

MODIS Surface Albedos and Distribution of Global Ecosystem Types

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Outline

- Motivation
- Issues with original albedo scheme
- New Ecosystem-Albedo seasonal model
- Description of ecosystem classifications
- Implementation of new model
- Summary and future directions

Motivation

- Retrieval of Cloud Optical Properties (MOD06OD)
 - Computes optical thickness and effective radius using White-Sky surface albedos at wavelengths of 0.659, 0.865, 1.24, 1.6, 2.1, and 3.7 microns.
 - Inaccurate albedo value will enhance or attenuate reflectance.
 - Can cause retrieval failures and unreasonable/unphysical results.
- Preparation for consistent year processing.
- Pre- and post-launch White Sky Surface Albedo scheme flagged for update.

Original Albedo Scheme

- Scheme used IGBP ecosystem classifications as a surrogate for albedo.
 - eg. Table of albedos for each ecosystem.
- Albedo data obtained from CERES/SARB.
- Issues with the scheme:
 - Broad-banded data.
 - Led to key bands having same surface albedo.
 - No seasonal variation in albedo.
 - Ecosystem with growth cycles not represented.
 - Coarse resolution CERES IGBP global ecosystem map.
 - 1 degree resolution left signatures

Design Parameters

- Fine resolution (10km) IGBP ecosystem and albedo data.
 - Albedos at wavelengths of interest.
 - Seasonally dependent albedo data set.

 - Sufficient data to generate global albedo maps.
- OR-
- Sufficient data to create an ecosystem-albedo surrogate.

MODIS-Land Products.

- Drs. Alan Strahler and Crystal Schaaf
 - Boston Univ. Center for BRDF/Albedo Research
- MOD12 - Ecosystem Classification
 - 10 km resolution, globally.
 - Includes updates of IGBP classifications.
- MOD43B - BRDF/Albedo Product
 - 10 km resolution, 16-day global composites.
 - Includes White-Sky Albedos at specific wavelengths of interest.

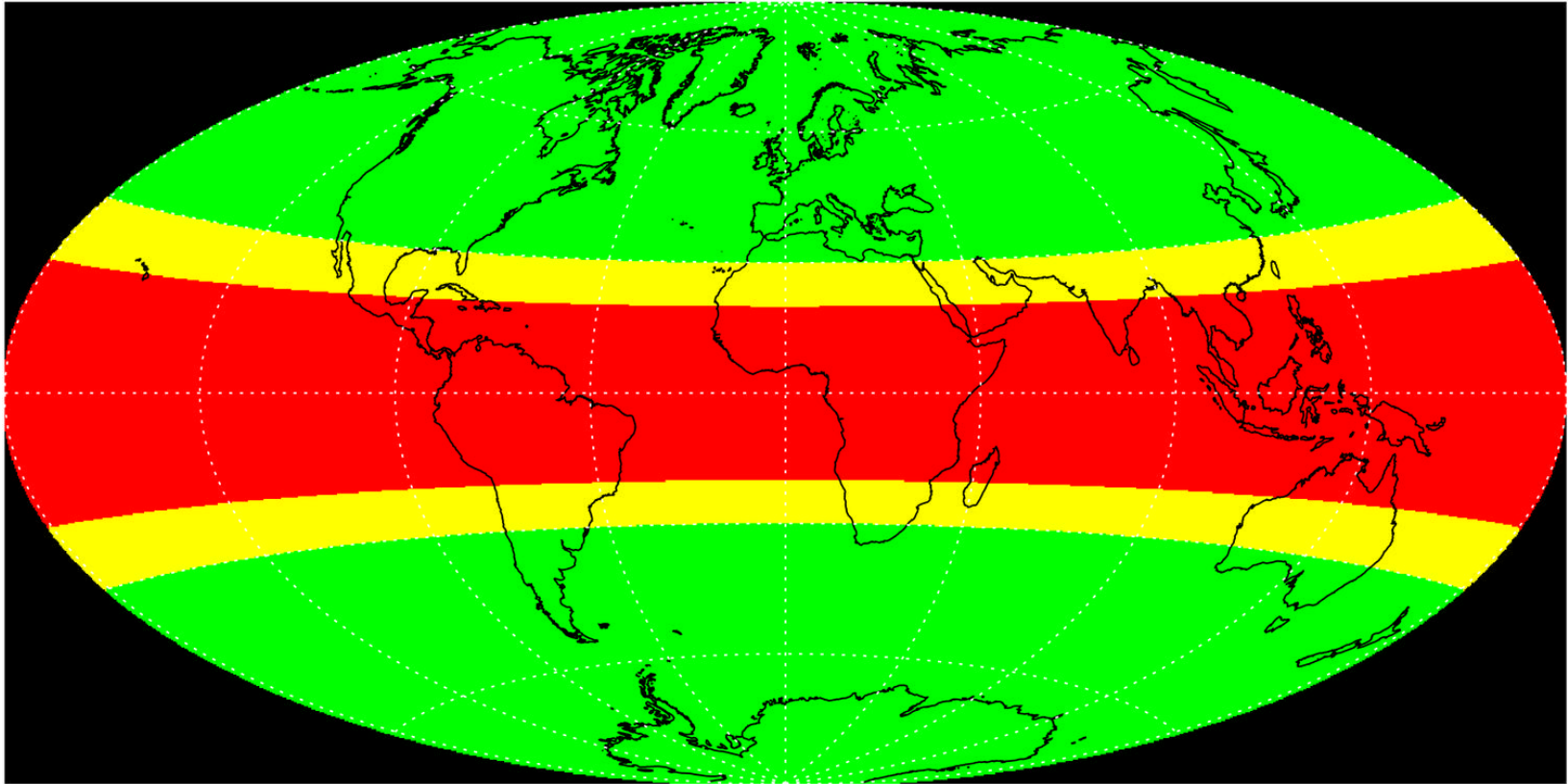
Sufficient Data Available?

- NO (at the time of consistent year code delivery).
- Only 2 data sets certified for quantitative use.
 - Spanned October, 2000.

Preliminary Analysis.

- Create seasonal ecosystem-albedo scheme if:
 - Northern and Southern Hemispheres differ statistically.
 - Sufficient data samples for each ecosystem type.
 - Ecosystem-Albedo correlate.
- Analysis
 - Compute statistics for “latitude belts” of varying sizes
 - Mean, standard deviation, and sample size
 - Albedos at various wavelengths, for each ecosystem type.
- Results
 - All three criteria met.

Model Description.



- Tropics, no seasonal effect.
- Seasonally dependant.
- Transition region.

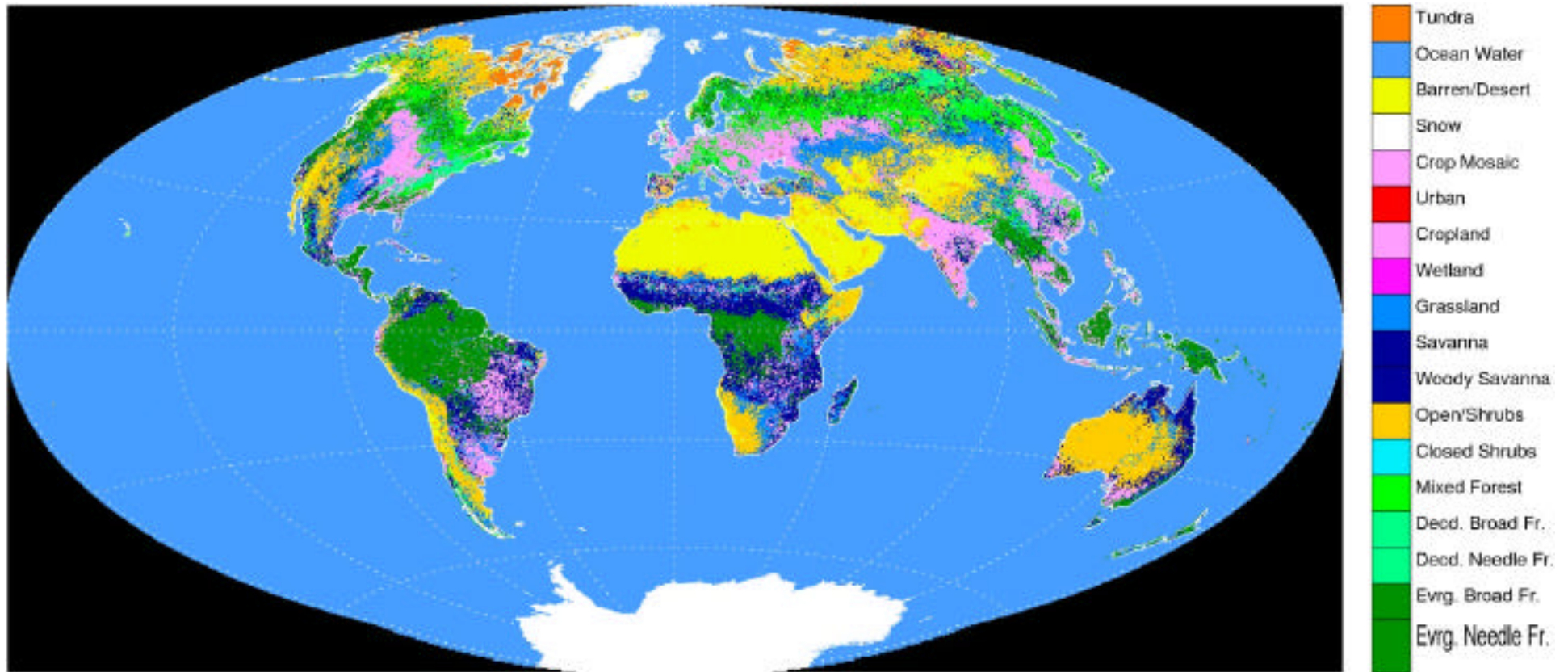
Model Data.

- Seasonally Dependent Regions.
 - Northern Hemisphere values assumed to be winter albedos at the winter solstice.
 - Southern Hemisphere values assumed to be summer albedos at the summer solstice.
 - Sinusoidal fit of these albedos to simulate seasonality.
- Tropical Region (no seasonal effects)
 - Albedos at various bands computed for ecosystem types
- Transition Region (some seasonal effects)
 - Linear fit between tropical and north/south albedos.

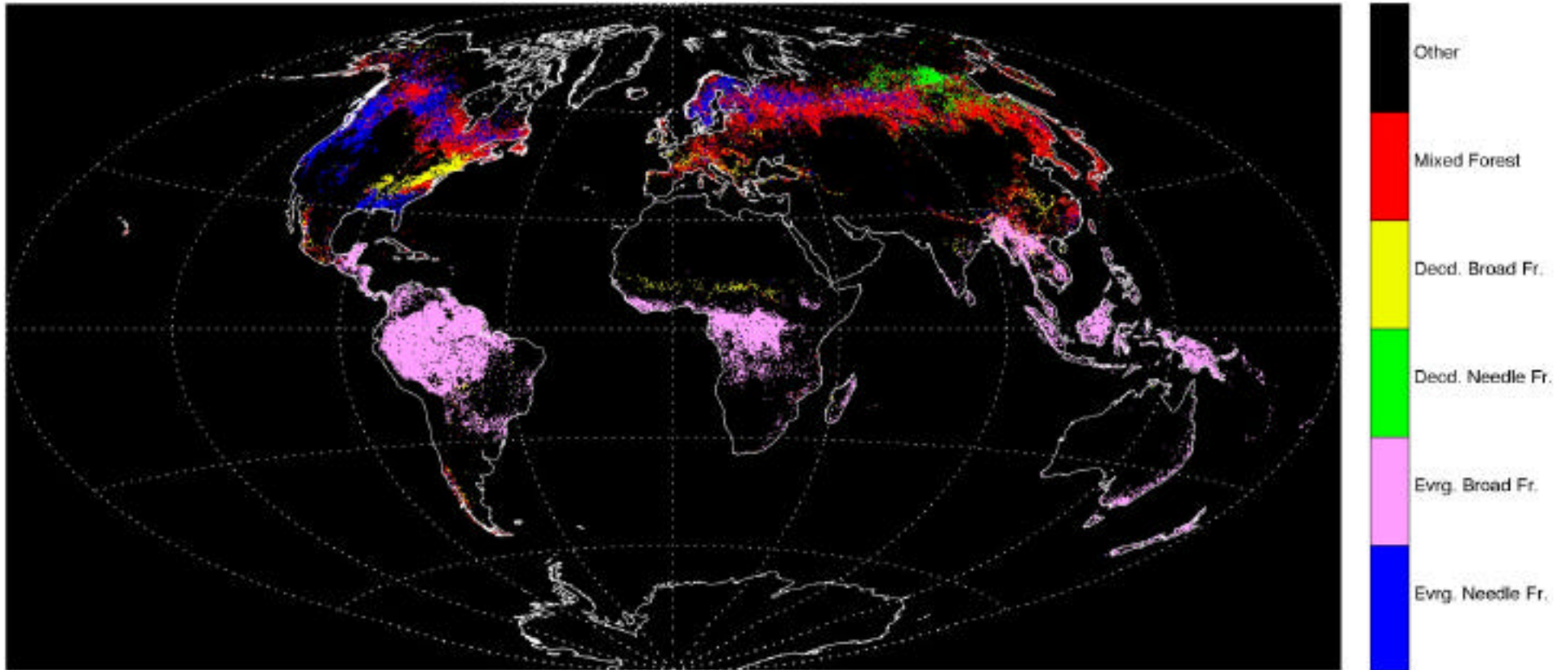
IGBP Ecosystem Classifications

- Forests:
 - Evergreen Needle and Broadleaf, Deciduous Needle and Broadleaf, and Mixed
- “Savannas”
 - Closed and Open Shrublands, Woody Savanna, Savanna, Grasslands
- Other Vegetation
 - Permanent Wetlands, Urban and Buildup, Cropland and Cropland Mosaics
- Miscellaneous:
 - Permanent Snow/Ice, Tundra, Barren/Sparse, and Water Bodies

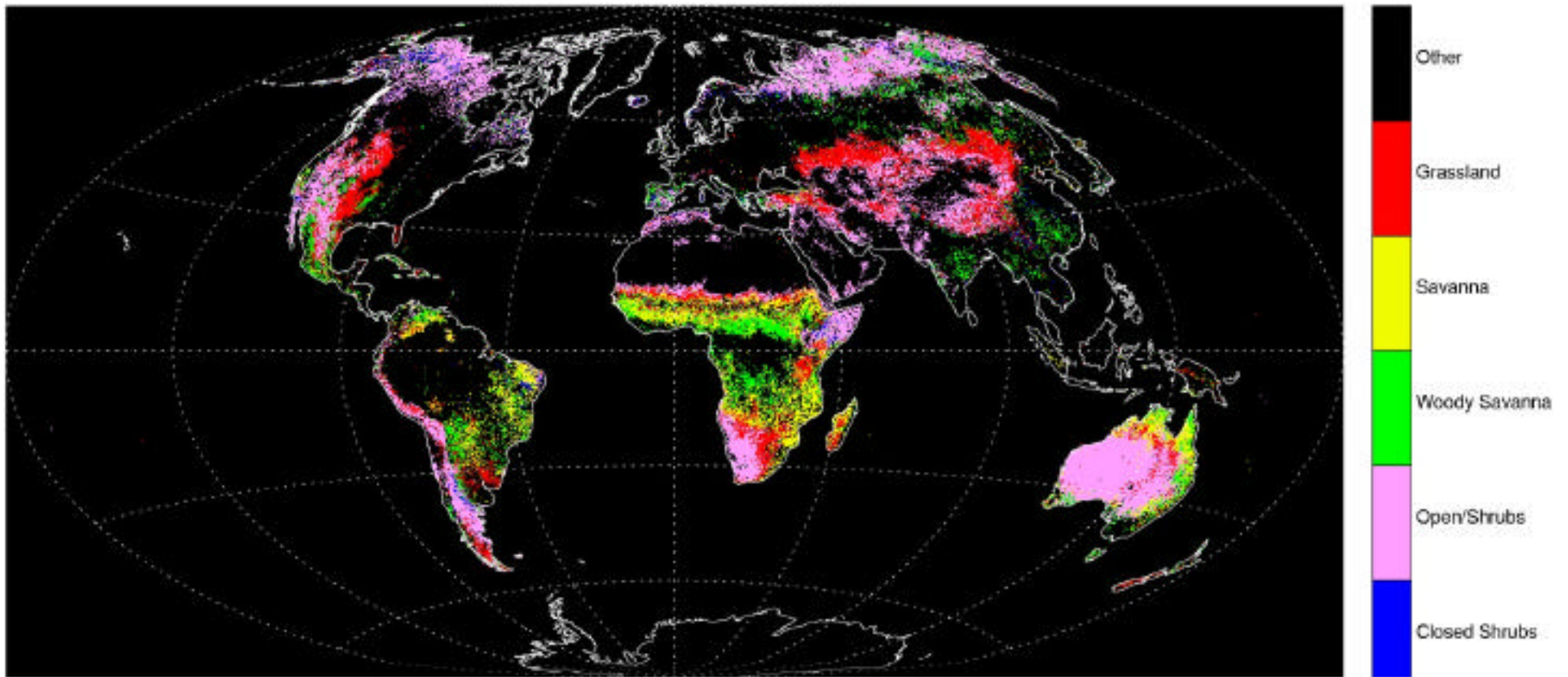
Global Ecosystem Distribution



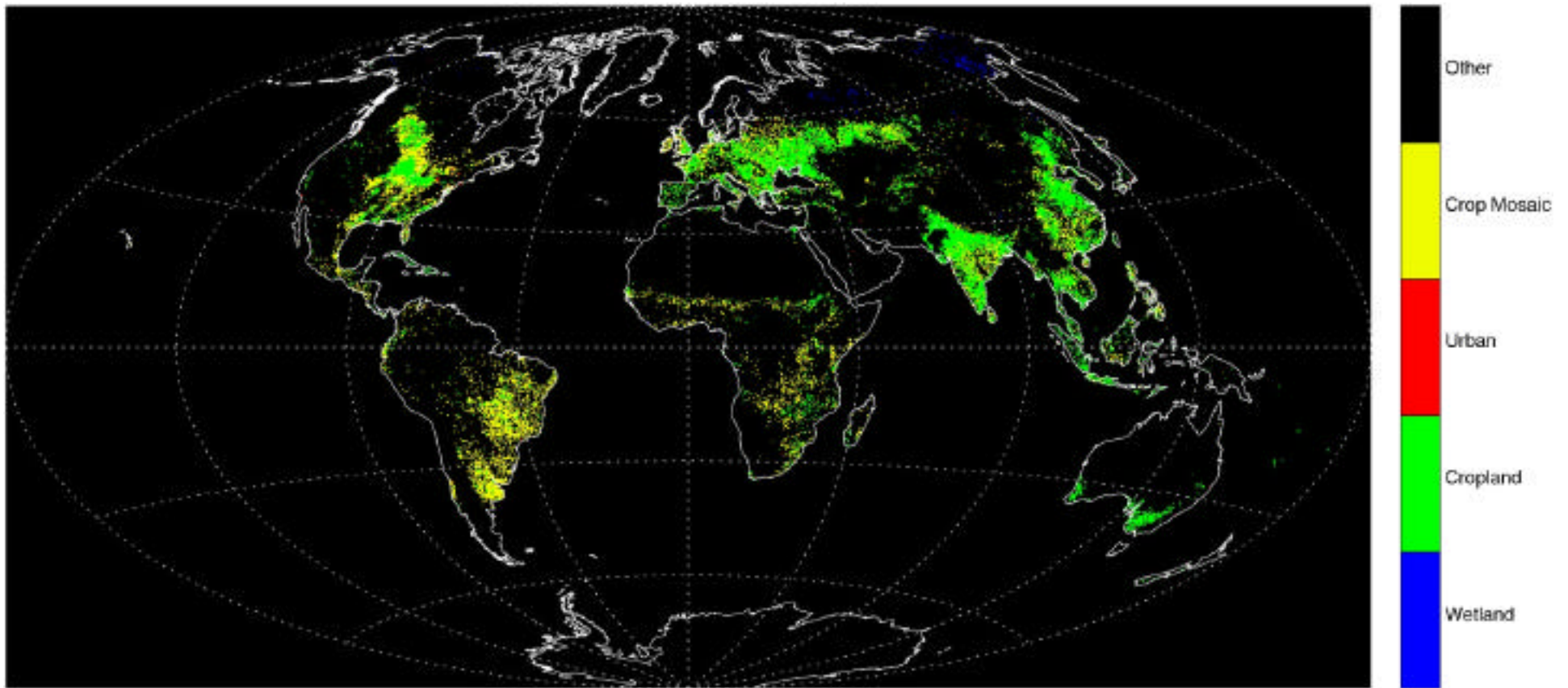
Forest Ecosystem Distribution



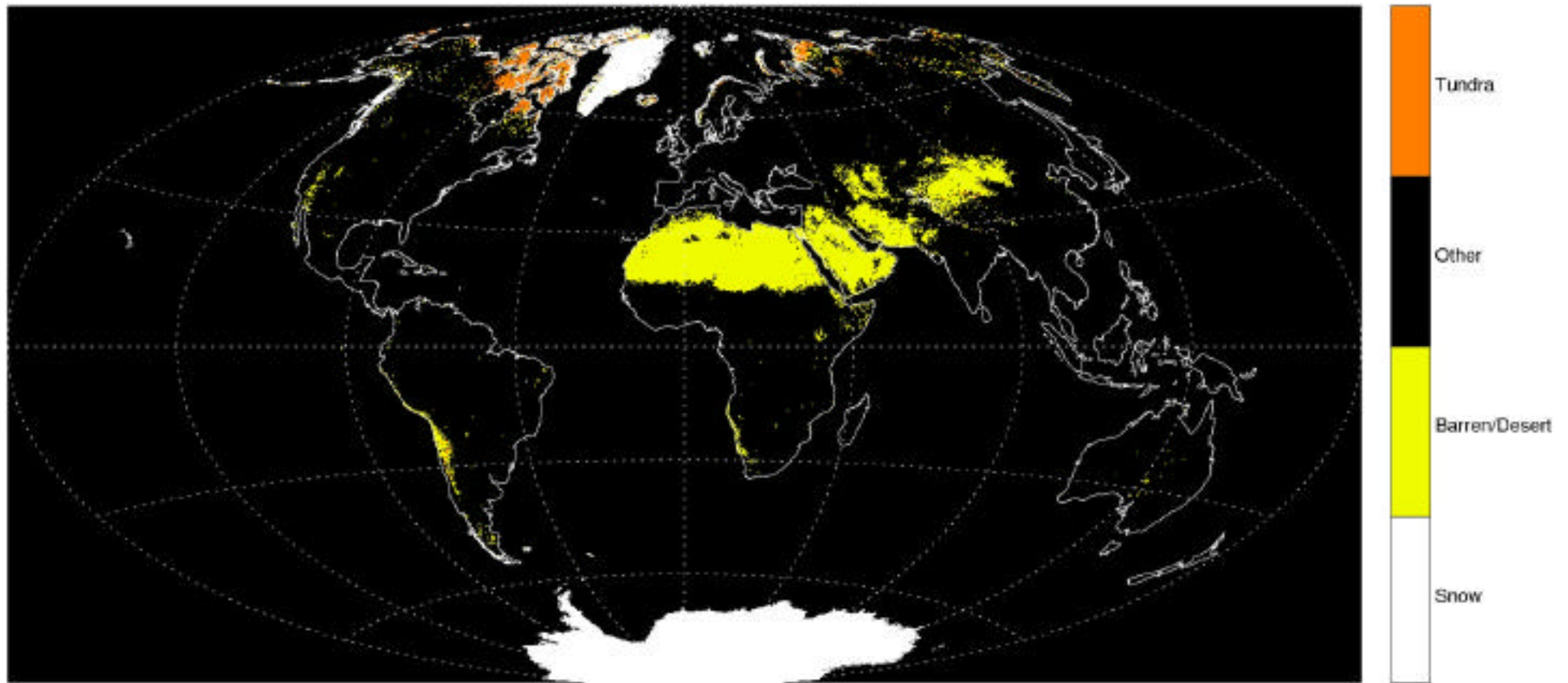
Savanna Ecosystem Distribution



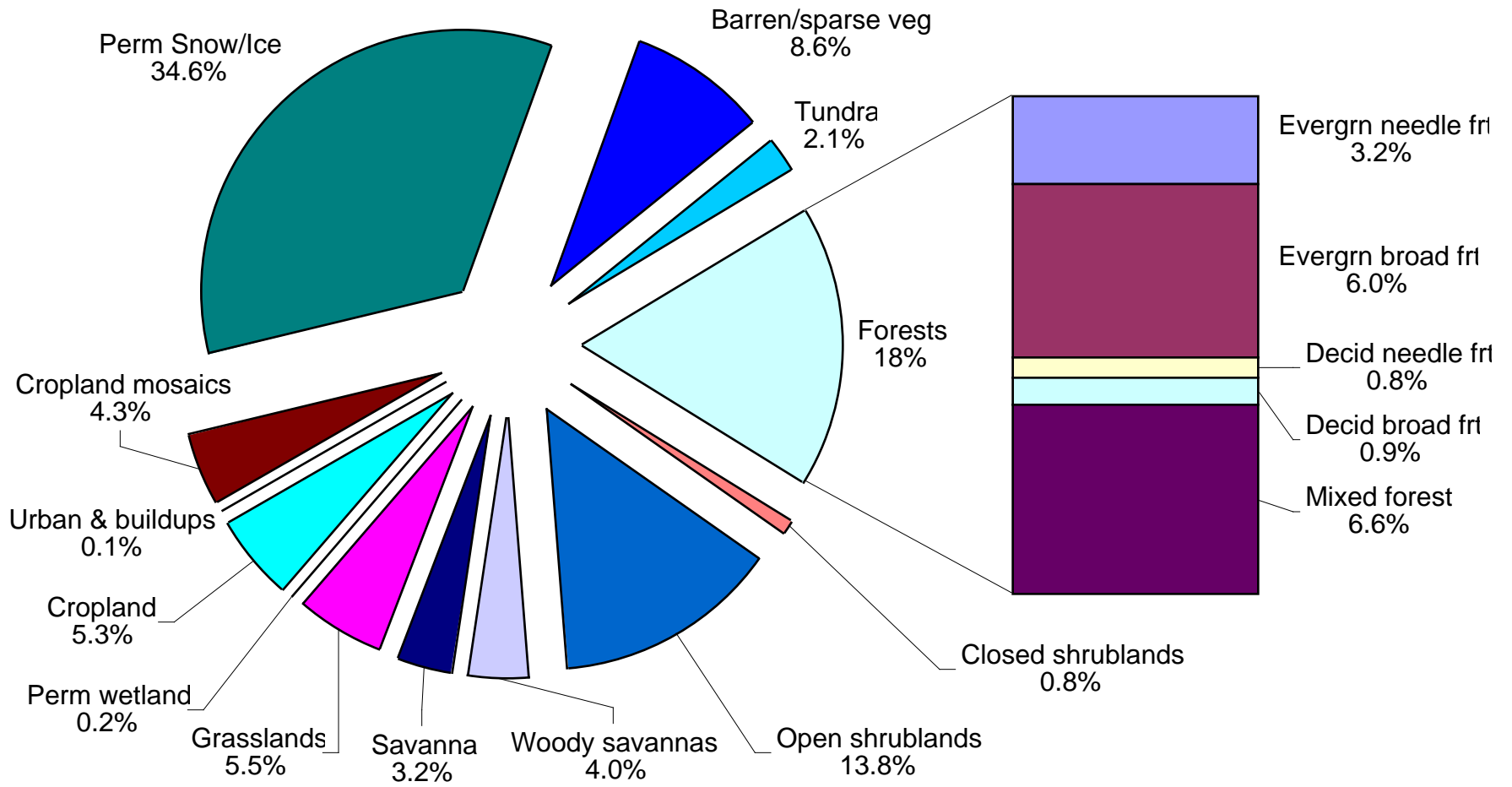
Other Vegetation Distribution



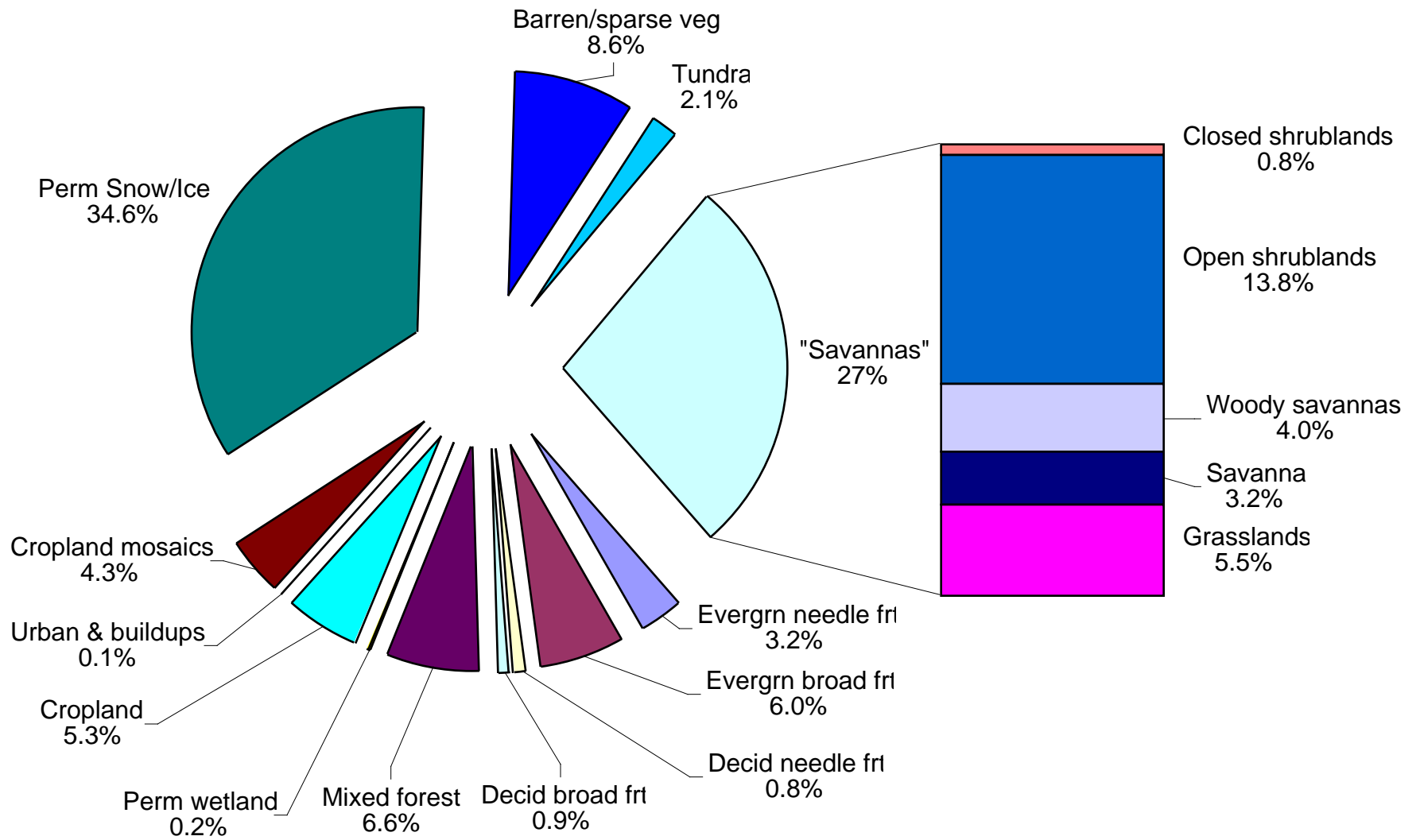
Miscellaneous Distributions



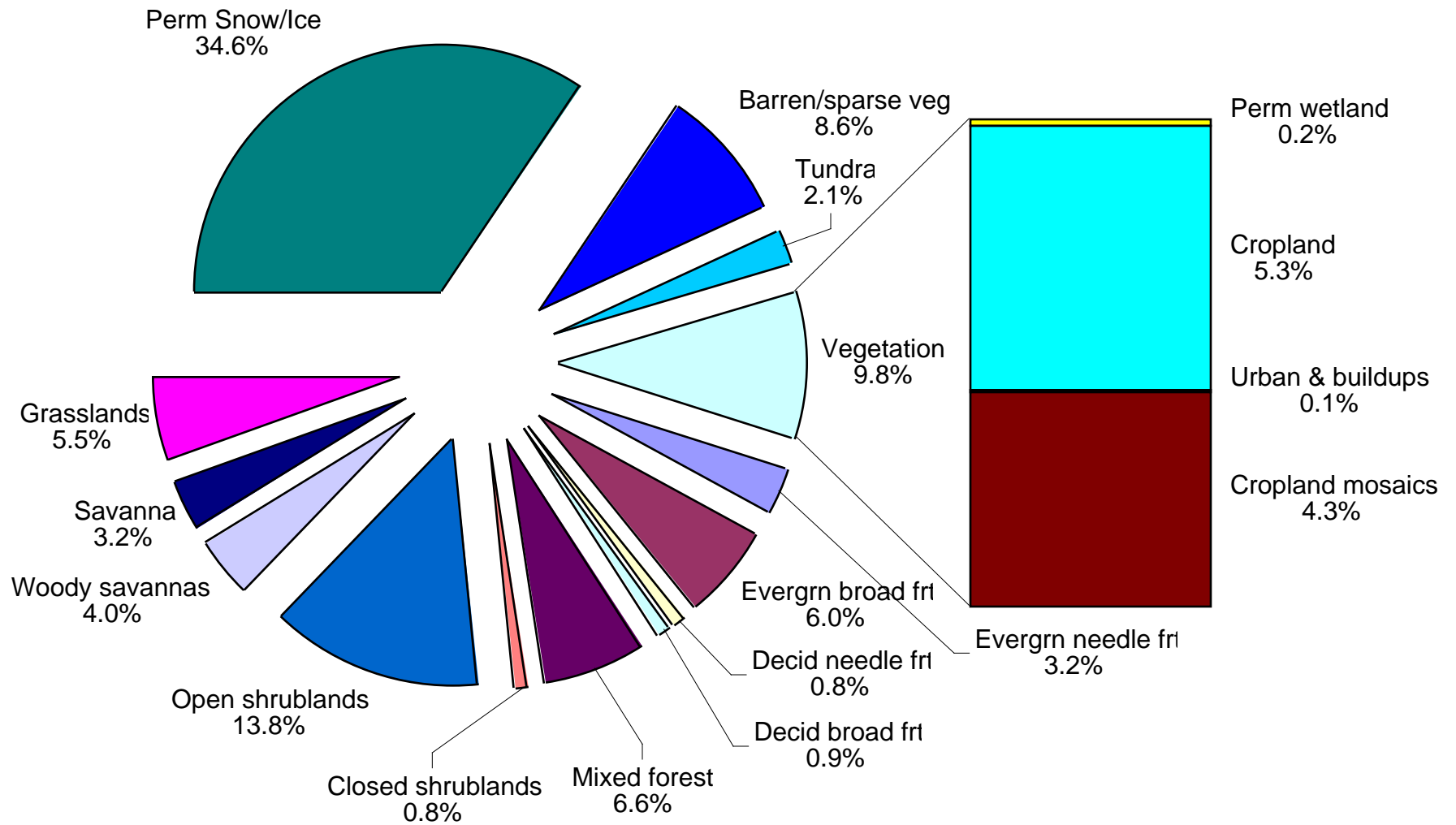
Ecosystem Distribution - Forest Breakdown.



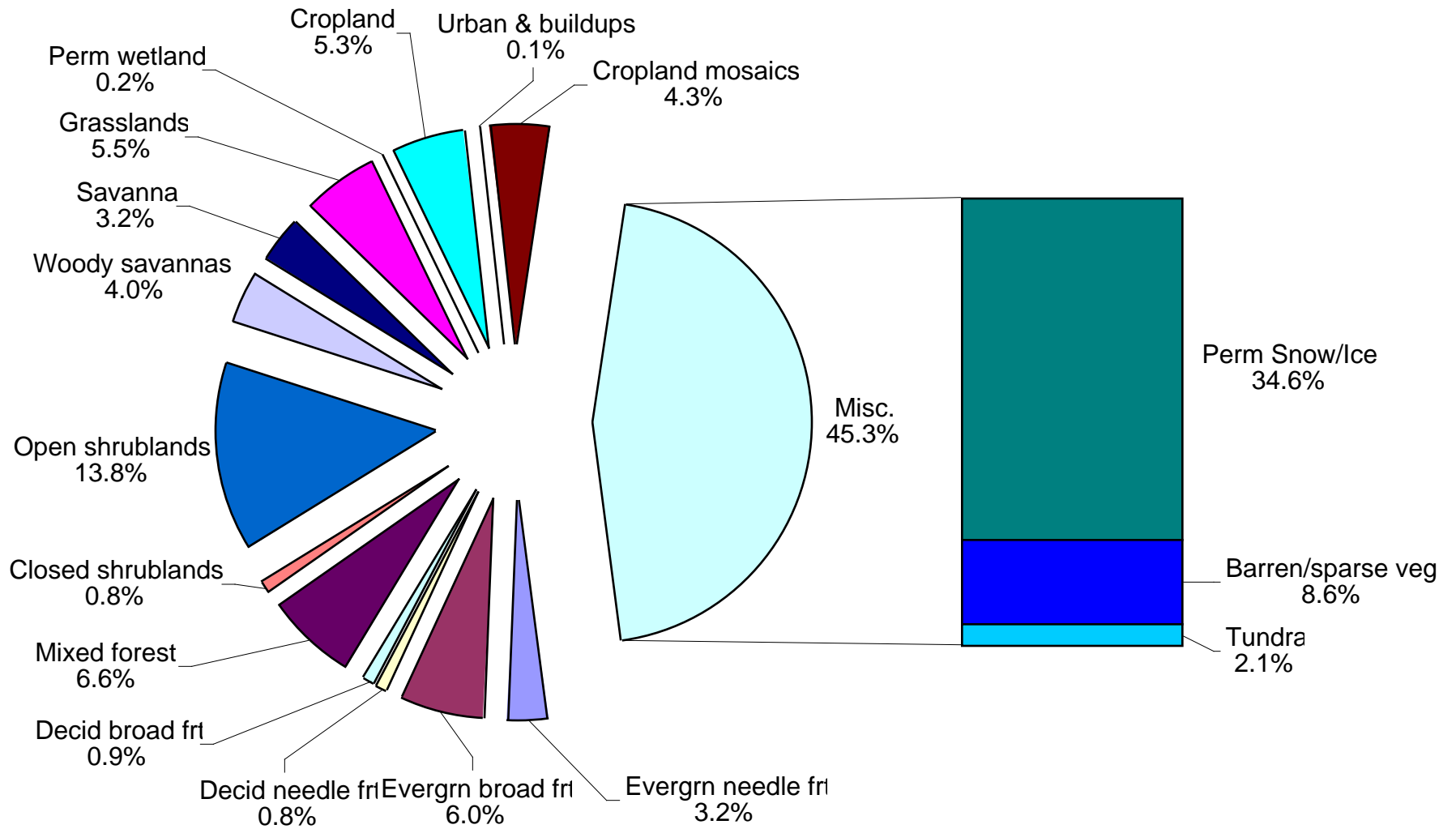
Ecosystem Distribution - Savanna Breakdown.



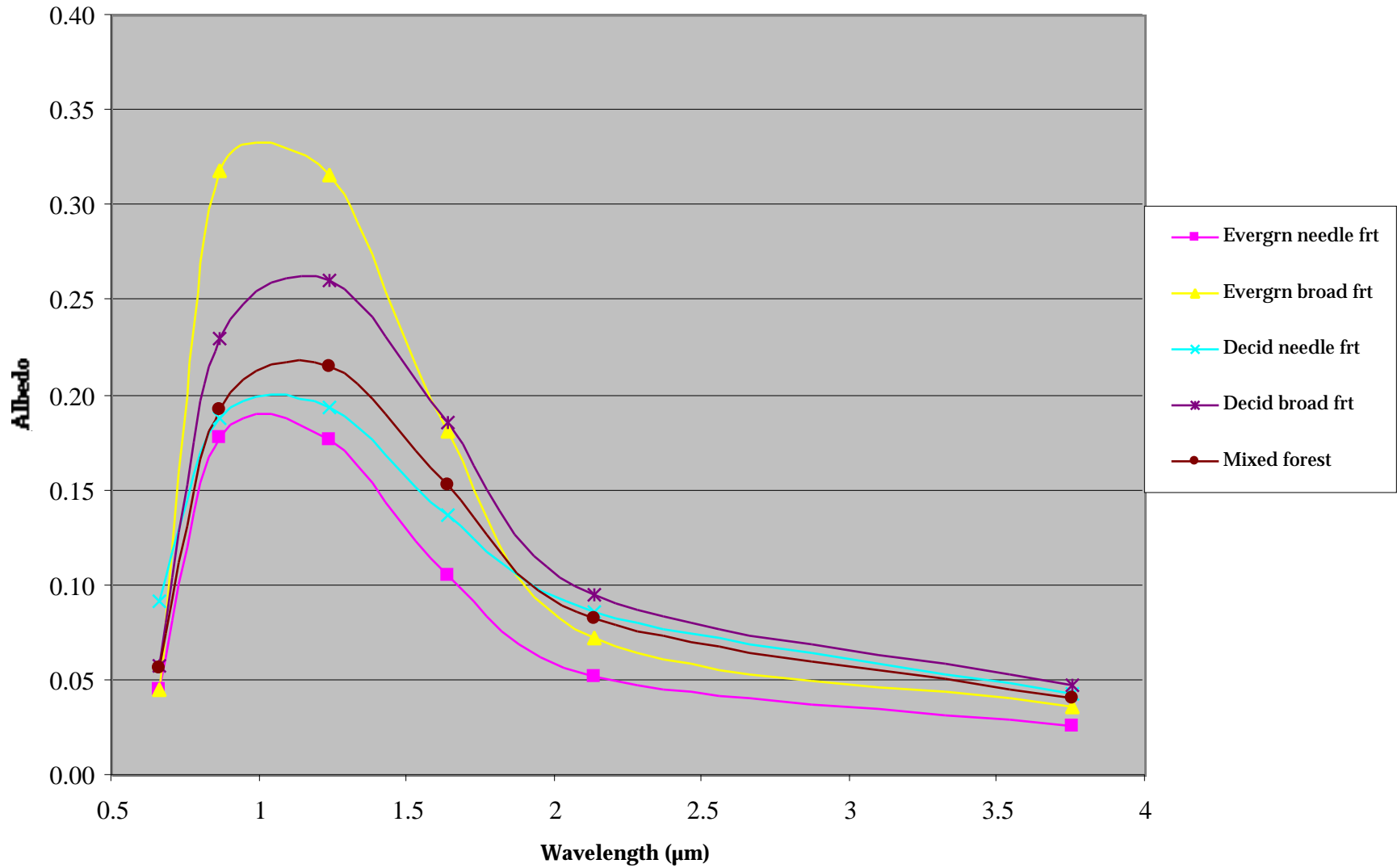
Ecosystem Distribution - Other Vegetation.



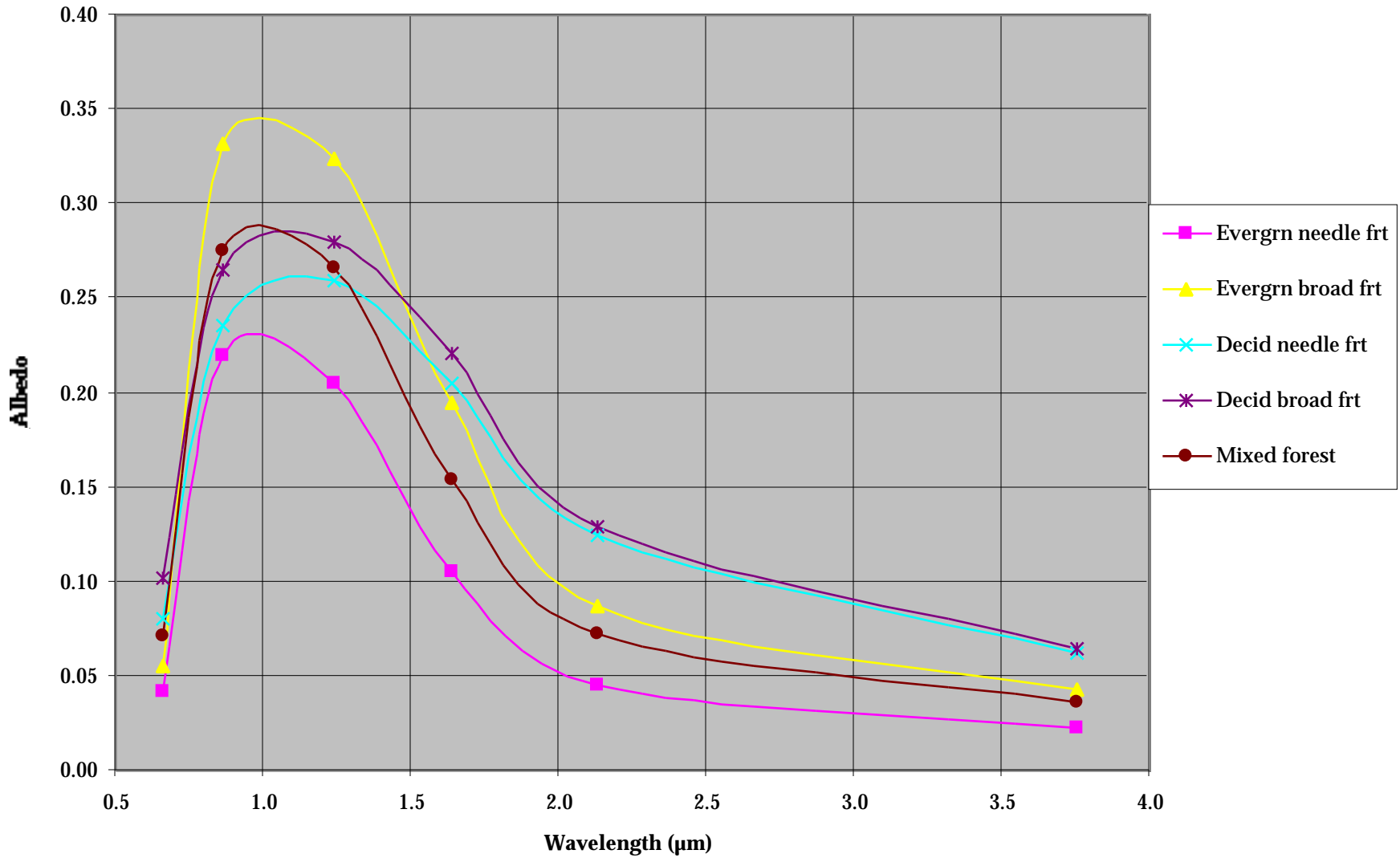
Ecosystem Distribution - Miscellaneous.



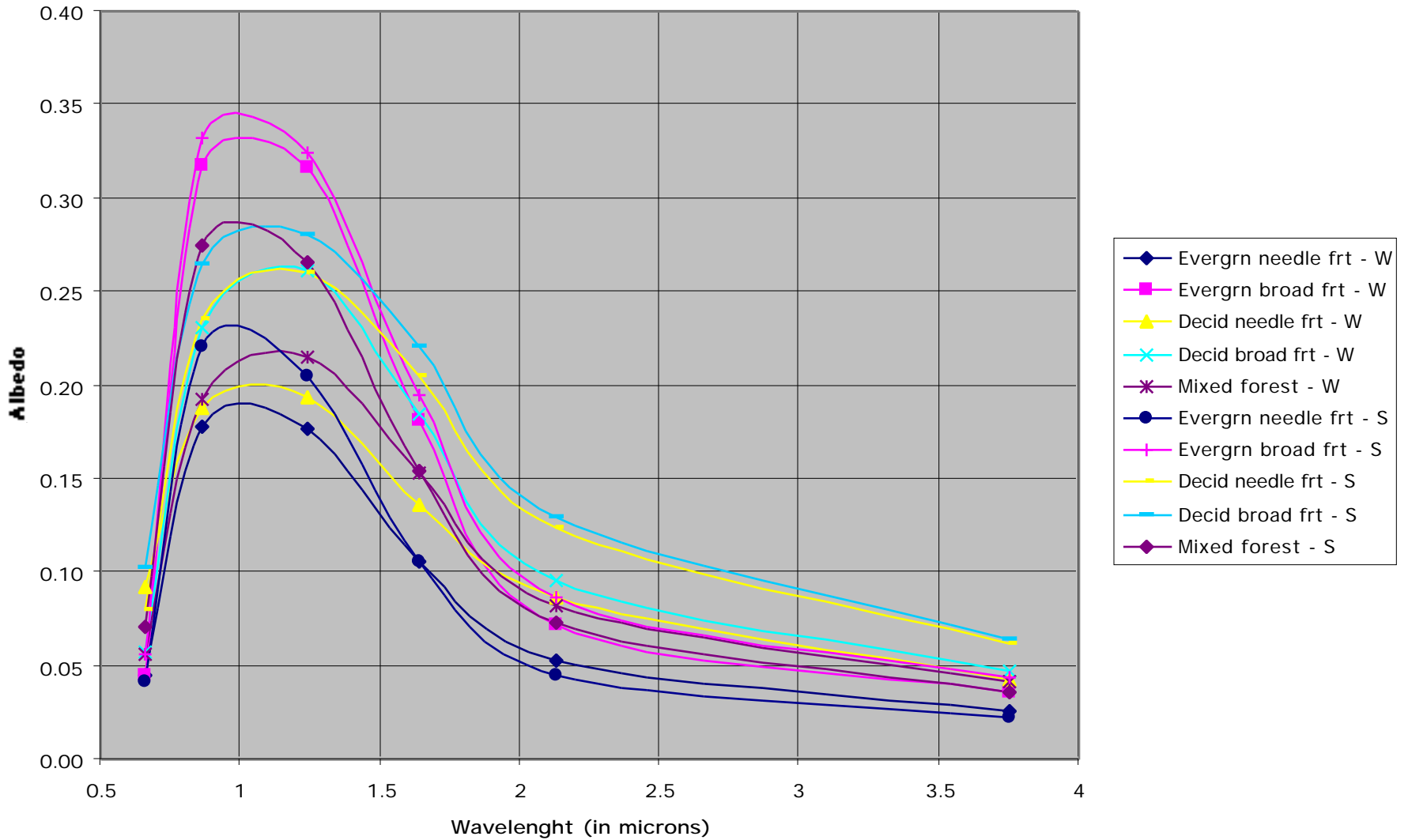
Winter Albedo Means (winter solstice).



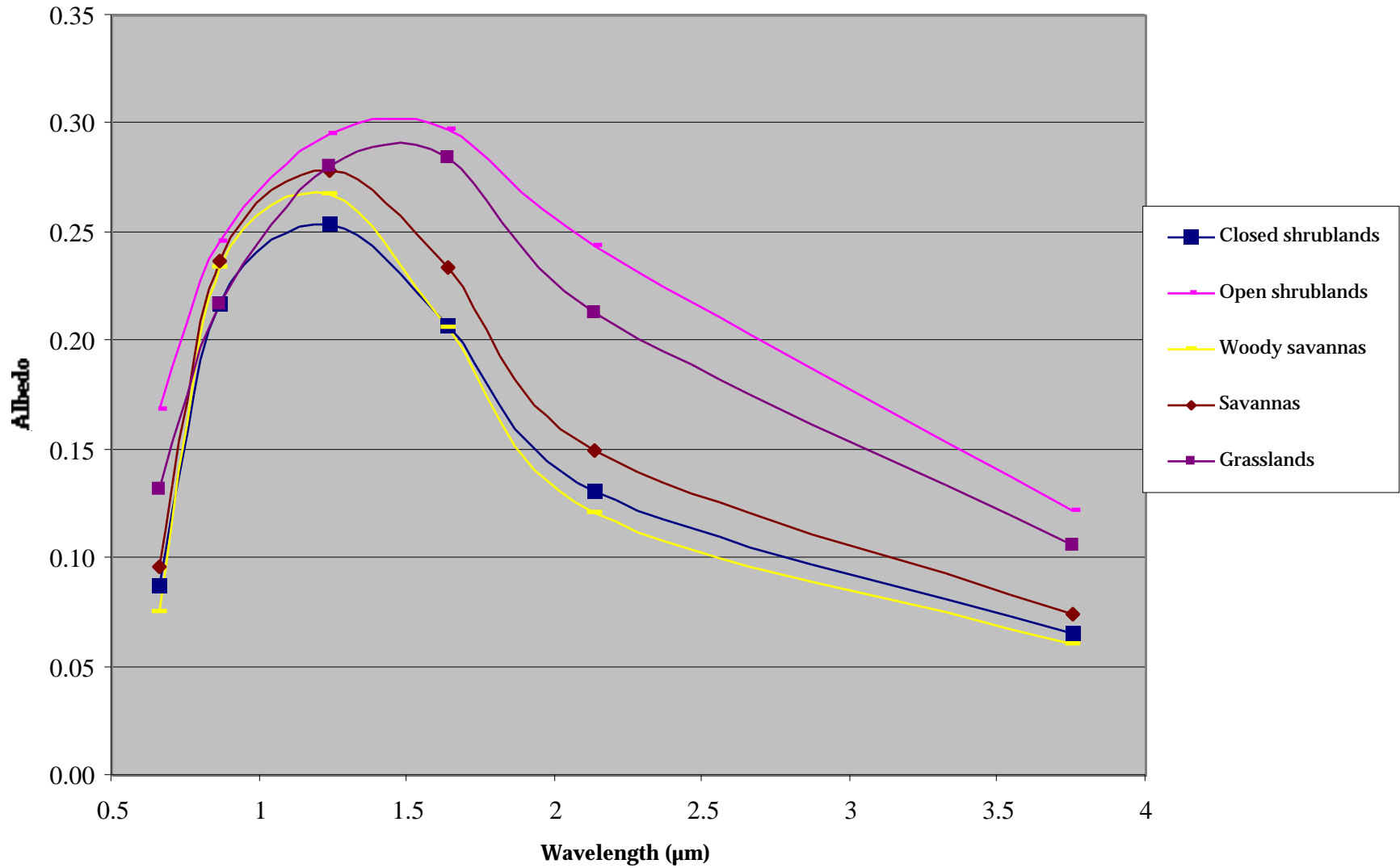
Summer Albedo Means (summer solstice)



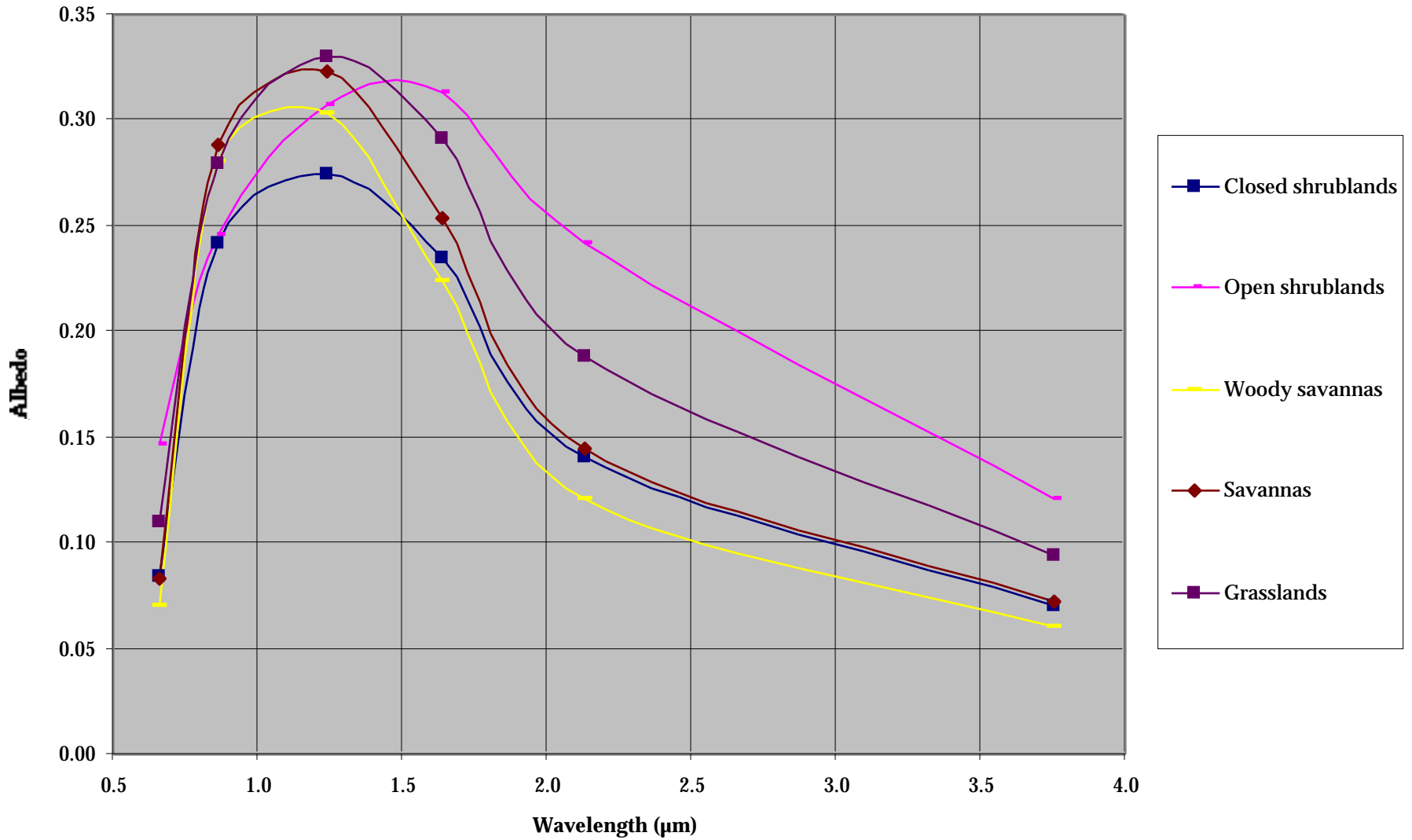
Forest Winter (W) and Summer (S) Albedo Means



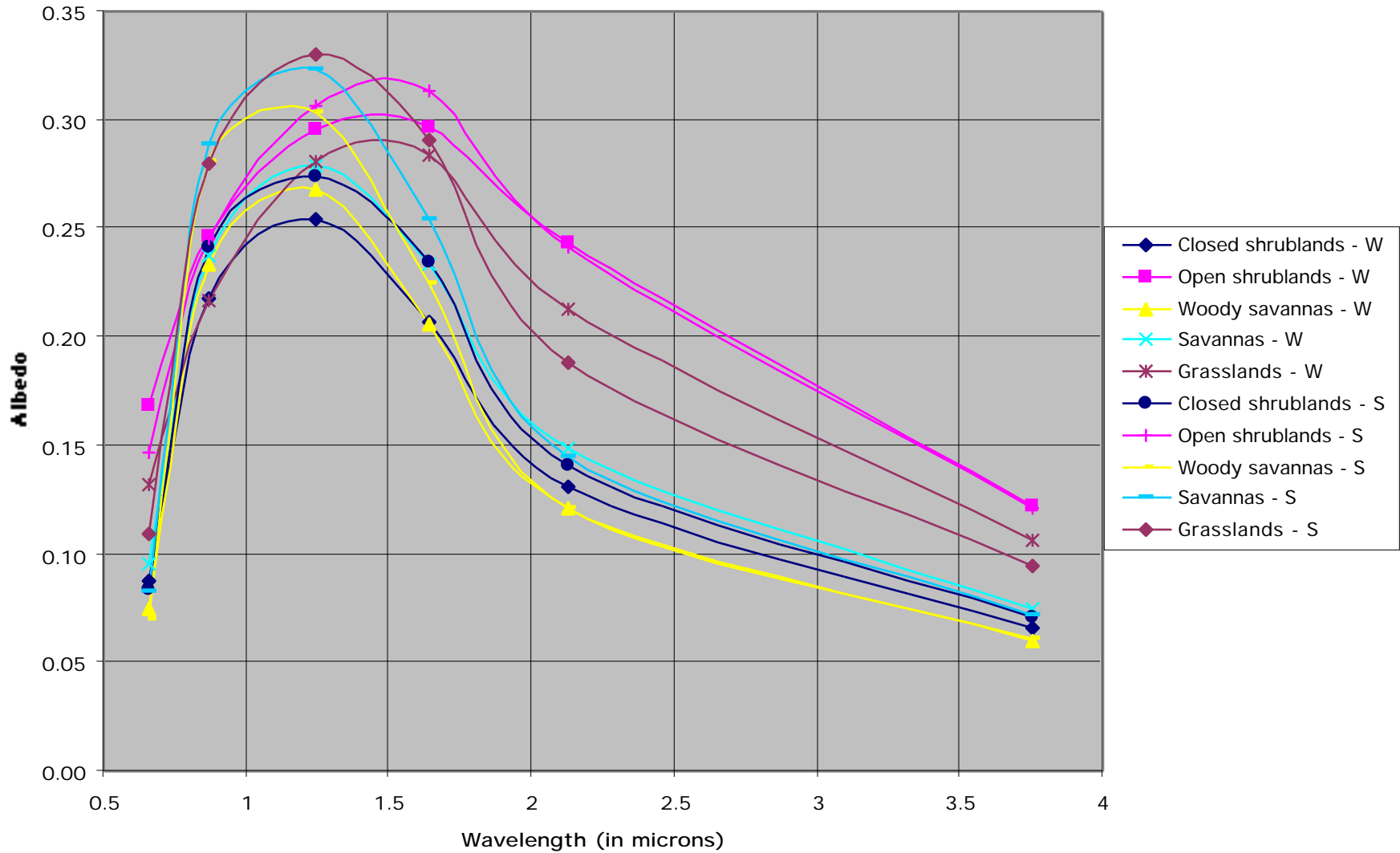
Winter Albedo Means (winter solstice).



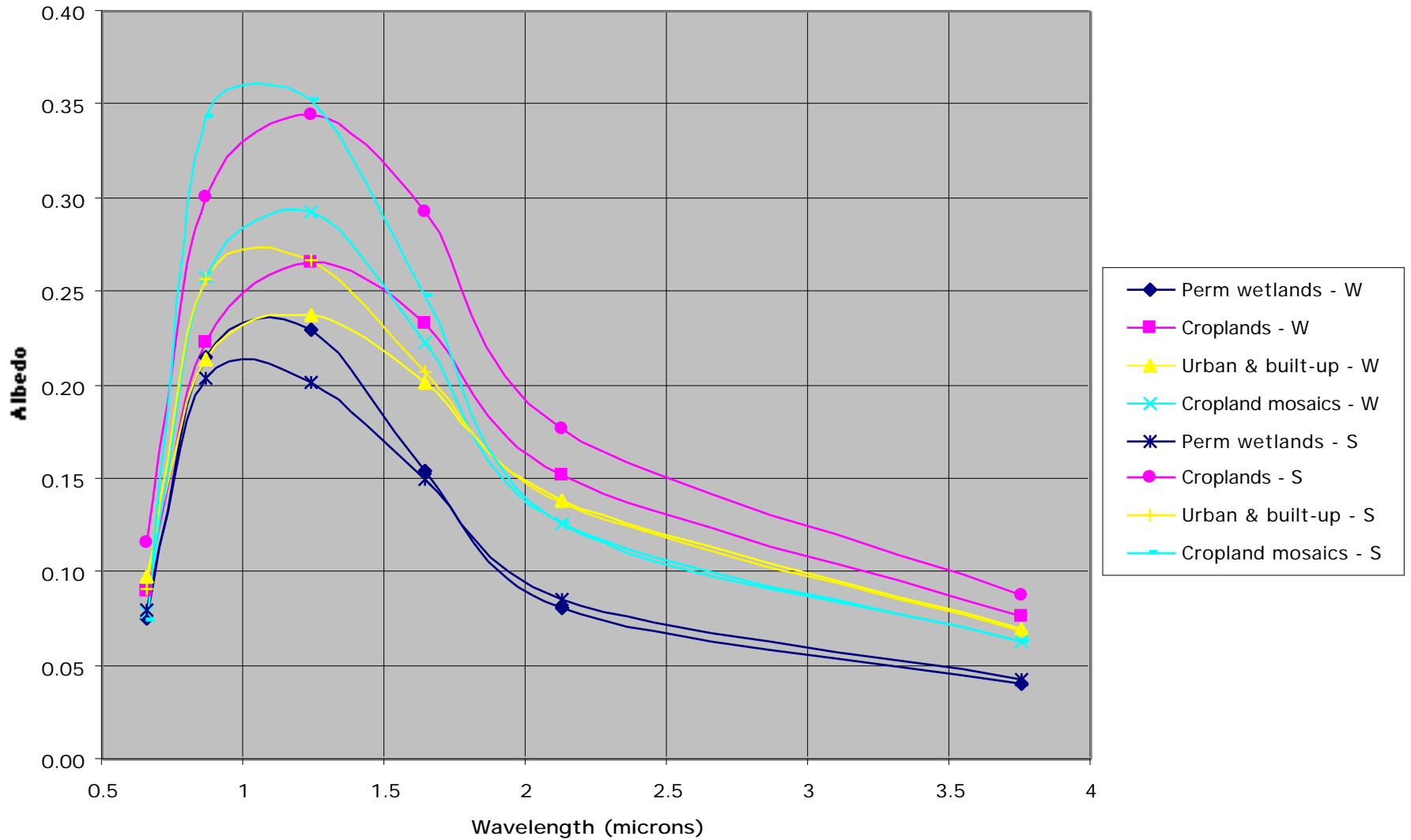
Southern Hemisphere Albedo Means



Combined winter (W) and summer (S) albedos.



Winter (W) and Summer (S) Albedos.



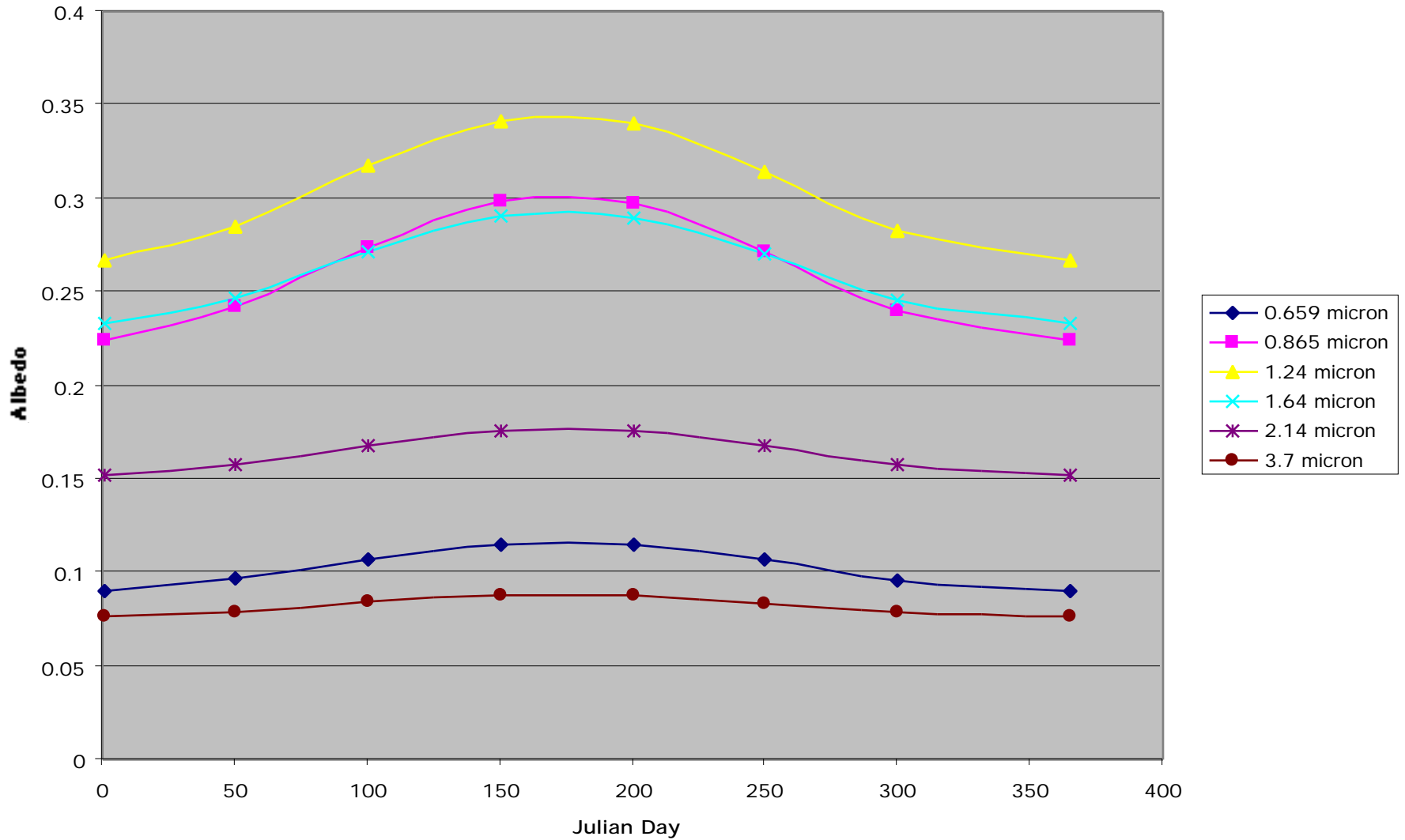
Standard Deviations.

	Southern Hemisphere				
Wavelength (in microns)	0.659	0.865	1.24	1.64	2.1
Average % Error	2.21%	1.61%	1.52%	1.78%	2.31%
Max % Error	4.10%	4.59%	6.30%	6.60%	7.18%

	Northern Hemisphere				
Wavelength (in microns)	0.659	0.865	1.24	1.64	2.1
Average % Error	2.56%	2.11%	1.90%	2.14%	2.58%
Max % Error	4.84%	4.20%	4.79%	4.87%	5.99%

- Albedo means at various wavelengths and times of year, for all ecosystem types, are within 7%.
- Majority are within 3%
- Suggests a reasonable correlation between ecosystem and albedo.

Cropland - Seasonal Albedo Spectra.



Download the movie referenced here at:

http://modis.gsfc.nasa.gov/sci_team/meetings/200112/presentations/atmos/moody/Images/QT-Alb_reg/NorthAmerica.qt

Albedo Movies

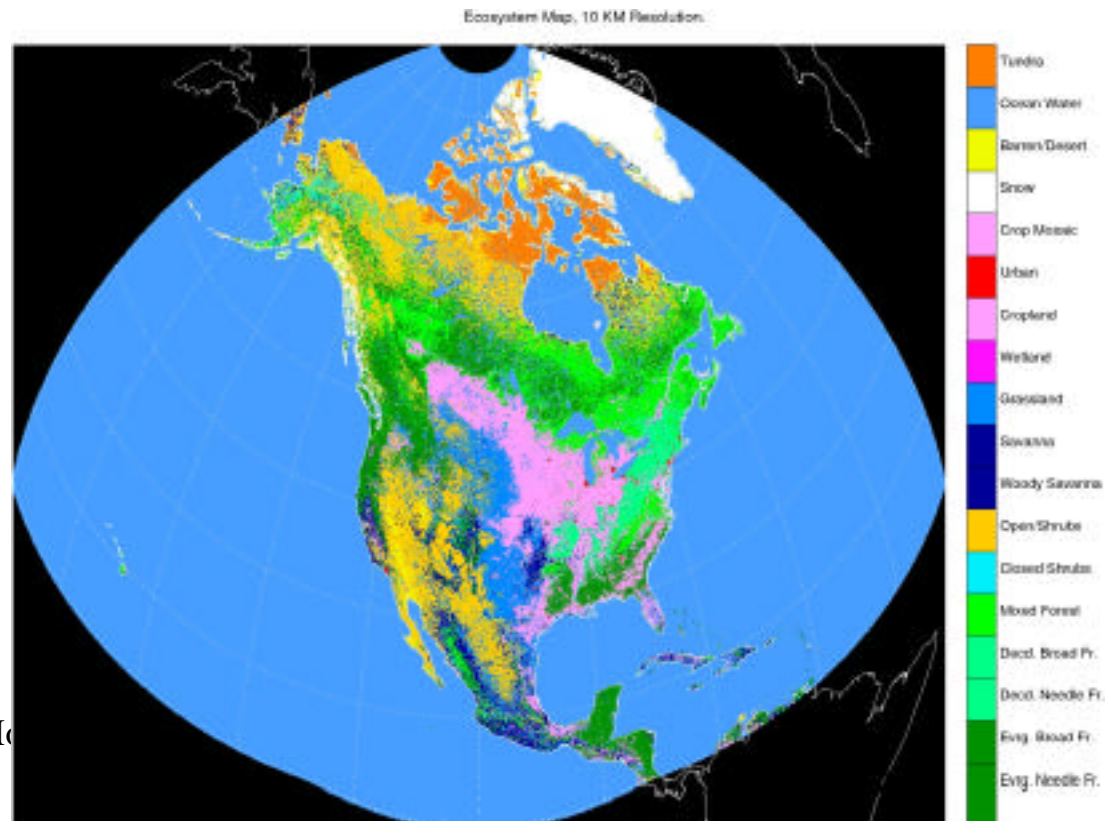
- Loops through bands 0.65, 0.86, 1.24, 1.64, 2.1, and 3.7
- Loops through seasonal equinox and solstice, progressing from Julian days 91, 173, 293, 356

Ecosystem Color Scheme

- Pink = Crops
- Green = Trees
- Yellows = Barren/Deserts
- Blues = Savannas

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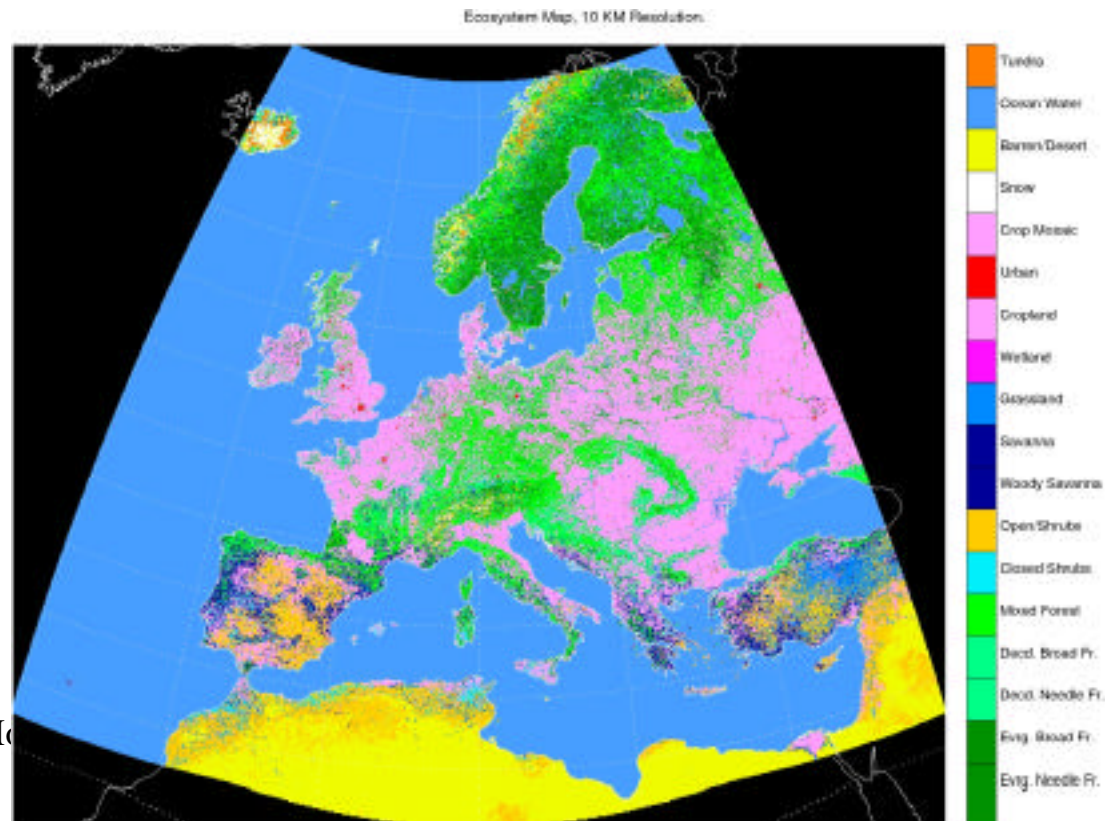
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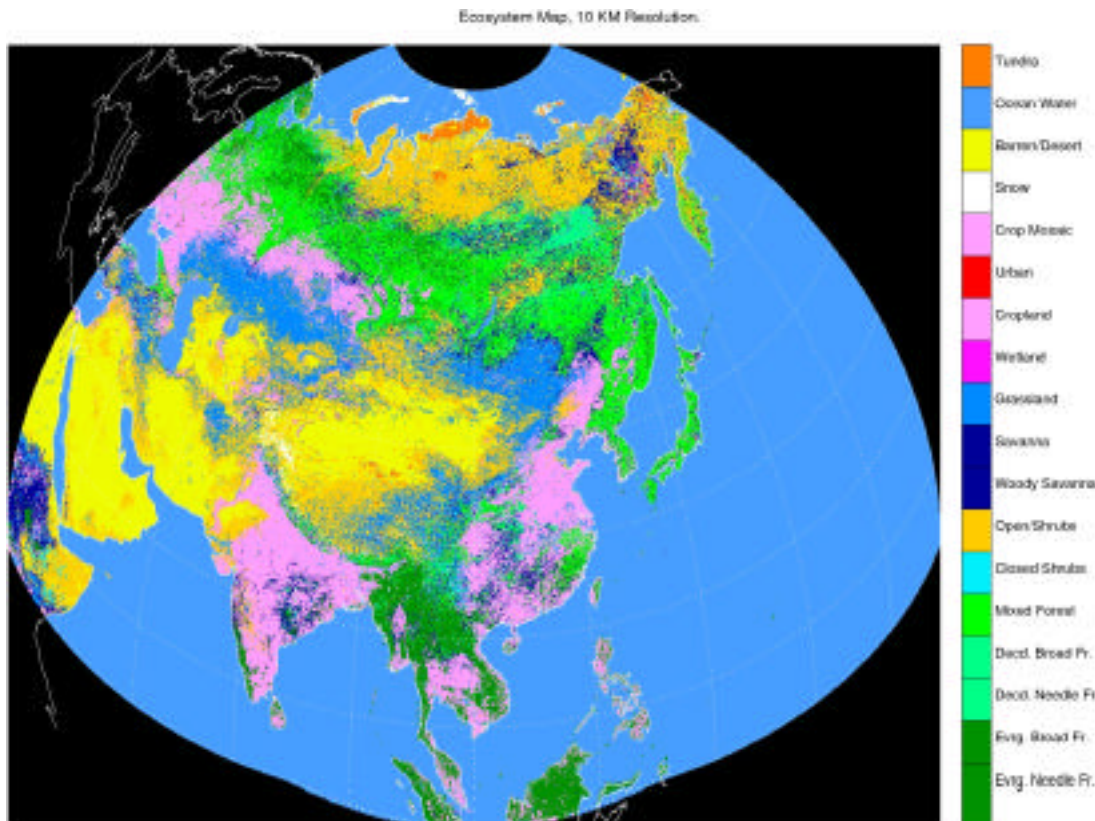


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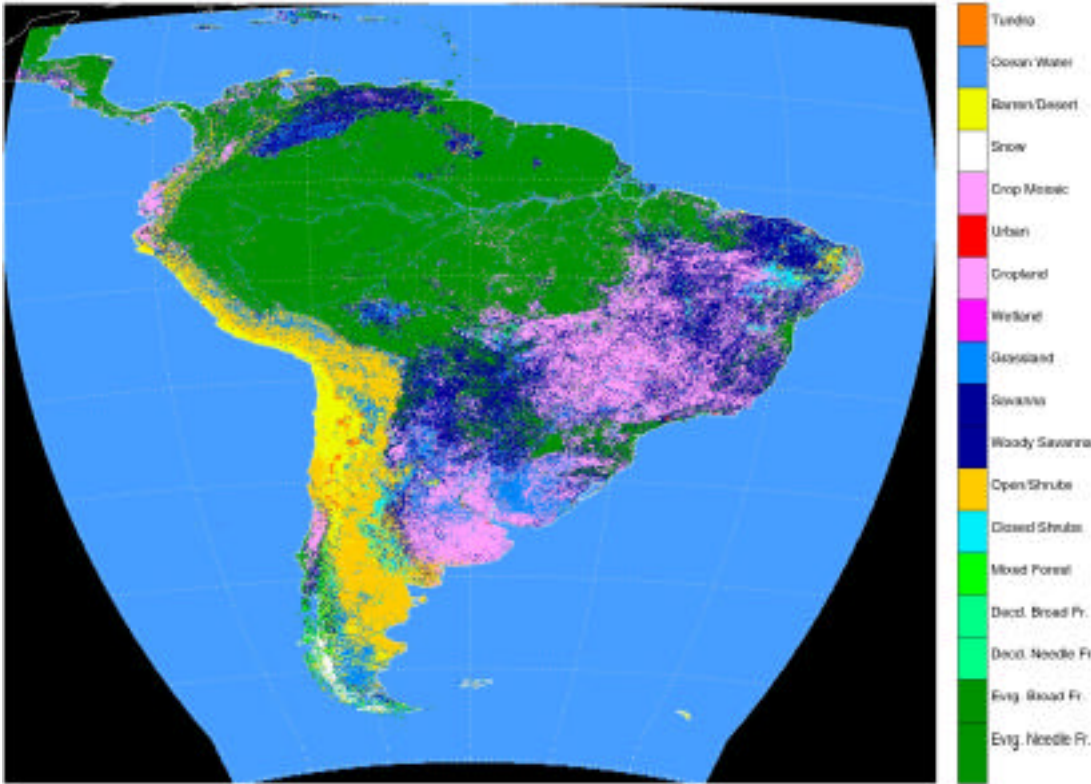
http://modis.gsfc.nasa.gov/sci_team/meetings/200112/presentations/atmos/moody/Images/QT-Alb_reg/Asia.qt



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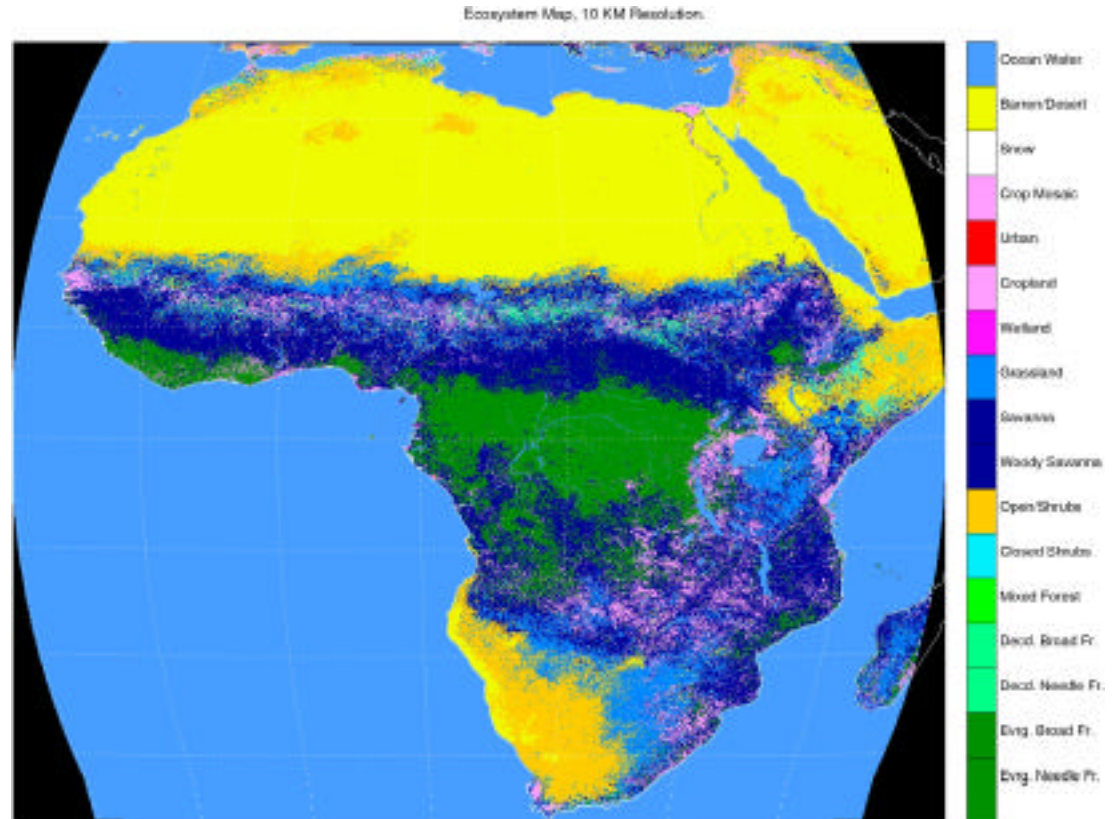
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Albedo Movies

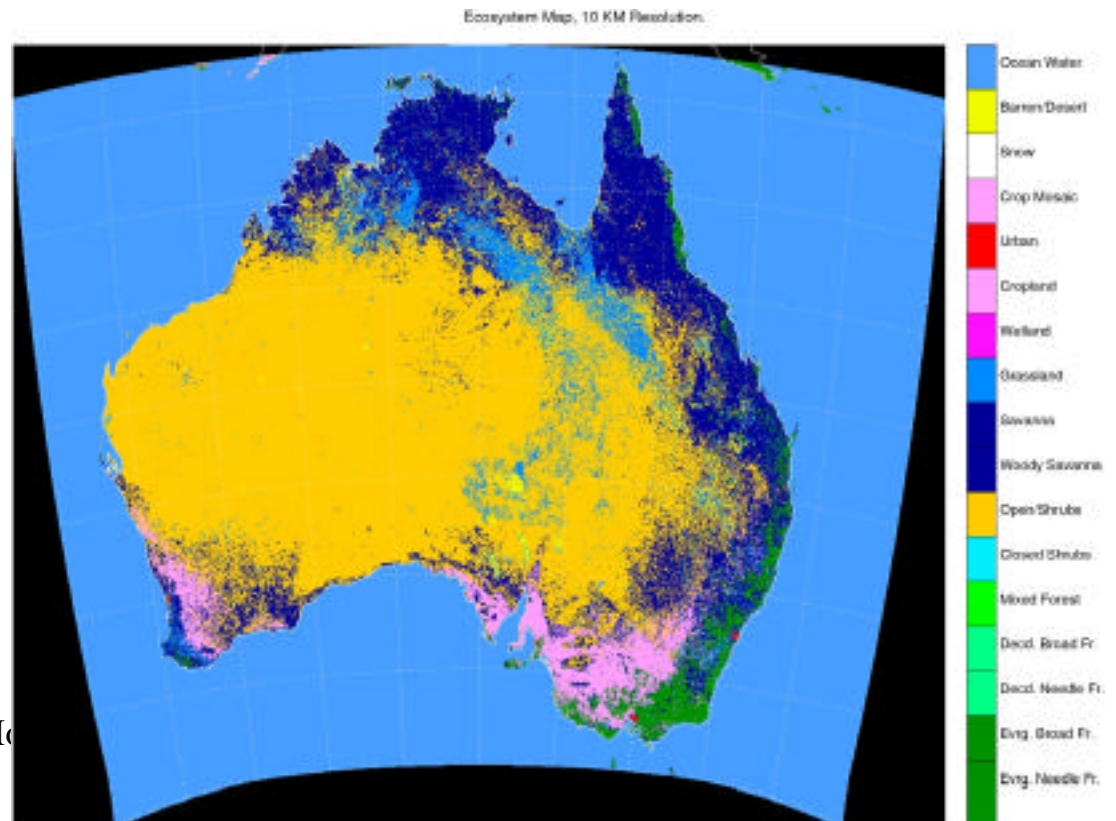
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Conclusions

- Improved surface albedo data for use in consistent year processing.
- Provided albedo and ecosystem data sets at a finer resolution.
- Added seasonal variability.
- Provided albedos at specific wavelengths of interest.
- Ecosystem can be used as a surrogate for albedo.

Future Directions

- Use a full year's data (from consistent year) to improve ecosystem and albedo statistics.
- Investigate global albedo maps.
- Investigate ecosystem-albedo surrogate.

- ISRSE presentation, April 2002.
- Publish this work with BU group.