PHOSAGRO

RUSOLAN activities 2022-2024

Webinar

29 October 2024

Shamrikova E.
Chair of RUSOLAN
shamrikovaelena@yandex.ru

RUSOLAN
RUSSIAN SOIL LABORATORY NETWORK

Main authors:

Boris Kondratenok – Deputy Director in Science, Candidate of Chemistry

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Evgenia Tumanova – Lead chemical engineer

Evgenia Vanchikova – Candidate of Chemistry

Natalia Bondarenko – Engineer of the 1 category

Olga Ostanina – Lead chemical engineer

Svetlana Kostrova – Head of the ecoanalytical laboratory

Tatyana Zonova – Lead chemical engineer

Yulia Bobrova – Lead chemical engineer

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RUSSIAN SOIL LABORATORY NETWORK

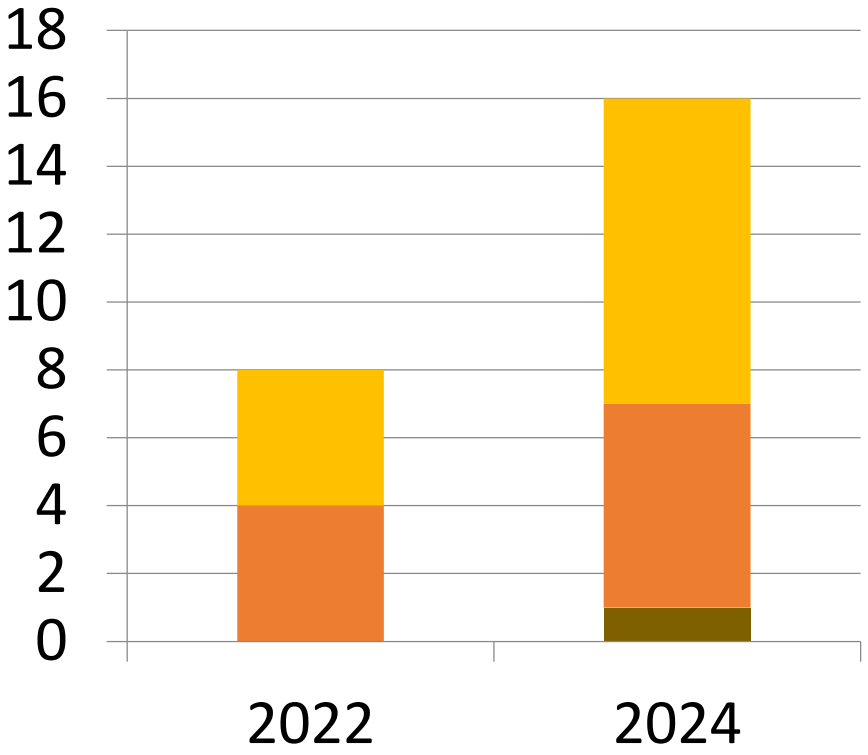
GLOSOLAN
GLOBAL SOIL LABORATORY NETWORK

RUSOLAN
RUSSIAN SOIL LABORATORY NETWORK

Aim –

achieving uniformity of measurements in soil research to obtain comparable analytical information on soils at national, regional and global levels

1. Growth of RUSOLAN



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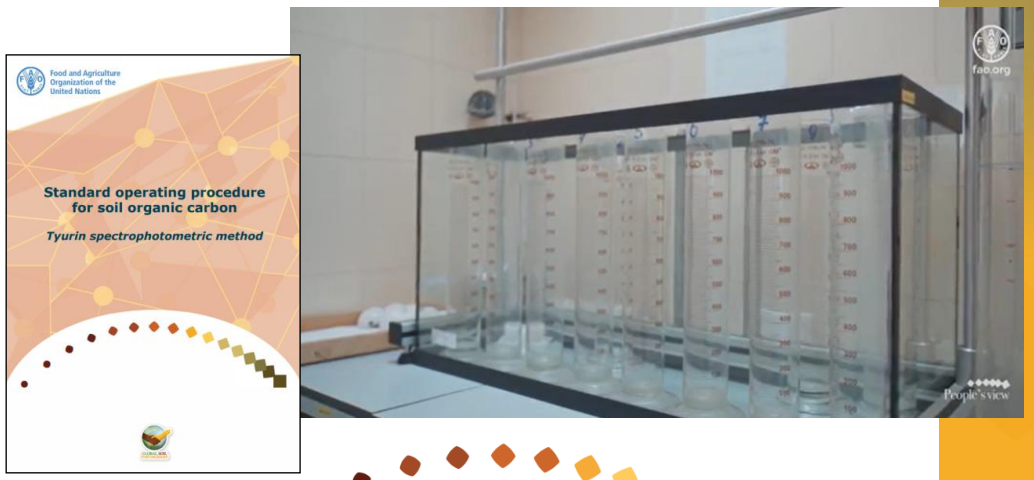
2. Development of methods/modifications of methods

In progress

- Modification of Kaczynski's method. *Particle size distribution*
- Modification of Tyurin's method with titrimetric ending. *SOC*



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3. Popularization. Publication of articles

Geoderma 412 (2022) 115547

Contents lists available at ScienceDirect

Geoderma

journal homepage: www.elsevier.com/locate/geoderma

Transferability between soil organic matter measurement methods for database harmonization

E.V. Shamrikova [a], B.M. Kondratenok [a], E.A. Tumanova [a], E.V. Vanchikova [a], E.M. Lapteva [a], T. V. Zonova [a], E.I. Lu-Lyan-Min [a], A.P. Davydova [a], Z. Libohova [b,*], N. Suvannang [c]

[a] Institute of Biology Komi SC UrD RAS, Kommunisticheskay 28, Syktyvkar, Russian Federation
[b] USDA-ARS Dale Bumpers Small Farms Research Center, 6883 S. Hwy 23, Booneville, AR 72927, United States
[c] Land Development Department, 2003/61 Phaholyothin Road, Chatuchak, Bangkok 10240, Thailand

Catena 228 (2023) 107151

Contents lists available at ScienceDirect

Catena

journal homepage: www.elsevier.com/locate/catena

Which method to choose for measurement of oranic and inorganic carbon content in carbonate-rich soils? Advantages and disadvantages of dry and wet chemistry

E.V. Shamrikova *, E.V. Vanchikova, E.I. Lu-Lyan-Min, O.S. Kubik, E.V. Zhangurov

Institute of Biology Komi SC UrD RAS, Kommunisticheskay 28, Syktyvkar, Russian Federation

ARTICLE INFO

Keywords:
Organic carbon
Carbonates

ABSTRACT

The pedosphere is an essential reservoir of carbon represented by organic (SOC) and inorganic (SIC) forms. Various methods are used worldwide to measure SOC and SIC. The trend towards globalization of data on soils

ISSN 1064-2293, Eurasian Soil Science, 2024, Vol. 57, No. 9, pp. 1433–1446. © Pleiades Publishing, Ltd., 2024.

SOIL CHEMISTRY

Effects of Different Factors on the Assessment of Total Alkalinity of Soils on Calcareous Rocks

E. V. Vanchikova[a], E. V. Shamrikova[a, *], E. V. Kizyurova[a], and E. V. Zhangurov[a]

[a] *Institute of Biology, Komi Scientific Center, Ural Branch, Russian Academy of Sciences, Syktyvkar, 167982 Russia*
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Russian Text © The Author(s), 2022, published in Pochvovedenie, 2022, No. 7, pp. 787–794.

APPROACHES AND METHODS FOR STUDYING SOIL ORGANIC MATTER

Problems and Limitations of the Dichromatometric Method for Measuring Soil Organic Matter Content: A Review

E. V. Shamrikova[a, *], E. V. Vanchikova[a], B. M. Kondratenok[a], E. M. Lapteva[a], and S. N. Kostrova[a]

[a] *Institute of Biology, Komi Science Centre, Ural Branch, Russian Academy of Sciences, Syktyvkar, 167982 Russia*
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SOIL CHEMISTRY

Methods for Measuring Organic Carbon Content in Carbonate-Containing Soils: A Review

E. V. Shamrikova[a, *], E. V. Vanchikova[a], E. V. Kyzyurova[a], and E. V. Zhangurov[a]

[a] *Institute of Biology, Komi Scientific Center, Ural Branch, Russian Academy of Sciences, Syktyvkar, 167982 Russia*
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SOIL PHYSICS

Metrological Aspects of Studying the Particle Size Distribution of Soils according to the Kachinskii Method

E. V. Vanchikova[a], E. M. Lapteva[a], N. A. Vasilyeva[a], B. M. Kondratenok[a], and E. V. Shamrikova[a, *]

[a] *Institute of Biology, Komi Science Center, Ural Branch, Russian Academy of Sciences, Syktyvkar, 167982 Russia*
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Received November 20, 2023; revised January 19, 2024; accepted February 20, 2024

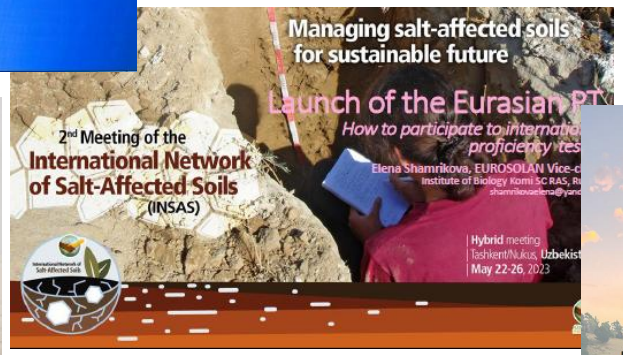
3. Popularization. Conferences

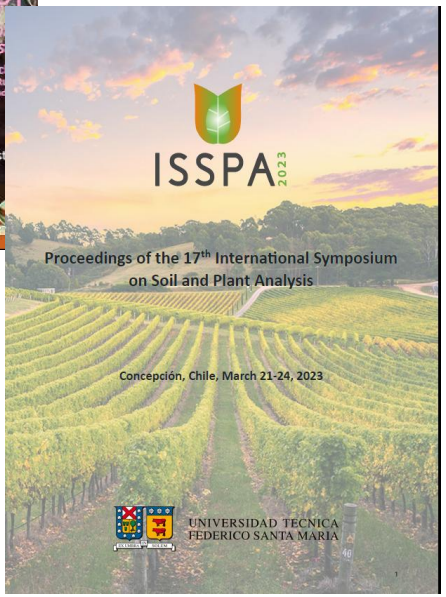
PHOSAGRO · РГАУ-МСХА имени К.А. Тимирязева

Open International Forum-Webinar on soil protection and sustainable land use

"Global soil conservation: international experience in soil fertility and health support"

April 27, 2023
13:00-16:00 CET





В 2017 году Глобальное почвенное партнерство Продовольственной и сельскохозяйственной организации Объединенных Наций создало Глобальную сеть почвенных лабораторий (GLOSOLAN) для наращивания и укрепления потенциала лабораторий в области анализа почв и удовлетворения потребности в гармонизации аналитических данных о почвах.

Успех GLOSOLAN во многом зависит от работы лаборатория-участниц, а также от их способности расширять деятельность глобальной сети, внедряя согласованные протоколы.

Создание национальных сетей почвенных лабораторий (NASOLAN), способных преодолевать языковые и культурные барьеры, обеспечивает выполнение миссии GLOSOLAN на уровне страны.

Объединяя российские почвенные лаборатории, РУСОЛАН помогает им взаимодействовать друг с другом, решать общие проблемы, развивать собственные возможности в области анализа почв.

Программа реализуется при финансовой поддержке ФосАгро.

Быть частью РУСОЛАН – это:

- Международное сотрудничество в области химического, физического, биологического анализа почв
- Возможность освоения и использования международных стандартов
- Разработка и усовершенствование методов анализа почв
- Гармонизация методов анализа и способов представления результатов измерений
- Участие в глобальных, региональных и национальных межлабораторных сличительных испытаниях
- Программы обмена опытом

Для регистрации лаборатории в сети РУСОЛАН заполните регистрационную форму на сайте: *www.fao.org*

Для удобства наведите камеру телефона на QR-код.

AUEZOV UNIVERSITY 1943

3. Popularization. Website

https://ib.komisc.ru/rusolan/

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Российская сеть почвенных лабораторий

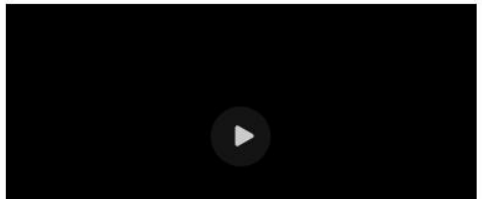
ГЛАВНАЯ ИСТОРИЯ НОВОСТИ УЧАСТНИКИ ДОСТИЖЕНИЯ КОНТАКТЫ

РУСОЛАН

Российская сеть почвенных лабораторий РУСОЛАН (RUSOLAN) — национальное подразделение, которое является частью Глобальной сети почвенных лабораторий ГЛОСОЛАН (GLOSOLAN), координируемой Глобальным почвенным партнерством Продовольственной и сельскохозяйственной организации ООН (Food and Agriculture Organization of the United Nations (FAO), Italy-Rome, https://www.fao.org/global-soil-partnership/glosolan-old/national-soil-laboratory-networks/country/russian-federation/en/). Постоянным партнером деятельности РУСОЛАН с момента организации национальной сети выступает ПАО "ФосАгро".

Регистрация и членство в сети бесплатны.

- Видеоэкскурсия по Национальной референтной лаборатории РУСОЛАН



3. Popularization. Website

https://ib.komisc.ru/rusolan/

Food and Agriculture Organization of the United Nations

ENHANCED BY Google

English

Global Soil Partnership

Overview | Partners | Regional partnerships | ITPS | Technical networks | Areas of work | Resources

- GLOSOLAN homepage
- Soil Analysis
- Capacity development
- Equipment
- Regional Soil Laboratory Networks
- National Soil Laboratory Networks
- SIMPLE - Soil Import Legislation

Russian Federation

Soil laboratories from the country are highly welcome to join the Global Soil Laboratory Network (GLOSOLAN) by filling the **REGISTRATION FORM** and send it to Lucrezia.Caon@fao.org and to GSP-Secretariat@fao.org.

STATUS OF THE NASOLAN OF THE RUSSIAN FEDERATION

NAME OF THE NATIONAL NETWORK: RUSSIAN SOIL LABORATORY NETWORK (RUSOLAN)

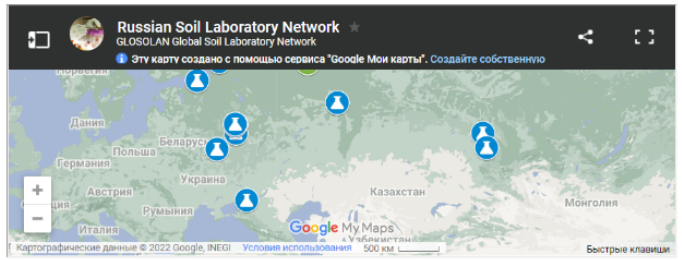
- STATUS: Established
- DATE OF ESTABLISHMENT: 29 April 2022
- NUMBER OF MEMBERS: 13

REFERENCE LABORATORY

NAME: Ecoanalytical laboratory of the Institute of Biology of Komi Scientific Center of the Ural Branch of the Russian Academy of Sciences

- ADDRESS: Syktyvkar, Russia, 167982
- GLOSOLAN MEMBER SINCE: 16 April 2018
- TYPE OF LABORATORY: Research center
- TYPE OF ANALYSIS PERFORMED: Chemical, physical, biological, fertilizers, plants, water, pollutants, tissues.
- HEAD OF THE LABORATORY: Ms Elena V. Shamrikova

RUSSIAN SOIL LABORATORY NETWORK (RUSOLAN) MAP

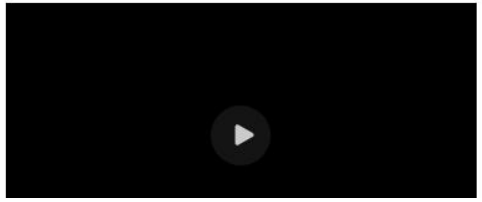


BRIEF HISTORY OF THE NETWORK

ленных лабораторий

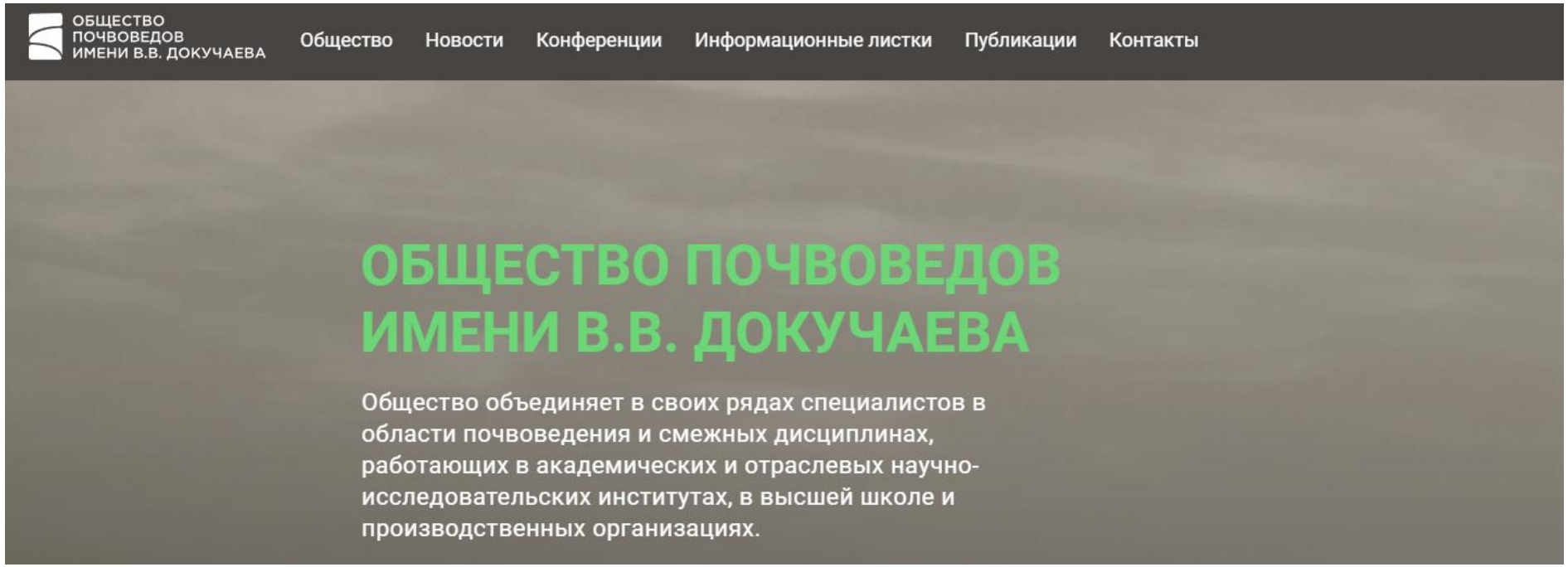
ТНИКИ ДОСТИЖЕНИЯ КОНТАКТЫ

- Видеоэкскурсия по Национальной референтной лаборатории РУСОЛАН



4. *Working Group on Methodological Support for Soil-Analytical Research* has been established within the V.V. Dokuchaev Soil Scientists Society (Russia)

https://soilsociety.ru/commissions



5. Proficiency Test

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Concept

Coordinator PT – NatRefLab of the RUSOLAN

Participation in PT – free and anonymous.

The purpose of the PT: to expand and promote harmonized GLOSOLAN protocols to SOC measurements among soil laboratories in the Eurasian region

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PT participants (~~26~~ / 21) from ~~9~~ / 6 countries*

- ~~Armenia (1)~~
- Georgia (1)
- Kazakhstan (2)
- ~~Moldova (1)~~
- Belarus (1)
- Russia (~~15~~ / 14 RUSOLAN's labs)
- Senegal (1)
- ~~Turkmenistan (1)~~
- Uzbekistan ~~(3)~~ / (2)

* - *with the support of Maria Konyushkova*

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Why did the labs refuse to participate?

- We do not have reagents for this.
- We don't have time for this.
- We see no point in this work.
- Fear (even anonymously) - suddenly an error will be discovered.

We need to work with this!

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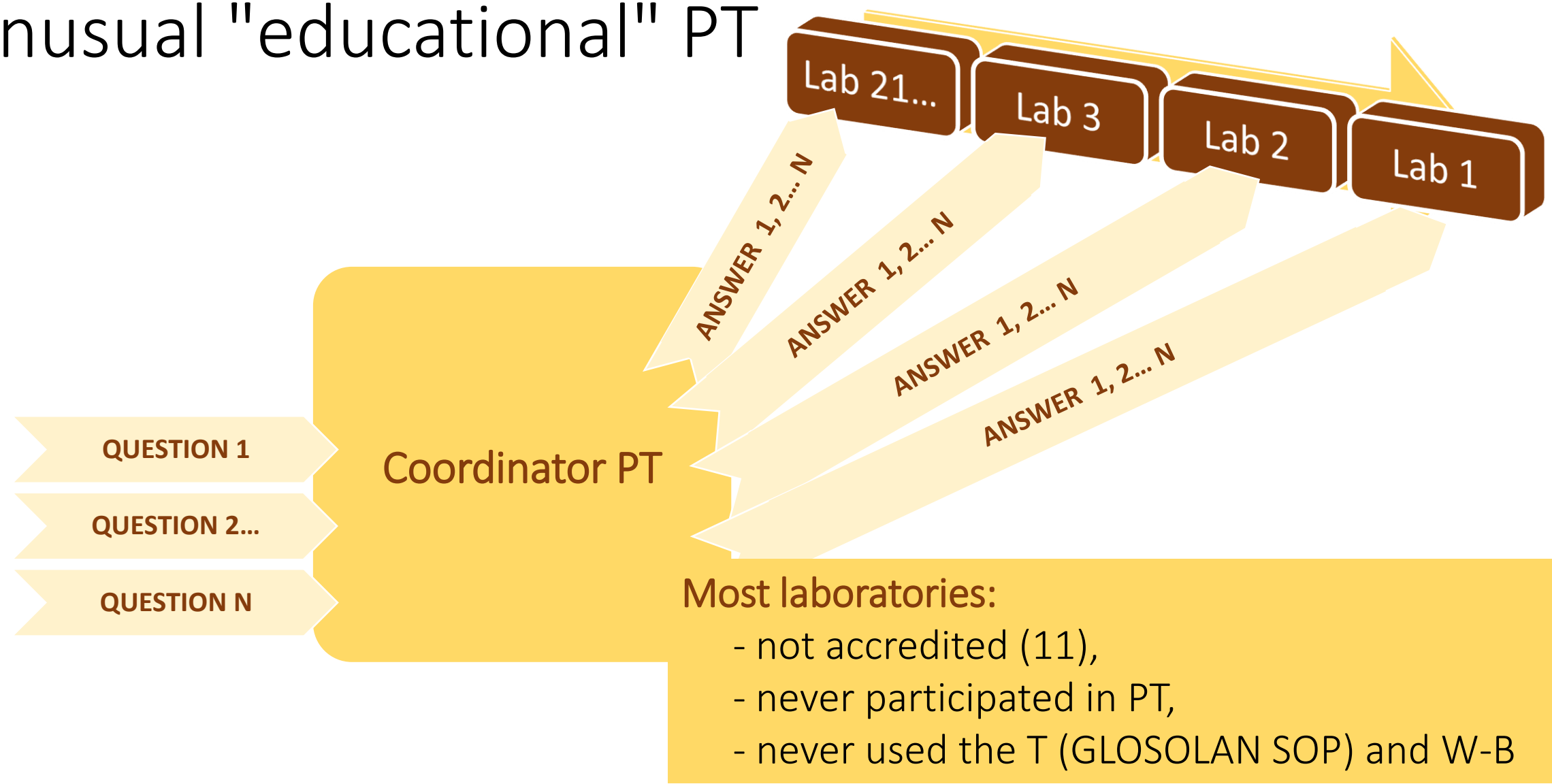
Unusual "educational" PT



Most laboratories:

- not accredited (11),
- never participated in PT,
- never used the T (GLOSOLAN SOP) and W-B

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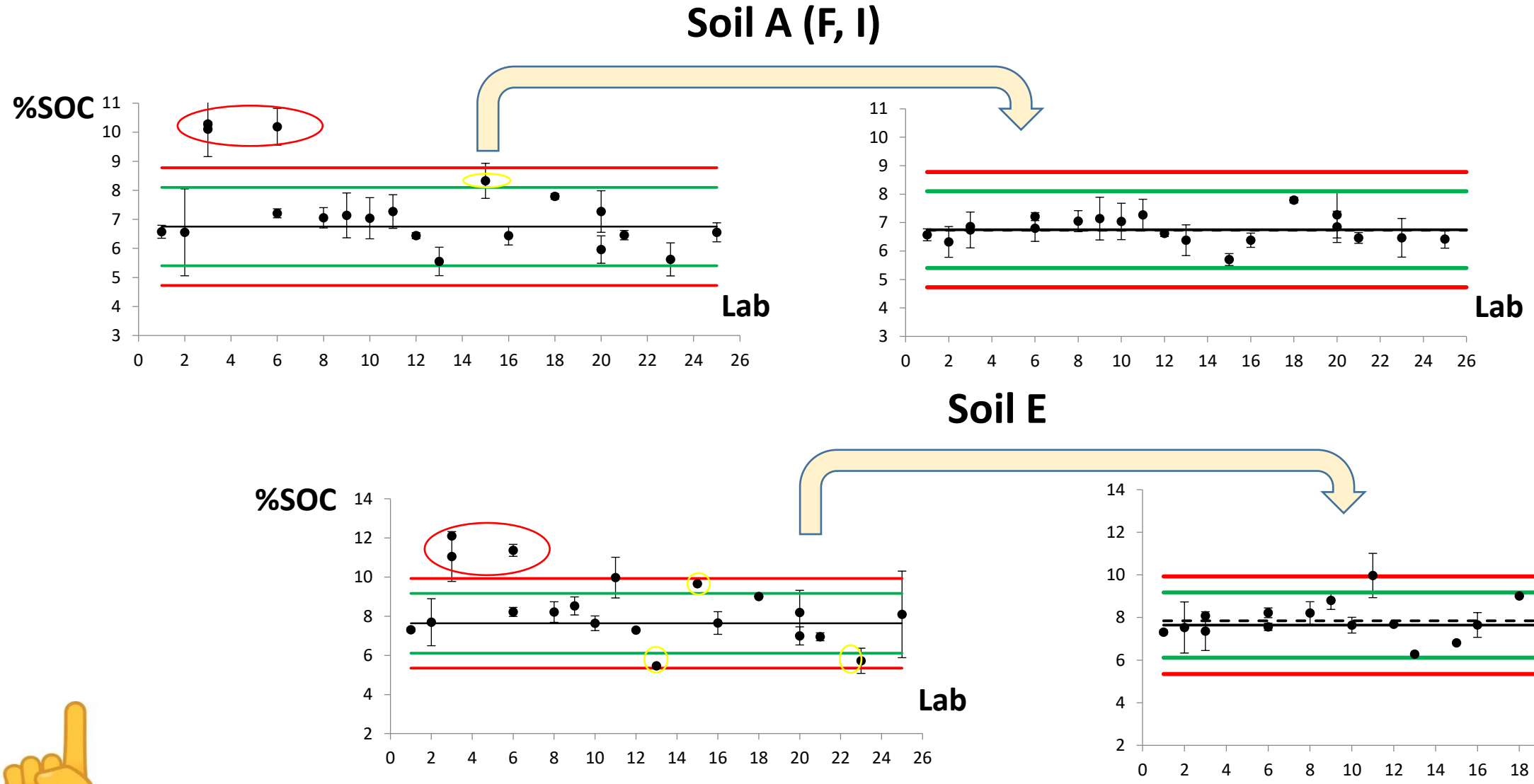
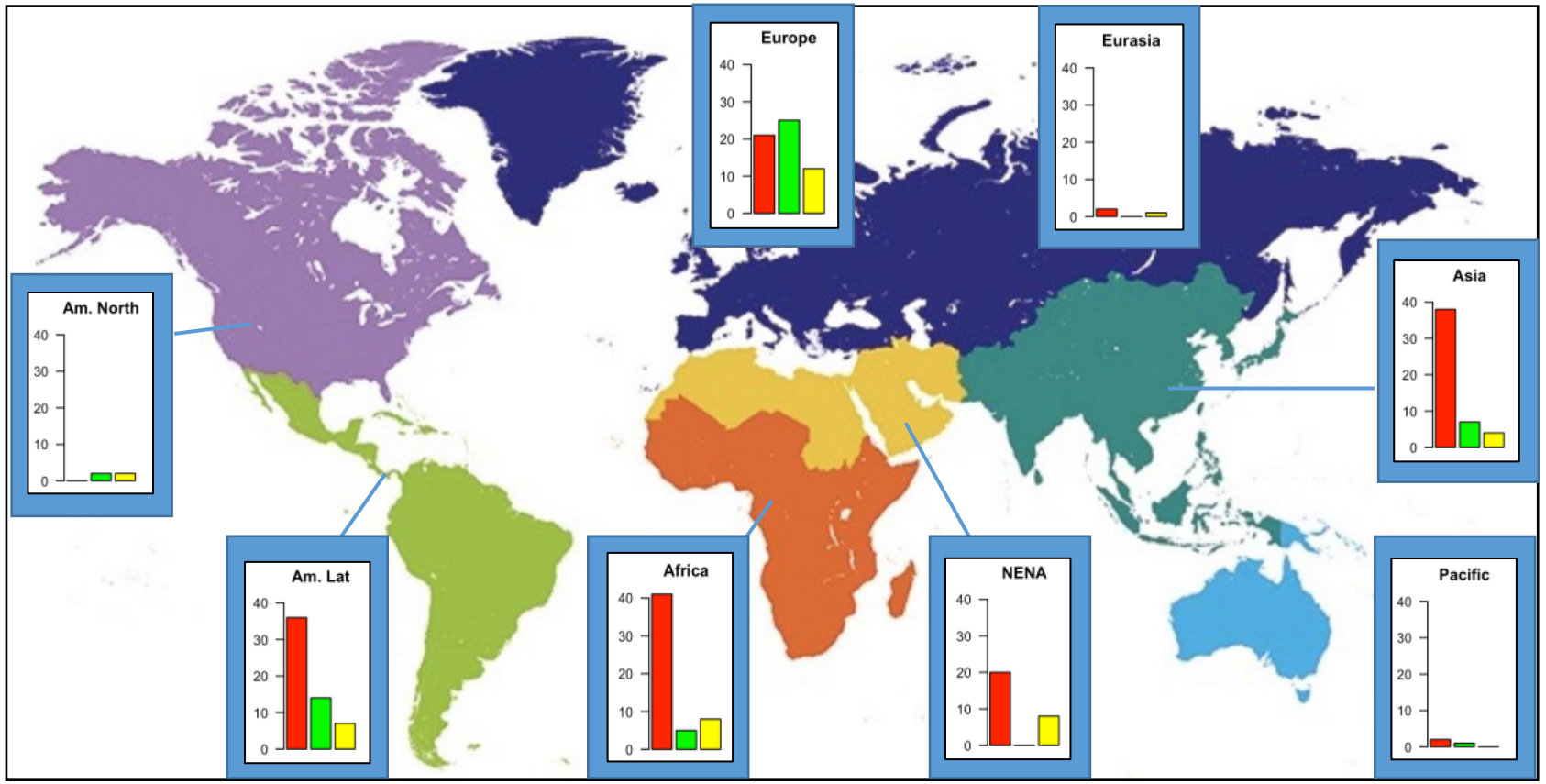
Result after correction (modification of Tyurin's method)



Unusual "educational" PT

Overview of the methods used to determine carbon from GLOSOLAN PT 2022

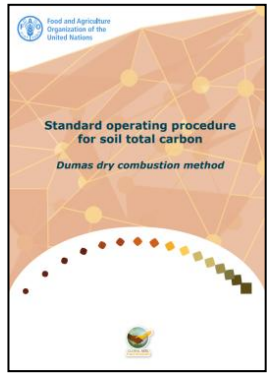


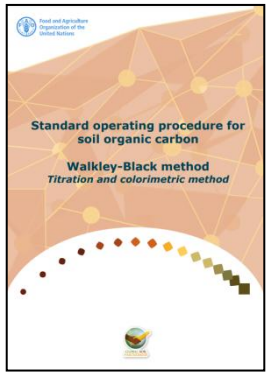
Walkley and Black
Dumas
Loss of Ignition

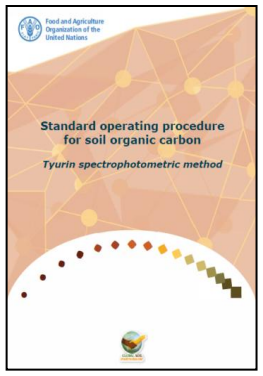
Tested methods

- Loss-on-ignition method **(LOI)**, SOP of GLOSOLAN in progress
- Dry combustion on the analyzer (**DC**),
- Walkley-Black's method (**W-B**),
- Tyurin's method (**T**) – %SOC = **0.17-8.7**,

SOPs of GLOSOLAN







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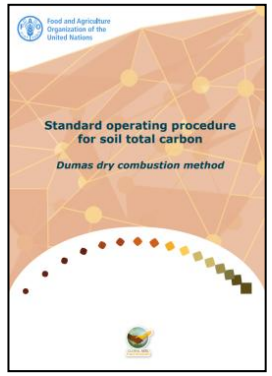
Teste

- Loss-or
- Dry cor
- Walkley
- Tyurin's




КОНТРОЛЬНЫЙ ЭКЗЕМПЛЯР

МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ
(Минобрнауки России)

Федеральное государственное бюджетное учреждение науки
Федеральный исследовательский центр
«Коми научный центр Уральского отделения Российской академии наук»
(ФИЦ Коми НЦ УрО РАН)

Институт биологии
Коми научного центра Уральского отделения Российской академии наук
(ИБ ФИЦ Коми НЦ УрО РАН)

УТВЕРЖДАЮ
Директор
ИБ ФИЦ Коми НЦ УрО РАН, д.б.н.
С. В. Дёгтева
«__» _____ 2020 г.

Методика измерений № 88-17641-001-2020

Методика измерений № 88-17641-001-2020 (ФР.1.31.2020.38218)

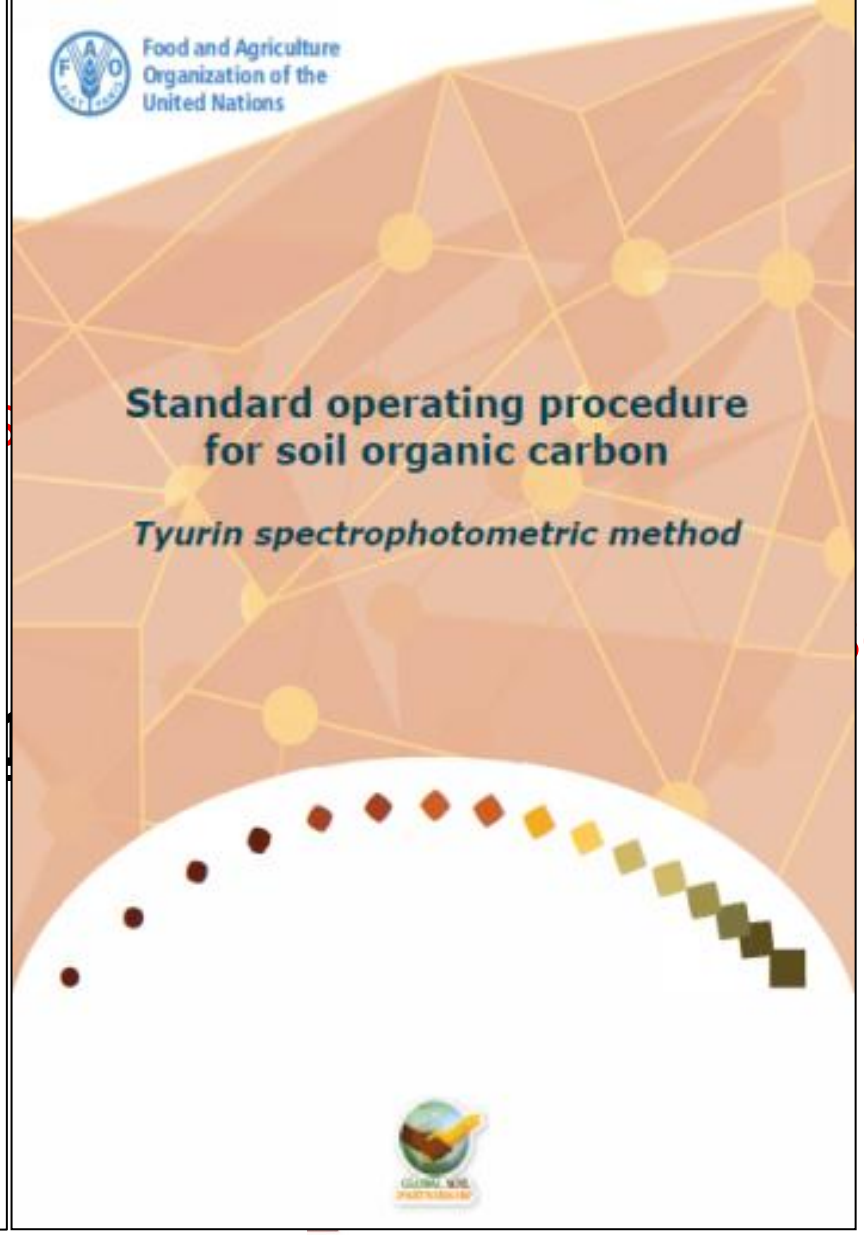
ПОЧВЫ, ГРУНТЫ, ПОЧВООБРАЗУЮЩИЕ ПОРОДЫ, ДОННЫЕ ОТЛОЖЕНИЯ

МЕТОДИКА ИЗМЕРЕНИЙ
МАССОВОЙ ДОЛИ УГЛЕРОДА
ОРГАНИЧЕСКИХ СОЕДИНЕНИЙ И ОРГАНИЧЕСКОГО ВЕЩЕСТВА
ФОТОМЕТРИЧЕСКИМ МЕТОДОМ
(методы Тюрина и Уолкли-Блэка)

Аттестована
Центром «СЕРТИМЕТ»
АХУ УрО РАН

Настоящая методика включена в реестр
методик измерений УрО РАН
за № 88-17641-001-2020

Сыктывкар
2020



Walkley-Black's method
-Tyurin's method

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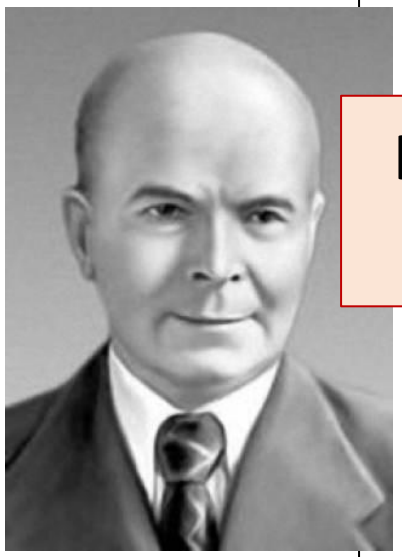
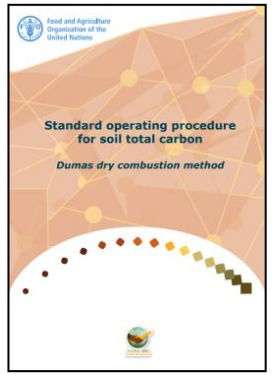


Ivan Vladimirovich Tyurin (1892-1962)

***f* = 1.17** (Arinushkina, 1962)

- Walkley
- Tyurin's

OLAN



КОНТРОЛЬНЫЙ ЭКЗЕМПЛЯР

МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ
(Минобрнауки России)

УТВЕРЖДАЮ
Директор
ФГБУН ИБПК ПЦ УрО РАН, д.б.н.
С. В. Дёгтева
2020 г.

Методика измерений № 88-17641-001-2020

Методика измерений № 88-17641-001-2020 (ФР.1.31.2020.38218)

ПОЧВЫ, ГРУНТЫ, ПОЧВООБРАЗУЮЩИЕ ПОРОДЫ, ДОННЫЕ ОТЛОЖЕНИЯ

МЕТОДИКА ИЗМЕРЕНИЙ
МАССОВОЙ ДОЛИ УГЛЕРОДА
ОРГАНИЧЕСКИХ СОЕДИНЕНИЙ И ОРГАНИЧЕСКОГО ВЕЩЕСТВА
ФОТОМЕТРИЧЕСКИМ МЕТОДОМ
(методы Тюрина и Уолкли-Блэка)

Аттестована
Центром «СЕРТИМЕТ»
АХУ УрО РАН

Настоящая методика включена в реестр
методик измерений УрО РАН
за № 88-17641-001-2020

Екатеринбург
2020

Food and Agriculture Organization of the United Nations

Standard operating procedure
for soil organic carbon

Tyurin spectrophotometric method

Walkley-Black's method
-Tyurin's method

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Methods / Modifications

- Tyurin's method

Protocol	SOC oxidation	Phase separation	Method	*f* (Tyurin)	Result
GLOSOLAN SOP = № 88-17641-001-2020	Heating in a water bath for 1 hour	Centrifugation Settling	Photometry	1,15	%SOC
GOST 26213-91	Heating in a sand bath for 1 hour	Settling	Photometry	1	%SOM
Recommendations	Heating in a thermostat: T = 150 °C , t = 20 min	-	Titrimetry	1	%SOC

- Walkley-Black's method – Centrifugation, Settling

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The task of the PT participant

From 1 to 4 methods depending on the capabilities of laboratories

№	Methods	Units of measure	Soil A			Soil B			Soil C			Soil D			Soil E			Soil F			Soil G			Soil H			Soil I		
1	DC	%	$A1_1$	$A1_2$	$A1_3$	$B1_1$	$B1_2$	$B1_3$	$C1_1$	$C1_2$	$C1_3$	$D1_1$	$D1_2$	$D1_3$	$E1_1$	$E1_2$	$E1_3$	$F1_1$	$F1_2$	$F1_3$	$G1_1$	$G1_2$	$G1_3$	$H1_1$	$H1_2$	$H1_3$	$I1_1$	$I1_2$	$I1_3$
2	W-B	%	$A2_1$	$A2_2$	$A2_3$	$B2_1$	$B2_2$	$B2_3$	$C2_1$	$C2_2$	$C2_3$	$D2_1$	$D2_2$	$D2_3$	$E2_1$	$E2_2$	$E2_3$	$F2_1$	$F2_2$	$F2_3$	$G2_1$	$G2_2$	$G2_3$	$H2_1$	$H2_2$	$H2_3$	$I2_1$	$I2_2$	$I2_3$
3	T	%	$A3_1$	$A3_2$	$A3_3$	$B3_1$	$B3_2$	$B3_3$	$C3_1$	$C3_2$	$C3_3$	$D3_1$	$D3_2$	$D3_3$	$E3_1$	$E3_2$	$E3_3$	$F3_1$	$F3_2$	$F3_3$	$G3_1$	$G3_2$	$G3_3$	$H3_1$	$H3_2$	$H3_3$	$I3_1$	$I3_2$	$I3_3$
4	LOI	%	$A4_1$	$A4_2$	$A4_3$	$B4_1$	$B4_2$	$B4_3$	$C4_1$	$C4_2$	$C4_3$	$D4_1$	$D4_2$	$D4_3$	$E4_1$	$E4_2$	$E4_3$	$F4_1$	$F4_2$	$F4_3$	$G4_1$	$G4_2$	$G4_3$	$H4_1$	$H4_2$	$H4_3$	$I4_1$	$I4_2$	$I4_3$

Soil A = Soil F = Soil I

Soil B = Soil G = Soil H

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Parameters of control samples

%SOC															%SOM				
DC					T					W-B					LOI				
					%SOC = 0.17-8.7														
Soils																			
AFI	BGH	C	D	E	AFI	BGH	C	D	E	AFI	BGH	C	D	E	AFI	BGH	C	D	E
6.44	2.32	0.197	0.118	7.87	6.75	2.30	0.188	**0.105**	7.64	7.2	2.47	0.195	**0.103**	7.89	12.9	5.45	0.657	2.77	19.0

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Standards for control of measurement result accuracy

T, W-B (Protocol № 88-17641-001-2020)	
SOC	**Accuracy**
%	
0.17-8.7 incl.	20
Soil D 0.1	**40**

DC (Protocol № 88-17641-004-2016)	
SOC	**Accuracy**
%	
0.1-2 incl.	23
2-5 incl.	15
5-10 incl.	10

LOI (based on the results of PT)	
SOM	**Accuracy**
%	
0.5-5 incl.	25
5-10 incl.	10
10-25 incl.	5

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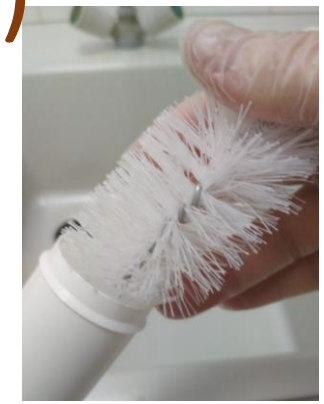
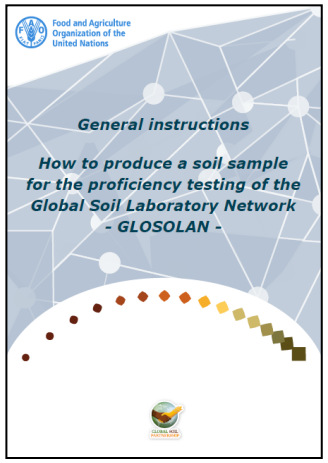
Homogeneity - Before the start of PT (GOST 8.531)

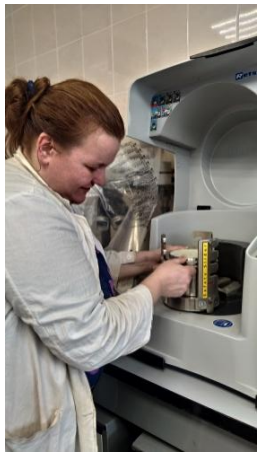


10 times 2 parallel repetitions for each sample for each method = 20 measurements for each sample for each method

Stability - During PT (R 50.2.031-2003)

10 times (May-September) 1-2 parallel replicates for each sample for each method = 10-20 measurements for each sample for each method



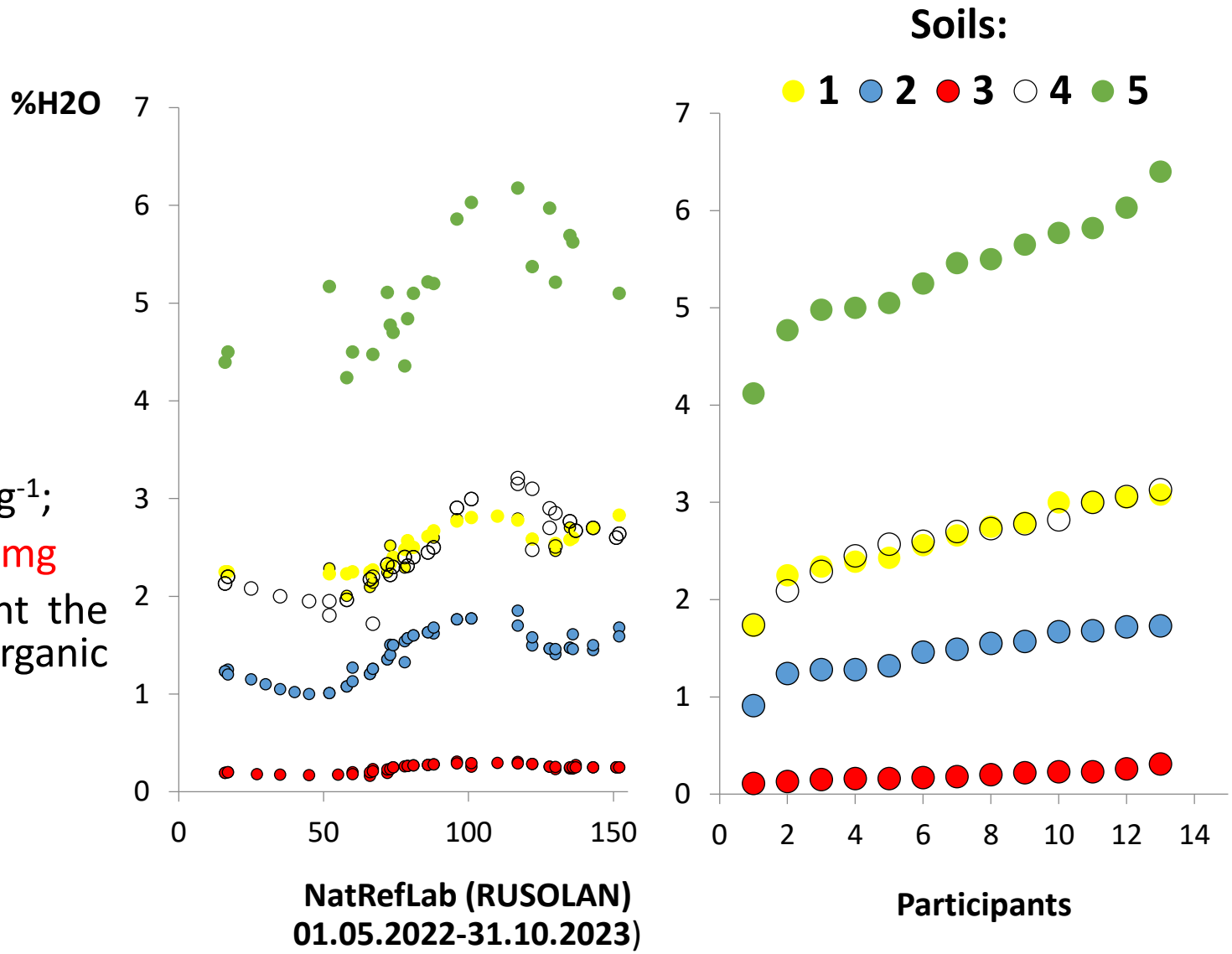


Soil moisture (*W*)

$$\%SOC = \frac{(A - A_0)}{Km} 100$$

- A – absorbance of study solution;
- A_0 – coefficient of calibration function;
- K – coefficient of calibration function, mg^{-1};
- m – mass of tested soil (***dried at 105˚C***), mg
- f – correction factor taking into account the incomplete oxidation of carbon of organic compounds

$$W = \frac{m_{\text{air dry soil}}}{m_{\text{dried at 105°C}}}$$



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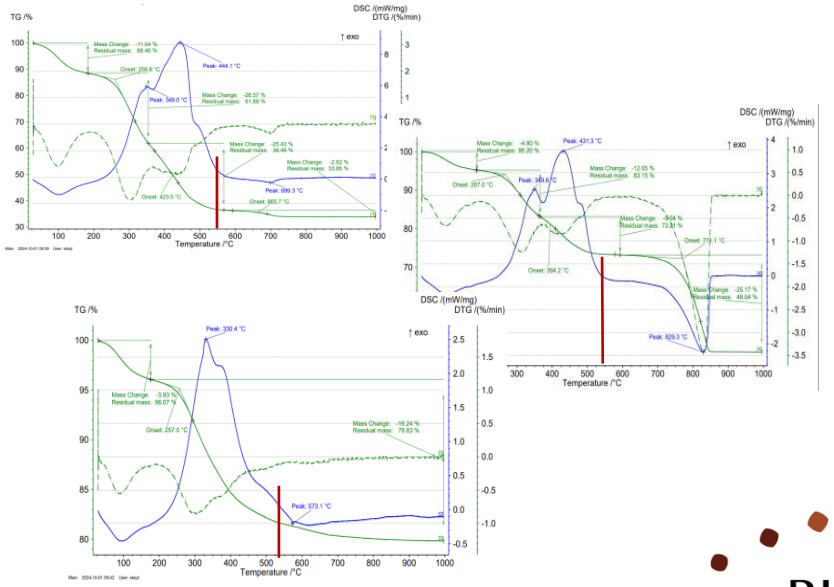
LOI: SOP of GLOSOLAN in progress

The bad news - **LOI has many modifications**!

T (450-550 °C), t, m_{soil}

Uniform LOI conditions.

The conditions were founded **experimentally**.



1. T = 550 °C,
2. t = 7 hours,
3. m_{soil} = 2,0-2,5 g

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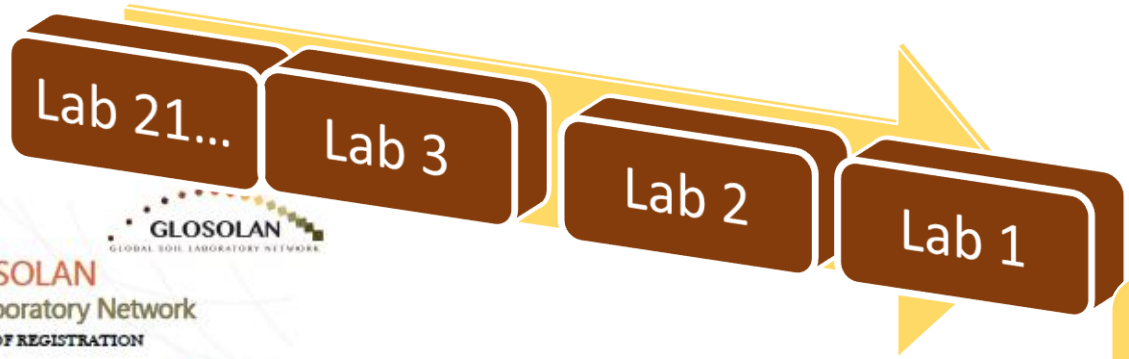


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CERTIFICATE OF REGISTRATION

This certificate is awarded to National Reference Laboratory of the Russian Federation (Institute of Biology, Komi Scientific Center, Ural Branch of the Russian Academy of Sciences) to acknowledge their role in the organization and implementation of the GLOSOLAN first Eurasian Inter-Laboratory Proficiency Test (PT) on the measurement of soil organic carbon, in 2025

Statistical (Math) analysis of results

Webinar

PT participants

Final summary report

Personal analysis of participation (anonymous)

Recommen-dations


CERTIFICATE
We certify that the
participated in the GLOSOLAN Proficiency test Eurasia 2023 on the measurement of soil organic carbon

Research Article

V V V V

In our plans

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Are conversion factors functional?

Walkley-Black * 1,3 = Tyurin * 1,15 = Dry Combustion (*P* = 0,95)

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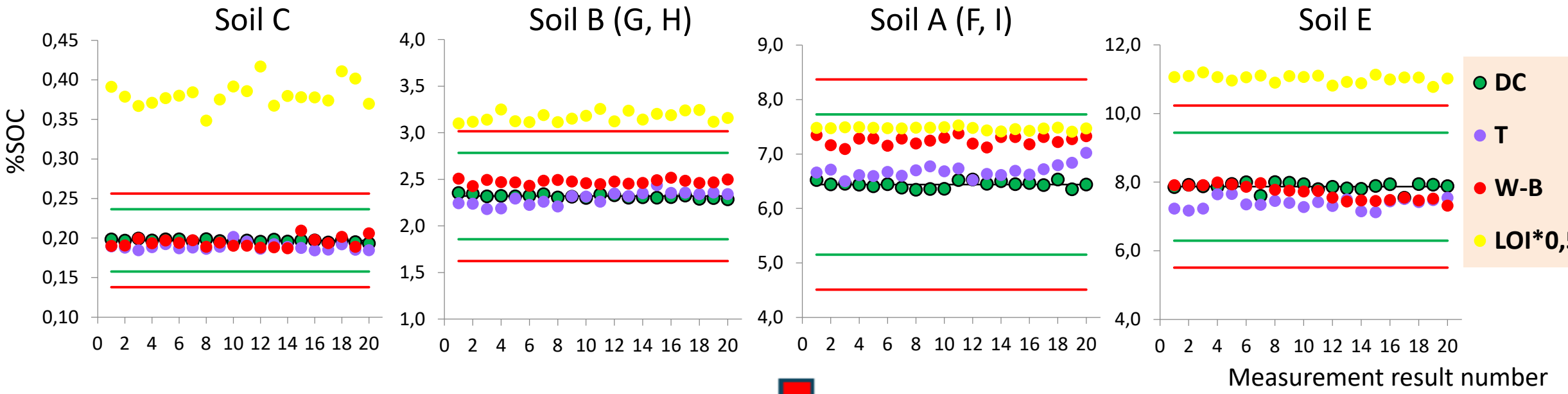
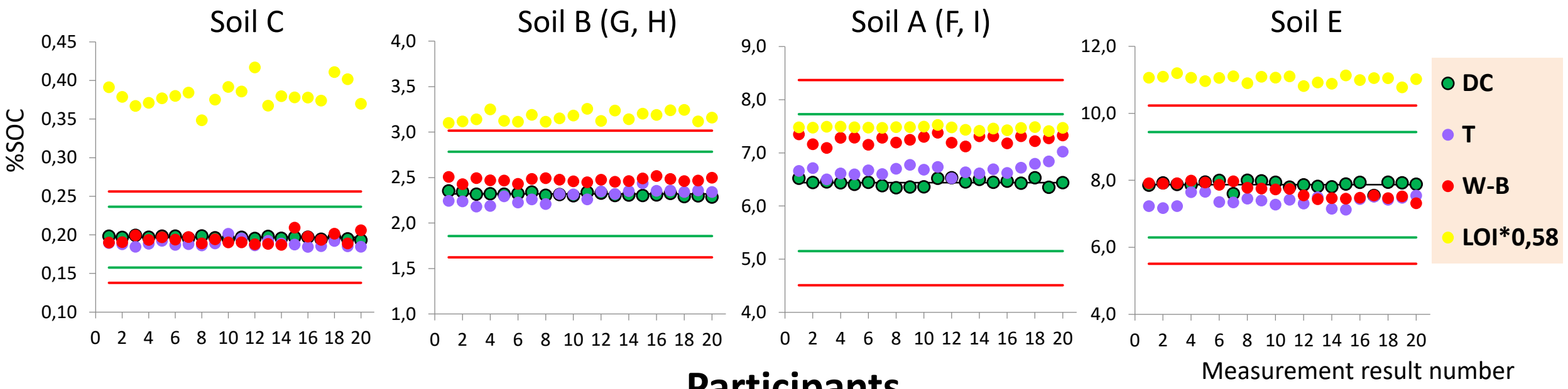
NatRefLab (RUSOLAN)

%SOM = %LOI, %SOC =%LOI * 0,58

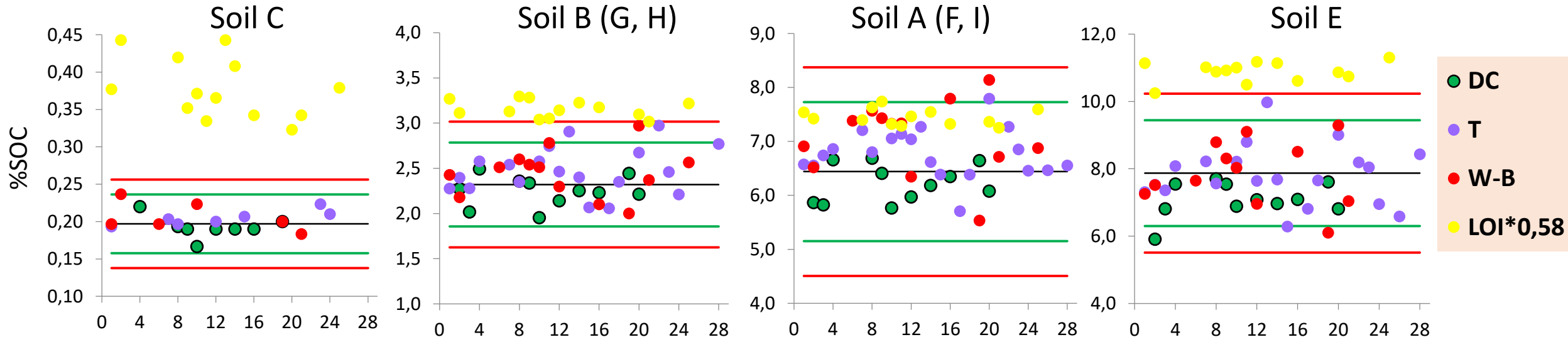


NatRefLab (RUSOLAN)

%SOM = %LOI, %SOC =%LOI * 0,58



Participants



Measurement result number / *not a laboratory number!!!!!!*

Are conversion factors functional?

Walkley-Black * 1,3 = Tyurin * 1,15 = Dry Combustion (*P* = 0,95)

YES!

If the researcher separates the solid and liquid phases by centrifugation!
Not settling, not filtration.
Modification of Tyurin's method (NatRefLab) passed the test.

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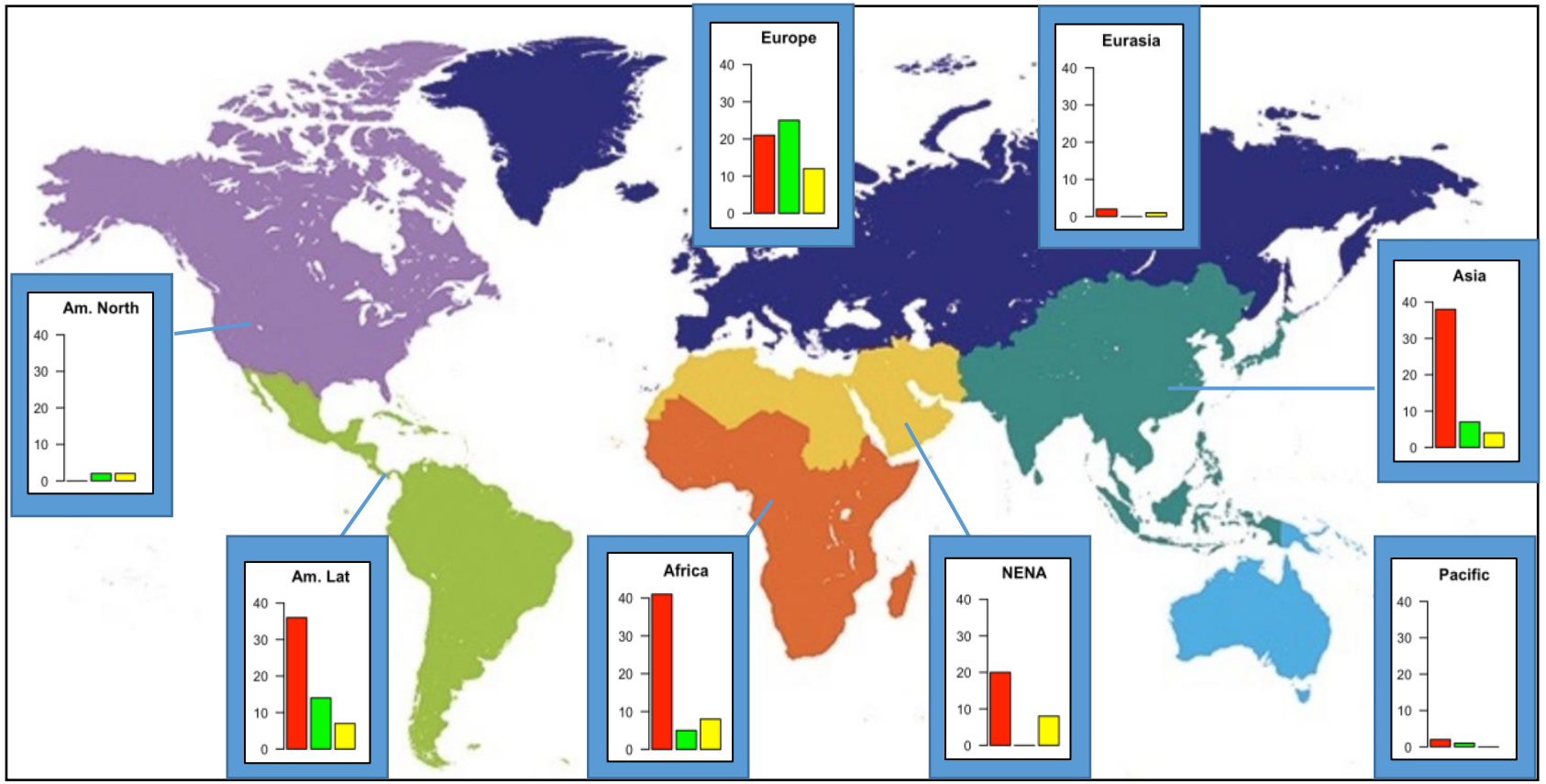
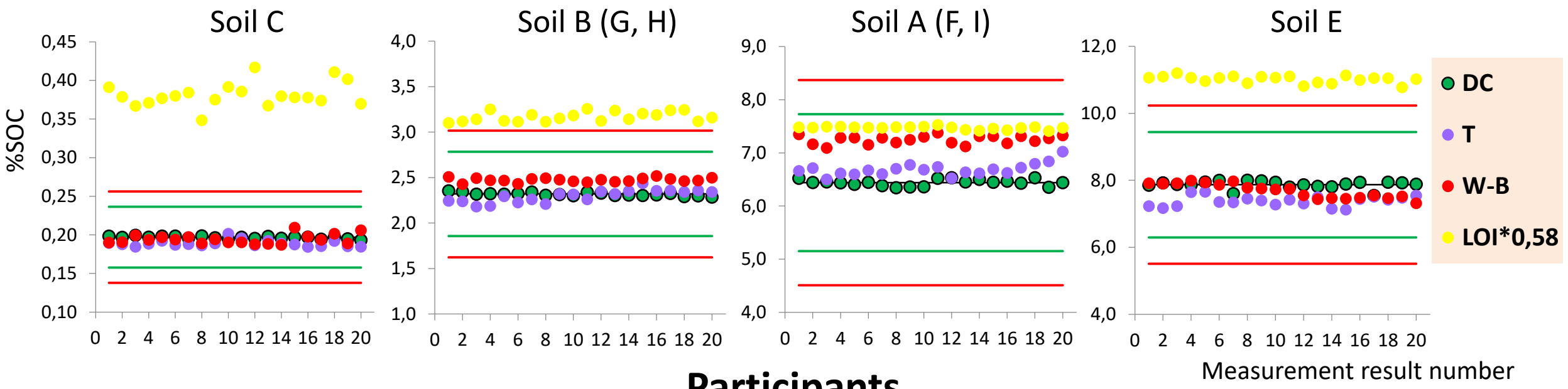
Overview of the methods used to determine carbon from GLOSOLAN PT 2022



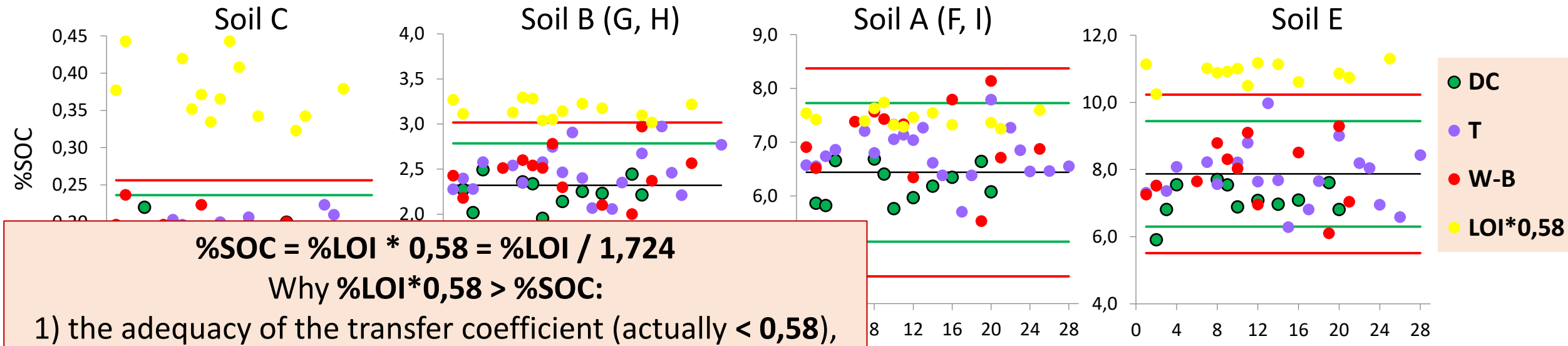
Walkley and Black
Dumas
Loss of Ignition

%SOM = %LOI, %SOC =%LOI * 0,58

NatRefLab (RUSOLAN)



Participants



%SOC = %LOI * 0,58 = %LOI / 1,724

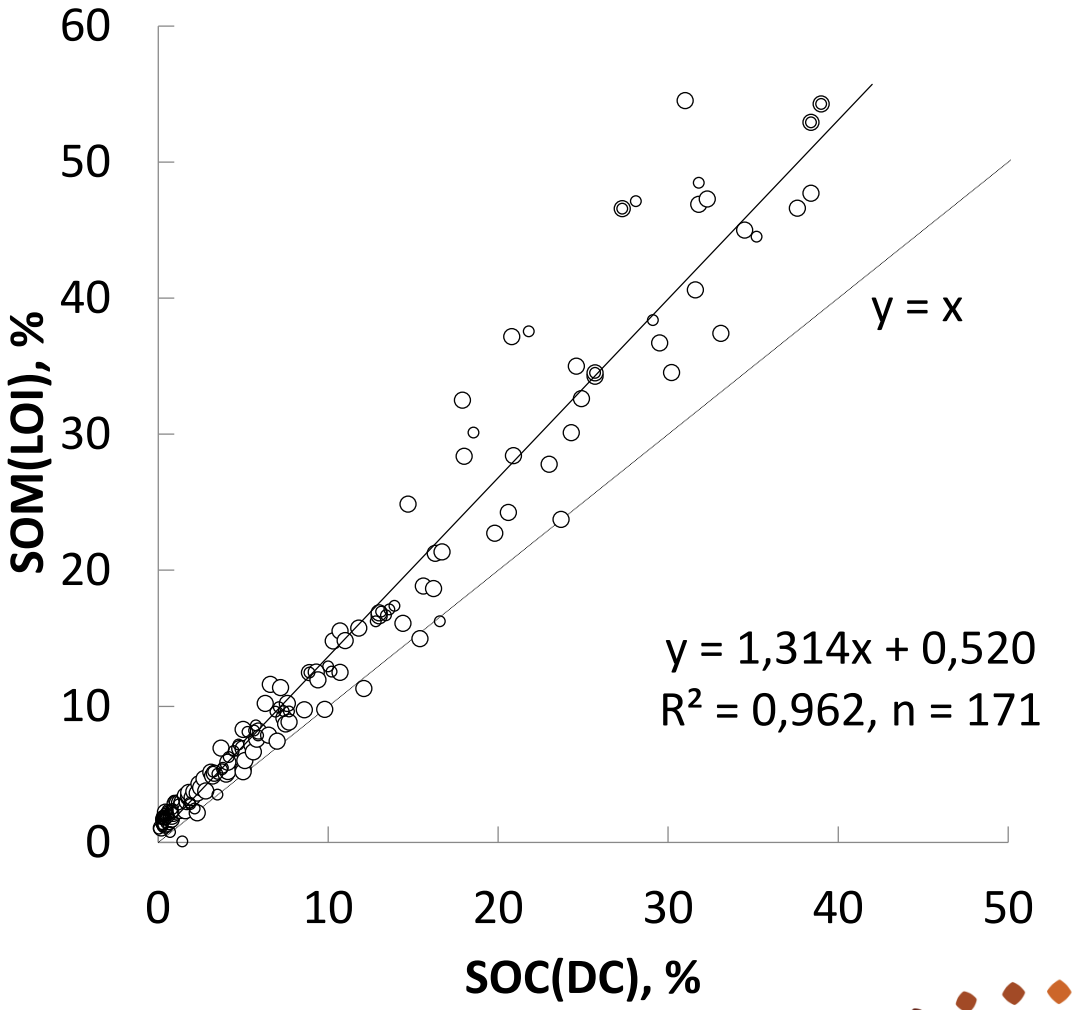
Why **%LOI*0,58 > %SOC:**

1) the adequacy of the transfer coefficient (actually **< 0,58**),

2) mineral components decomposing at *T* = 550 °C

In the literature ***k* = 0.4-0.71** (Kamara et al., 2007; Pribyl, 2010; Roper et al., 2019).

In our research ~~*k = 0.58,*~~ *k* = 0.43 (Organic carbon content 43%)



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Are conversion factors functional?

Walkley-Black * 1,3 = Tyurin * 1,15 = Dry Combustion (*P* = 0,95) = *?LOI*

LOI is waiting harmonization

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https://ib.komisc.ru/rusolan/

Thank you for attention!

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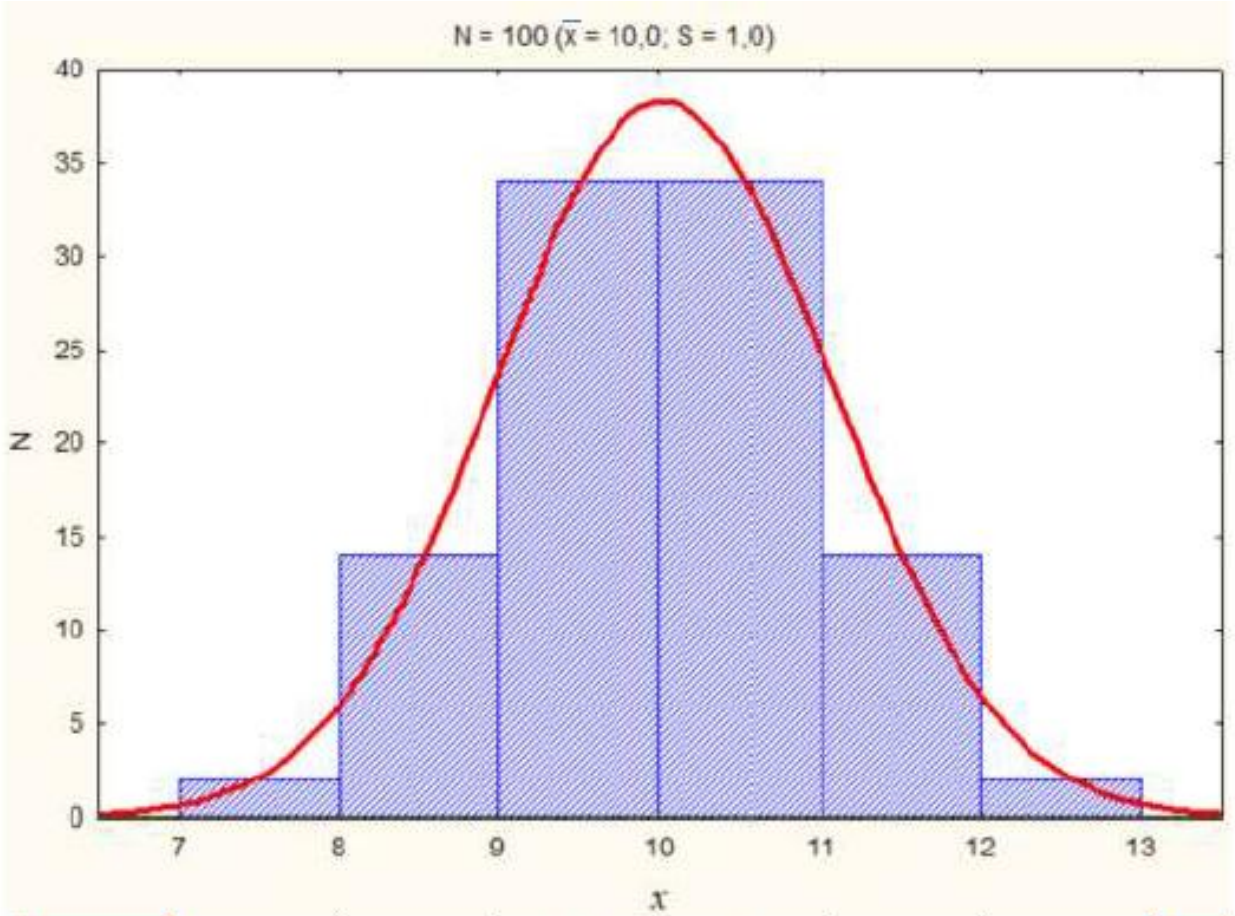
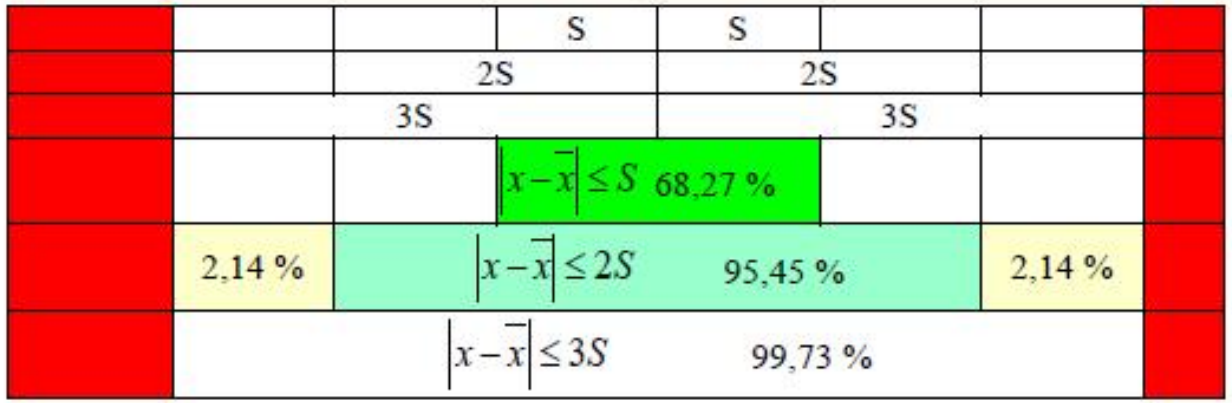
Метод	Относительное значение **внутрилабораторного** показателя правильности результатов измерений, $\theta_л(\delta)$, %	Относительное значение **межлабораторного** показателя правильности результатов измерений, $\theta(\delta)$, %
Soil E $\omega_{Ал}(C_{орг})_{СС} = 7{,}87\ \%$		
Сухого сжигания	0	-8,5
Тюрина	-2,9	0,38
Уолкли-Блэка	0,25	-1,4
ППП	**40**	**38**
Soil A(F, I) $\omega_{Ал}(C_{орг})_{СС} = 6{,}44\ \%$		
Сухого сжигания	0	-2,8
Тюрина	4,8	6,2
Уолкли-Блэка	**12** max	**12** max
ППП	16	16
Soil B(G, H) $\omega_{Ал}(C_{орг})_{СС} = 2{,}32\ \%$		
Сухого сжигания	0	-3,0
Тюрина	-0,9	7,8
Уолкли-Блэка	6,5	8,6
ППП	**36**	**36**
Soil C $\omega_{Ал}(C_{орг})_{СС} = 0{,}197\ \%$		
Сухого сжигания	0	1,6
Тюрина	0,5	7,0
Уолкли-Блэка	4,3	**12** max
ППП	**100**	**100**

Смещение результатов измерений массовой доли углерода органических соединений от аттестованного методом «сухого сжигания» – $\omega_{Ал}(C_{орг})_{СС}$ *(опорное значение)*

Примечание –

Для расчета показателя правильности результатов измерений (методы Тюрина и Уолкли-Блэка) использованы результаты измерений $\omega(C_{орг})$, полученные только при выполнении процедуры ***разделения твердой и жидкой фаз центрифугировани****ем.*





Из нормального распределения

2S – предел предупреждения,

3S – предел действия

δ = 2S.

Для всех методов приняли δ = ±20 %.