Landsat Ice Classification for the Baltic Sea: Development of a near real time service using neural networks

Stefan Kowalewski*[1], Egbert Schwarz,[1]

[1]German Aerospace Center (DLR), German Remote Sensing Data Center | National Ground Segment | Maritime Safety and Security Lab
*Stefan.Kowalewski@dlr.de

Deep Neural Network trained on Stage of Development (SOD) ice charts from German Ice Service (BSH)

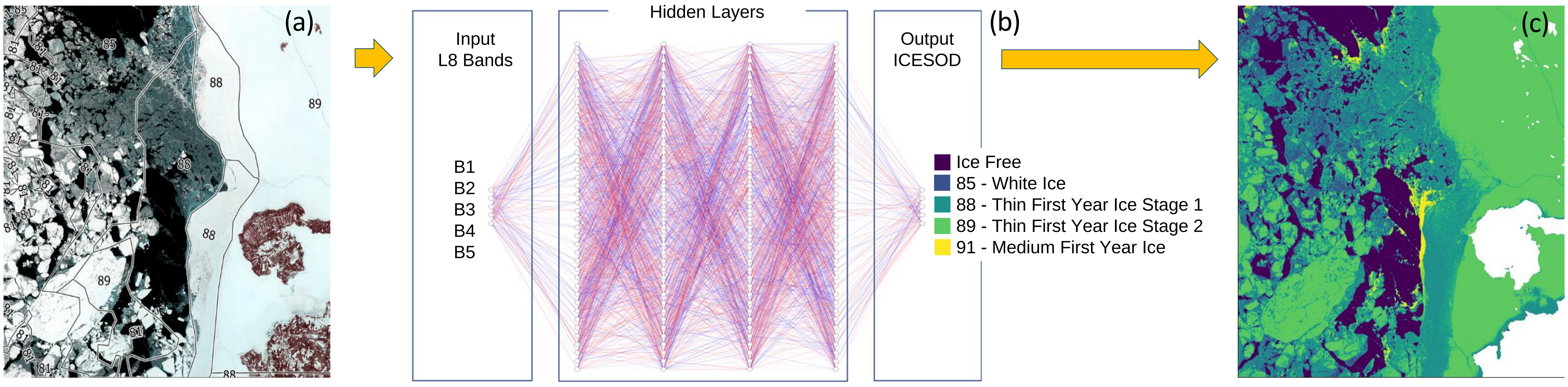

Fig.1: (a) Landsat 8 imagery (Island of Hailuoto, FI) 22-03-2019 with BSH ICESOD labels from 21-03-2019, (b) schematic visualization of Deep Neural Network, (c) predicted ICESOD

Motivation

BSH ice charts provide a **rich data source for model training.** First results from a trained **Deep Neural Network (DNN),** which uses Landsat 8 optical bands, show a promising near real time ice classification performance[R1].

Current challenges:

- Hand drawn BSH ice charts are not intended for **high resolution classification labeling**
- **Cloud- and Snow cover:** Source of misclassification and limiting the training data set
- **Imbalanced training** due to underrepresented ice classes

In addition to these challenges, the **DNN** architecture is limited to a **pixel-by-pixel based prediction**. Hence, any spatial autocorrelation within an ice class feature is ignored by this approach.

In contrast, **convolutional neural networks (CNN)** are sensitive to **spatial features**. The U-Net architecture (Fig.2) has become a highly popular semantic segmentation tool[R2].

It is currently under development for sea ice classification in our lab and will be tested against the DNN.

Development and integration of a U-NET Convolutional Neural Network for Sea Ice Classification

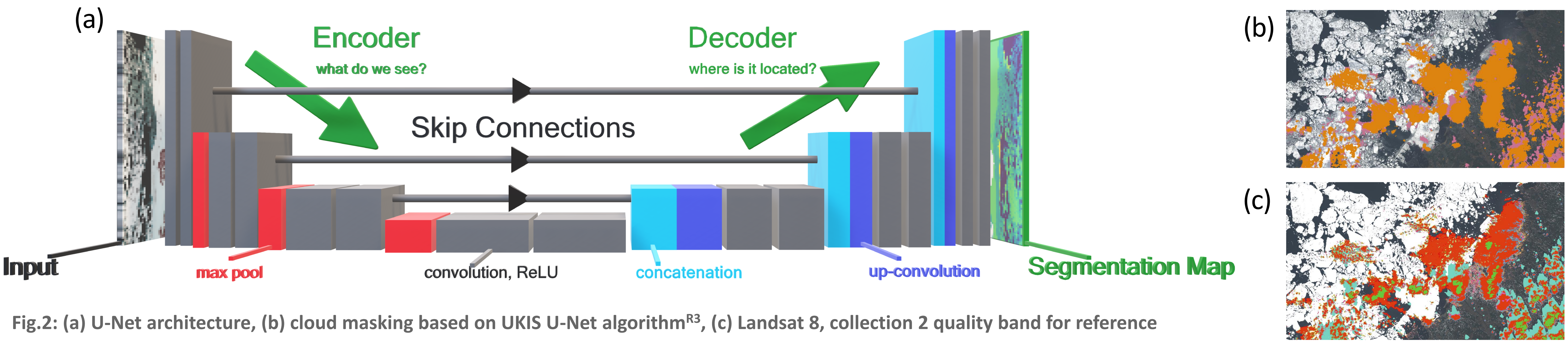

Fig.2: (a) U-Net architecture, (b) cloud masking based on UKIS U-Net algorithm[R3], (c) Landsat 8, collection 2 quality band for reference

BSH training data improvement

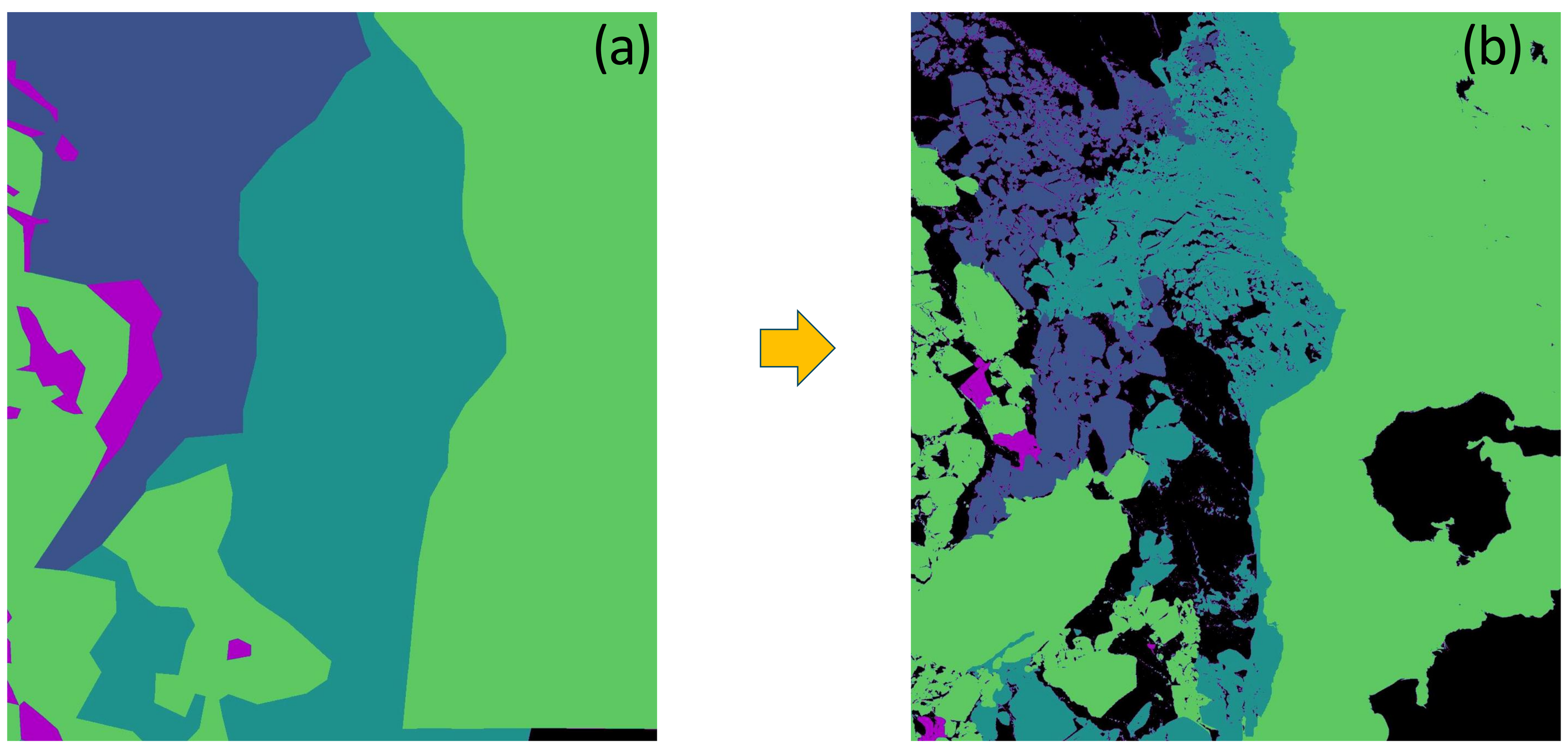

Fig.3: Remapping of BSH ICESOD chart (a) to segmented Landsat 8 imagery based on Felzenszwalb-Huttenlocher algorithm[R4] and normalized difference snow index[R1] (b).

Acknowledgments: This study is being conducted as part of Project EMS (Real-Time Technologies for Maritime Security) by DLR Security Research and is funded by the Ministry of Economics and Climate Protection. The authors thank the German Federal Maritime and Hydrographic Agency (BSH) for providing the ice charts to support this research and Christoph Pegel (DLR IMF) for sharing his implementation of the Fezenszwalb-Huttenlocher algorithm.

Outlook

The developed and tested processors will be integrated to the **operational** processing chain at the DLR (DFD-NBS) infrastructure.

We will test **data fusion** with SAR based sensors (Fig.4) in collaboration with DLR (IMF).

Upon successful evaluation, we may expand the model training to additional ice regimes of the **Arctic and Antarctic.**

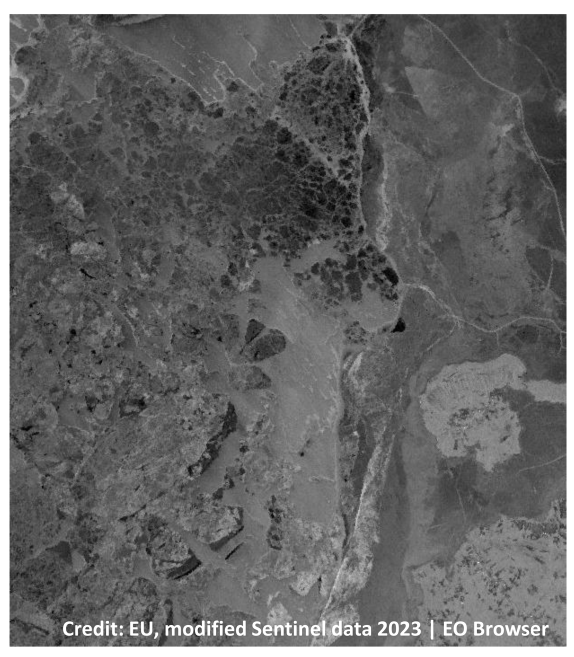

Fig.4: Sentinel 1 scene overlapping with Fig.1

Reference:
R1: Cáceres et al. (2022) doi.org/10.3390/rs14091975
R2: Ronneberger et al. (2015) doi.org/10.1007/978-3-319-24574-4_28
R3: Wieland et al. (2022) doi.org/10.5194/isprs-archives-XLIII-B3-2022-217-2022
R4: Felzenszwalb, Huttenlocher (2004) doi.org/10.1023/B:VISI.0000022288.19776.77

24th Meeting of the International Ice Charting Working Group
September 25-29, 2023 – Cambridge, United Kingdom
"Supporting Marine Safety in a Changing and Dynamic Environment"

DLR