Playing with Squalls:

Essential passagemaking skills

by

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Small dark clouds appear on the horizon. *Hawk* is halfway across the Atlantic and these are just the latest in a long series of little and big squalls, which represent the primary weather feature on most tropical passages. Over the course of dozens of passages, we have developed an almost automatic assessment process: how strong are the squalls going to be, are they isolated or do they represent the leading edge of a larger wave or frontal system, and how should we position the boat relative to the squall? A proper assessment will allow us to turn the wind fields around the squalls into a fast, safe and low effort boost along our way. However, if we get it wrong we could end up being driven the wrong way or even breaking expensive gear.

Squall Basics

A squall is essentially a downdraft created by wet cold air dropping down through a cloud. Squalls build during the afternoon as pockets of warm moist air rise into the cooler air above. Eventually, the air mass will cool enough to begin falling, creating a downdraft. In the evening, when the temperature drops, the process accelerates, creating more substantial downdrafts. The biggest squalls of all are the oldest ones, those collapsing last, which hit just before dawn. Earlier in the evening there will be more frequent squalls, but they will be less potent. The squalls will typically dissipate at first light.

To picture the wind field around a squall you add the strong outward flow of cold air, from the down-rush column hitting the surface and spreading out in all directions, to the wind pattern in the existing trade wind field. These two winds reinforce each other in front of the squall, and cancel out behind it, leaving you becalmed. Finally, you add the wind component from the motion of the squall cell itself, which will usually be deflected to the right relative to the surface wind. Occasionally, with an unusual upper level wind pattern, the squalls will be deflected to the left. However, all the squall on any given night will move the same, so by tracking the first squall of the night you can determine if it is a normal ‘right shift’ or unusual ‘left shift’ night.

Out at sea, the wind field is often more complex than this single cell model suggests, because squalls often come in connected groups rather than as isolated cells. When the downrush air turns horizontal and flows out in front of the squall, it forms a wedge of cold air that lifts more warm air up from the surface. This sets off a new convection cell of rising air immediately in front of the squall. This will have stronger winds than a simple single cell squall, and the strongest winds will be between the two cells.

Judging Squall Strength

As soon as a squall appears on the horizon, you can begin to assess squall strength. Squalls move on average at 15 knots. On a clear horizon you will be able to distinguish them from a simple dark cloud somewhere between 12 to 24 miles away. So, you have a maximum of about 1½ hours to position the boat properly to the left or right of the squall.

At maximum distance there are three ways to judge squall strength, all of which can be used at night:

1. If you see lightning you can be quite sure there will be strong winds.
2. Taller clouds have stronger downdraft. At night you can watch the stars disappear behind the cloud to judge height.
3. A stronger/darker radar return indicates heavier rain, which also usually (but not always) indicates stronger winds.

When squalls are close enough to see the rain and water surface under the cloud, their strength can be judged in three additional ways:

1. If the black wisps under the squall that mark the rainfall are straight down, there is little wind within the squall. If they are swept off to one side, beware!
2. If the water underneath the squall looks like fog or smoke, expect a heavy downpour and a great deal of wind. If the water looks white and churned up, then there is a hard rain without too much wind. If the water turns a darker color than the water in front of the squall, the squall carries a lot of wind and little rain.
3. At about this distance you will start to see a wave pattern coming from strong squalls.

Finally when the squall is just about on you there are two more indications:

1. If the rain hits first, the wind, will be strong when it comes. But if the wind increases before the rain arrives, the rain heralds the end of the wind. In the first case, if the rain hits first, you are almost certainly dealing with a complex multi-cell squall.
2. The temperature will drop as the squall approaches. Bigger temperature drops indicate stronger winds. Also, when the temperature drops, it is a sure indication that the squall is certain to actually hit you and it is time to reef.

Weak looking squalls will only increase the wind 5-10 knots, big squalls can cause a 15-25 knot increase, and squalls with lightning can pack 60 knots.

Isolated or frontal

If the approaching squall is an isolated event it will pass quickly. However, if it is the leading edge of a frontal system, tropical wave or convergence zone it represents the start of a sustained wind increase and shift. This determination will have a critical effect on how you deal with the squall. In isolated squalls you can carry more sail and hand steer downwind in the biggest gusts. However, if it is the leading edge of a front, wave or

convergence zone, you want to reef the boat down and make her comfortable under autopilot/wind vane.

The surest way to make this assessment is with external weather information, such as weatherfax, GRIBs or voice forecast on one of the cruising nets. These sources will tell you if there is a significant front/wave approaching. We have occasionally encountered fronts that were not predicted by any of these sources, but they were usually quite weak.

From the boat there are various advance signs of a frontal system, such as a 'mackerel sky' 24 hours ahead of the front and, in the last few hours, a line of clouds stretching across the horizon. However, you can get a lot of false positives with these signs and if the external weather sources do not show a front then you are better off assuming the squalls are isolated systems.

Positioning relative to the squall

The two big rules for positioning the boat are: #1 to avoid really strong squalls, and #2 to avoid the dead air behind squalls.

We do our best to sail away from squalls with lightning, especially late at night. These will often bring 40 knot winds and as much as 60 knots. If you are in front of a strong squall, the racing sailors say that getting on port tack and sailing left (toward the equator) is usually the fastest way to diverge from the squall track. This is because the squall is tracking right relative to the surface winds and when it comes close enough to effect your winds you will get a favorable wind shift. The winds to the equator side of a squall will also usually be lighter than on the right (pole) side. However, if you are already on the right of the squall it is best to go further that way rather than cross in front of the squall

If the squall is approaching closely and the temperature starts to drop we know we are not going to be able to duck it and then take a decisive sail reduction. We have learned through a couple difficult experiences to drop the main entirely. With the jib or staysail we can sail at any angle and easily reduce sail even further, while if we leave the main up we can get into trouble if the winds are really strong and we want to run off. It is hard to reef/drop the main when we are running in 40 knots or more and it is plastered on the spreaders and we run the risk of an accidental gybe. The ocean racers suggest treating the last squall just before dawn with similar respect, even if it does not have lightning.

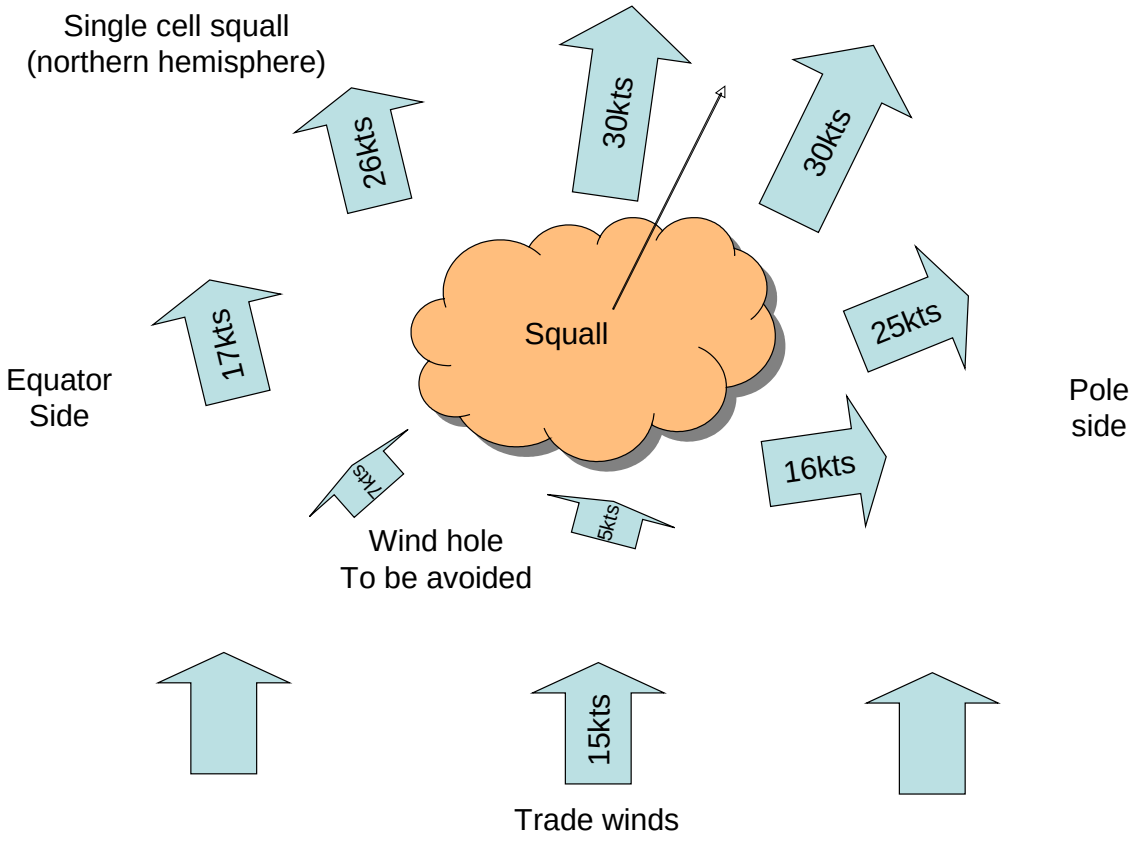
In strongish squalls without lightning, it usually works out perfectly to drop an extra reef in the mainsail, and take down any light air headsail (spinnaker or code zero). Then we can later roll in the headsail if we need a further reduction. Again, the time to do this is when you first feel the temperature drops before the wind has increased or shifted.

In light trade winds we will often head toward weak looking squalls, without reducing the sails, in order to get a bit more boat speed, cooler temperatures and a light fresh water rinse. We try to get on the right (pole) side of the squall if possible to get the stronger winds and avoid the dead air pocket on the back/south corner of the squall. As the squall

hits you need to take decisive action to avoid the wind hole behind the squall. As mentioned above, going left (equator side) will created the fastest divergence angle, but the winds will be stronger on the right (pole side). Typically we just go away from the squall, from whatever side we have ended up on.

Conclusions

Many sailing stories make tropical passage-making sound like a dream, with days on end of unchanging 15 knot winds over the stern. It's in fact rarely like that. Frequent squalls, often at 3am, create a lot of sail handling work. Making an accurate assessment as these squalls approach and then properly positioning the boat will allow you to take best advantage of these squalls with the least effort.


Single cell squall
(northern hemisphere)
26kts
30kts
30kts
Squall
25kts
Equator
Side
17kts
Pole
side
16kts
7kts
5kts
Wind hole
To be avoided
15kts
Trade winds