

# The Use of Satellite Data for Archaeology: an Overview of NASA's Experience

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# NASA Space Archaeology Program Overview

- The NASA Space Archaeology Program has the scientific objective to use the unique vantage point of space to improve our understanding of past human settlement patterns and the relationships between the natural environment and cultural adaptations as functions of time and space.
- The major goals of this program are:
  - To accelerate archaeological discovery and understanding through access to and analysis of remotely-sensed data obtained from space borne and airborne platforms; and
  - To facilitate the infusion of technological expertise and capacity in remote sensing into archaeological research by fostering multidisciplinary collaborative relationships
- NASA Program Manager: Craig Dobson



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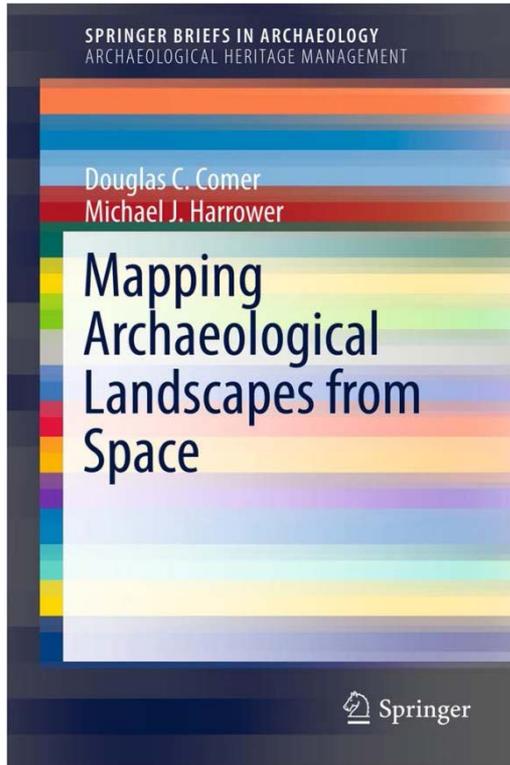
# NASA Space Archaeology Program Overview (cont.)

- The overall NASA contributions include:
  - Funded research competitively selected under a Research Opportunities in Earth and Space Science (**ROSES**) element
  - Acquisition of and access to NASA satellite and airborne remote sensing data
  - Support of US and international workshops and training efforts
  - Dissemination of findings at symposia and in journals and books



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# NASA Space Archaeology Program Contribution



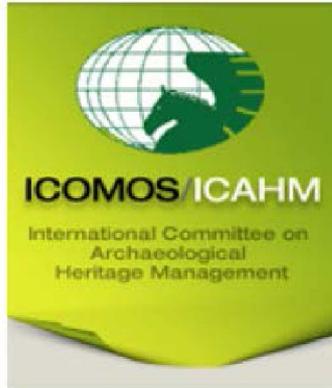
- Historic Air and Spaceborne Imagery
- Multispectral and Hyperspectral Imagery
- SAR (Synthetic Aperture Radar)
- LiDAR (Light Detection and Ranging)
- Archaeological Site Detection and Modeling

A NASA sponsored workshop in Fall 2011 lead to the recent publication of a book entitled 'Mapping Archaeological Landscapes from Space' edited by Comer and Harrower.



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# NASA Space Archaeology Program Contribution



- Elements in the remote sensing process of the greatest relevance to archaeological research and resource management
- The most widely available and reasonably priced image types of use to archaeologists, from multispectral to SAR
- Image enhancement and analysis techniques of greatest use to archaeological research and resource management
- Mutual support group of archaeologists working with this technology



NASA sponsored a Space Archaeology Workshop at Pontificia Universidad Católica del Perú, in Lima, Peru December 1-2, 2012 with Dr. Douglas Comer, Dr. Ronald Blom, and Dr. Bruce Chapman as instructors



# NASA Space Archaeology Program Solicitations

In 2007 and 2009 the NASA Space Archaeology Program solicited proposals that incorporate remote sensing observations in the following focus areas:

- Regional landscape analysis and modeling relating human settlement patterns and subsistence strategies to environmental factors derived from remote sensing (i.e., climate, topography, hydrology, vegetation cover, etc.)
- Protection and preservation of cultural heritage sites and/or planning for the sustainable development of cultural resources

In 2007, NASA received a total of 17 proposals and selected 7 for funding.

In 2009, NASA received a total of 12 proposals and selected 6 for funding.

The total funding was approximately \$2 million over three years

In 2011, an additional focus area was added:

- Identification and exploration of the extent and nature of past human settlement patterns



# Currently Funded Activities

- Flood Regimes and Carbon Cycling in Anthropogenic Landscapes of the Bolivian Amazon, Clark Erickson, Univ. of Pennsylvania
- Mounds, Microclimates, and Maize: Understanding the Influence of Inland Lakes on Agriculture in Pre-contact Indigenous Societies using Remote Sensing Data, Michael Palace, Univ. of New Hampshire
- Climate Change and Human Occupation of the New World, Doug Comer, Cultural Site Research and Management, Inc.
- Satellite Remote Sensing of Ancient Water Availability and Irrigation: A Comparative Study of Complex Societies in Oman and Eithiopia, Michael Harrower, Johns Hopkins Univ.
- Sub-Pixel Detection of Archaeological Materials Using NASA Satellite and Aircraft Data, Paul Buck, Desert Research Institute
- An Archaeolgical Investigation into the Northern Peruvian Desert Region Using Landsat, Hyperion, Advanced Land Imager (ALI), and ASTER Data, William Saturno, Boston Univ.

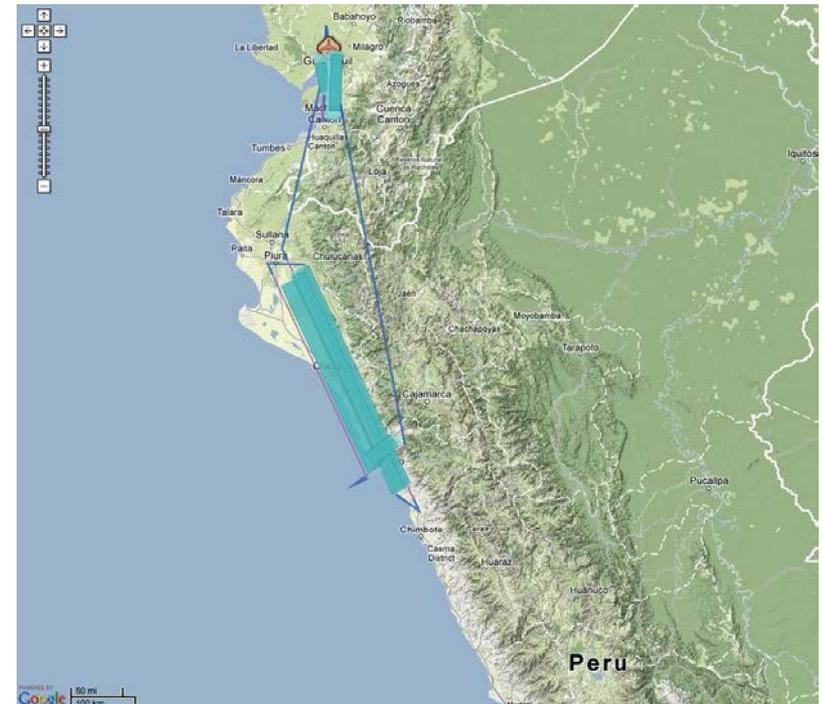


# Example of NASA Space Archaeology Research

- William Saturno, Boston University
- Douglas Comer, Cultural Site Research and Management
- CO-Is: Bruce Chapman and Ronald Blom, JPL
- UAVSAR science products: high-resolution, fully polarimetric PolSAR images will be used to identify and map archaeological features associated with the Moche culture
- Site: Peruvian coastal desert valleys
- Improved inventory of cultural sites will enable researchers to identify associations with ecological features and understand ancient environmental adaptations.



***Temple of the Sun near Trujillo, Peru***





# UAVSAR Deployment

- March 4<sup>th</sup> through April 3<sup>rd</sup> 2013
- North America:
  - Arizona and Gulf Coast
  - 12 Hours
  - 2 sorties
- Central and South America:
  - 112 hours
  - 20 sorties
- Airports:
  - New Orleans
  - San Jose, Costa Rica
  - Guayaquil, Ecuador
  - Antofagasta, Chile
  - Concepción, Chile





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## UAVSAR

Uninhabited Aerial Vehicle Synthetic Aperture Radar

Science & Applications
Technology
Education
Tools

**Calendar (2013)**

This Week: < >

Sun 4/21	Mon 4/22	Tue 4/23	Wed 4/24	Thu 4/25	Fri 4/26	Sat 4/27
Metolius - Spring	L: Slumgullion	L: Sac Delta	Ka: Engineering	Ka: Alaska	Ka: Alaska	
	BERMS - Spring		Ka: Transit	Metolius - Spring		
Metolius and BERMS - Spring 2013						
Global Hawk Integration and Test				Metolius - Spring		

L-band  
 NASA Dryden G3

P-band (AirMOSS)  
 NASA Johnson G3

Ka-band (GLISTIN-A)  
 Global Hawk

or

**Last Flight Flown: PLAN\_13077** (Apr 25, 2013)  
P-band. Location: Oregon

**Last Image Released: Walnut\_28011** (PolSAR)  
P-band. Acquired Sep 20, 2012  
Walnut Gulch

**NASA Flies Radar South on Wide-Ranging Expedition**

A versatile NASA airborne imaging radar system is showcasing its broad scientific prowess for studying our home planet during a month-long expedition over the Americas.

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[Flight Planning](#)

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# UAVSAR Data Access

## UAVSAR Data Search

Map Search (Switch to Text search)

You can search by **flight ID**, **line ID**, **line sitename**, **line description**, and **date of acquisition** (in YYMMDD format). Only flight IDs can be searched as a range (e.g. "09001-09035").

To search multiple criteria using OR, separate your search with commas (e.g. "San Andreas, 26532").

To search multiple criteria using AND, separate your search with period (e.g. "Haiti. 11042").

To search multiple criteria using NOT, separate your search with exclamation mark (e.g. "Haiti! 11042").

In the map, click on the **download icons**  to download the data.

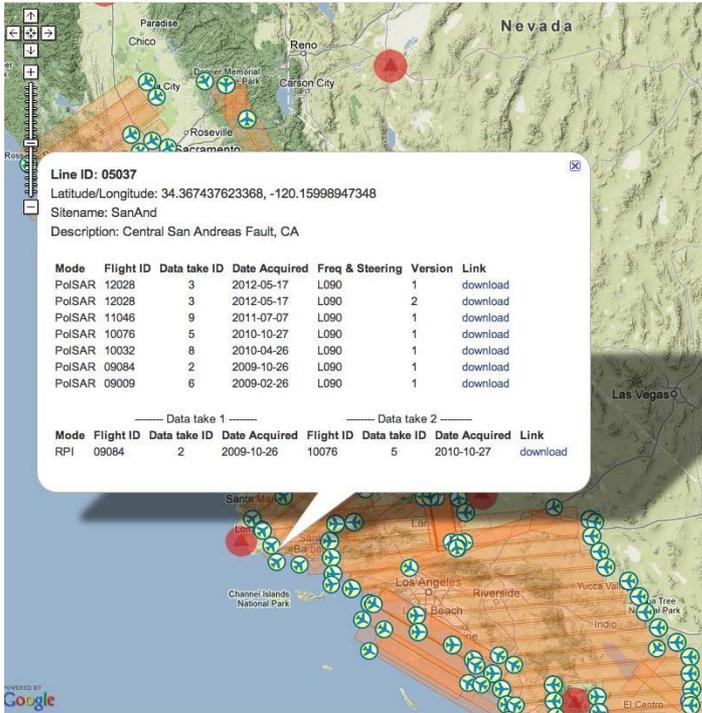
ALL  Band Selections: L  P  Ka   Search

Show   Show 





# UAVSAR Data Access (cont.)



**Product: SanAnd\_05037\_12028\_003\_120517\_L090\_CX\_01**

Polarimetric image of Central San Andreas Fault, CA (acquired May 17, 2012)

Flight line comments: San Andreas Fault (Pi: P. Lundgren)

This product: Version 1 (processor version v1.23.8.a)

Other versions: Version 2 (processor version v1.27.3.a; Reprocessed due to re-calibration.)

**Download** | **Related Data**

**Precision Data**  
 Data Format Documentation

**DOWNLOAD at ASF (Alaska Satellite Facility) for the following files (Checksums & Sizes)**

**Metadata**

- Text Annotation File

**Compressed Stokes Matrix**

- Compressed Stokes Matrix (AIRSAR format) (0.6104 Gbytes)

**Slant Range Multi-look Cross-Products [Download all using zip64]\*\***

- Slant Range: ShhShh\* (0.2441 Gbytes)
- Slant Range: ShvShv\* (0.2441 Gbytes)
- Slant Range: ShvSvv\* (0.2441 Gbytes)
- Slant Range: ShhSvv\* (0.4883 Gbytes)
- Slant Range: ShhSvv\* (0.4883 Gbytes)
- Slant Range: ShvSvv\* (0.4883 Gbytes)



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# San Clemente Island



NATIONAL AERONAUTICS  
AND SPACE ADMINISTRATION

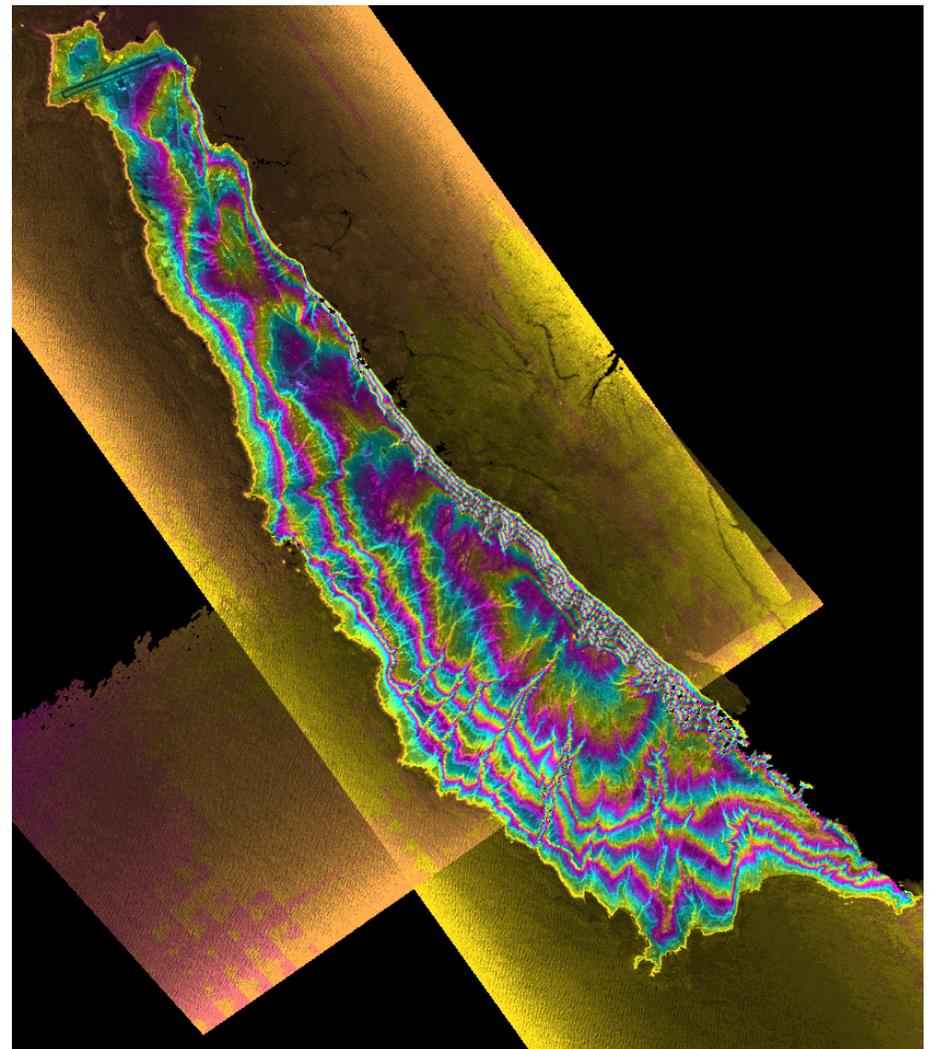


**AirSAR Flight Paths**  
San Clemente Island: April 7, 2002



**AirSAR Flight Paths**

- |  |                       |  |                       |
|--|-----------------------|--|-----------------------|
|  | 54-1_lv_topsar_40mhz  |  | 144-4_lv_polsar_40mhz |
|  | 144-1_lv_topsar_40mhz |  | 324-1_lv_topsar_40mhz |
|  | 144-2_lv_polsar_40mhz |  | 324-2_lv_polsar_40mhz |
|  | 144-3_lv_polsar_80mhz |  | 324-3_lv_polsar_80mhz |

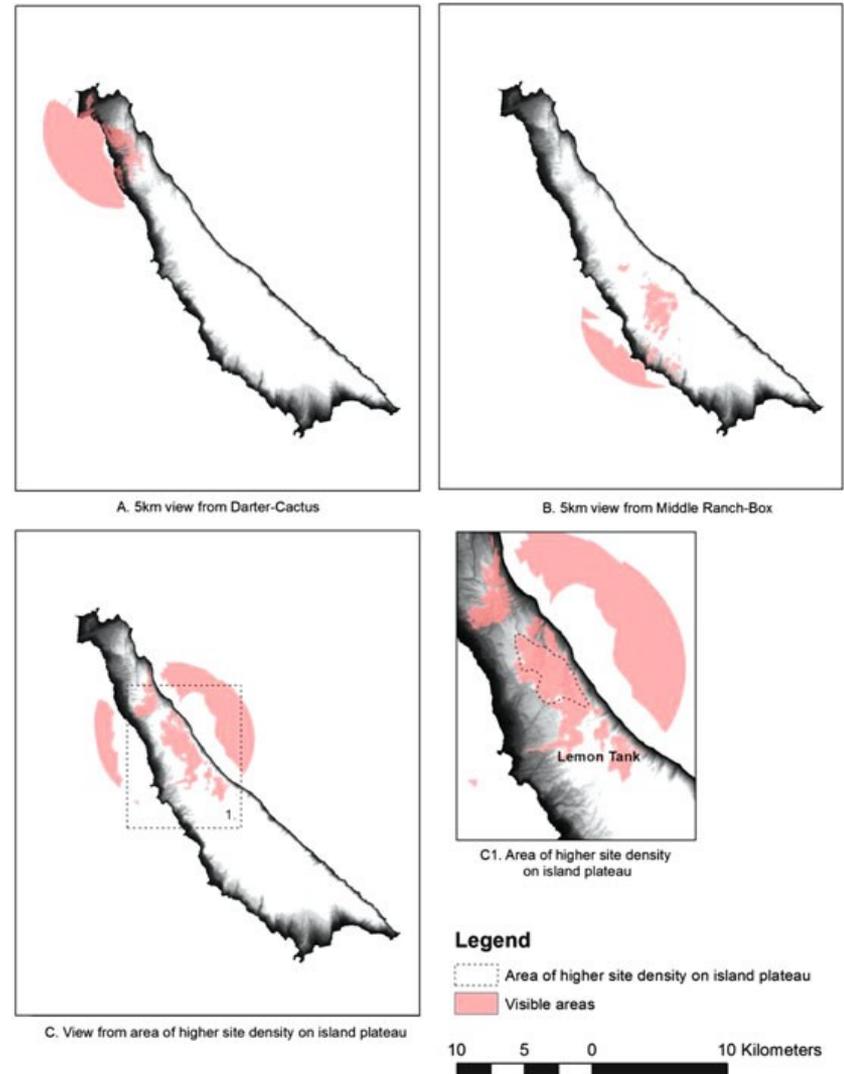


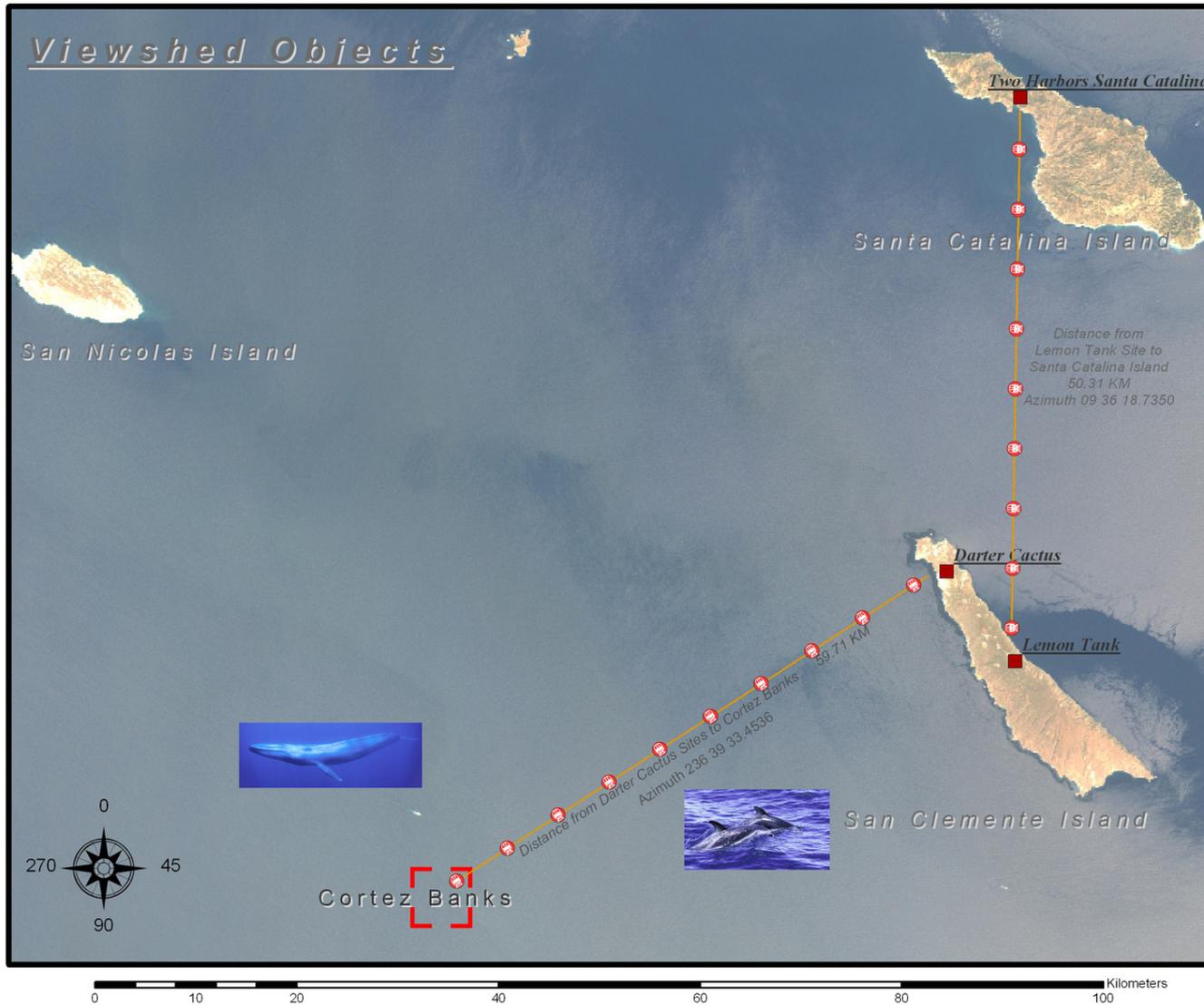
Courtesy of Doug Comer



- Ability to see wide areas of ocean
  - Exploit windows of opportunity as pods of sea mammals, logs, and whales pass by
- Ability to coordinate with those who must mobilize quickly to exploit resources

## Viewshed







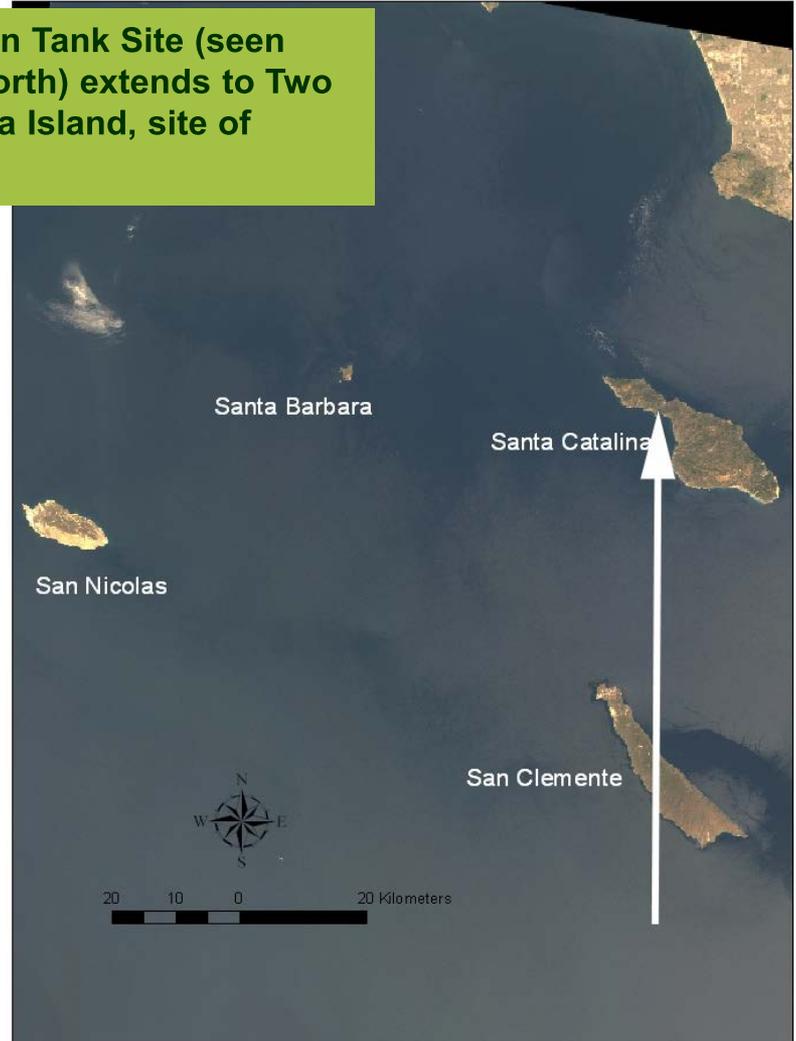
# Relationships Among Southern Channel Island Sites

ASTER Image  
Red: NIR  
Green: Red  
Blue: Green

Large Ritual Sites  
Seen as Bright Red Areas

ASTER Image  
(April, 2002)

Line from Ledge Site to Lemon Tank Site (seen below, photo taken looking north) extends to Two Harbors area of Santa Catalina Island, site of largest settlement there.



1 0.5 0 1 Kilometers



# Summary

- The NASA Apace Archaeology Program supports research, data acquisition and communications
- Investigators use a broad range of technologies for interpretation
- Example given (courtesy of Doug Comer) is use of UAVSAR for Viewshed assessment
- The next solicitation is expected to be in (???)