APPENDIX ONE
GREENLAND FLY OVER - AUGUST 2015

Photo essay by Pete Truch

I could title this "Why I always take a window seat." There are many magical moments I recall when I was flying at 35,000 feet or more and seeing – e.g. The Grand Canyon; the Northern Lights (I can't spell Aurora Borealis) (spell checker fixed it); the Southern Cross; the Panama Canal at night; the World Trade Center (while it was there), etc. but this one over Greenland is at least relevant to share. We were flying back from a very memorable expedition - first to Budapest; then on to Romania for a 6 week archaeological dig at a Roman Fort site (Castrum Cumidava); 15-day river cruise from Budapest to Amsterdam and a week in that City.

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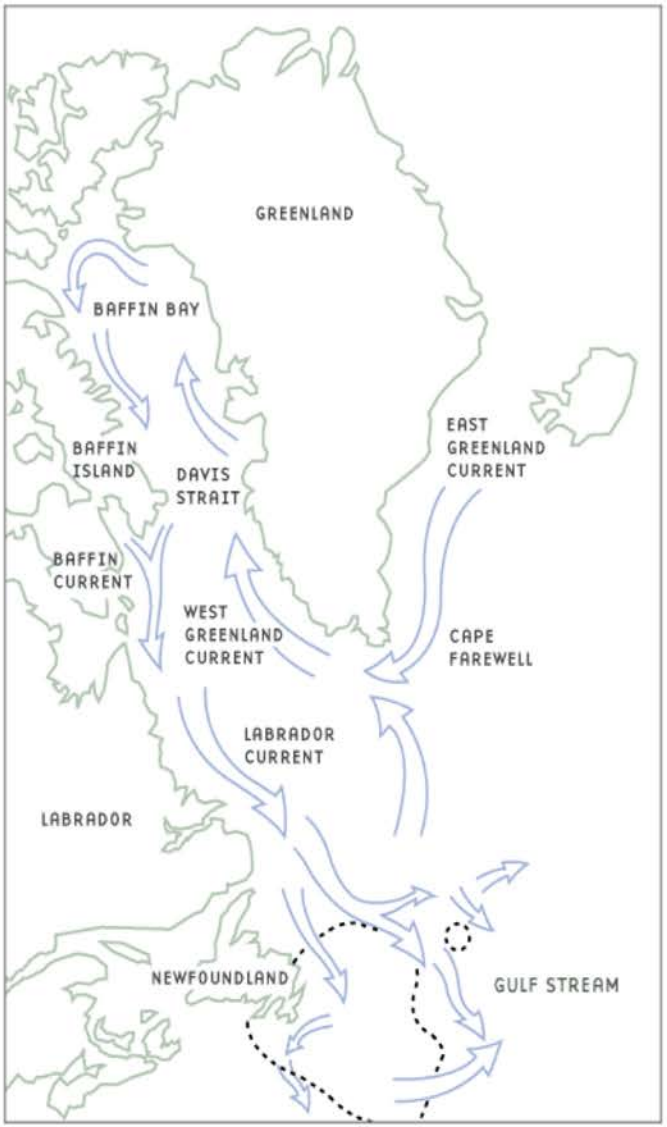
A rare set of atmospheric events transpired to give a break over the topography that is Greenland. Flying the Polar Route, I had never seen the skies so clear, and thanks to the magic of digital cameras, was able to record a number of glacial shots from the confines of a warm cabin where the monitor indicated an outside air temperature of -76 ˚F at 35,000 feet.

The bergs calve from tidewater glaciers primarily on the east coast of Greenland. Then they take a route as follows:

“Icebergs travel in the Baffin Island Current and then the Labrador Current south of Hudson Bay. Finally, they reach the Grand Banks of Newfoundland where they drift either eastward north of the Flemish Cap or southward between the Flemish Cap and the Grand Banks which is often referred to as "Iceberg Alley". The southern limit of drift is generally defined by the northern edge of the warm North Atlantic current (Gulf Stream). It is possible for icebergs to be transported across the warm current in cold water eddies, circular currents that flow in the opposite direction of normal flow. The drift of icebergs from their origin on the west coast of Greenland to the coast of Newfoundland is about 1800 nautical miles and takes an average of 2 to 3 years.” Source: https://www.canada.ca/en/environment-climate-change/services/ice-forecasts-observations/latest-conditions/educational-resources/icebergs/migration.html



DRIFT OF ICEBERGS FROM WEST GREENLAND GLACIERS TO THE GRAND BANKS OF NEWFOUNDLAND

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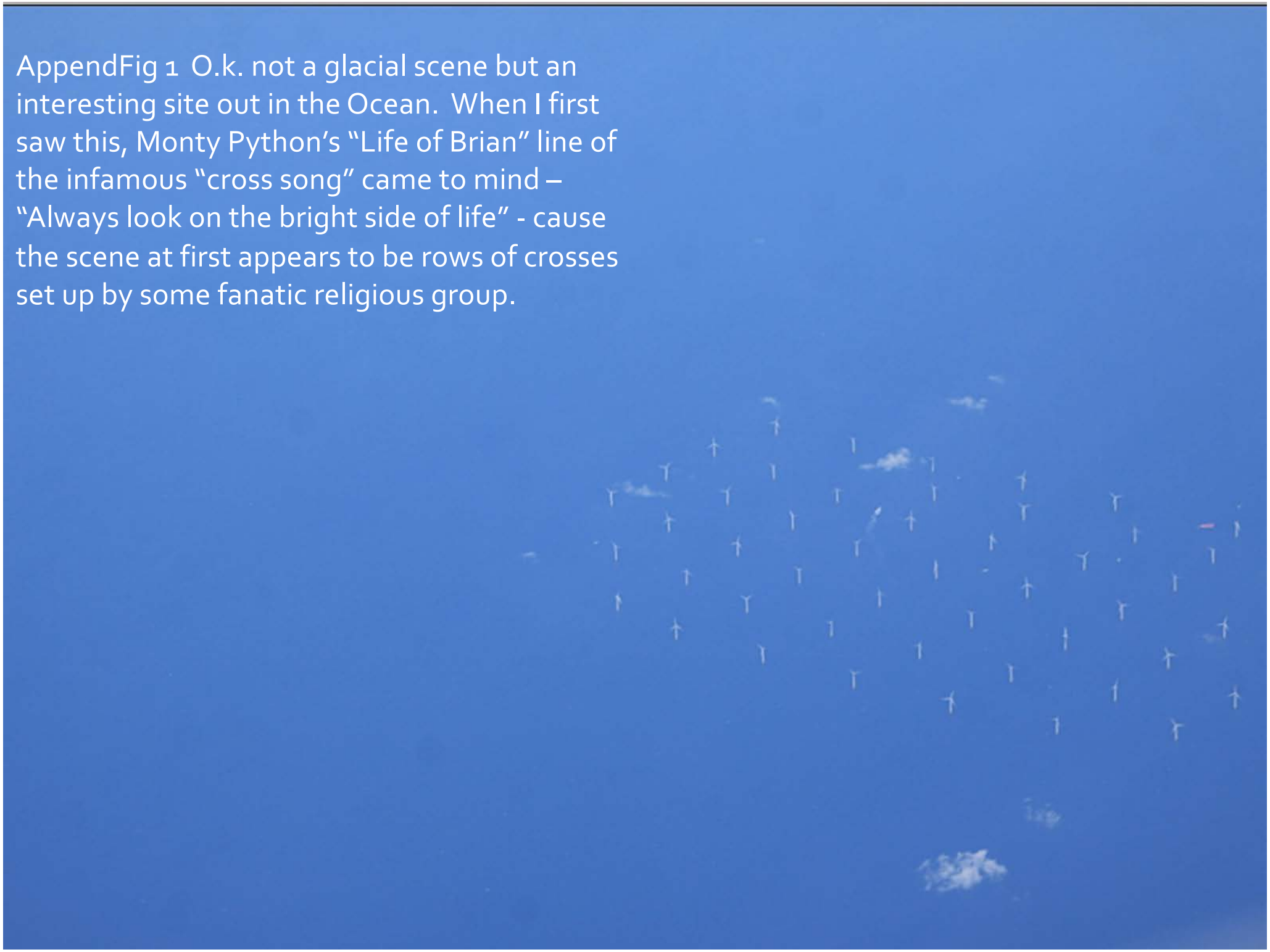
So the berg as shown in Stop Seven (St. Anthony) of the *Bulletin* article would likely have followed the route on the currents as previously described and indicated on the earlier map. Further, the Government web site offers this explanation as to why more bergs originate from Greenland:

"East Greenland, Devon, Ellesmere, Bylot, and Baffin Islands all have major glaciers that meet the water *(termed tidewater glaciers)*. Greenland glacier calving is so prevalent because, physically, Greenland is like a bowl. The island itself is actually below sea level with a huge ice dome sitting on top of it and it is this dome that rises above water. The ice dome is like a scoop of ice cream on a cone dripping into the ocean. The weight of the ice dome, coupled with wave erosion at the water line, erodes crevasses into the ice dome causing calving and fracturing."



AppendFig 1 O.k. not a glacial scene but an interesting site out in the Ocean. When I first saw this, Monty Python's "Life of Brian" line of the infamous "cross song" came to mind – "Always look on the bright side of life" - cause the scene at first appears to be rows of crosses set up by some fanatic religious group.

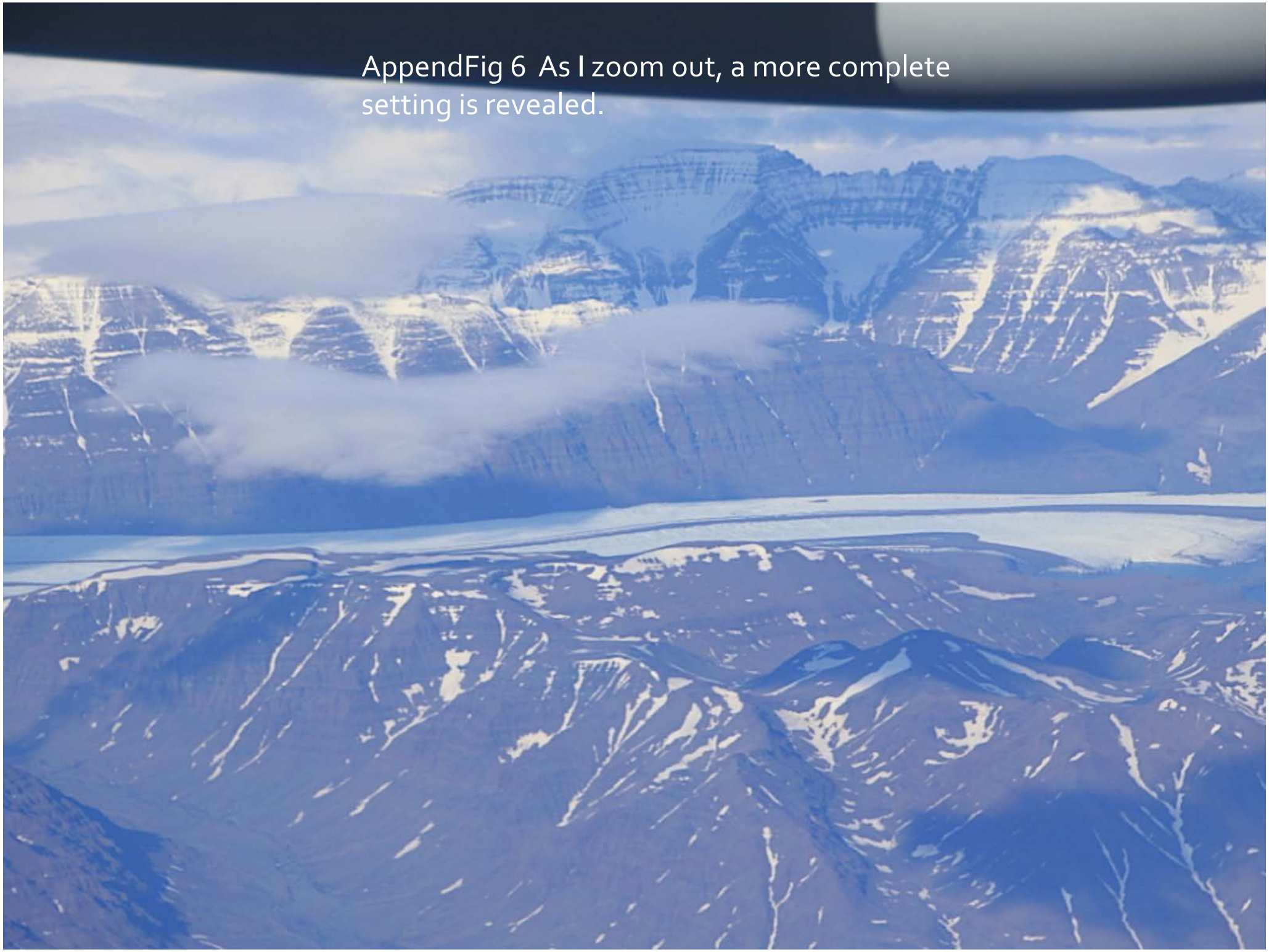
AppendFig 1a (Zoom) An Offshore Windmill Farm is revealed, and a service boat/wake is visible. Best to hide this stuff out where would-be environmentalists couldn't see what is going on, but just think of the technologies involved!

AppendFig 2 After flying for some period of time past the windmill farm, I notice 3 giant bergs and numerous smaller others from 35,000 feet. Given that height, these bergs are very large indeed and are of the size required for the long 2 to 3 year journey to become the boon of tour boat operators in Iceberg Alley in Newfoundland

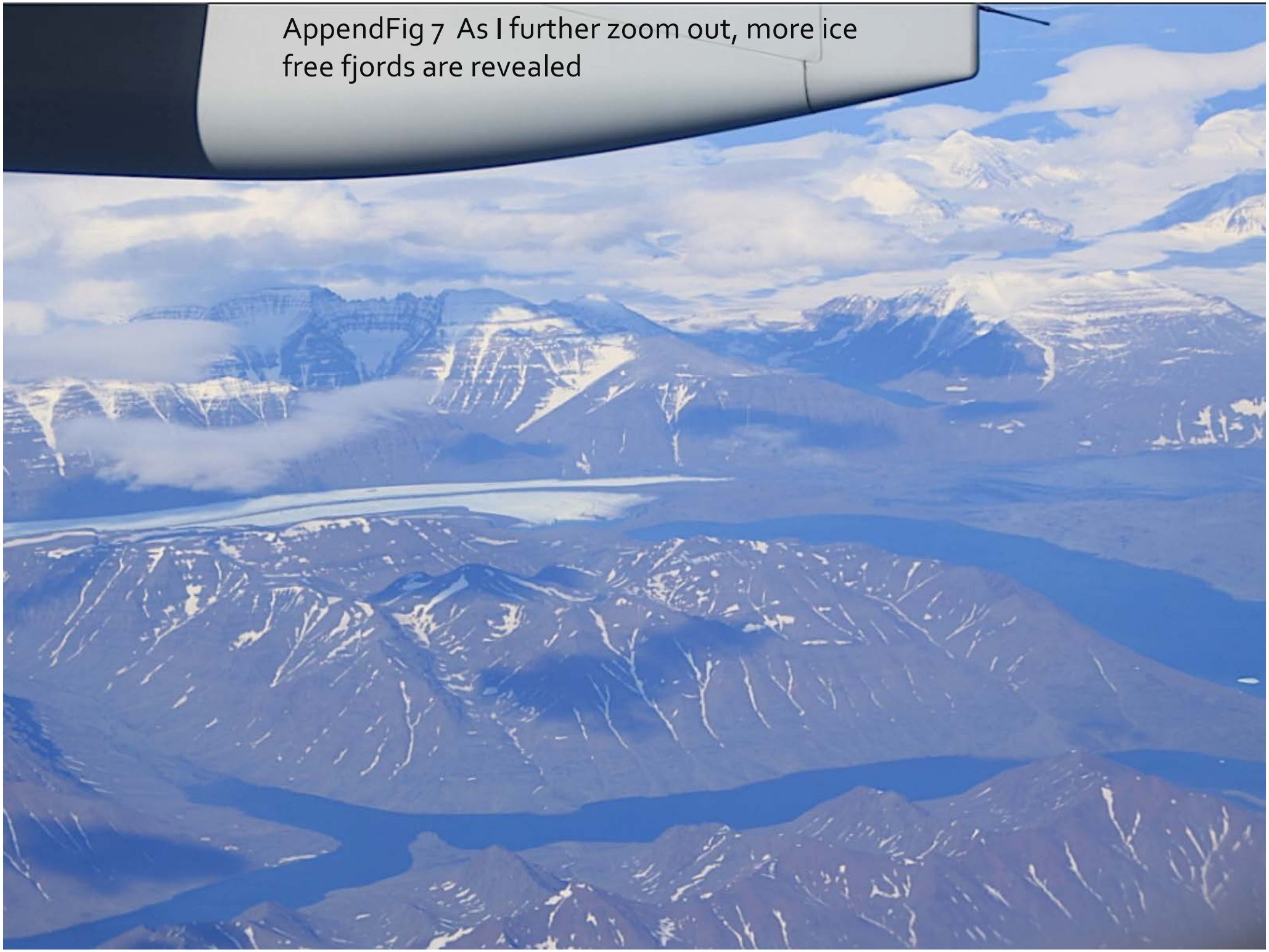
AppendFig 3 A Tidewater Glacier, the source of the bergs I first saw. The inner flap of the wing is visible in the top of the photo, as are many more bergs and the surrounding shorelines.

AppendFig 4 Tidewater Glacier in closer detail. Note the huge width of this ice face as it is split into two tidewater parts by the large rock outcrop in roughly the center of the ice flow.

AppendFig 5 The glacial setting suggests this ice river would be deemed a Valley Glacier judging by the high mountains containing it.



AppendFig 6 As I zoom out, a more complete setting is revealed.



AppendFig 7 As I further zoom out, more ice free fjords are revealed

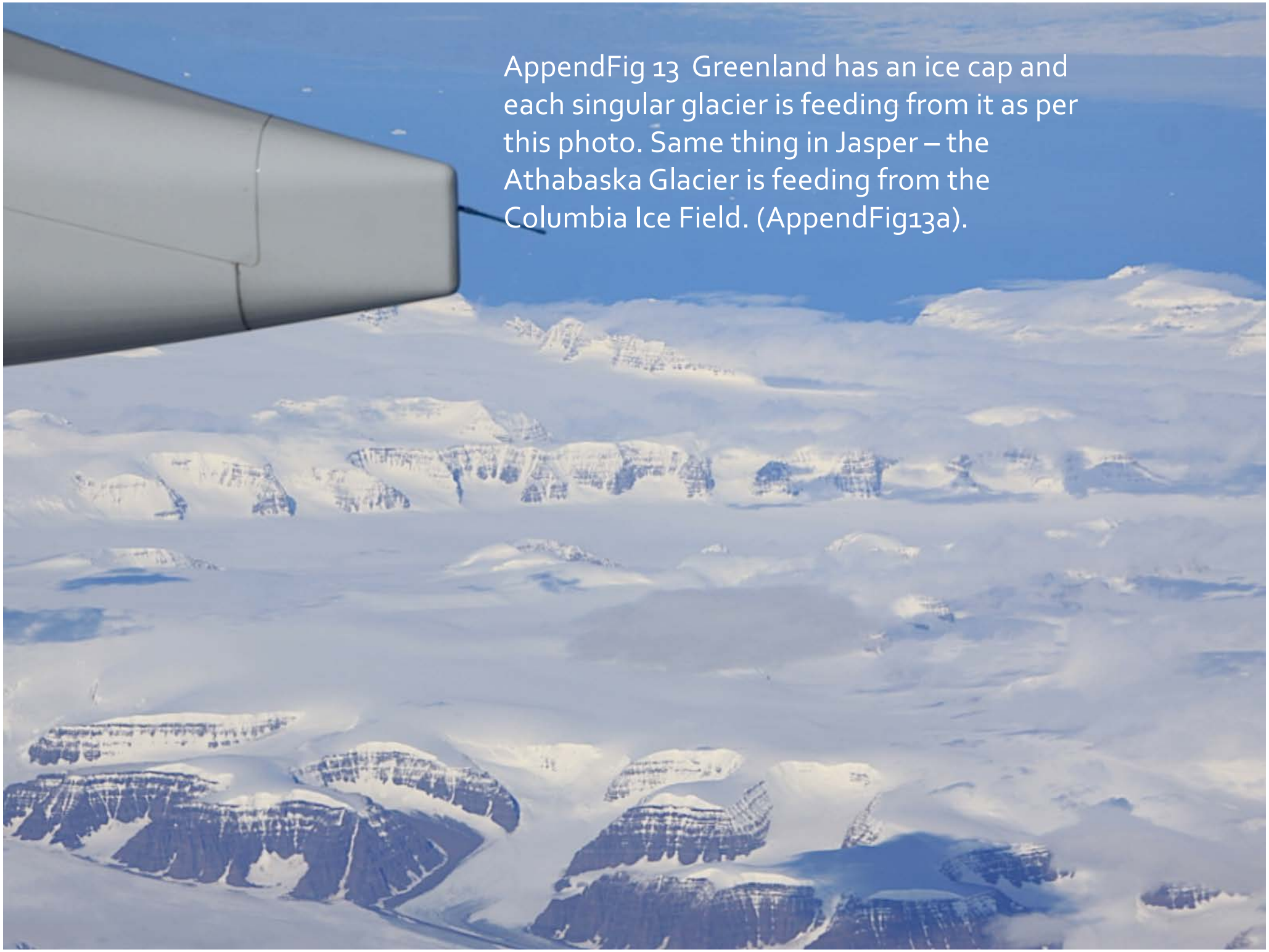
AppendFig 8 Glacial eviscerated landscape in the foreground, and the agent of change in the background. Also visible are the housings over the inner and outer wing flap controls in the top left of the photo.

AppendFig 9 —Glaciers are literally rivers of ice, moving at a greater speed in the middle than at the sides, so they always advance. They are only described as retreating when their melt zone is greater than their accumulation zone. This view of a Valley Glacier making its way down to tidewater displays strong lines of medial moraines (debris fields in the middle of the ice). Just under the inside housing of the innermost flap on the Airbus 320 wing is a single medial moraine. To the left of it is another valley glacier merging its lateral moraine with that of the main glacier and is slowly becoming a medial moraine – hence the appearance of a "double" medial.

AppendFig 10—Close up of the bend in the valley glacier of Fig 9. As a glacier moves, erosion forces work up debris, which is visible on either side of the river of ice and are termed lateral moraines. A well defined medial moraine is visible as well as more laterals coming in from the two other valley glaciers located near the top left corner and one just to the left of centre. Note also the mix of moraines to the right side of the glacier. The only other moraine is called a terminal moraine, a debris field defining the terminus of the glacier. These, of course, help define the extent of the glaciations, at least on land.

AppendFig 11 Moraines get more complicated as valley after valley merges in an almost interstate highway fashion. Moraines can contain very large rocks , which, after deposition, are called erratics; (much small ones are cobbles). (e.g. The Okotoks rock, part of the Foothills Erratic Chain, which I did an article on for Alberta Magazine, May/June 1982 "Alberta's big rock" pg. 21–23). Of course, none of the debris is restricted to moraine clustering—they can be located anywhere on the ice surface.

AppendFig 12 Cirques are the remnants of a glacial "plucking" process. (freeze/pull at the ice/rock interface). At least that's what I was taught in Geomorphology courses. But of course, in those days we barely had planes or cameras. Note the current level of the main glacier ice. When that ice disappears, the cirques will be left elevated, becoming a technical term known as a hanging valley. Good examples of these valleys can be seen on the west side of the Trans Canada from Canmore to nearly the east Banff Park entrance.

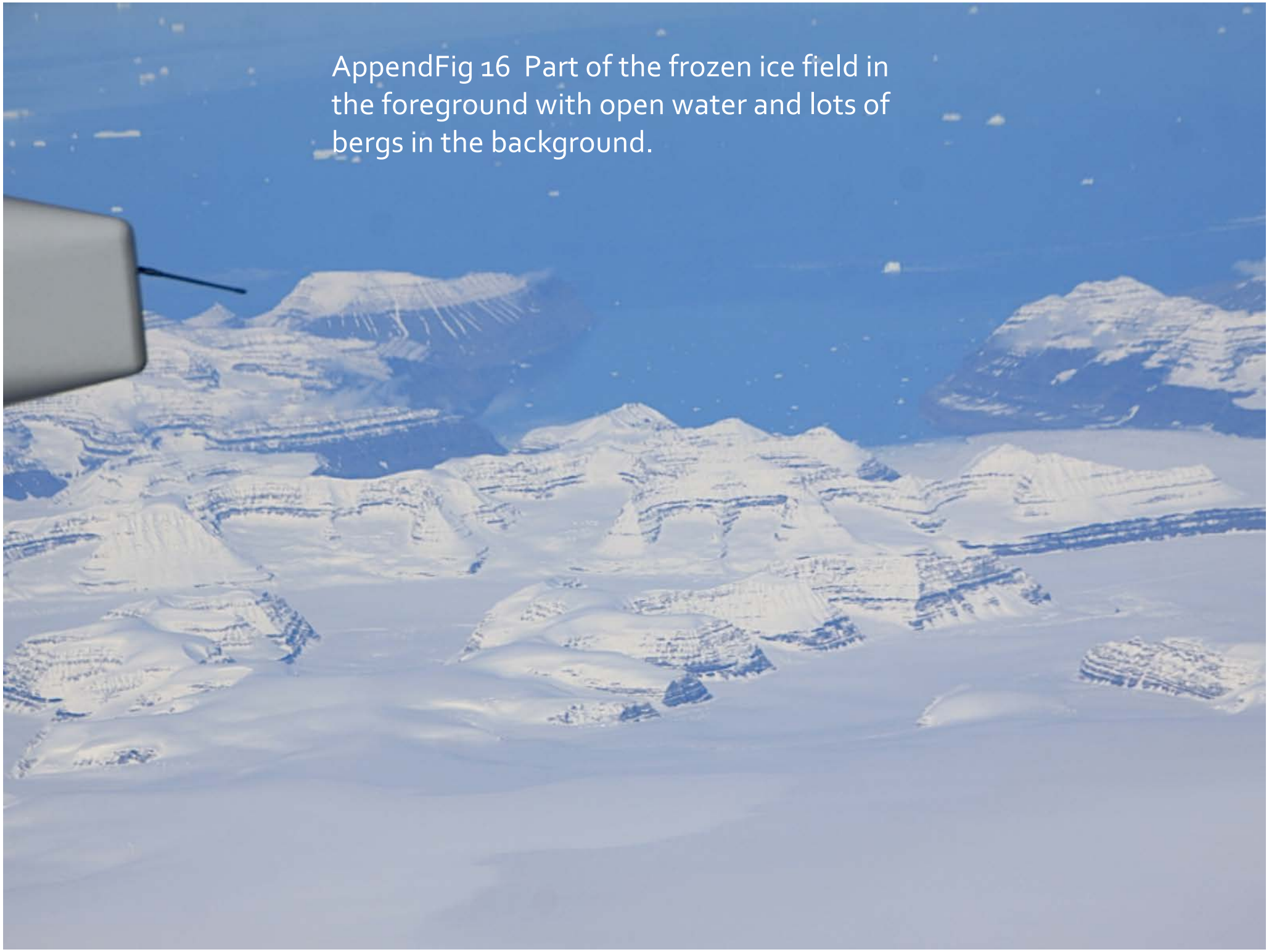


AppendFig 13 Greenland has an ice cap and each singular glacier is feeding from it as per this photo. Same thing in Jasper – the Athabaska Glacier is feeding from the Columbia Ice Field. (AppendFig13a).

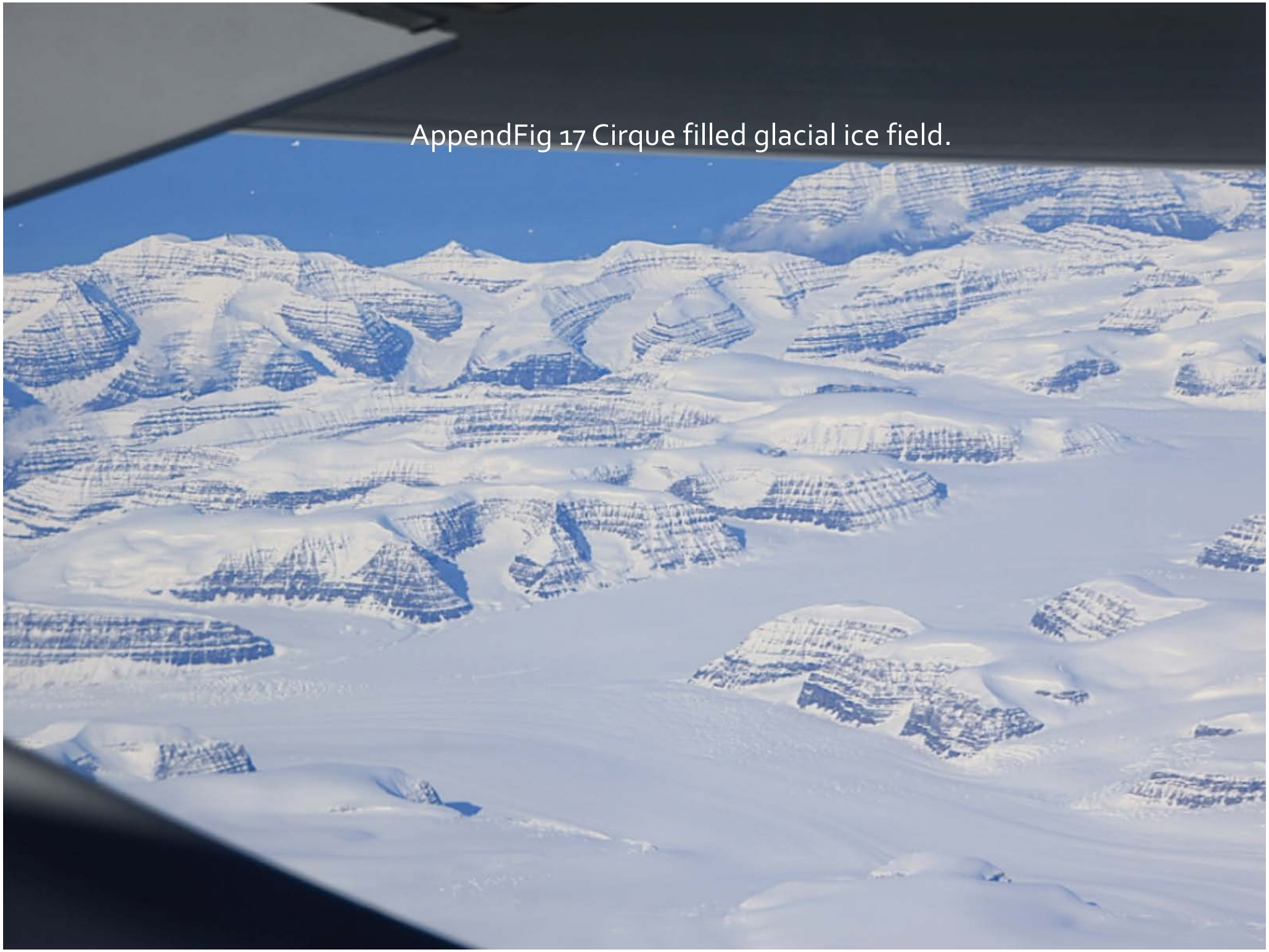
AppendFig13a Athabaska Glacier. Note also the huge lateral moraines on either side of the ice. Fireweed (*Chamaenerion angustifolium)* makes a colourful foreground.

AppendFig 14 Even large glaciers feed off the ice cap. Note some of the cirques in the lower portion of the photo are still partially filled with ice. A small lake can be forming in the hollow depression. The sharp ridges between cirques (more apparent in AppendFig 12) are known as arêtes. I remember this because of that famous French Canadian song that had the line – "Ohhhhh…, Al arête, gentille Al arête".

AppendFig 15 Separate Valley Glaciers forming from the ice cap



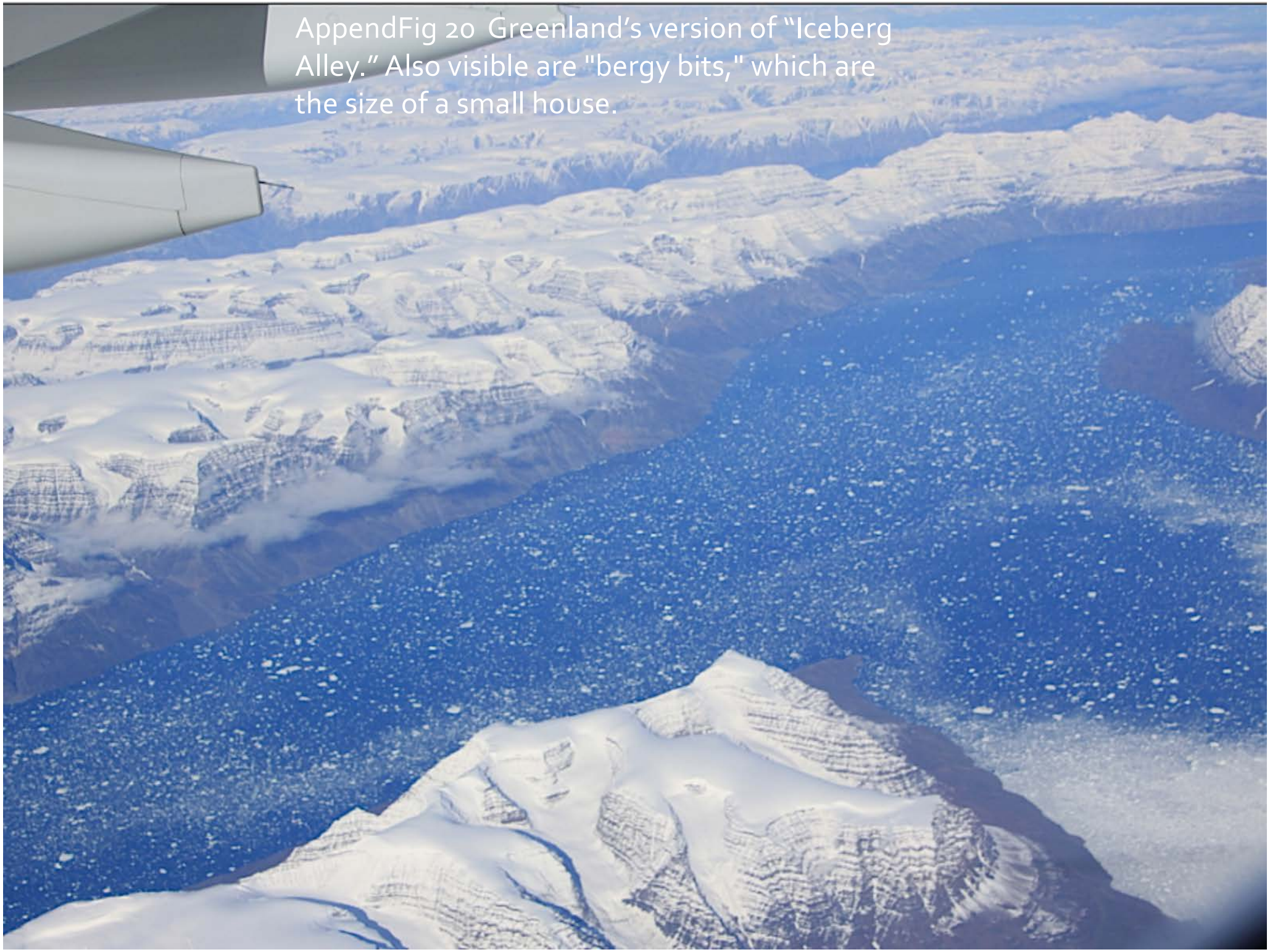
AppendFig 16 Part of the frozen ice field in the foreground with open water and lots of bergs in the background.



AppendFig 17 Cirque filled glacial ice field.

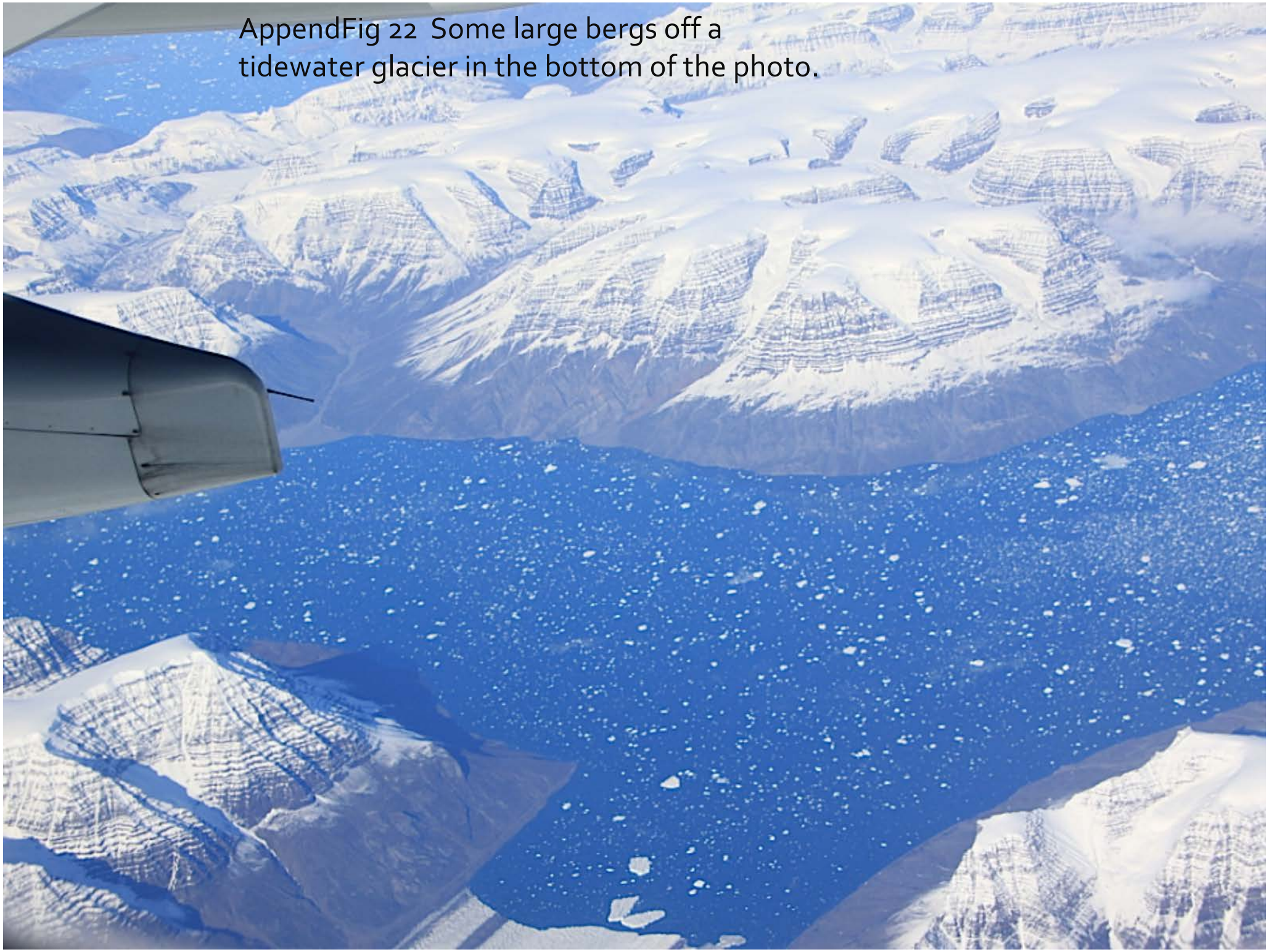
AppendFig 18 Large tidewater glacier at its terminus.

AppendFig 19 Bergs generated by the glacier dominate the fjord surface. Note the tidewater glacier/fjord interface in the lower portion of the photo, with the valley glaciers feeding from the right.



AppendFig 20 Greenland's version of "Iceberg Alley." Also visible are "bergy bits," which are the size of a small house.

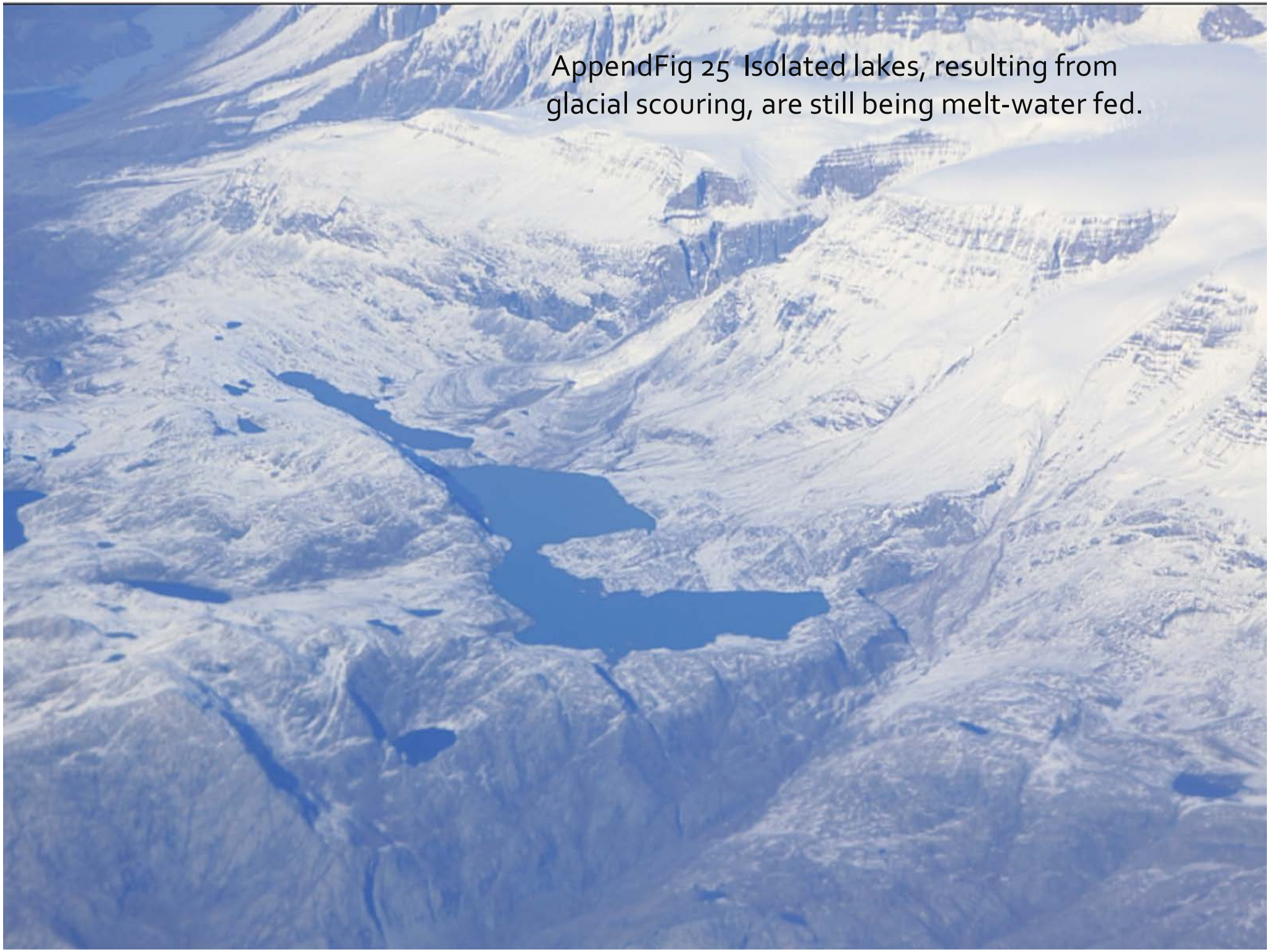
AppendFig 21 Wider view of "Iceberg Alley"



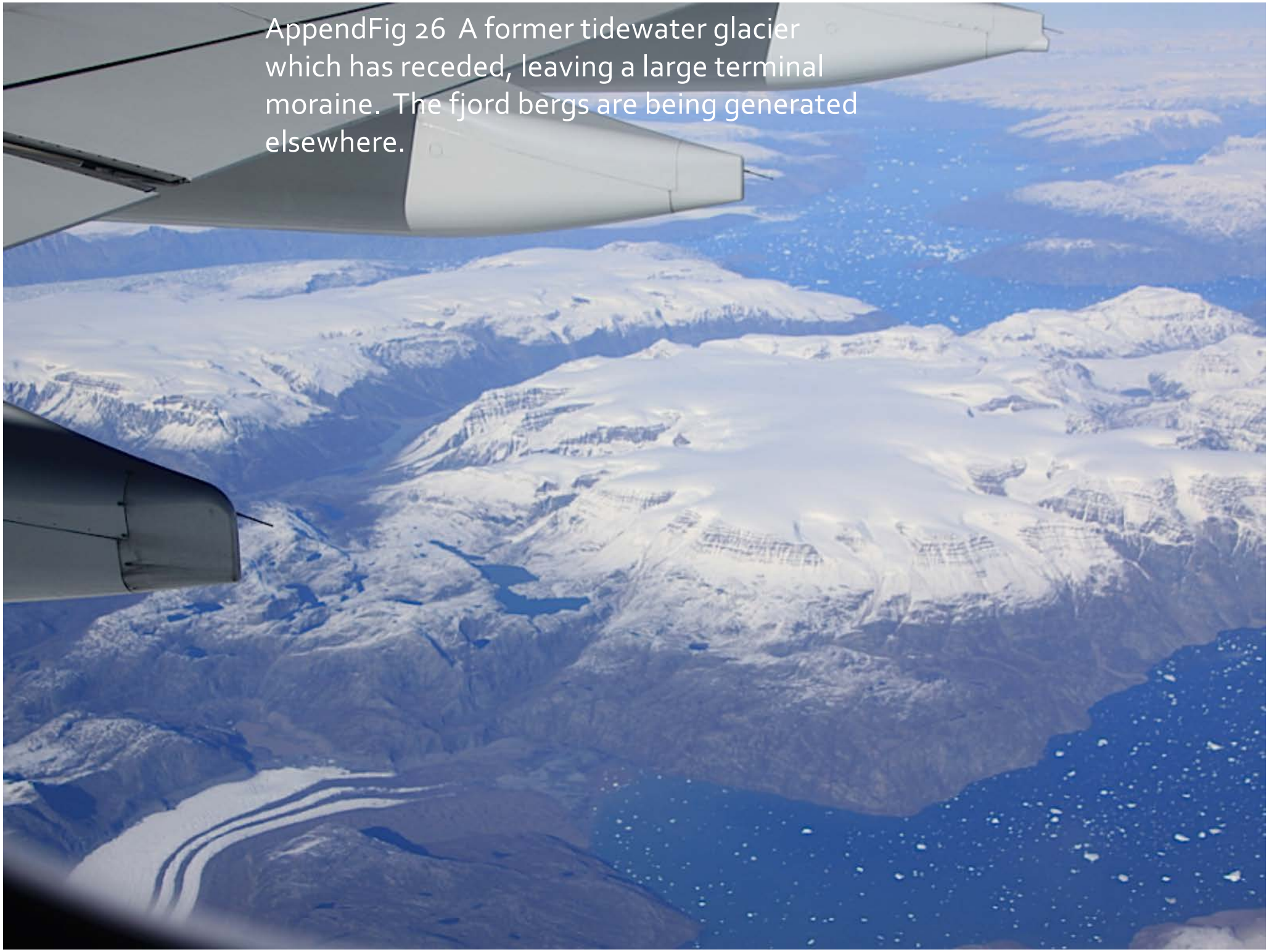
AppendFig 22 Some large bergs off a tidewater glacier in the bottom of the photo.

AppendFig 23 As the plane flies, further views come into sight.

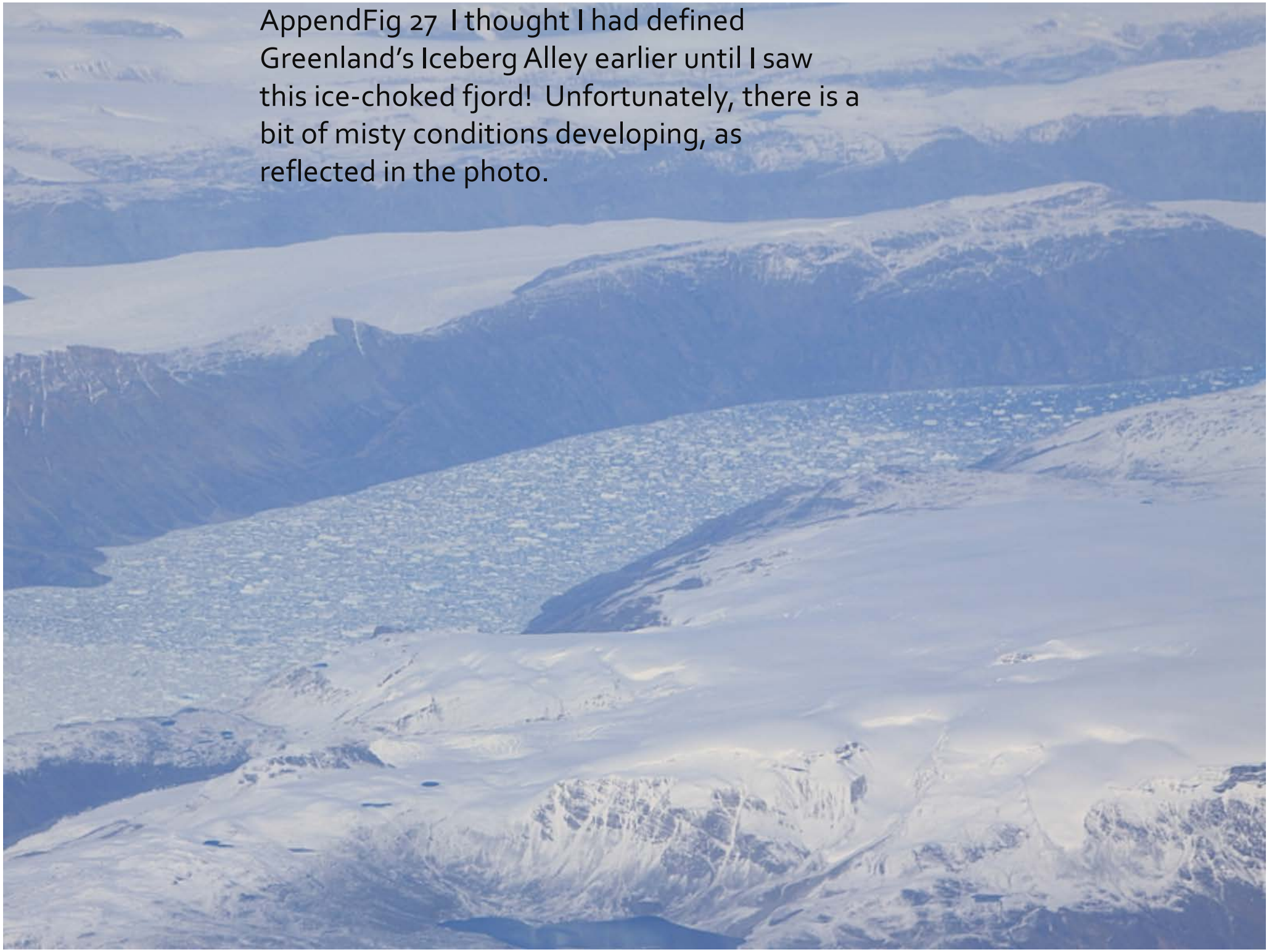
AppendFig 24 Greenland Tide Water Glacier
full view including the long fjord .



AppendFig 25 Isolated lakes, resulting from glacial scouring, are still being melt-water fed.



AppendFig 26 A former tidewater glacier which has receded, leaving a large terminal moraine. The fjord bergs are being generated elsewhere.



AppendFig 27 I thought I had defined Greenland's Iceberg Alley earlier until I saw this ice-choked fjord! Unfortunately, there is a bit of misty conditions developing, as reflected in the photo.

AppendFig 28 Tidewater's edge, just discernable for all the ice!

AppendFig 29 Full glacier view of the real Greenland "Iceberg Alley". It appears that 3 glaciers are feeding the frenzy. Note the melt water mid-glacier.

AppendFig 30 Close up of large melt water on the surface. Eventually such pools penetrate the ice and flow underneath. Also note the large flow cracks and the faint medial moraine.


AppendFig 31 Final Full View
Soon after this last shot, cloudy conditions returned till we were near Calgary.