



Example of Sentinel-1 use for grassland monitoring

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5th GEOGLAM RAPP Workshop in ESRIN, Frascati

May 17, 2017



Outline

1. Who we are and how the grasslands research started?
2. What we do – operational service development in Estonia, user trials project in Denmark and Sweden.
3. Main research findings.
4. Current research – grazing intensity estimation.



Tartu Observatory

- ✦ Estonian national space research centre.
- ✦ Three research fields: astronomy, space technology and Earth Observation.
- ✦ SAR group established in 2011, 3 PhDs, 2 doctoral students.
- ✦ *Tartu Observatory will join University of Tartu in 2018.*



Grasslands research in Estonia

- ✦ Started in 2011 from user demand – Estonian CAP PA – need to check the mowing!
- ✦ Applied research for grassland parameters' retrieval since 2011, 4 campaigns, 6 research papers published.
- ✦ In early days got a lot of education and support from DLR HR PolInSAR group and Aalto University.
- ✦ In 2011 almost nobody was doing grasslands with SAR, why? 😊



KappaZeta est. 2015

- ✦ TO spin-off company.
- ✦ Based on our research team.
- ✦ Creating the best “mowing detection engine” and other satellite based services for paying agencies.

KappaZeta





Our team - what do we believe in?

- ✦ Physics based approach – understanding the processes behind, no treating data as data without understanding the effects we see.
- ✦ We do the boring, but valuable systematic field surveys to have our feet on ground and quantitative data to claim something.



Operational service development for Estonian PA

- ✦ Country level operational mowing detection service in cooperation with CGI.
- ✦ Reporting the mowing detection results (mowing dates and probability estimates) NRT to the farmers and PA officials.
- ✦ Combining Sentinel-1 and Sentinel-2 time series and meteorological data.
- ✦ Development years: 2016-2017.
- ✦ Service operational starting from 2018.



Operational SATIKAS system

Web map



Legend



Too low biomass for reliable detection.



Unmown.



Mown.



Partly mown.

Parcel level time series view

Niitmise analüüsi tulemused

XV_ID Pindala ha Übermööd m

Tootlusobjekt Kanderaamat Tuvastamiste tabel

Biomassi osakaal ja niitmistuvastus 2016

| Tuvastamise nr | Kuupäev | Haritud | Biomassi osakaal | Niitmise tõenäosus | Staatust |
|----------------|------------|---------|------------------|--------------------|--------------------|
| 24 | 25.05.2016 | | 0,650 | - | Ei ole niidetud |
| 26 | 29.05.2016 | | 0,700 | - | Ei ole niidetud |
| 28 | 02.06.2016 | | 0,750 | - | Ei ole niidetud |
| 30 | 06.06.2016 | | 0,780 | - | Ei ole niidetud |
| 32 | 10.06.2016 | | 0,800 | - | Ei ole niidetud |
| 34 | 14.06.2016 | | 0,780 | - | Ei ole niidetud |
| 36 | 18.06.2016 | | 0,760 | - | Ei ole niidetud |
| 38 | 22.06.2016 | | 0,740 | - | Ei ole niidetud |
| 40 | 26.06.2016 | | 0,550 | 65 | Osaliselt niidetud |
| 42 | 30.06.2016 | | 0,540 | - | Ei ole niidetud |
| 44 | 04.07.2016 | | 0,320 | 95 | Niidetud |
| 46 | 08.07.2016 | | 0,350 | - | Ädal |
| 48 | 12.07.2016 | | 0,400 | - | Ädal |
| 50 | 16.07.2016 | | 0,450 | - | Ädal |
| 52 | 20.07.2016 | | 0,500 | - | Ädal |
| 54 | 24.07.2016 | | 0,500 | - | Ädal |
| 56 | 28.07.2016 | | 0,500 | - | Ädal |
| 58 | 01.08.2016 | | 0,511 | - | Ädal |
| 60 | 05.08.2016 | | 0,500 | - | Ädal |
| 62 | 09.08.2016 | | 0,490 | - | Ädal |
| 64 | 13.08.2016 | | 0,480 | - | Ädal |
| 66 | 17.08.2016 | | 0,210 | 90 | Niidetud |
| 68 | 21.08.2016 | jah | 0,000 | - | Haritud |

* - Niitmistulemus on Euroopa Kosmoseagentuuri tulenevatel põhjustel ümber arvutatud



Infosystem for Estonian PA

- ✦ Mowing date(s) per parcel.
- ✦ Ploughing date(s) per parcel.
- ✦ Supporting business logic to check the compliance with the CAP rules.



The new “Grassland mowing detection for agricultural subsidy checks with Sentinel-1 and Sentinel-2” EstIIS ESA project 2017-2019

Objectives:

- ✦ Provide reliable full scale and near real-time grassland management events monitoring for European paying agencies and farmers.
... for that build a scalable remote sensing based software solution that is validated in Northern Europe (Denmark, Sweden).
- ✦ Reach to 30% market share (12 countries) in Europe.
- ✦ ... for that develop viable business model to provide a high-quality service for target customer segments.



The Grasslands EstIIS ESA project

- ✦ In brief: (i) mowing detection engine development, (ii) technical and business feasibility analysis and (iii) user trials with Danish and Swedish paying agencies (PAs).
- ✦ Danish and Swedish PAs as the pilot users of the service.
- ✦ Also Finnish, Latvian and Lithuanian paying agencies have expressed their interest about the project outcomes.



The Grasslands EstIIS ESA project impact

- ✦ From *in situ* inspector checks covering 5% of the subsidy applications.

- ✦ To almost country-wide coverage.



2011-2016 – main research findings



TerraSAR-X and RADARSAT-2 based SAR studies

- ✦ HH/VV polarimetric coherence – probably the best X-/C-band polarimetric SAR parameter sensitive to mowing events.
- ✦ Dense time series needed (11 day time steps work, 22 and 24 day steps - complicated).
- ✦ Works better if more grass is left on ground.
- ✦ H2 α dominant alpha scattering angle another parameter that could work in case grass is left on ground.

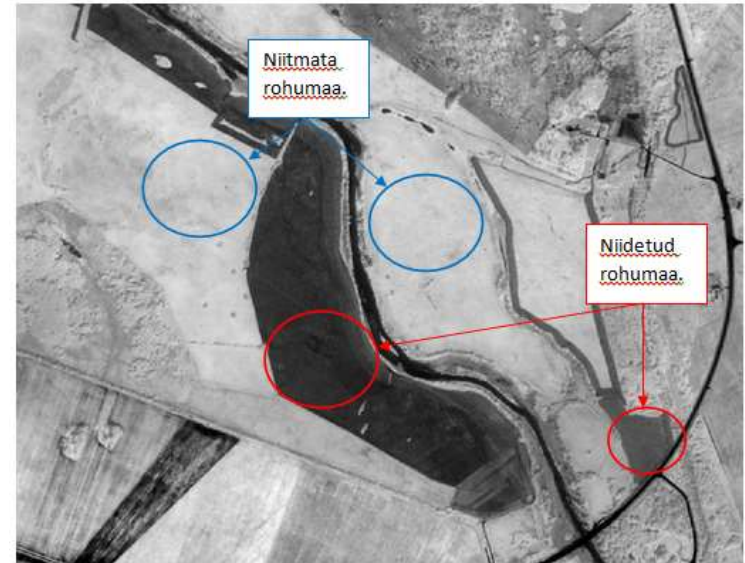


COSMO SkyMED 1 day InSAR experiment

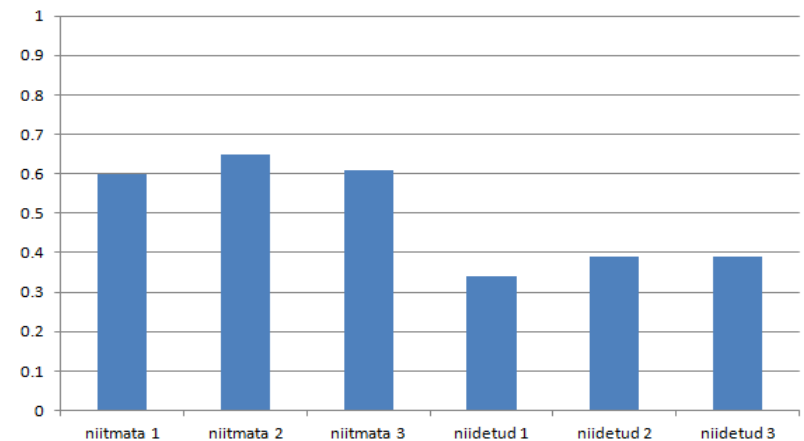
- ✦ 1 day repeat pass X-band InSAR coherence and grass height – strong exponential correlation up to 30 cm grass height.
- ✦ Over 30 cm grass – quick saturation.
- ✦ Need to take account precipitation and ploughing activities – drag the coherence down.

NDVI test 2012

- ✦ Of course it works as a mowing indicator. 😊
- ✦ Best in early season when a lots of biomass means a lot of chlorophyll.
- ✦ But: cloud-cover creates gaps in the optical data.



NDVI väärtus



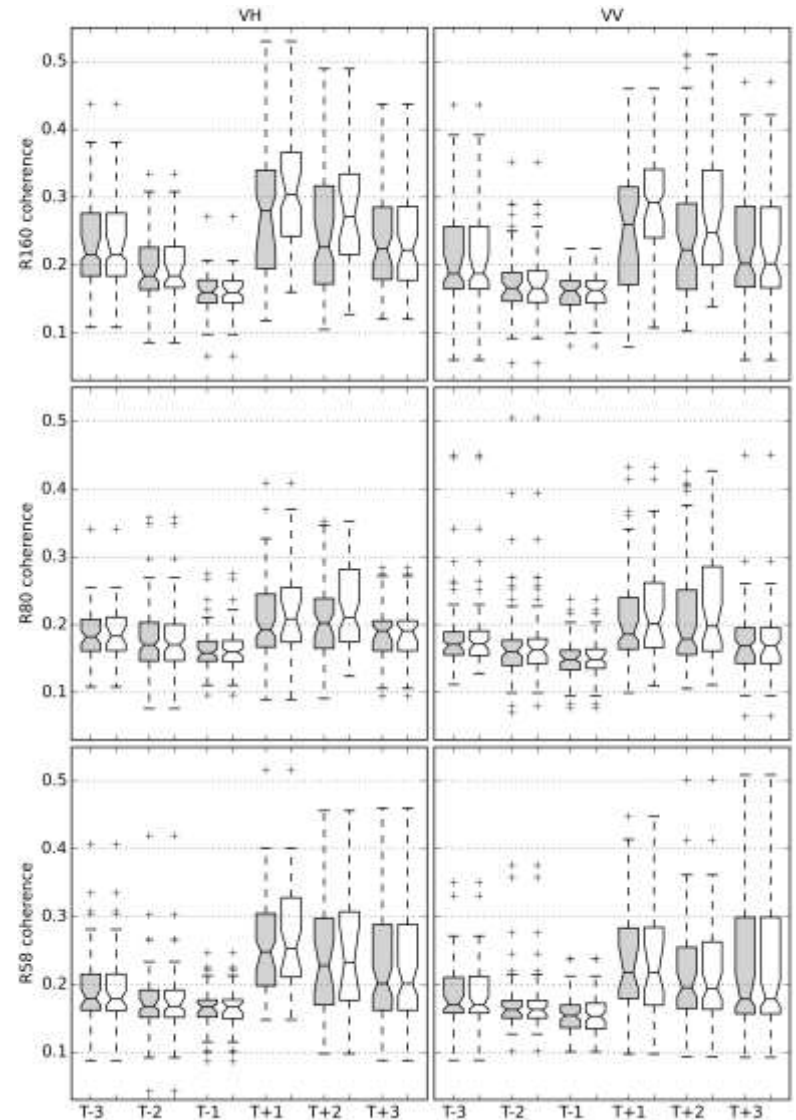


Latest article findings – Sentinel-1 data for mowing detection

- ✦ Tamm, T.; Zalite, K.; Voormansik, K.; Talgre, L. (2016), **Relating Sentinel-1 Interferometric Coherence to Mowing Events on Grasslands**, *Remote Sensing*, 8(10), 802
- ✦ <http://dx.doi.org/10.3390/rs8100802>

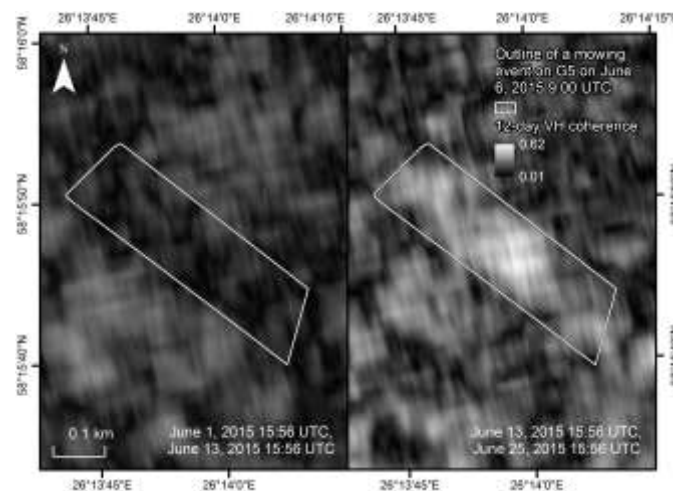
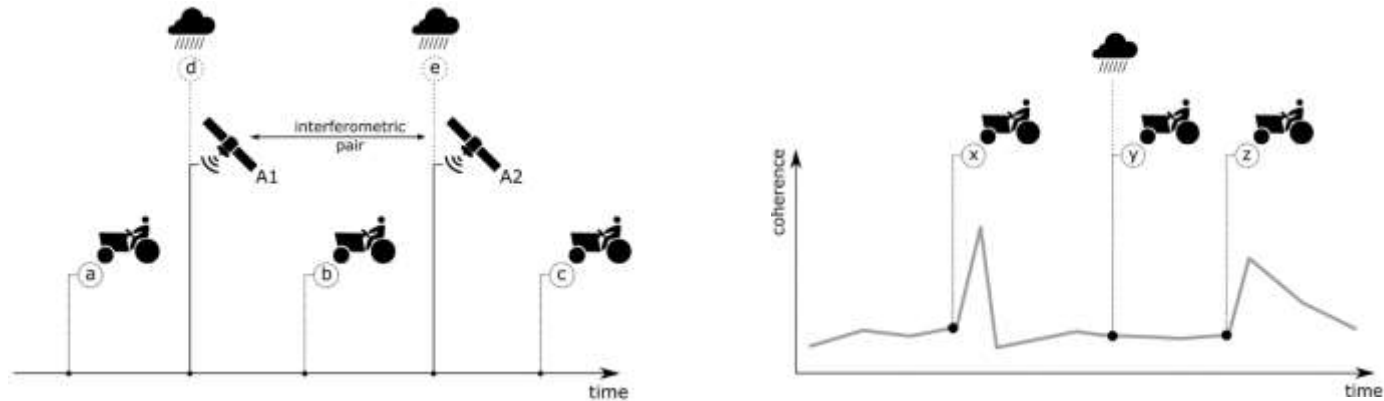
Interferometric coherence is the key parameter

- ✦ How to read the figure?
- ✦ Median with Q1 and Q3 borders.
- ✦ Grey – all data, white – precipitation filtered.





S1 InSAR coherence how does it work?





Current research - grazing

- ✦ Estimating grazing intensity from Sentinel-1 and -2 time series.
- ✦ Field surveys set up.
- ✦ Please help me! Suggest some approaches that might work?



Image source: Wikimedia 2017



List of publications from our group

- ✦ *K. Voormansik, T. Jagdhuber, A. Olesk, I. Hajnsek and K. P. Papahtanassiou, "Towards a detection of grassland cutting practices with dual polarimetric TerraSAR-X data," International Journal of Remote Sensing, vol. 34, no. 22, pp. 8081-8103, 2013.*
- ✦ *K. Voormansik, T. Jagdhuber, I. Hajnsek and K. P. Papathanassiou, "Improving Semi-natural Grassland Administration with TerraSAR-X," in Proceedings of the 17th GeoCAP Annual Conference, edited by: D. Fasbender, K. Taşdemir, Ph. Loudjani, V. Angileri, C. Lucau, P. Milenov, W. Devos, R. De Kok, S. Lemajic, A. Tarko and P. Pizziol, pp. 26-32, Tallinn, 2011.*
- ✦ *K. Zalite, O. Antropov, J. Praks, K. Voormansik and M. Noorma, "Towards detecting mowing of agricultural grasslands from multi-temporal COSMO-SkyMed data," 2014 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), pp. 5076–5079, 2014.*
- ✦ *K. Voormansik, T. Jagdhuber, K. Zalite, M. Noorma and I. Hajnsek, „Observations of Cutting Practices in Agricultural Grasslands using Polarimetric SAR“, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 2016.*
- ✦ *K. Zalite, O. Antropov, J. Praks, K. Voormansik and M. Noorma „X-band Repeat-Pass Interferometry for Monitoring of Grasslands,“ IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 2016.*
- ✦ *T. Tamm, K. Zalite, K. Voormansik and L. Talgre “Relating Sentinel-1 Interferometric Coherence to Mowing Events on Grasslands,” Remote Sensing, 2016.*



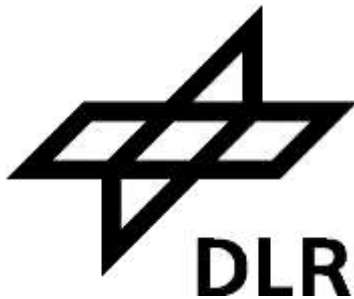
TARTU OBSERVATORY
space research centre



Thank you!



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Thank you!

Questions?

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