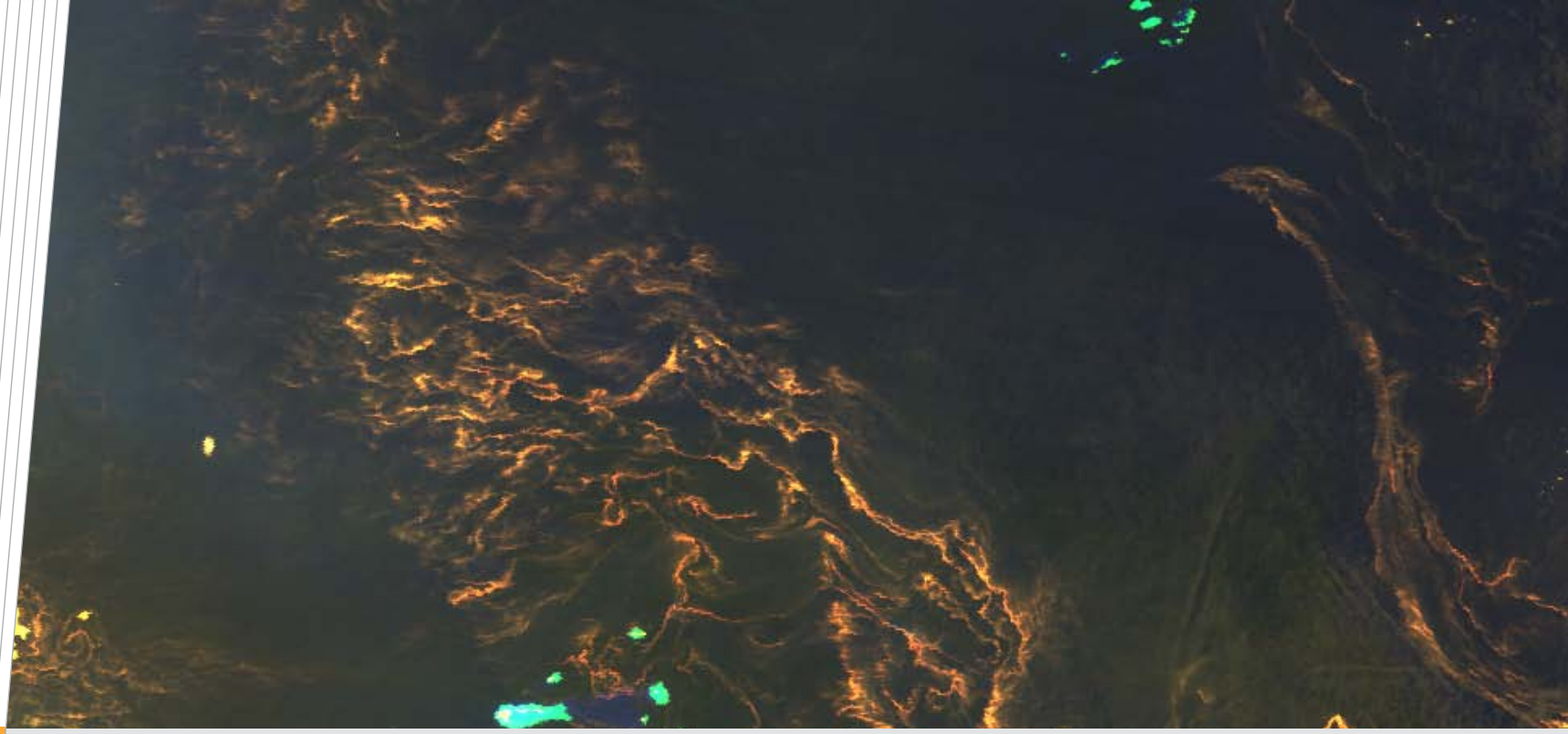


www.csiro.au

Glint-aerosol discrimination using NIR-SWIR wavelengths

Young-Je Park[1], Arnold Dekker, Eric Hochberg and HysplRI Sun Glint Subgroup

24-26 Aug 2010 HysplRI Science Workshop

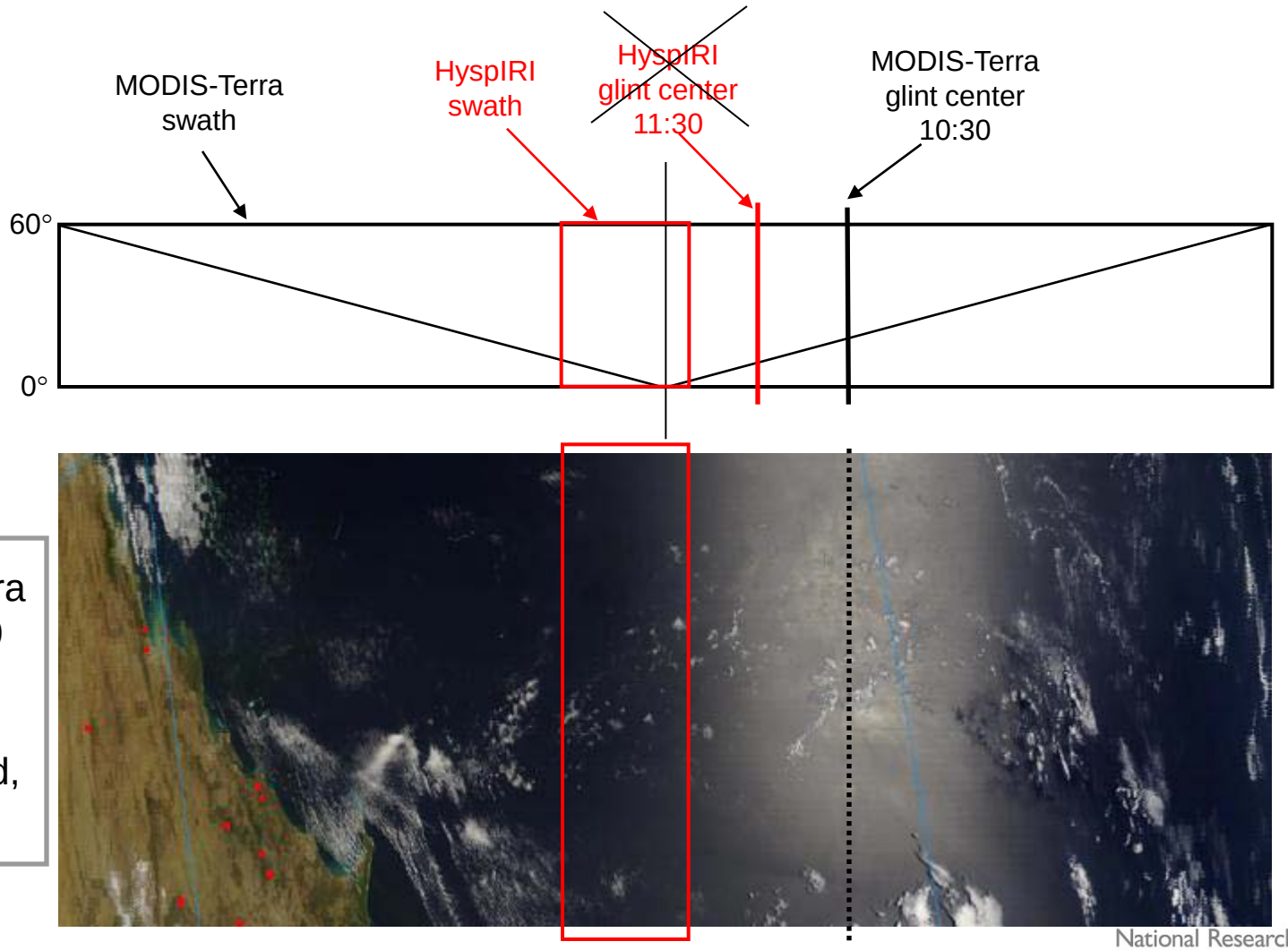
National Research FLAGSHIPS
Wealth from Oceans

CSIRO

Outline

- HyspIRI glint compared to MODIS
- Existing glint correction techniques
- Aerosol and glint discrimination approach
- AVIRIS example
- Discussion
- Application to algal bloom monitoring

Introduction



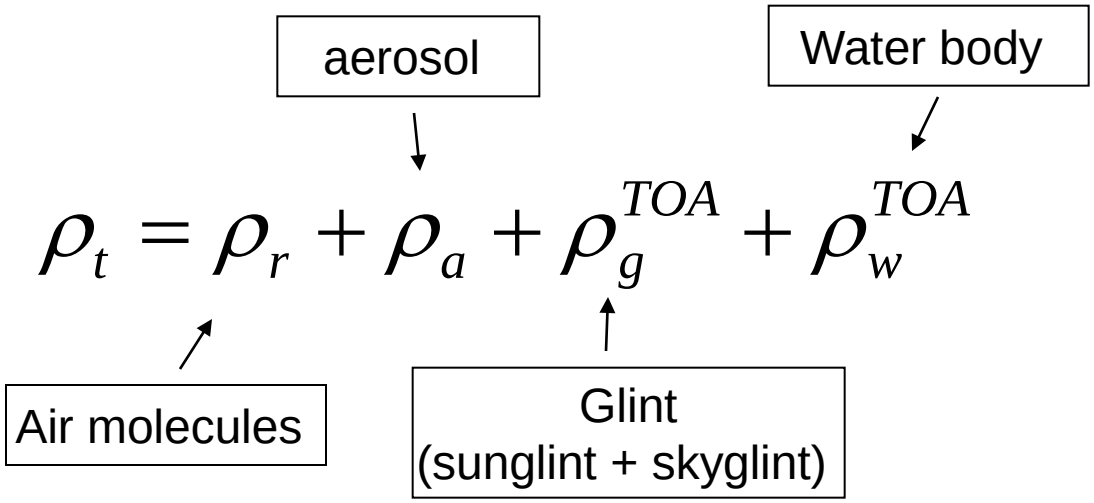
MODIS Terra image of 29 Nov 2006 over Queensland, Australia

Existing glint correction techniques

- For Medium-Coarse spatial resolution data (MODIS, MERIS)
  - Wind based surface slope model: Cox and Munk 1954
- High spatial resolution image
  - NIR-VIS linear relationship (Hochberg 2003)
  - NIR subtraction technique (Gao)
  - Uniform spectral offset approach (Goodman and Ustin, 2007)
- Why looking for new approach?
  - Use of adequate glint spectra normally decreasing to the blue
  - Automated processing

Glint-aerosol decoupling approach

- Top of atmosphere (at-sensor) reflectance



- Atmospheric-glint correction is meant to remove the reflectances due to air molecules, aerosols and glint from satellite measured reflectance.

- At wavelengths where water reflectance is zero

$$\rho_a + \rho_g^{TOA} = \rho_t - \rho_r$$

known

- Aerosol reflectance and glint reflectance can be decoupled
  - 1) using a spectral matching technique if we know the spectral shapes of aerosol and glint reflectances:

$$\rho_a(\lambda) = \rho_{a0} \cdot A(\lambda) \qquad \rho_g^{TOA}(\lambda) = \rho_{g0} \cdot G(\lambda)$$

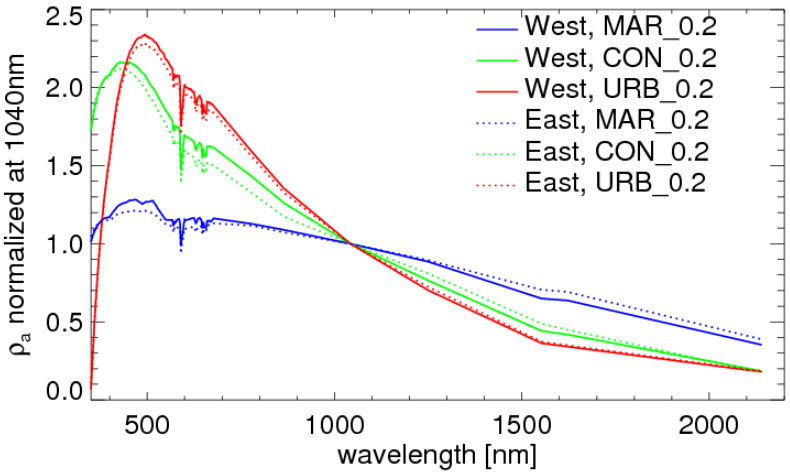
OR

  - 2)Using a look-up table for $\rho_a + \rho_g^{TOA}$ as function of aerosol and wind speed as well as sun-sensor angles

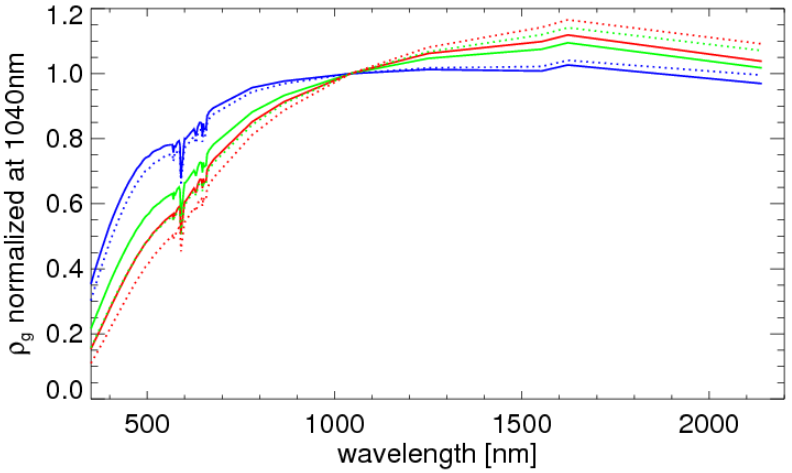
Glint-aerosol discrimination approach

- RT (6S) simulations for HyspIRI east and west edges

$$\rho_a(\lambda) = \rho_{a0} \cdot A(\lambda)$$



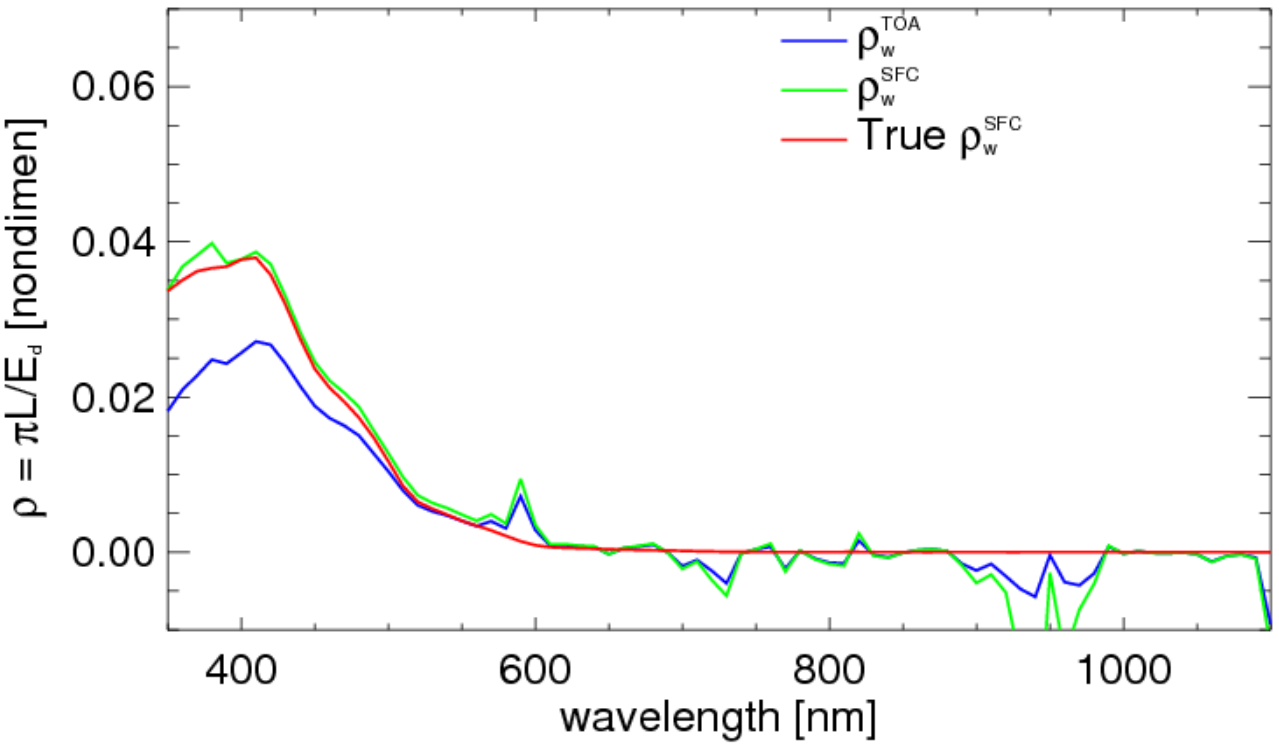
$$\rho_g^{TOA}(\lambda) = \rho_{g0} \cdot G(\lambda)$$



- Aerosol and glint reflectance have different spectral shapes
- TOA glint spectrum is the surface reflectance multiplied by a two-way atmospheric transmittance

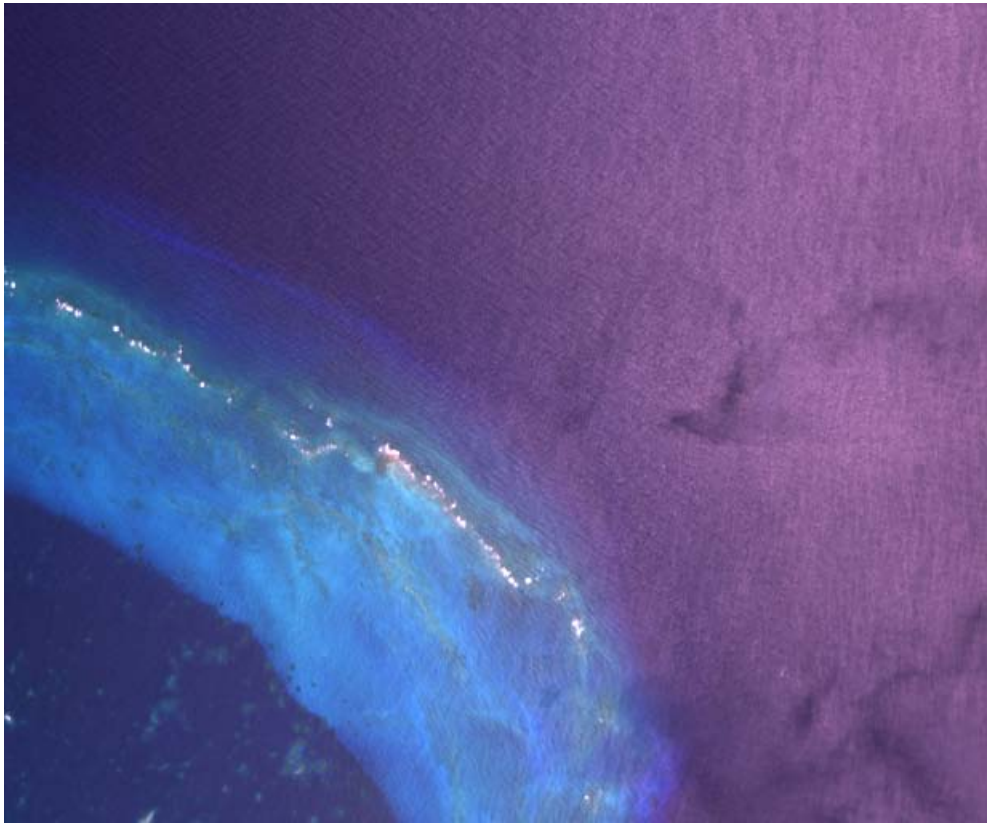
Verification with HyspIRI simulation data

- ALOHA-East edge U=10m/s



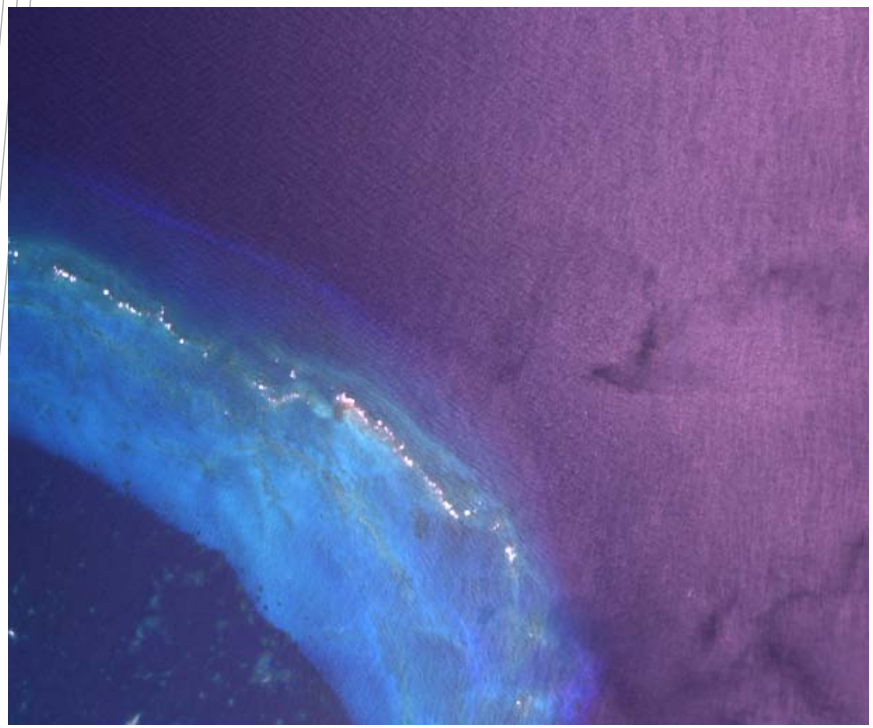
AVIRIS example: French frigate shoals

- Apr. 18 2000 on French Frigate Shoals, Hawaii

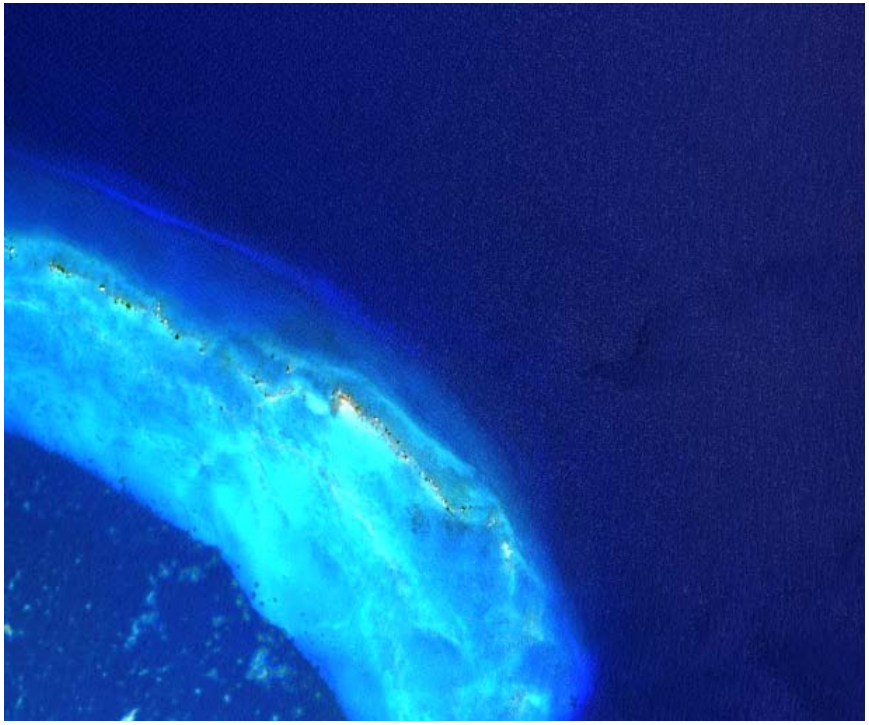


After correction

Before correction

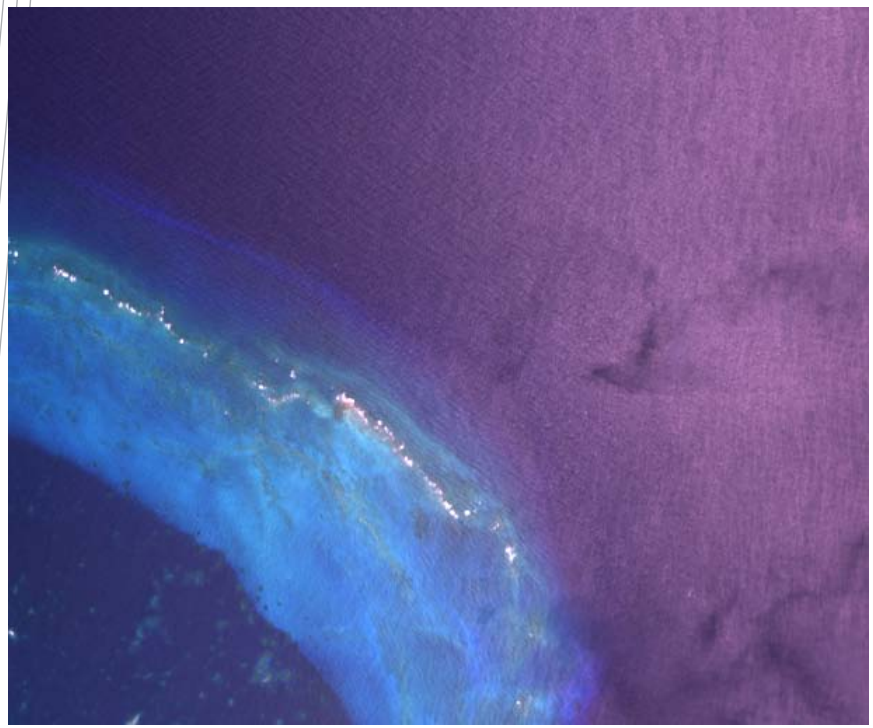


After correction

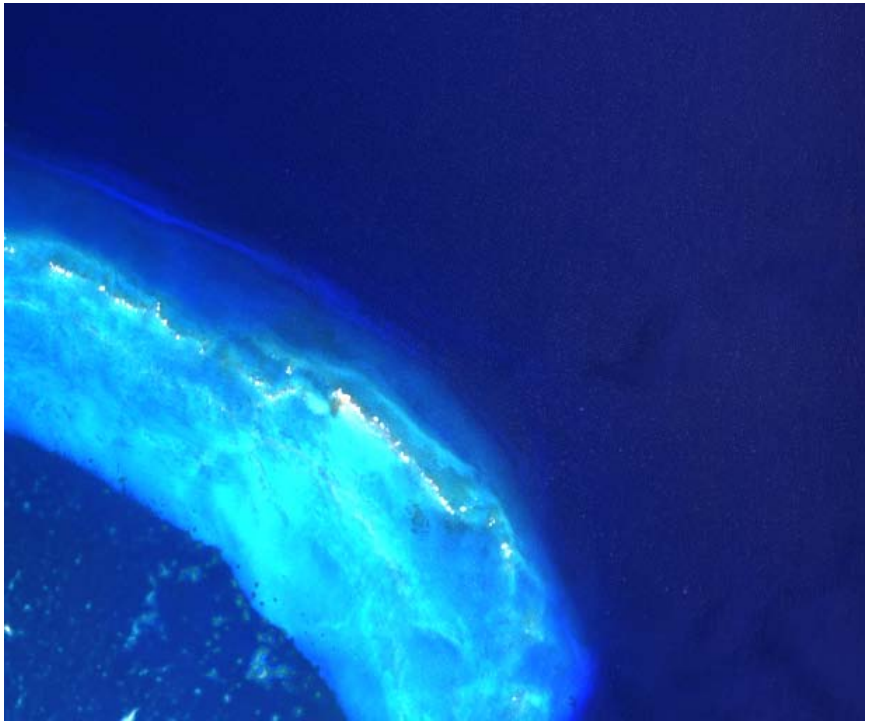


After correction with smoothed aerosol reflectance

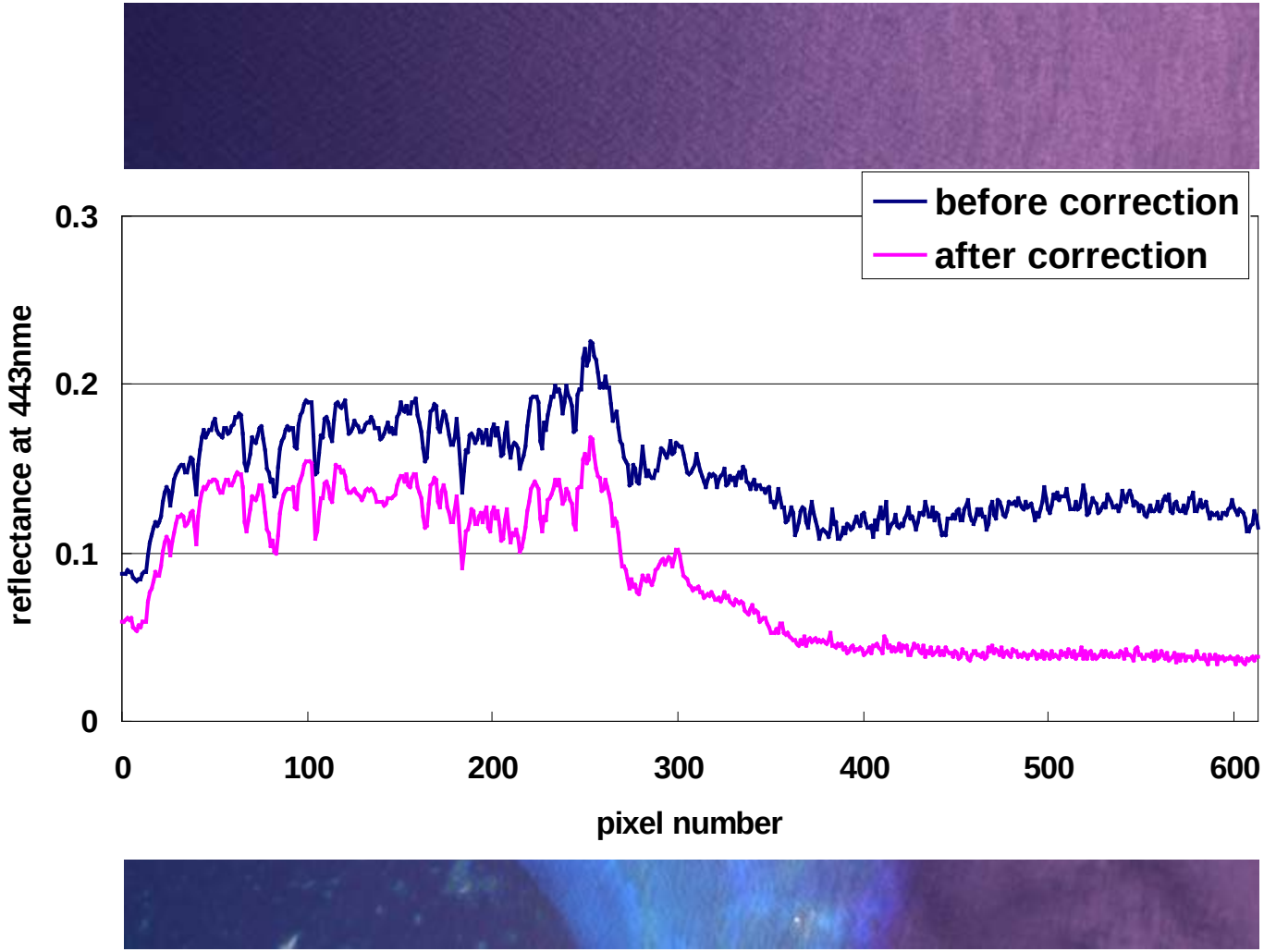
Before correction



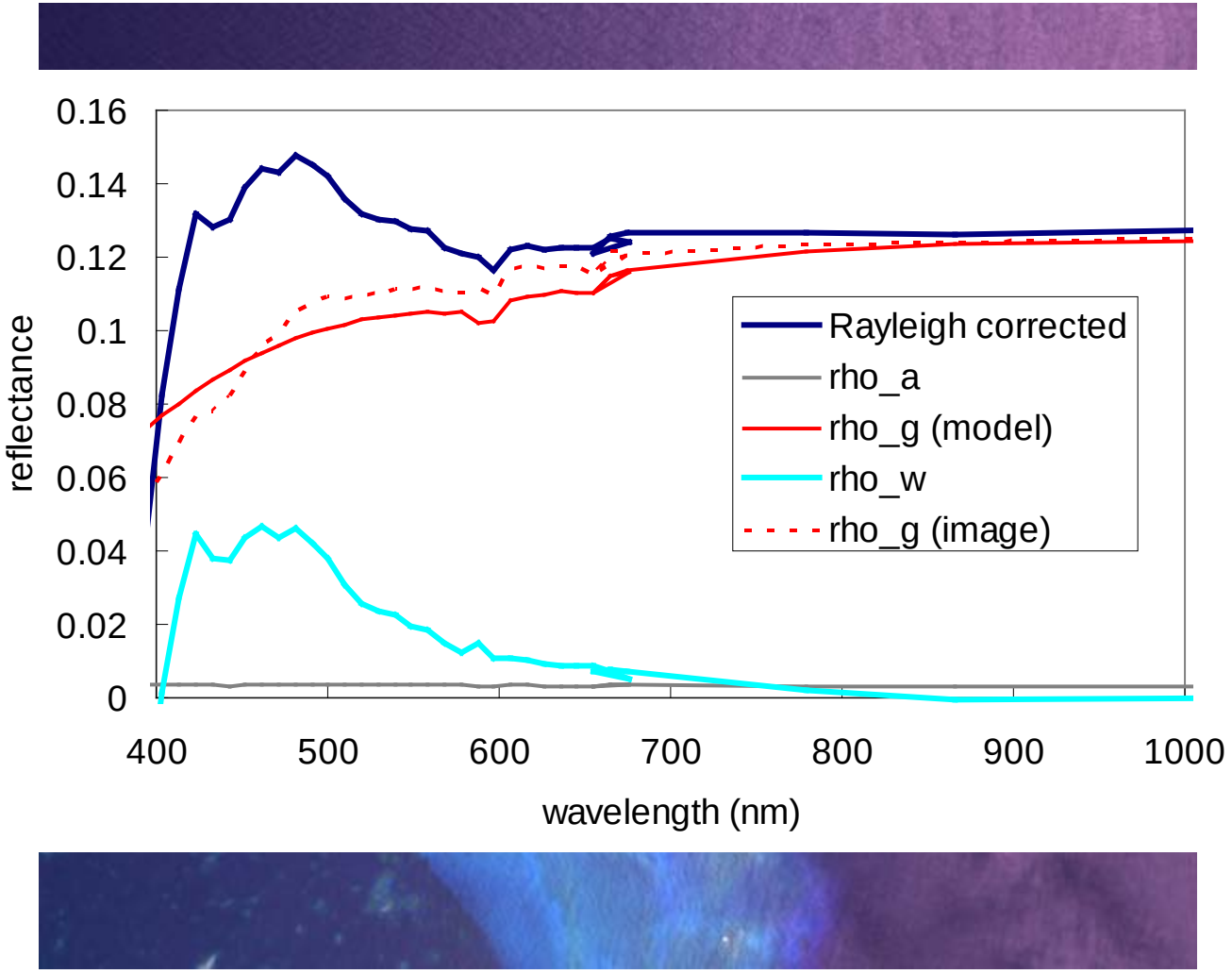
After correction



Transect



Spectra at a glint affected pixel



Discussion

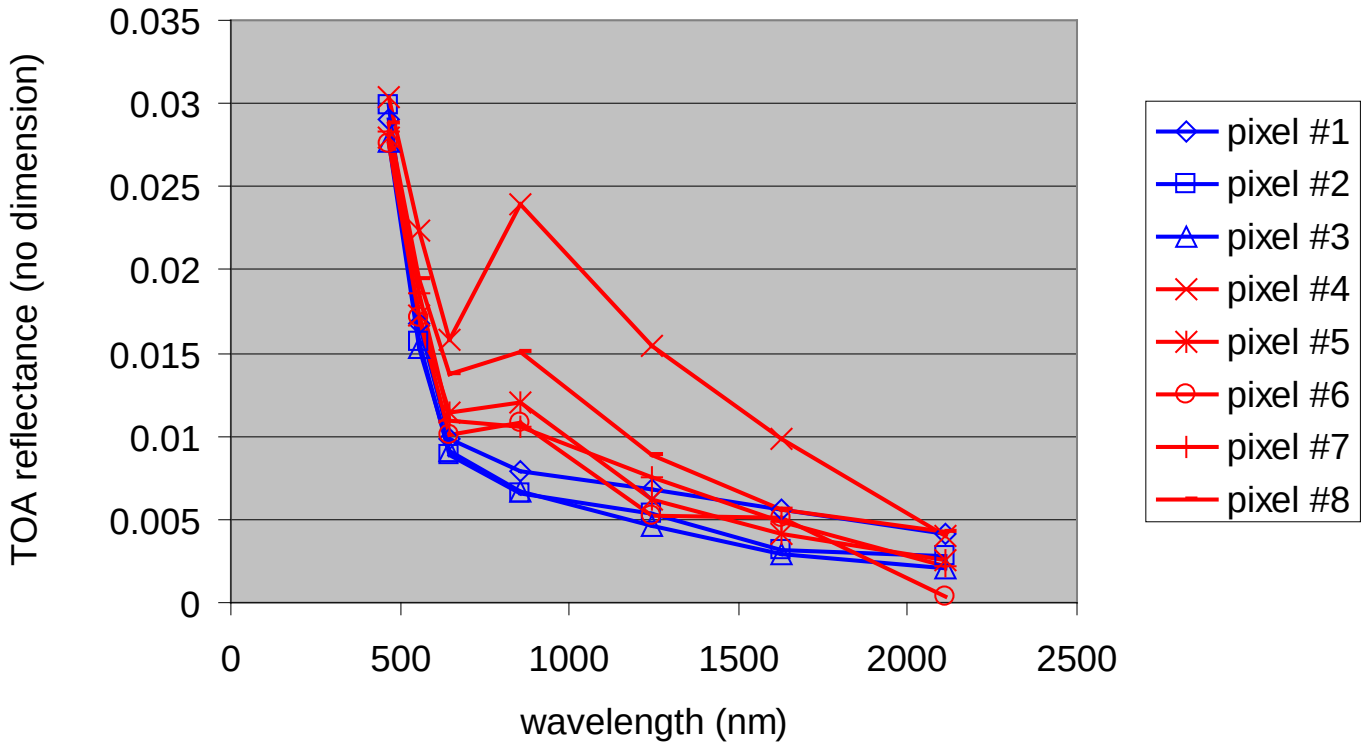
- Aerosol optical properties = type and optical thickness
  - Suggested to apply a low pass spatial filter to the retrieved aerosol optical thickness
  - Can aerosol model (spectral slope) be derived? Difficult where sun glint is significant.
- For operational use, vicarious calibration of satellite data against model would be required for glint correction.

Glint correction for algal bloom detection

- Intense blooms of the brown algae, *Hincksia sordida* in Southeast Queensland recently have substantially reduced the recreational value. Wide spread algal blooms confirmed by aerial overflights and in situ observations were not visible in true colour image from the MODIS Rapidfire website.

Hincksia Sordida
Non-toxic filamentous brown algae
(E. Abal et al., 2006)

Top Of Atmosphere MODIS reflectance spectra for bloom and non-bloom (=ocean water) pixels



- Spectra from Terra image of Oct 3 2006
  - Blue curves for non-bloom pixels and red curves for bloom pixels.
  - Reflectance at 869nm should indicate the bloom intensity if the atmosphere and sea surface conditions are same

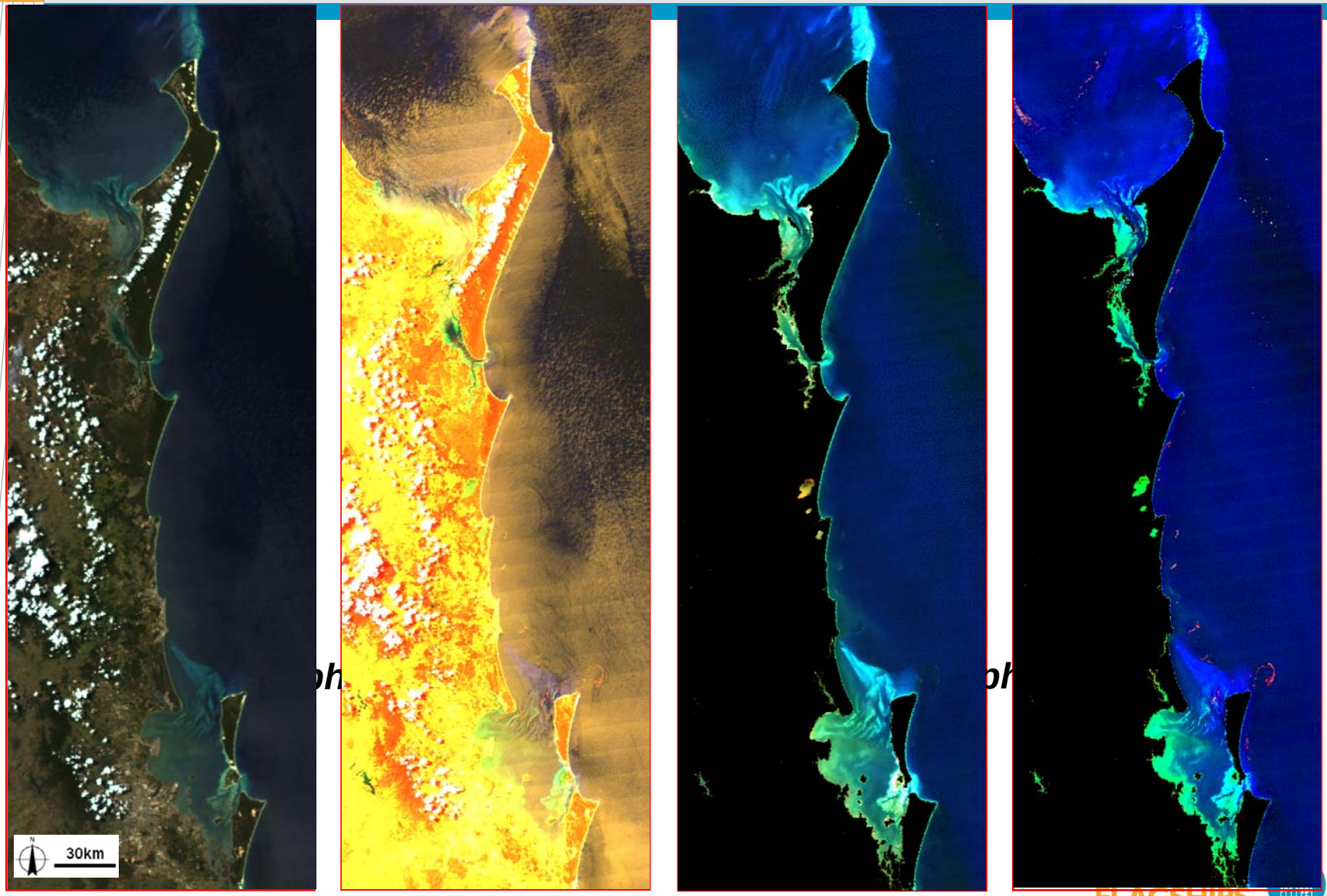
Satellite & Local Time

TOA RGB normal	TOA RGB FA	Rw RGB normal	Rw RGB FA
TOA RGB R - 645nm G - 555nm B - 469nm (≈ NASA rapid response imagery)	Floating Algae (FA) enhanced TOA RGB R - 859nm G - 645nm B - 469nm	water reflectance (Rw) RGB R - 645nm G - 555nm B - 469nm *(TENTATIVE)*	Floating Algae (FA) enhanced Rw RGB R - 859nm G - 645nm B - 469nm *(TENTATIVE)*
Before atmospheric correction		***After glint atmospheric correction***	

National Research FLAGSHIPS Wealth from Oceans CSIRO

Aqua 2006 Oct 2 (275) 13:30

TOA RGB normal	TOA RGB FA	Rw RGB normal	Rw RGB FA



Summary

- HyspIRI sun glint should be substantially reduced by shifting the equator crossing time from 11.30 to 10.30 AM.
- Glint-aerosol discrimination algorithm has been verified with simulation data and the results from application to AVIRIS and MODIS images look promising.
- It will be important to make sure consistency between satellite data and radiative transfer model that will be used for atmospheric-glint correction. Need vicarious calibration or similar.

Thank you

Environmental Earth Observation Group
CSIRO Land and Water
YoungJe Park
Email: young.park@csiro.au

CSIRO