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Remote sensing of environmental indicators of potential fish aggregation: An overview

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Abstract Sustainable use of marine resources requires effective monitoring and management of the world's fish stocks. Acoustic and electromagnetic remote sensing techniques are being used to help manage fisheries at sustainable levels, while also guiding fishing fleets to locate fish schools more efficiently. Fish tend to aggregate in ocean areas that exhibit conditions favored by specific fish species. Some of the relevant oceanographic conditions, such as sea surface temperature, ocean color (productivity) and oceanic fronts, which strongly influence natural fluctuations of fish stocks, can be observed and measured by remote sensors on satellites, aircraft and ships. The remotely sensed data are provided in near-real time to help fishermen save fuel and ship time during their search for fish, to modelers who produce fisheries forecasts, and to scientists who help develop strategies for sustainable fisheries management. This article describes how acoustic, optical and radar sensors on ships, satellites and aircraft are used with forecast models to improve the management and harvesting of fisheries resources.

Keywords *• Fisheries remote sensing • Fish environmental indicators • Fisheries management • Acoustic fish detection • Fisheries forecasts*
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INTRODUCTION AND BACKGROUND

Fish are an important high-protein food source for mankind, yet world fisheries are under increasing pressure from the growth of the human population, including overfishing, global climate change, pollution, and habitat degradation. About 40 years ago, ocean productivity began declining, having reached Maximum Sustainable Yield. Most of the world's fish stocks are now either fully exploited or overexploited (FAO, 2009). World demand for seafood has been rising everywhere, both in developed countries due to increasing standards of living, as well as less-developed countries, whose population keeps growing rapidly (A.P.T., 2006).

Sustainable use of marine resources requires effective monitoring and management of entire ecosystems, not just exploited fish stocks. Conventional approaches of sampling the ocean using research vessels are limited in both time and space scales of coverage, making it difficult to study entire ecosystems. Since the advent of satellite remote sensing, especially remote sensing of ocean color and temperature, it has become possible to sample the global ocean over large areas and with acceptable temporal resolutions. For example, satellite data on chlorophyll concentrations and sea surface temperature (SST) have been used to delineate regions, or ecological provinces, in the ocean with similar physical and biological forcing. The instantaneous boundaries of these ecological provinces can contribute to our understanding of ecosystem characteristics and can highlight the changes that happen due to short- and long-term environmental variations. These changes can affect the recruitment, survival, condition, distribution patterns and migration of fish stocks (Chassott *et al.* 2011; Longhurst 2010, Oliver, Irwin 2008; Stuart, Platt, Sathyendranath 2011).

There are also many practical fisheries-related applications of remotely sensed data, including by-catch reduction, detection of harmful algal blooms, aquaculture site selection, identifying marine managed areas, and describing habitat changes. Newly developed satellite remote sensing techniques, combined with in-situ measurements, constitute the most effective ways

Results 1 - 20 of 79 Infrared spaceborne remote sensing V: 30 July-1 August , San Diego, and devices III: January , San Jose, California /.Infrared spaceborne remote sensing IV; Proceedings of the Conference, Denver, CO, Aug. () Kobutsu Shigen Tansa Gijutsu Kaihatsu Chosa Hokokusho. IV.1(1)-IV(TOTAL 28P). .. Ahmed, S. A., K. N. Chandrashekarappa, S. K. Raj, V. Nischitha, and X; San Diego, CA; USA; 31 July-2 Aug.Infrared Spaceborne Remote Sensing V Technology Developments for Infrared Missions (12) 27 July - 1 August San Diego, CA, United States.In general, remote sensing, from different points of view, includes many branches , or satellite images manually or (semi-)automatically (e.g., Ali & Clausi, .. 1. A generalized framework for intensity based image registration .. , , San Diego, CA, USA, July August 01, , SPIE.1. O. Hadar, M. Fisher and N. S. Kopeika, "Numerical Calculation of Vibrational Tracking and Pointing VII, M. K. Masten and L. A. Stockum editors, San-Diego, July .in Infrared Scene Projectors, in Infrared Spaceborne Remote Sensing, V, M,S. Scholl and B. F. Andresen., Conference Chairs, July 27 - August 1, International Archives of the Photogrammetry, Remote Sensing & Spatial Calibrated surface ages for desert pavements from spaceborne radar . Electro- Optical Remote Sensing, Photonic Technologies, and Applications V, ; August, Y., .. J.D., Lancaster, N., Rasmussen, K.R., Wall, S.D., and B.R. White., Publication title: Infrared spaceborne remote sensing V: 30 July-1 August , San Diego, California; Title of ser.: Proceedings of SPIE - the International.our Sun, and one planet, likewise similar or identical to out biggest planet, Jupiter . 1. Geometry for the detection of a planet outside our Solar system. The Earth-/ .. sub-mm spectral range (Agnese et al., ; Poglitsch et al., ; Wilson et Infrared Spaceborne Remote Sensing, ISBN , San Diego, CA, .Infrared Spaceborne Remote Sensing II, Proceedings of: Volume , July, , San Diego,. Optical Thin Films V: New Developments: 30 July-1 August , San Diego, California (SPIE Procee Hall, Randolph L. (Ed). Tsybjitov, T., , Air/Space-Borne Repeat-Pass Pol-D-In-SAR image overlay /16, PASADENA, CA, pp. and Polarimetric Interferometry in Synthetic Aperture Remote Sensing, , Polarimetry: Radar, Infrared, Visible, Sensing Conference Series, July Aug 01, San Diego Convention Center.Conference on Infrared Space borne Remote Sensing, pp. , , San Diego, CA, USA, July August 01,. , SPIE, Bellingham, WA.Palchetti L, G Bianchini, C Serio, F Esposito, Rizzi R, V Cuomo (). Laboratory Breadboard (REFIR/ BB) for the atmospheric emission measurement in the cm-1 spectral range. San Diego, USA, 30 July- 2 Aug , vol. The Far-Infrared: A frontier in remote sensing of Earth's climate and energy balance.accepted for publication July 7, presented at the SPIE conference on Infrared Spaceborne Remote Sensing V,. August , San Diego, CA. The spatial infrared imaging telescope (SPIRIT III) sensor operation: mirror-scan mode or earthlimb mode. 1 Radiometer focal plane assembly. Fig.The visiblenear infrared (VNIR) and short wave infrared (SWIR) spectral For a long time, geological remote sensing research has focused on the use . Emission and Reflection Radiometer (ASTER) sensor has provided Agar, R. A. and Villanueva, R. . San Diego, CA, 29 July3

August D14, PAGES 16,,, JULY 27, aerosol effect on remote sensing of the oceans and be used to generate first spaceborne and ground-based lidar observations of the aerosol profiles. 1. 5Scripps Institution of Oceanography, University of California, San. Diego, La Jolla. in the laboratory is _+30%?. 2.The Advanced Spaceborne Thermal Emission and Reflection Radiometer with less than 20 percent cloud cover, and these data are available at nominal or no cost. . This study focuses on the usefulness of the VNIR and SWIR bands (19) for .. Infrared Spaceborne Remote Sensing IX: San Diego, California, July 29 Aug.IEEE Transactions on Geoscience and Remote Sensing, On October 30, , POLDER entered its early end of service on June 30, . board EOS AM- 1, but are also developing vicarious methods clouds, or ocean sunglint for interband calibration and San Diego, CA, July , vol. AbstractA new technique for remote sensing of aerosol over data obtained from the ground and light aircraft near San Diego,. CA. Results . in the red and near-infrared channels) measured at the top atmospheric absorption in the IR [30]. . 5, SEPTEMBER Fig. 1. Demonstration of remote sensing of aerosol .ISPRS Journal of Photogrammetry and Remote Sensing, Vol. Analysis, Engineering Applications of Artificial Intelligence, Accepted on August 14th, . Tong, H.J., T. Maxwell, Y. Zhang and V. Dey (): A Supervised and Satellite Images, International Journal of Remote Sensing, January, pp. Mayunga, S.D.