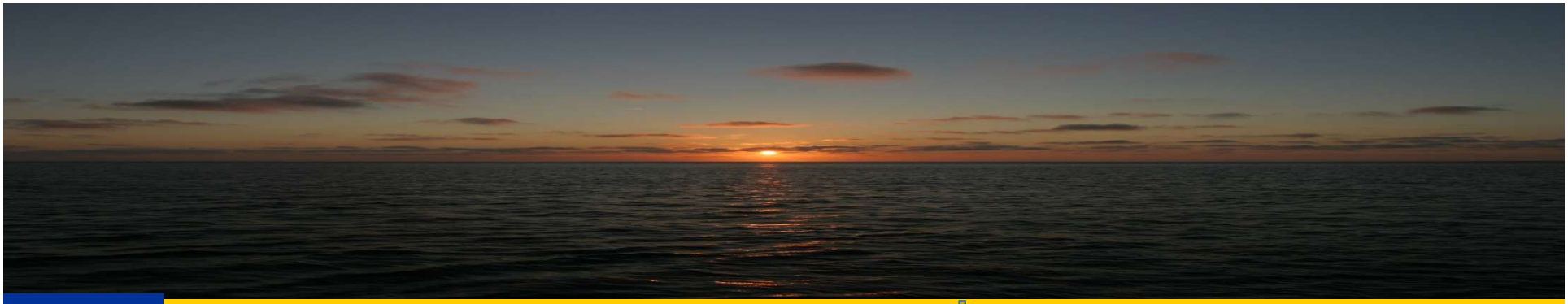
Storyline O1 :

Improving Coastal Lagoon Benefits Under Multiple Pressures

Focal PA : Wadden Sea



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Storyline O1

Focal Protected Area : Wadden Sea

- International Protected Area requiring tri-lateral agreements on management practices
- Wide range of national and international monitoring programs
- Highly heterogeneous system with a mosaic of habitats
- World Heritage Site, Natura 2000, Collection of National Parks
- Project focus is the Dutch Portion of the Wadden Sea including the German portion of the Ems Dollard

Geomorphological region	Area (km^2)
Salt marshes	400
Intertidal sand and mud flats	4,700
Subtidal flats and gullies	3,700
Islands and dry sandy shoals	1,000
Offshore area (to about – 15m depth-line seaward of the islands)	5,100
Total Wadden Sea Area	**14,900**

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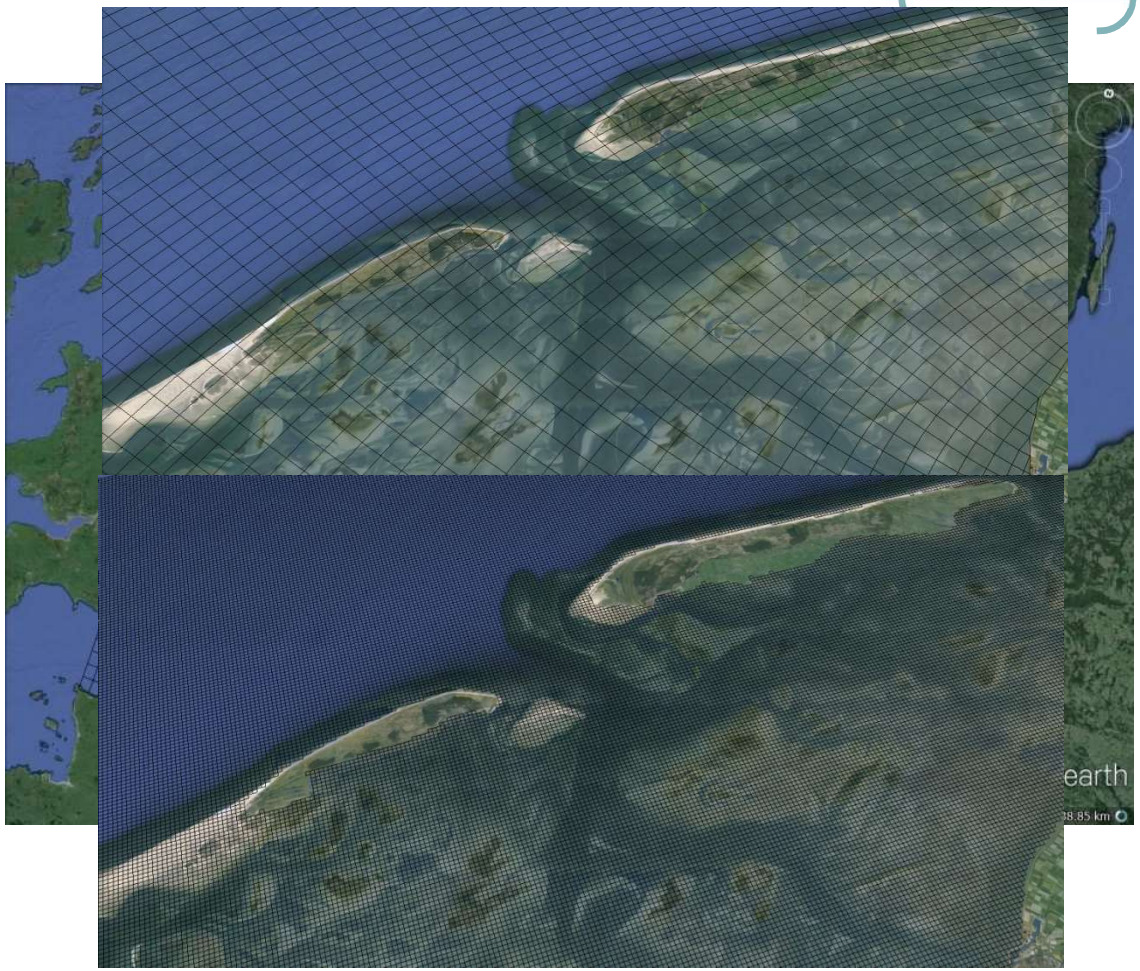
Storyline O1

Primary Services :

- Tourism
  - Mosaic of Habitats
  - Avian & Mammalian pop.
- Fisheries and Nurseries
- Shipping Channels
- Regulation and Maintenance
  - Flood Protection
  - Coastline Protection
  - Mediation of Wastes
  - Cycling of Nutrients



Assessment Methods :

- Process Based Modelling
- Derivation and combination of RS and modelling Applications
- Bayesian Networks for data product and information integration

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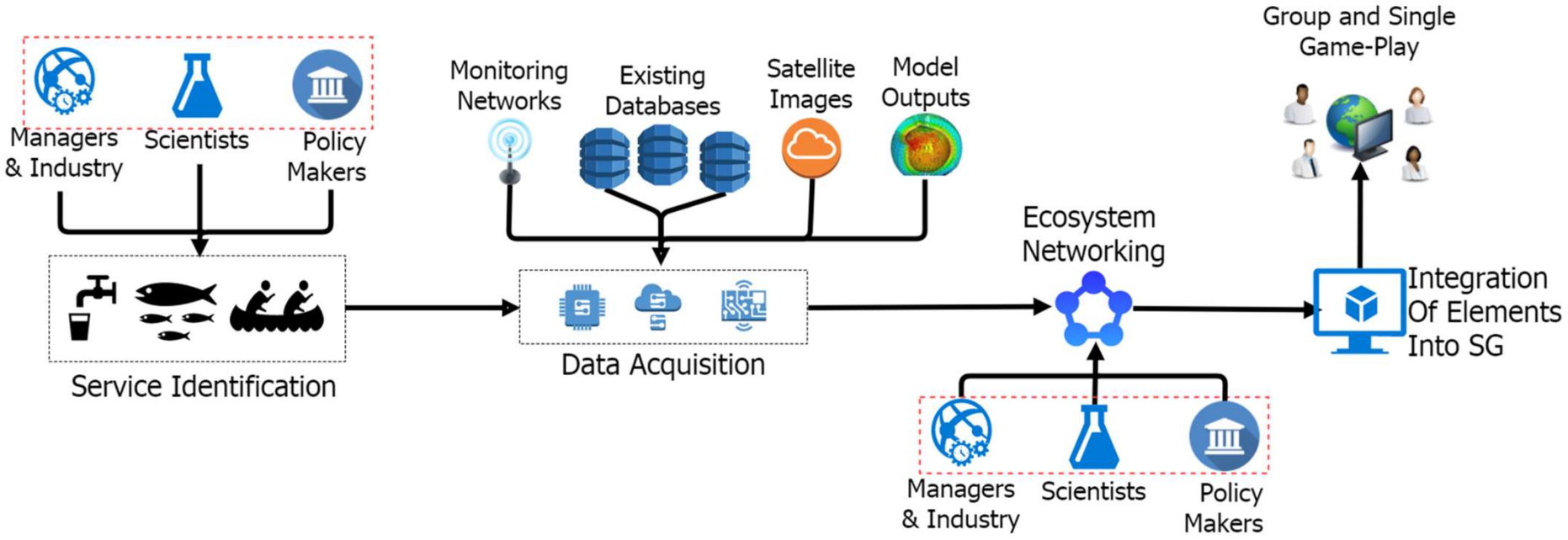
Storyline O1



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Storyline O1

DPSIR Type	Indicator	Nearest Essential Variable	Potential Datasets	
			RS	In situ
State	Habitat Types and Extent	Land cover (including vegetation type)	denoting the extent of the intertidal zones, and the types of cover within certain areas (sediment types)	determining sediment types and the cover of certain ranges
	Ratio in presence of successional stages salt marshes	Land cover (including vegetation type)	tracking the changes and evolution of the marsh areas, to be confirmed by In-Situ observations and field visits	Observation and tracking of the species and stage composition of the salt marshes
	Total production	Ecosystem function (Net primary productivity, Secondary productivity, Nutrient retention, Disturbance regime)	determine the primary production via Chl-a detection. Determine the clustering and locations of secondary producer colonies.	Determination of most and confirmation of some secondary producers, confirmation of primary production.

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Storyline O1

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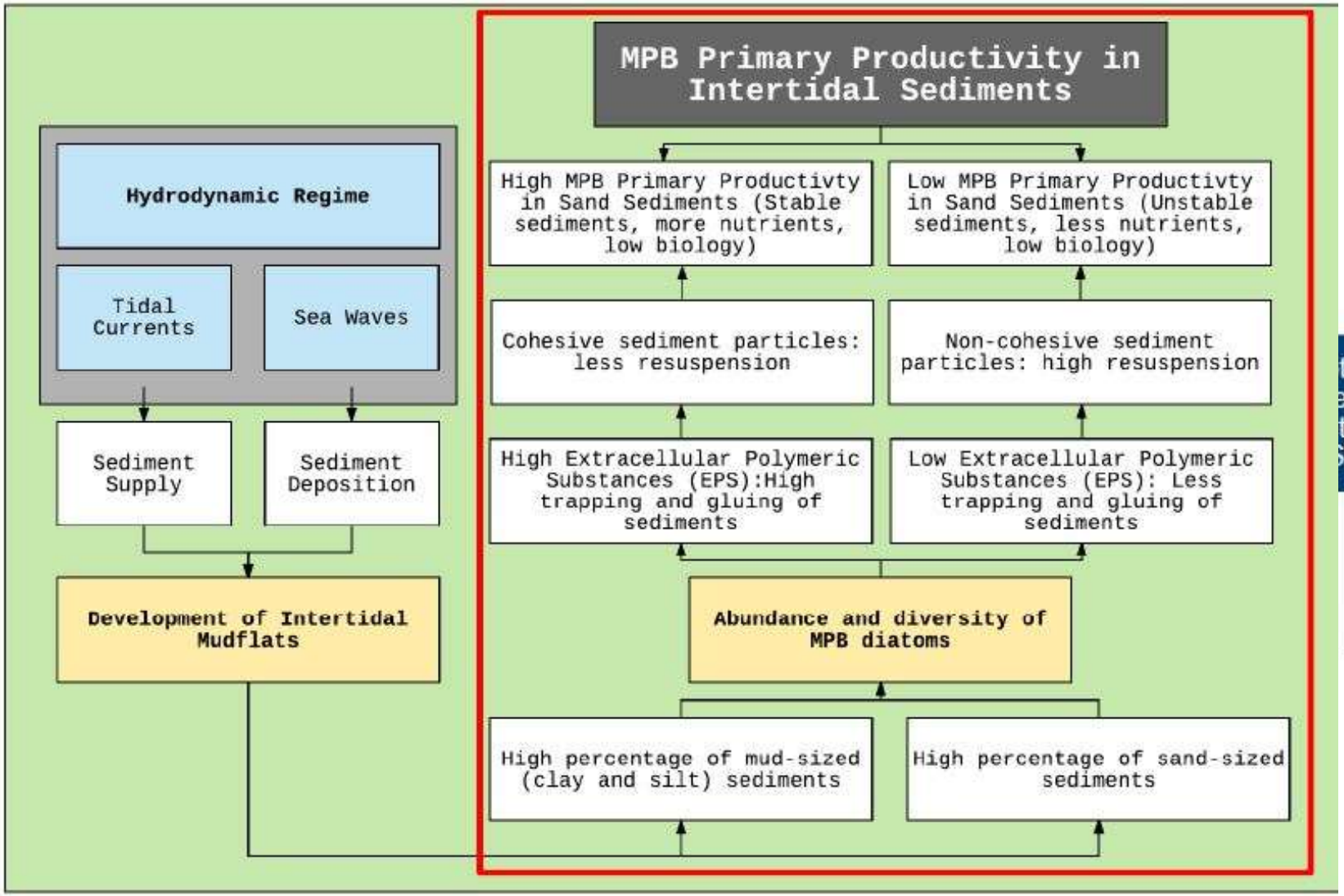

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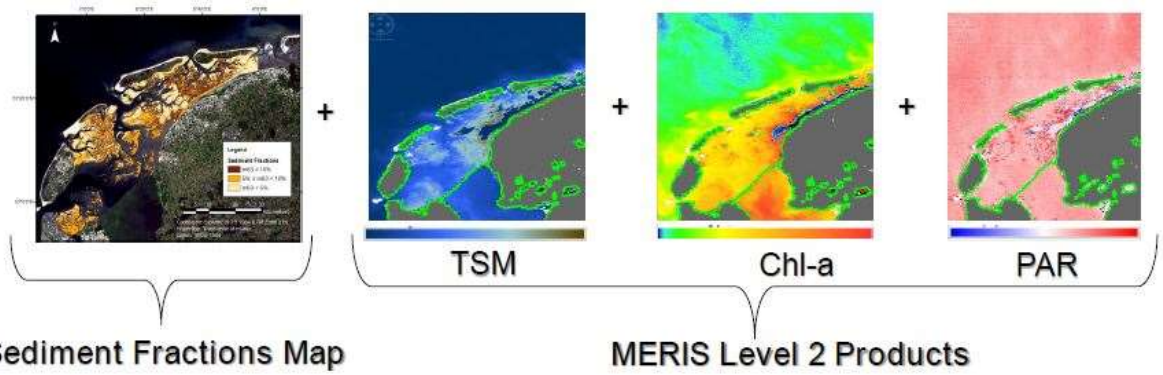
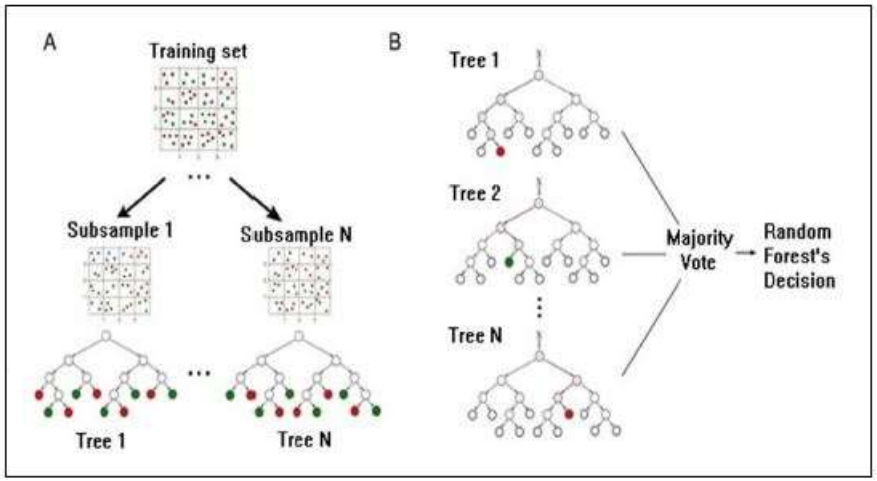
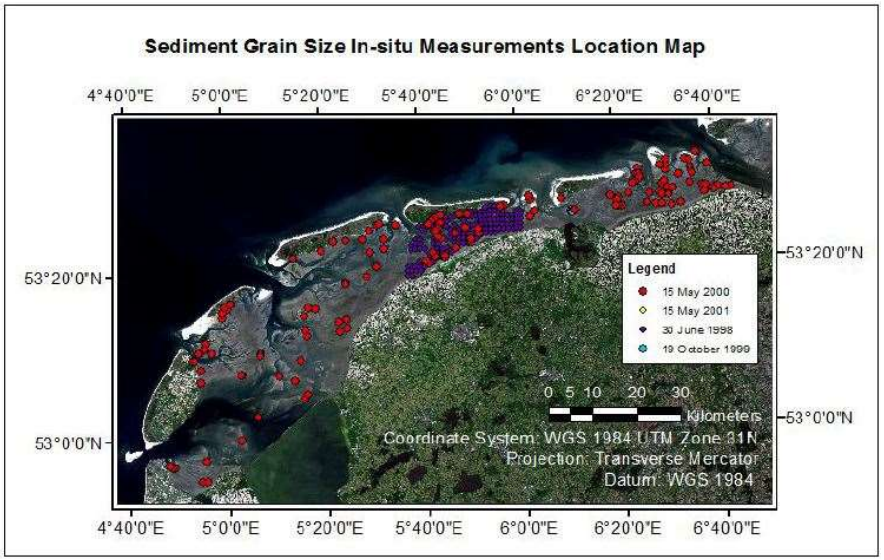
Storyline O1

The MPB model was trained using the four parameters from Part 1 as input and benthic diatom model from NIOZ as output using the Random Forests algorithm. Random Forests are an ensemble learning method for classification that construct a number of decision trees at training time and outputting the class that is the mode of the classes output by individual trees.







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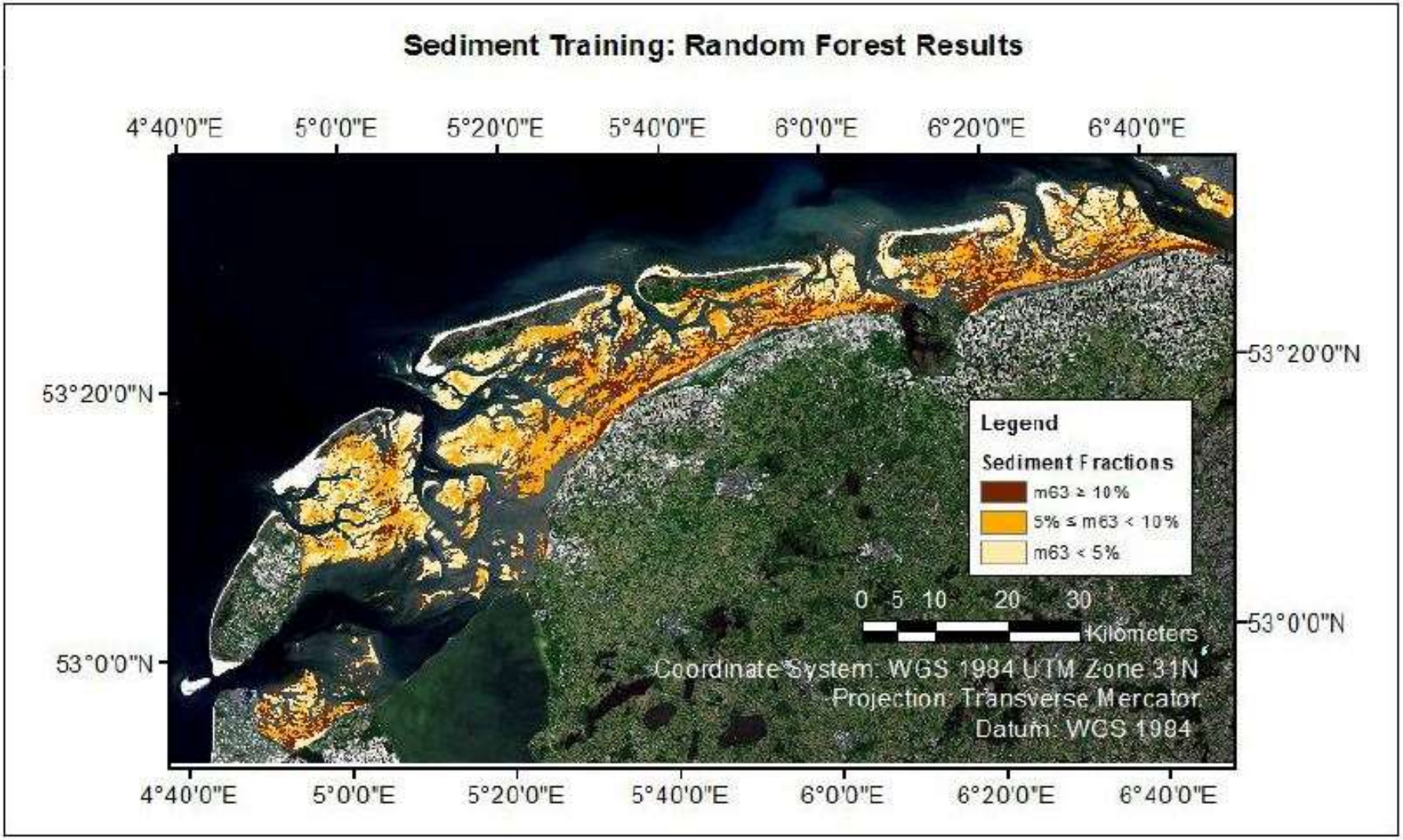
Storyline O1



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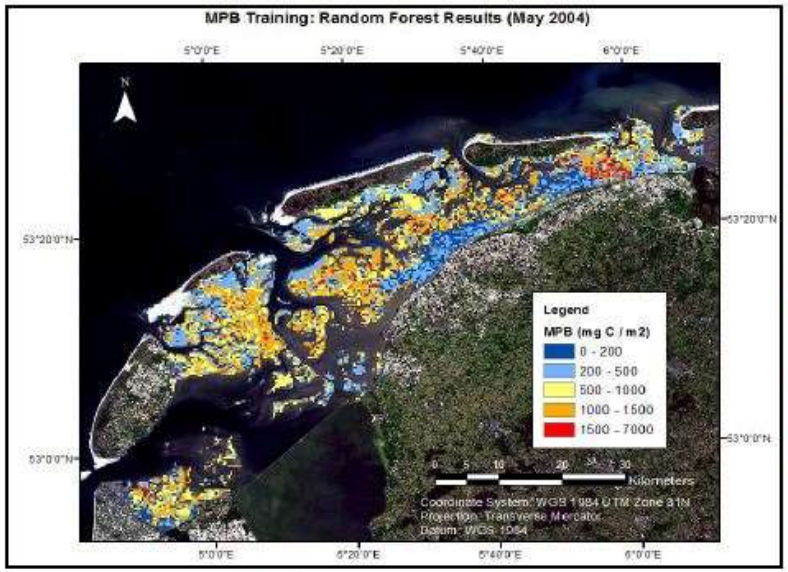
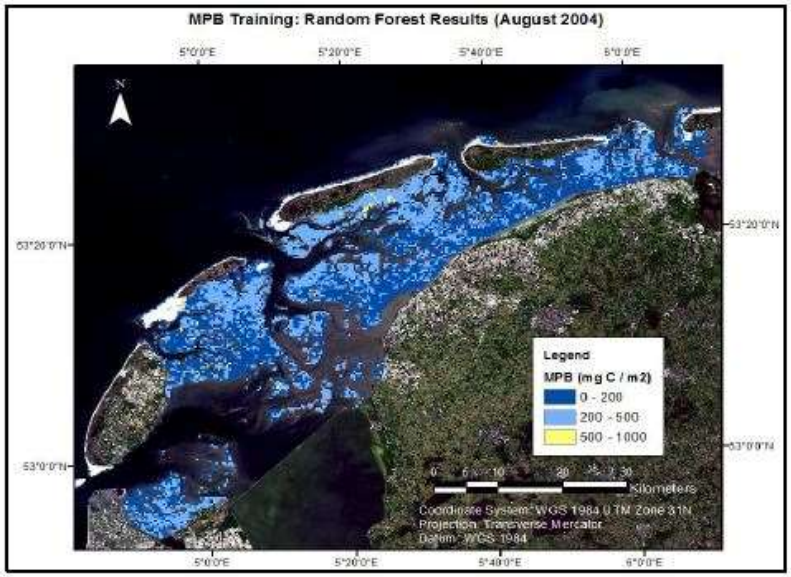
Storyline O1

MicroPhytoBenthos (MPB)

- Higher accuracy and model reliability in the winter months when overall concentrations are lower
- Requirement for more training and cross-validation data in order to enhance and improve the predictability of the model
- Additional information on the sediment atlas generated in order to have a better description of the dependent elements would aid in improving the predictive capabilities.





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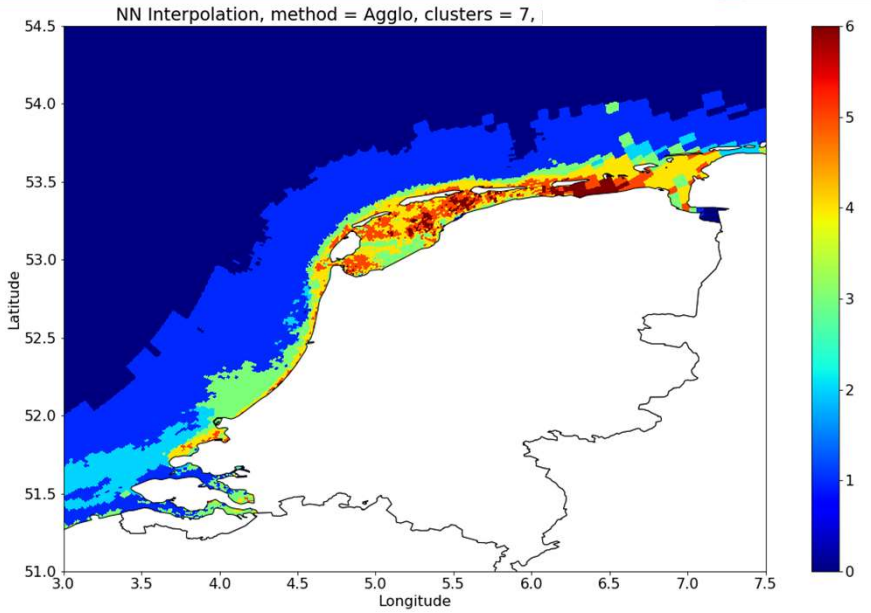
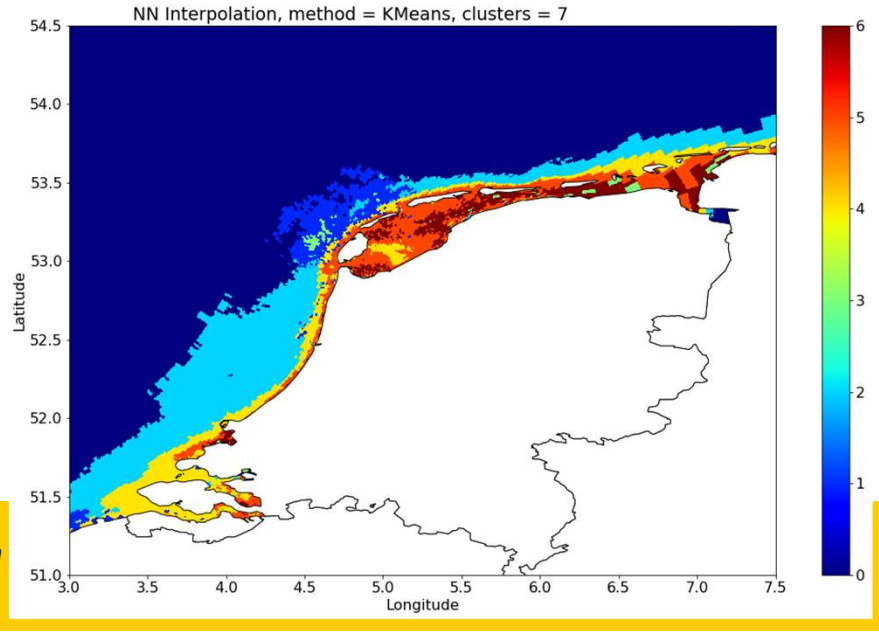
Trend Detection and Clustering for Remote Sensing Data Products

- Clustering techniques used:
  - Agglomerative – based on hierarchical clustering
  - Birch – based on construction of a Characteristic Feature Tree
  - K-Means – aims to create clusters of equal variance
- Clustering was used to identify spatial patterns for:
  - Daily (1D) data
  - Monthly data – multidimensional clustering of all dates in a month
  - Yearly data – multidimensional clustering of all dates in a bloom period





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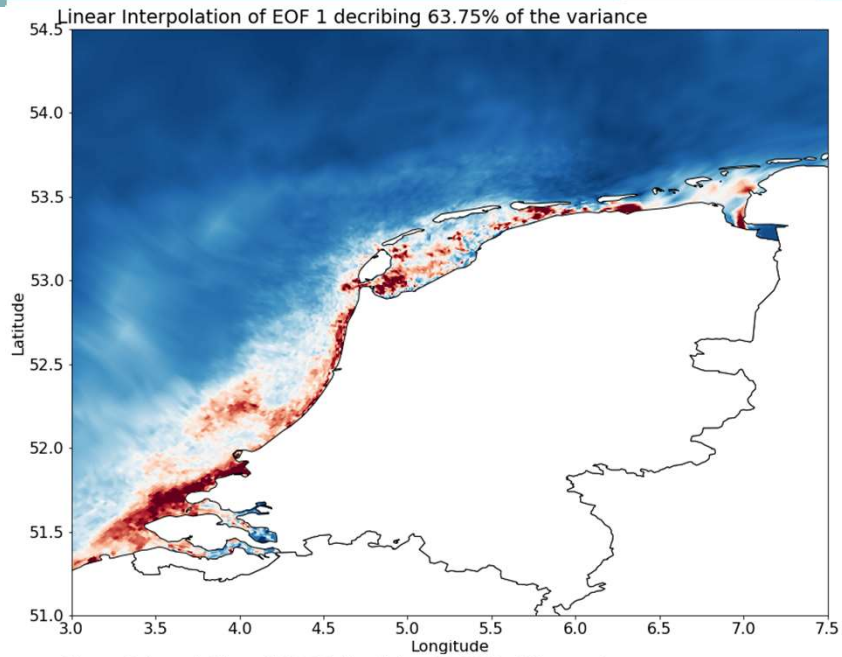
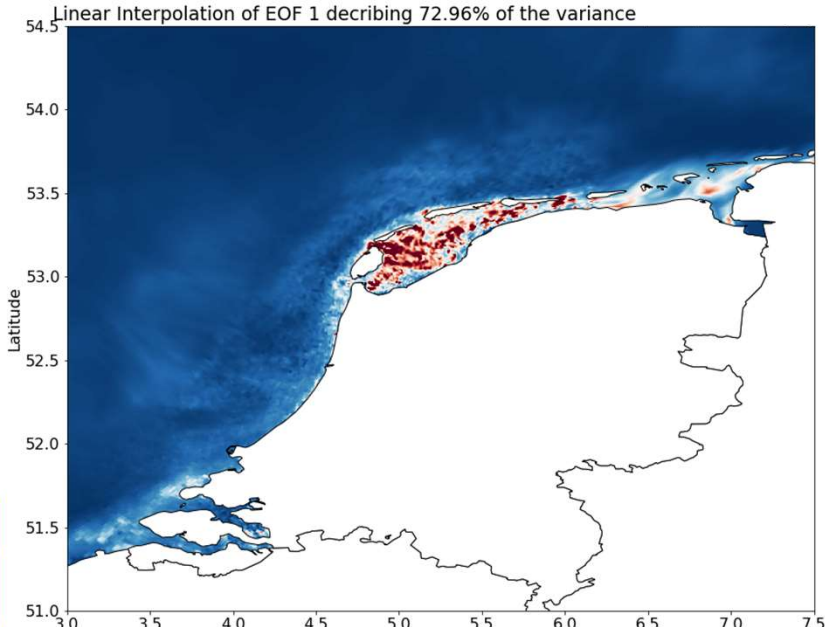
Trend Detection and Clustering for Remote Sensing Data Products

- Empirical Orthogonal Functions are a dimensionality reduction technique often used for spatiotemporal climate data (Filipponi et al 2017; Yosef et al. 2017)
- **Goal**: Identify dominant modes of spatiotemporal variability of Chlorophyll
- The dataset was reshaped to a 2D matrix **A** [MxN]:
  - M locations
  - N time steps
- **SVD** of A was computed:
  - $SVD(A) = U * S * V^T$
  - U and V contain the left and right singular vectors and S contains the singular values
- EOFs=$U * S$, where EOF1 = EOFs[:,1st column], EOF2 = EOFs[:,2nd column] etc.
- ECs=$S * V^T$, for temporal patterns.
- Variance described: $Cov(S,S) = S^T S$, 1st element of the diagonal of the auto-covariance matrix divided by the sum of the elements of the diagonal shows 1st EOF's percentage of variance description, 2nd element of the diagonal ...





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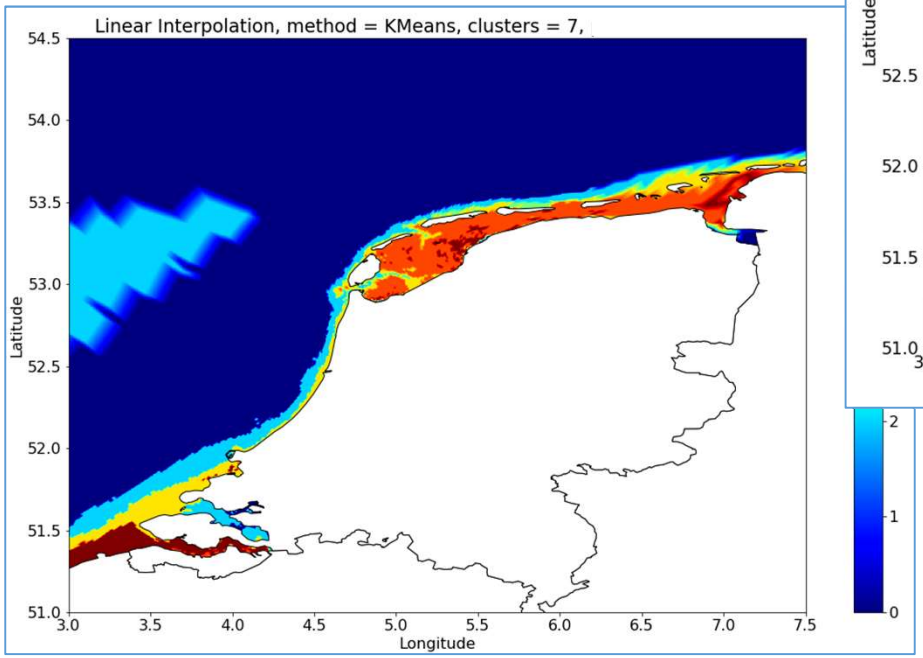
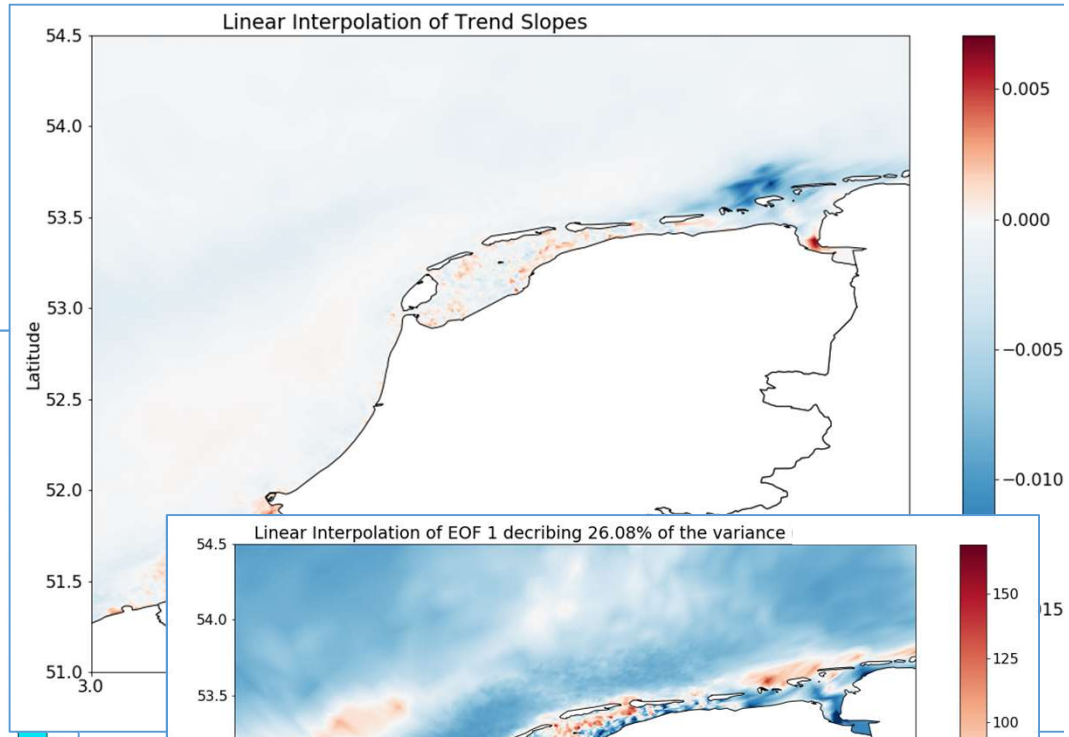
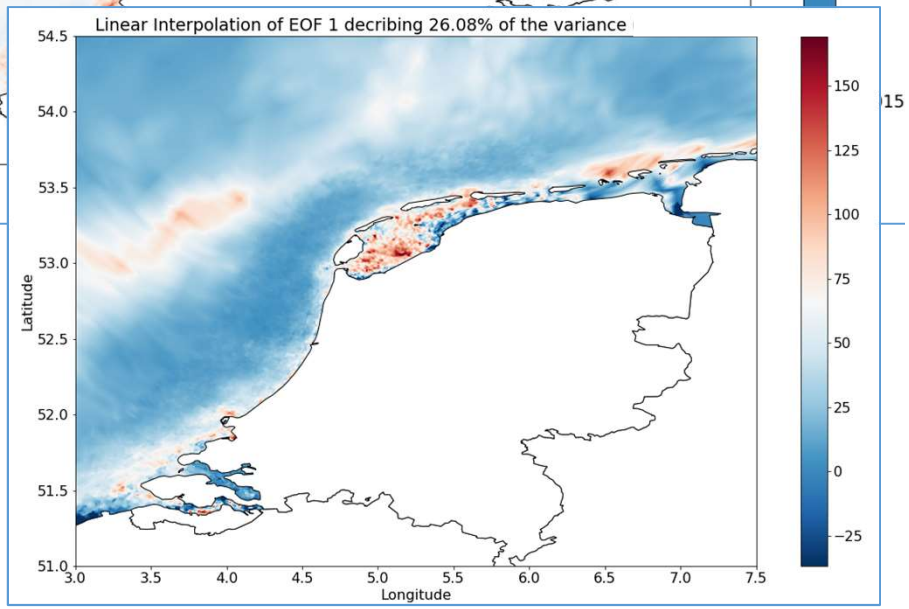
Chlorophyll-a and Total Inorganic Matter

- Information and location / acquisition potential for all codes and algorithms used available and provided via basecamp







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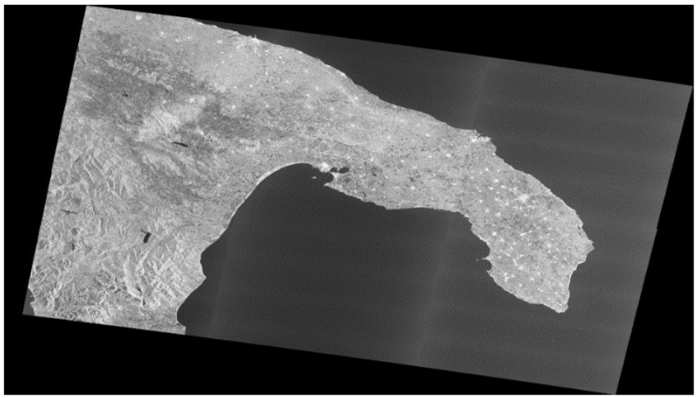
Automated Shoreline Detection

Sentinel-1 data products:

- Beginning from a Comparison of DLR Algorithm detection and open source codes
- Ground Range Detect
  - Focused SAR data detected, multilooked and projected to ground range using an Earth ellipsoid model
- Partial dual polarisation VH
- High Resolution
  - Pixel Spacing: 10x10 m
  - Spatial Resolution: 20x22 m
- https://scihub.copernicus.eu/



Very High Resolution image acquired by Sentinel-1 platform on 7th of June 2017.

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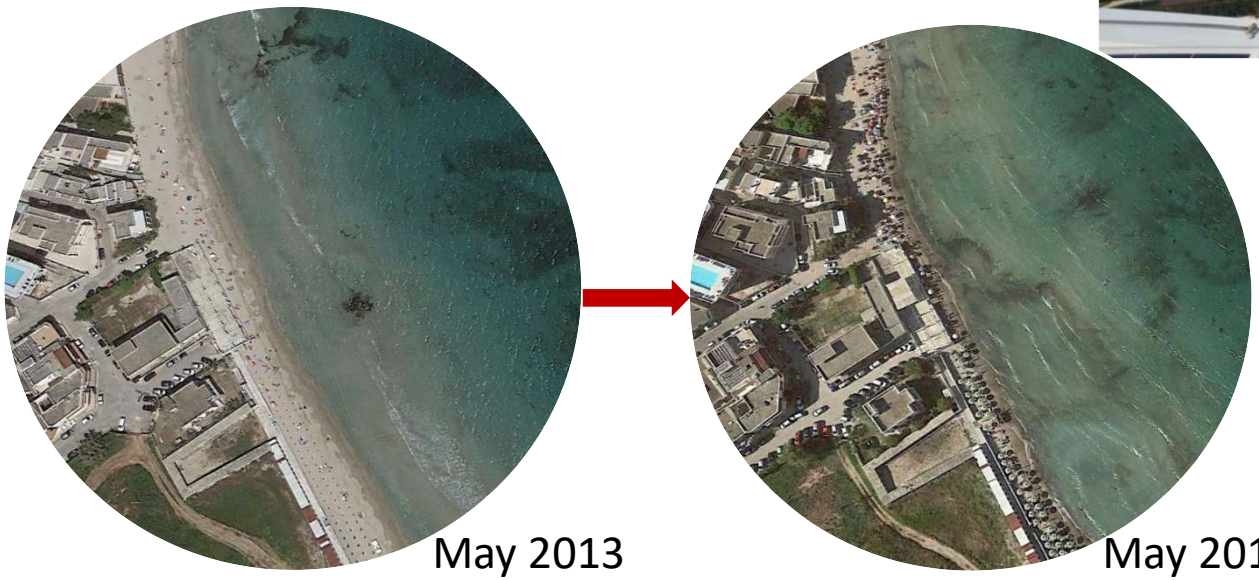
Automated Shoreline Detection

Video Monitoring System at Torre Canne, Italy

- Resolution: from decimeters to around 13 m
- 600 images every 30 minutes
- http://91.121.30.84/
- Mean difference: 1.17 pixels

Cameras location at Torre Canne and the coastal stretch framed. Valentini et al., 2017.



May 2013 May 2015

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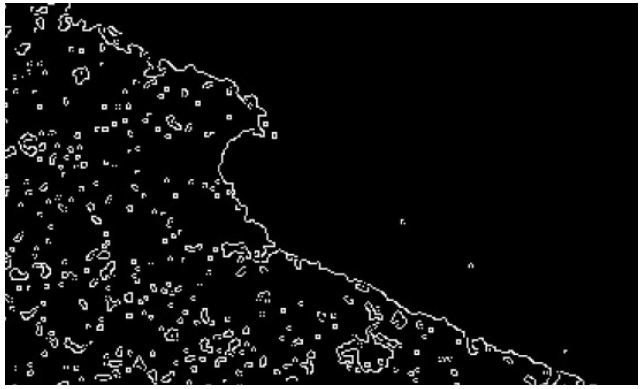
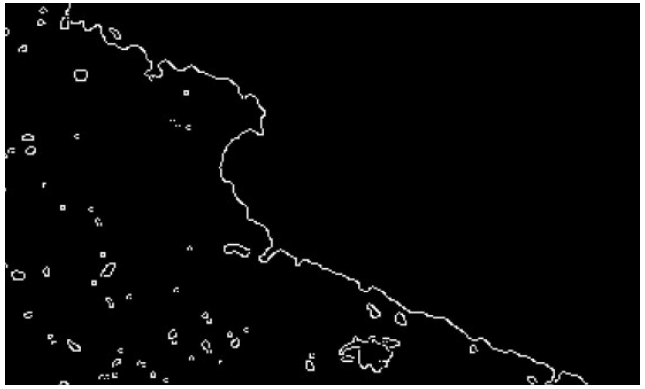
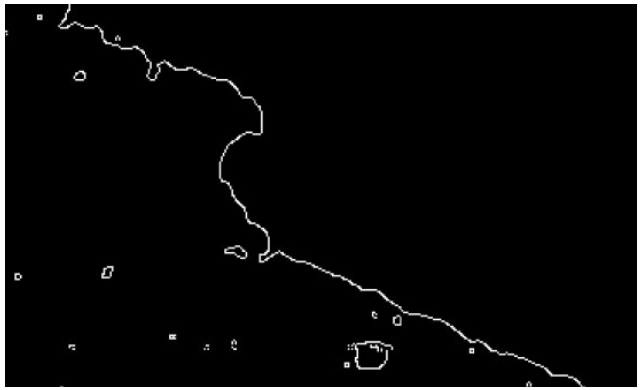
Automated Shoreline Detection



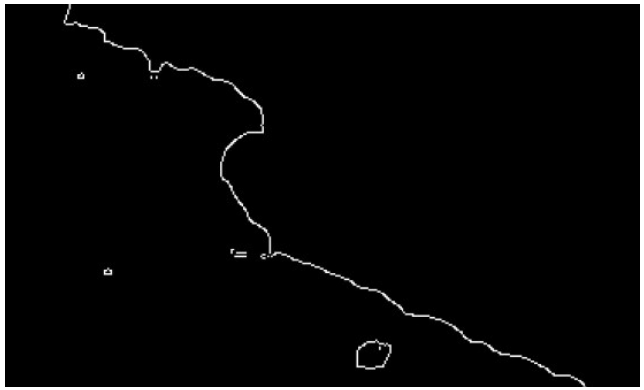
Result obtained by using a median-filtering approach by means of a kernel size of 3x3.



Result obtained by using a median-filtering approach by means of a kernel size of 5x5.



Result obtained by using a median-filtering approach by means of a kernel size of 7x7.



Result obtained by using a median-filtering approach by means of a kernel size of 9x9.

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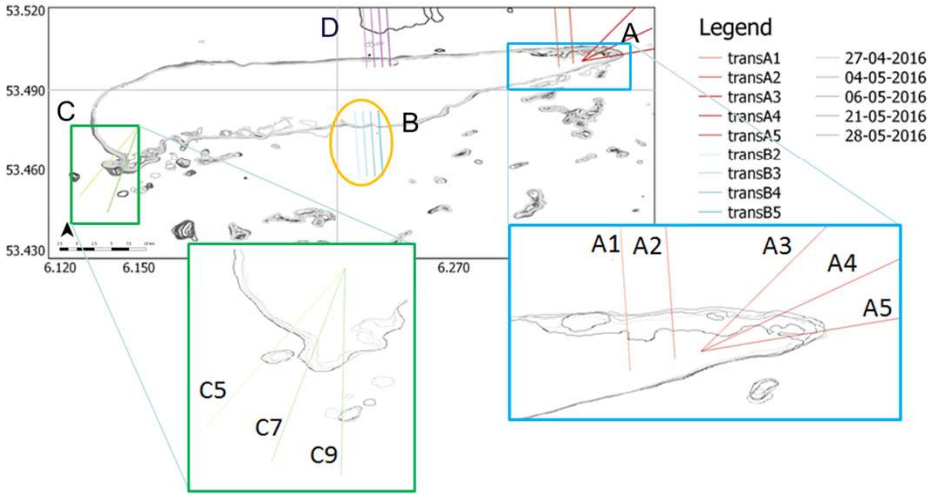
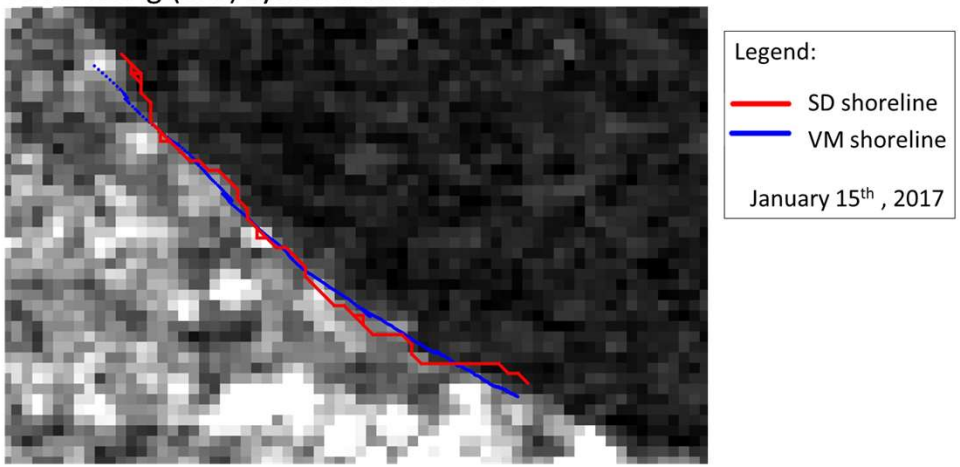
Storyline O1

Automated Shoreline Detection

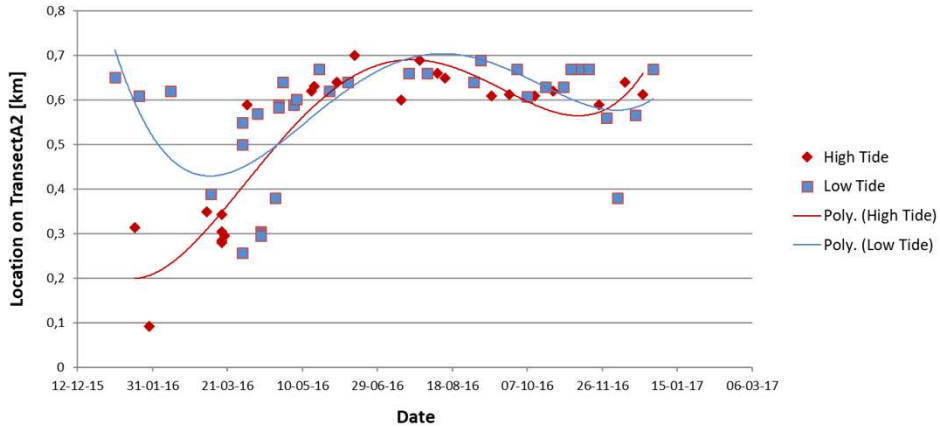
Applicability to shallow large tidal influence shorelines as well as rocky and rocky lower tidal influences



Comparison between Satellite Derived (SD) shoreline and Video-Monitoring (VM) systems shoreline.



Intersection points in 2016 for high [red] and low [blue] tide on transect A2



Spinosa, A., Ziemba, A., Saponieri, A., Navarro-Sanchez, V. D., Damiani, L., & El Serafy, G. (2018, October). Automatic Extraction of Shoreline from Satellite Images: a new approach. In 2018 IEEE International Workshop on Metrology for the Sea; Learning to Measure Sea Health Parameters (MetroSea)(pp. 33-38). IEEE. DOI: 10.1109/MetroSea.2018.8657864

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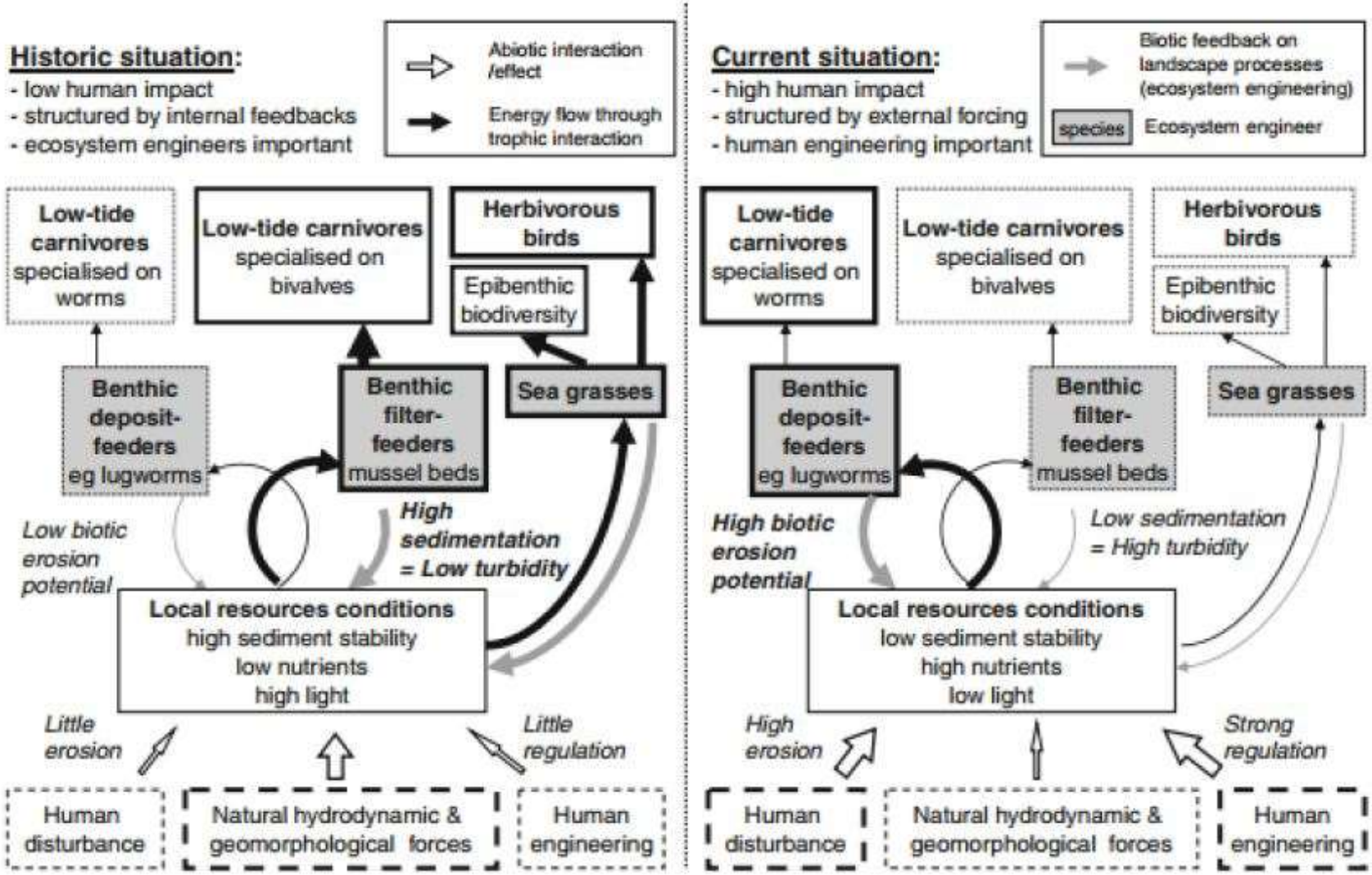
Storyline O1



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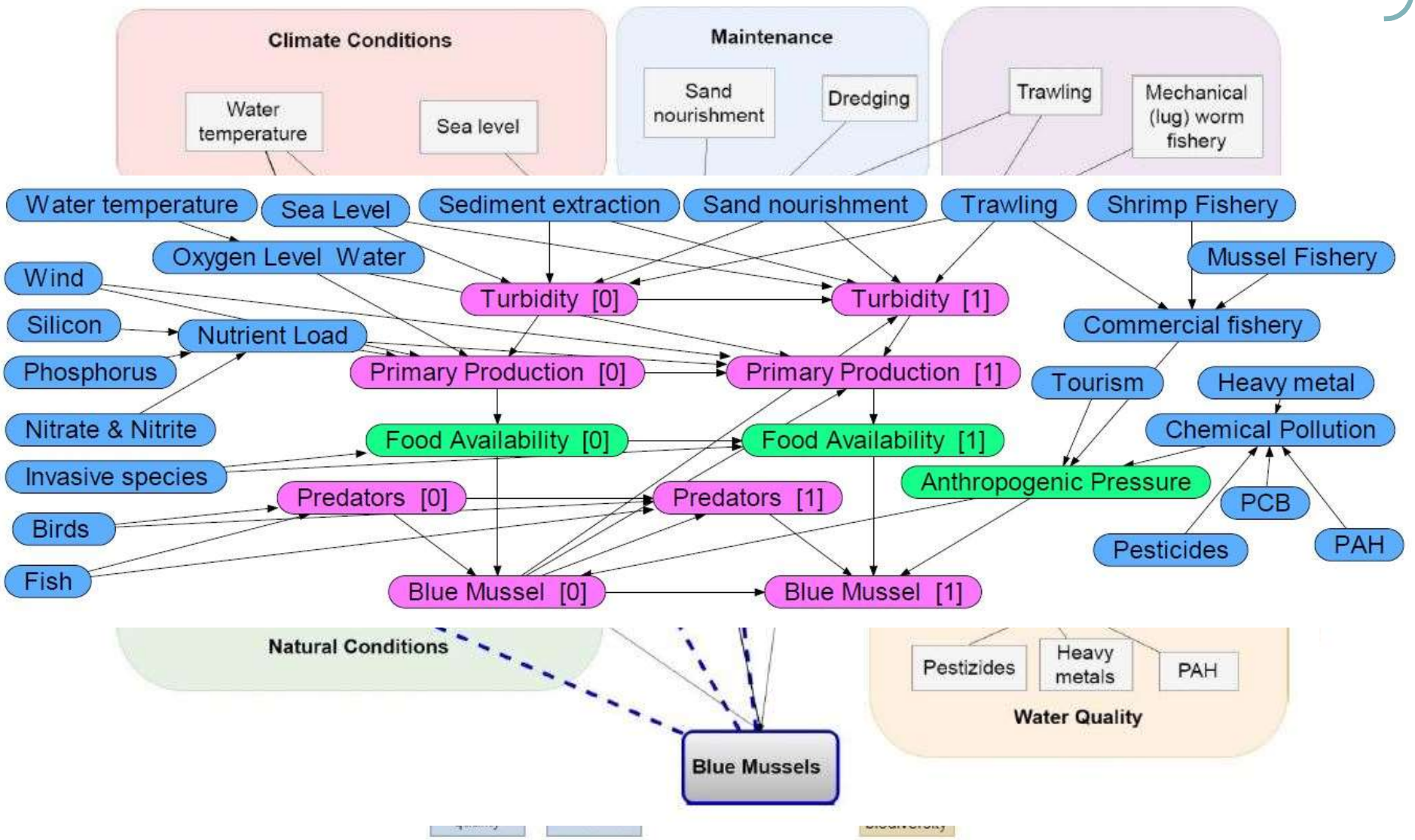
Storyline O1



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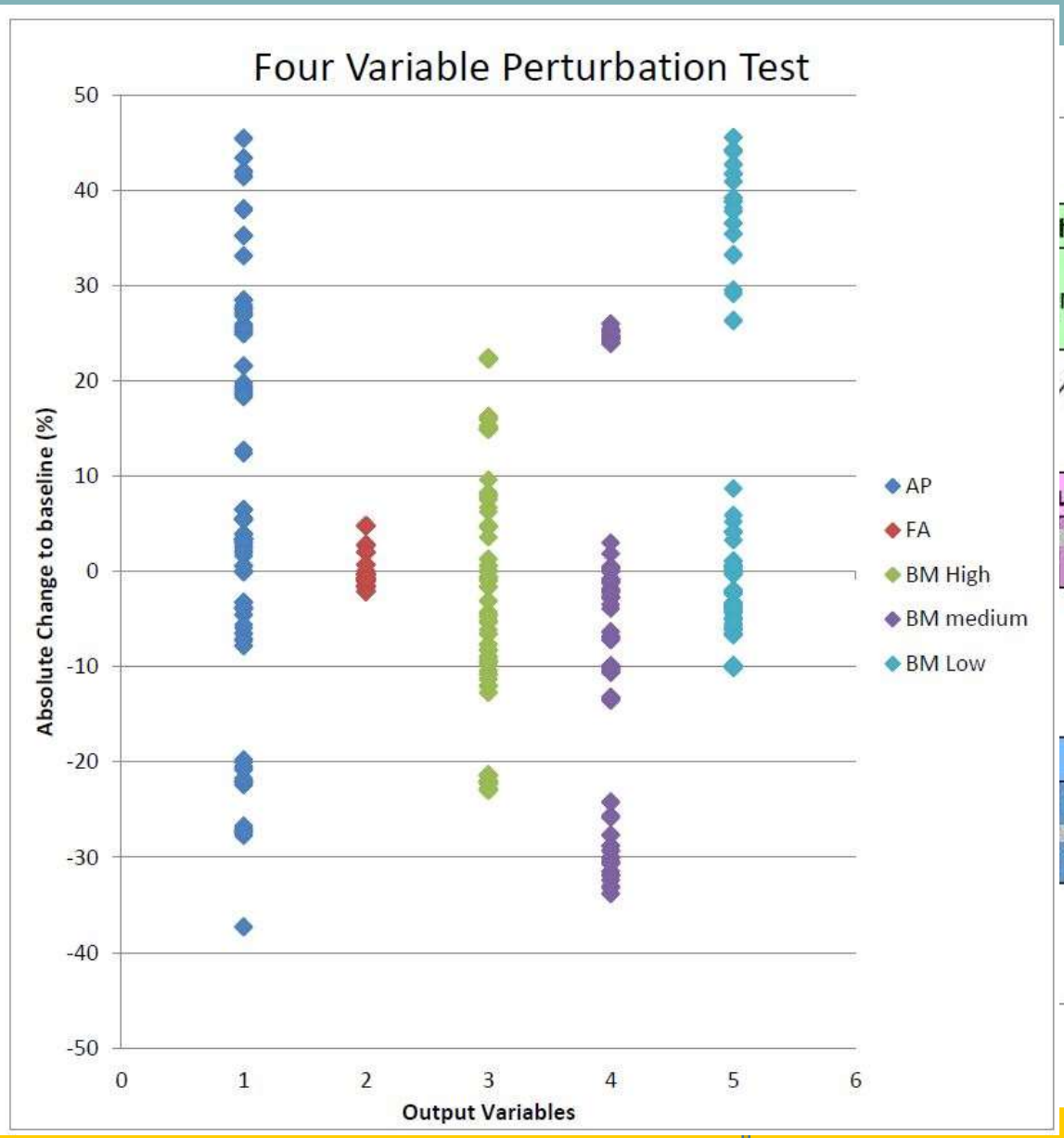
Storyline O1



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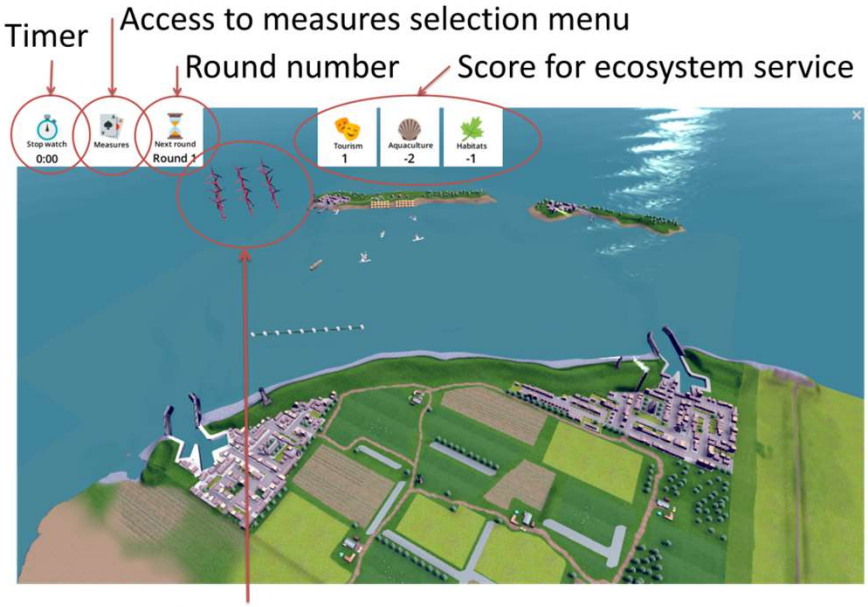
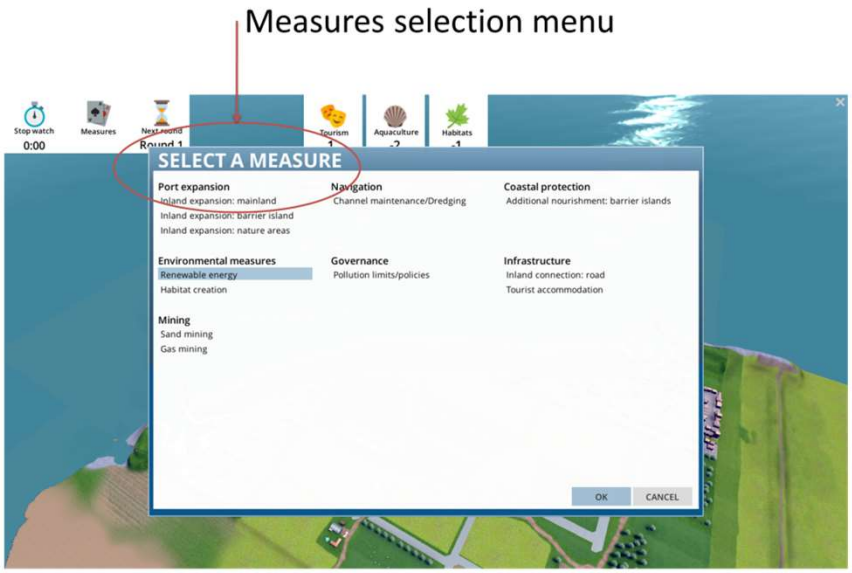
Storyline O1





1) Demonstrate **trade-offs** between ecosystem services

2) Based on modeling, remote sensing, and monitoring **data**

3) Takes advantage of **Bayesian Belief Networks** as the backbone of the game to highlight **uncertainty in measures**

4) **Facilitates discussion** between stakeholders on the implementation of possible measures and their effects, as well as the difficulties in coming to agreements

5) Allows players to explore the effectiveness in **optimizing ecosystem services for specific goals** and the uncertainty in the pathways measure to achieve such an optimization

6)Disseminate ECOPOTENTIAL outcomes in a **fun and interactive** manner

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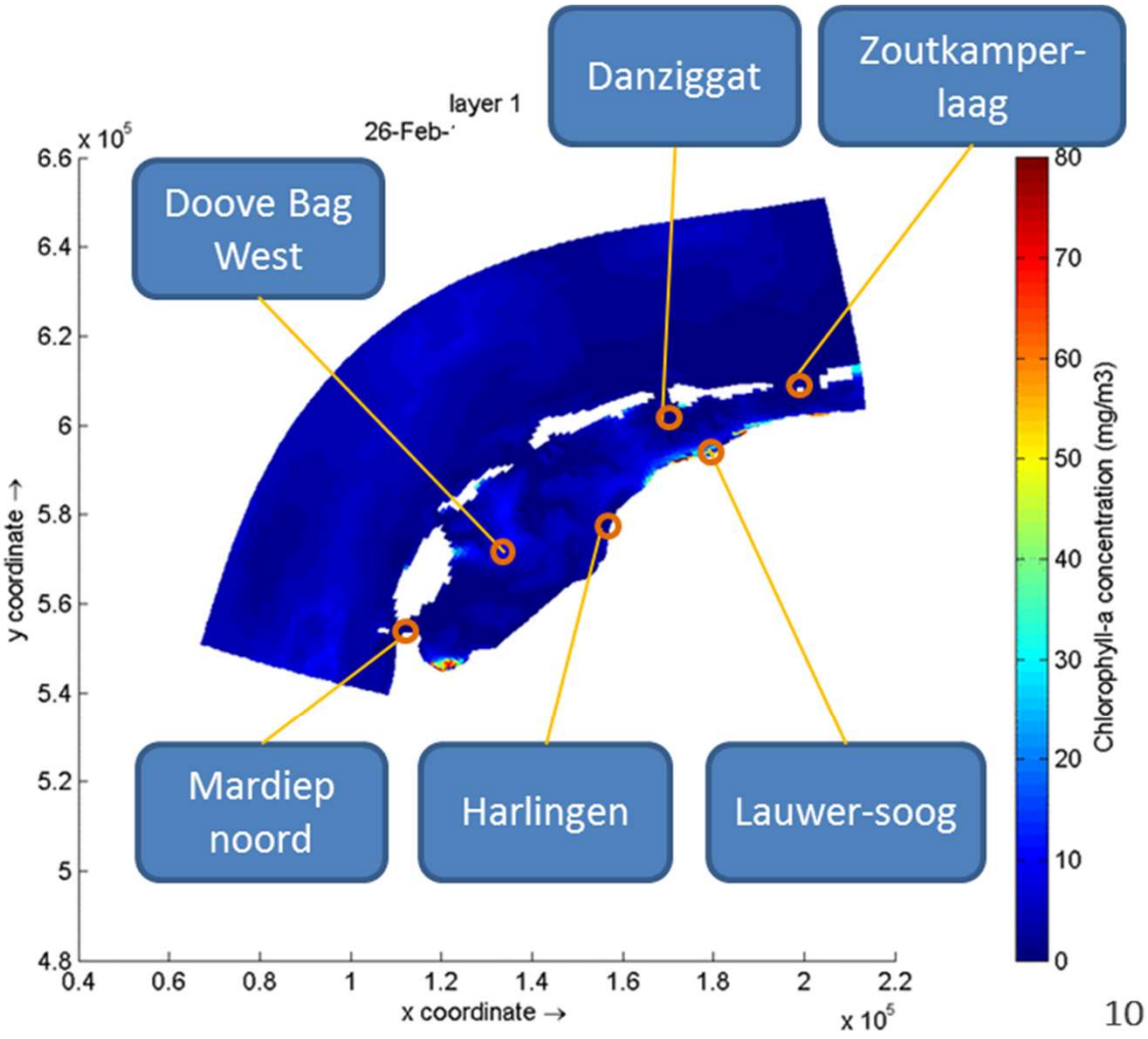
Storyline O1

Climate variabl

- Solar radiatio
- Temperature
- Sea level rise
- Precipitation
- Wind cycle



- Chlorophyll-a
- ALGx
- Net primary production
- Dissolved oxygen

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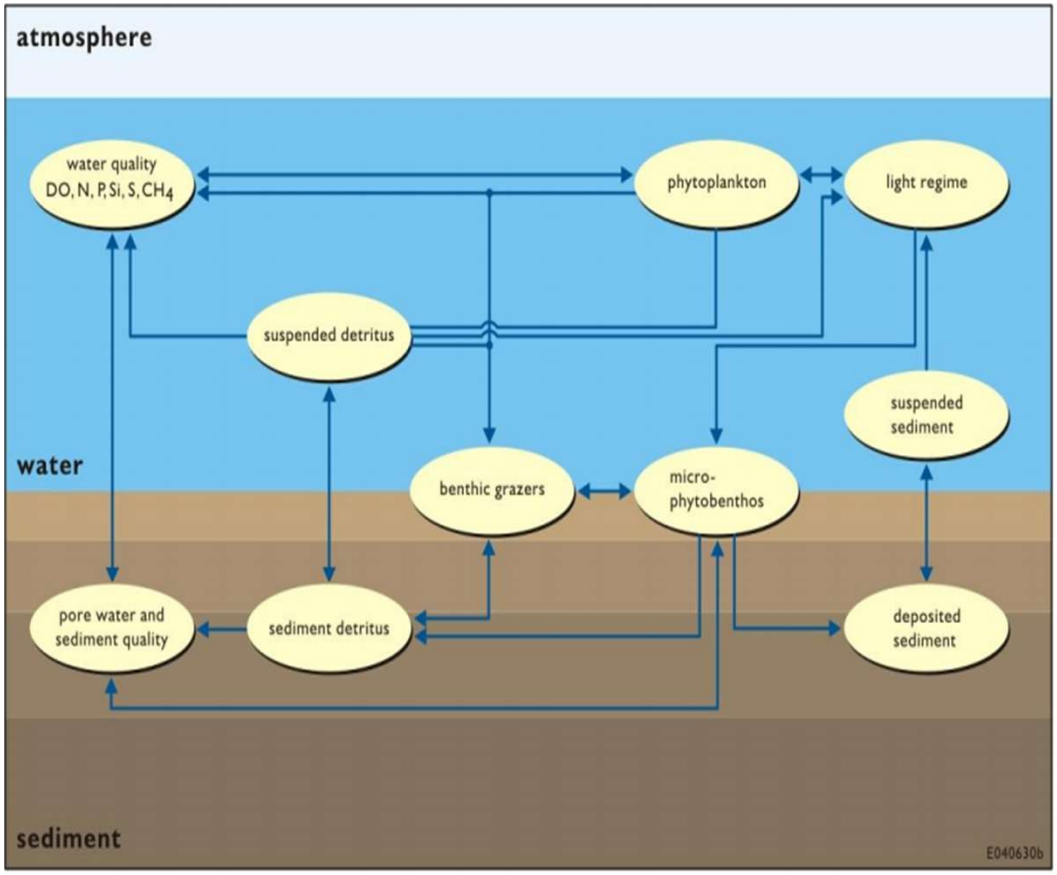
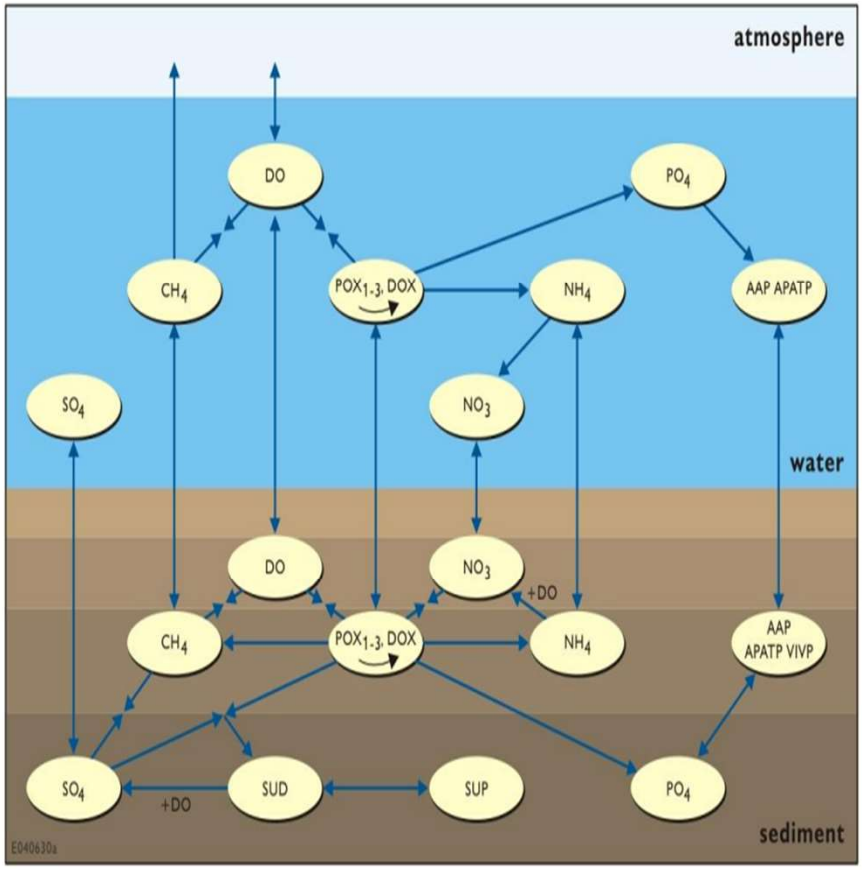
Storyline O1





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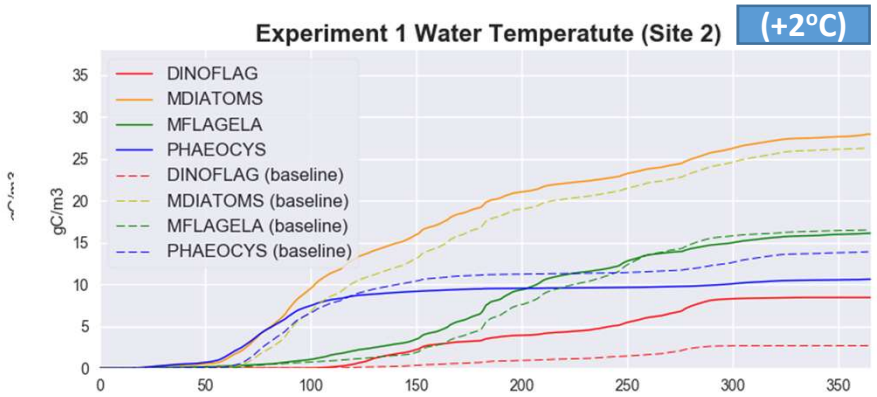
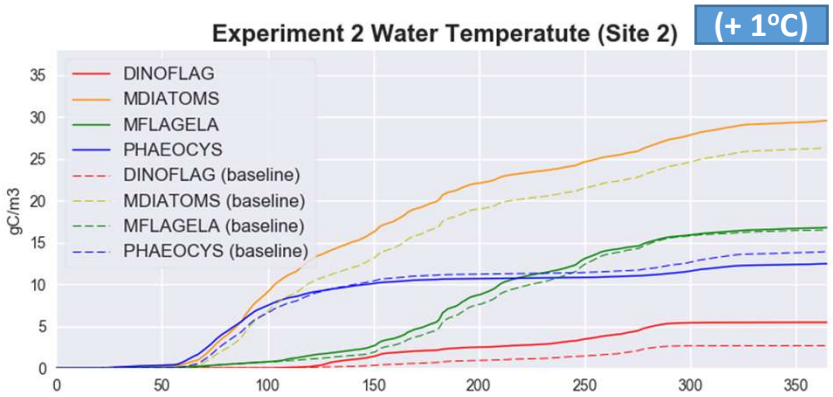
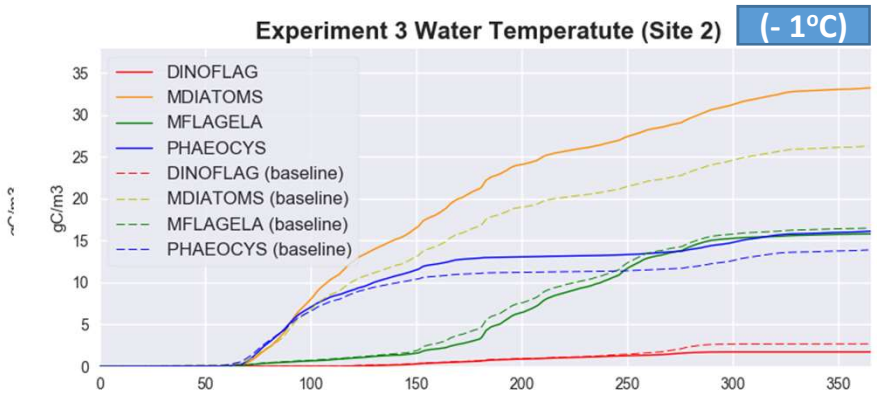
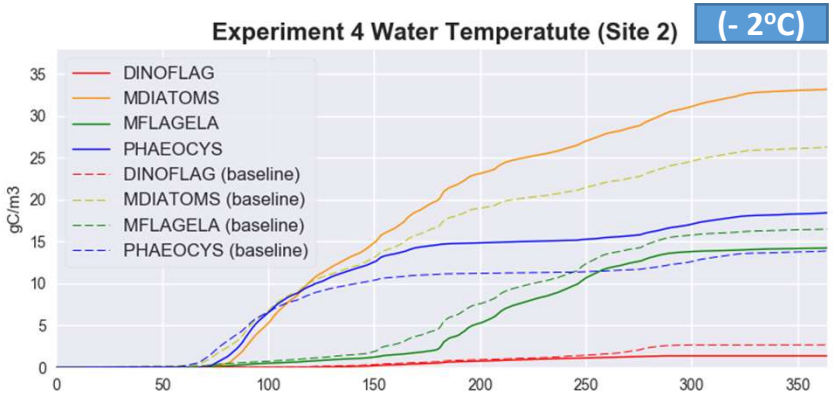
Storyline O1









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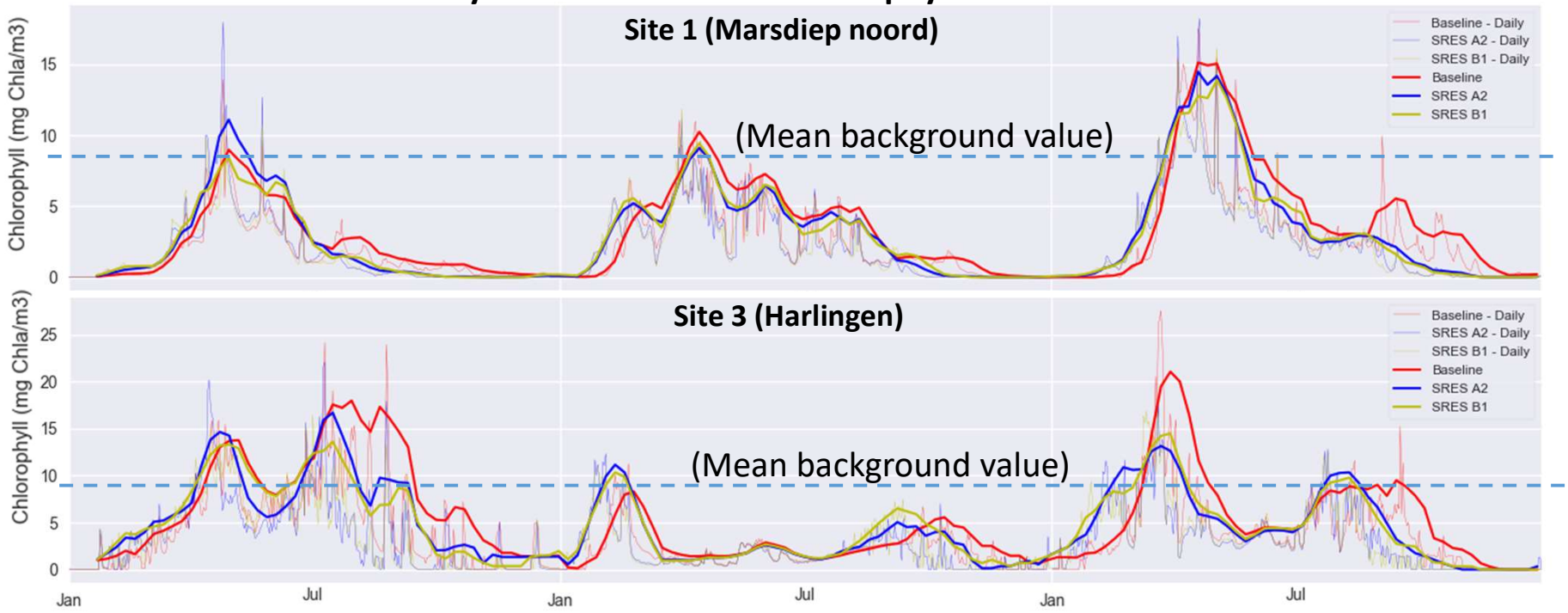
Storyline O1

Weekly trend of maximum Chlorophyll-a concentration



- The growing season occurs earlier
- Daily variation of Chlorophyll resulted higher value of peaks

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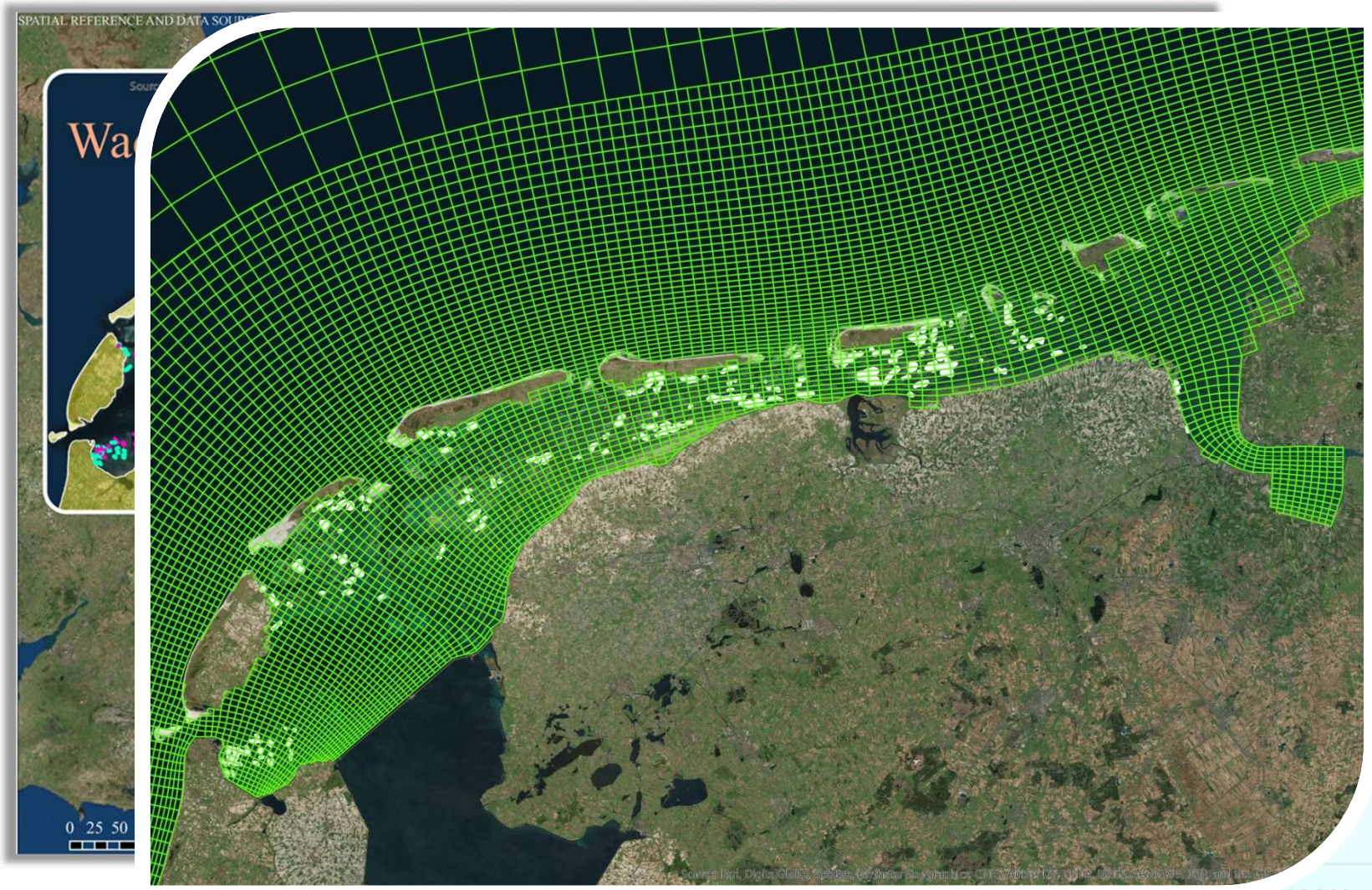
Future Projections



Pink

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Total	669	21.7	100%

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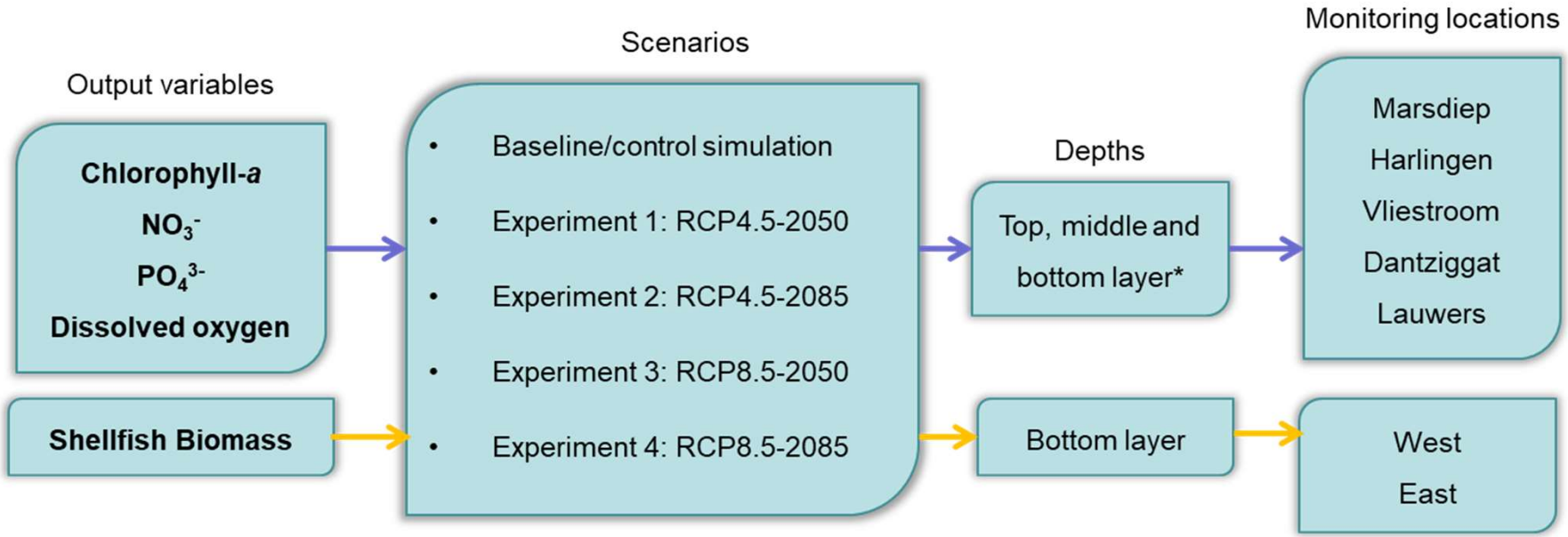
Future Projections



= 310 one-year time series

*Vertical averages were calculated and displayed

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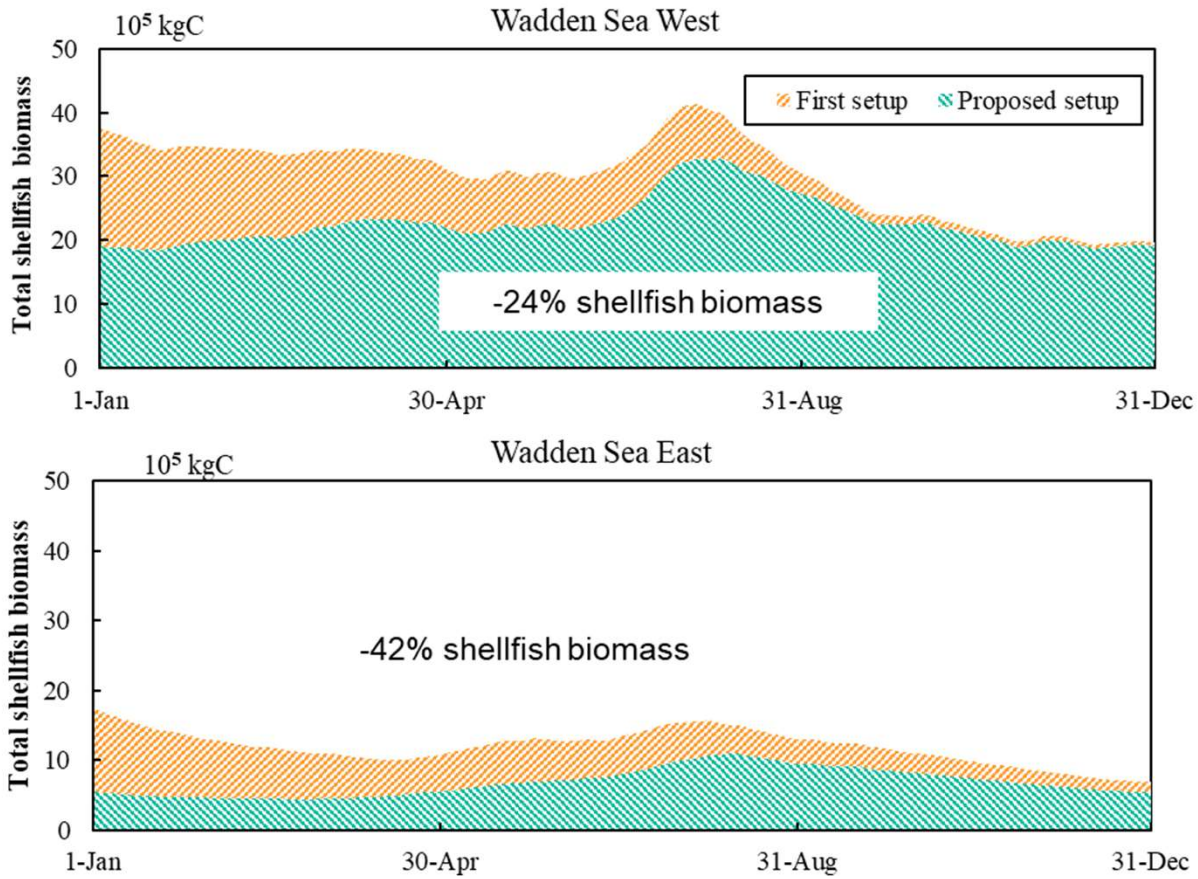
Future Projections



- Lower biomass on the East
  - Model underestimates shellfish abundance, previous slide
- Summer bloom more acute on the western side
- Both areas seem to find a balance towards the end of the year
- Drop in biomass due to oyster presence
  - High ingestion rate of *C. gigas*
  - Higher storage density of *C. gigas*

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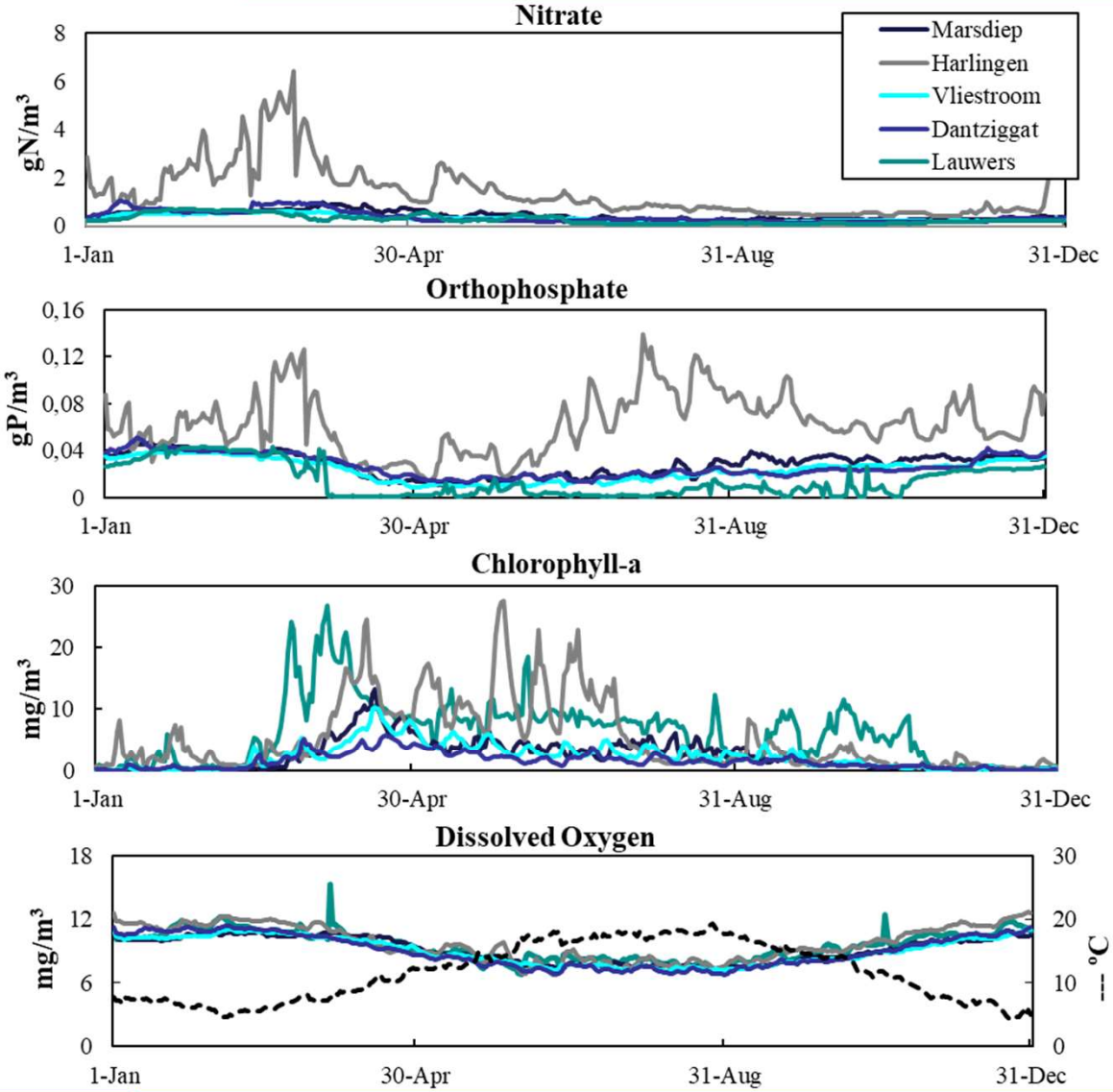
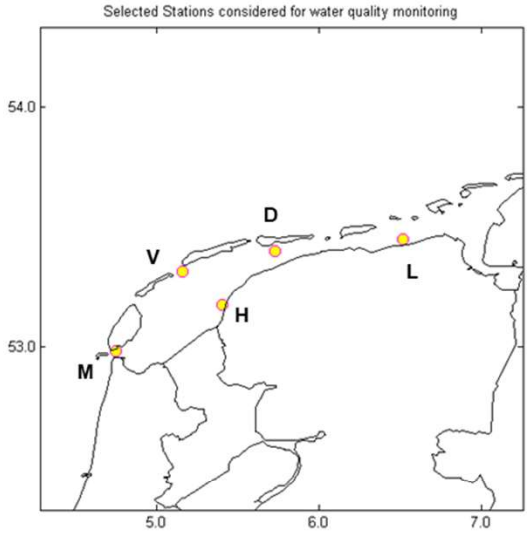
Future Projections





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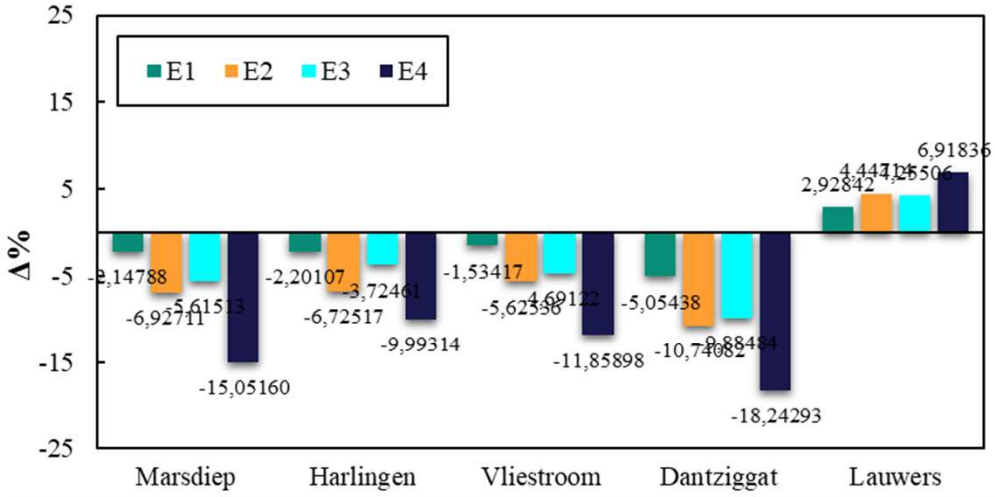
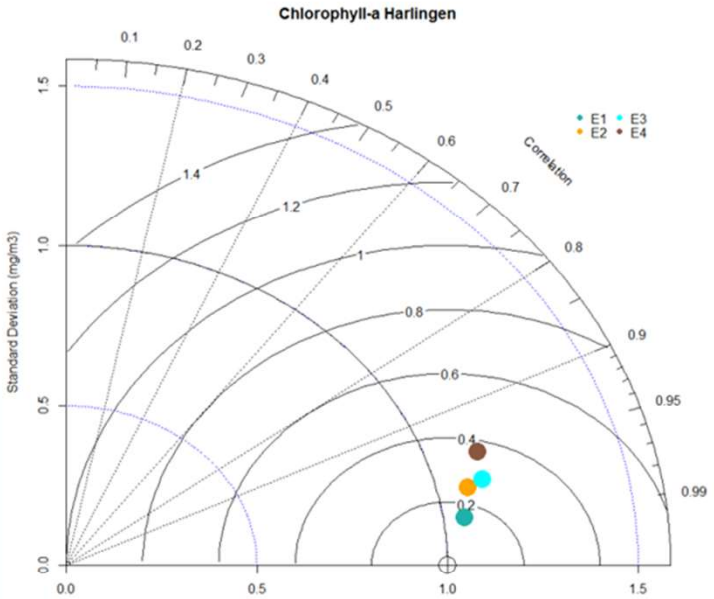
Future Projections





- MER ZW project report: primary production is more light-dependent than nutrient-dependent
- Lauwers: only station where Chla increases
  - Shallow channel, good light penetration
  - High nutrient load near the estuary
- Increasing RMSD + decreasing correlation
  - Changes to the general pattern of primary productivity
- CC in the North Sea would cause a reduction of Chla between 12% and 2% (Holt *et al.*, 2016)
  - My results fall within this interval

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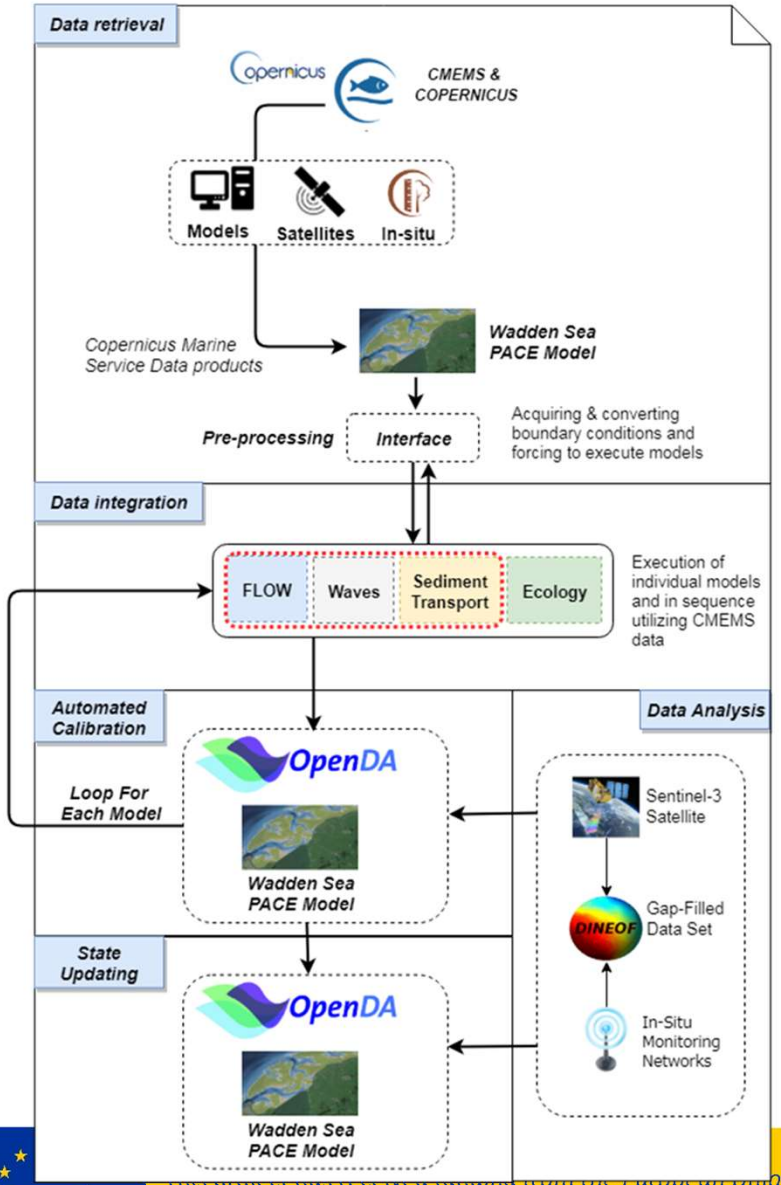
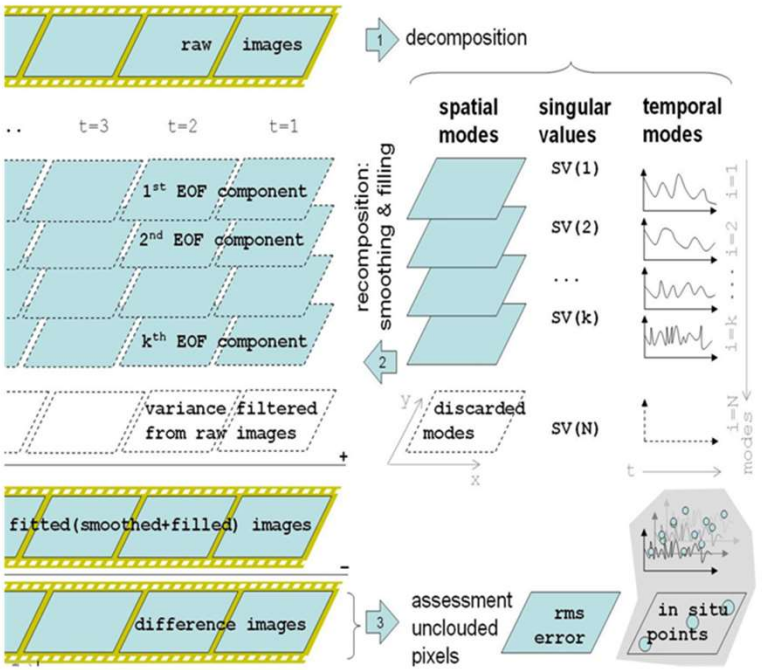
Calibration Via Hindcasting for Short Term Forecasts



Advantages:

- Confirms global patterns of SPM concentration variation resolved by remote sensing
- Local gaps could be smoothly interpolated
- Complete spring peaks could be reconstructed
- Spatiotemporal autocorrelation → error reduction in the data
- improved spatial coverage → better representation of both the spatial- and temporal variability



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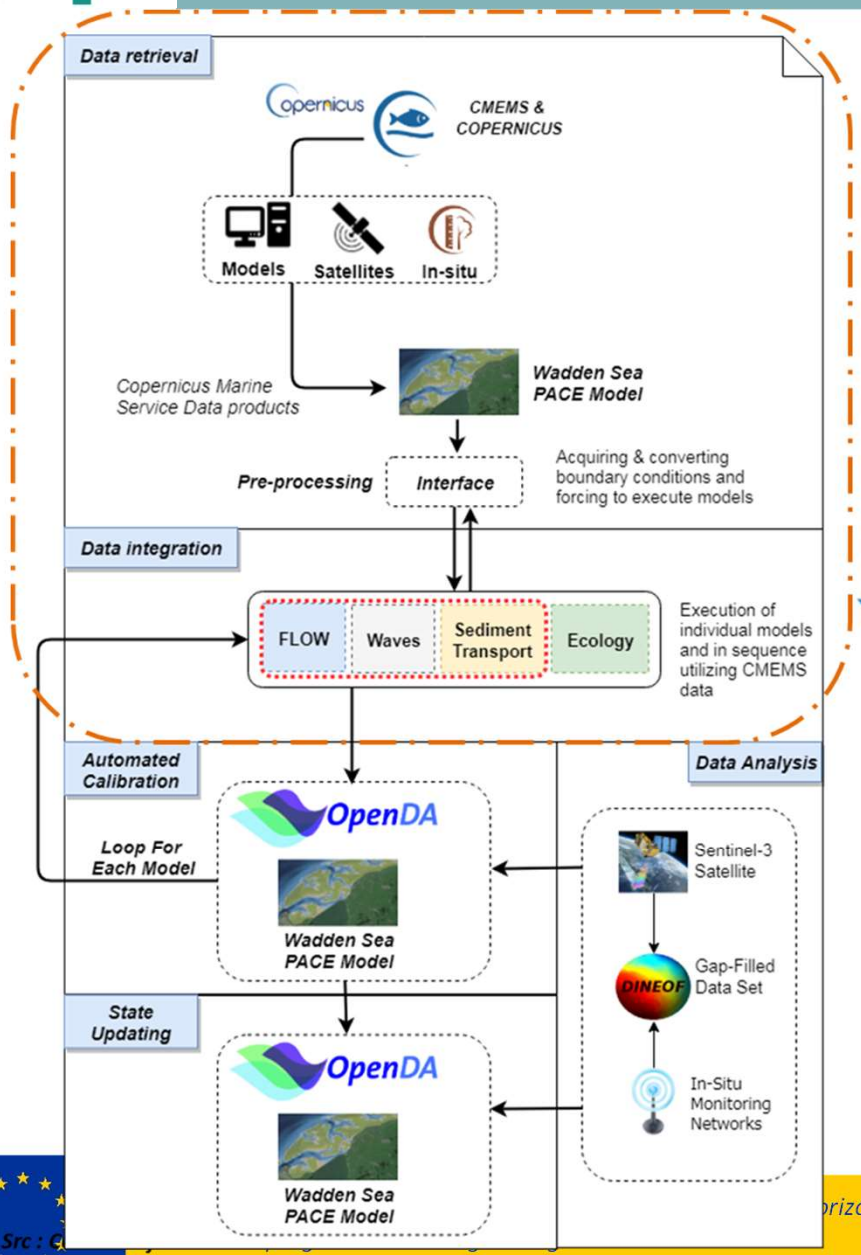
Calibration Via Hindcasting for Short Term Forecasts



1)→ CMEMS Regional Models:
Data is downloaded from COPERNICUS.

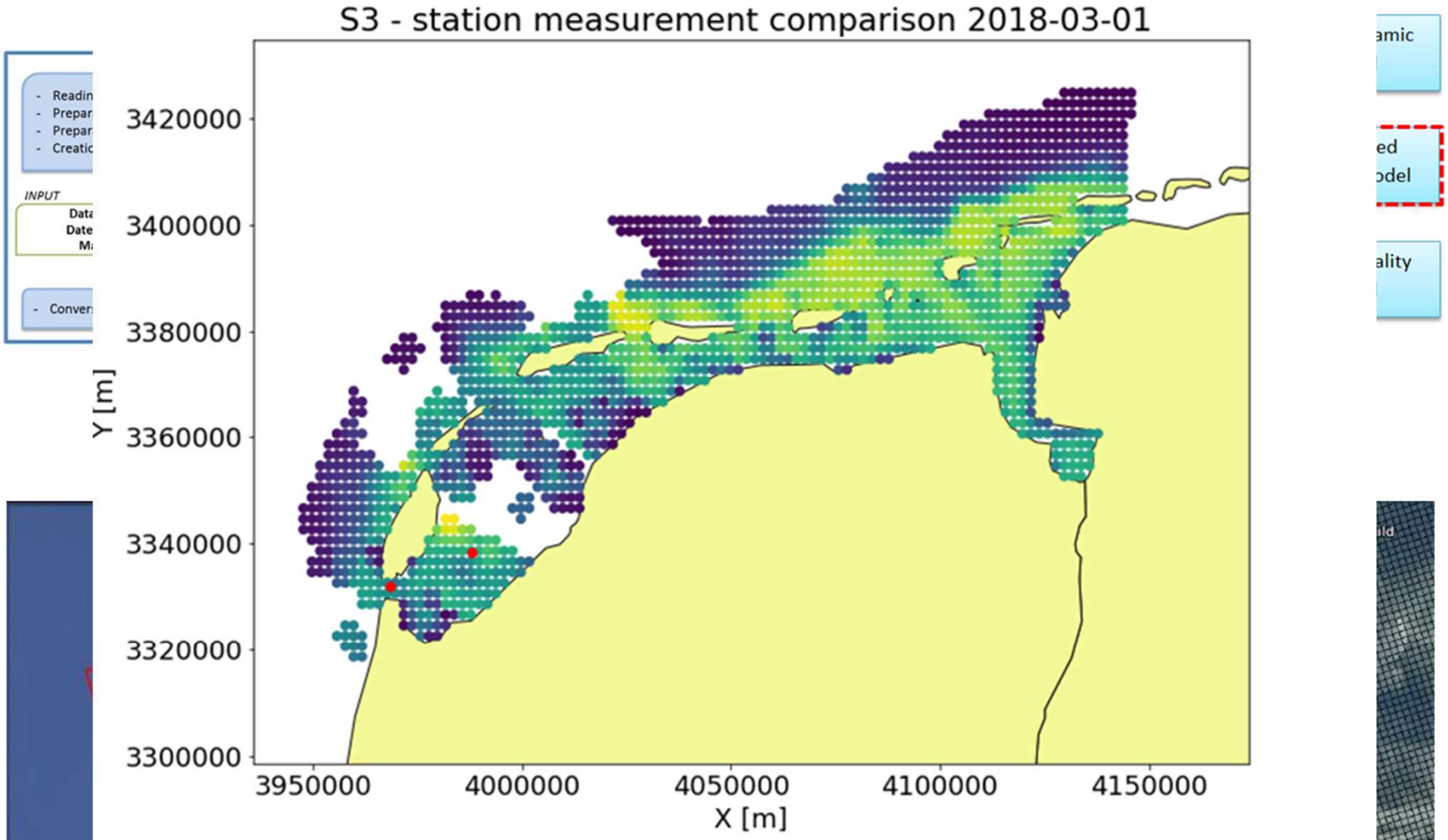
2) Conversion:
NetCDF data is converted to m file, compatible with MATLAB.

3) Processing:
Data is downscaled and fitted on the computational grid.

4) DELFT3D-FLOW:
Boundary conditions are defined.

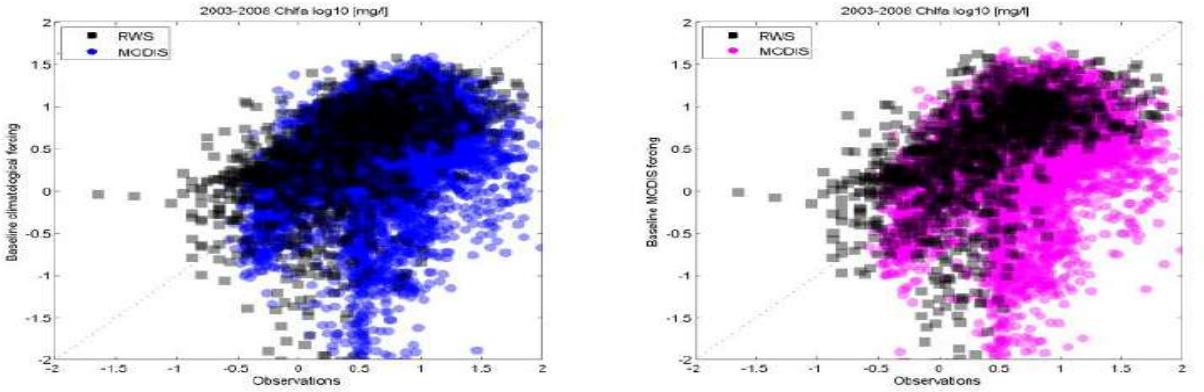
4) Calibration:
Model is run and calibrated.

Calibration Via Hindcasting for Short Term Forecasts

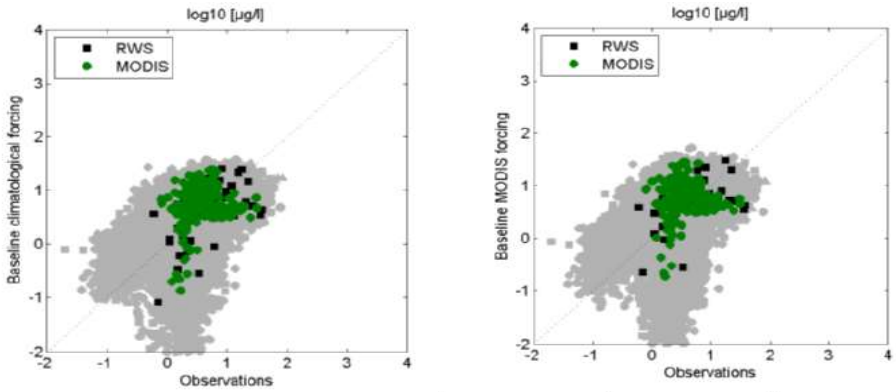


Calibration Via Hindcasting for Short Term Forecasts

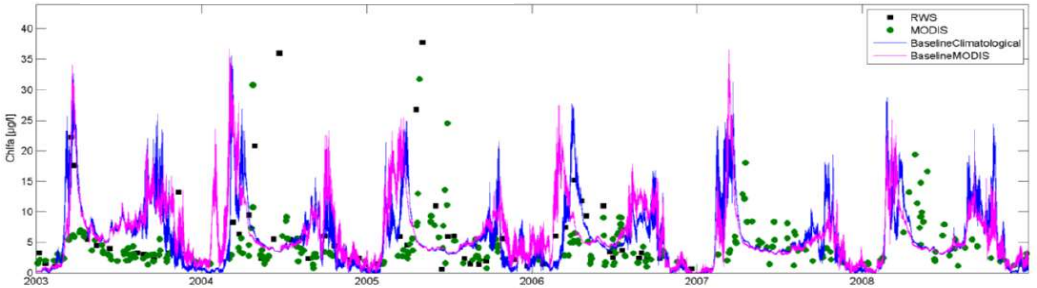
- Scatter plot of Chla model against different types of observations
- The in-situ Chl-a observations are given in black and those of MODIS are given magenta (right) and blue(left)



- In both figures, the EO TSM driving forces, are having a positive effect on the start of the bloom and the maximum concentration of the bloom.



- At low concentrations, noisy results are observed from the model results, smoothing of the EO-TSM is thus suggested by taking less modes in the DINOEF gap-filling procedure and apply smoother



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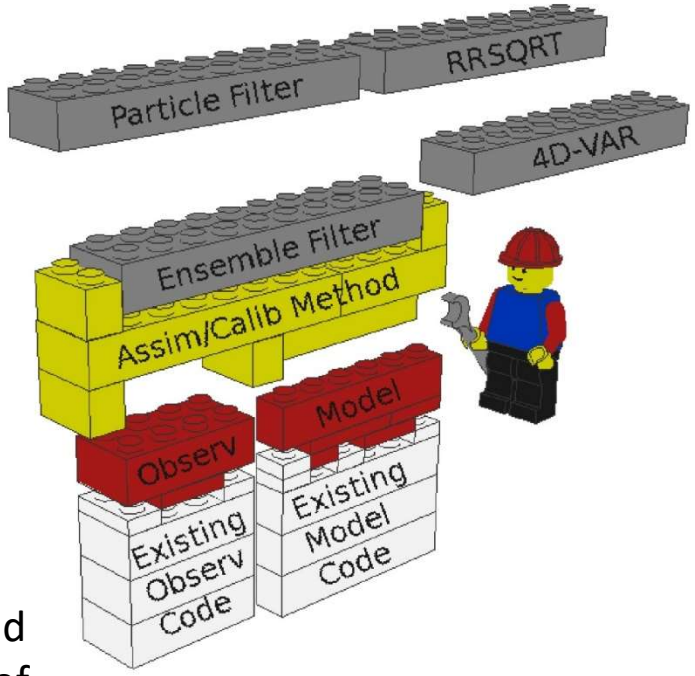
Calibration Via Hindcasting for Short Term Forecasts

- The model performance has been improved mainly at high concentrations in comparison to the in-situ measurements (black dots).
- It also indicates that the model underestimates the concentration at low concentrations.
- These results do show an improvement and a shift in the model performance which better aligns with the in-situ monitoring data which is typically taken as the ground truthing measurements.
- Further improvements are expected with the implementation of the Sentinel Series data (Ocean and Land Colour Instrument OLCI) are running expected publication of results in August



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Questions?

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