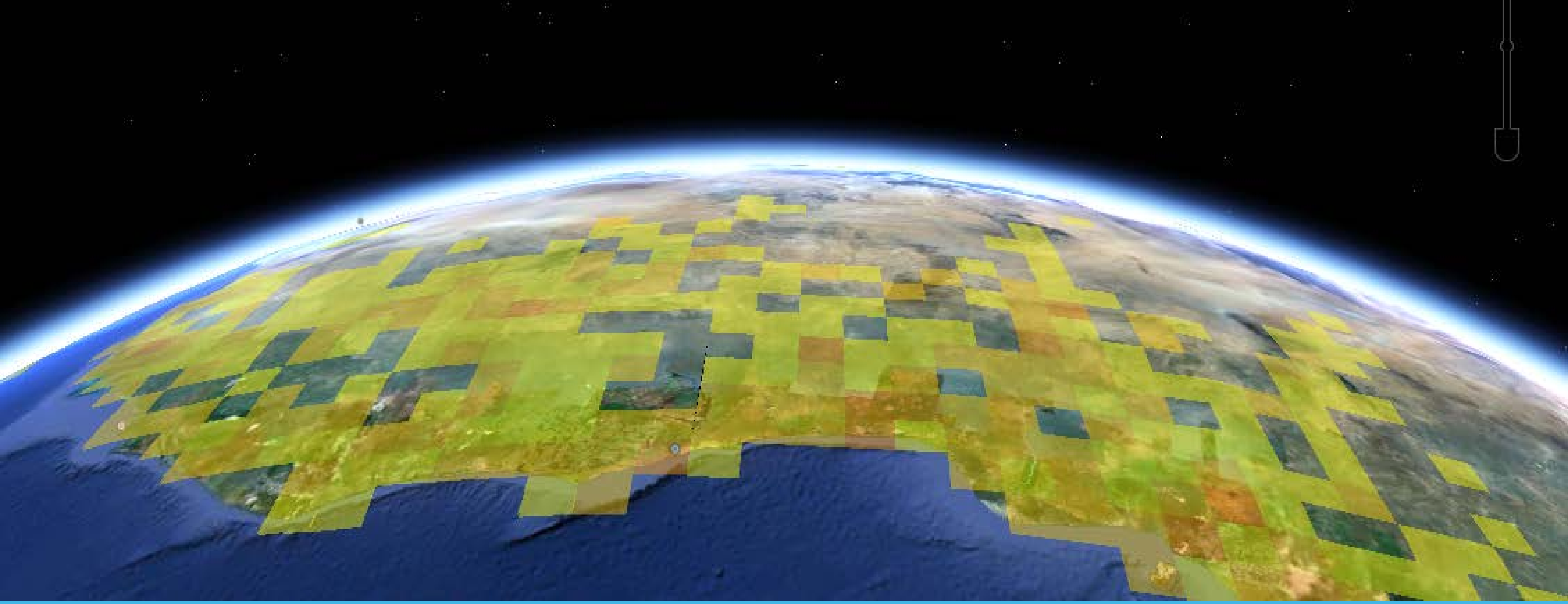


Community-level modelling for global biodiversity monitoring – challenges and opportunities

Simon Ferrier

Tom Harwood, Kristen Williams, Andrew Hoskins, Justin Perry

CSIRO LAND & WATER FLAGSHIP
www.csiro.au

Global biodiversity monitoring – multiple pathways to addressing multiple needs

Global biodiversity monitoring

Biological composition

Ecosystem structure & function

Detection from *in situ* observation only

Detection from RS
e.g. hyperspectral detection of dominant plant species / diversity

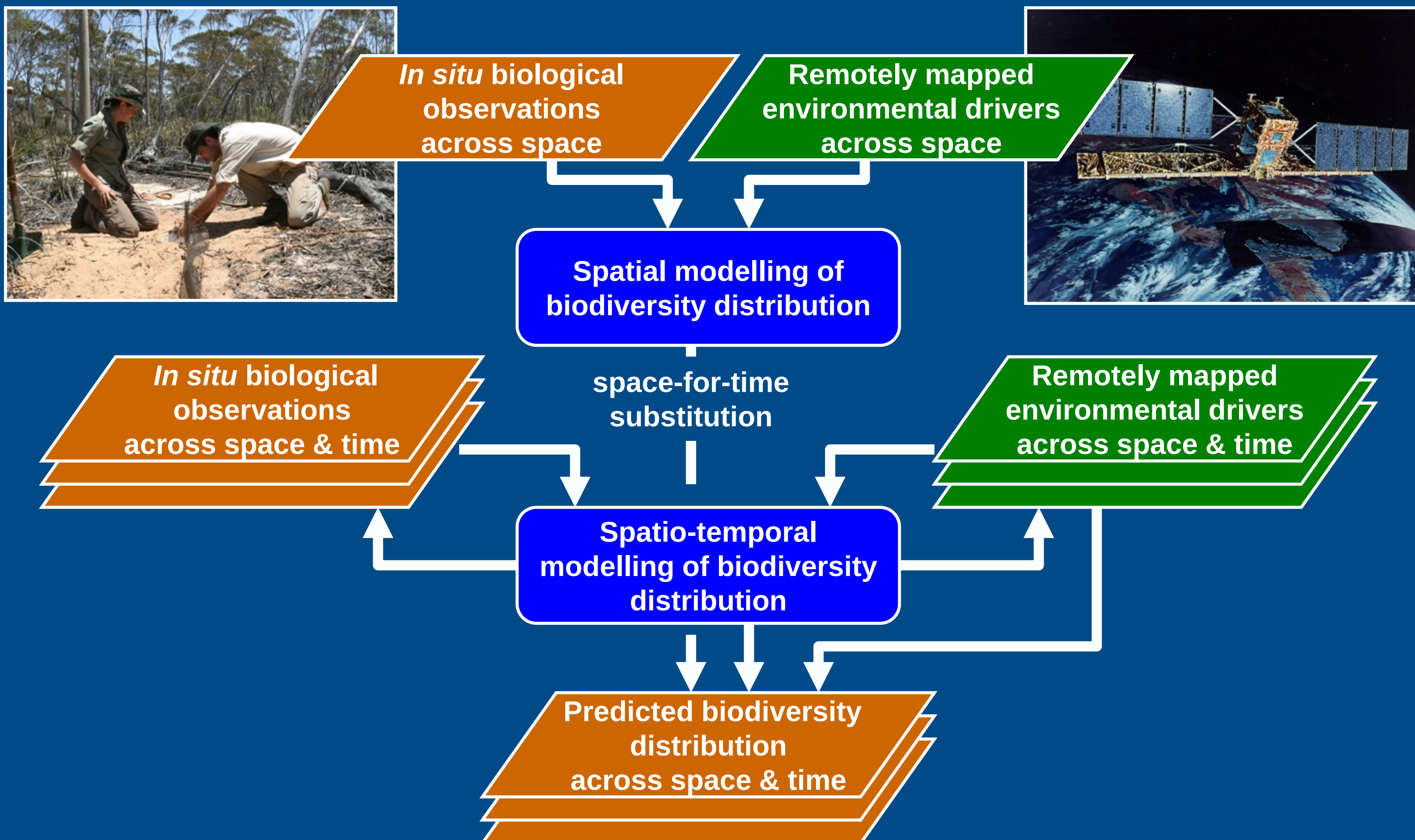
Repeat-visit site monitoring

In situ / RS model based integration

In situ observation

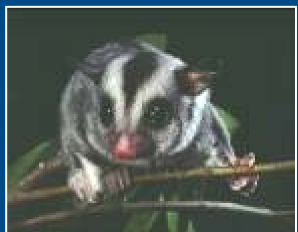
Remote sensing

Mapping biodiversity change through model-based integration of *in situ* and remote sensing observations



Spectrum of distributional modelling strategies

Ferrier & Guisan (2006) *Journal of Applied Ecology*

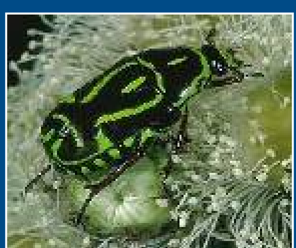


- interested in individual species of particular concern
- reasonable number of records per species

Individual species distribution (niche) modelling

"Predict first, assemble later" techniques

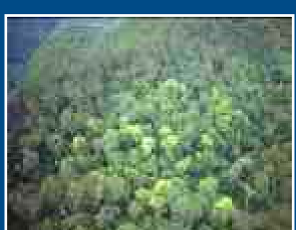
Simultaneous multi-response modelling of multiple species



"Assemble first, predict later" techniques

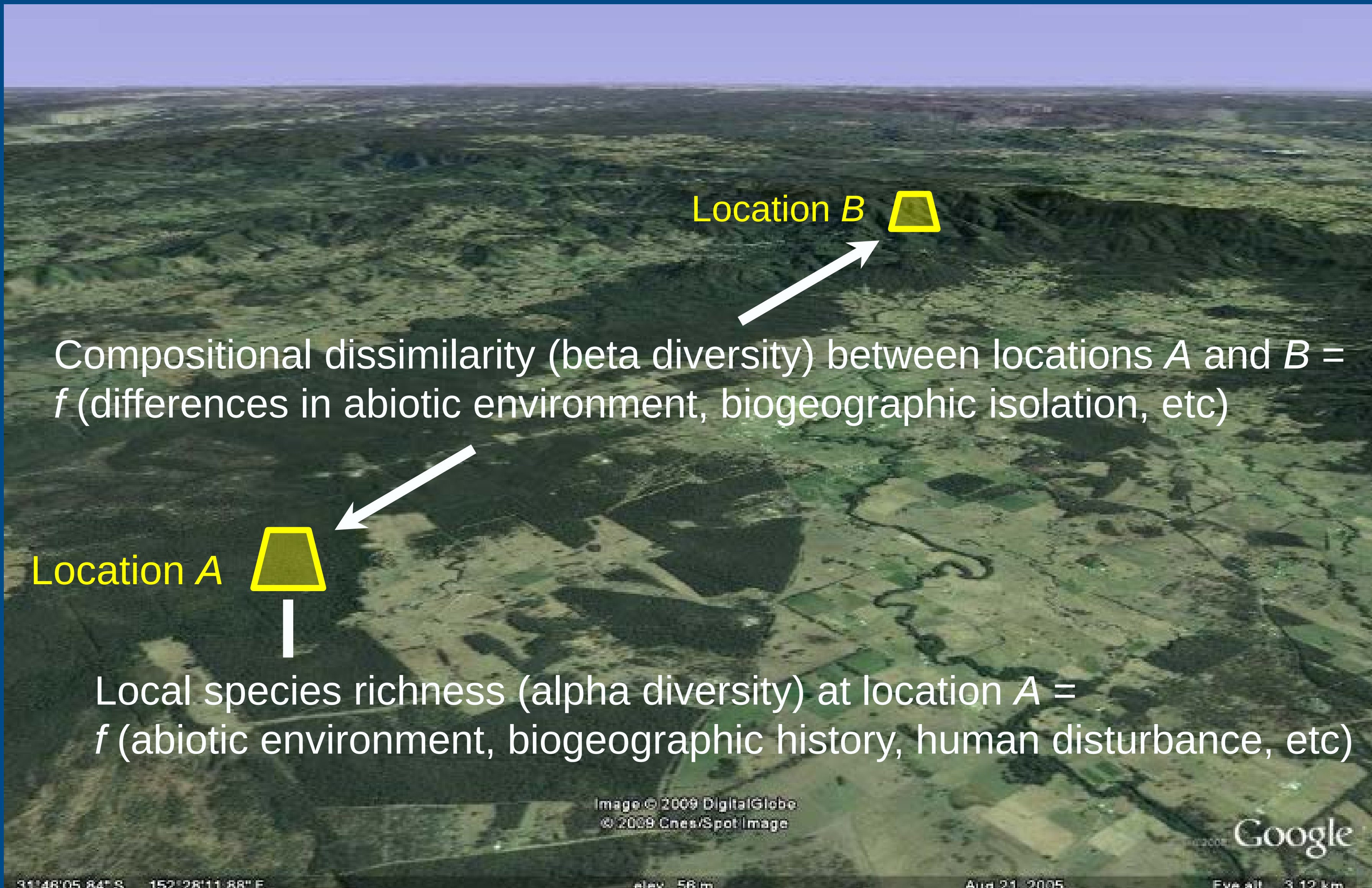
Macroecological modelling of collective biodiversity properties (richness, compositional turnover)

community-level approaches



- interested in biodiversity as a whole
- huge number of species, each with few (or no) records

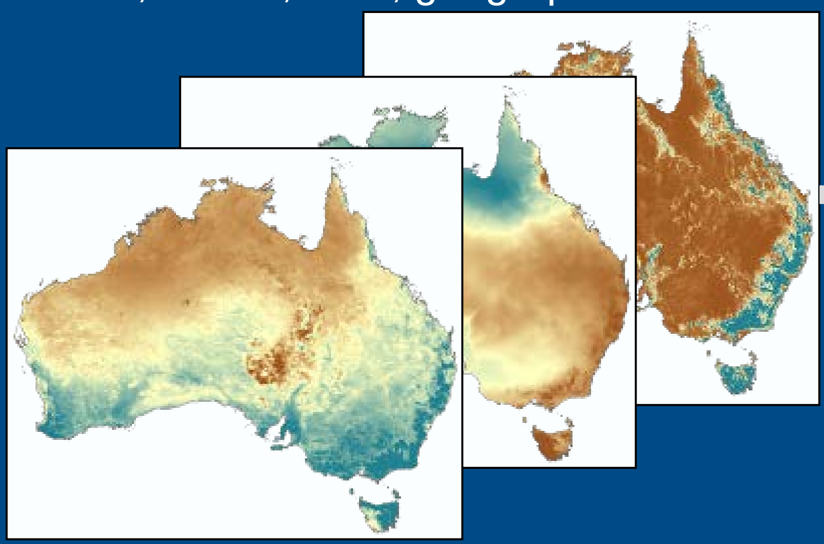
Macroecological modelling of collective biodiversity properties – richness and compositional turnover



Modelling compositional turnover using generalised dissimilarity modelling (GDM)

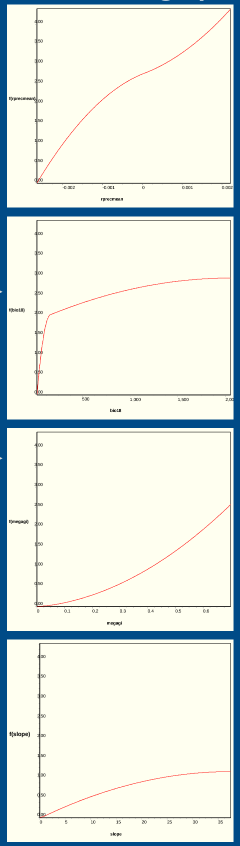
77,000 records of 2,700 land-snail species

Remotely derived environmental variables:
climate, terrain, soils, geographic isolation etc



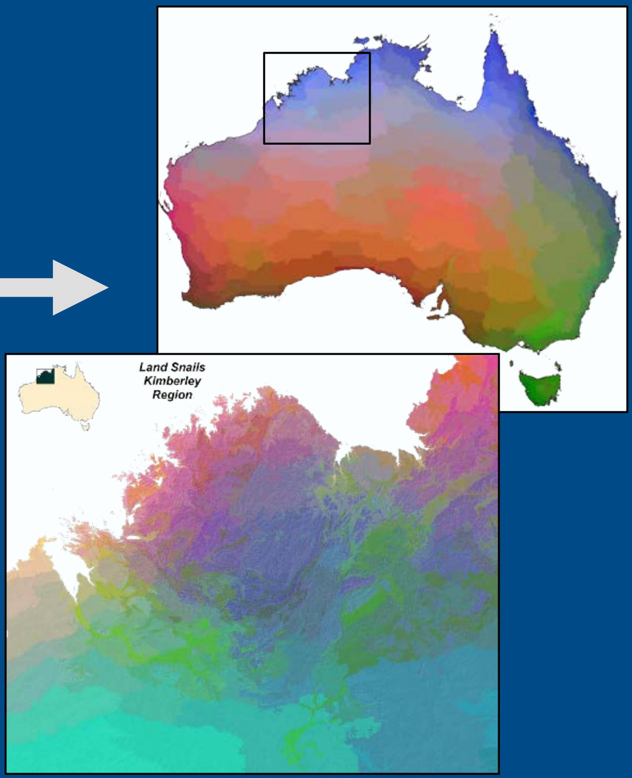
etc ...

Generalised dissimilarity modelling (GDM)



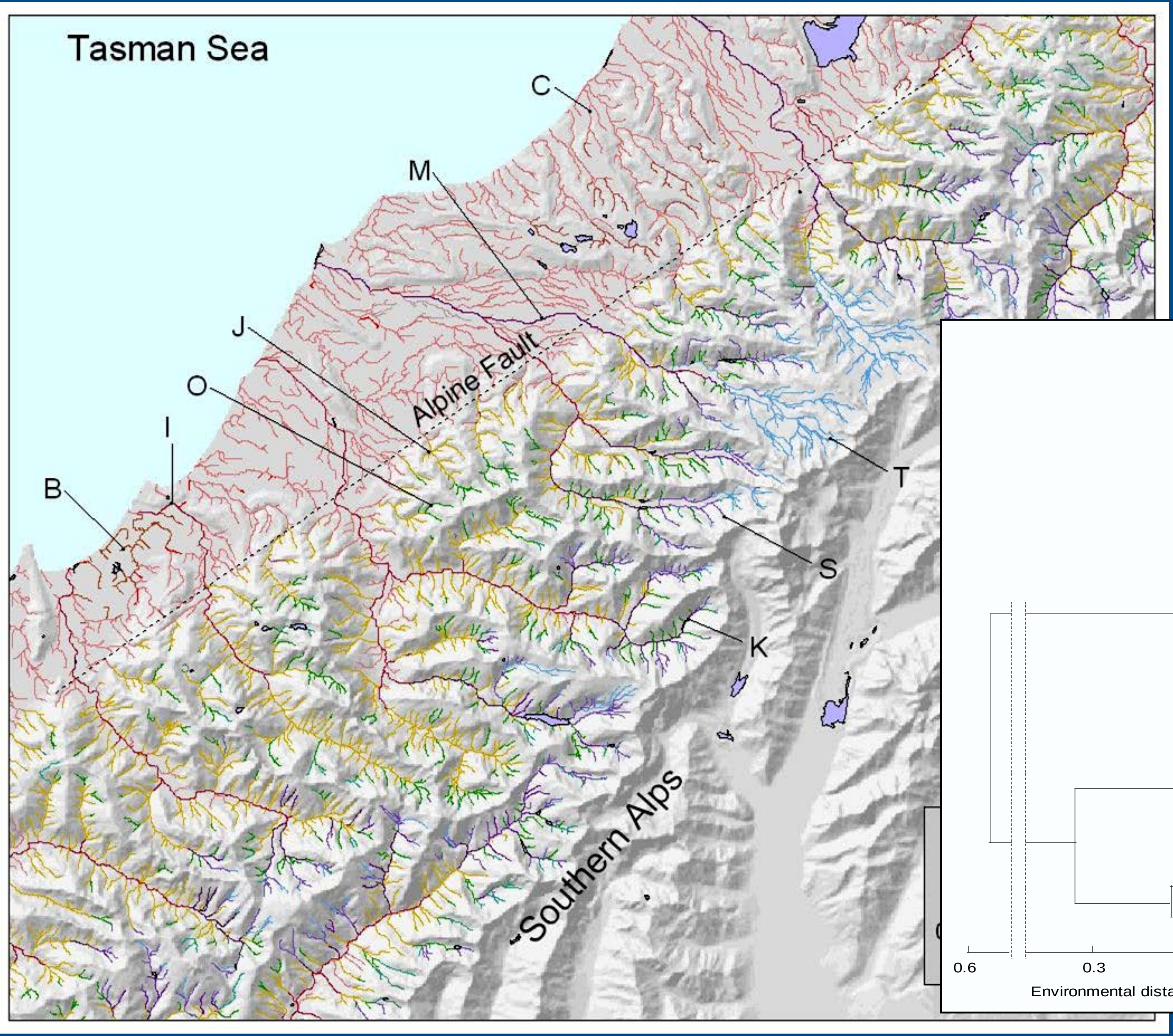
etc ...

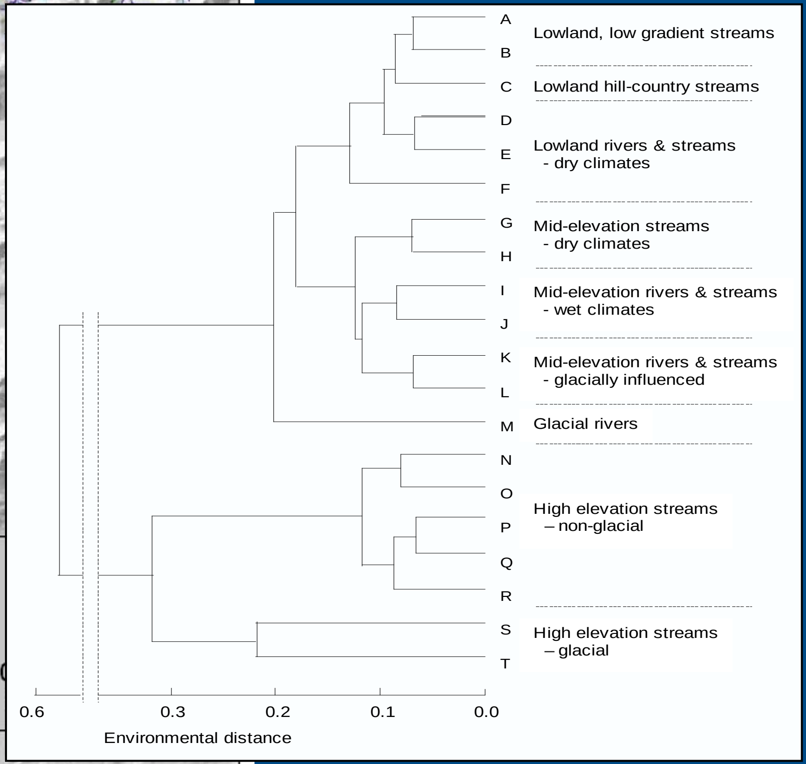
Spatial pattern in compositional turnover



Funded by Aust. Department of Environment

Applicable across a wide range of scales, from landscape scale …





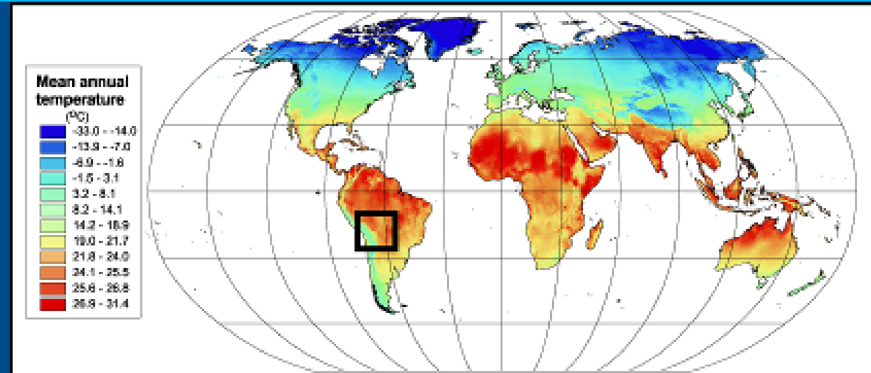
Leathwick, JR et al (2011) *Freshwater Biology* 56: 21-38

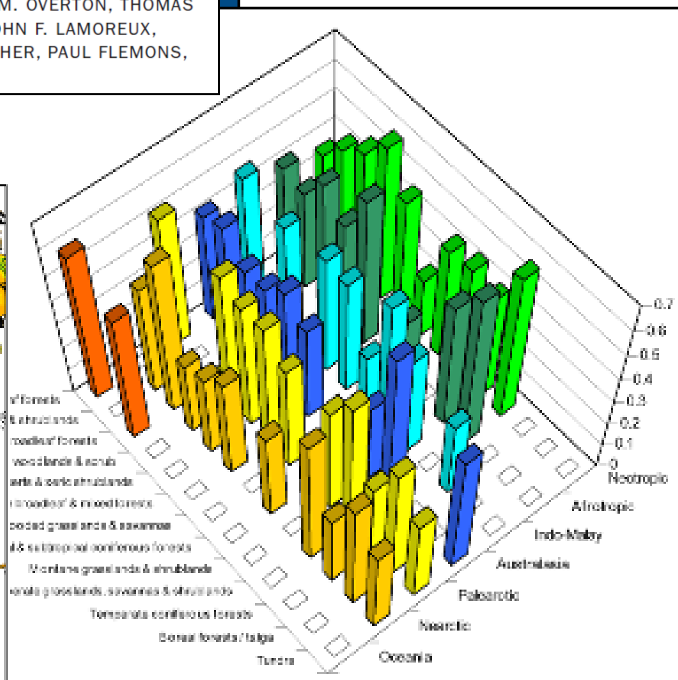
… to global scale

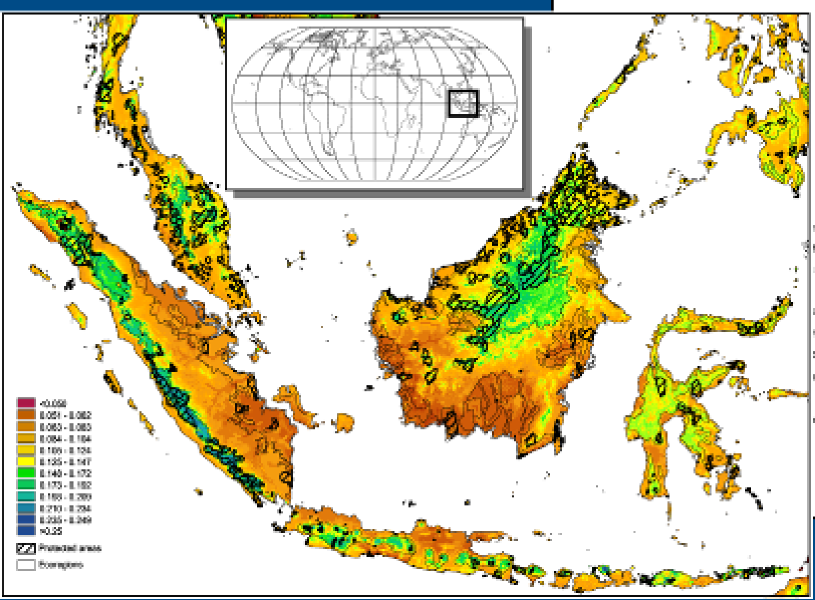
Articles

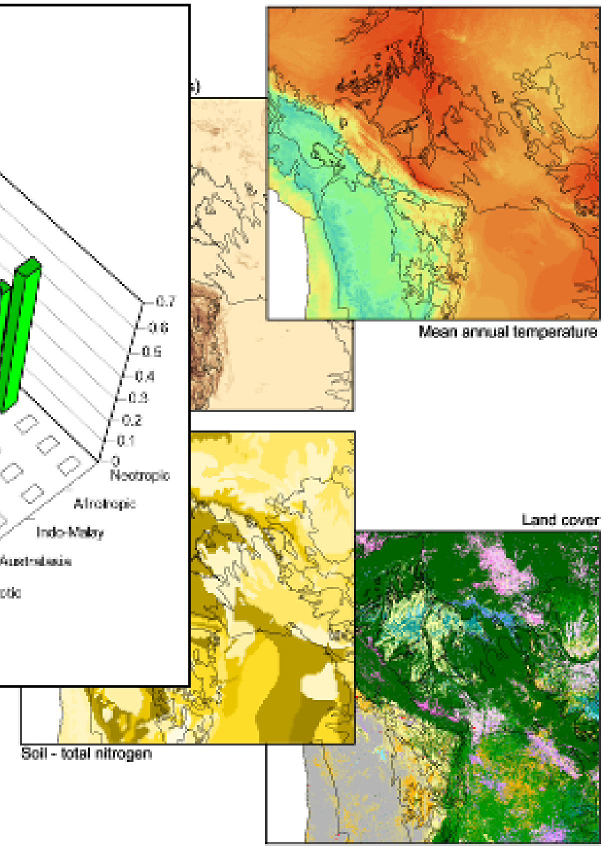
Mapping More of Terrestrial Biodiversity for Global Conservation Assessment

SIMON FERRIER, GEORGE V. N. POWELL, KAREN S. RICHARDSON, GLENN MANION, JAKE M. OVERTON, THOMAS F. ALLNUTT, SUSAN E. CAMERON, KELLIE MANTLE, NEIL D. BURGESS, DANIEL P. FAITH, JOHN F. LAMOREUX, GEROLD KIER, ROBERT J. HIJMANS, VICKI A. FUNK, GERASIMOS A. CASSIS, BRIAN L. FISHER, PAUL FLEMONS, DAVID LEES, JON C. LOVETT, AND RENAAT S. A. R. VAN ROMPAEY



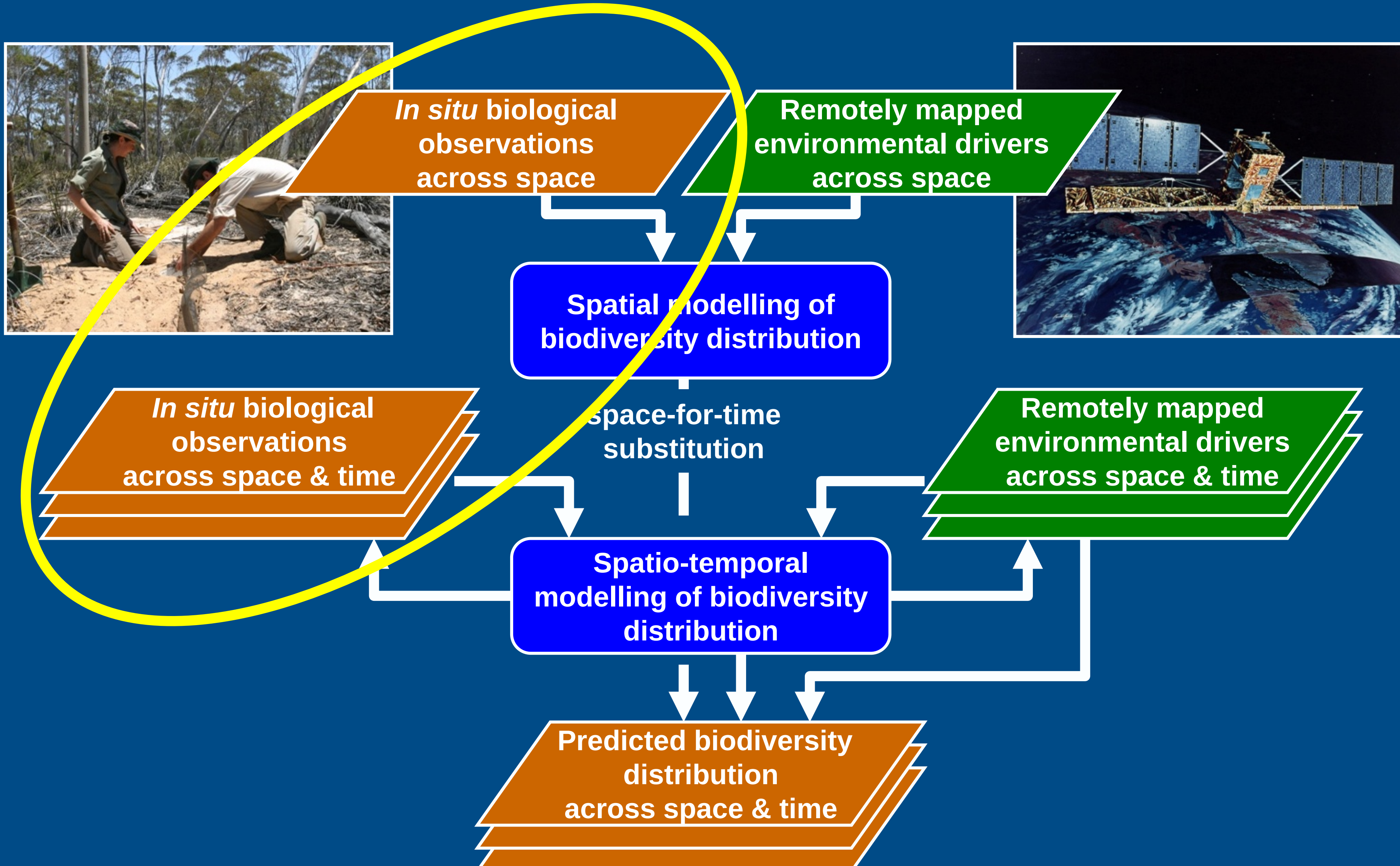






Ferrier et al (2004) *BioScience*

Challenges & opportunities in applying this approach to global biodiversity monitoring: biological data

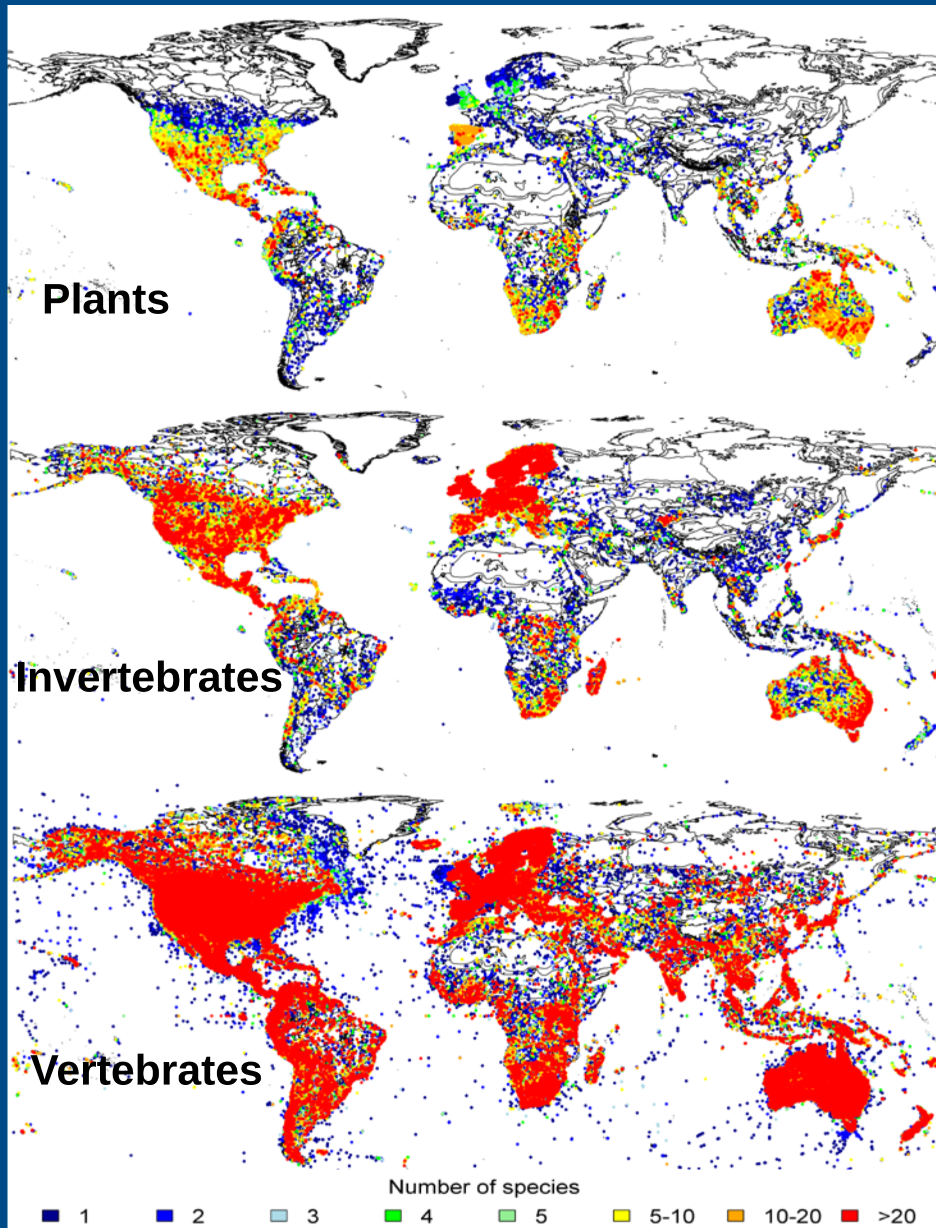


Making effective use of technological advances in biodiversity informatics, citizen science, metagenomics etc

52.5 million records of 254,000 species

13.2 million records of 133,000 species

286.4 million records of 24,000 species



All vascular plants

Ants, Bees, Beetles, Bugs, Butterflies, Centipedes, Dragonflies, Flies, Grasshoppers, Millipedes, Snails, Moths, Spiders, Termites, Wasps

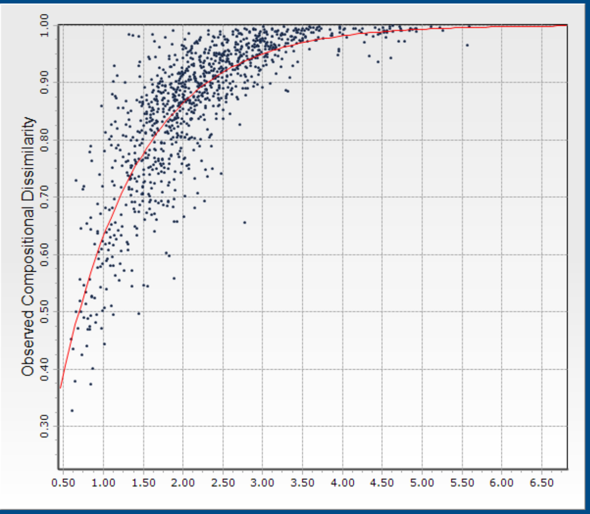
Reptiles

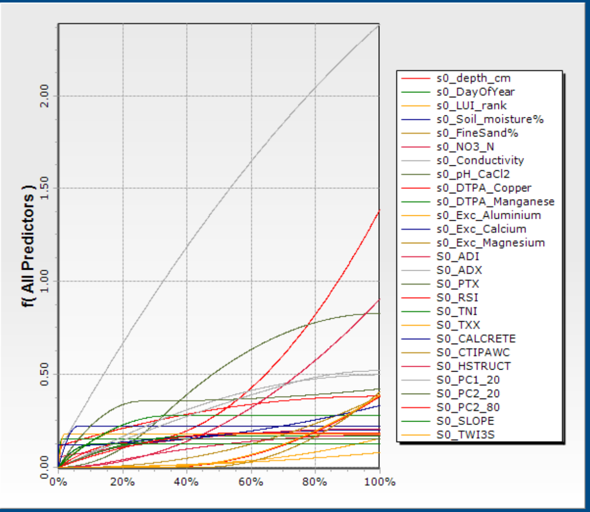
GBIF

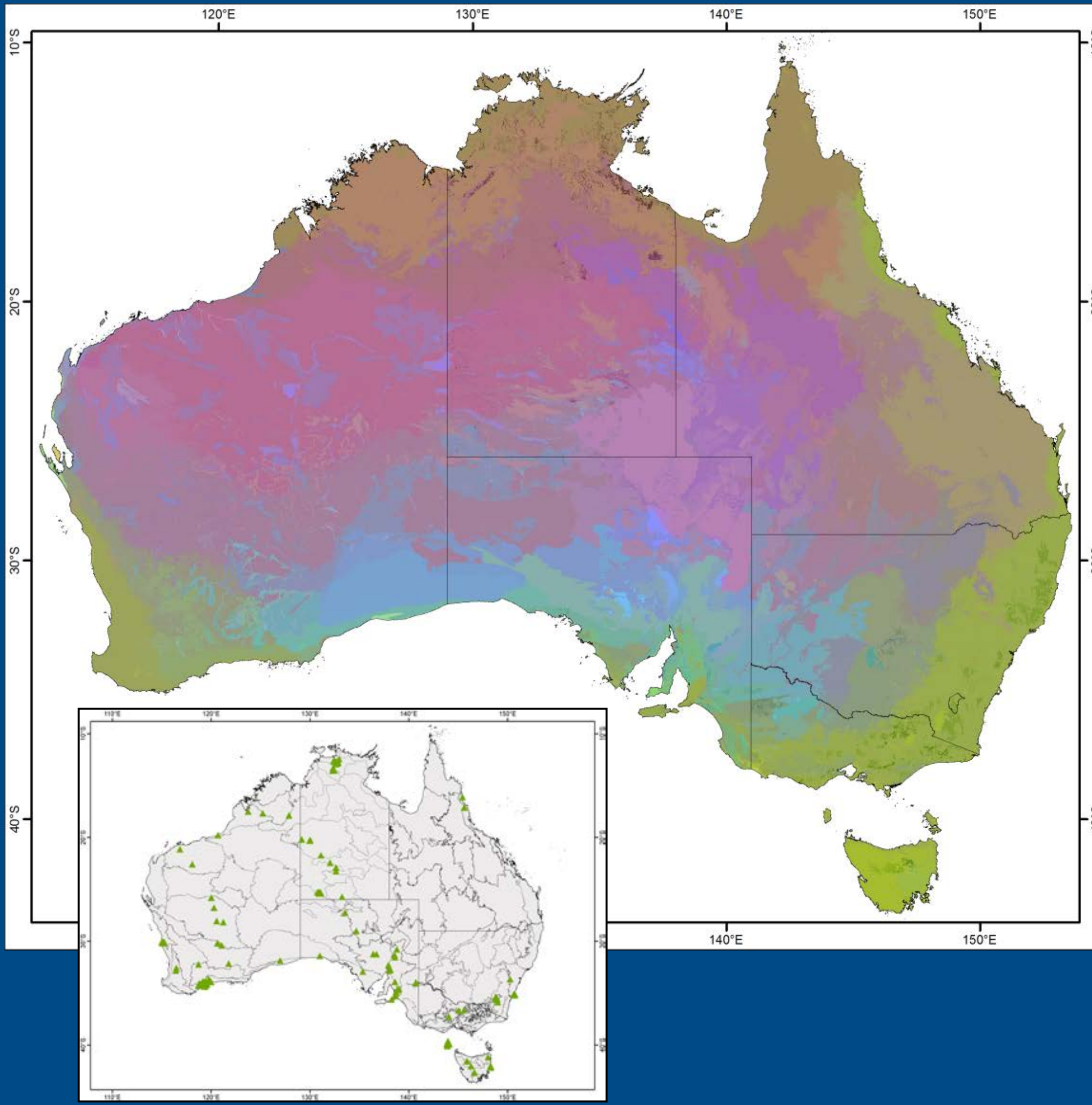
Amphibians
Birds
Mammals

MOL MAP OF LIFE

Making effective use of technological advances in biodiversity informatics, citizen science, metagenomics etc







GDM model run 9

Spatial environmental variables (landscape context) only

All soil depths combined

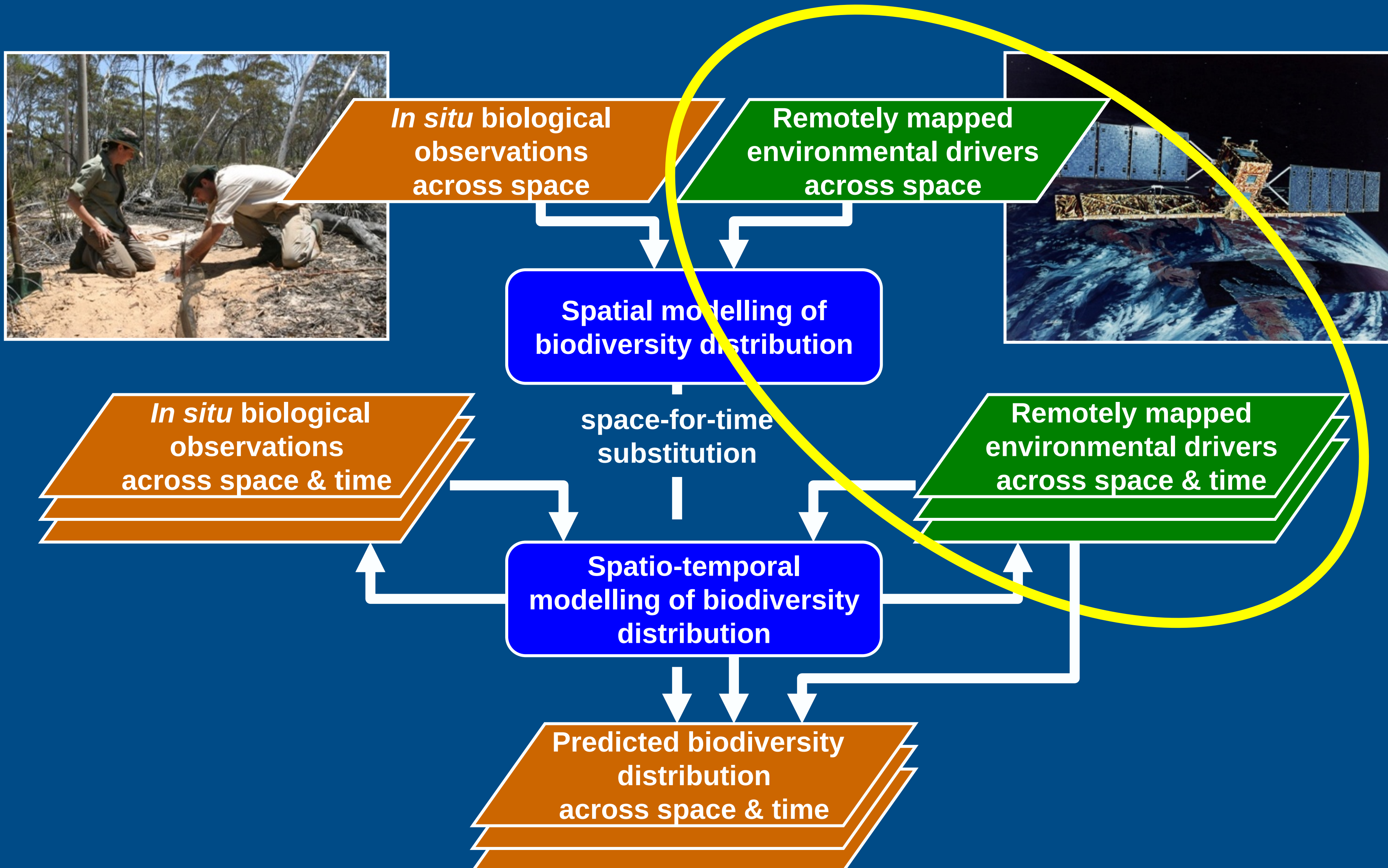
Geographic Distance predictor included

Site-level sampling covariates excluded

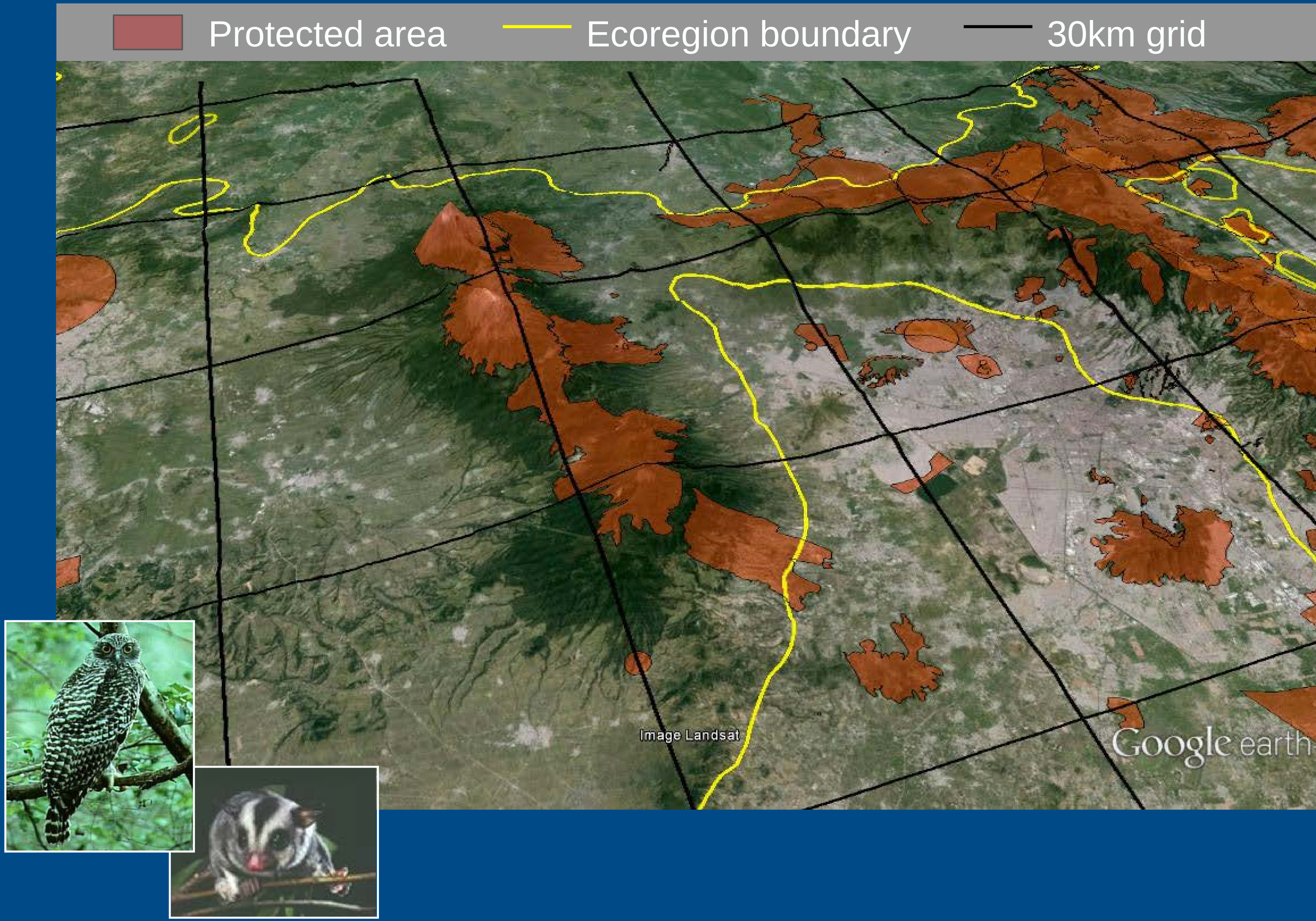
Classification:
20,000 samples
300 groups
BGR colouring by compositional similarity

Model Reference:
...\R159705_SIEFsoil\working\
GDM\ Allvars\ bck05\ GD\ bck05

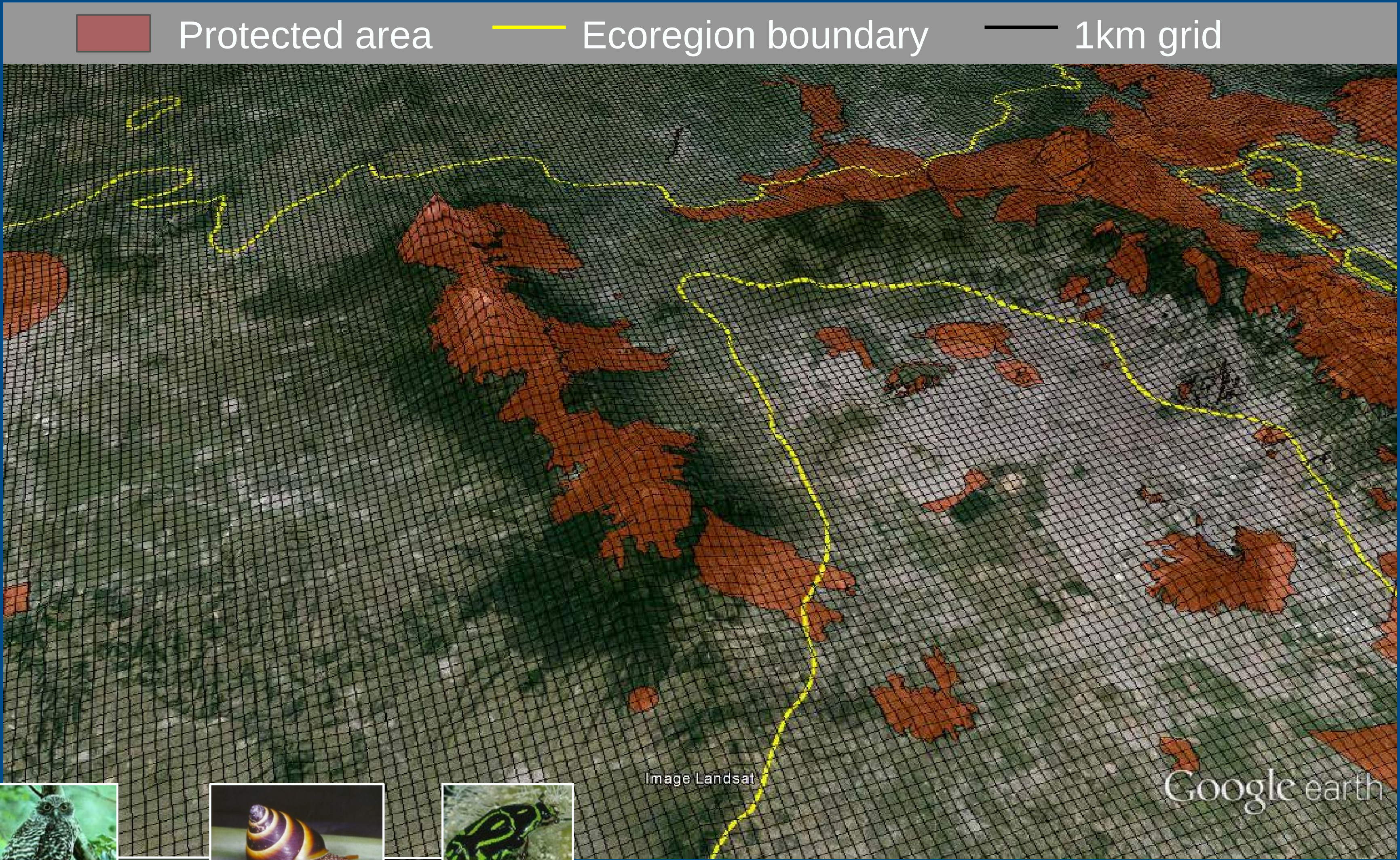
Challenges & opportunities in applying this approach to global biodiversity monitoring: environmental data



Making effective use of technological advances in mapping biologically-relevant variables at appropriate resolutions

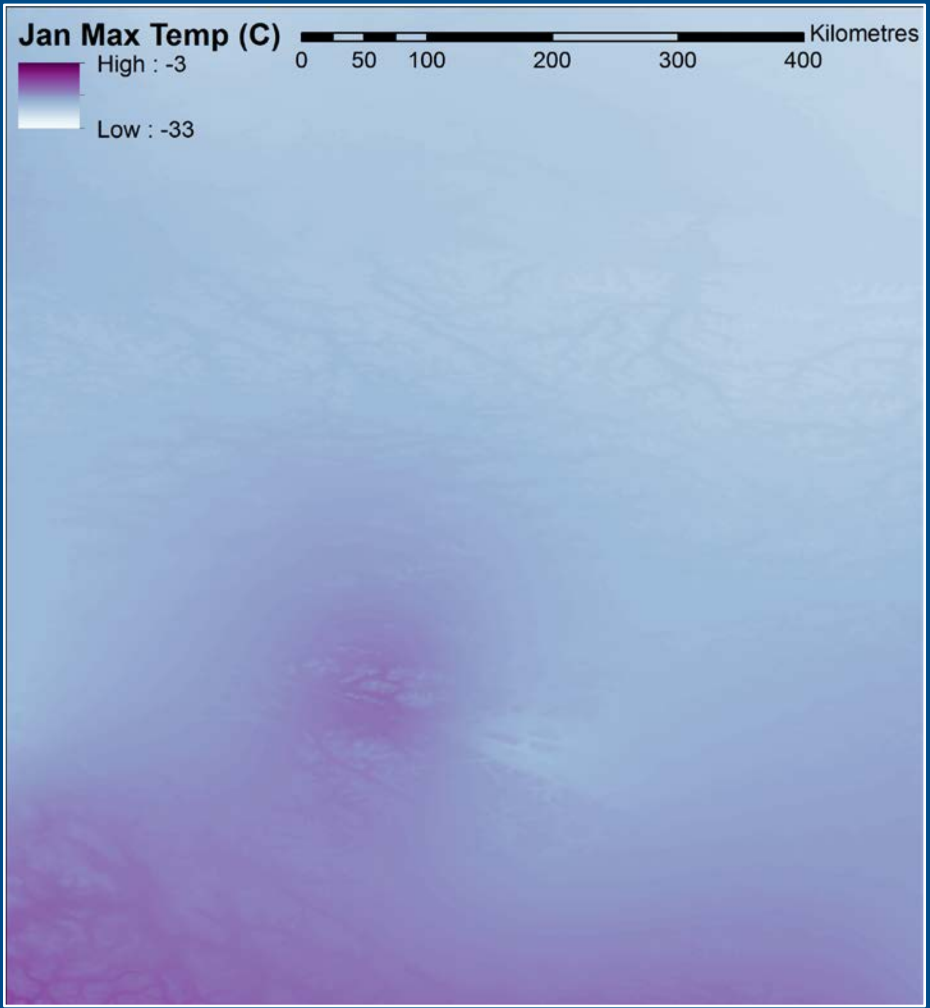


Making effective use of technological advances in mapping biologically-relevant variables at appropriate resolutions

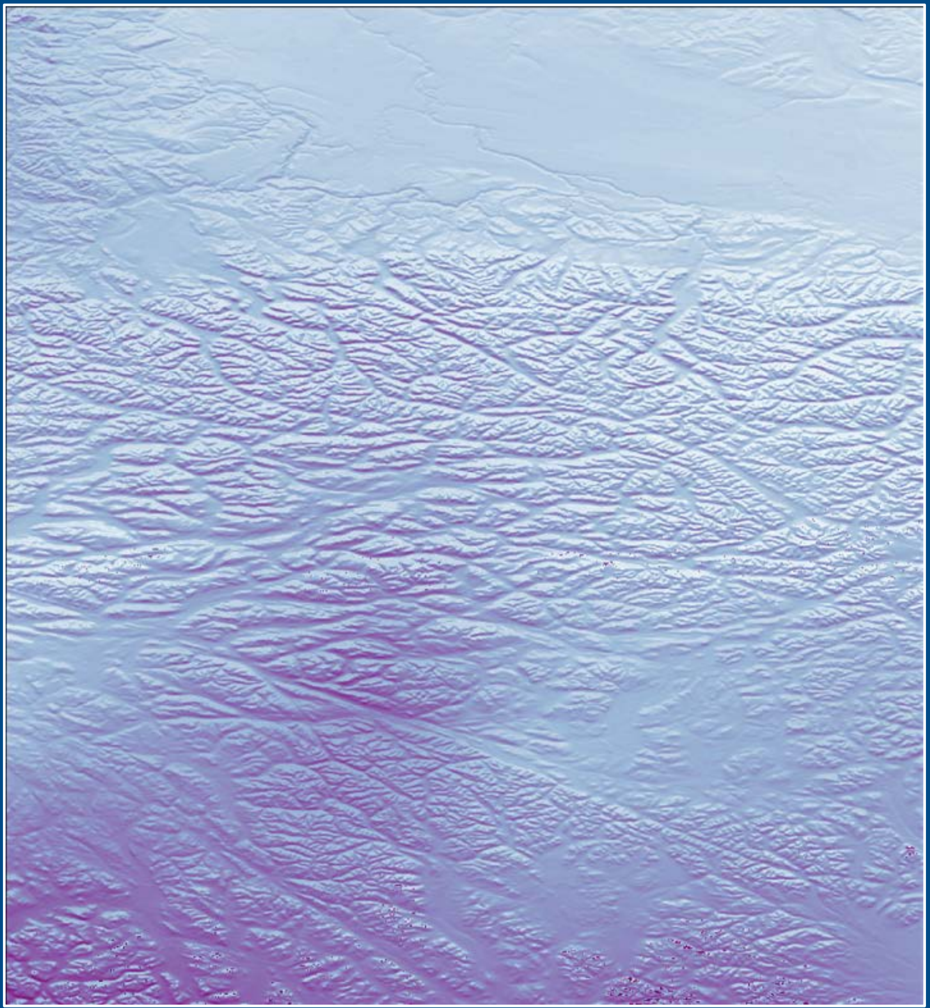


Making effective use of technological advances in mapping biologically-relevant variables at appropriate resolutions

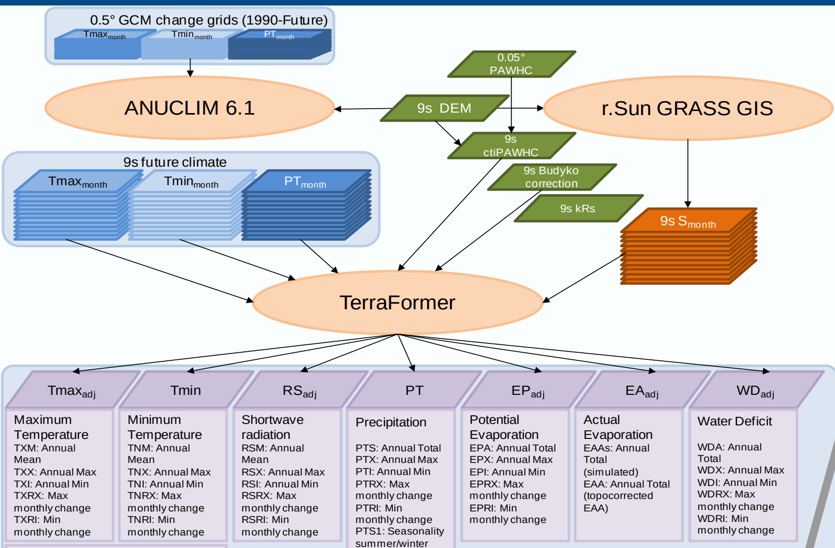
WorldClim: Jan Max Temp

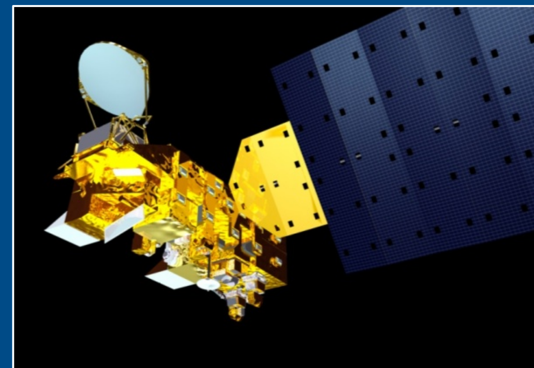


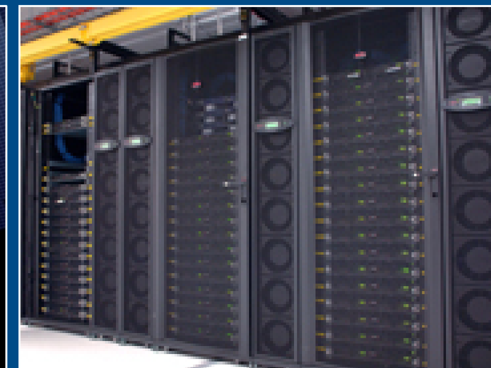
Adjustment for effects of terrain

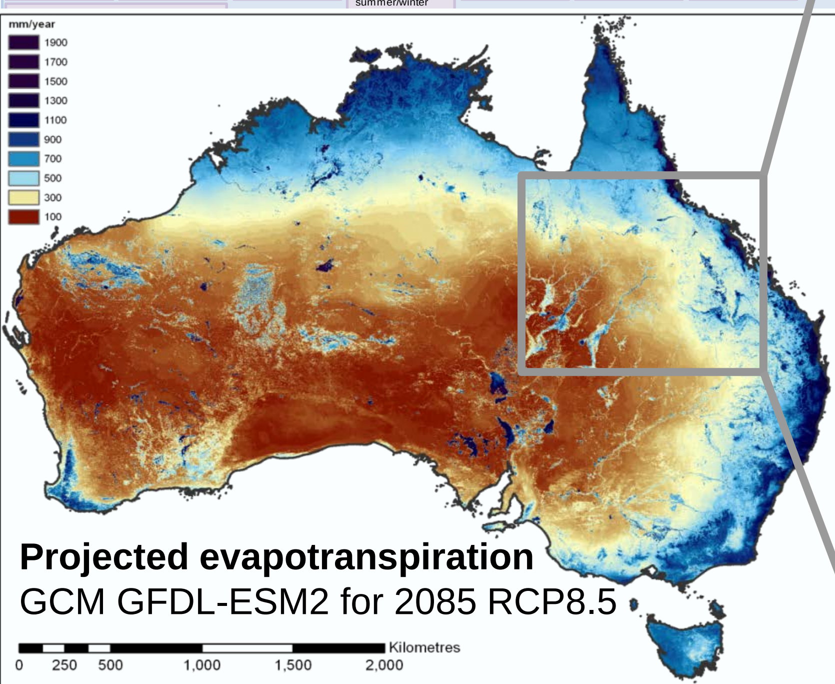


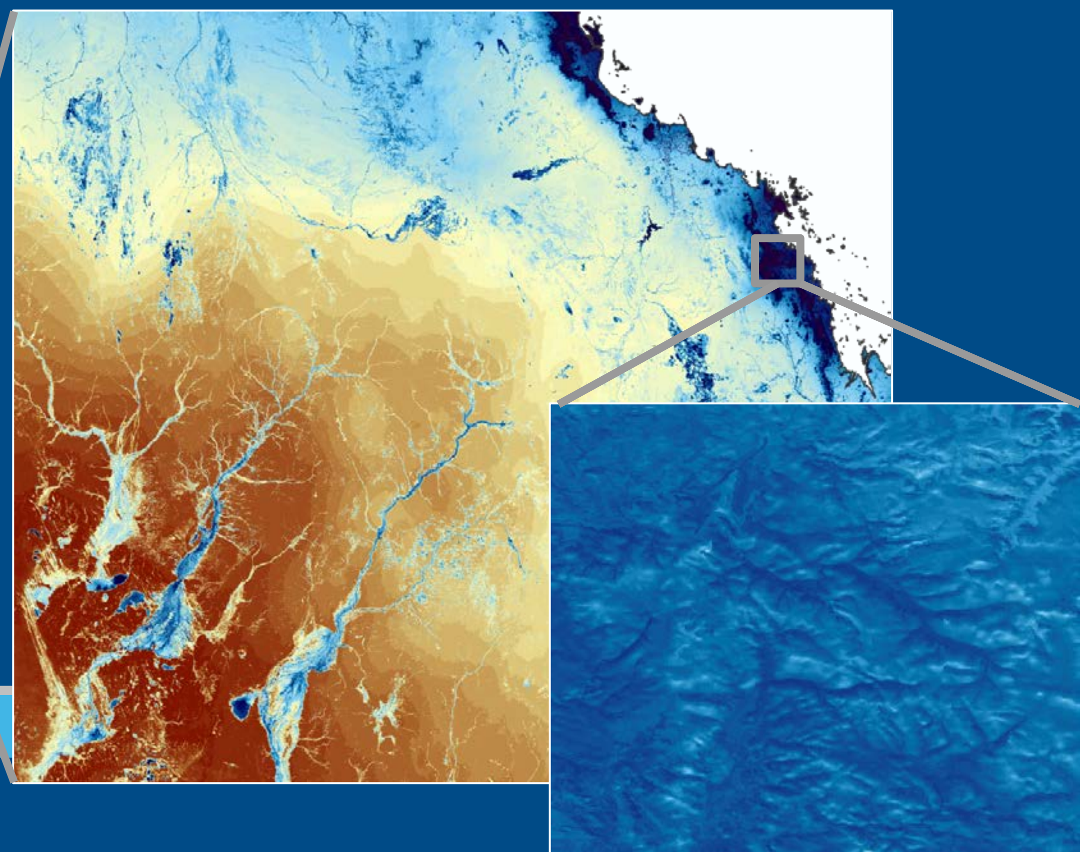
Making effective use of technological advances in mapping biologically-relevant variables at appropriate resolutions



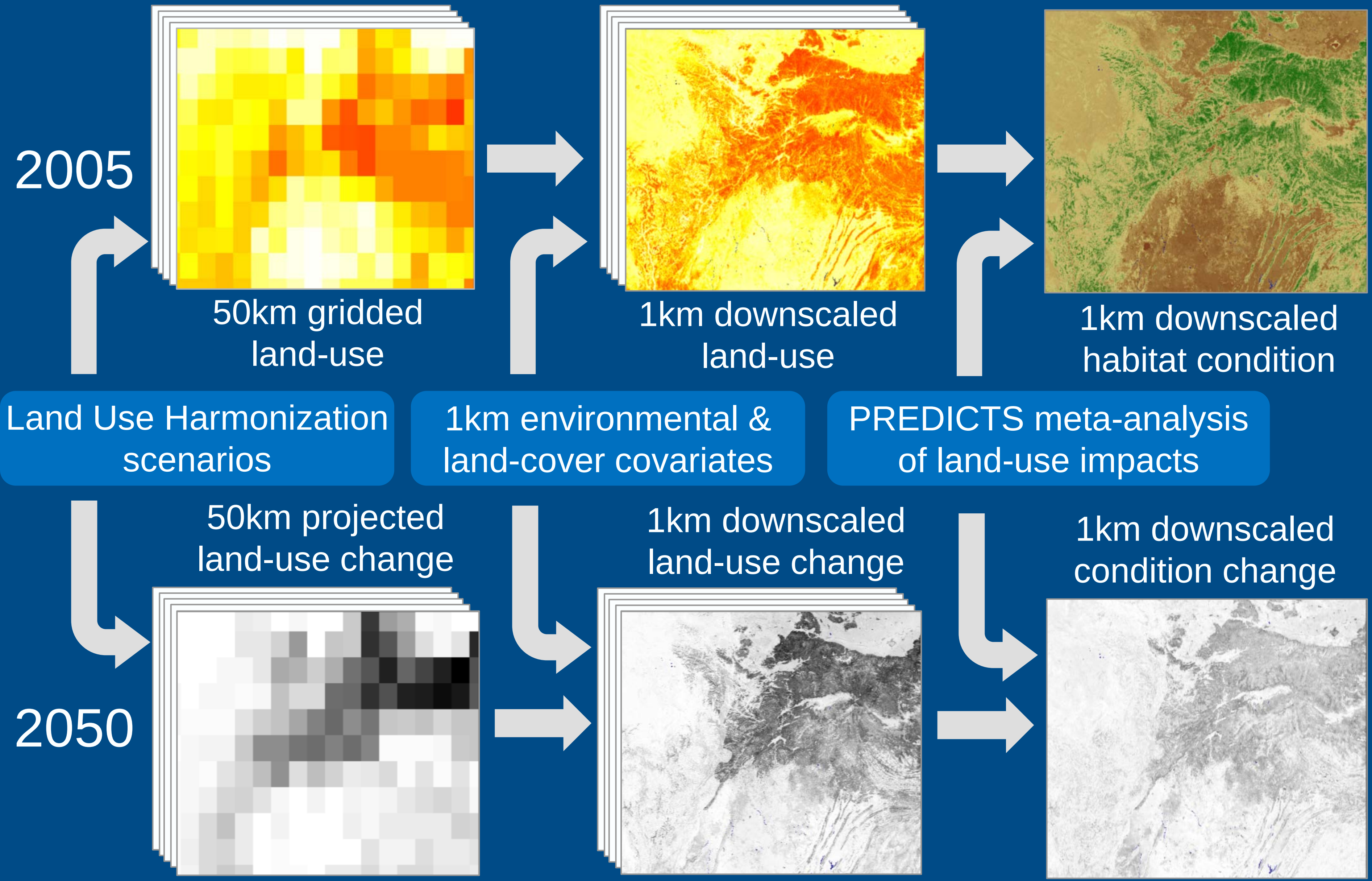




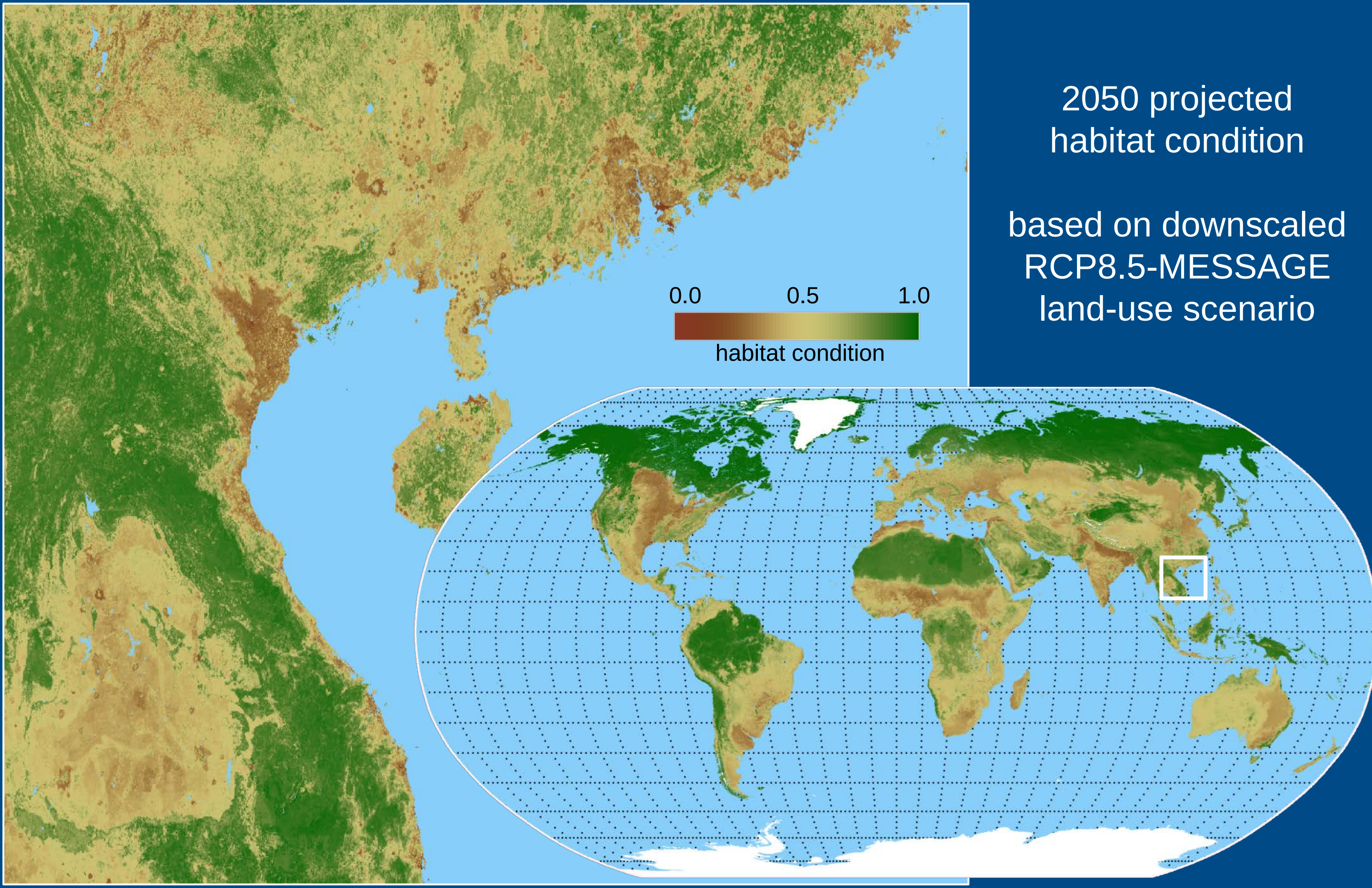




Making effective use of technological advances in mapping biologically-relevant variables at appropriate resolutions



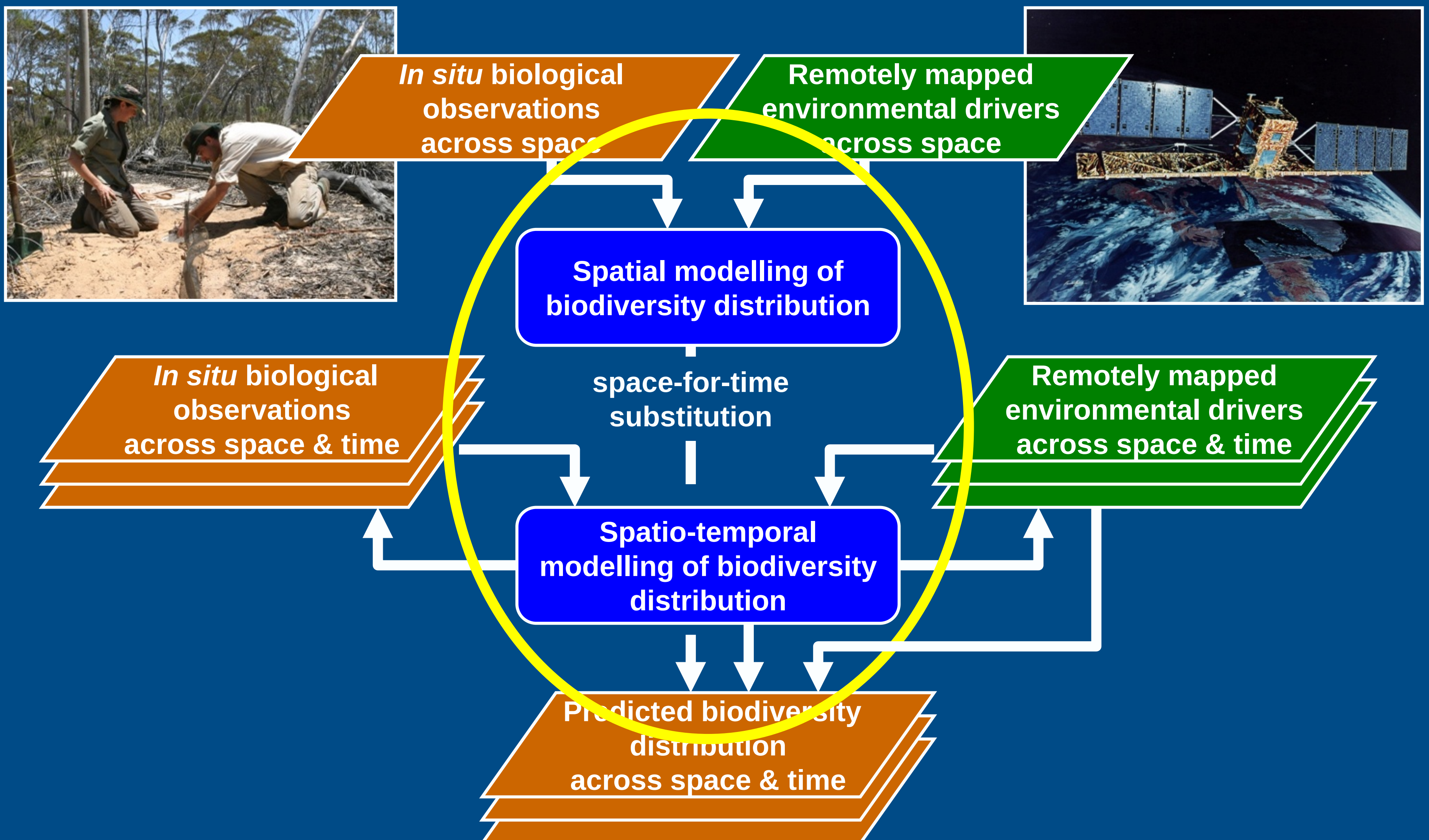
Making effective use of technological advances in mapping biologically-relevant variables at appropriate resolutions



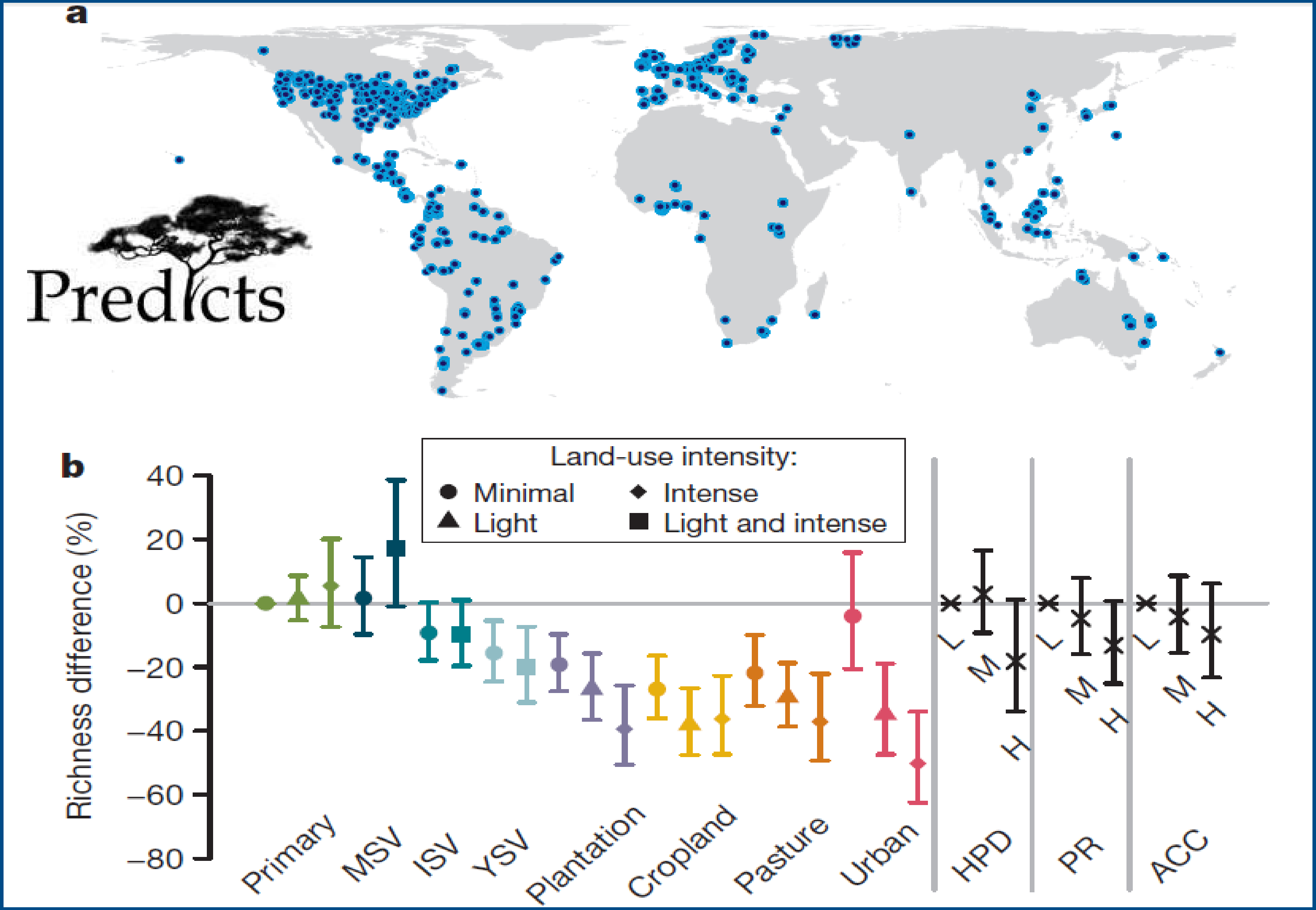
2050 projected habitat condition

based on downscaled RCP8.5-MESSAGE land-use scenario

Challenges & opportunities in applying this approach to global biodiversity monitoring: modelling techniques



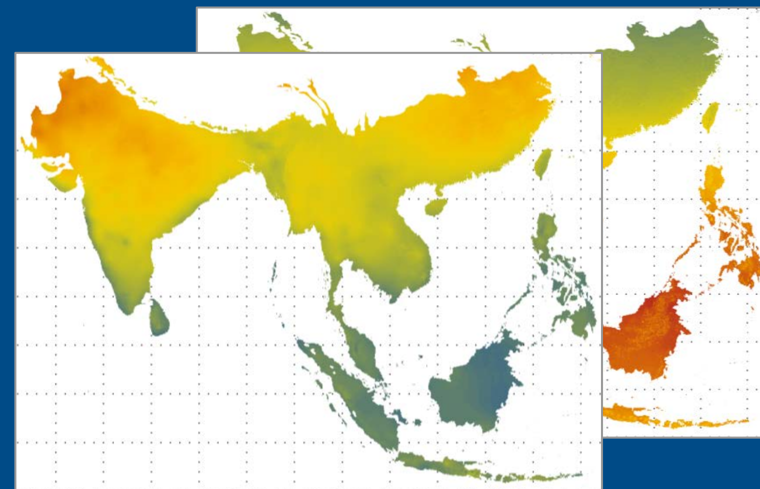
Adapting modelling techniques to extract maximum value from best-available biological & environmental data



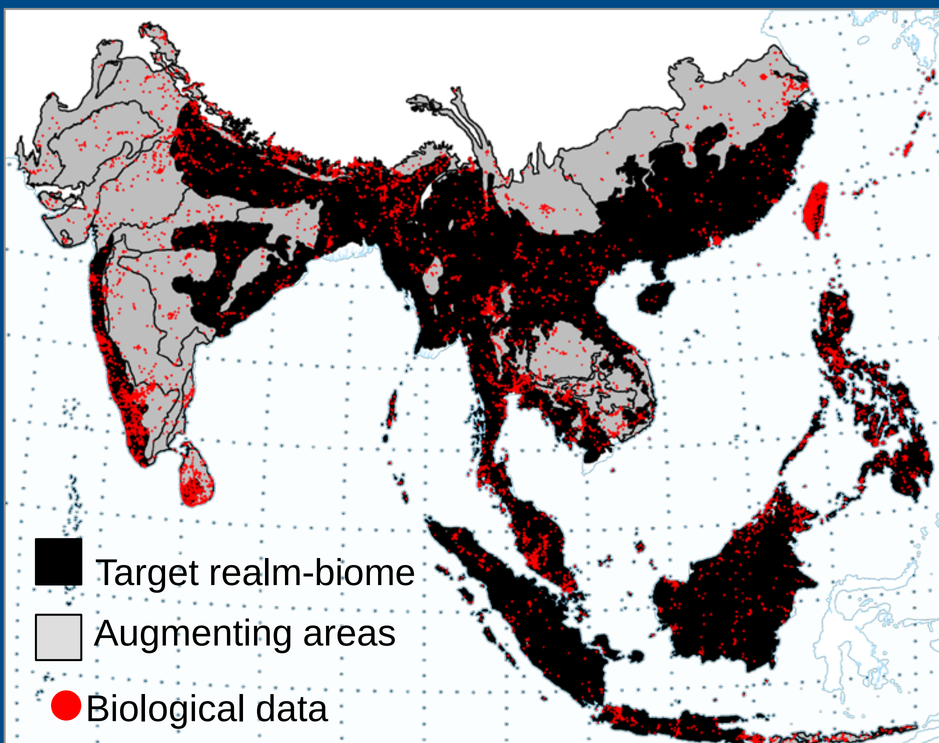
Newbold, T *et al* (2015) *Nature*

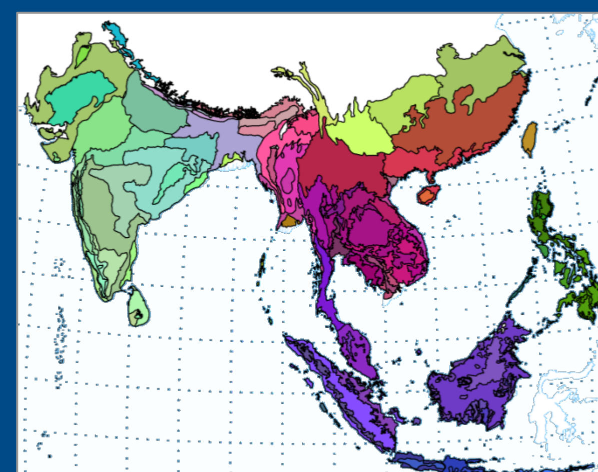
Adapting modelling techniques to extract maximum value from best-available biological & environmental data

Continuous environmental surfaces



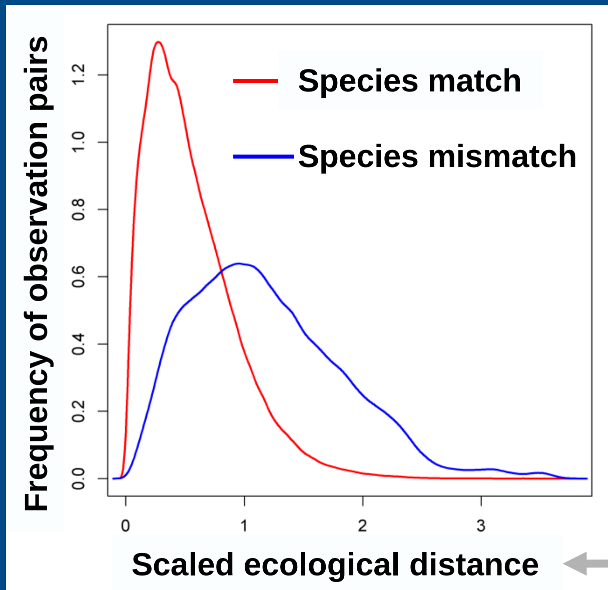
Biological data for targeted realm-biome & augmenting realm-biome combinations

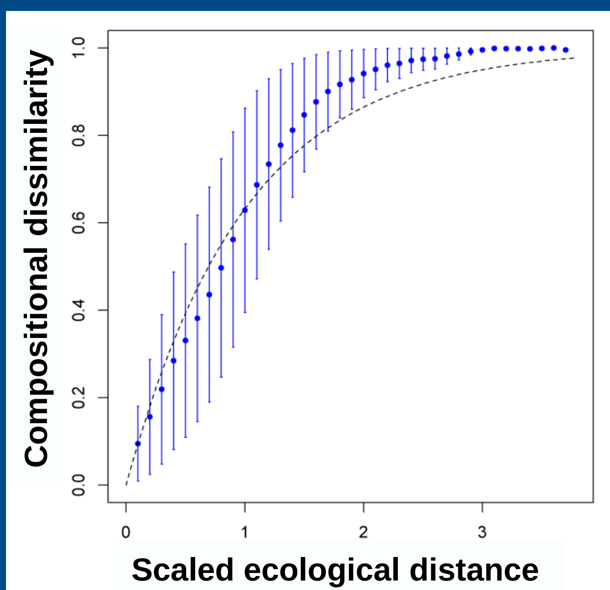




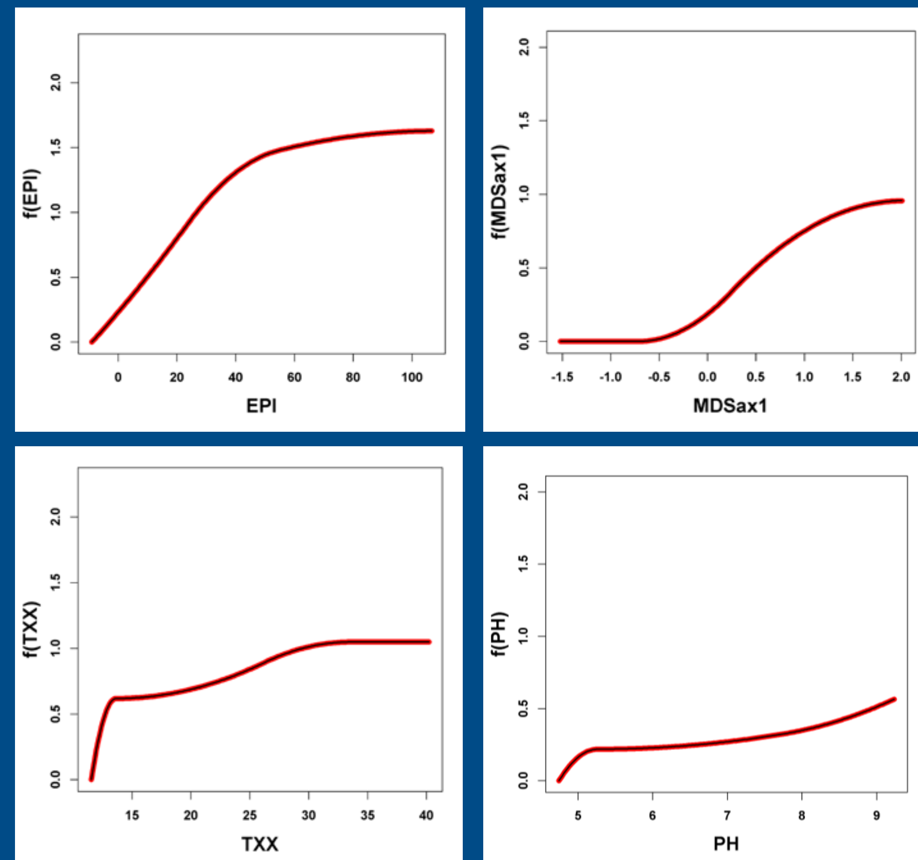
Inter-ecoregional MDS axes

Adapting modelling techniques to extract maximum value from best-available biological & environmental data





Biologically scaled environmental gradients



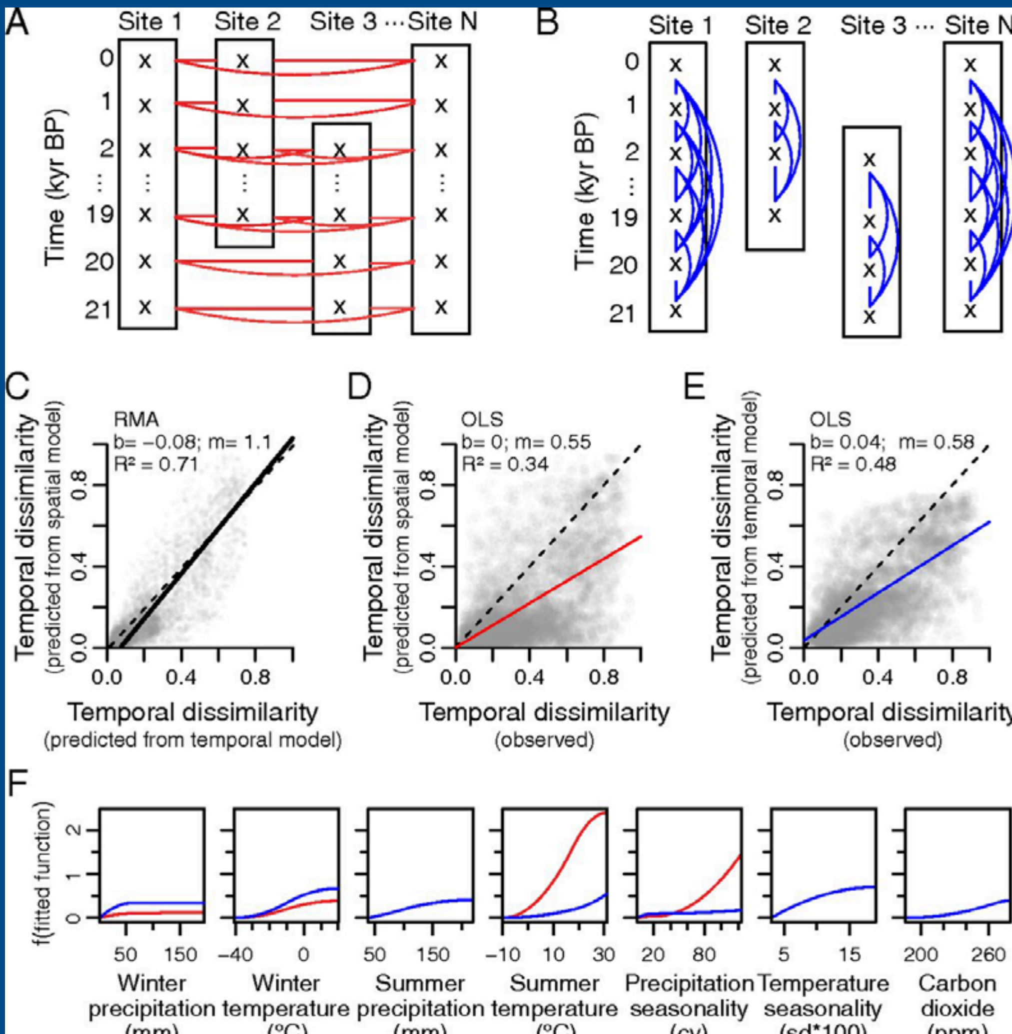
etc …

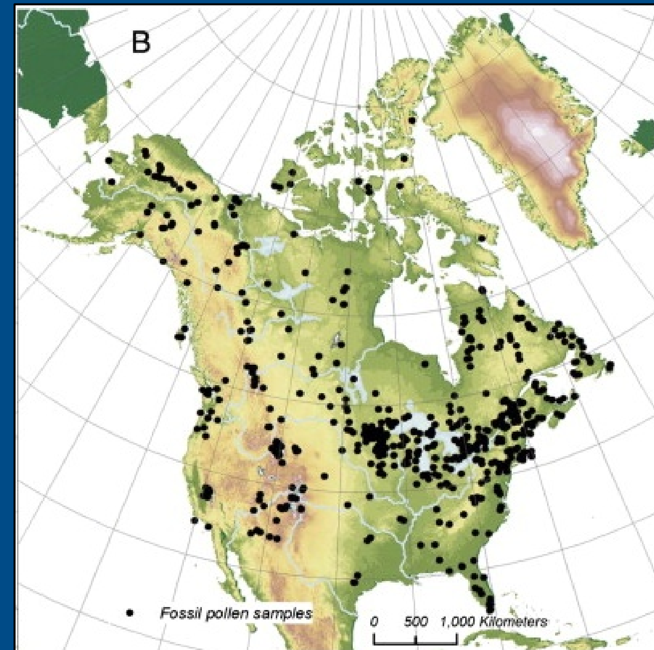
Adapting modelling techniques to extract maximum value from best-available biological & environmental data

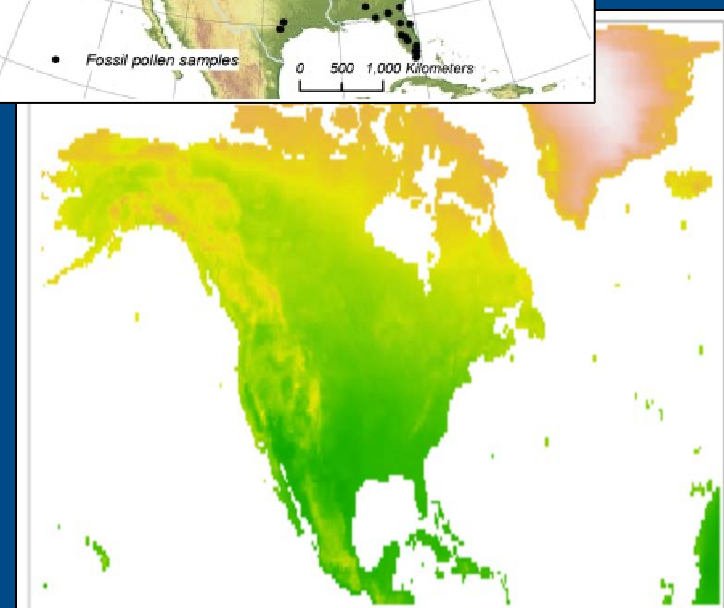

PNAS

Space can substitute for time in predicting climate-change effects on biodiversity

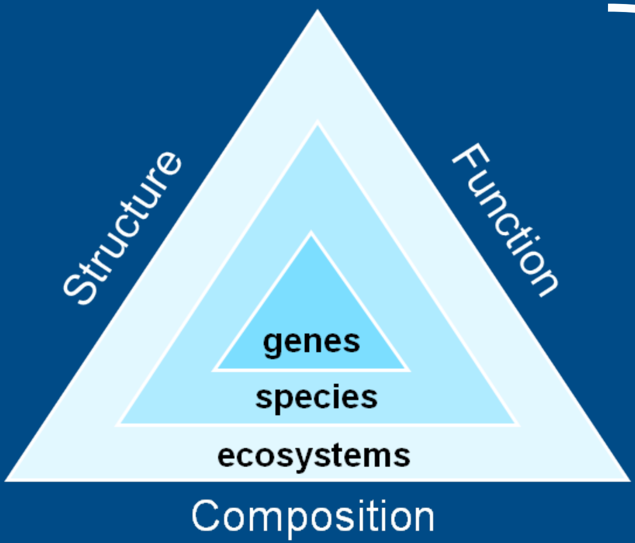
Jessica L. Blois[a,1], John W. Williams[a], Matthew C. Fitzpatrick[b], Stephen T. Jackson[c], and Simon Ferrier[d]

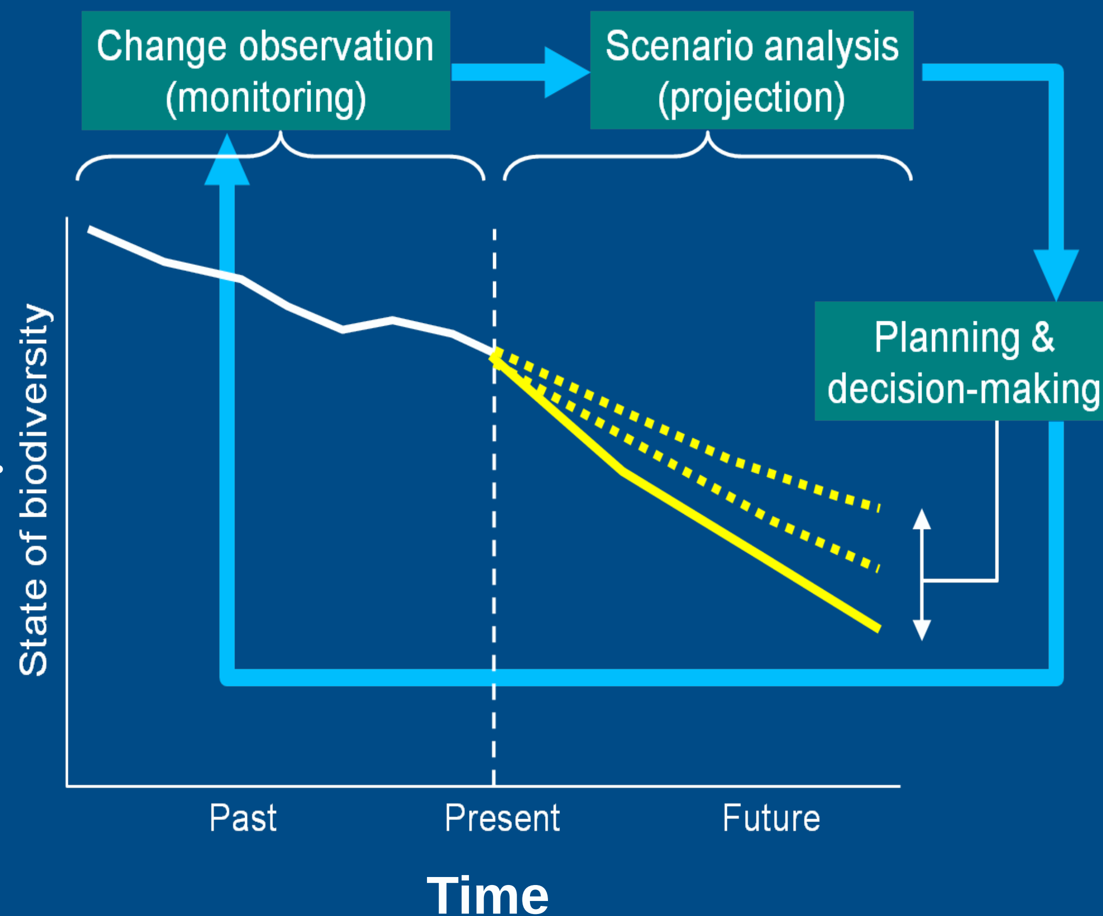




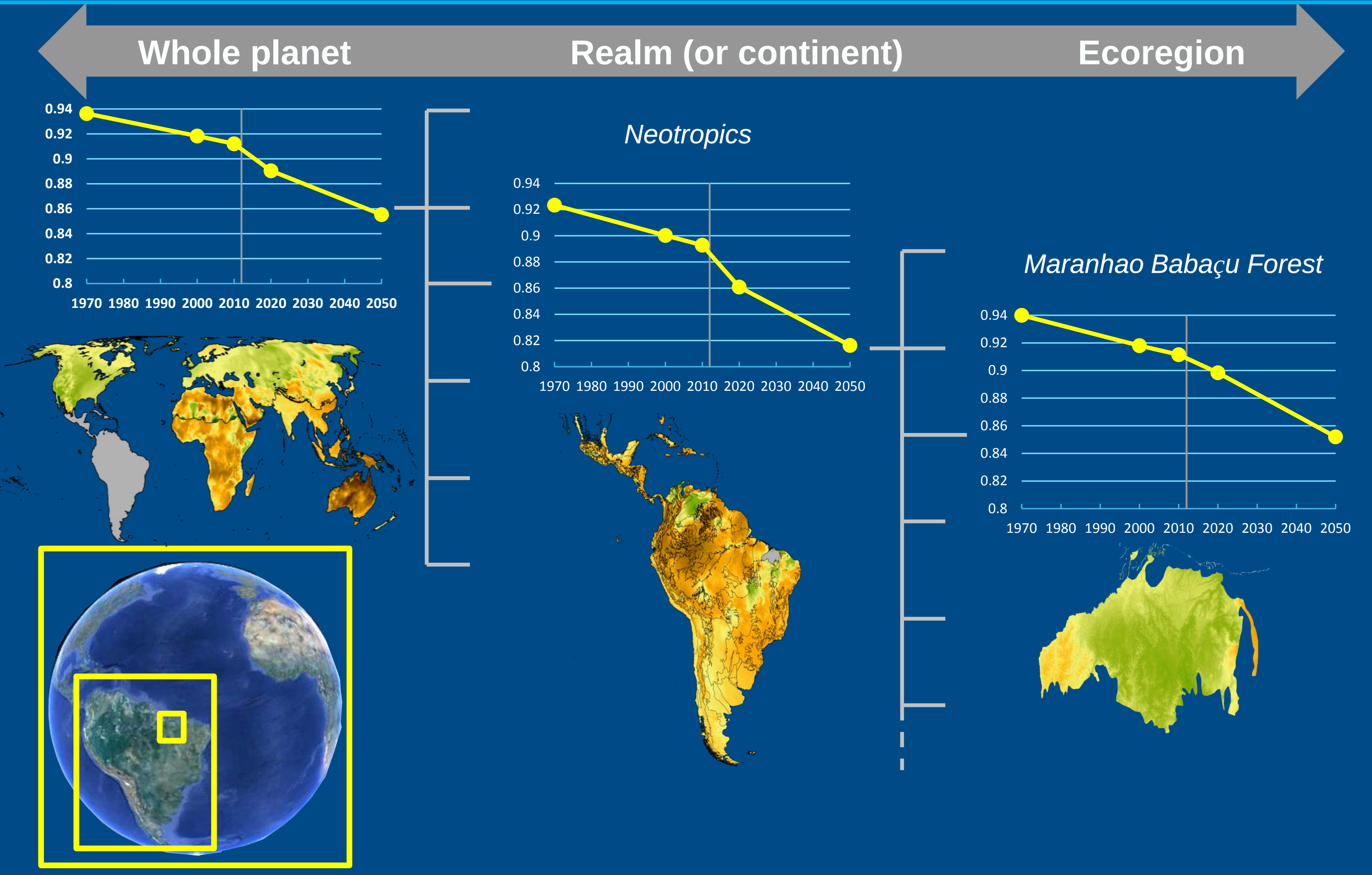

Mean summer temperature (°C) 6,000 years before present

Challenges & opportunities in applying this approach to global biodiversity monitoring: broader integration

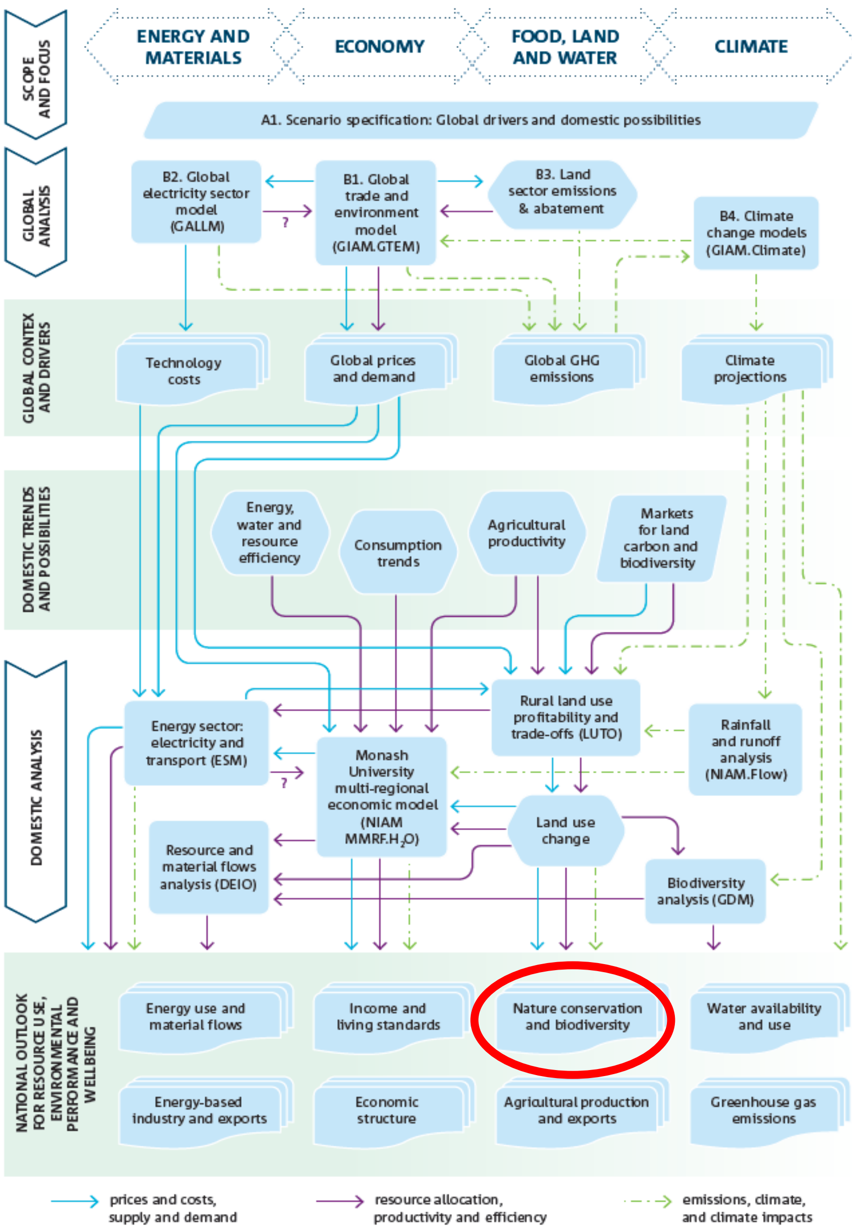


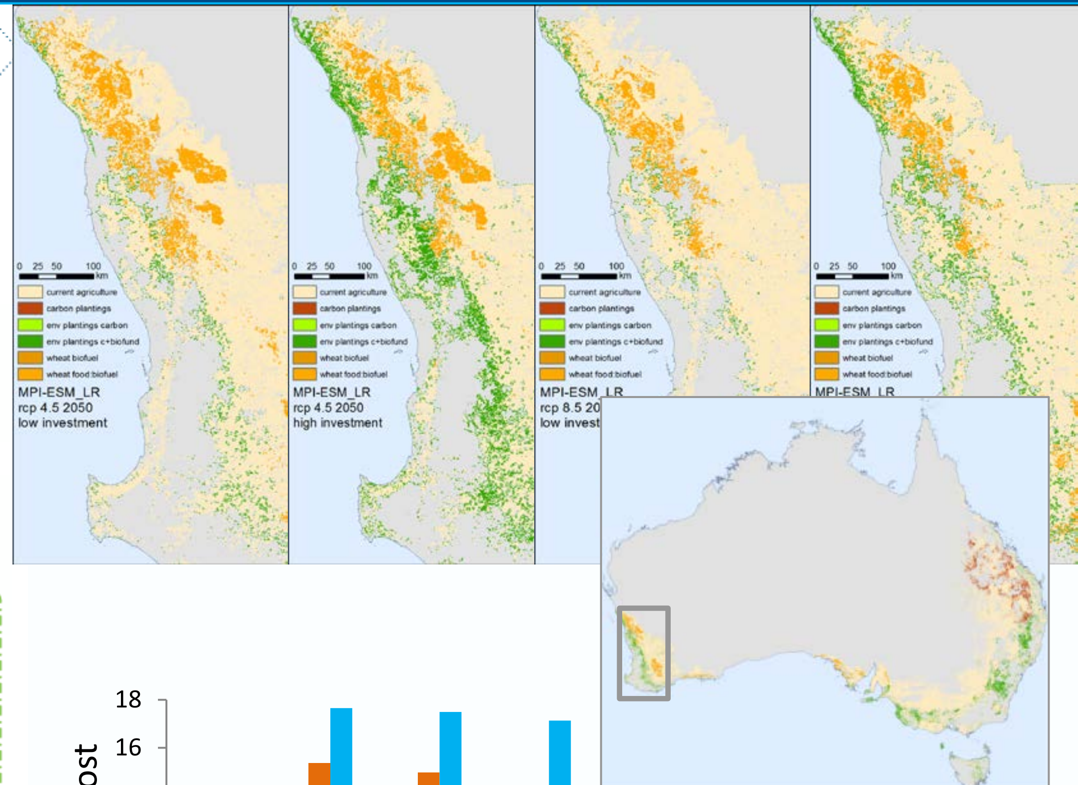


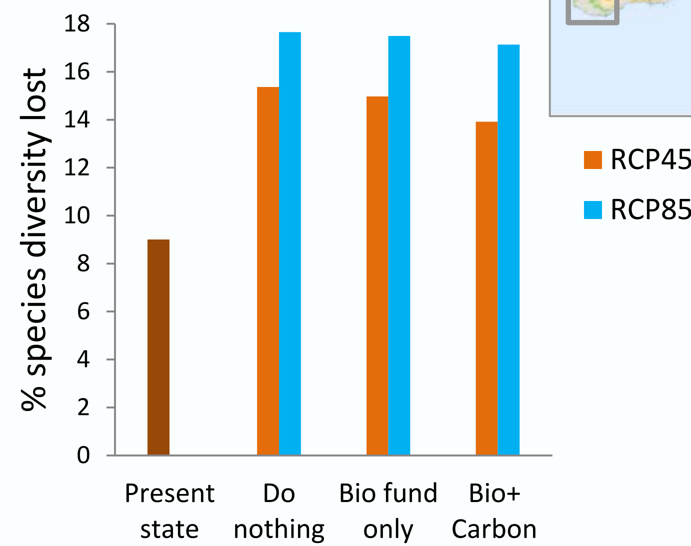
Effectively linking global biodiversity monitoring to future projection, scenario analysis and decision support



Effectively linking global biodiversity monitoring to future projection, scenario analysis and decision support







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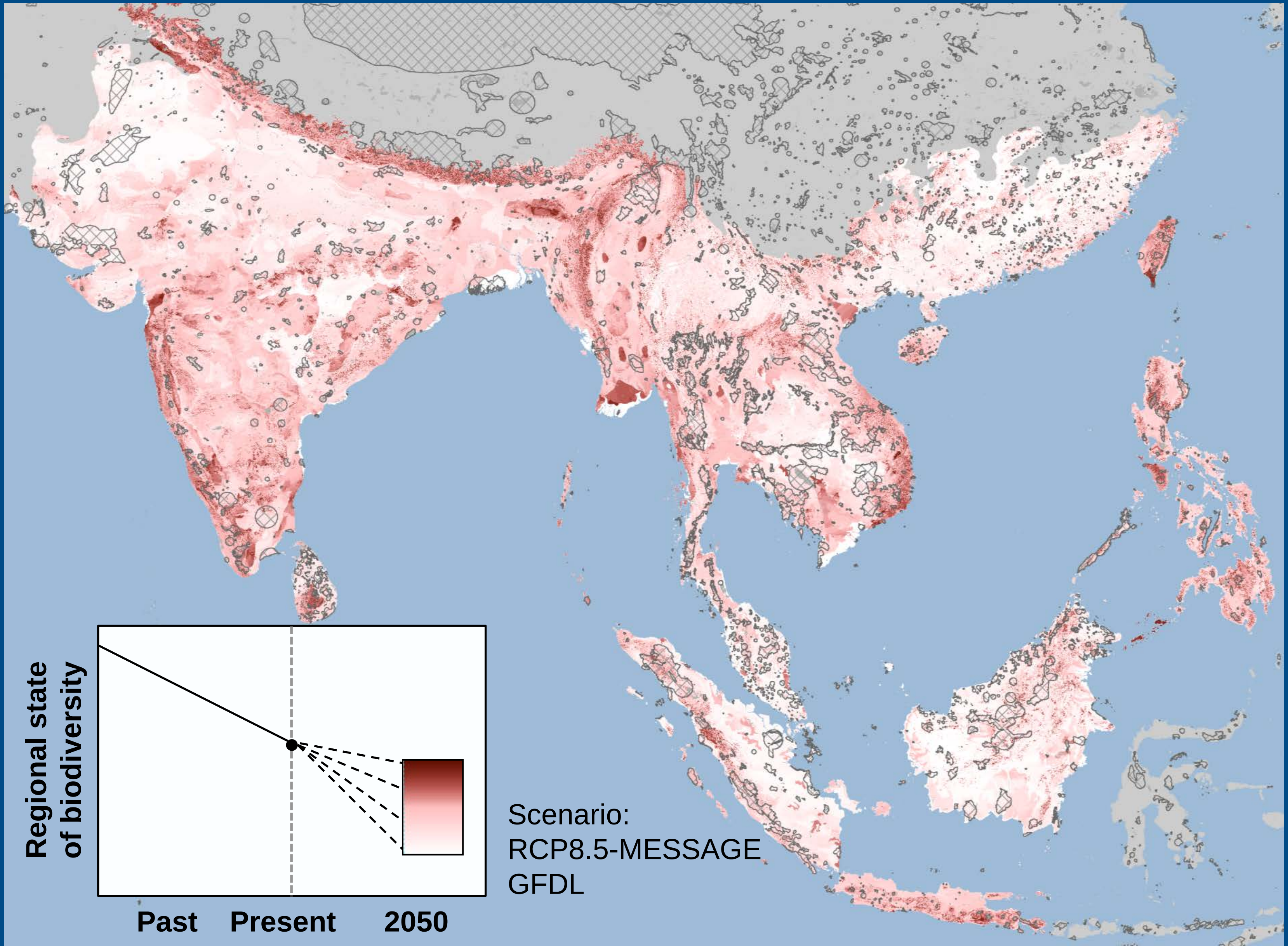

Effectively linking global biodiversity monitoring to future projection, scenario analysis and decision support