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MODIS QUARTERLY REPORT
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RSMAS/MPO

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Due to the interlocking nature of a number of projects, this and subsequent reports will contain coding to reflect the funding source. Modis funded activities are designated with an M, SeaWIFS with an S, Pathfinder with a P, and Headquarters with an H. There are several major sections within this report; Database, client/server, matchup database, and DSP support.

- A. NEAR TERM OBJECTIVES
- B. OVERVIEW OF CURRENT PROGRESS
- C. FUTURE ACTIVITIES
- D. PROBLEMS

A. NEAR TERM OBJECTIVES

A.1 Modis Objectives (M)

- A.1.1. Continue to develop and expand the processing environment
 - a. increase computational efficiency through concurrent operations
 - b. determine and apply more efficient methods of data availability for processes
- A.1.2. Begin extensive testing using global CZCS and AVHRR GAC data with database processing to test the following:
 - a. algorithm capability
 - b. machine and operating system stability
 - c. functionality required for the processing and analysis environment

A.2 SeaWIFS Objectives (S)

- A.2.1. Continue testing of DSP processing methodology across supported platforms.
- A.2.2. Continue to develop relationship between database and in- situ environment.

A.3 Pathfinder Objectives (P)

- A.3.1. Expand matchup database as applicable.
- A.3.2. Continue testing of methodology.

A.4 DSP Objectives (H)

A.4.1. Continue testing of processing methodology. A.4.2. Continue to expand the number of sites supported. A.4.3. Expand the supported hardware/software platforms

B. OVERVIEW OF CURRENT PROGRESS

B.1 Automatic Processing Database (P)

B.1.1 Operational Testing

B1.1.1 January Testing

In January, the command files used to load data from the optical disk to the VMS data staging disks were tested and integrated into the operation. The command files GET-SUEGAC.VMS, GET-SUEGAC.BUILD and PUT-SUEGAC.VMS check the available disk space on the staging disk, and if room is available, copies one day's worth of files from the optical disk.

Once this was in place, the system could run in more or less operational mode. That is, the processing began to proceed more smoothly, and less direct intervention was needed. Some problems that before had seemed minor now needed attention. For example, occasionally the client/server connections would fail, and one or more records would not be added for a given input file. Previously, the processing had proceeded step-by-step, so this would be caught. Now, an extra error trap had to be added to the ADDRECGAC batch job. If not all required records are added, the input file is renamed into an error directory instead of the spool area, the process control records are altered accordingly.

As the month progressed, the processing became somewhat smoother, with fewer errors and stops. The hardware and software were put in place to back the PST files up onto DAT tape, and a new set of disks made available for that task. At this point, the creation of daily maps from the daily time-binned files and to backing up procedure is still manual. Changes are planned that will also automate these steps. The transfer rate for data to DAT was a function of the channel and the protocol. TCP transfers achieved rates of 920 KB/sec. with Ethernet and 1.5 MB/sec using FDDI. NFS transfers ran at similar rates over both channels, approximately 60- 90 KB/sec.

In the early part of the month, the files were taking a day or more to process one day's worth of passes, but by the end of the month, multiple days were begin processes in one day. By the end of January, days 88265 through 88305 from NOAA-9 had been processed at the rate of 7 days/day.

B.1.1.2 February Testing

The AUTOPROC system, which had processed days 88260 through 88312 in January, processed 88180 through 88259 of NOAA-9 AVHRR GAC data. Global daily day and

night files were produced, and DSP images of "all" and "good" data were made for days 88235 through 88311. A preliminary threshold was used to eliminate more cloud-contaminated data. This procedure consisted of warmest-pixel compositing of day data over a 30-day interval, then a pixel-by-pixel comparison with the daily day data, marking as bad any pixels that differs from the reference pixel by more than 2 degrees. This seemed to produce promising results, so the method will be explored further.

During the testing, the database operations became the limiting factor in processing, so the use of indexes on database tables was begun, to speed up information retrieval.

Various problems and stops were encountered and resolved. Three of the problems were:

1. Difficulties making the RPC client/server connection were diagnosed and cured.
2. Use of indices confused some procedures; records were no longer being retrieved in the correct order. 'SORT' clauses were added to the affected database queries.
3. The DSP utility CALLER stopping has not yet been entirely cured, but is being investigated.

B.1.1.3 March Testing

Days 88001 through 88070 of global GAC AVHRR data were processed. The automatic processing consisted of:

1. Entry of control records into the database, moving the input file from the VMS disk to the UNIX disk.
2. Ingest a 1200-line piece of a file.
3. Apply the RSMAS atmospheric correction and preliminary cloud masking to the piece.
4. Space bin the piece to the 9.8 km equal-area binning scheme, separating the day and night sections of the pass.
5. TIMEBIN the pieces into a daily day or night file (as appropriate).

Further processing was done manually, and consisted of a preliminary attempt at further cloud masking. The steps for this consisted of:

1. Making warmest-pixel composites of seven daily files to form weekly composites.
2. For a given week, warmest-pixel compositing the previous week (n-1), that week (n), and the following week (n+1), to create a 3-week reference file.
3. Comparison of each of the daily files with the reference file on a pixel-by-pixel basis, and marking any pixels that differed from the reference by more than two degrees C as a cloud pixel.

This procedure was performed on the day passes of days 88008 through 88063. New weekly composites were also created from these declouded day files. Reference maps (4096 X 2048, cylindrical projection) were made for three cases: all pixels, good-only pixels before declouding and good-only pixels after declouding, for visual comparison.

B.1.2 Development

B.1.2.1 January

In late January, the executable versions of the AUTOPROC software were installed and tested on a VMS and UNIX computer at Jet Propulsion Laboratory, and the staff there is currently learning how to operate the system.

Work was begun on a generic template client program, which will allow the ease addition of service functions to the AUTOPROC system. A number of these tools already exist, such as programs to recover from a computer crash, to reset the database after an error in processing, and to move records between tables, but these currently work outside the scope of the client/server. When they are used, the work request and record addition programs must suspend operation, to avoid lock conflict in the database. The template client is nearly ready.

The entry procedures, work request and triggering will be revised to allow for the use of multiple computers.

B.1.2.2 February

Testing of new programs or procedures has become more challenging. Given the existing environment, operational processing must be halted, the new system installed and tested, and the operational system reinstalled. To expedite the process, a second computer was made available for testing of the development copy of the AUTOPROC system. This 'APTEST' database system was installed and tested, to insure that it did not interfere with the operational system.

Additional procedures are currently being developed that will facilitate processing at sites with multiple machines, and to automatically map and backup output from the processing.

B.1.2.3 March

A new job triggering scheme is being developed that will increase the flexibility to enhance old or develop new processing threads. In addition to triggering single jobs, the capability has been added to define and trigger classes of jobs. For example, in the old method, completion of all space bin jobs for a particular pass would trigger the release of ALL jobs marked with a process-status of "HOLD," so only the TIMEBIN jobs could be marked "HOLD," and any follow-on jobs (CLEAN for the GAC processing) had to be marked differently, and triggered in a separate manner. To be able to trigger these jobs, specific sections in the database interface were used. In the new scheme, each "class" of jobs is assigned a "trigger_class," as well as a "class_to_trigger". Thus, the spacebin jobs have a "class_to_trigger" of "TIMEBIN", which refers to both the day (GAC_PTD) and night (GAC_PTN) TIMEBIN jobs.

Other additions were made to the database interface, but the change in triggering was the most significant. These changes were implemented in the test database, but have not yet been installed in the operational system.

B.2 Client/Server Status (S)

Client/Server development focused on three areas during this period.

1. VDC was customized for our environment. VDC can now run on our computer network, including VMS and multiple vendor Unix machines.
2. With VDC modification completed; more than 25000 runs were made in three batches to process Gordon/Wang's rte data. Results of these runs have been provided to Gordon and Wang. The VDC process is being extended to CZCS data for testing purposes.
3. Modifications are being made to the CZCS SPACE BINNER, TIME BINNER and MOSAIC to accommodate Janet Campbell's request for the statistics and will provided the basis for SeaWIFS processing. Preliminary changes have been made and testing begun to gather comparison data; the changes included:
 1. Modification of gsfcbn9.mice to obtain czcsbin.mice as the CZCS space binner.
 2. modified spacetime.mice and mosaic9.mice to obtain CZCS time binner.
 3. modified mosaic9.mice to accommodate the space binner/time binner modifications.

B.3 Matchup Database (M)

B.3.1 SSM/I Global Atmospheric Water Vapor Fields

In addition to in situ and AVHRR data, data from the Special Sensor Microwave/Imager (SSM/I), a microwave radiometer flying on the DMSP spacecraft will be incorporated to the matchup database. Software was developed to read SSM/I geophysical data tapes produced by F. Wentz and provided by JPL's PO-DAAC. The initial version of the software had an error that resulted in only a small proportion of the data being retrieved. These errors were corrected and we began producing SSM/I global water vapor fields with a double purpose: (a) to extract water vapor values at the times/locations of AVHRR and in situ matchups, and (b) to support future quality control of Pathfinder SST fields.

The first step in producing the global water vapor fields was to extract the valid water vapor values from the daily SSM/I files that had been archived in optical disk at Miami. The water vapor values were then subsampled into a global 0.5° grid, using a block-median filter. The daily SSM/I files do not cover the oceans completely, as there are gaps in the sampling. To fill these gaps, global water vapor fields for a given day were constructed using information from that day, as well as the previous and following days. Data from adjacent days were weighted using a Gaussian filter.

The production of the daily SSM/I water vapor fields is in progress, and we expect that the fields and the extraction of data for the matchup locations will be completed by the next month.

B.3.2 Data-Day

The basic products to be generated by both the AVHRR Pathfinder and the SeaWiFS projects are global daily fields of geophysical quantities such as sea surface temperature and chlorophyll concentration. The daily fields will be the basis of subsequent temporal compositing into weekly and monthly products. One basic question, however, is: what constitutes "a day's worth" of data? We addressed this question as part of our combined Pathfinder/SeaWiFS activities.

We explored various alternatives for the definition of the data-day, from a 24-hour definition, to a spatially defined data-day. The proposed definition involves a pixel-by-pixel separation of data into different data-days as the spacecraft flies over the 180° meridian. The implications of the various alternatives were examined, with particular emphasis on the possibility of aliasing due to large temporal discontinuities in adjacent data. A document exploring the various possible data-day definitions was drafted and was circulated among participants in the SeaWiFS Science Group Meeting, as well as in various other meetings. A final version of the document is in preparation. The operational implementation of the proposed data-day definition is currently under testing.

B.3.3 Matchup Retrievals

East coast and global matchup retrievals processed with NOAA non-linearity approach. New sst algorithm and cloud rejection methods are being tested using new matchup data sets.

B.4 DSP Support (H)

B.4.1 Modifications/Additions to DSP:

B.4.1.1 January

Misc. changes for OpenVMS.

Add definition of workspace variable `_PATH_SEPARATOR` in DSP. Add `Dsp_DeleteFile` function to the `imageio` library. We changed the way we handle character strings in all Fortran source files.

B.4.1.2 February

Modifications/Additions to DSP:

Add new DSP function "getenv".

Add 'run away' error checking to catch missing ()'s in RATFOR. Add RECLLEN utility. More library modifications for Sparc with gcc. Add 'mr.clean' make option.

B.4.1.3 March

Complete new DSP function "getenv".

Complete 'run away' error checking to catch missing ()'s in RATFOR.

Add RECLLEN utility.

More library modifications for Sparc with gcc. Add 'mr.clean' make option.

Add 9k bin bit mask for land masking to PATHBIN. New programs to convert between image mask and 9k bin bit mask.

New program, PATHMASK, to mask bins from a pst file. New program, PATHCLOUD, to take cloudy bins out of a pst file. New program, PATHCOMP, to composite (ala COMPOS) two pst files.

New version of atmospheric correction: PATHNLC. Add quality checking to PATHBIN to handle the nlc mask bits. Add day splitting of pieces in PATHBIN.

B.4.2 Problems fixed:

B.4.2.1 January:

Misc. fixes to the utility programs.

Fix makefile's to properly handle files in other directories. Fix error handling in FILEEPS.

Rewrite EXIST in C so that it will work on all systems. Fix HIST to declare common properly (with the full size). Fix problem with PATHSCRIPP re NOTIFY_VALID_PRT.

Misc. fixes to makefiles, mostly for VMS. Properly handle asynchronous reads on Unix.

B.4.2.2 February

Final string fixes in TROUTC.

Fix string handling in the ingest programs. Fix the makefiles for some of the C programs. Some makefiles needed a special case for Sun's and gcc. Fix makefiles for utilities and libraries for VMS. Misc. changes to MAKE-BSD utility.

Misc. fixes to DSP (fix handling of user directories). Fix handling of multi-page menus.

"Fix" SLD CHAR command. On SGI, DECstation, and Unix Alpha the user must put the character string in double quotes (which are not printed).

Sun's work with or without the quotes (if present they are not printed).

For VAXstations the string should not be surrounded by quotes (or they will be printed).

Fix string handling in PATHSST.

PATHBIN: Change land mask to a dsp image file; fix string handling. Fix declaration of image pointers in PATHTIME. PATHMAP: Change subroutine so other programs can use it; fix pixel bounds; fix int/real type conversions.

B.4.2.3 March

More string handling fixes.

Modify 9 km bin mask handling routines so they can be called by programs other than PATHBIN.

Fix EXIST for VMS.

Fix SCRIPP for big endian machines (SGI, SUN).

B.5 Direct Project Support

B.5.1 SeaWIFS (S)

B.5.1.1 January

- i. Bob Evans attended Seawifs meeting at Annapolis, presented SeaWIFS level 2 and 3 processing programs, equal area grid and data day definitions. (Jan. 19-22)
- ii. Seawifs discussion with G. Feldman, C. McClain and Cal/Val group refining plans for level 2 and level 3 SeaWIFS Programs. Specifically, adding J. Campbell's MLE statistics to the binning programs, adding Cal/Val HDF routines for HDF file i/o, adding HDF access to the ancillary data fields (relative humidity, atmospheric pressure, wind speed, and ozone). Present ANLY7 routine implementing an early form of pixel level epsilon calculation and Rayleigh-aerosol interaction will be incrementally upgraded to current generation SeaWIFS algorithms and HDF i/o. SeaWIFS test processing has been shifted to use ANLY7 to more closely represent SeaWIFS level 2 machine loading. Dummy channels will be added to the present DSP output files to represent I/O resource requirements. A sequence of related changes then will introduce in the EDGEMASK, SPACEBIN and TIMEBIN programs. The MOSAIC program will be replaced by a mapping program supporting the various projections offered by the present REMAP program. (Feb. 3)
- iii. Have initiated discussions to define changes in the BIN programs and database control programs (VDC and MCP control databases) to support the data day definitions within SeaWIFS.

B.5.1.2 February

a. SeaWIFS: Radiative Transfer Equation Processing

i. Original Level of Effort

Original 10000 runs completed for aerosol
Additional humidity level added, 3000+ runs

ii. Overall Effort

19,000 out of 26,000 runs completed
Progressing at 600 to 800 runs a day
Completion expected within next two weeks
Results to be transferred to Gordon's group to incorporate into Rayleigh-aerosol routines.

b. SeaWIFS: Modifications and Integration

i. Adding J. Campbell's MLE Binning Statistics into Level 3 Programs

ii. Coordinating Developments with C. McClain

HDF I/O Routines

HDF Ancillary Data Field Routine

iii. Level 2 Conversions

Routines to work with CZCS and SeaWIFS Data will use
Gordon's new Atmospheric Correction

iv. Integration in March/April Time Frame v. Testing Beginning in May

B.5.1.3 March

Seawifs

- a. Dalu Li testing new binning statistics for Space and Time Binning programs. The operations for CZCS channels 1-4 have been replicated to simulate the computational and data loading for the Seawifs data stream.
- b. The spatial data day coding will be transferred to the Seawifs binning programs. The ANLY program will be modified to incorporate the Gordon's new method for atmospheric correction.
- c. Rayleigh-aerosol code will be integrated into Seawifs ANLY Level 2 program in late April, early May following J Brown's return from cruise.
- d. Dalu Li implementing and testing J. Campbell's Level 3 binning statistics. Coordination meetings have been held with Cal/Val group to clarify questions relating to the binning scheme. The results of these discussions were compiled by M. Darzi and transferred to D. Li for coding.

B.5.2 MODIS (M)

B.5.2.1 January

- i. Order DEC 3000/400 workstations to enhance the computational capability at RSMAS
- ii. Ordered SGI server upgrade 4D/480 to Challenge
- iii. Implemented Howard Gordon's RTE calculation on multiple workstations.

B.5.2.2 February

- i. Implemented NOAA Non-Linearity Algorithm
- ii. Extracted First Three Months of 1988
- iii. Investigating Use of SSM/I Data to Improve Cloud Detection
- iv. Preparing New Matchup Database
Will contain first three months of 1988
Available for distribution by end of April
- v. Processing Remainder of NOAA-9 for 1988
- vi. Extraction Rate
5 to 6 days per day
Expected completion within two months

B.5.2.3 March

- i. Bob Evans attended MODIS science team meeting and discussed the future work algorithm theoretical basis document (July, 93)
- ii. Worked with DEC to try and accelerate delivery of 3000/400 workstations; delivery now expected in early April.
- iii. Designed and ordered expansion disk configurations to support MODIS development and processing. Delivery expected in early April.
- iv. Angel Li and Jim Brown participated in set up for D. Clark's optical cruise, Jim remained to participate in cruise.
- v. Angel Li traveled to GSFC for one week to work with Seawifs personnel to implement HDF capability within the DSP I/O structure.

- vi. Completed work on 26,000 RTE simulations to obtain Rayleigh- aerosol interaction coefficients.
- vii. Generated prototype algorithm timing tests, results have been sent to P. Ardnoy. Product sizing estimate; results sent to R. Chin

B.5.3 Pathfinder (P)

B.5.3.1 January

a. Meetings

- i. Bob Evans traveled to JPL to discuss transfer of Pathfinder processing from Miami to JPL. (E. Smith, P. Cornillon, A. Tran, B. Evans). Discussed data day definition and equal area grid, refined definition of data products. (Jan. 28-30)
- ii. Bob Evans attended Pathfinder Chairs meeting. Presented Data day definition and equal area grid. Discussed AVHRR pre- launch sensor calibration for IR channels and sensor non- linearity. Presented slides to show implications for science due to AVHRR digitizer behavior. (Feb. 2)

b. Activities

- i. Extract 1988 matchup data set for NOAA 9 using NOAA method of non-linear sensor calibration. Presently have first two months of 1988 extracted. These matchup data will be provided to any group interested in generating AVHRR algorithms and cloud filters.
- ii. Pathfinder benchmark period for 1988 should begin in July, '93. Processing for data products will be distributed on a monthly basis, processing and distribution will be done by JPL, matchup database generation and algorithm coefficient testing will be done by Miami.
- iii. We have received 20 optical disks for 1987; 30% of the shipment have been duplicated. There are approximately 33 in one year's data.
- iv. Have initiated discussions to define changes in the BIN programs and database control programs (VDC and MCP control databases) to support the data day definitions within Pathfinder.
- v. The global 1988 test SST data set for both day and night was computed for days 265 through 311 using a 9.28 km. grid. Equal rectangular fields were computed using the test data; the results have been distributed to JPL and URI.

B.5.3.2 February

a. Direct Activities

- i. Processing of Days 88180 Through 88311 Completed
Miami Test Algorithms Used
88311 was transition date to NOAA-11
- ii. Daily Maps Prepared
Fields shipped to URI and JP
- iii. Second Pass Cloud Filter
Implemented
Applied to 28 days beginning with 88183

Will be applied to remaining 1988 test fields and made available to review group

iv. Processing Rate

6 to 7 data days per day

Approximately two months per data year

b. Related Activities

i. EOS V0 1 Km Project

Received and decoded baseband data tapes for April 1992 through November 1992

Approaching real-time within two weeks

Data copied to DAT and sent to EROS

ii. CZCS Processing for West Coast Time Series Completed

B.5.3.3 March

a. Extraction of global matchup data base continues, expect to be complete for 1988 NOAA-9 before end of April.

b. January and February, 1988 processed to test data flow and to check capability of using reference images in a second pass data quality test. At present the second pass quality test is defined as follows:

i) All images for ascending (descending) passes are binned into daily files using data quality flags generated during Level 2 computation. These flags are based on channel differences 4-5, 3-5 and homogeneity for channels 4 and 5. Preference is given to low scan angle data.

ii) daily ascending (descending) files are composited into 1 week intervals selecting the warmest pixel for each week. iii) three weekly files are composited using warmest pixel using the weeks before, including and following the week of interest to create a reference file for the center week.

iv) Each of daily files is compared to the reference file on a pixel basis. Pixels differing from the reference file by more than 2

degrees are rejected, i.e. the data quality mask for the pixel is marked as bad data.

v) New weekly files are generated by averaging the weekly files. The number of undetected bad pixels per daily file is reduced order several hundred.

vi) Processing of 1988 global data halted pending implementation of new SST algorithm and spatial data day definition in Level 3 binning programs.

B.6 Team Interactions

Meetings listed as part of projects; no others listed

C. FUTURE ACTIVITIES

C.1 Database Future Work

C.2 Client/Server Future Work

- C.2.1. Creation of a resource manager and a performance monitor.
- C.2.2. Expansion of the error handler to provide broader coverage and to integrate into the overall system error recovery scheme.
- C.2.3. Continue testing the client/server with CZCS and AVHRR data. This would include the acquisition of a UNIX resident database to run parallel tests.
- C.2.4. Continue enhancement of processing efficiency through greater use of concurrent processing.
- C.2.5. Examine other processing schemes to determine which elements could be either included or adapted for use within the client/server concept.

C.3 Pathfinder (P)

C.3.1 Ocean SWG

Meeting in Washington to review and discuss Pathfinder progress.

C.3.2 Algorithm Development

A test SST algorithm using the NOAA non-linearity method has been implemented and a new program created named PATHNLC. The process control procedures have been modified to include the new Level 2 program, equal area gridding and spatial data day definition. Each data day is now defined to include only those pixels that fall between the 180 longitudes that are contained within a defined sequence of orbits.

Processing for January and February is being repeated to provide a comparison data set. These images were available for the OSWG meeting.

C.4 Headquarters (H)

C.4.1. Create tools to assist in result's interpolation. C.4.2. Verify workstation DSP (SGI, SUN, DECstation, VAXstation) by comparing each program's output with the Adage system.

C.5 Modis (M)

C.5.1. Converting to Use Stripped Volume Sets Across Alternating SCSI Channels to Improve I/O Rates

C.6 SeaWIFS (S)

C.6.1. Sue Walsh has implemented the spatial data day for AVHRR data. Routine testing is underway.

C.6.2. Cruise work is completed and J. Brown returns to Miami.

D. PROBLEMS

D.1 Database Problems

None listed separately

D.2 Client/Server Problems

None listed separately

D.3 Matchup Database Problems

None listed separately

D.4 DSP And Headquarters Related Problems

None listed separately