
AWS
re:Invent
NOV. 28 – DEC. 2, 2022 | LAS VEGAS, NV

SUS208

Utilizing sustainability data at scale

Patti Carroll (she/her)

Sr. Sustainability Strategist
Amazon Web Services

Bishesh Adhikari (he/him)

ML Prototyping Solutions Architect
Amazon Web Services

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Agenda

I. The future of food – Big data challenges in sustainable agriculture

II. Architecting data-driven agriculture solutions on AWS

III. AWS customer success stories

IV. How to get started

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

I. The future of food

How we cultivate the Earth to meet our most basic needs for food, clothing, and shelter

Sustainably, to meet the needs of the present without compromising the ability of future generations to meet their needs

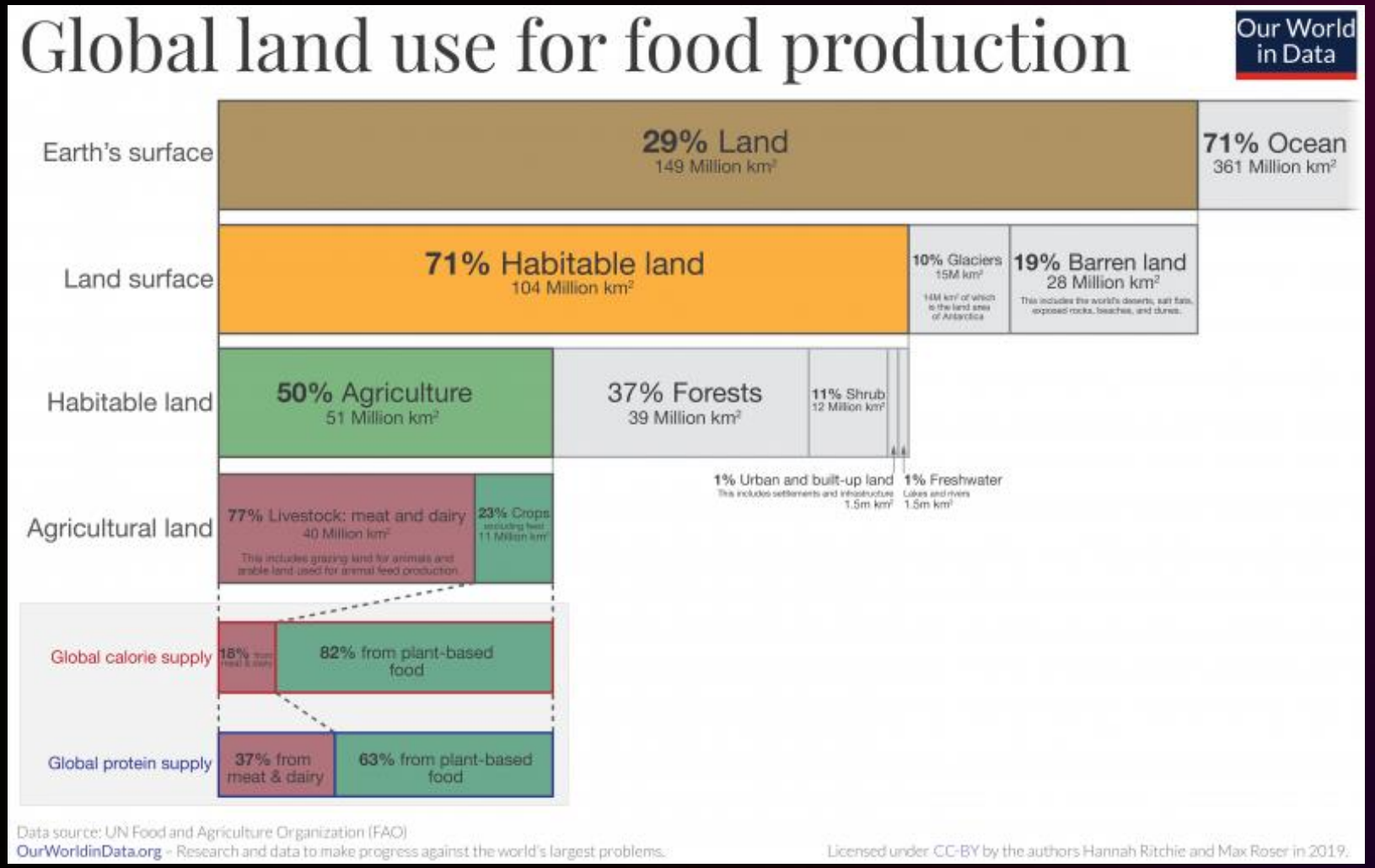


aws

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Food production – 50% of all habitable land

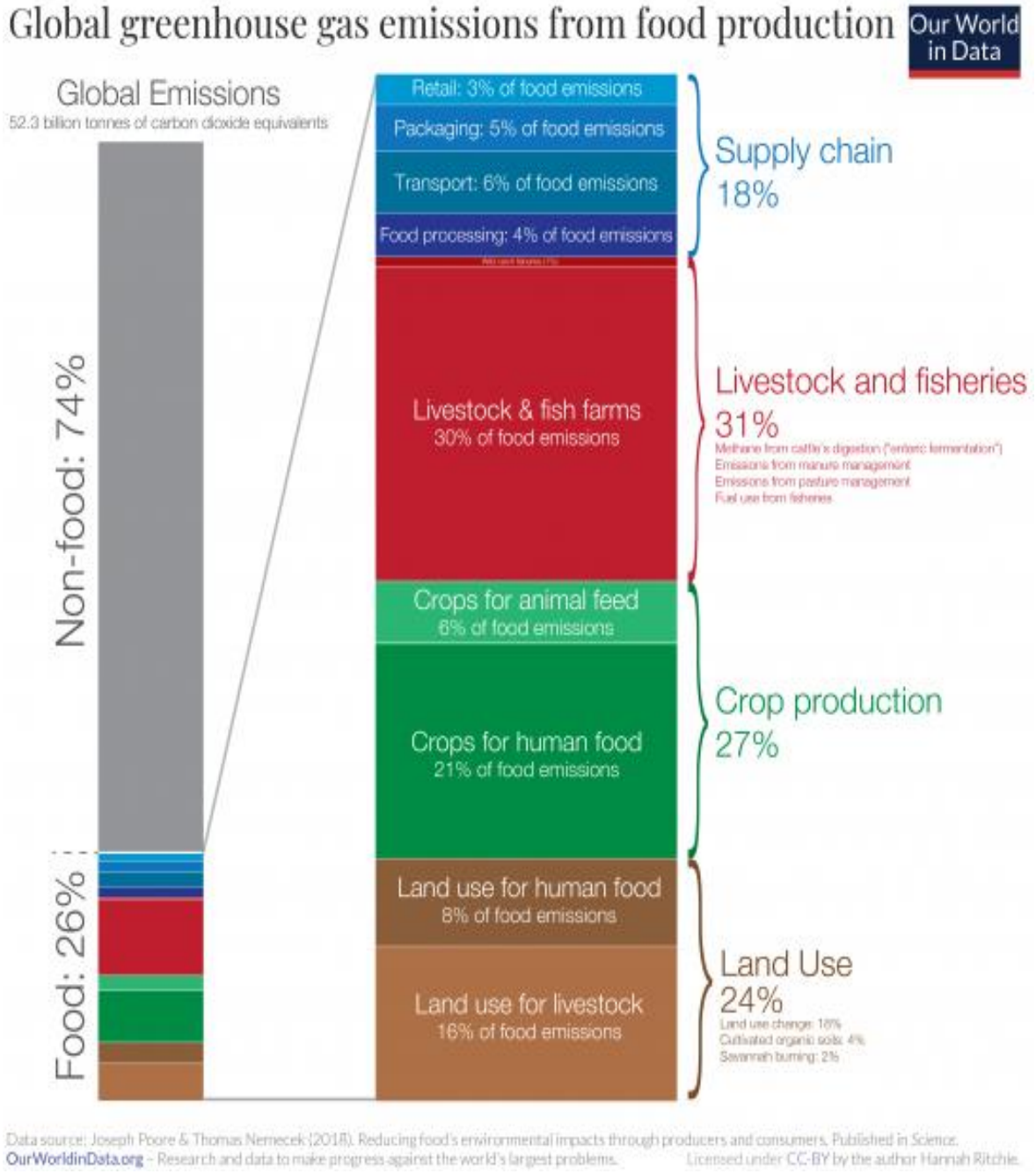
23% OF AGRICULTURAL LAND GENERATES 82% OF HUMAN FOOD



© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Food production – 26% of all GHG Emissions

- 18% supply chain & retail
- 29% plant-based food
- 53% animal-based food



© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

How can we continue to grow **more** food with **less**

- Arable land per capita
- Water, fertilizer, energy
- Greenhouse gas emissions
- Predictable weather patterns
- Risk to people and planet



© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

It starts with data

- Data gives us the power to address global sustainability challenges
- Effectively finding, accessing, and utilizing the data available is complex



Volume growing exponentially



From new and old sources, raw and derived



Disparate types and models, varying quality



Increasingly diverse users and analytics tools



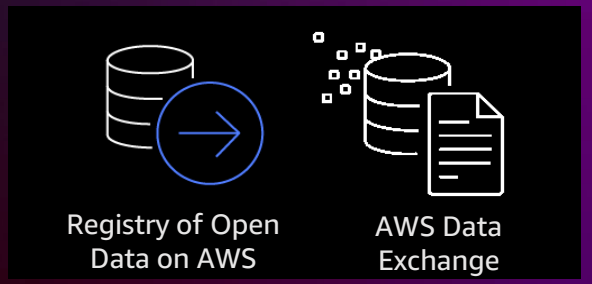
Processed and analyzed by more applications

aws

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Amazon Sustainability Data Initiative (ASDI)

Increasing the accessibility of Sustainability Data on AWS



- Climate data projections
- Weather forecasts
- Historical weather records
- Satellite imagery
- Air quality
- Water
- Energy
- Ocean forecasts
- Sea surface temperature
- Environmental indicators
- Soil data layers

esri NOAA MAXAR NASA NREL NATIONAL RENEWABLE ENERGY LABORATORY Met Office FINNISH METEOROLOGICAL INSTITUTE

aws

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.



From access to action

How can we *utilize* data more effectively to accelerate sustainability action at scale?

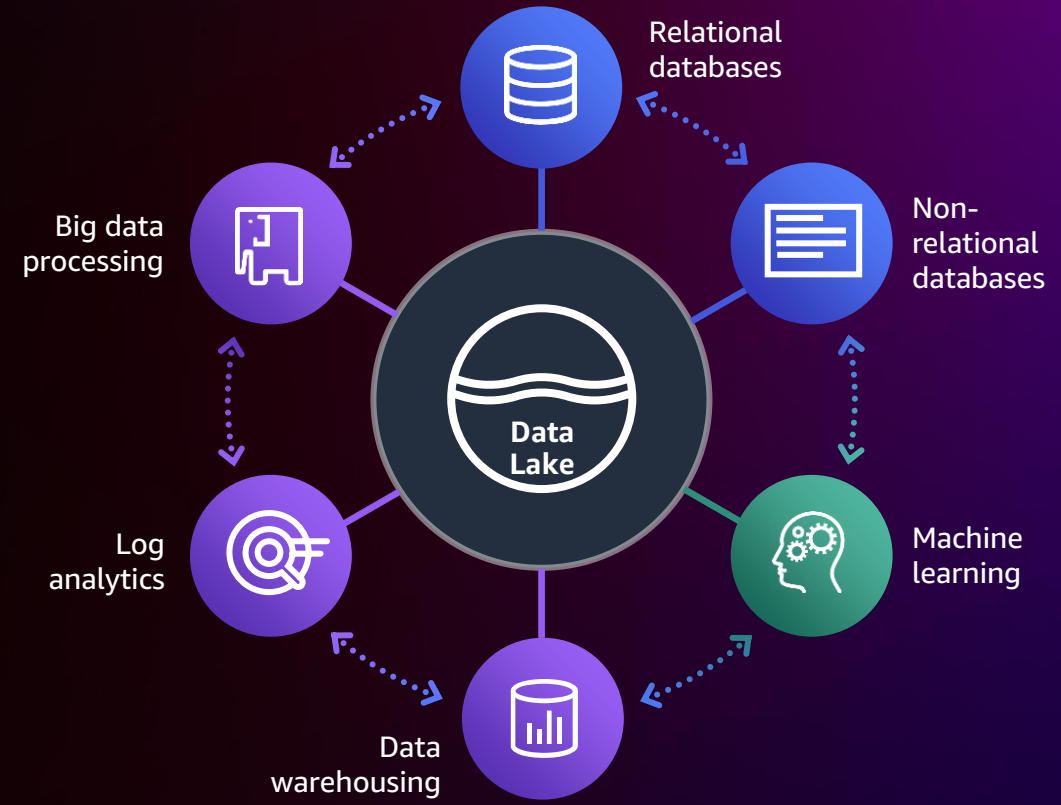
II. Architecting data-driven agriculture solutions on AWS



© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Moving from traditional approach to cloud





aws
© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Modern Data architecture on AWS



Scalable data lakes

Purpose-built data services

Seamless data movement

Unified governance

Performant and cost-effective

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.



Ingest



Transform



Learn



Act

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.



Ingest

IoT data at Edge

On-prem data

AWS IoT

Kinesis Firehose

Central Storage

S3

AWS Open Data

AWS Data Exchange

AWS Data Sync

AWS Snow Family

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.



Transform

Query

Amazon Athena

Big data processing

Amazon EMR

Central Storage

S3

Streaming data

Kinesis Data Analytics

Serverless ETL

AWS Glue

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.



Learn

AI Services

- Amazon Forecast
- Amazon Rekognition
- Amazon Textract
- Amazon Transcribe

Central Storage

S3

Cloud ML platform

Amazon SageMaker

aws

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.



Act

BI / Visualization

Amazon QuickSight

Expose API

Amazon API Gateway

Central Storage

S3

Web

Amazon CloudFront

Trigger action

AWS Lambda

aws

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.









Ingest

Transform

Learn

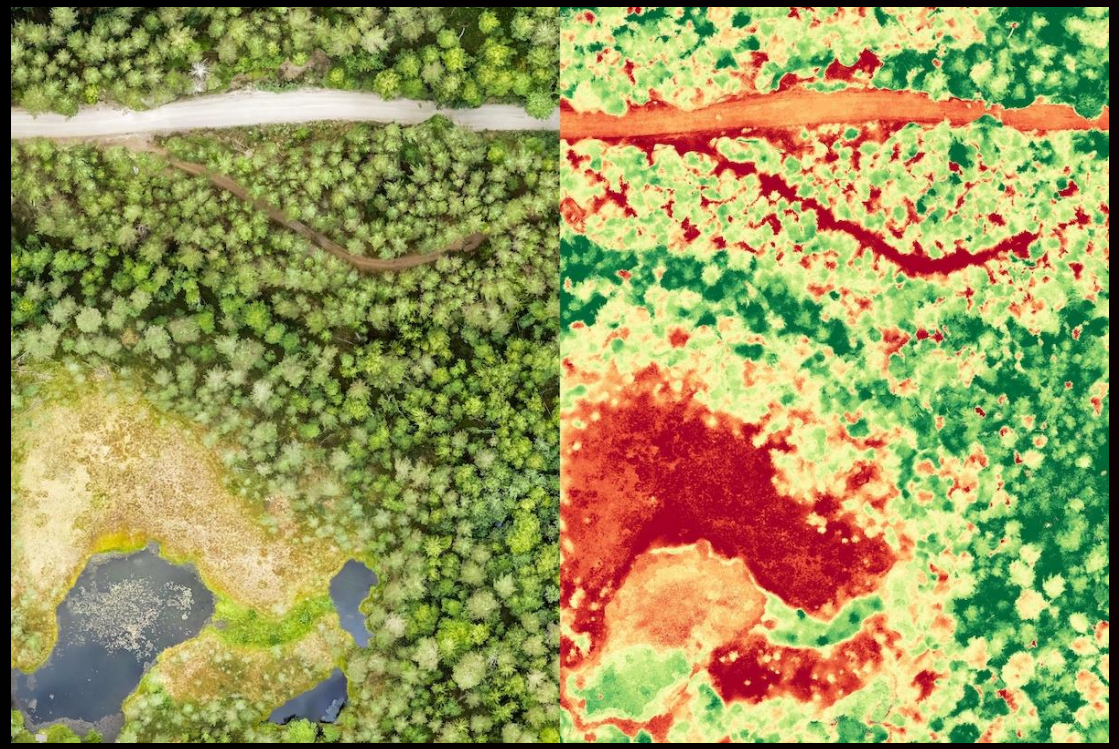
Act

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

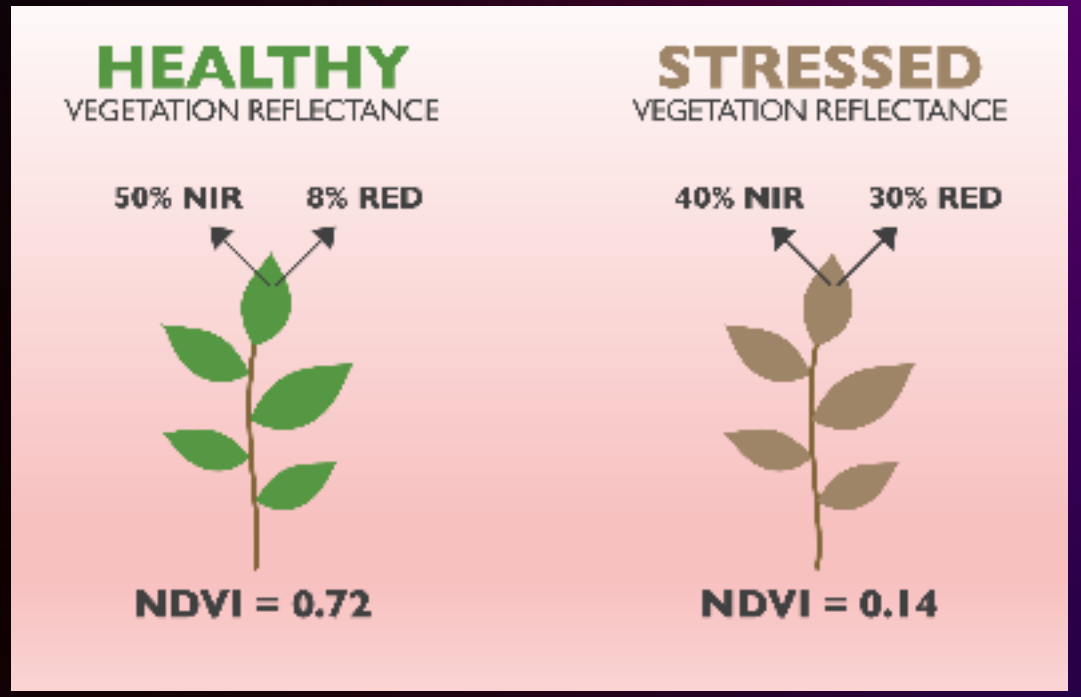
Use case: Crop health & growth monitoring

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

NDVI (Normalized Difference Vegetation Index): Vegetation index to asses crop health



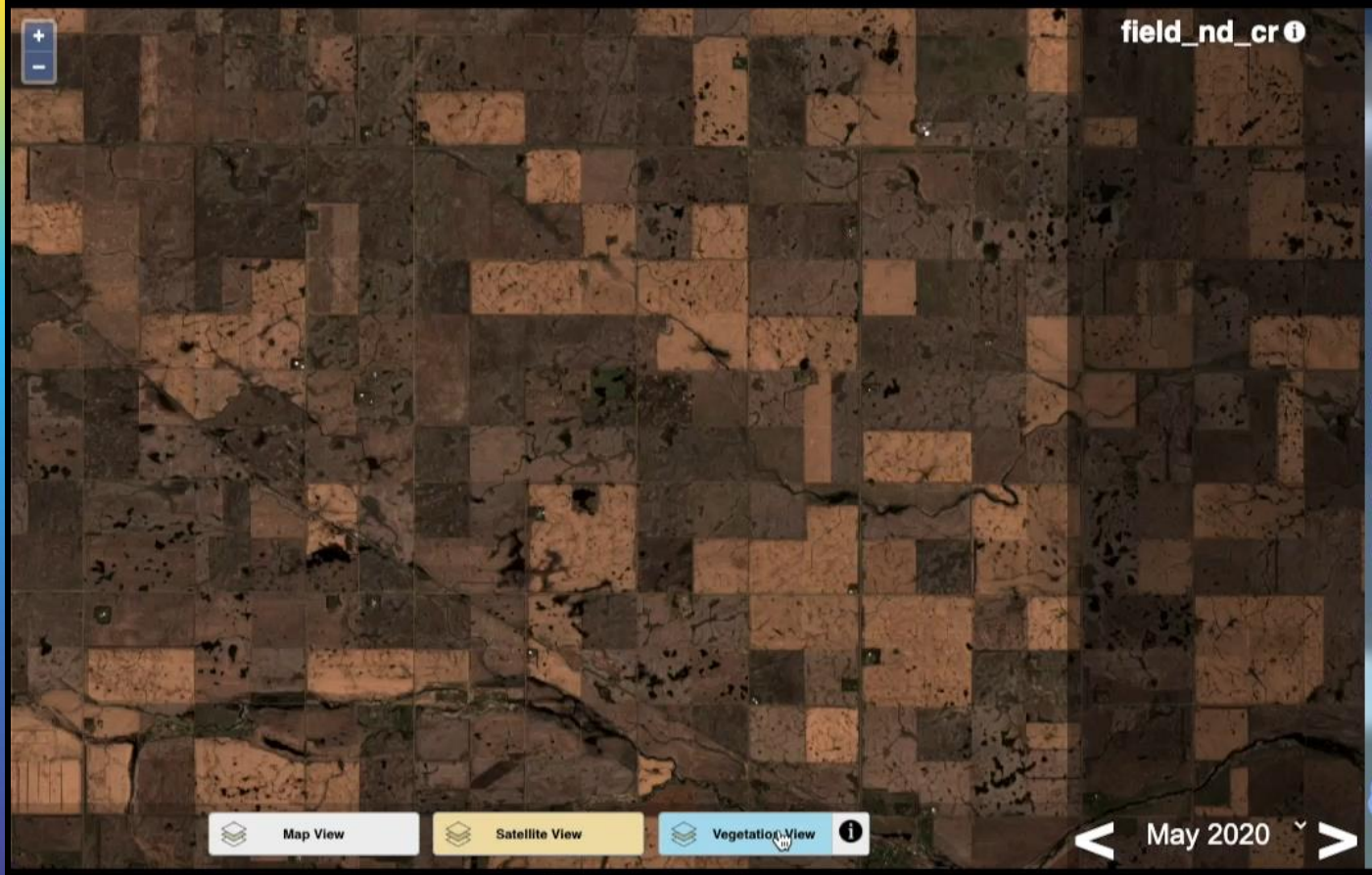
Satellite Image NDVI

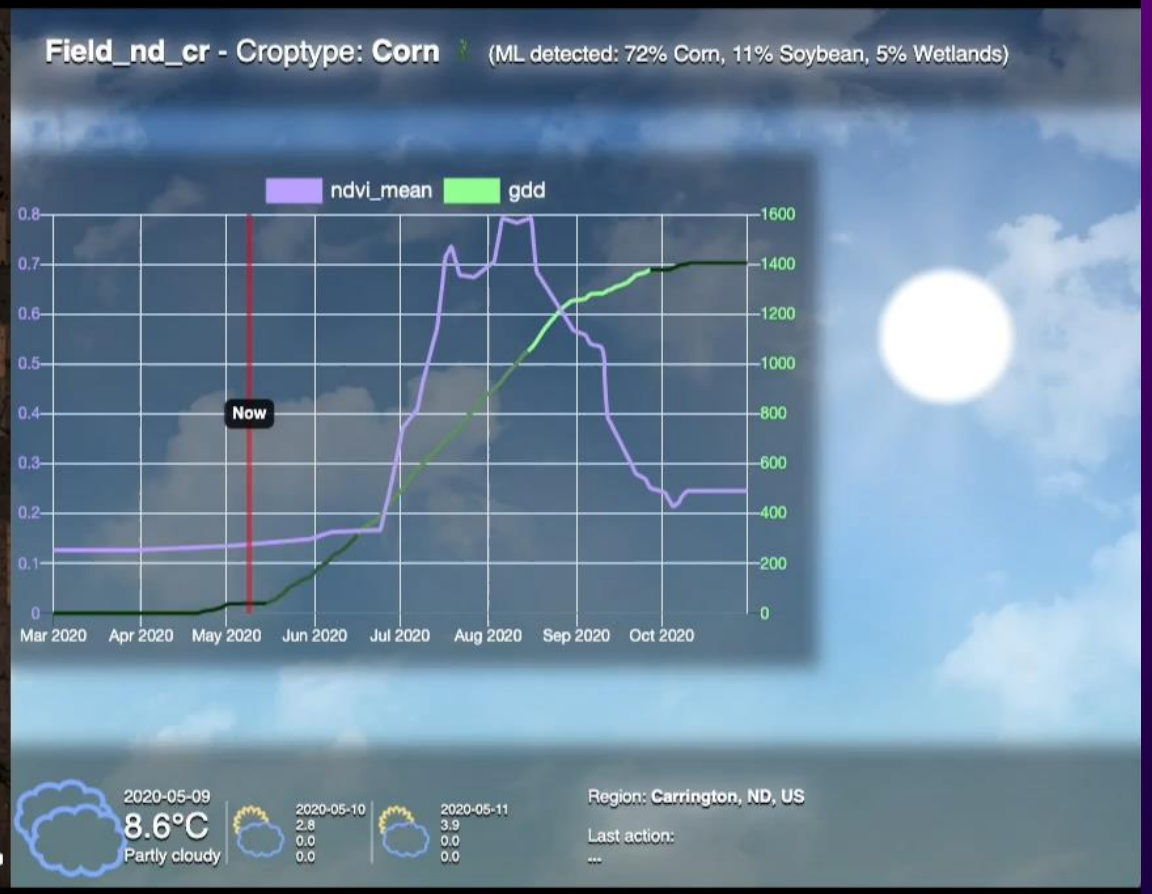


GDD (Growing degree days): temperature-based index to assess growth

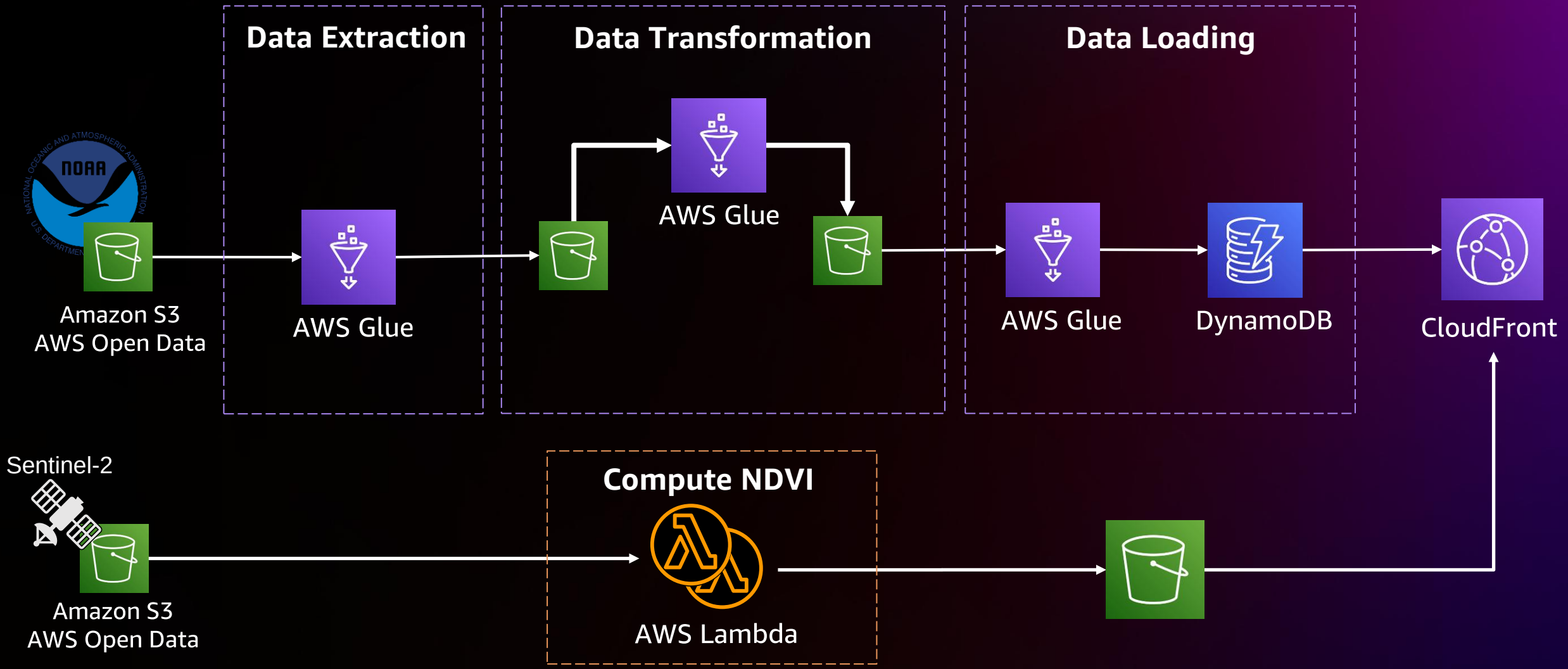
Source:
Agricolus: https://www.agricolus.com/

aws
© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.


field_nd_cr
Map View
Satellite View
Vegetation View
May 2020


Field_nd_cr - Croptype: Corn
(ML detected: 72% Corn, 11% Soybean, 5% Wetlands)
ndvi_mean
gdd
Now
Mar 2020
Apr 2020
May 2020
Jun 2020
Jul 2020
Aug 2020
Sep 2020
Oct 2020
2020-05-09
8.6°C
Partly cloudy
2020-05-10
2.8
0.0
0.0
2020-05-11
3.9
0.0
0.0
Region: Carrington, ND, US
Last action:

Reference architecture



© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Use case: Field boundary detection

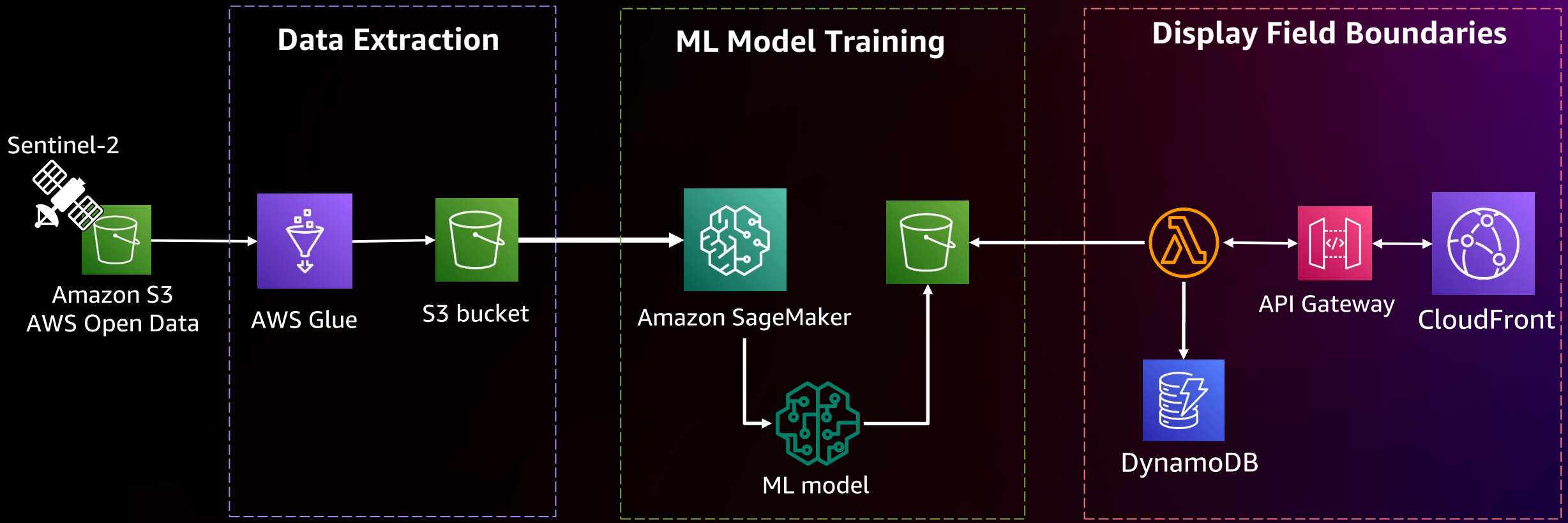
© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.





© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Reference architecture



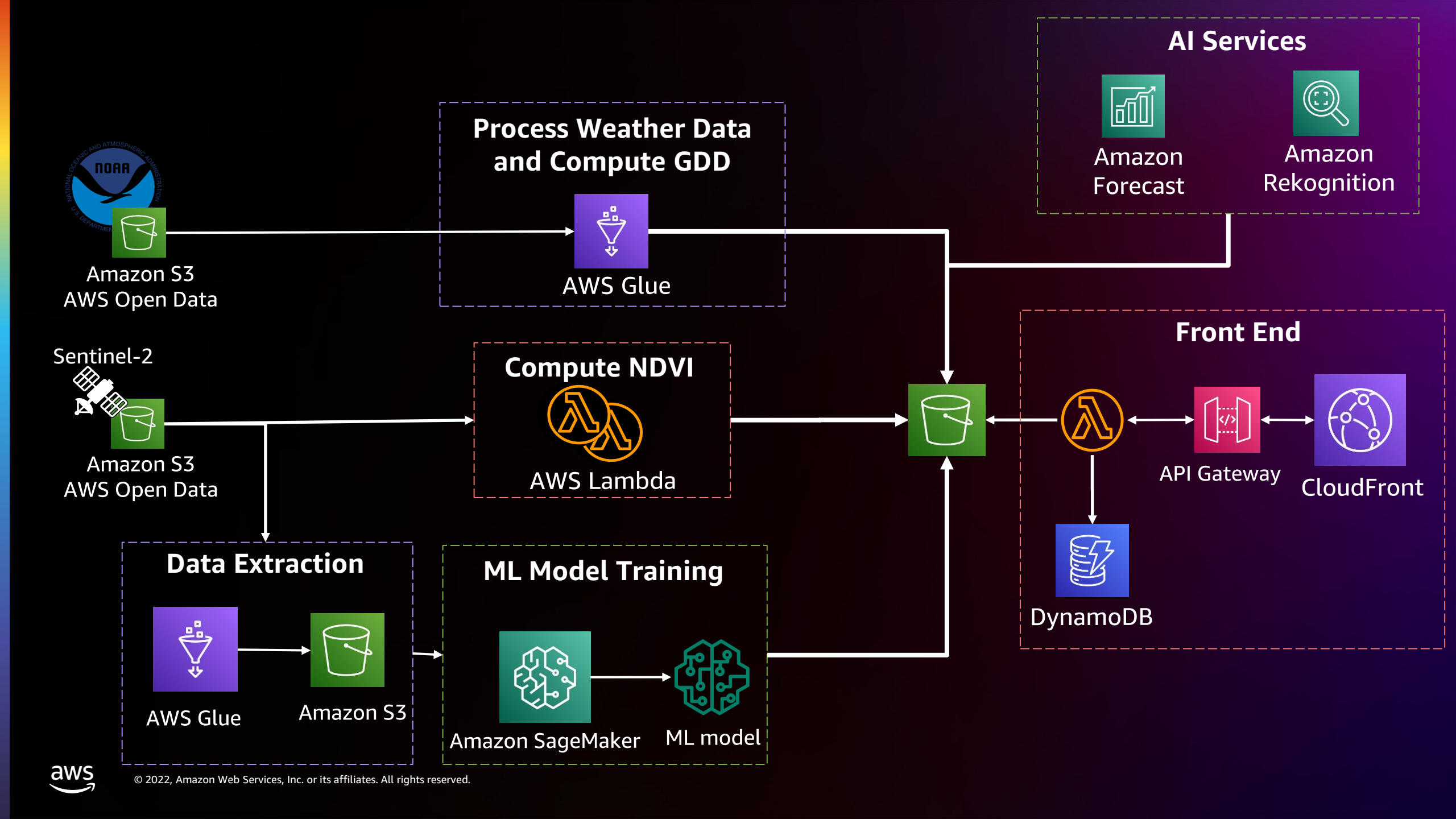
© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Use case: Crop management system

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.



© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.



© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

III. AWS customer success stories



© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

EOS Data Analytics (EOSDA)

SPACE SOLUTIONS FOR EARTH PROBLEMS

EOS Data Analytics is a global provider of AI-powered satellite imagery analytics.

- Providing Earth observation solutions across 22 industries with a focus on agriculture and forestry.

- **Mission**: Harness the power of satellite technologies to provide fast & accurate data-driven decisions in support of sustainable development globally.

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

EOS Data Analytics on AWS

LEVERAGING AWS TO HELP CUSTOMERS MAKE CRITICAL DECISIONS FASTER

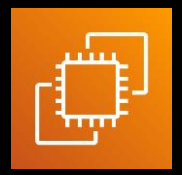
EOS DATA ANALYTICS

aws PARTNER

CROP monitoring

FOREST monitoring

LAND VIEWER



Amazon Elastic Compute Cloud (Amazon EC2)



AWS Lambda



Amazon Simple Storage Service (Amazon S3)



Elastic Load Balancing



Amazon CloudFront

aws

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Soil nutrient management in Paraguay

EOS DATA ANALYTICS

AGRONÓMICO

- Crops need the right nutrients to thrive
- Satellite-based productivity zones reduce soil testing requirements
- Variable Rate Application (VRA) maps enable precise fertilizer input
- Improves farmer's ROI, while reducing environmental impacts
- Farmers are empowered with data to build healthier, more resilient soils



aws

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Crop classification in Ukraine

EOS DATA ANALYTICS

- Ukraine is a major “bread basket” of the world
- Accurate crop classification is important for monitoring and managing risks to food supply
- EOSDA provides AI-driven crop classification across Ukraine with over 90% accuracy
- Data is available since 2016 in the EOSDA Crop Monitoring Platform



Top crops	Total size of fields, ha
Cereal	12.2 M
Sunflower	7.5 M
Maize	6.7 M
Soybeans	1.9 M
Rapeseed	1.5 M

aws

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Inclusive natural resource planning in Chad

EOS DATA ANALYTICS

Challenge: Indigenous pastoralists and local farmers don't agree on the fair use of land and freshwater sources

Conflicts are rising with scarcity, exacerbated by climate change

Solution: Participatory mapping project powered by EOSDA Land Viewer

Outcome: Cooperative written agreement on resource management and strategies for future conflict resolution



- 116 communities participated
- >2000 km^2 mapped

aws

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

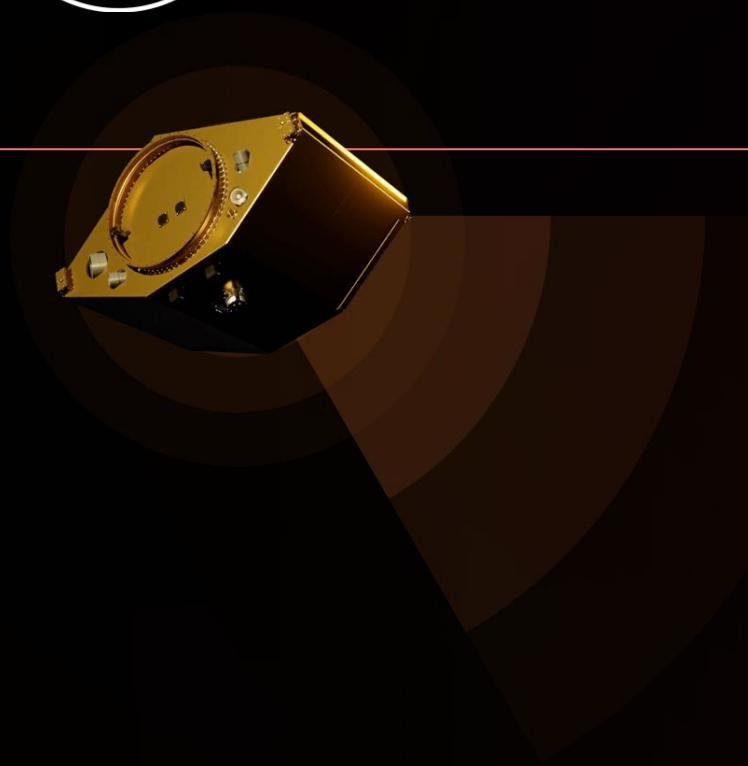
EOS SAT satellite constellation

EOS DATA ANALYTICS

EOS SAT
POWERED BY
EOS DATA ANALYTICS

The first **agriculture-focused satellite constellation** among remote sensing companies.

Powered by EOSDA for Sustainable Agriculture Practices.



7 small optical satellites generating panchromatic and multispectral imagery.

Exclusive data ownership, access to historical data.

Covering 98.5% of farm and forest lands across the globe.

aws

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.



© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

The Met Office

GLOBAL LEADERS IN WEATHER AND CLIMATE SCIENCE

The Met Office was founded in 1854 and is the national meteorological service for the UK. They provide weather and climate forecasts to help you make better decisions to stay safe and thrive.

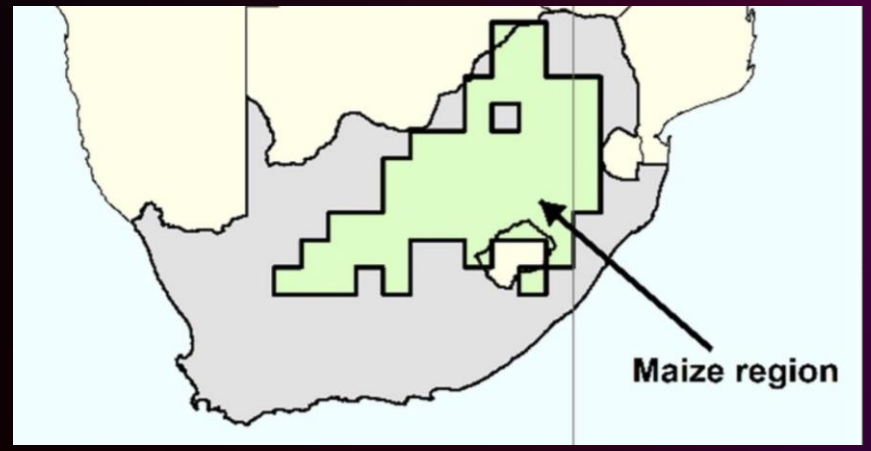


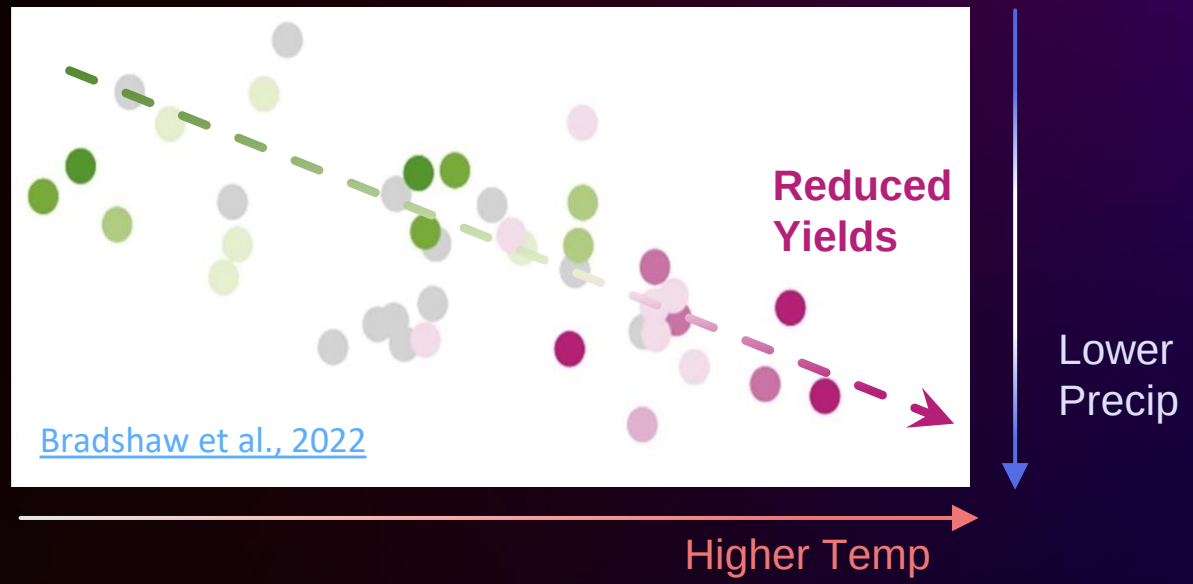
© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

The Met Office - Climate Research

EXAMPLE: UNPRECEDENTED CLIMATE EXTREMES THREATEN FOOD SECURITY IN SOUTH AFRICA

- Maize is the most important crop grown in South Africa
- Extreme high temperatures and low precipitation severely reduce yields
- How will climate change impact future yields and food security?





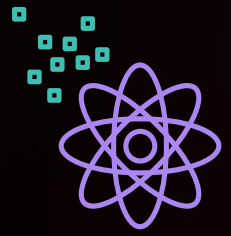
aws
© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Challenge

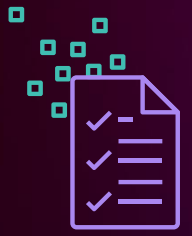
TOMORROW'S SCIENCE NEEDS NEW PLATFORMS



If scientists' questions are constrained by tooling, they are encouraged to confirm results they expect.



The most important scientific results are unexpected. We need tools that allow scientists to explore and discover with data.

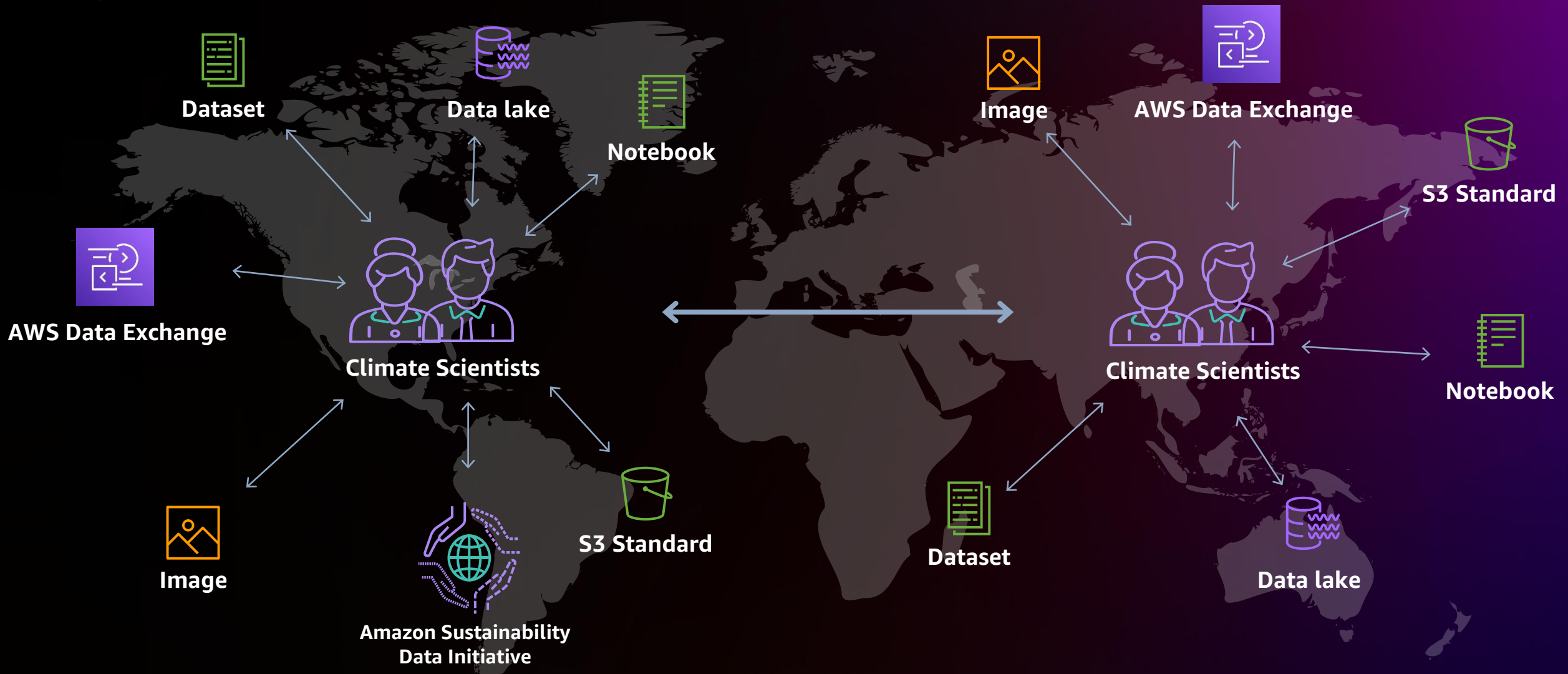


We need to give scientists back their "flow" by giving them tools and platforms that give them a modern user-experience.

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Challenge

LONG, COSTLY AND RESOURCE-INTENSIVE COMPUTE ORCHESTRATION



© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Innovation process

Identify



Identify needs
Start with the customer



Generate ideas
Brainstorm



Evaluate opportunity
Answer the 5 questions

Innovate



Discover solutions
Create PR FAQ, visuals



Select solution



Build prototype
Refine & Iterate

Implement



Finalize solution
Continually revisit PR FAQ, visuals



Production & distribution



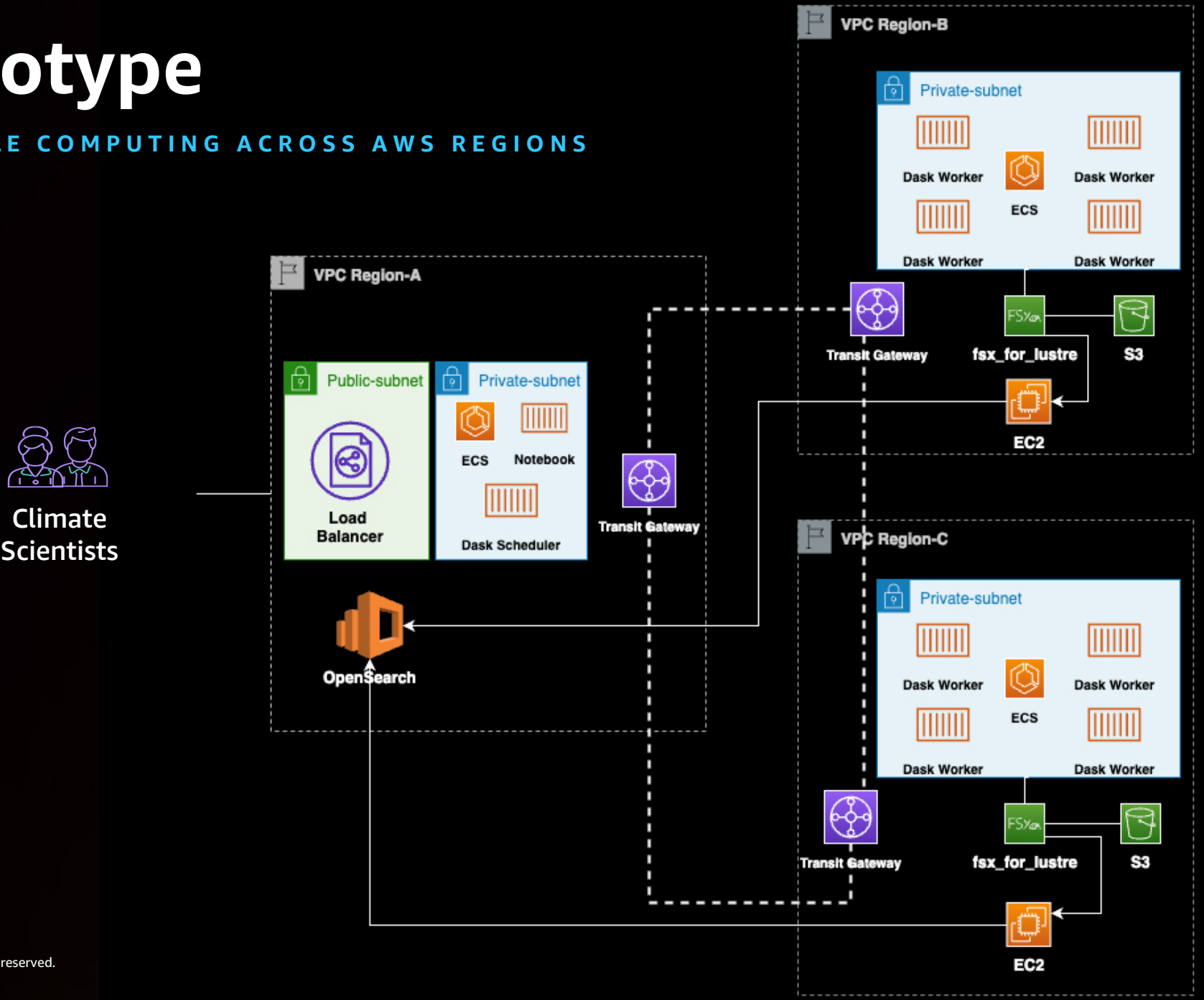
Transition to operations & scale

aws

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Solution prototype

ORCHESTRATE PETABYTE-SCALE COMPUTING ACROSS AWS REGIONS



© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Outcomes

SCIENTISTS CAN SPEND MORE TIME ON SCIENCE

- Improves speed and ease of data discovery and loading
- Automates distributed compute for large-scale modeling and analytics
- Automates efficient orchestration of compute across AWS Regions globally

Data exploration and analysis

We can now do analysis on the data set with the data as an xarray. The cells below calculate the mean and regrided value for the data set

[42]:
```
import numpy as np
from dask_worker_pools import pool, propagate_pools
```

[43]:
```
#some paramters for regridding
regrid_lon=np.arange(0.0,360.0,0.1)
regrid_lat=np.arange(-90.0,90.0,0.1)
regrid_method='slinear'
```

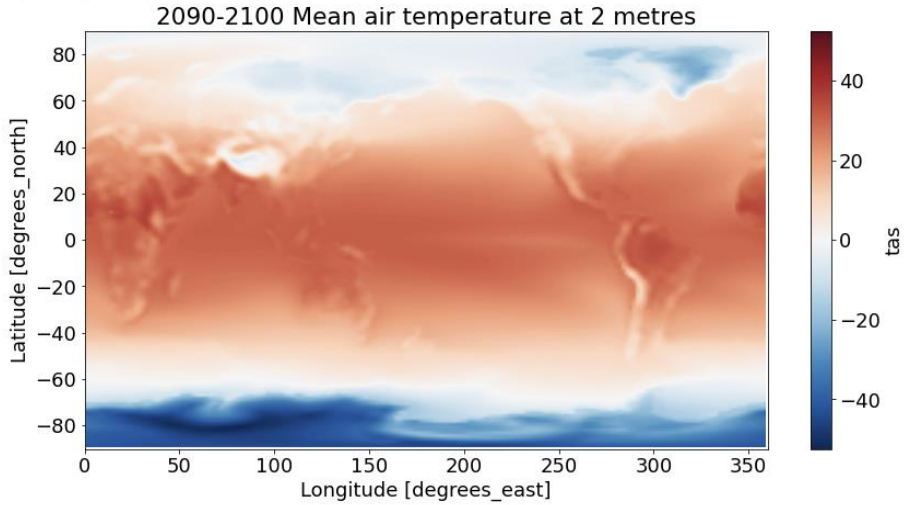
Predictive

Retrieve calculated data set

[44]:
```
%%time
if (data_type != "historical"):
    %store -r prediction_pool_region predictive_data_set
    with pool(prediction_pool_region):
        predicted_tas_mean = (predictive_data_set['tas']-273).mean(dim='time') #mean
        predicted_tas_regridded = predicted_tas_mean.interp(lon=regrid_lon,lat=regrid_lat,method=regrid_method)

    with pool(prediction_pool_region):
        predicted_tas_regridded.compute()
        predicted_tas_regridded
        predicted_tas_regridded.plot(figsize=(14,7))
        plt.title(f'2090-2100 Mean {desired_attribute.replace("_"," ")}')
else:
    print("Did not run predictive calculations for historical data")
```

```
CPU times: user 775 ms, sys: 212 ms, total: 987 ms
Wall time: 7.51 s
```



© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

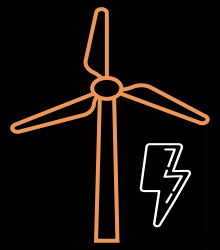
Outcomes

DATA PROXIMATE COMPUTE AND AMAZON FSX FOR LUSTRE



Compute Time

- Up to 65% time savings over traditional approach to data access



Compute Energy

- Energy savings equivalent to powering up to 40 homes every day, with less data transferred between AWS Regions



Climate Science

- Scientists can discover new results faster, with less time-to-insight.

aws

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

IV. How to get started

- Browse all open data usage examples
  https://registry.opendata.aws/usage-examples/
- Explore Sagemaker Studio Labs
  https://registry.opendata.aws/service/sagemaker-studio-lab/usage-examples/
- More ASDI use cases in AWS Samples
  https://github.com/aws-samples?q=asdi
- AWS Data Exchange ESG Datasets
  https://aws.amazon.com/data-exchange/sustainability/
- Read more AWS Customer Case Studies for Agriculture
  https://aws.amazon.com/solutions/case-studies/agriculture-customer-stories/



Smart Crops Demo
@ EBC Lounge 4th Floor
Venetian

aws
© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Thank you!

Patti Carroll
crrp@amazon.com

Bishesh Adhikari
abishesh@amazon.com

© 2022, Amazon Web Services, Inc. or its affiliates. All rights reserved.