

A satellite image of a river system, likely the Amazon basin, showing a complex network of brown and tan channels winding through a dense green forest. The image is overlaid with various data layers, including a blue line representing a river network and a white, semi-transparent grid or map overlay. The text is centered over the image.

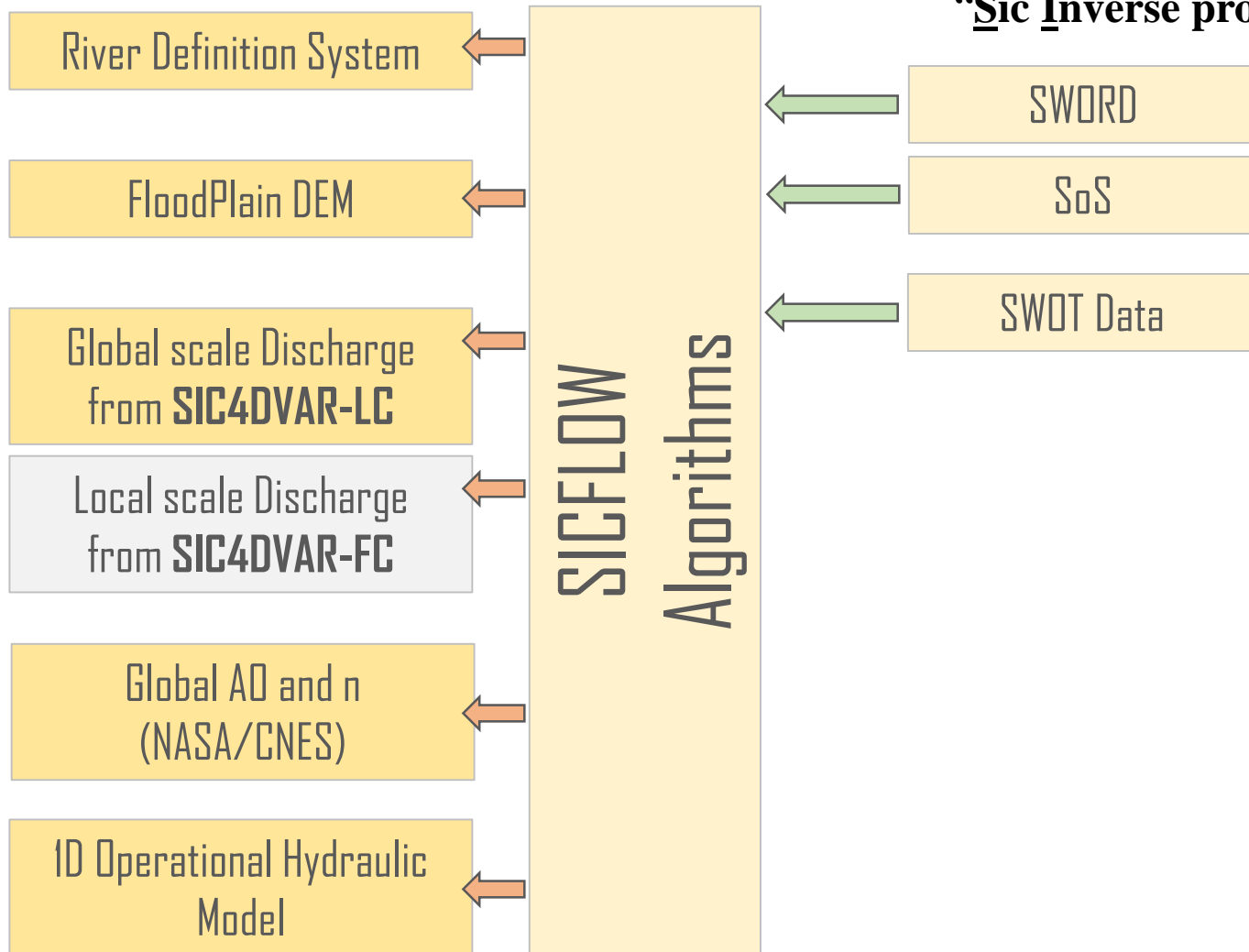
# **An Enhanced SWOT River SP Product (L3) using Densification Approaches**

**Hind Oubanas & Cécile Cazals**

**I. Gejadze, P-O. Malaterre, D. Quittard, C. Stuurman, T. Pavelsky**

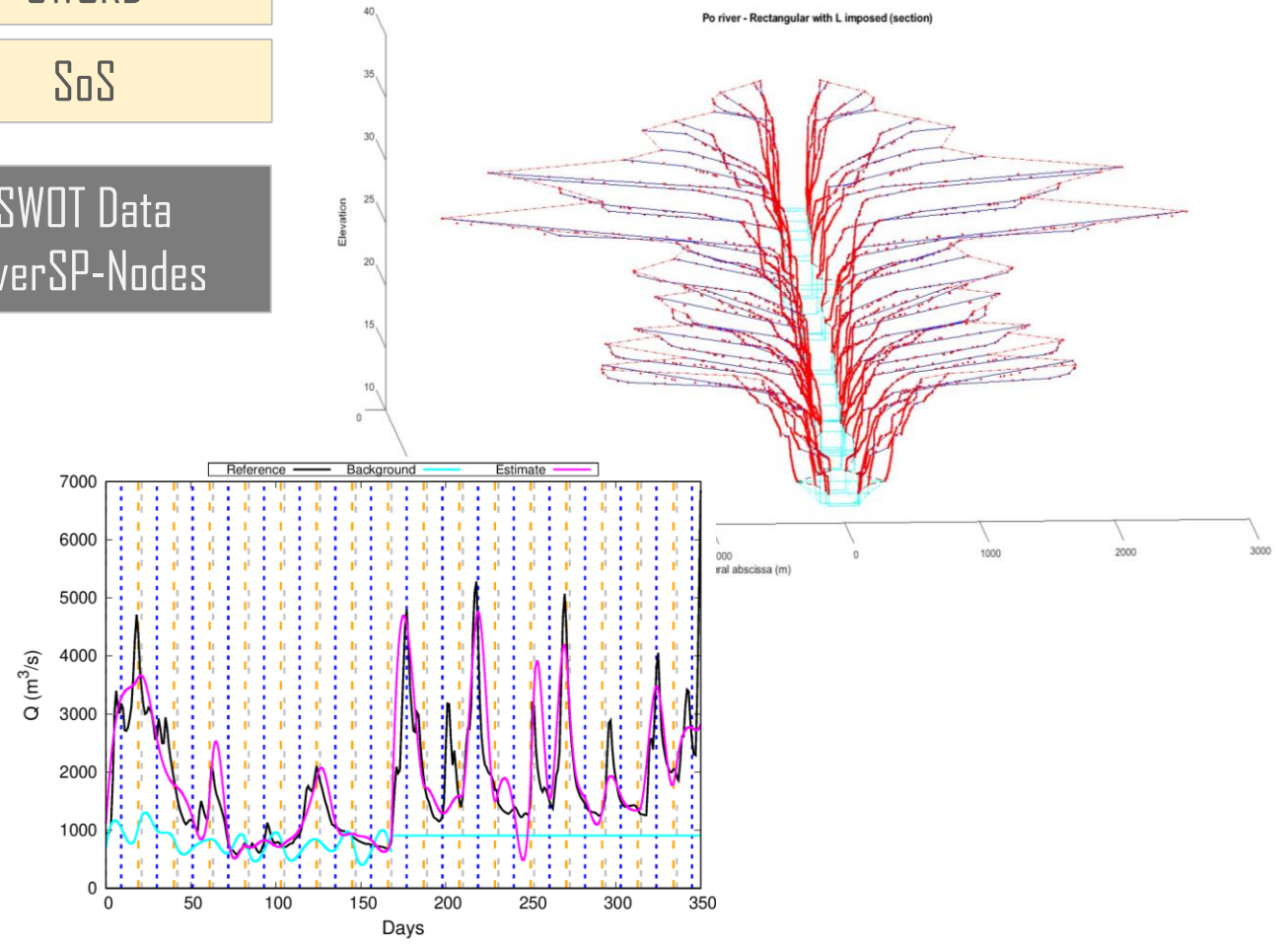
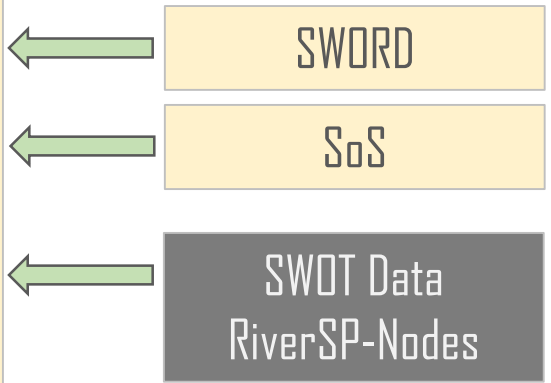
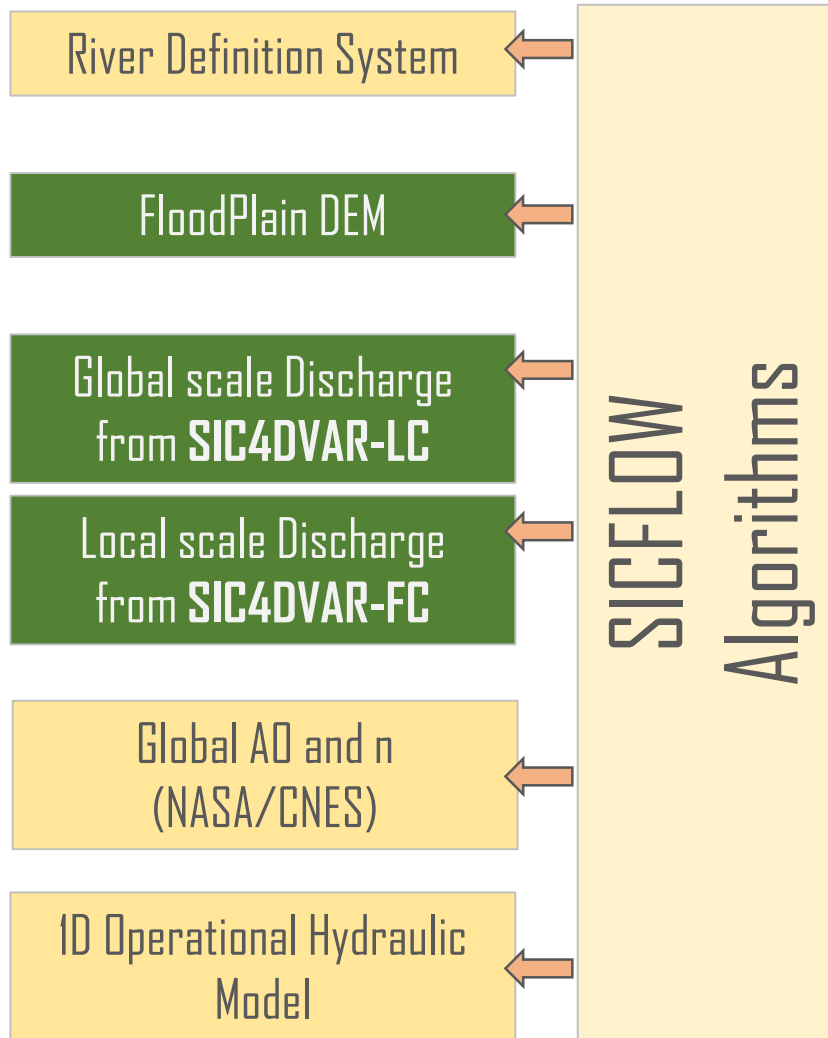
# SICFLOW

“Sic Inverse problem Capabilities for river FLOW dynamics”



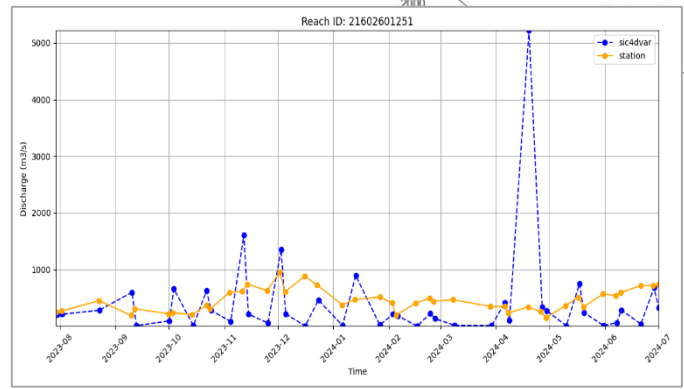
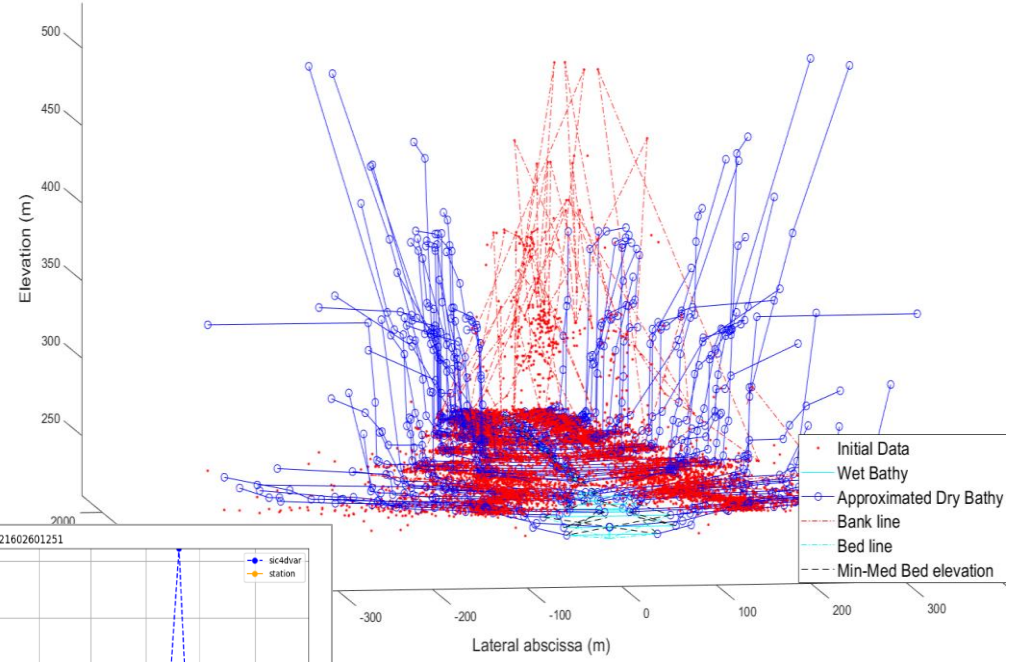
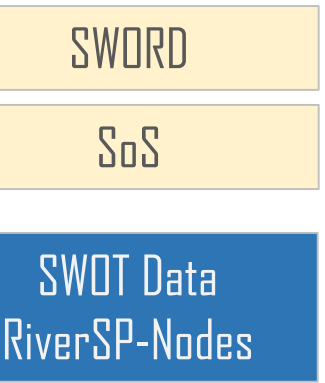
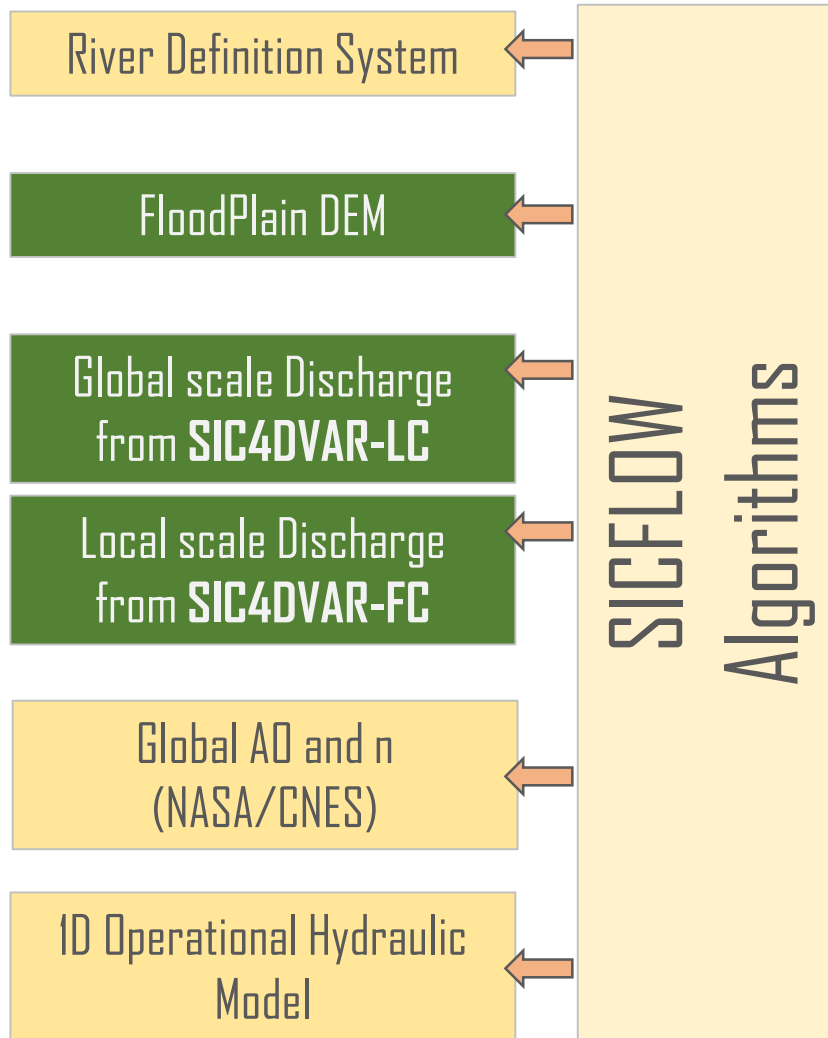
# SICFLOW

“Sic Inverse problem Capabilities for river FLOW dynamics”



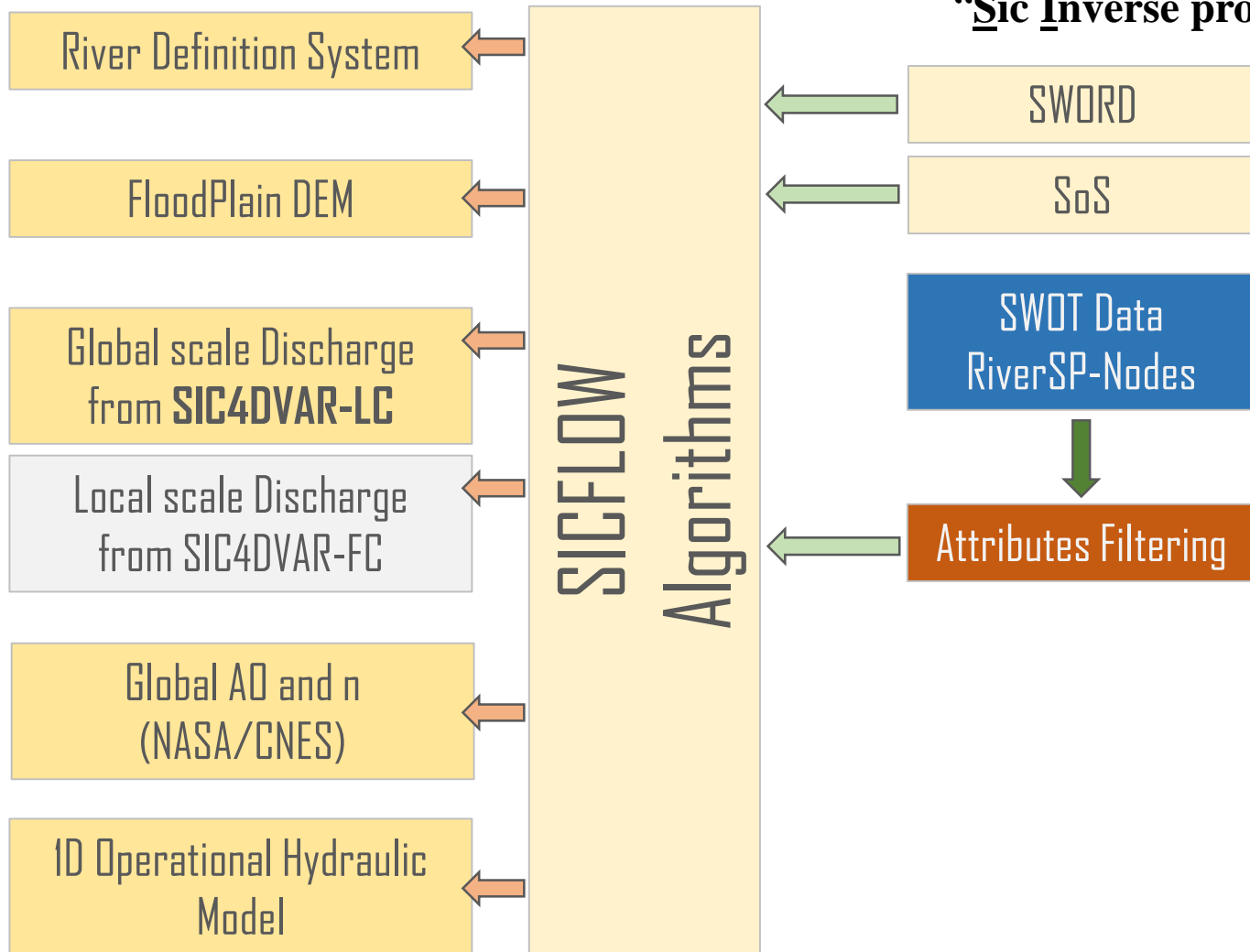
# SICFLOW

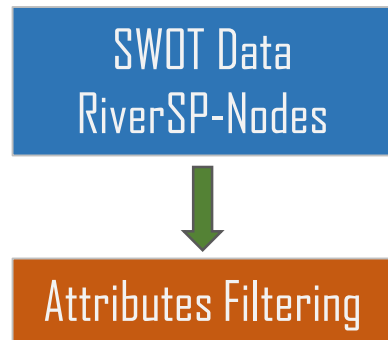
“Sic Inverse problem Capabilities for river FLOW dynamics”



# SICFLOW

“Sic Inverse problem Capabilities for river FLOW dynamics”





**Permissive Filter (Global Use)**

**prior\_width\_min\_m = 80**  
**prior\_slope\_min = 3.4 cm/km**  
**reach\_length\_min\_m = 7 km**  
**|cross\_track\_dist| between 10 and 60 km**  
**(from |x\_trk\_dist| > 15 km)**  
**ice\_max = 0**  
**Dark\_frac\_max = 0.4**  
**obs\_frac\_min = 0.5**  
**xover\_cal\_q\_max = 1**  
**Tukey\_number = 1.5**  
**n\_node\_pix\_min = 10**

**target\_bit\_node= 532680192**  
**adds flags 9,10, 11, 23, and 24 to the reach**  
**9,10,11,22,23,24,25,26,27,28**  
**few\_sig0\_observations**  
**few\_area\_observations**  
**few\_wse\_observations**  
**wse\_outlier**  
**wse\_bad**

**target\_bit\_reach= 507510784**  
**FUNCTIONALLY EQUIVALENT TO \_q<=2**  
**Bit 22,25,26,27,28**

- lake\_flagged
- below\_min\_fit\_points
- no\_area\_observations
- no\_wse\_observations
- no\_pixels

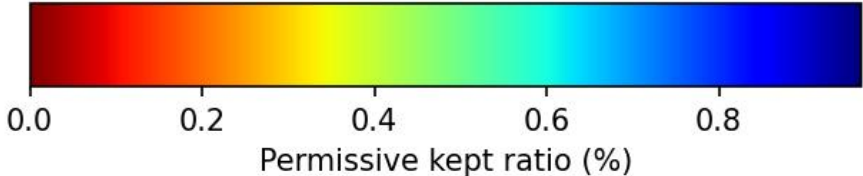
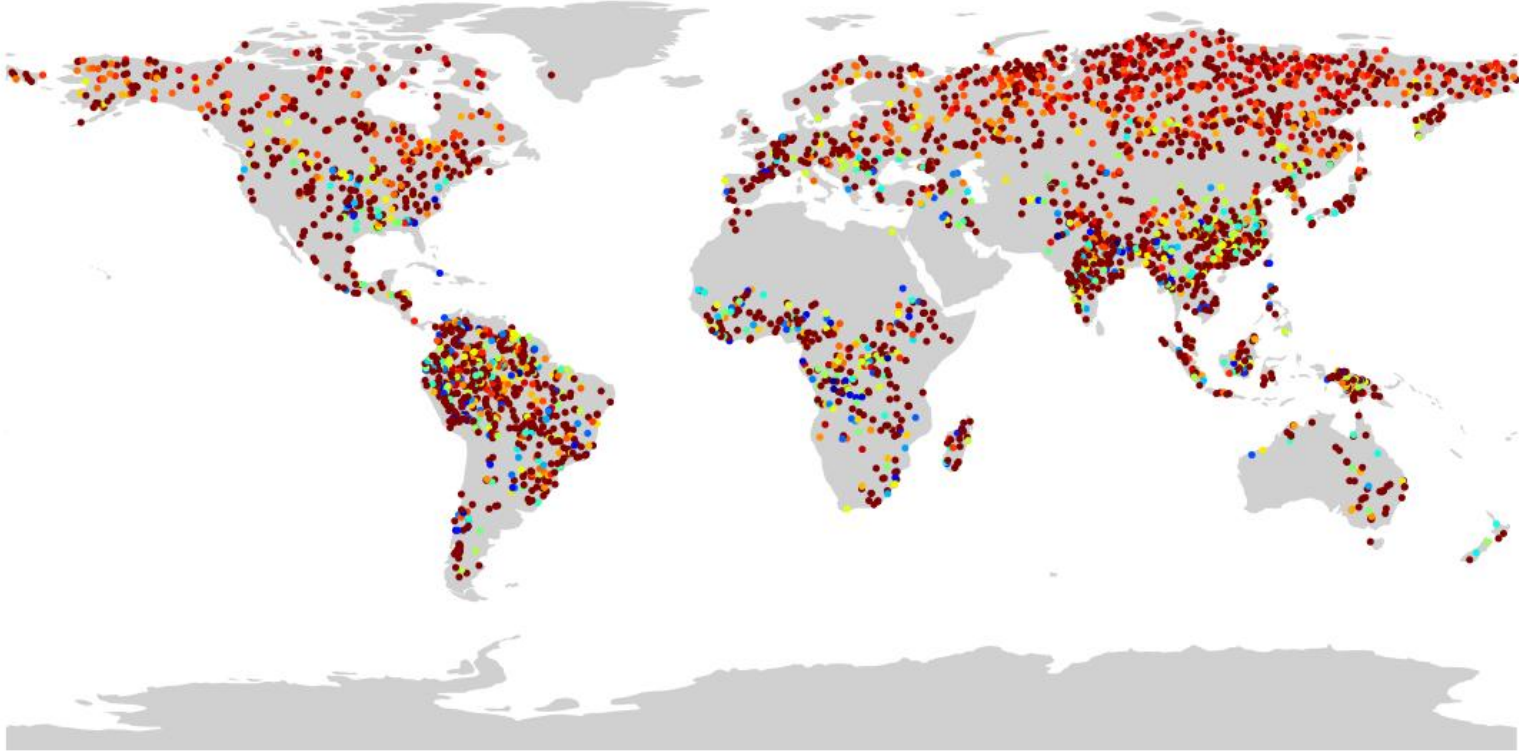
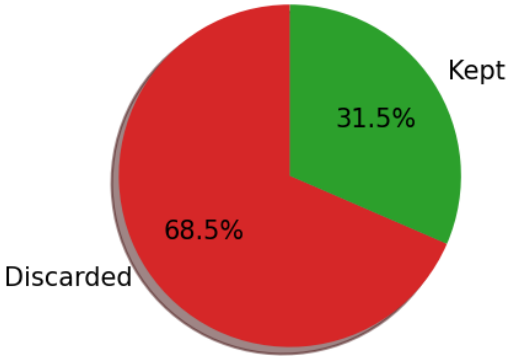
# Permissive filtering kept ratio at reach level

SWOT Data  
RiverSP-Nodes



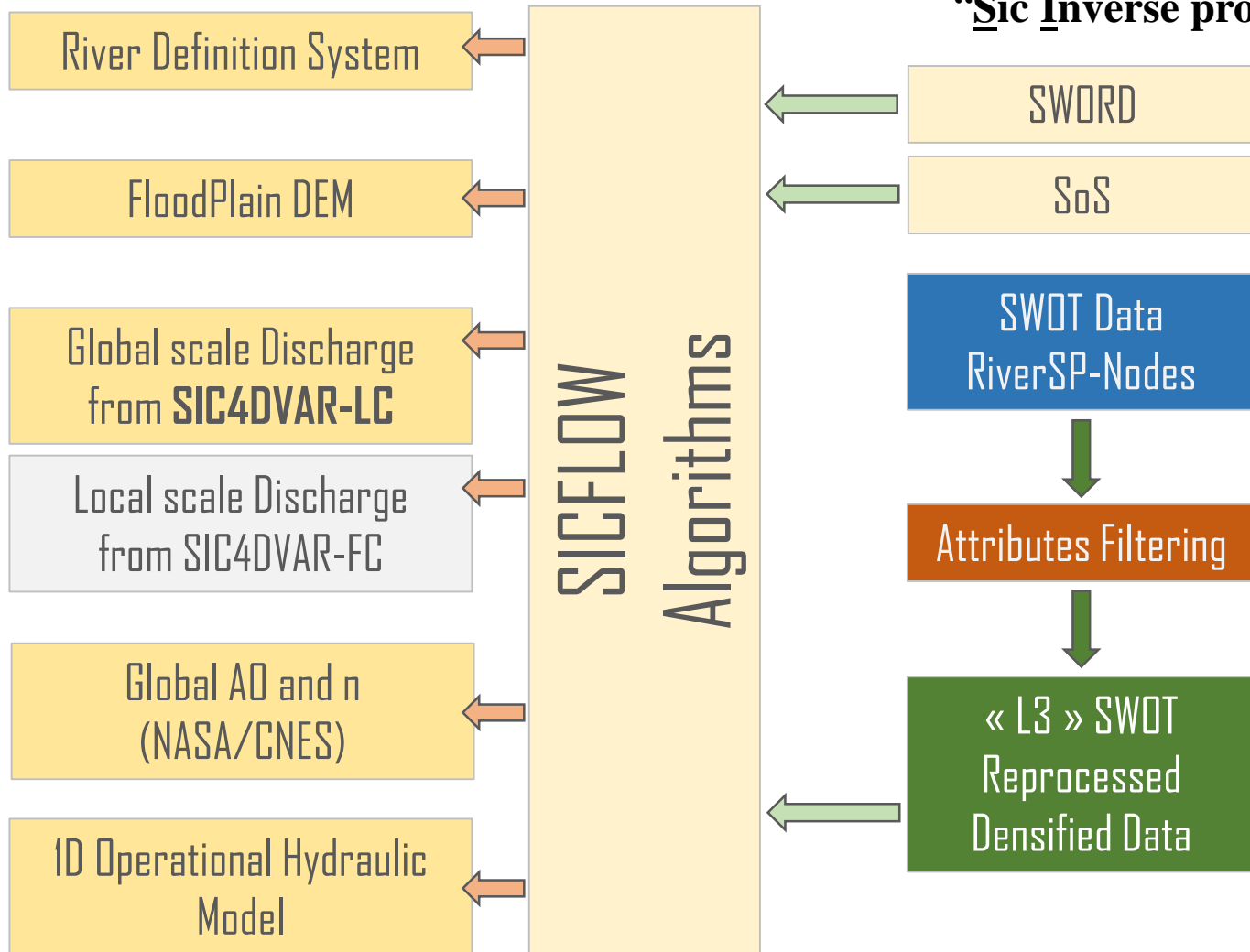
Attributes Filtering

Node level (2.1e+06 obs)



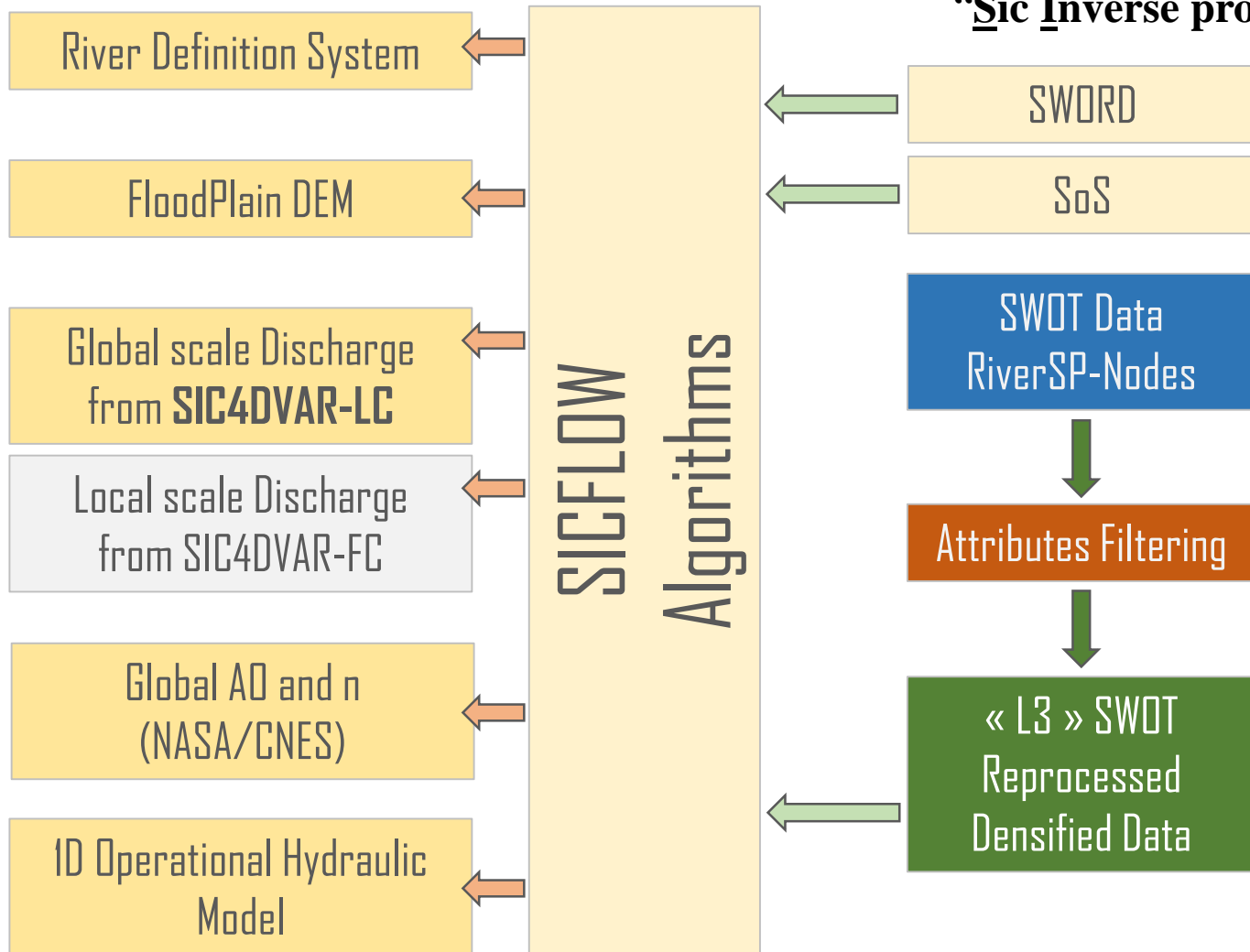
# SICFLOW

“Sic Inverse problem Capabilities for river FLOW dynamics”



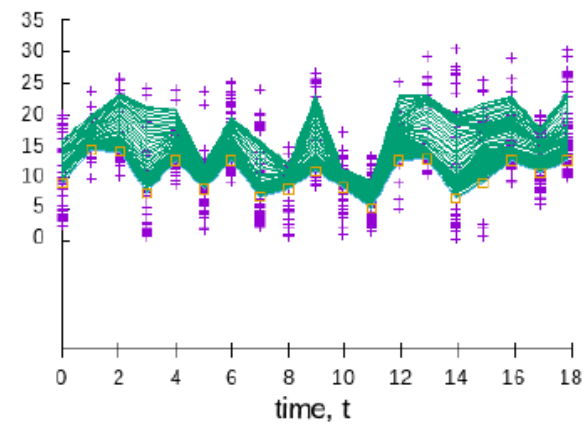
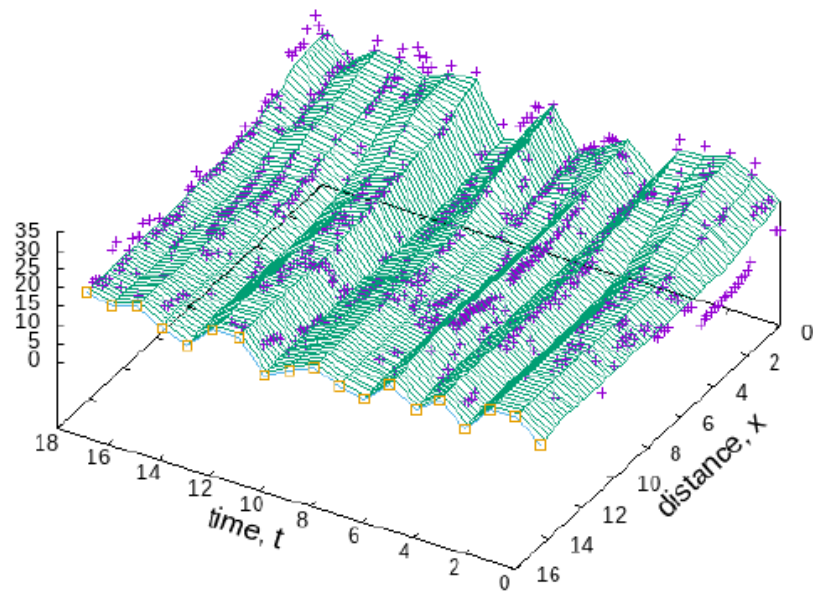
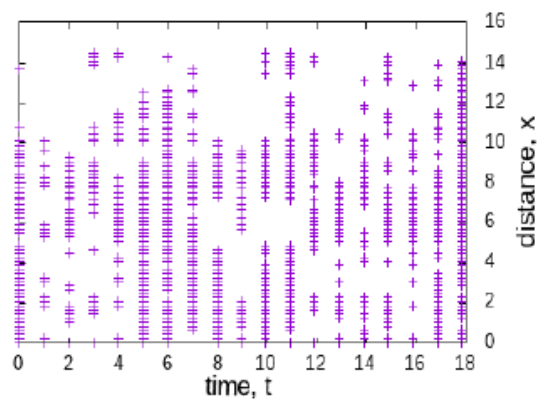
# SICFLOW

“Sic Inverse problem Capabilities for river FLOW dynamics”

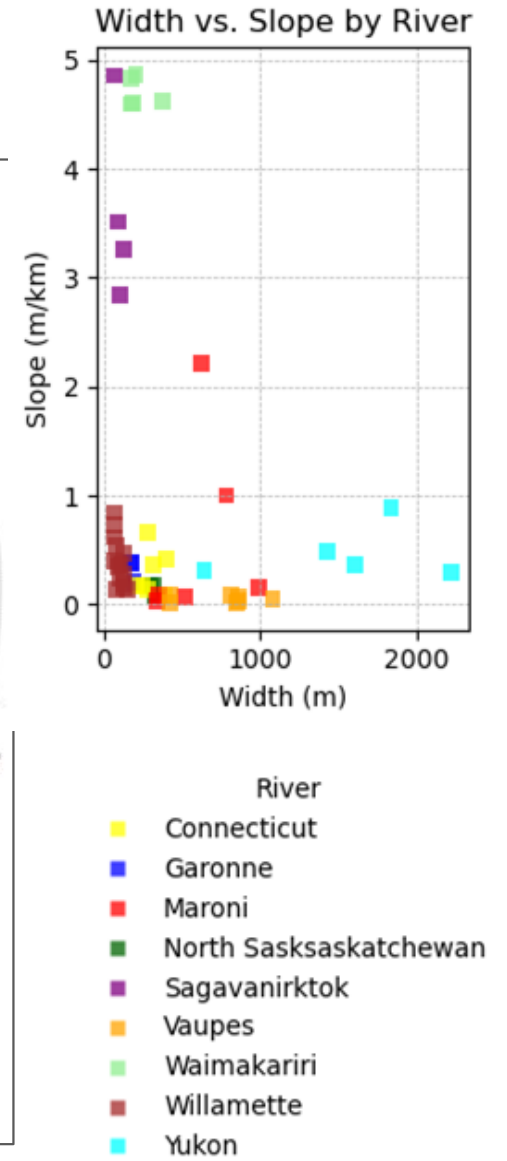
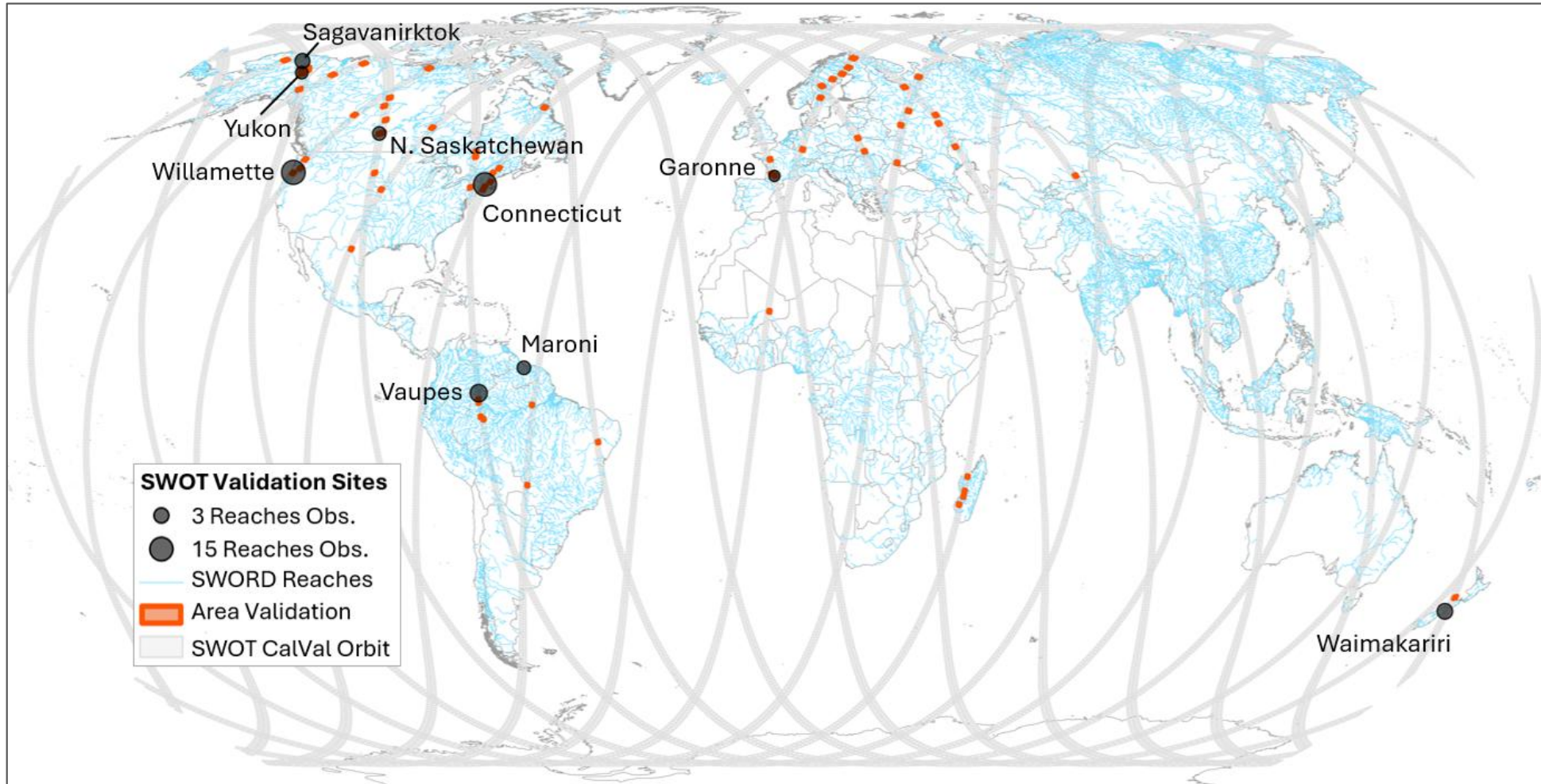


1. **Quality Flags Filtering**
2. **Outliers Filtering**
3. **Spatio-Temporal Densification**
4. **Smoothing**

*The Garonne*  
*Downstream*



(a) Validation site location map; (b) plot of width vs. slope to show spread of rivers chosen.

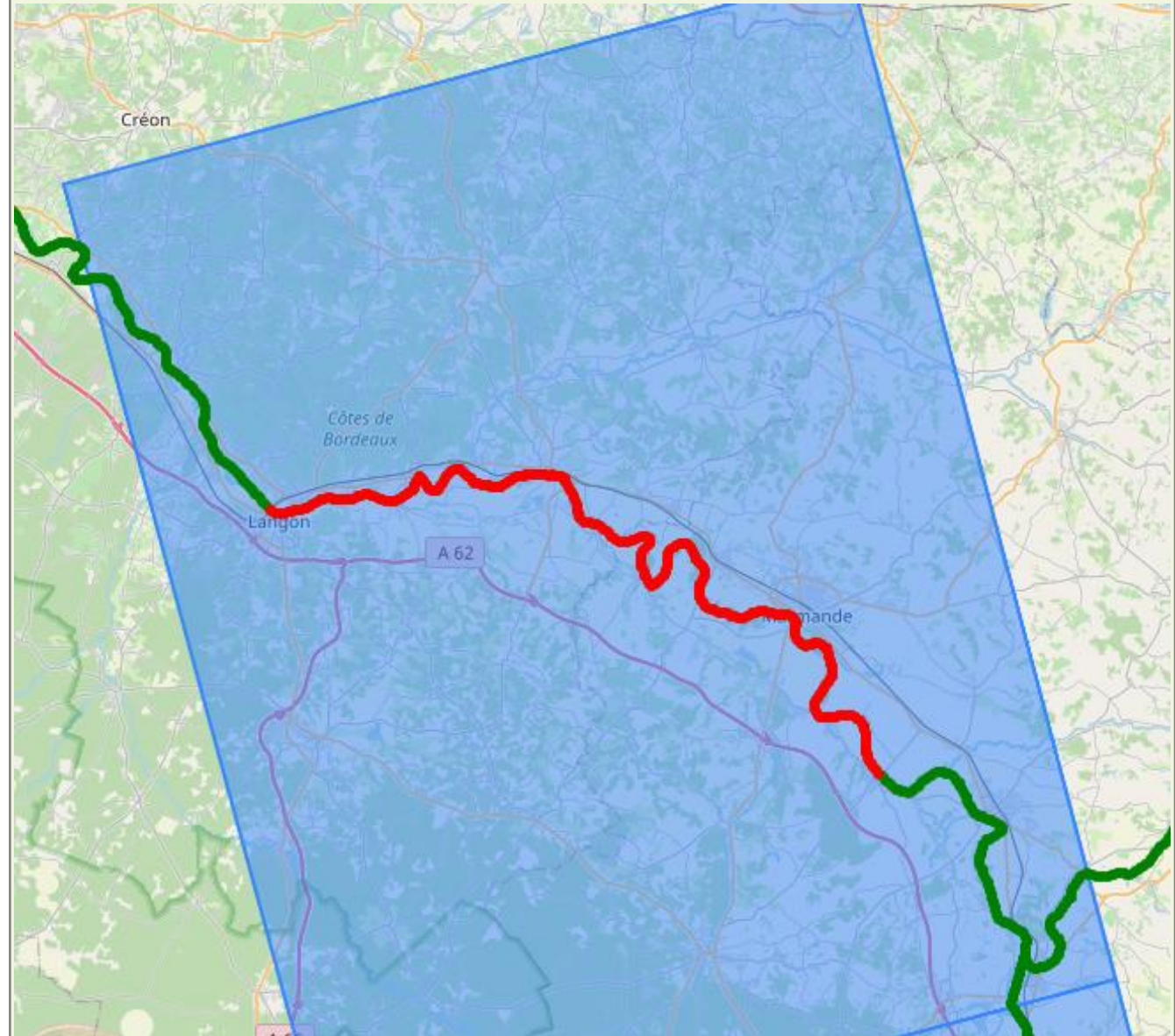
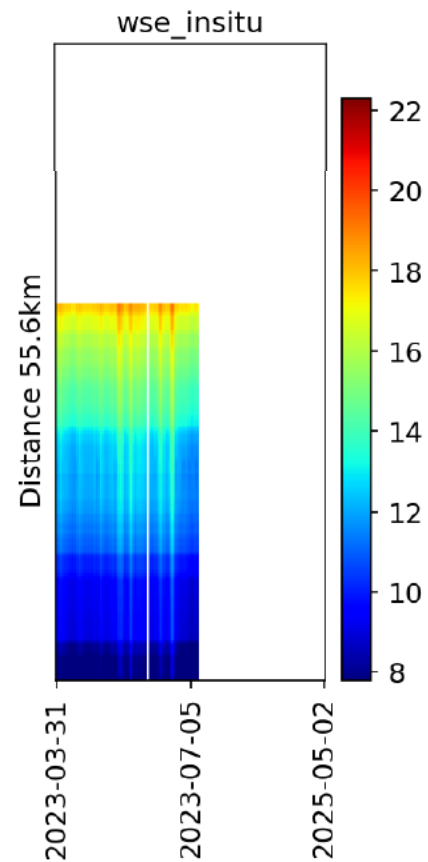


# *The Garonne - Downstream*

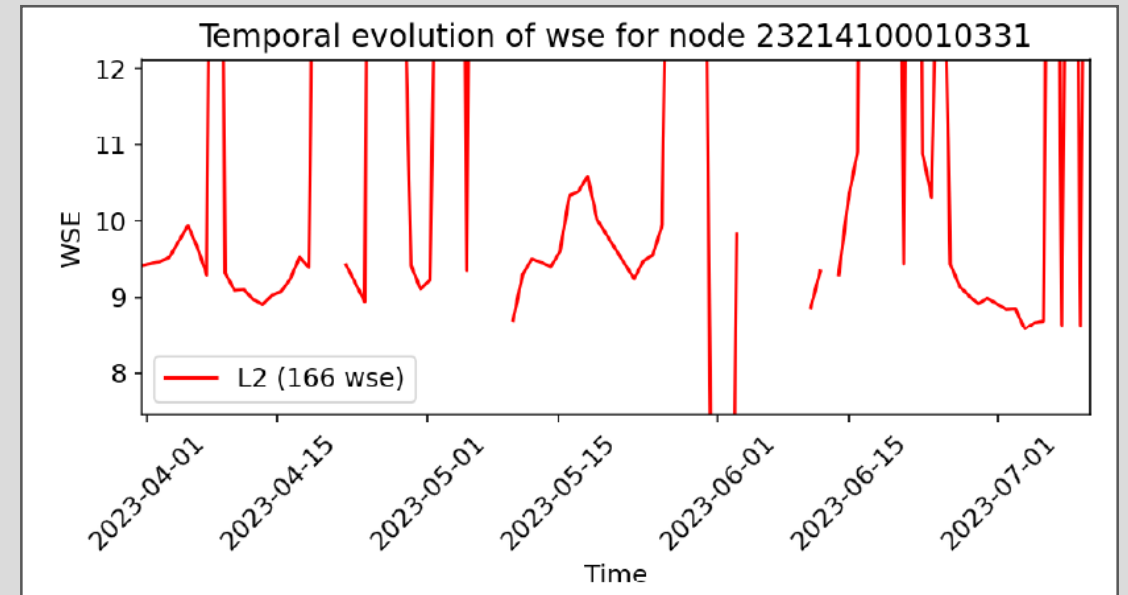
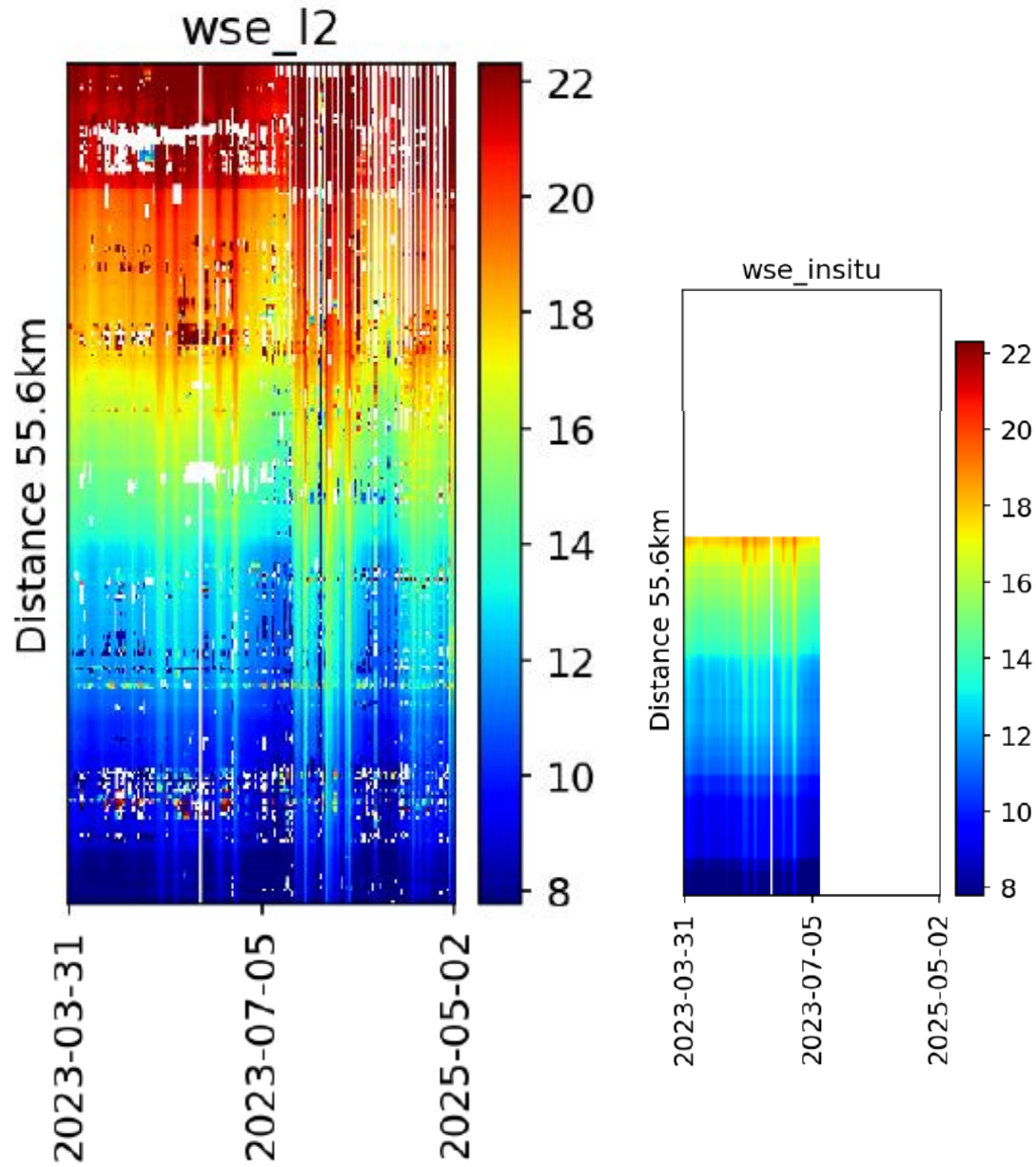
Period : 30/03/2023 - 10/07/2023 (104 time instants)

5 reaches : [ 23214100051,  
23214100041,  
23214100031,  
23214100021,  
23214100011 ]

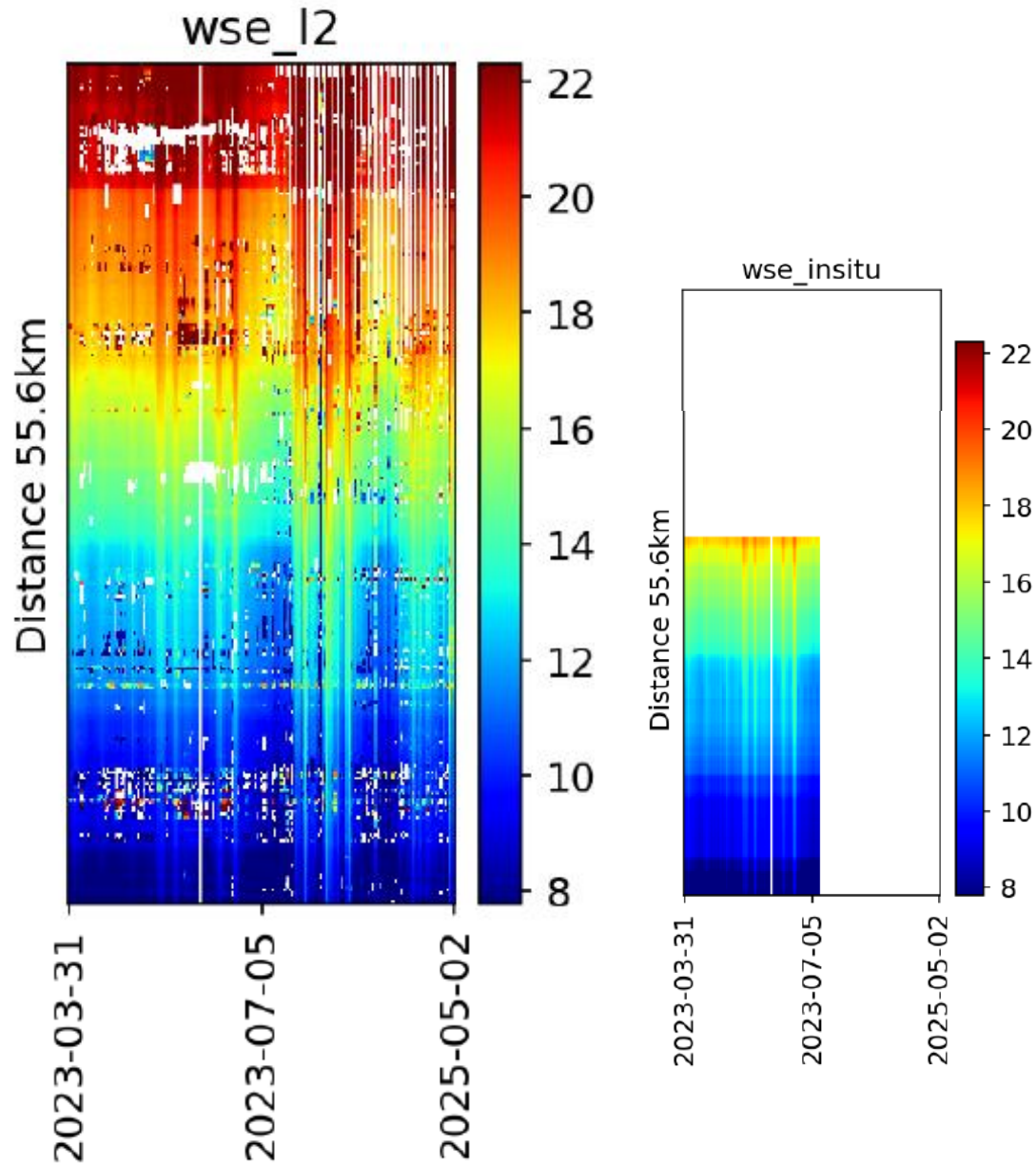
208 nodes



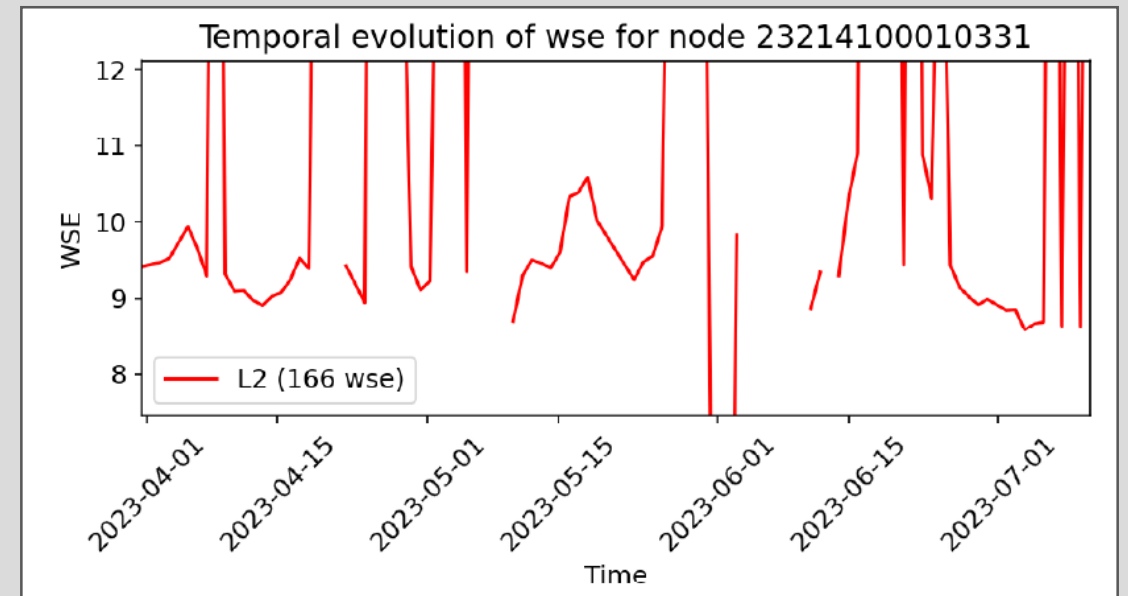
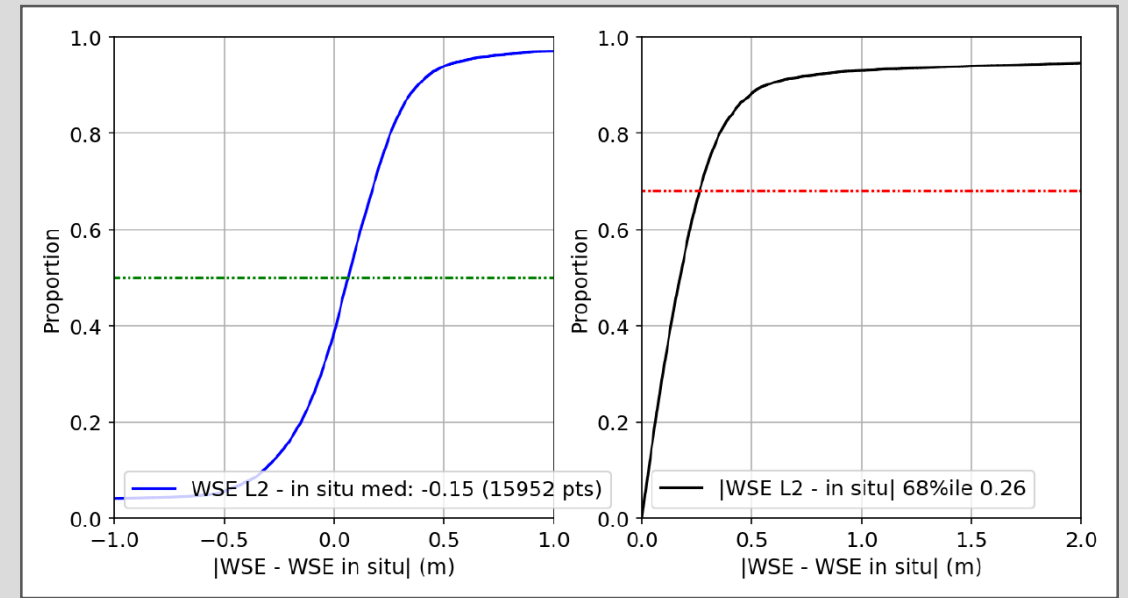
# The Garonne - Downstream



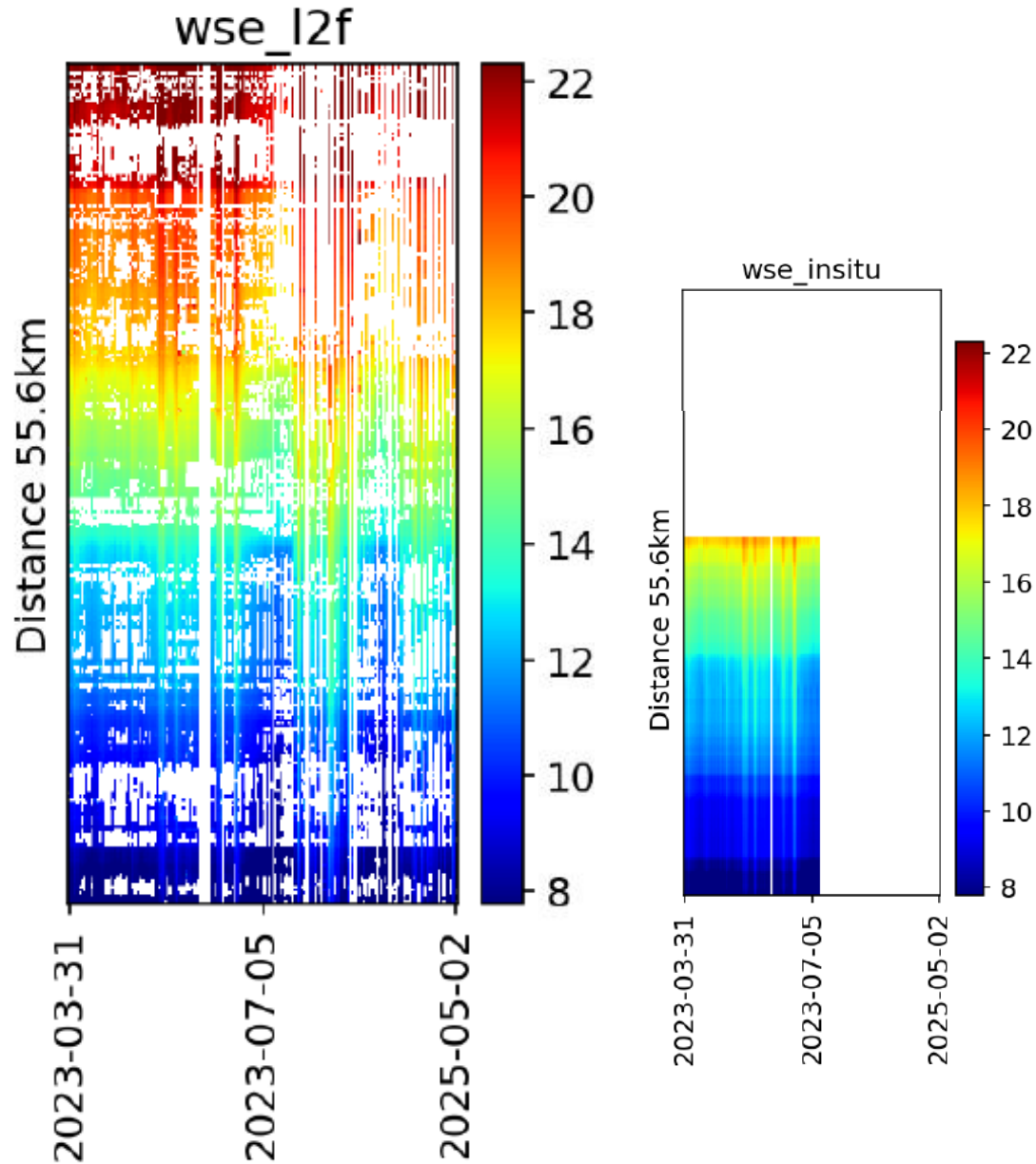
# The Garonne - Downstream



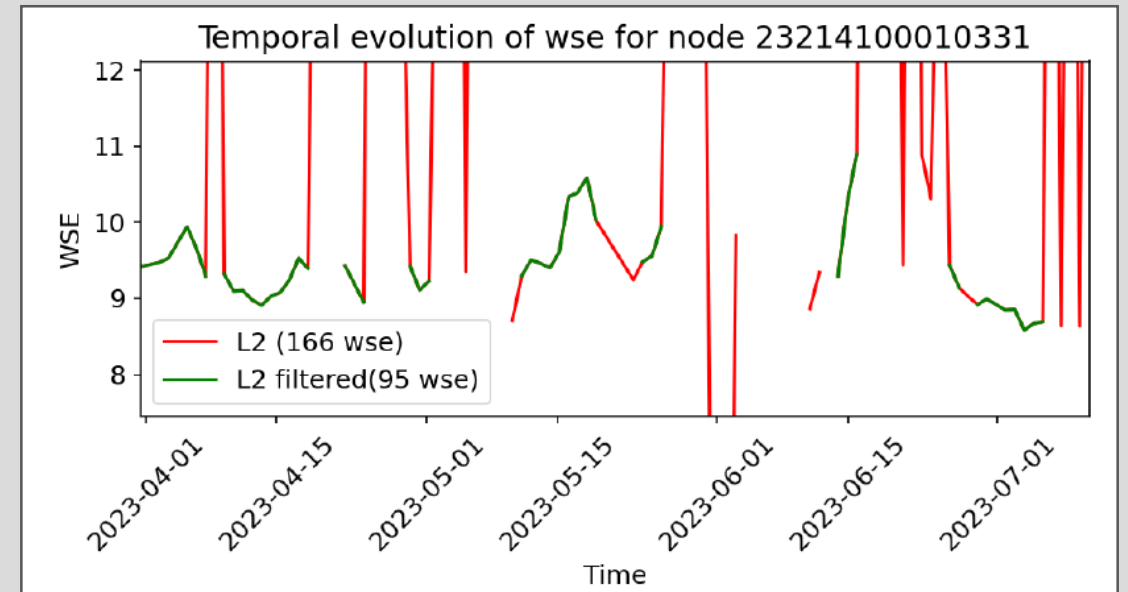
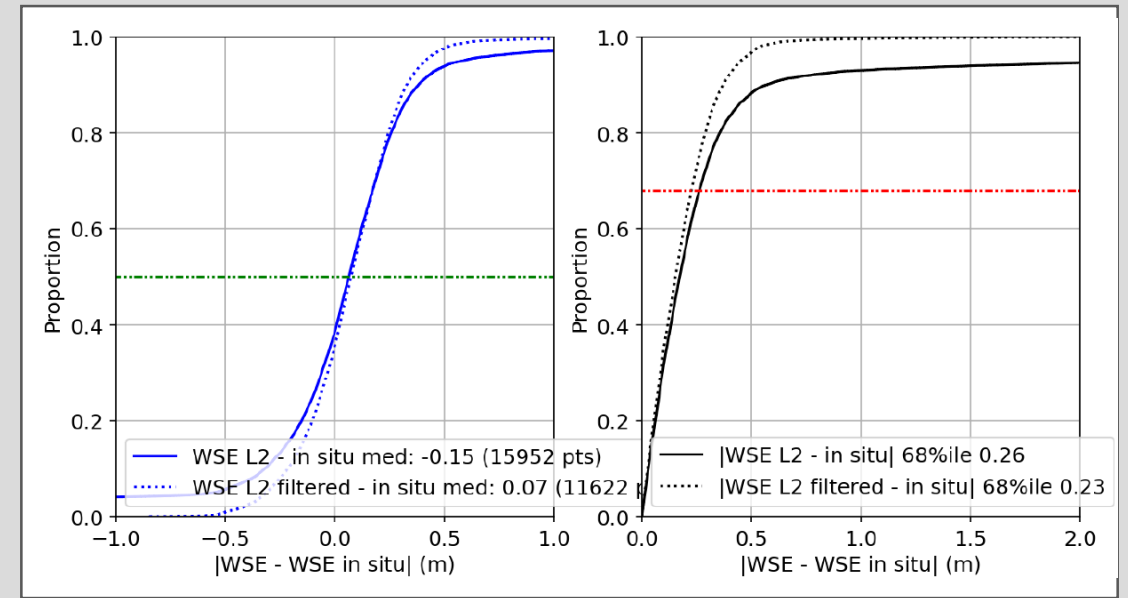
|            |              |
|------------|--------------|
|            | <b>L2</b>    |
| NBR of obs | <b>43854</b> |
| RMSE       | <b>1.63</b>  |



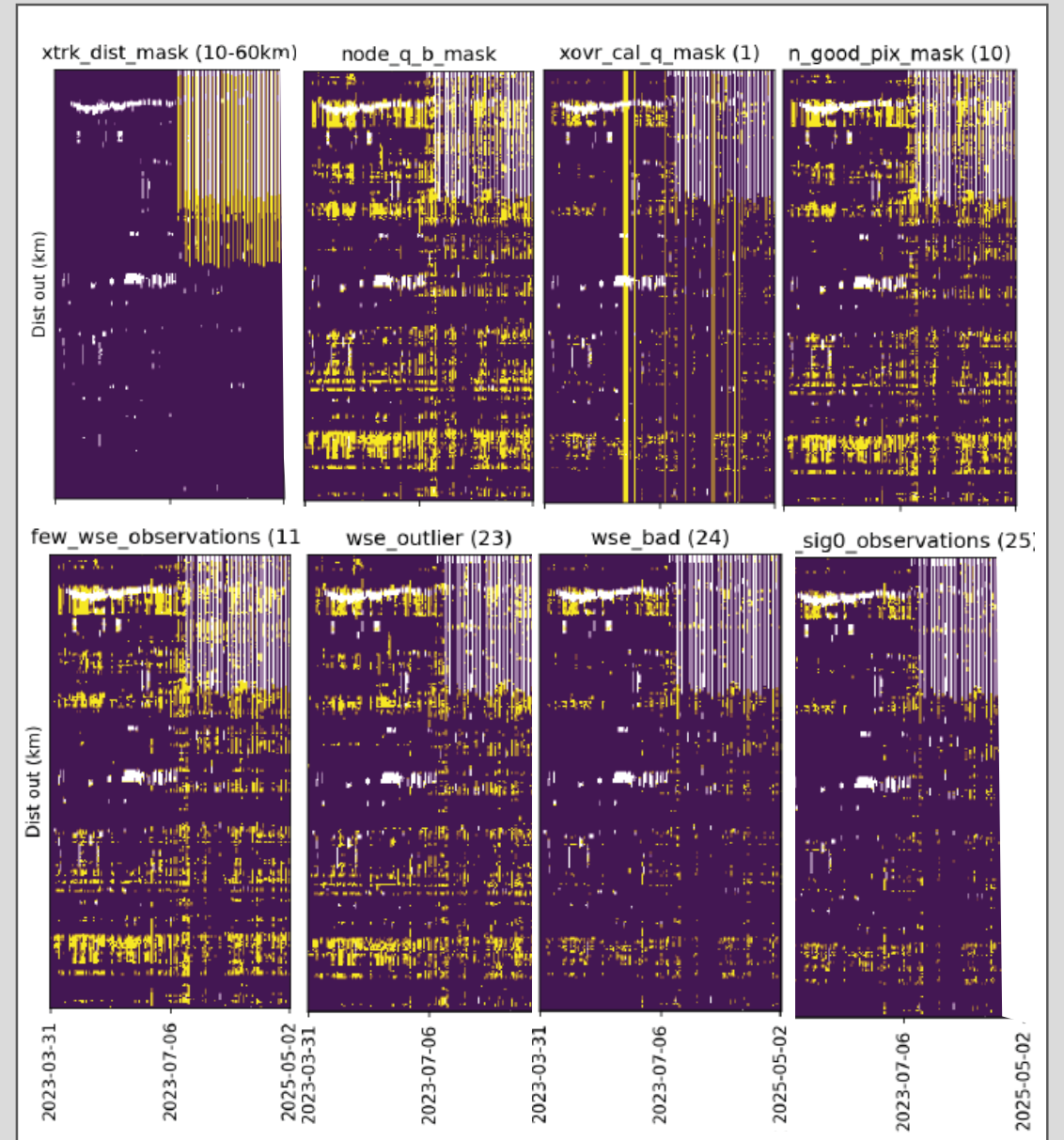
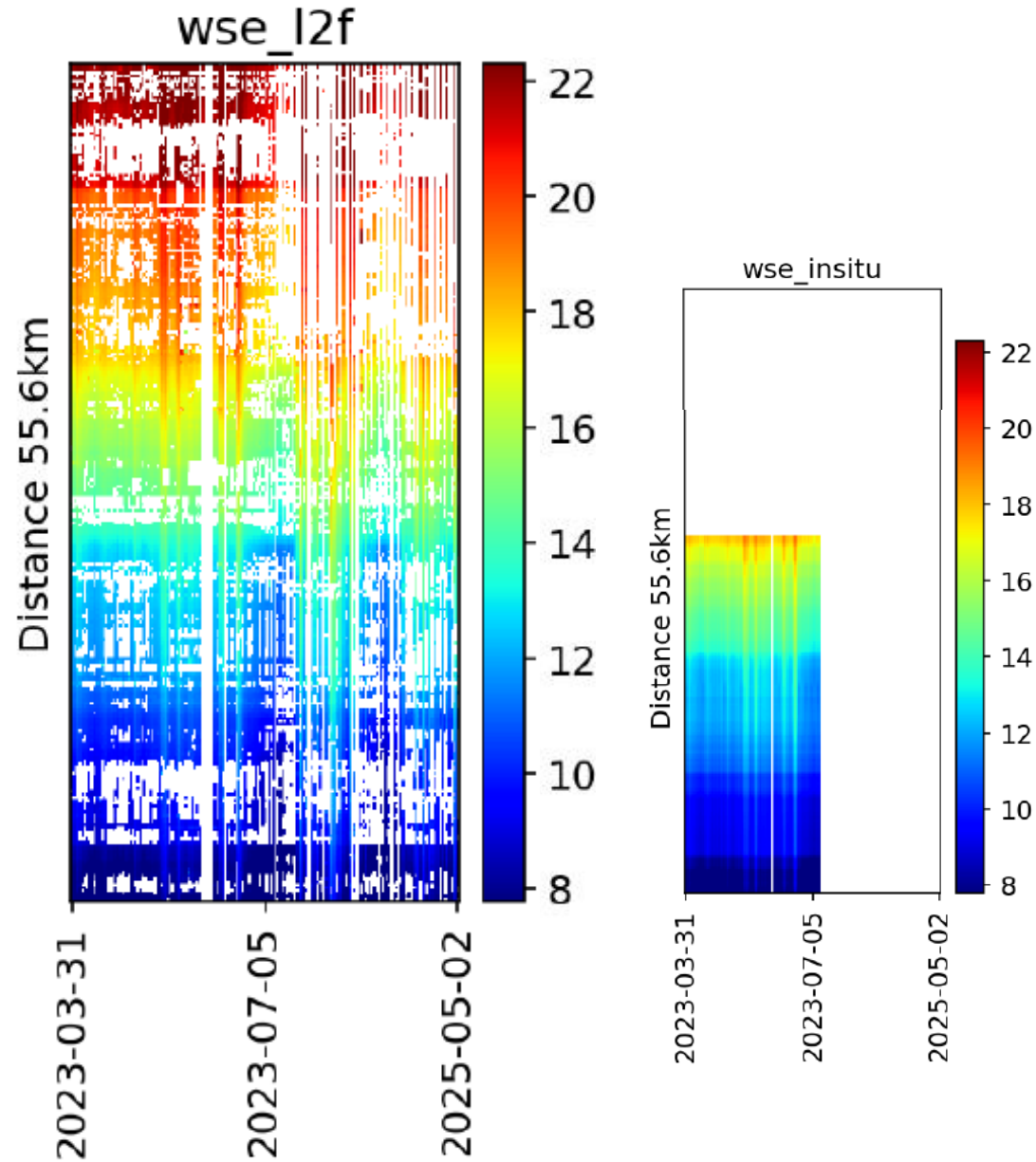
# The Garonne - Downstream



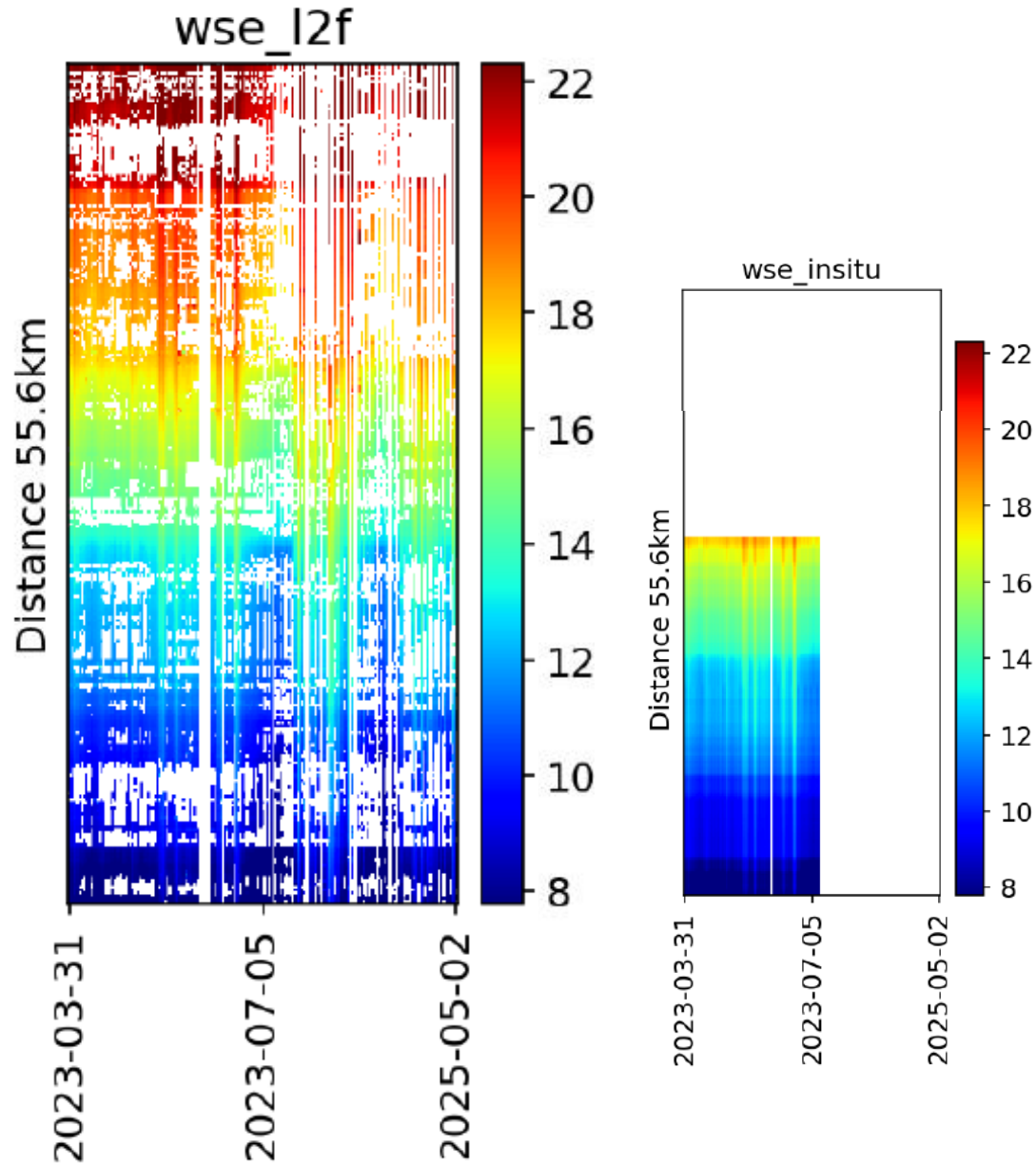
|            | L2    | L2 Filtered |
|------------|-------|-------------|
| NBR of obs | 43854 | 26595       |
| RMSE       | 1.63  | 0.25        |



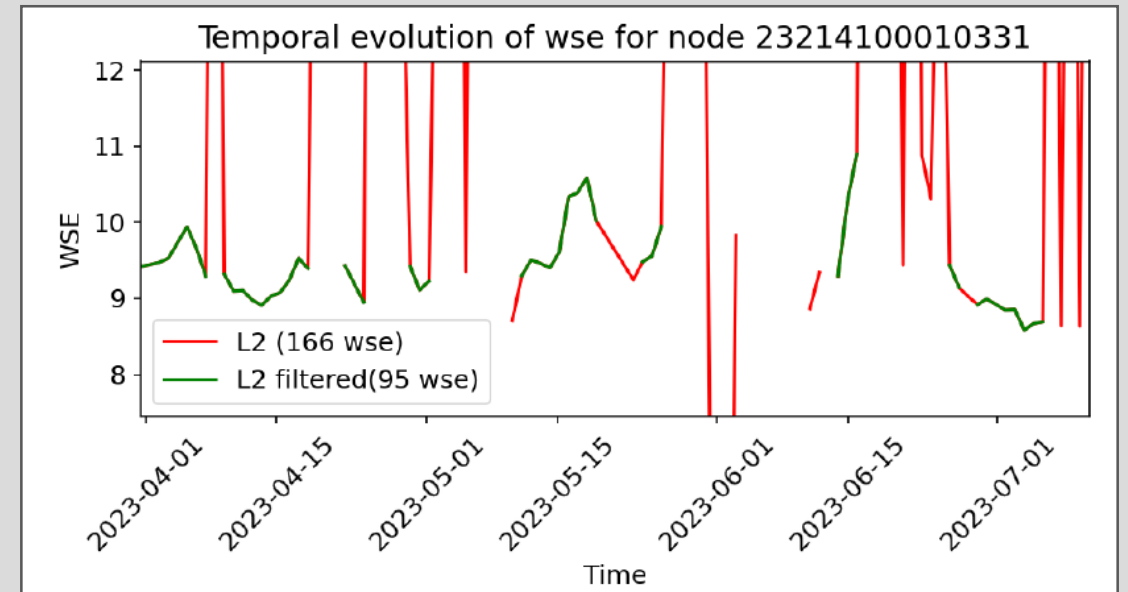
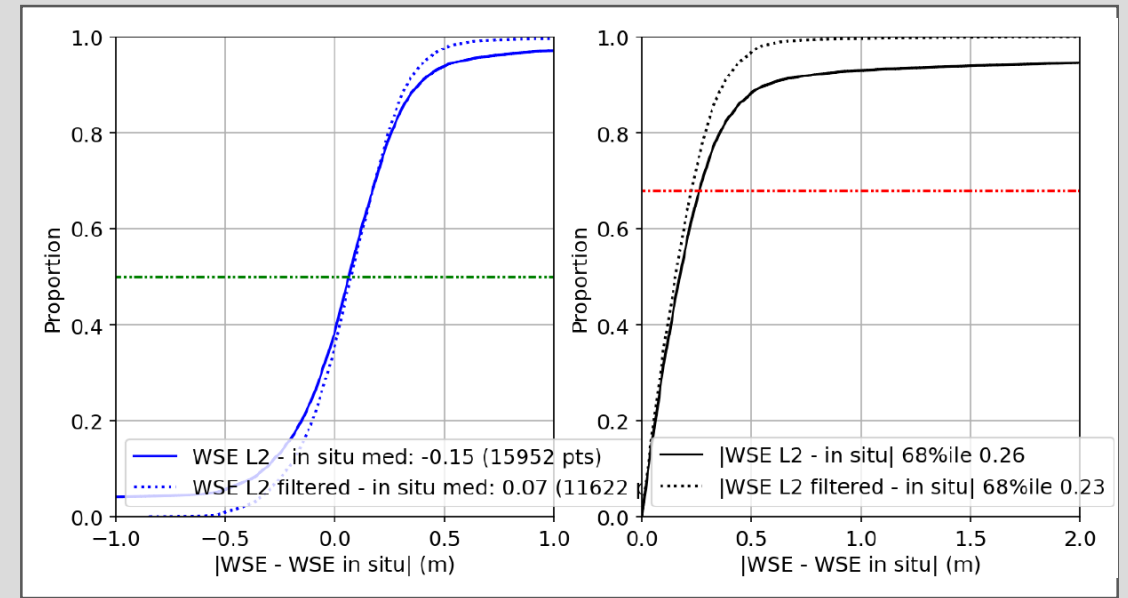
# The Garonne - Downstream



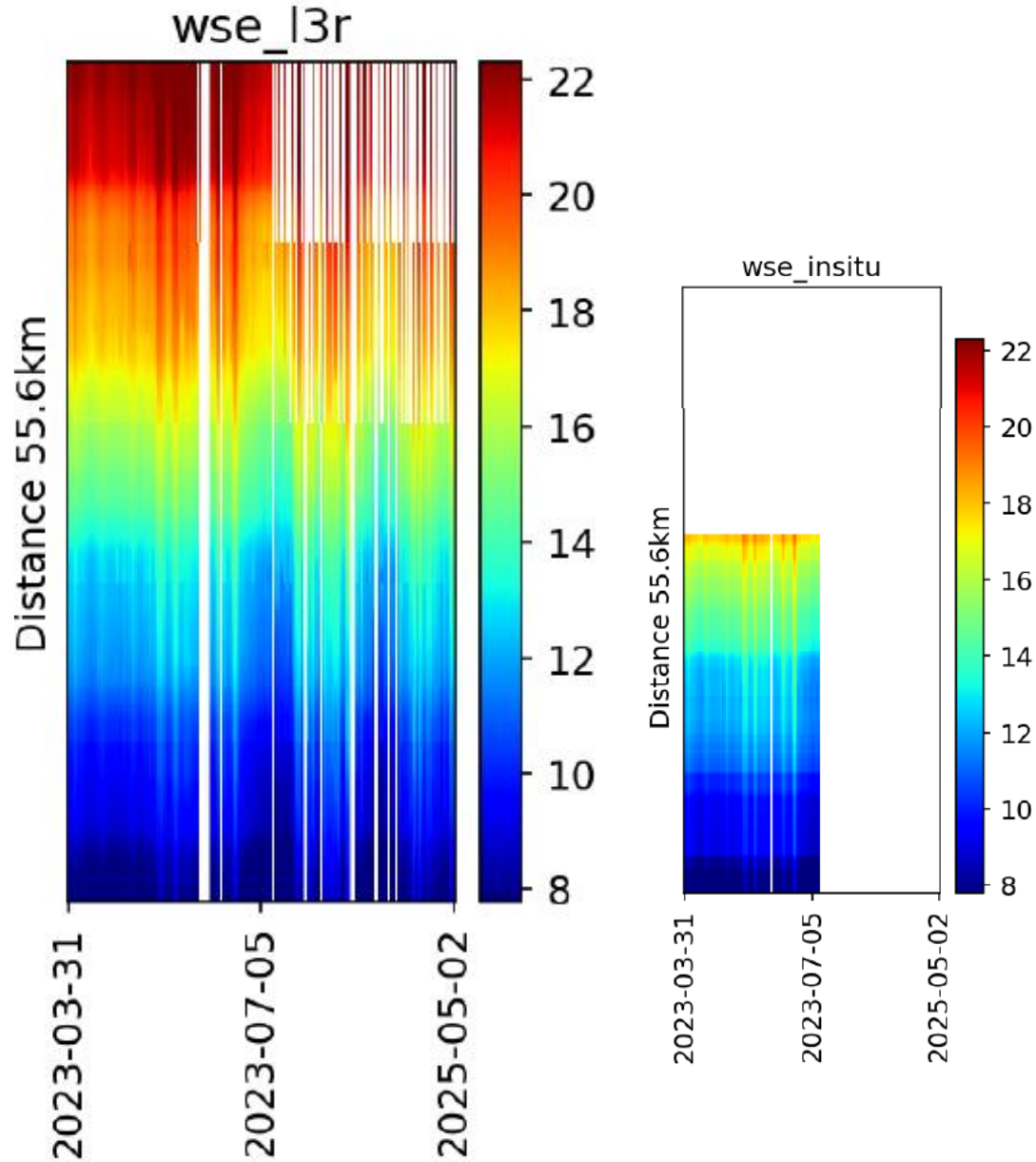
# The Garonne - Downstream



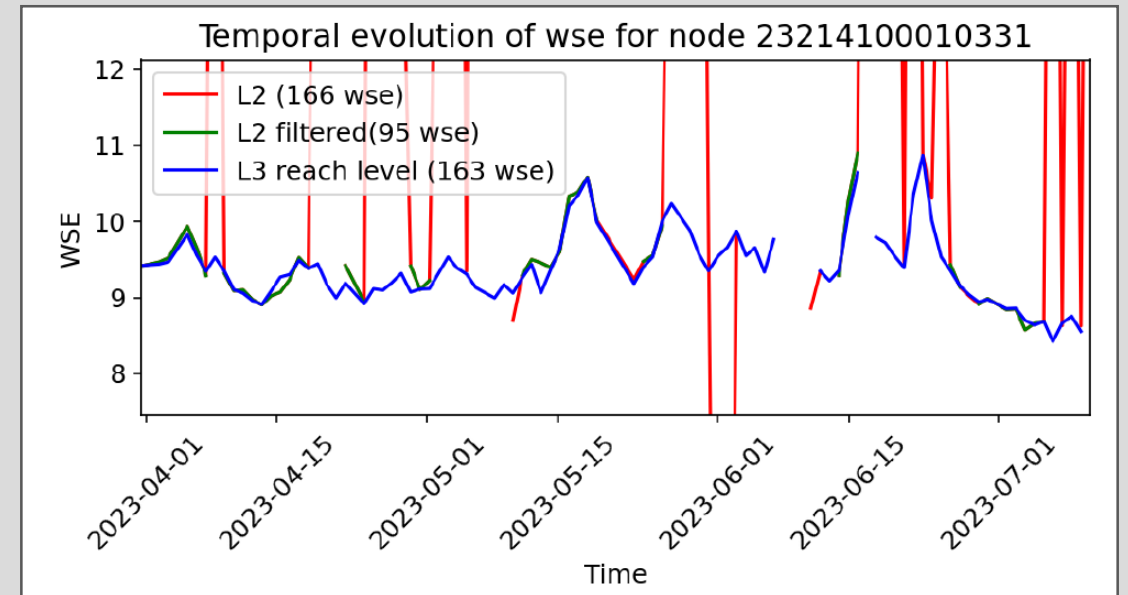
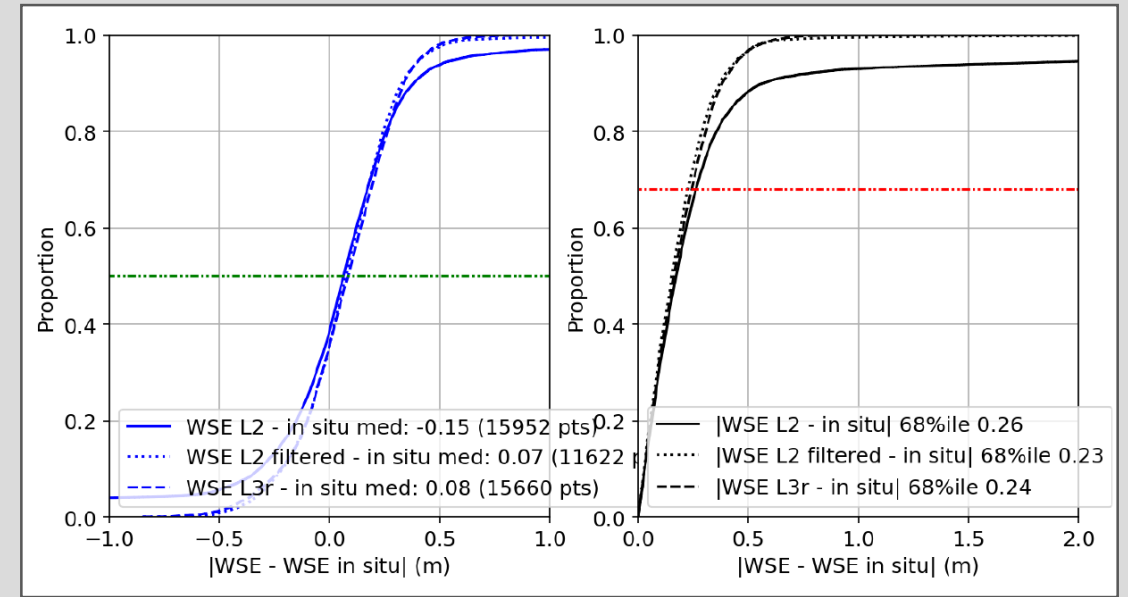
|            | L2    | L2 Filtered |
|------------|-------|-------------|
| NBR of obs | 43854 | 26595       |
| RMSE       | 1.63  | 0.25        |



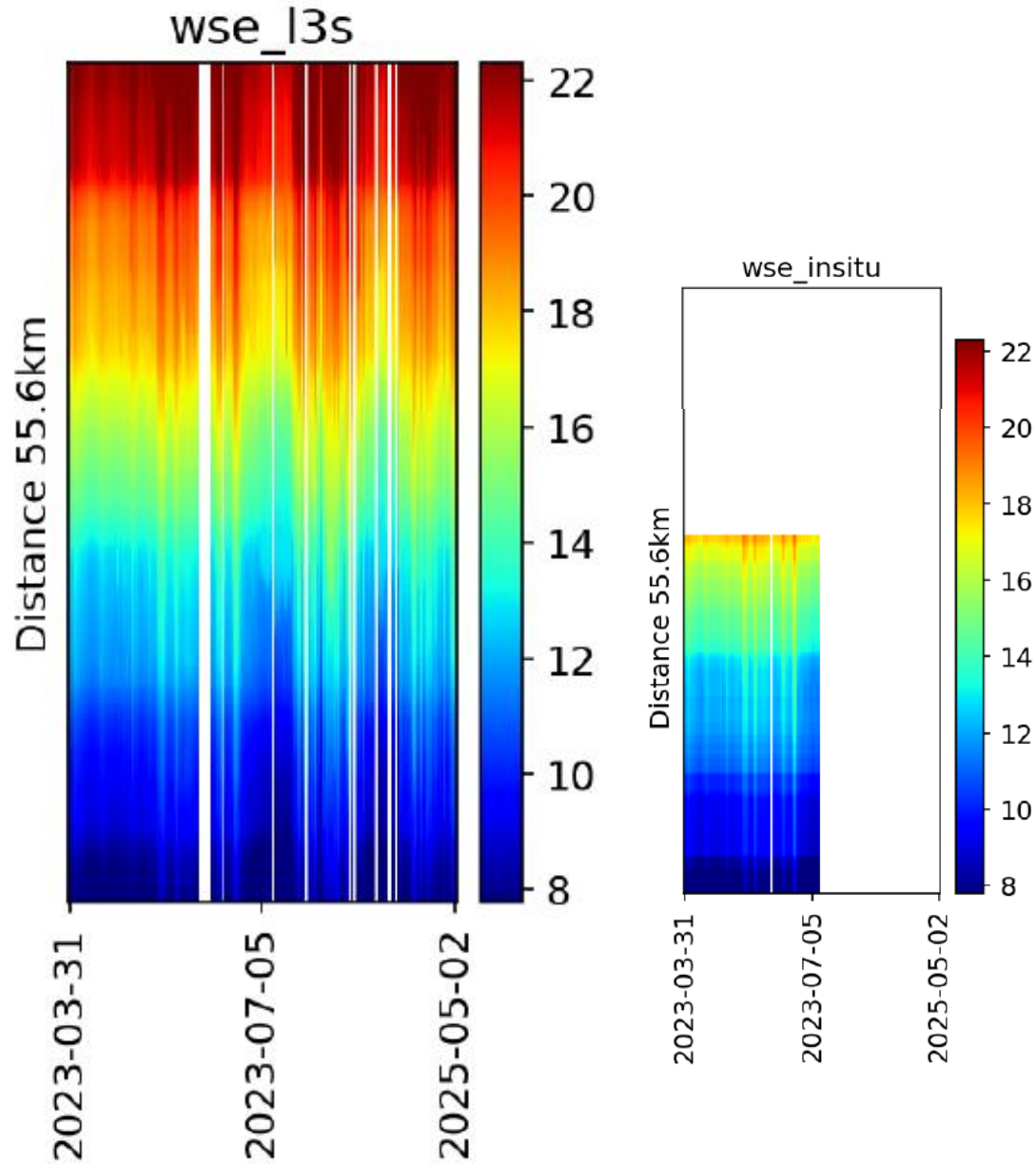
# The Garonne - Downstream



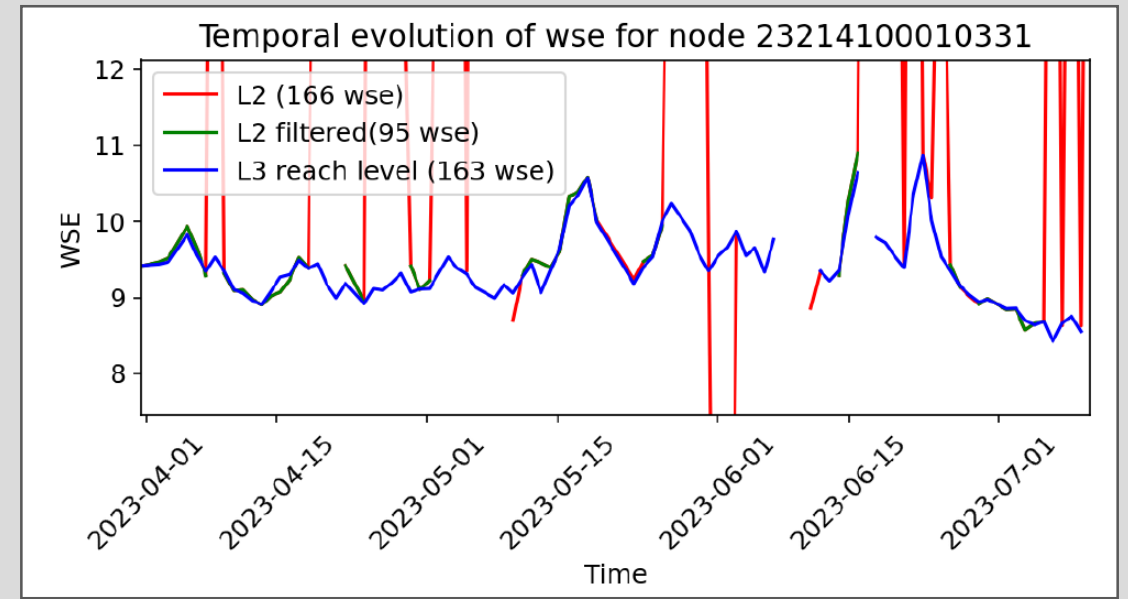
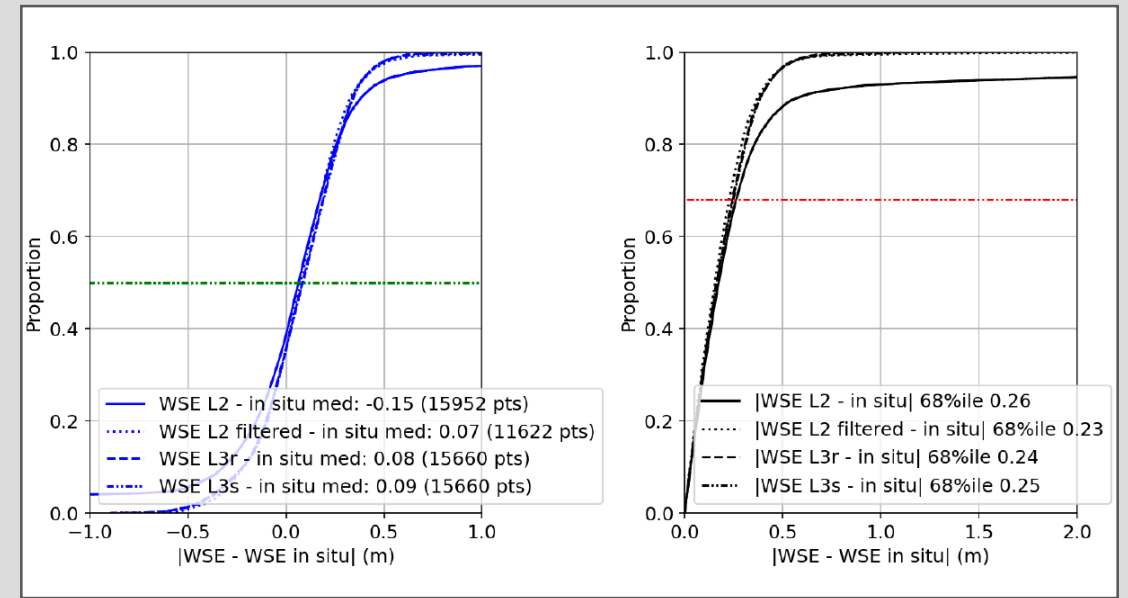
|            | L2    | L2 Filtered | L3 Reach |
|------------|-------|-------------|----------|
| NBR of obs | 43854 | 26595       | 41174    |
| RMSE       | 1.63  | 0.25        | 0.24     |



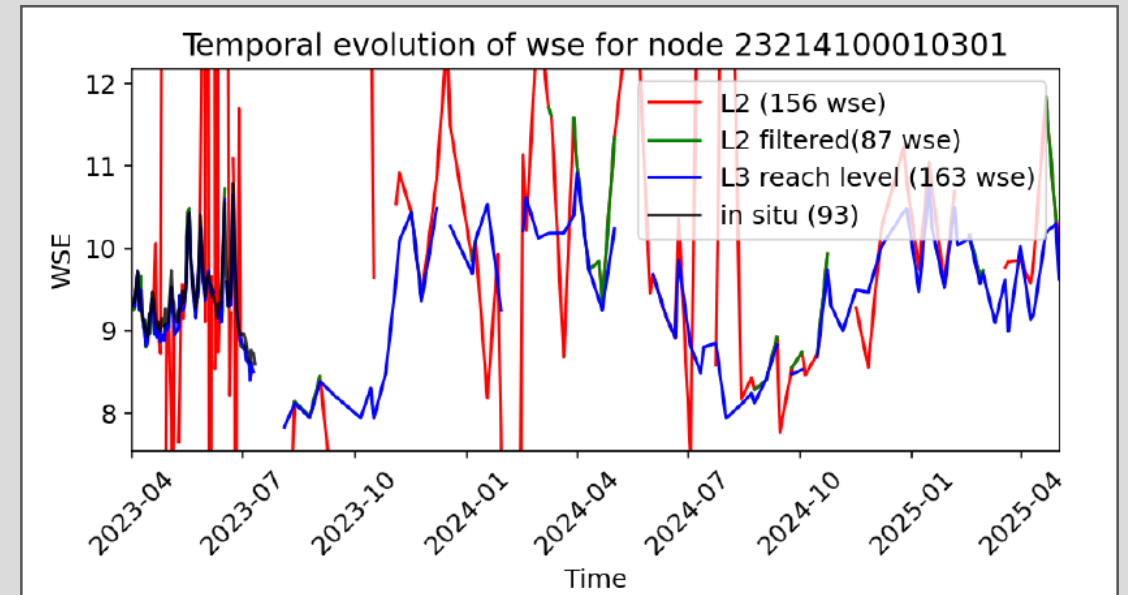
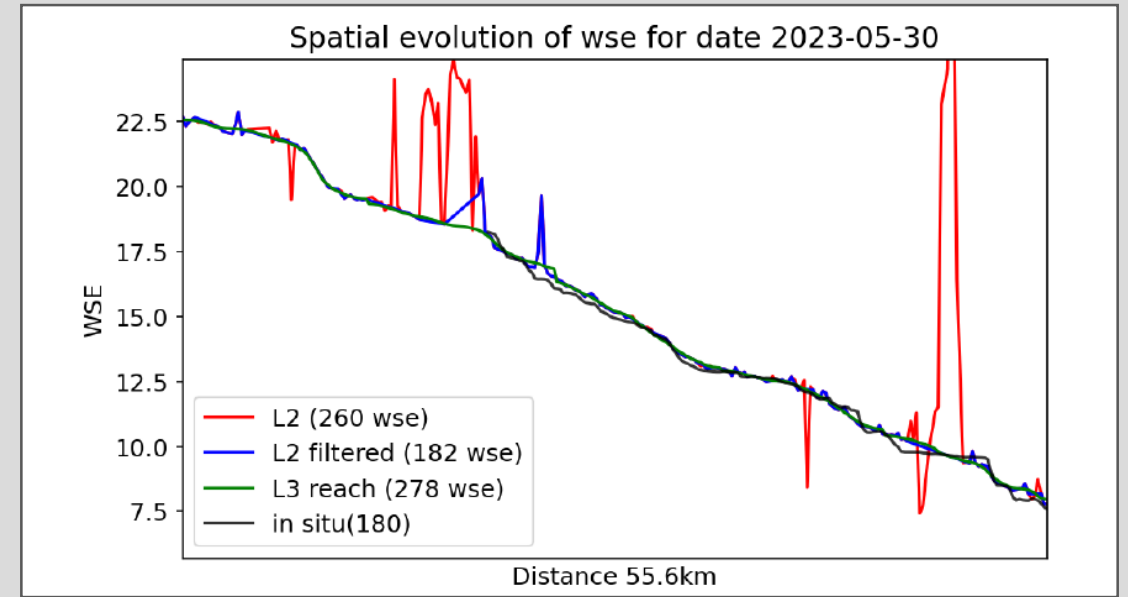
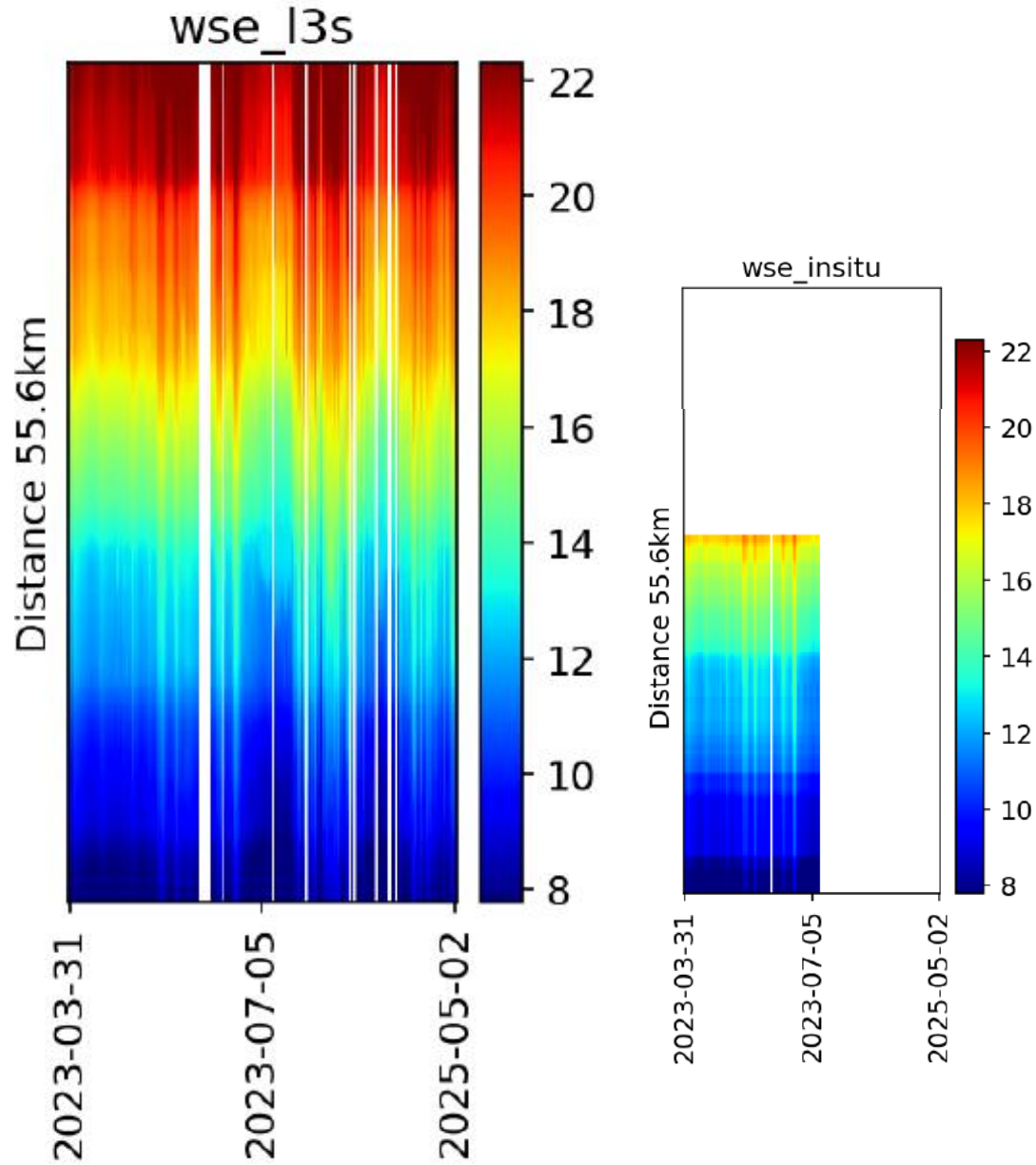
# The Garonne - Downstream



|            | L2    | L2 Filtered | L3 Reach | L3 Set |
|------------|-------|-------------|----------|--------|
| NBR of Obs | 43854 | 26595       | 41174    | 45592  |
| RMSE       | 1.63  | 0.25        | 0.24     | 0.24   |



# The Garonne - Downstream



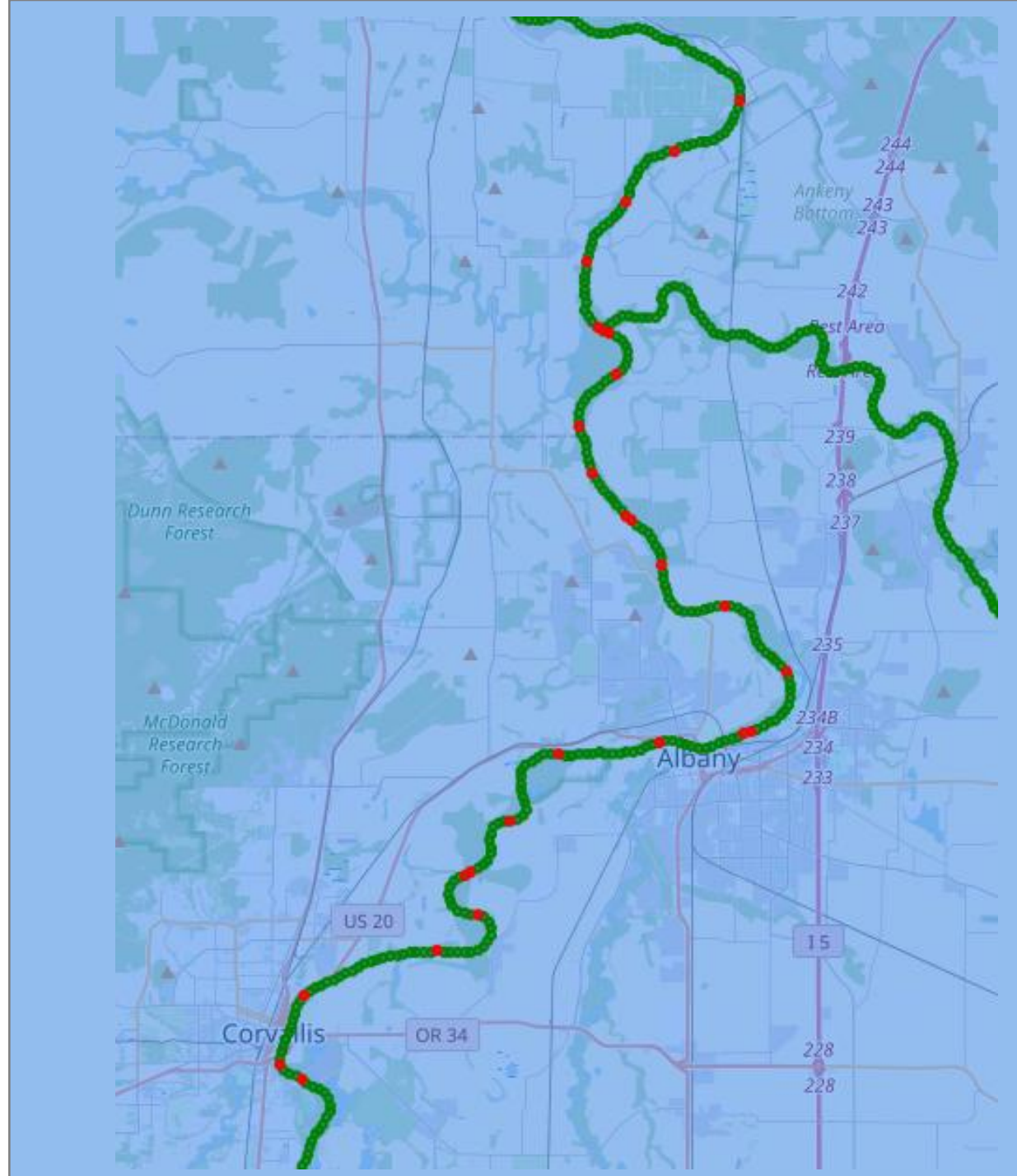
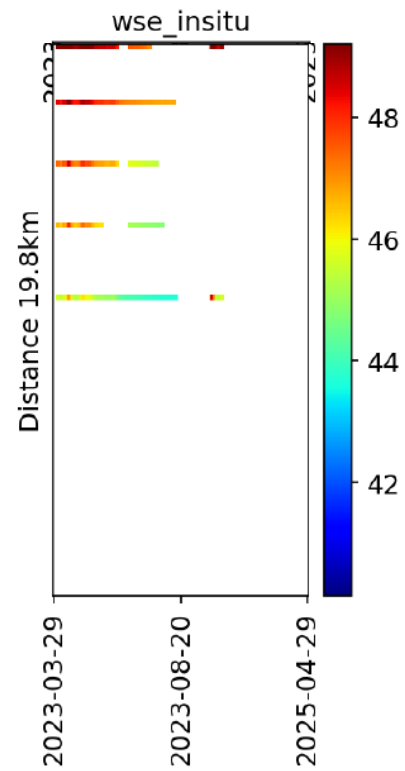
# The Willamette

[78220000191, 78220000181]

Period : 29/03/2023 - 19/03/2024 (92 dates time instants)

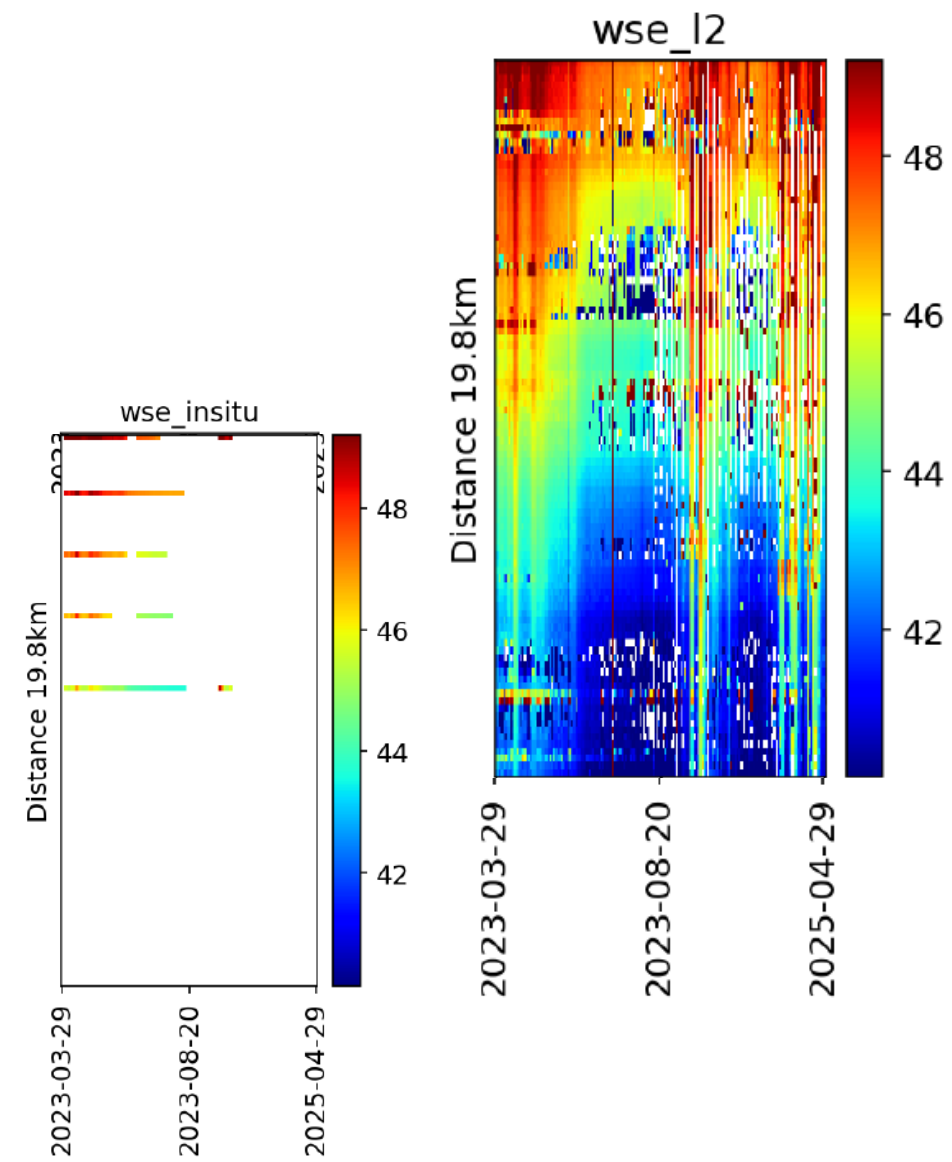
5 Reaches : [ 78220000191,  
78220000181 ]

27 Nodes



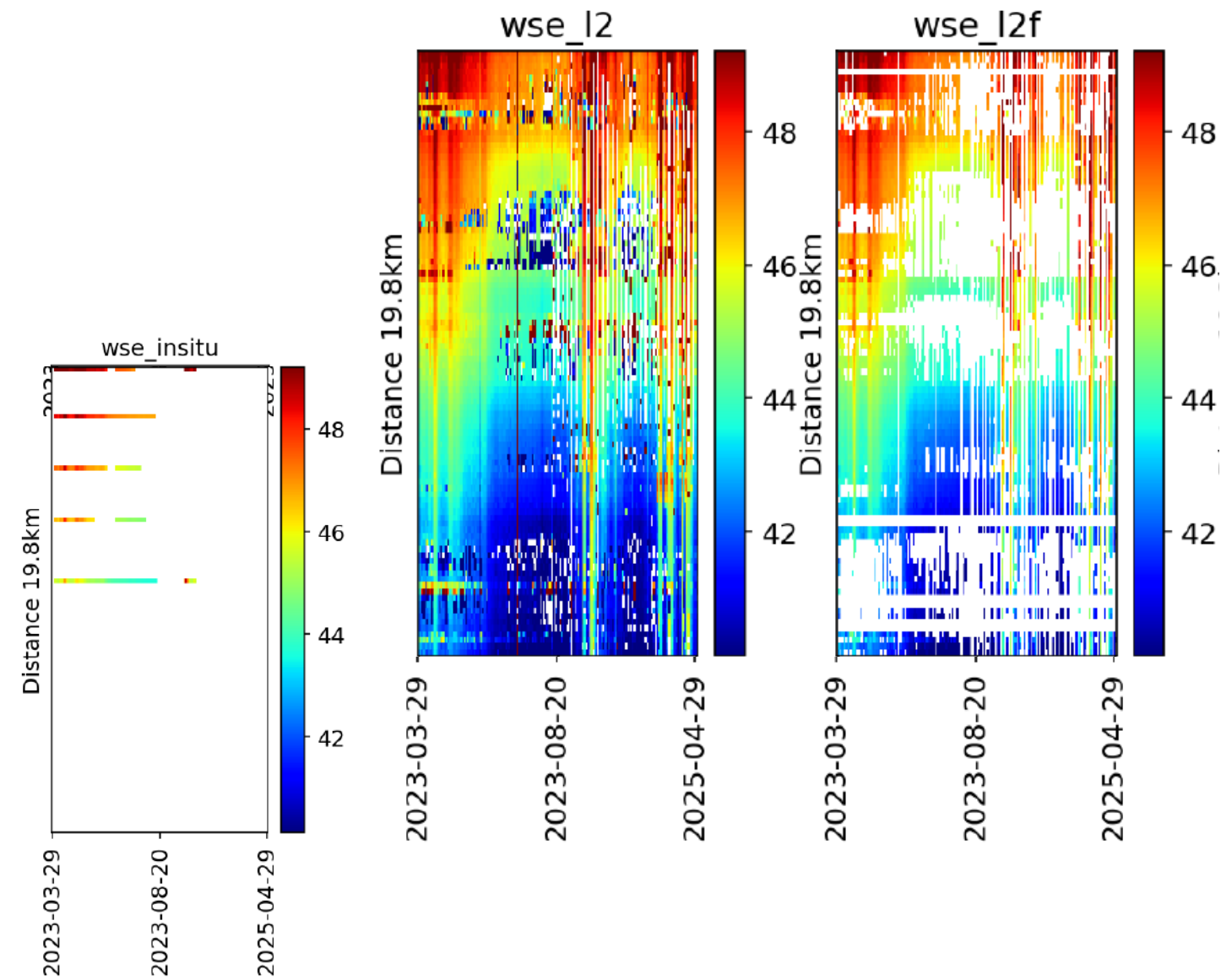
# *The Willamette*

[78220000191, 78220000181]



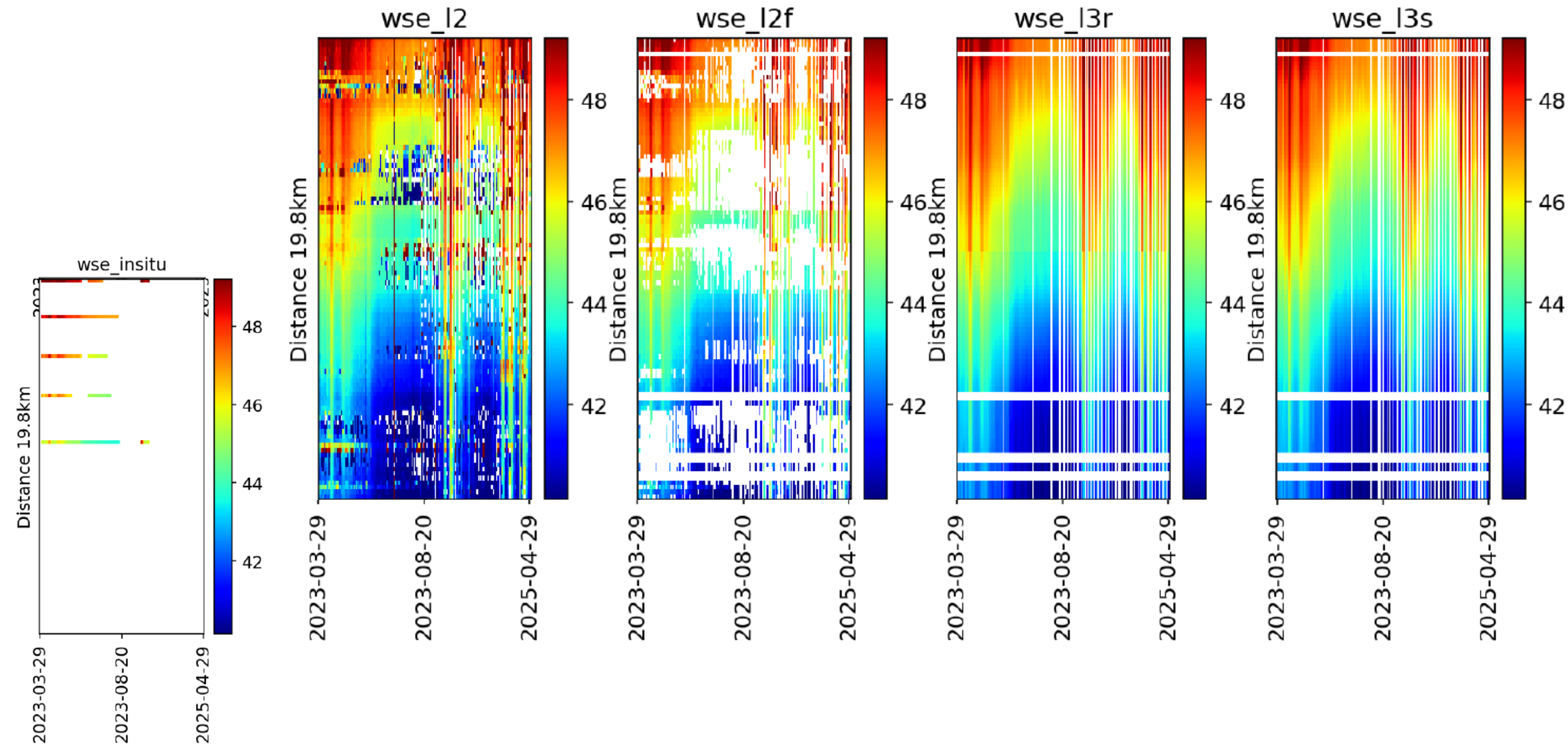
# *The Willamette*

[78220000191, 78220000181]



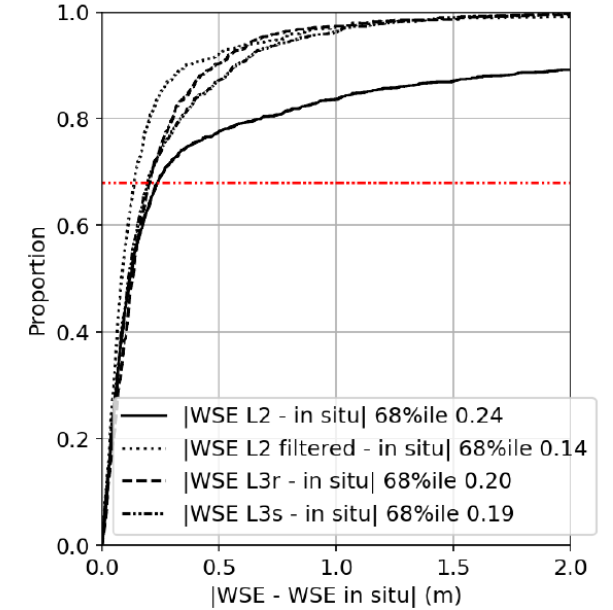
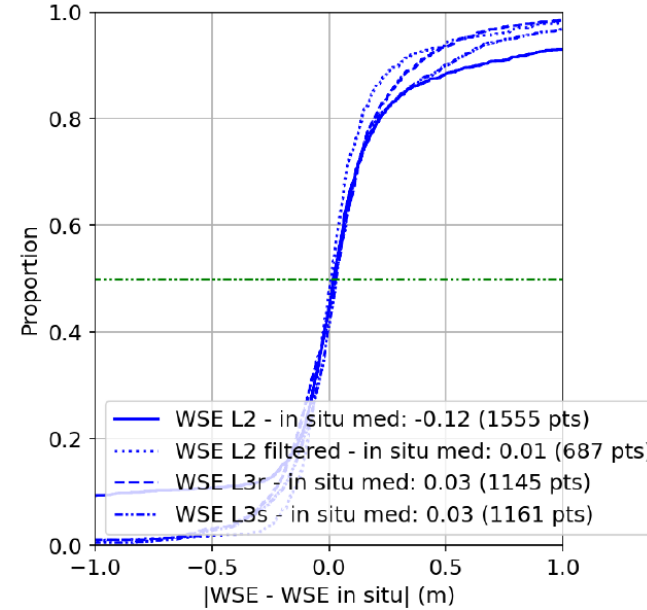
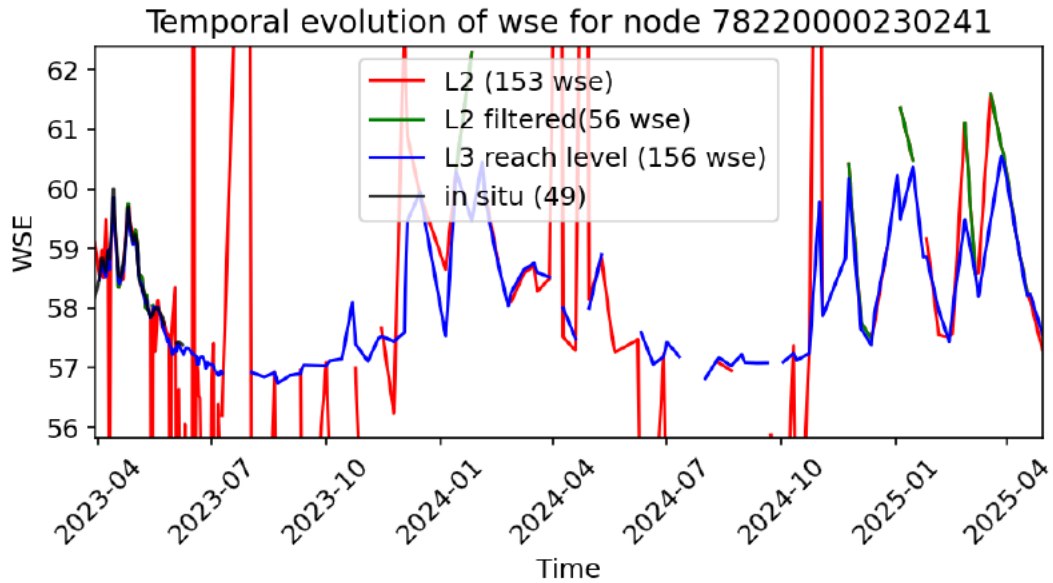
# The Willamette

[78220000191, 78220000181]



# The Willamette

[78220000191, 78220000181]



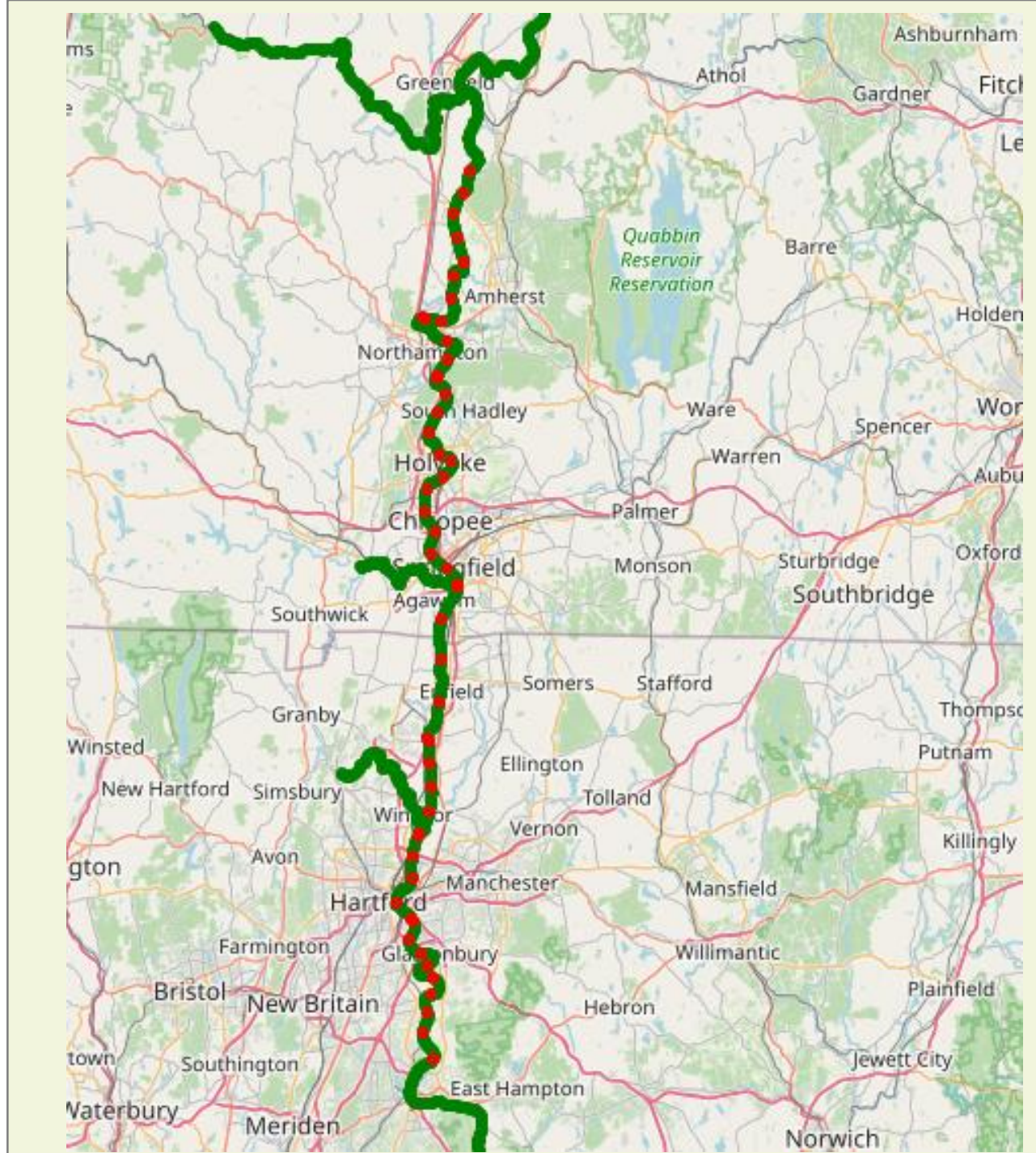
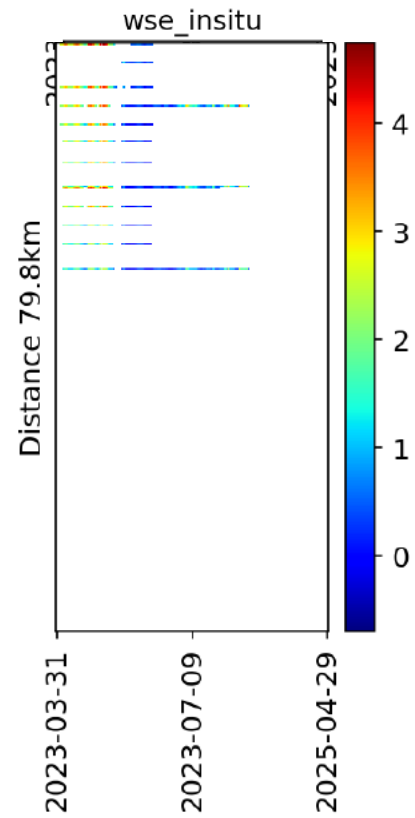
|                            | L2    | L2 Filtered | L3 Reach | L3 Set       |
|----------------------------|-------|-------------|----------|--------------|
| NBR of obs                 | 14814 | 7950        | 12144    | <b>12144</b> |
| RMSE                       | 5.02  | 0.46        | 0.37     | <b>0.35</b>  |
| rel_diff  68%ile           | 0.45  | <b>0.18</b> | 0.29     | <b>0.24</b>  |
| rel_diff  68%ile densified | -     | -           | 0.37     | <b>0.35</b>  |

# The Connecticut

Period : 02/04/2023 - 30/04/2024 (121 dates time instants)

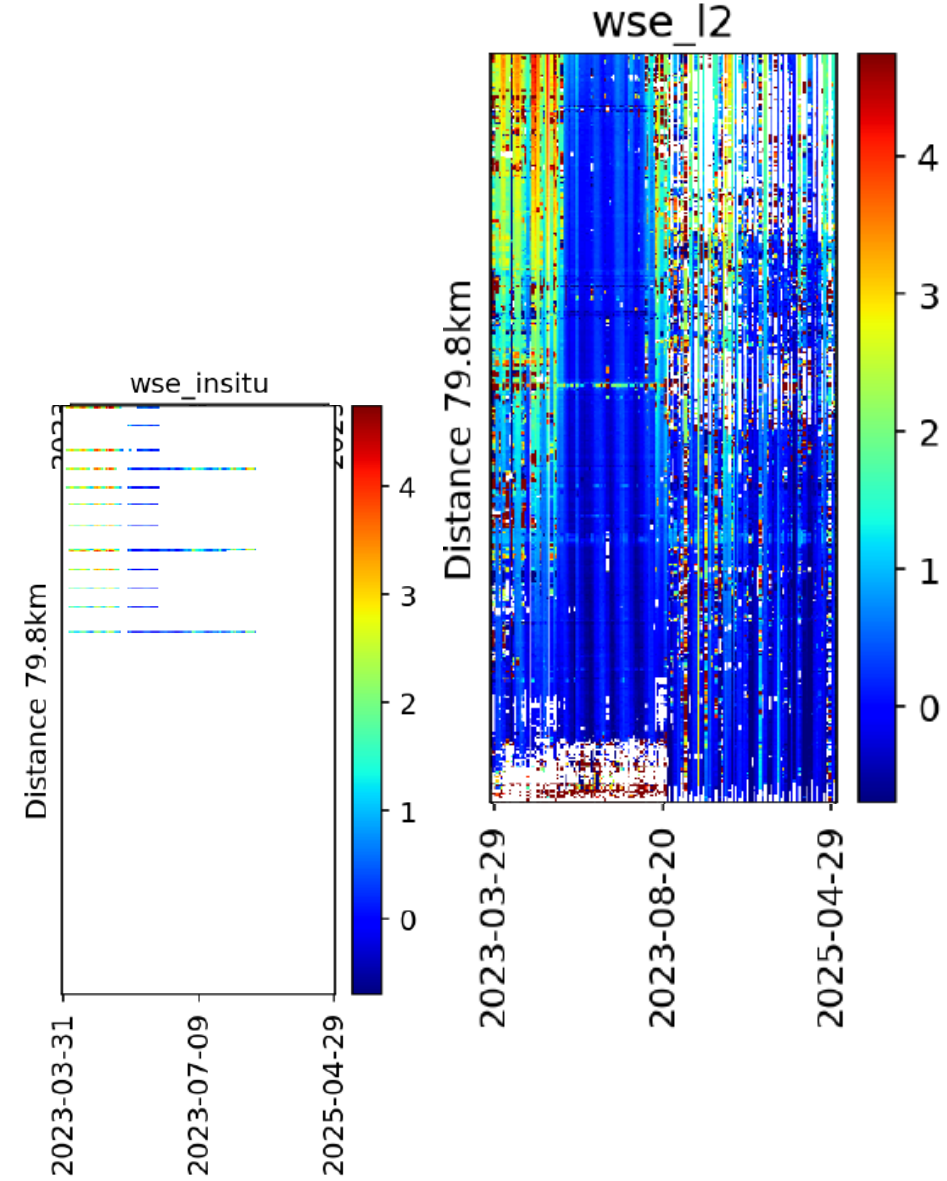
3 Reaches : [ 73120000071,  
73120000061,  
73120000051 ]

56 Nodes



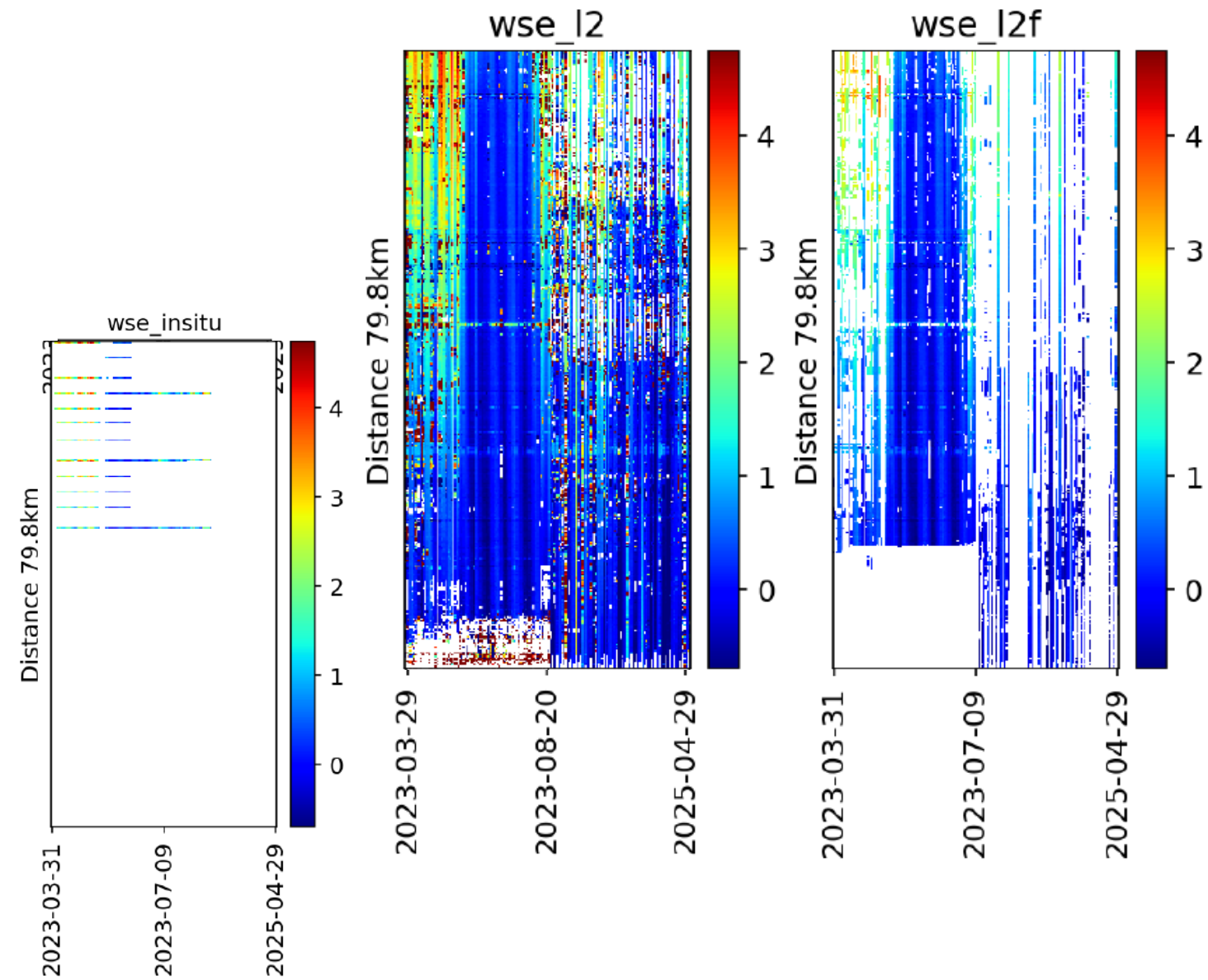
# *The Connecticut*

[73120000091, 73120000081, 73120000071, 73120000061,  
73120000051, 73120000041, 73120000031, 73120000021]



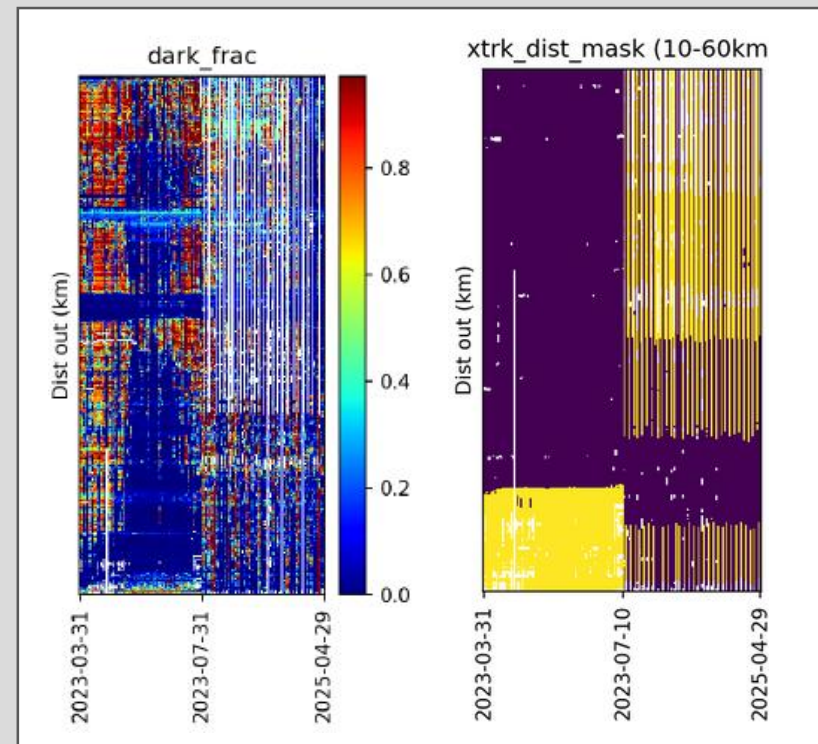
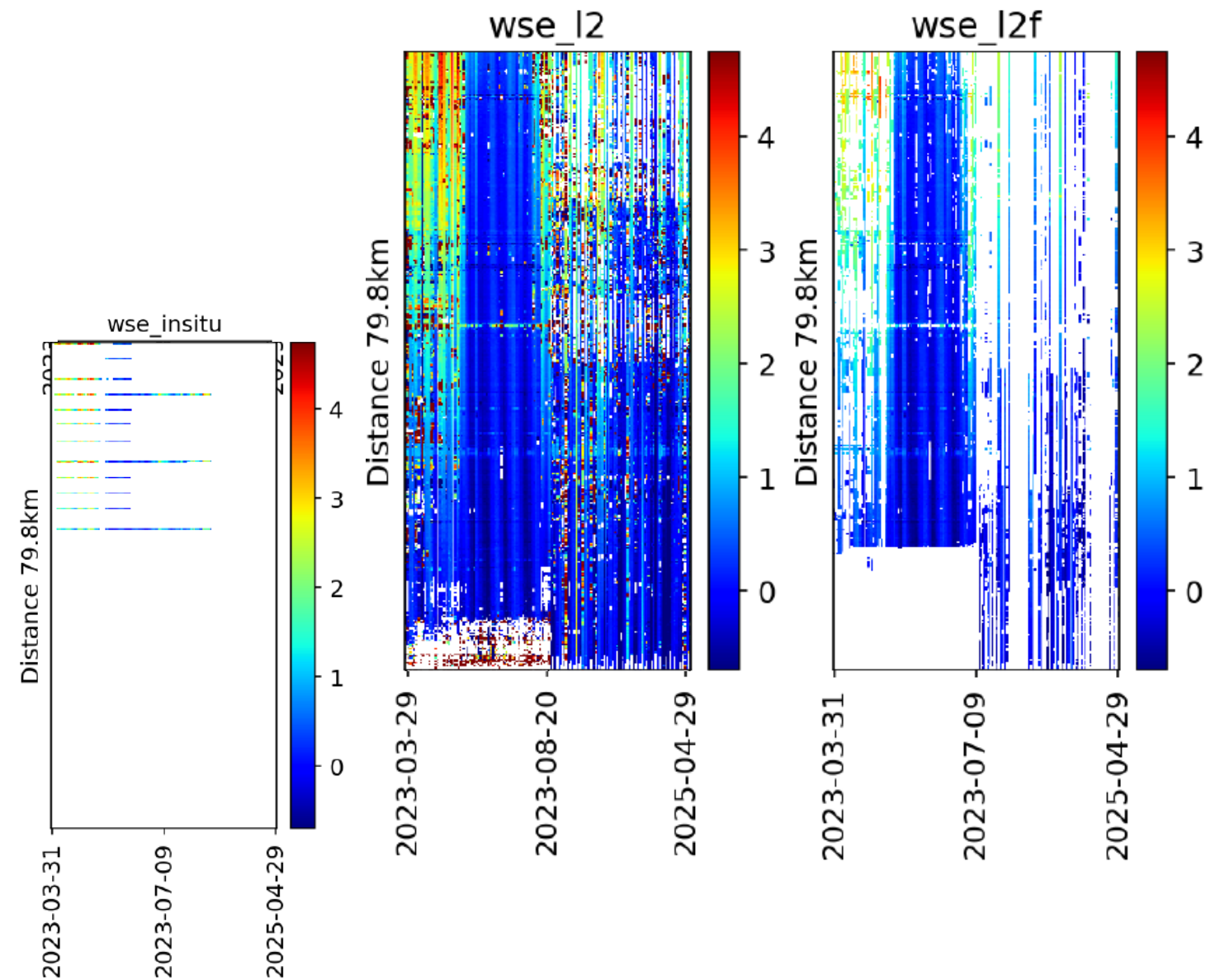
# The Connecticut

[73120000091, 73120000081, 73120000071, 73120000061,  
73120000051, 73120000041, 73120000031, 73120000021]



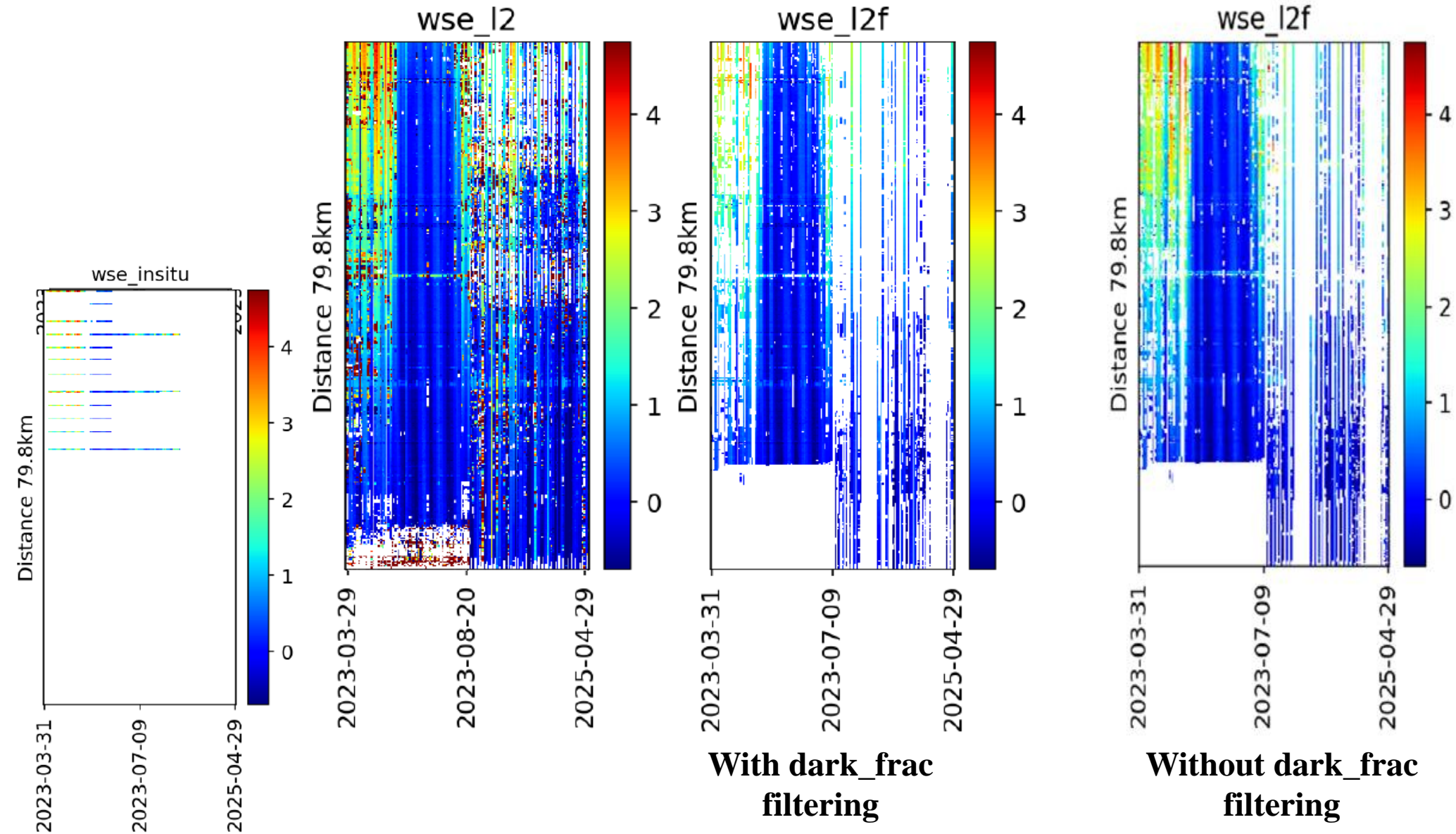
# The Connecticut

[73120000091, 73120000081, 73120000071, 73120000061,  
73120000051, 73120000041, 73120000031, 73120000021]



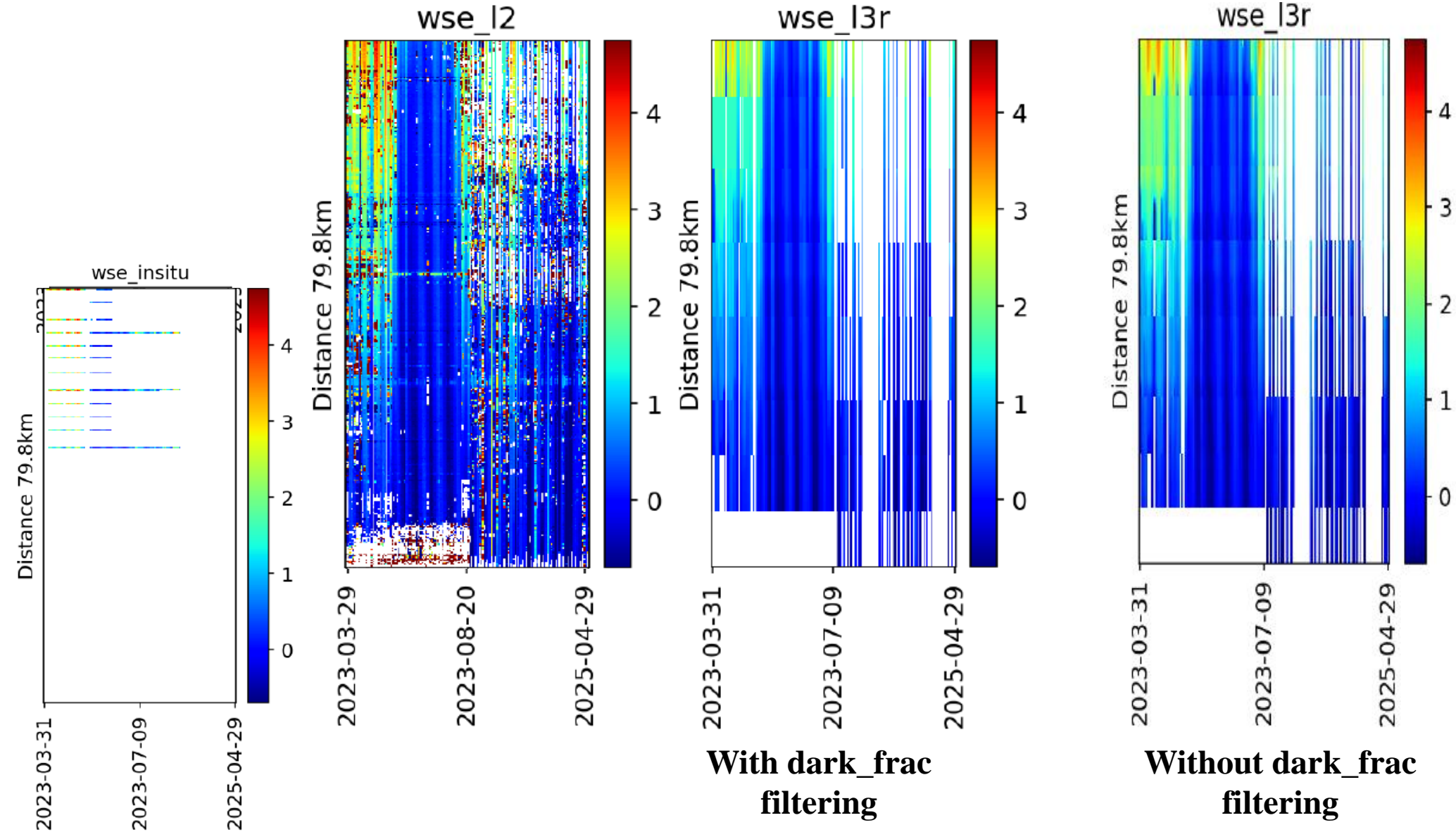
# *The Connecticut*

[73120000091, 73120000081, 73120000071, 73120000061,  
73120000051, 73120000041, 73120000031, 73120000021]



# *The Connecticut*

[73120000091, 73120000081, 73120000071, 73120000061,  
73120000051, 73120000041, 73120000031, 73120000021]

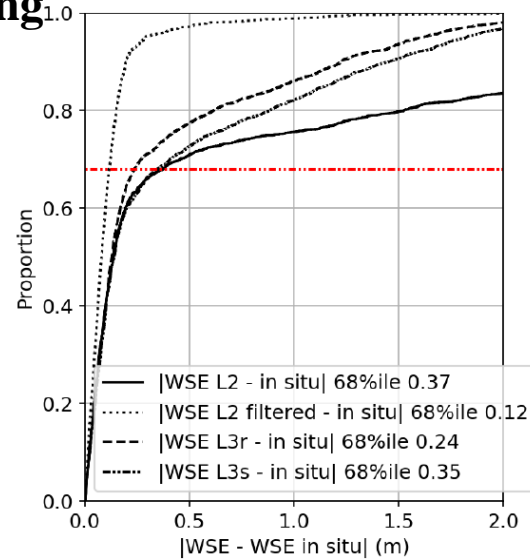
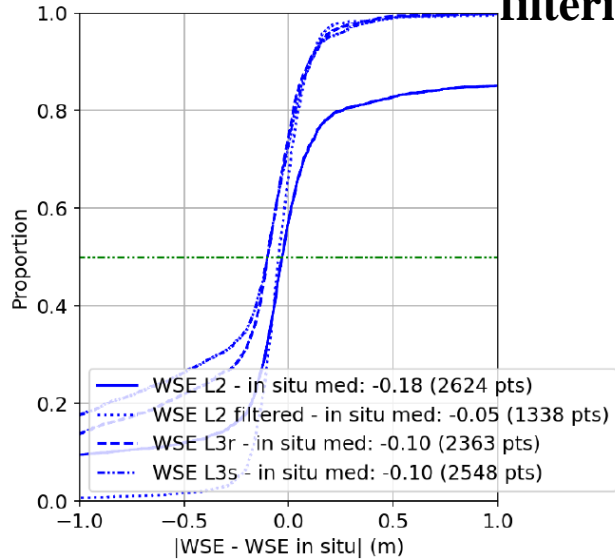


# The Connecticut

[73120000091, 73120000081, 73120000071, 73120000061,  
73120000051, 73120000041, 73120000031, 73120000021]

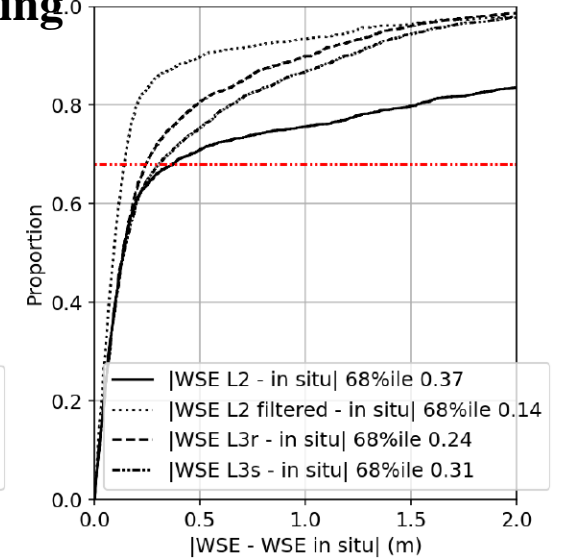
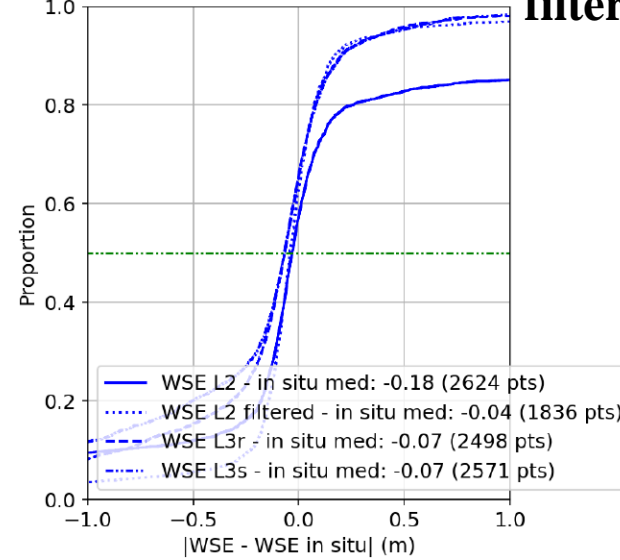
**With dark\_frac**

**filtering**



**Without dark\_frac**

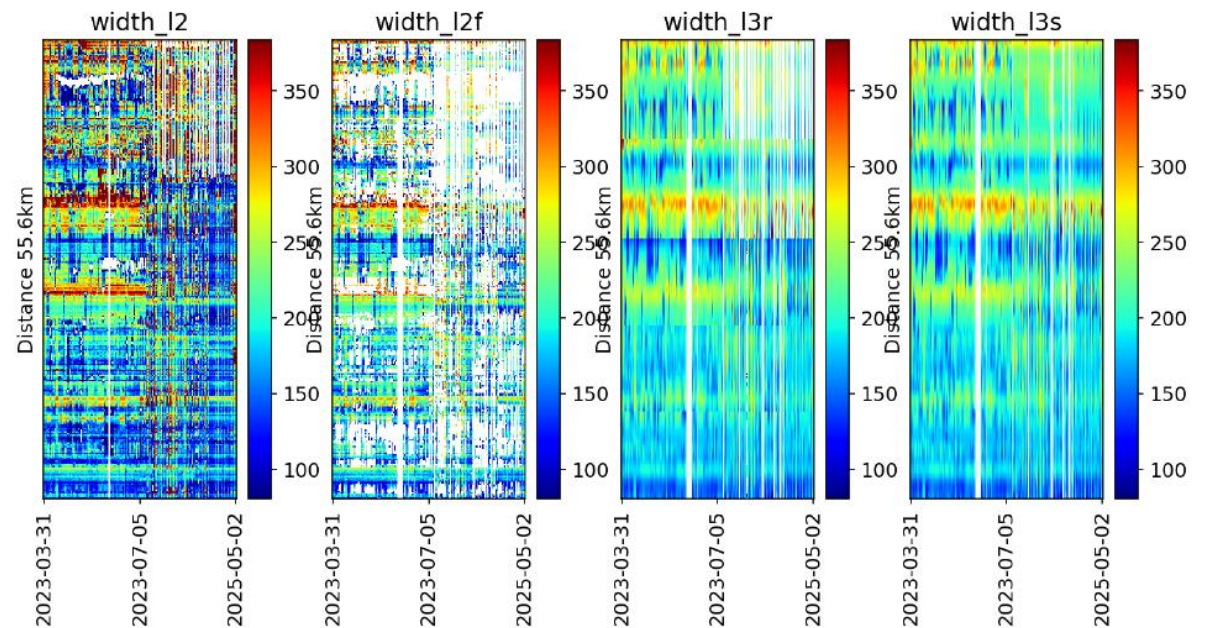
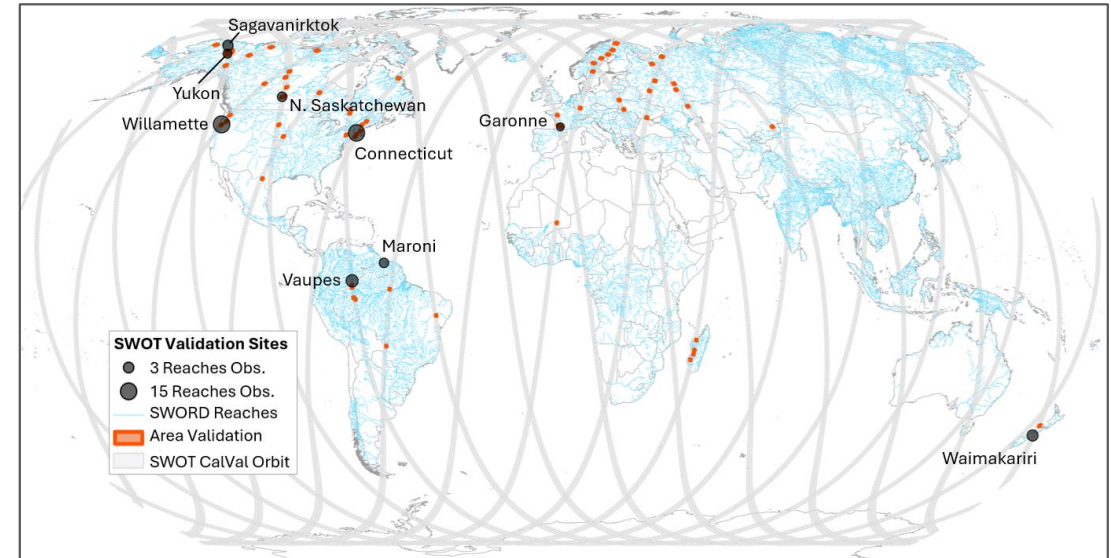
**filtering**

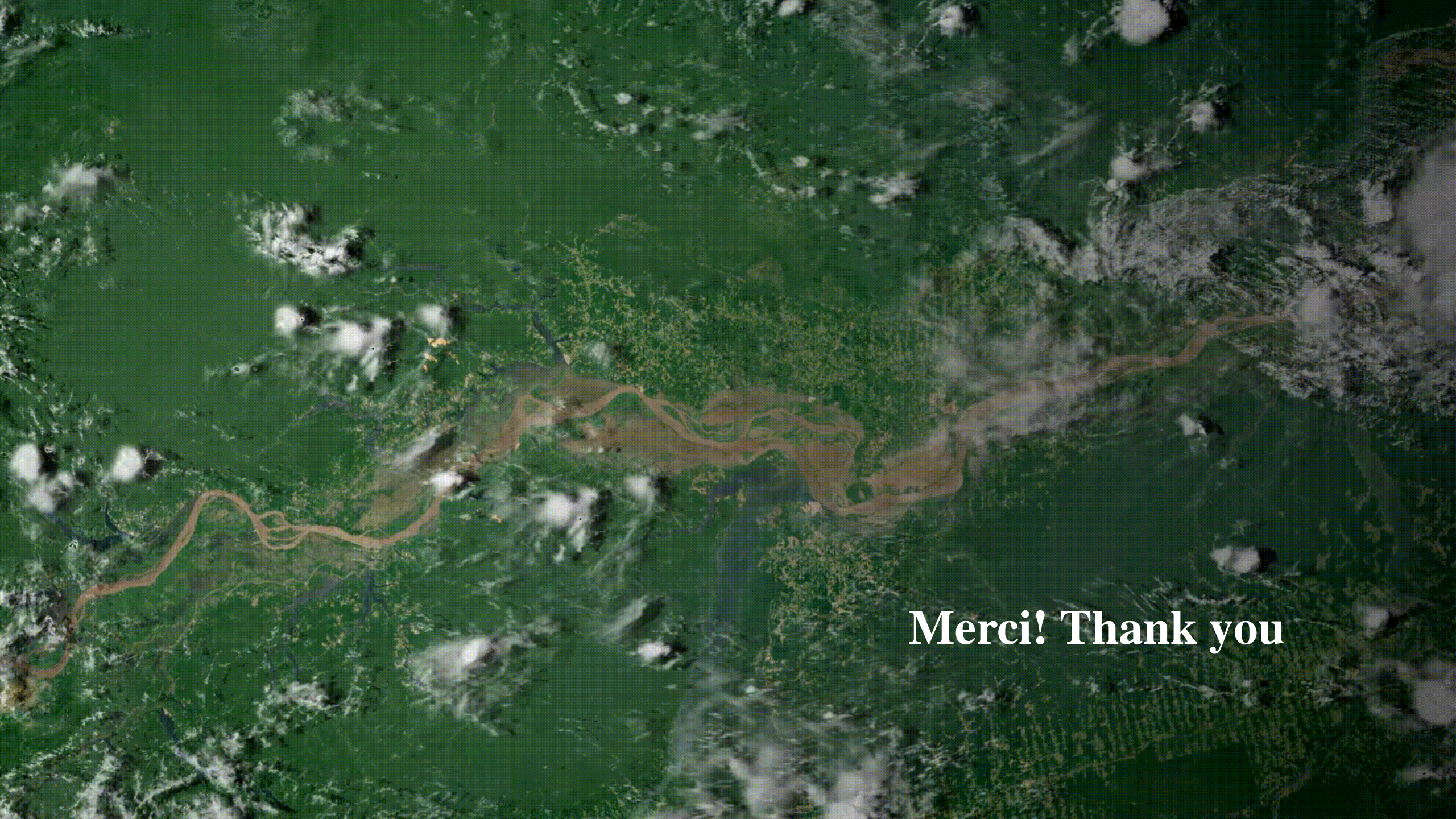


|                            | L2    | L2 Filtered | L3 Reach | L2 Filtered | L3 Reach |
|----------------------------|-------|-------------|----------|-------------|----------|
| NBR of obs                 | 59020 | 27352       | 42156    | 32674       | 42959    |
| RMSE                       | 4.14  | 0.27        | 0.69     | 0.45        | 0.48     |
| rel_diff  68%ile           | 0.23  | 0.15        | 0.24     | 0.16        | 0.21     |
| rel_diff  68%ile densified | -     | -           | -        | -           | 0.42     |

# Perspectives

- Extensive validation over CalVal sites and globally available in-situ.
- Improve robustness in handling drops within reaches.
- Improve reaches sets definition adequate for densification purposes.
- Width densification improvement.
- Discharge estimation using densified observation (already default for SIC4DVAR).





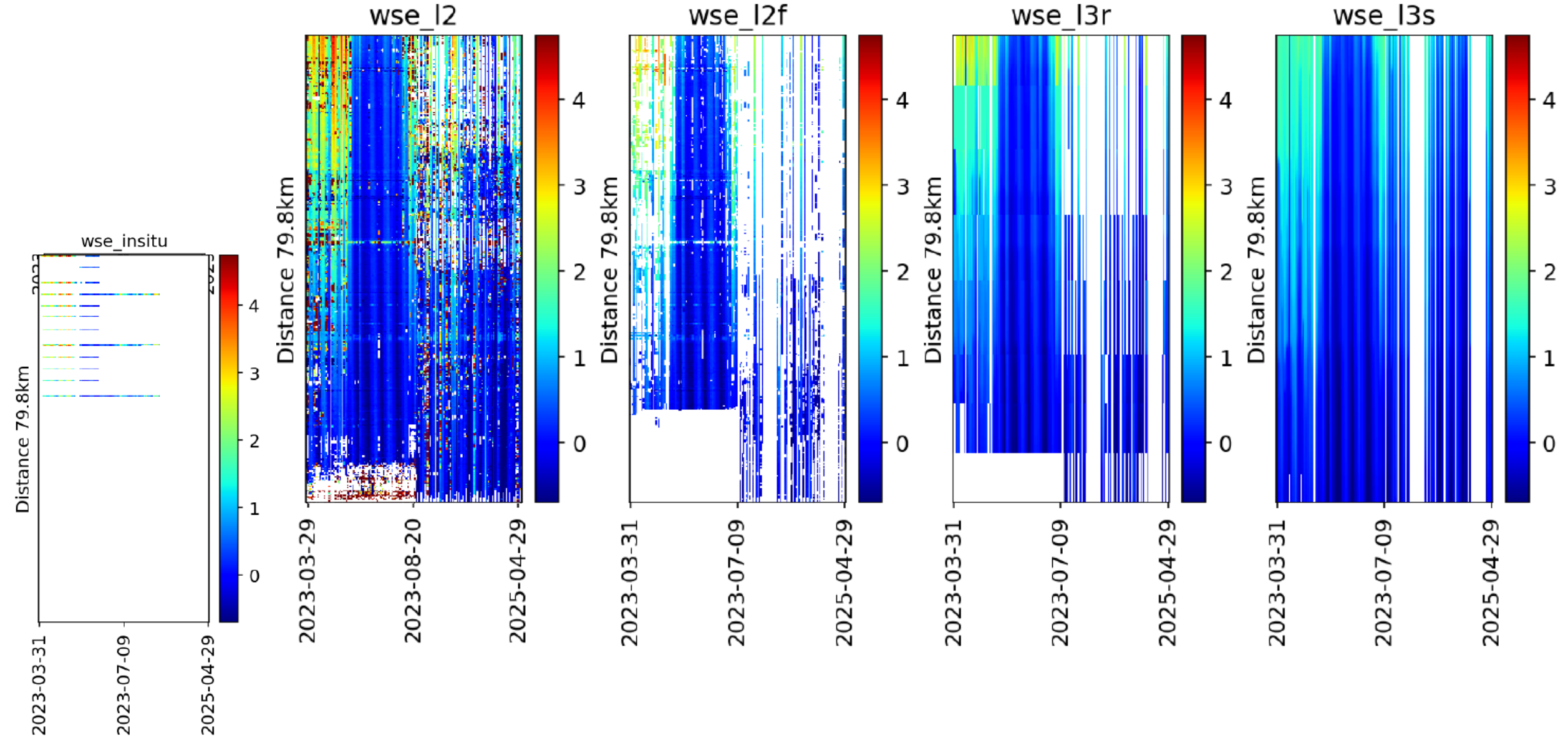
**Merci! Thank you**

**Extra**



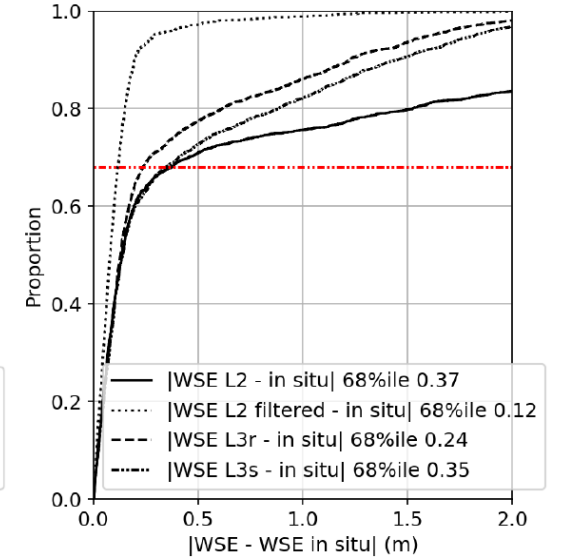
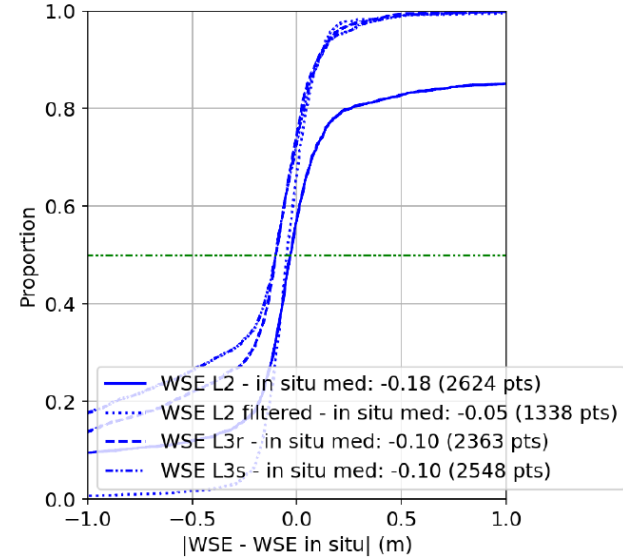
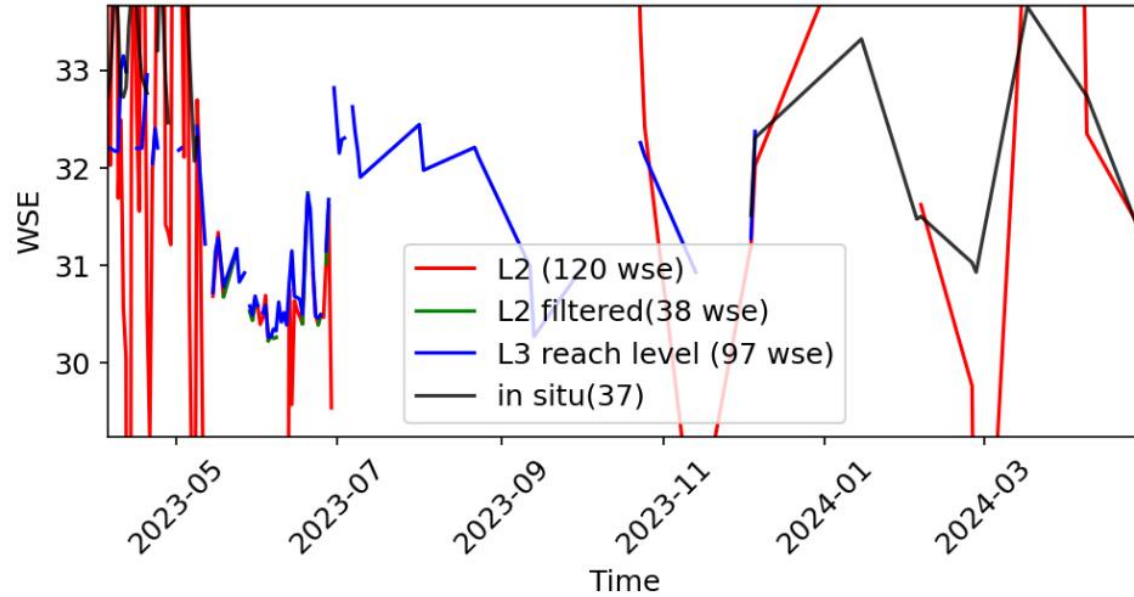
# The Connecticut

[7312000091, 7312000081, 7312000071, 7312000061,  
7312000051, 7312000041, 7312000031, 7312000021]



# The Connecticut

[73120000091, 73120000081, 73120000071, 73120000061,  
73120000051, 73120000041, 73120000031, 73120000021]

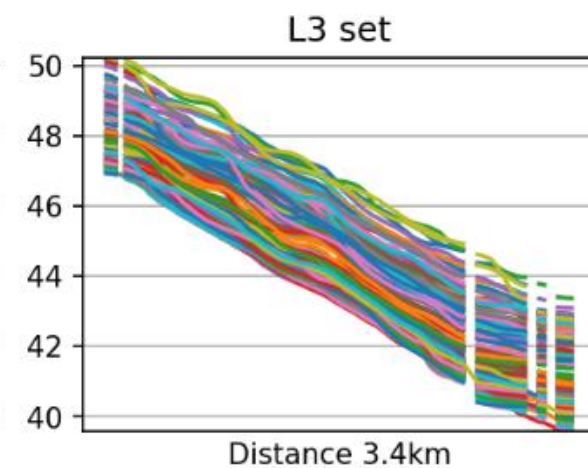
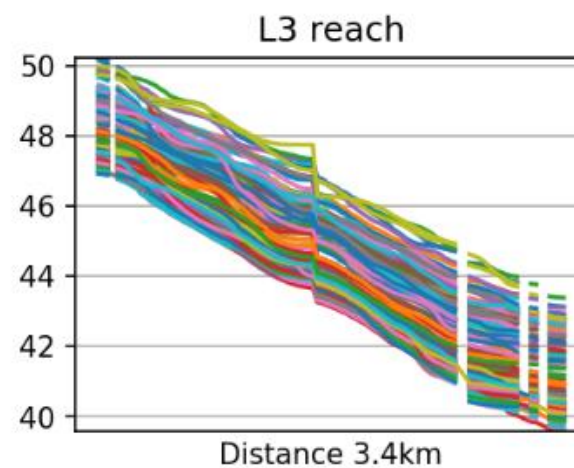
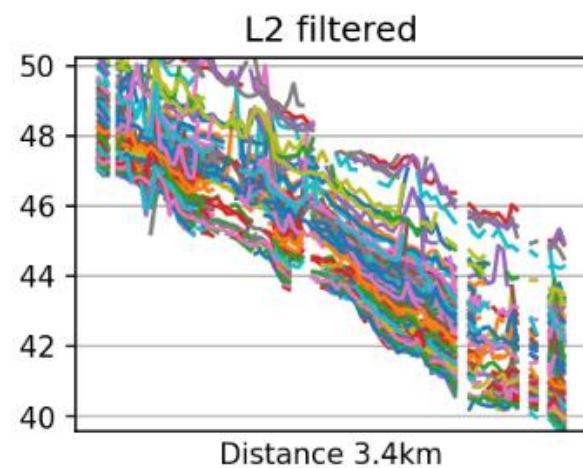
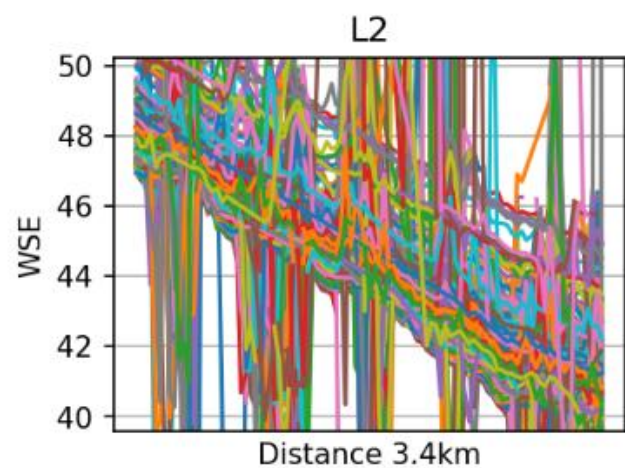
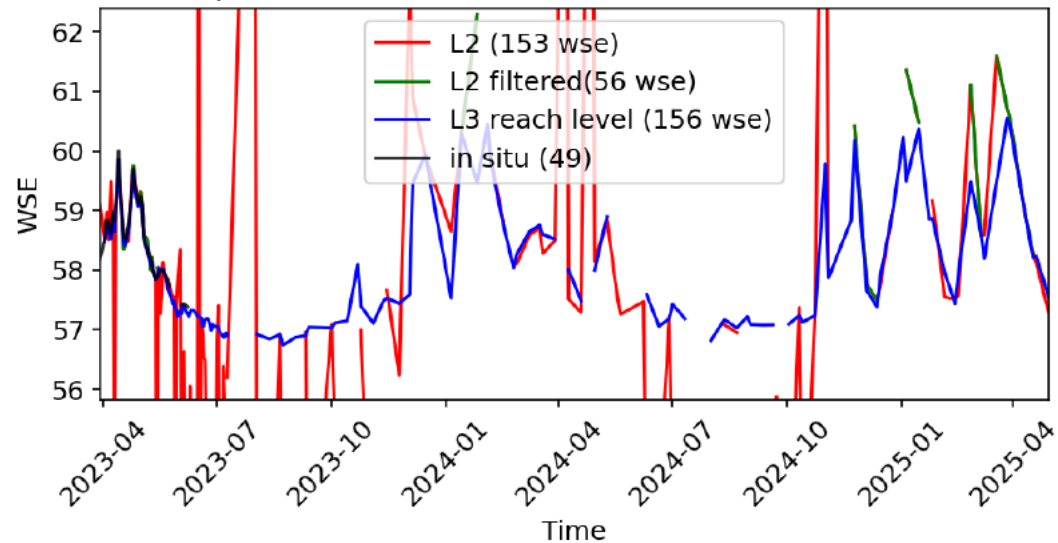


|                            | L2    | L2 Filtered | L3 Reach    | L3 Set      |
|----------------------------|-------|-------------|-------------|-------------|
| NBR of obs                 | 59020 | 27352       | 42156       | 55812       |
| RMSE                       | 4.14  | <b>0.27</b> | <b>0.69</b> | 0.84        |
| rel_diff  68%ile           | 0.23  | <b>0.15</b> | <b>0.24</b> | 0.54        |
| rel_diff  68%ile densified | -     | -           | -           | <b>0.99</b> |

# The Willamette

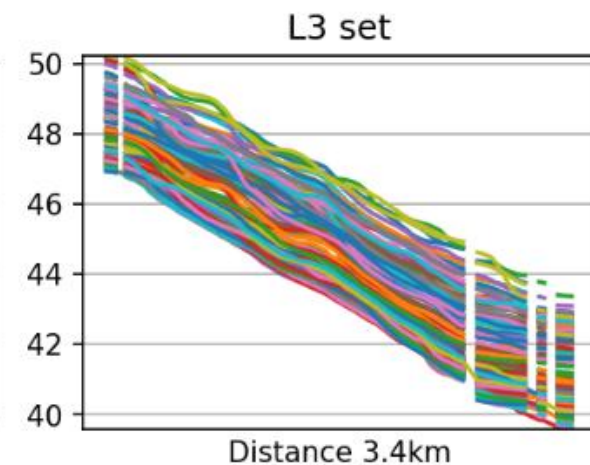
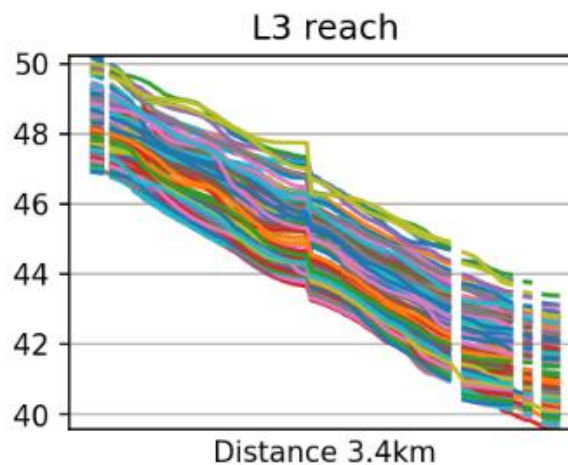
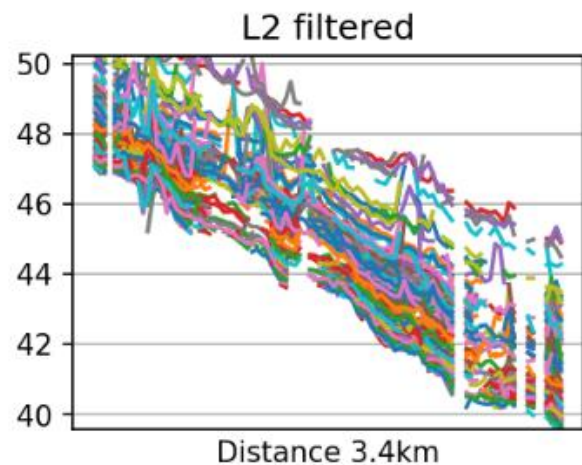
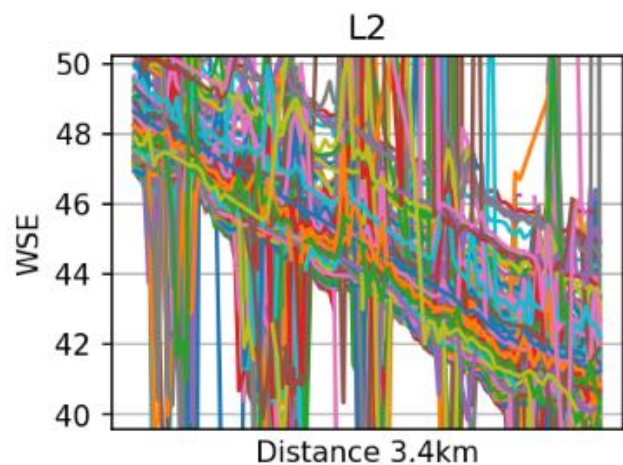
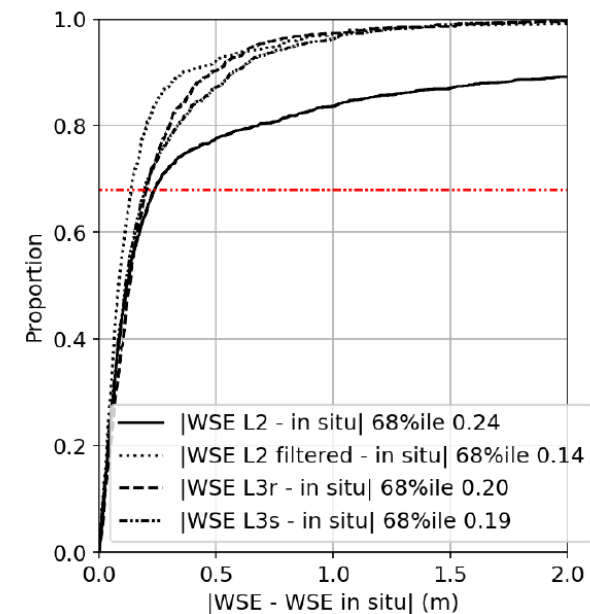
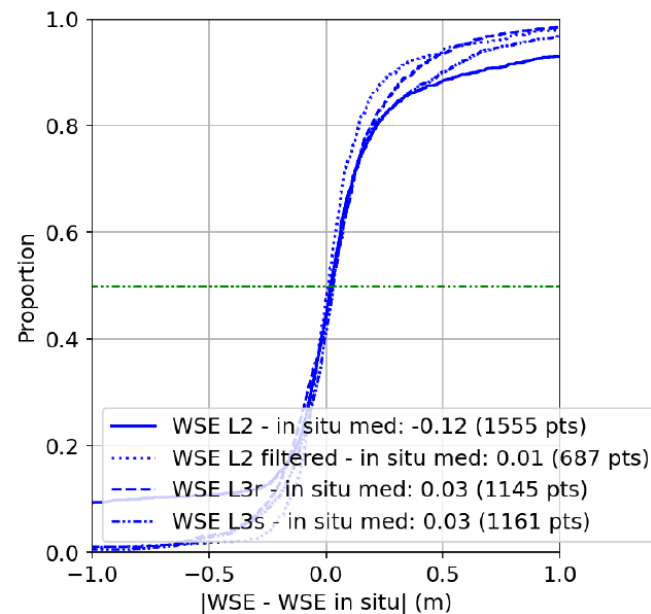
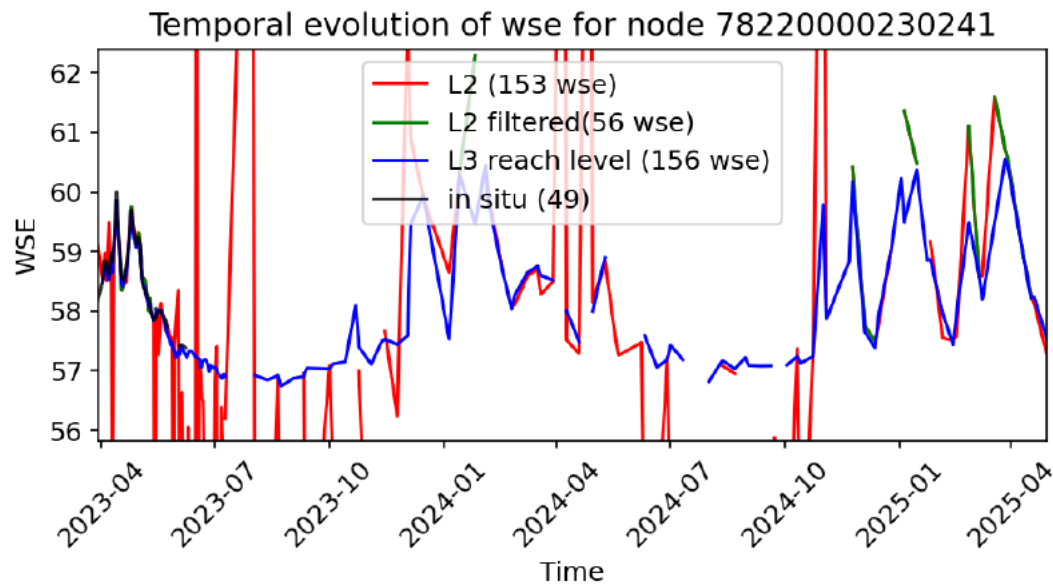
[78220000191, 78220000181]

Temporal evolution of wse for node 78220000230241



# The Willamette

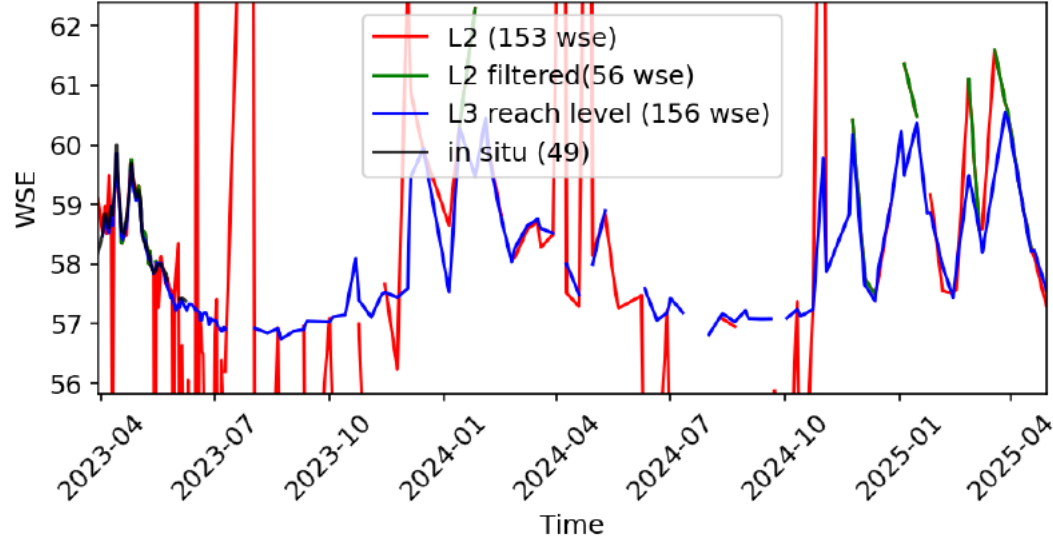
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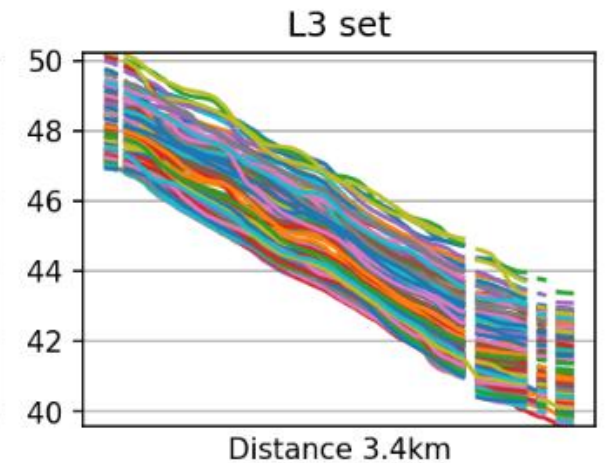
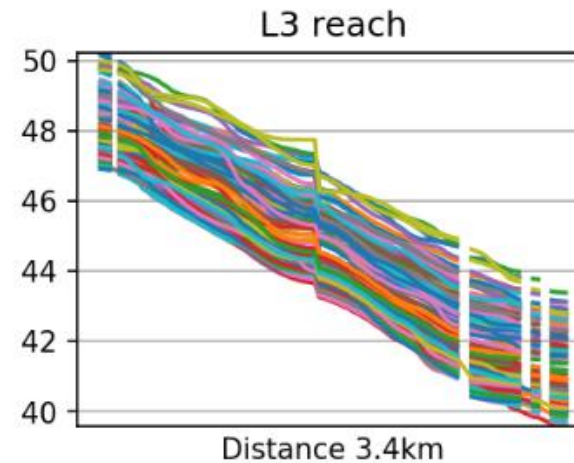
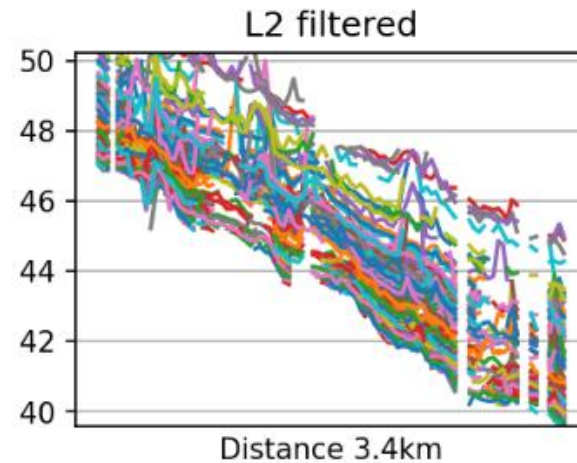
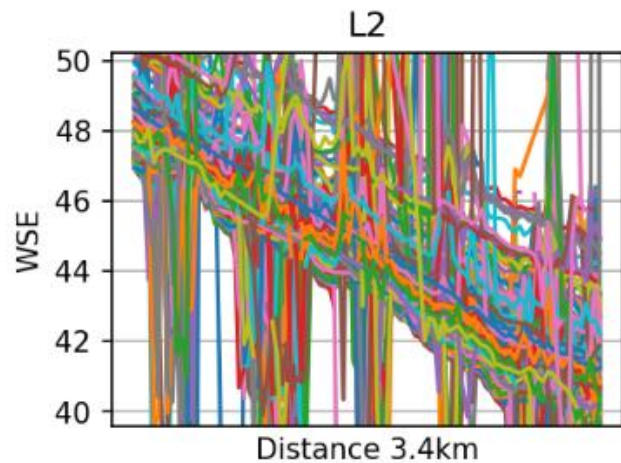
# The Willamette

[78220000191, 78220000181]

Temporal evolution of wse for node 78220000230241

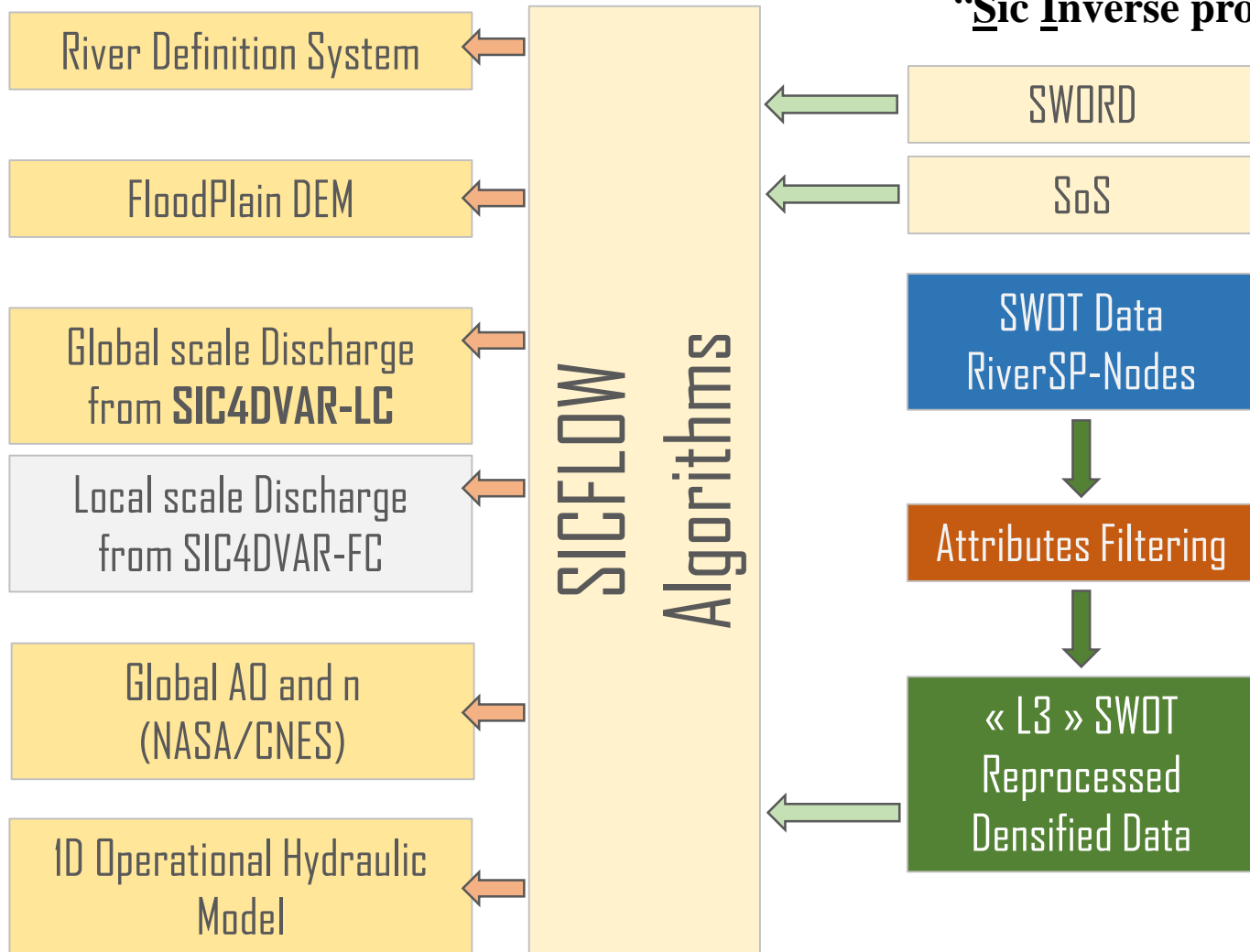


|                            | L2    | L2 Filtered | L3 Reach | L3 Set       |
|----------------------------|-------|-------------|----------|--------------|
| NBR of obs                 | 14814 | 7950        | 12144    | <b>12144</b> |
| RMSE                       | 5.02  | 0.46        | 0.37     | <b>0.35</b>  |
| rel_diff  68%ile           | 0.45  | <b>0.18</b> | 0.29     | <b>0.24</b>  |
| rel_diff  68%ile densified | -     | -           | 0.37     | <b>0.35</b>  |

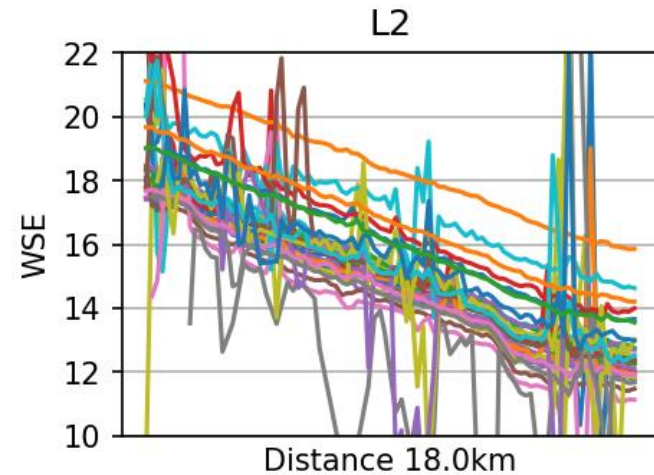


# SICFLOW

“Sic Inverse problem Capabilities for river FLOW dynamics”

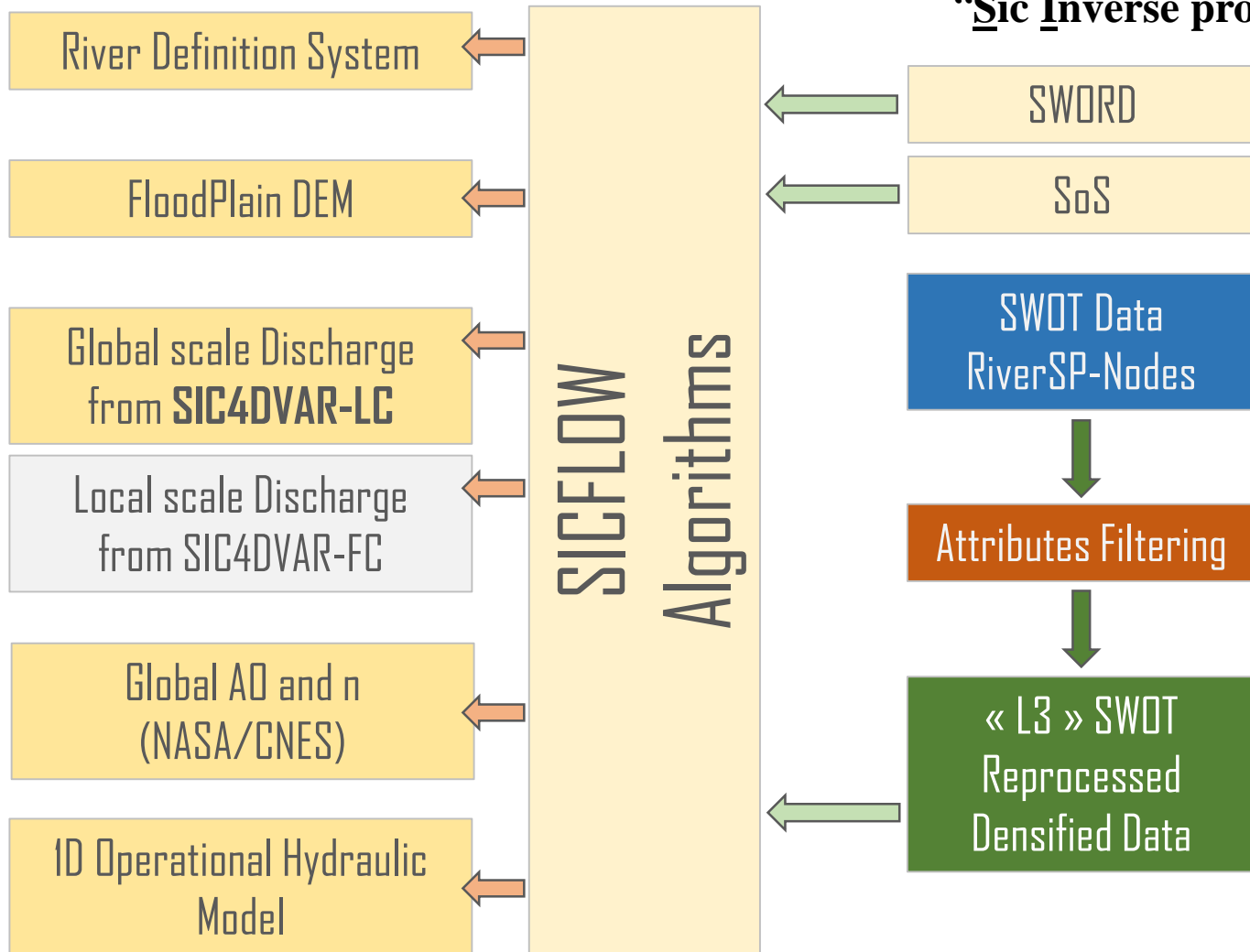


1. Quality Flags Filtering
2. Outliers Filtering
3. Spatio-Temporal Densification
4. Smoothing

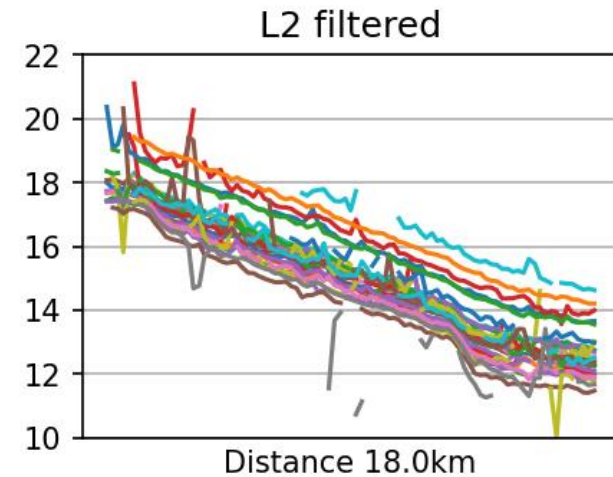


# SICFLOW

“Sic Inverse problem Capabilities for river FLOW dynamics”

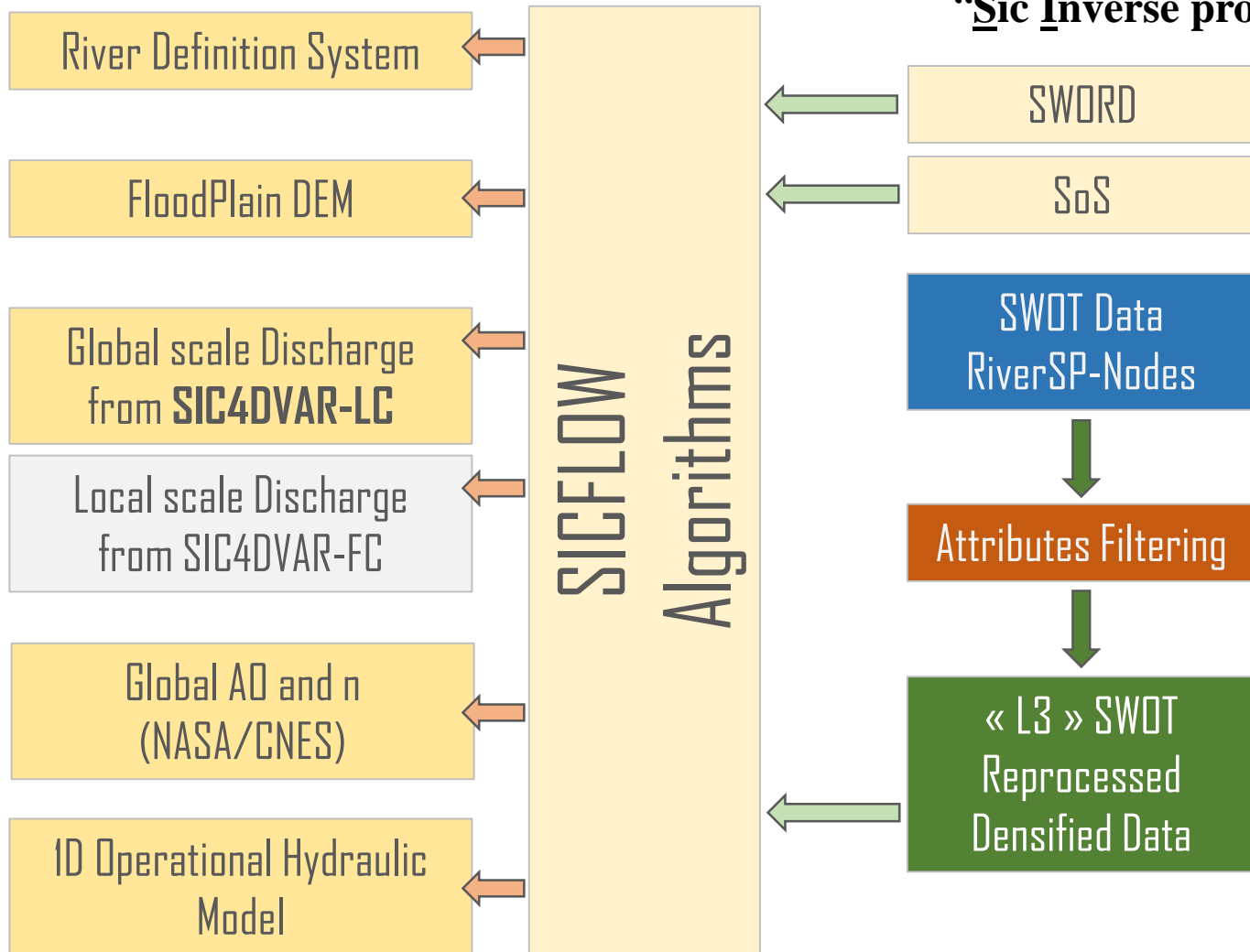


1. Quality Flags Filtering
2. Outliers Filtering
3. Spatio-Temporal Densification
4. Smoothing



# SICFLOW

“Sic Inverse problem Capabilities for river FLOW dynamics”



1. Quality Flags Filtering
2. Outliers Filtering
3. Spatio-Temporal Densification
4. Smoothing

