Satellite-Based Estimates of River Runoff

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Surface Current Measurements by Along-Track InSAR

- Two SAR antennas acquire images with short time lag
- Phase differences are proportional to line-of-sight velocities
- Imaging of surface current fields in SAR quality

Launched in June 2007!
Project AnaNAF

Analysen zur Nutzbarkeit zukünftiger Satellitendaten für die Fernerkundung des Ausstroms von Flüssen
(Analyses on the Usability of Upcoming Satellite Data for the Remote Sensing of River Runoff)

Project phase: 2006-2009

- Evaluation of the potential of current measurements in rivers by spaceborne along-track InSARs
  - Measuring accuracy of upcoming InSARs for different scenarios (river width, shape, surface roughness, etc.)
  - Relation between measured surface currents and depth-averaged currents
  - Applicability to major rivers all around the world

- Investigation on the suitability and achievable accuracy of combining various remote sensing techniques / strategies
  - Current measurements by along-track InSAR and water level measurements by radar altimeter
  - Sampling problems
  - Requirements for utilization of models and additional data

- Development and demonstration of a data synthesis system for global river runoff monitoring
Lateral current variations are resolved
Good agreement with InSAR model
Similar data quality is predicted for TerraSAR-X
3-D High-Resolution Model Data of Elbe River

- 3-D model of currents, water levels, water depths from Federal Waterways Engineering and Research Institute (BAW)
- Temporal coverage: Complete neap-spring tide cycle (17 days), resolution: 10 min
- Spatial resolution: Gridded to 100 m
Discharge Estimation

\[
Q_{est}(V/W) = k_3 \cdot V_s^{1.67} \cdot W^{1.67}, \quad k_3 = 0.05; \quad W = \text{surface width} \quad V_s = \text{surface velocity}
\]

Bjerklie et al. (2005)

- Without fitting, only using width and surface velocity, transports are resolved

\[
Q_{ref} = A \cdot V_s \cdot 0.85, \quad A = \text{cross-sectional area}
\]

\[
Q_{est} = A \cdot V_s^{1.85}
\]

\[
V_m = 1.42 \text{ [m/s]}
\]

\[
W = 26.5 \text{ [m]}
\]

\[
V_m = 1.16 \text{ [m/s]}
\]

\[
D = 27.5 \text{ [m]}
\]
Temporal Sampling Considerations

- phase variations in the tidal cycle within 17 days
Conclusions

- Along-track InSAR permits surface current measurements in rivers from satellites
- TerraSAR-X (launched June 2007) experimental InSAR mode available in 2008
- Project AnaNAF: Investigations on usability for river runoff estimates
- Volume transport estimates from surface currents and widths appear feasible
- Spatial and temporal sampling by spaceborne sensors is an important issue

Outlook

- Development of improved volume transport and net discharge estimate algorithms
- Realistic satellite sampling simulations
- Combination of along-track InSAR and altimeter measurements (WatER-HM)
- Analysis of applicability to major rivers around the world
- Demonstration with actual TerraSAR-X data before end of project
Thank you for your attention