

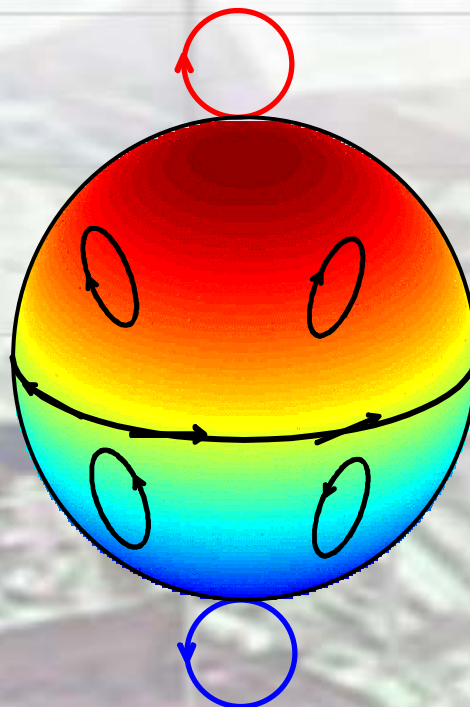
## BASIC THEORY



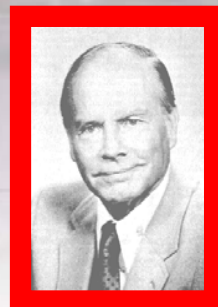
**G.A. DESCHAMPS**  
(1911 - 1998)



**E. M. KENNAUGH**  
(1922 - 1983)



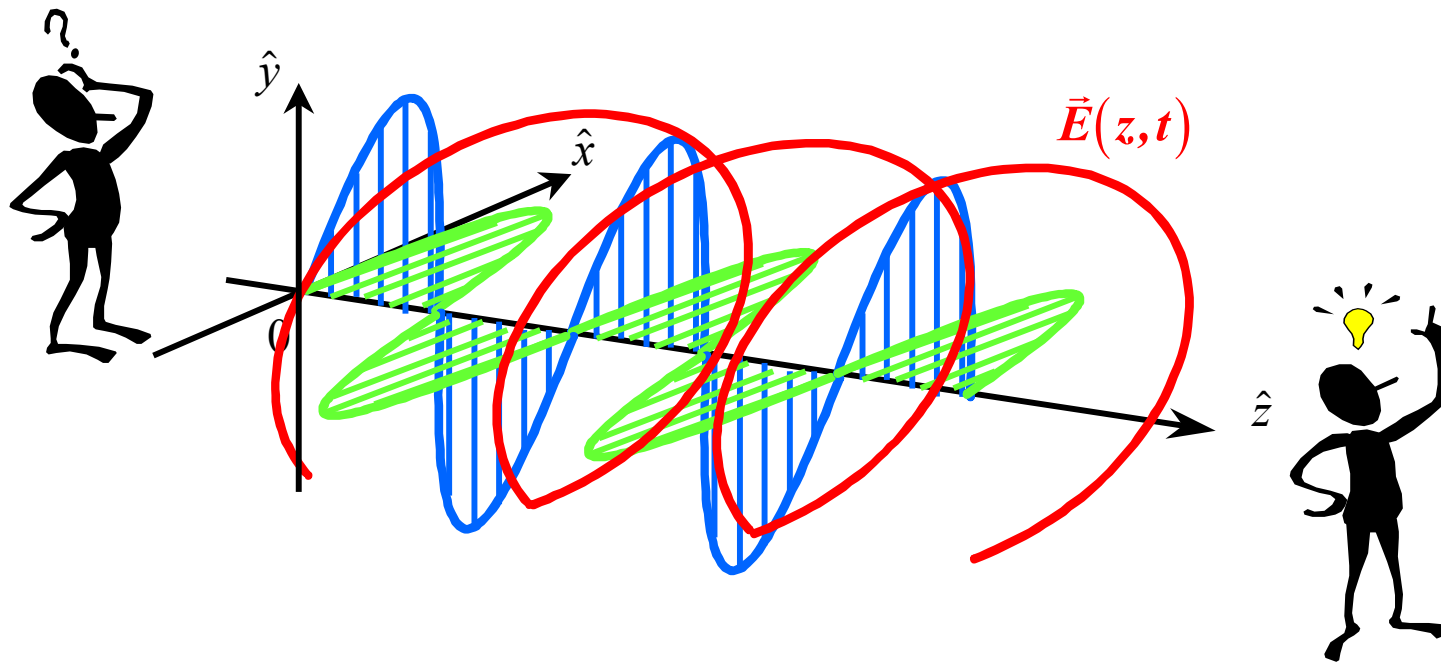
**S.R. CLOUDE**



**J.R. HUYNEN**



**W.M. BOERNER**

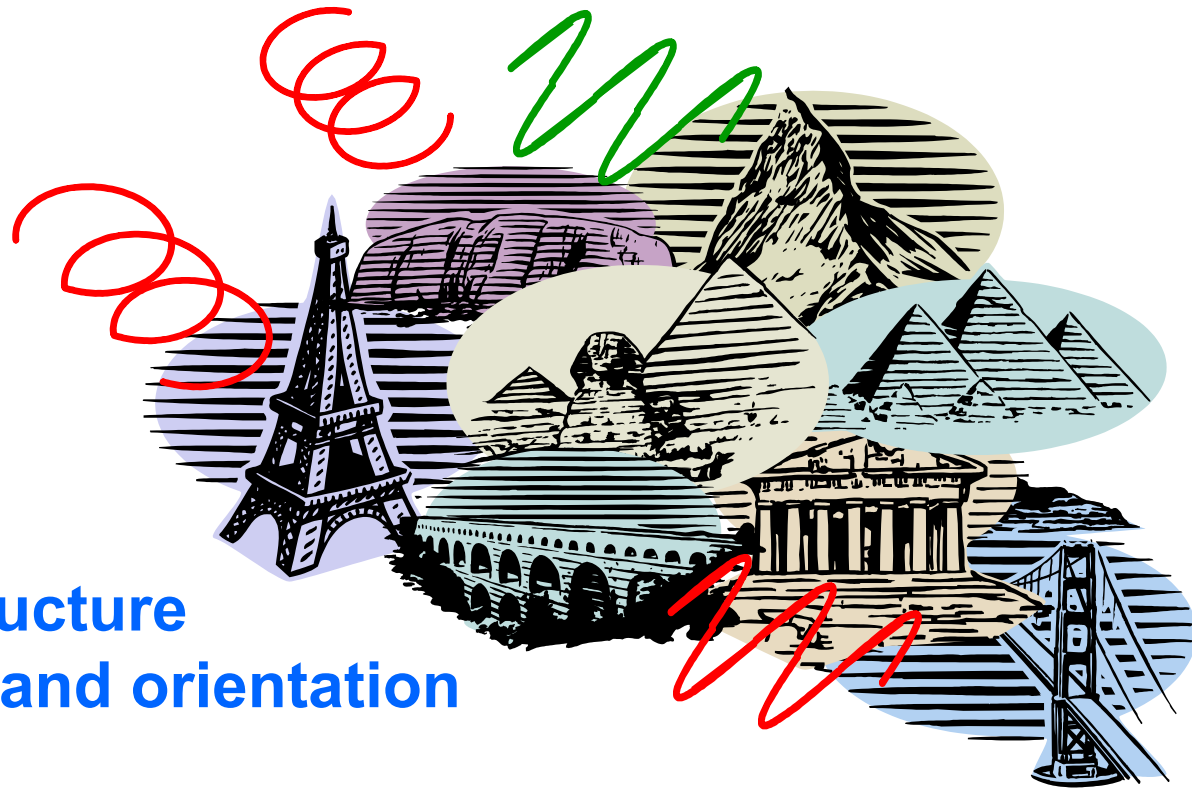


**Radar Polarimetry (Polar : polarisation Metry: measure)**  
 is the science of acquiring, processing and analysing  
 the polarization state of an electromagnetic field

**Radar Polarimetry deals with the full vector  
 nature of polarized electromagnetic waves**



The POLARISATION information  
Contained in the waves backscattered  
from a given medium is highly related to:



its geometrical structure  
reflectivity, shape and orientation

its geophysical properties such as humidity, roughness, .

## MOTIVATION FOR RADAR POLARIMETRY



Scattering Amplitudes  
Amplitude Ratios  
Relative Phase Angles  
Polarimetric Coherence



**RADAR  
PARAMETERS**



**GEO-PHYSICAL  
PARAMETERS**



**BIO-PHYSICAL  
PARAMETERS**



Surface Roughness  
Surface Slopes  
Soil Moisture



Vegetation Biomass  
Vegetation Heights  
Tree Species



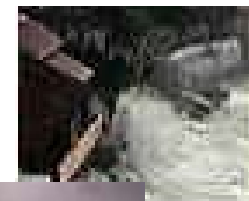
Snow Monitoring  
Water Equivalent  
Ice Thickness

## APPLICATIONS OF RADAR POLARIMETRY IN REMOTE SENSING (EARTH MONITORING)

AGRICULTURE  
LAND USE



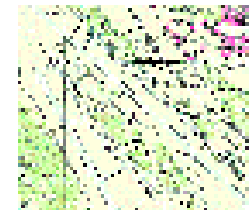
METEOROLOGY  
HYDROLOGY  
GEOLOGY



FORESTRY



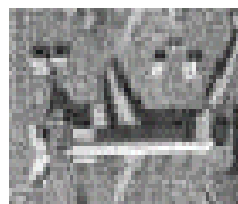
TOPOGRAPHY  
CARTOGRAPHY



SECURITY  
HUMANITARIAN DEMINING



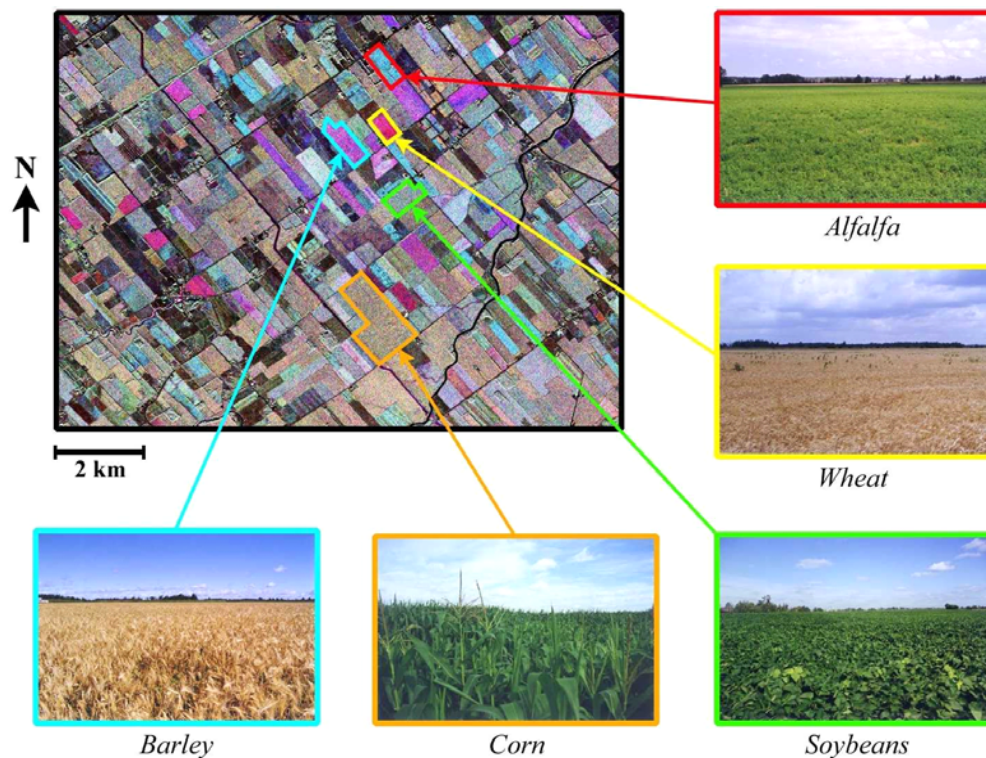
SEA / ICE  
OCEANOGRAPHY



## APPLICATIONS OF RADAR POLARIMETRY IN REMOTE SENSING (EARTH MONITORING)

### AGRICULTURE

Crop Classification/Moisture Content Estimation, Precision Farming Suite  
Crop Ripeness / Inventory, Yield Prediction Cereals



The availability of multiple polarizations will greatly improve the potential for crop type mapping

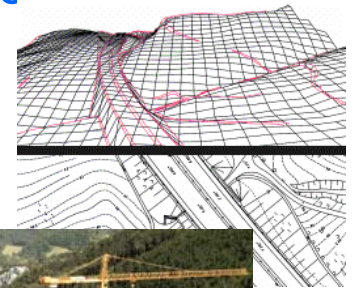
## APPLICATIONS OF RADAR POLARIMETRY IN REMOTE SENSING (EARTH MONITORING)

### LAND-USE

Urban Area mapping, Urban Topography for Mobile Communications

### HUMANITARIAN DEMINING

Surface Penetrating Radar (SPR), SAR for Mine Field Detection  
Security-Reconnaissance



## APPLICATIONS OF RADAR POLARIMETRY IN REMOTE SENSING (EARTH MONITORING)

### FORESTRY

Biomass Estimation: (Saturates For High Biomass)

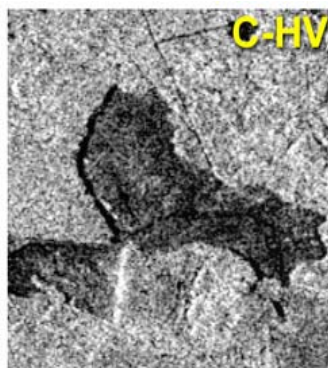
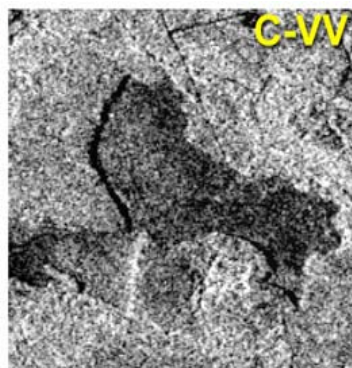
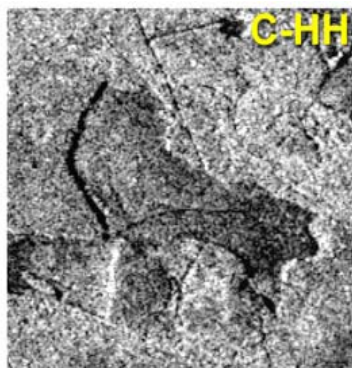
C-band saturation at 50 tons/hectare

L-band saturation at 100 tons/hectare

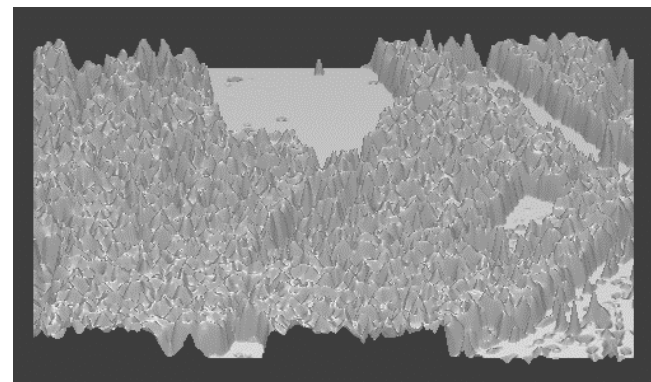
P band saturation at 200 tons/hectare

Deforestation, Forest Canopy Height Estimation, Tree Species Discrimination

Forest Re-growth Monitoring



C-HV data will offer better potential for detection and delineation of clearcuts than C-HH or C-VV data



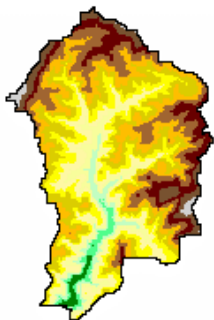
Courtesy of Dr S.R. CLOUDE and  
Dr K. PAPATHANASSIOU



## APPLICATIONS OF RADAR POLARIMETRY IN REMOTE SENSING (EARTH MONITORING)

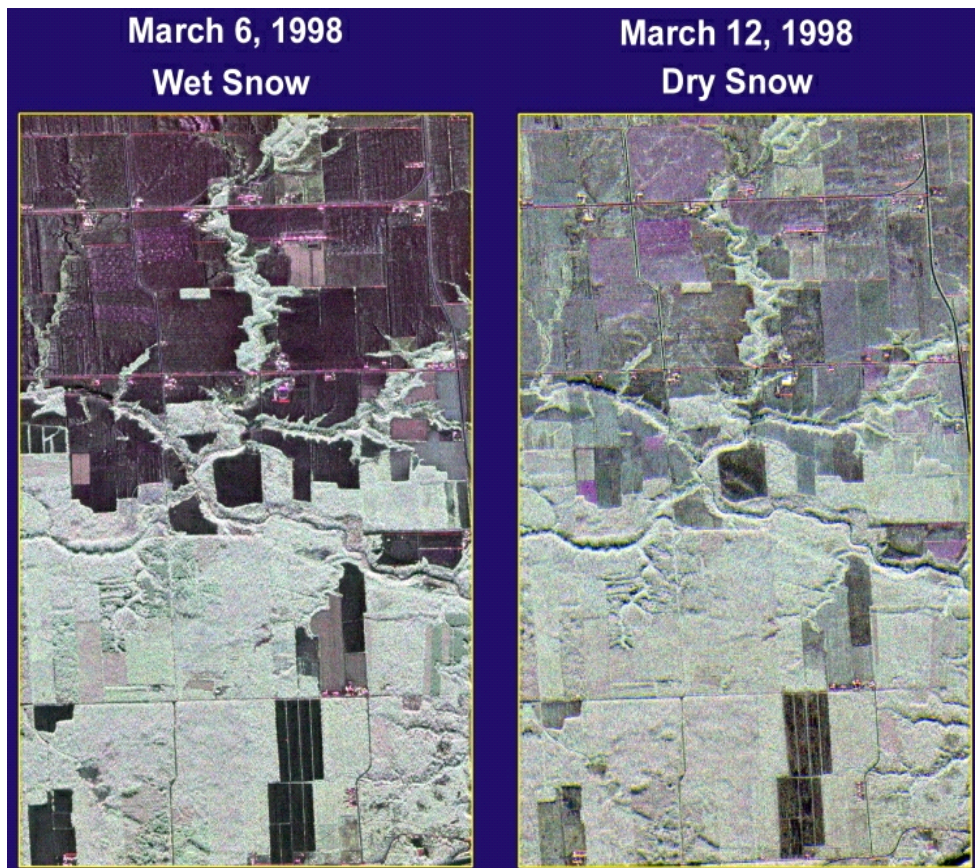
### METEOROLGY

- Rain rate estimation
- Water/Ice particle studies
- Severe Storm/Flood warning



### HYDROLOGY

- Flood / Inundation Mapping
- Snow Hydrology, Snow monitoring
- Soil Moisture



Polarimetric data provide information on snow state (wet/dry) and structure within the snowpack. Capability for Snow Water Equivalent (SWE) monitoring

## APPLICATIONS OF RADAR POLARIMETRY IN REMOTE SENSING (EARTH MONITORING)

### GEOLOGY

Playas : Smooth Natural Surfaces (rms = 1cm)

Alluvial fans, Sand Dunes, Moraines

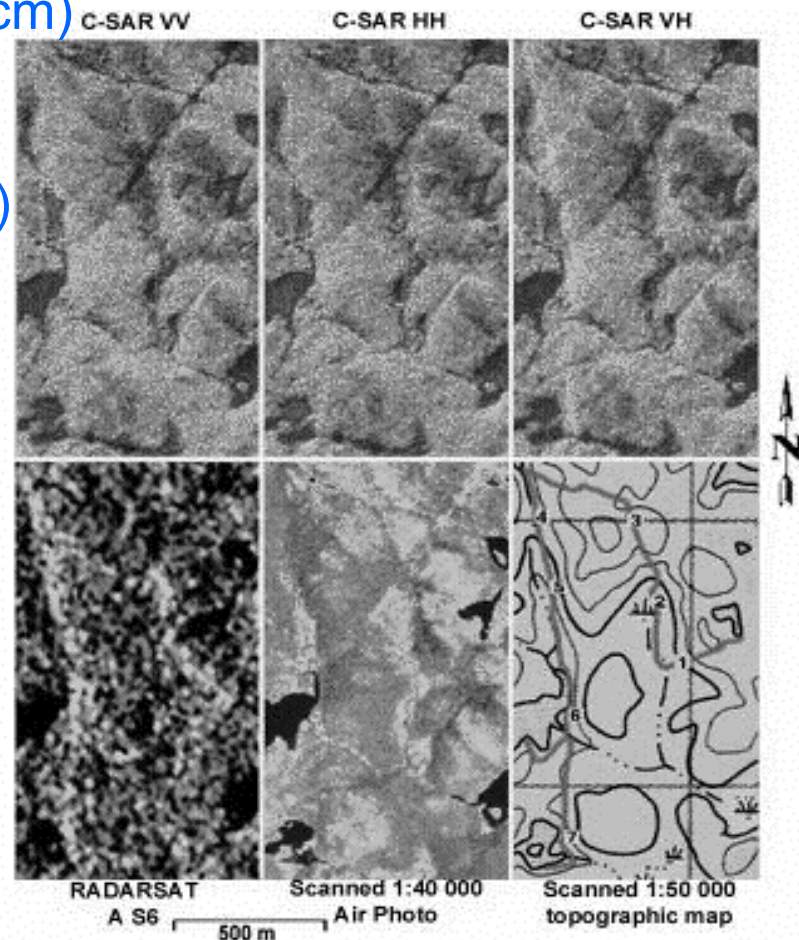
Sedimentary Rock formations

Lava Flows (extreme in surface roughness)

Weathering Erosion Studies

Surface Roughness Estimates

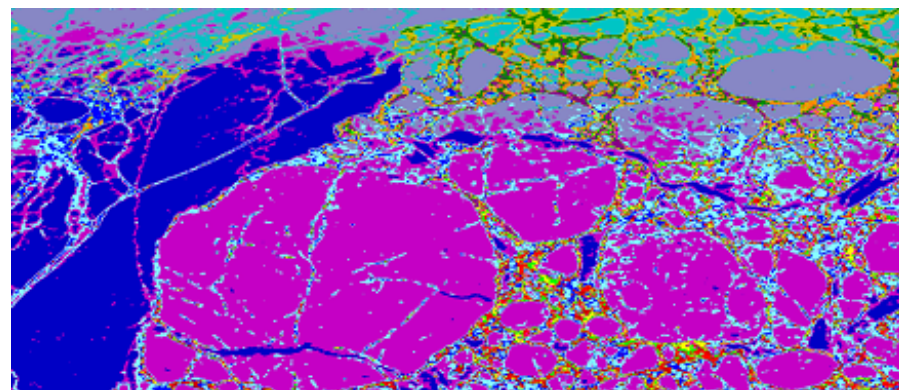
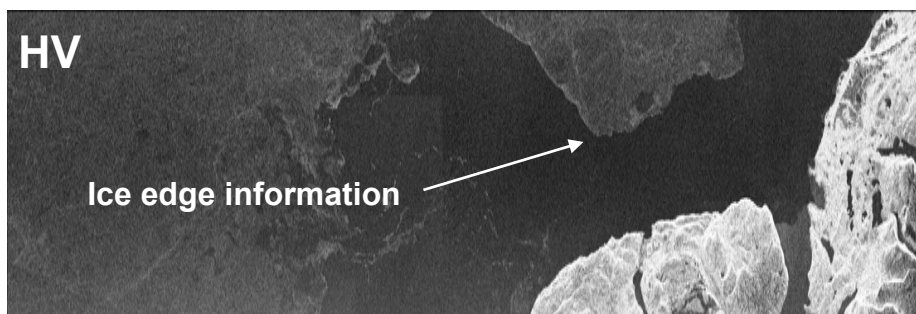
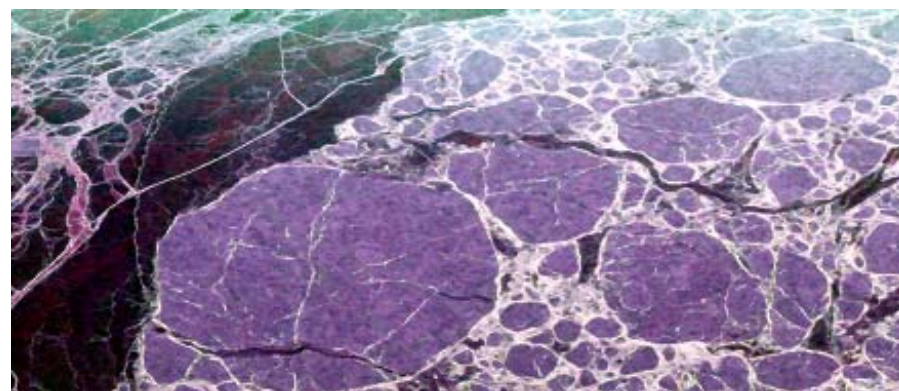
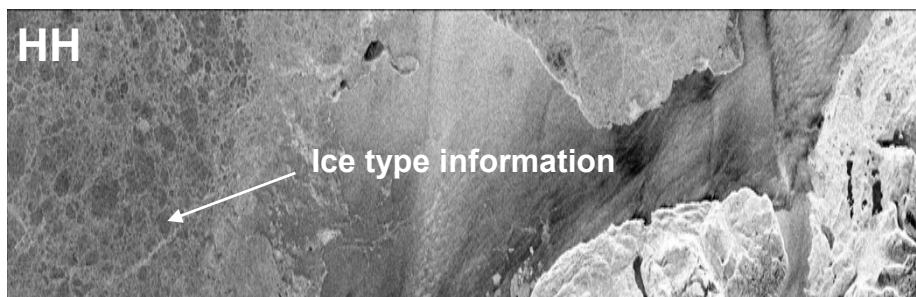
Geology Structure / Elevation Mapping



## APPLICATIONS OF RADAR POLARIMETRY IN REMOTE SENSING (EARTH MONITORING)

### SEA ICE

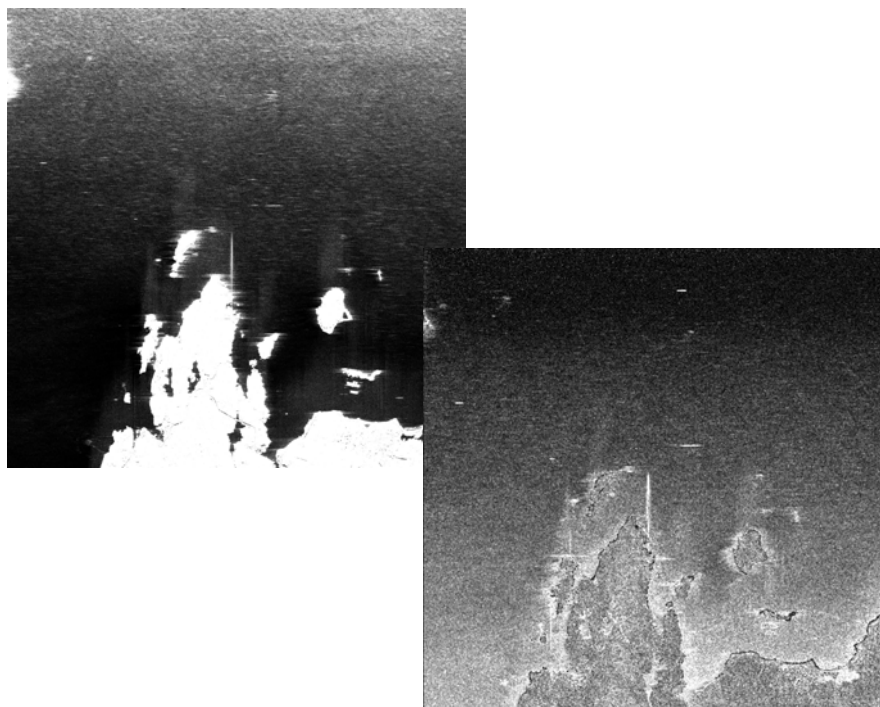
Ice Roughness/Thickness Studies, Polar Ice Cap Studies  
Extra-Terrestrial Ice/Water Studies



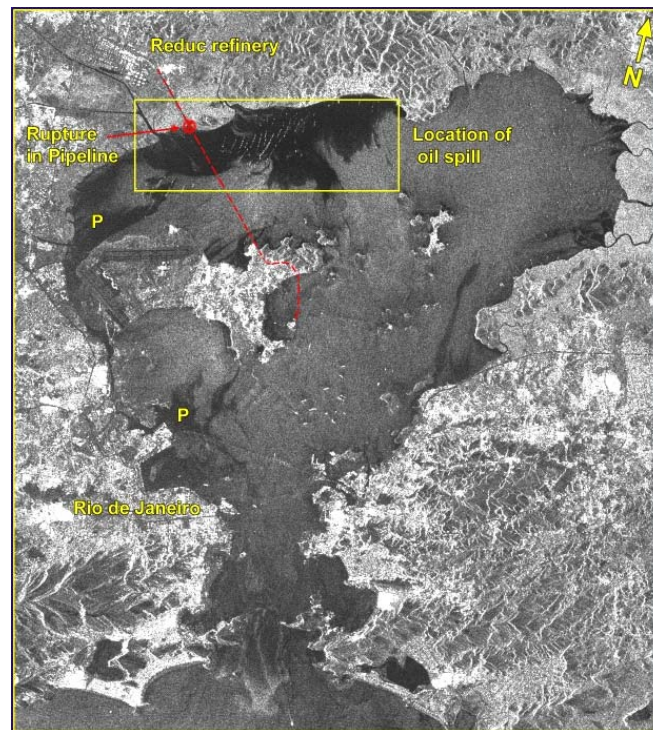
## APPLICATIONS OF RADAR POLARIMETRY IN REMOTE SENSING (EARTH MONITORING)

### OCEANOGRAPHY

Ship Detection Service, Oil Spill Detection / Monitoring



Detection and identification of ships



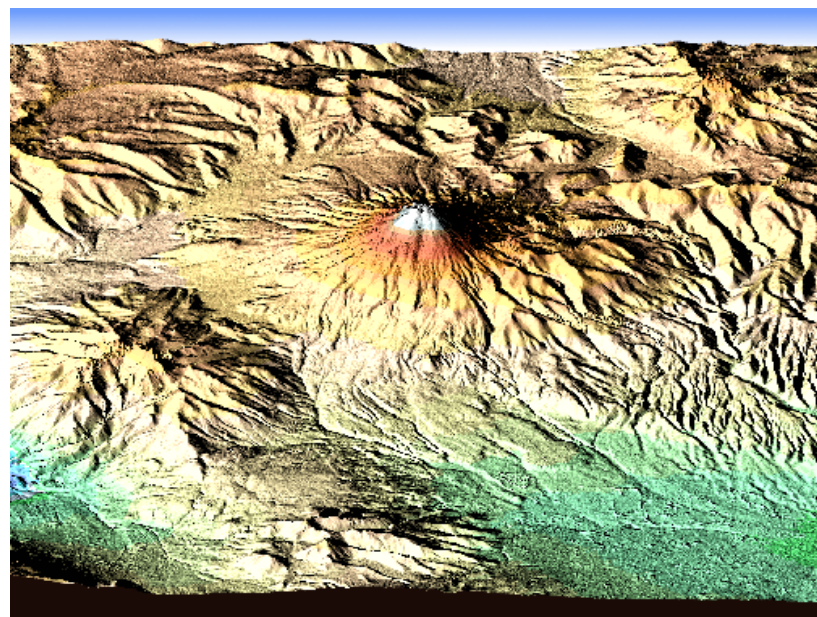
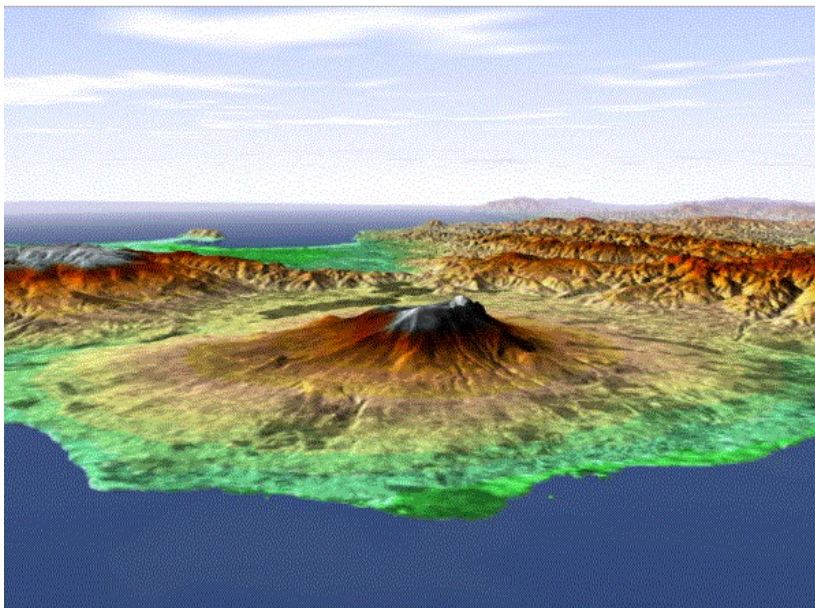
Guanabara Brazil, January 2000

C-VV data will provide better oil-water contrast  
than C-HH or C-HV data

## APPLICATIONS OF RADAR POLARIMETRY IN REMOTE SENSING (EARTH MONITORING)

### TOPOGRAPHY / CARTOGRAPHY

Direct Surface Slope Estimation, Accurate DEM Generation, Difference of DEMs for Vegetation mapping, Topo Map Local / Regional, Environmental Planning Map, Infrastructure Planning Map



## POLARIMETRIC SAR SENSORS

### AIRBORNE SENSORS



**AES1**  
AeroSensing (D)



**AIRSAR**  
NASA / JPL (USA)



**DOSAR**  
EADS / Dornier GmbH (D)



**ESAR**  
DLR (D)



**EMISAR**  
DCRS (DK)



**MEMPHIS / AER II-PAMIR**  
FGAN (D)



**PHARUS**  
TNO - FEL (NL)



**PISAR**  
NASDA / CRL (J)



**RAMSES**  
ONERA (F)



**RENE**  
UVSQ / CETP (F)

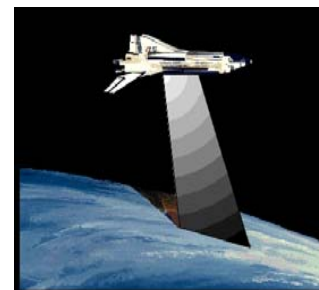


**STORM**  
UVSQ / CETP (F)



**SAR580**  
Environnement Canada (CA)

### SHUTTLE / SPACEBORNE SENSORS



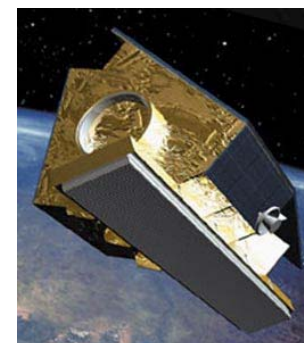
**SIR-C**  
NASA / JPL (USA)



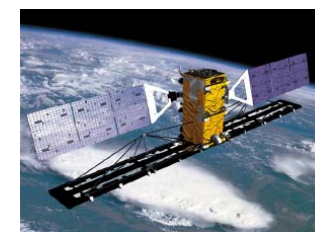
**ENVISAT / ASAR**  
ESA (EU)



**ALOS / PALSAR**  
NASDA / JAROS (J)



**TERRASAR**  
BMBF / DLR / ASTRIUM



**RADARSAT 2**  
CSA - MDA (CA)