Components of a Systematic Data Acquisition Strategy

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Outline

- Meaningful parameter retrieval
- Existing data archives
- Systematic data acquisitions - issues to consider
  - Spatio-temporal consistency
  - Repetition frequency
  - Acquisition timing
  - Sensor configuration consistency
  - Long-term continuity
- Conclusions

What is ”meaningful” parameter retrieval?

- Retrieval of biophysical parameters is a key ingredient in carbon cycle science and climate change research;
- Research of mere academic interest unless it can be applied in an operational manner;
- Climate change is regional-global scale, long-term phenomenon - Parameter retrieval confined in time or space of questionable utility.

From model to operation

- Algorithm development:
  - Theoretical/empirical modelling
  - Field experiment on small & well verified site
  - "Optimal" set of satellite data;

  Aim: Generalized model, applicable in any environment with some specific characteristics

- Operational stage:
  - Regional scale model extrapolation to all such environments, beyond the study area…

BUT - are there data to do this?

High resolution EO data archives - very fragmented

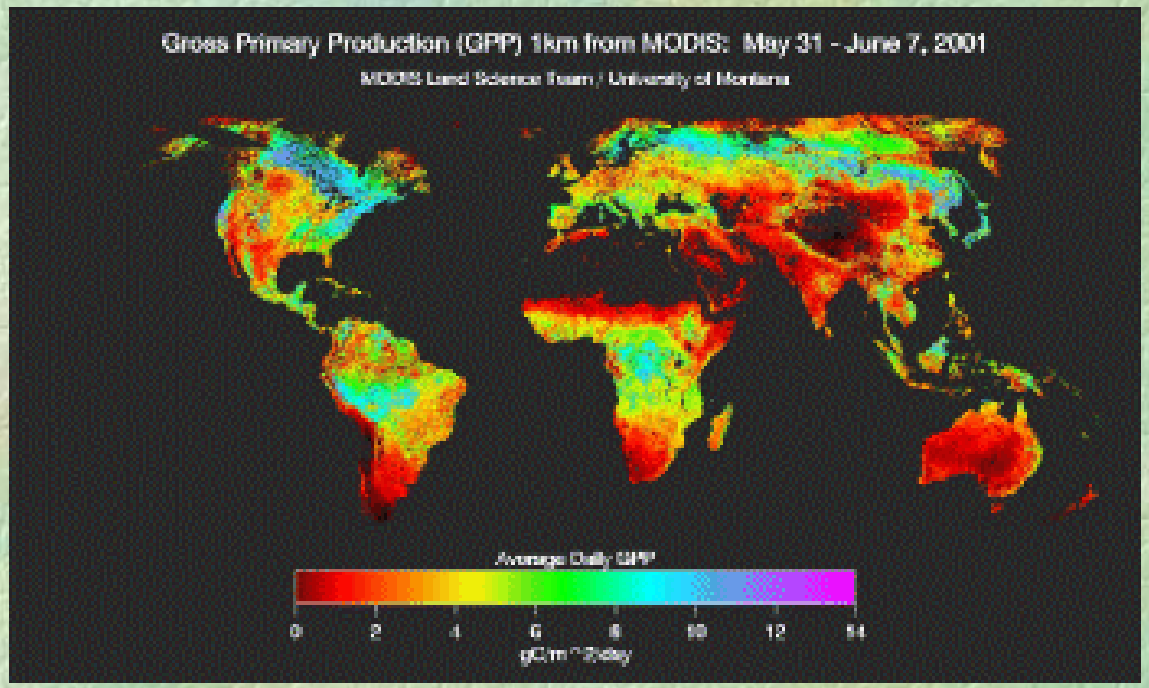
- Technology driven missions
- Acquisitions on request
  - Non-commercial - PI focus (individual & local)
  - Commercial - customer requests (individual & local)

  ---> Frequent coverage over specific sites BUT poor coverage over others
- Background missions: Typ. "Global coverage" - aim: ”at least one acquisition over each node"
  - Temporal component totally ignored.

Fragmented archives - a high resolution problem

Coarse and medium resolution (>250m) archives:

- Extensive use despite ”poor” resolution



- Spatio-temporal consistency (global coverage)
- High T-repetivity & Long-term (AVHRR) consistency;
- Easy accesibility & Low data prices

Required for high resolution satellites:

Comprehensive and systematic data acquisition strategies with regional-global emphasis on a repetitive and long-term basis;

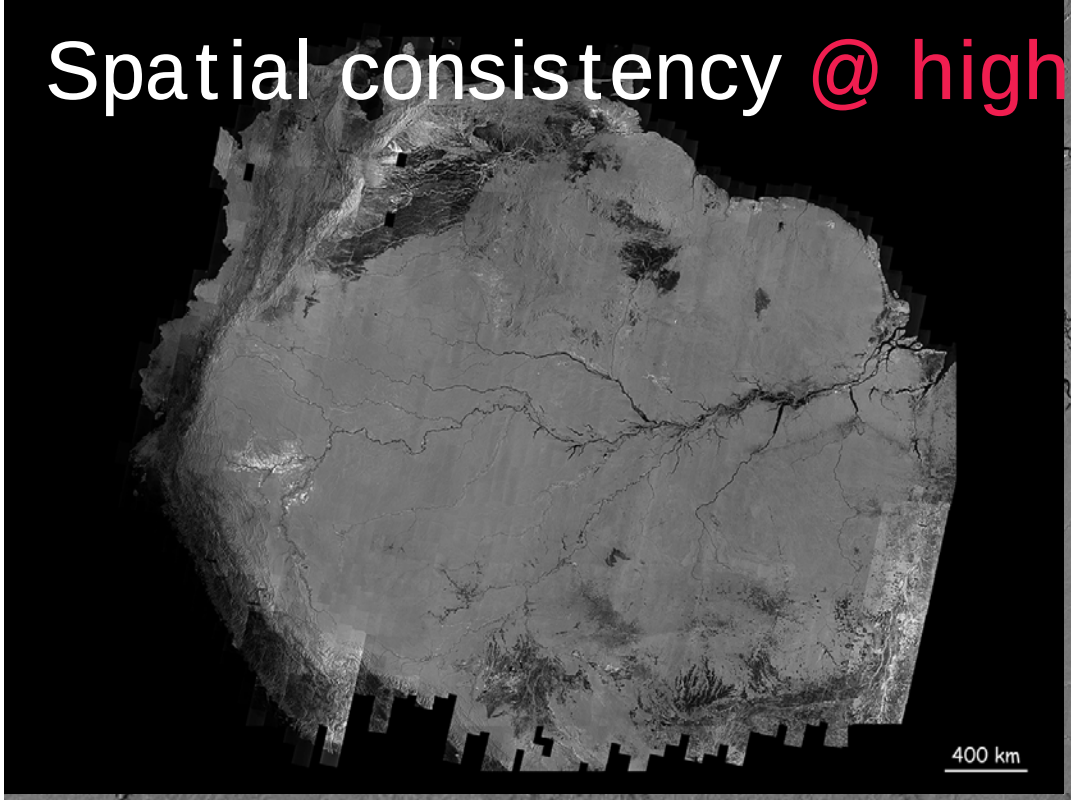
Systematic data acquisition strategy - key components

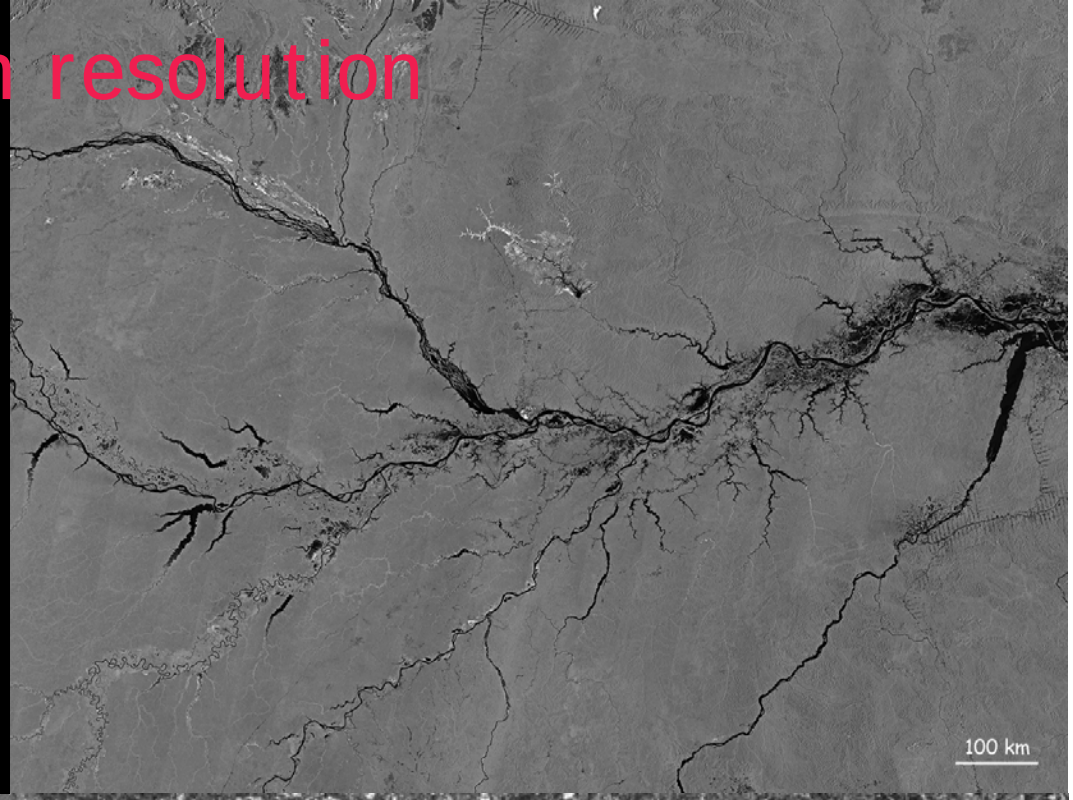
1. Spatial (wall-to-wall) consistency over regional scales;
2. Temporal consistency over regional scales;
3. "Adequate" temporal repetition;
4. Acquisition timing;
5. Consistent sensor configuration;
6. Long-term continuity;
7. Multi-sensor synergy

1. Spatio-temporal consistency

- Regional-scale coverage without acquisition gaps;
- Regional acquisitions performed within a short (one revisit cycle) time period;
- Acquisitions at fine spatial resolution.

Spatial consistency @ high resolution

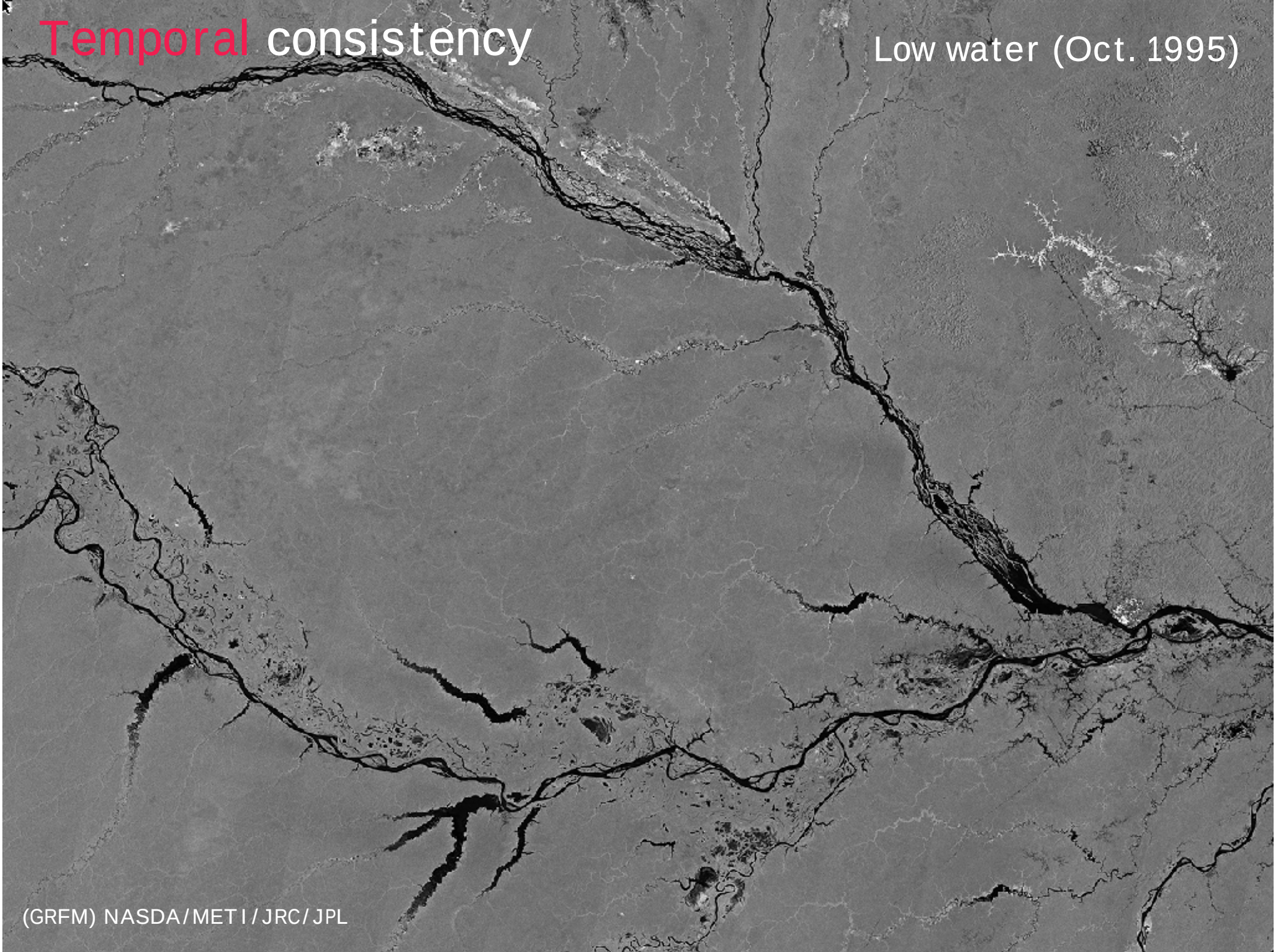




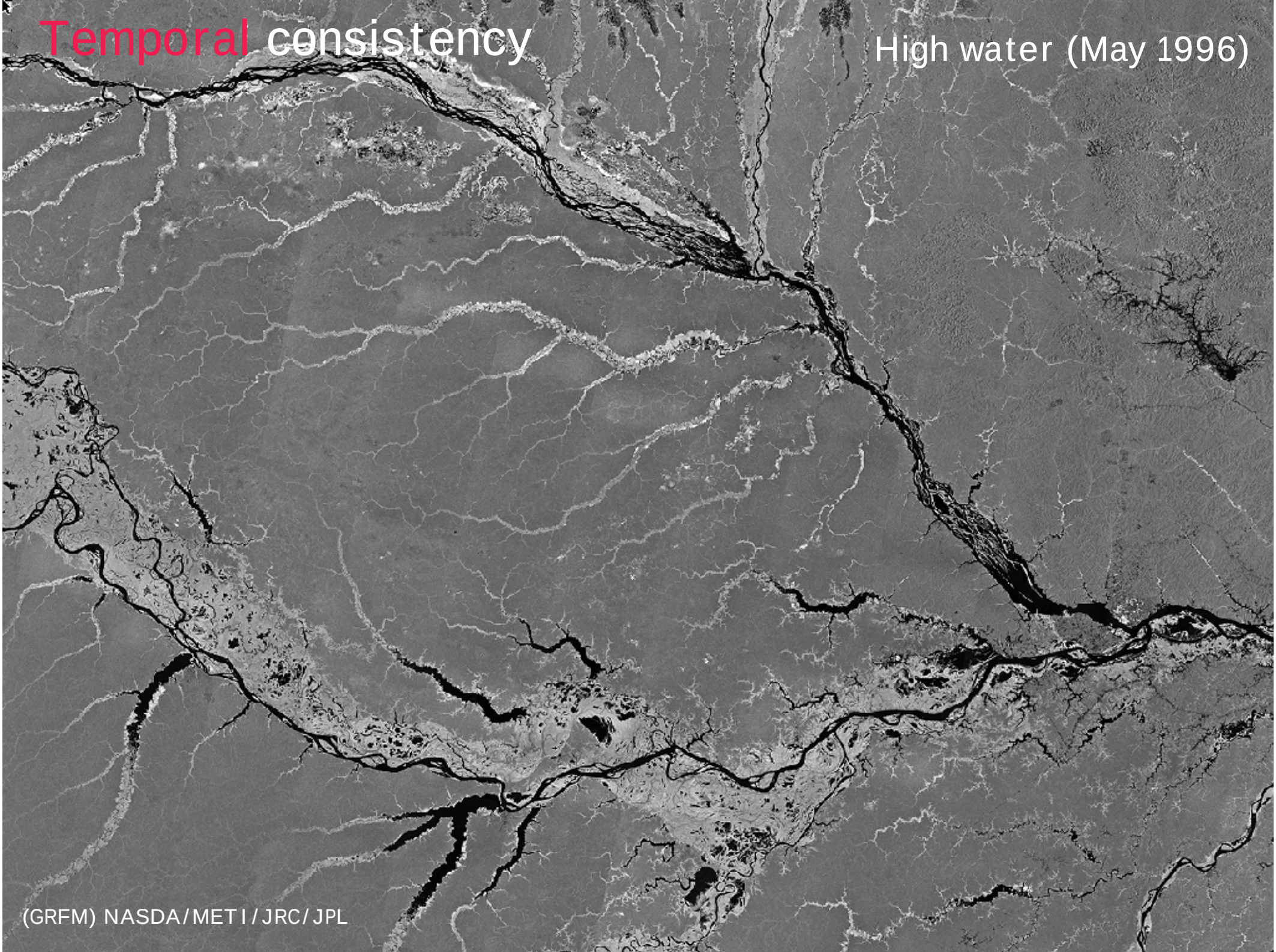
Spatial consistency

- Homogeneous wall-to-wall coverage at high resolution enables consistent parameter retrieval and analysis at arbitrary spatial detail and in a local-regional-global scale context.

Temporal consistency



Temporal consistency



Spatio-temporal consistency

- Certain phenomena vary rapidly over time and homogeneous temporal coverage is an absolute requirement.

- Missed acquisitions - even if replaced by data acquired at different dates - may result in loss of important temporal information .

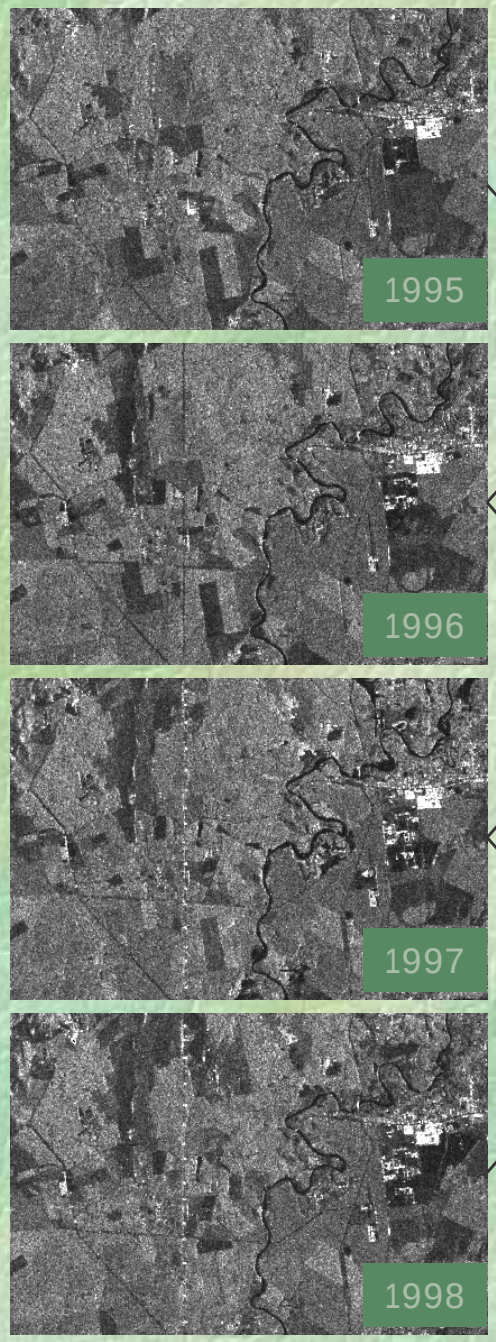
3. Adequate temporal repetition

- Monitoring of change - a key element of interest;
- Multi-temporal coverage a requirement for any kind of change study;

How often? What is *adequate*?

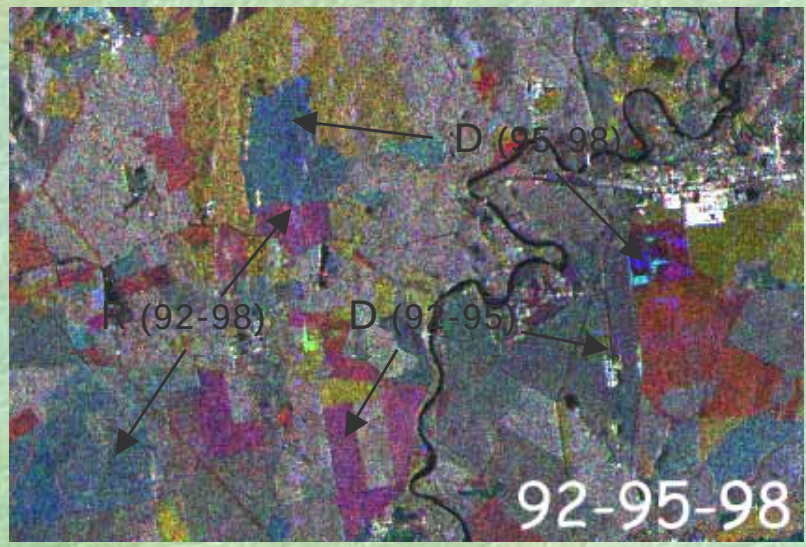
- The *adequate* repetition frequency depends on phenomenon of interest.

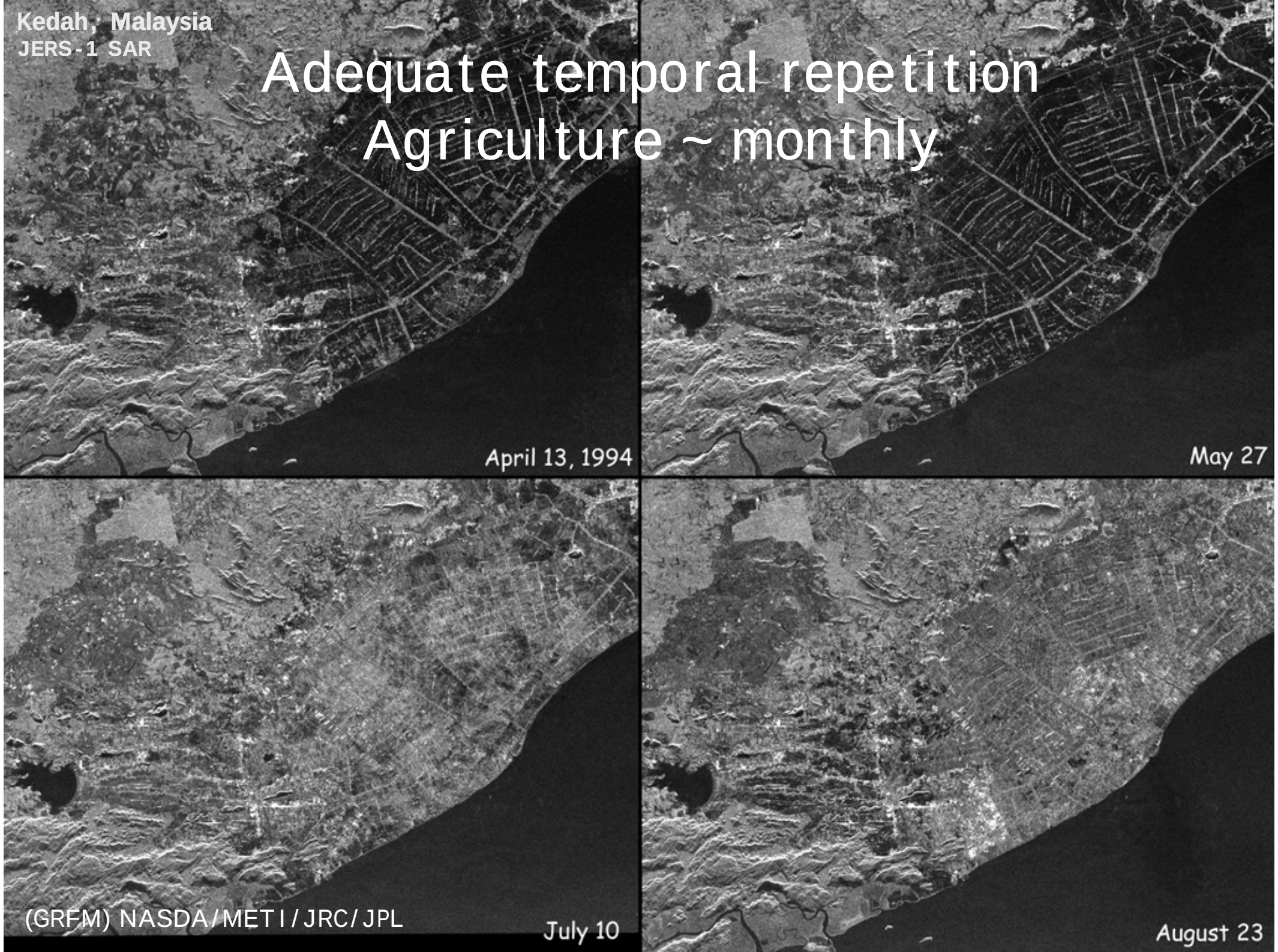
Adequate temporal repetition - Forest monitoring ~ annual

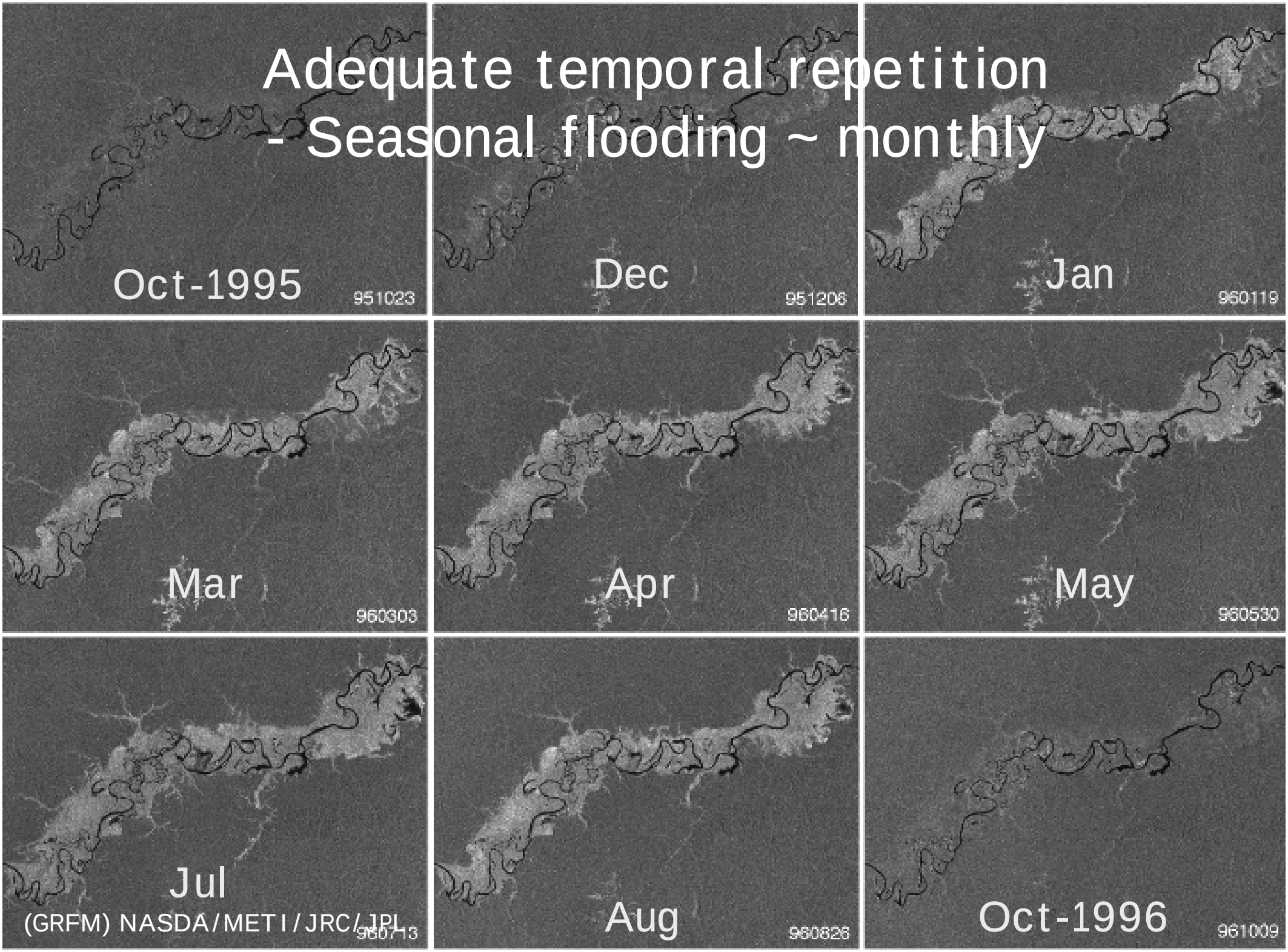


SAR time sequence

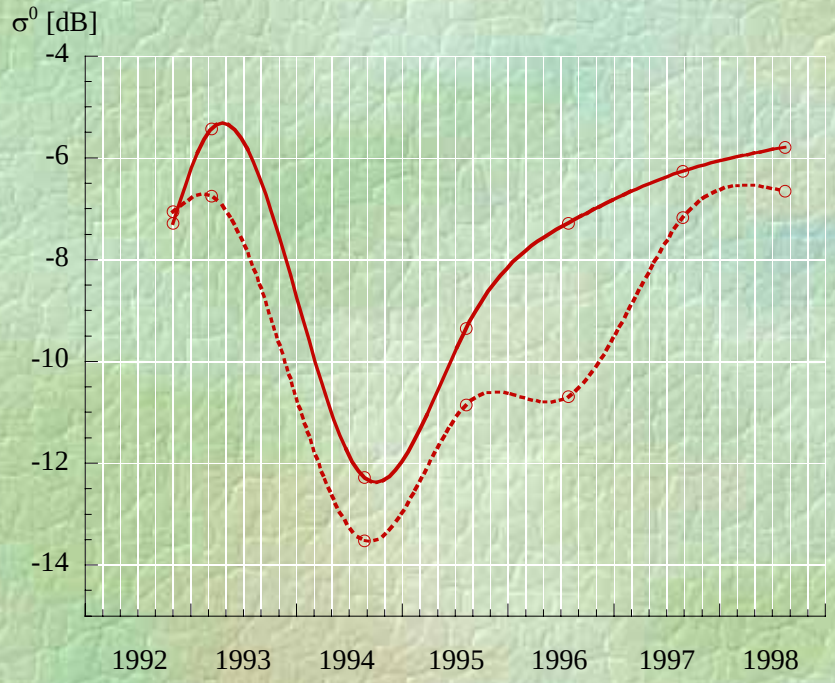
Annual forest change (red areas)



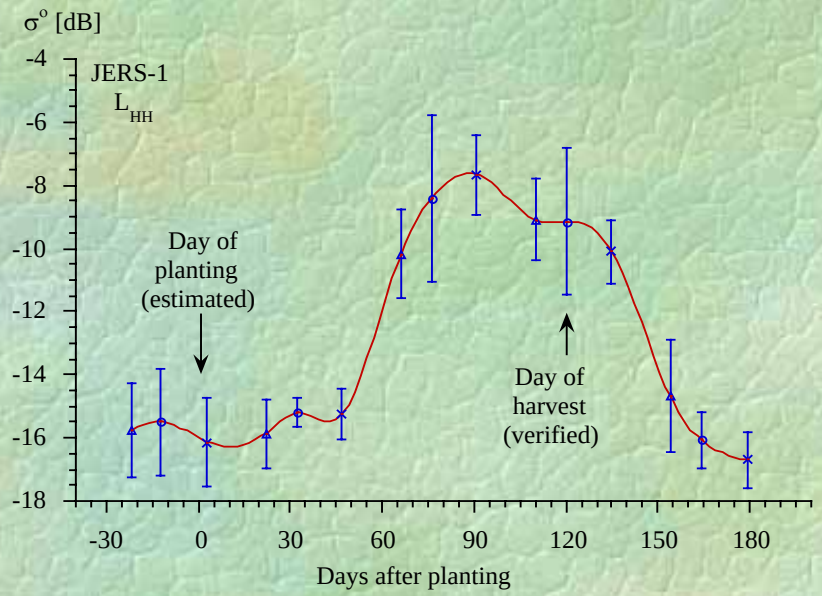

Kedah, Malaysia
JERS-1 SAR
Adequate temporal repetition
Agriculture ~ monthly
April 13, 1994
May 27
July 10
August 23
(GRFM) NASDA/METI/JRC/JPL


Adequate temporal repetition
- Seasonal flooding ~ monthly
Oct-1995
951023
Dec
951206
Jan
960119
Mar
960303
Apr
960416
May
960530
Jul
960713
Aug
960826
Oct-1996
961009
(GRFM) NASDA/METI/JRC/JPL

Adequate temporal repetition



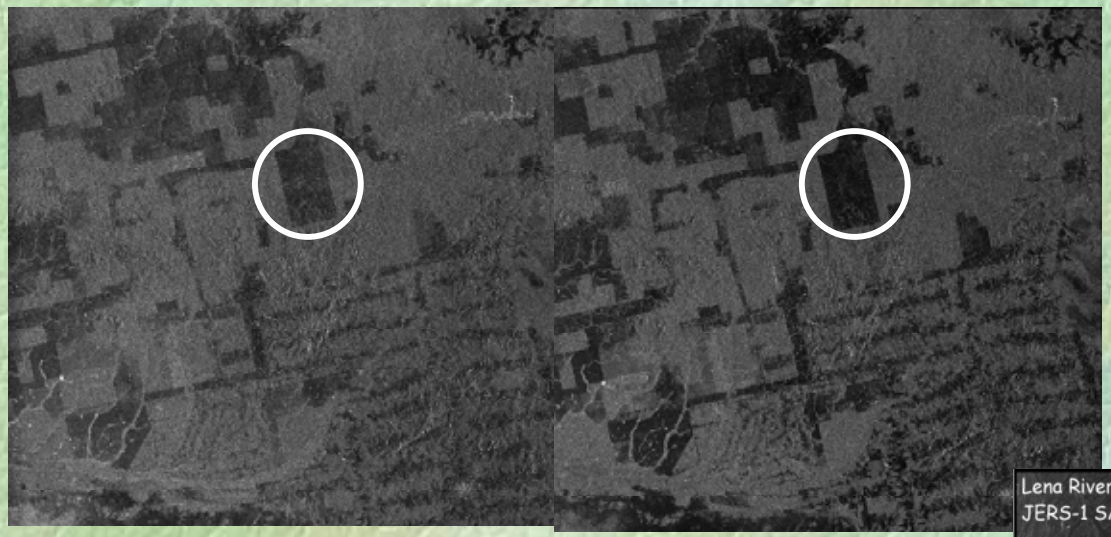
Forest changes ~ annual



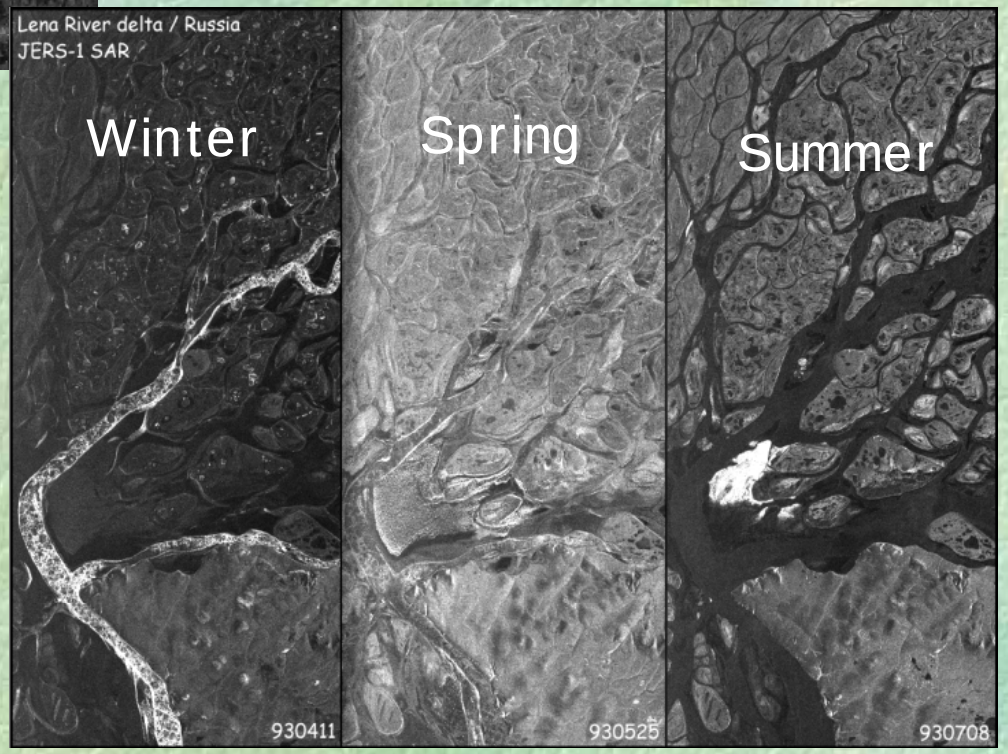
Agriculture ~ monthly

- Adapted repetition required to capture temporal change;
- Land use/land cover stratification necessary in acq. plan.

4. Accurate timing



Boreal/temperate:
4 seasons



Tropics: wet/dry season

- SAR is not weather independent - seasonal influence on SAR data significant;
- Accurate timing of acquisitions mandatory.

5. Sensor configuration

- changes image characteristics

- **Incidence angle**
  - + increased local revisit time;
  - - complicates multi-temporal analysis;
  - regional acq.: Conflict -> gaps in regional coverages
- **Illumination direction (ascend/descend)**
  - + increased revisit time;
  - regional acq: no conflict (asc. OR desc.)
- **Polarization mode:**
  - ++ additional information content;
  - ! mode selection affects swath width, spatial res. & inc. angle
- **Radar frequency**
  - ++ additional information content;
  - ! collaboration between space agencies highly desired

Consistent sensor configuration

- Consistent monitoring of long-term changes on regional scales requires a fixed set of sensor parameters;
- ”Best trade-off” configuration(s) must be agreed upon by the different science communities and satellite operators for an optimal systematic acquisition strategy;

6. Long-term continuity

- Long-term continuity fundamental requirement both from the point of scientific utility as well as from political credibility
- No plans for long-term (decadal) spaceborne monitoring at fine resolution of climate change and carbon related phenomena (ALOS-2 ?…);
- Space agencies must commit to long-term continuity of missions to assure existence of consistent time-series archives

7. Multi-mission synergy

- Presently no coordination between space agencies at mission level (despite CEOS…)
- Great potential for sensor synergy - optical, L/C/X-band SAR.
- Synchronous timing of acquisitions (month-level) a key point
- Present missions (Optical, ENVISAT, ALOS, TerraSAR-X, Cosmo-SkyMed, Radarsat): Joint acquisition campaigns with regional focus
- Future missions: coordination of systematic acquisition strategies

Summary

Systematic data acquisitions - key components

- Spatial wall-to-wall consistency
- Temporal consistency
- Adequate repetition frequency
- Acquisition seasonal timing
- Sensor configuration consistency
- Long-term continuity
- Multi-sensor synergy

Conclusions

Systematic data acquisitions:
simple in concept, but surprisingly uncommon in practice

- Implementation of acquisition trategies with long-term, regional-global scale focus are fundamental for operational support to climate change and REDD monitoring - a potential win-win scenario for the public, science community and space agencies;

- Although simple in concept, systematic observations do not ”just happen”. Observations must be actively scheduled, and implemented with highest observation priority.

Conclusions

Proposed new GEOSS Work Task:

Establishment of guidelines for coordinated systematic and synchronous acquisition strategies, in support to international environmental conventions and the UNFCCC post-2012 climate regime.