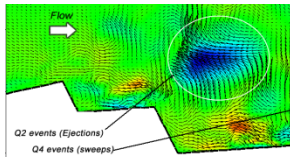


October 29th, 2011



## Morphodynamics and river modeling

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<http://www.pitt.edu/~jabad/>

**Assistant Professor**

*Dept. of Civil and Environmental Engineering (CEE)*

: <http://www.engineering.pitt.edu/Civil/>

*Dept. of Geology and Planetary Science (GPS)*

: <http://>

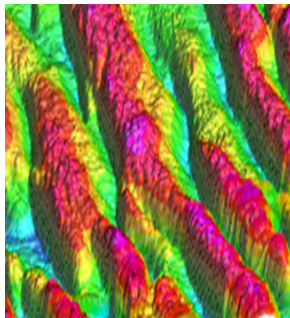
[www.geology.pitt.edu/](http://www.geology.pitt.edu/)

*Center for Simulation and Modeling (SAM)*

: <http://www.sam.pitt.edu/>

*Center for Latin American Studies (CLAS)*

: <http://www.ucis.pitt.edu/clas/>



**Director**

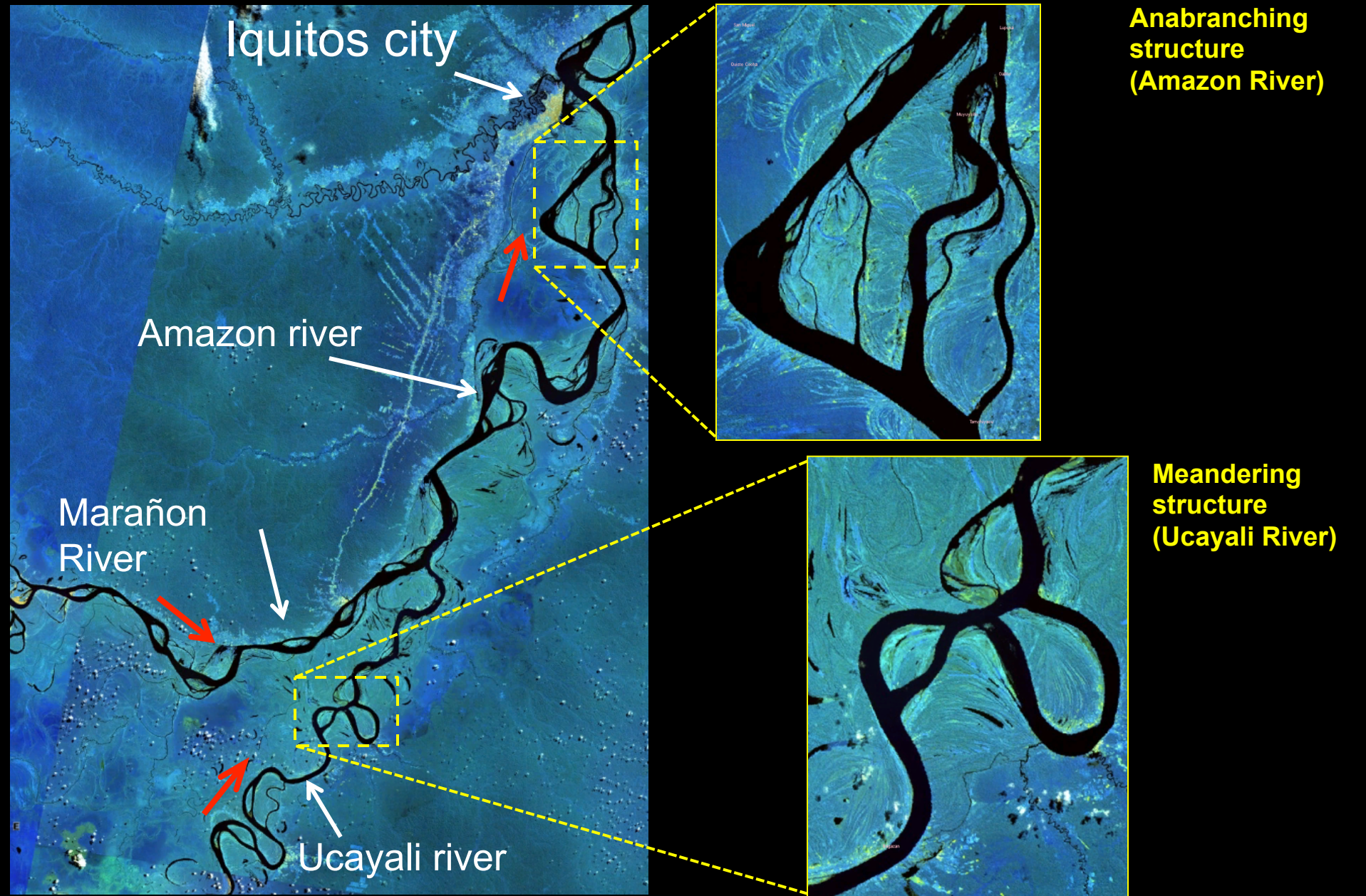
**CREAR**

**Center for Research and Education of the  
Amazonian Rainforest**

<http://www.creamazonia.org>

# **□ Planform dynamics in meandering and anabranching systems**

## □ Dynamics of meandering and anabranching systems





# Evolution of meandering channels

Lancaster, 2002



Dynamic equilibrium



**Conceptual model for a bend migration**

$S_e$ : equilibrium slope

$S_{AB} < S_e$   
 $S_{BC} < S_e$

The diagram illustrates the process of bend migration on a river channel. The top part shows a plan view of a meandering channel with segments labeled A, B, and C. Segment A is the straight reach, B is a bend, and C is a point bar. Arrows indicate the direction of flow and the migration of the bend. The bottom part shows a cross-section of the channel bed. The bed profile is shown as a blue line, and the equilibrium slope is indicated by a red line. The cross-section is divided into segments labeled 1, 2, C, B, and A. The horizontal distance between points A and B is labeled  $\Delta_{AB}$ , and the horizontal distance between points B and C is labeled  $\Delta_{AB} + \Delta_{BC}$ . The vertical axis is labeled "Elev" (elevation). The horizontal axis is labeled "s" (distance). The bed profile shows a "deposition" area between points A and B. The equilibrium slope is labeled  $\sim S_e$ . The cross-section labels at the bottom are 2, C, 2, C, B, B, A, and 1. The cross-section labels on the left are 1, 2, C, 2, B, B, A, and 1.

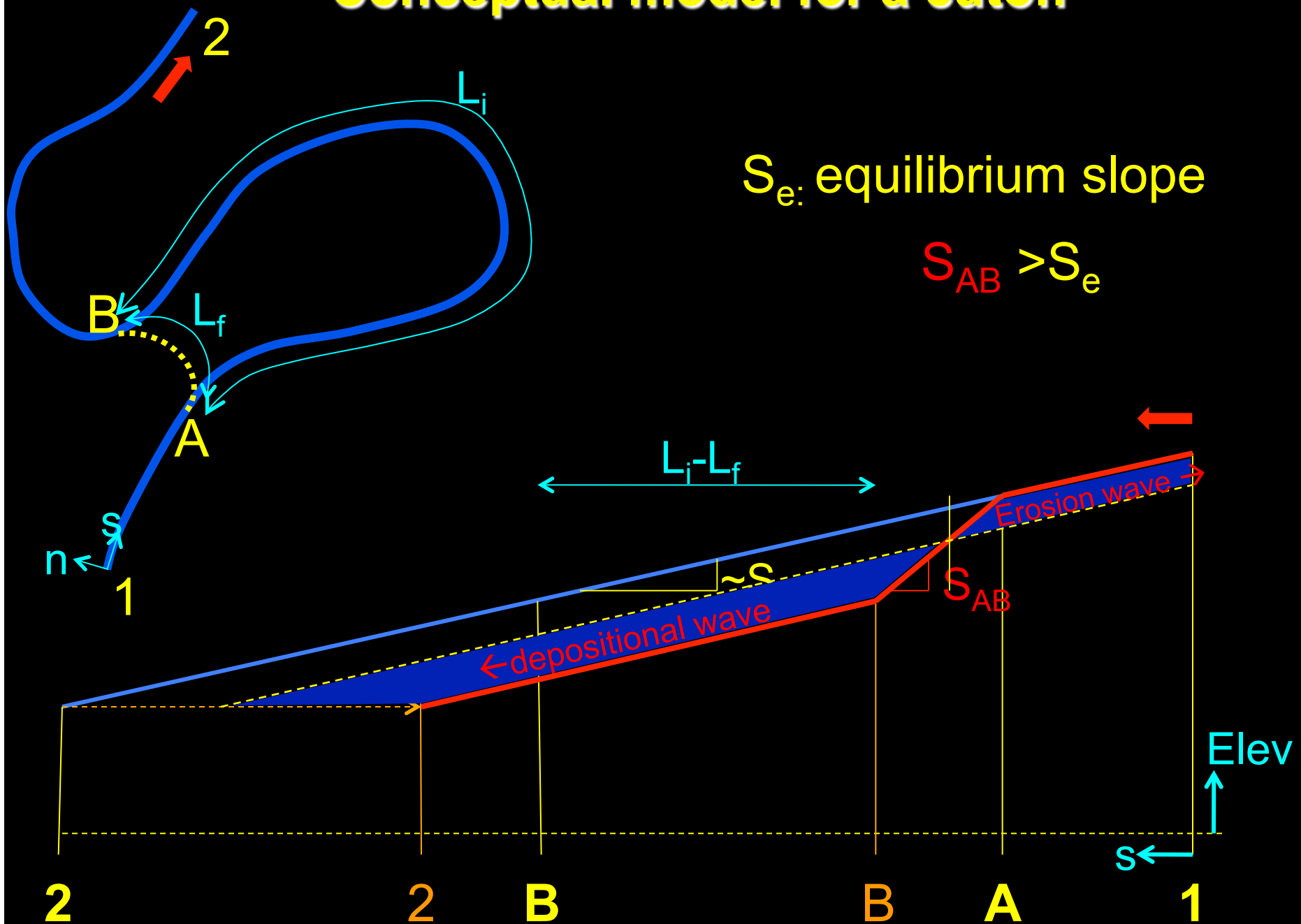
$S_e$ : equilibrium slope

$$S_{AB} < S_e$$

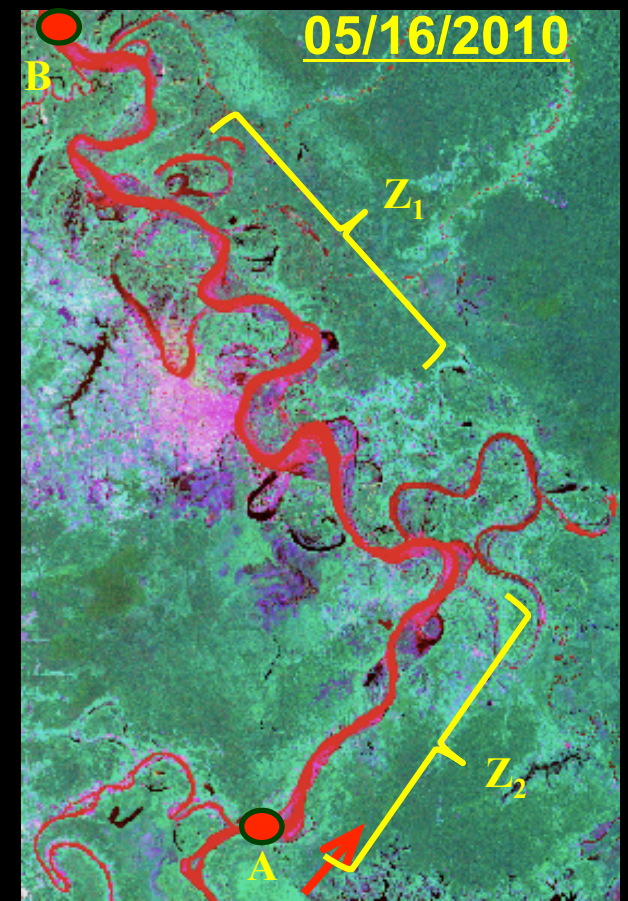
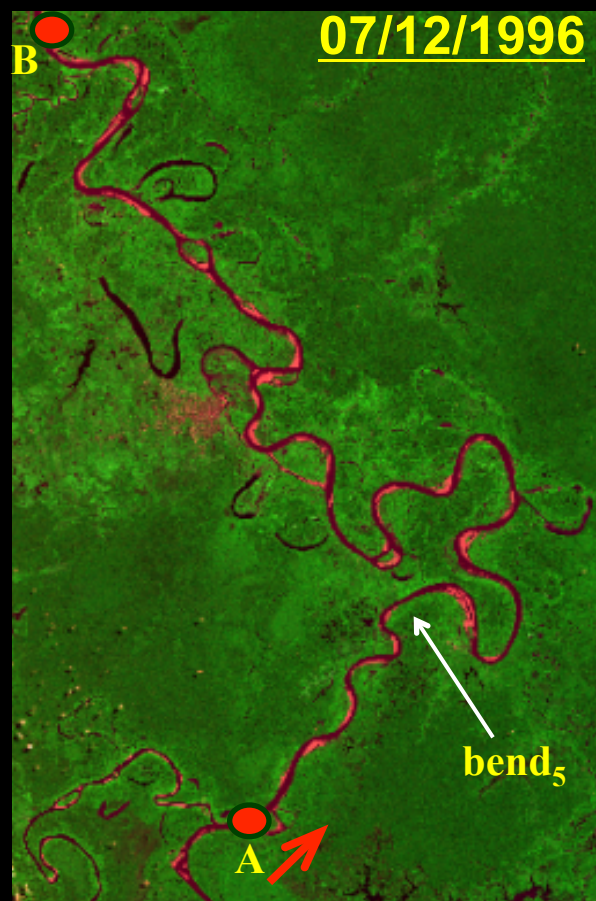
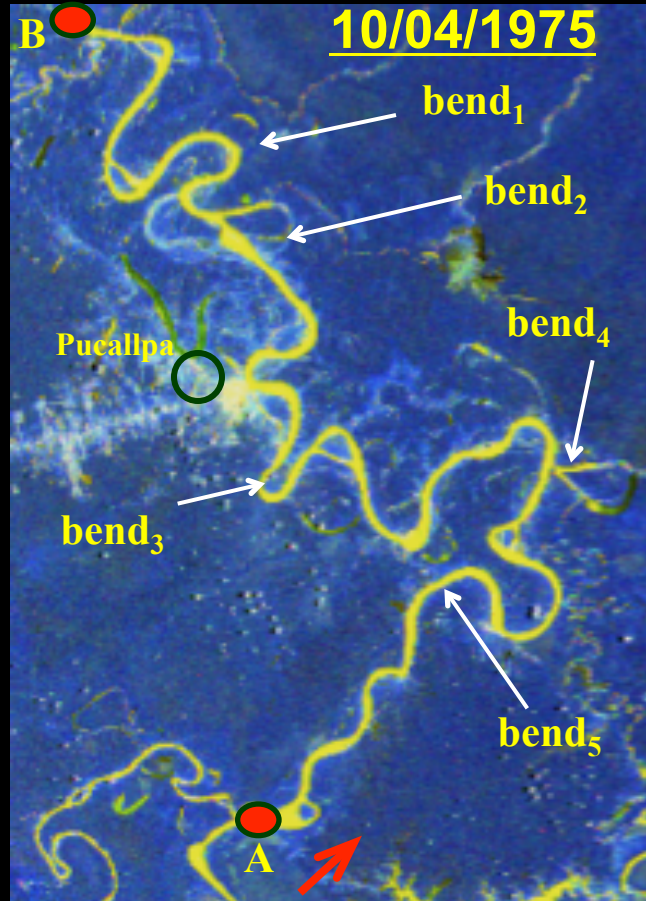
$$S_{BC} < S_e$$

Elev

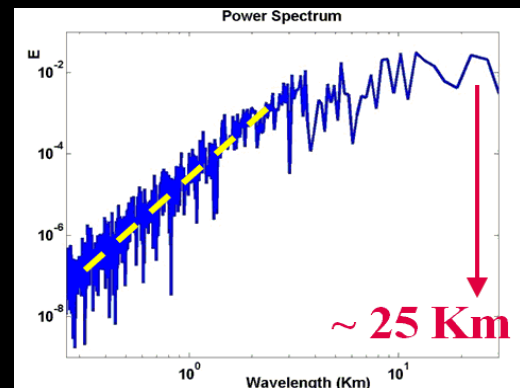
# Conceptual model for a cutoff



# Dynamics of the Ucayali River near Pucallpa City, Peru

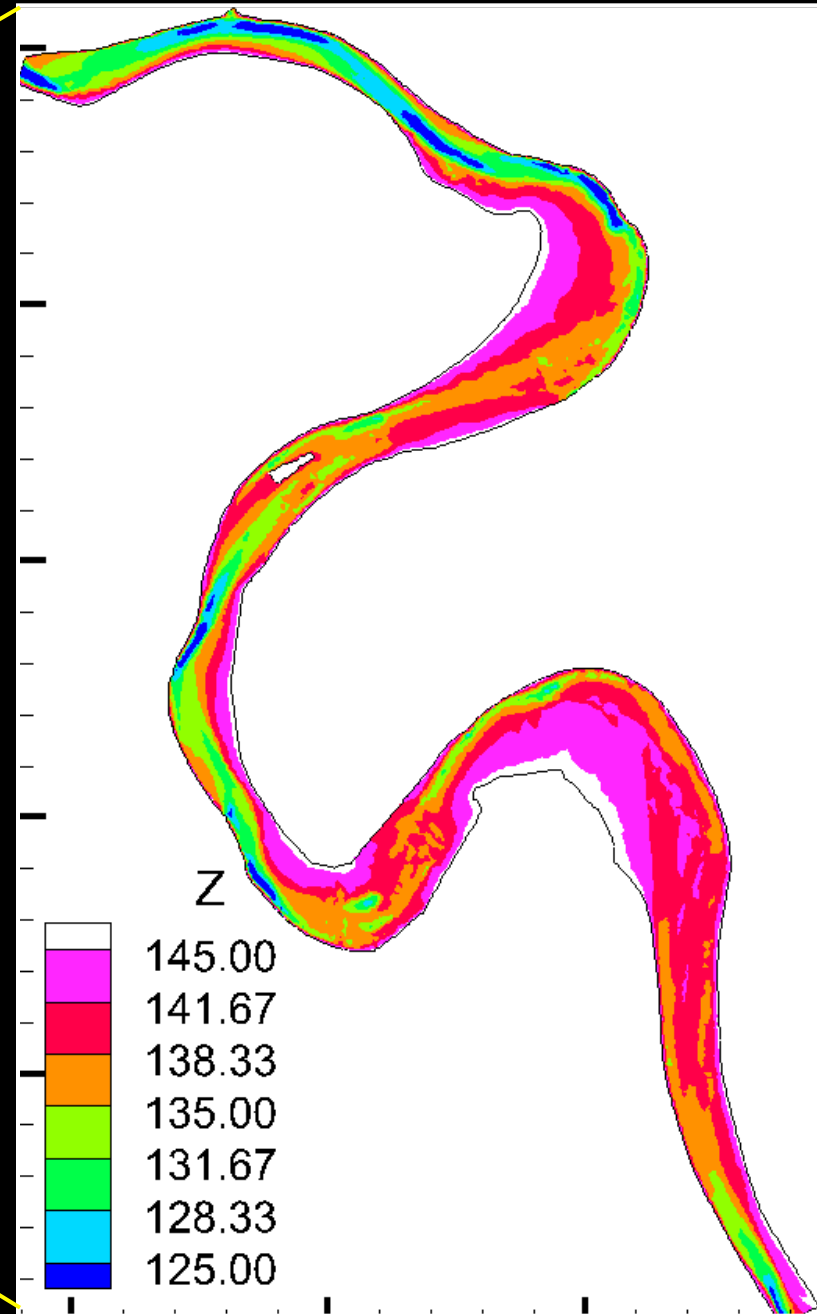
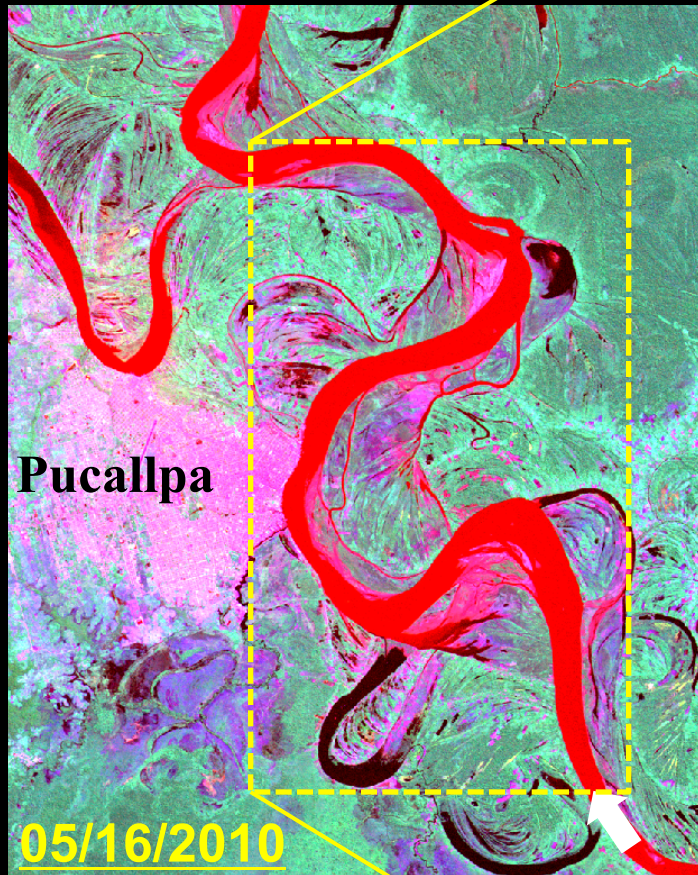


$$\text{Sin}_{\text{Ucayali}} \sim 1.70$$

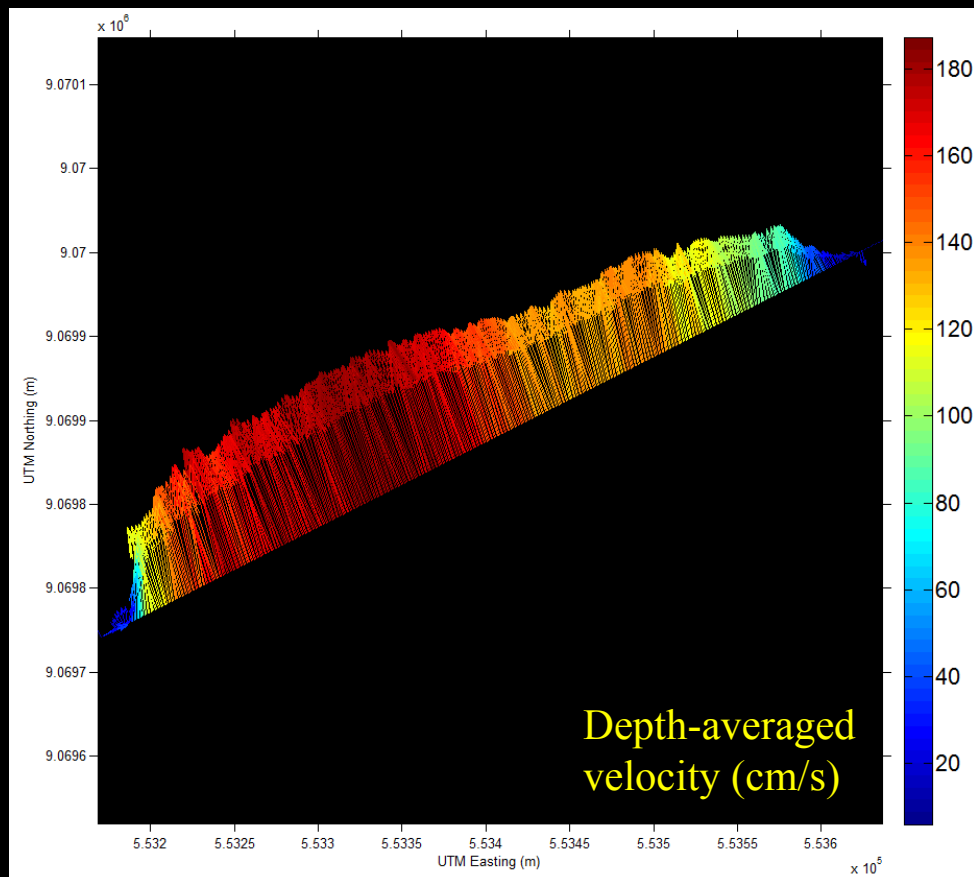
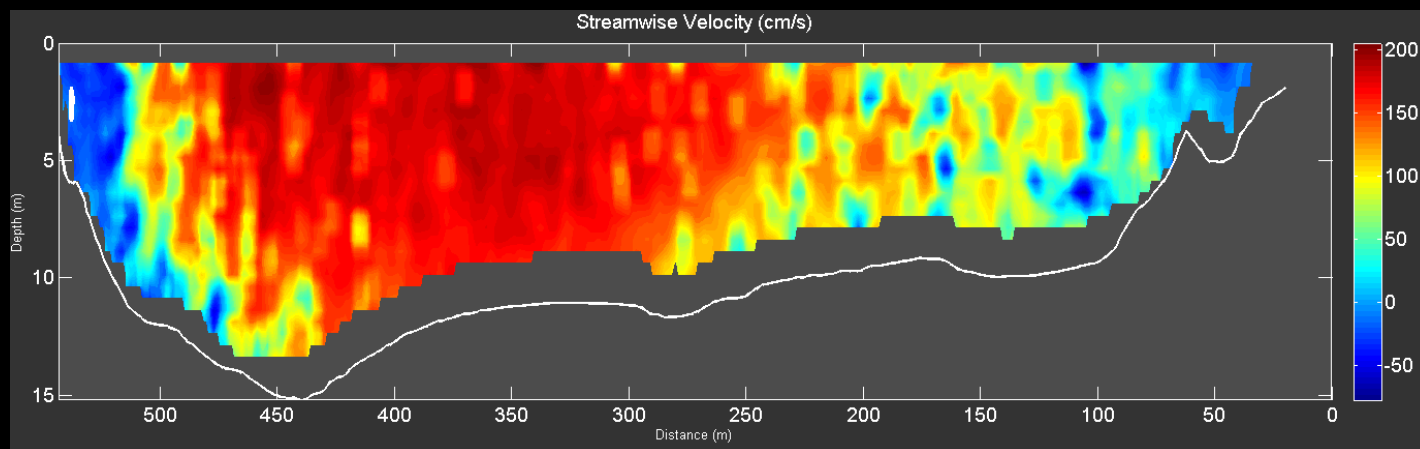




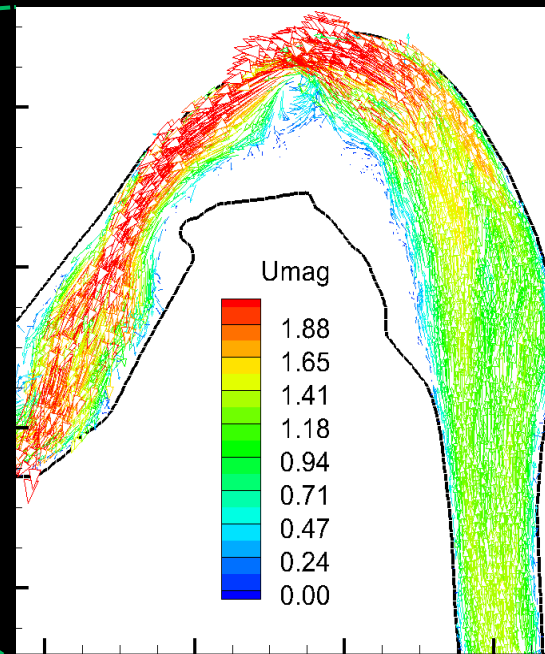
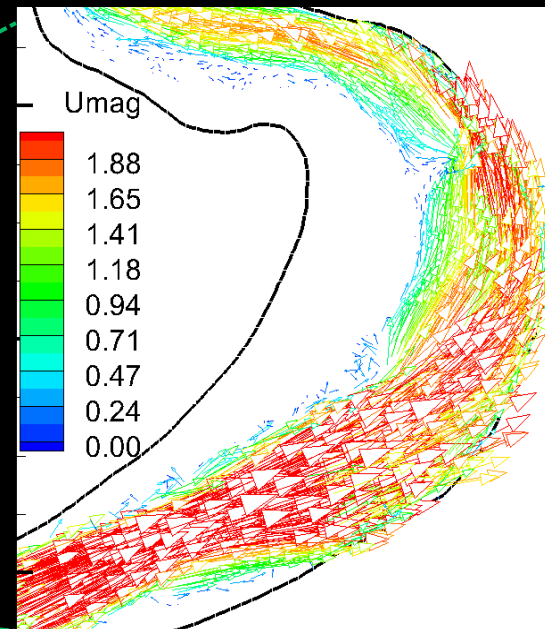
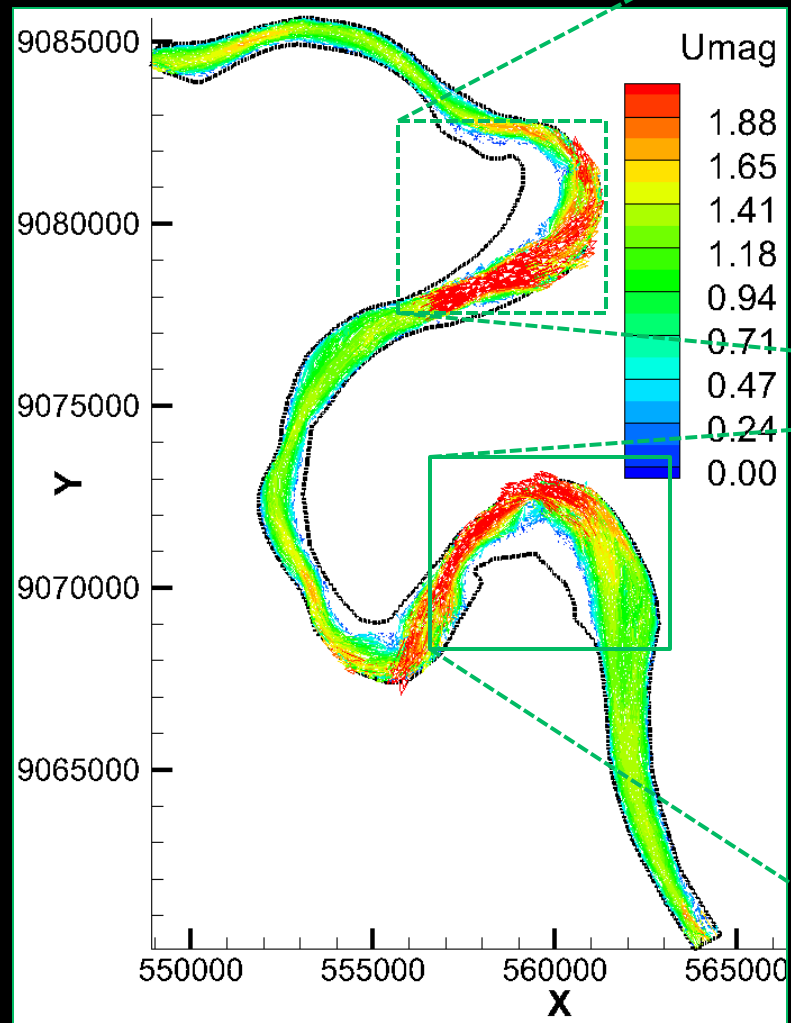
# Bathymetry 2011



# aDcp measurements 2011



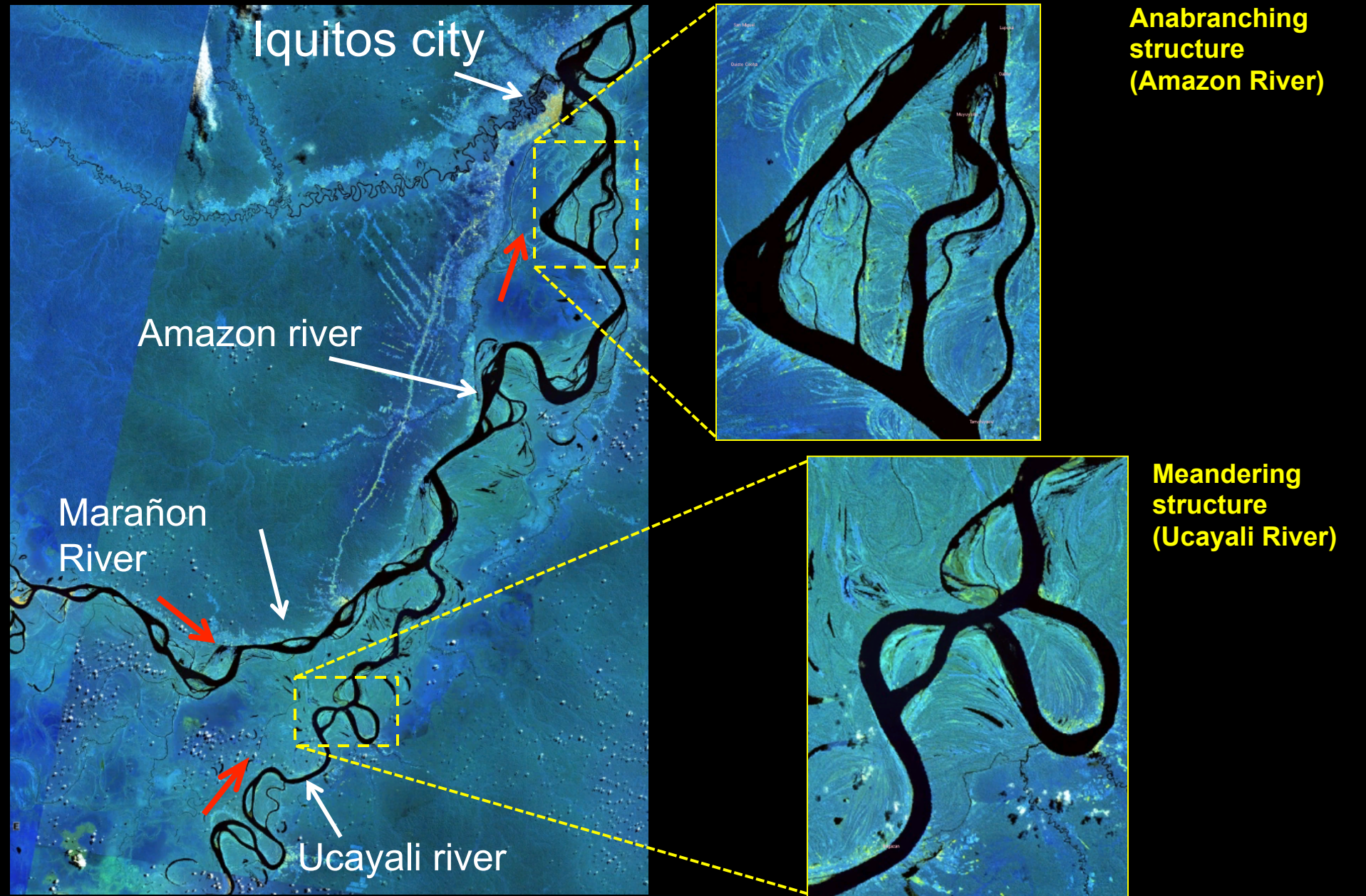
# 2D modeling



*Abad et al. (in preparation)*

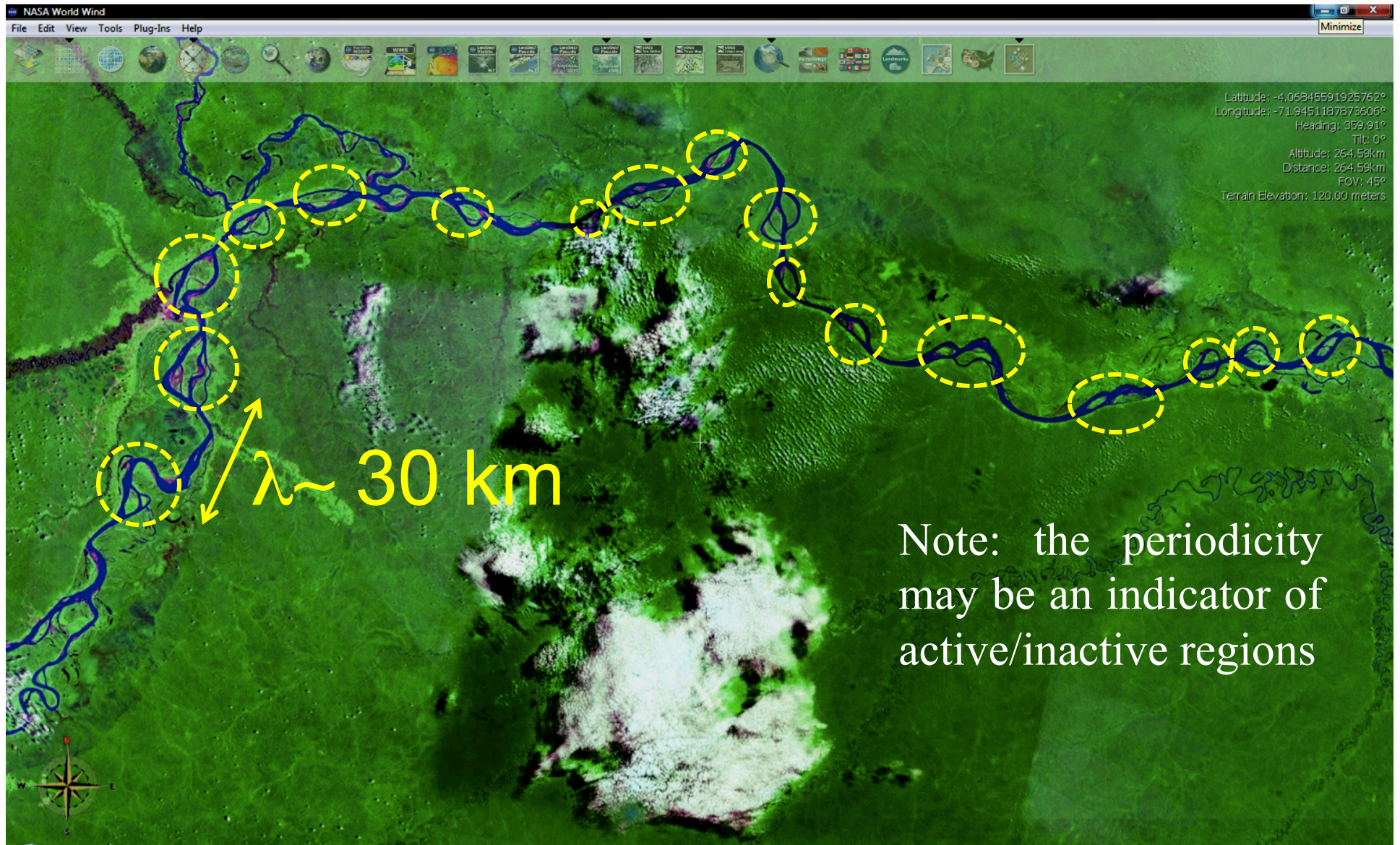


## □ Dynamics of meandering and anabranching systems



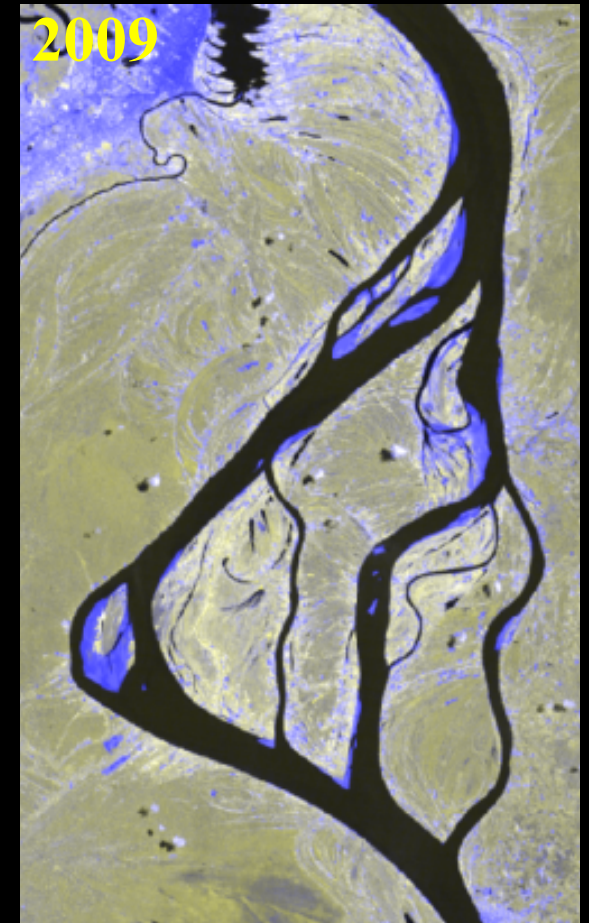
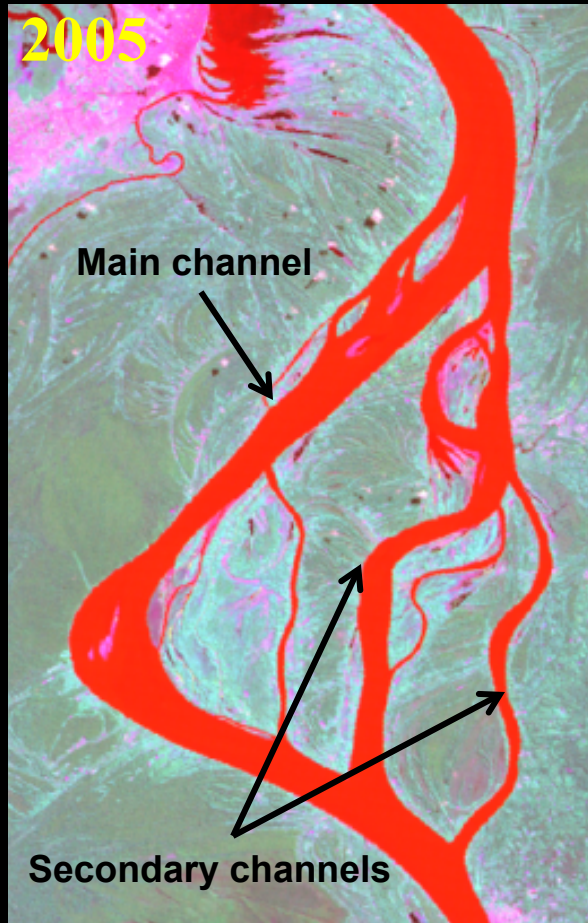
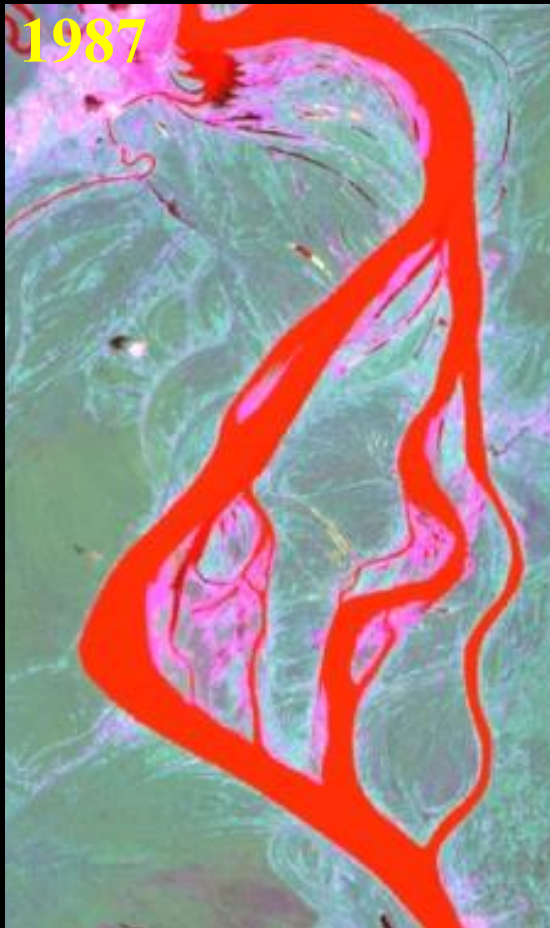


# Occurrence of anabranching structures





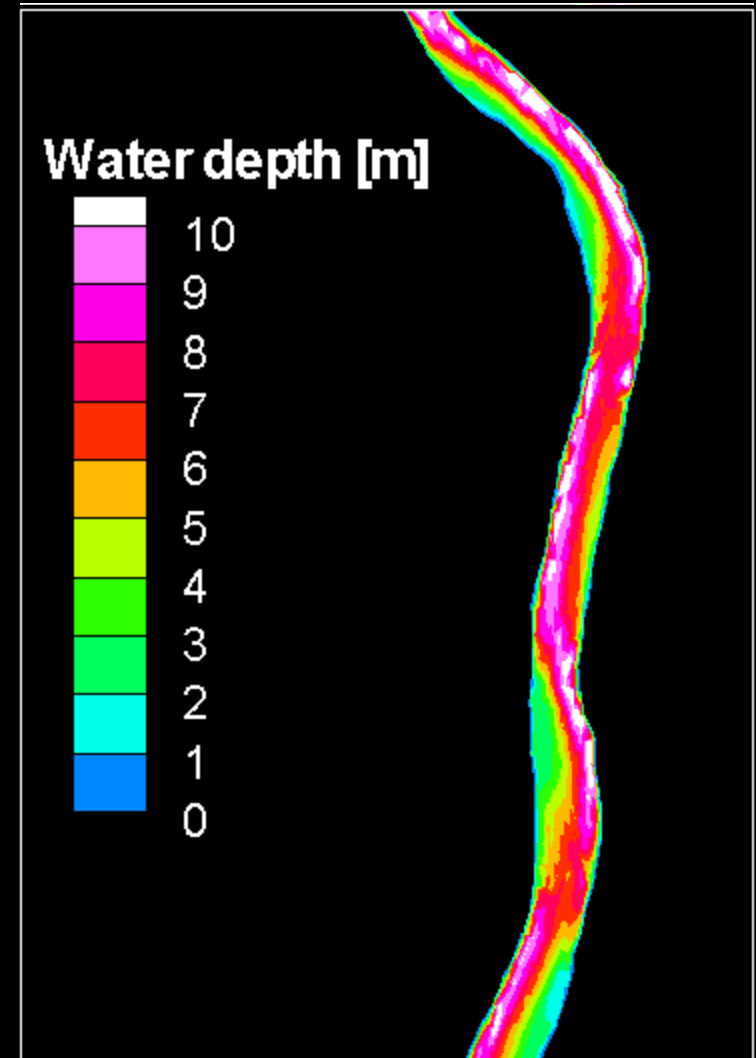
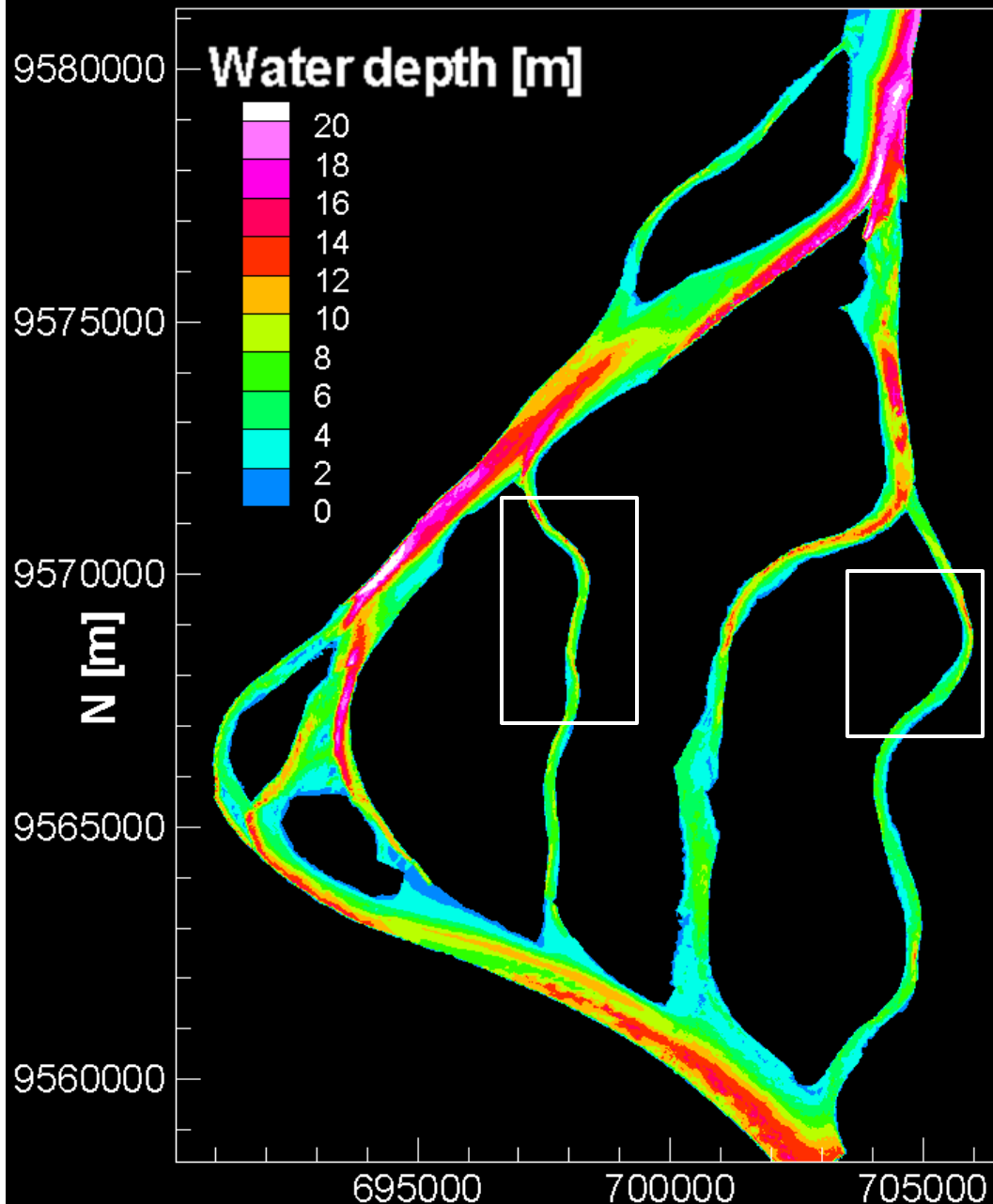
## Muyuy area



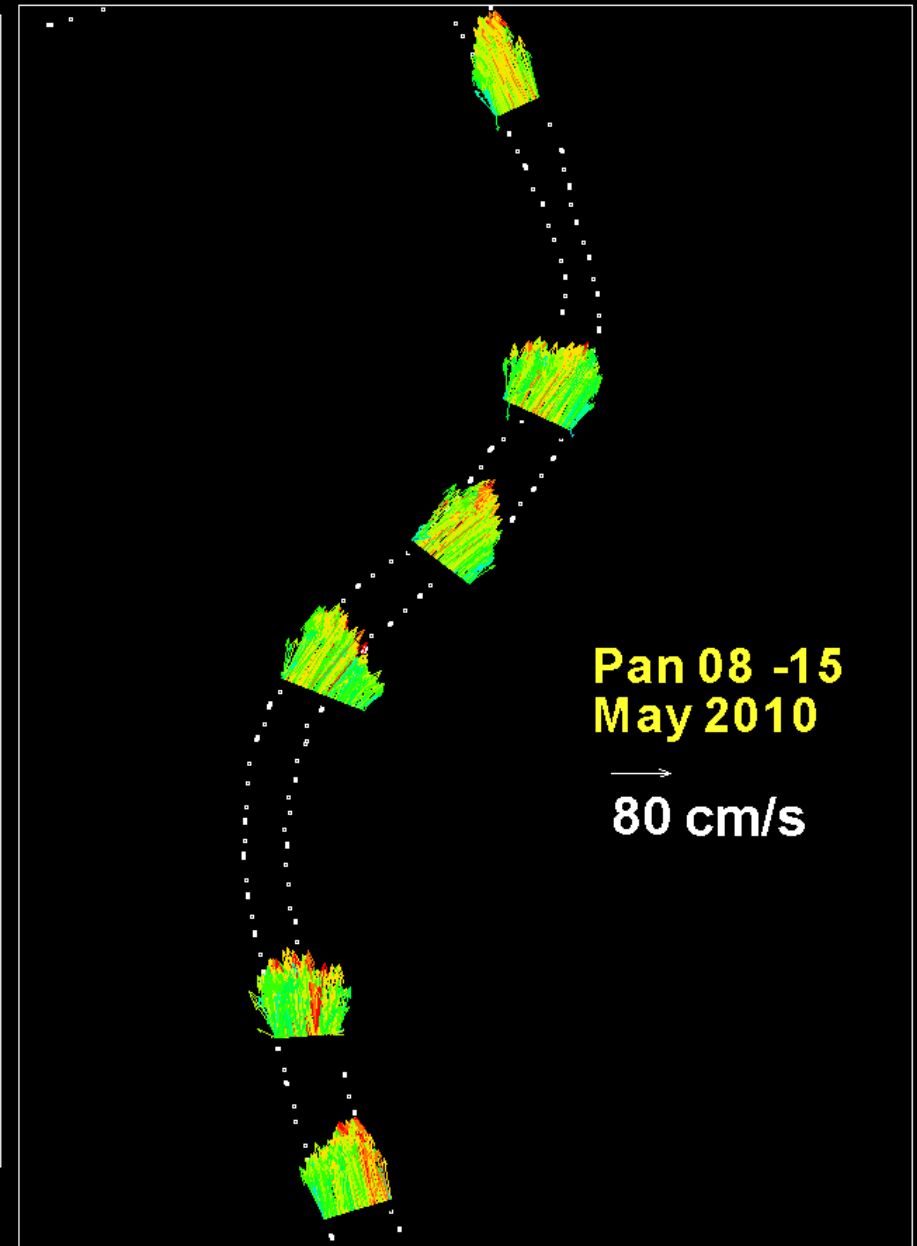
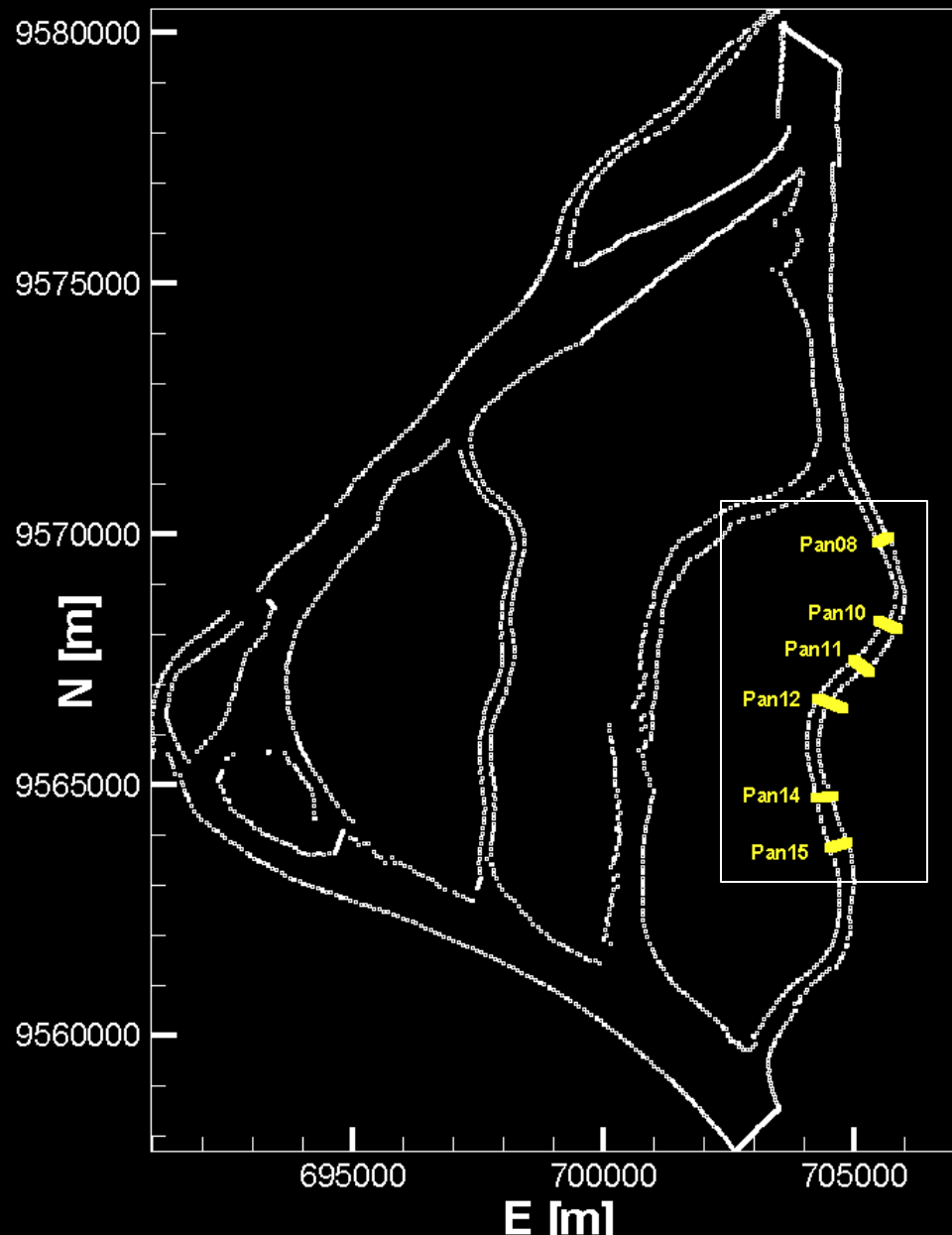
Notice: Individual secondary channels are behaving as meander bends, maybe the main channel will start to evolve more if other regions are turn off to be inactive



## Single beam measurements (Aug 2010) – low flow



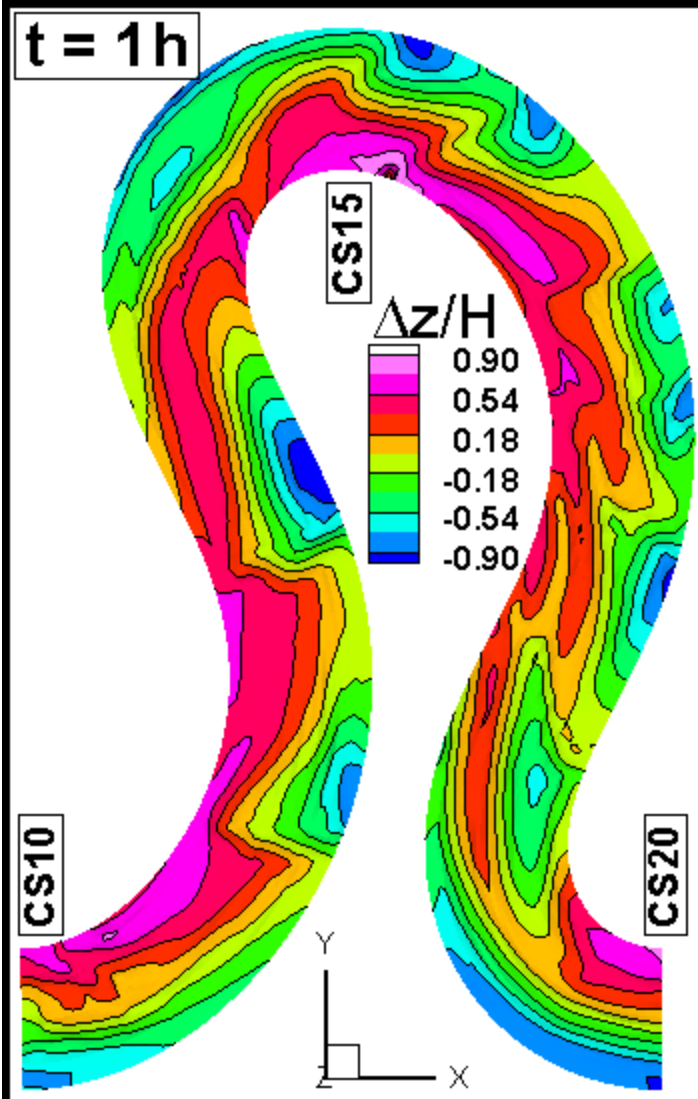
# SC are non-developed meandering channels *Abad et al. (in preparation)*



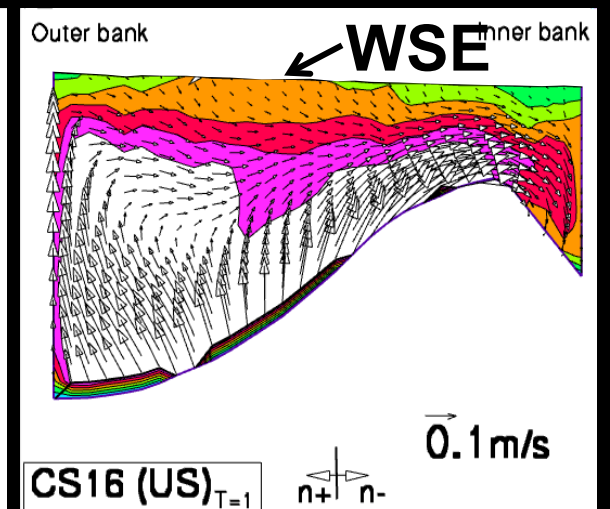
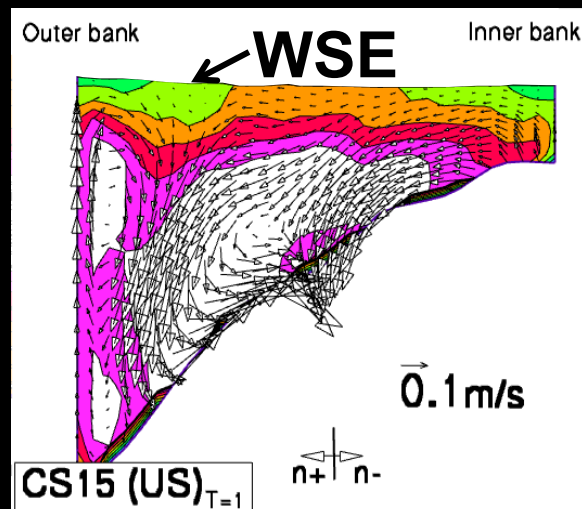
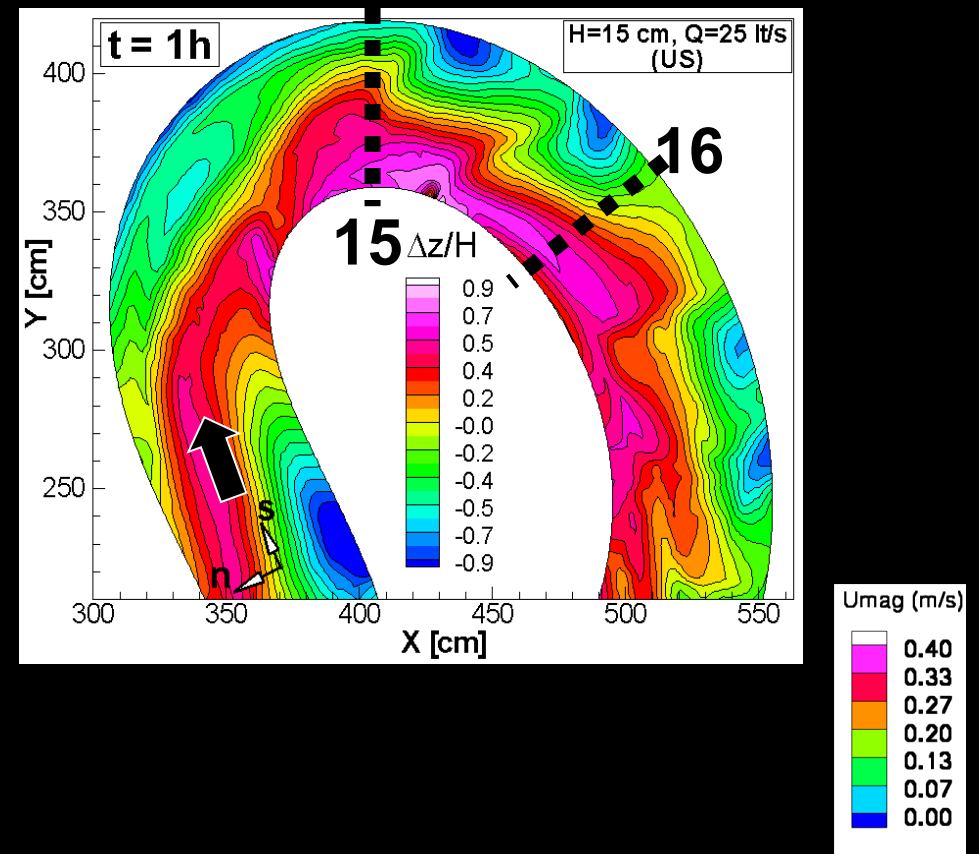
# ☐ Bed morphodynamics



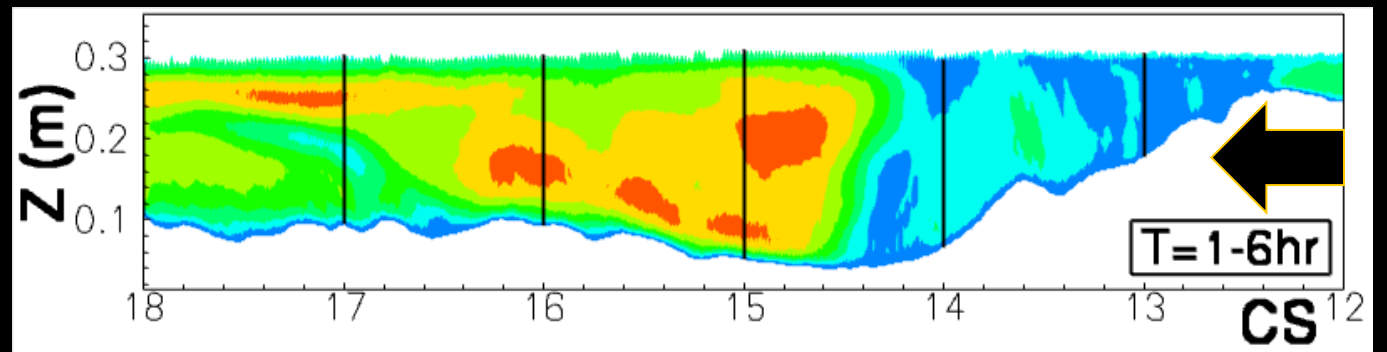
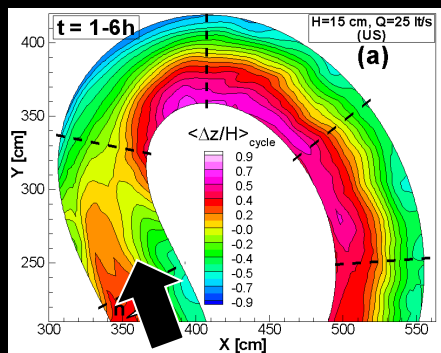
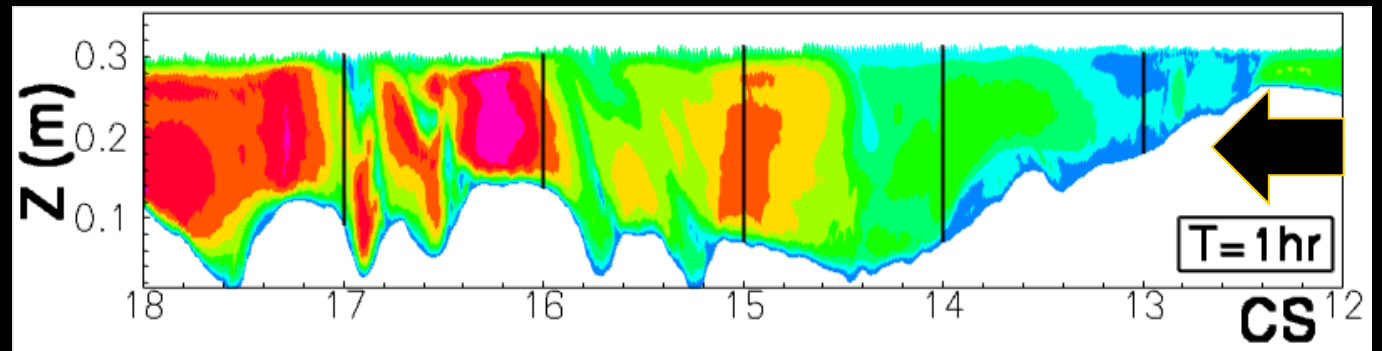
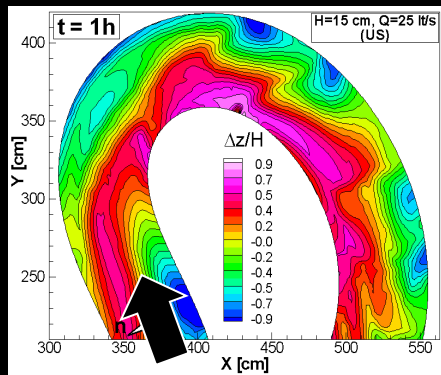
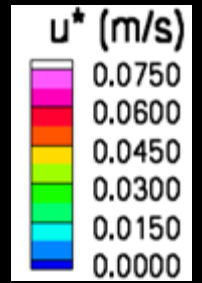
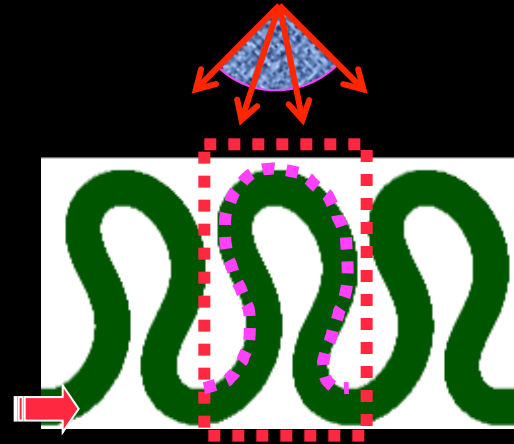
# Kinoshita channel – UofI Secondary flow



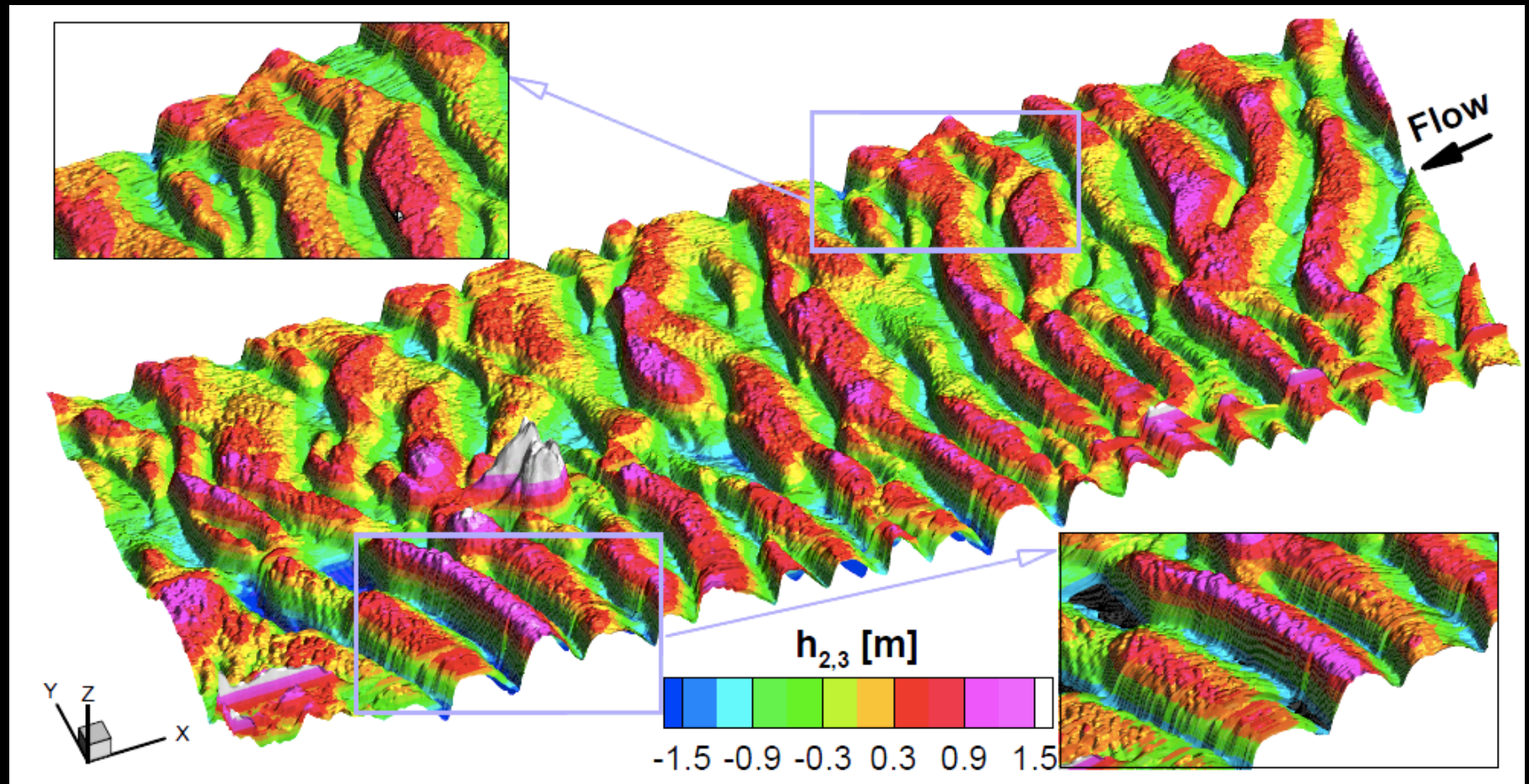
Abad (2008)



# Kinoshita channel – UofI Shear stress - banks



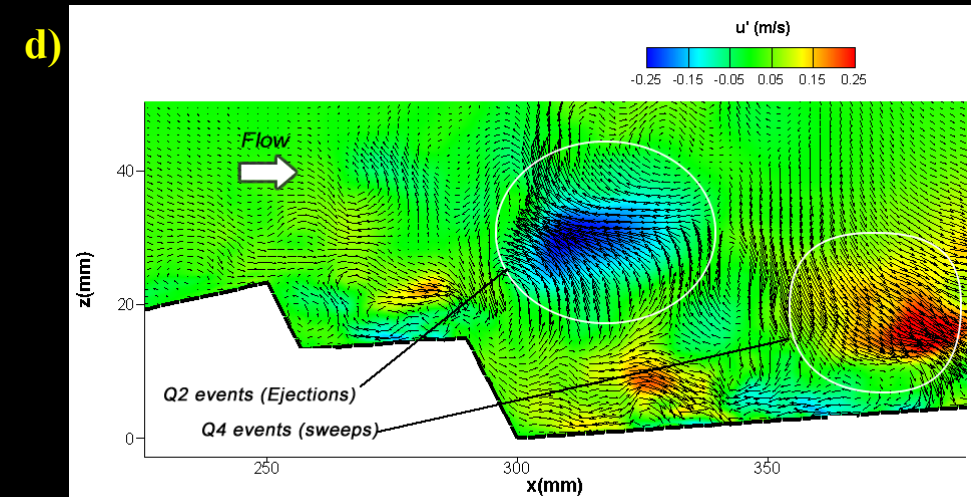
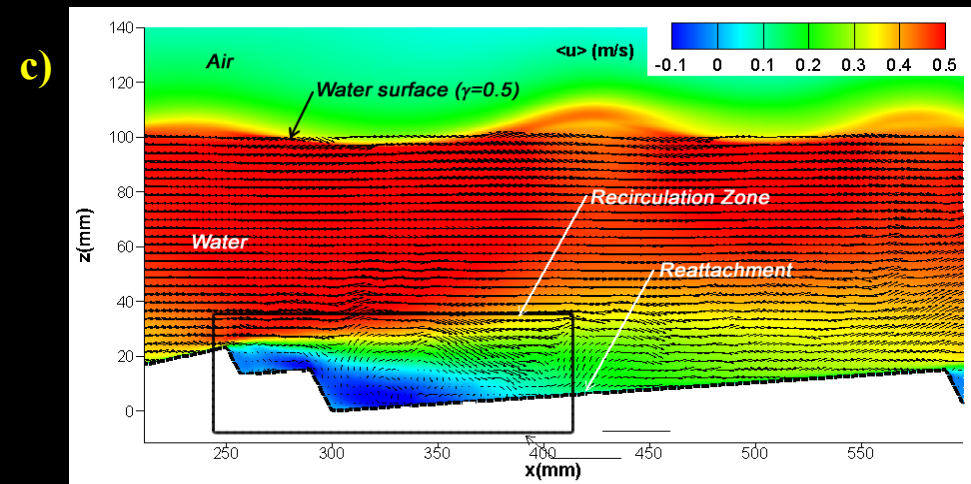
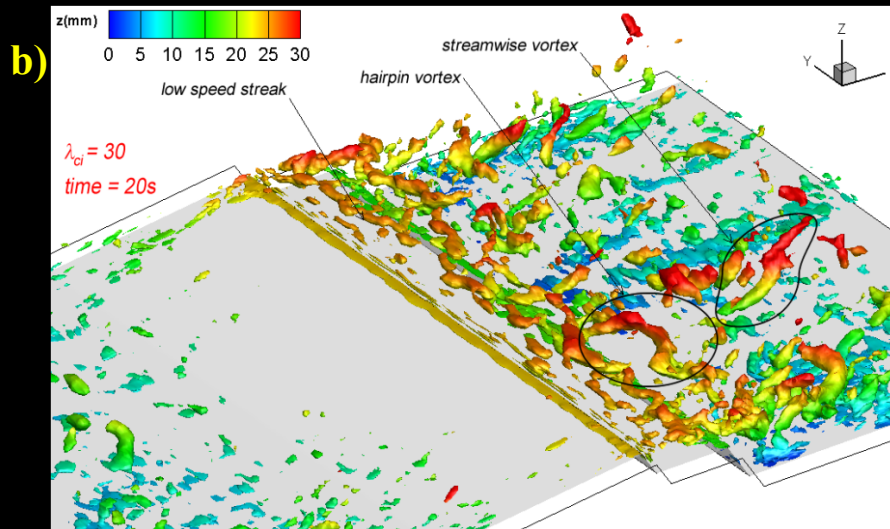
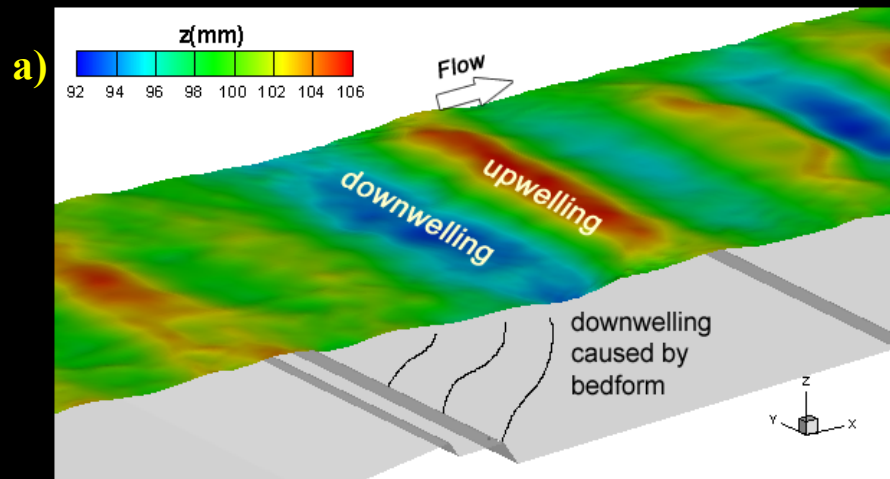
## Wavelet Analysis of Bedforms in Large River Systems



*(Gutierrez et al., in submission)*



# Large Eddy Simulation (LES) of superimposed bedforms



a) Bedform effect in the water surface, b) Isosurfaces for a swirling strenght of 30 to visualize vortical structures, c) Contours of average velocities and vectors of instantaneous velocities, d) Streamwise velocities perturbations in a plane  $Y=0$ .

Frias and Abad (in submission)

## GIS-based long-term morphodynamic model

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river meander migration software



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### OVERVIEW

The RVR Meander platform merges the functionalities of the first version of RVR Meander (Abad and Garcia, 2006) and CONCEPTS (Langendoen and Simon, 2008). It is written in C++ language and is composed by different libraries for preprocessing, hydrodynamics, bank erosion, migration, filtering, plotting, and I/O. It runs as stand-alone application on Windows and Linux operating systems and needs 4 input text files, specifying general parameters for simulation, channel centerline, valley centerline, and initial bank properties (geometry and erodibility). Several output files are produced, which describe the migrated centerlines, the two-dimensional (2D) hydrodynamics or bed morphodynamics field, and the evolution of bank geometry. All these files can be visualized in Tecplot or imported in Excel.

RVR Meander also has an ArcGIS-ArcMap interface, written in C # language. Its toolbar can be added to ArcMap, and provides same capabilities as the stand-alone version. In particular, the tab "Layer Definition" defines channel and valley centerlines, now input as shapefile polylines (therefore they can be created and edited inside the GIS environment). The other tabs "Channel Properties", "Preprocessing", "Hydrodynamics", "Bank Erosion", "Migration", "Smoothing", and "Output" specify other required parameters. A menu allows importing input data into the user form, to export input data to text file, to add the initial bank properties as text file, to run the simulation, and to import the results in the GIS environment, in terms of migrated centerlines (shapefile) or 2D representation of hydrodynamics or bed morphodynamics.

In terms of units, the stand-alone version works exclusively with SI (International) Units, while the ArcGISArcMap interface can either work with SI or English Units

#### LATEST NEWS

**09/03/2011**  
Pre-conference Short Course of RVRMeander in RCEM 2011  
[→ read more ...](#)

#### ADDITIONAL LINKS

[→ Ven Te Chow Hydrosystems Laboratory](#)  
[→ USDA- Concepts](#)

## Acknowledgments:



### RP1: Morphodynamics of Complex Meander Bends on Large Rivers

Collaborators: Jim Best, Bruce Rhoads, Marcelo Garcia (Univ. of Illinois at Urbana-Champaign)

Funding: NSF-Geomorphology & Land Use Dynamics, Hydrologic Sciences (2009-2013)



### RP2: Enhancement of the channel evolution model CONCEPTS

Collaborators: Eddy Langendoen (USDA-ARS, National Sedimentation Laboratory)

Funding: USDA-ARS (2010-2013)



### RP3: Peruvian Navy

Collaborators: Commander Hugo Montoro

Funding for field campaigns

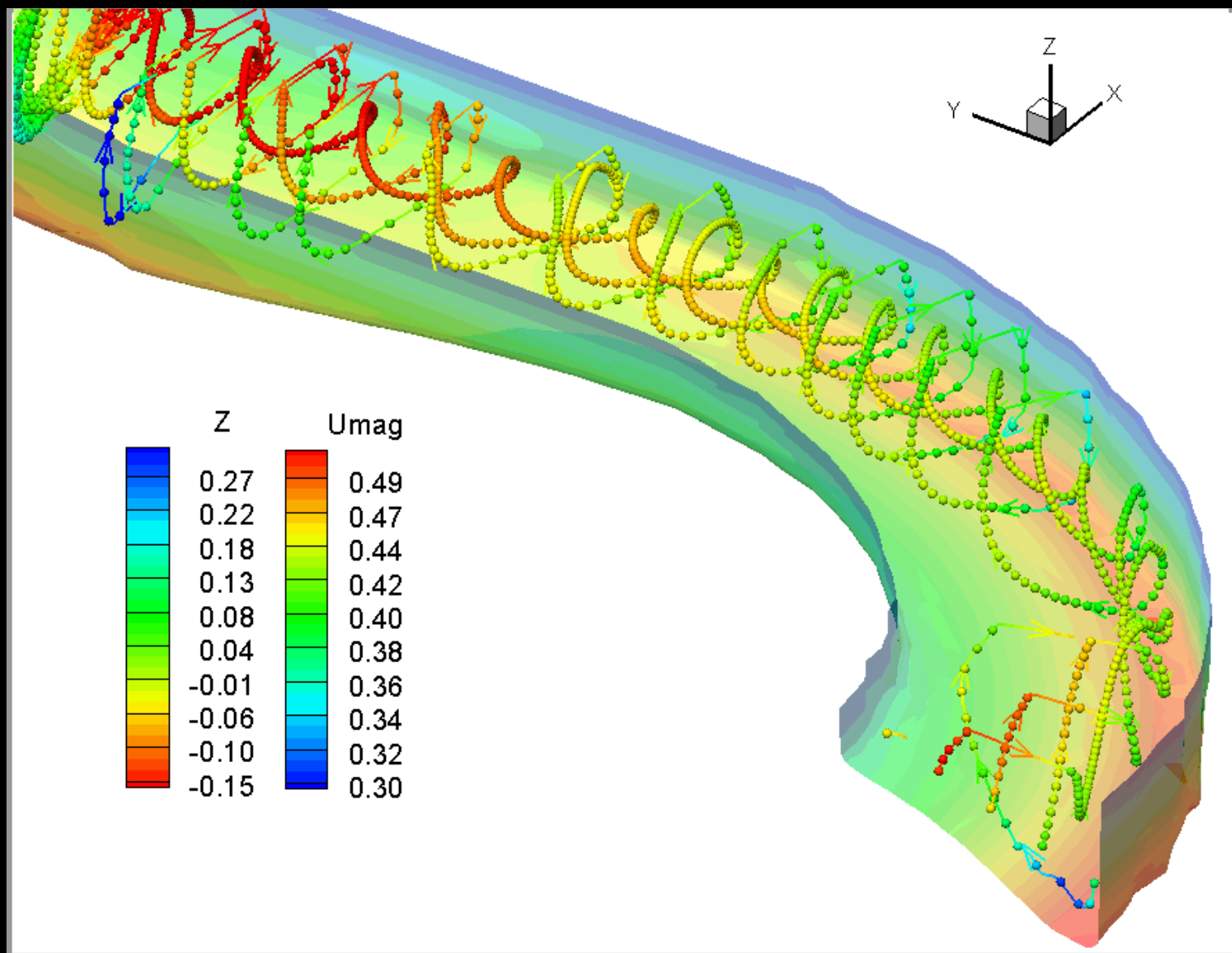
### @ University of Pittsburgh

My students

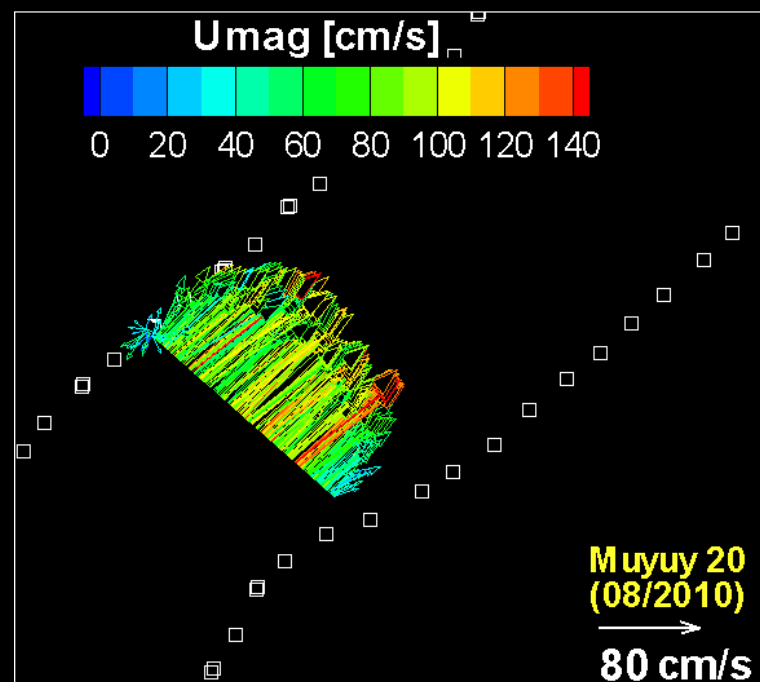
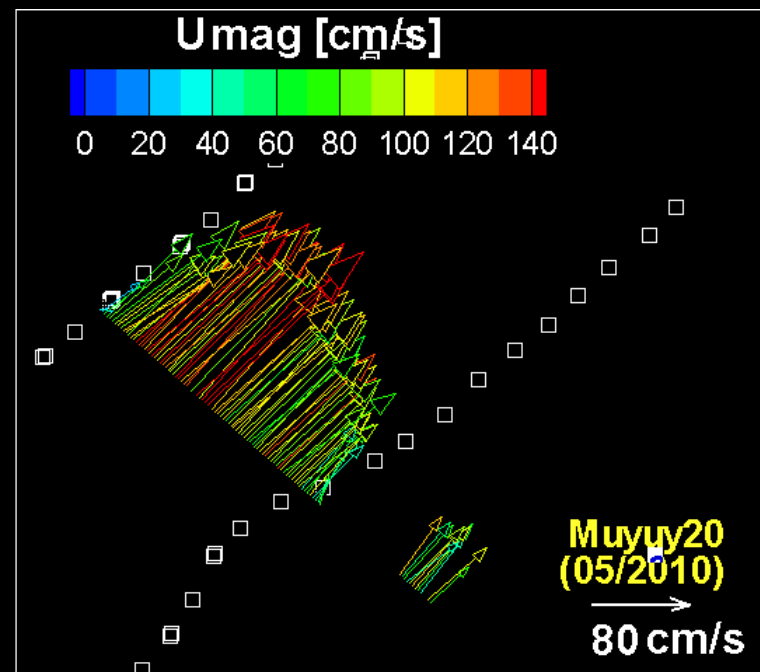
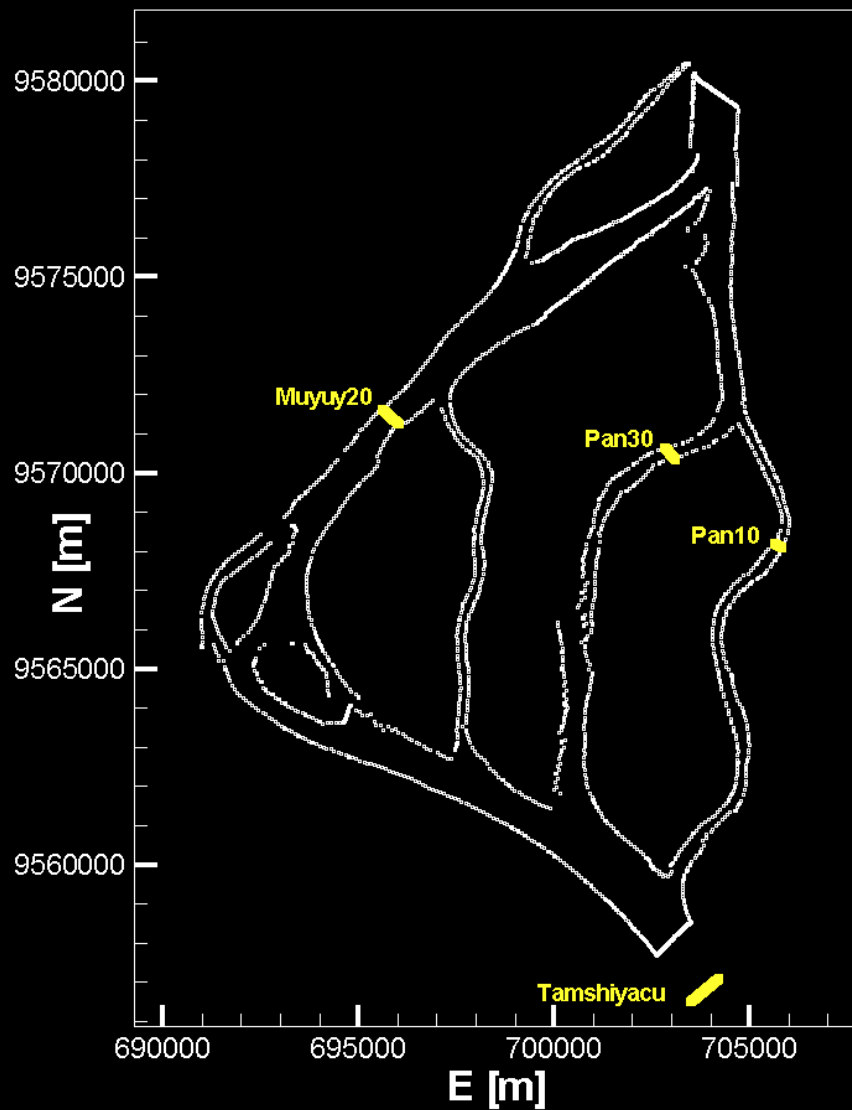
CEE and SSOE start-up funding



# Flujo secundario



# ADCP measurements

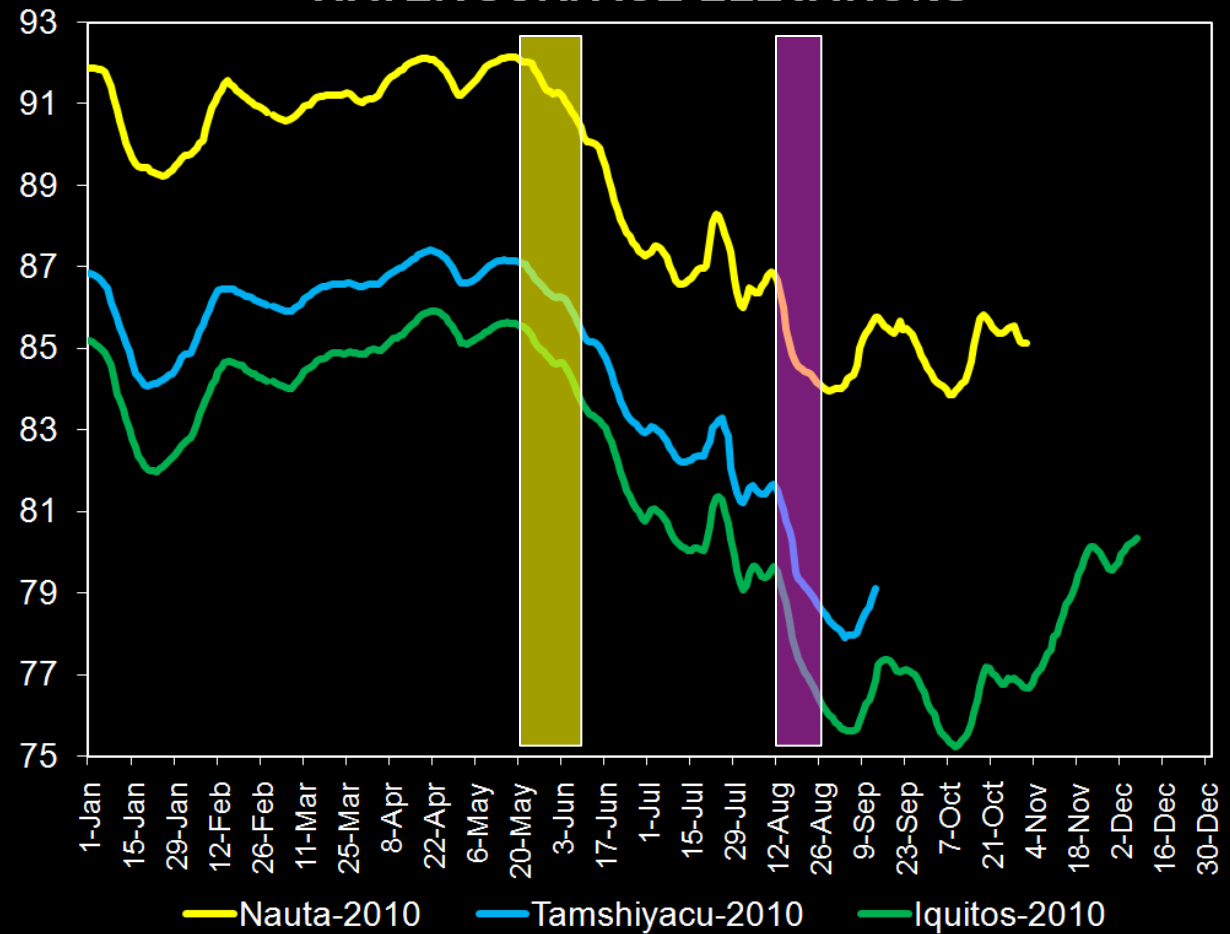


[3]

## Field measurements: Campaigns May and August 2010



### WATER SURFACE ELEVATIONS



Marañón River   Ucayali River   Amazon River

~ 21280 m<sup>3</sup>/s   ~ 12270 m<sup>3</sup>/s   ~ 33550 m<sup>3</sup>/s  
 ~ 12390 m<sup>3</sup>/s



# Water changes in the Amazon River

	Low flow	High flow
<b>U (m/s)</b>	1.5	2.2
<b>Qw (m<sup>3</sup>/s)</b>	5 000	55 000
<b>Qs (Ton/day)</b>	150 000	4' 000 000
<b>B (m)</b>	1 000	3 000
<b>H (m)</b>	10	50



# Superimposition of ripples over dunes

