A fractal problem: surface scums how to quantify?
Confined accumulations in "slicks" with a few kms extension and a few meters large concentrations show vertical low thickness of these accumulations. The 25 october 2002 Chl\textsubscript{a} < x 366 higher at 1m and 7 m depth than in the slick and the Chlc1+2/Chla = 0 in surface increased towards the bottom (as cyanobacteria do not have accessory chlorophylls). On the 29th October, there was a decrease of a factor of 4 between the « slick » and 3 meters deep.

Horizontal distribution also shows abrupt decrease of Chl (a factor of 7) on the 27/12/2002 inside and outside the "slick" Increase of the Chlb/Chla and Chlc1+2/Chla indicate picoeucaryotic biomass outside the slick

Figure IV.25-A : Accumulations of *Trichodesmium erythraeum* Lagoon New Caledonia South West in *Tenorio 2006*
Weekly Biomass measurements in slicks (Tenorio, 2006)

<table>
<thead>
<tr>
<th>Local</th>
<th>Date</th>
<th>Heure</th>
<th>Filtration</th>
<th>Profondeur (m)</th>
<th>Chla</th>
<th>Chlb/Chla</th>
<th>Chlc 1+2/Chla</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baie de Sainte Marie</td>
<td>23/10/2002</td>
<td>10h</td>
<td>Totale</td>
<td>&quot;Slick&quot;</td>
<td>6,88</td>
<td>0,000*</td>
<td>0,011*</td>
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<tr>
<td>Baie de Sainte Marie</td>
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<td>10h</td>
<td>Totale</td>
<td>&quot;Slick&quot;</td>
<td>7,94</td>
<td>0,000*</td>
<td>0,005*</td>
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<tr>
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<td>10h</td>
<td>Totale</td>
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<td>Baie de Sainte Marie</td>
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<td>10h</td>
<td>Totale</td>
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<td>0,38</td>
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<tr>
<td>Baie de Sainte Marie</td>
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<td>10h</td>
<td>Totale</td>
<td>0</td>
<td>1,17</td>
<td>0,005*</td>
<td>0,0</td>
</tr>
<tr>
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<td>10h</td>
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<tr>
<td>Baie de Sainte Marie</td>
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<td>10h</td>
<td>&gt;10µm %Chl_a</td>
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<td>20</td>
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<td>&quot;Slick&quot;</td>
<td>13,97</td>
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<tr>
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<tr>
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<tr>
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<td>&quot;Slick&quot;</td>
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<tr>
<td>Baie de Sainte Marie</td>
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<td>Totale</td>
<td>&quot;Slick&quot;</td>
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<td>0,010*</td>
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<tr>
<td>Baie de Boulari</td>
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<td>13h</td>
<td>Totale</td>
<td>&quot;Slick&quot;</td>
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<td>0,003*</td>
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<tr>
<td>Baie de Sainte Marie</td>
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<td>12h</td>
<td>Totale</td>
<td>&quot;Slick&quot;</td>
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<tr>
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<td>%Chl_a</td>
<td>&quot;Slick&quot;</td>
<td>2,01</td>
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</table>

Chla in slicks Ste Marie Bay, Noumea Tenorio, 2006

![Chla in slicks Ste Marie Bay, Noumea Tenorio, 2006](image)
Trichodesmium IOP’s (Tricho Bleu Workshop)

$A_{part} \text{ m}^{-1}$

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>$b_{bp} \text{ m}^{-1}$</th>
</tr>
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<tbody>
<tr>
<td>300-400</td>
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</tr>
<tr>
<td>400-500</td>
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<tr>
<td>500-600</td>
<td>0.1</td>
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<tr>
<td>600-700</td>
<td>0.15</td>
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</tbody>
</table>

MAA’s
330nm, 360nm

Mycosporine-Like Amino Acids
(shinorine & Porphyra-334)

$A_{cdom} \text{ m}^{-1}$

Troughs at 440nm, 550nm

MAA’s
330nm, 360nm

Dupouy et al., 2008, JARS
Trichodesmium (floating)

Need a Hyper-Spectral sensor

- maximum at 555 nm
- minimum at 443, 490, 520, 670
- increasing suspensions
- above water blooms

Dupouy, Neveux, Ouillon et al., 2008, JARS
McKinna et al., 2011
Outpace cruise Aps & CDOM in Trichos patches
Remote sensing *Trichodesmium* surface aggregations (scums/slicks/blooms/mats...)

McKinna (2015)
Why do we need to compensate for absorbing gases in the AC?

- Absorbing gases including: water vapor, oxygen, ozone and nitrogen dioxide modulates the measured TOA radiance significantly within the visible spectrum.

- A correction algorithm for gases is need to remove the unwanted spectral features in ocean reflectance.

- Erroneous correction of gases can significantly degrade ocean color data quality and plankton type algorithms.
If the AC algorithm does not flag bright pixels as clouds, the algorithm treats the bright water as an increased in aerosols concentration in the atmosphere, and therefore over correcting for aerosols leading to negative reflectance of the ocean.
Remote sensing *Trichodesmium* surface (scums/slicks/blooms/mats...)

![Graphs showing various data]

- **SBE-19**
- **D&A OBS**
- **FLNTU**
- **C-STAR**
Identical cyanobacterial biomass creates very different reflectance

Kutser et al. (2008)
Challenge discriminating from other floating material

• Requires appropriately placed bands
Sensor spatial resolution

Landsat OLI, 19 September 2014. Capricorn Channel, Australia
Caveats/limitations

- Vertical distribution
- Spectral resolution of sensor
- Spatial resolution of sensor
Standing problems with AC

• AC typically fails over bright surfaces such as extreme turbidity and surface blooms
• NASA’s operational AC algorithm relies on the dark pixel assumption when detecting light in the near infrared (NIR)
• To mitigate bright ocean problems, an iterative NIR correction based on radiative transfer model is successfully utilized
• In extreme bloom conditions or surface blooms such as Trichodesmium, the NIR correction method fails due to improper modeling of the bloom spectral signature.
• Also the AC algorithm tend to flag bright surface blooms as clouds.
• In some cases ocean color detectors (bands) saturates, rendering these bands useless for detection due to loss of sensitivity
Future outlook

- Hyperspectral information can improve the flagging that can discriminate between clouds and extreme blooms or floating vegetation.
- The appropriate flagging of *Trichodesmium* would allow an improved AC capabilities based on an improved radiative transfer modeling of NIR reflectance in bloom conditions.
- Future efforts are needed to improve the radiative transfer modeling of bloom conditions and surface vegetation.
Recommandations Biomass estimates

- Encourage the community to routinely sample accessory phycobilin pigments!
- Phycoerythrin algorithms will need more spectral resolution that we have in any sensor right now but is a hope for the future.
- Determine all biomass parameters in at least a 8L volume
- Spectrofluorometry (cheap!). Nets do not provide quantitative measurements! PE < and > 10 μm fractions
Final thoughts....

Exciting times!
• New sensors in orbit or in development with improved capabilities

Remaining challenges
• Mixed assemblages
• Atmospheric correction
• Sub-bloom concentrations
• Algorithms are hard to validate
• We are seeing a surface expression, not a volume
  Units: mg Chl m\(^{-3}\) OR mg Chl m\(^{-2}\)?