



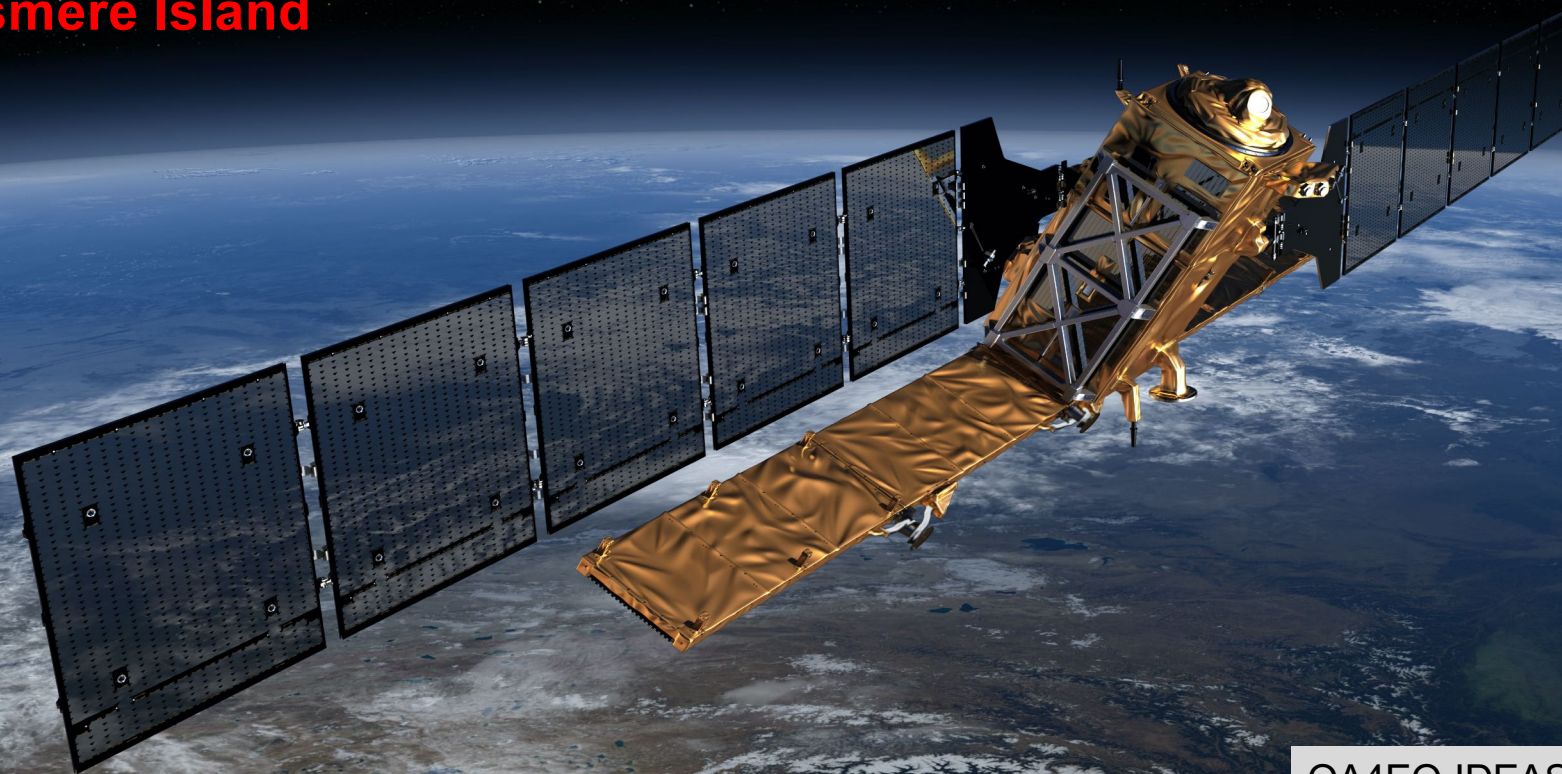
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Support to CEOS CARD4L for SAR and snow mapping over Alps and Ellesmere Island



David Small (UZH)

QA4EO-IDEAS Cal/Val Workshop #2
Dec. 2, 2020



SAR terrain corrections

- Geometric Terrain Correction (**GTC**)
 - Range-Doppler *Orthorectified Backscatter*
- Radiometric Terrain Correction (**RTC**)
 - *Terrain Flattened Backscatter* – Small, “Flattening Gamma: Radiometric Terrain Correction for SAR Imagery”, TGRS, Aug. 2011
- Wide area backscatter *composites* from Local Resolution Weighting (**LRW**)
 - Small et al., “Wide-area Analysis Ready Radar Backscatter Composites”, in review.



CEOS CARD4L Goals

Dense time-series analyses at national-global scales

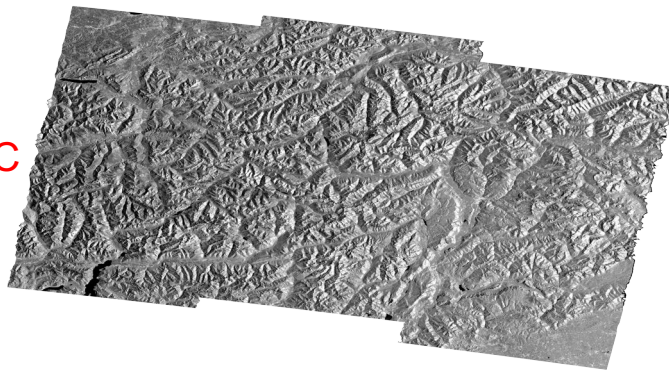
Broaden user community

- Provide data products that do not require expert knowledge
- Move from radar geometry (slant & ground range) to map coordinates

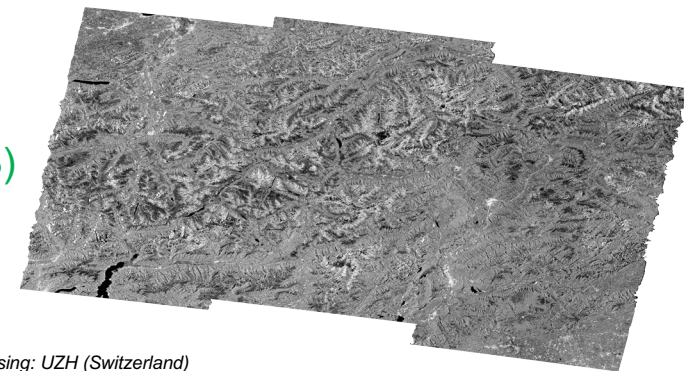
Radiometric Terrain Correction

- A level playing field for multi-sensor data integration
- Backscatter normalised using **local scattering area**, not incident angle

GTC



RTC
(NRB)



Contains modified
Copernicus
Sentinel data
(2016)



Terrain-flattened Gamma Nought

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Interlaken, Switzerland
Sentinel-1A IW GRDH VH-pol.
May 26, 2015

Terrain-flattening: Small D. *Flattening Gamma: Radiometric Terrain Correction for SAR Imagery*, IEEE Trans. on Geoscience & Remote Sensing, 49(8), Aug. 2011, pp. 3081-3093.

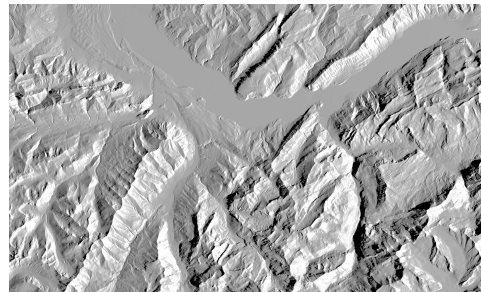
Normalise β^0 : divide by simulated image



β^0

GTC

-26dB -1dB



A_γ/A_β



γ_T^0

=


RTC

$$\gamma_T^0 = \beta^0 \cdot \frac{A_\beta}{A_\gamma}$$



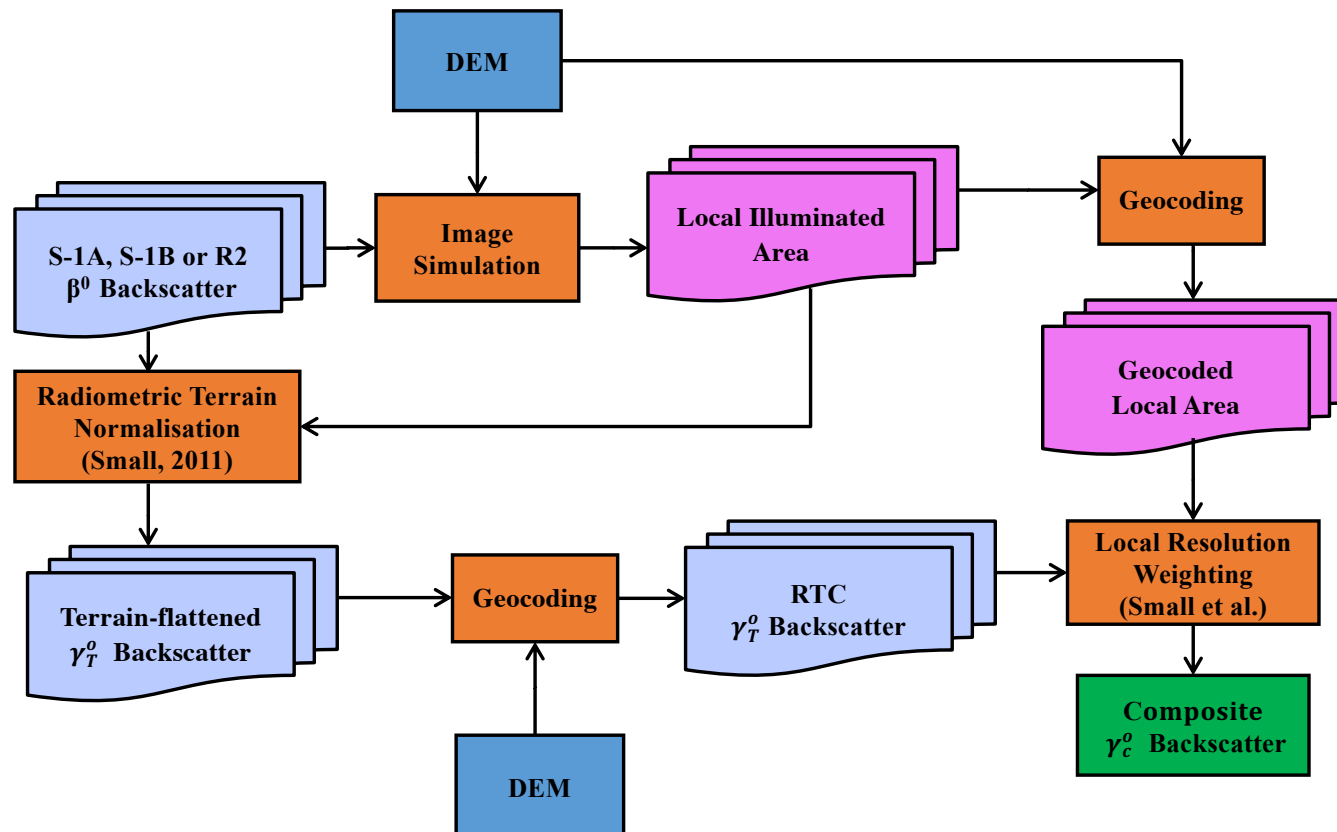
CEOS CARD4L

- Analysis Ready Data for Land Processes
 - See: ceos.org/ard
 - Define standards for ARD backscatter products
 - Coordination by Ake Rosenqvist of soloEO, Japan
 - RTC (L1): Terrain-flattening: **Normalised Radar Backscatter (CARD4L *NRB*)**
 - *NRB Product Family Specification revised in multiple iterations*
 - *Late-night collaborations with participants from Japan, USA, Canada, Australia, ...*
 - *v5.0 approved by CEOS Land Surface Imaging - Virtual Constellations (LSI-VC) virtual meeting in May 2020*
 - Further products: **polarimetric, interferometric, geocoded SLC**: reviews ongoing
 - All further products to date include NRB terrain flattening
 - LRW (L3): Wide-area **Analysis Ready Data**
 - *Multi-Source Backscatter (MSB)*
 - *Initial draft of Product Family Specification being drafted*

| | | |
|---|--|---|
|  | Analysis Ready Data For Land (CARD4L) | Product Family Specification: Normalised Radar Backscatter |
|---|--|---|

Document Status

For Adoption as: **Product Family Specification, Normalised Radar Backscatter**



Small et al.,
“Wide-area Analysis Ready
Radar Backscatter Composites”
In Review.



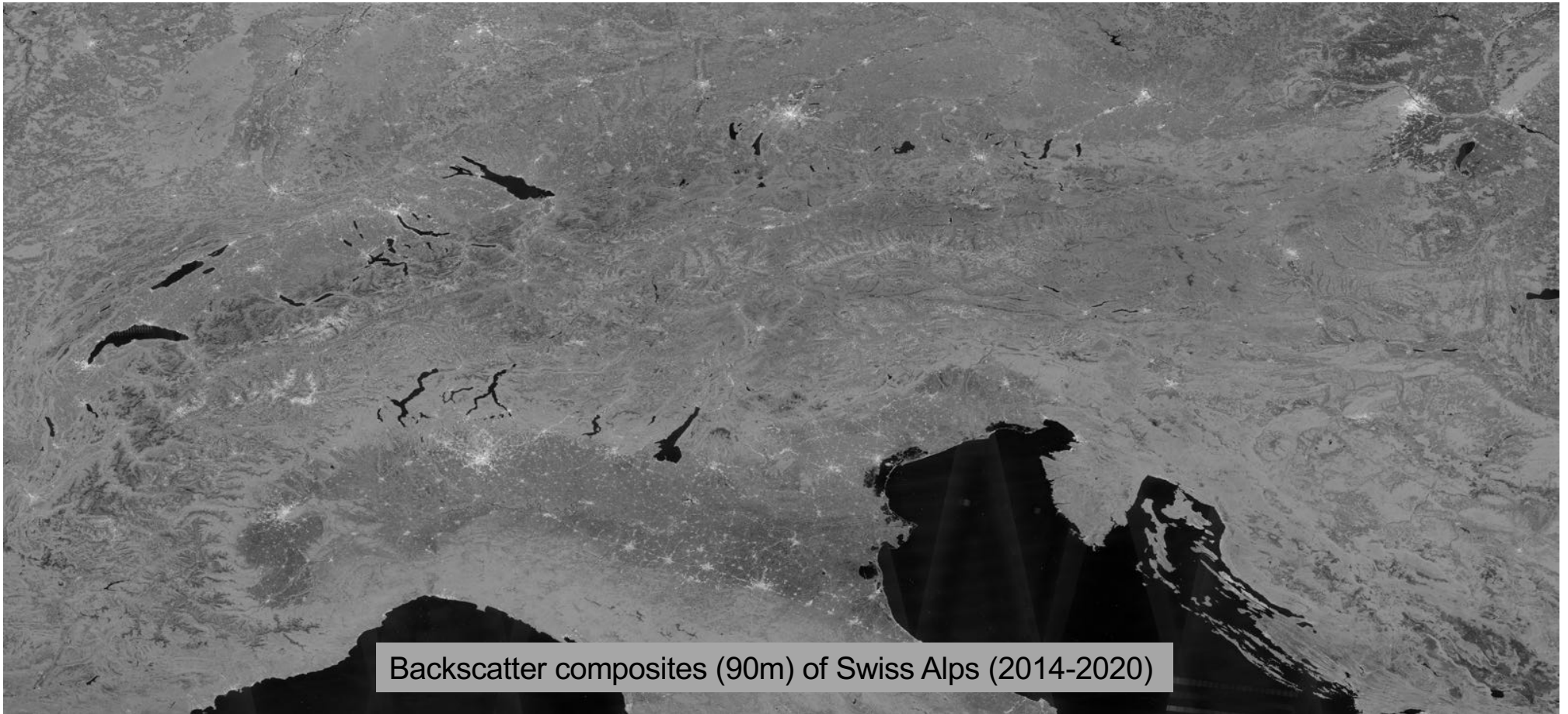
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Sentinel-1 Alpine Backscatter Time-Series

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S-1A + S-1B IW VH-pol. **Apr. – Aug. 2020**: 12 day windows





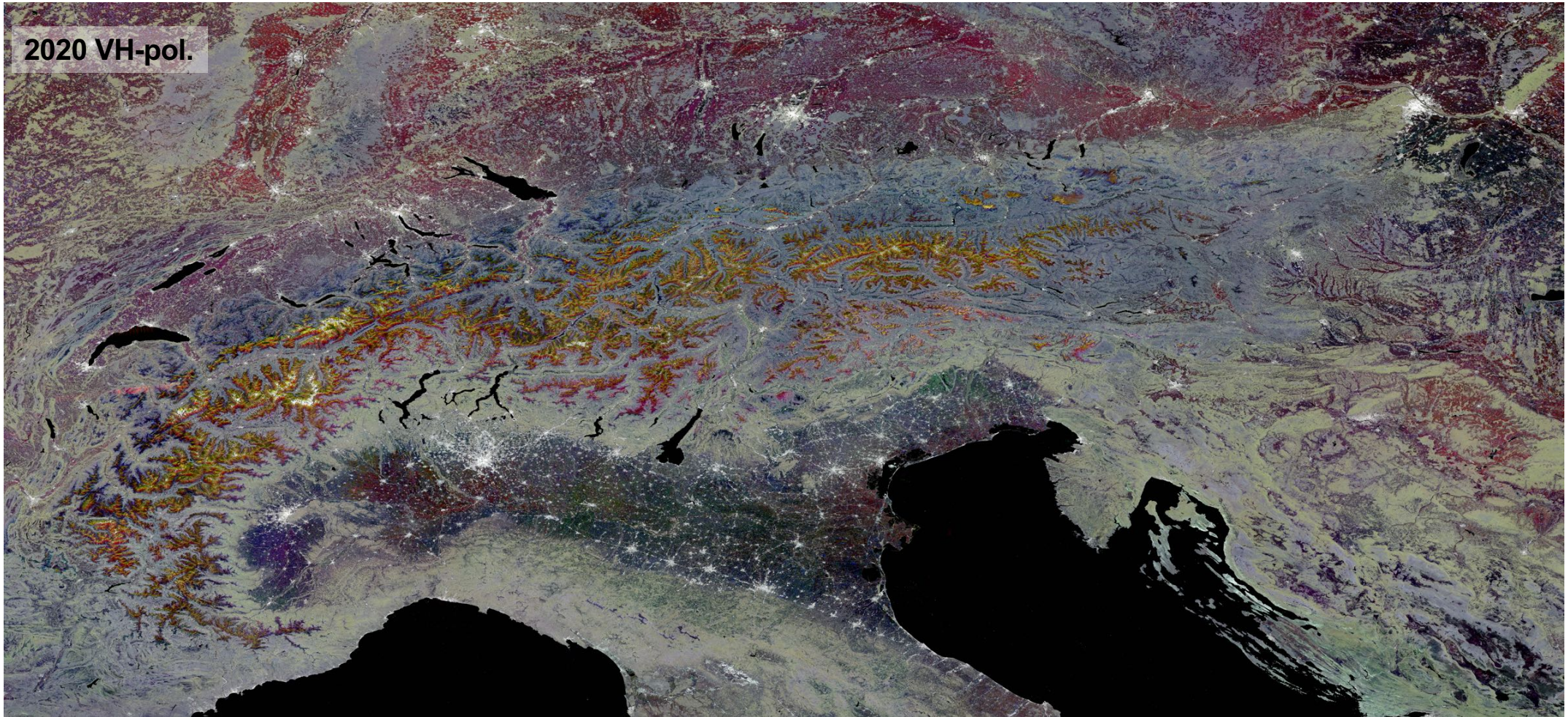
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Copernicus
Sentinel data (2020)

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Sentinel-1 IW Backscatter Composites 2020 **VH**: Feb 6-17, Mar 31-Apr 11, Apr 30-May 11; -21dB (black) to -6dB (white)





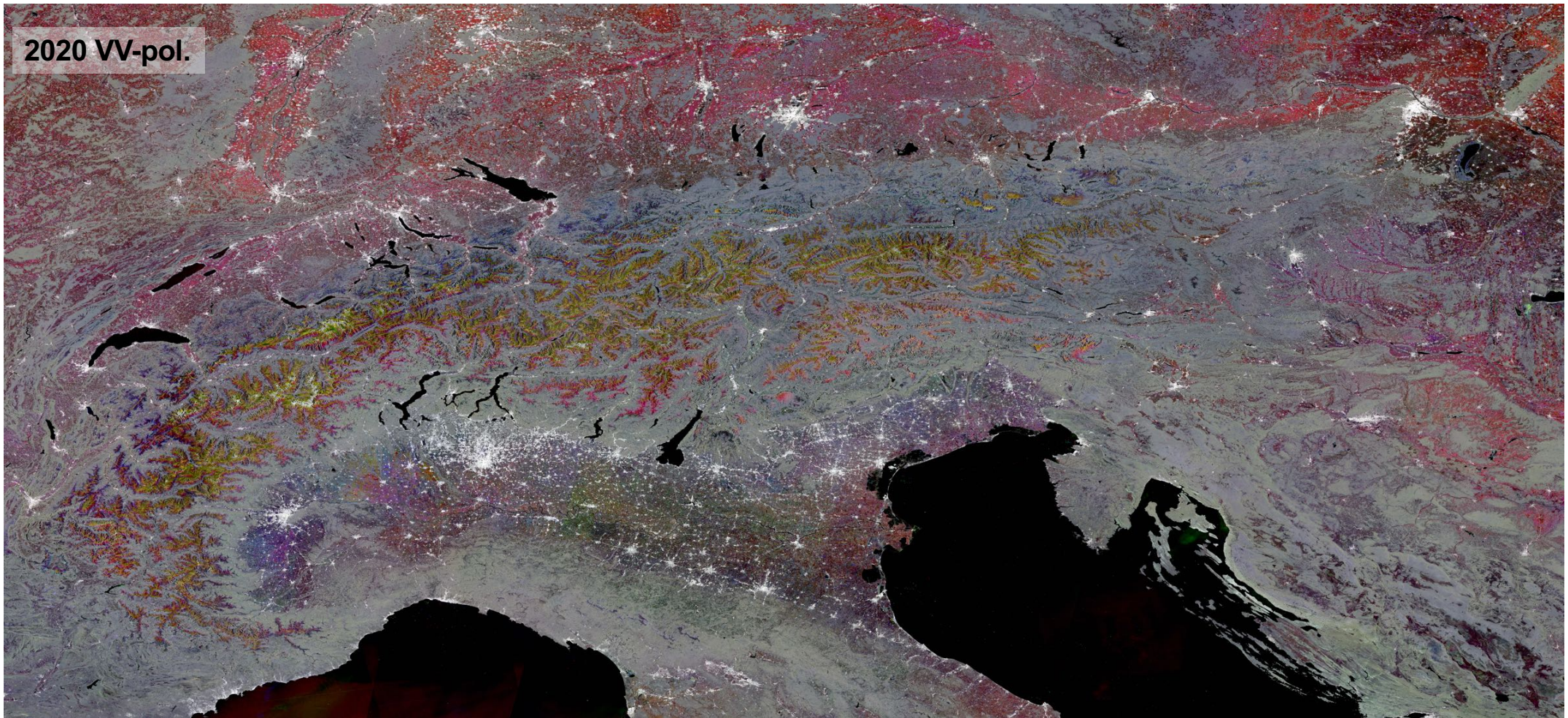
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Sentinel data (2020)

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Sentinel-1 IW Backscatter Composites 2020 VV: Feb 6-17, Mar 31-Apr 11, Apr 30-May 11; -15dB (black) to 0dB (white)



Ellesmere Island Backscatter Composites

S-1A+S-1B
EW+IW HV

+RS2 SCWA

1 day delta
1 day window

N.B. CDEM

May – Aug. 2019

Contains modified
Copernicus Sentinel data (2019)

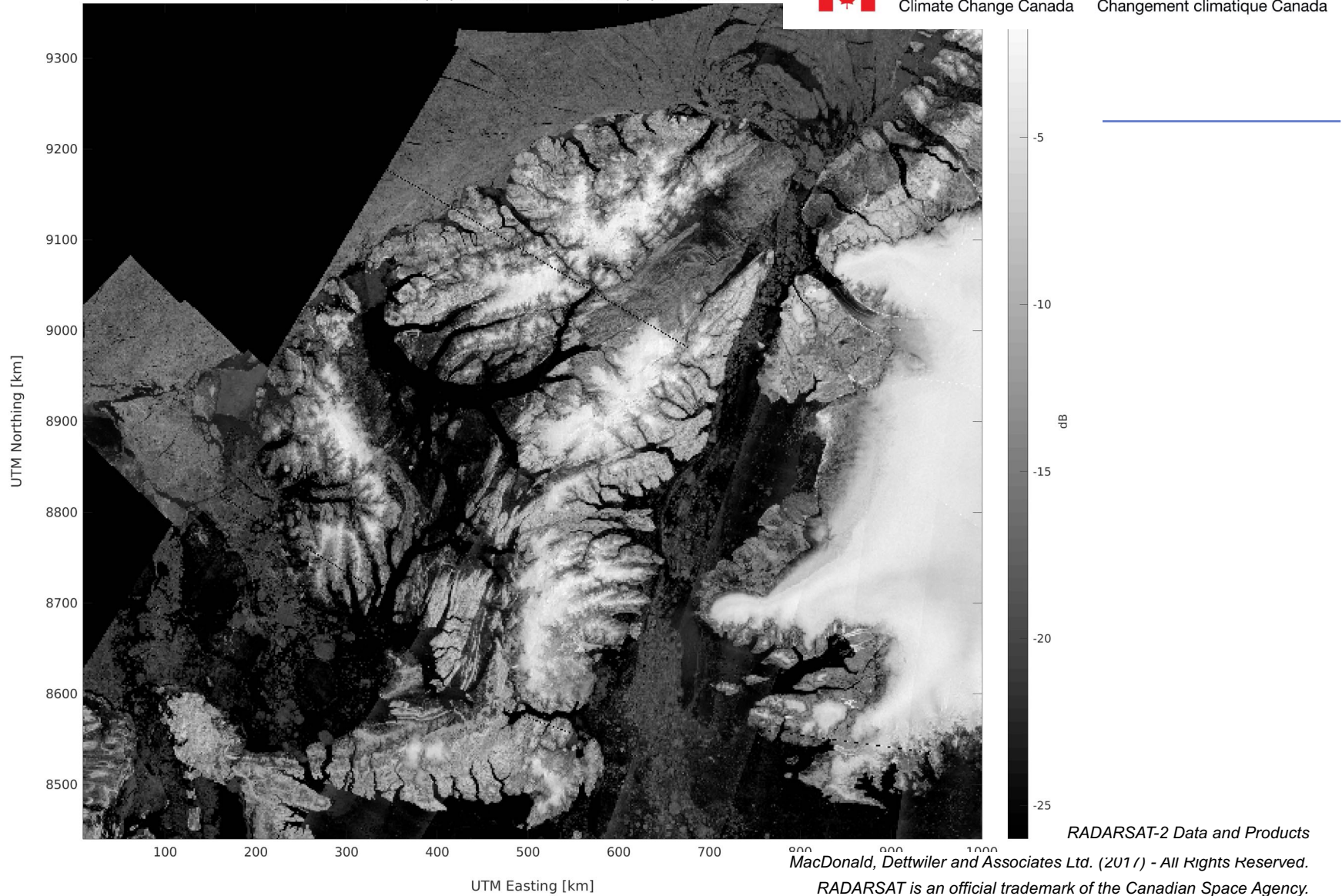


Composite backscatter from 14 scenes
between 2019/05/01 00:00:00 and 2019/05/01 23:59:59



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Progress with Ellesmere Island Data

- Level 3 2019 Composites for S1AB+RS2 generated and delivered to ECCC
- 2020 Sentinel-1A, Sentinel-1B:
 - Level 1 2020 RTC products generated Jan. – Nov.
 - Level 3 2020 Composite backscatter generated for Jan. – Oct.
- Cooperation with ECCC and Carlton University on analysis of 2018 data
- Initial **RCM** datasets downloaded
 - RCM data policy still a work in progress
 - Currently, also low resolution (50m) ScanSAR images that intersect Canadian coastline (e.g. Ellesmere Island) are not accessible outside of Canada
 - No “deep” backscatter history currently accessible
 - Considering switch to different site for tests with RCM



QA4EO

- Paper describing backscatter composite methodology (IDEAS+ support acknowledged) in review, close to publication
- Presentations on radar composites given at:
 - U Alaska remote lecture, Feb. 25, 2020
 - EGU Town Hall, May 7, 2020
 - CEOS SAR Workshop, Oct. 6, 2020
 - ESA EO4Polar, Oct. 29, 2020
 - ARD Zone, Nov. 3, 2020
 - ESA Ad hoc Expert Group on Sentinel-1 Next Generation, Nov. 2020
- Expert advice in response to inquiries to CEOS/CARD4L on NRB production in practice

Recommended next steps:

- Finalize publication of methodology paper
- Prepare draft of CARD4L Multi-Source Backscatter (MSB) specification for expert review
- Test and validate thermal noise removal based on SLC and GRDH S1 products
- Investigate mitigation of RFI presence. Integration of L3 Test Data Set within PDGS data cube?
- Build and test processing interface with existing small set of RCM data products
 - Possibly adopt new test site for S1/RCM combination to fit with CDN data policy



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Copernicus
Sentinel data (2017)

Acknowledgments

Thanks for support from:

- WMO Polar Space Task Group for coordinating collaboration
- ESA/Copernicus <http://scihub.esa.int> for Sentinel-1 data
- Environment & Climate Change Canada (ECCC) & MDA for RS2 data