Hosszú távú távérzékelési vizsgálatok és tervek

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Vizsgálatok

GOVERNEMENT OFFICE
OF THE CAPITAL CITY BUDAPEST

Retrospective analysis of long-term landscape evolution

BASED ON ARCHIVE SATELLITE IMAGERY AND HISTORICAL MAPS

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Context

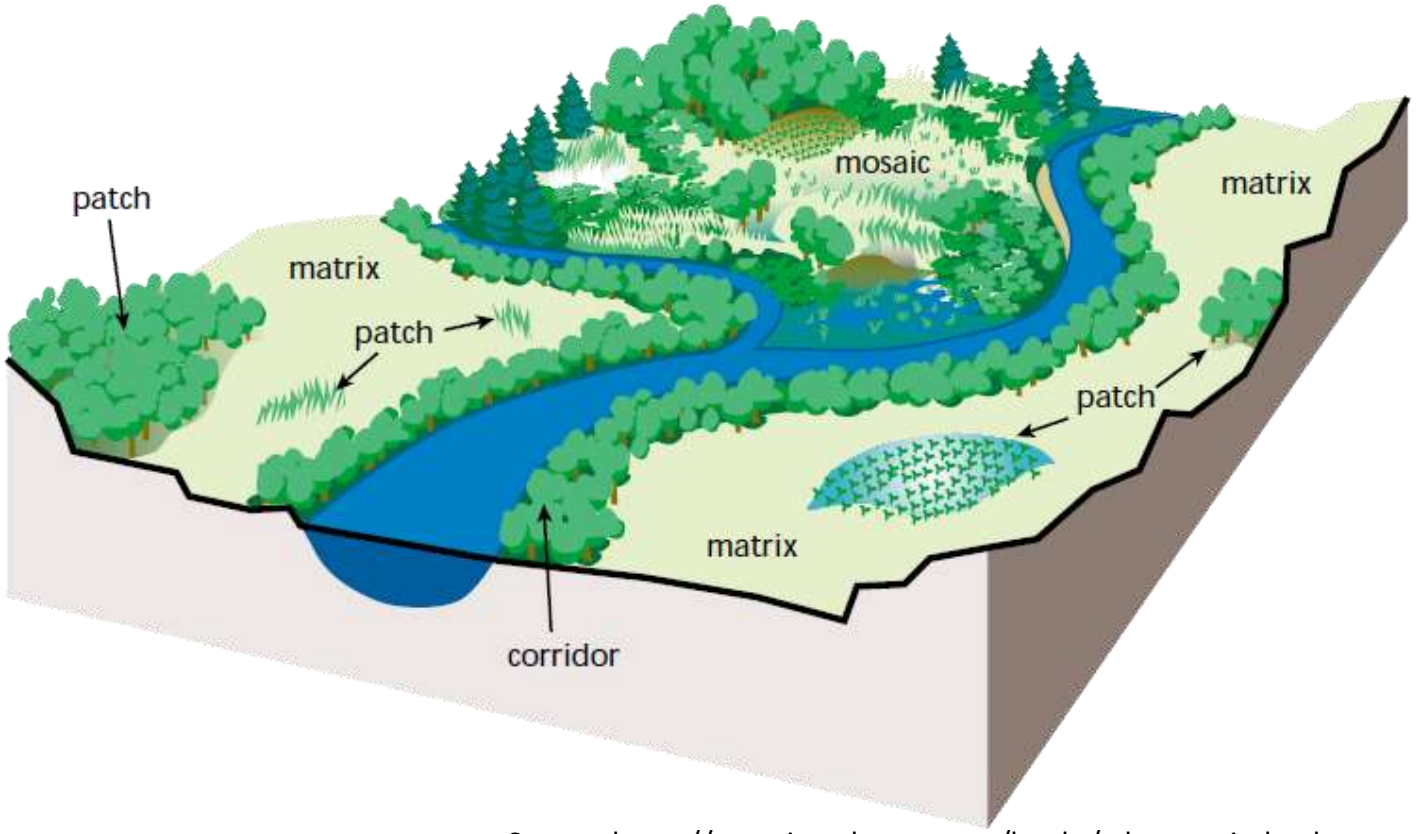
- EU-funded national project for the strategic planning of long-term nature conservation and the implementation of the European Biodiversity Strategy 2020
- Country-wide ecosystem mapping and status assessment, now in preparatory phase
- Input for:
  - assessment of ecosystem services
  - green infrastructure planning
  - landscape characterization

Objectives

- Project:
  - Produce a country-wide detailed ecosystem map for the base year 2015
  - Integration of existing data sets related to land cover (GIS)
  - Remote sensing
  - Modeling based on environmental conditions if needed
- Remote sensing work package:
  - Help mapping
  - Provide data for ecosystem status assessment

Goals of this study

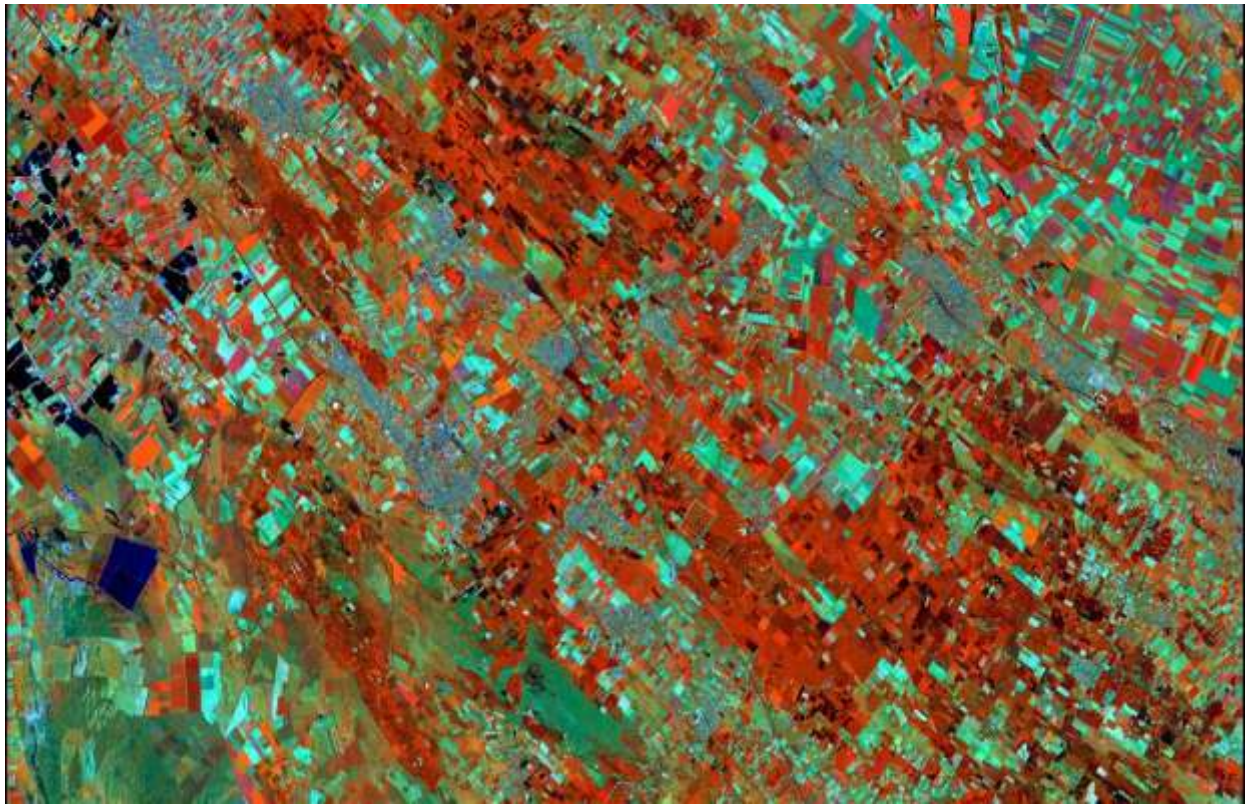
- Extract and analyse landscape changes recorded in EO data sets
- Reveal the past and assess the stability of landscape objects of multiple types
- Provide processed data for subsequent analysis and methodology for follow-up monitoring



Source: https://www.intechopen.com/books/advances-in-landscape-architecture/understanding-landscape-structure-using-landscape-metrics

Study area

- 50 x 50 km in Hungary
- To be extended to the whole country in the next phase
- Key dates behind land use processes:
  - 1989: fall of the socialist regime
  - 1990-1999: changes in land ownership – privatisation process
  - 2004: EU membership, agricultural subsidies accessible



Data

- Imagery
  - Currently: 37 Landsat TM/ETM+/OLI scenes from 1984 to 2016
  - can be complemented with MSS at the beginning
  - Sentinel-2 and Landsat-8 OLI for monitoring in the future
- GIS data
  - CORINE Land Cover (1990, 2000, 2006, 2012)
  - Land Parcel Identification System / MePAR Land Cover (2015)
  - Detailed ecosystem maps (ÁNÉR)

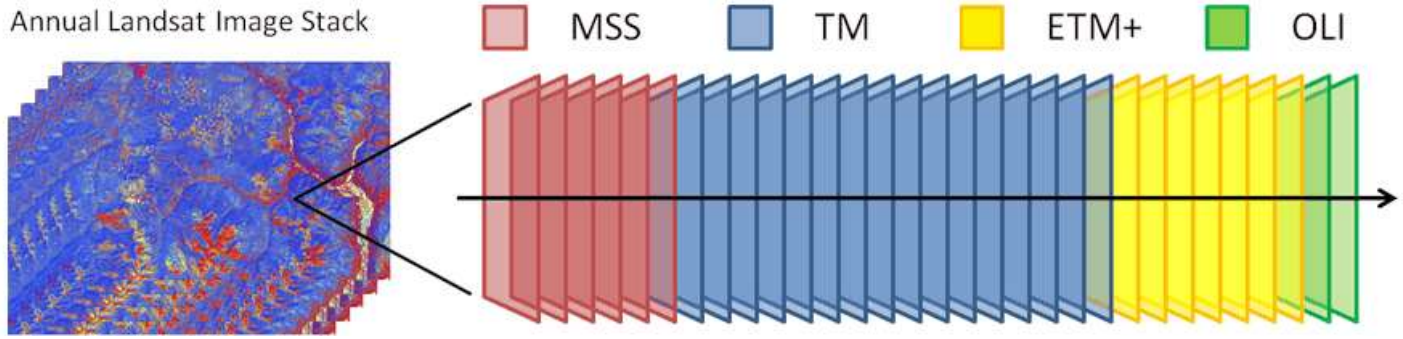
Preprocessing: Reflectance series

- Landsat Collection 1 Surface Reflectance products downloaded from USGS
- Data gap from 1994 to 2002 – migration from international archives in process
- ⇨ Complemented with ESA EarthNet Level 1 scenes
- Successfully calculated SR and cloud mask with LEDAPS and Cfmask for the ESA scenes – good fit with the NASA series
  - https://github.com/USGS-EROS/espa-surface-reflectance/tree/master/ledaps
  - https://github.com/USGS-EROS/espa-cloud-masking

Preprocessing: LandsatLinkr

- LandsatLinkr was used for preprocessing images prior to running LandTrendr
- Justin Braaten, http://landsatlinkr.jdbcode.com/

decompresses & resamples & reprojects & stacks & creates cloud masks & improves georegistration accuracy & applies atmospheric correction and data transformations & spectrally calibrates MSS data to TM data & spectrally calibrates OLI data to ETM+ data & creates annual cloud-free image composites and stacks

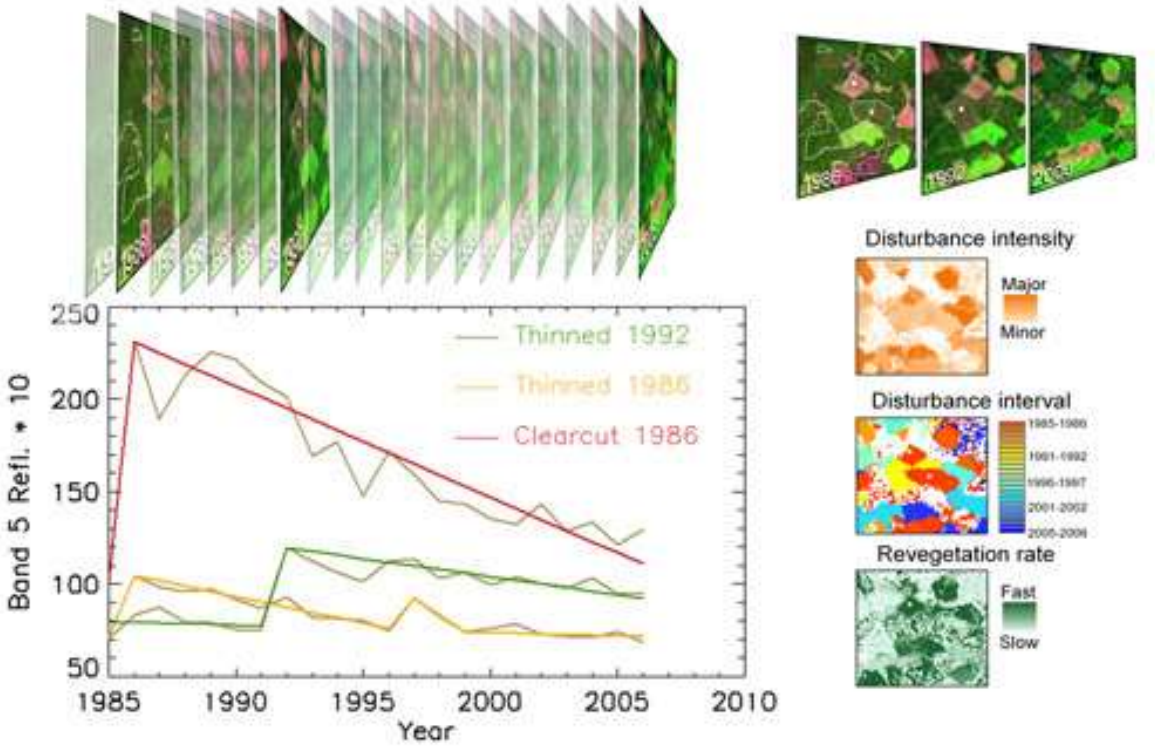


Processing: Overview

- Spectral characteristics:
  - LandTrendr
    - temporal segmentation and trend analysis
    - based on Tasselled Cap indices (brightness, greenness, wetness, angle)
    - creation of thematic change maps
  - Bi-temporal PCA invariant detection
    - serial execution over the whole series
    - for independent spectral stability assessment
- Spatial characteristics:
  - High-pass filtering, summarized in time
  - to detect changes / assess stability in the spatial domain

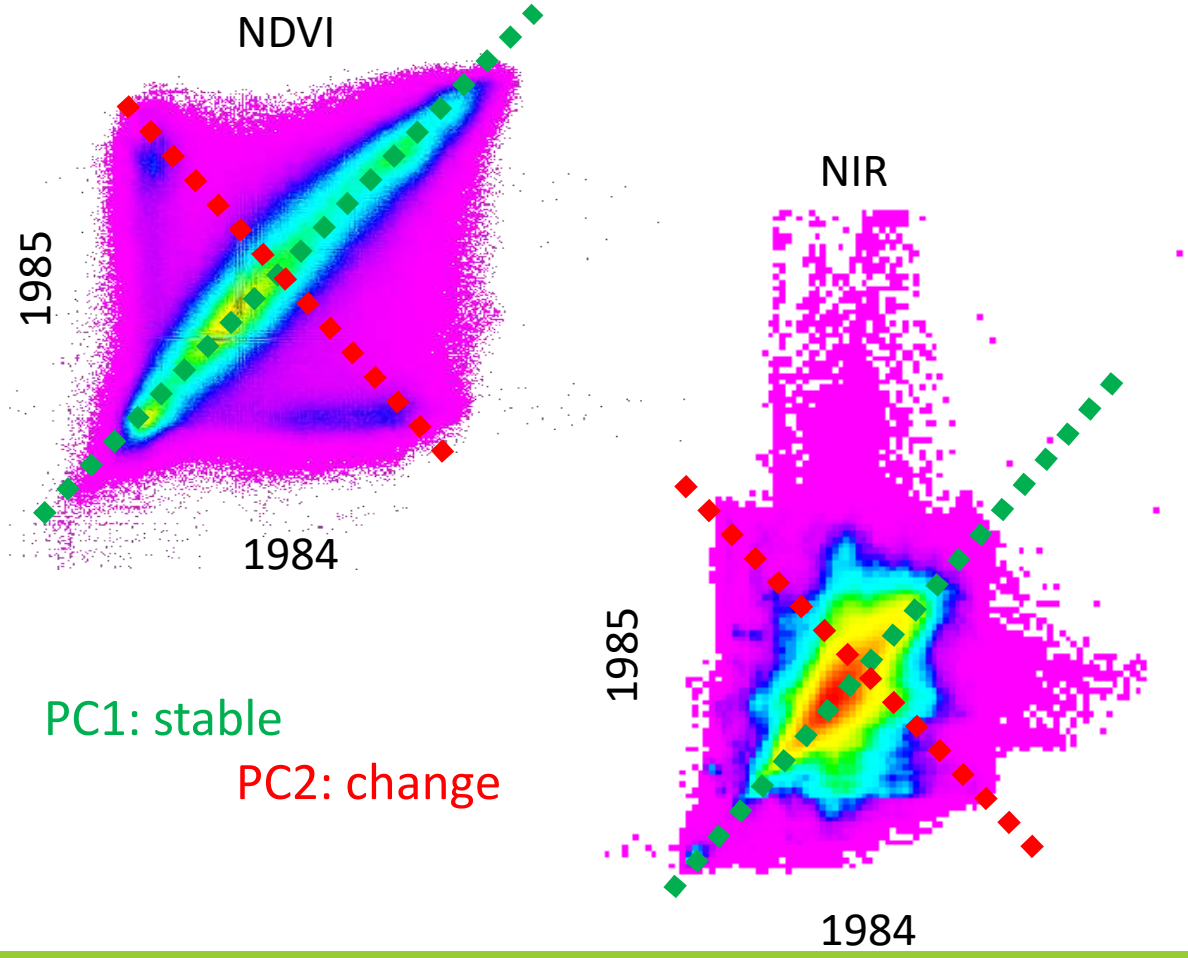
Processing: Trend analysis with LandTrendr

- LLR-LandTrendr, a special variety of LandTrendr for LandsatLinkr input
  - *Kennedy, Robert E., Yang, Zhiqiang, & Cohen, Warren B. (2010). Detecting trends in forest disturbance and recovery using yearly Landsat time series: 1. LandTrendr - Temporal segmentation algorithms. Remote Sensing of Environment, 114, 2897-2910*
  - https://github.com/jdbcode/LLR-LandTrendr
- Outputs:
  - fitted time series
  - thematic maps
    - vertex years and values, greatest disturbance, revegetation rate, and many others



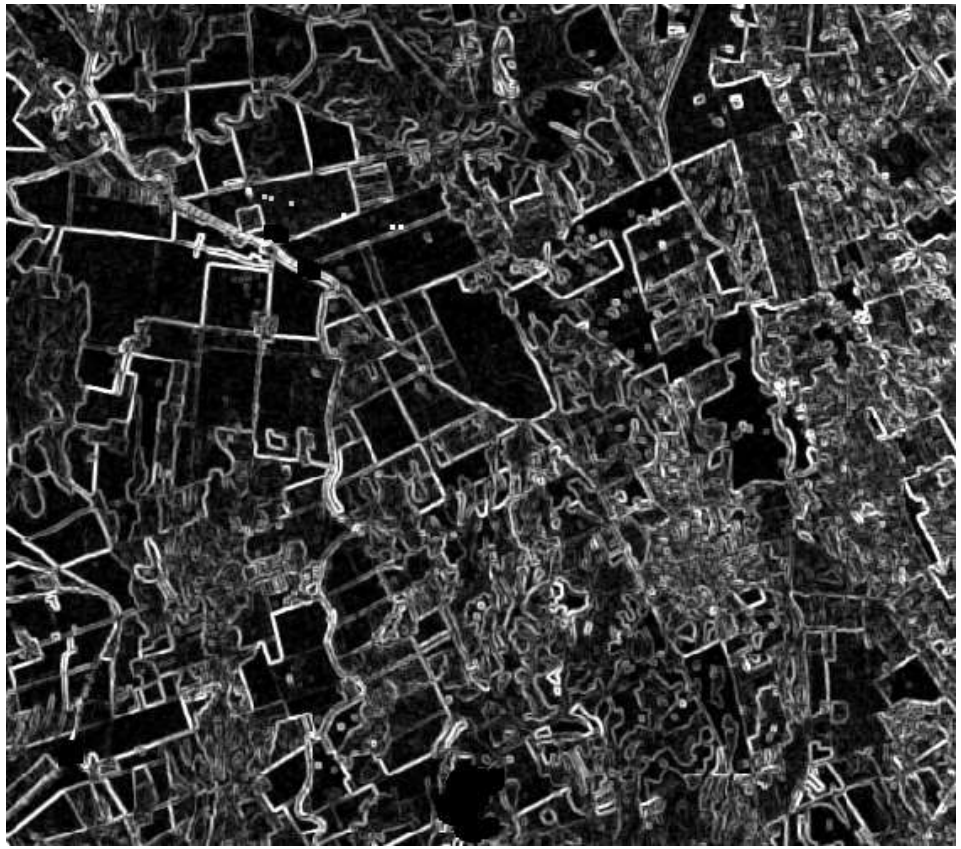
Processing: Bi-temporal PCA

- Bi-temporal PCA invariant detection
  - Executed on pairs of matching spectral band or indices over the same area
  - Output: change/no change map per band or index for consecutive dates
  - Summarized over periods to create stability maps

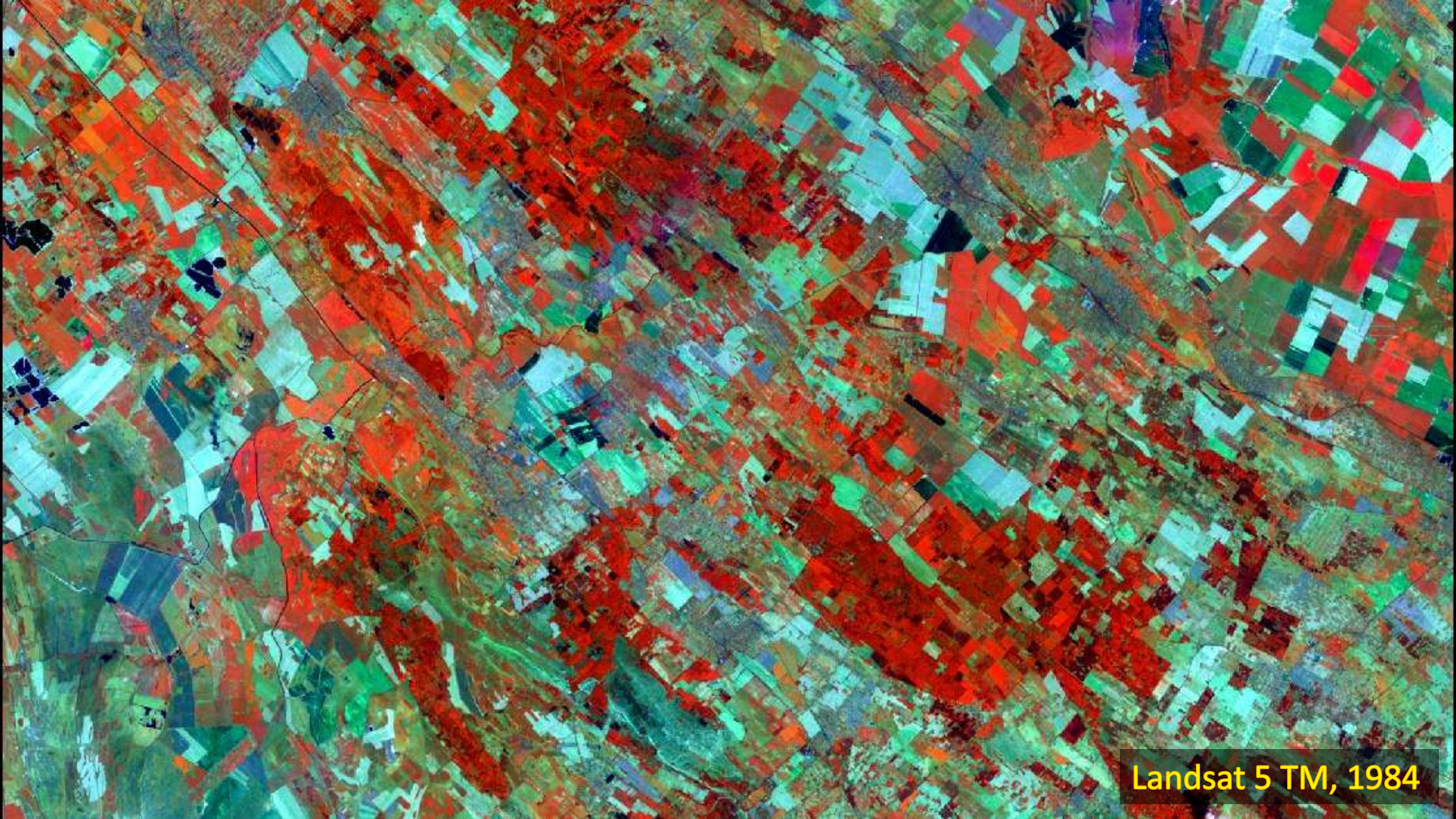


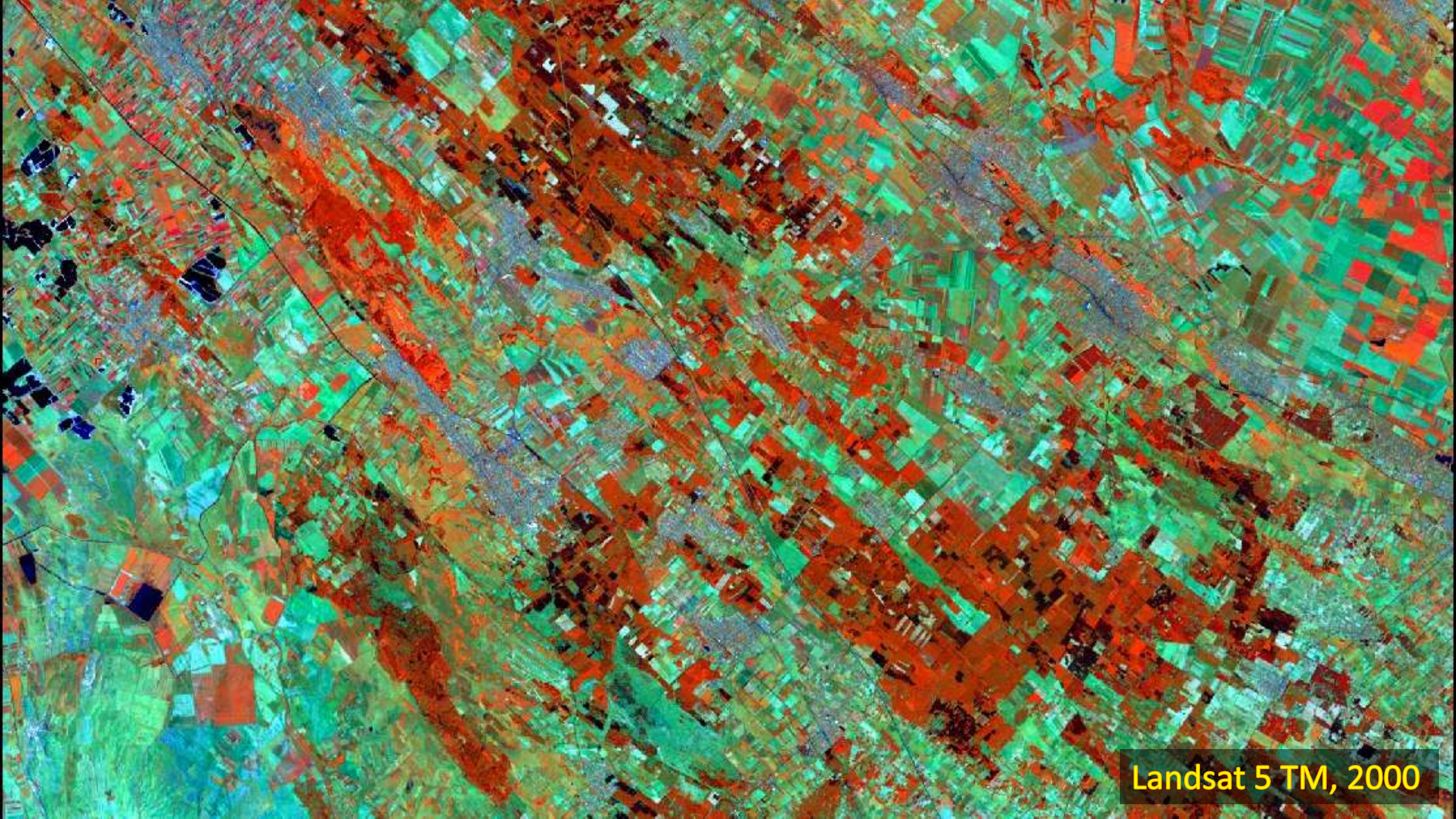
Processing: High-pass filter

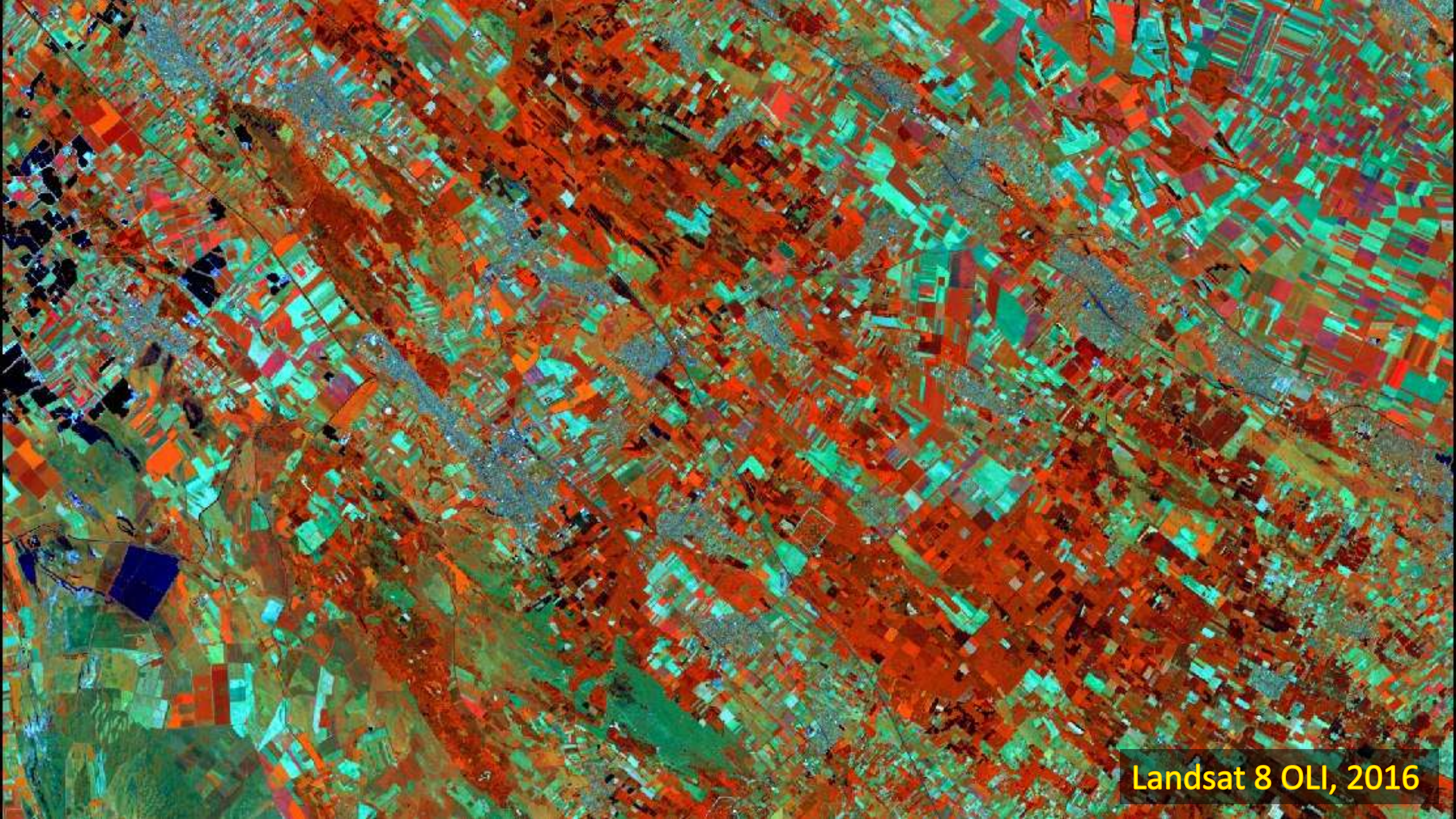
- Emphasizes spatial characteristics and linear structures (borders, barriers, corridors)
- Spectral characteristics are less important: lower sensitivity to spectral variability
- Well suited to detect and track changes in spatial structure, e.g. agricultural land use, constructions, human interventions
- NDVI was used as a basis to emphasize vegetation structure (~ contrast metric)



Results


Landsat 5 TM, 1984


Landsat 5 TM, 2000


Landsat 8 OLI, 2016

Results: LandTrendr

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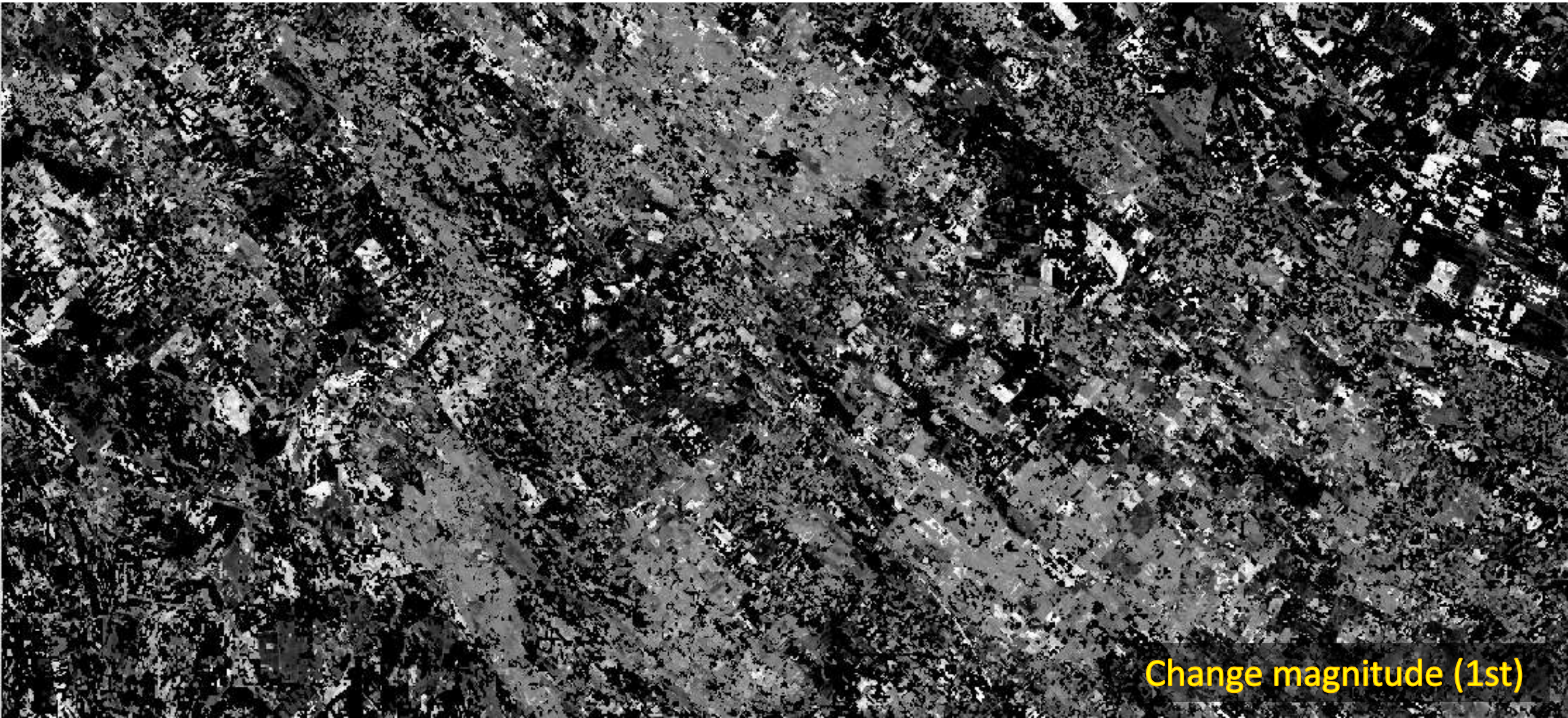
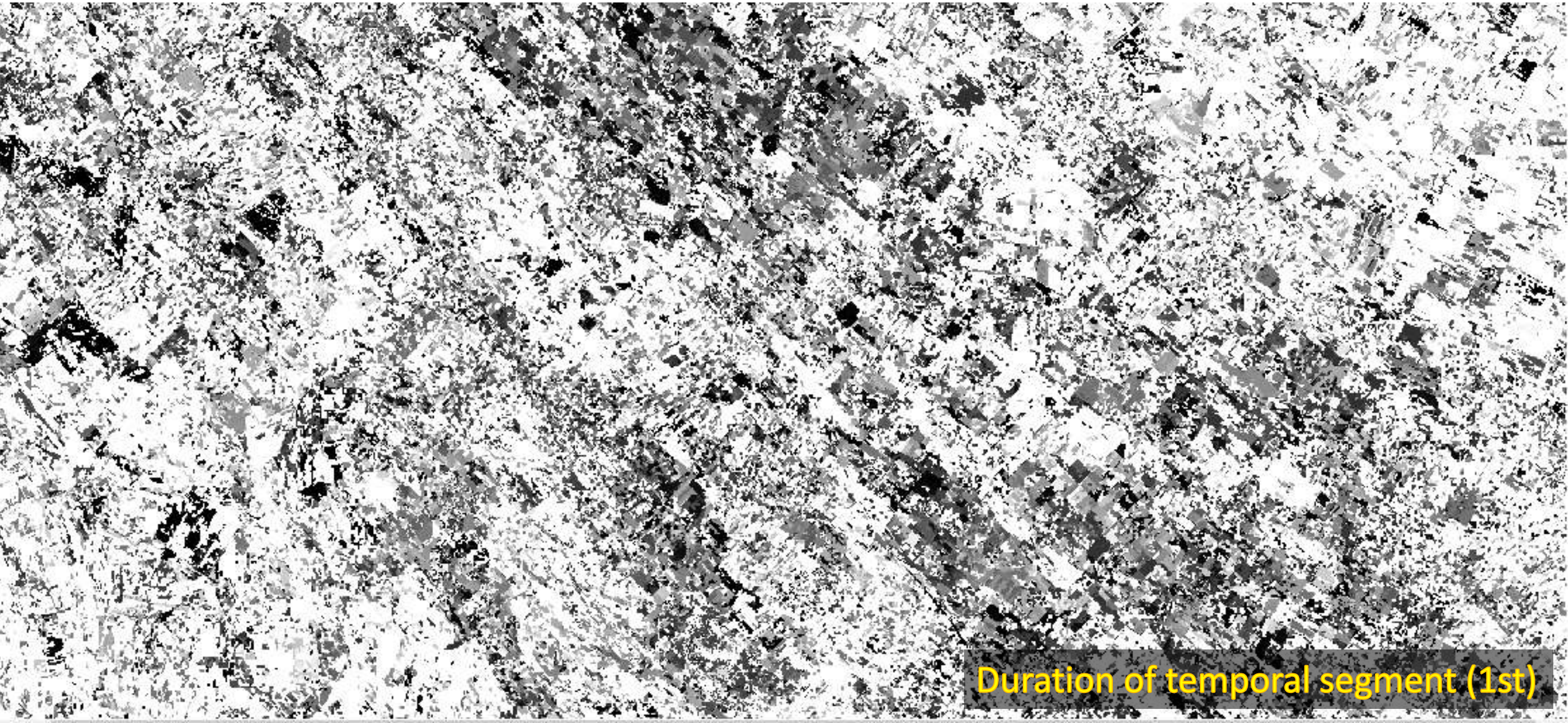


Fény-Tér-Kép 2017



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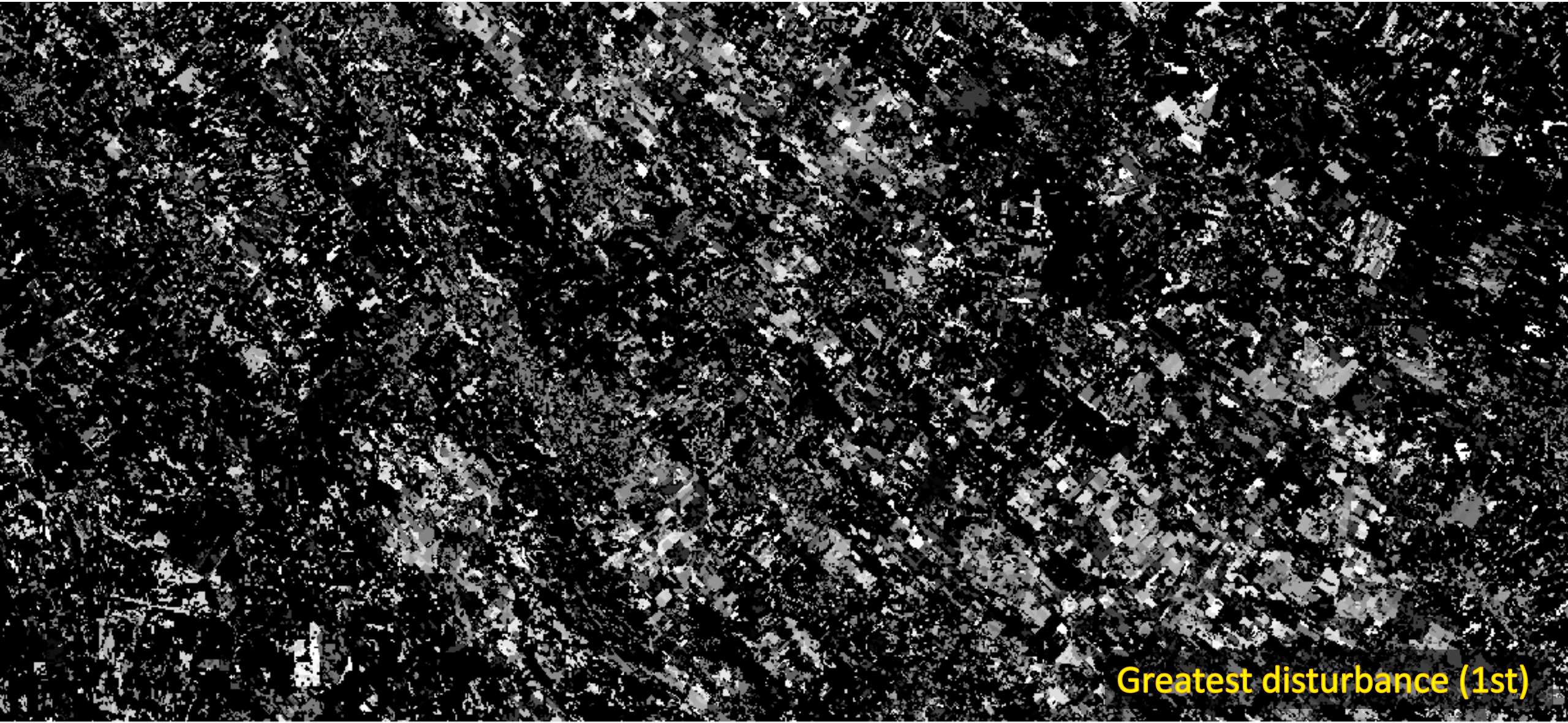
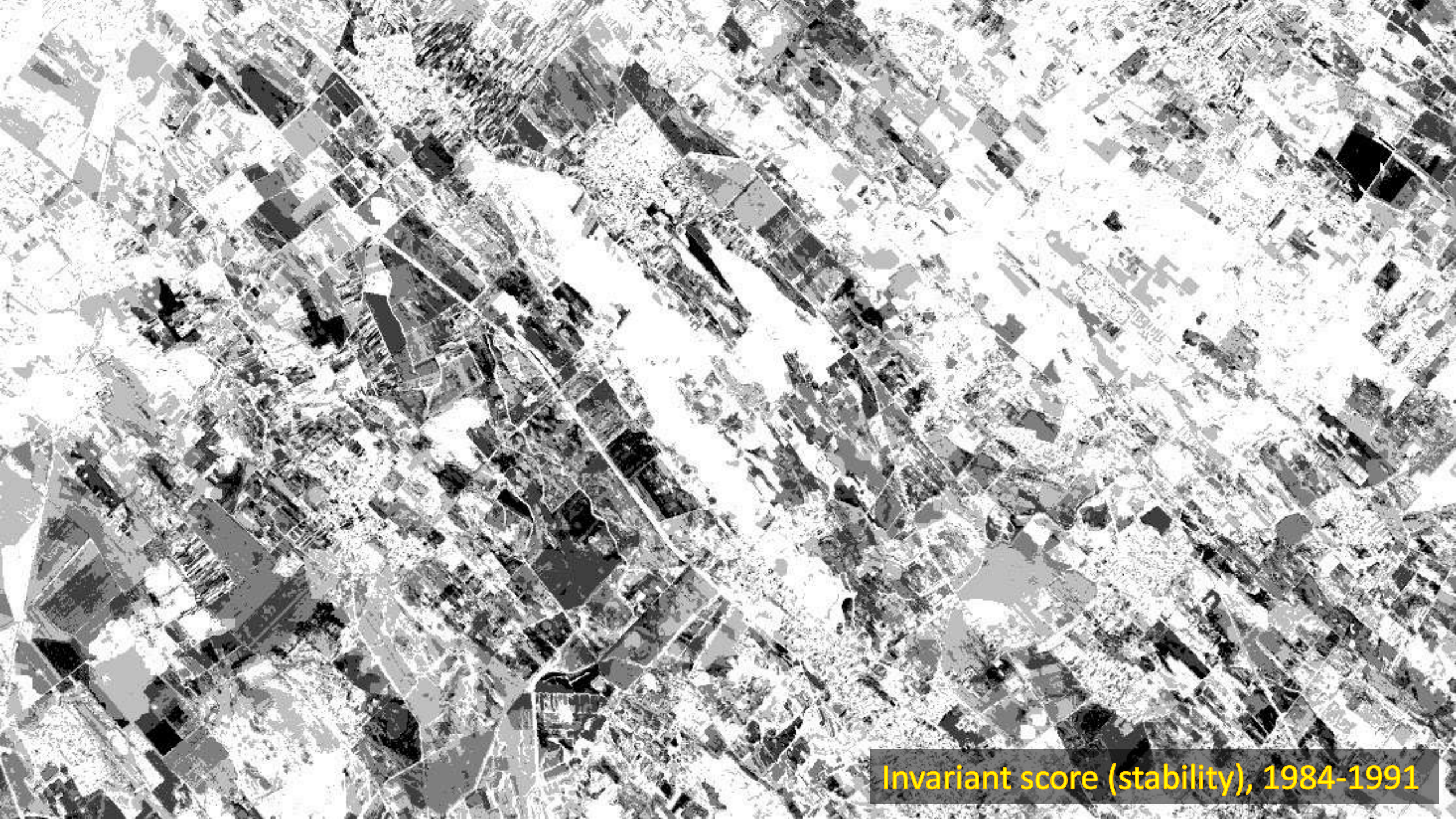
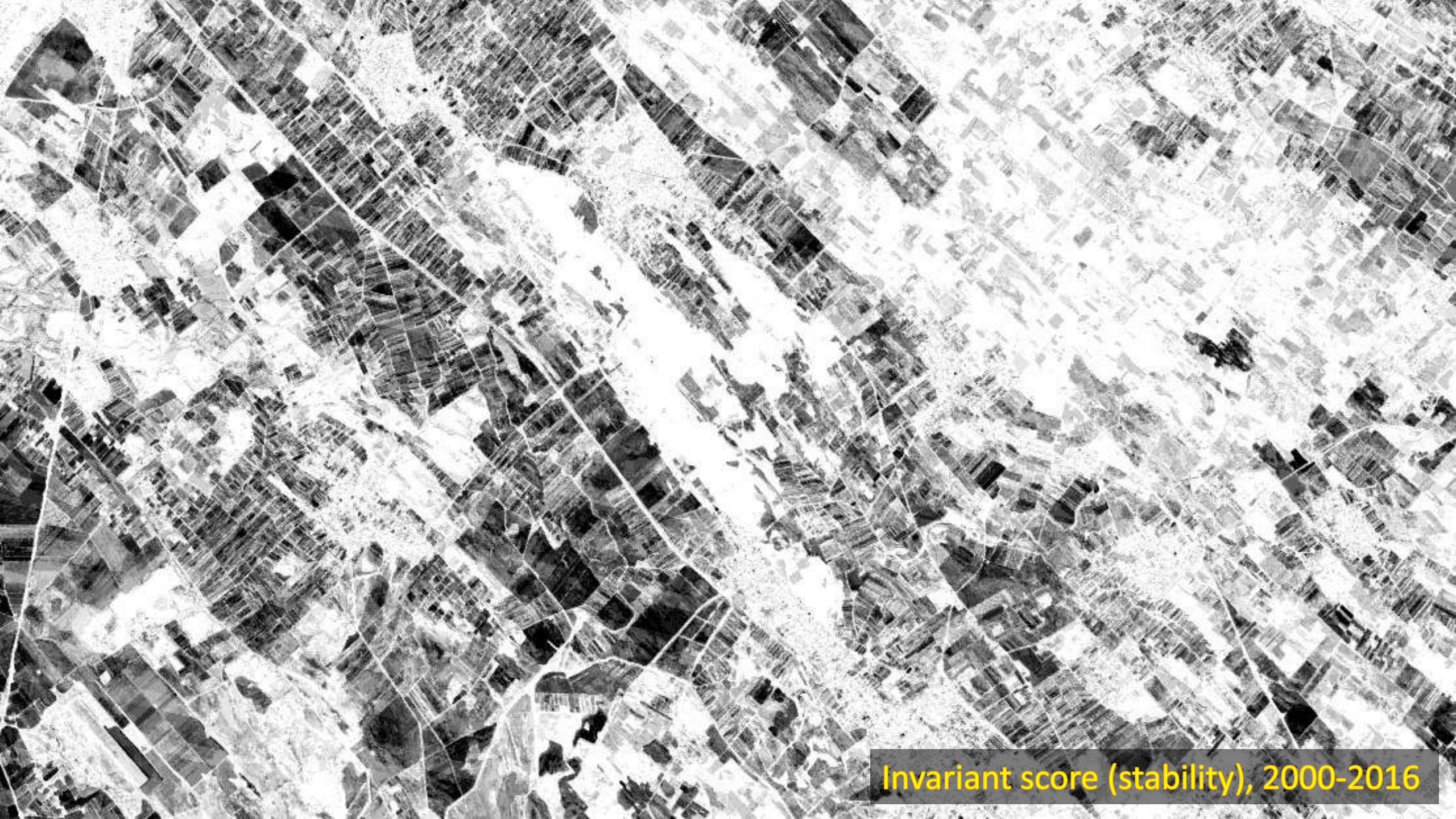
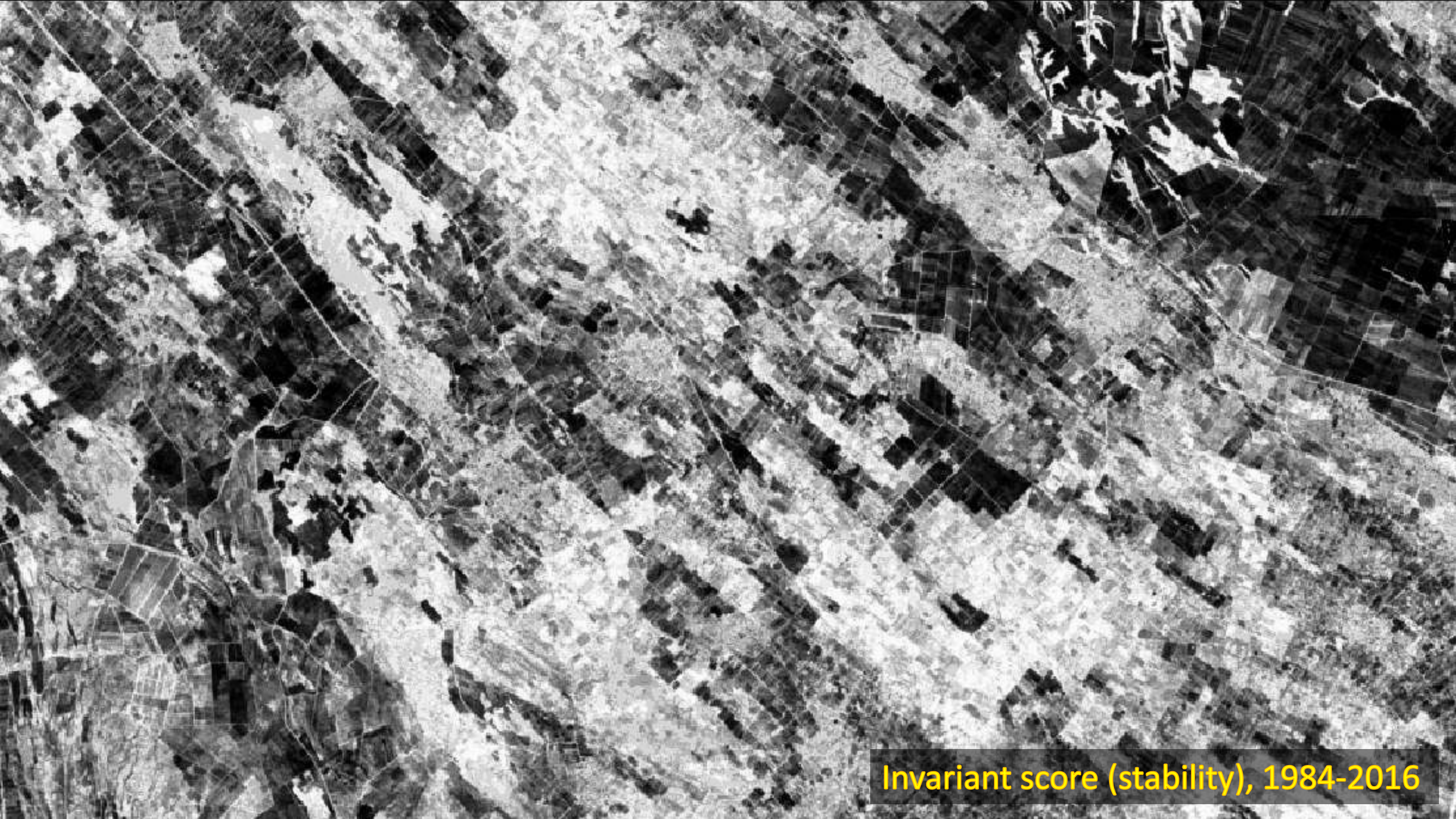


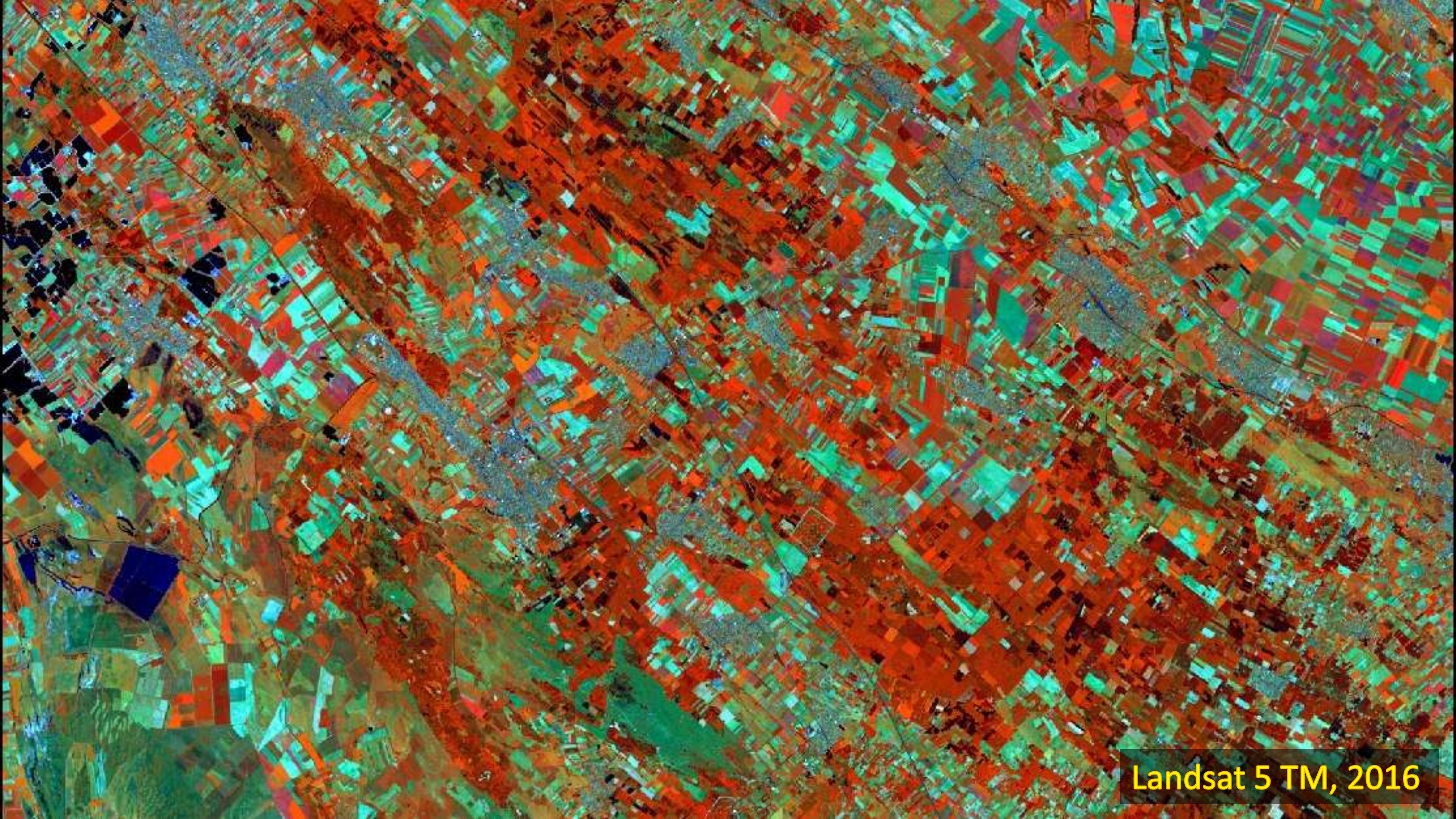
Results: Stability


Invariant score (stability), 1984-1991


Invariant score (stability), 1991-2000

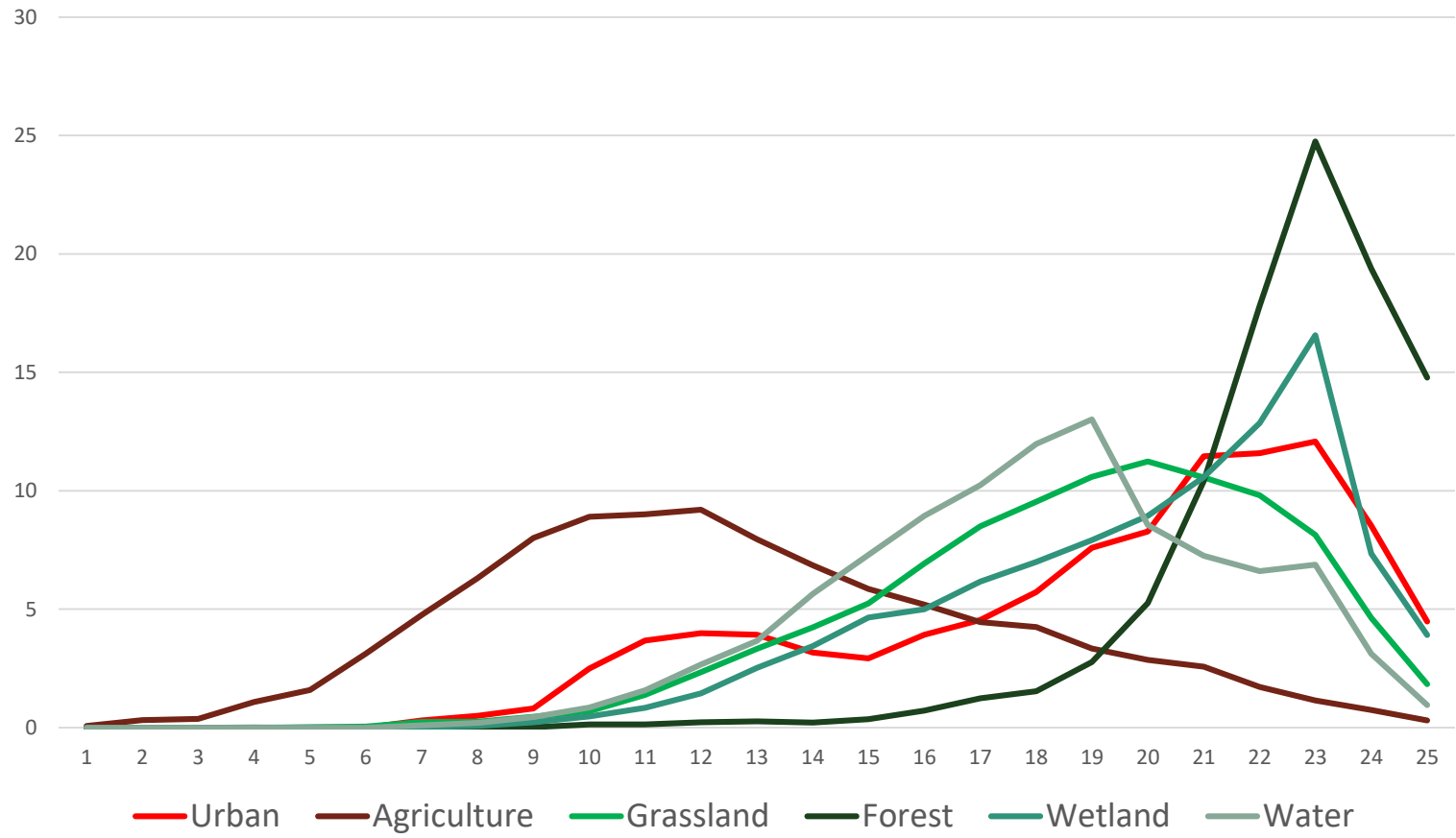

Invariant score (stability), 2000-2016


Invariant score (stability), 1984-2016


Landsat 5 TM, 2016

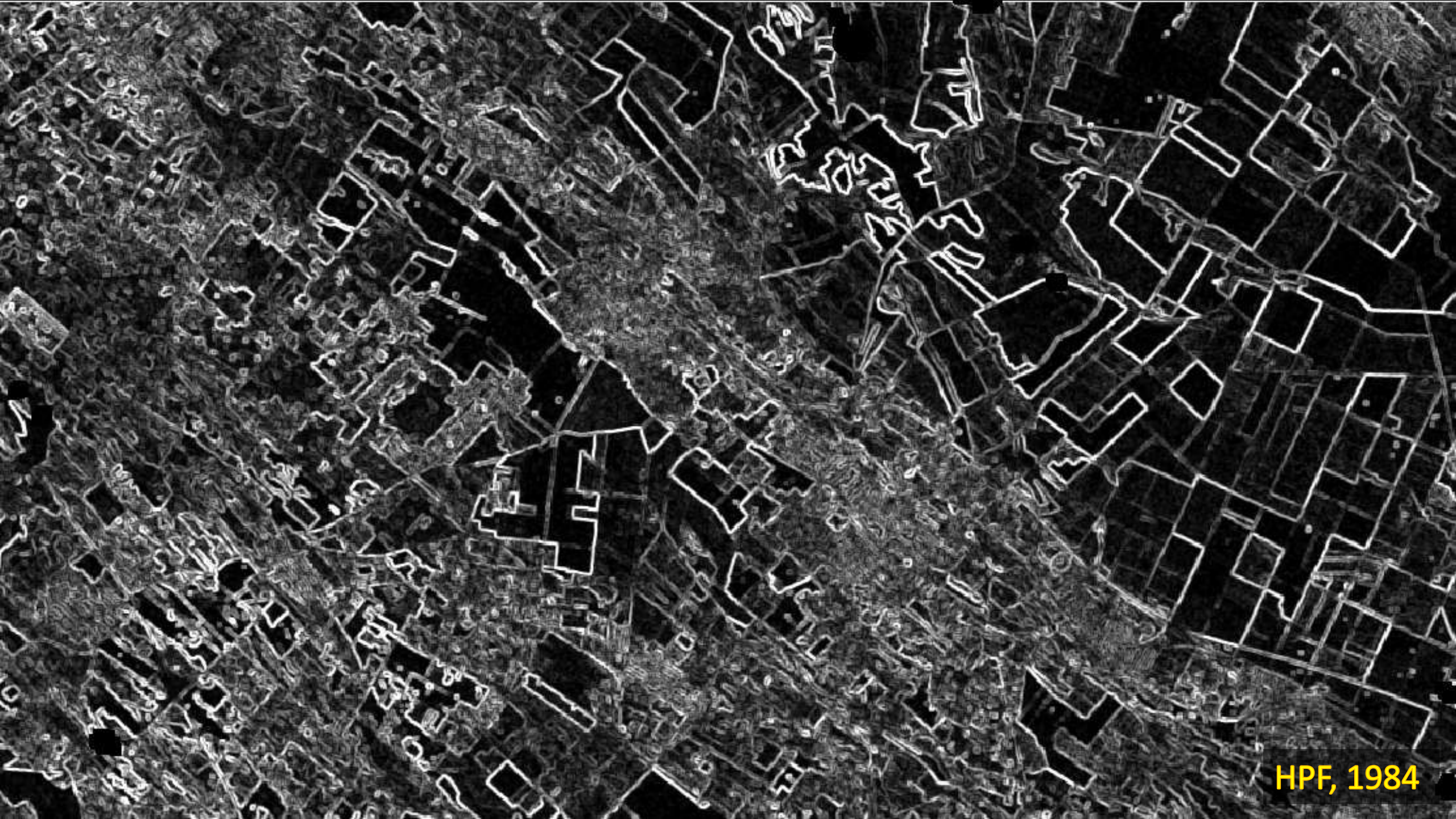
Results

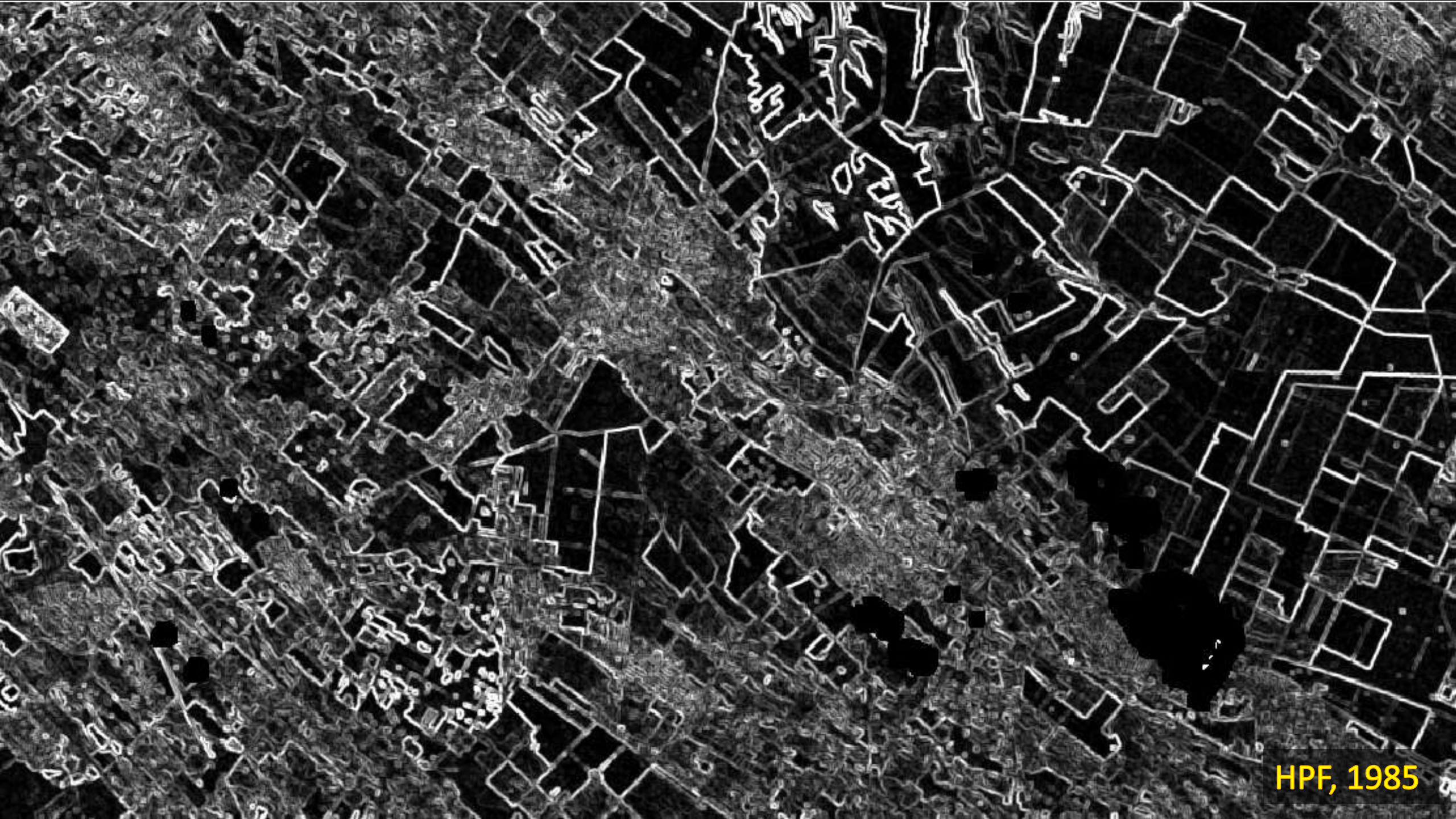
- Distribution of invariant score (number of times selectes as invariant) among land cover categories



Results: Spatial structure

HPF: Time series

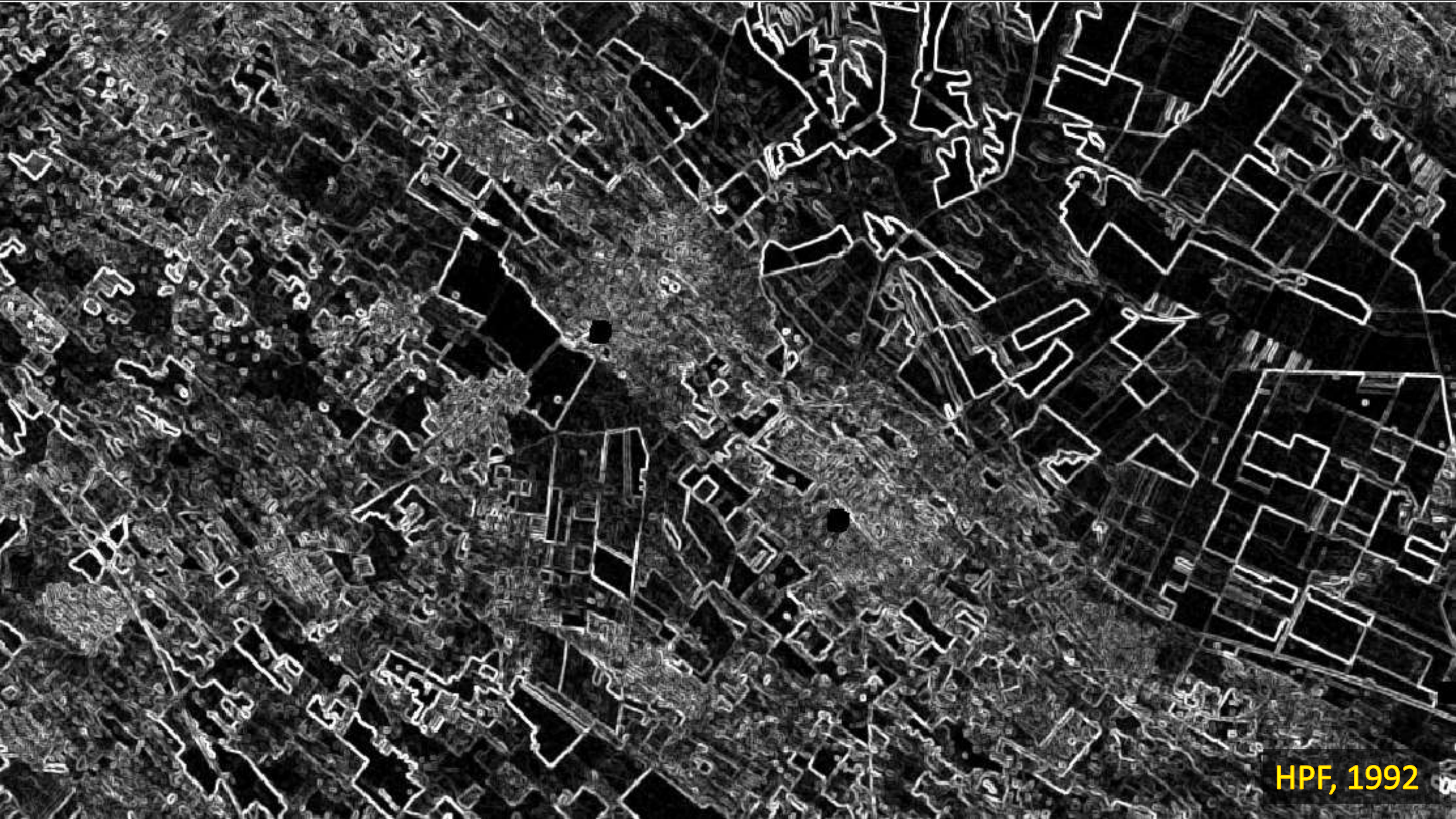

HPF, 1984

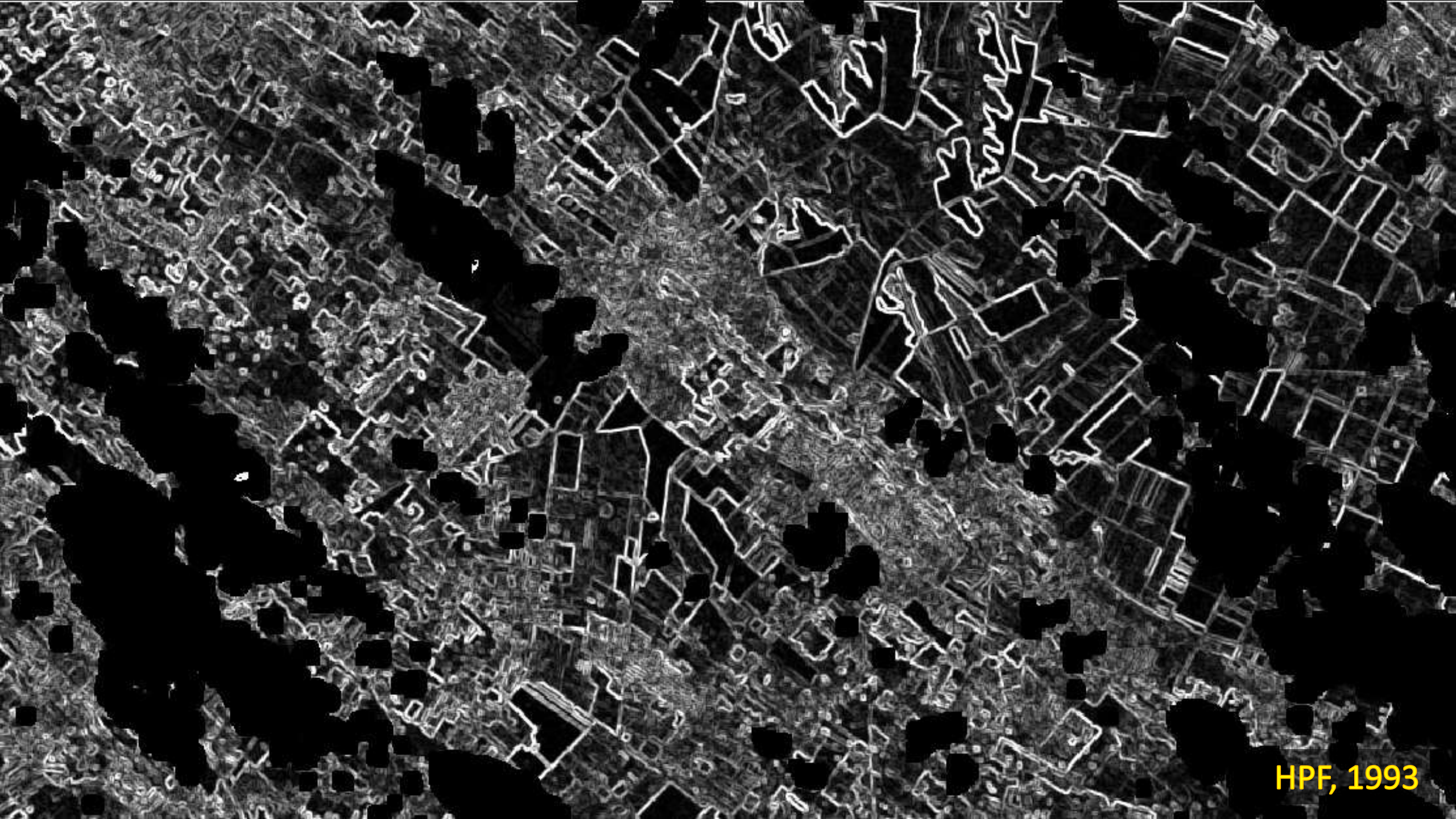

HPF, 1985


HPF, 1986


HPF, 1987


HPF, 1991


HPF, 1992


HPF, 1993


HPF, 1994


HPF, 1995


HPF, 1996


HPF, 1997


HPF, 1999


HPF, 2000


HPF, 2001


HPF, 2002


HPF, 2003


HPF, 2004


HPF, 2005

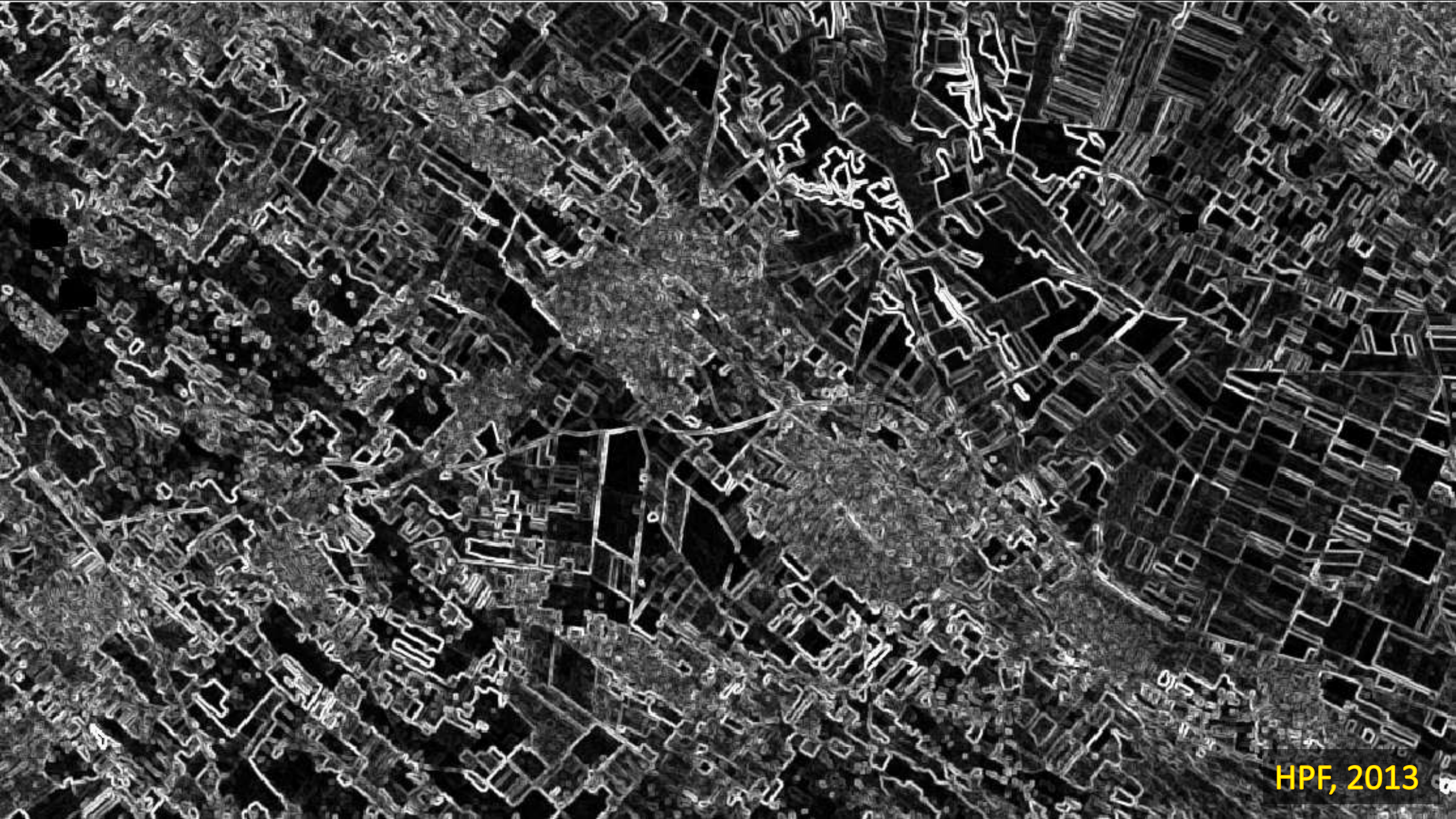

HPF, 2006


HPF, 2007


HPF, 2009

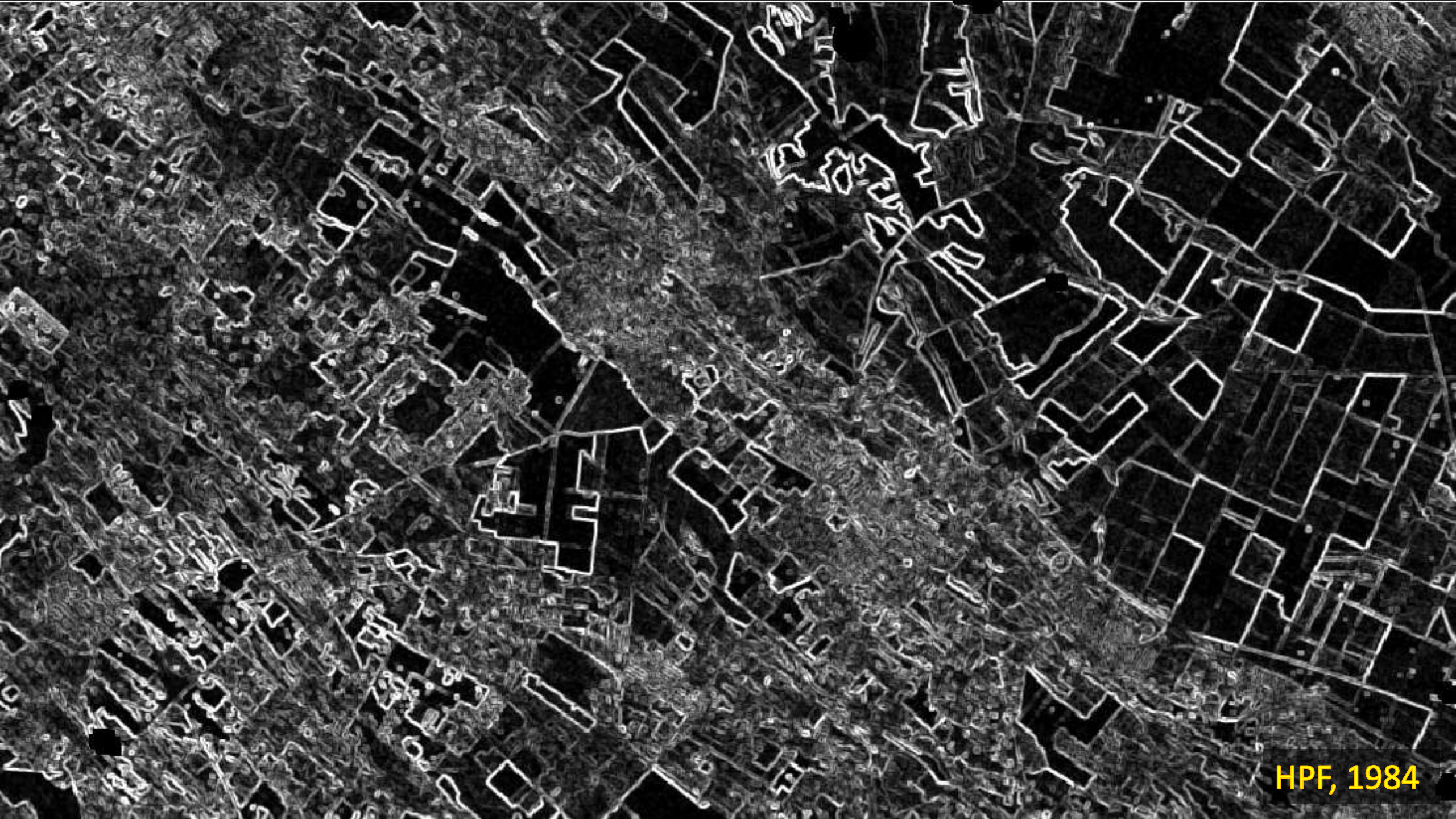

HPF, 2010


HPF, 2011


HPF, 2013


HPF, 2014


HPF, 2015

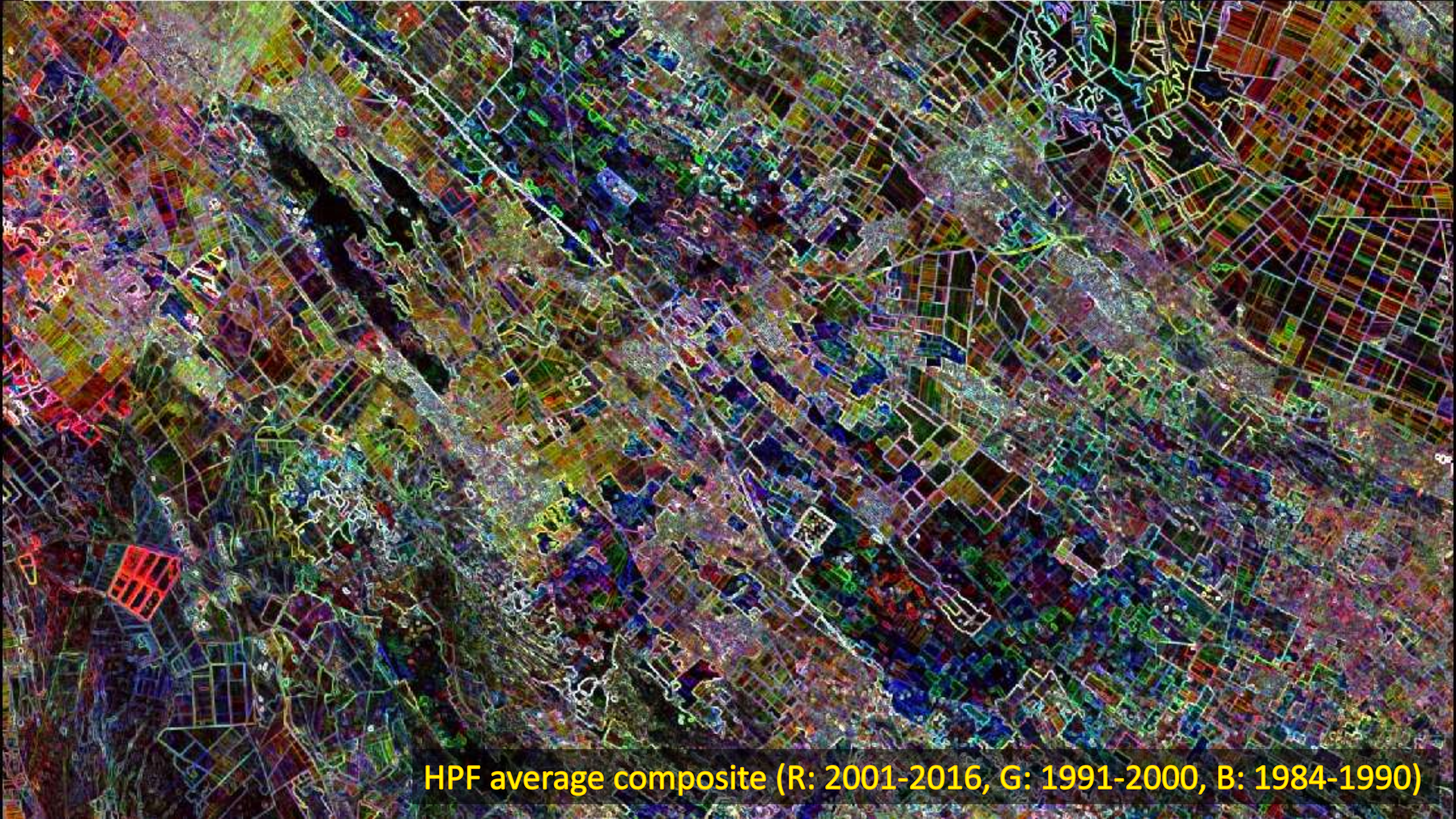

HPF, 1984

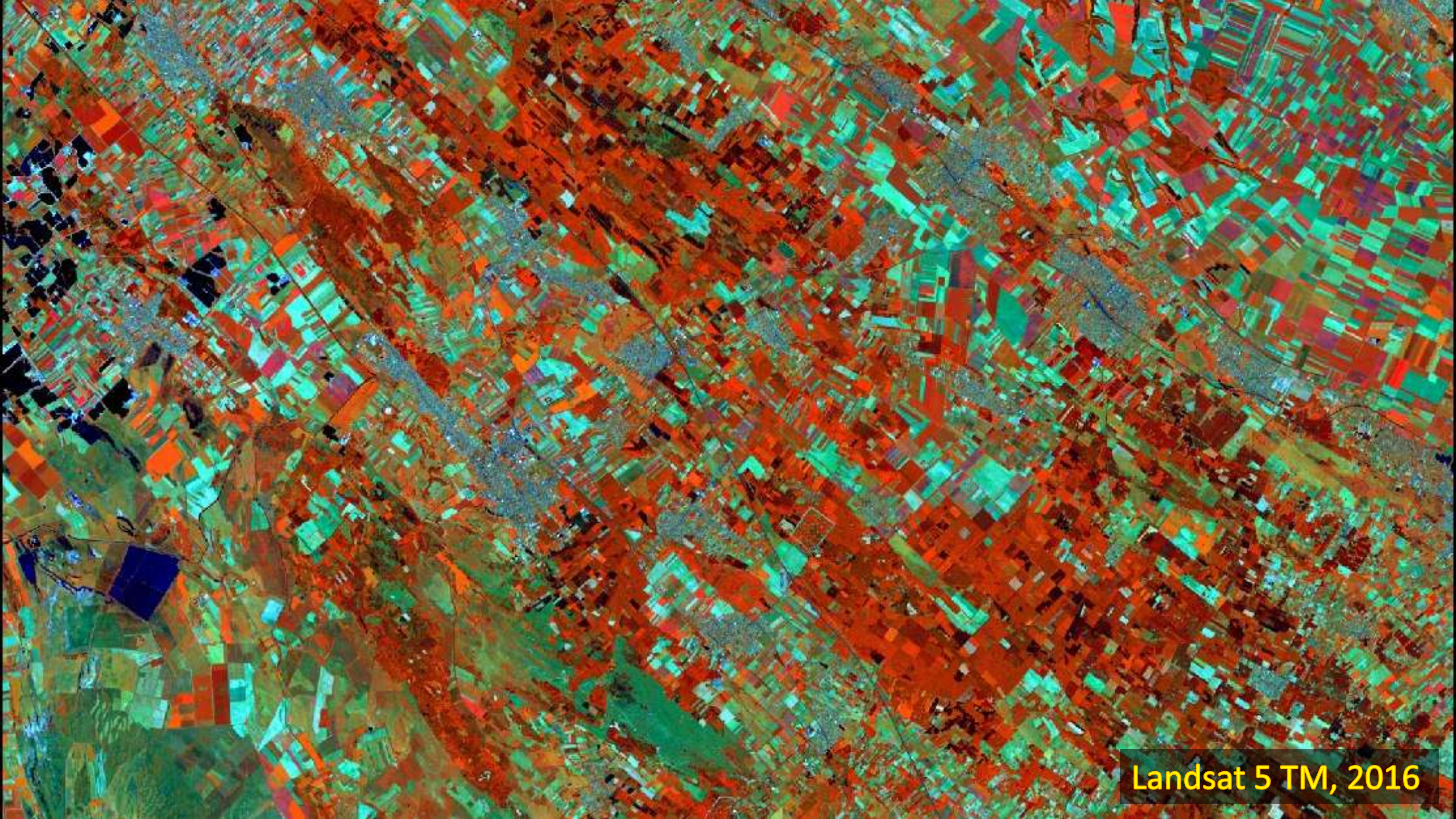
HPF: Temporal aggregation


HPF average , 1984-1991


HPF average , 1992-2000


HPF average , 2001-2016


HPF average composite (R: 2001-2016, G: 1991-2000, B: 1984-1990)


Landsat 5 TM, 2016

Conclusions and outlook

Conclusions

- It was possible to construct long-term Landsat surface reflectance annual time series by the combination of NASA/USGS and ESA archives
- Preprocessing supported by LEDAPS, data preparation by LandsatLinkr
- LandTrendr provides a tremendous amont of information, very useful for forested areas, but less suitable for grasslands, no trends in agriculture. Also, optimization of parameter settings is needed.
- Bitemporal PCA-based invariant mapping executed over the time series provided tangible stability scores
- Changes in spatial structure of land use and linear landscape elements were successfully emphasized and tracked by HPF filtering and its temporal aggregation

Outlook

- MAJA / MACCS (https://logiciels.cnes.fr/en/content/maja) to remove residual clouds from the time series
- Cross-validate detected changes with reference data (forest inventory database, CORINE change maps, extensive visual inspection)
- Investigate the relationship between land cover stability and ecosystem services
- Extend processing over Hungary
- Involve MSS data and historical maps to dig deeper into the past
- Adapt the methods for Sentinel-2 to prepare future monitoring activities

Tervek

ESA Open Invitation To Tender: AO8859

Title: ANNOUNCEMENT OF OPPORTUNITY "PERMANENTLY OPEN CALL FOR OUTLINE PROPOSALS UNDER THE HUNGARIAN INDUSTRY INCENTIVE SCHEME - EXPRO PLUS"

Open Date: 15/12/2016

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Status: ISSUED

Special Prov.: HU

Price Range: KEURO

a. Hardware activities (e.g. flight hardware) with preference for those related to generic technologies, products and equipment for satellite platforms or ground stations and with potential for re-use;

b. **Research and development activities** (including technology demonstrations, industrial processes and their qualification/certification) leading to hardware or software products, services or generic technologies with potential for re-use;

c. **Activities preparing for the future** (e.g. feasibility studies, technology assessments, user requirements or market surveys) **and/or ESA mission related services to support national competitiveness** in ESA programmes (optional and mandatory) to which **Hungary subscribes or intends to subscribe**;

d. **Space applications, products and services making use of space infrastructure** (e.g. data, satellites) that is already existing or scheduled for operation in the near term and with a clear potential market and sustainable business.

Köszönet

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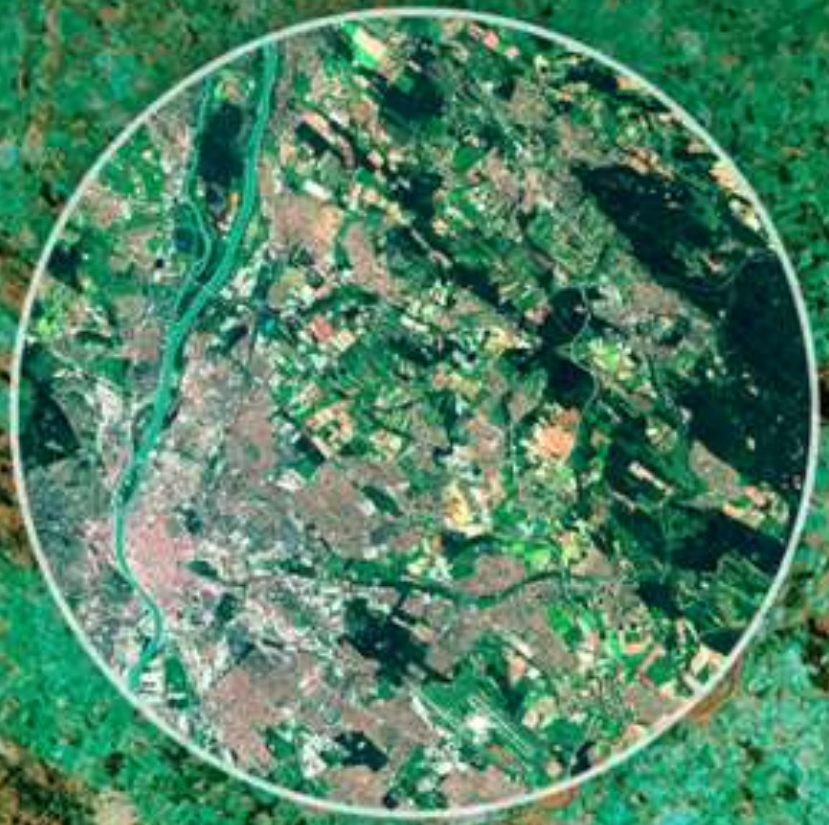

Directly contributed to this presentation:

Thank you!

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Thank you!

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