Remote sensing: aerial and satellite image interpretations and Image processing challenges

Imaging whales from space

Dr Peter Fretwell, British Antarctic Survey

Talk structure

- Big data problems
- Wildlife from space – challenges and opportunities
- Whales from space – the biggest opportunity but the most challenging

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Small UAVs

Large long range UAVs

Very High (VHR) resolution satellites

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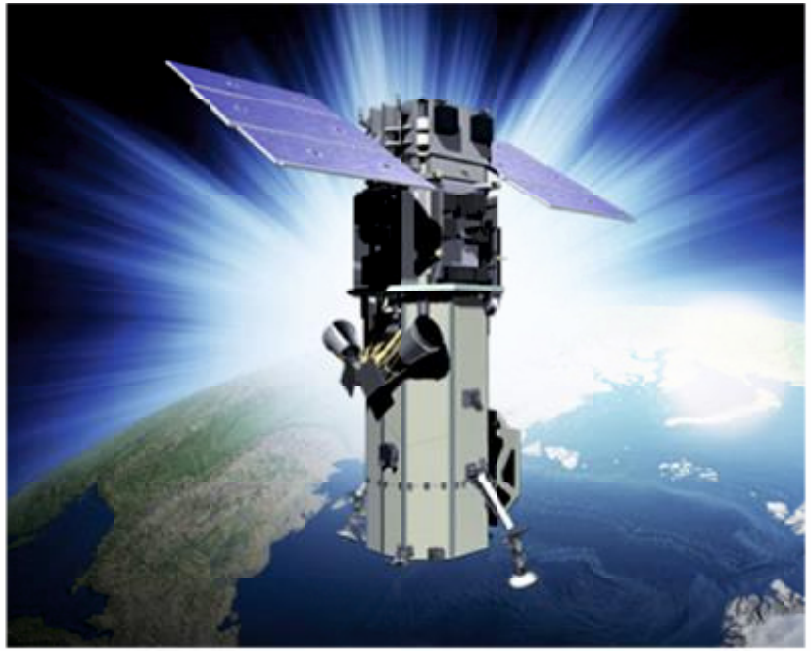
Worldview 3 satellite

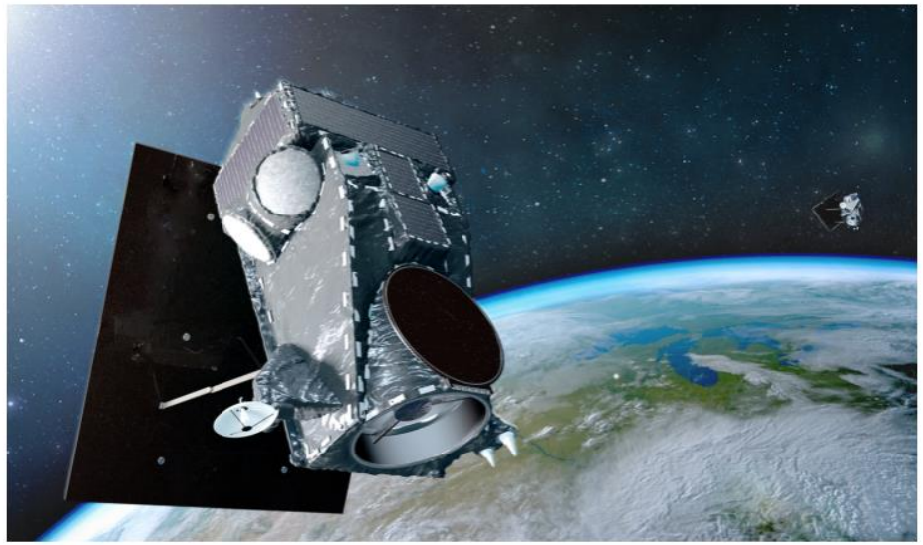
- Operational 2015
- Spatial resolution 30cm ground sample distance (panchromatic)
- 8 Multispectral bands at 1.2 m resolution
- Each image is 100km x 17 km (~20 billion panchromatic pixels)
- Each image is around 50-60 Gb
- Possibility of getting up to four images a day of anywhere on earth



By 2021 – 30cm anywhere on earth every 20 minutes

Next gen satellites will count people 40 times a day at desired spots anywhere on earth

brian wang | August 28, 2017 | 6 comments



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DigitalGlobe will launch the WorldView Legion constellation of satellites from 2020 to 2021. called Scout—can snap a photo of a high-demand spot (say the Port of Shanghai) 40 times a day. Scott declined to specify how many satellites count as legion, but they will be 30-centimeter- and 50-centimeter-class, meaning they could resolve a laptop or a TV. The first will rocket up in 2020, the last in 2021. The satellites will belong to Space Systems Loral (SSL) of California, which builds its satellites in Palo Alto. DigitalGlobe is in the final stages of a merger with a communications company called MDA, which also bought SSL back in 2012. With DigitalGlobe and MDA under a single umbrella, they control 54 percent of the market. And with SSL, they can in-house legions of satellites, big and small, for themselves and others.

Wildlife from space

- Started with Penguins

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Science & Environment

Emperor penguins counted from space

Jonathan Amos
Science correspondent

13 April 2012 | Science & Environment | Share

NOT SPECIFIED

Emperor penguins on the sea ice close to the UK's Halley Research Station

Counted every colony in a single season
Used a supervised classification method

But now we've gone global

Adelie penguins
Magellanic penguins
Chinstrap penguins
Polar Bears
Musk ox
Weddell Seals
Elephant seals
Crabeater seals
Juniper trees
Stromatolites
Petrels
Right whales
Humpback whales
Pelicans
Flamingos
Wandering Albatross
Royal Albatross
Dolphins
Cows









Many advantages

- Cheaper
- Less bureaucracy
- Less disturbance
- Can survey remote and difficult to access areas
- At any time (depending upon cloud cover)
- Can survey over much larger areas than ships or planes

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Individual counts

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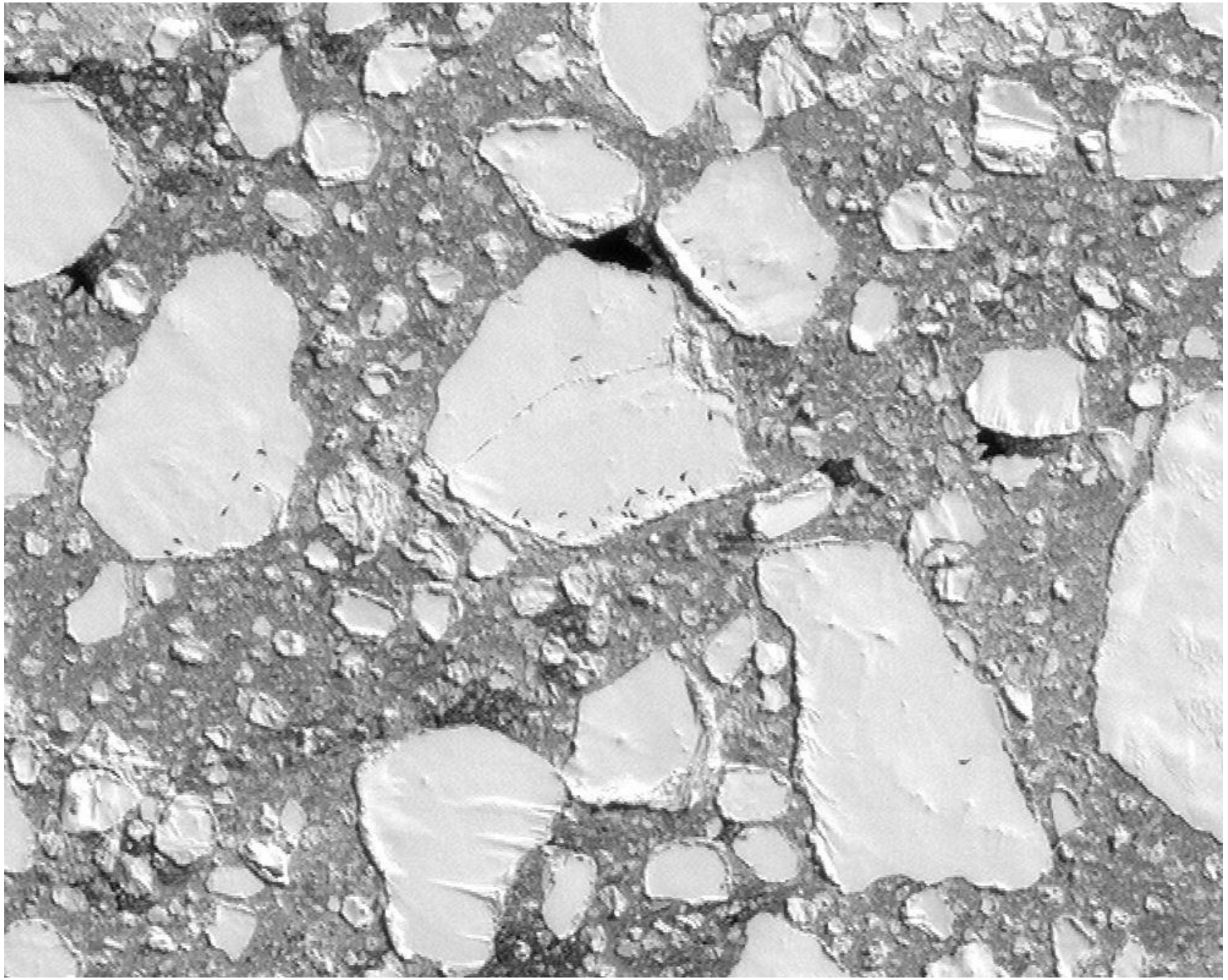
Ice seals:

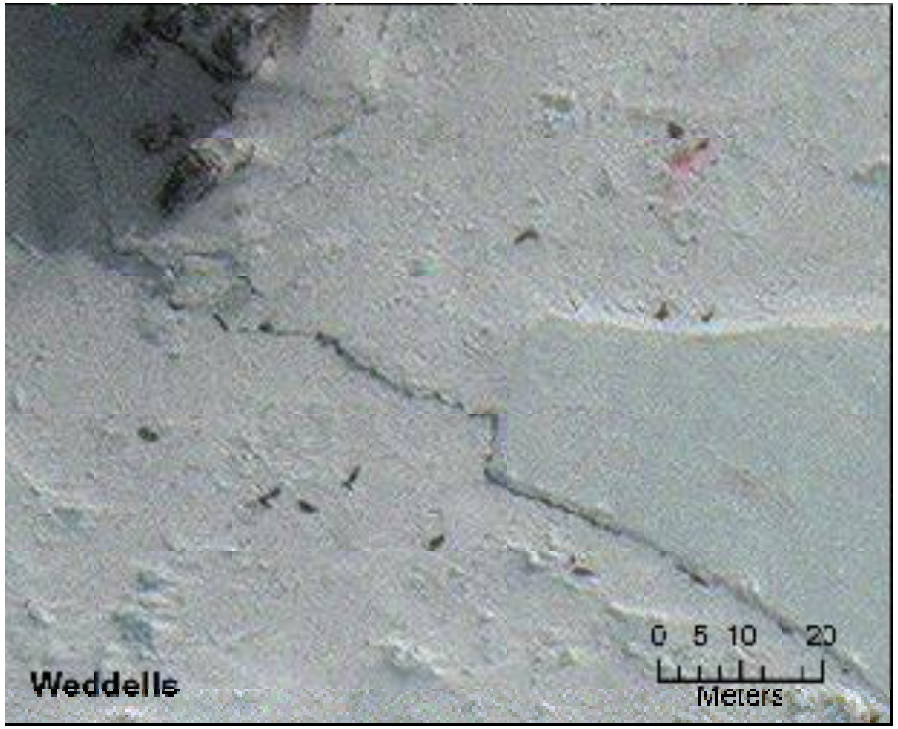
organic and irregular shape

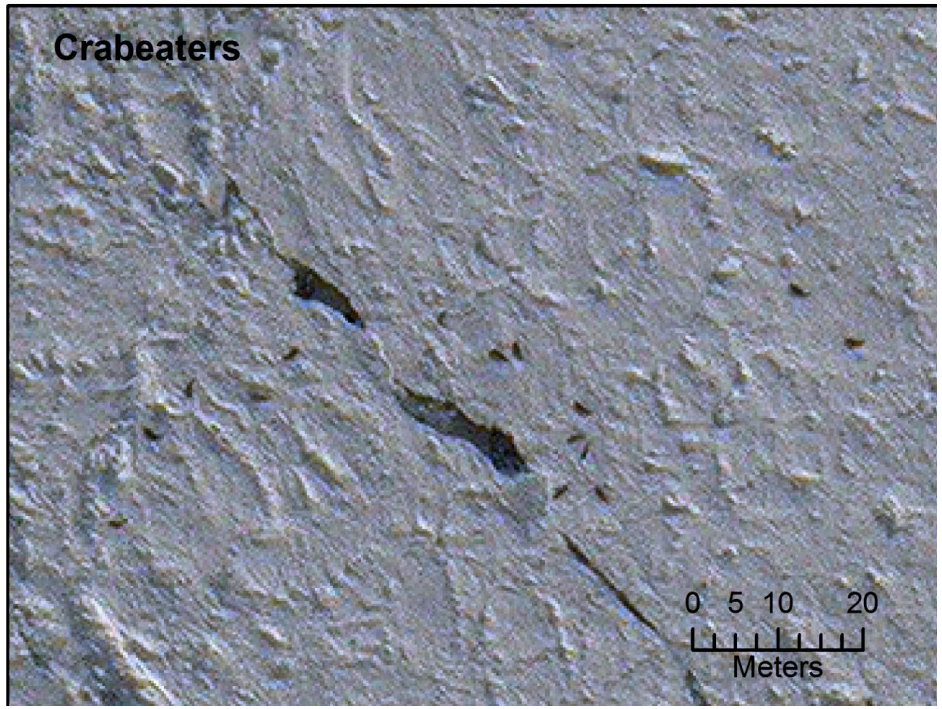
Can be confounded by shadows and cracks in the ice



30cm ice seals

- Should be possible to automated better and even differentiate between seal species, even count the pups.





Previous work on automation

Automating Marine Mammal Detection in Aerial Images Captured During Wildlife Surveys: a Deep Learning Approach

Frederic Maire[1], Luis Mejias Alvarez[1], and Amanda Hodgson[2]

[1] Science and Engineering Faculty,
Queensland University of Technology,
Brisbane, Australia
f.maire,luis.mejias@qut.edu.au
[2] Murdoch University Cetacean Research Unit,
Murdoch University,
Perth, Australia
a.hodgson@murdoch.edu.au

Abstract. Aerial surveys conducted using manned or unmanned air craft with customized camera payloads can generate a large number c images. Manual review of these images to extract data is prohibitive i terms of time and financial resources, thus providing strong incentive t automate this process using computer vision systems. There are potentis applications for these automated systems in areas such as surveillanc and monitoring, precision agriculture, law enforcement, asset inspection and wildlife assessment. In this paper, we present an efficient machin learning system for automating the detection of marine species in aeria imagery. The effectiveness of our approach can be credited to the com bination of a well-suited region proposal method and the use of Dee Convolutional Neural Networks (DCNNs). In comparison to previou algorithms designed for the same purpose, we have been able to dramat ically improve recall to more than 80% and improve precision to 27% b using DCNNs as the core approach.

ELECTRO-OPTICAL APPROACH FOR AIRBORNE MARINE MAMMAL SURVEYS AND DENSITY ESTIMATIONS

Jon S. Schoonmaker, Yuliya Podobna, and Cynthia D. Boucher
Advanced Coherent Technologies, LLC
San Diego, CA 92108

Donald R. Statter
Naval Air Warfare Center
Patuxent River, MD 20670

Vincent M. Contarino
R Cubed Engineering
Washington, DC 20003

(Received April 29, 2013)

Observing marine mammal distribution and determining population densities is a complex problem that has been ongoing for many decades. Modern approaches use a varying combination of sophisticated acoustic monitoring and highly trained visual observers from both ships and aircraft. New electro-optical and infrared (EO/IR) camera systems with automatic detection algorithms offer the option to do quantitative airborne surveys safely and quickly. This paper discusses an airborne EO/IR modular system used to observe marine mammals, make density measurements and eventually be used to quantify animal behaviors.

Original Articles

Using object-based analysis of image data to count birds: mapping of Lesser Flamingos at Kamfers Dam, Northern Cape, South Africa

Geoff Groom, Ib Krag Petersen, Mark D. Anderson & Anthony D. Fox

Pages 4511-4539 | Received 04 Nov 2009, Accepted 08 Mar 2010, Published online: 22 Aug 2011
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Abstract

Knowing instantaneous locations and numbers of individuals in animal populations is a major requiremen: for wildlife and conservation ecology. Recent advances in very high spatial resolution digital-imaging systems and in object-based image-analysis methods offer great potential for developing remote sensing in new application arenas, including direct mapping and counting of birds, mammals and other larger organisms. We present the successful application of an automated object-based image-mapping strategy that has been applied to total mapping, using aerial image data, of *Phoenicoparrus minor* (Lesser Flamingo) individuals at Kamfers Dam, a large perennial lake in central South Africa. The object-based method used quadtree image segmentation and sequential object-brightness thresholding to identify individual birds with high accuracy (>99% compared to human visual interpretation). Accuracy-assessment results are presented, with discussion of the error factors related to the object-based method and the reference data. An under-estimation by the object-based method of less than 0.5% is indicated. The automated procedure mapped 81 664 Lesser Flamingos at this one site, which is 30% above the most recent estimated size of the entire southern Africa Lesser Flamingo population, indicating a need for further work to reassess this population's size.

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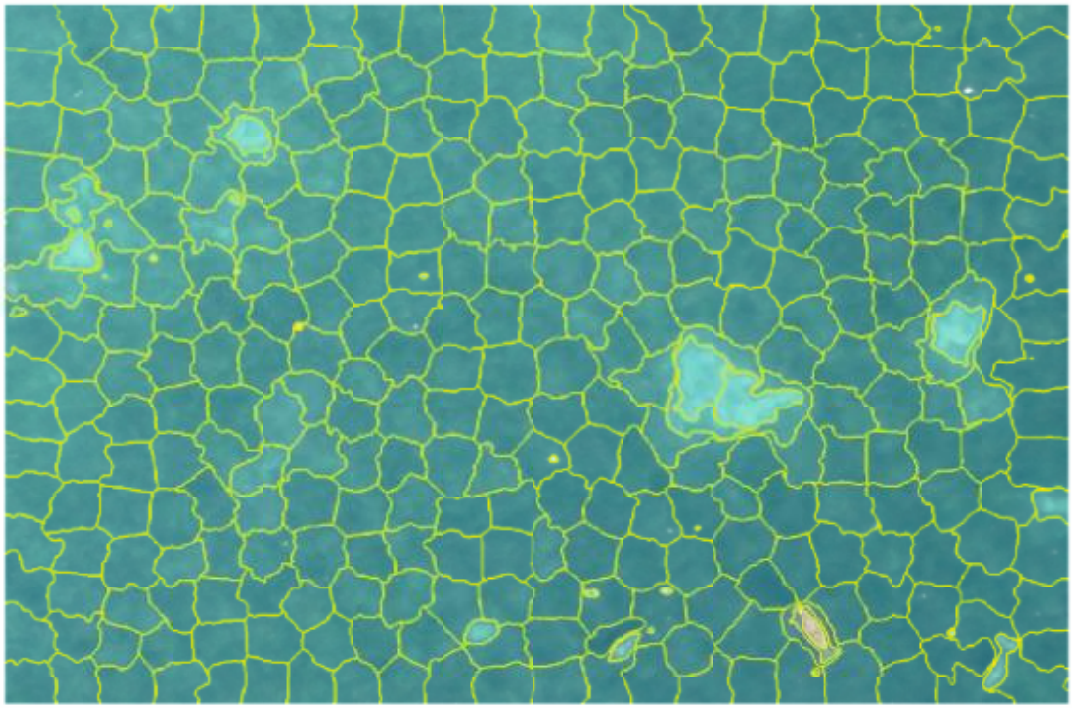
- Various works mostly using aerial or UAV imagery
- Mixture of;
    - Rule based image analysis
    - Objected based image analysis
    - One or two examples of deep learning but not on satellite imagery
- Many of the process run a segmentation algorithm but this is processor intensive over large areas.

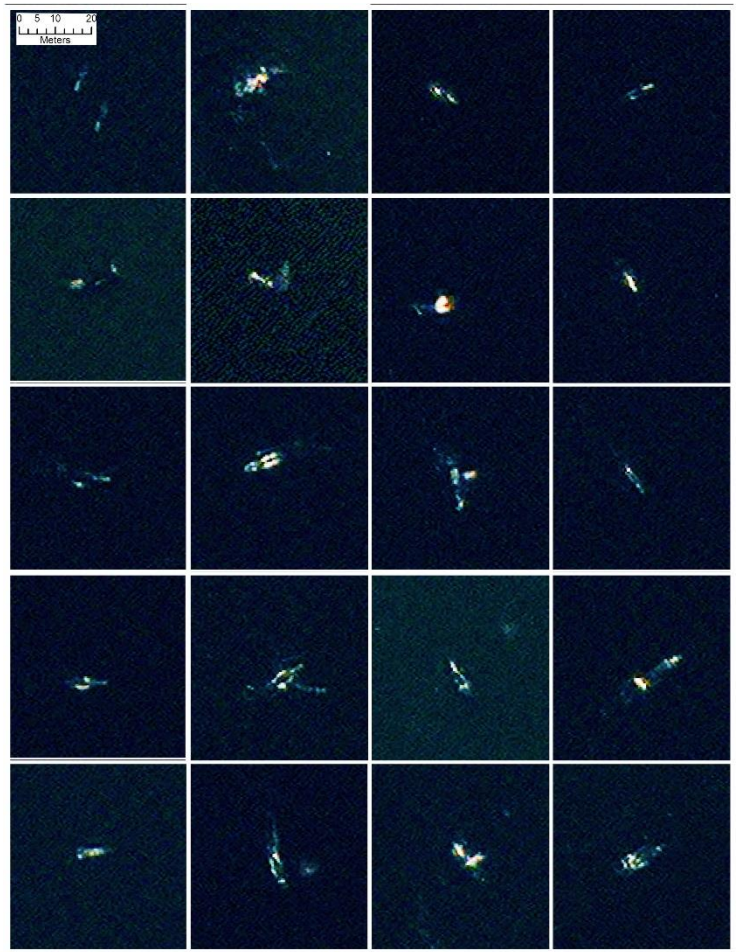


Segmentation process in the Maire et al paper is the first step in the DL automation of Dugong detection.

Case study: whales from space

Biggest opportunity is also the biggest challenge

- Whales are sparsely distributed
- Can only be seen in calm conditions
- Only at the surface a limited amount of time
- At various depths beneath the surface
- Rarely the same shape in the image
- Each species looks different



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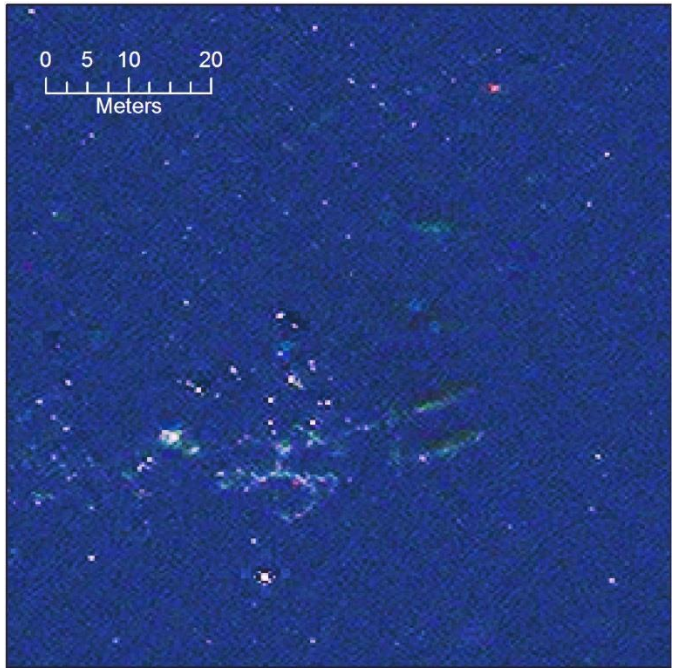
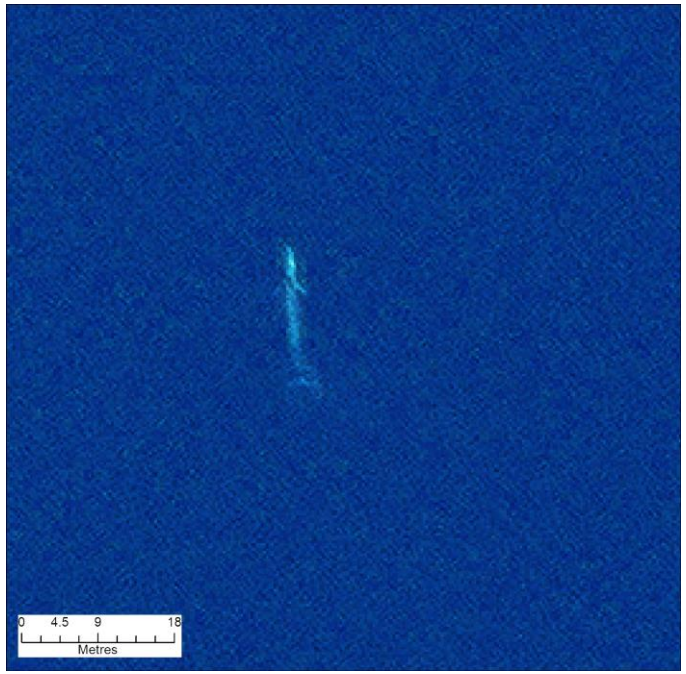
Different species = different colour/size/shape/ behaviour

- Humpbacks; very active, dark colouration



- Fin whales; lighter, larger, more constant shape



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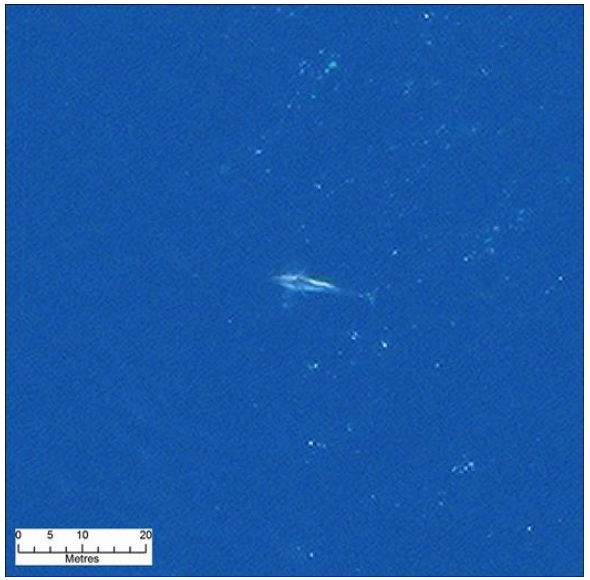
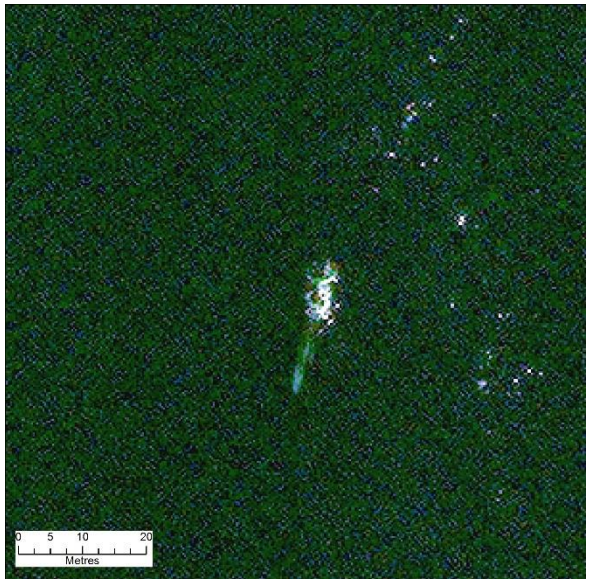
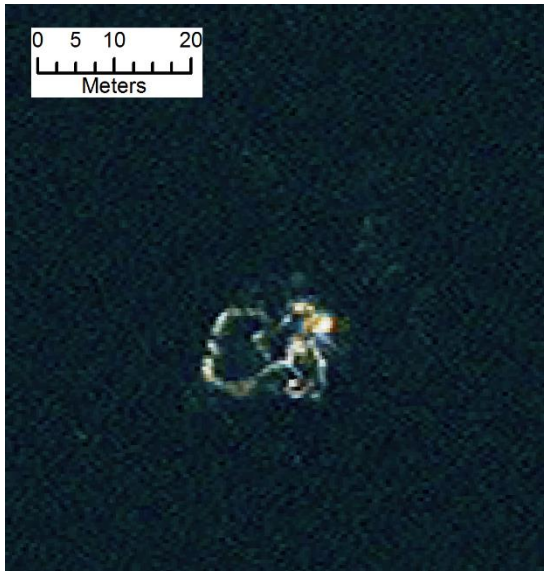
Typical features from above

- Reflective sides (contouring)
- Wake
- Breaching
- Whale sign







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The biggest demand is for the smallest populations

- Rarity increases the need for monitoring
- Fewer observations means less ground truthing and fewer potential signatures to train an algorithm
- For example the critically endangered North Pacific Right Whale is in desperate need of study – no-one even knows where its breeding ground are, but how can you train an algorithm to detect it when numbers are so few (estimated total population 40 animals).

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Stakes are high

- Many whale species are endangered
- Many fisheries are moving towards a more environmentally friendly ecosystems approach and need to know about interactions with top predators such as whales.
- Many governments routinely spend millions on cetacean population assessments
- The government sponsored *International Whaling Commission* (IWC) is tasked with having up-to-date population assessments for all species of whales.

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Building links

- The IWC is supportive of whale monitoring by satellite and has highlighted ten priority areas where the technology could be best used
- The satellite provider Digital Globe has agreed to support this initiative with free VHR imagery
- This could lead to the need to analyse 100's of images – this urgently needs a working, efficient system of automation

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Endless opportunities

- Many other potential question on many different species
- Wildlife from space is only a very small part of the satellite revolution
- Several groups are interested in helping
- As yet no published work on machine/deep learning on wildlife from satellite imagery

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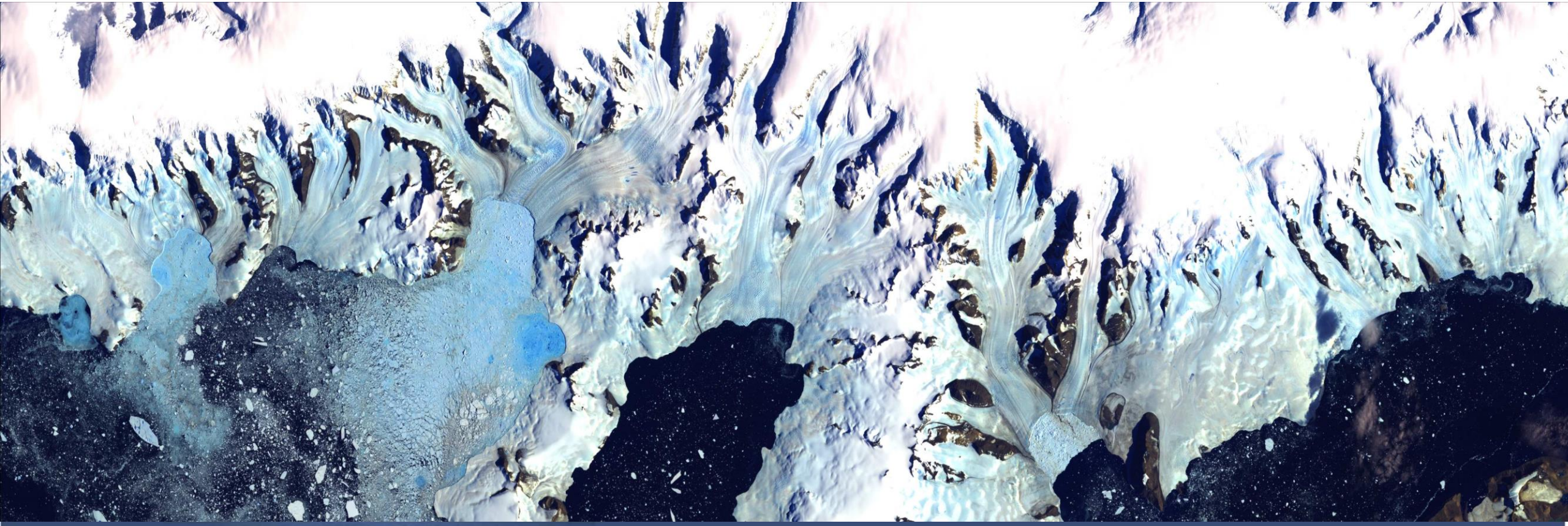
Thank you for listening, Questions?



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