



Supplement of

Internal and forced ocean variability in the Mediterranean Sea

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S1 Ensemble validation

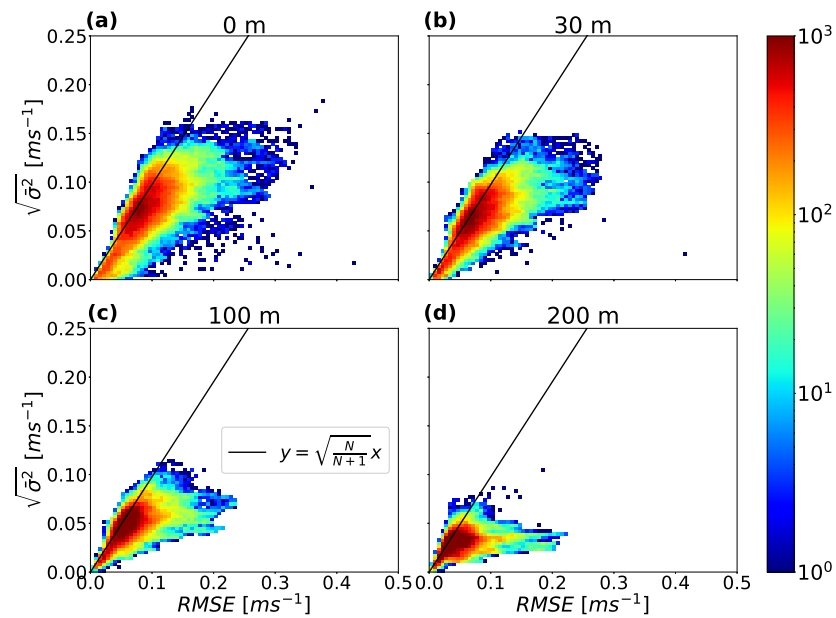
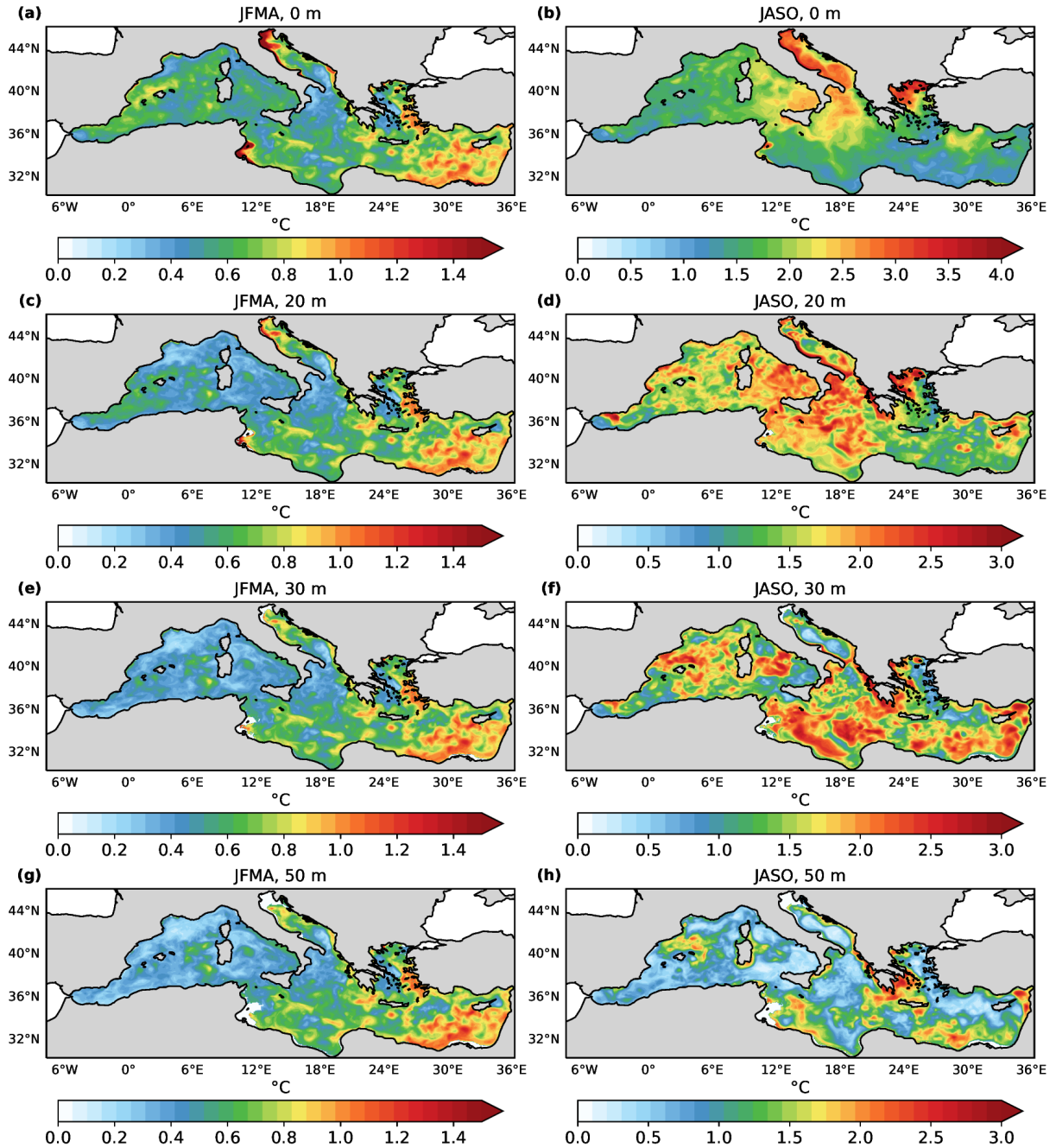


Figure S1. Ensemble dispersion relative to current speed: verification of Equation 4 averaged over the entire year 2021 for each grid point at the surface (a), at 30 m (b), at 100 m (c) and at 200 m (d). The black line indicates the ideal relation expressed in Eq. 4 of the manuscript.

Standard deviation σ_{2021} from 2021 reanalysis, temperature



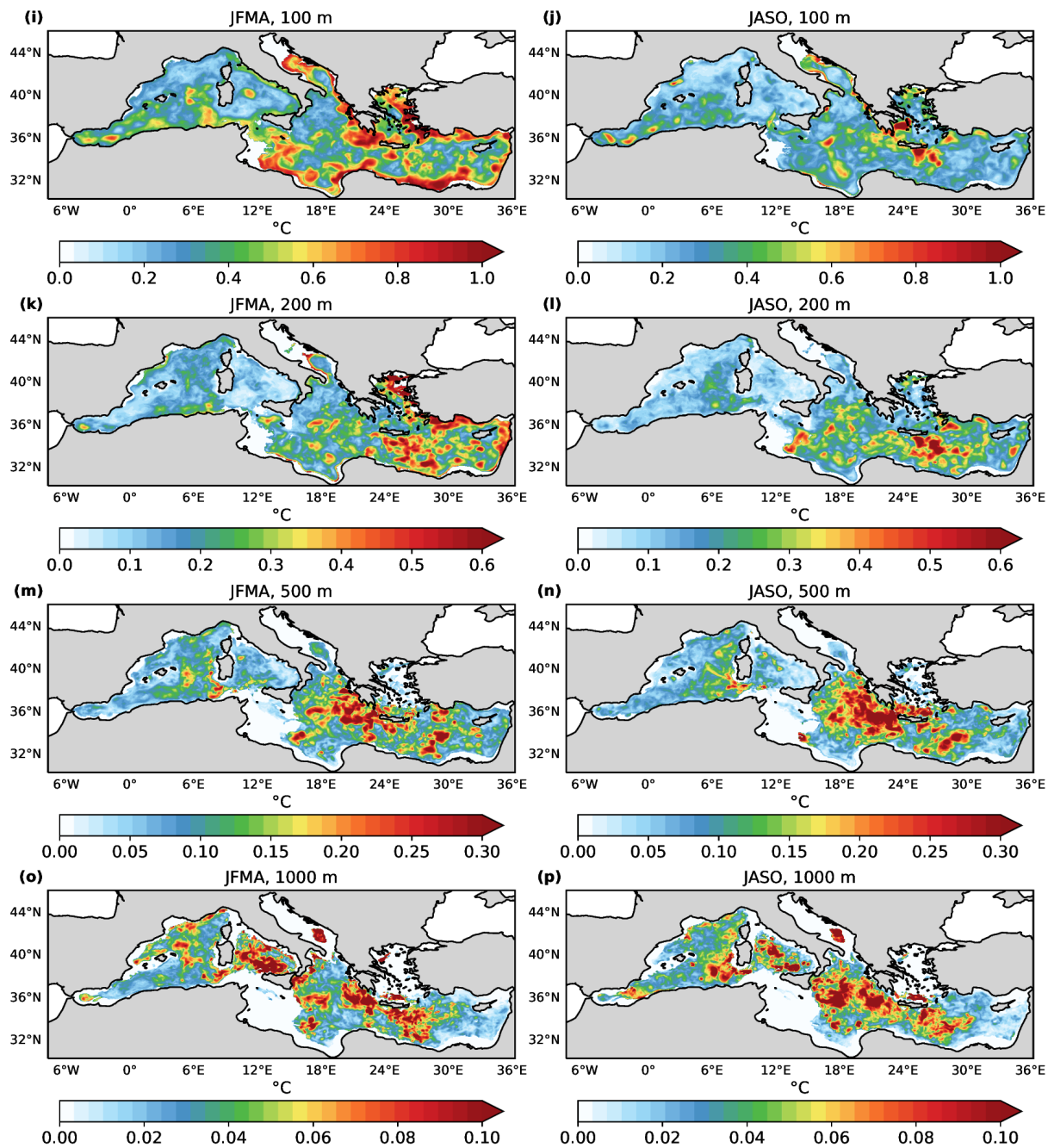
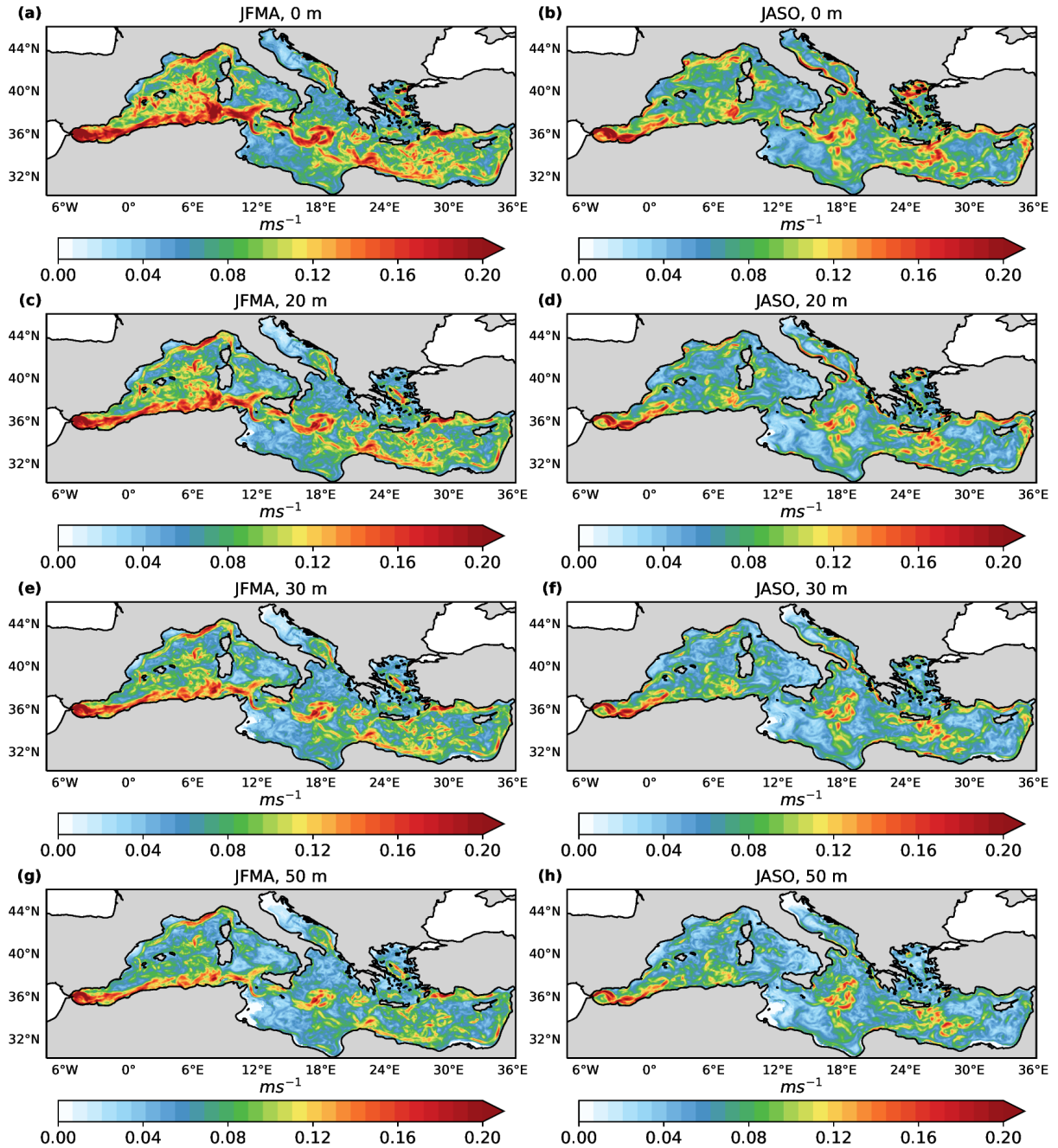


Figure S2. Seasonal standard deviation for potential temperature T at different depth levels for the year 2021: at the surface (a), at 20 m depth (c), at 30 m (e), at 50 m depth (g), at 100 m depth (i), at 200 m depth (k), at 500 m depth (m) and at 1000 m depth (o) for winter and similarly in (b), (d), (f), (h), (j), (l), (n) and (p) for summer. Please note the different units used at different depths.

Standard deviation σ_{2021} from 2021 reanalysis, current speed



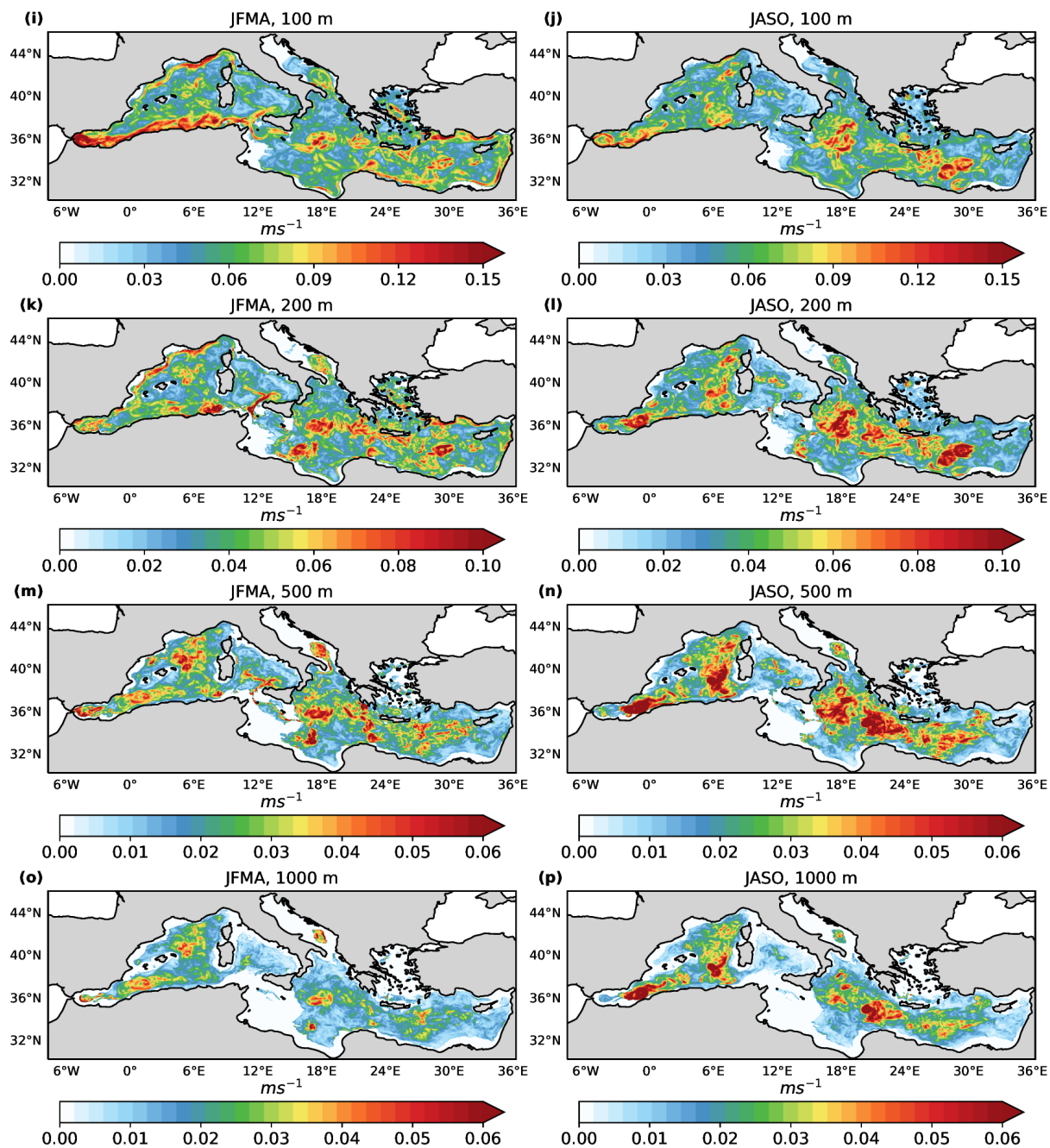


Figure S3. Seasonal standard deviation for current velocity v at different depth levels for the year 2021: at the surface (a), at 20 m depth (c), at 30 m (e), at 50 m depth (g), at 100 m depth (i), at 200 m depth (k), at 500 m depth (m) and at 1000 m depth (o) for winter and similarly in (b), (d), (f), (h), (j), (l), (n) and (p) for summer. Please note the different units used at different depths.

Ensemble spread σ_t , temperature, N=5

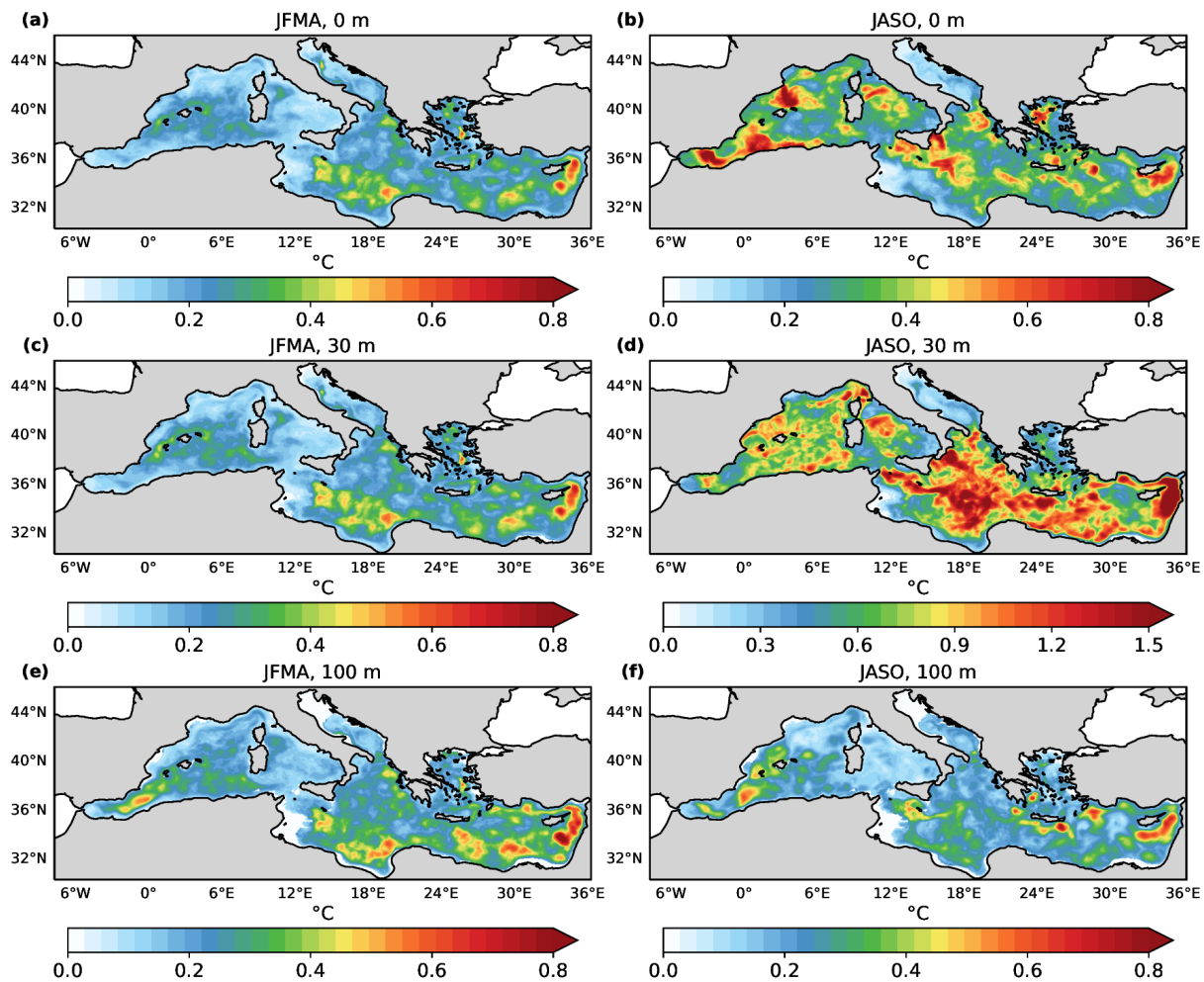


Figure S4. Seasonal average of the ensemble spread with N=5 for potential temperature T at different depth levels for the year 2021: at the surface (a), at 30 m depth (c) and at 100 m depth (e) for winter and similarly in (b),(d) and (f) for summer. Please note the different units used at different depths.

Ensemble spread σ_v , current speed, N=5

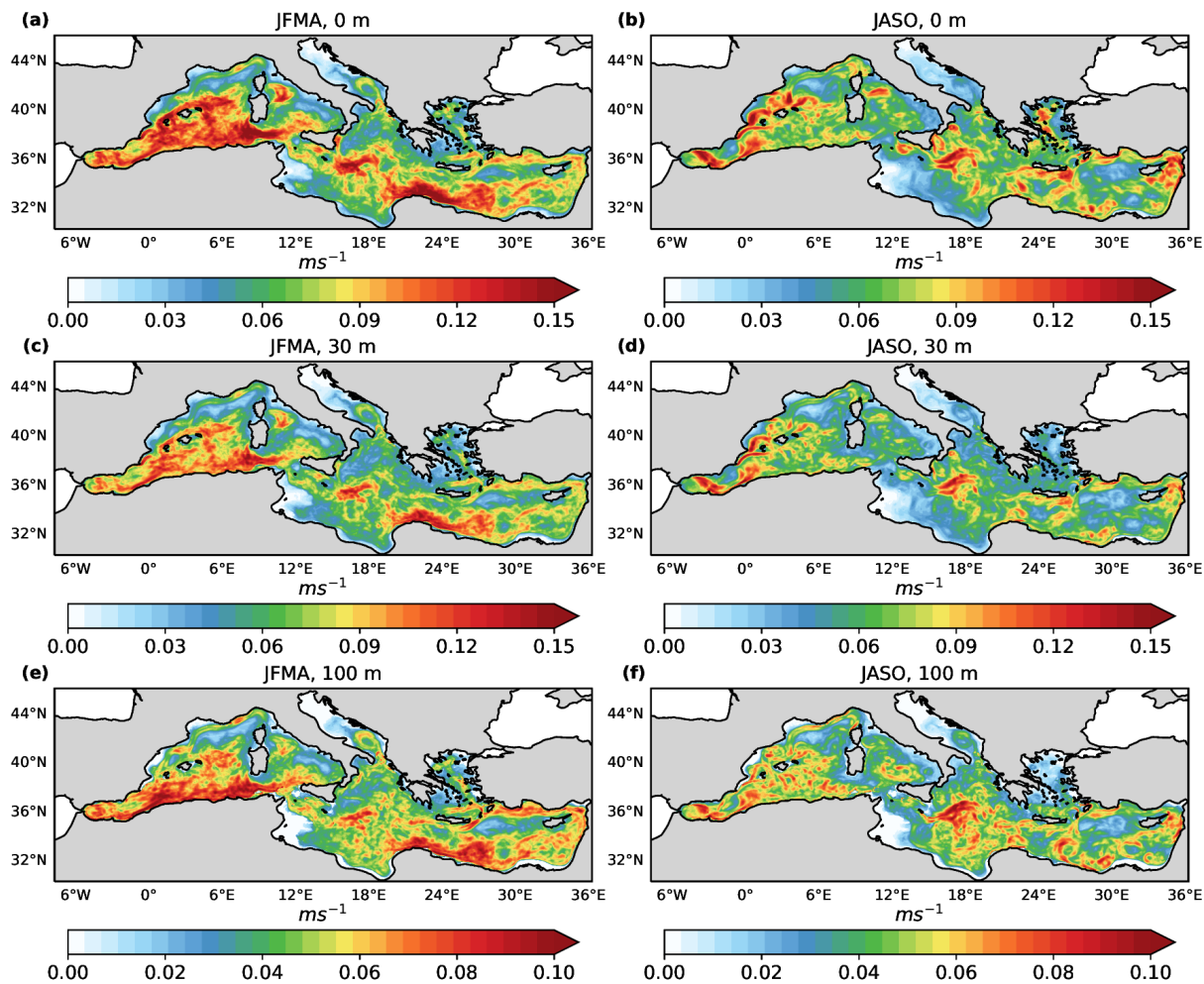
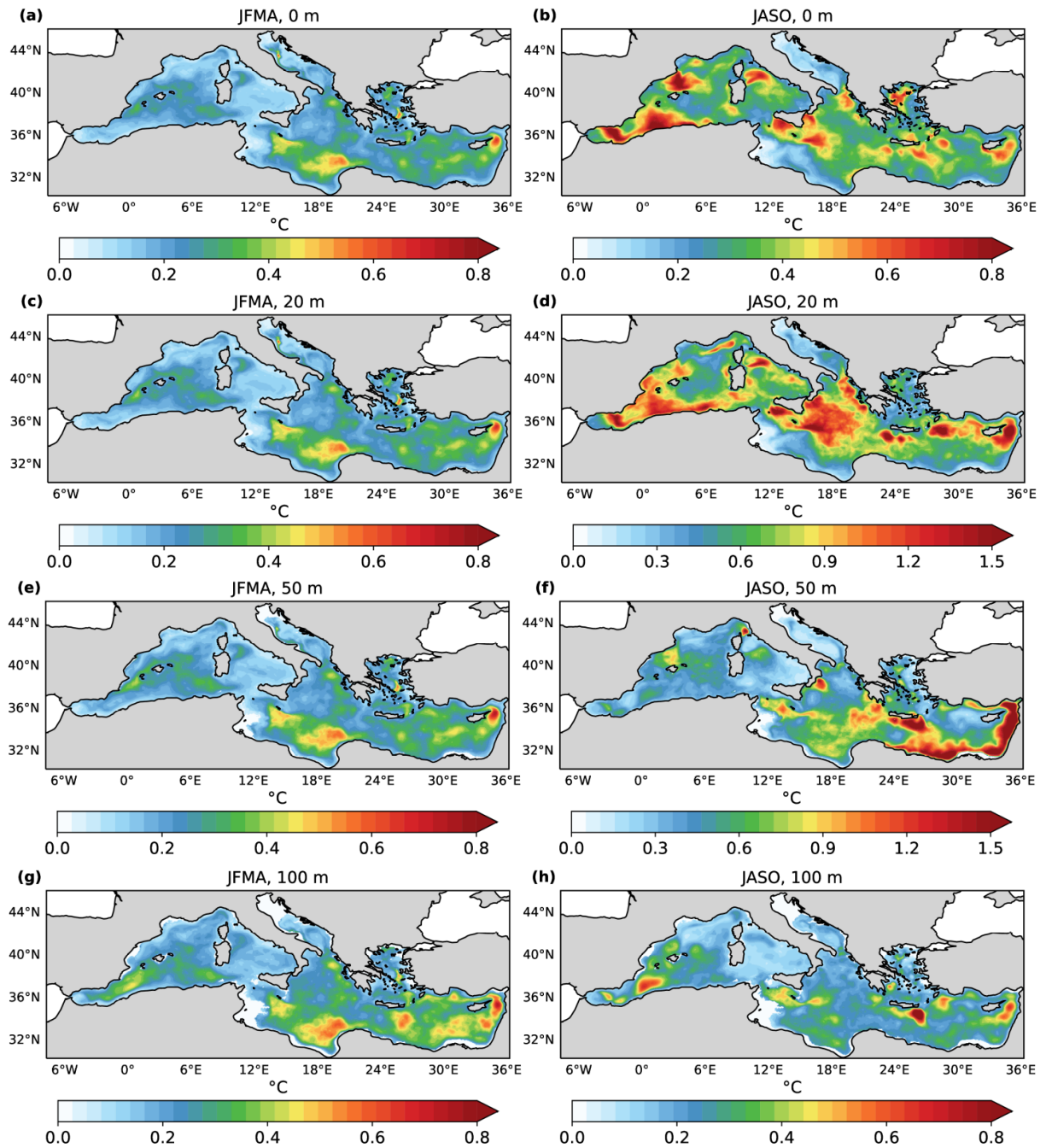


Figure S5. Seasonal average of the ensemble spread with N=5 for current speed v at different depth levels for the year 2021: at the surface (a), at 30 m depth (c) and at 100 m depth (e) for winter and similarly in (b),(d) and (f) for summer. Please note the different units used at different depths.

S2 Internal variability

Ensemble spread σ_t , temperature



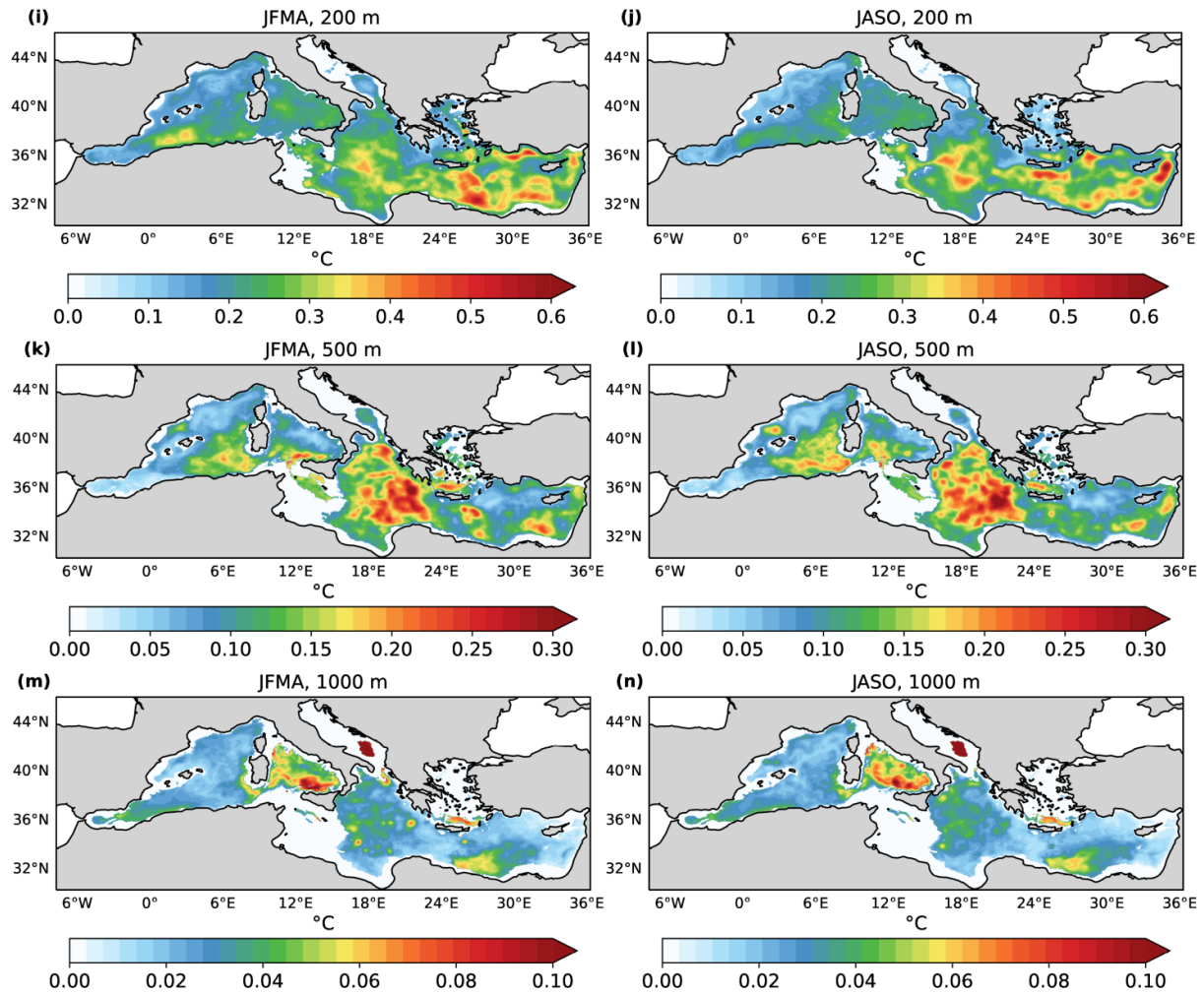
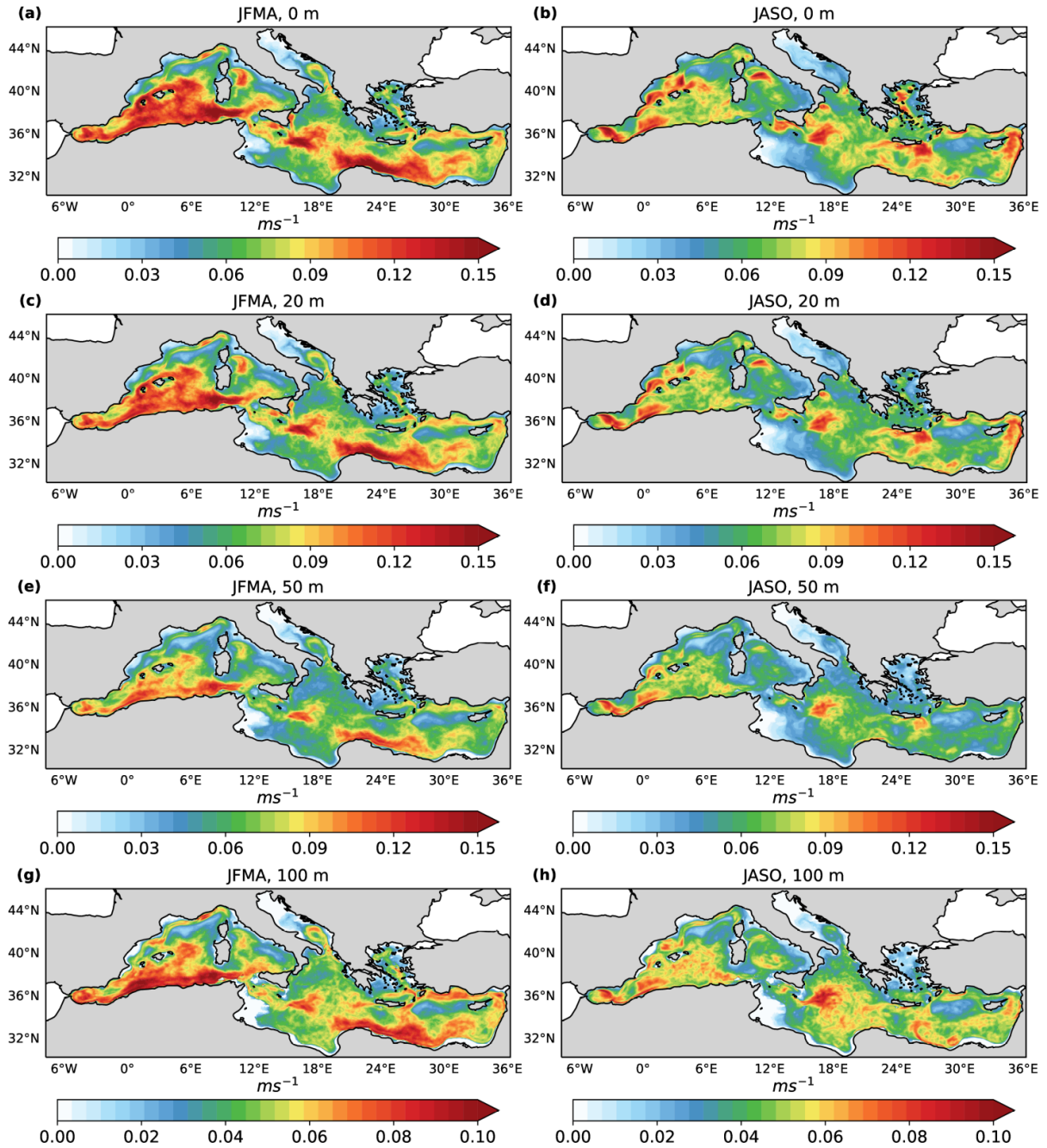


Figure S6. Seasonal average of the ensemble spread for potential temperature T at different depth levels for the year 2021: at the surface (a), at 20 m depth (c), at 50 m depth (e), at 100 m depth (g), at 200 m depth (i), at 500 m depth (k) and at 1000 m depth (m) for winter and similarly in (b), (d), (f), (h), (j) and (n) for summer. Please note the different units used at different depths.

Ensemble spread σ_I , current speed



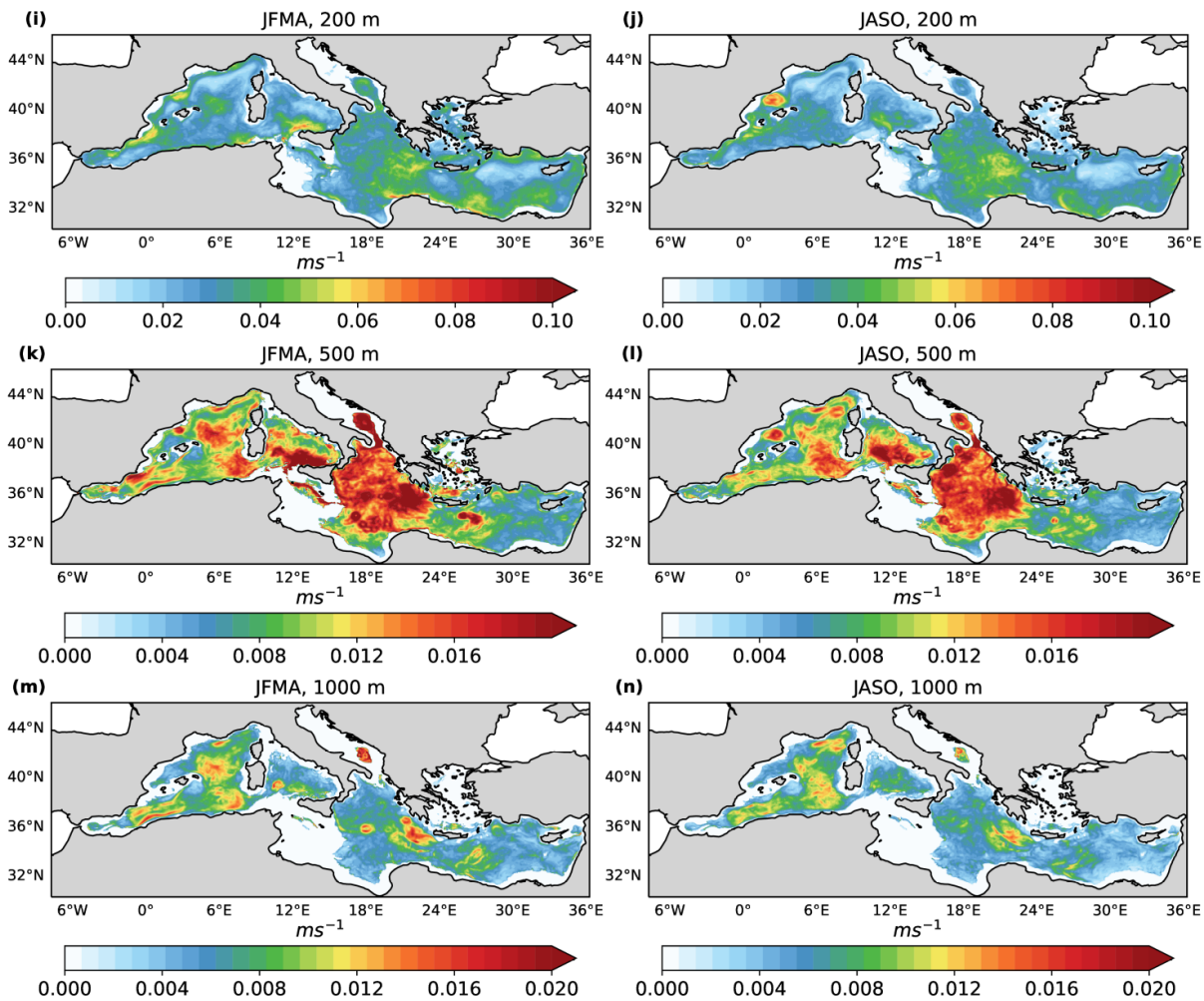


Figure S7. Seasonal average of the ensemble spread for current speed v at different depth levels for the year 2021: at the surface (a), at 20 m depth (c), at 50 m depth (e), at 100 m depth (g), at 200 m depth (i), at 500 m depth (k) and at 1000 m depth (m) for winter and similarly in (b), (d), (f), (h), (j) and (n) for summer. Please note the different units used at different depths.

S3 Vertical profiles

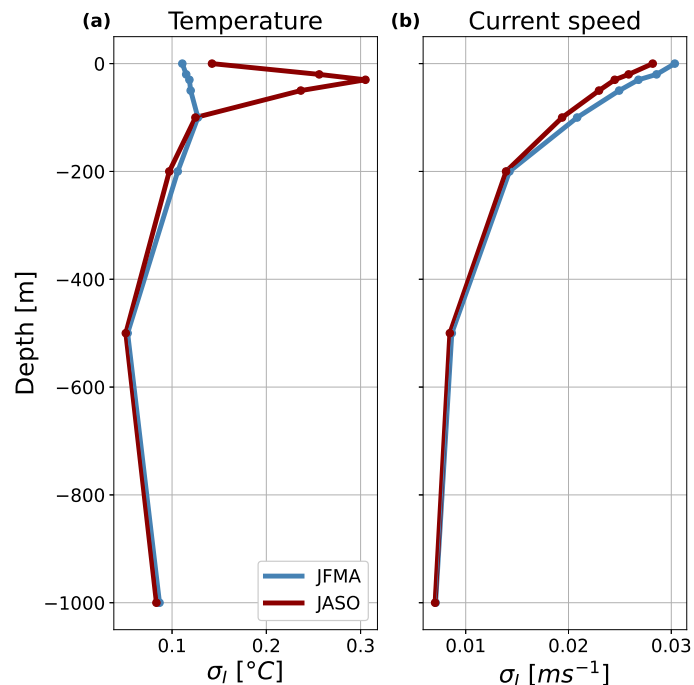


Figure S8. Vertical profile of the seasonally and spatially averaged ensemble spread for potential temperature **(a)** and current speed **(b)**. Red represents summer, whereas blue is winter

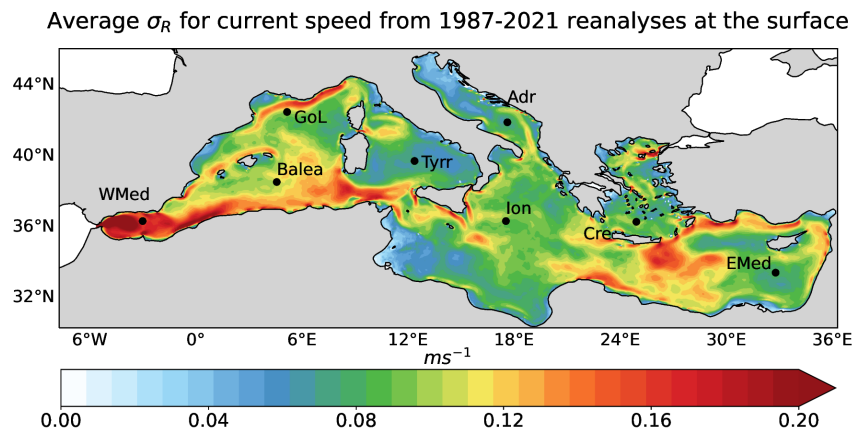


Figure S9. Average interannual spread σ_R at the surface in the Mediterranean Sea computed with the reanalyses from the period 1987 - 2021. σ_R is computed as the spread of an ensemble composed of the current speed field of each year from 1987 to 2021. The dots indicate the locations that were chosen for the analysis: Western Mediterranean Sea (**WMed**), Balearic Islands (**Balea**), Gulf of Lion (**GoL**), Tyrrhenian Sea (**Tyrr**), Adriatic Sea (**Adr**), Ionian Sea (**Ion**), Cretan Sea (**Cre**) and Eastern Mediterranean Sea (**EMed**).

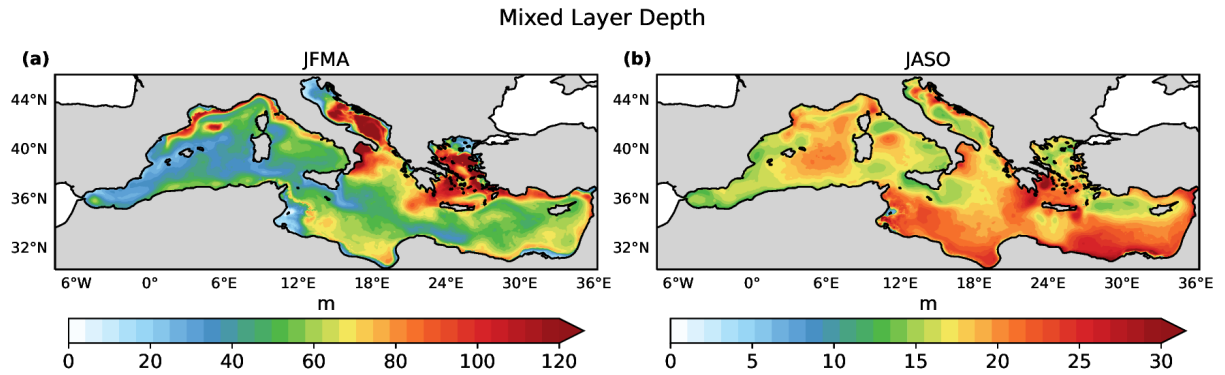


Figure S10. Seasonal average of the Mixed Layer Depth in both winter (a) and summer (b) in the year 2021. Please note the different scales used in the two sub-plots.

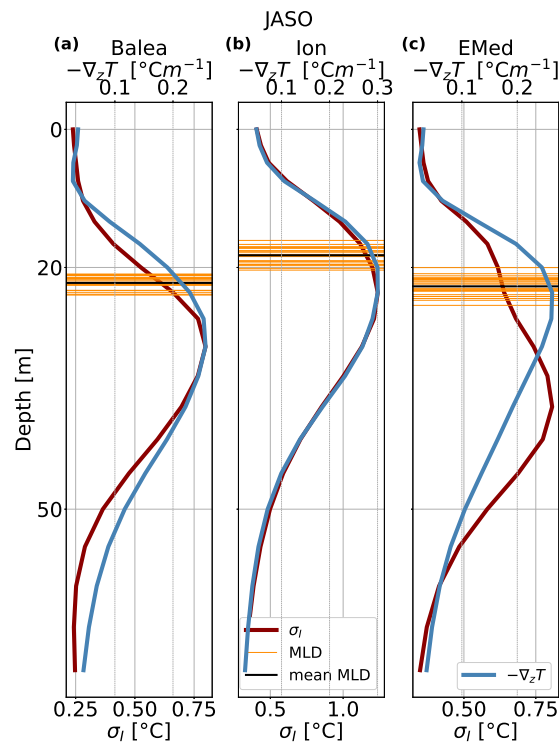


Figure S11. Seasonally averaged vertical profile up to 70 m depth of the ensemble spread σ_I (red) for potential temperature and of the vertical temperature gradient $-\nabla_z T$ (blue) in summer at **Balea (a)**, **Ion (b)** and **EMed (c)**. Horizontal lines indicate the seasonally averaged Mixed Layer Depth: black corresponds to the ensemble mean, while orange indicates the ensemble members.

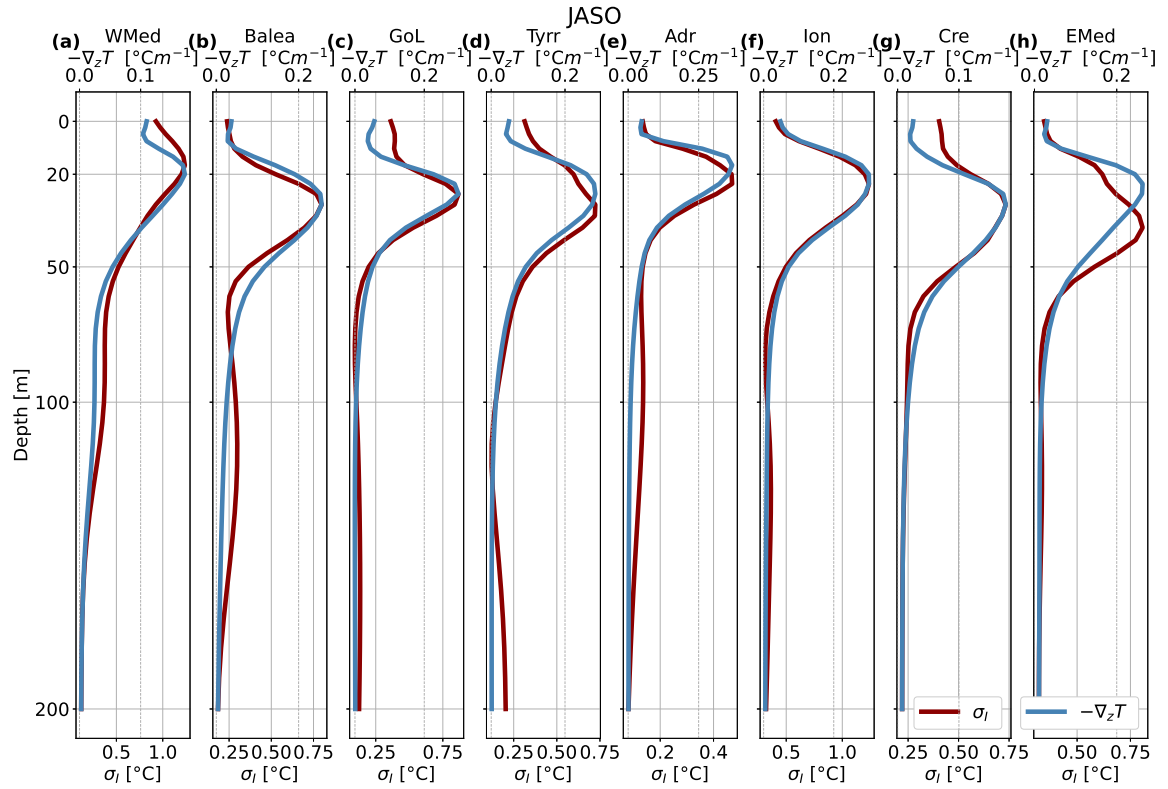


Figure S12. Seasonally averaged vertical profile of the ensemble spread σ_I (red) for potential temperature and of the vertical temperature gradient $-\nabla_z T_z$ (blue) in summer at **WMed (a)**, **Balea (b)**, **GoL (c)**, **Tyrr (d)**, **Adr (e)**, **Ion (f)**, **Cre (g)** and **EMED (h)**.

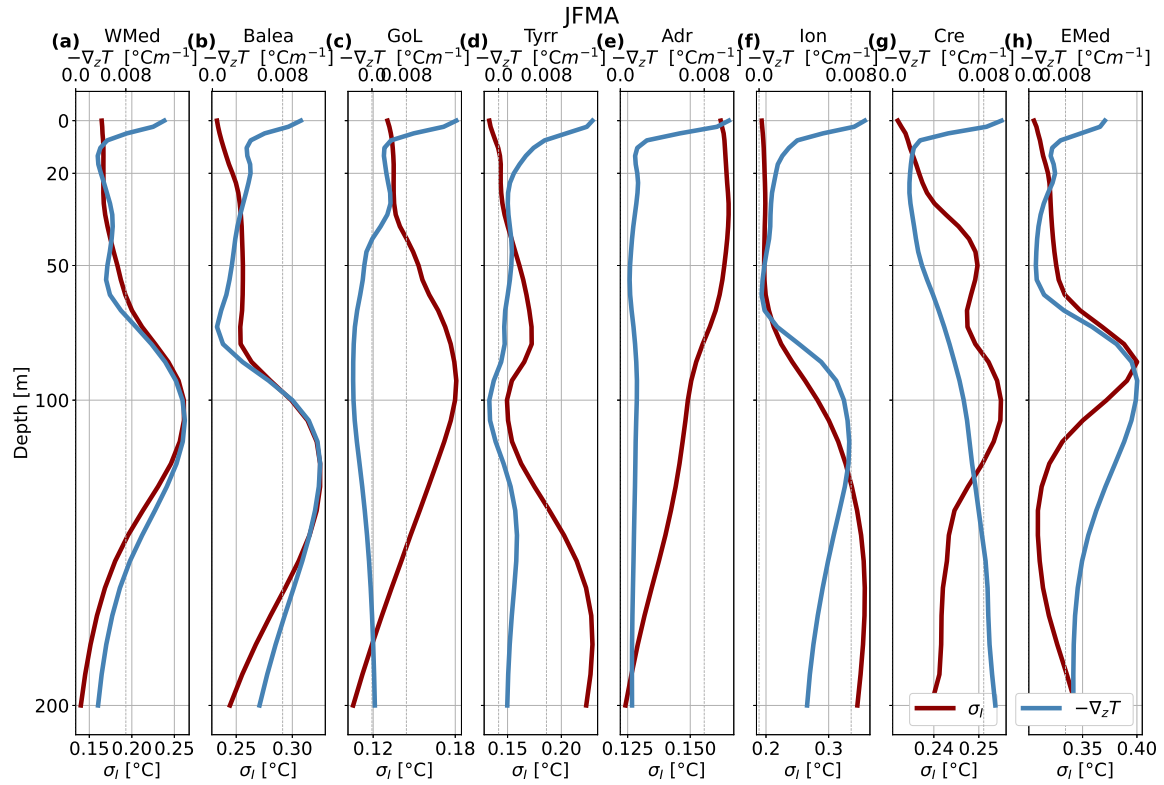
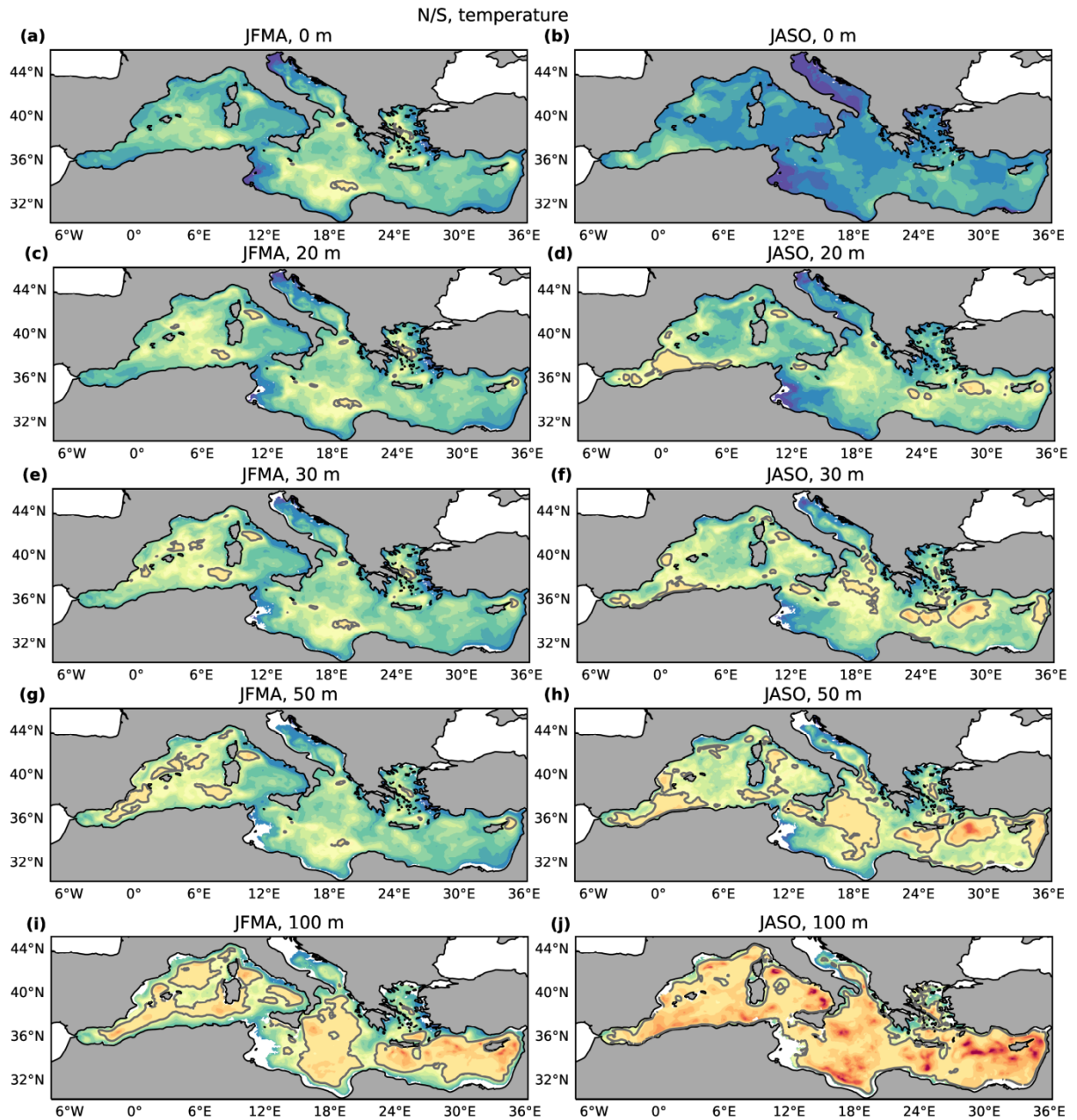


Figure S13. Seasonally averaged vertical profile of the ensemble spread σ_I (red) for potential temperature and of the vertical temperature gradient $-\nabla T_z$ (blue) in winter at **WMed (a)**, **Balea (b)**, **GoL (c)**, **Tyrr (d)**, **Adr (e)**, **Ion (f)**, **Cre (g)** and **EMed (h)**.

S4 Noise-to-signal ratio



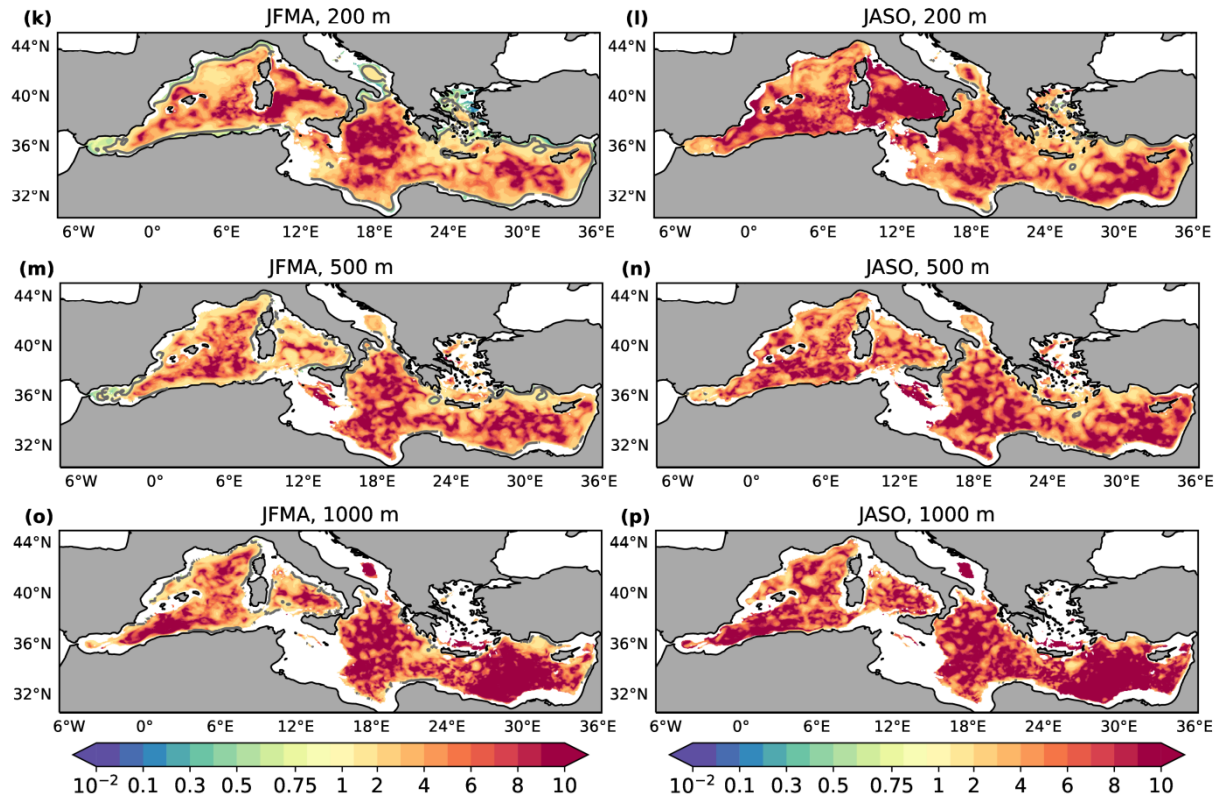
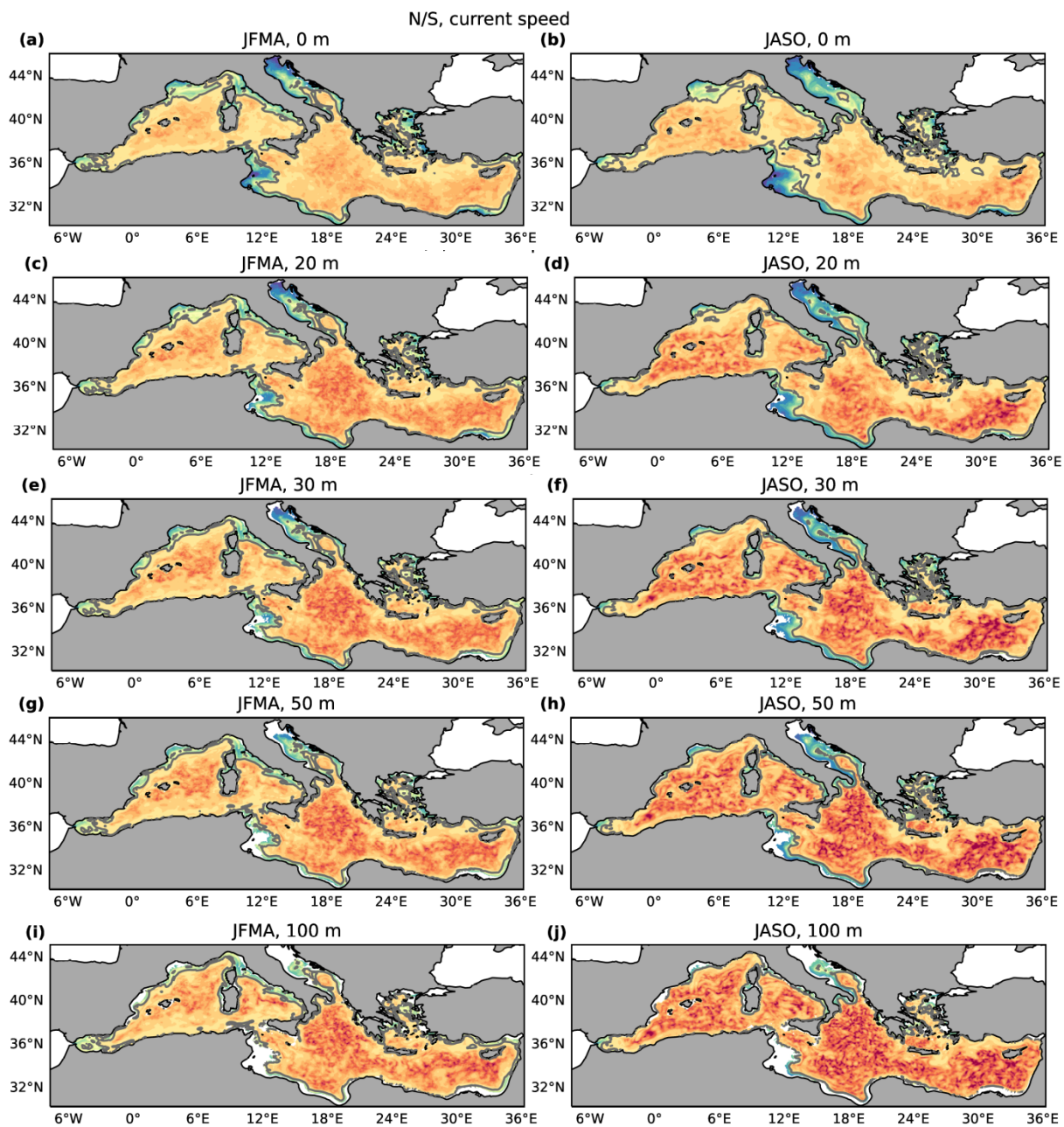


Figure S14. Seasonal average of the noise to signal ratio for potential temperature T at different depth levels for the year 2021: at the surface (a), at 20 m depth (c), at 30 m depth (e), at 50 m depth (g), at 100 m depth (i), at 200 m depth (k), at 500 m depth (m) and at 1000 m depth (o) for winter and similarly in (b), (d), (f), (h), (j), (n) and (p) for summer.



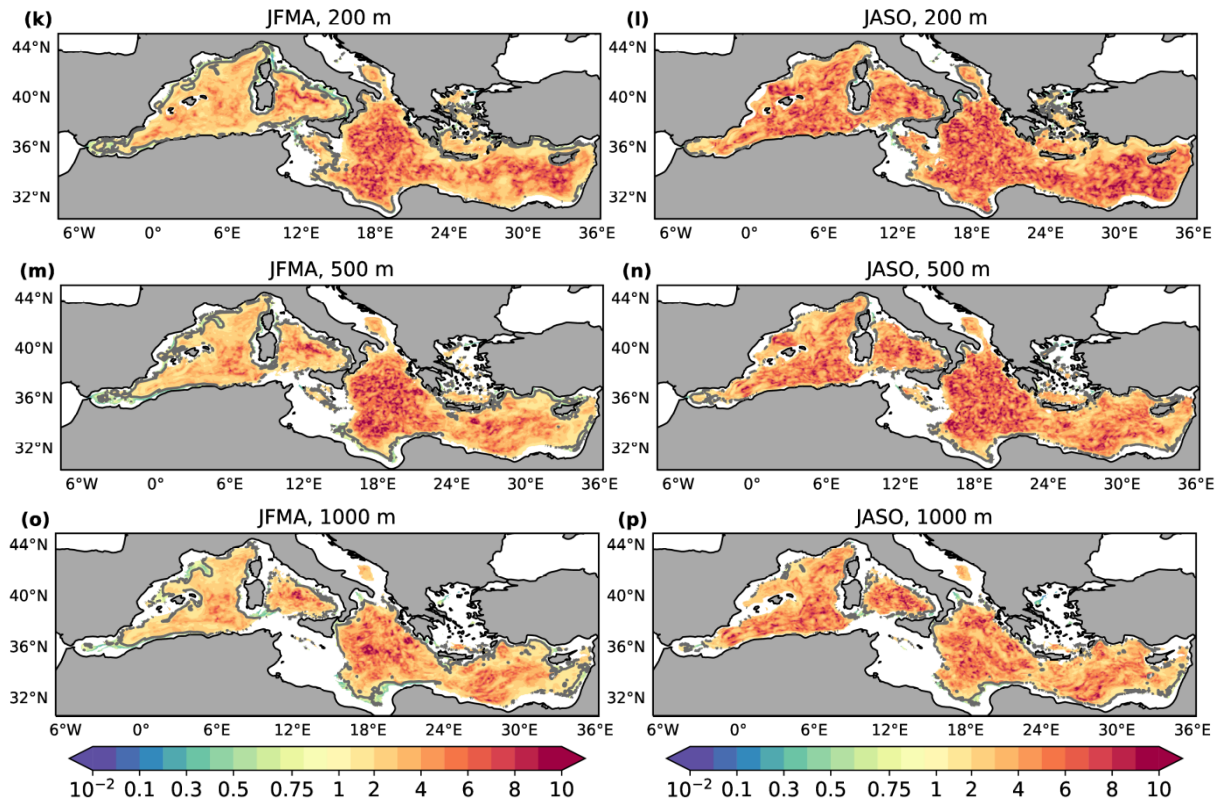
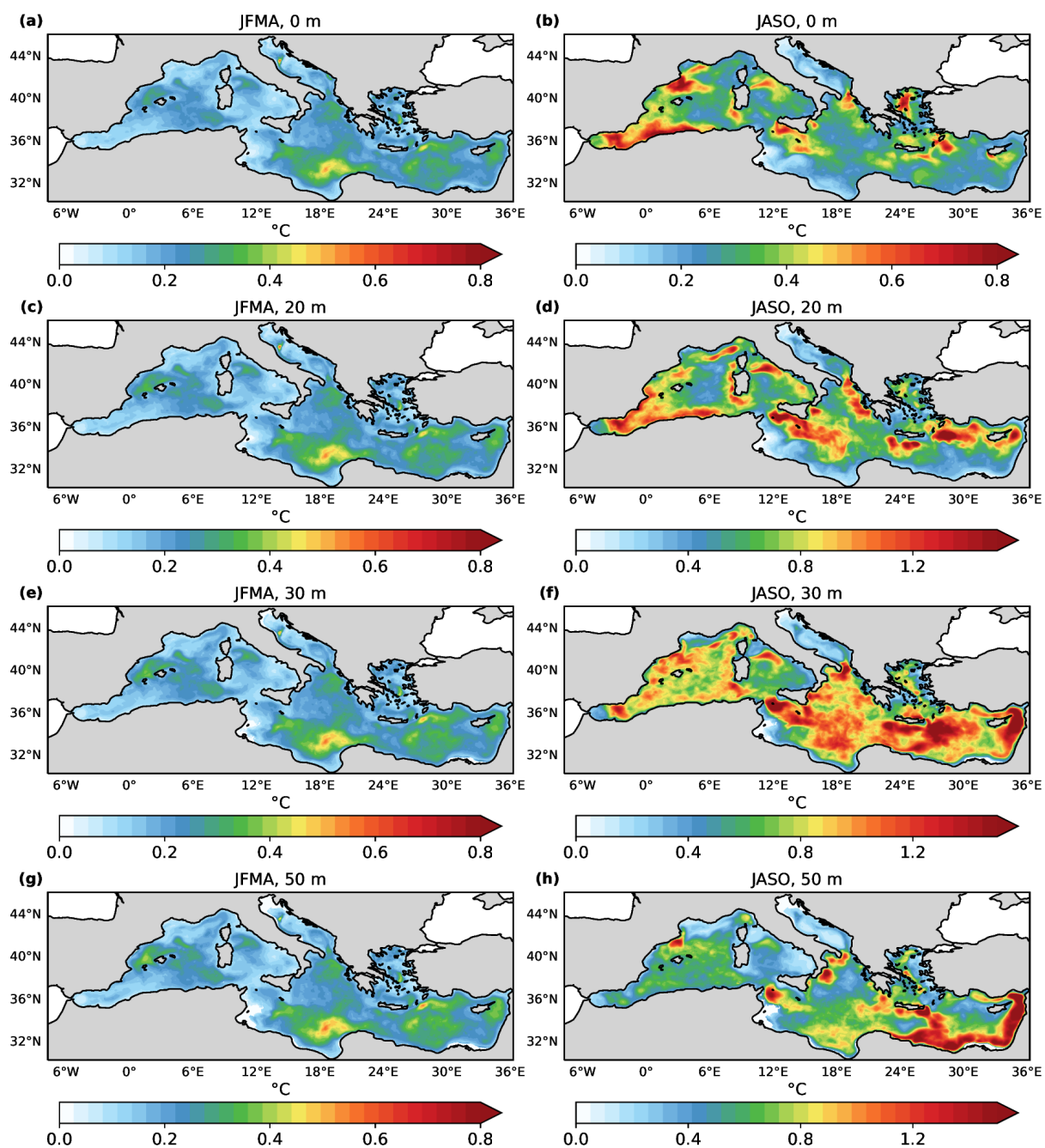


Figure S15. Seasonal average of the noise to signal ratio for current speed v at different depth levels for the year 2021: at the surface (a), at 20 m depth (c), at 30 m depth (e), at 50 m depth (g), at 100 m depth (i), at 200 m depth (k), at 500 m depth (m) and at 1000 m depth (o) for winter and similarly in (b), (d), (f), (h), (j), (n) and (p) for summer.

Ensemble spread σ_t , temperature

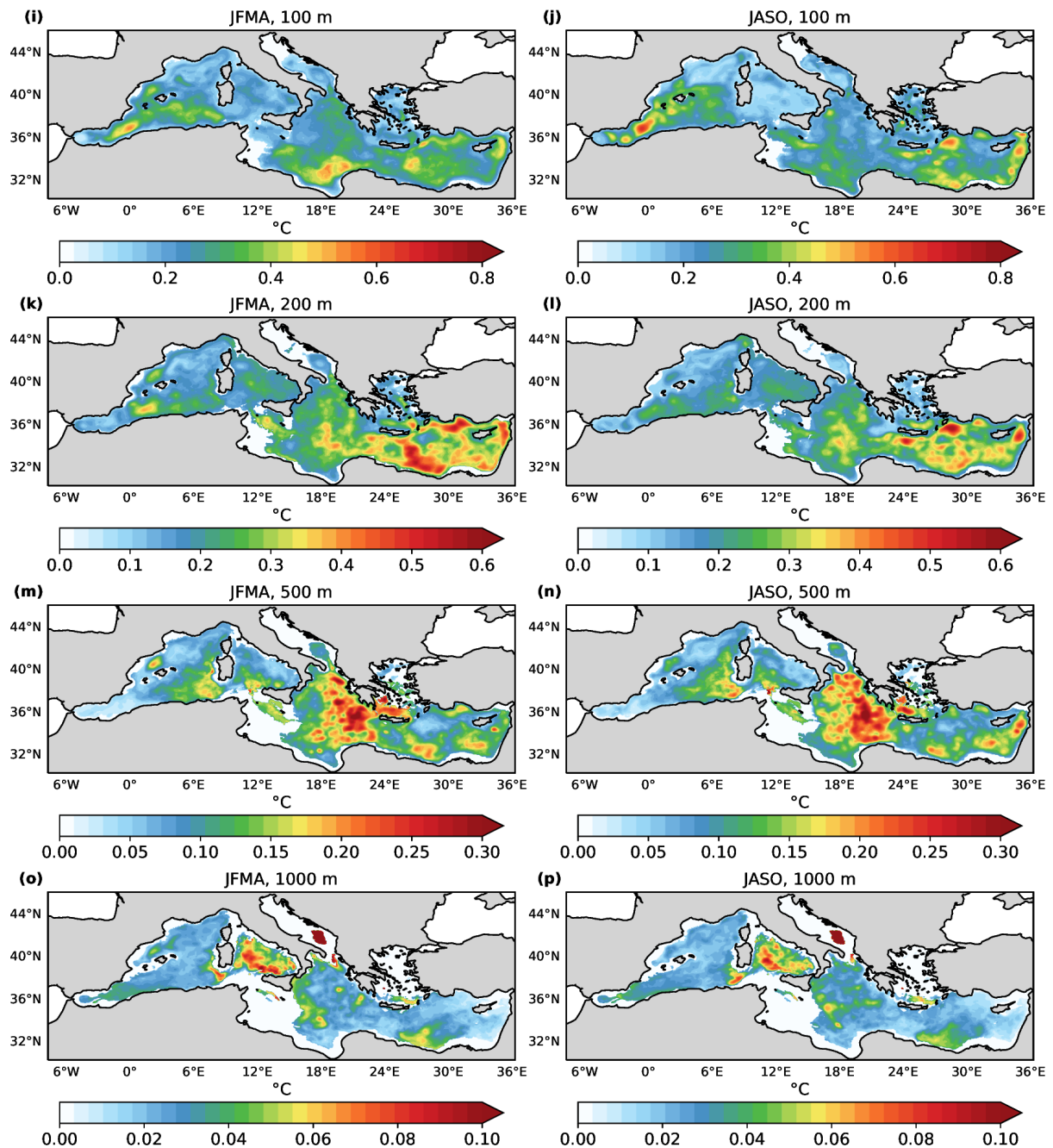
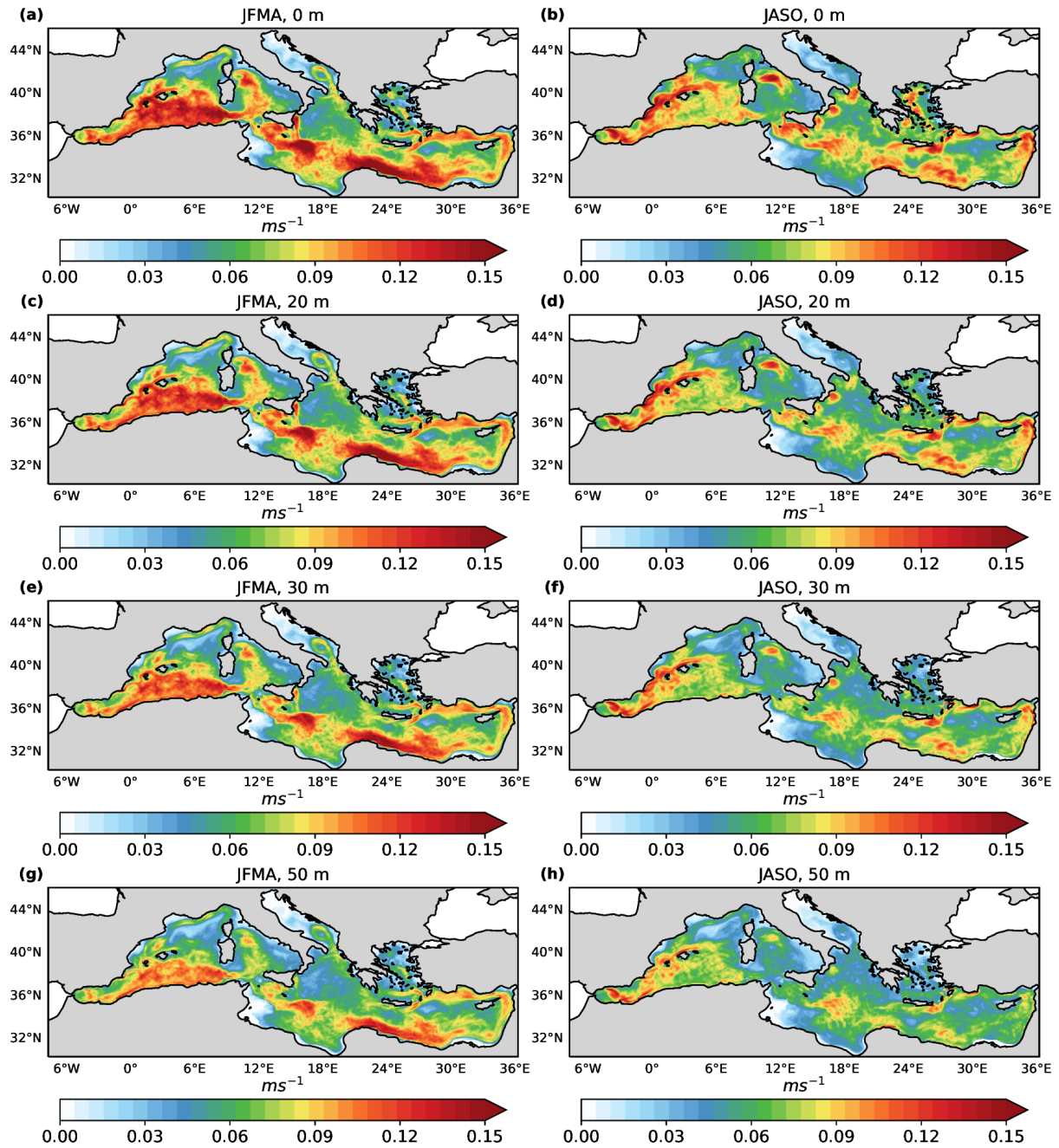


Figure S16. Seasonal average of the ensemble spread for potential temperature T at different depth levels for the year 2020: at the surface (a), at 20 m depth (c), at 30 m (e), at 50 m depth (g), at 100 m depth (i), at 200 m depth (k), at 500 m depth (m) and at 1000 m depth (o) for winter and similarly in (b), (d), (f), (h), (j), (l), (n) and (p) for summer. Please note the different units used at different depths.

Ensemble spread σ_t , current speed



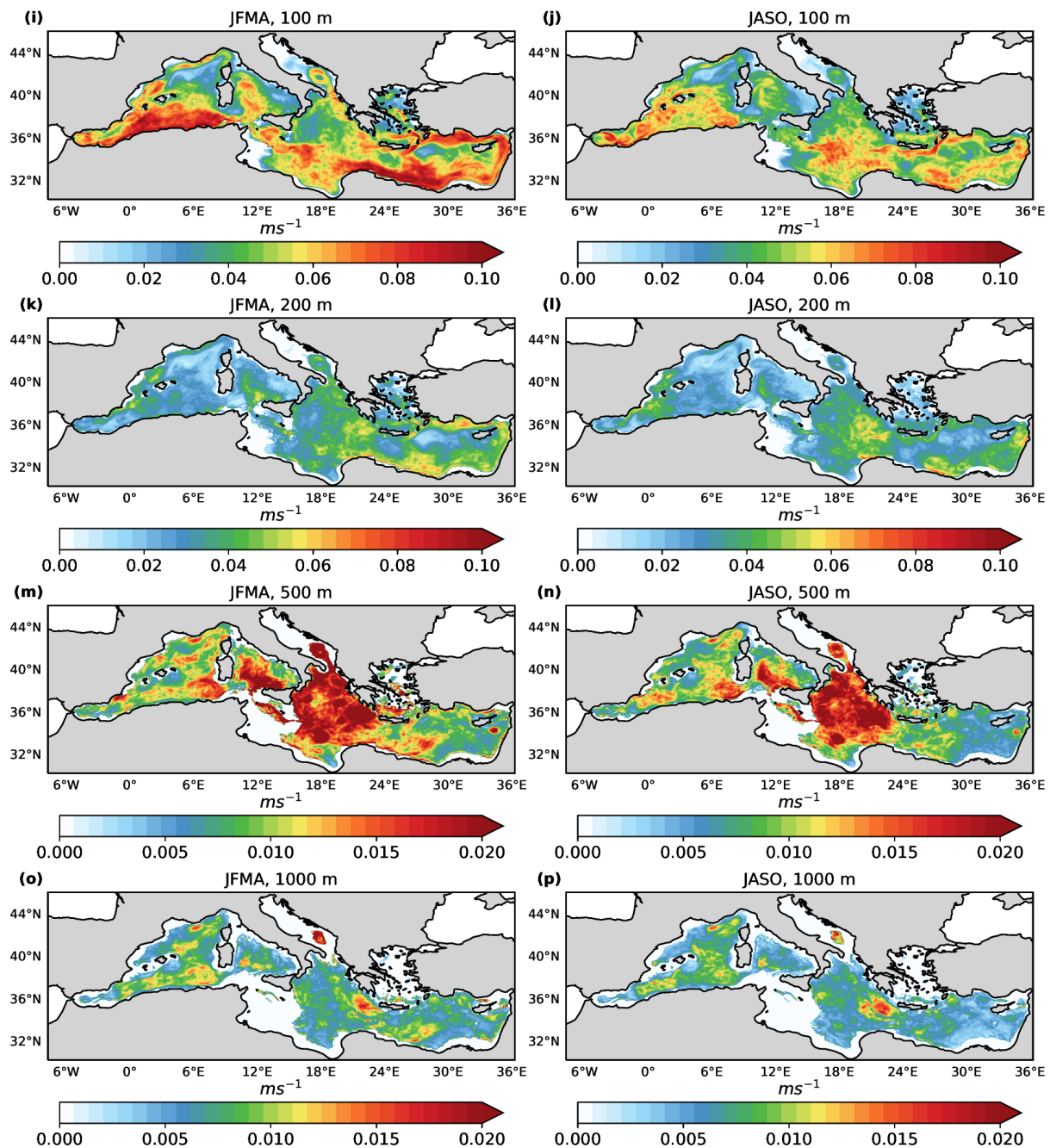
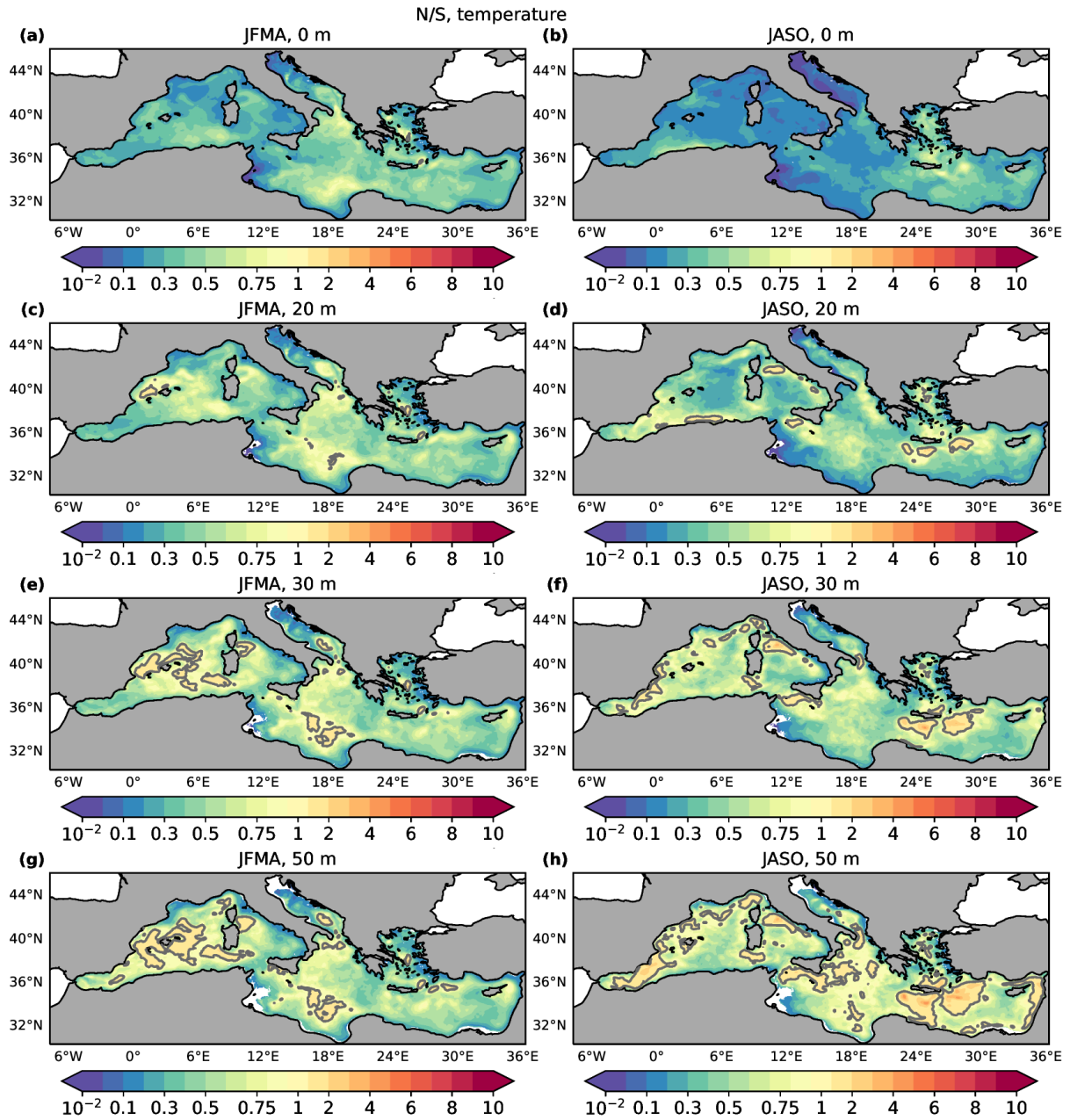


Figure S17. Seasonal average of the ensemble spread for current speed v at different depth levels for the year 2020: at the surface (a), at 20 m depth (c), at 30 m (e), at 50 m depth (g), at 100 m depth (i), at 200 m depth (k), at 500 m depth (m) and at 1000 m depth (o) for winter and similarly in (b), (d), (f), (h), (j), (l), (n) and (p) for summer. Please note the different units used at different depths.



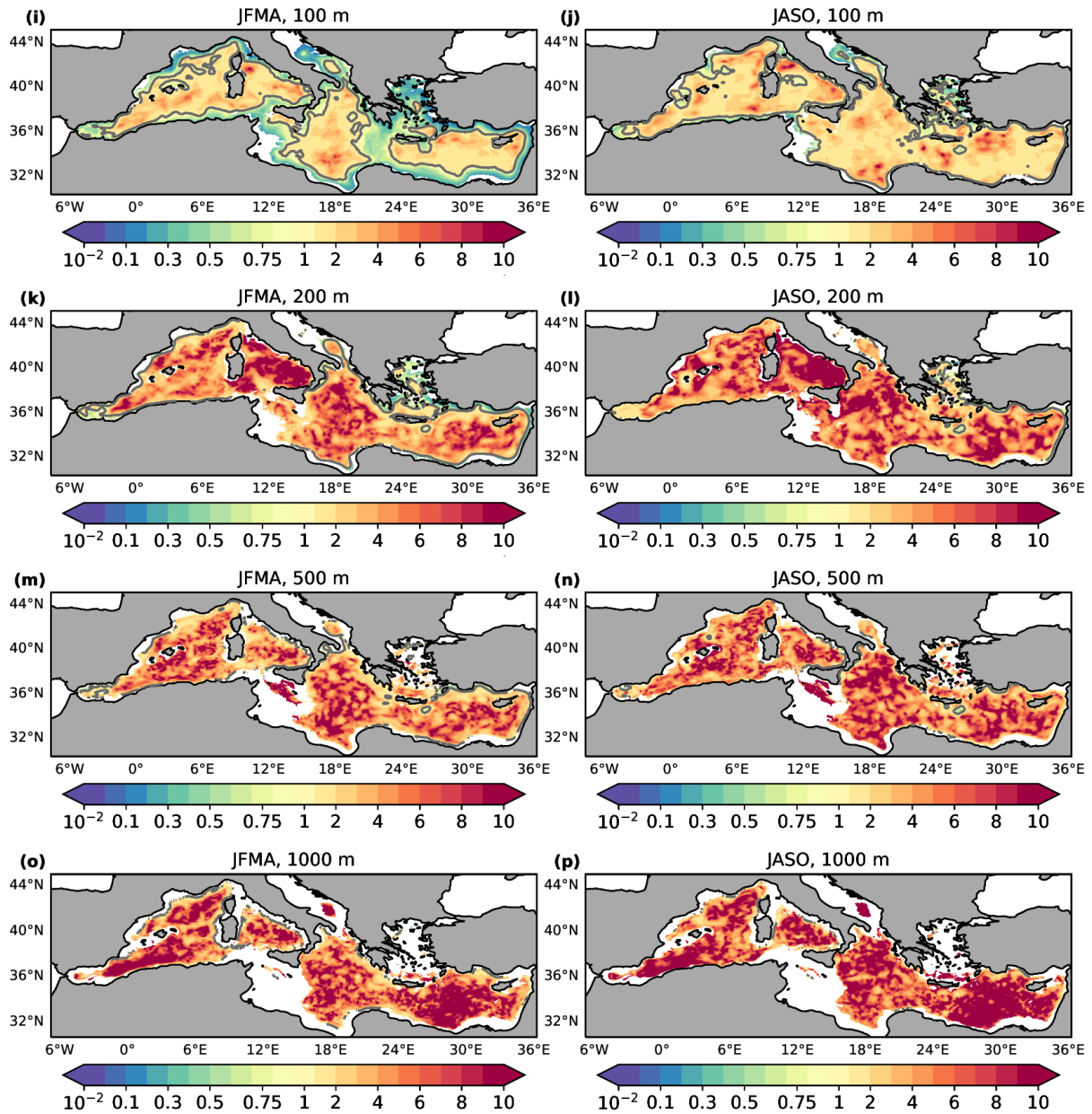
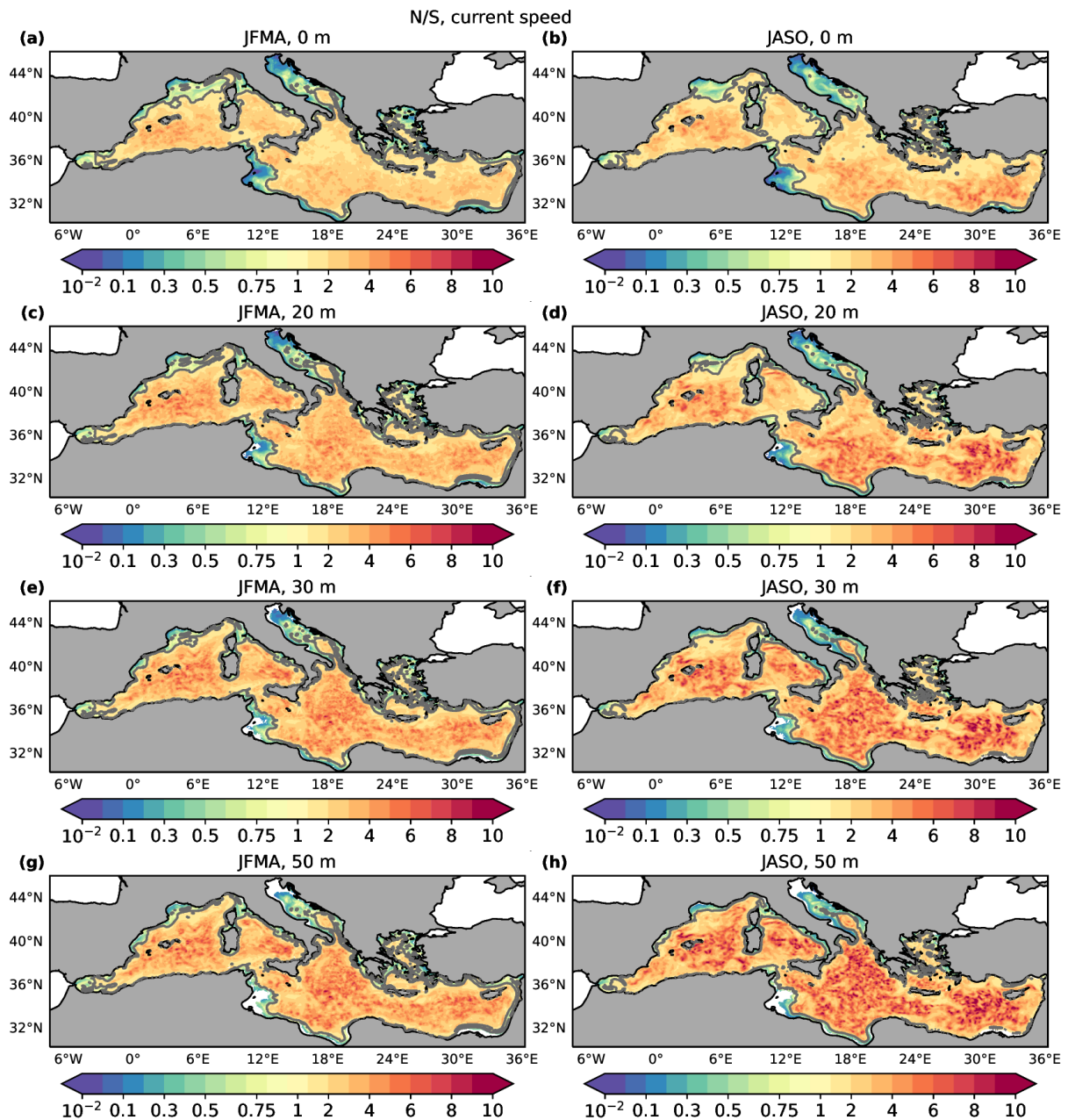


Figure S18. Seasonal average of the noise to signal ratio for potential temperature T at different depth levels for the year 2020: at the surface (a), at 20 m depth (c), at 30 m depth (e), at 50 m depth (g), at 100 m depth (i), at 200 m depth (k), at 500 m depth (m) and at 1000 m depth (o) for winter and similarly in (b), (d), (f), (h), (j), (l), (n) and (p) for summer.



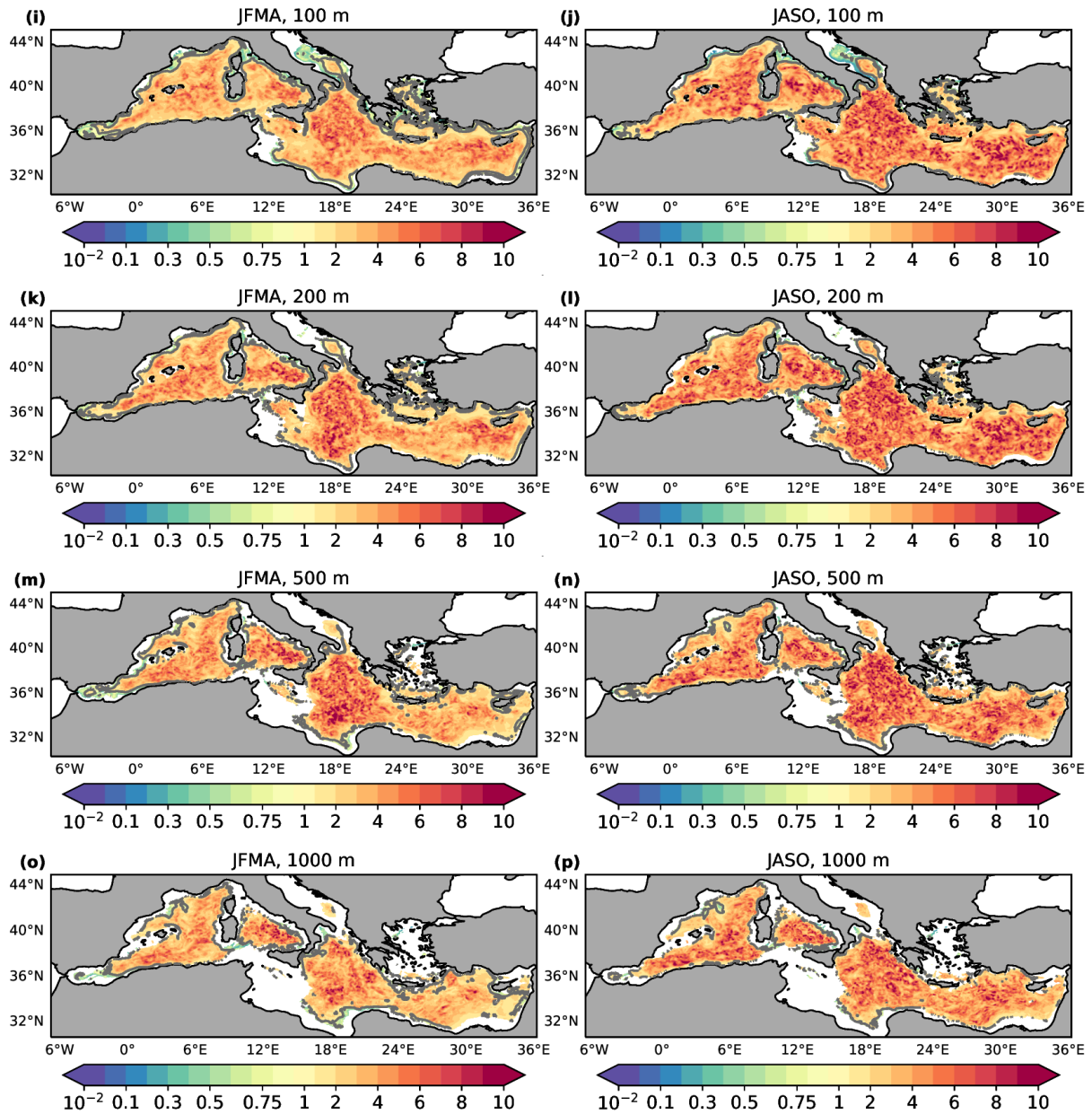


Figure S19. Seasonal average of the noise to signal ratio for current speed v at different depth levels for the year 2020: at the surface (a), at 20 m depth (c), at 30 m depth (e), at 50 m depth (g), at 100 m depth (i), at 200 m depth (k), at 500 m depth (m) and at 1000 m depth (o) for winter and similarly in (b), (d), (f), (h), (j), (l), (n) and (p) for summer.