AVHRR

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MONITORING GLOBAL AEROSOL MOVEMENTS

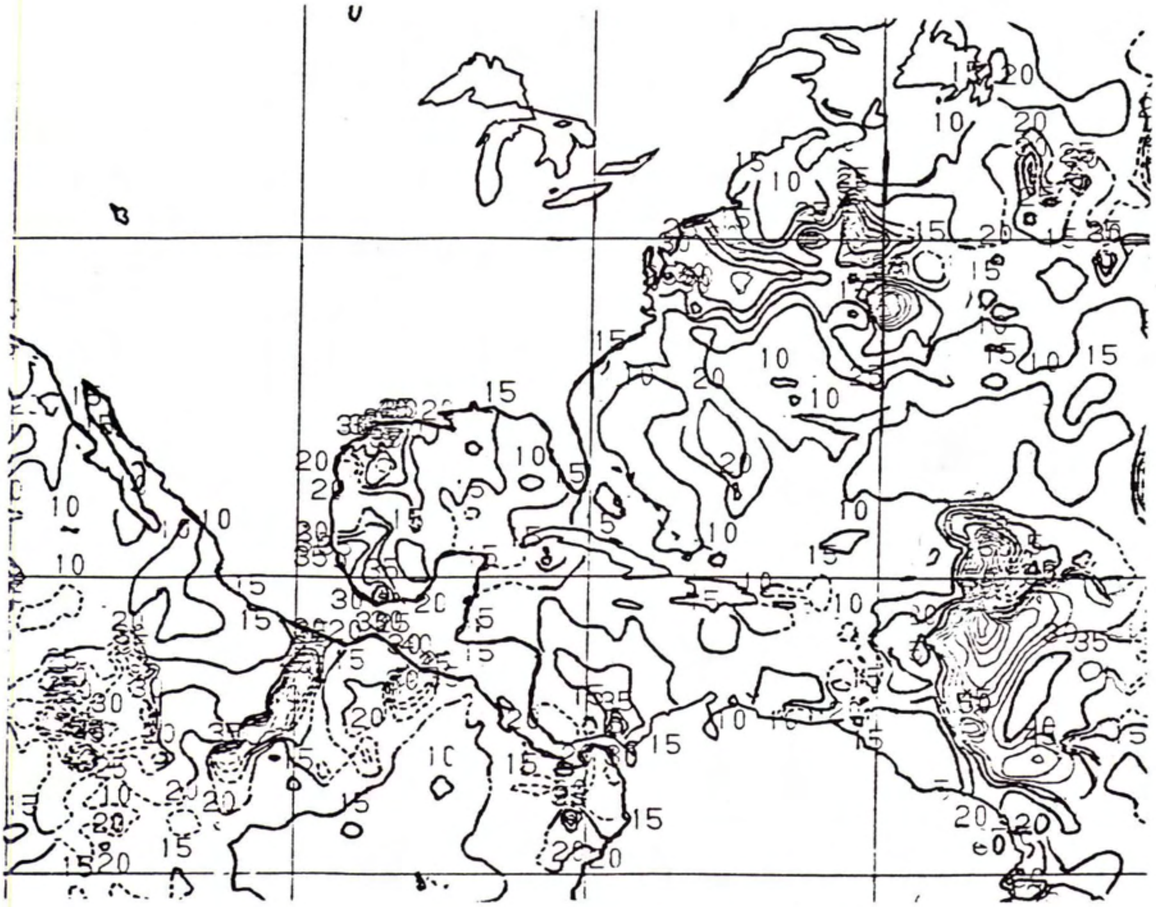

Figure 1

Aerosols are airborne particulate matter. Their sources range from urban/industrial activity, to wildfires and deserts.

Several aerosol phenomena have global impact. The arrival of the "Hermattan," associated with the dry West African winter, brings dust from the Sahara and Sahel to regions farther south. It is accompanied by the migration of birds and the increase in incidence of common colds. Aerosols from fires and industrial areas are considered possible causes of acid rain.

More directly related to remote sensing, aerosols impede the transmission of light and thermal energy, distorting computations of the AVHRR vegetation index, sea surface temperature, and other quantitative measurements.

However, the same AVHRR system that is bothered by aerosols shows us their distribution. L.L. Stowe of NOAA's National Environmental Satellite, Data, and Information Service and C.R. Nagaraja Rao of Oregon State University (and a visiting scientist at ORA for the past two years) led a project to produce experimental maps of global aerosols, and co-convened a workshop on this project in April 1988.

The experimental product is a contour map of atmospheric optical thickness. It is derived by first determining which AVHRR GAC pixels are cloud-free (using techniques similar to those used to derive sea surface temperature). The radiance of reflected radiation in channel 1 for these selected pixels is compared with the computational results from an atmospheric radiative transfer model to determine the amount of aerosol needed to match the observed radiance. The aerosol amount is expressed as an optical thickness, scaled by 100. Thus, a value of 20 can be interpreted to mean that 82% of a vertically incident beam of solar radiation at a wavelength of 0.5 microns would be transmitted to the surface, i.e., solar transmittance = 100 times exp(0.2) = 82%. Observations are composited over a seven-day period before being analyzed and contour-mapped at a resolution of 100 km.

Two examples from the experimental contour maps are given here:

1. The map for the period ending 4 June 1987 shows plumes of aerosols emanating from the northeastern and Gulf coasts of the USA, as well as from Central America (figure 1). The former are inter-

preted as being from industrial sources, the latter from fires derived from farming practices. Elsewhere on this map (but not on the portion shown here) are aerosols produced by the great forest fires of northeastern China of that time, plus dust from the Arabian and Sahara deserts over their adjacent oceanic areas.

2. The map for the period ending 21 January 1988 (with revised contour interval) exhibits a much clearer North American Atlantic seaboard, but shows the dust pattern from the Sahara reaching across the Atlantic to northeastern South America. This is a graphic but not unusual example of the distribution of aerosols in this region. If you ever get a chance to fly across the Atlantic from North America to Africa during winter, try to see the coastline through the Hermattan's hazel.

Note that the experimental product is an initial attempt at monitoring global aerosol distributions. There are several areas where refinements would make the product more useful and truly global.

1. The radiative transfer model becomes unreliable at large solar zenith angles (70 degrees), so high latitudes are not well sampled by the current product (although the NOAA-11 orbit will noticeably improve that situation). Information from high latitudes is useful, even if it may be less reliable than that for lower latitudes. With corrections or improvements to the model for large solar incidence angles this information could be provided, with the advice about the lesser accuracy of the product in such regions.

2. Areas over land are not modeled. Though one could develop a lookup table for "zero optical thickness," and thus develop a radiative transfer model for land surfaces, the highly variable reflectance properties of these surfaces makes this a complex task. The importance of land areas cannot be ignored, as they are the source for much of the world's aerosols, as well as the recipient for many. The land is also the ecosystem that most immediately affects most of the lives that we know well. Here's a good project for our readership.

3. The current product uses only one relectance channel. There are two such channels on the current AVHRR, with a third planned for the AVHRR on the NOAA/K.L.M. satellites in the 1990s. Recent research has shown that aerosol size distribution information can be derived from a multichannel approach, simultaneously improving the accuracy of the derived optical thicknesses. Here is another area where further improvements are possible.

4. The experimental product presented here is a contour map, though a collection of gridded digital data would be particularly valuable for comparisons through time and space.

5. Details on distribution of contour maps and digital data are currently being worked out.

Further information about the experimental aerosol product can be obtained by contacting: Dr. L.L. Stowe, NOAA/NESDISs/Office of Research and Applications, Satellite Research Laboratory (E/RA11), World Weather Building, 7th Floor, Washington, DC 20233, 301-763-8102.

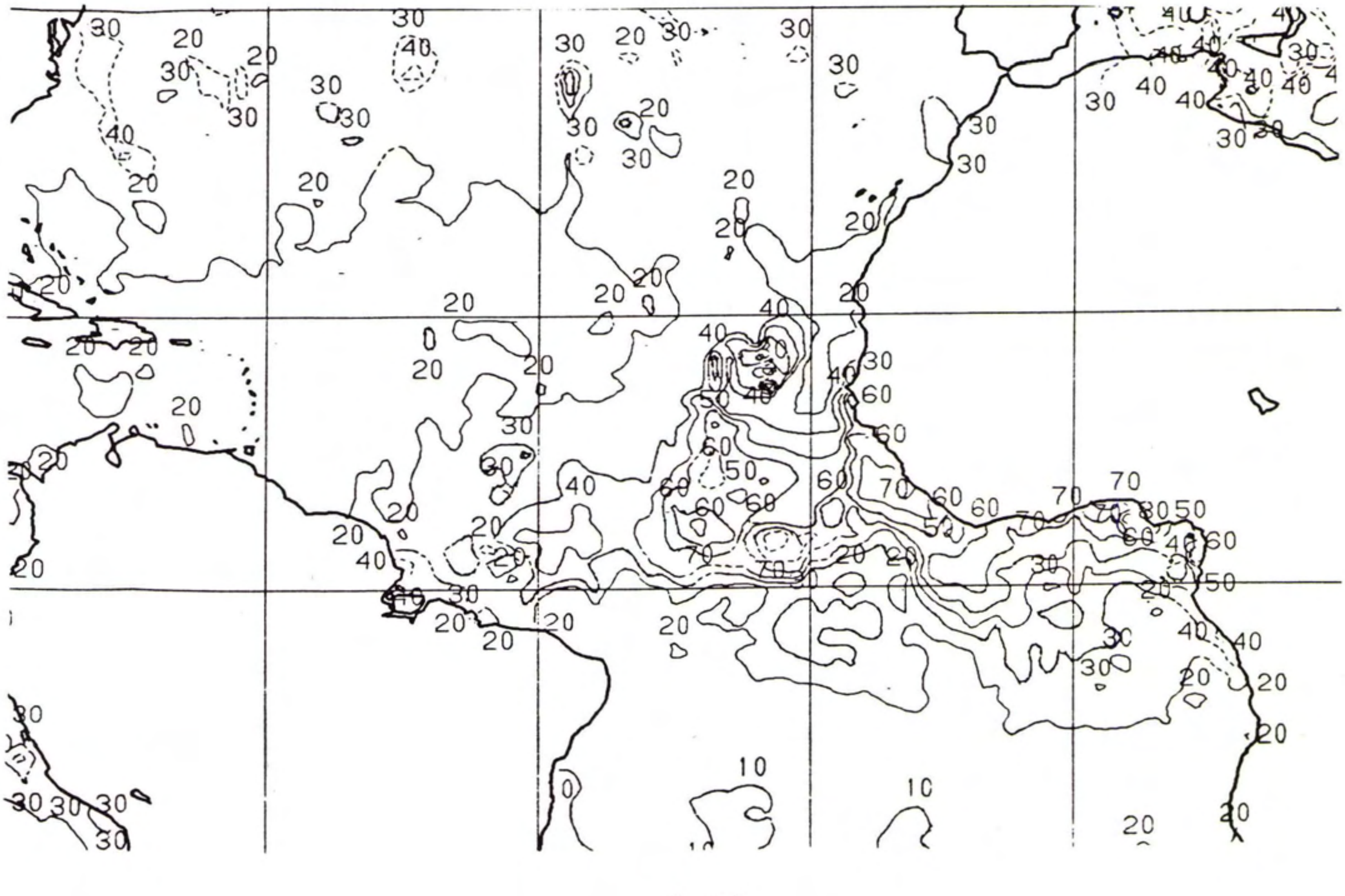

Figure 2