Earth Studies using L-band Synthetic Aperture Radar
violations.

should be no concern about technology transfer or ITAR
taken from published literature. This is a review talk, so there
The following text slides will be supplemented by color images

To the Reviewer of this Package:

DRAFT
Show that L-band penetrates dry soils
Show that L-band penetrates vegetation
Show that L-band has more stable temporal properties

Strengths of L-band SAR observations
From published records:

Make a timeline showing known SAR’s using L-band in history.

Timeline of Civilian L-Band SAR Development
Early L-band Radars and Missions

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Snow depth and coverage results
Soil moisture results
Land cover classification

Polarimetric L-band Radar Science Results

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Amazon mosaic and change signatures •
Kobe and Northridge using JERS
Hawaii deformation using SIR-C
SIRC L-band DEM
TOPSAR L-C comparison of topography

Interferometric L-band Radar Science Results
Experience with JERS shows us how to design future L-band SARs for science applications

- Land cover change
- Crustal Deformation Studies
- Creates a valuable L-band database for JERS showed that sustaining measurements over six years
- JERS is the first long-term Earth observing system at L-band

The Place of JERS-1 in History

Draft
To recover surface height and canopy height/lass

Polarization and Frequency Diversity

Disaster management and mitigation

Land-use classification and management

Fine resolution topography

Commercial applications

Expanded role of interferometric systems for science and
to recover optical quality imagery over targeted areas

Future Trends L-band SAR

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Announcement of Opportunity

way into these science requirements listed in the LIGHTSAR
Many of the concepts proposed for ECHO-EISIE have made their
Science and technical plan was highly regarded.
Proposal was evaluated by NASA to be "selectable", and the
Proposal was not selected because it was not ranked as highly

ECHO-EISIE Status

Draft
Expected characteristics of LIGHSAR:

- Is a dynamic approach to a radar mission.
- Commercial markets, but these are not required.
- May have high-resolution modes at L-band or X-band to satisfy additional needs needed to be provided by proposal partners.
- Will have funding limited to about $120M from NASA, so band full polarization observations.
- Will secondarily study biomass and canopy properties using L-
  - mapping using L-band repeat-pass interferometry.
- Must primarily focus on crustal deformation and ice motion

Based on Announcement of Opportunity LIGHSAR:
L-band observing campaigns

• NASA and NASDA may be able to find common ground in future bands

• Some of these instruments will use L-band as at least one of the

  – Soil moisture and freeze-thaw monitoring
  – Land cover and biomass decadal change
  – Beyond LIghtSAR

  – Sustaining deformation measurements on the decadal scale

• NASA plans to fly science missions that use SAR instruments:

Earth Observing System Follow-on Plans

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Conclusions
Digital Technologies for Topography Generation

- RadarSAT (Can), ALOS (Japan), ENVISAT (ESA), LighISAR (USA)
  - Repeat pass Radar
  - New technology expected to deliver global products
  - SRTM (USA)
  - Radar Interferometry
  - Lack of coverage prevents global mapping
  - New technology delivering profiles of canopy height
  - Icesat, VCL (USA)
  - Speckleborne Laser Altimeters
  - Traditional but so far unable to deliver global products
  - SPOT (France), ALOS (Japan), EOS (USA), Commerical
  - Optical Stereo Mappers

In the Next Decade
\[ \frac{\gamma}{\nu} \delta \phi = ((\gamma_1) \delta - (\gamma_1) \delta)^2 \frac{\gamma}{\nu} = \phi \delta \]

Any change in the range of a surface feature directly.

but at different times, the interferometric phase is proportional to

When two observations are made from the same location in space

Differential Interferometry

Draft
Surface change can be eliminated to reveal the second term can be known.

If topography is known,

\[
\left( \frac{d}{z} \right)^0 \sin \theta \cos \left( \phi_0 - \phi_0 \right) \sin \theta - \frac{1}{\mu} \frac{\gamma}{dV} = \left( \left( \frac{\partial}{\partial x} \right)^0 \sin \theta \cos \left( \phi_0 - \phi_0 \right) \sin \theta - \frac{1}{\mu} \frac{\gamma}{dV} \right) = \frac{\gamma}{\mu} \frac{1}{dV} = \phi_V
\]

Proportional to topography and topographic change. Generally, two observations are made from different locations in space and at different times, so the interferometric phase is different.

Differential Interferometry and Topography

\[\text{DRAFT}\]
For typical polar-orbiting SARs

\[ \frac{z}{0} \theta \sin \frac{0}{\theta} \frac{d}{\text{change \( \sigma \)}} \quad > \quad \frac{\text{T}}{B} \]

What is the baseline below which the 10 m SRTM elevation noise contributes less than 3 mm of displacement noise?

\[ \frac{z}{0} \theta \sin \frac{0}{0} \frac{d}{\text{change \( \sigma \)}} \quad = \quad \frac{\text{T}}{B} \quad \frac{\gamma}{\nu} \quad = \quad \phi \quad \sigma \]

Phase noise component

If one uses SRTM data to remove topography in an interferogram to reveal surface change, then its height noise will contribute a

**SRTM Topography for Surface Change Applications**

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