A Neural Network Approach to Filtering OCO-2 Retrievals Over Snow

Environment and Climate Change Canada / Environnement et Changement climatique Canada

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Overview

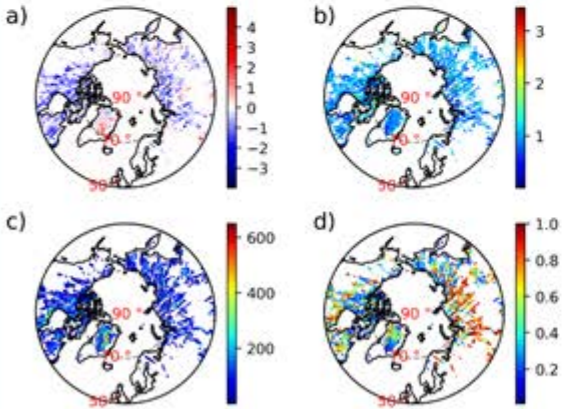
- Developed a Neural Network (NN) to filter OCO-2 v10r bias corrected XCO_2 retrievals over snow scenes. The v10r quality control flag filters out all these retrievals. With the NN filter we recover some of these retrievals.
- Trained NN's using truth proxies: model mean (MM) and small area approximation (SAA).
- Validated the NN's using Total Carbon Column Observing Network (TCCON) and model XCO_2.

Model Mean

Training Criteria:

- Using the mean XCO_2 from 6 models coincident with OCO-2 snow flag = 1 soundings > 50° N for 2018.
- Soundings not used if within 200 km of TCCON site, city of population > 250K, and oil sands.

Validation with model (not used to train NN): .



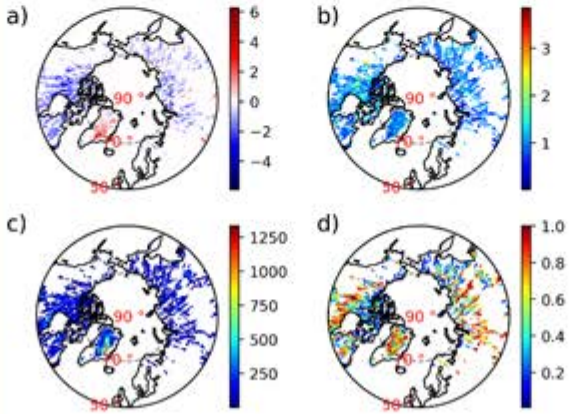
- Figure shows a) bias, b) Precision, c) Throughput, and d) % Throughput.

Small Area Approximation

Training Criteria:

- Assumes that XCO_2 is constant in area with radius < 50 km.
- Using all snow flag =1 soundings > 50° N up to 2022. Soundings not used if within 200 km of TCCON site, city of population > 250K, and oil sands.

Validation with model (not used to train NN):



- Figure is model validation showing a) bias, b) Precision, c) Throughput, and d) % Throughput.

TCCON

- Bias is defined as OCO-2 minus TCCON.
- All TCCON sites are GGG2020 except eu which is GG2014.
- % Good is amount of soundings passing NN filter divided by total amount of coincident soundings (aka "throughput").

		Small Area NN		Model Mean NN	
Site	Lat	Bias ± precision	% Good	Bias ± precision	% Good
All		0.3 ± 1.4	21%	0.4 ± 1.5	24%
eu	80°	-0.5 ± 1.8	6%	-1.1 ± 1.9	10%
ny	79°	1.5 ± 2.0	2%	0.8 ± 2.0	4%
so	67°	0.6 ± 0.9	45%	0.9 ± 1.0	65%
et	54°	-0.5 ± 1.3	51%	-0.2 ± 1.3	50%
pa	46°	0.4 ± 1.3	59%	0.4 ± 1.3	69%
rj	43°	0.5 ± 1.2	63%	0.4 ± 1.3	75%

Results

- Biases are relatively similar at most sites between the two NN trainings (SAA and MM), but are somewhat different at the highest latitude sites (Ny Alesund & Eureka).
- The throughput is higher with the NN trained with MM data, with only slightly worse precision for the SAA-trained NN.
- Both TCCON and model validation show that the precision is in the 1 -1.5 ppm range and % Good is higher at lower latitudes.
- Regardless of NN filter used OCO-2 snow retrievals have a negative bias compared to the model, except over Greenland where OCO-2 has a positive bias.
- NN filter is able to recover snow retrievals but how useful these measurements are will depend on the bias and precision requirements for carbon cycle research.