



Cape Town Water Wise



Water Vision

*Can Glacial Water & Icebergs be
a source of Water for the City of
Cape Town?*

*Water Wise – Cape Town
March 23rd 2018*



RESOLVE
MARINE GROUP INC

Berg River dam

*Bringing ideas
to life*



Berg River above the dam, May 2017

- Surface water resources in the Western Cape are almost fully exploited and the growing water demands of Cape Town will have to be met from other sources such as groundwater, reuse, desalination and perhaps icebergs

Thewaterskloof Dam 2010 to January 2018

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to life*



Thewaterskloof Dam in October 2010 was over 90% full



Thewaterskloof dam in January 2018.

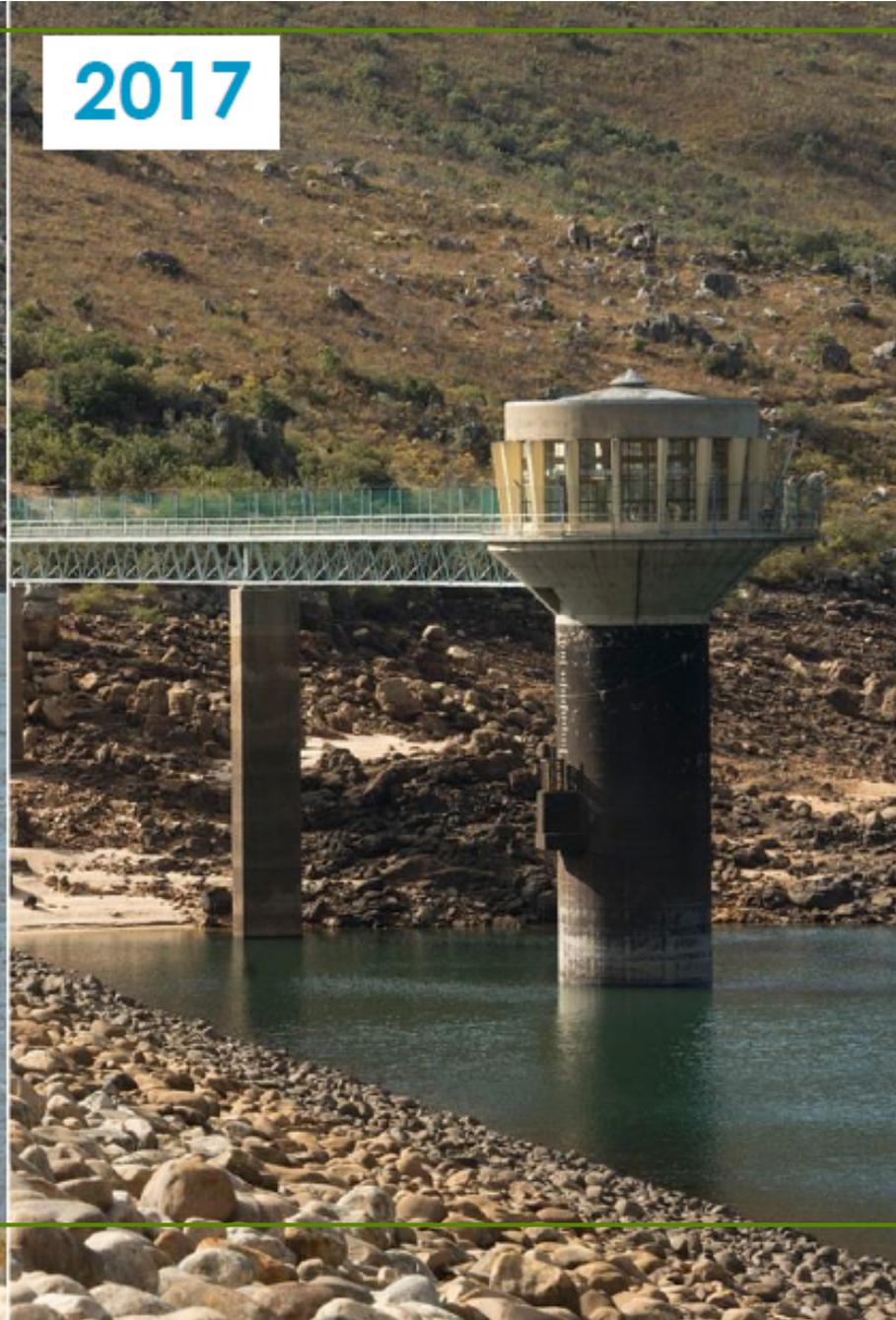
Wemmershoek Dam 2013 to 2017

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2013

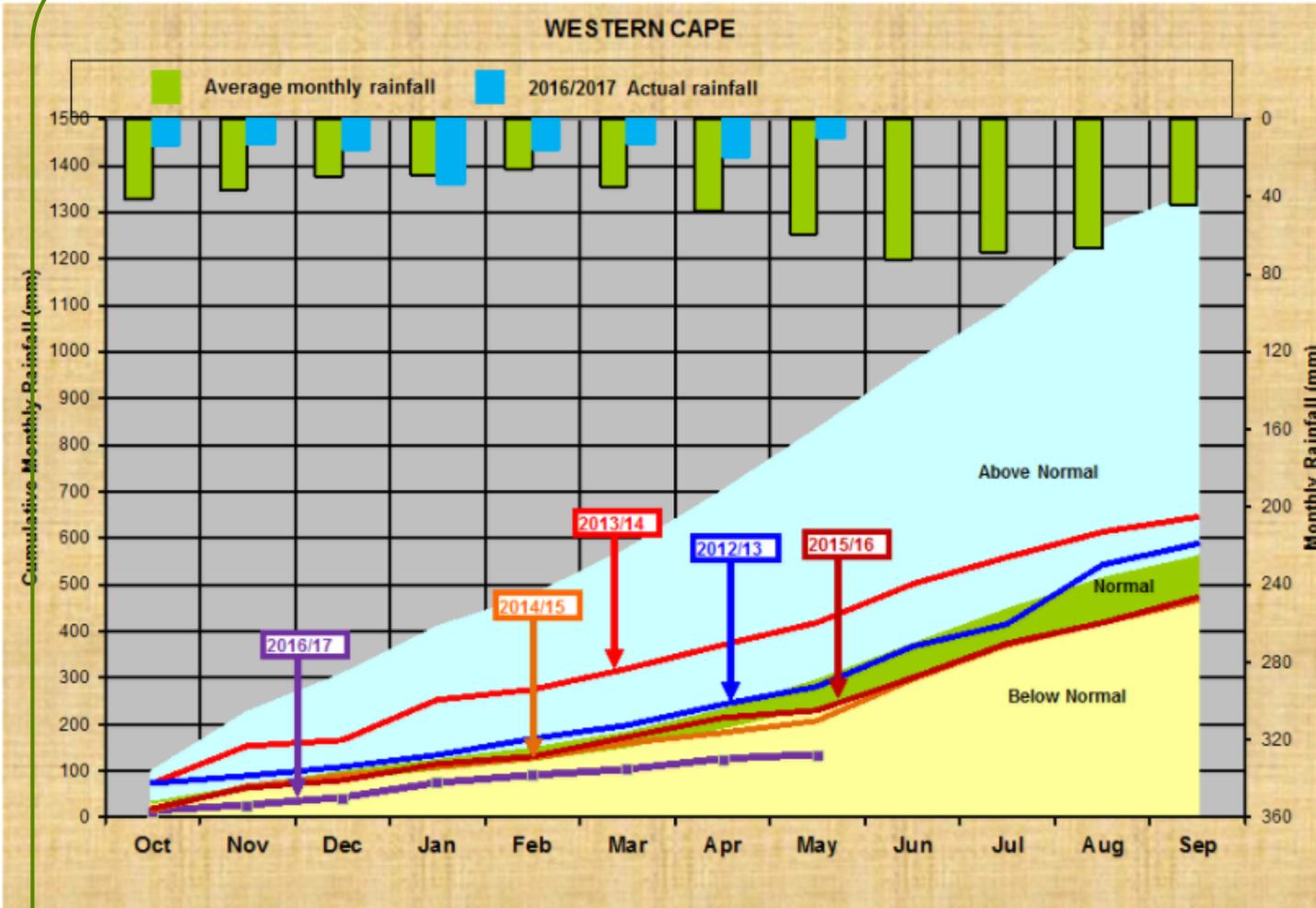


2017



2017 Rainfall Data (i)

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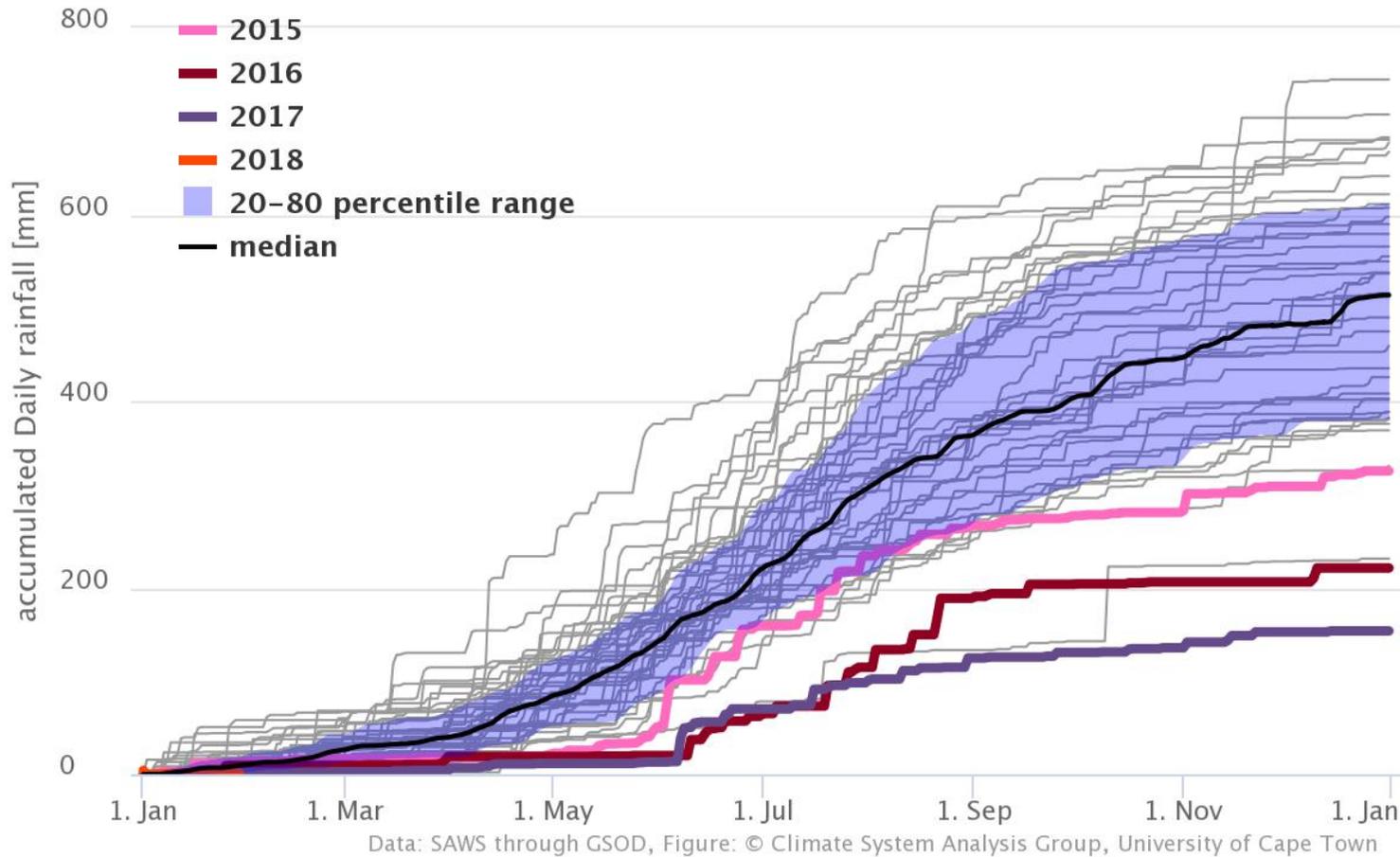
Actual rainfall, month-on-month has been significantly below average

Status quo as per the graph (May 2017) shows cumulative rainfall as well below normal

2017 Rainfall Data (ii)

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Accumulated daily rainfall at Cape Town Airport



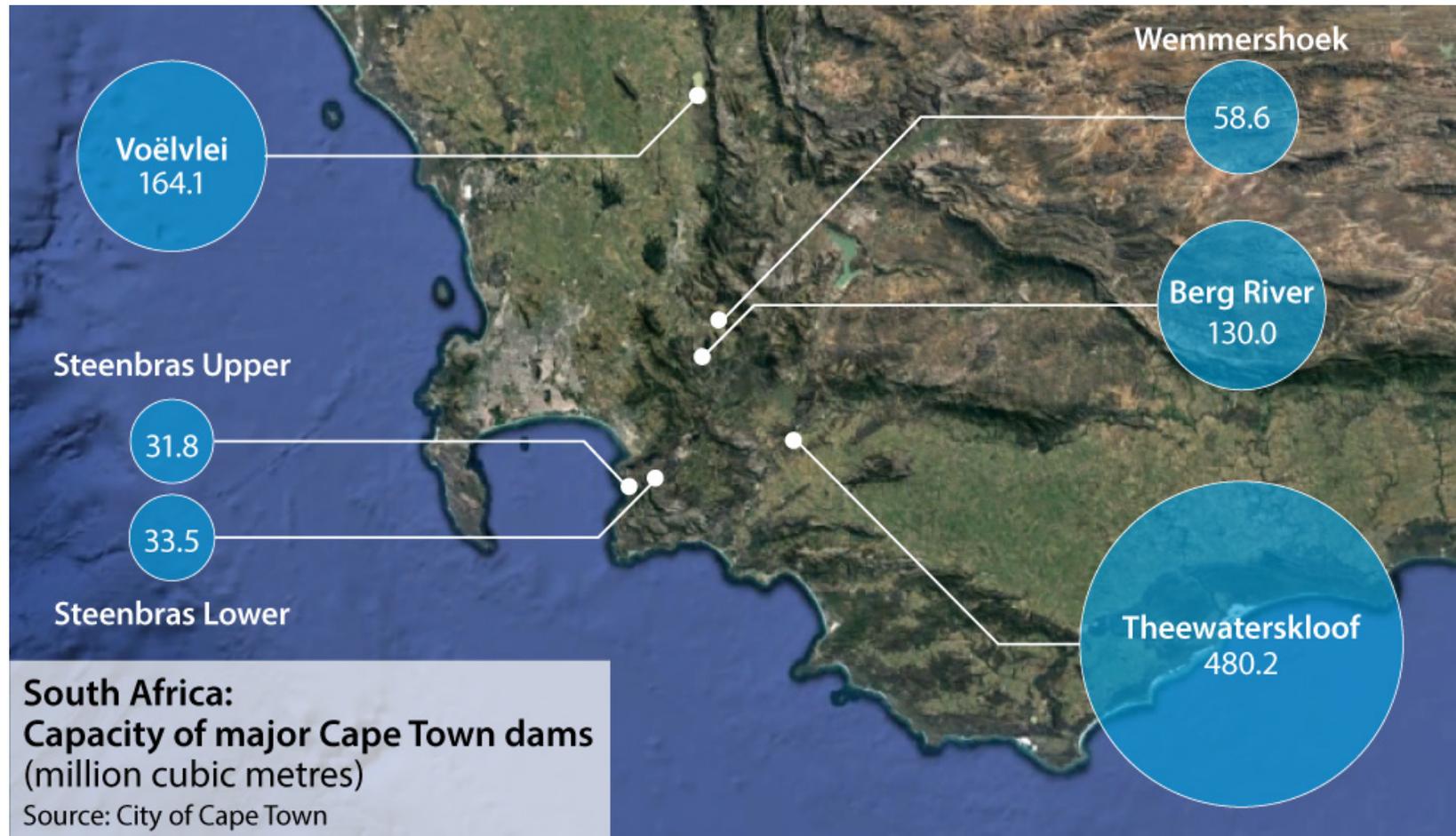
- Purple line (2017) indicates that the accumulated daily rainfall over the last year was significantly below usual
- The annual rainfalls for the past three years are amongst the lowest on record

Is this the new normal?

Current water sources for the City

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Six major dams supply water to Cape Town

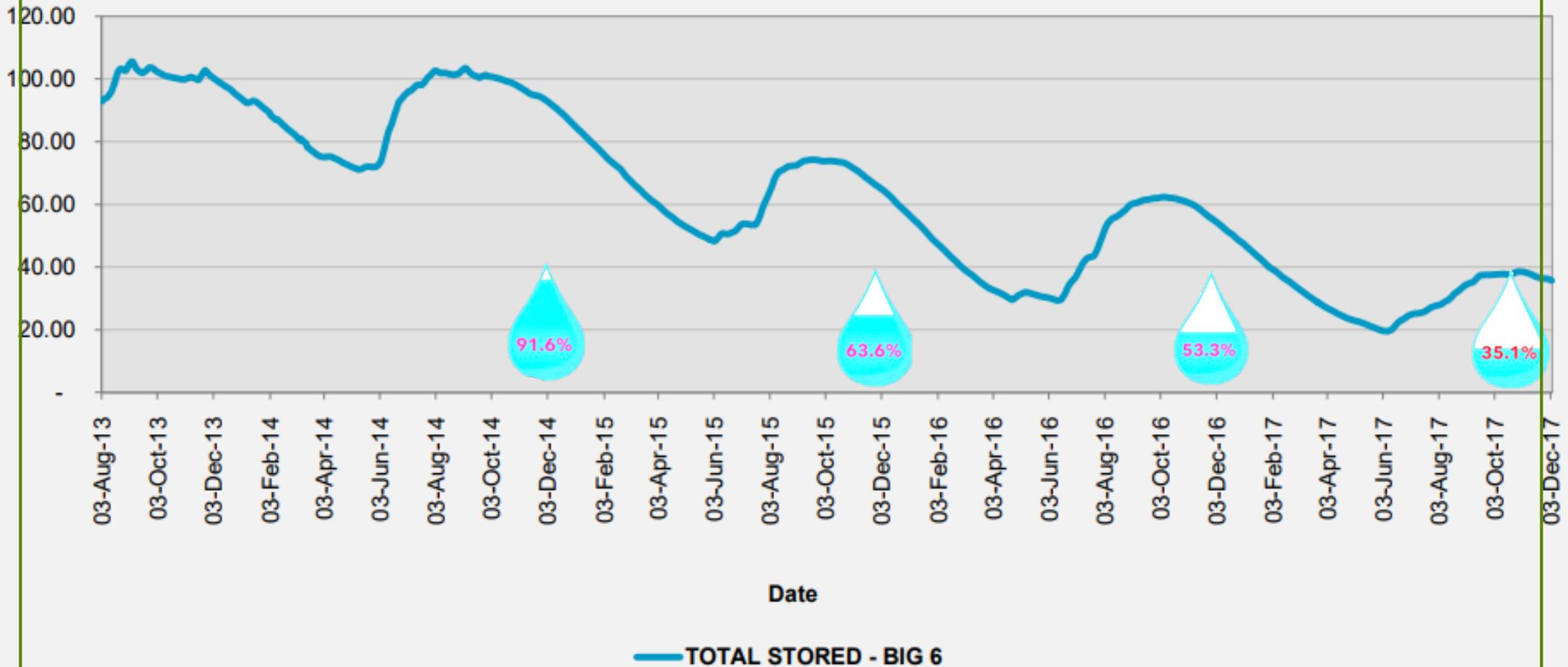


These hold **99.6%** of the City's water capacity, with eight smaller dams, mostly on Table Mountain, responsible for a mere 0.4%.

Current Dam Levels – Big 6

Bringing ideas to life

City of Cape Town Dams: Graphs indicating % of water stored:



Most recent data as at 2018/02/08 indicate dam levels are at **25.1%**

Consumption of water for the City of Cape Town

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to life*

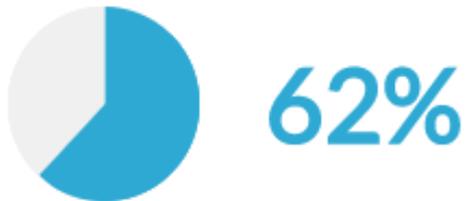
- Current daily consumption rate for the City is approximate 600ML per day
- Water restrictions aiming to drop daily consumption to 500ML per day
- It is predicted that water may run out before the winter rains expected in July/August 2018
- Thus at current consumption levels there is a shortfall in excess of 36,000ML for 2018 alone ⁽¹⁾
- Planning for alternative water augmentation schemes is underway
- However, these schemes may not provide enough water to last to the next rainy season

Current Programs : Alternative Water Sources

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to life

THE CITY

The City's progress on securing alternative water sources.



| | |
|----------------------------------|-----|
| Cape Town Harbour (Desalination) | 50% |
| Strandfontein (Desalination) | 70% |
| Monwabisi (Desalination) | 69% |
| V&A Waterfront (Desalination) | 54% |
| Cape Flats (Ground Water) | 67% |
| Atlantis (Ground Water) | 64% |
| Zandvliet (Recycled) | 55% |

Behind Schedule - On Schedule - Ahead of Schedule

The City has mobilised resources to augment the water supply through a number of alternative water schemes:

- 4 desalination plants < 20 million litres / day
- 2 Ground Water Schemes
- 1 large scale recycled water scheme

Alternative water sources will aim to provide in the region of **100 ML** of water per day⁽¹⁾

An additional source of water must be found to fill the gap in the water consumption needs of the City

GLACIAL WATER FROM SCANDINAVIA / ICELAND



As the glacier and snow fall melts, the water passes through natural sand and gravel filters, entering an "encapsulated" artesian aquifer, or a huge chamber encapsulated by the rock walls created by the glacier with fissures and fractures all along it. As the water passes through this aquifer, gravel and sand, the water is filtered leaving the purest water available. And due to the virginity of the region, its age and remoteness to civilization, there is virtually no organic contaminants or mineral infiltration.

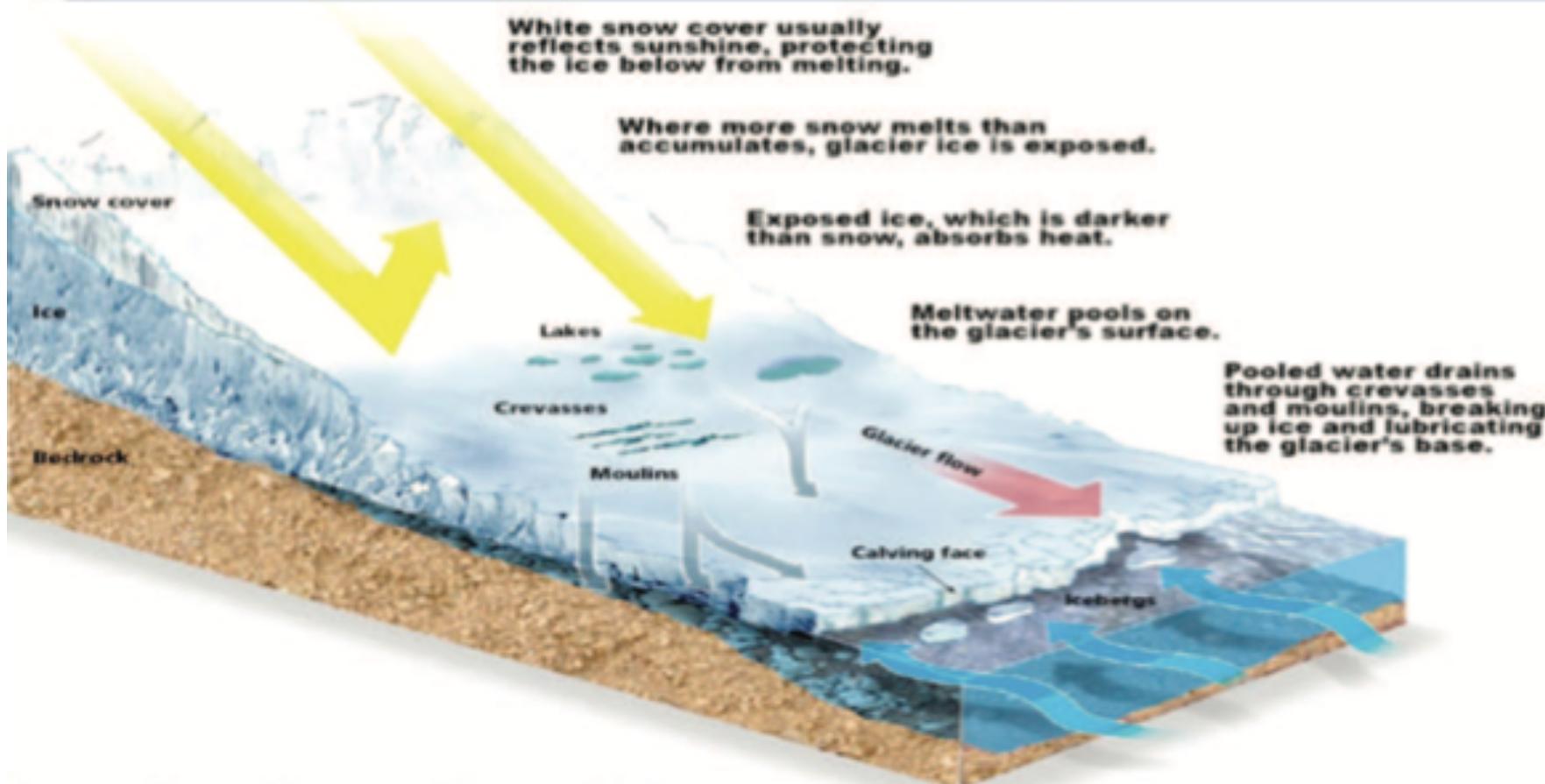
White snow cover usually reflects sunshine, protecting the ice below from melting.

Where more snow melts than accumulates, glacier ice is exposed.

Exposed ice, which is darker than snow, absorbs heat.

Meltwater pools on the glacier's surface.

Pooled water drains through crevasses and moulins, breaking up ice and lubricating the glacier's base.





GLACIAL WATER'S JOURNEY OF PURITY

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to life*

With unmatched purity begins with the glacial process!

! Glacial water is comprised of glacier melt, rainfall, and snow melt.

! When the glacier retreated, it stripped the mountaintops of vegetation; consequently, there is little plant life that would put organic contaminants in the water as it begins it's journey atop the mountain wilderness.

! When the glacier retreated, it left behind large gravel and sand deposits that serve as natural filters for Glacial water.

! Normally, when water percolates through rock, the minerals in the rock leach into the water. Because the climate where Glacial water sources are located remains cold year round, this mineral infiltration does not occur.

! As an example - In the Valley beneath the mountain range, the water collects in a subterranean aquifer. Thanks to the deposits left behind by the glacier, this aquifer is a rare "encapsulated" artesian formation, protecting the water from ground contamination.

!¹³As a result, the water completes its geological journey as pure as it began.



This photograph shows a plant in Norway. This source – the Hardangerjoekulen Glacier - rises in the background.

WHY NOT WATER FROM RIVERS – CLOSER BY?

APART FROM.....

- ALIEN INVASIVE SPECIES
 - PATHOGENS
 - ECOLI
-
- ZAMBESI – TOO SHALLOW FOR TANKERS
 - CONGO – BORDER BETWEEN ANGOLA & CONGO – ALSO TOO SHALLOW FOR LARGE TANKERS
 - AMAZON – 12.0M DRAFT RESTRICTION – SO AGAIN – TOO SHALLOW FOR LARGER TANKERS

Should the City of Cape Town consider Icebergs as a future supply option?

*Bringing ideas
to life*



Approximate size of
800m x 400m x
220m deep

Over 70 million m³ of
fresh water

Assuming a 70%
yield, an iceberg
would then provide
50 million m³ of
water in total

This equates to
approx. 135 ML per
day over 1 year

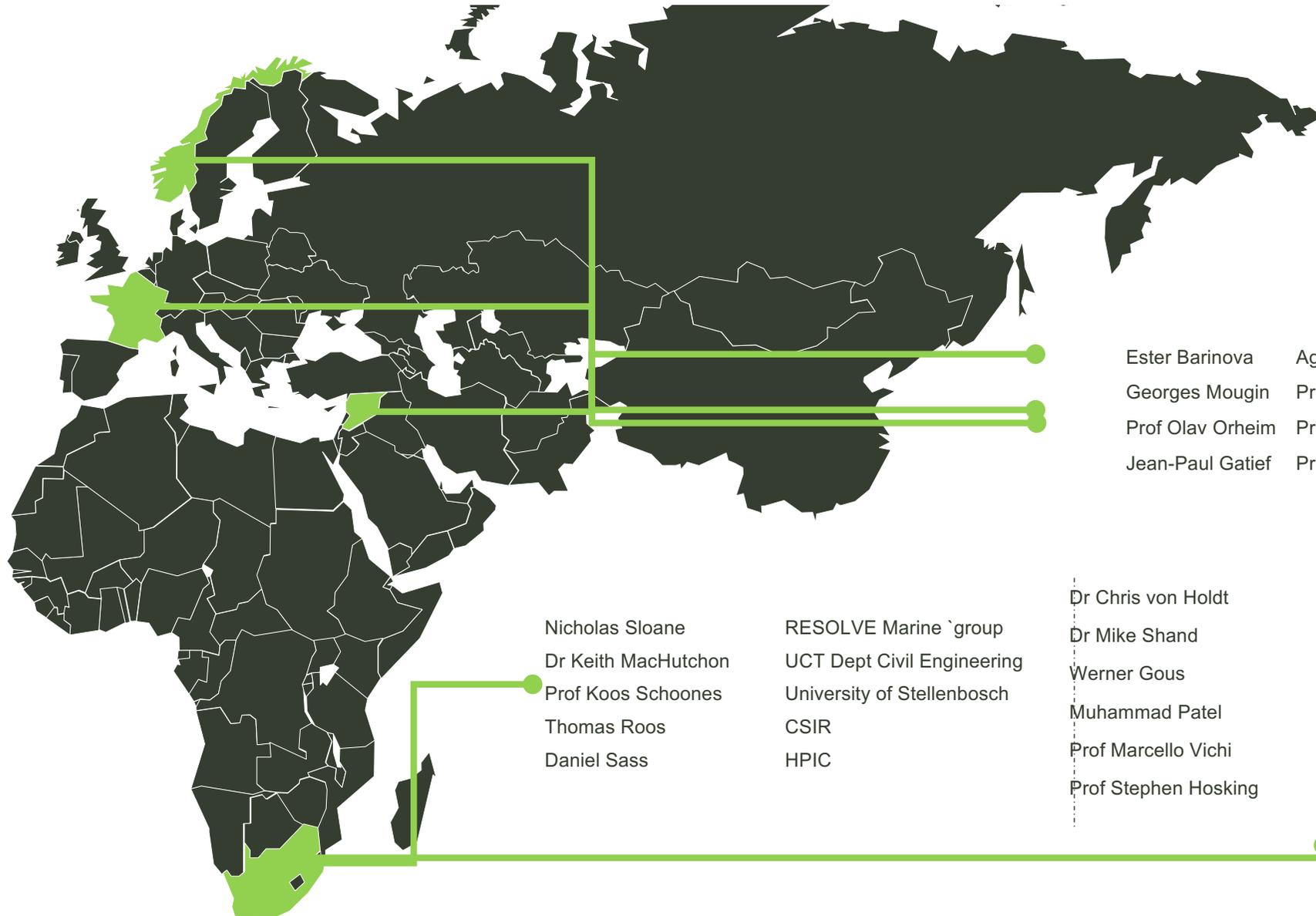


**OVER 2,000 BILLION TONNES
OF ICEBERGS FRACTURE OFF
ANTARTICA – EVERY YEAR....**

**TO DRIFT AROUND THE
SOUTHERN OCEANS**

AND MELT!!

We've put together a team – to look at this possibility



Ester Barinova Agriyos
 Georges Mougín Private
 Prof Olav Orheim Private
 Jean-Paul Gatief Private

Nicholas Sloane RESOLVE Marine `group
 Dr Keith MacHutchon UCT Dept Civil Engineering
 Prof Koos Schoones University of Stellenbosch
 Thomas Roos CSIR
 Daniel Sass HPIC

Dr Chris von Holdt Aurecon
 Dr Mike Shand Aurecon
 Werner Gous Aurecon
 Muhammad Patel Aurecon
 Prof Marcello Vichi UCT Dept of Oceanography
 Prof Stephen Hosking CPUT Business School

Key contributors

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to life*



Georges Moughin

French engineer and the technical director of Iceberg Transport International (ITI). Beginning in the 1970s, Moughin undertook a series of modeling experiments to test the (economic and physical) feasibility of towing an iceberg from Antarctica to Saudi Arabia.

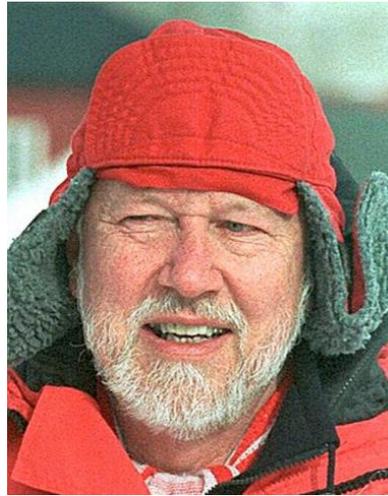
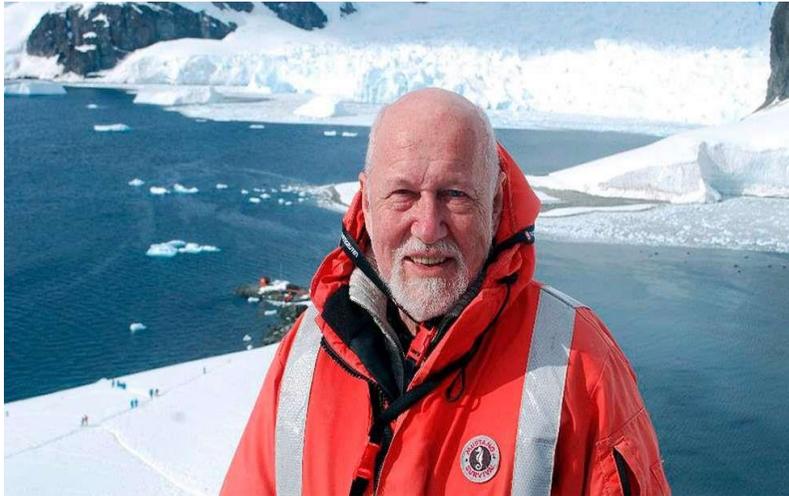


Nick Sloane

Salvage Master who began his career in 1980 working on the tugs of a South African salvage company. He famously refloated the Costa Concordia. His work has taken him around the world, wrestling with wrecks of boats, rigs and planes from New Zealand to Yemen.

Key contributors

*Bringing ideas
to life*



Prof Olav Orheim

A Norwegian glaciologist. He served as director of the Norwegian Polar Institute from 1993 to 2005. He was appointed associate professor in glaciology at the University of Bergen in 1989. Orheim was a central participant in the establishment of the research station Troll in Queen Maud Land in Antarctica

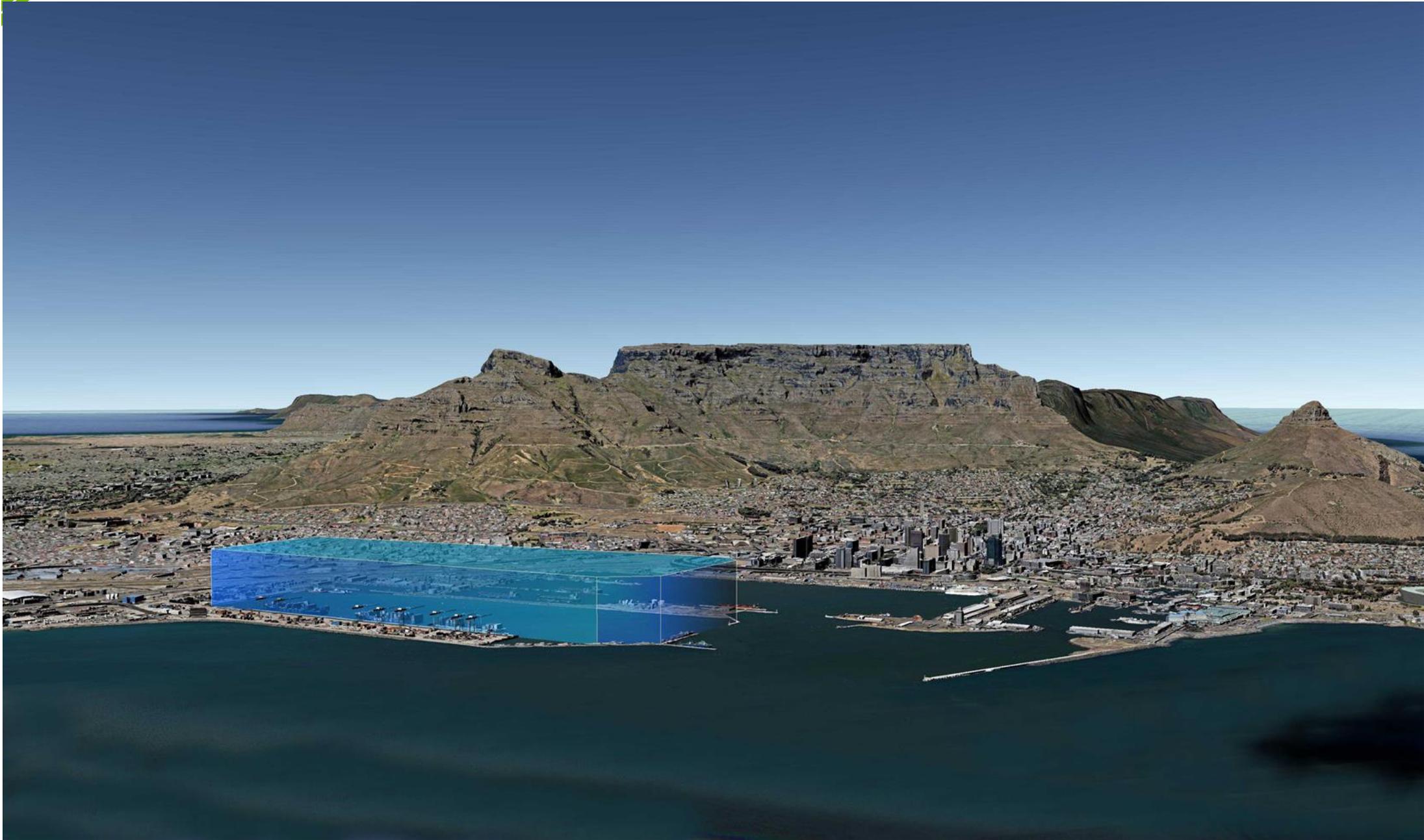


Dr Mike Shand

Professional Engineer and resident of Cape Town with 50 years of experience in water engineering. Honorary Fellow, South African Institution of Civil Engineering (SAICE); Senior Member Water Institute of Southern Africa (WISA); Vice-president of the South African Academy of Engineering.

THIS IS HOW MUCH WATER CAPE TOWN USES A YEAR

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to life*





This is the actual size of one iceberg

Capture: Iceberg specifications

Types of icebergs:

- Tabular icebergs are the only suitable iceberg type for this purpose.
- Steep sides with a flat top - like a huge tablet.
- They all form by breaking away from ice shelves.
- They have fairly uniform thickness (approx. 200m – 250m)
- The upper parts 40-60m are less dense, permeable and erode more easily
- The main mechanical strength lies in the ice core



Tabular iceberg in the Ross Sea





**WHAT WE HAVE CONSIDERED –
FROM OVER 38 YEARS OF STUDY SINCE THE
“ANNALS OF GLACIOLOGY”**

*Bringing ideas
to life*

WAS PRODUCED IN APRIL OF 1980

- ICEBERG PHYSICAL CHARACTERISTICS & LIFE EXPECTANCY
- ICEBERG DYNAMICAL MODELING
- ICEBERG DRIFT ANALYSIS & TRACKING
-
- MELTING & PRESERVATION

THE SIZE AND SHAPE – THAT WE SHALL ENCOUNTER

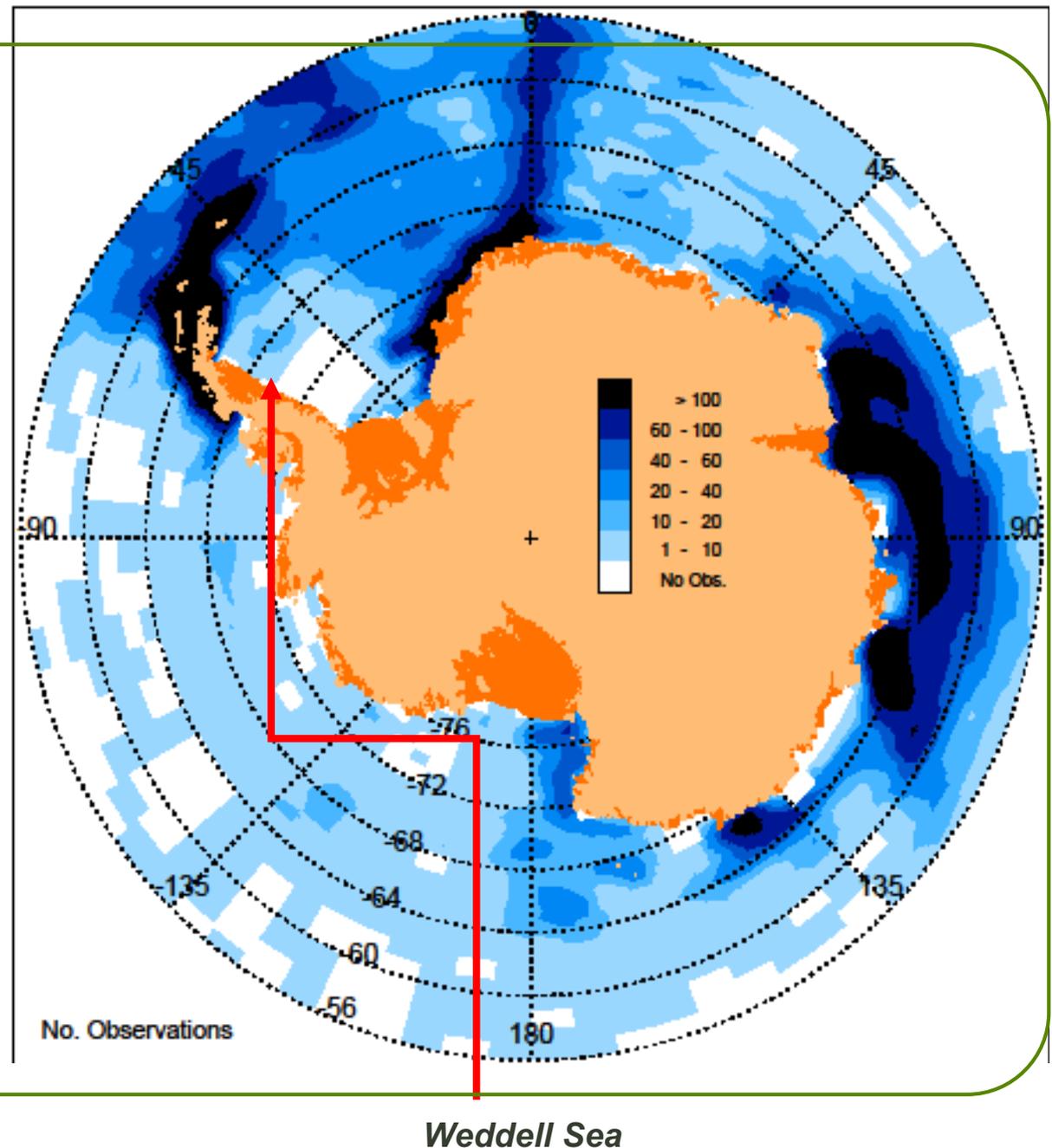
*Bringing ideas
to life*

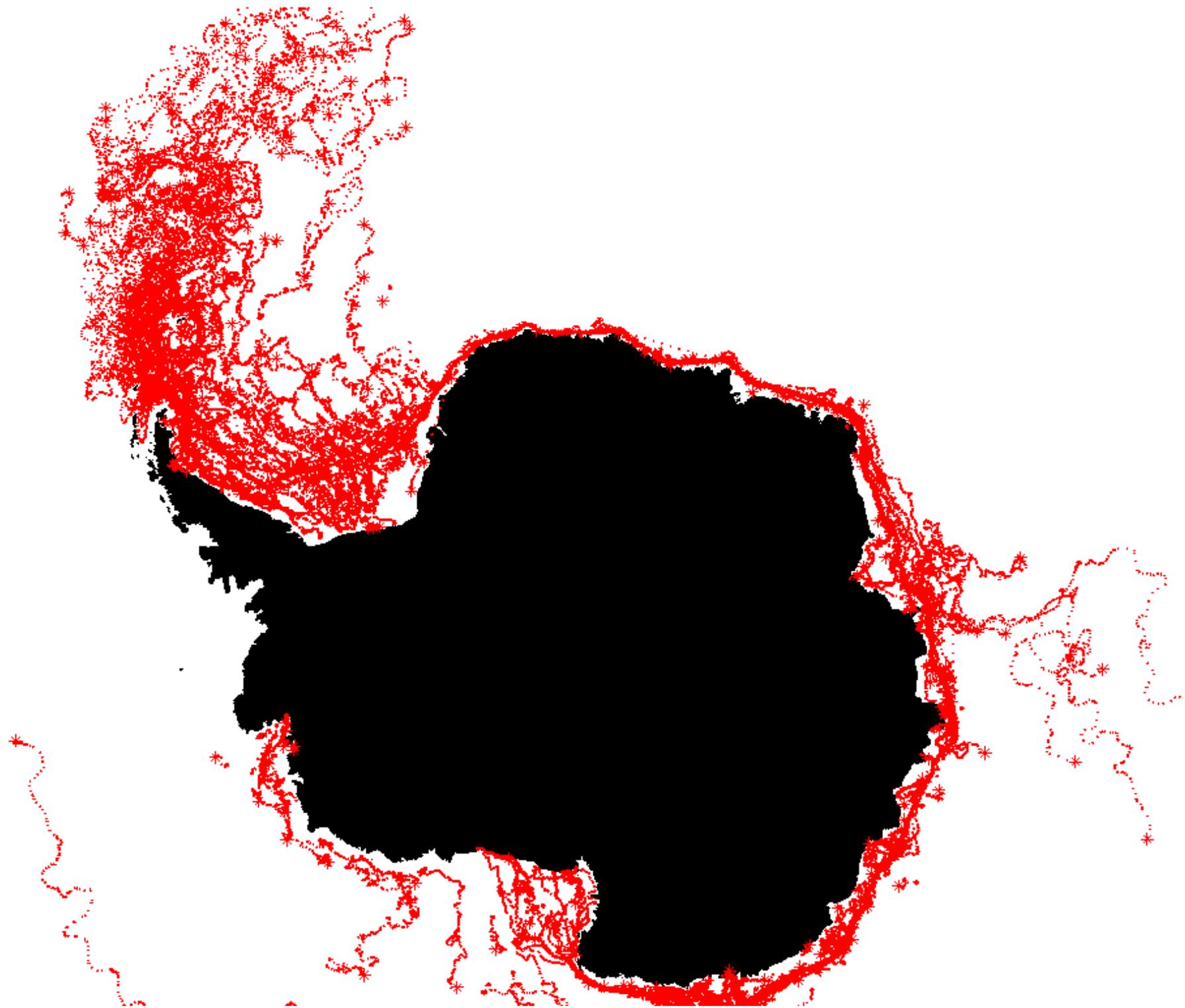


Capture: Availability of Icebergs in General

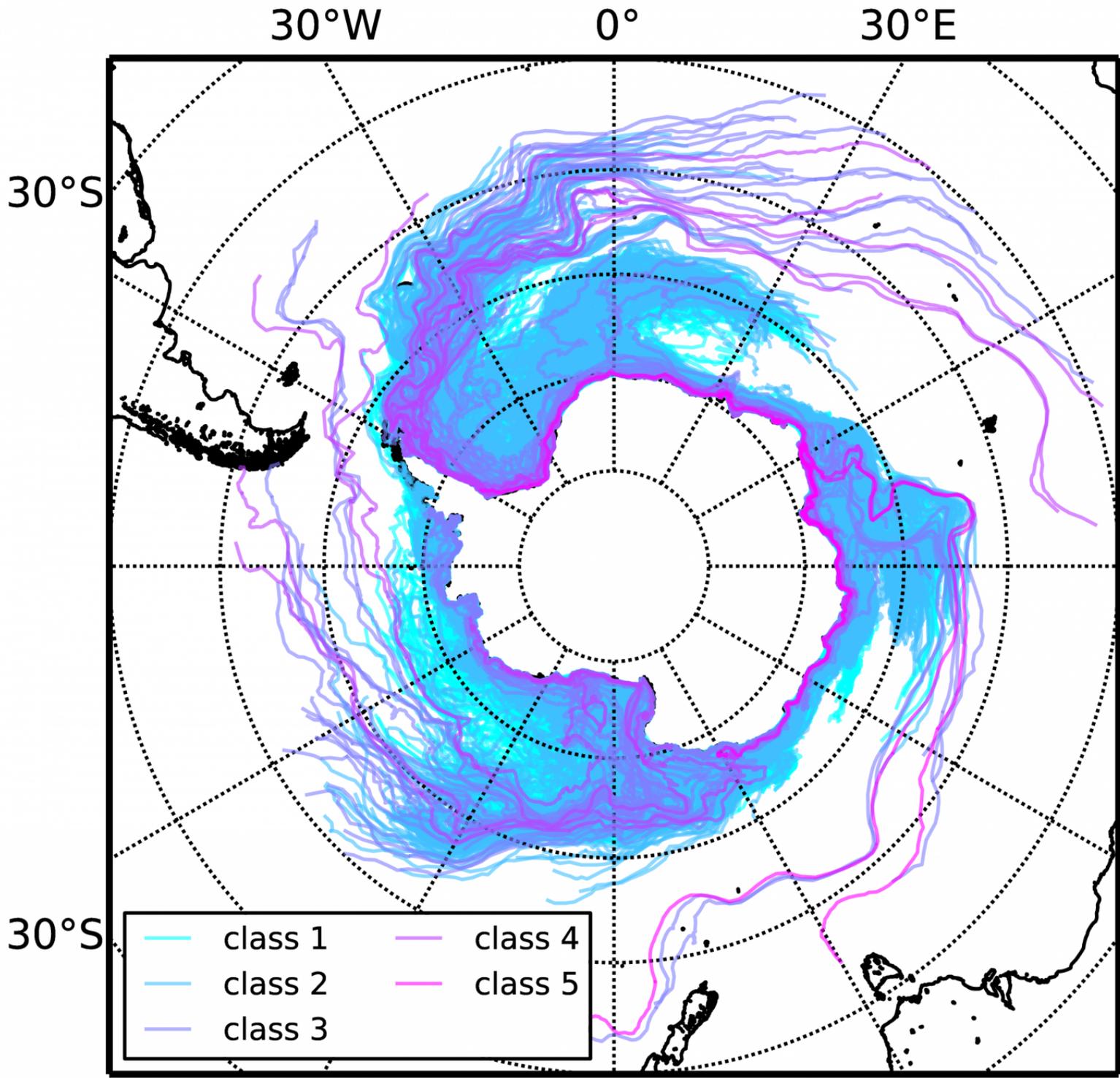
Bringing ideas
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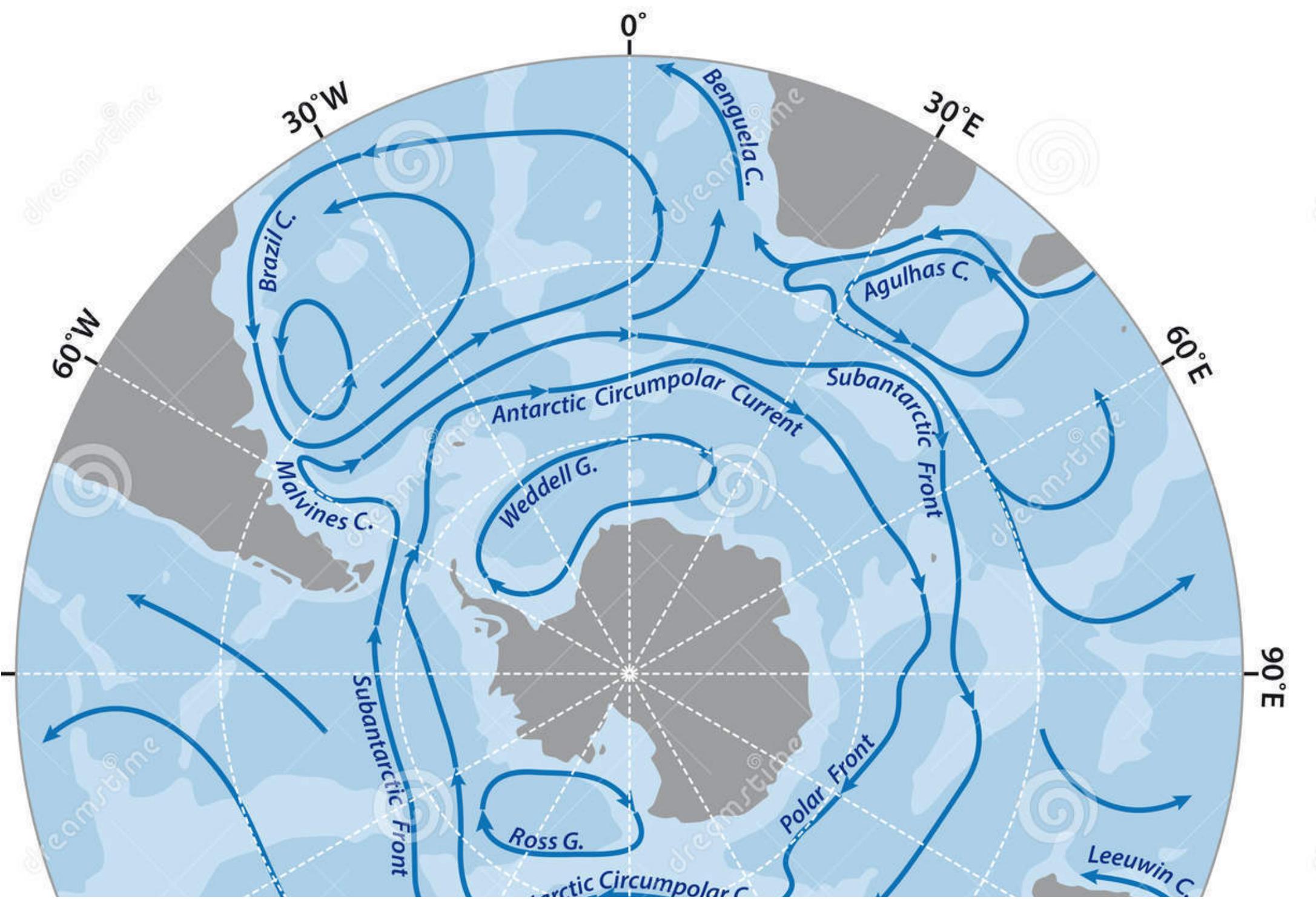
- Observations show that there is good data coverage in Atlantic sector of Southern Ocean south of 56°S latitude.
- However, the density of observations mirrors ship tracks to the coastal research stations
- The intention is not to tow icebergs from Antarctica, but to focus on icebergs that have been transported northwards by currents in the South Atlantic Ocean closer to Cape Town*





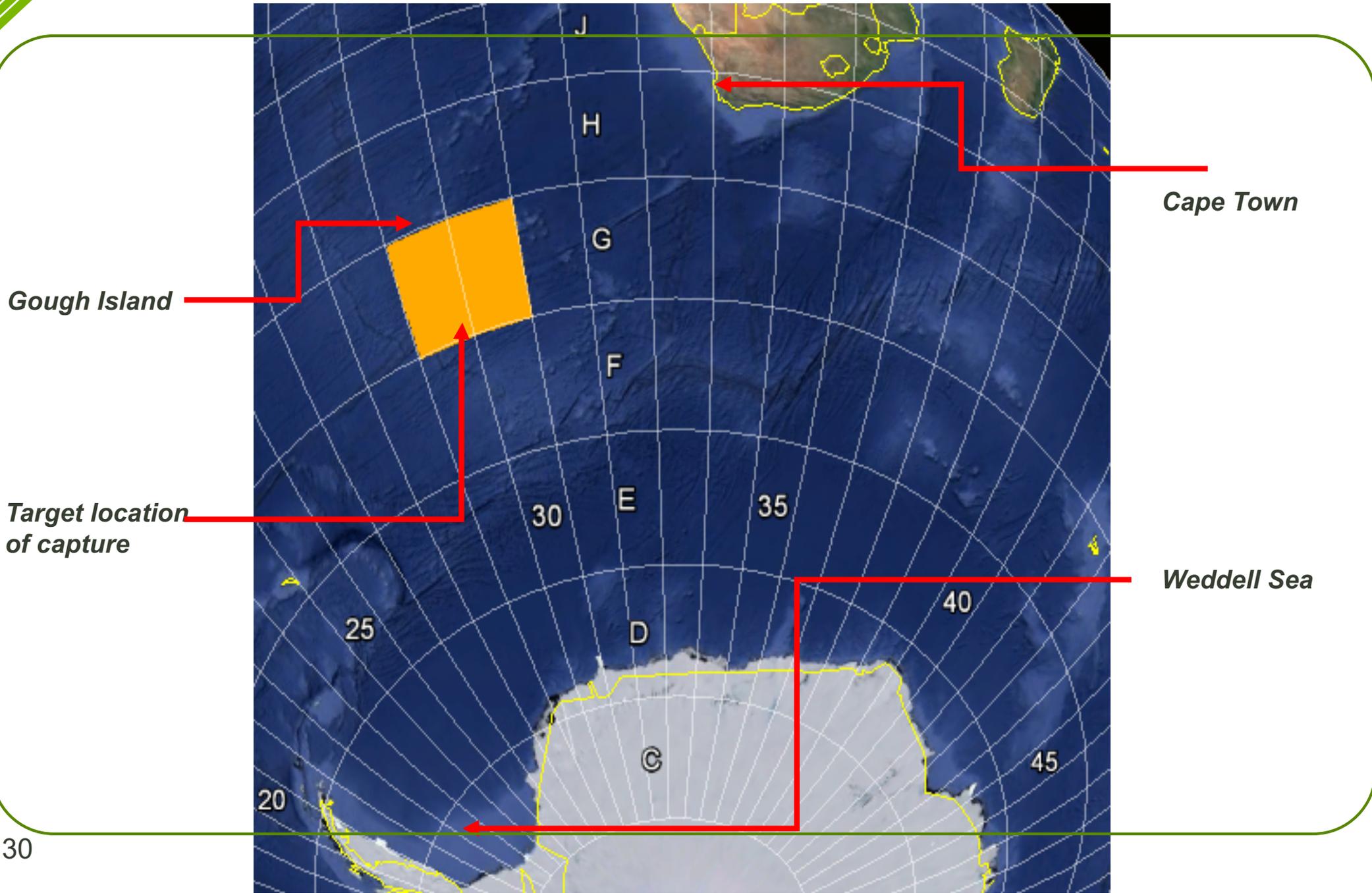
*Bringing ideas
to life*





Iceberg: Proposed Location of Capture

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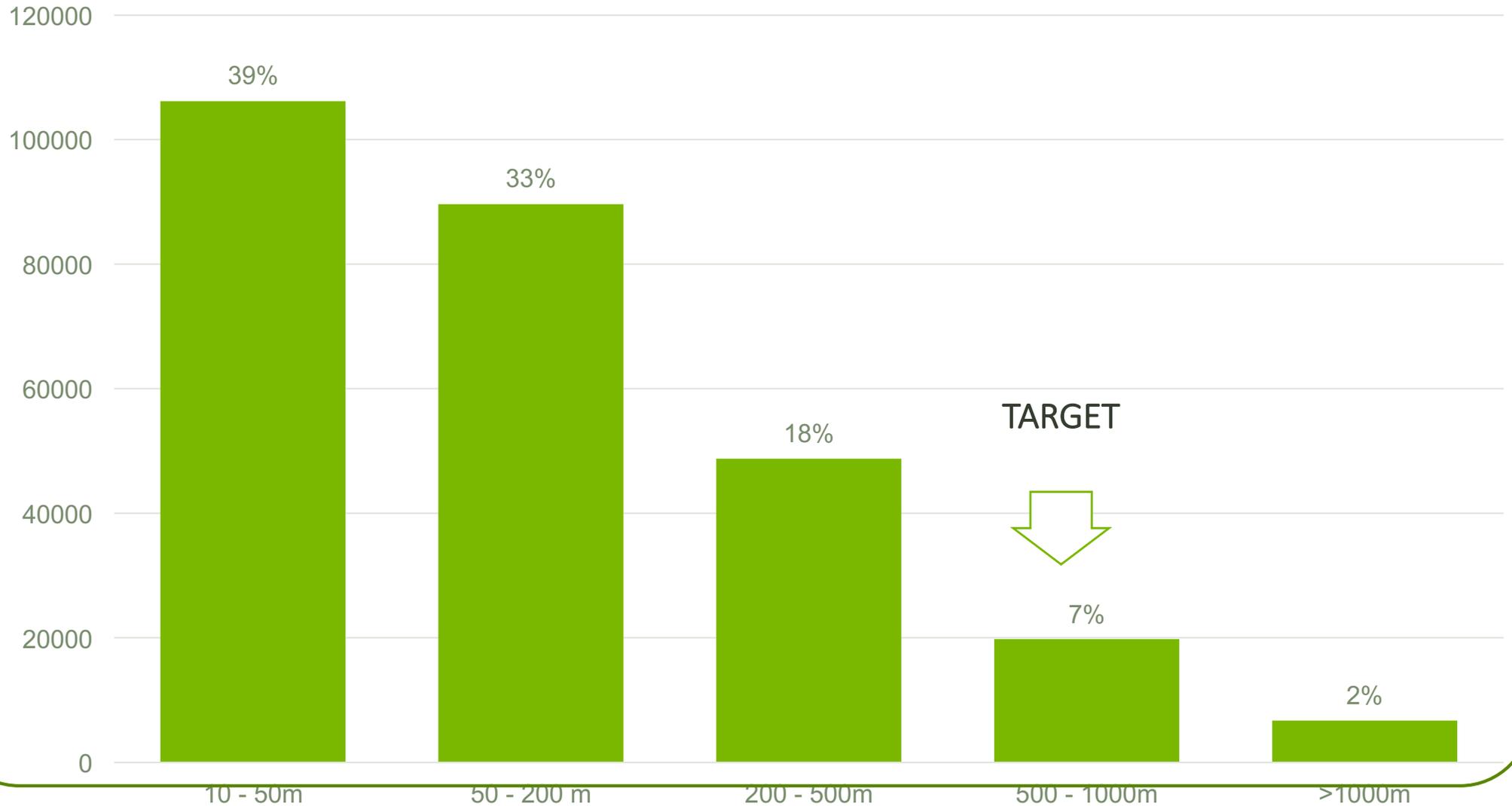


Capture: Availability of "Larger" Icebergs

*Bringing ideas
to life*

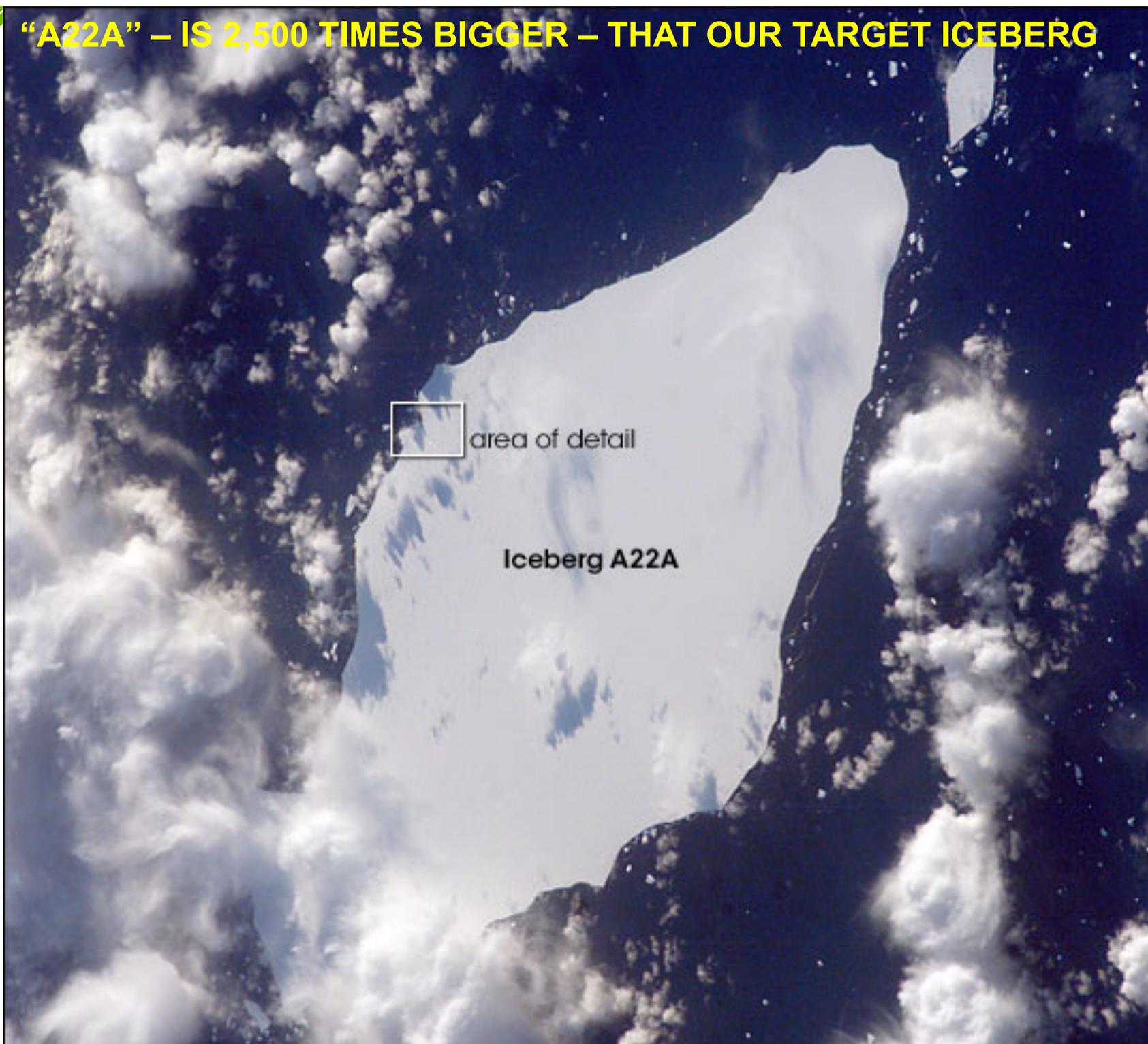
Observations of icebergs by a team of researchers reflected in the graph below (Olav Orheim)

Total of 271,000 icebergs analyzed



“A22A” – IS 2,500 TIMES BIGGER – THAT OUR TARGET ICEBERG

*giving ideas
to life*



Iceberg Capture: Method of Capture

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- After successful identification of the targeted iceberg, assessment and capture is required
- Iceberg can be captured either using:
 - Two - Three tugs, two tugs to encircle the iceberg , with the third tug ensuring a single measure of redundancy



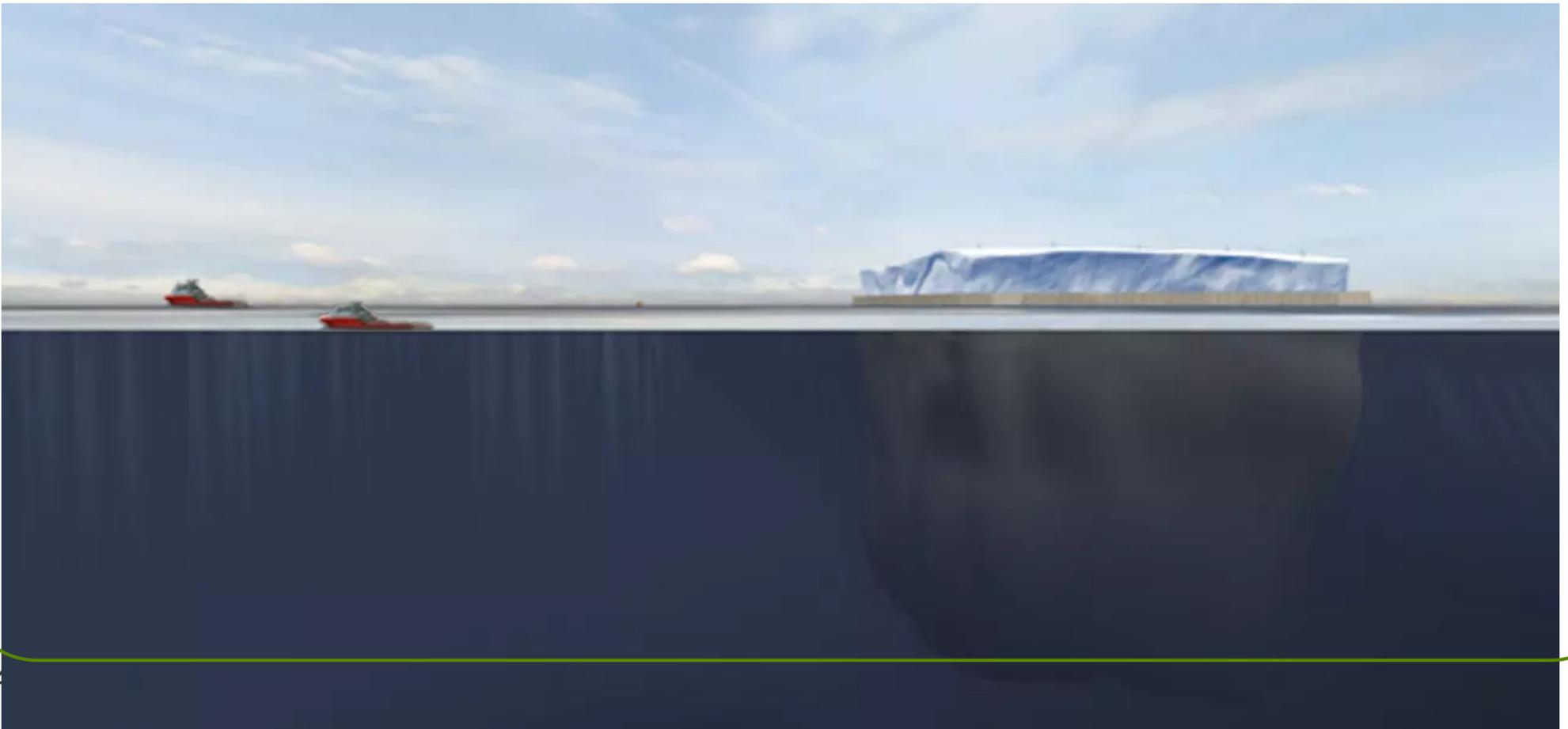
- The time to do an assessment, evaluation and capture will need to be assessed and quantified in more detail

Transport: Minimization of Loss

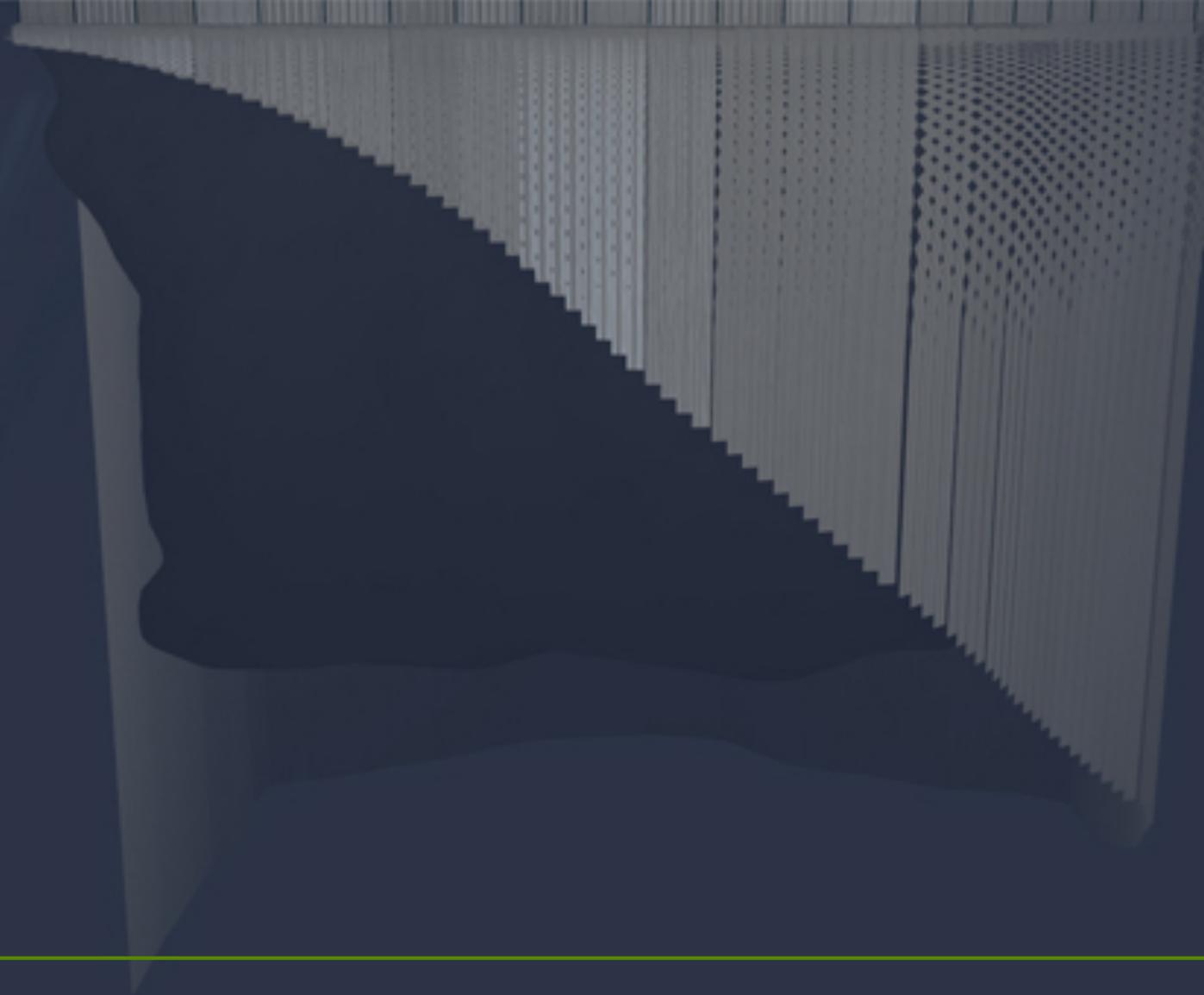
*Bringing ideas
to life*

Use of a geo-textile iceberg skirt

- Below the surface, icebergs may be smoothed by ocean currents, making it unlikely the skirt will tear as it protects its cargo.
- The skirt will also not reach the very bottom of the berg, with water temperatures at that depth (>150-200m deep) likely to not cause much of an increase in the melting of the berg itself due to thermocline's



Transport: Geotextile “skirt”



Transport: Tug & VLCC Tanker - Power

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- It has been noted by other studies that one tug is able to “tow” a large berg
- The world’s most powerful tugs such the ALP Tugs (bollard pull of 300 tonnes) would be required to tow the iceberg in the open seas (*Nick Sloane*)
- However it is recommended that a large tanker be used to tow the berg itself, with two tugs supporting alongside to ensure correct alignment with the pre-determined route (*Nick Sloane*)



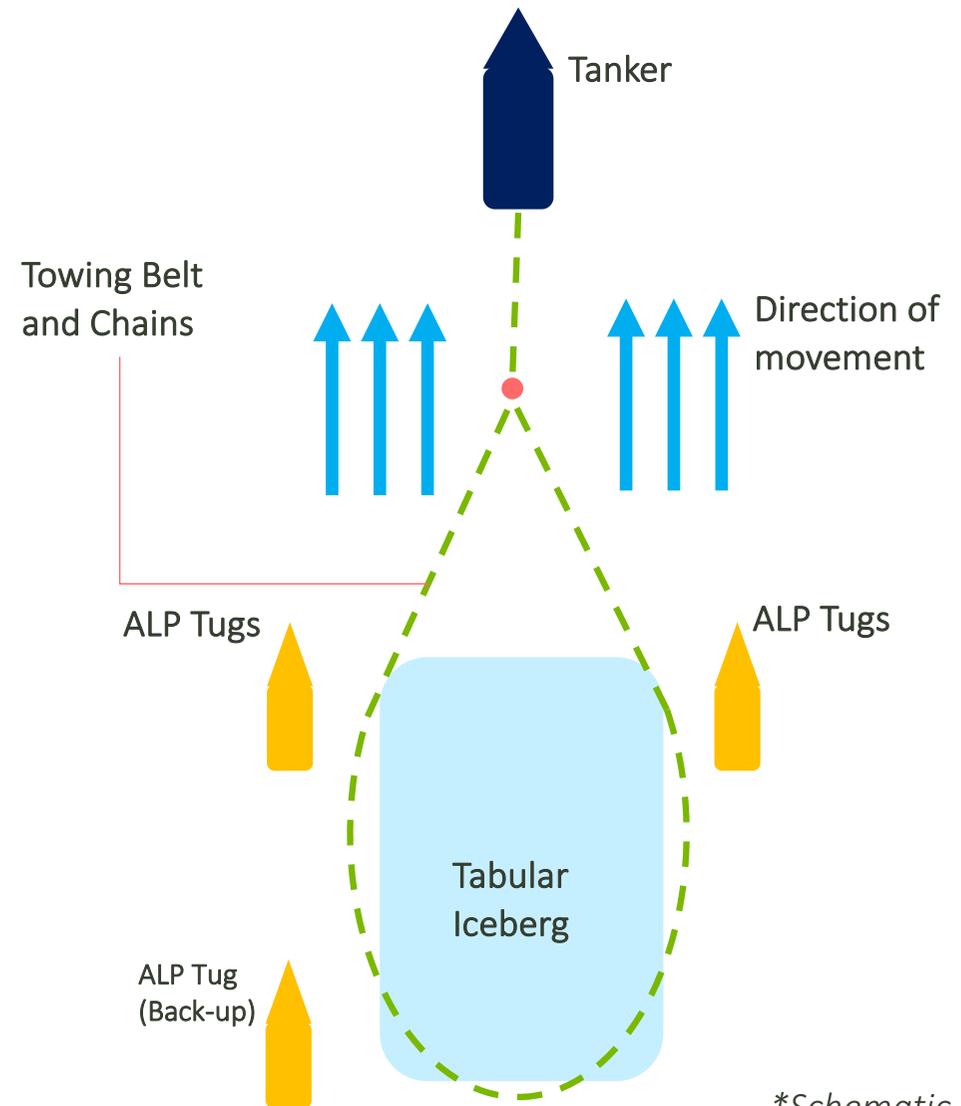
ALP Tugs



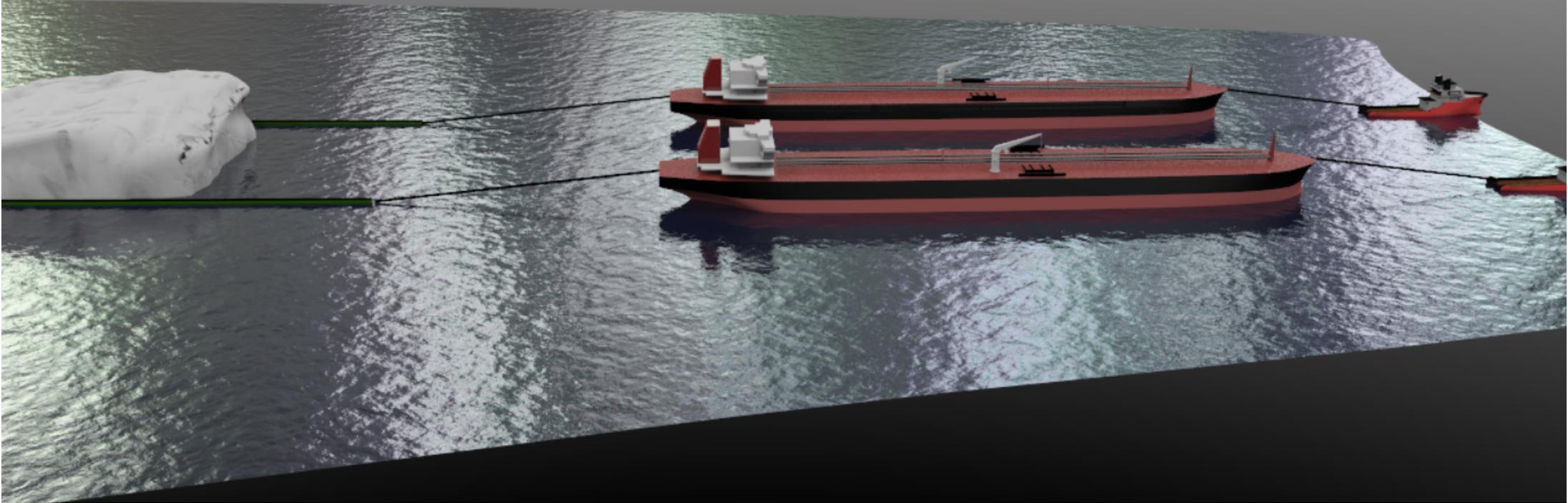
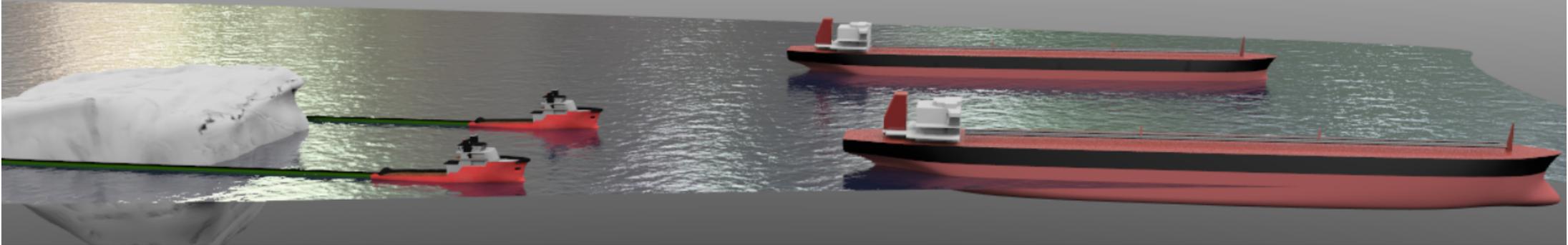
Transport: Method of towing

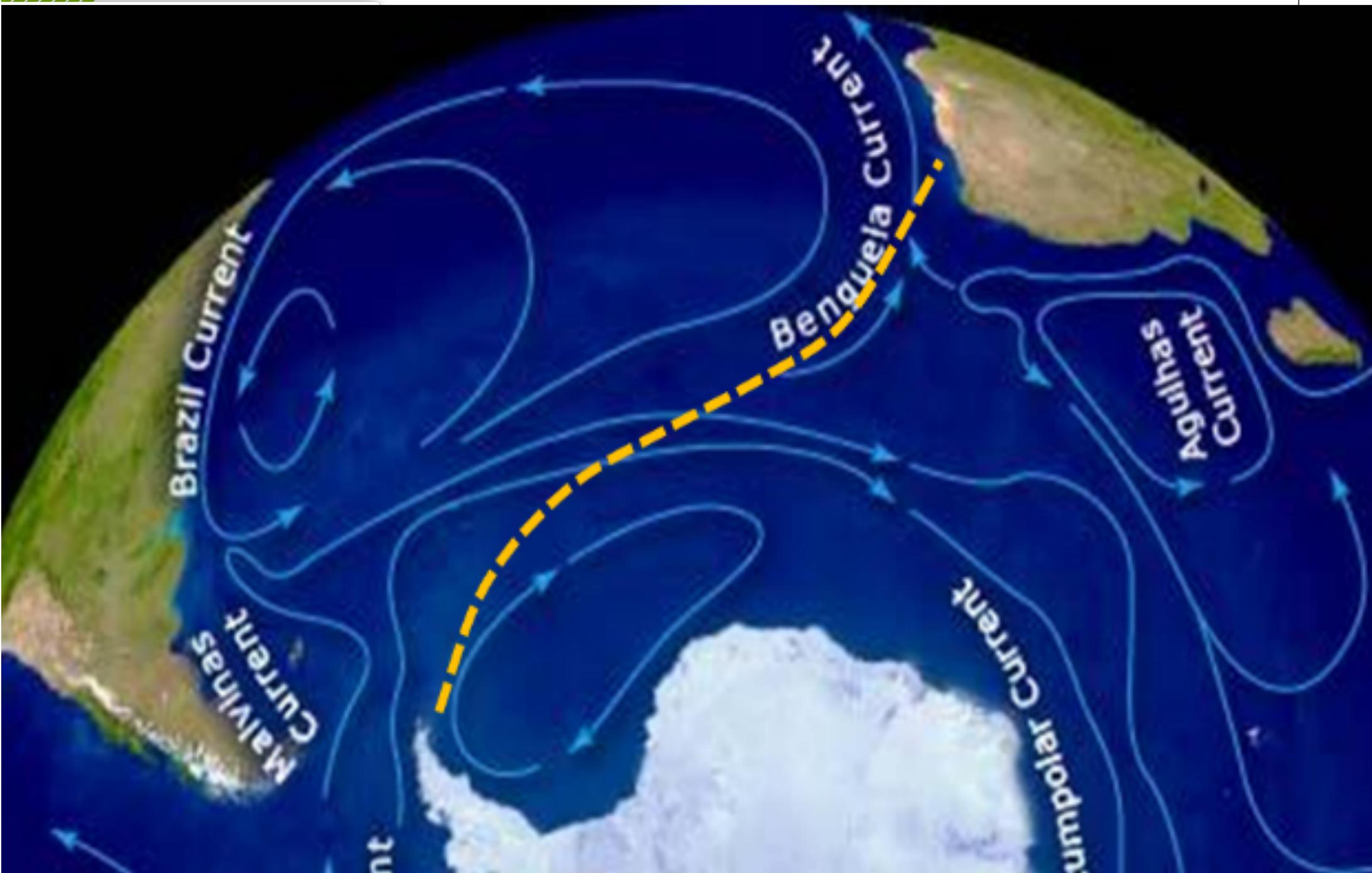
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to life

- According to Resolve Marine Group (*Nick Sloane*), the desired method of towing is based on a three tug – single or twin tanker towing arrangement.
- This arrangement allows for the larger tanker to be the primary towing vessel, with two of the tugs in support, allowing the berg to stay on its course
- The third tug acts as a measure of redundancy
- In order to reduce the forces in the chain link used in the towing, it is envisaged that the length of chain-link between the towing tanker and the berg will be in the order of 1 – 1.5 km's, potentially combined with the use of a submerged hawser.



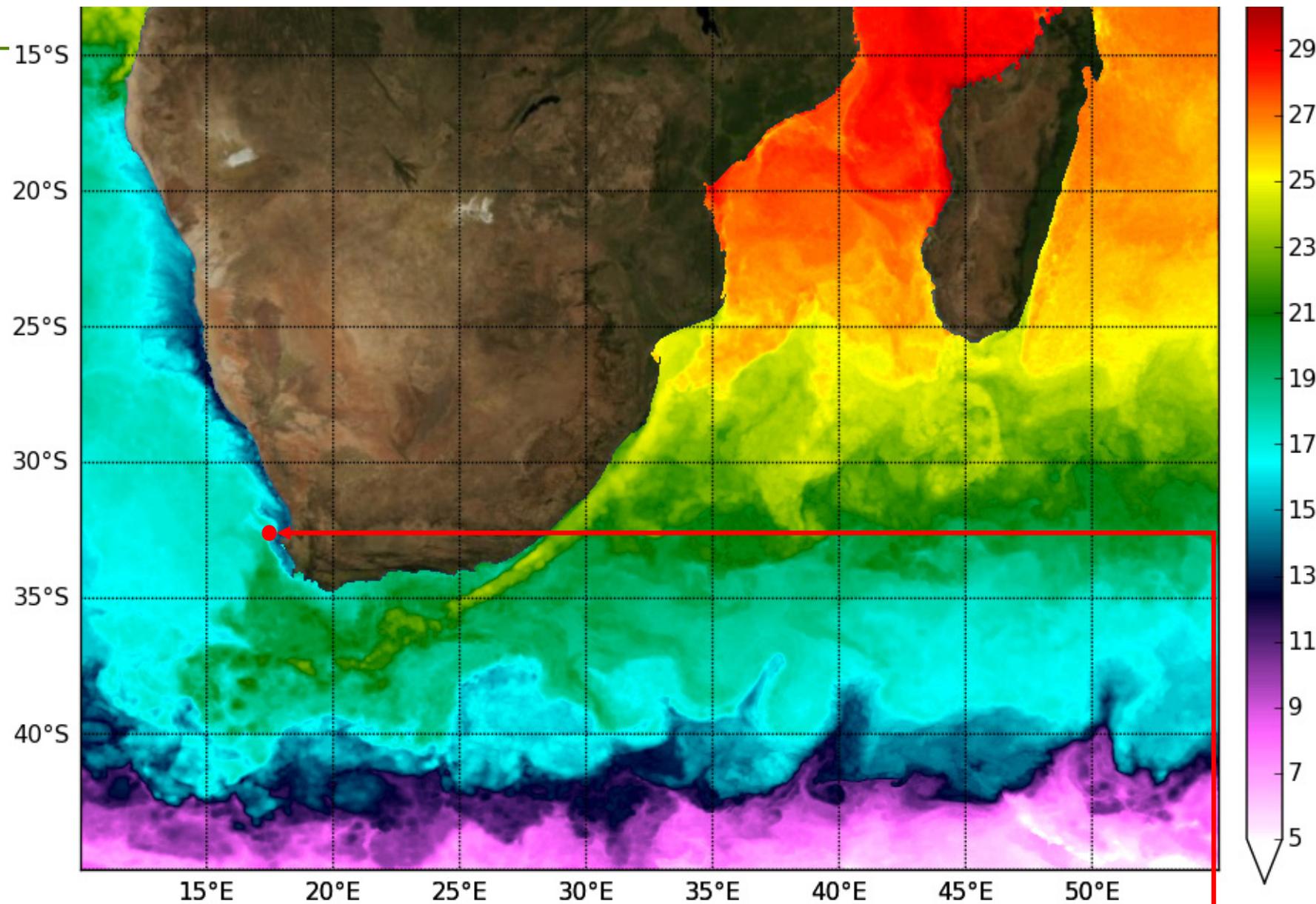
*Schematic





Placement: Water Temperature

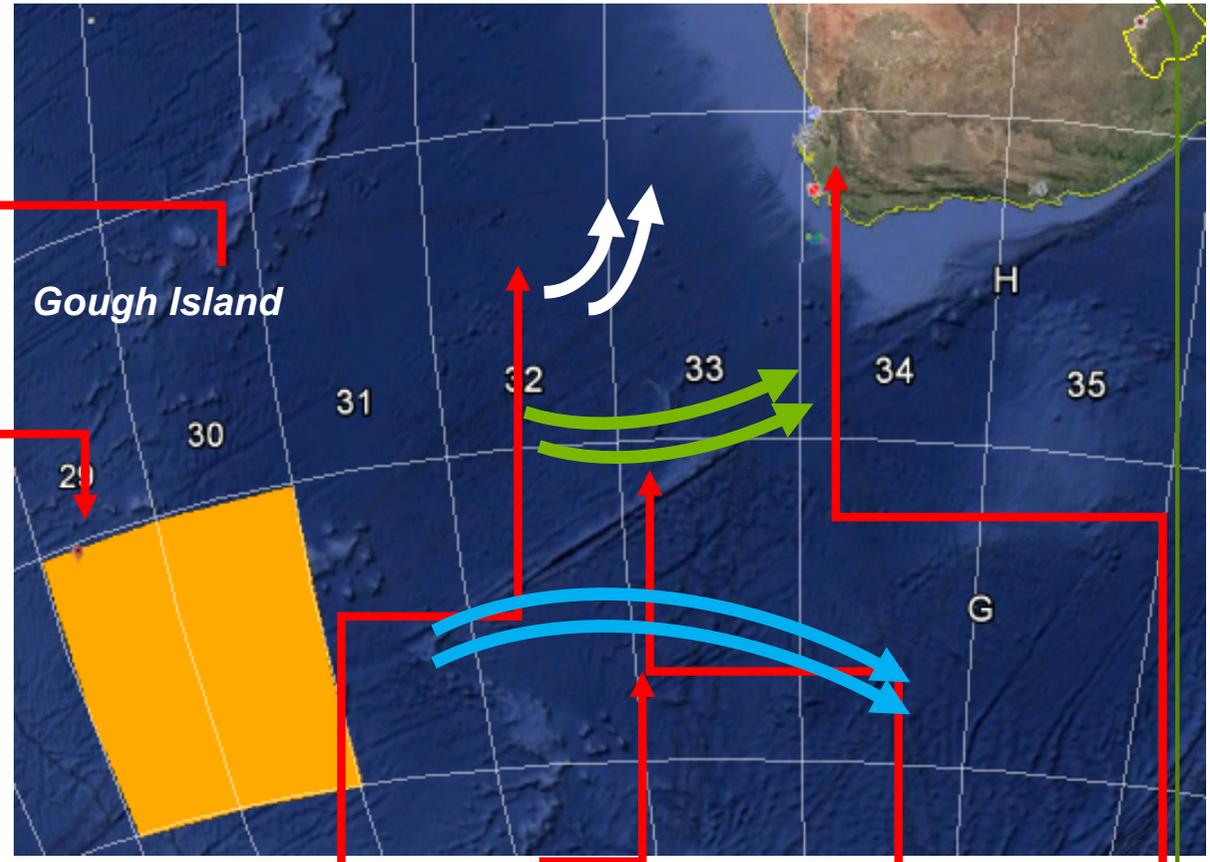
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Transport: Assisted Drift Approach

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- Assuming the capture is done in a location westward of RSA, the combined impact of the Circumpolar Current, Coriolis effect and the Benguela Currents may assist in reducing the towing power required
- Less time and less energy consumed, that is less money spent and cheaper water.
- Real "Live" current data is required to test this assisted drift approach, and its impact in reducing the power required to tow
- Today's knowledge and availability of ocean-meteorological data (including prevailing currents) make it possible to simulate and assess the viability of such scenarios

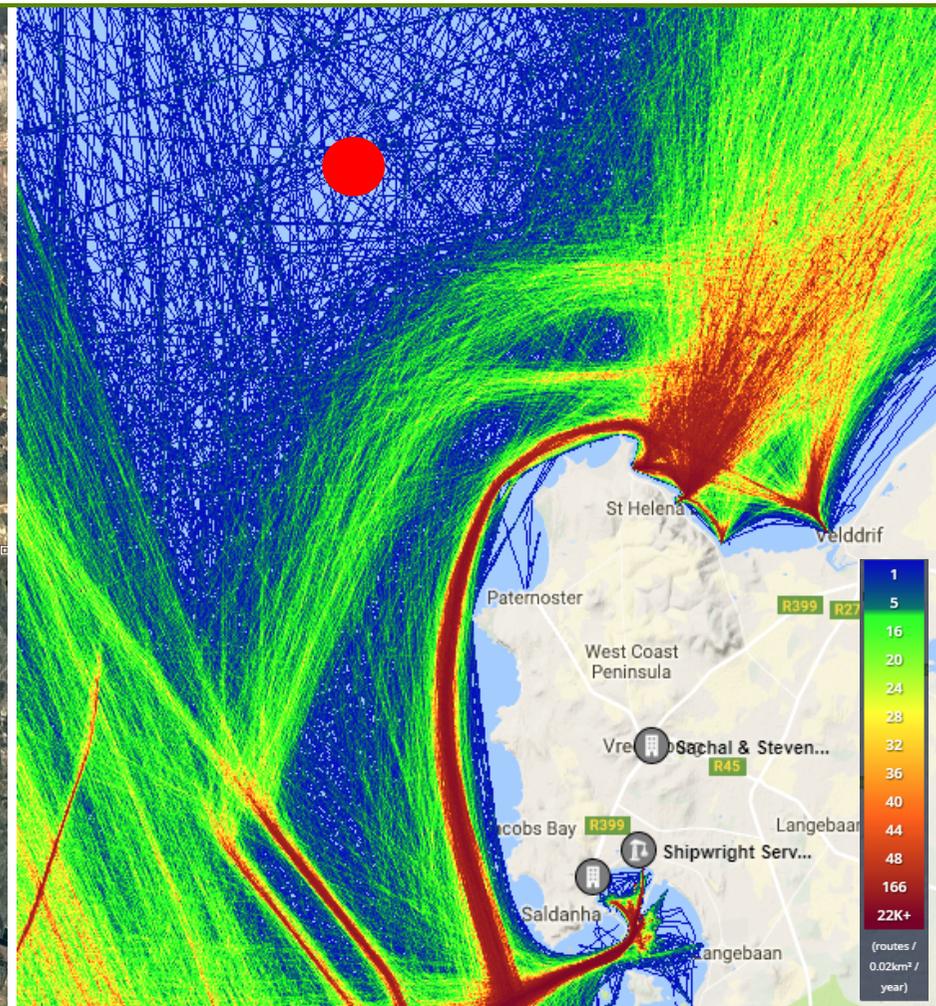


Slow moving Benguela could aid the northbound movement

Coriolis Effect beneficial towing Cape Town northwards on east-direction track

West Wind Drift could also aid the transport

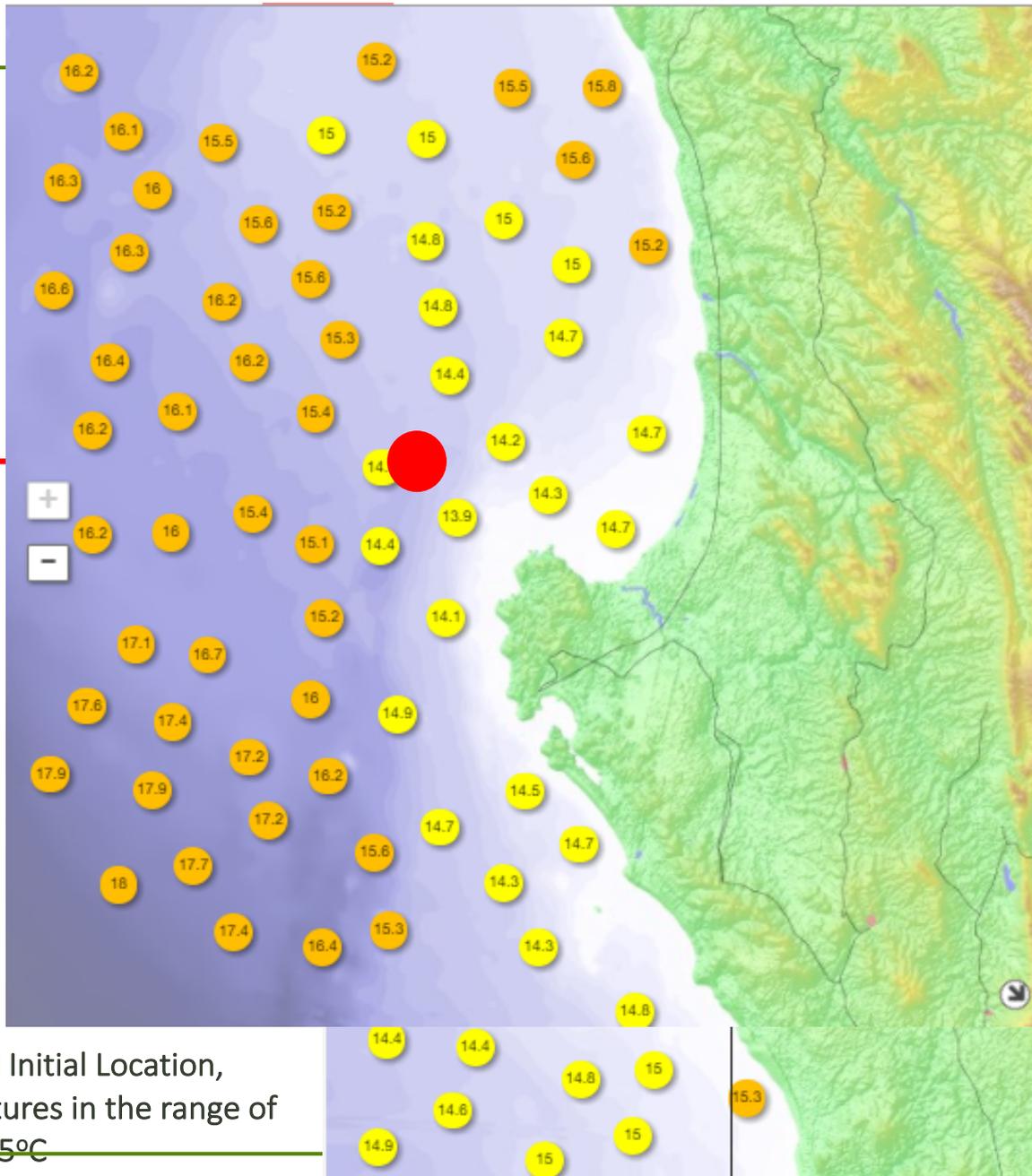
Placement: Depths and Shipping Actions – RSA West Coast



- - Proposed Initial Location of Iceberg – Cape Columbine
- - 2017 shipping activity in the range of 16 – 20 vessels per annum along that Route

Placement and Securing: Water Temperature

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to life*

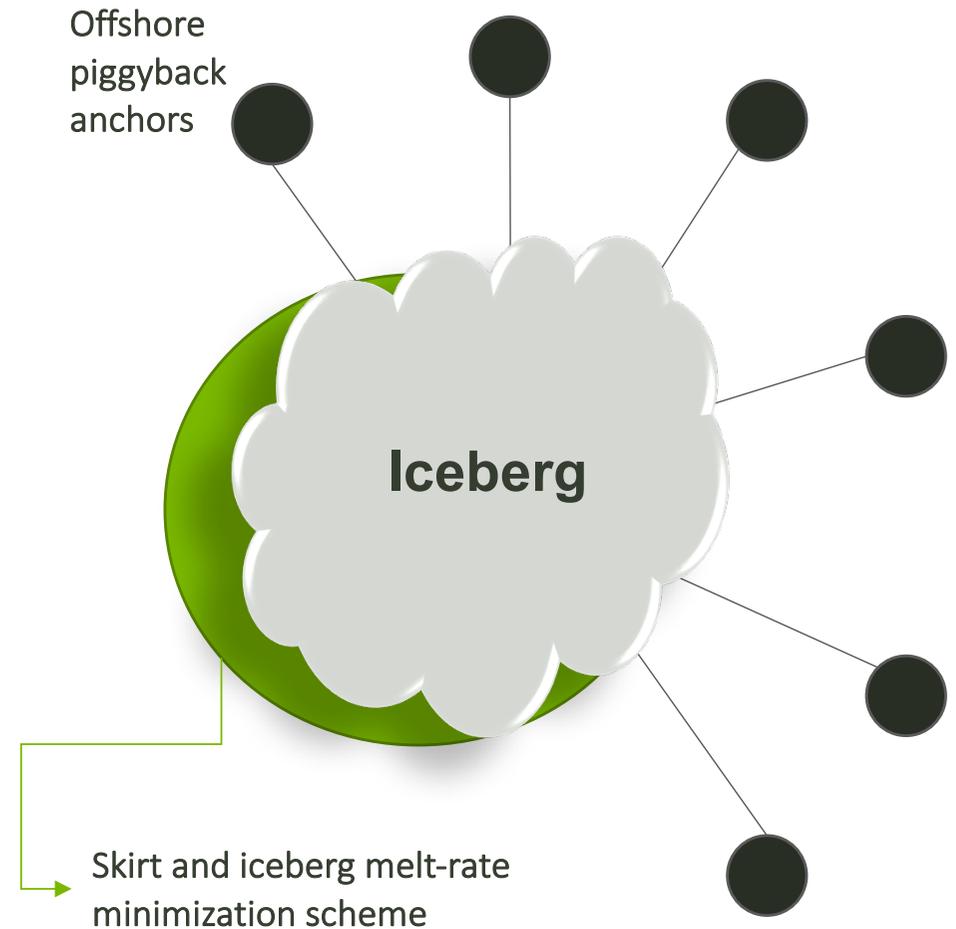


Surface
Temperatures
around RSA West
Coast
(Subsea temps
may be as much as
8-10 degrees less)

Proposed Initial Location,
Temperatures in the range of
14°C to 15°C

Placement and Securing: Anchoring

- It is proposed that initial placement will be in and around the 200m isobaths
- The Iceberg shall ground / “anchor” itself on the sea bed
- The very high forces involved in mooring icebergs requires use mooring systems – as per offshore Semi-Sub Oil Rigs.
- The skirt will remain attached to the berg throughout the year, and the depth of the skirt is reduced – as the draft of the ice-berg reduces due to the melting / harvesting on the top-sides.



Harvesting of the water: Mining Method

- It is proposed that the heavy lift helicopters are used to transport “yellow” machinery and other mining plant up from the support barge and vessels onto the surface of the iceberg
- The plant shall be re-assembled on the surface of the berg, where the creation of a “saucer” can then commence
- An open-cast mining scheme is proposed, with the envisaged result of the harvested and melted ice being a pool of water at the centre of the berg
- This water / slurry mixture can then be pumped out into waiting tankers



Conveying: Tankers and SBM scheme

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to life*

- Charters chemical tankers with food quality coatings of capacity of between 30 – 50,000 m³ to be used
- It is envisaged that a fleet of 3 – 6 of these tankers be used, in a rotational scheme
- This will require the harvest technology at the iceberg to feed water into a manifold & loading pipeline arrangement where the tankers vessel “fills up”
- It is envisaged that there should be at least 2 pumping locations around the berg, thus allowing for two tankers to be filled simultaneously
- Typical SBM arrangements can be used for the mooring of the tankers near the coastline
- A typical day in the tanker cycle is envisioned to be:
 - 8 hours filling
 - 3-4 hours travel to offload point
 - 8 hours discharge
 - 3-4 hours travel to filling point



Offtake and Distribution Water Treatment

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to life*

- To reduce the aggressiveness of the pure water from the iceberg, minor treatment and chlorination will be required on land
- The pumping capacity shall be around 6,000 cu/m per hour
- All infrastructure shoreward of the meter is proposed to be developed by investors, while land infrastructure adaptors and reservoirs could be developed through the City



Target Market

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to life*

- Bulk water – it’s “FREE” –
- BUT - “delivery” costs
 - City of Cape Town
- **Medical Research**
- Speciality product producers



MEDICAL USAGES

There is a Hungarian biologist, Gabor Somlyai who observed in 1993 that cancer cells are very sensitive for the decrease of deuterium (^2H) concentration of the culturing medium in vitro [1]. His idea was that deuterium depletion in water may delay the progression of cancer. Clinical trials with pancreatic cancer patients revealed that the consumption of deuterium depleted water (DDW) applied parallel with the traditional treatment increased the medium survival time by about 6-fold compared to the traditional treatment alone [2, Figure 1].

As far as we know **the water frozen in polar ice contain deuterium in lower concentration compared to the typical values in the drinking water of many areas** (the lowest concentration is 90 ppm versus 130-150 ppm; $^2\text{H}/^1\text{H} = 155.76$ ppm, Standard Mean Ocean Water (SMOW)) [4, 5;

The Antarctic ice is deuterium depleted by about 40% (< 90 ppm, depending on the location of the formation).

After the planned simple purification, it could be directly used for medical treatments and prevention of such diseases.

– Bulk water to City of Cape Town

- Supply 150Ml/day over 1 year = 55 million kilolitres per year
 - Pricing between long term desal and short term desal
 - Advantage of less CAPEX risk than long term desal e.g. Australian major cities
 - Advantage of more supply flexibility than long term desal
 - Advantage of far lower cost than short term emergency desal

– Speciality iceberg water wholesale

- Est. supply 10kl/day over 1 year ~ 3,650 kilolitres per year
- Revenue at market rates (current premium market)
 - International retail of end product currently at R170/litre
 - Wholesale at ~ R10/litre;

▪ Costs

- First order non-risk adjusted cost estimate ~ +/- R25/kl
- The cheapest purest water – EVER!!



CONCLUSIONS

- Glacial Bulk Water – short term solution 4-6 months – pricey
- River Bulk Water – 4- 6 months -
BUT – environmentally not acceptable & very pricey
- Icebergs to the Cape – 1 year from order...
Challenging perceptions



WHAT'S NEXT??

*Bringing ideas
to life*

Week of the 16th May –

Global experts in Glacial Ice - Meteorology –
Oceanology – Satellite Tracking – to meet in CAPE
TOWN

Objective is – IS the Ice Berg –
a “**GO**” – or “**NO_GO**”

Watch this space.....!!



**THANK YOU
FOR YOUR KIND ATTENTION.....**

Captain Nick Sloane
WWW.RESOLVEMARINE.COM
www.water-vision.co.za