



International Satellite Land-Surface Climatology Project

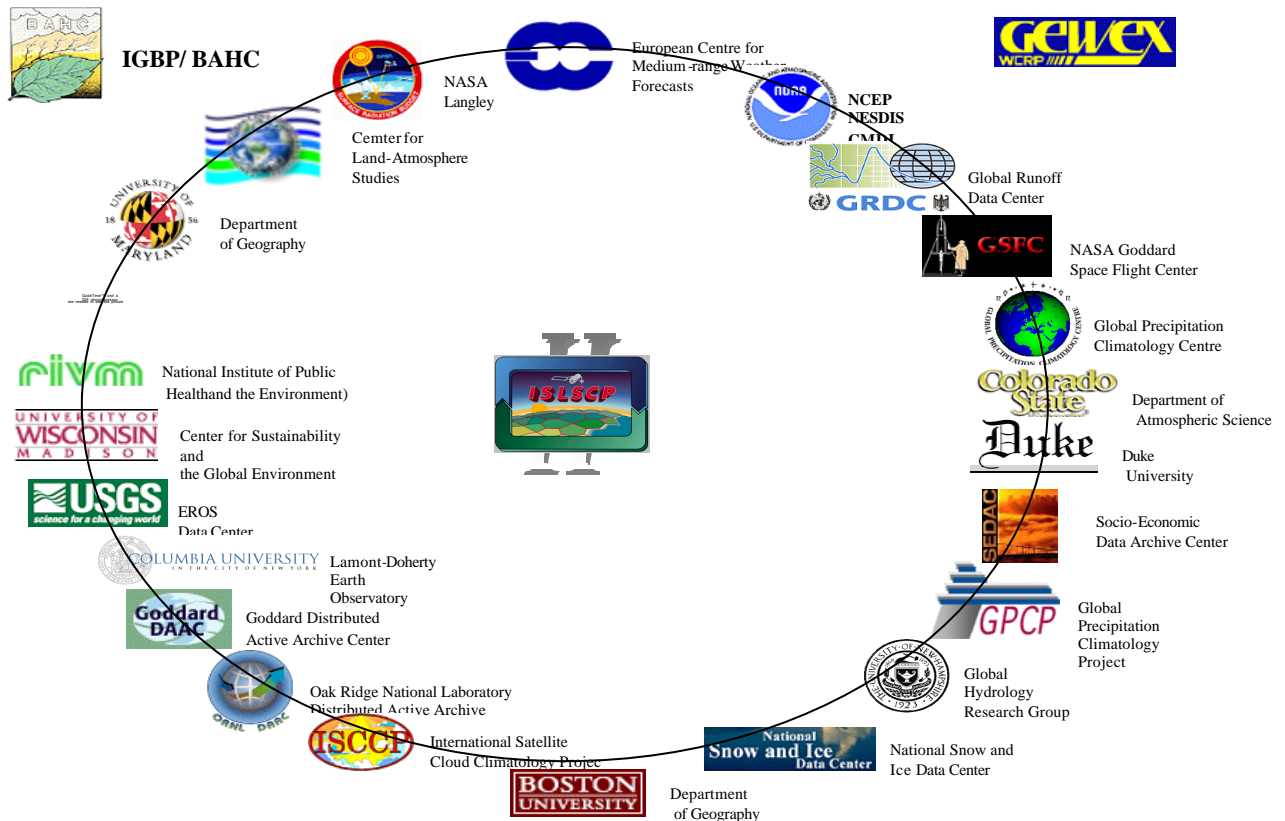


ISLSCP Data Initiatives: The Future Forrest G. Hall UMBC/NASA GSFC and Jim Collatz NASA GSFC

There is a need within the global change research community for a standard, uniformly gridded, multi-year, global, interdisciplinary data collection. Interdisciplinary data collections are crucial as input to and validation of the scientific analysis framework to study the fundamental processes that power climate, weather and natural hazards and the impact of these processes on life. This framework links satellite and conventional observations, carbon, water and energy flux models, climate models, and field experiments. The International Land Surface Climatology Project (ISLSCP) has played a leading role in defining, acquiring and developing interdisciplinary data collections (Initiatives I and II), in collaboration with other projects within the World Climate Research Program (WCRP) and the International Geosphere-Biosphere Program (IGBP). Initiative II is nearing completion. However, data like those in the Initiative II collection continue to be extended in time. Furthermore, an astounding array of new sensors aboard earth observing satellites such as TERRA, AQUA, and TRMM (U.S.), ENVISAT (E.U.), and ADEOS2 (Japan) are providing improved additional critical information. Thus a follow-on effort is needed to extend the period of record of Initiative II and to add improved data from the new sensors to better understand and quantify interactions and feedbacks among the land, oceans, and atmosphere.

Background: Initiative I and II Data Collections

It takes a community to build a data collection. As seen below, that community consists of data providers and data users responding to the scientific vision laid down by the GEWEX and IGBP.



The many individual efforts within this community are funded by many agencies, both national and international. It also takes a small, dedicated staff to bring this diverse, interdisciplinary community together on a regular basis to define the broad outlines and details of the data collection and to coordinate its production, documentation, quality assurance and consolidation into a uniform format. Working with a largely voluntary community, consisting of a science working group, data providers and data users, the Initiative II staff accomplished this through regular telephone and face-to-face communications, critical to breach the often abrupt interdisciplinary and international boundaries within the community.

INITIATIVE II SCIENCE WORKING GROUP

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The volume and diversity of earth science data grows by leaps and bounds as the community matures and takes on increasingly challenging problems. And, as many more satellite and other data sets become available. Fortunately, rapid advances in information technology have kept pace, permitting the community to meet the challenge.

ISLSCP Initiative I, a pilot project, produced the first interdisciplinary data collection that included monthly surface meteorology, soils, surface routing and runoff, and atmospheric radiation data, as well as topography for 1987 and 1988. The Initiative I collection was published in 1995. Scientists, educators and others have ordered over 13,000 ISLSCP I CD-ROMs from the NASA/Goddard Distributed Active Archive Center (DAAC) to support a range of uses shown in Table 1. The ISLSCP I data collection is also accessible electronically via the NASA/Goddard DAAC. Since the ISLSCP I release, over 267,000 files have been acquired via anonymous FTP and its use is increasing. Over 500 Initiative I citations have been made in the scientific literature.

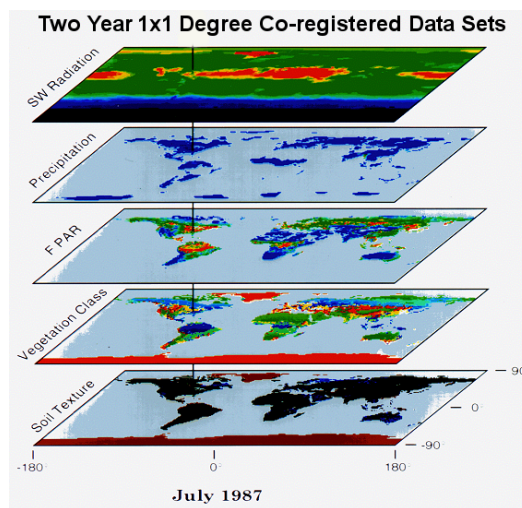


TABLE 1: INVESTIGATIONS USING ISLSCP INITIATIVE I

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|---|--|
| <ul style="list-style-type: none"> • Carbon modeling • Hydrologic modeling • Snow modeling • Surface radiation studies • Planetary boundary layer studies • Canopy modeling • Surface heat flux estimation | <ul style="list-style-type: none"> • Surface water flux estimation • Soil moisture modeling • Surface heat partitioning • Ocean PLB modeling • Surface parameters for LSS • Data assimilation • Cloud studies |
|---|--|

- Deforestation

- Climate Change Studies

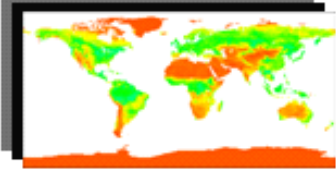
The ISLSCP Initiative II collection is greatly expanded in both time and spatial resolution. Initiative II is a 10-year core global data collection spanning the years 1987 to 1995 with improved spatial and temporal resolution (one-quarter to 1 degree) using improved data generation algorithms. In addition, Initiative II includes some data sets spanning the 18-year period, 1982-1999. The data collection includes additional carbon and socioeconomic data sets uniquely designed to support global carbon cycling studies. Initiative II provides a comprehensive collection of high priority global data sets in a consistent data format and Earth projection.

Even though seventeen new data types were added in the Initiative II collection, the spatial resolution was increased from 1 to 1/4 degree, and the period extended from 2 to 10 years, the small Initiative II staff was not significantly larger than that of Initiative I (about 2 people, including resources to develop the 18-year global biophysical product). Hence the completion of Initiative II will require 5 years rather than the 3 years of Initiative I. The increased complexity of the collection resulted in a longer definition and development period than Initiative I and as well the data preparation time by the staff. Initiative II also has a much more comprehensive evaluation effort than did Initiative I including comparisons of alternative data series (e.g. ECMWF and NCEP reanalyses, multiple land cover products, and multiple surface meteorology time series). The Initiative II staff, again working in coordination with the community, will compare and contrast trends and variations in these alternatives at regional scales to provide user guidance in the selection and use of these series in their investigations. This is a potential problem for future data initiatives as the complexity and volume of the data increases if the data consolidation resources remain fixed.

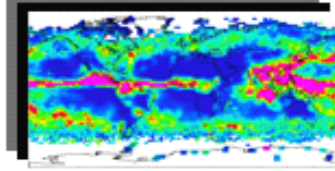
A number of WCRP and IGBP initiatives are leveraged on ISLSCP Initiative II, including the GEWEX Global Soil Wetness Project (GWSP), the Global Carbon Observing System (GCOS), NASA's Interdisciplinary Science Projects (IDS), NASA's Seasonal to Interannual Prediction Project (NSIPP), the GEWEX Global Land Atmosphere System Study (GLASS) and others.

10 Year + (One Quarter to One Degree) Co-Registered Data Sets

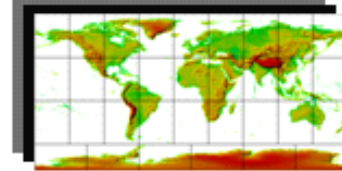
Vegetation Biophysics (fPAR)



Precipitation



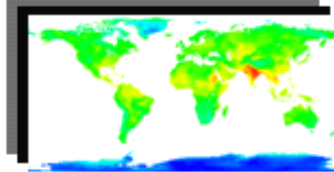
Topography



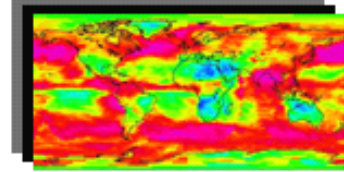
Soil Carbon



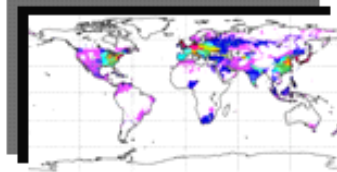
LW Radiation



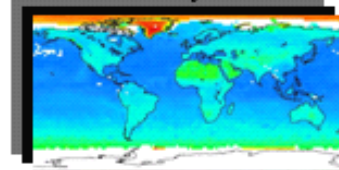
Cloud Amount



Fossil Fuel Emissions



Clear-Sky Albedo



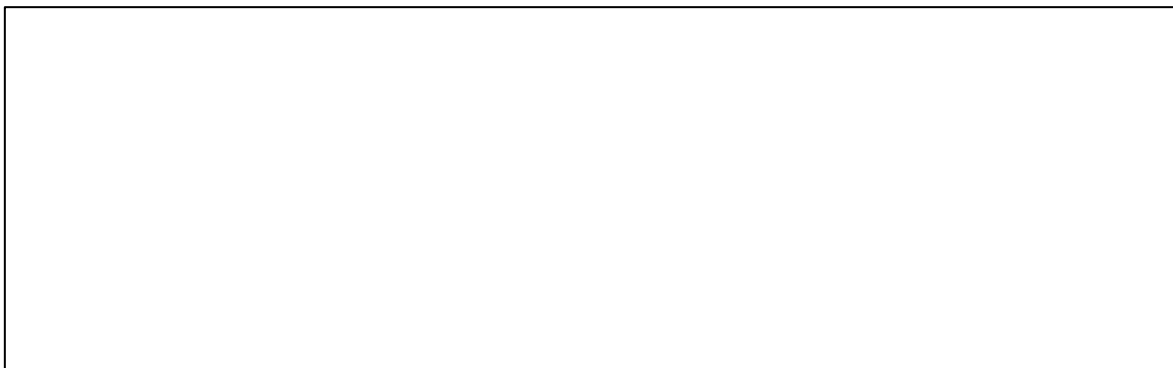
Nine examples of the data sets in Initiative II.

Data Distribution

The data collected for Initiative II will be accessible to the user community in three ways. The simplest form will be a Web site with a description of the project, giving users easy access to the smaller-volume data sets and documentation. The Web site will also give users access to the Distributed Oceanographic Data System (DODS) server allowing geographic and temporal subsetting, making the large data sets more accessible. The second form of access will be Secure FTP (SFTP) on the same server, allowing users to download many data files using a graphical SFTP client. This combined server will reside at the Goddard DAAC. The third form of user data access will be DVD-ROMs, published at the end of the ISLSCP funding cycle, that can be mailed to the user.

A separate development system with a GrADS-DODS server (Section 5.2) will be used for staging, testing, and verification of the data sets. The Initiative II staff and data reviewers will use this to perform needed verification checks on the data, looking for inconsistencies and correctable problems. When a data set passes peer review, it will be transferred to the DODS server for public access. These two systems will serve as the starting point of information system development (see figure below) and will evolve as new technologies and requirements emerge.

As individual data sets complete the peer review process, they will be placed online at the Goddard DAAC. Through this incremental review and transfer process, a complete, archive-ready copy of the entire data collection will reside on the Initiative II site at the Goddard DAAC at the end of the project.



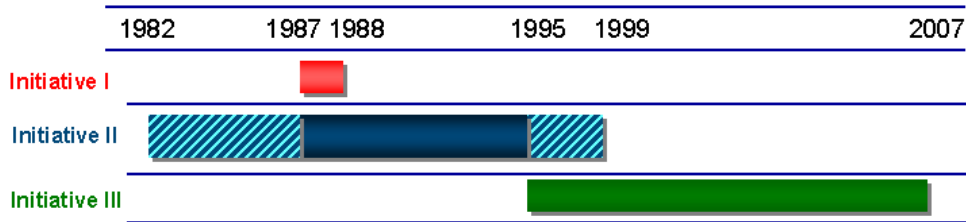
TERRA, AQUA, EVISAT, ADEOS II, etc.) Additional efforts need data sets relevant to carbon cycling and human dimensions studies. In the past 3 years an accelerated effort to understand and predict climate change has resulted in a flood of new data sets at a myriad of time and space scales. While these new data sets are rapidly becoming available, most of the data are at best, underutilized, and in many cases not utilized at all. Too few know what is available. Many do not have the resources to understand and deal with the plethora of data formats. Without a consolidated effort to organize the community, identify data requirements, locate, reformat and evaluate these data, enormous amounts of human and other resources will be wasted dealing with the data sets in numerous laboratories.

The Earth's lands and oceans play a key role in climate by absorbing nearly one-half the carbon released into the atmosphere by human activities. Where that carbon is being absorbed, by what processes, and how long these cleansing processes can continue are poorly understood. To more completely resolve these processes will require, in addition to the data sets already in the ISLSCP collection, observations of ocean physical and biophysical properties such as ocean color; for land, higher resolution land use, land cover change maps from Landsat. To locate and quantify the carbon sources and sinks on land and ocean, improved data sets of atmospheric carbon dioxide and methane are needed. Climate studies need improved global maps of aerosols. As the community begins to focus on the anthropogenic effects on climate and carbon, and the impact of climate change on humans, increasingly requirements for gridded population, gross national product and other economic variables are needed. Thus, there is an urgent need to continue the ISLSCP heritage of working with the various WCRP and IGBP projects to identify the requirements for, and to provide gridded data collections to address the important questions and issues that are the foci of these projects.

An international ISLSCP workshop was held in Washington D.C. (October 2002) to address this question. The workshop recommended first that the 10-year Initiative II series be extended to lengthen the data record. Second, the collection must be expanded to incorporate greatly improved data series that are available from new satellites, such as precipitation from TRMM and land cover from TERRA and AQUA. Finally, entirely new data series will be available that did not exist for Initiative II. In summary the next initiative should:

- ❖ Extend the period of record of individual ISLSCP II data series in a *seamless* way through 2007.
- ❖ Add Selected New Data Series to the ISLSCP Collection, for example
 - 30-year Landsat-based land disturbance record
 - Biomass products from GLAS
 - Atmospheric Carbon Dioxide concentrations
 - Ocean-Atmosphere CO₂ exchange products
 - Socioeconomic data
- ❖ Evaluate the ISLSCP II data series
 - Evaluate the individual data series against independent data sources
 - Evaluate the value of the ISLSCP II collection as a whole to address changes in the surface-atmosphere exchange of carbon, water and energy
- ❖ Utilize recent technology developments to efficiently distribute the collection, and promote data system interoperability.

ISLSCP Data Sets



*Hatched lines represent supplemental data sets

Data Needs for a Future Initiative

Following the recommendation of the ISLSCP science user community, the staff polled data providers to ascertain more specifically what new data sets might be available for a follow on to Initiative II and when they might be available. Indeed, development activities continue to extend all the data series available in the Initiative II collection and in addition, new data series will be added. The findings of the ISLSCP staff poll are summarized below within the following categories.

- Hydrology, Topography, and Soils
- Near-Surface Meteorology
- Radiation and Clouds
- Vegetation
- Carbon
- Snow and Sea Ice
- Oceans
- Socioeconomic and Human Dimensions

Hydrology, Soils and Topography

Precipitation

The principal global precipitation data sets in Initiative II were produced by the Global Precipitation Climatology Project (GPCP) and were provided at both monthly and pentad (5-day) temporal resolutions. The native spatial resolution of the GPCP data is 2.5 degrees. The GPCP data will continue to be produced until 2005, and possibly 2007, using the best available satellite and rain gauge data and internally consistent algorithms.

Parallel to this, it is expected that by 2007 there will be also be a fully global, fine-scale precipitation product with a spatial resolution of one-quarter degrees with a three-hourly temporal resolution from October 1996 to December 2007. This data set will be produced from the best available microwave and infrared satellite data, Tropical Rainfall Mapping Mission (TRMM) and the TIROS Operational Vertical Sounder (TOVS). This data set can then be used to reprocess the entire GPCP 1979-2007 archive with improved algorithms (2.5 degrees). Finally, it may be possible to produce a consistently processed, global, 1 degree rainfall data set for the period 1986 to 2007 using the latest version of the ISLSCP data described in Section 3.3. These satellite-based precipitation data sets will be complemented by planned updates of the monthly rain gauge-based Global Precipitation Climatology Center (GPCC) and the Climate Research Unit (CRU) data sets. Updates and improvements to the Initiative II daily rain gauge data set from the Climate Prediction Center (CPC) at NOAA are also expected.

Runoff

Initiative II modeled runoff estimates were developed by the University of New Hampshire (UNH) using the GTOPO30 digital elevation model to develop river routing and basin boundaries. Near surface meteorology forcings were an Initiative II data set from the Climate Research Unit of the University of East Anglia and potential evapotranspiration computed from the Shuttleworth and Wallace model (Fekete *et al.*, 2001). There are three potential improved runoff data sets for inclusion in Initiative III.

University of New Hampshire : The UNH Water Systems Analysis Group will expand the thematic content and time-frame of the runoff fields it is currently constructing on behalf of Initiative II. It will expand the time frame to a 20+ year time frame, 1986-2007. The blending of the discharge and water balance modeling fields will be improved to consider explicit interstation time delays in routing, water diversions, and losses including those from irrigation and net reservoir losses. Both runoff and discharge fields will be prepared. These will be organized at a more refined 6-minute spatial scale and made part of the Webster-II REASoN hydrology data bundle. An intercomparison with other gridded runoff fields in the collection will be made. As with its current commitment to distribute hydrographic data products, the new outputs will be shared fully and interactively with the ISLSCP community.

Princeton: As part of the NASA Pathfinder project, a 50-year global forcing data set, with a planned spatial resolution of 0.5 ° and 6-hourly temporal resolution is being finalized. The forcing data set is corrected NCEP reanalysis model output; corrected to remove spectral noise, to adjust the monthly precipitation with respect to gauged precipitation, and to adjust the solid precipitation for estimated undercatch. This extended data set will be used to drive the VIC LSM model and the results will be validated against long-term river discharge measurements for major basins across the global continents. This data product is expected to be available in mid-year 2003.

Kassel University: A gridded runoff product that is now available from this group relates the discrepancy between the model runoff estimates and observed runoff with several geographical and climatological factors and globally *corrects* the products. The KU group also considers anthropogenic effects on the runoff before comparing the model products with real observation. Products from Kassel University will be available for implementation in the future.

Irrigated Crop Water Demand

The hydrology science community has requested the inclusion of a gridded "crop irrigation water requirements" data set. A principal use of the data set is to adjust gridded runoff estimates for irrigated crop water usage. Such a data set is available from the Institute of Industrial Science, University of Tokyo (IIP/UT) who have generated a global gridded data series of daily crop water requirements for irrigated rice, wheat, maize, and soybeans. The spatial resolution of 0.1 degree has been generated for 1978 to 1992. The data set is a modeled data set based on monthly climate drivers, soils data and topographic data (both included in Initiative II), available irrigation equipment, river discharge data, ratio of irrigated to non-irrigated land, and country-based crop production and yield statistics.

Soils

Soils represent the primary interface between the surface and atmosphere and are critical to hydrology in their capacity to store water and their influence on the rates at which water infiltrates and evaporates. A proposal is being submitted from the United States Geological Survey (USGS) and its collaborators to improve the IGBP soils map. Should the USGS soils map become available, it will be incorporated into Initiative III. Most models with land surface parameterizations have the potential for describing soil hydrology in some detail, but more detailed and realistic surface characterizations are required. Initiative II included the data set compiled by the IGBP Soils Task Force providing the range of soil characteristics required by the land surface hydrology community, such as soil texture and a range of pedon characteristics.

Topography

Topographic data for Initiative II were developed by the USGS. The Hydro1K digital elevation model (based on GTOPO30 at 1km) provided the elevation, slope, aspect, and other topography information. A potential new data set for inclusion in Initiative III is the 30-meter resolution Shuttle Radar Topography Mission (SRTM) product, which will be essential to the analysis of GLAS Lidar data for vegetation height and biomass. SRTM also provides the potential for improving river routing and surface radiation estimates.

Near Surface Meteorology

ECMWF provided a surface data set for Initiative II (Simmons and Gibson, 2000) from their 40-year reanalysis (ERA40). ERA40 covers the period 1957-2001, and it will be completed in March 2003. There are firm plans of reanalyzing a recent period (possibly 1979-present, and continuing in near-real time) with a better assimilation system, and better usage of data than ERA40. An archive is planned from this reanalysis for the Coordinated Enhanced Observing Project (CEOP) period (1 October 2001-31 December 2004). It is likely that an Initiative III surface data set for the period 1996-2005 could be prepared from these ERA reanalyses.

NCEP also provided a surface data set for ISLSCP II based on their operational reanalysis model. Their reanalysis covered the period 1979 to the present and has been submitted to the Center for Land-Ocean Atmosphere (COLA) for final processing into the Initiative II format. This product is now complete. NCEP will continue their reanalysis during the Initiative III time period. Based on evaluations and comparisons between the ERA 40 and the NCEP product during that period, a decision will be made as to inclusion in Initiative III. An improved product is in planning, based on collaboration between Goddard's Data Assimilation Office (DAO) and the National Center for Atmospheric Research (NCAR). This 3-hourly global reanalysis product at 1-degree spatial resolution would cover the Initiative III time period. Potential improvements over the NCEP products would include assimilation of SSMI data and incorporation of better land surface physics from the NCAR CCM-3 land surface model.

Radiation and Clouds

The ISLSCP II collection includes an extensive radiation and clouds data set produced by NASA's Langley Research Center (LaRC) using satellite data processed by the International Satellite Cloud Climatology Project (ISCCP). The ISCCP satellite data archive extends from July 1983 to the present, with a future ending date of 2005 and potentially 2007. The ISCCP data will continue to provide a uniquely continuous and consistently processed record from 1983 to 2007, which would in turn allow the production of continuous and consistently processed data sets of cloud cover and cloud properties, as well as radiation. New improvements to the ISCCP data will include the removal of aerosol effects and reprocessing of the entire archive based on cross-comparisons with new satellite-based sensors, such as those on the EOS platforms. The improved ISCCP data will facilitate the production of an improved Surface Radiation Budget (SRB) data set at LaRC for the entire period of the ISCCP record, leading to potential new future data sets such as 3-hourly PAR and diffuse radiation. These cloud properties and SRB data sets are core components of GEWEX and have been requested by the ISLSCP user community. We will work with the producers of these data sets to obtain any new or reprocessed SRB and ISCCP data sets as these evolve in the future. We will also work with the scientific community to reach a consensus on the best methodology for using surface topography data to correct the effect of sub-grid topography on the radiation fields.

Vegetation

Land Cover and Land Cover Change

Accurate descriptions of land cover characteristics are important for the parameterization of a wide variety of global models. For Initiative II, current state-of-the-art classifications based on AVHRR 1km global data were included as well as the first global classifications from MODIS data. The AVHRR data sets include land cover classifications (Hansen *et al.*, 2000, Loveland *et al.*, 2000) and continuous fields of vegetation characteristics, such as percentage tree cover (DeFries *et al.*, 2000). With improved training data, AVHRR data sets, and automated classification techniques, it is now possible to produce a time series of both classification and continuous fields products for the entire AVHRR archive. Experiences gained processing the MODIS land cover and continuous fields products should lead to improved accuracy. Another benefit of the MODIS products is validation against field-collected data. Finally, global 1km classification products from the VEGETATION sensor (the European GeoLand Initiative) will

soon become available and could be included in Initiative III, based on cross-comparisons and evaluation of the various land cover products. We will consult with our land cover partners to acquire the re-gridded coarse resolution land cover and vegetation continuous fields products.

The production of global land cover change data sets is an active area of current research. As an example, multi-year data sets of vegetation continuous fields have been produced at the University of Maryland from the 8km AVHRR data and could be used to produce a first order land cover change product indicative of broad land cover changes. Other more regional data sets using Landsat Thematic Mapper (TM) data are currently in production. These data sets could be used as precursors to the various MODIS land cover change products that are planned and are currently being developed (Strahler *et al.*, 1999).

Land Surface Disturbance and Biomass Recovery

North America has been identified as a major sink of carbon. Carbon storage processes on land are a result of biomass change in vegetated land cover. Satellite estimates of above-ground biomass change have been defined as a "high priority need" for locating and quantifying the strength of the North American sink, and for understanding the underlying processes (Wofsy and Harriss, 2002, McClain *et al.*, 2002). The scale of the disturbance requires the use of high-spatial resolution data such as Landsat. While no Landsat land surface disturbance and recovery maps exist, we anticipate that an effort to develop one will be funded soon, with global products available in the Initiative III time frame. If so, we will work with the developer to incorporate the product into Initiative III. Another key product will be biomass density. A potential source for this data product is the laser altimeter instrument (GLAS), to be launched on ICESat in December 2002. It is anticipated that development of a vegetation height and biomass product will certainly be proposed and funded. If so, we will include these products in Initiative III.

Vegetation Biophysical Characteristics

A core component of the Initiative II data collection is the FASIR-NDVI product and its suite of derived vegetation biophysical parameters, such as total and green LAI, FPAR, roughness length, etc. (Los *et al.*, 2000). This data set covers the period 1982-1998 and provides a consistently processed suite of data for modelers. As more and more climate modelers are introducing the carbon component into the GCM Land Surface Processes (e.g., DAO, GLDAS, CLM, ECMWF), there is an obvious and immediate need for a global, internally consistent, and temporally coherent data set describing the biophysical properties of the land surface. While Initiatives I and II provided a useful biophysical data set that was received with enthusiasm by modelers at large, Initiative III will extend the series, add more data, and conduct a comprehensive sensitivity analysis on the data set.

The critical element to deriving global biophysical fields is the need for a consistent NDVI data set. The GIMMS product based on AVHRR data will continue to be processed at GSFC using improved calibration, satellite drift, and solar/viewing geometry information. This data set will provide a consistently processed NDVI data set for the period 1982-2007. Another improved long-term data set being proposed by a GSFC group uses MODIS algorithms to reprocess the AVHRR archive, including the individual bands of AVHRR as well as NDVI. This data set would provide continuity between the AVHRR and MODIS data. Efforts are also continuing to improve the FASIR NDVI data sets at the University of Wales for the entire period of the AVHRR record. Finally, consistent and improved NDVI data sets, which combine satellite data from sensors such as AVHRR, MODIS, SeaWiFS, and VEGETATION, can be produced by merging the data streams of these satellites in a nearly seamless fashion.

Each of the above data sets can be used to produce the required long-term archive of biophysical parameters. For example, one proposed study aims to use the reprocessed AVHRR-MODIS archive in conjunction with the current LAI and FPAR algorithms for MODIS to produce a long-term LAI and FPAR data. Either the GIMMS or FASIR NDVI data sets can also be used to produce these parameter fields for the 1982-2007 period.

Because this will continue to be an important component of ISLSCP data initiatives, we will work closely with the producers of the above data sets and the modeling community to ensure that the Initiative III collection provides the best possible NDVI and biophysical parameter data set. We will also consult with these groups to perform intercomparisons and evaluations of the various potential products. Fields of FPAR, LAI, roughness length, and greenness obtained from the various approaches will also be intercompared and evaluated against observations, where available, in order to ascertain the strengths and weaknesses of each product.

Albedo

The Initiative II collection contained five different albedo data sets from AVHRR and MODIS. Current plans are to reprocess the GIMMS 8-km AVHRR archive to calculate albedo over the 1982-present period at $1/10^\circ$ and a monthly time step. This data set will be processed with methods consistent with the MODIS albedo product and thus can be combined with this to provide continuous coverage to 2007. Consistent, global land, ocean, ice, and snow albedo products for global climate and SEB modelers can also be produced by merging data from various sensors such as AVHRR, MODIS, and Meteosat. Also available for the entire archive of AVHRR data will be the snow-free albedos that are generated directly from the FASIR data. We will interact with the producers of these albedo data sets to obtain the most up-to-date data.

Carbon

An important contribution of ISLSCP Initiative II was the inclusion of various data sets to support carbon and biogeochemical models. These data sets included both point measurements (CO_2 and CH_4 atmospheric concentrations, NPP, LAI, surface-atmosphere carbon, water, and energy exchange (FLUXNET)) and currently available gridded products (e.g., fossil fuel emissions, historical land cover and land use, NPP, and riverine flux of carbon to the oceans).

Atmospheric Chemistry

The GLOBALVIEW CO_2 and CH_4 data sets produced by NOAA's Climate Modeling and Diagnostics Laboratory (CMDL) will continue to be updated biannually, respectively. We propose to include any updates or expansions to the GLOBALVIEW data sets. CMDL has recently been funded to greatly expand the cooperative air sampling network with emphasis on regular vertical profiles using light aircraft (~35 new sites) and continuous carbon measurements from tall towers (~8 new sites) at North American locations. Measurement programs from ships of opportunity, across the Atlantic and Pacific Oceans and the South China Seas, are other components of this expansion. In a few years, the number of observations from this expanded CMDL program will greatly enhance GLOBALVIEW products. The GLOBALVIEW data sets may also incorporate data from the multinational Aerocarb program sponsored by the European Union that has greatly expanded sampling in Eurasia.

Surface-Atmosphere Carbon, Water and Energy Exchange

For the time period of Initiative II, only data for two sites and for 2 years were available from the FLUXNET global network of micrometeorological towers. The FLUXNET network is currently comprised of over 200 towers that provide ground-based measurements of the exchange of carbon, water vapor, and energy between terrestrial ecosystems and the atmosphere. FLUXNET also provides ground information for validating estimates of NPP, evaporation, and energy absorption that are being generated by sensors on the NASA Terra and Aqua satellites. These data are processed into a consistent data set that is available through the Oak Ridge National Laboratory (ORNL). We will work closely with our partners at ORNL to acquire all appropriate FLUXNET data sets to be used for the validation of Initiative III products and data sets. Finally, the field-based validation products currently being generated for MODIS (e.g., LAI), also archived at ORNL, will also be included. These data sets will complement the point LAI and NPP data sets that were provided in Initiative II, as well as the gridded NPP data set produced under the auspices of the Gross Primary Production Data Initiative (GPPDI). While

there are no concrete plans to grid these point measurements, we will continue to actively engage the scientific community to obtain any such data sets as they are produced.

Fossil Fuel Emissions

The gridded fossil fuel emissions data set produced by the Carbon Dioxide Information Analysis Center (CDIAC) was a core component of the carbon data sets provided in Initiative II. While we will include any updates to these CDIAC products in Initiative III we propose to use the more extensive Emission Database for Global Atmospheric Research (EDGAR) data base produced by the National Institute for Public Health and the Environment (RIVM) in the Netherlands. RIVM also produces the History Database on the Global Environment (HYDE), which is currently being updated in concert with the EDGAR database. Upon completion of an update of the historical population maps in HYDE, the historical land use maps provided in Initiative II will also be updated. EDGAR is scheduled to be updated to the base year 2000, providing coverage of anthropogenic emissions (CO₂, CH₄, CO, SO₂, etc.) for the period from 1700 to 2000, and will include improvements on allocation and new sources. These updates are expected by the year 2004. Last, plans are being made to reprocess the data from the historical emissions project (100 years of HYDE activity data combined with emission methodology of EDGAR).

Riverine Carbon Flux

Initiative II contained a global gridded data set of riverine carbon flux. Several of the Initiative II data sets could potentially be used to produce an improved data set of riverine fluxes. The data series would be of higher resolution and better quality than that currently available, and could provide multi-temporal coverage. We will consult with data providers and partners to ascertain the feasibility of producing such a product, and will provide data sets and assistance to those partners. These improved data sets would provide important contributions to a better accounting of the global carbon cycle.

Snow and Sea Ice

Snow cover and sea ice extent were provided for Initiative II by the National Snow and Ice Data Center (NSIDC). For Initiative III, NSIDC will offer a global monthly mean snow extent and snow water equivalent derived from passive microwave satellite remote sensing for the period 1978 to 2007. A prototype of this data set will be presented at AGU in December. NSIDC will also have new research products for both snow and sea ice derived from MODIS and AMSR-E but they will be stand-alone time series beginning in 2000 for MODIS and in 2002 for AMSR-E. The primary advantage of the new sensors is higher spatial resolution.

Oceans

The GSFC Oceans Branch is proposing to develop and maintain a seamless ocean color time series from 1978 to 2008 using compatible and consistent processing algorithms. Their missions of interest for the duration of this proposal are the Coastal Zone Color Scanner (CZSC), OCTS, and SeaWiFS when it becomes historical. We would work with this group to incorporate their ocean color data series together with other data (e.g., wind fields, sea surface temperature, salinity) relevant to the estimation of ocean-atmosphere carbon exchange.

Finally, the Optimally Interpolated (OI) Sea Surface Temperature data set of Reynolds *et al.*, (2002), will continue to be processed in the same fashion with incoming AVHRR data thus providing complete SST coverage for the entire Initiative III time period. Integration of microwave and MODIS data is also planned and may provide improvements over what is currently available. We will consult with Dr. Richard Reynolds from NOAA-NESDIS to obtain the latest versions of the weekly and monthly OI SST fields.

Socioeconomic and Human Dimensions

We believe that the inclusion of gridded, global socioeconomic data sets such as the global population of the world and gross domestic product produced by the Socio-economic Data and Applications Center (SEDAC) was an important first step in fostering more cross-disciplinary studies that include the human aspects of global change. Based on recommendations from the socioeconomic data community, we propose to extend both of the above data sets to 2005 based on updates from SEDAC, and to expand the number of socioeconomic and human dimensions data sets in Initiative III.

Global data sets of stable city lights (Imhoff *et al.*, 1997) are currently available for 1995 and 2000, with proposed extensions to 2005 and production of change over time as well. These data sets are being used to produce global maps of urban and peri-urban areas that provide an improvement over what is possible with visible/near-infrared data sets. The city lights data are also being used to examine global patterns of energy consumption and fossil fuel emissions. Other interesting new data sets are being produced at GSFC (Imhoff *et al.*, 2002), using FAO consumption reports with gridded population data and provide global gridded estimates of the human appropriations of NPP; in other words, the NPP that is required to support the consumption of food, meat wood, paper, and fiber by the global population.

Because this is an area of active research, we will consult with our GSFC and SEDAC partners to identify new or improved data sets that may be available in the 2007 time frame.

Next Steps

In 2002 NASA issued an announcement of opportunity soliciting “data bundling” activities of the type pioneered by ISLSCP. The language in that opportunity responded directly to GEWEX desires. It was custom made for the proposed new ISLSCP data initiative. Why NASA? We should not forget that S in I“S” LSCP stands for SATELLITE. New satellite data sets are being produced at an unprecedented rate. But they are difficult to utilize because their formats are not customized to the needs of the GEWEX community. That these data are properly utilized is NASA’s prime interest of course, but only in the context of needs defined by the Earth Science community. Satellite data sets are not a tool unto themselves. NASA will not and in fact cannot proceed with future data initiatives without the blessing of international programs like GEWEX.

Prior to the NASA announcement and in anticipation of it, ISLSCP hosted two open science workshops during 2001 and 2002 involving data users and data providers. In response to this workshop, a white paper was prepared and circulated. The recommendation from GEWEX members was to proceed with a proposal for a follow-on data initiative, although most, but not quite all data in the Initiative II collection were available. A proposal was submitted by the ISLSCP staff to complete Initiative II and initiate a follow on. However it was only partially successful. The completion and evaluation portion of Initiative II was approved. And while the proposal review panel felt that the follow on initiative was important, they also felt that an evaluation of Initiative II should be completed prior to funding a new initiative. This of course will require another opportunity and another proposal.

A work plan and schedule for completing Initiative II and its evaluation is shown below. It is likely that following the completion of Initiative II, and a successful evaluation, that NASA, with recommendations from GEWEX will issue a future opportunity, and of course any and all will be welcome to respond by submitting a proposal. However, the review panel did raise issues that should be addressed prior to a future initiative.

Reviewers commented that the proposed new initiative seemed “very expensive”. 3.3 full time equivalents were requested with hardware, equipment etc. being provided at no cost by NASA. Initiative II suffered from inadequate resources and the perception that it was too expensive (about 2 full-time equivalents, including data production of the 18-year NDVI series). Understaffing was a significant (but not the only) factor in the delayed publication. How do we then resolve the conflict between timeliness and “very expensive”? Utilization of rapidly improving information technology is part of the answer, but not all. We can automate many of

the functions performed manually for Initiative II, but this will likely only offset the increasing complexity and volume of the data in the collections. If we want these data collections we must be more realistic about their cost. In the end, having one group rather than many do the integration saves money.

The review panel also felt that the new proposed ISLSCP initiative included data outside the bounds of the “traditional view of land surface climatology (ocean color, for example)”, The expanded data requirement reflected the express desires of the expanding user community attracted by Initiative II. The community wanted to move beyond the traditional bounds in recognition of the fact that the land and ocean carbon, water and energy cycle studies can no longer be stove piped.

These two facts held together suggests that agencies other than NASA be involved in the funding of any new data initiatives. This should be a focus of the GEWEX as they develop strategies for future data initiatives. A new white paper, addressing the issues raised by the last panel review, and describing the need for and structure of a follow on data initiative should be prepared, reviewed and approved by the GEWEX and circulated among international scientific organizations and potential funding agencies with the intent of stimulating a joint funding opportunity to which all interested parties can respond.

Activity	2nd Qtr CY04	3rd Qtr CY04	4th Qtr CY04	1st Qtr CY05	2nd Qtr CY05	3rd Qtr CY05
Complete Processing		X				
Transfer to DAAC		X				
Complete DAAC Implement.			X			
Complete Evaluation	telecons	Wkshp 1	telecons	telecons	telecons	
Publish Results			Init II Paper		Final Wkshp	Eval Paper

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