



Near-Real-Time Forecasting and Change Detection for a Fire-Prone Shrubland Ecosystem

(NASA 80NSSC21K1183)

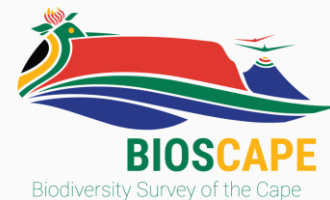
emma.eco

Adam M. Wilson¹, Yingjie Hu¹, Jasper A. Slingsby^{2,3}, Glenn R. Moncrieff³, Brian Maitner¹, Yue Ma¹

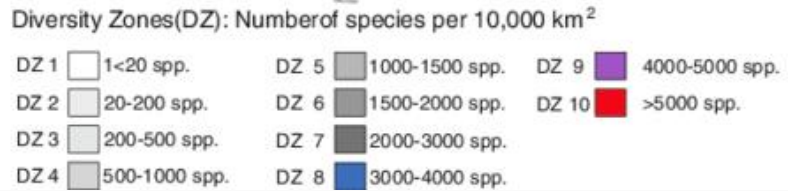
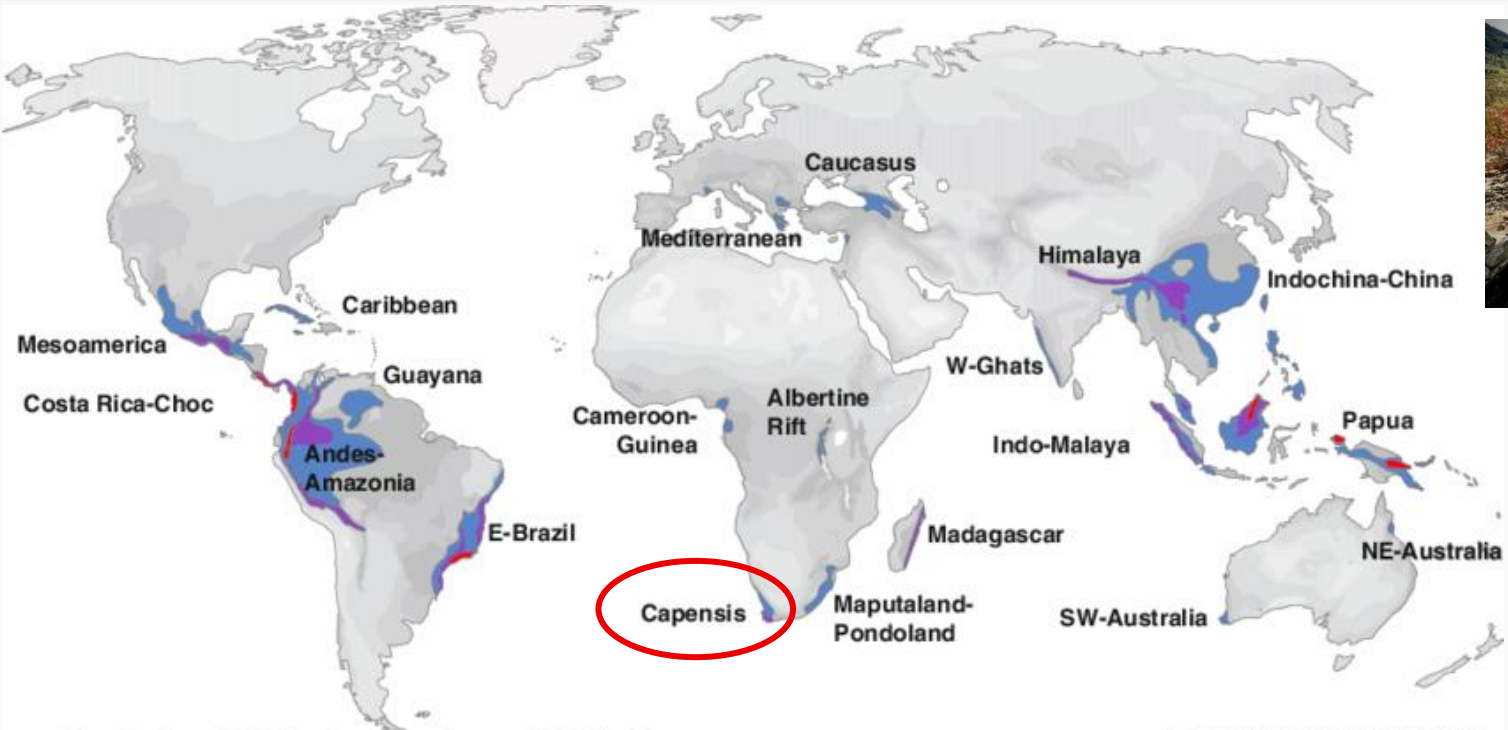
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³SAEON Fynbos Node



Global Biodiversity Hotspots



W. Barthlott, G. Kier, H. Kreft, W. K. Per, D. Rafiqpoor & J. Mutke 2005 revised after W. Barthlott, W. Lauer & A. Placke 1996 Nees Institute for Biodiversity of Plants University of Bonn

Robinson Projection
Standard Parallels 38°N and 38°S



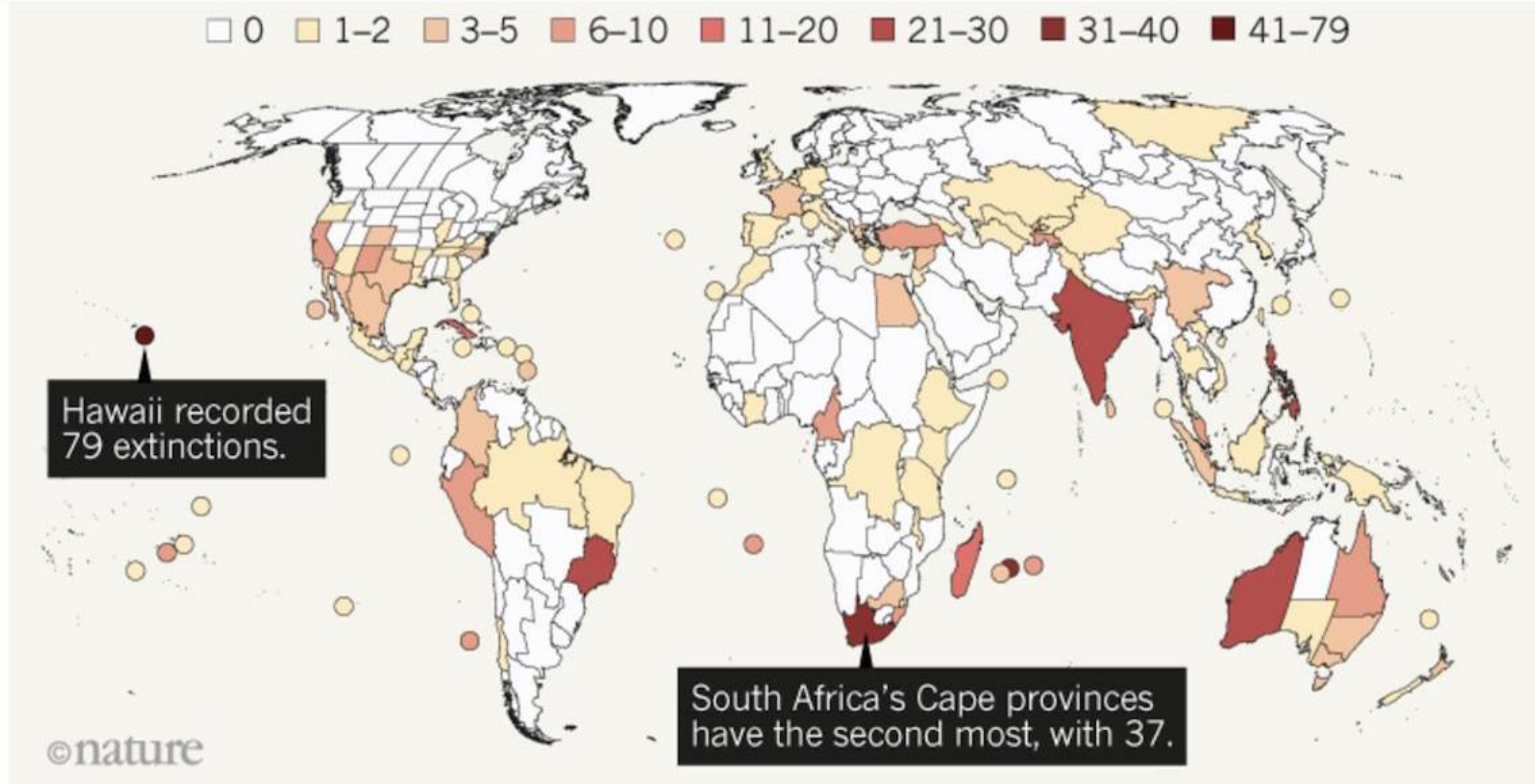
Semi-arid shrubland

Global map of species richness of vascular plants highlighting the 20 centres of highest species richness. Vascular Plant Diversity in a Changing World: Global Centres and Biome-Specific Patterns (2011)

DOI:10.1007/978-3-642-20992-5_5

Global Extinction Hotspot!

Seed-bearing plant species lost since 1900

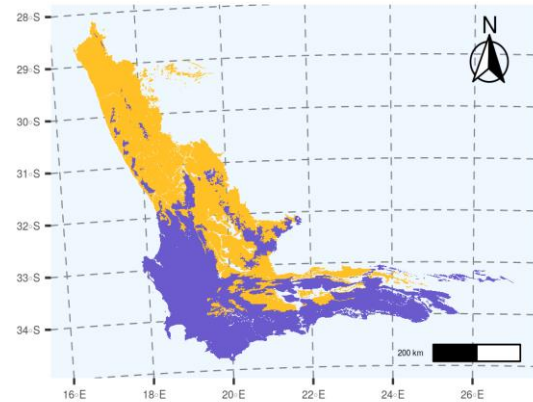


Major Threats

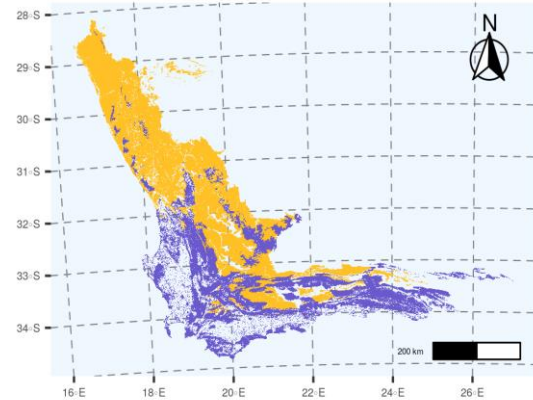
Habitat loss and fragmentation...



Skowno et al. 2021. SAJS <https://doi.org/10.17159/sajs.2021/8182>
Ntshanga et al. 2021. Aus Ecol <http://dx.doi.org/10.1111/aec.13037>



Historical
Biome
Distribution



Current
Biome
Distribution

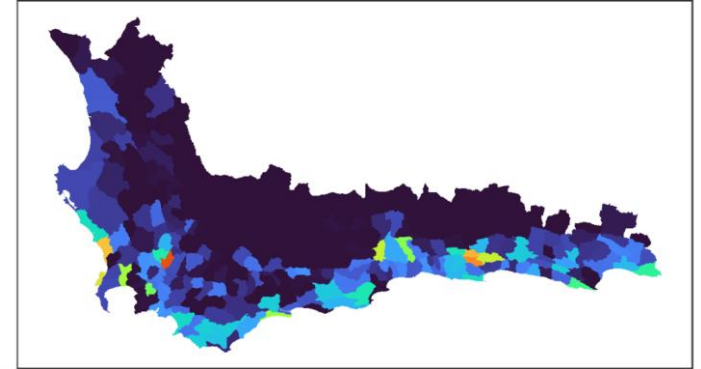
Major Threats

Invasive alien plants (trees in particular)

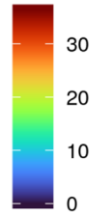
- outcompete local flora
- alter fire regimes
- reduce runoff



Reduction of freshwater supply due to alien plants



runoff reduction (%)



Moncrieff et al. Hydr Proc 2021

<http://dx.doi.org/10.1002/hyp.14161>

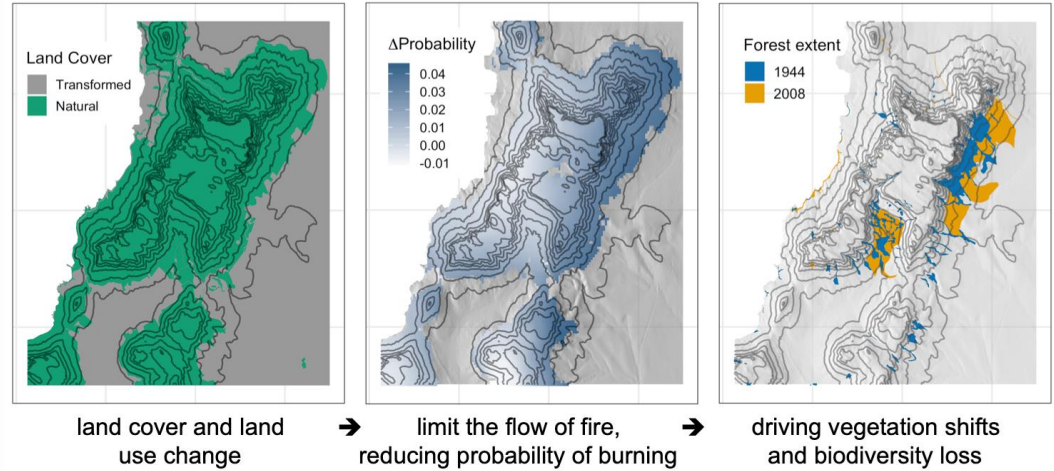
Slingsby et al. 2017 PNAS

<http://dx.doi.org/10.1073/pnas.1619014114>

Major Threats

Altered fire regimes

- population die-offs
- vegetation state shifts



Slingsby et al. 2020. *Global Change Biology*.
<http://dx.doi.org/10.1111/gcb.14861>

Major Threats

Climate change...

- population die-offs
- reduced postfire regeneration
- diversity loss
- shifts in functional composition



Slingsby et al. 2017 PNAS
<http://dx.doi.org/10.1073/pnas.1619014114>
Slingsby et al. 2020 ISPRS
<https://doi.org/10.1016/j.isprsjprs.2020.05.017>

How do we manage
such a complex and
dynamic system?



South African
NATIONAL PARKS



CapeNature

Photo: Jasper Slingsby

2021 Fynbos Forum: Satellite monitoring of the Fynbos biome: identifying user needs

THEME
Fynbos: Virtual Realities

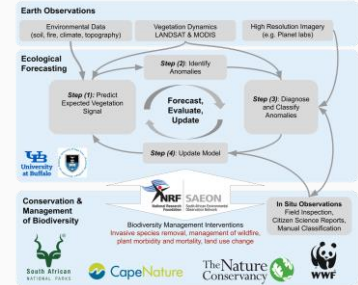
43rd
FYNBOS FORUM 2021
ONLINE EVENT

07-09 SEPT

CONNECTION
COMMUNITY
COMMITMENT

FYNBOS FORUM

~80 Participants
from a variety of
organizations
across South Africa



SANBI
Biodiversity for Life
South African National Biodiversity Institute

NELSON MANDELA
UNIVERSITY

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

CSIR
Touching lives through Innovation

The Nature Conservancy

South African NATIONAL PARKS

BOTANICAL SOCIETY OF SOUTH AFRICA

CapeNature

SEEC - Statistics in Ecology, Environment and Conservation

NRF SAEON
National Research Foundation South African Environmental Observation Network

UNIVERSITY OF CAPE TOWN

Breakout Rooms

1. Fire management
2. Monitoring species and ecosystems
3. Invasive Species
4. Hydrology
5. Illegal vegetation clearing

User Requests:

- Records of past changes
- Current ecosystem status *in context*
- Spatial resolutions < 1 km
- Regular updates

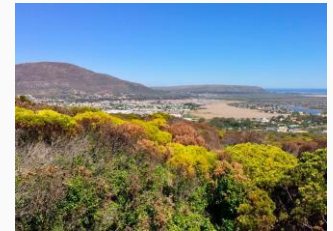
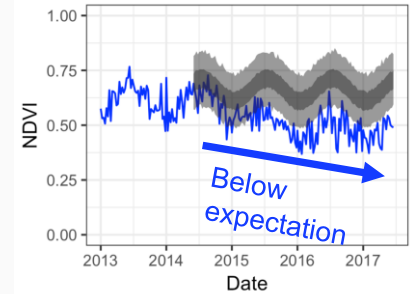
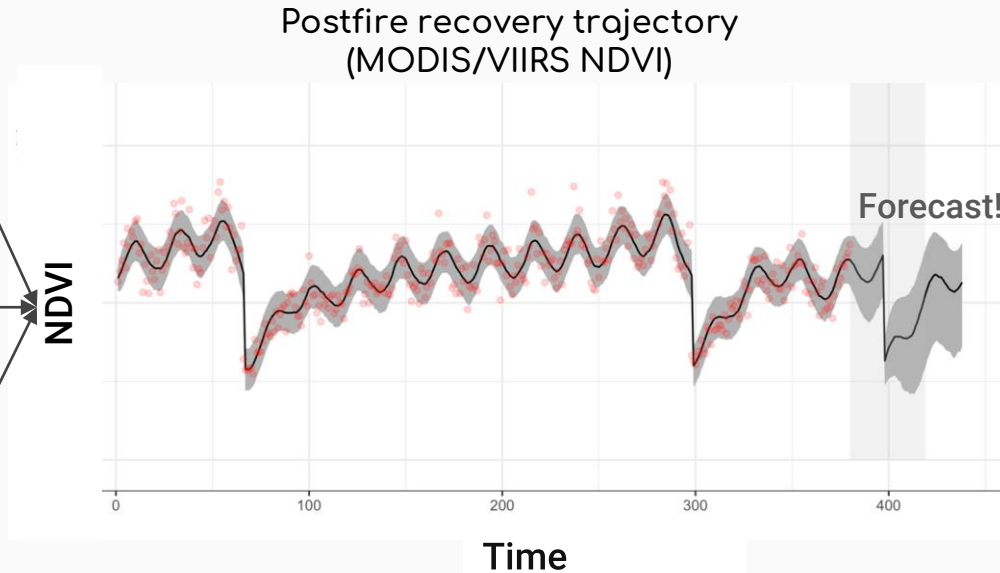
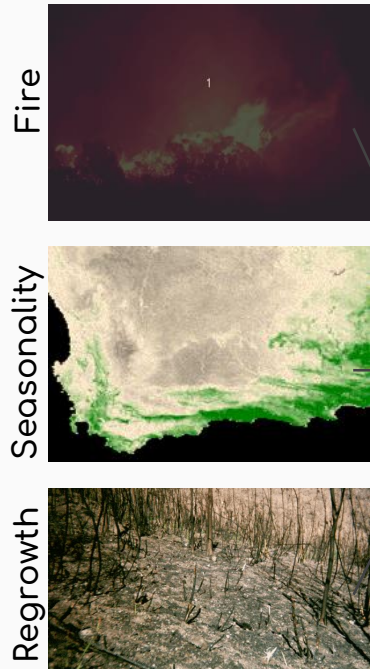
Near-real-time monitoring and forecasts of ecosystem state



Use satellite time-series to identify fire, recovery, invasion, and change



<https://doi.org/10.1016/j.isprsjprs.2020.05.017>



Shrub Mortality due to drought

Comparing bayesian, state-space, & AI methods

Near-real-time change detection for Cape Floristic Region

Regional summaries

EMMA Report

- Model Overview
- Park Information

Page last updated at 2022-09-18 03:46:02.

Model Overview

We estimate the age of a site by calculating the years since the last fire. We then fit a curve to model the recovery of vegetation (measured using NDVI) as a function of it's age. An additional level models the parameters of the negative exponential curve as a function of environmental variables. This means that sites with similar environmental conditions should have similar recovery curves. More details are available [here](#).

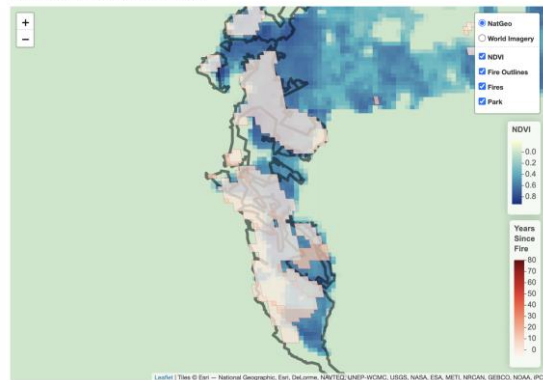
Park Information



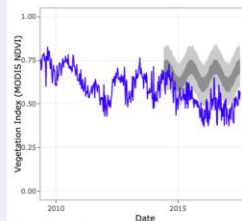
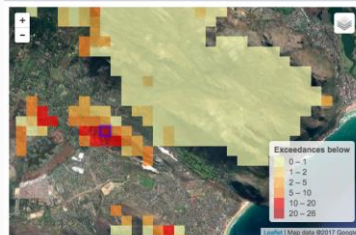
Park-level Reports

Park-specific Information

NDVI and Time Since Fire



Click a pixel to view time series data. Move to the diagnosis tab to view high resolution satellite imagery



Use satellite time-series to identify fire, recovery, invasion, and change



Partnering with regional stakeholders to develop an operational monitoring system in a dynamic ecosystem

Earth Observations

Environmental Data
(soil, fire, climate, topography)

Vegetation Dynamics
LANDSAT & MODIS

High Resolution Imagery
(e.g. Planet labs)

Ecological Forecasting

Step (1): Predict Expected Vegetation Signal

Step (2): Identify Anomalies

Step (3): Diagnose and Classify Anomalies

Step (4): Update Model

Forecast, Evaluate, Update



Conservation & Management of Biodiversity

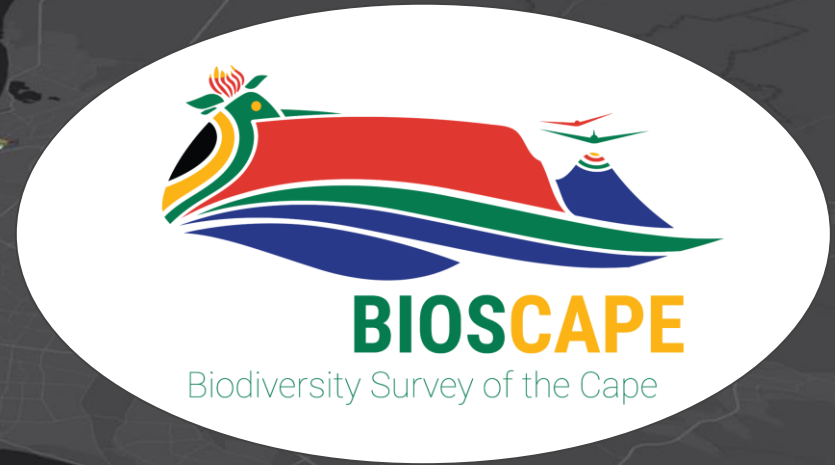
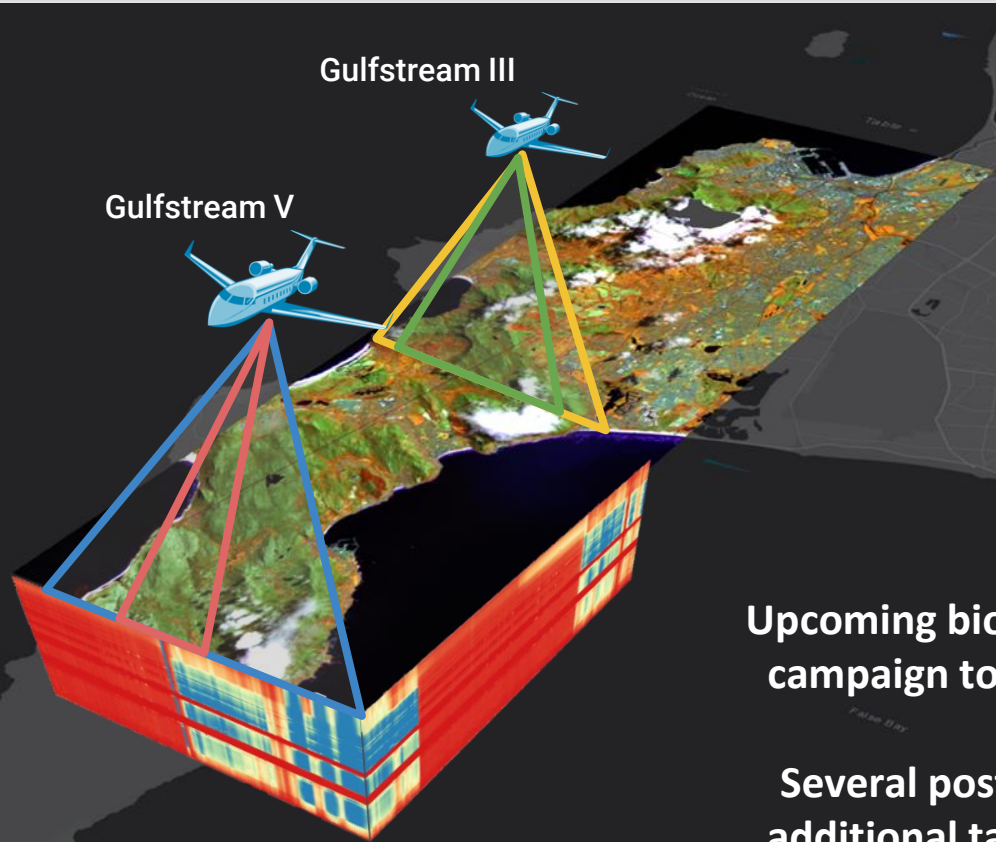


Biodiversity Management Interventions
Invasive species removal, management of wildfire, plant morbidity and mortality, land use change

In Situ Observations
Field Inspection, Citizen Science Reports, Manual Classification



Applied component of the Biodiversity Survey of the Cape (BioSCape)



**Upcoming biodiversity field
campaign to South Africa**

**Several posters today &
additional talk tomorrow**



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Thank you!

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