AI-Empowered Physical Inversion of Water Quality and Benthic Parameters from Multi- and Hyperspectral Images

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WASI-AI

A new methodology integrated as a new module within the Water Colour Simulator (WASI) software.

Download WASI-AI!

Key Features of WASI-AI

- WASI-AI tackles the spectral ambiguity problem.
- Speeds up the inversion process.
- Despite the existing AI-based models, WASI-AI is sensor-independent and adaptable to a wide range of bio-optical conditions in both optically shallow and deep waters.

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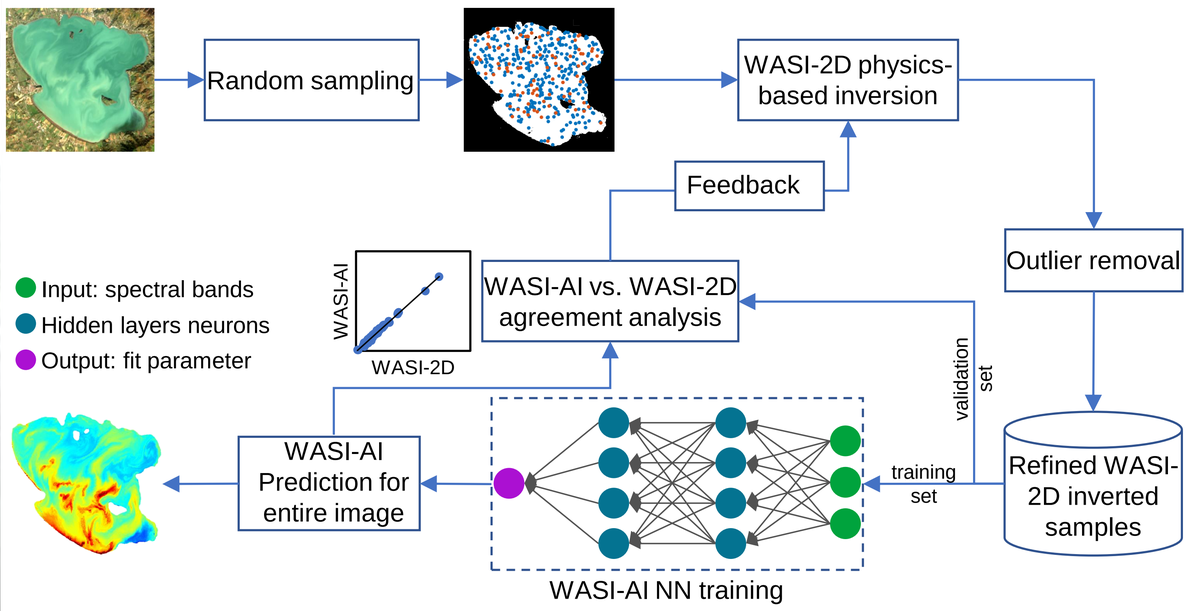
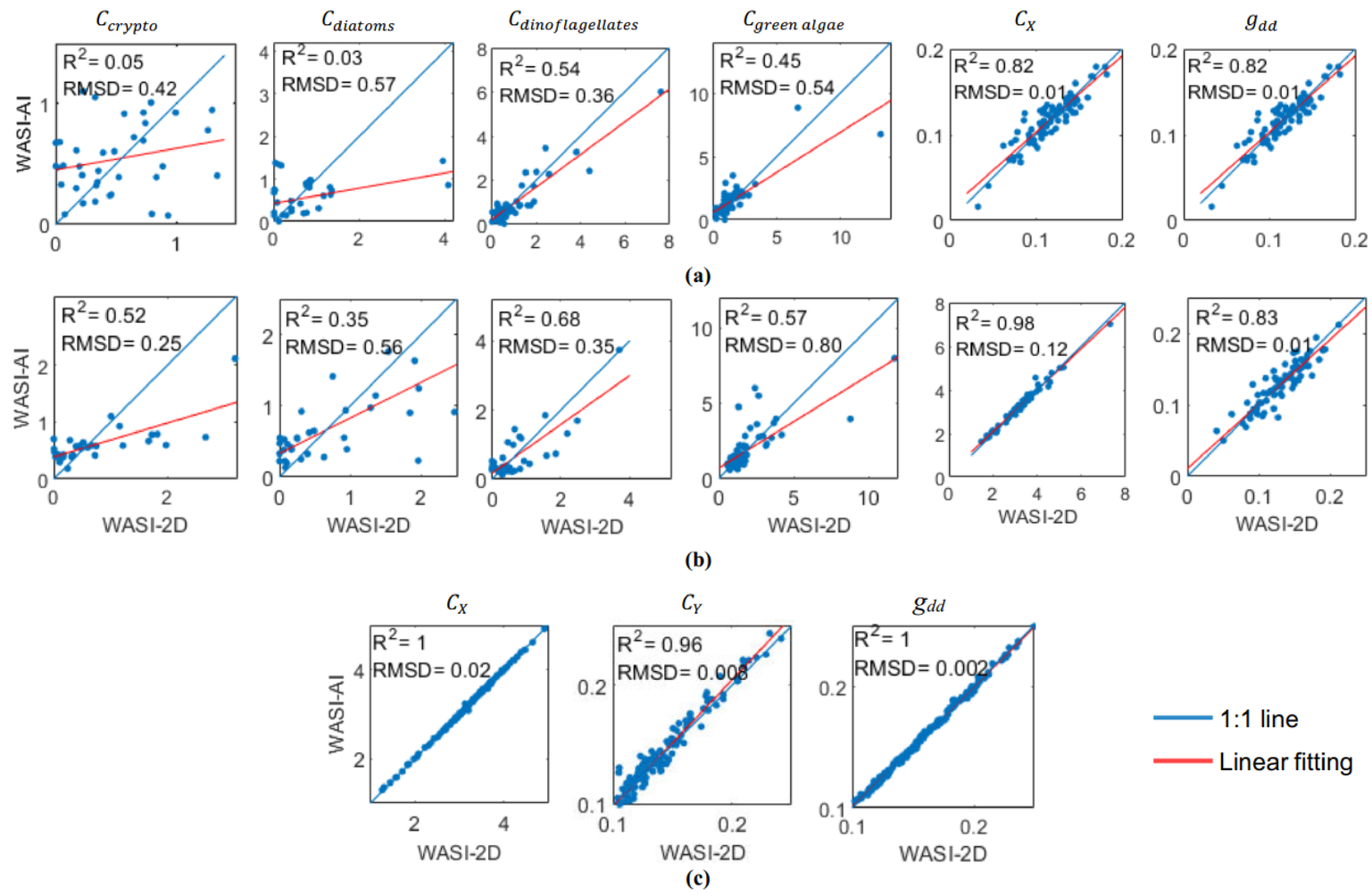
WASI-AI: Synergistic Integration of AI and Physics



- Physics-based WASI-2D retrieves the biophysical parameters for a small subset of image pixels.
- A portion of the samples is utilized to train neural networks to predict the fit parameters for all water pixels.
- The remaining portion of the samples is used to assess the agreement between WASI-AI and WASI-2D.
- Without ambiguity problems, both methods produce similar results for validation samples.
- In the presence of strong ambiguities, the results become less correlated suggesting fine-tuning inversion parameters.

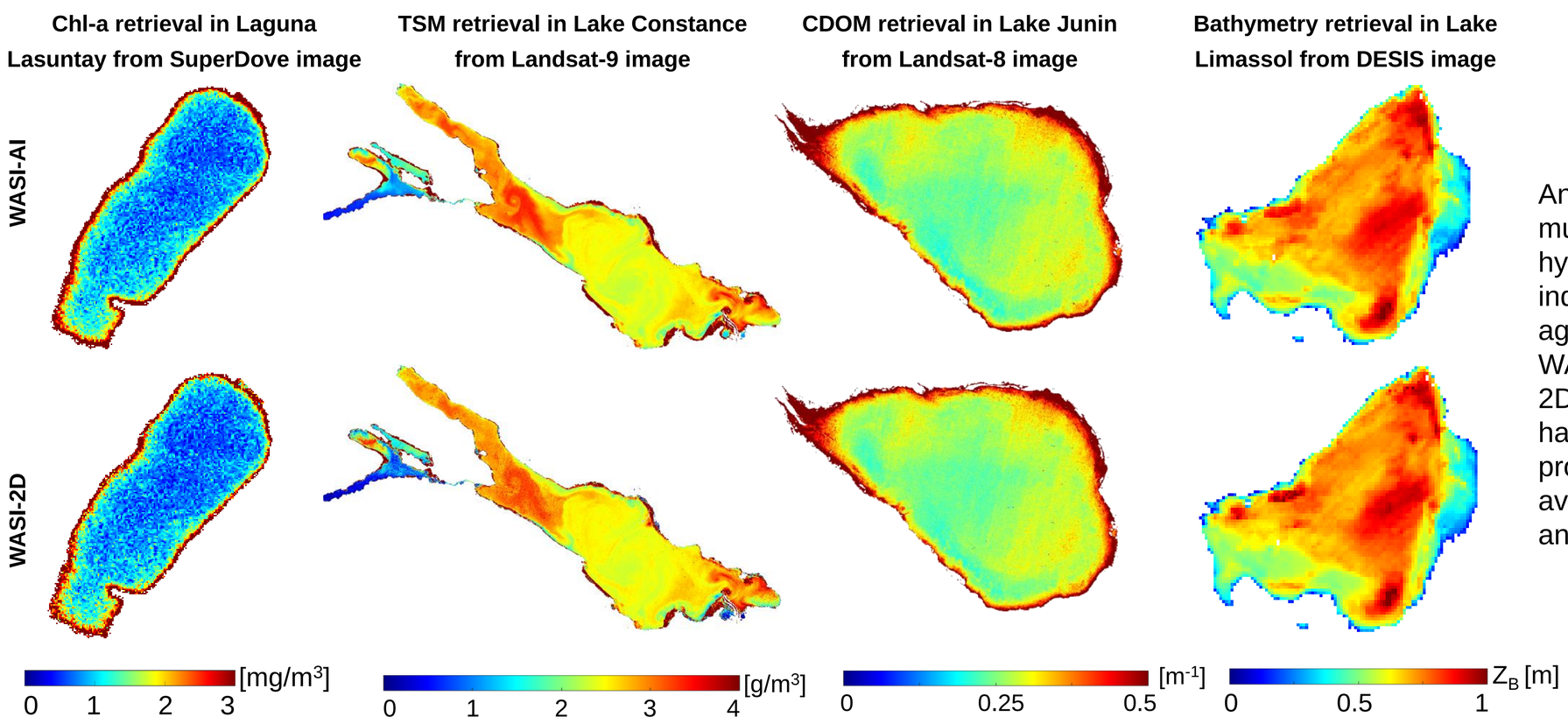
Handling Spectral Ambiguity

Example: Phytoplankton classification from a DESIS image of Lake Constance



- Row **(a)**: six fit parameters having all bands weighted equally.
- Row **(b)**: the same six fit parameters with spectral weighting applied.
- Row **(c)**: three fit parameters having all bands weighted equally without phytoplankton classification.

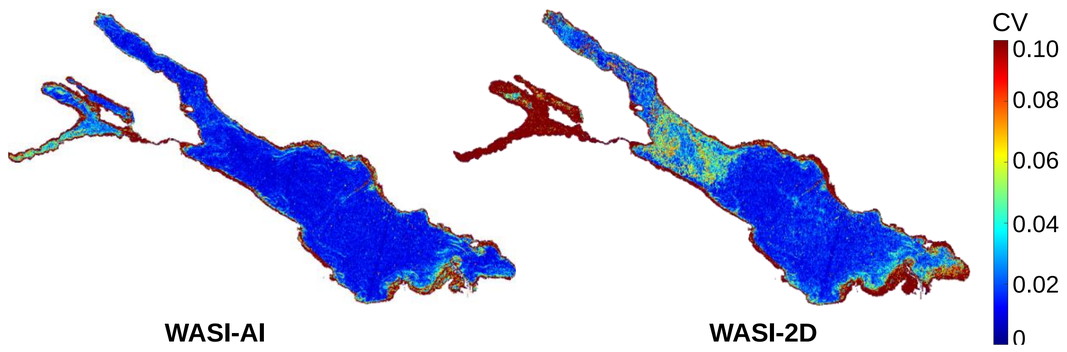
Strong agreement between WASI-AI and WASI-2D



Analyzing various multi- and hyperspectral images indicates strong agreement between WASI-AI and WASI-2D results after handling ambiguity problems with an average $R^2 > 0.95$ and NRMSD < 3%.

Reduced Noise on WASI-AI Maps

Coefficient of variation (CV), the ratio between standard deviation and mean of pixel values within sliding windows of 5×5, quantifies the noise level. An average relative CV < 0.9 indicates lower noises on WASI-AI maps than WASI-2D.



Significant Reduction of Processing Time

- The integration of AI significantly speeds up the inversion, reducing the processing time from hours/days to mere minutes.
- For instance, the WASI-2D processing takes up to ~26 hours in the case of the Sentinel-2 image of Lake Constance, whereas it takes only ~2 minutes for WASI-AI (749 times faster).