

High resolution (<100m) remote sensing Breakout Session 6 Report

Speakers: Kevin Ruddick, Stewart Bernard, Chuanmin Hu, Antoine Mangin, Nima Pahlevan, Quinten Vanhellemont

NEW!

Landsat-8 (30m, 15m) free of charge and easily available from USGS

Sentinel-2 (10m) free of charge and coming soon from ESA

Pléiades (2m, 70cm) at ~5-13€/km², programmable

Worldview-4 (1.8m, 50cm)



What new **processes, users, applications?**

What New **algorithms, processing challenges?**

NEWS

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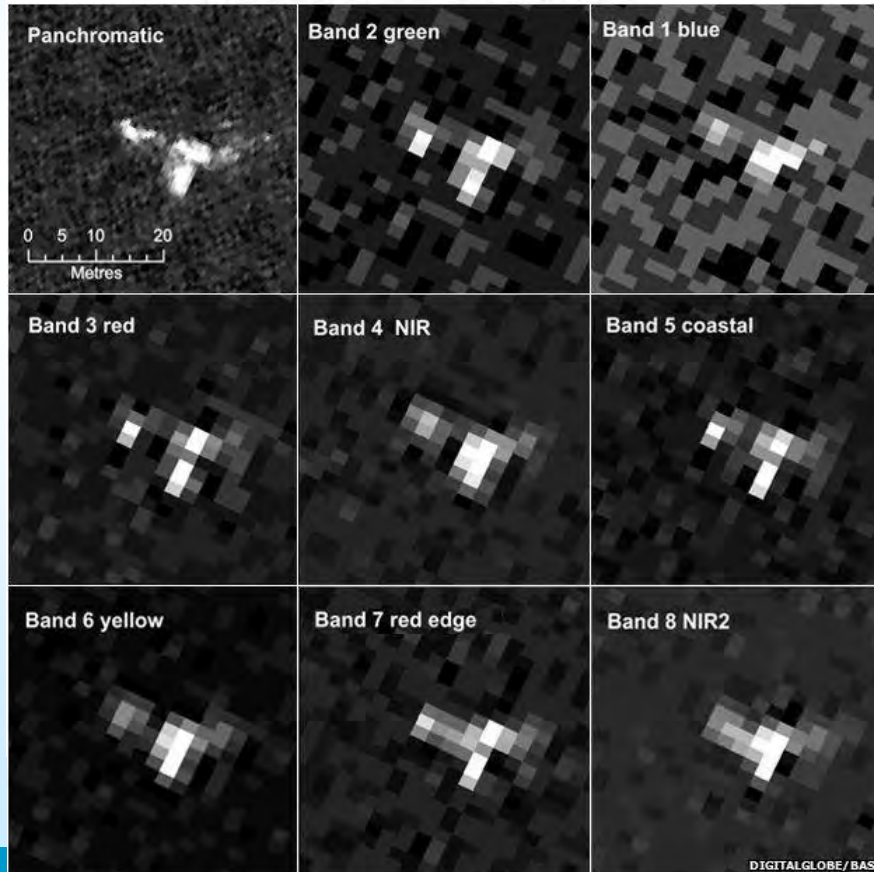
Entertain

Science & Environment

New processes, e.g. marine animal detection

Scientists count whales from space

By Jonathan Amos



Southern right whale



- A baleen whale growing up to 18m in length

Worldview-2, 50cm

[Fretwell et al, Whales from Space: Counting Southern Right Whales by Satellite, Plosone, 2014]

New users and applications: e.g. Port of Zeebrugge



[Dredgingtoday.com]

Black (anoxic?)
sediments

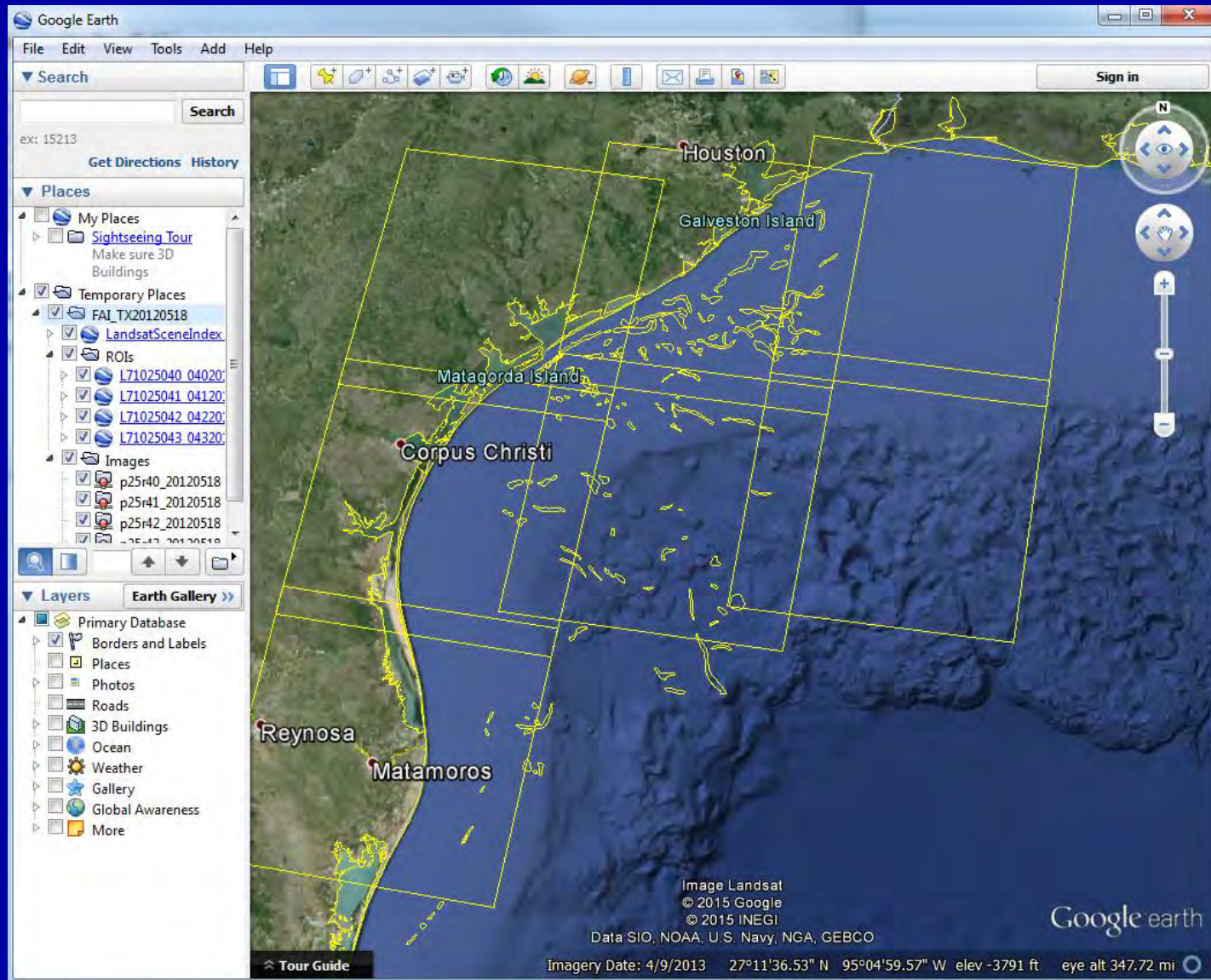
Ships and wakes

Bird sanctuary

In/Out Water and Sediment
flux (and jellyfish ... ?)

+Around port:
Beach change and tourism
Dumped WWI munitions

<http://optics.marine.usf.edu>, Sargassum monitoring



Courtesy Chuanmin Hu

Spatial Resolution: Trade Offs from an Inland Perspective

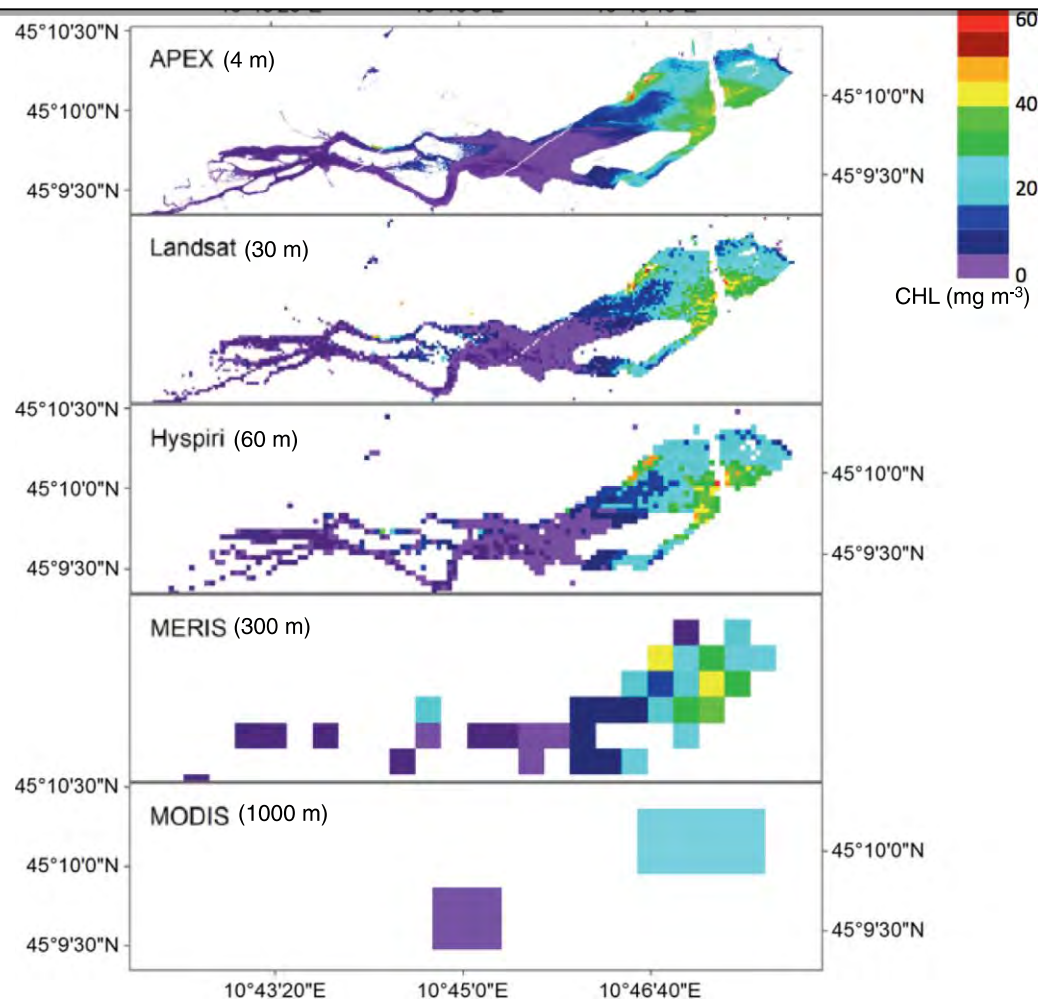
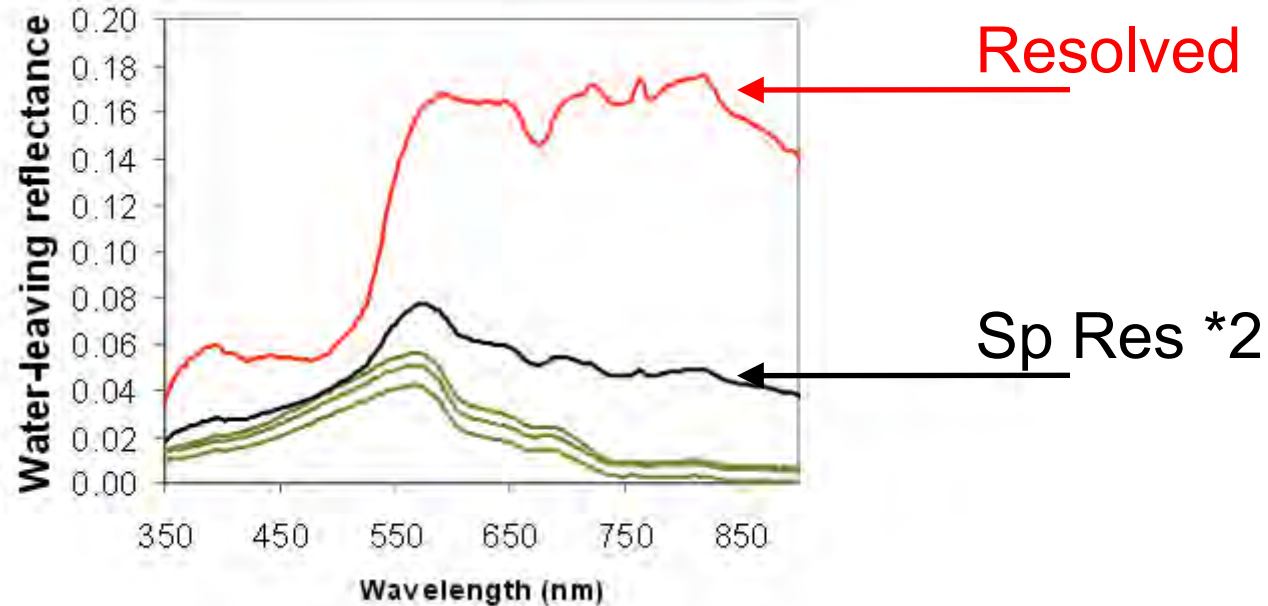


Fig. 9. CHL concentration in Upper Mantua Lake from the APEX airborne imaging spectrometer (top), and re-sampled to different sensor spatial resolutions. Color scale ranges from purple to red for CHL ranging from 0 to 60 mg m^{-3} . (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Processes and features – seen better at high res

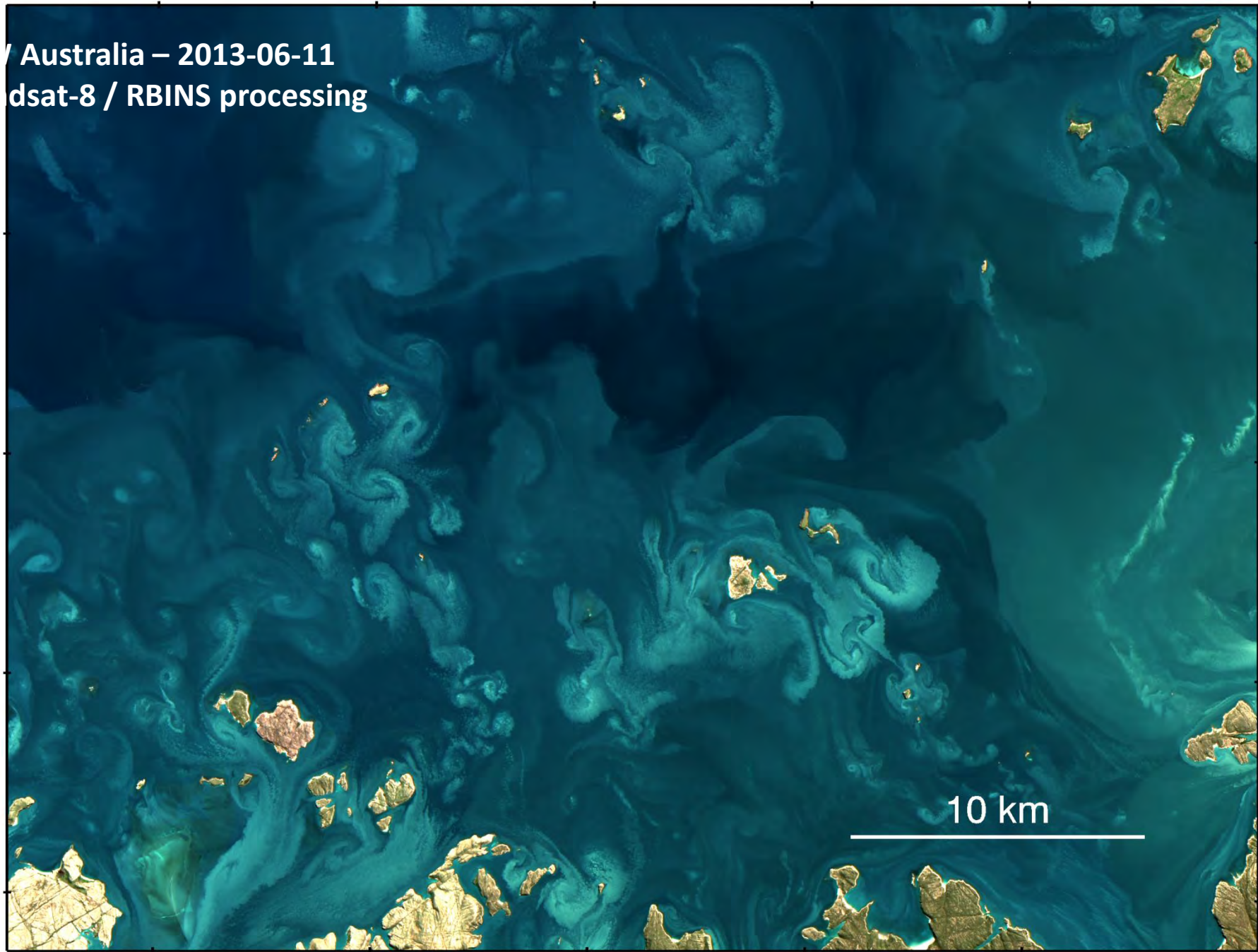
Spatial Resolution => Spectral Contrast



[Van Mol B., Ruddick K., Astoreca R., Park Y. & Nechad B. (2007). Optical detection of a *Noctiluca scintillans* bloom. EARSel eProceedings, 6, 130–137]

Australia – 2013-06-11
Satellite / RBINS processing

15°4'S
15°8'S
15°12'S
15°16'S



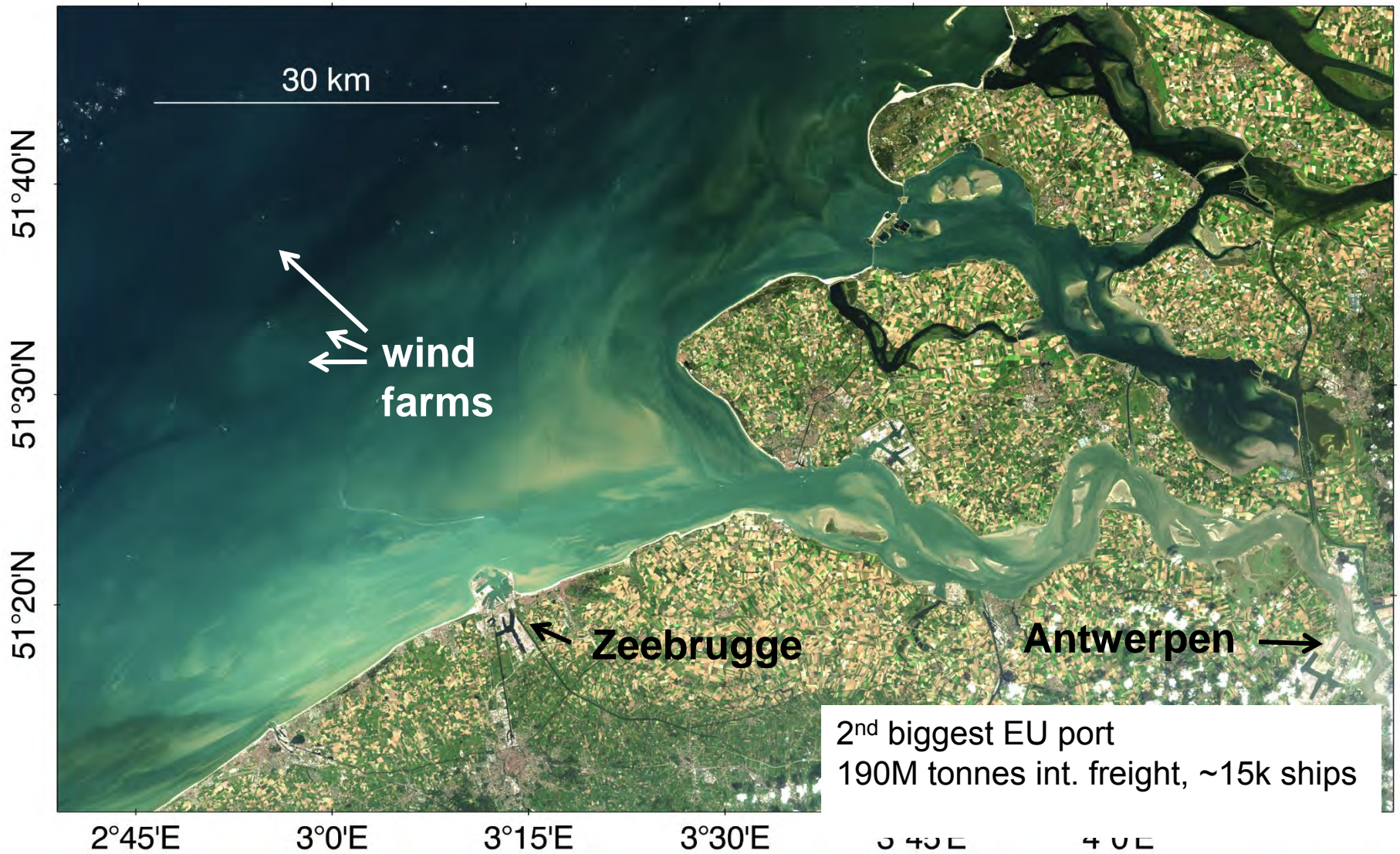
124°28'E 124°32'E 124°36'E 124°40'E 124°44'E

Alaska – 2014-09-06

Landsat-8 / RBINS processing

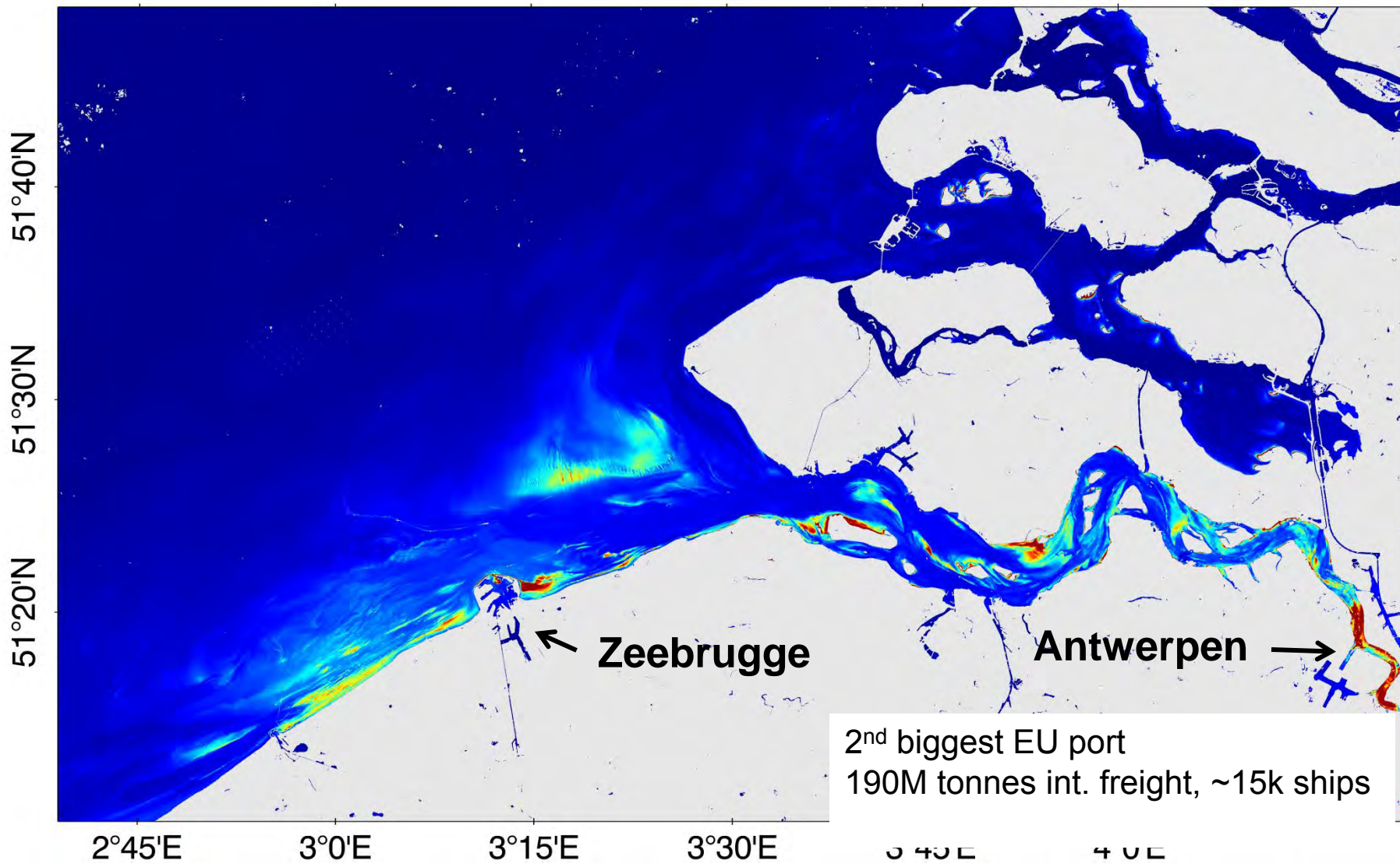
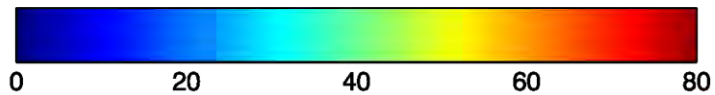


Belgian/Dutch coastal zone and Western Scheldt Estuary



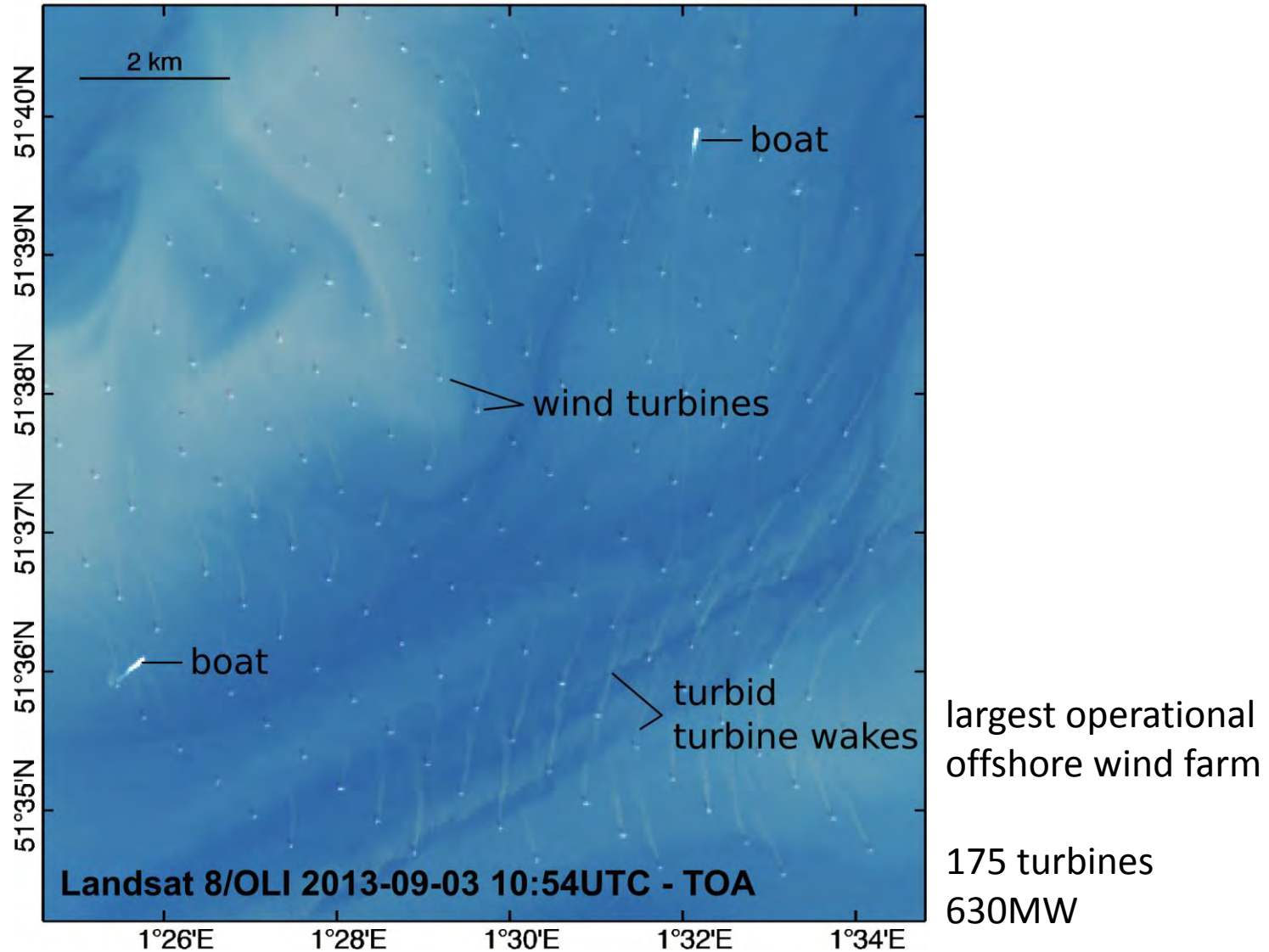
Landsat-8/OLI Rayleigh corrected RGB 2014-09-08

Turbidity (FNU)



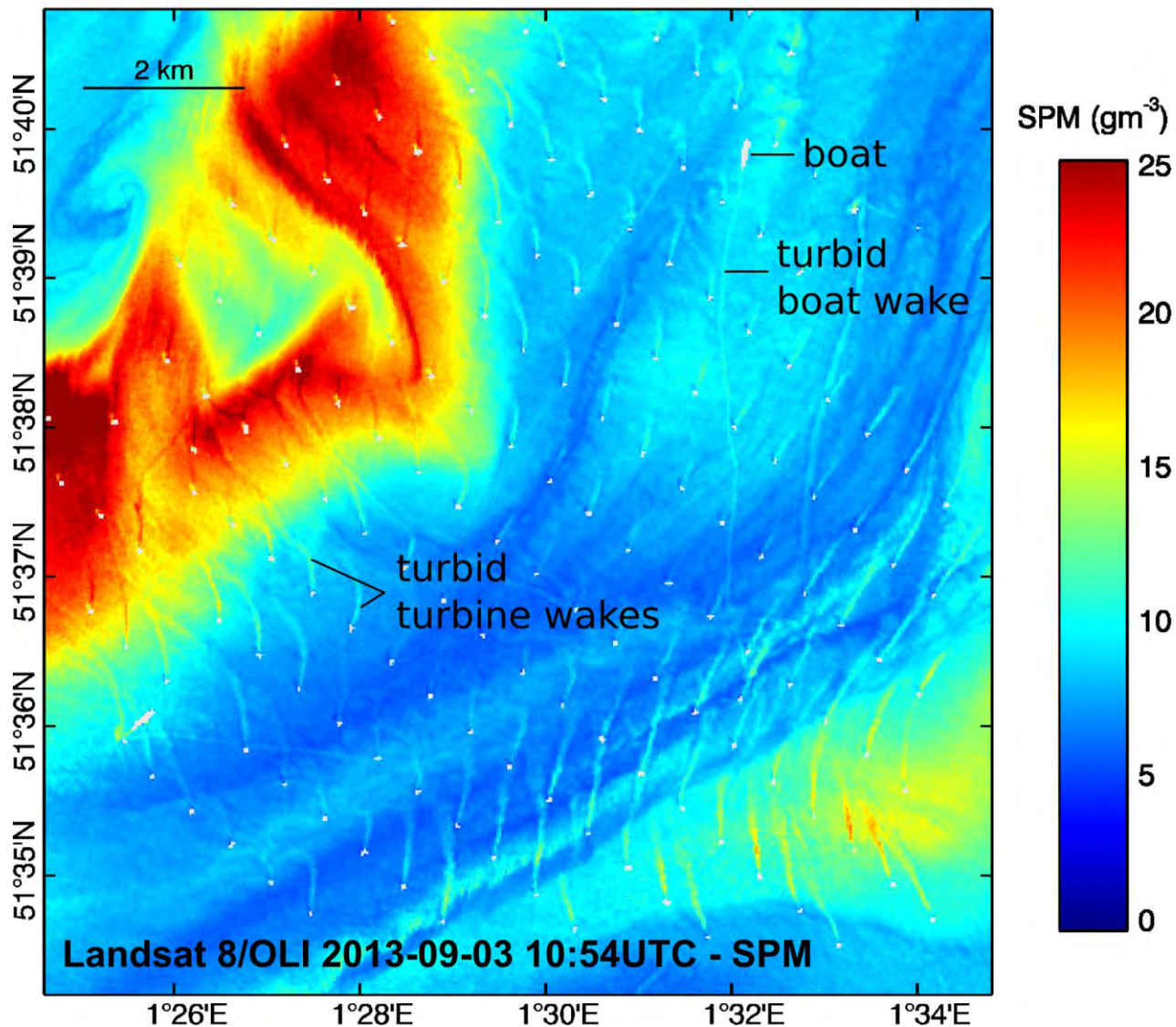
Landsat-8/OLI Turbidity (V2015+D2015) 2014-09-08

London Array offshore wind farm



Vanhellemont, Q., Ruddick, K., 2014a. **Turbid wakes associated with offshore wind turbines observed with Landsat 8**. *Remote Sens. Environ.* 145, 105–115.

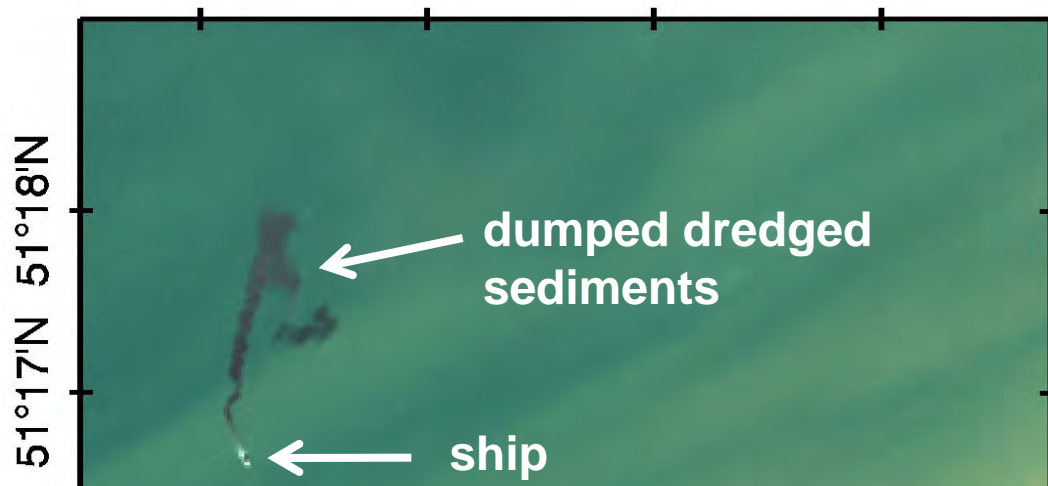
OLI-derived suspended particulate matter (SPM)



Vanhellemont, Q., Ruddick, K., 2014a. **Turbid wakes associated with offshore wind turbines observed with Landsat 8.** *Remote Sens. Environ.* 145, 105–115.

Landsat-8/OLI 2013-10-30

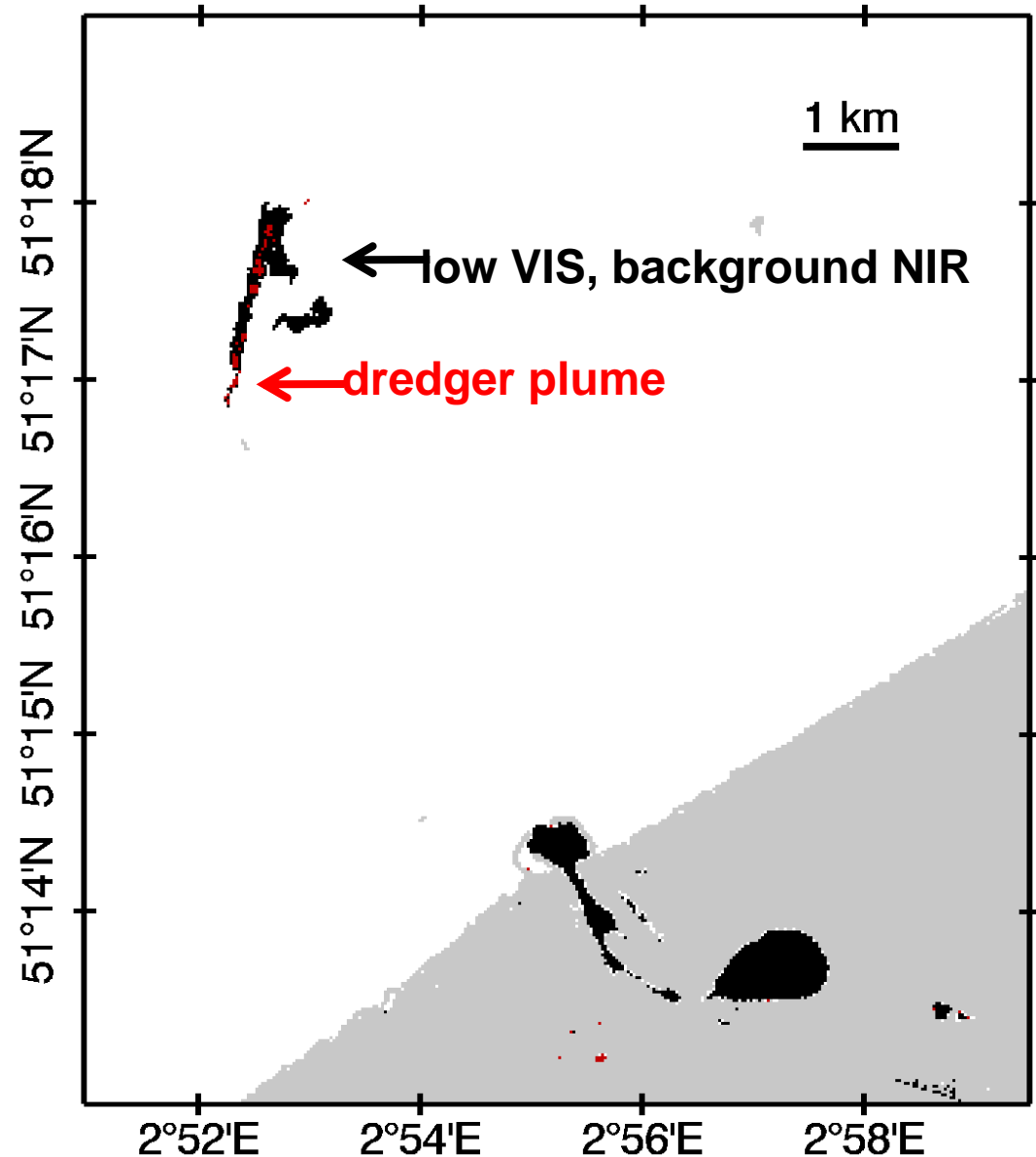
Rayleigh corrected RGB



Vanhellemont, Q., Ruddick, K., 2014b. **Landsat-8 as a Precursor to Sentinel-2: Observations of Human Impacts in Coastal Waters.**, in: ESA Special Publication SP-726.

Landsat-8/OLI 2013-10-30

NEW black sediments
flag algorithm



Vanhellemont, Q., Ruddick, K., (2015a). Advantages of high quality SWIR bands for ocean colour processing: examples from Landsat-8. <http://dx.doi.org/10.1016/j.rse.2015.02.007>

Pléiades very high resolution (2.8 m MS, 0.7 PAN)



www.deme-group.com



Zeebrugge – dredger (PANs)
Pléiades 2014-09-08 – RBINS processing

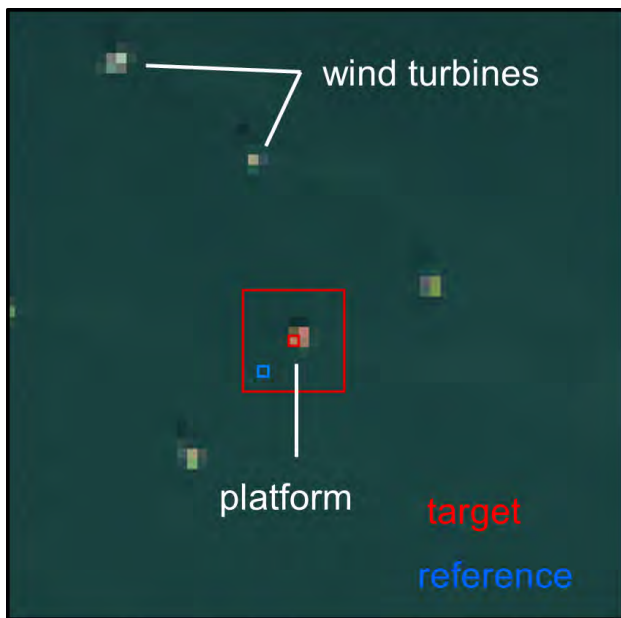
C-Power Offshore Transformer Station (PANs)
Pléiades 2015-04-14 / RBINS processing

Sub-pixel scale variability
and platform effects



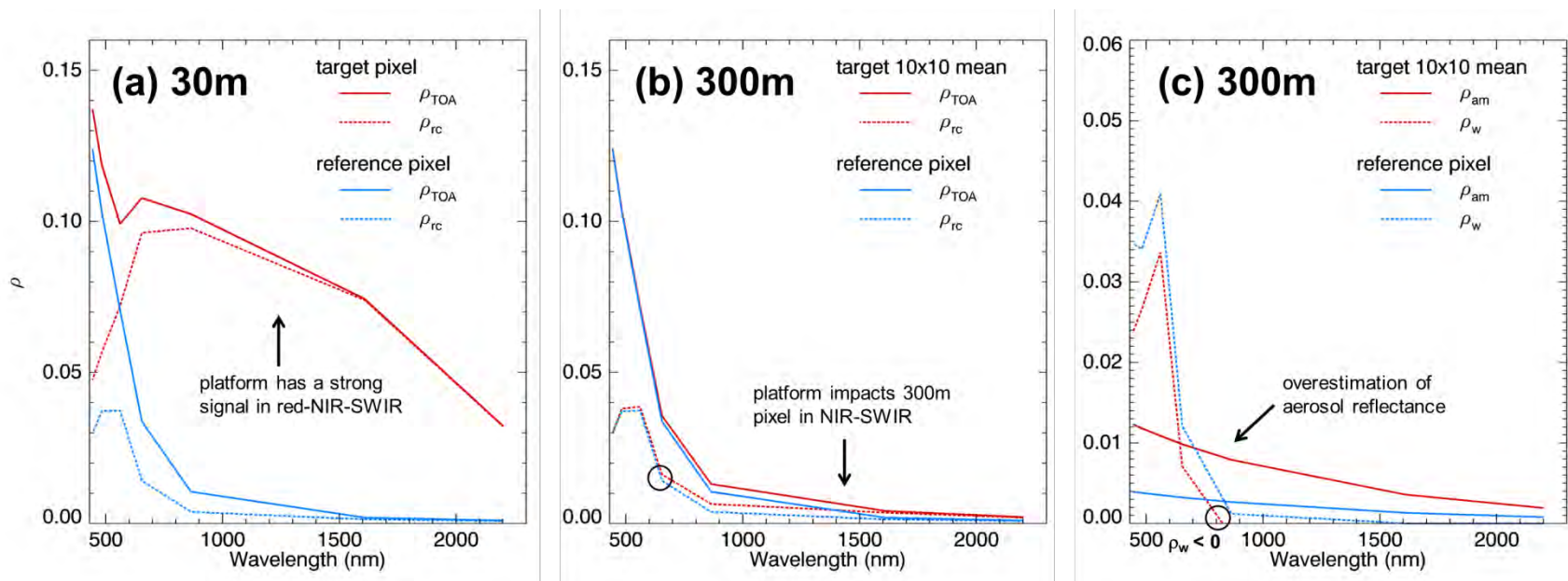
Aeronet-OC





Platform impact on moderate resolution (MODIS/MERIS/OLCI) pixel

Landsat-8/OLI data



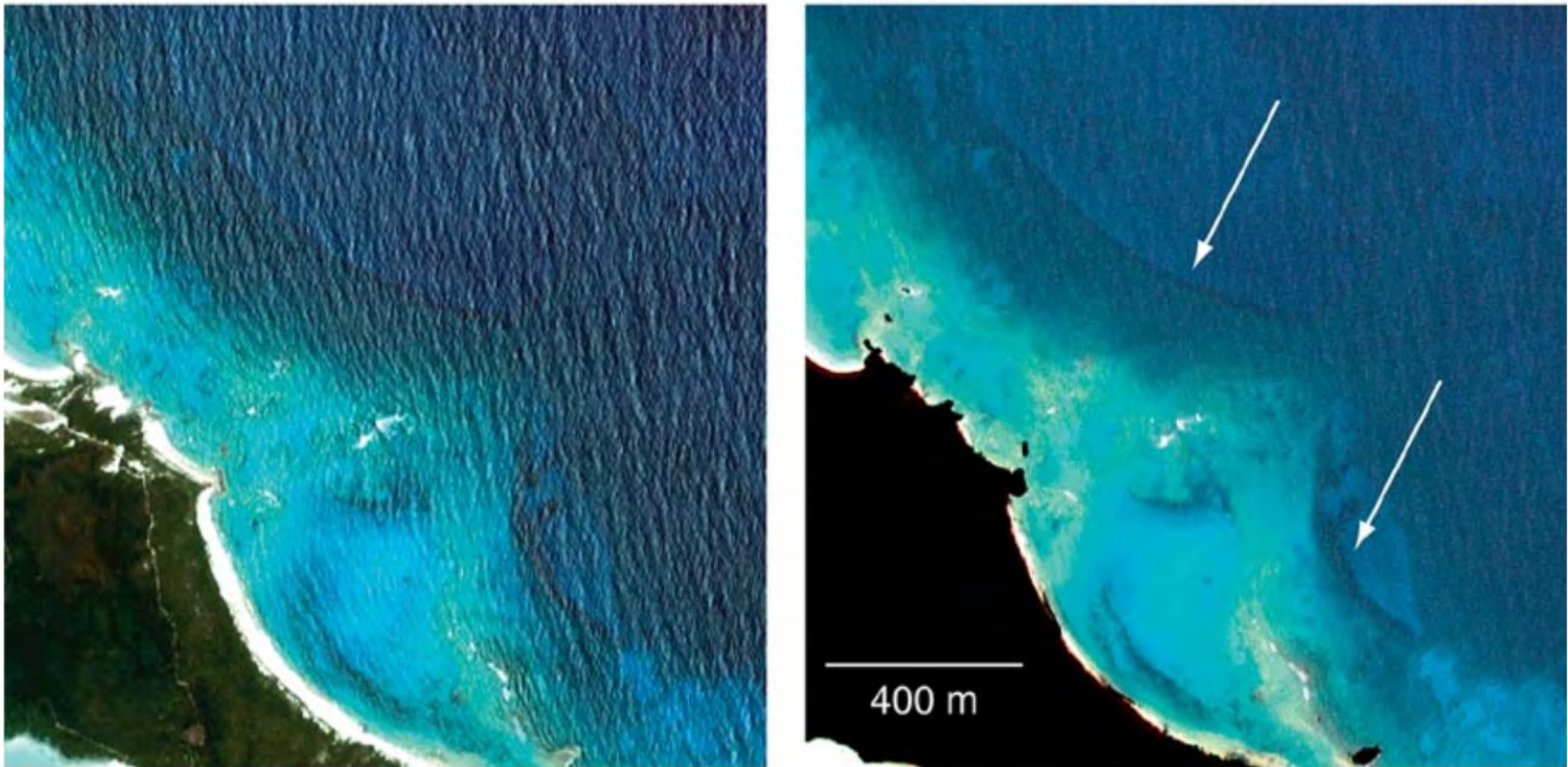
Spatially resolved sun and sky glint, wave facets



Courtesy Antoine Mangin

Glint features due to surface waves

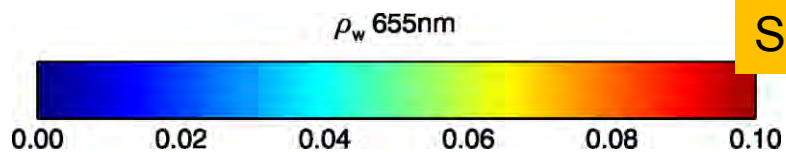
From Hochberg et al. (2003, IEEE TGRS)



IKONOS image showing sky glint patterns due to surface waves

Pan-sharpening for marine applications

(Not just High Res, also
MODIS-250, VIIRS-I,
SEVIRI-HRV)



(a) 30 m

1 km



ship



(b) 15 m sharpened

surface gravity waves



sharper features



New users, features, applications

Human impacts are more evident at higher resolution:

Sediment transport – ports, offshore constructions, dredging/dumping

... **Environmental Impact Studies**

Inland waters, estuaries, ports are often small

Better spectral contrast for **patchy distributions** (Algae, Sargassum , corals...)

Support for medium res OC (**sub pixel variability**, platform effects)

Measurement of **sun glint and sky glint** ... improved med res algos?

Challenges for HR data processing

- using chiefly land missions for water applications
 - low **spectral resolution**, broad bands (need to adapt our OC algos?)
 - low **SNR** – (need spatial binning eg for SWIR?)
 - use of **panchromatic /broad bands** for marine applications?
- **low temporal revisit**
 - many features at small spatial scale have small temporal scales
 - calibration and validation challenges

Need improved Algorithms for

Sun glint correction

sky glint correction

cloud shadowing

adjacency (bright target may be outside image!)

Can we influence future (land) missions?
Extra bands? (L9, L10, S2E/F ...?)

Need good georeferencing (automated!)

Per pixel processing ... **full image processing**

cloud shadow masking

adjacency land/cloud

estimate aerosol parameters from larger region (macropixel/tile?) than pixel