Determination of compost maturity using near infrared spectroscopy (NIRS)

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Objectives

were to examine weather …

1.) ... **near infrared spectroscopy** (NIRS) can be used as an alternative, quick method to determine **compost maturity**.

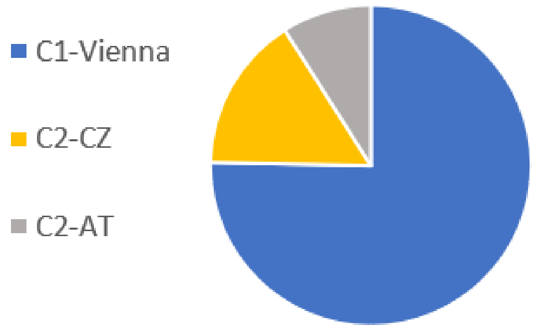
2.) … a calibration model can be developed to be used by different compost plants for the determination of compost maturity

Material & Methods

Compost samples were collected from 28 plants in AT and CZ with **different compost process technologies** and methods

Number of compost samples:

C1	Compost plant in Vienna (AT)	n= 360
C2	Smaller compost plants in AT and CZ	n= 116



the samples differed in their **material composition** due to seasonal effects (proportion of greenwaste, biowaste, wood, leaves, etc.) and in **composting time** (average 45 till >150 days).

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Material & Methods

Compost maturity parameter = sum parameter

calculated from contents of

- dissolved organic carbon (DOC),
- nitrate nitrogen (NO_3-N),
- ammonium nitrogen (NH_4-N),
- oxygen consumption (Oxitop® method)
- Solvita™-maturity index (Solvita™ test),

with the individual parameters weighted differently in the calculation

measurable with NIRS - crucial requirement !

this developed **maturity parameter** serves as **reference** for the calibration

Material & Methods

AOTF-NIR spectrometer - wavelength range 1200-2150 nm

Statistics: - principal component analysis (PCA) -> spectral properties

- partial least square regression (PLS1) -> developing the model

A **principal component analysis** (PCA) performed on the spectral data presented:

samples differ **tendentially** in the **origin of the composting plants** (interaction of -> materials **x** technologies **x** biol.process **x** etc.)

Calibration models were developed for

a) all samples - **one overall model**

b) two groups of samples divided according to the PCA results:
   - **submodel S1:** mainly consisted of samples from the composting plant **C1**
   - **submodel S2:** consisted of samples from composting plants **C2 and C1** as well

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Calibration and validation parameters of developed models

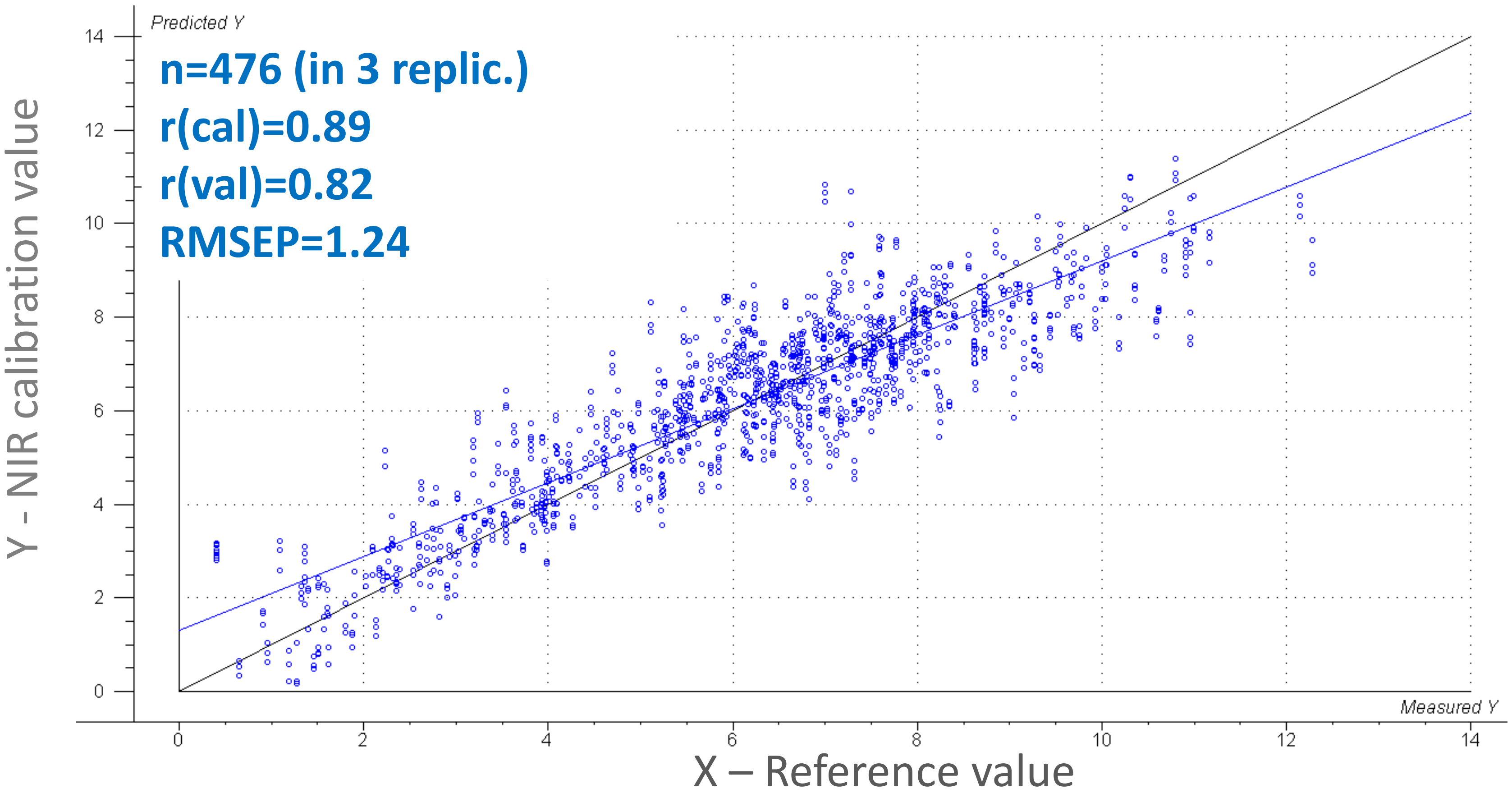
Model	N samples	R - calibration	R - validation	N PC	value min-max	RMSEP Validation
overall model	476	0.89	**0.82**	12	0.5 - 12.4	1.24
submodel 1	227	0.91	**0.89**	11	0.5 - 10.1	0.95
submodel 2	249	0.89	**0.82**	10	0.5 - 12.4	1.36

N PC = number of prinicipal components to develop the model

- The **overall model** showed good results with correlation coefficients of r(cal)= 0.89 and r(val)= 0.82 and a prediction error (RMSEP) of 1.24.
- The **submodel S1** performed better with r(cal)= 0.91, r(val)= 0.89 and a prediction error of 0.95.
- The **submodel S2** showed correlations with r(cal)= 0.89, r(val)= 0.82 and a prediction error of 1.36.

Calibration

overall model „compost maturity“



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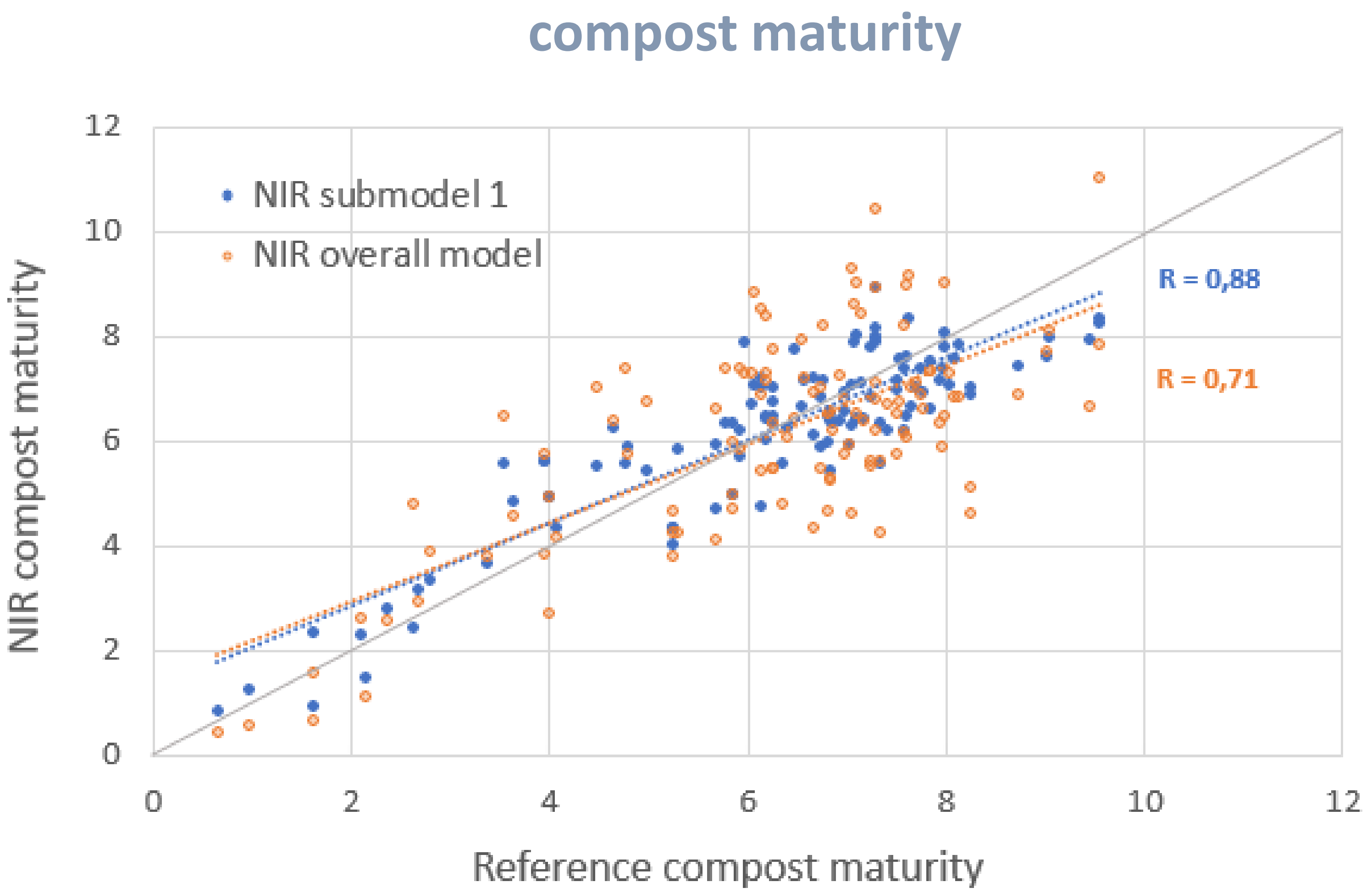
Validation



Performance **submodel 1** and **overall model** versus **reference** (including validation samples C1, n=114)

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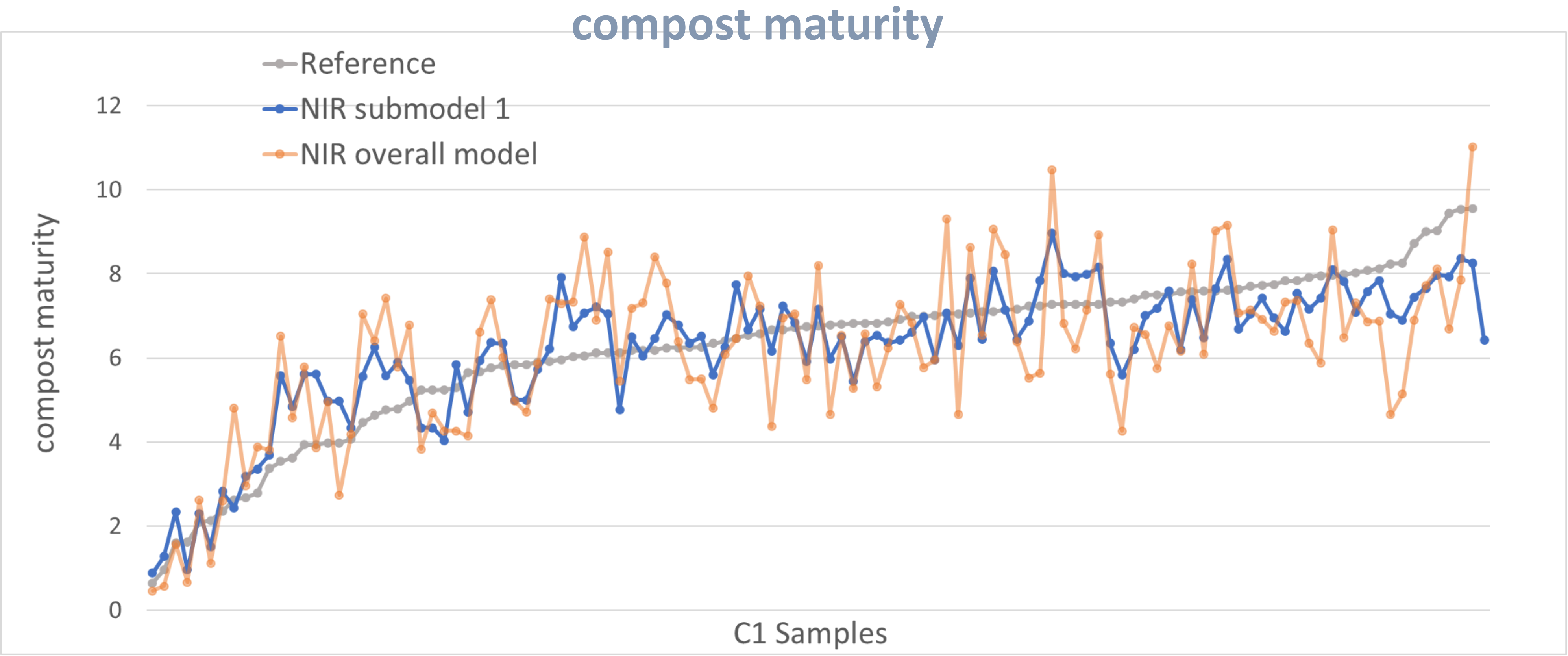
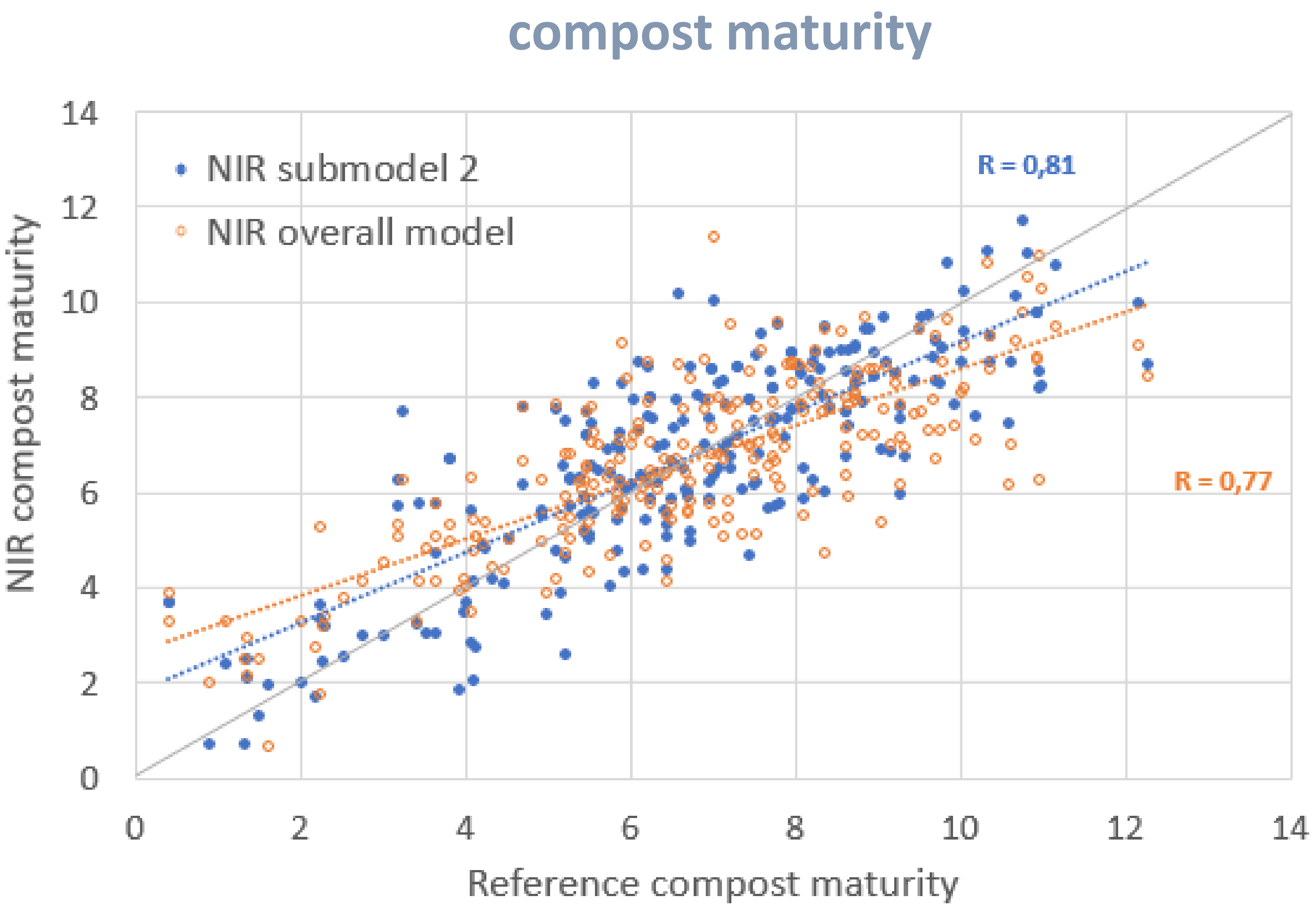
Validation



Validation results of C1 samples. Reference in ascending order, results of **submodel 1** compared with the **overall model.**

Validation



Performance **submodel 2** and **overall model** versus **reference** (including validation samples C1 n=134 and C2 n=83)

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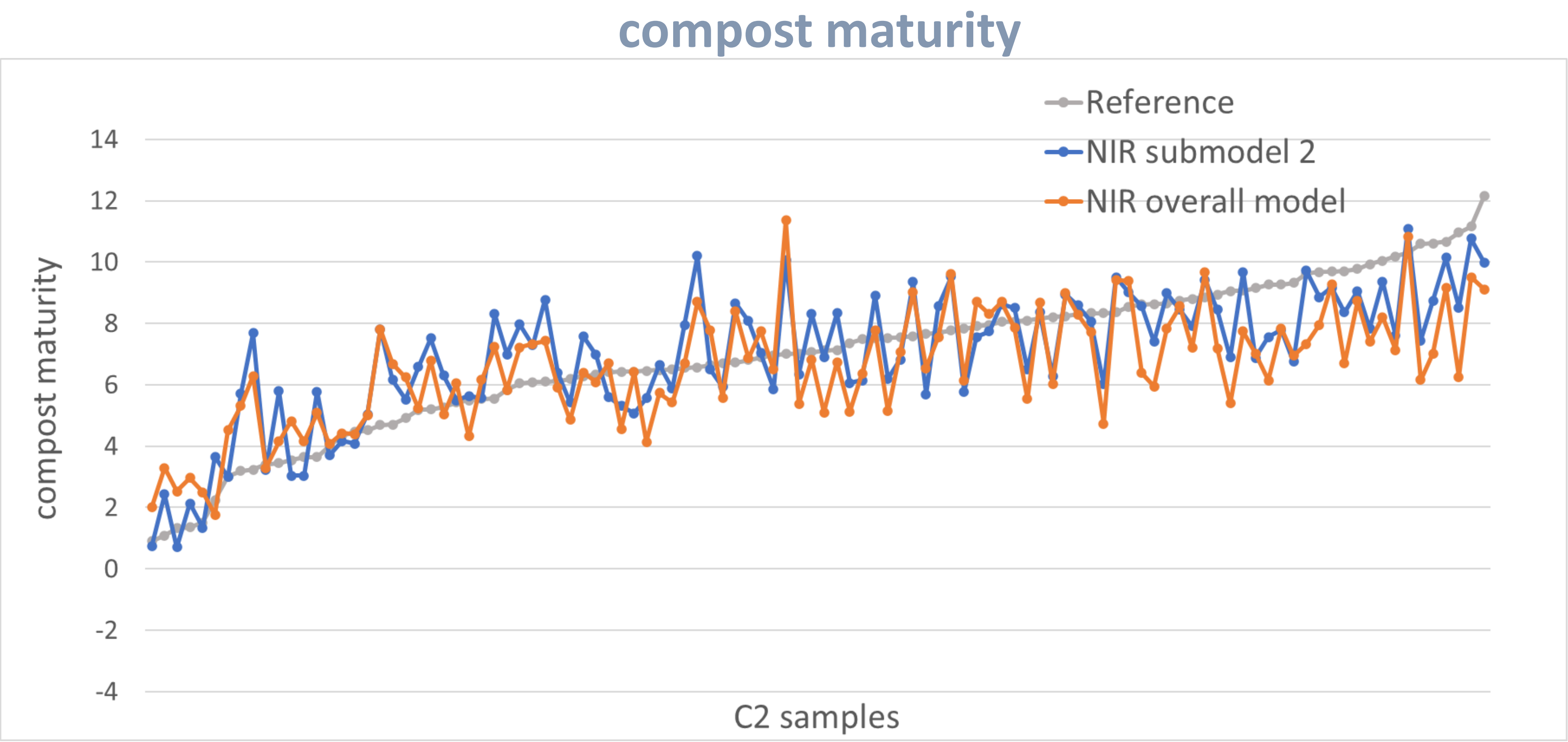
Validation



Validation results of C2 (–AT and CZ, n=83) samples. Reference in ascending order, results of **submodel 2** compared with the **overall model.**

Conclusion

- The validation of the models showed that the **use of submodels** provides **better predictions** than an **overall model.**
- Generally, prediction results of C1 samples (Viennese compost plant) were better than that of C2 samples (different compost plants in AT & CZ) due to **less influencing factors** like different process technologies and composition of materials.
- For one part of the C2 samples the prediction works well. The large number of calibration samples originating from the Viennese composting plant provides a good basis for developing a calibration model that can also be used for other composting plants.
- For the prediction of the other C2 samples, it will be necessary to **collect more samples** of the same origin or with similar spectral properties in order to adapt the model.

Thank you for attention !

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