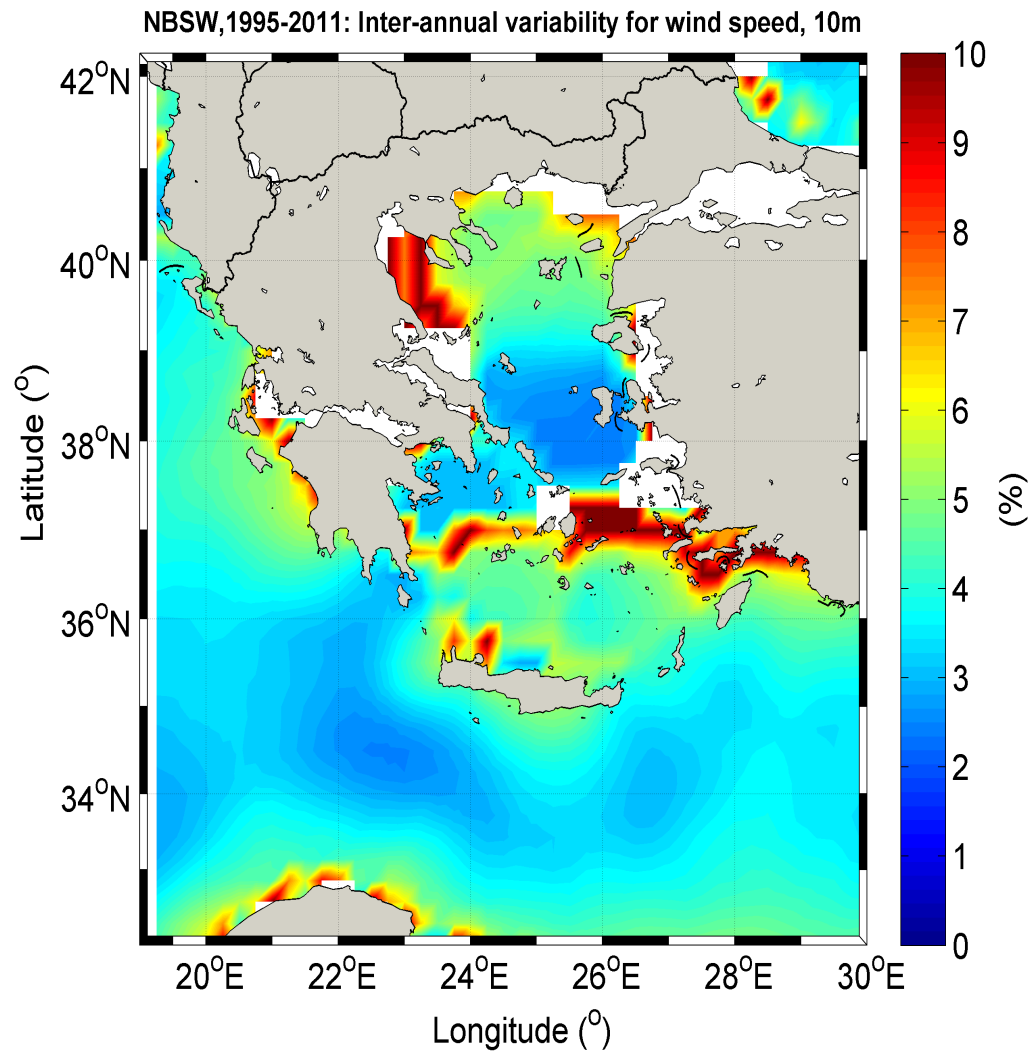


100m

NBSW - Wind Speed Variability

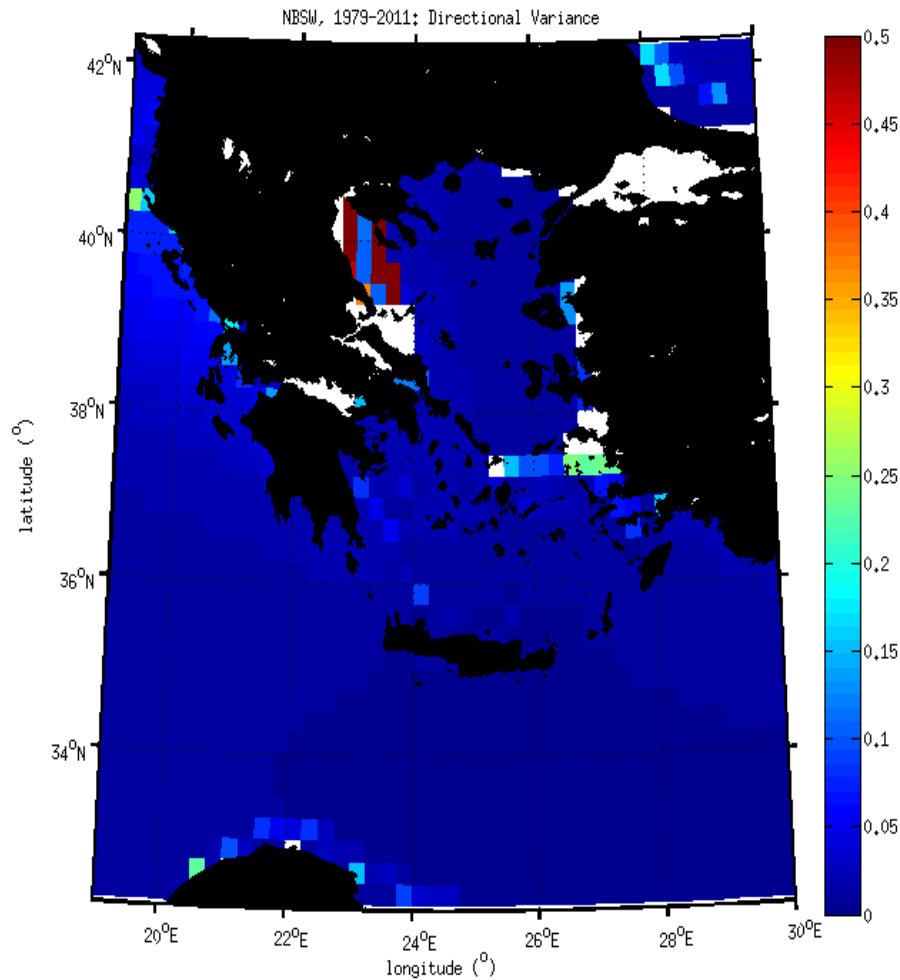


NBSW: Mean annual variability

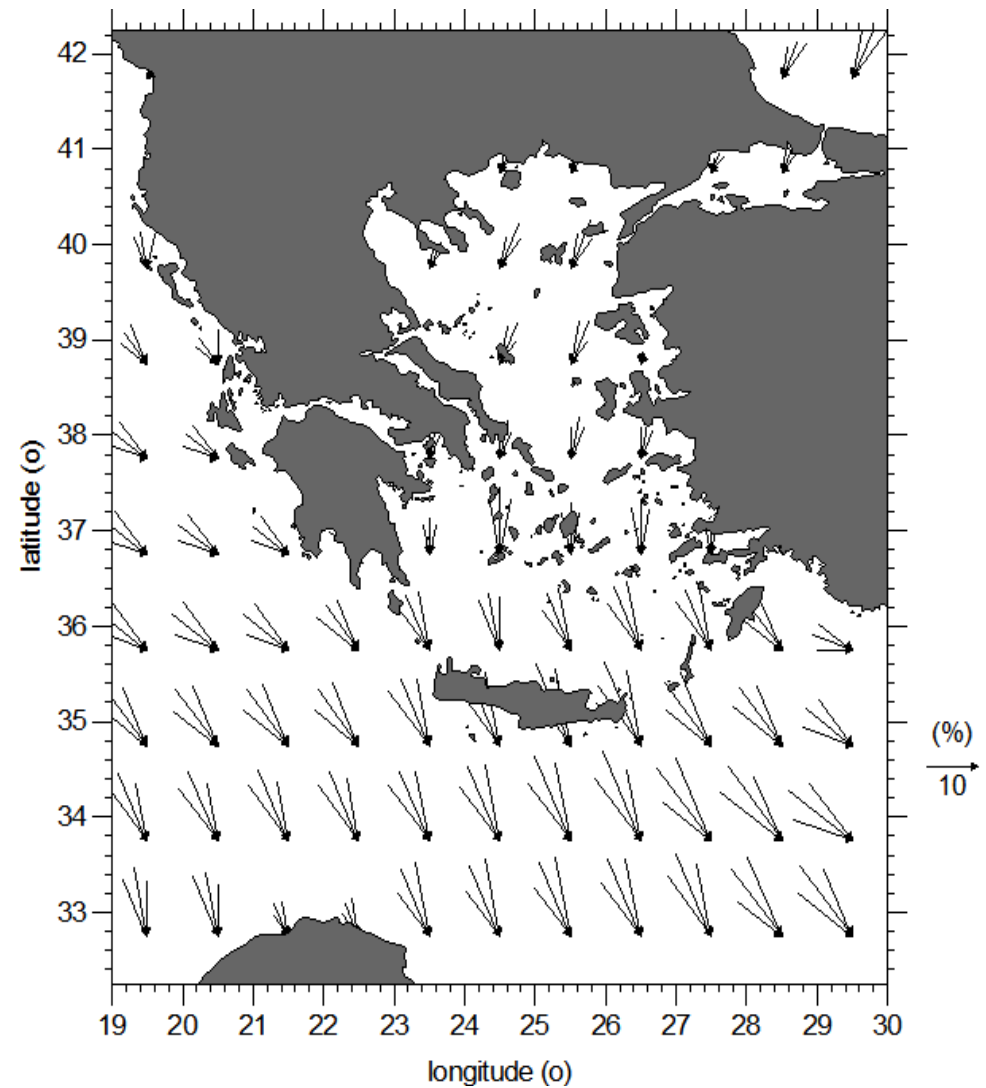


NBSW: Inter-annual variability

NBSW: Annual Wind Direction 10m

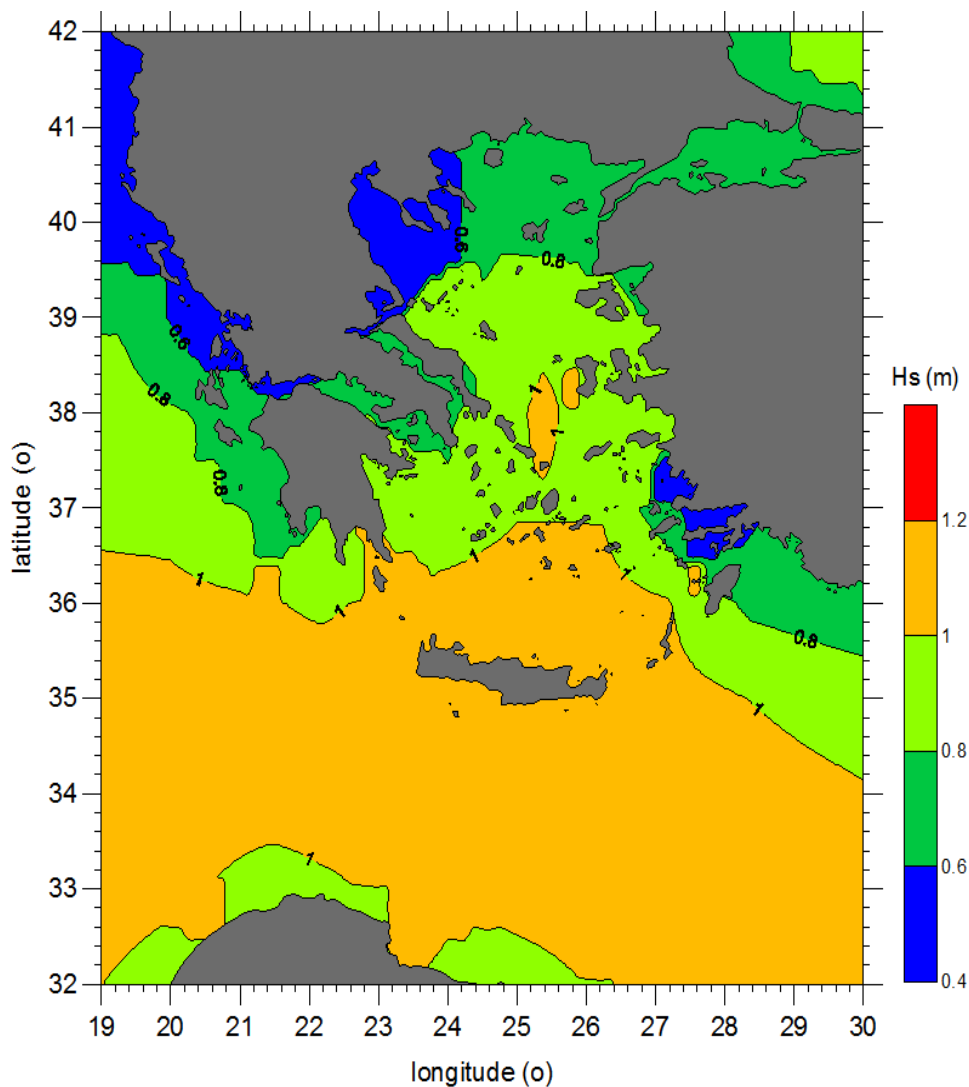


Mean annual wind direction variance

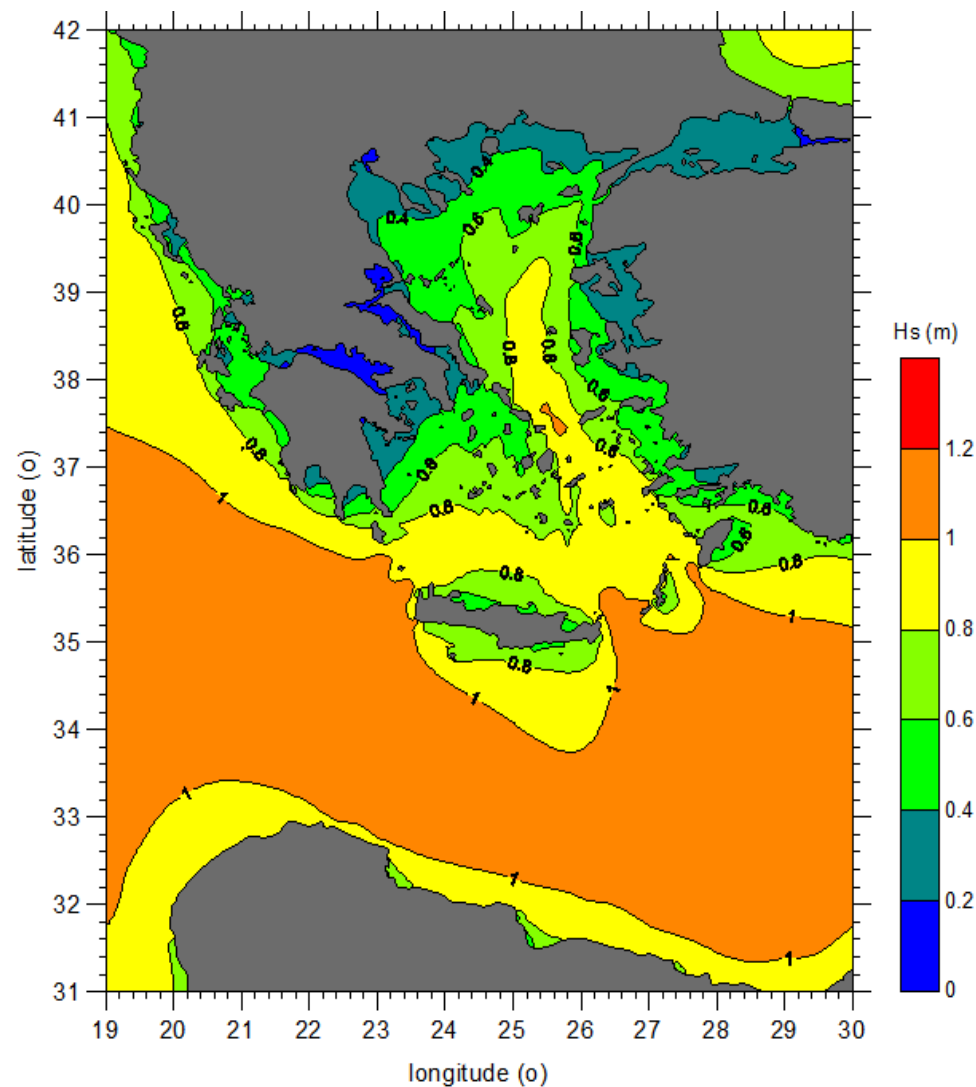


3 most probable annual wind directions

Wave Data Analysis – Sign. Wave Height

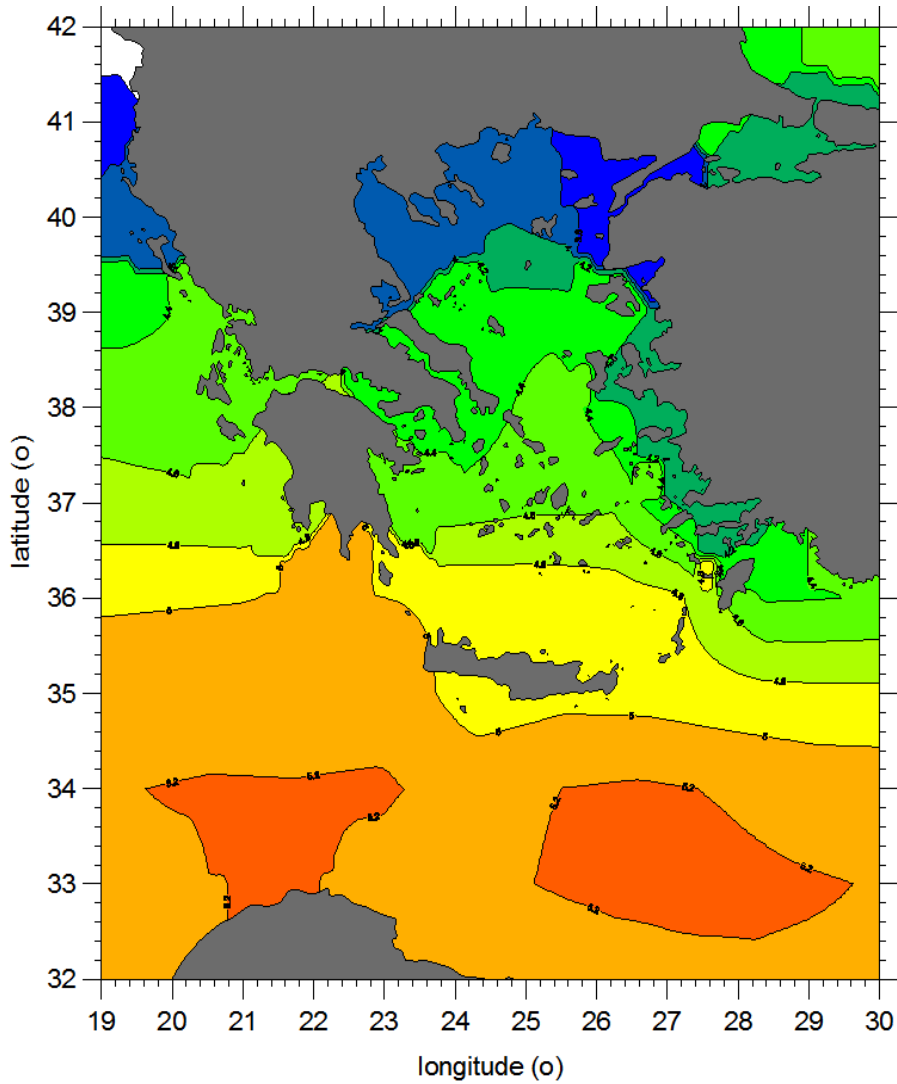


Era Interim - Mean annual H_s (m)

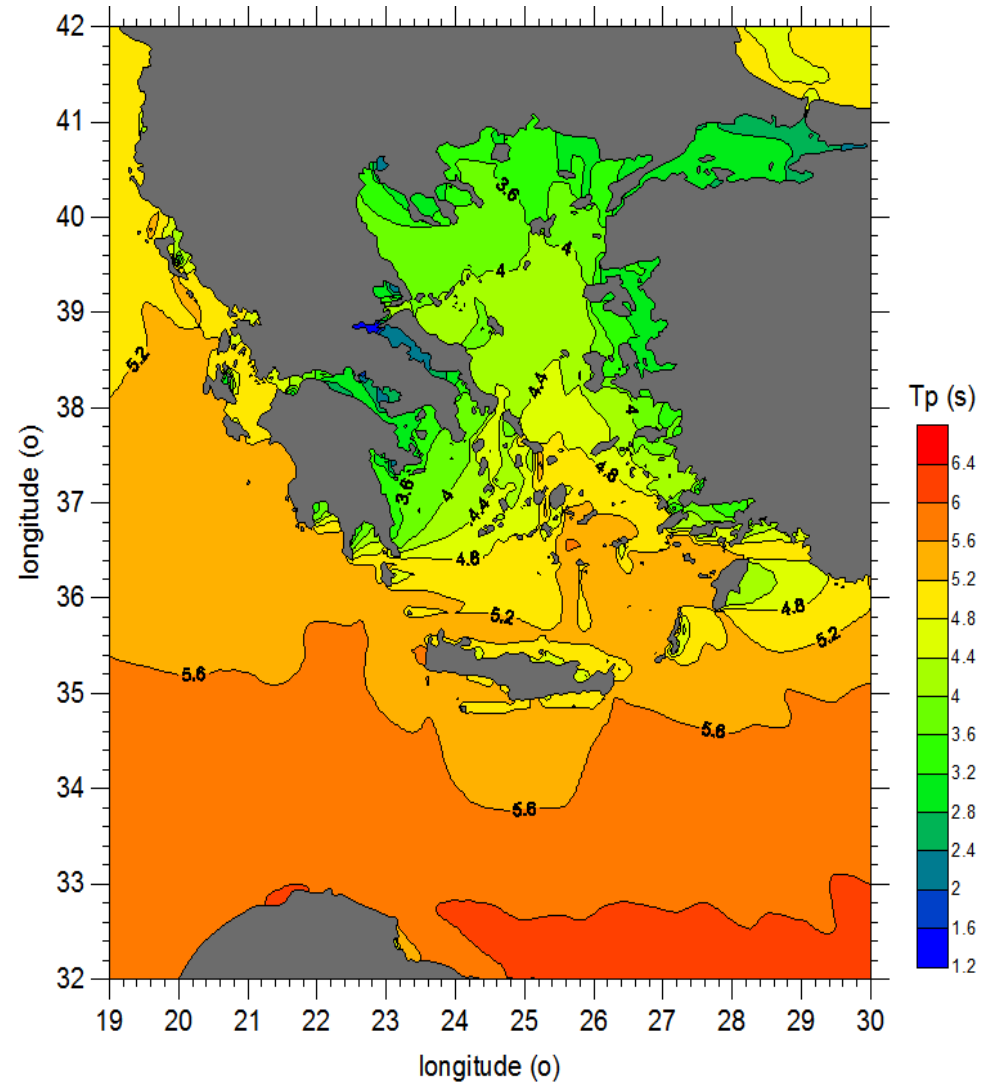


WAM, Cycle 4 – Mean annual H_s (m)

Wave Period Analysis

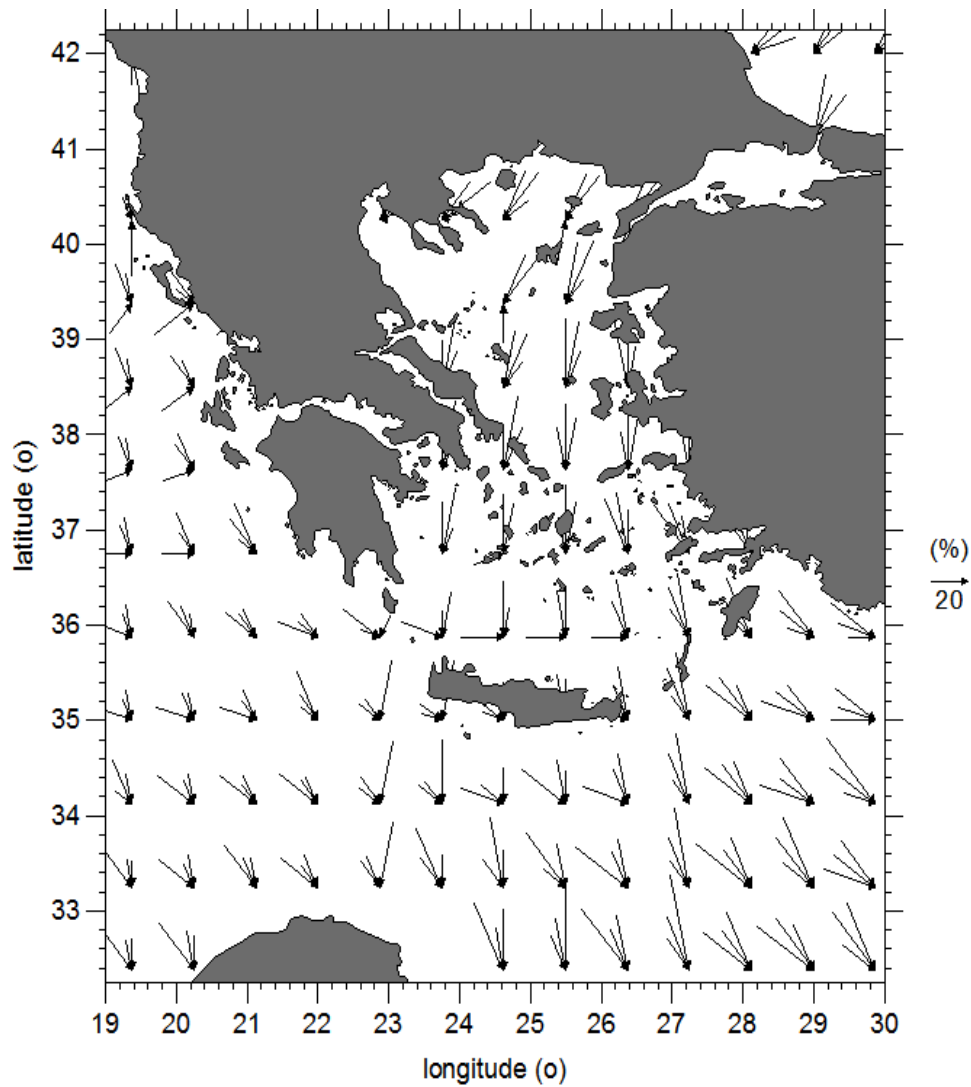


Era Interim - Mean annual Wave
(Energy) Period T_e (s)

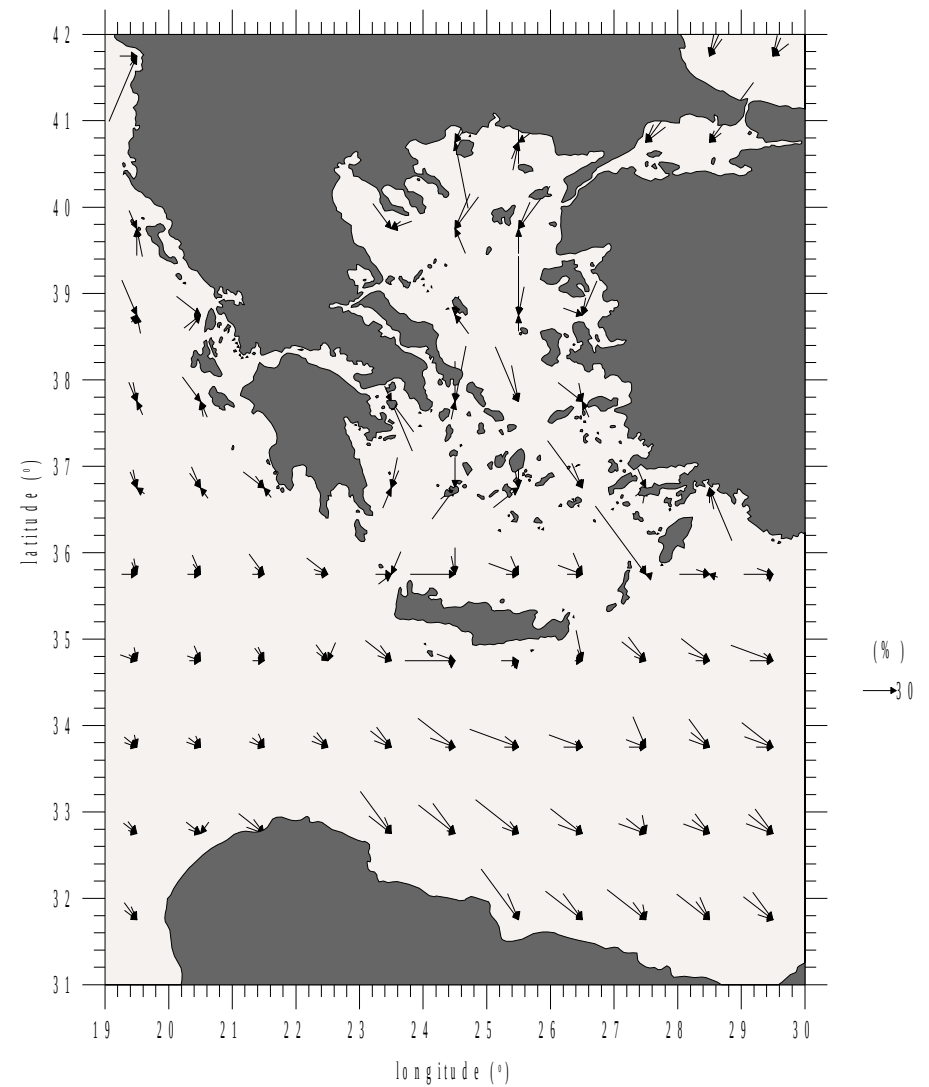


Wam Cycle 4 - Mean annual Peak
Wave Period T_p (s)

Most probable wave direction

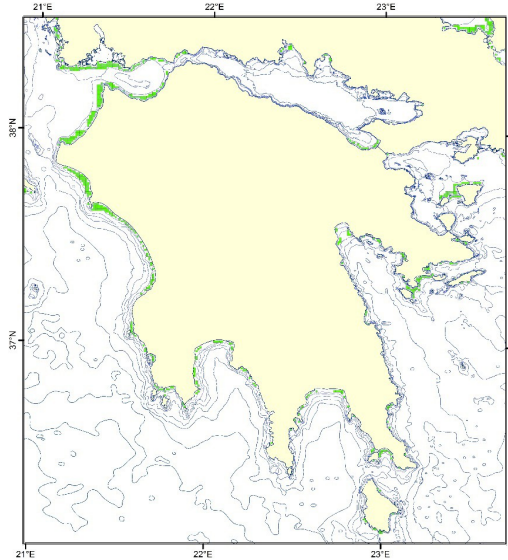
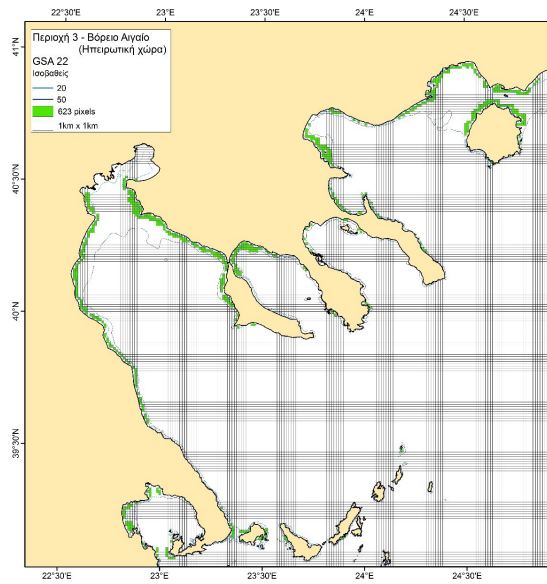


ERA Interim – 3 Most probable wave direction

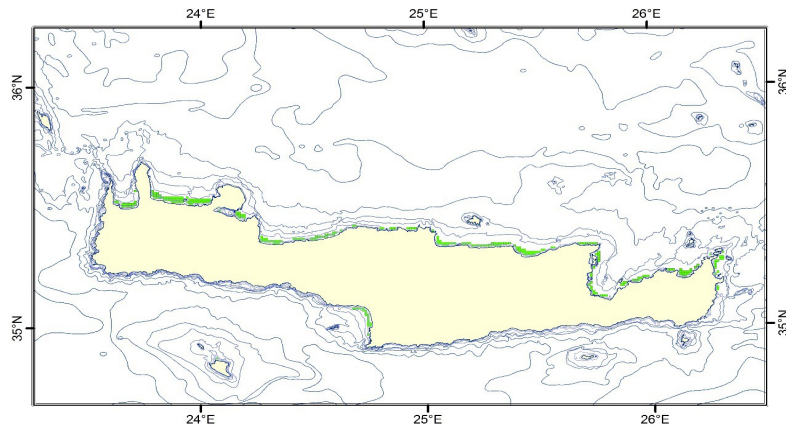


WAM Cycle 4 – 3 Most probable wave direction

Posidonia Oceanica

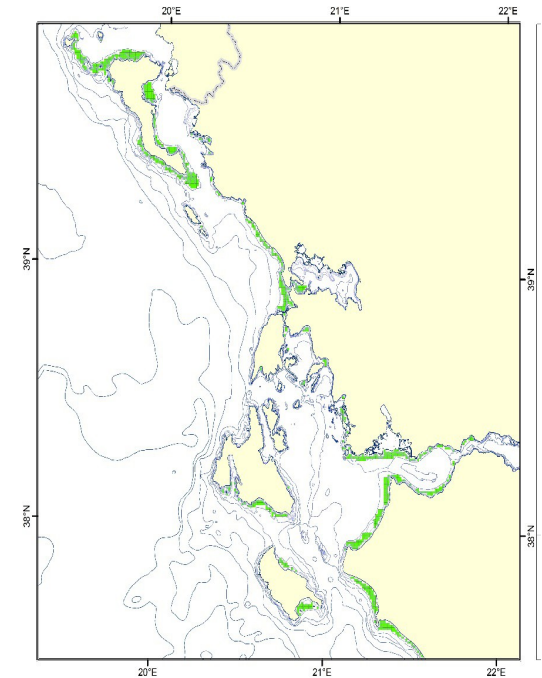


EMODnet
1km x 1km



Χάρτης:
Λιβάδια Ποσειδωνίας - Βαθυμετρία

Υπόμνημα
Depths (μ)



Results

Wind Analysis

- Consistent wind direction pattern between data bases
- Wind speed ~ 9 m/s at 100m height in annual basis
- Spatial variability in various temporal scales

Wave Analysis

- Significant wave height over 1m in Central and South Aegean, Crete island and South Ionian region
- Max T_e , T_p in west and south of Crete island.



Hot spots of potential
Offshore Sites

References

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- 2) Dee, D.P., et al. (2011), The ERA-Interim reanalysis: configuration and performance of the data assimilation system, Q.J.R. Meteorol. Soc; 137(656): 553-97.
- 3) Zhang, H. - M., J.J. Bates and R.W. Reynolds, Assessment of composite global sampling: Sea surface wind speed, GRL , vol. 33, L17714, 2006, doi: 10.1029/2006GL027086.
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- 5) Soukissian, T.H., Prospathopoulos A., 2003, Implementation of the 3rd generation Wave Model WAM – cycle 4 in Aegean Sea, Tech. Chron. Scientific Journal of the Technical Chamber of Greece , IV, Vol. 23, No. 1-2, pp. 7-19, (extended summary in English).
- 6) Soukissian T.H. et al., 2001, Performance of three numerical wave models on the Aegean Sea. First results, Proceedings of the 11th International Offshore and Polar Engineering Conference, Vol. III, pp. 40 – 45, ISBN 1-880653-51-6
- 7) The Med-Atlas Group: Gaillard, P. et al., 2004, Wind and Wave Atlas of the Mediterranean Sea, 420 pp.

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Thank you !



Appendix

