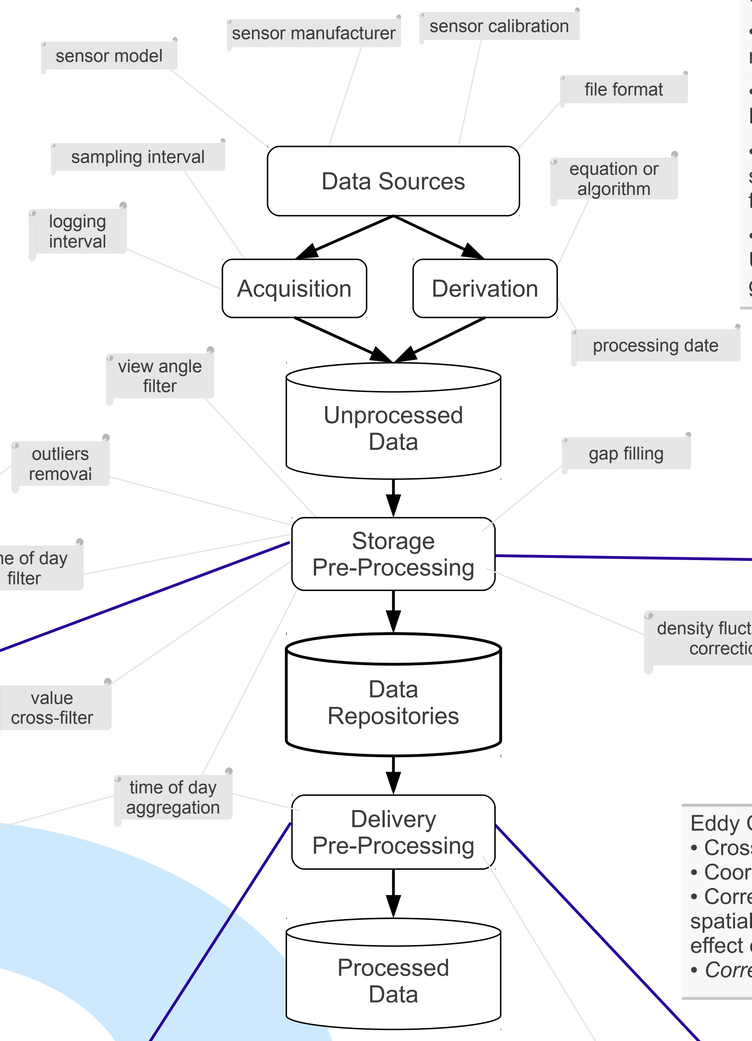
A METADATA ORIENTED MODEL FOR INTEGRATION AND EXPLORATION OF OPTICAL AND FLUX DATA

Gilberto Z. Pastorello, John A. Gamon, Saulo Castro, and Scott Williamson

University of Alberta

Edmonton, AB, Canada

- Carbon flux monitoring, using both optical and eddy covariance methods, involve several data dimensions.
- Common dimensions: spatial and temporal.
- New dimensions: spectral and metadata.
- Metadata are generated and consumed from data acquisition time (mostly equipment and field metadata) to data delivery time (processing choices also need documentation).
- Examples of key processing steps involving choices: gap filling, filtering, integration and aggregation methods, spectral calibration, atmospheric corrections, sensor view angle.
- All these dimensions need to be an integral part of data analysis and visualization in order to isolate and understand factors affecting the upscaling of field measurements and carbon fluxes in general.
- This work aims at building a system that leverages these dimensions in data querying, transformation, analysis and visualization.

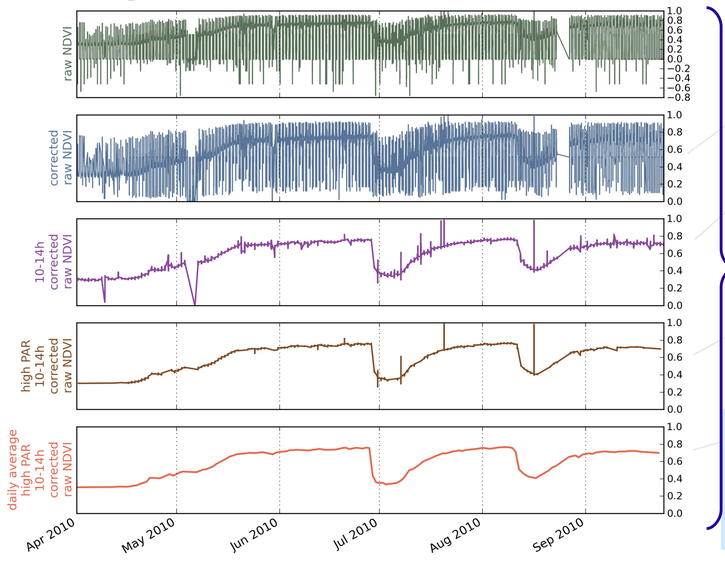


Metadata

Categories of metadata:

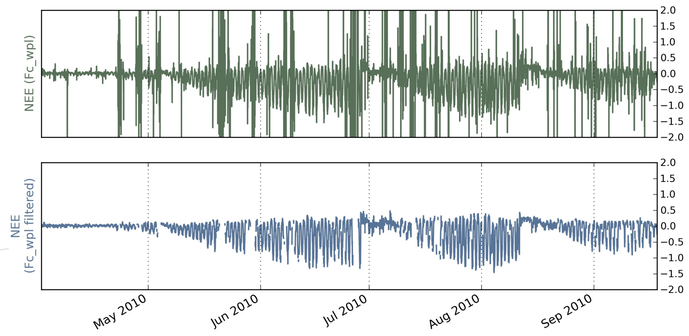
- **Equipment metadata.** Widely adopted and automated. Examples: sensor serial number, calibration factor, sampling interval.
- **Field metadata.** Restricted to specific experimental setups; often harder to automate. Examples: visual sky conditions, manual battery check, alignment angles.
- **Processing metadata.** Ad-hoc adoption with potential for automation (dependent on software support and standards). Examples: spectral calibration, gap filling method, filtering threshold selection.
- **"Intrinsic" metadata.** Always present (defines a data set) and "easy" to automate. Usually considered part of the data and not metadata. Examples: timestamps, geographic coordinates, spectral ranges and steps.

Optical: Tower Broadband



Tower Broadband NDVI in an alfalfa field in Edmonton, Alberta (53.497° N 113.552° W). Sensors are located 3m above ground in a phenology and meteorology stations. Graph shows data cleaning through simple filters. Such filters can be configured in several ways, leading to many possible choices.

Flux: Tower Eddy Covariance



NEE from an alfalfa field in Edmonton, AB. Graph shows the effect of correction for rainy periods based on thresholds density fluctuations.

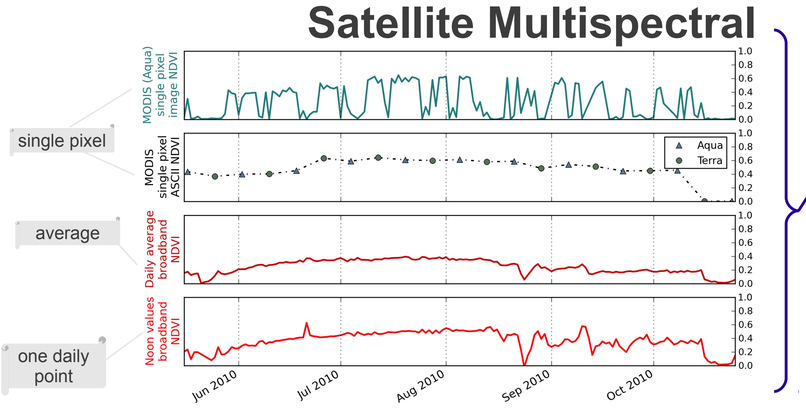
Eddy Covariance Pre-Processing (Mauder et al. 2006):
- Cross-wind correction of the sonic temperature
- Coordinate rotation after Planar Fit method
- Correction of spectral loss (path length averaging, spatial separation of sensors and frequency dynamic effect of of signals)
- *Correction for density fluctuations (WPL, shown above)*

Light Use Efficiency (LUE) Model

NEE = (fAPAR * PAR) * ε

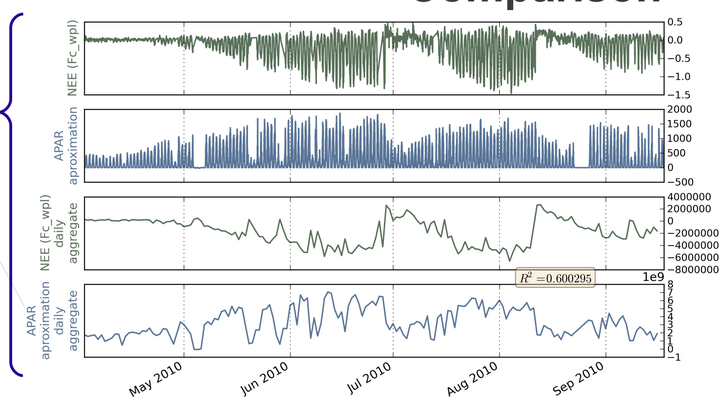
APAR

Optical: Tower Broadband vs Satellite Multispectral



Comparison of MODIS NDVI (calculated from reflectance data and retrieved through the MODIS ASCII Subset Tool) and Tower Broadband NDVI (daily average and noon values) for an arctic fen in Churchill, Manitoba (58.665° N 93.830° W).

Optical vs Flux: Aggregated Comparison

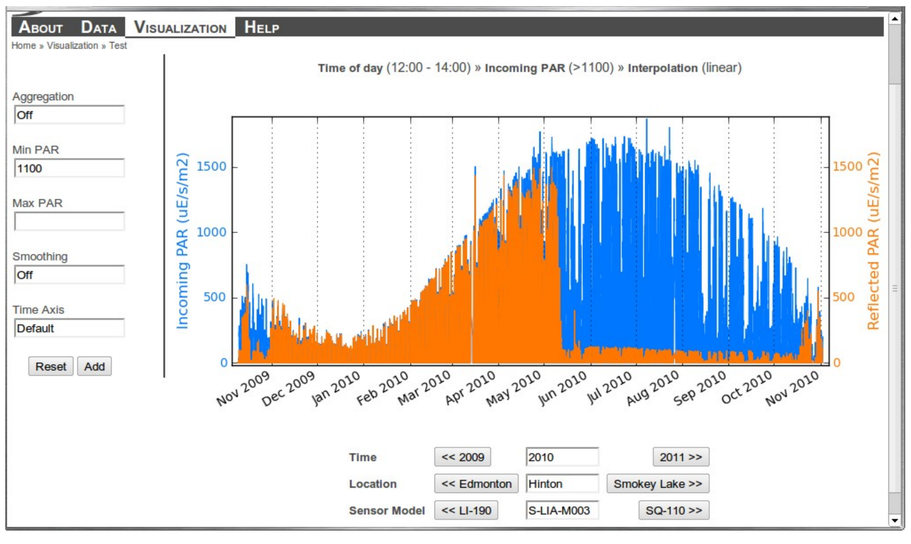


Comparison between NEE and APAR from an alfalfa field in Edmonton, AB. NEE corrected for density fluctuations and APAR calculated from combining Tower Broadband NDVI and incoming PAR, simulating fAPAR.

Common integration (technical) challenges:
- incompatible data formats
- undocumented changes in the data
- lack of QA/QC information
- unavailable original (raw) data sets
- incomplete software support

Collect and Associate Metadata with Data Sets → Active Usage of Metadata for *Exploration* of Data Sets

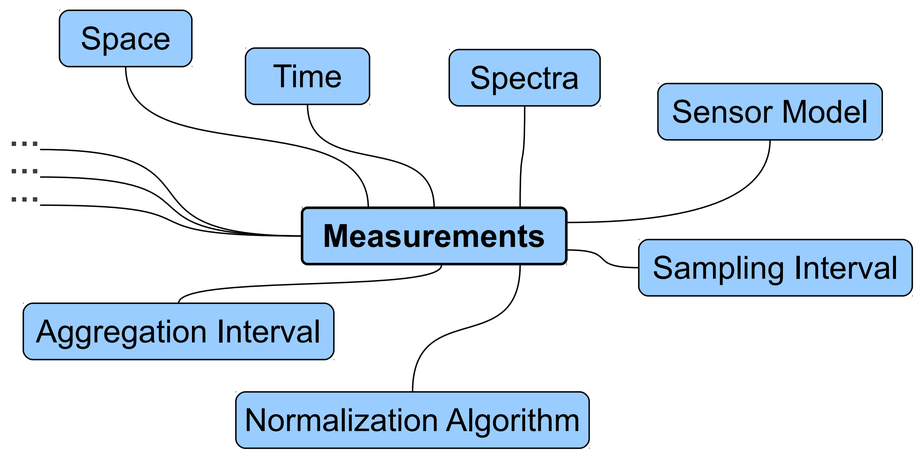
User Interface



Data Model:
- Support for multiple dimensions
- Representation of any metadata type as a dimension
- Allow new metadata types
- Query based on any dimension, with grouping, averaging, filtering, cross-filtering, sums, etc.

User Interface:
- Apply filter (cross-filter) to any dimension or measurement type
- Integration operations for multiple datasets
- Library of operations to be used side by side with filters
- Navigation through dimensions (both continuous and discrete)

Data Model



Support

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Contact

Gilberto Z. Pastorello (gilbertozp@acm.org)
John A. Gamon (jgamon@gmail.com)