



WHAT IS THIS POSTER ABOUT

1. Coastal water depth estimation using Sentinel 2 imagery
2. Application of a Radon Transform to obtain wave direction, wave phase shifts and celerity
3. An analysis on global application
4. Image resolution augmentation using the Radon Transform

DEPTH INVERSION: WAVE CELERITY (c) TO DEPTH (h)

offshore nearshore

$$c^2 = \frac{g}{k} \tanh(kh) \Leftrightarrow h = \frac{\tanh^{-1}\left(\frac{c^2 k}{g}\right)}{k}$$

Lower celerity = shallower, greater celerity = deeper

SENTINEL 2 CONSTELLATION – TIME-INTERVAL TO ESTIMATE WAVE CELERITY

CELERITY = $\Delta X / \Delta TIME$

Detector band	Δt [sec]	t [sec]	res [m]
B02 (BLUE)	0	0	10
B08 (NIR)	0.264	0.264	10
B03 (GREEN)	0.263	0.527	10
B04 (RED)	0.478	1.005	10
B05	0.264	1.269	20
B06	0.264	1.525	20
B07	0.265	1.790	20
B08A (ndir)	0.265	2.055	20
B11 (SWIR)		1.468	60
B12 (SWIR)		2.085	60

METHOD

Every detector band, apply a Radon Transform:

$$R_I(\theta, \rho) = \iint_D I(x, y) \delta(\rho - x \cos(\theta) - y \sin(\theta)) dy dx$$

Find the phase in spectral space per direction:

$$\Phi(x, y, \theta, \rho) = \tan^{-1}\left(\frac{\partial \Phi_{R_1}}{\partial \Phi_{R_2}}\right)$$

Calculate the phase shift to get celerity (c)

$$c = \frac{\Delta \Phi}{2\pi k \Delta t} = \frac{\Delta \Phi \lambda}{2\pi \Delta t}$$

Radon Transform

SCAN ME

RESULTS AT CAPBRETON, FRANCE

North section: $r^2 = 0.86$, RMSD = 3.70 m

Central section: $r^2 = 0.77$, RMSD = 4.06 m

South section: $r^2 = 0.88$, RMSD = 1.88 m

APPLICATIONAL LIMITS

Revisit time-interval (days): 1 day, 1-2 days, 2-3 days, 3-5 days, 5 days

Probability of estimating DOC [%]

Theoretical depth limit [m]

FUTURE WORK: ADD BANDS THROUGH IMAGE AUGMENTATION for a more stable estimation of the wave celerity

Band B02: 10 m

Band B05: 20m

Band B05: 10m

CONCLUSIONS

- Coastal water depths can be estimated using a relation between wave celerity and depth
- Sentinel 2 detector bands have time-lag between the bands that can be used to detect wave celerity
- The Radon-transform ameliorates wave signals and is used to determine the wave direction and wave phase shift: hence celerity
- Water depths are estimated with an RMS error of 2.58 m, at Capbreton, France.
- The method is world-wide applicable and prevails at open coasts; exposed to direct ocean swell.
- Currently only 2 detector bands are used, Radon Transform based image augmentation enables the use of 8 bands.

Article:

SCAN ME