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European Marine Observation and Data Network
Your gateway to marine data in Europe

Stress test on Baltic Sea observations

A methodological analysis

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The European Marine Observation and Data Network (EMODnet) is financed by the European Union under Regulation (EU) No 508/2014 of the European Parliament and of the Council of 15 May 2014 on the European Maritime and Fisheries Fund.

Objectives of BSCP

- EMODnet: collect once, use it many times
- BSCP:
  - What has been collected in the Baltic Sea?
  - What data are needed in the Baltic Sea?
  - What has been used in the Baltic Sea?
  - Availability of data to fit-for-the-purposes (11challenges)
  - Adequacy of data to fit-for-the-purposes

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Definition of challenge areas

- 11 chanllenges defined
  - Wind farm siting,
  - Marine protected areas,
  - oil platform leak,
  - climate change,
  - coastal protection,
  - fishery management,
  - fishery impact,
  - eutrophication,
  - river discharge,
  - Bathymetry,
  - Alien species.
- More challenges recommended
  - MSP
  - Operational oceanography
  - Ocean acidification
  - Hypoxia
  - Marine pollutant
  - Underwater noise
  - Atmospheric deposition
- More in-depth definition of some of the existing challenges, e.g. fishery, will reveal more data needs

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What has been collected? A review of Baltic Sea observations

- Different EMODnet Lots have included following data sources in Baltic Sea:
  - CMEMS
  - BOOS
  - SeaDataNET(partly)
  - HELCOM (partly)
  - ICES (partly)
  - AQUANIS
  - EUSEAMAP
  - AIS
  - BSHC etc.
- More efforts needed
  - Research projects (eg BONUS)
  - Coastal fishery
  - Rivers
  - National data
  - Commercial data

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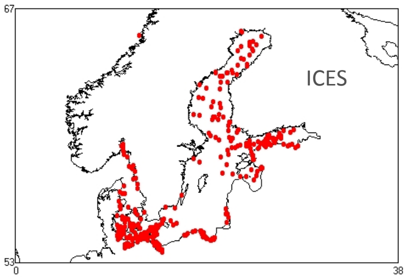
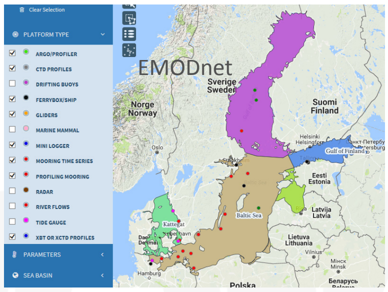
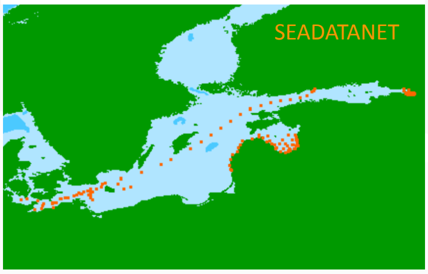
Data collection in May 2015: ICES, SeaDatanet & EMODnet at 20170828







Taking T/S profiles in May 2015 as an example, there are still some issues:

1) R/V CTD data are not collected in NRT, so not able to use in OO
2) Data are stored in different places
3) Some R/V data are not shared, eg in Germany, Poland

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What data have been used?
How the data have been used?

- A description of data usage for given challenge areas: key variables, data types, data usage

Table 3.1. Data usage in "Wind farm siting"

Variable	Data type	Usage
Wind profiles (speed, direction)	In-situ	Obs. at site: wind resource estimation, normal/extreme condition assessment, safety and cost assessments i.e. expectable wind load on the wings, wind shear, availability analysis of suitable maintenance and construction windows. General: Model validation and data assimilation.
	Model	Use as defined in "Obs. at site"; boundary forcing for ocean models.

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Identify user needs on data

Variable	Data type	Accessibility		Completeness/ coverage		Resolution			Precision
		Delivery type	Delivery time	Spatial	Temporal	Hor.	Ver.	Temp.	
Wind profiles	In-situ	open, free	months -years	Baltic Sea	>10-20yr	N/A*	5 heights up to 130m hub-height and surface.	Hourly-Monthly	0.1m/s
	Model	open, free	months -years	Baltic Sea	>10-20yr	Max. 5km			0.5-1 m/s
Meteo.-data: T_{air}, P_{air}, RH, Cloudiness	In-situ	open, free	months -years	Baltic Sea	>10-20yr	N/A			T_{air}: 0.1°C P_{air}: 0.15hPa RH: 3%
	Model	open, free	months -years	Baltic Sea	>10-20yr	Max. 5km			T_{air}: <0.5-1 °C P_{air} :<0.5hPa RH: 3-4%
Currents (speed, direction), Sea level, Salinity, Temperature	In-situ	open, free	months -years	Baltic Sea	>10-20yr	N/A	<3m at surface and seabed		Current speed: 0.01m/s sea level: 1cm
	Model	open, free	months -years	Baltic Sea	>10-20yr	Max.2km for Baltic 1km for Danish Straits			Current speed: 0.05m/s, Sea level: 5-10cm Salinity: 0.5-1 Temperature: 1°C

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Assess data availability

Variable	Data type	Accessibility	Completeness/ coverage		Resolution			Precision
		Delivery type/time	Spatial	Temporal	Hor.	Ver.	Temp.	
Wind profiles	In-situ (private/ institutional data)	Restricted, on request, in months-years	Baltic Sea	1960-now	Sparse points	A few heights up to 250m	Hourly	0.1m/s
	Model (DMI)	On request or open, free, in months-years		2003-now	3-5km	User specified		1 -1.5m/s
Winds at 10m	In-situ (ECAD, GTS)			1900-	Sparse points	N/A		0.1m/s
	Satellite			1993-	7-25km			1m/s
	RAN/ HC*			1980-now	3-5km			1-2m/s
T_{air}, P_{air}, RH, Cloudiness	In-situ		Baltic Sea	1960-now	Sparse points	User specified		T_{air}: 0.1°C P_{air}: 0.15hPa RH: 3%
	RAN/HC		Baltic Sea	1980-now	3.5km			T_{air}: <1-2 °C P_{air} :<0.5hPa RH: <30%

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Data adequacy assessment

Variable	Data type	Accessibility	Completeness/ coverage	Resolution	Precision
		Delivery type/time	Spatial/ Temporal	Hor./Ver./Te mp.	
Wind profiles	In-situ	Existing data should be more open to research	More new data are needed. Time series over sea are sparse and too short on hub height (100m-130m)	Lack of offshore wind profile measurements	FFU* Observed and modelled winds are roughly of the same quality. .
	Model	Post processing should make wind profile data available	Current data are adequate for extreme estimation up to 50yr return period. Longer time series are needed for 100yr return periods.	Reanalysis needs higher spatial resolution	
Air Temperature, Air Pressure, humidity, Cloudiness	In-situ (ECAD, GTS)	FFU	More data are needed. Time series are sparse over sea .	FFU	FFU
	Model data	FFU	FFU	FFU	FFU

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What is data adequacy? How can it be assessed?

- **Definition:**
  - Quanlitative: Data availability against user needs -> adequacy
  - Quantitative: effective coverage, explained variance, quality for reconstructing fields etc.
- **Way of assessment:**
  - Fit-for-purpose assessment: for specific challenges, to assess if the data are adequant to F4P (delivery time window, accessibility, resolution, coverage and precison).
  - Quantitative assessment (combine model and satellite data): OSE, OSSE.
- **Complexity in F4P assessment:**
  - From data to user applications, it's often not a direct use rather than via a value chain (e.g., intermidiate users). For same application, skillful users need less data (e.g. in sea level challenge, in optimal design of sampling)
  - User needs definition may not be precise (eg for eutrophication assessment) as user cases can be limited.
  - User needs may evolve with time (eg wind profiles)

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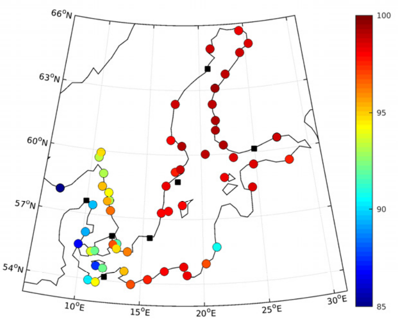
The way of using data in BSCP – an example of sea level task

- Problem: only 15 sea level stations have data longer than 100 years, but users need 100y sea level data everywhere in the Baltic Sea
- Solution: 20 year model reanalysis is used to establish a statistical model to reconstruct the 100yr sea level time series on the model grid
- Coloured circles (validations): correlation with independent gauges [%]
- Black squares: model stations



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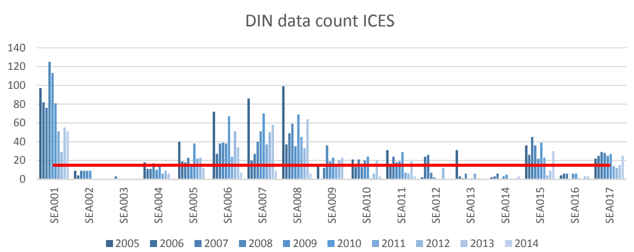
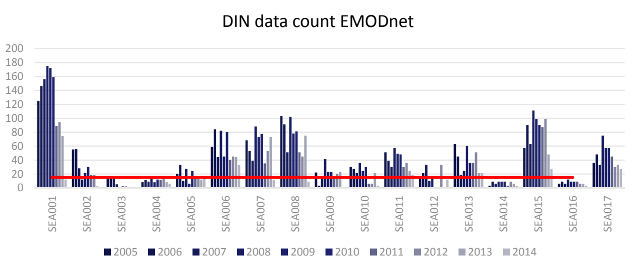
Data adequacy for Baltic Sea eutrophication assessment





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Sustainability of basin checkpoint

- Good user cases are needed
  - Blue growth sectors
  - MSFD
  - Operational oceanography
  - MSP
- New challenge areas
- Clear evidence of data use – regular service report
- Coherent data policies to ensure EMODnet data collection and dissemination

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Assessment of in-situ monitoring network – OSE/OSSE

OSEs/OSSEs	Monitoring network	Major outcomes
She et al. (2007)	SST from NOAA satellites and in-situ	RMSE is reduced by 43%; satellites have much larger impacts than in-situ data
Fu et al. (2012)	ICES T/S (20 years)	Below 60m, RMSE of T is reduced by 35%, mean bis of S by 80%, RMSE by 52%
Zhuang et al. (2011)	ICES T/S	Impact time of T/S assimilation is about 3 weeks
Fu (2016)	ICES T/S (10 years)	Mean bias of SST, T, S, and mixed layer depth is decreased by 57%, 49%, 43% and 43%; for Chl-a, DIN and DIP 15.5%, 9%, and 23%.
Liu et al. (2016)	Baltic T/S/N/P, oxygen, ammonium (30 years) from SHARK database	RMSD is reduced by 59% , 46%, 78% and 45% for oxygen, nitrate, phosphate and ammonium.
Wan (2014)	2 T/S sections (Route 1 and Route) of two gliders, (OSSE)	Mean deviations is reduced by 6.6%, 2.3%, 13% for T and 3.8%, 27%, 30% for S for Route 1, Route 2 and Route 1+2
Madsen et al. (2015)	Tidal gauges and altimetry	RMS error is reduced by 35%

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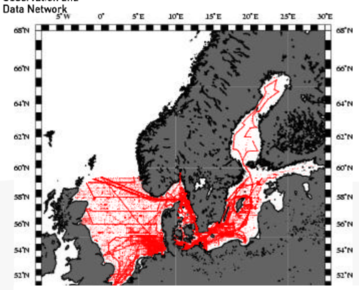
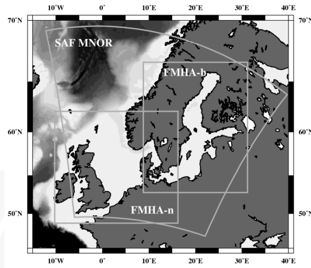
Assessment of Baltic-North Sea satellite-in situ SST monitoring networks (She et. al 2007)





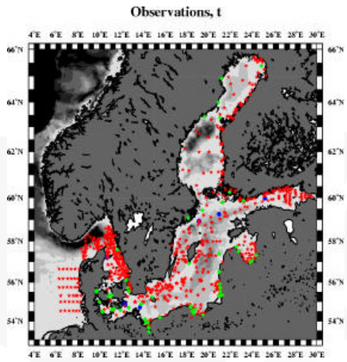
	Control run	S3	SI	S3c
Bias (°C)	0.78	0.09	0.08	0.07
RMSE (°C)	1.20	0.66	0.66	0.64

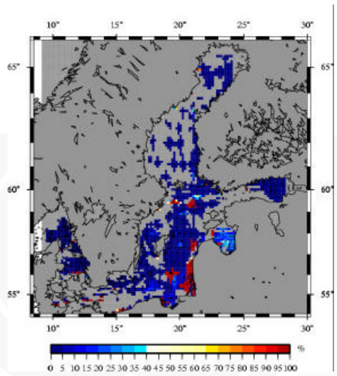
Table 8 Model error statistics for the four full year model runs with different observational networks.

	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.

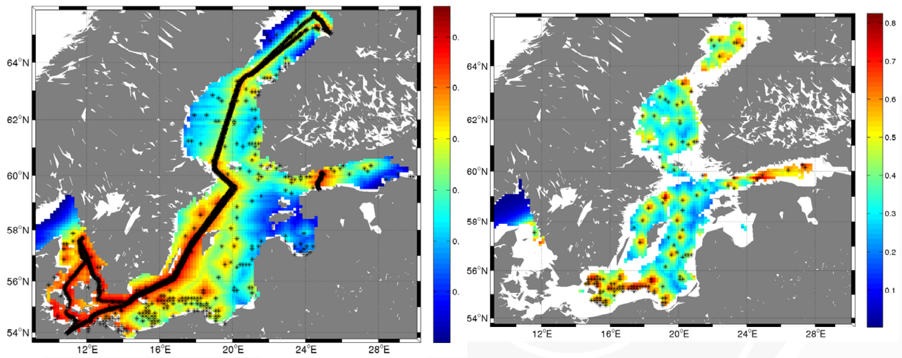
Assessment of Baltic-North Sea 3D T/S monitoring networks (ODON, Sci. Rep.)





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

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)

Assessment of in-situ monitoring network – OSE/OSSE

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She et al. (2007)	SST from NOAA satellites and in-situ	RMSE is reduced by 43%; satellites have much larger impacts than in-situ data
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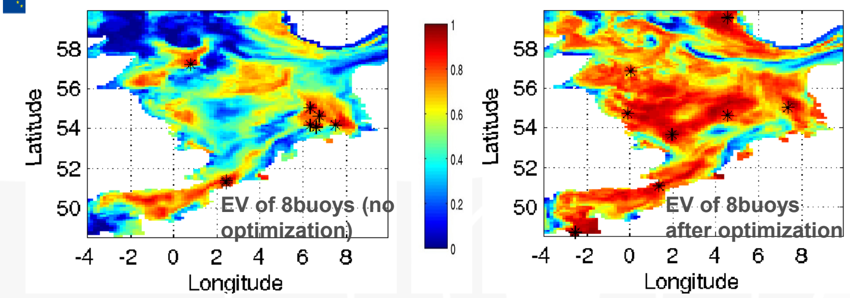
Optimal design of North Sea mooring arrays (ODON Scitific Report)



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