# **Biography --- *Pat Chavez (Remote Sensing Scientist)***

Pat Chavez joined the Department of Geography, Planning, and Recreation at Northern Arizona University (NAU) in an adjunct research position after retiring from the United States Geological Survey (USGS) where he worked for thirty-eight years at the Flagstaff field center. As a research remote sensing scientist with the USGS he developed an in-depth expertise in remote sensing and digital image analyses as it relates to earth science during a career that started before the launch in late 1972 of ERTS-1 (now called Landsat 1). He received his B.S. and M.S. degrees in mathematics with a minor in physics in 1970 and 1971 from NAU. He has done pioneering work in the processing and analyses of digital images collected by various satellite, airborne, and shipborne imaging systems carrying a broad array of imaging sensors including ones designed to collected optical, radar, acoustics, thermal, and lidar image data. One aspect of his research included the radiometric calibration of imaging sensors and the development of an operational atmospheric correction procedure which is critical for applications that require absolute radiometric surface reflectance values. This includes applications dealing with multi-temporal and multi-location/spatial image analyses, comparisons, and change detection (Google '*remote sensing COST Chavez 1996*').

He has worked with images covering many different types of landscapes including those on several planets (Mars, Venus, Mercury), the bottom of the ocean (acoustics), Antarctica, Mojave Desert, Saudi Arabia, North Africa, Alaska, Grand Canyon, and coral reefs in Hawaii. He served on various committees dealing with remote sensing including as an invited member of several international working groups of the International Society of Photogrammetry and Remote Sensing (ISPRS) and *received the American Society for Photogrammetry and Remote Sensing Alan Gordon Memorial Award*. He was the principal investigator in the development and implementation of the algorithms, software, and procedures to generate digital image maps of the ocean floor covering the United States Exclusive Economic Zone (EEZ) using side scan sonar (acoustic) image data. For work that resulted in a satellite image map of Antarctica *a glacier was named after him*.

Some of his work included investigating methods to detect, map, and monitor the temporal and spatial dynamics of vegetation in arid lands at different resolutions using satellite and airborne imaging (pixel resolutions of 30m to 0.1m). The spatial dynamics of vegetation in arid lands is important for many different reasons including due to its impact to the landscape's vulnerability to wind and water erosion, wildfires, wildlife habitats, and invasive grasses and plants. He was the leader in the design and use of an airborne digital imaging system that collected digital images with a pixel resolution of 5 to 15 cm and the data were used for various applications. One of the spectral bands in the airborne imaging system was selected to optimize clear water penetration to map the bottom of shallow coastal waters in Hawaii and along the Colorado River.

Under recent grants at NAU he researched and developed models using remote sensing to detect and map the potential for shallow groundwater and infiltration in arid regions of Kenya and Ethiopia, and to forecast weeks ahead of time the relative level of dust storm activity for a region in the Middle East. Recently he has gotten involved in wildland fire issues and developed methods to detect active fires and separate false positives from true positives using satellite images. He is in the process of developing concepts related to the specifications for a satellite imaging system that could be *used on an operational basis* to detect and monitor wildfires, as well as for long-term (weeks ahead of time) forecasting of wildfire behavior.

*In a recent study by Stanford University professors he was classified as being in the top two percent of the world scientists (all disciplines) based on the impact of his research.*

## Some of his publications (*over 10,000 citations*)


### *Image Based Radiometric Calibration*

*Chavez, P.S., Jr., 1996*. Image-based atmospheric corrections - revisited and improved, Photogrammetric Engineering and Remote Sensing, vol. 62, no. 9, pp. 1025-1036 (the COST model).

*Chavez, P.S., Jr., 1989*, Radiometric calibration of Landsat Thematic Mapper multispectral images, Photogrammetric Engineering and Remote Sensing, vol. 55, no. 9, pp. 1285-1294.

*Chavez, P.S., Jr., 1988*, An improved dark-object subtraction technique for atmospheric scattering correction of multispectral data, Remote sensing of Environment, vol. 24, pp. 459-479.

### *Spectral Analyses*

*Chavez, P.S., Jr., and Kwarteng, A.W., 1989, Extracting spectral contrast* in Landsat Thematic Mapper image data using selective principal component analysis, Photogrammetric Engineering and Remote Sensing, vol. 55, no. 3, pp. 339-348.
*Chavez, P.S., Jr., 1988, Comparison of the spectral information content* of Landsat Thematic Mapper and SPOT for three different sites in the Phoenix, Arizona region, Photogrammetric Engineering and Remote Sensing, vol. 54, no. 12, pp. 1699-1708.

*Chavez, P.S., Jr., G.L. Berlin, and L.B. Sowers, 1982, Statistical Method* for Selecting Landsat MSS Ratios, Journal of Applied Photographic Engineering, vol. 8, no. 1, pp. 23-30 (this paper presented a quantitative technique which I called the *Optimum Index Factor (OIF)* that uses statistical information of the various spectral bands to automatically rank combinations of groups of bands.

***Spatial Analyses***

*Chavez, P.S., Jr., and H.A. Karl, 1995*, Detection of barrels and waste disposal sites on the seafloor using *spatial variability analysis* on side scan-sonar and bathymetry images, in special issue of Journal of Marine Geodesy, vol. 18, no. 3, 1995, pp 197-211.

*Chavez, P.S., Jr., and Gardner, J.V., 1994*, Extraction of *spatial information* from remotely sensed image data - An Example: GLORIA sonar images, Canadian Journal of Remote Sensing, vol. 20, no. 4, pp. 443-453.

*Chavez, P.S., Jr., 1992*, Comparison of *spatial variability* in visible and near-infrared spectral images, Photogrammetric Engineering and Remote Sensing, vol. 58, no. 7, pp. 957-964. (*Note: this paper received the Best Scientific Paper in Remote Sensing Award*).

*Chavez, P.S., Jr., and B. Bauer, 1982*, An *automatic optimum kernel-size selection* technique for edge enhancement, Remote Sensing of Environment, vol. 12, pp. 23-38 (this paper presents a method I developed to automatically predict what the optimum kernel/spatial filter-size should be to apply an edge enhancement; the size is directly related to the amount of textural or local spatial variability contained in the image --- this is done without the need to visually look at the image).