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Assessing efficiency of observation networks feeding into EMODnet

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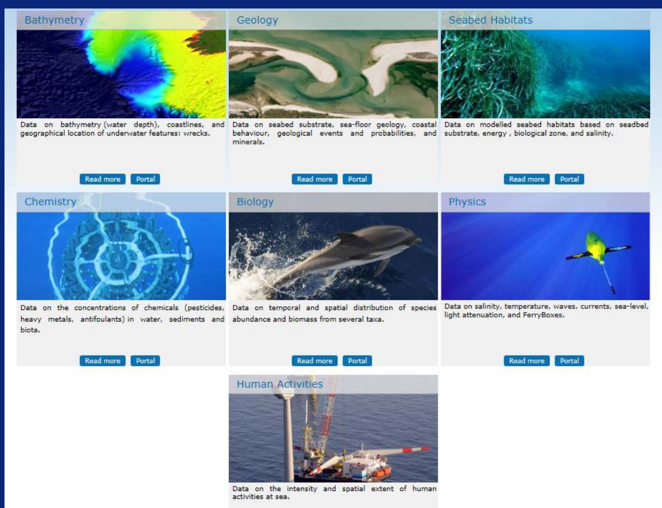
EMODNET components



Fit-for-purpose assessment

- An ad hoc assessment (EOVs):
  - Demonstrate usefulness of data in SBAs
  - Identify gaps/inadequancy of observations
- Quantitative assessment on
  - Availability
  - Quality
  - Accessibility

based on a combined satellite-in situ-model approach.

Assessment based on monitoring categories

- Monitoring for research and development
  - For understanding physical-biogeochemical-ecosystem processes: OS(S)Es
  - For testing new monitoring technology: cost-effective analysis
- Monitoring for operational purpose
  - For telling current status: concerning quality of reconstructured fields, in terms of effective coverage, explained variance or analysis error.
  - For telling future ocean status: concerning about quality of forecasts, in terms of forecast error or sensitivity of forecasts to sampling schemes.
- Monitoring for long-term purpose
  - For telling the trend: concerning the length, consistency and accuracy of the data and products
  - For telling long-term variability: concerning representativeness and consistency of the data, in terms of explained variance, signal-noise ratio or analysis error in reconstructing long-term time series.

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Previous EU projects on assessment of observational networks (ad hoc)

- FP5 PAPA: WP3 – Observing systems (Baltic)
- FP5 MAMA: WPX – Observing systems (Med. Sea)
- FP7: GISC – EEA report on in-situ observations
- Focus on
  - Accessibility and availability
  - Ad hoc analysis of synergy between different platforms
  - Potential of new technology

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Previous EU projects on assessment of observational networks (quantitative)

- FP5: ODON - Optimal Design of Observational Networks (2003-2005)
  - Focus on Baltic-North Sea temperature and salinity
  - Assessment based on **Effective Coverage** and **Explained Variance**
  - Assessment based on **Observing System Experiment** and **OSSEs**
  - **Optimal design method** for moored buoy sampling schemes
- FP6: ECOOP – European Coastal Shelf Sea Operational Forecasting System, WP1, 2009-2011
  - Assessment of **physical** observational network in **European Seas**
  - Assessment of **biogeochemical** observational networks in **S. North Sea and GoF**.
- FP7: JERICO – Joint European Research Infrastructure for Coastal Observatories, 2011-2014, WP9
  - Observing System Simulation Experiment on **new technologies**
- FP7: OPEC – Operational Ecology, 2012-2014, WP5
  - Assessment of **BGC** observational networks in **European Seas** (chl-a, nutrients)

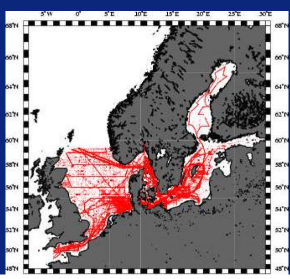
Methods developed for assessment

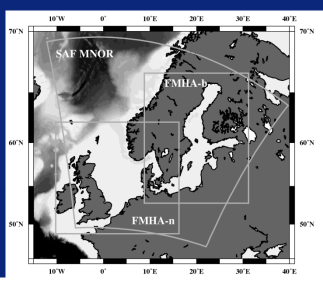
- Statistical method for assessment of a given sampling scheme
  - Assessment indicators:
    - Sampling error (She and Nakamoto, 1996)
    - Signal-noise ratio (N. Smith, 1995)
    - Effective coverage & explained variance (She et al, 2007, Fu et al, 2011)
  - Database:Metadata (sattlite, in-situ), model ocean as proxy ocean
- Semi-dynamic method
  - Use Kalman gain to assess the impact of a given sampling scheme (Wang et al, 2009)
- Dynamic method:
  - Observing System Experiment (OSE, She et al, 2007)
  - Observing System Simulation Experiment (OSSE, Halliwell et al. 2014)
  - Process oriented assessment
- Method for optimal design:
  - Statistical annealing: global optimal design method, developed in ODON

In quantitative assessment of in-situ networks, satellite and model information are included; spatial, temporal and multi-variate correlation are also included to derive assessment indicators

Some examples

Assessment of Baltic-North Sea satellite-in situ SST monitoring networks (She et. al 2007)





	Control run	S3	SI	S3c
Bias (°C)	0.78	0.09	0.08	0.07
RMSE (°C)	1.20	0.66	0.66	0.64

Table 8 Model error statistics for the four full year model runs with different observational networks.

	Control run	S14	S14+16	S12	S12+14	S3
Bias (°C)	0.90	0.50	0.39	0.16	0.15	0.13
RMSE (°C)	1.31	1.01	0.94	0.77	0.76	0.75

Table 9 Model error statistics for the six model runs during 25 June – 5 November, 2001, for different observational networks.

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Recommendations from ODON SST network assessment study

- Relative importance of in-situ SST:
  - OSEs showed the improvement is negligible by including in-situ SST together with satellite SST
  - in the assimilation. It was found that the major contribution of in-situ SST is to be used in correcting satellite SST, which can improve the satellite SST quality by 15-30%.
- Gaps and redundancy:
  - There is a big redundancy between different infrared satellite sensors: results vary little between OSEs by assimilating NOAA AVHHR 12 only and that by assimilating 3 satellites 12, 14 and 16.
- Recommendations for further optimisation:
  - high quality in -situ SST data (e.g.,measured by buoys) should be made in the Baltic Sea. 3-5 buoys are sufficient to cover the entire Baltic Sea for this purpose. This will improve the quality of the SST field product by 15-30%. Current observing networks are not sufficient in monitoring local small scale phenomena, such as upwelling. Cost-effective in-situ measurement in coastal stations (e.g., combined with tidal gauge stations) should be made available.

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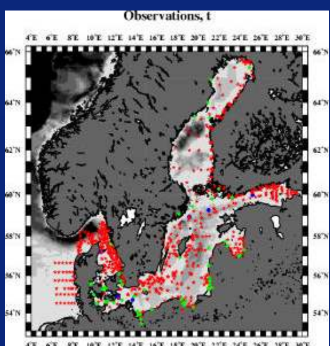
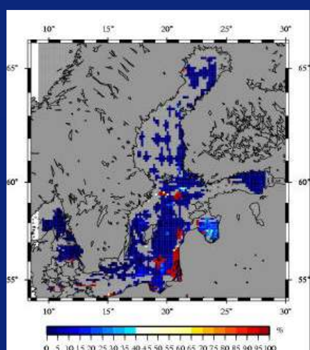
Assessment of Baltic-North Sea 3D T/S monitoring networks (ODON, Sci. Rep.)





Effective coverage ratio (in percent, right) of Baltic Sea temperature monitoring networks at 24m depth (left)

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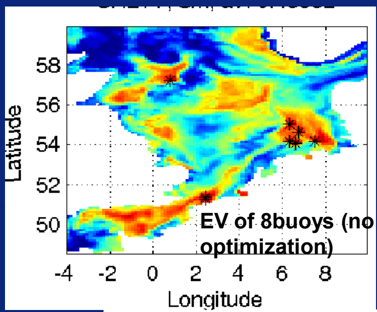
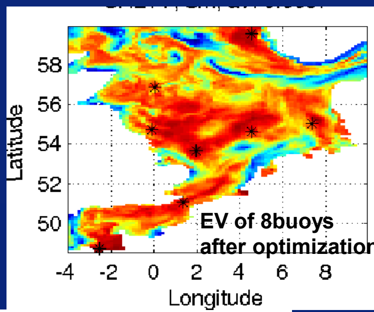
Optimal design of North Sea mooring arrays (ODON Sci. Rep)





Network	Number of effectively covered grids	Explained variance
Reference network	11624	0.33
Optimal network	25305	0.56
Reference kept + one more buoy	23701	0.39
5 buoys unchanged, 3 buoy locations optimised	24531	0.46

Table 3.8.1 Efficiency (number of effectively covered grid points and explained variance) of different type of observational networks

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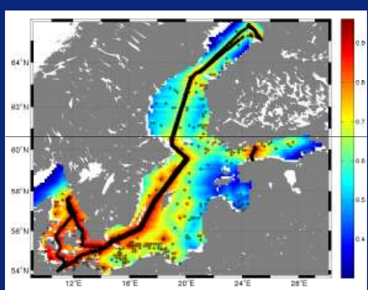
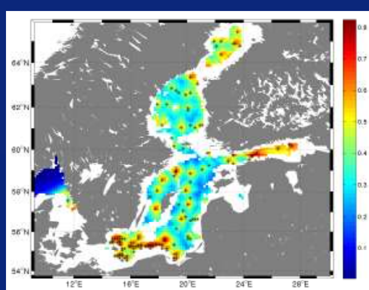
Assessment of Baltic Chl-a monitoring network (OPEC D5.2)





Effective coverage ratio of Baltic Sea chl-a monitoring network at surface (left) and 47m depth (right)

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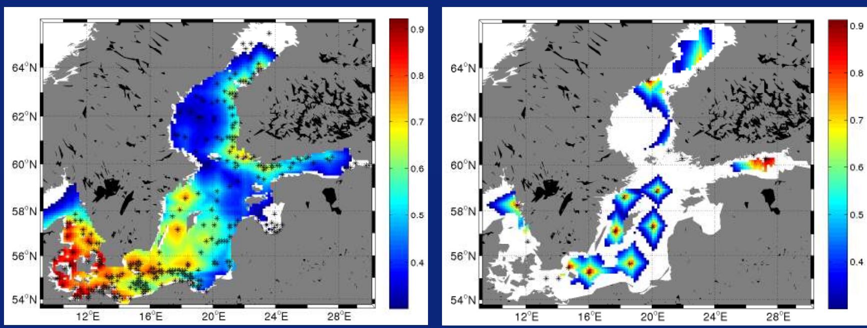
Assessment of Baltic DIP monitoring network



Effective coverage ratio of Baltic Sea DIP monitoring network at surface (left) and 47m depth (right)

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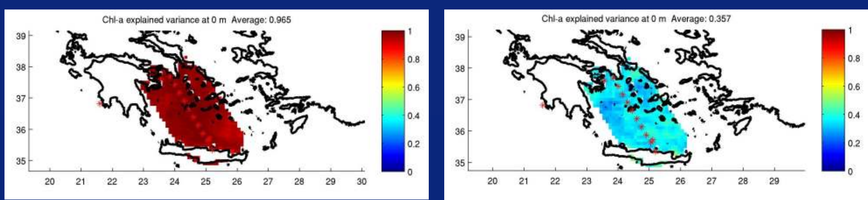
Assessment of Agean ferrybox Chl-a monitoring (OPEC D5.2)



Explained variance for ferrybox Chl-a measurements in Aegean with daily (left) and weekly (right) sampling frequency

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Summary and suggestions

- Statistical and dynamical methods have been developed and successfully applied for quantitative assessment and design of physical and chemical observational networks in European Seas
- Since scale of the existing projects was small and focusing mainly on methodology, there is lack of integration of statistical and dynamic methods with monitoring community and stakeholders. Hence results from quantitative assessments have not been applied in practical decision making. It is now time to strengthen this integration in order to bring some useful tools and products for guiding the rationalization of European maritime observational networks.
- Combine two types of assessment: fit-for-purpose and quantitative

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Thank You !