May 2nd, 10:30 AM - 12:00 PM

Eyes Over Puget Sound: Producing Validated Satellite Products to Support Rapid Water Quality Assessments in Puget Sound

Brandon Sackmann  
*Integral Consulting Inc.*, bsackmann@integral-corp.com

Christopher Krembs  
*Washington (State). Department of Ecology*

Suzan Pool

Julia Bos

Tarang Khangaonkar  
*Pacific Northwest Pollution Prevention Resource Center*

Follow this and additional works at: [https://cedar.wwu.edu/ssec](https://cedar.wwu.edu/ssec)

Part of the [Terrestrial and Aquatic Ecology Commons](https://cedar.wwu.edu/collections/nat/terrestrial-aquatic-ecology)


This Event is brought to you for free and open access by the Conferences and Events at Western CEDAR. It has been accepted for inclusion in Salish Sea Ecosystem Conference by an authorized administrator of Western CEDAR. For more information, please contact [westerncedar@wwu.edu](mailto:westerncedar@wwu.edu).
Eyes Over Puget Sound

Producing Validated Satellite Products to Support Rapid Water Quality Assessments in Puget Sound

Brandon Sackmann (bsackmann@integral-corp.com)
Christopher Krembs, Suzan Pool, Julia Bos, and Tarang Khangaonkar

2 May 2014
Salish Sea Conference 2014
What is Eyes Over Puget Sound (EOPS)

- Communication/outreach product developed by WA Ecology with a focus on near-surface conditions
- Merges aerial photographs, satellite data, ferry observations, in situ CTD measurements, mooring data, and regional weather

!!! 3+ yrs ... 640+ subscribers ... 1M+ downloads ... 2-day turn-around !!!
Satellite observations are most useful when they can be reconciled with ground truth observations.

Ferries provide a unique dataset that lets us do this in a scientifically-rigorous and cost-effective way.

Ferries provide a novel source of ground truth information.
Ferries for Science

- Turner Designs C3 optical sensor (May 2010-present)
  - Phytoplankton (chl a fluor.)
  - Turbidity
  - River water (CDOM fluor.)
  - Sea Surface Temperature

- RDI Citadel Thermosalinograph (2012-present)
  - Sea Surface Temperature
  - Sea Surface Salinity

- RDI Workhorse Mariner ADCP 300 kHz (May 2014)
  - Depth-resolved currents
  - Acoustic backscatter
Ferries for Science

- Cost-effective data collection
  - 100 m spatial resolution (5 sec.)
  - 4-hr temporal resolution
- Regular schedules/Reliable
  - 80 mile long transect (30 knots)
  - 1-2 time daily (year-round)
  - 300 m spatial resolution
  - ~1-hr temporal resolution
- 5 mile long transect (8-10 knots)
  - 10-17 time daily (year-round)
- Daily data pickup (WSF data available via web)
What can be measured from space?
Hi-res products for coastal and offshore applications

- Time period: 2000 - Present (1-8 day revisit)
- Resolution: 30 - 500 m, hi-res; >1 km, standard-res
- Water Quality Indicators
  - Water Color (True Color/RGB)
  - Algal Biomass (Chlorophyll a, FLH, MCI)
  - Water Clarity (Turbidity)
  - Freshwater Influence (CDOM)
  - Sea Surface Temperature
- Combined approach using traditional ocean color sensors and terrestrial platforms
What can be measured from space?
Hi-res products for coastal and offshore applications

- Multiple parameters from a single image
- MERIS (ESA) provided global, hi-res (300 m) ocean color products for coastal and offshore applications (2002-2012)
- Follow-on missions (OLCI) planned for 2015/2017; we need to be able to take advantage of these datasets...
Phytoplankton Bloom Off Bainbridge Island
22 August - 12 September 2011

- Ferry data corroborated satellite images.
- Merged dataset remotely defined temporal and spatial extent of the bloom!

MERIS Chl
27 Aug
Hi-res satellite products can be challenging to produce due to optical complexity, lack of standard algorithms, and insufficient ground truth spanning large optical gradients.
Partial Least Squares Regression

- Widely used in chemometrics, bioinformatics, sensometrics, neuroscience and anthropology
- Well suited when predictors are many and highly collinear
- Emphasis is on predicting the responses; not necessarily on understanding the relationship between variables
- Leverages information from all spectral channels (visible -> near IR)
- Can be used with a variety of ocean color sensors
- Requires no atmospheric correction (TOA radiances adjusted for Rayleigh scattering only)

>75% of variance explained using 5 PLS components

$n = 3495$
Partial Least Squares Regression

PLSR with 5 components

Turb Fitted vs Turb Observed

Hour

Observed

Fitted

Turb

20

30

35

10

15

20

25

30

35

8

10

12

14

16

18

20

Integral
Partial Least Squares Regression

Integral Turb PLSR (Puget Sound)

NASA Kd490 (SeaWiFS - Global Open Ocean)

23 April 2011
Partial Least Squares Regression
Uses for validated satellite information products

Retrospective Analyses <-> Real-time Monitoring <-> Forecasting/Risk Assessment

- Habitat characterization, ecological impact assessments, and permitting (e.g., aquaculture facilities)
- Seasonal anomalies <-> climate change (e.g., develop a comprehensive ocean color baseline for Puget Sound)
- Red tides and harmful algal blooms
- Eutrophication/shifting food webs
- Optimize field operations/sampling in dynamic areas
- Spill assessment and management
- Initial conditions and cal/val data for WQ modeling
Recommendations/Future Efforts

- Blend data from multiple sources to create value-added information products
- PLSR method refinements
- QA procedures for in situ data (including mid-day F quenching)
- Operational workflow for creating validated products
- Move beyond static maps of individual WQ indicators
  - Characterize spatial variability/gradients
  - Feature/anomaly detection