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Machine Learning, Climate Variability and Disease Dynamics (MEDINA)

PI: Assaf Anyamba

Report Date: April 23, 2024

Health and Air Quality Applications Program Review
April 23-24, 2024
Jackson, WY

Project Partners/Collaborators



Assaf Anyamba (PI),



Inst.PI/Co-I: Co-PI: Seth
Kenneth J. Gibson
Linthicum



LTC Kevin
Taylor.
*now USU



Inst.PI: Stephanie
Schollaert Uz



Co-I: Ana Rivière Cinnamond



Co-I: Wassila M.
Thiaw (NOAA-
CPC)

Co-I: Claudia Pittiglio



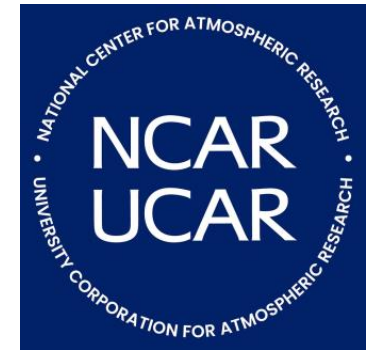
Assaf Anyamba
Heidi Tubbs
Bhaskar Bishnoi
Karly Harrod



Seth Gibson



Wassila M. Thiaw



Endalkachew
Bekele



Richard Damoah

Project Summary



- Project title: Machine Learning, Climate Variability and Disease Dynamics
- **Short title** : MEDINA
- **Project PI:** Assaf Anyamba
- **Solicitation:** NNH21ZDA001N-HAQ
- **Project Summary:** Develop (MEDINA App) and enhance risk mapping and forecasting of a suite of vector-borne disease models driven by extreme weather and climate conditions to serve the needs. This unified platform will support the dynamic needs of our collaborating partners including the Global Emerging Infections Surveillance (GEIS) Branch - Armed Forces Health, Surveillance Division, Pan American Health Organization (PAHO), USDA-Center for Medical, Agricultural, & Veterinary Entomology (CMAVE), and Food and Agriculture Organization (FAO) of the United Nations.
- **Geographic Scope (Focus):** Global, Continental

Earth Observations, Models, and/or Technologies



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Satellite Sensor/Model/Tech.	Product Used	Temporal Coverage and Latency required	Comments
Terra-MODIS	NDVI, LST	Monthly	
GPM-IMERG	Precipitation	Daily, Monthly	
NOAA-ARC	Precipitation	Daily, Monthly	
SMAP	Soil Moisture	Daily, Monthly	
SRTM	Elevation	Baseline	
NMME	Precip, Temp	Monthly, Seasonal	
GMAO	Precip, Soil Moisture	Monthly, Seasonal	Some delay
CIESEN, ORNL	Human Population	Baseline	
WAOH, ProMED	Disease Data	Baseline, On Demand	ProMED – not available

Project End-users &

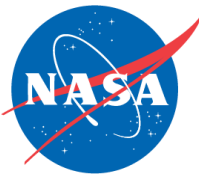


Organization Name	Organization Type	Decision Making Activity
FAO	LIVESTOCK HEALTH - INTERNATIONAL	EARLY WARNING
GEIS	GOV-DEFENSE/GLOBAL	EARLY WARNING/ASSESSMENT
USDA/CMAVE	GOV-AGRICULTURE-ENTOMOLOGY	VECTOR SURVEILLANCE/CONTROL
PAHO	PUBLIC HEALTH - REGIONAL	MONITORING, EARLY WARNING
NASA GSFC	GOV	EO DATA APPLICATIONS

Engagement plan and recent updates

- Meet with end users/stake holders : semi-annual basis
- Engagement with FAO , USDA/CMAVE – Monthly
- Provided Early Warning Products to FAO
- Hosted USDA/CMAVE Post-Doc
- Presented at Chapman and AMCA Conference, Seminar and UTK-Geography
- Invited as External Member (USDA-APHIS) Disease Response Strategy Working Group on Rift Valley fever

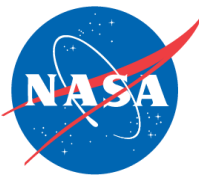
Schedule & Milestones



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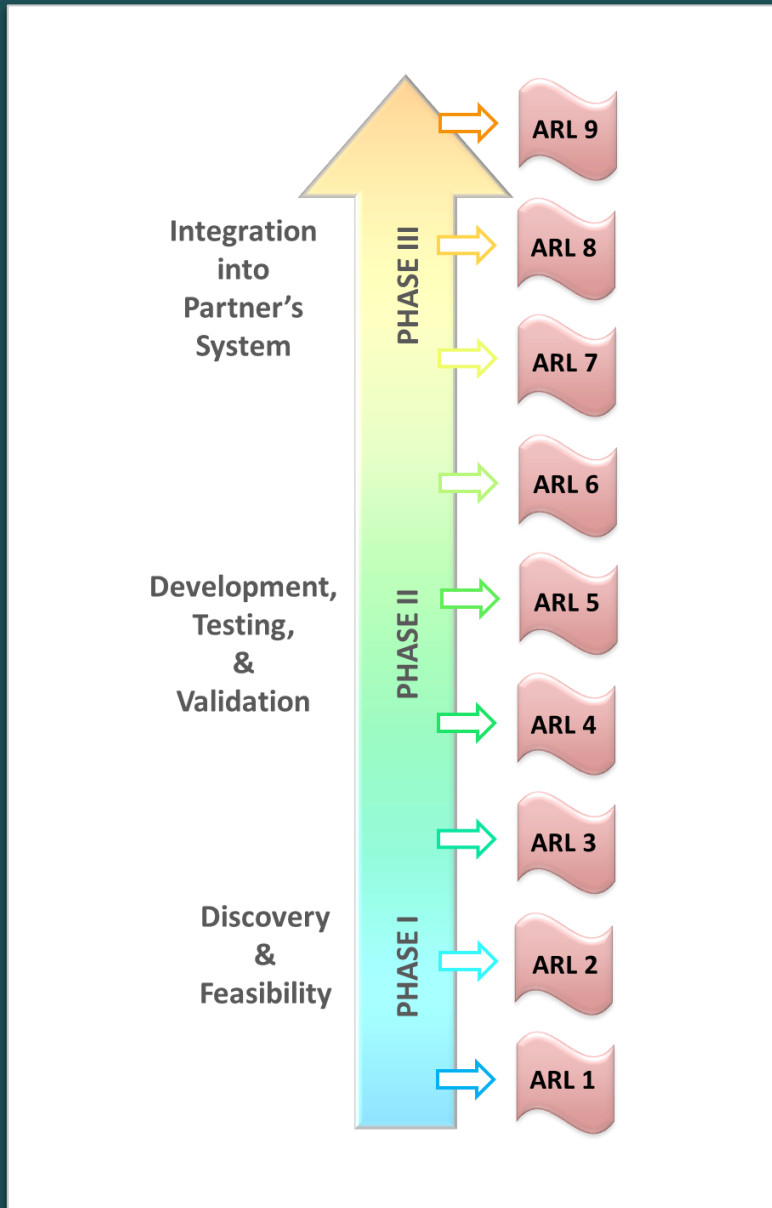
Task Description`	Year 1				Year 2				Year 3				
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Task A. Data processing: disease data, climate and environmental and ancillary data													
Disease data processing													
<i>Milestone: Disease data (up to present) ready for use in analysis (other tasks)</i>													
Ancillary Data													
<i>Milestone: Human population, Livestock Population and SRTM Elevation</i>													
Climate Data Processing and NMME Forecasts													
<i>Milestone: Climate data (up to present) ready for use in analysis (other tasks)</i>													
Task B: Disease Suitability and Modeling													
<i>Dengue, Zika suitability and ML Evaluation</i>													
<i>Rift Valley fever, Hantavirus suitability and ML Evaluation</i>													
Task C. MEDINA App development and Deployment													
<i>Curation and Development</i>													
<i>Deployment to AWS and Component Updates</i>													
<i>Development of Interoperability with Pesticide App, API's for RVF DST, HSE, PLISA</i>													
Task D: Application Readiness Levels (ARL)													
<i>Chikungunya</i>	8	8	8	8	8	8	8	8	8	8	8	8	8
<i>Dengue</i>	2	2	2	3	4	4	5	6	7	7	8	8	
<i>Zika</i>		2	2	2	3	4	4	5	6	7	7	8	
<i>Rift Valley fever</i>			4	4	5	5	6	6	7	7	8	8	
<i>Hantavirus</i>			2	3	4	5	5	6	7	7	8	8	
Task E: Manuscript Writing and Submission													
<i>MEDINA Concept Paper</i>													
<i>Other Project Manuscripts</i>													

ARL Performance



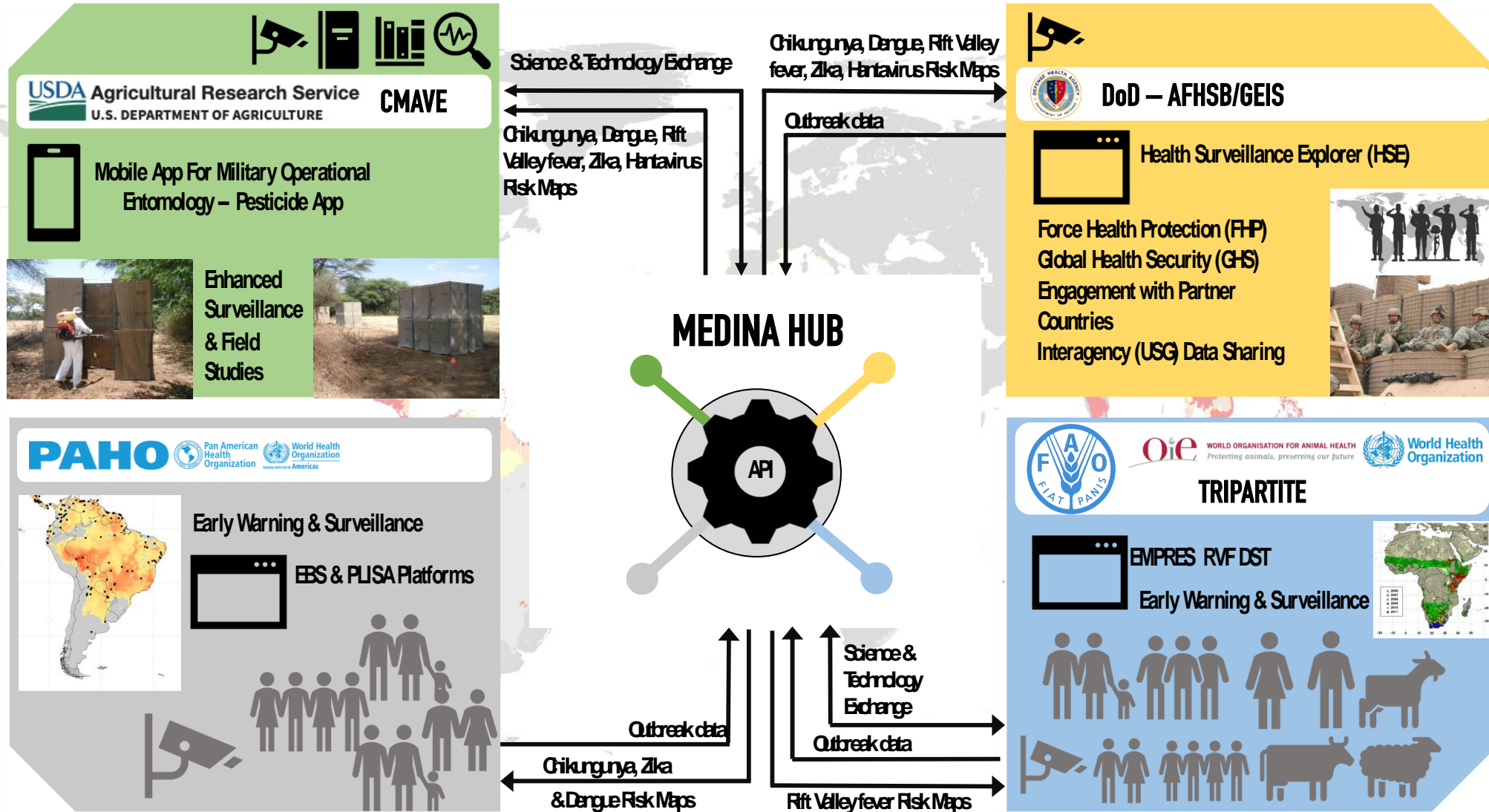
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COMPONENT	START ARL (06/15/2024)	GOAL ARL	CURRENT ARL (04/23/24)
Chikungunya	8	8	8
Dengue	2		3-4
Zika	2		2
Rift Valley fever	2	8	5
Hanta Virus	2	8	2
MEDINA App	1	8	2-3



Add short title here

MEDINA Decision Support Network

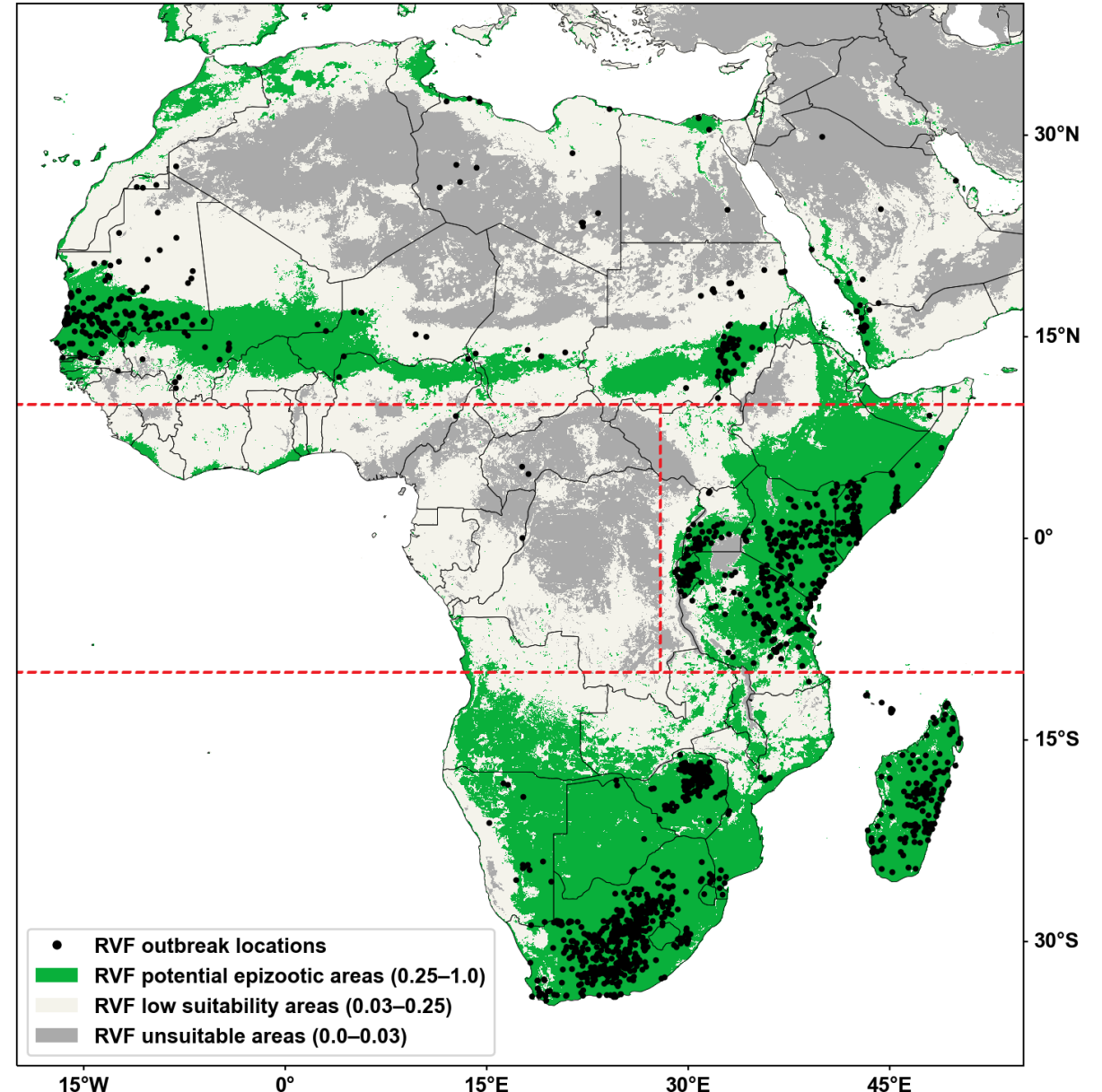


MEDINA Decision Support System Network (MDSSN) illustrating data and product flows to support various decision-making elements for various project partners as well as science and technology exchange

Rift Valley fever: suitability

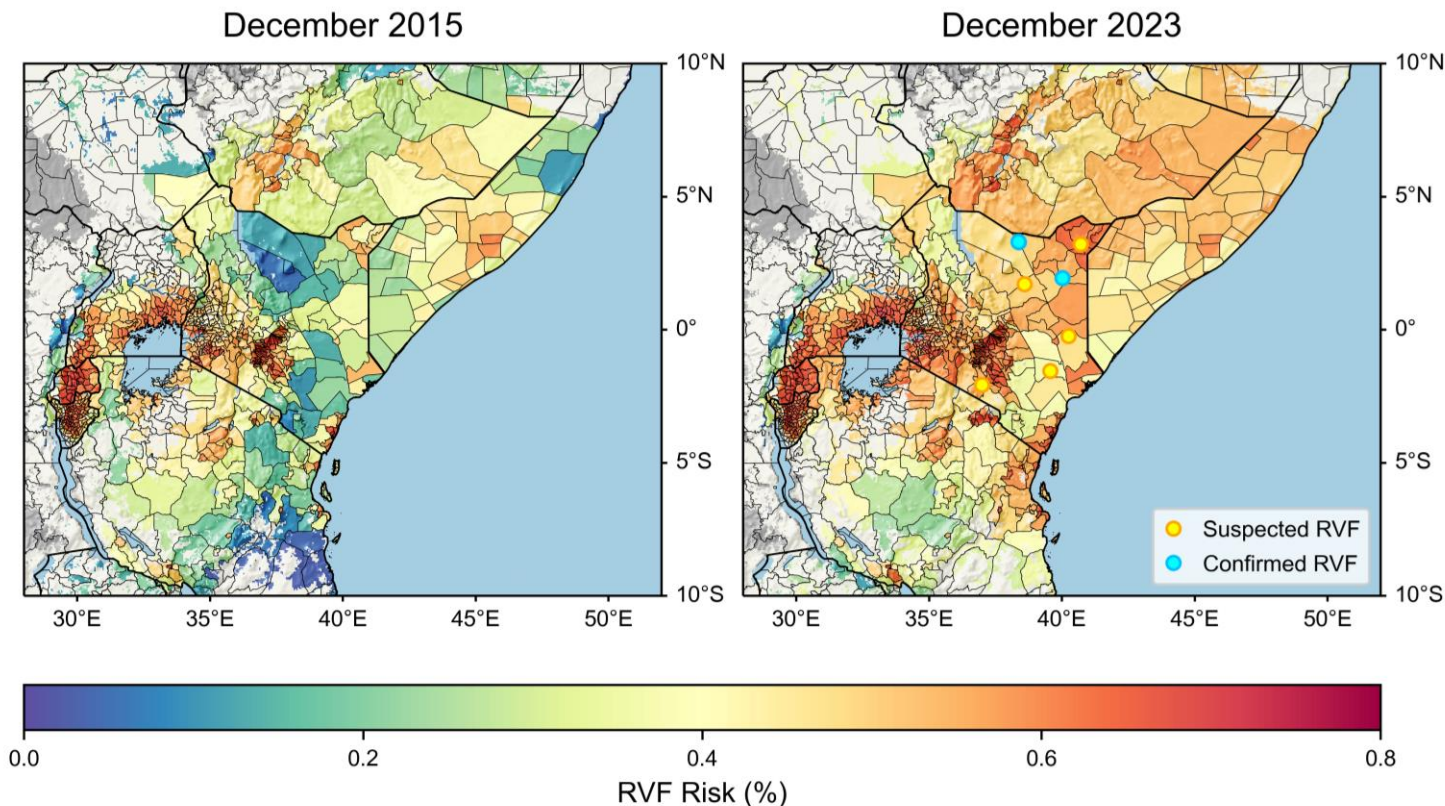
- Final suitability map created with Maxent software from AMNH*
- Features:
 - Bioclimatic variables derived from 2000-2023 climate data
 - MODIS/Terra NDVI
 - MODIS/Terra LST
 - ARC2 Precipitation
 - SRTM Elevation
 - RVF presence (outbreaks)

*American Museum of Natural History



Rift Valley fever Risk Mapping

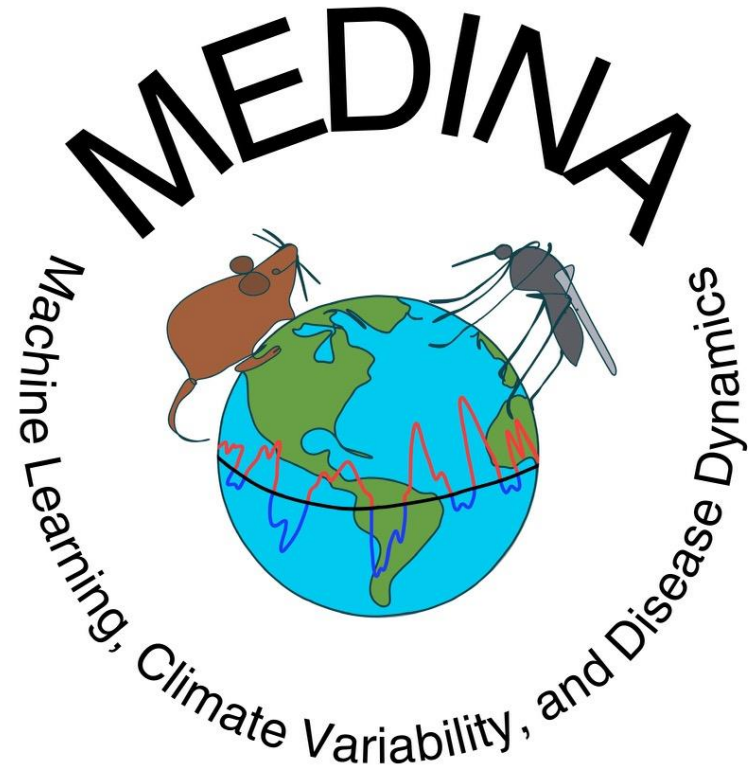
- Random Forest models implemented in Python
- Three regions of Africa (South, East, North) modeled independently to utilize unique ENSO responses
- Able to produce monthly risk maps



ARL: 5 Development and Testing

MEDINA App Development

- Uses React instead of Vanilla JavaScript - due disease volume compared to the CHIKRisk application.
- JavaScript would - unmanageable over time
- React – has capability of reusability and modularity.
- Mapping Library: Change to MapLibreGL JS instead of Leaflet. MapLibreGL JS uses WebGL to render interactive maps in a browser.





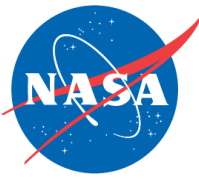
MEDINA

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ORNL | © MapTiler © OpenStreetMap contributors

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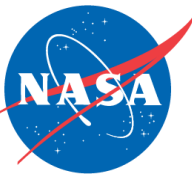
Accomplishments since Last Update

- Designed prototype MEDINA App – current ARL3 and in progress
- Implemented regionalized RVF Model – East Africa done, Sahel – on going: ARL 5
- Started work on Dengue Model – ARL-3
- Compiled and standardized various Disease data sets
- Coordinated with Dr. Stephanie Schollaert Uz, Applied Sciences Manager, NASA Goddard Space Flight Center on provisioning of GMAO Forecast products

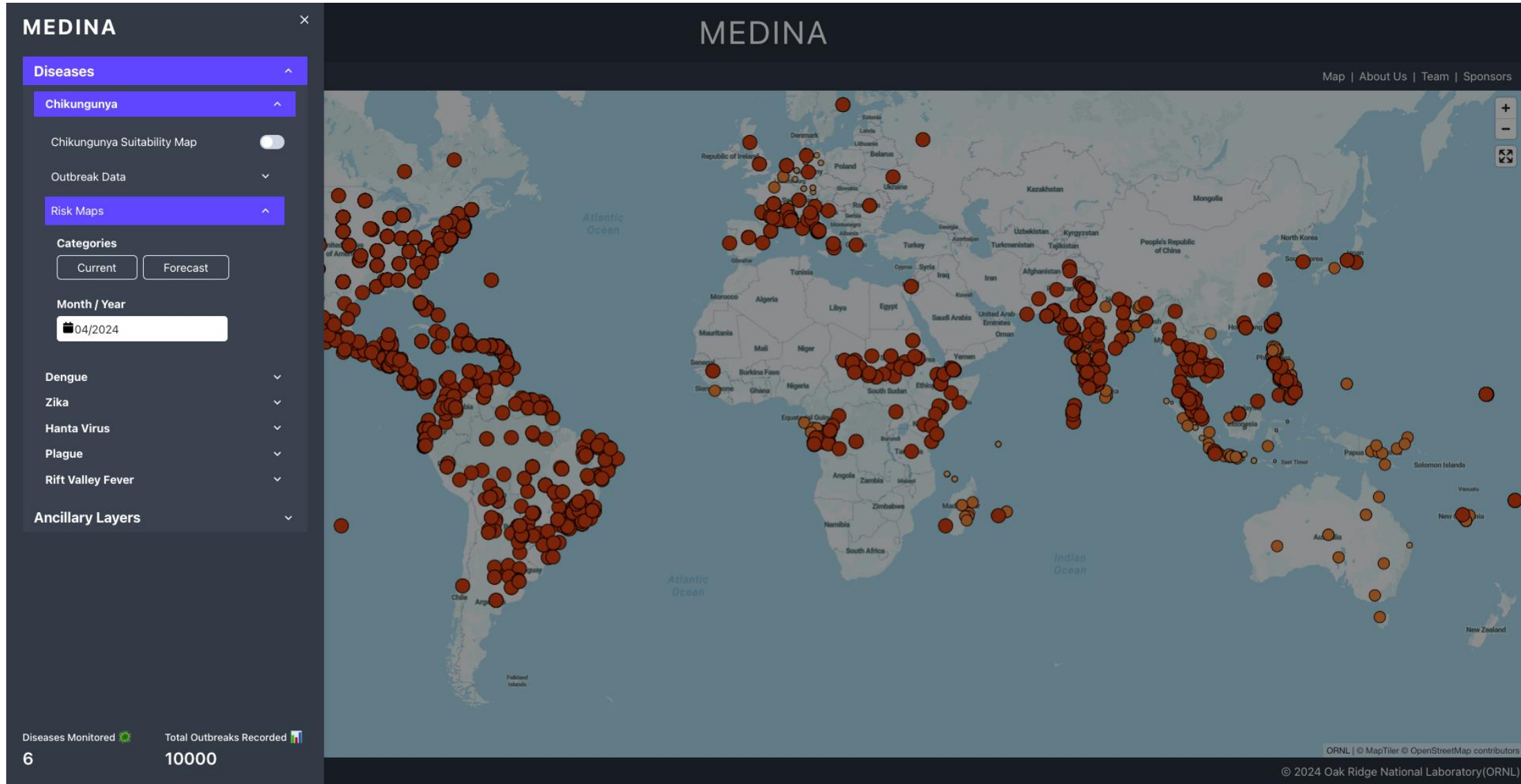
Other

- Coordinated with FAO on 2023/2024 RVF Outbreak in East Africa and contribute to FAO interoperability RVF DST workshop, April 17, 2024
- Presented
 - AMCA – Designing a Global Surveillance and Forecasting System for Selected Vector-borne Diseases Session: Using NASA Satellite Data to Enhance Understanding of Vector Habitats and Disease Transmission, March 5, 2024.
 - Chapman Conference on Remote Sensing of the Water Cycle: Present and Future Satellite Observations to Benefit Vectorborne Disease Monitoring and Early Warning, February 12-17, 2024
 - UTK: Remote Sensing of Vegetation: Science to Applications

Highlight Image



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Other: Associated Fieldwork – South Africa

March 2024

