Towards Pan-European wet snow mapping using SAR

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Why detect wet snow

- As an alternative/companion to snow cover from optical

- SAR have no problems with cloud cover or (polar) nights

- Better spatial resolution (vs temporal coverage)

- Also in its own to determine start of melting season etc

Detecting wet snow with SAR

- We use C-band SAR to detect wet snow at 50 m resolution (currently Radarsat-2, under the Norwegian RS-2 agreement)

- Apply standard threshold of difference with reference image (Nagler&Rott, 2000), wet snow if

$$\sigma - \sigma_{ref} < -3 \text{ dB}$$

- Norut works together with NR and KSAT to integrate and operationalize the Nordic regional snow service run at KSAT

- The tools are scalable for S1 spatial resolutions

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Going Pan European

- Sentinel-1 good spatial and temporal resolution make pan European products possible

- Use Envisat ASAR WSM data to create test products

- Create reference mosaic for Europe for each track, 100 m res

- EU DEM cover most of Europe, 30 m resolution

- All scenes from two distinct four-day periods are processed and the results combined in one pan-European product.

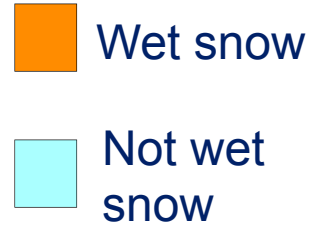- Compared to snow cover fraction from Modis and temperature data from E-OBS (EU-FP6 project ENSEMBLES)
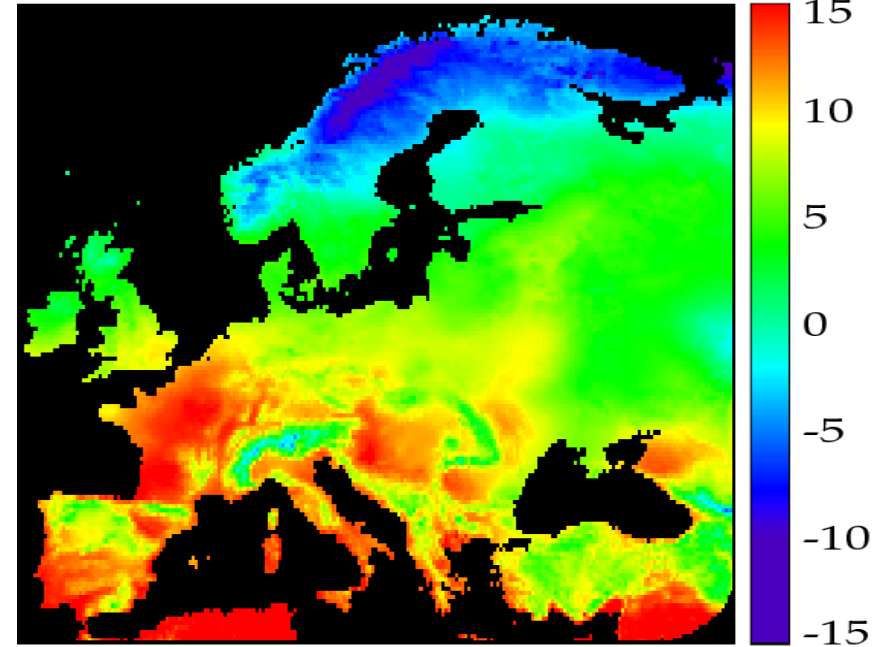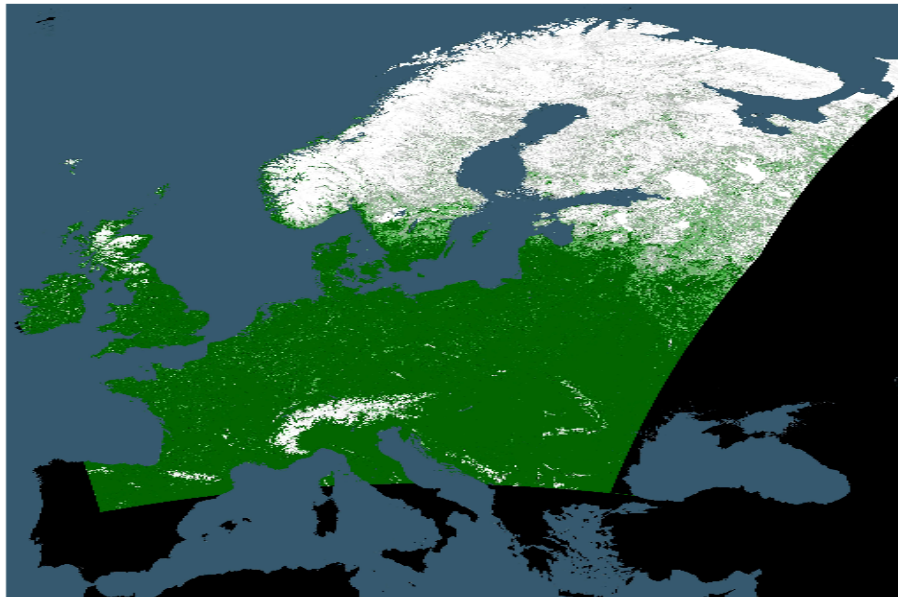
Wet snow 23rd-26th March 2010
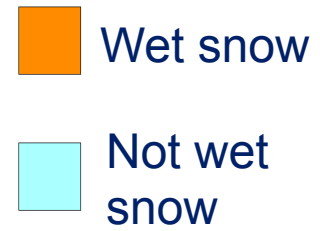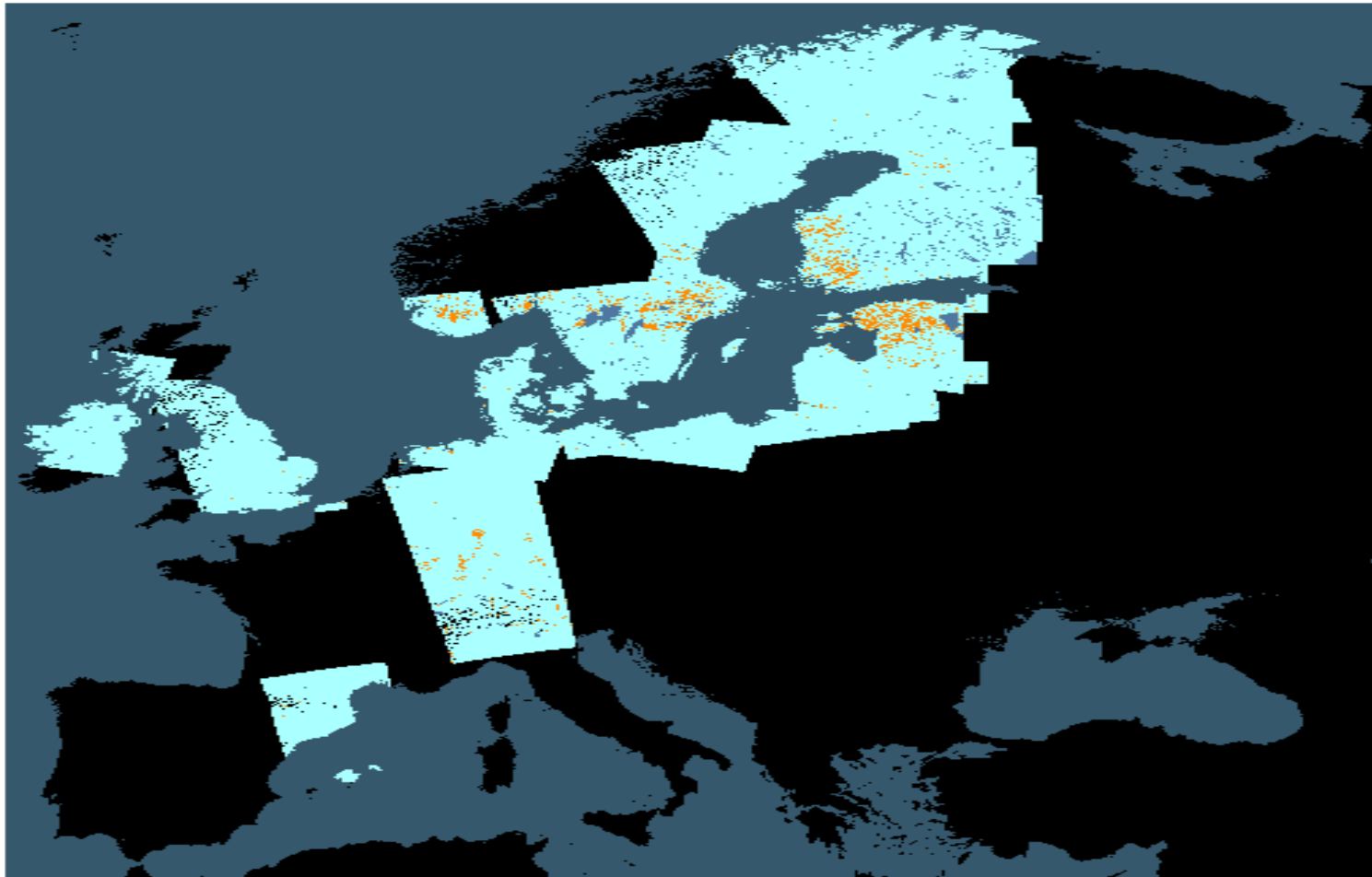
Wet snow

Not wet snow

Wet snow 23rd-26th March 2010

Wet snow 28th-31st March 2010

Wet snow

Not wet snow
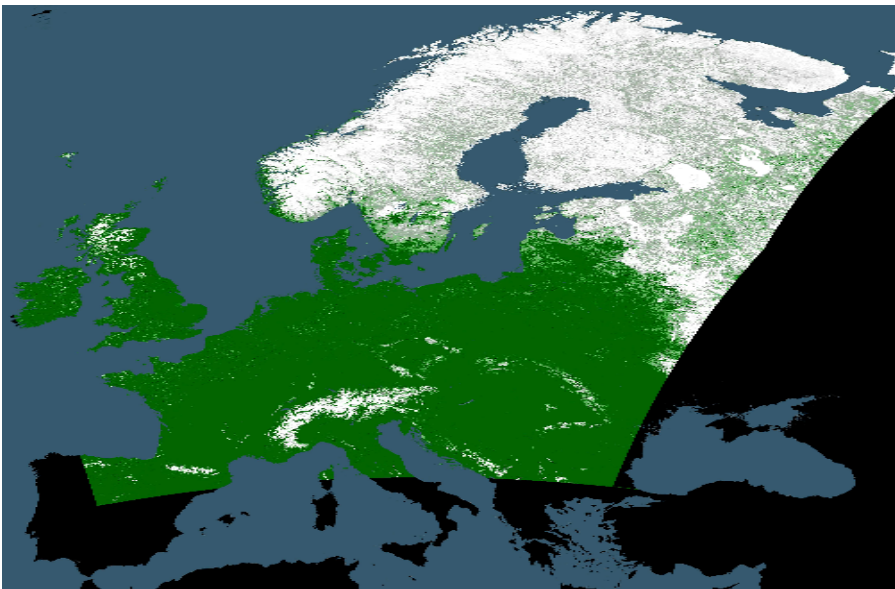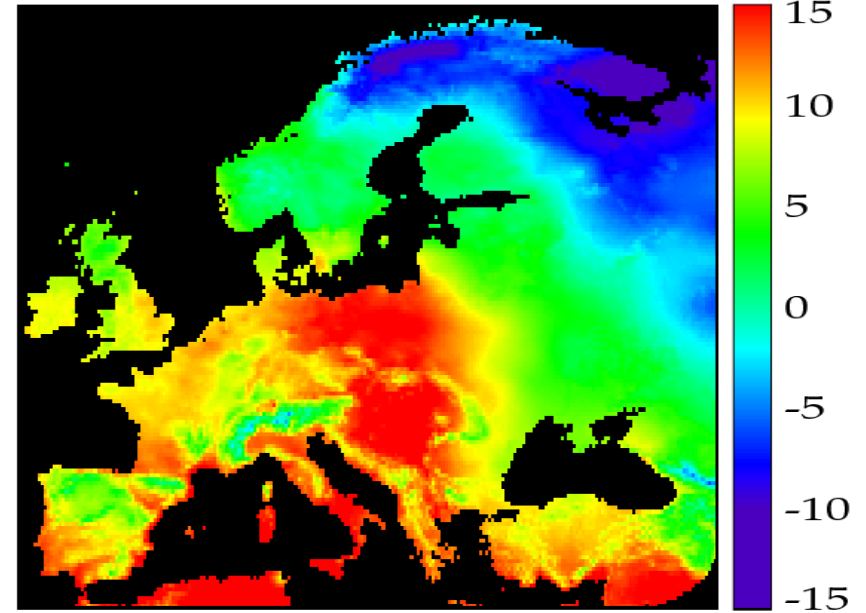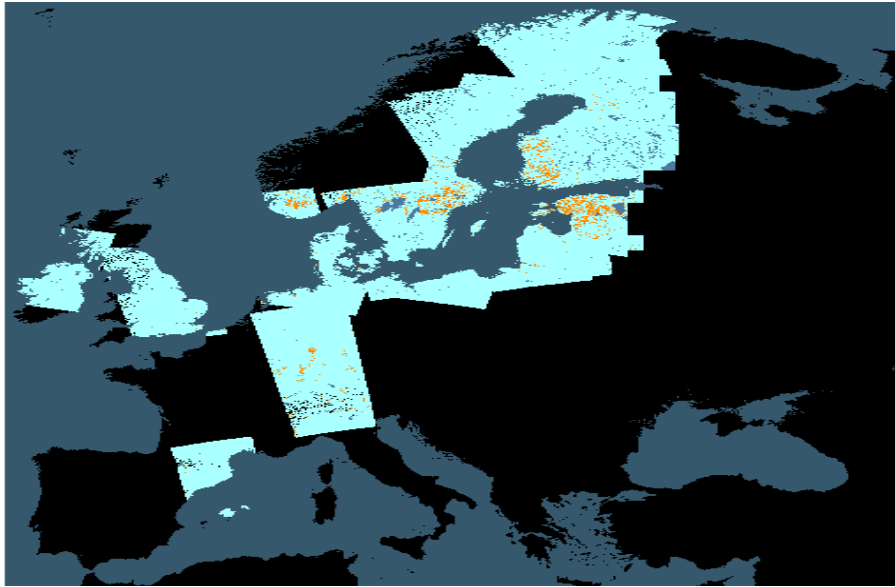
Wet snow 28th-31st March 2010

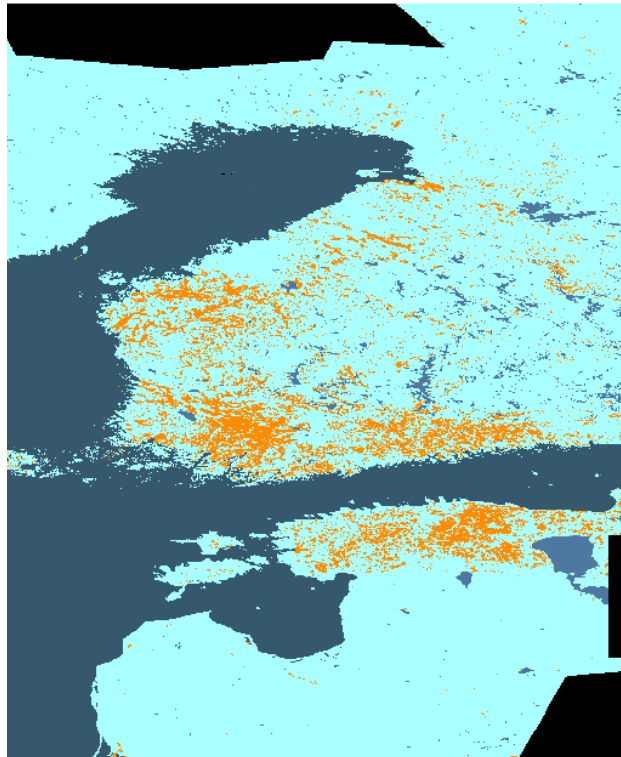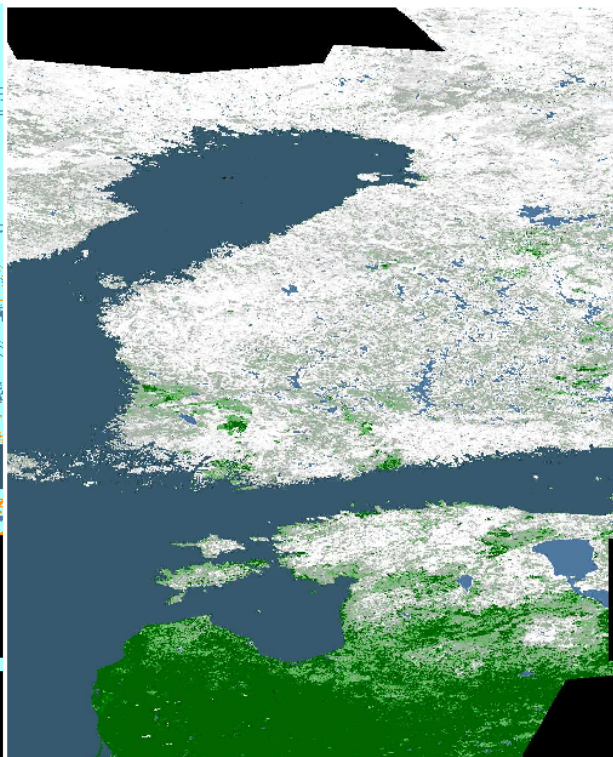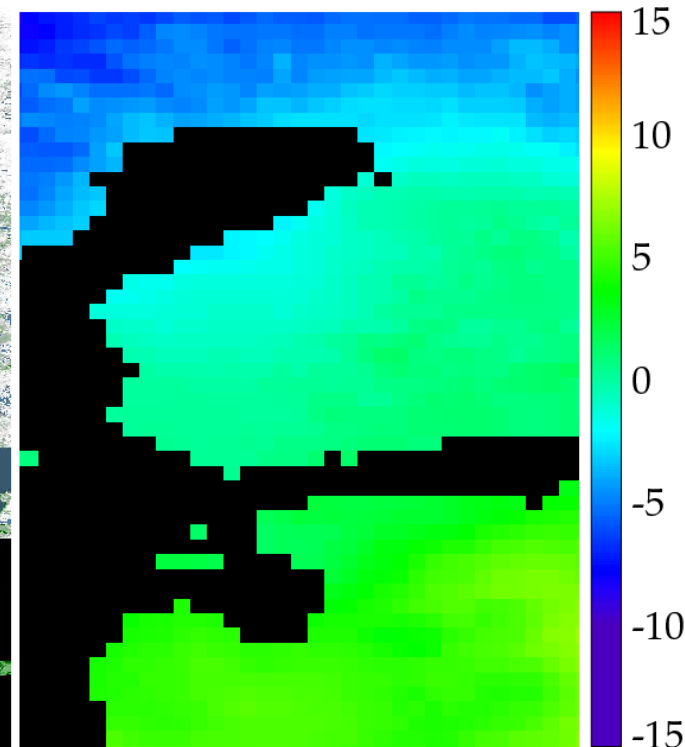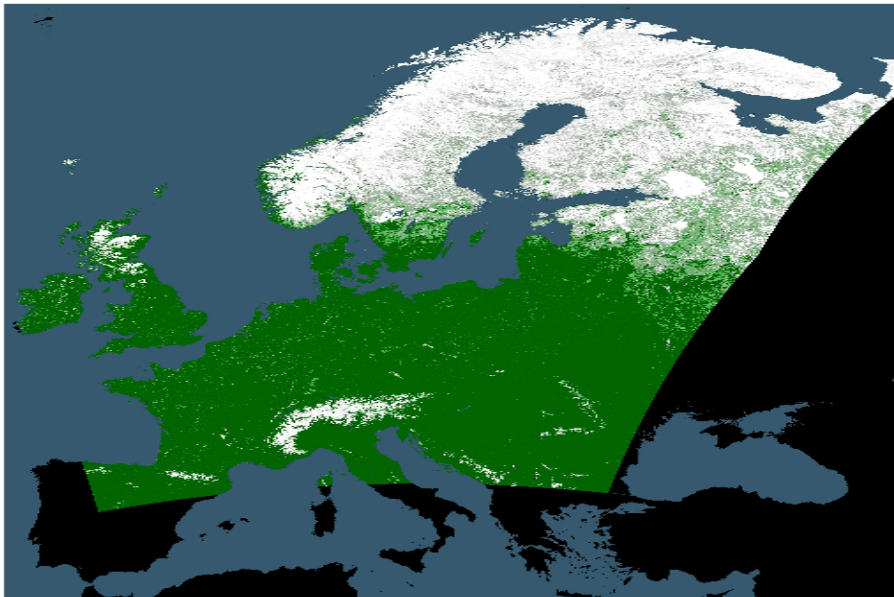# Wet snow 28th-31st March 2010
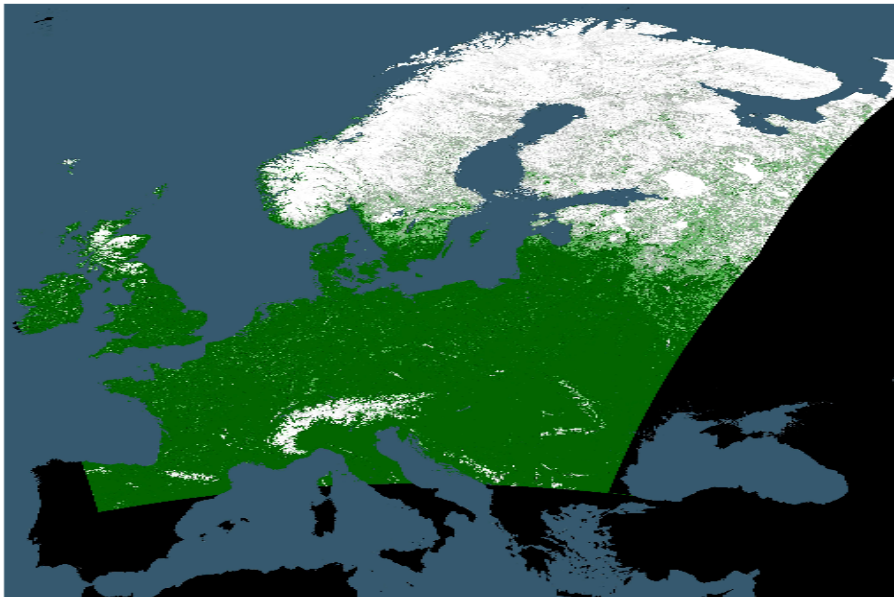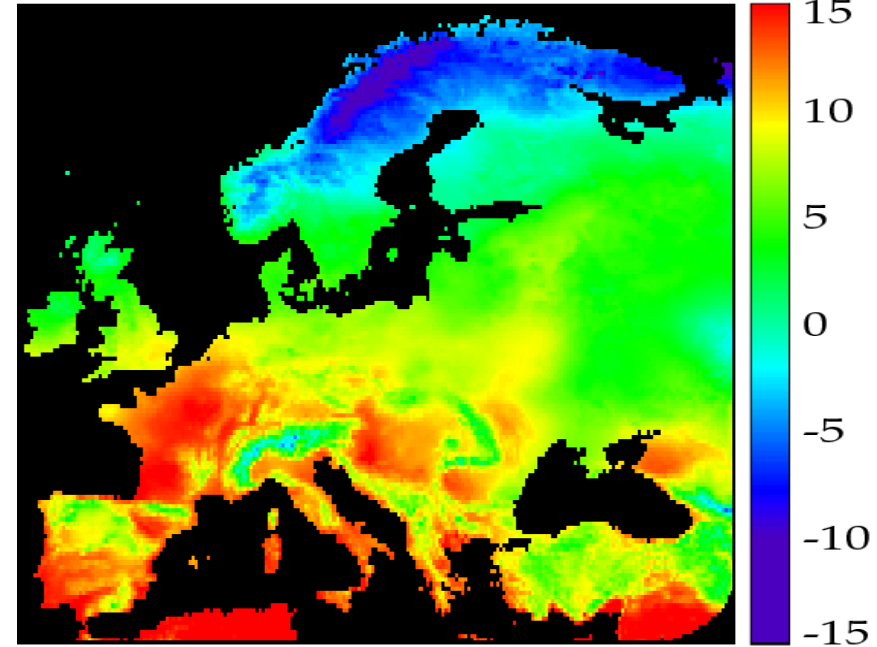
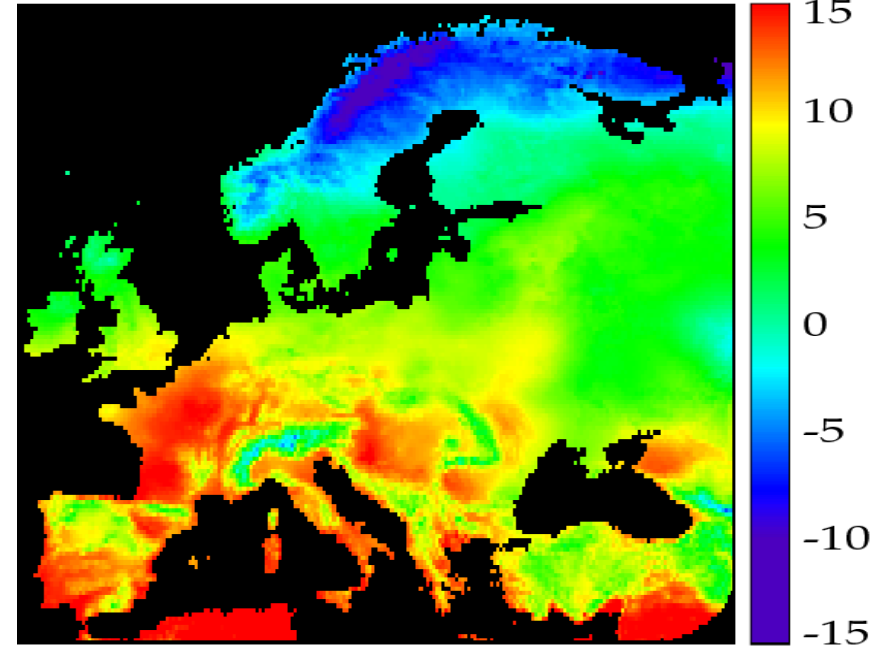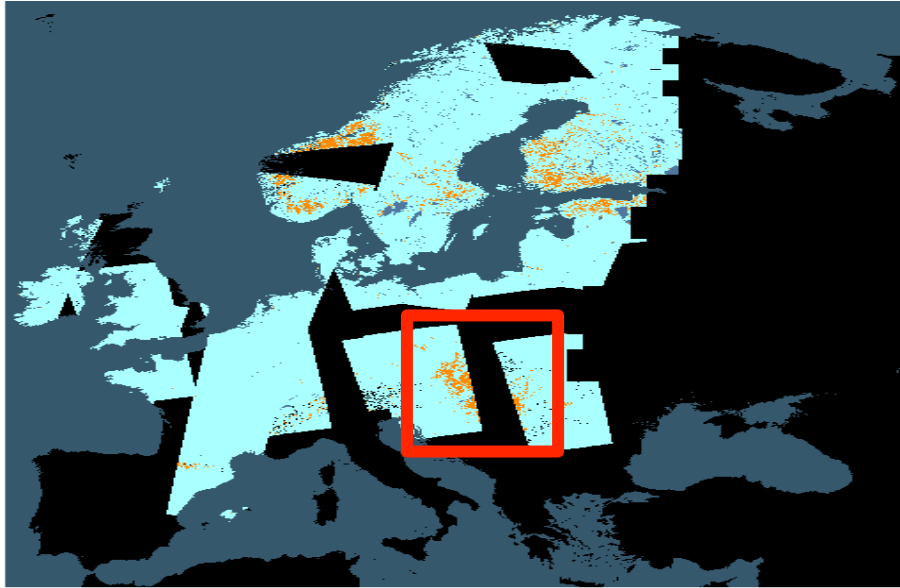# Consistent area example

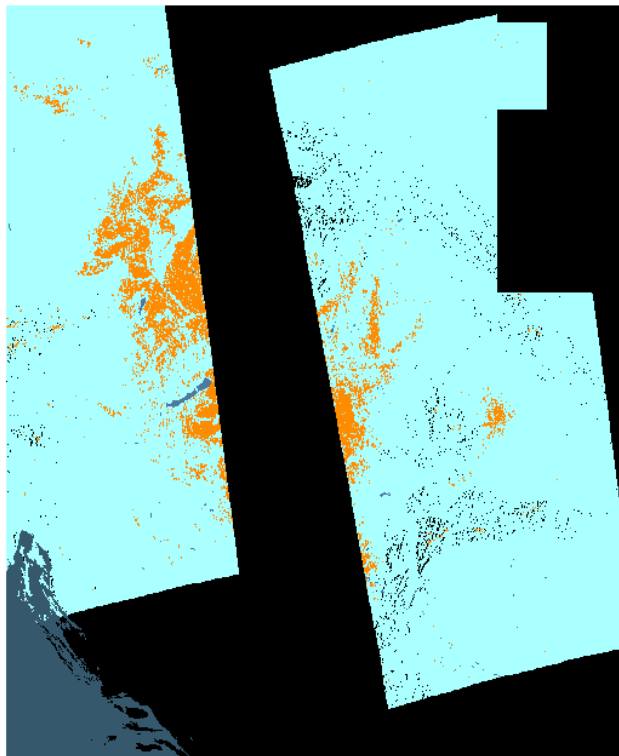

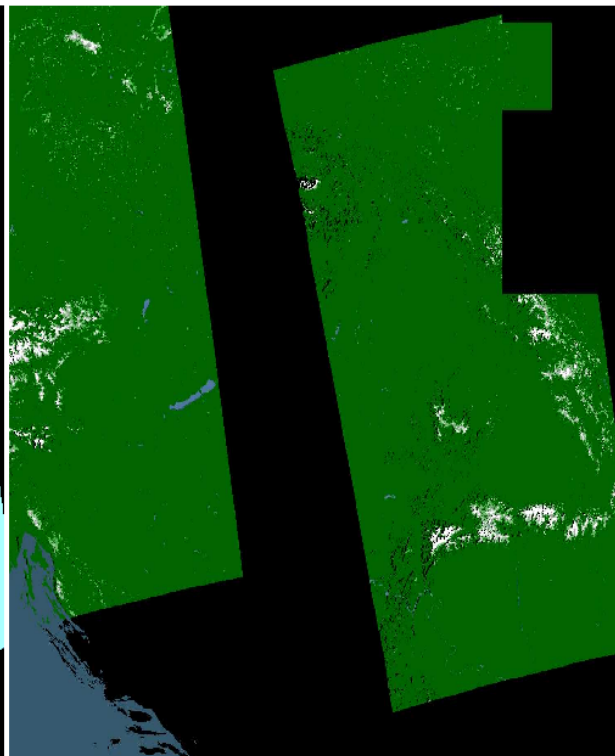Wet snow from SAR   Snow from Modis   Temperature data
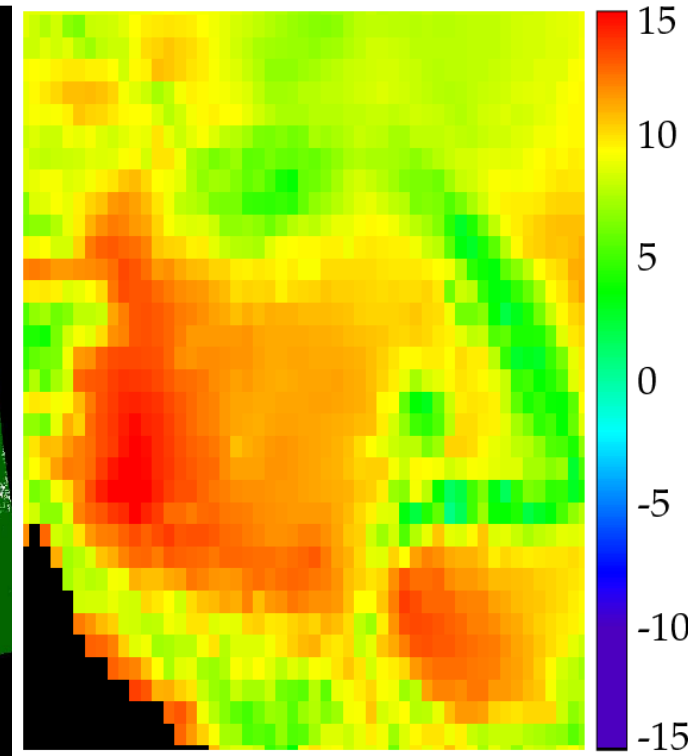
Wet snow 28th-31st March 2010

Inconsistent area example

Wet snow from SAR

Snow from Modis

Temperature data

Validation/potential of dual-pol

- Compare wet snow from dual-pol RS-2 to Landsat-8 and Spot5 scenes

- Scenes at end of may → all snow should be wet

- Three different approaches

  – Threshold copol data
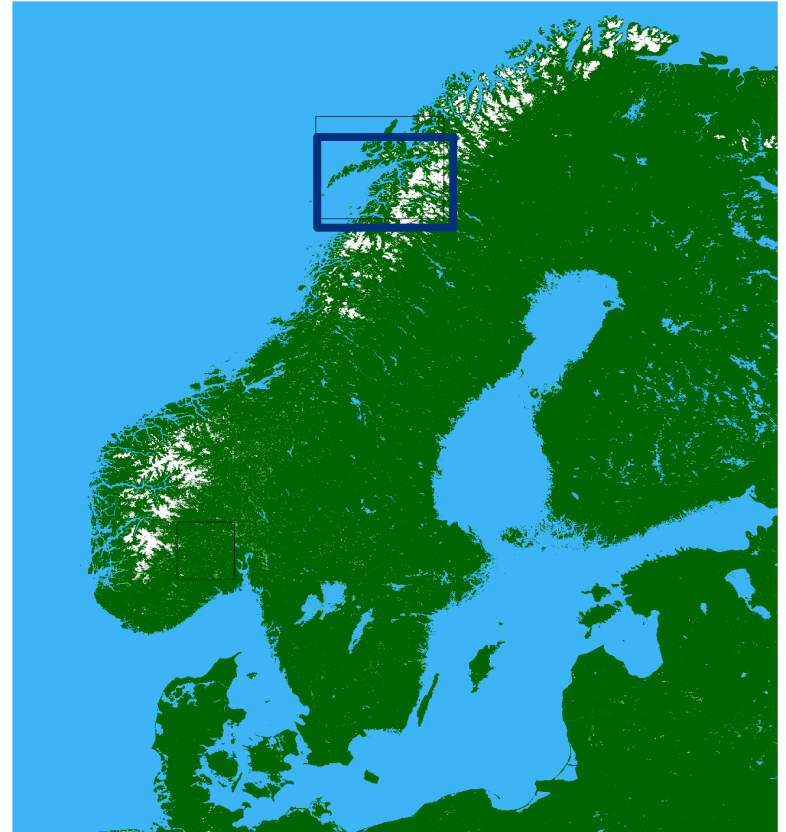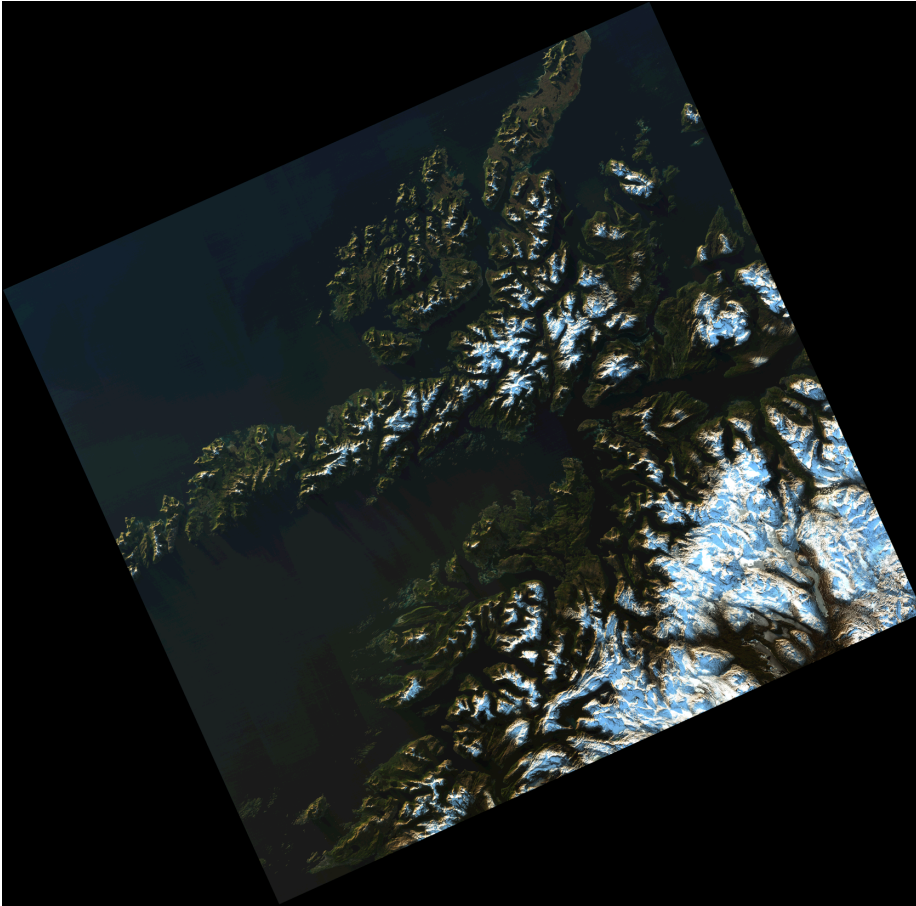
$$\sigma_{HH} - \sigma_{HH\_ref} < -3 \text{ dB}$$

  – Threshold sum of data

$$(\sigma_{HH} - \sigma_{HH\_ref}) + (\sigma_{HV} - \sigma_{HV\_ref}) < -3 \text{ dB}$$
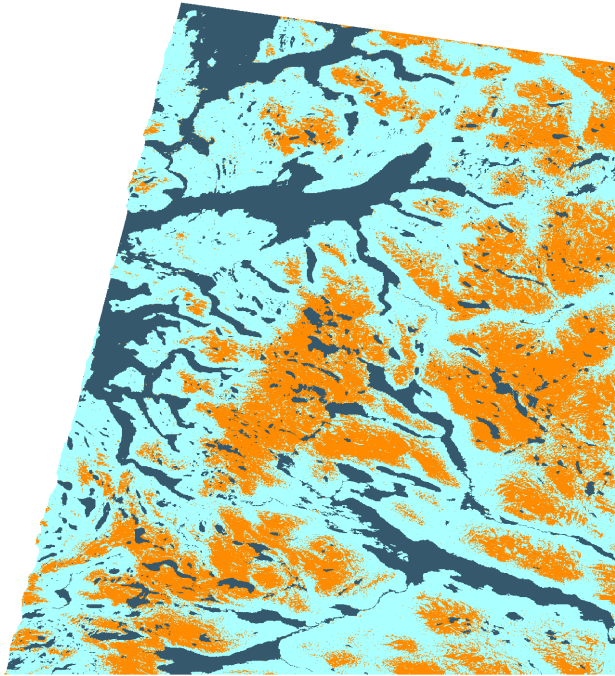
  – Threshold both and combine

$$\sigma_{HH} - \sigma_{HH\_ref} < -3 \text{ dB OR } \sigma_{HV} - \sigma_{HV\_ref} < -3 \text{ dB}$$
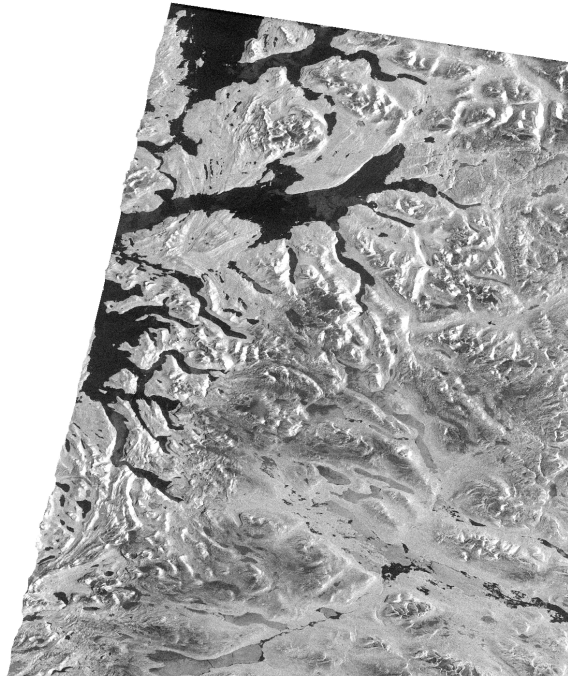
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Landsat-8 scene Lofoten May 29ᵗʰ 2013

Wet snow detection May 29th 2013

Wet snow
(either co or cr)

Copol HH data

Crosspol HV data

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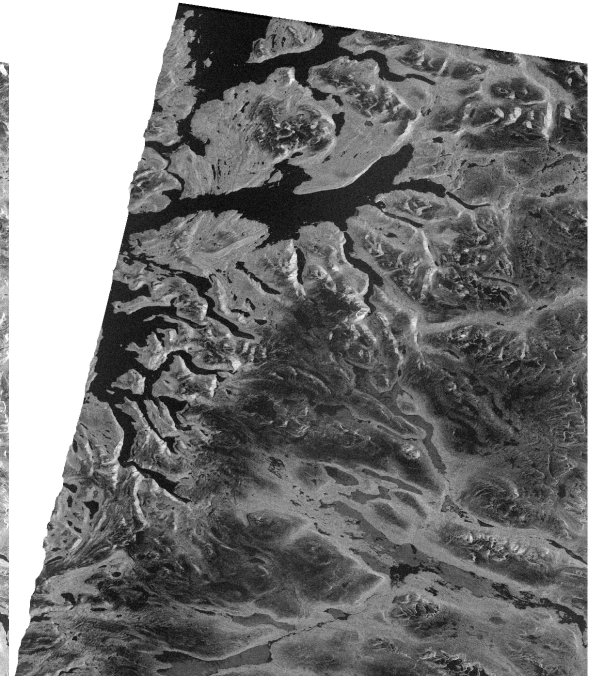
Comparison LS8 vs RS-2
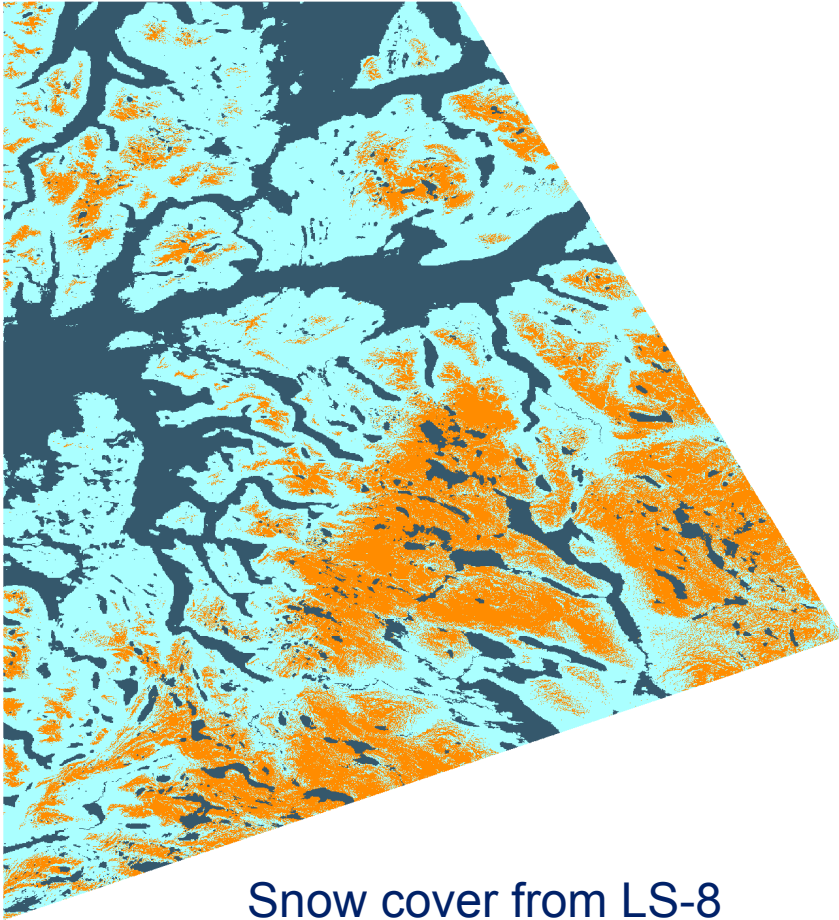
Snow cover from LS-8

Wet snow from RS-2

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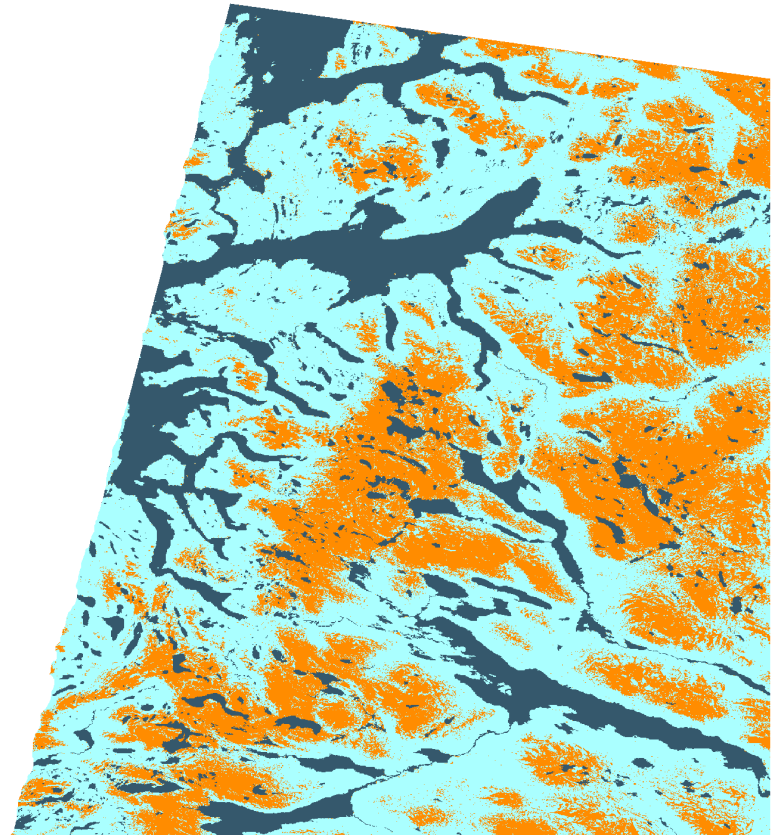
Error images LS8 vs RS-2

Threshold sum

Either one below

Optical snow, not sar

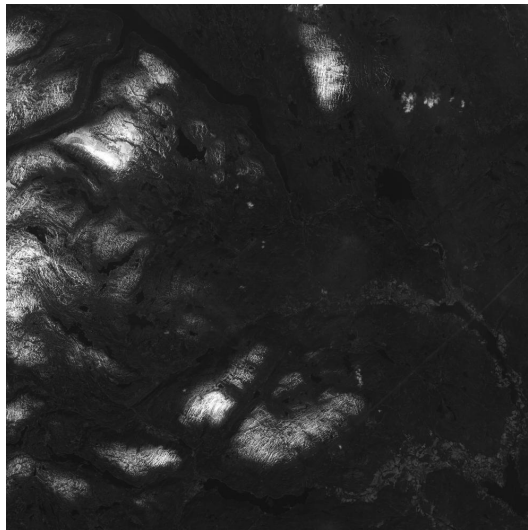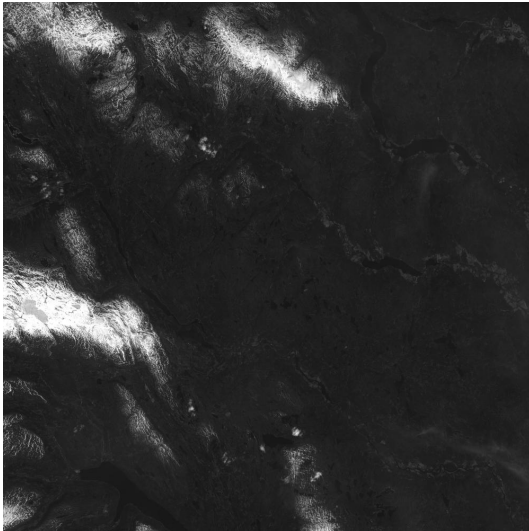Optical not snow, sar snow

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Comparison LS8 vs RS2
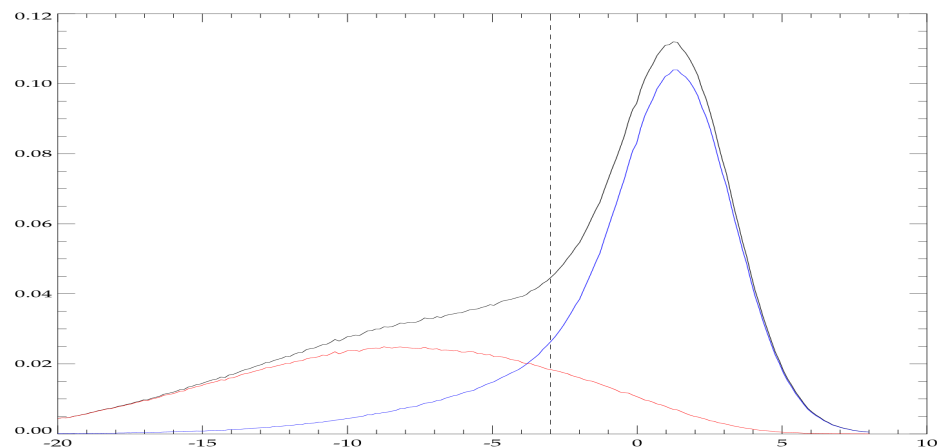
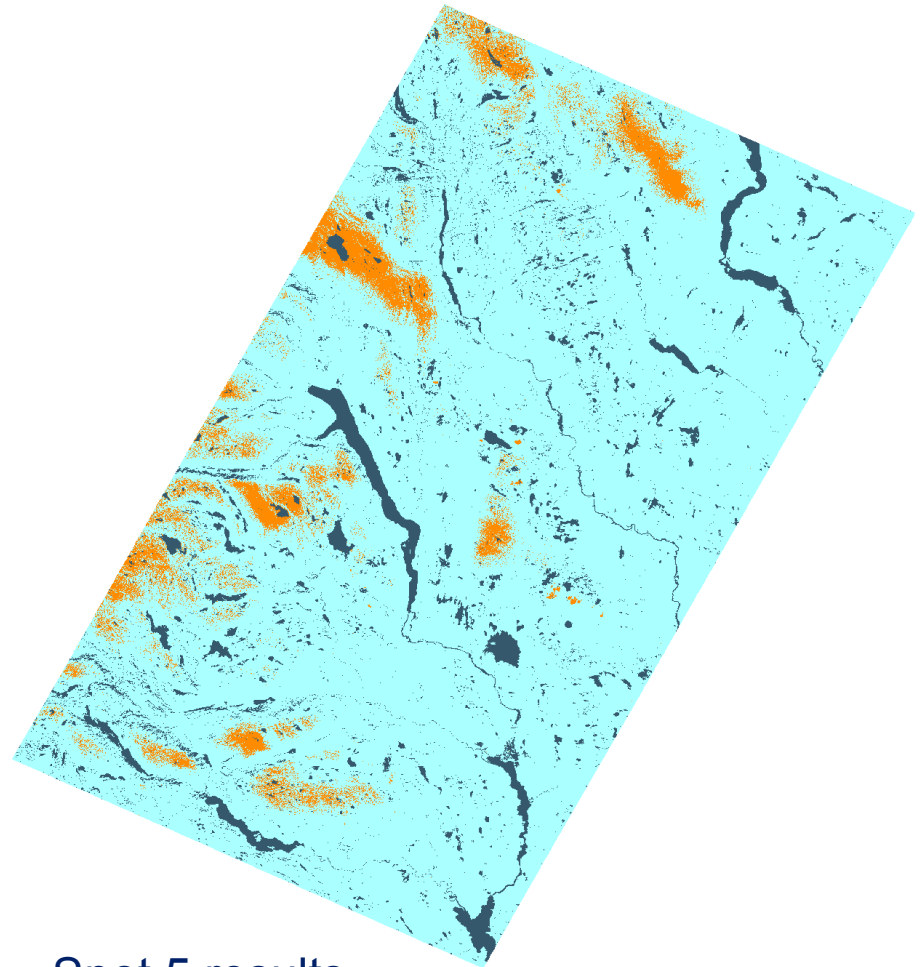| LS8 vs RS2, % of all pixels	Both snow	Both not snow	Optical snow/ SAR not	Optical bare/ Sar snow	Total error
HH < T	25.5	57.7	11.3	5.5	16.8
HH + HV < T	30.2	53.8	6.6	9.4	16.0
HH < T or HV < T	27.3	56.6	9.5	6.6	16.1

Spot 5 scenes May 24th 2012

Wet snow detection May 24th 2012
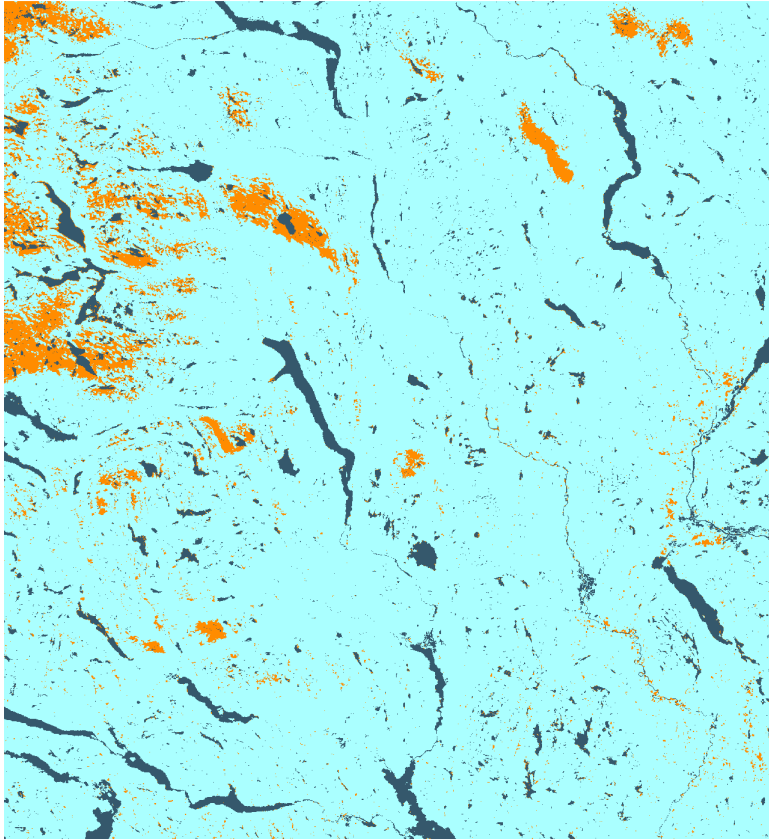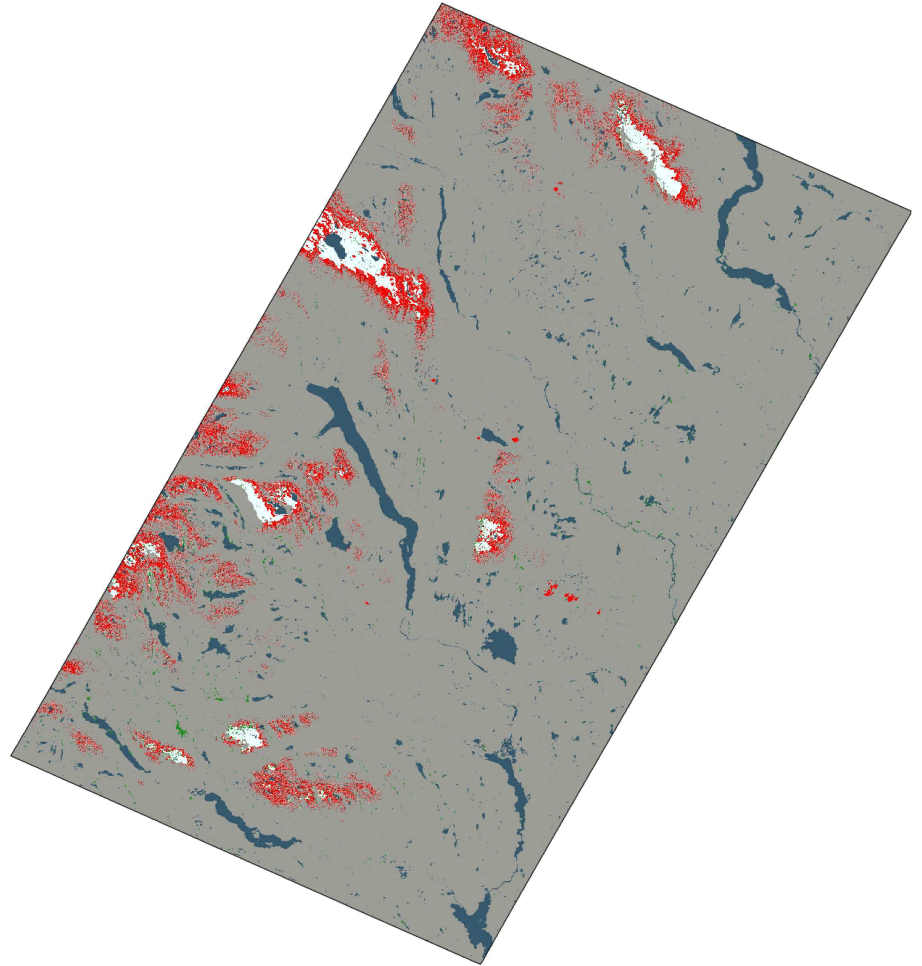

Wet snow
(either co or cr)

Spot 5 results

Wet snow detection May 24th 2012

Small error of about 5%, but only about 6 % snow covered.

Misses most of the snow pixels in sar.

Error image

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Conclusion

- Pan European wet snow maps from S1 data can be produces as soon as we have accumulated reference data

- Results are mostly consistent with MODIS, however there are some erroneous results

- Initial results indicate dual-pol can increase the accuracy of wet snow detection, but not certain how significant

- Validation efforts show there are differences between optical and SAR products

Thank you for your attention!

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