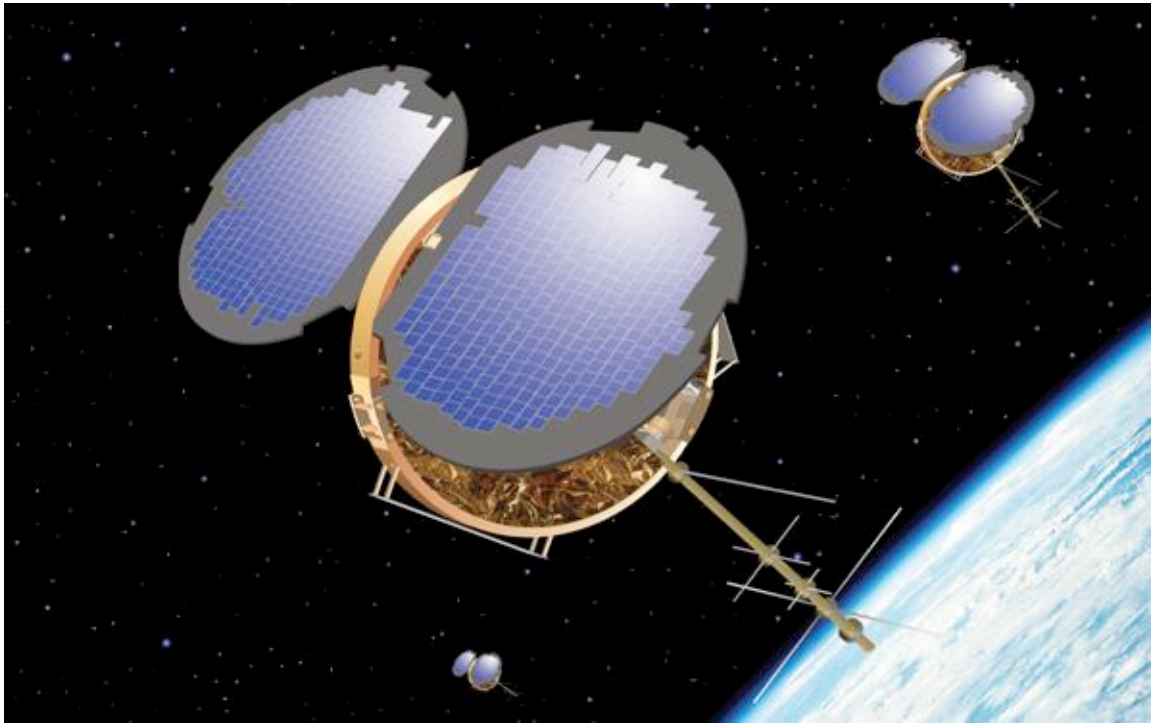
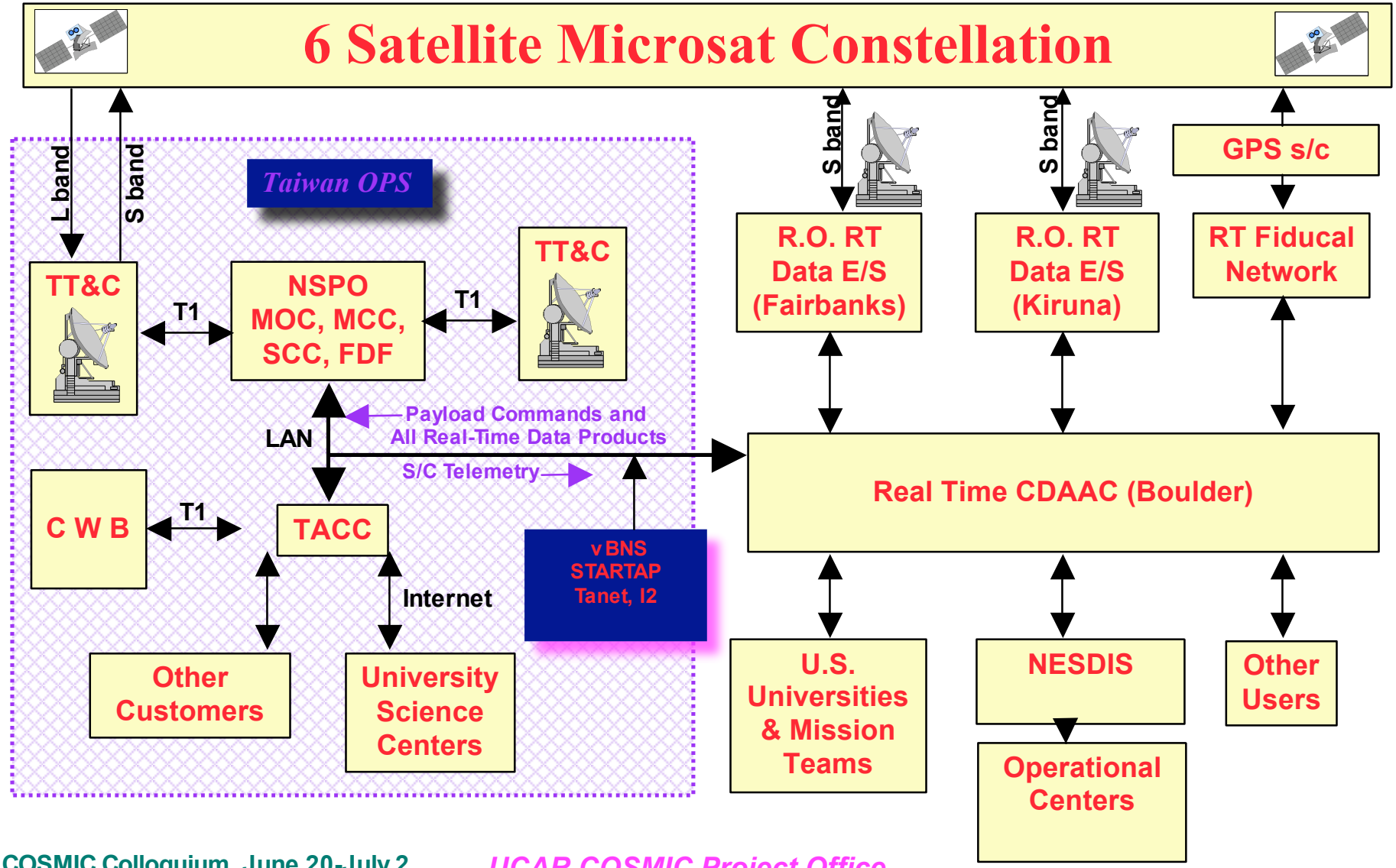
COSMIC Data Analysis and Archive Center Overview and Web Tool Tutorial



Overview

- CDAAC Summary
- CDAAC Remaining tasks
- CDAAC Web Interface
  - Tutorial Demonstration movies


6 Satellite Microsat Constellation
L band
S band
Taiwan OPS
TT&C
T1
NSPO
MOC, MCC,
SCC, FDF
T1
TT&C
LAN
Payload Commands and
All Real-Time Data Products
S/C Telemetry
C W B
T1
TACC
Internet
v BNS
STARTAP
Tanet, I2
Other
Customers
University
Science
Centers
S band
S band
GPS s/c
R.O. RT
Data E/S
(Fairbanks)
R.O. RT
Data E/S
(Kiruna)
RT Fiducal
Network
Real Time CDAAC (Boulder)
U.S.
Universities
& Mission
Teams
NESDIS
Other
Users
Operational
Centers

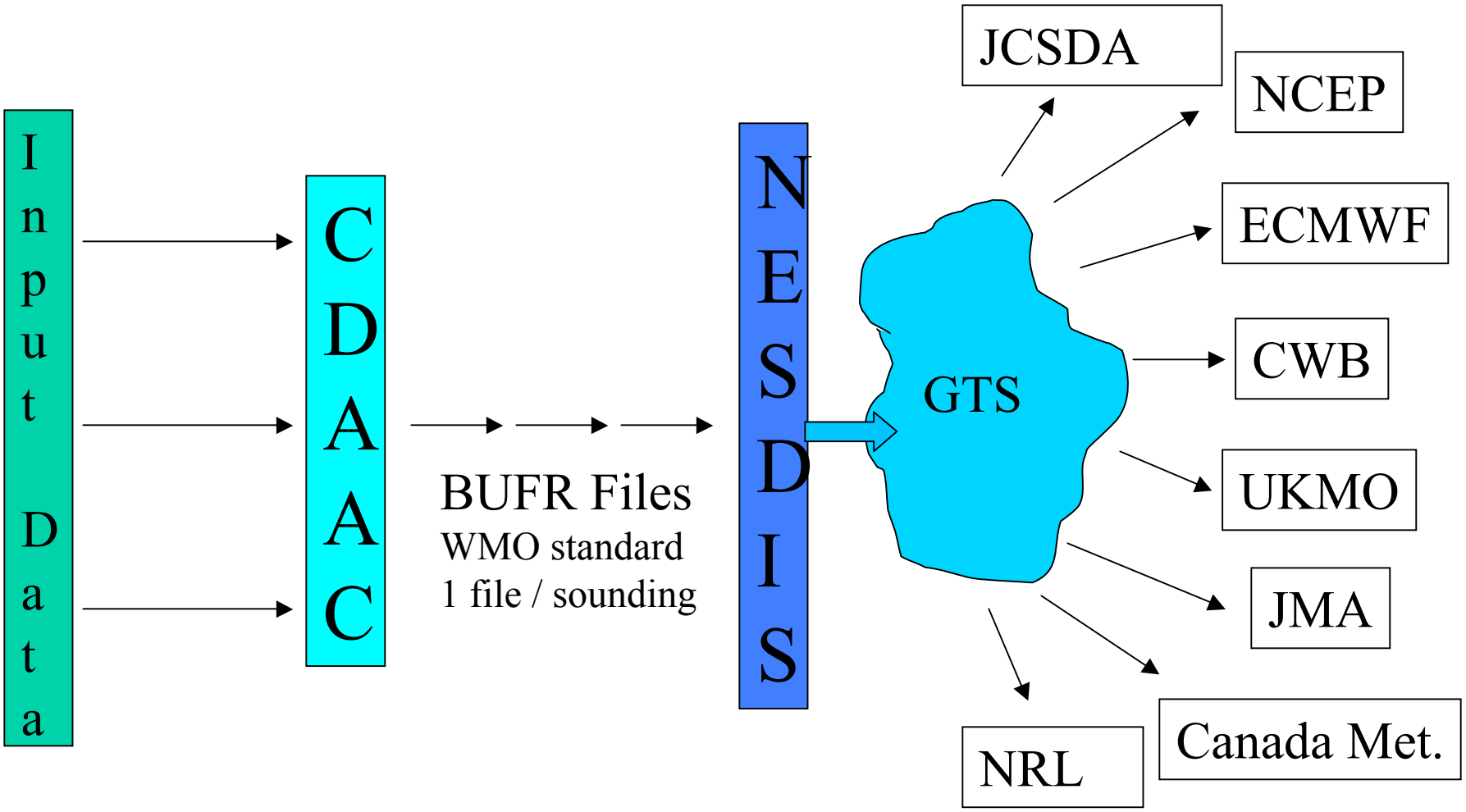
CDAAC responsibilities

- Process all COSMIC observations
  - LEO/GPS orbit determination
  - Atmospheric & Ionospheric profiles
  - Rapid analysis for operational demonstration
  - Post-processed analysis for climate and other research
- Provide data to universities and research laboratories
- Provide data feeds (< 3hr) to operational centers
- Archive data & provide web interface

What is CDAAC?

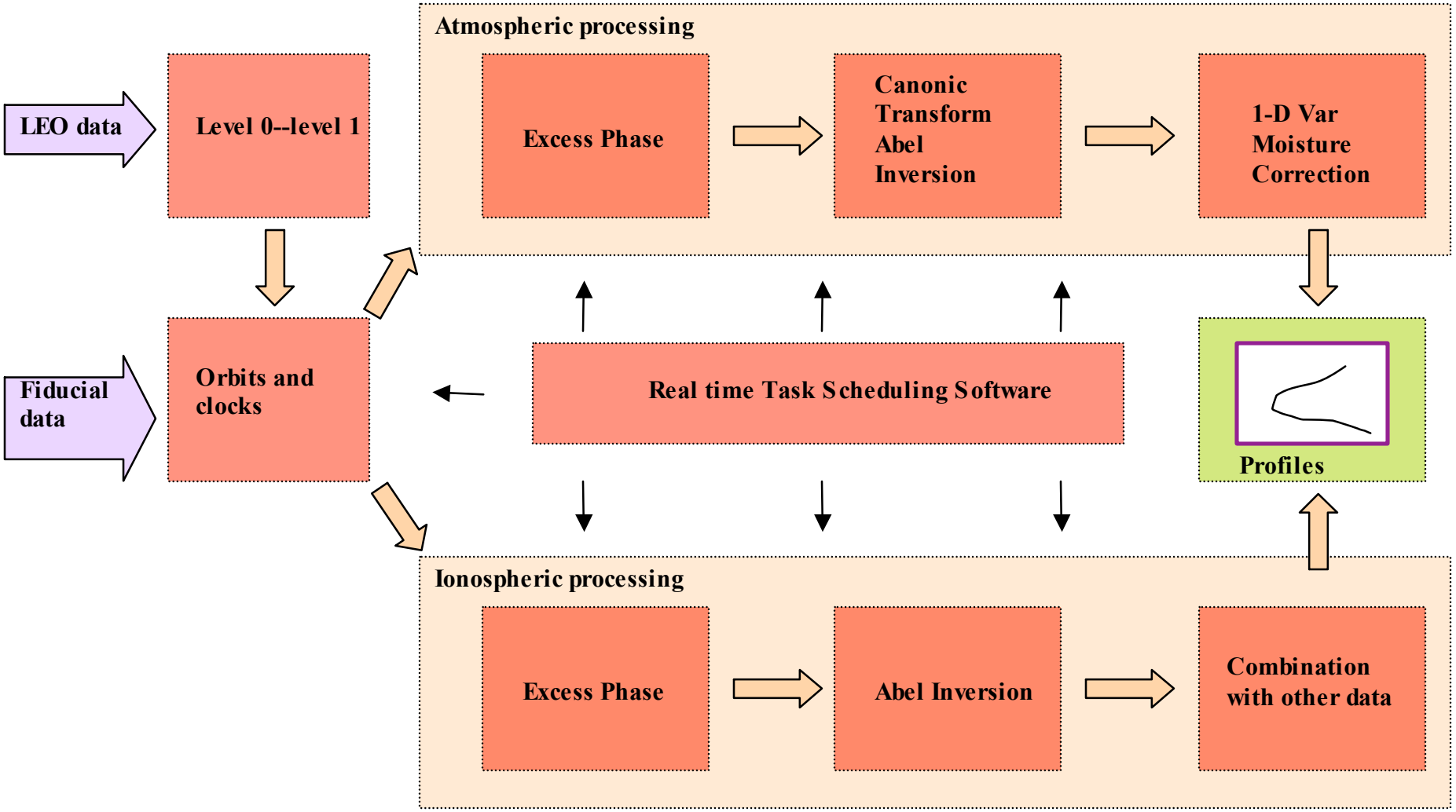
- **System to** run programs in response to arrival of data files
  - Includes post-processing and real-time modes
    - Both utilize custom daemons to distribute processing over multiple nodes in a cluster
  - Works off of a configuration table ('task list') which specifies which programs to run for which input files
  - Includes simple dependency resolution
  - Programs can optionally update a database for each file processed.
  - Files follow CDAAC standards:
    - 6chars_id.and.date.stamp_type, for example:

      `atmPrf_CHAM.2002.222.00.03.G10_0028.0002_nc`



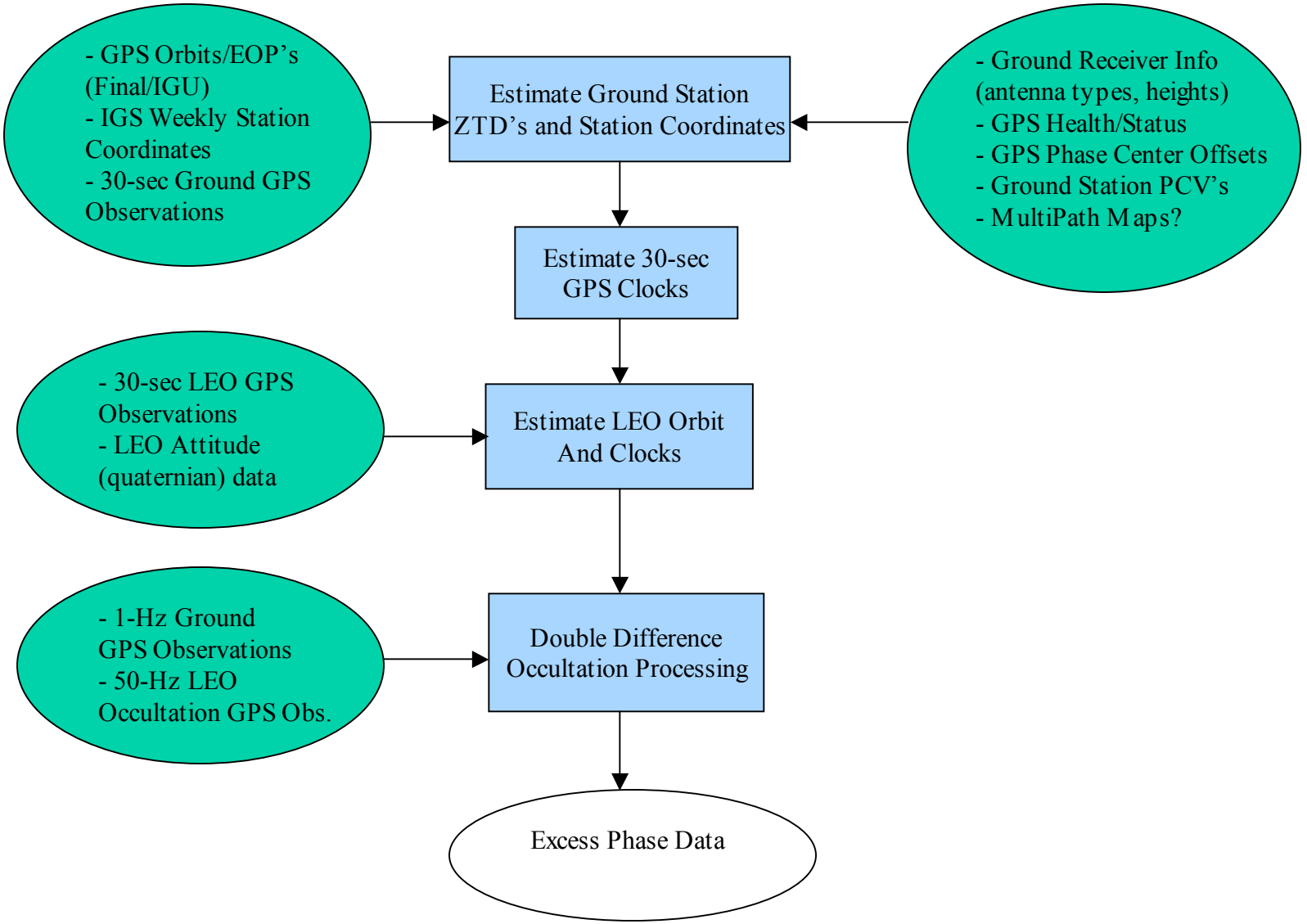
This system is currently under development by UCAR, NESDIS, + UKMO
Data available to weather centers within < 180 minutes of on-orbit collection

CDAAC overview



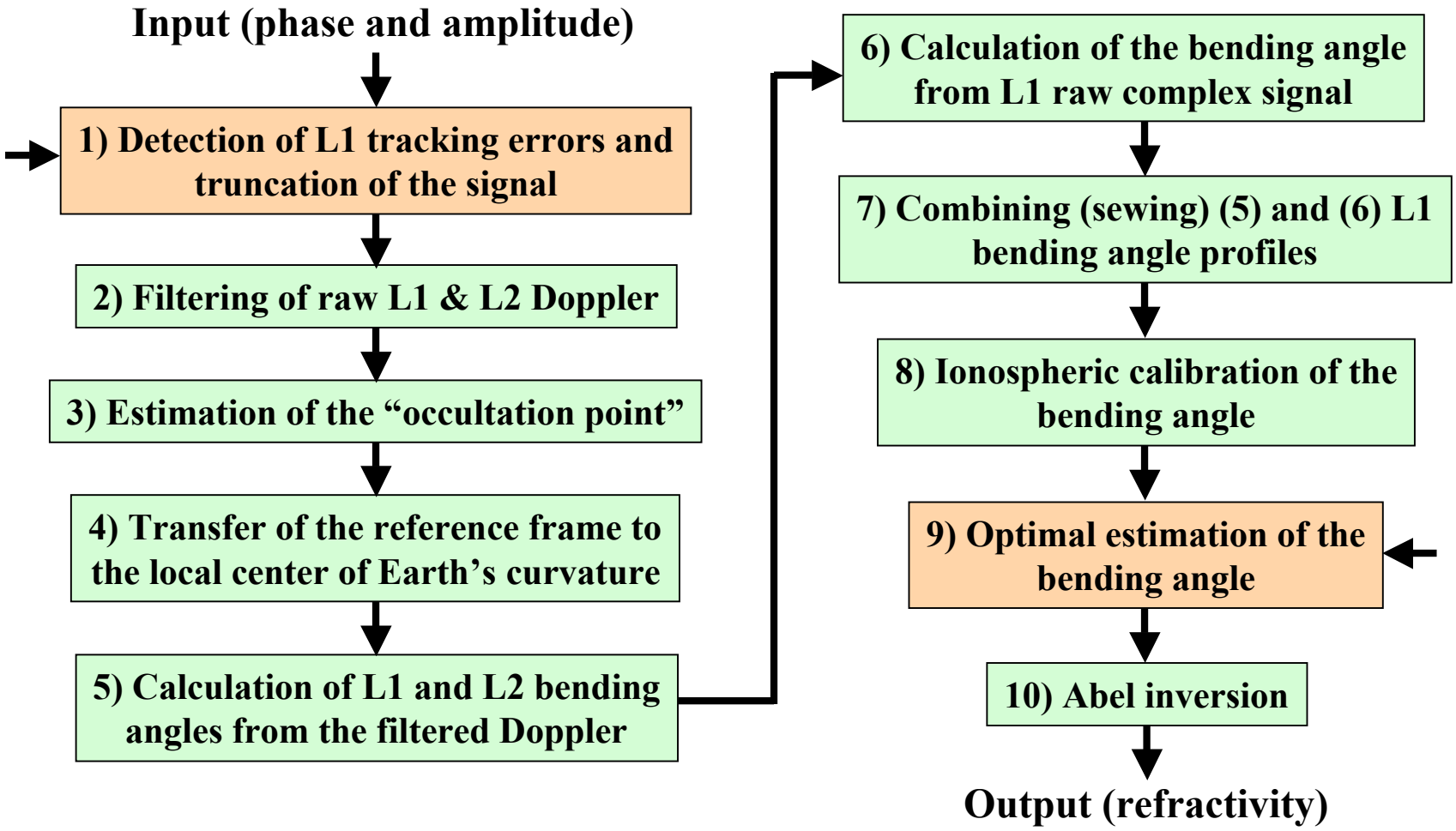
Current processing time for 35 occultations + 100 minutes of fid data: 9min

CDAAC Excess Phase Processing



Lay-out of radio occultation data processing at CDAAC

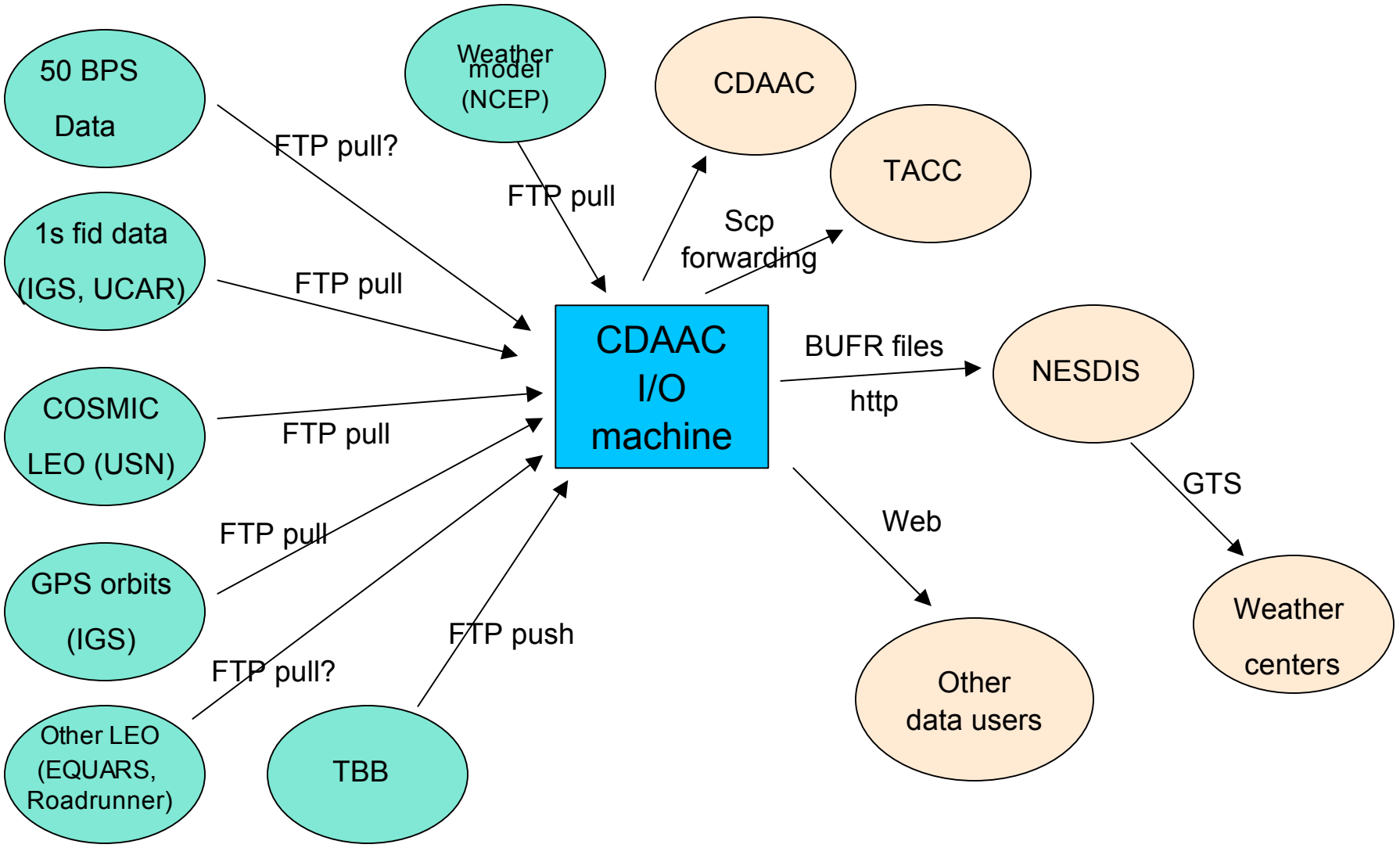
indicates the use of ancillary data (climatology)



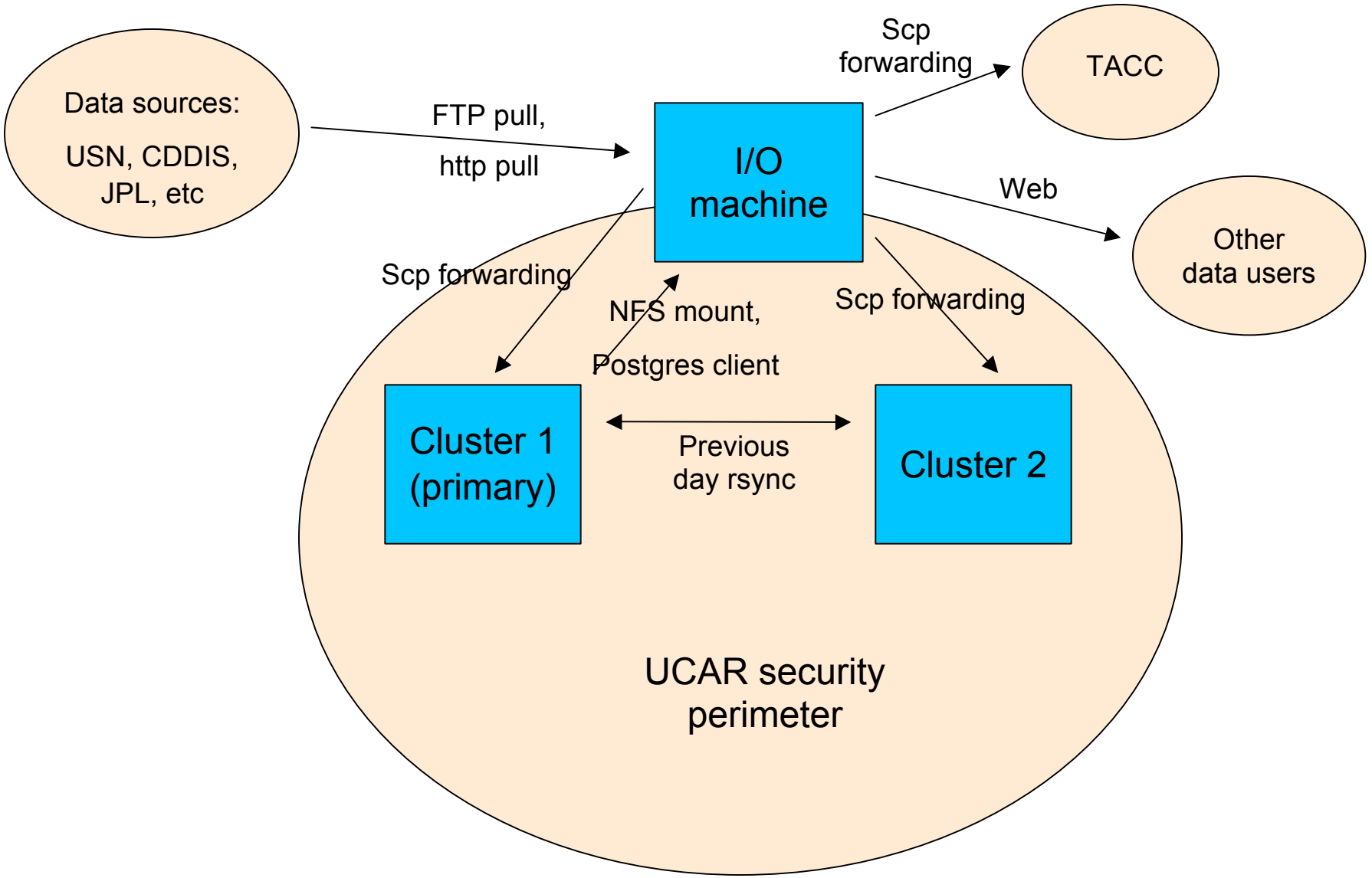
CDAAC software

- Software written in perl, C and FORTRAN
- Currently consists of around 100 separate packages:
  - CVS modules for source developed at UCAR
  - open source packages:
    - apache
    - postgres
    - perl
    - perl modules
  - Commercial packages
    - Bernese
    - F90 compiler
- Includes install system for easy compilation and testing on a basic Linux system

Data Sources



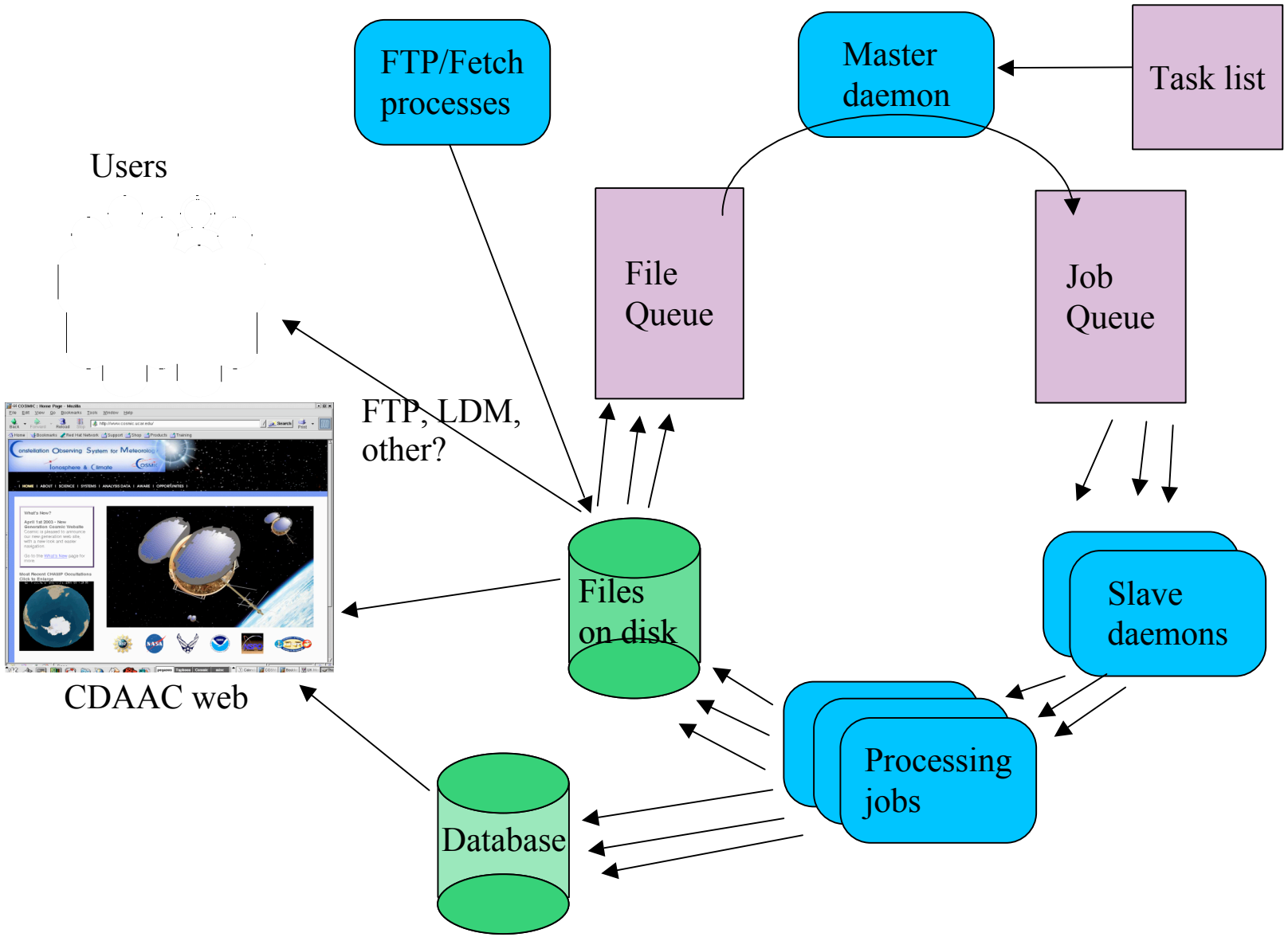
Dual string processing



Real-time processing

- Run automatically, as data are received, on one or more cluster nodes. Uses the task list to determine which job to run
- Currently processing CHAMP data with 12-24 hour latency
- Results are generated on average 45 minutes after receipt of CHAMP level 0 data
  - We expect to tune this to < 20 minutes for COSMIC
- Uses predicted GPS orbits and forecast weather grids
- Designed to allow processing of multiple missions (CHAMP, SAC-C, COSMIC, etc) on the same cluster of machines at the same time
- Processing controlled by three perl daemons:
  - Queue daemon (one per cluster—manages queues)
  - Master daemon (one per mission—determines jobs)
  - Slave daemon (one per task—runs jobs)

Real-time processing



Post-Processing

- Done 1-2 months behind real time, in batchs of one month
- Done with more fiducial sites, better orbits, better fiducial site positions and better fiducial troposphere values than real-time processing
- Used to establish fiducial site positions and parameters for real time processing
- Runs by stepping though the task list and processing all available files of a given type
- Can be run either:
  - Serially on a single processor
  - In parallel on one SMP node
  - In parallel on several nodes of a cluster

CDAAC database

- Postgres database
- In either real-time or post-processed mode, each job run may update a database table
- The CHAMP mission table currently has 14 separate tables
- The champ_fid table has over 4 million entries (one per 15 minute fiducial data file over 4 years)
- The champ_occt table has almost 800,000 occultation entries (all possible occultations over 4 years)

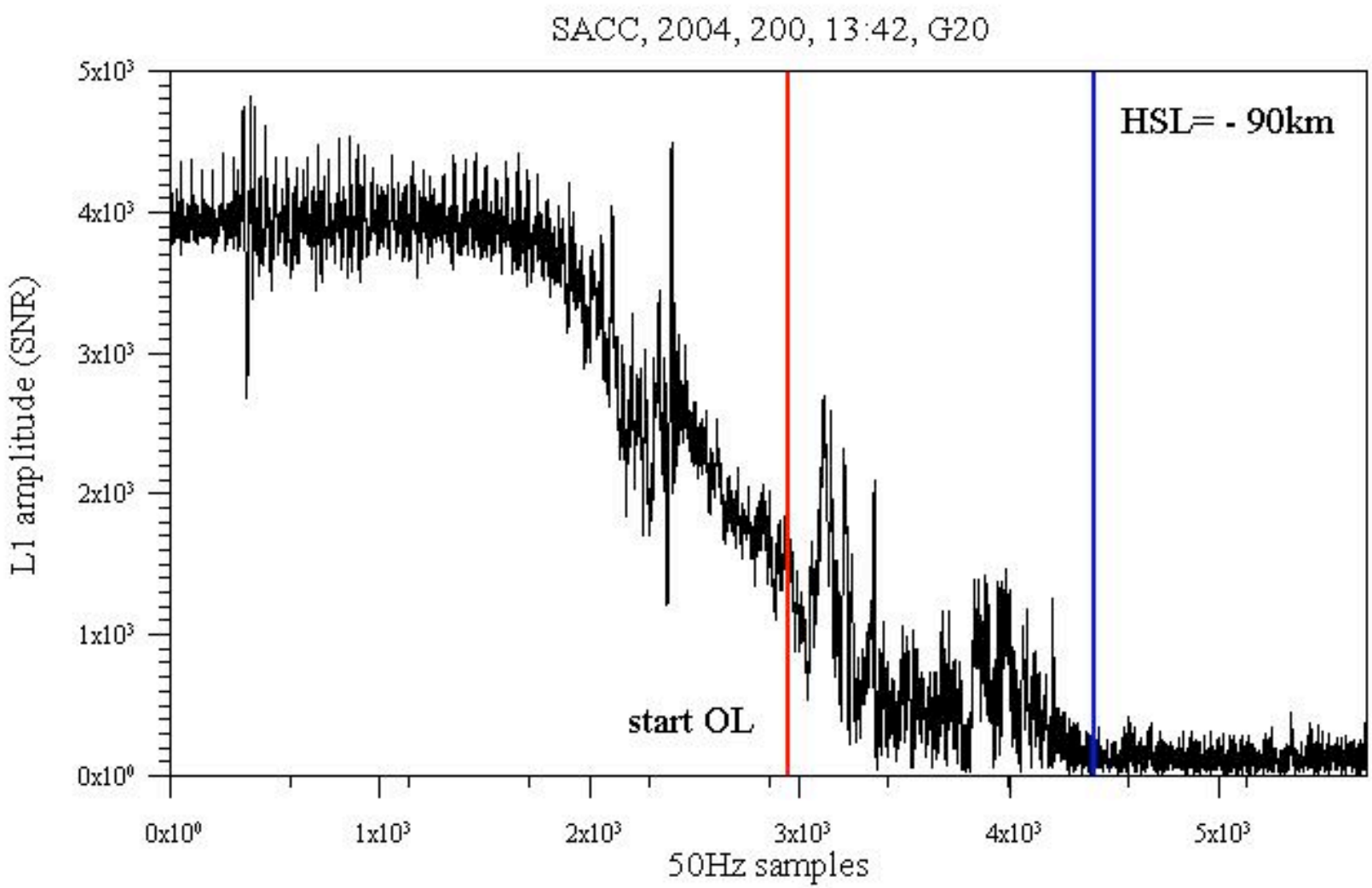
CDAAC work in progress

- Open Loop Data
  - Status of firmware at JPL
  - Processing status at CDAAC
  - Bit-Grab receivers
- Fiducial network
  - COSMIC Sites, IGS Sites, Status of CDDIS sites
- CDAAC Data Processing
  - QC and data assimilation
  - Result improvements at UCAR
  - BUFR and data distribution
  - Real-time orbits - Use of multiple antennas
  - Space weather analysis, TIP
  - Antenna phase center calibration

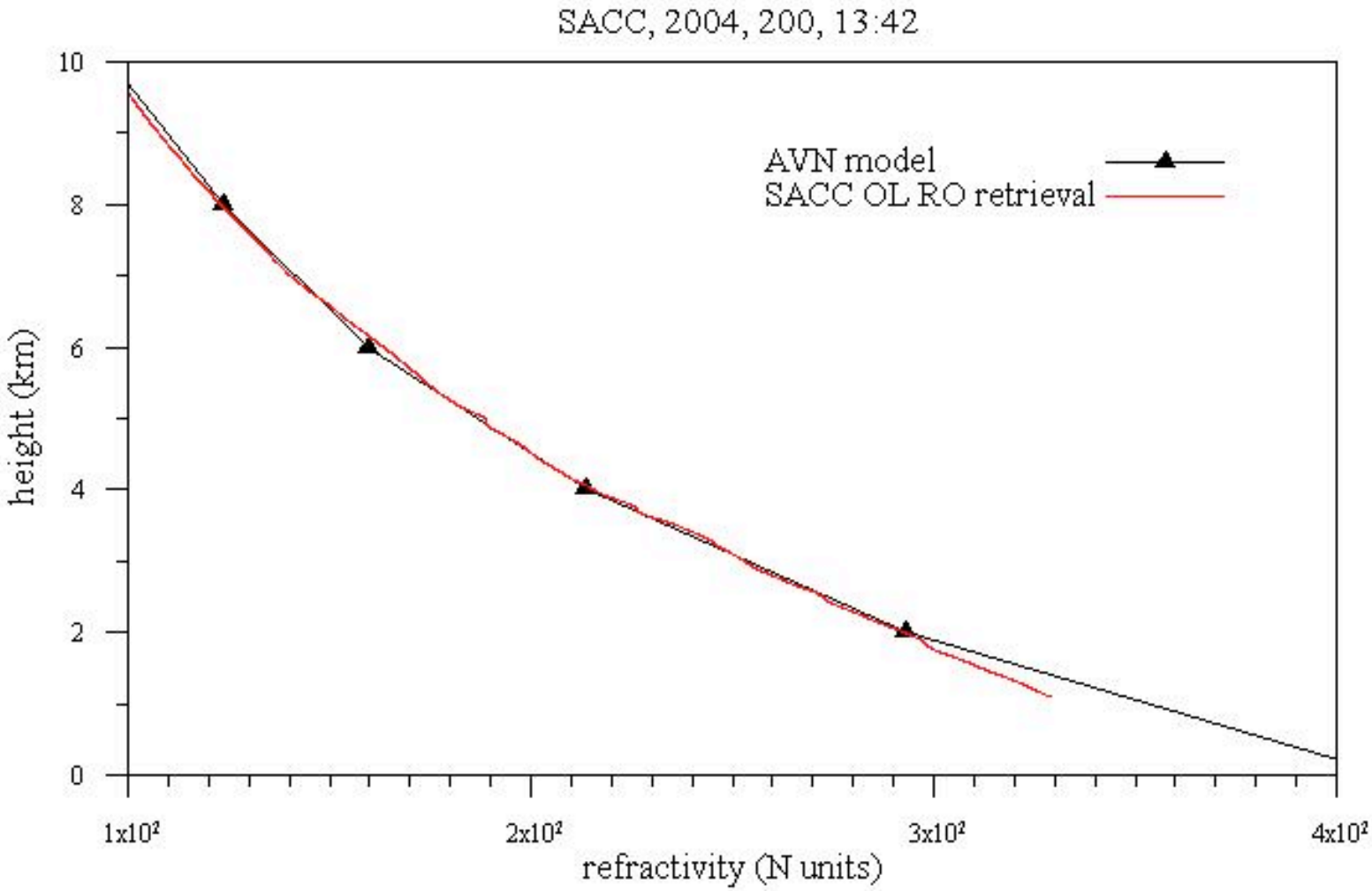
Open Loop Status

- JPL is currently tracking in OL mode on SAC-C
- Flight software delivered to UCAR
- Setting and rising OL occultation data look promising
- Theretical prediction on how OL data should work (Sokolovskiy, Radio Science, 2001) is proving true

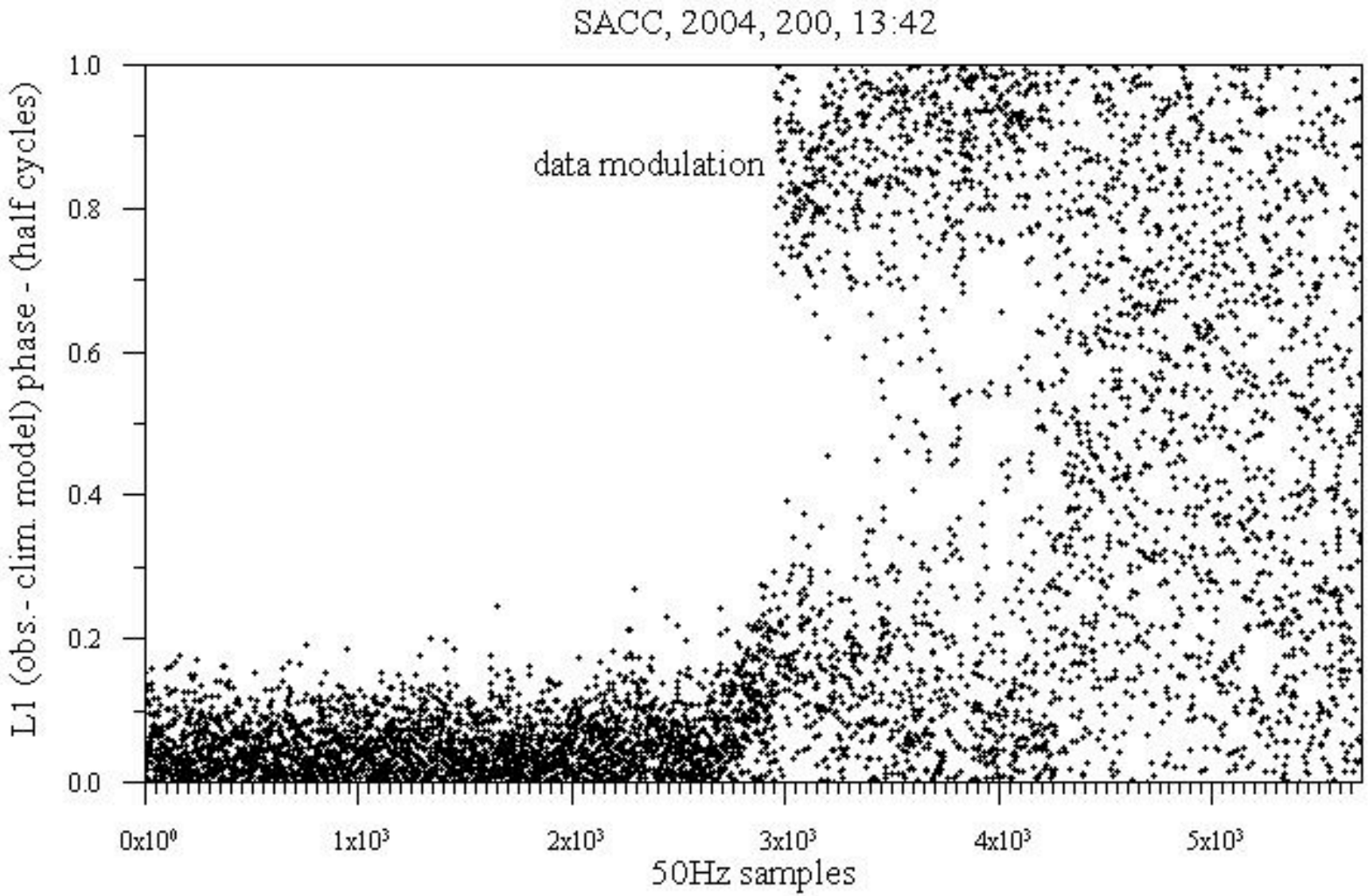
- CDAAC processed some initial OL data received from JPL
- Significant changes to the CDAAC software due to OL data:
  - Level 0 - Level 1 translator
  - Additional external data are needed (50 bps data stream)
  - Format of excess phase file had to be changed to include OL model information
- Software changes have been applied and OL data processing has been automated



Reasonable SNR can be observed for open loop data (right of red line)



Refractivity profile from one of the early OL profiles from SAC-C



OL starts at ~ 3000, Data bit modulation cannot be removed after 4000 samples

Bit Grab Receivers

- COSMIC had to develop GPS receivers to collect and send to CDAAC all GPS data bits (50 bps data stream)
- 10 such receivers have been built
- Receivers must be installed at global sites (Boulder, Taiwan, Potsdam, Sao Paulo, Wellington, Johannesburg, ….) host sites must still be found and negotiated
- Prototype is currently collecting data bits at UCAR
- Establishing this network is challenging - but on track
- Without this network tropical OL data profiles would be of reduced quality

Fiducial Network for COSMIC

- Three COSMIC fiducial sites installed in TWP
- Two COSMIC fiducial sites delivered to Brazil
- Seventeen fiducial sites are regularly received in real-time from NRCan (IGS)
- 30 sites are received with 15 minutes latency from CDDIS
- Presently we receive sufficient amount of fiducial data for the COSMIC mission goals (still we plan to add ~20 more real-time sites for greater redundancy)

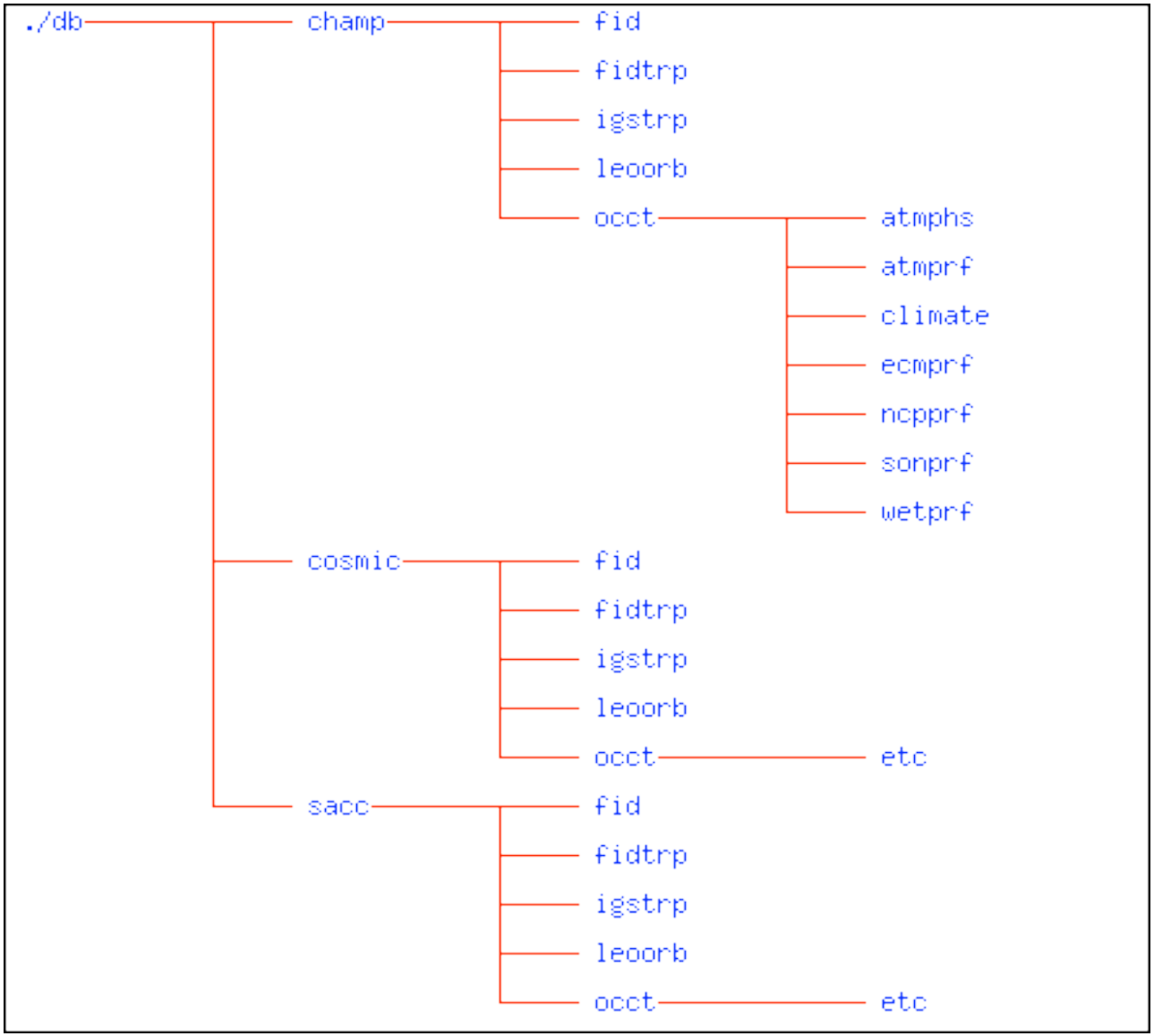
BUFR Output

- BUFR files have been regularly created and available via the CDAAC web site since early 2004
- New BUFR files are available since the recent reprocessing
  - Smoothing done before interpolation
  - Simple 'Percent Confidence' vectors filled in
  - Error profiles included for bending angle and refractivity in the stratosphere
- After check-out by NCEP, these files will be pushed via FTP to NESDIS

Database Design

- Tables form a tree structure:
  - <mission>_<parent>_<child>, for example:
    - champ_occt_atmprf:
      - Mission = CHAMP
      - Parent = occt, data relating to occultations
      - Child = atmprf, dry atmospheric profile data
- Entries in child tables are linked to entries in parent tables by a master key:
  - champ_occt_atmprf.parent = champ_occt.id
- Tables are linked for database normalization purposes
  - Avoiding redundant data
  - data consistency problems
- Tables don't in general contain all high resolution profile data, just the name of the data file

Database design, illustrated



Web Database Interface

- Need a method for researchers to access this rich resource: the CDAAC database (beyond plain SQL)
- Web interface: http://cosmic-io.cosmic.ucar.edu/cdaac
  - High level interface for quick, simple queries of the most common types
  - Low level interface for more general queries
  - Automatic query generation and table joining
  - Integrated tools for viewing not just the database, but the data files behind the database as well
  - Plotting tool for viewing/comparing single data files
  - Statistics tool for generating scalar and profile variable statistics and histograms
  - 1-3 dimension scatter plotting tool for viewing relations between database variables

Example 1 A

- Using the high level interface:
  - Determine how many occultations have been processed for GPS/MET
    - How many different 'prime times' (periods of favorable satellite attitude) were processed?

COSMIC : Home Page

http://www.cosmic.ucar.edu/

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Constellation Observing System for Meteorology Ionosphere & Climate

COSMIC

| HOME | ABOUT | SCIENCE | SYSTEMS | CDAAC | AWARE | OPPORTUNITIES | INSIDE COSMIC |

New! COSMIC Newsletter

What's New?

CHAMP, SAC-C and GPS/MET missions completely reprocessed with CDAAC version 1.01 software. Go to the CDDAC Web Site to see the results

May 30 - June 3, 2005: Taipei, Taiwan: FORMOSAT-3/COSMIC Science Summer Camp.
Click here for more information

Go to the What's New page for more.

Click here to join our Cosmic Discussion Board

Click here to join JPL's GENESIS Monthly Newsletter

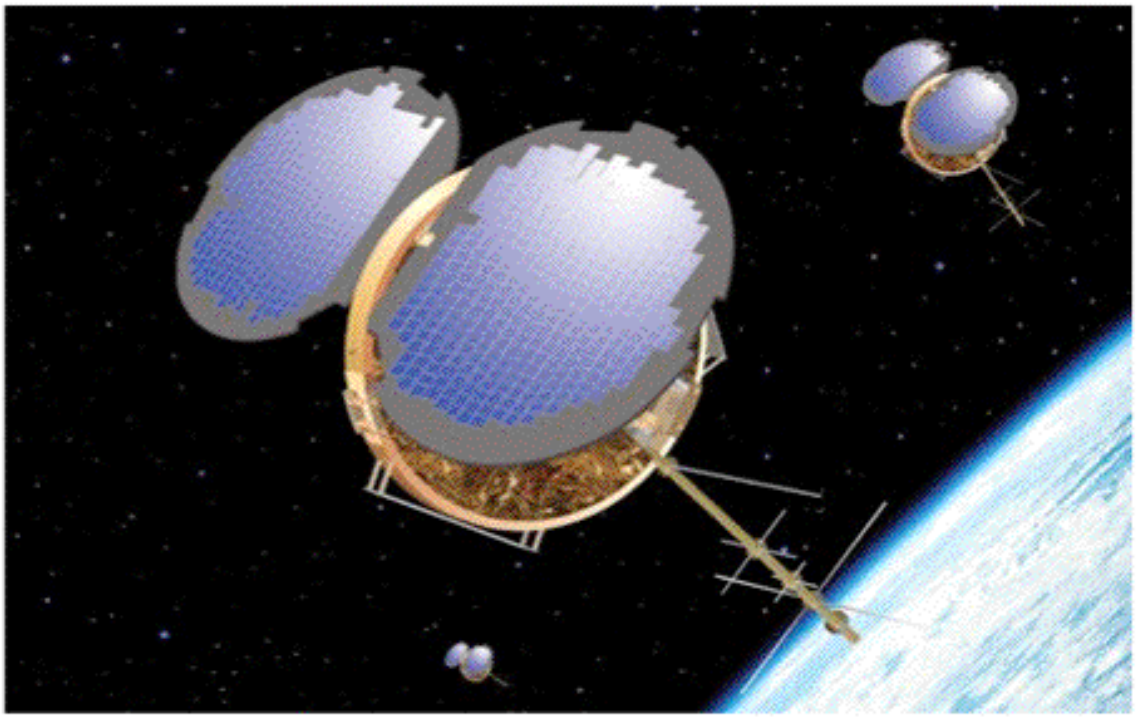
New! CDAAC Data Access

[Login] [Sign Up]

Most Recent CHAMP Occultations

Example 1a

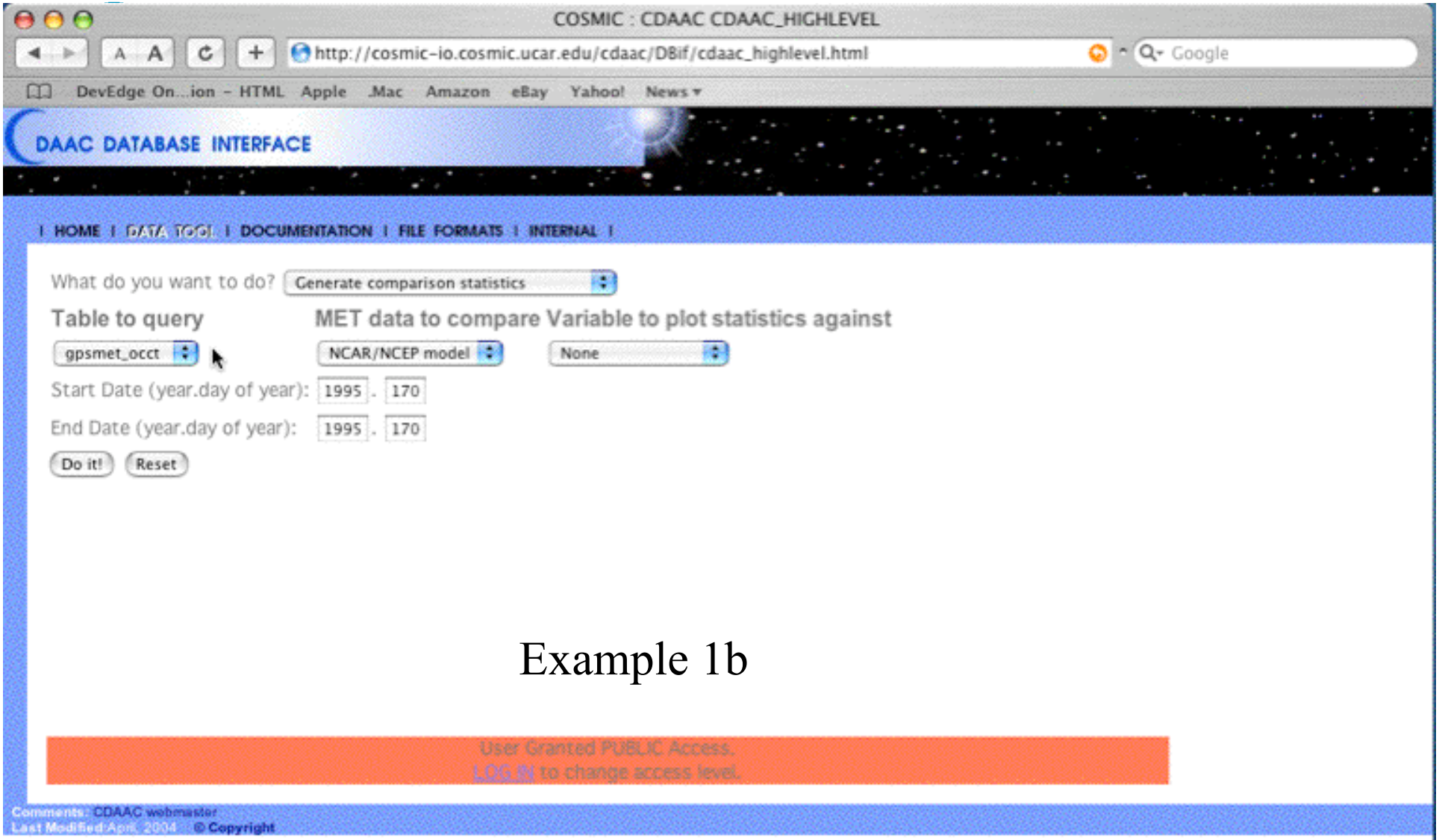
FORMOSAT-3/COSMIC



NSF NASA NOAA

Example 1 B

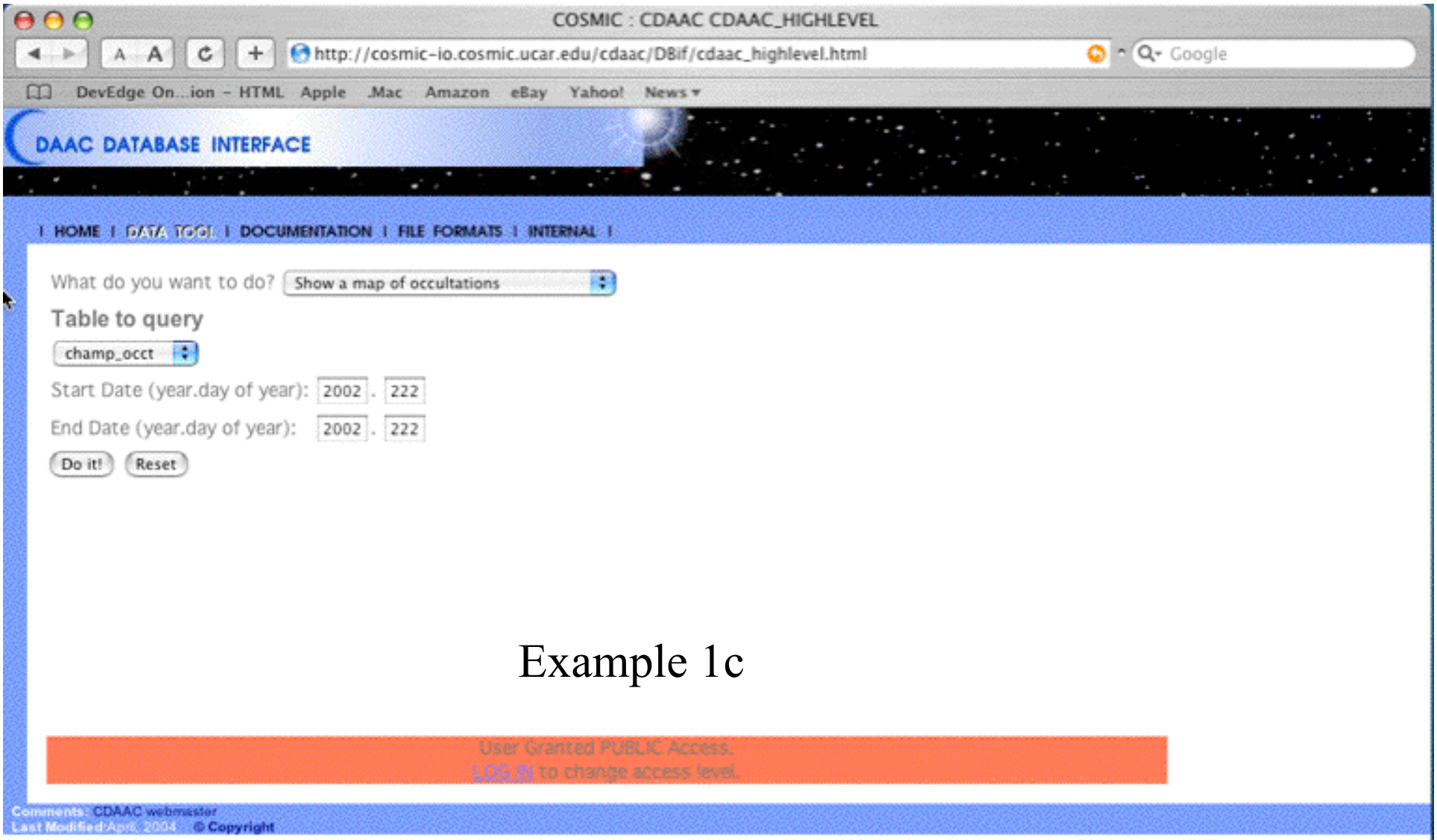
- Using the high level interface:
  - Find the worst GPS/MET occultation compared to NCEP analysis for day 1995.170. Compare temperatures.
    - At what altitude does the greatest difference occur beween NCEP and RO for this occultation?


COSMIC : CDAAC CDAAC_HIGHLEVEL
http://cosmic-io.cosmic.ucar.edu/cdaac/DBif/cdaac_highlevel.html
Google
DevEdge On...ion - HTML
Apple
.Mac
Amazon
eBay
Yahoo!
News
DAAC DATABASE INTERFACE
HOME | DATA TOOL | DOCUMENTATION | FILE FORMATS | INTERNAL |
What do you want to do?
Generate comparison statistics
Table to query
MET data to compare
Variable to plot statistics against
gpsmet_occt
NCAR/NCEP model
None
Start Date (year.day of year):
1995 . 170
End Date (year.day of year):
1995 . 170
Do it!
Reset
User Granted PUBLIC Access.
LOG IN to change access level.
Comments: CDAAC webmaster
Last Modified:April 2004 © Copyright

Example 1b

Example 1 C

- Using the high level interface:
  - What is the four character name of the fiducial station used for double differencing (champ_occt.fidid in the database) in the only occultation over California for CHAMP on day 2002.222?
    - For this same occultation, does the LEO subpoint pass from North to South, or from South to North during the occultation?


COSMIC : CDAAC CDAAC_HIGHLEVEL
http://cosmic-io.cosmic.ucar.edu/cdaac/DBif/cdaac_highlevel.html
Google
DevEdge On...ion - HTML
Apple
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Yahoo!
News
DAAC DATABASE INTERFACE
HOME | DATA TOOL | DOCUMENTATION | FILE FORMATS | INTERNAL
What do you want to do?
Show a map of occultations
Table to query
champ_occt
Start Date (year.day of year):
2002 . 222
End Date (year.day of year):
2002 . 222
Do it!
Reset
User Granted PUBLIC Access.
LOG IN to change access level.
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Example 1c

Example 2

- Using the low level interface:
  - For CHAMP show all occultations in the area of Taiwan
  - Compare these profiles with ECMWF, NCAR/NCEP reanalysis, and radiosondes
  - ….. But first a general introduction to the low-level data base interface

COSMIC : CDAAC Data Analysis and Archival Center

http://cosmic-io.cosmic.ucar.edu/cdaac/DBif/index.html

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DAAC DATABASE INTERFACE

| HOME | DATA TOOL | DOCUMENTATION | FILE FORMATS | INTERNAL |

Welcome to the CDAAC database interface!

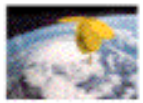
NOTE: For this interface to work, **Cookies** must be enabled on your browser!

Start

Low-Level Interface

Help Pages

For the Low-Level Interface



CDAAC

High-Level Interface

Troubles

Report a bug

There are two interfaces available:

- High-Level interface. This interface offers a simpler way to generate common plots for CDAAC.
- Low-Level interface. This interface allows much more flexibility in querying the database, but can be tricky! Please check out the help pages below.

Intro to low level data interface

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LOG IN to change access level.

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CHAMP data Taiwan Region 03 04

Getting data for your research

- Most Researchers will prefer to download data for more detailed studies. There are several ways to do that:

1. Go to CDAAC data base and access data directly

2. Use the High Level data interface for basic requests

3. Use the Low level data interface for more sophisticated requests

4. Use command line commands to get the data you want

- The following movie clips will show examples how to do this

COSMIC : COSMIC Data Analysis and Archival Center

http://cosmic-io.cosmic.ucar.edu/cdaac/index.html

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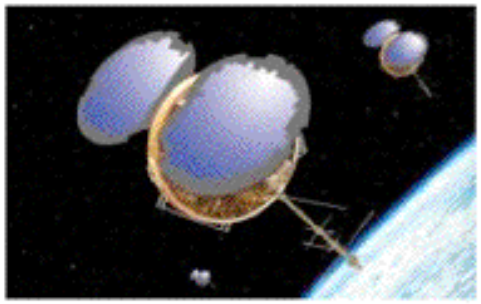
DAAC 1.01

| HOME | DATA TOOL | DOCUMENTATION | FILE FORMATS | INTERNAL |



| ZENITH TROPOSPHERE COMPARISONS |

MONTHLY STATISTICS

| CHAMP | SAC-C | GPSMET |

OCCULTATION FAILURE PERCENTAGES

| CHAMP | SAC-C | GPSMET |

FILE INVENTORIES

| CHAMP | SAC-C | GPSMET |

IONOSONDE COMPARISONS

| CHAMP | SAC-C | GPSMET |

CDAAC Data Access

| Login | | Sign Up |

COSMIC Data Analysis and Archive Center version 1.01

February 2005

All CHAMP, SAC-C and GPS/MET data are now processed and on-line with CDAAC 1.01 software.

- Click on 'Data Tool' to view data interactively
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New CDAAC features as of December 2004

- Completely re-written for Bernese 5.0
- Improved LEO orbit computation
- Post-processing now can be spread to all nodes of a cluster
- Improved statistical optimization and error characterization in atmospheric inversions
- Ionospheric processing added to CHAMP and SAC-C missions
- Automatic Ionosonde comparisons
- New 1D variational assimilation for moisture computation
- Web-based operator interface and configuration editor
- Extensive documentation improvement
- Bug fixes and code cleanup

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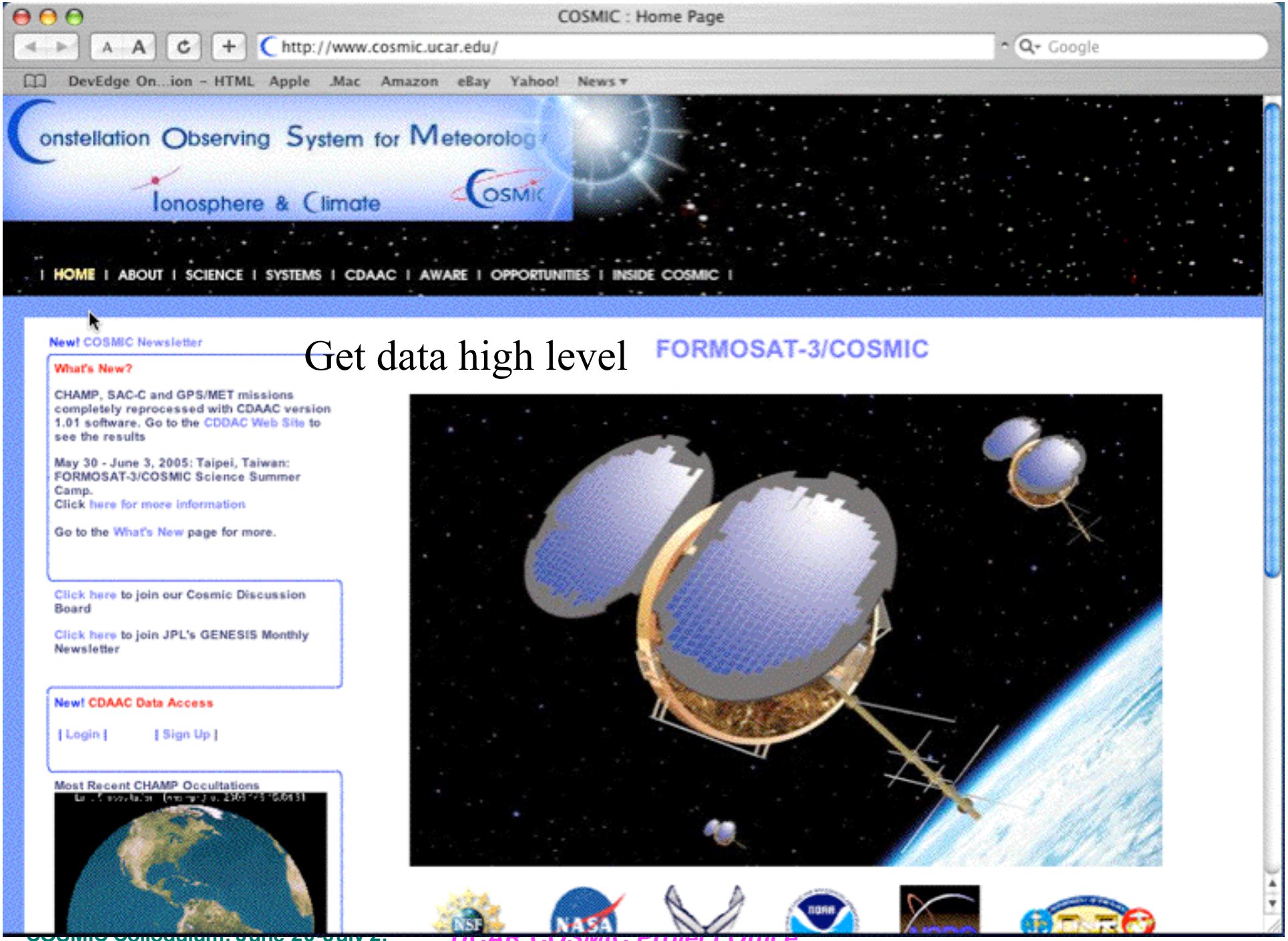
Fetch Data 1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DAAC 1.01

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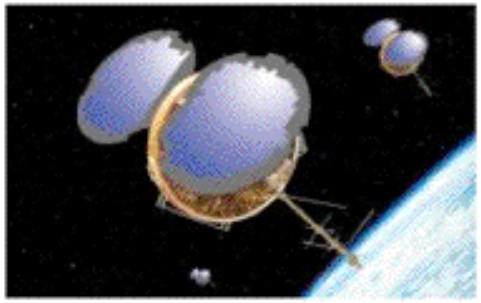

| ZENITH TROPOSPHERE COMPARISONS |

MONTHLY STATISTICS

| CHAMP | SAC-C | GPSMET |

OCCULTATION FAILURE PERCENTAGES

| CHAMP | SAC-C | GPSMET |

FILE INVENTORIES

| CHAMP | SAC-C | GPSMET |

IONOSONDE COMPARISONS

| CHAMP | SAC-C | GPSMET |

CDAAC Data Access

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COSMIC Data Analysis and Archive Center version 1.01

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Get data low level

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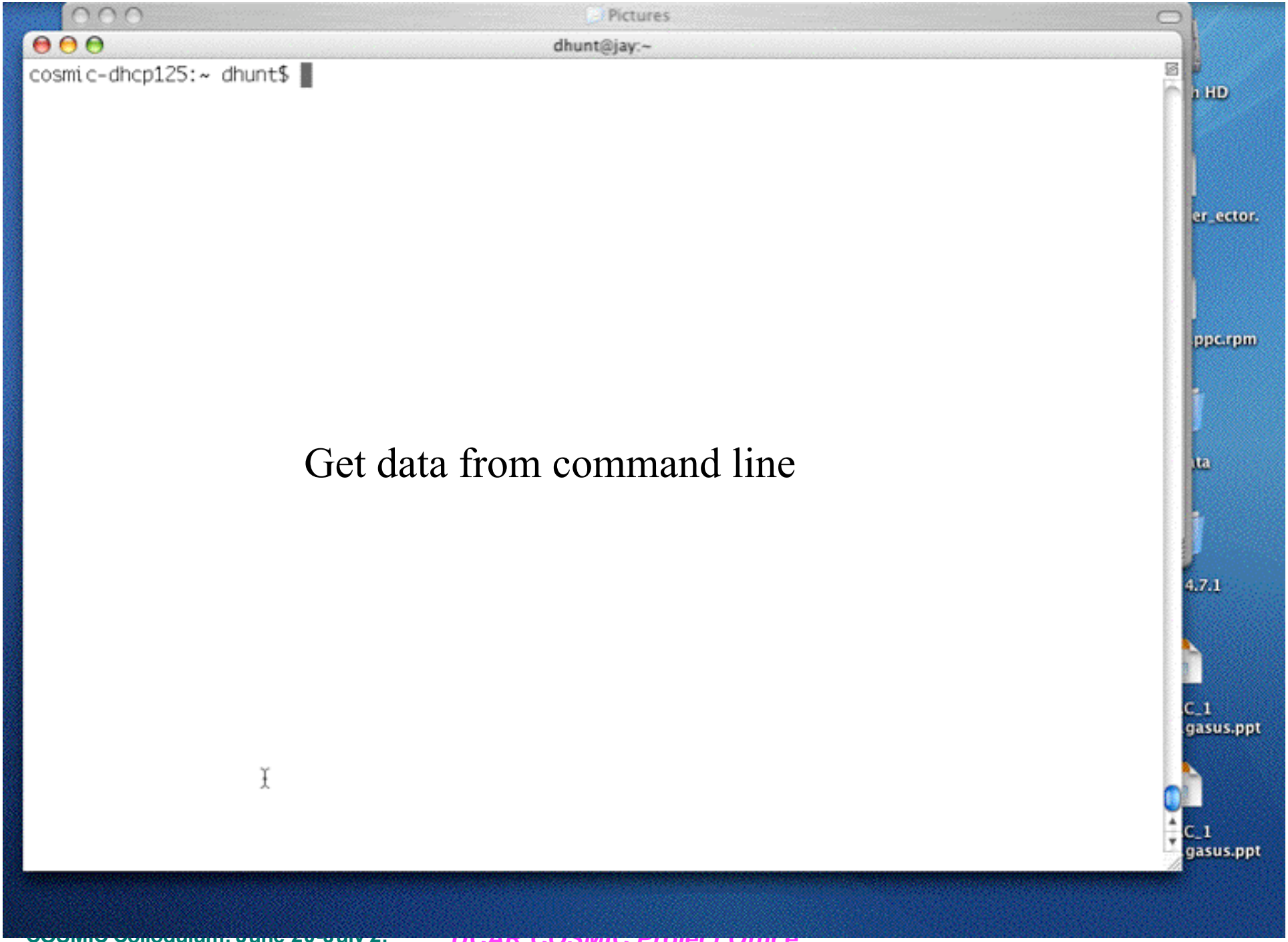
Pictures
dhunt@jay:~
cosmic-dhcp125:~ dhunt$
Get data from command line
HD
er_ector.
ppc.rpm
ta
4.7.1
C_1
gasus.ppt
C_1
gasus.ppt