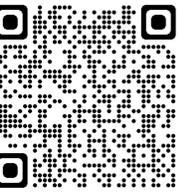


# FAST MACHINE LEARNING SIMULATOR OF AT-SENSOR RADIANCES FOR SOLAR-INDUCED FLUORESCENCE RETRIEVAL WITH DESIS AND HYPLANT



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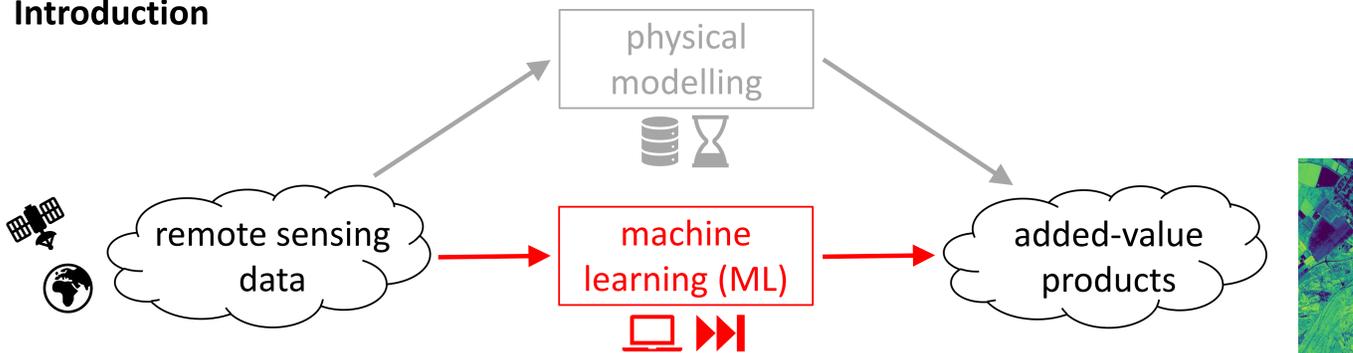
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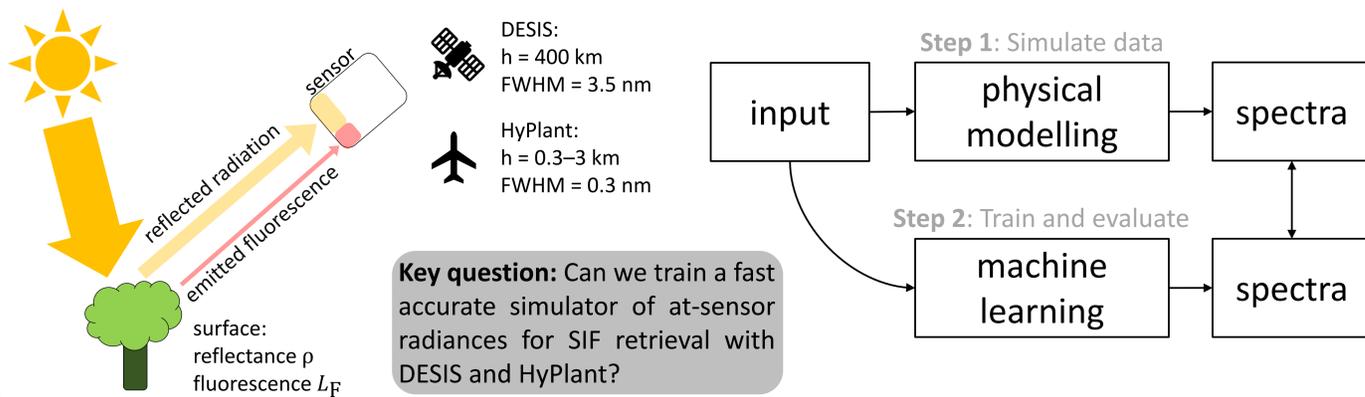
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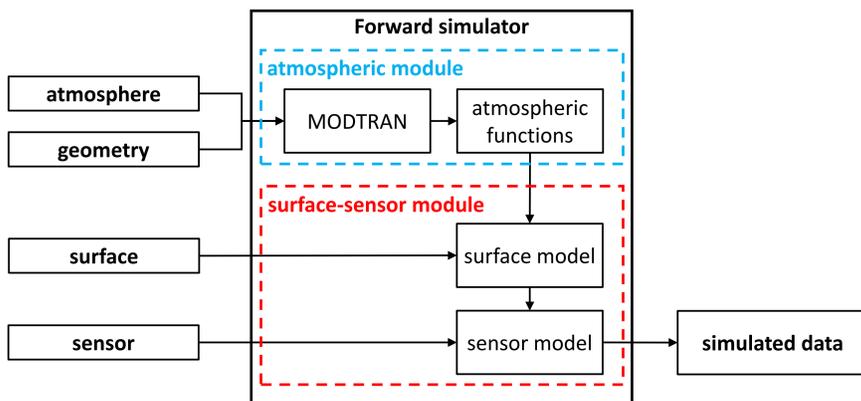
## Introduction



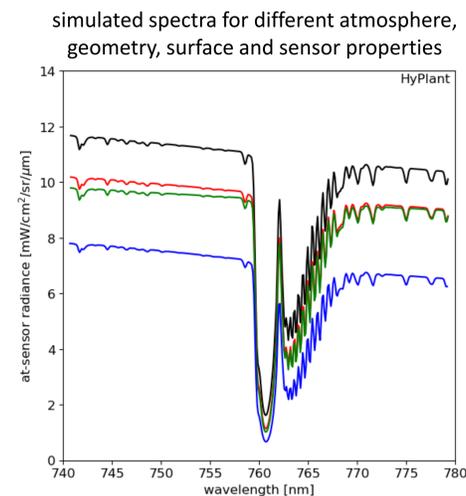
## Retrieval of solar-induced fluorescence (SIF)



## Simulation of DESIS and HyPlant spectrometer data



## Step 1



Specification	Databases	
	DESIS	HyPlant
Input dimensions	11	13
Output dimensions	13	349
Number of samples	1.2×10 <sup>7</sup>	1.5×10 <sup>7</sup>
Data size [GB]	5.6	64.7

See related work in poster MOP.P17.5:  
Buffat et al, Deep learning based prediction of  
Sun-induced fluorescence from HyPlant imagery



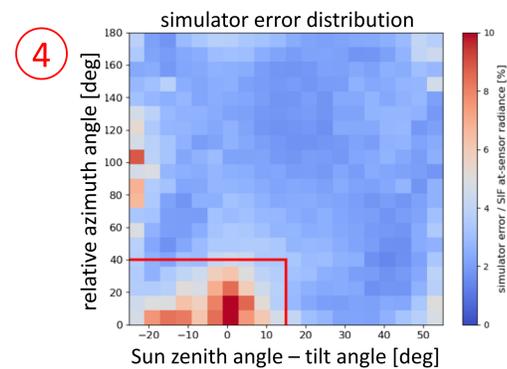
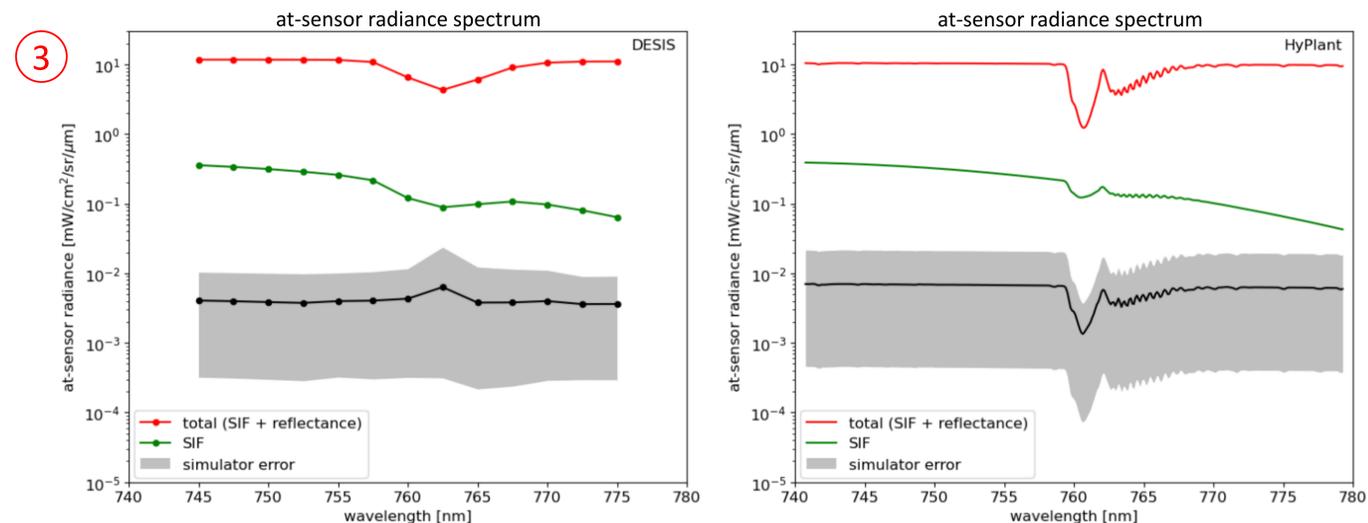
## Training and evaluation of ML simulator

## Step 2

Regression problem  $L_S = F(x) \quad F: \mathbb{R}^d \rightarrow \mathbb{R}^m$

features (input):  $x = [\text{atmosphere, geometry, surface, sensor}]$   
 targets (output): at-sensor radiance spectrum  
 ML methods: Ordinary Least Squares (OLS), Polynomial Ridge Regression (P2, P4), Neural Networks (NN)  
 evaluation: mean absolute error (MAE)

Performance parameter	DESIS				HyPlant			
	OLS	P2	P4	NN	OLS	P2	P4	NN
Test set MAE [mW/cm <sup>2</sup> /sr/µm]	0.65	0.13	0.0041	0.017	0.53	0.080	0.0060	0.026
Total training time	1.6 s	14 s	1.4 min	1.7 h	35 s	18 s	1.6 min	1.0 h
Prediction time per sample [µs]	0.04	0.9	11	31	0.8	1.8	16	35



- Polynomials of 4th degree are fast and accurate.
- Speed: 10<sup>7</sup> times faster than the simulation.
- Accuracy: errors 10 times below SIF signal.
- There is room for improvement.

**Bottomline:** We developed a fast and accurate ML simulator of at-sensor radiances for DESIS and HyPlant. The simulator enables the swift generation of large data sets and can be integrated into SIF retrieval methods. This illustrates how ML and physical modelling can be combined to unlock the full potential of remote sensing data.

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