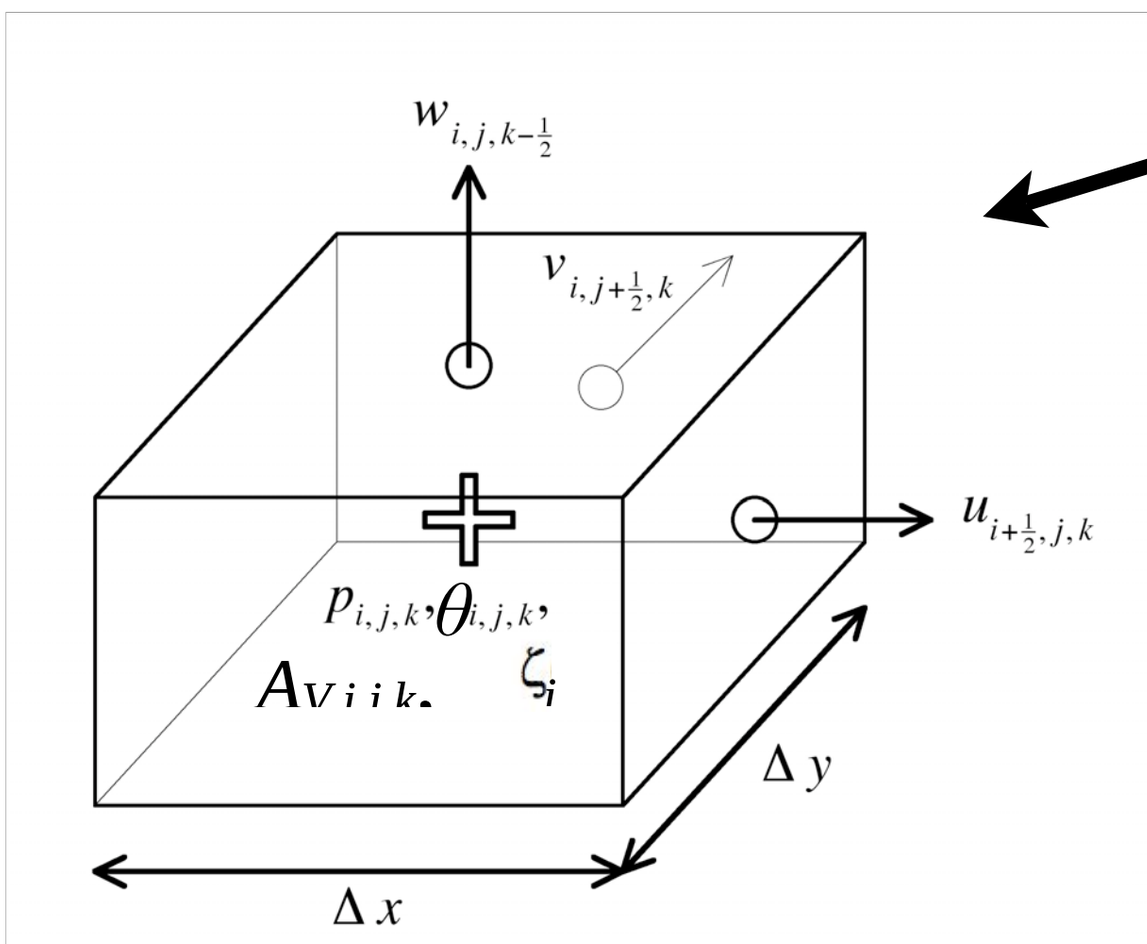
# 3D Model

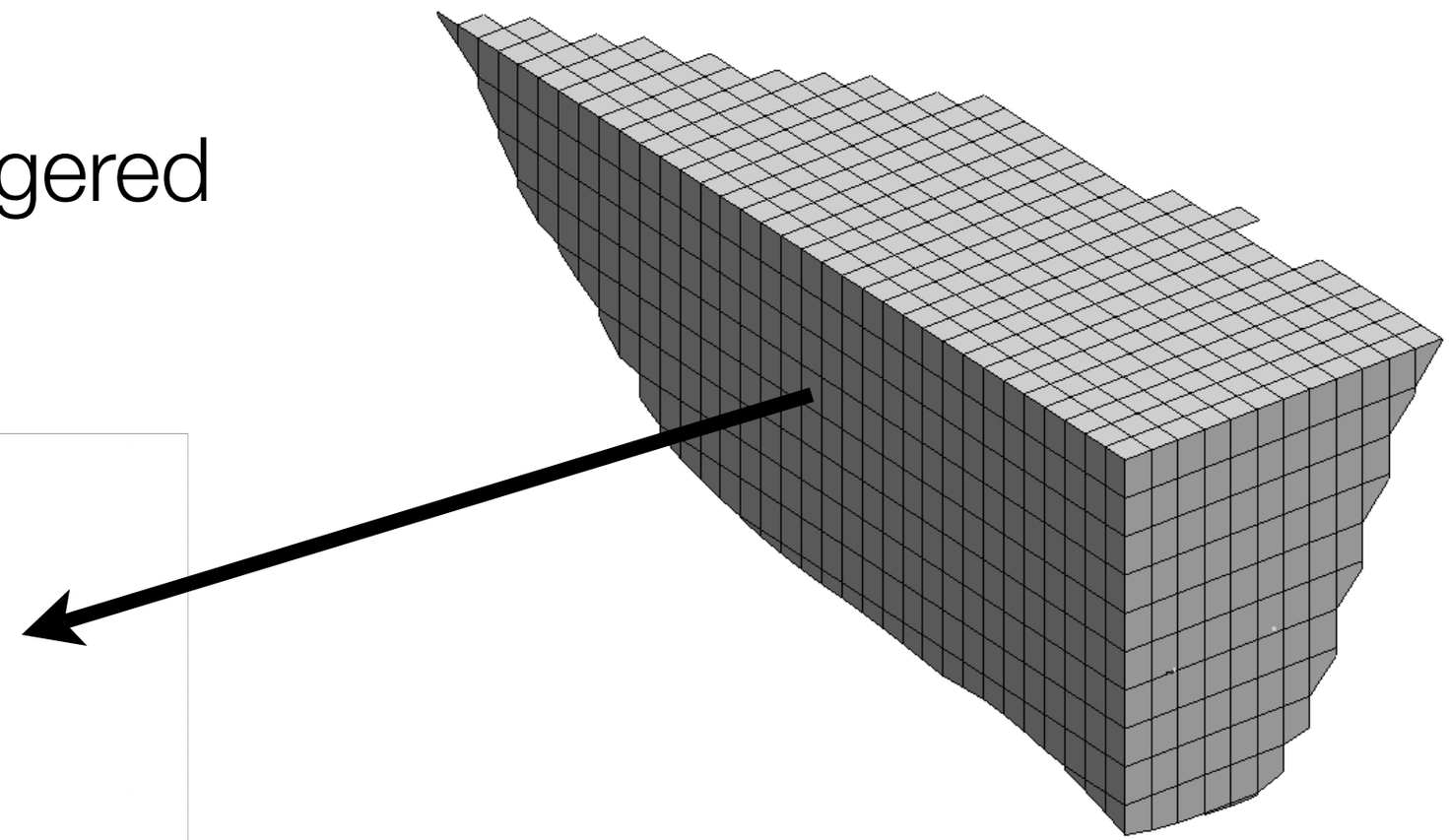
## **Si3D** = **S**emi-**i**mplicit **3 D**imensional

- Developed at University of California Davis in Geoff Schladow's reseach group
- Pete Smith (1997) created core routines and benchmarked using canonical flows
- Francisco Rueda (2001) further developed for field applications
- Utilized by USGS, University of Granada, and others

# SI3D: Spatial Discretization

Finite volume staggered
Cartesian grid

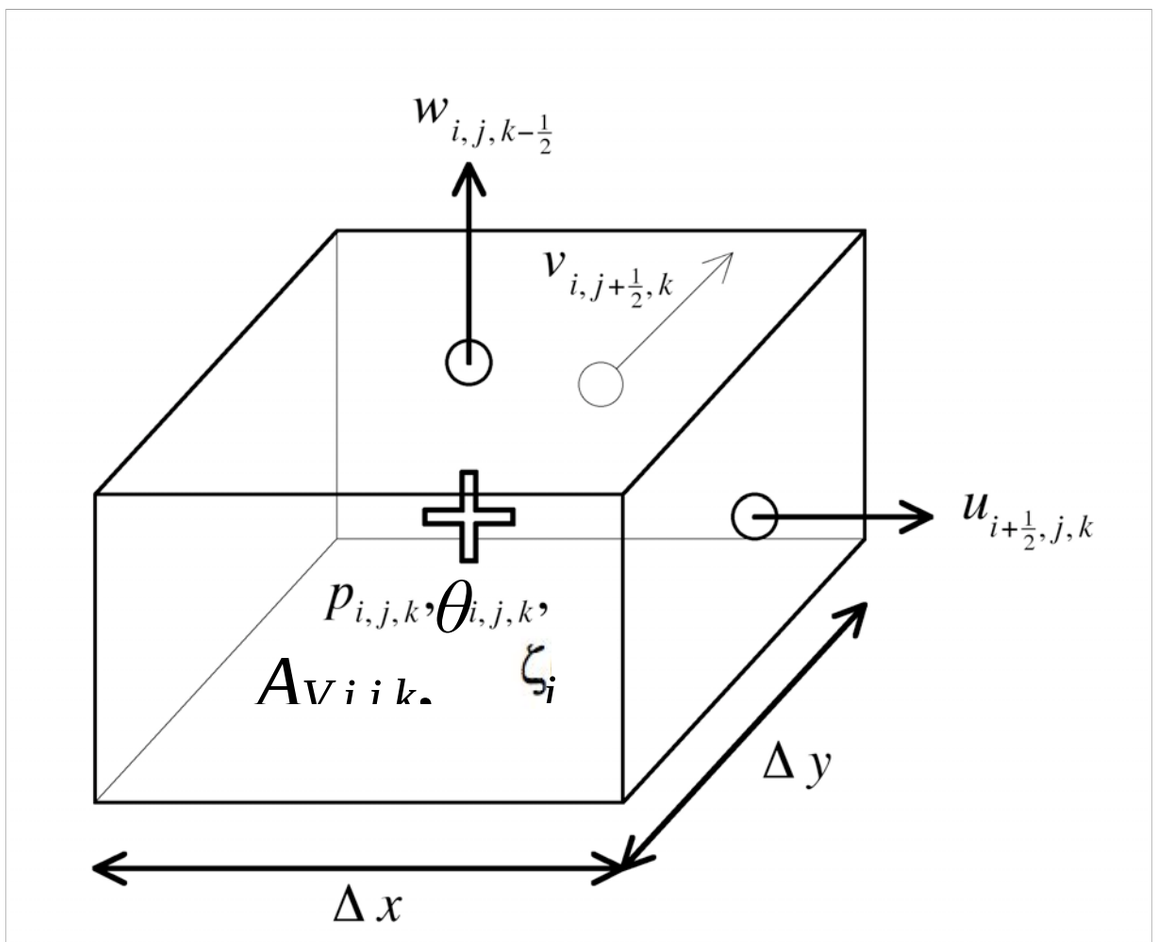


# SI3D: Governing Equations

Reynolds Averaged

- Conservation of Mass
- Conservation of Momentum
- Conservation of Energy
- Conservation of Tracer Mass



# SI3D: Initial and Boundary Conditions

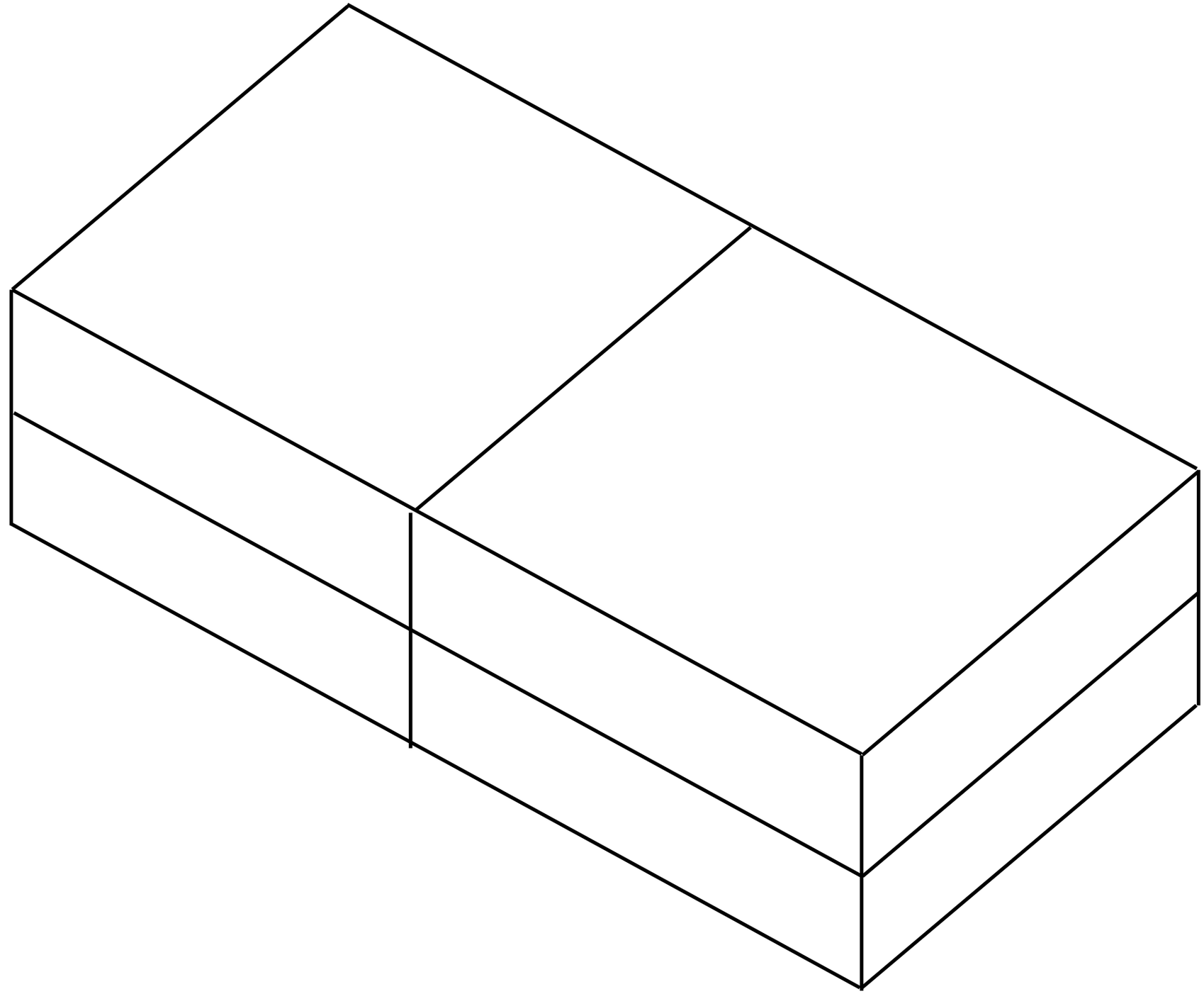
Initial Condition

- Vertical temperature profile

Boundary Conditions

- Meteorological variables (including wind)
- Tributary flow rates and temperatures
- Water surface elevation at one boundary

# SI3D: Transport Between Cells



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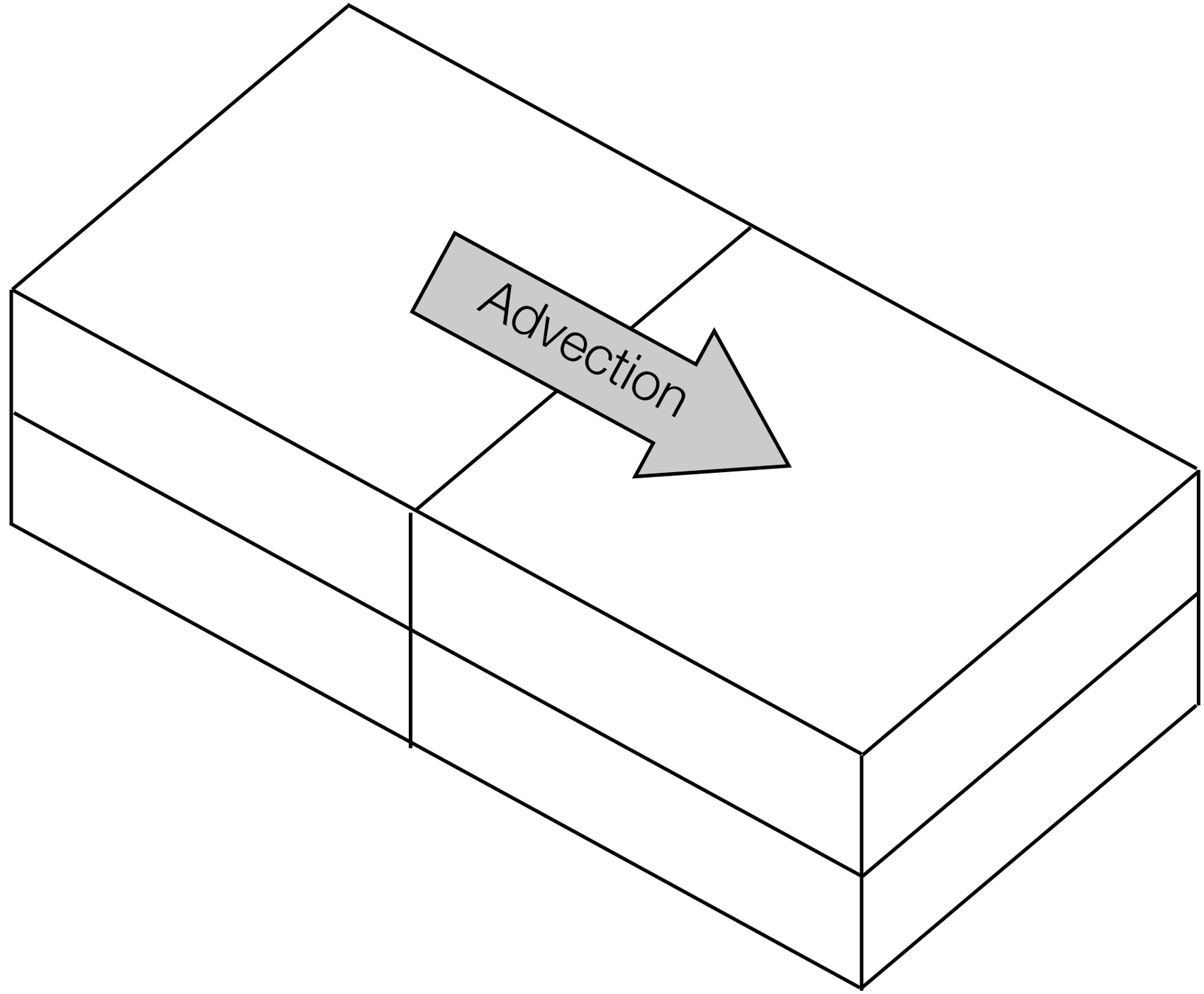


## Advection

- upwind differencing for mometum
- flux limiter methods for scalars

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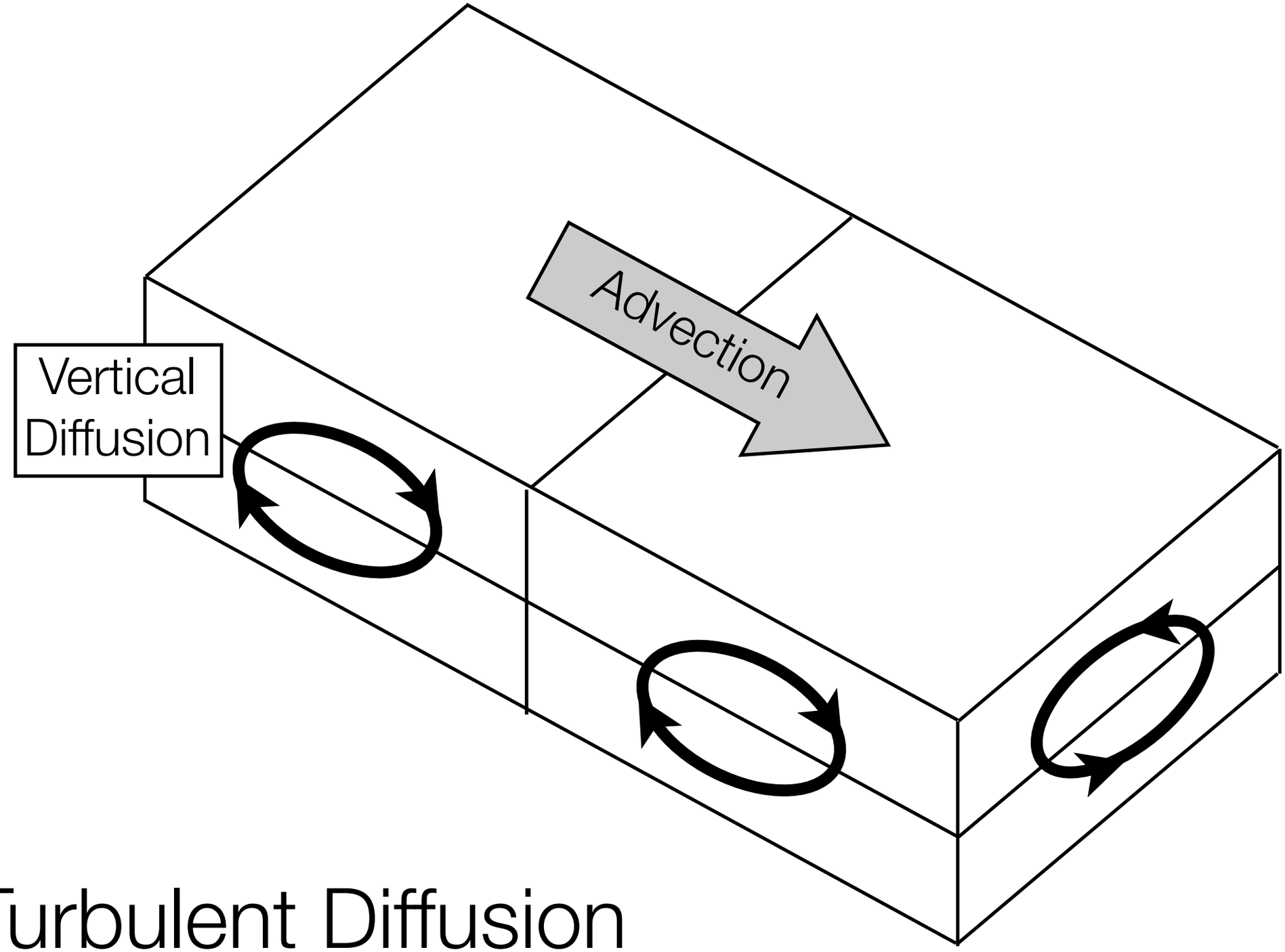


## Vertical Turbulent Diffusion

- GOTM suite of turbulence models for vertical eddy diffusvity $\nu_V$
- Mellor-Yamada 2.5-level scheme

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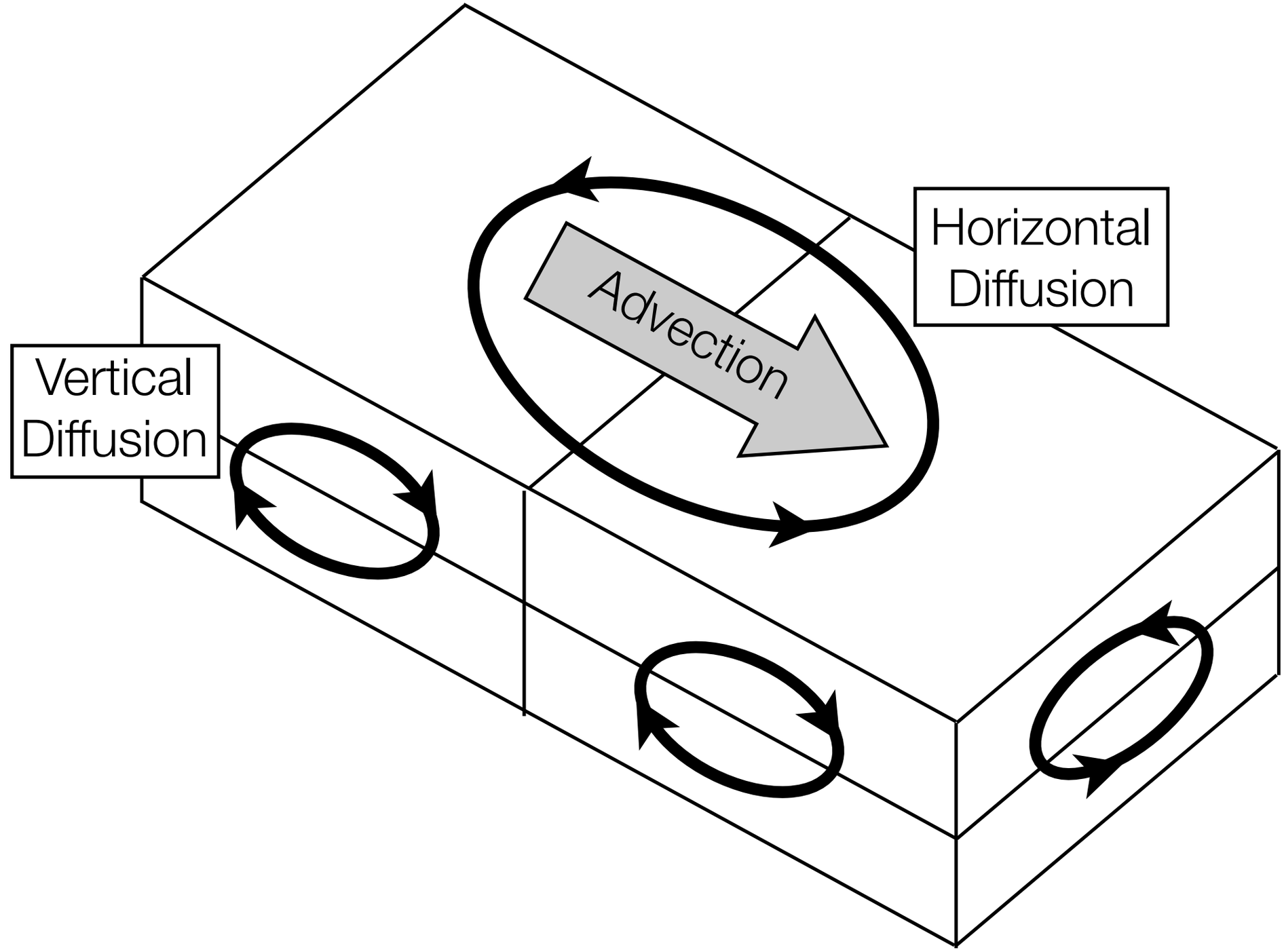
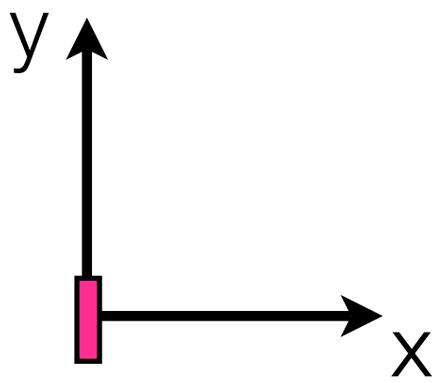



## Horizontal Turbulent Diffusion

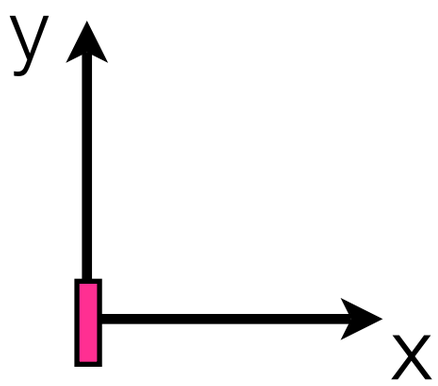
- Constant horiztonal eddy diffusivity $\nu_H$

# SI3D: Adding Point Sources



# SI3D: Adding Point Sources

➡ Constant $v_H$ is good for **passive** point sources



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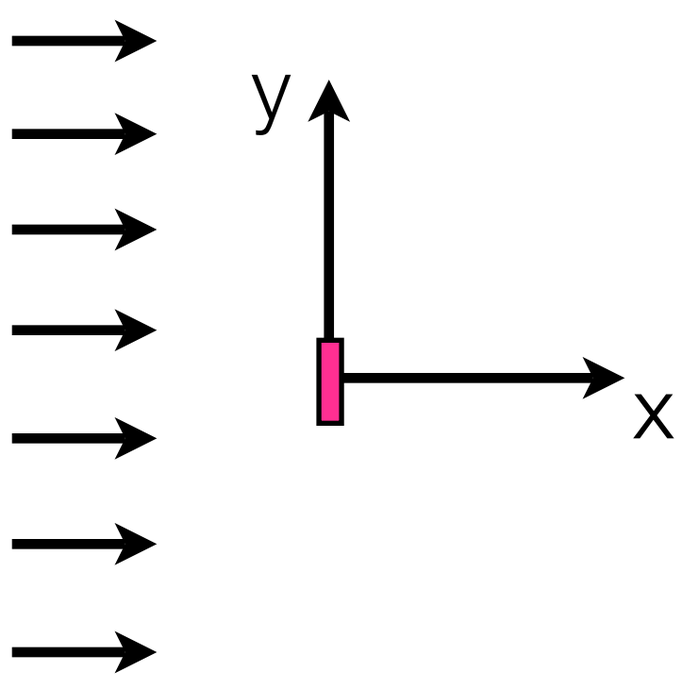


Ambient flow drives advection and diffusion of plume

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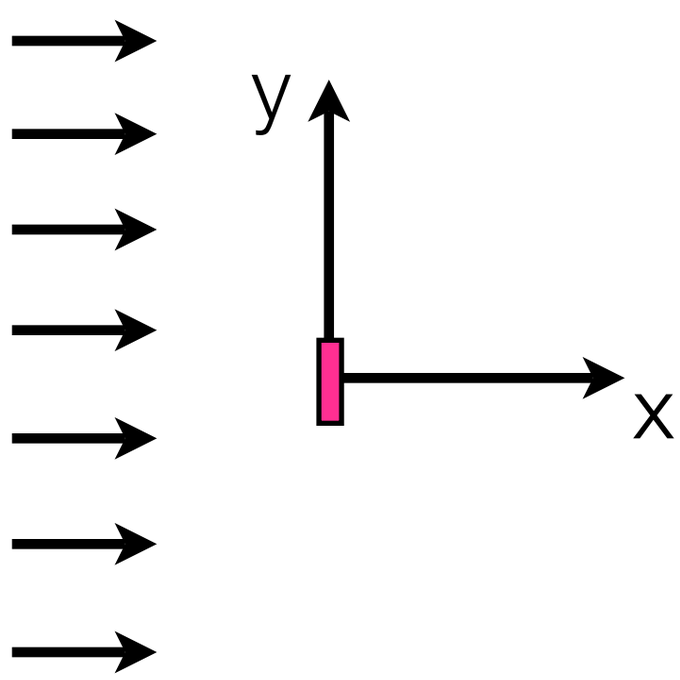


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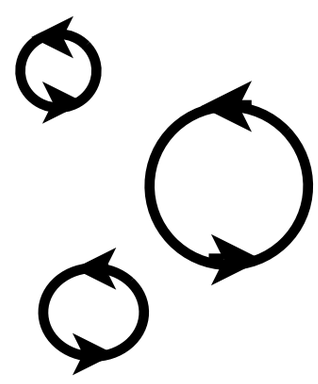

Ambient turbulence is well-approximated by $\nu_H$ = constant

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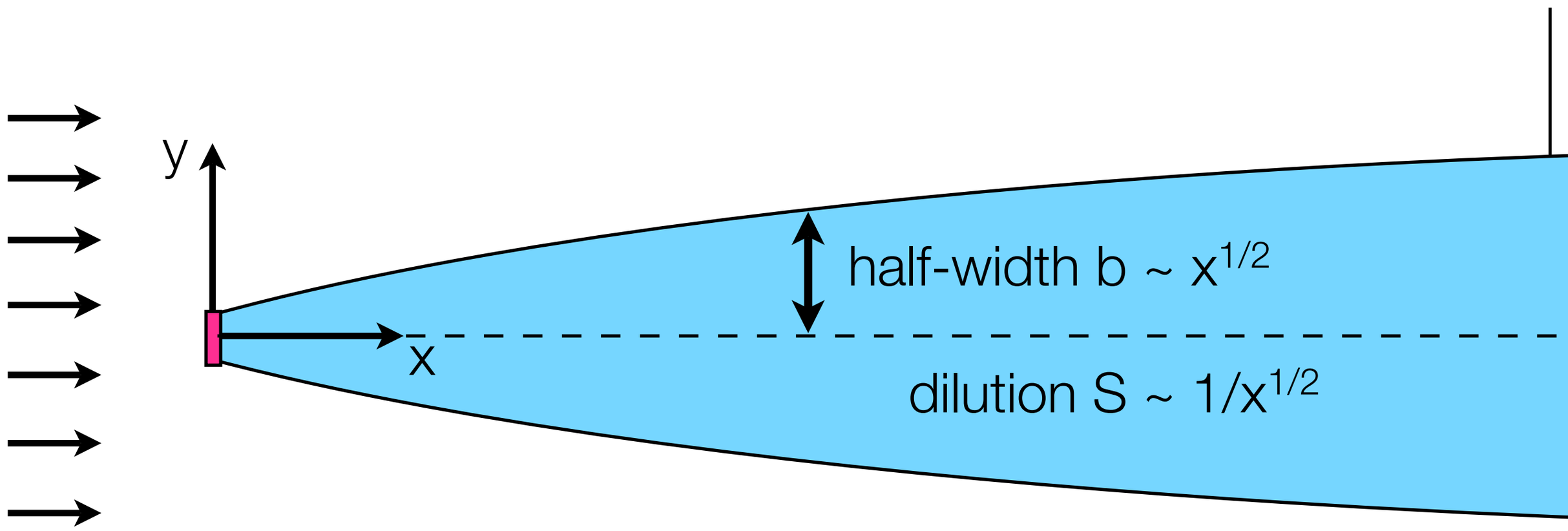


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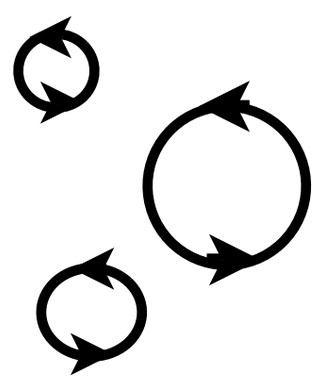

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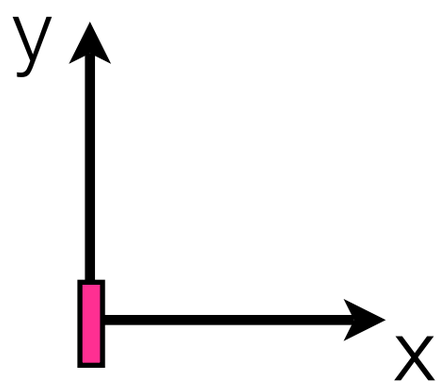

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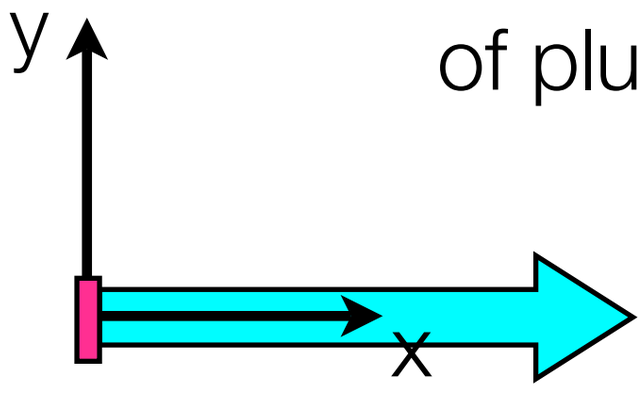

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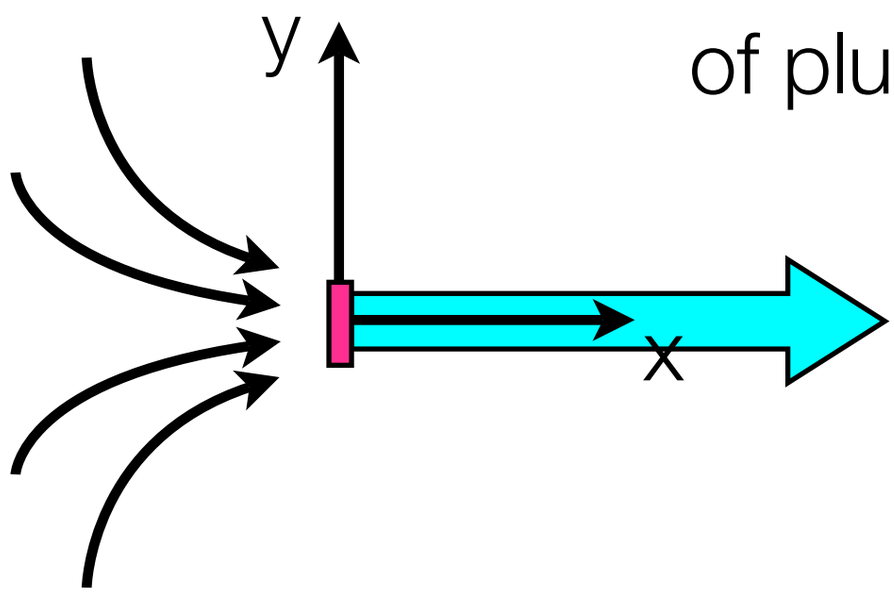


Disturbance in water surface drives strong back entrainment

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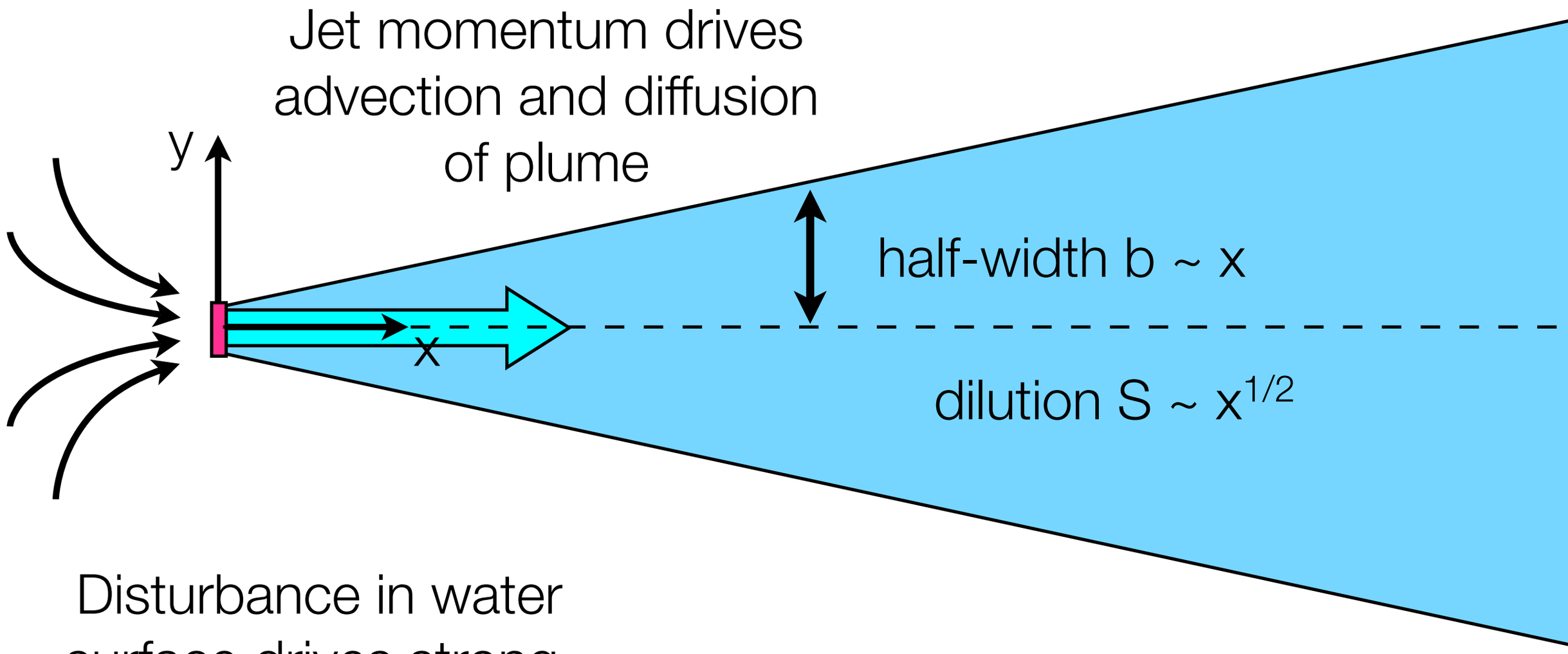


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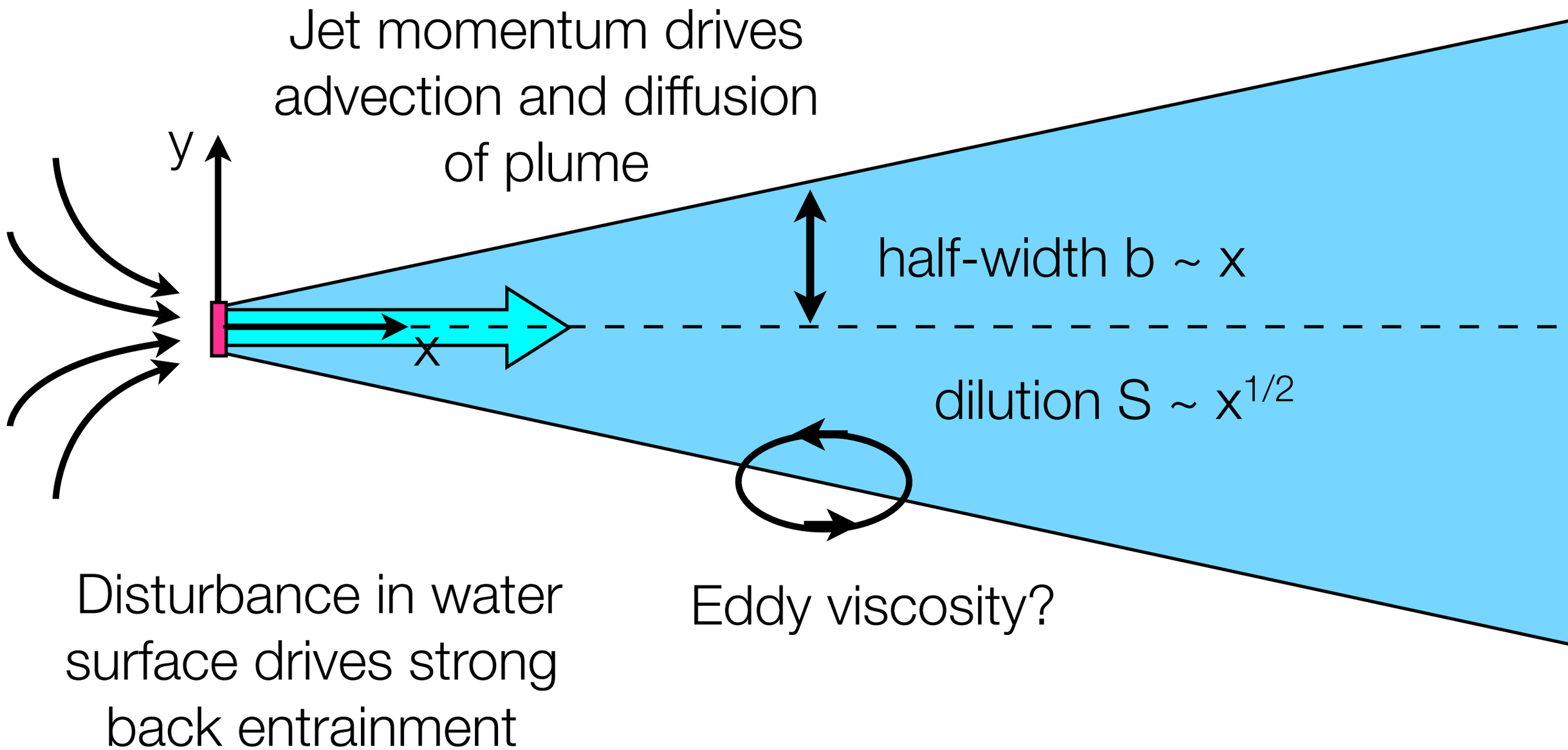

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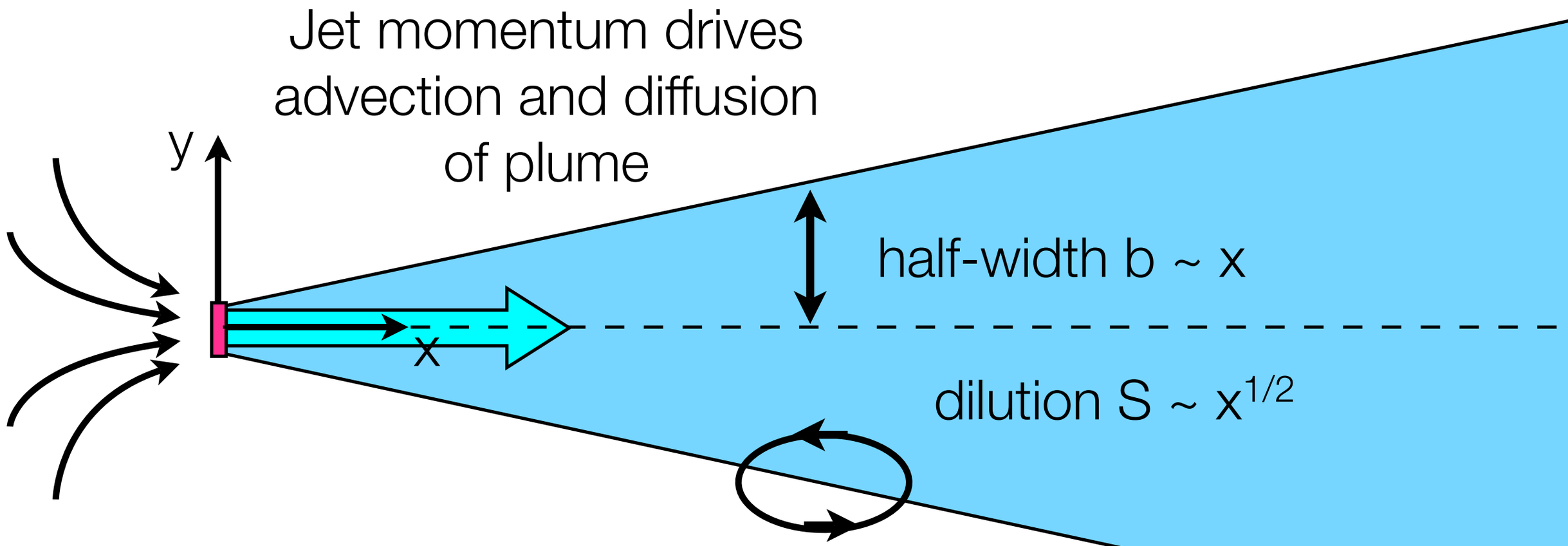


Disturbance in water surface drives strong back entrainment

Eddy viscosity?

$\nu_H \sim x^{1/2}\exp(-y^2/x^2)$ seems to work!

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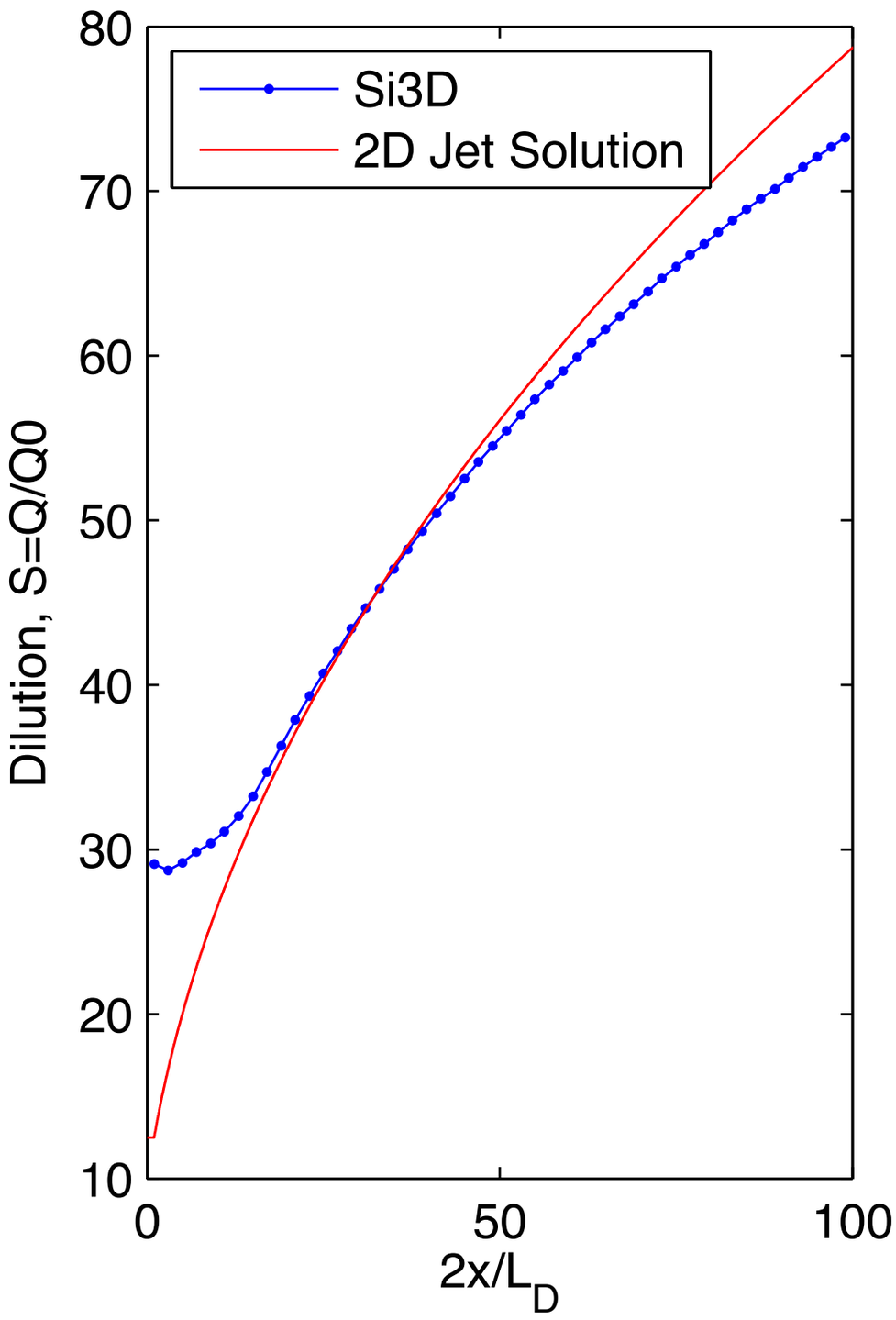
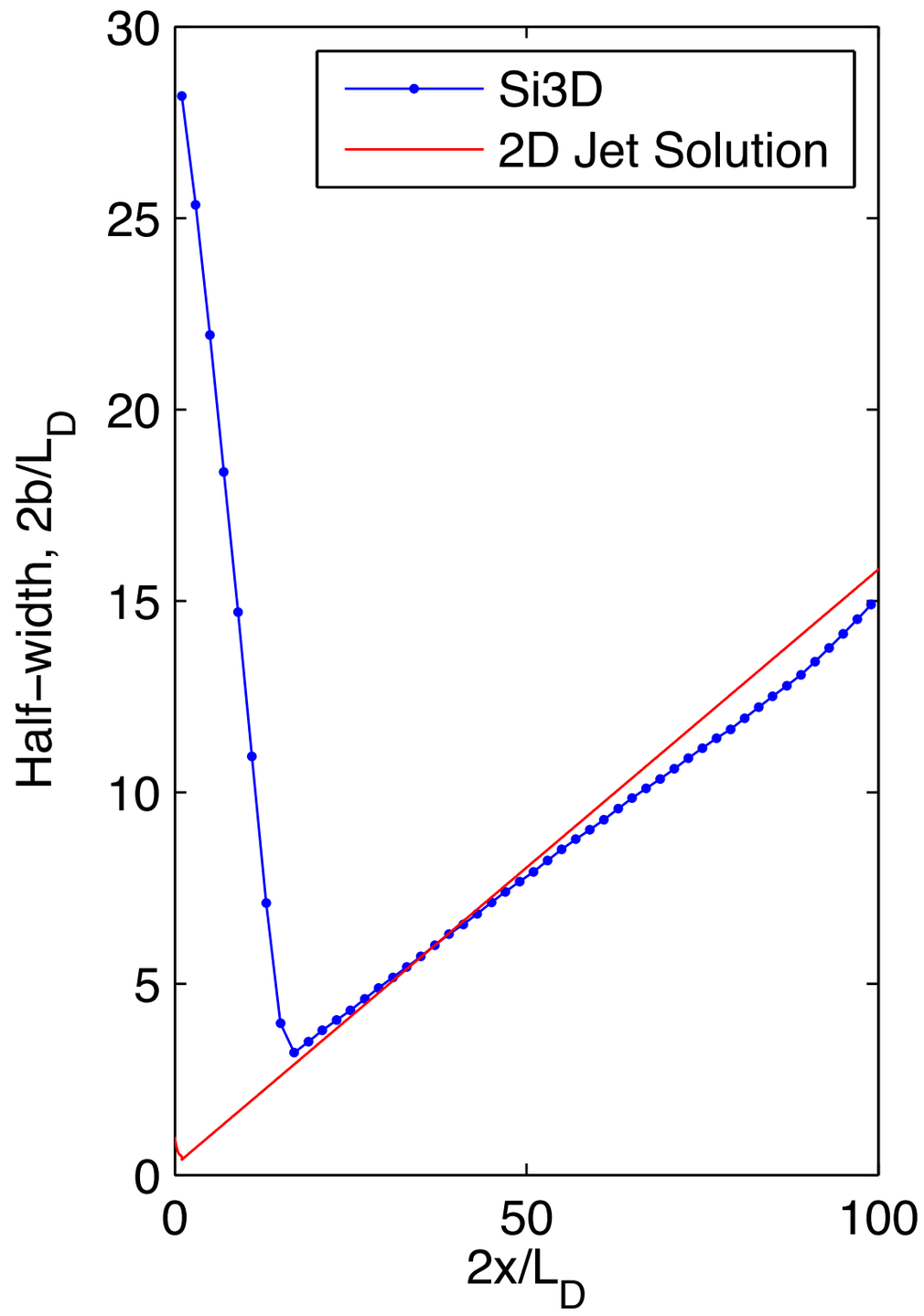
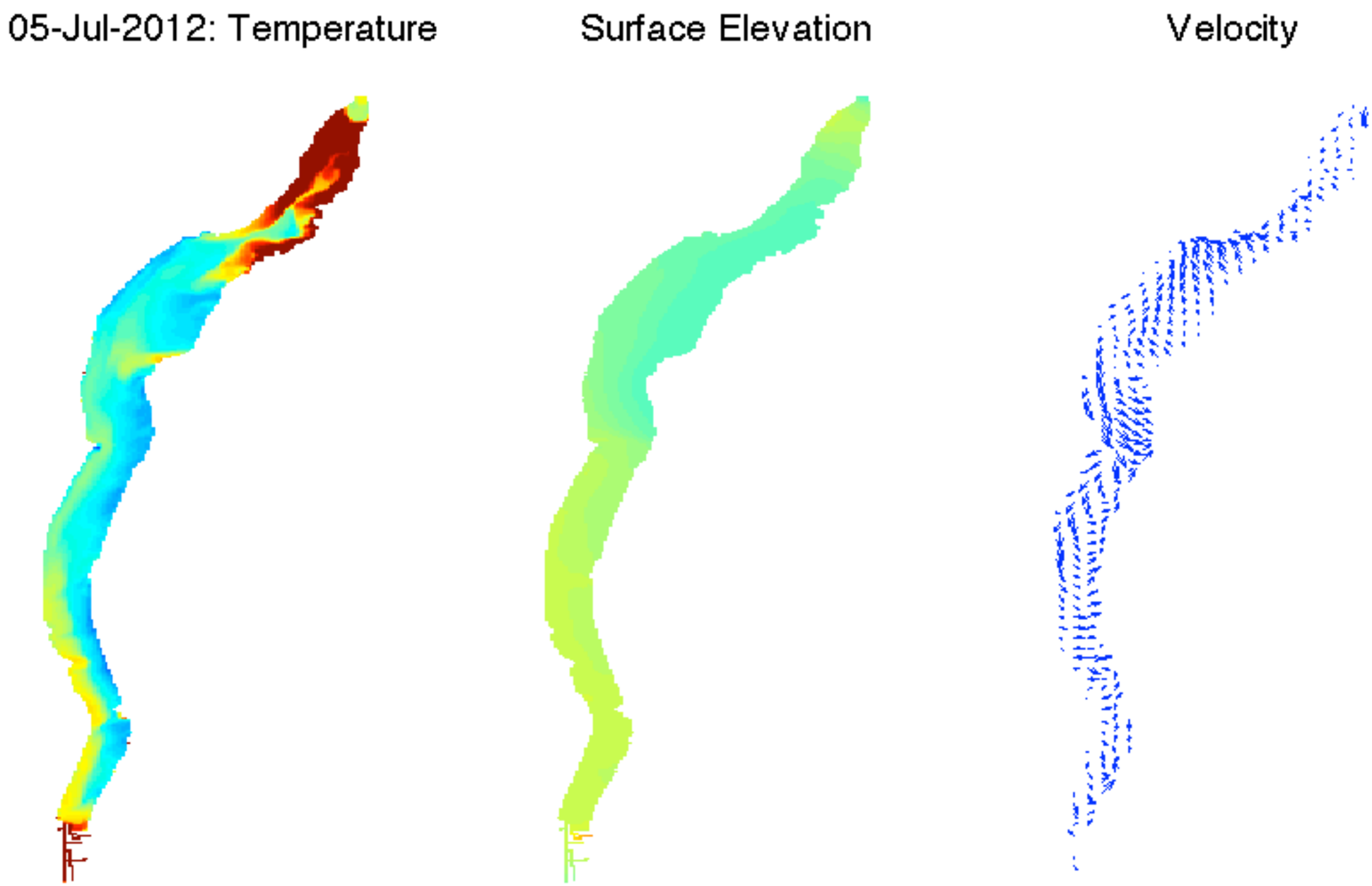


# SI3D: Output



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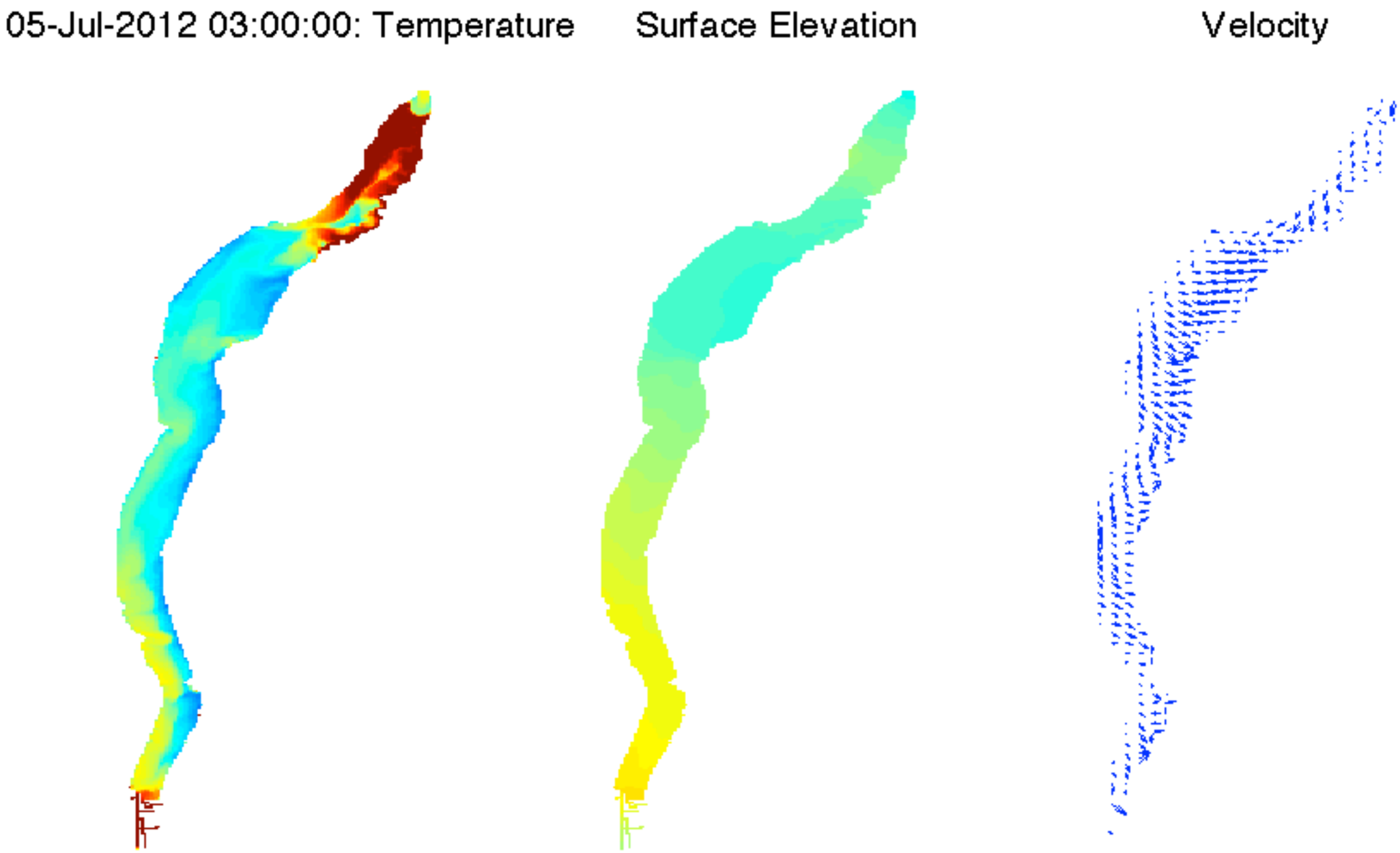
05-Jul-2012 03:00:00: Temperature
Surface Elevation
Velocity

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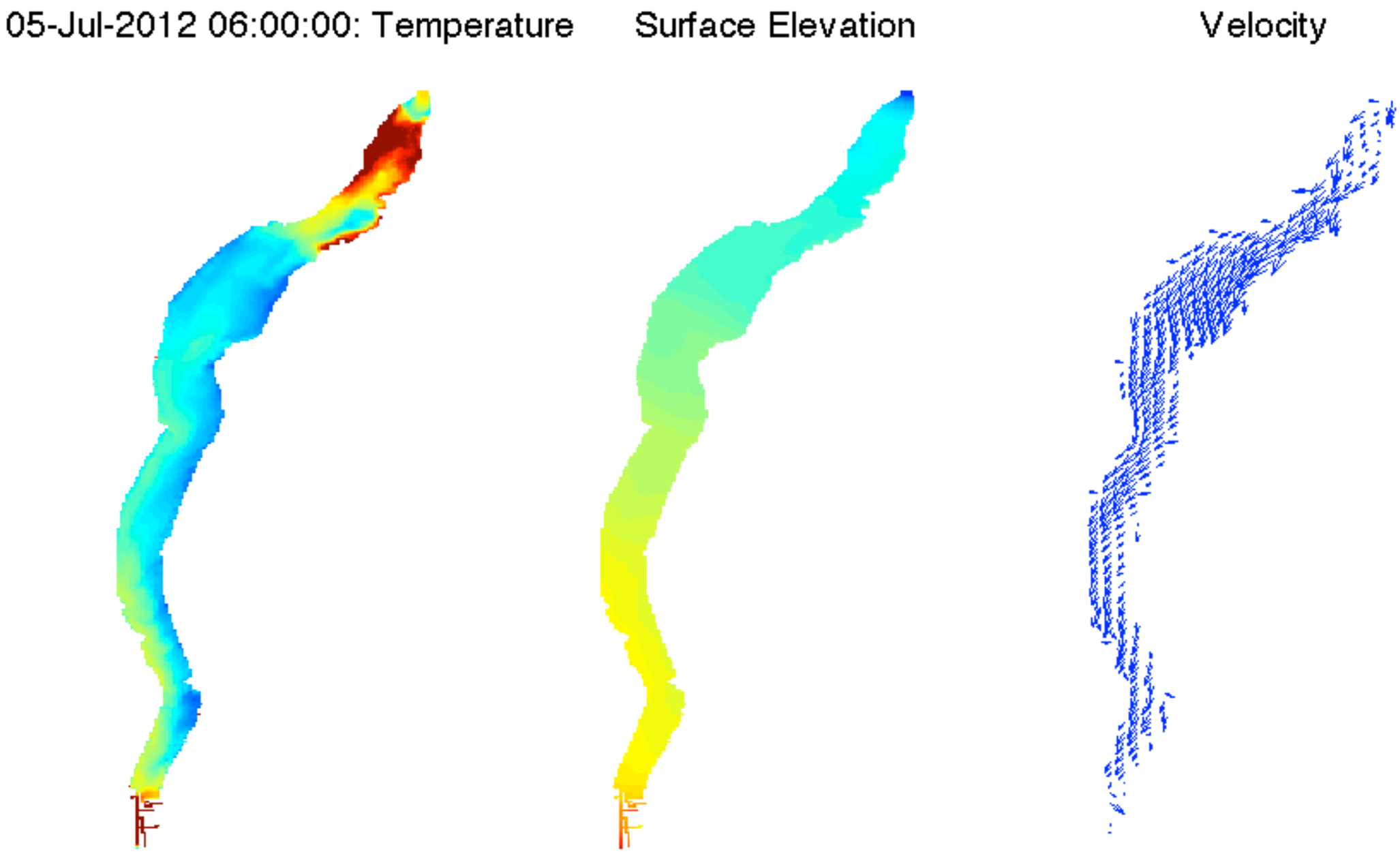
05-Jul-2012 06:00:00: Temperature
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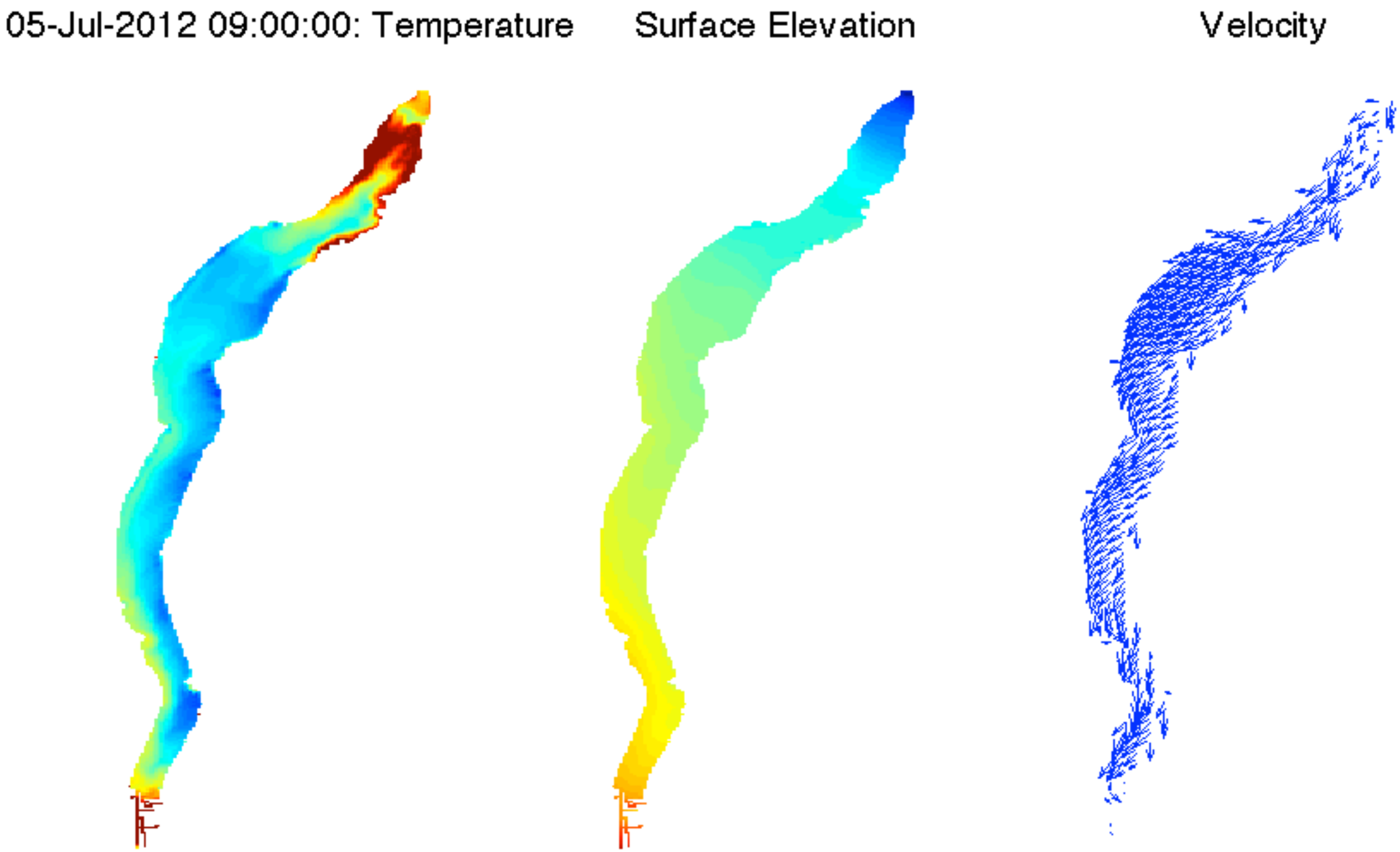
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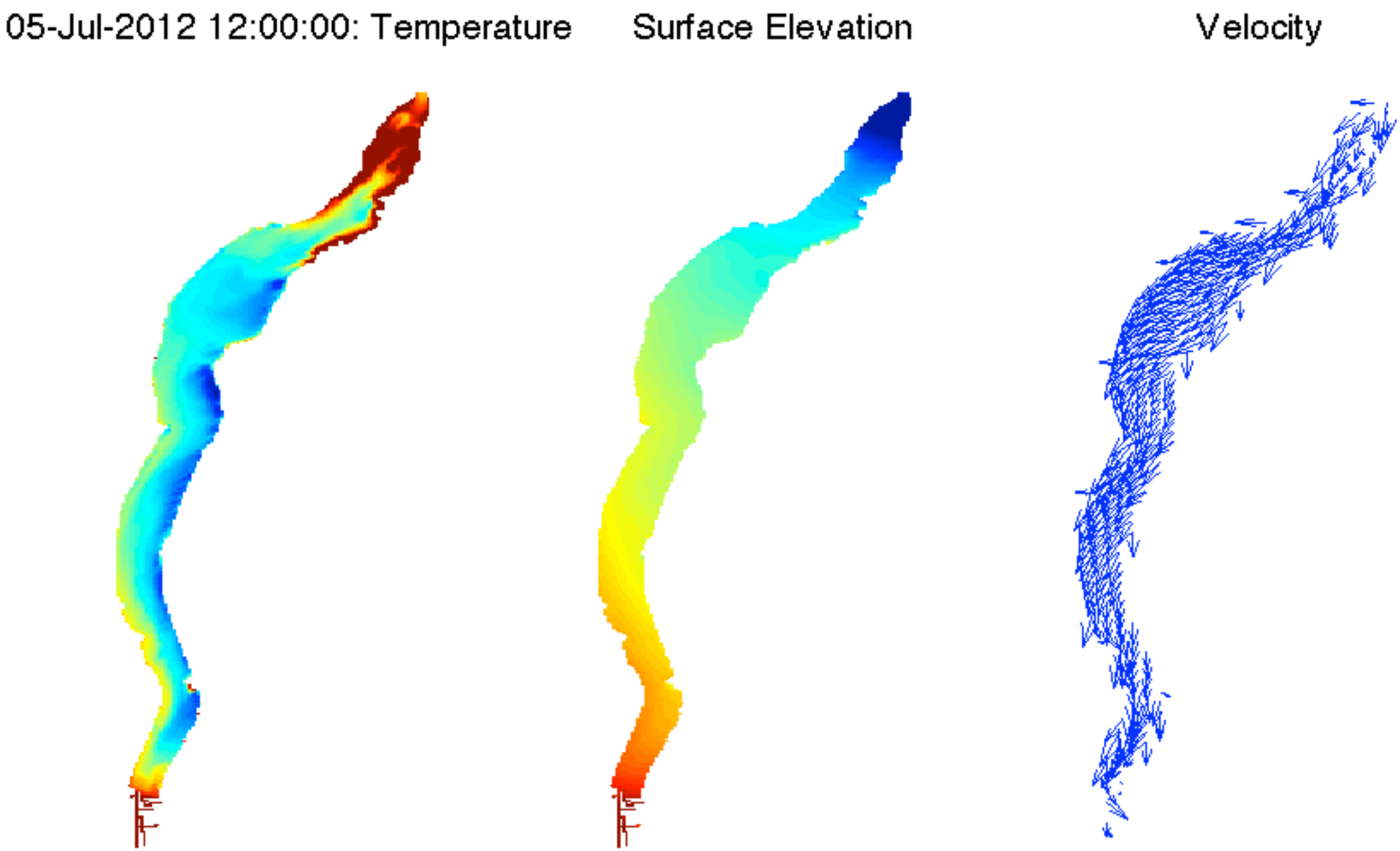
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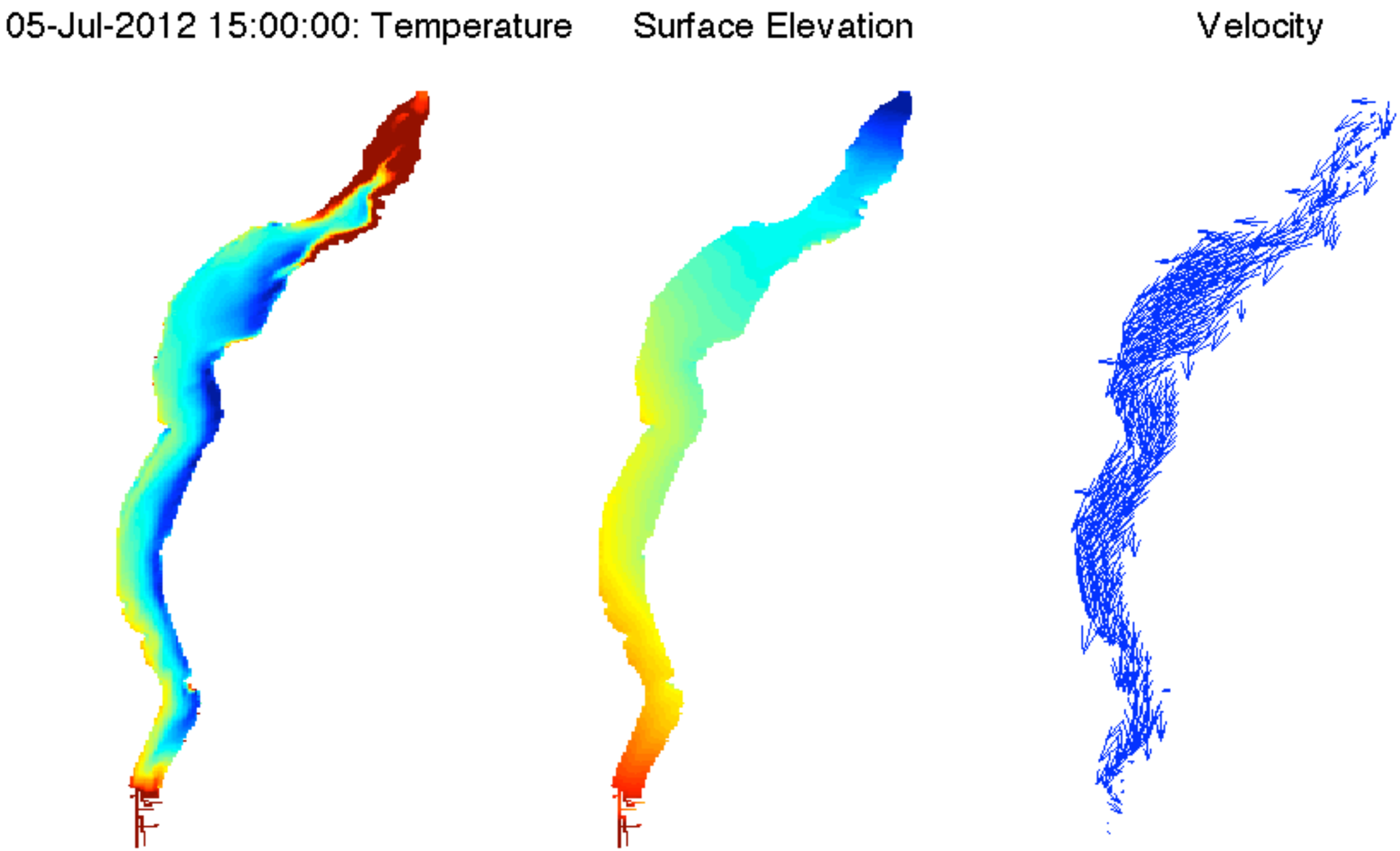
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Surface Elevation
Velocity

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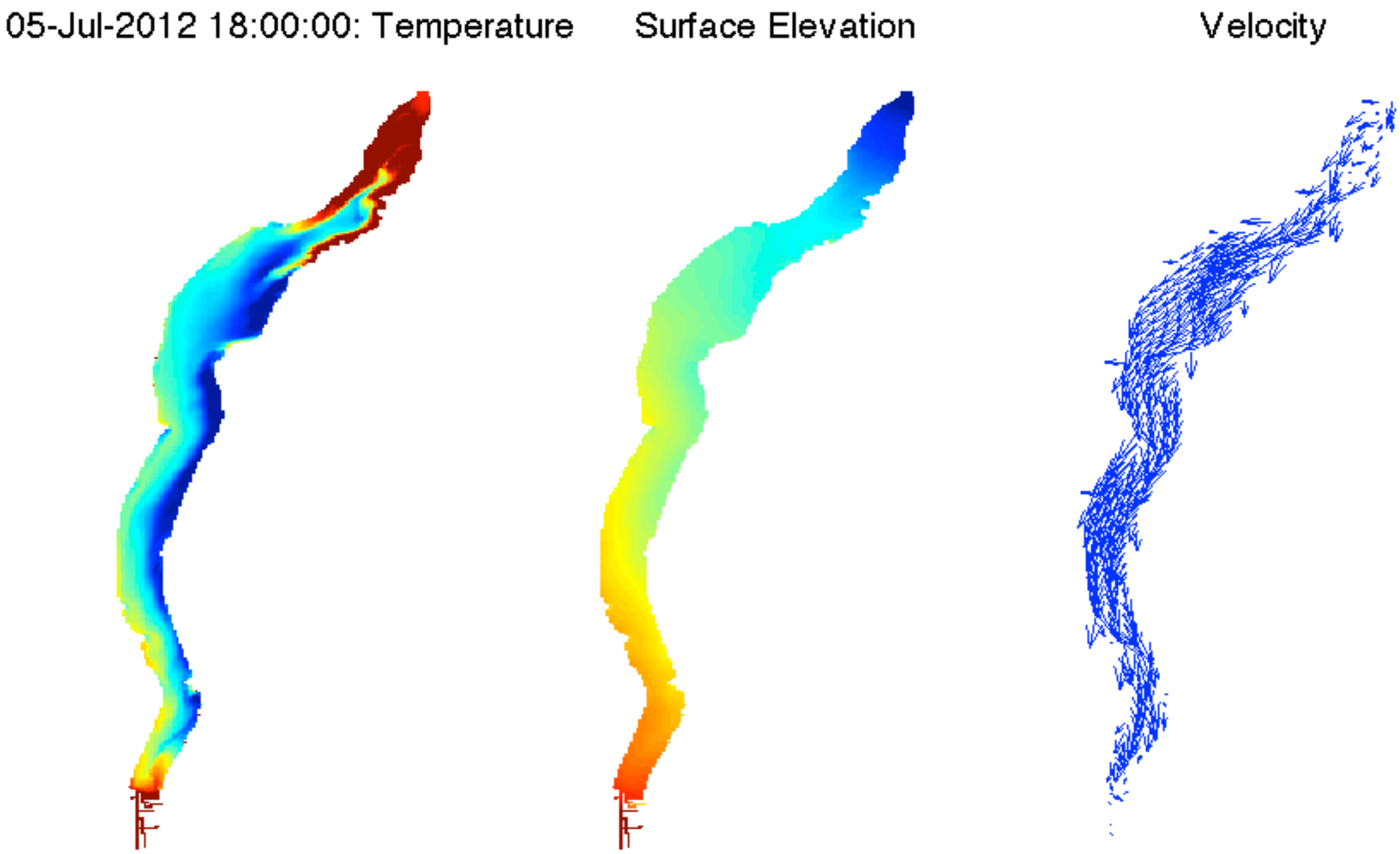
05-Jul-2012 18:00:00: Temperature
Surface Elevation
Velocity

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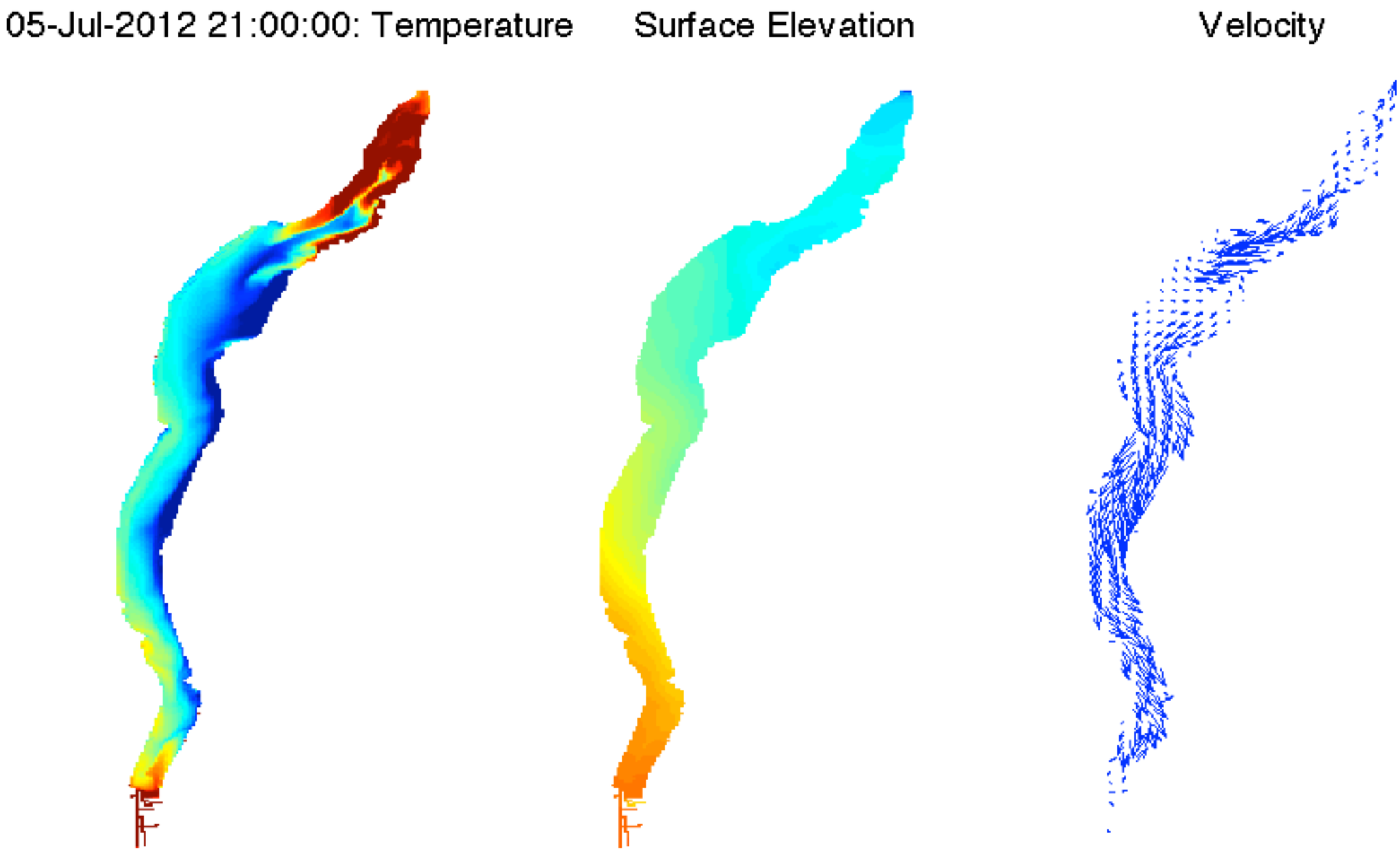
05-Jul-2012 21:00:00: Temperature
Surface Elevation
Velocity

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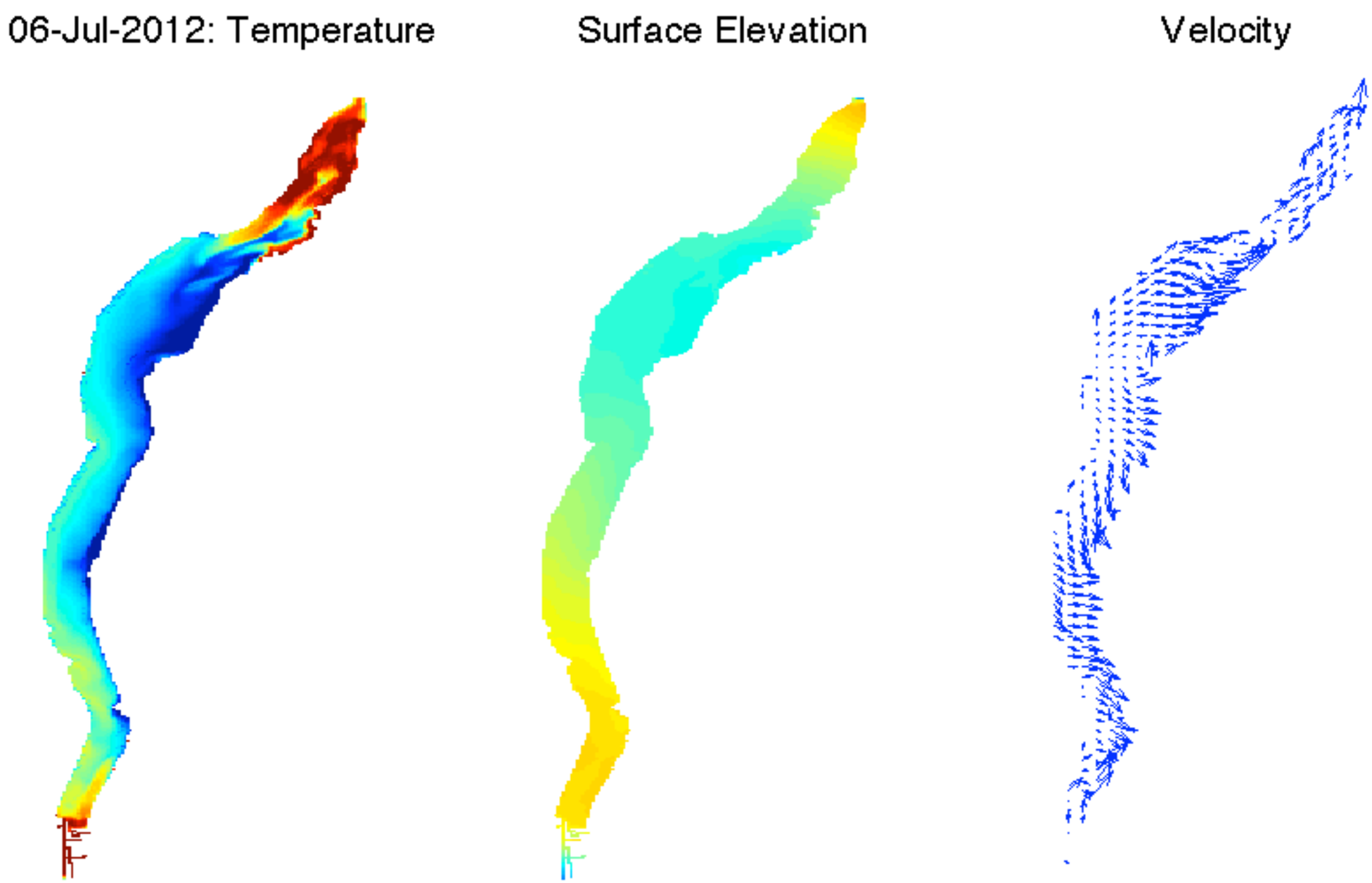

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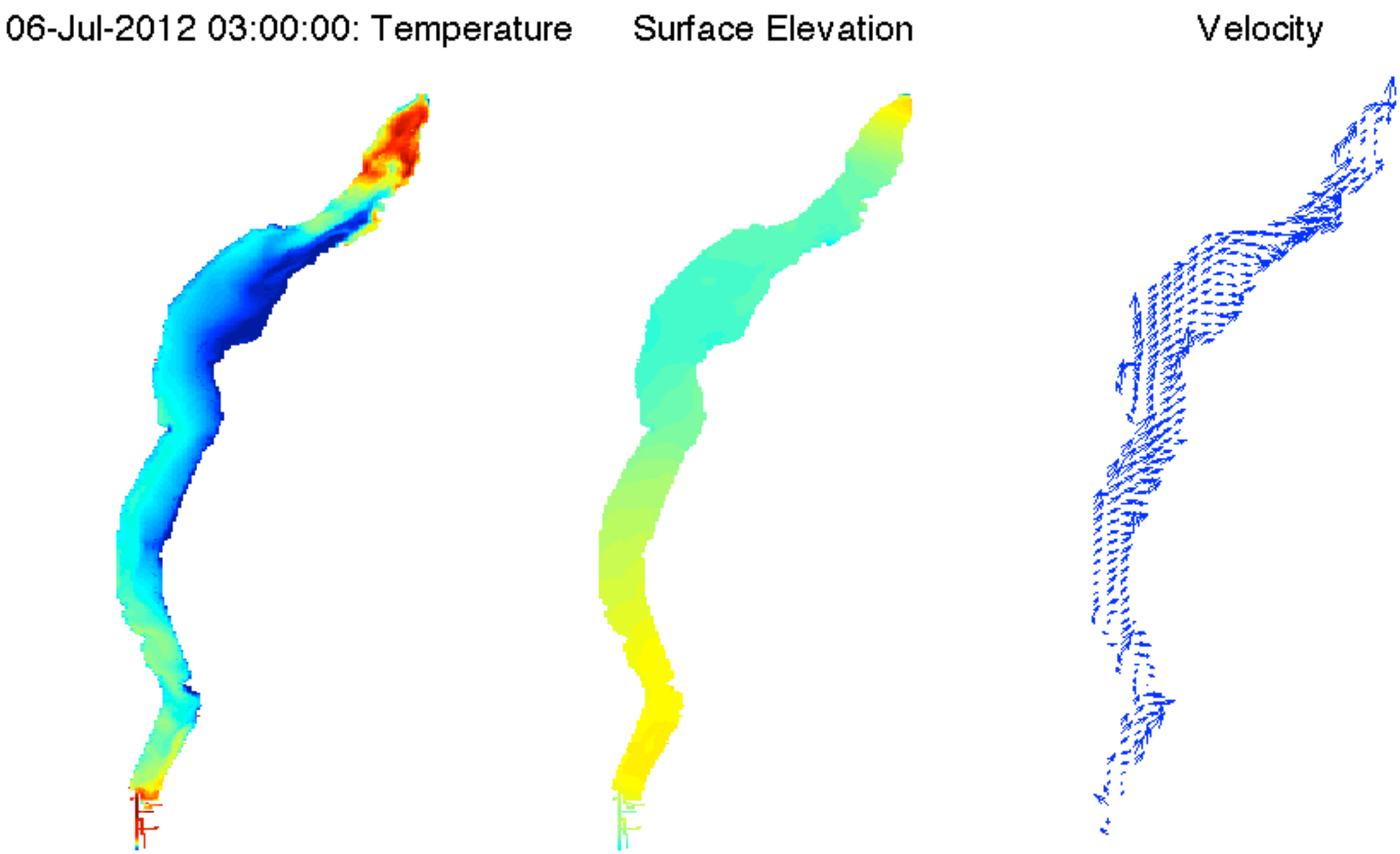
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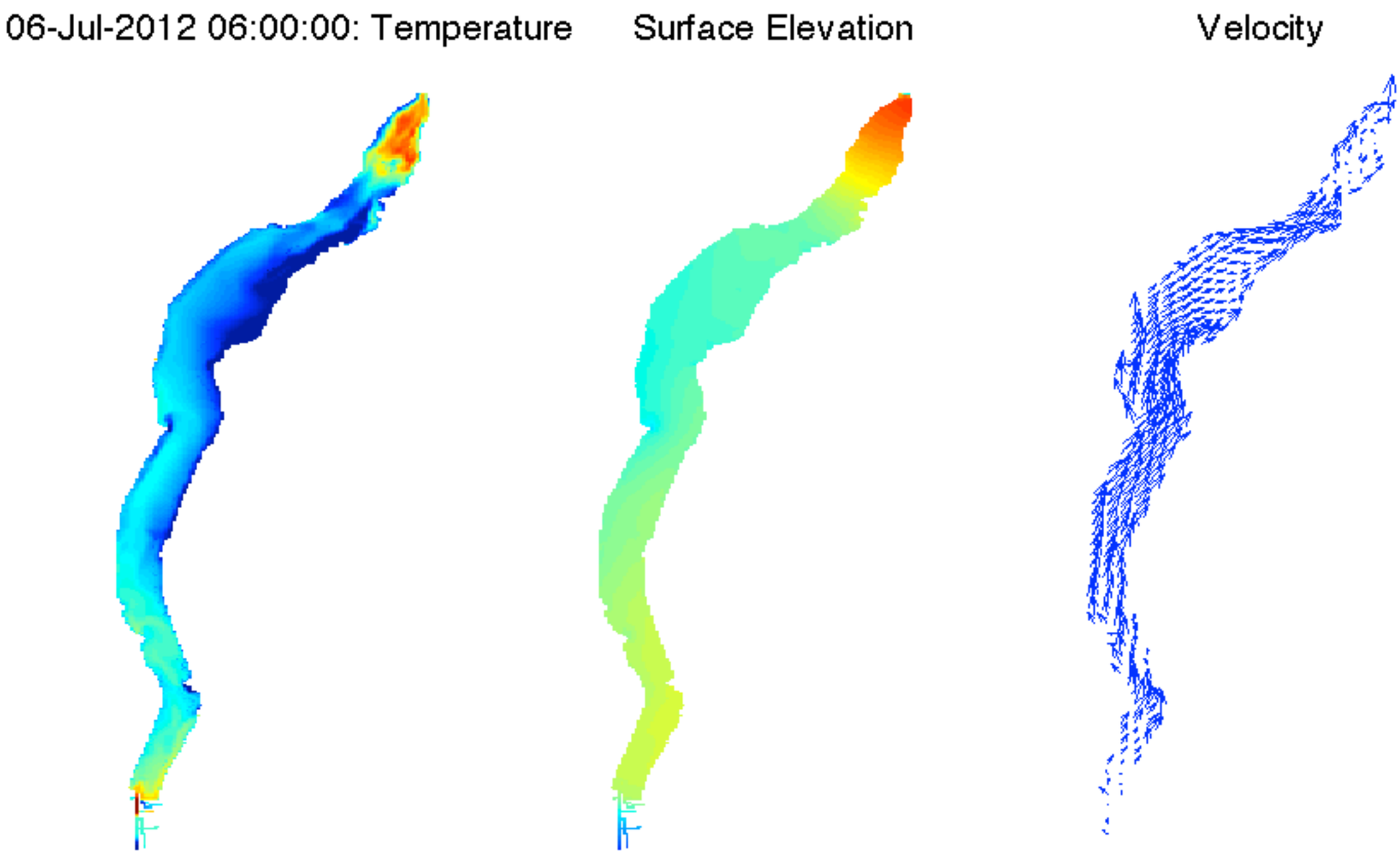
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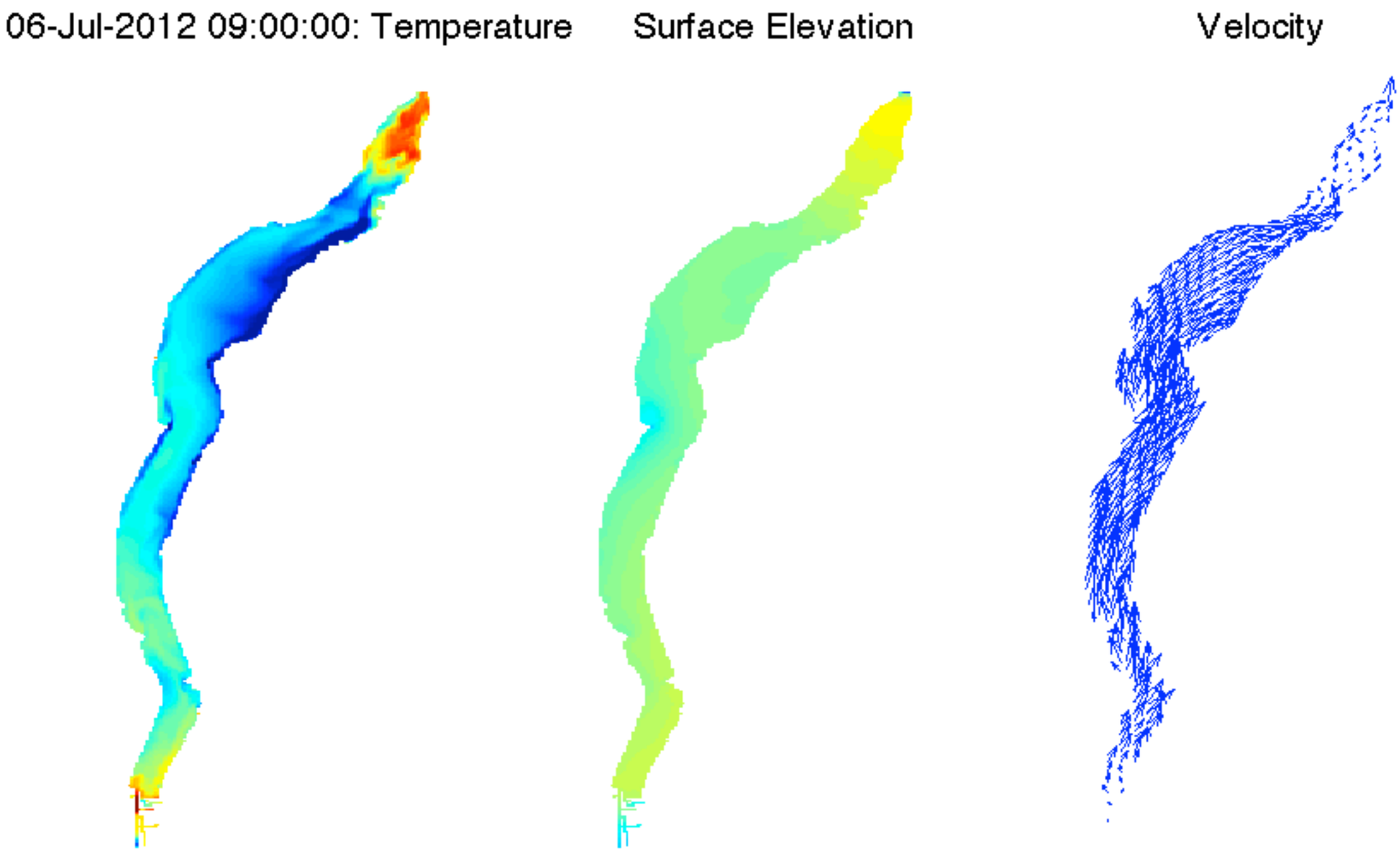
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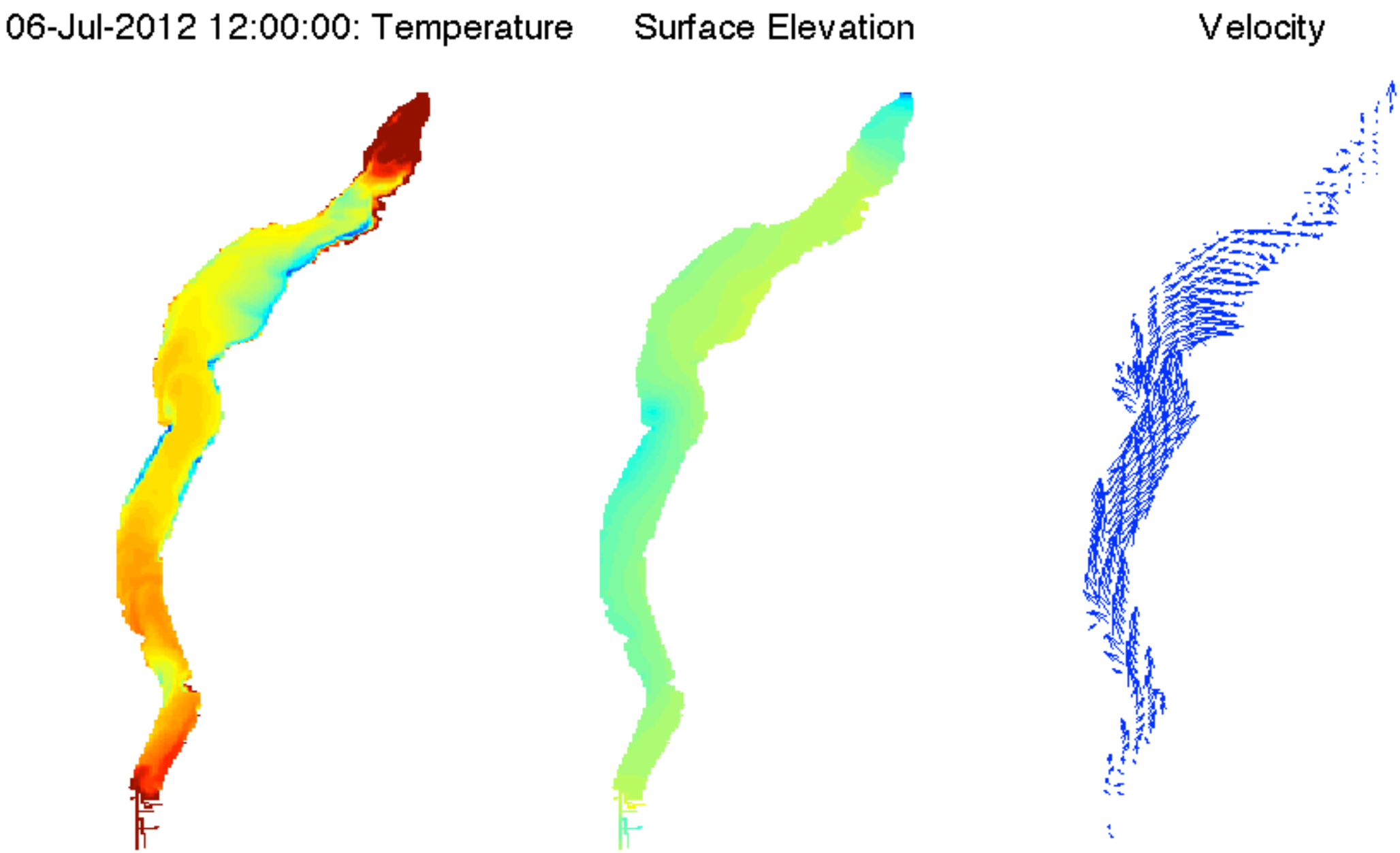
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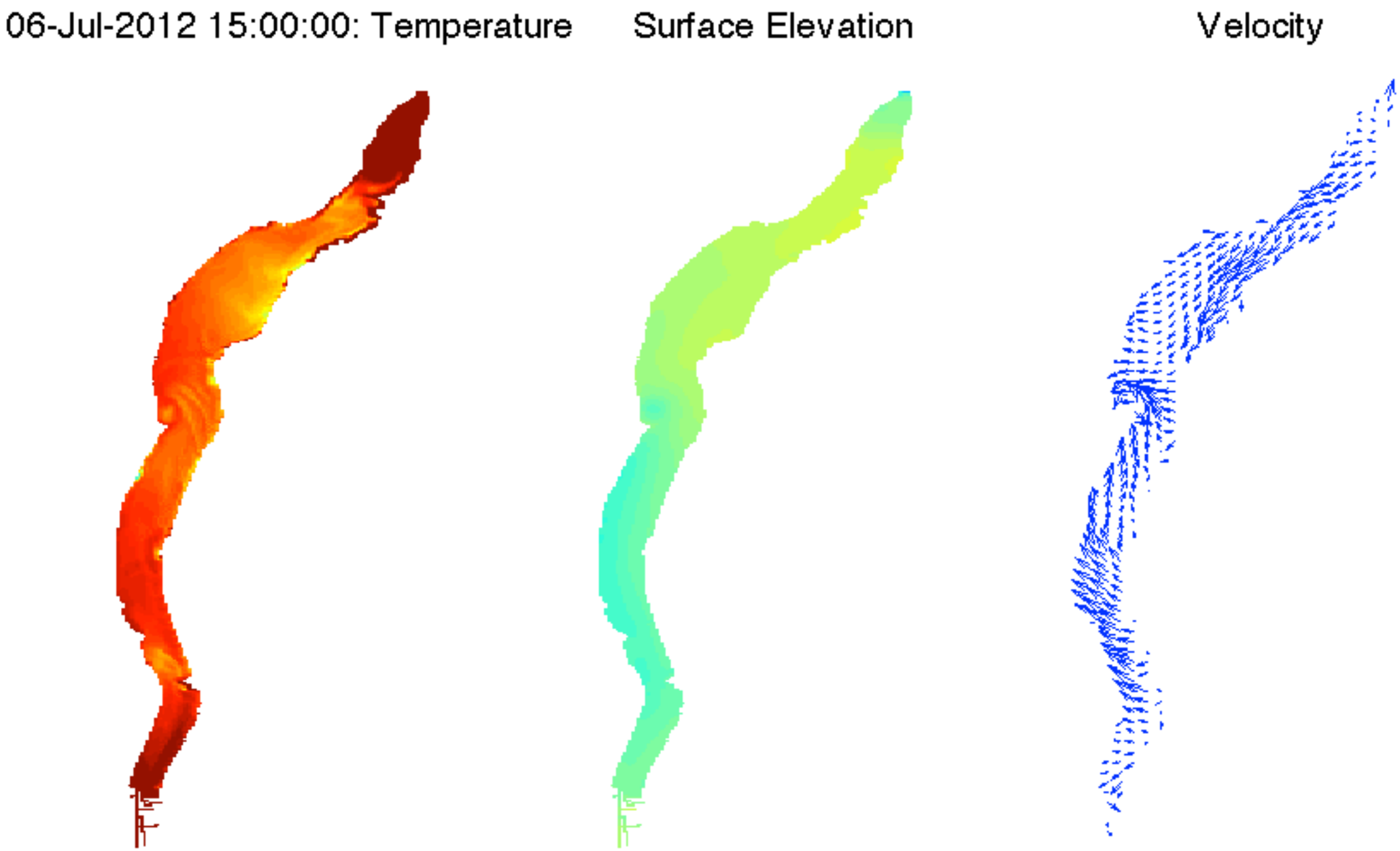
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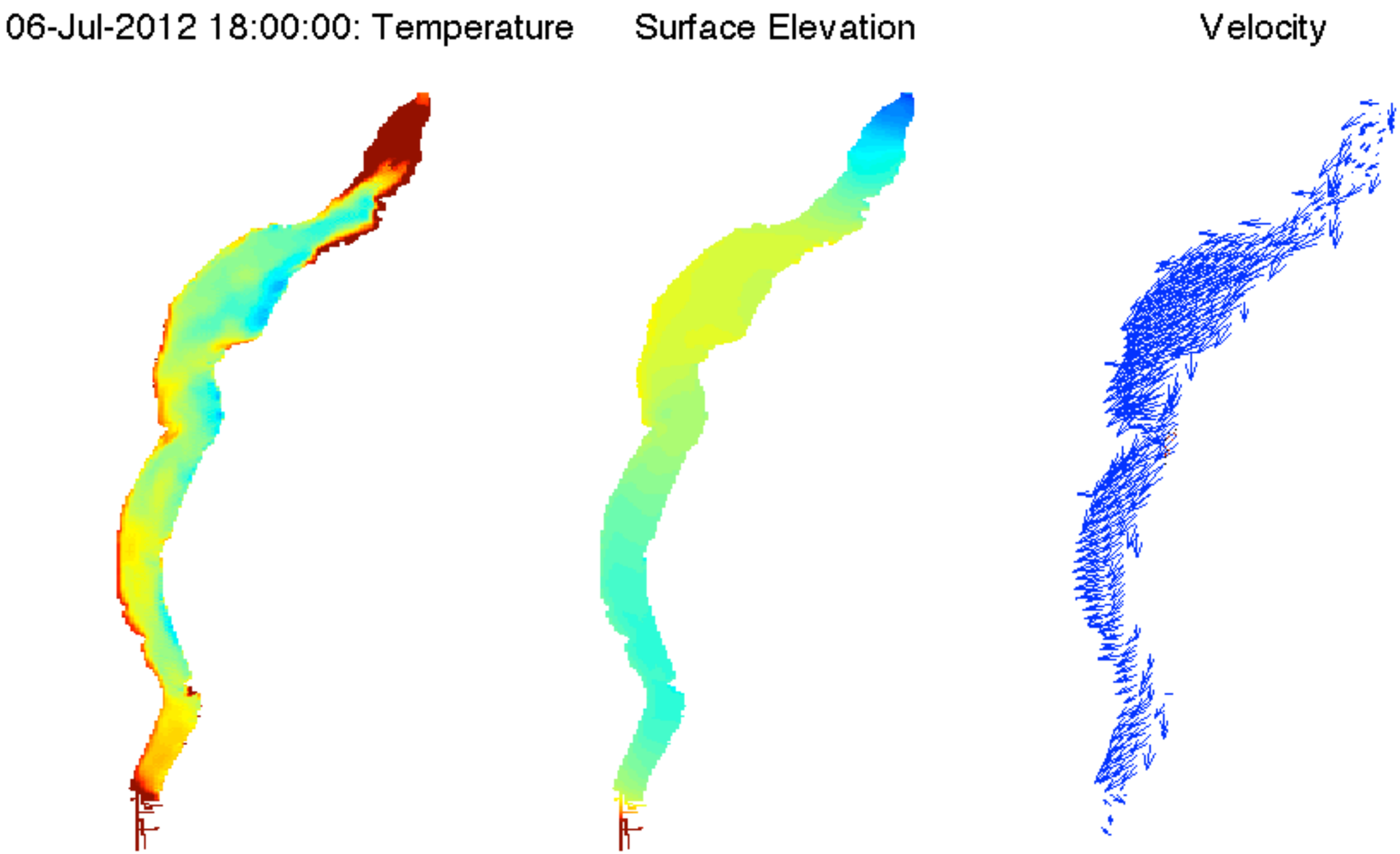
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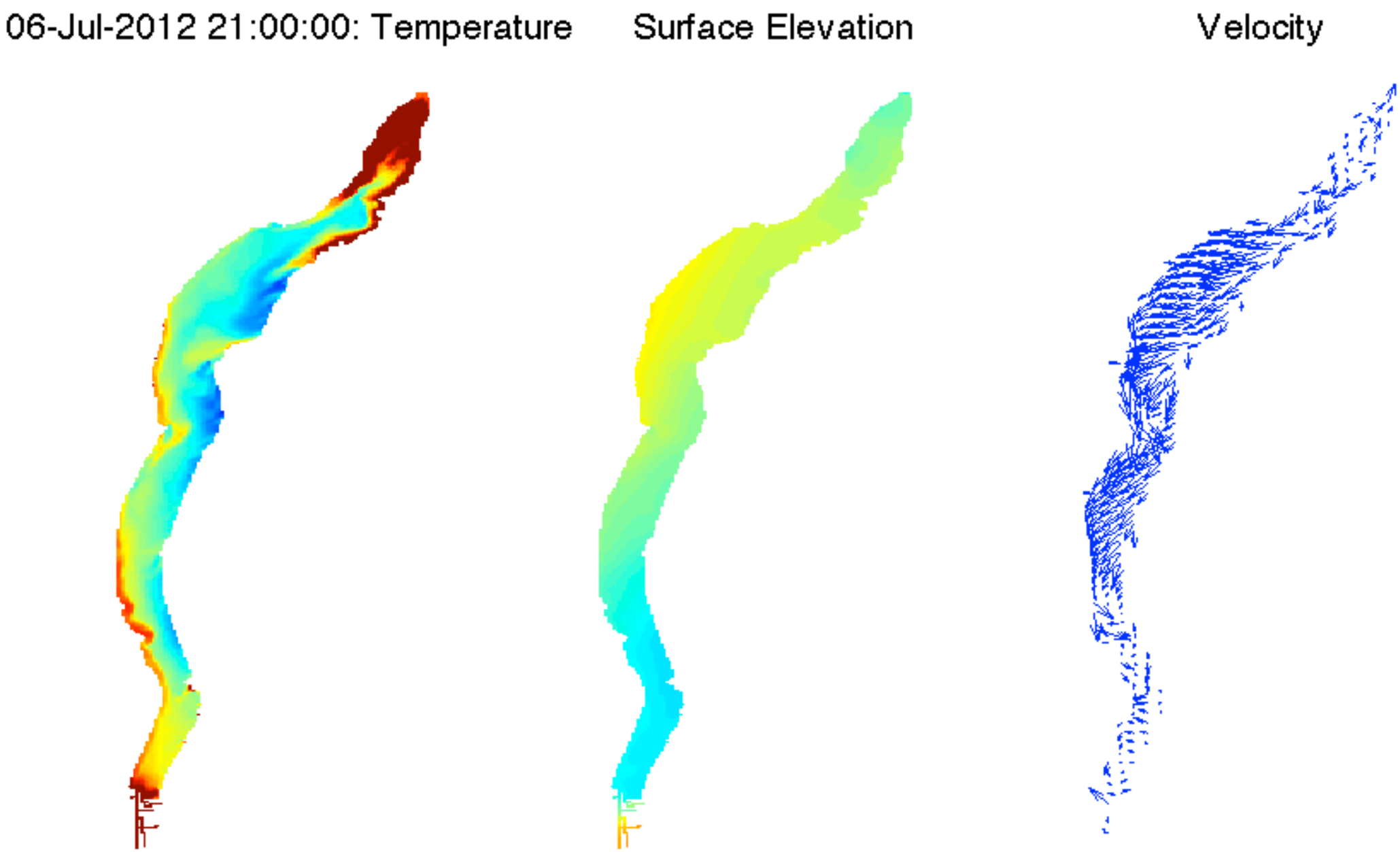
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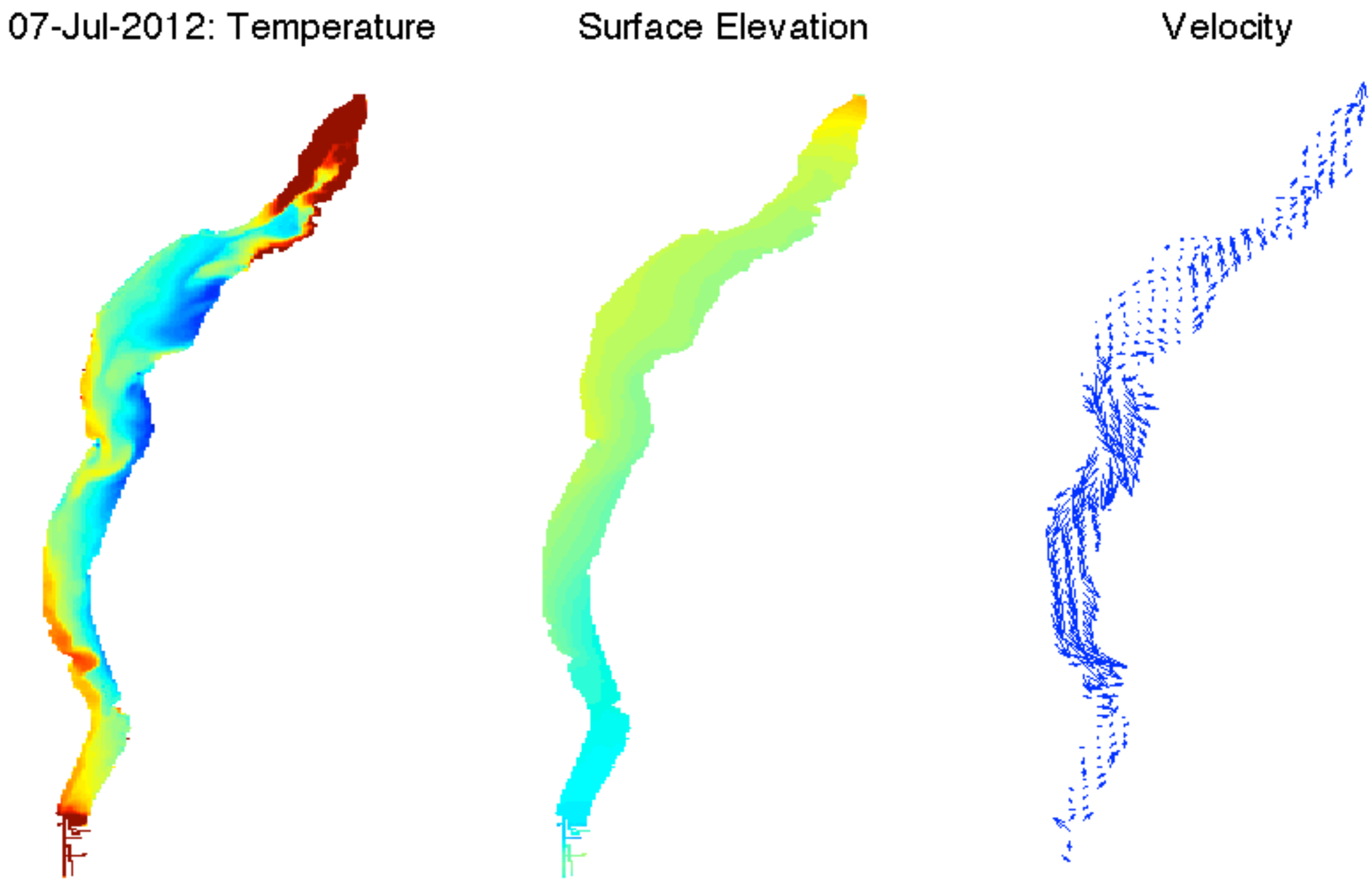

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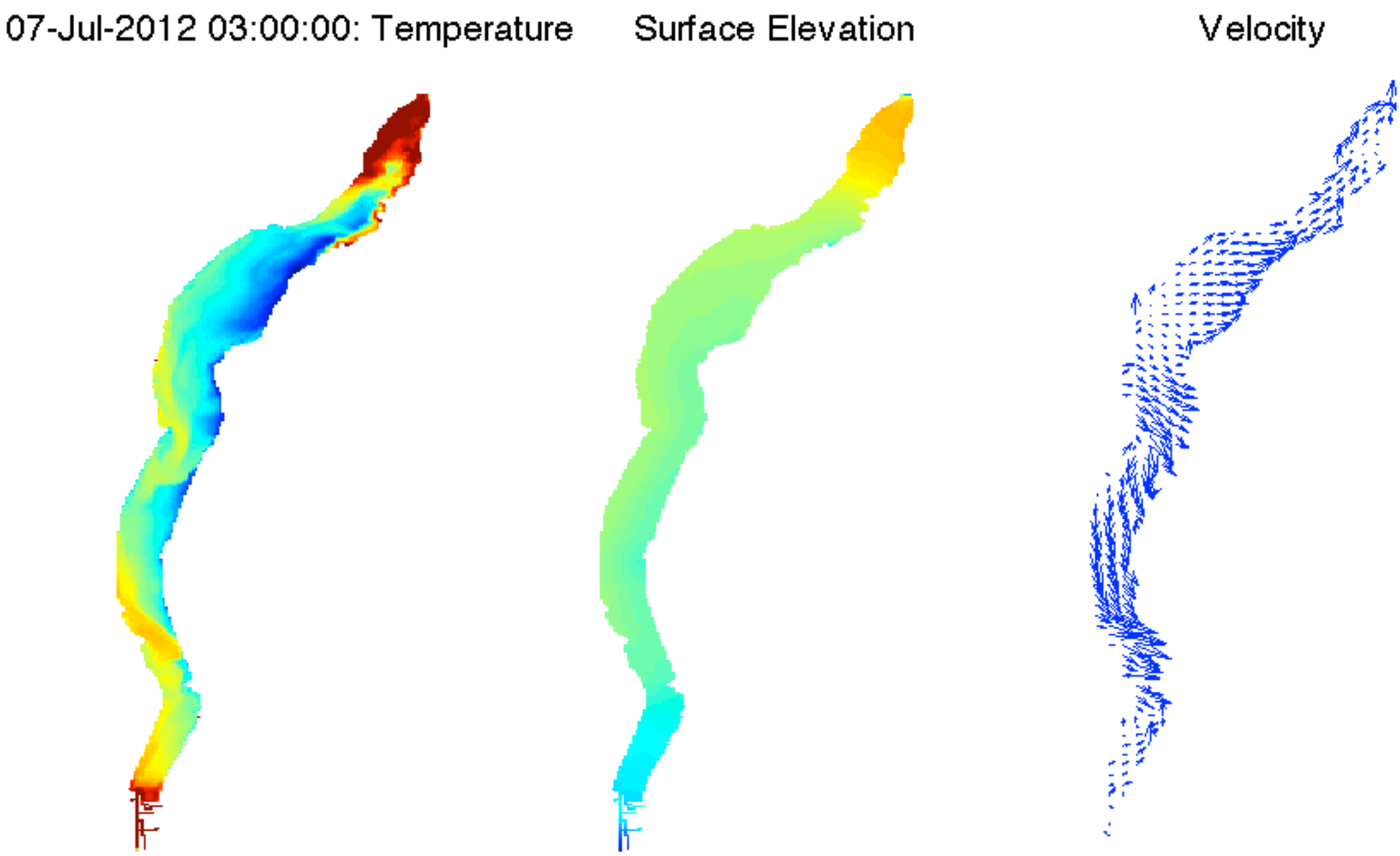
07-Jul-2012 03:00:00: Temperature
Surface Elevation
Velocity

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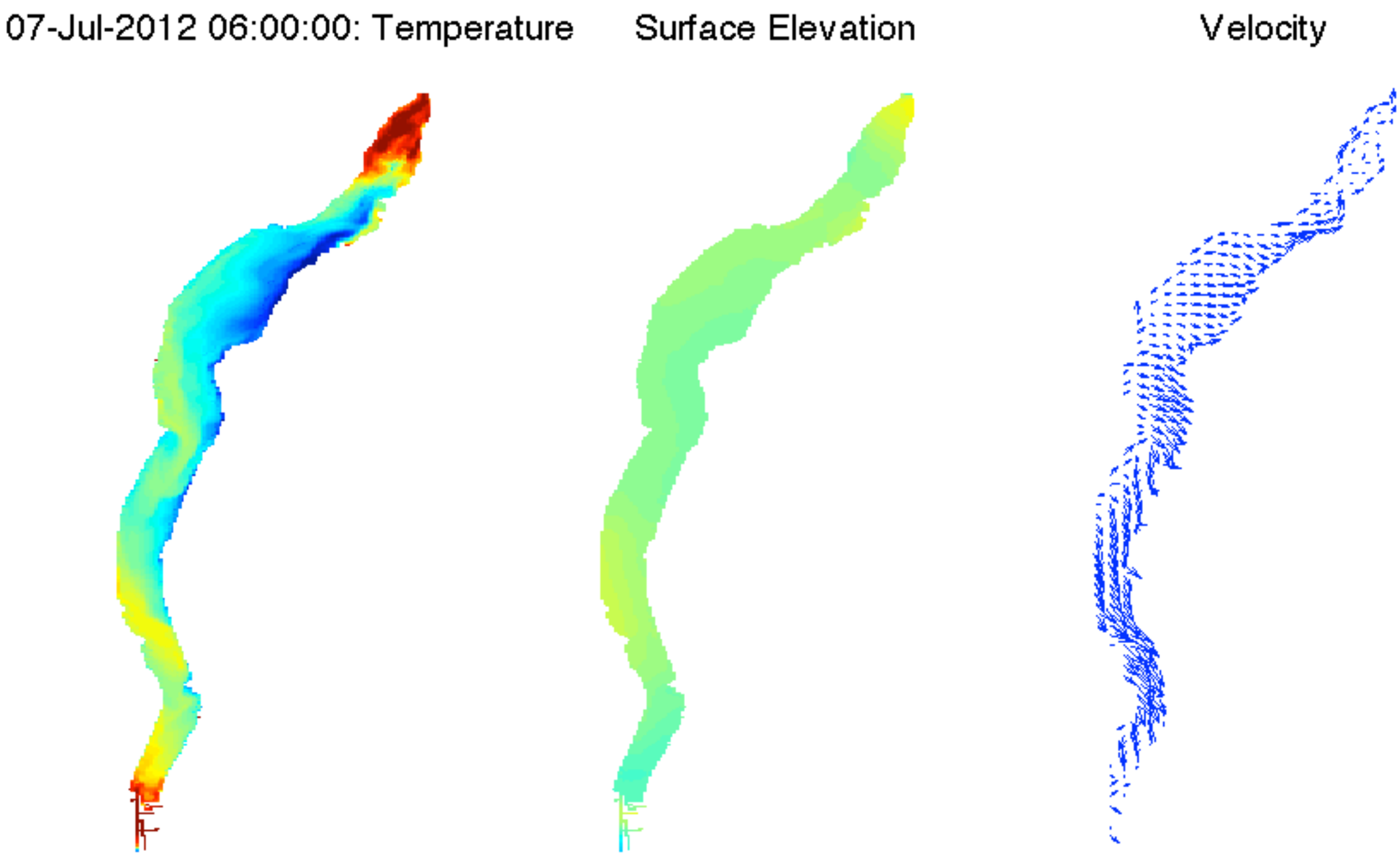
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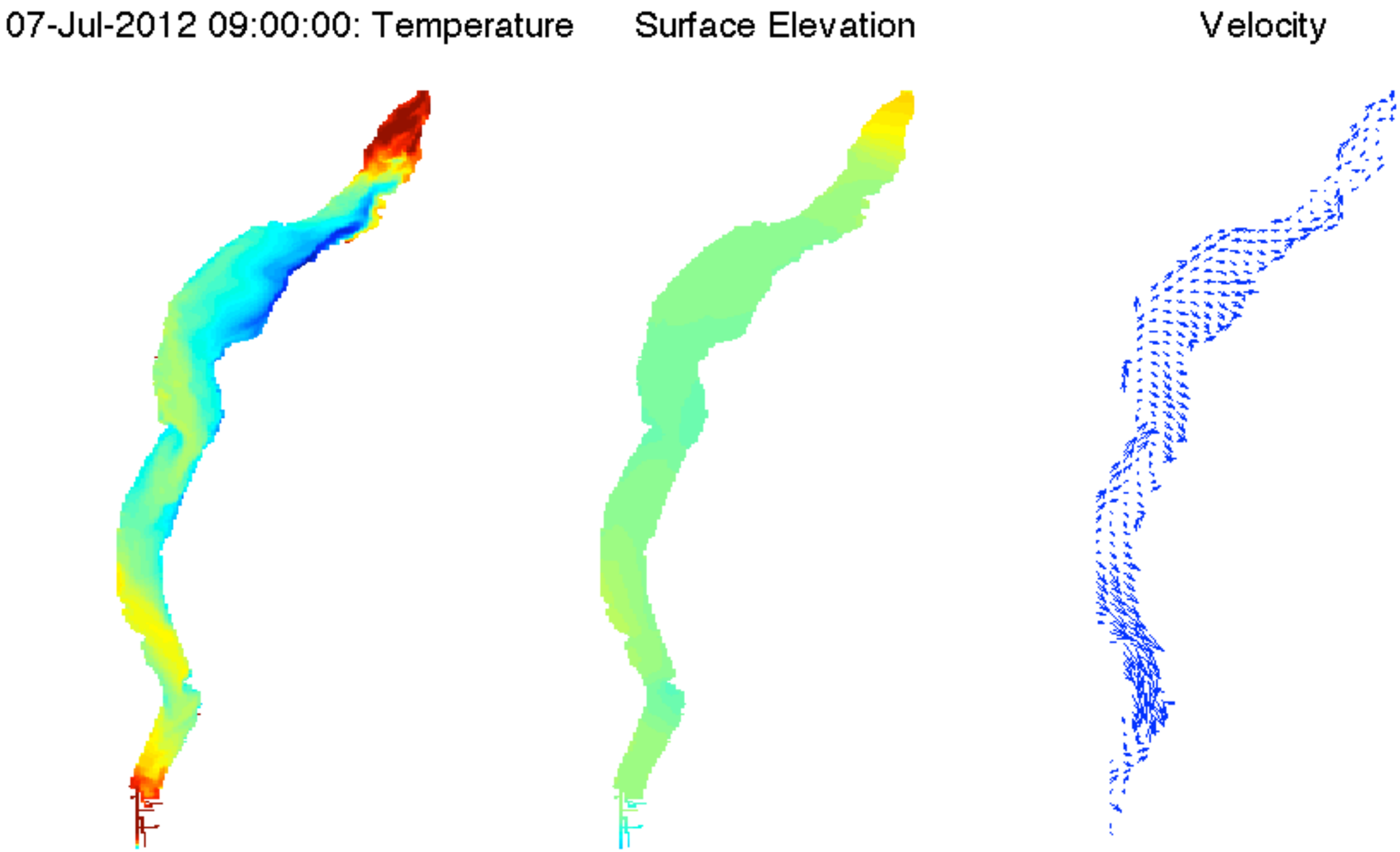
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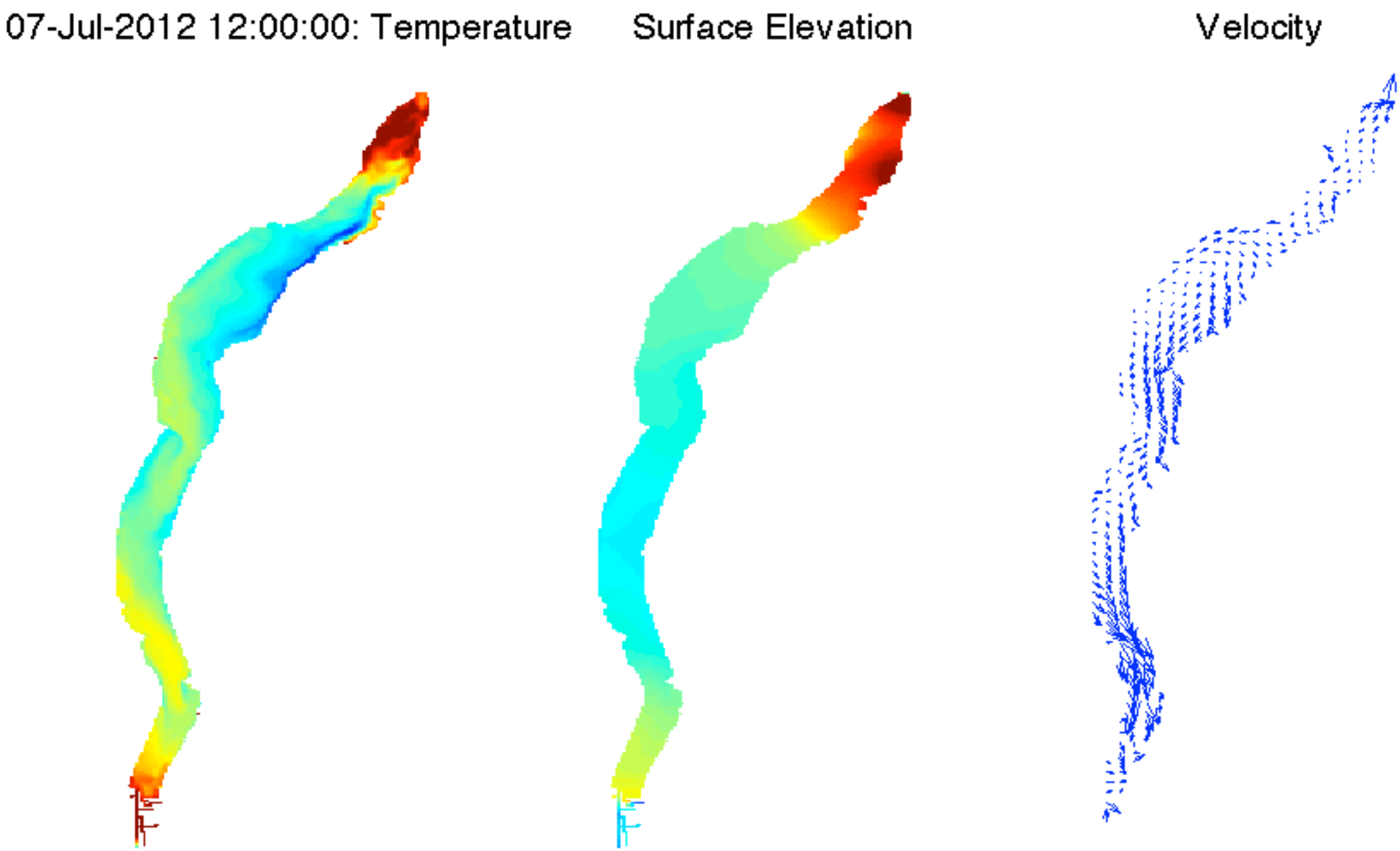
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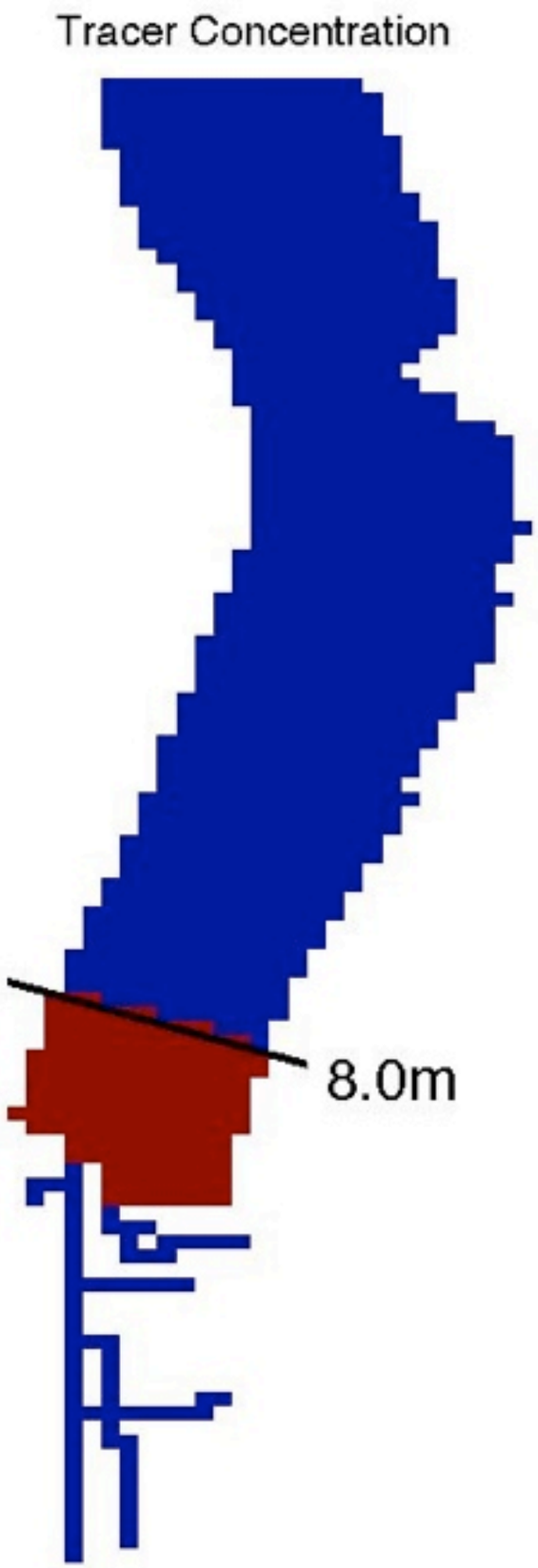
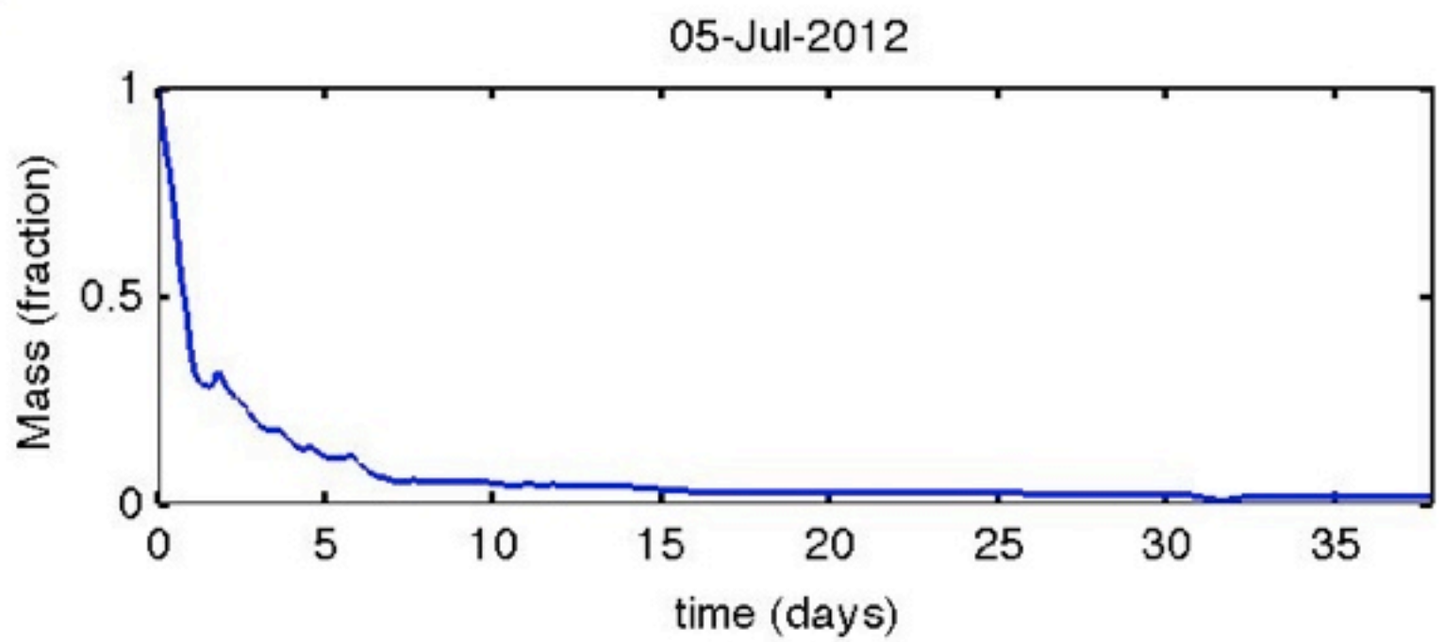
# SI3D: Flushing Time Experiments



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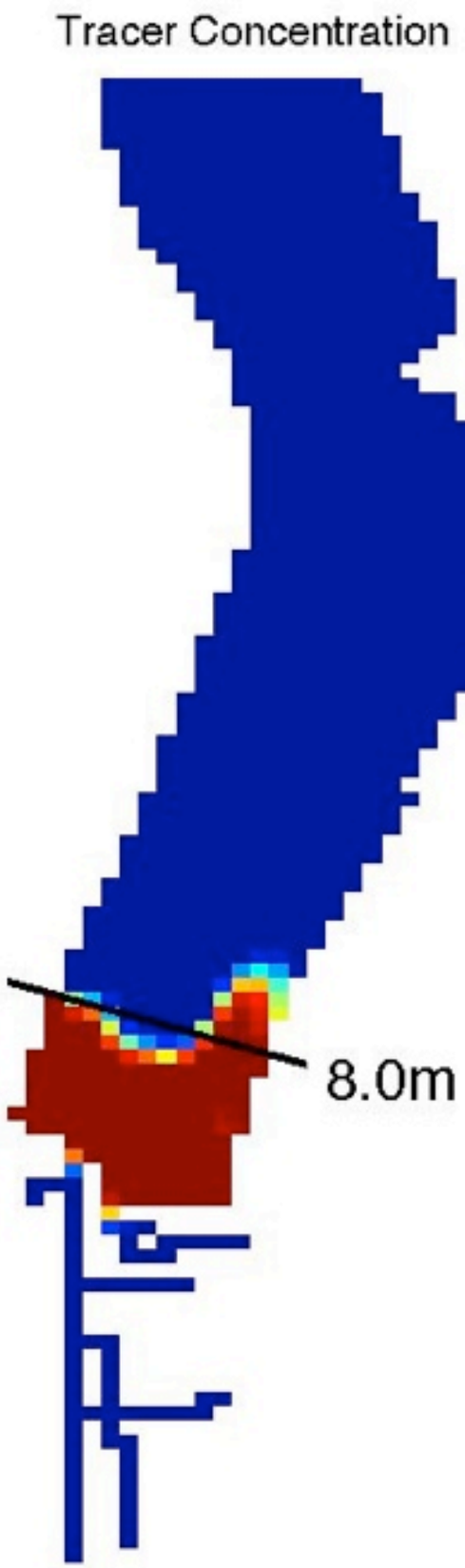


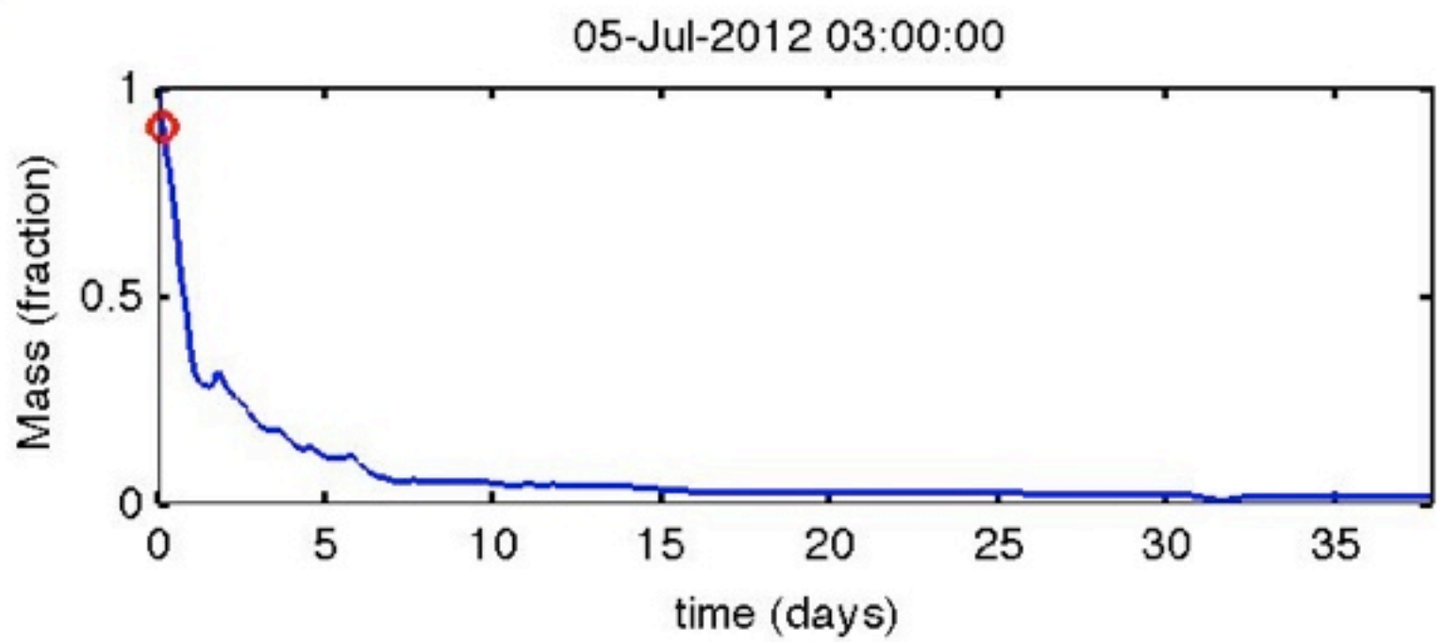

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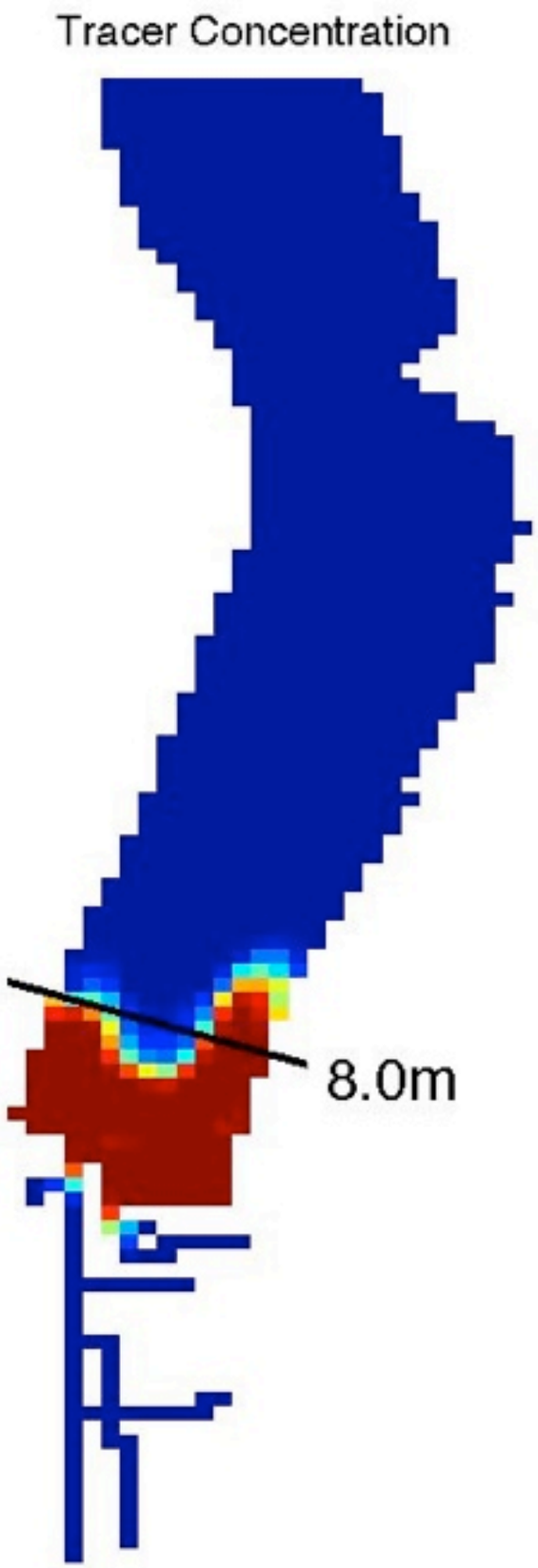


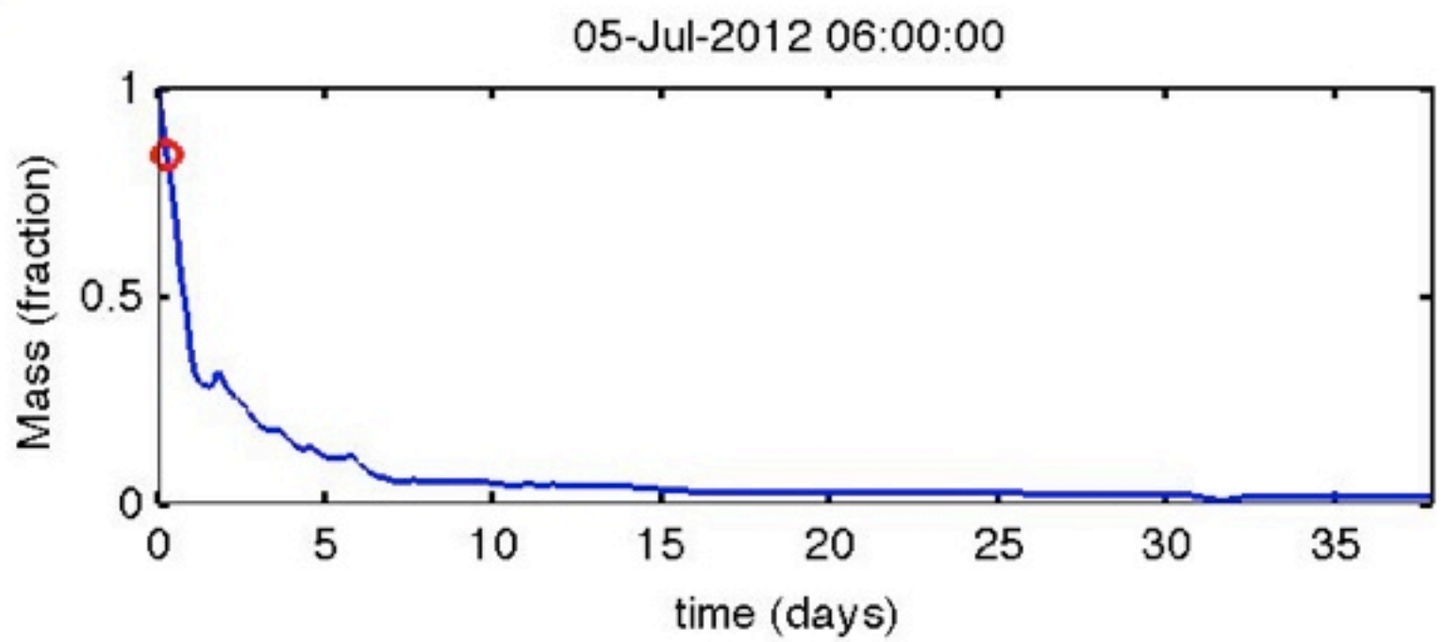

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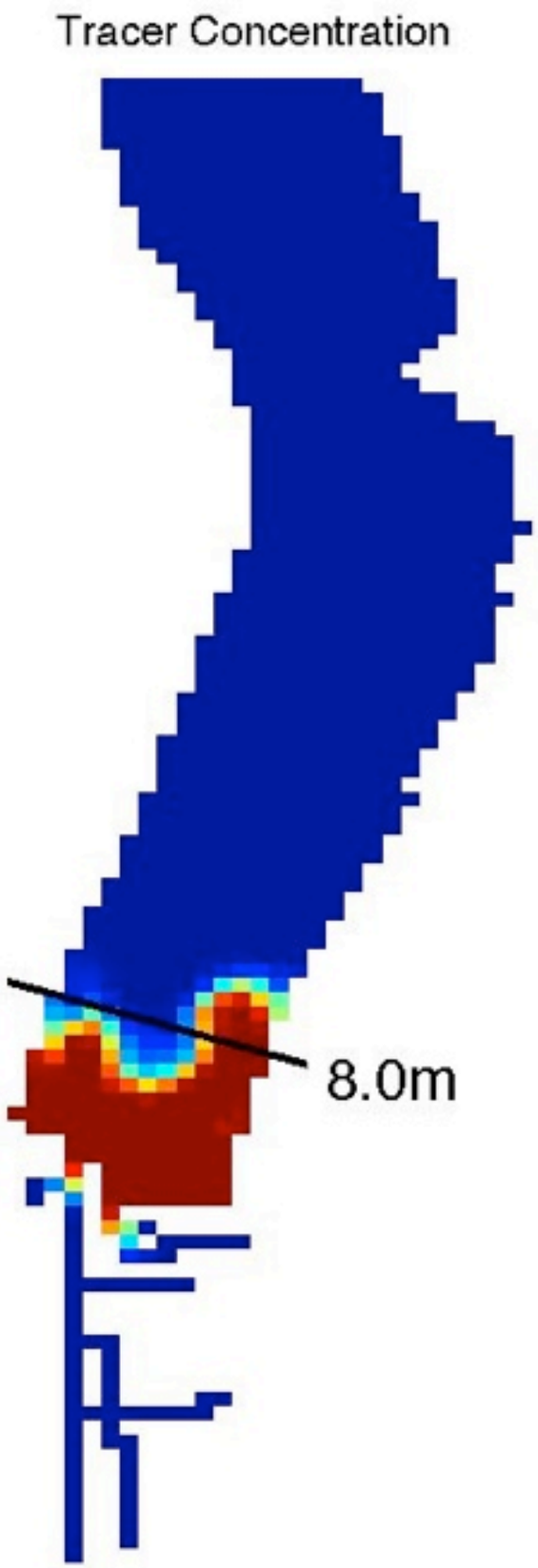


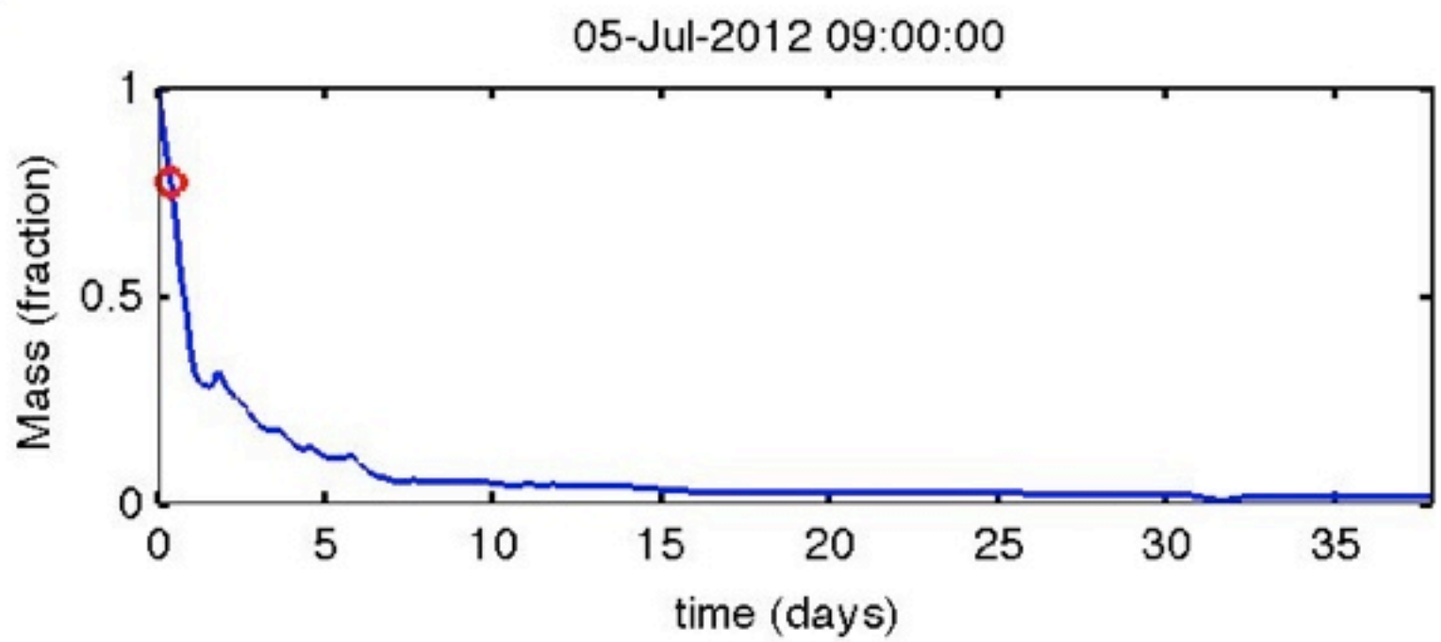

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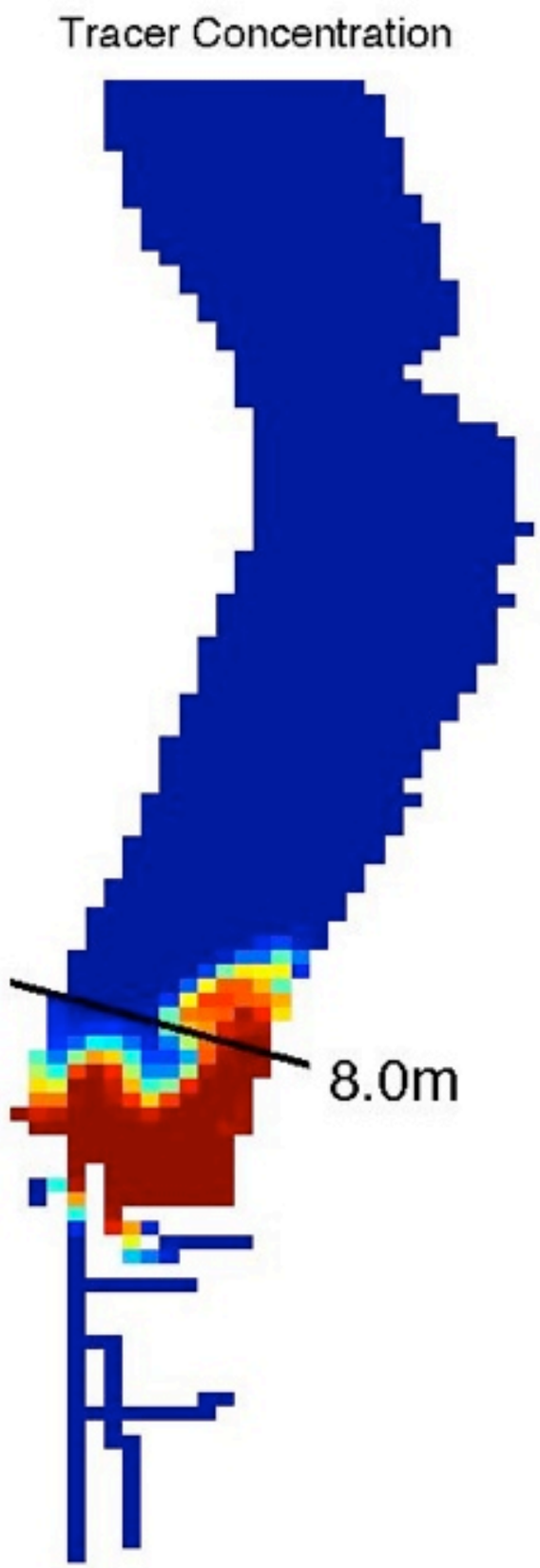


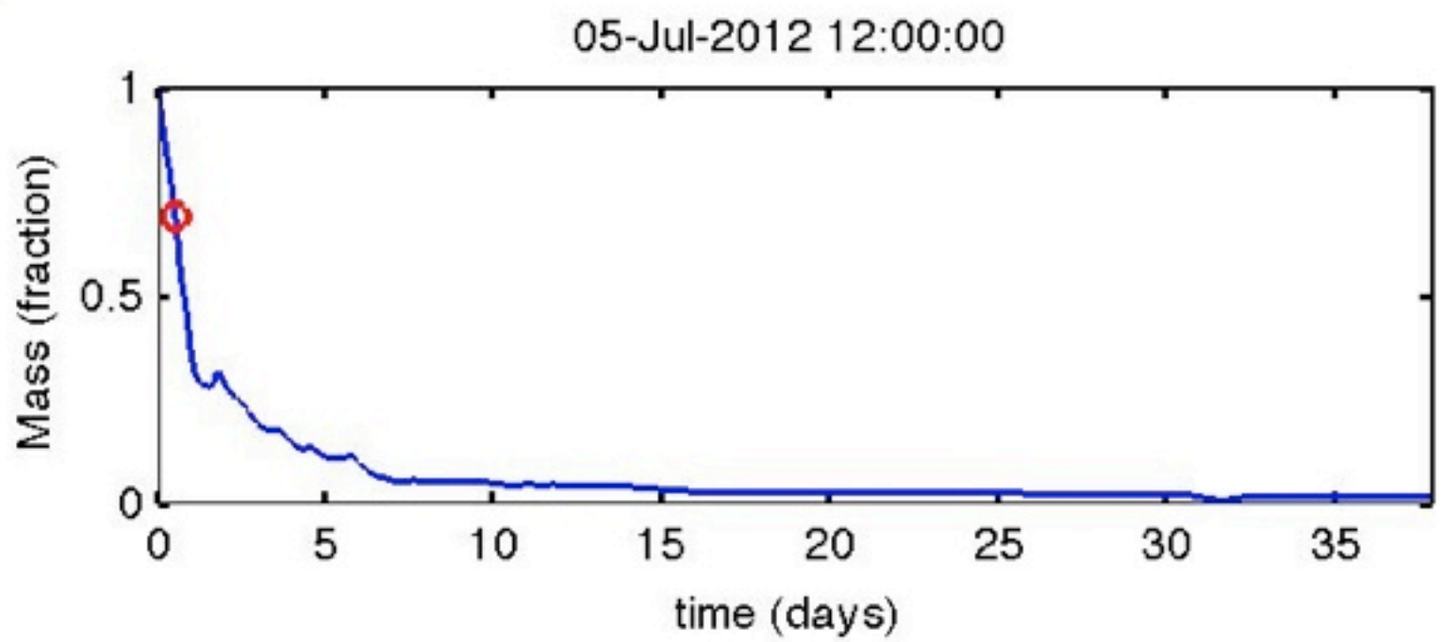

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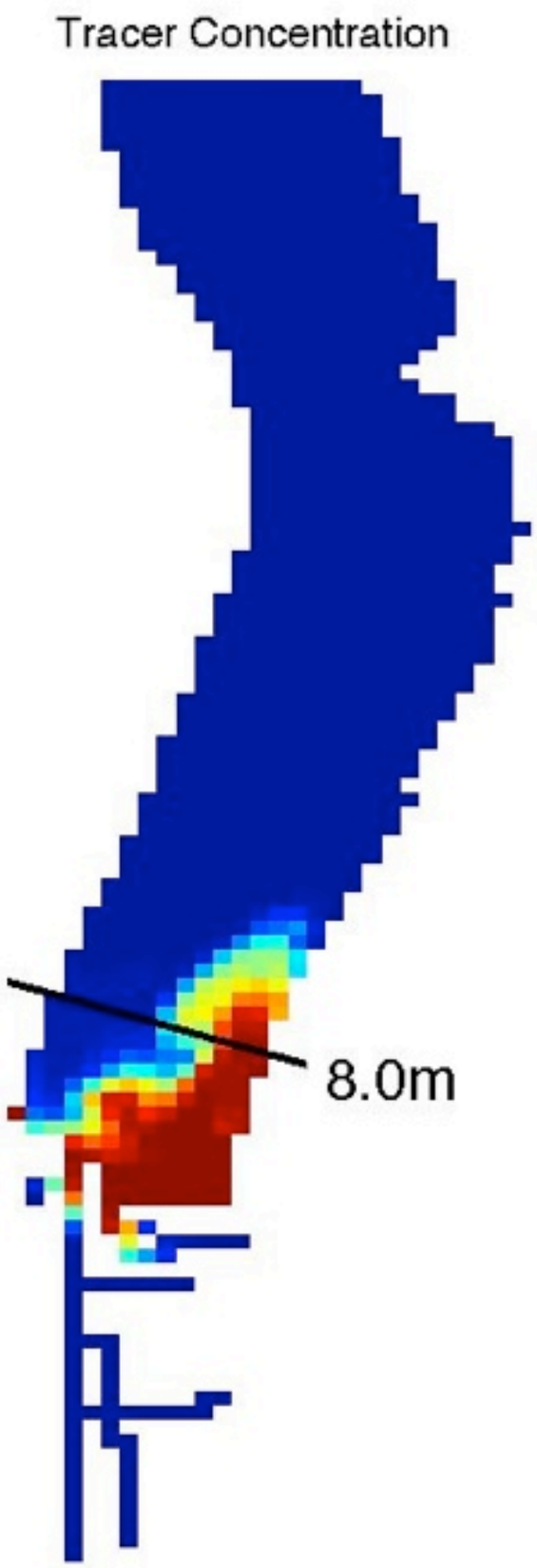


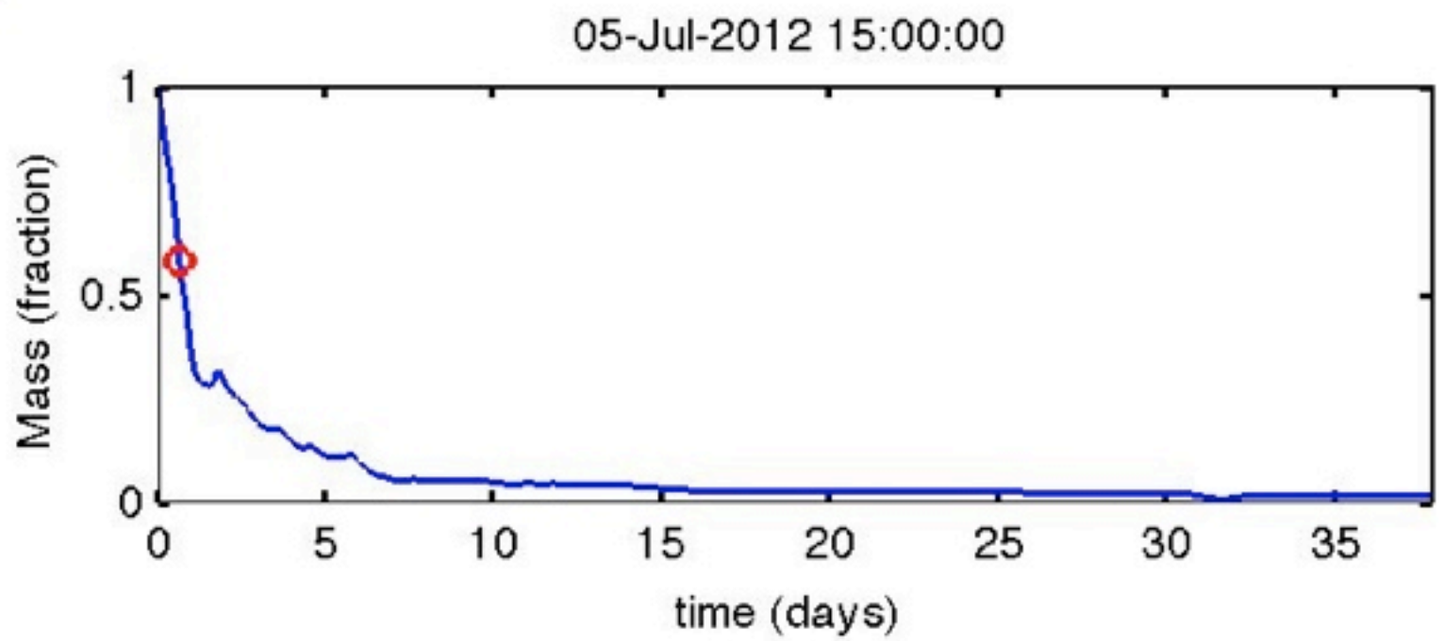

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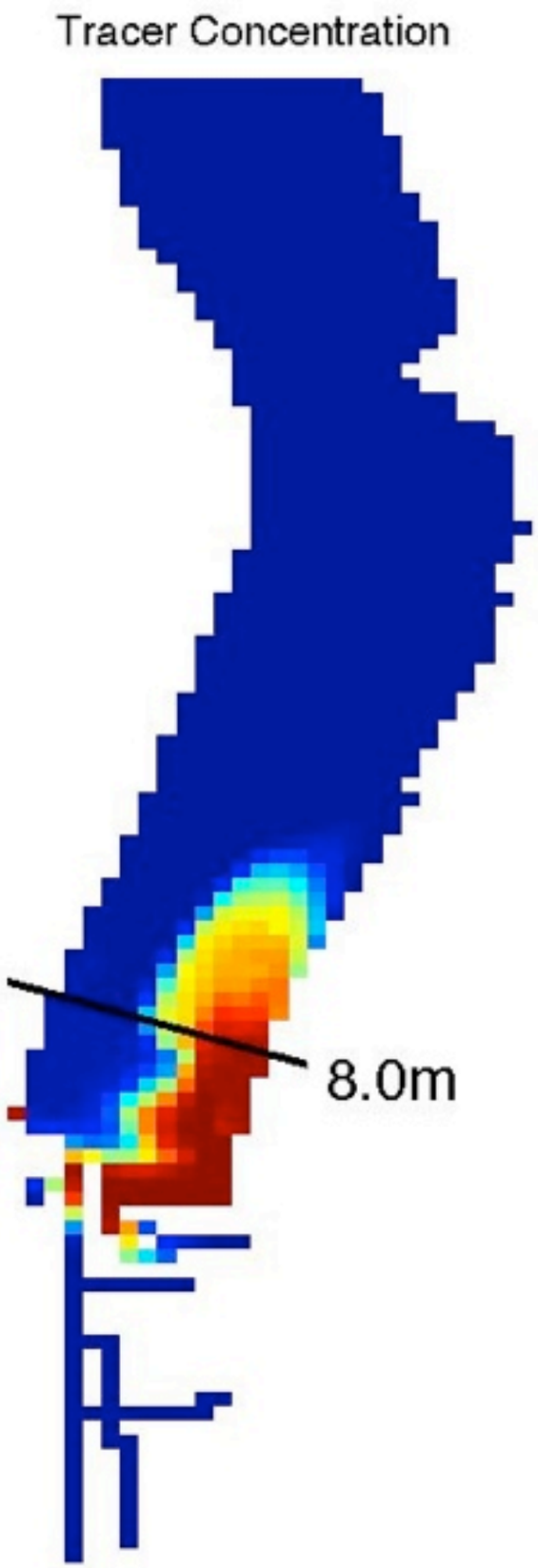


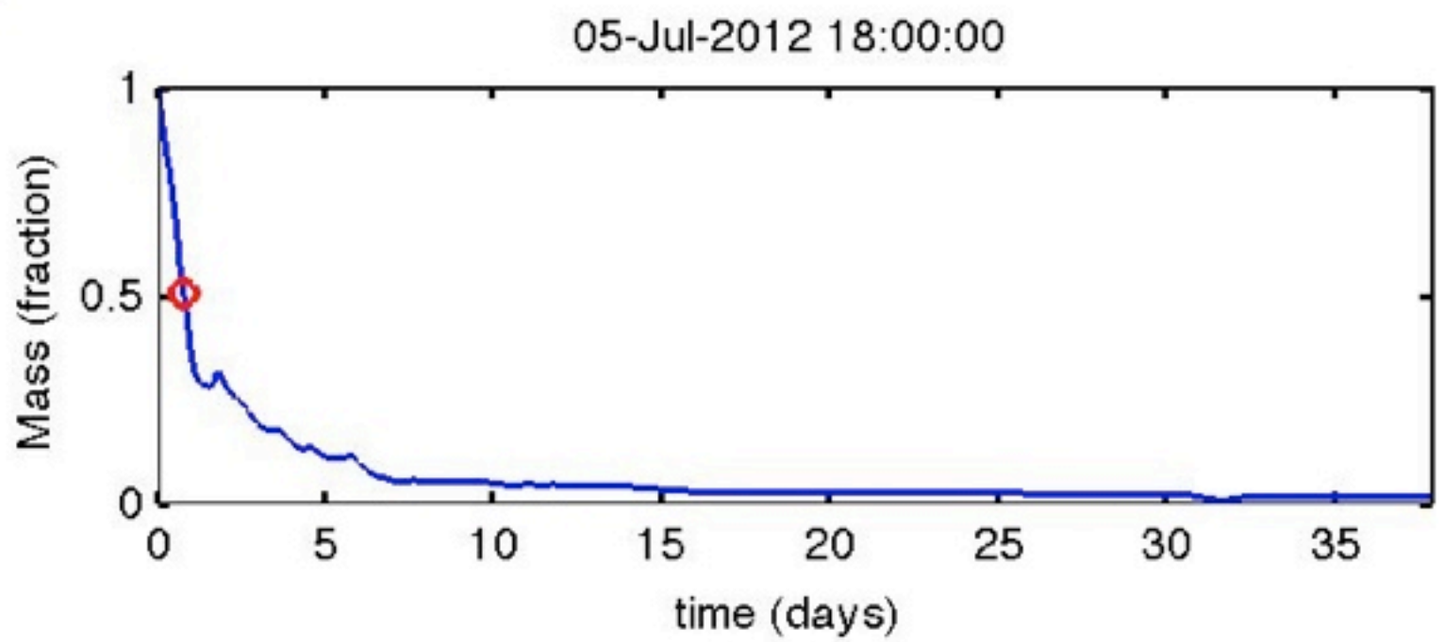

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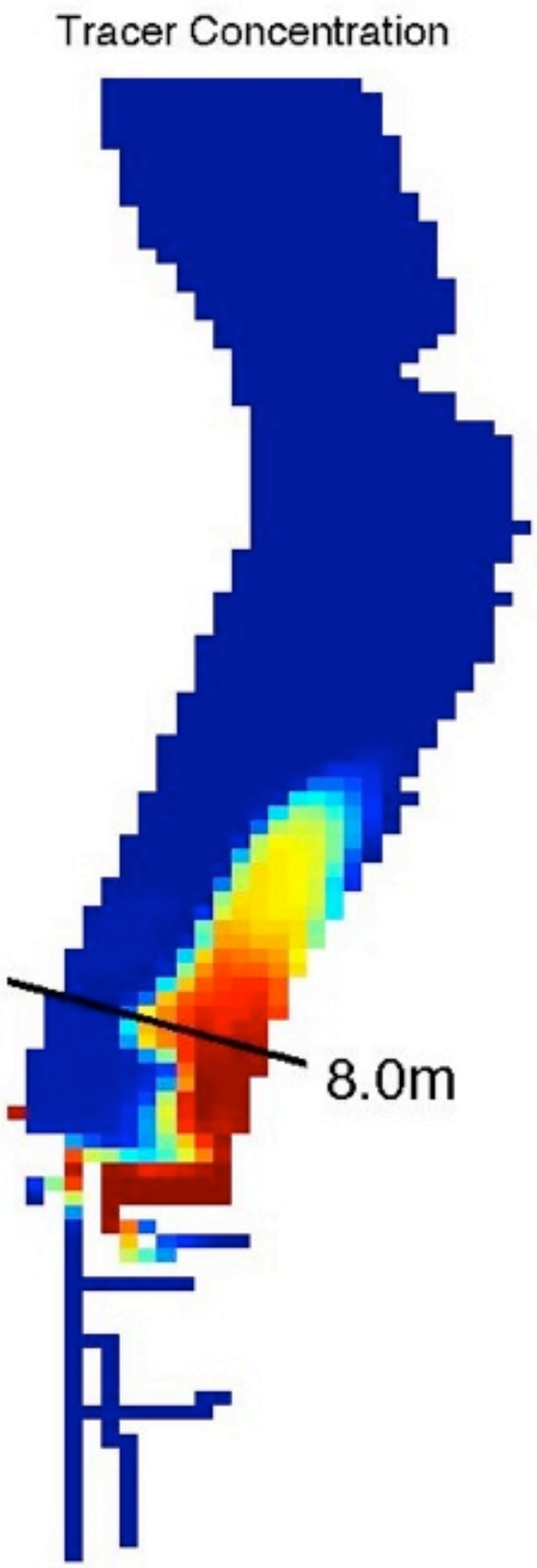


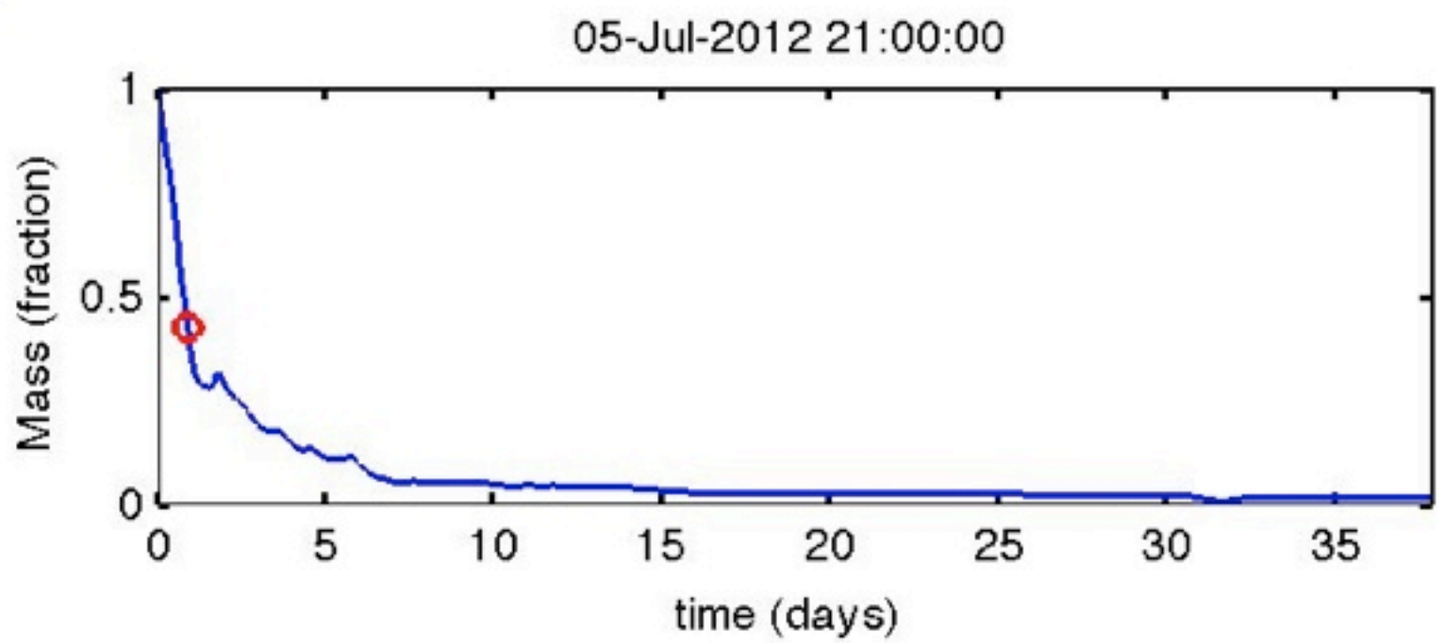

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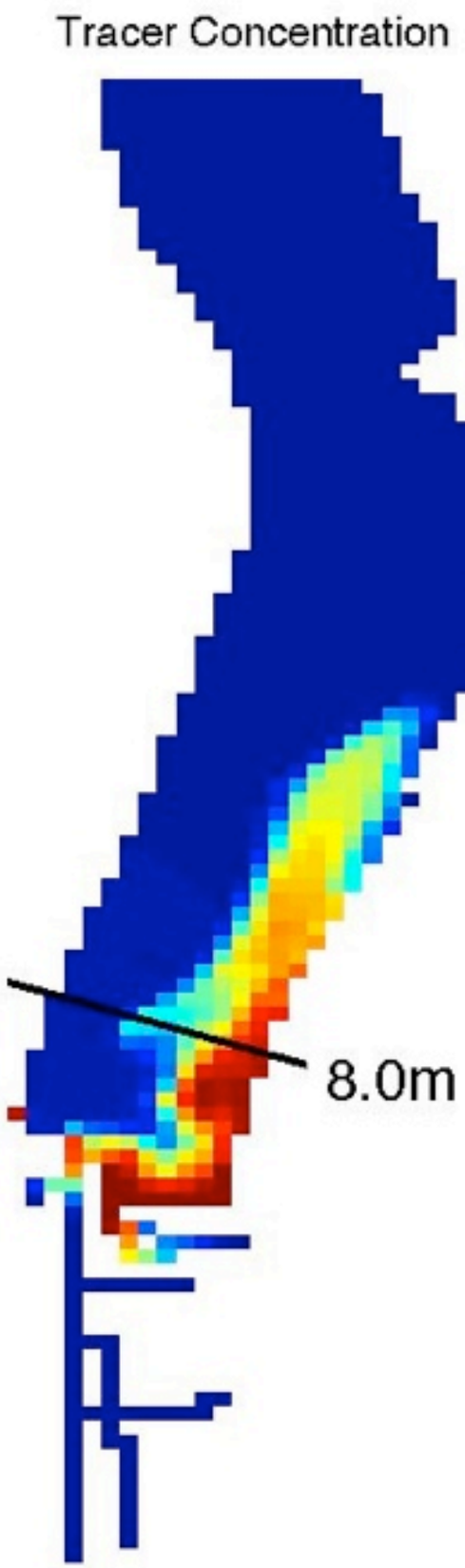


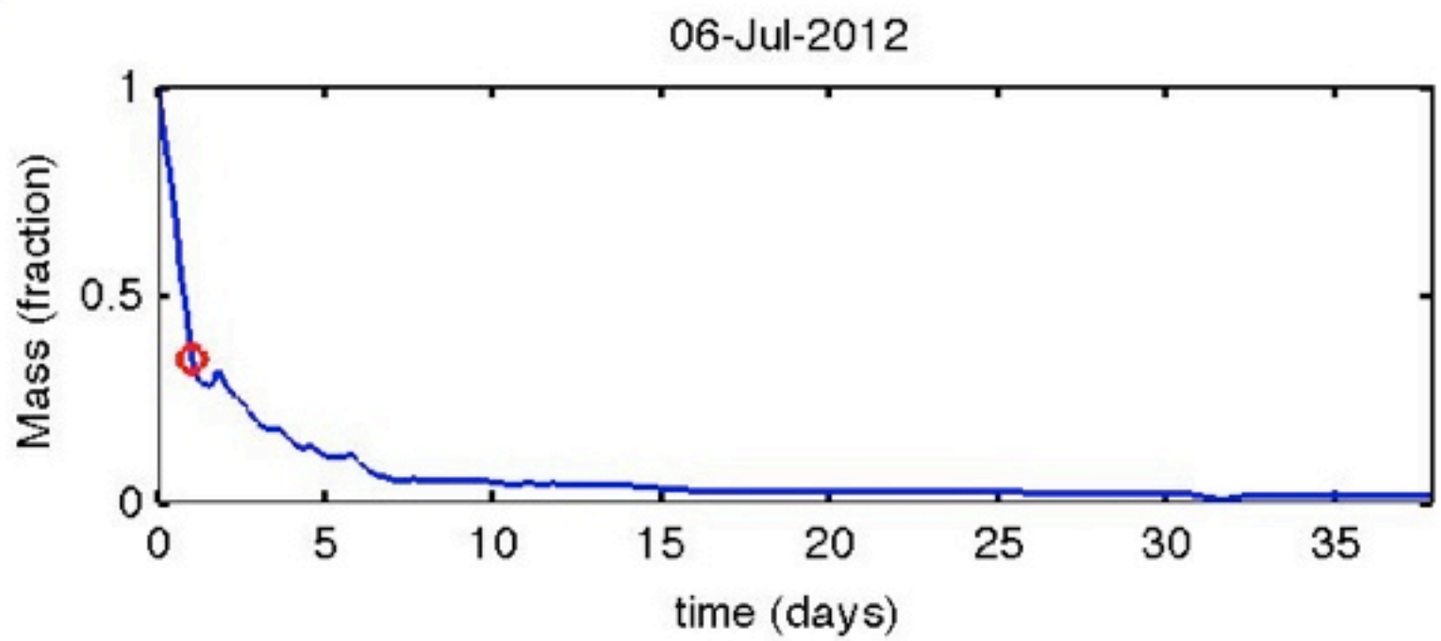

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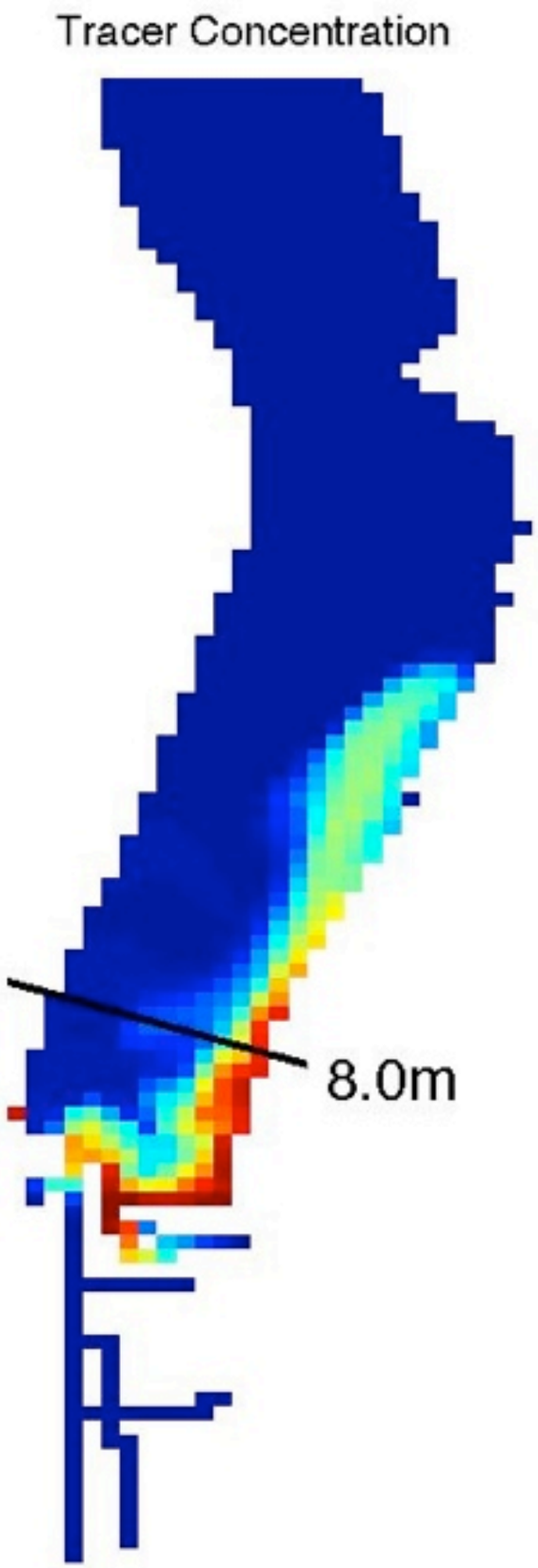


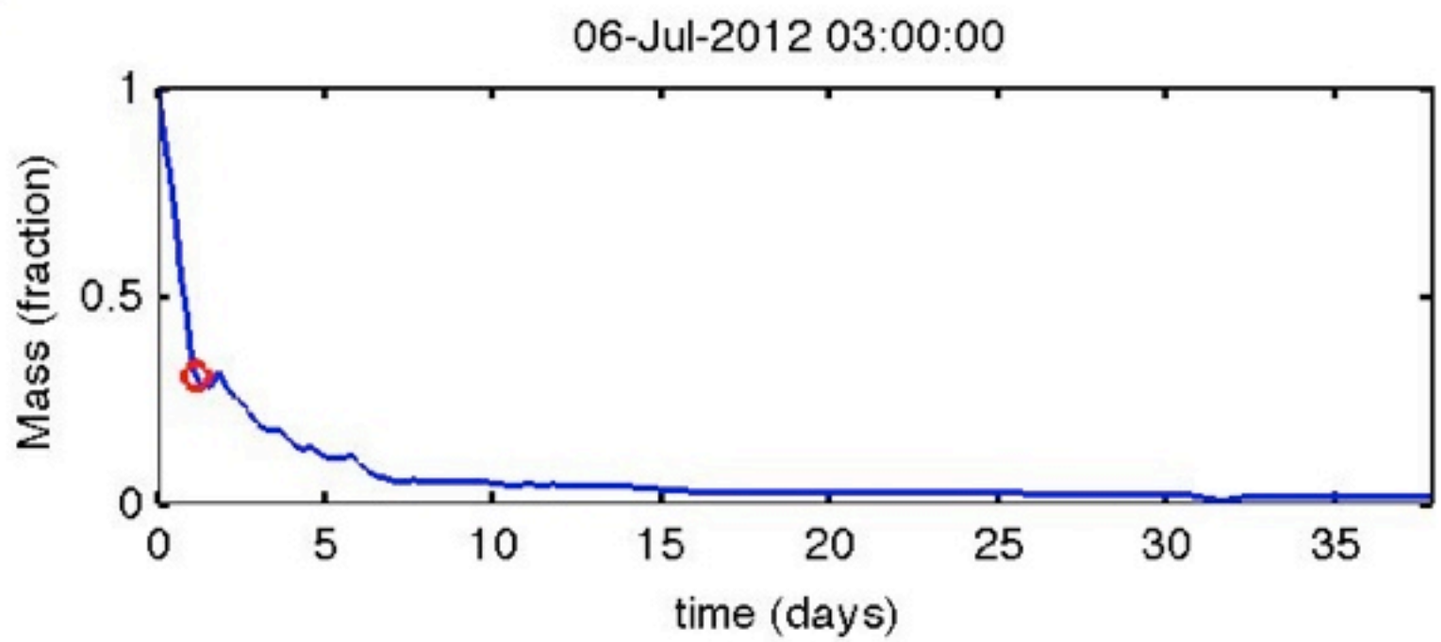

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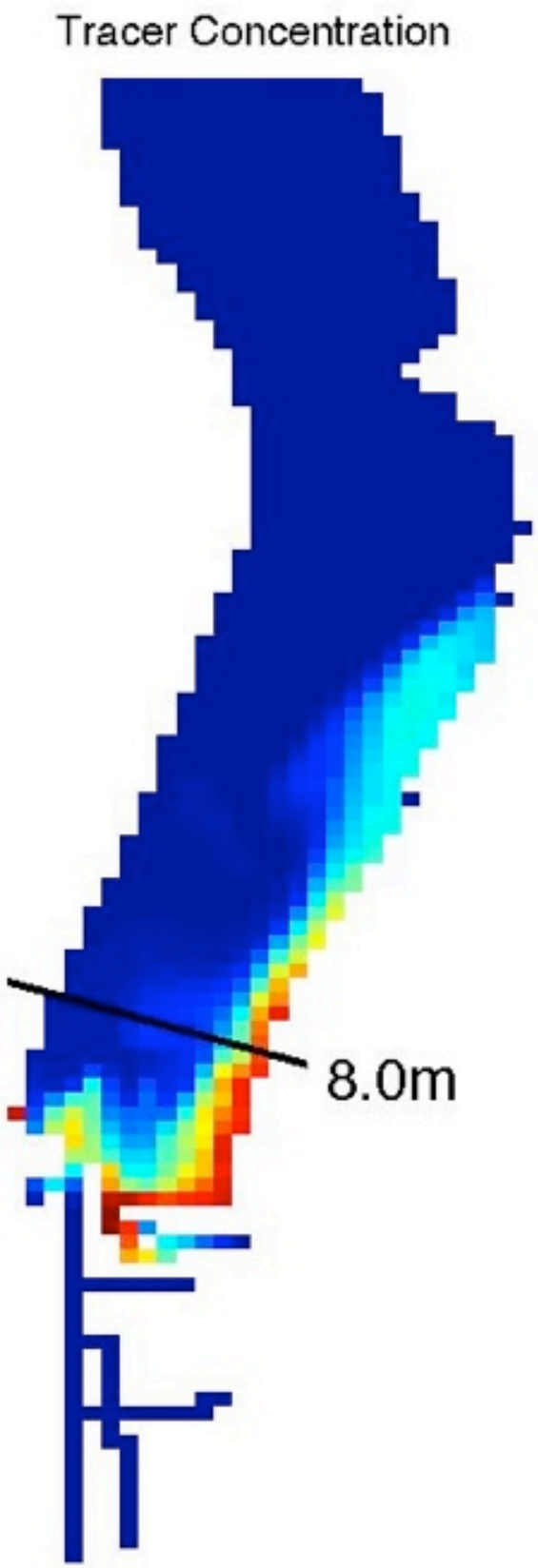


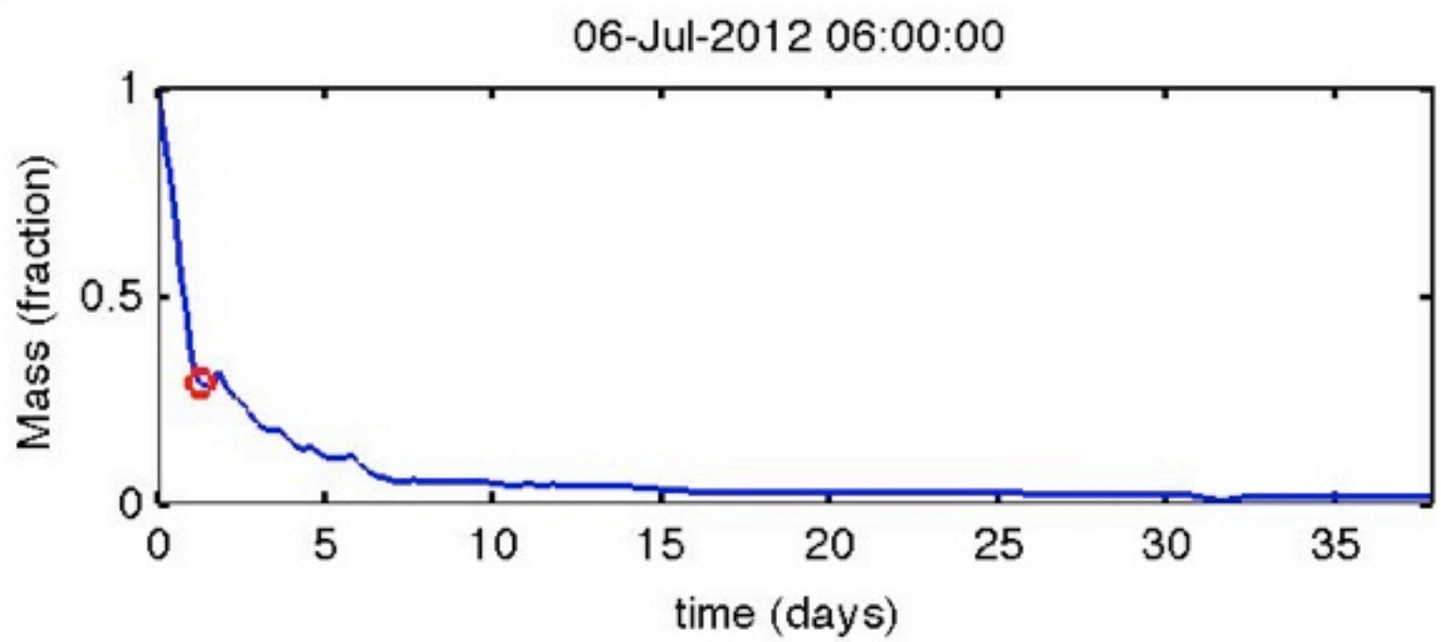

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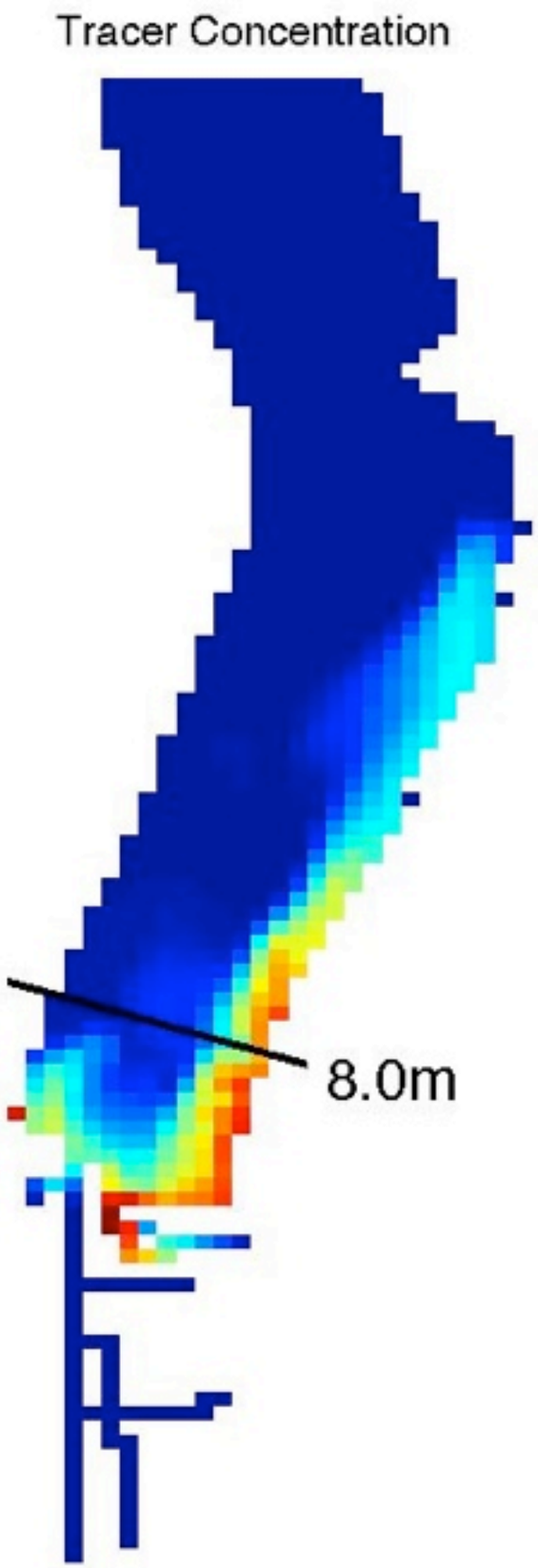


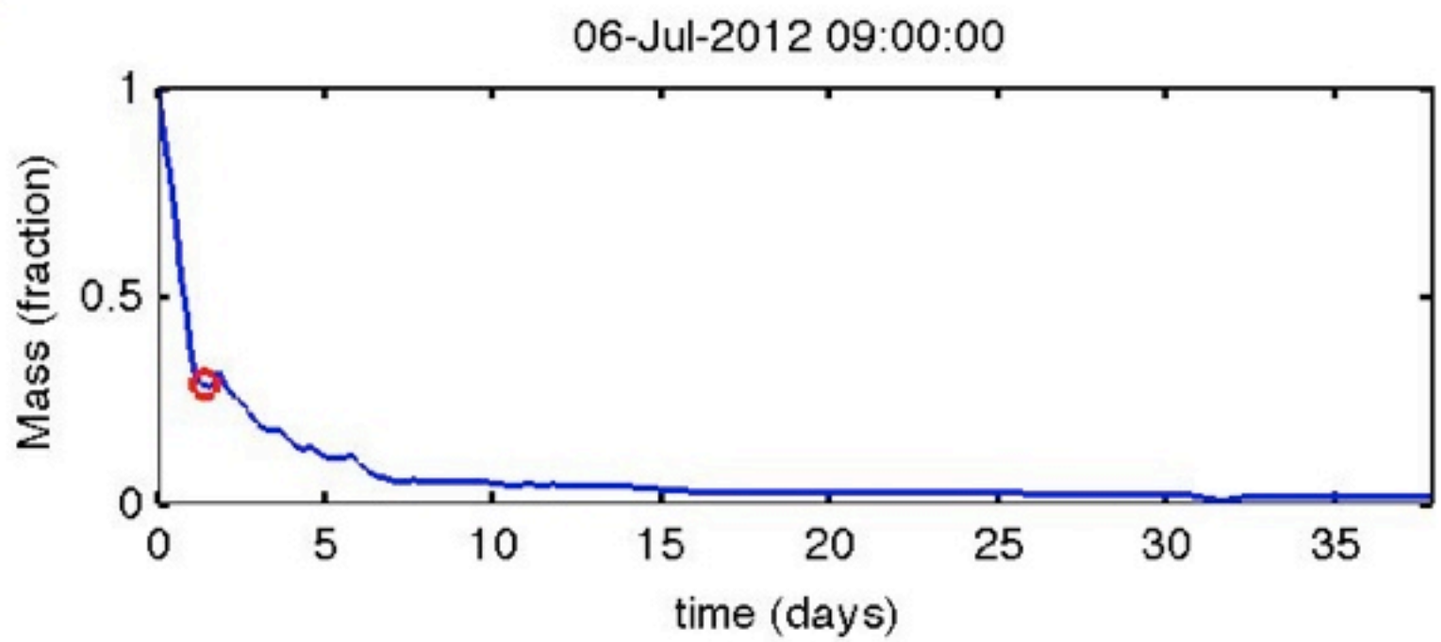

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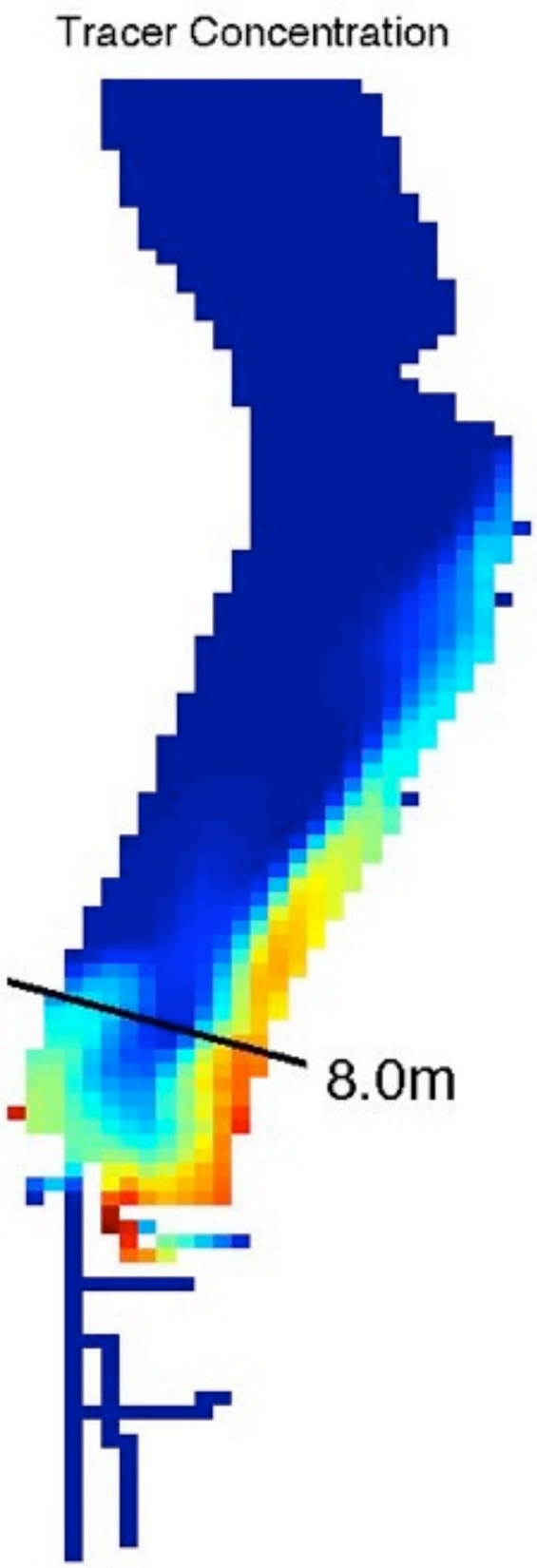


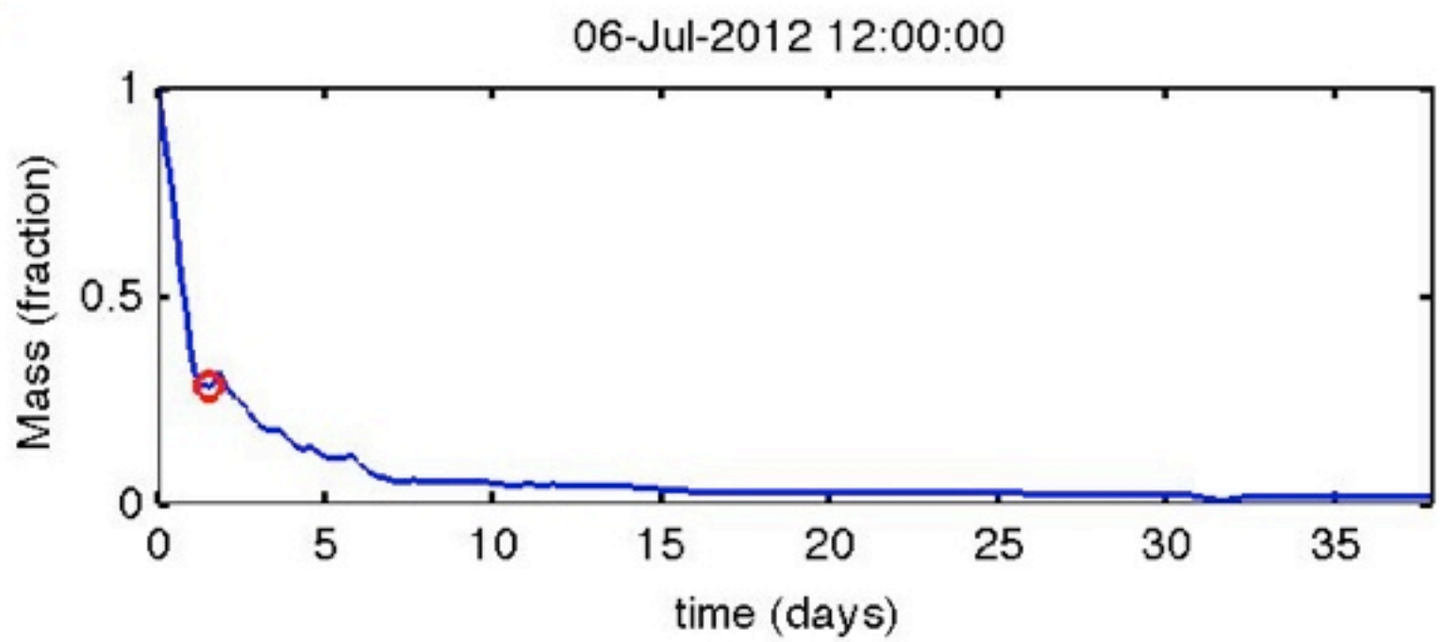

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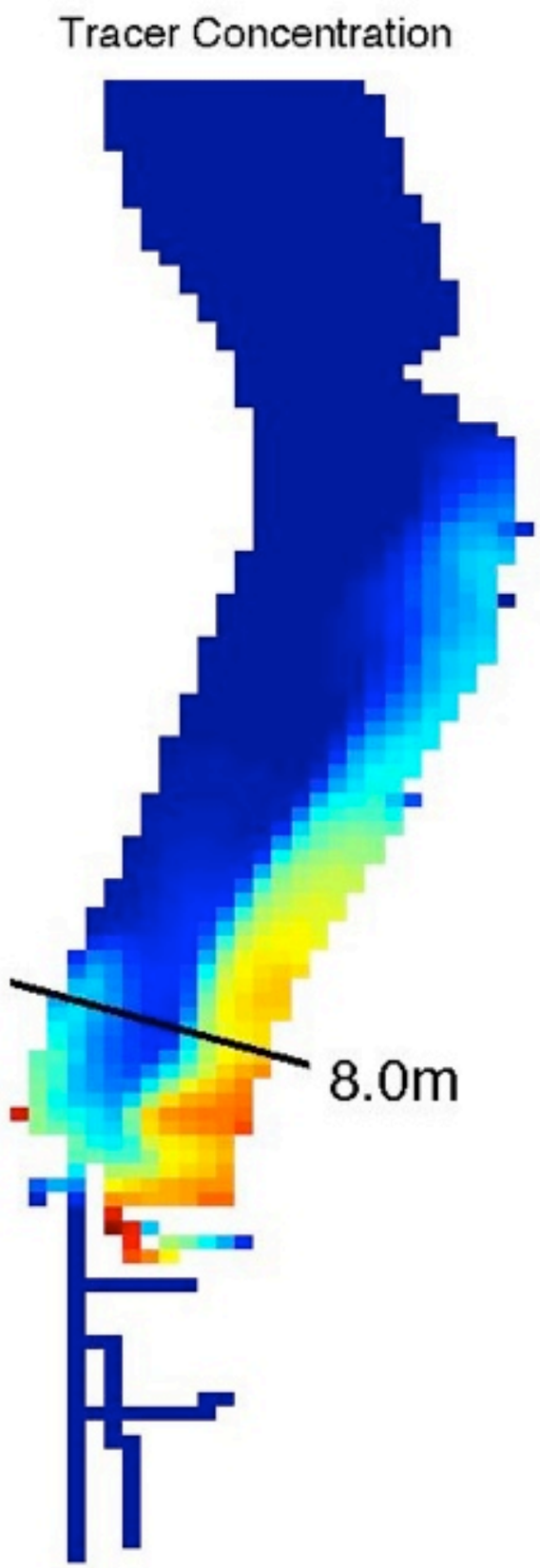


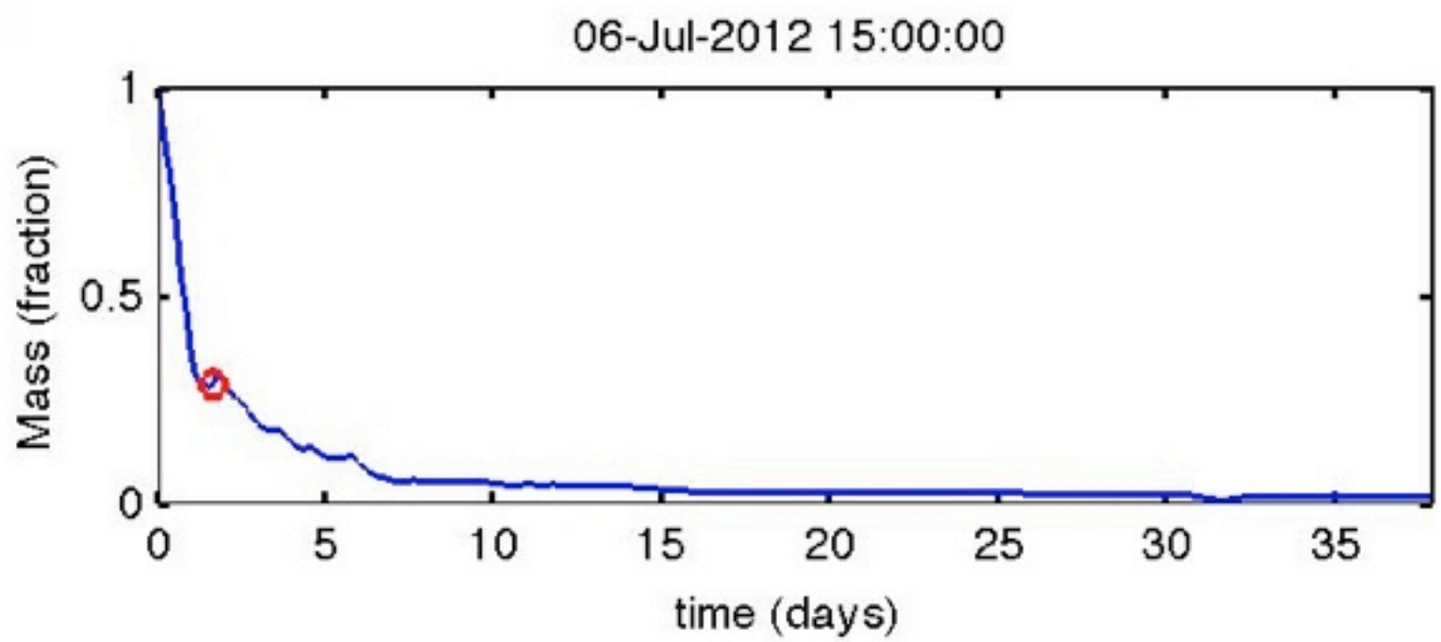

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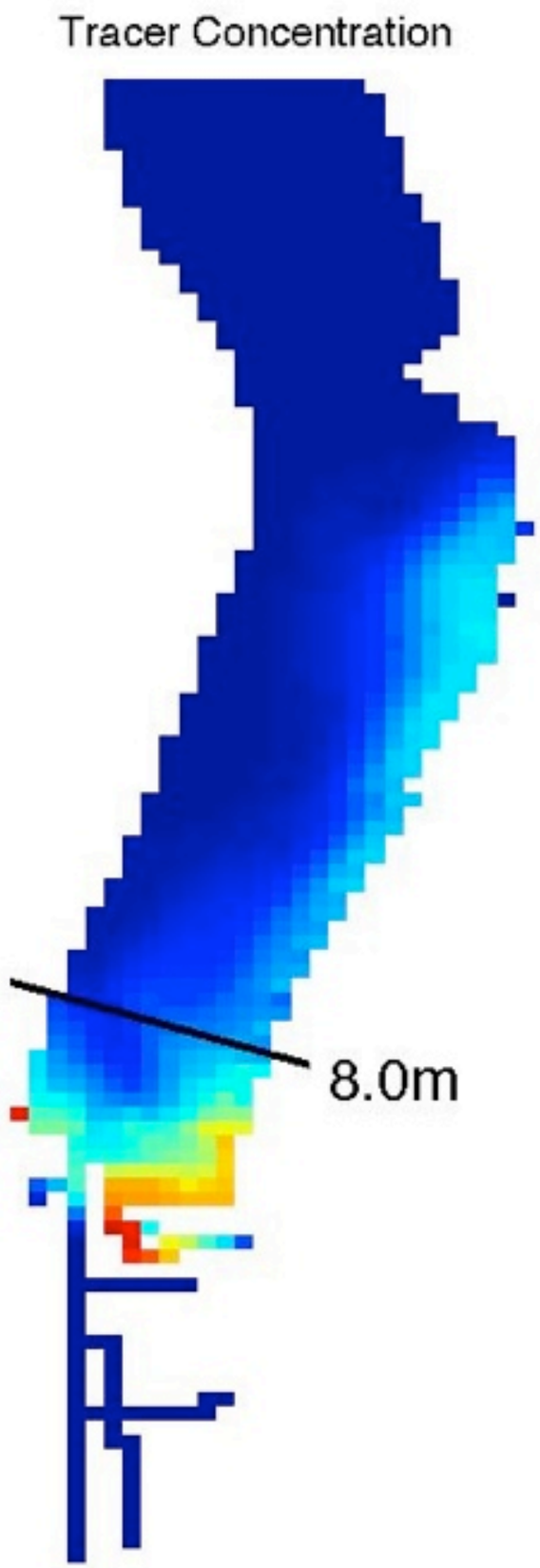


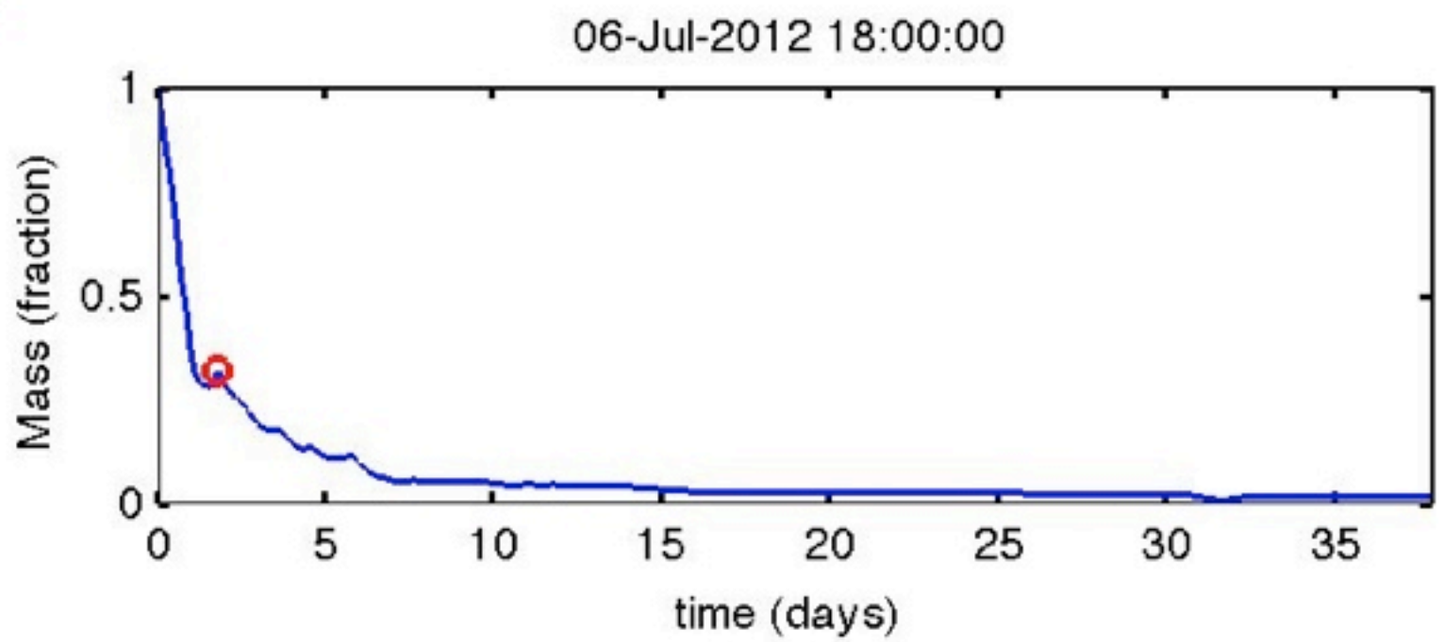

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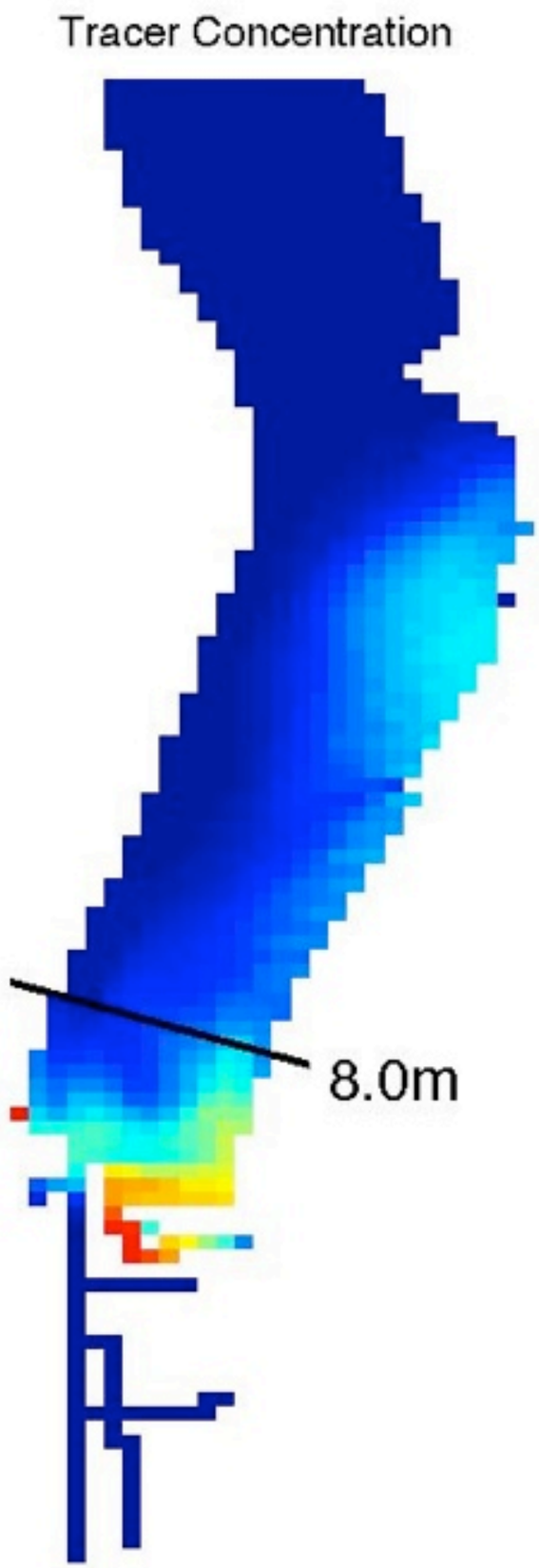


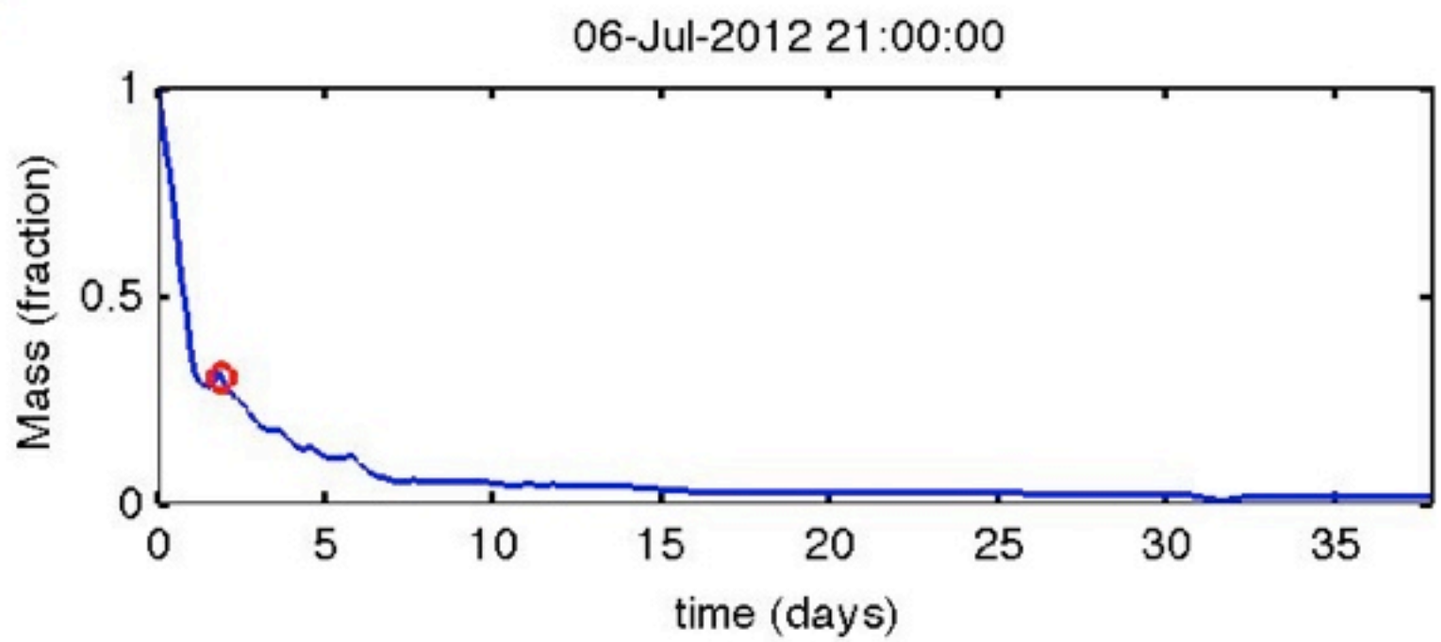

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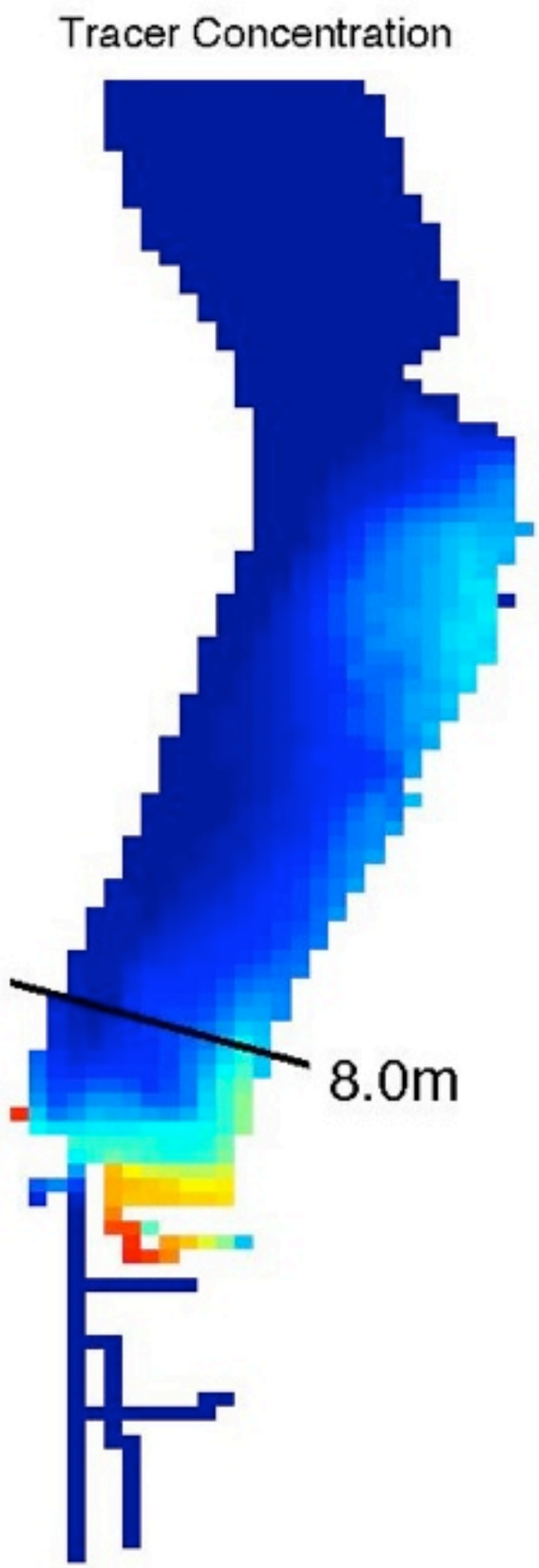


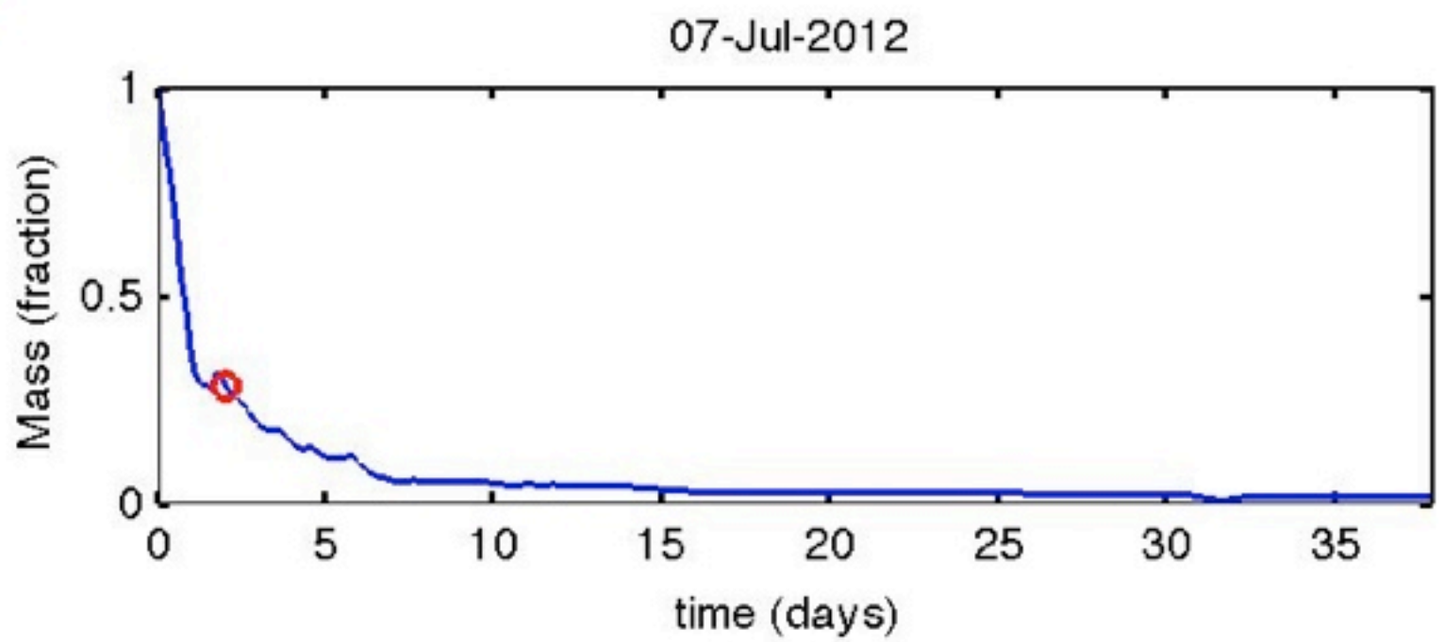

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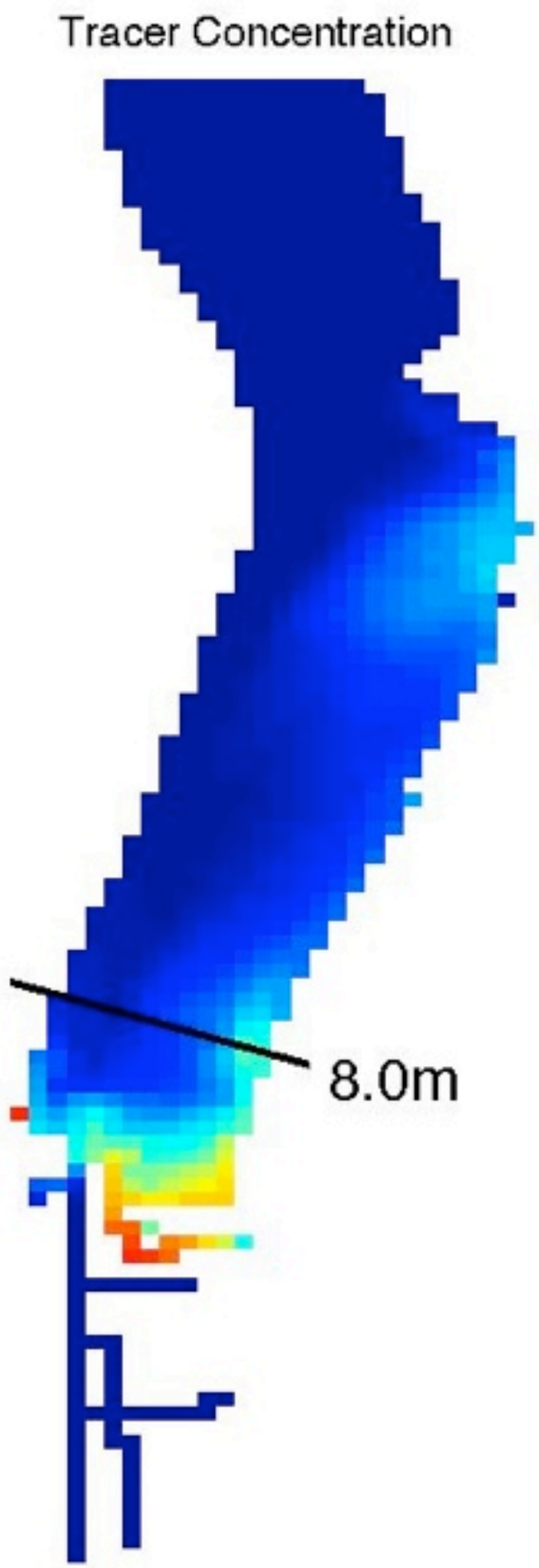


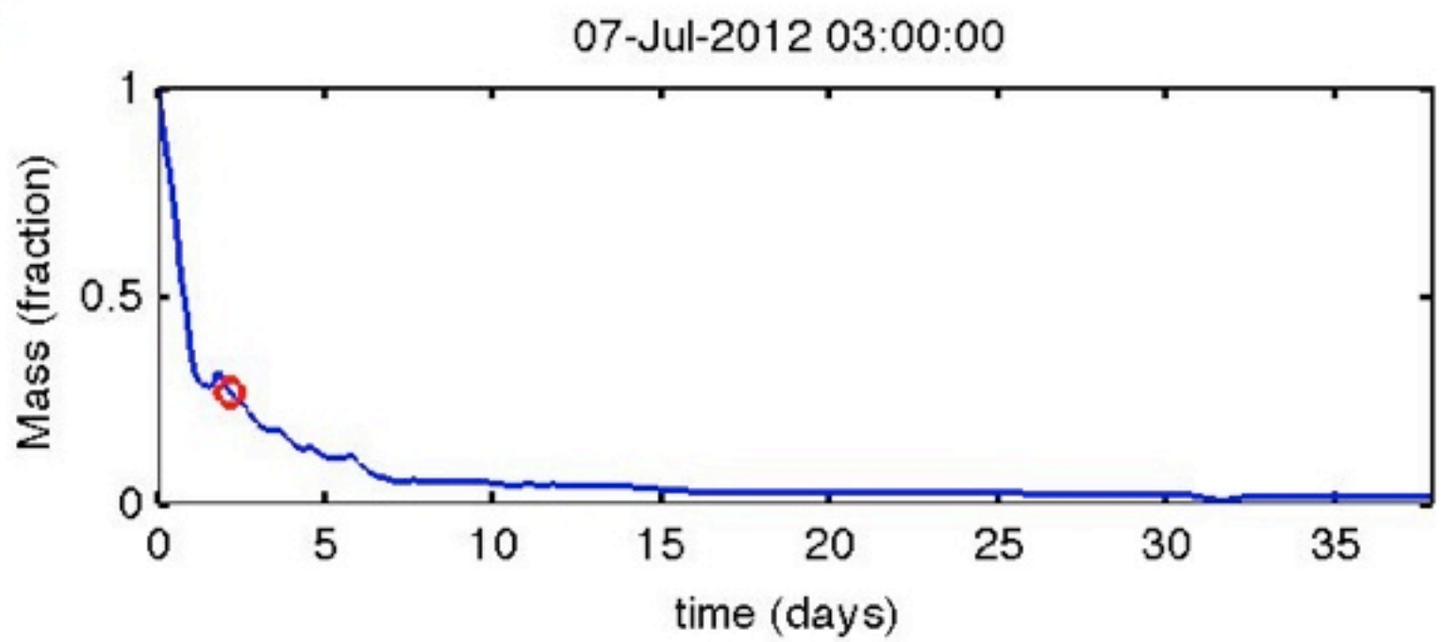

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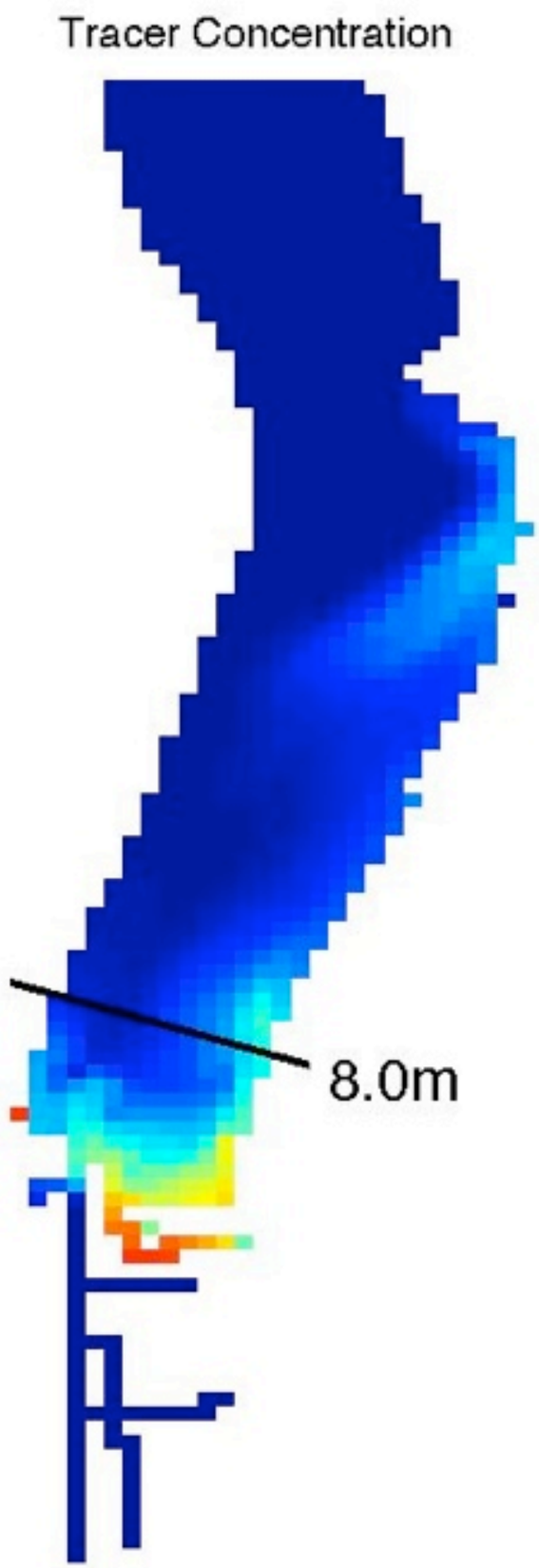


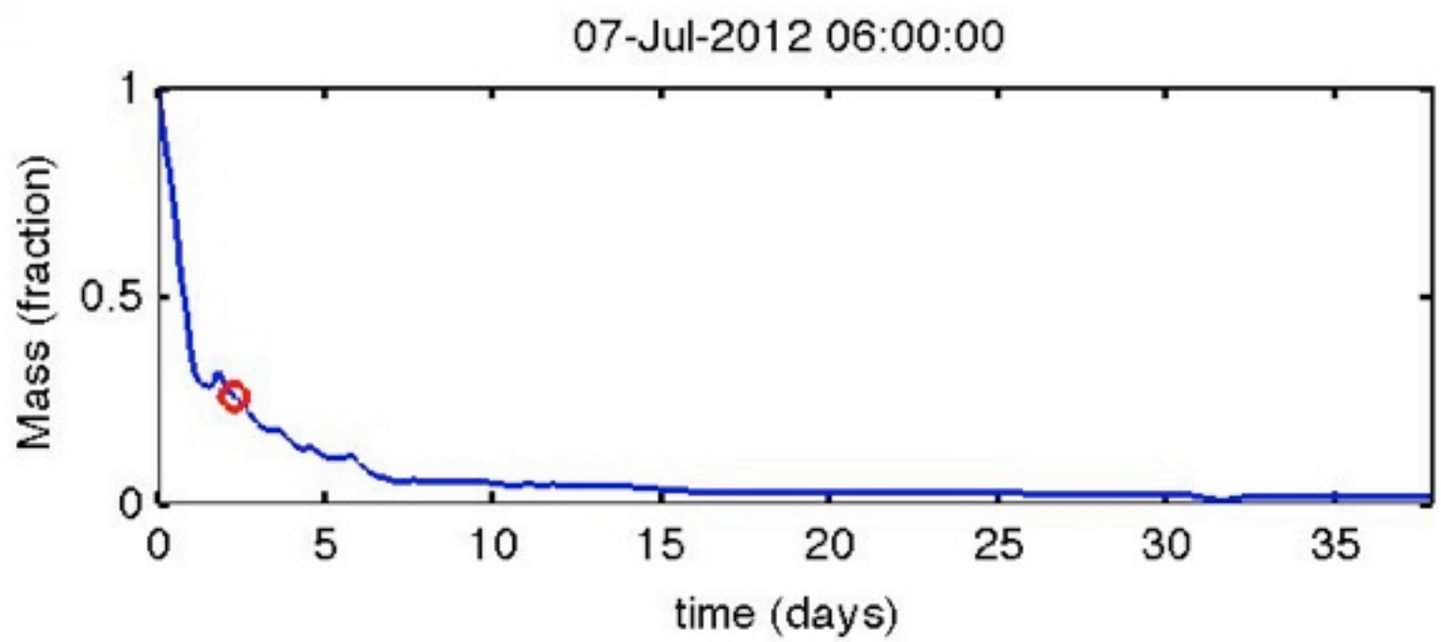

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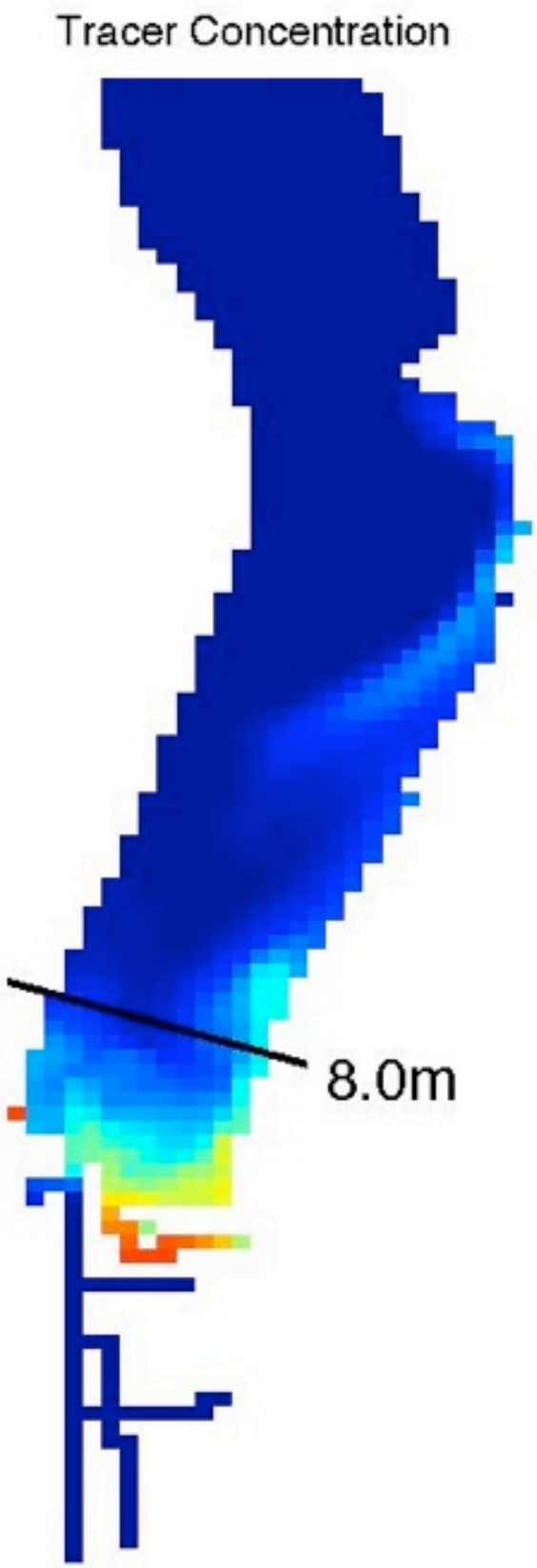


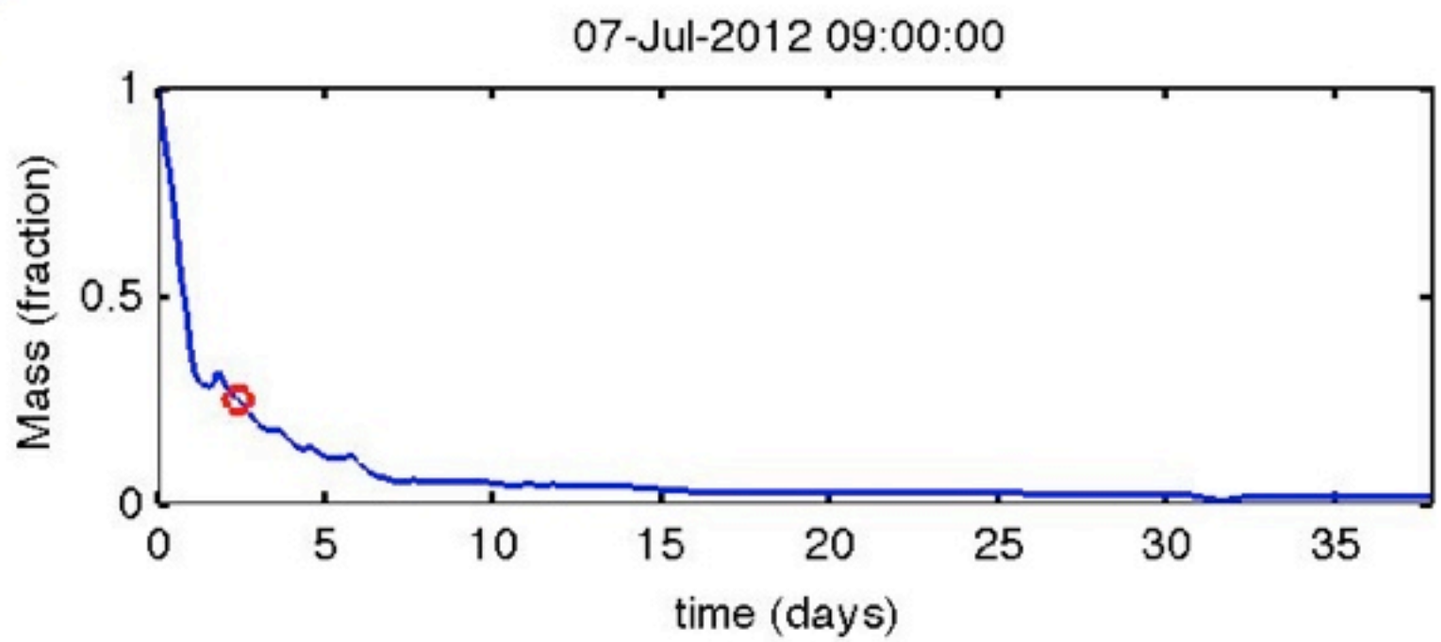

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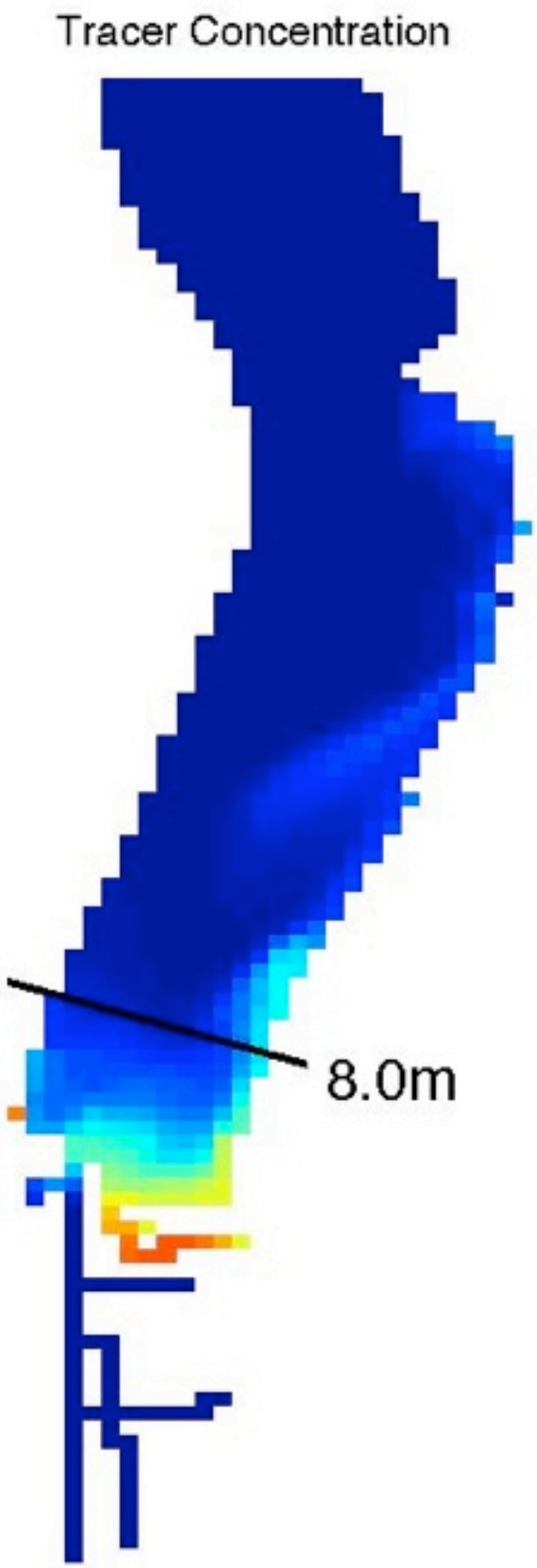


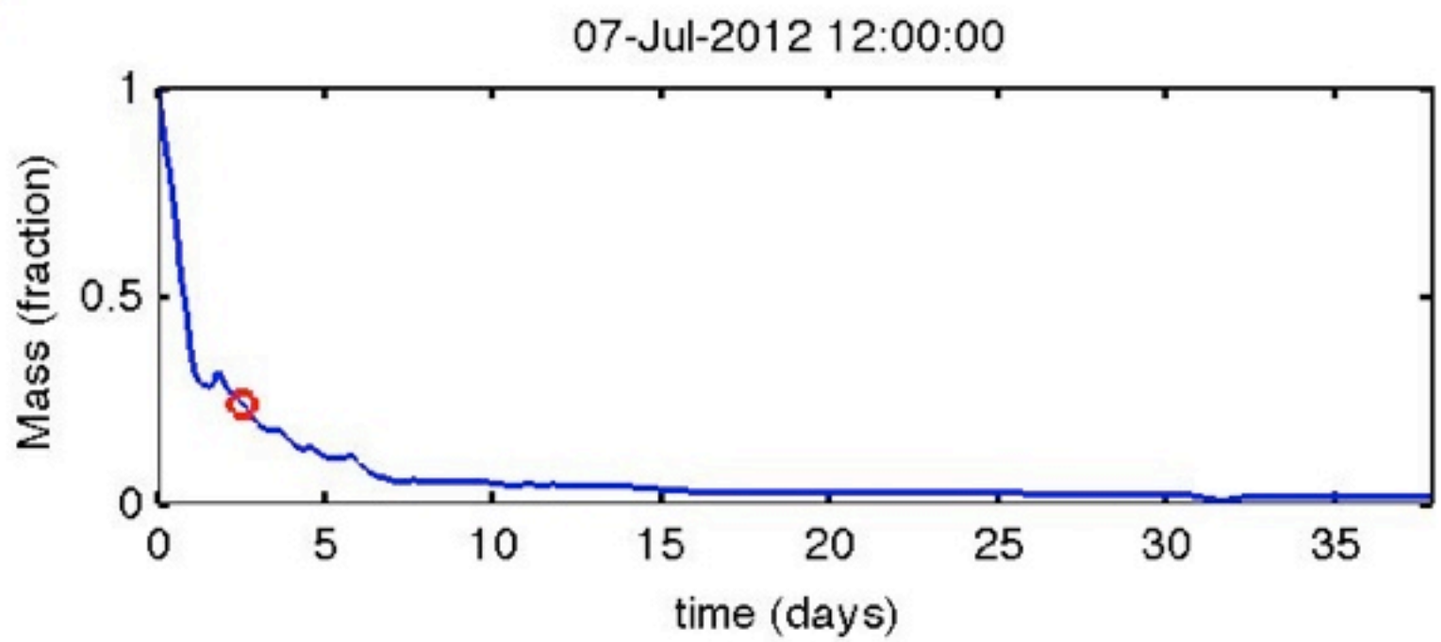

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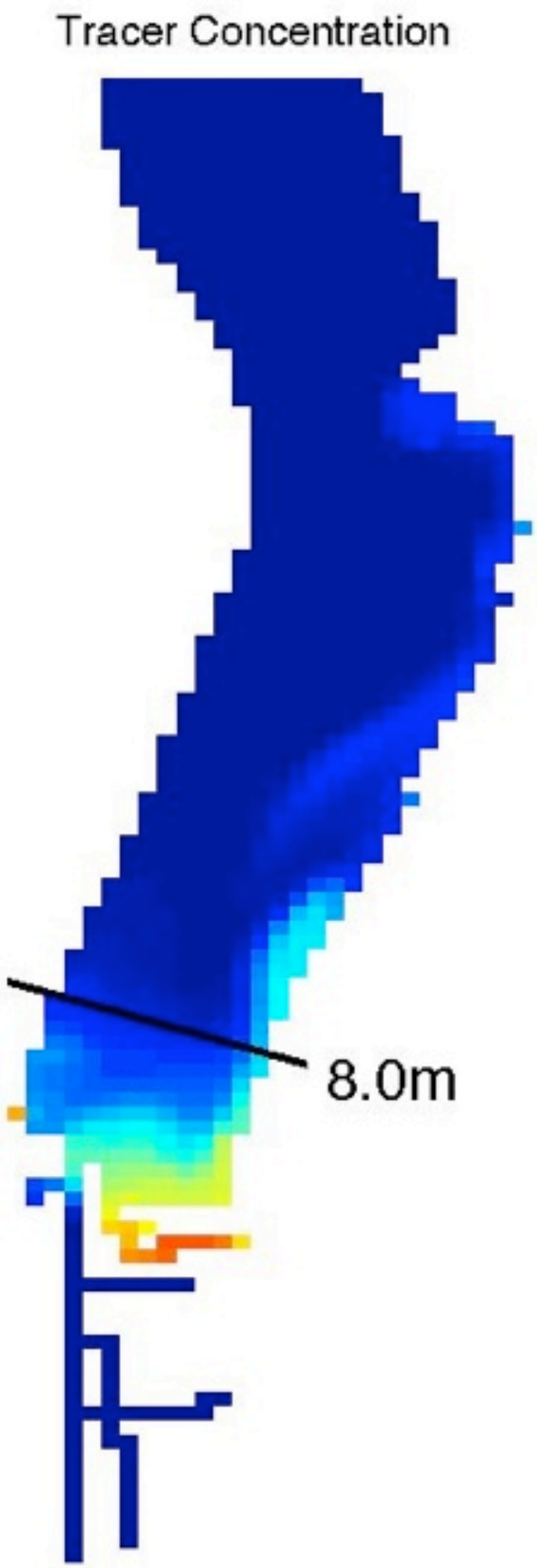


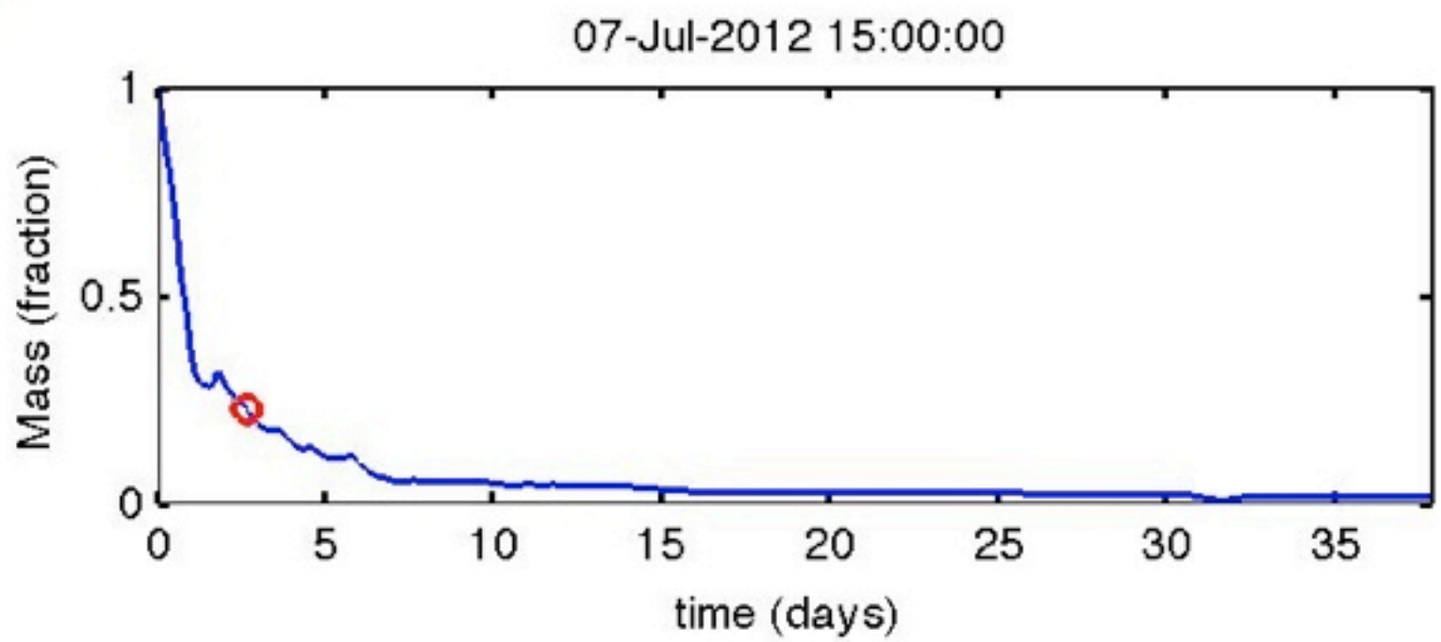

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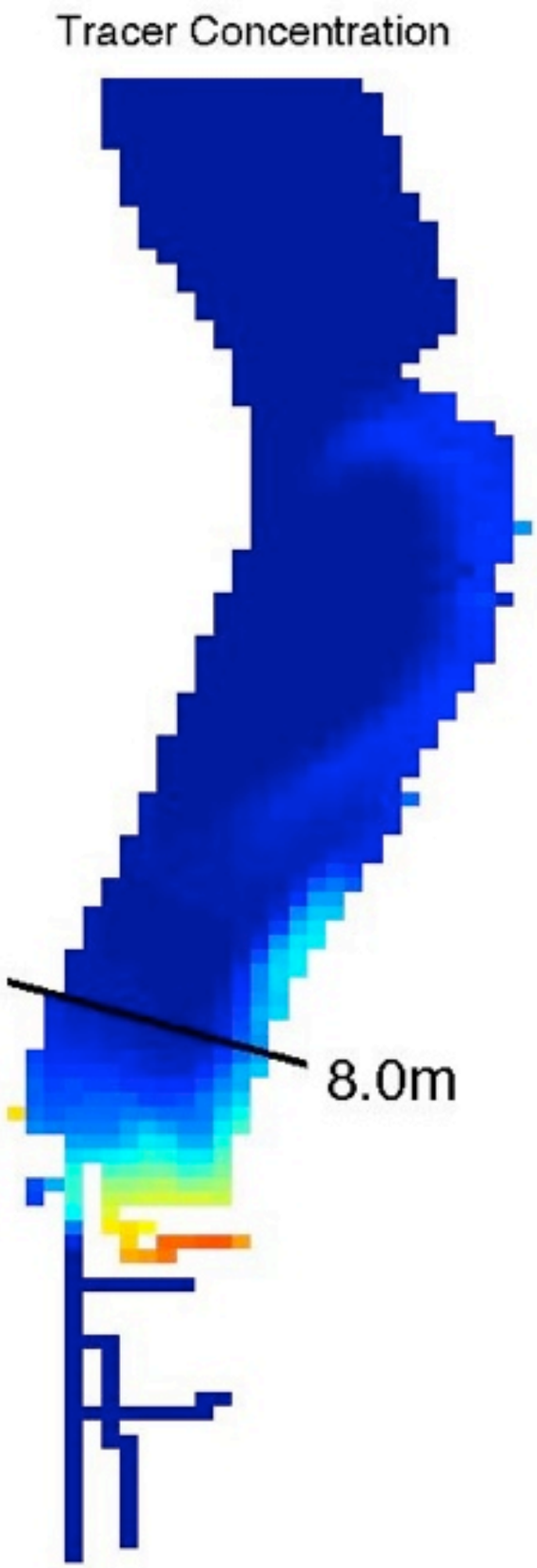


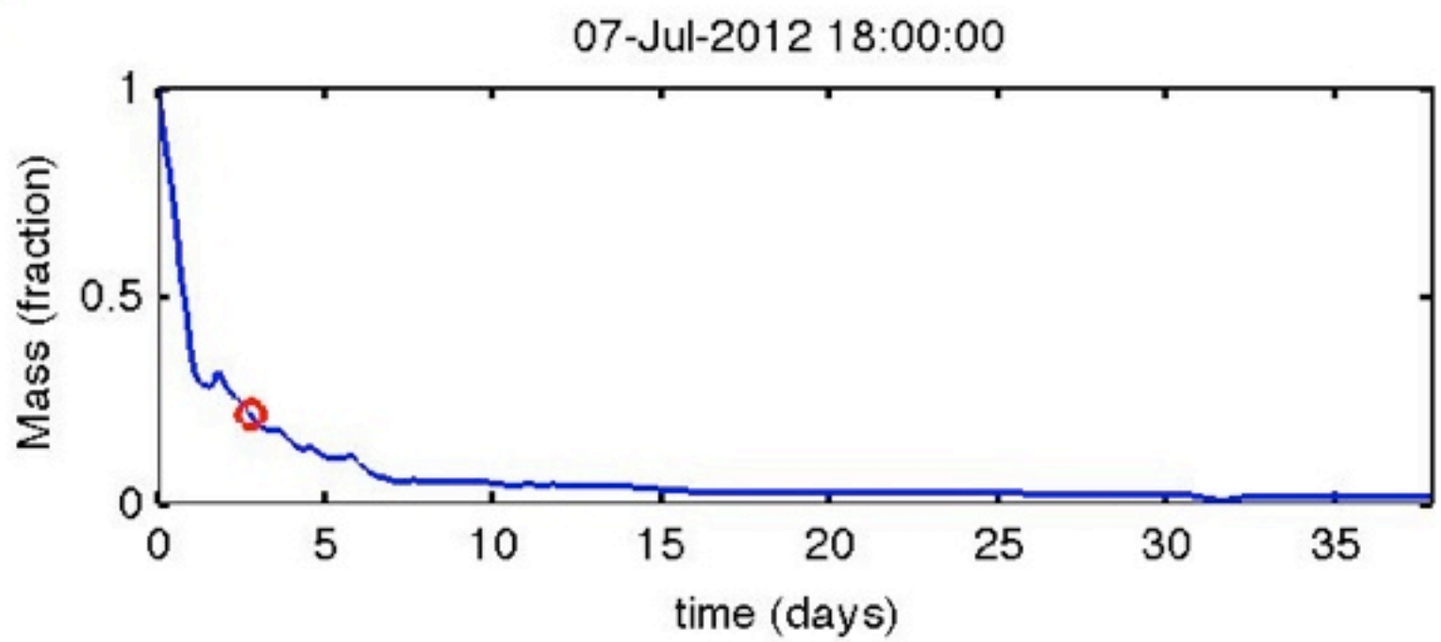

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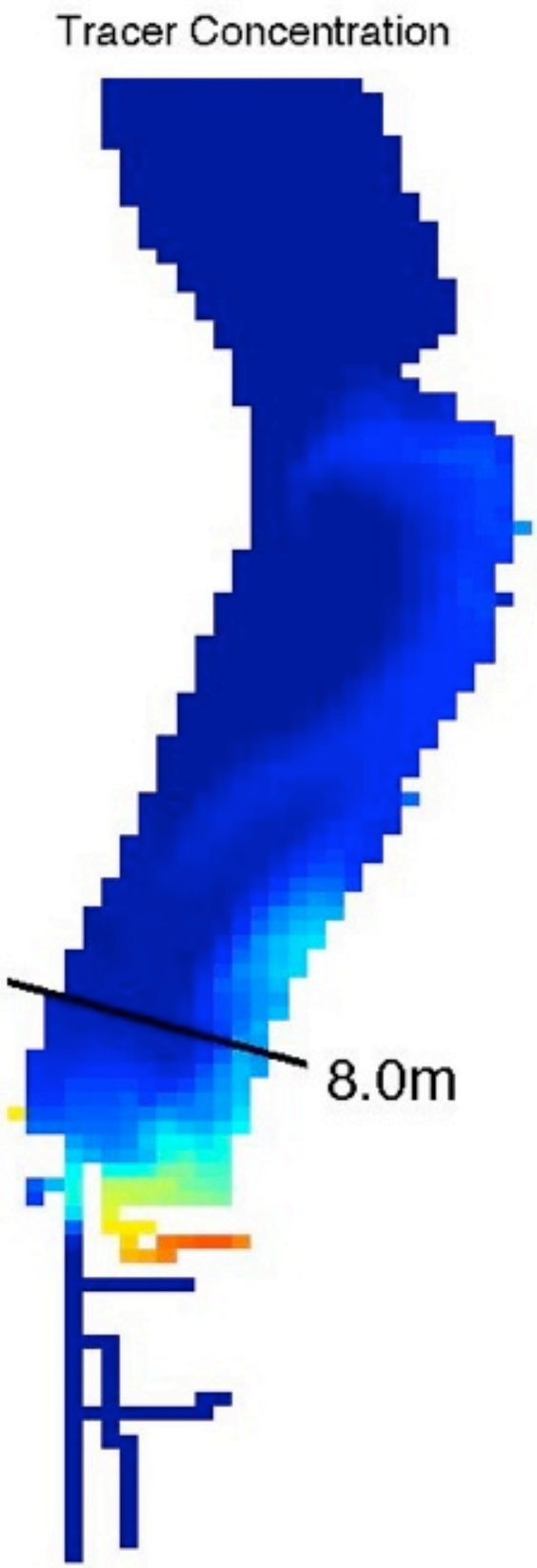


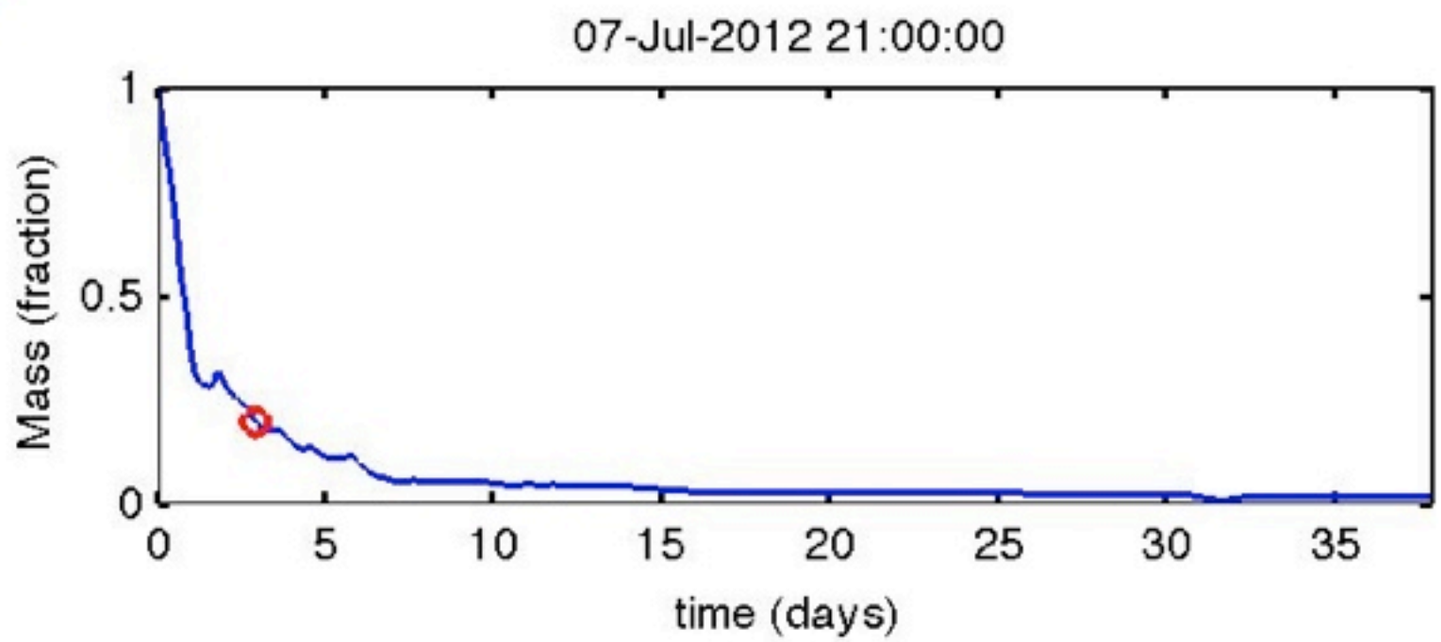

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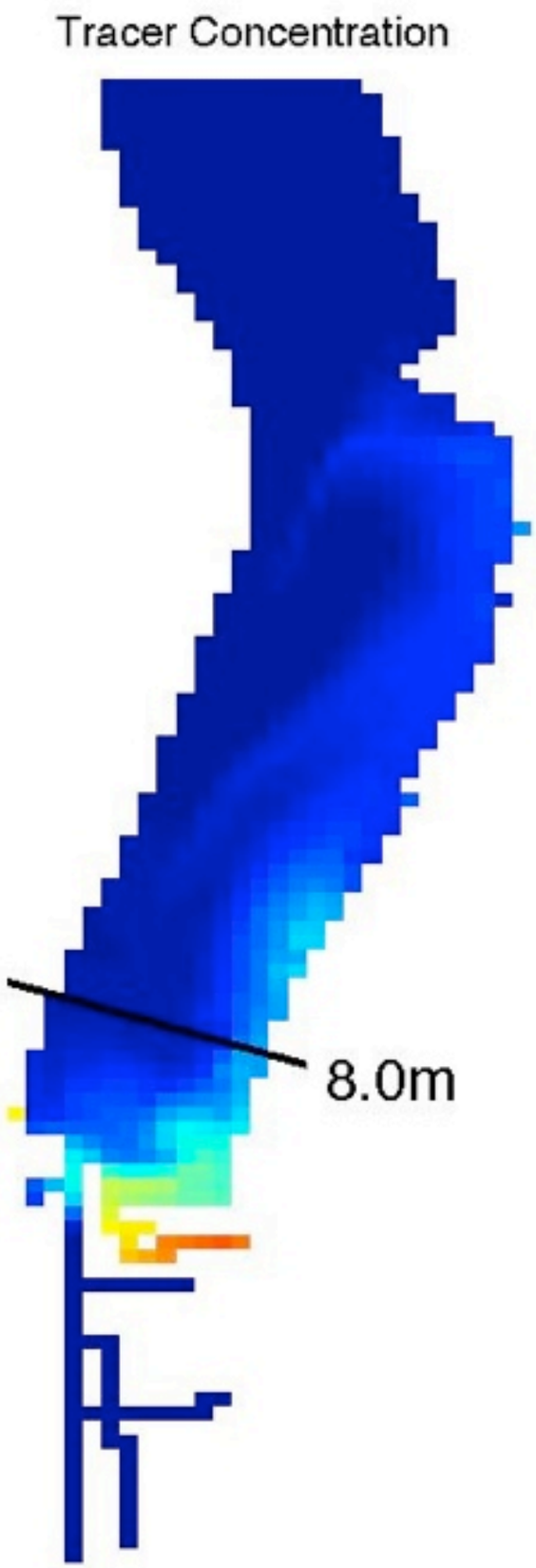


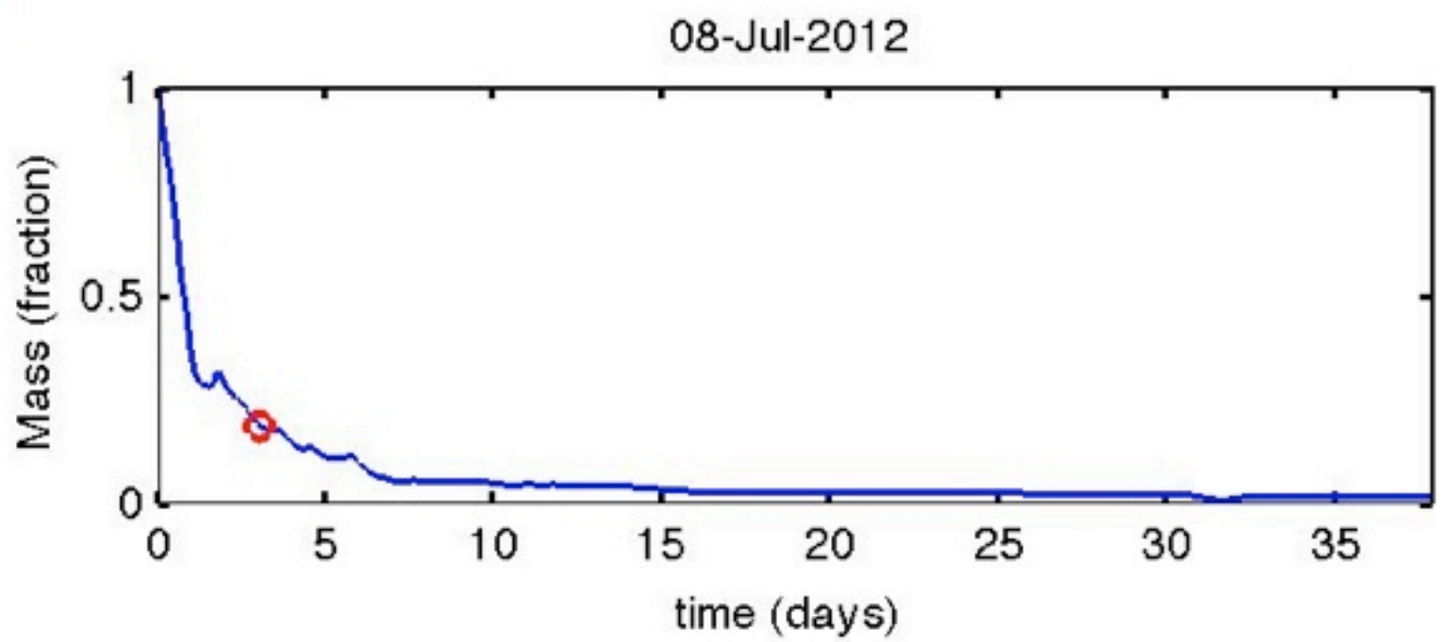

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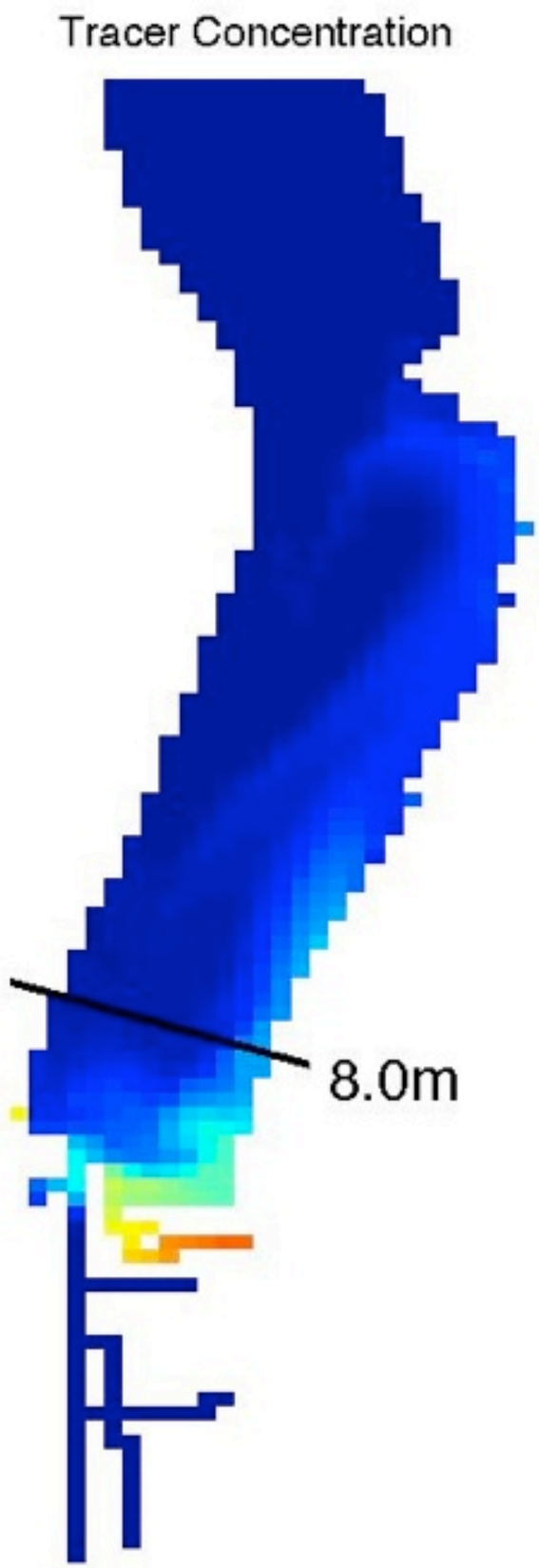


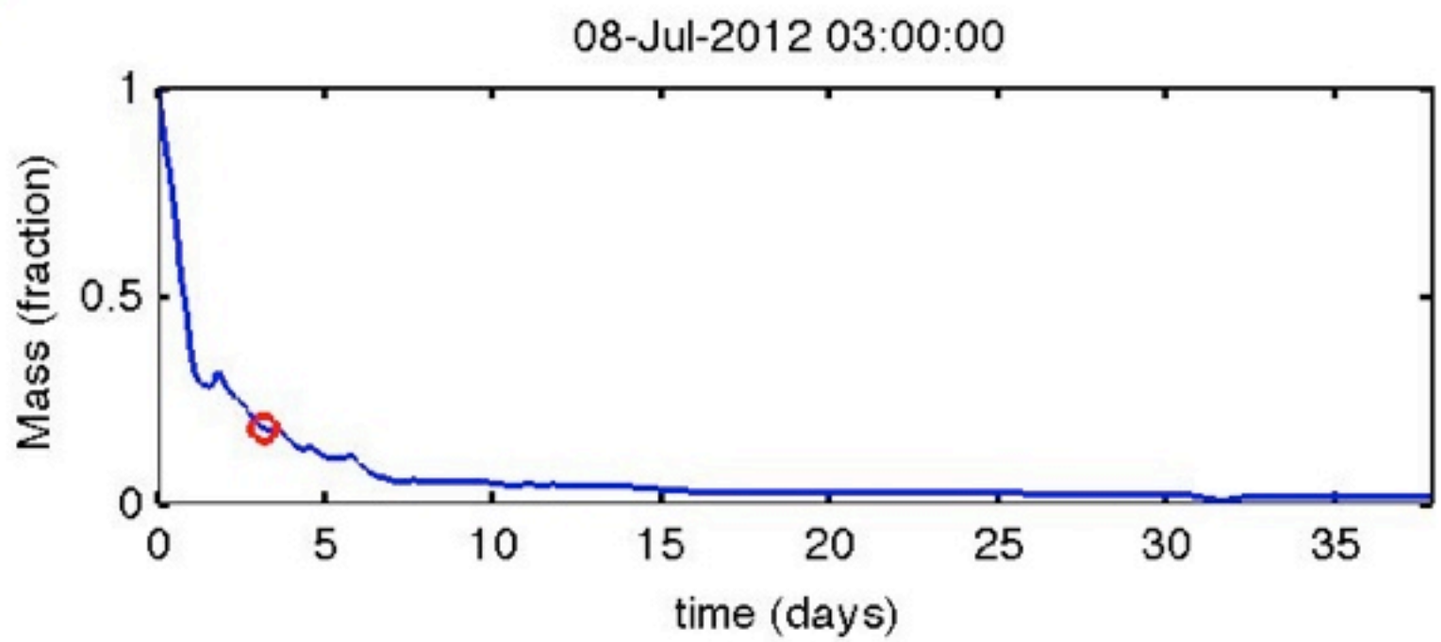

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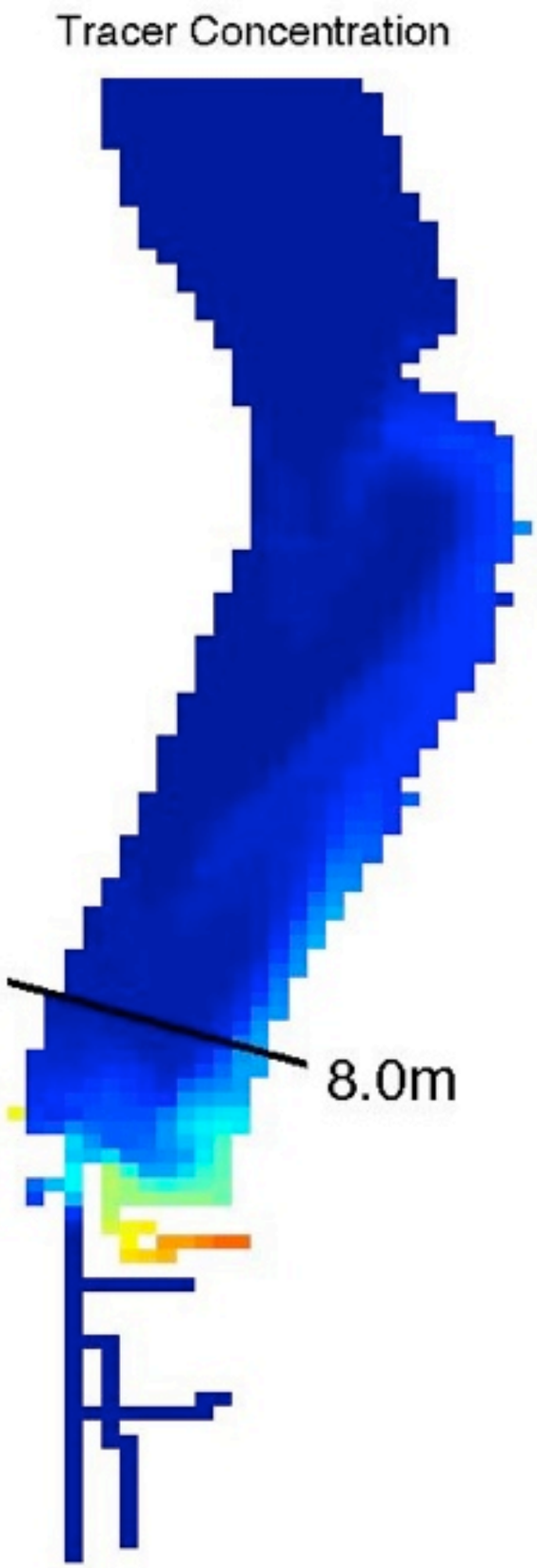


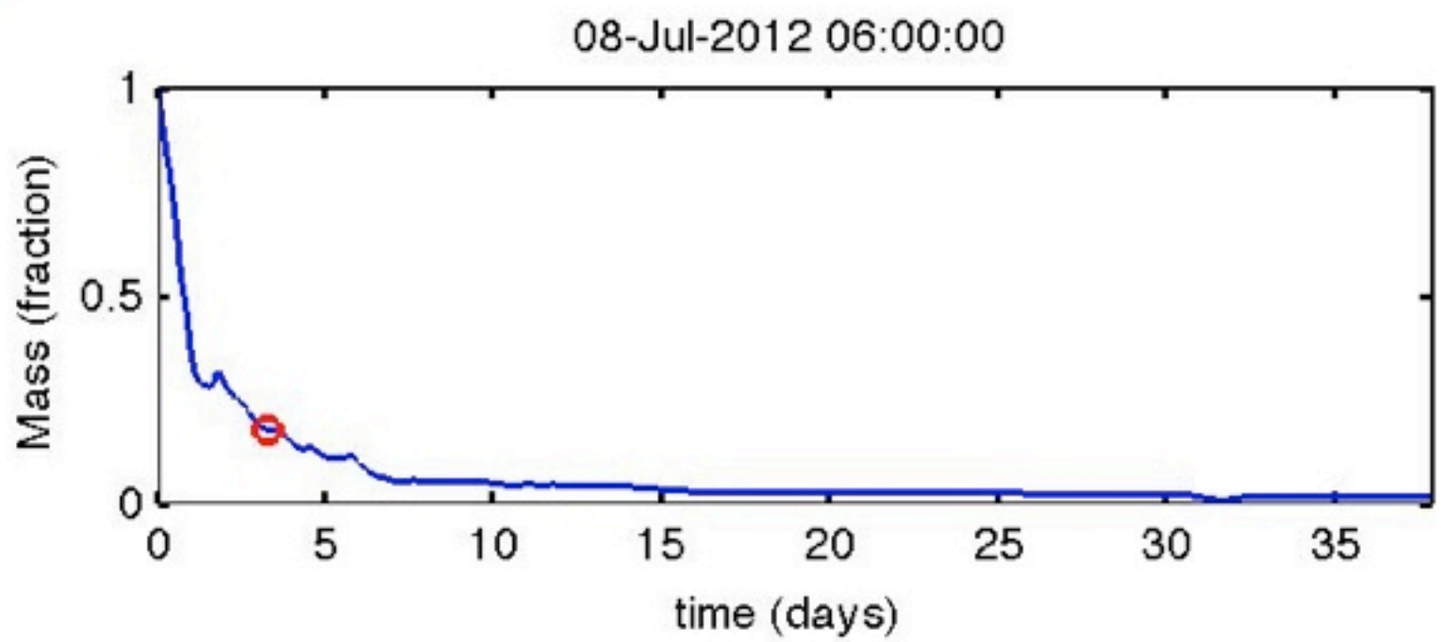

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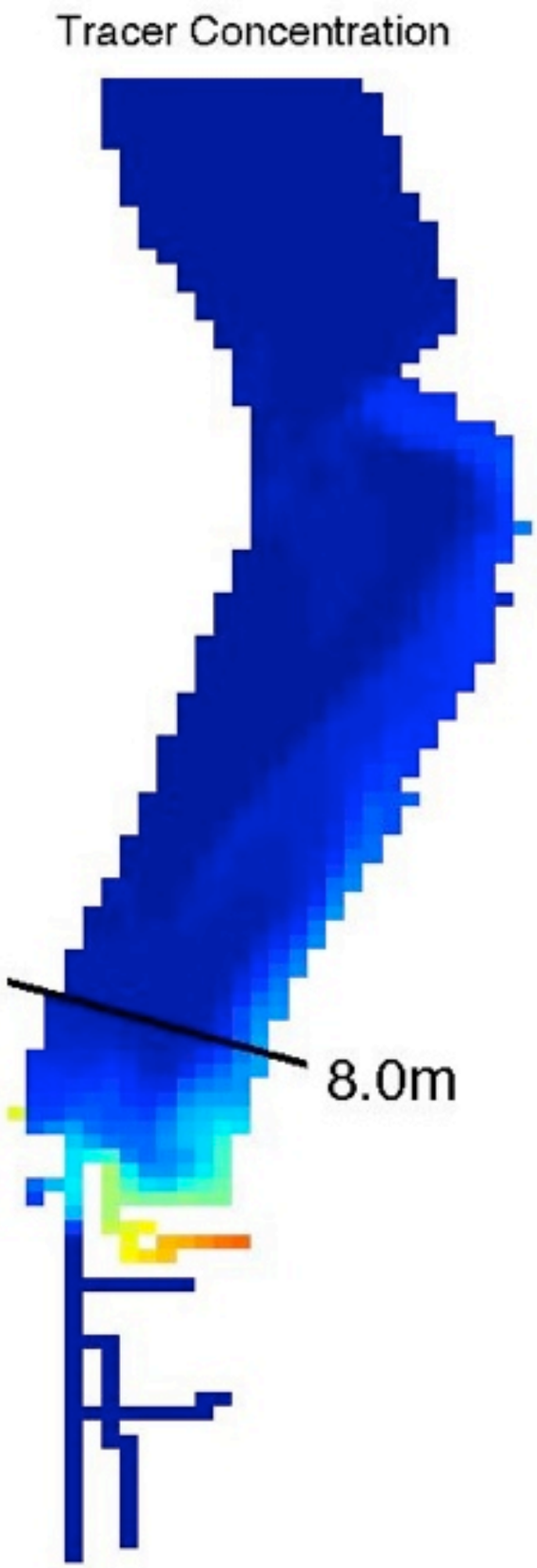


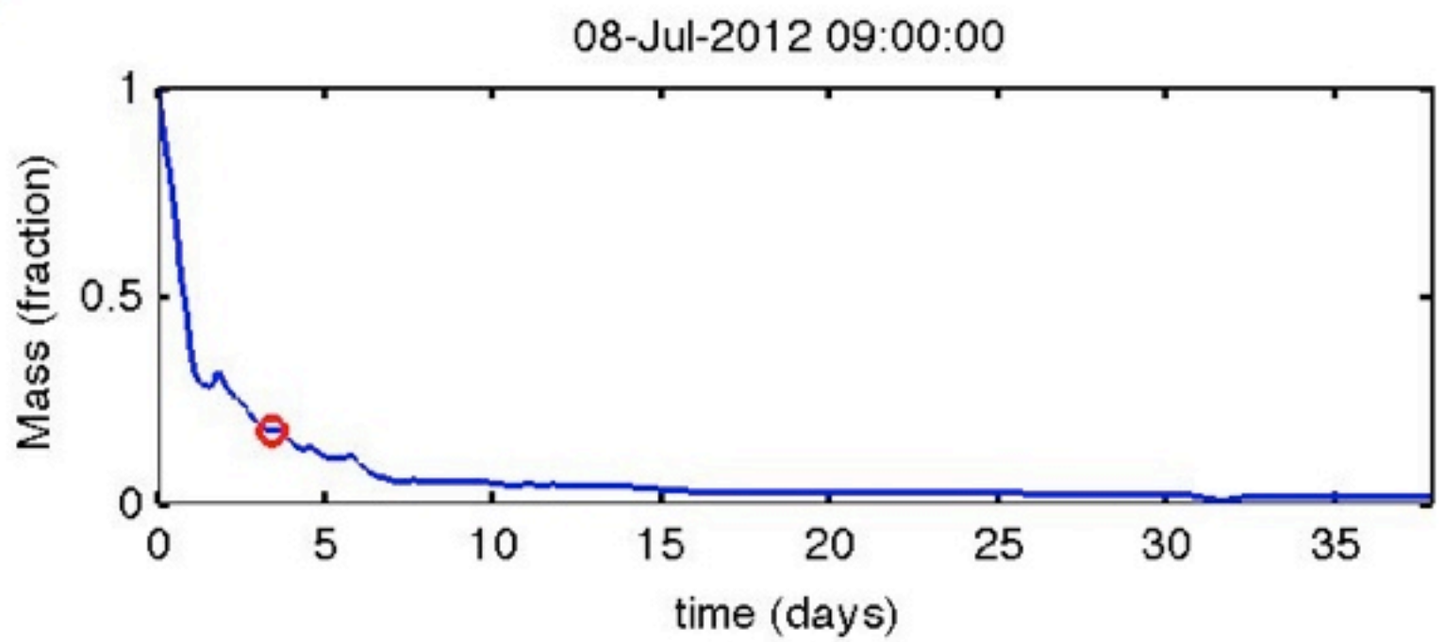

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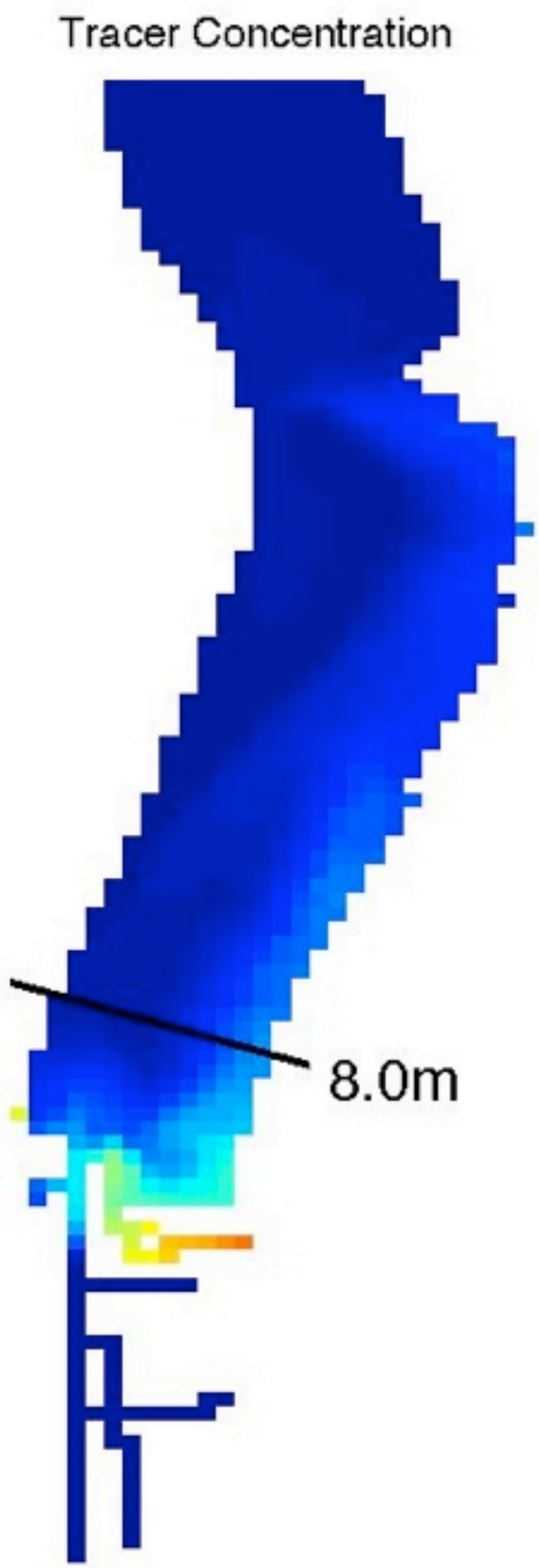


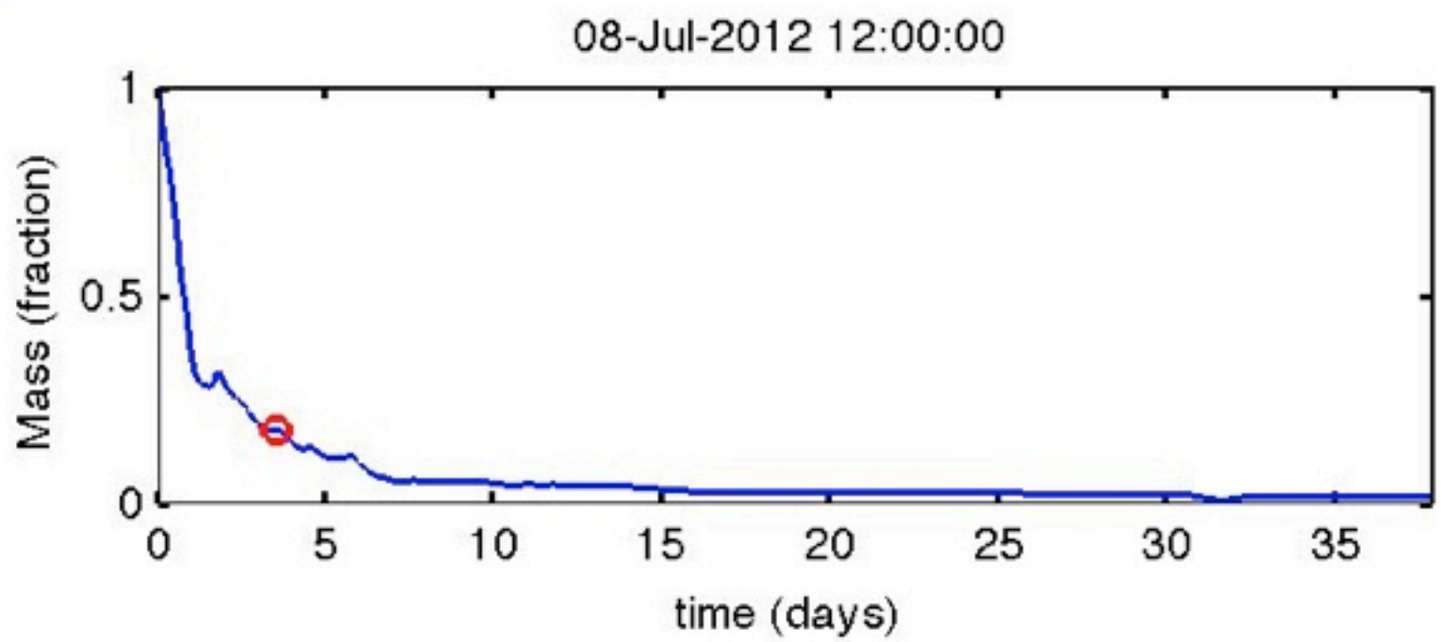

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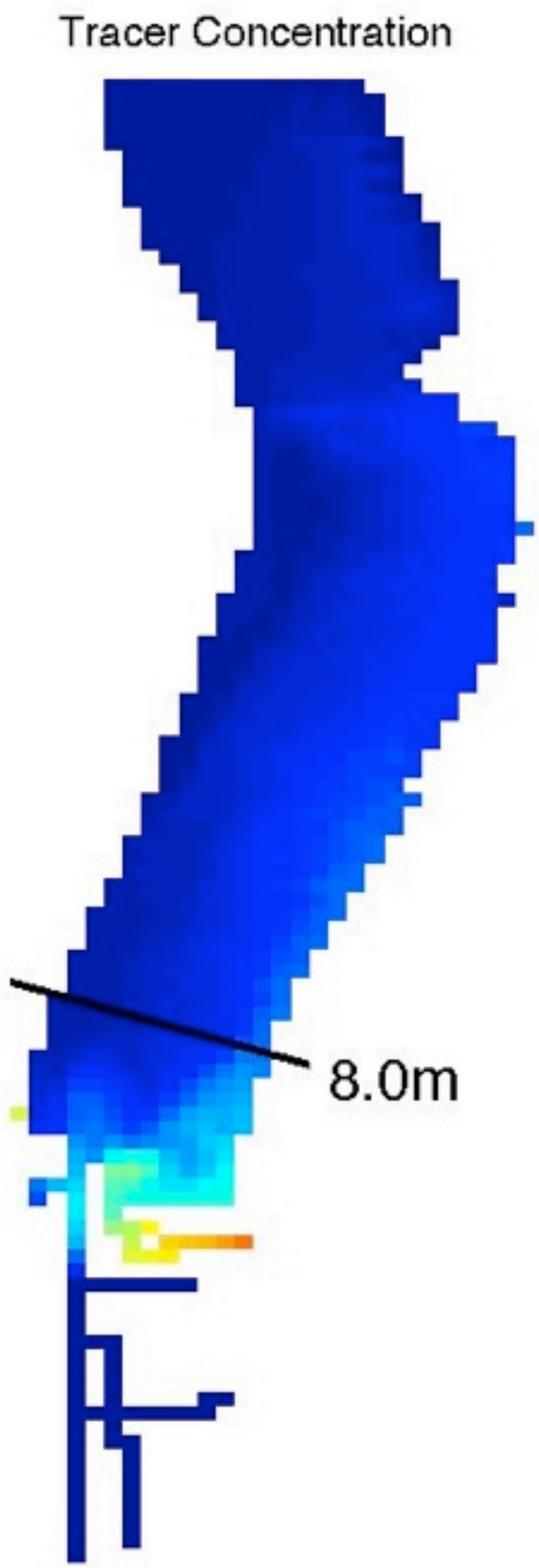


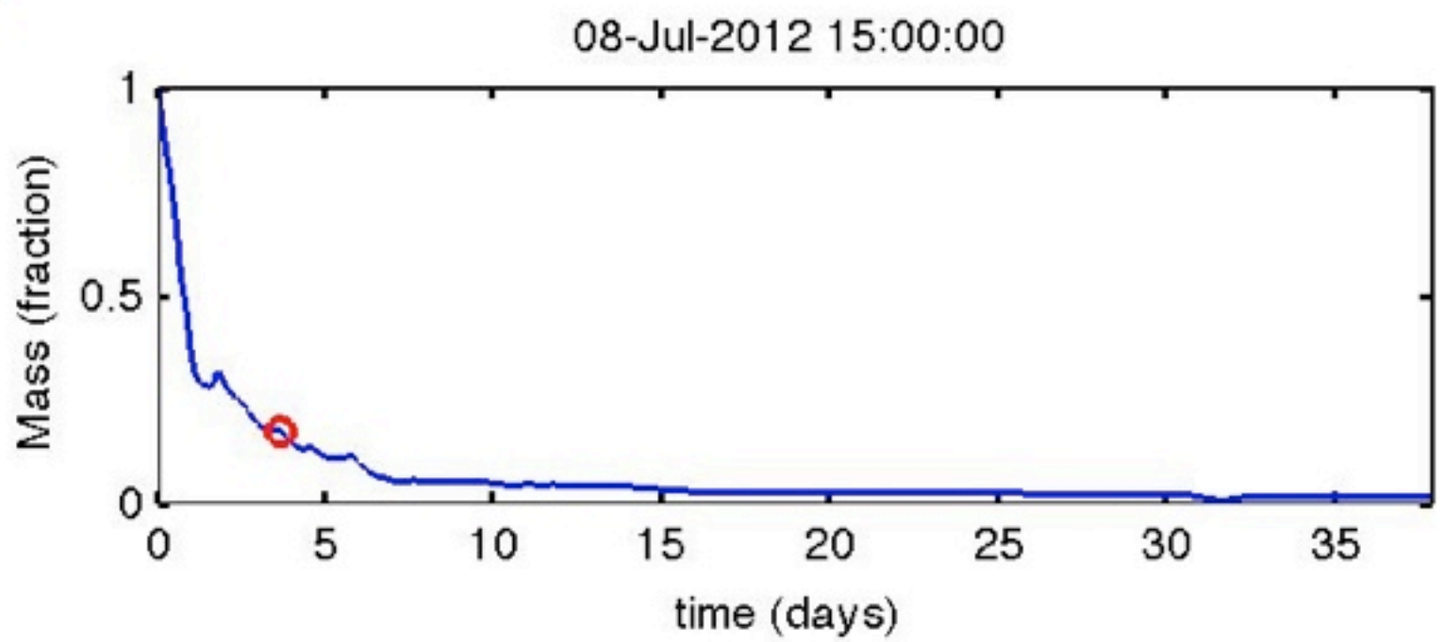

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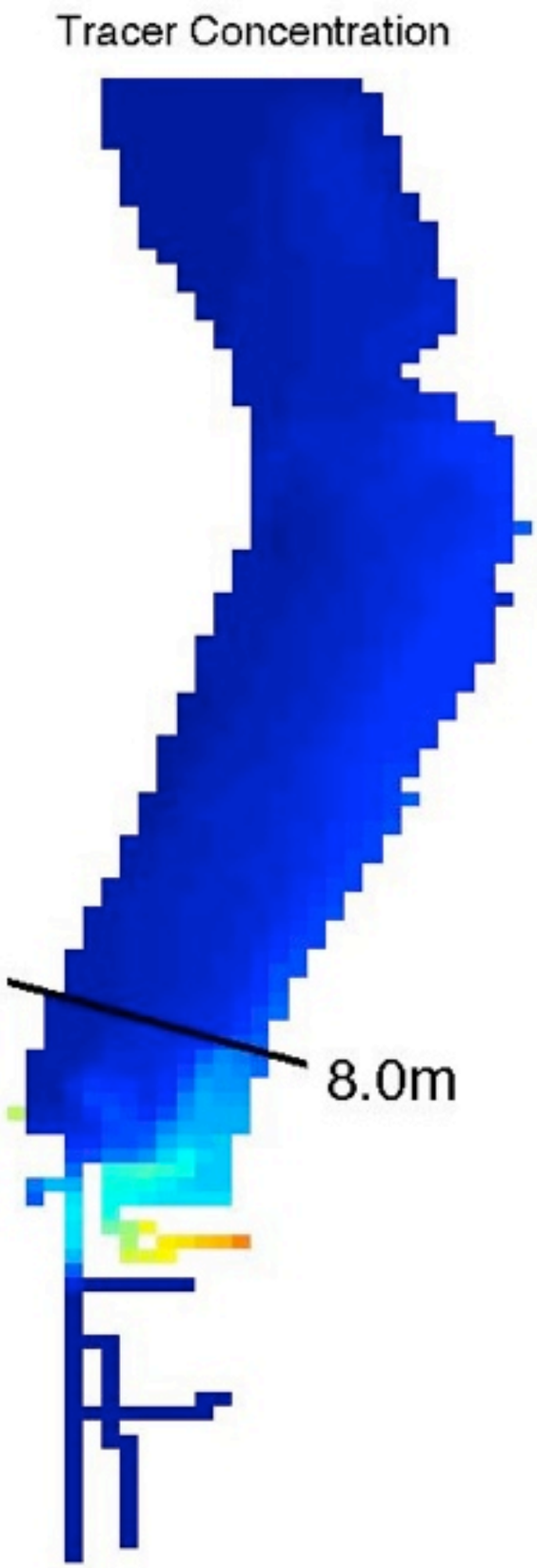


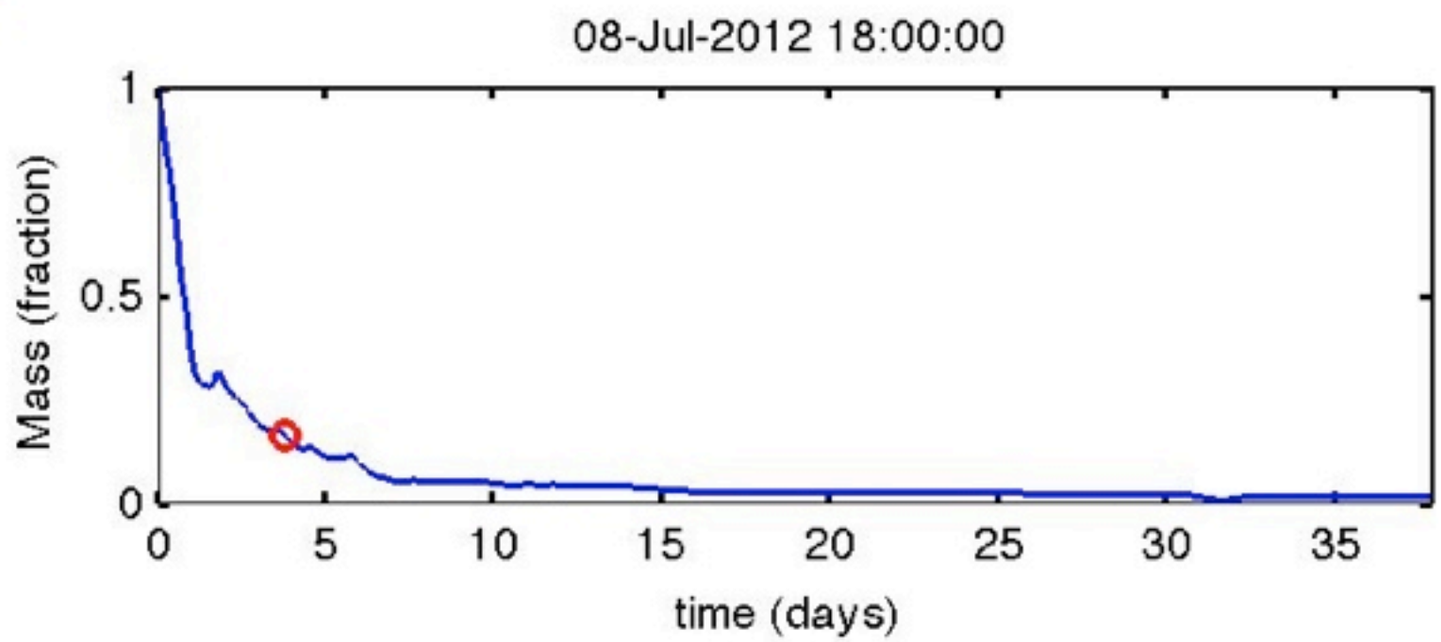

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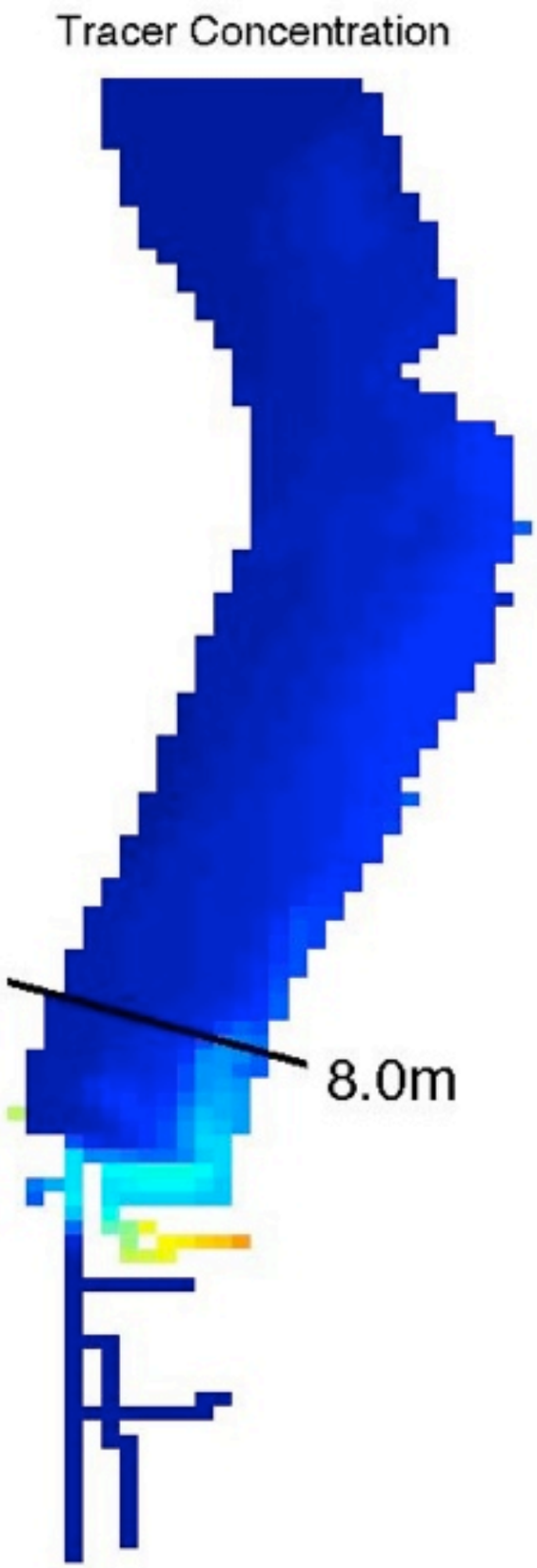


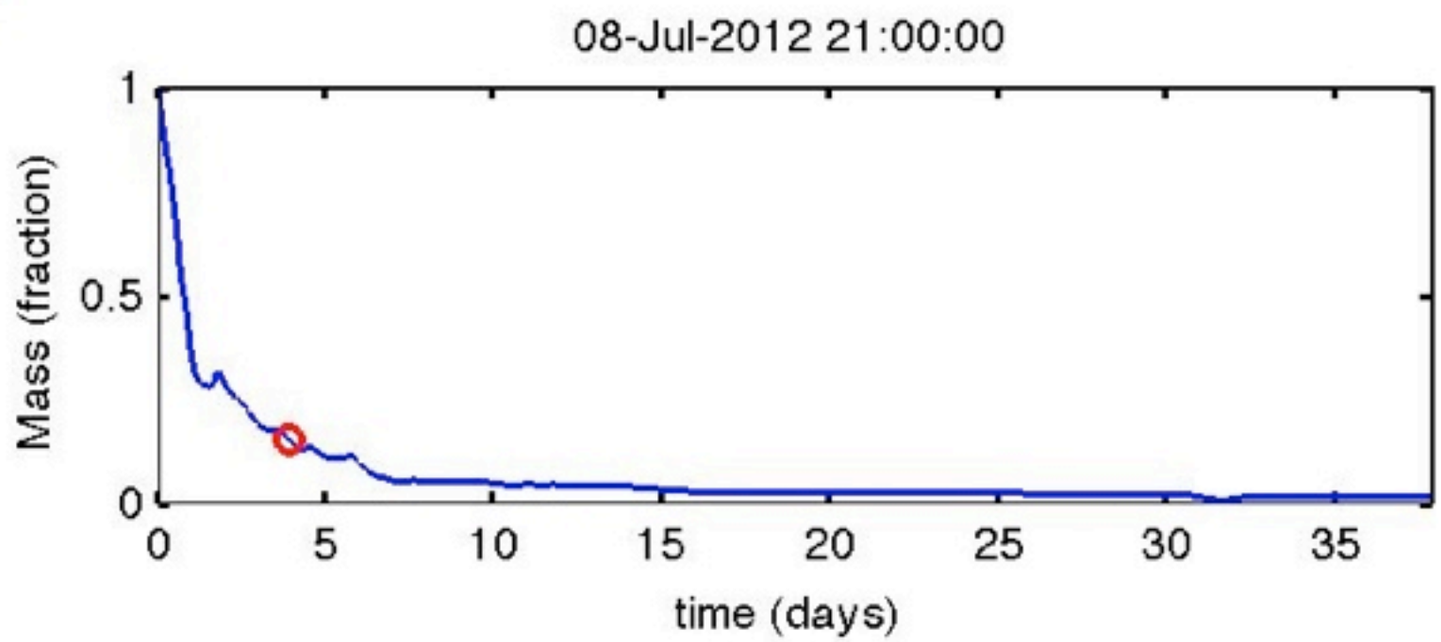

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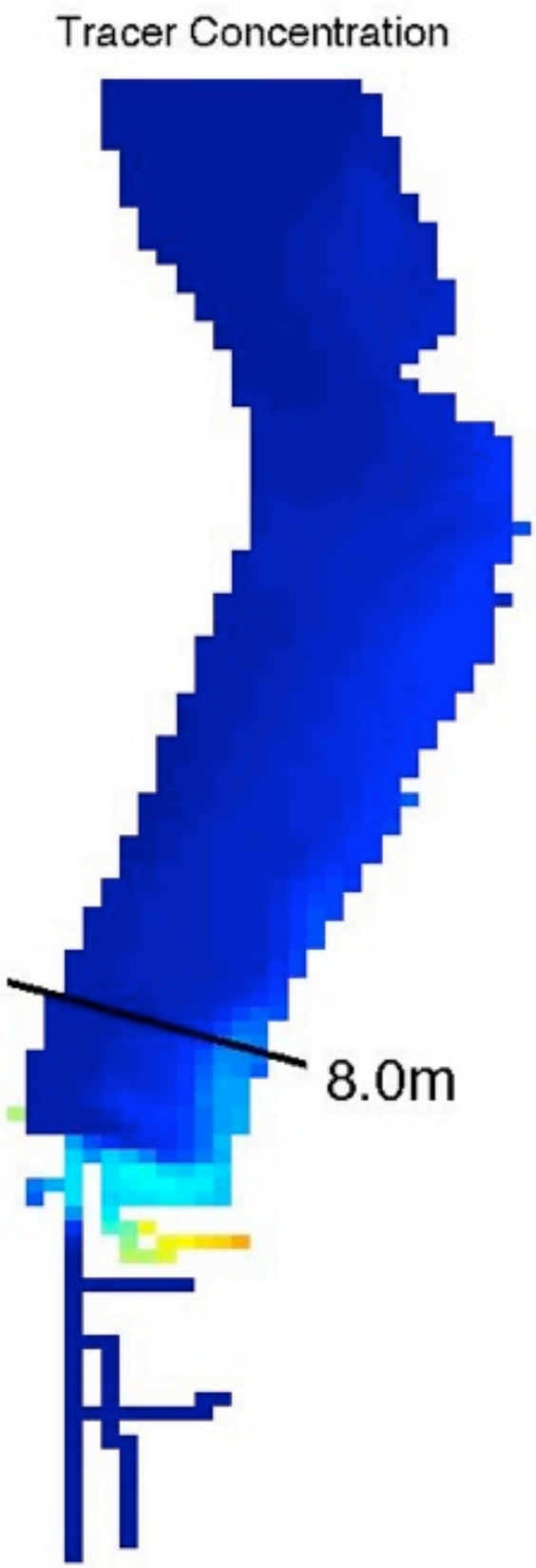


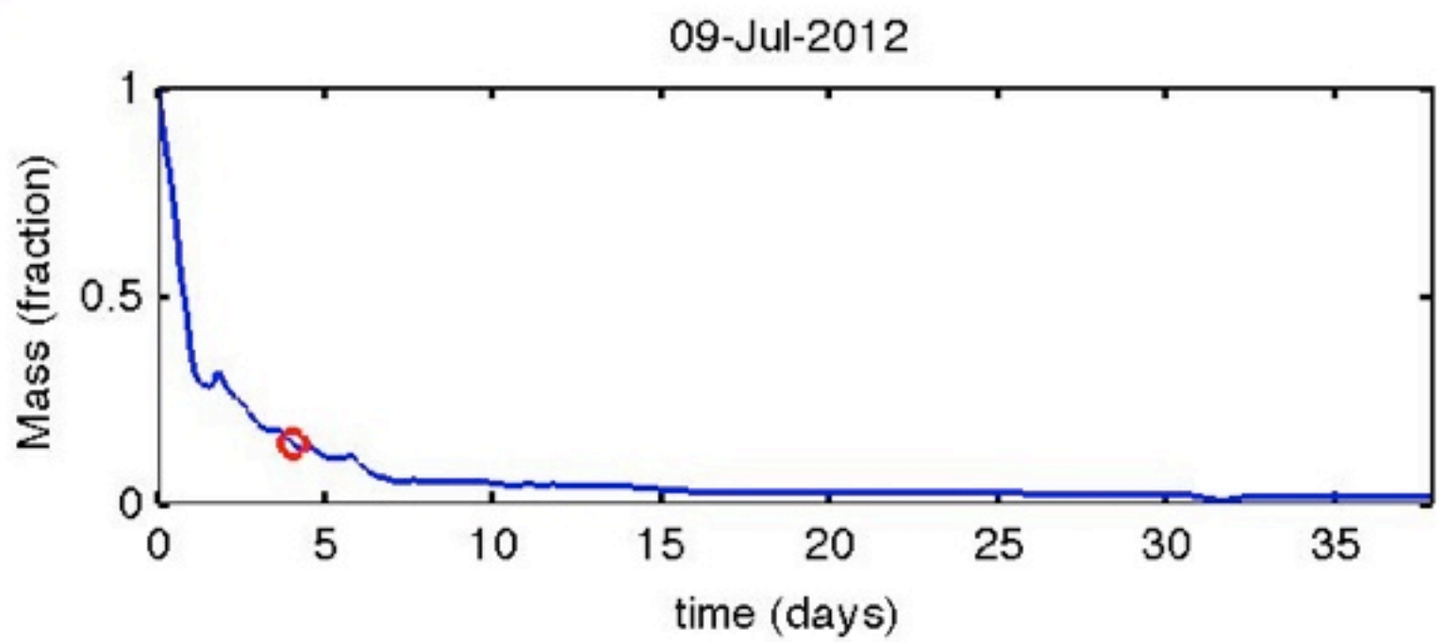

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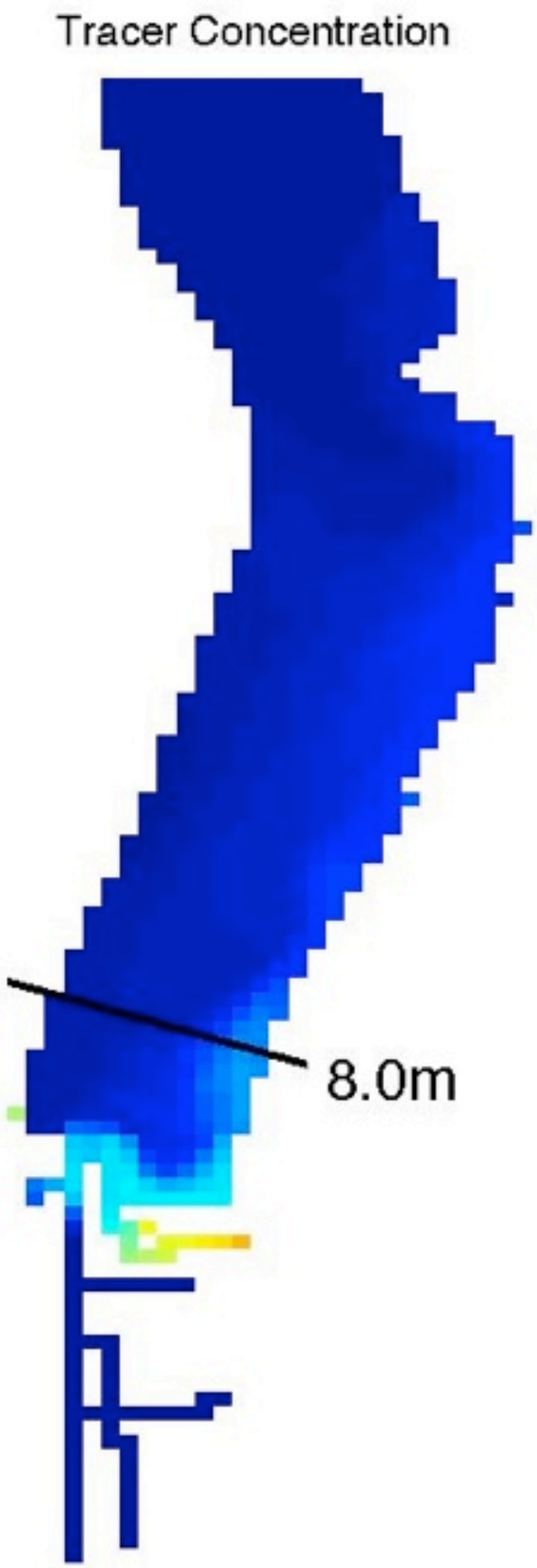
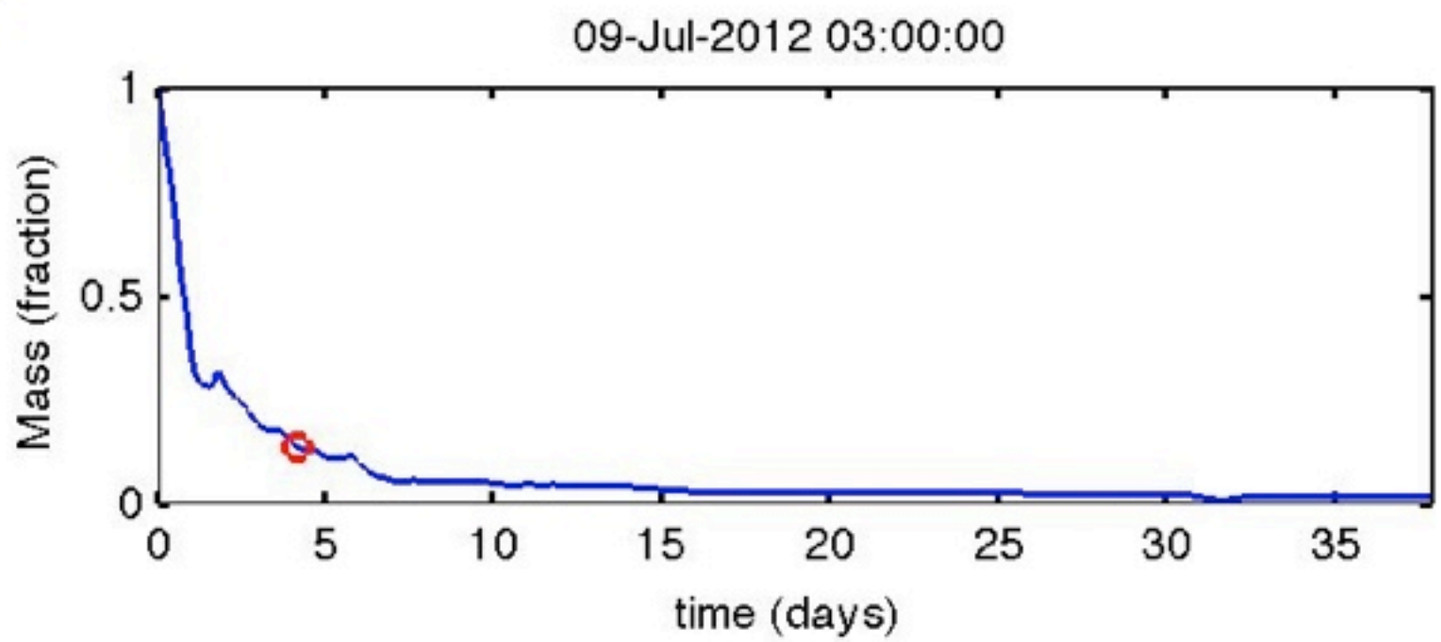
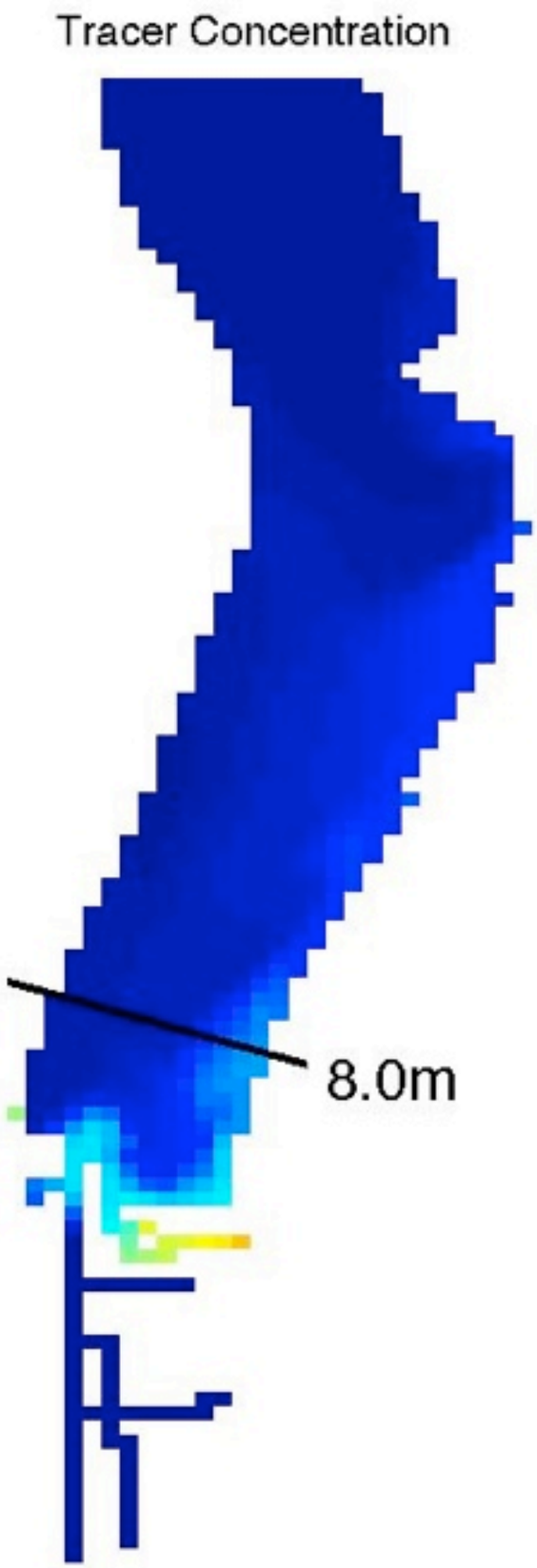
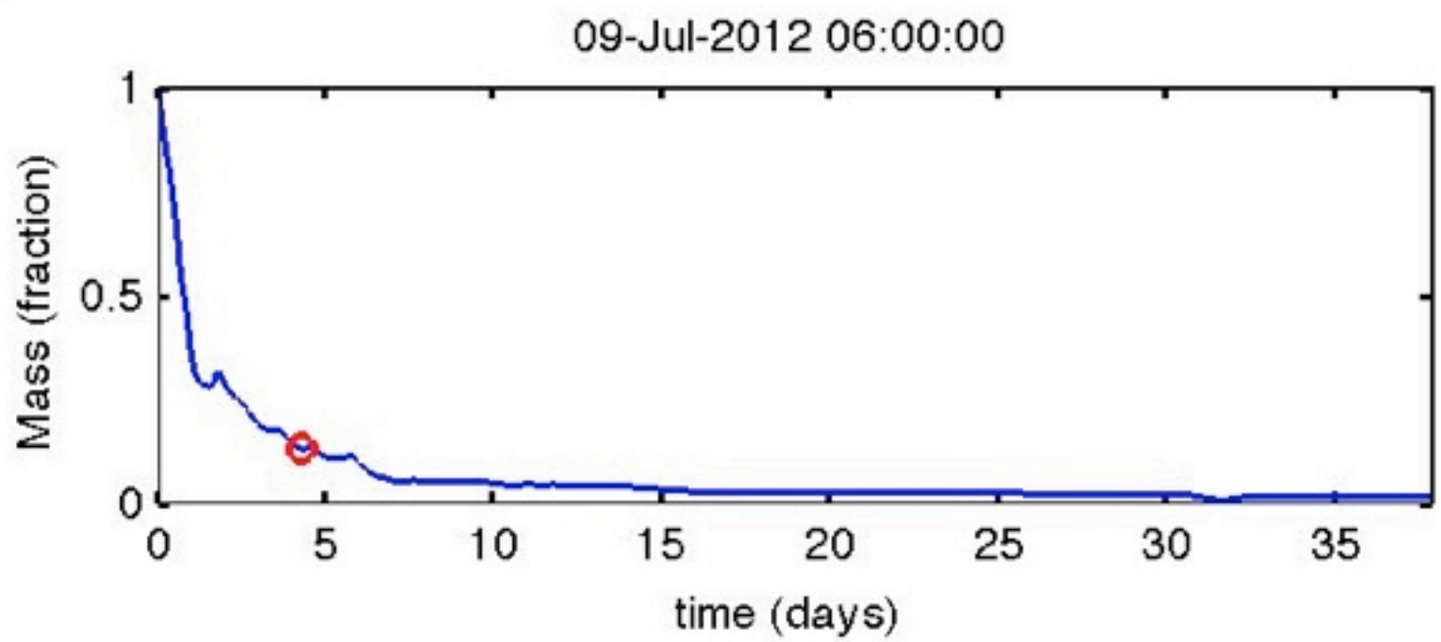


# SI3D: Flushing Time Experiments



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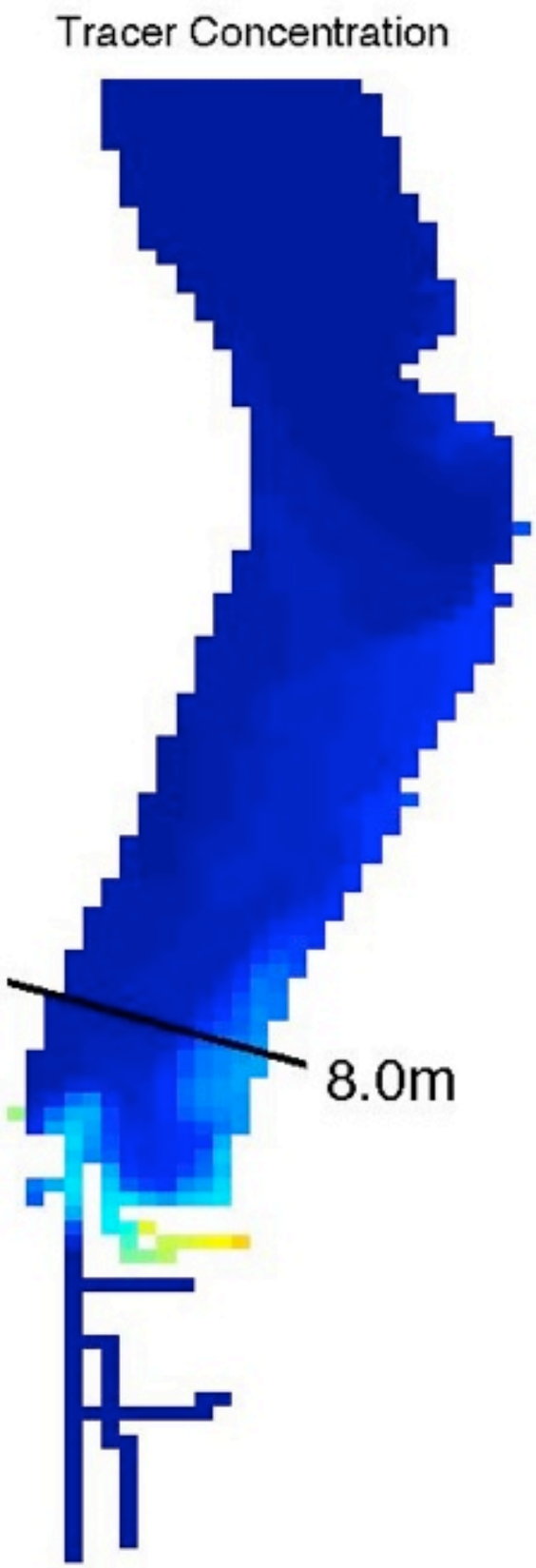


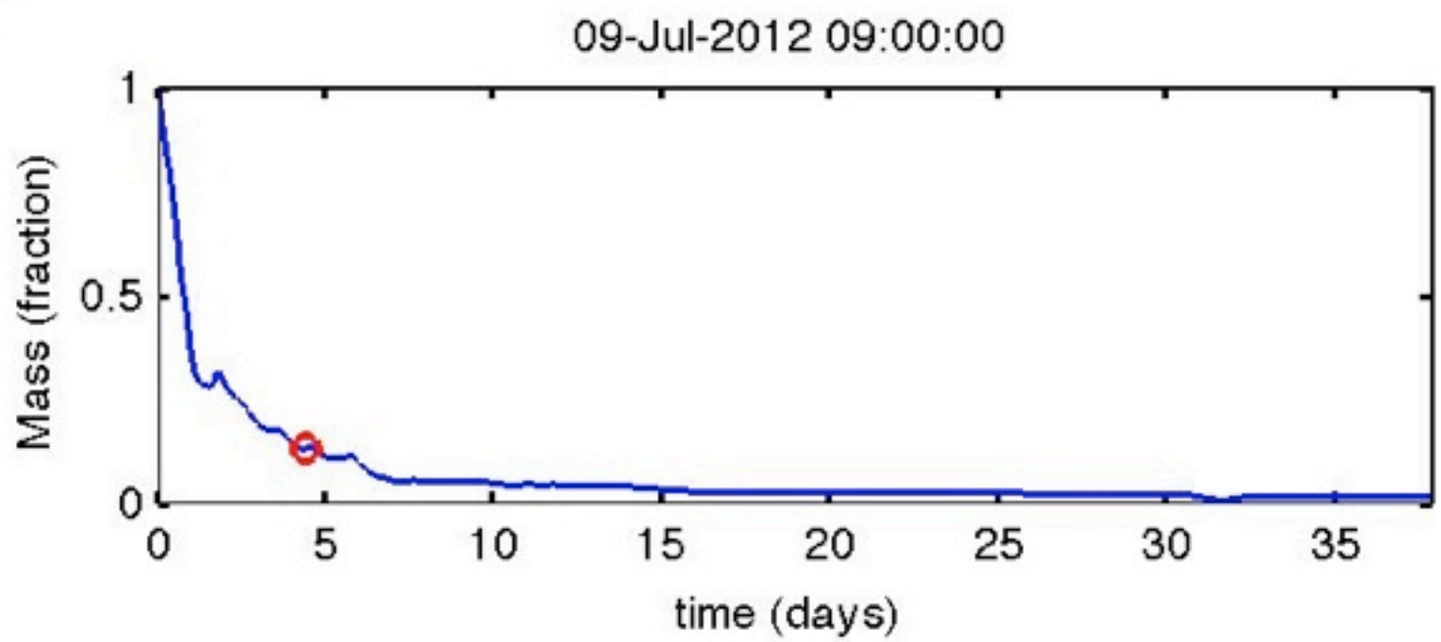

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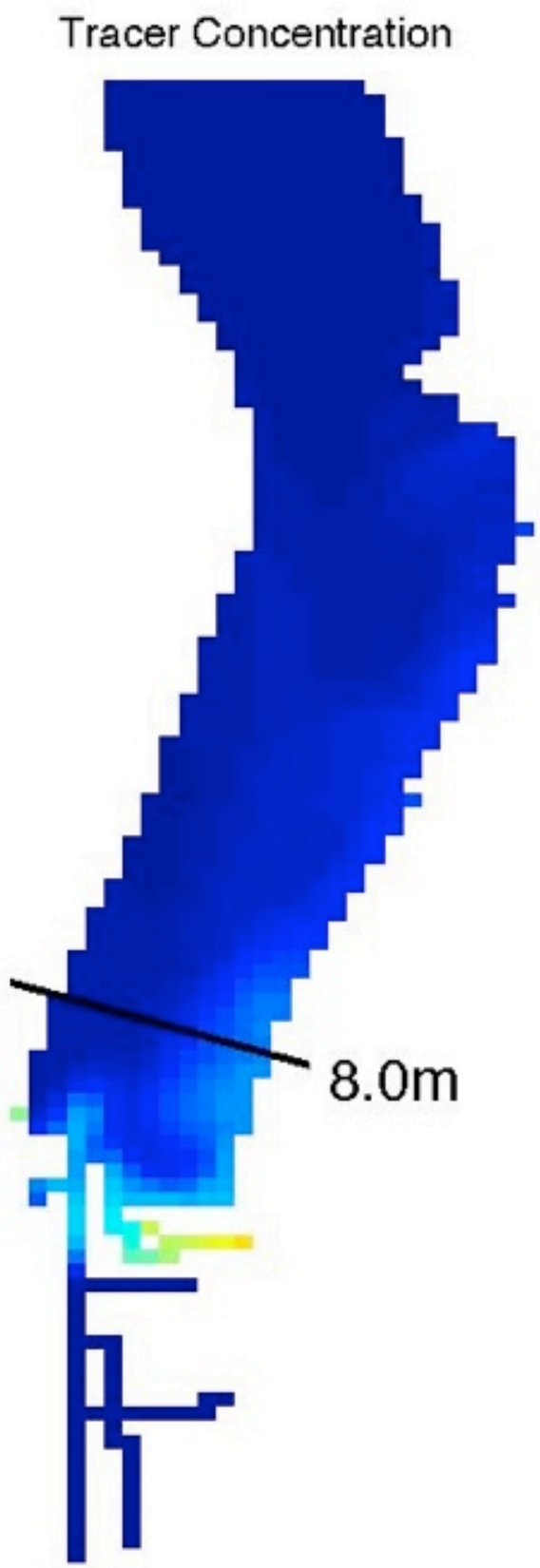


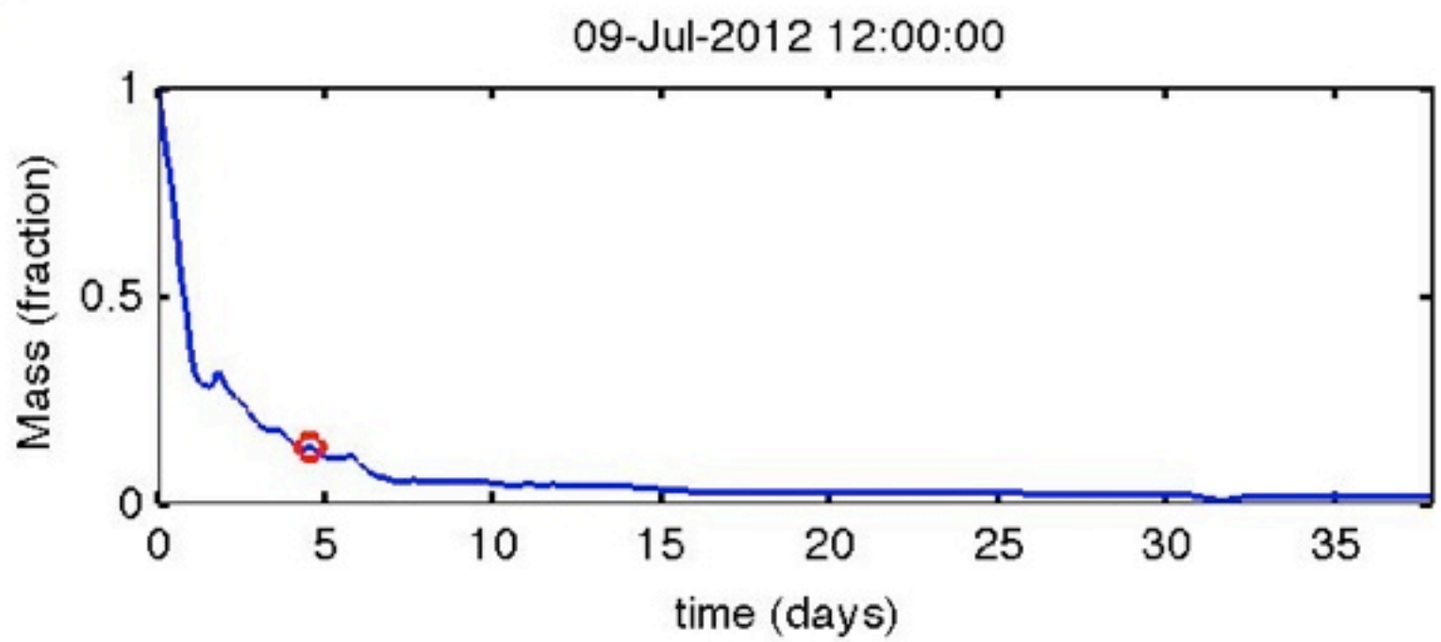

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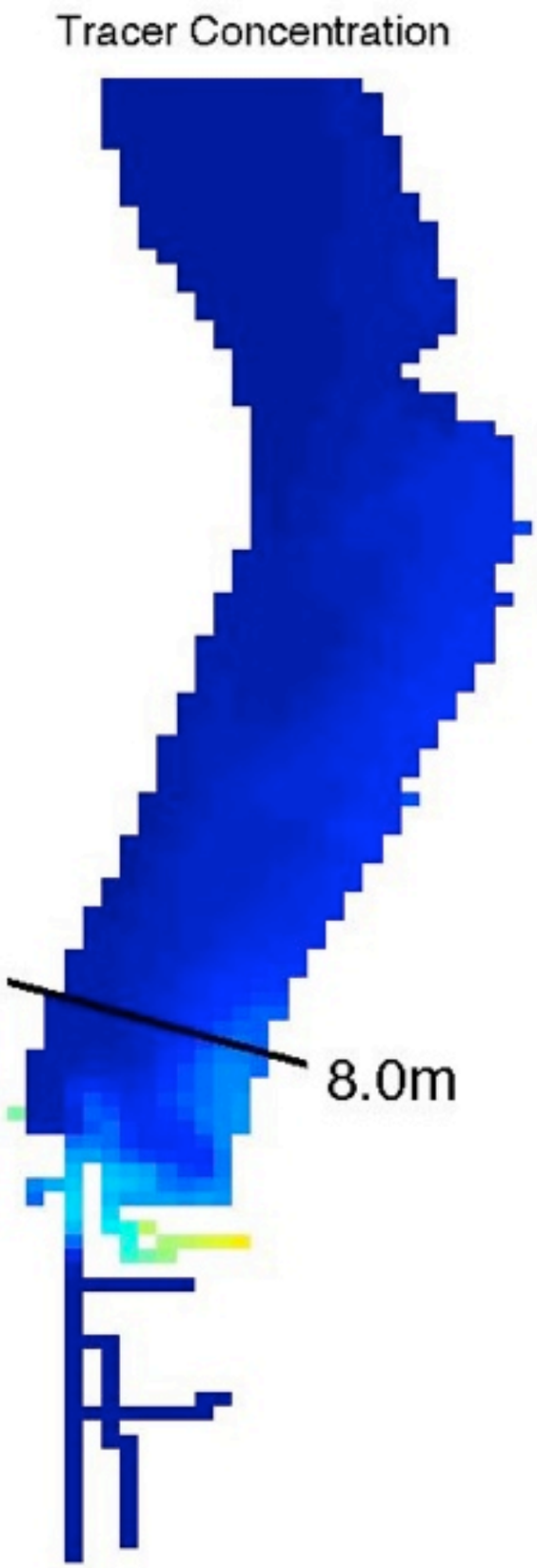


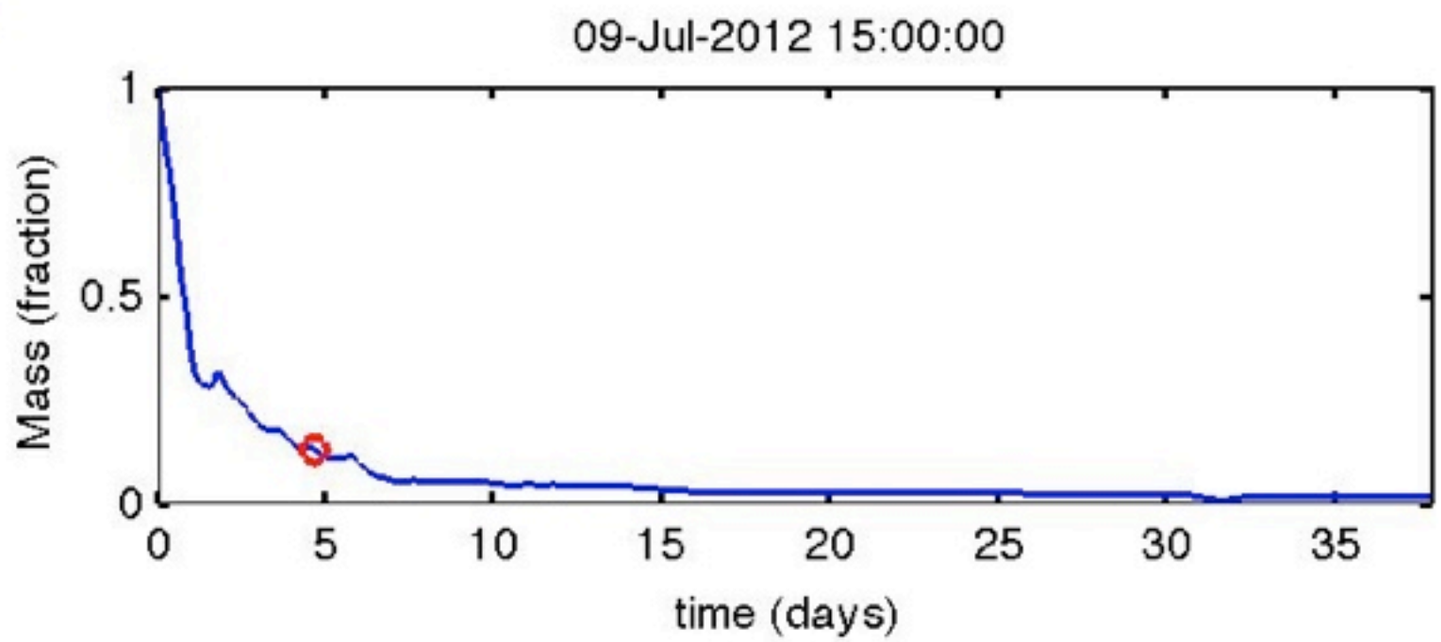

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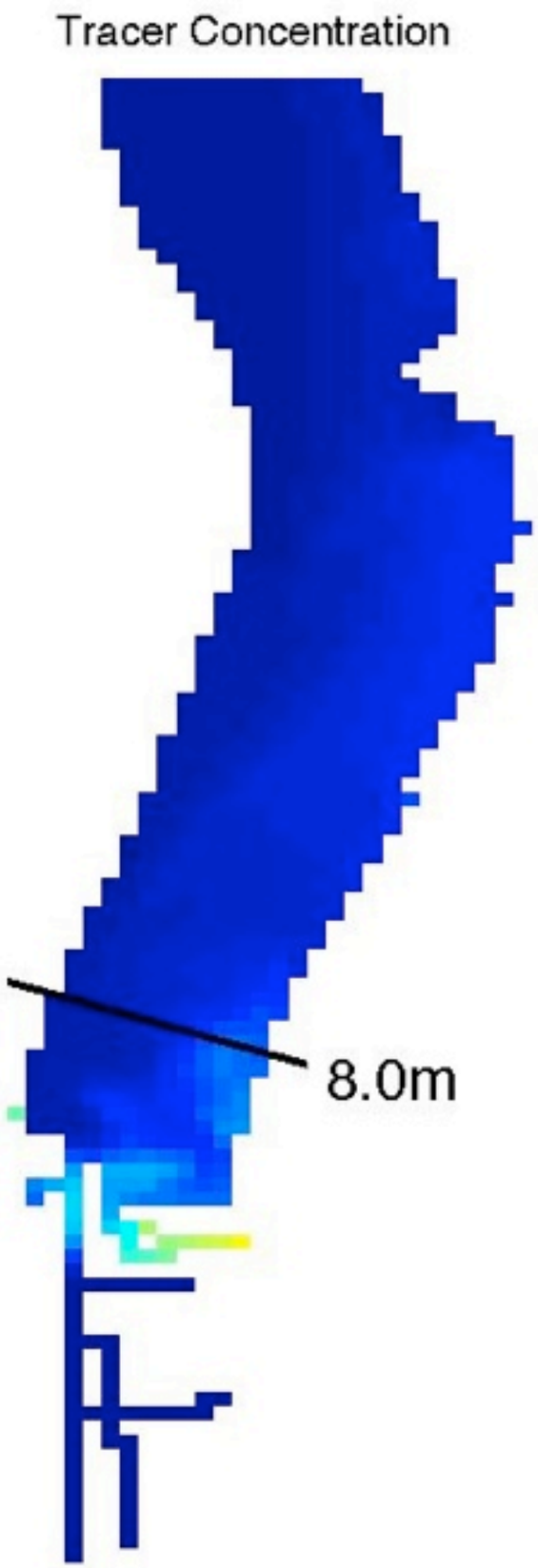


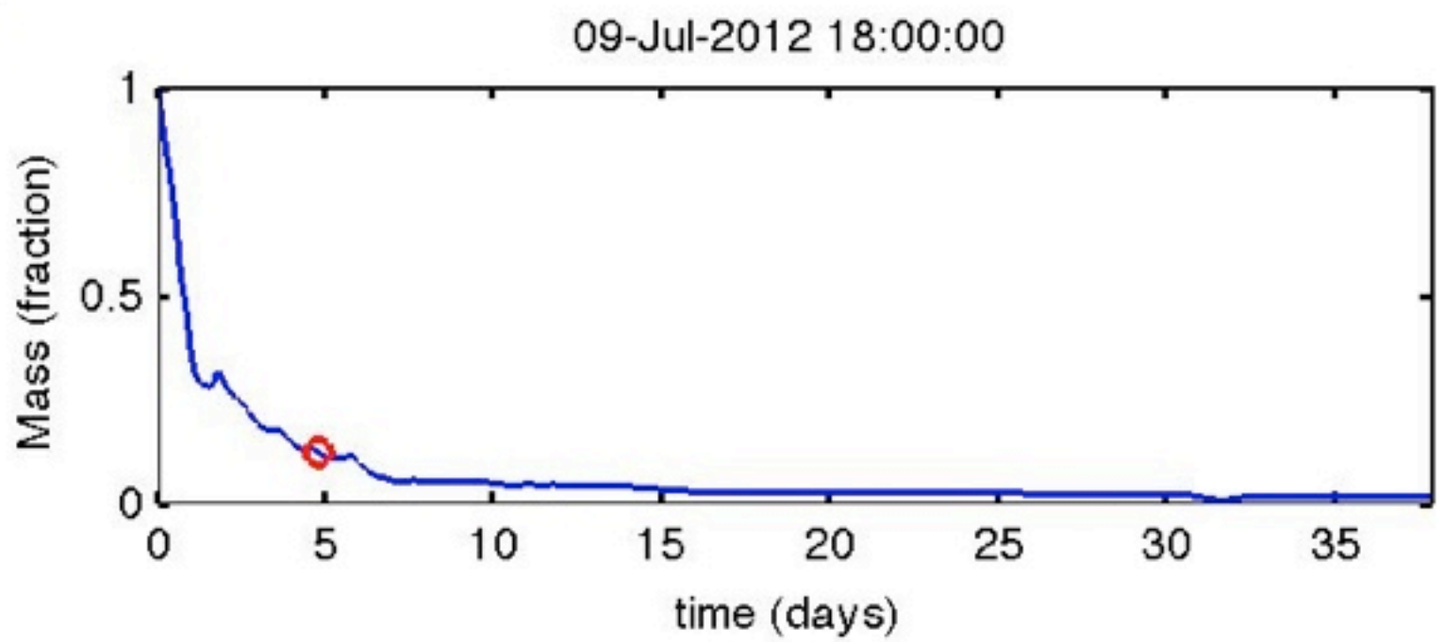

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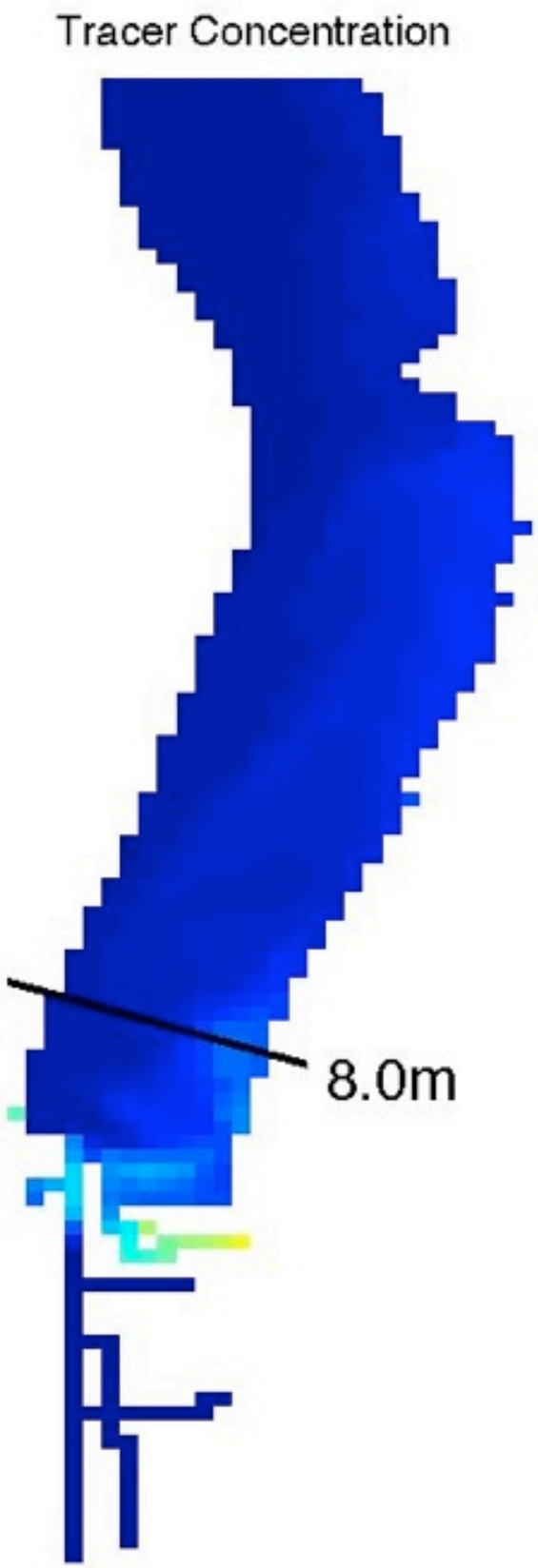


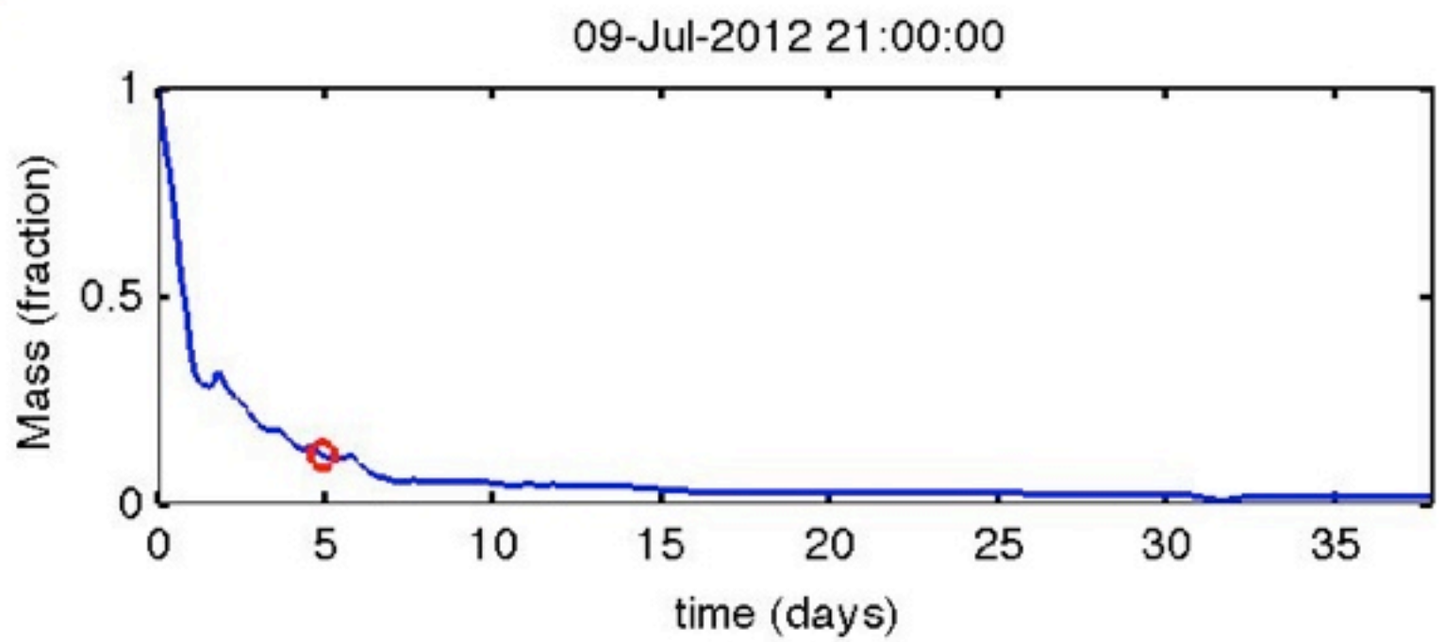

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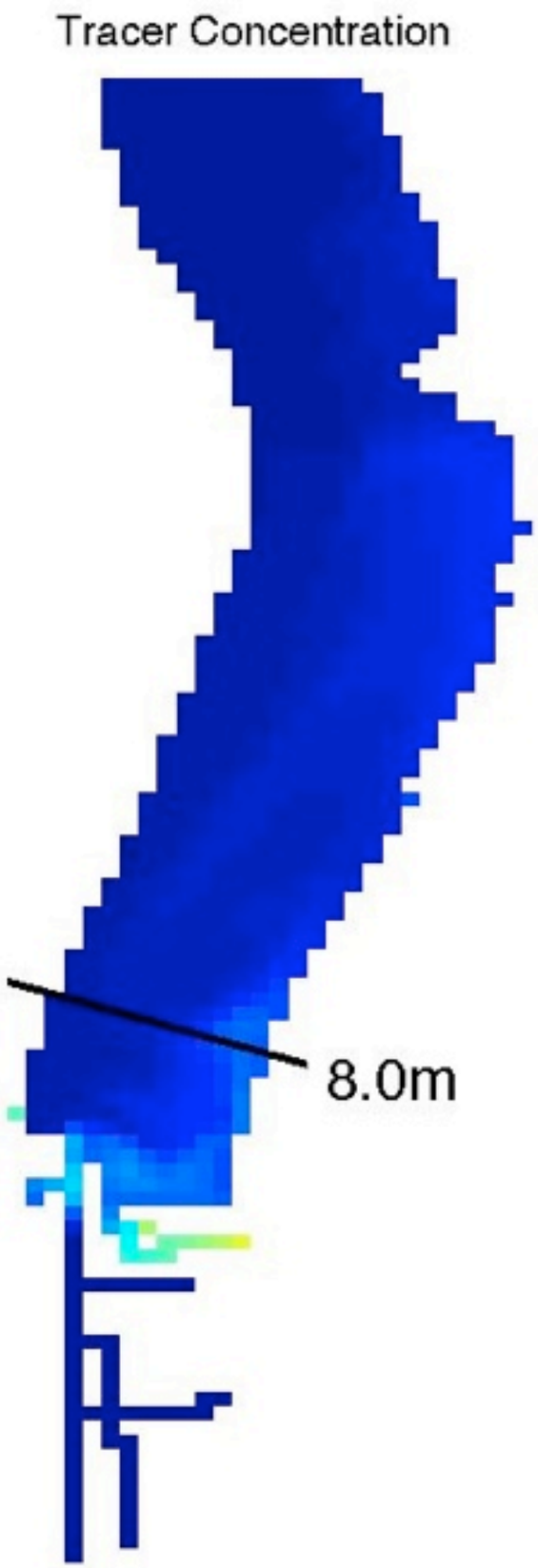


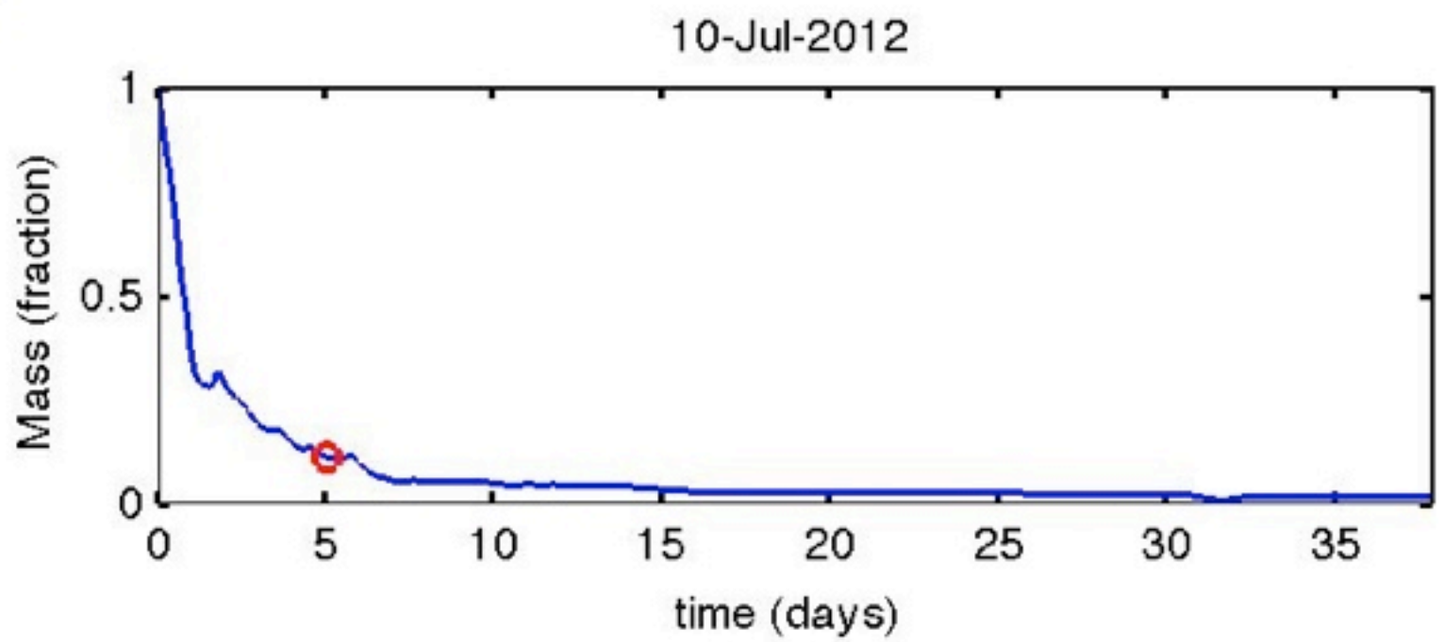

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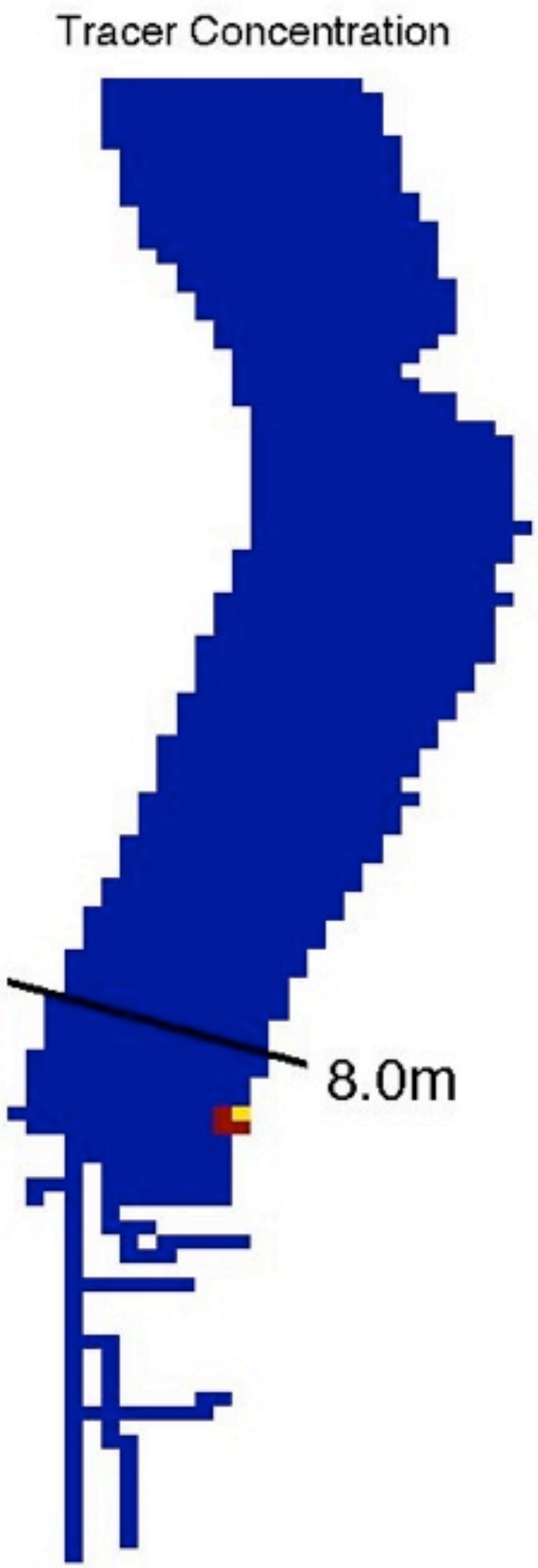


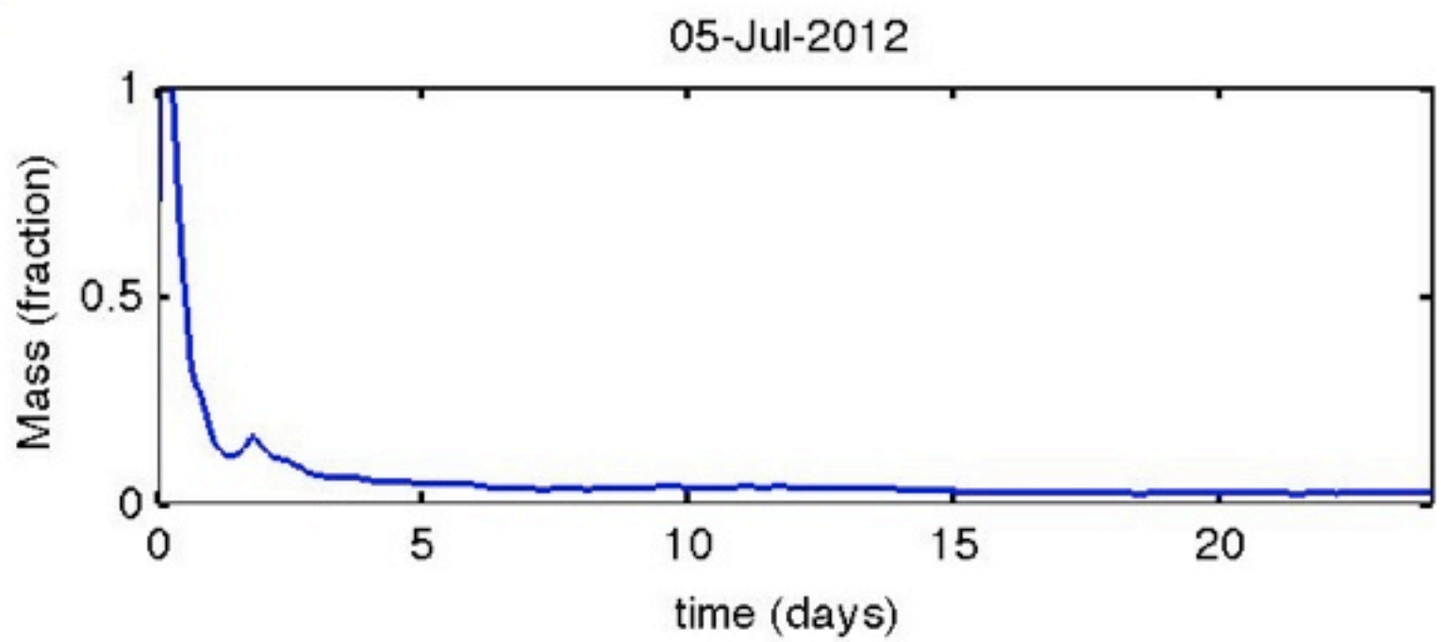

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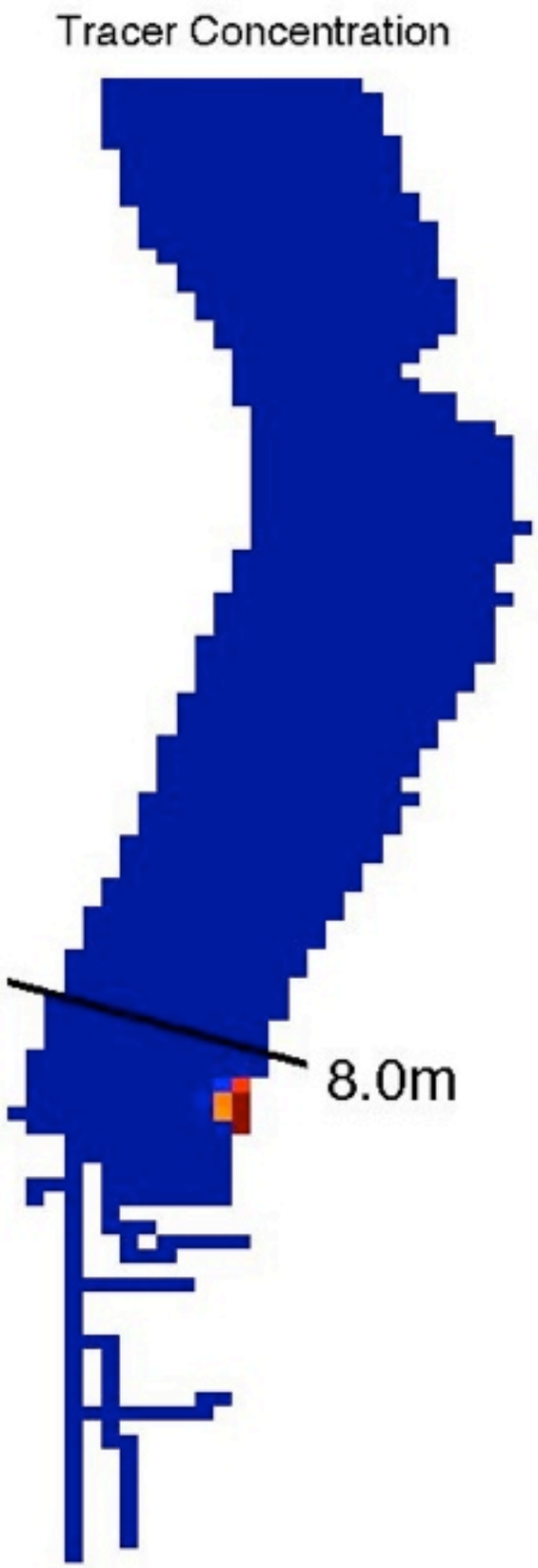


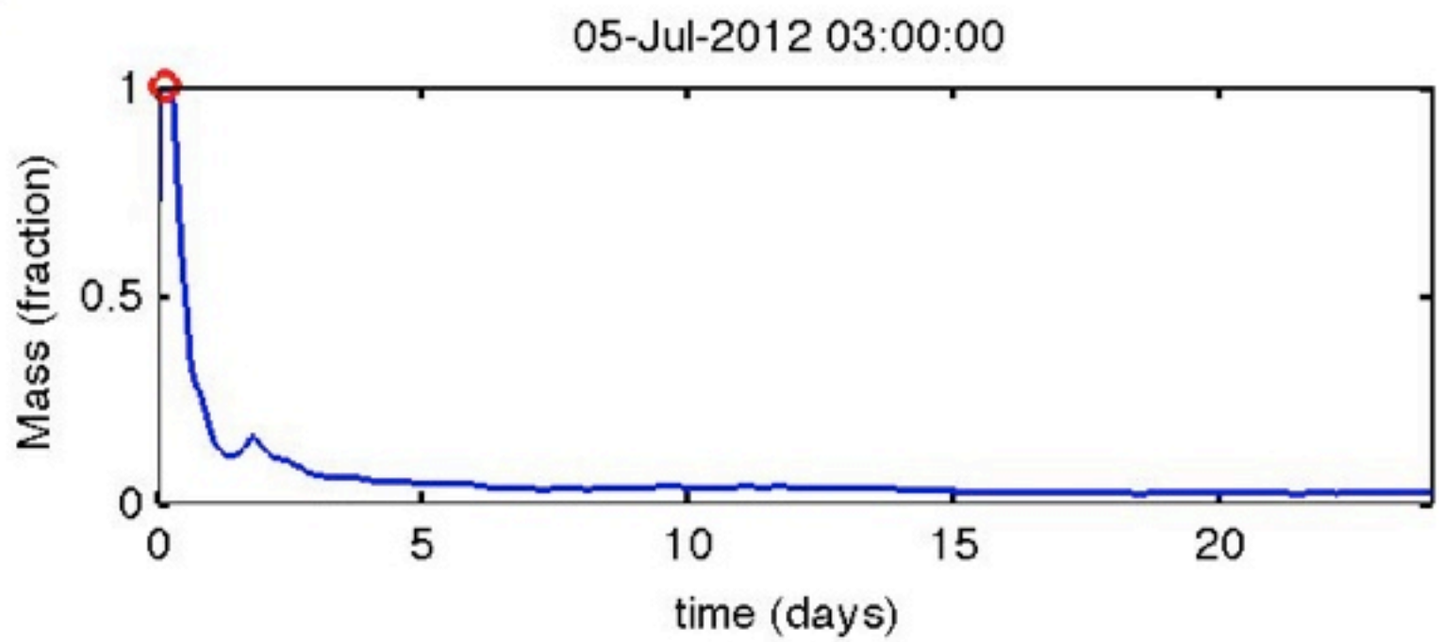

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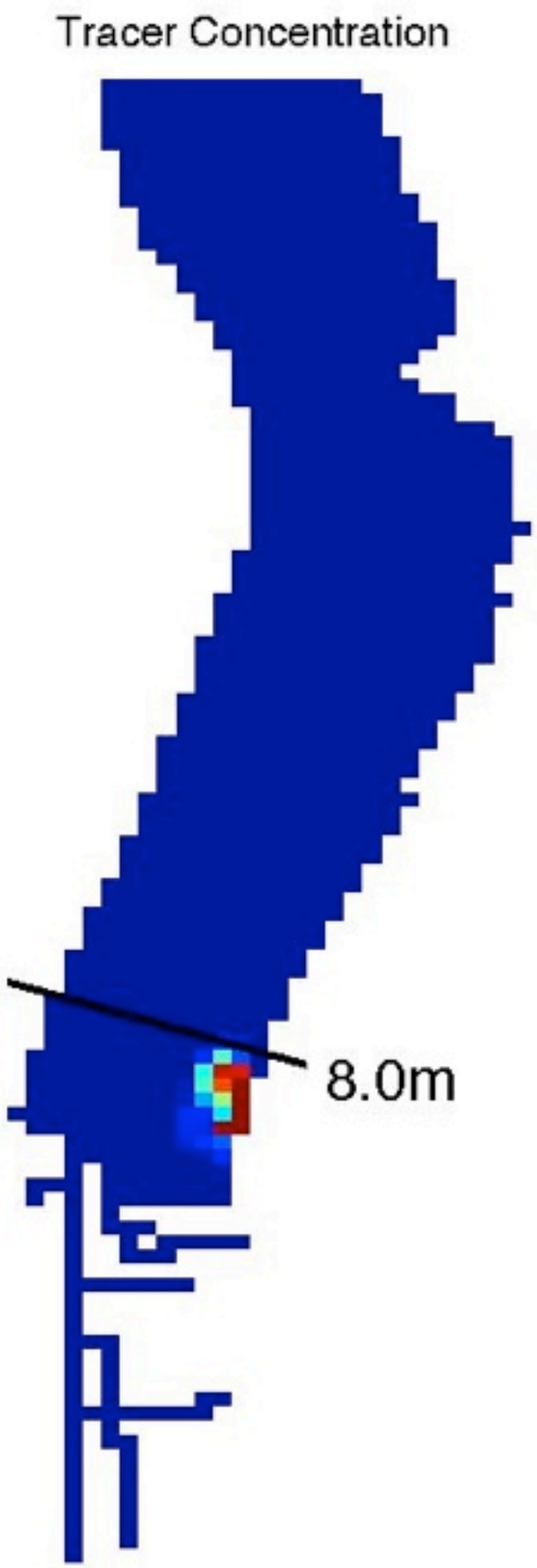


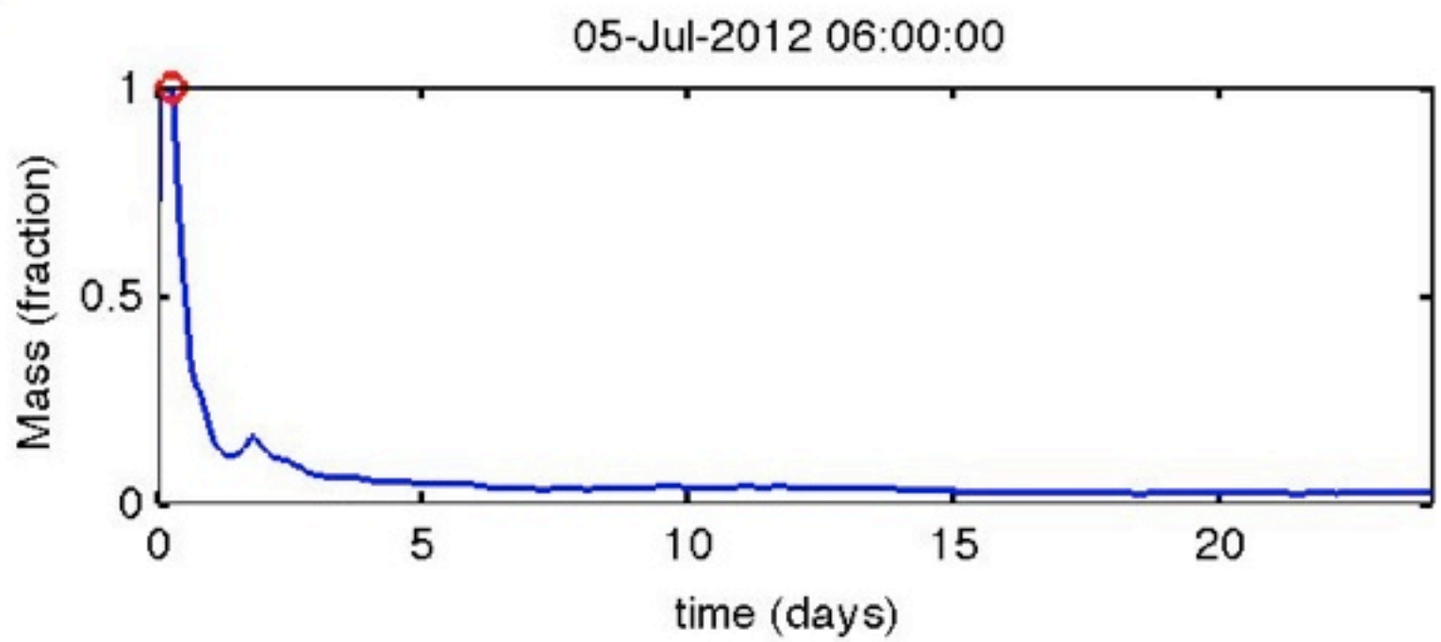

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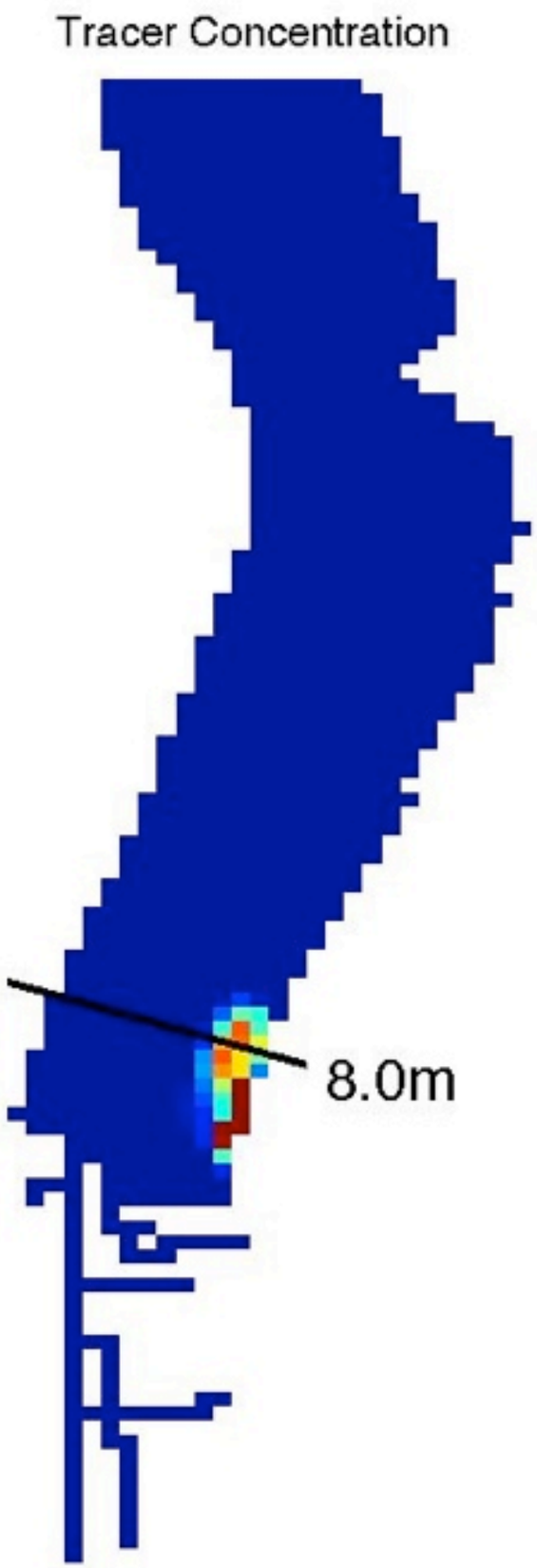


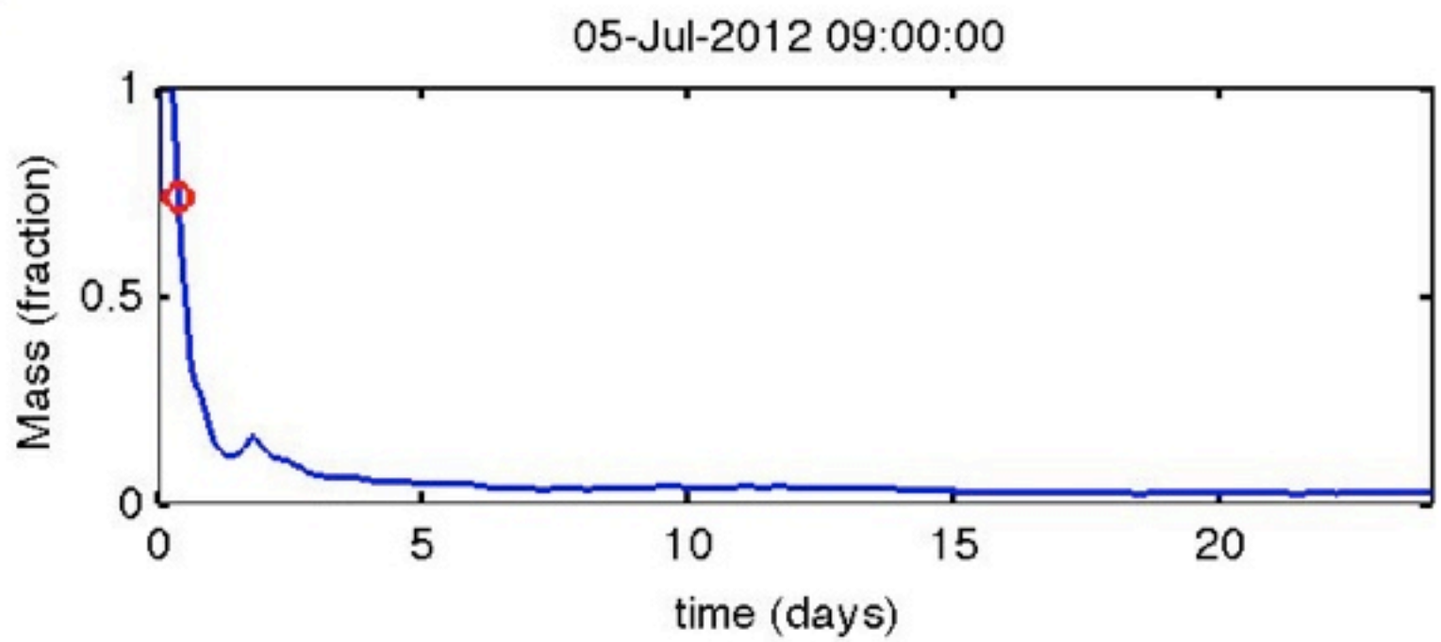

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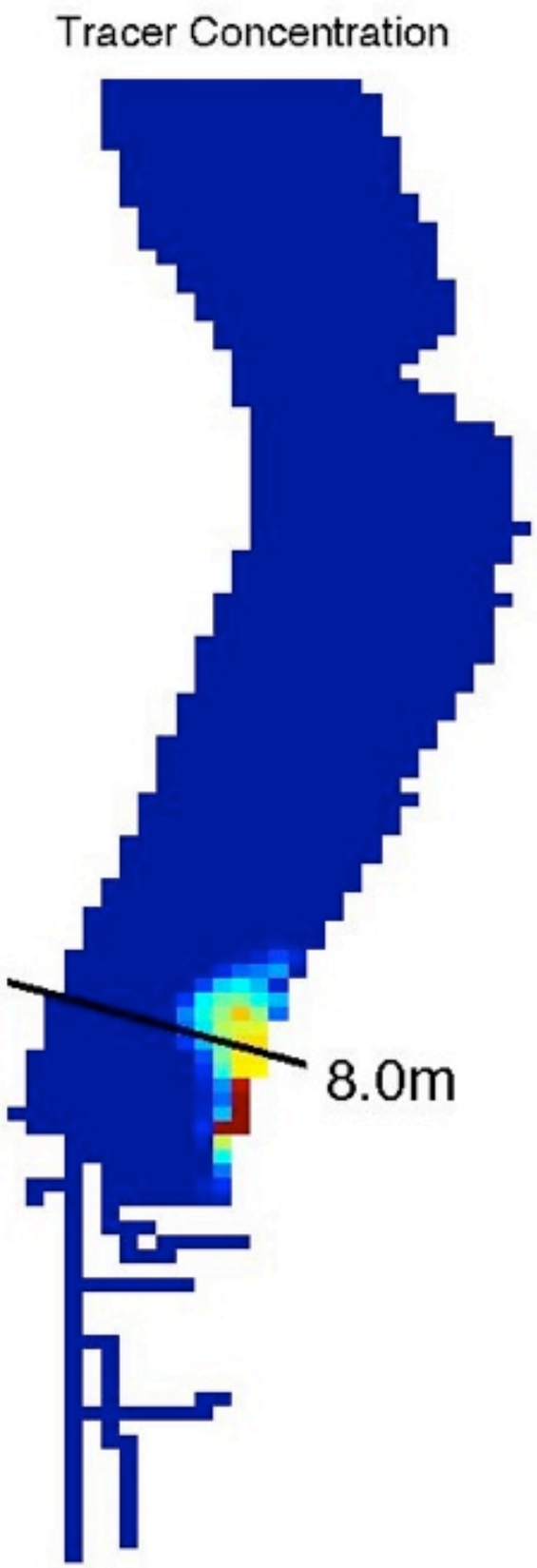


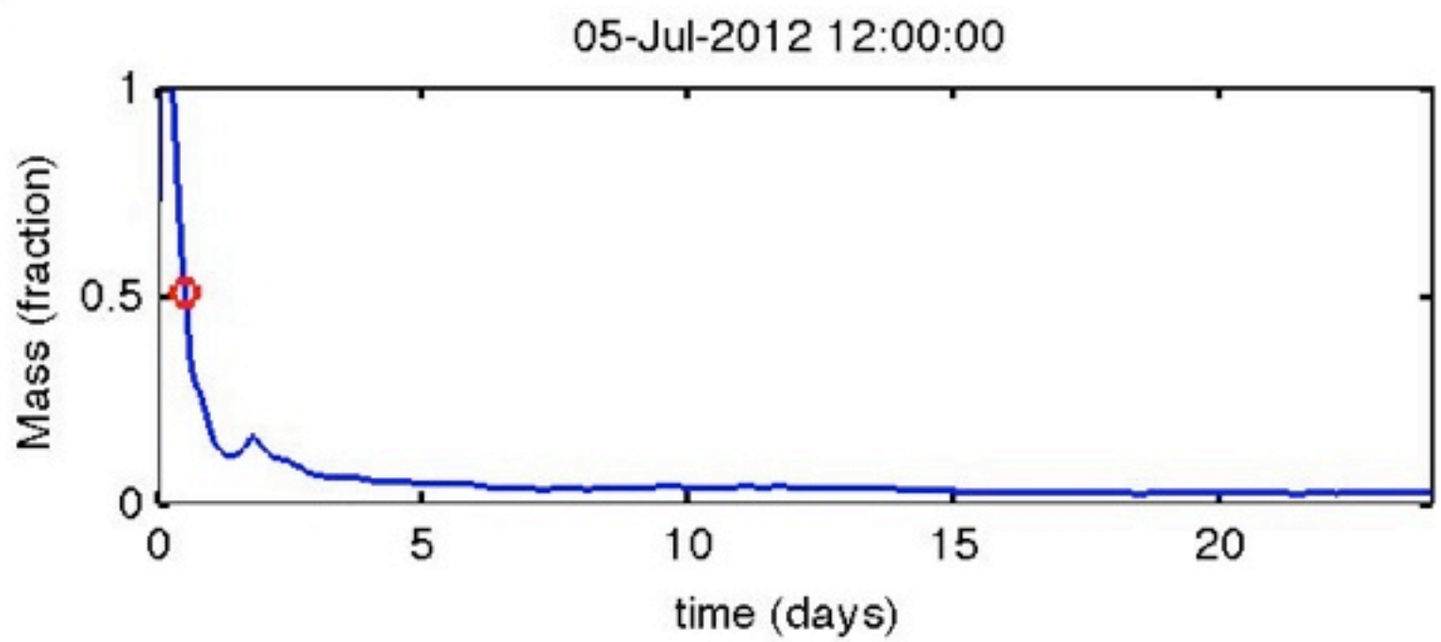

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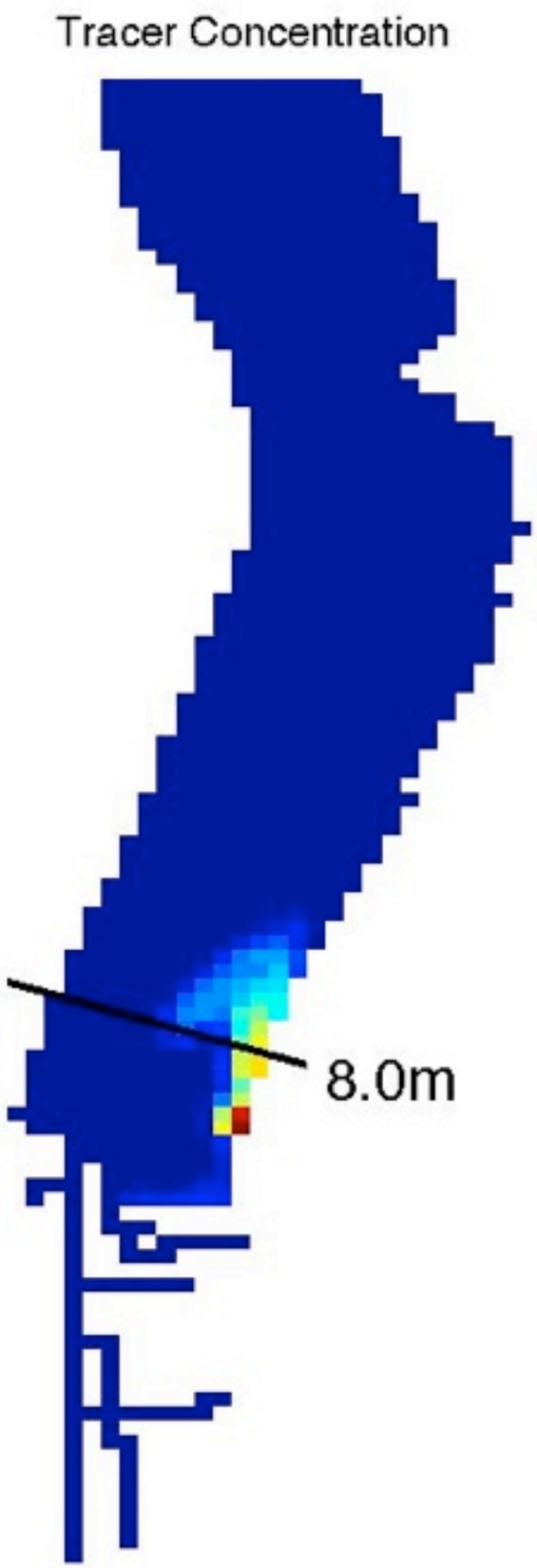


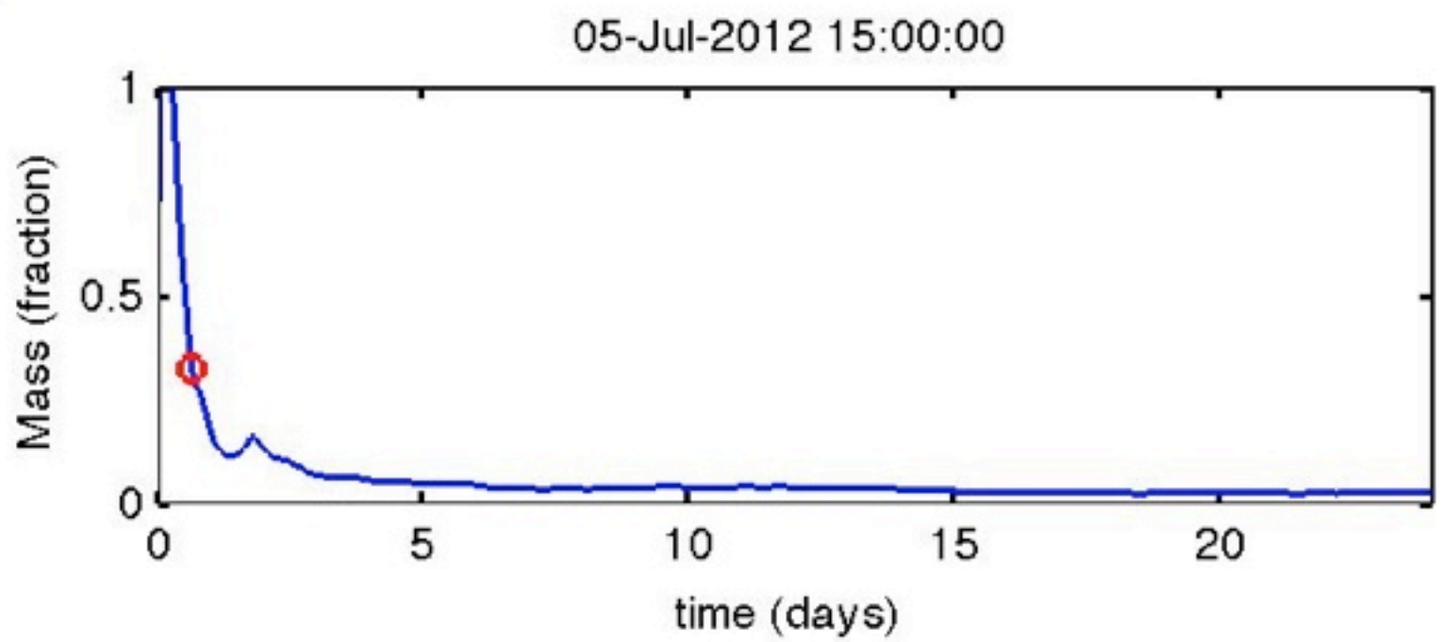

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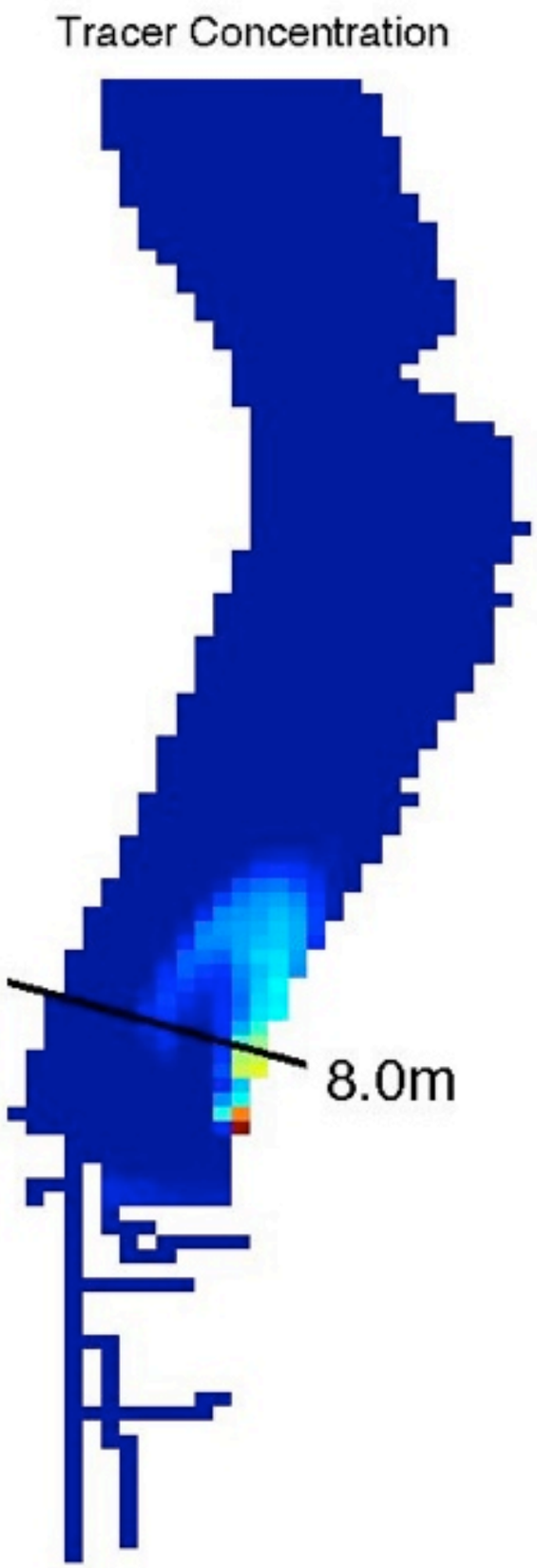


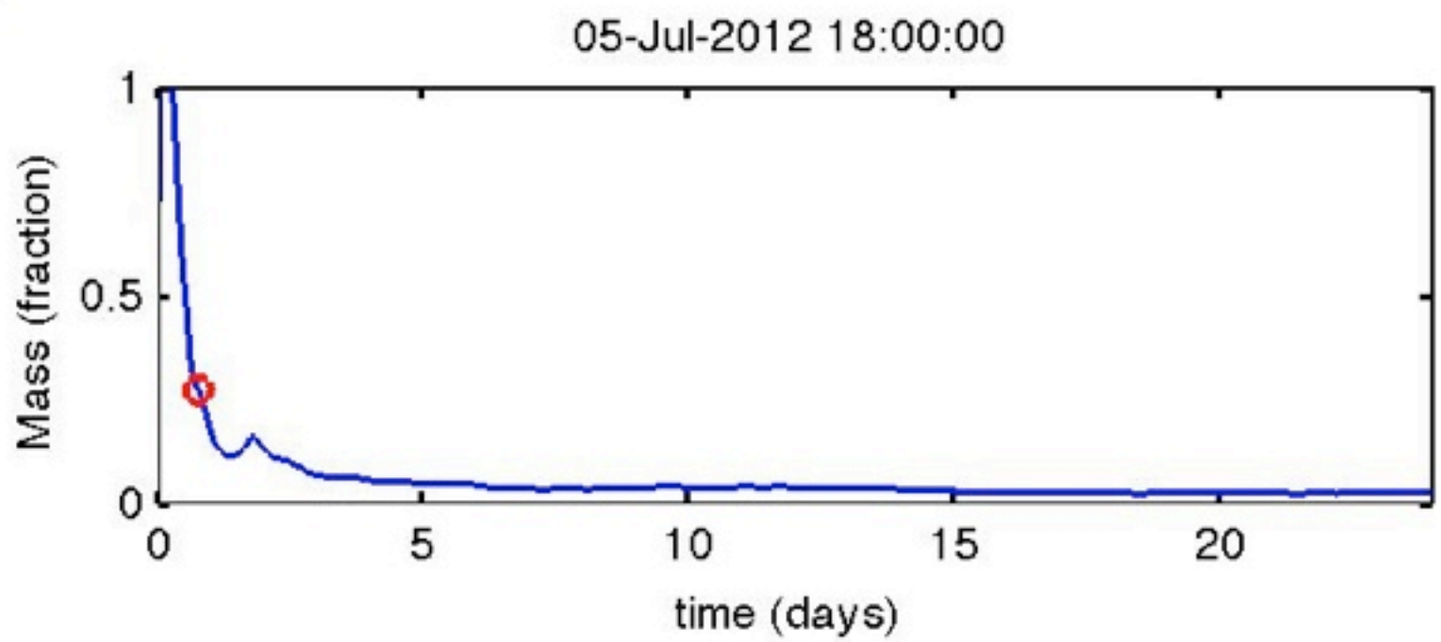

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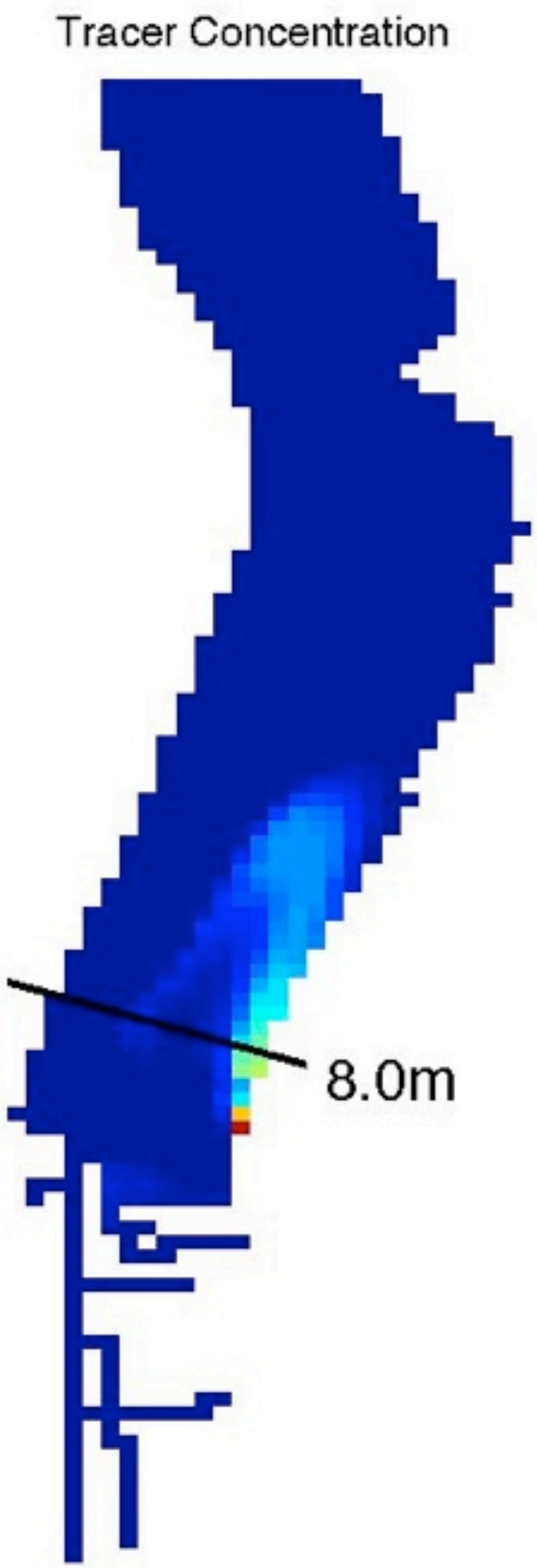


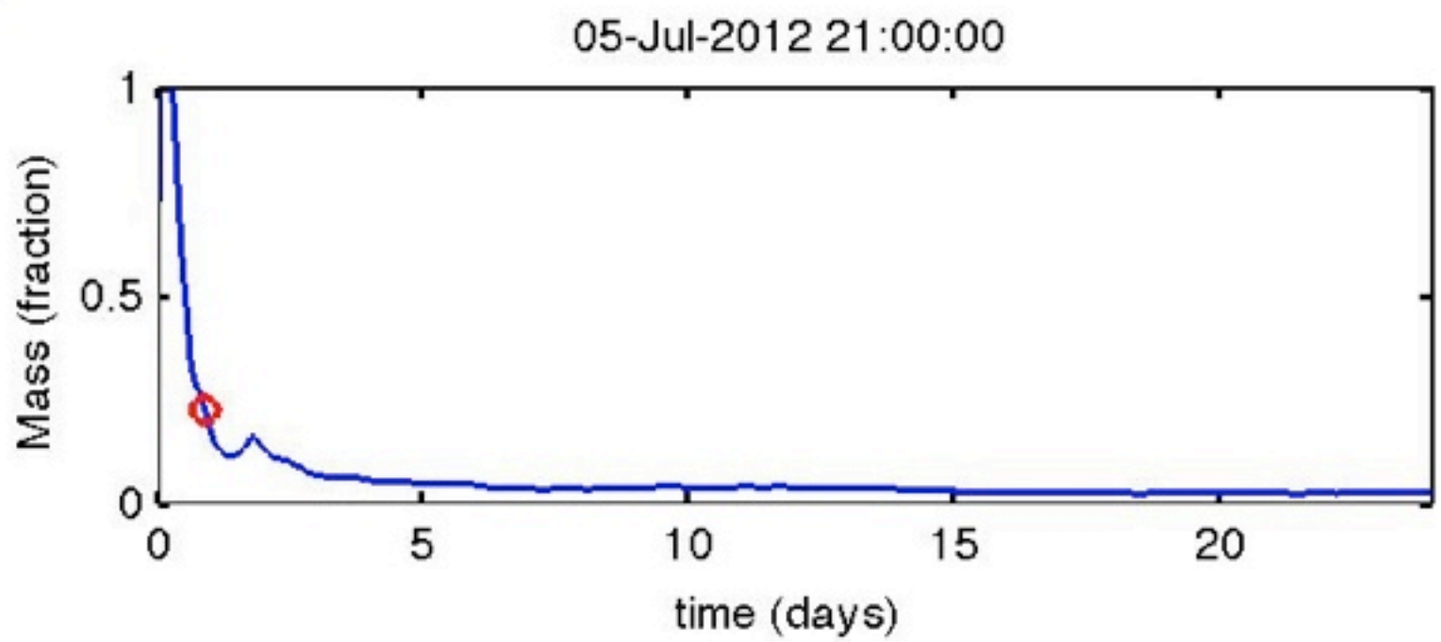

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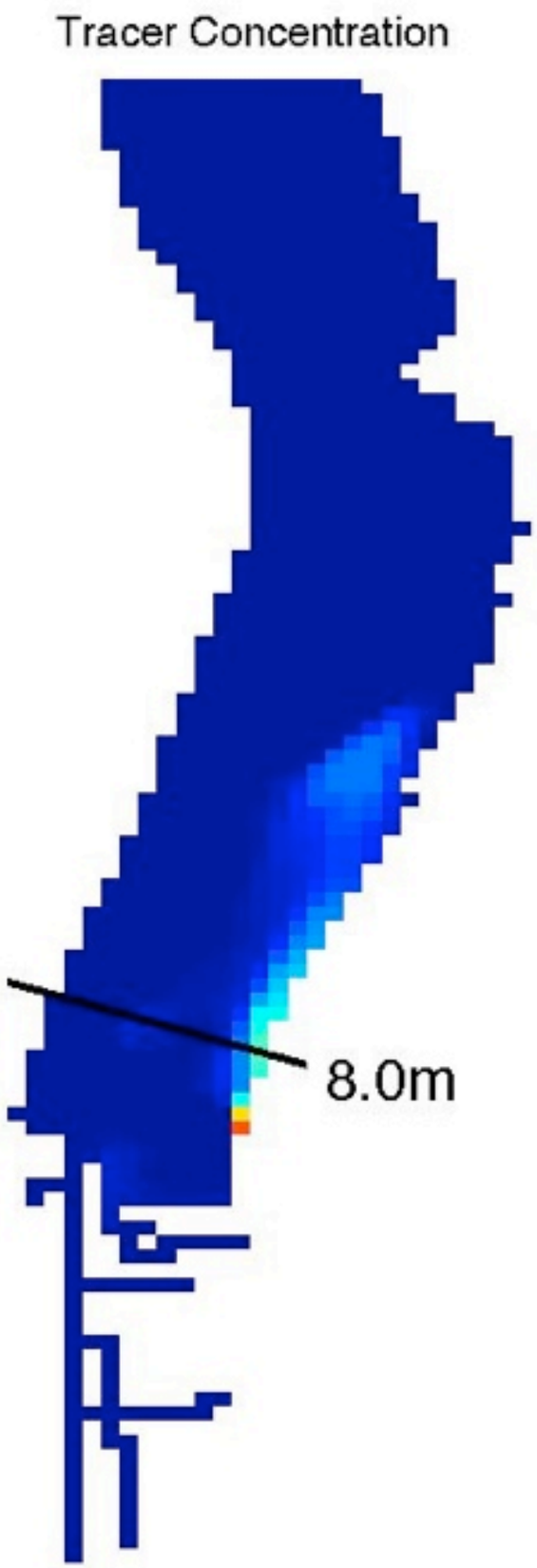


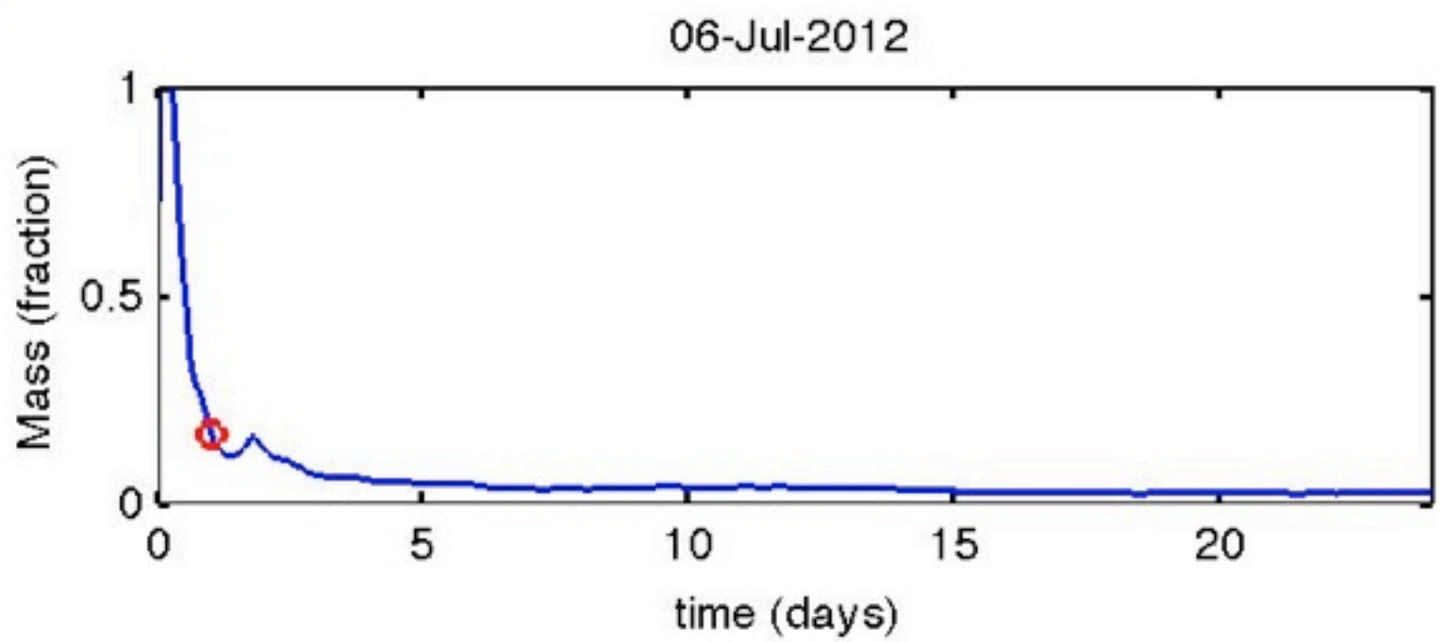

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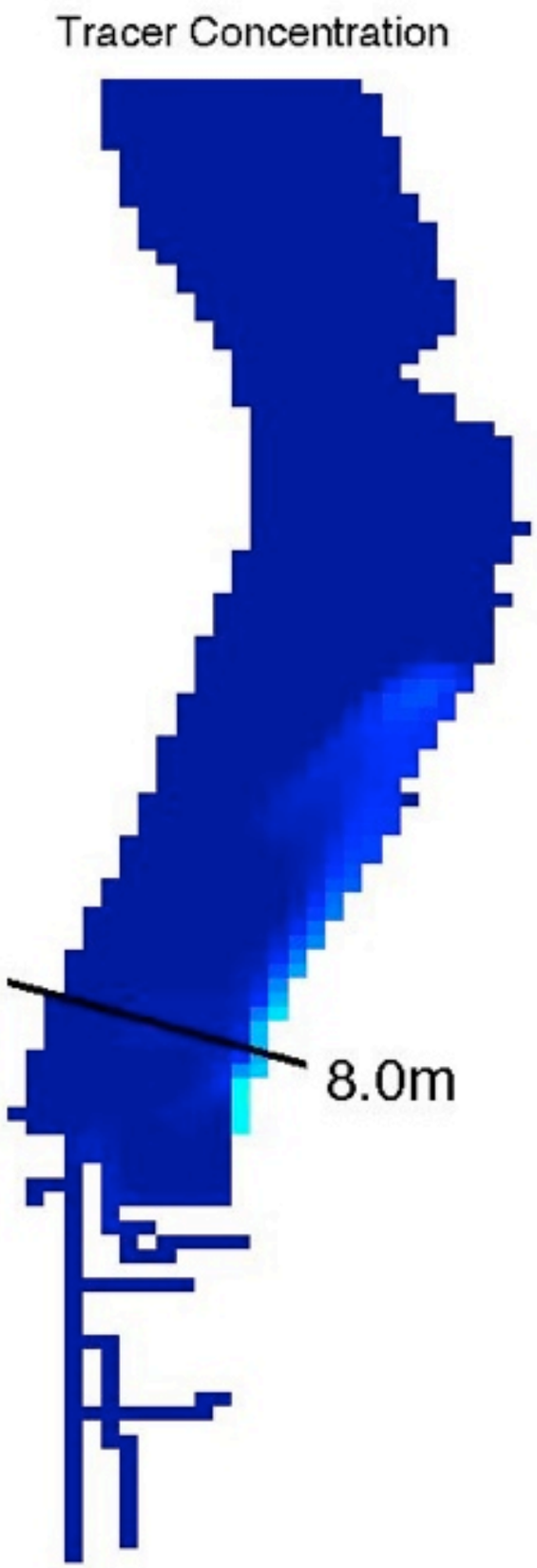


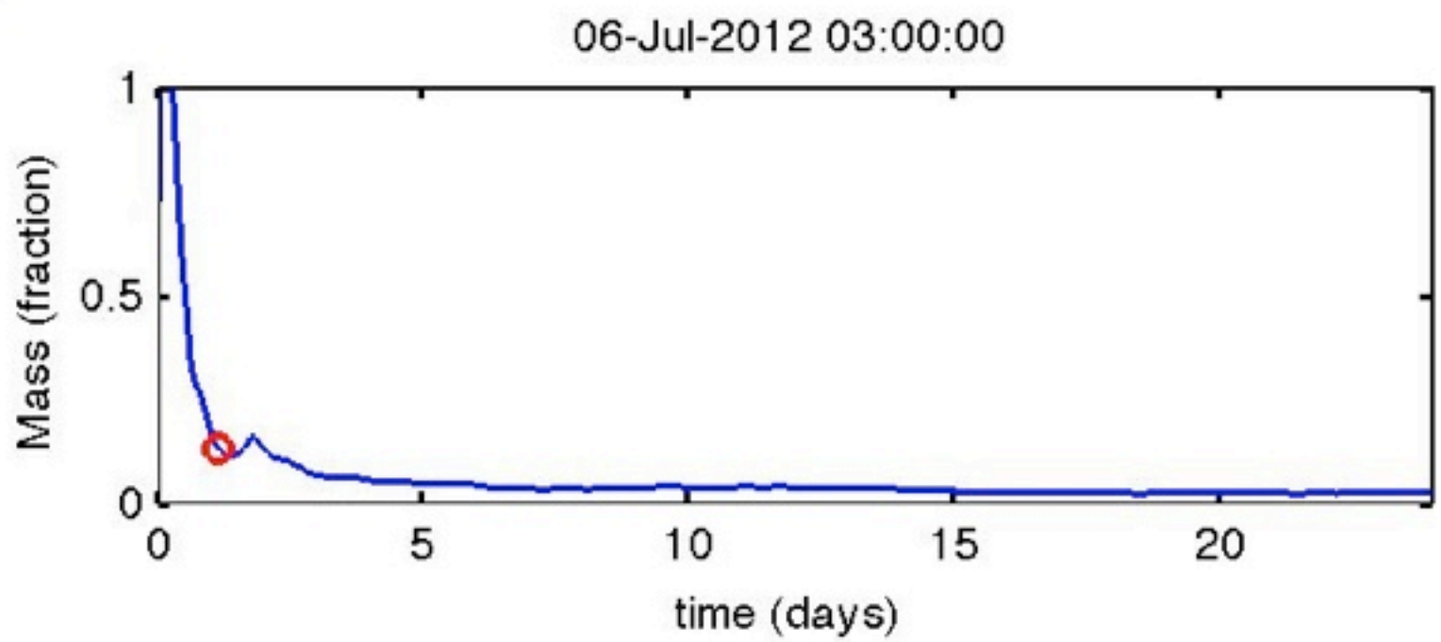

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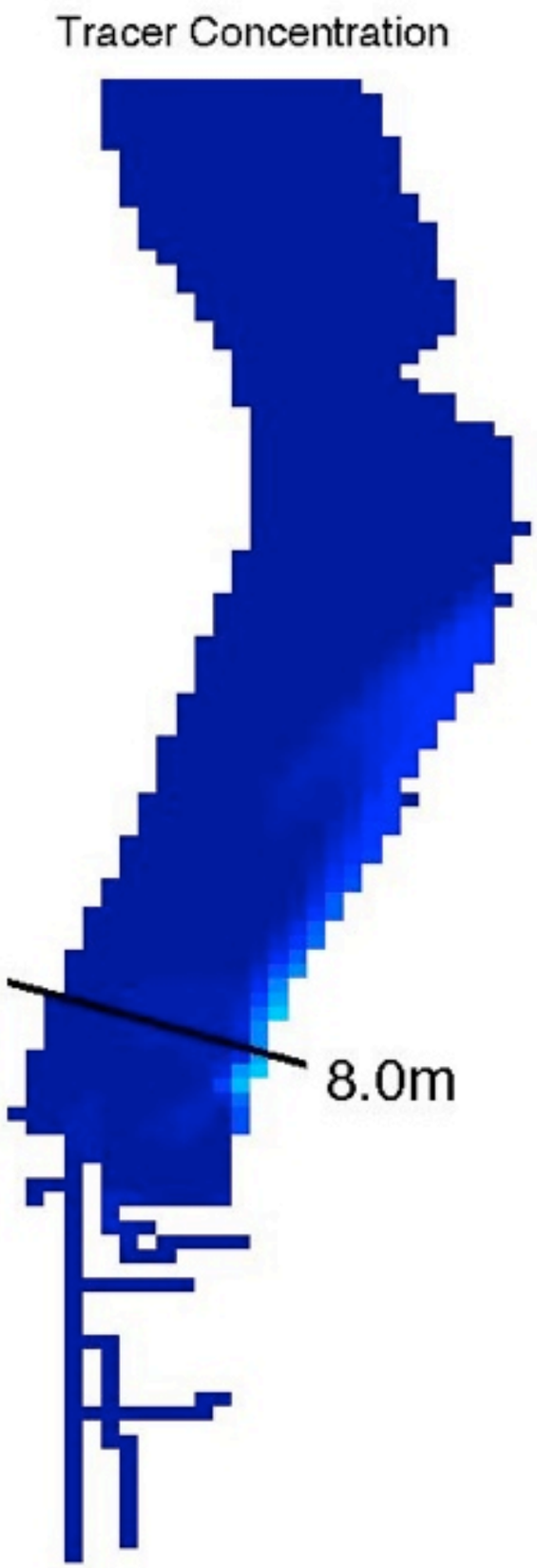


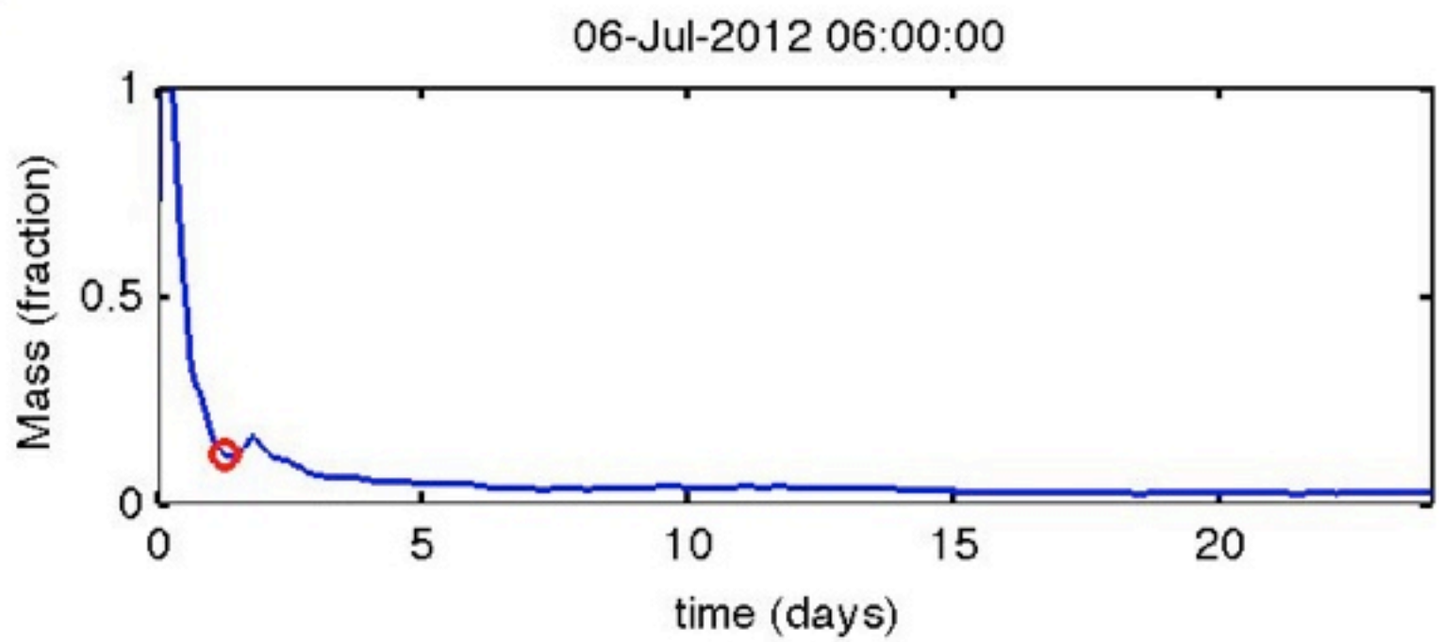

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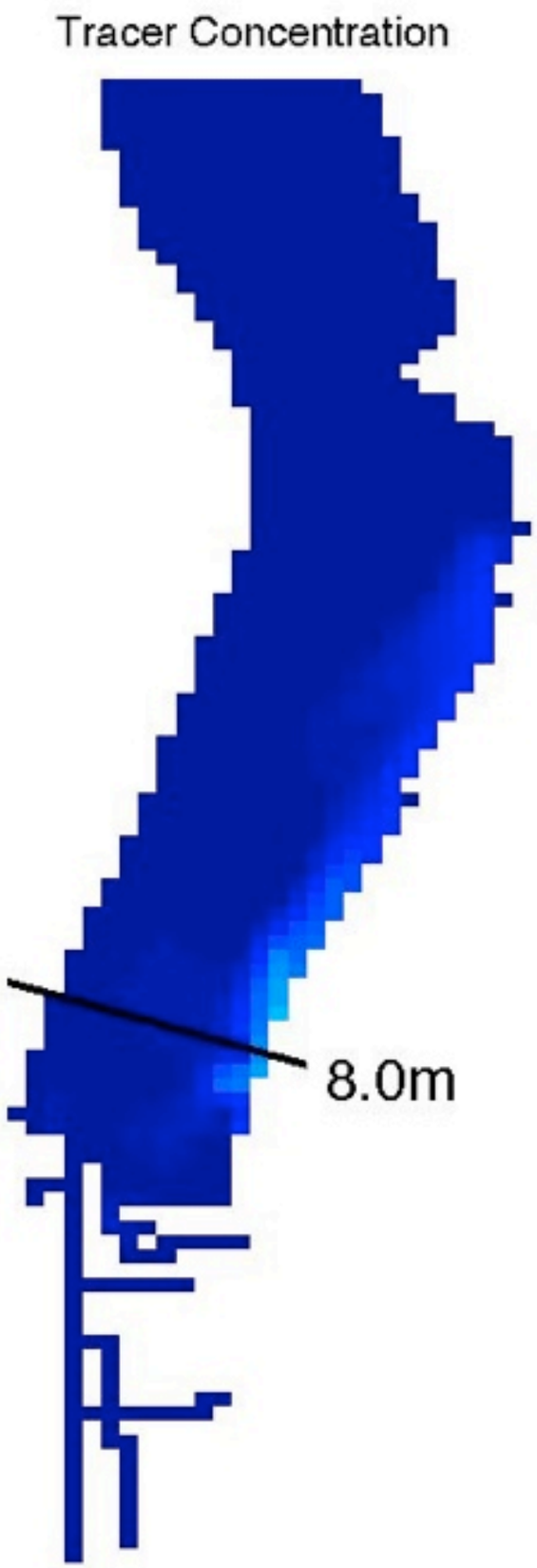


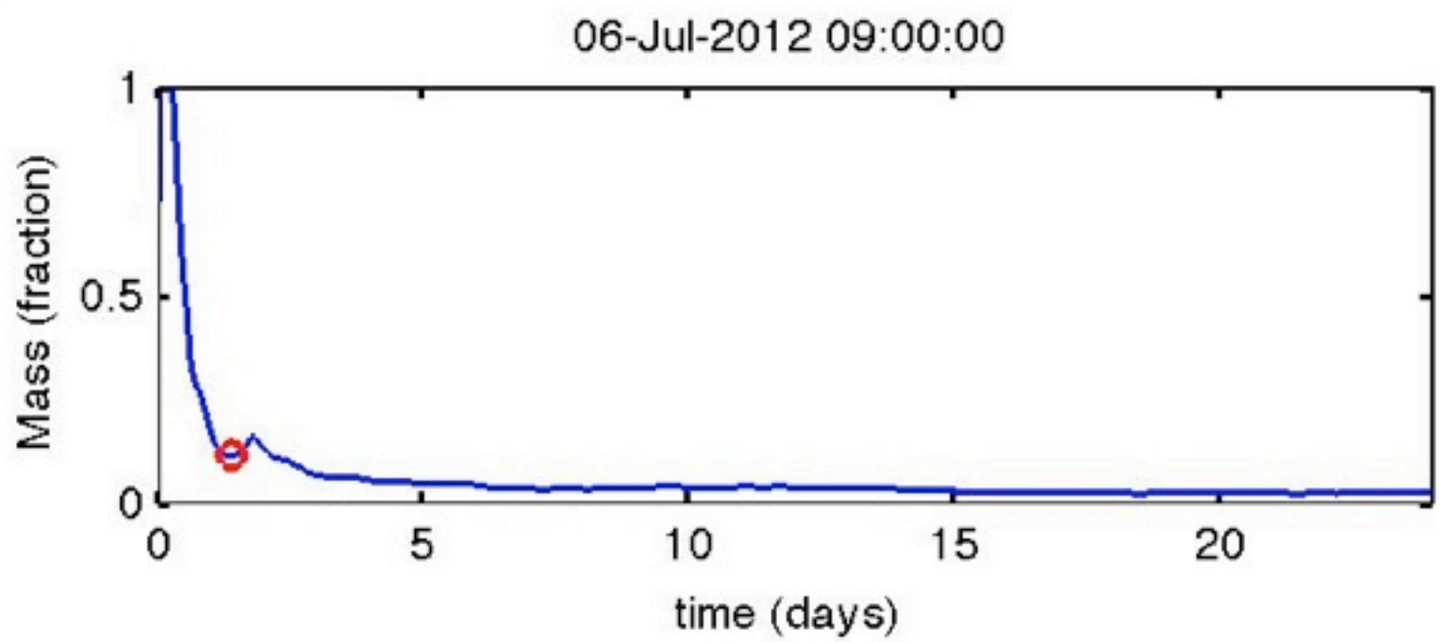

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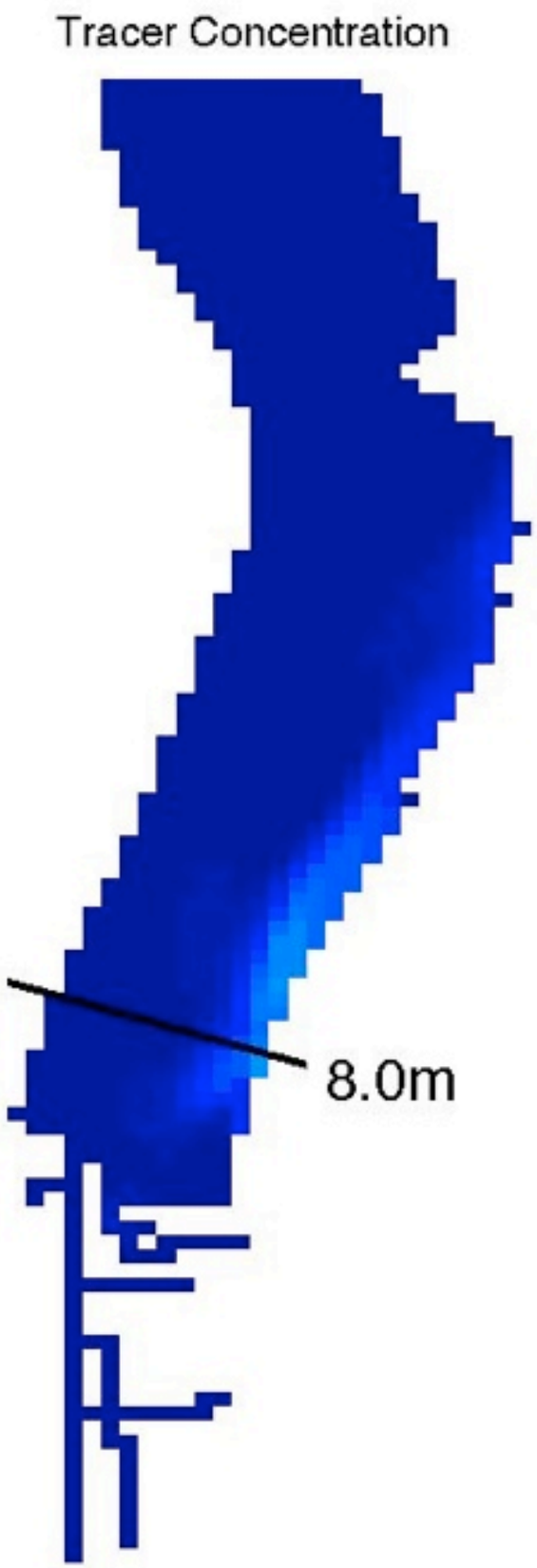


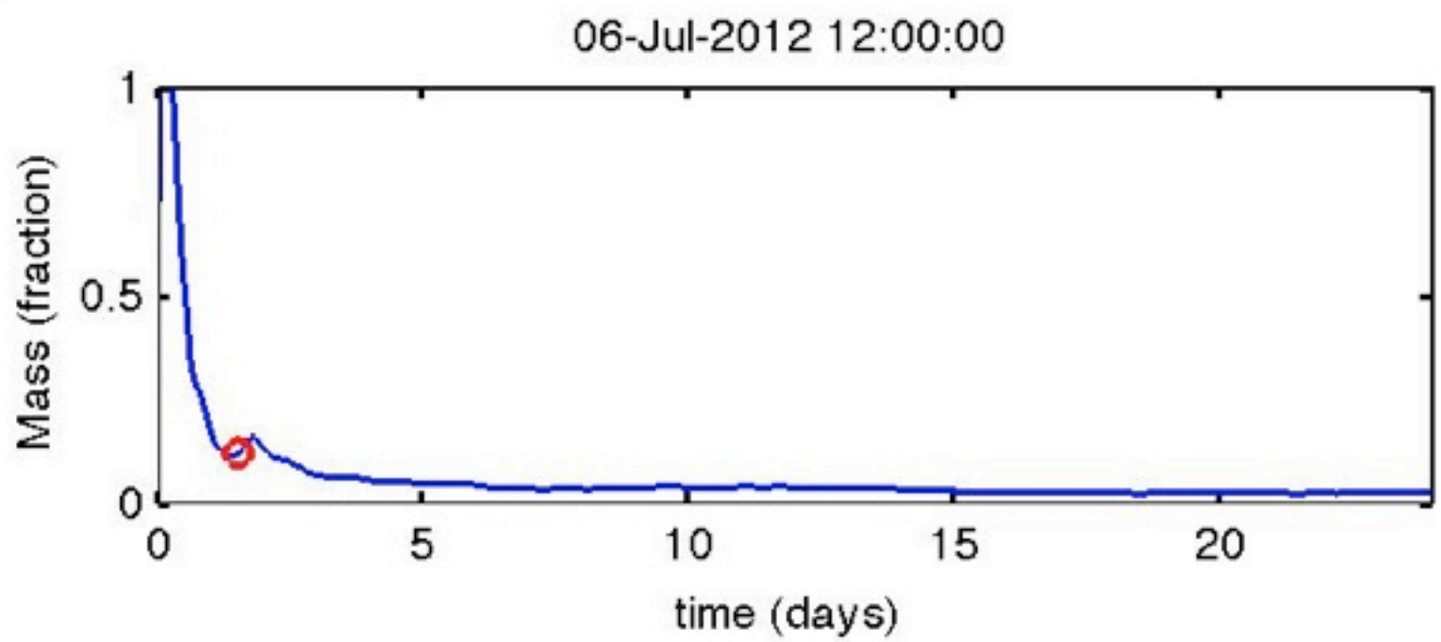

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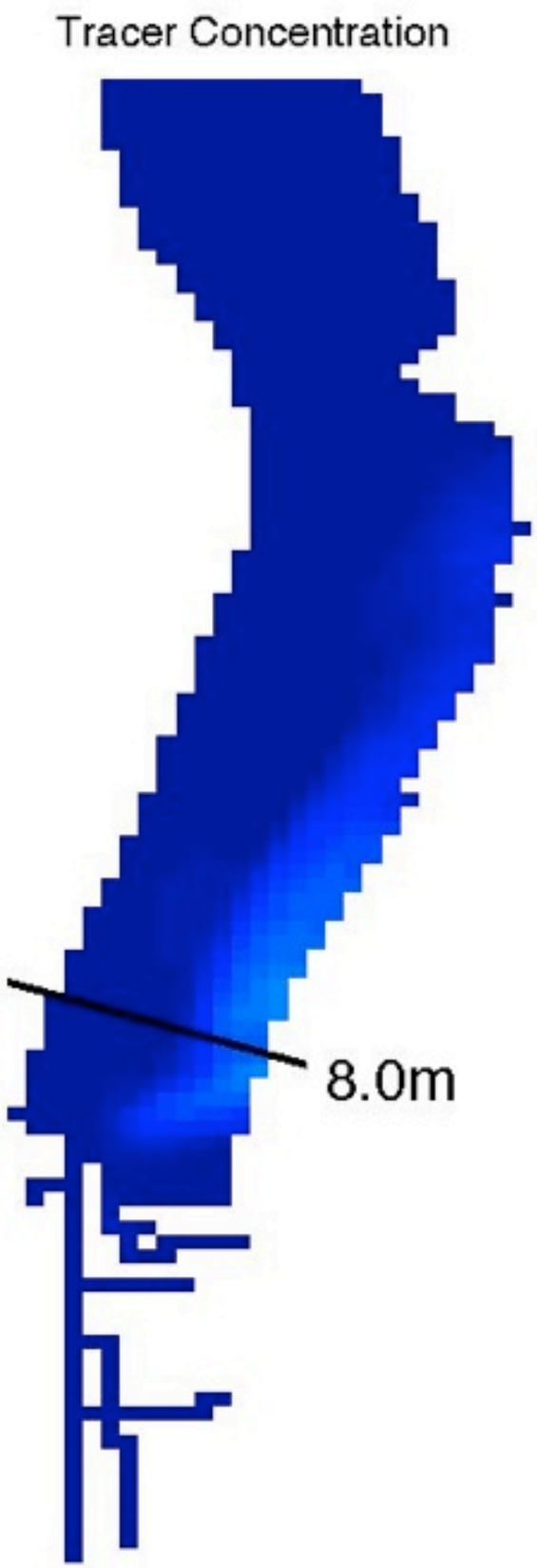


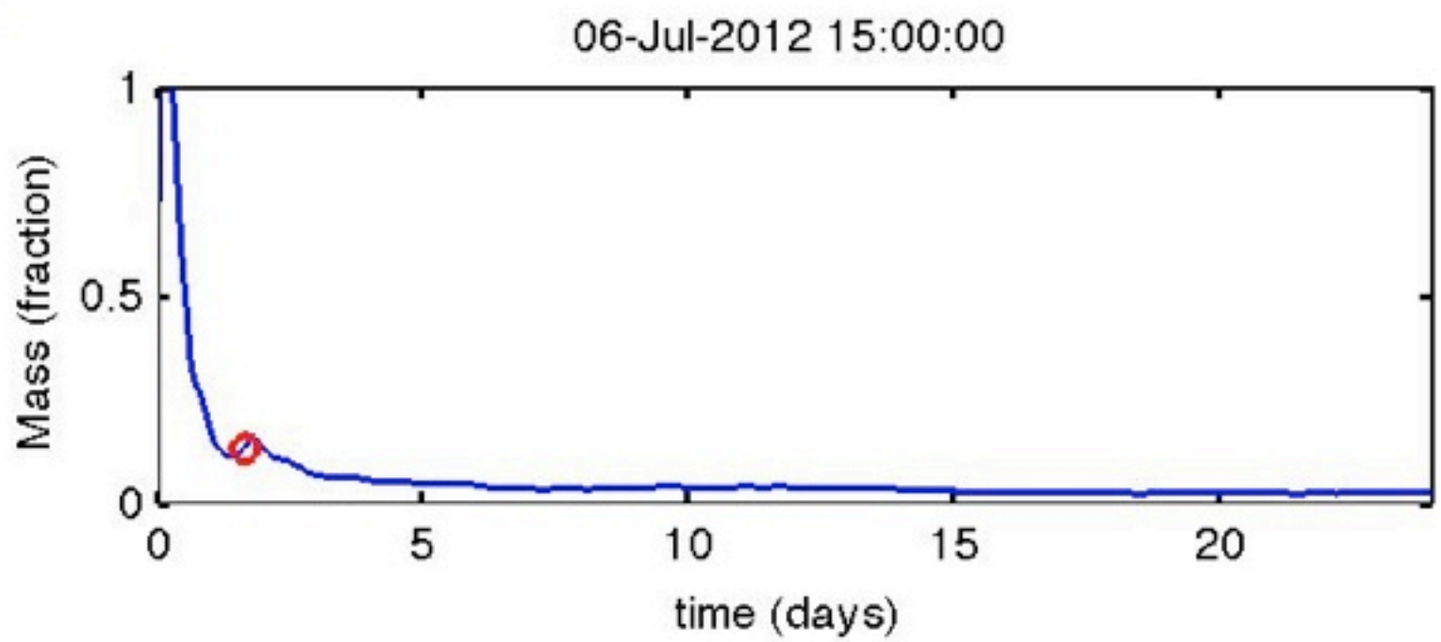

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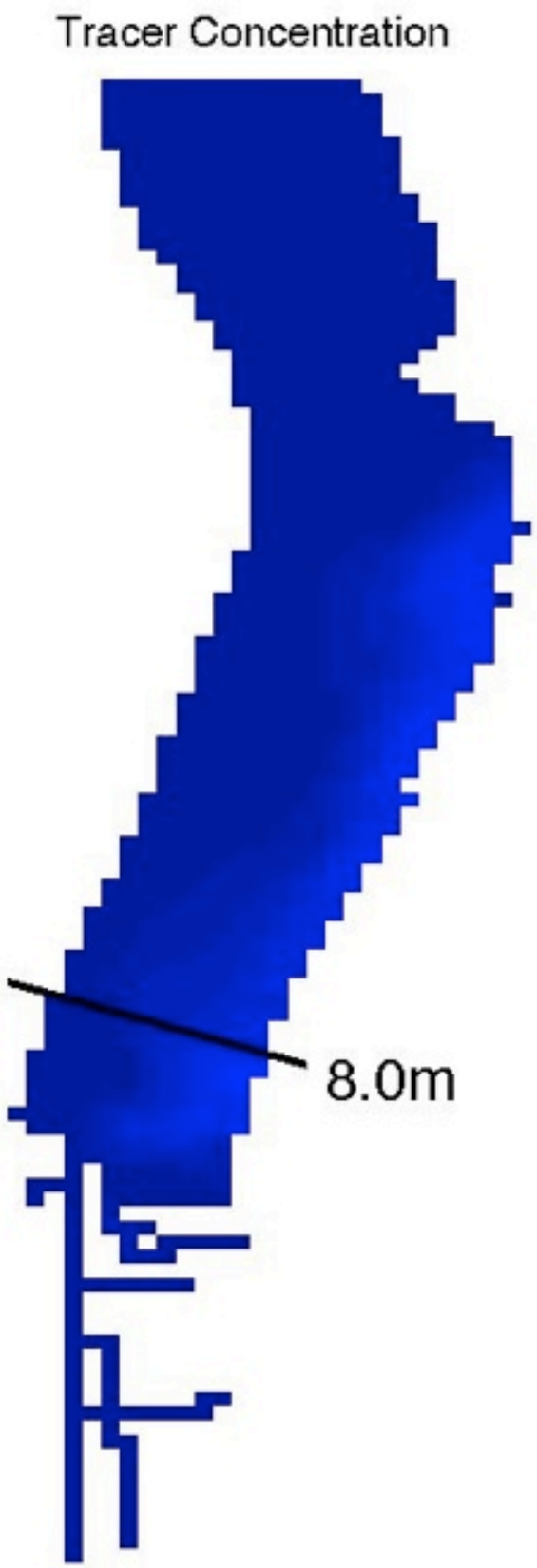


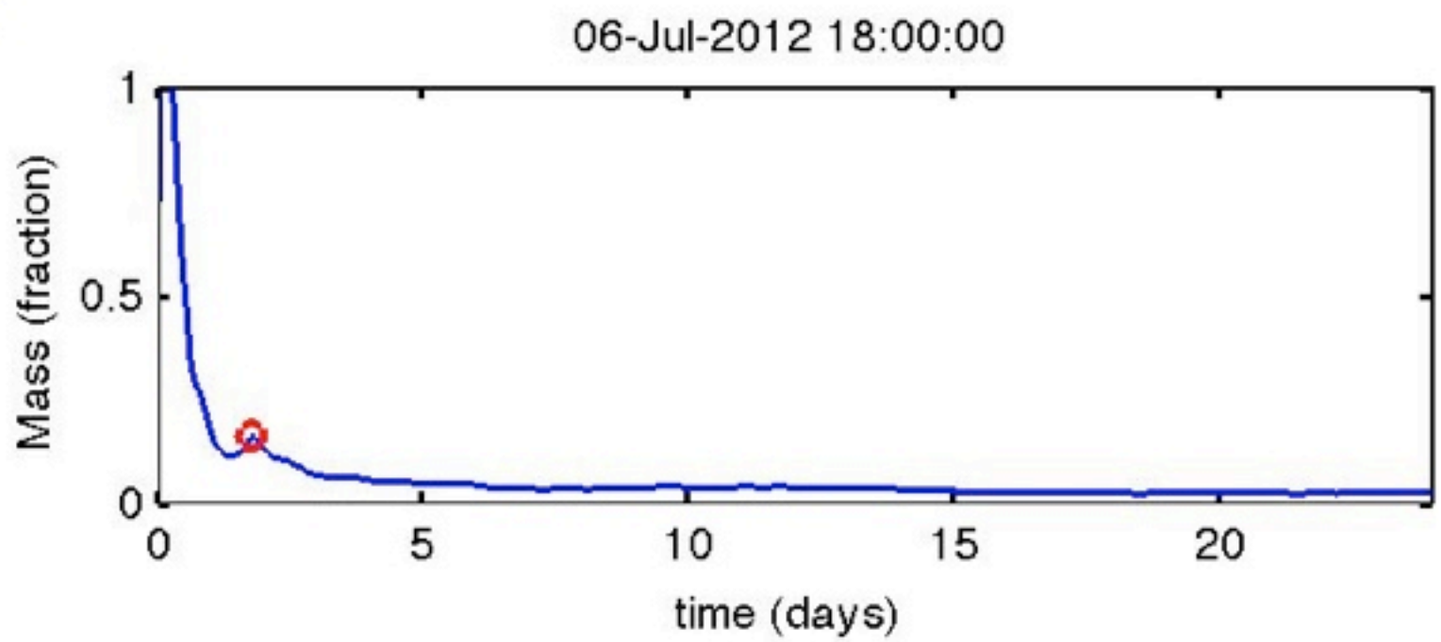

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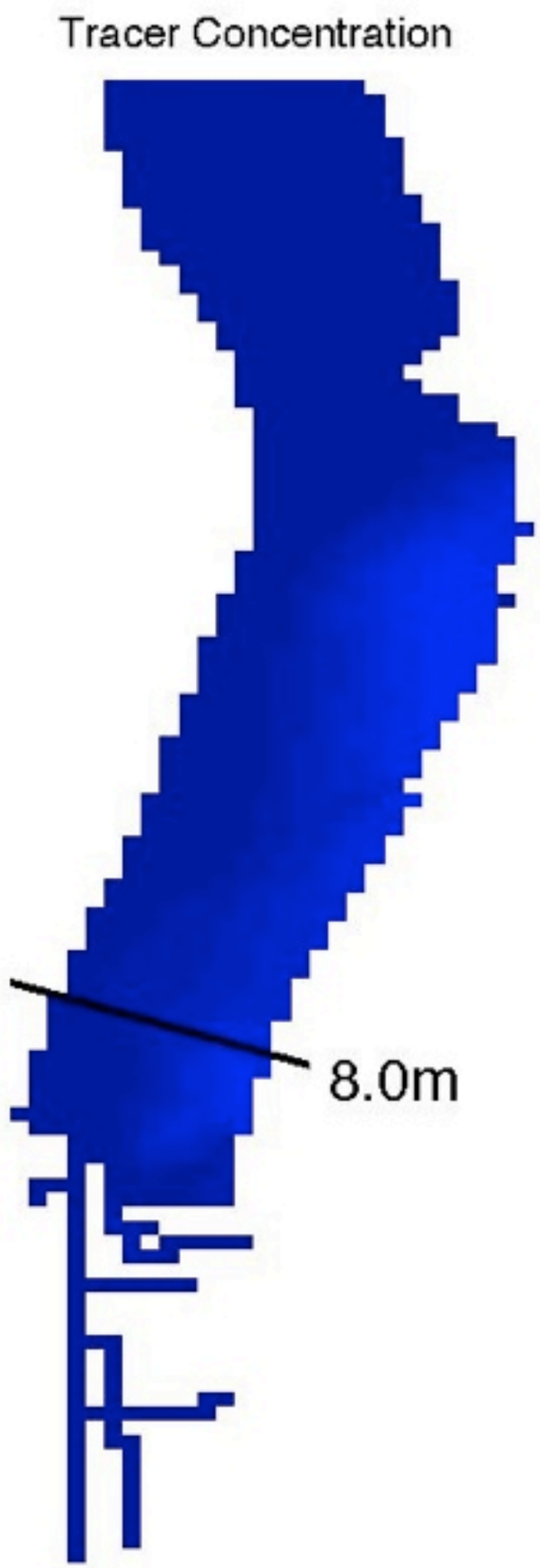


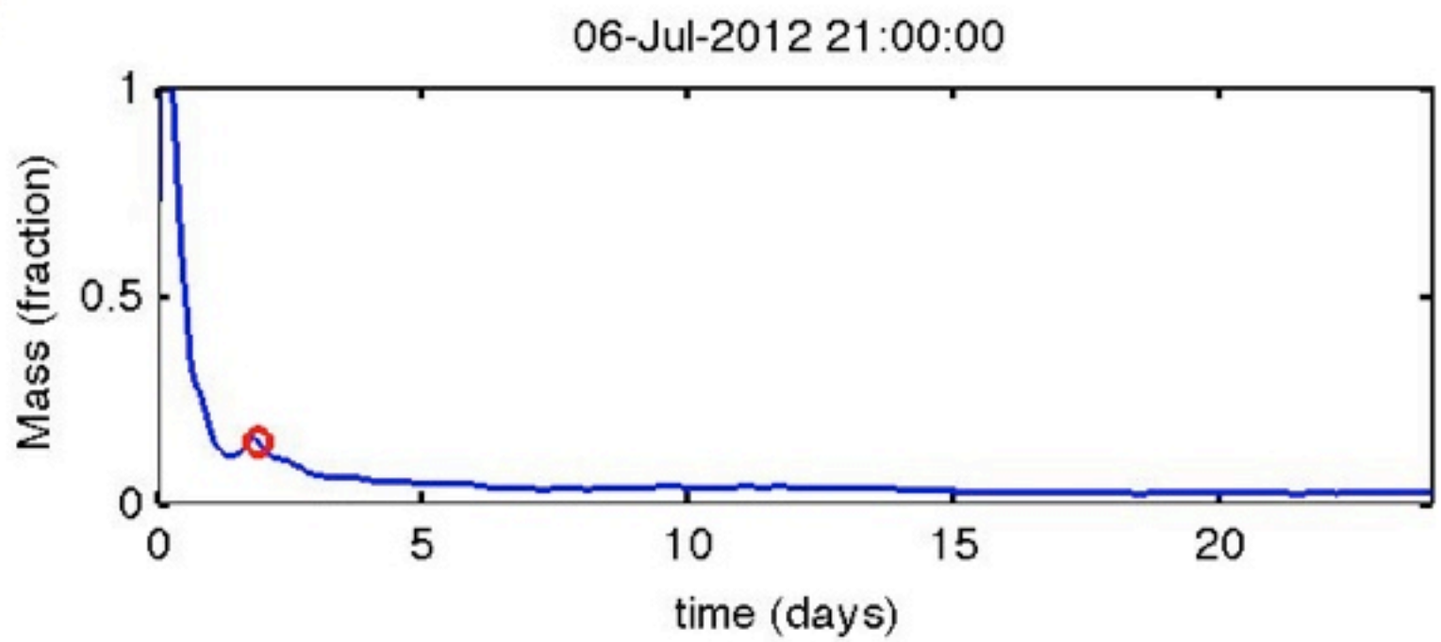

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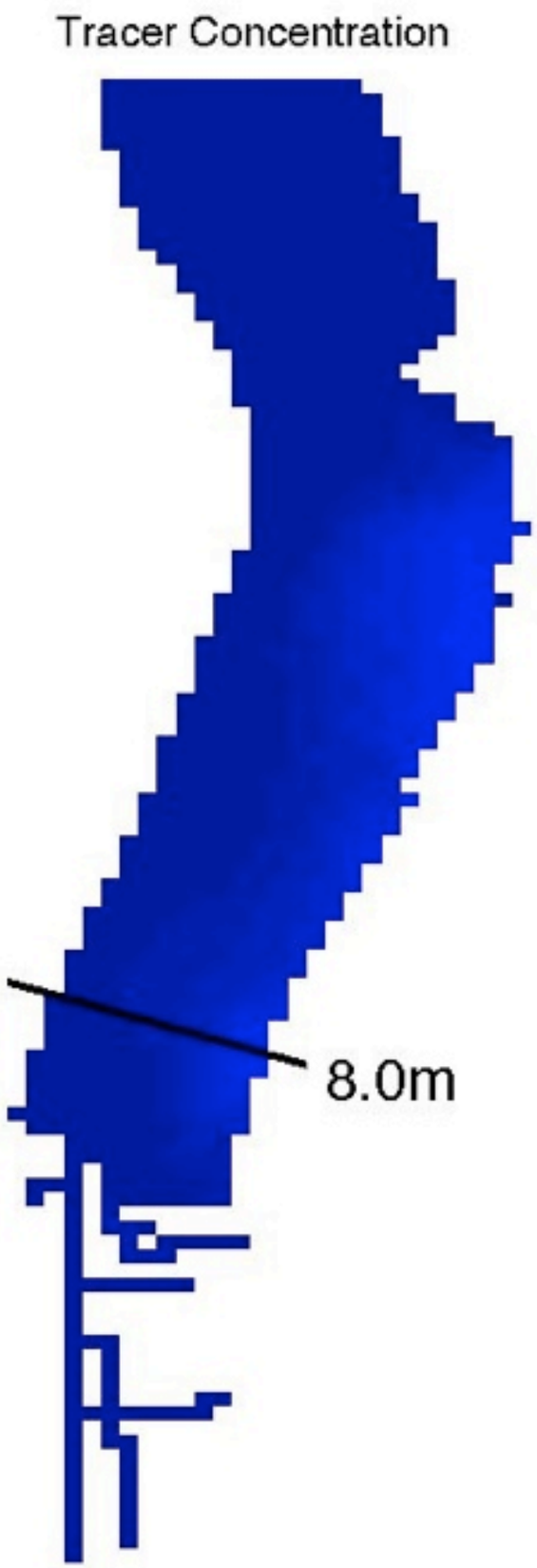


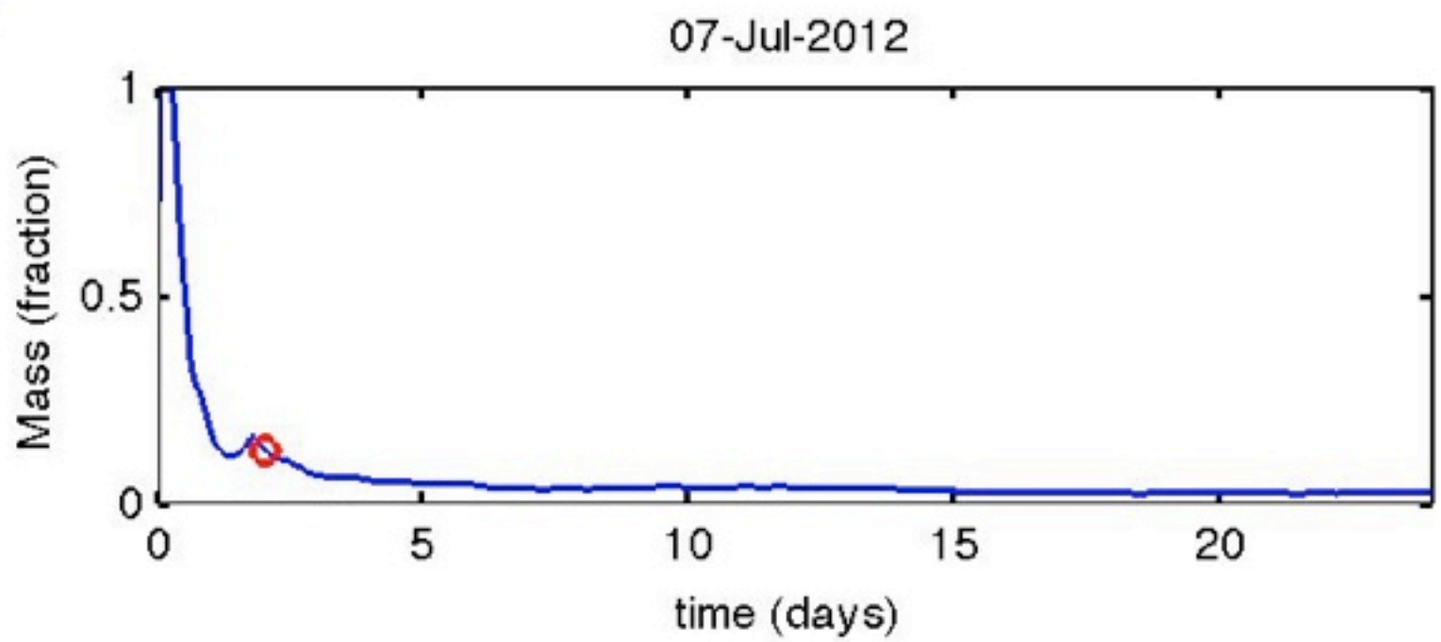

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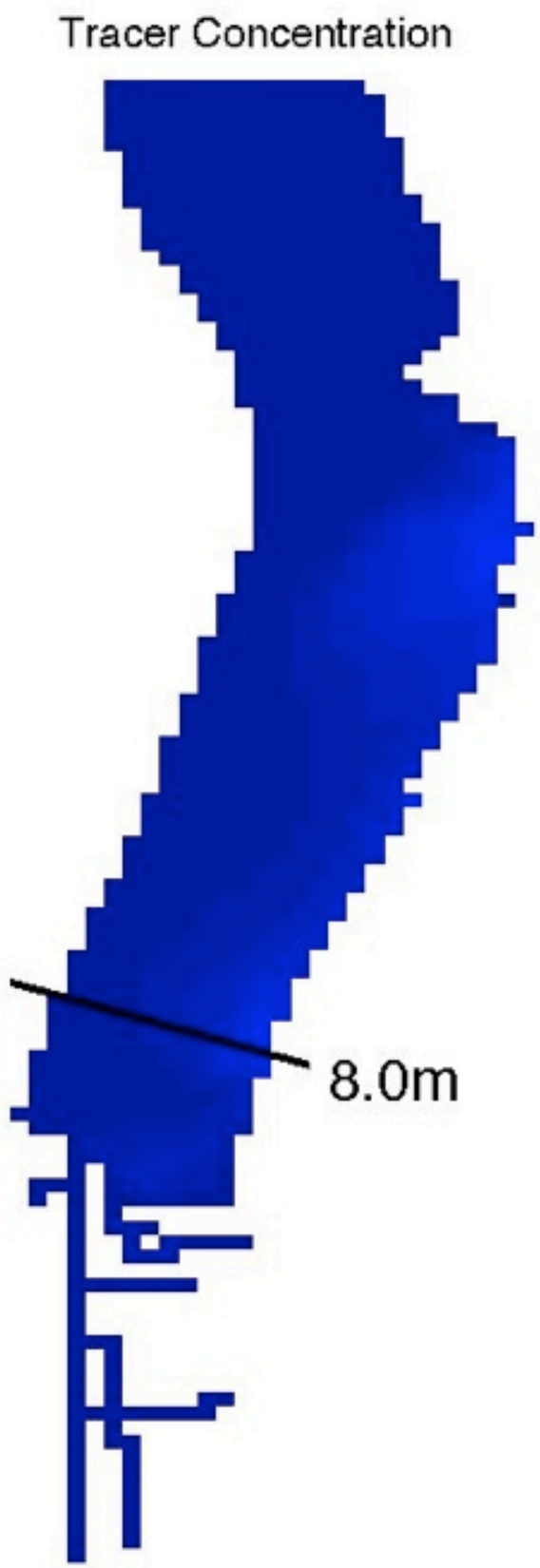
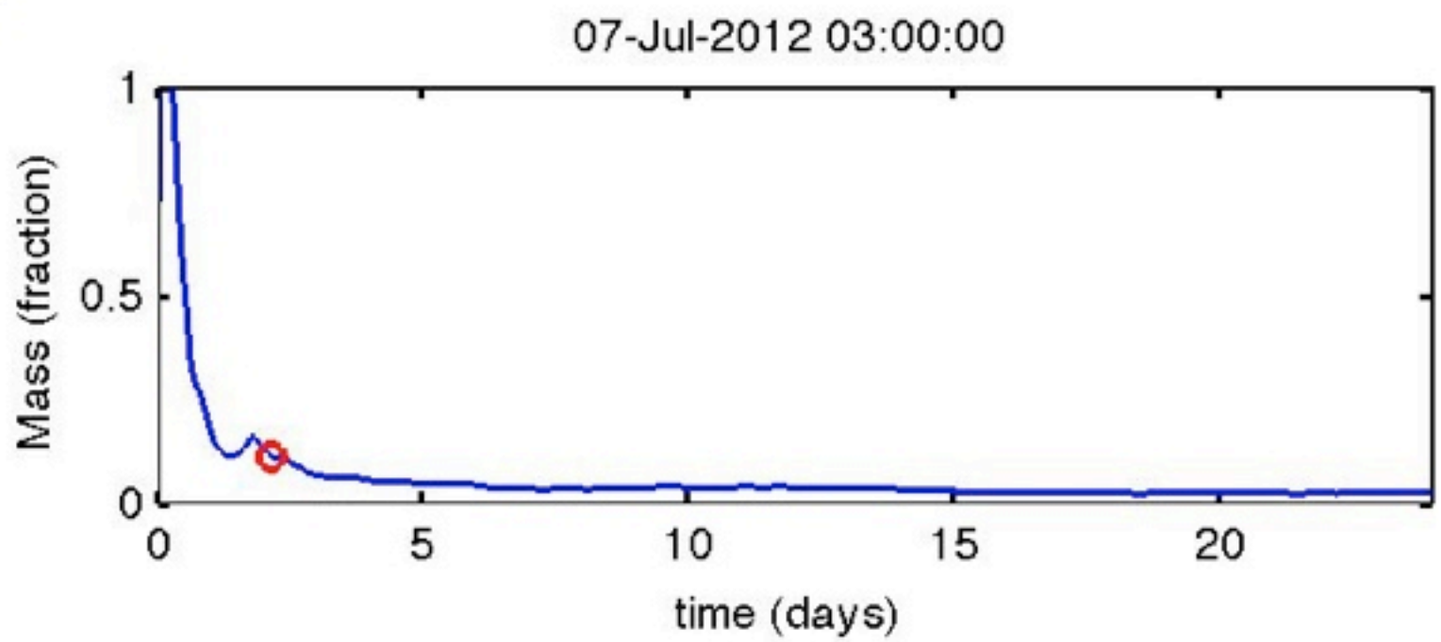
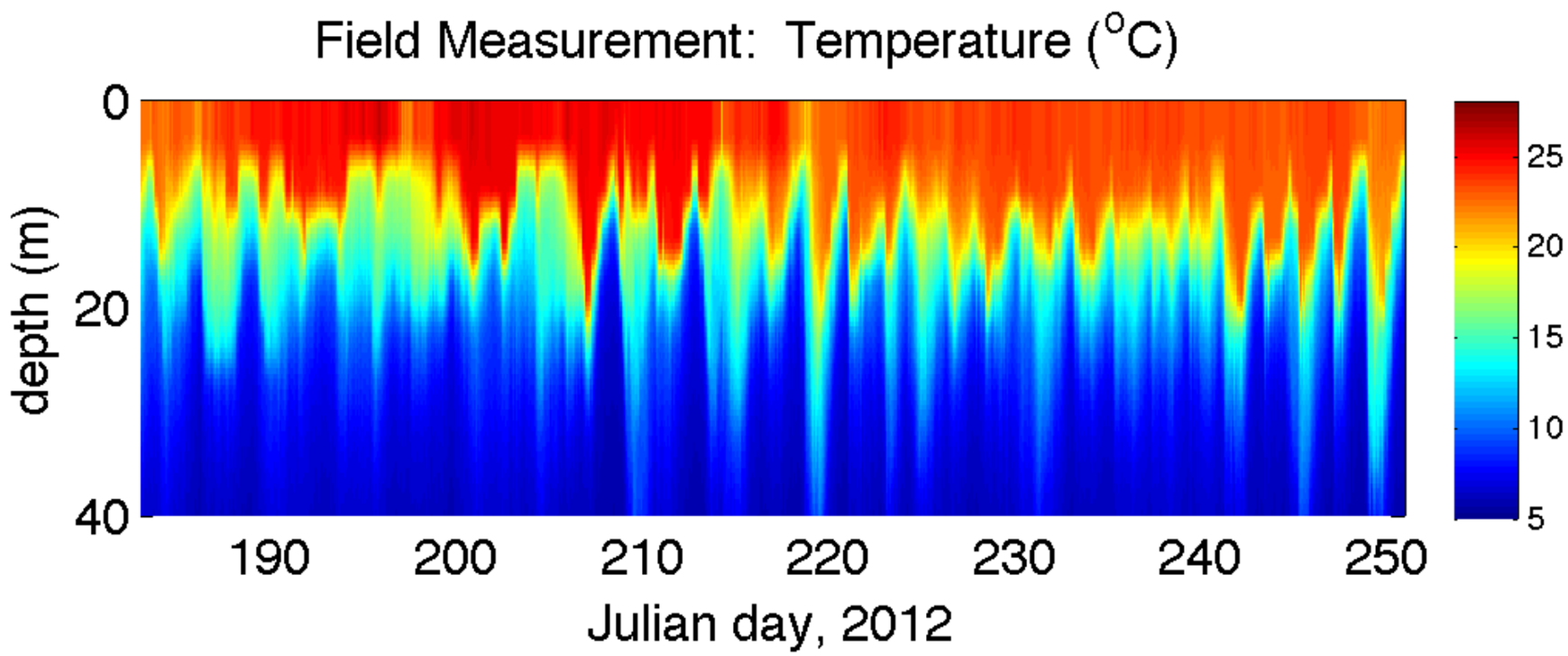
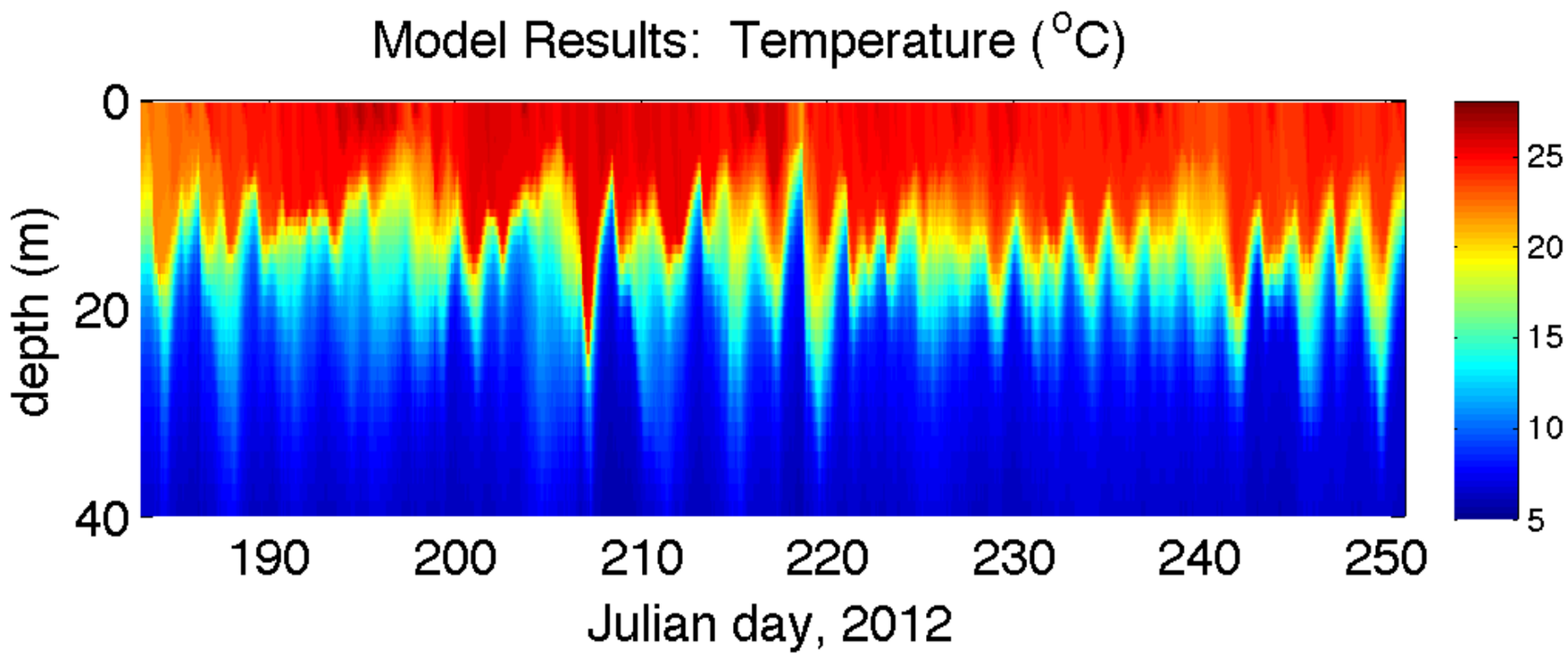


# SI3D Validation: Summer 2012



# SI3D Results: 2012 Shelf Flusing Times

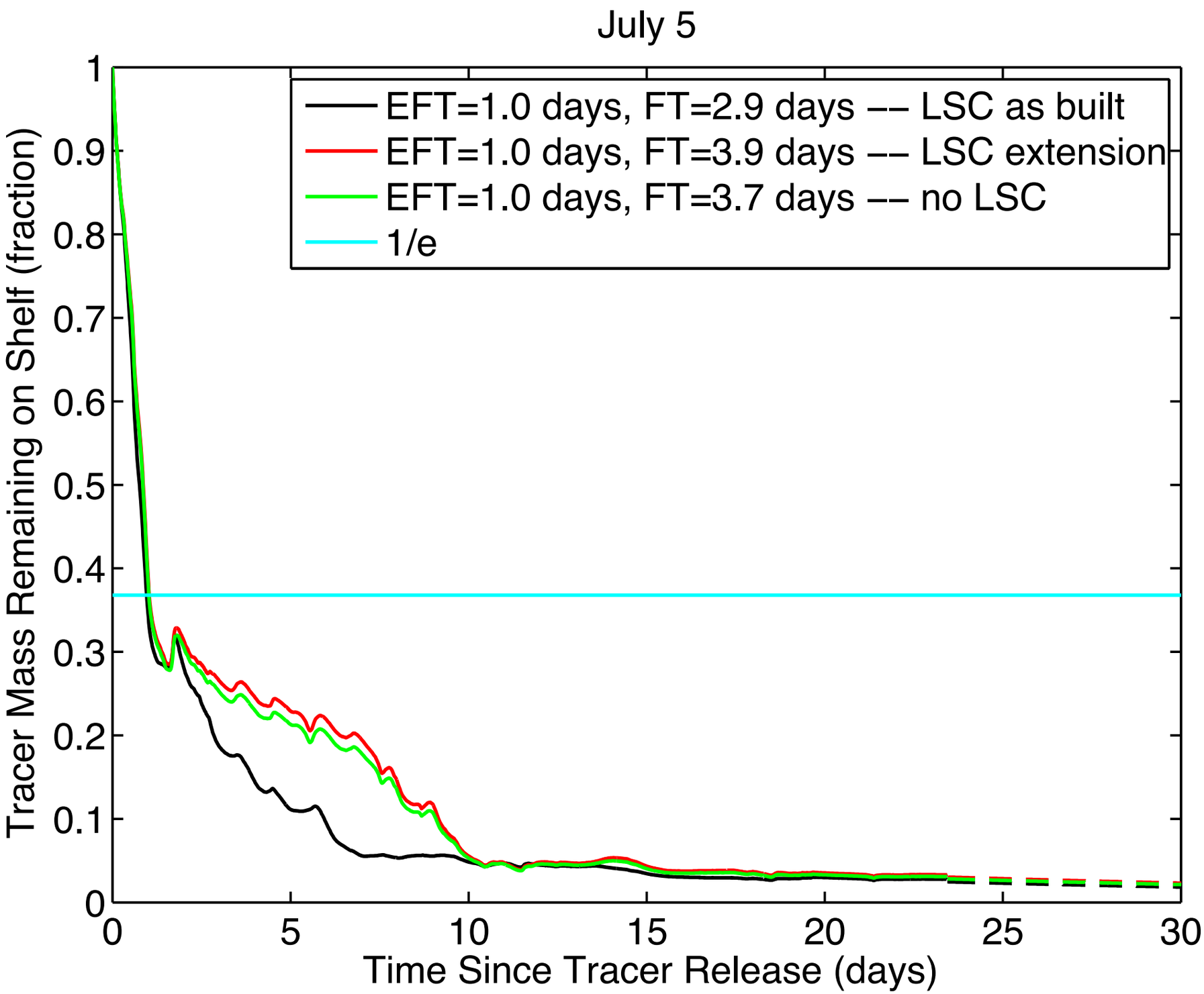
➡ 6 flushing time experiments (so far):

July 5
July 16
August 5
August 16
September 5
September 16

On each date, 3 cases:

1. LSC outfall as built
2. LSC outfall extension
3. No LSC outfall

# SI3D Results: 2012 Shelf Flusing Times



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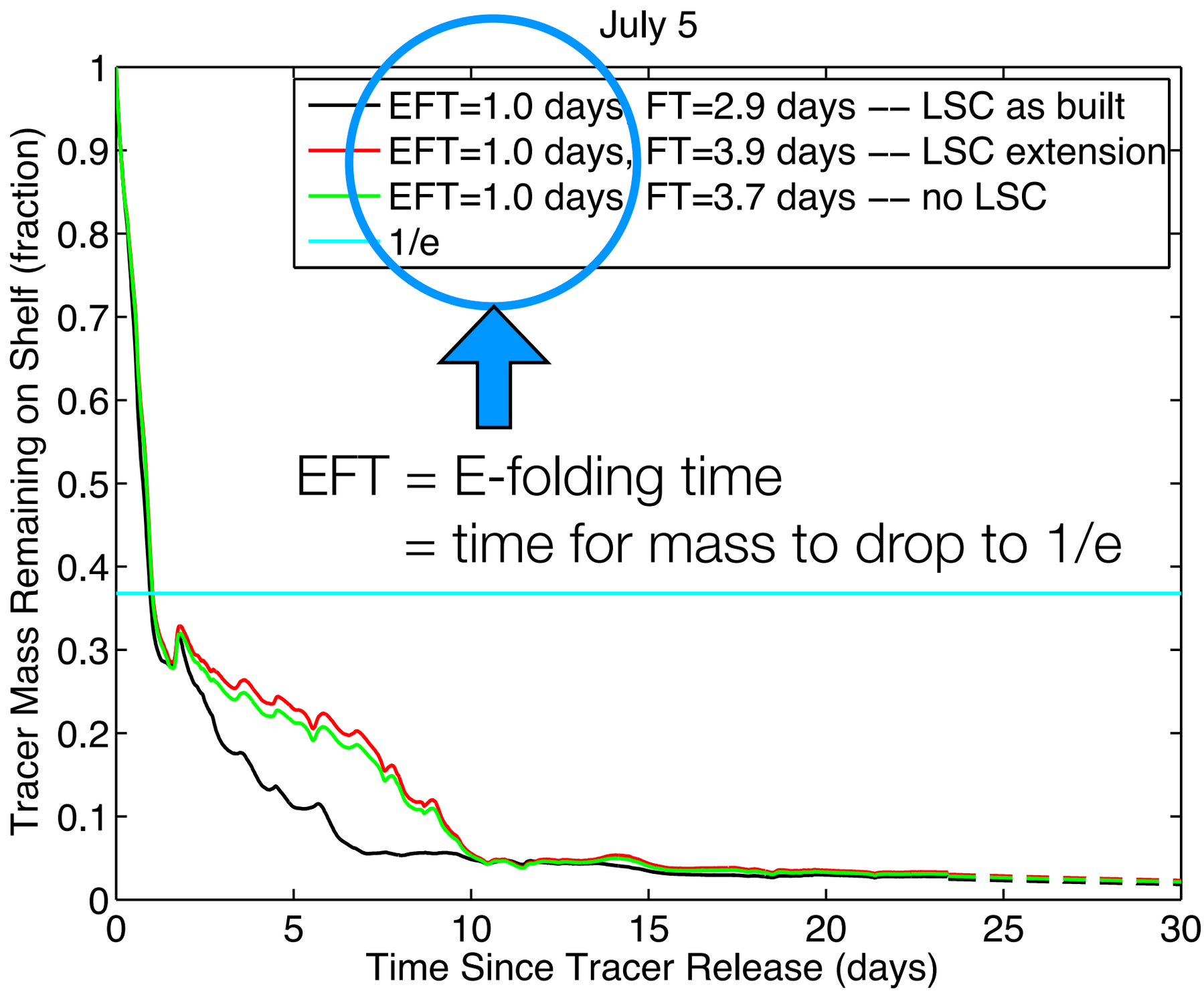

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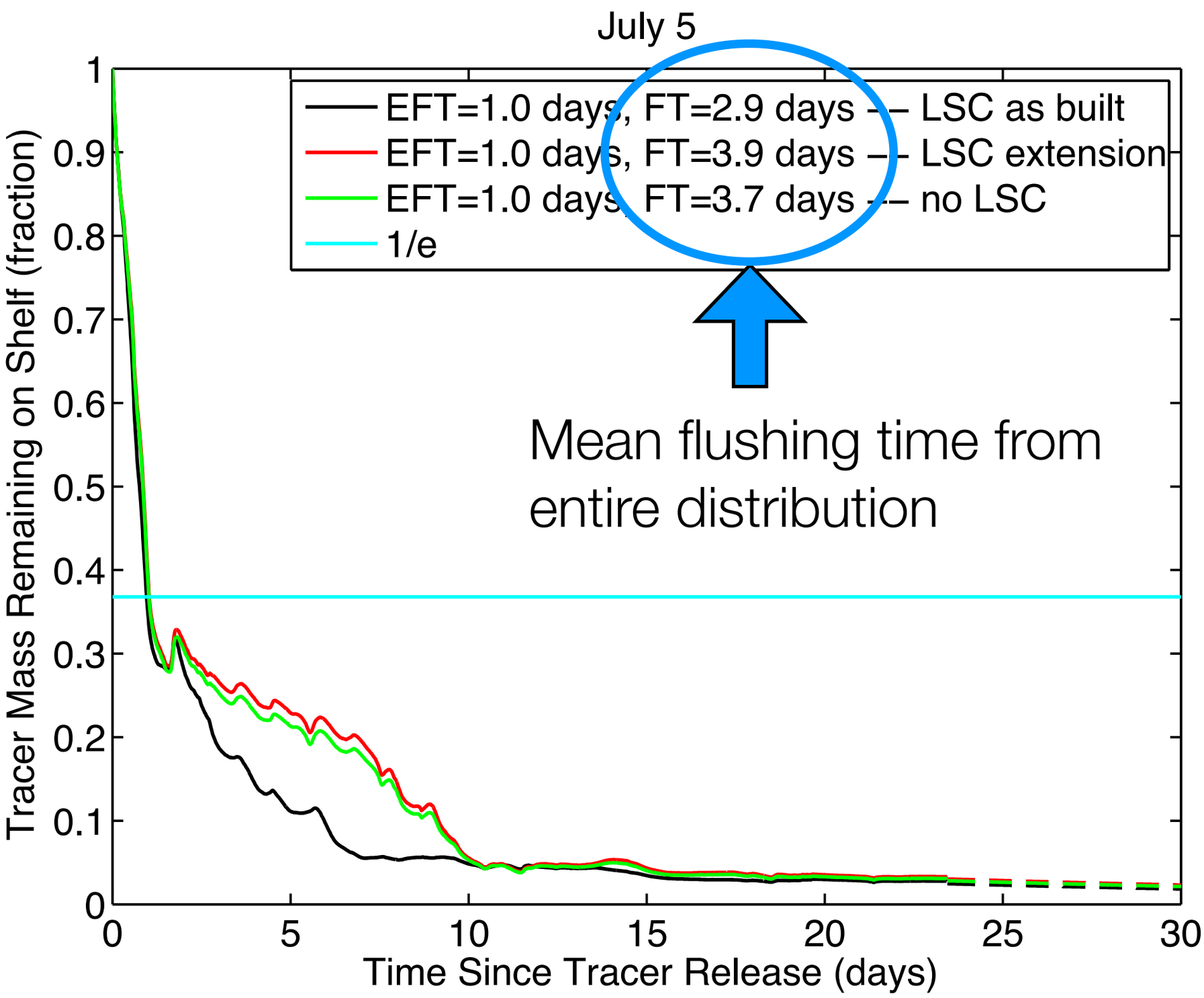

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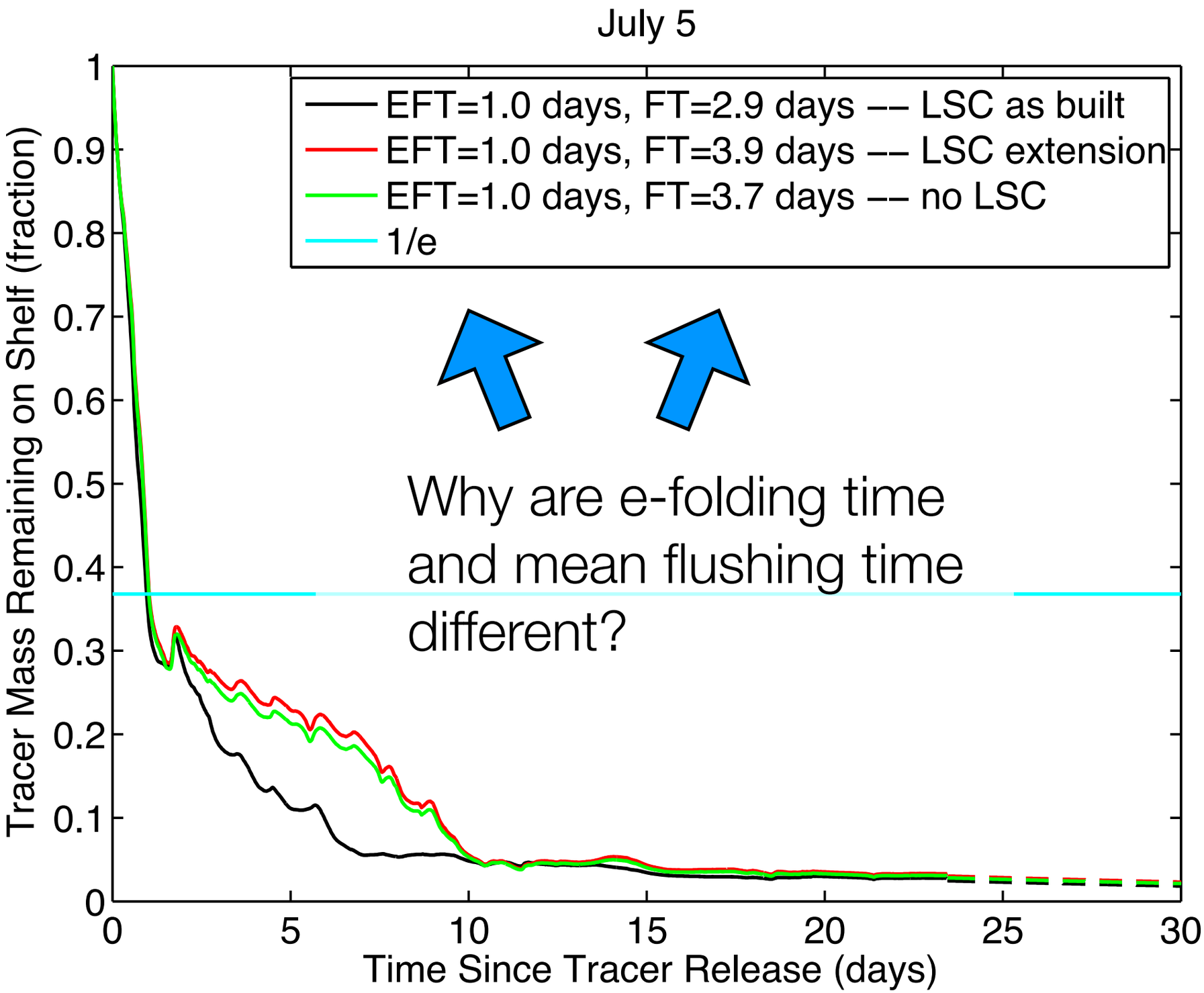

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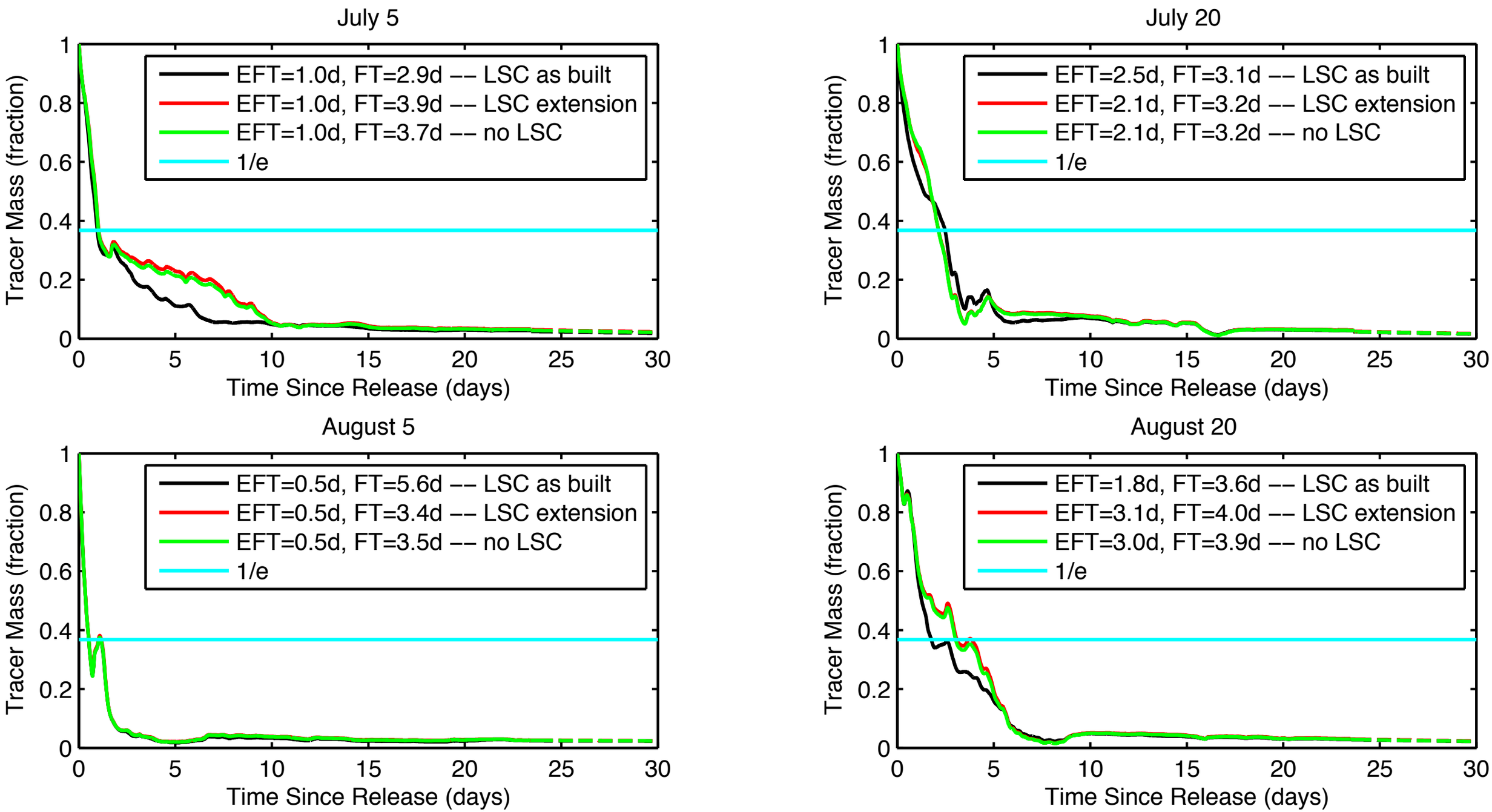
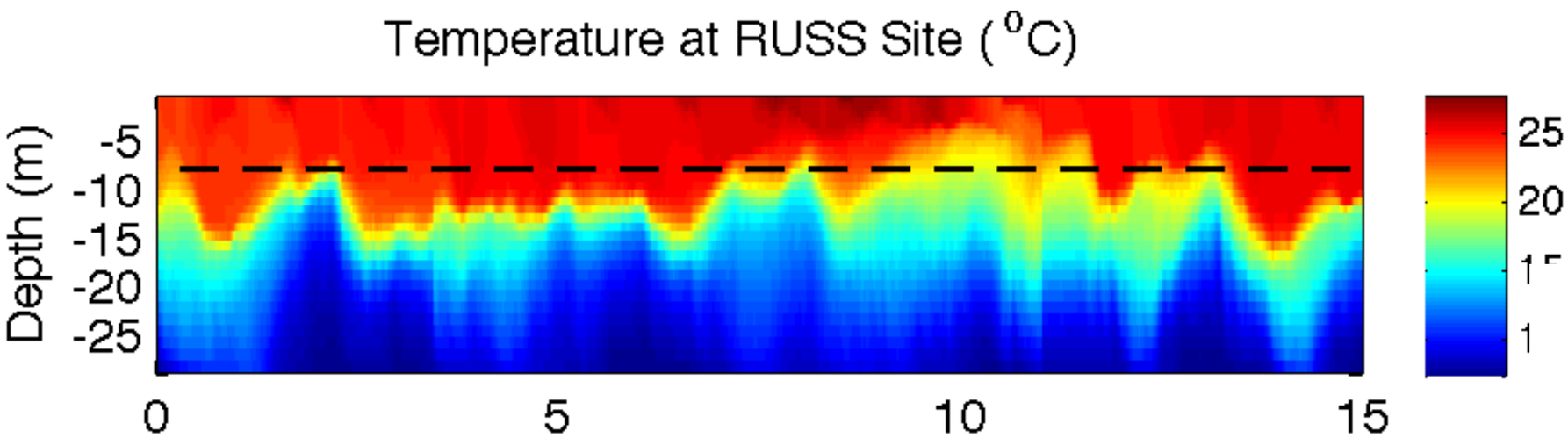
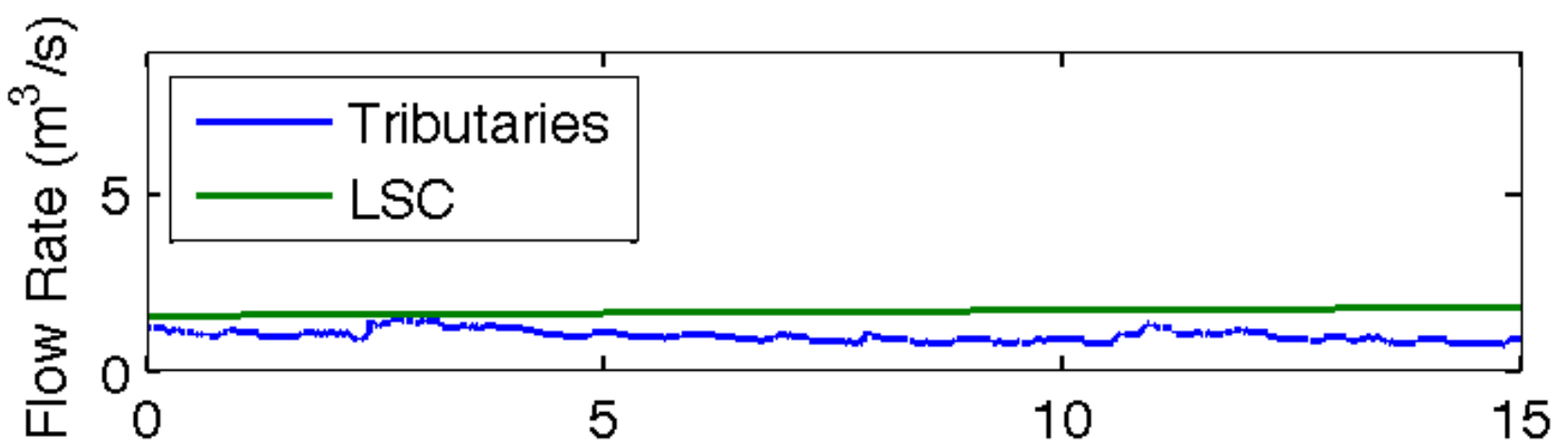
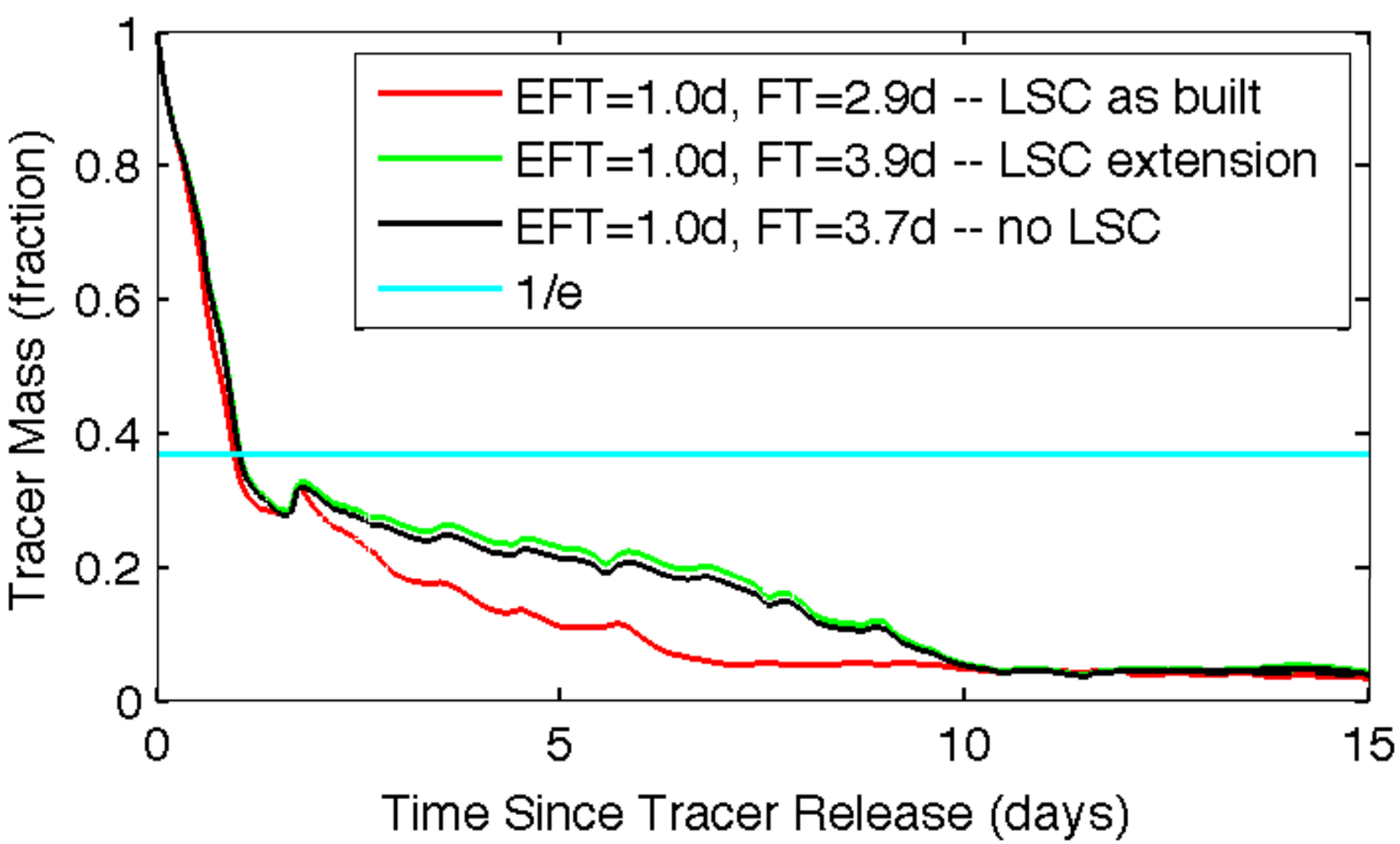
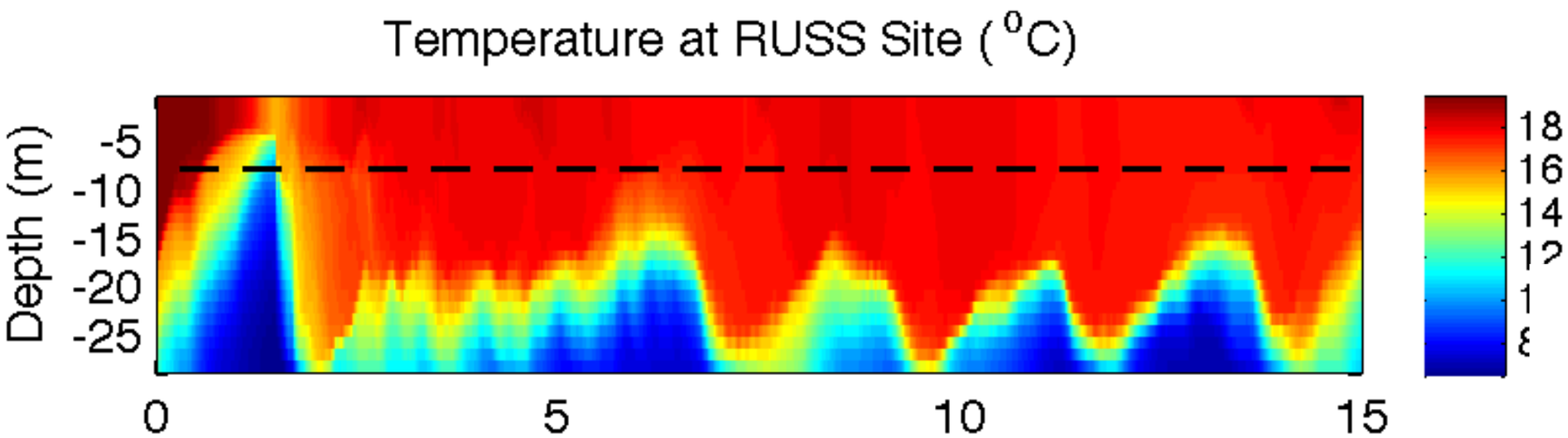


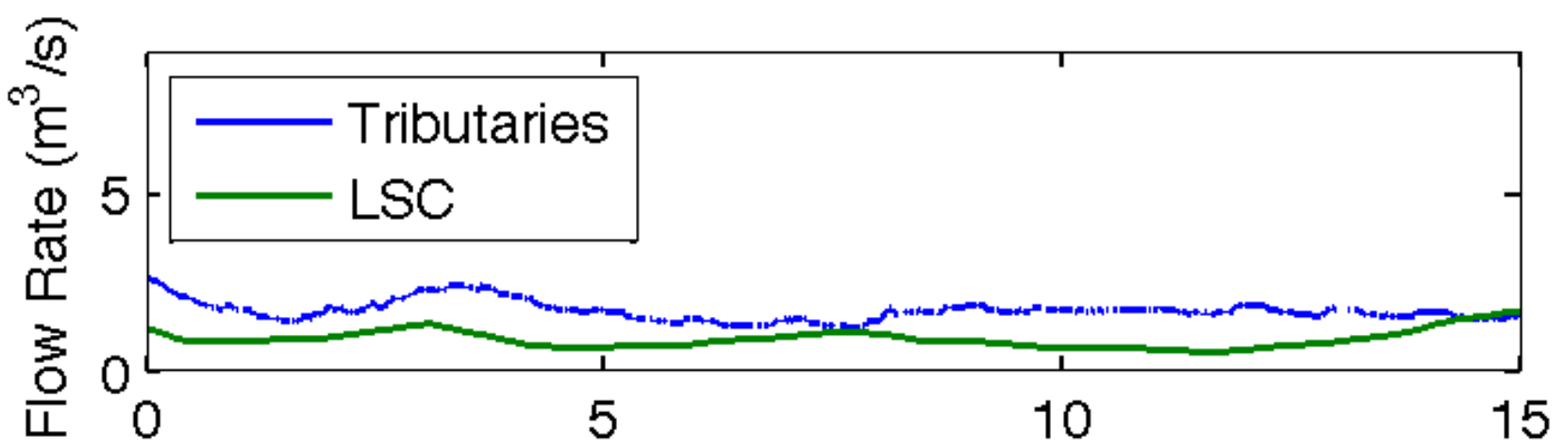


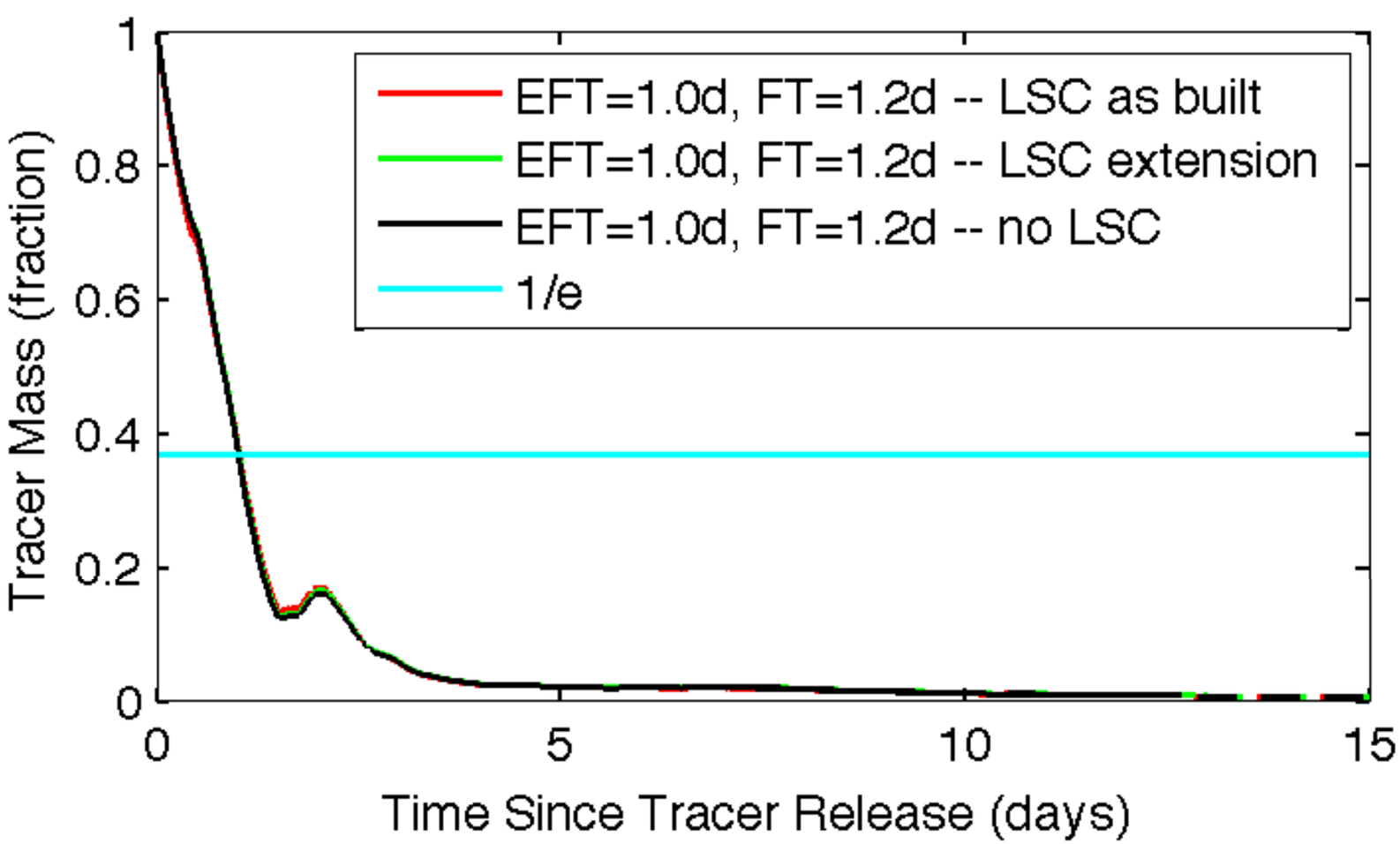




# What Physical Processes Control Flushing Time?




# What Physical Processes Control Flushing Time?

# Work in Progress

- Refine grid to 25m x 25m on shelf
- Improve near field model for point sources on shelf
- Validate SI3D using 2012 velocity, water surface elevation, and possibly herbicide release data (not just temperature)
- Calculate flushing times for summers other than 2012
- Compute/compare residence times for point sources, tributaries, and LSC sampling sites
- Correlate flushing/residence times to physical forcing
- Continue to develop model for outfall extension
- Support UFI estimates of bulk transport coefficients