First optical observations in the turbidity maximum zone in the Río de la Plata: A challenge for atmospheric correction algorithms

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INTRODUCTION

The **Río de la Plata** (RdP) estuary carries high amounts of nutrients, suspended particulates and dissolved organic matter to the adjacent shelf waters. It's considered one of the most turbid estuaries in the world. Standard atmospheric corrections (AC) tend to fail in these highly turbid waters, being a critical step to retrieve in-water properties from remotely sensed data. Previous AC evaluations have been qualitative due to the lack of field data[1].

The **objective** of the present work is to validate for the first time different AC algorithms using *in situ* water reflectance measured in the highly turbid waters of RdP.

DATA

In situ

Two cruises: Maximum turbidity zone (Fig. 2)

Reflectance: ASD Fieldspec FR spectrometer (350-2500 nm)

Turbidity (*T*): HACH2100P ISO turbidimeter [FNU]

Total Suspended Matter (*TSM*): gravimetry [mg L^{-1}]

Satellite

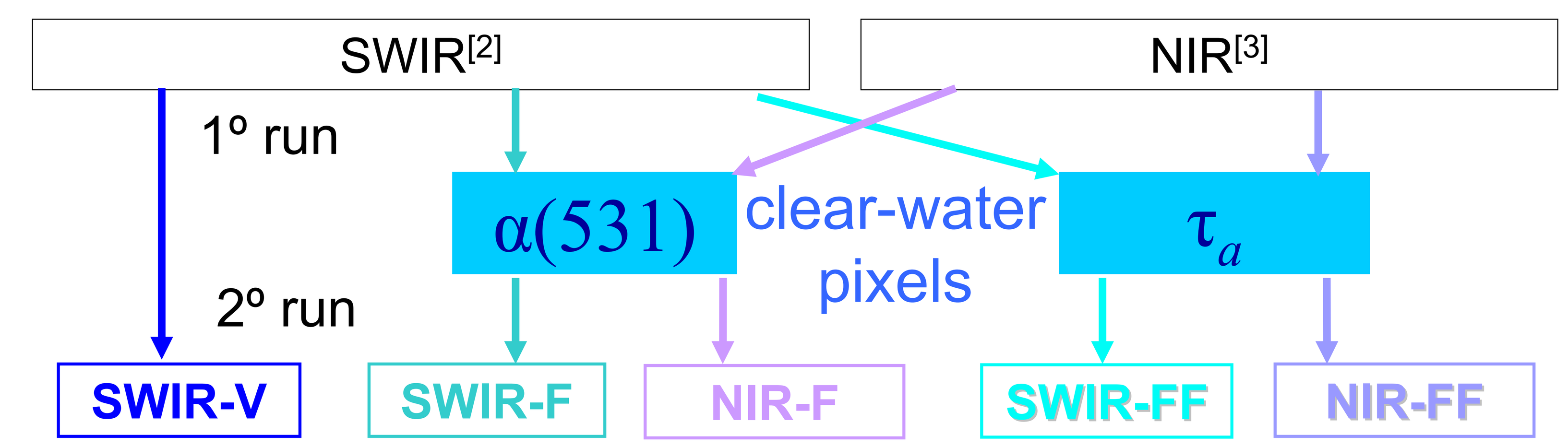
MODIS-Aqua L1A + anc. data (http://oceancolor.gsfc.nasa.gov/)

L2 using SeaDAS v7.02: Rayleigh-corrected reflectance (ρ_{rc}), Remote sensing reflectance (R_{rs}), Aerosol optical thickness (τ_a), Angström exponent coefficient at 531 nm ($\alpha(531)$)

Match-up: mean value of 3x3 pixel window (5 out of 9); CV<20%

ATMOSPHERIC CORRECTION ALGORITHMS

Five AC algorithms have been evaluated using: 1) variable aerosol type and concentration (SWIR-V); 2) fixed aerosol type, α(531) (F); 3) fixed aerosol type and concentration, τ_a, (FF). For 2 and 3 the AC is run twice getting the aerosol optical properties from clear water pixels of the image (Fig.2) from either SWIR or NIR bands.



RESULTS

Typical spectral signatures of highly turbid waters (Fig. 1): R_{rs} increases with *T*; wavelength of main peak increases from green to red and NIR with increasing *T*; non-zero R_{rs} at NIR & SWIR (1071nm)

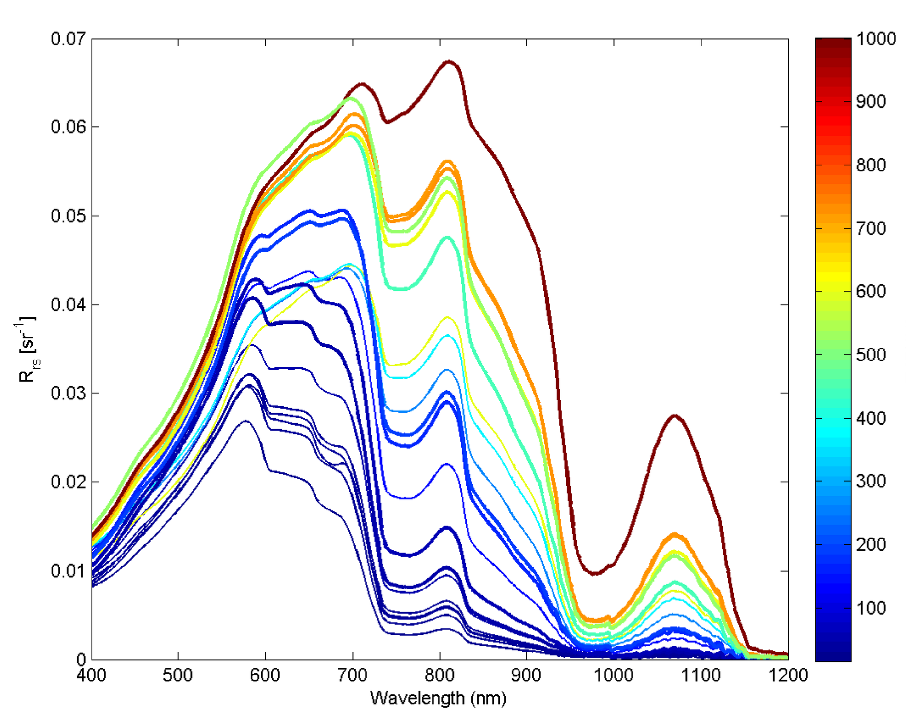


Fig.1. In situ $R_{rs}(\lambda)$ for different *T* collected in 27 Feb 2013 (thin lines); 30 Apr 2013 (bold lines) (Table 1)

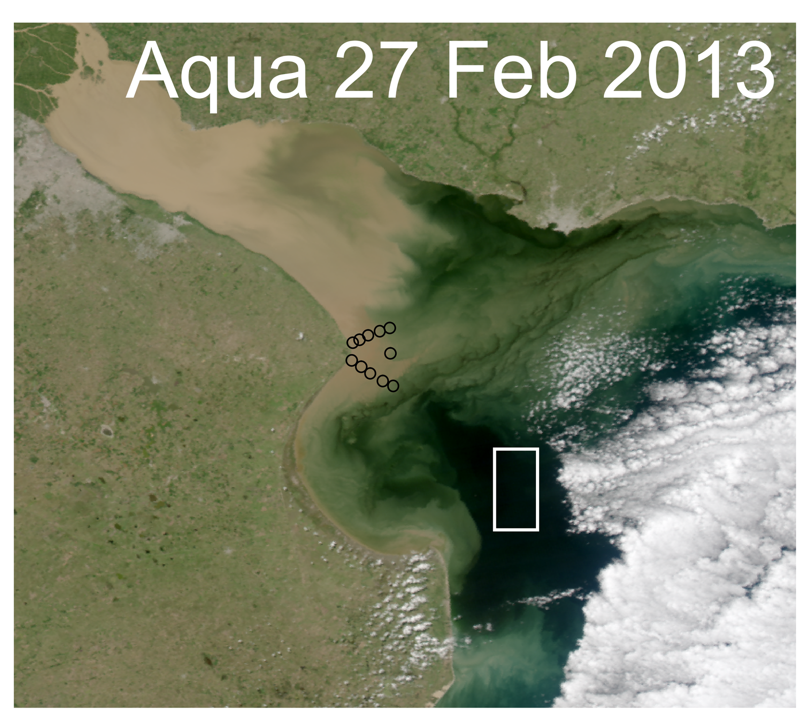


Fig.2. Location of stations (circles) & region of "clear pixels" for the AC algorithms (white rectangle).

Table 1. Summary of cruises conducted in 2013

Date	T [FNU]	TSM [mg L^{-1}]	# St.
27 Feb 2013	16-602	16-664	11
30 Apr 2013	41->1000	25-940	12

Negative mean relative percentage error (RE) for VIS/NIR bands and all AC (Fig.3). SWIR worst performance (non-zero $R_{rs}(1240)$?). NIR-F over-estimates α(531) Fig.4 (non-zero R_{rs}(NIR)?)

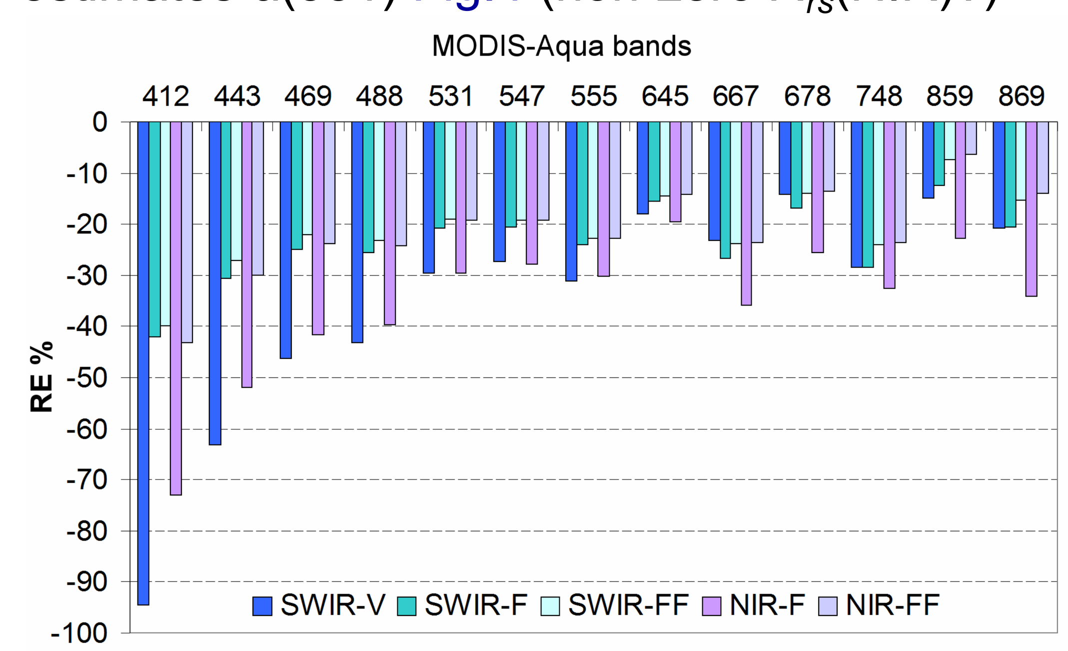


Fig.3. Mean relative error for VIS/NIR & different AC

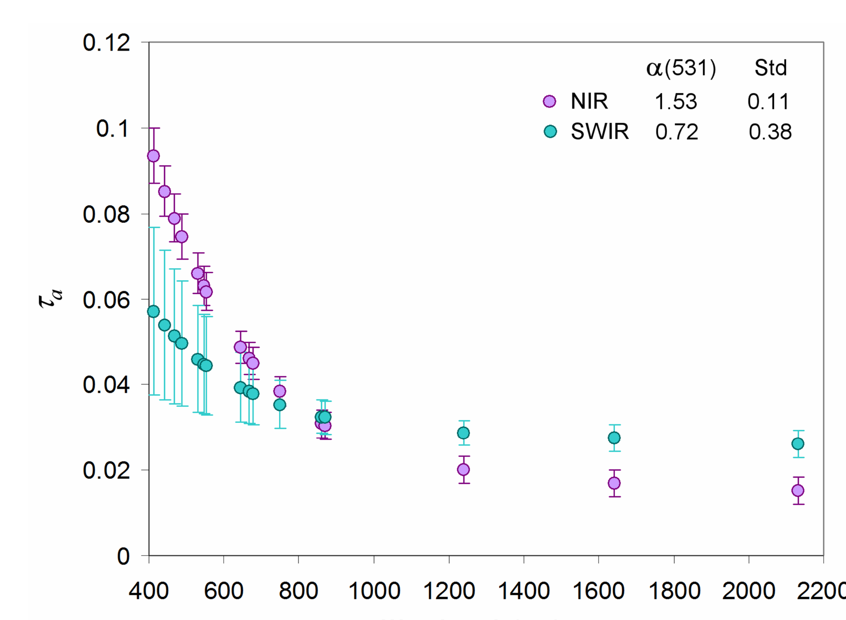


Fig.4. Mean α(531), standard deviation (Std), & spectral τ_a retrieved using NIR[3] & SWIR[2] from MODIS-Aqua 27 Feb 2013

Match-up comparison along a transect St. 7-11 in 27 Feb 2013 (Fig.5). All AC under-estimated R_{rs} in the VIS & NIR for high *T* (600 FNU); better results in the NIR at St. 6 for low *T* (16 FNU)

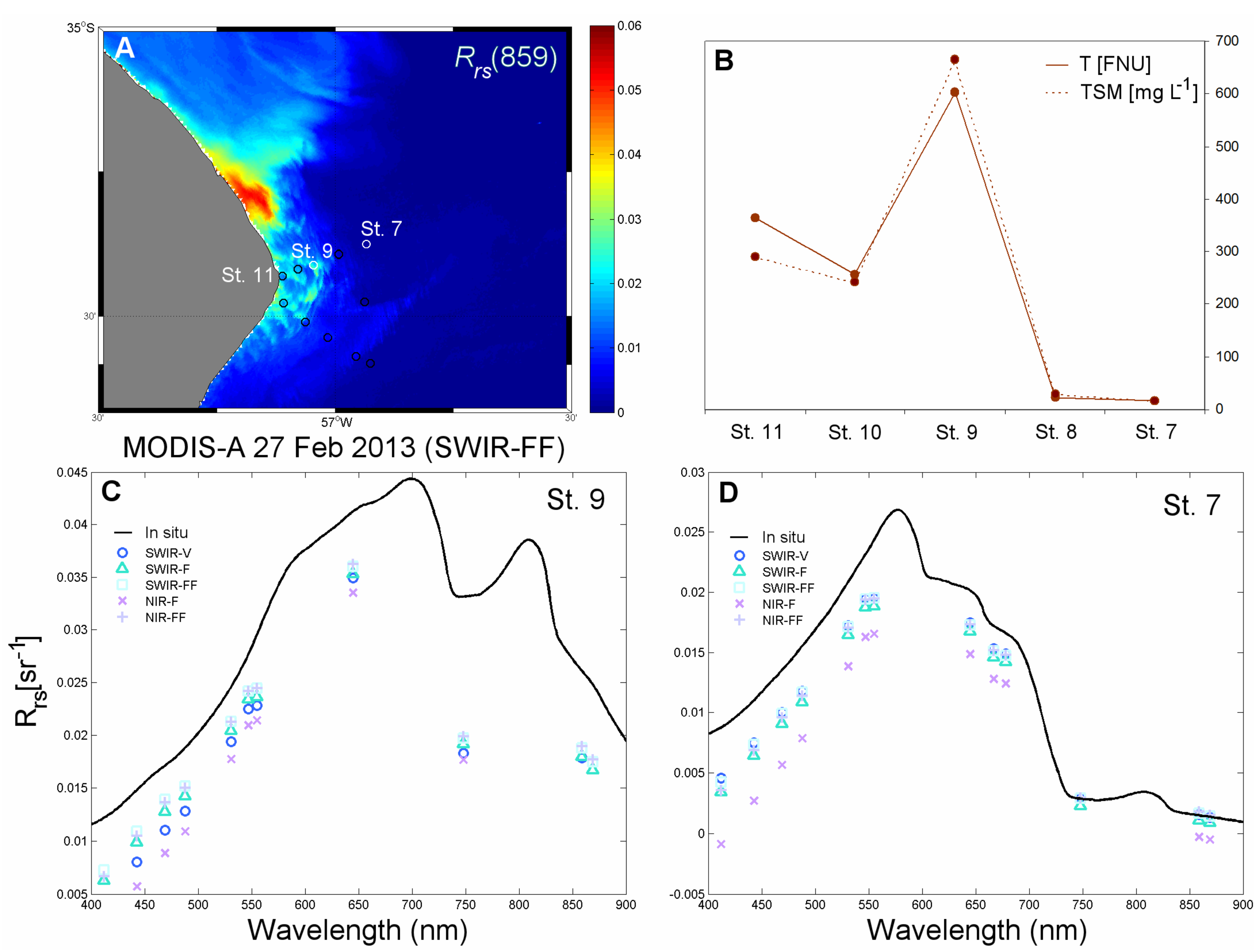


Fig.5. A) MODIS-Aqua $R_{rs}(859)$ using SWIR-FF (27 Feb 2013). B) Measured *T* and *TSM* at St. 7-11. Satellite and field R_{rs} spectra for different AC at St 9 (C) and 7 (D).

CONCLUSIONS

- First optical observations in the turbidity maximum zone in the Río de la Plata estuary have been presented (non-zero in the NIR & SWIR)
- All AC algorithms analyzed under-estimated measured R_{rs} values (between -95% and -7%)
- Larger errors in the VIS (largest in the blue) and lower errors in NIR bands.
- SWIR-V had a poor performance (~-90% in the blue) and SWIR-FF and NIR-FF performed better (~-20% VIS, -10% NIR)
- Lower error were found in the 859 nm band (-7%)

REFERENCES

[1] Dogliotti, Ruddick, Nechad, Lasta 2011. Proc. VI Conf. ONW. Russia.
[2] Wang, 2007. Applied Optics, 46, 1535–1547
[3] Bailey, Franz, Werdell. 2010. Optics Express, 18, 7521-7527

This study was supported by PICT 2010-1831 (ANPCyT)

Ocean Optics XXII Portland, Maine October 26–31, 2014