NEW EYE ON HIGH— OR IS IT AN EAR?

By either name, Seasat's imaging radar offers intriguing perspective on the world below

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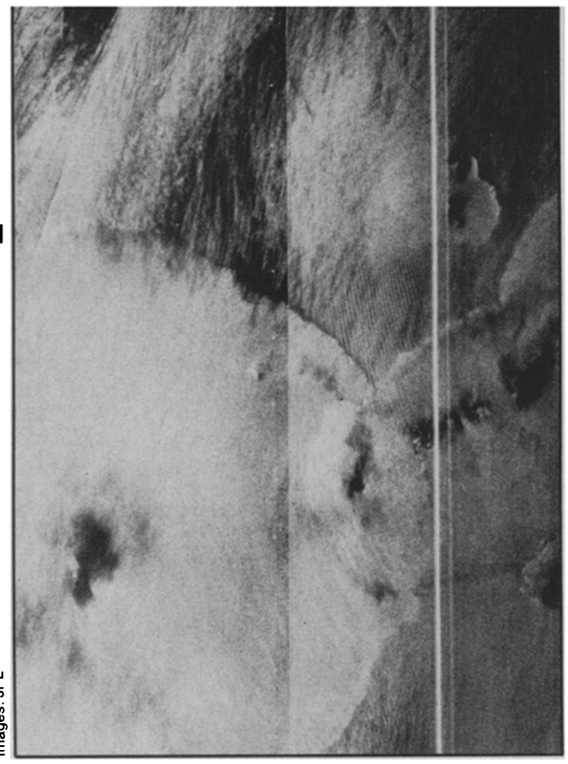

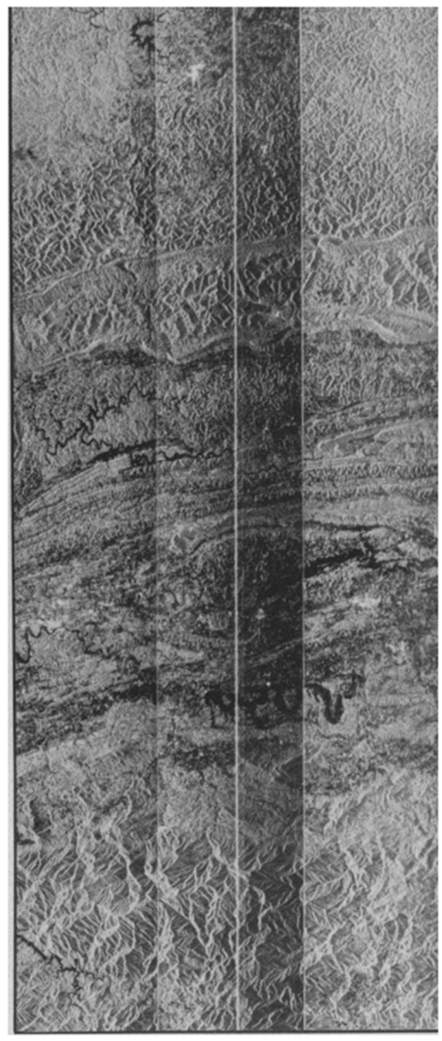

Images: JPL

SAR *image of part of the Gulf Stream (above) north of Grand Bahama Island shows no clouds or other atmospheric features. Circular area and other light regions may represent effects on the sea surface of wind and rainfall; ocean waves show near center, while striations above may correlate with internal features of Gulf Stream current. Overland image (right) near Knoxville, Tenn., shows (bottom to top) Smoky Mountains; folds of Appalachians with rivers and reservoirs; Cumberland "overthrust."*

At 12 meters in length and 2,300 kilograms, Seasat is a *big* satellite. Carrying a host of sensors primarily for monitoring conditions at the top of the ocean, it was launched June 26 into a circular orbit about 800 kilometers above the earth (SN: 7/1/78, p. 4). One of those sensors, however, does a job that is huge even on Seasat's scale: Called a synthetic-aperture radar (SAR), it carries a 2.1-by-10.7-meter antenna that works as the equivalent of a conventional radar antenna 14.8 *kilometers* long. Such a monster would span more than 160 football fields — nearly 36 New York World Trade Centers — laid end to end. It will be several weeks before Seasat is declared fully operational, but project officials at Jet Propulsion Laboratory last week released the first results from the SAR, and they are striking.

Like conventional radar, the SAR transmits electromagnetic pulses and monitors their return, or echo. Seasat is moving along its orbit at about 7.4 km/sec., and the SAR antenna transmissions spread over an angle of slightly less than 1.5°, which means (with the antenna canted 20.6° away from straight down) that a given spot on the earth's surface is within the beam for 2 seconds. Successive echoes are integrated, or added together, over that 2-second period, so that each ground spot returns the radar beam from a range of angles. The "synthetic aperture" is the product of the satellite's orbital velocity and the integration time.

The result, although not a photograph, is an image. It is a clear one, far different from the mere silhouettes of many conventional systems, and Seasat's SAR can resolve details as small as 25 meters across. (The actual resolution is better than 7 meters, but to reduce scattering effects called "speckle" in the returned signal, four "resolution units" are averaged together, cutting by four-fold the resolution of the finished product.)

Unfortunately, the SAR cannot be used in all parts of Seasat's orbit. There are 110 million bits of data per second used in the radar imagery, and the instrument can only be operated when it is within range of the three ground tracking stations with that capacity. Seasat carries recorders, but their 350-megabit capacity — enough for all of the satellite's other sensors combined — would be filled up by the SAR in a little over three seconds.

The other key aspect to the SAR's operation is that it works in the microwave band, which simply ignores clouds, rain and other atmospheric disturbances. Thus it always sees through to the surface, day or night and in any weather. What appear to be clouds in its images are more likely to be, say, the spattering of raindrops on the ocean beneath. The images can easily be misleading (the cover photo, taken at about 5 a.m., looks as if the sun is shining from the west, and radar would ignore such shadows anyway), and the SAR researchers will have to learn what they are really "seeing." Says one official, "It's like trying to judge a photographic print from the negative." □

North of the arctic circle by about 800 km, Canada's Banks Island (right) shows stream channels, alluvial fans, beaches. Adjacent dark zone is shore-fast, first-year sea ice, 1 to 2 meters thick, showing bright, linear pressure ridges. Westward is open water (light gray), followed by ice floes and the main polar pack with pressure ridges and very bright "rubble fields."