Sensitivity Modeling of Biogeochemical Drivers Controlling Dissolved Organic Carbon in the Yukon River

Amadini Mendis Jayasinghe

Georgina A. Gibson, Nicole Jeffery, Scott Elliott

HILAT-RASM

Los Alamos National Laboratory

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Changes in the Global Climate

Global Temperature Rise in the Arctic

Melting of Frozen Ground (Permafrost Thaw)

Release of *Stored Carbon*

Carbon Release to the *Arctic Rivers*

Carbon Fluxes to the Ocean

Biophysical Impact on Coastal Regions

Potential Climate Feedback

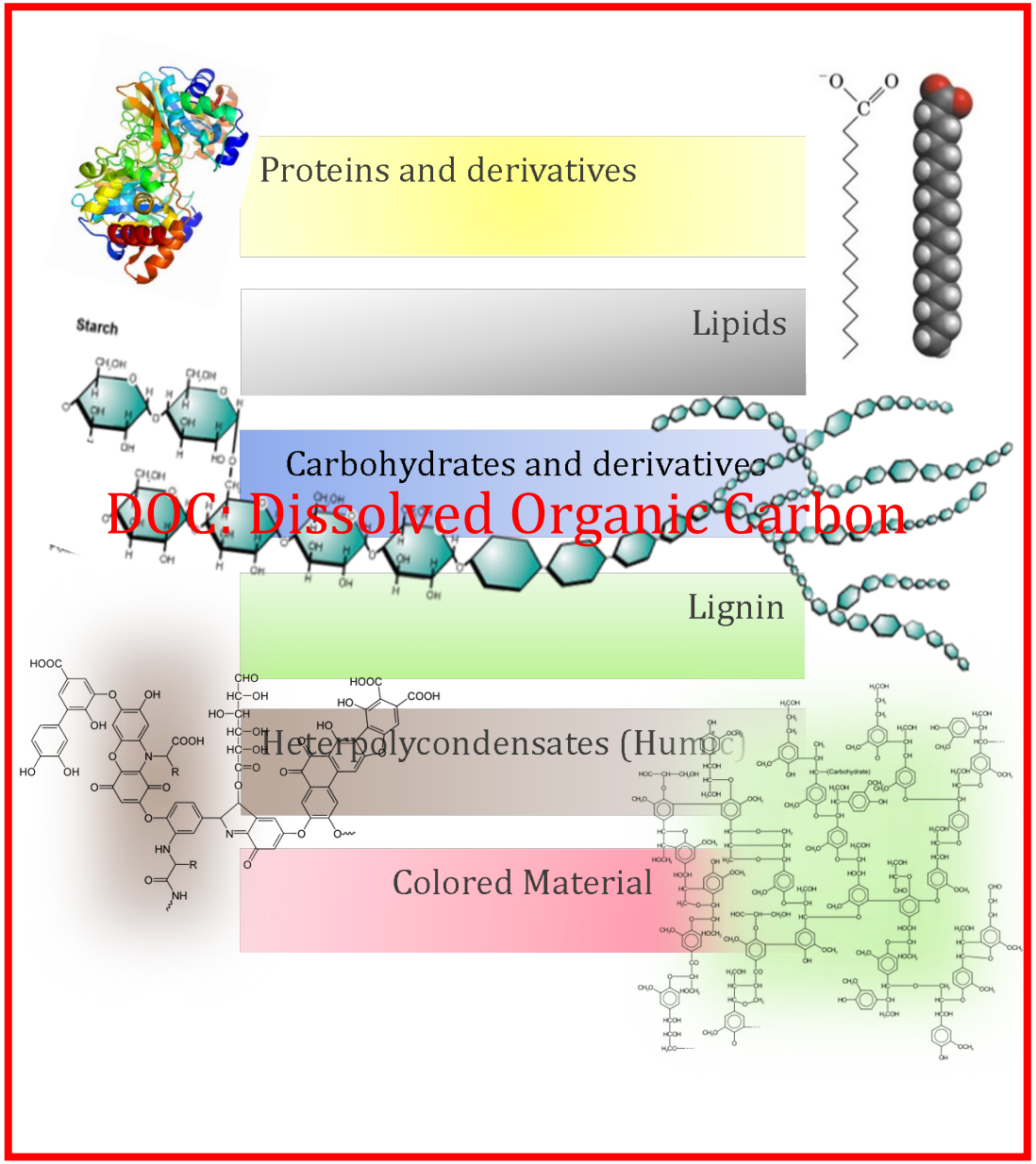
https://www.nrdc.org/stories/permafrost-everything-you-need-know

https://www.thesupcoach.co.uk/

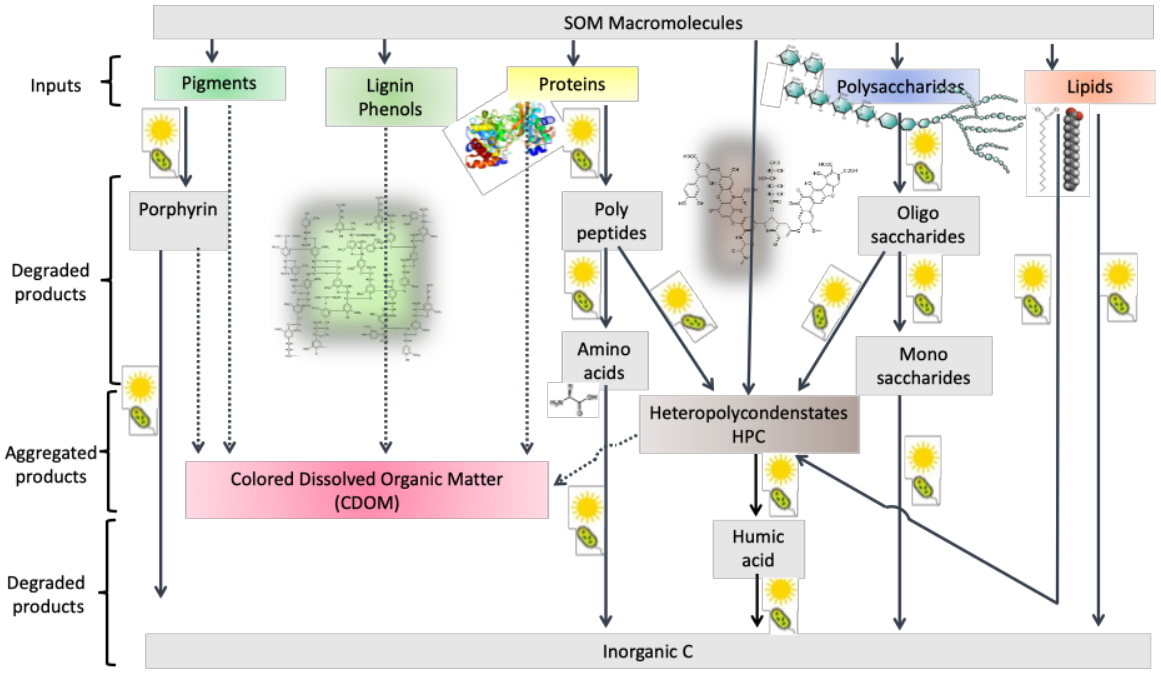
Arctic Rivers carry high load of DOC (Dissolved Organic Carbon)

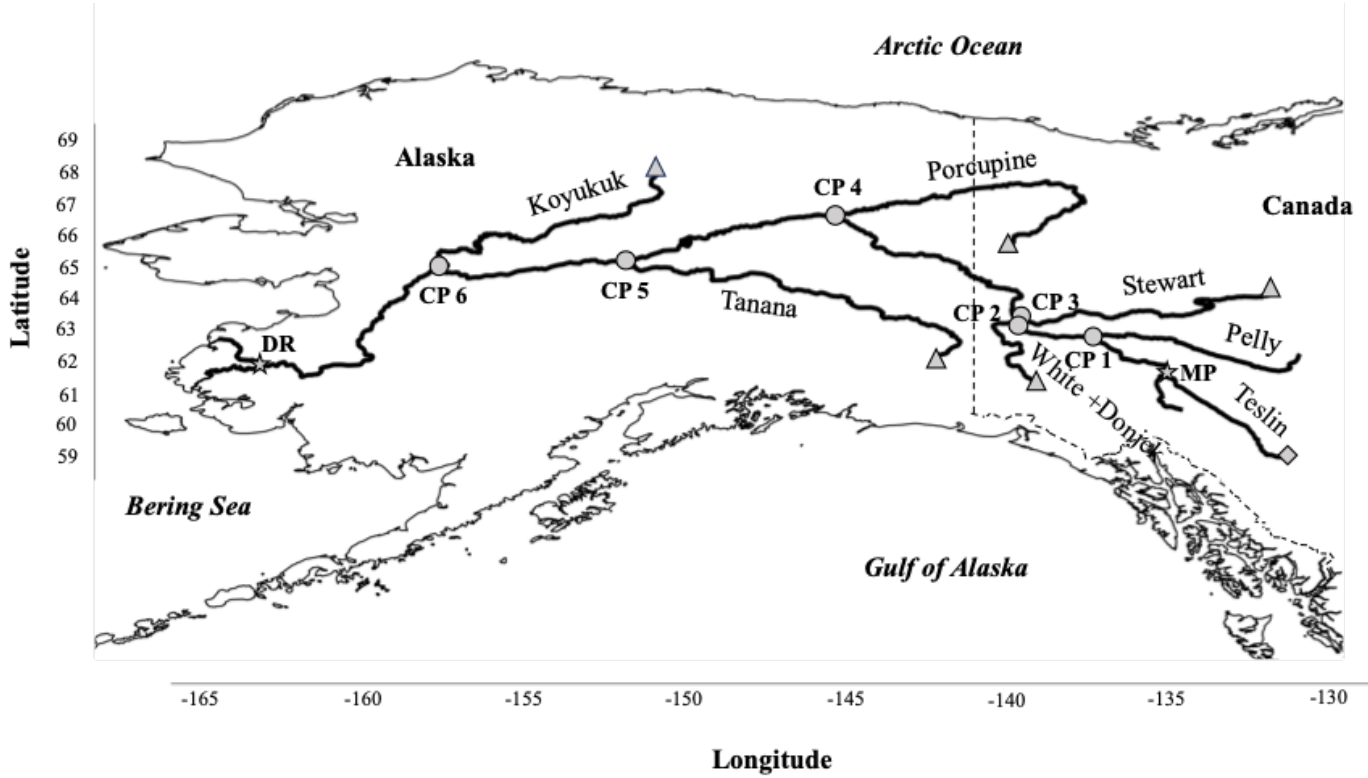
Current models have total DOC

DOC Macromolecular Composition can determine the impact of the DOC on the marine ecosystems



We Model *Chemical Evolution of Macromolecular DOC Composition* along the Arctic Rivers





Chemical Mechanism Inside the model

Input macromolecules undergo *microbial and photochemical reactions*, resulting in **degraded and aggregated products**

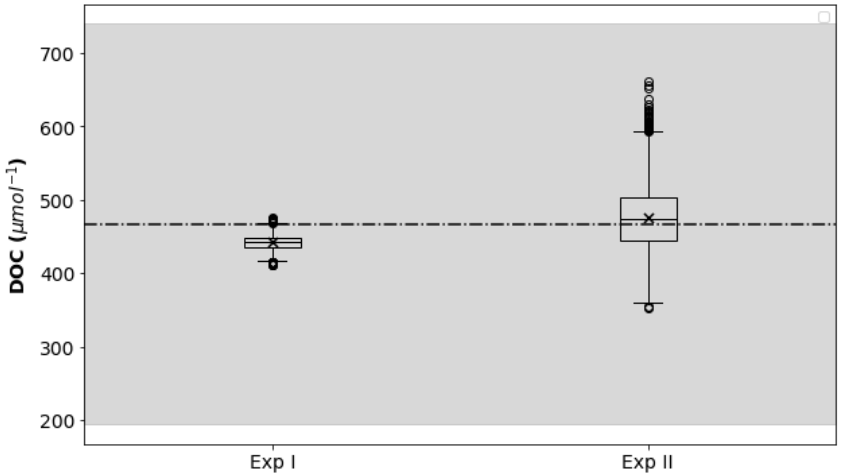
Parameterized *River Model of Yukon River*

Physical Parameters - Flow Velocities(8), Dilution factors(6)
Chemical parameters - Turnover time of the macromolecules(15)
Soil parameters - Initial DOC(7) , fraction of the macromolecules(1)

The Monte Carlo Sensitivity Analysis of the Yukon river model results …

Exp I - We assume a triangular probability distribution for all 37 parameters with ±10% limits around the baseline mean

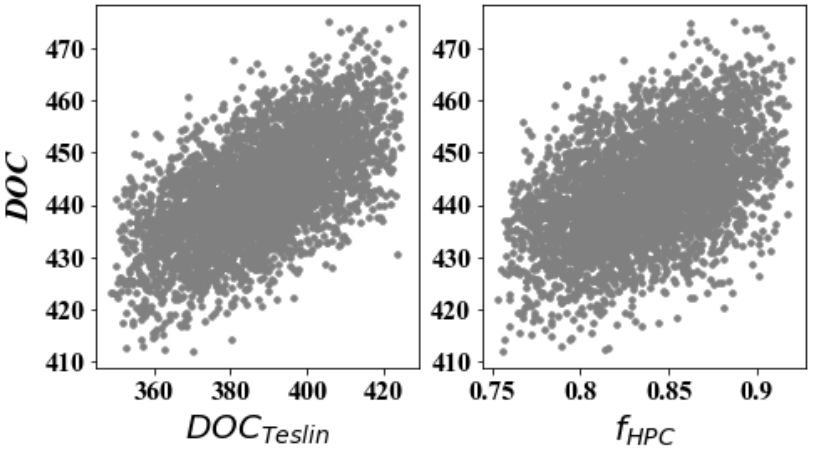
Exp II - Same mean values as Exp I but parameter space refined using literature and expert judgment



❖ Observed and modeled Yukon River DOC concentration

	DOC			
	Exp I	**R^2**	**Exp II**	**R^2**
1st	DOC_{Teslin}	**0.37**	DOC_{Teslin}	**0.32**
2nd	f_{HPC}	**0.21**	DOC_{Pelly}	**0.20**
3rd	DOC_{Pelly}	**0.17**	DOC_{Stewrt}	**0.12**
4th	$DOC_{Stewart}$	**0.10**	$DfPelly$	**0.10**
5th	DOC_{Tanana}	**0.05**	DOC_{Tanana}	**0.06**
Top 5		**0.90**		**0.79**

❖ R^2 for the five most sensitive Top 5 ranked model parameters for modeled DOC



❖ Positive correlation between modeled DOC and (left) input DOC from the Teslin tributary (DOC_{Teslin}) and (right) the HPC fraction (f_{HPC}) for Exp I

- Initial DOC from SOC, labile/refractory sizes, and dilution factors **significantly influence** DOC output at the river mouth.
- These factors together explain approximately **80-90%** of variability in simulated DOC concentration
- Hydrological parameter-river velocity shows **minimal contribution** to the simulated DOC concentration.

Conclusion

- Frequent monitoring of initial DOC inputs, soil conditions, and dilution dynamics is essential.
- Ongoing climate change and seasonal variability in the Arctic make these parameters increasingly dynamic and impactful.
- Enhanced observations will improve model accuracy and support predictions of Arctic carbon export under future scenarios.