Climatology of temperature, salinity and dissolved oxygen in a changing Adriatic Sea

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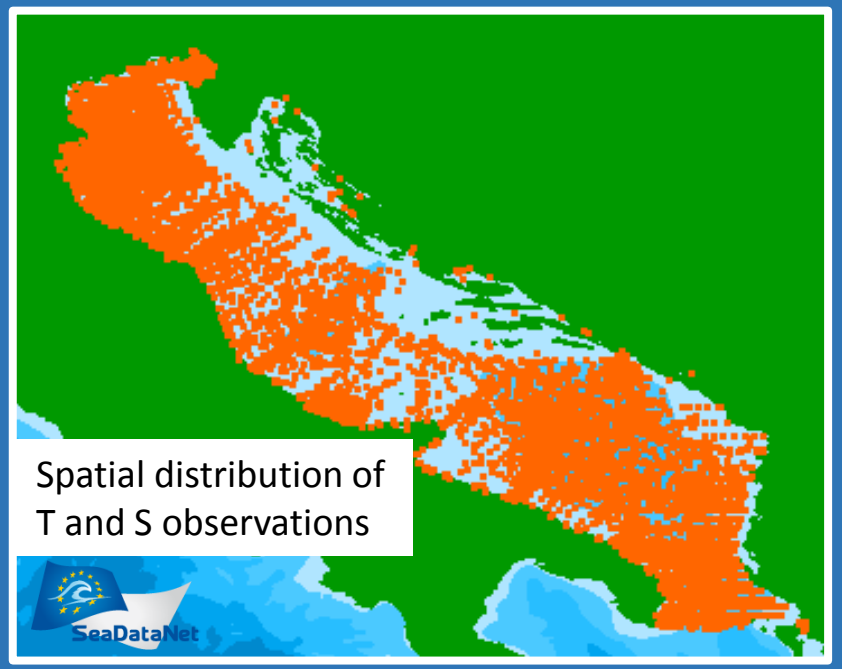
Motivations

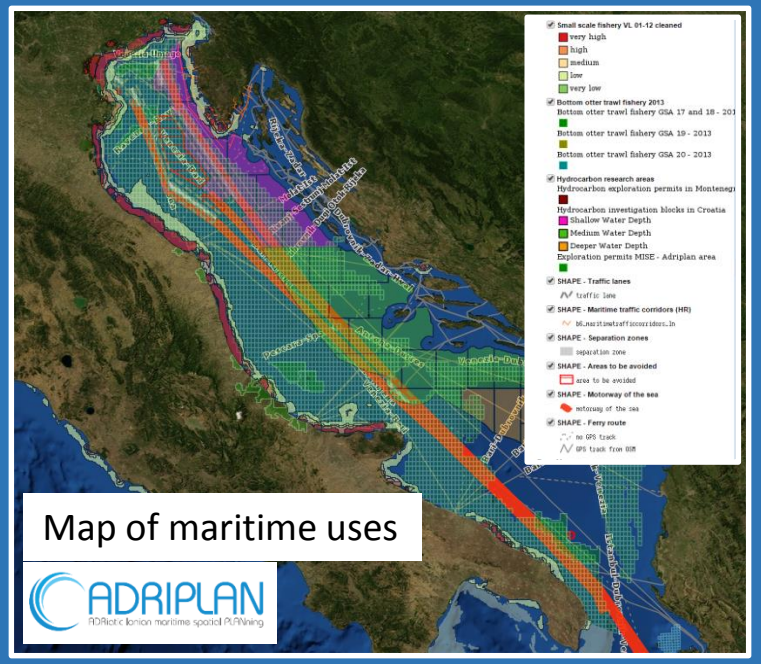
Why climatology

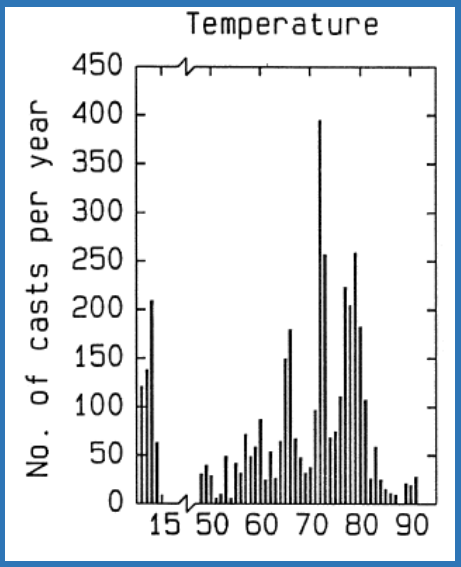
- Baseline to characterize spatial distribution of water properties
- Initial conditions for numerical models
- Quality check for new data

Why the Adriatic

- Well known basin and site of several overlapping human activities **BUT** latest basin scale climatology dates back to early ‘90s (Zavatarelli et al., 1998)







Why «changing» Adriatic

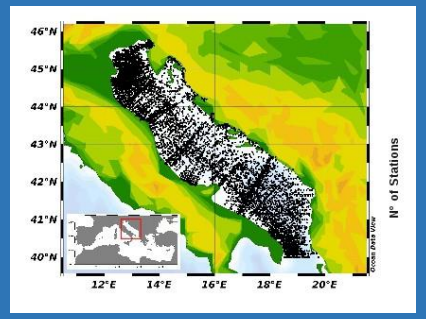
- Climatology creates an “average” field which is supposed to be stationary.

  Is this true? Estimate of “uncertainty” to address variability

Outline:

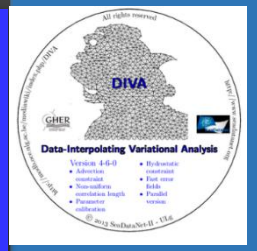
For: Temperature, Salinity and Dissolved Oxygen

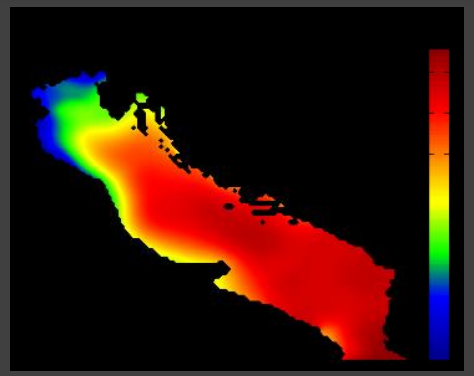
Data



Approximation:

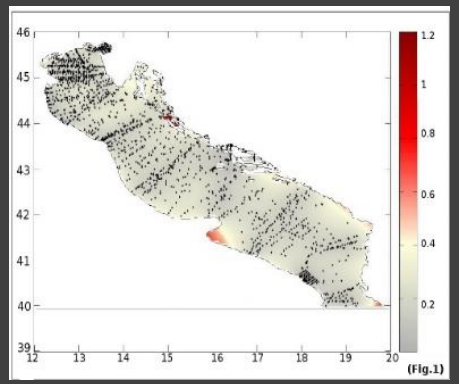
- Spatial analysis (DIVA – VIM)
- Error field estimate





Climatological map

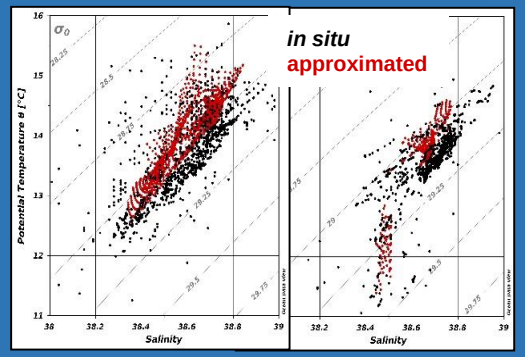
- 26 depth levels
- 1/16° resolution



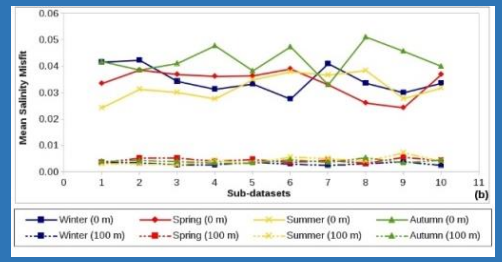
Error map

Validation:

- Real *vs* synthetic T-S comparison
- Ordinary Cross-validation



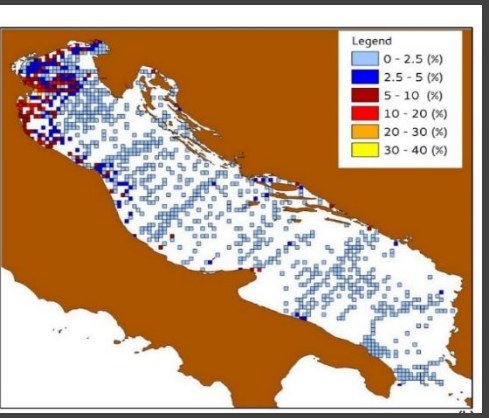
Real *vs* synthetic T-S diagrams



Ordinary Cross-validation

Climatology-Observation Misfit

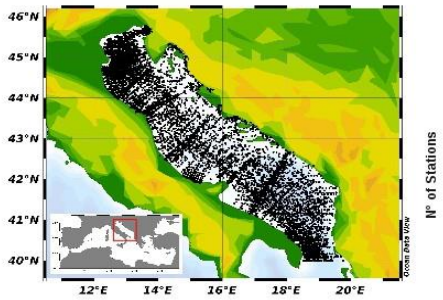
Uncertainity estimate

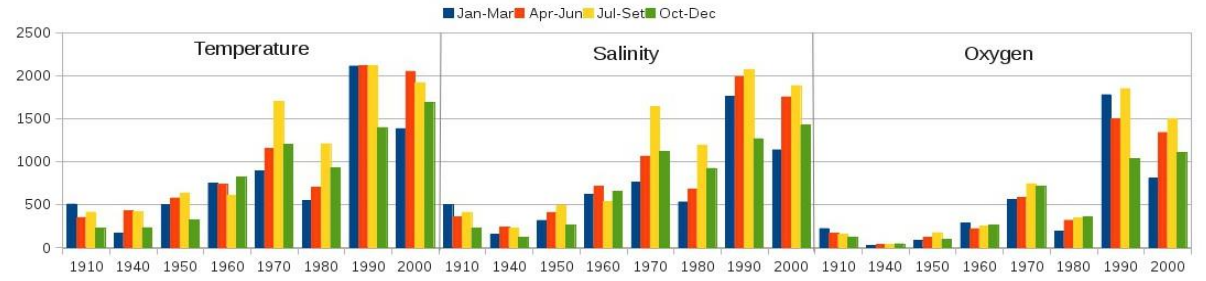


Uncertainity map

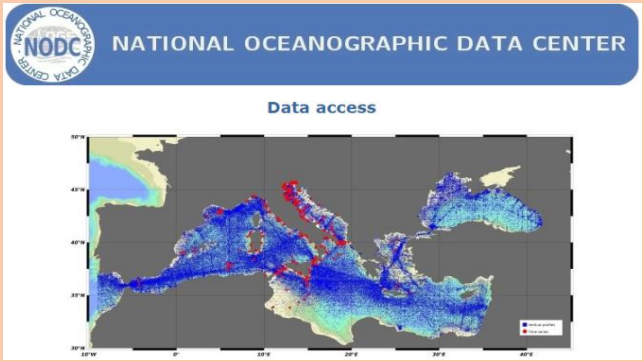
Data used:

1911-2009





34 research institutes



QC procedures

SeaDataNet

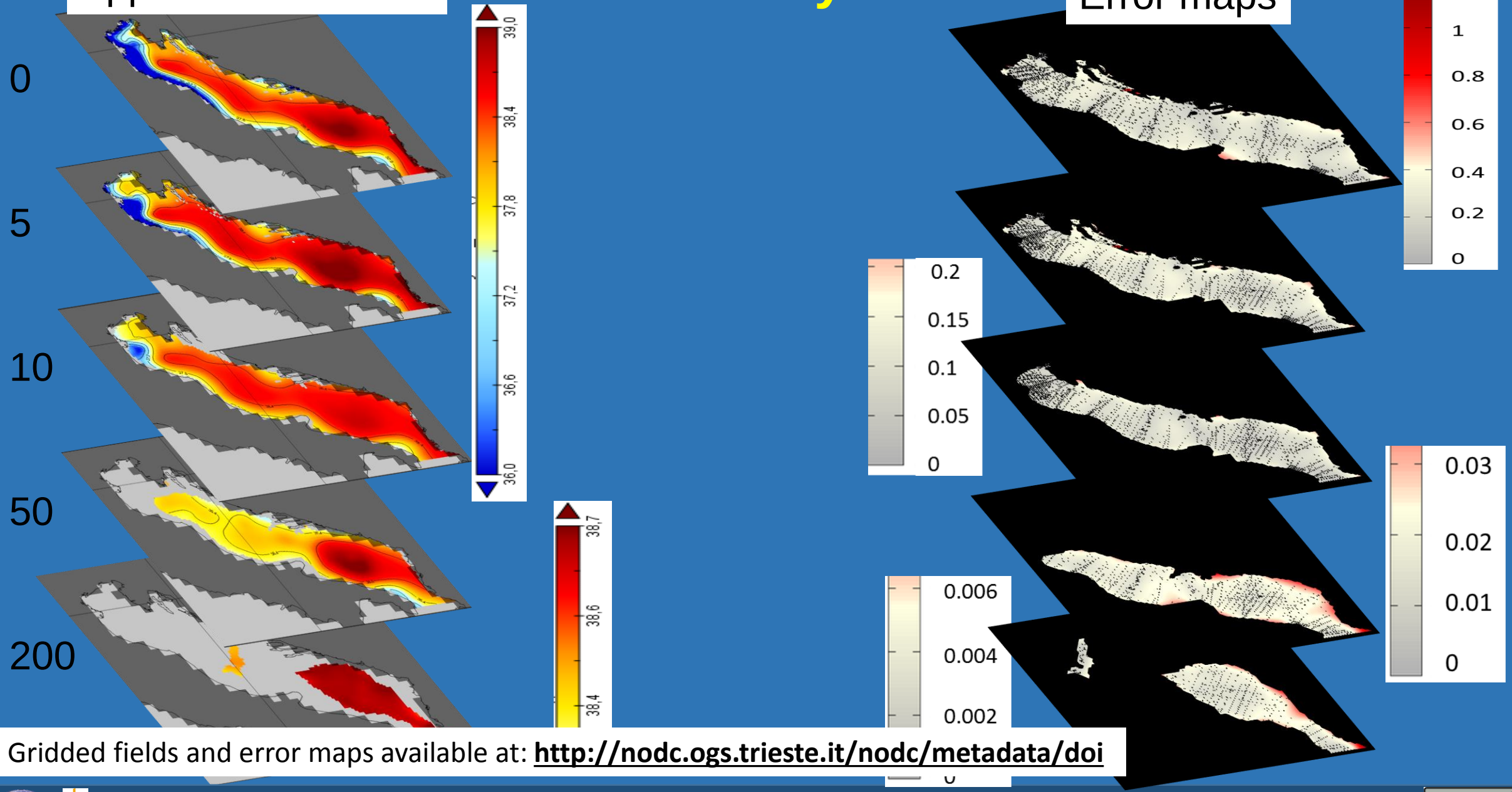
- Spikes
- Global range check
- Regional range check
  - ➢QF assignement

Results:

- Validated climatology: approximated fields + error map (ex. Salinity)
  - Example of spring climatology of temperature
    - Seasonal climatology of dissolved oxygen
      - Error *versus* uncertainty maps

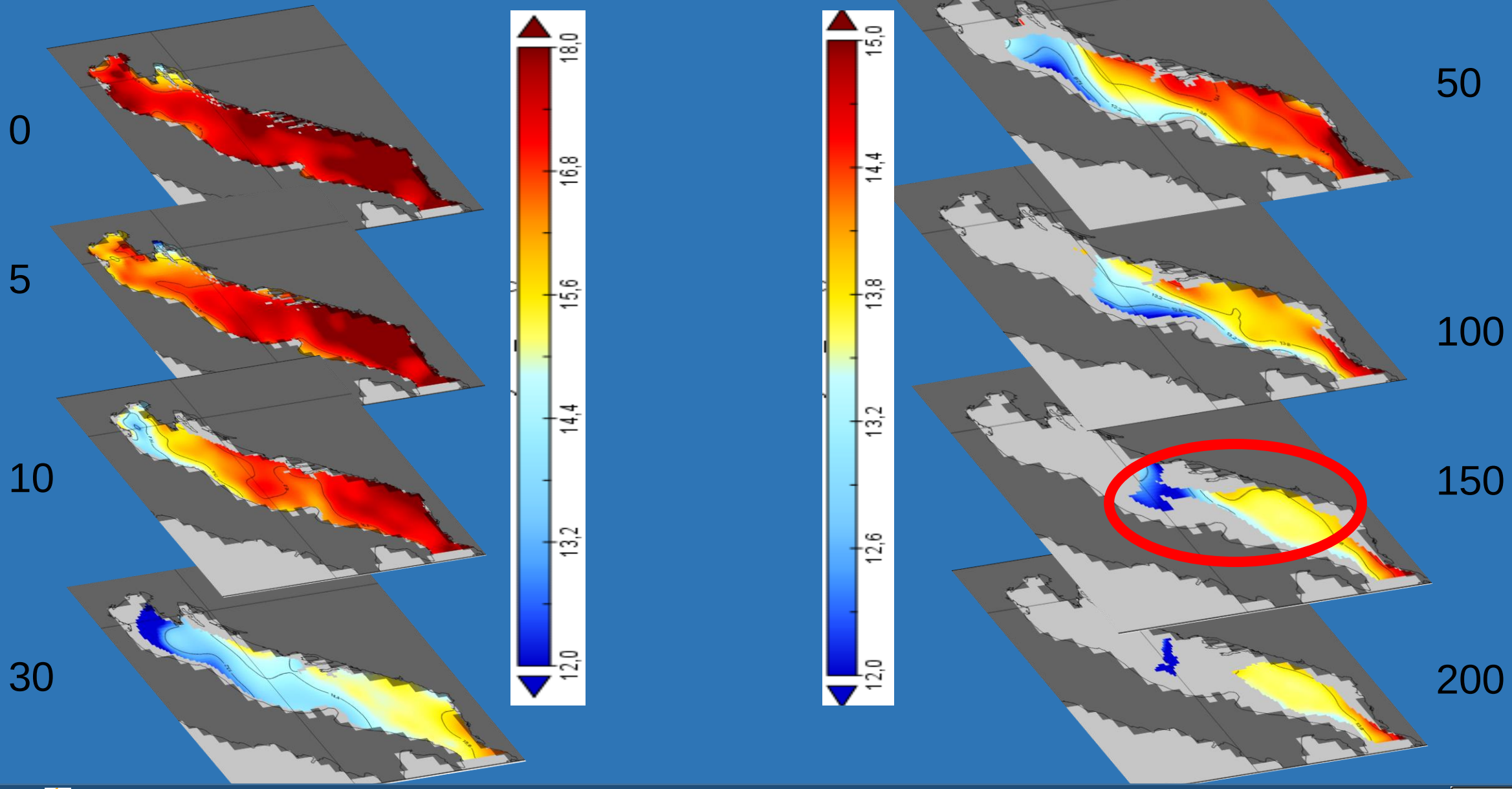
More results are published on:
Lipizer et a., 2014 Qualified temperature, salinity and dissolved oxygen climatoloies in a changing Adraitic Sea. Ocean Sciences

Winter salinity

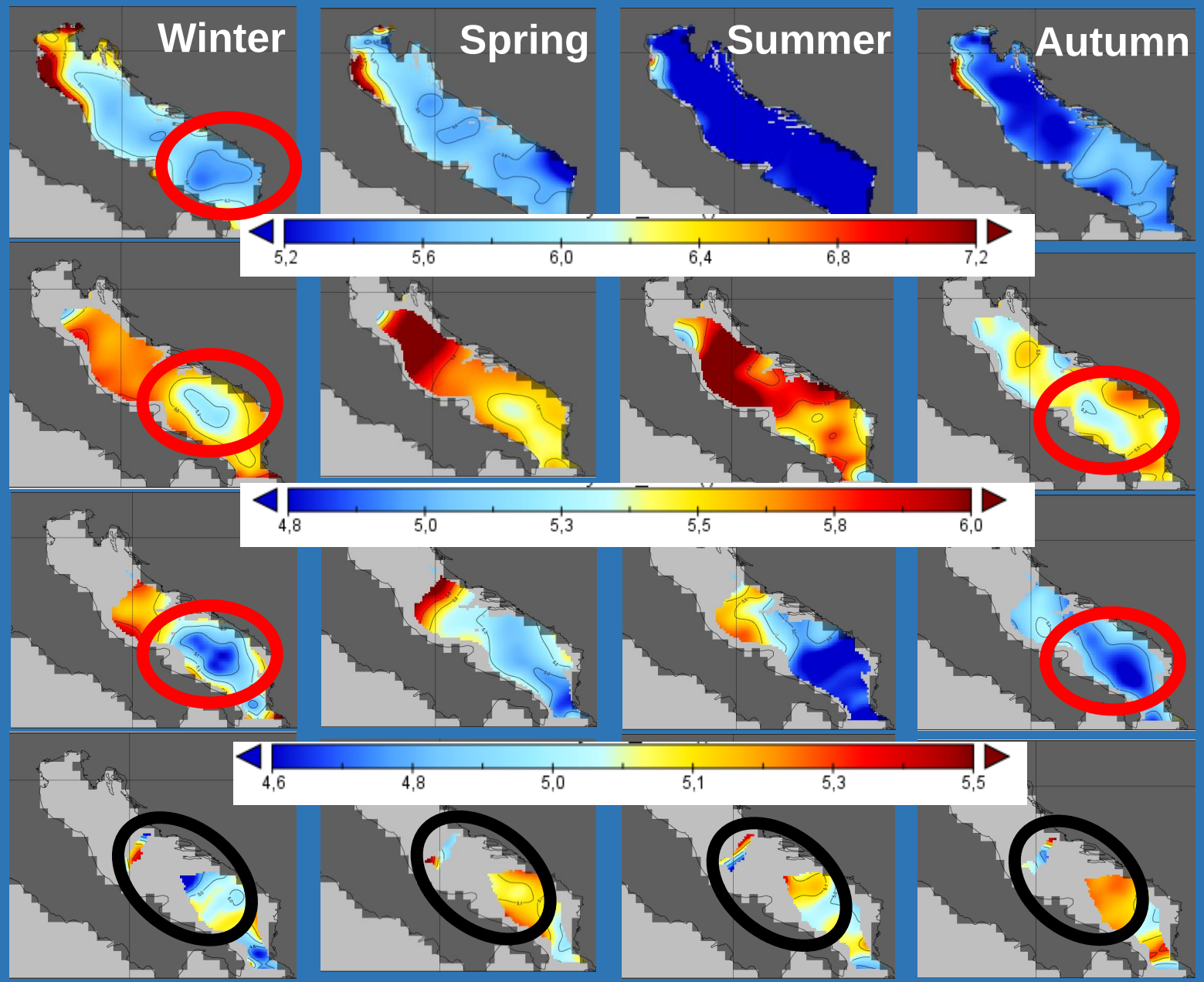


Gridded fields and error maps available at: **http://nodc.ogs.trieste.it/nodc/metadata/doi**

Spring temperature



Dissolved oxygen seasonal climatology



Stronger cyclonic circulation

Differences in the deep layers

Error *versus* uncertainity

Error field associated to Data Interpolating Variational Analysis (DIVA) based on a real covariance function, depends on:

- Noise of data
- Spatial data coverage

$$e^2(r) = \varepsilon^2(r) - \boldsymbol{T_1}(r)K^{-1}\boldsymbol{T_2}(r)\,\boldsymbol{g}(r)$$

$\varepsilon^2(r)$ = noise in the *r* position

T_1, T_2 = transfer operators

K = finite elements stiffness matrix

g(r) = covariance vector in the *r* position

Uncertainity:
Climatology – Observation Misfit

Mean deviation of data from approximated field

$$u_i = \frac{1}{N_i}\sqrt{\sum_{m=1}^{N_i}(d_m - y_i)^2}\,\{m = 1, \ldots, N_i\},$$

d_m = original data

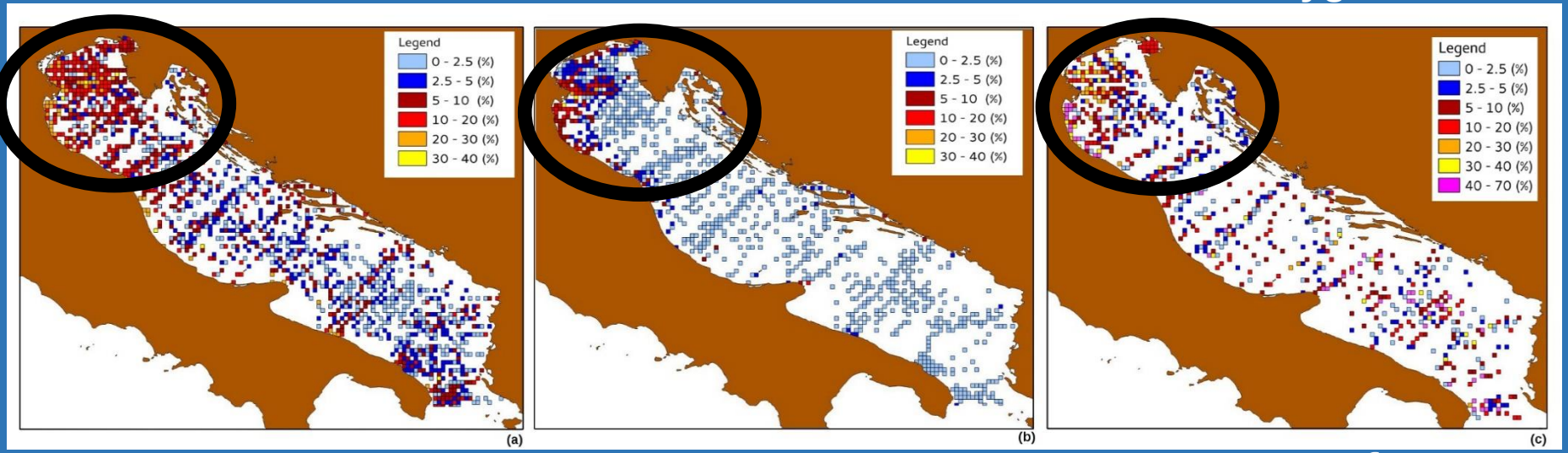
y_i = value of the approximated field

N_i = number of *in situ* data available in the same point

Uncertainity assessment

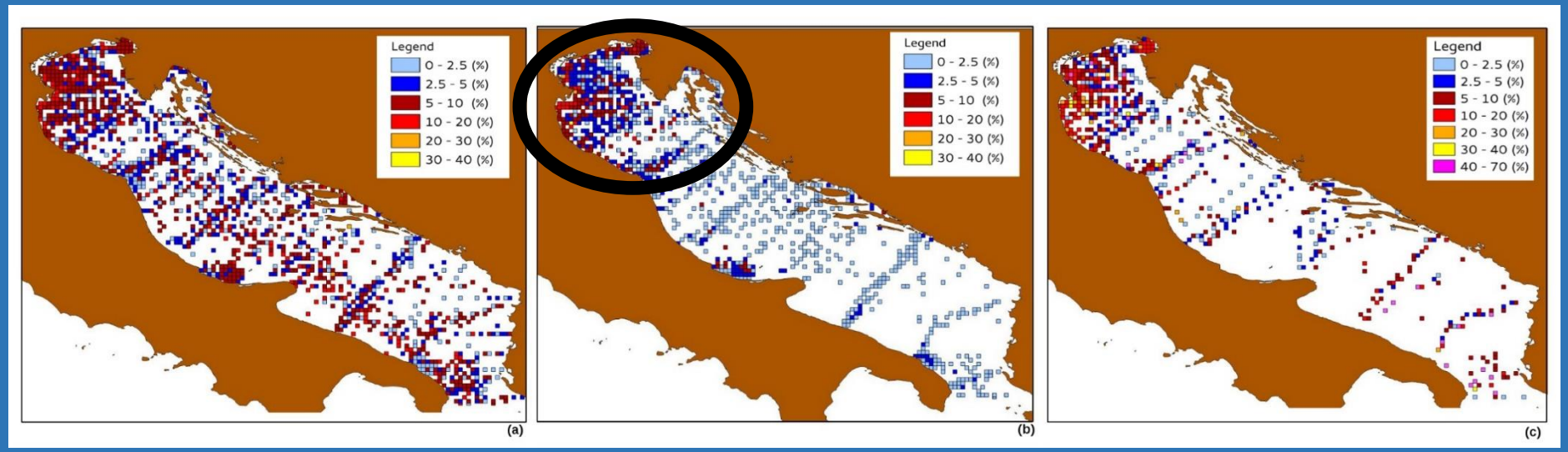
Winter - surface

temperature **salinity** **dissolved oxygen**



Deviation of observations from the approximated field (as %)

Summer - surface

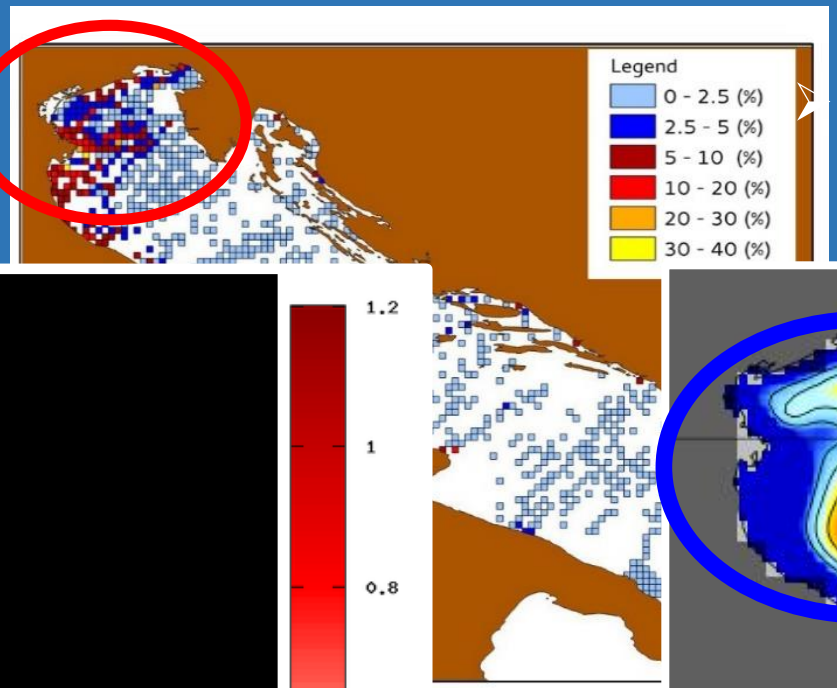


- **Higher in the North**
- **Highest in dissolved oxygen**
- **Clear spatial distribution in salinity**

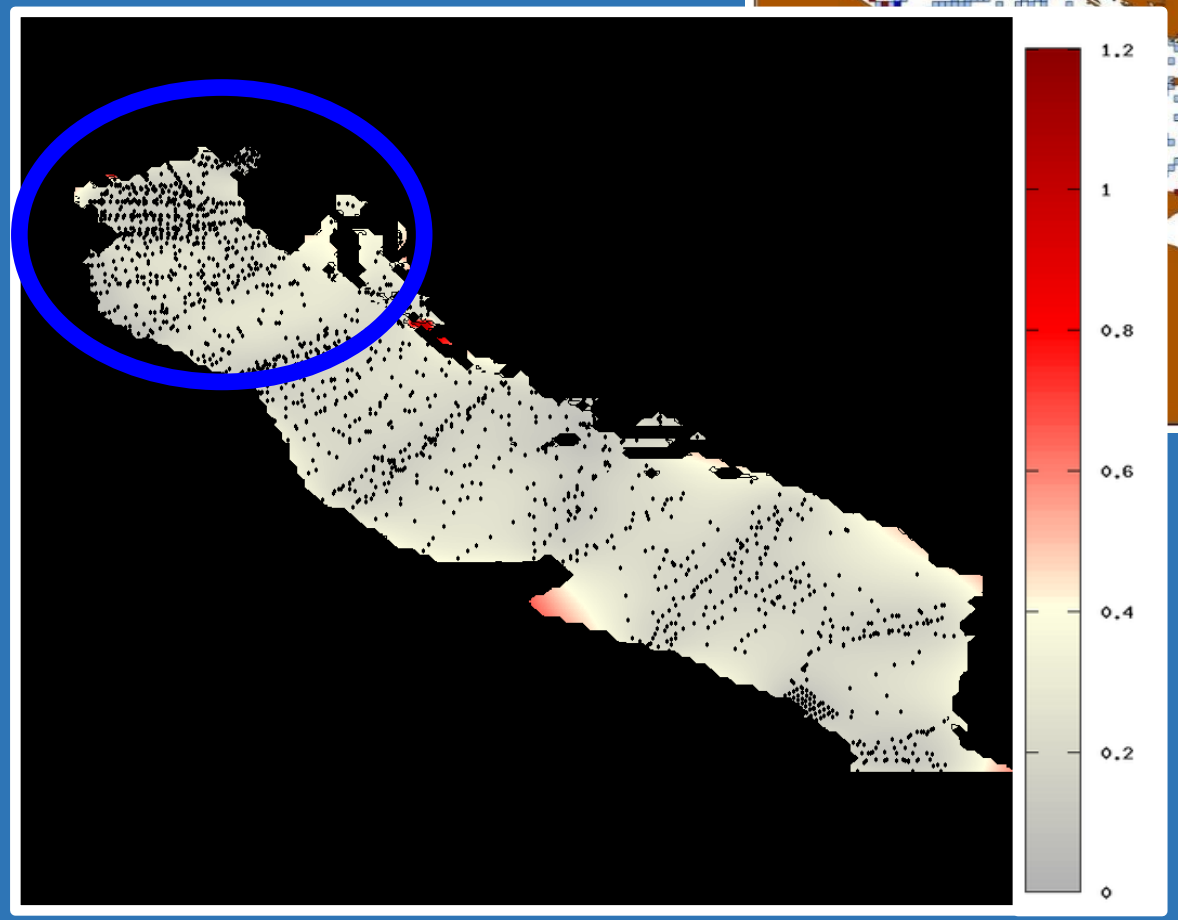
Uncertainity assessment

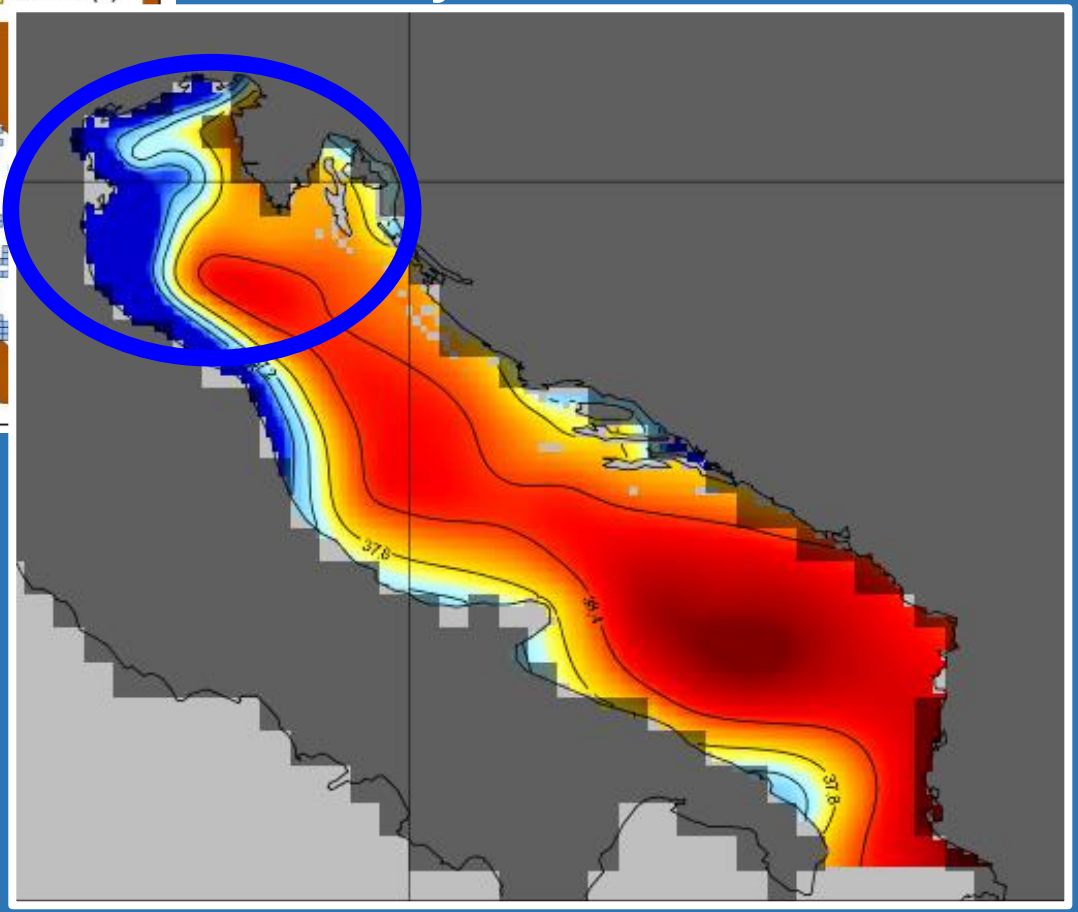
Winter – surface salinity

- Low approximation error



- Uncertainity in climatological pattern = spatial/temporal variability





Uncertainity assessment: seasons & depth layers

	Level	Winter		Spring		Summer		Autumn	
		Median	95%	Median	95%	Median	95%	Median	95%
Temperature	0 m	4.6	18.9	14.9	27.9	5.6	12.5	11.7	27.6
	50 m	2.8	9.5	3.8	9.2	3.8	9.3	4.8	12.2
	100 m	2.5	7.8	3.1	7.3	3.3	4.2	3.3	8.3
	200 m	1.4	4.9	1.8	4.9	2	5.6	2.2	5.3
Salinity	0 m	0.9	8.4	1.3	8.1	2.1	8.8	1.2	10.2
	50 m	0.3	0.8	0.3	0.9	0.4	0.9	0.3	0.8
	100 m	0.2	0.6	0.2	0.6	0.2	0.8	0.2	0.5
	200 m	0.1	0.4	0.1	0.4	0.1	0.4	0.1	0.4
Dissolved oxygen	0 m	6.1	51.6	6.4	26.3	6	34.3	7	32.9
	50 m	5.9	34.8	4.3	50.8	7.7	39.2	9	51.1
	100 m	11.4	44	3.9	50.7	5	50.7	6.1	51.2
	200 m	14.2	35.7	4.7	50.6	5.6	46.8	18.5	50.9

Deviation of data from approximated field (as %)

- Higher in the surface for Temperature & Salinity
- higher in spring for T, in summer for S and in autumn for O_2

Conclusions:

- **Updated and validated climatology coupled with error and uncertainity information**
  - **Better resolved features (spreading of freshwaters, differences in the deep waters, winter cyclonic circulation,…)**
    - **“Uncertainity”: index of areas of strong variability**

Thanks for your attention

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Gridded fields and error maps are freely available at: **http://nodc.ogs.trieste.it/nodc/metadata/doi**

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Part of the data is published on:

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