CERES
Science Data Processing
for
NPP

Erika Geier

and the CERES DMT

February 28, 2008

CERES Inputs

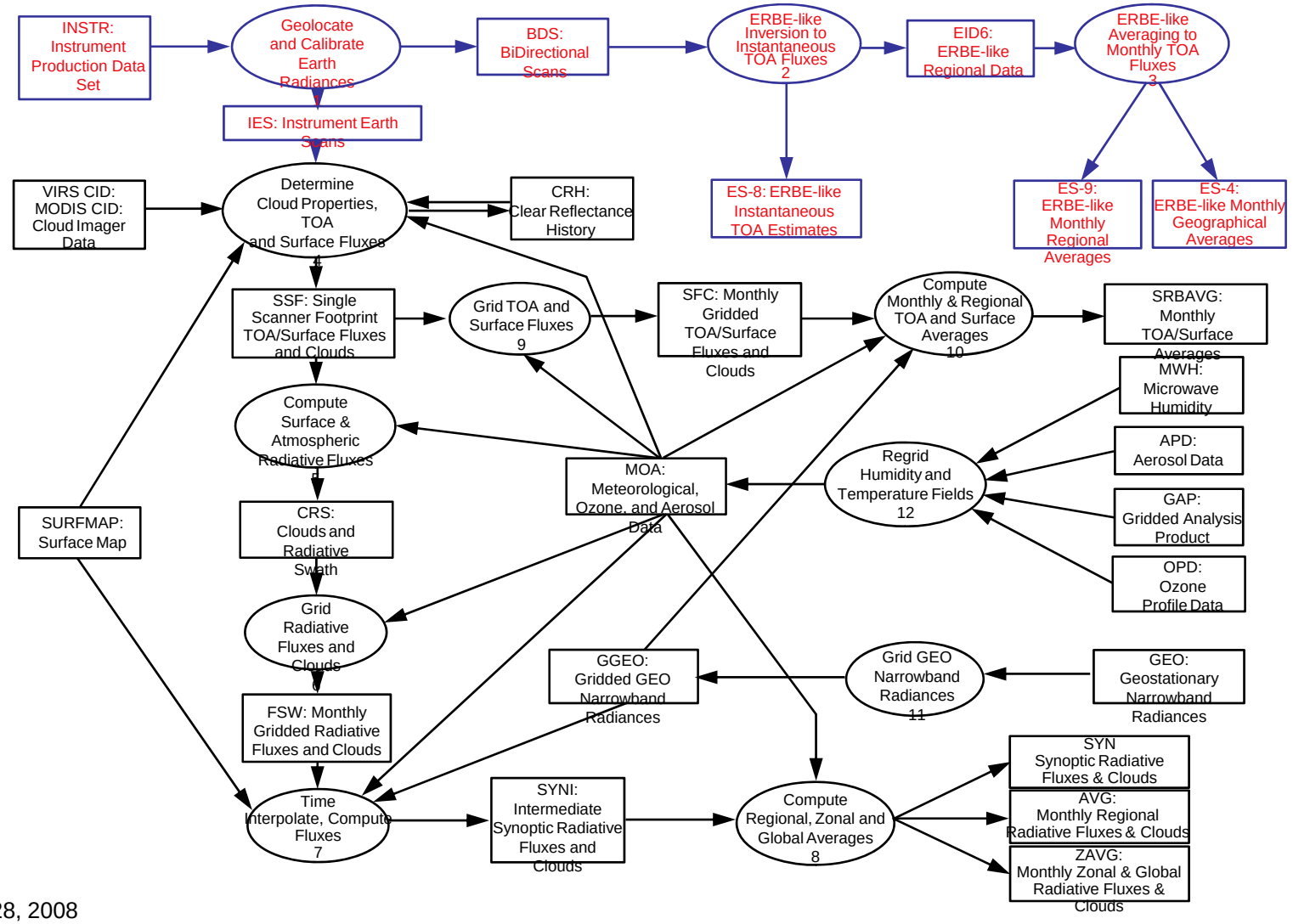
Parameter	Parameter Description	Freq	Terra/Aqua CERES Source	FM5 Source	Comments
Instrument Output	Instrument level 0 data organized in packets. 660 data samples per packet.	Up to 3/day Terra/Aqua	CERES Instrument	FM5 Instrument via IDPS/CLASS or IDPS/SDS/Land PEATE	3 channels
Attitude	Attitude	12/day	GSFC Flight Dyn Facility	NPP via IPTS/CLASS or IDPS/SDS/Land PEATE	Separate file or in CERES RDR?
Ephemeris	Ephemeris	12/day Terra 1/day Aqua	GSFC Flight Dyn Facility	NPP via IPTS/CLASS or IDPS/SDS/Land PEATE	In CERES RDR?
Aerosol data	Aerosol (Coln) Optical thickness, type/size	1/day	MODIS MOD08 and MATCH	??	
Ozone data	Ozone Profile	1/day SMOBA 1/day OMI	NCEP SMOBA OMI	NCEP SMOBA ?? OMI ??	
Meteorological data	3-D Met Data	4/day	GMAO	GMAO	MOU in place
Meteorological data	2-D atmospheric data	24/day	GMAO	GMAO	
Meteorological data	2-D constants	1	GMAO	GMAO	
Precipitable Water	2-D constants	10/day	Global Hydrology Resource Center (GHRC)	GHRC	
Cloud imager data	Imager radiances, geolocation, and aerosols	288/day 288/day ~144/day	MODAPS	VIIRS L1b Rad from Land PEATE or possibly CLASS	2km subsamples?
Geostationary data	MCIDAS data from 5 geostationary satellites per month	120/day	University of Wisconsin Space Science and Engineering Center (SSEC)	SSEC	Only every 3rd hour is used for production
SURFMAP(Snow/Ice)	Snow/Ice Map	1/day	NCEP/NESDIS	NCEP/NESDIS	
SURFMAP(Snow/Ice)	Snow/Ice Map	1/day	NSIDC	NSIDC	

Science Data Processing for FM5

Processing can be divided into 2 Streams:

- Instrument and ERBElike
  - Critical for establishing Instrument health
  - Critical for establishing CERES calibration/validation
  - Produces ERBElike data sets using only CERES instrument data
    - Data sets exist for CERES instruments on TRMM, Terra, and Aqua
    - Similar data sets exist for ERBE instruments on ERBS, NOAA-9 and NOAA-10
- Fused data sets beginning with Cloud/Inversion processing and the SSF
  - Use inputs from imager and other data sources
    - Higher resolution imager data is Point Spread Function (PSF) weighted
  - Produces higher quality climate data
    - Data sets exist for CERES instruments on TRMM, Terra, and Aqua
  - Does not have to be in production immediately after covers open

Current CERES Climate Data Record Production

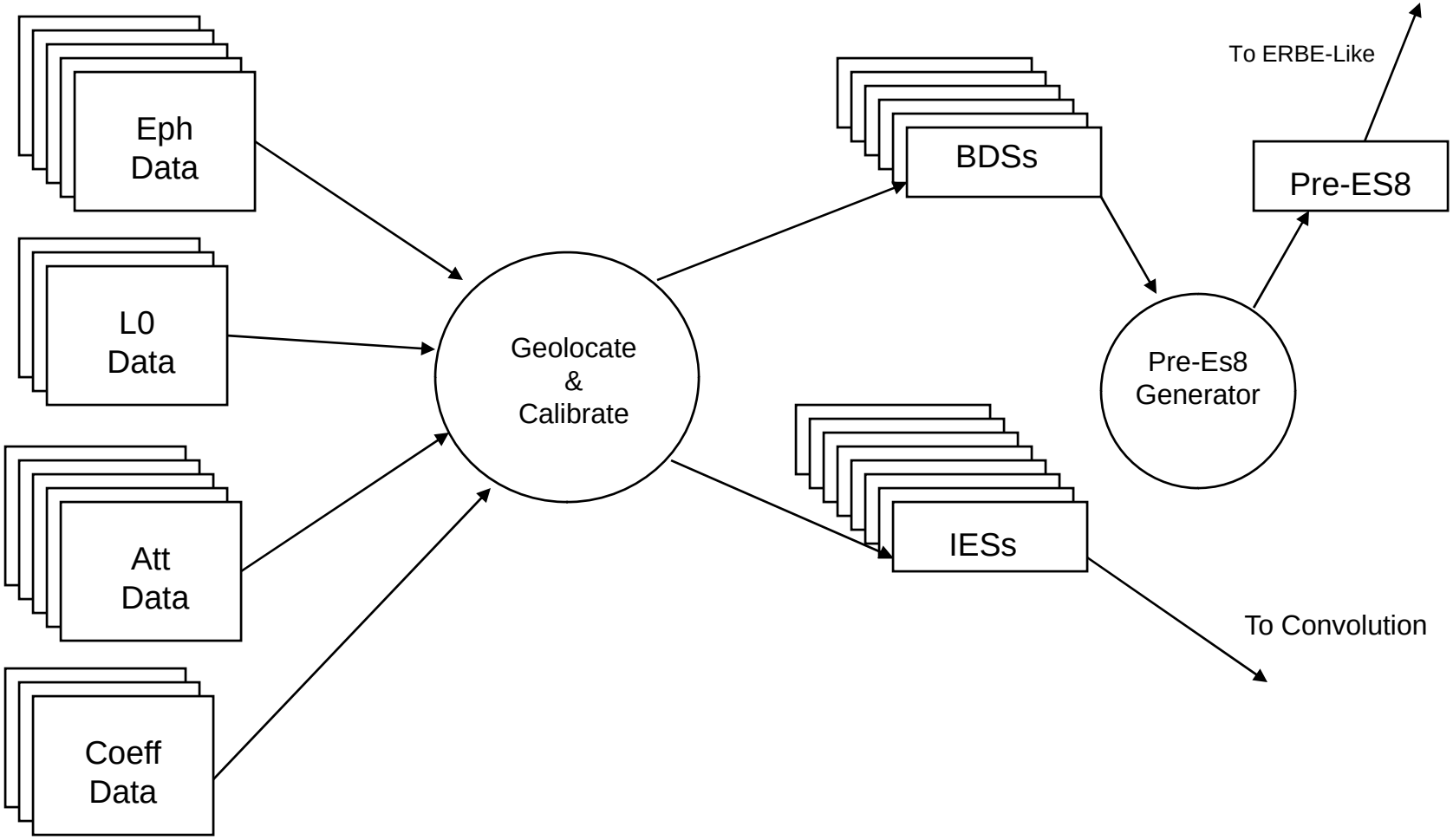


CERES
Instrument Subsystem

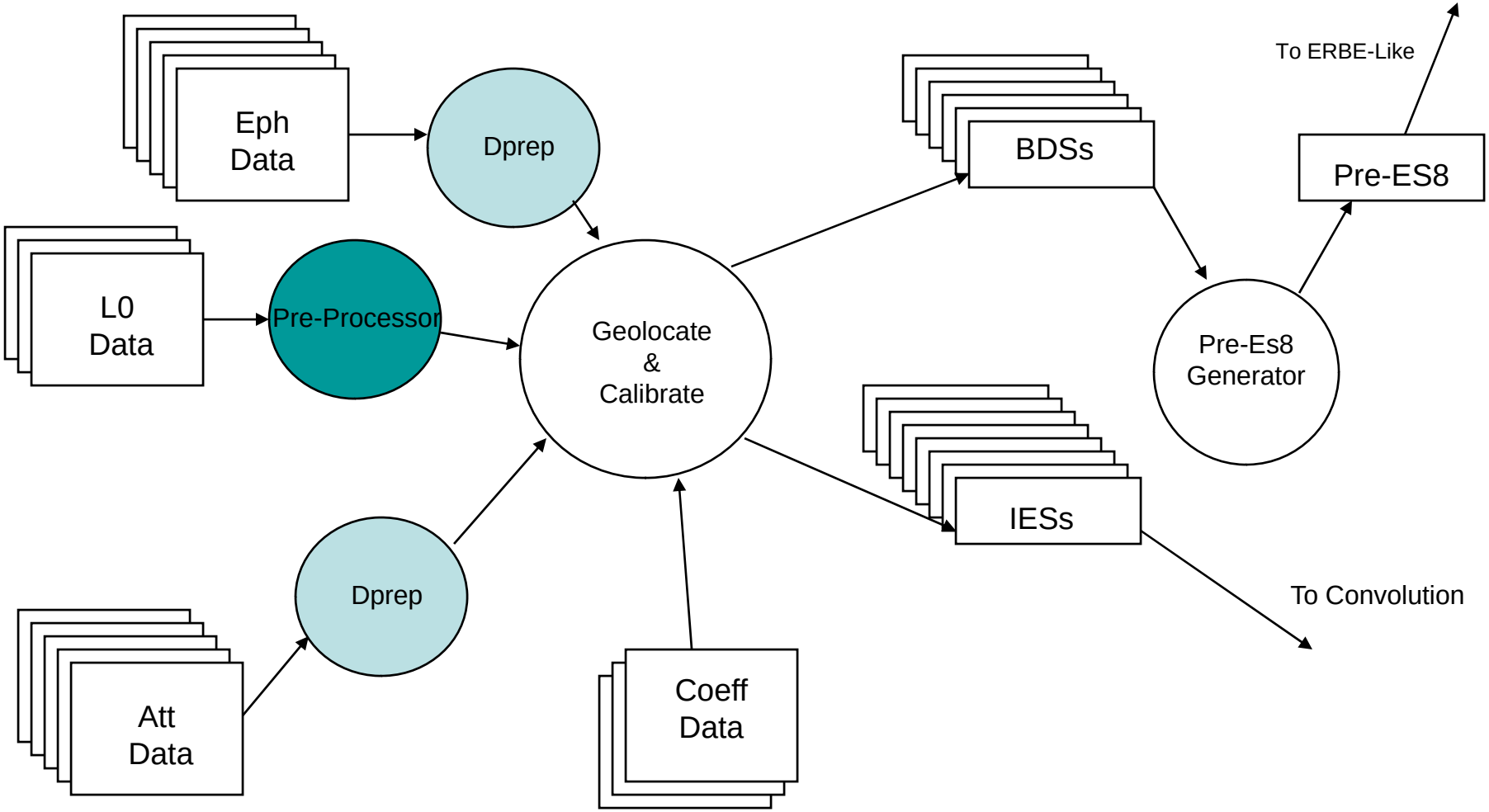
Denise Cooper (CERES DM POC)

February 28, 2008

Existing Instrument Subsystem



NPP Instrument Subsystem



Concerns

- Format Definition for Level-0, Ephemeris & Attitude Data Files
- C++ Code Conversion of Main Processor
- Toolkit Issues
  - Spacecraft & Instrument not handled in existing Toolkit

CERES
ERBElike Subsystem

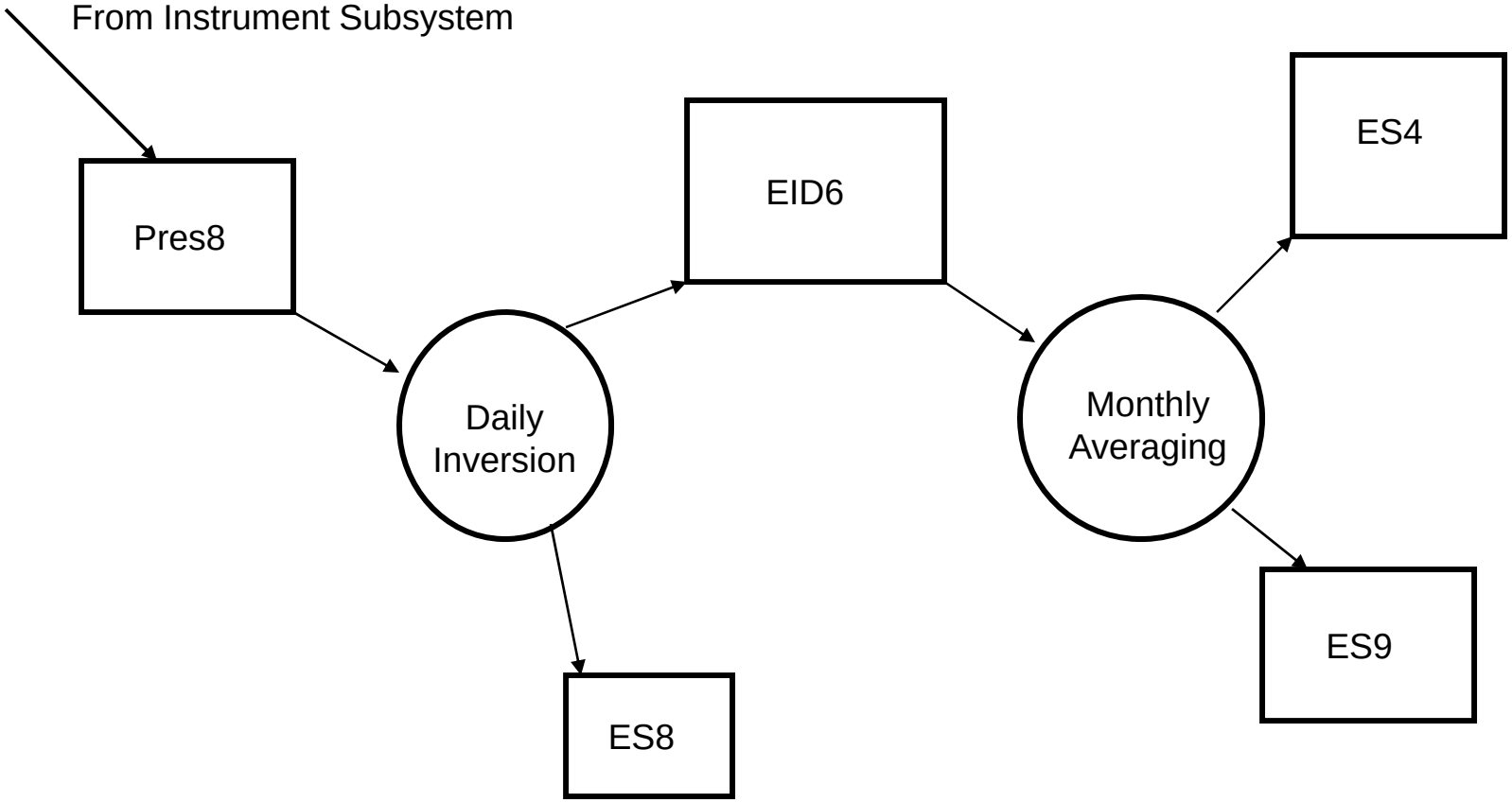
Dale Walikainen (CERES DM POC)

February 28, 2008

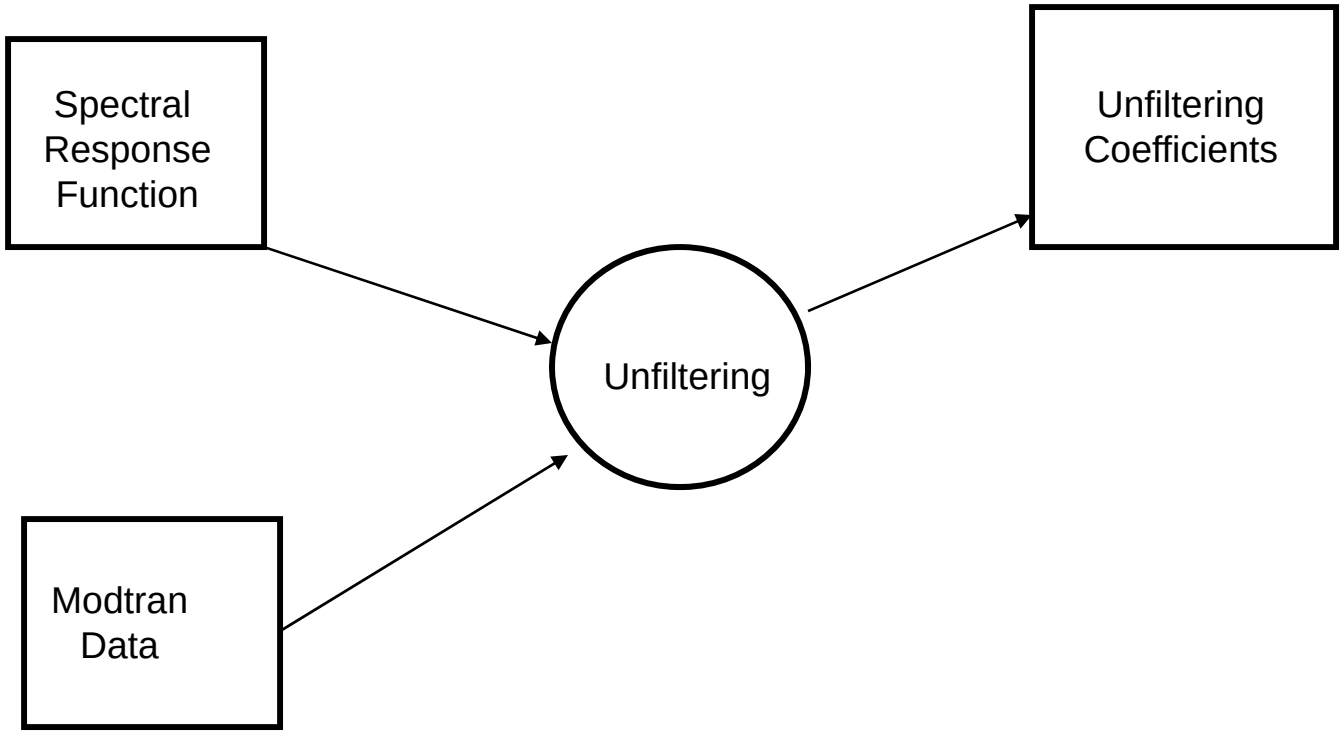
ERBElike processes CERES data
using ERBE Algorithms.

The same algorithms used for the first set of scanners launched in the 1980s.

Inversion


From Instrument Subsystem
Pres8
Daily Inversion
EID6
ES8
Monthly Averaging
ES4
ES9

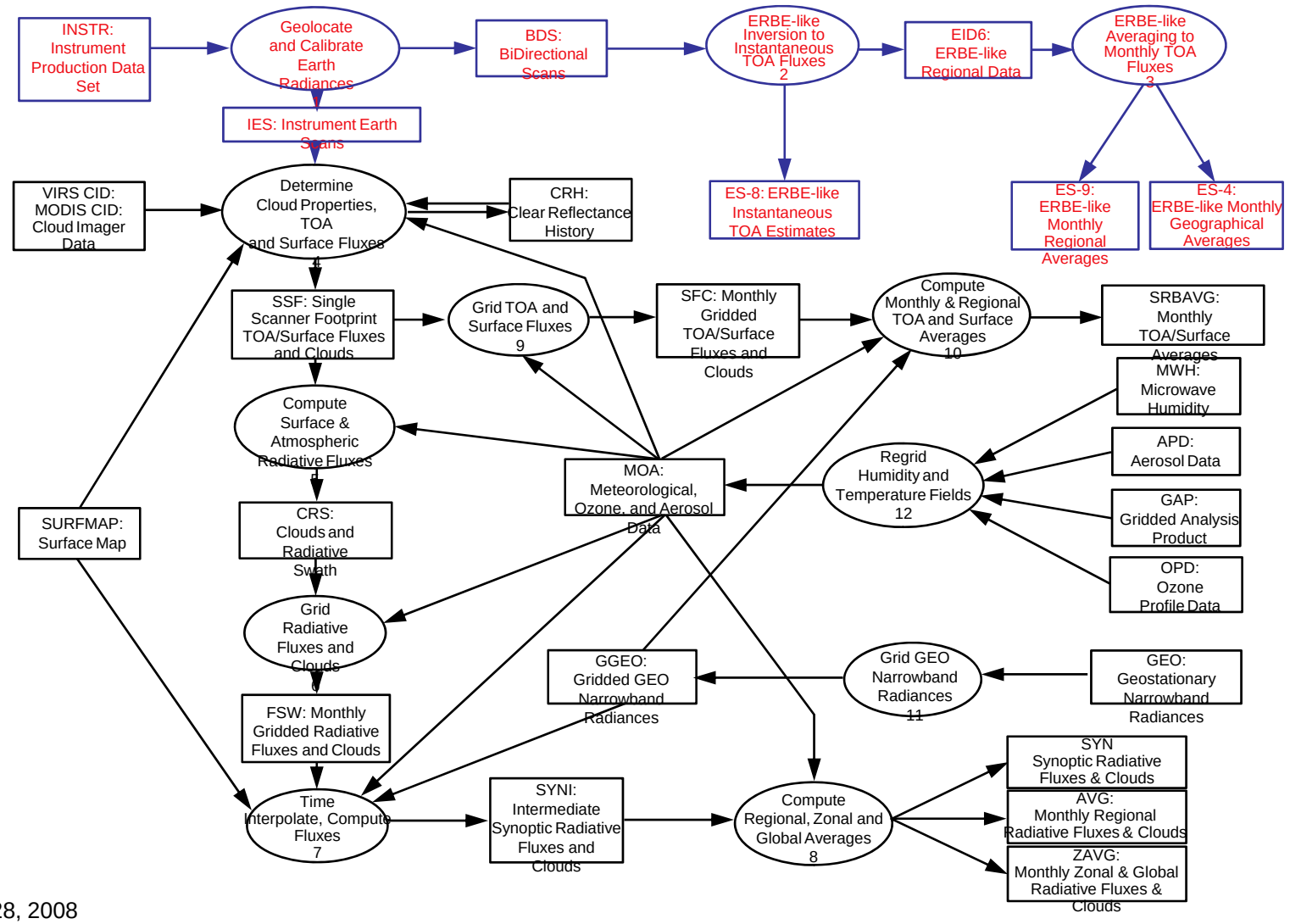
Spectral Corrections



Concerns

- Currently, we use two instruments on the same spacecraft to determine gains and spectral response changes.
- Developing a scheme to use a single instrument.

Current CERES Climate Data Record Production



CERES SSF processing (Subsystem 4)

Subsystem 4, Determine Cloud Properties, TOA and Surface Fluxes, is made up of 3 different sets of code

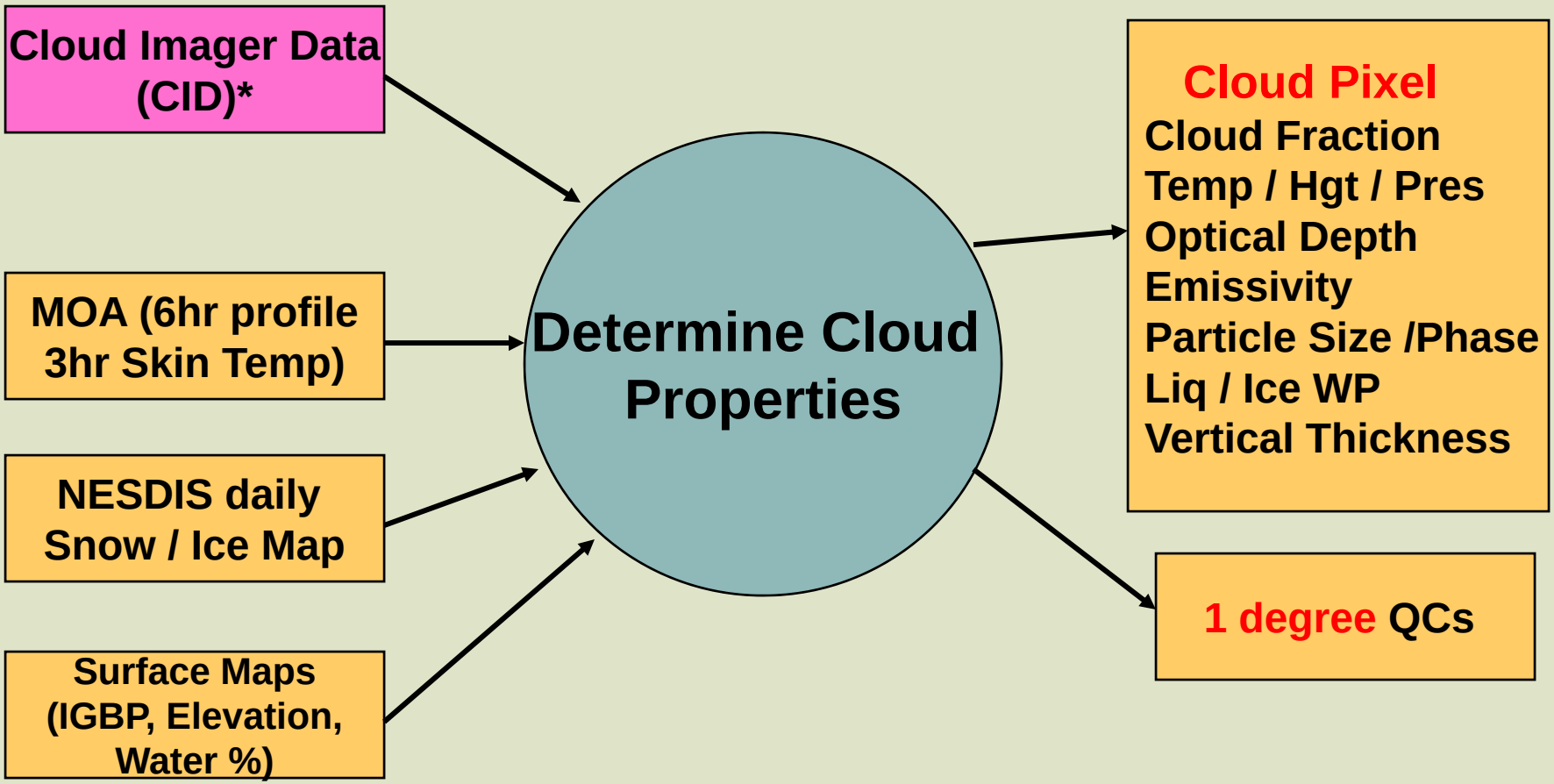
- Clouds
  - Processes the imager data
  - Resulting pixel level output written to temporary file
- Convolution
  - Merges the pixel level data with the CERES footprint data
  - Resulting footprint level output written to a temporary file
- Inversion
  - Reads the footprint level output file containing CERES radiance data and cloud properties
  - Computes unfiltered radiances, TOA fluxes, and surface fluxes
  - Generates the SSF data product which is archived and publicly released

CERES
Cloud Subsystem

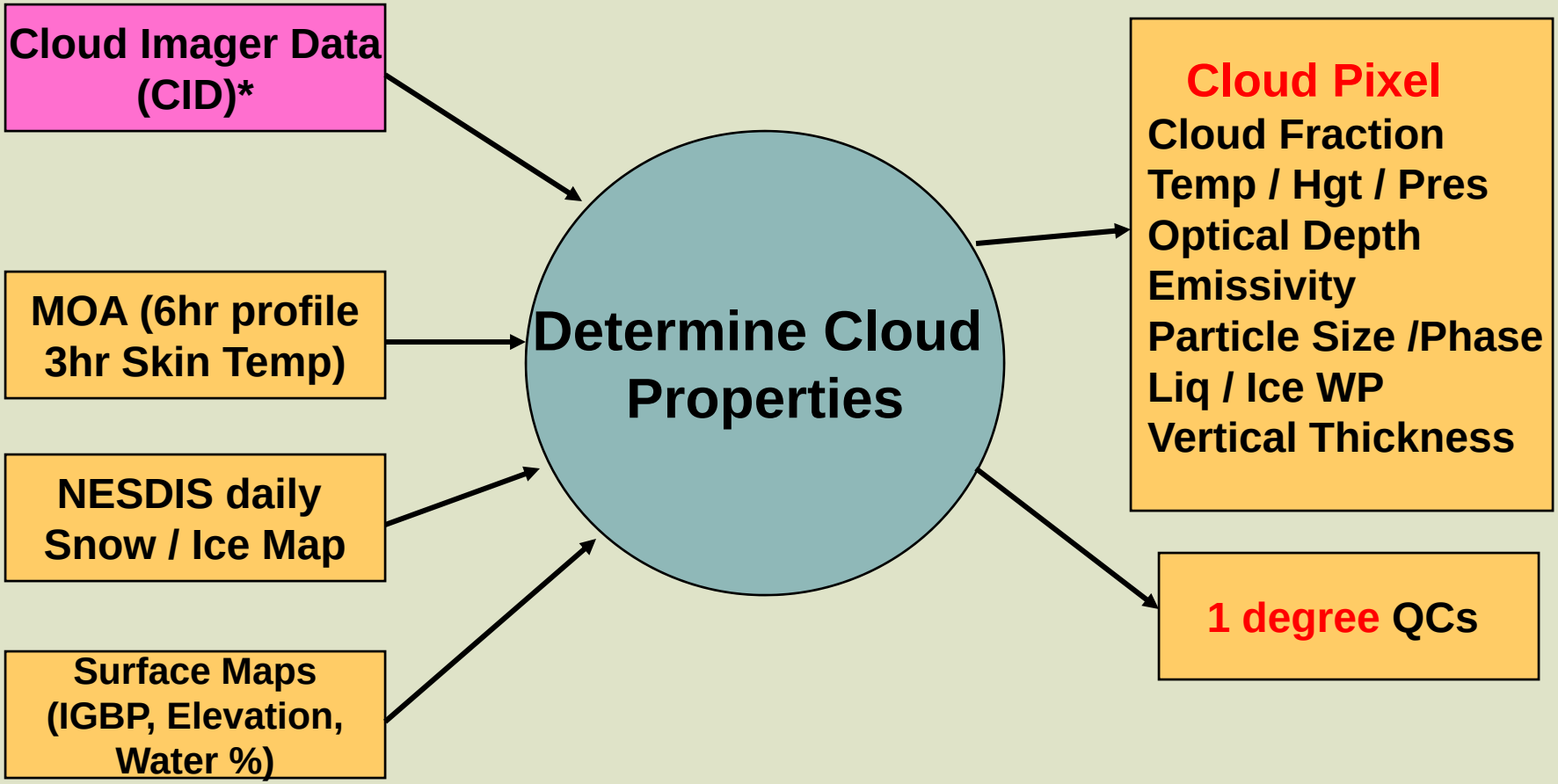
Sunny Sun-Mack (CERES DM POC)

February 28, 2008

Cloud Subsystem Top Level Data Flow Diagram



Cloud Subsystem Top Level Data Flow Diagram



*CID: VIRS on TRMM
MODIS on Terra and Aqua
VIIRS on NPP

Current MODIS Products Used By Cloud Subsystem

(1) MOD02SS1 / MYD02SS1 (MODIS Radiance ~ 10 GB / Day)
(Spatial and channel subset of MOD021KM and MOD02QKM)

(2) MOD03 / MYD03 (MODIS Geolocation ~ 8.5 GB / Day)

(3) MOD04 / MYD04 (MODIS Aerosol ~ 0.2 GB / Day)

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(3) MOD04 / MYD04 (MODIS Aerosol ~ 0.2 GB / Day)

NAME	(um)	
Band		
M_250_Aggr1km_RefSB_1	0.645	1
M_250_Aggr1km_RefSB_2	0.858	2
M_500_Aggr1km_RefSB_1	0.469	3
M_500_Aggr1km_RefSB_2	0.555	4
M_500_Aggr1km_RefSB_3	1.240	5
M_500_Aggr1km_RefSB_4	1.640	6
M_500_Aggr1km_RefSB_5	2.130	7
M_1KM_RefSB_1	0.412	8
M_1KM_RefSB_2	0.443	9
M_1KM_RefSB_3	0.488	10
M_1KM_RefSB_4	0.531	11
M_1KM_RefSB_5	0.551	12
M_1KM_RefSB_6	0.667	
13lo		
M_1KM_RefSB_7	0.667	
13hi		
M_1KM_RefSB_8	0.678	
14lo		
M_1KM_RefSB_9	0.678	
14hi		
M_1KM_RefSB_10	0.748	15
M_1KM_RefSB_11	0.869	16

CERES Channel Subset
(19 out of 36 channels)

NAME	(um)	
Band		
M_1KM_Emissive_1	3.792	20
M_1KM_Emissive_2	3.960	21
M_1KM_Emissive_3	3.960	22
M_1KM_Emissive_4	4.050	23
M_1KM_Emissive_5	4.470	24
M_1KM_Emissive_6	4.520	25
M_1KM_Emissive_7	6.720	27
M_1KM_Emissive_8	7.330	28
M_1KM_Emissive_9	8.550	29
M_1KM_Emissive_10	9.730	30
M_1KM_Emissive_11	11.030	31
M_1KM_Emissive_12	12.020	32
M_1KM_Emissive_13	13.340	33
M_1KM_Emissive_14	13.640	34
M_1KM_Emissive_15	13.940	35
M_1KM_Emissive_16	14.240	36

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M_500_Aggr1km_RefSB_3	1.240	5
M_500_Aggr1km_RefSB_4	1.640	6
M_500_Aggr1km_RefSB_5	2.130	7
M_1KM_RefSB_1	0.412	8
M_1KM_RefSB_2	0.443	9
M_1KM_RefSB_3	0.488	10
M_1KM_RefSB_4	0.531	11
M_1KM_RefSB_5	0.551	12
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M_1KM_Emissive_7	6.720	27
M_1KM_Emissive_8	7.330	28
M_1KM_Emissive_9	8.550	29
M_1KM_Emissive_10	9.730	30
M_1KM_Emissive_11	11.030	31
M_1KM_Emissive_12	12.020	32
M_1KM_Emissive_13	13.340	33
M_1KM_Emissive_14	13.640	34
M_1KM_Emissive_15	13.940	35
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CERES Spatial Subset

Every other 1 km pixel and every other scan line.

Impact of NNP Products on CERES Cloud Subsystem

Cloud Imager Data will be VIIRS, instead of MODIS.

Impact of NNP Products on CERES Cloud Subsystem

Cloud Imager Data will be VIIRS, instead of MODIS.

		Band No.	Wave-length (μm)	Horiz Sample Interval (km Downtrack x Crosstrack)	
				Nadir	End of Scan
VIS/NIR FPA	Silicon PIN Diodes	M1	0.412	0.742 x 0.259	1.60 x 1.58
		M2	0.445	0.742 x 0.259	1.60 x 1.58
		M3	0.488	0.742 x 0.259	1.60 x 1.58
		M4	0.555	0.742 x 0.259	1.60 x 1.58
		I1	0.640	0.371 x 0.387	0.80 x 0.789
		M5	0.672	0.742 x 0.259	1.60 x 1.58
		M6	0.746	0.742 x 0.776	1.60 x 1.58
		I2	0.865	0.371 x 0.387	0.80 x 0.789
		M7	0.865	0.742 x 0.259	1.60 x 1.58
CCD		DNB	0.7	0.742 x 0.742	0.742 x 0.742
S/MWIR	PV HgCdTe (HCT)	M8	1.24	0.742 x 0.776	1.60 x 1.58
		M9	1.378	0.742 x 0.776	1.60 x 1.58
		I3	1.61	0.371 x 0.387	0.80 x 0.789
		M10	1.61	0.742 x 0.776	1.60 x 1.58
		M11	2.25	0.742 x 0.776	1.60 x 1.58
		I4	3.74	0.371 x 0.387	0.80 x 0.789
		M12	3.70	0.742 x 0.776	1.60 x 1.58
		M13	4.05	0.742 x 0.259	1.60 x 1.58
LWIR	PV HCT	M14	8.55	0.742 x 0.776	1.60 x 1.58
		M15	10.763	0.742 x 0.776	1.60 x 1.58
		I5	11.450	0.371 x 0.387	0.80 x 0.789
		M16	12.013	0.742 x 0.776	1.60 x 1.58

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		M5	0.672	0.742 x 0.259	1.60 x 1.58
		M6	0.746	0.742 x 0.776	1.60 x 1.58
		I2	0.865	0.371 x 0.387	0.80 x 0.789
		M7	0.865	0.742 x 0.259	1.60 x 1.58
CCD		DNB	0.7	0.742 x 0.742	0.742 x 0.742
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LWIR	PV HCT	M14	8.55	0.742 x 0.776	1.60 x 1.58
		M15	10.763	0.742 x 0.776	1.60 x 1.58
		I5	11.450	0.371 x 0.387	0.80 x 0.789
		M16	12.013	0.742 x 0.776	1.60 x 1.58

Questions and near future tasks:

(1) We would really like to know: the format, the file size, the content, how many and what they are, and the time coverage for each MODIS-Like-VIIRS product?

(2) Once we know the answers to these questions, we can then make a decision whether we need to further sample (spatially or/and channelly) MODIS-Like-VIIRS products, like what we did with MODIS data.

(3) If the decision is yes, then we will write a program to further select (spatially and/or channelly) VIIRS pixel with MODIS-Like-VIIRS products.

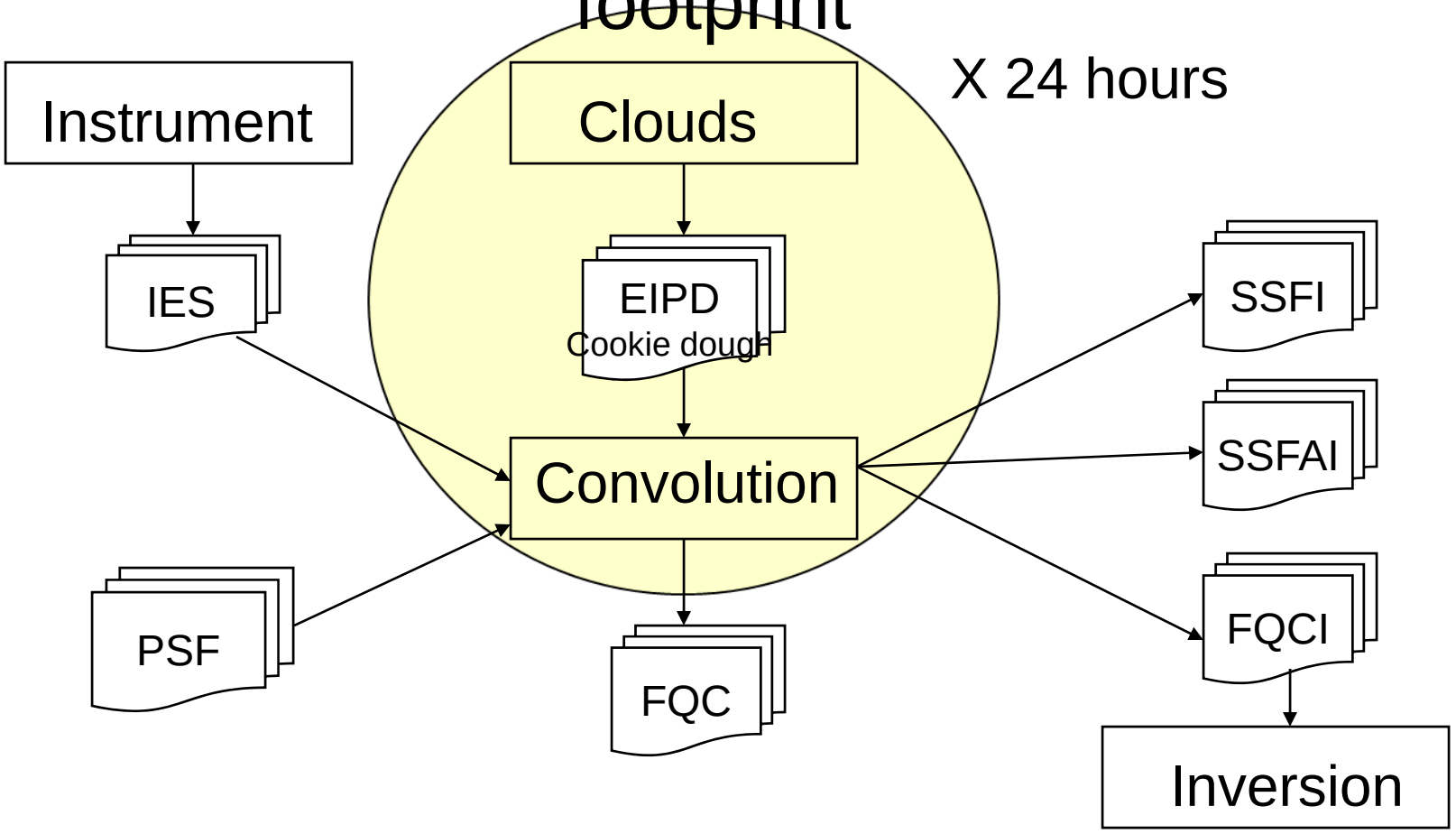
CERES
Convolution Subsystem

Walt Miller (CERES DM POC)

February 28, 2008

Convolution Subsystem Description

Convolve imager radiances, cloud properties, and aerosol into CERES footprint



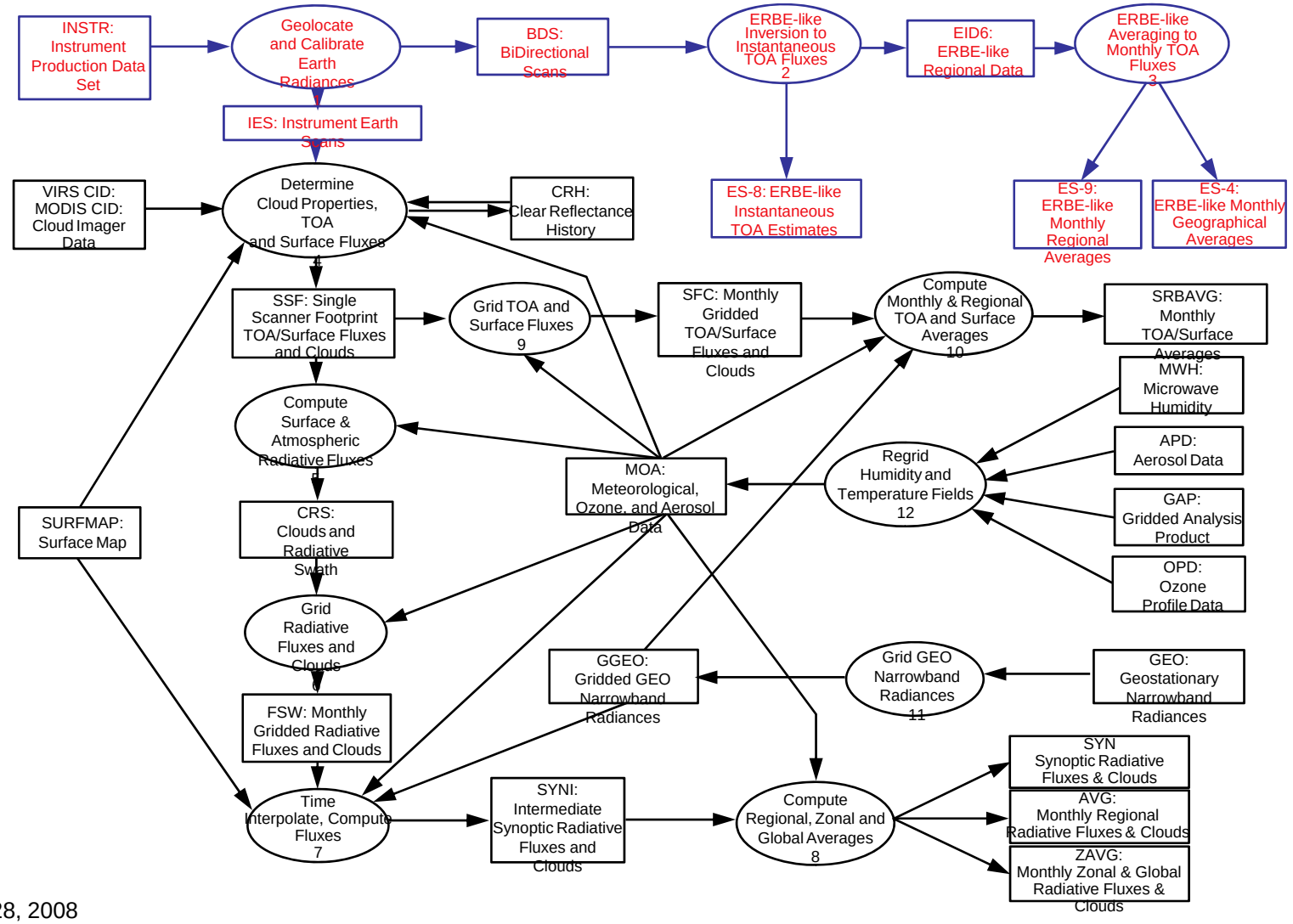
NPP Impact

- VIIRS will replace MODIS as imager source
  - Ability to generate certain cloud properties
  - Some radiances, CO2 slicing, maybe missing
- Aerosol may not be part of input from clouds SS
- Expect IES interface to be the same
- New PSF will need to be generated for VIIRS imager resolution
- SSF interface change possible

NPP Issues

- Will aerosols be created using VIIRS?
- Will MODAPS create their standard aerosol product or repackage VIIRS?
- If VIIRS aerosol not available feasibility of using Aqua MODIS derived files in convolution.
- Will cookie dough be provided in hour chunks?
- Will Science change SSF format?
- Generate PSF once sampled imager resolution is known.
- Time frame for sample data arrival.

Current CERES Climate Data Record Production



CERES
SARB Subsystem

Tom Caldwell (CERES DM POC)

February 28, 2008

Primary Inputs

- Single Satellite Footprint (SSF) product produced by preceding CERES subsystems
- Meteorological, Ozone, and Aerosol (MOA) data - Generated by the Regrid MOA Subsystem from external sources
- MATCH aerosol data - MODIS-based aerosol data generated by Bill Collins for the CERES project

Processing Overview

- Cloud properties and atmospheric properties are retrieved from the SSFB, MOA, and MATCH files
- The data are input into the Langley version of the Fu-Liou radiative transfer model
- Vertical flux profiles from surface to TOA are generated for various wavelengths for total-sky conditions as well as multiple theoretical sky conditions such as all clear and pristine skies
- Additional passes through the model are run to constrain the profiles to CERES observed values at TOA and surface defined by the Inversion/SOFA software.
- The constrained profile data along with constrainment-related data are archived on the output file.
- QC statistics and plots are generated for Science Team members

Output/Target

- CER_CRS (Clouds and Radiative Swath)

  Vertical flux profiles from surface to TOA for longwave, shortwave, and window channel wavelengths for total-sky, clear-sky, pristine, and aerosol-free.
- 24 CRS files per data day (Hours 0 .. 23)

  225 MB per hour; 5 GB per day; 163 GB per month
- Files are input to TISA Gridding (Subsystem 6) where the data are organized according to the CERES grid.

Impact of NPP

- Changes in externally supplied sources of data, such as the data contained on the MOA product, will impact the results of Subsystem 5.0
- *Will Overlapped Clouds be provided? (CO2 slicing ?)*
  - *If so, use of Edition3 style CRS code.*
- *What will source of AOT be?*
  - *A MOD04 like product?*
  - *T.ZHOU Cloud/Aerosol retrieval?*
- *Will there be a MATCH aerosol assimilation product?*
  - *Migration to CAM assimilation?*

CERES Publicly Available Products

Data Product	Data Product Name	File Freq
BDS	Bidirectional Scan	1/day
ES-8	ERBE-Like Inst TOA Filtered Radiances	1/day
ES-9	ERBE-Like Monthly Regional Averages	1/mo
ES-4	ERBE-like Monthly Geographical Averages	1/mo
SSF	Single Scanner Footprint TOA/Surface Fluxes & Clouds	1/hr
SFC	Monthly Gridded Radiative Fluxes & Clouds	36/mo
SRBAVG	Monthly TOA/Surface Averages	5/mo
CRS	Clouds and Radiative Swath	1/hr
FSW	Monthly Gridded Radiative Fluxes & Clouds	60/mo
SYN	Synoptic Radiative Fluxes and Clouds	1/day
AVG	Monthly Regional Radiative Fluxes and Clouds	1/mo
ZAVG	Monthly Zonal and Global Radiative Fluxes & Clouds	1/mo

CERES
Points of Contact

Science POC	Data Management POC	Working Group Affiliation	Data Products Generated
Kory Priestley	Denise Cooper	Instrument	BDS, IES
Kory Priestley Tak Wong	Dale Walikainen	ERBElike	ES8 ES4, ES9
Pat Minnis	Sunny Sun-Mack	Clouds	Cloud properties on SSF
	Walter Miller	Convolution	Merges pixel and footprint level data on SSF
Norman Loeb	Victor Sothcott	Inversion	TOA radiances and fluxes on SSF
Dave Kratz	Victor Sothcott	SOFA	Surface fluxes on SSF
Tom Charlock	Tom Caldwell	SARB	CRS, SYNI, MOA
Dave Doelling	Raja Raju	TISA Gridding Grid GEO	SFC, FSW GGEO
Dave Doelling	Cathy Nguyen	TISA Averaging	SRBAVG, SYN, AVG, ZAVG