New tools for Altimetric Data Selection and Interpolation

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Colloque HYBAM, 19-21/11/2007, Manaus
Satellite Radar Altimetry

Provides geodetic altitude of the reflective surface

- **TECHNOLOGY**
  - Satellite (Topex, ENVISAT, ...)
  - Radar altimeter (NRA, RA-2, ...)
  - Tracker (Ocean, ICE1, ICE2, ...)

- **APPLICATIONS**
  - Oceans
  - Great lakes et rivers
  - Floodplains
Satellite Altimetry on the Continent

- 1 passing = 1 cycle
- Several cycles = track
- Track \cap \text{river/lake/floodplain} = \text{Virtual limnmetric station}
# Synergy between Satellite and *In situ* Observations

<table>
<thead>
<tr>
<th><strong>In situ</strong></th>
<th><strong>Altimetry</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Errors</td>
<td>• Infinity of data selection methods</td>
</tr>
<tr>
<td>• Daily measurements</td>
<td>• Objective / repeatable / reproducible</td>
</tr>
<tr>
<td>• Low spatial density</td>
<td>• Low measurement frequency</td>
</tr>
<tr>
<td></td>
<td>• High spatial density (including floodplains)</td>
</tr>
</tbody>
</table>
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Manual « 3D » Selection

Geographical selection

Projection

Selection within the river section plan
Manual « 3D » Selection

Geographical selection

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Automatic Selection

DEM

Flow Accumulation

Drainage Network

Track $\cap$ Network = Line

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River width = $\alpha \cdot \text{Accumulation}^\beta$

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ADCP measurements $\Rightarrow$ river width

(A. Getirana)

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Automatic Selection  DEM

Drainage Network

\[ \alpha = 0.0835 \]
\[ \beta = 0.71 \]

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## Results

### Rio Negro

<table>
<thead>
<tr>
<th>Method</th>
<th>Nb of Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEM (SRTM90)</td>
<td>124</td>
</tr>
<tr>
<td>Classification</td>
<td>128</td>
</tr>
<tr>
<td>Manual 3D</td>
<td>43 (J. Silva)</td>
</tr>
</tbody>
</table>

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Globally, the 3 methods differ a little
(Nb. Of Points / cycle > 4 ~ width > 1500 m)

Very subjective

Manual Post-processing required
Perspectives

• Explaining results differences at the station level
  – River morphology
  – Landscape fragmentation
  – Relief (rugosity)
  – ...

• Choosing the selection method/tracker according to the context
  (decision tree, discriminant analysis)
Altimetric Time-Series Interpolation - Model

\[ h_v(t) = a_0 \cdot H_{is1}(t) + b_0 \cdot H_{is2}(t) + a_{-1} \cdot H_{is1}(t-1) + b_1 \cdot H_{is2}(t+1) + \ldots + c_0 \]
Parameters Estimation

1. Least Squares
2. Weighted Least Squares
3. Multi-criteria optimisation :
   – Altimetric height
     *(amplitude)*
   – Smoothness
     *(Frequencies distribution, spectrum)*
Evaluation

Simulated altimetric time-series from in situ stations
Results

• Adding information (in situ stations) ⇒ Significantly decreases RMS errors
• Taking into account time lags ⇒ Decreases RMS errors by 16.4 cm (32.7%)
• Absolute RMS errors from 0.6 to 40.9 cm
• Multicriteria Optim. globally better than Least Squares
• Multicriteria Optim. significantly less sensitive to missing values and noise

[Roux et al. Journal of Hydrological Sciences, 53(1), 2008
Discussion and Perspectives

The method
• Needs a lot of data \textit{(in situ)}
• Depends on \textit{in situ} data quality

⇒ Using only virtual stations

Needs many \textit{a priori} information
\textit{(background knowledge)}

\cite{TarantolaValette}
Conclusion

• For relatively large rivers (>~1500m), automatic and manual methods give comparable results (globally)

A need to better understand methods differences at the station level
⇒ choice of the method according to the context

• Interpolation gives satisfactory results

In the future, trying to only exploit satellite information