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FIFTEENTH ASIA-OCEANIA METEOROLOGICAL SATELLITE USERS' CONFERENCE
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Modeling Near-Surface Air Temperature Using FengYun-LST: A Regression-Based Approach for Climate Monitoring

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This presentation details a regression-based approach to model near-surface air temperature using Land Surface Temperature (LST) data from the FengYun satellite series.

This method is crucial for enhancing climate monitoring, particularly in regions with sparse traditional weather station coverage.



Background — Climate Context & Problem

Global Temperature Rise

Global surface temperatures are projected to rise 2–4°C by the end of the 21st century under high-emission scenarios (IPCC AR6).

Vulnerability in South Asia

South Asia and Pakistan are among the world's most vulnerable regions to extreme heat, drought, and urban heat islands.

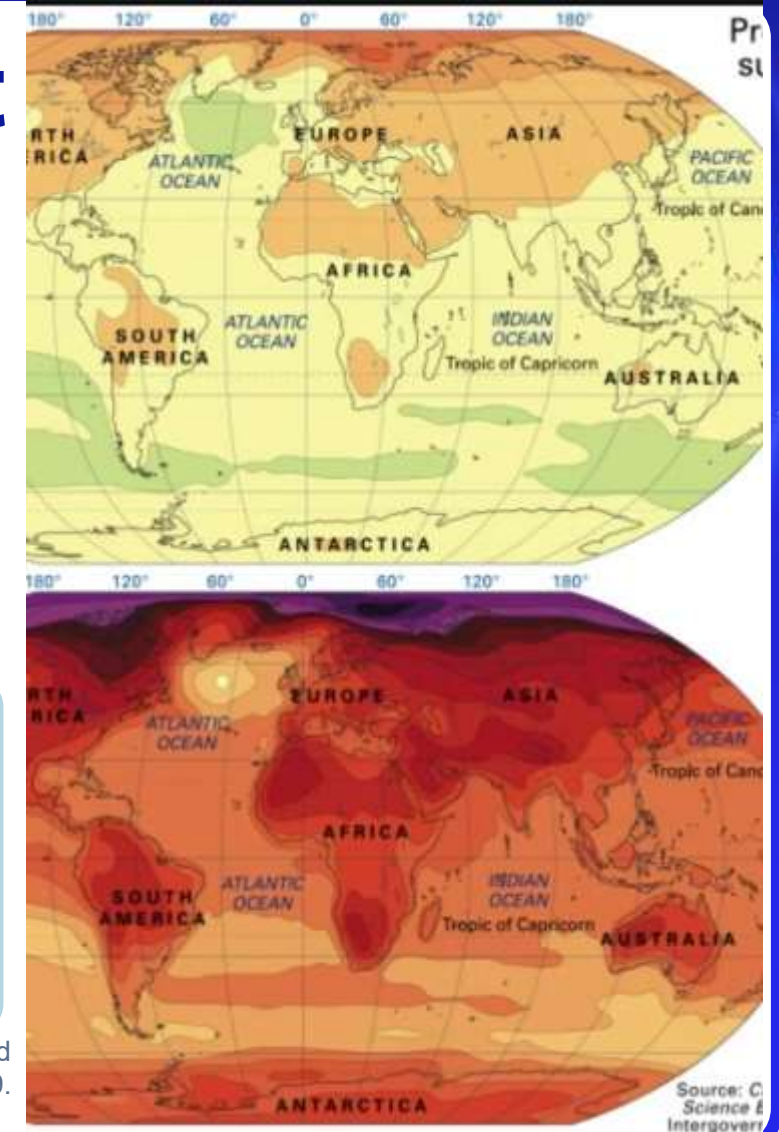


Figure 1: IPCC projected changes in mean surface temperatures for the period 2090–99 relative to the mean temperature values for the period 1980–99.



Background — Climate Context & Problem

Extreme Heat Events

The 2022 Pakistan heatwave recorded temperatures exceeding 50°C, highlighting the need for robust monitoring systems.

Data Gaps

Traditional weather stations are sparse and clustered in urban/institutional areas, leading to poor representation of rural, arid, or mountainous regions.

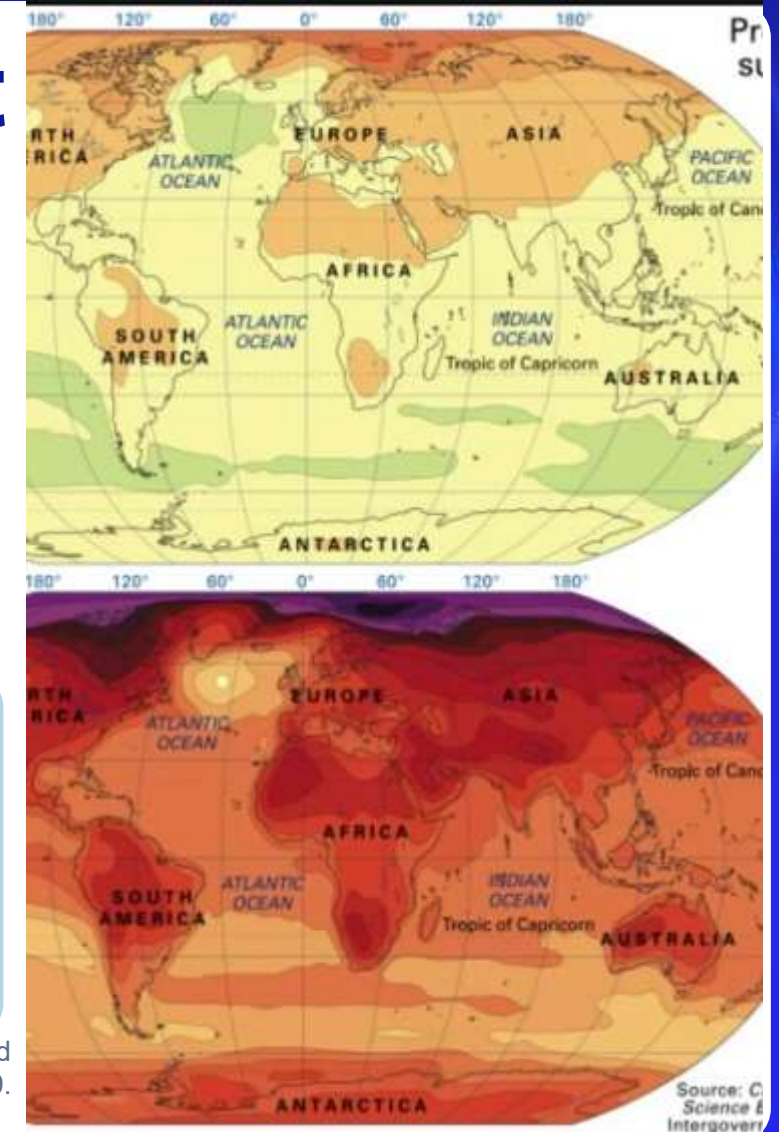


Figure 1: IPCC projected changes in mean surface temperatures for the period 2090–99 relative to the mean temperature values for the period 1980–99.



Study Objectives: Bridging the Data Gap



Establish Regression Relationship

Develop quantitative models linking FengYun satellite LST with gridded daily maximum air temperature data.



Validate Spatial Accuracy

Assess the correlation strength across Pakistan's diverse climatic and topographic zones to ensure model reliability.

- ❑ The primary goal is to leverage the continuous spatial coverage of LST to overcome the limitations of sparse, point-based weather station data, especially in vulnerable regions.



Fundamental Variables: Air Temperature vs. LST



Air Temperature (T_{air})

- Standard meteorological parameter, measured at 1.5-2 meters above ground.
- Represents atmospheric conditions experienced by biological systems and humans.
- Point-based measurements with high temporal resolution.
- Limited spatial coverage due to sparse station placement.



Land Surface Temperature (LST)

- Radiative temperature of Earth's surface, measured by satellite thermal infrared sensors.
- Represents the energy balance between the surface and atmosphere.
- Spatially continuous coverage with moderate temporal resolution.
- Availability is weather-dependent (e.g., cloud cover).

Spatial Bias in Conventional Monitoring

Traditional weather station networks in Pakistan suffer from significant spatial bias. Approximately 68% of stations are concentrated in urban areas, airports, and institutional locations.

This clustering results in substantial data gaps in critical areas such as rural, mountainous, and arid regions, where temperature extremes are often most pronounced and monitoring is essential for climate resilience and public safety.



- ❏ Satellite-derived LST offers a solution by providing continuous, high-resolution temperature data across all landscapes, filling these crucial monitoring voids.



Data Sources: FengYun Meteorological Satellites

The study utilizes data from the FengYun (FY) series of Chinese meteorological satellites, which provide crucial Land Surface Temperature (LST) data.

🔗 Sensors & Resolution

Sensors include VIRR, MERSI, MWRI (FY-3), and AGRI (FY-4). Spatial resolution ranges from 250 m to 5 km, depending on the sensor and product.

🕒 Temporal Coverage

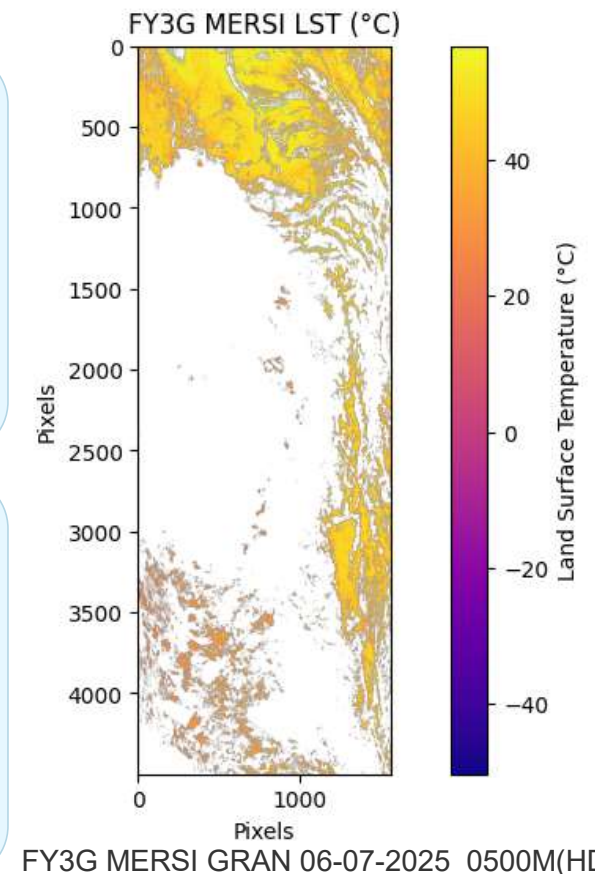
Sensors include VIRR, MERSI, MWRI (FY-3), and AGRI (FY-4). Spatial resolution ranges from 250 m to 5 km, depending on the sensor and product.

📁 Data Format & Variable

Sensors include VIRR, MERSI, MWRI (FY-3), and AGRI (FY-4). Spatial resolution ranges from 250 m to 5 km, depending on the sensor and product.

🔧 Preprocessing Steps

Sensors include VIRR, MERSI, MWRI (FY-3), and AGRI (FY-4). Spatial resolution ranges from 250 m to 5 km, depending on the sensor and product.





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Satellites	File count	Volume(TB)
FY-3C	9491680	412.1
FY-3B	25052796	1542.1
FY-3A	28516529	1533.4
FY-2G	995004	10.7
FY-2F	2447025	27.4
FY-2E	4242826	40.8
FY-2D	4738322	58.2
FY-2C	2878931	39.8
FY-1D	270455	6.5

[Data Overview>>](#)

FY-LEO

☐ FY-3C ☐ FY-3B ☐ FY-3A ☐ FY-1D [More...](#)

LT DATA

Image:

Start Date: Start Time:

End Date: End Time:

Time Range: ☐ Each Day

Spatial Sel:

Coverage: ☒ Intersect ☐ Entirely Within

[Availability](#) [Search](#)

Sign In

User ID:

Password:

Verify:

☐ Stay Signed In

[Forget Password?](#) [SIGN UP](#)

[Sign In](#)

Statistics

DOWNLOAD SINCE 2005 (MB)

2,204,124,612 MB

Satellites	23
Products	92
Data	3988.3 TB
Users	33,881
Download(24h)	421.7 GB

SATELLITE TRACK

ALL | FY-3C | FY-3B | FY-3A | FY-2G | FY-2F | FY-2E | FY-2D

Orbit Parameters

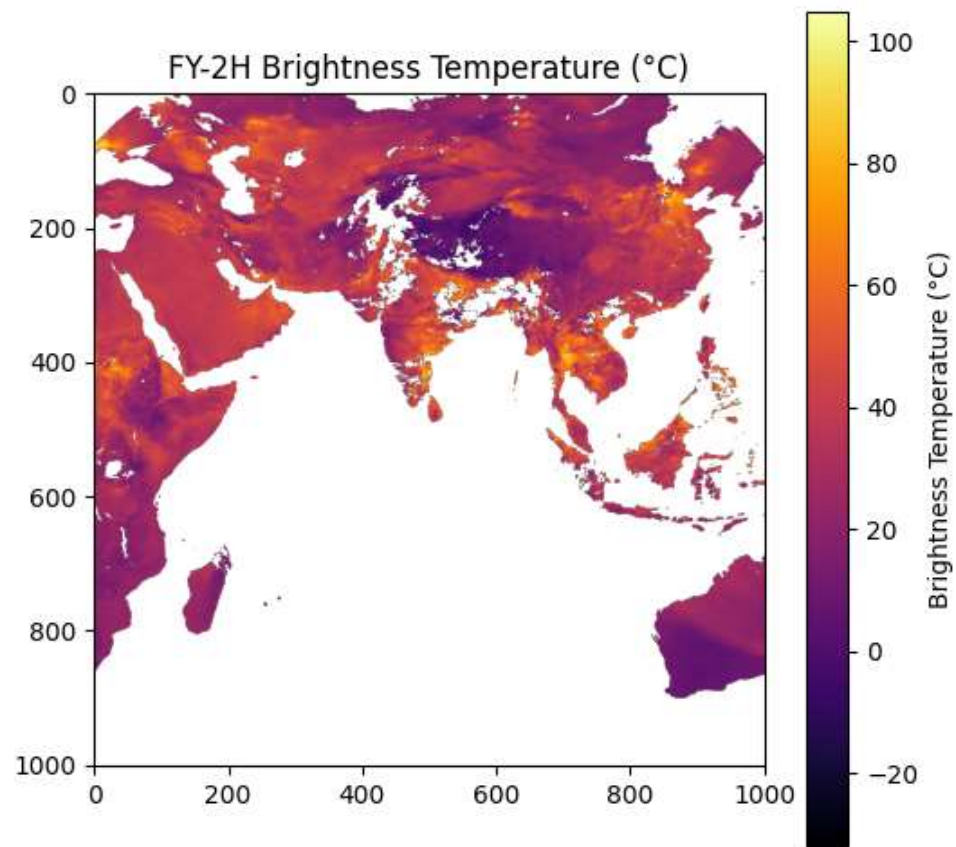
TBUS	FY-3C	FY-3B	FY-3A
Two Line	FY-3C	FY-3B	FY-3A
One Line	FY-3C	FY-3B	FY-3A
Time Table	FY-3C	FY-3B	FY-3A
	FY-2E	FY-2F	
CAL	FY-3C	FY-3B	FY-3A
	FY-2		

[DCPC/NSMC](#)

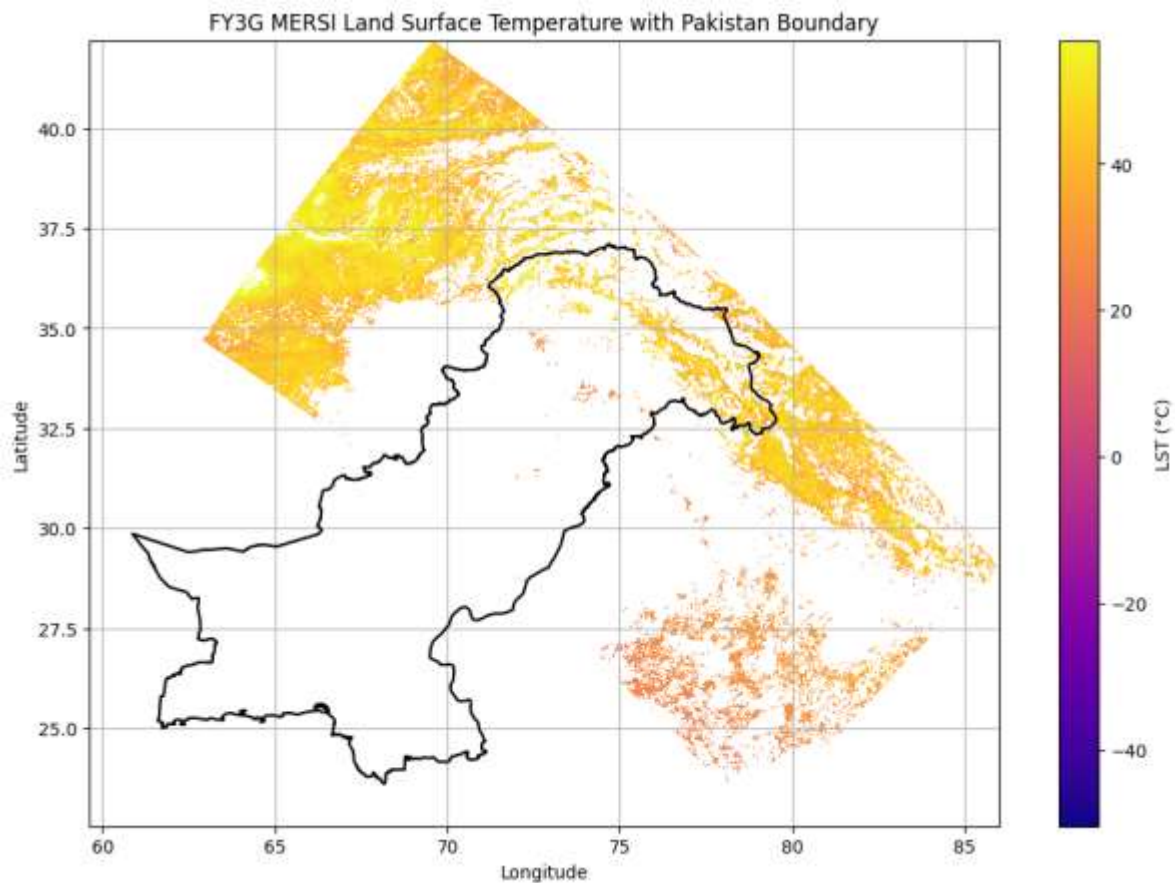


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FY2H VISSR 14-07-2025(AWX)



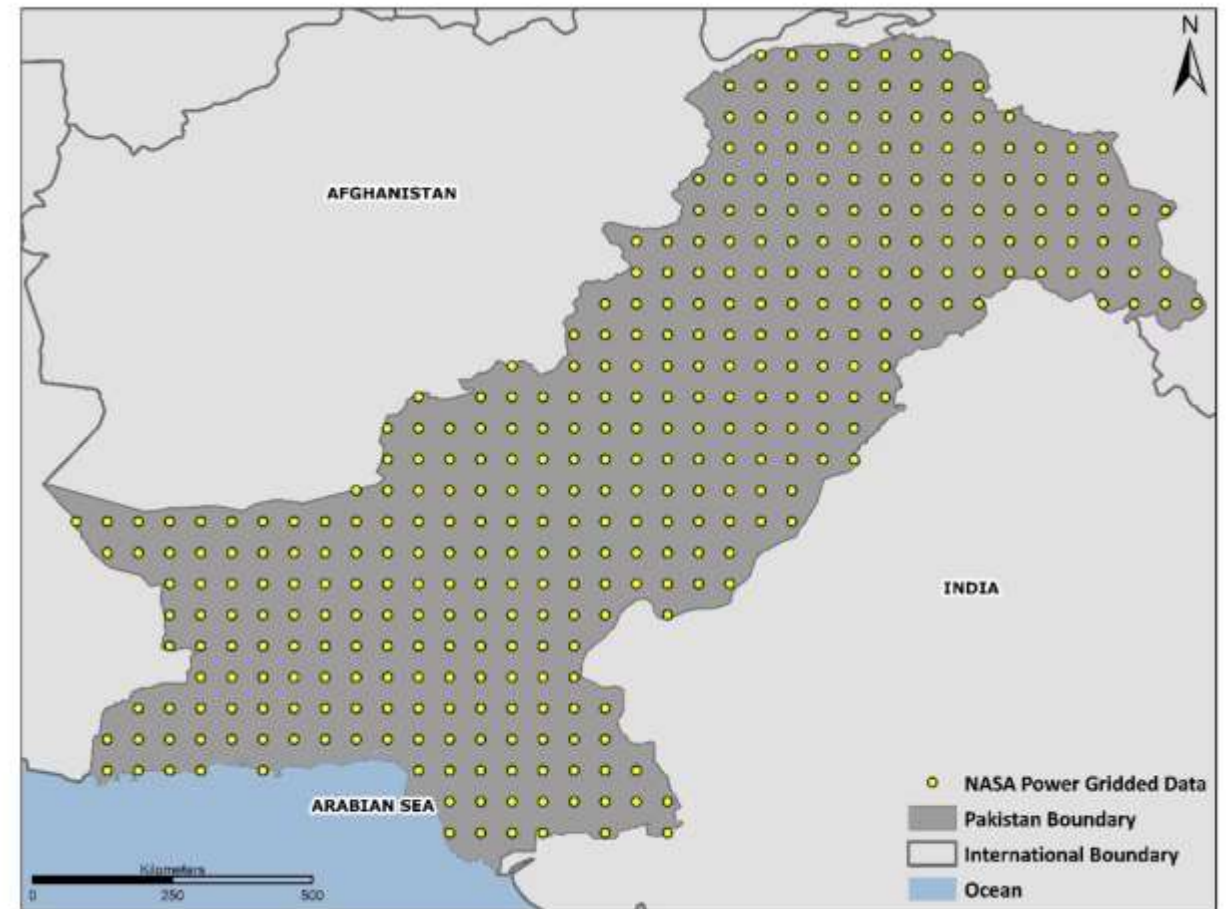
FY3G MERIS 14-07-2025 (AWX)



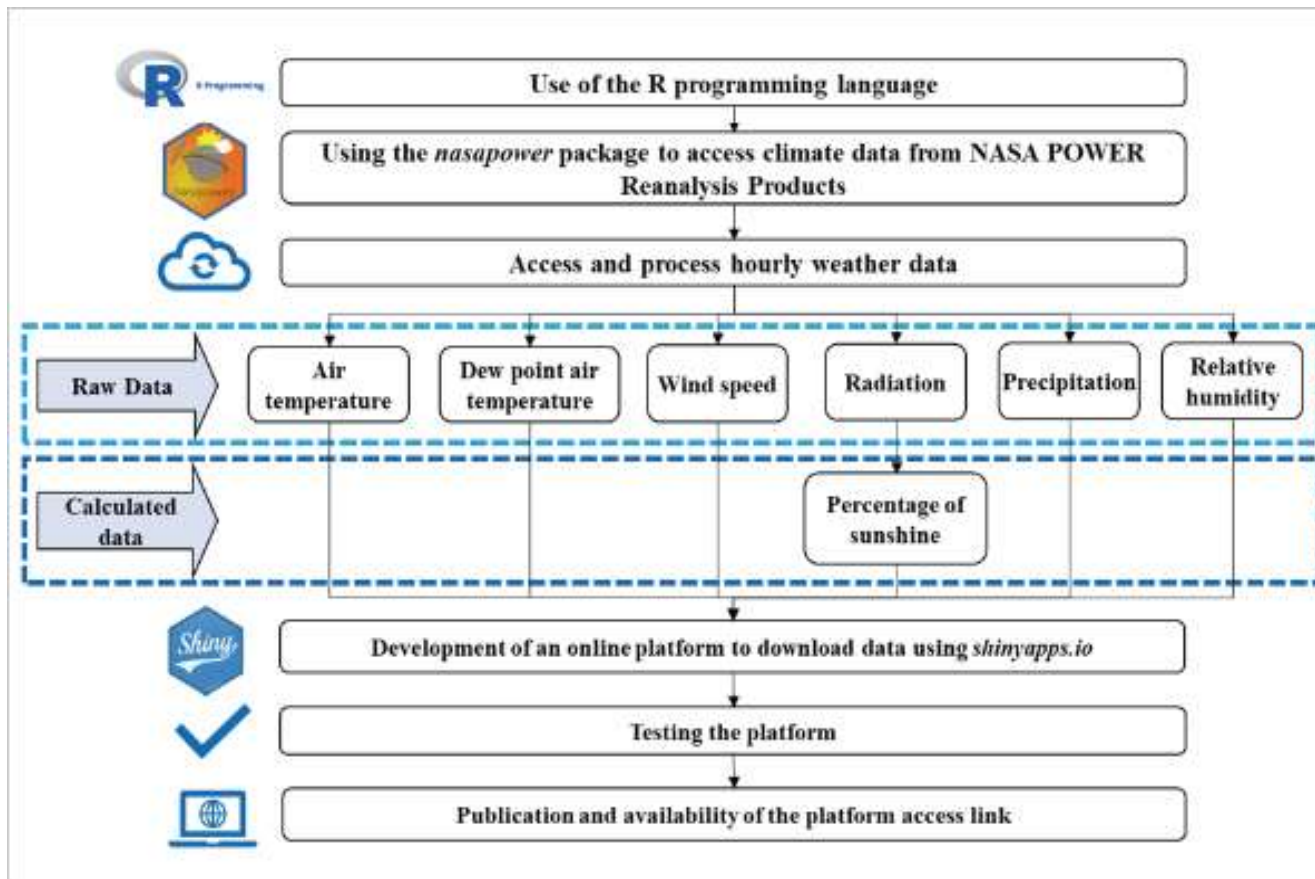
Data Sources — NASA POWER & Gridded Air Temperature

NASA POWER provides daily Tmax & Tmin (2 m air temperature) with $\sim 0.5^\circ$ (~ 50 km) global coverage for 1981–present using reanalysis + satellite inputs. Variables extracted include air temperature, solar radiation, wind speed, and relative humidity. Grid cells aligned with Pakistan station coordinates for regression pairing.

For this study, grid cells aligned with Pakistan station coordinates were extracted to ensure accurate comparison with the LST data.



Data Sources — NASA POWER & Gridded Air Temperature

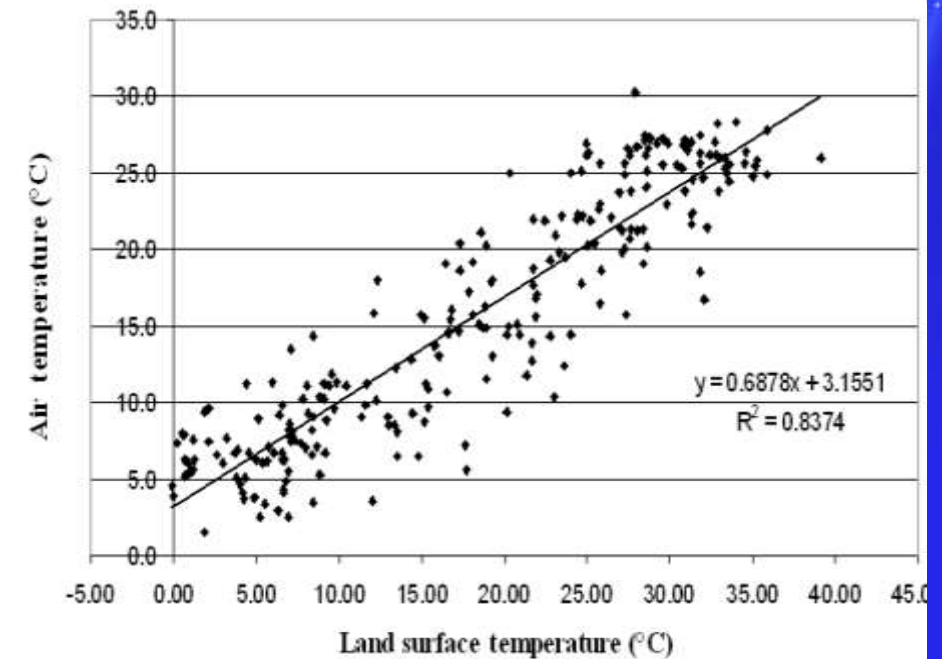
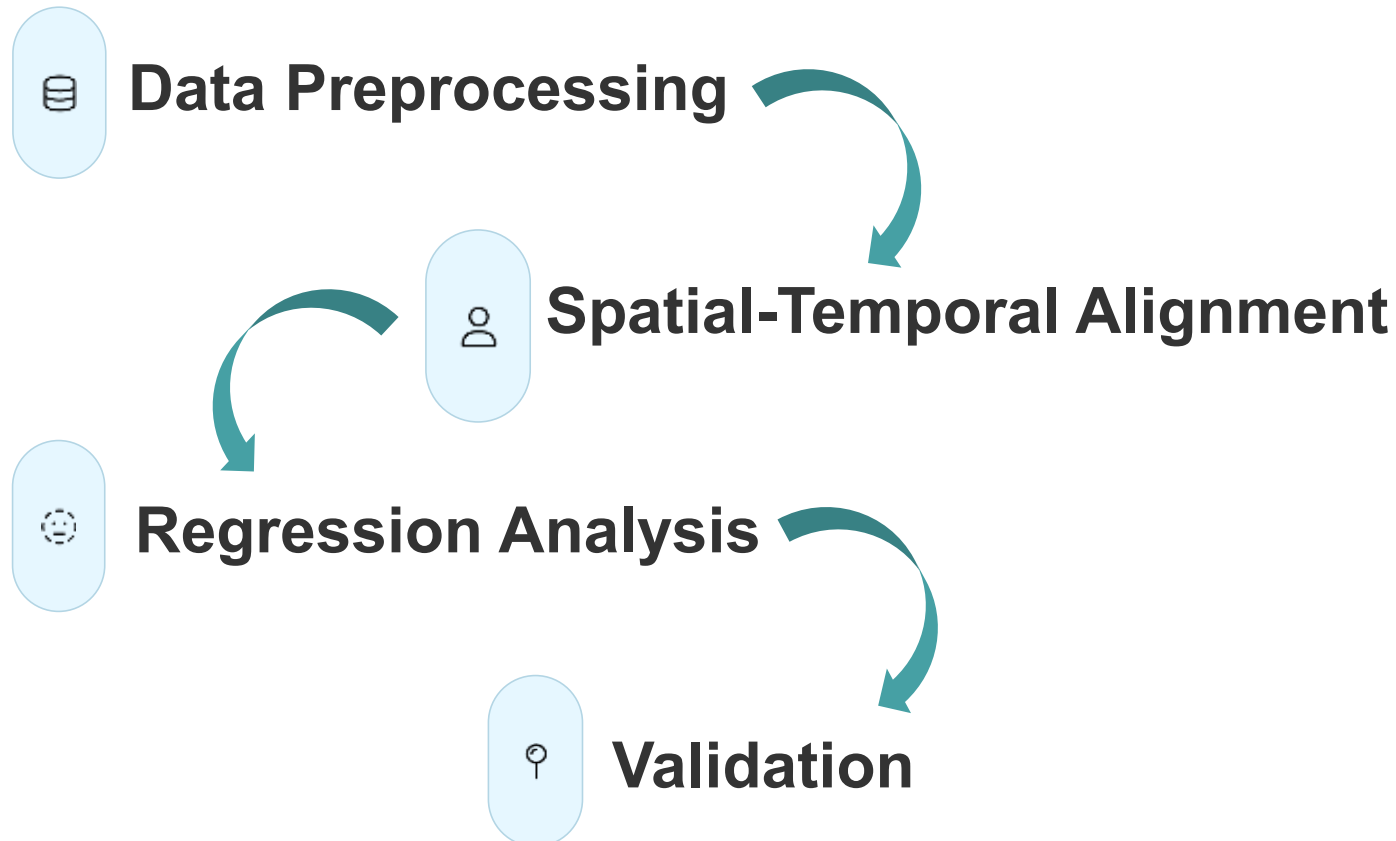


	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	LON	LAT	YEAR	MM	DD	DOY	YYYYMMDD	T2M_MAX	T2M_MIN	RH2M	T2MDEW	WS2M_MAX	latitude	longitude
2	60.894	30.257	2025	7	1	182	01-07-25	44.82	24.61	7.72	-6.1	3.95	30.257	60.894
3	60.894	30.257	2025	7	2	183	02-07-25	46.35	26.77	7.62	-4.75	4.1	30.257	60.894
4	60.894	30.257	2025	7	3	184	03-07-25	46.71	27.41	8.86	-2.16	3.67	30.257	60.894
5	60.894	30.257	2025	7	4	185	04-07-25	46.16	28.69	8	-3.25	4.52	30.257	60.894
6	60.894	30.257	2025	7	5	186	05-07-25	45.04	29.98	10.01	-0.26	4.88	30.257	60.894
7	60.894	30.257	2025	7	6	187	06-07-25	45.34	28.32	13.56	3.51	4.07	30.257	60.894
8	60.894	30.257	2025	7	7	188	07-07-25	43.71	28.29	11.63	0.87	4.96	30.257	60.894
9	60.894	30.257	2025	7	8	189	08-07-25	43.73	26.78	12.52	1.26	5.03	30.257	60.894
10	60.894	30.257	2025	7	9	190	09-07-25	43.01	26.95	14.98	3.18	6.15	30.257	60.894
11	60.894	30.257	2025	7	10	191	10-07-25	42.27	26.99	14.22	2.87	6.94	30.257	60.894
12	60.894	30.257	2025	7	11	192	11-07-25	41.18	26.1	9.43	-3.93	5.51	30.257	60.894
13	60.894	30.257	2025	7	12	193	12-07-25	42	24.91	9.59	-4.18	5.43	30.257	60.894
14	60.894	30.257	2025	7	13	194	13-07-25	39.88	24.43	10.93	-3.07	6.09	30.257	60.894
15	60.894	30.257	2025	7	14	195	14-07-25	37.6	24.64	12.6	-1.55	7.15	30.257	60.894
16	60.894	30.257	2025	7	15	196	15-07-25	38.55	24.65	13.74	0.14	5.99	30.257	60.894



Methodology Framework:

The modeling process follows a structured four-step framework to ensure robust and validated results.





Key Findings: Regression Performance

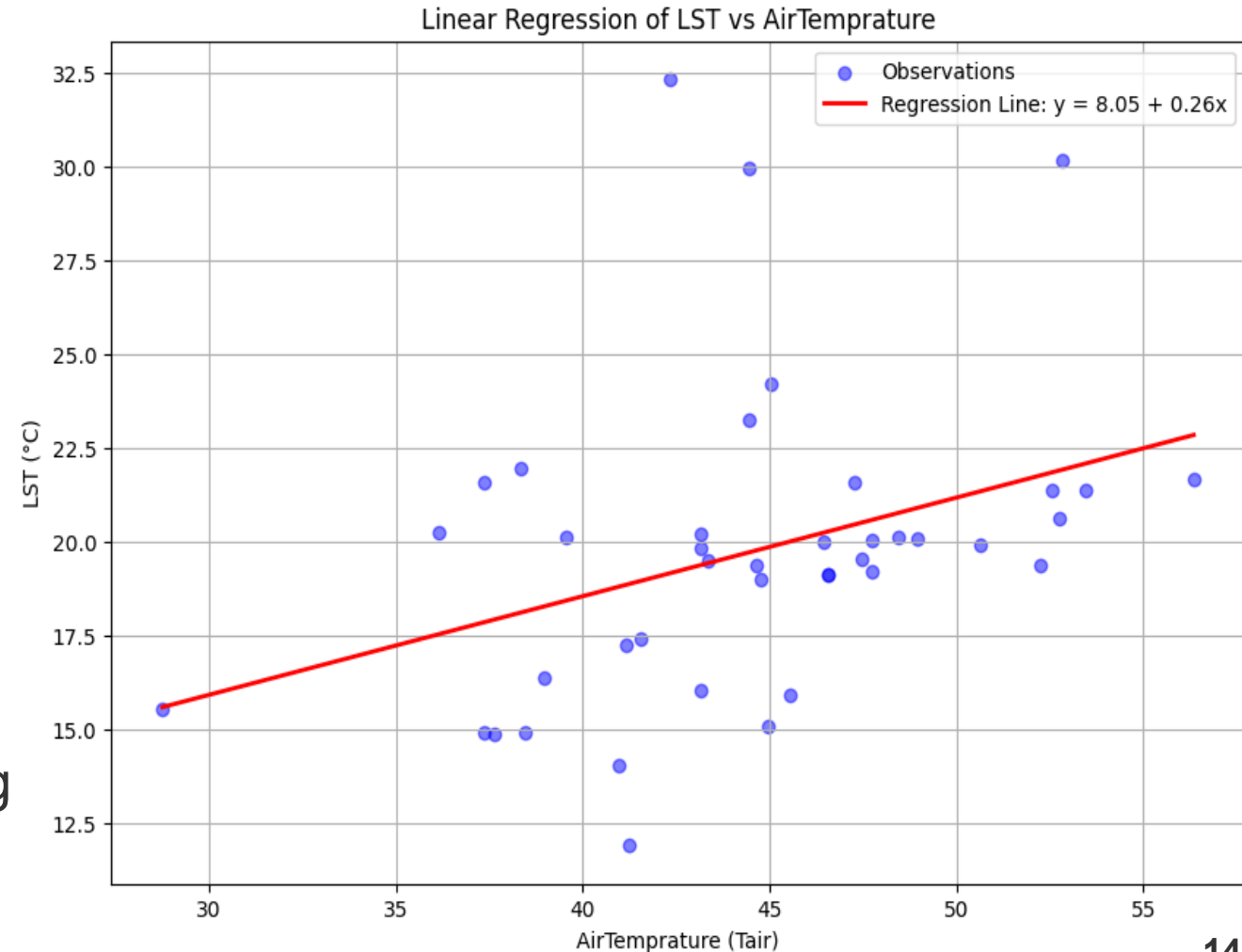
The regression analysis demonstrates a strong relationship between FengYun LST and air temperature, with performance varying by region.

Overall Performance Metrics

0.86
Excellent R^2

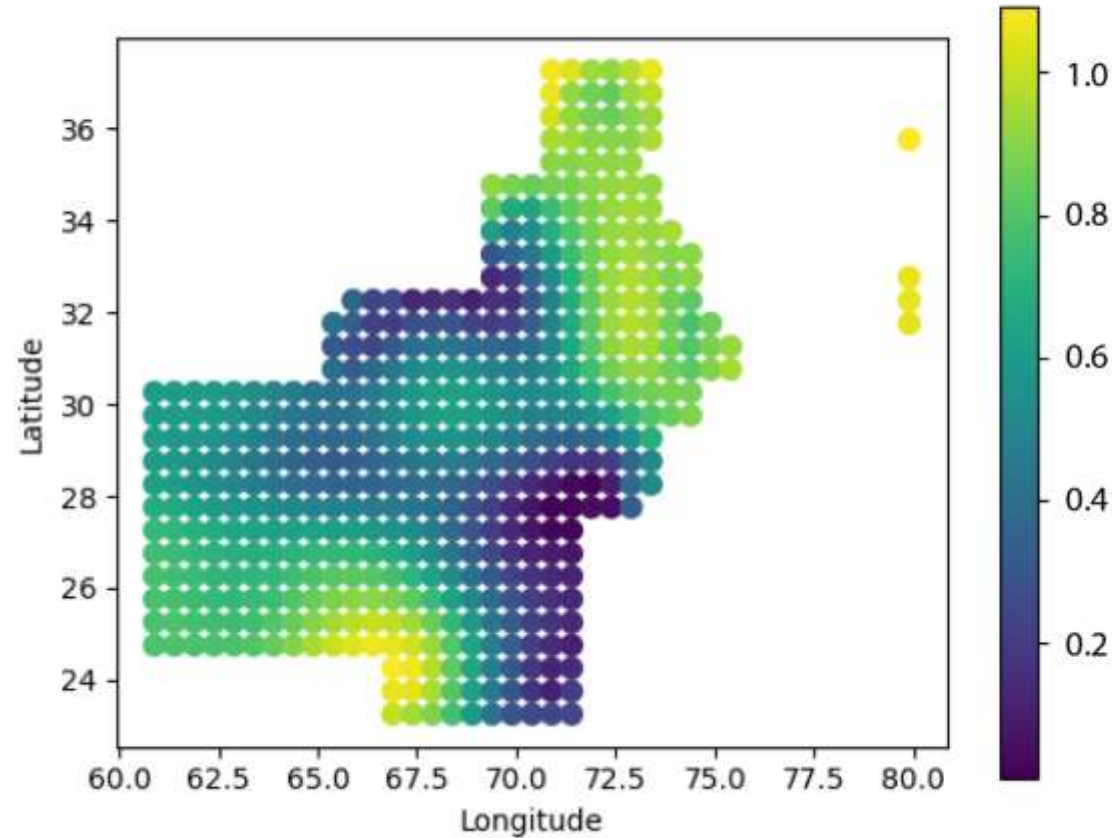
0.76
Moderate R^2

These results validate the use of satellite LST data as a reliable proxy for estimating near-surface air temperature, especially where ground measurements are scarce.





Key Findings: Regression Performance



Spatial distribution of correlation coefficients between land surface temperature and near-surface air temperature across Pakistan

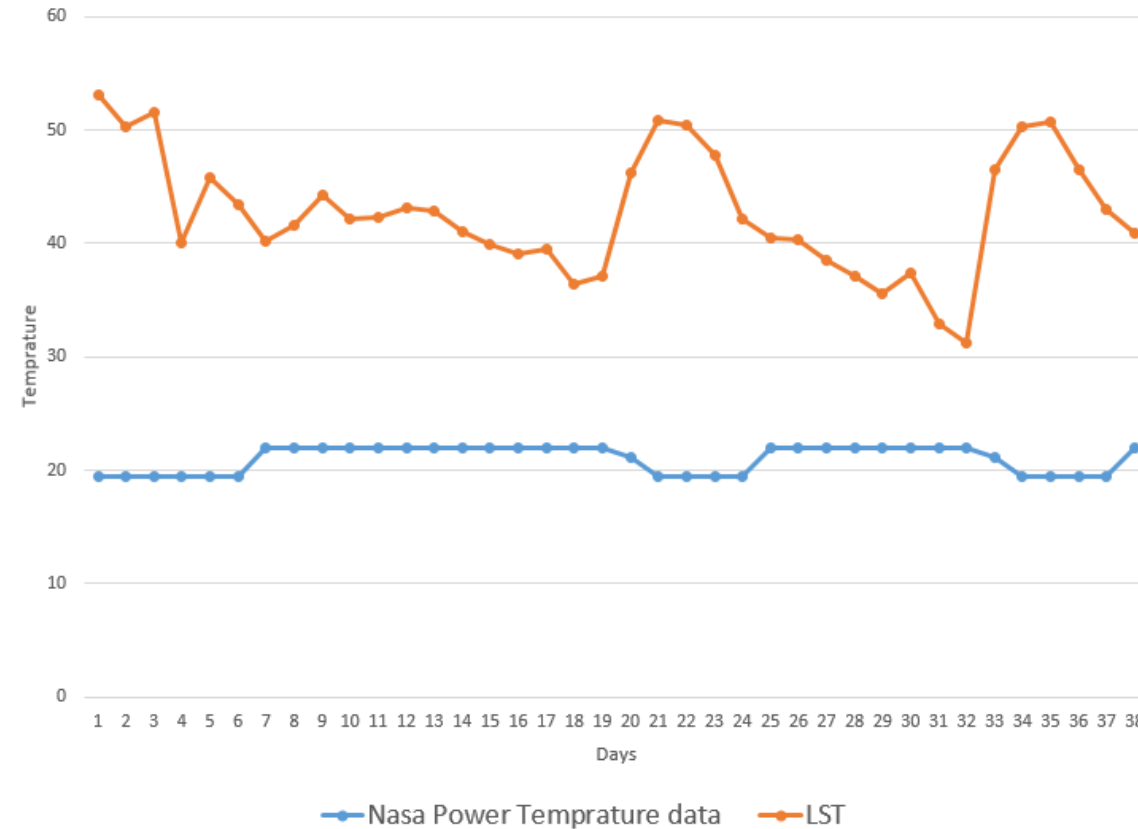


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Key Findings: Regression Performance



Temporal variation of satellite-derived Land Surface Temperature (LST) and NASA POWER near-surface air temperature, illustrating the consistent positive bias of LST relative to air temperature



Application and Significance



Heatwave Detection

Enhanced spatial resolution enables identification of localized extreme temperature events missed by conventional station networks.



Drought Risk Assessment

Critical for developing public health early warning systems and monitoring agricultural stress across Pakistan's diverse climate zones.



Climate Research

Validates satellite-derived climate products for long-term trend analysis and climate model evaluation. Contributes to improved understanding of regional climate variability and change detection capabilities.



Literature Review

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