Spectroscopy in the soil carbon method

Soil Carbon Co-design Workshop 19 May 2021

soil & landscape science lab

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Outline

- Why spectroscopy in the ERF soil carbon method
- Spectroscopy in the 2018 Method
- Recent advances in soil spectroscopy
- Possible revisions to the 2018 method

Why sensors were considered in the ERF method

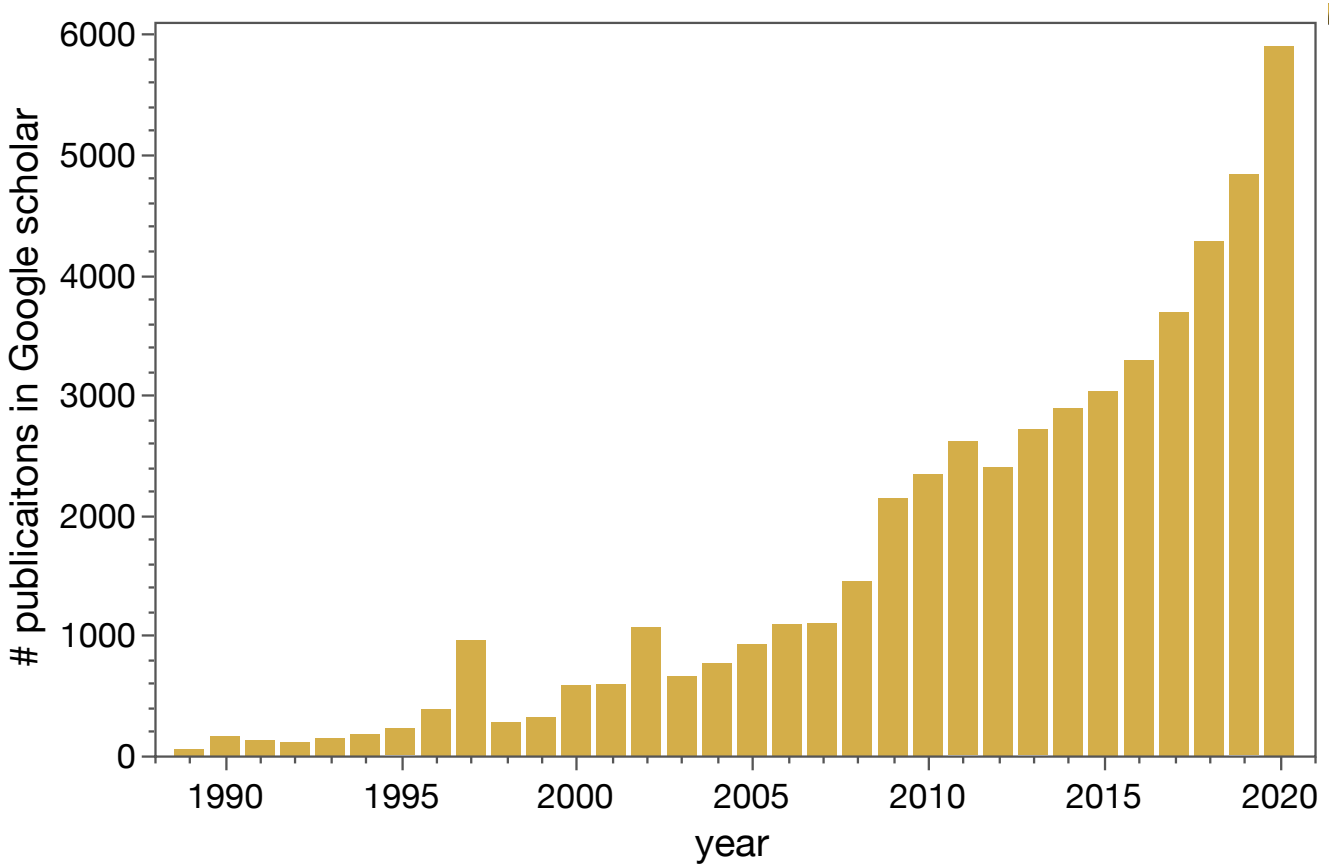
$$\underset{\text{Mg/ha}}{\text{C stocks}} = \underset{\%}{\text{C content}} \times \underset{\text{g/cm}^{-3}}{\text{Bulk density}} \times \left[1 - \text{Proportion gravel}\right] \times \underset{\text{cm}}{\text{Soil Layer}}$$

at least the 0–30 cm layer

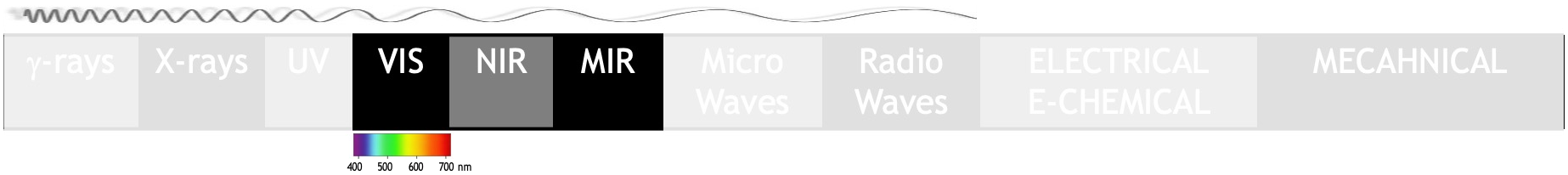
Attribute	Laboratory analysis	Cost /$ per sample
Soil preparation	Drying, crushing, grinding	10–30
Inorganic carbon	Acid treatment	10–15
Organic carbon	Dry combustion (LECO)	10–20
Bulk density	Oven dry and weigh	30–50
Gravel content	Sieve and weigh	10–20
Sub total $AU		**70–135**
Carbon fractions (POC, HOC, ROC)	Wet sieve and NMR	250–2000
Total $AU		**320–2135**

+ around $130 soil sampling costs per sampling site

Research on soil NIR spectroscopy over last 30 years

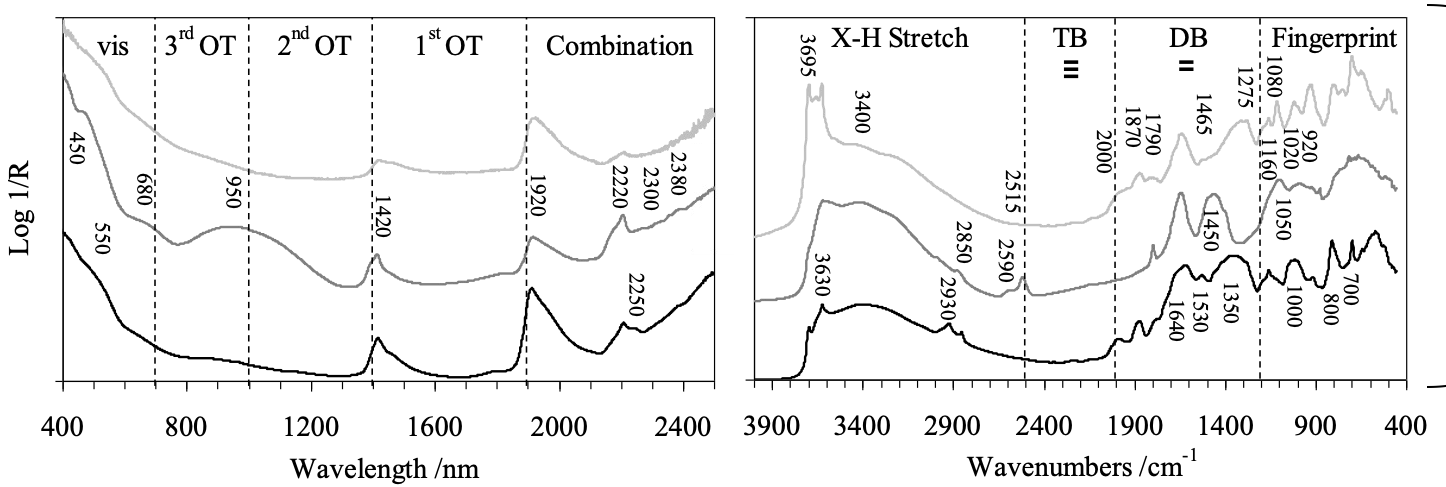


Soil spectra



vis: electronic transitions
NIR: combinations and overtones

mid-IR: fundamental molecular vibrations of soil mineral and organic structures



Soil composition:

- Colour
- Iron oxides
- Clay minerals
- Quartz
- Carbonate
- Organic matter
- Water
- Particle size

Soil spectra, and the properties they measure determine most soil functions

Viscarra Rossel et al., (2006)

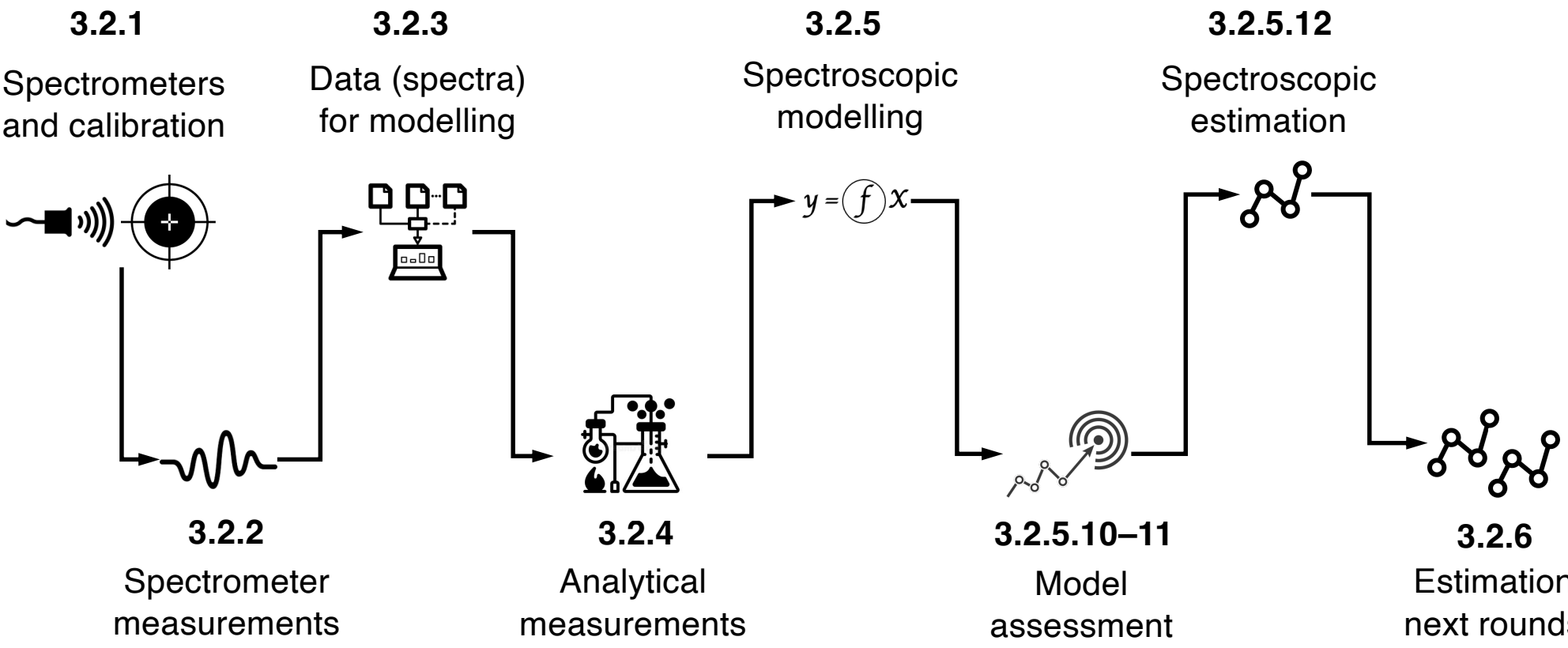
Sensors for soil C accounting and monitoring

$$\text{C stocks} = \text{C content} \times \text{Bulk density} \times \left[1 - \text{Proportion gravel}\right] \times \text{depth}$$

	C content	Bulk density	Proportion gravel
Sensing methods	• vis–NIR • mid-IR	• γ-ray attenuation	• Wet sieving and image analysis
	Measures the organics and minerals in soil – can be calibrated to predict C content	Measures the attenuation of gamma rays thru soil – directly proportional to density	Wet sieving and imaging are faster and more efficient than conventional drying, crushing, weighing

England & Viscarra Rossel (2018)

Spectroscopy in the 2018 ERF method



Most significant recent advances

1. Spectrometers are **smaller**, smarter, **cheaper**, more energy efficient

2. Improvements in modelling using ‘global’ methods that fit ‘locally’

3. Global initiatives working towards standardization of soil spectroscopy

Possible revisions to the 2018 method

- Revise *requirement* on the specific wavelength ranges
- Revise *requirements* and potentially move to *recommendation*
- Revise the domain for the spectroscopic modelling: training and validation (e.g. from the CEA to the Project)
- Revise spectroscopic modelling towards greater reliance on validation.
- The CER has asked for feedback on other changes for consideration

Reduce complexity and enable **adoption** and **innovation**
while maintaining **integrity**

Thank you.

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