Mapping the Surface of TITAN

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Presentation Preview

1. SAR Coverage of Titan
2. Looking at the Surface
3. A Titanic Catalogue of Features
4. Applications and Adjustments

Cassini-Huygens Mission

- Titan, Saturn’s largest moon
- The Imaging Problem
- Wavelength $\lambda_{Ku} = 2.17$ cm
- The Huygens Probe

The Cassini Orbiter

- Measurement Modes
  - Altimeter
  - Radiometer
  - Scatterometer
  - Synthetic Aperture (SAR)
- Orbital Period
  - Initially Elliptical (120 days)
  - Finally Circular (7 days)
- Current Position

Cassini Scheduled Fly-Bys of Titan

<table>
<thead>
<tr>
<th>Orbit</th>
<th>SAR</th>
<th>Scatterometer</th>
<th>Date</th>
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Cassini SAR Coverage of Titan

Cassini Synthetic Aperture Radar High-Resolution Coverage of Titan as of January 2007
LOOKING AT TITAN’S SURFACE

A Closer Look at Titan
Swath Width of 120 – 450 km
No Pattern
Compress & Zoom
Features

Features

Dunes
Craters
Lakes
Lines
Unknown

Surface Types

Mixed Surface on TA
Edge of Xanadu

Xanadu – Titan’s Brightest Region

Shangri-La – One of Titan’s Darkest Regions

Creating a TITANic Catalogue

Writing the Catalogue

Write (x,y) image coordinates
Extract latitude and longitude
Identify regions on map
Determine large regions, eliminate small ones
Dune Fields on Titan

Applications of the Feature Catalogue
- Scatterometer Data
  - Wide incidence angle coverage
- Overlapping data
- Plotting backscatter

The Backscatter Model

\[ \sigma_\theta(\theta) = (1 - A_{diff}) \times \sigma_0 \times A_{diff} \times \sigma_\theta(\theta) \]

\[ \sigma_\theta(\theta) = \frac{\rho^2}{\eps^2} \exp(-C \tan^2 \theta) \]

\[ \sigma_{diff}(\theta) = A_{diff} \cos^n \theta \]

Remember the Backscatter?

Possible Materials on Titan

<table>
<thead>
<tr>
<th>Material</th>
<th>(\varepsilon)</th>
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<tr>
<td>Liquid Hydrocarbons</td>
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<td>Solid Hydrocarbons</td>
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<td>CO2 Ice</td>
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<td>Snow</td>
<td>1.5-3.0</td>
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<td>Water Ice</td>
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<td>Water-Ammonia Ice</td>
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<td>Terrestrial Rocks</td>
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<td>Meteoric Material</td>
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Cataloguing Surface Types
- Categorize by reflectivity \(\sigma_0\)
- Identify regions of similar \(\sigma_0\)
- Plot backscatter
Backscatter by Surface Reflectivity

- Advantages
  - Smaller regions
  - Fitting characterization
  - Refined backscatter map

- Drawbacks
  - Fewer data points
  - Vulnerable to randomness
  - Harder to fit the model
  - Standardization

The Standardization Problem

- Backscatter $\sigma_0 > 0$ ?
- Should be normalized...
- Several pixels > 2 or 3

Brightness and Darkness

- Scale inconsistencies
- Max and min ambiguity

Xanadu File Types

- Corrected vs. Uncorrected
- Noise-Subtracted

Xanadu (T13) $\sigma_0 \approx 0.688$

Xanadu (T3) $\sigma_0 \approx 1.102$

The Next Step

- Data – More passes will expand catalogue
- Modeling – More points will improve fit
- Inferences – Characterize dunes, lakes, etc.
- Calibration – Standardize SAR data
- Mapping – Divide surface into types
- Other forms of data
  - HISAR
  - Altimetry Data

Acknowledgments

Fin