GLOBAL SYMPOSIUM ON SALT-AFFECTED SOILS

20 - 22 October, 2021
Virtual meeting

Monitoring three-dimensional soil salinity patterns at the field scale using electromagnetic induction sensing and inversion

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Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible

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Scope

- B-XII irrigation district (SW Spain, 14000 ha)
- Reclaimed saline marshes; subsurface drainage system @ 1m depth and 5-10 m spacing; 500 x 250 m plots
- Heavy clay (60-70%); saline water table @ ~1-1.5 m
- Conversion from furrow/sprinkler to drip irrigation
- Climate change (less winter rainfall)

⇒ Concerns about sustainability of this system

⇒ Demand for efficient salinity monitoring tools

B-XII irrigation district

Objectives

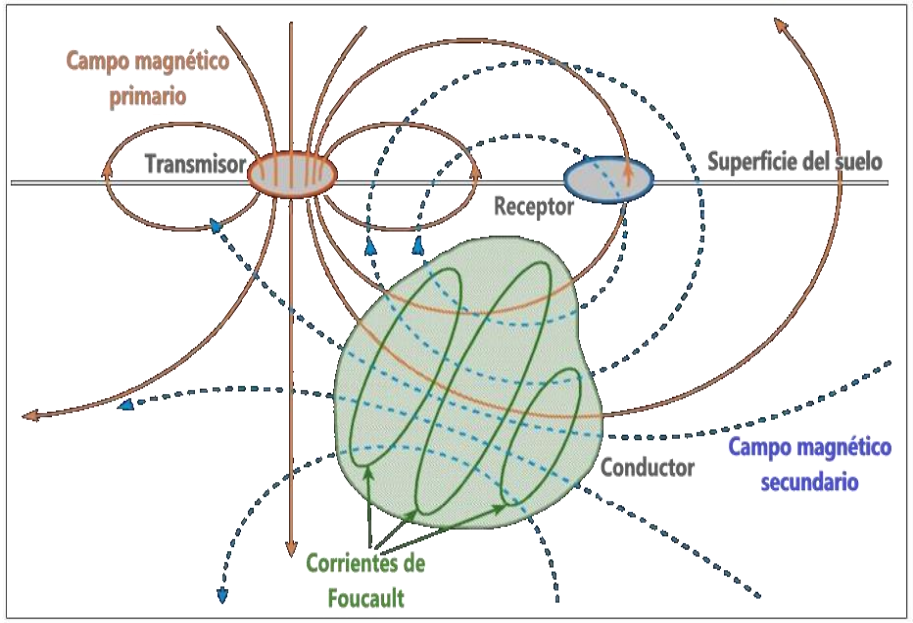
Evaluate **EMI sensing + inversion** as soil salinity monitoring tool in this hyperconductive environment

1. Evaluate **calibration equations** to estimate ECe and ESP
2. Map **depth-specific changes** in soil salinity/sodicity status at field scale
3. Relationship with **crop development (NDVI)**

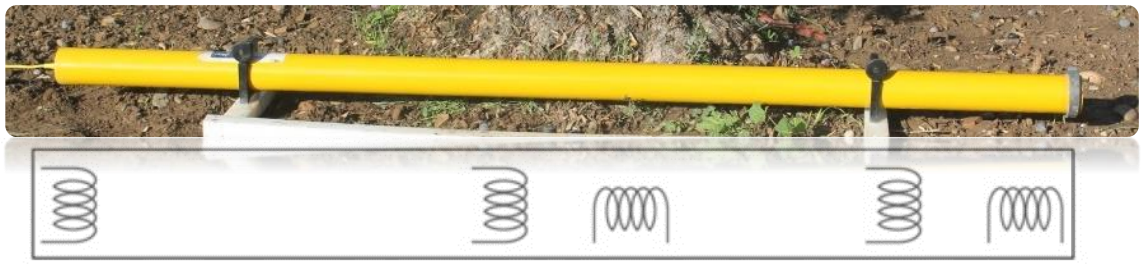


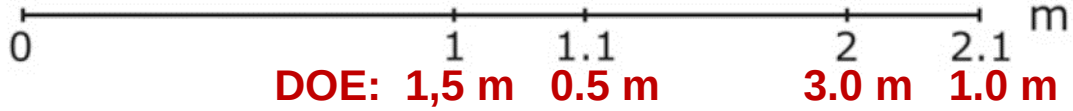



Methods - Electromagnetic induction (EMI) + inversion

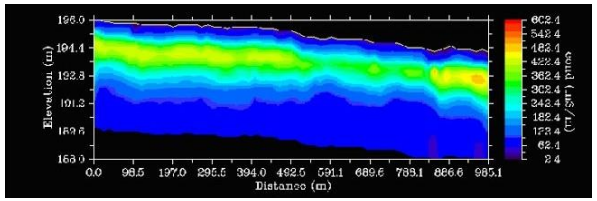


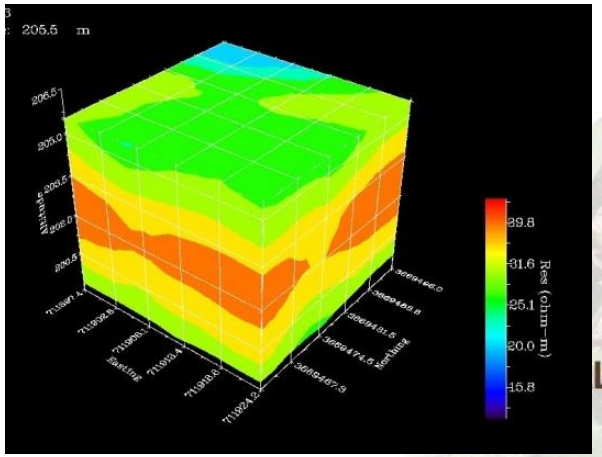
DUALEM-21S





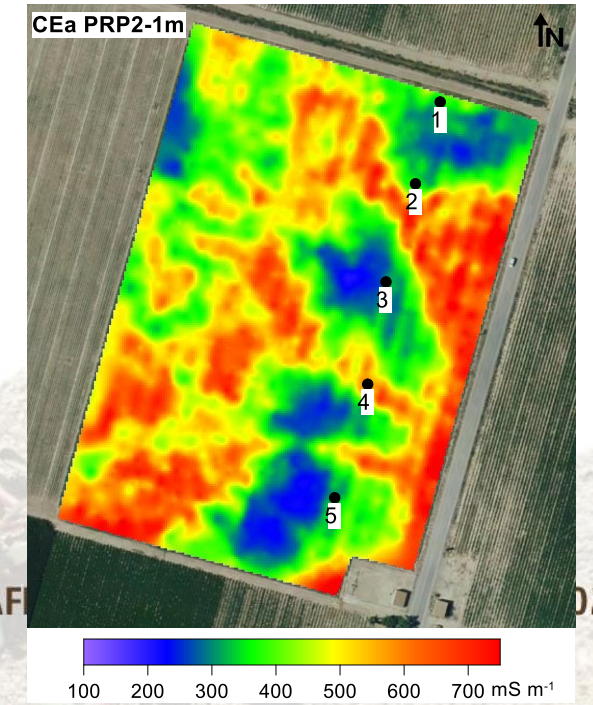
EM4Soil → EC imaging
(Triantafilis & Monteiro Santos, 2013)





Soil sampling & analysis

- ECa measurements in 4-ha field in Nov. 2017 and Feb. 2020
- Soil samples at 5 locations along transect; 5 depths, down to 1 m
- Analyzed for ECe and ESP



Results – ECa images 2017

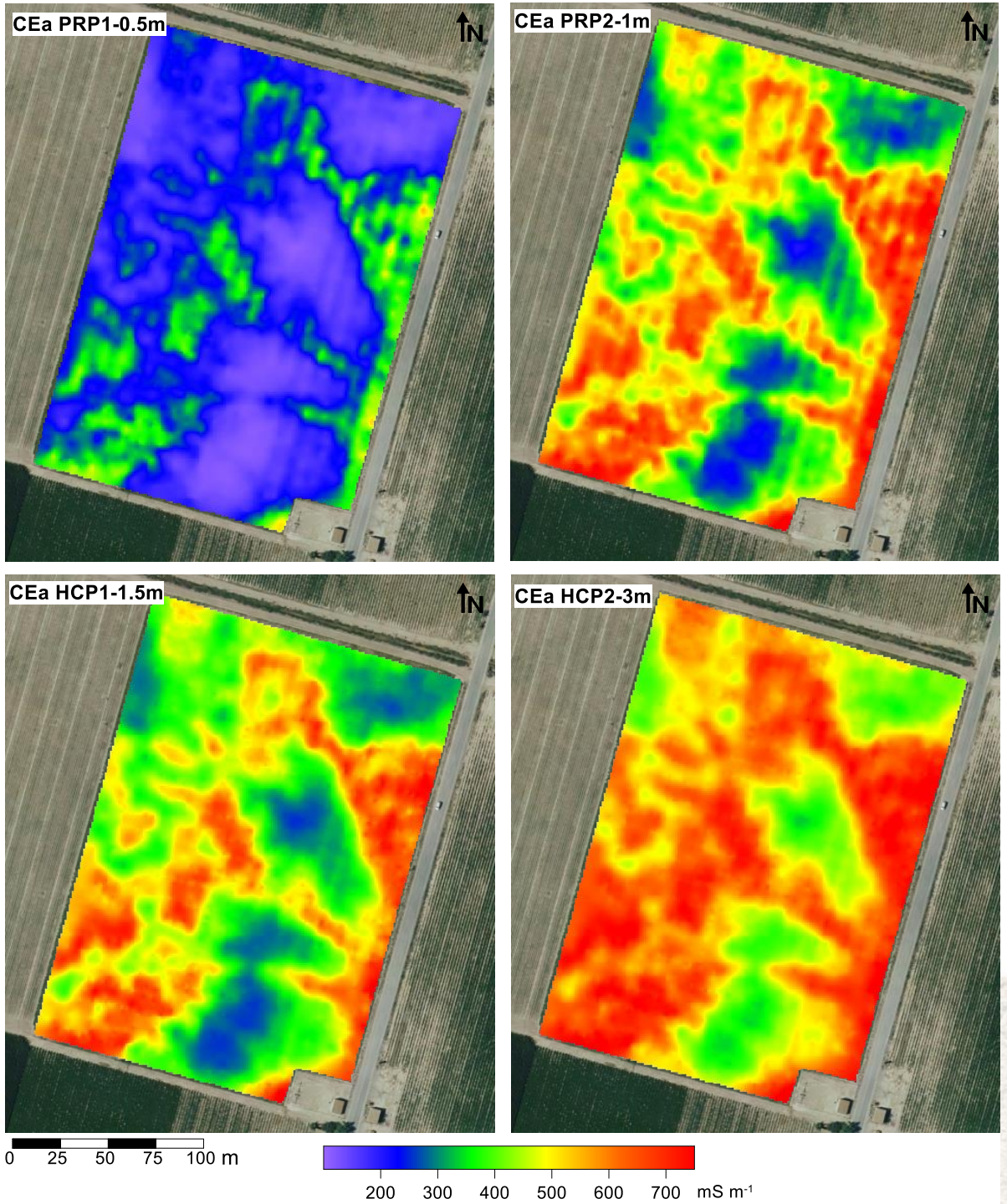
- Increasing ECa with DOE
- ECa **> 600 mS/m** for DOE ≥ 1 m!

  → shallow saline groundwater
- Areas with **ECa > 400 mS/m** for 0.5-m signal potentially harmful for crops
- Within field **variability**?

  ⇒ Clogged drainage pipes?

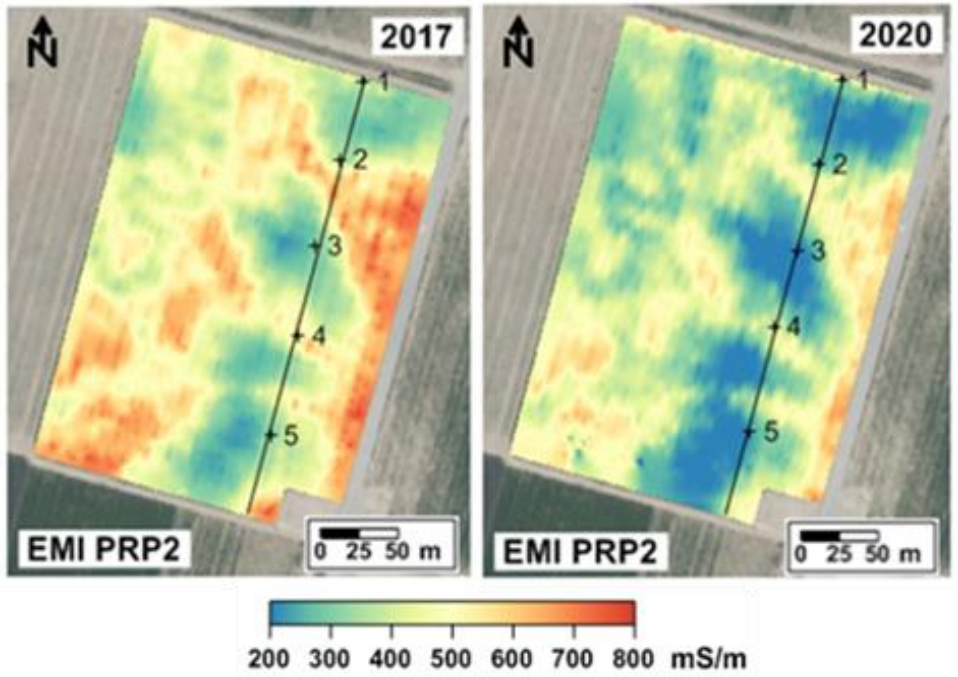
  ⇒ Road along eastern edge limits water+solute movement

  ⇒ Variability of soil physical properties?



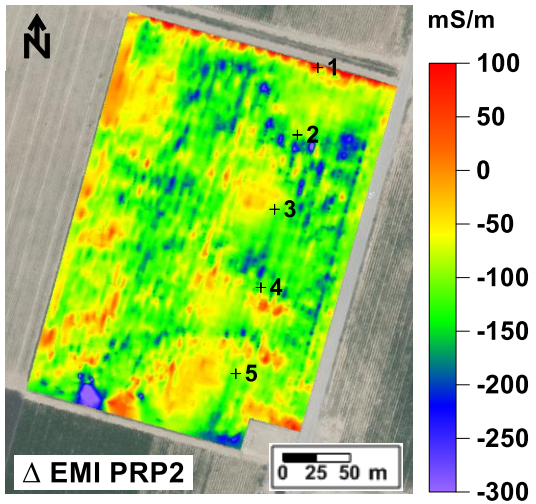
Results – ECa Nov. 2017 vs. Feb. 2020

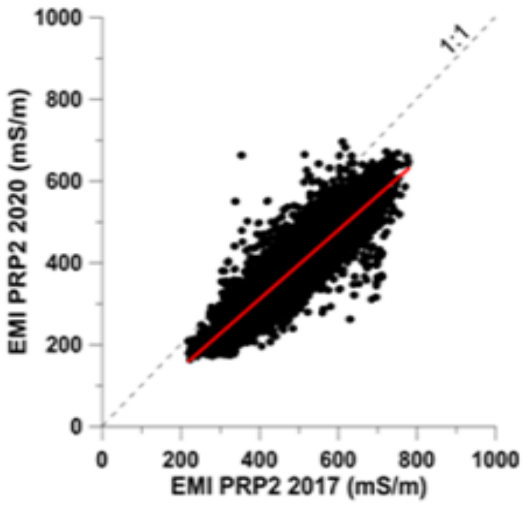
DOE 1 m

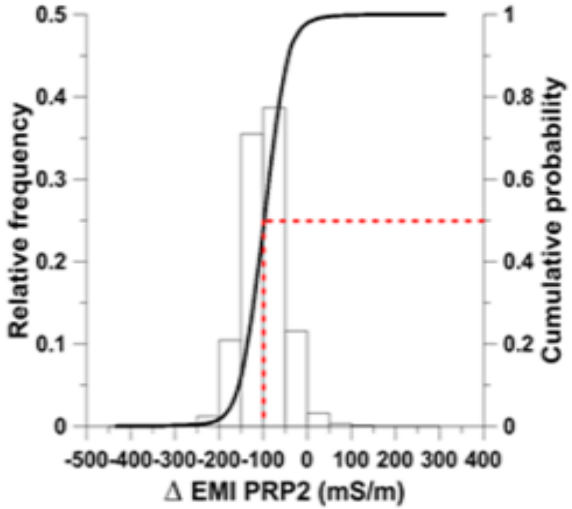


	DOE	~ 0-1 m		~ 0-3 m
ECa	PRP2 2017	PRP2 2020	HCP2 2017	HCP2 2020
m*	474.0	376.0	566.8	484.2
min	204.9	96.1	337.1	266.3
max	831.0	753.1	790.0	780.7
med	477.5	376.3	574.4	491.1
s	118.7	109.3	98.3	100.0
CV	0.25	0.29	0.17	0.21
Curt.	-0.826	-0.779	-0.885	-0.866
Skewn.	0.019	0.128	-0.185	-0.121

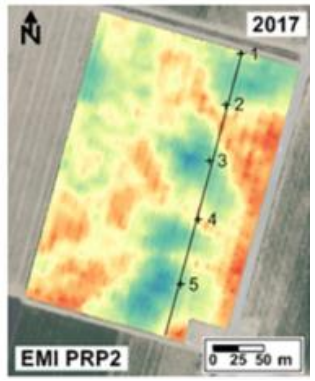
- ✓ Similar spatial ECa patterns
- ✓ Larger ECa in 2017 due to wetter soil
- ✓ ΔECa ~ ECa

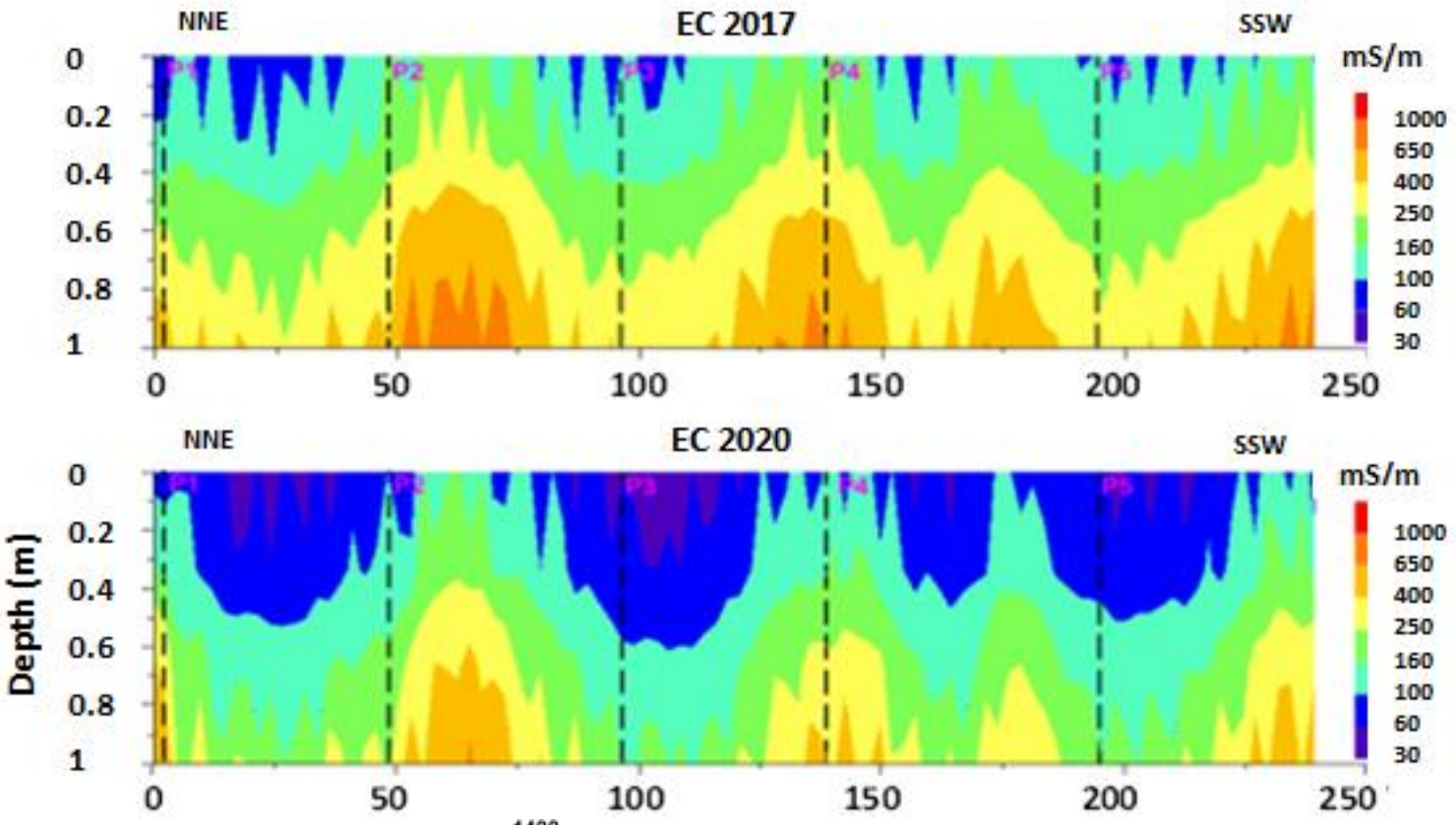




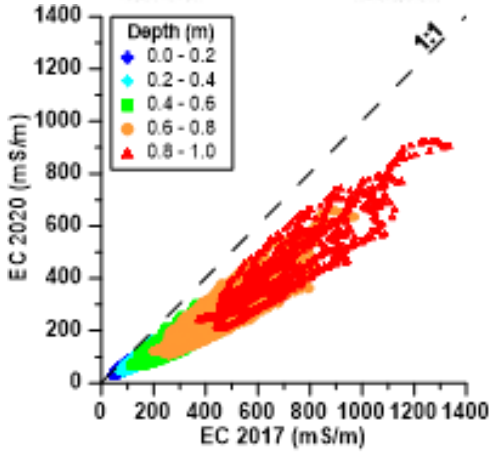


Results – 2D inversion along transect 1-5

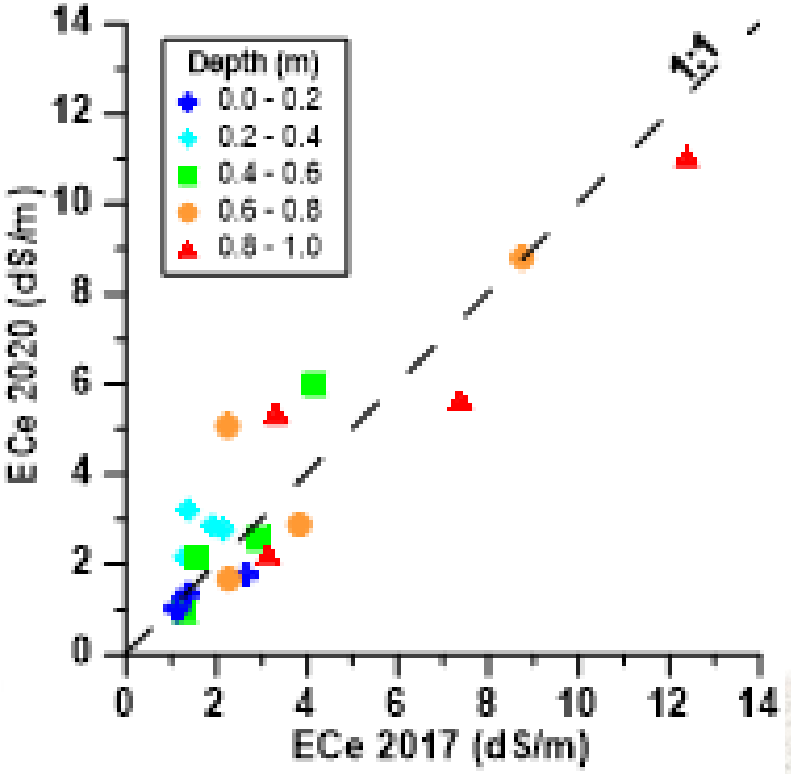




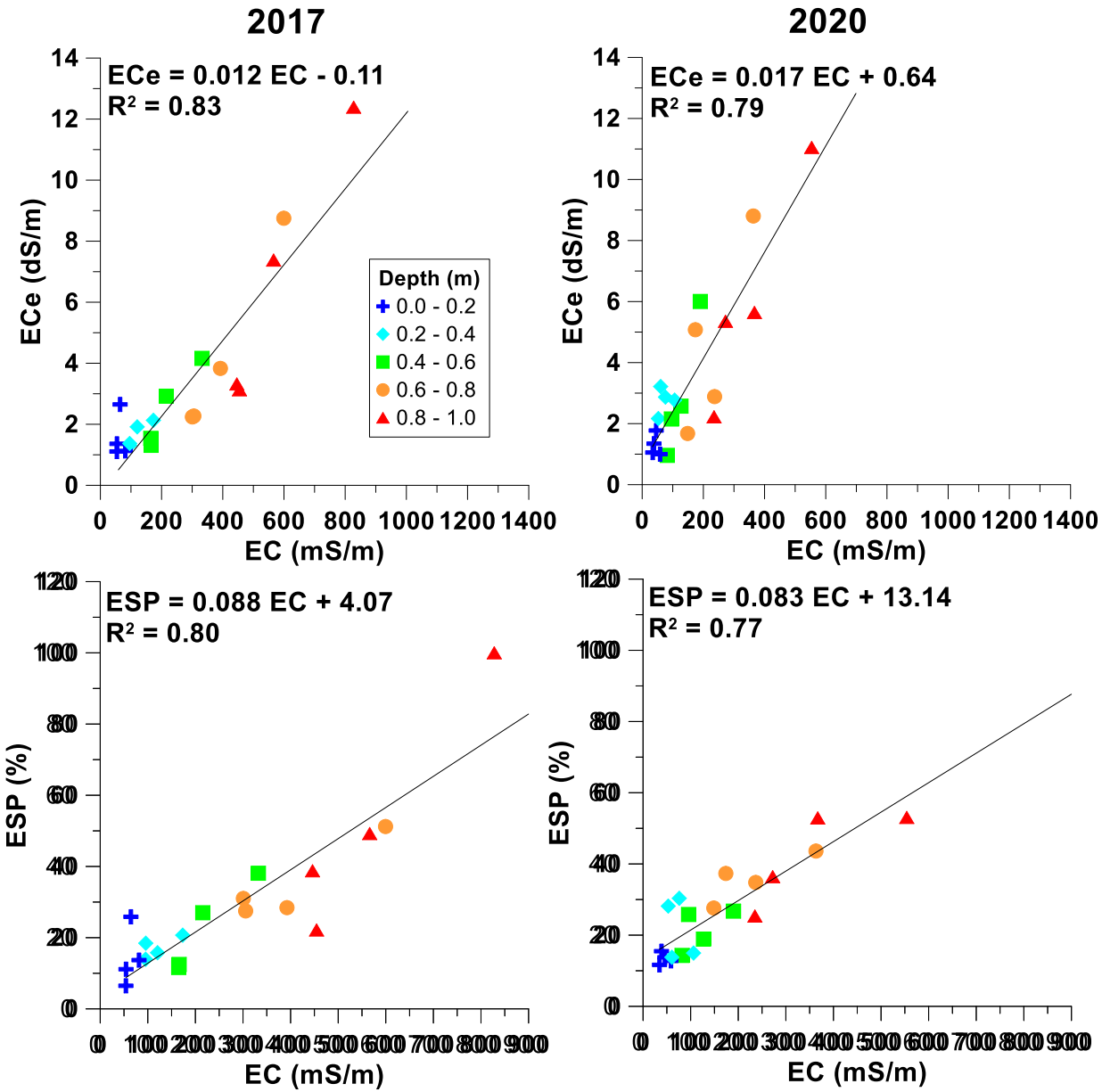
Estimated EC



Measured ECe

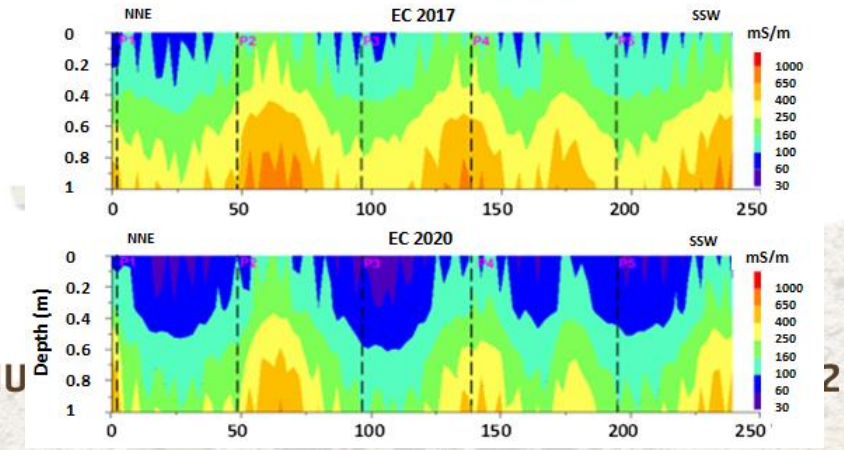


Results – ECe and ESP calibration 2D inversion

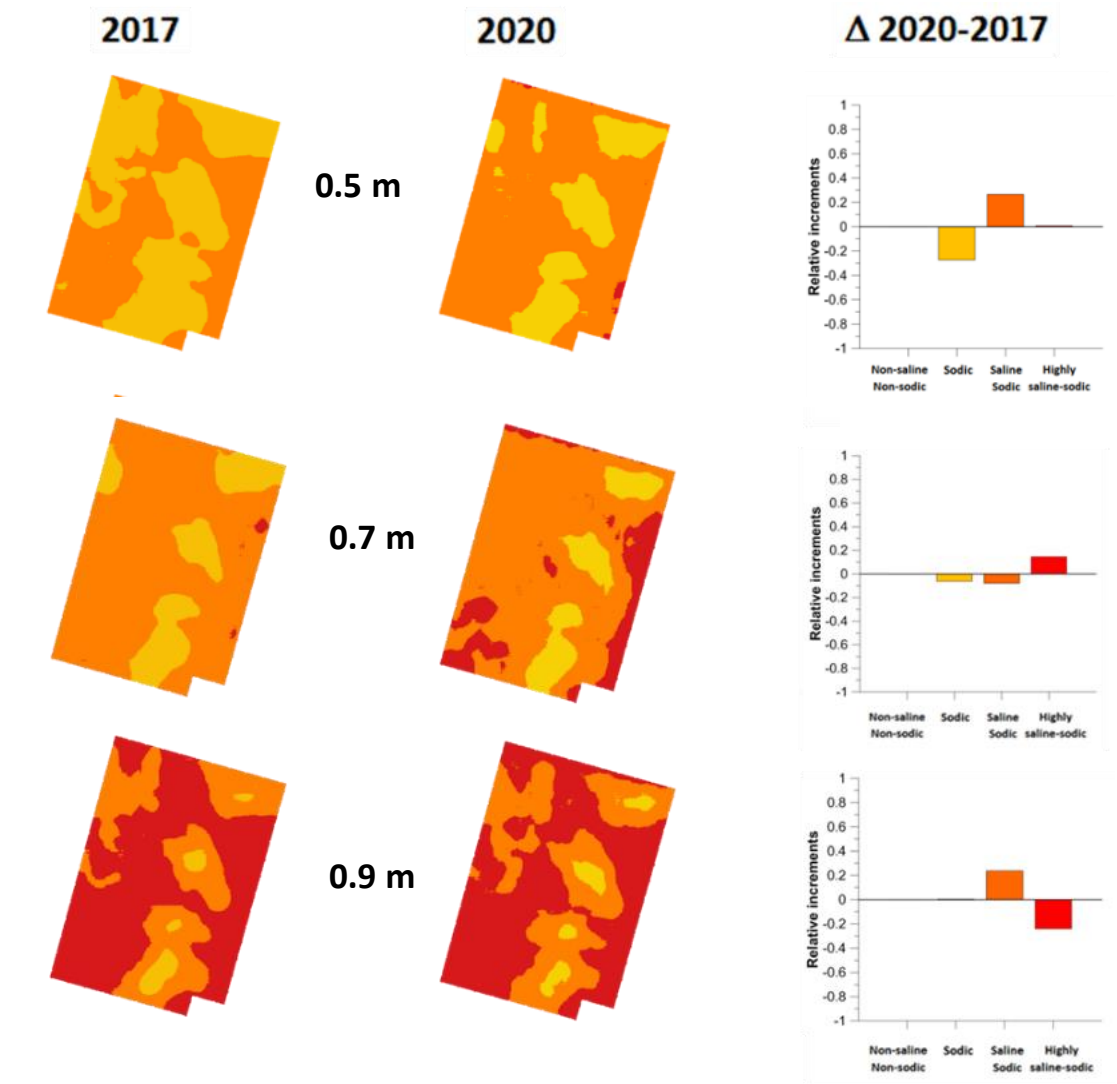


Depth-specific correlations with EC

R		0.1 m	0.3 m	0.5 m	0.7 m	0.9 m
ECe	2017	-0.02	0.92	0.96	0.99	0.99
	2020	-0.12	0.22	0.98	0.84	0.96
ESP	2017	0.33	0.72	0.96	0.71	0.83
	2020	-0.06	-0.37	0.61	0.85	0.83



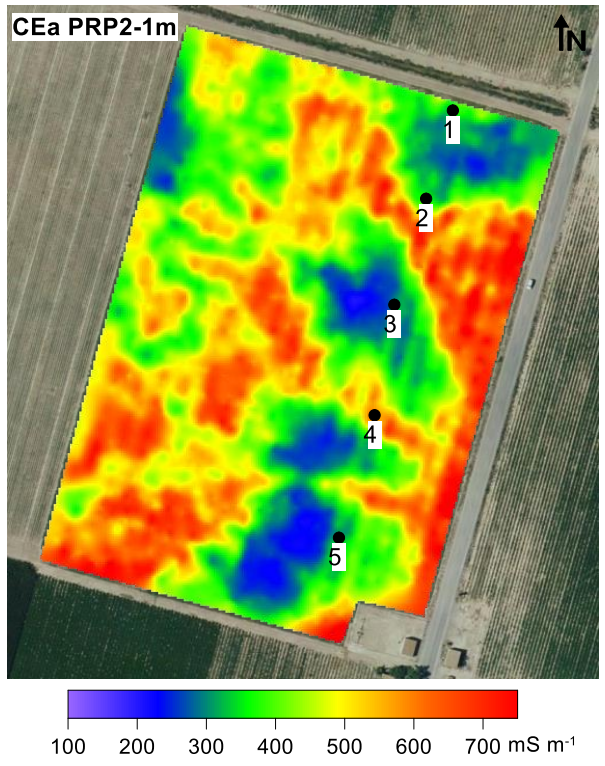
Results – 3D inversion and saline/sodic classification

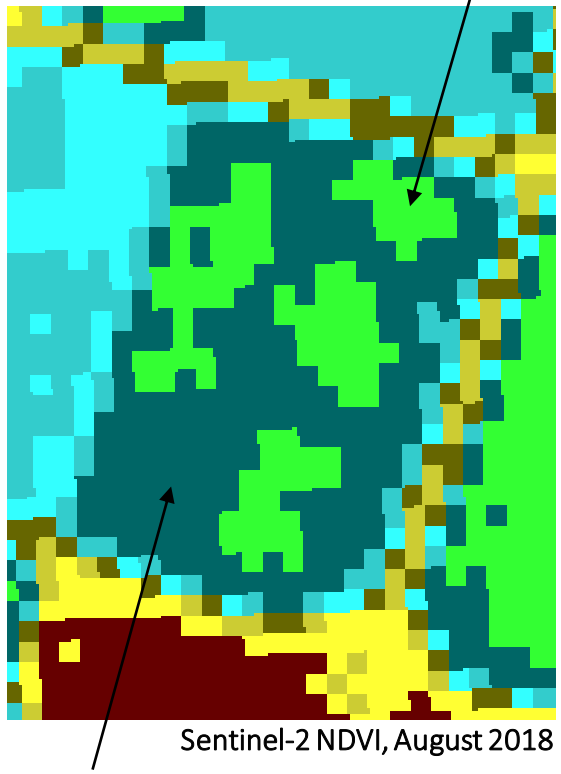


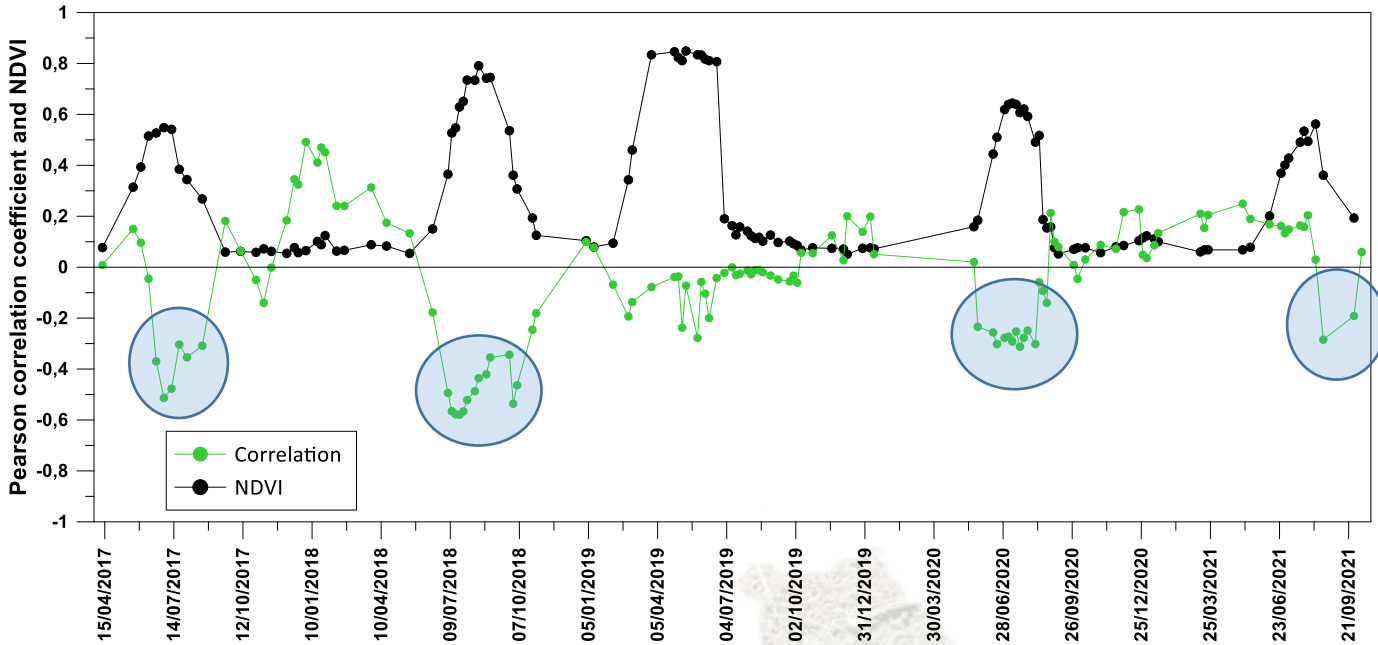
- ✓Potential for detailed **depth-specific** classification of salinity/sodicity status
- ✓So far no reliable estimates for **topsoil** (0-0.4 m)

Results – Relationship with crop development

ECa vs. NDVI







ECa-related pattern emerges in NDVI images (Sentinel-2) of irrigated summer crops (*e.g.* tomato, cotton)

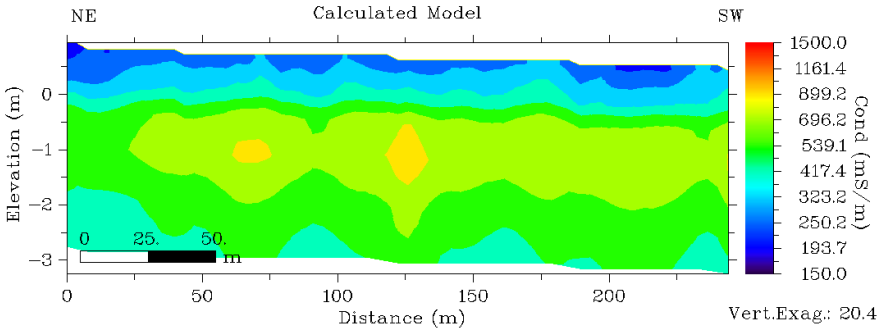
Conclusions

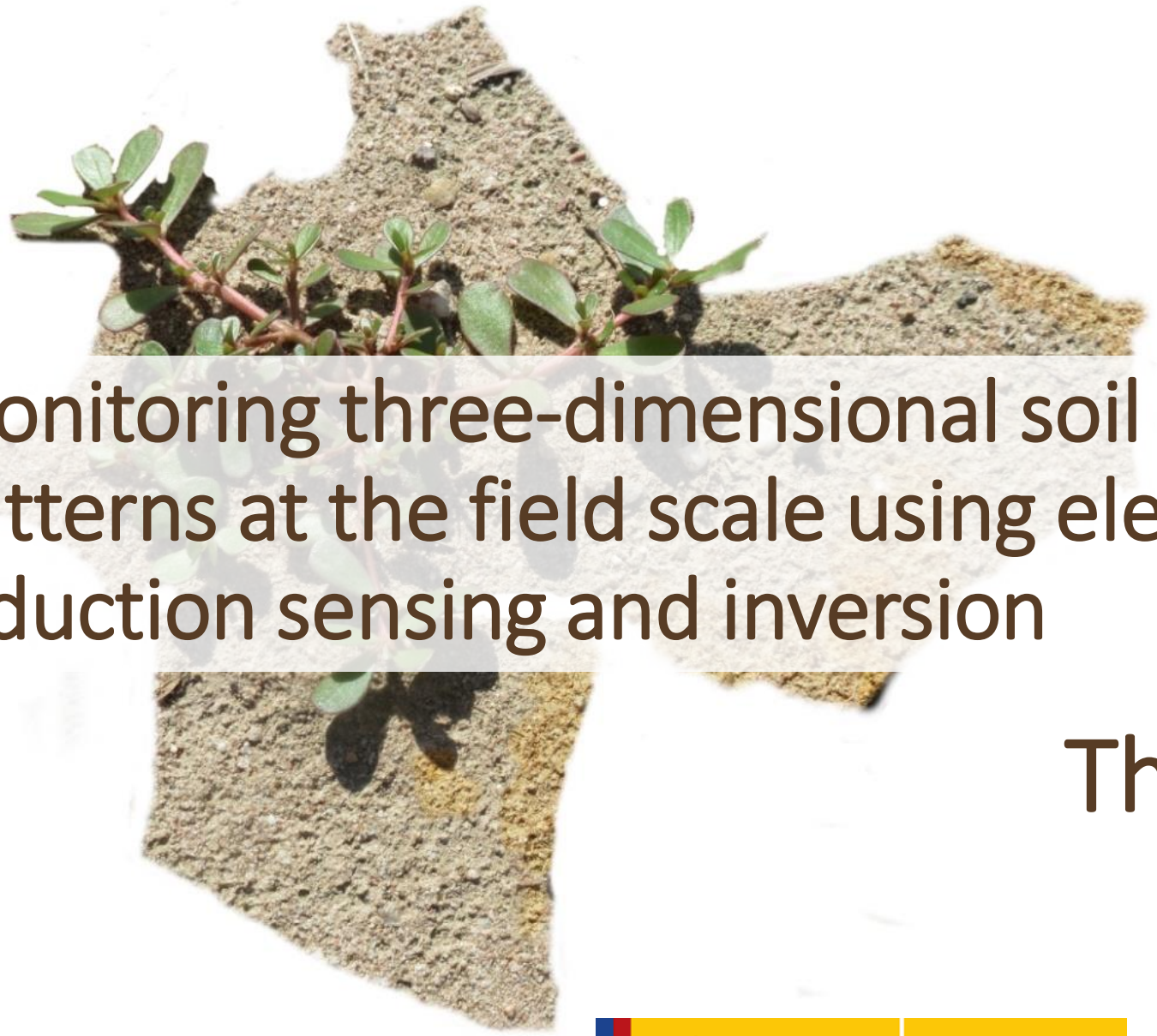
- ✓ Overall useful **EC-ECe and EC-ESP relationships** ($R^2 \approx 0.8$)
- ✓ Reliable depth-specific relations only for **> 0.4 m depth**
- ✓ Depth-specific classification of **salinity/sodicity status**
- ✓ Inverse relationship between **ECa and NDVI** during growing season (summer!)

⇒ Potential for use of EMI + inversion for **monitoring soil salinity status** in B-XII irrigation district

⇒ Use **EMI sensor** that provides more detail in the **topsoil**

⇒ Consider **soil water content** in EC-ECe and EC-ESP relationships





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Thank you!

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