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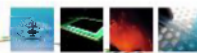
**Using NIR and SWIR wavelengths for turbid water corrections:**

**the SIMEC Environment Correction and in-situ evidence of non-zero reflectance**

Els Knaeps, Sindy Sterckx, Dries Raymaekers, Kevin Ruddick (MUMM), Ana Dogliotti (IAFE)

Presented at Workshop on atmospheric correction of ocean color satellite data in coastal waters: algorithms and uncertainties, 13-14 June, 2012 Wimereux, France

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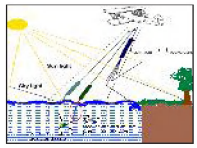
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**Using NIR and SWIR wavelengths for turbid water corrections:**

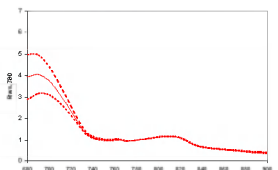
**the SIMEC Environment Correction and in-situ evidence of non-zero reflectance**

Els Knaeps, Sindy Sterckx, Kevin Ruddick (MUMM)

**SIMEC Environment Correction Background**



A "similarity" NIR reflectance spectrum is defined by normalization at 780 nm (Ruddick *et al.*, 2006).



→ can be used to **detect** and **correct** adjacency effects

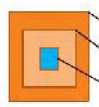
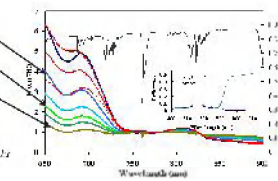
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**SIMEC Background: Workflow**

- Atmospheric correction (Modtran based)
  - AOT from land targets or sun photometer readings
  - ignoring adjacency effects
- Normalization at 780 nm
- Deviations from the NIR similarity spectrum = measure of the magnitude of the adjacency effect.
- Iteratively calculate contributing background until agreement with NIR similarity spectrum

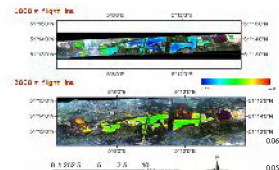
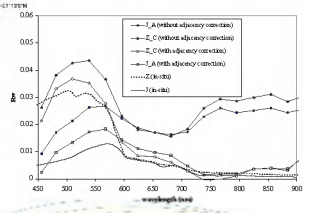
$$R(\lambda) = \frac{R_{780}(\lambda)}{R_{780}(780)} \times \left( 1 - \frac{R_{780}^2(\lambda) - R_{780}^2(780)}{R_{780}^2(\lambda) + R_{780}^2(780)} \right) \times R_{780}(780)$$

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**SIMEC application to airborne data**

Sterckx S., Knaeps E., Ruddick K.  
*International Journal of Remote Sensing*  
Vol. 32, Iss. 21, 2011


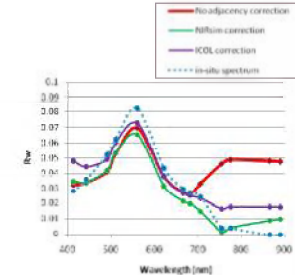
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**SIMEC application to MERIS : inland lakes**

Lake Trasimeno (Italy)

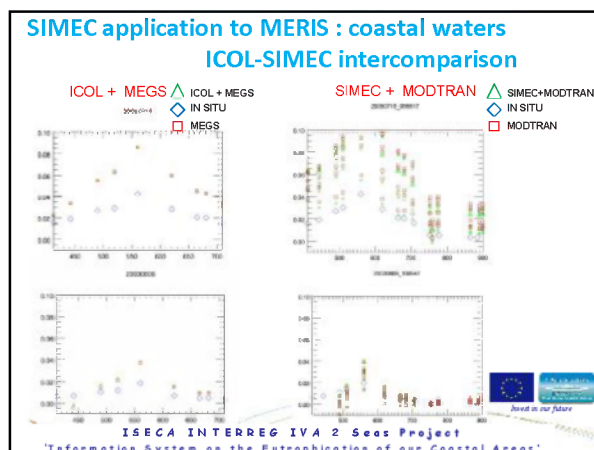
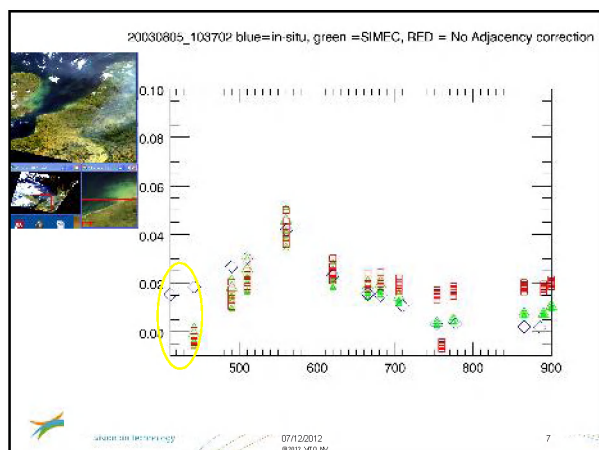



Knaeps, E., S. Sterckx, K. Ruddick, C. Giardino, B.  
Proceedings of Ocean Optics XX, 2010

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### Using NIR and SWIR wavelengths for turbid water corrections:

**the SIMEC Environment Correction and in-situ evidence of non-zero reflectance**

Els Knaeps, Sindy Sterckx, Dries Raymaekers, Kevin Ruddick, Ana Dogliotti

### SWIR potentially interesting !

Using new ocean color satellites

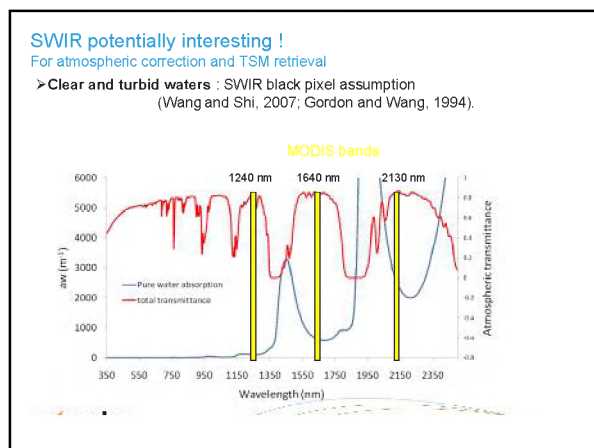
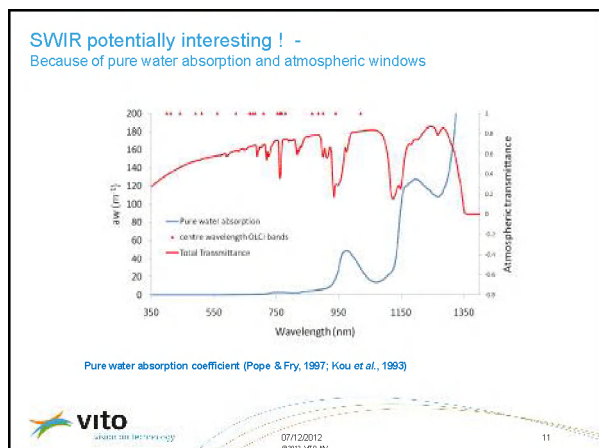
> Incorporation of SWIR wavelengths in ocean color satellites

Wavelength (nm)	Wavelength (nm)
412.5	442.5
442.5	460
460	480
480	500
500	520
520	540
540	560
560	580
580	600
600	620
620	640
640	660
660	680
680	700
700	720
720	740
740	760
760	780
780	800
800	820
820	840
840	860
860	880
880	900
900	920
920	940
940	960
960	980
980	1000
1000	1020
1020	1040
1040	1060
1060	1080
1080	1100
1100	1120
1120	1140
1140	1160
1160	1180
1180	1200
1200	1220
1220	1240
1240	1260
1260	1280
1280	1300
1300	1320
1320	1340
1340	1360
1360	1380
1380	1400
1400	1420
1420	1440
1440	1460
1460	1480
1480	1500
1500	1520
1520	1540
1540	1560
1560	1580
1580	1600
1600	1620
1620	1640
1640	1660
1660	1680
1680	1700
1700	1720
1720	1740
1740	1760
1760	1780
1780	1800
1800	1820
1820	1840
1840	1860
1860	1880
1880	1900
1900	1920
1920	1940
1940	1960
1960	1980
1980	2000
2000	2020
2020	2040
2040	2060
2060	2080
2080	2100
2100	2120
2120	2140
2140	2160
2160	2180
2180	2200
2200	2220
2220	2240
2240	2260
2260	2280
2280	2300
2300	2320
2320	2340
2340	2360
2360	2380
2380	2400
2400	2420
2420	2440
2440	2460
2460	2480
2480	2500

Sentinel-3 (OLCI) SABIA/MAR GCOM-C(SGLI)

> Hyperspectral sensors

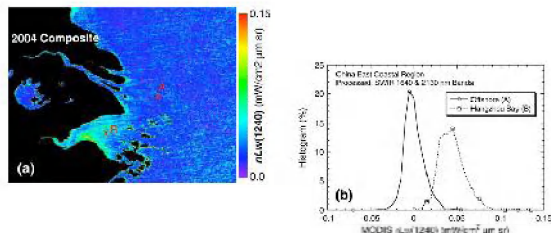
HYSPIRI APEX



### SWIR potentially interesting !

For atmospheric correction and TSM retrieval

- > Clear and turbid waters : SWIR black pixel assumption (Wang and Shi, 2007; Gordon and Wang, 1994)
- > Extreme turbid waters: **new atmospheric correction <-> TSM retrieval** (saturation at shorter wavelengths?) (Shi and Wang, 2009)



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### SWIR potentially interesting !

BUT

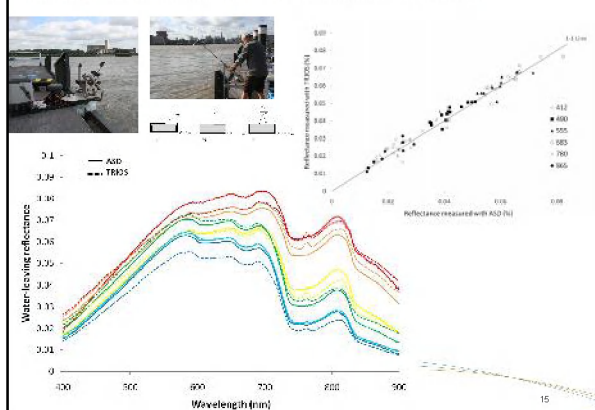
- > only little knowledge available
- > instrumentation lacking
  - > to measure IOPS in the SWIR
  - > to measure water reflectance in the SWIR

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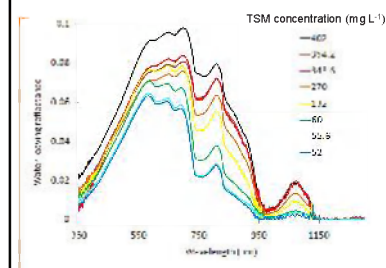
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### Intercomparison of ASD and TRIOS water reflectance measurements;



Knaeps, E., Raymaekers, D., Sterckx, S., Ruddick, K., Dogliotti, A.J., In situ evidence of non-zero reflectance in the GLI 1020nm band for a turbid estuary, Remote Sensing of Environment, Sentinel special issue, 133-144, 2012



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For a threshold reflectance of 0.002 at 1020nm:

limit of 35 mg L<sup>-1</sup> for the TSM concentration  
46.7 FNU for the turbidity

For the same threshold at 1071 nm:

a limit of 17.5 mg L<sup>-1</sup> for the TSM concentration  
23.3 FNU for the turbidity.

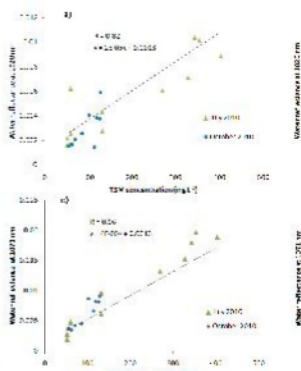
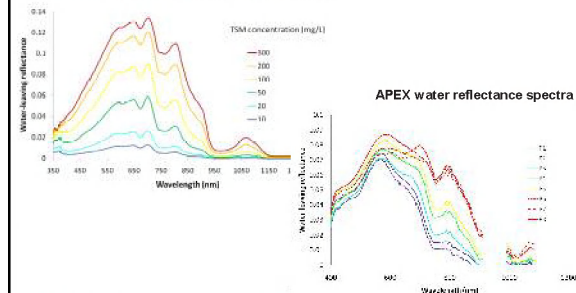


Figure 10: a) Correlations between TSM and a) water reflectance at 1020 and c) water reflectance at 1071; Correlations between turbidity and b) water reflectance at 1020 and d) water reflectance at 1071.

### Simulations with Hydrolight and SIOPS from the Scheldt



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## CONCLUSIONS

- ❑ black pixel assumption invalid for scheldt estuary. A significant increase in reflectance was observed between 950 and 1150 nm where pure water absorption has a local minimum.
- ❑ SNR and atmospheric influences does not seem to alter these findings.
- ➡ **WARNING** when using the SWIR black pixel assumption for atmospheric correction
- ➡ need for an **adjusted atmospheric correction for highly turbid waters.** (Incorrect use of the black pixel assumption in atmospheric correction can lead to an overestimation of the aerosol contribution and a significant underestimation of the derived water reflectance!)
- ❑ correlation of water reflectance with TSM concentration.
- ➡ Suggest that spectral bands beyond 1000 nm contain information on the concentrations of optical constituents.



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## SEASWIR: REMOTE SENSING OF TURBID WATERS IN THE SHORT WAVE INFRARED

- ❑ Determine the variability of marine reflectance in SWIR
- ❑ Analyze the effects misapplication of the SWIR black pixel assumption
- ❑ Provide information for exploitation of SWIR bands on the next generation of ocean colour sensors

