The South American Land Data Assimilation System (SALDAS): A Combined Approach for Atmospheric Forcing

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The definition and derivation of a 0.125°, 3-hourly atmospheric forcing dataset for the South America continent is described which is appropriate for use in a Land Data Assimilation System and which, because of the limited surface observational networks available in this region, uses remotely sensed data merged with surface observations as the basis for the precipitation and downward shortwave radiation fields; while other variables are model-calculated values from South American Regional Reanalysis (SARR), (i.e., air temperature, wind speed and specific humidity at 2m, surface pressure, etc). For rainfall retrieval, the merging methodology is based on a combination of additive and multiplicative bias correction schemes in order to get the lowest bias when compared with the observed values. Inter-comparisons and cross-validations tests have
been carried out for the control algorithm (TMPA real-time algorithm) and the proposed merging scheme. There are regional differences in the biases for all variables in the dataset, with biases in precipitation of the order 0-1 mm/day and RMSE of 5-15 mm/day, biases in surface solar radiation of the order 10 W/m² and RMSE of 20 W/m², positive biases in temperature typically between 0 and 4 K, depending on region, and positive biases in specific humidity around 2-3 g/Kg in tropical regions and negative biases around 1-2 g/Kg further south.

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**Near Real-Time Satellite Support for the VOCALS Sea-Going Field Program**

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The VAMOS (Variability of the American Monsoon Systems) Ocean-Cloud-Atmosphere-Land Study (VOCALS) Cruise Support Website (VCSW) offers a central location for near real-time (NRT) satellite data to assist in the planning and implementation of the VOCALS-REX field program scheduled to take place in the November of 2008. The VCSW acts as a virtual clearing house for publicly accessible satellite observation of the oceans and atmosphere. Oceanic satellite products include microwave and infrared measurements of sea surface temperature, altimeter measurements of sea surface height, ocean color and true color images. Satellite observations of the atmosphere include microwave measurements of atmospheric water vapor and cloud liquid water, infrared measurements of cloud cover, and scatterometer measurements of surface vector winds. The data are harvested and mapped daily, allowing VOCALS researchers to identify and track dynamic features of interest to VOCALS, such as oceanic mesoscale eddies and pockets of open cells in the atmosphere. This website has been designed to incorporate any domain allowing for relatively simple adaptation to other future study regions.

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**Determining Objective Biophysical Provinces from Multiple Satellite Sensor Observations**

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If the structure of marine ecological systems is constrained by physical forcing, biophysical provinces, defined as regions displaying coherent patterns among physical forcing and biological response, may emerge as quasi-stable properties of regional oceans. They therefore may predict differences in phytoplankton community structure...
and function; marine provinces can facilitate objective comparisons of ecosystem properties in space and time- including their resilience to seasonal and interannual perturbations. However, there remains a considerable need for the development of objective mapping of biophysical provinces in the major regions of the global oceans and an understanding of how these provinces change in time, with different data scale, or with different sensor availability. Using monthly averages of satellite-derived sea-surface temperature, photosynthetically-active radiation, and chlorophyll-a, we have established objective biophysical provinces in the North Pacific Basin and are validating these provinces with available in situ data. In this presentation we will discuss preliminary efforts to determine the effect of different chlorophyll products (i.e. SeaWiFS or MODIS-AQUA), domain size, and season on the total number of distinct provinces and the location of boundaries between provinces. These results will provide intercalibration of sensors with finite mission lengths and thus will allow us to determine the feasibility of creating a long term record of marine biogeographic dynamics.

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**Potential Transport of the Copepod, *Calanus finmarchicus*, in the Labrador Sea and Scotian Shelf Regions During Diapause**

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*Calanus finmarchicus* is common throughout the North Atlantic with peak abundances in the Labrador, Norwegian, and Barents Seas. During the late summer, *C. finmarchicus* sinks to depths greater than 300m, and enters diapause for up to six months. Continental shelves, such as the Scotian Shelf and the Gulf of Maine, are too shallow and must be seasonally repopulated by individuals from adjacent basins through ascent and onshore transport. The southward Labrador Current may transport diapausing *C. finmarchicus* from the Labrador Sea to these shelf regions. Using an individual-based model (IBM) coupled to ROMS simulations we evaluate the potential transport of diapausing *C. finmarchicus* from the Labrador Sea to the Scotian and Slope regions. We examine high-NAO(1980-1993) and low-NAO (1962-1971) periods. Particles were seeded at depths of 300m to 1000m in the Labrador Sea, and were tracked throughout diapause. Diapause duration was determined in two ways: (1) copepodites emerge from diapause at predetermined dates; (2) emergence from diapause was based upon temperature-dependent depletion of lipid stores by copepodites.

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**Characterizing Basal Melt Rate for the Larsen-C Ice Shelf with Satellite Data and Numerical Modeling**

Rachael Mueller, Laurie Padman, Helen Fricker, and Ian Joughin
Larsen-C (L-C) is last remaining of the formerly three pieces of the Larsen Ice Shelf, the other two collapsing in 1995 and 2002. The current state of the ice shelf is determined from satellite radar and laser altimeter measurements of ice shelf surface height, interferometric synthetic aperture radar (InSAR) measurements of lateral ice velocity, and optical imagery (MODIS) of significant surface features that include rifts and crevasses. Altimetry from 1978 to 2007 suggests that the L-C has thinned significantly during this period. However, the processes that led to this thinning are still too poorly understood to support accurate predictions of future shelf evolution. This study addresses the specific and significant process of melting and freezing at the base of the ice shelf due to ice/ocean interactions.

We describe preliminary investigations of basal melt by using the Regional Ocean Modeling System (ROMS) to model 3D ocean circulation in the L-C cavity, with explicit parameterizations included for heat and freshwater exchanges at the ocean/ice-shelf interface. The sensitivity of ice-ocean interactions to ambient ocean temperature, tides and thermodynamic parameterizations is explored by comparing several model runs for an idealized L-C cavity. These model results help identify the kinds of in situ and satellite observations that could improve the predictive skills of models that use a realistic representation of the ice shelf cavity. This preliminary examination of techniques, tools and uncertainties is used to address how a warming of ocean temperatures around the L-C ice shelf may affect future basal melt rates, L-C thickness and ice-shelf stability.

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**Snowfall Estimation from Multi-Spectral Satellite-based Information**

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Dr. Shayesteh Mahani and Dr. Reza Khanbilvardi, Advisors  
The City University of New York

Accurate estimation of snowfall rate is very important particularly for the regions where snow is the major source of water supply, as well as for transportation safety. This study is focused on the application of satellite-based observation for estimating snowfall rate. There are not enough ground-based gauge networks and radar coverage available for the areas with heaviest precipitation for estimation. Consequently, remote sensing information will be useful for these regions by providing a better idea of the magnitude and distribution of snowfall coverage. Therefore, the main objective of this study is to develop a multi-sensor algorithm based on an artificial neural network (ANN) system for snowfall estimation using microwave frequencies from the Advanced Microwave Sounding Unit (AMSU) and infrared (IR) from geostationary GOES satellites. Accordingly, using MW information is expected to improve IR-based snowfall rate estimates because MW spectrum with longer wavelength can penetrate and provide some information related to cloud physics and properties. The ANN model in development is
trained and validated with snow water equivalent depths data available from the Quality Controlled Local Climatological Data product from NCDC. Currently, this study is focused on exploring ANN parameters that will provide better results for snowfall estimation. Preliminary investigation indicates that the combination of higher frequency microwave channels, such as AMSU-150, -183±1, and -183±3 GHz are more correlated with snowfall rate, and are thus an appropriate source of information to use as model input.

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**Estimating Quantum Efficiency of Chlorophyll Fluorescence in Coastal Waters Using MODIS Instrument**


Understanding and quantifying quantum efficiency (QE) is of particular interest since an accurate interpretation of fluorescence line height (FLH) must take quantum efficiency into account. In this manner, FLH measurements can provide an alternative mean of estimating chlorophyll concentrations [Chl] and gives additional information on phytoplankton state and productivity. Therefore, attention has recently been focused on quantifying quantum efficiency. Historically, it was supposed that QE can vary dramatically but recent results seem to indicate a much more stable value. These recent results are based on a general approach which compares observed fluorescence signal with a theoretical fluorescence signal computed theoretically based on radiative transfer using measured apparent and inherent optical properties (AOPs) and (IOPs).

Unfortunately, this approach requires extensive field instrumentation and their limitation in spatial and temporal coverage makes it difficult to consider waters with different optical properties. On the other hand, satellite data processing of ocean color provides the tools in obtaining a theoretical fluorescence signal for a given quantum efficiency based on existing retrievals of [Chl], instantaneous photosynthetically available radiation, $ipar$, absorption of non algae particles at 412 nm, $a_{bud}(412)$ and geometrical input parameters. However, to make these comparisons, we need confidence that both FLH and CHL retrievals are accurate. Considered separately, this is not possible but if both products are compared to each other, self consistency of the spatial distribution of data provides a good check that both products are accurately obtained. Therefore, comparisons were performed based on spatial correlation maps between [Chl] and FLH and only pixels with high spatial correlation were extracted for analysis. In particular, we show that the QE estimated in this manner is found to be well within our previous field measurement estimates.

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**Comparison of GOES-Based Nowcasting Algorithms over the New York City Area**
A collaborative framework is being pursued by personnel at NOAA/NESDIS, the NOAA/NWS Meteorological Development Laboratory (MDL), the NOAA/OAR National Severe Storms Laboratory (NSSL), and the NOAA Cooperative Remote Sensing Science and Technology Center (CREST) at the City College of New York (CCNY) to develop a prototype satellite-based nowcasting capability for the New York City metropolitan area. This nowcasting capability would also serve as a test bed for implementing satellite based nowcasting capability throughout the United States as part of the System for Convection Analysis and Nowcasting (SCAN) which is a component of the NWS’ Advanced Weather Information and Processing System (AWIPS).

Still in the exploratory phase of the project, the CREST nowcasting team has implemented the NESDIS satellite-based nowcasting algorithm Hydro-Nowcaster (HN) with rainfall retrieval algorithm, Hydro-Estimator (HE), and satellite-based Rapidly Developing Thunderstorm (RDT: Meteo-France) models to compare their ability to detect convective cells. We have also employed other collaborators to run the FORTRACC (Daniel Vila) and K-Means Correlation (Valiappa Lakshaman) models to compare their forecasting abilities. Preliminary results of these comparisons will be presented. Also included will be an outline of how the tracking algorithm of RDT may be used to improve precipitation estimates from IR imagery.

Improved MODIS Aerosol Retrieval Using Modified VIS/MIR Surface Albedo Ratio Over Urban Scenes

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In this paper, we focus on the use of simultaneous MODIS and AERONET sky radiometer data to refine the MODIS AOD retrieval surface albedo models regionally and improve on the current AOD operational retrieval. In particular, we show that the correlation coefficient assumption used in the MODIS Collection (5) model between the VIS and MIR channels used for surface reflection parameterization are still severely underestimated in urban area in comparison with high spatial imagery data from Hyperion thereby leading to an underestimate in the VIS ground albedos and explaining the subsequent overestimate of the VIS optical depth. Furthermore, we find that the
VIS/MIR ratios depend only weakly on the scattering geometry allowing us to generate a regional VIS/MIR surface reflectance correlation coefficient map in New York City area at spatial resolutions down to 1.5km. When applying the new VIS/MIR surface reflectance ratio model, we show the MODIS and AERONET derived optical thickness agreement is significantly improved for the operational 10km resolution product. Furthermore, we show the high resolution surface model allows us to improve the resolution of the retrieved AOD to 1.5km. Although direct comparisons for a given day can only be made at the AERONET site (CCNY site), we find the AOD spatial variability from the improved MODIS retrievals is in far better agreement with temporal statistics seen in the AERONET time series retrievals.

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**Analysis and Estimation of Snowpack Properties Using CLPX Data**

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Estimation of snowpack properties is significantly important in regional scale for various problems such as flood predictions and water resource management. Satellite passive microwave data from SSM/I, SMMR, and AMSR-E have shown potential for estimation of snowpack properties. Many algorithms have been introduced for SWE and snow depth estimations based on the statistical, empirical and physical analysis of snow and microwave data. However, none have been very successful in taking the variation and evolution of snow grain size into account. Snow grain size, besides snow depth and water equivalent, plays a major role in microwave radiation of snow. Then, a comprehensive method for estimation of snowpack properties need to take snow grain size into account. In this study, I focus on analysis of snow grain size behavior with respect to other snow parameters such as snow depth, density, and temperature. Then, I derive a pattern which can be used to approximate the range of grain size variations. Data used in this research are from NASA Cold Land Processes Field Experiment (CLPX) in Colorado. This intensive field survey has been conducted in February and March of 2002 and 2003. The measurements include the grain size, density, and temperature in different layers of snowpack profile. As a result of analysis, I observed that the snow grain size variation is highly correlated with both snow density, and temperature but the correlation is generally higher between snow grain size and snowpack temperature as compared with grain size and density. In order to better analyze evolution of snowpack properties, the very top layer of the fresh snow was excluded from the analysis. The results showed an increase in correlation between snowpack temperature and grain size. Snowpack temperature profile was able to be estimated by a function (possibly linear) since the bottom layers of snow temperature are found as almost constant. Using this bottom temperature as an intercept, the regression line was derived. The slope of the regression line indicates the dependency of the regression slope to the snow depth. Then, with snow temperature, the grain size evolution can be approximated.
Multi-Source Precipitation Estimates

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Development of a multi-source merging approach, for improving Satellite-based Precipitation Estimates (SPE) over the radar gap coverage by merging SPE with ground-based radar (RR) and rain gauge (RG) rainfall measurements is the objective of the present study. Enhancement of remotely sensed rainfall estimates is very important because satellite is the only possible source of capturing information from the areas where radar and gauge network cannot cover. Although, satellite is a source of collecting information with no spatial limitation, precipitation estimates from satellite imagery have greater uncertainties particularly on estimating precipitation intensity. Hence, application of remote sensing data for precipitation estimation, particularly over the remote and mountainous regions, where there is usually heavier precipitation and cannot be completely covered by ground-based observation sources, is a challenging research area.

The merging algorithm will be capable of extending radar information from pixels with available radar and/or rain gauge rainfall to their neighboring pixels with no ground-based information. The first step in this approach is bias correction of SPE with respect to radar and/or rain gauge rainfall data and then applying the merging algorithm to combine multi-sensor rainfall information. Study site in this study id northwest of the US for both summer and winter storms. Kriging-Bayesian technique will be used to merge SPE with RR and/or RG.

Multi-angular Hyper-spectral Polarized Reflectance from Coastal Waters

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Polarized solar radiation reflected from water bodies contains useful additional information on inherent optical properties, concentrations and size distributions of water constituents if compared with unpolarized data. We report the use of a modified hyperspectral radiance sensor with very high sensitivity in order to study in detail polarization characteristics of reflectance from field measurements in coastal waters. To compare multi-angular hyperspectral field measurements with theory, radiative transfer computations of the water-leaving radiance were performed. Good agreement between simulation and angularly-resolved field measurements was observed in a certain angular range, which can be considered less affected by Sun glint. The results of the analysis are
also used to develop design criteria for effective polarization sensors aimed to measure above and underwater characteristics of polarized light in coastal regions.

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**A GOES Multi-Spectral Cloud-Patch-Based Rainfall Algorithm over Puerto Rico**

1Melvin J. Cardona-Soto, 2Nazario D. Ramirez-Beltran, 3Robert J. Kuligowski, and 4Eric W. Harmsen, CREST

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Precise remote detection and estimation of rainfall has become critical for protecting human lives and infrastructure. Researchers have developed diverse algorithms for deriving rainfall rates from instruments on geostationary satellite platforms such as the Geostationary Operational Environmental Satellites (GOES) due to its relatively high spatial and temporal resolution and uniform spatial coverage.

Validations of the operational NOAA/NESDIS Hydro-Estimator (HE) algorithm conducted over Puerto Rico (PR) at a pixel and island-wide scale showed that the algorithm has a low probability of detection. This is due to the algorithm’s failure to detect storms with warm cloud tops, which can produce significant rainfall within this region. In order to achieve greater accuracy of detection and estimation over PR, the development of a GOES Multi-Spectral Cloud-Patch-Based Rainfall Algorithm is proposed. The proposed algorithm in this study will utilize data from multiple bands of GOES-12 to extract temperature, geometric, texture and microphysics features from clouds. Microphysics features will be extracted from multiple GOES-12 bands and be used to discriminate between rain and no rain events. Temperature features will be used to create cloud patches. These will then be classified into cloud classes by an artificial neural network. To improve rainfall estimation, the cloud patch classification system will create multiple brightness temperature-rain rate relationships ($T_b$-R), one for each cloud class.
Fast Repetition Rate Fluorometry and Beam Attenuation to Chlorophyll Ratio, an Optical Index of Phytoplankton Photosynthetic Potential at Caribbean Mesoscale Eddies

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Enhanced biological activity has been associated with mesoscale events and attempts have centered their attention to relate bio-optical variables to the physiological state of phytoplankton. Particularly the beam attenuation to chlorophyll ratio (cp *) which have been previously linked to phytoplankton physiological state. During the Caribbean vorticity experiment (Cavortex) the physiological state of phytoplankton was addressed using fast repetition rate fluorometry (Fv/Fm), this parameter measures the changes in phytoplankton physiology by a rapid, noninvasive assessment of phytoplankton in vivo fluorescence signatures. During this expedition enhanced Fv/Fm was observed as a result of the baroclinic instabilities created by Eastern Caribbean Sea mesoscale eddies and an inverse correlation with cp* was observed at cyclonic regions, for other regions the parameters were directly correlated. This result suggests that the baroclinic instabilities promote influx of material from depth with a lower cp* ratio that enhance the photosynthetic potential of the cells possibly due to higher concentration of refractive materials. These findings suggest a relationship with these parameters, with the possibility of cp * being retrievable by remote sensors (e.g. MODIS), and used with the available chlorophyll fluorescence products to address photosynthetic potential of phytoplankton.

UPRM Lidar and Aerosol Characterization

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Lidar power profiles data from three wavelengths of 355nm, 532nm, and 1064nm are utilized to determine the aerosol size distribution for three atmospheric categories. An algorithm in MatLab is developed which determines the aerosol parameters of extinction and backscatter coefficients, aerosol optical thickness, leading to the determination of aerosol size distribution for a range of radii from 1 to 10 microns. The results show radii variations for urban, anthropogenic, and marine aerosols. The power profiles data for this algorithm is expected to be obtained from UPRM Lidar, at various ranges. The Lidar system is being developed at UPRM will be capable of transmitting the three fundamental wavelengths, receiving the reflected wavelengths using a 20 inch telescope, processing the received data, and displaying the power profiles per wavelength using LabView software.