OBSERVING LIFE IN A TIME OF CHANGE:

BIODIVERSITY IN THE ANTHROPOCENE

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STRUCTURE OF THIS TALK

1. Biodiversity in the Earth System
2. Information *about* biodiversity
3. Information *from* biodiversity
4. A spectroscopy-based observing strategy

Information *about* biodiversity

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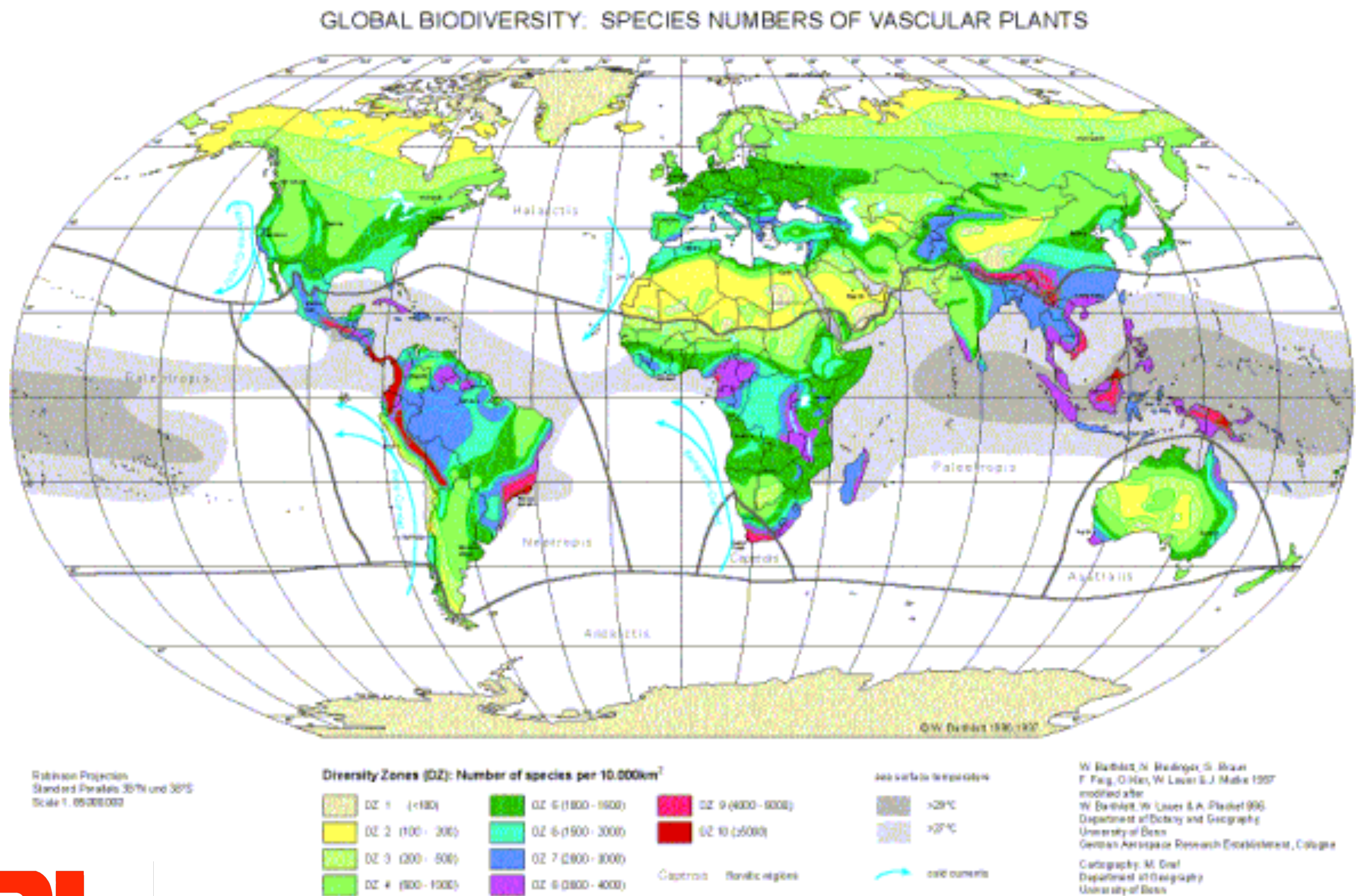
Understanding species ranges as a basis for forecasting change:

"distributional information is crucial for constructing models to understand future ecological responses to climate and global change" (Schimel et al in press).



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GLOBAL PLANT DIVERSITY MODELED FROM SPECIES RECORDS.

STATE OF THE ART: RESOLVING LENGTH SCALES OF 500-1000 KM AND EQUIVALENT PRECISION IN CONTROLS

(Kreft and Jetz 2007)

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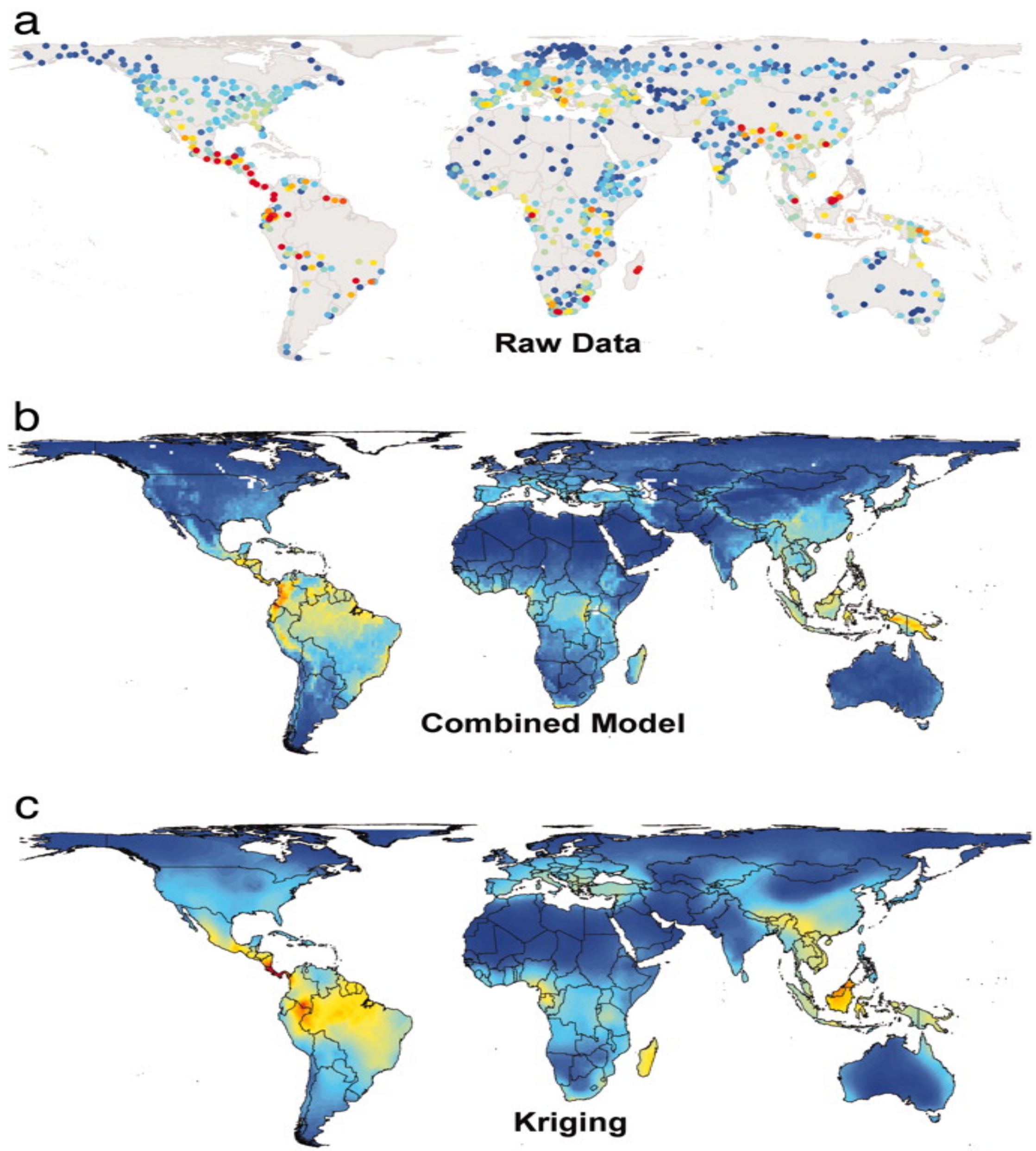
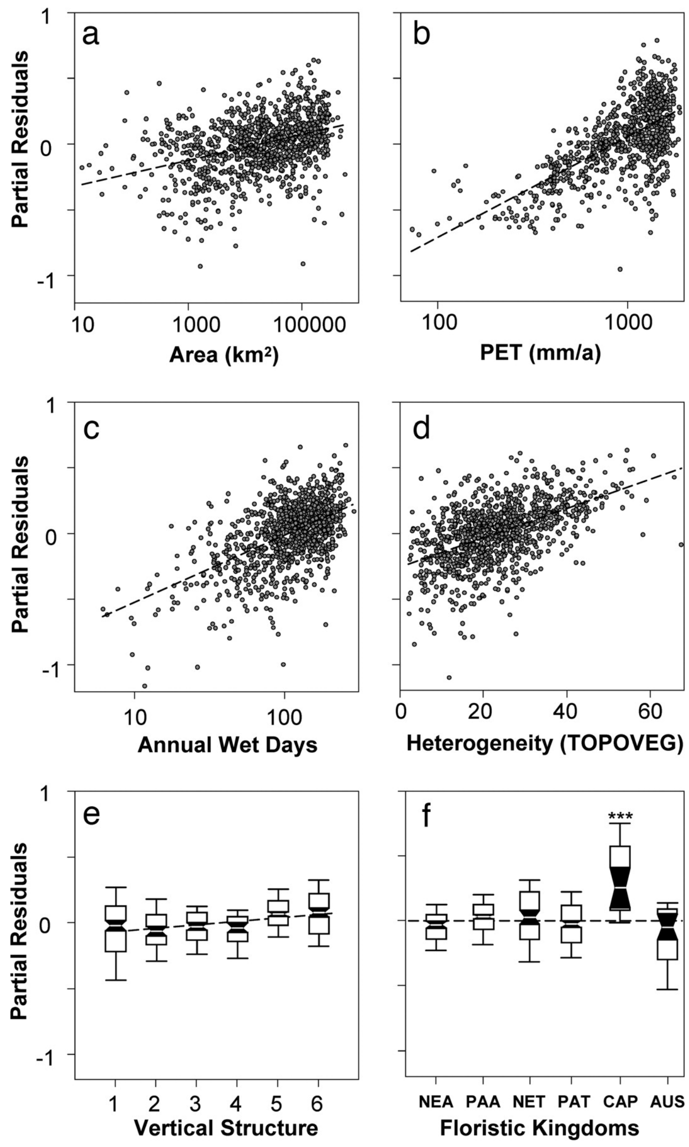


STATIC MODELING OF GLOBAL VASCULAR PLANT BIODIVERSITY (KREFT AND JETZ 2007)



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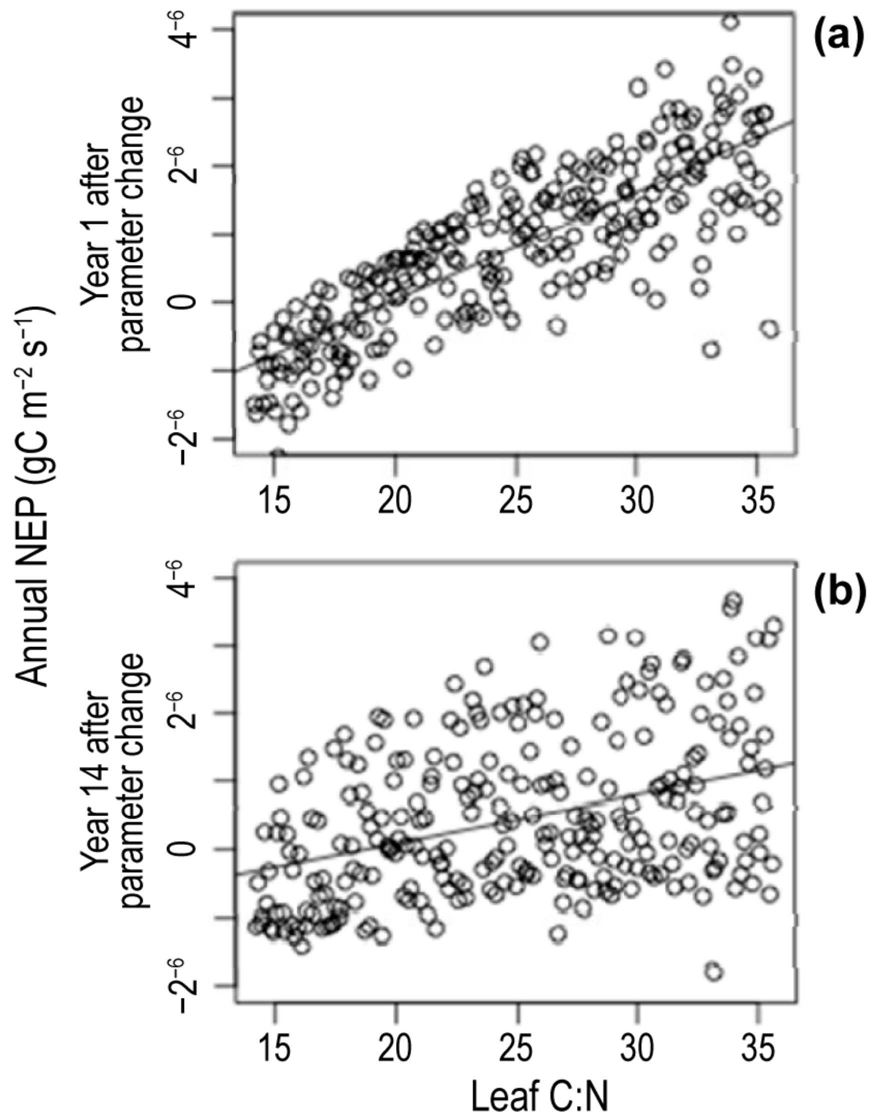
LARGE SCALE CONTROLS OVER PRODUCTIVITY:

Extending the species-energy paradigm:

…the ‘‘water–energy dynamics hypothesis,’’ species richness at higher latitudes is controlled by the availability of ambient heat, whereas, in the thermally suitable tropics, water- and humidity related variables are the main driving factors… (Kreft and Jetz 2007)

….. strong correlations between carbon, water, and nitrogen fluxes that lead to equilibration of water/energy and nitrogen limitation of net primary productivity (Schimel et al 1997).



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INFORMATION *FROM* BIODIVERSITY:

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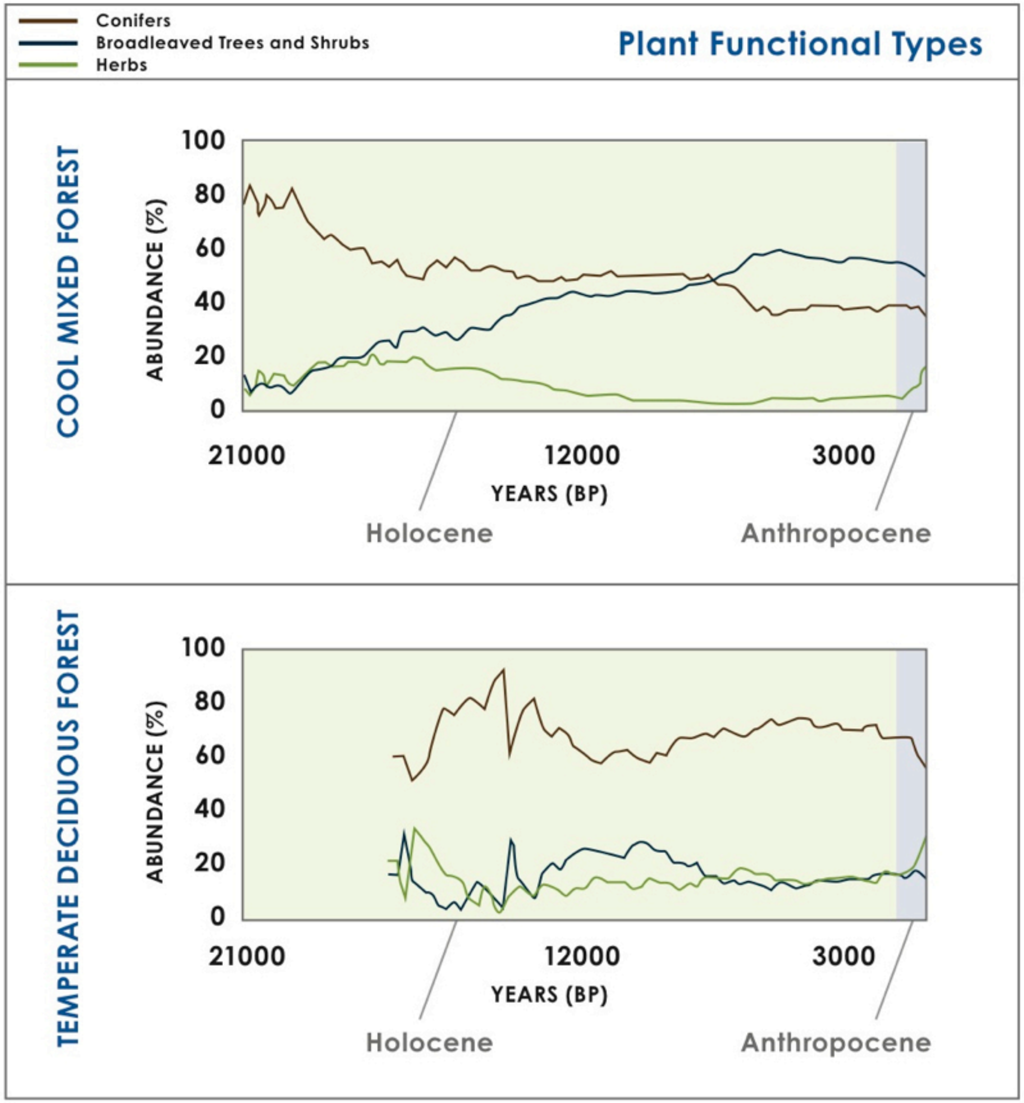
A paleo-perspective on recent ecological change

Accelerated change entering the Anthropocene



Williams et al 2007
Ecol. Monog.

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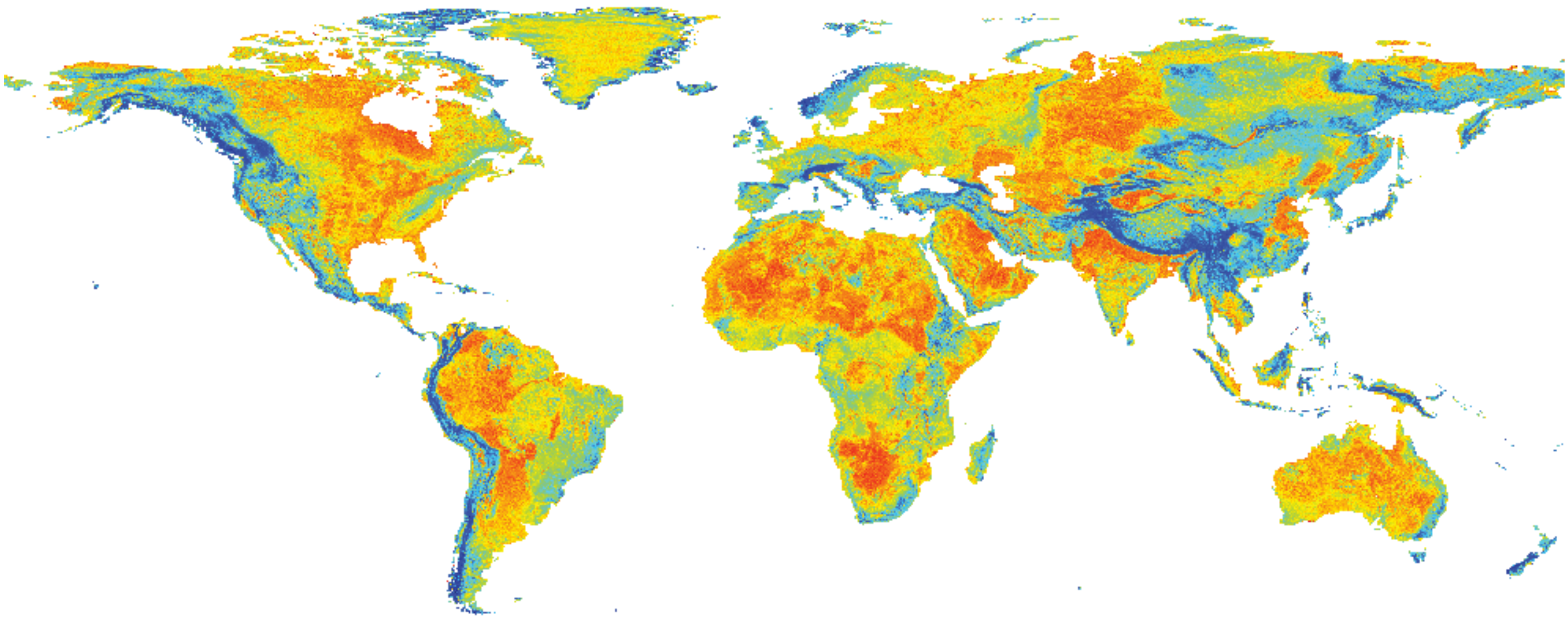
VELOCITY OF CLIMATE CHANGE



0.01 1.0 10

Km yr^{-1}

Loarie et al 2009
Nature

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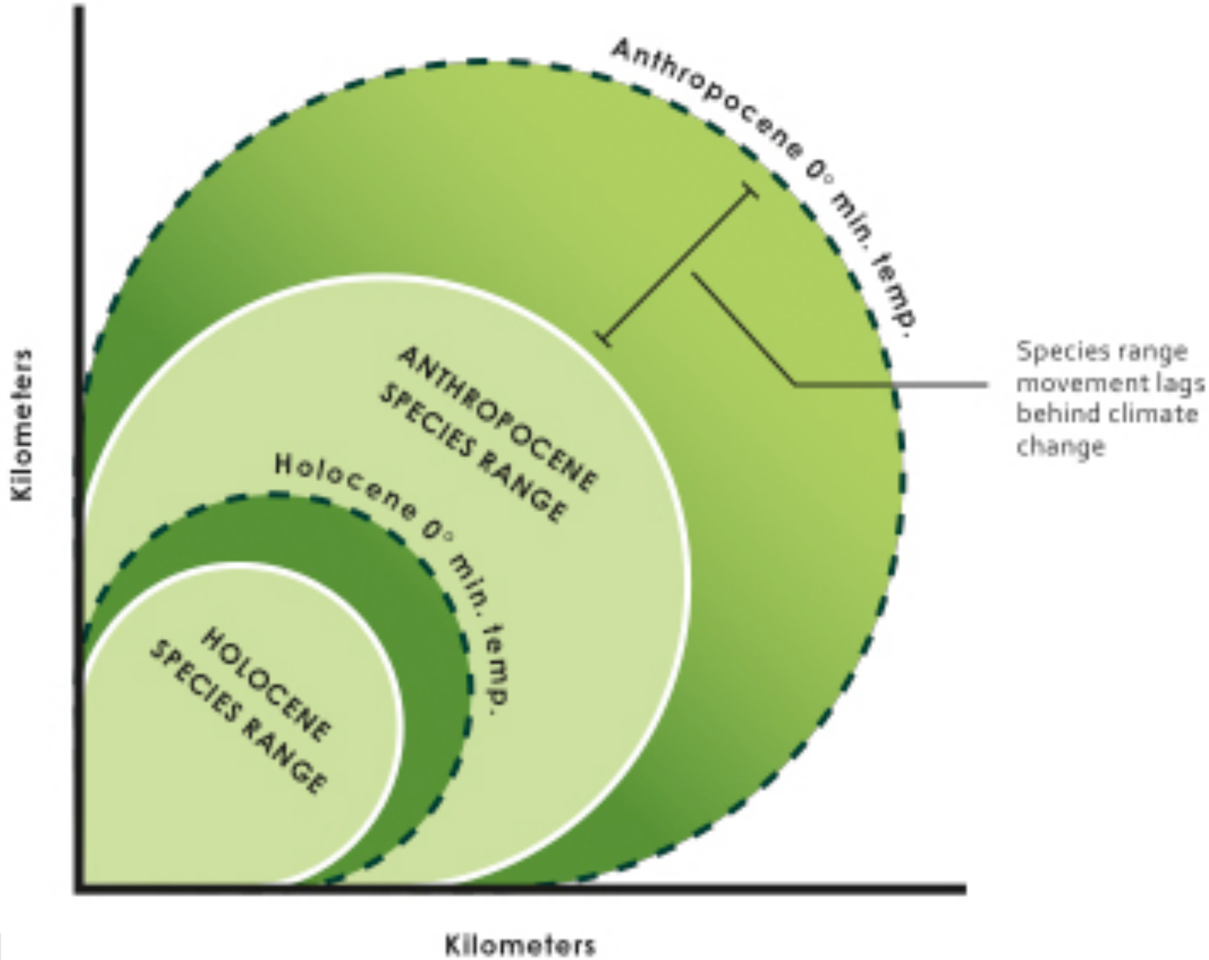
Why is the equilibrium assumption so key?



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Observing biodiversity

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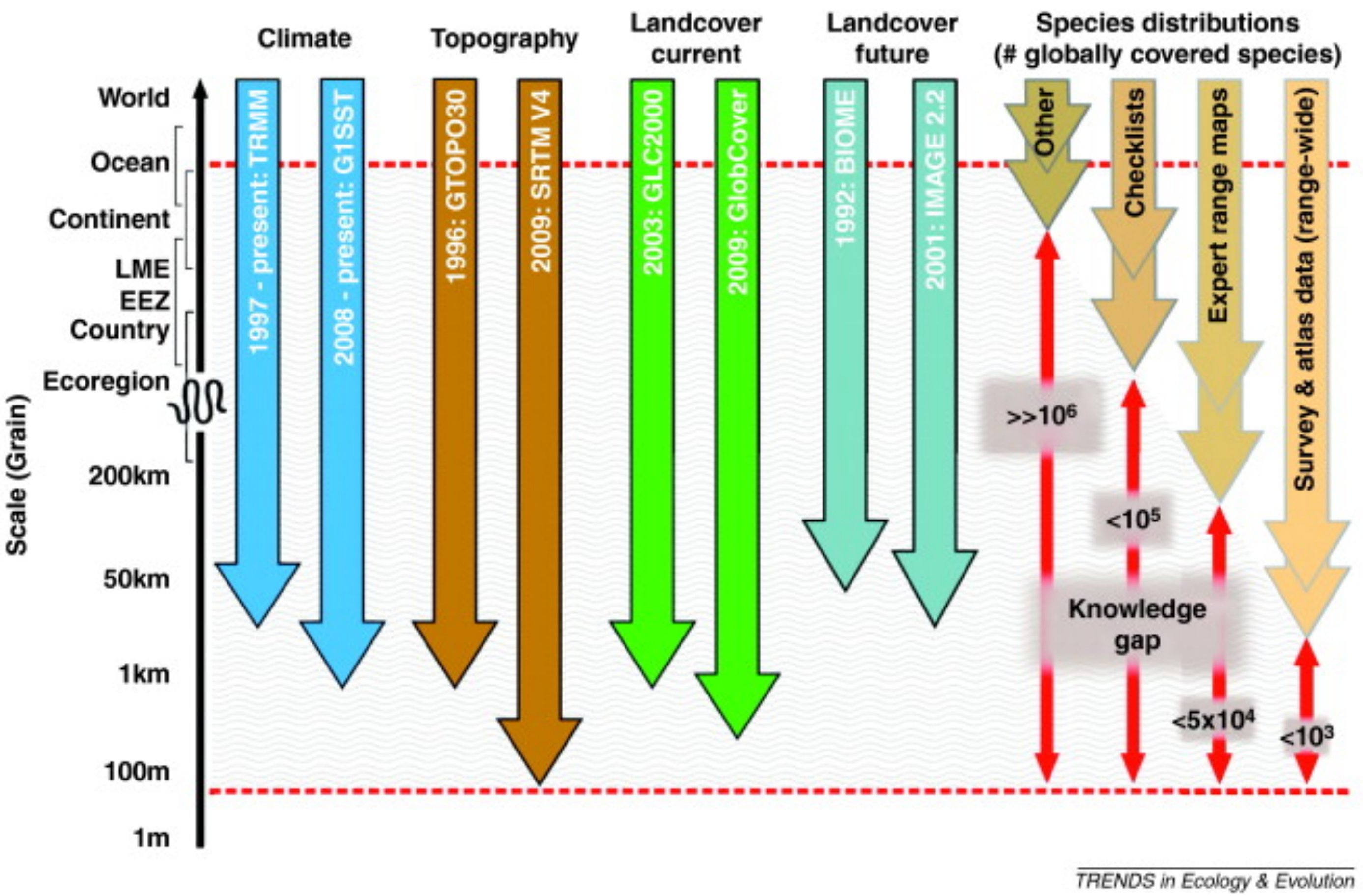
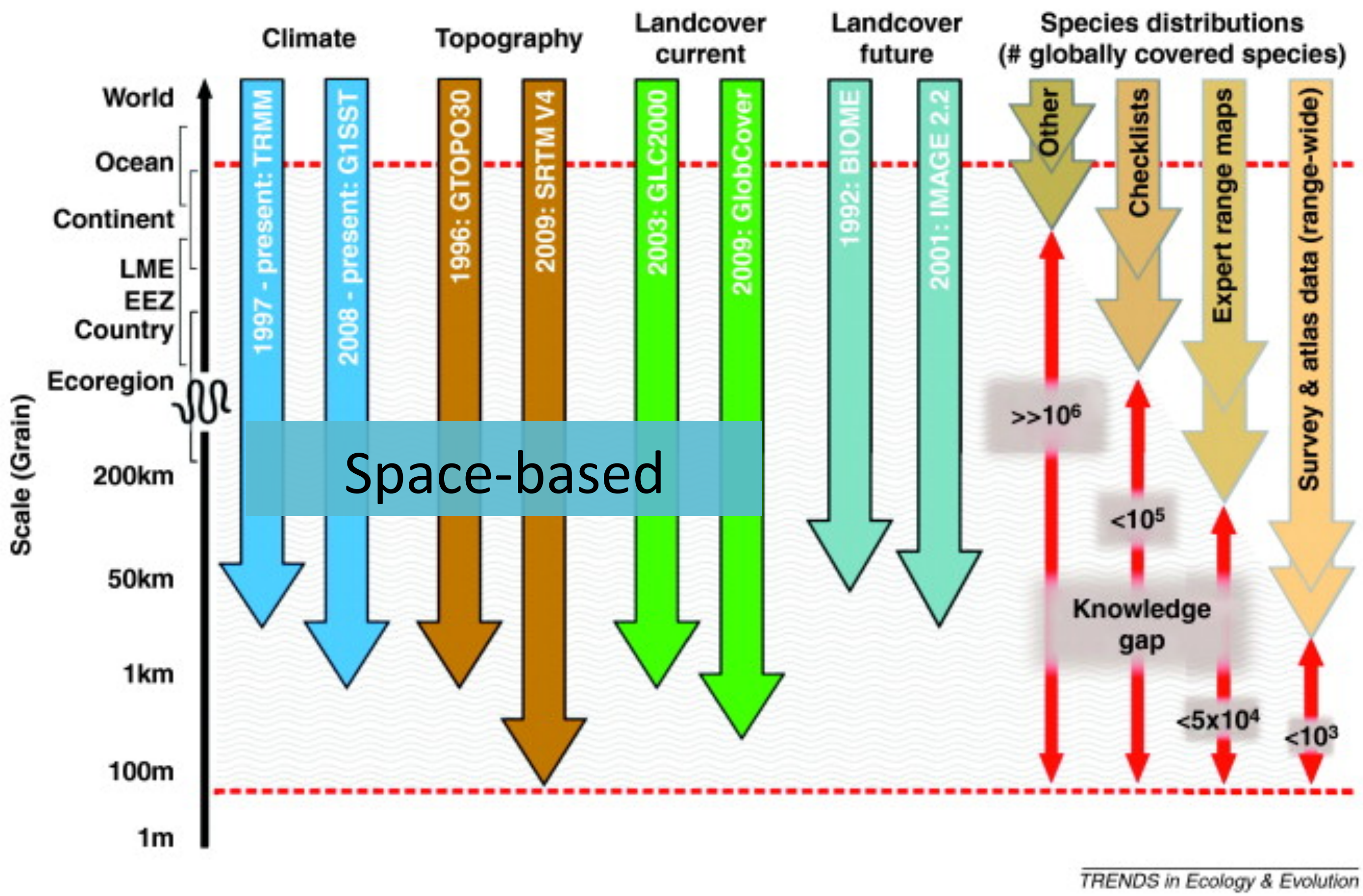
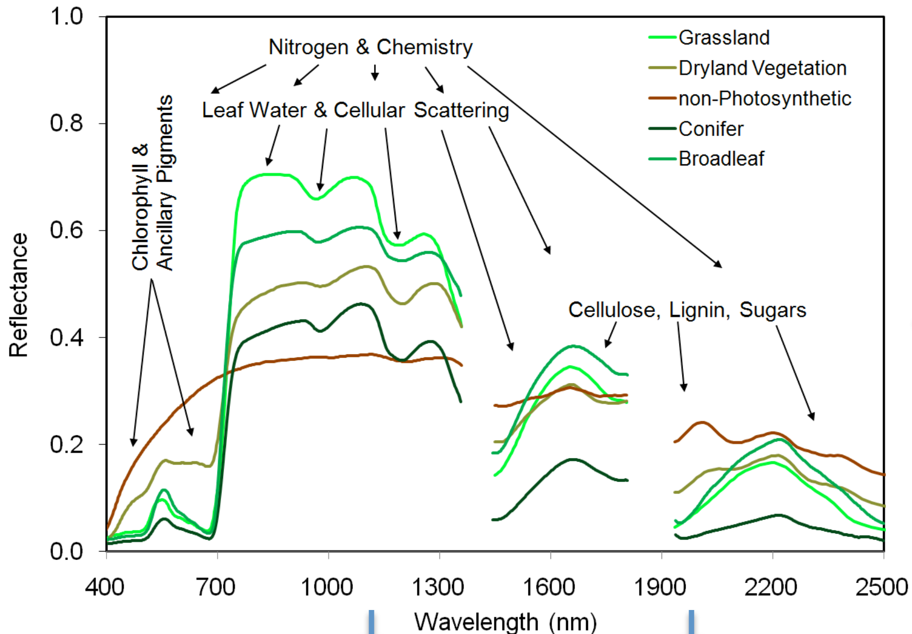
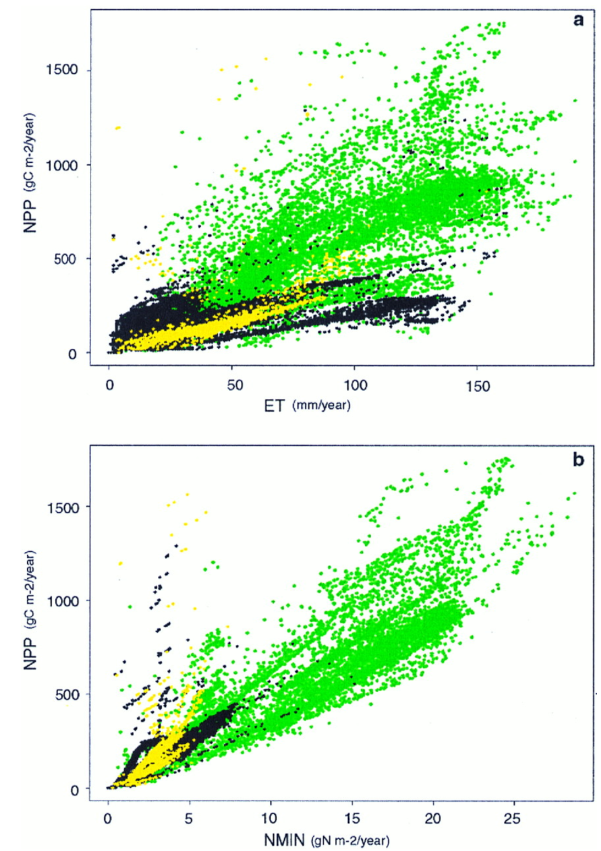
The biodiversity *scale gap* and the value of space-based observations



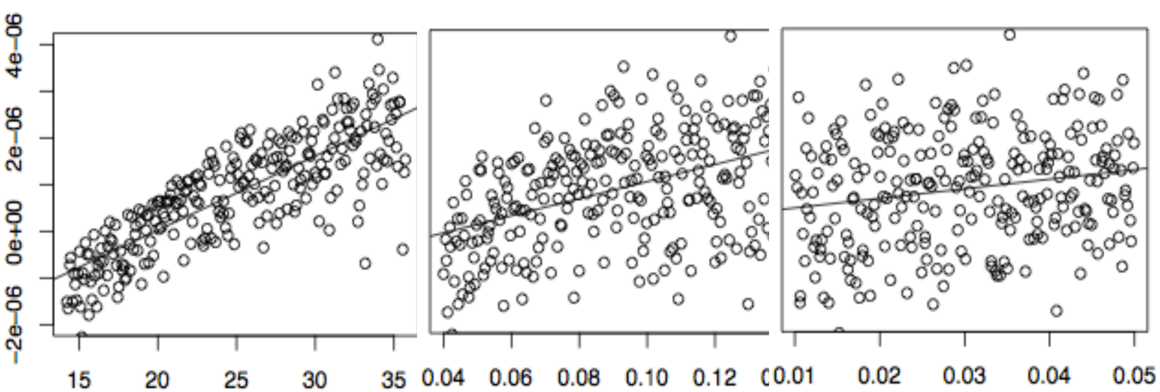
The biodiversity *scale gap* and the value of space-based observations





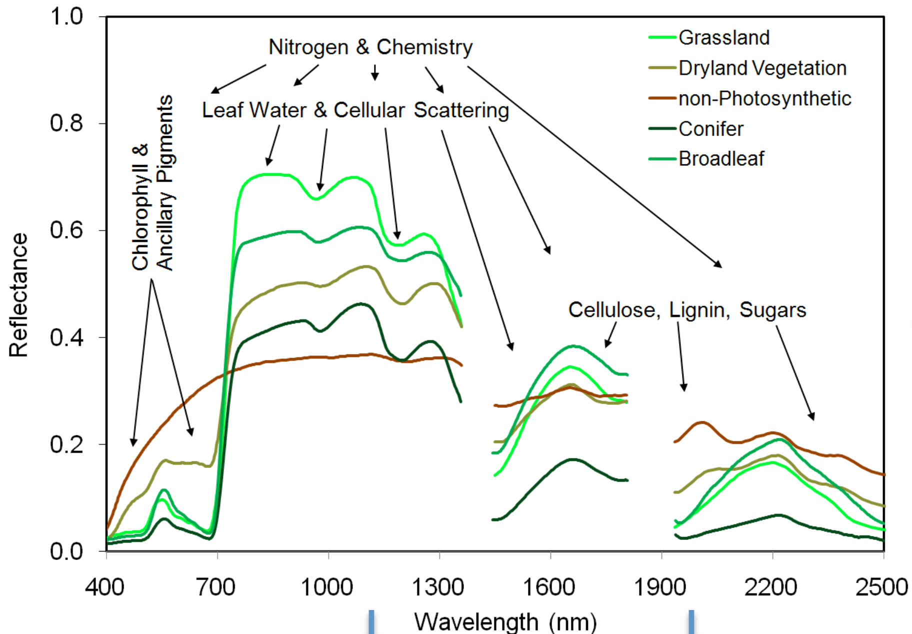


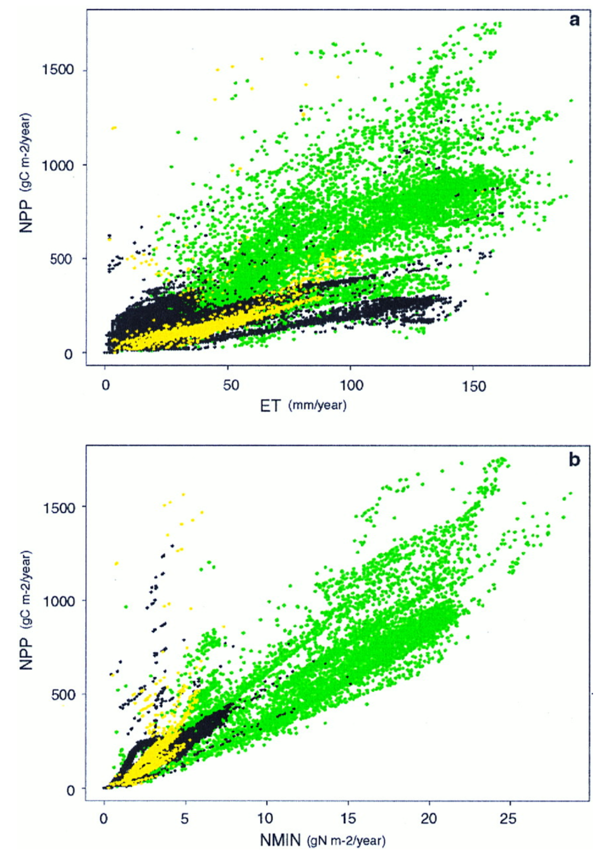
Partial effect on carbon uptake (NEP)



Foliar nitrogen Rubisco Leaf area

SPECTROSCOPY CAN RETRIEVE CHEMICAL INFORMATION LINKED TO KEY PLANT TRAITS AND IDENTIY





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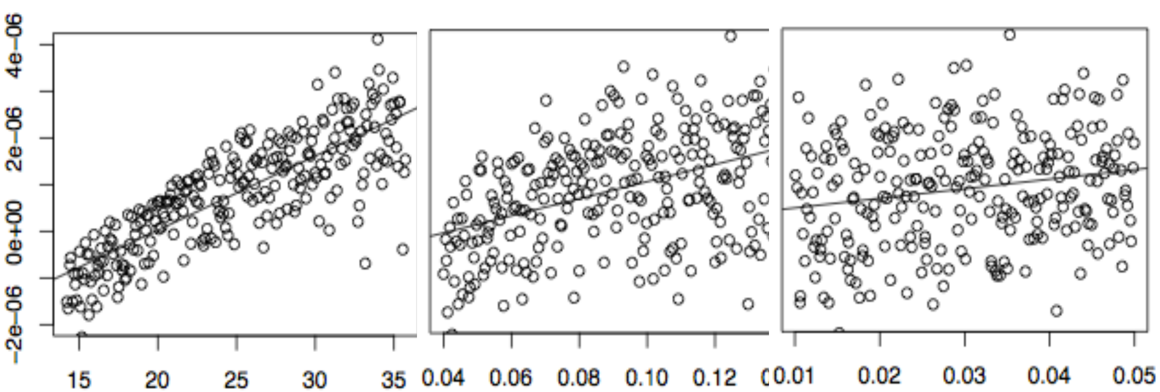
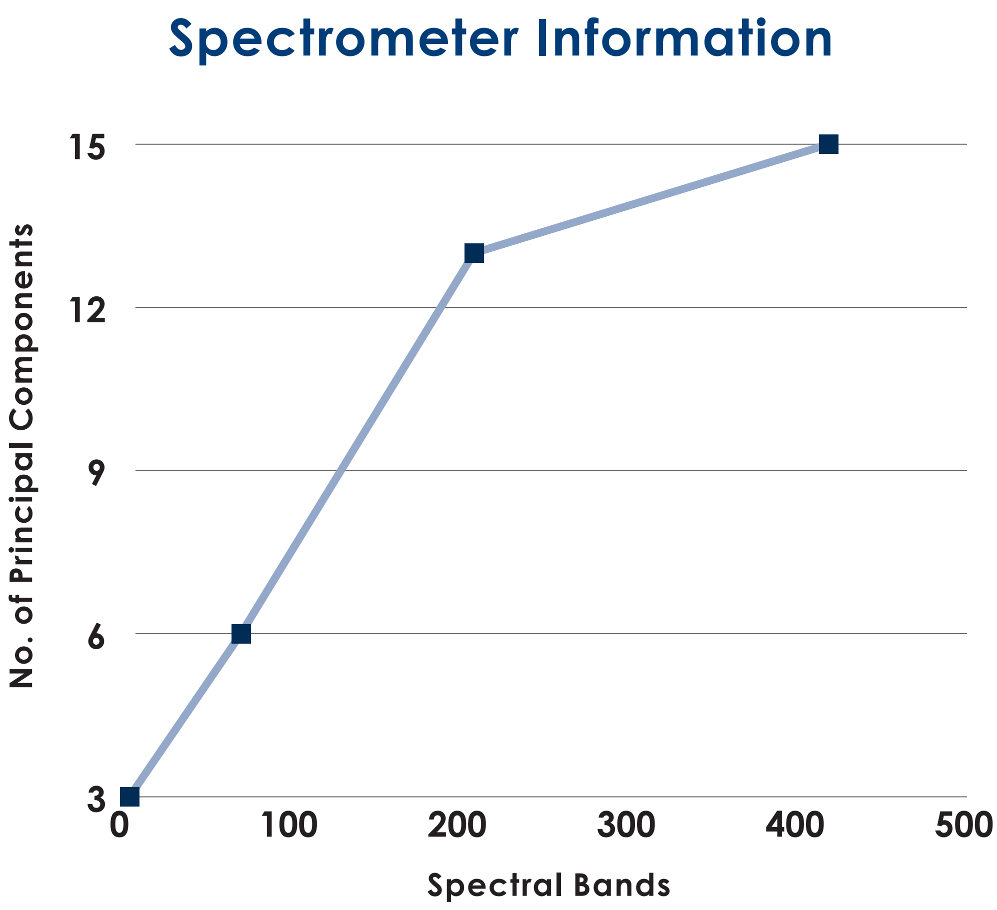


Foliar nitrogen   Rubisco   Leaf area

INCREASING CHEMICAL INFORMATION WITH SPECTRAL RESOLUTION



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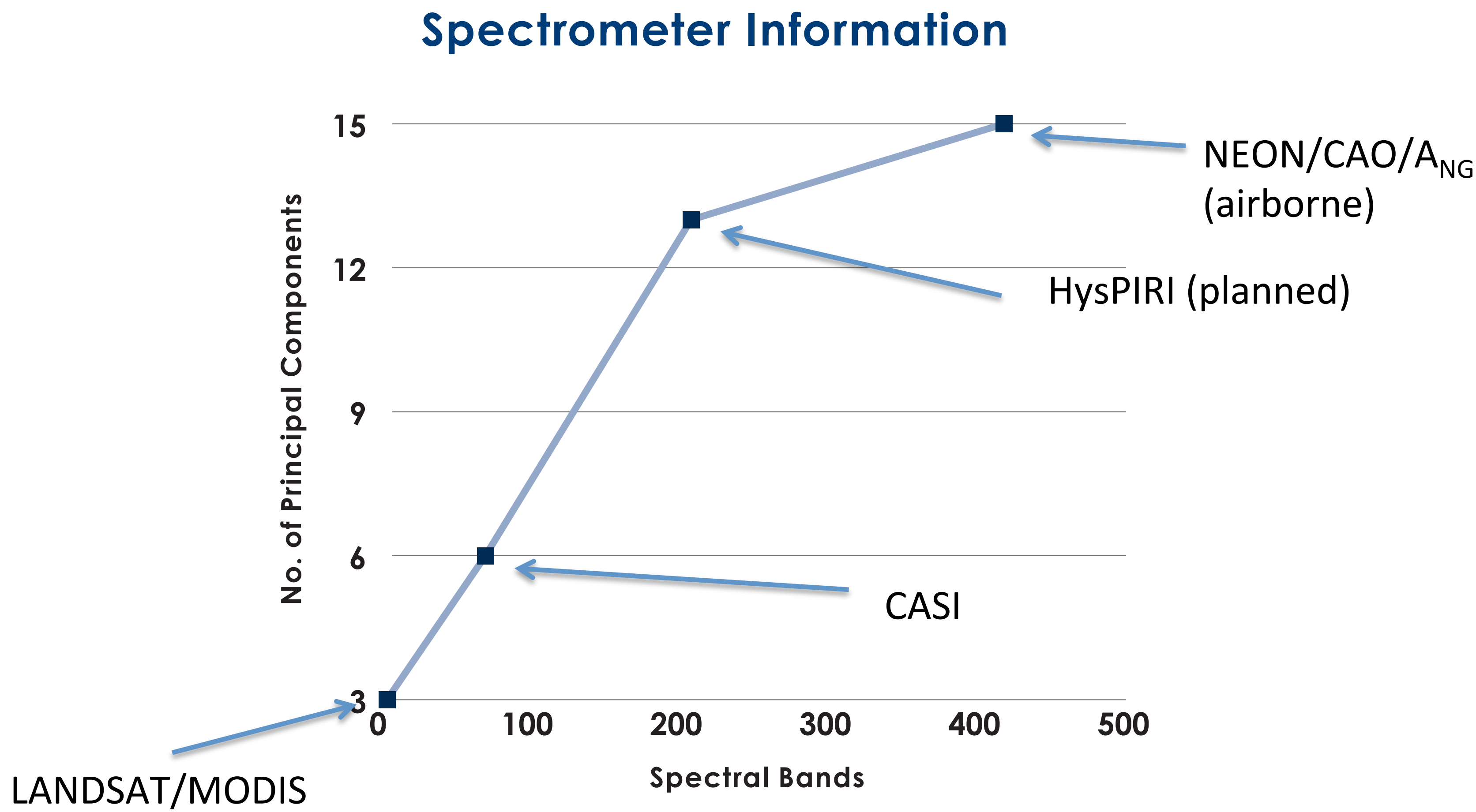
INCREASING INFORMATION PER UNIT AREA WITH SPECTRAL RESOLUTION



Schimel, Asner and Moorcroft, in press)

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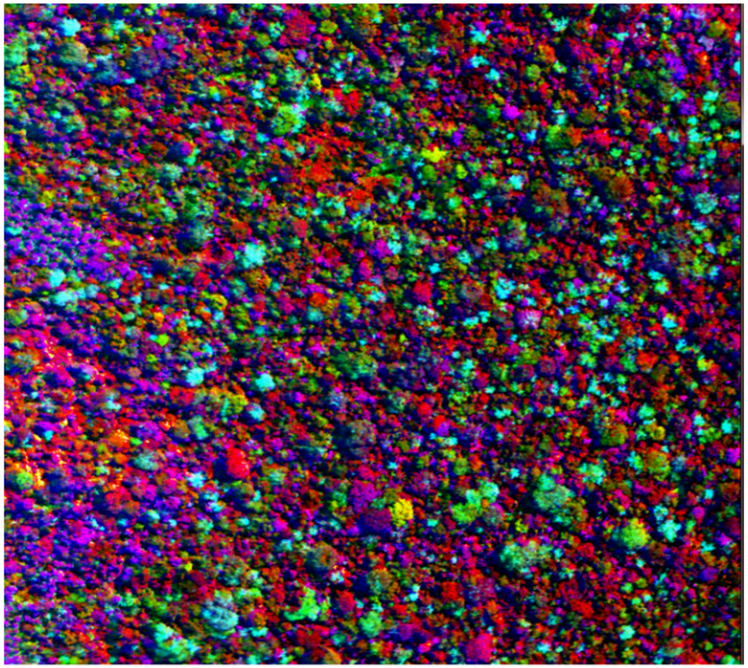
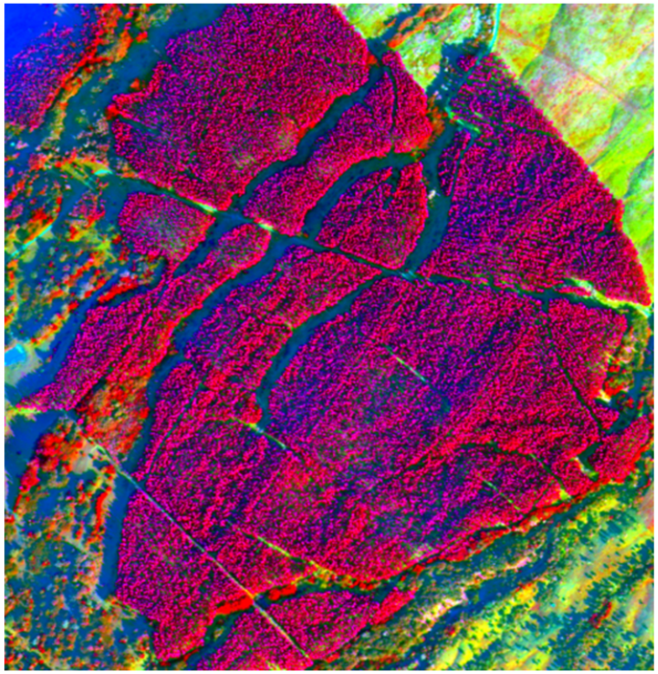
VISUAL REPRESENTATION



Megadiverse Forest



Monospecific plantation

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Biodiversity and species identification retrievals

Ecosystem Type	Sensor	Spatial Resolution (m)	Source
Sub-tropical broadleaf forest (S)	CAO	0.5	Féret and Asner (2011)
Sub-tropical broadleaf forest (F)	AVIRIS	3.0	Carlson et al. (2007)
Temperate broadleaf forest (F)	EO-1 Hyperion	30.0	Goodenough et al. (2003)
Temperate grasslands (S)	AVIRIS	19.0	Carter et al. (2005)
Temperate mixed forest (S)	AVIRIS	20.0	Martin et al. (1998)
Temperate needleleaf forest (S)	DAIS	1.0	Gong et al. (1997)
Temperate shrubland-grassland (F)	DAIS	1.0	Yu et al. (2006)
Temperate wetlands (F)	CASI, other	1.0-3.0	Belluco et al. (2006)
Temperate wetlands (S)	HyMap	3.0	Lucas and Carter (2008)
Tropical broadleaf forest (S)	HYDICE	1.6	Clark et al. (2005)
Tropical broadleaf forest (F)	EO-1 Hyperion	30.0	Papeş et al. (2010)
Tropical lowland-to-montane rainforest (S,I)	AVIRIS	3.0	Asner et al. (2008)
Tropical mangroves (S)	CASI	2.5	Held et al. (2003)

Information content of remote sensing:

Today's satellite instruments can classify landscapes into tens of categories

New technologies can potentially identify millions of categories, numbers commensurate with vascular plant diversity

CONCLUSIONS

- Understanding controls over global biodiversity is a critical scientific and practical undertaking.
- At equilibrium, species ranges and spatial biodiversity data provide vital information on climate-biology relationships and allow building powerful models.
- The information inherent in species ranges is being lost due to high rates of environmental change.
- New remote sensing technologies on airborne and spaceborne platforms can provide regional-to-global plant biodiversity data in unprecedented quantities
- This information will inform process-based monitoring if the mission flies before high rates of climate change result in widespread disequilibria.

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