Ecosystem Spectral Information System (EcoSIS):

Integration of Spectral Data with Measurements of Vegetation Functional Traits

Alphabetically:
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John Gamon, University of Alberta, SpecNet
Simon Hook and Rob Green, JPL
Shelley Petroy and Tom Kampe, NEON, Inc.
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Art Zygielbaum, University of Nebraska
…..and…..
You!

Why Spectral Libraries?

Tool for discovery.

Document species characteristics and map them.

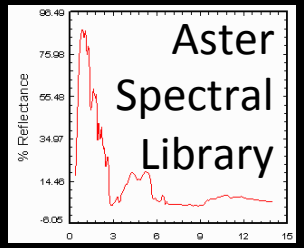
Characterize the diversity of function and its variability on earth.

Deliver scientifically vetted data to an international and open community of researchers…

…and metadata to ensure inter-comparability.

Tools to facilitate the synthesis of large data sets by community.

Precedents:



Example Contributions

Table 2. Examples of spectral data contributions from the project Principal Investigators.

Site	Veg Type/Species	Vegetation Conditions	Spectral Data	Temporal/Sample Characteristics	Ancillary Data
Missoula, Montana	lodgepole pine, sagebrush	Retained old and emergent new needles, separated into two samples	hemispherical leaf/needle reflectance and transmittance, 350-2500 nm	weekly for 4+ months, 4 sites, 8 samples per site, adaxial and abaxial sides	Time series moisture content, partial biochemical analysis
Missoula, Montana	lodgepole pine, sagebrush	Maturing leaves and needles over field season	branch and canopy field spectra, 350-2500 nm	weekly for 4+ months, 4 sites, approximately 10 areas per site	Time series live fuel moisture
Fivemile, Utah	sagebrush, NPV, soil	Mature sagebrush with declining canopy moisture over time	canopy field spectra, 350-2500 nm	every two weeks for 4 months, 10 canopies per site for 5 sites	Time series live fuel moisture
Range Creek, Utah	desert scrub, NPV, soil		canopy field spectra, 350-2500 nm	field campaign, approximately 15 plant species	
Santa Monica Mountains, California	chaparral, coastal sage scrub, NPV, soil		branch and canopy field spectra, 350-2500 nm	field campaigns 1995-2000, approximately 20 plant species	
Mead, Nebraska	corn, soy crops, row planted	irrigated and non-irrigated fields	350-2500 nm reflectance	weekly through growing season covering ten years, 36 samples per field, 3 fields	pyranometer, quantum sensor, GPS, IRT
				Roughly monthly	

Example Data – a whole range of data and metadata in different formats

Attribute	Variable
Plot/Sample ID	A06-42
NEON Domain	1
Domain Site	Core
Type	Vegetation
Form	Deciduous Tree
Measurement Scale	Leaf
Estimate - Sample Location on Tree	Mid Canopy - exposed
Measurement Type	Field
Instrumentation	ASD
Spectra Collection Protocol	Plant Probe
Calibration Protocol	Plant Probe Reference
Measurent Protocol	Standard Measurement Sequence
Spectra per Sample	20
Samples per Save	1
Acquisition Conditions	Not recorded
Field Personnel	Nathan Leisso

D1373a

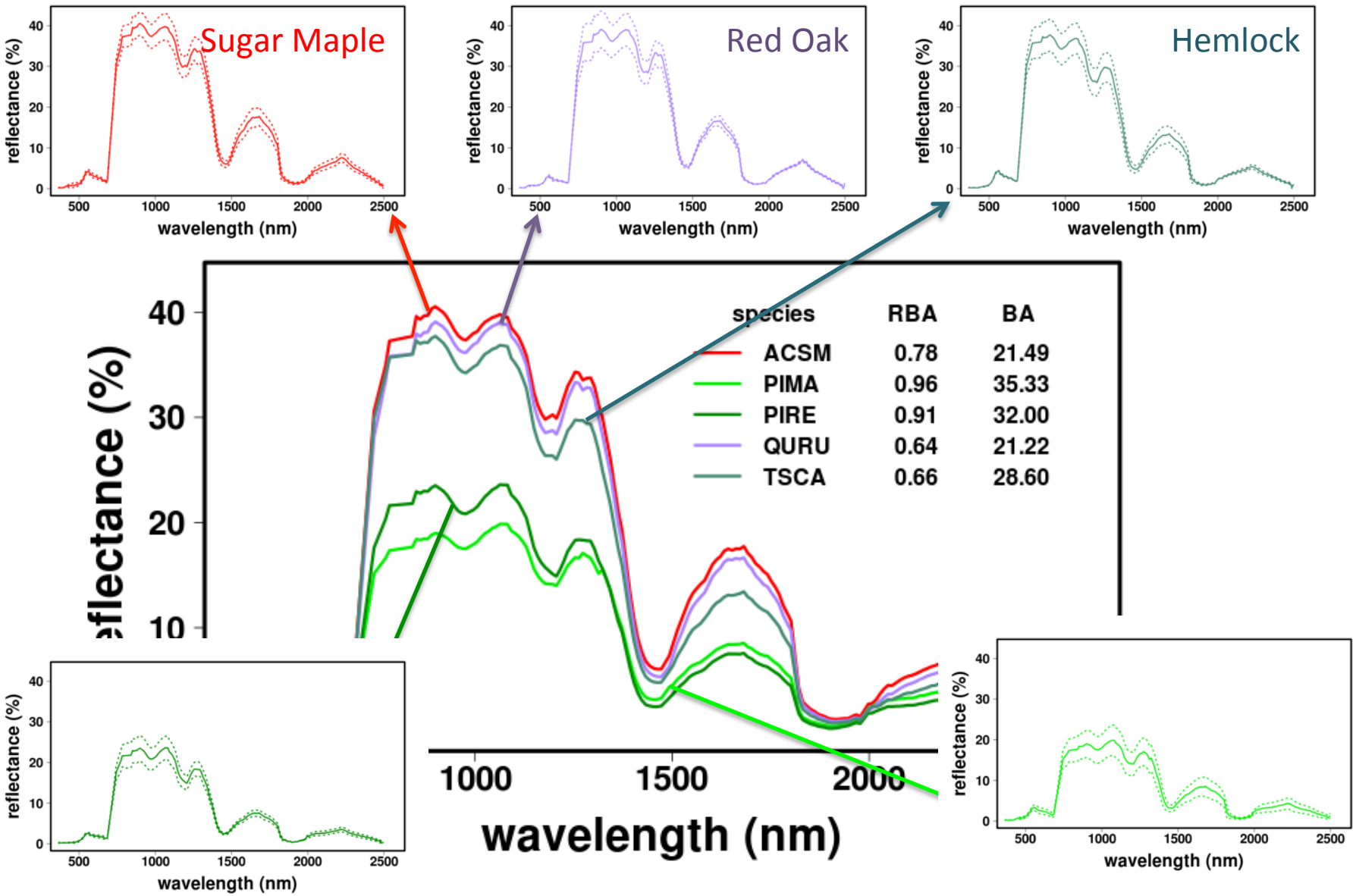
Douglas-fir #1373 sampled from Wind River Crane on Sept 9, 1996, by John Gamon & John Surfus

"Dark-to-Light" reflectance spectra during 10 minute transition from darkness to full sun

For method, see Gamon JA, Surfus JS (1999) Assessing leaf pigment content and activity with a reflectometer. New Phytologist 143:105-117.

Difference Spectrum (duaDIFF, ColumnW) shows delta Reflectance (10 minute - 0 minute of sun), illustrating features due to Xanthophyll pigment conversion and chl fluorescence quenching

minutes	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8
Wavelength	dua00001	dua00002	dua00003	dua00004	dua00005	dua00006	dua00007	dua00008	dua00009	dua00010	dua00011	dua00012	dua00013	dua00014	dua00015	dua00016	dua00017
305.56	0.349091	0.32	0.34545	0.32	0.32364	0.34545	0.33455	0.32364	0.33818	0.34545	0.36727	0.33091	0.34909	0.32364	0.36364	0.32364	0.35273
308.91	0.36619719	0.35563	0.34507	0.33099	0.34155	0.32747	0.34155	0.34155	0.33099	0.35211	0.39789	0.35211	0.33099	0.34507	0.35916	0.35563	0.35916
312.26	0.36824304	0.375	0.34122	0.36486	0.37838	0.33784	0.34797	0.36149	0.35135	0.37838	0.35473	0.38176	0.36486	0.40203	0.36824	0.38176	0.37162
315.61	0.34768208	0.34768	0.36424	0.37417	0.3543	0.36755	0.37748	0.36093	0.3543	0.36755	0.35762	0.37748	0.37417	0.39073	0.35762	0.38411	0.38079
318.95	0.35915487	0.33099	0.33803	0.35915	0.34507	0.35915	0.37676	0.37324	0.38028	0.3662	0.35211	0.35563	0.35563	0.32746	0.37324	0.34155	0.38028
322.3	0.36610165	0.34576	0.3661	0.35254	0.34915	0.3322	0.32881	0.35932	0.35932	0.33559	0.38305	0.34915	0.36271	0.32542	0.3661	0.37288	0.35932

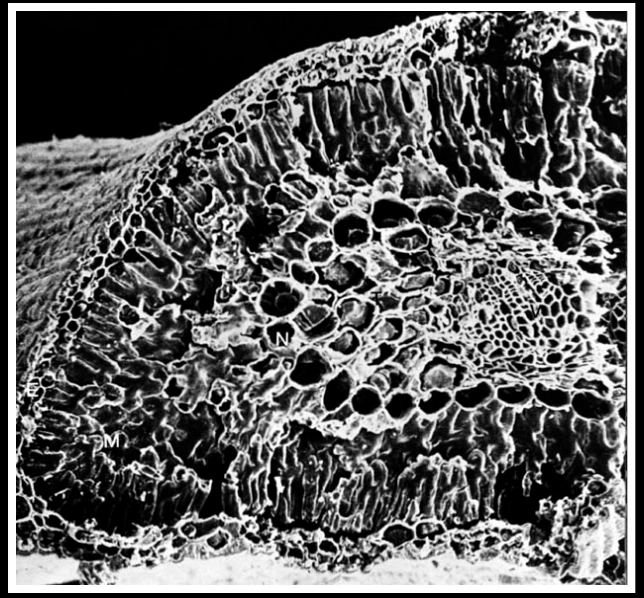


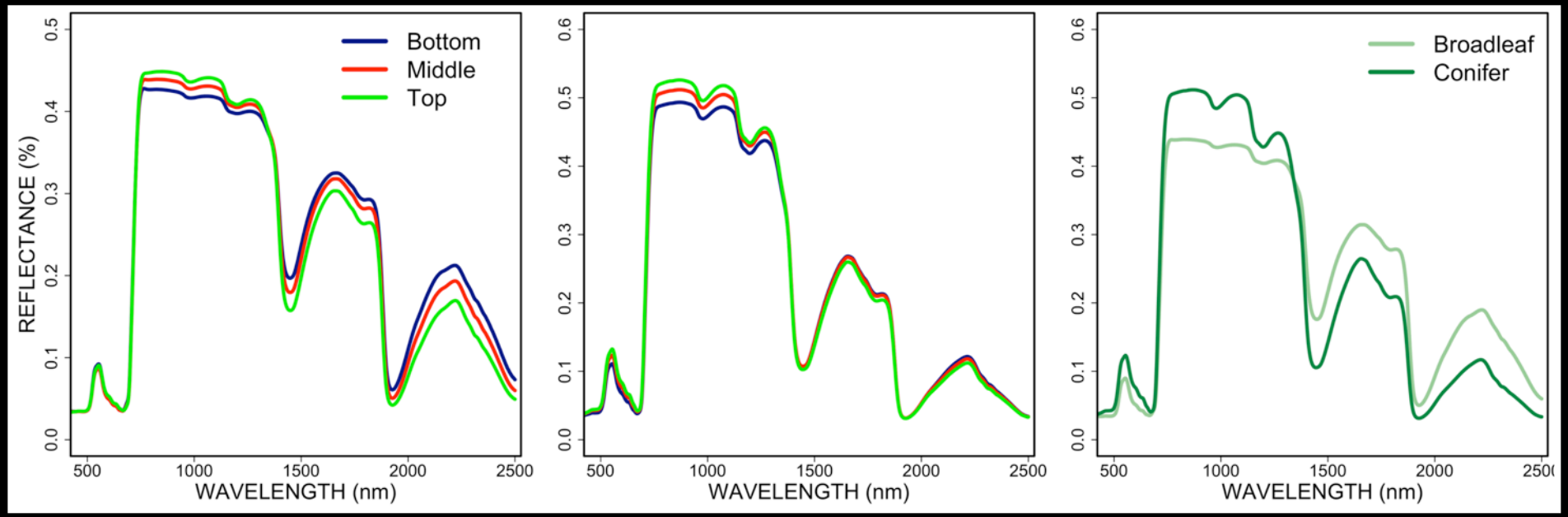
Spectral information can be about about species, differences between species, and geographic variations within a species. It can also be at the canopy and the leaf level.

Leaf-level spectra

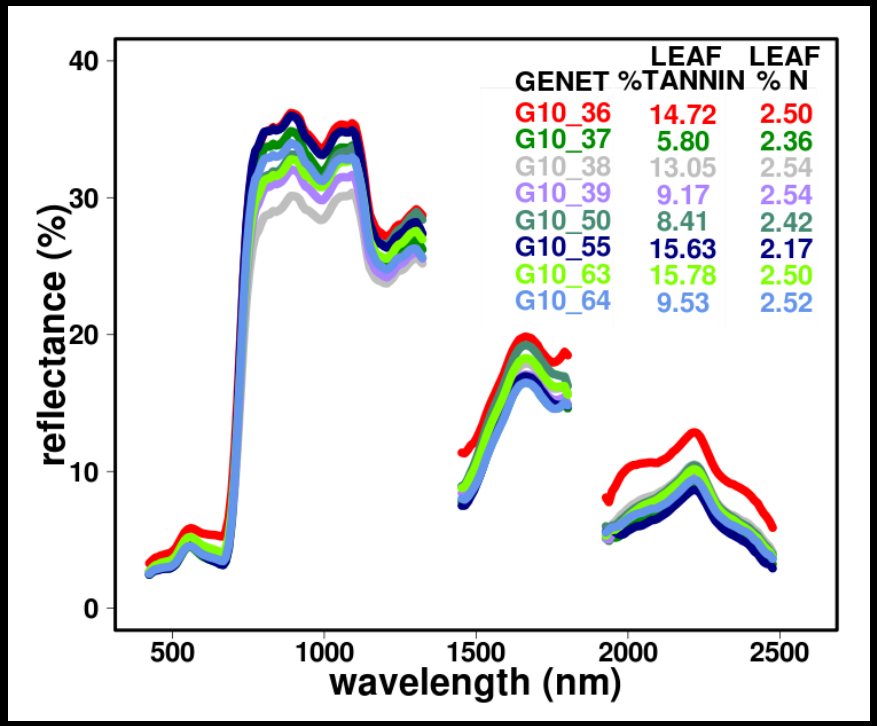
Maple

Pine



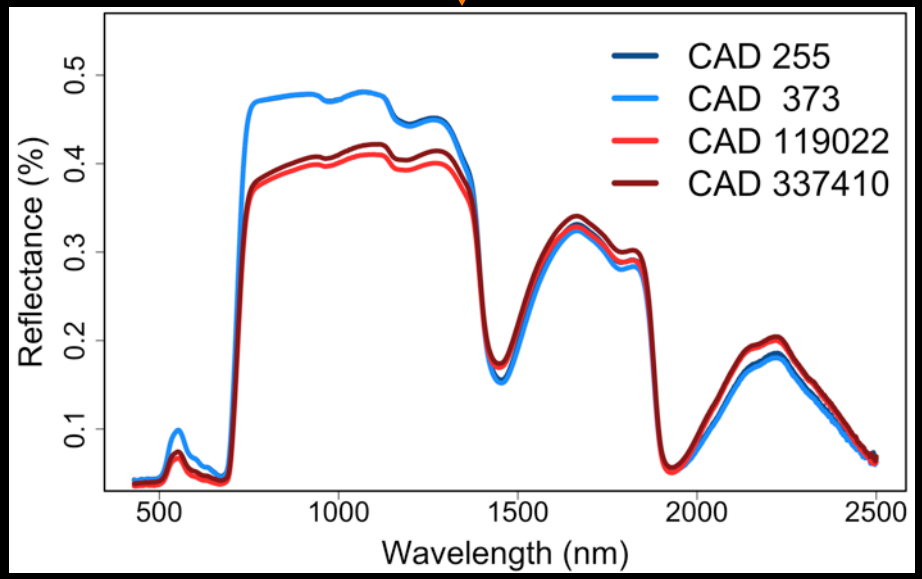


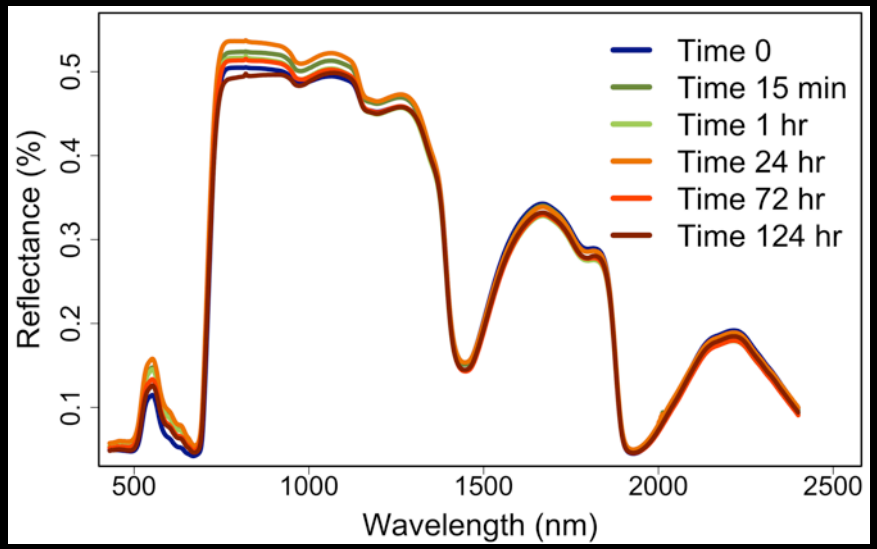
Spectral information can be about differences in reflectance through the canopy of a tree.



Genotypes of aspen.
Different reflectance.
Different chemistry.

Soybeans: same variety, different levels of pest pressure.

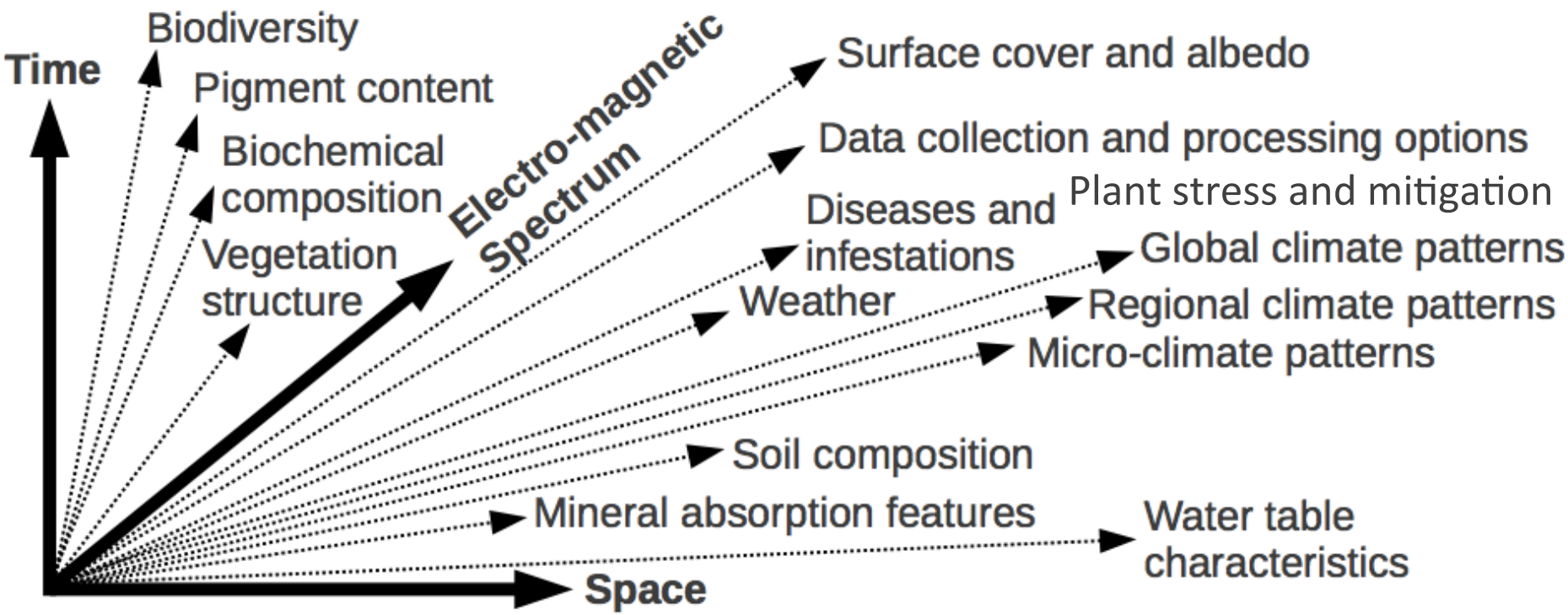




Milkweed.
Rapidly induced chemical defenses to perturbations.

Spectral data serve as "proxy" measurements for all ranges of underlying properties and functions in ecosystems that are costly, impractical, inconvenient or impossible to otherwise characterize at broad spatial and temporal scales.

***Metadata Dimensions** for optical data in vegetation monitoring*



G. Pastorello and J. Gamon

EcoSIS

EcoSIS Activities
(lead institutions)

- Develop Database Back-End (UC-Davis, JPL)
- Develop EcoSIS User Interface (UC-Davis, JPL, UW)
- Metadata Standards (UW, NEON, Alberta, UNL)
- Best Practices (UCSB, NEON, Alberta, UNL)
- Populate EcoSIS (all members, coordinated by UW)
- QAQC, Error Assessment (UW, JPL)
- EcoSIS Tools (UW, Alberta, community)

Deliverable

EcoSIS Public Database

JPL

- Spectral Library (0.35-13.0 µm)
- Metadata
- Associated measurements (species, chemistry, etc.)

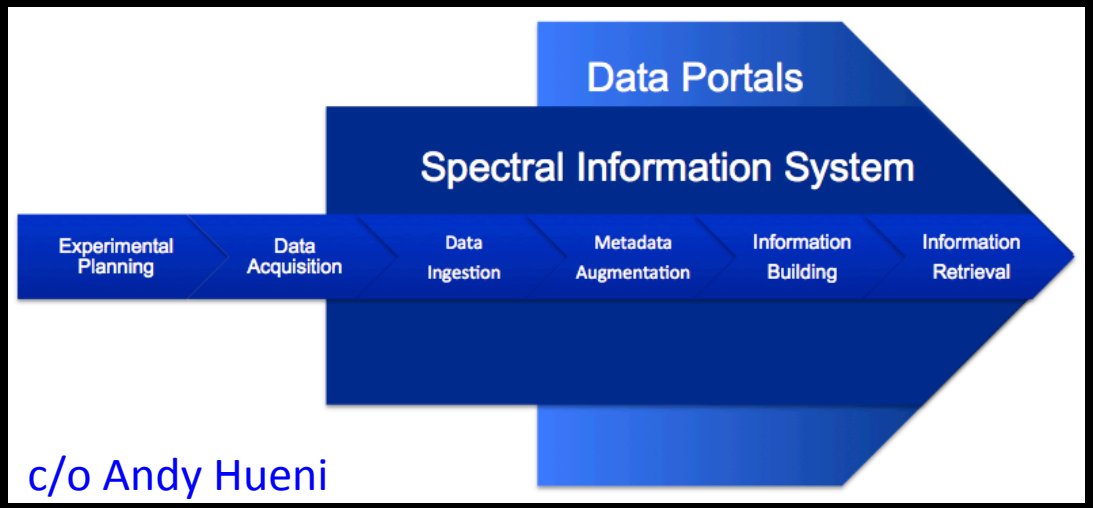
EcoSIS Tools (Open Source)

- Visualization, Query, Discovery

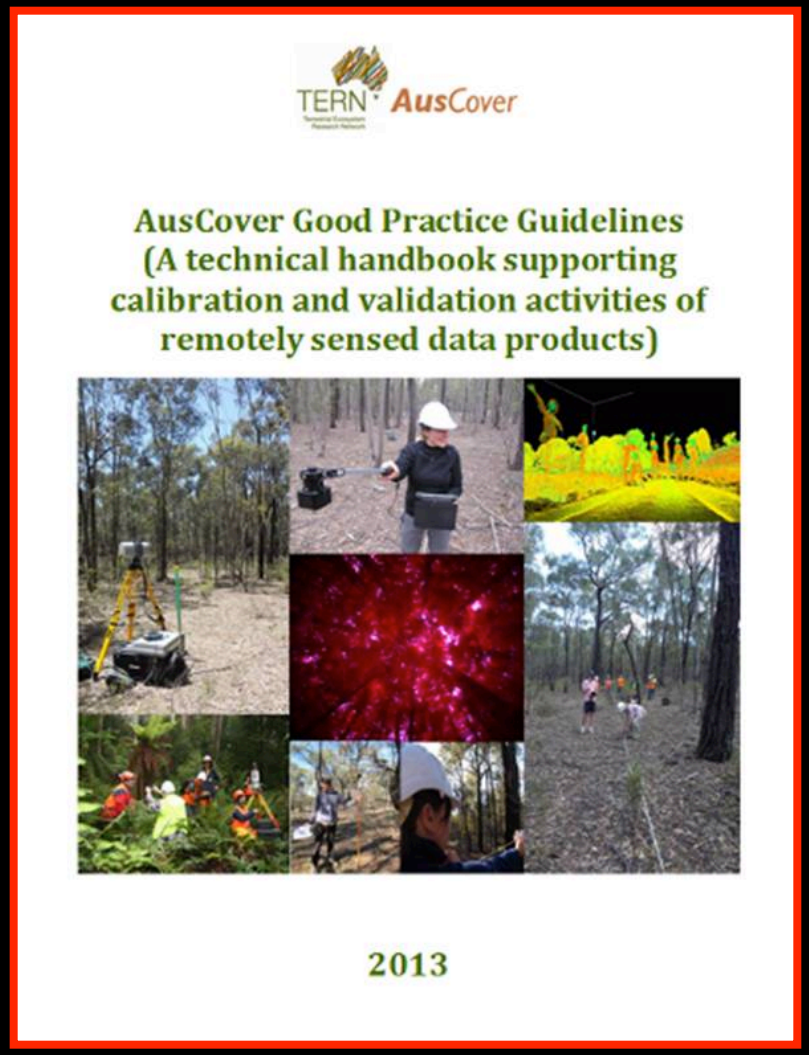
EcoSIS Outcomes
(via community engagement)

- Accommodation of Legacy and New Data Sets
- Evolution of Open-source Tools for Discovery & Analysis
- Synthesis Studies & Meta-Analyses
- Development of a Broader EcoSIS User Community
- Growth of EcoSIS to Reflect Evolving Science Needs

International linkages are important:



c/o Andy Hueni



Moving Forward:

Community participation is essential:

- Decision-making open process
- Review/oversight committee
- Your data contributions to EcoSIS
- Open source data and tools

Virtual meetings, side meetings at AGU, etc.

join-ecosis-community@lists.wisc.edu