OBSERVATIONS ON HERRING GULL SOARING

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FOR sustained soaring flight the Herring Gull (*Larus argentatus smithsonianus*) makes use of two types of air motion. The first type is caused by obstructions in the path of the wind (ships, the sea surface, a land mass) which deflect the air upward and cause sharp velocity gradients in the flow. Soaring under these conditions is here called obstructional-current soaring. The second type of air motion used by the soaring gulls is caused by a condition in which colder air overlies a warmer under surface. When cold air overlies warm water, the air near the water is heated. When this heating produces a falling-off of temperature with height, in excess of the adiabatic change, instability occurs, and any vertical displacement will start the warm air moving upward. This air motion is here called convection flow, and soaring therein is referred to as convection soaring. It may be added that the frictional influence of the sea surface in retarding the flow of air over the water, when inter-related with waves, produces a condition which makes another type of obstructional-current soaring possible. This soaring response, used by shearwaters, gannets and albatrosses, will be discussed in a subsequent study.

A search through the available literature on gull soaring, has failed to reveal any indication that other observers have noted the following significant points: (1) the strength of convection over the open sea along our eastern seaboard; (2) the importance of this convection in influencing if not controlling the sea economy of the birds; and (3) their reluctance to use wing-flapping flight whenever soaring conditions obtain. The purpose of this paper is to discuss the observations which have led to the formulation of these points, and to suggest further problems which have arisen from them.

The sea observations that follow, were made between latitudes 16° north and 42° north, and within six hundred miles of the eastern coast of North America. They are a result of many cruises on board the research vessel 'Atlantis,' extending over a period of about two years. The 'Atlantis' affords an unusual opportunity for watching seabirds, for the vessel often spends many hours, and sometimes days, on one location. The shore observations were made on Cape Cod, Massachusetts, at or near Woods Hole.

Along our eastern seaboard during the winter, there is an almost continual movement of cold continental air out over the warmer sea, resulting from the prevailing westerly winds in this latitude. The temperature differences between the air and the water cause convection currents in the air which vary in strength, depending upon the magnitude of the thermal differences, and upon the speed of the wind. The Herring Gulls indicate the existence and the strength of these convection eddies in a type of soaring response which I have called convection soaring. This type of soaring is invariably associated with situations in which the water is warmer than the air, and becomes impossible when the air temperature rises above that of the water.

Horton-Smth (1938) has classified gulls as 'low-soarers,' with wings of 'high aspect ratio' ill adapted to soaring in ascending currents. Despite the fact that gulls' wings are poorly adapted to high soaring, we, on the 'Atlantis,' must often resort to binoculars in order to follow their soaring ascent in convection currents. This seems a clear indication of the great strength of this sea convection.

Headley (1912) has stated that "at sea, in our northern latitudes, there are no up-currents . . . sufficient to make soaring possible." He was speaking about convectional "up-currents." 'Atlantis' observations give a decidedly contrary view. In a 28-miles-per-hour surface wind, with a five-degree Centigrade difference between air and water temperatures, we have seen Herring Gulls soaring directly to windward, and at the same time rising rapidly. Considering the fact that the wind velocity usually increases with height, and also, estimating the gulls' windward motion (relative to the vessel hove-to) as ten miles per hour, it seems fair to assume that these birds must have had an air speed of forty miles per hour, or more. Assuming a three per cent angle of descent, which Idrac (1923) used for albatrosses (this angle is probably too low to apply to gulls), we find that the estimated horizontal speed of these birds would require an up-motion in the air of about one and two-tenths miles per hour. But these birds gained altitude as they moved to windward! This must mean that the convection up-flow of the air under these conditions was considerably greater than that required to maintain the birds in position and in altitude.

Two years of recording the distribution and number of Herring Gulls seen far (over fifty miles) at sea, have suggested that the birds do not venture far from shore until the cold continental air of the late autumn assures adequate convection action as it flows out over the warmer sea. This idea is further supported, when we consider that there is a three-month interval between the time when the birds are finished breeding, at the end of July, and the time when they are seen far at sea.

During periods when the air temperature closely approaches or exceeds the sea temperature, Herring Gull flight is invariably labored. Soaring under these conditions seems impossible, save in the obstructional currents off the ship's sails. The comments of Dutcher and Bailey (1903) about the "marked evidence of fatigue" of Herring Gulls upon returning to their breeding grounds from daily sea trips, are entirely in agreement with our observations. Along the New England coast during the late spring and most of the summer, the air is often much warmer than the sea. Under such conditions the birds must flap their wings continuously.

In August 1938, while the 'Atlantis' was anchored about thirty miles east of Highland Light (Cape Cod), we saw Herring Gulls making daily trips to the fishing grounds to the east. In the early morning all of the birds were flying eastward; in the late afternoon all of them flew landward, into the setting sun. During these two days there was never an exception to the labored, wing-flapping flight. Warm air over cold water means hard work for the gulls.

Even during mid-winter off our coast, there are times when warm air masses coming from the southwest practically 'ground' the Herring Gulls until colder air moves in. During the 'Atlantis' cruise to Bermuda, January 4 to 11, 1939, there were two such periods. On January 5, we were in a high-pressure area, and the air was six degrees Centigrade colder than the water. The gulls were in the air soaring during the whole of the day. The evening of the 5th, a warm front passed us, bringing in a mass of air which was warmer than the surface water. This warm air remained with us on the 6th of January, and all of the gulls were either sitting on the water about the ship, or riding the obstructional-current up-drafts off the mainsail. On the 7th, the wind changed to a cold northwester, starting convection currents which all of the gulls immediately began to use in soaring flight. On the 8th, the cold air continued over us, and the soaring was magnificent to see. The wind had risen to 28 miles per hour, which seemed only to increase the rate of convection and the ease of soaring. Late on the 9th of January, another warm front passed, and during the whole of the 10th and 11th the gulls were 'grounded,' or beating their way laboriously about on flapping wings.

During the periods when an air mass warmer than the water covers the sea, the gulls seem very reluctant to expend their energy in fighting the unfavorable conditions. Most of the time they sit on the water and wait for a change in the weather, rising into the air on flapping wings only when they come near our vessel for food.

As a means of conserving energy, the gulls will often use convectional and obstructional currents alternately. This they do on shore as well as at sea. During the spring, when the herring are running up the streams of the Cape, the gulls move inland following the fish. As solar heating sets up convection currents over the land, the gulls may be seen swinging inland on these currents from their roosting places along the shore. The prevailing southwesterly winds, pouring over the irregular terrain of the inland region, furnish many up-flow areas on windward slopes near the streams. The gulls glide down from their passing convection eddies on to these obstructional up-flow areas, and in these areas they can soar easily up or down stream in the course of their fishing.

At sea, gulls riding the up-drafts off 'Atlantis' sails are often seen to change over to convection-current soaring, but not without obvious searching for the convection eddies on flapping wings. When a convection up-flow is found, the birds must lift themselves fifty, a hundred, two hundred feet, depending upon the strength of the up-flow and of the wind, before the rising rate of the air exceeds their own settling rate, and they are able to begin soaring. However, they detect the presence of the convection when they are flying just a few feet over the sea surface, for one sees them change abruptly from a wing-flapping horizontal flight to a steep climb, before they start the flying tactics characteristic of convection soaring.

The efficiency of convection soaring in helping a bird to maintain its position in relation to some area of the sea, or in making it possible for it to move about easily, depends upon the relative air and water temperatures, and upon the wind velocity. The optimum conditions for convection soaring seem to obtain when the air is over five degrees Centigrade colder than the water, and the wind speed is between twenty and thirty miles per hour.

The habit of gulls in changing readily from the obstructional up-flow areas of a ship to convection eddies, and then back again, suggests that they may use this method to move rather easily from the favorable eddies of one ship to those of another. Thus they might change from ship to ship in their continual search for food. Many times gulls are seen arriving over 'Atlantis' from the two windward quadrants;

sometimes high in the air and still in a convection up-flow, sometimes lower, and in a straight glide.

The reluctance of gulls to waste their energy in opposing unfavorable conditions, is seen on shore as well as at sea. From a steep air slope over a windward embankment on Juniper Point (Woods Hole), the gulls can get enough altitude in a sixteen-miles-per-hour southwest wind, to enable them to glide directly to windward four-tenths of a mile to a roosting place off the northeastern tip of Nonamesset Island. It is amusing to note that, upon failing to reach the roosting place on the first trial, the birds will return to the region of the up-flow (while they still have enough altitude for the quick down-wind glide), rather than flap their wings for the last few hundred feet of the flight. Apparently several minutes of extra soaring time are preferable to a few seconds of wing-flapping.

Inexplicable changes in flight tactics, which accompany physical changes in the air and water at sea, have led me to think that meteorologists might learn much about the motions of air flowing over the sea surface, by watching the flight evolutions of seabirds. In the waters off our coast we have, at various seasons, three kinds of seabirds which use three very different flight methods. These three kinds of seabirds normally inhabit three different bands of air: Wilson's Petrels, the first few feet of air over the water; shearwaters, the first fifty feet of air; and gulls, the first thousand feet, or more.. The different flight characters of these birds are a reflection of the normal air motions in their respective bands of air. It seems reasonable to suppose that a study of the changes in the flight tactics of these birds, in response to changes in the physical characteristics of their particular air strata, would reveal much of the nature of the air motion in the different strata.

A particularly obvious problem in air motion has arisen from these observations of the flight movements of gulls. Why is it that Herring Gulls, convection soaring in winds below fifteen miles per hour, must circle about as they rise, being carried along down wind all of the time; while in stronger winds of eighteen to thirty miles per hour, they can soar straight into the wind, gain altitude, and move rapidly to windward? Some very significant change takes place in the form of the convection eddies between the wind velocities of fifteen and twenty miles per hour.

Perhaps the system of 'helical vortices' which Langmuir (1938) found developed, under the influence of the wind, in the surface waters of lakes, also develops on the surface of the open sea, as Langmuir has suggested. The flight tactics of gulls sometimes suggest that this system of helical vortices in the water has its counterpart in the air over the water, and that increasing wind velocities cause an extension of the system higher and higher into the air.

REFERENCES

DUTCHER, WILLIAM, AND BAILEY, W. L.

1903. A contribution to the life history of the Herring Gull (*Larus argentatus*) in the United States. Auk, 20: 417–431, pls. 21, 22; see p. 430.

HEADLEY, F. W.

1912. Flight of birds. 8vo, Witherby and Co., London, see p. 145.

HORTON-SMITH, C.

1938. The flight of birds. 8vo, H. F. and G. Witherby, Ltd., London, see pp. 55, 101–103.

IDRAC, P.

1923. Remarques sur le vol de l'albatros et sur un procède simple d'étudier les variations d'inclinaison du vent. La Technique Aëronautique, no. 19, May 15, pp. 602–606.

LANGMUIR, IRVING

1938. Surface motion of water induced by wind. Science, new ser., 87: 119–123.

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