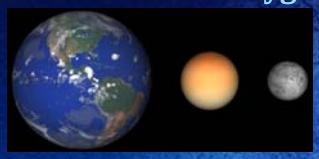
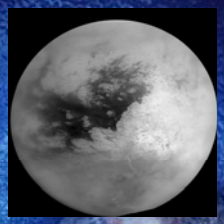
Presentation Preview

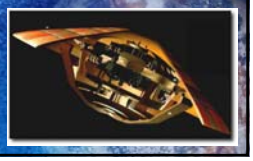
1. SAR Coverage of Titan
2. Looking at the Surface
3. A Titanic Catalogue of Features
4. Applications and Adjustments

Cassini-Huygens Mission



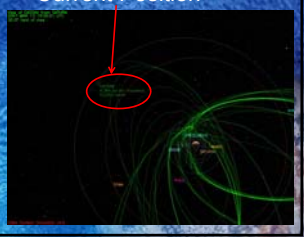


- Titan, Saturn's largest moon
- The Imaging Problem
- Wavelength λ_{Ku} = 2.17 cm
- The Huygens Probe



The Cassini Orbiter

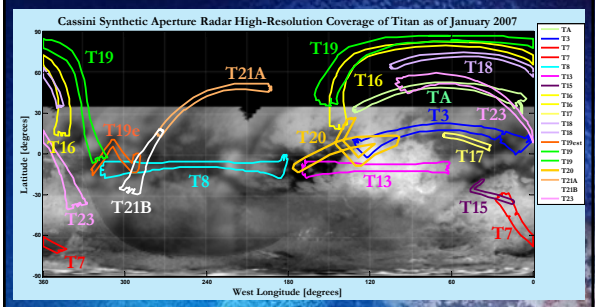
- Measurement Modes
  - Altimeter
  - Radiometer
  - Scatterometer
  - Synthetic Aperture (SAR)
- Orbital Period
  - Initially Elliptical (120 days)
  - Finally Circular (7 days)
- Current Position



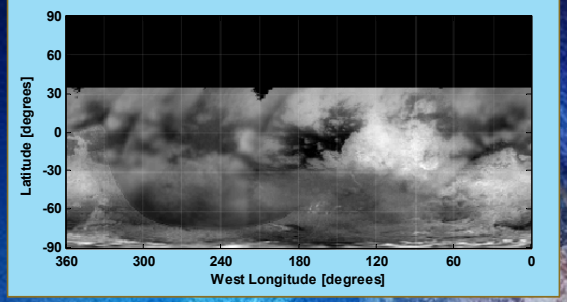
Cassini Scheduled Fly-Bys of Titan

Orbit	SAR	Scatterometer	Date
TA	✓	✓	October 26, 2004
T3	✓	✓	February 15, 2005
T4	✖	✓	March 31, 2005
T7	✓	✖	September 7, 2005
T8	✓	✓	October 27, 2005
T13	✓	✓	April 30, 2006
T16	✓	✓	July 21, 2006
T17	✓	✖	September 7, 2006
T18	✓	✖	September 23, 2006
T19	✓	✓	October 9, 2006
T21	✓	✓	December 12, 2006
T23	✓	✓	January 13, 2006
T25	✓	✓	February 22, 2007
T28	✓	✓	April 10, 2007
T29	✓	✓	April 26, 2007
T30	✓	✓	May 12, 2007
T36	✖	✓	October 2, 2007
T39	✓	✓	December 20, 2007
T41	✓	✓	February 22, 2008
T43	✓	✓	May 12, 2008
T44	✓	✓	May 28, 2008

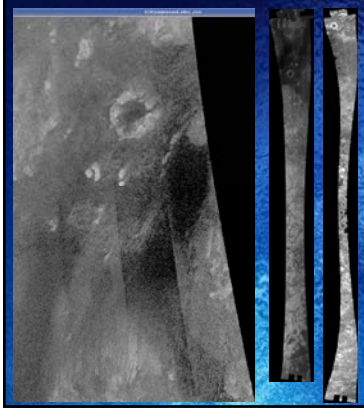
Cassini SAR Coverage of Titan



LOOKING AT TITAN'S SURFACE

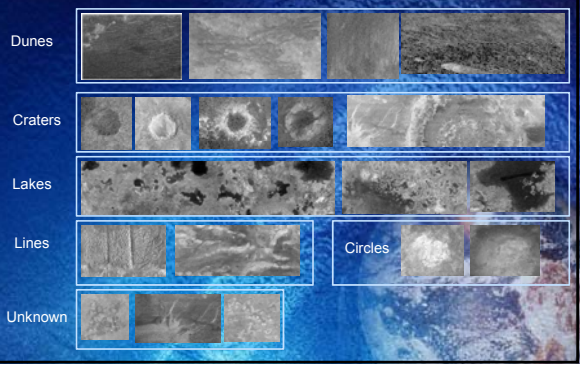


A Closer Look at Titan



- Swath Width of 120 – 450 km
- No Pattern
- Compress & Zoom Features

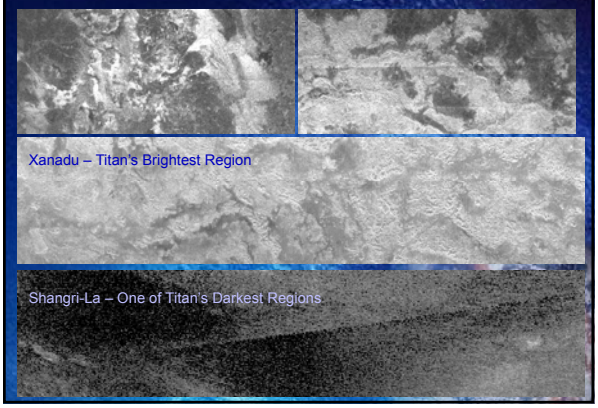
Features



Surface Types

Mixed Surface on TA

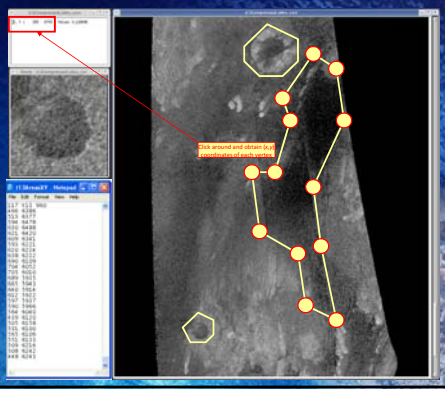
Edge of Xanadu



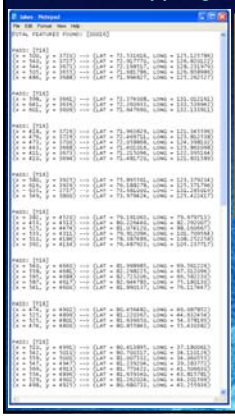
Xanadu – Titan's Brightest Region

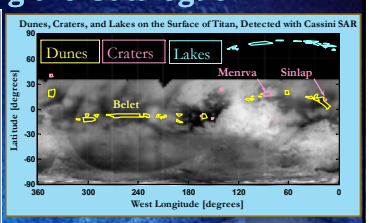
Shangri-La – One of Titan's Darkest Regions

Creating a TITANic Catalogue



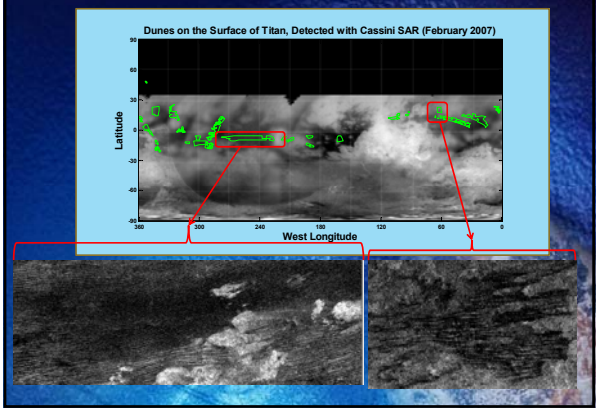
Writing the Catalogue





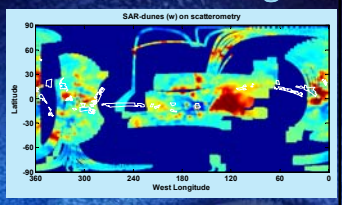
Write (*x*,*y*) image coordinates
Extract latitude and longitude
Identify regions on map
Determine large regions, eliminate small ones

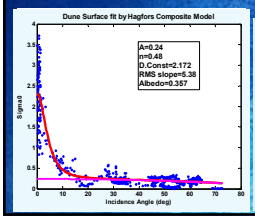
Dune Fields on Titan

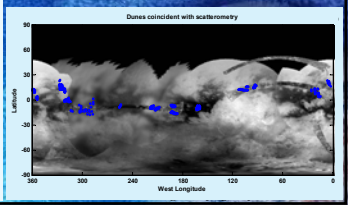


Applications of the Feature Catalogue

- Scatterometer Data
  - Wide incidence angle coverage
- Overlapping data
- Plotting backscatter





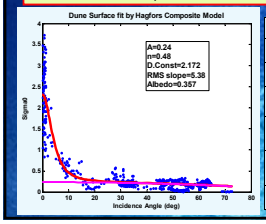


The Backscatter Model

$$\sigma_0(\theta_i) = (1 - A_{dif}) \times \sigma_{0\_qs}(\theta_i) + A_{dif} \times \sigma_{0\_dif}(\theta_i)$$

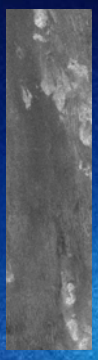
$$\sigma_{0\_qs}(\theta_i) = \frac{\rho C}{\cos^4 \theta_i} \exp\left(-C \tan^2 \theta_i\right)$$

$$\sigma_{0\_dif}(\theta_i) = A_{dif} \cos^n \theta_i$$



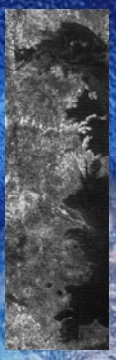
θ_i	Incidence Angle of Radar
$\sigma_0(\theta_i)$	Normalized Radar Cross-Section, or Surface Reflectivity
ρ	Fresnel Power Reflection at Incidence
$C = \tan^{-2}(\theta_{rms})$	Parameter Inversely Related to Surface Roughness
ε	Dielectric Constant, obtained by solving $\rho = \left(\frac{1-\sqrt{\varepsilon}}{1+\sqrt{\varepsilon}}\right)^2$
$\tan(\theta_{rms})$	RMS Surface Slope $\approx \frac{1}{\sqrt{C}}$
θ_{rms}	Tilt Angle of Surface Facet

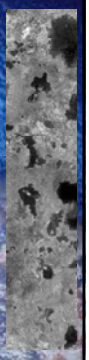
Possible Materials on Titan



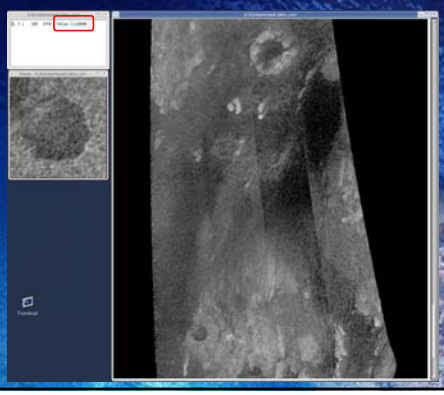
Material	ε
Liquid Hydrocarbons	1.6-1.9
Solid Hydrocarbons	2.0-2.4
CO_2 Ice	2.2
Snow	1.5-3.0
Water Ice	3.2
Water-Ammonia Ice	4.5
Terrestrial Rocks	3.0-9.0
Meteoric Material	8.6

Dielectric constants of possible surface materials on Titan.
(Thompson and Squyres, 1990; Lorenz et al., 2003)



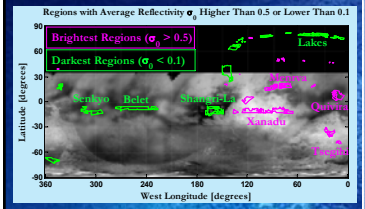


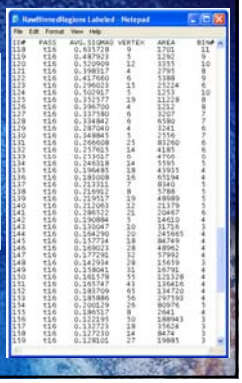
Remember the Backscatter?



Cataloguing Surface Types

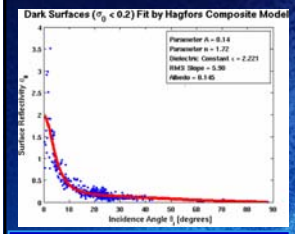
- Categorize by reflectivity σ_0

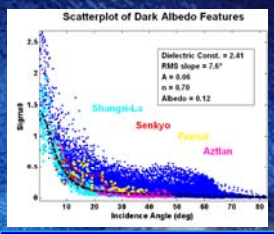




- Identify regions of similar σ_0
- Plot backscatter

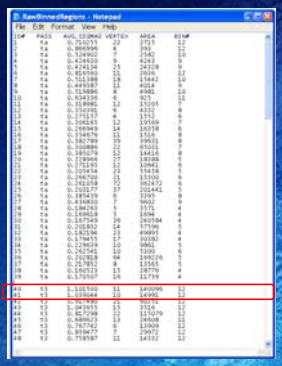
Backscatter by Surface Reflectivity





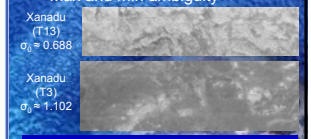
- Advantages
  - Smaller regions
  - Fitting characterization
  - Refined backscatter map
- Drawbacks
  - Fewer data points
  - Vulnerable to randomness
  - Harder to fit the model
  - Standardization

The Standardization Problem



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

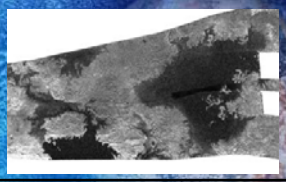
Brightness and Darkness
- Scale inconsistency
- Max and min ambiguity



File Types
- Corrected vs. Uncorrected
- Noise-Subtracted

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