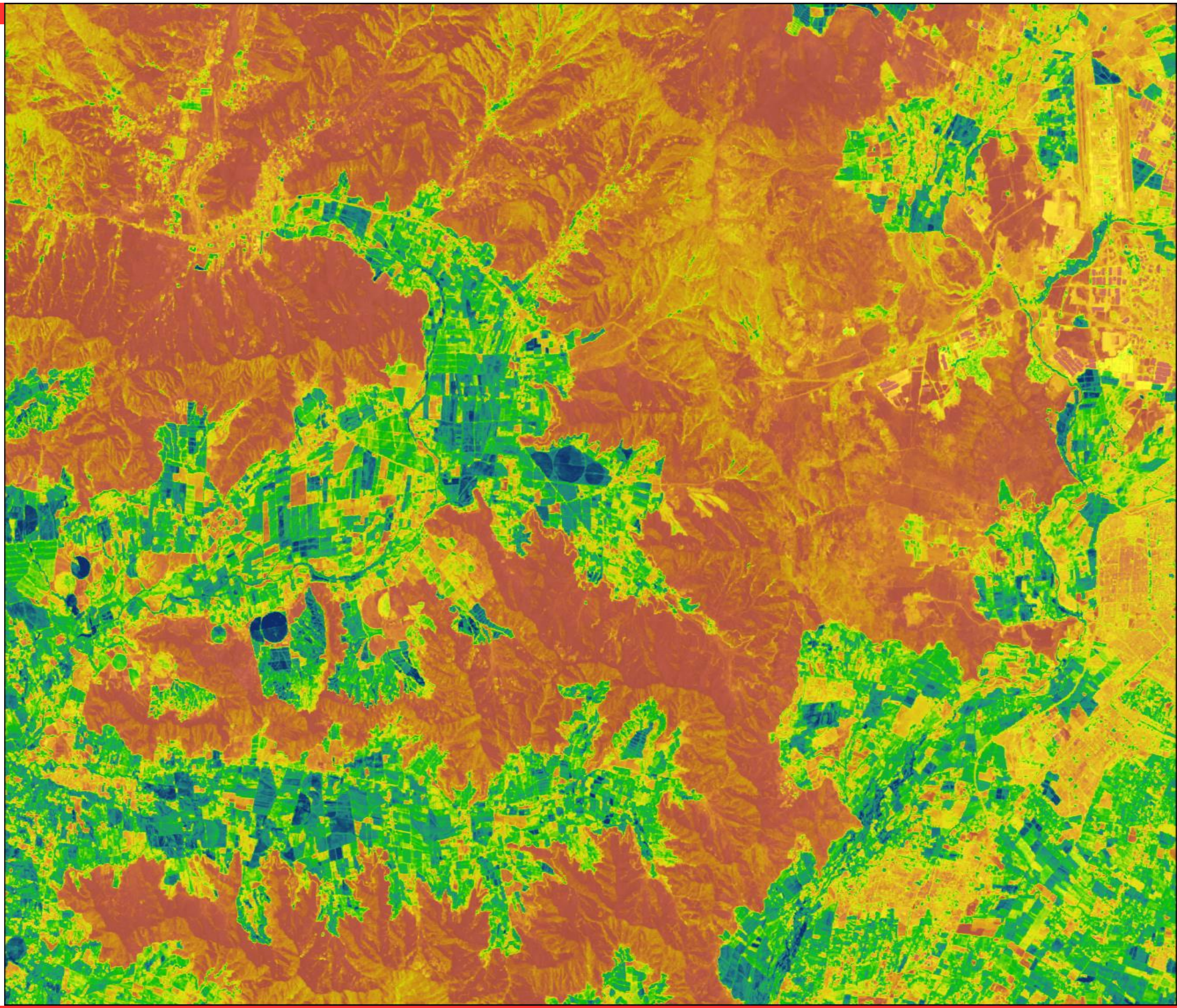
National Aeronautics and Space Administration

Chile
Wildfires

Utilizing NASA and NOAA Earth Observations to Determine Lightning-ignited Wildfire Risks in Central Chile

Christopher Matechik
Stephen Sene
Reuben Alter
Jennifer Ruiz



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STUDY AREA

- Central Chile
  - Mediterranean climate
  - Warm, dry summers
- Climate change has reduced precipitation leading to an increase in wildfire frequency and intensity
- Mar 1, 2018 - Feb 28, 2022

Jan	Feb	Mar	Apr	May	Jun
Jul	Aug	Sept	Oct	Nov	Dec

Fire Season

Off Season

COMMUNITY CONCERNS

- Ecosystems are significantly impacted by wildfires.
- Wildfires:
  - Negatively impact farming, natural resources, and the health and well-being of communities.
  - Are occurring at higher frequency & greater intensity.

Image Credit: Matt Palmer

Image Credit: NOAA/NASA

OBJECTIVES

- Determine the relationship between lightning strikes and wildfires.
- Map relative lightning-ignited wildfire risk as a function of:
  - Lightning frequency
  - Land surface temperature
  - Vegetation moisture

PARTNERS

Corporación Nacional Forestal (CONAF)

Manages and protects Chile's forest ecosystems

The Embassy of Chile, Agricultural Office

Facilitates partnerships between NASA and Chile

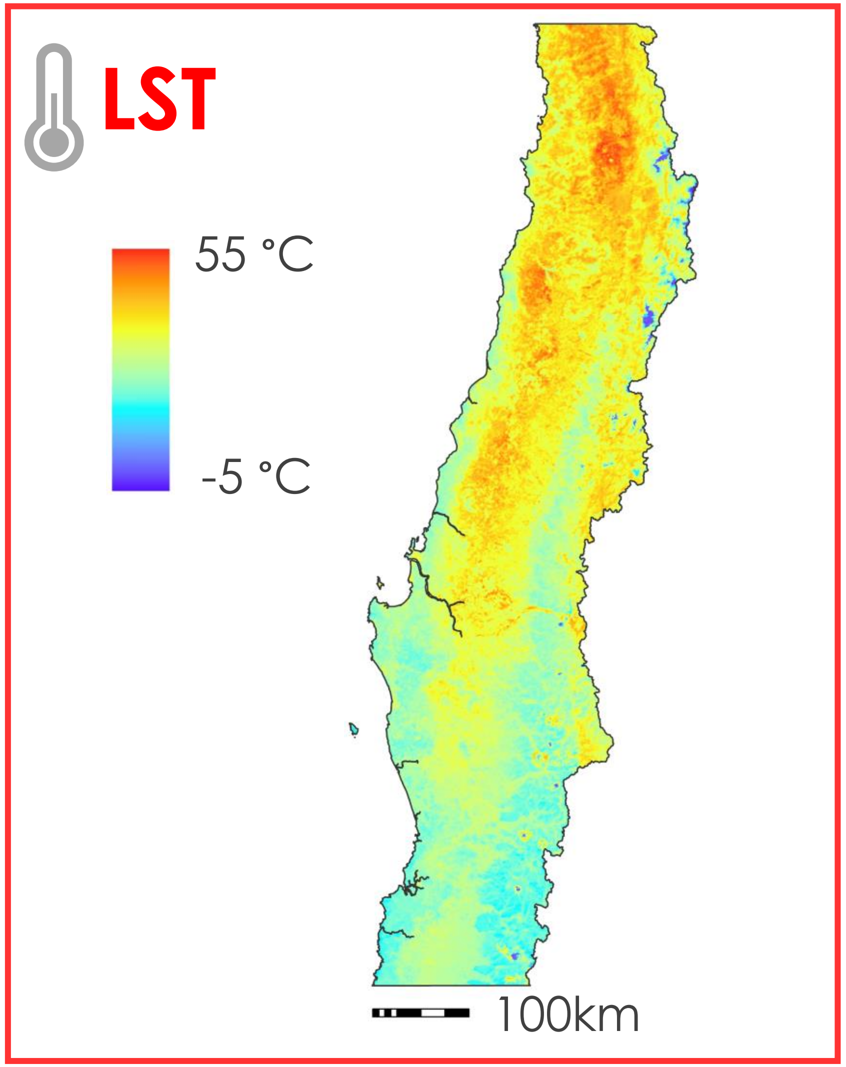

Image Credit: Diego Marín

NASA SATELLITES AND SENSORS USED

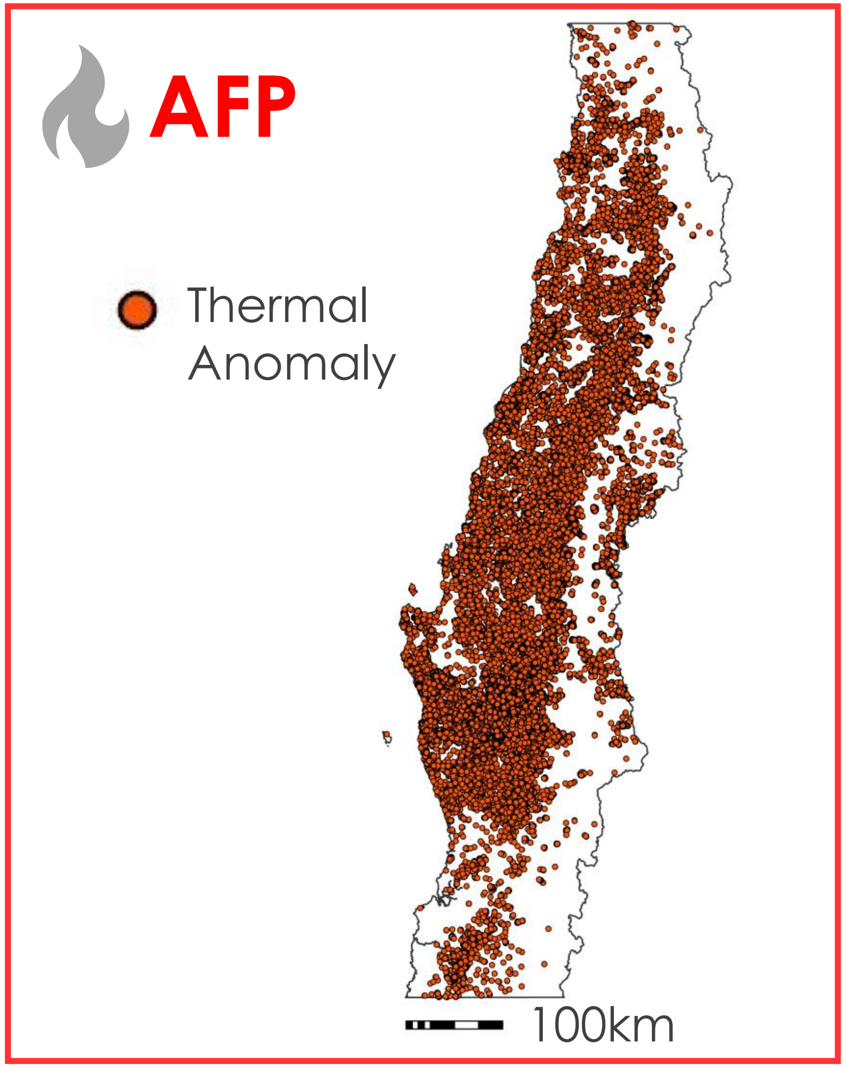
Suomi NPP VIIRS	Active Fire Product (AFP)
Suomi NPP VIIRS	Land Surface Temperature (LST) and Emissivity
Landsat 8 OLI	Normalized Difference Moisture Index (NDMI)
NOAA's GOES-16	Geostationary Lightning Mapper (GLM)

METHODOLOGY

VIIRS

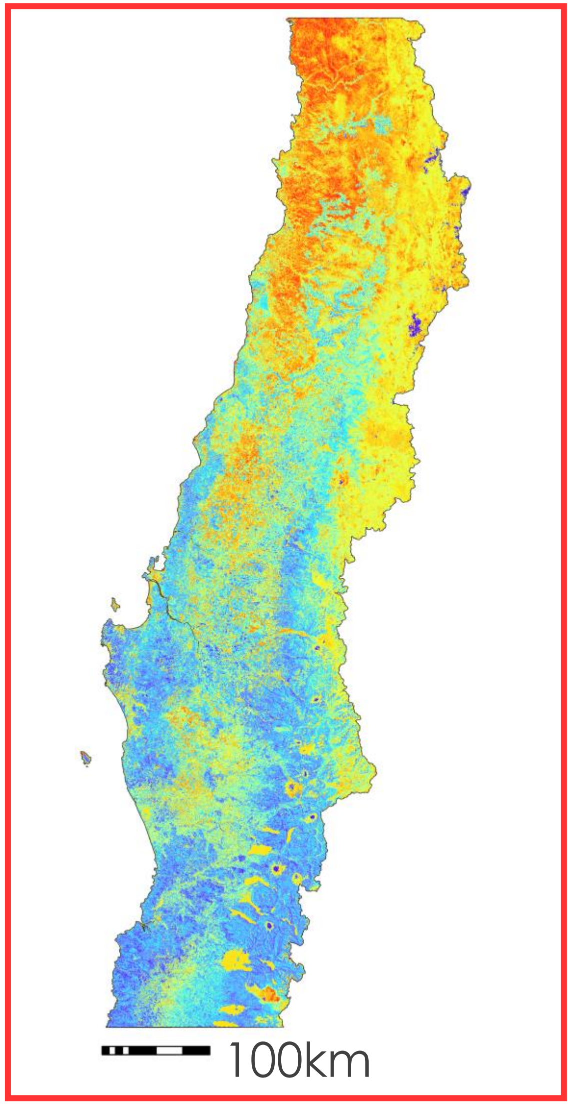


- Sourced from NASA data archives
  - LST: NASA Earthdata
  - AFP: NASA FIRMS
- Subsets created for **fire season** and **off-season**
- Using ArcGIS Pro, LST data were:
  - Converted to °C
  - Median reduced



Landsat 8

$$\frac{\text{NIR} - \text{SWIR}}{\text{NIR} + \text{SWIR}}$$



NDMI

- Raw data from GEE was median reduced
- Subsets created for **fire season** and **off-season**
- NDMI:
  - Indicates vegetation moisture content
  - Proxy for fuel moisture

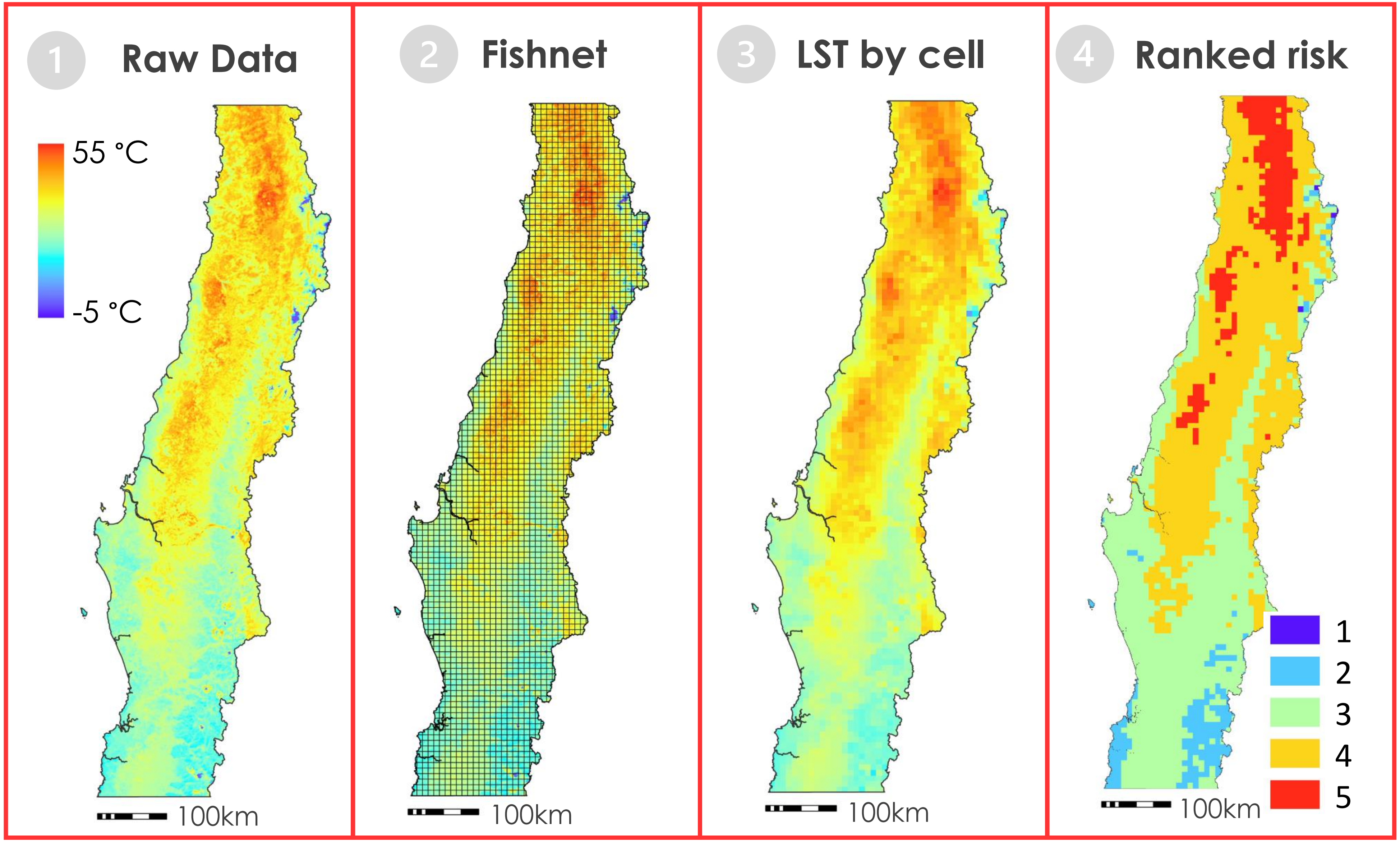
GOES-16

GLM

1. Download from NOAA Amazon Web Service data repository
2. Use Python to aggregate and reformat files
3. Convert into point data in ArcGIS
4. Visually determine if there is a relationship between lightning strikes and wildfires

All data sets were divided between fire season and off-season

Ranked Risk Calculations Example

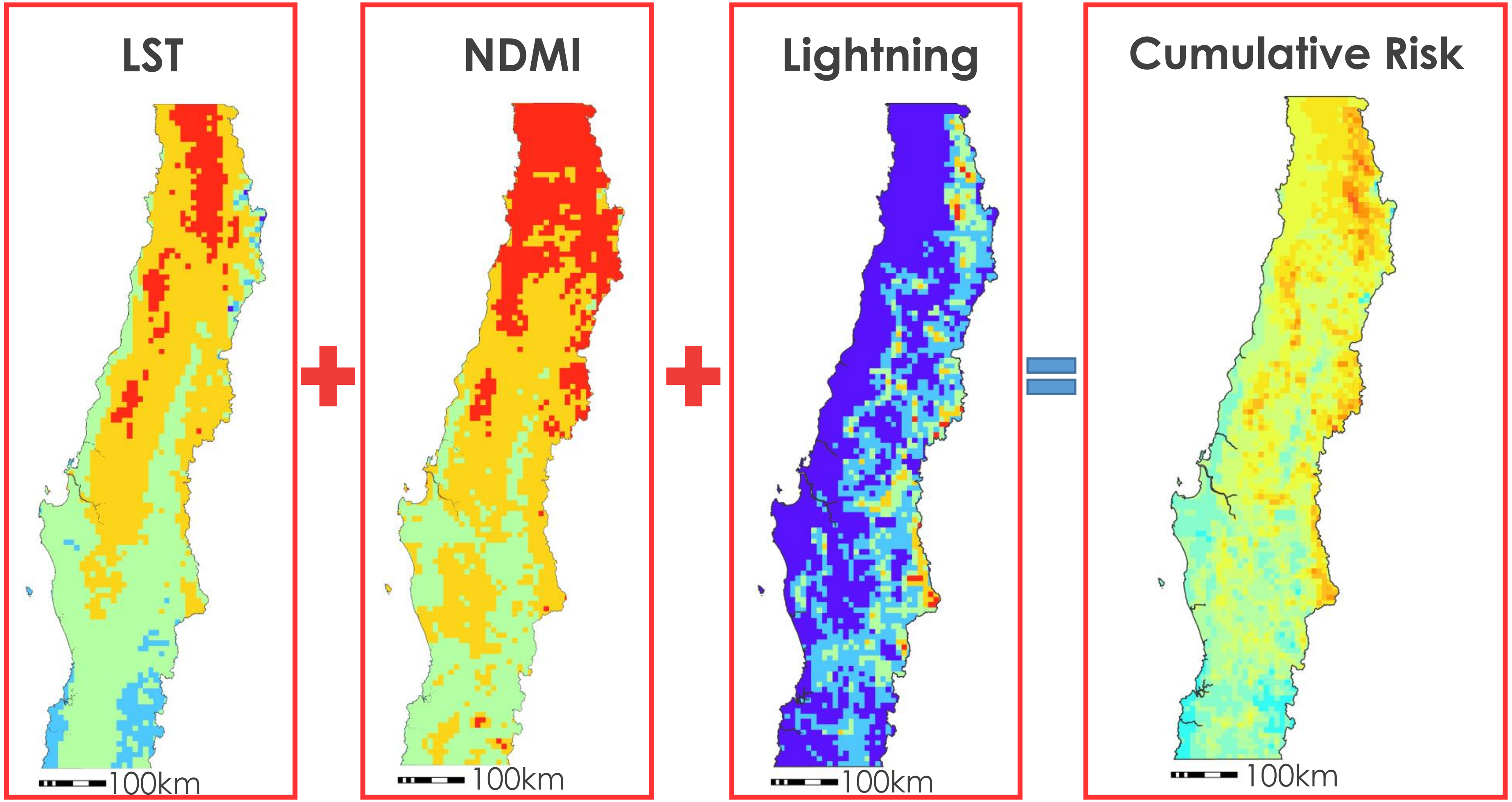


Repeated for:

- **Fire season** and **off season**
- Lightning
- NDMI

Cumulative Risk Calculation Example

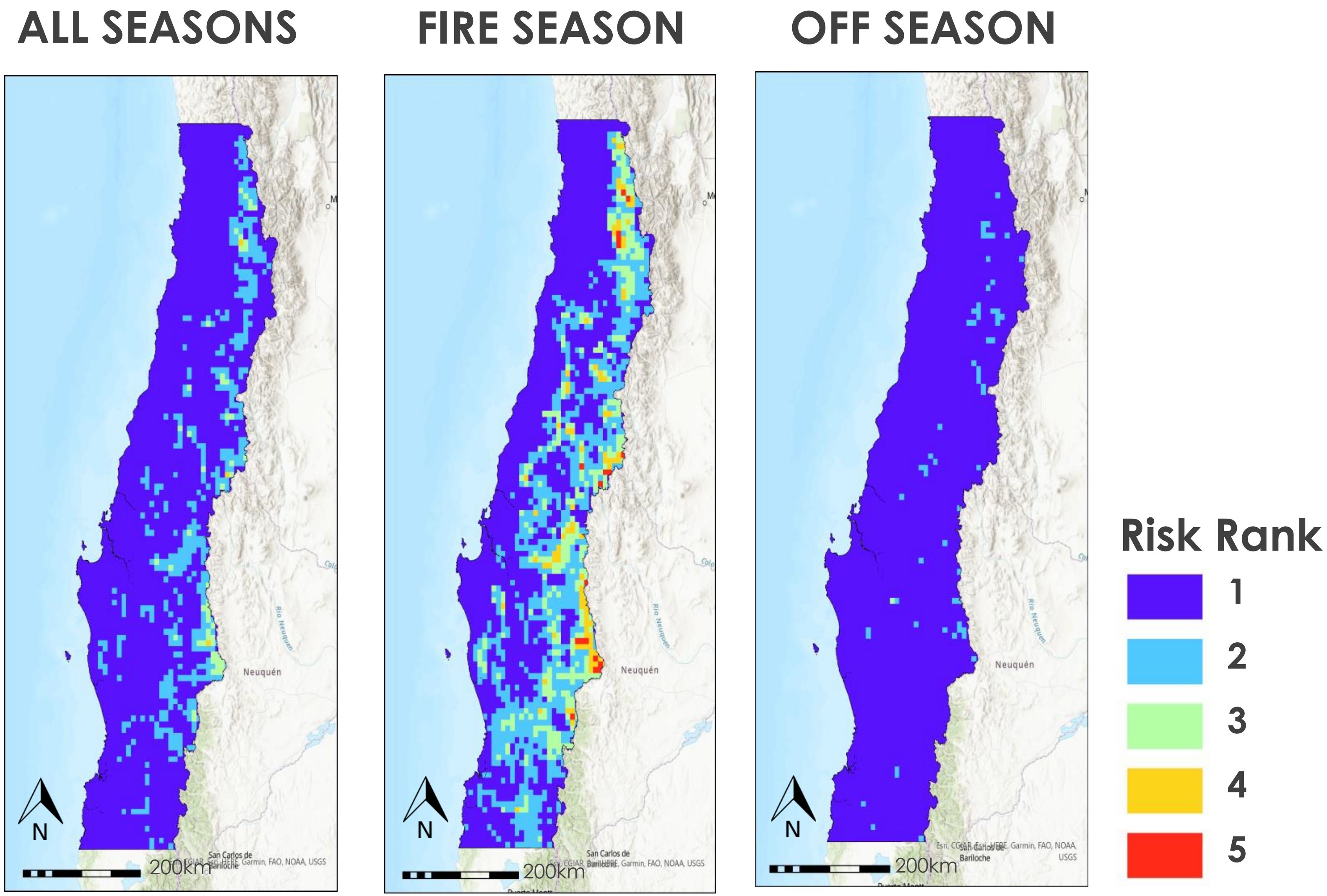
LST Fire Season



- Repeated for **off season** and **entire year**
- Represents relative risk for lightning-ignited wildfire
- All factors given equal weight

RESULTS

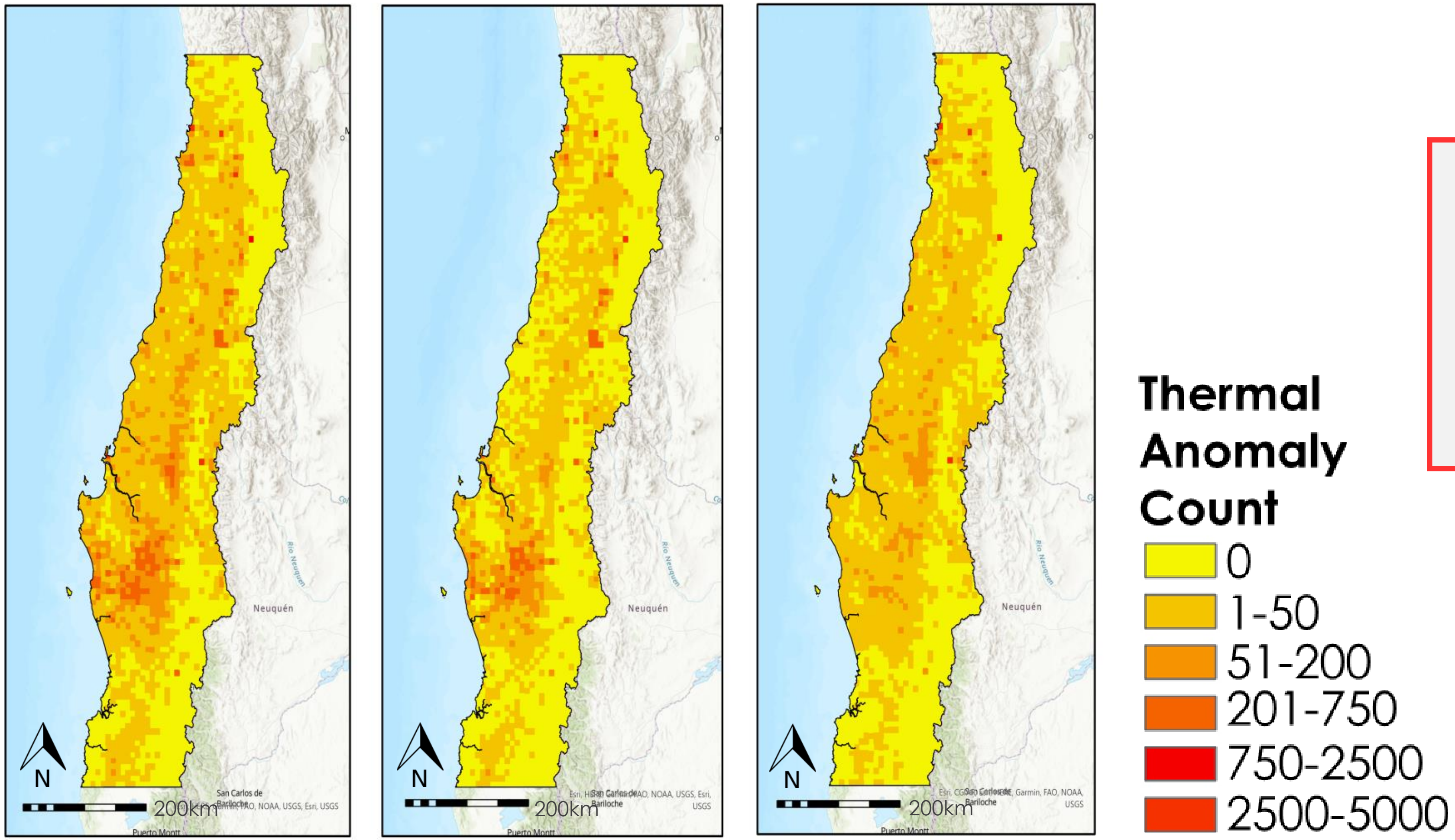
Lightning



High Rank = high relative lightning frequency

Fire frequency

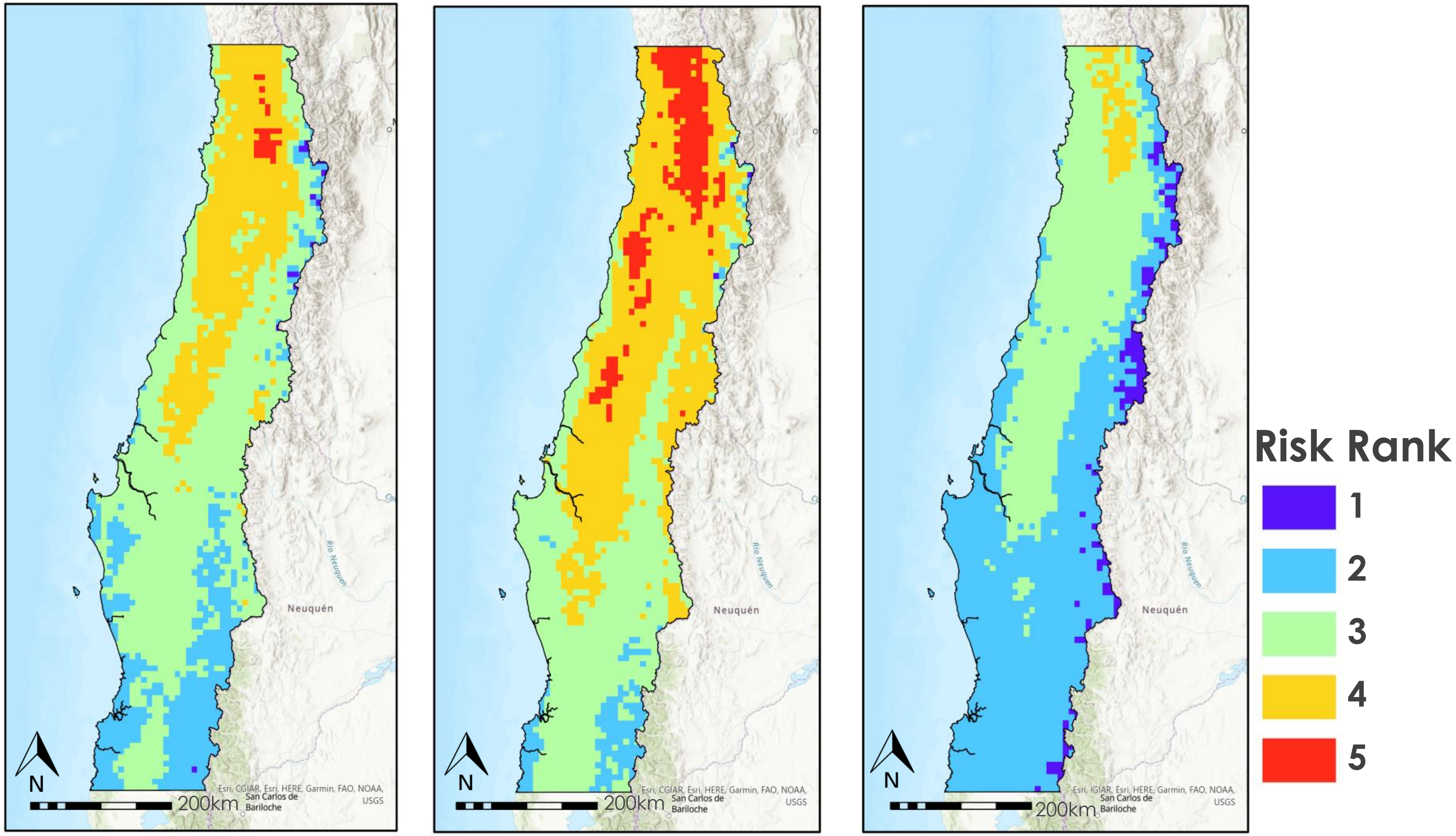
ALL SEASONS FIRE SEASON OFF SEASON



Thermal anomalies were used as a proxy for fires

LST

ALL SEASONS | FIRE SEASON | OFF SEASON

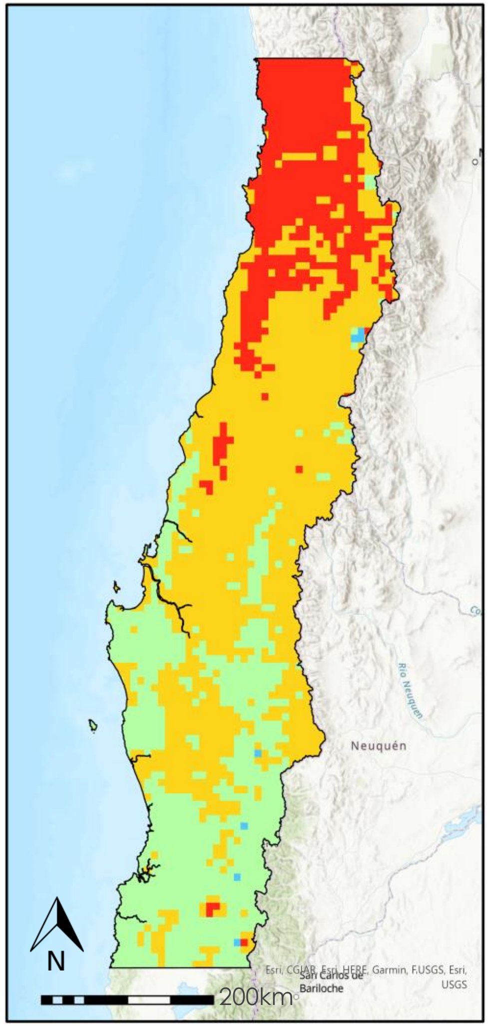


Higher LST risk ranks = higher temperatures = greater risk for wildfire ignition

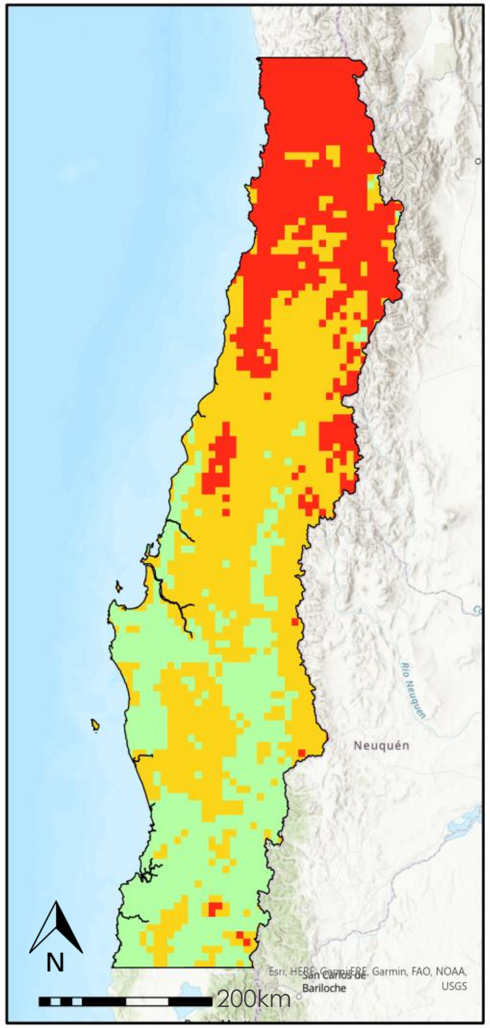
(ranks derived from grouped LST values)

NDMI

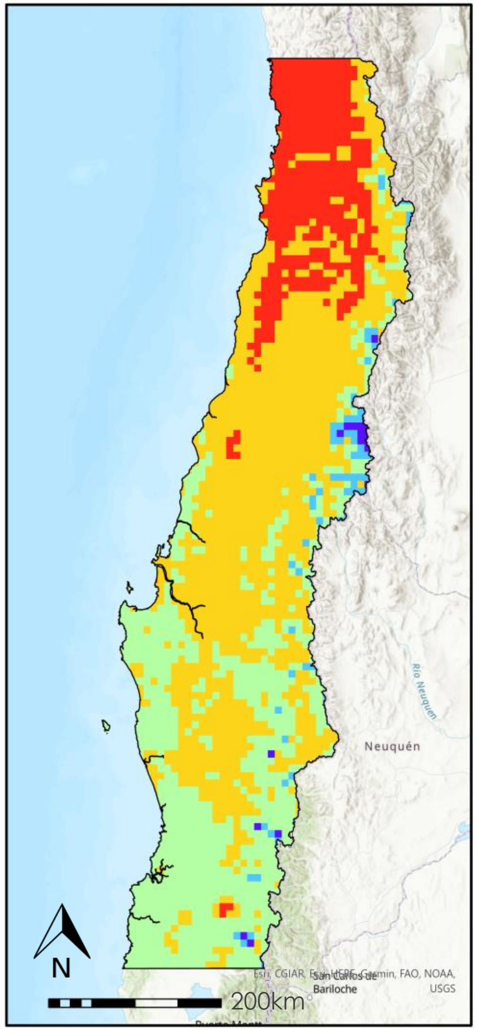
ALL SEASONS



FIRE SEASON



OFF SEASON



Risk Rank

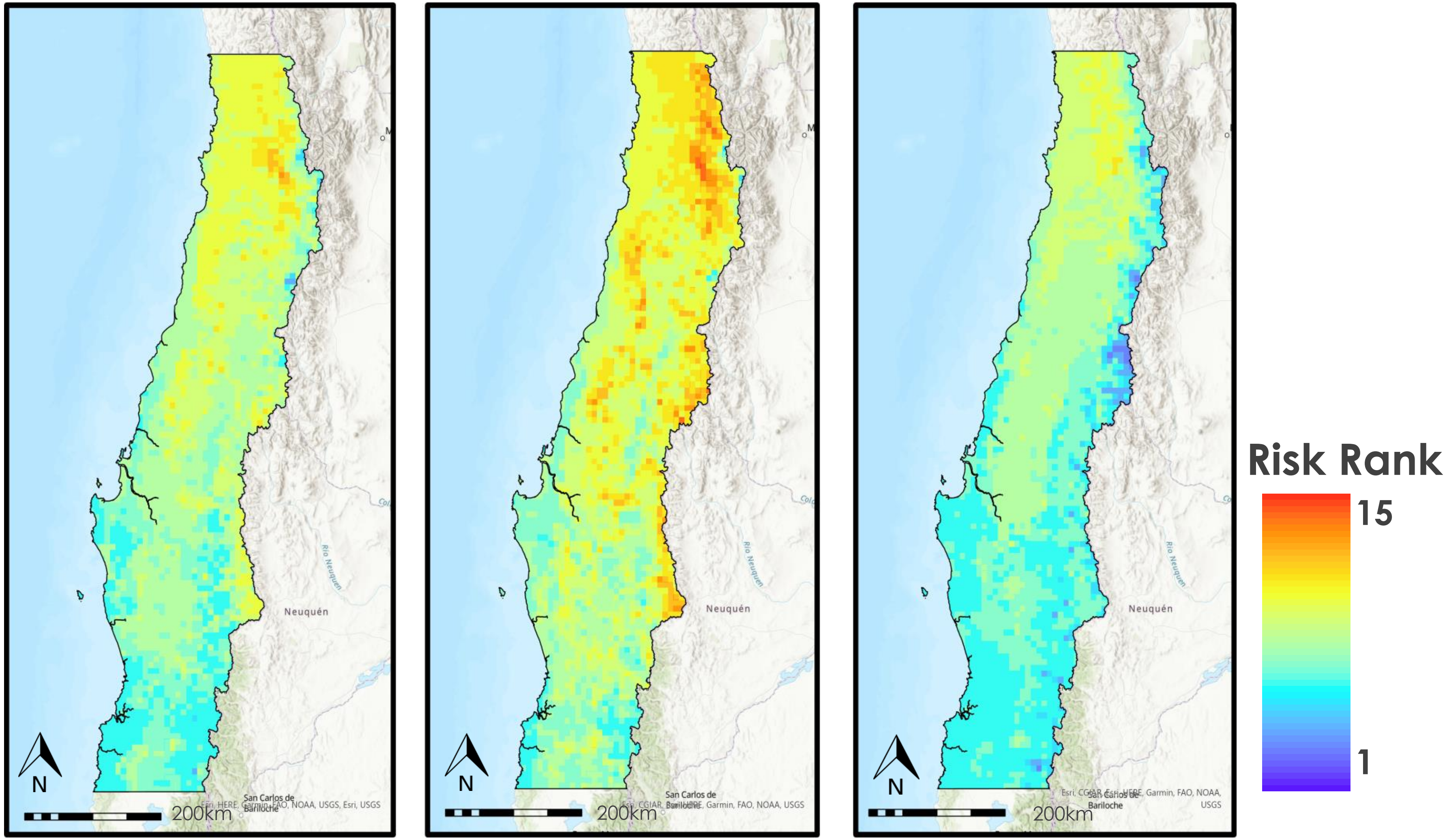
1
2
3
4
5

Higher NDMI risk ranks = drier vegetation = greater risk for wildfire ignition

(ranks derived from grouped NDMI values)

Cumulative Risk

ALL SEASONS | FIRE SEASON | OFF SEASON



Higher cumulative risk was found during fire season in the northern and eastern sections of our study areas

(ranks summed from prior rasters)

CONCLUSION

- Lightning strikes most common during fire season → temporal correlation
- Unable to detect spatial relationship between lightning and wildfires
  - Continue to investigate using spatial and temporal buffers
- LST and NDMI:
  - Show similar patterns
  - Contribute the most to wildfire risk in the northern third of the study area during fire season

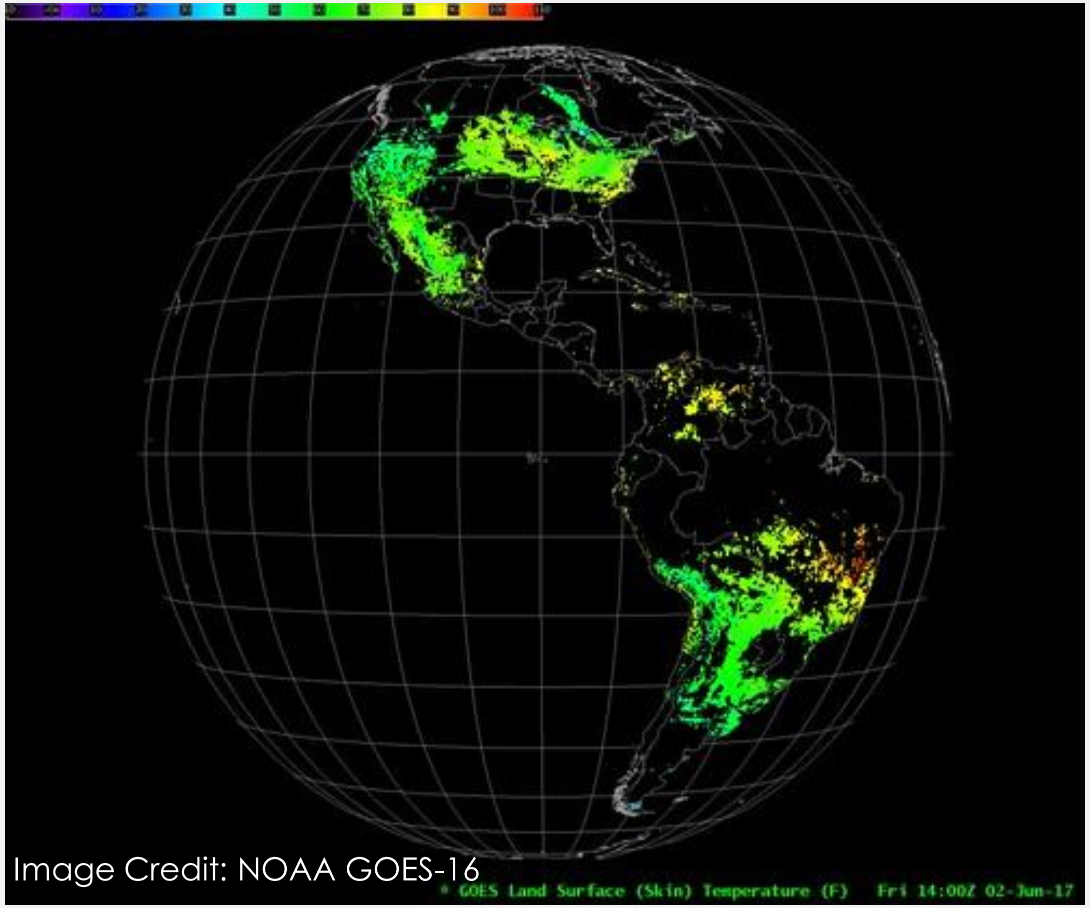


Image Credit: NOAA GOES-16

ERRORS AND UNCERTAINTIES

- GLM data:
  - Imprecise
  - Doesn't differentiate between strike types
- Risk factors:
  - Based on arbitrary intervals
  - Weighted equally
- Lacks:
  - Fine scale factors
  - Past burn history, fuel, and elevation as parameters

Image Credit: Martyn Gorman

FUTURE WORK

- Spatial analysis comparing lightning strikes and thermal anomalies
- Determine quantitative thresholds for risk ranks
- Incorporate fuel continuity and quantity as risk factors

ACKNOWLEDGEMENTS

- Dr. Kenton Ross, NASA Langley Research Center
- Adriana Le Compte, DEVELOP Virginia – Langley
- Kristopher Bedka, NASA Langley Research Center
- Jordi Brull, CONAF
- Tatiana Osses, CONAF
- Jorge Saavedra Saldías, CONAF
- Pablo Lobos, CONAF
- Fernando Vásquez, Embassy of Chile
- Andres Rodríguez, Embassy of Chile

This material is based upon work supported by NASA through contract NNL16AA05C. Any mention of a commercial product, service, or activity in this material does not constitute NASA endorsement. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration and partner organizations.