Update on Corsica shallow water simulation project

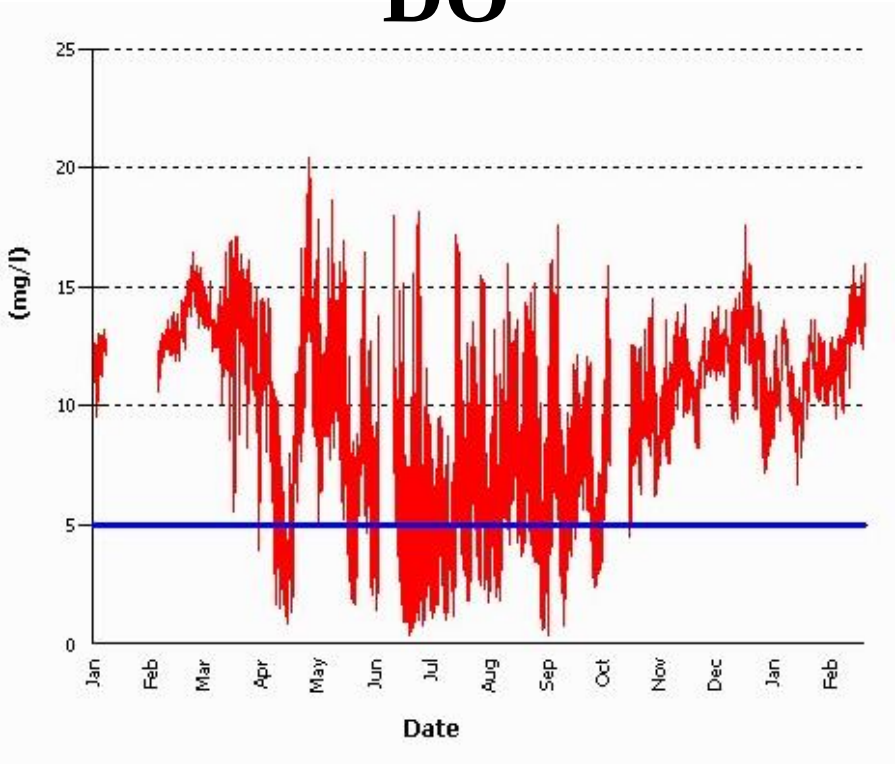
Richard Tian, Jeremy Testa, Nicole Cai, Damian Brady,
Carl Cerco and Lewis Link

Modeling Quarterly Review
07/12/2022
Annapolis

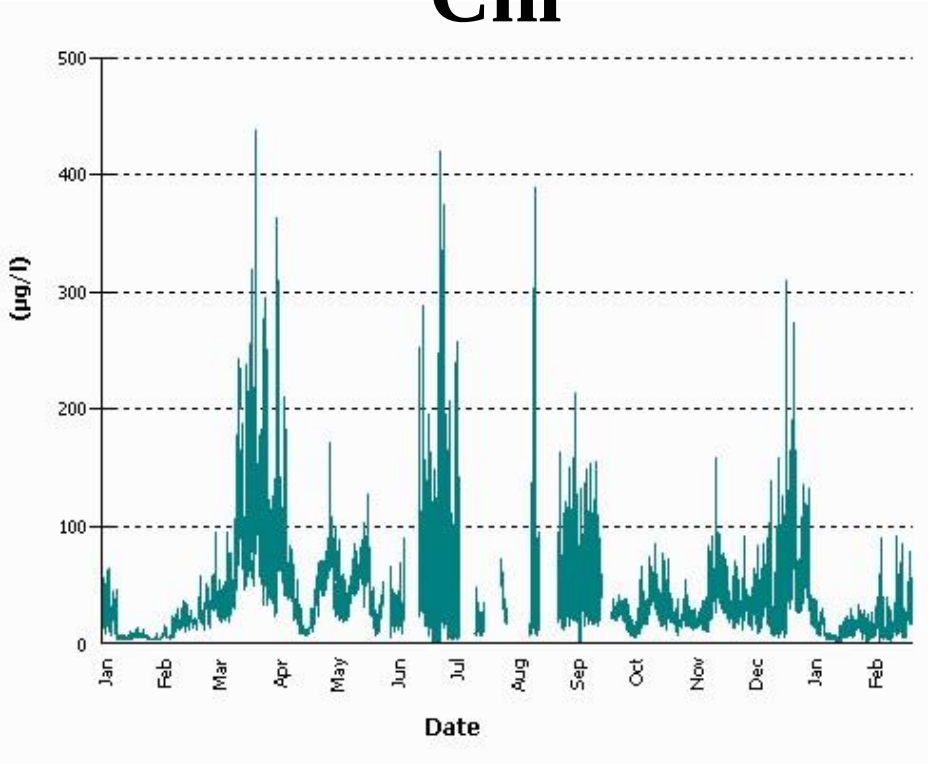
DO and Chlorophyll CMON Data 2013 at Station 3851

(Data from MD DNR)

DO



Chl



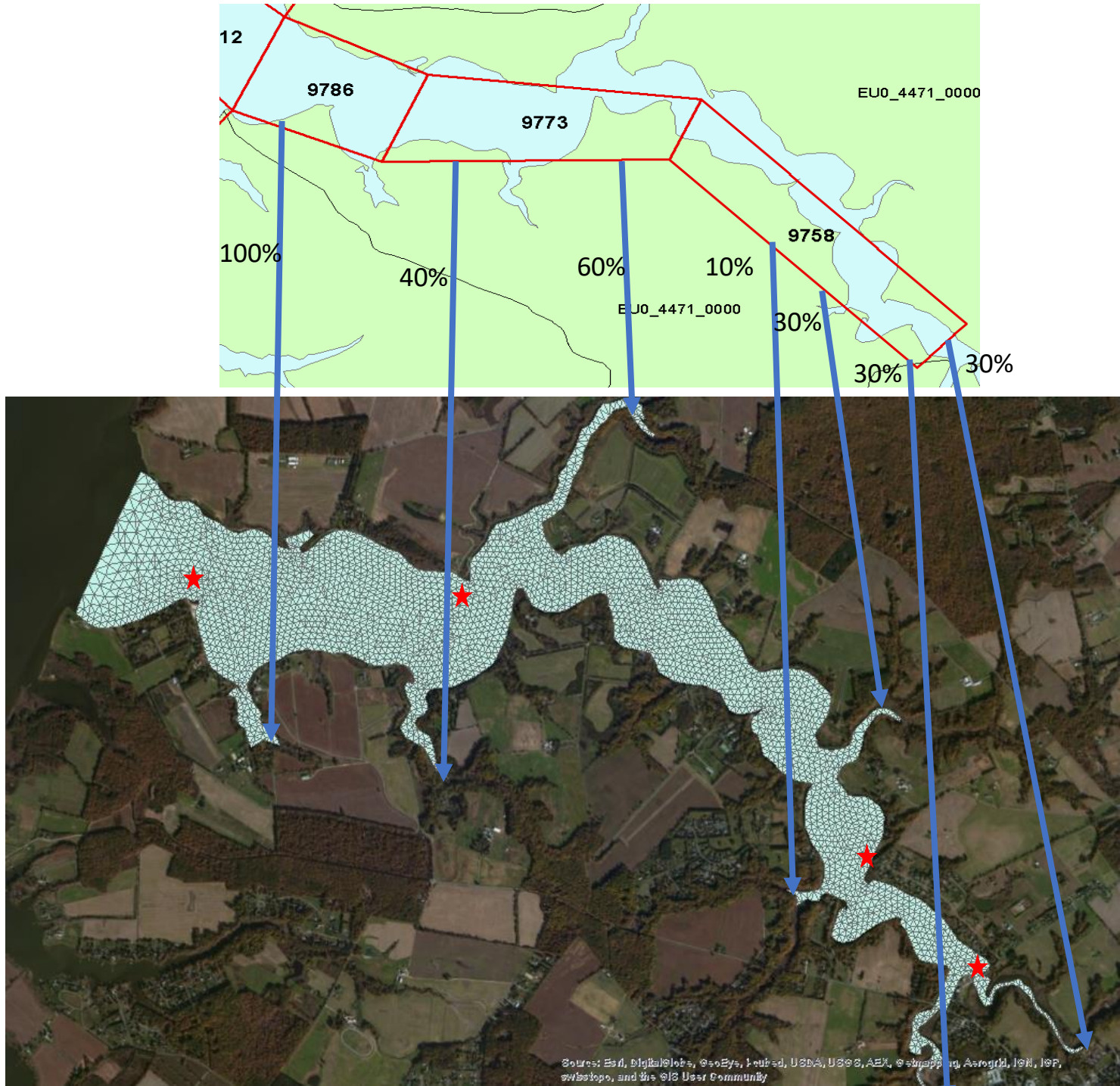
Can any model reproduce this?

Quote from Carl Cerco: "You can't grab a bottle of water and ask me: Model it!"

We tried

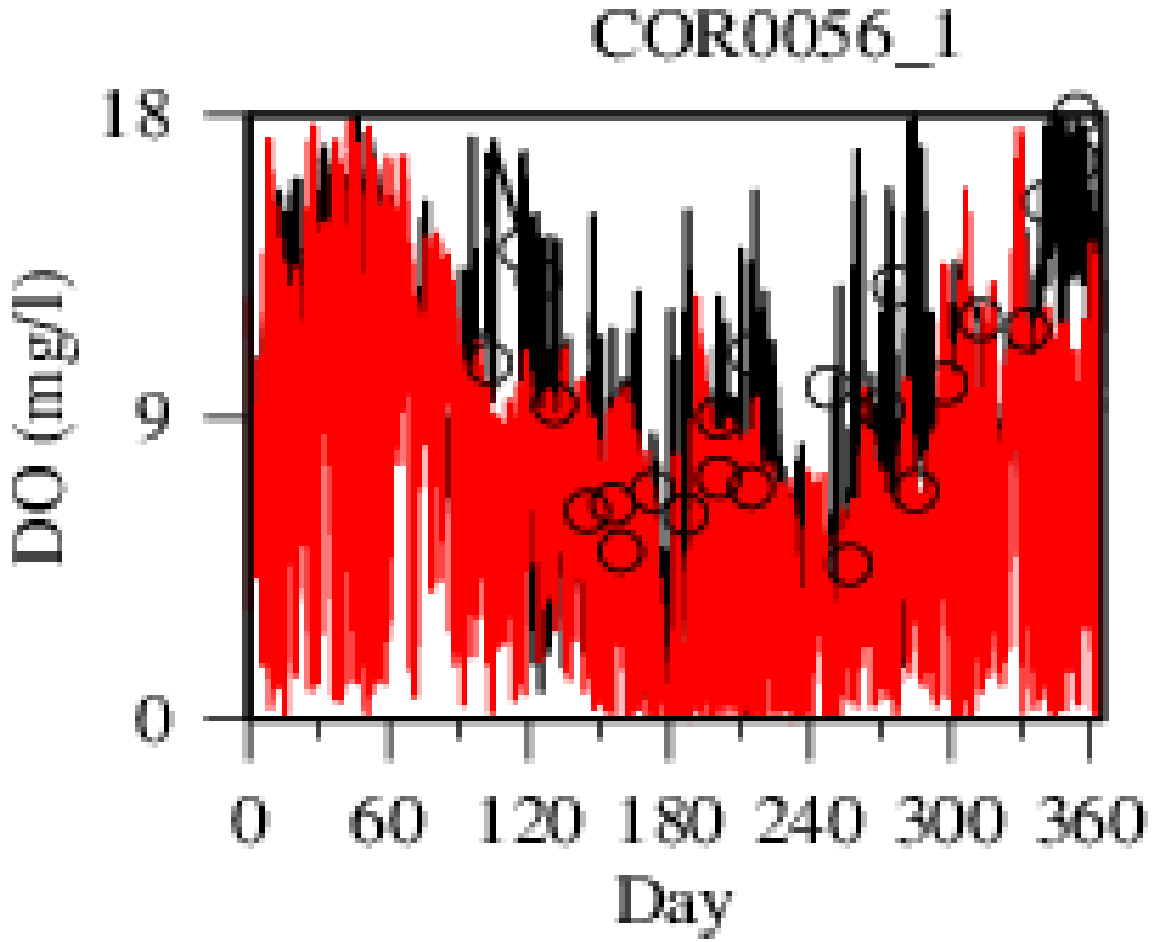
Model, grid and forcing data

- SCHISM.
- 5029 cells with up to 20 m resolution and 5 sigma layers.
- 3 CH3D runoffs partitioned into 7 loading points.
- Open boundary from CH3D simulation.
- ERA5 Solar radiation and NARR surface forcing.



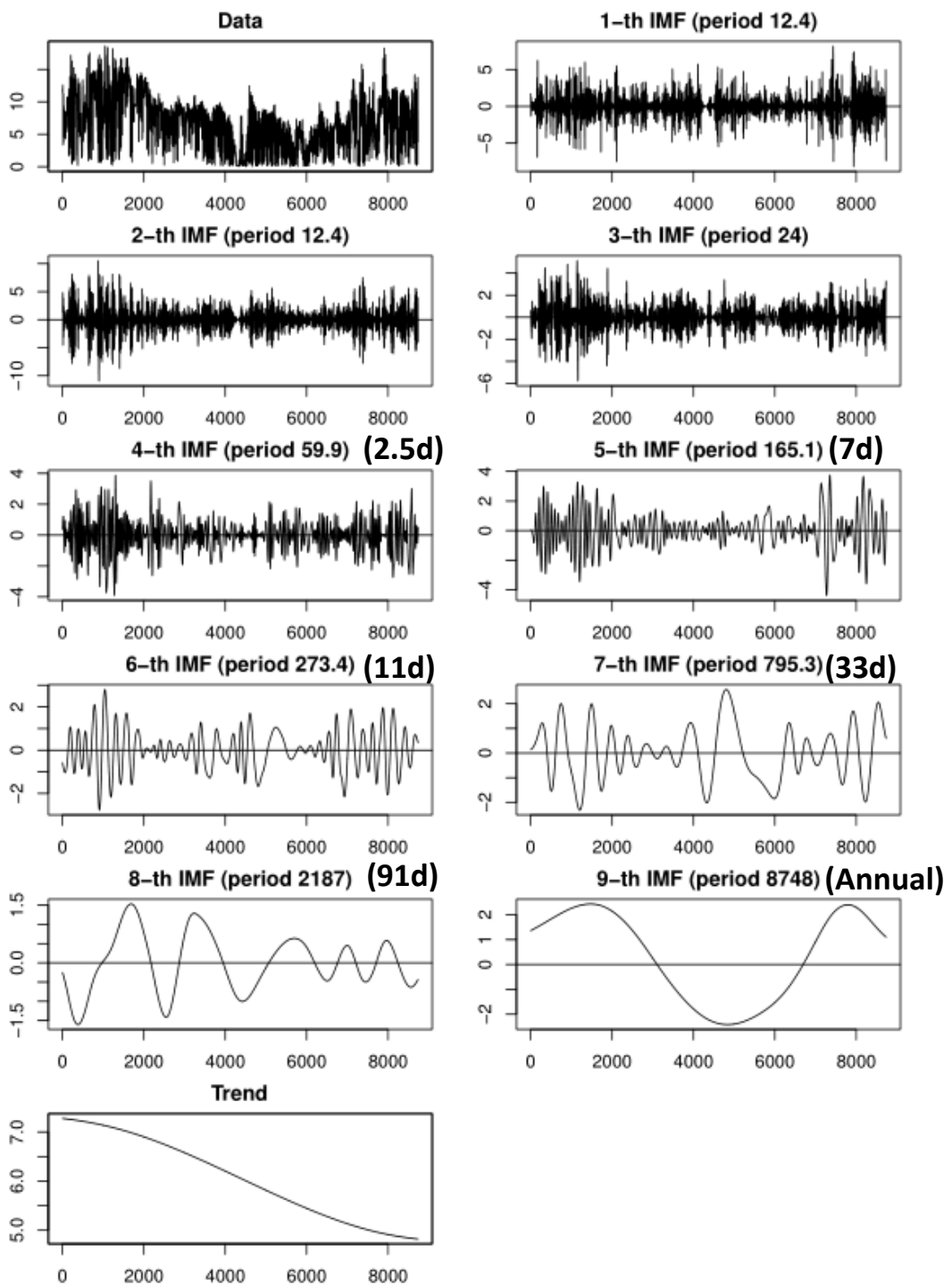
Modeling solution versus CMON data at the upper estuary

- **Is this real or model instability?**
- **Are there interpretable signals embedded in the high-frequency variability?**
- **Are there relationships with forcing data that can predict the variations?**

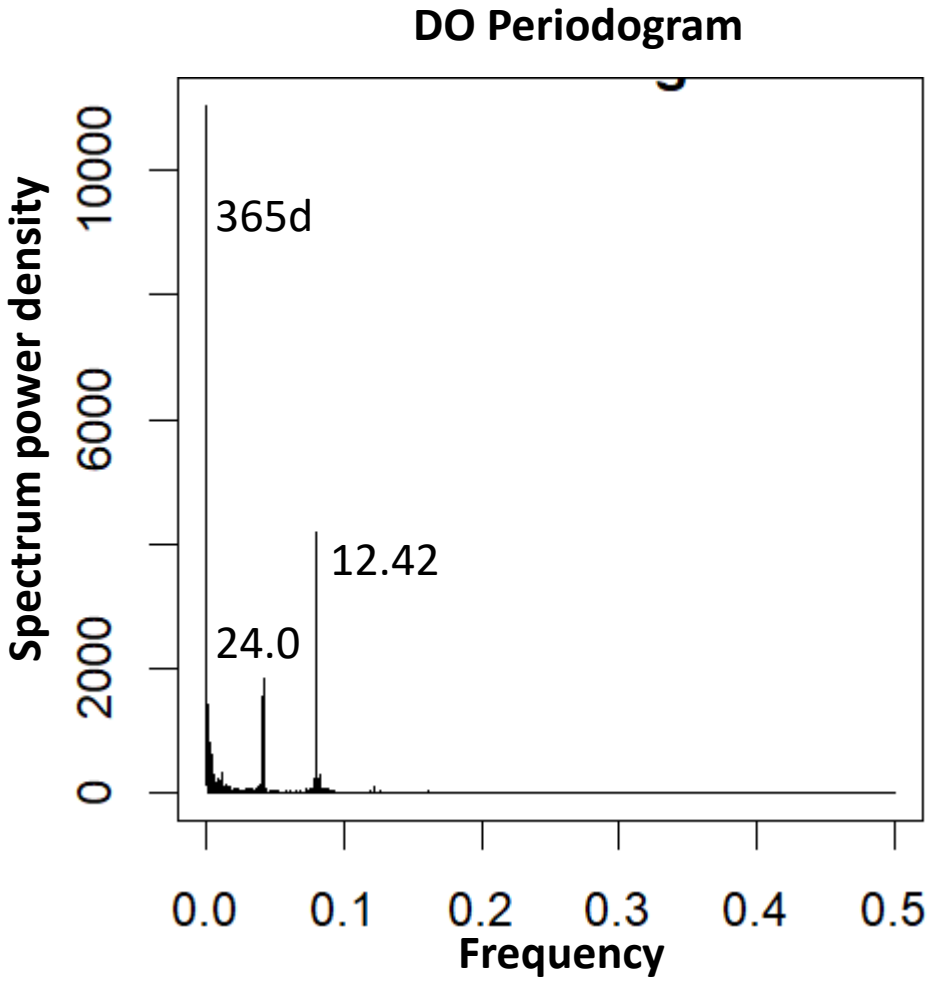


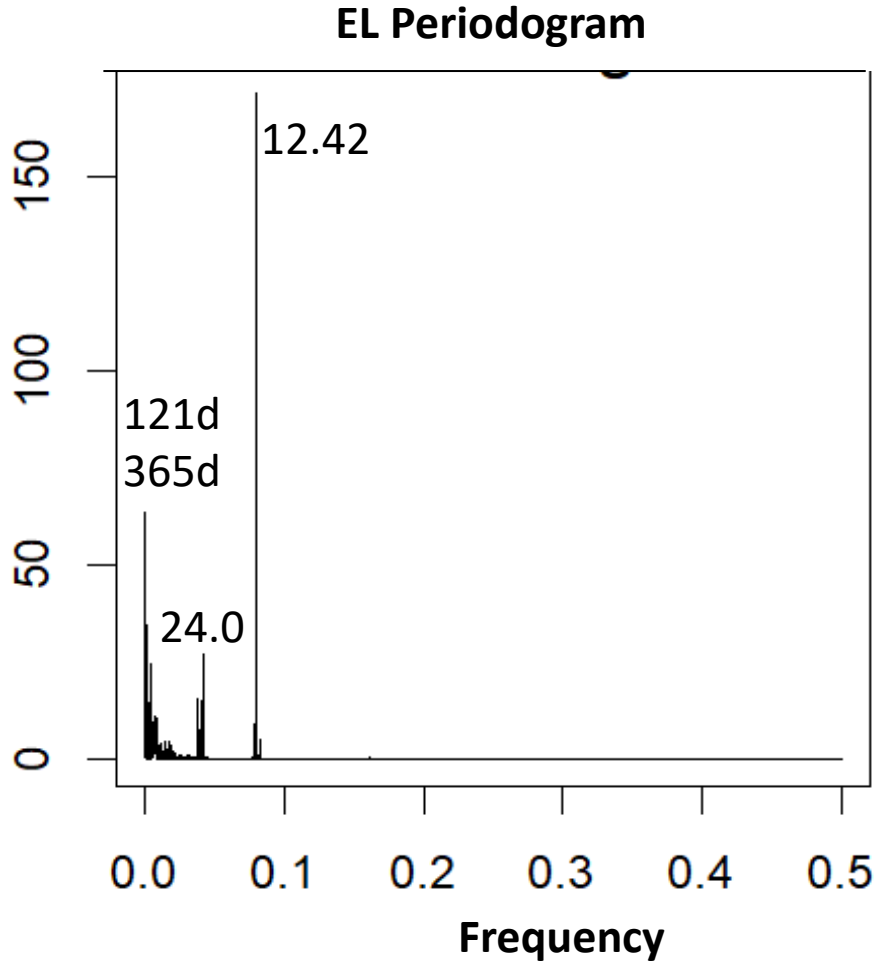
DO EMD (Empirical Mode Decomposition)

- Frequency in hours.
- The first two modes have M2 tide frequency.
- The third mode is diurnal.
- The nineth mode is the seasonal cycle.
- Trend is the residual.



DO and Sea surface elevation spectral analysis

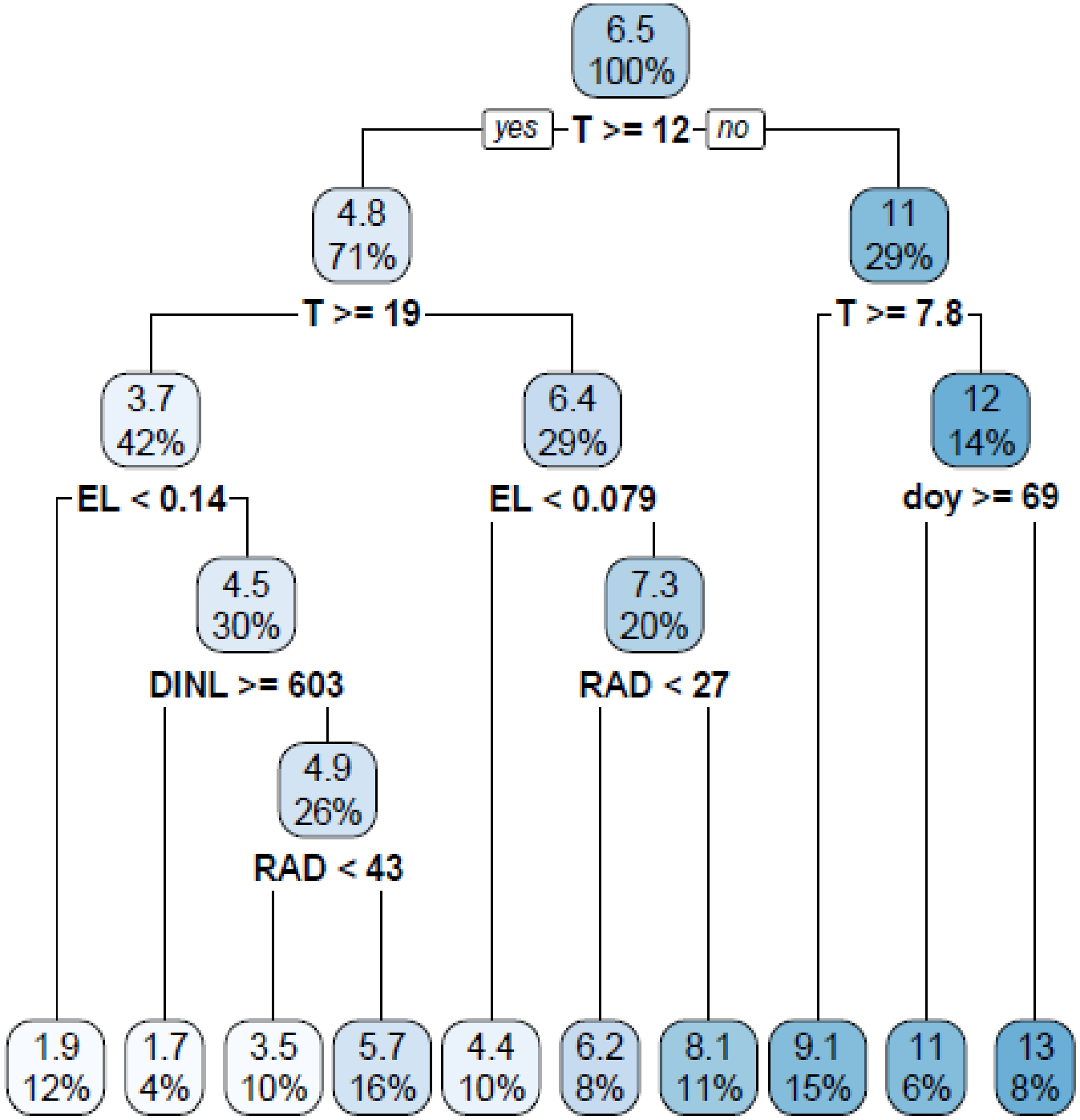




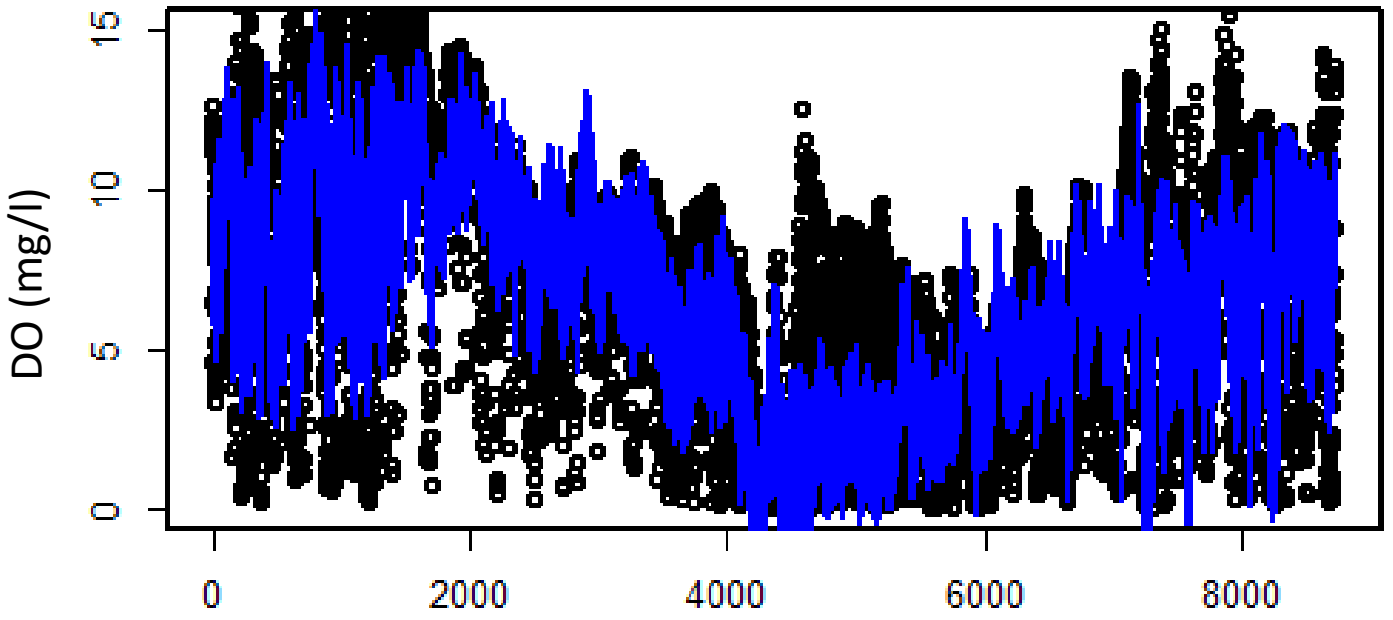
Seasonal cycle dominant overall, M2 frequency prevailing for high-frequency variability. There are interpretable signals.

DO CART analysis

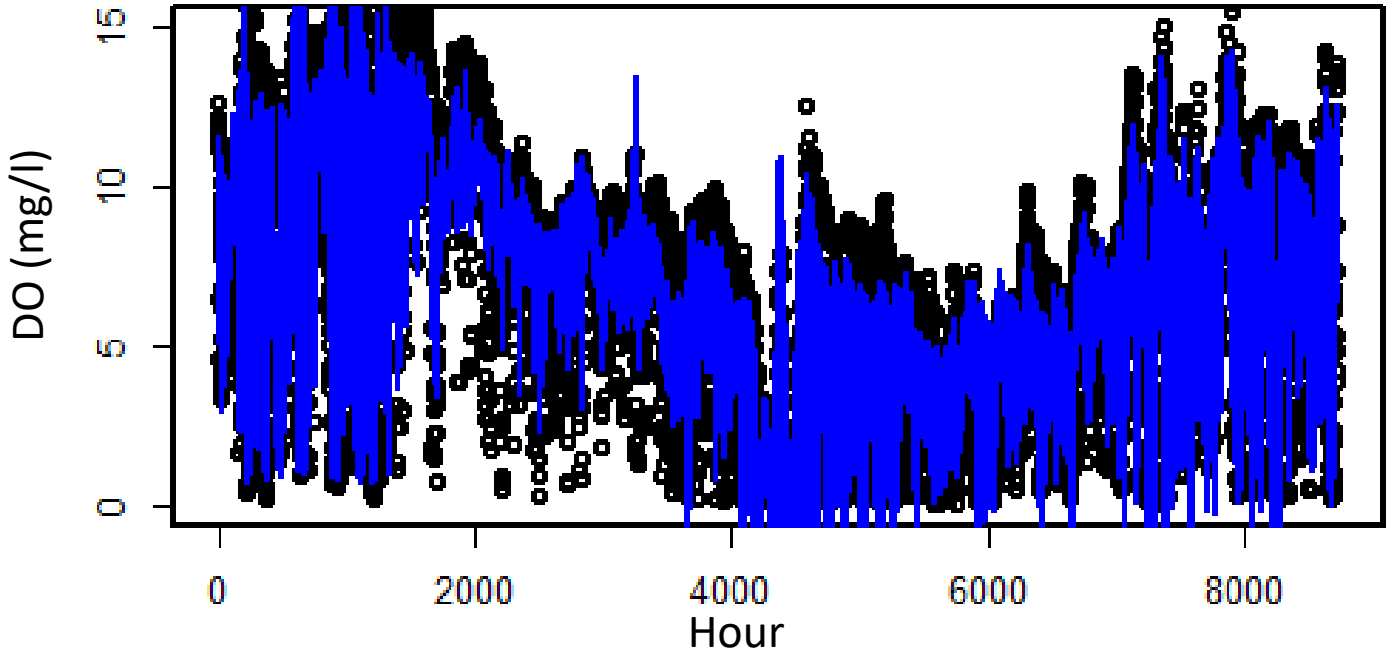
- **Model: cart <- rpart(DO ~ EL + DINL + RAD + hod + doy + T + WS)**
- **Temperature is the dominant predictor, followed by tide, day of the year (doy), nutrient loads (DINL) and solar radiation (RAD).**
- **Limitation: Binary.**



GAM prediction, same equation as CART:
R^2=0.70



GAM prediction with chlorophyll added:
R^2=0.86

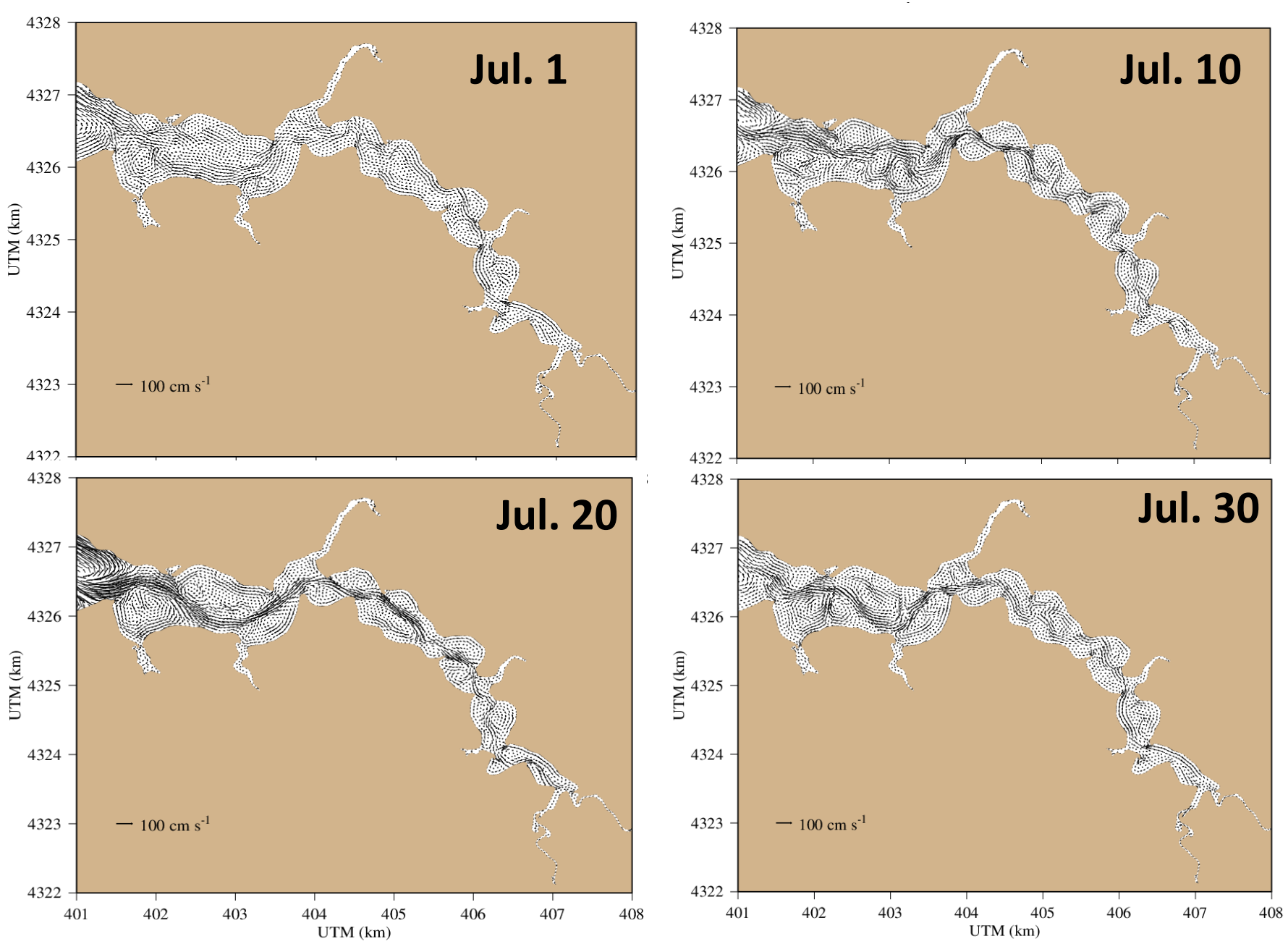


Yes, the results are predictable.

What are the relationships with predictors?

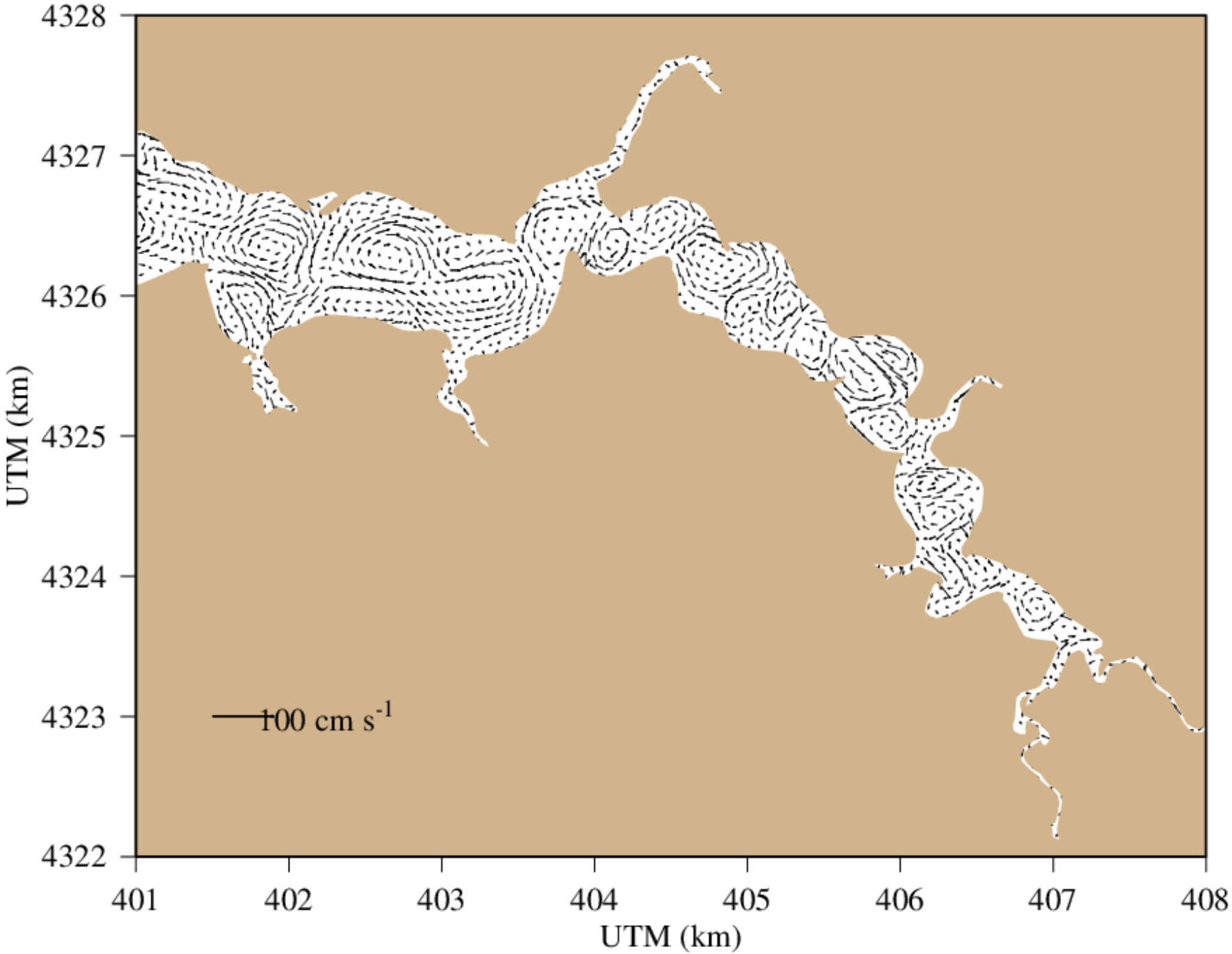
Simulated Surface current

Eddies resulted from geometry

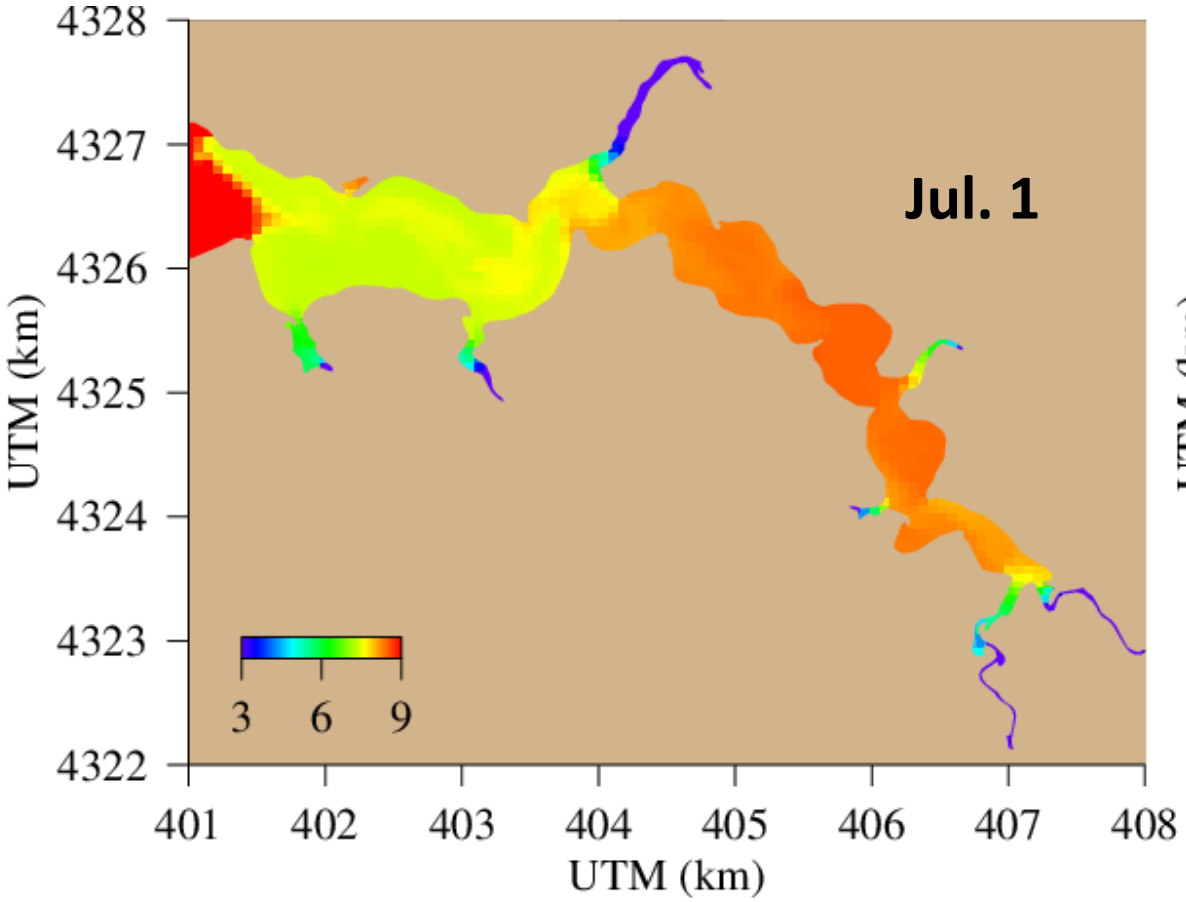


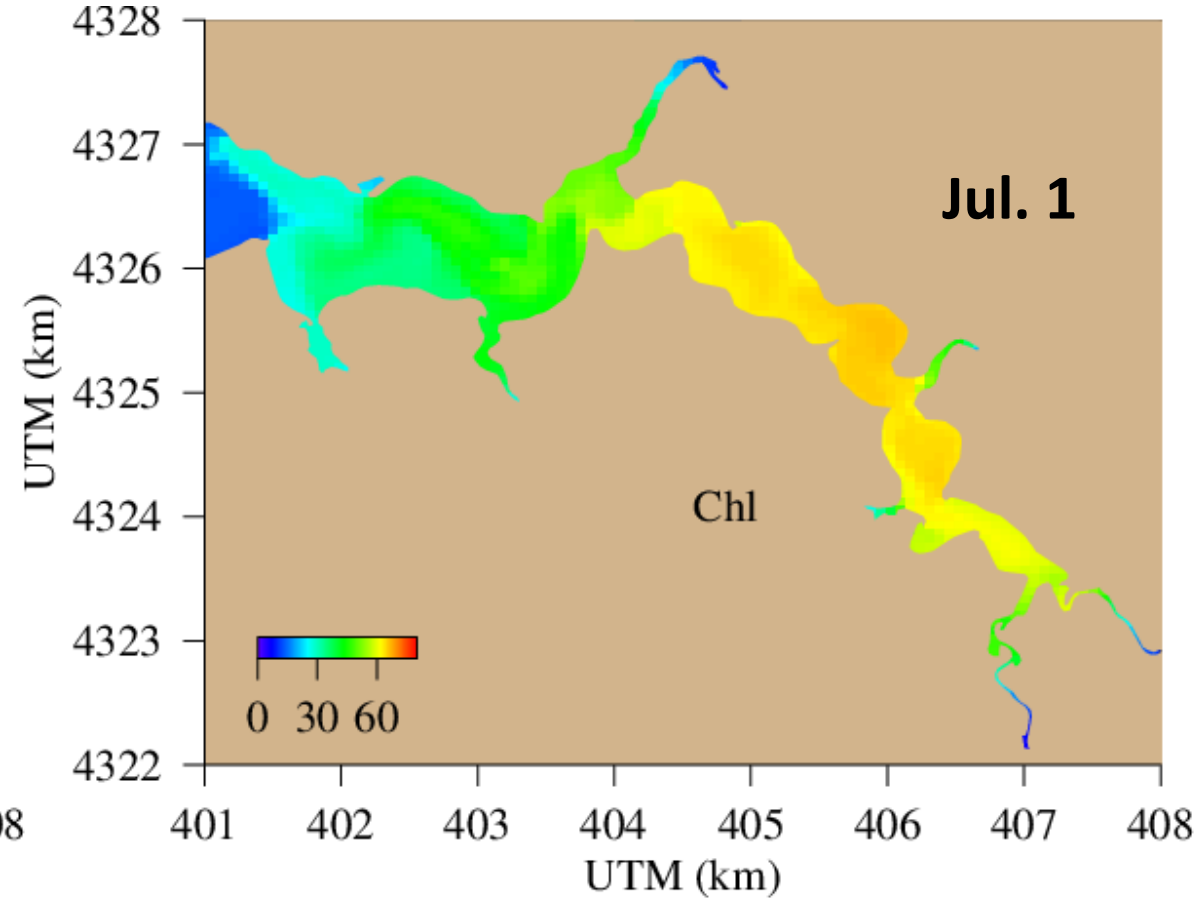
Simulated Surface current at a particular time

Eddies resulted from geometry

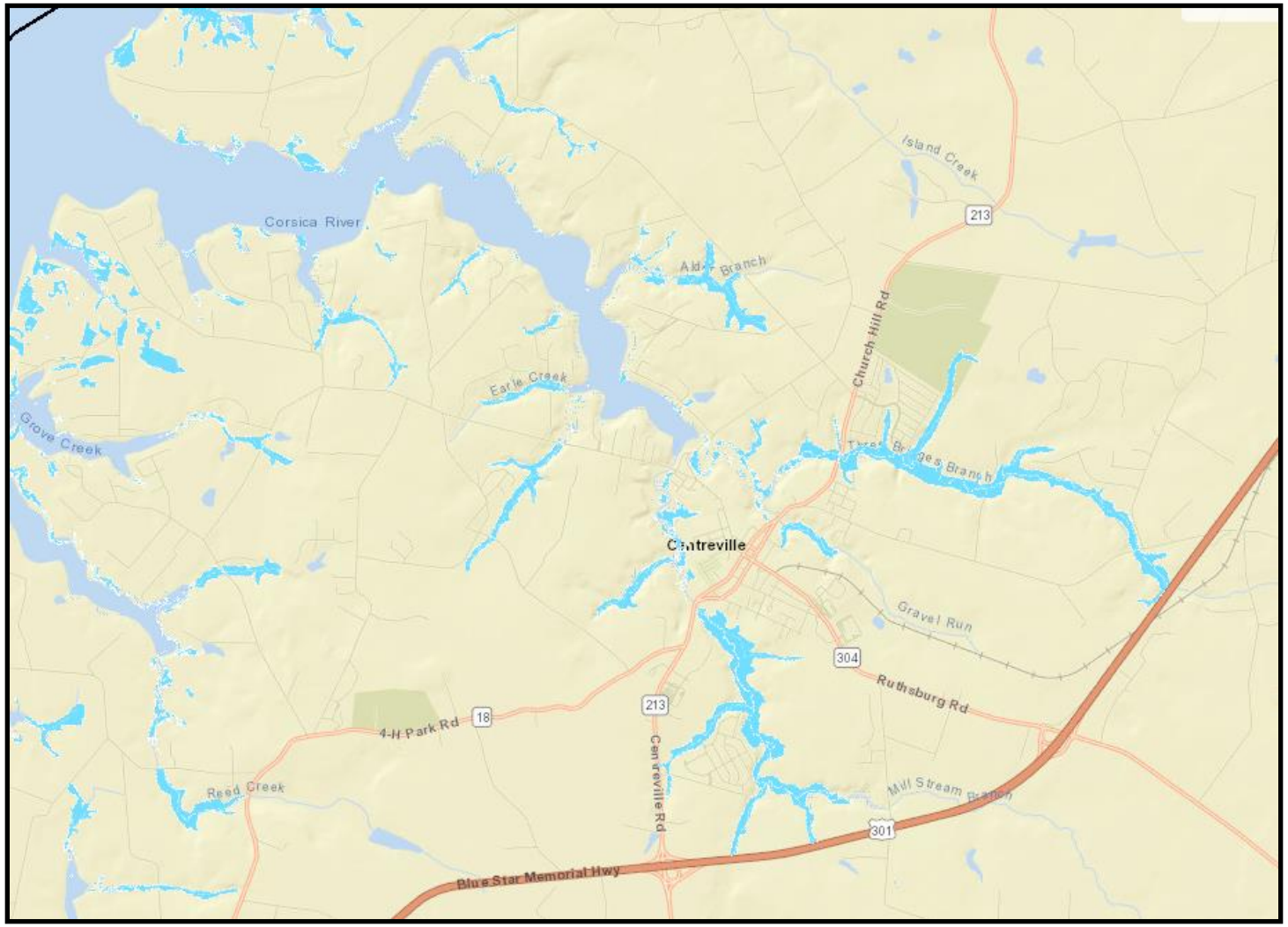


Simulated surface DO and chlorophyll





Wetland distribution in the Corsica



Contribution of each Factor in determining DO variations (in %)

Hourly

Station	Physics	Respiration	Primary P.	Aeration	SOD
COR0056	60	14	10	7	9
XHH3851	76	7	9	3	6
XHH4931	74	9	7	1	8
XHH4916	81	9	4	1	6

Daily

Station	Physics	Respiration	Primary P.	Aeration	SOD
COR0056	24	25	26	11	14
XHH3851	35	16	29	5	14
XHH4931	36	23	20	3	18
XHH4916	44	25	12	1	17

Annual

Station	Physics	Respiration	Primary P.	Aeration	SOD
COR0056	1	35	37	12	15
XHH3851	7	25	46	4	18
XHH4931	22	30	25	3	20
XHH4916	36	33	13	1	17

Messages

- **Geometry-induced eddies prevails in the Corsica, leading to heterogeneity and patchy distribution in water properties.**

- **Physical dynamics can be as important as biogeochemical processes in determining high-frequency DO variability in the Corsica.**