OceanPredict
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Empirical consistency of regional and coastal ocean model uncertainties using stochastic methods and a global atmospheric ensemble

V. Vervatis, P. De Mey-Frémaux, J. Karagiorgos,
B. Lemieux-Dudon, N. Ayoub, S. Sofianos

8th meeting of the COSS-TT: International Coordination Meeting (2nd online meeting)

Task Team meeting | 12 Apr 2022 – 13 Apr 2022, MS Teams (virtual)

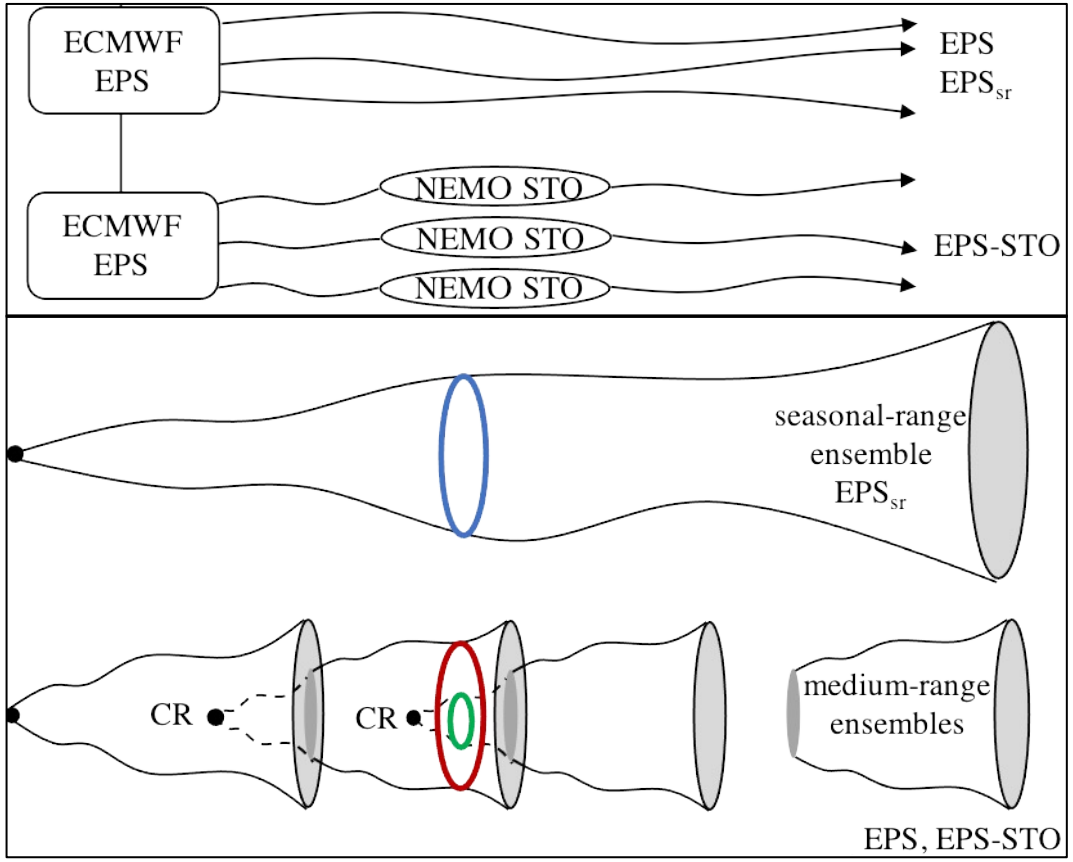
Study objectives

- Ocean physics and biogeochemistry uncertainty modelling (SPPT, SPP, SPUF)
- Use of atmospheric forcing from the ECMWF global ensemble system
- Ensemble-based consistency verification and tune-up
- Ensemble data assimilation

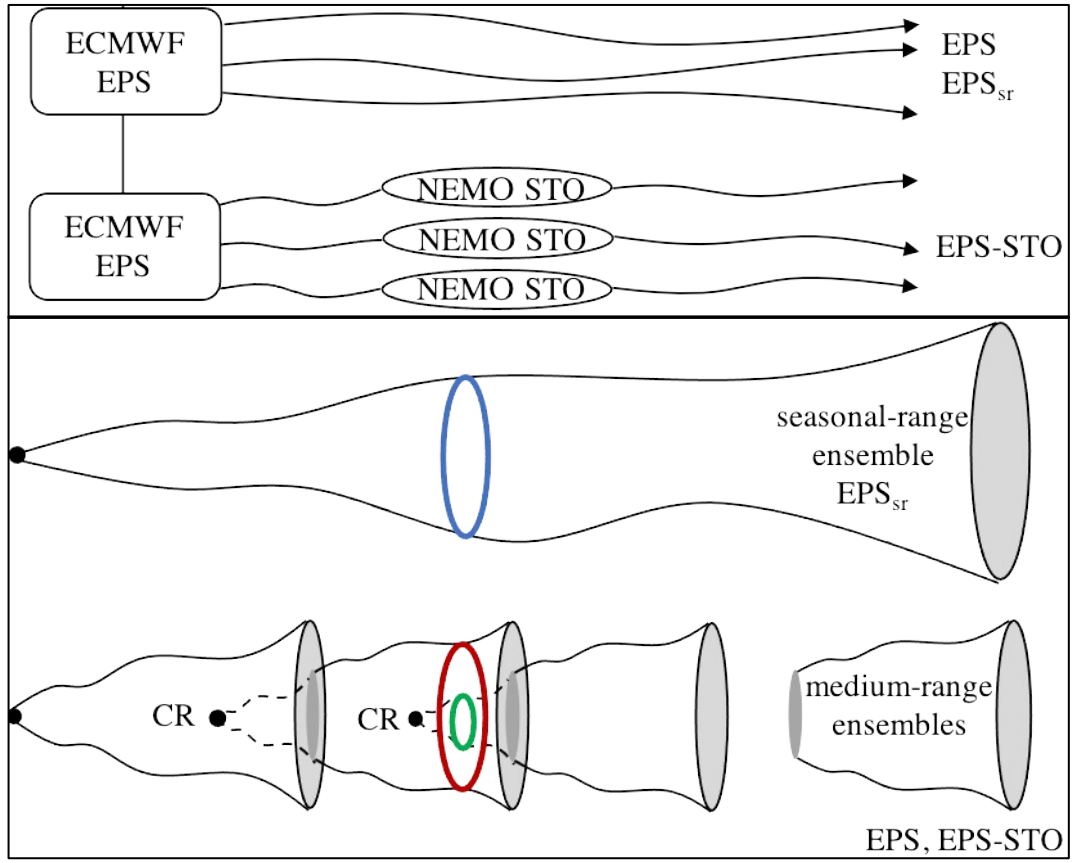
Study area and modelling tools

- Bay of Biscay (CMEMS IBI-MFC subdomain)
- NEMO-PISCES high-resolution 1/36 configuration
- Sequoia Data Assimilation Platform (SDAP) https://sourceforge.net/projects/sequoia-dap/
- Study builds on previous CMEMS Service Evolution projects SCRUM and SCRUM2 (Vervatis et al., 2021a; 2021b)

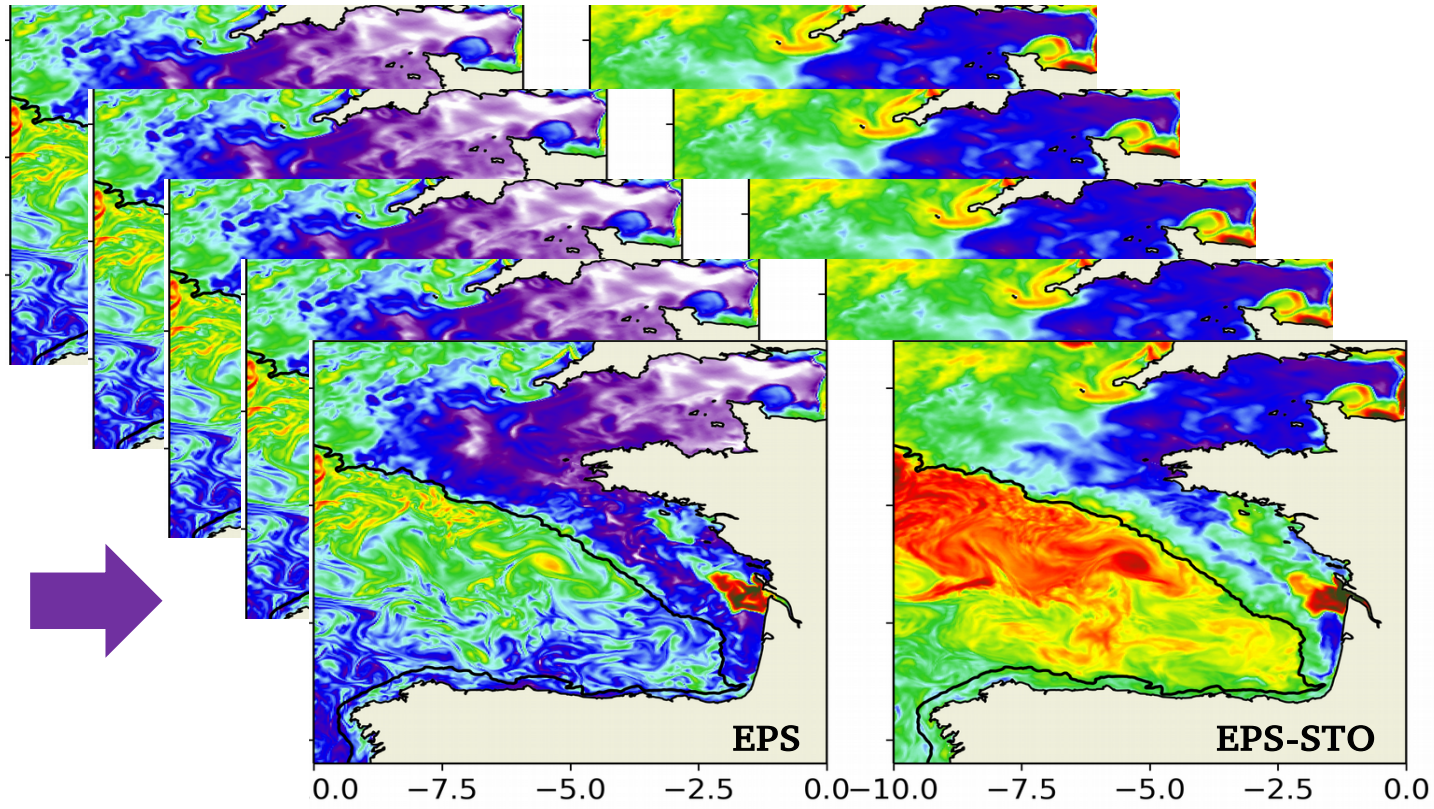
Experiments of model uncertainty



Experiments of model uncertainty

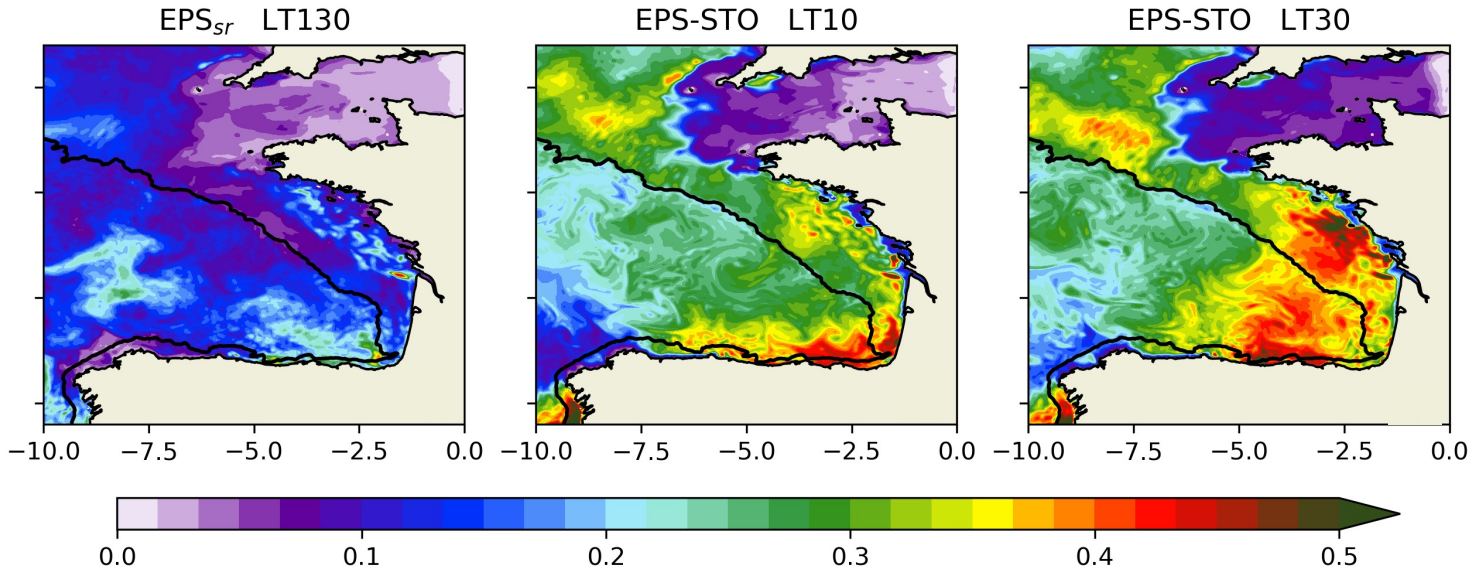


Production of Ensemble members

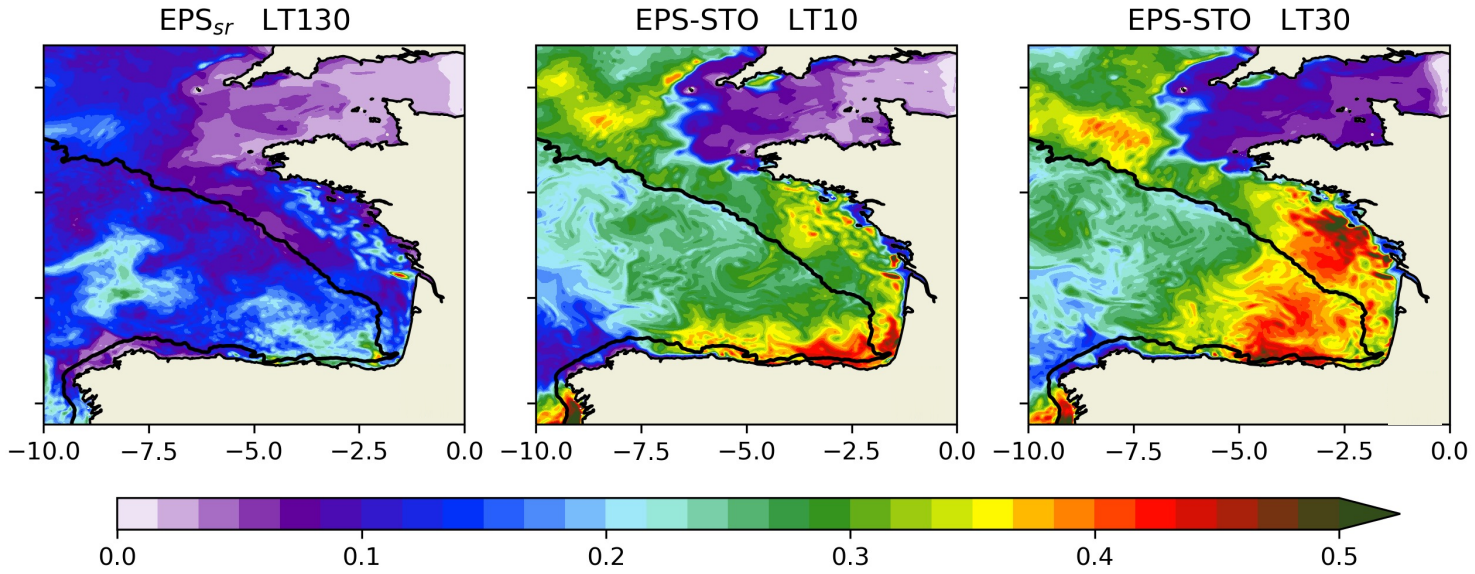


Production of 50 ensemble members (per experiment)

Model errors
(SST Ensemble spread)



Model errors
(SST Ensemble spread)



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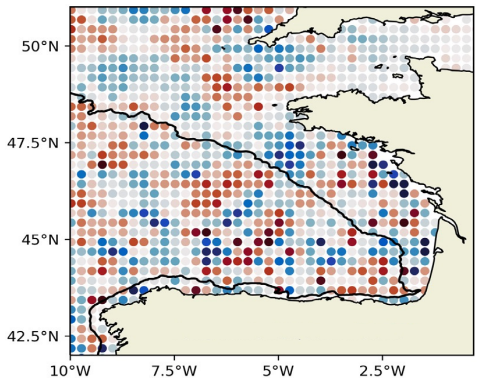
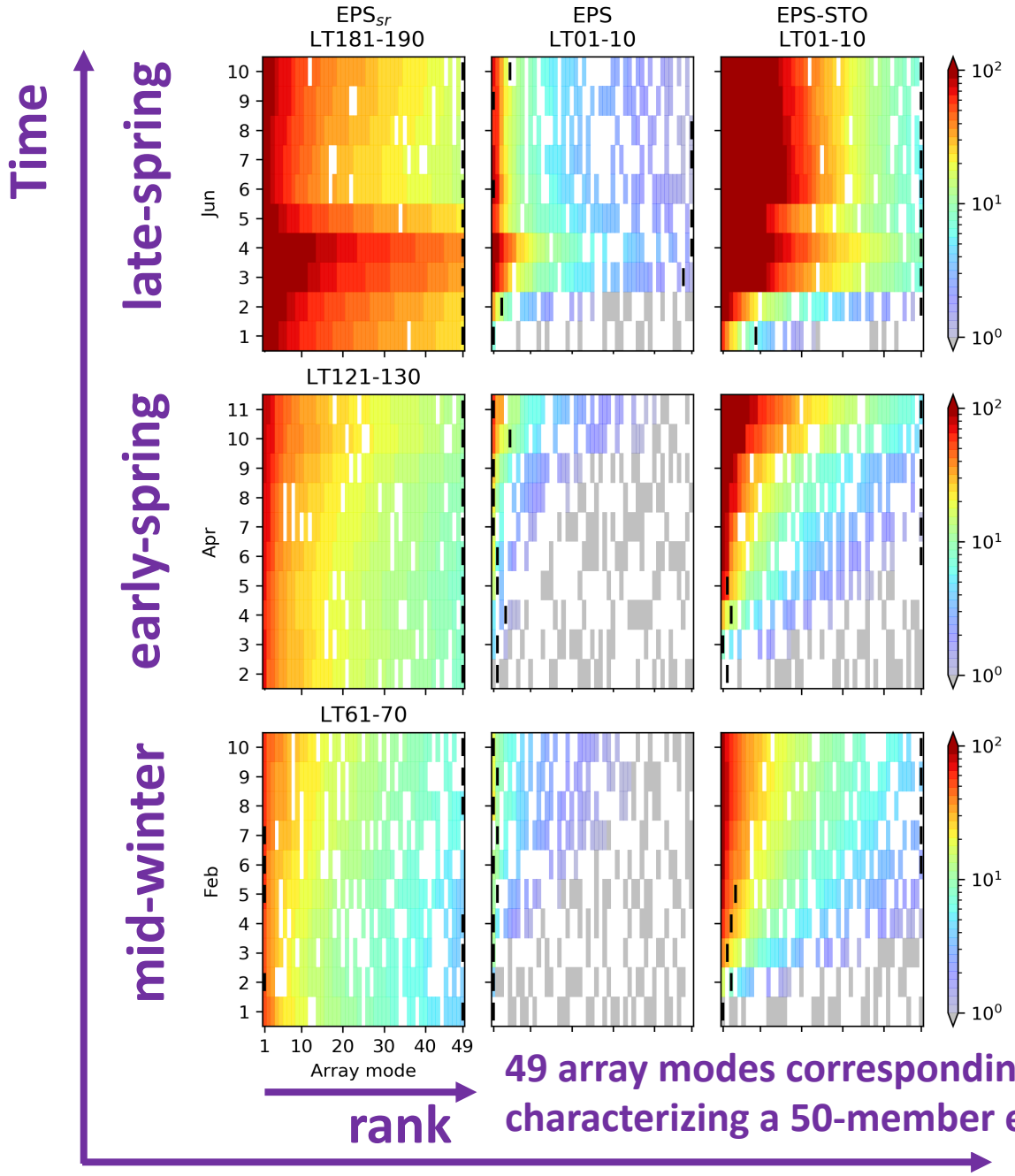
Observational errors
OSTIA-SST available via CMEMS



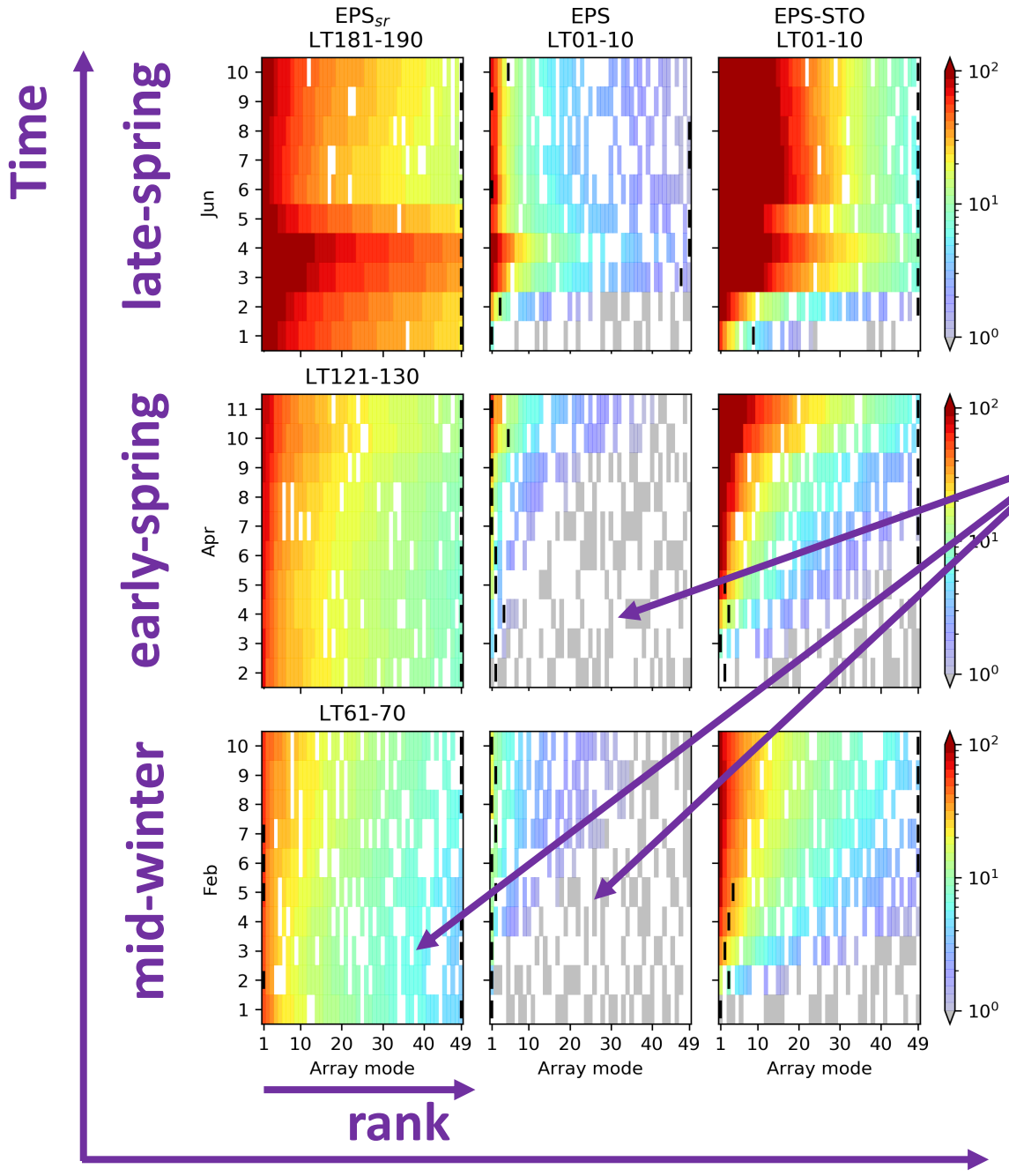
Empirical ensemble consistency Criteria on array modes

- ArM1 – Array performance is measured by the number of modes above obs. noise
- ArMCA1 – Diagonal ensemble consistency is measured by statistically consistency of innovation variance with the sum of prior model and obs. error variance estimates
- ArMCA2 – Extradiagonal ensemble consistency is measured by operator norm of observational ECM with diagonal elements removed

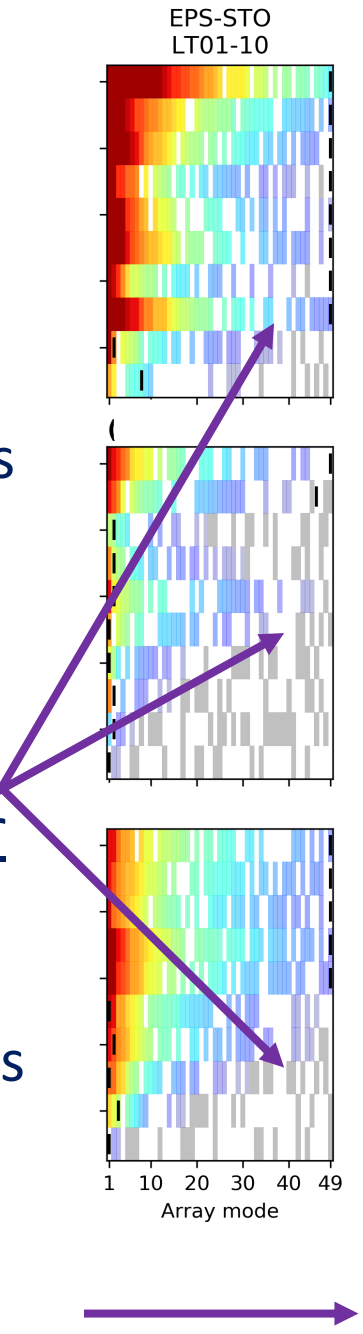


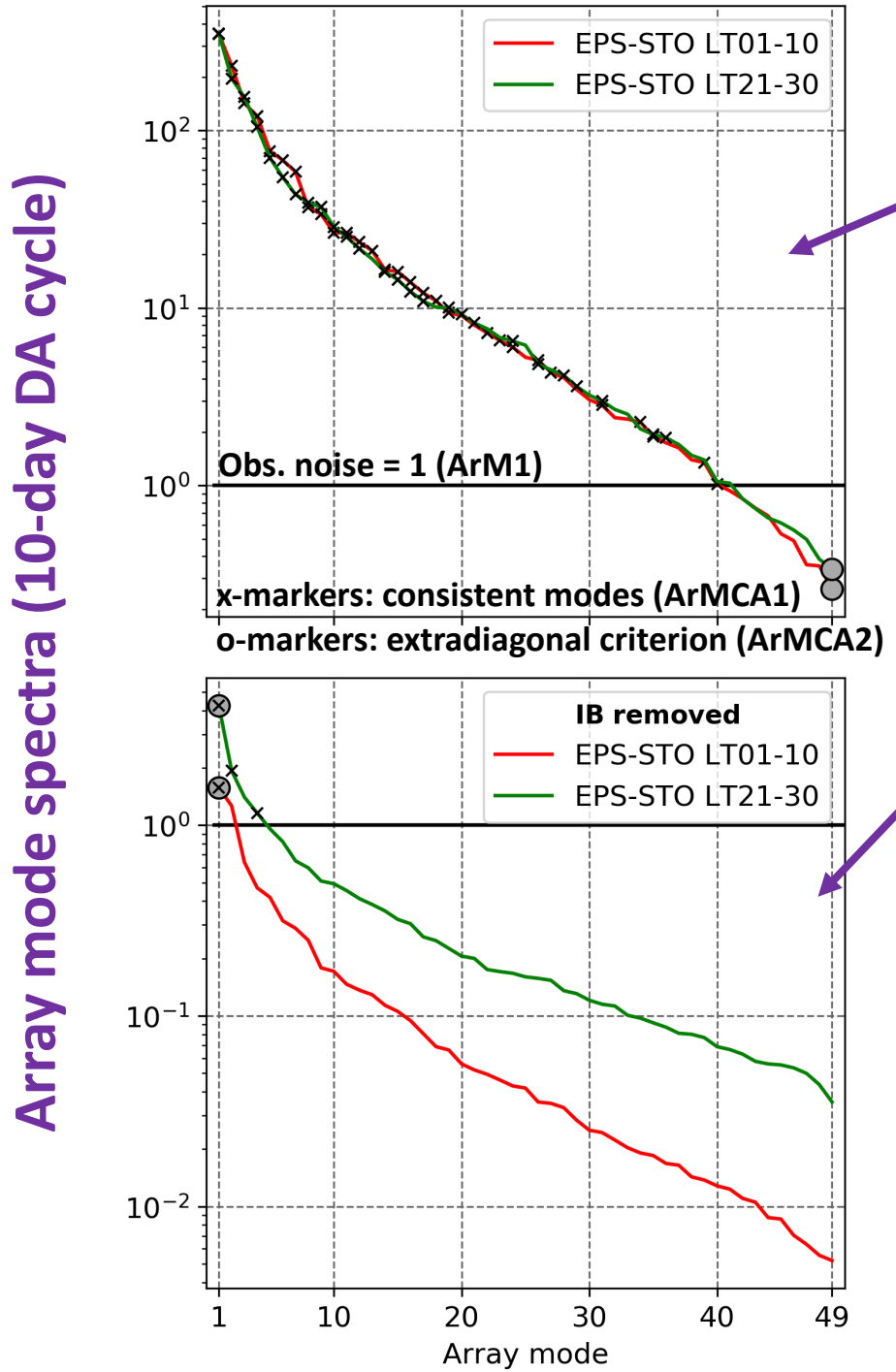
How to read the Hovmöller diagrams

- ArM1
  - Colorbar - spectra of array mode per rank and per day (as if 1-day DA cycle was performed)
  - Grey pixels - below obs. noise
- ArMCA1
  - White pixels - rank of inconsistent array modes
- ArMCA2
  - Dashed black line – number of submatrices of extradiagonal obs. ECM which are “close” to null matrix



- Marginal array performance at "detecting" model SST errors was observed during winter for the non-stochastic ensembles
- Empirical consistency was harder to be verified for chlorophyll *a* and the obs. ECM is most of the time full of nondiagonal elements





$$SLA_{uncorrected} = SLA + dac - lwe$$

dac = dynamic atmospheric correction
lwe = long wave error

Model and data detided

- Array performance appeared to be satisfactory when the dac was not applied to the SLA data (i.e. having the $SLA_{uncorrected}$)
  - Possibly explained also by the SLP stochastic perturbations
  - Diagonal obs. ECM
- When dac is subtracted from the SLA data, array modes are below obs. noise

References

De Mey-Frémaux, P., 2020: Array-space analysis tools in SCRUM and SCRUM2 (Version 2). Zenodo. http://doi.org/10.5281/zenodo.3688509

Vervatis, V.D., De Mey-Frémaux, P., Ayoub, N., Karagiorgos, J., Ciavatta, S., Brewin, R., Sofianos, S., (2021a). Assessment of a regional physical-biogeochemical stochastic ocean model. Part 2: empirical consistency. Ocean Modell., 160 (4), 101770, http://dx.doi.org/10.1016/j.ocemod.2021.101770

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