Agenda
Glory Science Team Meeting
10-12 August 2011
Goddard Institute for Space Studies, New York, NY

Wednesday, 10 August 2011

Introduction

0830-0835 Welcome, Logistics, and Announcements Mishchenko

0835-0850 Programmatic Perspectives and Charge to the ST Maring
Why Glory Science Team without Glory? It is very justifiable because we still need to advance in the knowledge of aerosol radiative forcing, and there are airborne data (RSP and HSRL) and other satellite data to work with and develop the science, pending the APS relaunch, if approved. More measurements will be acquired during SEAC4RS (Aug-Sep 2012): to look at biomass burning impacts on pollution, and Asian monsoon circulation.

0850-0900 Science Team Meeting Agenda Details Ichoku

Atmospheric Complexity, Polarimeter Capabilities, and RSP Data Availability

0900-0920 Aerosol Properties in a cloudy world Marshak
60% of all clear sky pixels are located within 5 km of clouds (from MODIS analysis). Aerosols grow near clouds. Could be due to real microphysics or artificial effects. Two-layer model is used to correct for cloud enhancement from MODIS based on CERES. Calipso is used to help characterize 3D effects. Log of backscatter and color ratio, both increase closer to clouds. Cloud-aerosol discrimination (CAD) product from Calipso is great for this analysis. For dust, depolarization ratio increases with altitude, but color ratio is not affected. Low-altitude dust increases near clouds, but not high altitude dust.

0920-0940 Polarimeter Capabilities – Theory/Instruments Martins
Emphasis is on the scattering of different types of particles, including a collection of dust samples from around the world, volcanic ash, and salt (to represent sea salt) for lab analysis. Polarized imaging (PI) nephelometer will be flown on Langley B200 aircraft as part of DEVOTE to analyze the scattering and polarization (linear and circular) properties of these aerosol types in situ. Also PACS/HARP imaging polarimeter is being developed, to be used for airborne remote sensing. It is being integrated in a commercial aircraft at the time of this ST meeting (Aug 10, 2011). The idea is to cover the spectral range from 360 to 2500 nm.

0940-1000 RSP Measurement Details and Data Cairns
RSP airborne polarimeter has around 100-m ground pixel size, and 9 wavebands from 410 to 2260 nm. Sequential measurement differences of polarized radiances act as a good edge detector. Since 2002, RSP has an onboard calibrator with an

accuracy within 0.1%. No polarimetric calibration changes beyond 0.2% for the past 12 years of operation. Uncertainty in radiometric calibration is about 3%. Geometrically, all bands of the RSP match within 0.5% of IFOV. RSP smoke data available over California fires 29 Oct 2003. Data also available from CLAMS, ALIVE, Milagro, CSTRIPE, Crystal-Face, ARCTAS, RACORO (broken cloud fields), CALNEX, CARES, COCOA (Calipso validation of desert dust), Birmingham AL (Sep-Oct 2008), along with measurements from other instruments aboard the same plane. Lookup Tables that can be used to analyze RSP are available and will be formatted for easy download. Existing vector radiation code is available. Level 2 processing of CALNEX expected to be available in Sep 2011, followed by MILAGRO, then ARCTAS. Attitude issues are the biggest uncertainty in the analysis. All of the field experiments with HSRL have a context imager onboard as well. MILAGRO does not.

1000-1020 Polarimeter Capabilities – Sensitivity Analysis Knobelspiesse
Goal: Systematically estimate retrieval error, given measurement characteristics. Only diagonal errors, which are errors that are correlated with each other, are considered. Thus far Dubovik et al. (2001) AERONET climatology is used, but more elaborate LUT developed for RSP will be used later. Uncertainty increases with optical depth, chlorophyll, and wind speed, but decreases with refractive index, effective radius, and effective variance. Parasol and MISR contain some relevant information related to polarimeter and multi-angle, respectively, but do not attain the accuracy requirements expected from APS. The method provides an infrastructure to systematically test a priori instrument performance based on expected information content.

1020-1040 Break

Airborne Lidar Profiling and HSRL Data Availability
1040-1110 HSRL Measurement Details and Data Hostetler/Ferrare
HSRL flew first time in 2005, began deployment as a workhorse instrument since 2006 (during Milagro), and has been flown alongside RSP since 2008. Principle of HSRL enables the reduction of the Lidar problem to 2 equations and 2 unknowns. The channels are internally calibrated. Measurements are in 2 categories: extensive (aerosol extinction and backscatter) and intensive (depolarization, depolarization ratio, …). Measurements validated against AERONET, in situ, and aircraft profiling measurements with AATS-14 and HiGEAR. About 3 missions per year have been conducted since 2006, making a total of about 1,000 flight hours so far. List of campaign flights are available. Level 2 processing are available about 2 hours after each flight. HSRL and RSP are being modified to support ACE and GEOCAPE mission development. Multi-wavelength HSRL is being developed for ER-2 but can also fly on B200.

1110-1140 Airborne Aerosol Profiling and related Studies Ferrare
HSRL data are used to examine aerosol profiles and the boundary layer height, and both have a good agreement with WRF-Chem simulations, but HSRL resolves details better because of its high resolution. HSRL is used to do aerosol classification based

on the Mahalanobis distance construct, to determine different aerosol types (smoke, urban, dust, marine, etc.). HSRL is used to measure profiles of the aerosol submicron fraction (SMF), which is equivalent to the passive measurements of the fine mode fraction (FMF). SMF is correlated with Angstrom exponent and ???. HSRL enables the characterization of aerosol humidification (hygroscopic growth). Smoke depolarization varies a lot.

1140-1200 Airborne Campaign Details (incl. DEVOTE) Hair
DEVOTE: 'Development of Validation … Experimenters'. DEVOTE is about opportunities for future data sets; to enable the capability to perform satellite validation, demonstrate new instruments, assess current and future satellites, compare measurements with AERONET. DEVOTE will include several instruments: HSRL, RSP, Polarized Imaging nephelometer (PI-Neph). Flight schedule: Sep 1 – Oct 31: Will cover 40 flight hours, perhaps 4-5 flights total, all flights will be based out of Langley, within 250 flight radius both over land and ocean, mostly along A-Train tracks. All data products are archived in ICARTT format and available. There are tools available to read this format.

1200-1230 Discussion of Existing Data and Studies All (Ichoku)

1230-1400 Lunch

Aerosol Retrievals
1400-1420 Aerosol Composition and Information Content Russell
Identify aerosol type from space. Absorption optical depth= AOD x (1-SSA). It is power-log distributed. Absorption Angstrom Exponent can help separate aerosol types, especially if utilized with size distribution. From AERONET, dust SSA increases with wavelength while urban/industrial decreases with wavelength, and biomass burning is in between. Combining AAE (Absorption AExp), (EAE Extinction AExp), RRI (real part of refractive index) helps to separate these types using the Mahalanobis distance classifiers, which can be generalized into a number of different classes. Remote sensing is continuously tending toward multi-dimensional data sets.

1420-1440 AERONET Skylight Retrievals Wang
There is need to include polarization in AERONET in addition to radiance, in order to develop a scheme for the validation of RSP (originally APS) aerosol retrieval. This involves the use of a chemical transport models and radiative transfer models. The code for this analysis is available and can be easily run by an undergraduate. The results are validated with relevant models. Linearized T-matrix code is utilized together with Mie code to enhance analysis capability for refractive index components and shape factor. Total degrees of freedom for retrieval increases with number of parameters. The framework is available for anyone who wants it.

1440-1500 Combined HSRL and RSP retrievals Hostetler
Using RSP and HSRL as proxis for APS and CALIOP. Assess RSP microphysical retrievals. Compare HSRL and RSP aerosol types. Investigate advanced lidar-constrained polarimeter retrievals. Fly HSRL and RSP together as much as possible into the future.

1500-1520 Break

Aerosol Characterization

1520-1540 Aspect Ratios of Airborne Dust Yang
Downwind dust particles have different characteristics from those near the sources because the former are covered by soot, etc. Use of spherical models results in dust underestimation by about 30%. Therefore, it is important to consider non-sphericity. There is no single method to cover the entire size spectra of dust. Hexahedra seems to give the best fit (with only one or two aspect ratios) compared to spheres or even spheroids. A large database has been developed and is made available to those that want to use it. The use of non-sphericity makes a big difference in radiative transfer calculations. Linear Discrimant Analysis (LDA) and Quadratic Discriminant Analysis (QDA) techniques are applied to improve analysis.

1540-1600 Laboratory Aerosol Characterization Moosmuller
Global change parameters are characterized by emissivity and planetary albedo. Current value of planetary albedo is 0.29. Energy surplus at low latitudes and deficit at high latitudes, and the energy balancing processes drive the atmospheric and oceanic circulations. A photoacoustic instrument is used to measure absorption of carbonaceous and mineral dust aerosols in ambient environments to improve radiative transfer calculations. 87% of organic carbon (OC) is from biomass burning, of which 86% is from smoldering combustion. Black Carbon (BC) is black and related to Elemental Carbon (EC), Graphitic Carbon (GC), and insoluble carbon. Brown carbon (BrC) is part of OC. BrC constituents are not fully identified. Flaming combustion produce chain aggregates, while smoldering produces detached spherical particles. Mean annual temperature in Northeast India is increasing at the rate of 0.11° C/yr. Soil samples have been collected from Africa and the Middle East and analyzed in the lab to determine properties. Then, photoacoustic measurements are conducted. X-Ray fluorescence is used to measure the iron (hermatite) content, which is correlated with absorption but not scattering, showing that Hermatite is probably responsible for the absorption. Negative Scattering Angstrom Exponent is quite common for dust.

1600-1700 General Discussions on Aerosol Retriev./Charact. All (Cairns)
Use spheroids to model non-sphericity (by Jacek Chowdhary). Spheroids produce a good fit both for the Total reflectance and polarized reflectance of the RSP, unlike spherical shape assumption. Aerosol retrievals above clouds is an important issue, which can affect radiative forcing calculations.

1830 Group Dinner (if there's enough interest) Mishchenko
Postponed to Thursday.

Thursday, 11 August 2011
0830-0840 Preliminaries and Settling Down All (Ichoku)

Aerosol Direct Radiative Forcing
0840-0900 Detailed Aerosol Direct Radiative Forcing Remer
Direct Radiative Forcing (DRF) calculations from satellite can be done in two ways: either using CERES flux or other sensor AOD measurements. With AOD, other parameters required are SSA, asymmetry parameters, and surface information. Flux is more correlated with radiance than it is with AOD. Using a set of consistent radiance measurements can be a viable alternative. DRF calculations using radiances agrees with other methods. However, APS could provide better estimates of SSA and other parameters needed for DRF calculations. Plans for the project are: Analyze PI-Neph measurements to calculate DRF, and compare with other methods. Will participate in AEROCLIMA in Brazil, DEVOTE, and TCAP flying the PI-Neph.

0900-0920 Constraining Global Aerosol DRF using GEOSChem Henze
Aerosol DRF is large and uncertain. Policy makers have interest in understanding the radiative forcing relationship to economic sectors or regions, e.g. how does black carbon from fossil fuel combustion in NYC contribute to DRF anywhere. Adjoint model sensitivities from GEOS-Chem transport model and LIDORT help to resolve these different sources. This is also applied to forecast future scenarios, by calculating how future emissions of a given species will affect radiative forcing e.g. in 2050. MODIS AOD is being assimilated into GEOS-Chem to constrain for instance SO2 emissions. Polarimeter data will be added to achieve further improvements.

0920-0940 Discussion of Aerosol Direct Radiative Forcing All (Remer)
APS measurement uncertainty predictions are educated expectations. If it cannot meet those goals, then the community has a problem. Using satellite to calculate forcings is a stretch and does not really agree with model calculations. A good alternative will be multi-everything lidars, but this has a steep price tag. PI-Neph will be a good means of validating APS measurements.

Cloud Retrieval
0940-1000 Disentangling Aerosols and Clouds Davis
The problem is that clouds are almost always submerged in aerosols. This project will: Learn to use cloud cameras (CC) to detect partial cloudiness and estimate gross cloud properties. Mixture models used to do a first order correction for cloud contamination. Evaluate and predict forward model error and address unresolved adjacency effect. Build a simulation framework for APS based on both 1D and 3D paradigms. To do all this, APS signal is predicted with vector MYSTIC radiative transfer code (vMYSTIC). 3D vector Radiative Transfer (vRT) is in the signal, not the noise.

1000-1020 Ice Particles Baum

Many treads exist in the ice cloud retrieval world by different groups (MODIS, POLDER, CALIPSO/CloudSat, etc.), and need to be tied together to obtain a robust solution for ice cloud retrieval. Library of Single-Scattering Properties for ice clouds are being provided to the different groups. Most existing algorithms have been assuming smooth ice cloud surface, but roughening should be considered. The difference between smooth and roughened ice clouds is manifested in the backscattering direction (120 – 180). APS or equivalent can help address some of the existing discrepancies. Adding roughening will have the effect of decreasing optical thickness and increasing particle size. ICARE in France will provide combined MODIS/POLDER/CALIPSO cloud data.

1020-1040 Sub-visual Clouds Sun

Undetected sub-visual clouds are often classified as aerosols, which introduces errors to both aerosol and cloud retrievals. Analysis is done within CERES 20-km footprints using MODIS and CALIPSO data. From CERES, ~10% is clear, but from MODIS only ~50% of that 10% is actually clear during the daytime. High cloud zonal distribution tends to be collocated with the circulation patterns such as Hadley, Ferrel, etc., cells. Sub-visual clouds affect SW radiative effects but not LW. Modeling however shows that thin cloud effect on LW flux is significant especially at night. There are 4% cases where MOD04 says clear and CALIPSO says cloudy, and 11% cases of the opposite. Sub-visual clouds have the potential to double the AOD values from MODIS near the poles. This project plans to use 1.37 micron polarized radiance to characterize the physical properties of sub-visual clouds.

1040-1100 Discussion of Cloud Retrieval All (Baum)

Ice cloud data exist from RSP during CRYSTAL-Face. More data will probably be acquired during SEAC4RS. However, the high resolution of the RSP data may not be ideal for disentangling aerosols and clouds because of adjacency effects. Instead POLDER will be used.

1100-1120 Break

Cloud/Aerosol/Water Retrieval/Interaction

1120-1140 Aerosols, Clouds, Ocean Interactions Hu (Zhai presenting)

Motivation: understand radiative transfer associated with the coupling of scattering in the atmosphere and rough ocean surface and below. A vector radiative transfer model has been developed to do this using Lidar and polarimetry together. Some of the issues to address are atmospheric correction, decoupling of the atmosphere for ocean color, and resolving multilayer aerosol sensitivity and the radiative forcing of aerosols above clouds. Lidar is important for vertical structure analysis.

1140-1200 Aerosol Water Uptake Schuster

Water is everywhere in the atmosphere and can be responsible for 50% of aerosol forcing. Work has been done using AERONET sky scans based on Dubovik inversion to obtain a 3-component aerosol (3CA) retrieval: Black carbon, water, and dry

aerosols, which include insoluble dust and soluble ammonium sulfate aerosols. POLDER will be used together with Dubovik's scheme. The amount of water is more correlated with fine mode than with coarse mode aerosol. A new scheme will include retrieval of water content based on refractive indices.

1200-1220 Polarization of Water-leaving Radiance Voss
Idea of ocean is to know the Muller matrix to transform incoming radiance to outgoing radiance. Built DPOL instrument to measure downwelling light on the ocean surface. True degree of polarization (DOP) is often less because of multiple scattering and the diffuse skylight. Maximum DOP goes down with increasing solar zenith angle and wavelength. Upwelling from water is polarized, and polarization varies. Would like to participate in upcoming field experiments.

1220-1400 Lunch

1400-1430 Discussion of Cloud/Aerosol/Water Interactions All (Schuster)

Ocean and Solar

1430-1450 History and Availability of Solar Irradiance Data Kopp
Solar irradiance brings all the input energy to our climate system. Sun radiation varies with time, with sunspots causing a decrease, and the larger the sunspot the larger the decrease. Climate data record requires accurate measurement over long periods of time. Climate solar measurements started in 1978 with the ERB instrument. Several instruments have been flown to do the measurements and the data are being composited to create the long-term data record. Solar variability is difficult to measure because it is usually tiny (on the order of 0.01% or less per year). SORCE/TIM (Total Irradiance Monitor) has an uncertainty of ~100 ppm. Nickel-Phosphorous is used for calibration instead of black paint because it is resistant to degradation. None of the solar instruments has been validated end to end, in order to understand the offsets between them.

1450-1510 Solar Irradiance, Variability and Climate Lean
What is the true solar constant: 1361 or 1367 W/m2. GISS Climate Model 3 is being used to examine this question. Compare average climate patterns with data from different satellites. Variability of solar irradiance needs to be determined in the climate record. Facular brightening increases irradiance while sunspot darkening decreases irradiance. There will be both warming and cooling in the next few decades. There has not been a net surface temperature warming in the last decade. Plans: Absolute TSI value and climate average state, solar irradiance variability, track and evaluate the solar-climate variability in the near future, validate climate models using responses to solar variability.

1510-1530 Discussion of Solar All (Kopp)

1530-1600 Break

Related Potential Future Missions

1600-1630 Future for APS and related Mishchenko/Cairns

After Glory's failure, NASA Earth Science Director, Mike Freilich, sent an e-mail inquiring whether it makes scientific sense to propose a re-flight of APS i.e. APS-2. Following that letter, a panel was constituted to write a justification, which was completed and submitted to HQ last month and is available online for download. Based on the current state of science, the panel recommended that the APS is still very much needed to improve our knowledge of aerosol forcing. APS= 9 channels x 250 angles x 3 Stokes parameters = 6750 units of data, meaning that the ratio of units of data to unknowns is greater than 200. If approved, the anticipated tentative launch schedule is July 2015.

1630-1700 Future for TSI and related Kopp et al.

TIM was originally selected to fly on SORCE (launched 2003) and future JPSS/TSIS (scheduled for launch in 2014). Glory was supposed to be a gap filler. Therefore, without Glory, there may be a gap. However, if SORCE continues much longer, there may not be a gap, but the degradation of TIM would need to be well tracked to ensure accuracy or consistency. VIRGO has a drift and 90-day keyhole spikes, which may make it inadequate for use in filling a potential gap. TIM shows high stability. However, ACRIM3 TIM seems to have developed a drift during the last couple of years. SORCE battery is having issues, and is a matter for concern, given that one of the batteries just gave up in a matter of a day. CERES and TIM are improving radiative balance understanding.

Friday, 12 August 2011

0900-1030 Discuss General Direction of ST Research All (…)

1030-1100 Break

1100-1145 Way Forward and Expectations Maring/Mishchenko

Communication within the science team is important. Information repository will be good, including where to put news and publications. The existing Glory web site could be revamped and a section created for the science team. Science Team meeting has been very useful and will be good to have in the future, including both the Polarimetry and Solar sides. Another ST meeting would be good in about a year and a half i.e. after DEVOTE, TCAP, and SEAC4RS. Based on the positive experience from the GACP era, it would be a good idea to have a special issue that collects papers from the different projects. Special issues receive twice the number of citations than a regular issue. It could be entitled "advances in aerosol remote sensing featuring polarimetry". Note that the Paris meeting in September 2011 may propose a special issue as well.

1145-1200 Scheduling of Future ST Meetings Maring/Ichoku

Probably in 18 months.

1200 Adjourn

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