Floodplain Influence on Carbon Transport in the Atchafalaya River Basin

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MAY 31, 2018

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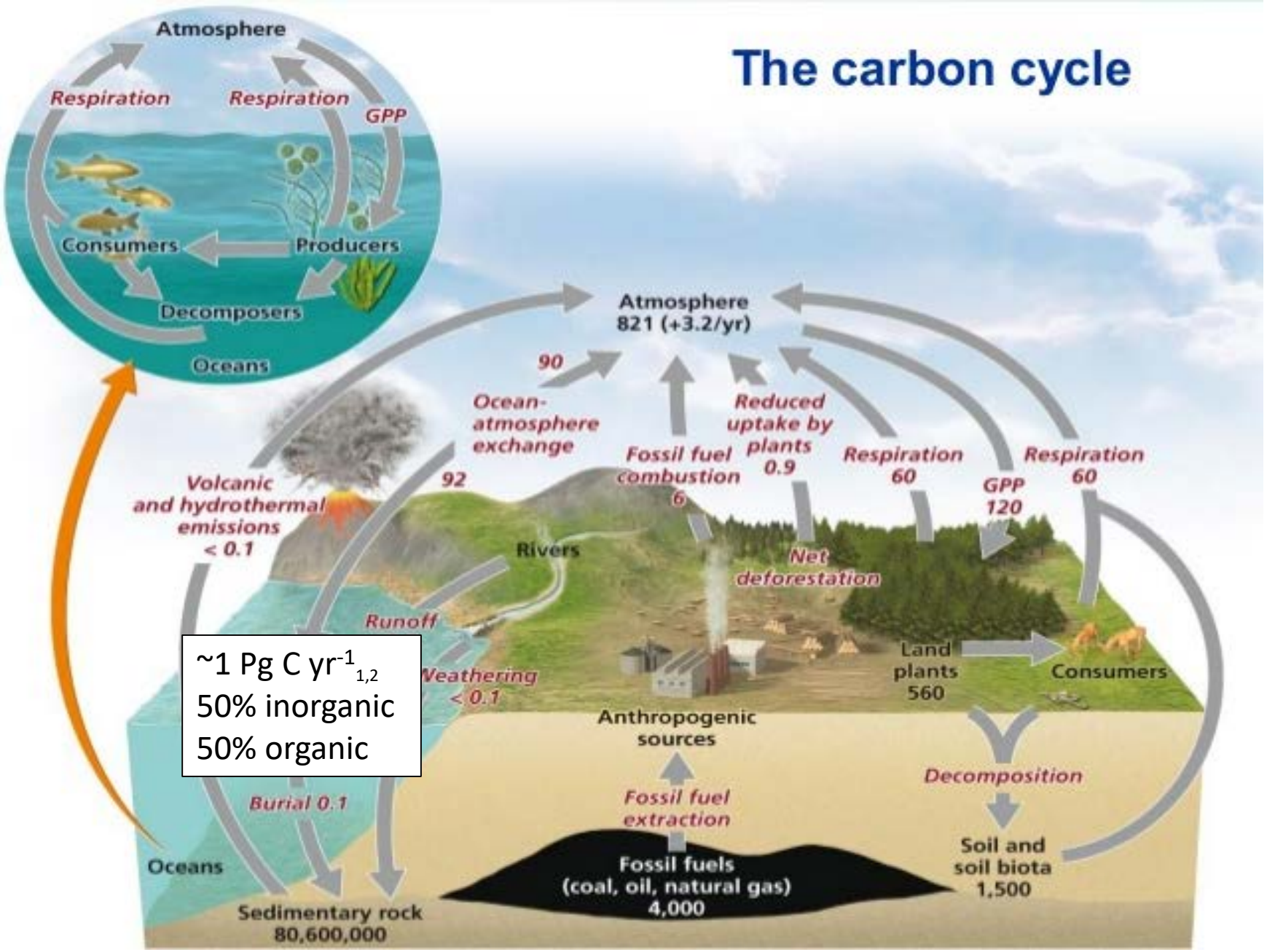
Acknowledgements

The carbon cycle

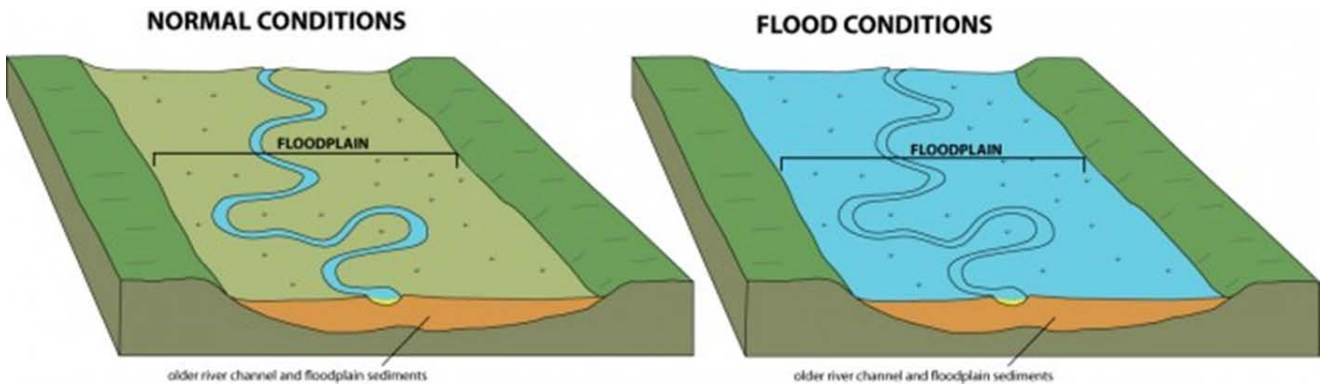


~1 Pg C yr^{-1} [1,2]
50% inorganic
50% organic

Role of River Floodplain Connectivity

Site for physical and biogeochemical processes influence water chemistry

- Sedimentation[3,4]
- Denitrification[5]
- Sorption of heavy metals[3,6]
- Biological uptake nutrients/heavy metals[3,6]



Retrieved from http://www.geoforcxc.com/water/river-features/

How do river floodplain wetlands influence carbon transport in river systems?

Goals and Objectives

Primary goal

- Determine how riverine floodplains influence dissolved carbon transport

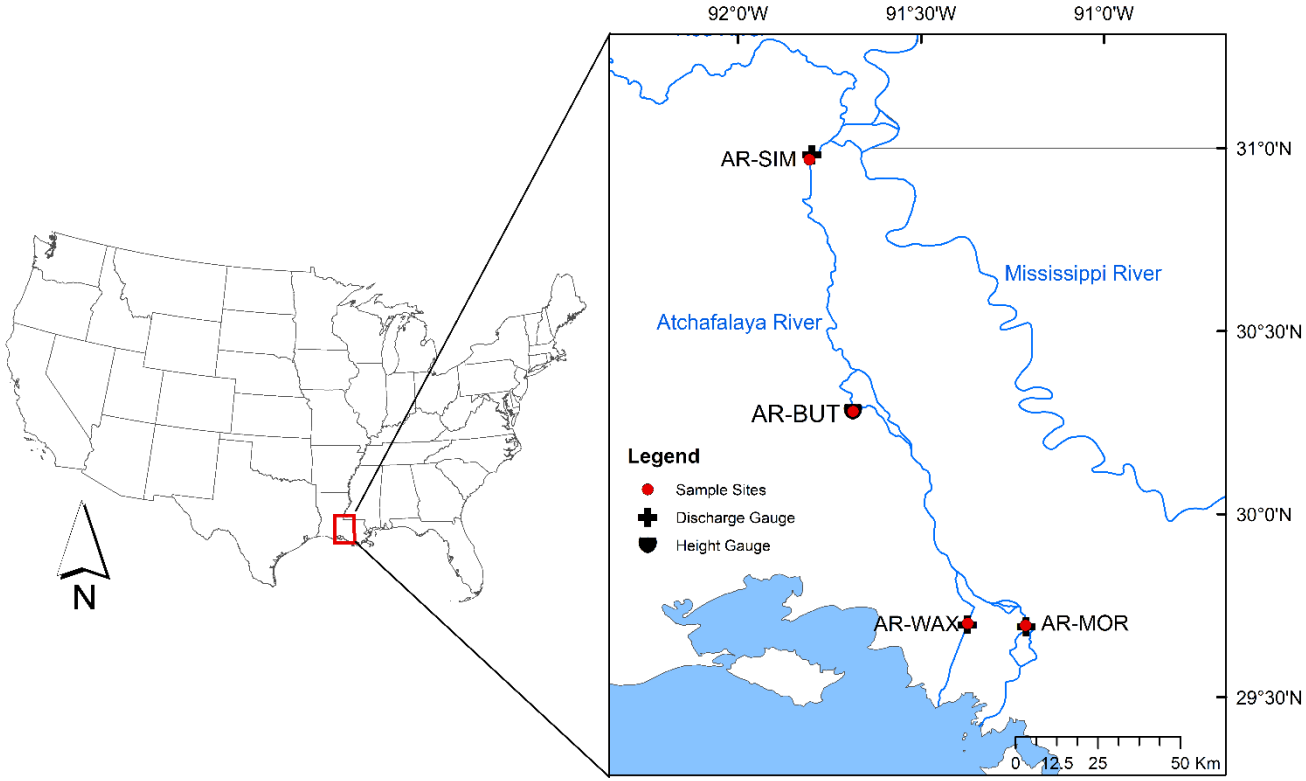
Objectives

- Analyze DOC and DIC concentrations and $\delta^{13}C$ in the Atchafalaya River, upstream and downstream of the Atchafalaya River Basin
- Calculate carbon daily mass loading entering and exporting from the ARB
- Calculate annual mass load of carbon to the Northern Gulf of Mexico from the Atchafalaya River

Hypothesis

- DOC concentrations ↓ and DIC concentration ↑ downstream of the ARB due to respiration
- Significant removal of DOC loads in basin and increase of DIC loads

Study Area - Atchafalaya River



U.S. largest contiguous wetland-floodplain system

AR-SIM → AR-BUT – levee confined

AR-BUT → AR-WAX

→ AR-MOR – floodplain connectivity

20-80% inundation[7]

Direct comparison of confined/connected

- Pairwise comparisions

3 sites have discharge: 1 river height

Field Collection

Monthly grab samples and in-situ measurements

- May ‘15 – May ‘16
- Jan ‘17 – Jan ’18
- Full range of flow conditions

Grab Samples

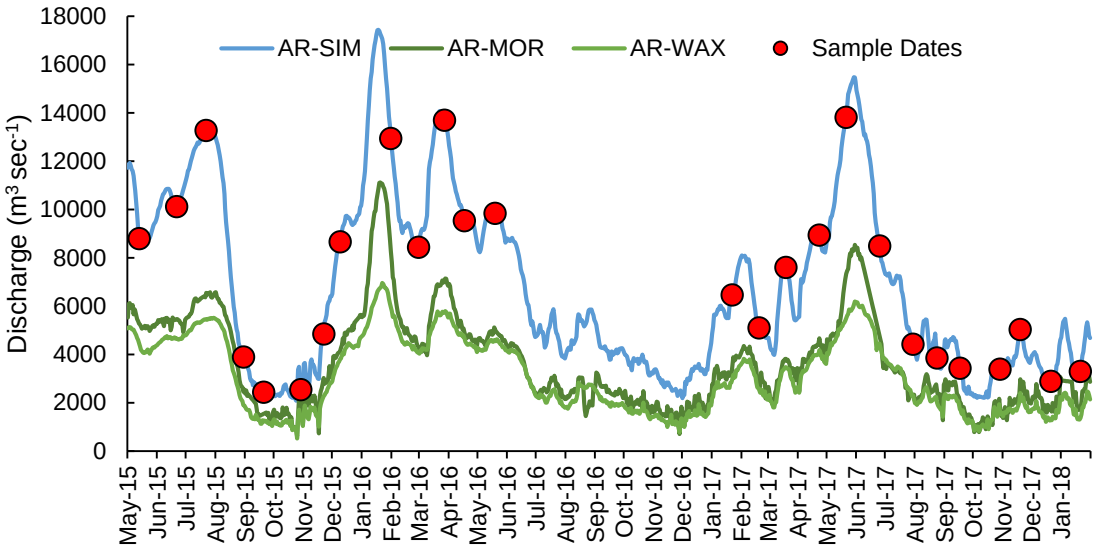
- DOC concentration and $\delta^{13}C_{DOC}$
- DIC concentration and $\delta^{13}C_{DIC}$

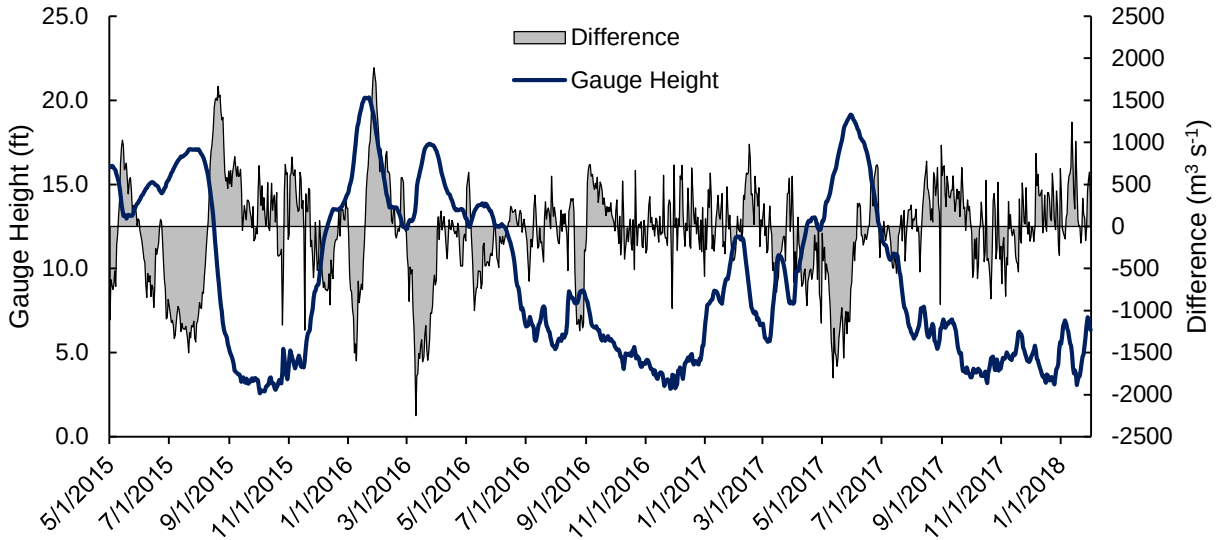
In-situ measurements

- pCO_2 – C-Sense
- Temp, DO, pH – YSI

Results

Hydrology





2,083 – 17,441 m^3 sec^{-1}

MOR > WAX

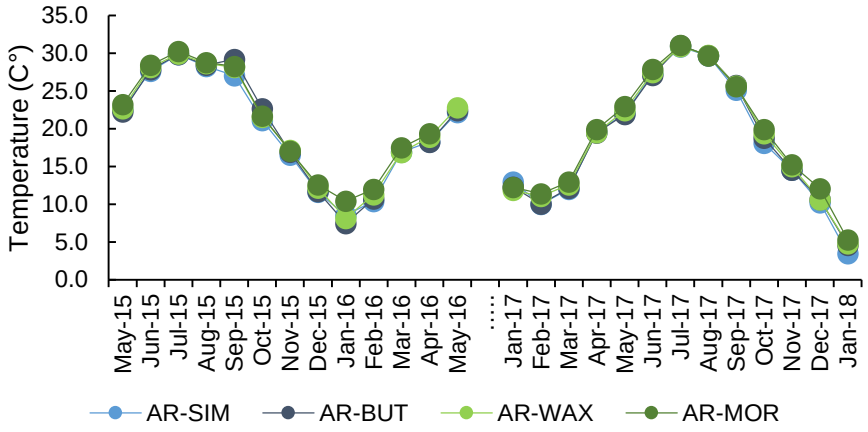
Few uncharacteristic high flow periods

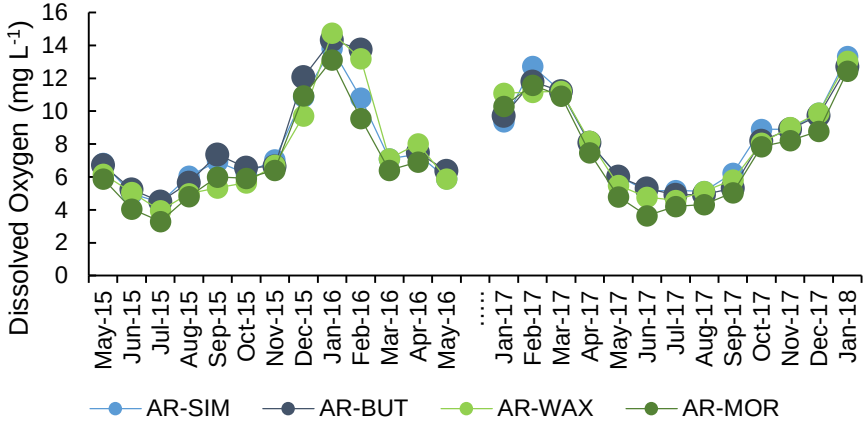
Difference = (MOR+WAX) - SIM

As gauge height increases, water trapped in basin

Fairly balanced annual water budget

Ambient Conditions

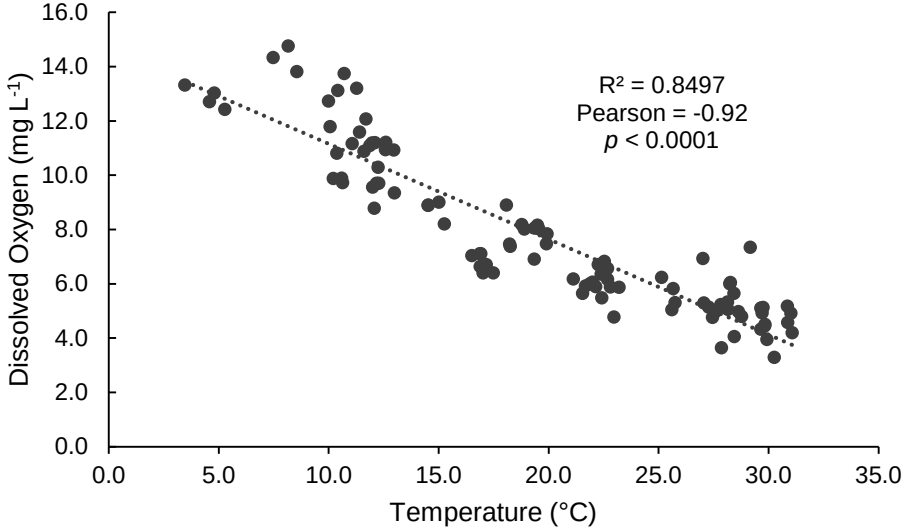




Temperature: 3– 30 °C

Dissolved Oxygen: 3.3 – 14.8 mg L^{-1}

- AR-BUT → AR-MOR ↓ 0.9 mg L^{-1} $p = 0.0001$
- Respiration of OM?



pCO_2

Primary sources

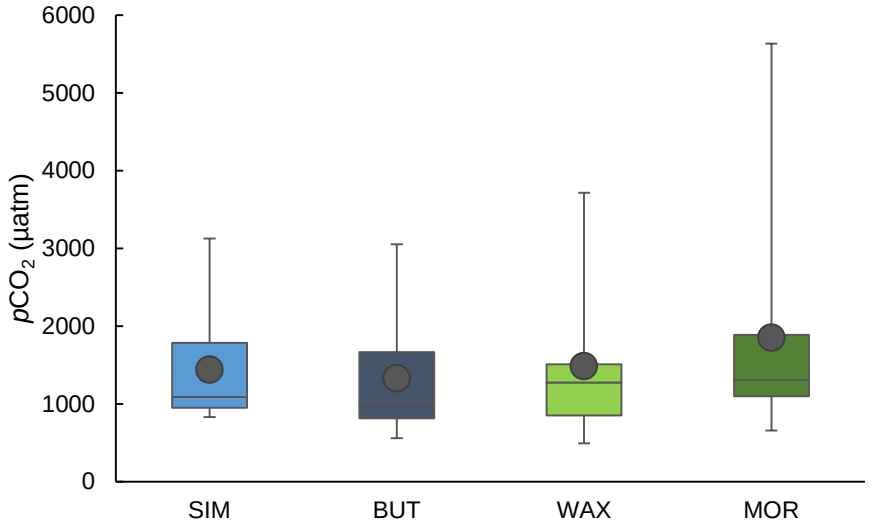
1. In-situ respiration OM
2. Flushing in of terrestrial respiration OM

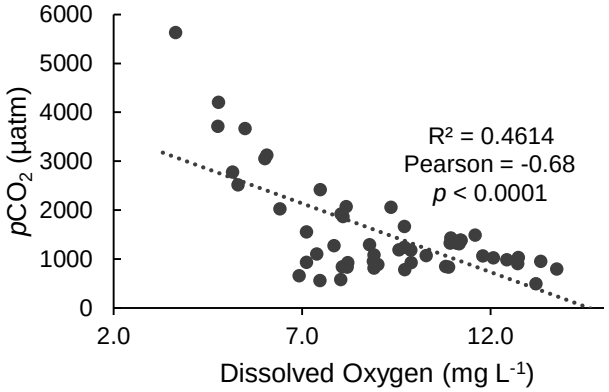
pCO_2: 1329 – 1852 µatm

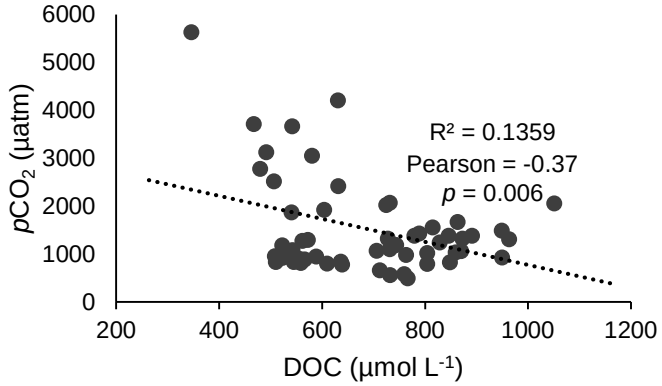
Inverse relationships DO and DOC

AR-BUT → AR-MOR ↑ 510 µatm

Significant respiration occurring between BUT-MOR?







DOC & $\delta^{13}C_{DOC}$

DOC: 635 – 680 µmol L^{-1}

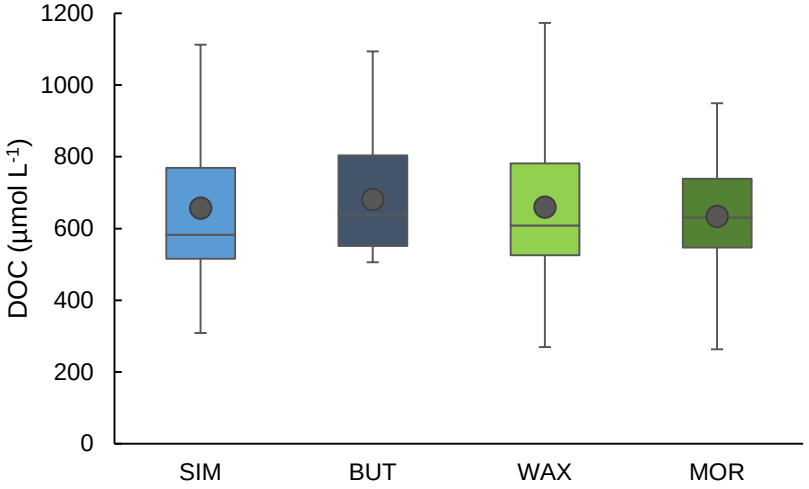
- No significant difference upstream to downstream between sites
  - Two outlets lower concentrations than upstream of ARB
- No clear relationship with gauge height

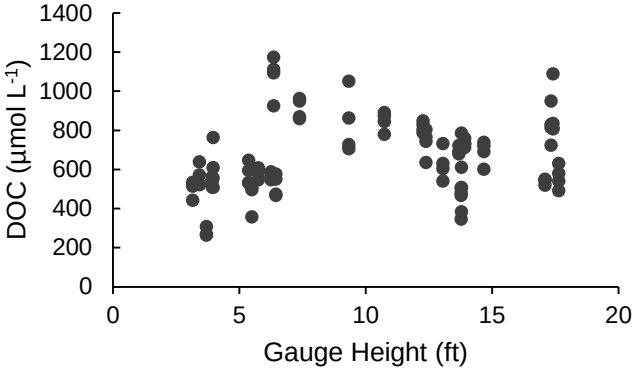
$\delta^{13}C_{DOC}$: -28.1 – -28.3 ‰ VPDP

- C3 plant dominant source
- No significant difference

If respiration is occurring, it has having no significant effect of DOC concentrations

- Rejects out initial hypothesis





DOC Loads

Loads driven by discharge

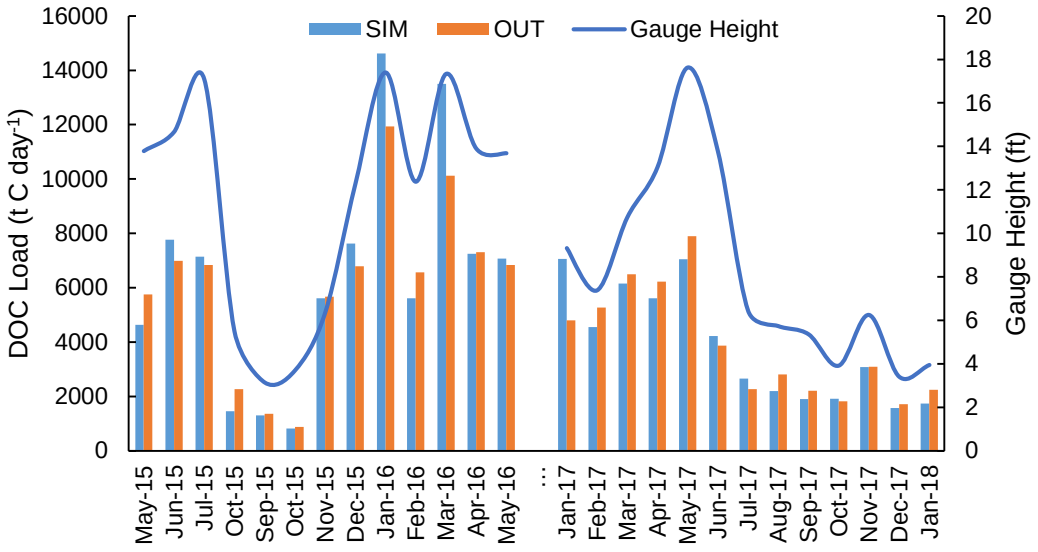
No significant change in loads IN/OUT

- Despite lower downstream concentrations

On average functions as a DOC sink

Table 1 DOC daily loads (t C day^{-1})

Location	Mean	Median	Min	Max
IN	5,158 ± 3,503	5,123	819	14,623
OUT	5,001 ± 2,831	5,473	875	11,930
DIFFERENCE	-140 ± 1,137	63	-3,375	1,107



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Load decreases correlate with Q decrease

- Water retention in basin regulating DOC export

Partially accept our hypothesis

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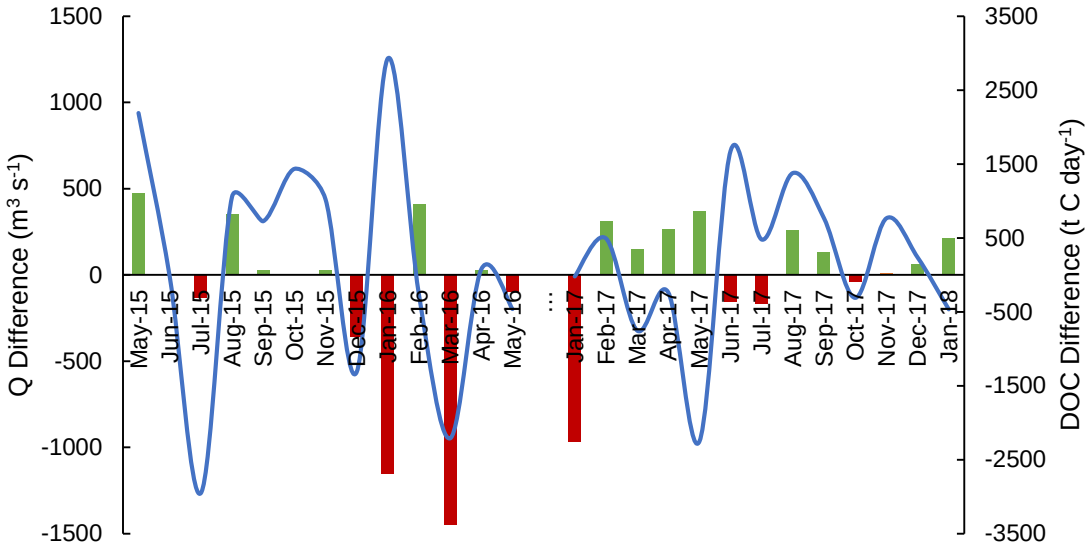


DIC & $\delta^{13}C_{DIC}$

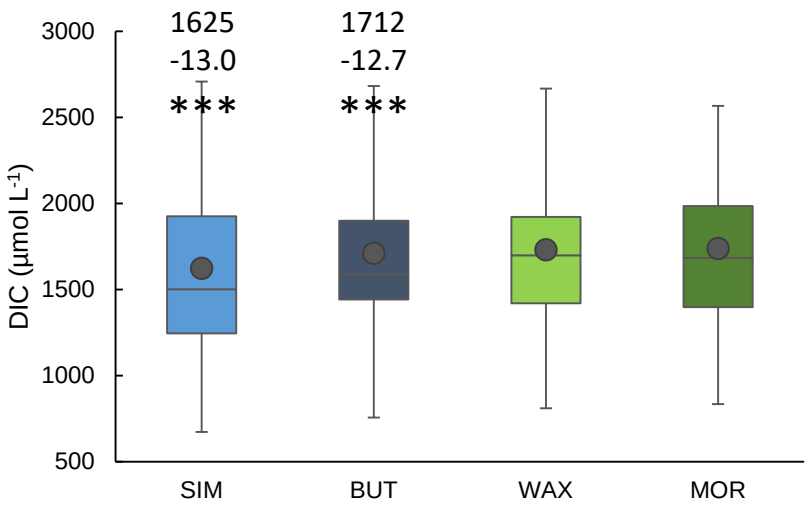
DIC: 1625 – 1740 µmol L^{-1}

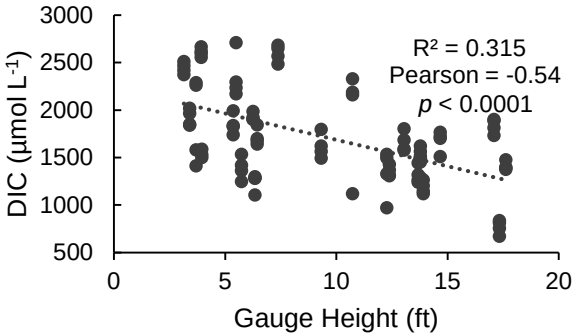
- Strong inverse relationship with gauge height
- AR-SIM → AR-BUT ↑ 120 µmol L^{-1} $p = 0.04$

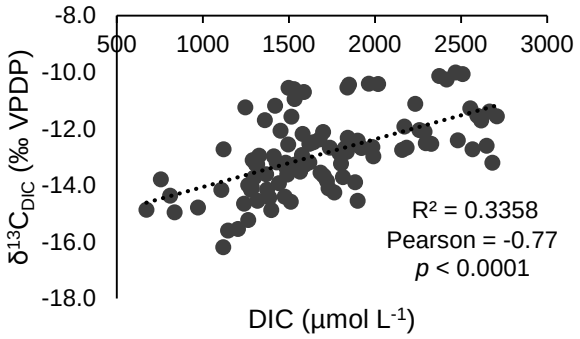
$\delta^{13}C_{DIC}$: -12.7 – -13.0 ‰ VPDP

- Mix of mineral weathering and respiration of OM
- Strong relationship DIC & $\delta^{13}C_{DIC}$
- AR-SIM → AR-BUT ↑ 0.3 $p = 0.03$

Respiration not likely having a strong influence on DIC concentrations either







DIC Loads

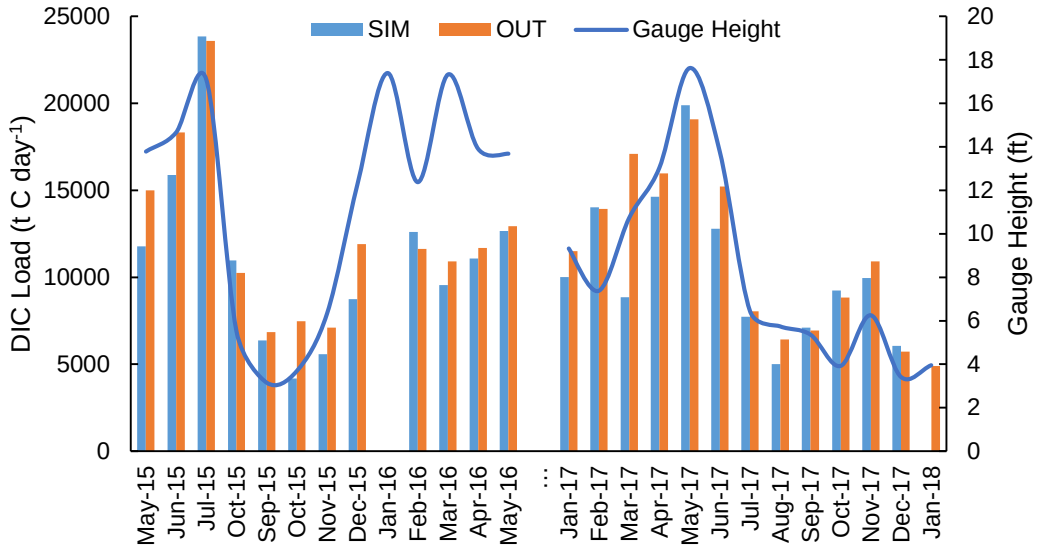
Loads driven by discharge

Significant increase in loads IN/OUT

- Likely driven by concentration increase at upstream sites and not within basin

Table 2 DIC daily loads (t C day^{-1})

Location	Mean	Median	Min	Max
IN	***10,774 ± 4,656	9,993	4,187	23,843
OUT	***11,689 ± 4,730	11,499	4,890	23,591
DIFFERENCE	1,047 ± 2,003	539	-969	8,243



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No clear relationship between load change and Q change

- Future work

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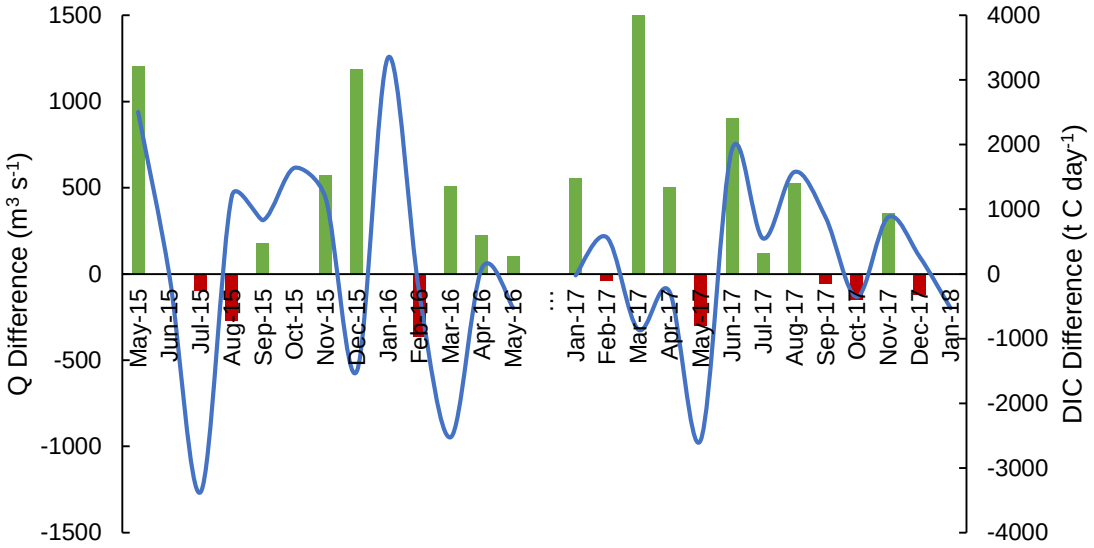


DOC/DIC Annual Loads

Q balanced budget

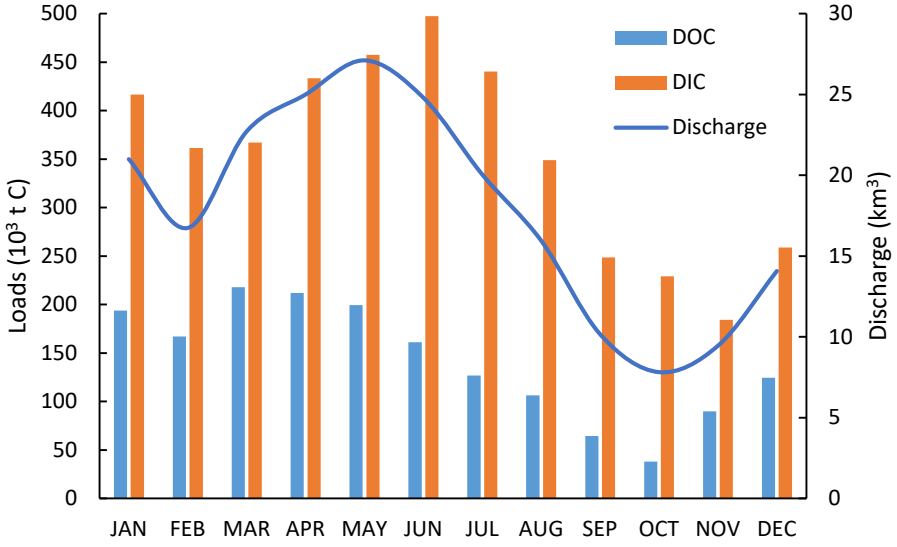
DOC
- 1,701,000 t annually to NGOM
  - Mississippi 1,880,000 t annually (Cai et al., 2015)
- 73,000 (4%) t trapped in ARB

DIC
- 4,244,000 t annually to NGOM
  - Mississippi 13,360,000 t annually (Cai et al., 2015)
  - Proportional to discharge
- Increase in loads despite balanced water budget

Atchafalaya is a significant source of carbon to NGOM

Table 3 Annual discharge, DOC, & DIC loads

Parameter	IN	OUT	Difference	
Q (km^3)	218	215	-3	-1%
DOC (10^3 t)	1774	1701	-73	-4%
DIC (10^3 t)	3925	4244	319	8%



Future Work

Continuing to gather monthly DIC/DOC data

Calculation of discharge at AR-BUT

- Improve calculation of loads entering the basin

In-depth analysis of high/low flow events

Addition of Chlorophyll A and Colored Dissolved Organic Matter (CDOM) fluorescence data

Conclusion

Riverine floodplains did not have a significant influence on DOC concentrations, however the ARB functions as a significant sink for DOC loads during high-flow events

- Reduce DOC loads delivered to NGOM

Atchafalaya River is a significant source of dissolved carbon to the Northern Gulf of Mexico

Conclusion

Riverine floodplains did not have a significant influence on DOC concentrations, however the ARB functions as a significant sink for DOC loads during high-flow events

- Reduce DOC loads delivered to NGOM

Atchafalaya River is a significant source of dissolved carbon to the Northern Gulf of Mexico

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