Improved Altimetric Retrievals in the Coastal Zone

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Pseudo high spatial resolution dynamic topography from currents

la Currents - MCC
Ocean surface currents, in both open ocean and the coastal zones, can be estimated from sequential thermal IR (AVHRR) and ocean-color (MODIS, SeaWiFS) imagery using the well-developed MCC (Maximum Cross Correlation) method (1).

1024 x 1024 AVHRR scene grid – 1 unit = 1 km

MCC pseudo SSH & OI geostrophic current vectors – AVHRR composite 15-17 Oct '07
The white box indicates the area containing the corresponding CODAR coincident current field.

CODAR stations on the US West coast

Subregion of 1024 x 1024 AVHRR scene grid – 1 unit = 1 km

Ib Currents - CODAR
High frequency CODAR (Coastal Ocean Dynamics Applications Radar) stations measure real-time surface currents up to 50-70 km off the coast with a nominal spatial resolution of 1 km and up to 500 m in certain cases. CODAR stations cover a vast portion of the US West Coast and give hourly high-temporal resolution data independent of weather conditions.

I Concept
Use AVHRR and MODIS sensors to retrieve the columnar Integrated Water Vapor (IWV) from an empirically optimized split window model, given the open ocean ground truth IWV derived from coincident Microwave Radiometers (MR)(2).

I Preliminary results
MODIS and AMSRE onboard Aqua
MODIS: T11 and T12 (1 km resolution at nadir)
AMSRE: 0.25° x 0.25° IWV product
Region: Open ocean off US west coast

I Preliminary results

AMSRE-IWV
T11
T12

AMSRE

5 km MODIS MOD07 Infrared IWV (g/cm²)

5 km Model-MODIS-IWV

5 km Model-MODIS-IWV

5 km Model-MODIS-IWV

II Preliminary results

MODIS and AMSRE onboard Aqua

AMSRE-IWV

AMSRE

T11

T12

AMSRE

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5 km Model-MODIS-IWV

II Application : 5 km coastal altimetry wet path delay

Daily/weekly Δα, Δβ known
Least squares retrieval coastal IWV

Least squares retrieval coastal IWV

Last valid along track IWV altimeter MR

Wet path delay correction

Coastal tidal corrections provided by Goddard Space Flight Center (courtesy of Richard Ray)

Advantages:
valid in coastal regions
high resolution

Drawbacks:
affected by clouds
Won’t work for low contrast temp.
for very low and high IWV

Improved coastal wet tropospheric correction using IR satellite data

Ila Currents - MODIS

I Concept

Ia Estimation of the two absorption coefficients
Combining 9 non cloudy data sets, gives a broad range of temperatures and water vapor values. Although the RMS seems higher for wet conditions.

I Part II

Ib Open ocean 5 km IR Model-Modis-IWP product

AMSRE-IWV

AMSRE

T11

T12

AMSRE

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Improved Coastal retracking

Altimeter retracted waveforms ——> altimeter coastal SSH

Various retraction methods exist
Select the optimal regional retraction system by comparing the altimeter coastal SSH with our high resolution pseudo height field

References:

III Analysis / Conclusions

General Geostrophic equation:

\[
\Delta \alpha = k T_{11} \mu_{T_{11}} \mu_{T_{12}} - \Delta T
\]

\[
\Delta \beta = \sin \theta - \cos \theta \ln \cos \theta
\]

Current Field
Optimal Interpolation (OI)
Geostrophic-Constrained Current Field
Currents-to-SSH Inversion
SSH Field
Process Flowchart

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IV Future Work

1. Using wind data from satellite and/ or coastal measurements to explicitly account for the Ekman component.
2. Using a tidal model to explicitly correct for tides, which are eliminated now by composing over adequate number of days.
3. Merging the MCC-derived and CODAR-measured current fields to achieve a higher spatial and temporal resolution dataset.
4. Using variants of the MCC method with weather-independent TerraSAR-X radar data to estimate currents.