# Field and Imaging Spectroscopy for Monitoring Intertidal Sedimentation Dynamics

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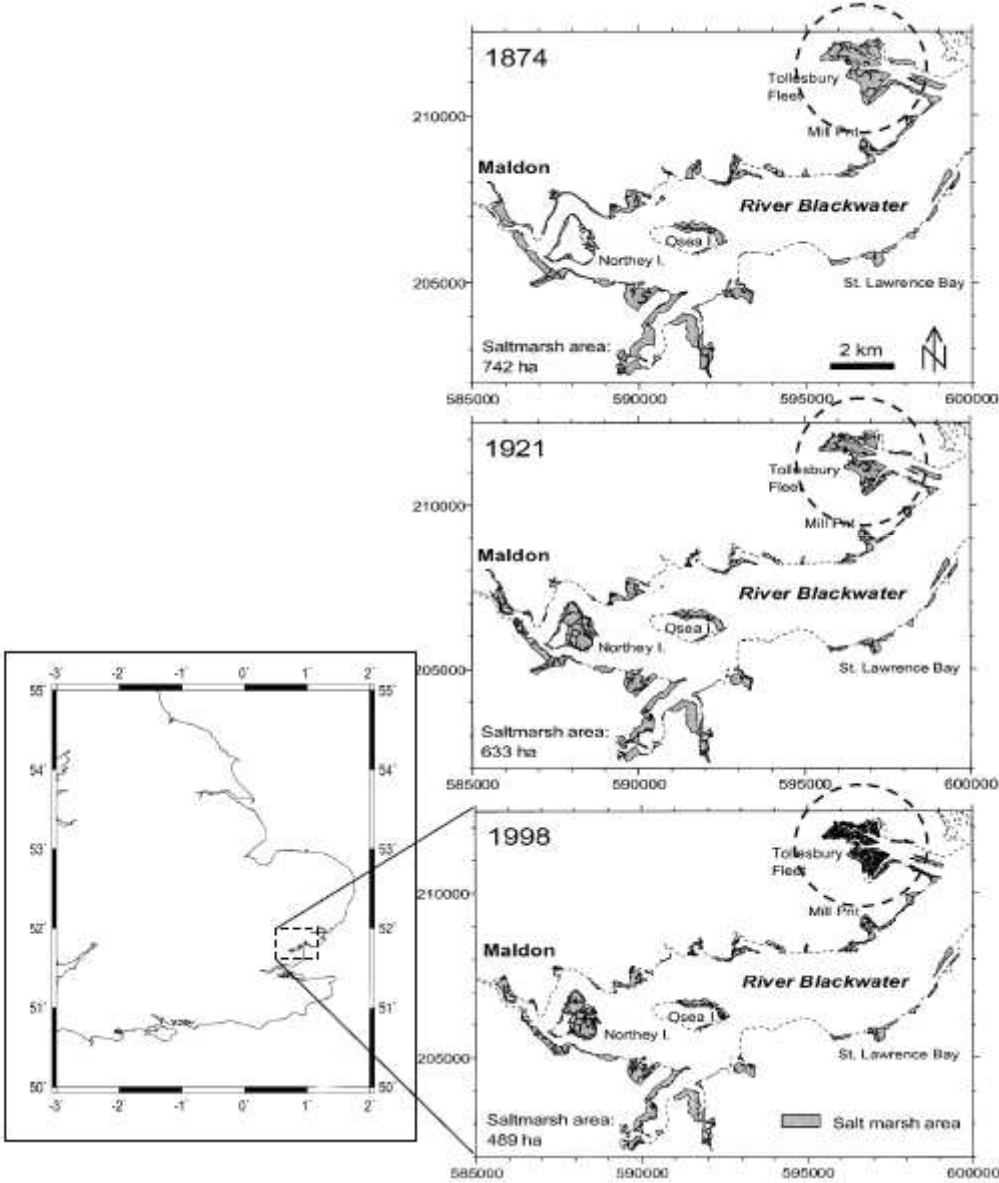
Cambridge, United Kingdom

EARSeL

Birkbeck
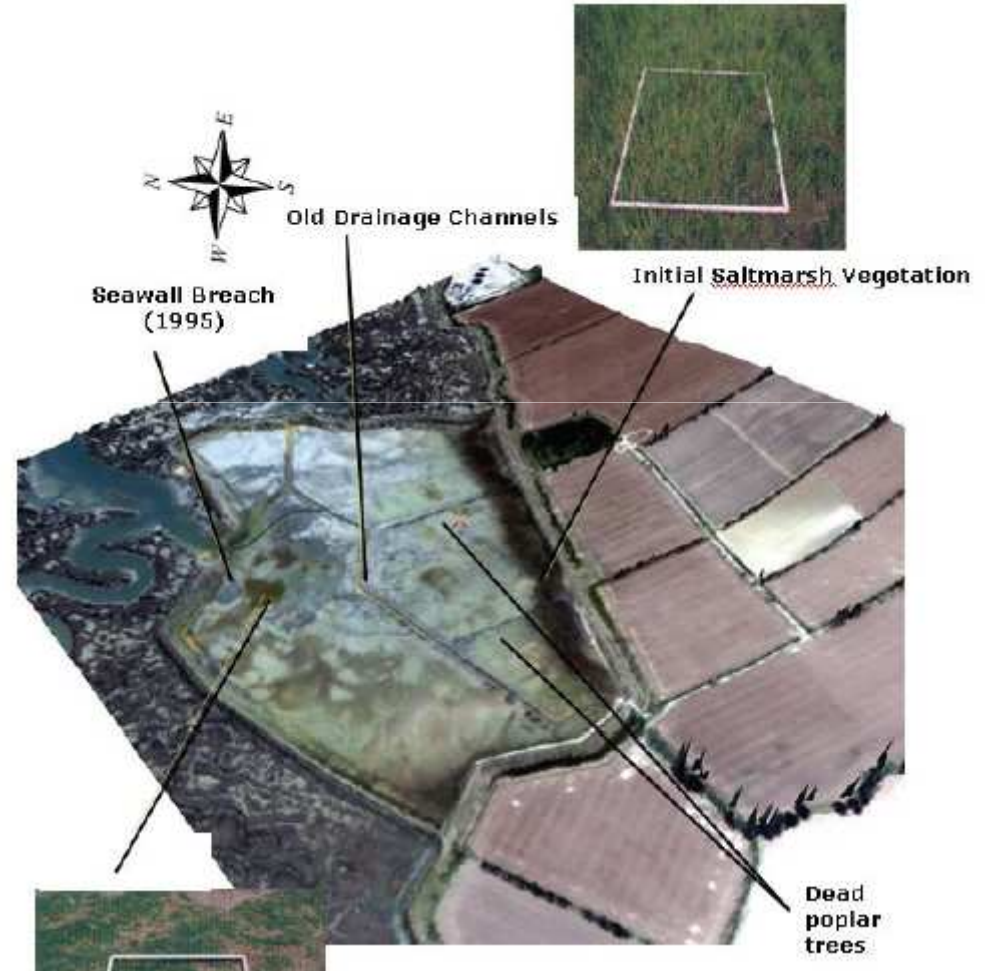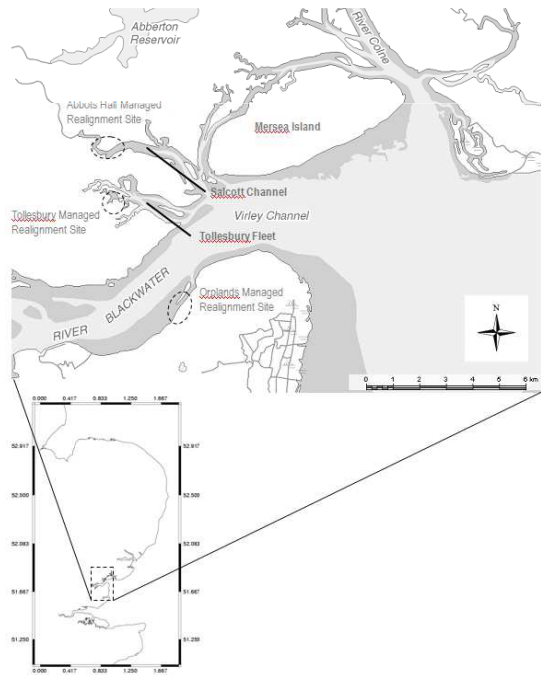UNIVERSITY OF LONDON

# Coastal Erosion

Loss of saltmarsh and
their wave
attenuation capacities

"coastal squeeze"

Need to better
understand intertidal
sedimentation
processes

# Tollesbury Managed Realignment

# Timing of overflights

- Favourable weather conditions need to coincide with tidal conditions
- No concurrent ground reference measurements
- CASI

| Band | Start nm | End nm |
|------|----------|--------|
| 1 | 407.5 | 417.5 |
| 2 | 437.5 | 447.5 |
| 3 | 485 | 495 |
| 4 | 505 | 515 |
| 5 | 555 | 565 |
| 6 | 615 | 625 |
| 7 | 660 | 670 |
| 8 | 677.5 | 685 |
| 9 | 700 | 710 |
| 10 | 750 | 757.5 |
| 11 | 767.5 | 782.5 |
| 12 | 855 | 875 |
| 13 | 885 | 895 |
| 14 | 895 | 905 |



Tollesbury, 29 July 1999
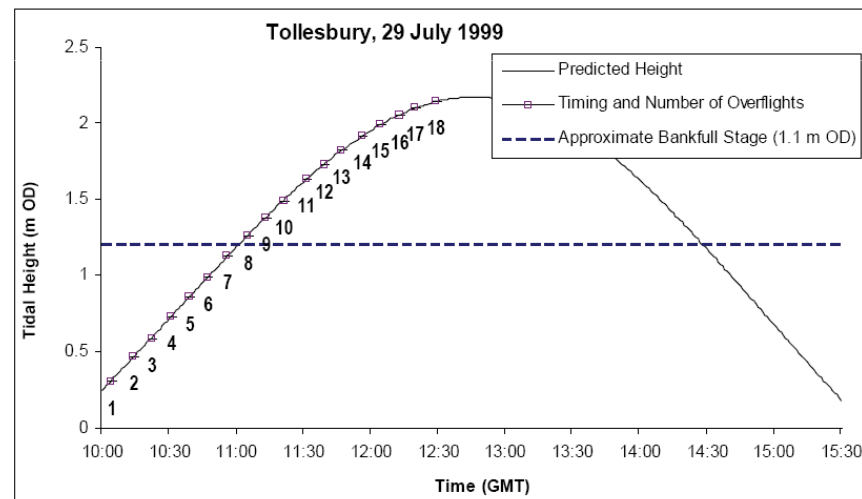
# Hydro-optical modelling

- Empirical approaches not feasible
- Need to calibrate physically-based model
- Gordon (1975):

$$R(0) = f \frac{b_b}{a + b_b}$$

- Retro-active spectral characterisation of water body
- Estimation of inherent optical properties

$$R(0) = f \frac{b_{bw} + C b_{bc} + S b_{bs}}{a_w + C a_c + Y a_y + S a_s + b_{bw} + C b_{bc} + S b_{bs}}$$
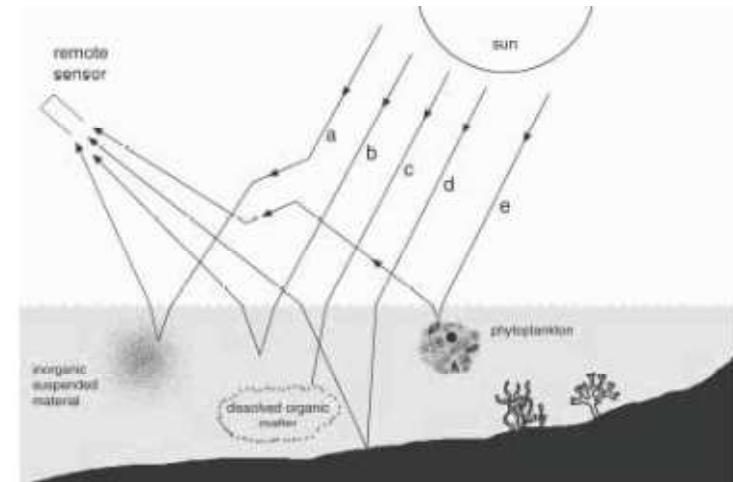
# Parameterising Water Colour Simulator (WASI)

- developed by P. Gege (DLR), initially developed for Lake Constance

- uses non-linear optimization procedures to analyze and simulate a wide range of hydro-optical parameters, including the concentration of suspended particulate matter.
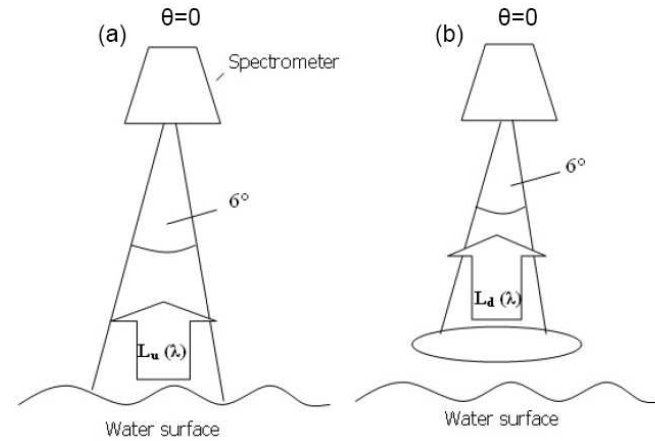
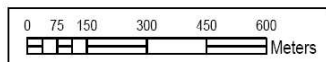- Can be parameterized for other environments

# Field Spectroscopy
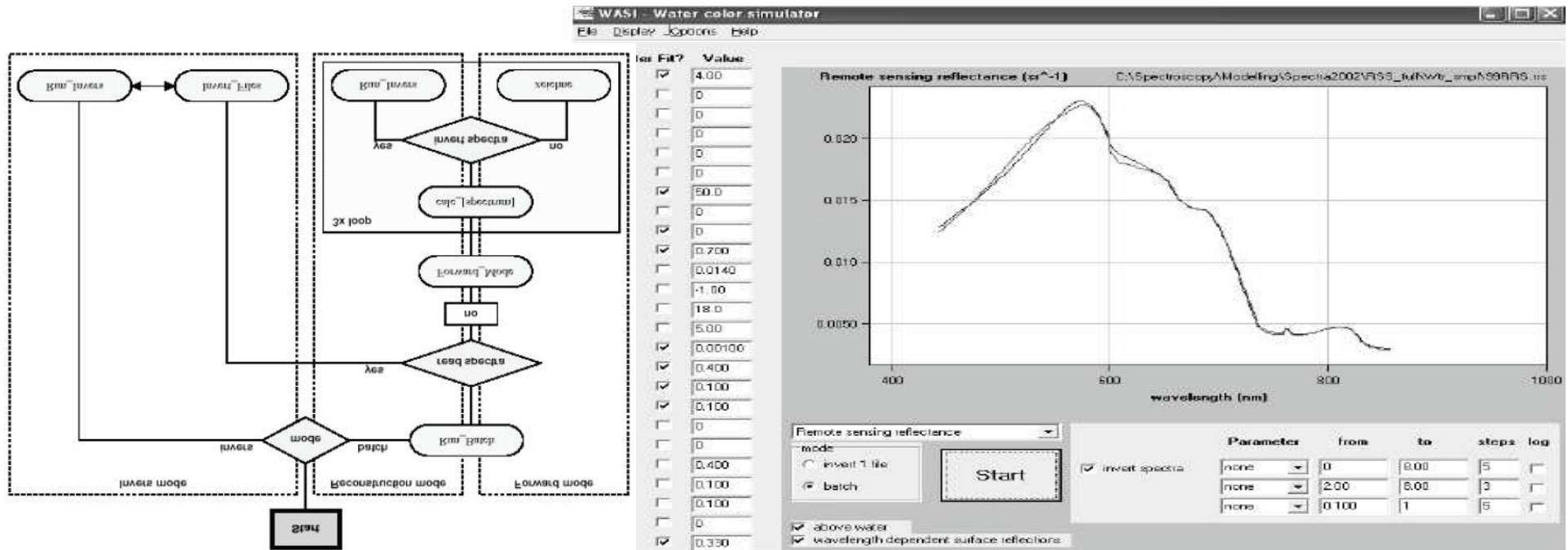


GER 1500
Sampling
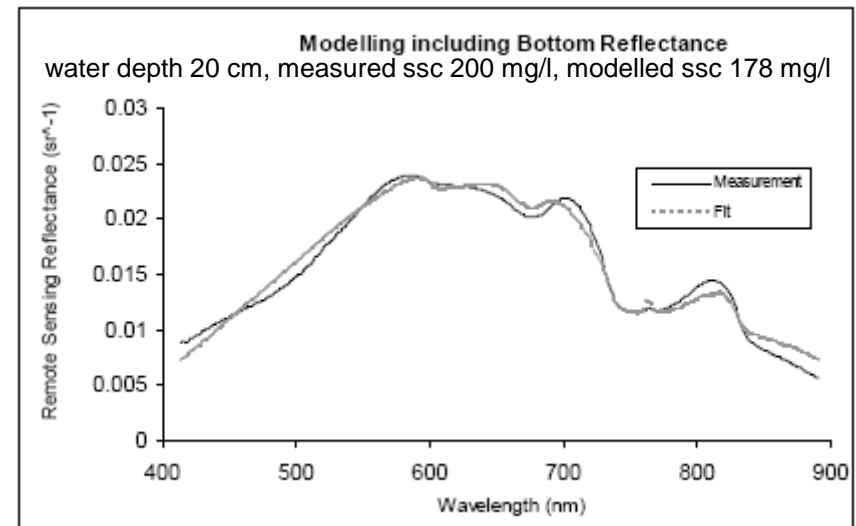at Tollesbury



PIF (a): Bright concrete
Old Hall Farm
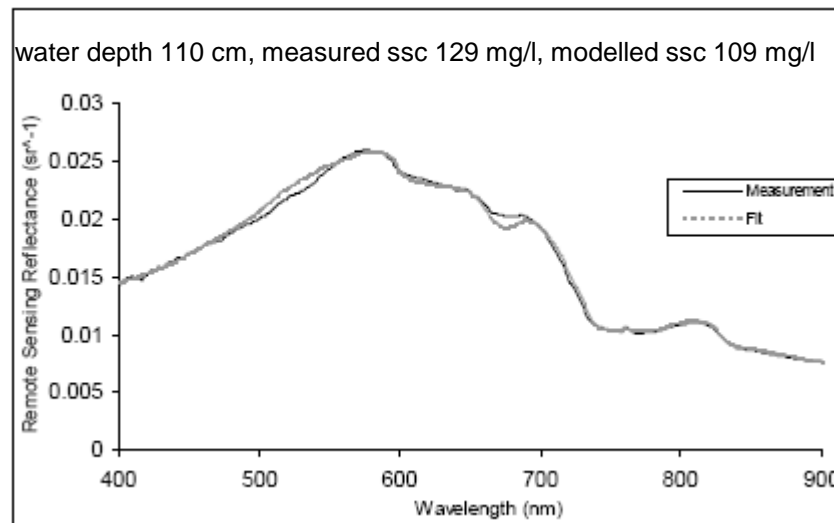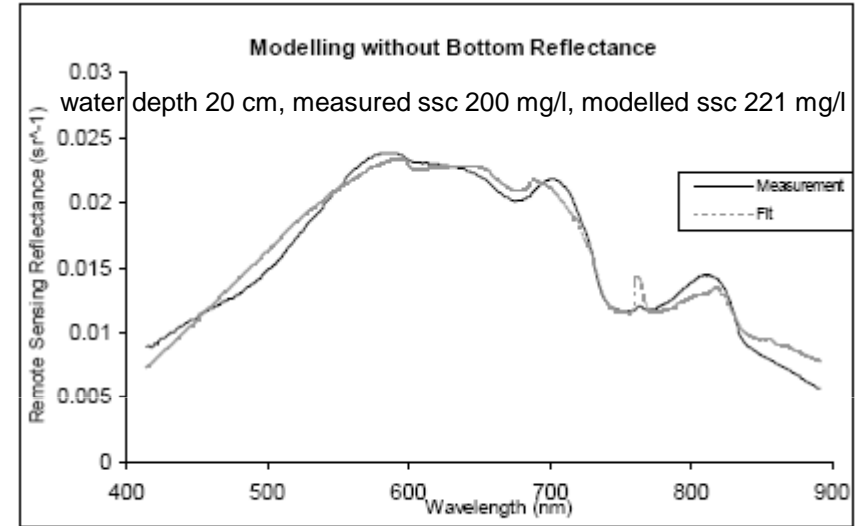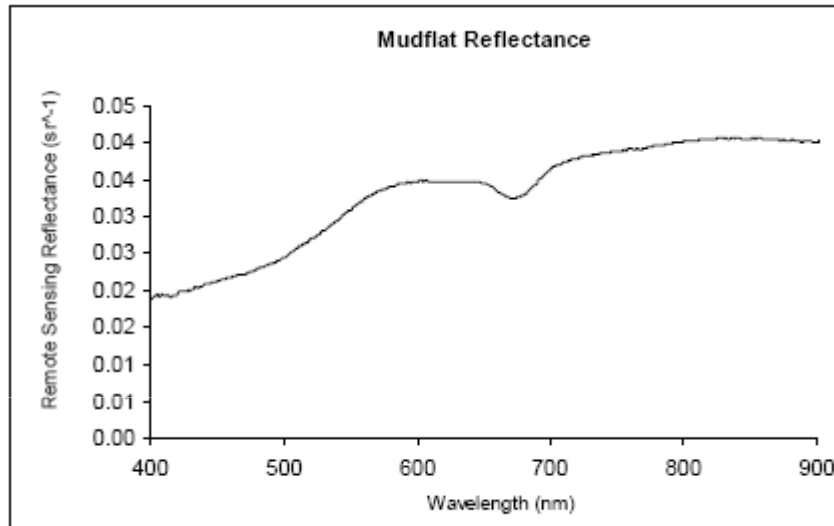
PIF (b): Dark asphalt
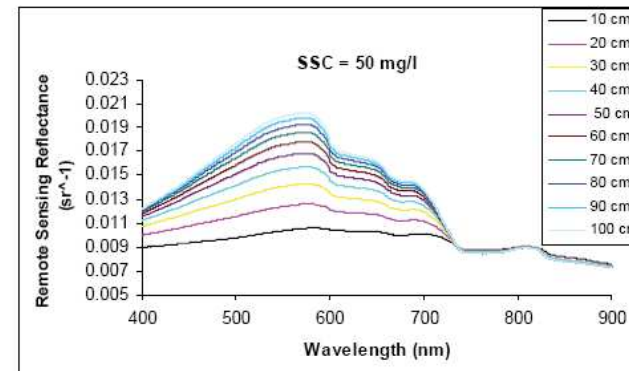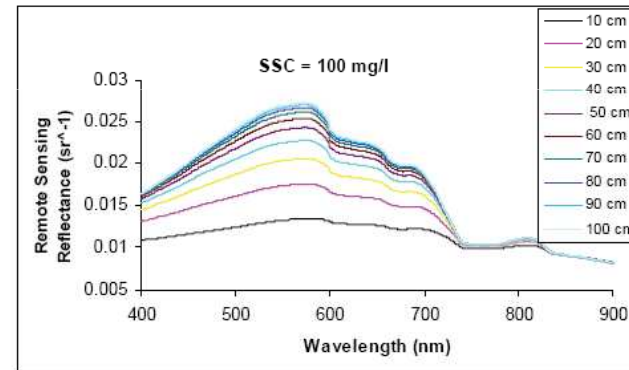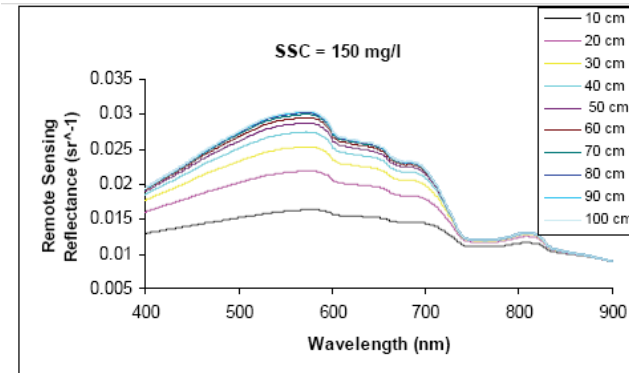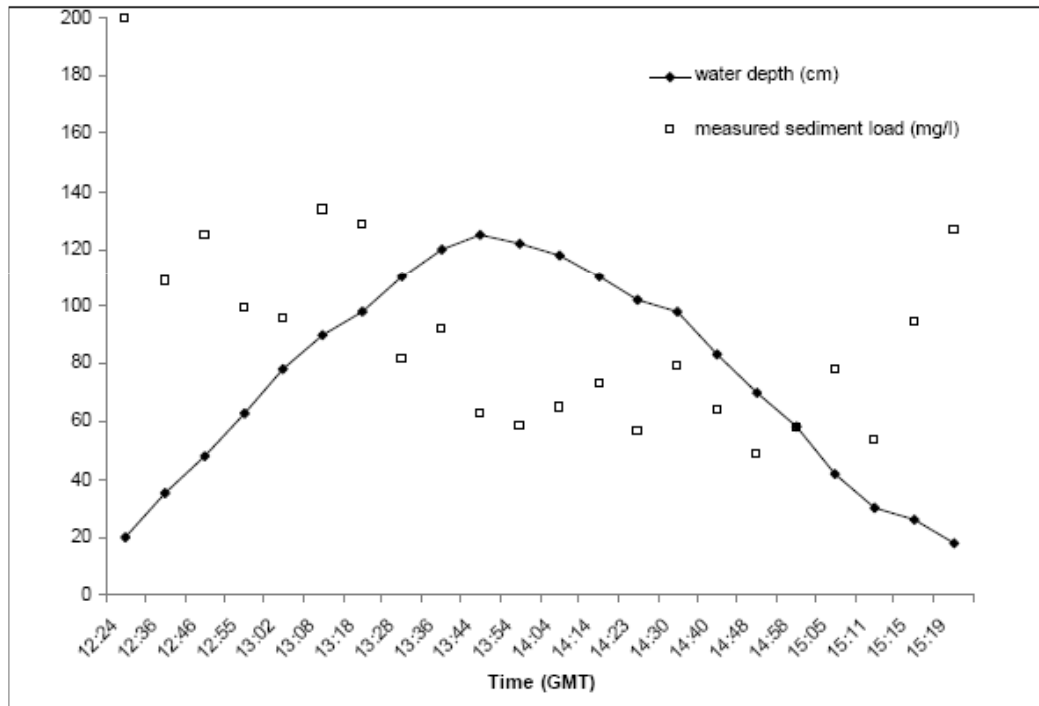at market square

PIF (c): Red surface of
tennis court

0  75  150    300    450    600
Meters



(a)  $\theta=0$
Spectrometer
$6°$
$L_u(\lambda)$
Water surface

(b)  $\theta=0$
$6°$
$L_d(\lambda)$
Water surface

*From: IOCCG, 2000*

# Bottom Reflectance

# Impact of hyper-turbid layer at initial tidal inundation

# Model Performance

**Full GER 1500 resolution**
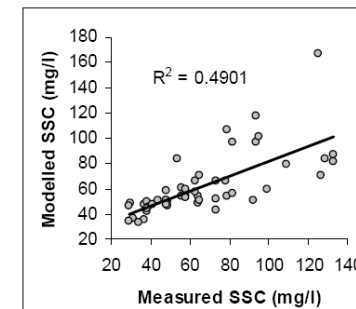


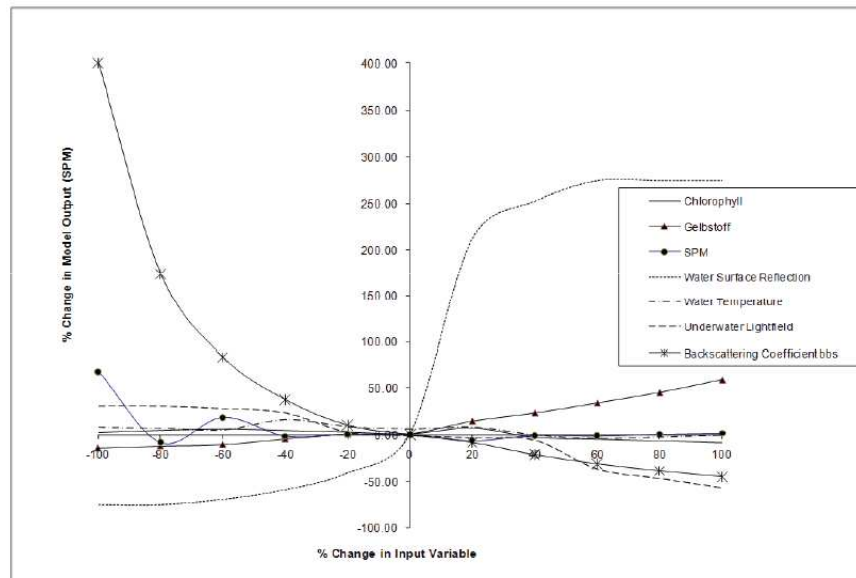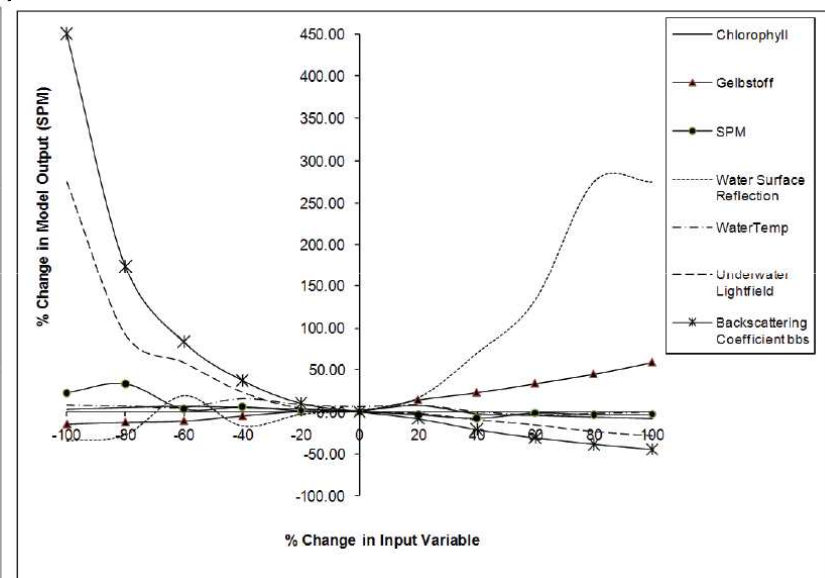|                                           | Field Spectra Full Resolution | Field Spectra CASI Bandset | CASI Flights 2002 |
|-------------------------------------------|------------------|------------------|------------------|
| Coefficient of Determination ($R^2$)      | 0.4              | 0.49             | *0.87( p>.05)*   |
| Model Efficiency (NS)                     | 0.8              | 0.83             | 0.97             |
| Mean Average Error (MAE)                  | 16.5 mg/l        | 15.3 mg/l        | 10 mg/l          |
| Normalised Mean Average Error (NMAE)      | 23%              | 20.9%            | 5.5%             |
| Root Mean Squared Error (RMSE)            | 23.2 mg/l        | 21.5 mg/l        | 13 mg/l          |
| Normalised Root Mean Squared Error (NRMSE)| 27.4 %           | 26.4 %           | 7.5%             |
| Ratio RMSE/MAE                            | 1.41             | 1.4              | 1.3              |
| Mean Difference (M)                       | +6.1 mg/l        | +4.4 mg/l        | -9.3 mg/l        |
| Relative Difference (R)                   | +9.1%            | +6.6%l           | -4.9%            |
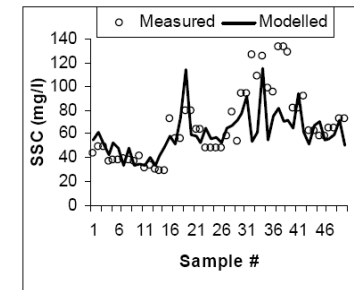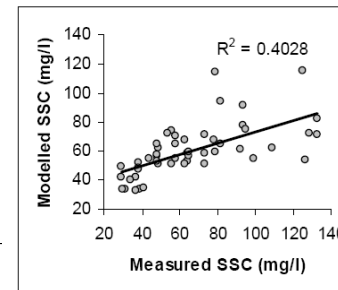
**CASI resolution**

# Model Sensitivity



Full GER 1500 resolution

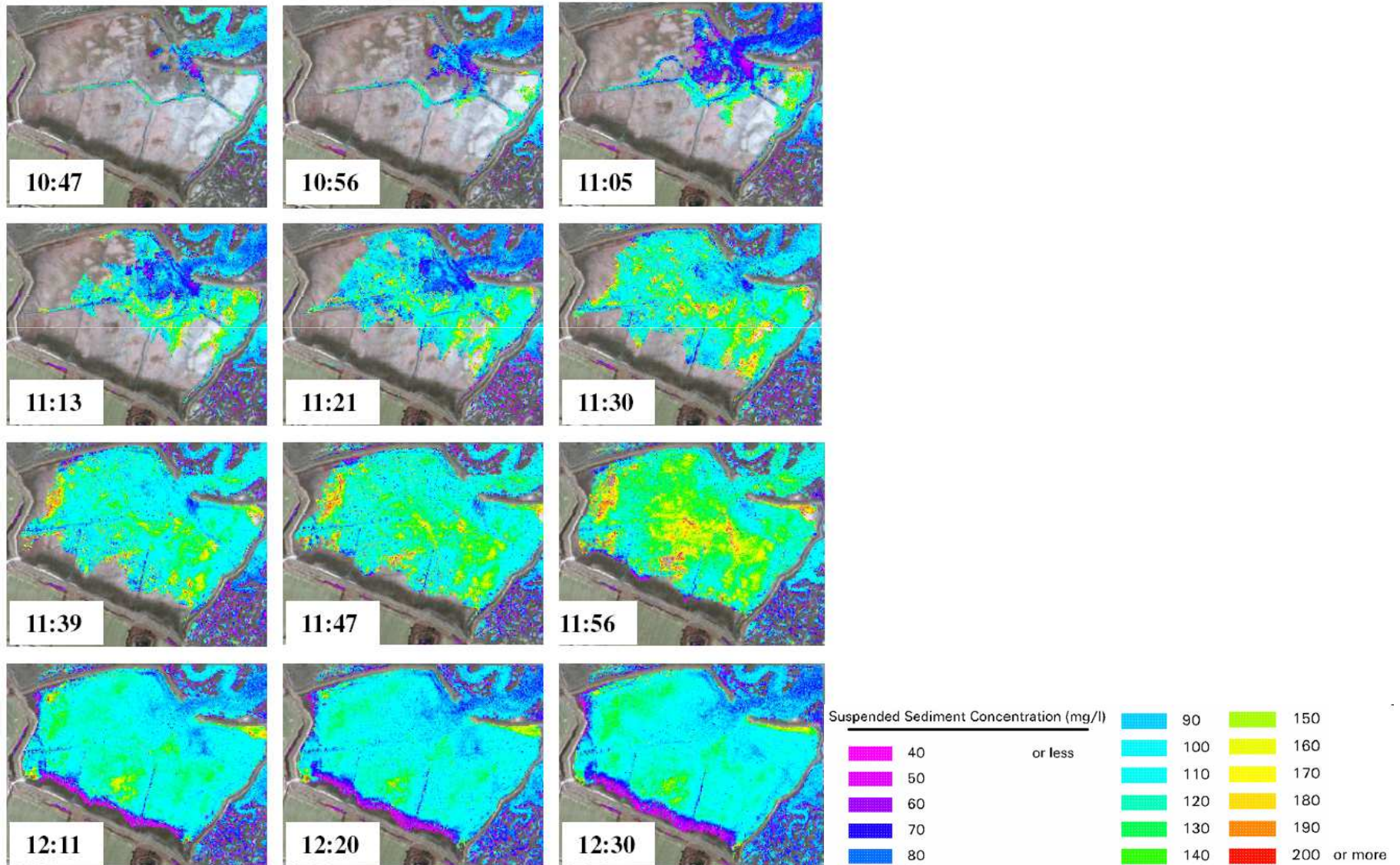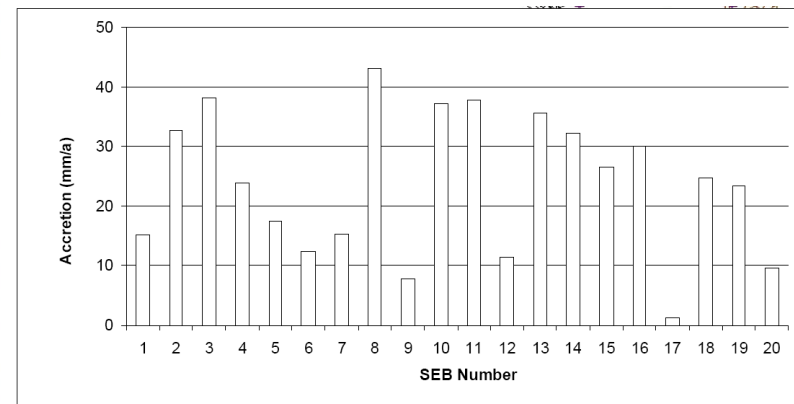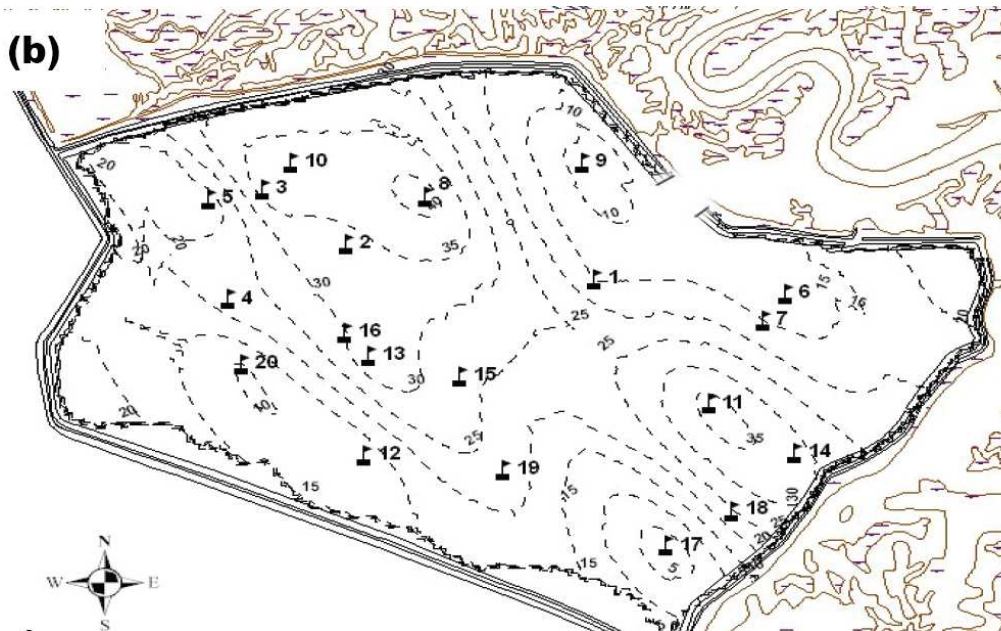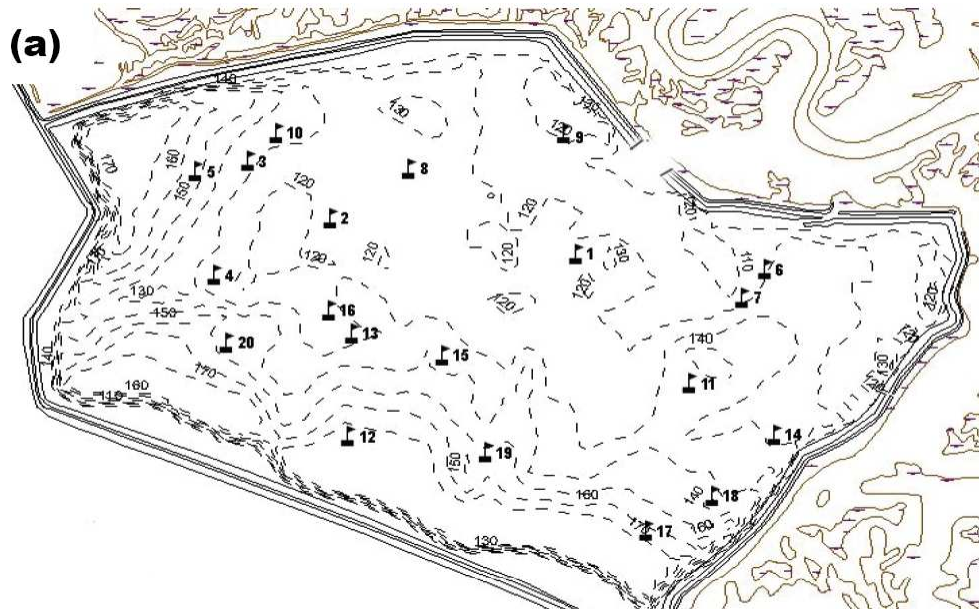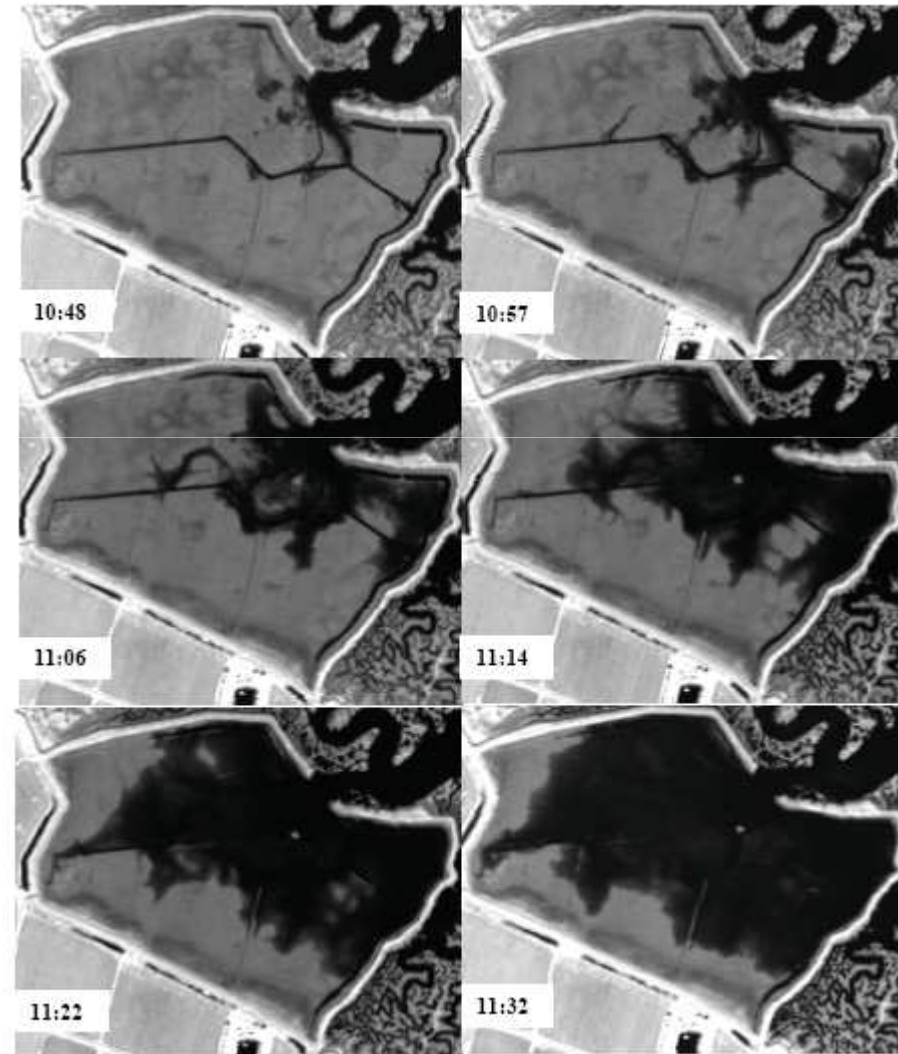CASI resolution

Impact of temporary aggregates/flocculation?

# Results



Suspended Sediment Concentration (mg/l)

| | | | |
|---|---|---|---|
| 40 | or less | 90 | 150 |
| 50 | | 100 | 160 |
| 60 | | 110 | 170 |
| 70 | | 120 | 180 |
| 80 | | 130 | 190 |
| | | 140 | 200 or more |

# Elevation and Accretion

# Estimating water levels using waterline method

| Overflight Number | Mean Elevation (m ODN) | Standard Deviation (cm) | Number of Pixels |
|---|---|---|---|
| 6 | 1.16 | 8 | 126 |
| 7 | 1.2 | 9.2 | 251 |
| 8 | 1.22 | 9.1 | 524 |
| 9 | 1.26 | 10.9 | 661 |
| 10 | 1.31 | 10.8 | 669 |
| 11 | 1.45 | 12.9 | 439 |
| 12 | 1.58 | 11.6 | 435 |
| 13 | 1.68 | 10.9 | 373 |
| 14 | 1.80 | 15 | 310 |
| 16 | 2.03 | 13.9 | 276 |
| 17 | 2.16 | 13.8 | 257 |
| 18 | 2.28 | 12.9 | 201 |

# Quantifying tidal dynamics
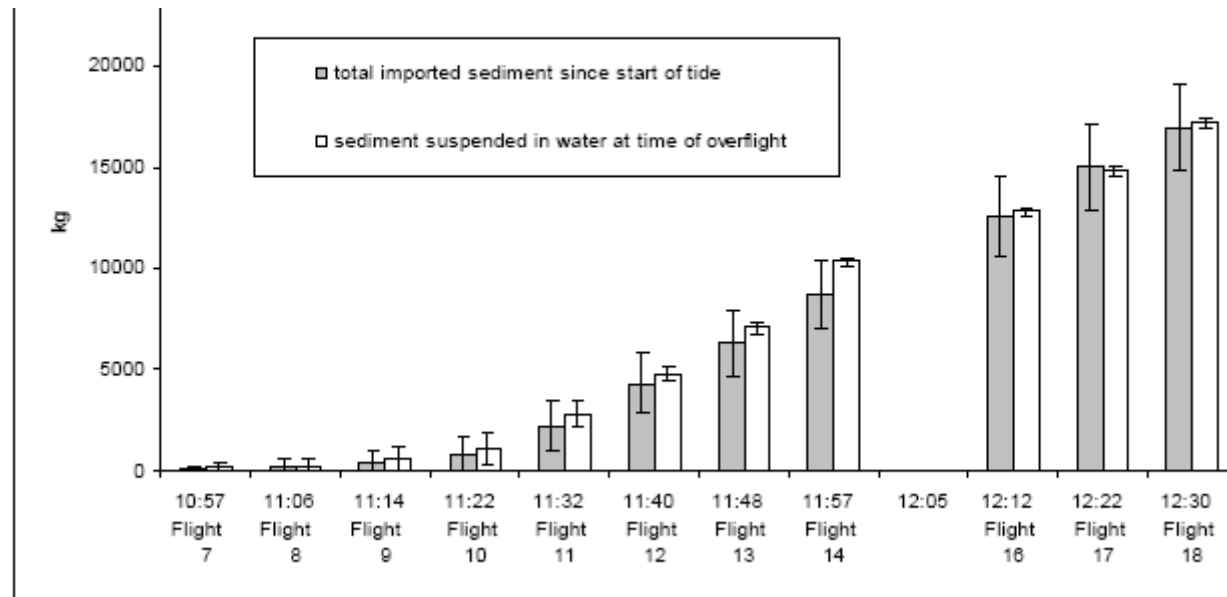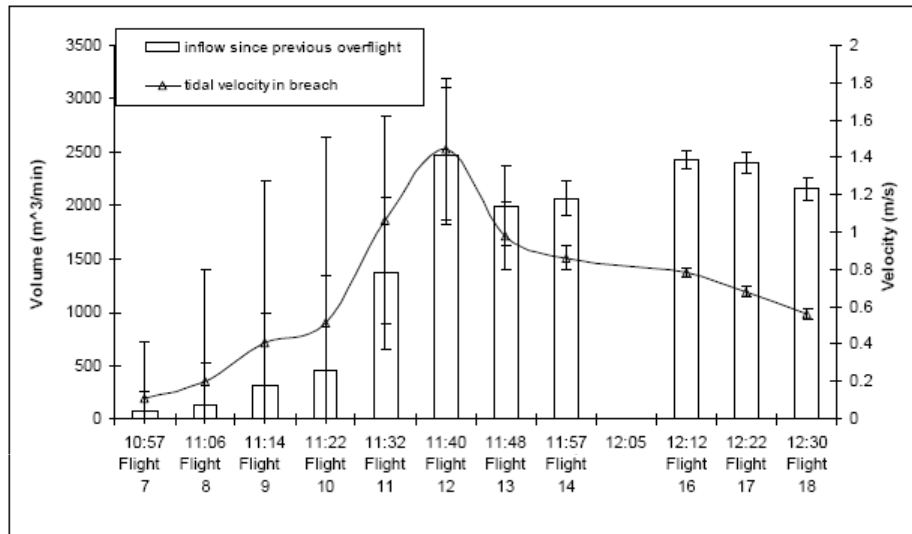
# Future Research: Investigating impact of tidal spatio-temporal IOP variations on spectral signal
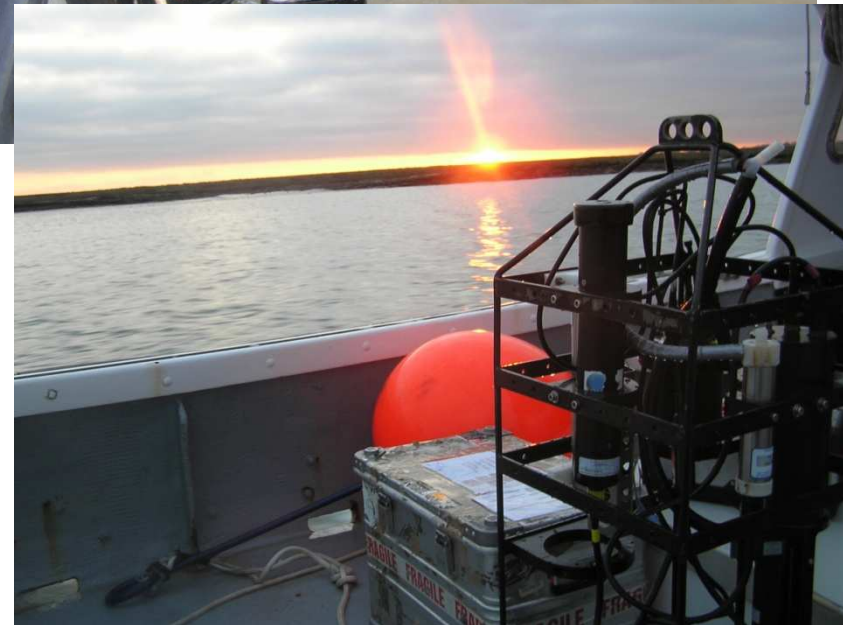


NERC/FSF supported AC-S sampling at Blackwater Estuary

# Acknowledgements