The model has been integrated by using various wind patterns for over 75 days. In this short report we cannot properly present the model output. Instead, we choose to present distributions of $u_1(x,y)$ at 30 and 60 days, $h_2 - H_2$ (the pycnocline anomaly) at 30 days, and the free surface anomaly at 30 days. The upper layer transports are shown for 30 and 60 days.

After 30 days a narrow jet is well developed over the entire equatorial ocean (Fig. 2). The numerical grid was chosen such that all boundary currents are well resolved in the computations. This was accomplished by using a variable resolution grid (*3*). The equatorial jet reached a speed of 45 cm sec^{-1} after 30 days. The tilt of the ocean surface is 20 cm across the basin, as observed by Wyrtki (*1*). The flow has induced upwelling in the western ocean and downwelling near the eastern boundary.

After 2 months the jet has reached a strength of 50 cm sec^{-1} (Fig. 3) but the maximum has migrated far westward. The upper-layer flow shows a very interesting pattern. At the equator in the eastern third of the basin the pressure gradient is balanced by the wind stress. The surface current has reversed and flows westward. The equatorial jet separates from the equator at 3000 km and flows north and south in two narrow, strong (> 10 cm sec^{-1}) currents. Wyrtki does not report this current.

The thermocline (pycnocline) anomaly calculated after 60 days indicates a 25-m rise in the western ocean and a 45-m drop in the eastern ocean. These are very close to the rise and fall of the 20°C isotherm observed by Wyrtki. The tilt of the ocean surface is not shown after 60 days since the mean east-west tilt remains about 20 cm.

We have not shown the flow structure in the lower layer. It is interesting to note that the depth-averaged velocities are small, no more than 3 cm sec^{-1}. This implies that the currents seen in Figs. 2 and 3 are reversed in direction in the lower layer.

Each of Wyrtki's observations has been simulated in the numerical model. A more detailed report and interpretation of this simulation will be reported elsewhere (*7*).

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References and Notes

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2. J. J. O'Brien and H. E. Hurlburt, *J. Phys. Oceanogr.* **2**, 14 (1972); H. E. Hurlburt and J. D. Thompson, *ibid.* **3**, 16 (1973); R. T. McNider and J. J. O'Brien, *ibid.*, p. 258.
3. The numerical model developed by H. E. Hurlburt [thesis, Florida State University (1974)] was used for these computations. The details of the open boundary conditions, the variable mesh, numerical scheme, and so forth, are described in Hurlburt's thesis.
4. The Coriolis parameter, f, which depends on the sine of the latitude, is approximated by a linear function, $f_0 + \beta y$, where f_0 is a reference value (here 0) and Cartesian coordinates are used.
5. K. Yoshida [*J. Oceanogr. Soc. Jap.* **15**, 159 (1959)] first derived Eqs. 2 and the solutions in Fig. 1.
6. A. E. Gill (preprint) discusses a model for the westward surface currents and eastward undercurrent which are found in the Pacific and Atlantic oceans. The extension to this Indian Ocean case is trivial; our contribution here is the numerical solution. G. Philander [*Rev. Geophys.* **11**, 513 (1973)] has reviewed the evidence for the westward-flowing equatorial jet found in the equatorial Pacific and Atlantic.
7. J. J. O'Brien and H. E. Hurlburt, in preparation.
8. Supported by the Office of Naval Research, Ocean Science and Technology Branch. Partial support was derived from Coastal Upwelling Ecosystems Analysis, a program of the International Decade of Ocean Exploration, NSF grant GX-33502. The numerical work was done at the National Center for Atmospheric Research, which is supported by the National Science Foundation. Partial computer support was provided by the computer center, Florida State University. This is Contribution No. 98 of the Geophysical Fluid Dynamics Institute, Florida State University.
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Satellite Photograph Presents First Comprehensive View of Local Wind: The Santa Ana

Abstract. *The photograph of the 1 January 1973 Santa Ana wind condition reveals local atmospheric dynamics rarely recorded on satellite imagery. The Santa Ana wind implies very specific weather conditions for the Los Angeles coastal lowland. Destructive land uses, in part, provided the material visible in the dust plumes.*

Images sensed by the National Aeronautics and Space Administration's Earth Resources Technology Satellite (ERTS-1), orbiting 855 km above the earth, in January 1973 dramatically recorded a Santa Ana wind condition in Southern California (Fig. 1). The image shown is a mosaic of two returns taken on 1 January 1973 in band 7 (0.8 to 1.1 μm). The San Gabriel Mountains, bounded on the north by the San Andreas fault, angle across the lower portion of the image; the Mojave Desert is seen in the middle, and the Garlock fault, which separates the Mojave from the Sierra Nevada and Great Basin, is shown in the upper portion of the picture (see map inset in Fig. 1). The dust plumes in the Mojave are 10 to 30 km in length and cover a landscape of 300 km^2. A Santa Ana wind results in particular weather conditions, and its ramifications are important to both agriculturalists and conservationists.

A Santa Ana (a foehn type wind) may develop in Southern California after the passage of a cold front in central California and Nevada. A mass of stagnant air settles over the Great Basin, developing a deep high-pressure cell. Air flows from the cell across the Mojave Desert and spills over the Southern California Mountains into the coastal lowland of the Los Angeles Basin. Cool temperatures prevail in the Mojave, but, as the air flows downslope and through the canyons of the San Gabriel, San Bernardino, and Santa Ana mountains, it warms and dries adiabatically. As a result high winds, unseasonably warm temperatures, and low humidities develop in the Los Angeles (*LA*) Basin. In addition, the danger of brush fires increases, crop damage is likely, and the relatively open desert environment is susceptible to increased wind erosion and damage.

On 1 January at the Santa Monica (*SM*) Pier (elevation, 4.6 m) a maximum temperature of 21.1°C (70°F) was reached while at Palmdale (*P*) (elevation, 767 m), in the Mojave Desert, a maximum temperature of 11.7°C (53°F) was attained. Wind velocities during a Santa Ana are comparatively high. For example, at Riverside (*R*), a daily wind total (*1*) of 269 km was recorded on 1 January, and on the following day, a continuation of the Santa Ana condition, a daily wind total of 268 km was reached. For the next 7 days, as the Santa Ana subsided, daily wind totals of 61, 73, 60, 30, 18, 15, and 13 km, respectively, were recorded at Riverside. Because the low-level inversion layer that contributes to air stagnation in the Los Angeles Basin could not develop, visibilities were virtually unlimited in many locations in the Los Angeles metropolitan area.

During a Santa Ana, which may last

Fig. 1. Composite of two National Aeronautics and Space Administration ERTS-1 images (1162-18013 and 1162-18011) showing a Santa Ana wind condition in Southern California on 1 January 1973.

for several days and have high-velocity gusts associated with it, damage to citrus and other agriculture from both mechanical destruction and desiccation is a threat. Agricultural damage during a severe Santa Ana can amount to millions of dollars. Agricultural fields in the Mojave Desert can be recognized on the image by their regular geometric pattern and dark signature. Within the Los Angeles Basin, the agricultural areas are not as easily discerned as in the desert.

The sites from which the dust originates warrant scrutiny. Preliminary field reconnaissance has shown that many of the source sites of the dust correspond to areas of intensive off-road vehicle (ORV) operation. Surface material is loosened under ORV usage, and the material is then more subject to removal by wind. Consequently, dust has become a major complaint of desert residents and a major concern of conservationists because of the accelerated erosion. Glass damage due to sand pitting of windows in homes and motor vehicles and structural damage to camper trailers and large truck trailers during the Santa Ana condition make travel warnings necessary. Structural damage to power lines and poles, dwellings, ornamental trees, outdoor advertising, and recreational and transport facilities may be costly.

The actual extent and magnitude of the dust plumes have rarely been recorded because of the extensive area involved. The ERTS-1 image presents the first compact view of the entire dynamics in progress at one point in time. Neither aircraft imagery nor ground data presents such a complete overview of the affected area. Monitoring of such environmental conditions for long periods of time with sequential imagery may be very useful to those engaged in making sensible resource management decisions.

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Notes

1. The daily wind total is the total distance of omnidirectional air flow that passes a recording point in a 24-hour period.

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