



Il sistema modellistico CADEAU: un focus ad alta risoluzione sul Nord Adriatico a partire dai prodotti CMEMS

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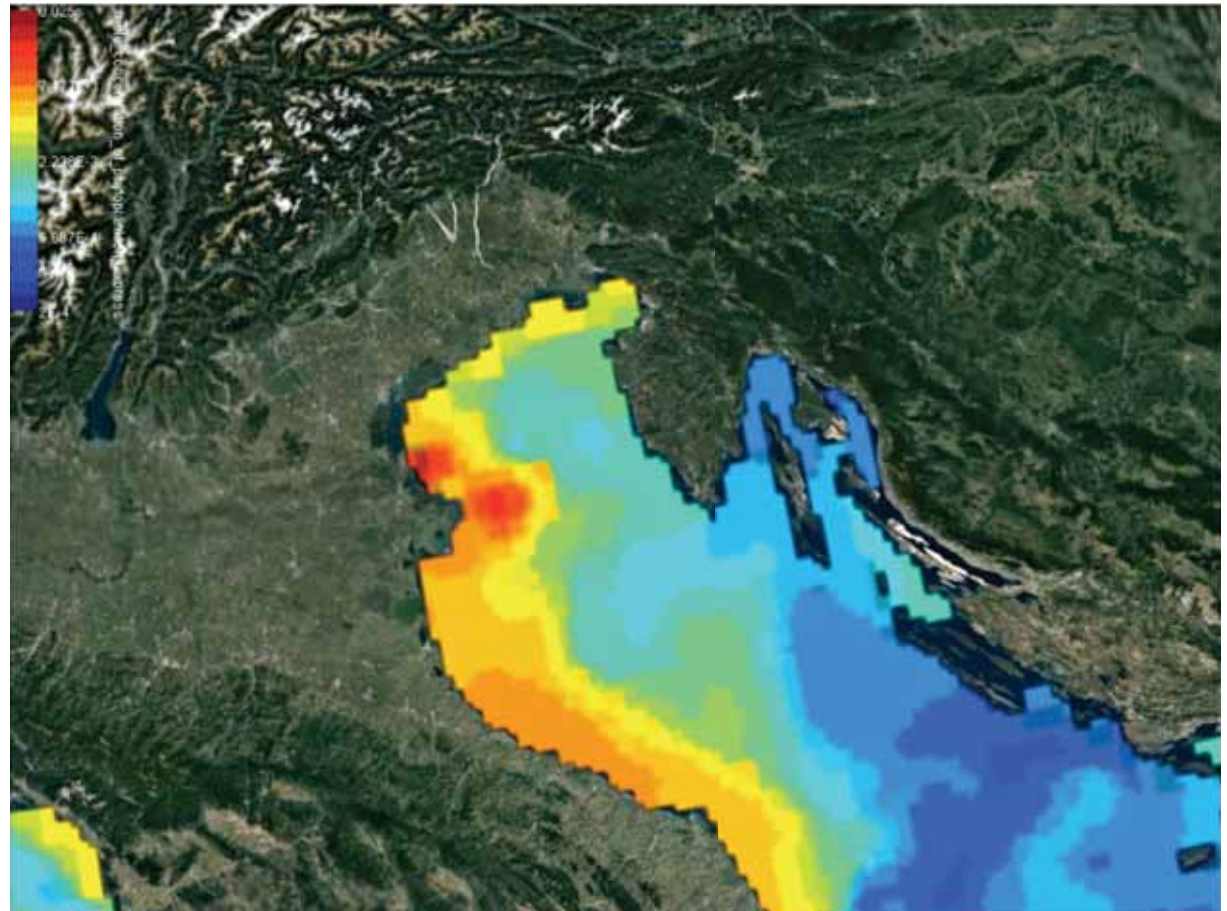
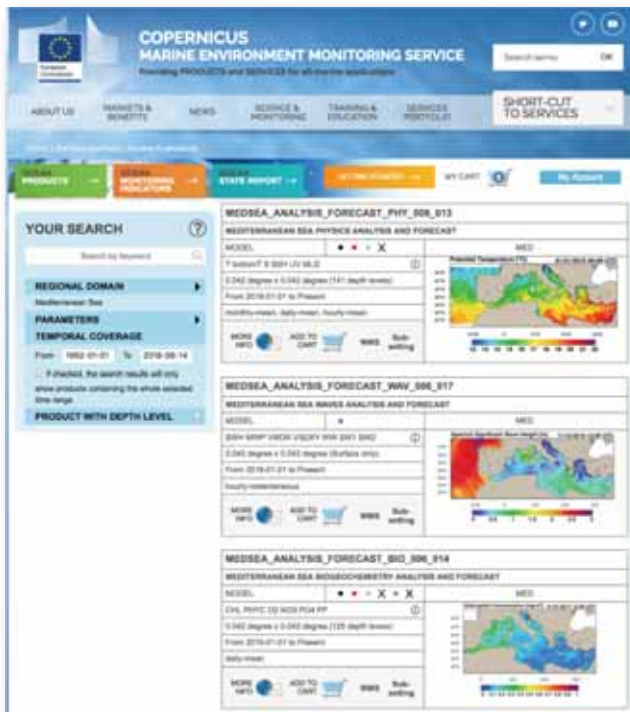
Workshop CADEAU, Venezia, 5 giugno 2018



Downscaling del servizio COPERNICUS MEDITERRANEO in Alto Adriatico

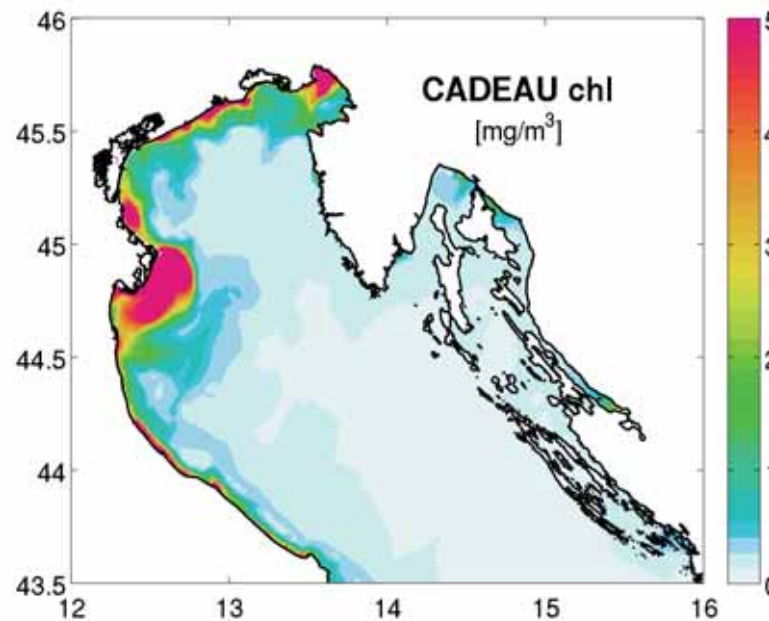
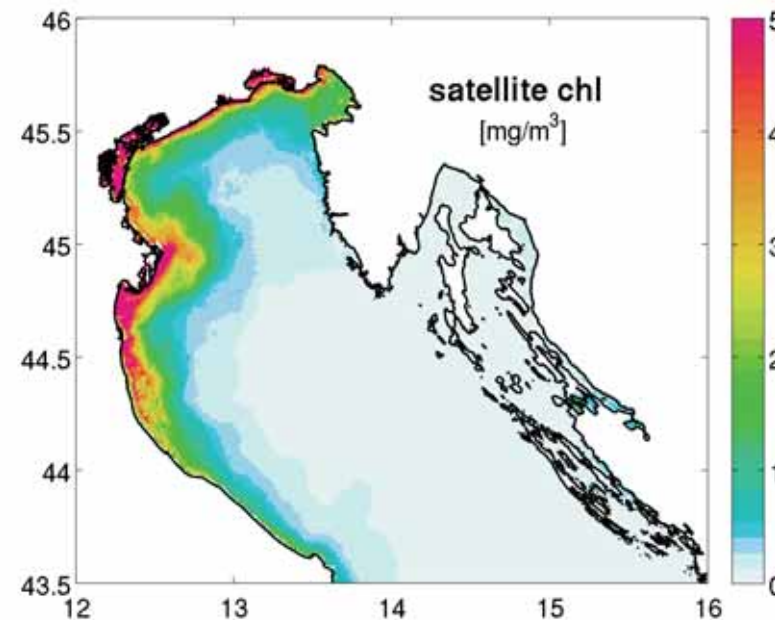
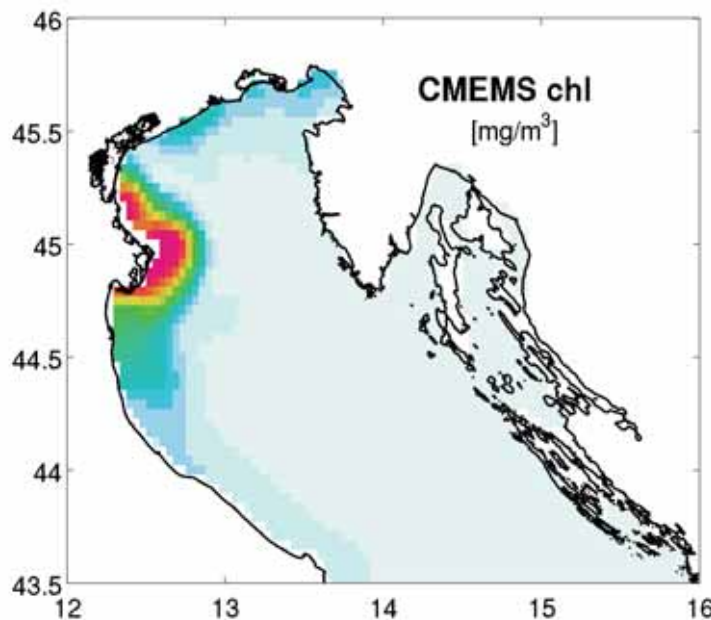
MARINE.COPERNICUS – Mediterraneo:
servizio di **previsione giornaliera dello stato del mare** alla risoluzione di circa **4.5 km**

Catalogo on line (libero e gratuito)
dei prodotti per le variabili **fisiche**,
biogeochimiche e per il **moto ondoso**



PROBLEMA: per molte applicazioni **costiere**, la risoluzione (**1/24°**) non è sufficiente

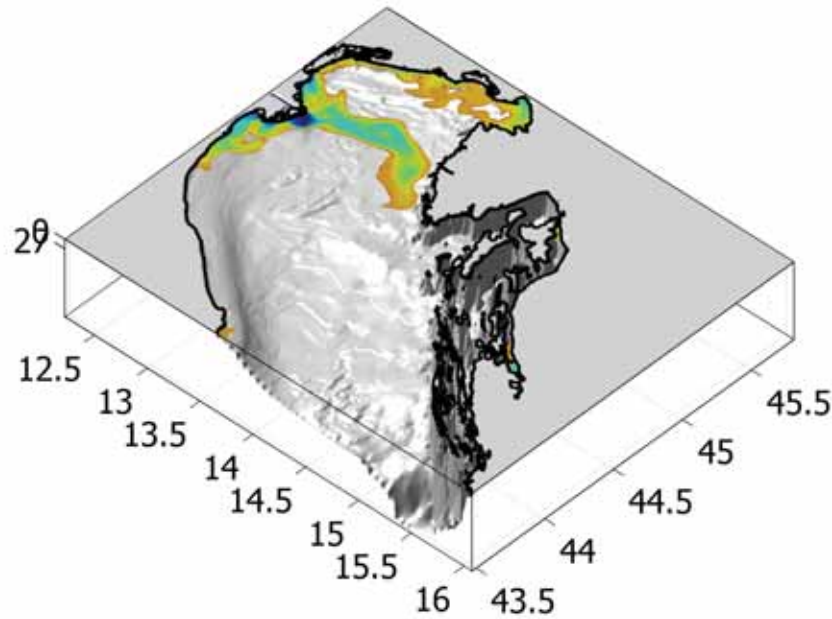
Confronto modello CMEMS, modello CADEAU e dato satellitare



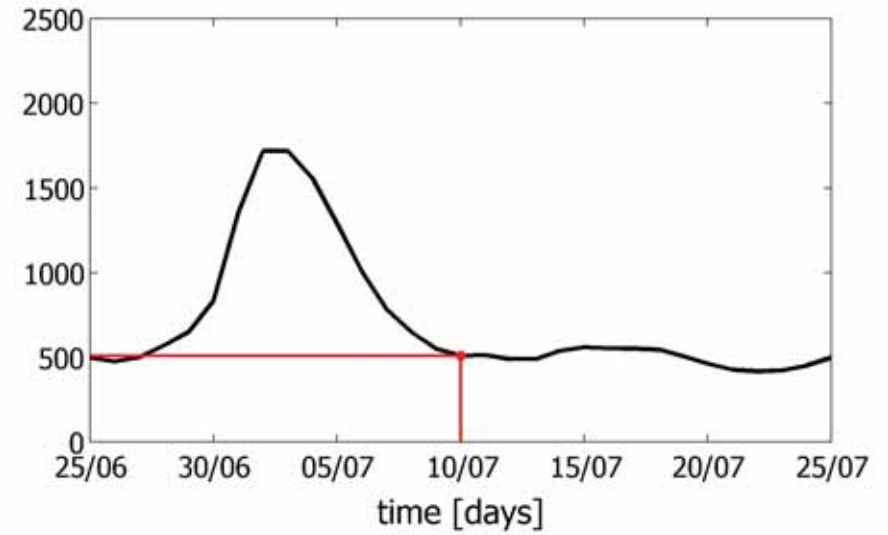
**clorofilla
superficiale**

10-14 giugno 2017

salinity
36 PSU

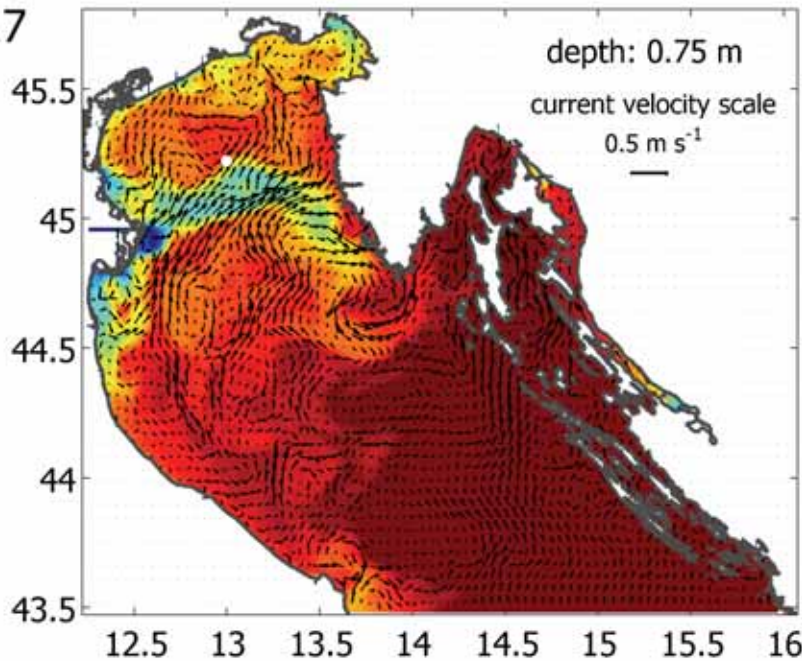


Po river discharge [m^3s^{-1}]

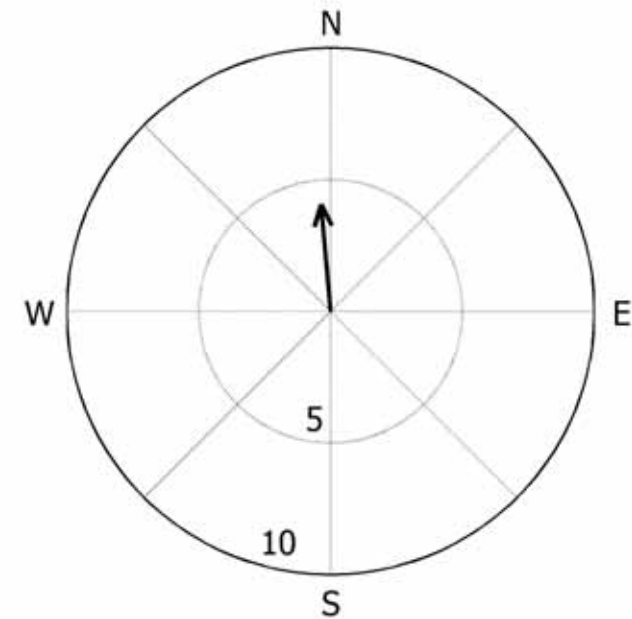


10/07/2017

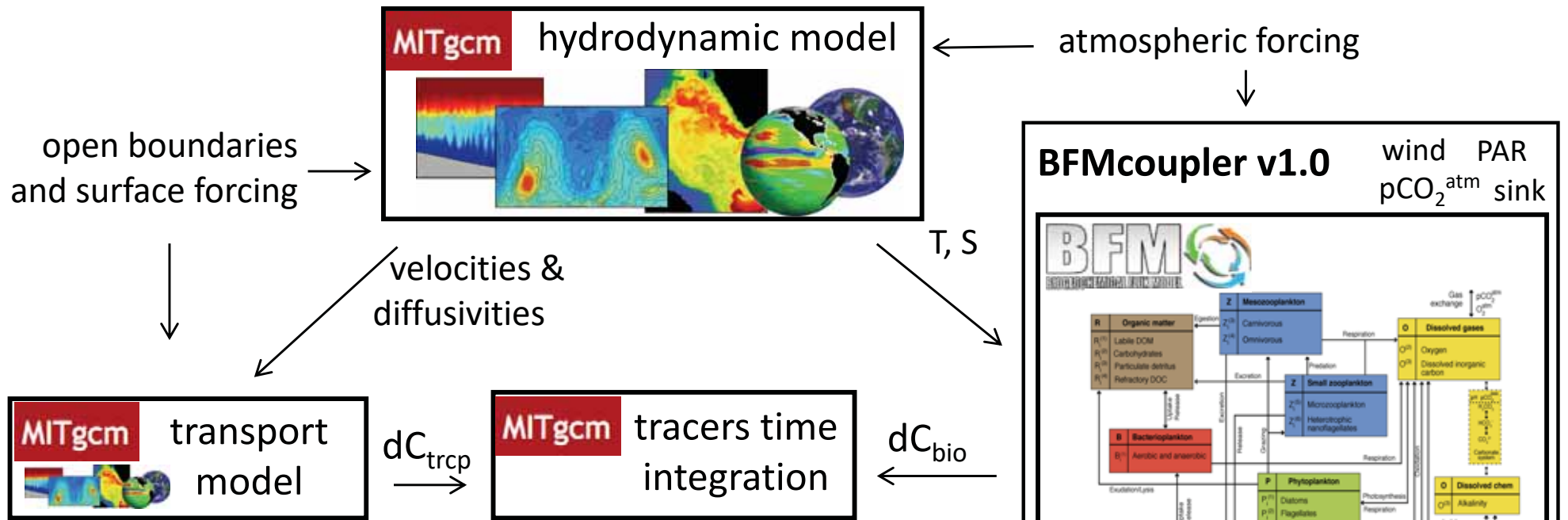
salinity and currents



wind [m s^{-1}]



Sistema modellistico CADEAU basato sul modello accoppiato MITgcm-BFM a $1/128^\circ$ (~ 700 m)



[Cossarini et al., 2017]

BFM: modello biogeochimico ufficiale della comunità CMEMS Med-MFC

MITgcm: modello idrodinamico “state-of-the-art”

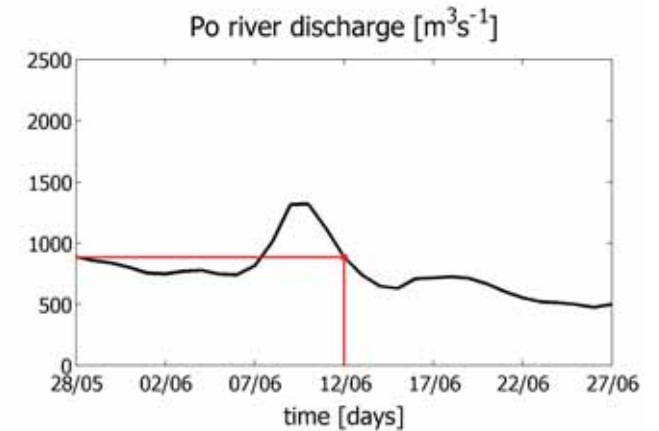
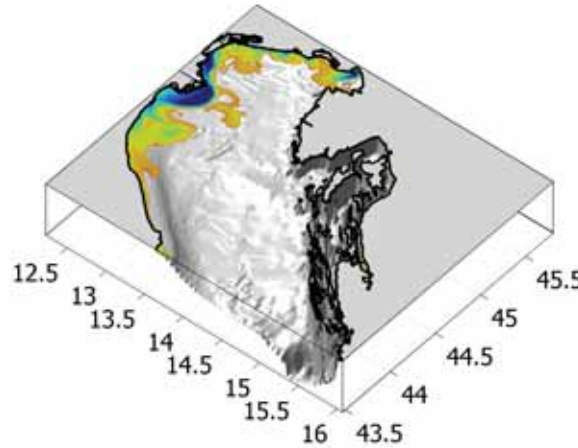
BFMcoupler v1.0: nuovo accoppiamento online (possibili feedback a due vie), approccio modulare, schemi di integrazione ottimizzati, open source

3DVAR-BIO/NUDGING: assimilazione di clorofilla superficiale e dei dati costieri di nutrienti/clorofilla

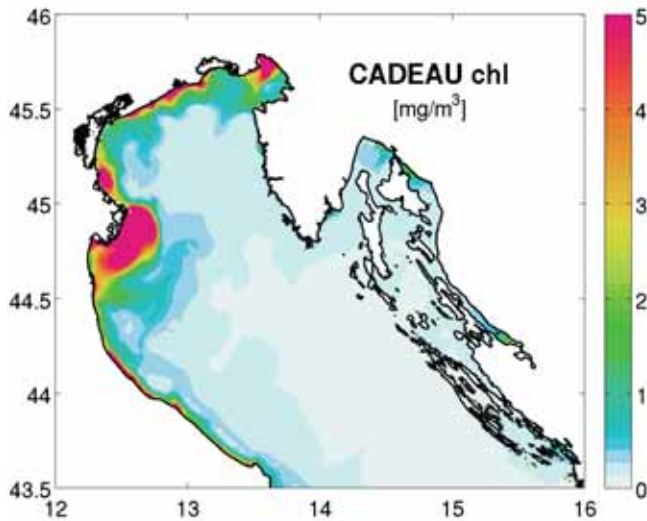
3DVAR-BIO/NUDGING
(surface chlorophyll, coastal data)

Interazione fra processi idrodinamici e biogeochimici:
grande **variabilità spaziale e temporale!**

salinity
36 PSU

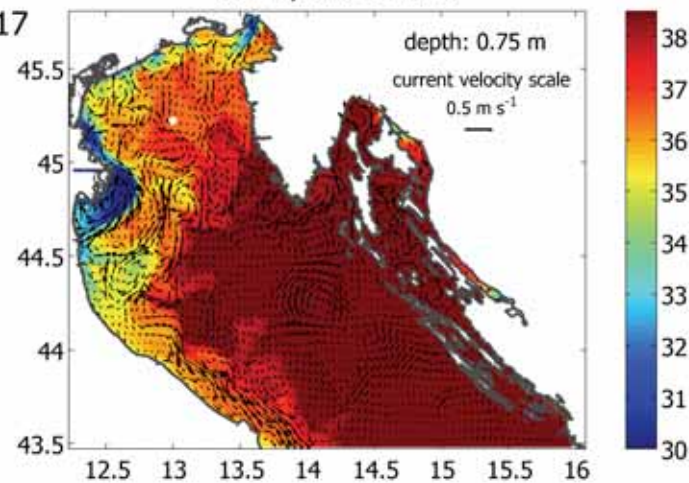


surface chlorophyll
10-14/06/2017

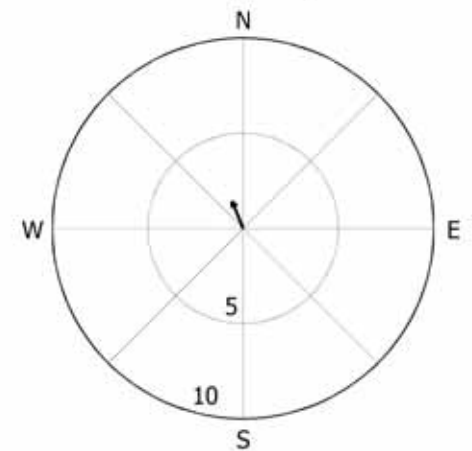


salinity and currents

12/06/2017



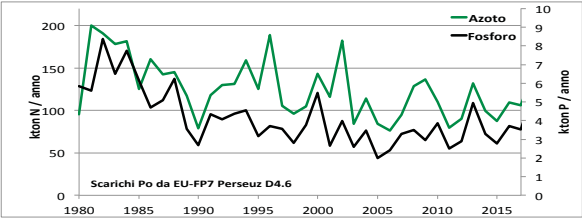
wind [m s^{-1}]

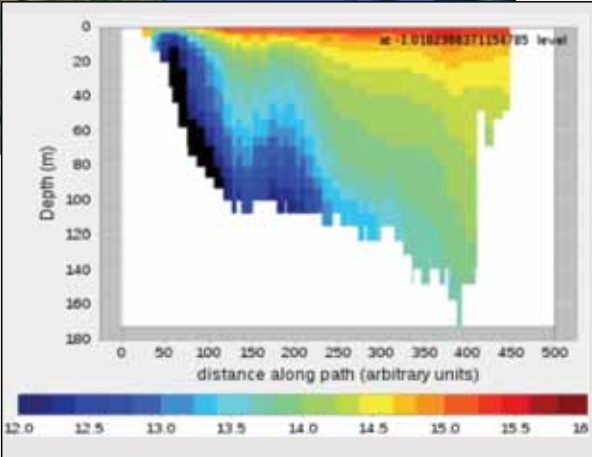
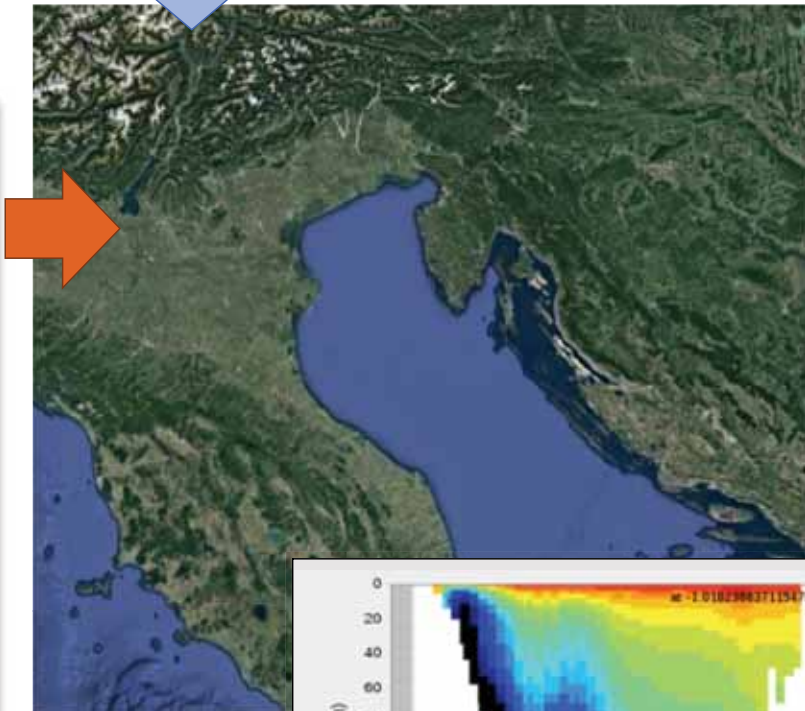


Runoff fluviale: ARPAE, ARPA-FVG, climatologie [Raicich et al., 1994]



**Forzante atmosferico:
ECMWF, COSMO I2
(ARPAE)**

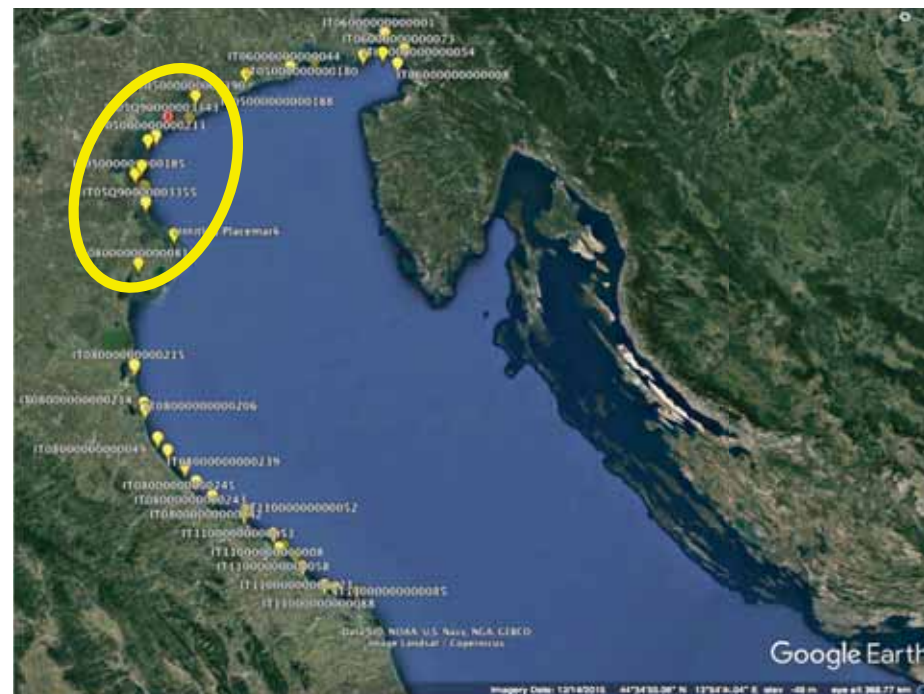
- Input di nutrienti:**
- ✓ **FIUMI:** progetto EU-FP7 Perseus, D4.6
- 
- ✓ **LAGUNA di VENEZIA** [Solidoro et al., 2006]
 - ✓ **ATMOSFERA** [Ribera d'Alcalà et al., 2003]
 - ✓ **REMIN. FONDO** [Giordani et al., 2002; Bertuzzi et al., 1997]
 - ✓ **RETE SCARICHI A MARE:** ISPRA-UWWTP



Condizioni al contorno per il bordo aperto a sud (*nesting*) per variabili fisiche e biogeochimiche: COPERNICUS

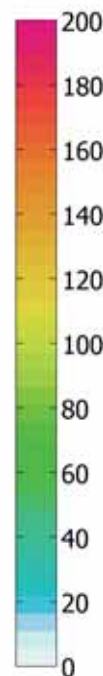
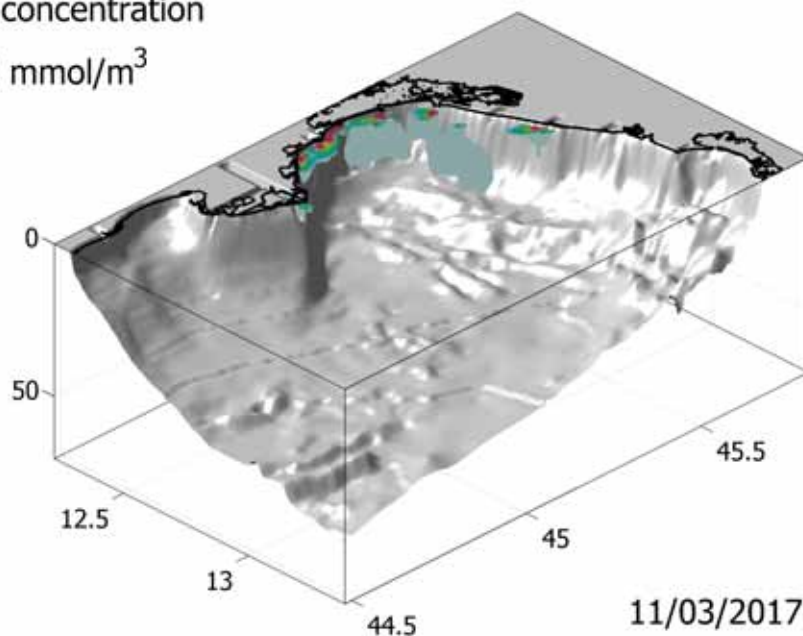
Simulazione degli scarichi costieri:
flusso dal fondo di nitrato e fosfato
 (dataset ISPRA)

Caso studio **balneazione** (Chioggia):
 12 sorgenti di “escherichia coli”



tracer concentration

10 mmol/m³



legge di decadimento [Chan et al., 2013]

$$k(z, t) = (k_b + k_s S(z, t)) \theta^{T-20} + k_I I(t) e^{-e_t z}$$

z (depth)

t (time)

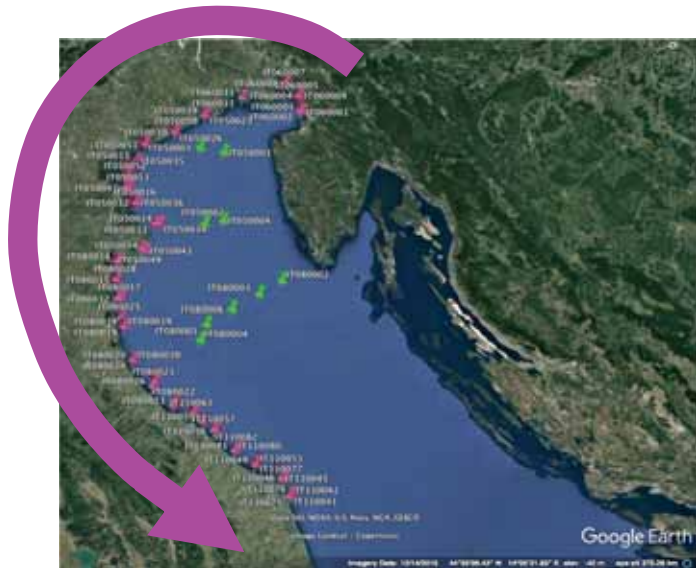
$$k_b = 0.8$$

$$k_s = 0.017$$

$$k_I = 0.086$$

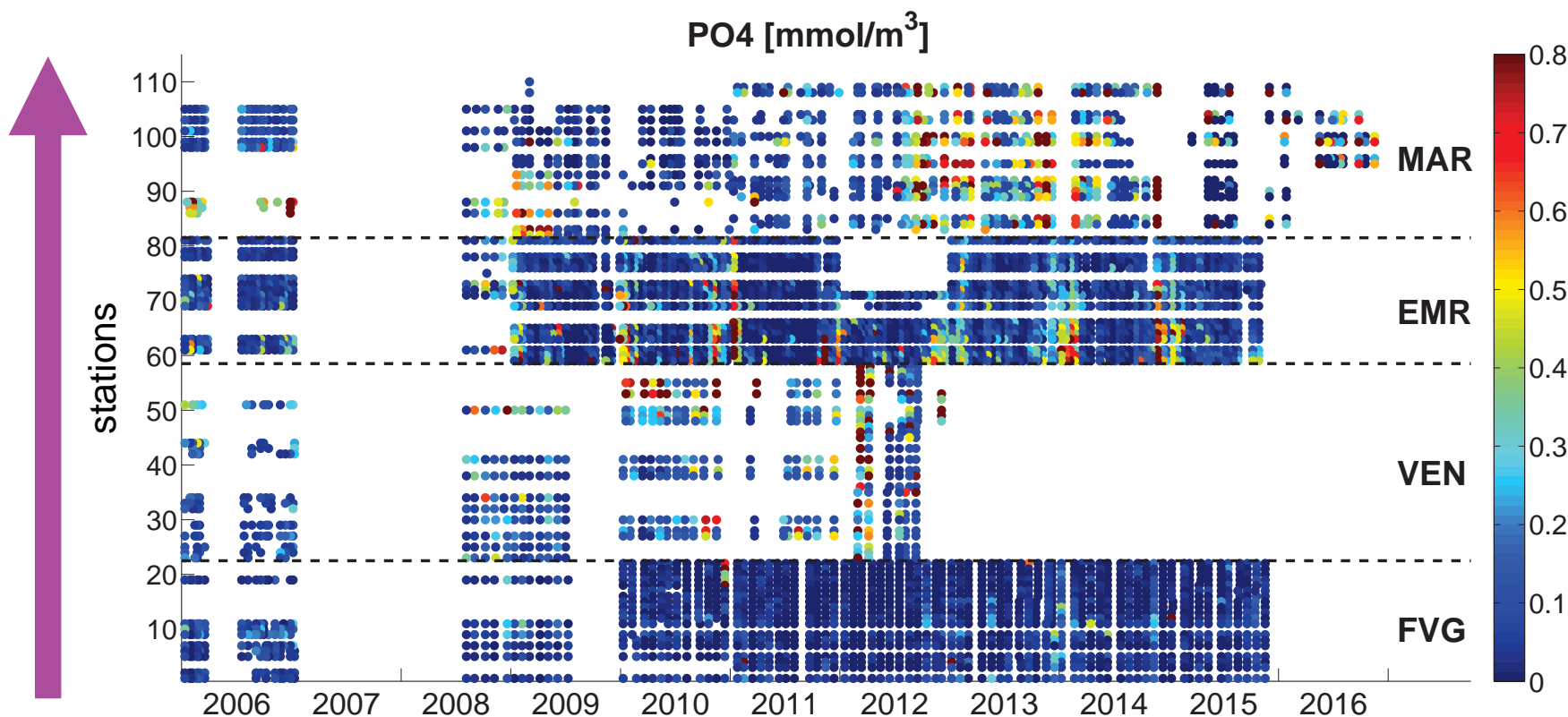
$$e_t = 0.5 \text{ (higher transparency)}$$

$$\theta = 1.07$$

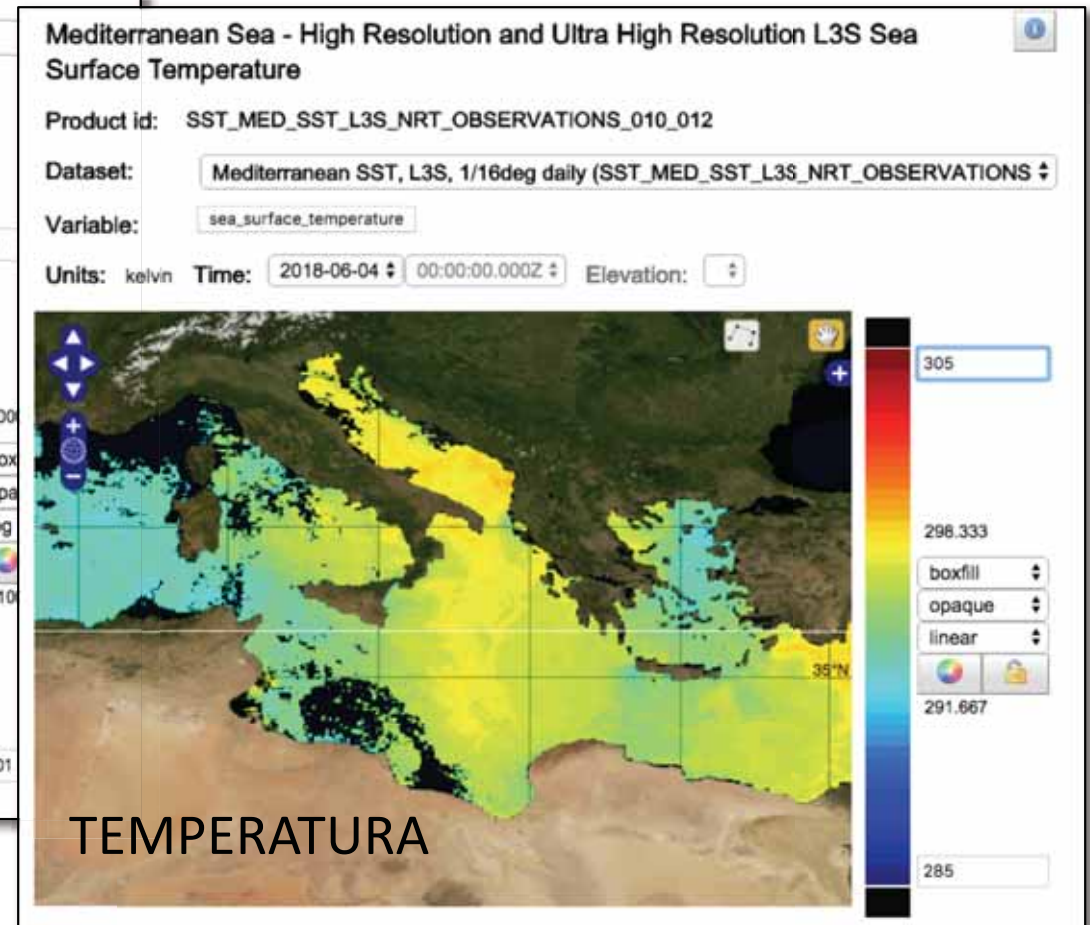
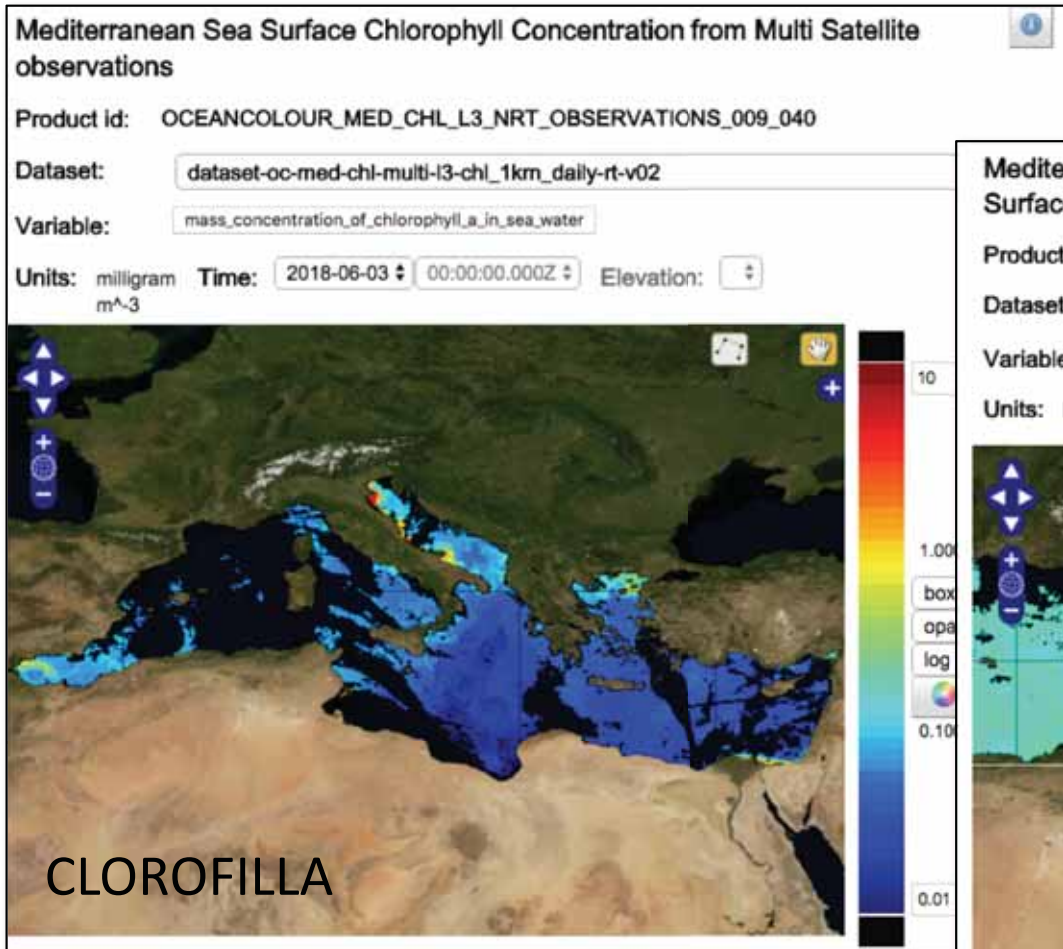


Dati sperimentali *in-situ* (stazioni ISPRA)

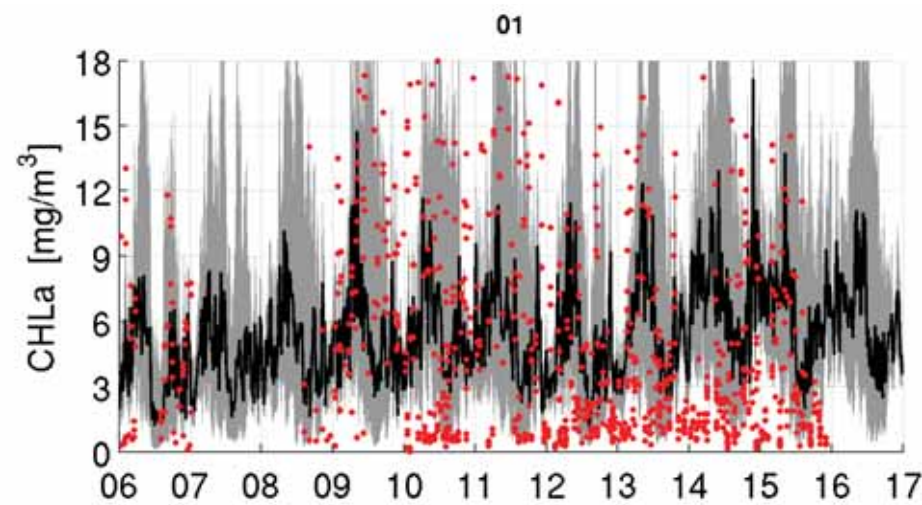
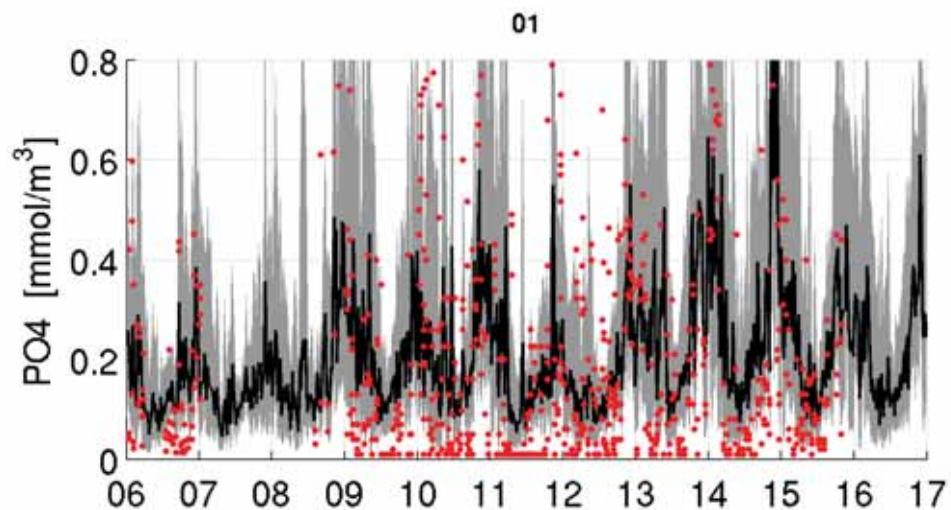
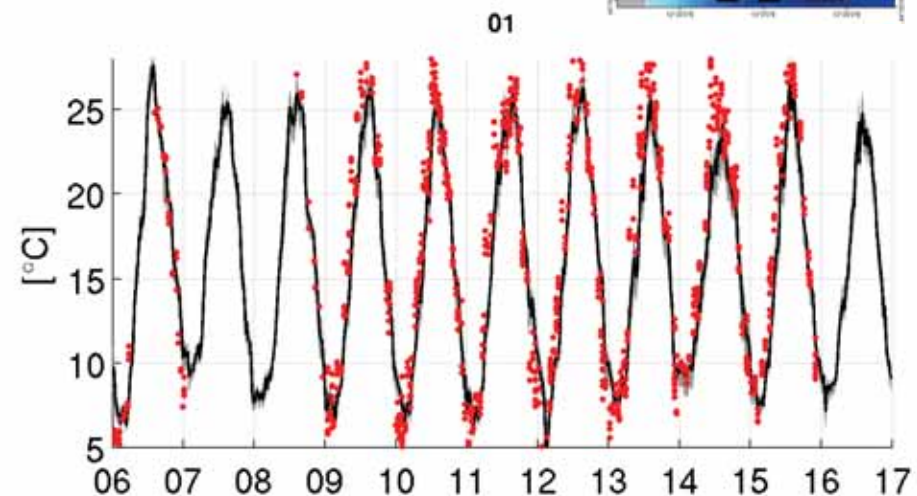
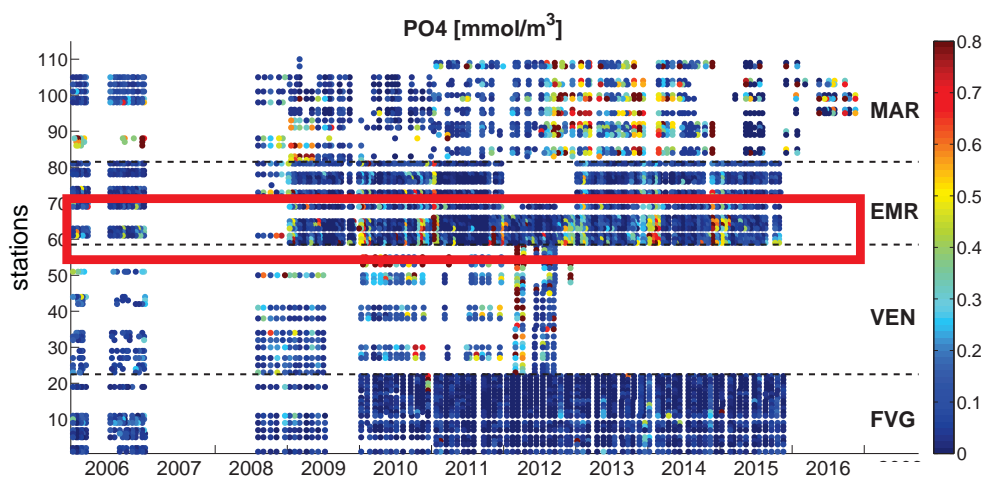
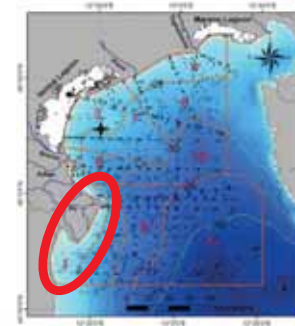
- ✓ dati costieri
- ✓ transetti
- ✓ utilizzo nelle simulazioni numeriche: **validazione e assimilazione**
- ✓ contributo della modellistica: **integrazione e interpretazione**



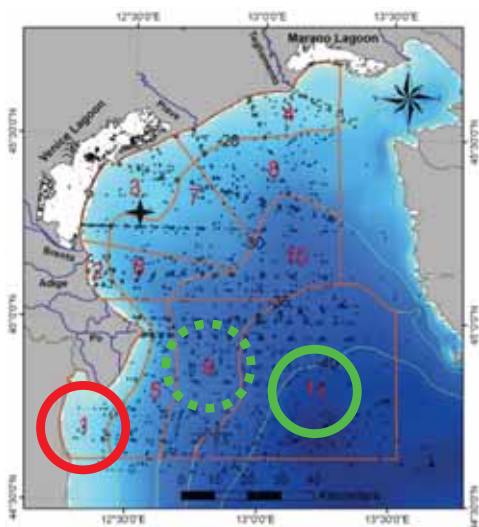
Osservazioni da **satellite** ad **alta risoluzione**, fino a 1 km (e anche oltre), con la nuova generazione di satelliti **Sentinel** gestiti dall'**ESA**.
Dataset resi disponibili dal sistema COPENICUS.



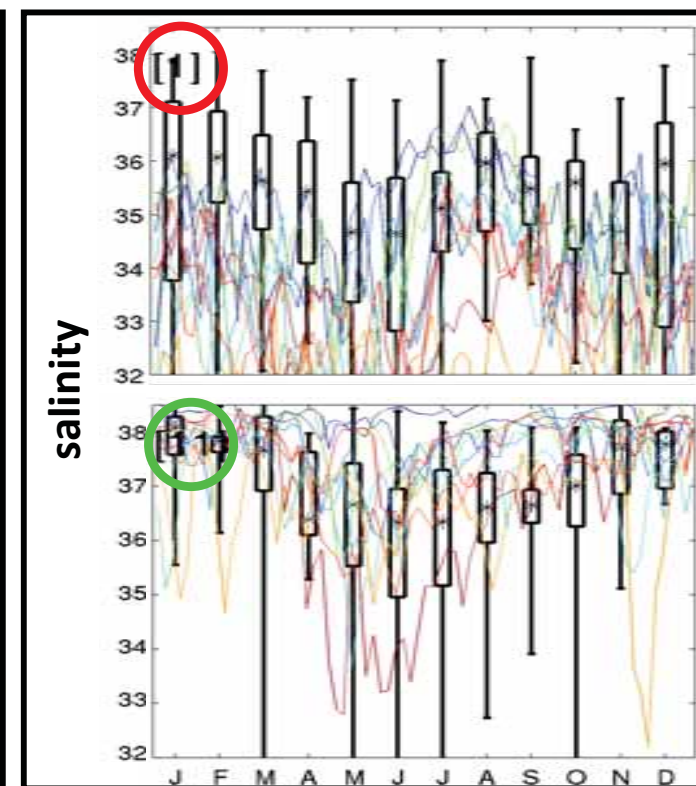
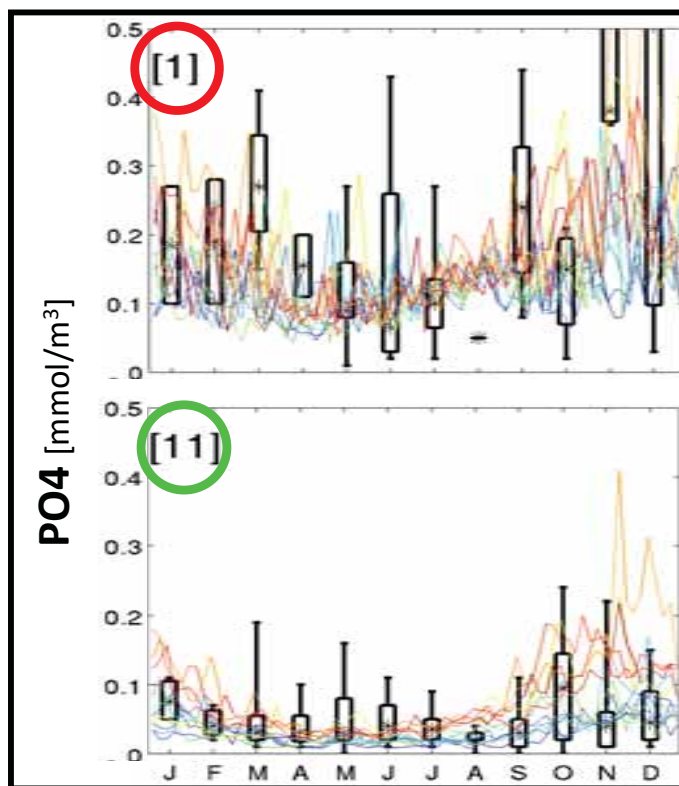
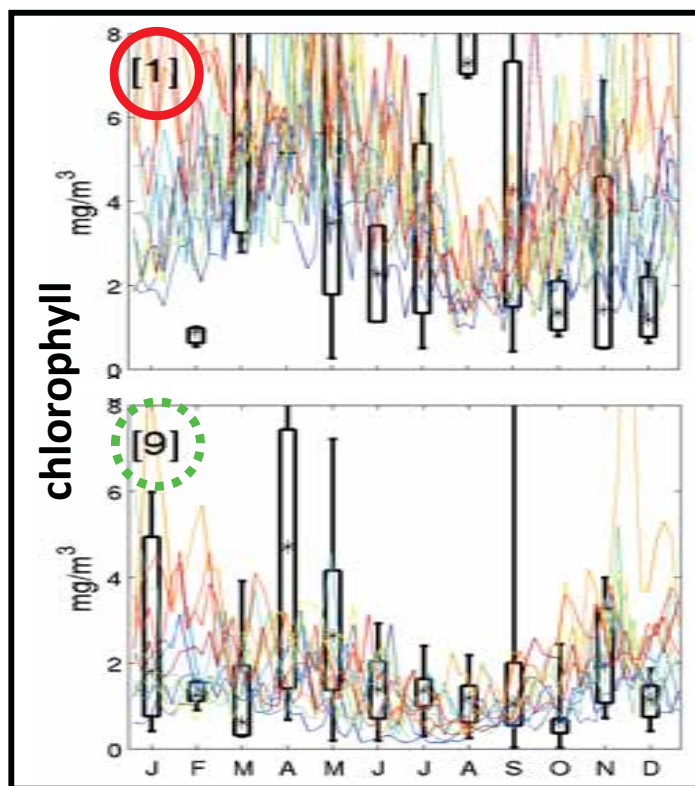
Serie temporali 2006-2016: confronto con il dataset ISPRA



Risultati consistenti con le climatologie per l'Alto Adriatico [*Solidoro et al., 2009*]



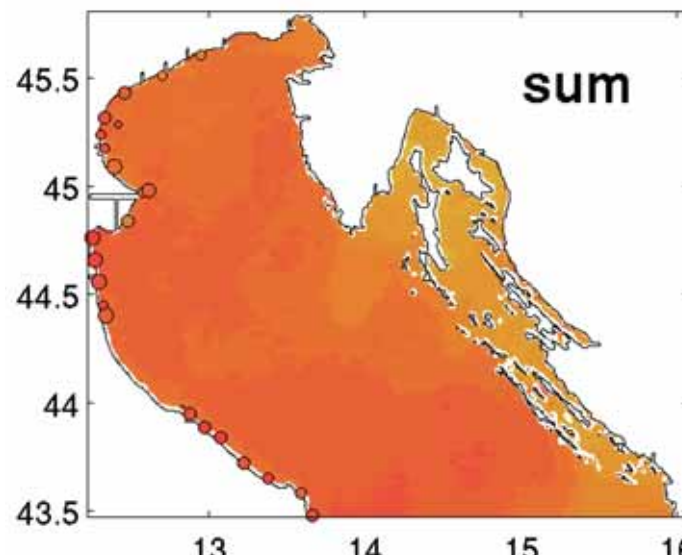
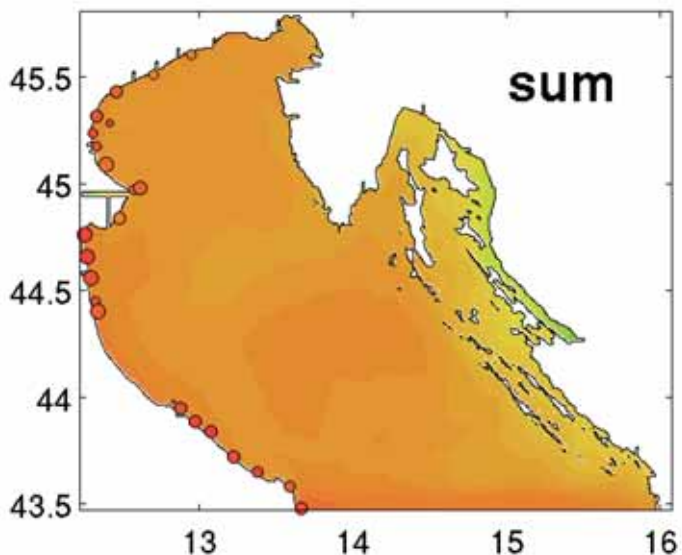
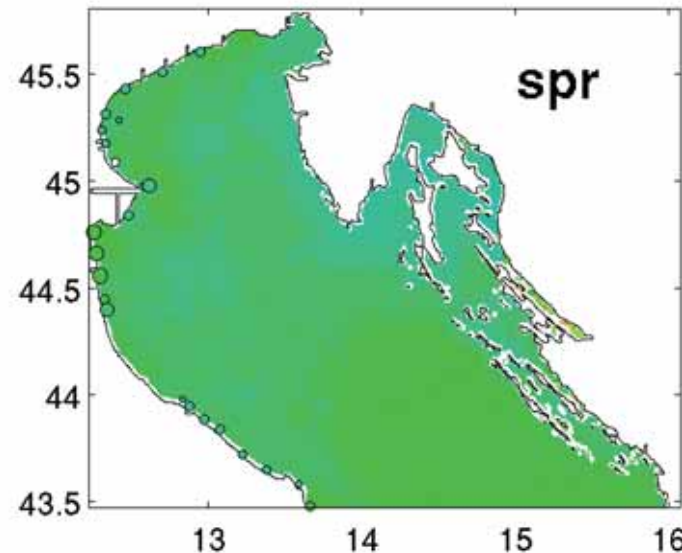
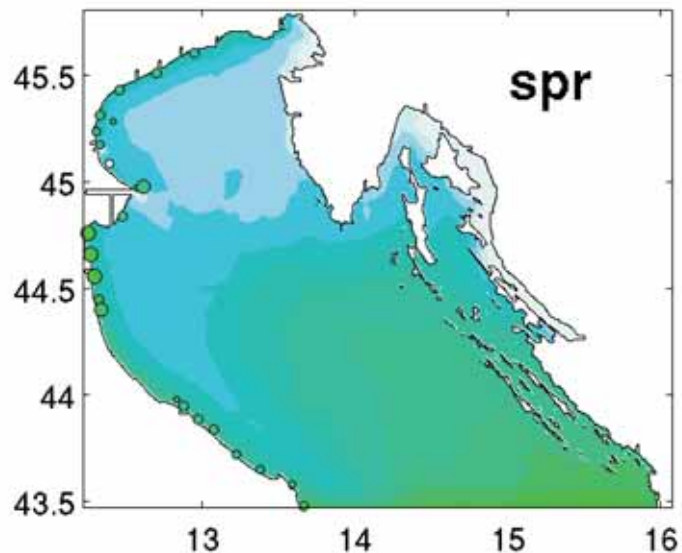
Nord Adriatico caratterizzato da elevati gradienti costa - largo



Mappe di temperatura superficiale (medie stagionali)

Modello (senza assimilazione)

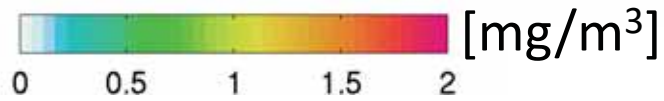
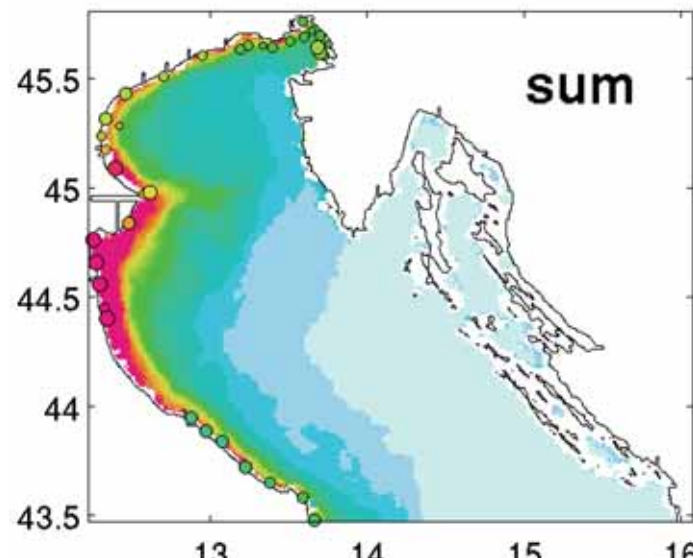
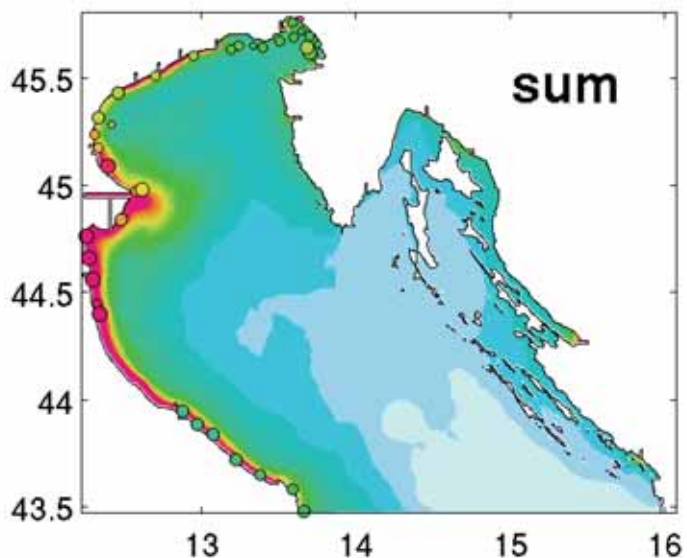
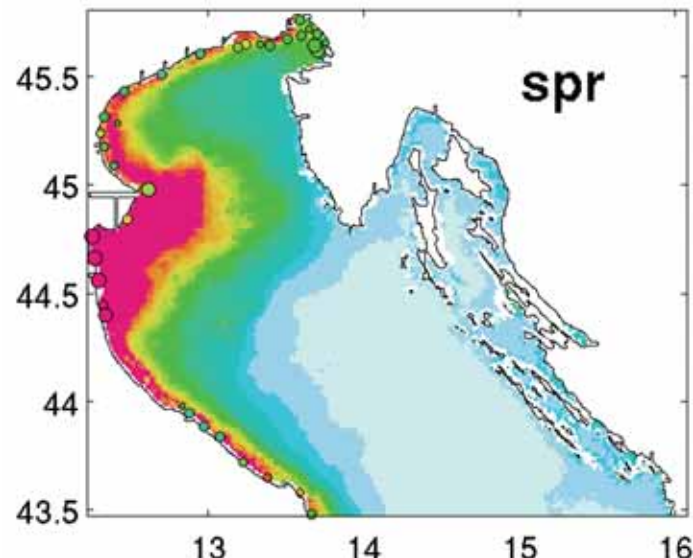
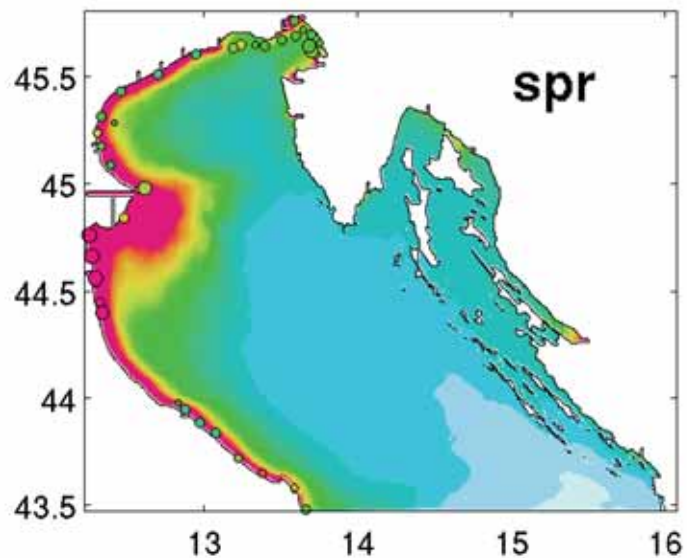
Satellite



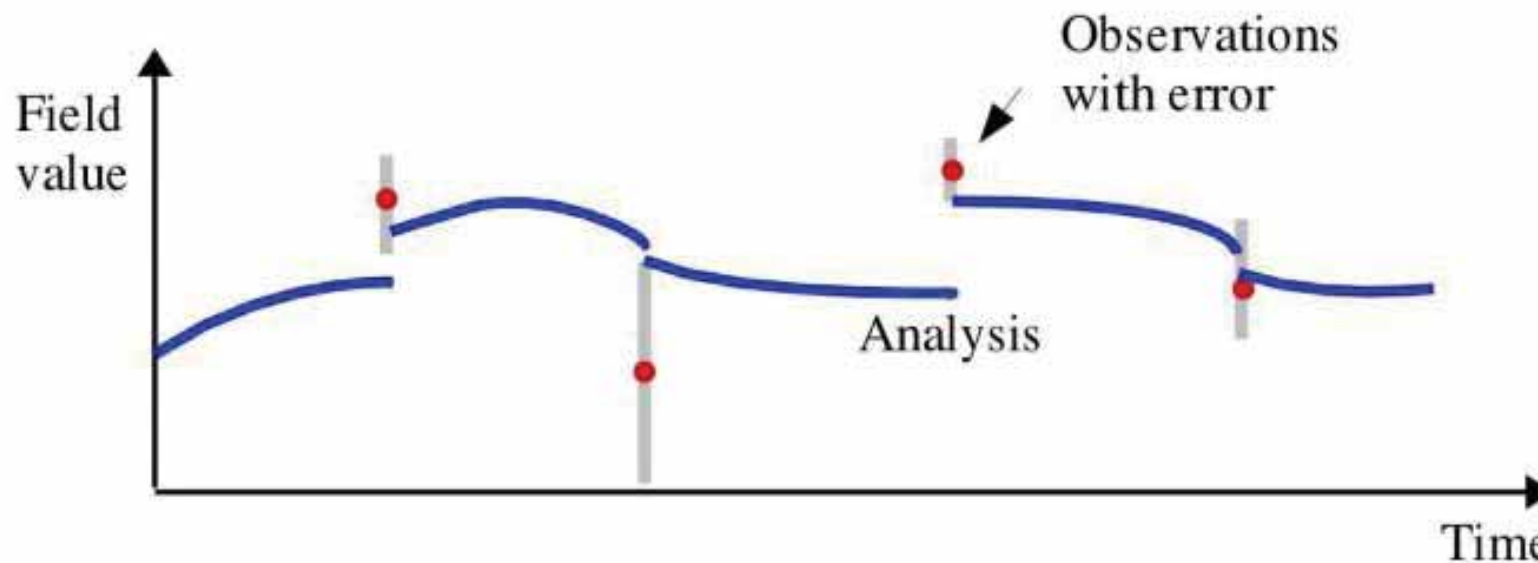
Mappe di clorofilla superficiale (medie stagionali)

Modello (senza assimilazione)

Satellite



Data assimilation: integrazione tra modello e osservazioni



Osservazioni da assimilare:

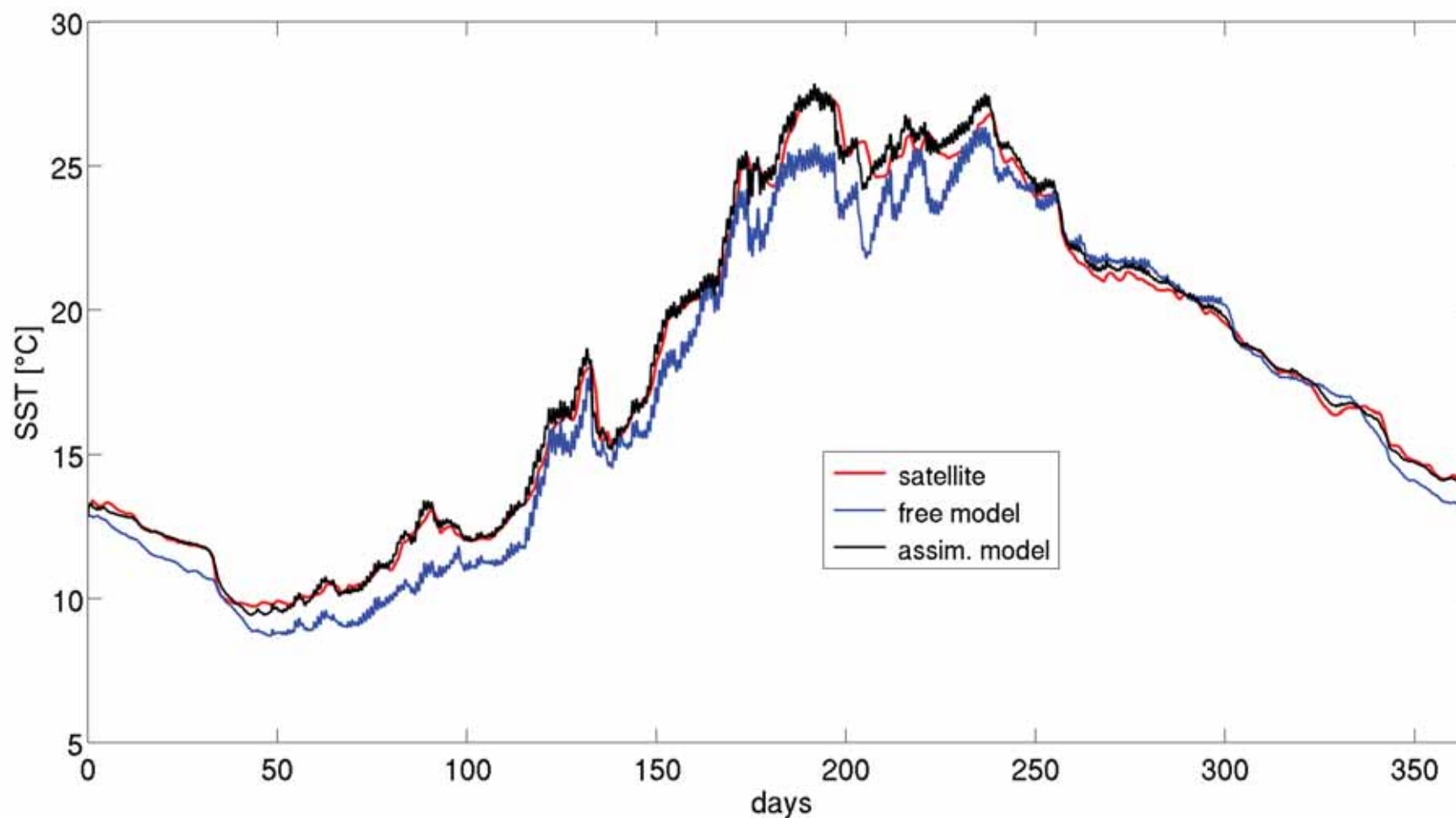
- ✓ **temperatura** superficiale da satellite (COPERNICUS)
- ✓ **clorofilla** superficiale da satellite (COPERNICUS)
- ✓ **concentrazione di nutrienti** nelle stazioni ARPA (ISPRA, EIONET/SOE dataset)

Metodologie di assimilazione:

- ✓ **nudging** (MITgcm-RBCS [*Adcroft et al.*, 2013])
- ✓ **schemi variazionali** (3DVarBio [*Teruzzi et al.*, 2014])

Serie temporale della **temperatura superficiale (SST)** nel 2012
(valore mediato sull'intero bacino):

dato osservato (satellite) e **modello senza** e **con assimilazione**

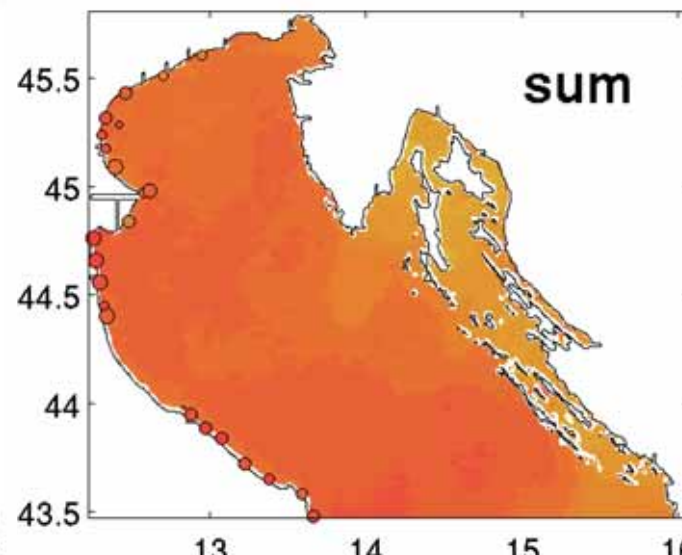
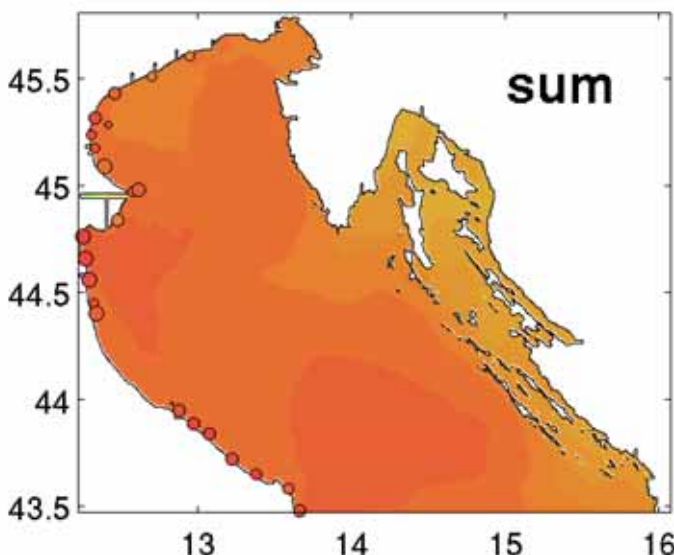
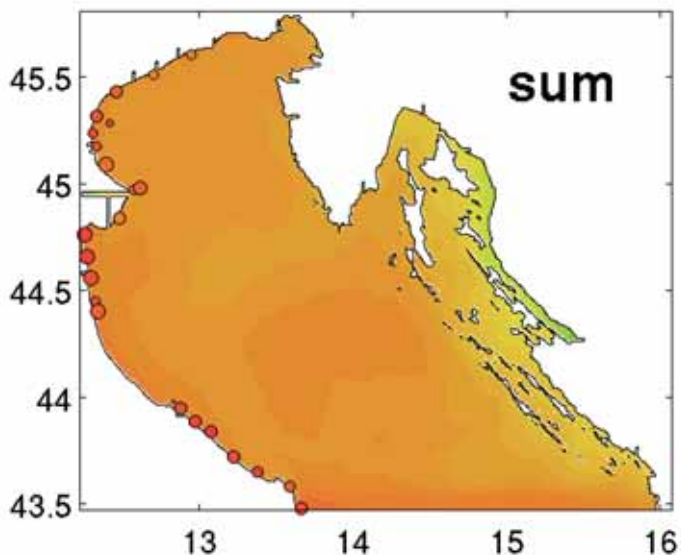
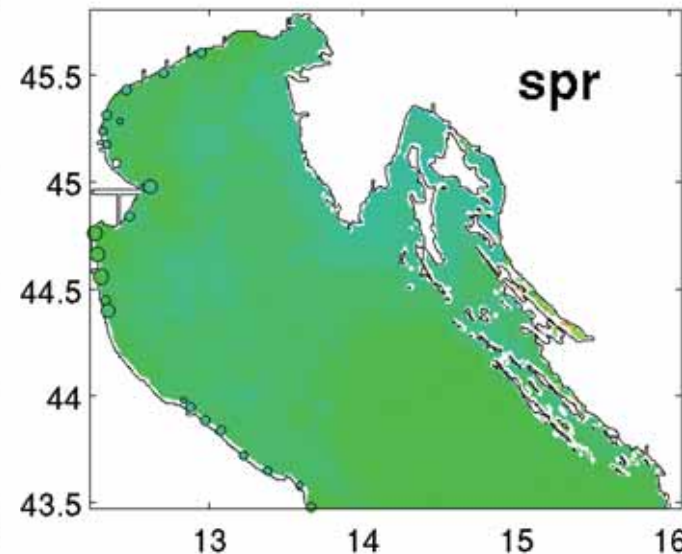
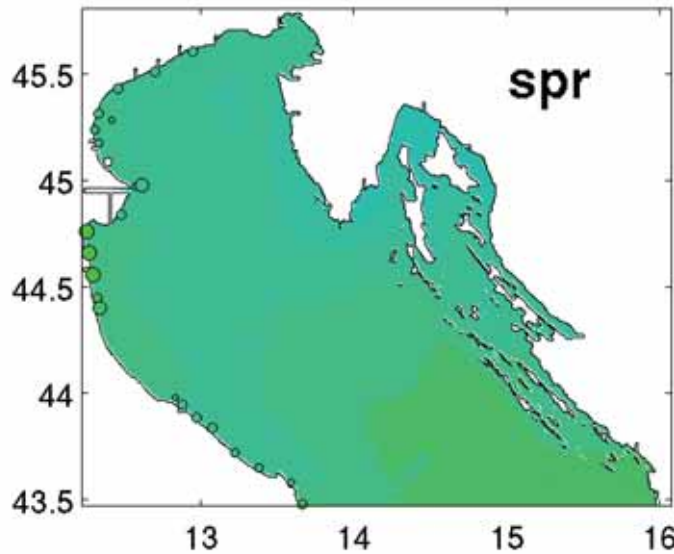
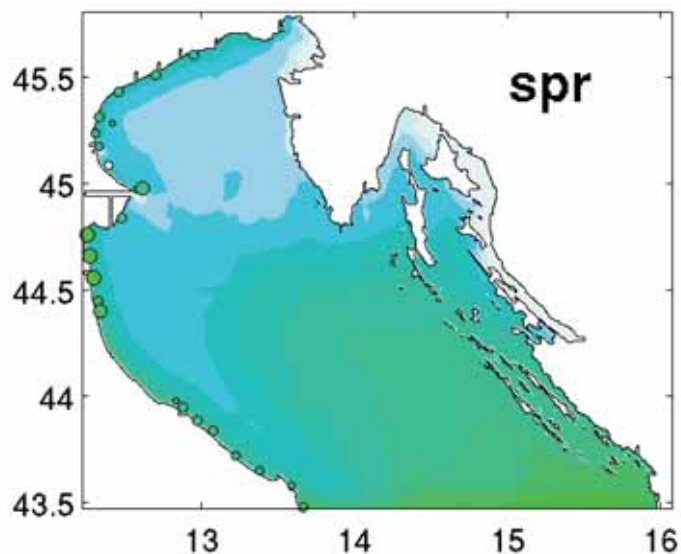


Mappe di temperatura superficiale (medie stagionali)

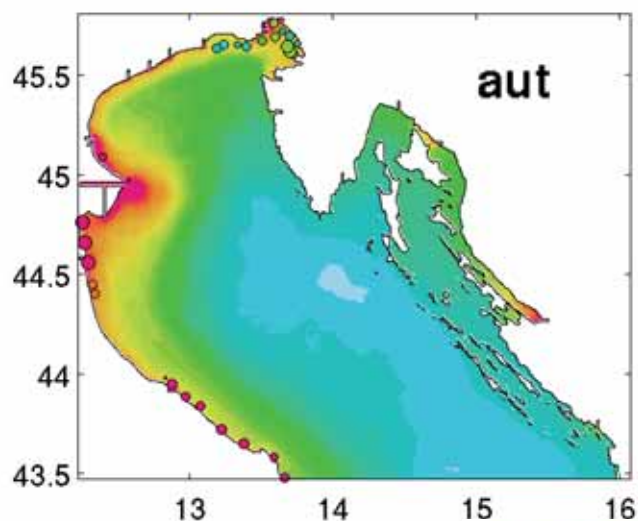
Modello (no assimil.)

Modello (assimilato)

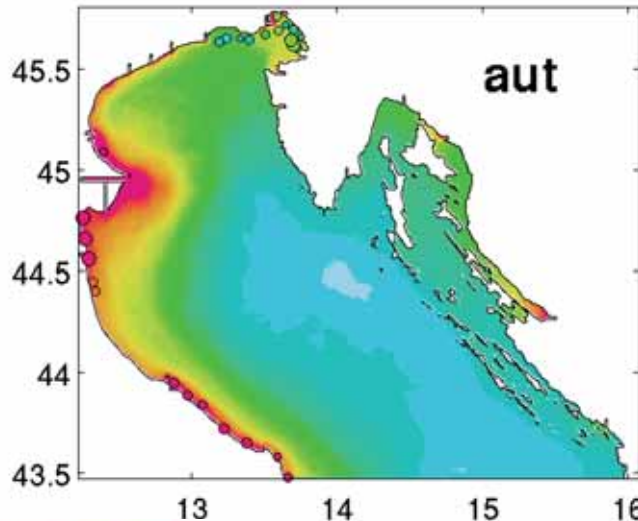
Satellite



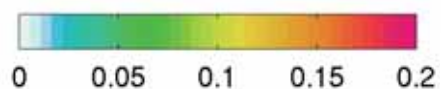
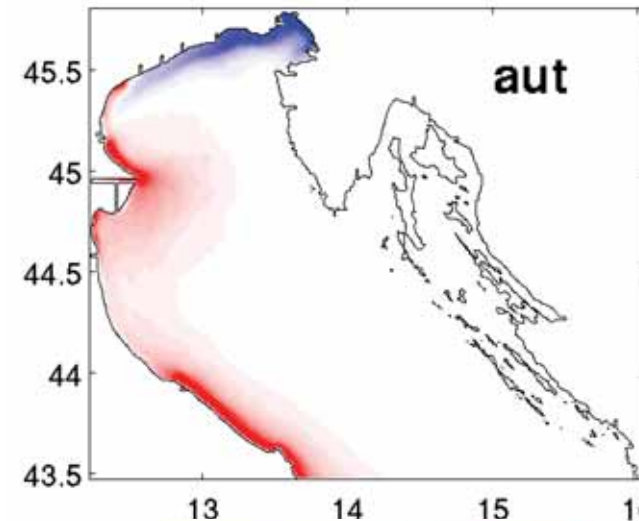
PO4 (non assimil.)



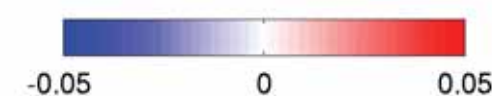
PO4 (assimilato)



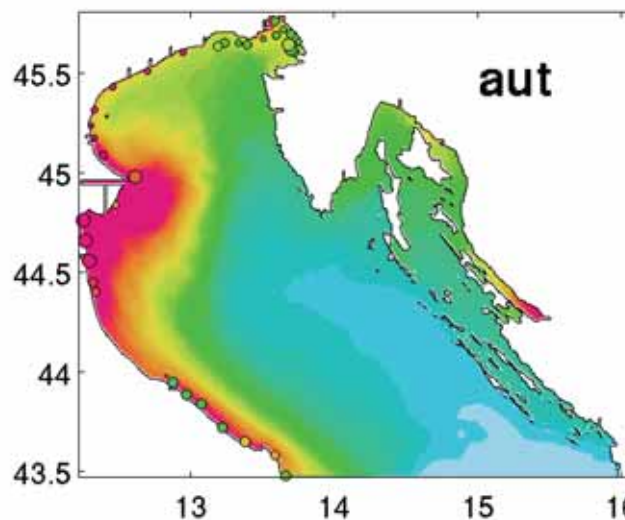
PO4 (anomalia)



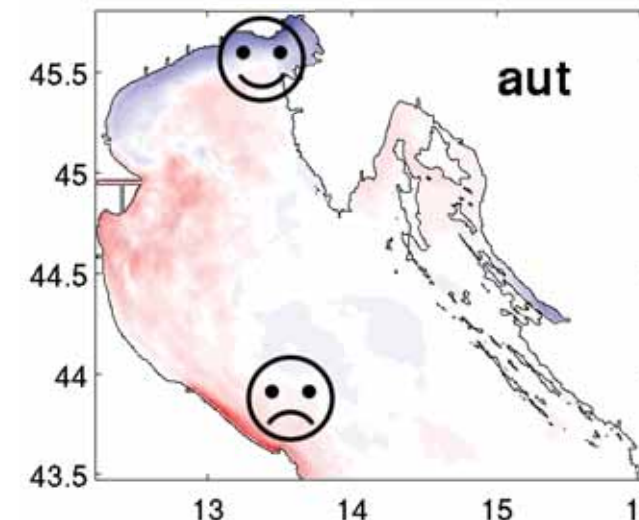
[mmol/m³]



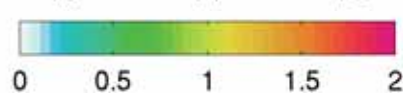
CHL (assimilato)



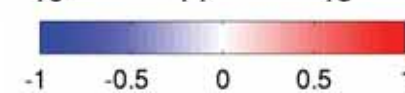
CHL (anomalia)

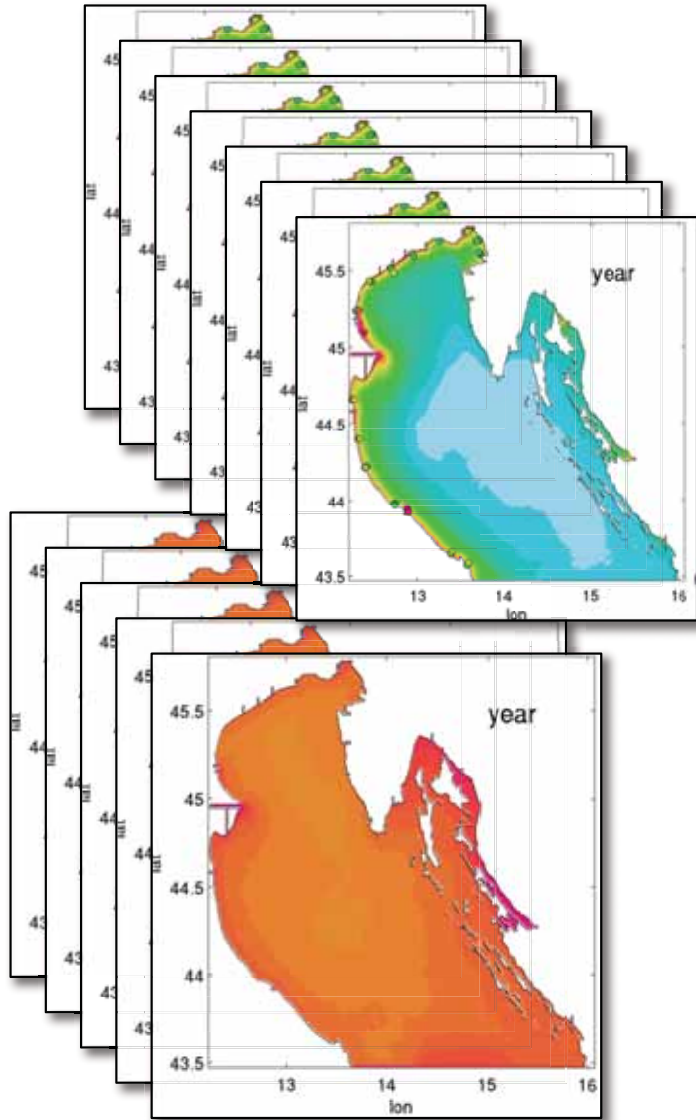


effetto dell'assimilazione
dei nutrienti sulla
concentrazione di
clorofilla



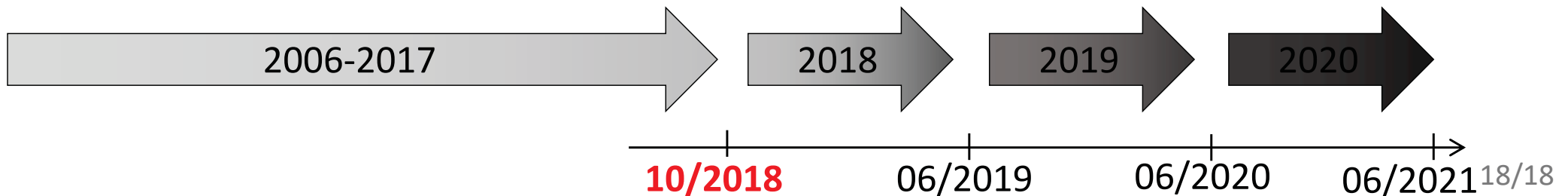
[mg/m³]





Modello fisico-biogeochimico ad alta risoluzione (~700 m) validato e integrato con le osservazioni sperimentali e da satellite (*data assimilation*):

- ✓ **rianalisi 2006-2017** → ricostruzione dello stato recente dell'Alto Adriatico dal punto di vista oceanografico/ecologico (riferimento per valutare i cambiamenti);
- ✓ **simulazioni annuali** dal 2018 al 2020 → bollettino dello stato del mare per l'anno precedente e prodotti derivati;
- ✓ **variabili simulate**: nitrato, fosfato, ammonio, clorofilla, produzione primaria, ossigeno, DOC...
- ✓ **variabili derivate**: TRIX, indice di impatto...





CADEAU



THANK YOU
 GRACIAS
 ARIGATO
 SHUKURIA
 JUSPAXAR
 DANKSCHEEN
 TASHAKKUR ATU
 YAQHANYELAY
 SUKSAMA
 MEHRBANI
 BOLZIN
 MERCI
 BIYAN
 SHUKRIA
 TINGKI
 HATUR GUI
 EKHMET
 PALDIES
 MAAKE
 GRAZIE
 MERASTAWHY
 GOZAIMASHITA
 EFCHARISTO
 KOMAPSUMNIDA
 LAH
 MERSI
 DENKAUJA
 NENACHALHYA
 UNALCHEESH
 SIKOMO
 MINMONCHAR
 SPASSIBO
 SNACHALHUYA
 NUHUN
 CHALTU
 WABEEJA
 MAITEKA
 HUI
 YUSPAGARATAM
 DHANYADAAD
 ANHA
 ATTO
 MERSI
 SPASIBO
 DENKAUJA
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 UNALCHEESH
 HATUR GUI
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 GAEJTHO
 AGUYJE
 FAKAAUE
 SAMCO
 MERASTAWHY
 GAEJTHO
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 MERASTAWHY
 GAEJTHO
 AGUYJE
 FAKAAUE



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