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# Navigation as instrumental negotiation

Report and observations on a transatlantic field trip and training on sailboat “Albatros” (2016-2017)

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**TRANSAT RETOUR**

*a Knowledge in the Wind Project*

*Summary.* We describe some instrument-based practices of navigation on the high seas, and we introduce the notion of instrumental negotiation and navigational shortcut. We assess the role of astronomic navigation in second-to-second steering and in wayfinding. We detail a number of observations concerning time, space representation, redundancy as a facilitator, and the modulation of social interactions.

The report uses data collected during the trip, the Captain's logbook (fig. 1; see Appendix 2), and publicly available data about weather and sea conditions during the trip.

## Data from Captain's Journal

Position at about 17h00 UT daily

Main events

Problems

Sails

Direction and speed

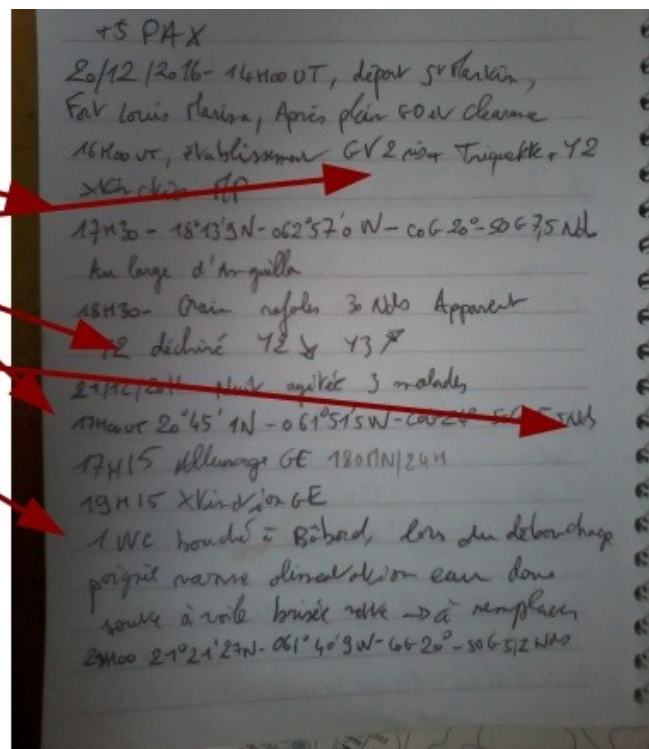


Fig. 1 A page from the Captain's logbook, with some of the main types of events recorded.

The report covers a training experience aboard a school vessel, sailboat Albatros. Alabatros set sail from Marigot on St. Martin in the Caribbeans on dec 20<sup>th</sup>, 2016, and landed at Horta on Fajal in the Azores on Jan 5<sup>th</sup>, 2017.

*The boat.* Albatros is a 67ft (21 m), 17ft beam, 9ft draught, 41 tons steel monohull, designed by David Thomas and Thanos Condylis, built in 1991 by Devonport, Plymouth UK, as a member of a monotype

fleet used for a specific race, the BT Global Challenge, that sailed around the world “the wrong way” against prevailing winds and currents. Previously known as “Albatross”, it bears hull number 4. It has been refitted in 1996 as training boat, its current use. Its mast tops 25 m. It typically sails with mainsail, staysail and jib (a number of jibs are available, yankee 1, 2 and 3, as well as genoa. However, in this particular navigation, the genoa was not used, and no spinnaker was used either.) To stabilize the mast, a running backstay is in tension in the windward side, typically on close haul. Given the use of Albatros as a school boat, no furling mechanisms are available for jib and mainsail, and there is no autopilot. This means that sails must be changed and reefed the old way, and that the wheel must constantly be attended.

*Crew.* The crew included captain and second (Cp and Sn), as well as five trainees (R, C, Pa, Pt, Pk). Cp is a professional captain (French Diplôme Marine Marchande, DMM) and Sn is a professional sailor (DMM). All trainees had previous extensive sailing experience on monohulls. Pa, Pt and Pk own and sail their own boats. C practices competition sailing. R, the author of this report, had a ten-year skipper experience, mostly in the Mediterranean. C and Pk have already practiced watchstanding. None of the trainees had before piloted a boat the size of Albatros.

*The itinerary.* The route (called a “transat retour”) is largely pre-determined by the prevailing winds.

The starting point, Marigot, is located at N 18°4'12", W 63°5'15"; the end point, Horta, is located at N 38°31'56", W 28°37' 29". The start and end point differ of more than 20° latitude and about 35° longitude. This means 2177 nautical miles (nm), i.e. 4032 km on the orthodromic.

In the first part of the journey, it is necessary to make important latitude gains before sailing eastward, in order to exit the trade winds blowing from the north-east quadrant. Once outside the influence of the trade winds, one can either go further north and take advantage of a depression flux, at the same time reducing the eastward distance given the latitude gain, or keep close to the anticyclone and take advantage of a reaching or running point of sail. Cp set for the second, less demanding solution. Albatros sailed for five days mostly northward up to N 29° W 59° (close haul) on a single uninterrupted tack, then “made a right” in the tail of a depression (reaching) and entered an anticyclonic area. It motored out of the anticyclone and sailed east by northeast (mostly broad reach/running). At the end, many tacks were necessary given frequent changes in wind direction. It motored again on another occasion, and finally when approaching the Azores on day 17. The orthodromic (great circle), shorter route measures 2177nm; our route was longer because of the various wind constraints (fig. 2-5; the estimated distances are shorter than the actual sailed distances).

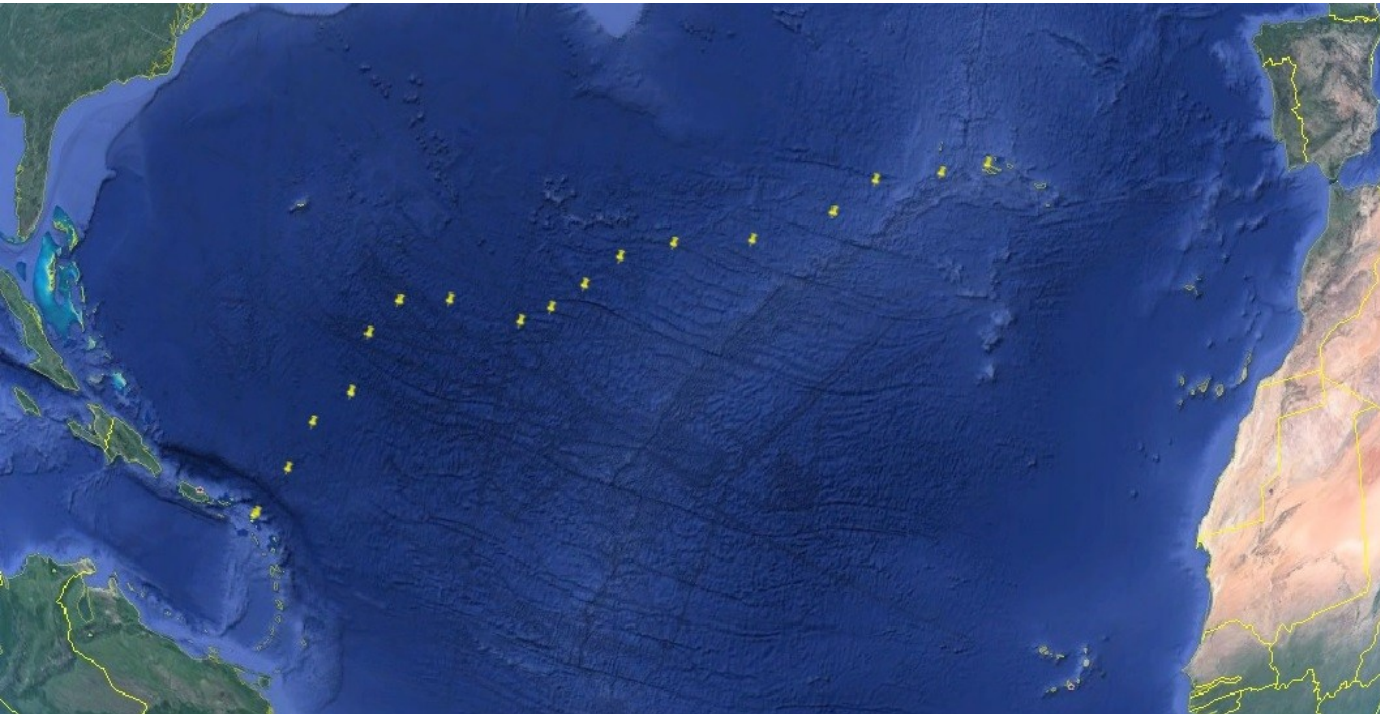


Fig. 2 The route based on CP’s logbook recorded positions

	Miles/segment	Km/segment	Km, cumulativ	Miles, cumulative ( 0,54)
12/20/16	12.96	24	24	12.96
12/21/16	161.46	299	323	174.42
12/22/16	147.96	274	597	322.38
12/23/16	139.86	259	856	462.24
12/24/16	164.16	304	1160	626.4
12/25/16	122.58	227	1387	748.98
12/26/16	137.7	255	1642	886.68
12/27/16	193.86	359	2001	1080.54
12/28/16	88.02	163	2164	1168.56
12/29/16	103.68	192	2356	1272.24
12/30/16	113.94	211	2567	1386.18
12/31/16	138.24	256	2823	1524.42
01/01/17	201.42	373	3196	1725.84
01/02/17	219.24	406	3602	1945.08
01/03/17	135.54	251	3853	2080.62
01/04/17	174.96	324	4177	2255.58
01/05/17	128.52	238	4415	2384.1
mean	140.24117647	259.70588235		
max	219.24	406		
min	12.96			
without outlier				
mean	148.19625	274.4375		
max	219.24	406		
min	88.02	163		

Fig. 3 Distances covered. These are approximated based on the Cp’s logbook, considering GPS positions, converted into distances on Google Earth.

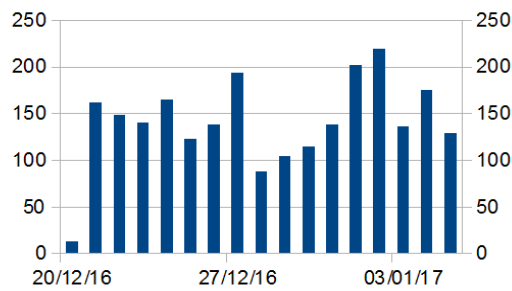


Fig. 4 Miles traveled, daily (registered at about 17:00 UT each day– hence low gains on first day, sail started out in the afternoon.)

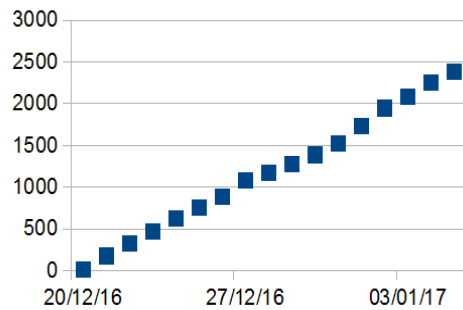


Fig. 5 Miles traveled, cumulative.

*Food.* Albatros has ample storage space, including a small fridge, for food. Fresh food was available until

approx day 12. Later on, we only ate canned food. Cooking was done on a gas stove mounted on a cardan joint. A gas oven allowed baking (bread, various meals.) We did not succeed in fishing with a line.

*Safety.* Safety briefing was imparted on crew. Crew wore life jackets and were attached to jacklines with a harness at all times when on deck, except in extremely light sea conditions.

*Watchstanding.* A typical crew of Albatros includes 10 peoples on top of Cp and Sn. Given the reduced crew, Cp set for 3 hour watches over 9 hour periods. Two people were thus permanently on deck, one of them at the wheel, with either Cp or Sn taking part in one of the three watches. In the remaining six hours, each crew member could rest, cook, eat and attend the boat. We totaled 45 watches over a 17-day navigation. Either Cp and Sn were always available for emergencies or short replacements. Watches are demanding, both physically and psychologically, and they can have an influence on short- and long-term decision-making and possibly on memory consolidation.

*Note taking.* After each watch, and sometimes during the watch, I took notes and made drawings of the salient events of the day, totaling four notebooks. (see Appendix 2).

*Observations on circadian rhythms: "boat lag".* The particular itinerary implied a significant change in both longitude and latitude. Moving North at the very beginning of the boreal winter meant moving from near equal nights and days (daytime of 11:02:55 hours in St. Martin on Dec 20<sup>th</sup>) to much shorter days (daytime 9:35:31 hours in Horta on Jan 5<sup>th</sup>). As a consequence, the proportion of night watches increased during the navigation. Moving East, on the other hand, required two adjustments of boat time (from UT-5 to UT-4 to UT-3), as sunrise and sunset would occur earlier each day (however, given the lengthening of the night as we moved North, the effect was more evident on sunsets than on sunrises). These changes, combined with a change in climate (much chiller temperatures), were large enough to be perceived, and felt as a "boat lag". The phenomenon is compounded by the unnatural sequence of watches. In our case, it took 72 hours before one could get back to a watch starting on the same hour of the day of a given watch (eg. starts at 3:00, 12:00, 21:00, then 6:00, 15:00, then 00:00, 9:00, 18:00, then back to 3:00).

*Onboard instruments and design of the training experience.* Albatros uses state-of-the art technology for wayfinding, communication and navigation. It is equipped with an Inmarsat standard-C transmitter-

receiver, an Iridium satellite phone, and GPS. Whenever necessary, Cp communicates with a ground router who sends Gridded Binary (GRIB) weather files of the sailing sector, provides four-day forecasts, and suggests an optimal route. Communication instruments are available at the chart table. On deck, the pilot accesses a traditional magnetic compass positioned just behind the wheel (model Plastimo, half spherical mount), a GPS compass with digital display and speedometer (indicating ground speed), and two wind instruments (a general purpose one, indicating the angle and speed of the apparent wind relative to the boat, and one for close haul, essentially an amplification of the former.) GPS and wind instruments are located three meters in front of the wheel and on some occasions are not easily visible (see fig. 1). A traditional low-tech wind instrument situated at the top of the mast can be seen from the pilot's position.

I carried on board a sextant (Davis Mark 3, a simplified training sextant) and made meridian observations whenever conditions made it possible. The purpose of the use of the sextant was to measure the difference with the GPS position, and to check on a possible improvement of personal measures over time.

	error, km	in direction
20161222	484	117deg
20161223	226	194deg
20161225	264	196deg
20161230	278	61deg

Errors in sextant measurement (for the only four days in which it was possible to use the sextant)



With the exception of Cp and Sn, no trainee was allowed to communicate with the mainland. E-mail facilities and phone facilities were not available to trainees. This particular choice has the purpose of avoiding distraction and also of avoiding the acquisition of information that could disrupt the demanding chores of the navigation. Over long periods, of course, the trade-offs of ignorance and anxiety need some adjustment.

*Difficulties.* We experienced moderate-to-serious sailing difficulties on a number of occasions, in one case due to incorrect or absent weather forecast, which left Albatros over-canvassed. We had to postpone the departure due to weather conditions, and gusts over 30kn on Dec 20<sup>th</sup> ripped the Yankee2. On one occasion (Jan 4<sup>th</sup>) we had to flee the bad weather, with 45kn gusts on running, high (6m) waves and consequent surfing.

In all, we came close enough to sight a dozen big vessels – container ships or tankers. On one occasion (at night) , the distance was as low as 200 meters. On another occasion, the other ship steered clearly in order to signal its awareness of our position. On a third occasion we spent twenty minutes before determining that we were not on collision course with the vessel. We turned the AIS on every time other vessels were in sight. (It must be said that not all large vessels appear to have AIS turned on.)

*Animal sightings.* On a number of occasions we could see spotted dolphins, and on Dec 31<sup>st</sup> we encountered two sperm whales.

*Sky phenomena.*

When we left Marigot on Dec 20<sup>th</sup> the Moon was in its last quarter. Thus star visibility increased until new moon, on Dec 29<sup>th</sup>. On moonless nights, the absence of light pollution makes it possible to observe the faint light of the background sky (behind visible stars), which is all the more remarkable as passing clouds are surprisingly *darker* than the background sky. After the setting of the Moon, we observed Venus-light and Sirius-light (analog to Moon-light).

*Second-to-second navigation.* Second-to-second navigation is not the same thing as wayfinding on a larger

temporal and spatial scale. However, it is a necessary element of navigation: you cannot reach your remote target (the Azores) if you do not move *now* from *here* to the next useful location (negotiating the next approaching wave, say in an unfriendly upwind condition.) Progress is necessarily local and continuous; there are no magic quantum leaps in navigation. How is second-to-second navigation performed, and what is the role of navigation instruments in second-to-second navigation?

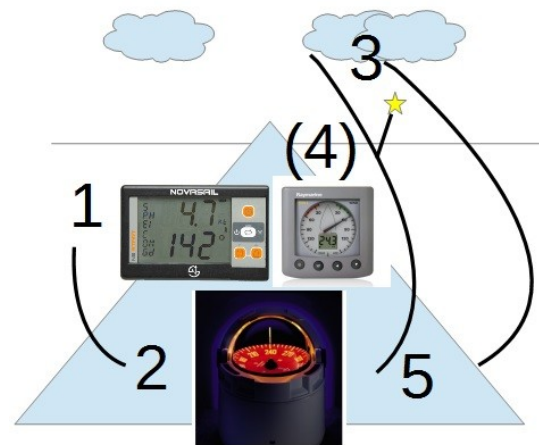


Fig. 6 Left hand: Albatros' deck: GPS compass and log, wind instrument, and magnetic compass. Note the peculiar distance of a subset of the instruments from the wheel. Dec 25, 2016. Image credit: Roberto Casati. Right hand: The instrumental cycle.

*Instrumental negotiation.* In a typical situation, Cp tells the helmsman to keep a route that is (for example), about  $95^\circ$  on GPS, about  $110^\circ$  on magnetic compass, and  $45^\circ$  to the wind. How is the helmsman to keep to this route in the hour that follows? My observation is that *she engages in instrumental negotiation*, with various back-and-forth between instruments and some features of the environment when available, following a more or less precise *cycle*. A bodily feeling of the boat's position relative to wind and waves, and a feeling of the dynamics of the wheel are mobilized as well, although they sub-serve the interaction with the instruments (fig. 6).

It is to be noted that the instruments used come in a variety of very different features or *representational styles*. The GPS compass – provided with a digital display – determines a bearing (of the direction of the boat's main axis) based on the recording of two different positions of the boat at different times. Its

accuracy depends on the length of the interval between measurements (sample frequency) (Thurston *et al*, 2006), with a complex tradeoff: if the sampling frequency is too high, the bearing will change too quickly because of the continuous yaw (pivoting) of the boat; if the frequency is too low, the bearing will be truer to the general direction of the boat, but will not be useful for the second-to-second navigation. The magnetic compass, mounted on a hydraulic cardan, has a certain mass that stabilizes it, but that also makes its movements ballistic. The wind instrument, registering apparent wind, i.e. the vectorial sum of true wind and movement-generated wind, is extremely sensitive to boat movement: as the sensor is mounted at the top of the mast, it is influenced by the neverending accelerations imparted by each of roll, pitch and yaw of the boat.

Cp and Sn discouraged trainees to use the GPS for steering the boat, and asked us to just check on it from time to time as a backup for the general route direction and for detecting wind changes. They insisted on using the compass first, and wind instrument second. (We spent the first two days of navigation in practicing instrumental navigation under the supervision of Cp and Sn.)

Steering is influenced by the interactions of the boat with wind and sea, which depend on some design features of the boat itself. Albatros has strong weather helm, i.e. it tends to run towards the wind as soon as it is given the possibility to so do, and the tendency must be counterbalanced by constantly acting on the wheel. Untimely action results on further weather helm, and requires much more energetic counterbalancing. As weather helm makes the boat deviate from its intended direction, it must constantly be counterbalanced by the helmsman, who at the same time must keep an eye on the instruments to make sure that the maneuver does not take the boat too much off course.

The difference in readings between magnetic compass and GPS compass is a standard issue in navigation. Not only the magnetic compass points to the (imprecise and large area of) magnetic north, but it is strongly influenced by the presence of metallic masses on the boat. This is all the more the case with Albatros, a massive steelboat. Some boats come equipped with a polar representation of the deviation, that is felt differently for different orientations of the boat (in some cases magnetic pull and the pull from the boat's iron masses add up, in other cases they cancel each other). Polar representations can be studied and used to assess the reliability of the magnetic compass for each bearing. However, in the presence of the GPS compass, it is sufficient for the helmsman to keep for a while a direction in order to get an immediate estimate of the deviation, by simultaneously reading magnetic compass and GPS compass. The figures

given above are representative of some segments of the route we followed (an approximate 15° deviation).

Moreover, magnetic deviation has no major practical consequences on second-to-second navigation. As a matter of fact, the magnetic compass is massively used in steering *not because of its capability of accurately representing a direction* (as we have seen, in this respect the magnetic compass is inaccurate), *but because of its high sensitivity to local changes in direction*. The helmsman needs to constantly consult it in order to correct the changes in direction imparted by the wind and the waves. Our observation is that the magnetic compass is the most used instrument during steering. Its use is explicitly recommended by captain and second, who specifically trained the crew in the use of the magnetic compass in the first hours of navigation.

GPS's standard digital display and its sampling frequency make it difficult to see acceleration, i.e. rate of change, in angular movement. These are instead perfectly visible on the face of the magnetic compass. In that sense, the GPS compass forces the helmsman to do *costly inferential work*: first, observe a certain sequence of bearing, say 75°, 75°, 76°, 78°, then infer an acceleration. Even with a sampling rate of a second, it takes too much time before one realizes a problematic change in direction. *This inferential work is not needed when using the magnetic compass*.

A side advantage of the magnetic compass is its robustness. As it does not depend on the power supply of the boat (except for the night light, which can be provided by a headlight), it works in all conditions. GPS and wind instrument may just stop working because of a shortage in the power supply.

*The value of redundancy*. Studies of wayfinding (Koester 2008; Huth 2013) point out the importance of redundancy as a factor of success. Reliance on a single instrument or body of knowledge is fragile – the instrument can break down, and knowledge may be contextually impossible to apply (for instance, poor visibility can prevent the wayfinder from using her knowledge of constellations.) Our observation is that redundancy is an important *facilitator* in the case of second-to-second navigation as well. In theory, the helmsman could perform the second-to-second steering by using just one of the three instruments, i.e. without consulting either of the other two. In practice, the inferential work required by the GPS compass, the lower accuracy of the magnetic compass, and the general interest of the wind instrument (detection of wind changes), together militate for an endless instrumental back-and-forth.

*From instrument to environment and back. The role of stars and clouds*.

When navigating near a coastline, one can eyeball a number of environmental features and use them as

cues to navigation. (This is not in general recommended on close haul, where the combination of drift and visual alignment with target makes the boat stop facing the wind, as taught in sailing classes and textbooks, e.g. Castiglioni and Bagliani, 1985). Eyeballing is obviously not possible on the high seas, where visual patterns are unstable to the point of appearing random. However, the marine environment is not clueless, and given the large adaptive capital stored in the human orientation system, the brain uses spontaneously whichever cue is available (Denis 2018). The main visually salient items are *proximal waves*, *near and distant clouds*, and *remote stars and planets*. It should be noted that each of these items is in constant motion relative to the observer, in idiosyncratic ways. Waves have periods measured in seconds, clouds can move a few degrees per minute, depending on distance and wind speed, and stars have visual angular motions of up to 15°/hour (¼ of a degree per minute), depending on their position of the celestial vault and the position of the observer on Earth. Casati 2017 suggested that the human navigation system should actually inhibit relying on clouds and waves in order to keep a direction, and although this holds in principle (one should not head for a cloud that will change its position in a few minutes!); the ground truth is more complex.

The key point is, clouds and stars undergo *sufficiently small angular motions* relative to the boat over short time spans. A cloud that is 5 km away and that moves at a speed of 30 km/h (0.5 km/min) along the normal to the observer, i.e. in the most unfavorable case, will span an angle of less than 6° ( $\arctan 1/10=5.71^\circ$ ) over a minute. Clouds or cloud features (the top, the tail of a cloud) can thus be and are used for second-to-second navigation, under the condition that the helmsman “refreshes” the sighting at a reasonable rate (say, once a minute), by checking back one of the navigation instruments. The same holds for stars, for which the refresh rate is less demanding (as a rule of thumb, once every ten minutes.) In practice, the helmsman visually aligns the mast with the nearest available star or cloud feature, and tries to keep the alignment for a certain time interval.

The great cognitive advantage of distant environmental cues is that they are, first, more ecological than a compass' face, thus the visual system can more easily take them in, and, second, that they are seen along the boat's main axis, with bow and sails always in view, so that the minimal deviation from route is immediately detected and can be corrected in real time; third, corrections can be much finely tuned than by looking at the compass, whose resolution depends on the thickness of the lines printed on its face. There are strong cognitive incentives to use distant landmarks, in spite of their costs: and the costs can be mitigated by inserting the landmarks in the instrumental cycle.

On our navigation, clouds were typically benign local storm lines, at different angles and distances from the boat. We only had completely clear skies on three days and completely covered sky on five days. On two nights out of three it was possible to sight at least some stars that were useful for the helmsman in positions close to the horizon for a sufficiently long, if discontinuous, periods of time. In general, for the most part of the navigation, environmental cues were available and regularly used.

*The navigation cycle.* The typical navigation cycle is thus the following. A bearing is determined as the general target of the boat, based on the destination's location and current wind direction. This bearing is already the result of a compromise (speed-bearing compromise): as the boat is faster at certain angles to the wind, approaching that angle will produce mileage gains, but may distance the boat from its destination. Once the optimal bearing is determined, the helmsman converts the GPS true direction into its magnetic compass equivalent by aligning the boat with the GPS compass and quickly reading the magnetic compass. The magnetic compass direction is mentally memorized. Then the cycle moves to a compass-environment loop. On a one minute (clouds) to ten minute (stars) period, environmental cues can be used effectively, after which the magnetic compass takes over, in general in time for the cycle to get started anew. The wind instruments and the GPS compass are checked from time to time.

*Use of stars for orientation: an observation and a hypothesis about naming the stars.* On the second night of navigation, Sn instructed the crew to use stars for second-to-second steering. On another occasions, she told me "I'm looking for a star for you to follow". As it happens, I am a stargazer, and in the past years, before any extended journey at sea, I set myself the target of identifying and learning the names of fifty stars and constellations. This created interesting conversations as I was able to name some of the stars that were used for second-to-second steering, or at least stars that were in the useful vicinity (Fig. 7).

From Day 2 journal (22.12.2016): "*Stars used to steer (actually, it was Capella). Then Dubhe at 10p. (I did not recognize it at first.) Spent one hour trying to figure out known stars. Wonderful December sky, but oriented differently. What is up, what is down? - relative to Orion.*"

As we were still close to the tropical area (on night 2, between N23° and N24°) it took me a while to find the stars I knew, given the different orientation and position in the sky. Moreover, in the learning phase years back, I never had had such a complete view of the sky, in such unusual sighting conditions (no light pollution), which made many more stars available to the naked eye than I was used to, paradoxically

creating information noise.

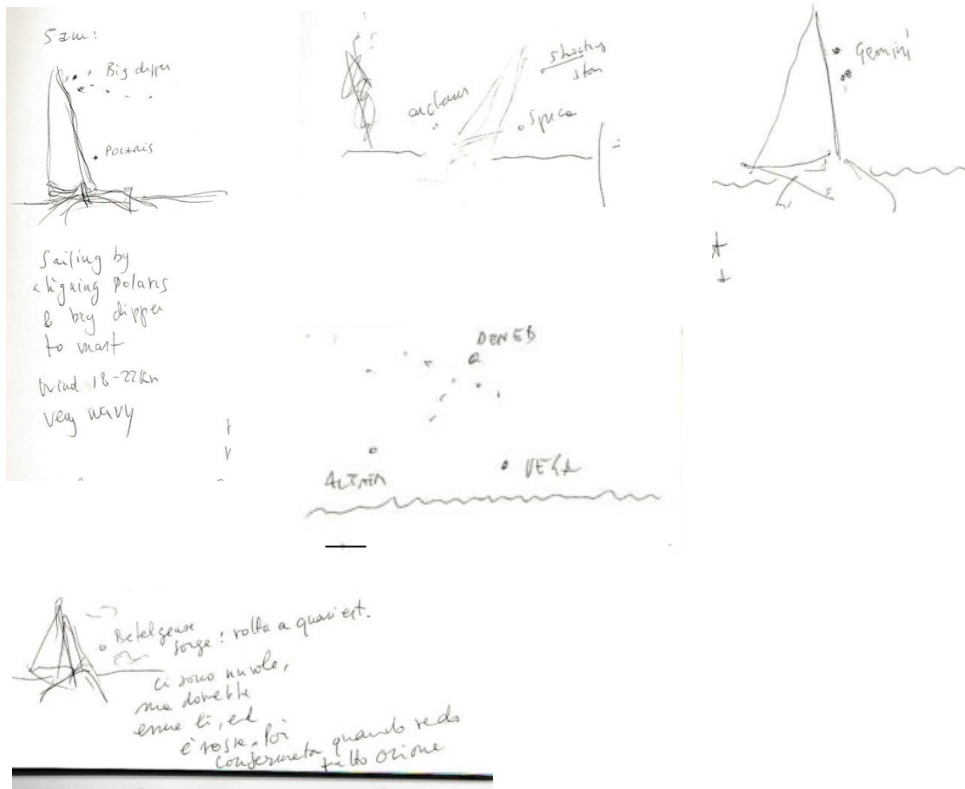


Fig. 7 Some observations of stars (from Author's notebook).

This observation suggests a theory about the origin of names of stars and constellations. The hypothesis is that they were used at first *not as elements of a general, unified map of the sky*, of determining long-range routes, but for *locally helping out second-to-second navigation*. As a matter of fact, with the notable exception of Polaris, the possibility of using star sightings for planning a long route depend on the availability of accurate ephemeris tables specifying the elevation of stars at any moment in the night. On the other hand, no particular knowledge is required for negotiating second-by-second steering using a conveniently located star. However, effective communication requires alignment of referential practices. “Align your bow with that star over there” “Which one?” “The one that seems to be at the end of a dipper”. Hour after hour, night after night, names would appear and consolidate, in particular as the route would not change dramatically. (In our own navigation, we rarely had to steer West or South – 300° and 120° were the west-most and south-most bearings, respectively. Historically, sailing across the Mediterranean with no land in sight may take up to two-three full days (Wolfschmidt 2008), thus two to three nights, depending on route, and trying to keep a constant direction would be the logical way to sail from land sighting to land sighting.)

An experienced helmsman would probably be able to use stars for determining a route (Giudici 2016), but on top of that stars are of extreme usefulness for keeping a direction on second-to-second navigation, hence communicating and reasoning about them would create a sufficient pressure for consolidating names over time. The proof of concept of the likeliness of this historical source for naming is thus provided by the current sailing practice.<sup>1</sup>

It would be nice if stars could come packaged in neat constellations that are clearly delineated from each other and against the background of the sky, but this is not the case, as is testified by the cultural variation in constellation shapes. Constellation merge into each other and very clear skies make a number of “distracting” stars salient.

Some differences in star behavior became apparent as we moved North. Near the equator, equatorial stars such as those belonging to Orion undergo fast angular motion, but keep a more constant bearing for a longer time (Krupp 1983). The direction in which we see Orion changes at a faster rate at higher latitudes. This acquired some importance as in the second week of navigation we started heading East, and used stars in Orion and then Leo as guides for second-to-second navigation. In the first week (sailing North) we mostly relied on Polaris, Cassiopeia, the Big and Small Dipper, and later in the night on Arcturus and Spica. Except for Polaris, these stars display a very perceptible pattern of counterclockwise rotation. This would make them useless for keeping a long-range route, but would not affect second-to-second navigation.

1 In “Sea-Fever”, a celebrated poem by John Masefield, (1902), the idea of using stars for steering is adumbrated. This can be interpreted both as route navigation, or as second-to-second steering.

I must go down to the seas again, to the lonely sea and the sky,  
And all I ask is a tall ship and a star to steer her by,  
And the wheel's kick and the wind's song and the white sail's shaking,  
And a gray mist on the sea's face, and a gray dawn breaking.





Fig 8. Antisolal point shadows. Jan 3<sup>rd</sup>, 2017. Image credit: RC.

*Observation and navigation use of antisolal point.* We observed antisolal shadows (fig. 8) in three occasions. Antisolal shadows are atmospheric shadows that converge to the antisolal point. In a sense, they are the dual to so called “divine rays” that appear to emanate from the sun when the latter is close to the horizon. Indeed they are created in the continuation of “divine rays”. They are seldom observed, partly because of the difficulty of their production, and partly because observers neglect to check the horizon towards the antisolal point when noticing “divine rays”. In one occasion, it was possible to use it for second-to-second navigation. Shadow-casting clouds can move in any direction, but the antisolal points only moves with the motion of the Sun, thus it is at least as stable as the Sun.

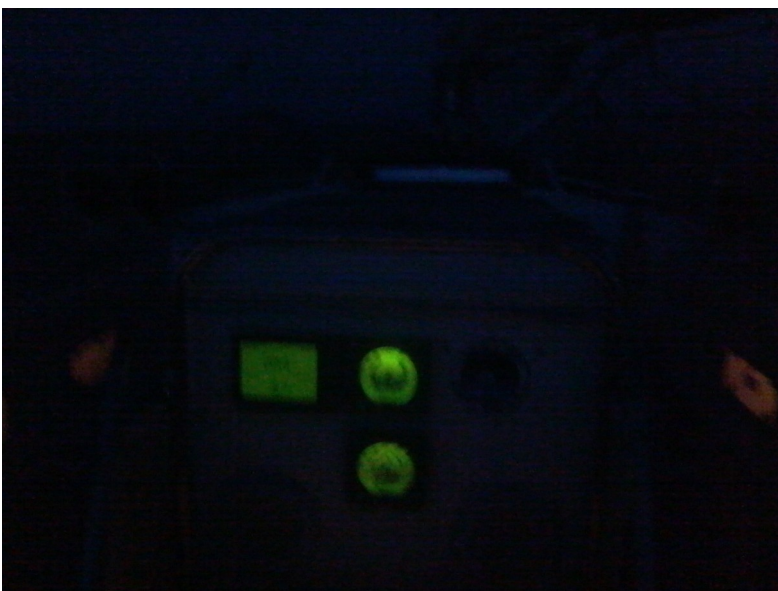


Figure 9. Navigating at night. Dec 30<sup>th</sup>, 2016. Image credit: RC.

*Poor visibility conditions: pure instrumental navigation.* On moonless nights (fig. 9), with overcast skies, and under heavy rain, the only way to ensure second-to-second steering is a constant observation of the instruments. Even this chore can be very difficult as the helmsman can have a very reduced visibility field (rain pouring on her face, spray). In one occasion (rainy night) the compass was constantly covered with a water film and the strong wind required constant use of both hands on the wheel, so that it was not easy or even possible to wipe out the compass' glass case. And as the wind instrument display is too far away, Cp had to read it out for me as I was piloting.

*Imaginary points.* I kept thinking of the position of the Azores under the horizon in a certain direction. After a while, these representations were active and appeared to enter the navigational computation. This is to be compared with the micronesian practice of etak (Hutchins and Hinton, 1984). It is debatable whether they contributed to navigation; a deflationary hypothesis is just that they were by-products of a number of inferential procedures elicited by navigation and by thinking of the route.

*Fake memory of coastal presence.* My recollection of some key moments of the navigation (sail change or trim, change of tack, emotionally charged conversations) includes fake memories of coastal features. It is as if at some point I had islands on my port side, say, within visibility range. These fake islands are associated with night periods.

*Navigational shortcuts.* Once the direction is set, and sails are adjusted to the wind, in good visibility conditions it is possible for the helmsman to keep the bearing by checking the behavior of the sails and feeling the wind and the angle of list of the boat, factoring in the presence of gusts. Changes in direction have immediate consequences on some or all of these properties. If on close haul the boat comes too close to the wind, the sails will start to flap and one will feel a stronger wind on one's face; if it moves away from the wind, the boat will change its angle of list. Haptic feelings help negotiating waves, and a sense of balance is used as well.

These are all “navigational shortcuts” that spare the helmsman more complex instrumental or inferential work. I do not subscribe here to a more demanding “offloading” thesis according to which the sails, say, are “computing” changes of direction in the helmsman's stead. The notion of “shortcut” is meant to suggest that a certain computation is no longer needed, not because someone or something else is doing it,

but because one's input is a different set of environmental properties (Casati 2017).

*Conclusions.* Hutchins' classic *Cognition in the wild* made forcefully the case for a “distributed” cognitive activity in route planning, dead reckoning and steering. Aboard large ships, at least before the massive reliance on GPS, it turns out that nobody is omniscient about the route and the position of the ship: a number of actors collectively possesses this knowledge, without any of them – not even the captain – being fully in command of it. Here I would like to make the case for a deeper study of the individualistic, first person aspects of navigation, in second-to-second steering.

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Appendix 1: Captain's logbook

Appendix 2: Sample pages from Author's notebook.

Appendix 1: Captain's logbook

Manuel Pelton  
 Capitaine Louis BIANSE  
 Second Jean-Luc WÄBERSTICH  
 TS PAX  
 20/12 12h16 - 14h00 UT, départ St Martin,  
 For Louis Thaux, Après plein 50v clearance  
 16h00 UT, établissement GV 2 00 + Triplette Y2  
 > 12-ohm NP  
 17h30 - 18°43'N - 062°52'0" W - CoG 20 - 506°35'N  
 au large d'Angilla  
 18h30 - Beau temps 3 Nds Appareil  
 Y2 décliné Y2 & Y3  
 21/12/2016 - Nuit agitée 3 orages  
 19h00 UT 20°45'N - 061°51'5" W - CoG 26° - 506°55'N  
 17h15 Allumage GE 180 (N) 24H  
 18h15 Xtraction GE  
 1 VC bordée à Bâbord lors du débouché  
 pour le centre direction eau dans  
 route à volée bordée rive → de remplacement  
 20h00 21°21'2"N - 061°40'3"W - CoG 20° - 506°52'N

Dec 20<sup>th</sup>, 2016 – Dec 21<sup>st</sup>, 2016

Quatre 2 personnes / 30t à partir de 00h00  
 Pat Patrick + Pascale  
 Car Patrick + Carole  
 Rebotek + 1 crew  
 21/12/16 03<sup>h</sup>00 21°48'19"N - 061°35'5"W - CoG 00° - 506°55'N  
 6h45 - 20°32'7"N - 061°26'4"W - CoG 0° - 506°51'N  
 13<sup>h</sup>05 - Allumage GE  
 15<sup>h</sup>25 - Xtraction GE, 22°05'6"N - 061°06'W - CoG 10° - 506°57'  
 17<sup>h</sup>10 - 23°08'5"N - 061°07'66"W - CoG 00° - 506°52'N  
 20<sup>h</sup>30 - 23°29'0"N - 061°02'9"W - CoG 00° - 506°51'N  
 21<sup>h</sup>50 Allumage GE  
 22<sup>h</sup>50 Xtraction GE  
 23/12 - 04<sup>h</sup>10 24°08'2"N - 060°36'2"W - CoG 00° - 506°55'N  
 07h45 - 24°17'4"N - 060°21'7"W - CoG 00° - 506°52'N  
 12h00 - Allumage GE  
 Tête @ N bordée avec deux jusqu'à l'extrême  
 bordée @ 1002 30N55W → CoG 35W 950 Flotte Tally  
 jusqu'au matin  
 Samedi bon jour  
 13h15 26°41'8"N - 059°43'3"W - CoG 20° - 506°51'N  
 15<sup>h</sup>30 - Xtraction GE. 180 & Y3 174

Dec 22<sup>nd</sup>, 2016 – Dec 23<sup>rd</sup>, 2016

Dec 24<sup>th</sup>, 2016 – Dec 26<sup>th</sup>, 2016

17<sup>h</sup>30 24°58'5"N - 059°33'3"W - CoG 40° - 506°52'N  
 20<sup>h</sup>50 - 25°14'6"N - 059°30'4"W - CoG 47Nds - 506°41°  
 21<sup>h</sup>45 - Allumage NP  
 Virement de bord CoG 00° → CoG 115° → Revirement  
 de bord  
 22h40 - 25°20'2"N - 059°23'2"W - CoG 00° - 506°57'N  
 22h30 Manœuvre AP  
 24/12 05<sup>h</sup>05 Vent monte. Y2 & Y3 2 743  
 25°52'3"N - 059°22'5"W - CoG 10° - 506°57'N  
 19<sup>h</sup>50 UT 27°41'5"N - 059°23'5"W - CoG 10° - 506°57'N  
 Allumage GE  
 22<sup>h</sup>1 Xtraction GE  
 25/12 8<sup>h</sup>30. Vent tombe. Allumage NP  
 29°01'5"N - 059°10'1"W - CoG 20° - 506°55'N  
 18<sup>h</sup>30 UT Virement de bord sans NP. Y3 & Y2  
 29°15'8"N - 058°59'1"W - CoG 10° - 506°57'N  
 20<sup>h</sup>45 UT 29°26'9"N - 058°15'9"W - CoG 40° - 506°45'N  
 Xtraction NP  
 23h10 - Allumage NP. Vent tombe - CoG 115 - 506°57'N  
 GE de nouveau / 29°31'9"N - 058°24'5"W - CoG 50° - 506°57'N  
 26/12 - 8<sup>h</sup>00 29°53'4"N - 057°08'6"W - CoG 75° - 506°45'N

13<sup>er</sup> 29°58'4"N - 056°21'5"W. Cof 10 Soc 8 Nds  
 16<sup>er</sup> Demorage HP. 30°03'6"N - 055°58'5"W.  
 Cof 30 Soc 9 Nds. Awa 80°8' Awa 9 Nds  
 17<sup>er</sup> 30°2'4"N - 055°43'6"W. Cof 110 Soc 5 Nds 100N  
 17<sup>er</sup> 10 Awa 10 Nds Cof 95  
 27/12 10<sup>er</sup> 28°53'N - 052°56'3"W. Soc 8 Nds  
 12<sup>er</sup> 10<sup>er</sup> LP 06 51N 49W → Inland 10 Nds a/c  
 Talang ne LP 10 Nds au ocean  
 11<sup>er</sup> 10 38 41N 68W → 33N 46W (Rouge)  
 29°50'21" - 052°36'0"W - Cof 50 - Soc 1, 2, 3  
 12<sup>er</sup> 30 Allumage HP pour change  
 14<sup>er</sup> 30 Xhibition HP  
 16<sup>er</sup> 00 28°50'3"N - 052°08'8"W. Cof 30 Soc 7,5  
 17<sup>er</sup> 00 29°50'2"N - 052°33'1"W - Cof 80 - Soc 7,2 Nds 100N/100W  
 21<sup>er</sup> 50 Allumage HP pour change Cof 95  
 23<sup>er</sup> 00 Xhibition HP. 29°41'6"N - 051°23'8"W. Soc 6 Nds  
 23<sup>er</sup> 30 Vent tombe. Allumage HP  
 29/12 05<sup>er</sup> 00. Pêche lors de la 2<sup>e</sup> arrivée au la barrière CV  
 Remplacement par pêche + dépose dans celle-ci  
 29°53'8"N - 051°41'4"W - Vitesse de bord Cof 5 - Soc 5 Nds  
 10<sup>er</sup> HP 10 30 pour 13<sup>er</sup> 10 Nds au 31<sup>er</sup> 10 Nds Jule  
 après 100 W. bord pour 30

03<sup>er</sup> 30 Xhibition HP diverse allumage HP 100N/100W  
 05<sup>er</sup> 00 - Pompage CO dans le 2<sup>e</sup> canal avant impossible  
 arides?  
 13<sup>er</sup> 30 30°23'3"N - 050°58'2"W. Cof 000 Soc 5 Nds  
 18<sup>er</sup> 30 30°41'1"N - 050°42'3"W. Cof 048 Soc 4,5 Nds  
 changement d'heure (2) changement de equate  
 Roberts et Cande / Patrick et Pascal / Patrick + Caus.  
 23<sup>er</sup> 50 30°53'7"N - 050°18'6"W. Cof 60 Soc 4,5 Nds  
 29/12 03<sup>er</sup> 30 31°01'8"N - 050°02'7"W. Cof 60 Soc 5 Nds  
 08<sup>er</sup> 30 31°18'1"N - 049°31'7"W. Cof 60 Soc 5 Nds  
 11<sup>er</sup> 30 - Pêche Bob Amour, Y3, Y1 Xhibition HP  
 12<sup>er</sup> 30 - 31°23'9"N - 048°22'6"W - Cof 18 - Soc 5,7 Nds  
 17<sup>er</sup> 00 - 31°33'6"N - 048°46'6"W - Cof 12 - Soc 6,3 Nds 30N/100W

03<sup>er</sup> 30 Xhibition HP diverse allumage HP 100N/100W  
 05<sup>er</sup> 00 - Pompage CO dans le 2<sup>e</sup> canal avant impossible  
 arides?  
 13<sup>er</sup> 30 30°23'3"N - 050°58'2"W. Cof 000 Soc 5 Nds  
 18<sup>er</sup> 30 30°41'1"N - 050°42'3"W. Cof 048 Soc 4,5 Nds  
 changement d'heure (2) changement de equate  
 Roberts et Cande / Patrick et Pascal / Patrick + Caus.  
 23<sup>er</sup> 50 30°53'7"N - 050°18'6"W. Cof 60 Soc 4,5 Nds  
 29/12 03<sup>er</sup> 30 31°01'8"N - 050°02'7"W. Cof 60 Soc 5 Nds  
 08<sup>er</sup> 30 31°18'1"N - 049°31'7"W. Cof 60 Soc 5 Nds  
 11<sup>er</sup> 30 - Pêche Bob Amour, Y3, Y1 Xhibition HP  
 12<sup>er</sup> 30 - 31°23'9"N - 048°22'6"W - Cof 18 - Soc 5,7 Nds  
 17<sup>er</sup> 00 - 31°33'6"N - 048°46'6"W - Cof 12 - Soc 6,3 Nds 30N/100W  
 21<sup>er</sup> 45 - 32°17'9"N - 049°01'1"W - Cof 20 Soc 5,5 Nds  
 30/12 - 05<sup>er</sup> 00 Vent tombe. Allumage HP. Cof 15 Soc 6 Nds  
 05<sup>er</sup> 15 - 32°3'2"N - 048°32'3"W - Cof 05 Soc 5,7 Nds - Xhibition HP  
 06<sup>er</sup> Pêche. Allumage HP.  
 07<sup>er</sup> 30 Empennage, Xhibition HP.  
 11<sup>er</sup> 45 - Pêche HP lors de la 2<sup>e</sup> arrivée au la barrière CV  
 → Pêche lors de la 2<sup>e</sup> arrivée au la barrière CV  
 Samedi 5/15/20 Dimanche 11/15/20 Lundi 21/30/20  
 Mercredi 5/16/20

Dec 27<sup>th</sup>, 2016

Dec 28<sup>th</sup>, 2016

Dec 29<sup>th</sup>, 2016 – Dec 30<sup>th</sup>, 2016

0100 Allumage NP  
 13<sup>00</sup> Vent tombe, Allumage NP. 33°15'N-047°43'W.  
 16<sup>00</sup> 33°13'N-047°45'W. COG 044° SOG 5,1 Nds.  
 1<sup>er</sup> départ  
 31/12-01/15-33°38'N-047°08'W-COG 70°-SOG 5,1 Nds  
 Vent ~~forte~~ = ondu. ~~est~~ cal. Hôte de tout bruit  
 03<sup>00</sup> 33°57'N-046°17'W-COG 65° SOG 6,1 Nds.  
 11<sup>00</sup> Allumage NP. 11430 34°03'N-045°53'W-COG 73°-SOG 5,1 Nds  
 14<sup>00</sup> Eclaircie. GV+Tq. COG 78° SOG 7,1 Nds.  
 18<sup>00</sup> 34°14'N-045°12'W-COG 70° SOG 7,0 Nds.  
 23<sup>00</sup> (sans bruit) 2416-2215-1147/2117. Dernière pour l'instant  
 34°32'N-043°58'W-COG 75° SOG 8,5 Nds  
 01-01-30 07: Bonnes nouvelles!  
 06<sup>00</sup> 34°40'N-043°26'W. Grains.  
 Empannage. COG 80° SOG 8,1 Nds. AWA 120° 38, 15 Nds.  
 14<sup>00</sup> Allumage NP débrayé pour charge.  
 34°45'N-041°41'W-COG 80° SOG 12 Nds  
 17<sup>00</sup> 34°48'N-041°13'W.  
 16<sup>00</sup> Allumage NP. 205 Nds  
 24h20 (3h20 UT) = 35°01'32"N  
 COG: 70° SOG: 10 Nds 39°07'34"W

02-01-20 17. 13<sup>00</sup> 35°43'N-037°32'W.  
 COG 45° SOG 9,5 Nds. AWA 130° T, 17 Nds.  
 14<sup>00</sup> Allumage NP. charge 35°38'N-037°48'W-COG 155° SOG 20 Nds  
 15<sup>00</sup> NN NW 12/30 Nds → faibles Nds. public. en course N  
 pour NE. Vachette. 11<sup>00</sup> 11<sup>00</sup> Allumage NP.  
 16<sup>00</sup> 36°16'N-037°28'W-COG 36°-SOG 7,0 Nds. 205 Nds  
 45 Nds de Hôte / Agnes  
 23<sup>00</sup> 37°01'N-036°23'W-COG 24°-SOG 9,1 Nds  
 23<sup>00</sup> Empannage. Virement. COG 80° SOG 9,5 Nds  
 03/01. 6<sup>00</sup> 37°15'N-036°15'W-COG 80° SOG 6,5 Nds  
 NP charge. COG 80° SOG 6,5 Nds  
 37°29'N-035°55'W.  
 10<sup>00</sup> Petite Allumage NP. 37°32'N-035°36'W-COG 80°  
 11<sup>00</sup> 30 Virement. COG 35° SOG 3,8 Nds  
 14<sup>00</sup> 37°31'N-035°16'W-COG 70° SOG 5,5 Nds.  
 17<sup>00</sup> 37°43'N-034°57'W-COG 80° SOG 5,5 Nds  
 305 Nds de Hôte.  
 11<sup>00</sup> 37°45'N-034°56'W-COG 85° SOG 7,1 Nds. 11<sup>00</sup> 11<sup>00</sup> Allumage NP  
 20<sup>00</sup> Allumage NP GV+Tq+11-COG 85° SOG 6,1 Nds  
 04/01. 01<sup>00</sup> 37°05'N-033°56'W, Grains  
 COG 95° SOG 6,5 Nds

02/01- Empannage. COG 60° SOG 9,5 Nds  
 09<sup>00</sup> Empannage. COG 90° SOG 10 Nds.  
 09<sup>00</sup> 38°18'N-032°32'W. Prive 215 Nds SOG  
 13<sup>00</sup> 38°07'N-031°05'W-COG 111° SOG 11,5 Nds  
 13<sup>00</sup> → 14<sup>00</sup> → chargeur sans TU-3 → TU-2  
 15<sup>00</sup> Empannage 37°33'N-031°31'W-COG 61° SOG 8,1 Nds  
 16<sup>00</sup> Allumage NP sans charge 180 Nds  
 17<sup>00</sup> 38°23'N-031°46'W-COG 78° SOG 9,2 Nds 130 Nds de Hôte  
 18<sup>00</sup> Allumage NP  
 19<sup>00</sup> Petite Allumage NP. 20<sup>00</sup> 11<sup>00</sup> Allumage NP  
 20<sup>00</sup> chargeur visible de gg.  
 05/01. 05<sup>00</sup> Vent tombe. Allumage NP.  
 38°19'N-030°29'W-COG 80° SOG 6,1 Nds.  
 90 Nds de Hôte.  
 09<sup>00</sup> 38°27'N-029°25'W-COG 80 SOG 5,5 Nds  
 38 Nds de Hôte. Belle vue sur facial et Rico

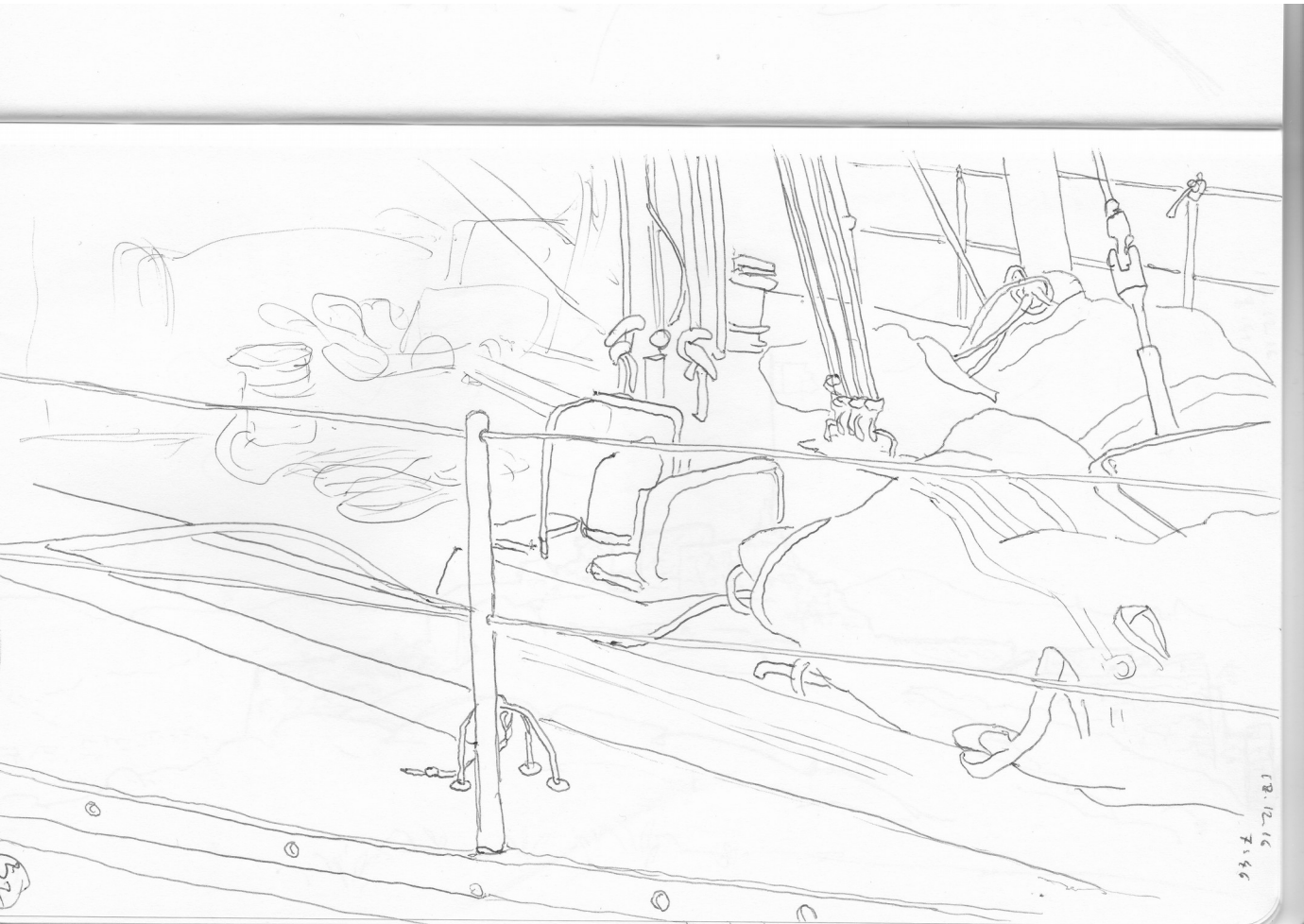
Dec 31<sup>st</sup>, 2016

Jan 1<sup>st</sup>, 2017 – Jan 4<sup>th</sup>, 2017

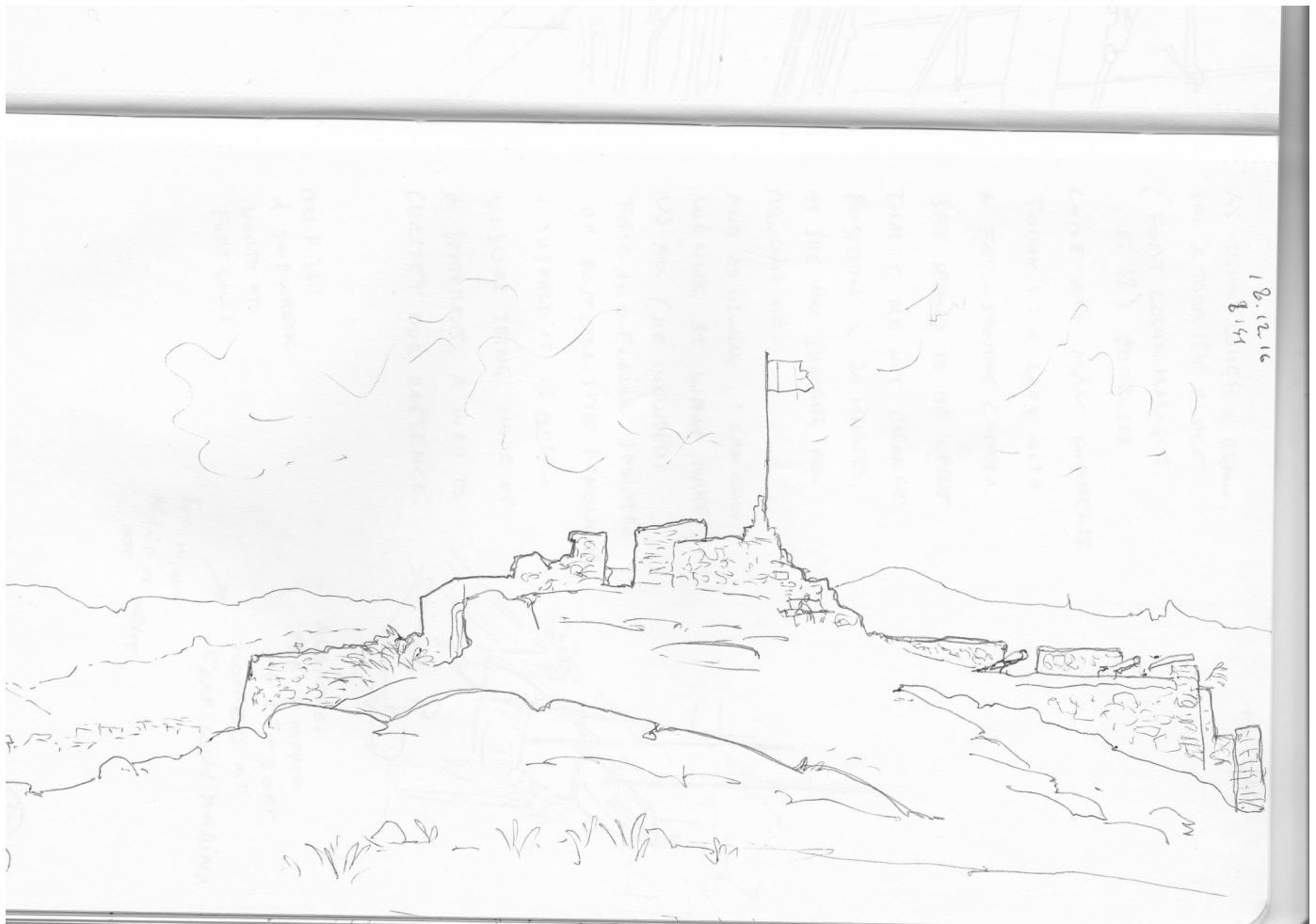
Jan 5<sup>th</sup>, 2017



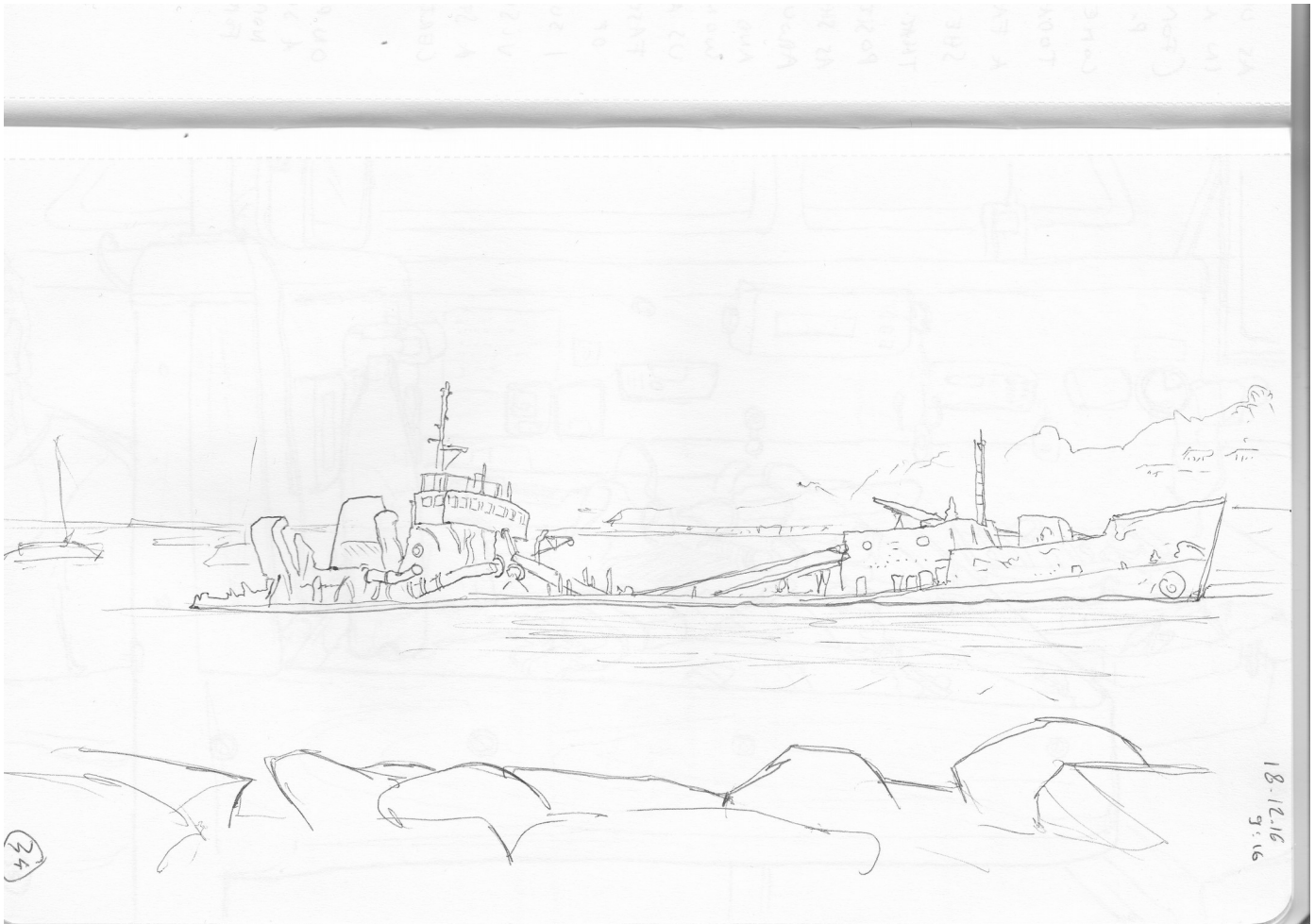
Appendix 2: Sample pages of Author's notebook.



Dec 18<sup>th</sup>, 2016 – Marigot. Boat moored, preparations, Interior of cabin. Dec 18<sup>th</sup>, 2016, 07:46. Marigot. Albatros moored. Sail bag.



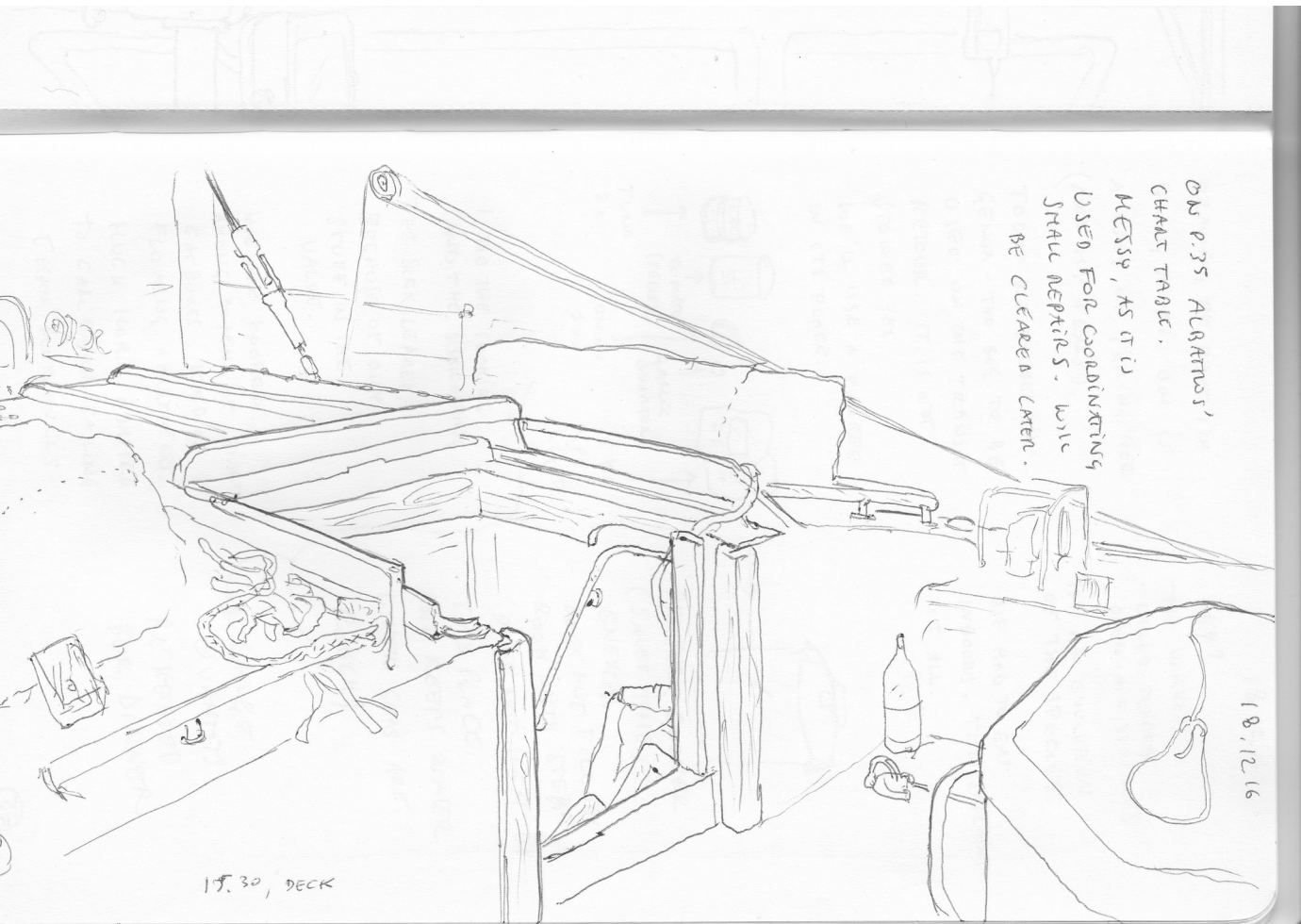
Dec 18<sup>th</sup>, 2016, 08:41 Marigot. Fort St. Louis.



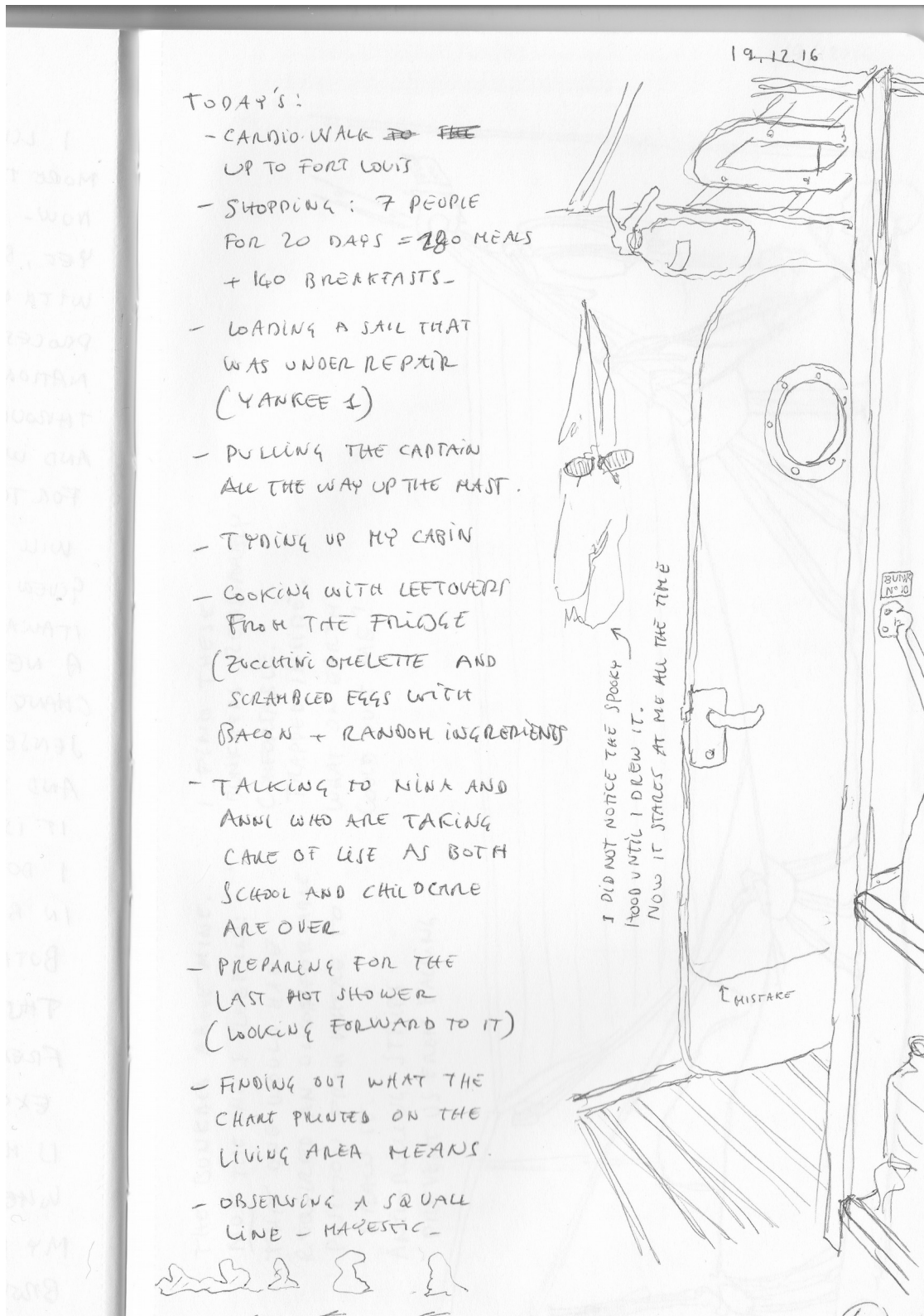
Dec 18<sup>th</sup>, 2016. 09:16 Marigot. Shipwreck.



Dec 18<sup>th</sup>, 2016. Marigot. Chart table of Albatros.



Dec 18<sup>th</sup>, 2016. Marigot. Albatros' companion.



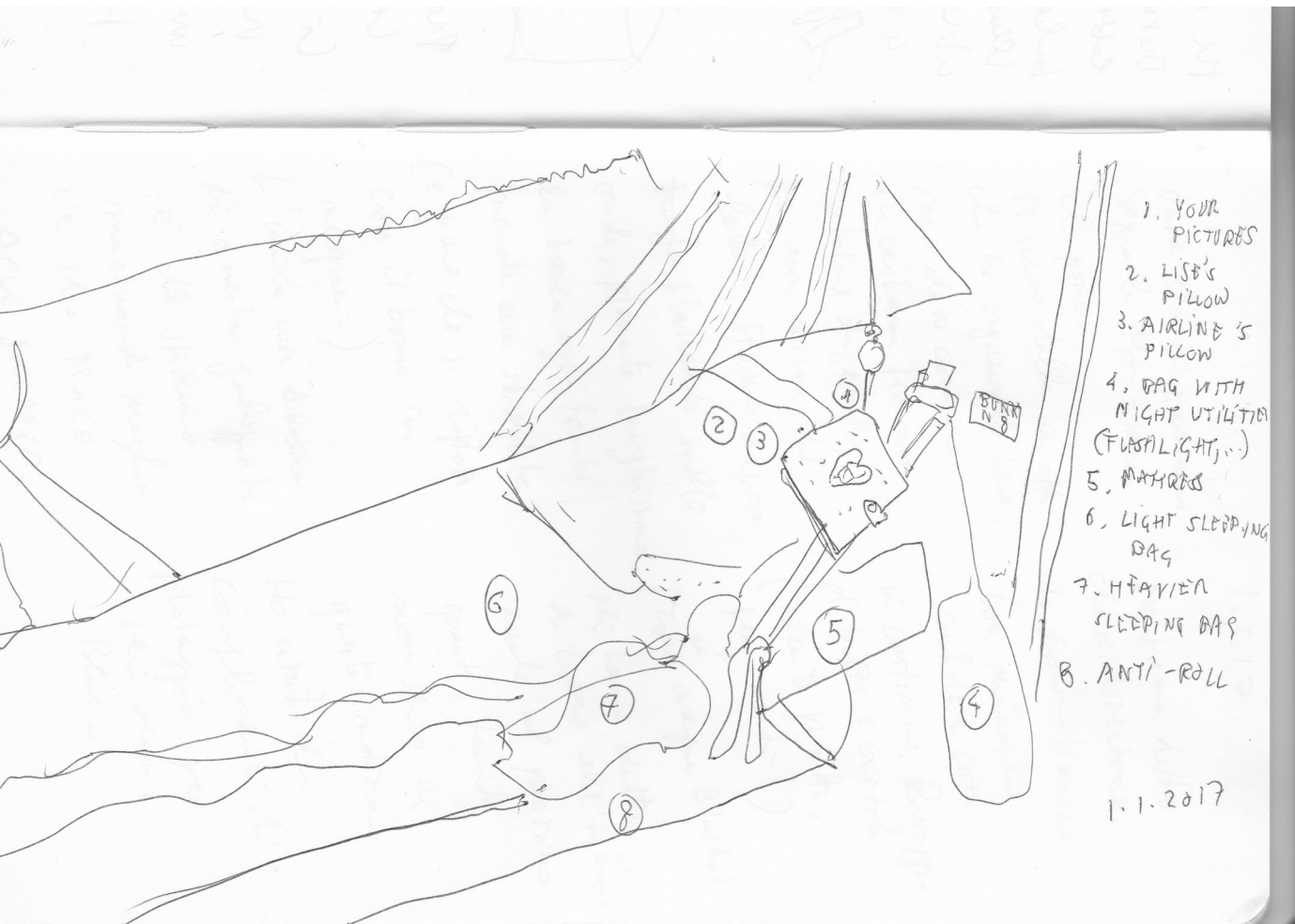
Dec 19<sup>th</sup>, 2016. Albatros' middle port cabin.

23.12.16  
OBSERVED AT  
NIGHT,  
WITH STEERING  
ALBATROSS  
00-3 am

CAPTAIN'S REQUEST:  
"KEEP THE BOAT  
BETWEEN  
30°-40° OF THE  
WIND, TRY  
TO CLOSE CLOSER  
TO THE WIND  
LITTLE BY  
LITTLE"

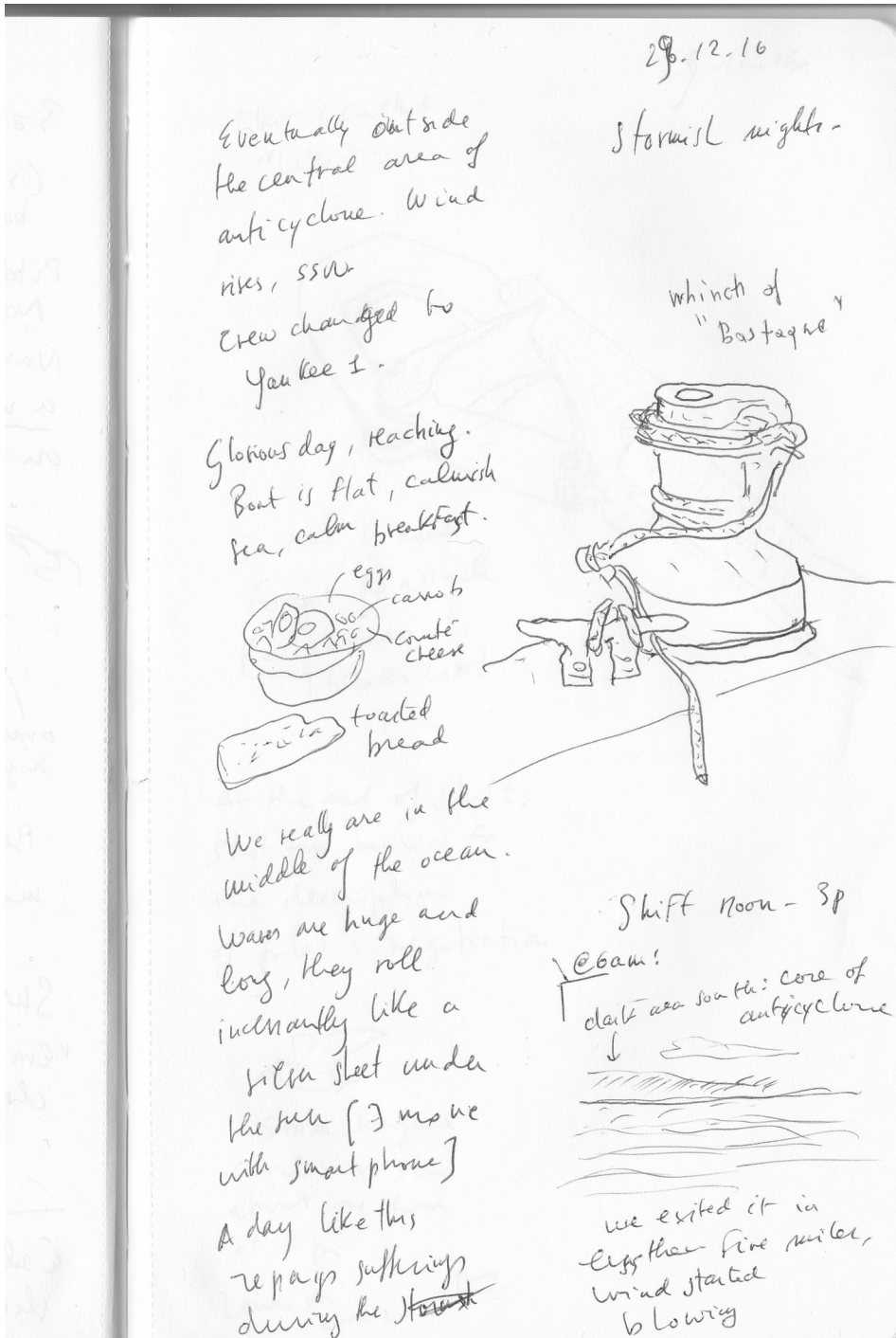
	<del>PERFORMANCE</del> TIME FACTORS	DIFFICULTY
STAR	v. Slow CHANGE (2h)	IDENTIFICATION TRACKING, WRONG POSITION
CLOUD	Slow (5 min)	
GPS COMPASS	slow (5 sec)	ILLUSORY FAST REACTION
SPEED		
WIND AMPLIFIER	IMMEDIATE	
WIND	IMMEDIATE BUT SUBJECT TO MAJOR OSCILLATION	
COMPASS	FAST BUT BALLISTIC	
WHEEL		

Dec 23th, 2016. Navigation notes.



Jan 1<sup>st</sup>, 2017. Albatros. Bunkbed.

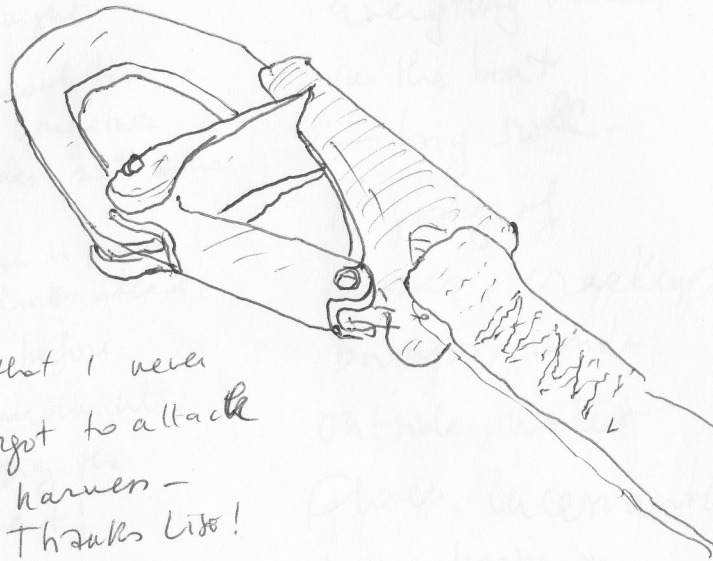




Dec 28<sup>th</sup>, 2016. Navigation notes.

29-12-16

This I called  
"Life":



So that I never  
forgot to attack  
the harness -  
Thanks Life!

At the end of shift,  
shot two movies for  
the description  
of pilot's negotiation



Small seagull  
circles in air  
about one hour  
at 2 pm

Lands on  
water



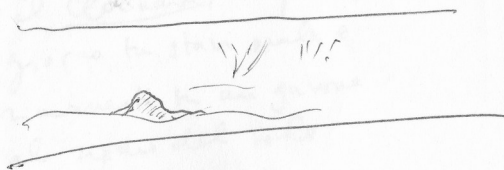


Dec 31<sup>st</sup>, 2016. Crew member (piloting) and captain.

31.12.16

# WHALES!

13<sup>h</sup>00

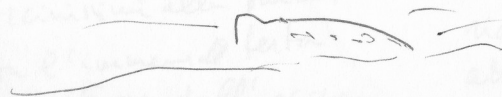


3 cachalots

spraying

at the east of  
the boat

We turned  
around to  
look at them.



13<sup>h</sup>30:  
another  
passage, 20 m  
from the boat!

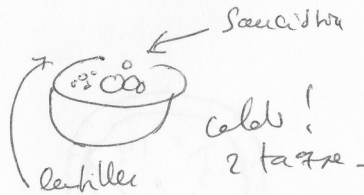
3.1.17

Night wake: change of tack - (at 2 am)

Quarto delle 6 a notte 9a.  
Verbo confuso, debole -  
320 miglia dalle  
Azzorre. (Pauzi - nome!)  
Il vento si porta a nord,  
dobbiamo fare rotte  
a 118°, allora  
viriamo, rotta a 36°.

Pioggia solo un  
gruppo. Riprendo a  
finanziare.

Houle immensa, frontale,  
se guardo di lato la  
barca va su e giù -  
per valli



fisaca  
"drainage et  
élimination"  
forse ho una  
piccola infezione  
urinaria.  
Bere molto!

Arcoaleui.  
Uccelli-gabbia alle -  
ci vengono a  
levare, un  
gruppo di tre -



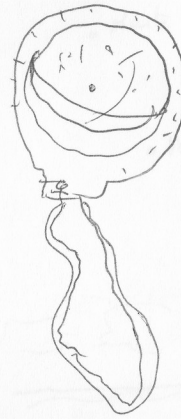
Sotto l'orizzonte la  
fata è un bianco e nero,  
a colori - cielo assai pallido,  
... miki

3.1.17


An Astrolabe is  
a perspectival model :

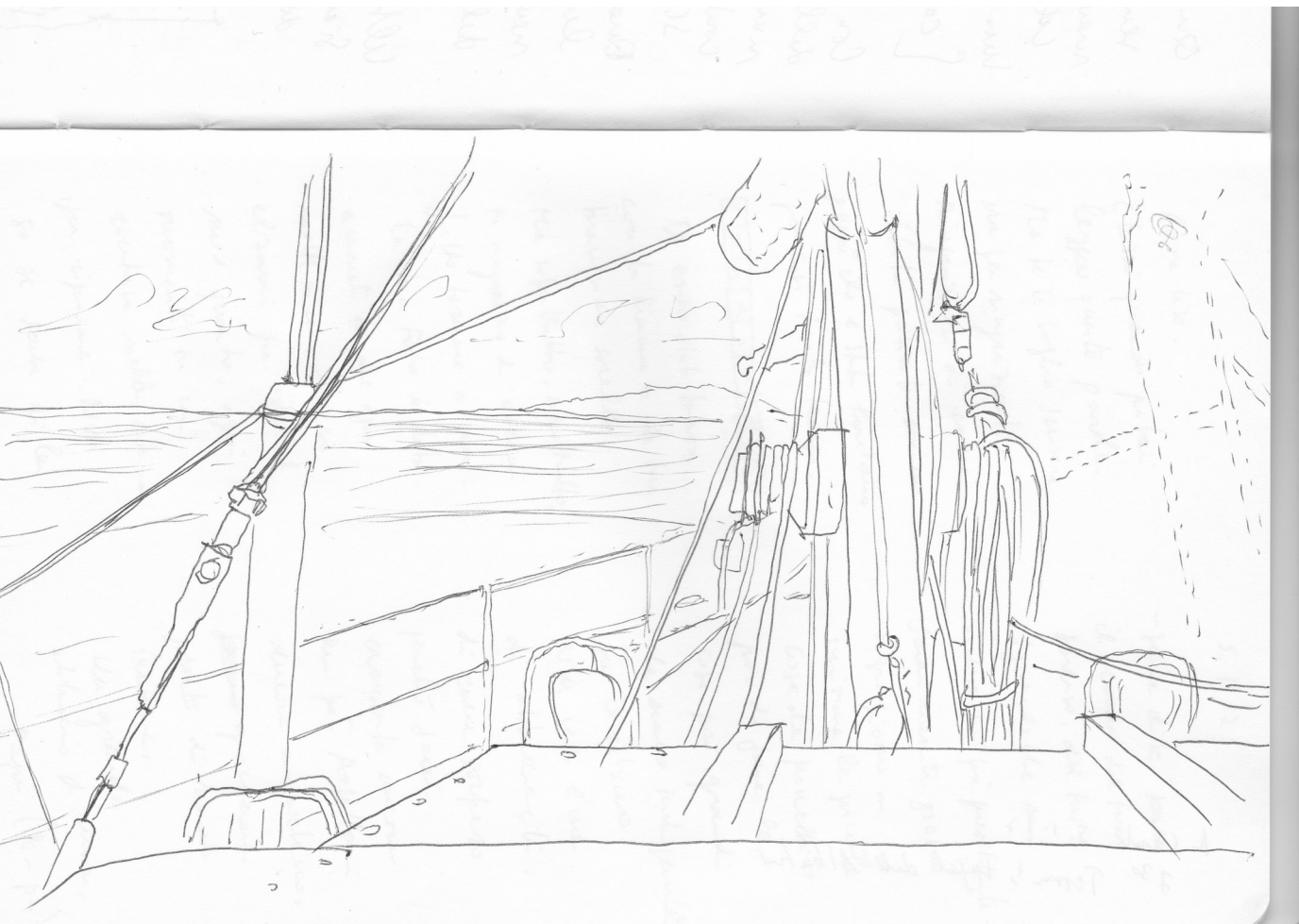
You set time of the  
day and day of the  
year, and you obtain  
an image of how  
the sky looks like at  
that time -

[add to Borchsenius  
paper: what happened  
to it ??]



Models for  
latitudes  
da 30° a 40°,  
compete negli  
States,  
made in California  
a Montecito -

  
E piedi delle navi è  
sotto l'orizzonte  
(la terra è curva)

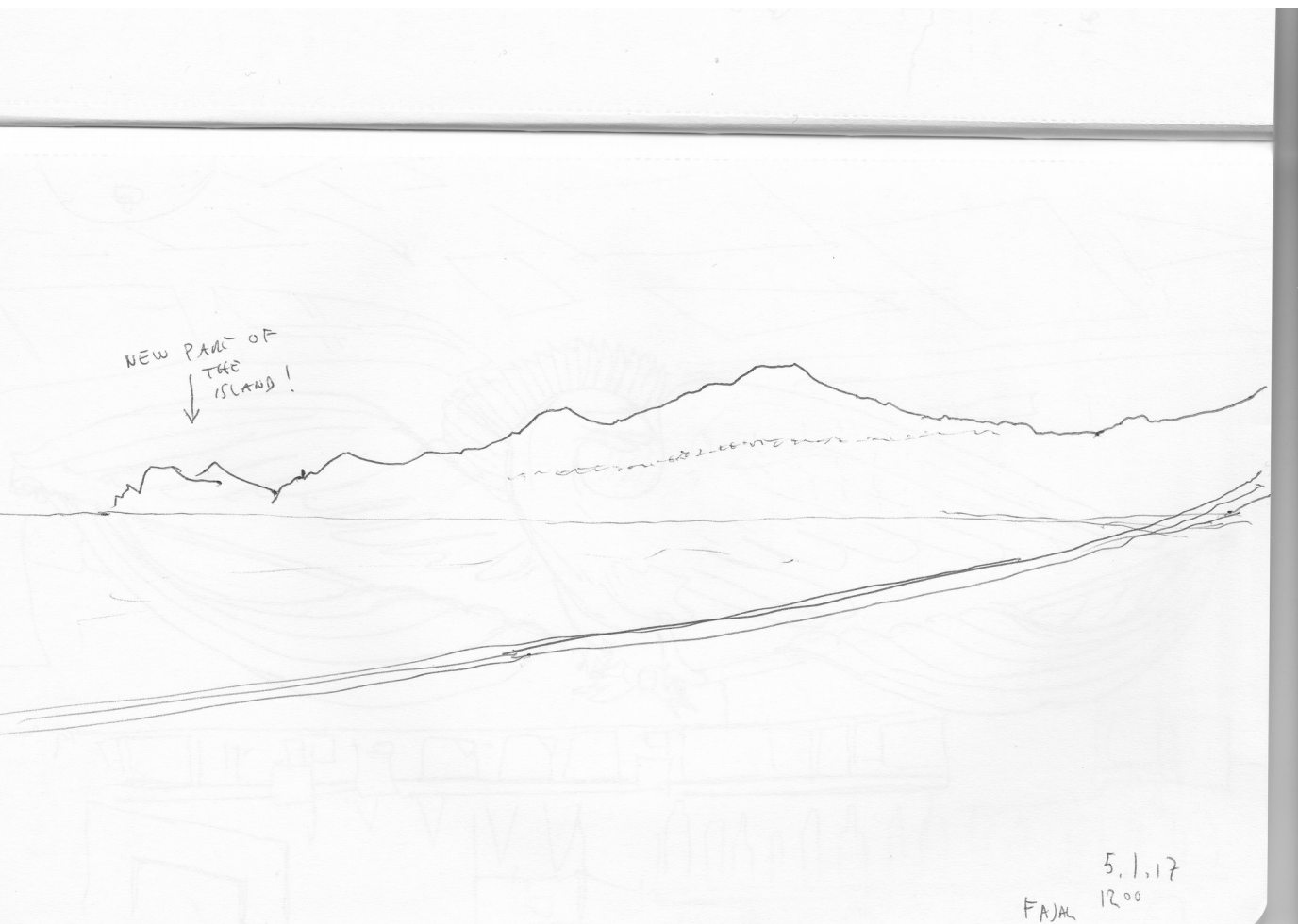


Jan 5<sup>th</sup>, 2017. First sighting of Fajal.



Jan 5<sup>th</sup>, 2017. Approaching Fajal. Observation on horizon.





Jan 5<sup>th</sup>, 2017. Coasting Fajal.



Jan 5<sup>th</sup>, 2018. Peter's in Horta.