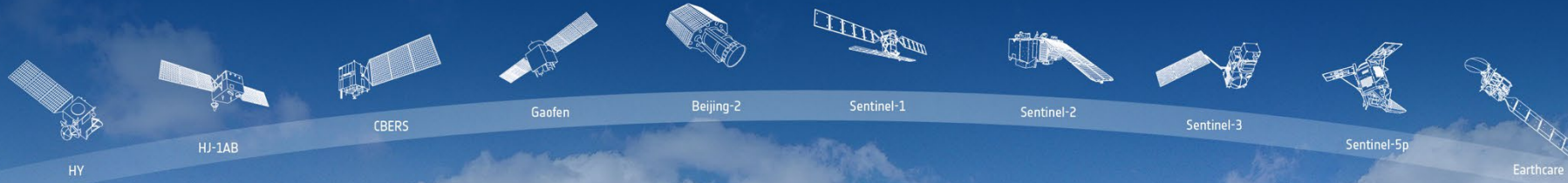




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2025 DRAGON 6 SYMPOSIUM

14-18 JULY 2025

PROJECT ID. 95458

MICROWAVE AND OPTICAL REMOTE SENSING OF SALT LAKES FROM SPACE



2025 Dragon 6 Symposium



<THURSDAY JULY 17>

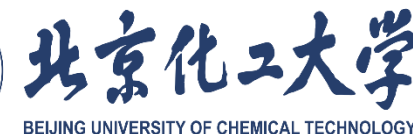
ID. 95458

PROJECT TITLE: **MICROWAVE AND OPTICAL REMOTE SENSING OF SALT LAKES FROM SPACE**

PRINCIPAL INVESTIGATORS: **QIANG YIN & HERVÉ YESOU**

CO-AUTHORS: **WEN HONG, CARLOS LOPEZ MARTINEZ, FEI MA,
JEAN REHBINDER, FRANÇOISE NERRY, MAXIME AZZONI
DANAE FELDIS (YS), FABIN DONG (YS), YIBO ZHANG (YS), MINGHAN HUANG (YS)**

PRESENTED BY: **QIANG YIN & HERVÉ YESOU**





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- Project objectives
- Main test sites in China & Europe
- Copernicus Sentinels, ESA, Chinese and ESA Third Party Mission data
- In-situ measurements plan
- Working Packages & Time schedule
- Expected results
- Contribution and training of young scientists
- Preliminary study results

Project objectives



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- Develop approaches to characterize salt lakes and its surrounding environments
- Based on optical (multi/Hyper spectral) and microwave data (polarimetry) and techniques
 - => the segmentation of salt lake areas,
 - => the classification of the salt crystals states in salt water fields,
 - => dynamic maps of salt lakes across years.
- Closely related to the ecology of salt lake area, and the salt production of different kinds.



Key Project Funded 2024-2028 (No. 62331026)

“Information acquisition and processing of salt lake resource using Polarimetric SAR” (Prof. Wen Hong)



Project objectives



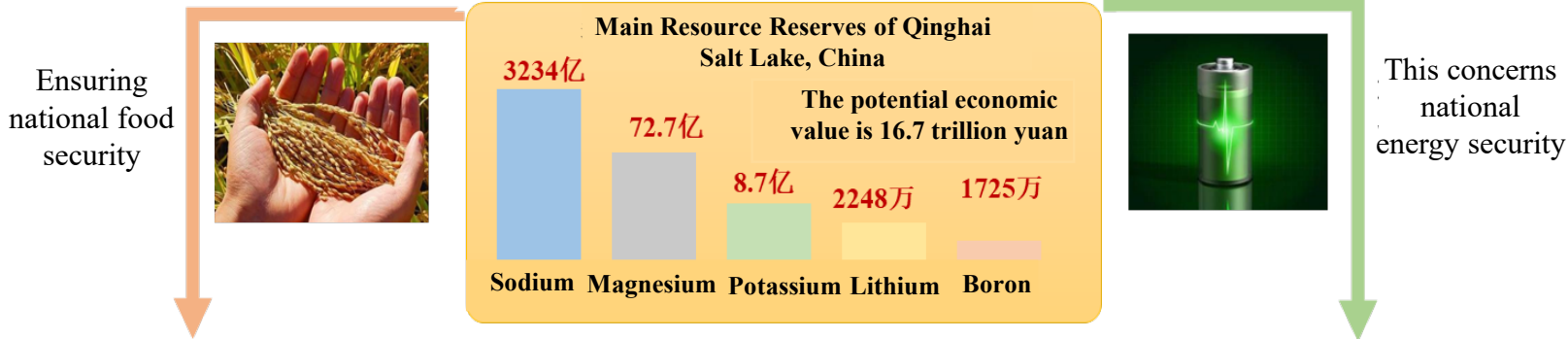
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▶▶▶ The Salt Lake region is **rich** in **mineral resources**

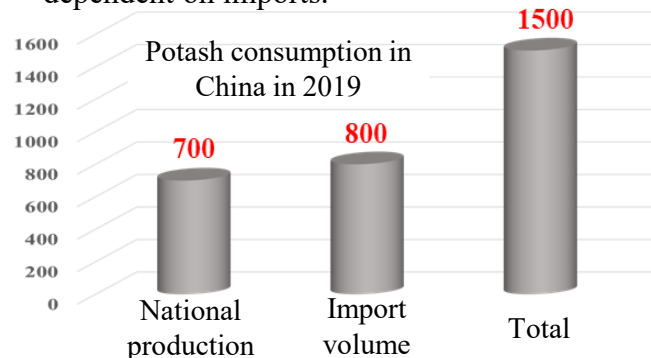
Salt Lake Strategic Resources



General Secretary **Xi Jinping** pointed out the need to accelerate the construction of a **world-class salt lake industrial base**.

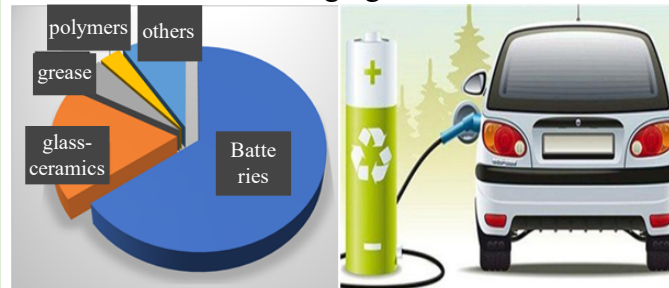
Potash production base

The supply of potash in China has long been dependent on imports.



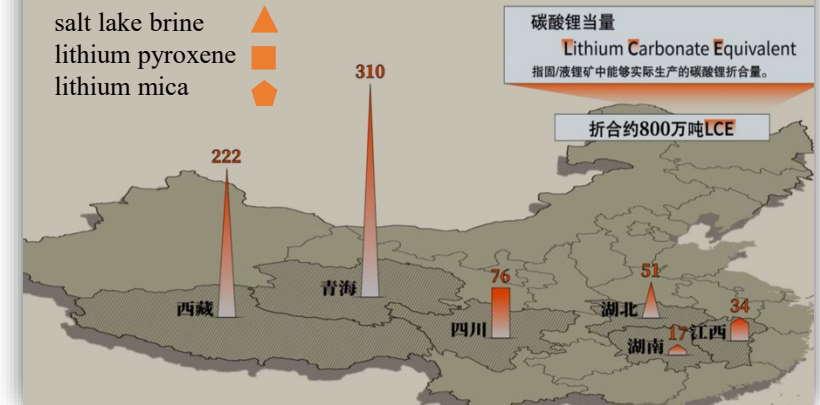
Lithium industry base

The new energy vehicle and energy storage market is developing rapidly, and the demand for lithium resources is surging.



Forms of resources:

- ▲ salt lake brine
- lithium pyroxene
- ◆ lithium mica



Salt Lake has **resources** in **many forms**.

Main test sites



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Salins de Giraud and Aigues-Mortes
Camargue, France



Salines de la Trinita,
Ebro Delta, Spain



Qarhan Salt Lake,
China



Chinese test site: Qarhan salt lake



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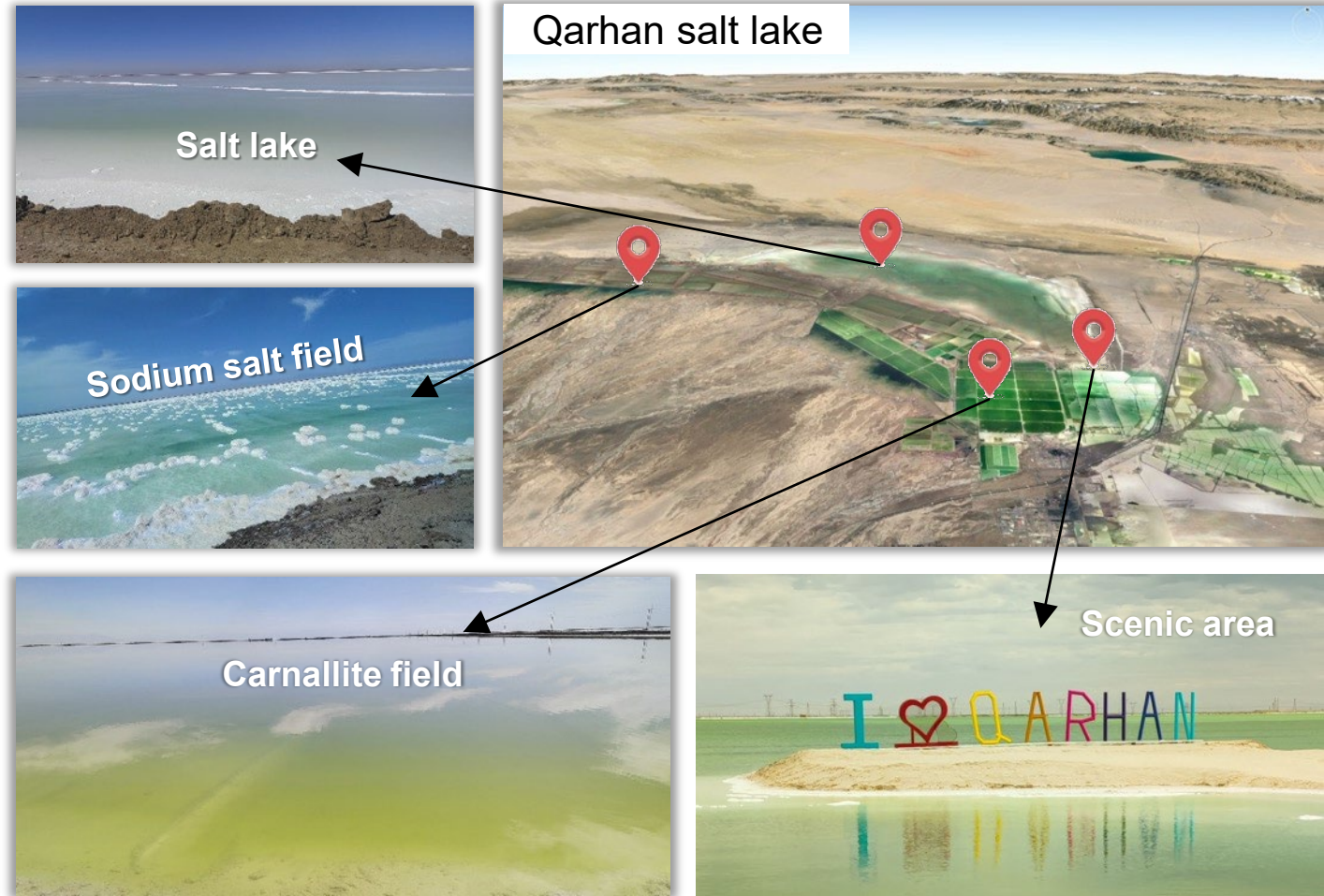
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Qarhan salt lake geographical elements :

- Qarhan salt lake, largest of many saltwater lakes
- Elevation of 2,675 m above sea level
- Lake depth, 1,7m max
- Mean annual temperature of 0.1 °C
- Qaidam's hyperarid climate: generally only 28–40 mm of annual rainfall
- 3,000 mm of annual evaporation
- Water extent very variable inter and intra year

Salt origin.

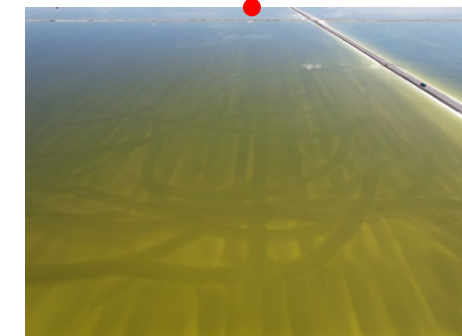
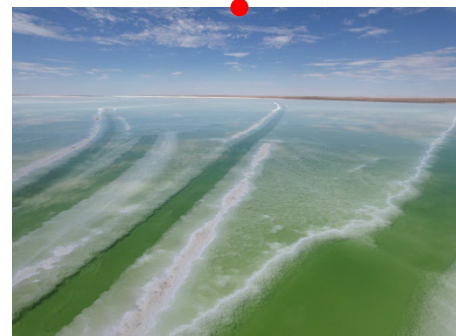
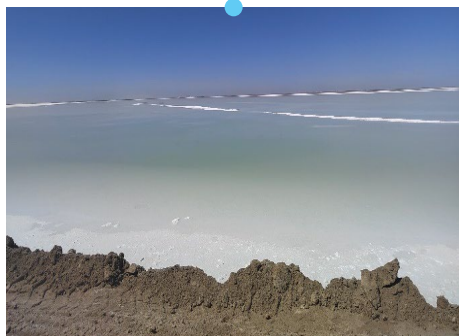
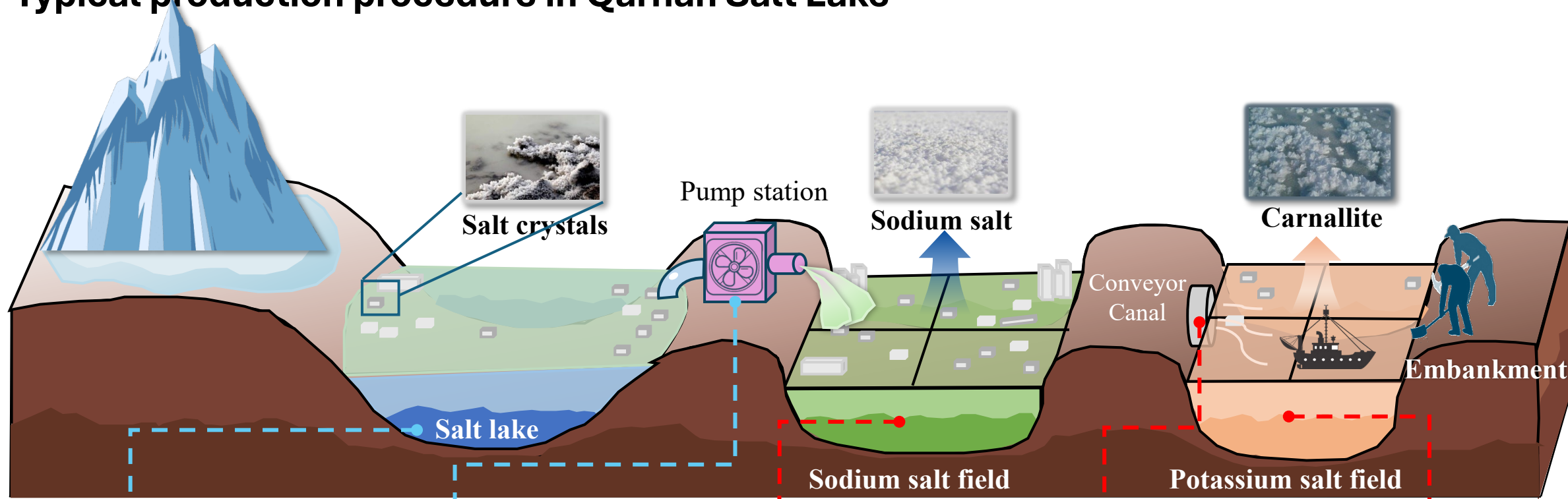
- **Water springs:** waters carry far greater concentrations of solutes and are important to the chemical composition of the lake
- **Geological beds:** halite (common salt) extend at least 40 m and abundance of carnallite (potassium magnesium chloride) and magnesium sulfate.
- **Mineral suite:** sodium chloride, potassium, bromine, halite, gypsum, and magnesium chloride
- => China's largest potassium production industry
- => + Potassium, magnesium and Lithium production



QingHai Salt Lake Industry Co.,Ltd.
Located in Golmud City, Qinghai Province,
it is China's potash fertilizer industrial production base 7/52



Typical production procedure in Qarhan Salt Lake



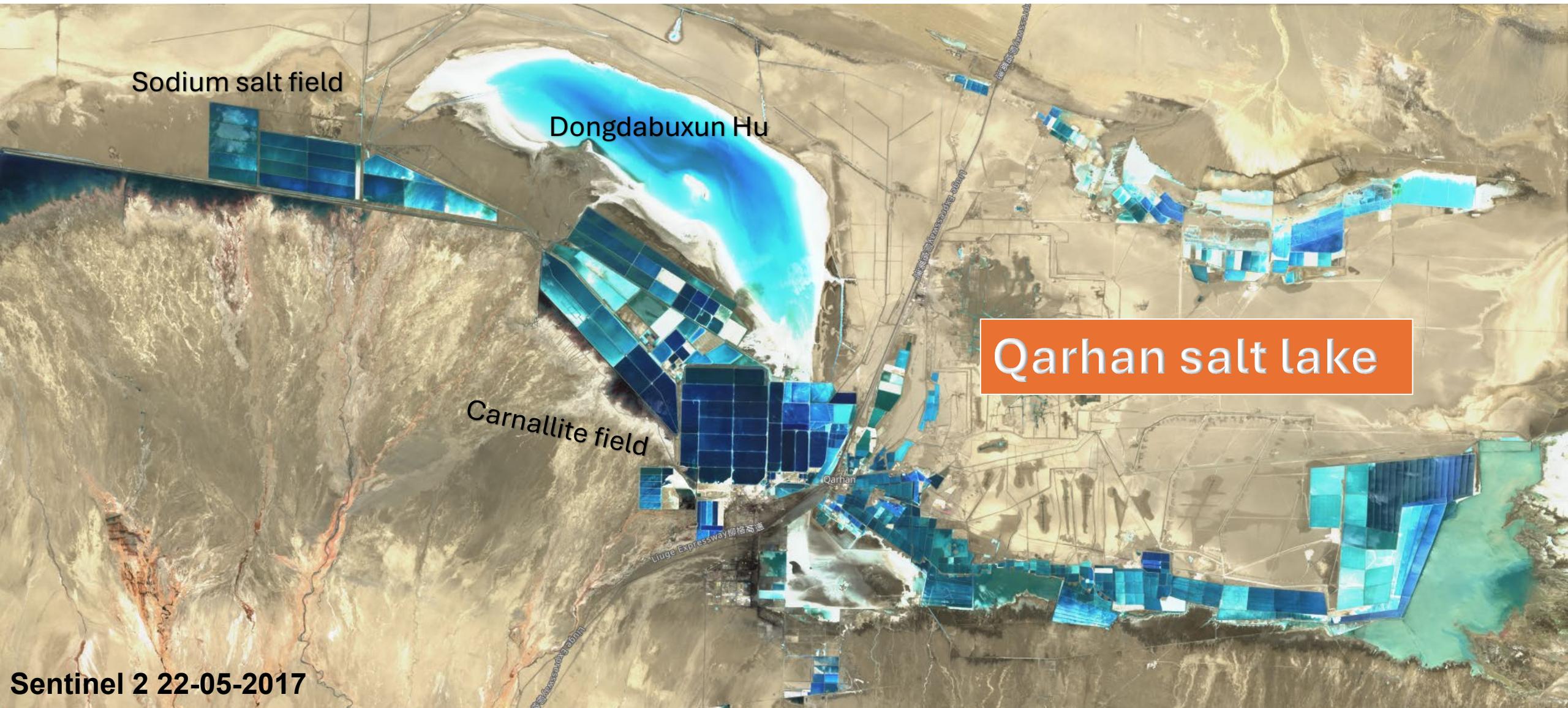
Chinese test site: Qarhan salt lake



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Sentinel 2 22-05-2017

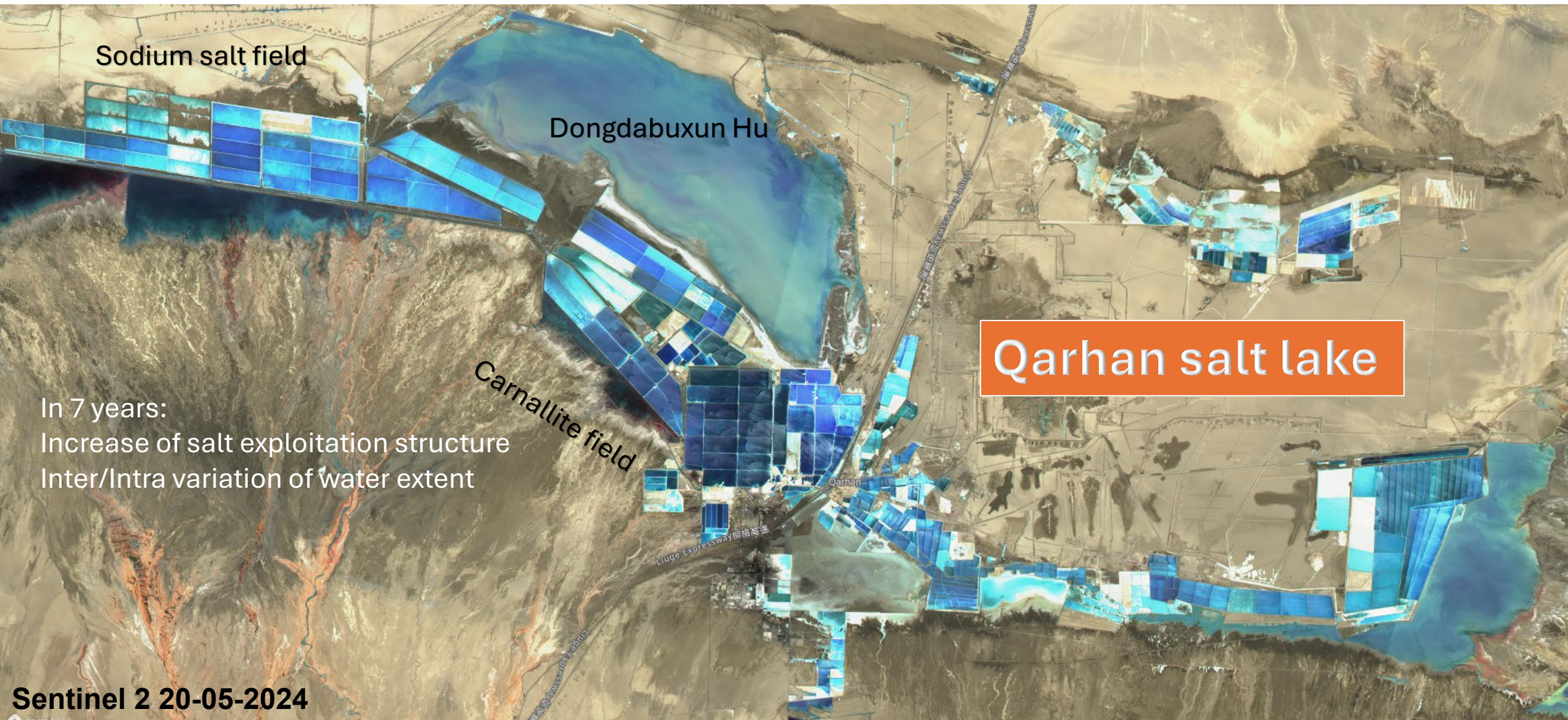
Chinese test site: Qarhan salt lake



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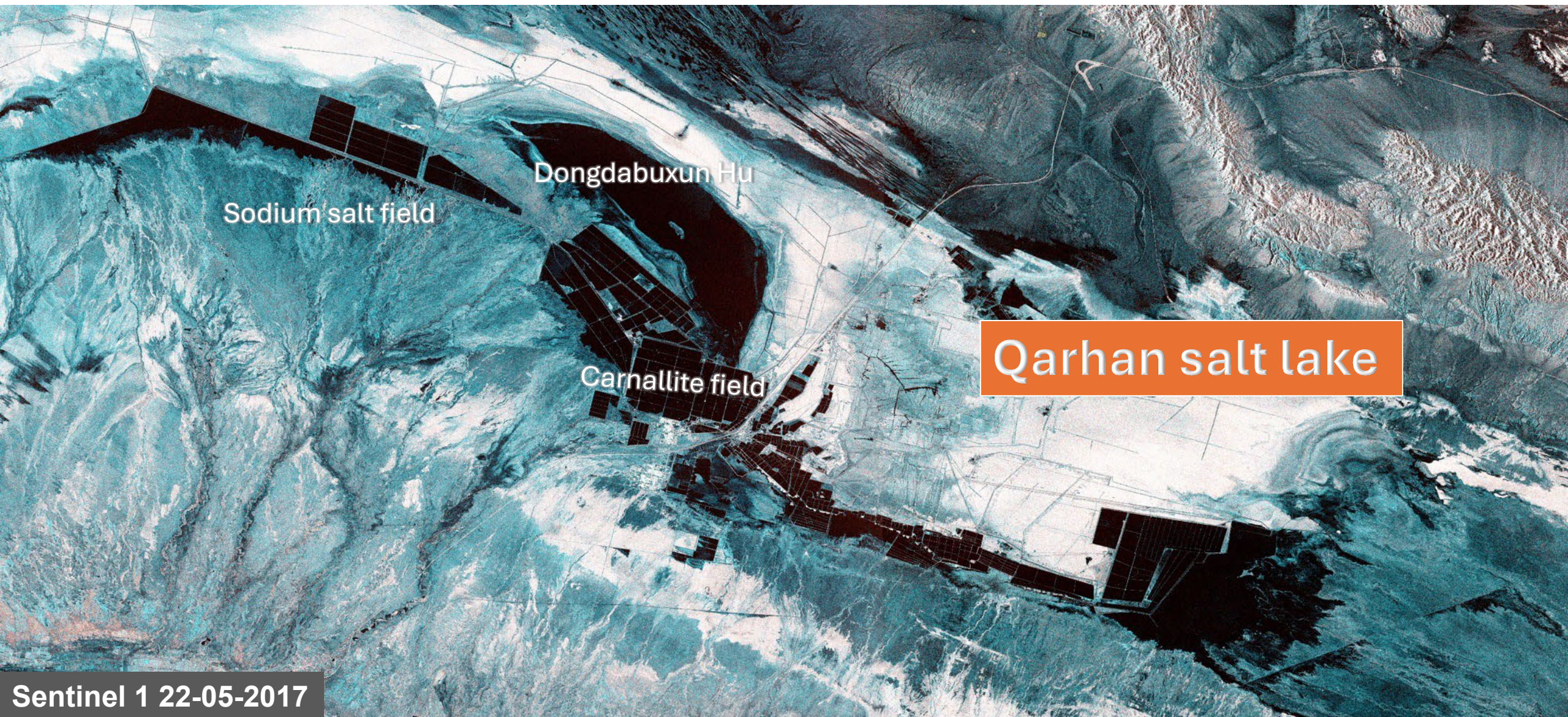
Chinese test site: Qarhan salt lake



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Sodium salt field

Dongdabuxun Hu

Carnallite field

Qarhan salt lake

Sentinel 1 22-05-2017

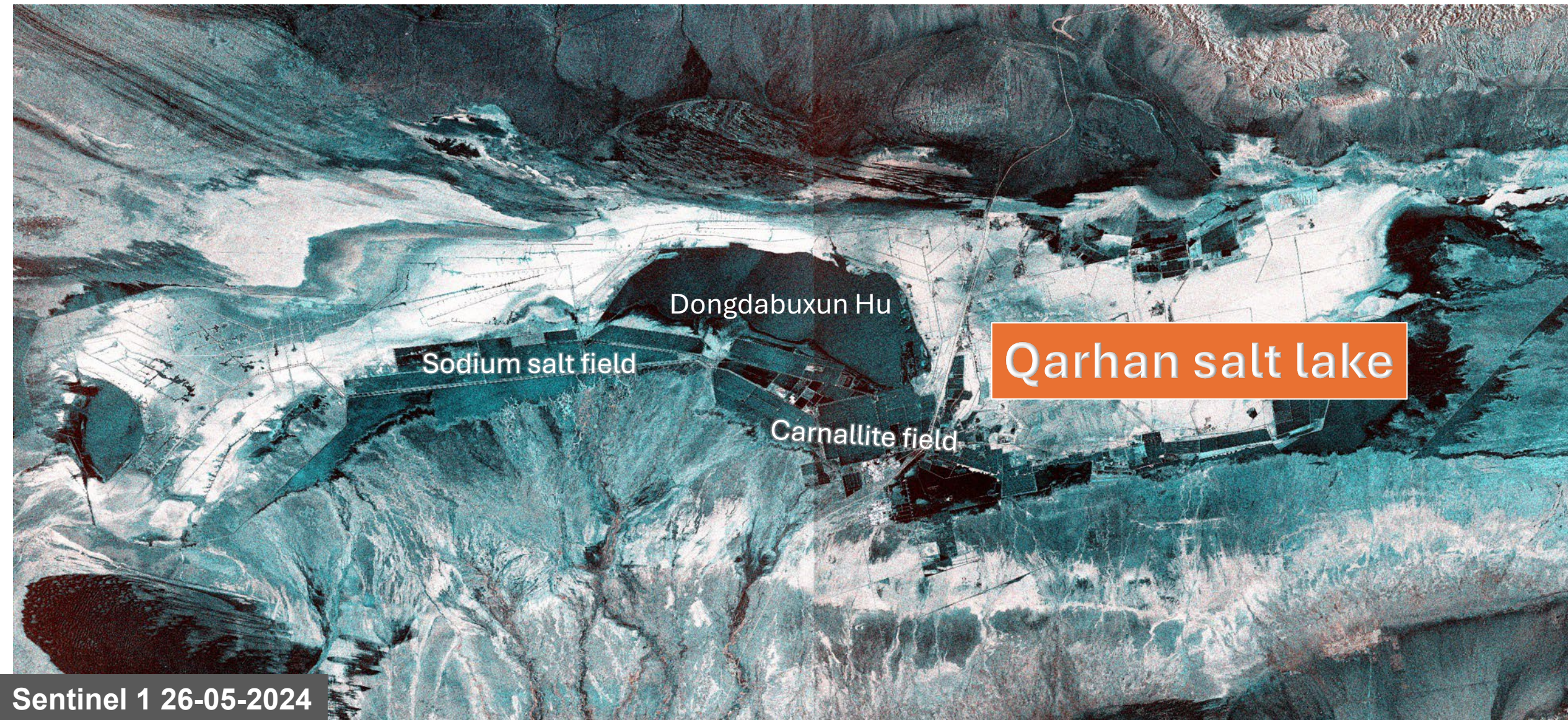
Chinese test site: Qarhan salt lake



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Dongdabuxun Hu

Sodium salt field

Carnallite field

Qarhan salt lake

Sentinel 1 26-05-2024

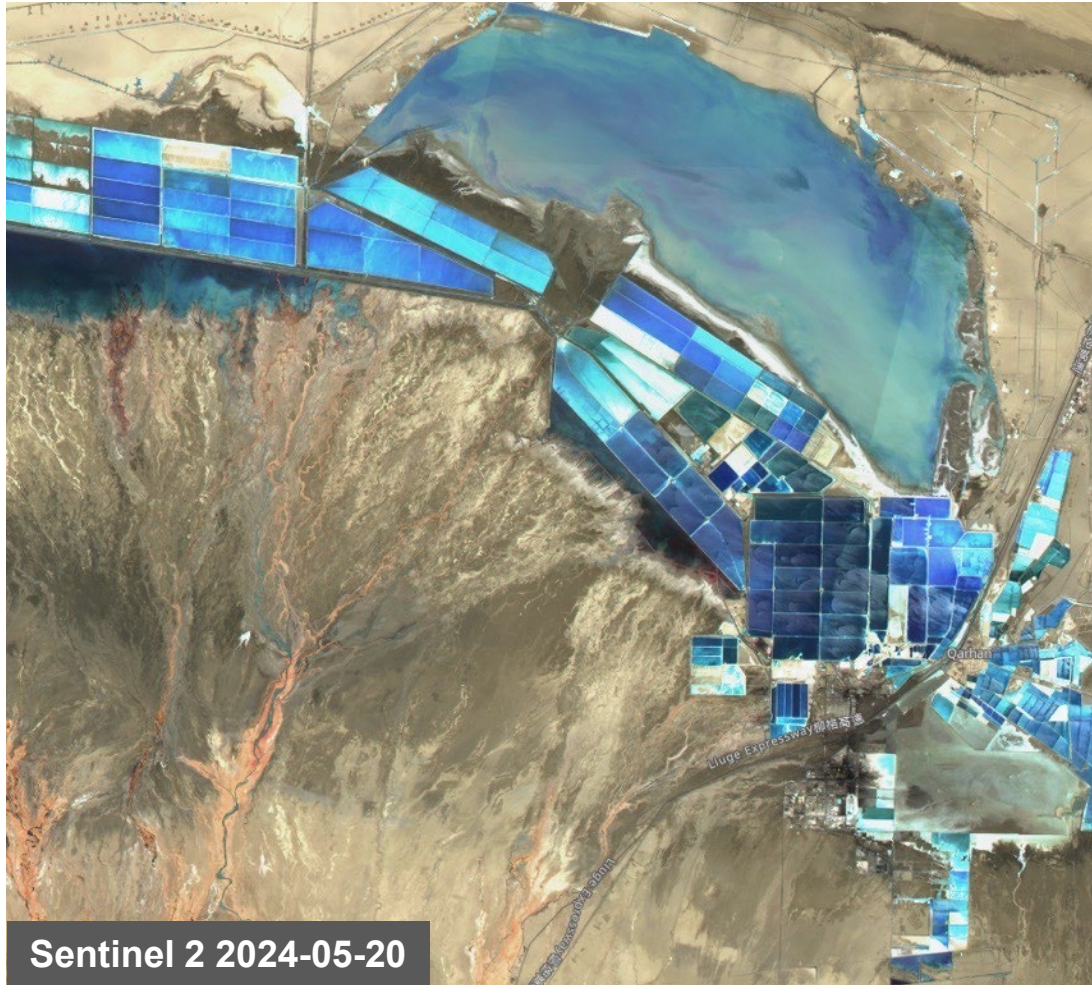
Chinese test site: Qarhan salt lake



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Sentinel 2 2024-05-20



Sentinel 1 2024-05-26

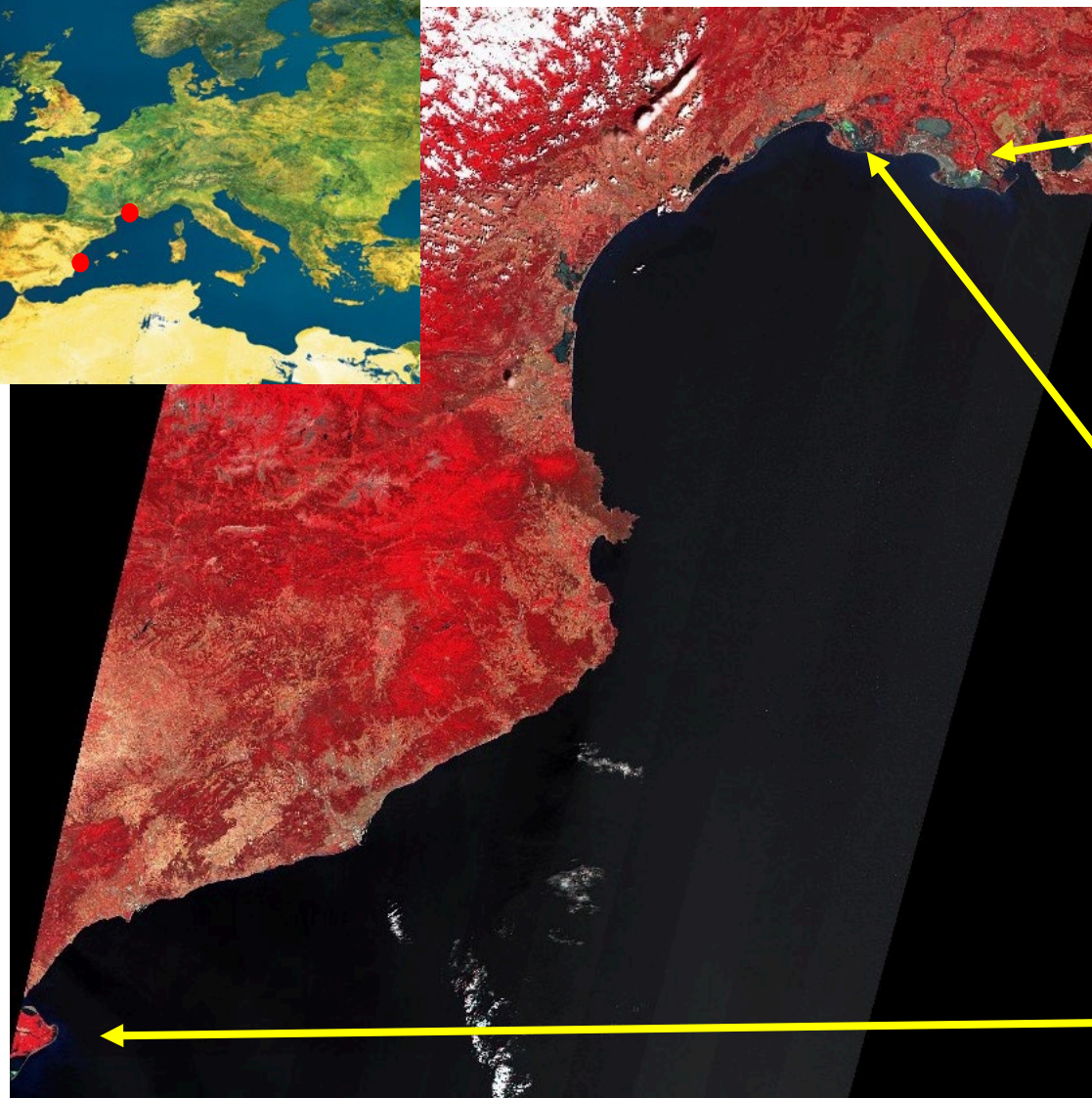
European test sites: Spain & France



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Les Salins de Giraud
(FR:吉鲁粉红盐湖)



Salins d'Aigues-Mortes
(FR:艾格莫尔特盐湖)



Les Salines de la Trinitat (SP:特里尼塔盐池)



European test sites: Spain & France



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Salin de Giraud (6 000 ha) extraction from sea water of **chlorure de sodium** (340 000 t/an) for road network, industrial uses

Aigues-Mortes (10 000 ha) more geared to the production of food salt (450 000 t/an).



Salines de la Trinitat

1000ha

salt evaporation pond 20,000 tons of a highly-prized variety of salt sold by top gastronomic and speciality stores.



European test sites: Spain & France

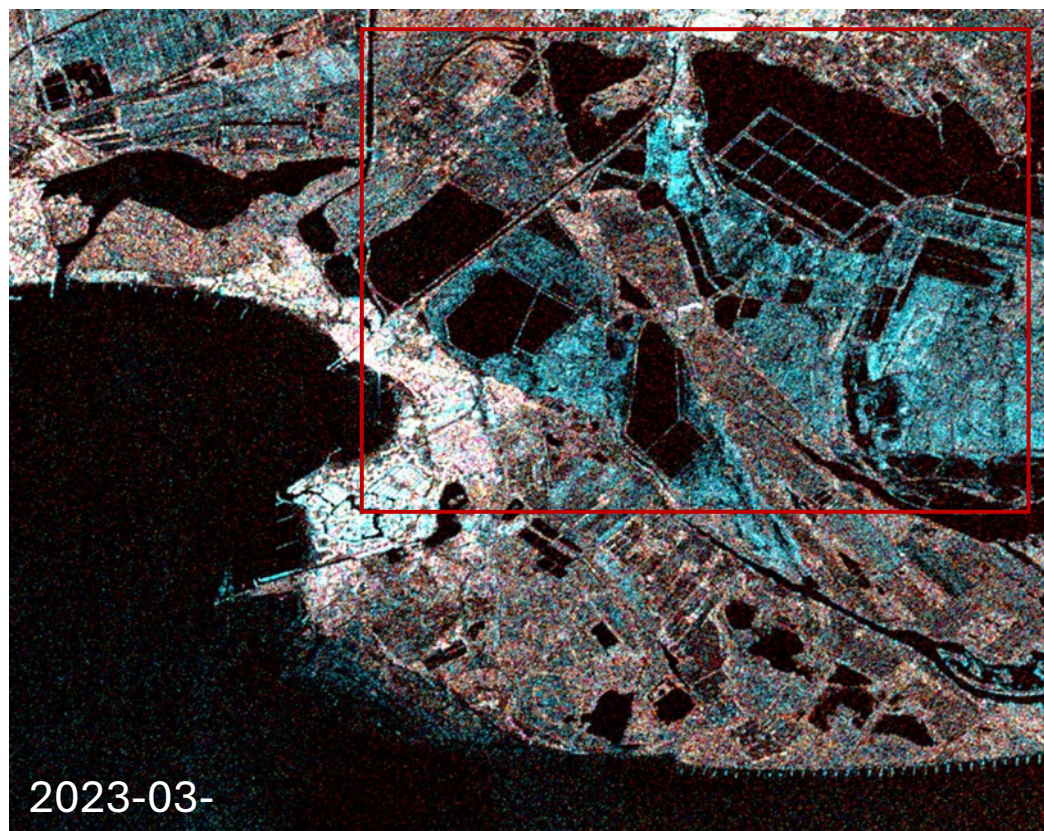


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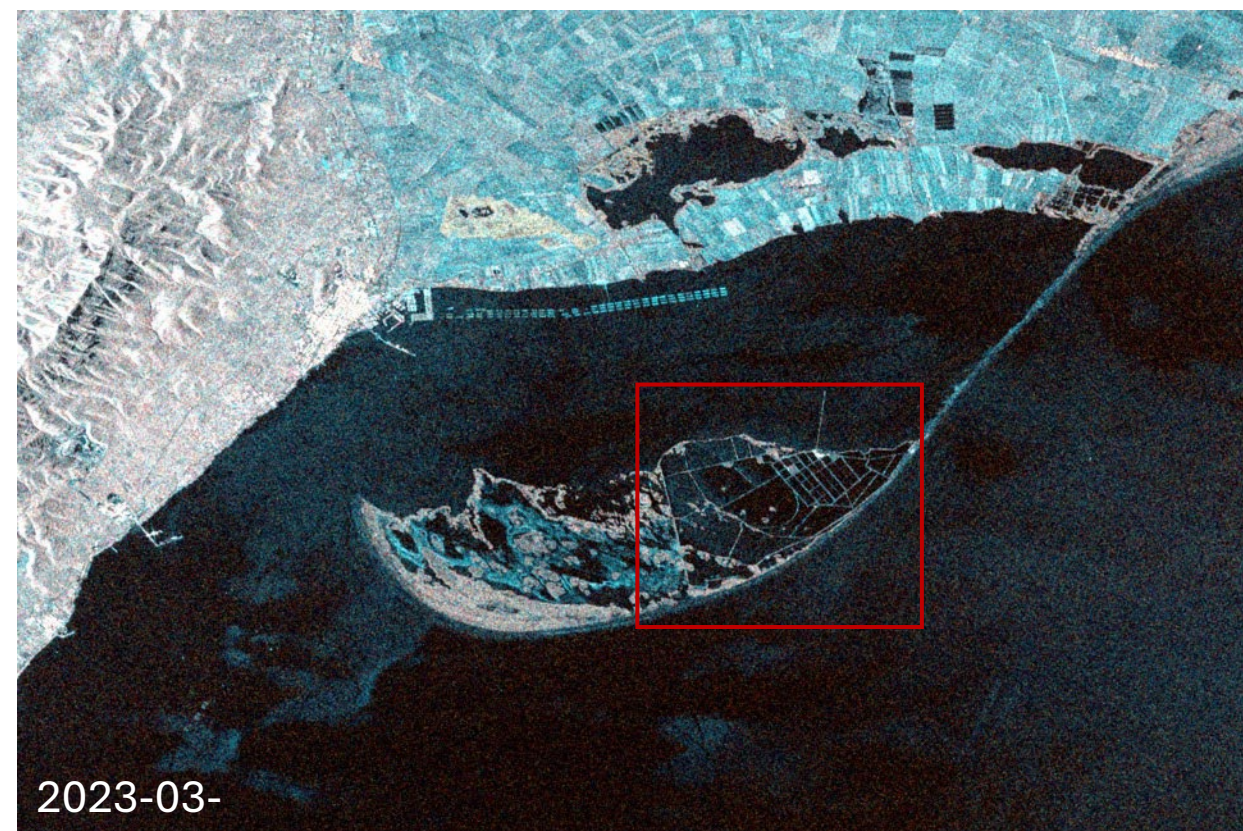


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Salins d'Aigues-Mortes



Les Salines de la Trinitat



Sentinel 1 Data

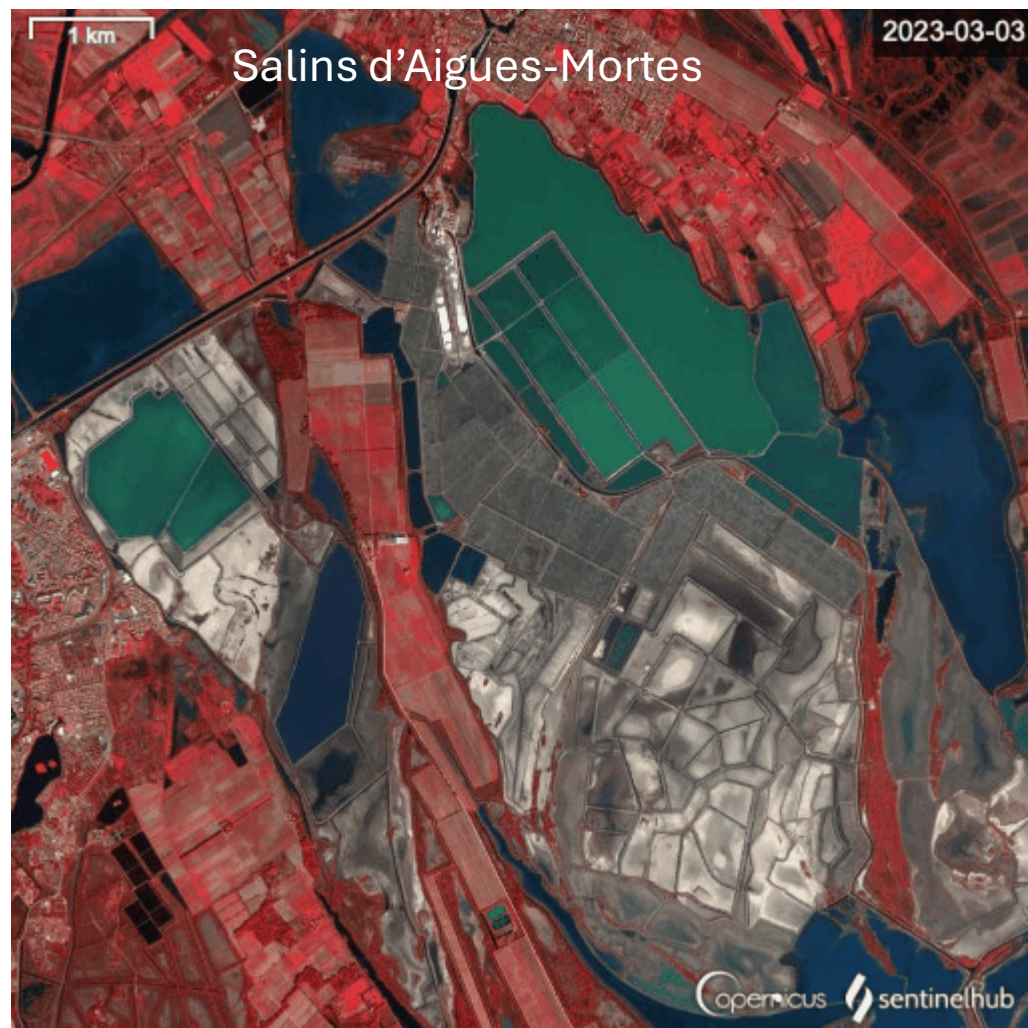
European test sites: Spain & France



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Temporal variations of water extent and water color
Sentinel 2 Data

Chinese Mission data



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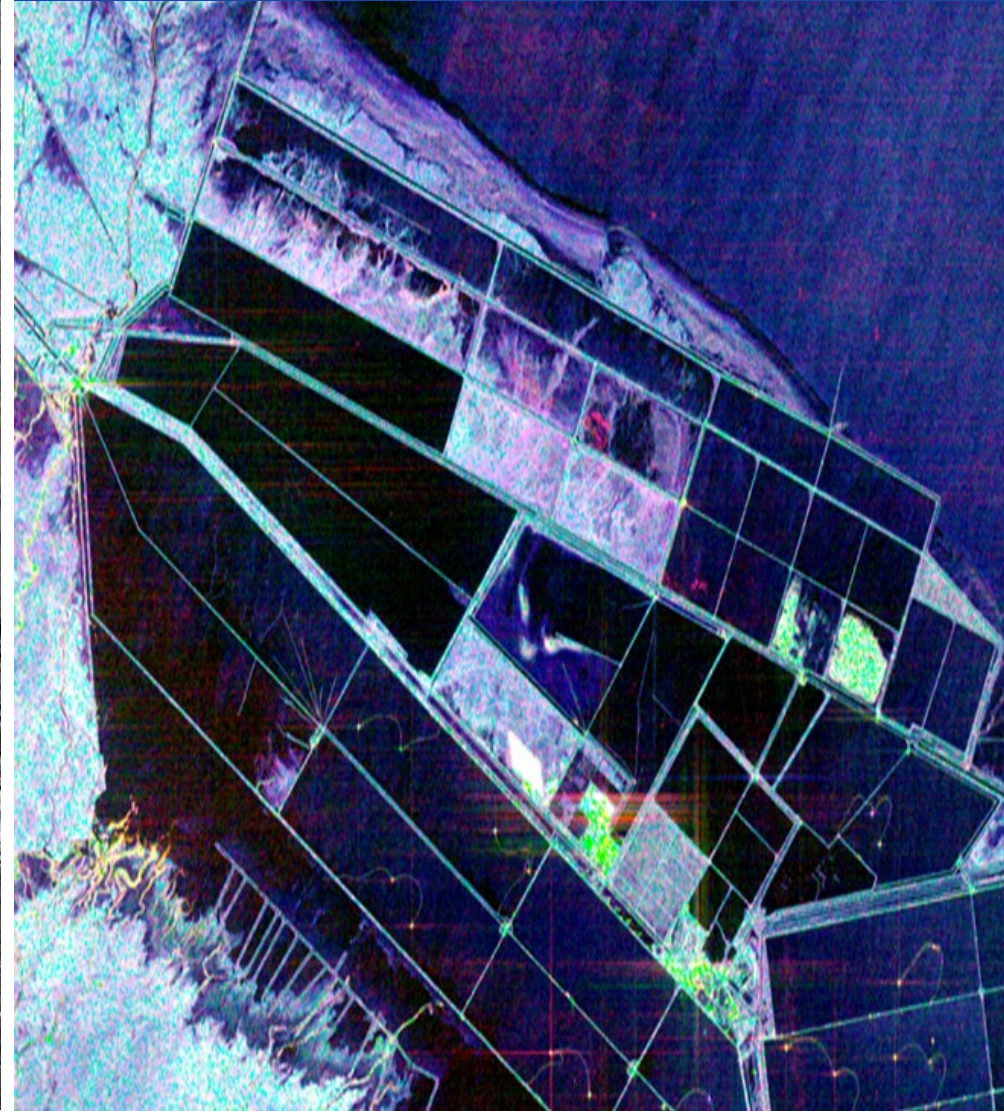
- Gaofen-3
@Qarhan
8m res
C-band
2020.8.26



HH



Pauli RGB



Chinese Mission data



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→ THE EUROPEAN SPACE AGENCY

- Gaofen-1D
@Qarhan
2m res
multispectral
2023.10.2



Dragon 6 EO Data Delivery



Data access (list all missions and issues if any). NB. in the tables please insert cumulative figures (since June 2024) for no. of scenes of high bit rate data (e.g. S1 100 scenes). If data delivery is low bit rate by ftp, insert “ftp”

ESA /Copernicus Missions	No. Scenes	ESA Third Party Missions	No Scenes	Chinese EO data	No. Scenes
1.Sentinel 1 SAR	400	1.SAOCOM SAR Band L Full Pol	20	1. GAOFEN 1 Optical	20
2.Sentinel 2 Optical	400	2.CSK 2d Gen. Band X Quad Pol	20	2. GAOFEN 3 SAR	20
3.		3.NovaSAR-1 Band S dual/triple Pol	20	3.Jilin 1 HR Optical + Hyp 02	20
4.Biomass (2025)	tbd	4 Paz Band X	6	4.GAOFEN 5 Hyperspectral AHSI	20
5.		5 Radarsat 2 Quad Pol	10	5. LT 1 SAR Band L	20
6.		6 NISAR, L + S band, 2025	tbc	6.	
Total:		7.Pleiades & Pleiades NEO	6	Total:	
Issues:		8. WV 3, VHR 8 bands including SWIR	6	Issues:	
		Total:			
		Issues:			

In-situ measurements plan



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@ Qarhan Salt Lake

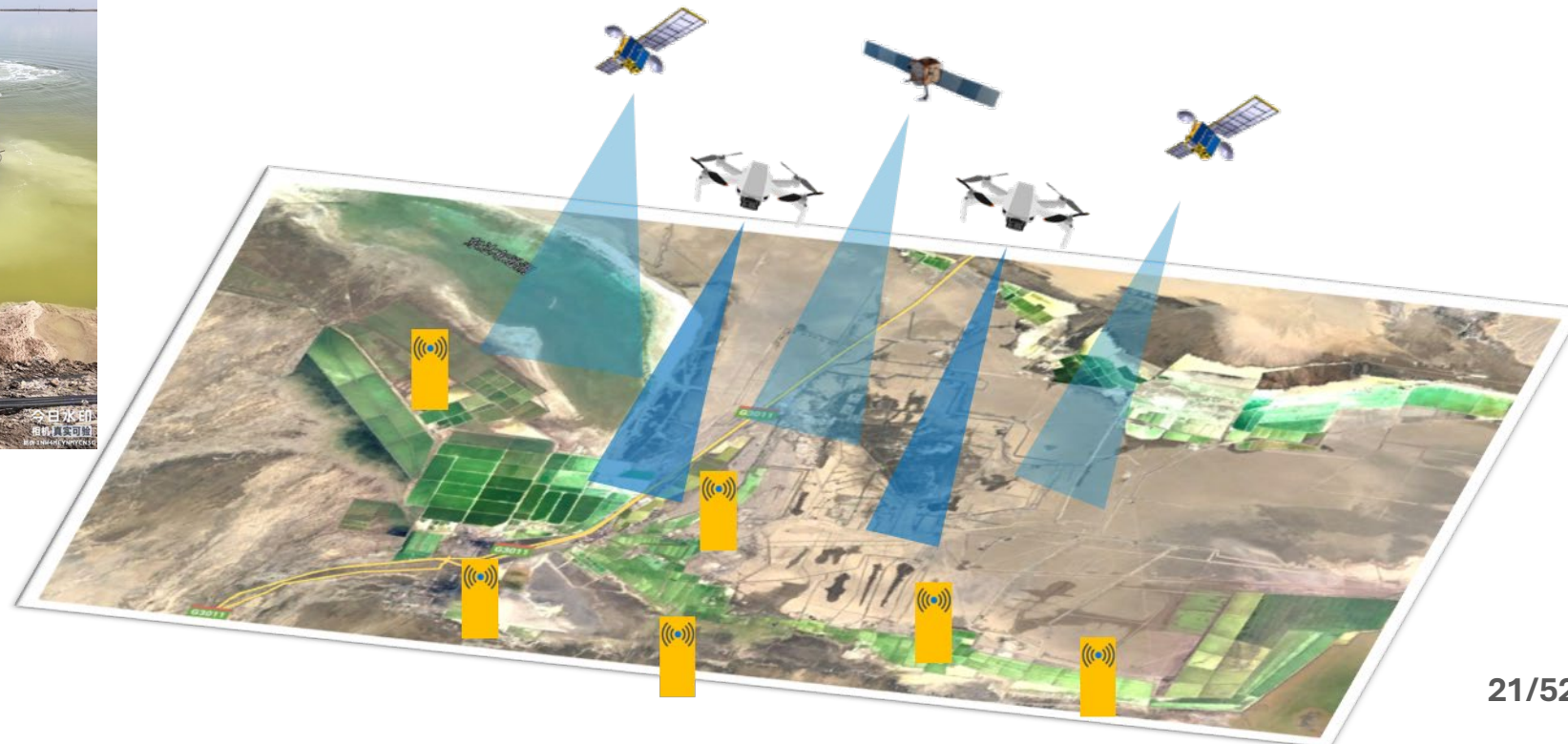
In July 2024&June 2025, **on-site research** work on salt lakes was carried out (salt field type and states, crust roughness etc.).



Future Plans

When the **satellite** passes through, implement **UAV** experiment campaign for extensive data acquisition with optical & miniSAR simultaneously.

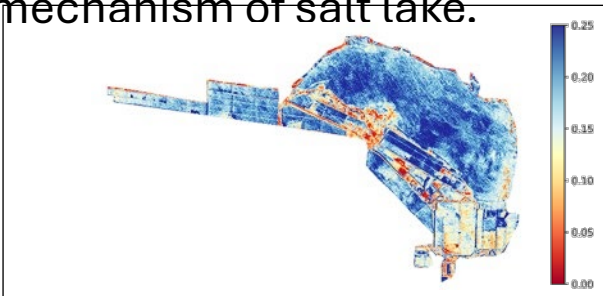
On site **ground truth measurements** are obtained, including parameters such as temperature, wind direction, crystal states and other salt indicators.





Working Package 1

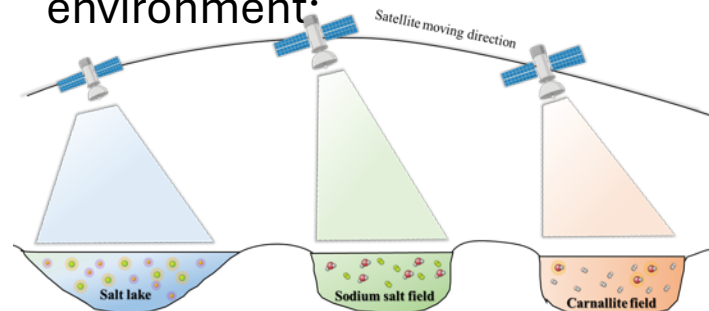
- ✓ To establish the feature mapping of polarimetric data and terrain types;
- ✓ Develop water segmentation and fine classification methods based on the physical scattering mechanism of salt lake.



scattering mechanism of salt lake

Working Package 2

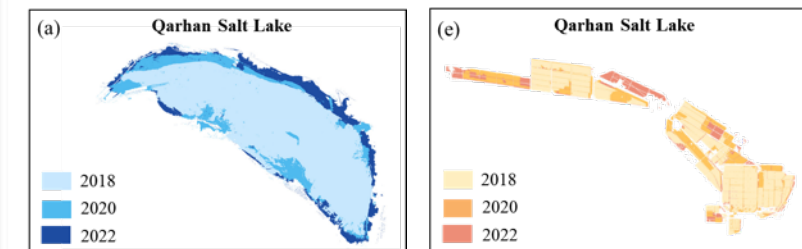
- ✓ To analyze the reflectivity and absorption characteristics of different wavelength bands;
- ✓ To obtain the physical and chemical information of the salt lake water body and the environment:



the reflectivity and absorption characteristics

Working Package 3

- ✓ To fuse the mapping results of joint microwave and optical satellite remote sensing data;
- ✓ A synergistic use of multi-source EO sensors will be developed in order to accurately monitor the temporal evolution of salt lakes;



the temporal evolution of salt lakes

To explore the microwave and optical fusion theory and methods with the Sentinel, GF and LT series data sets in the test sites in China (Qarhan) and Europe (France & Spain).

Time Schedule



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First Phase of the project (2024-2026)

- ✓ Establish the feature mapping of polarimetric data and terrain types, and develop water segmentation and fine classification methods.
- ✓ Obtain the physical and chemical information of the salt lake water body and the surrounding environment from multispectral and hyperspectral data.
- ✓ Validate and test the different methodologies described in the proposed Work Packages.
- ✓ Report the results to mid-term symposium.

Second Phase of the project (2026-2028)

- ✓ The second phase of the project will focus on the Working Package 3:
- ✓ Study on the fusion of the mapping and classification results of joint microwave and optical satellite remote sensing data.
- ✓ Report the results to final symposium.

2024-2026:
Working Package 1
Working Package 2



2026-2028:
Working Package 3



Expected results



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Research reports

Research reports on segmentation of salt lake areas, the classification of the salt crystals states in different salt water fields and the dynamic maps of salt lakes across years, in the annual DRAGON symposium and related international conferences/workshops.

Joint publications

Joint Chinese-European papers in international journals concerning the techniques and concepts developed in the project.



Young scientists

- Exchange of young scientists between Chinese and European institutions;
- Posters of young scientists on the Dragon symposiums;
- Training of young and confirmed scientists through international tutorials.

Young Scientists contributions in Dragon 6



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Name	Institution	Poster title	Contribution including period of research
Danae FELDIS	ICUBE SERTIT France	Remote Sensing of Salt Lakes from Space: study of Aigues Mortes salted field (South France)	Database set up Sentinel 2 analysis Hyperspectral data search
Yibo Zhang	BUCT, China	A Classification Method for the Sediment Thickness of Salt Ponds based on Sentinel-2 Data	Salt Lake Area Classification Based on Multi source Remote Sensing Data
Minghan Huang	BUCT, China	Time-series Detection of Water Depth in Darbeson Salt Lake Based on Joint Multispectral Data and Lidar Data	Salt Lake Water Level and Water Volume Estimation
Fabin Dong	AIRCAS, China	N/A	Salt Crust Classification of Salt Lake Based on Polarimetric Feature
Yi Liu	BUCT, China	N/A	Self-Supervised Multimodal Learning Framework for Salt Lake Mapping



OPTICAL REMOTE SENSING OF SALT LAKES FROM SPACE: CASE STUDY OF AIGUES-MORTES SALTED FIELD (SOUTH FRANCE)

Danaë Feldis¹, Maxime Azzoni², Qiang Yin² & Hervé Yésou¹

¹ ICUBE SERTIT, University of Strasbourg, Pole APIbw Sébastien Brant, BP 10413, 67412 Illkirch Graffestaden, France
² Beijing university of chemical technology, Beijing PR Chinois

✉ d.feldis@unistra.fr



 **Abstract**

Salt-lake are ecologically and culturally significant, their remote locations and rapid seasonal changes makes them hard to monitor with field method alone. This study explores the use of optical satellite data to track salt crust information, surface moisture, and vegetation dynamics. Focusing on selected parcels in the Salin d'Aigues-Mortes across 2023, we used spectral analysis and indices to detect seasonal patterns. SWIR bands proved critical for detecting water content and distinguishing between dry, wet and algae-covered surfaces. The combination of spectral indices, band-level reflectance and time-series analysis provides a robust approach to understanding salt-lake surface dynamics.

 **Context**

Salt-lake information is important in ecological protection, water resource management, economic development, and tourism culture. This above information is closely related to the ecology of salt-lake area, and the salt production of different kinds (for industry, alimentation, and also in terms of rare earth element's exploitation).

 **Objectives**

- Develop approaches to characterize salt lakes and its surrounding environments, using optical and techniques.
- The segmentation of salt-lake areas, the classification of the salt crystals states in different salted water fields.
- Establish the dynamic maps of salt lakes across years.

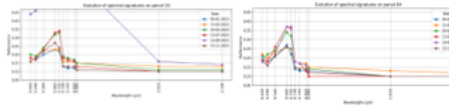
4 studies sites :

- FRANCE:** Salin-de-Giraud and Salin d'Aigues-Mortes
- SPAIN:** Salines de la Trinitat, the Elbro Delta
- CHINA:** the Qarhan Salt Lake



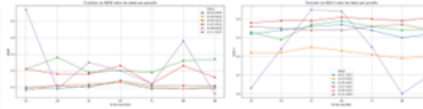

 **Results**

► **Temporal evolution of spectral signatures.**



- Between March and November 2023, reflectance spectra show typical vegetation signals (e.g., algae), with NIR peaks from May to July.
- March shows flat reflectance in the visible range, suggesting water presence.
- Persistently low SWIR reflectance (1.61 – 2.19 µm) throughout the period indicates ongoing free water on the parcels.

► **Temporal evolution of indices**



- NDWI peaks in May (0.18 - 0.28) reflect maximum moisture and growth, while NDSI dips, indicating reduced salinity.
- March and September show anomalies, possibly from early growth, irrigation or halophytes.
- While July and winter months mark dry, saline conditions with high NDSI and low NDWI.
- Spatially, parcels like 88 fluctuating, suggesting, localized management or variability.

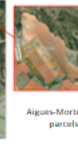
 **Data/ Methods**

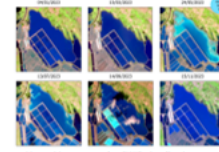
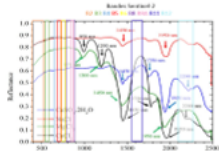
Six Sentinel-2 L2A images, acquired between January and November 2023 were processed.

Index	Formula
NDSI (Normalized Difference Salinity Index)	$\frac{(1)(B11-B8)(B11+B8)}{(2)(B4-B8)(B4+B8)}$
NDWI (Normalized Difference Water Index)	$\frac{(B6-B11)(B8+B11)}{(B8-B11)(B8+B11)}$
SI (Salinity Index)	$\frac{(B4+B11)/2}{(B4+B11)/2}$
BI (Brightness Index)	$\frac{(B4+B8+B8+B5)}{(B4+B8+B8+B5)}$

A parcel dataset of the salt pans was retrieved, corrected and completed, resulting in a total of 197 parcels. From these, 7 parcels (including one reservoir) were selected for preliminary analysis.

Several salinity-related spectral indices from literature were tested in order to assess their ability to characterize saline conditions and monitor their evolution over time.

 **Discussion**

- Spectral & Temporal Trends**
NIR peaks indicate algae growth, SWIR & NIR remain low persistent dryness.
- Salt crust spectral behavior**
Dry salt, high reflectance wet/dry salt, lower reflectance (e.g., SWIR).
- NDWI & NDSI insights**
Low NDWI and high NDSI = dry or saline zone.
Seasonal and spatial trends reveals salinity stress.

 **Conclusion and future work**

- These initial results highlight clear seasonal trends linked to algae and salinity through drying parcels. However, water color, chemical composition, surface crystals and grain size may also influence reflectance.
- Perspectives :** collecting field data and hyperspectral imagery Prisma, EnMap and if possible Gaofen 5-01A-ASHI to gain a comprehensive understanding of the salt flat's surface conditions (salt chemistry composition...) and dynamics.

Acknowledgement : « This work was conducted as part of the Dragon-6 cooperation Programme between the European Space Agency (ESA) and the Ministry of Science and Technology (MOST) of China. The authors acknowledge the support and coordination provided by the Dragon Office. The author would also like to thank the ESA Team for their exchange and support particularly for granting Dragon 65458 young scientist. »

Please have a look on the poster of **Danae FELDIS**, DRAGON YS

Thanks ESA for its support

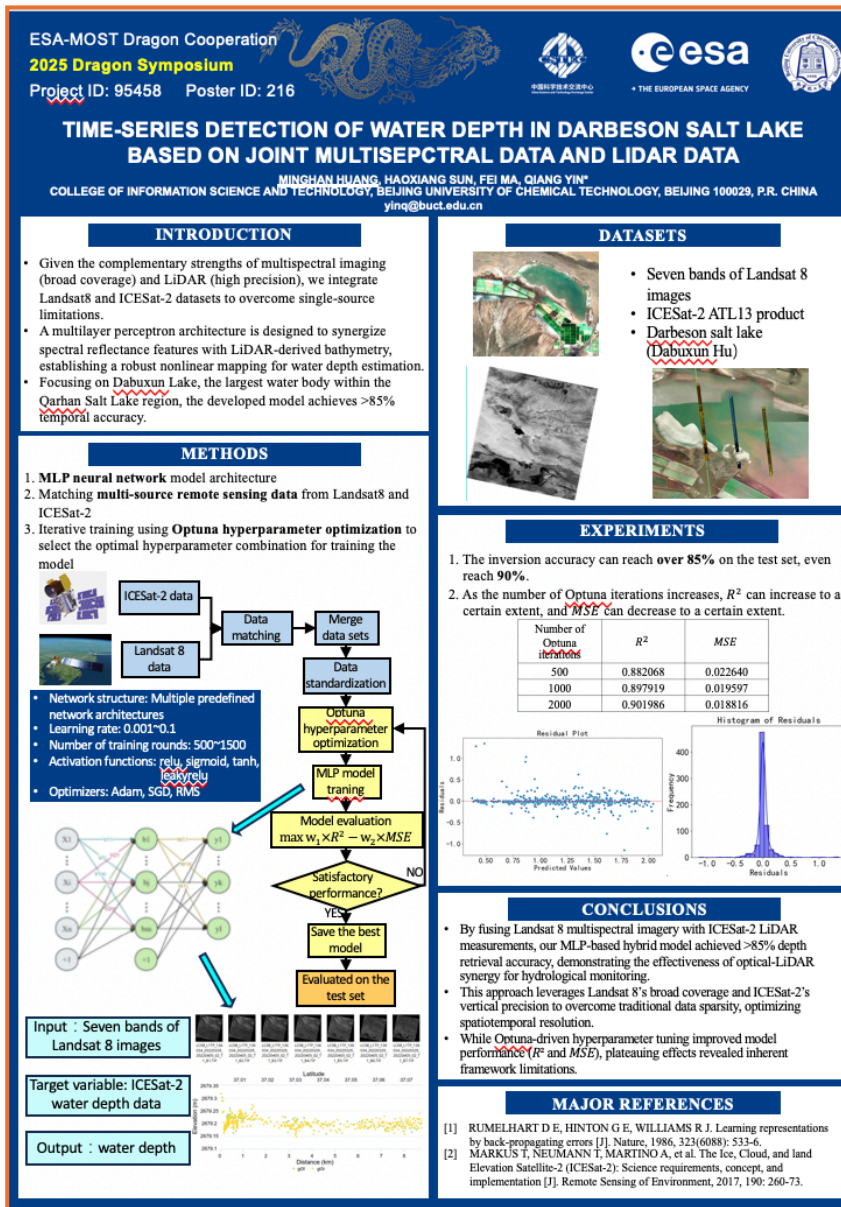
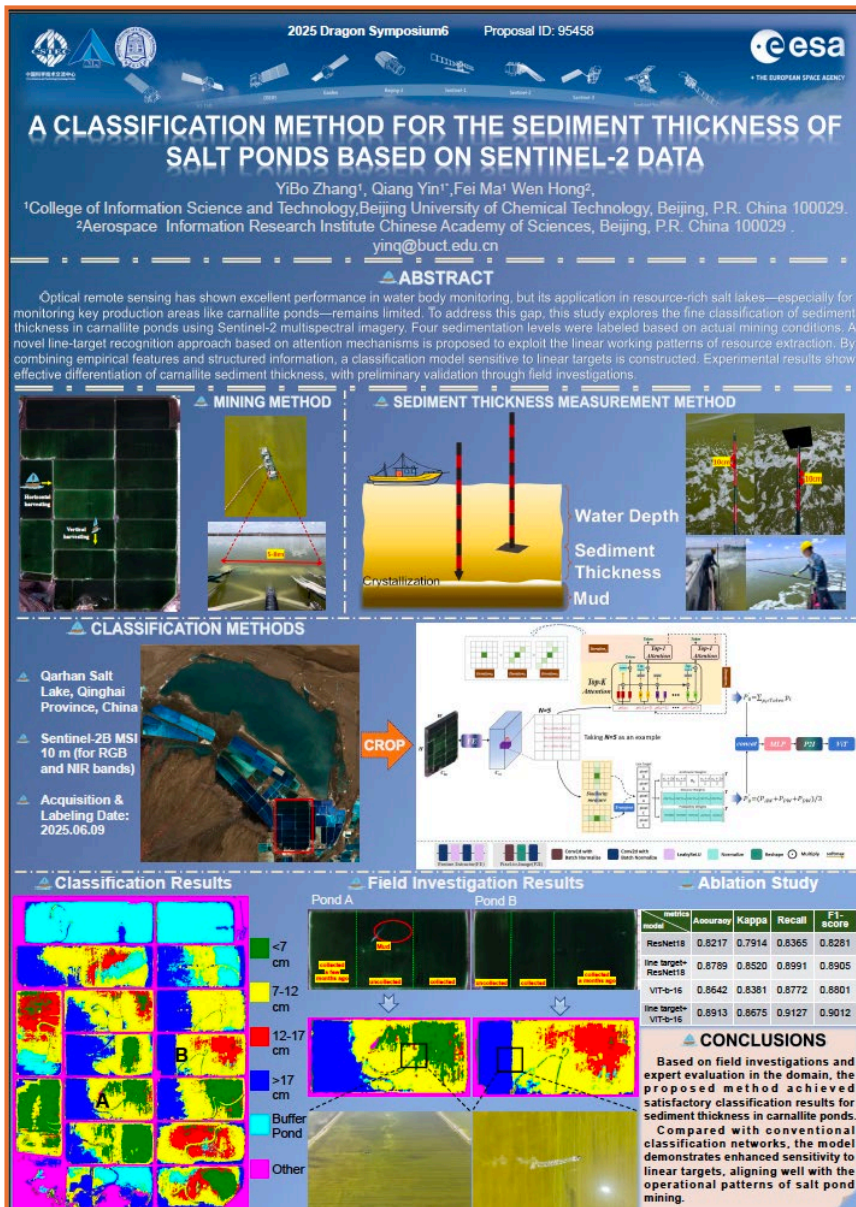
Chinese Young Scientists contributions in Dragon 6



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Please have a look on the poster of **Yibo Zhang & Minghan Huang**, DRAGON YS

Thanks ESA for its support



Salted crust: spectraly complex material

■ Salt chemical composition

Principal composant	Formula	Spectral type	Remarks
Sodium chloride	NaCl	High reflectance everywhere	Very common, very bright
Sodium Sulfate	Na ₂ SO ₄	Less reflecting	More complex spectrum, absorption peaks
Gypsum	CaSO ₄	More variable SWIR reflectance	Commission with dry salt
Carbonates	Various	Various spectral answers	Depending of granulometry and cristallins shape

Mineral forms
absorb more
SWIR
identification
spectroscopy /
hyperspectral

■ Contaminants or coatings:

- Dust, algae and sediment can alter reflectance
- Natural salts: a mixture of minerals: mud, clay, gypsum, halite, etc.
- Composite spectrum (confused with other materials)



crust status	Visible	NIR	SWIR	Commentaires
Dry fine crystals	Very high	High	High	White saltuniform brillance
Wet crust (after rain fall)	Medium	Low	Very low	Water absorbs the signal
Aged crust (coarse grains)	High	Moyen	Medium to high	Less diffusion, more internal reflection
Dirty crust (dust/algae)	Low to medium	Low	Low	Modified spectrum, could be similar to bare soil

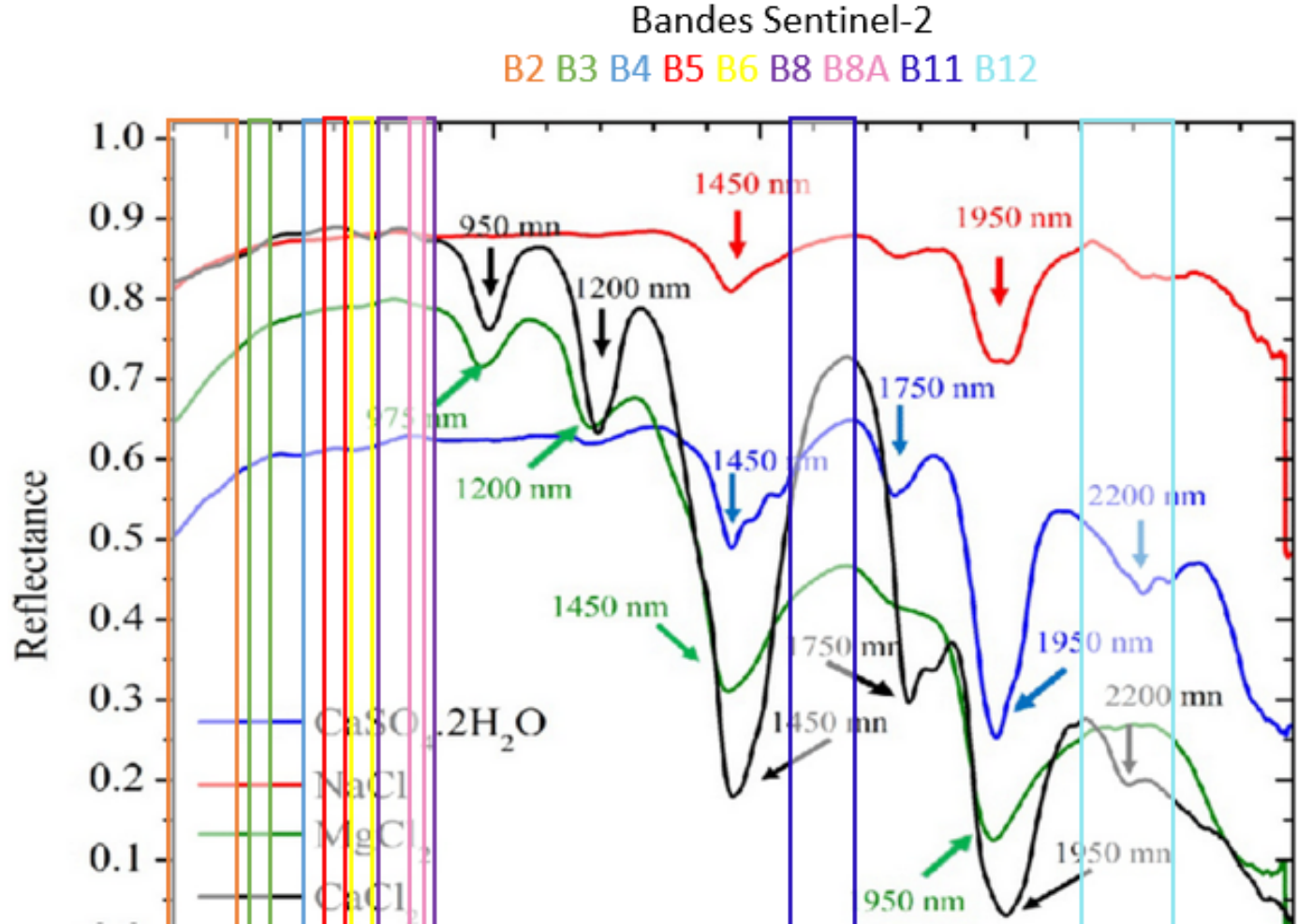
J. Farifteh et al. (2007). Quantitative analysis of salt-affected soil reflectance spectra : a comparison of two aaptative methods (PLSR and ANN)

J. Farifteh et al. (2008). Spectral characteristics of salt-affected soils : a laboratory experiment

S.Nawar et al. (2024). Modeling and Mapping of Soil Salinity with Reflectance Spectroscopy and Landsat Data Using Two Quantitative Methods (PLSR and MARS)

J.M. Nield et al. (2015). The dynamism of salt crust patterns on playas

L.G.M. Pessoa et al. (2015). Spectral Reflectance Characteristics of Laboratory-Grown Salt Crusts on Silty Clay and Sandy Soils.



Salt spectral behaviors versus S2 bands

Index	Formula
NDSI (Normalized Difference Salinity Index)	(1) (B11-B8)/(B11+B8) (2) (B4-B8)/(B4+B8)
NDWI (Normalized Difference Water Index)	(B8-B11)/(B8+B11)
SI (Salinity Index)	(B4+B11)/2
BI (Brightness Index)	Sqrt(B4*B4+B8*B5)

Sentinel2 indices

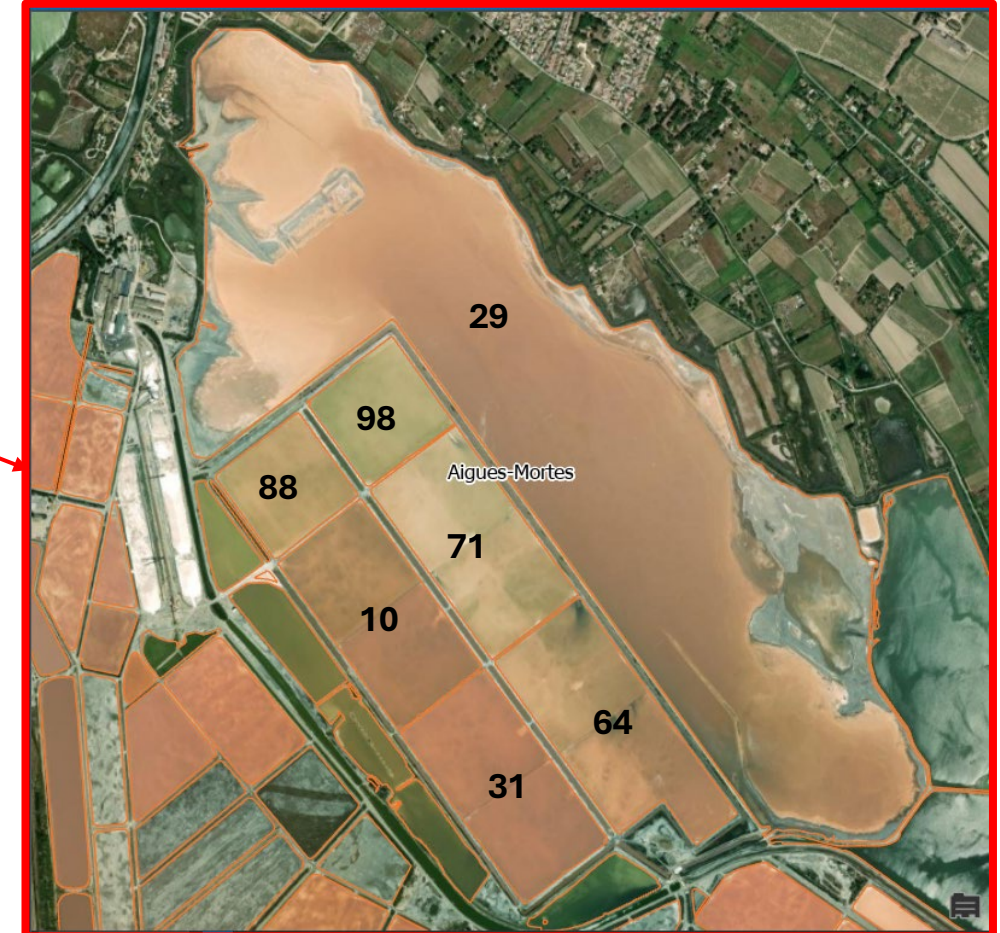
Salins d Aigues Mortes



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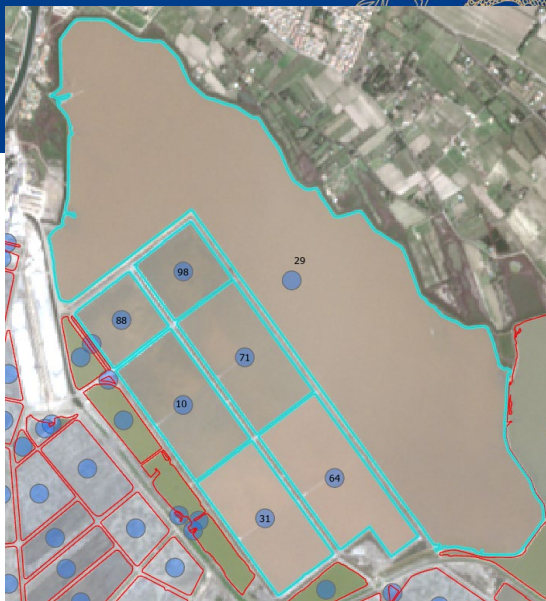
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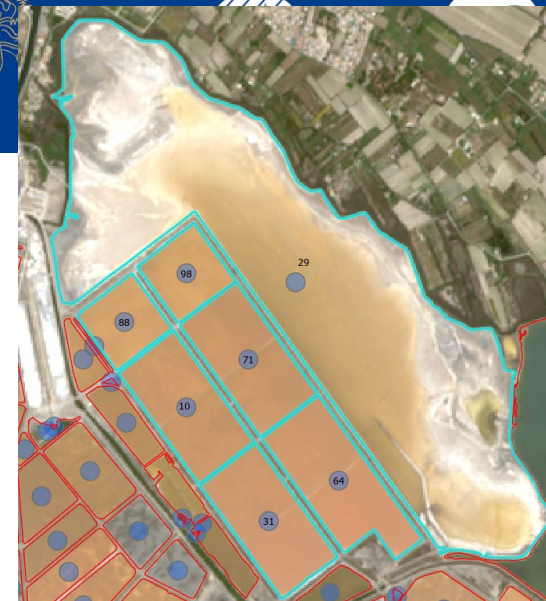
197 parcels



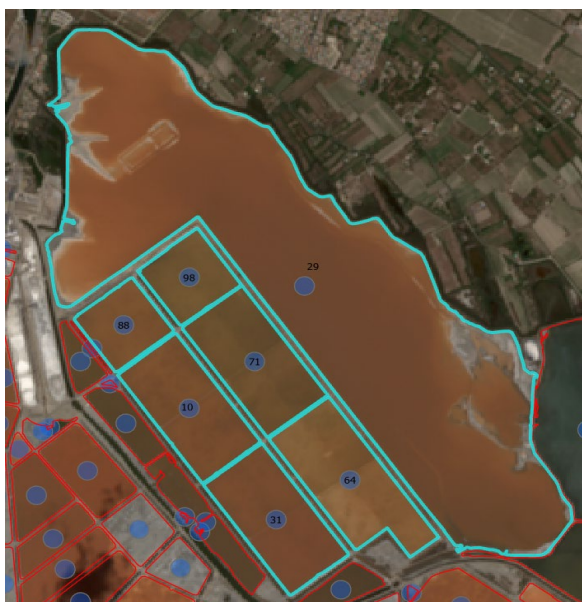
04/01/2023



15/03/2023



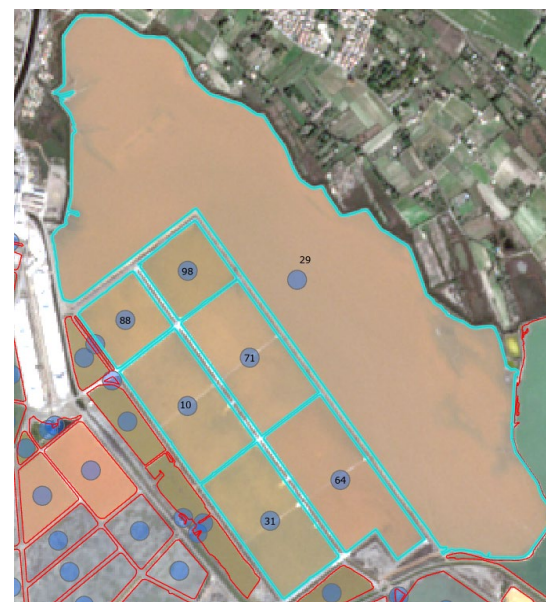
24/05/2023



13/07/2023



17/09/2023



15/11/2023

RED
GREE
N
BLUE



04/01/2023



15/03/2023



24/05/2023



13/07/2023



17/09/2023



15/11/2023

SWIR
NIR
RED

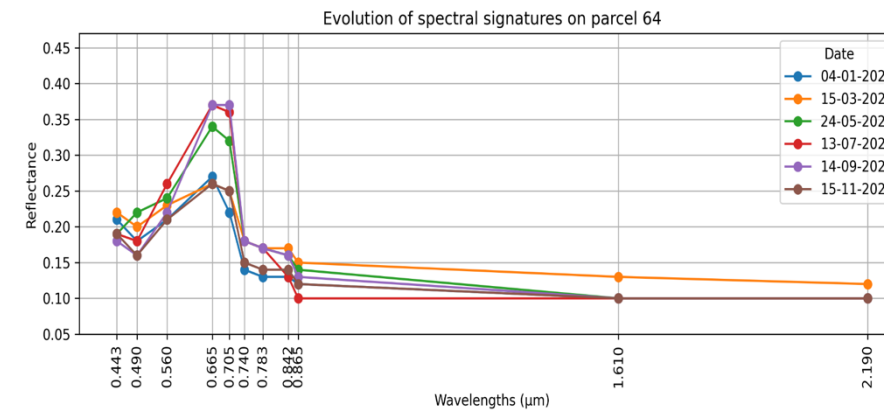
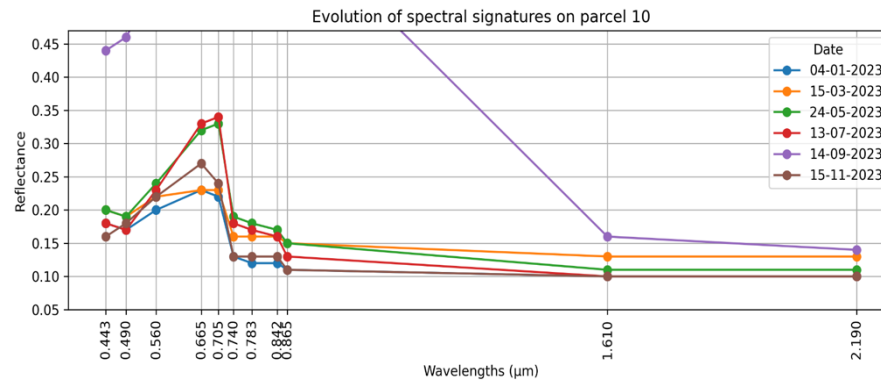
Temporal trends at parcels' scale



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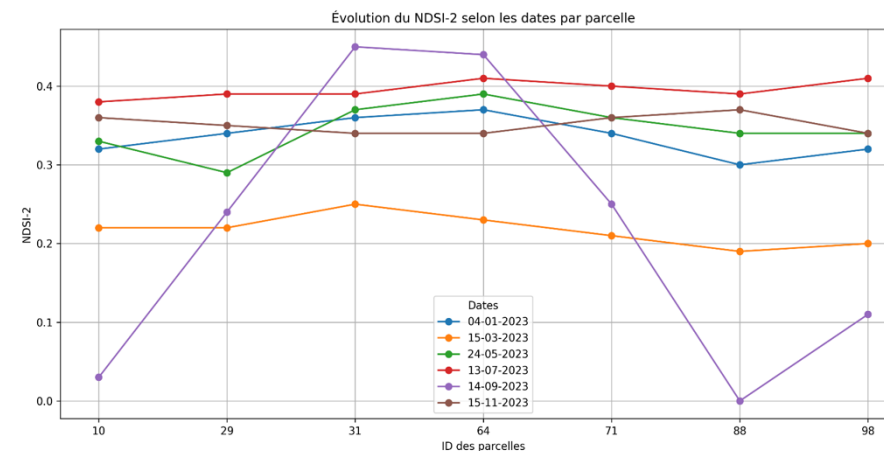
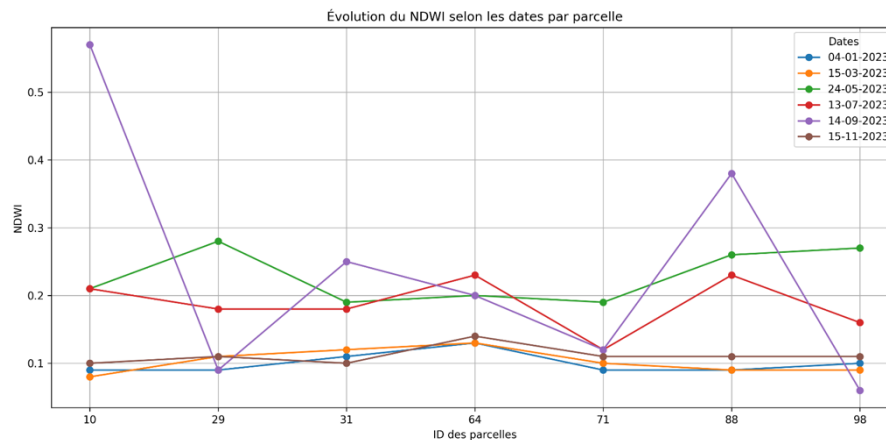


■ Spectral & Temporal Trends

NIR peaks indicate algae growth, SWIR & NIR remain low persistent dryness.

■ Salt crust spectral behavior

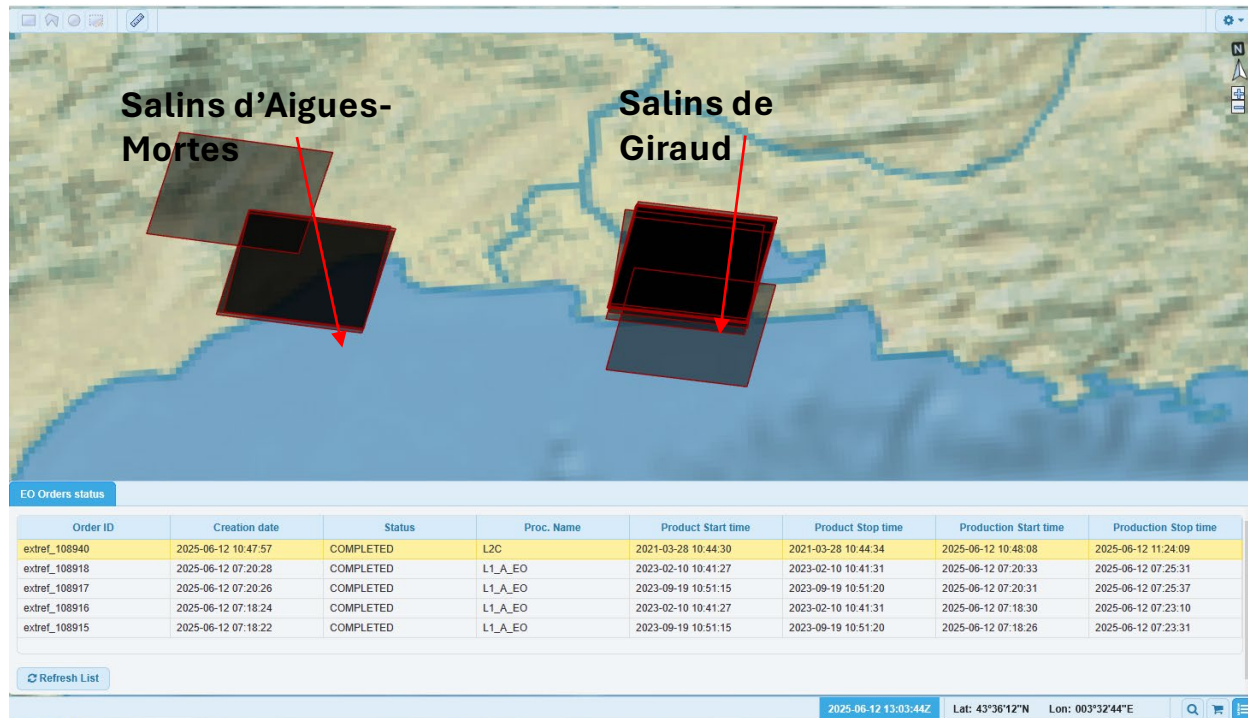
Dry salt, high reflectance wet/dry salt, lower reflectance (e.g., SWIR).



■ NDWI & NDSI insights

Low NDWI and high NDSI = dry or saline zone.
Seasonal and spatial trends reveals salinity stress.

Next steps - hyperspectral approach



Access to new acquisition over the test sites for EnMap and Prisma.

Request to salt manufactures of field data

Request access to Chine hyperspectral data

4.Goafen 5 Hyperspectral AHSI

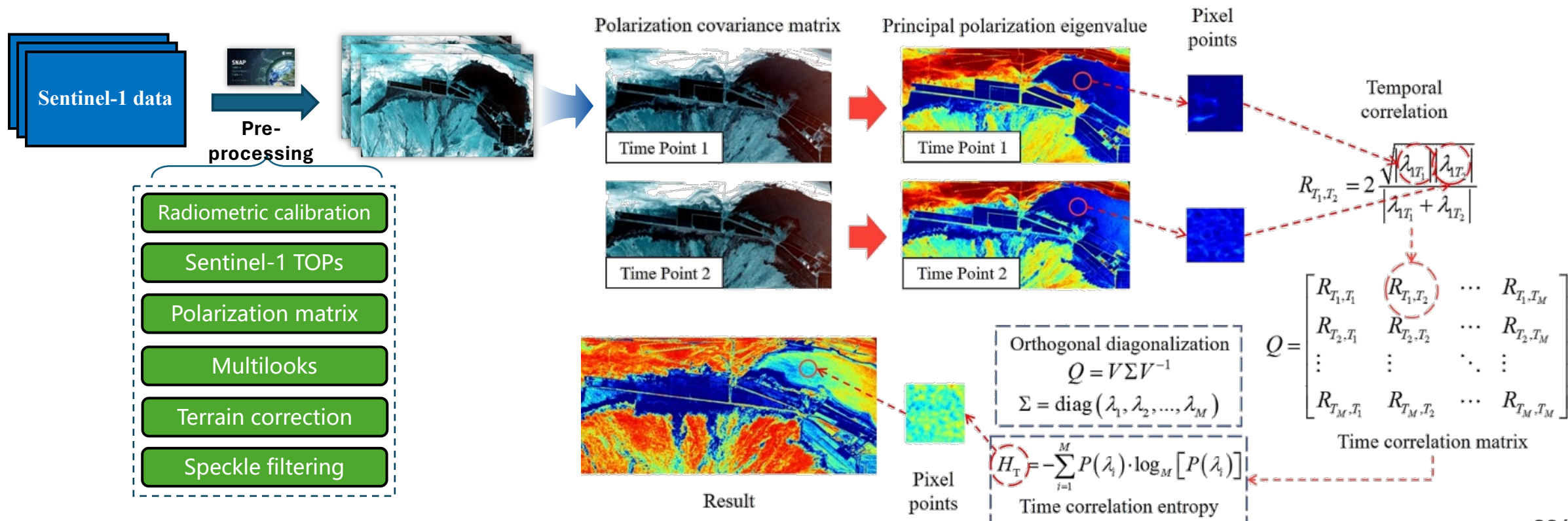


- Salt Lake/Field Classification
SAR+Optical ➡ Multi-temporal PolSAR and Spectral Features for Classification in Salt Lake Region
- Salt Crust Classification
SAR ➡ Salt Crust Classification of Salt Lake Based on Polarimetric Feature
- Sediment Thickness Classification
Optical ➡ Classification for the Sediment Thickness of Salt Ponds Based on Sentinel-2 Data
- Salt Lake Mapping
SAR+Optical ➡ Salt Lake RS Foundation Model



Time Correlation Entropy: A Novel Multitemporal PolSAR Feature and Its Application in Salt Lake Classification.

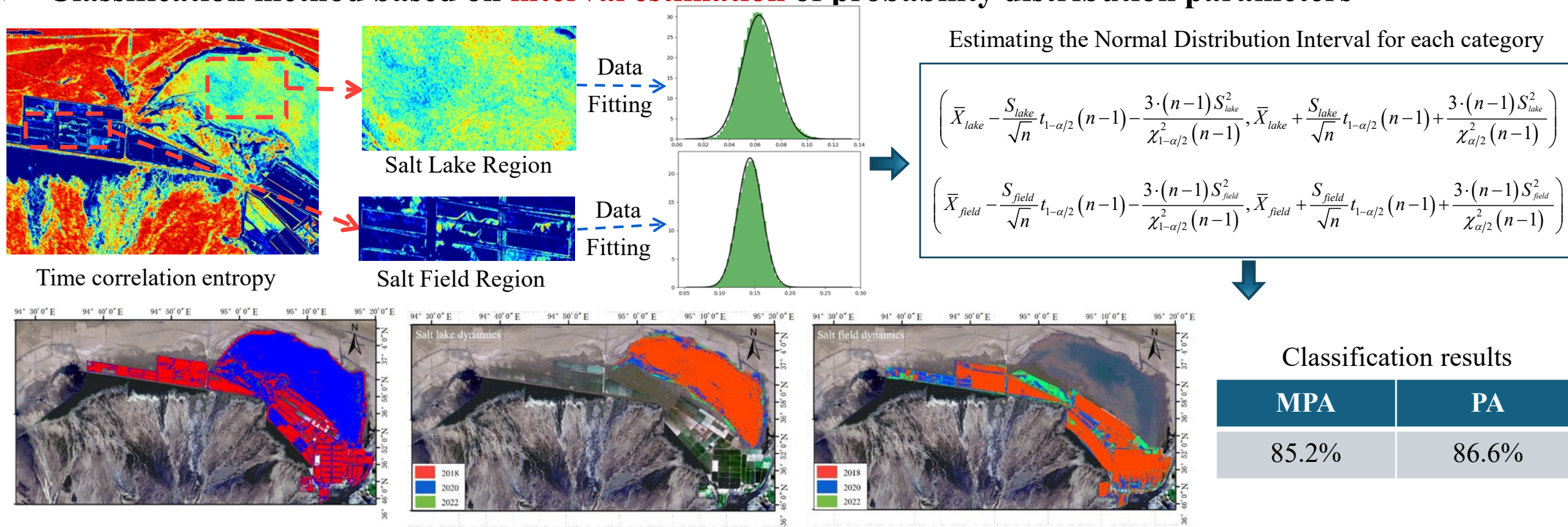
- A new multi-temporal polarization feature, **time correlation entropy**, is proposed, which can distinguish between salt lakes and salt fields using **cumulative changes** in land covers





Time Correlation Entropy: A Novel Multitemporal PolSAR Feature and Its Application in Salt Lake Classification.

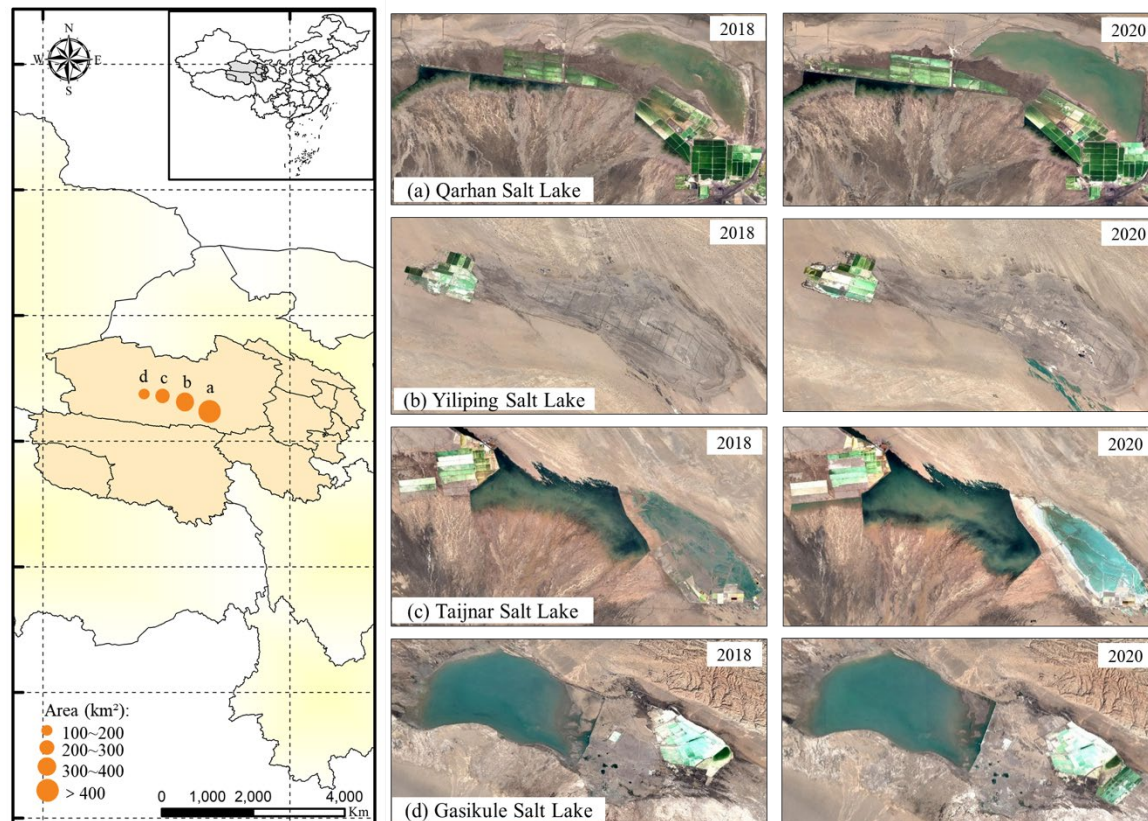
- Classification method based on **interval estimation** of probability distribution parameters





Fusion multi-temporal PolSAR and spectral features for classification in salt lake region

- **Study area: Qarhan Salt Lake, Yiliping Salt Lake, Tajinar Salt Lake and Gasikule Salt Lake;**



- **Experimental data: Sentinel-1 data and Landsat 8-9 for easy access and short re-entry.**

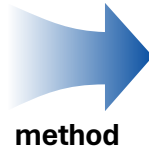
Study area	PolSAR data		Multi-spectral data	
	Satellite	Acquisition dates (YY/MM/DD)	Satellite	Acquisition dates (YY/MM/DD)
Qarhan	Sentinel-1A	2022/01/20; 2022/02/13; 2022/03/21; 2022/04/14; 2022/05/08; 2022/06/13.	Landsat-8	2022/07/19
Yiliping	Sentinel-1A	2023/01/25; 2023/02/18; 2023/03/26; 2023/04/19; 2023/05/25; 2023/06/18.	Landsat-9	2023/01/01
Tajinar	Sentinel-1A		Landsat-9	2023/08/06
Gasikule	Sentinel-1A	2023/03/20; 2023/04/25; 2023/05/19; 2023/06/24.	Landsat-8	2023/07/26



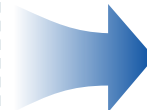
Fusion multi-temporal PolSAR and spectral features for classification in salt

Cumulative changes and salt ion concentrations

Entropy makes it **difficult** to distinguish between **sodium salt pools** and **salt lakes**.



Introduction of **spectral features**



Entropy + Blue band



Polarimetric-Optical Salt Dynamics Feature (POSD)

POSD:
$$D^{(i,j)} = \underbrace{\alpha H^{(i,j)}}_{\text{Entropy}} + \underbrace{\gamma B^{(i,j)}}_{\text{Blue band}}$$

The **scattering mechanism entropy** obeys **normal distributions**; the **spectral features** can be represented by **Gaussian mixture distributions** with two Gaussian components. (Zhang et al., 2012)



X denotes the random variable of the entropy

$$f_X(x) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left[-\frac{(x-\mu)^2}{2\sigma^2}\right],$$

Y denotes the random variable of the blue band

$$f_Y(y) = \frac{\omega_1}{\sqrt{2\pi}\sigma_1} \exp\left[-\frac{(y-\mu_1)^2}{2\sigma_1^2}\right] + \frac{\omega_2}{\sqrt{2\pi}\sigma_2} \exp\left[-\frac{(y-\mu_2)^2}{2\sigma_2^2}\right],$$

Z denotes the random variable of POSD

$$Z = \alpha X + \gamma Y$$



Definition of the **cumulative distribution function**

$$F(z) = P(\alpha X + \gamma Y \leq z) = P\left(X \leq \frac{1}{\alpha}z - \frac{\gamma}{\alpha}Y\right) \\ = \int_{-\infty}^{+\infty} f_{msi}(y) \int_{-\infty}^{\frac{1}{\alpha}z - \frac{\gamma}{\alpha}y} f_{pol}(x) dx dy = \int_{-\infty}^{+\infty} f_{msi}(y) F_{pol}\left(\frac{1}{\alpha}z - \frac{\gamma}{\alpha}y\right) dy$$

Definition of **probability density function**

$$f(z) = F'(z) = \frac{1}{\alpha} \int_{-\infty}^{+\infty} f_{msi}(y) f_{pol}\left(\frac{1}{\alpha}z - \frac{\gamma}{\alpha}y\right) dy$$

Probability distribution of POSD: **Gaussian mixture distribution**

$$f(z) = \frac{\omega_{msi1}}{\sqrt{2\pi}\sqrt{\sigma_{pol}^2\alpha^2 + \gamma^2\sigma_{msi1}^2}} \exp\left[-\frac{(z - \alpha\mu_{pol} - \gamma\mu_{msi1})^2}{2(\sigma_{pol}^2\alpha^2 + \gamma^2\sigma_{msi1}^2)}\right] + \frac{\omega_{msi2}}{\sqrt{2\pi}\sqrt{\sigma_{pol}^2\alpha^2 + \gamma^2\sigma_{msi2}^2}} \exp\left[-\frac{(z - \alpha\mu_{pol} - \gamma\mu_{msi2})^2}{2(\sigma_{pol}^2\alpha^2 + \gamma^2\sigma_{msi2}^2)}\right] \\ = \frac{\omega_1}{\sqrt{2\pi}\sigma_1} \exp\left[-\frac{(z - \mu_1)^2}{2\sigma_1^2}\right] + \frac{\omega_2}{\sqrt{2\pi}\sigma_2} \exp\left[-\frac{(z - \mu_2)^2}{2\sigma_2^2}\right]$$



Fusion multi-temporal PolSAR and spectral features for classification in salt lake region



Method	Salt lake			Salt field			OA	Kappa
	Pc	R	F1	Pc	R	F1		
Proposed	88.76	95.48	92.00	94.00	85.39	89.49	90.91	81.52
TSCA	63.70	98.68	77.42	96.60	39.95	56.53	70.28	39.37
STMA	84.19	99.98	91.41	99.97	77.32	87.20	89.72	78.85
CNNM	72.80	99.97	84.25	99.95	54.88	70.85	79.55	57.07
IOPF	73.25	99.99	84.56	99.99	55.89	71.70	80.02	58.09

Method	Salt lake			Salt field			OA	Kappa
	Pc	R	F1	Pc	R	F1		
Proposed	98.90	86.54	92.78	86.35	99.25	92.68	92.73	85.53
TSCA	80.18	78.53	79.34	75.39	77.22	76.29	77.92	55.64
STMA	79.68	99.99	88.69	99.98	70.04	82.37	86.22	71.62
CNNM	79.87	84.79	82.26	80.75	74.92	77.73	80.25	60.03
IOPF	81.16	85.39	83.22	81.73	76.73	79.15	81.41	62.40

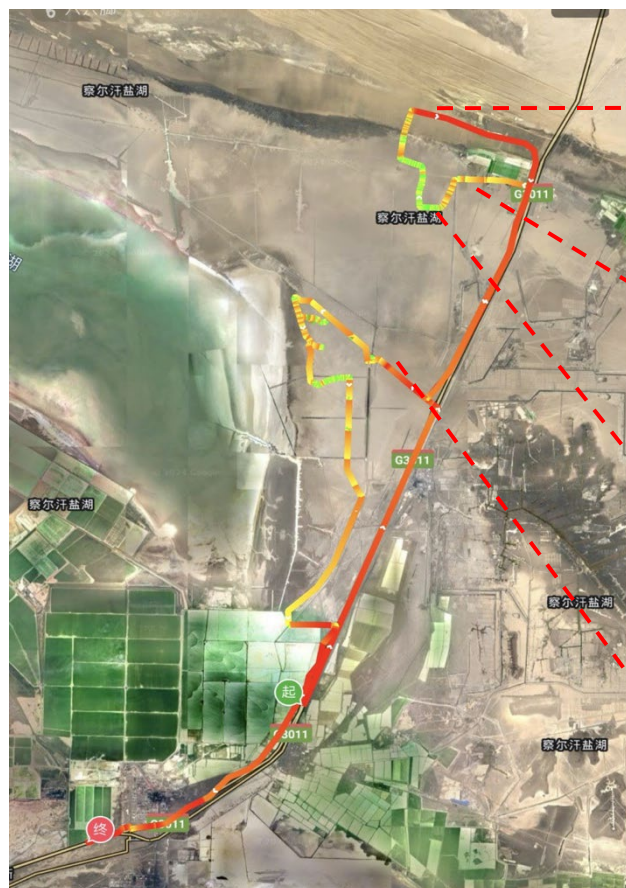
Method	Salt lake			Salt field			OA	Kappa
	Pc	R	F1	Pc	R	F1		
Proposed	97.41	99.36	98.37	97.35	89.95	93.51	97.40	91.88
TSCA	90.80	96.50	93.57	82.52	62.80	71.32	89.49	65.03
STMA	91.67	99.97	95.64	99.81	65.33	78.97	92.77	74.83
CNNM	90.67	95.46	93.01	78.39	62.64	69.63	88.63	62.75
IOPF	93.56	91.90	92.72	71.13	75.93	73.45	88.58	66.18

Method	Salt lake			Salt field			OA	Kappa
	Pc	R	F1	Pc	R	F1		
Proposed	97.69	99.52	98.60	99.98	88.51	93.89	97.65	91.36
TSCA	87.23	98.40	92.48	79.16	29.61	43.10	86.71	37.30
STMA	88.69	99.97	94.01	99.81	37.67	54.73	89.41	50.09
CNNM	95.80	99.62	97.68	97.72	78.68	87.17	96.07	84.88
IOPF	94.87	99.50	97.13	96.79	73.72	83.69	95.12	80.88



Salt Crust Classification of Qarhan Lake Based on Polarimetric Feature Reconstruction and Optimization

➤ Types of Salt Crusts: Flat (Fl), Micro-mound Shaped(Mm), Acutely Ribbed(Rb), and Cracked(Cr).



Flat (Fl): The salt is gradually eroded by wind, which increases the mud and sand content and leads to the formation of a softer and more fragile surface.



Micro-mound Shaped (Mm): A transitional form between ridged and flat salt crusts, with gentler undulations and higher mud and sand content than ridged salt crusts.



Acutely Ribbed (Rb):, Characterized by significant uplift of 10–20 cm, up to 30 cm, with low mud and sand content and pronounced topographic undulations.

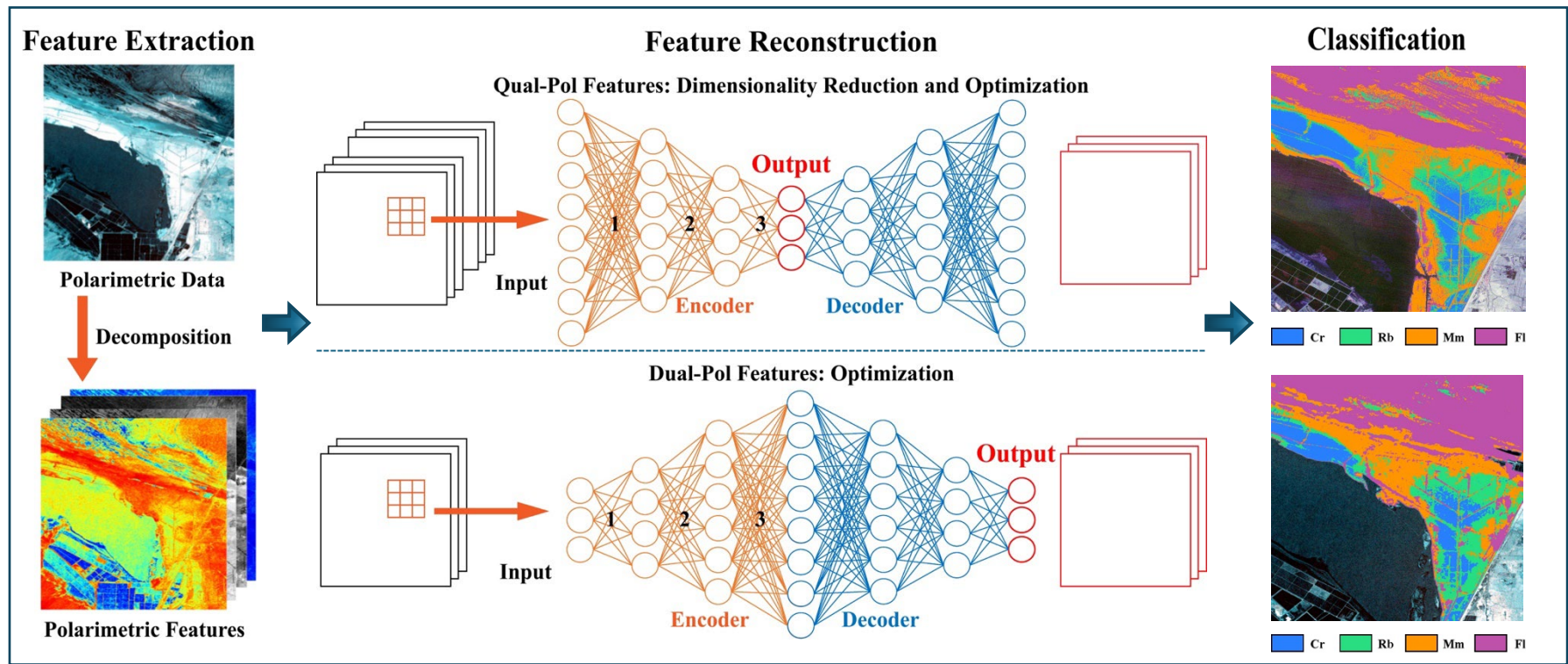


Cracked (Cr): Composed of newly formed fractured but non-uplifted rock layers, featuring a hard, flat surface with a thin layer of fine-grained milky-white halite.



Salt Crust Classification of Qarhan Lake Based on Polarimetric Feature Reconstruction and Optimization

➤ Classification based on feature reconstruction to describe the spatial distribution of salt crusts



Classification Results in Gaofen-3				
	Method	OA	AA	Kappa
Before reconstruction (22 features)	RF	0.8810	0.8591	0.8423
	SVM	0.8893	0.8689	0.8533
	CNN	0.9060	0.8959	0.8752
	ViT	0.9131	0.8952	0.8824
After reconstruction (8 features)	RF	0.8720	0.8495	0.8305
	SVM	0.8768	0.8544	0.8369
	CNN	0.9053	0.8972	0.8743
	ViT	0.9044	0.8858	0.8706

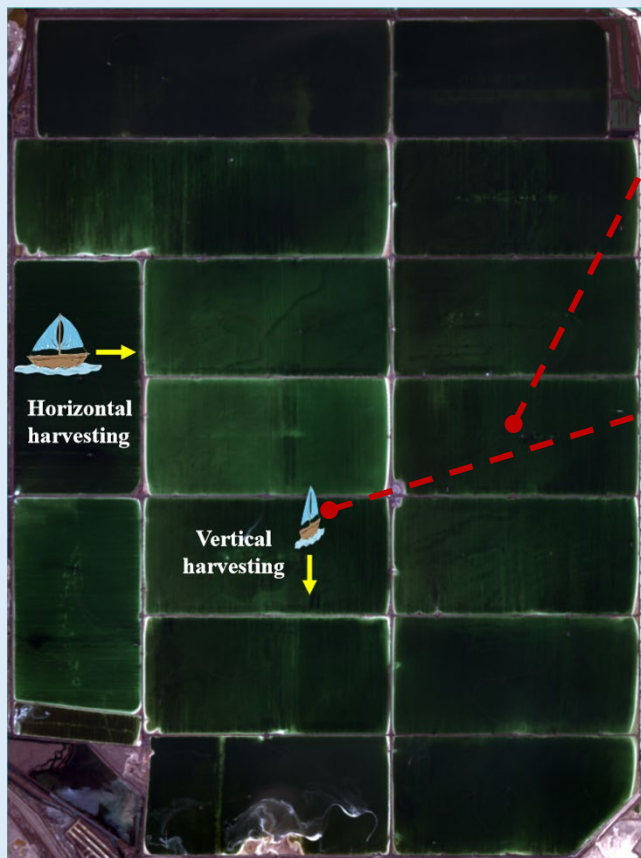
Classification Results in Sentinel-1				
	Method	OA	AA	Kappa
Before reconstruction (6 features)	RF	0.8295	0.8353	0.8005
	SVM	0.8374	0.8237	0.7912
	CNN	0.8782	0.8745	0.8447
	ViT	0.8504	0.8341	0.8045
After reconstruction (6 features)	RF	0.8422	0.8504	0.8172
	SVM	0.8606	0.8509	0.8218
	CNN	0.8907	0.8897	0.8614
	ViT	0.8663	0.8679	0.8273

Preliminary study results

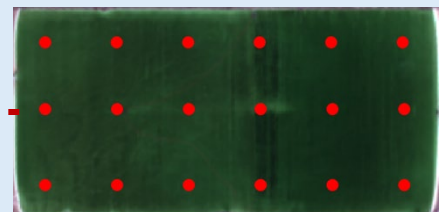


A Classification Method for the Sediment Thickness of Salt Ponds Based on Sentinel-2 Data

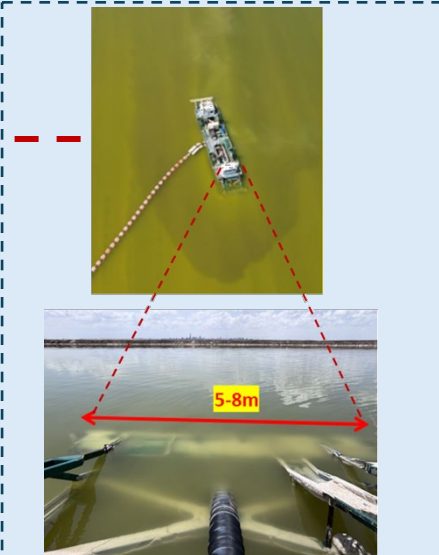
Sentinel-2 data(10m)



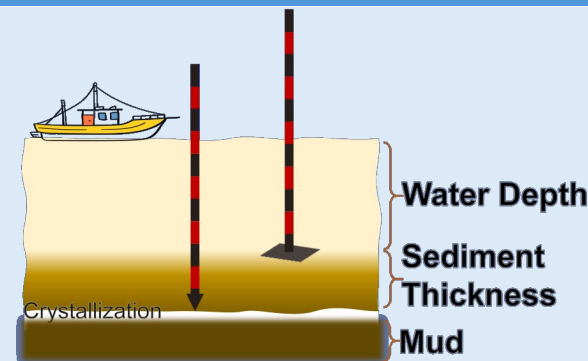
Field Investigation



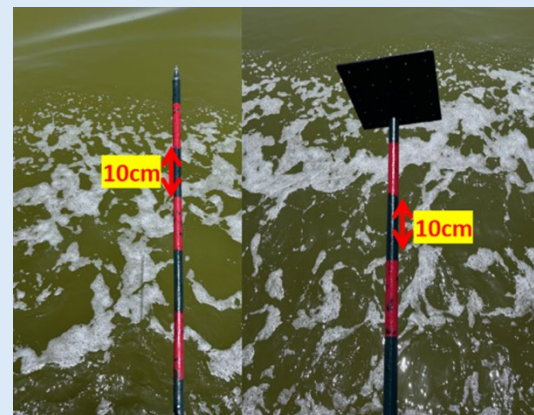
18 points collected monthly



Salt harvesting boat



Measurement method



Measuring instrument

High-resolution Imagery(0.5m)

Worldview2(2020.06)



GiLin1(2022.08)



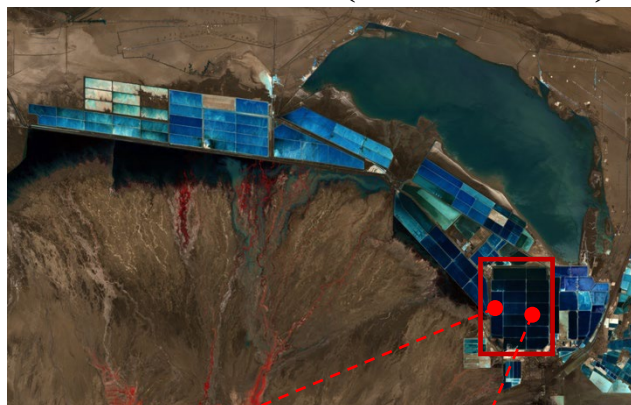
**Reducing cost by
introducing RS technique!**



A Classification Method for the Sediment Thickness of Salt Ponds Based on Sentinel-2 Data

- A **linear-target-sensitive** classification model for identifying salt pond collection states

Sentinel-2 data(NIR-R-G-B)

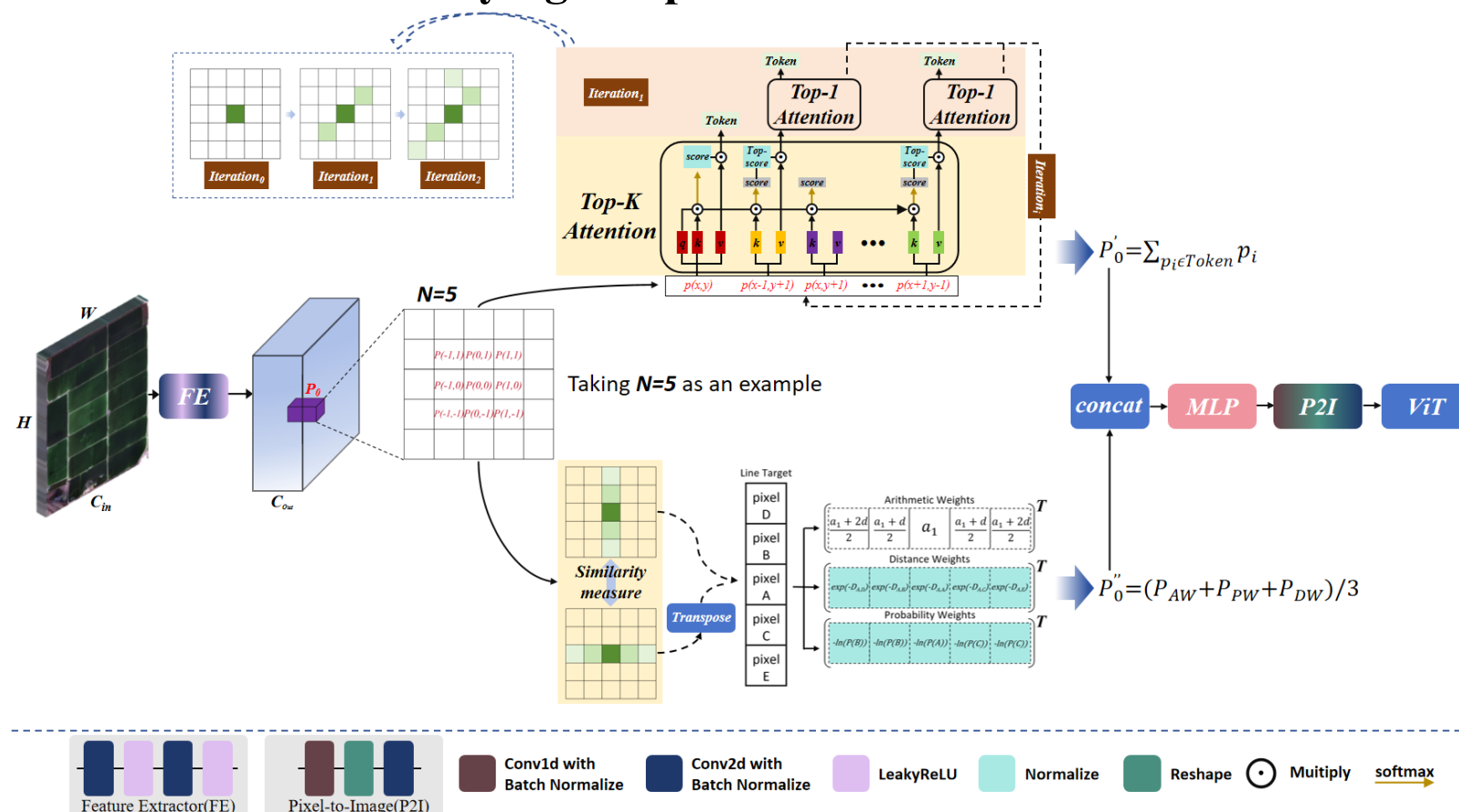


crop



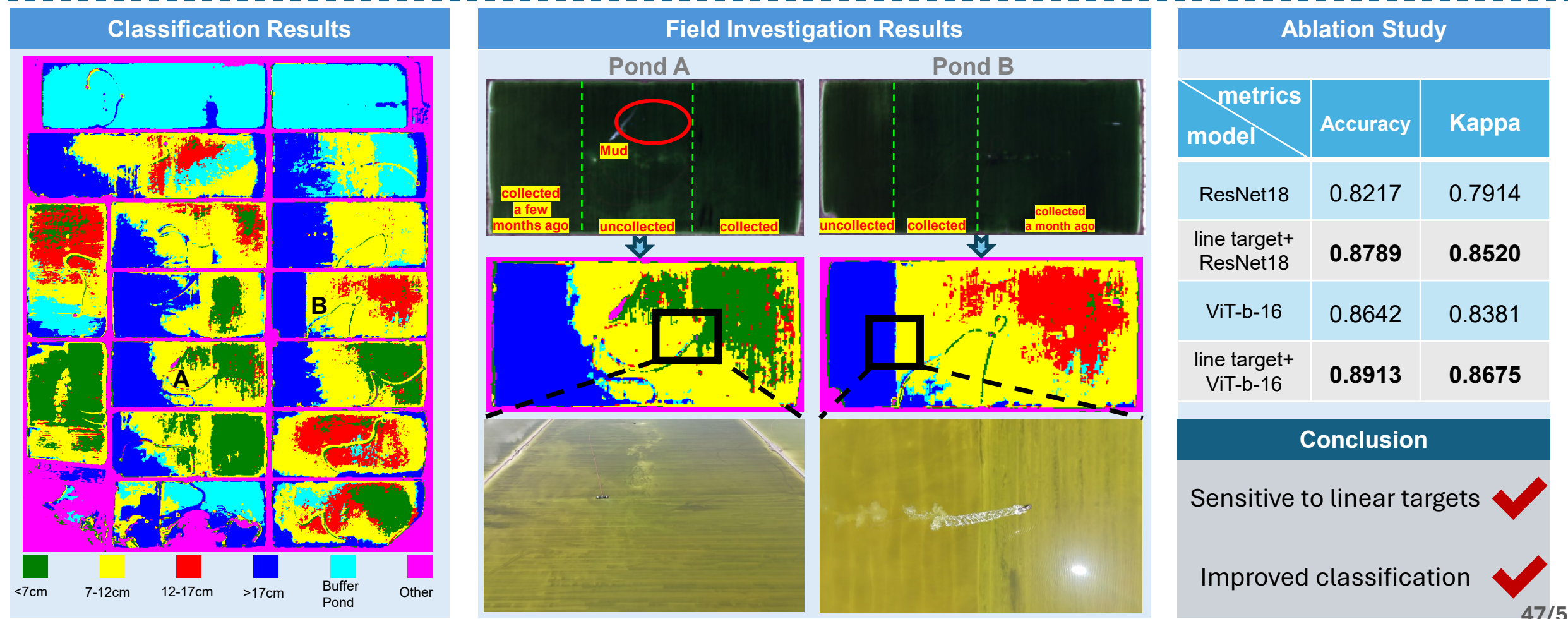
Horizontal harvesting

Vertical harvesting





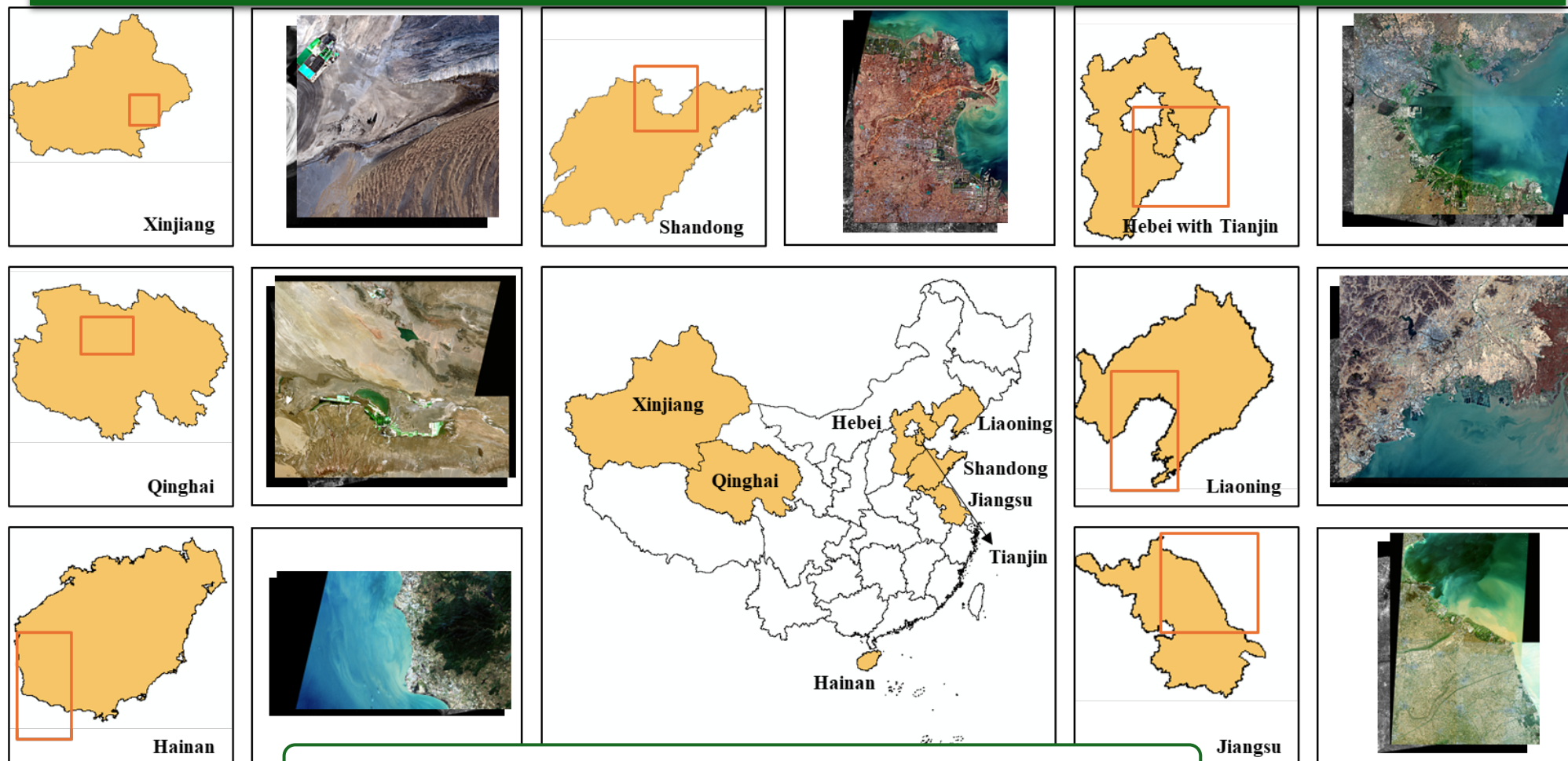
A Classification Method for the Sediment Thickness of Salt Ponds Based on Sentinel-2 Data





Remote sensing Salt lake Big Data

A China-wide PolSAR and multispectral dataset for salt lakes

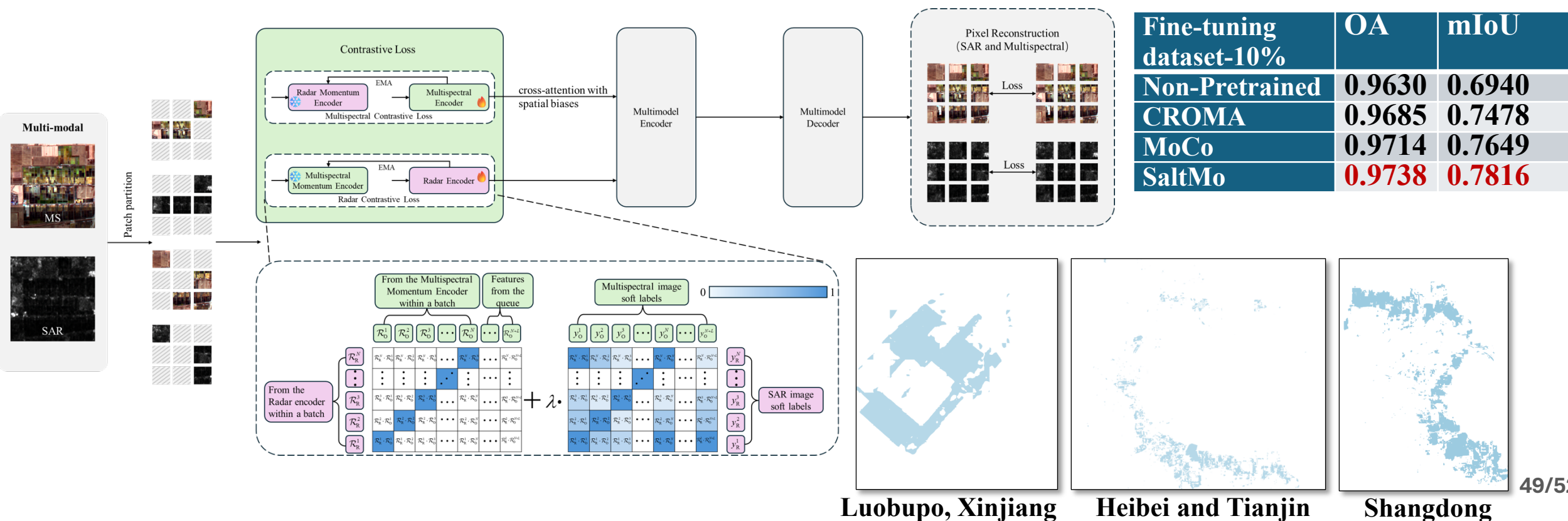


1) Registered 2) Covering 10 provinces



SaltMo: A Self-Supervised Multimodal Learning Framework for Salt Lake Mapping

- We created for the first time a salt lake RS foundation model
- Trained by Salt Lake Large-scale dataset
- Superior performance across downstream tasks, including salt lake classification





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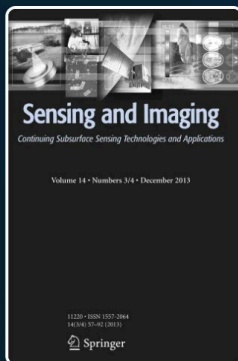
- Project objectives
- Main test sites in China & Europe
- Copernicus Sentinels, ESA, Chinese and ESA Third Party Mission data
- In-situ measurements plan
- Working Packages & Time schedule
- Expected results
- Contribution and training of young scientists
- Preliminary study results



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Open for submissions



Submission deadline
31 March 2026

Special Issue on the Advances in Remote Sensing for Inland Water Monitoring



Participating journal: Sensing and Imaging

Inland water bodies such as lakes, reservoirs, rivers, and wetlands play critical roles in global hydrological processes, biodiversity conservation, and socioeconomic development. Monitoring dynamic changes of these water bodies is essential for effective water resource management and environmental protection and understanding the impact of climate change. Recent advances in remote sensing technologies, particularly time series data from multispectral, hyperspectral, and radar sensors, have significantly enhanced our ability to observe and analyze inland water bodies at various spatial and temporal scales. These tools enable continuous, large-scale, and cost-effective monitoring of water areas, water levels, water quality parameters, flooding dynamics, and wetland changes.



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Thanks for your attention

Questions

