

Floating Platform Motion Correction Using Video Camera Images

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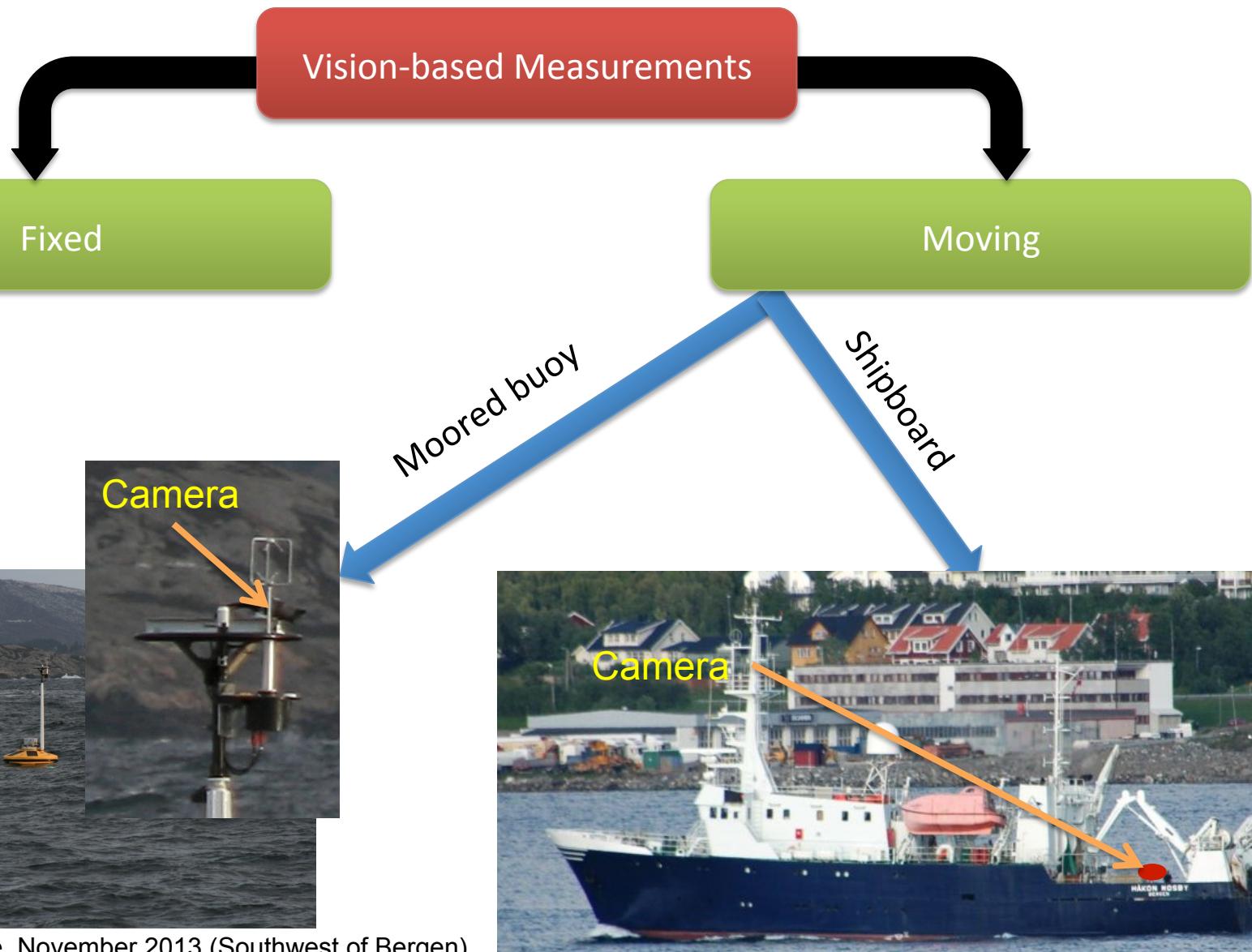
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Canada*

Outline

- 1) Brief Measuring systems
- 2) Attitude Estimation.
- 3) Results and comparisons.
- 4) Applications.



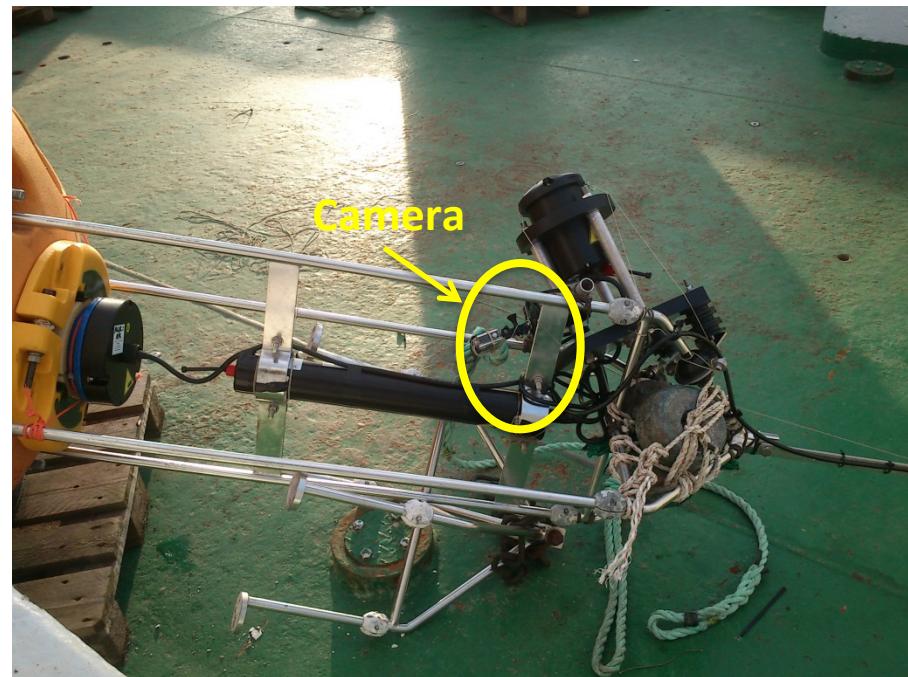
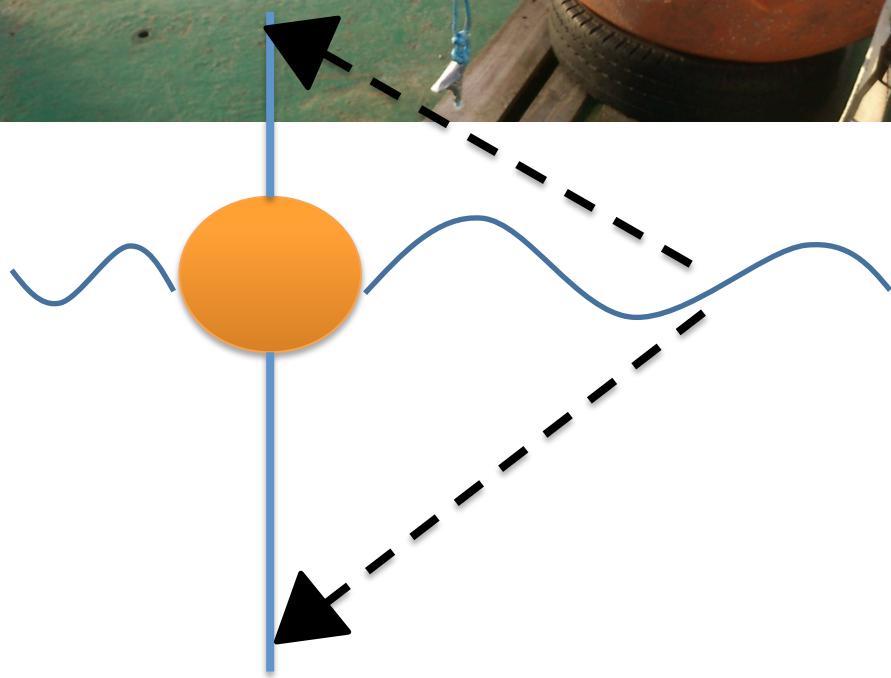
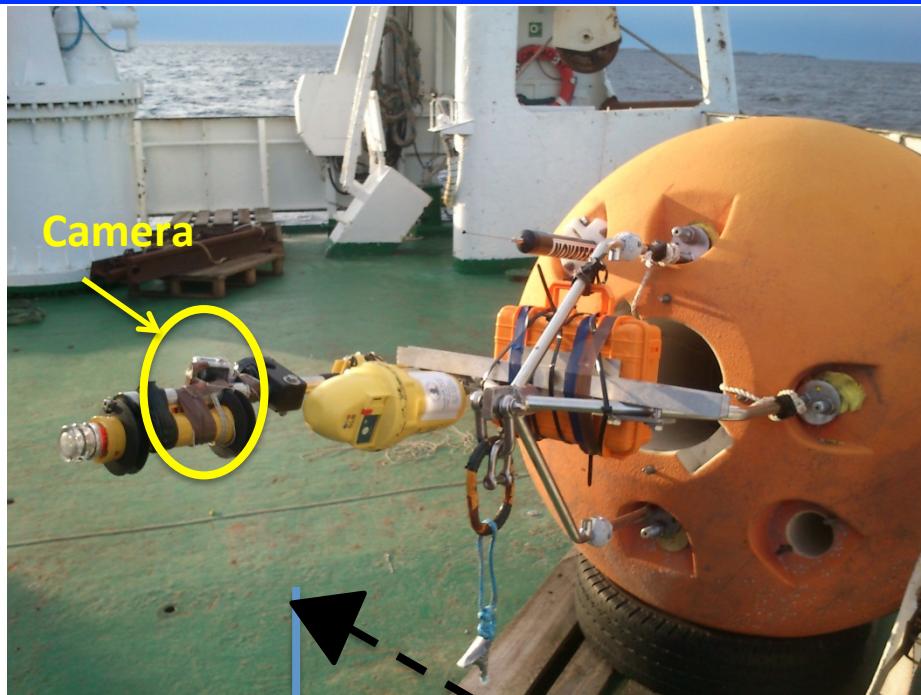
Measurements:



1- Marestain cruise, November 2013 (Southwest of Bergen)

2- Karmøy cruise, November 2014 (Stavanger)

Measurements: Lagrangian-mounted camera



Measurements: Lagrangian-mounted camera



Attitude Estimation

$$\Omega = \begin{pmatrix} -\dot{\theta} \sin \psi + \dot{\phi} \cos \psi \cos \theta \\ \dot{\theta} \cos \psi + \dot{\phi} \sin \psi \cos \theta \\ \dot{\psi} - \dot{\phi} \cos \theta \end{pmatrix}$$

$$T = \begin{bmatrix} \cos \psi \cos \theta & -\sin \psi \cos \varphi + \cos \psi \sin \theta \sin \varphi & \sin \psi \sin \varphi + \cos \psi \sin \theta \cos \varphi \\ \sin \psi \cos \theta & \cos \psi \cos \varphi + \sin \psi \sin \theta \sin \varphi & -\cos \psi \sin \varphi + \sin \psi \sin \theta \cos \varphi \\ -\sin \theta & \cos \theta \sin \varphi & \cos \theta \cos \varphi \end{bmatrix}$$

Complementary Filtering

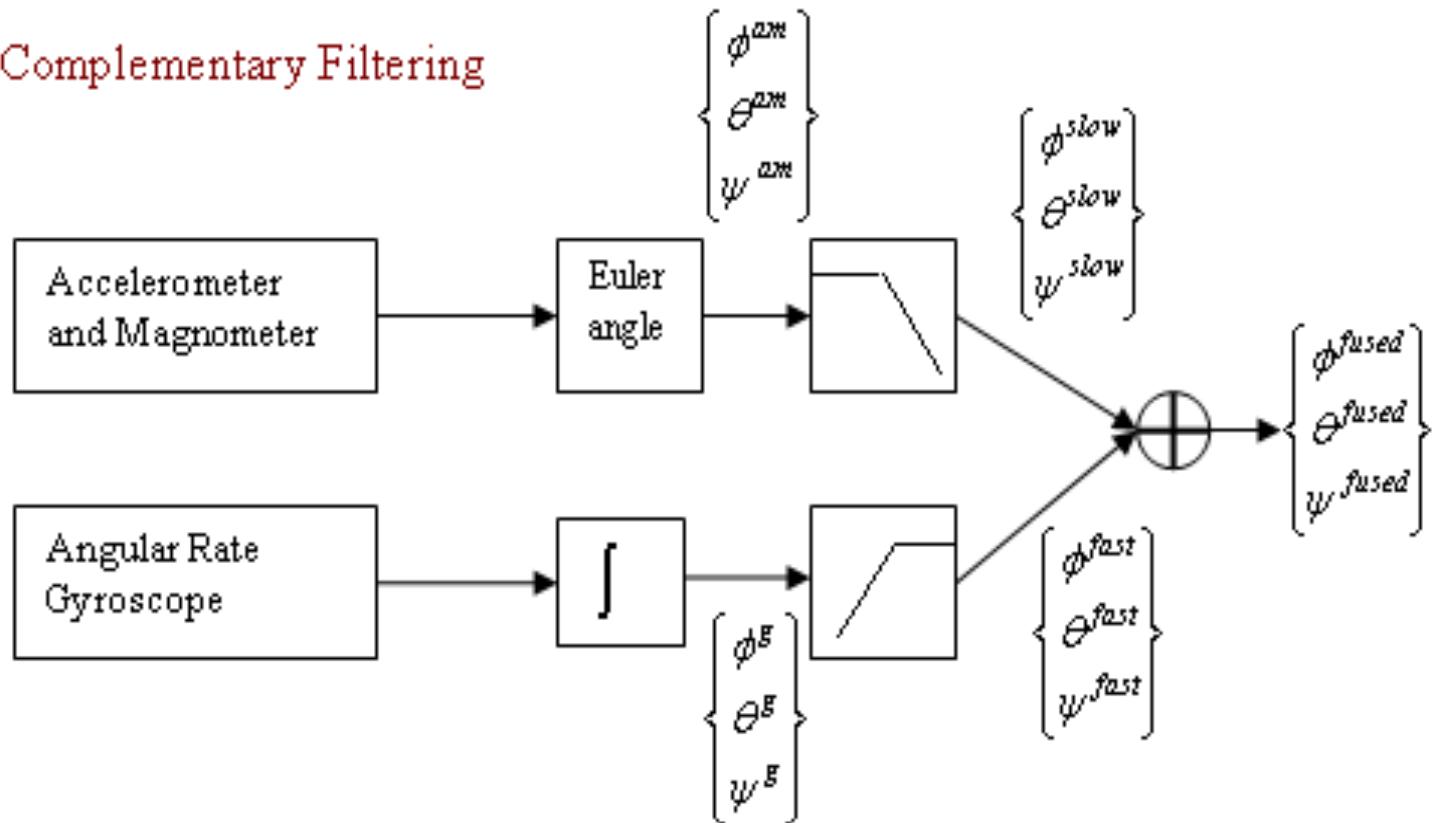
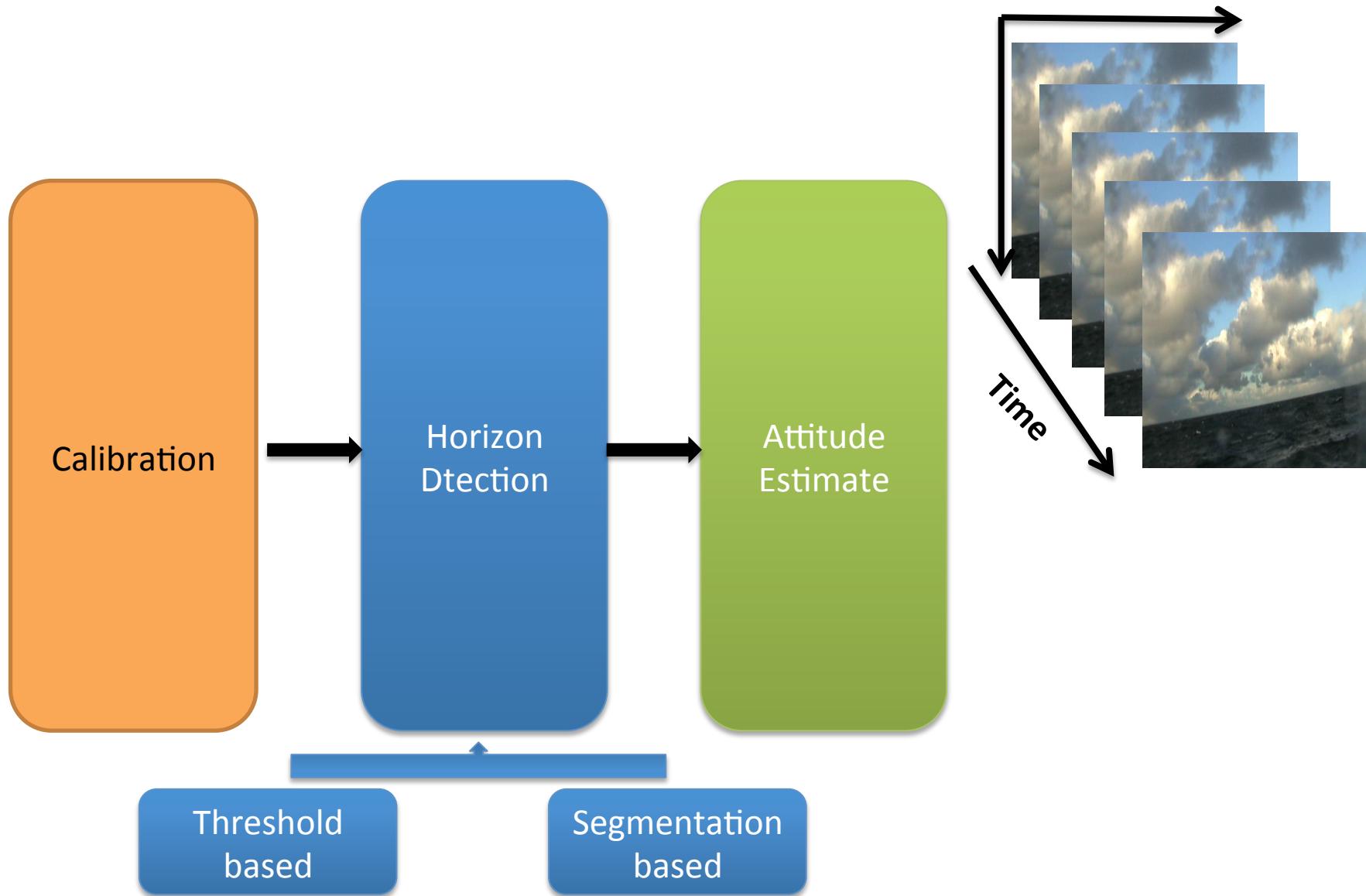


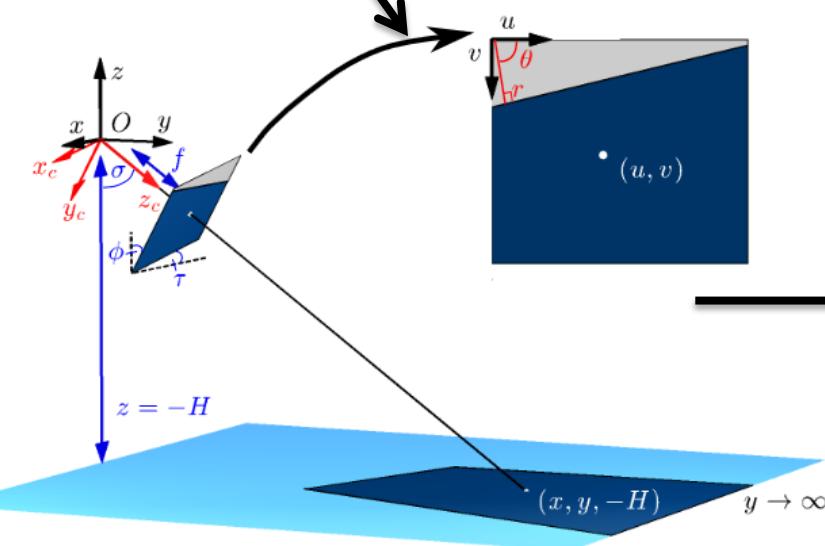
Image based Attitude Estimate



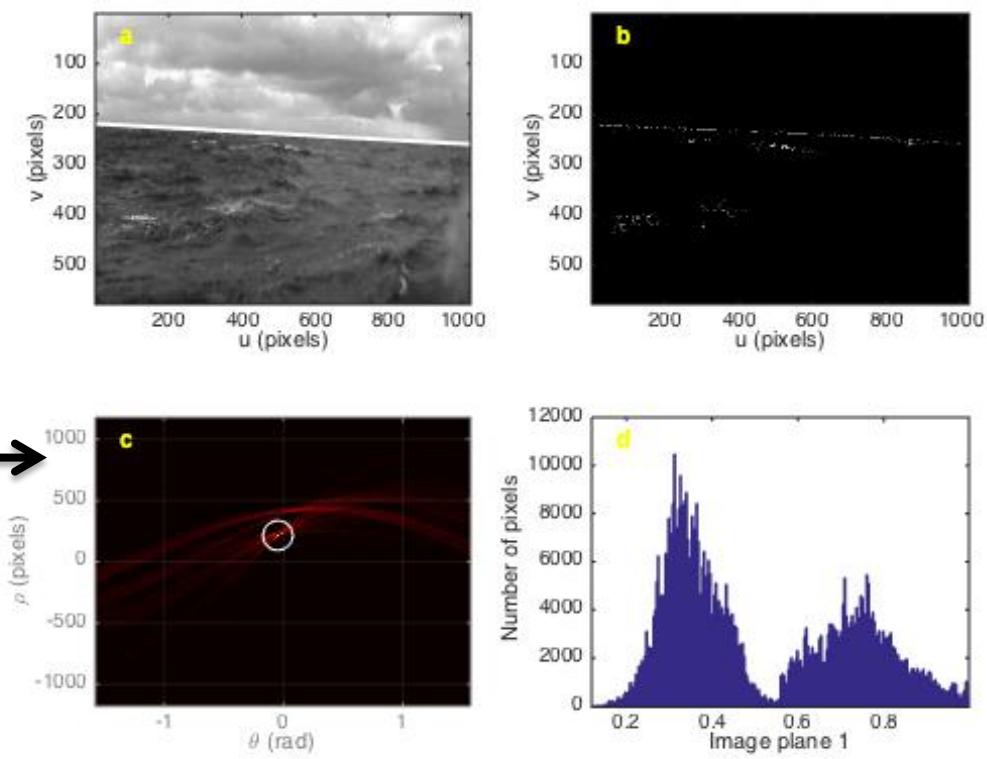
Results

Horizon Detection: Hough transformation

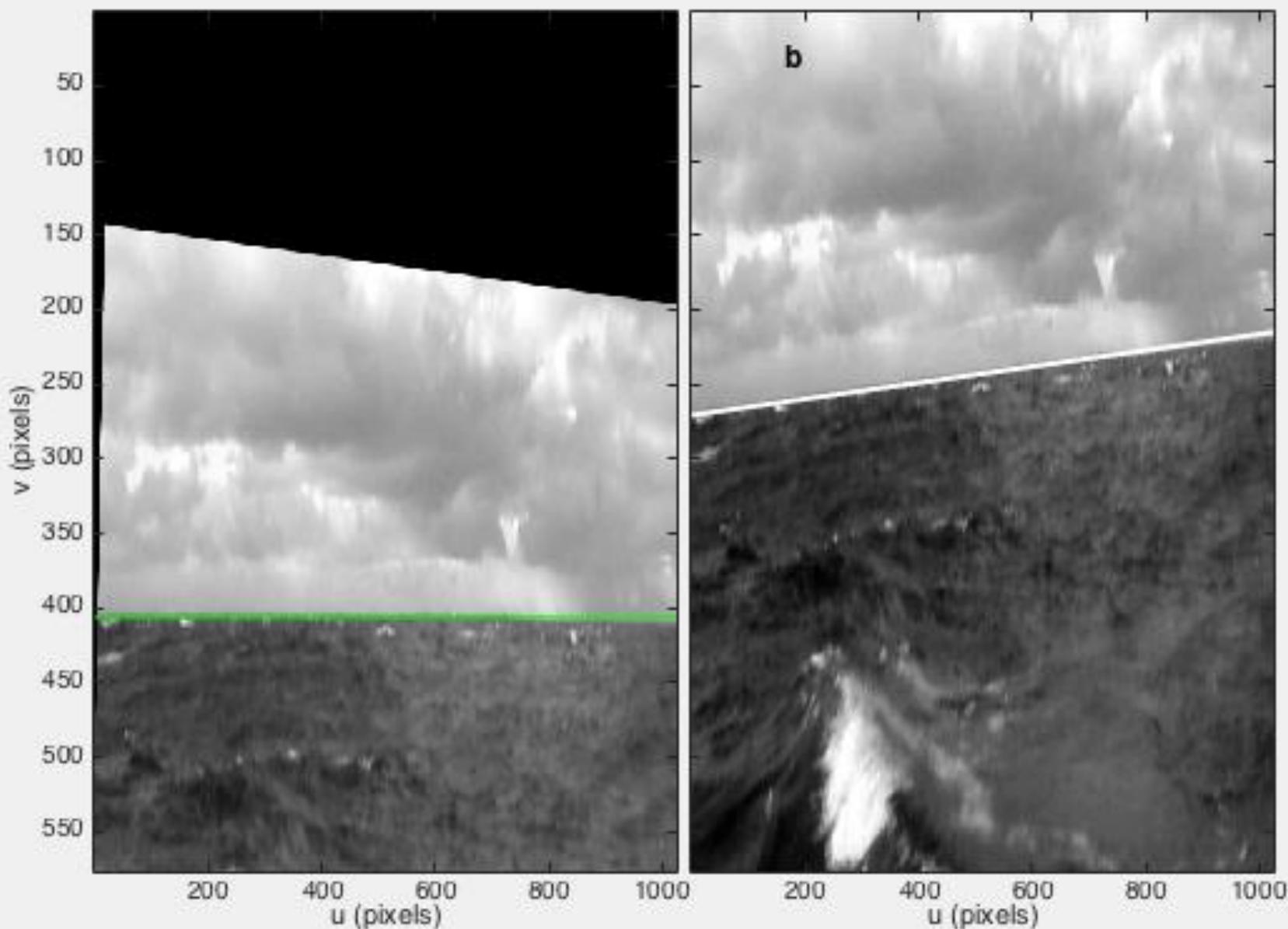
Calibration



Edge detection

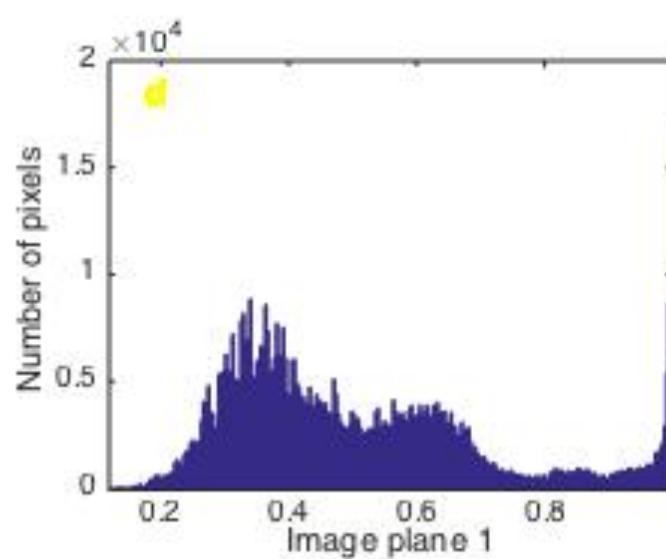
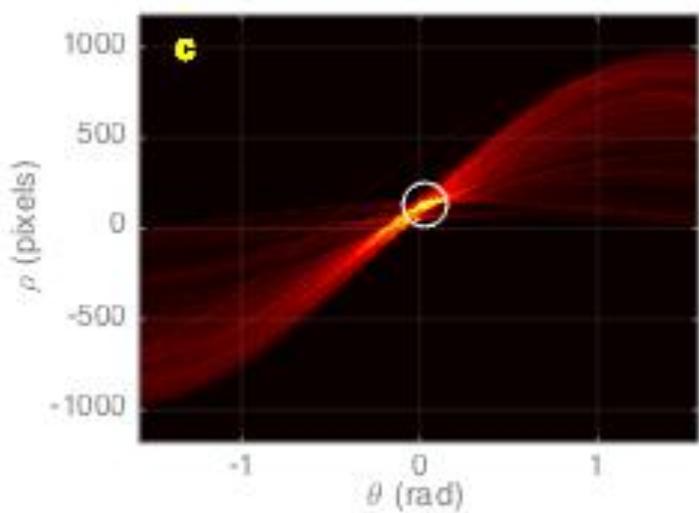
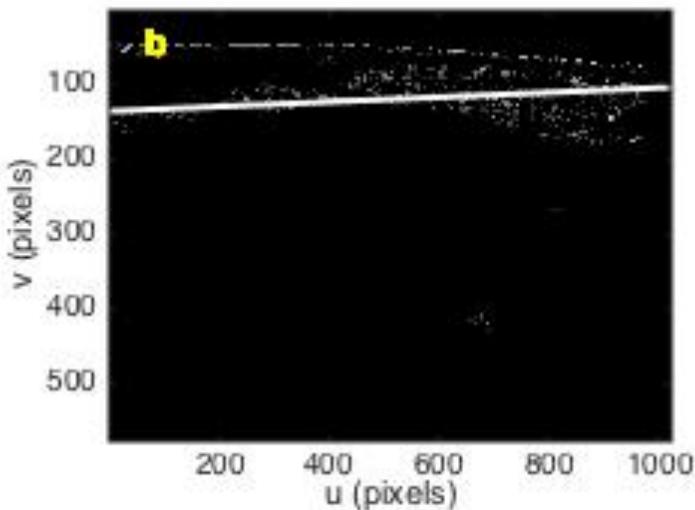
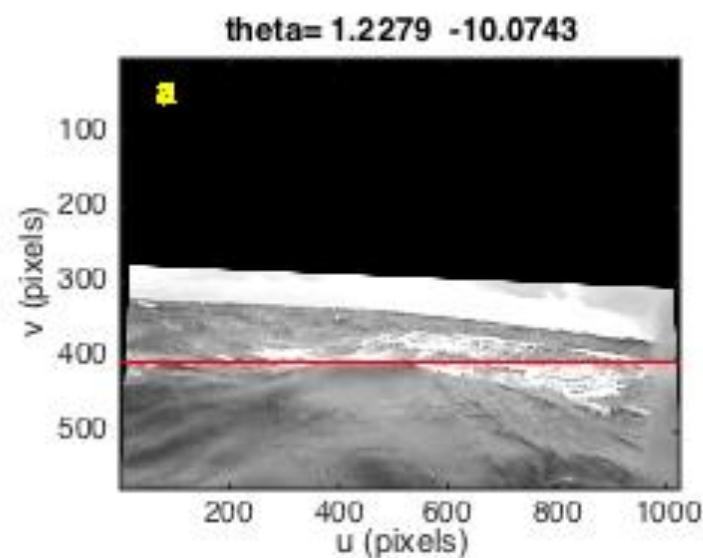


Results



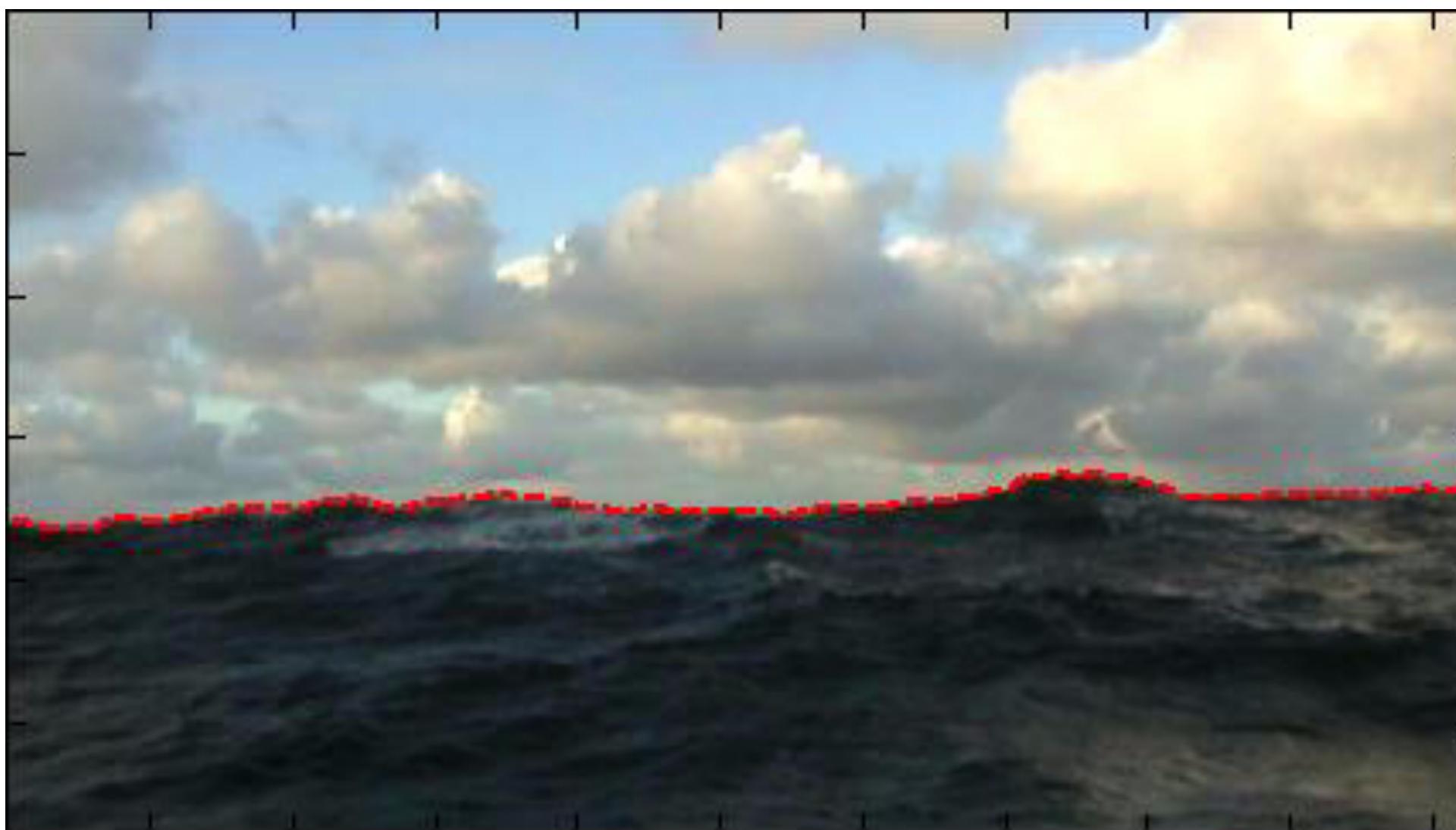
Results

Rejected horizon line



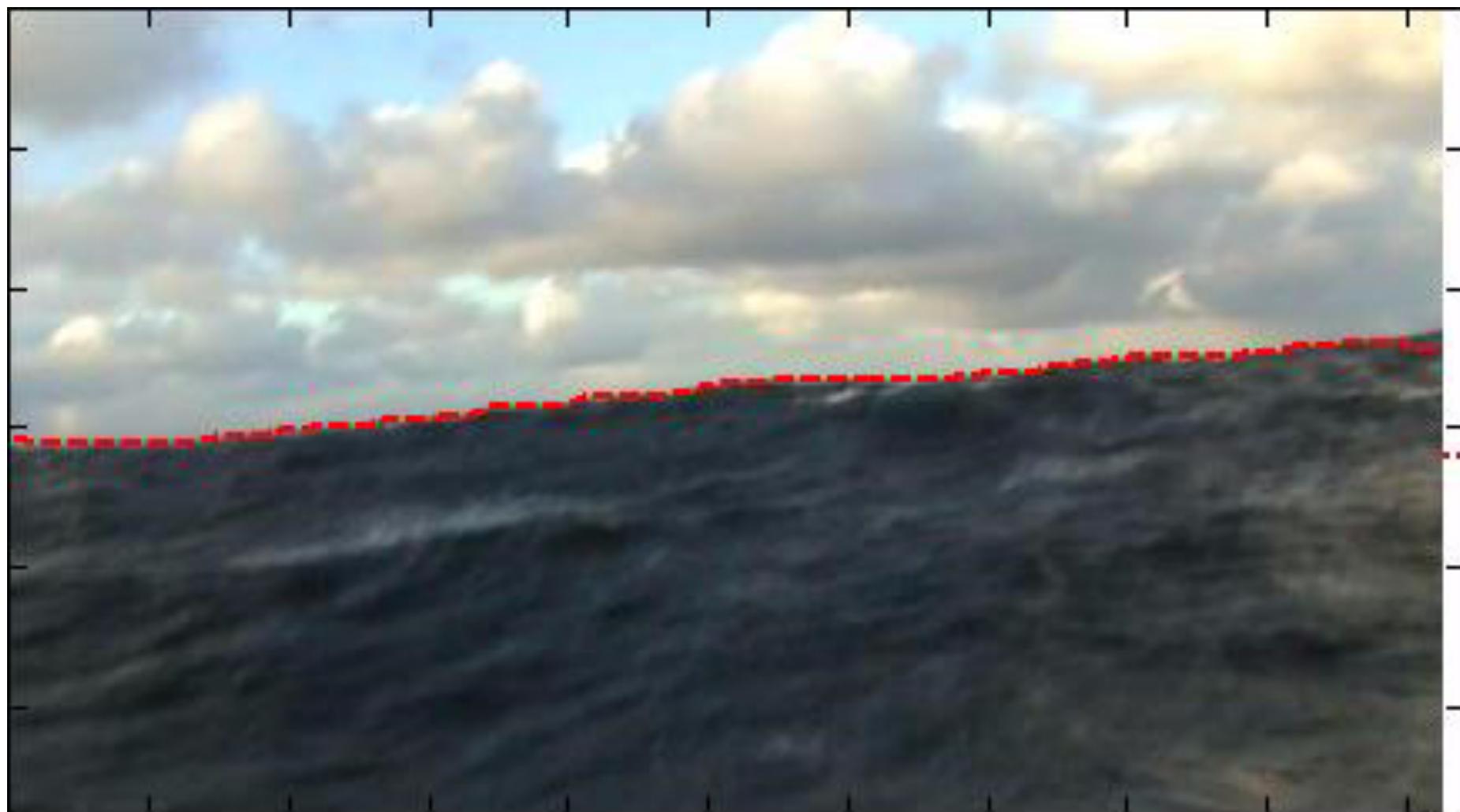
Results

Horizon line profile:



Results

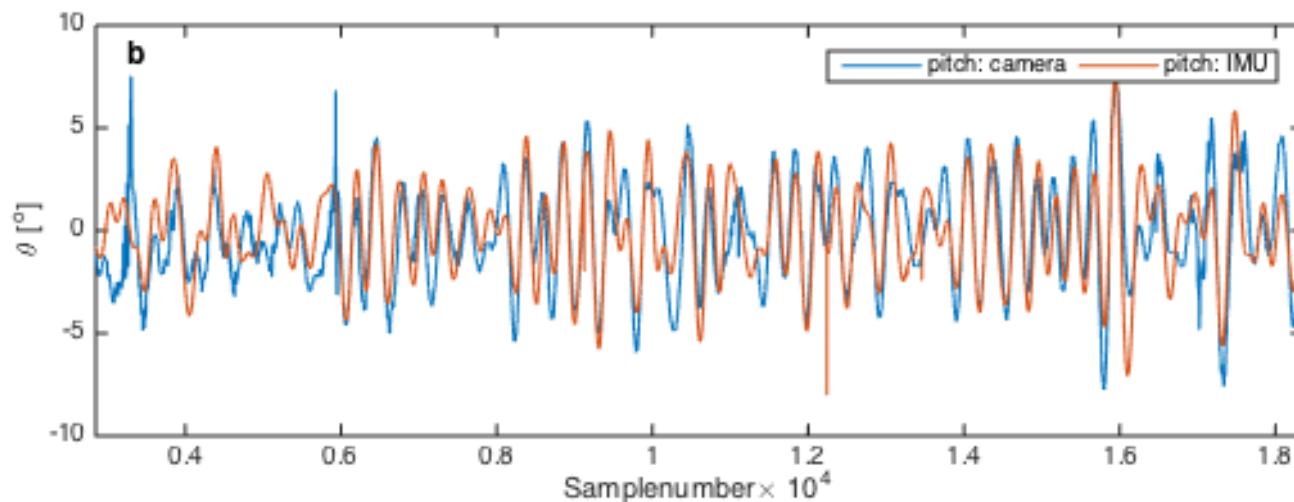
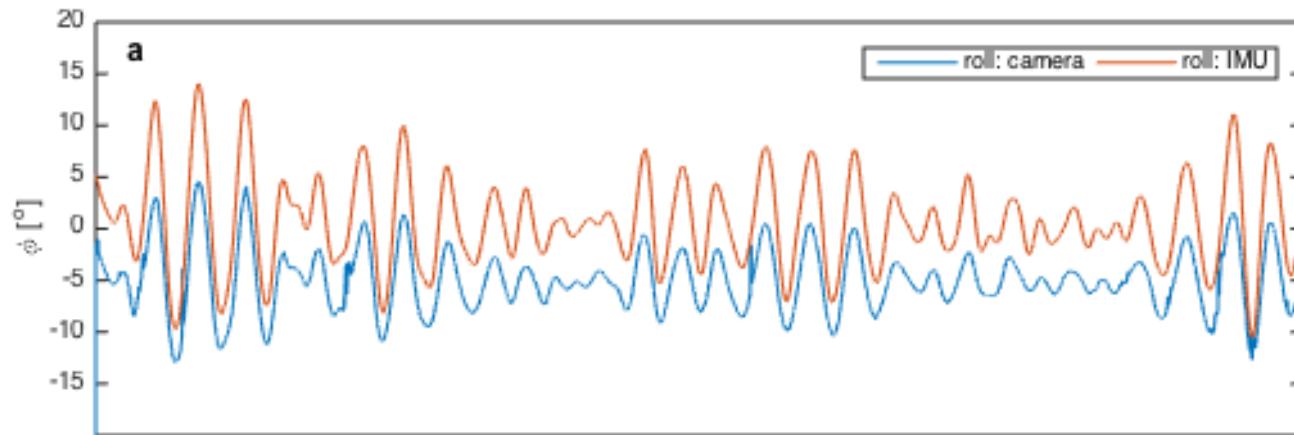
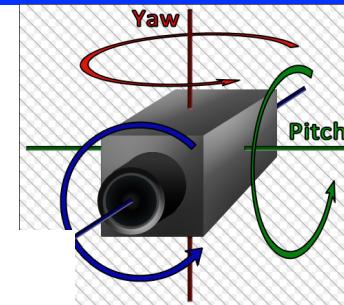
Horizon line profile



Results: pitch

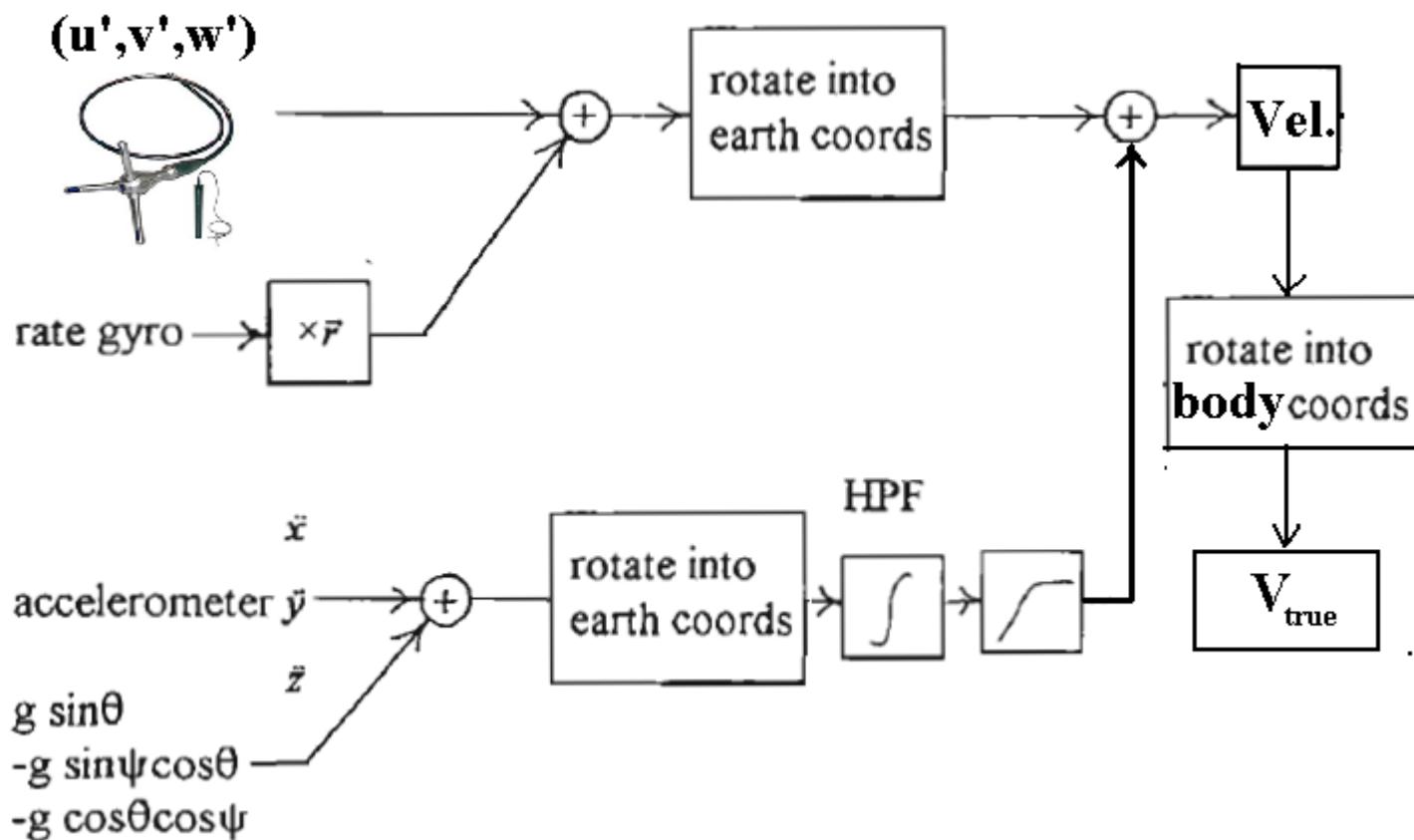
Black: IMU

Red: Camera



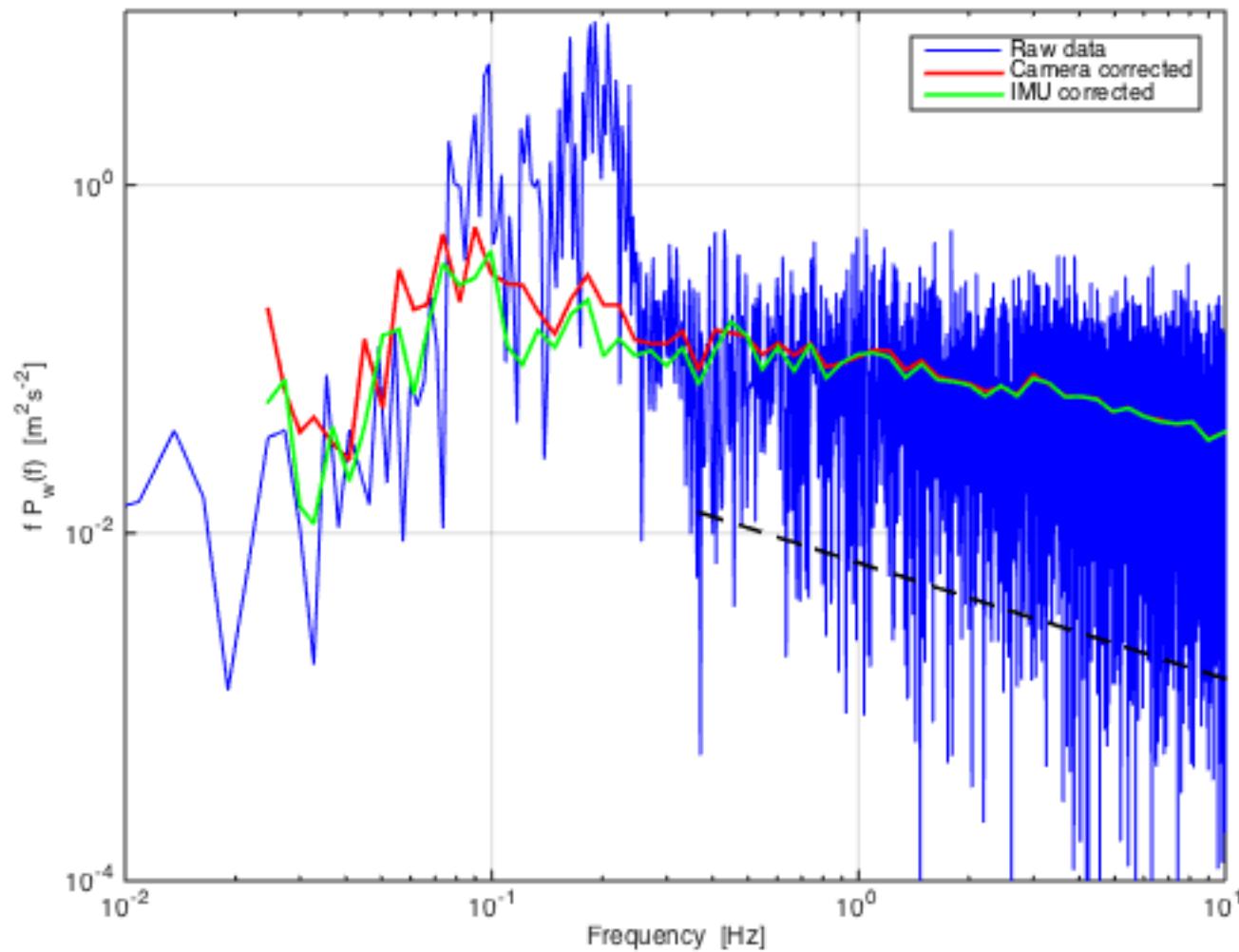
Models: Motion Correction

$$\overrightarrow{V}_{true} = T\overrightarrow{V_0}' + \overrightarrow{\Omega} \times T\overrightarrow{R}' + \overrightarrow{V}_{trans}$$

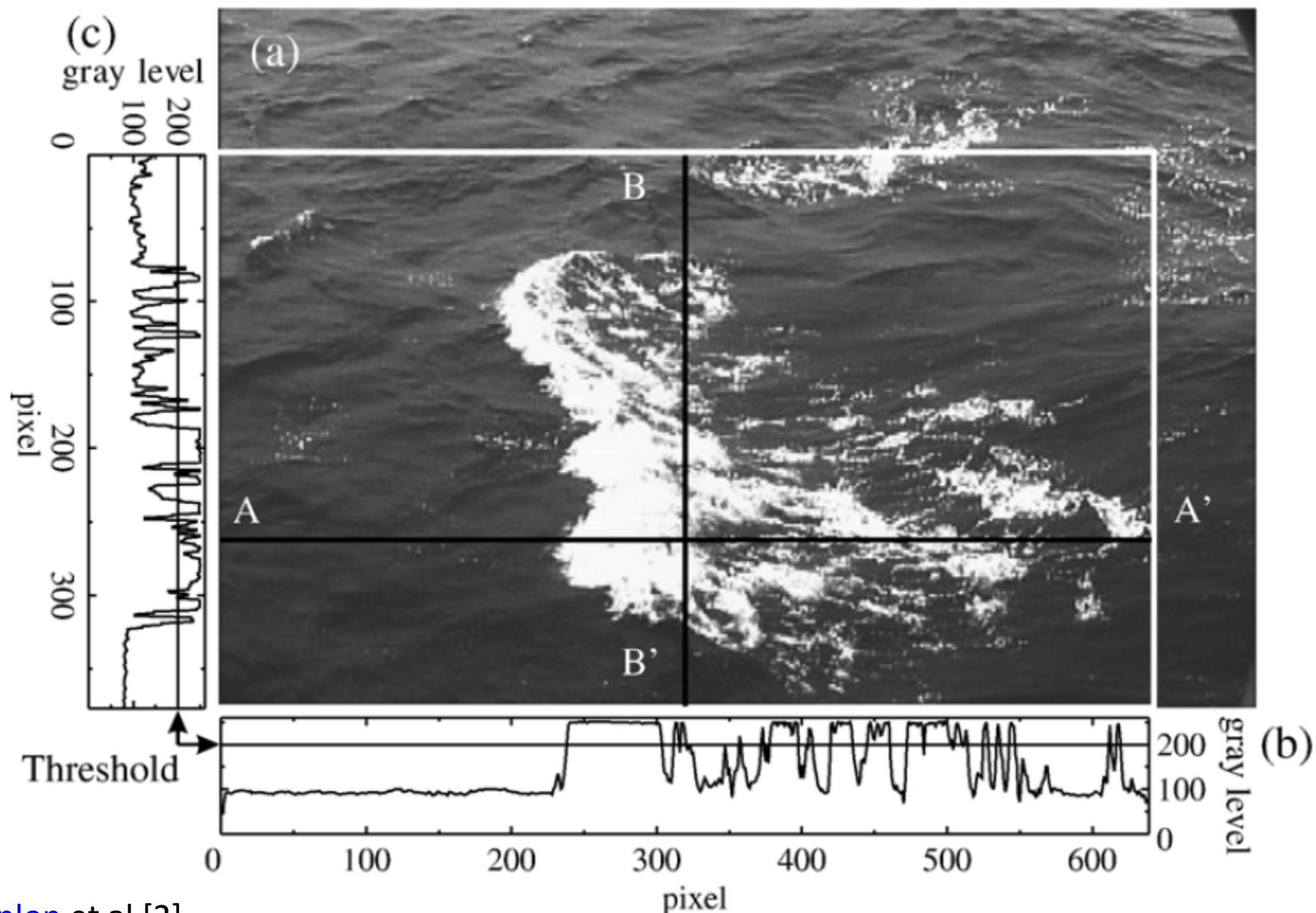


Models: Motion Correction

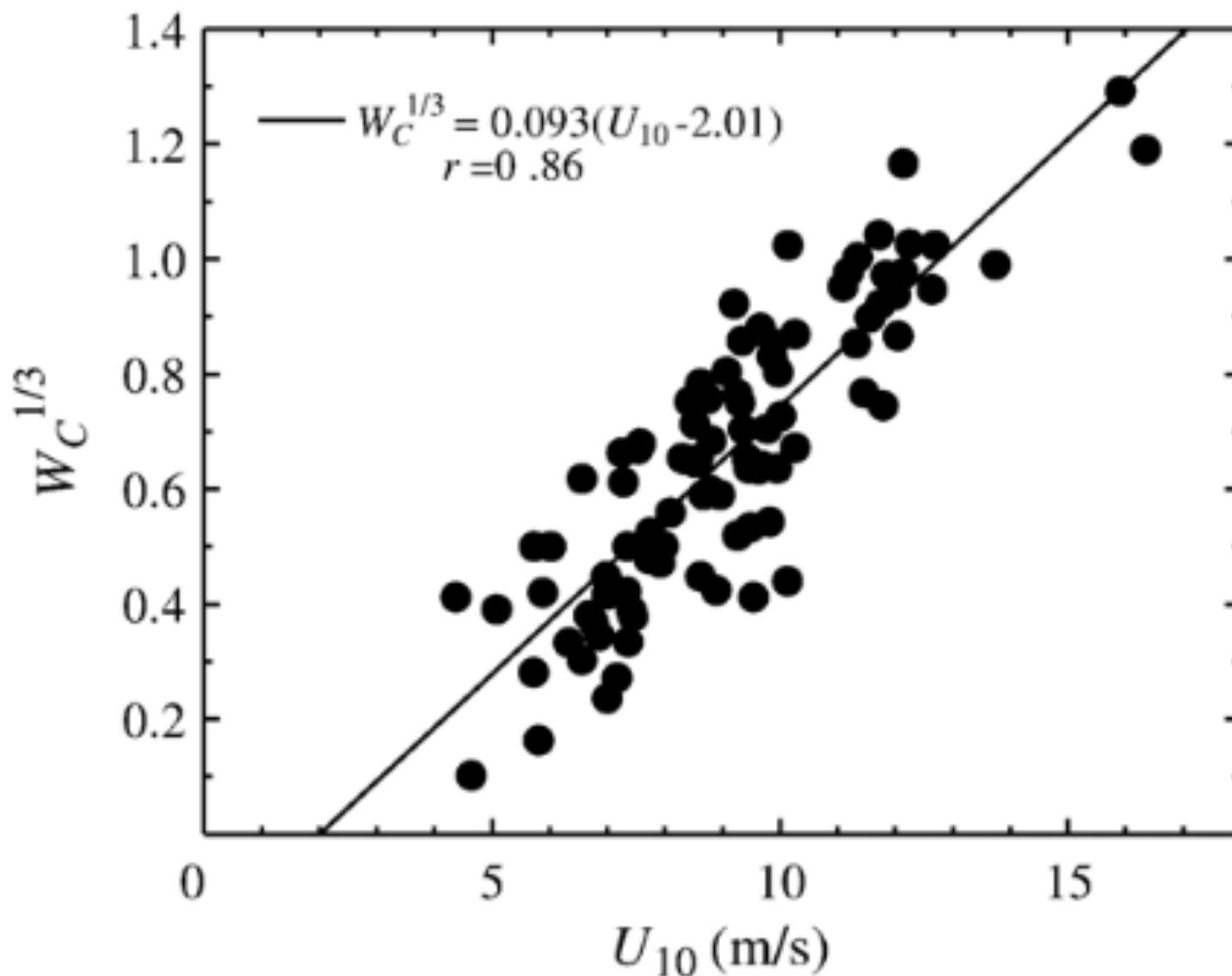
$$\overrightarrow{V}_{true} = \overrightarrow{TV_0} + \overrightarrow{\Omega} \times \overrightarrow{TR} + \overrightarrow{V}_{trans}$$



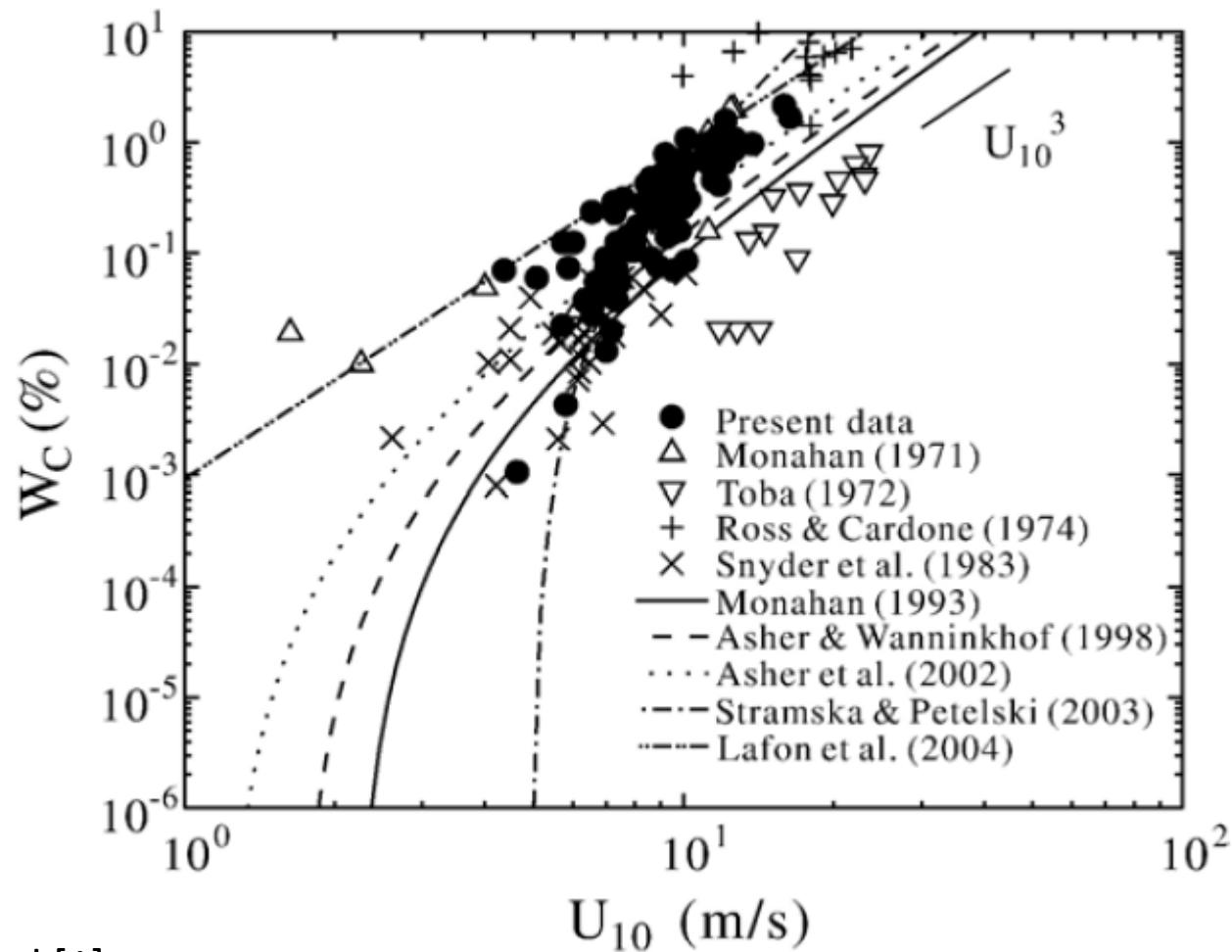
Application: Whitecapping coverage



Whitecapping coverage-wind speed



Whitecapping coverage-wind speed



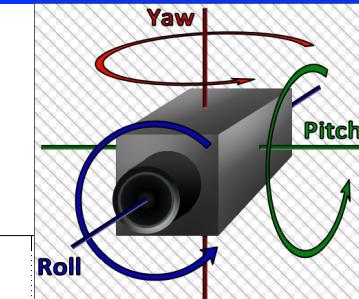
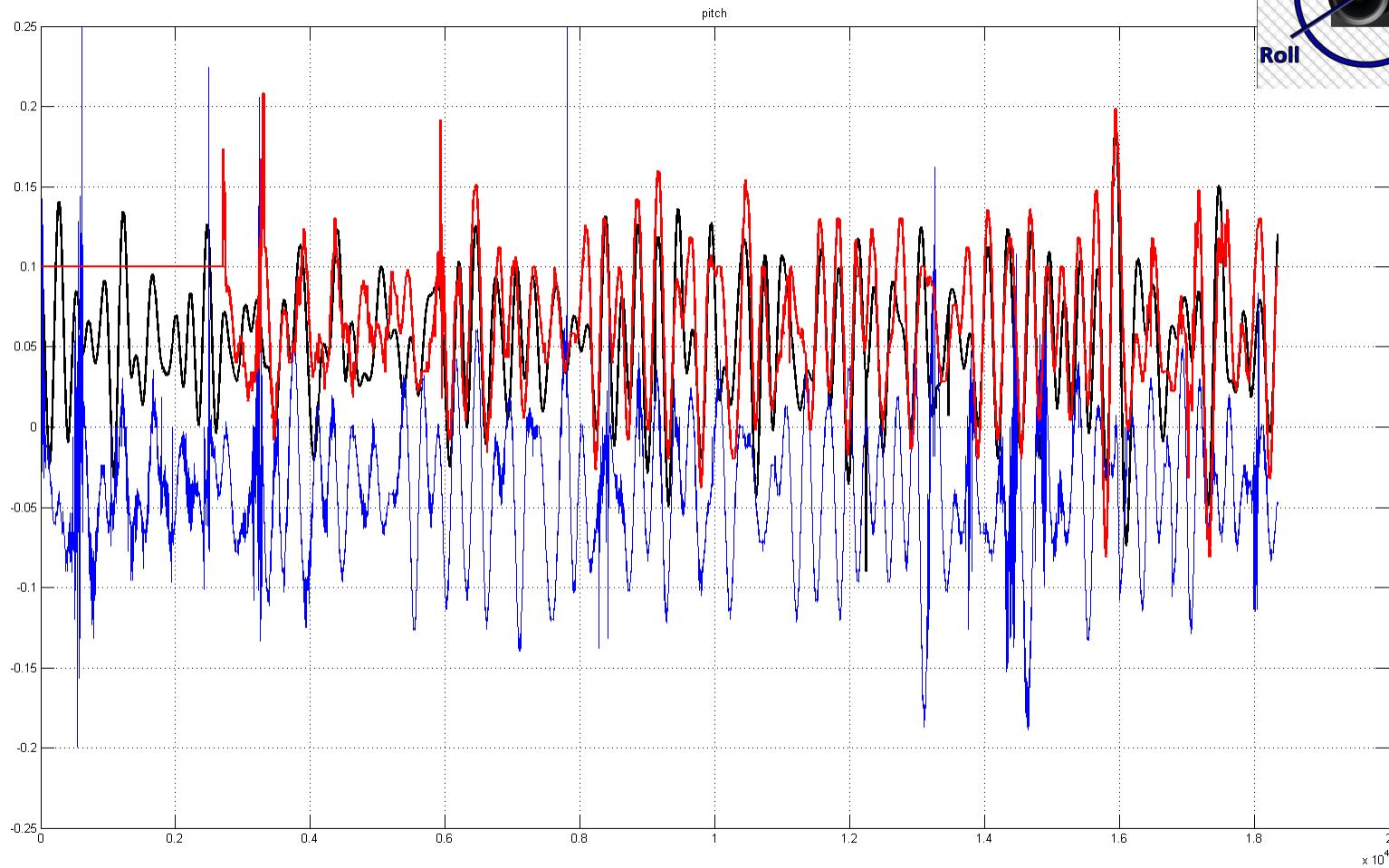
Summary

- **Horizon line detection able to provide attitude information in the absence of IMU system.**
- **Vision-based attitude can remove successfully the motion-induced contamination to platform.**
- **Wave breaking crest length scale, whitecapping coverage, and surface gravity waves can be extracted from a undistorted video camera.**

Results: pitch

Black: IMU

Red: Camera



References

- [1] Sugihara Y., H. Tsumori T. Ohga, H. Yoshioka, S. Serizawa,*Journal of Marine system*, Variation of whitecap coverage with wave-field conditions, 2007
- [2] Brian Scanlon, Brian Ward, Oceanic wave breaking coverage separation techniques for active and maturing whitecaps, *methods in oceanography*, 2211-1220, 2013.
- [3] Schwendeman M, Thomson J. A Horizon-Tracking Method for Shipboard Video Stabilization and Rectification. *J. Phys. Ocean.*, 2015, 32, 164–176.