

CERES Surface and Atmospheric Radiation Budget (SARB)

T. Charlock, Fred G. Rose, David A. Rutan, and Zhonghai Jin

CERES Data Products Workshop (Norfolk Airport, 29 January 2003)

"CRS" product has fluxes at surface, 500-200-70 hPa, and TOA,
cloud and aerosol forcing

Inputs: SSF (TOA flux, clouds, aerosols), ECMWF, MATCH (Collins)
aerosol assimilation, NCEP O3 (SBUV & HIRS)

Langley Fu-Liou 2 stream SW (2/4 LW with Kratz-Rose window)

Adjustments (tuning) to PW, Upper Tropospheric H₂O, skin T, aerosols
Cloud LWP/IWP, cloud fraction, cloud height

A priori uncertainties assigned to each adjustable parameter

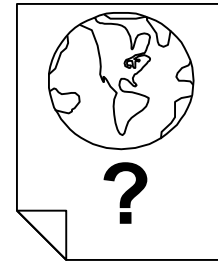
Minimum sum of squares of normalized differences between
(1) computed TOA fluxes and adjusted inputs
and
(2) observed TOA fluxes and initial inputs

Q: Is belief in CERES possible? And this mad SARB “everything” stuff?

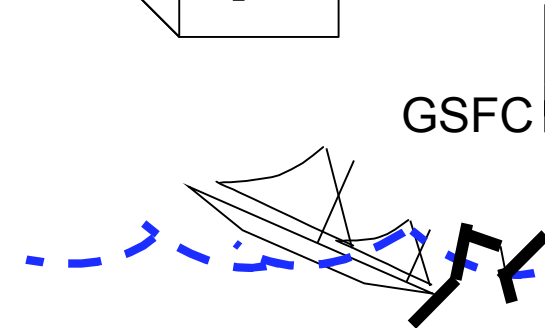
A: Virginia is not Boulder. Belief is allowed here. But history comes first.

1700s:

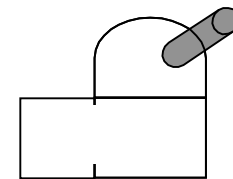
Lacking precise time keeping,
longitude could not be determined accurately.



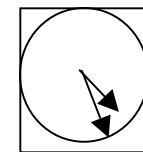
Not surprisingly, many ships were lost due
to errors navigation.



Greenwich Royal Observatory (astronomy!) was supported
to solve the problem.



The solution was the invention of a superior
mechanical chronometer, the modern clock.



LaRC

Rough accuracies of some instruments

Common digital wristwatch: $10e-5$

Mercury thermometer (undergraduate calibration): $10e-4$

Meter stick: $10e-3$

Very high quality radiometer (i.e., BSRN, EOS): $10e-2$

Clocks in 1700s were better than our radiometers are now. And then the king offered a great prize for a better measurement of time...

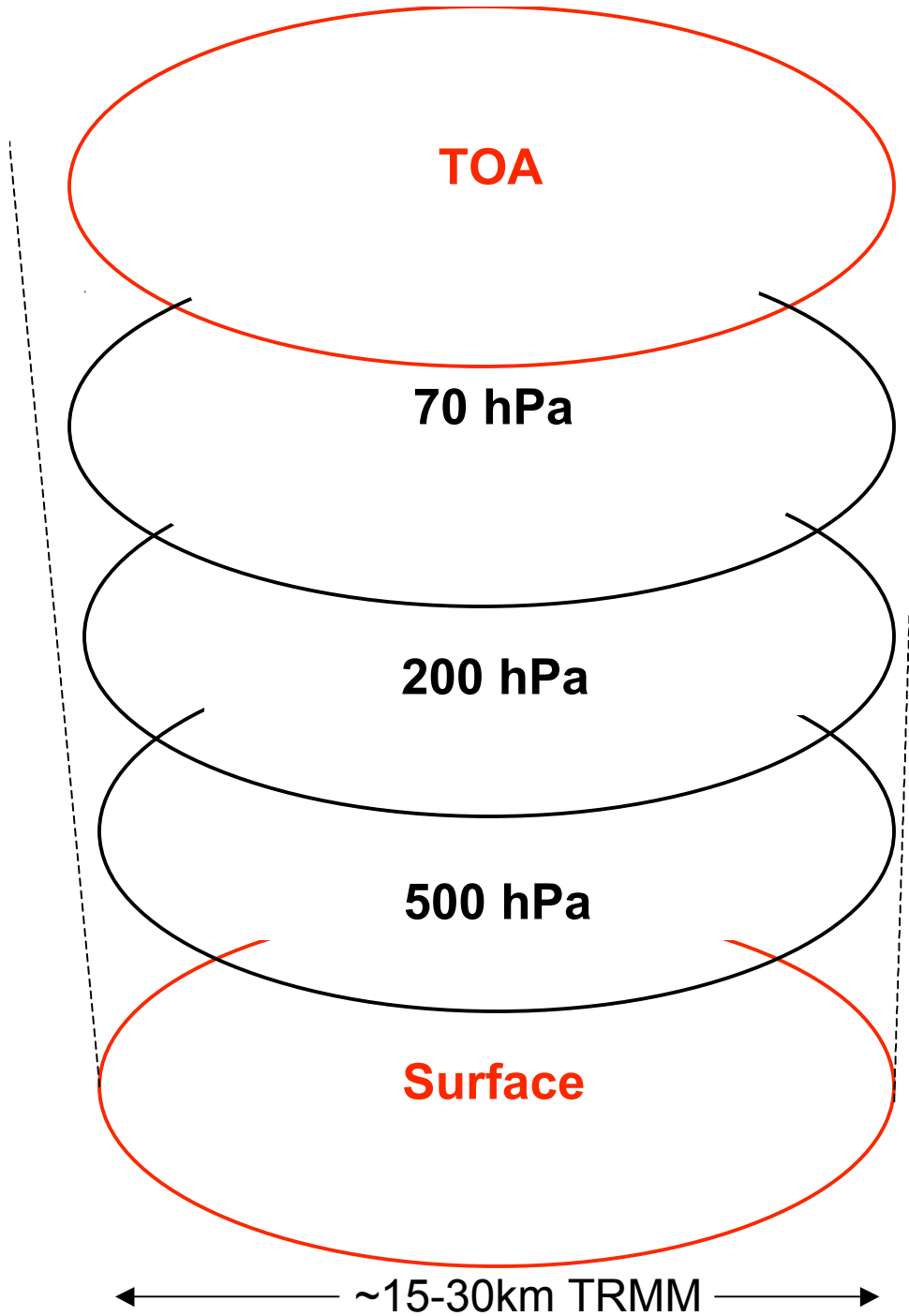
Believe as you wish. Jefferson's proposal for religious freedom is here law.

You indeed will hear of the "everything" CERES SARB.

But pay closer attention to the ways we test it.

And tell us later what you believe, what you don't believe, how we can make it better, and what science we call all make of it.

CERES CRS: Surface and Atmosphere Radiation Budget (SARB) Product



Tuned fluxes at all 5 levels

All-sky & Clear- sky
SW, LW, 8-12.5um non-CERES Window
Up & Down

Surface & TOA also have Untuned fluxes
& Pristine (no aerosol) fluxes

Emulated 8-12um CERES Window at TOA

Photosynthetically Active Radiation
(PAR 400-700nm) at surface

Tuning does NOT yield a perfect
match to TOA observations.

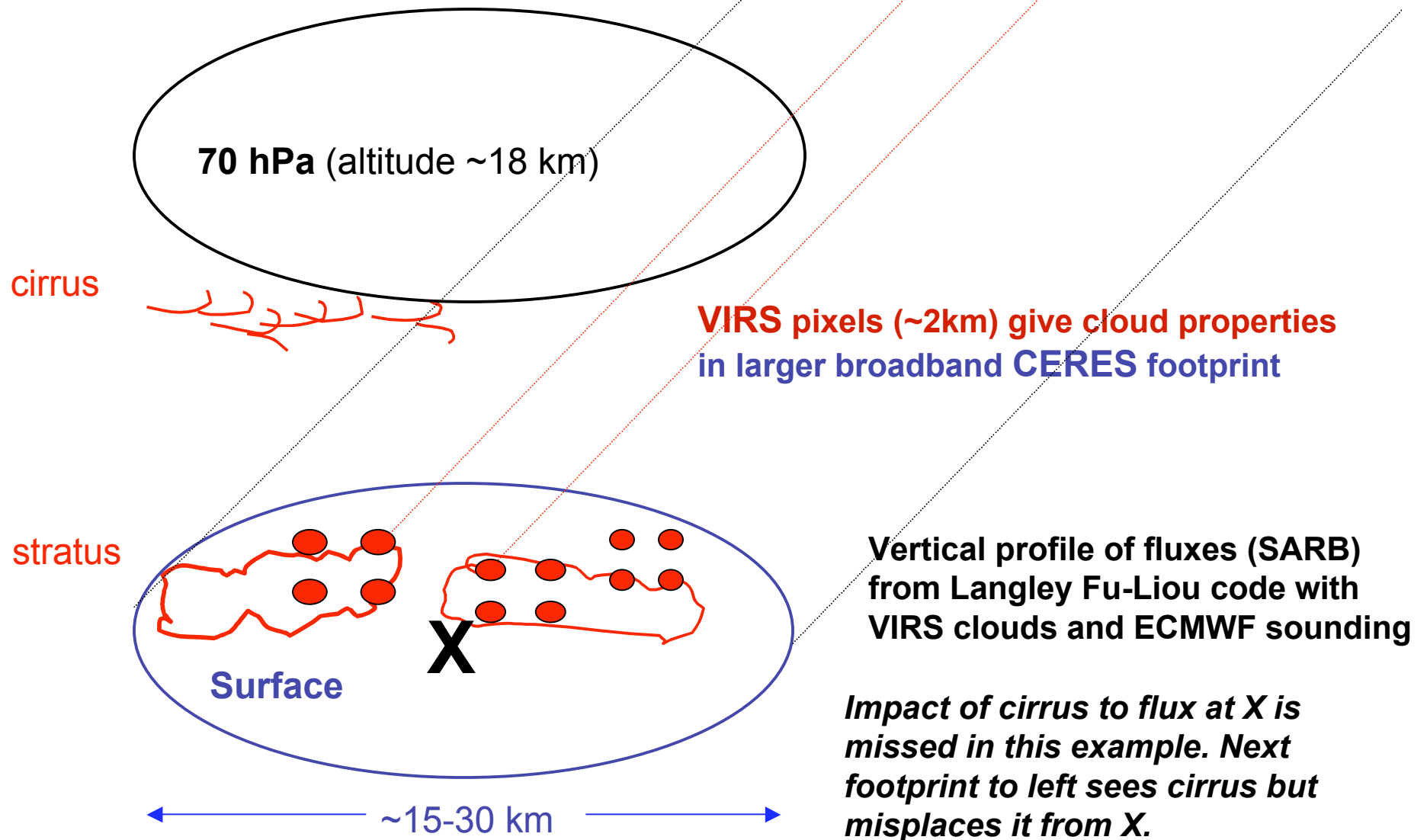
Parameters adjusted when clear:
Skin temperature, aerosols,
lower & upper tropospheric humidity

Parameters adjusted when cloudy:
LWP/IWP, cloud top temperature,
cloud fractional area within footprint

← ~15-30km TRMM → Instantaneous, geolocated at surface, ungridded

Viewing geometry and vertical profile of SARB fluxes

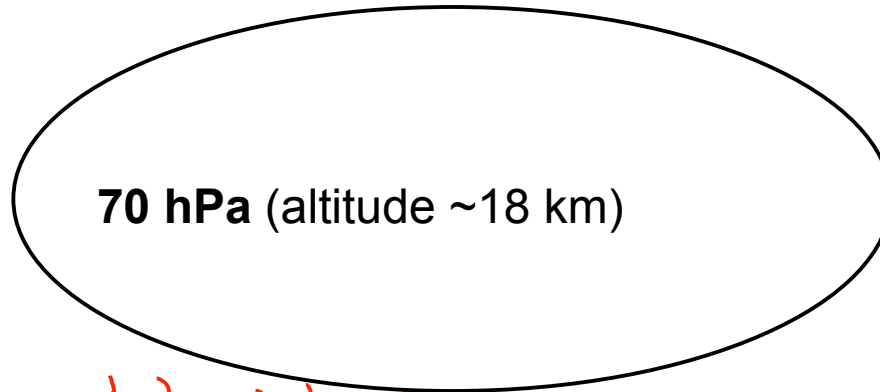
Output levels at 500 hPa, 200 hPa, and TOA not drawn



Input data for computing SARB vertical profile at ~4,000,000 footprints/day

Output levels at 500 hPa, 200 hPa, and TOA not drawn

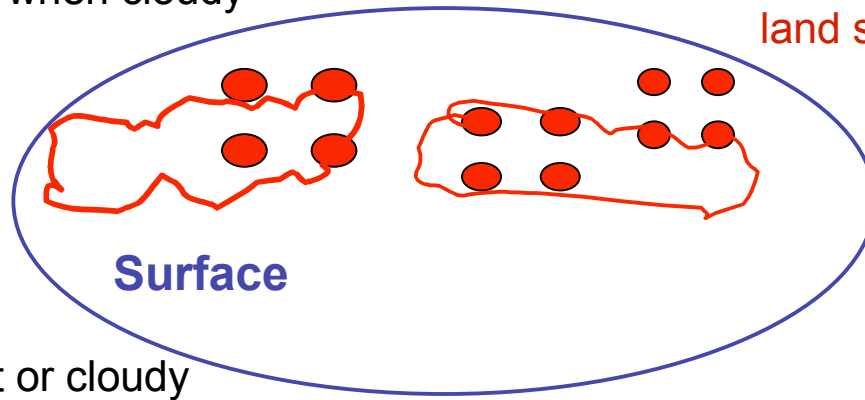
NCEP O3(z)
mostly SBUV/2



ECMWF T(z) and q(z)
wind speed for ocean surface albedo
land skin temperature when cloudy

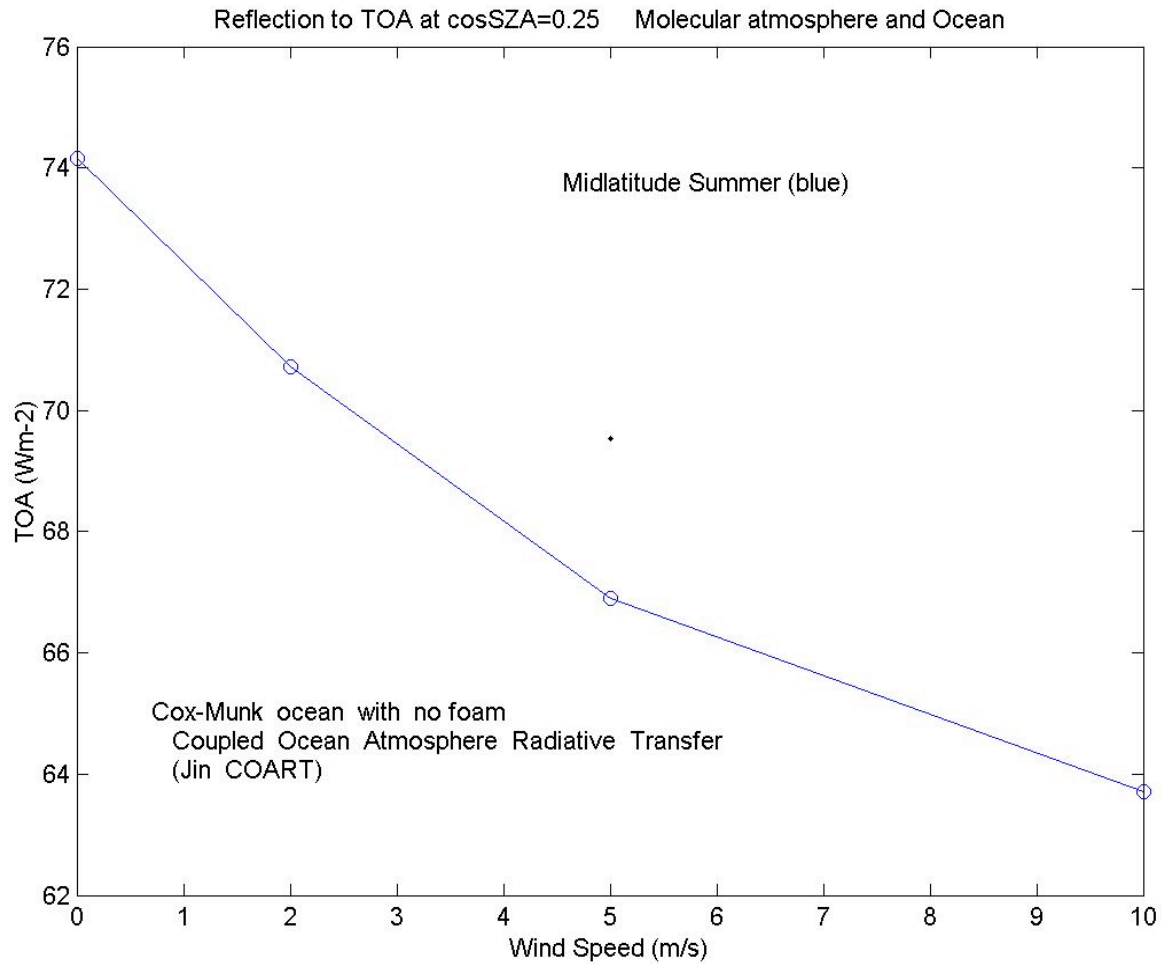
VIRS pixels (~2km) provide
cloud properties (almost always)
ocean aerosols (sometimes)
land skin temperature (when clear)

MATCH aerosols
all land
all night
ocean when VIRS glint or cloudy



← ~15-30 km →

**Large CERES footprint
(geolocated at surface)
for TOA flux**

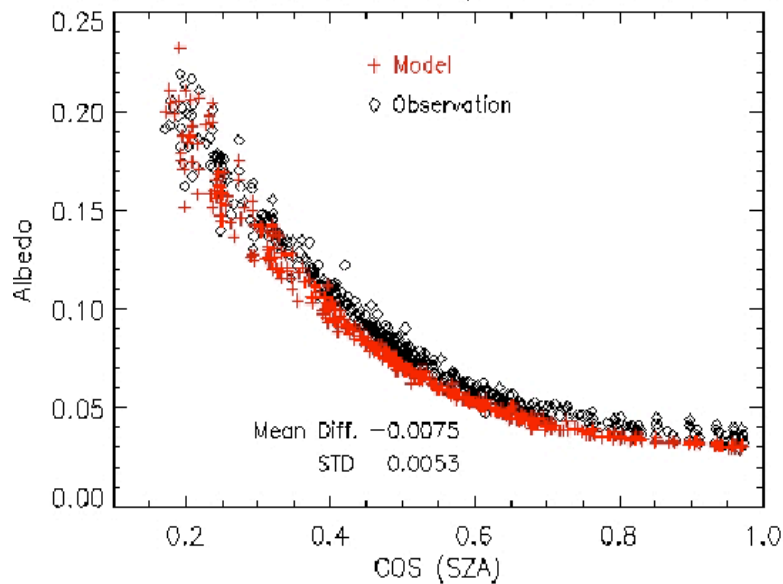


Example of why we need good boundary conditions:
 For large SZA, signal of change in ocean albedo at very
 low wind speeds could be confused with aerosol.

Coupled Ocean Atmosphere Radiative Transfer (COART)

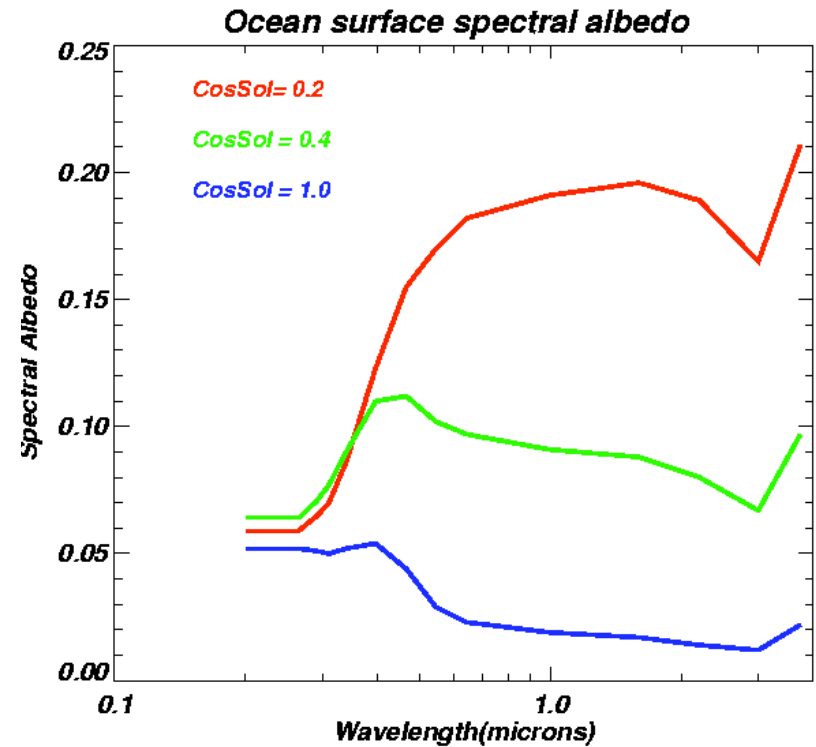
Explicit scattering in both air & sea (i.e., aerosols and phytoplankton)

Model and Observation Comparison For Ocean Surface Albedo at COVE (3-1-00 to 3-1-01)



Jin, Charlock, and Rutledge, 2002: Analysis of broadband solar radiation and albedo over the ocean surface at COVE. J. Ocean. Atmos. Tech., Vol 19, pp. 1585-1601.

COART look up table (LUT) for SARB calculation



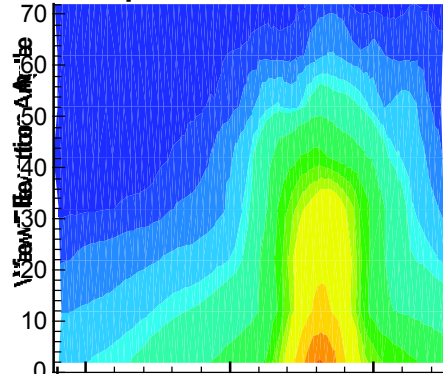
$f(\text{wind speed, cosSZA, tau})$

wind = 5m/s aerosol tau = 0.1

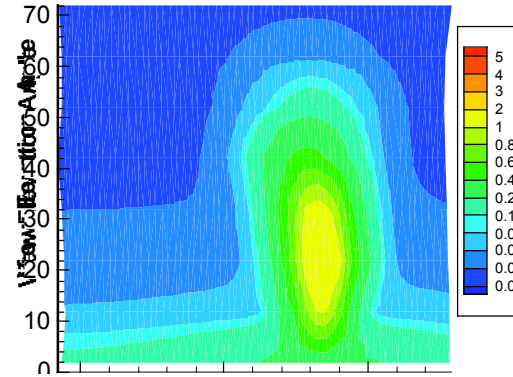
Checking basic assumptions for ocean boundary conditions

Cox-Munk statistics of wind waves \rightarrow mirror facets

Downlooking photometer

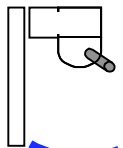


6S Model

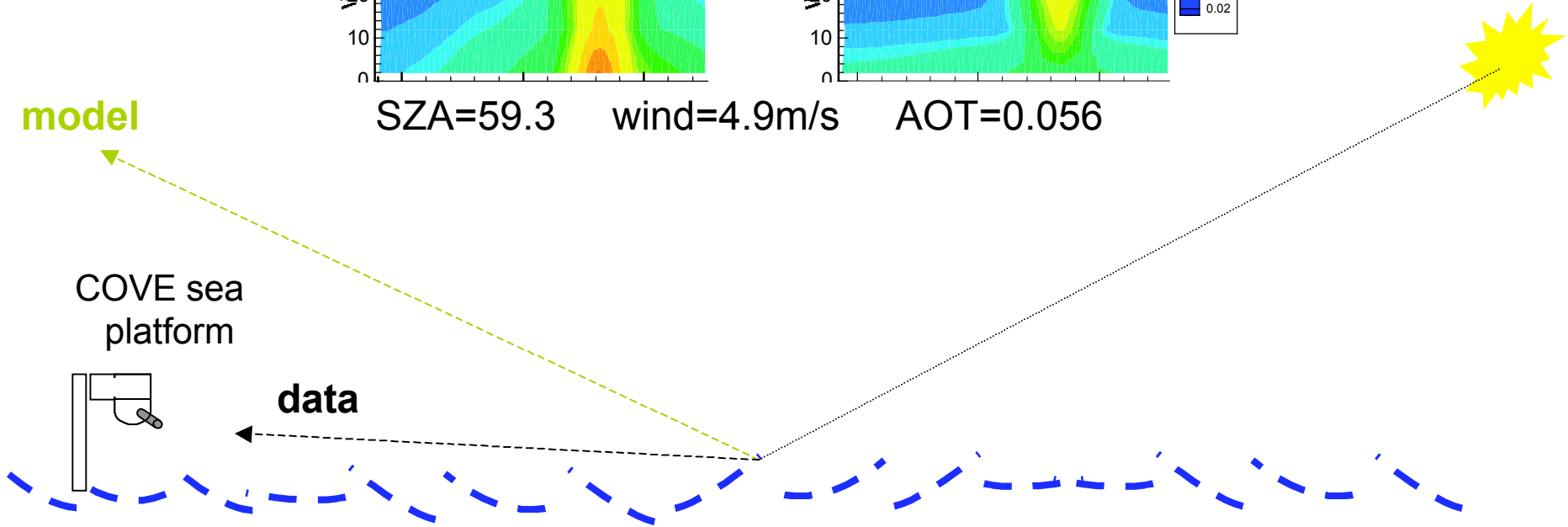


model

COVE sea platform

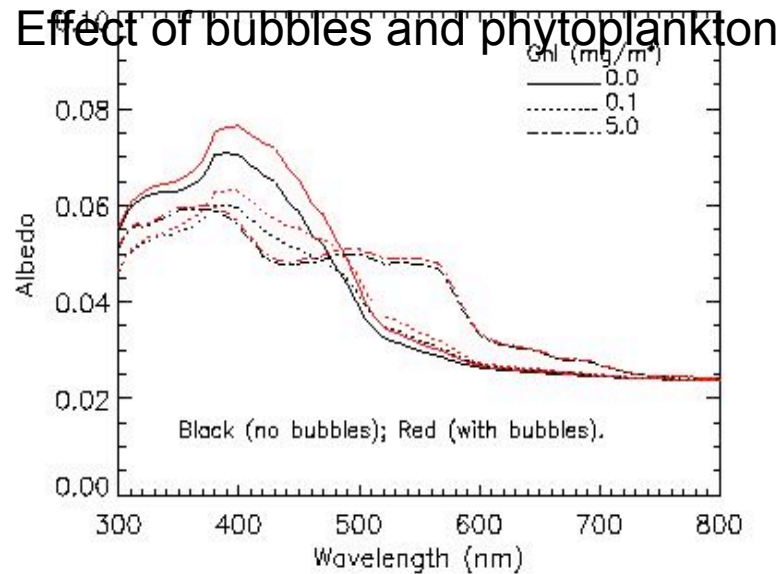


data



Su, W., T. Charlock, and K. Rutledge, 2002: Observed ocean reflection around sun glint at CERES Ocean Valiation Experiment (COVE) site. *Applied Optics*, 41, 7369-7383.

Coupled Ocean Atmosphere Radiative Transfer (COART) Modeled Ocean Spectral Albedo



Phytoplankton and Dissolved Organic Matter (DOM):

Tested in CLAMS field campaign at low wind speeds,
matching observed spectral albedos from MFRSRs
on sea platform.

Bubbles: Measurements for foam/bubble effects starting at CERES
Ocean Validation Experiment (COVE) sea platform.

X axes: observations

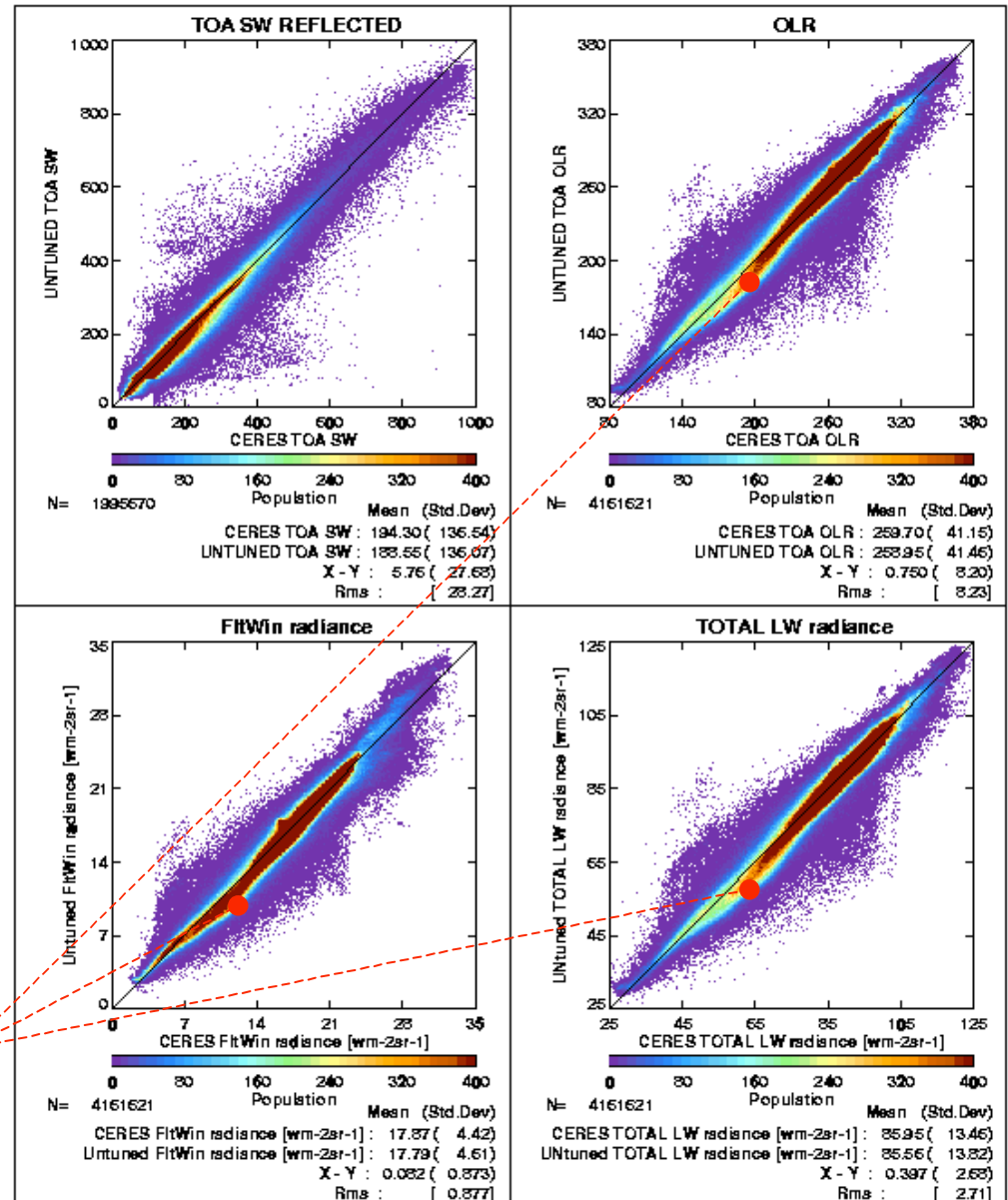
Y axes: calculations (no tuning)

bias = observations - calculations (Wm⁻²)

	bias	rms
untuned SW	5.8	28.3
untuned OLR	0.8	8.2
tuned SW	-0.3	14.7
tuned OLR	0.4	4.2

Plots of tuned SW, OLR are not shown

Significant IR bias for high clouds



X axes: observations
 Y axes: calculations (untuned)

OVERCAST ICE CLOUD :UNTUNED
 CRS Edition 2b
 April 14th 1998 (RAPS)

OVERCAST ICE CLOUDS

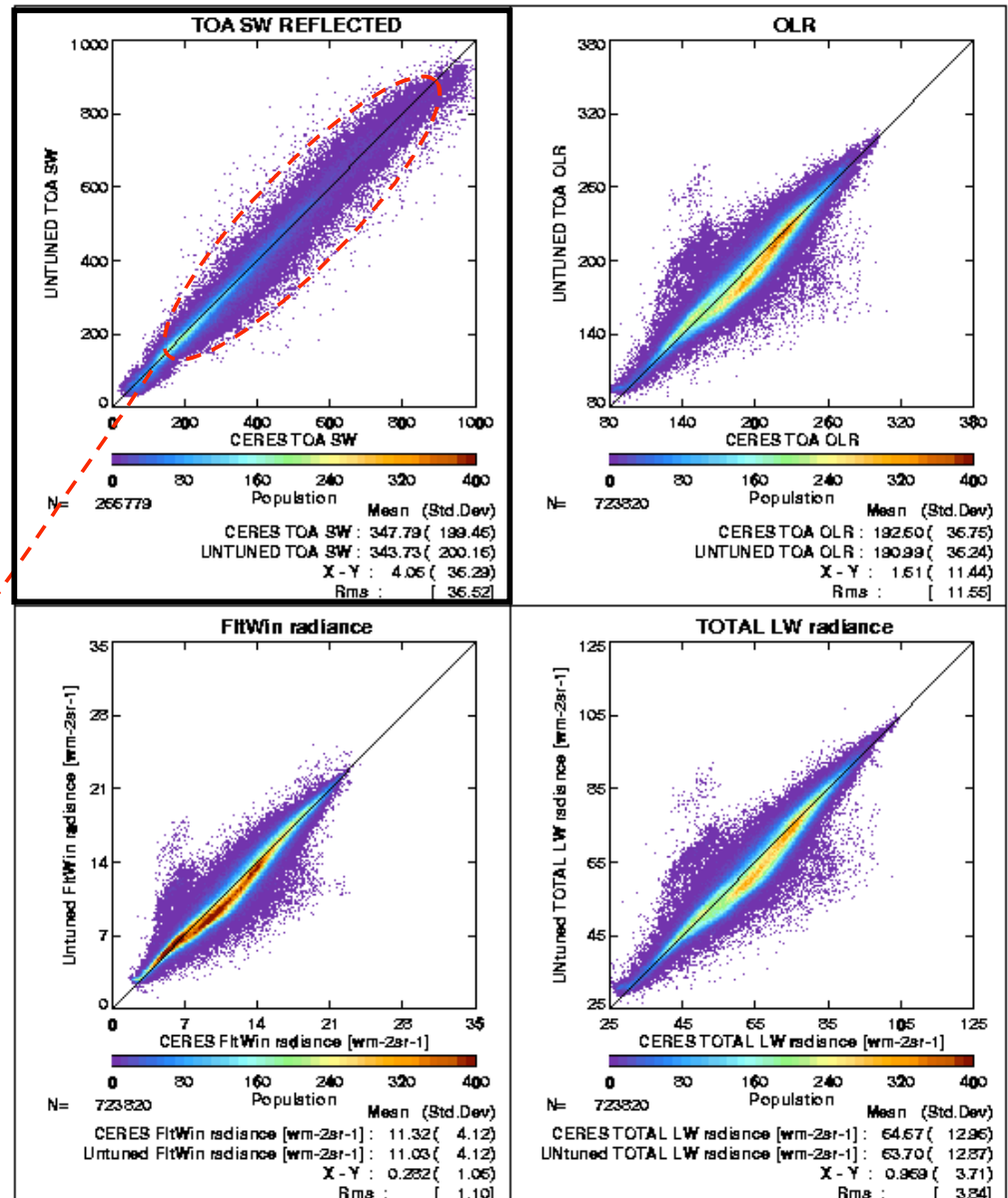
Both cloud retrievals and broadband calculations assume for ice:

- Hexagonal crystals
- Random orientation
- Gamma size distribution

RAPS: cloud retrievals (VIRS) and broadband observations (CERES) have different look angles.

Untuned SW rms = 36.5 Wm⁻² for Overcast Ice

Untuned SW rms = 28.3 Wm⁻² for All Sky (previous page)



X axis: observations
Y axis: calculations (untuned)

Clear ocean only

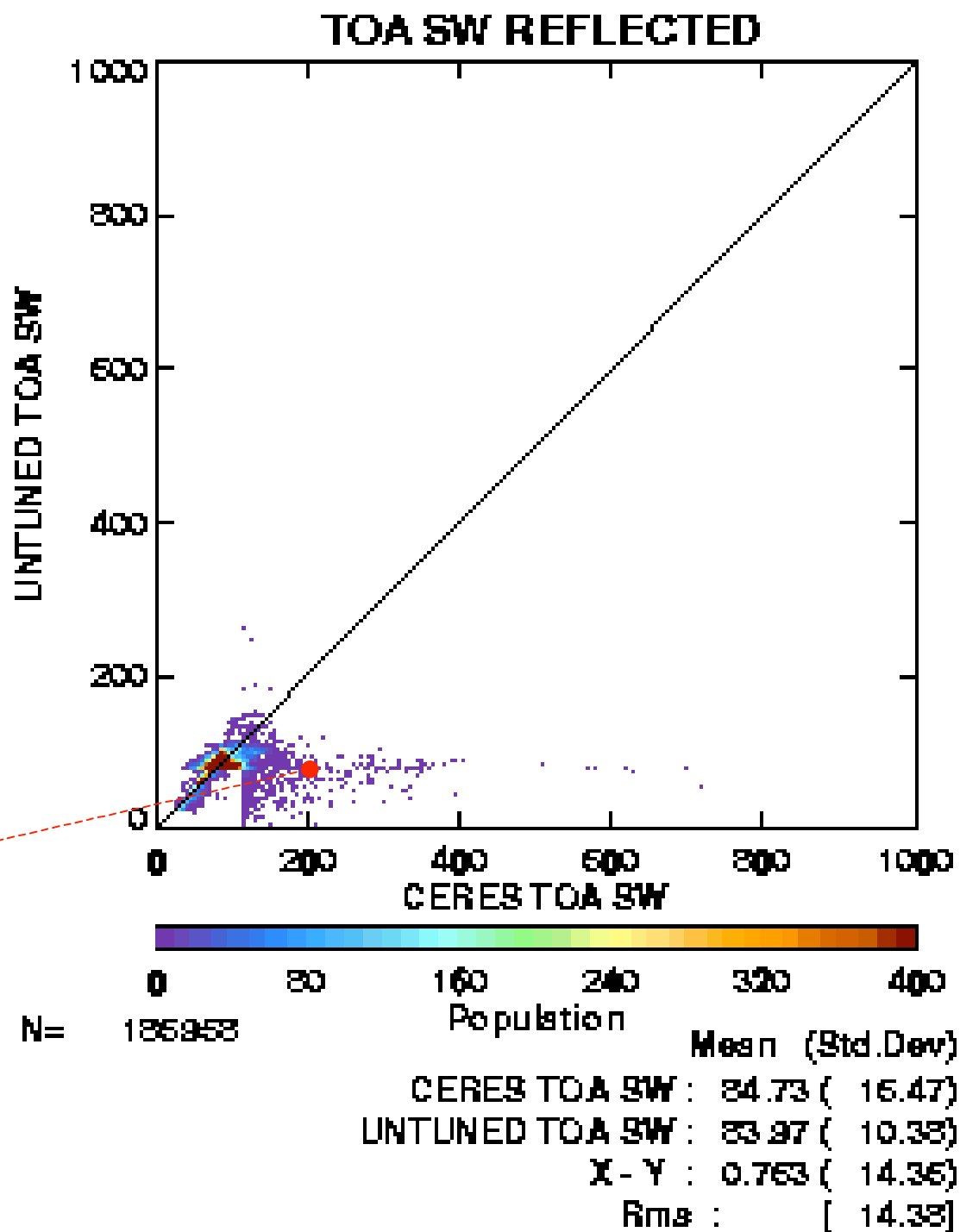
Aerosols from
SSF (VIRS)
or MATCH assimilation

Wind speed from ECMWF

Lookup table for
ocean spectral albedo

Calculated << Observed ●

Tiny number of footprints where
sunglint bugs observed TOA flux.



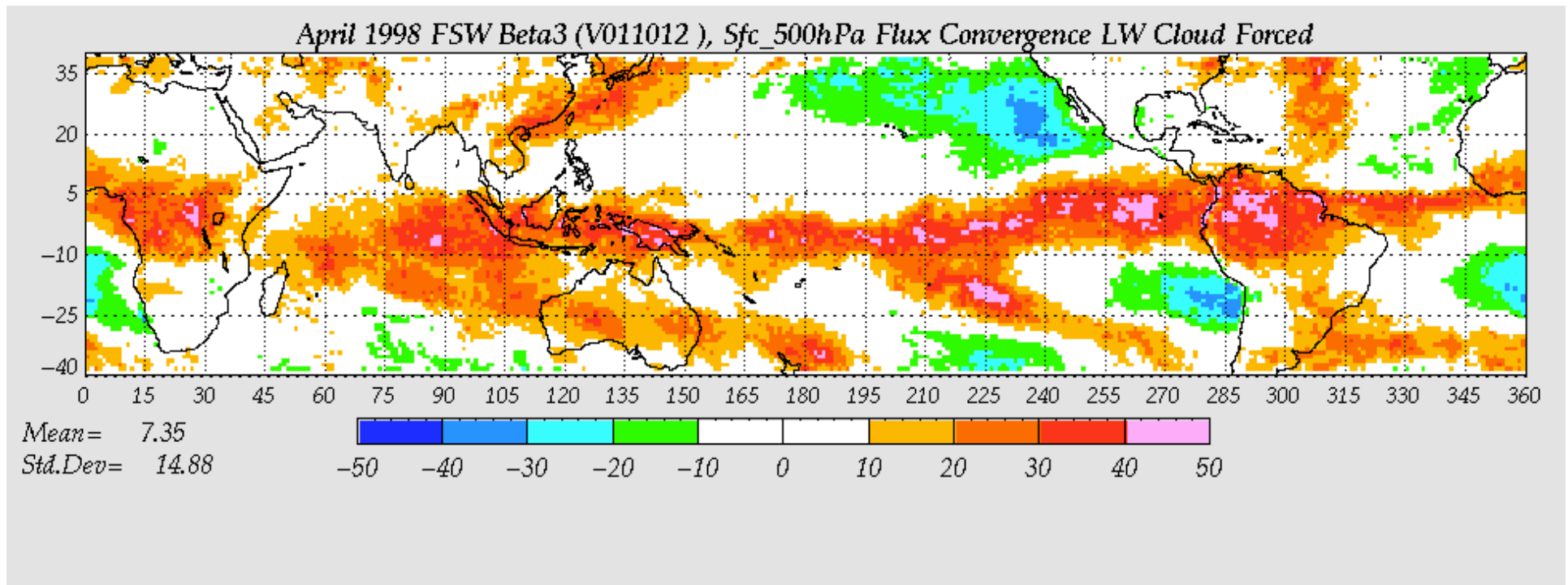
Cloud forcing to LW “convergence” (Surface to 500hPa) April 1998

All sky LW convergence is generally negative.

gridded “FSW Beta3”= hourly mean of ungridded “CRS Ed2B”

Gridding here does not account for diurnal effects, but should

give reasonable estimate for LW during this month.

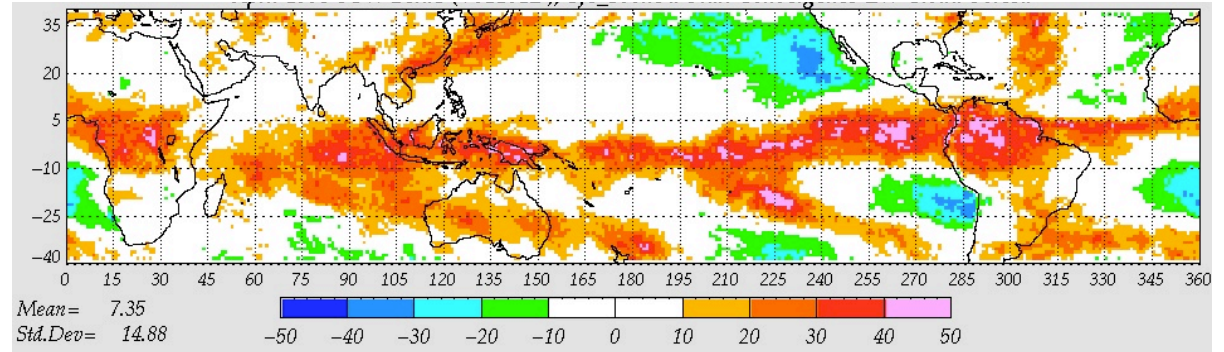


Cloud Forcing

LW Conv Sfc-500hPa

crude mean = 7 Wm⁻²

range -50 to +50 Wm⁻²



Omega at 700 hPa

red = ascent

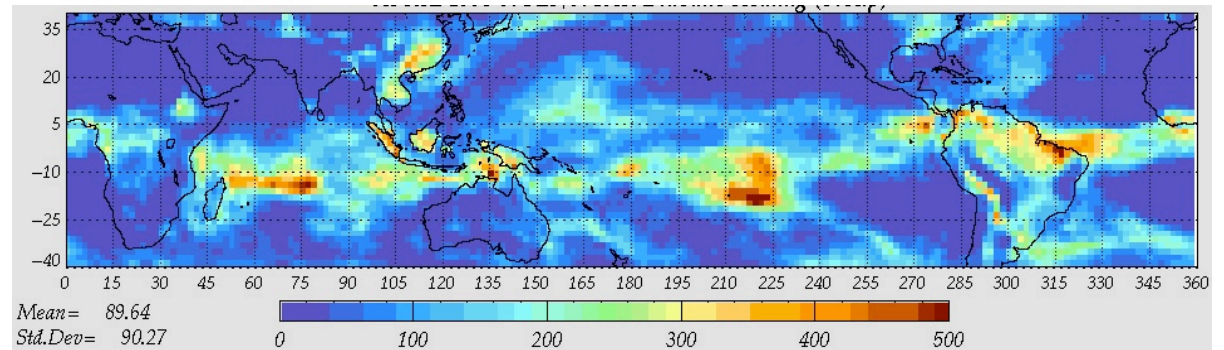
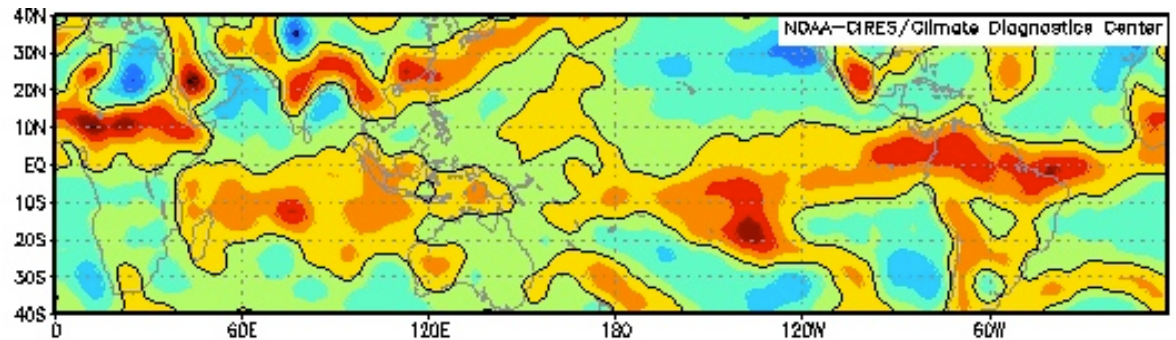
NCEP/NCAR April 98

Precipitation expressed

as Diabatic Heating

mean = 89 Wm⁻²

range 0 to 500 Wm⁻²

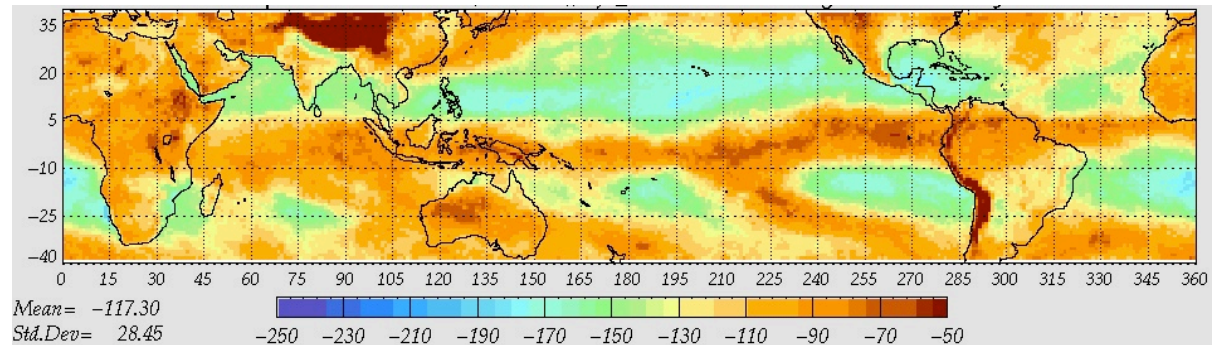


All Sky

LW Conv Sfc-500hPa

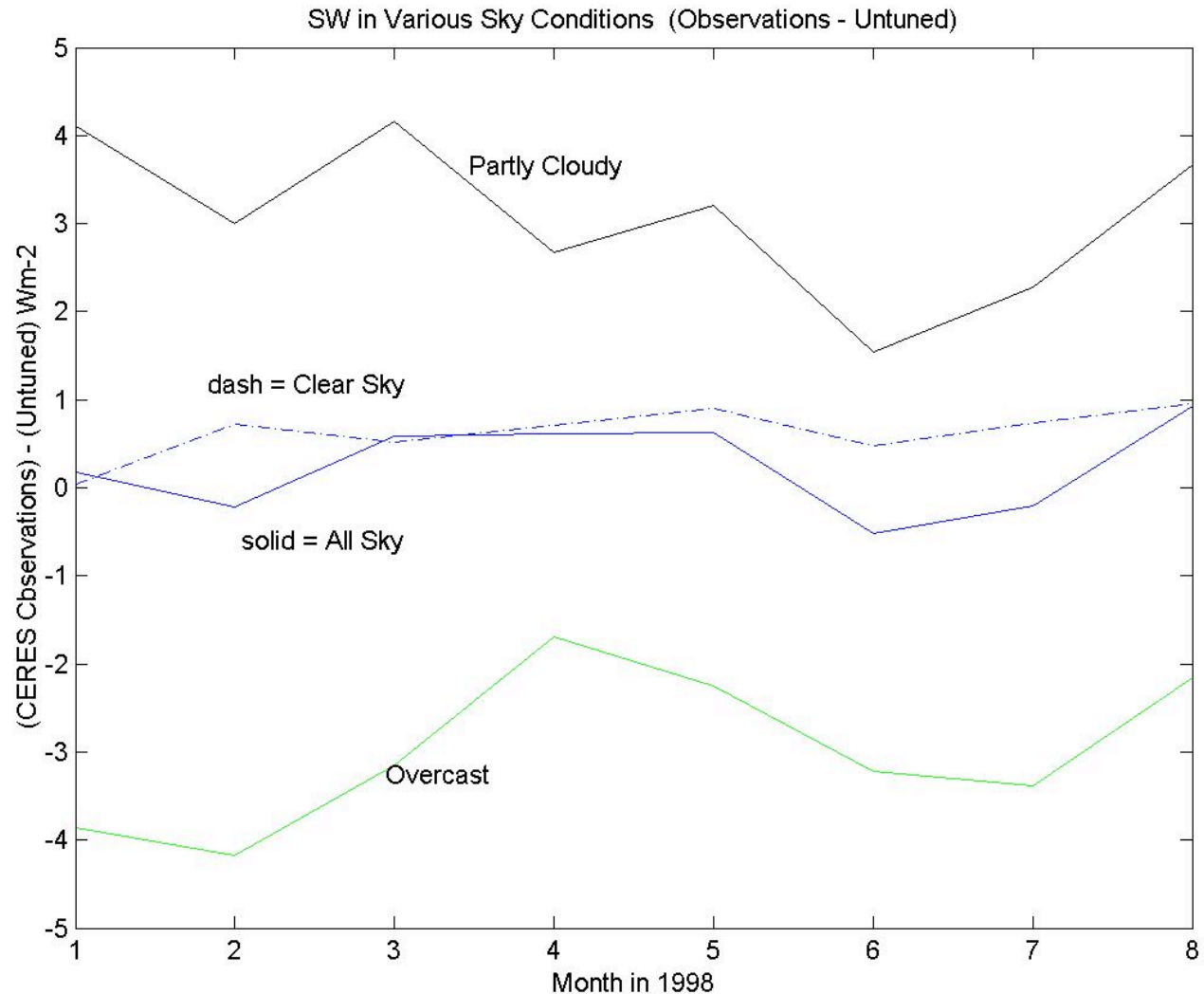
crude mean = -117 Wm⁻²

range -170 to -70 m⁻²



Reflected SW at TOA as coarse means (Jan-Aug 98) (CERES Observations) minus (untuned Calculations)

For SW, errors in simulating partly cloudy and overcast are significant but compensating.



Google "CERES CAVE": fruitful domain of David Rutan

Netscape: CERES ARM Validation Experiment CAVE Homepage

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

GIF image 810x810 pixels WebMail Connections SmartUpdate Netscape Handbook: Menu Items Welcome to MODIS C...upport Team (MCST) PICASSO-CENA Satellite A

Bookmarks Location: <http://www-cave.larc.nasa.gov/cave/>

NASA Langley CERES ARM Validation Experiment CAVE

[Home](#) [Surface Observations](#) [CERES CRS Data](#) [CERES ES8 Data](#) [Atmospheric Profiles](#) [Useful Links](#)

Welcome to the CAVE web site. Data collected in this effort are meant for use in validation studies of Clouds & The Earths Radiant Energy System (CERES) instruments operating on the Tropical Rainfall Measurement Mission (TRMM) and Earth Observing Systems(EOS) Terra (soon Aqua) satellites.

Global Coverage

Collocated CERES Observations

Continuous Surface Data Record

Atmospheric Profiles

Overview and Site Map

Plot Data On Line

Cloud Fraction In CAVE

Aerosols In CAVE

Site by Site Statistics

Posters & Publications

TRMM Microwave

Updates
DEC 5, 2002

Referencing CAVE data

The Group

Ocean Radiation Transfer

Point & Click Fu & Liou

CRS Advice

CLAMS

Balloon Observations

NASA Privacy Statement

Site Map

CAVE is an informal record containing radiation and meteorological data for a number of specific sites having

- (1) CERES top-of-atmosphere (TOA) broadband observations in *low volume, easy to use*, subsets collocated with,
- (2) surface broadband flux measurements from ARM, SURFRAD, CMDL, and BSRN networks.

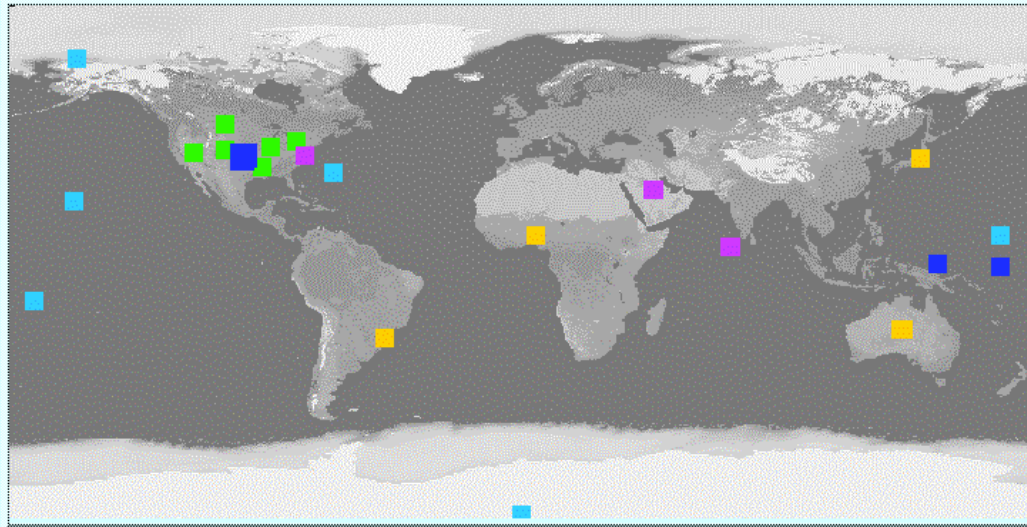
Please read the [CAVE overview](#) for a complete introduction to the project.

Questions, comments, or information about these data or these pages may be directed to site manager David Rutan at d.a.rutan@larc.nasa.gov or CERES liaison Tom Charlock t.p.charlock@larc.nasa.gov revised November, 2002.

www-cave.larc.nasa.gov/cave/



Contributing Projects


[Home](#)
[Surface Observations](#)
[CERES CRS Data](#)
[CERES ES8 Data](#)
[Atmospheric Profiles](#)
[Useful Links](#)


ARM – Atmospheric Radiation Measurement

The Department of Energy's Atmospheric Radiation Measurement (ARM) project supplies to CAVE a number of surface observations at 23 different locations. There are 21 sites in and around Kansas and Oklahoma, and two on the islands of Nauru and Manus in the Tropical West Pacific Ocean.

BSRN – Baseline Surface Radiation Measurement

The BSRN project is an international effort to obtain long-term high-quality surface observations of downwelling broadband radiation. We are downloading data for 4 sites around the globe.

CMDL – Climate Monitoring & Diagnostics Laboratory

The National Oceanic & Atmospheric Association (NOAA) CMDL supplies a high quality data set of primarily downwelling radiation from a number of remote sites about the globe.

SURFRAD – Surface Radiation Budget

SURFRAD supplies a complete set of radiation and surface meteorology from 6 sites located within the US. These sites provide a reliable data set of both upwelling & downwelling radiation, and located in a diverse set of surface vegetation types.

Independent Sites

INDOEX – Indian Ocean Experiment

www-cave.larc.nasa.gov/cave/



CAVE: On line plots at over
30 surface radiation sites

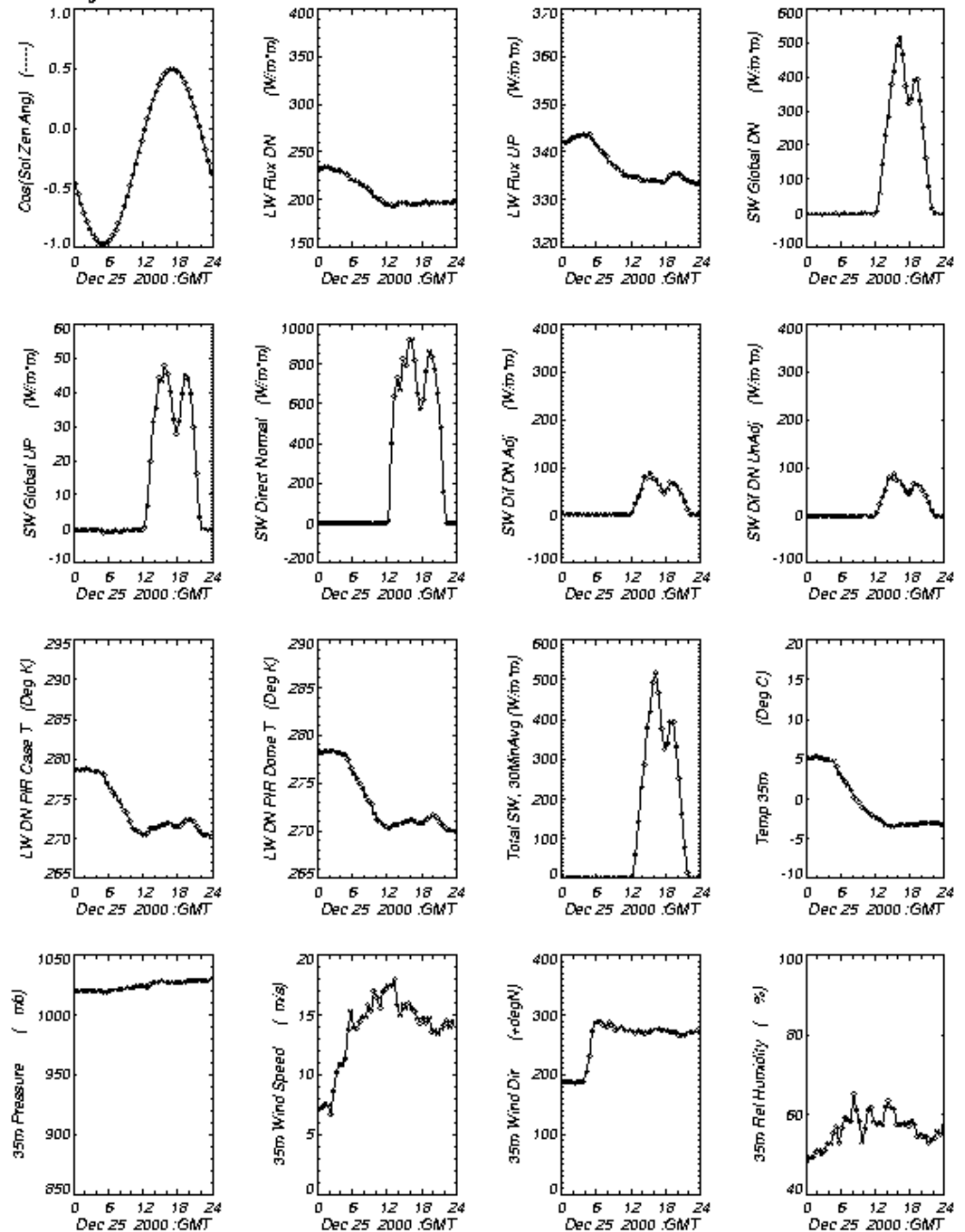
CERES TOA also plotted

Files by ftp

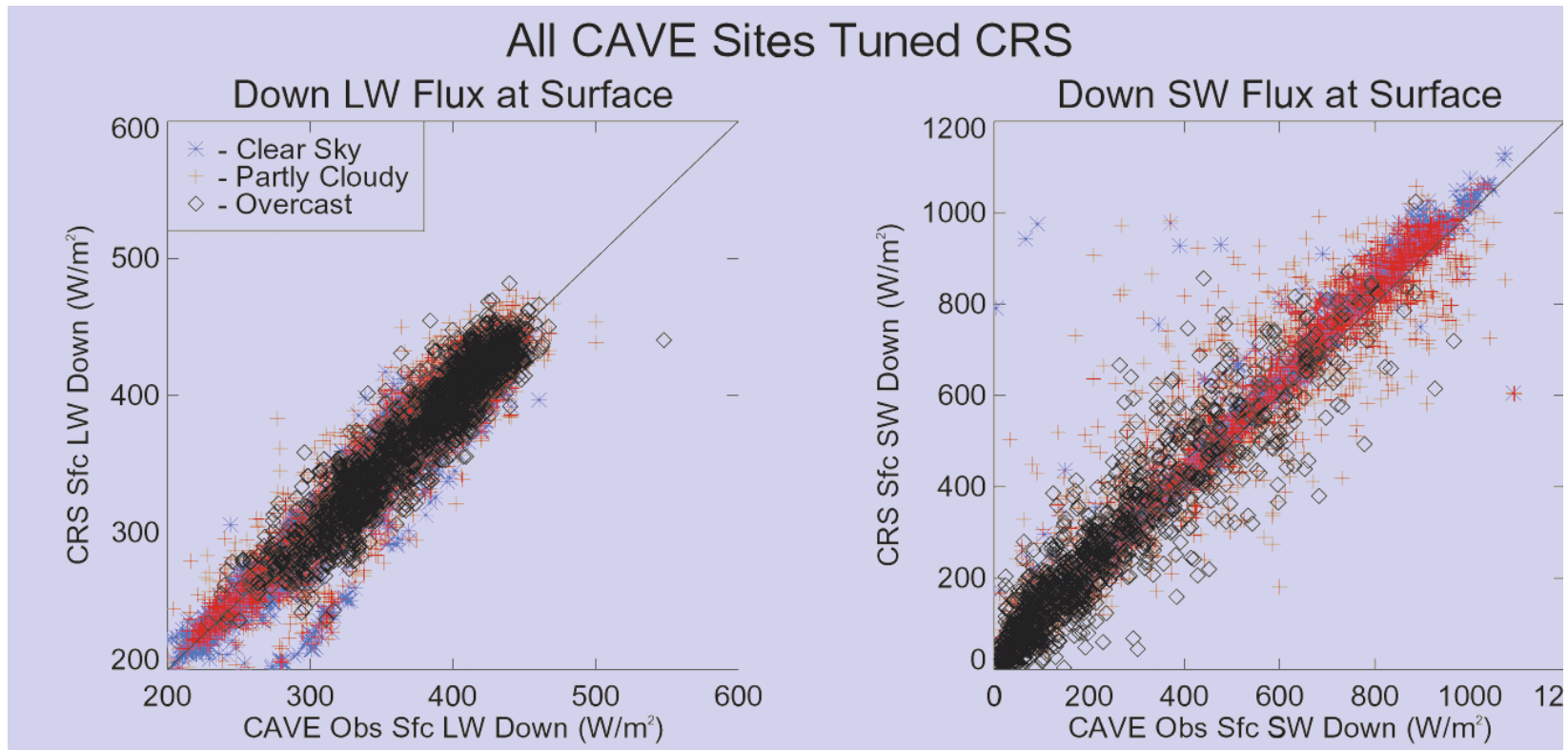
Half-hourly (30 min.) means

Record starts 1 January 1998

INDPND/larc_COV_200012_avg.v2.1
Chesapeake Lighthouse (LaRC COVE)
Day 25



www-cave.larc.nasa.gov/cave/



	Obs Mean	N	Bias Obs - CRS	RMS	Cld Forc All-Clr
ALL SKY					
LW Dn Sfc	358	8601	2	19	18
LW Up Sfc	429	6780	2	20	
SW Dn Sfc	443	4990	-34	89	-142
SW Up Sfc	91	4162	12	26	
LW Up TOA	252	9282	0	4	-24
SW Up TOA	219	5158	1	17	89

24 hour SW bias = -34/2 Wm-2

www-cave.larc.nasa.gov/cave/ select "Site Statistics"

Satellite retrieval uses NO ground radiometer data. Pyranometers corrected for IR offset.

ARM SGP E-13 Collocated with Central Facility

Obs Mean	N	Bias Obs-SARB	RMS	Cloud forcing
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ALL SKY

LW Dn Sfc	349	455	-3	18	17
LW Up Sfc	416	430	-3	16	
SW Dn Sfc	428	260	-21	60	-128
SW Up Sfc	87	260	11	20	
LW Up TOA	247	457	0	4	-27
SW Up TOA	224	258	2	10	87

24 hour SW bias
= -21/2 Wm⁻²

OVERCAST

SW Dn Sfc	243	68	-27	87	
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CLEAR VIRS

SW Dn Sfc	512	94	-23	29	Aer Forc -16/0.6
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SW/LW

CLEAR VIRS + pyranometer

SW Dn Sfc	324	17	-14	17	-12/0.5
SW direct			-5		
SW diffuse			-9		

We do not see “anomalous cloud absorption” (i.e., 25 Wm⁻² of unexplained 24-hour SW cloud forcing).

Insolation biases in clear and cloudy skies are similar.

Surface insolation measured at a point is affected by surface albedo

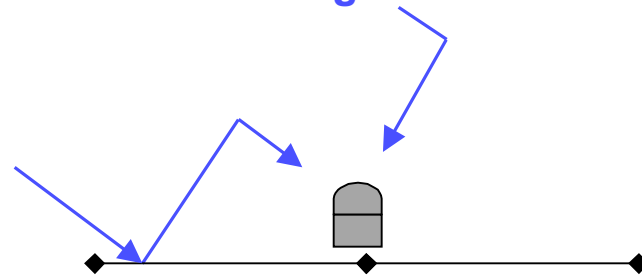
MODIS retrieves surface spectral albedo, but aerosol correction is tenuous.

Aircraft can observe spectral albedo, but aircraft radiometry is tricky.

Very low altitude: small area covered

Moderate altitude: larger area covered, but aerosol correction required.

Clear sky: surface albedo impact on insolation is usually small. Relevant albedo scale is large $\sim 10\text{km}$.

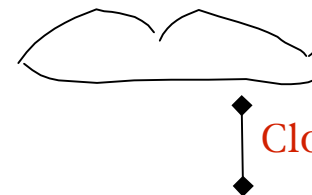
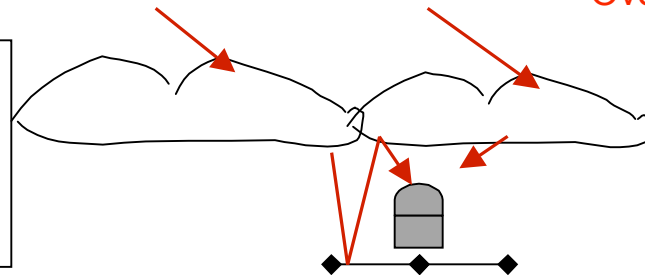


500 hPa at $\sim 6\text{km}$
50% of Rayleigh scattering to surface comes from above 5 km

Cloudy sky: surface albedo impact on insolation can be large. Relevant albedo scale is $\sim 2 \times$ cloud base height.

Overcast: $d(\text{SfcAlb}) 0.1 \sim d(\text{Ins}) 30 \text{ Wm}^{-2}$

Not a problem at COVE sea platform, where we know the surface albedo.



Cloud base 2km

Field Campaign Test of CERES at ARM SGP during August 1998

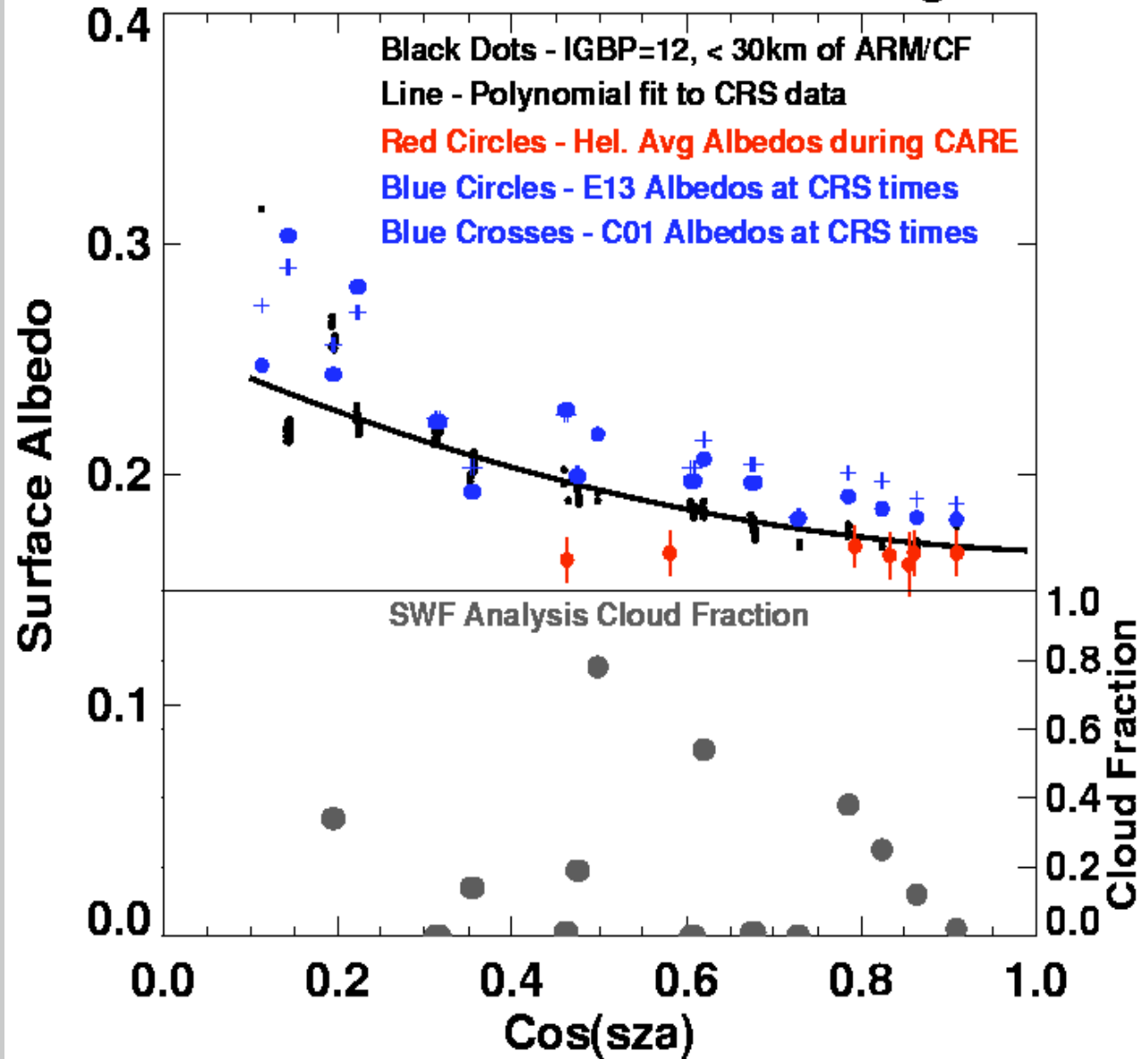
CRS Clear Surface Albedo Aug 1998

Black dots: CRS

Red dots: helicopter

Blue: 10m towers

Grey circles: clouds from time series of surface radiometers at TRMM overpass



On line surface
spectral optical
properties

Maps with point
and click to
reference optics
assumed by
CERES SARB

SW and LW
keyed to IGBP

CAVE “Useful Links”:
to CERES ARM
Rad. Exp. (CARE)
aircraft spectral
BRDF measurements

Netscape: Scene Type

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

GIF image 810x810 pixels WebMail Connections SmartUpdate h Netscape Handbook: Menu Items Welcome t

Bookmarks Location: http://snowdog.larc.nasa.gov/surf/pages/sce_type.html

CERES/SARB Surface Properties

[Surface Home](#) [IGBP Scene Type Map](#)

Maps

- [Scene Type](#)
- [Albedo](#)
- [Emissivity](#)
- [Water Map](#)
- [Digital Elev](#)

These pages explain the use of the International Geosphere/Biosphere Programme (IGBP) scene types in the CERES/SARB surface map.

The map below shows the 18 surface types used by the SARB group to identify surface properties of a given region. Scene types were delineated by IGBP. This map is determined using a 1km IGBP scene types supplied by USGS. (*) An 18th scene type (TUNDRA) is added to distinguish the rocky/barren scene of northern climes vs that of other deserts.

These scene types map the geographic region to longwave and shortwave spectral emissivity and albedo properties defined within the spectral ranges of the Fu & Liou Code. The [spectral properties page](#) has a complete description of data source.

Download a copy of this map (~2.3MB) from [here](#).

To zoom in on any area click near the desired location.

[Lookup by Lat/Lon](#)

[Download Data](#)

[Related Links](#)

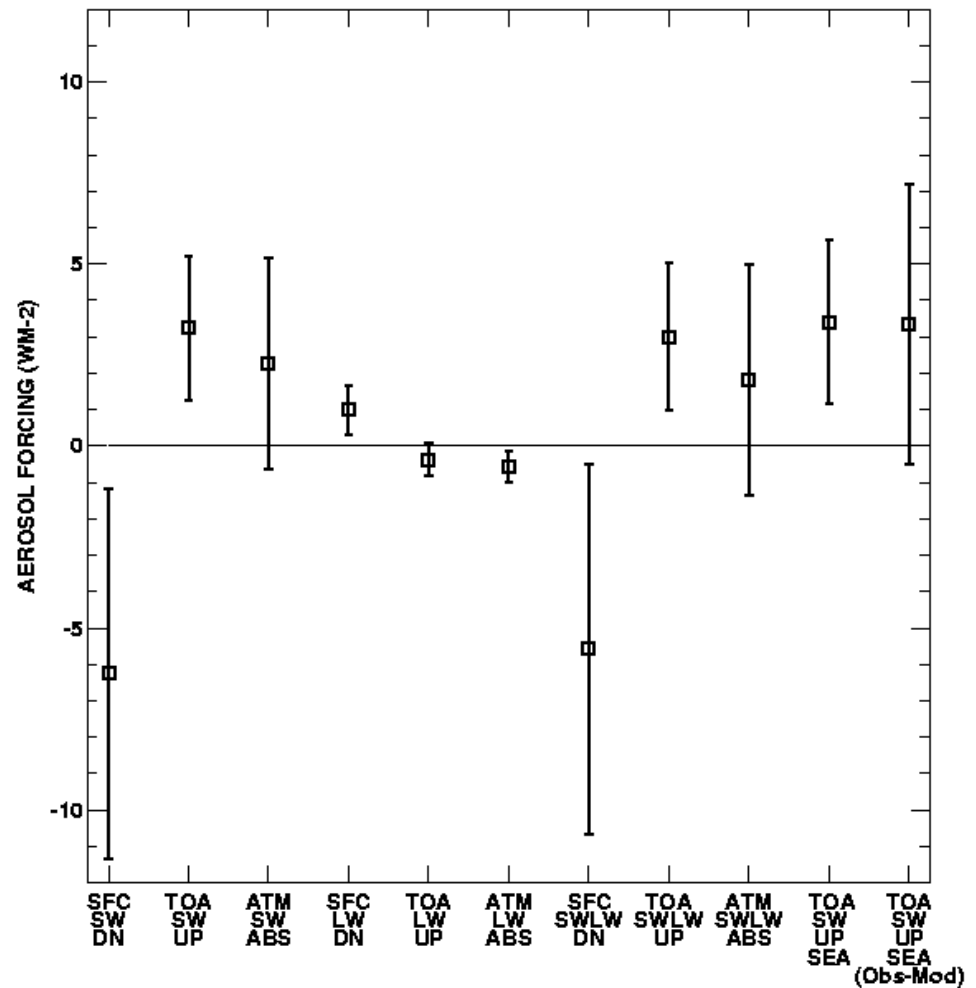
[NASA Privacy Statement](#)

*Estimate of clear sky
aerosol forcing for
April 1998*

SARB calculations

Not diurnally smoothed

Raw mean of proto-FSW



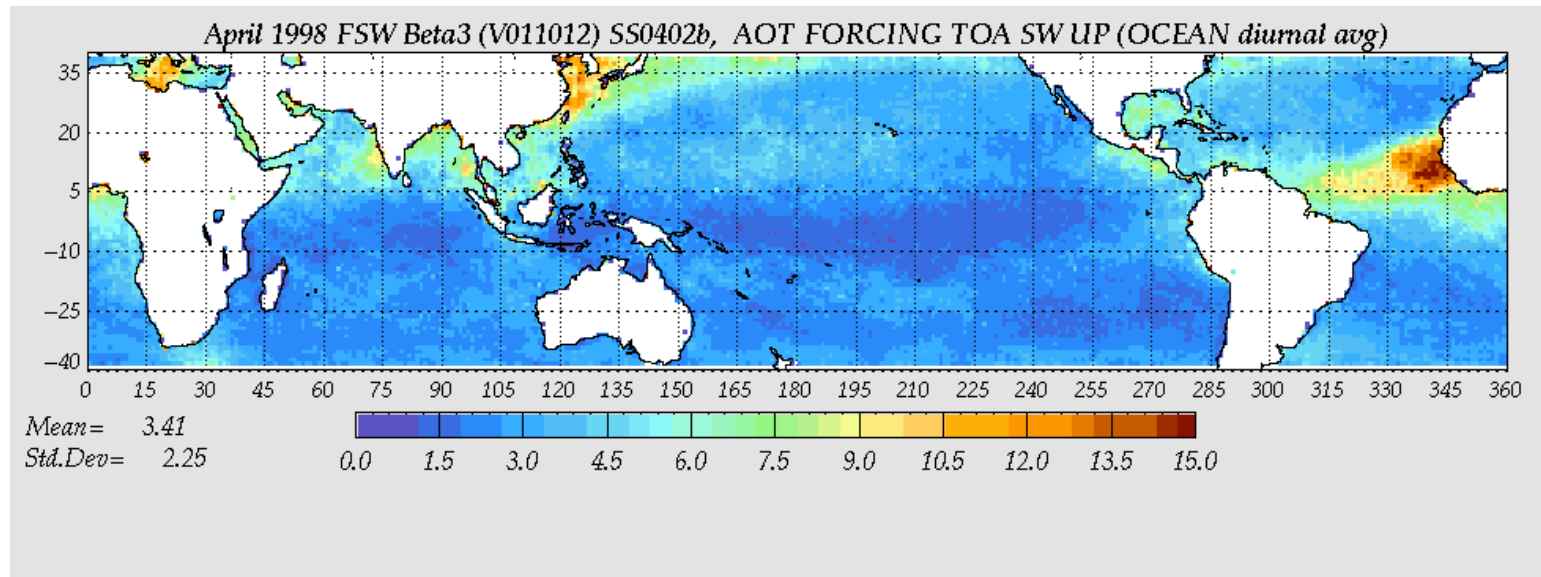
*Has more absorption than found
by Kaufmann and Dubovik*

Assignment of aerosol characteristics: Based on MATCH

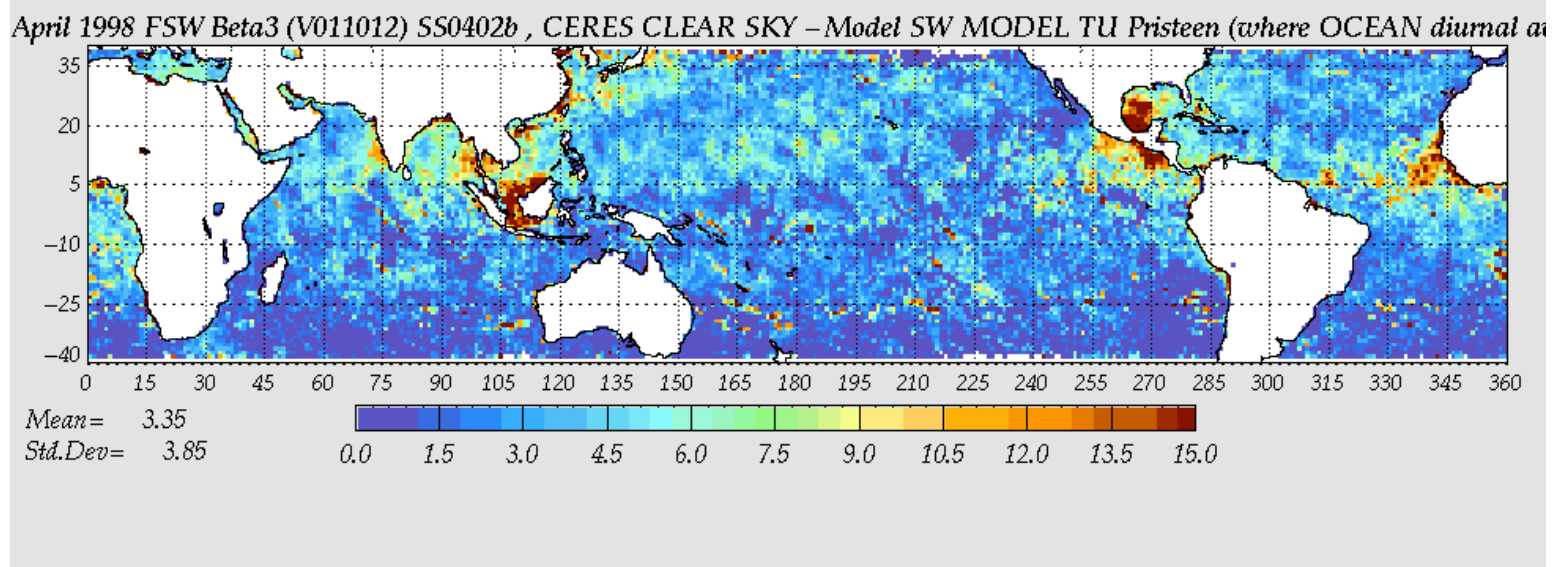
MATCH aerosol type	CRS aerosol optics	scale height
dust (0.01-1.0 um)	dust (0.5 um) Tegen-Lacis	3 km
dust (1-10 um)	dust (2.0 um) Tegen-Lacis	1 km
dust (10-20 um)	dust (2.0 um) Tegen-Lacis	1 km
dust (20-50 um)	dust (2.0 um) Tegen-Lacis	1 km
hydrophilic black carbon	soot (OPAC)	1 km
hydrophobic black carbon	soot (OPAC)	1 km
hydrophilic organic carbon	soluble organic (OPAC)	1 km
hydrophobic organic carbon	insoluble organic (OPAC)	1 km
sulfate	sulfate (OPAC)	1 km
sea salt	sea salt (OPAC)	0.5 km

Mistake: organic carbon was zeroed out (~10% of aerosol)

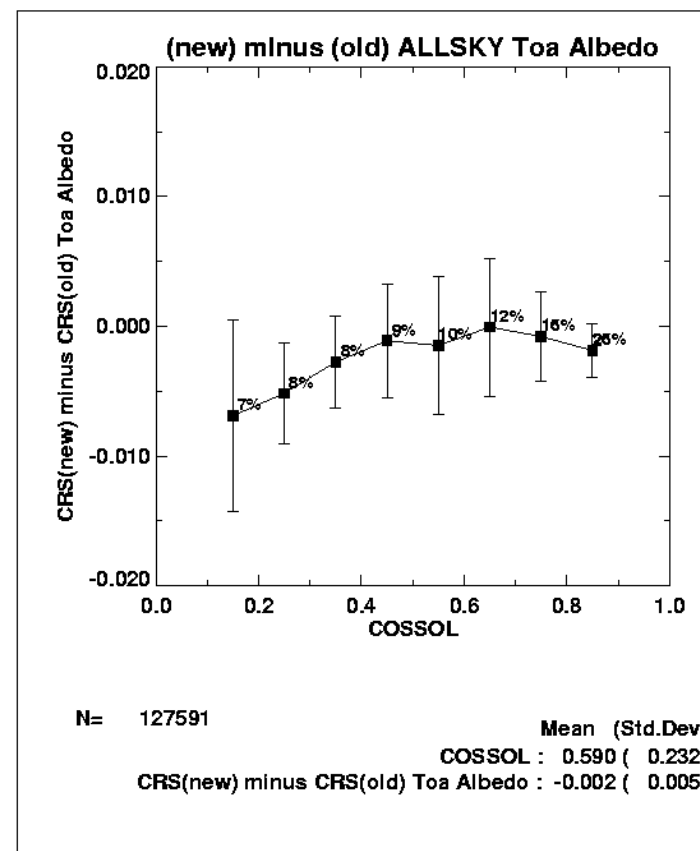
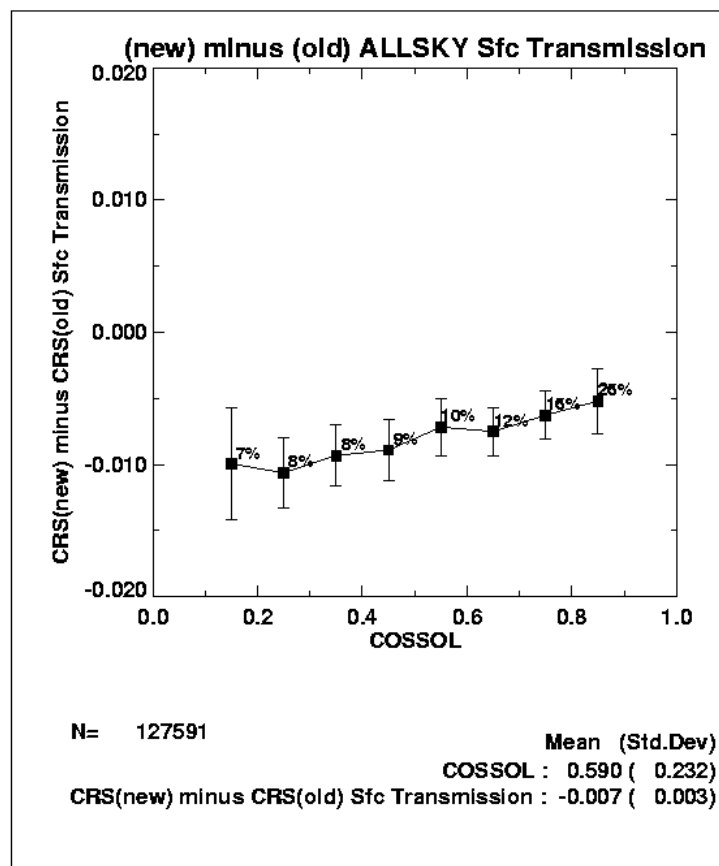
Tuned calculations: (Clear TOA SW) – (Pristine TOA SW)



(Observed SSF clear SW) – (Calculated pristine TOA SW)



NEW Langley Fu-Liou SW (H2O, O3, CO2, O2, CH4, Kato-Clothaux k's, Rose)
 OLD " " " (H2O, O3, gerry rigged insert of Chou O2, CO2)
 All CERES SARB (CRS) shown earlier used OLD code



Excuses for error in surface insolation: Old code, aerosol forcing, surface albedo, questionable measurement of diffuse insolation.

Chesapeake Lighthouse and Aircraft Measurements for Satellites (CLAMS):
 New code here, aerosols measured to death, & we know surface albedo.

FU-LIOU(0602) Forcing

- Only Aerosol Forcing
 - Only Cloud Forcing
 - Cloud + Aerosol Forcing
- PRESS ME: Compute**

Cloud Vis Optical Depth:

Cloud Level (Km):

Cloud Phase:

Cloud Particle Size (microns) Water(Re) Ice(De):

Aerosol Constituent 1

AOT(1):

Aerosol Type(1):

Scale Hgt(1) Km:

Aerosol Constituent 2

AOT(2):

Aerosol Type(2):

Scale Hgt(2) Km:

Atmosphere:

Cos Sol Zen:

Hitran 2000 SW Absorption CONTINUUM CKDv2.4

	Control	Perturbed
AEROSOL TAU(s)	9.999999776E-3	0.100000001
AEROSOL TYPE(s)	SOOT	8.0_dust
Input Cloud Vis Optical Depth	10.	
ICE Water Content	0.187169656	
ICE Particle Size(microns)	46.315197	
Cloud Level (km)	5	

On line Fu-Liou radiative transfer

	Shortwave						
	TOA			SURFACE			
	Control	Perturbed	Forced	Control	Perturbed	Forced	
Up	146.5	667.4	521.0	106.8	36.8	-70.0	
Down	1368.3	1368.3	0.0	1067.8	368.3	-699.5	
NET	1221.8	700.9	-521.0	961.0	331.5	-629.6	
ALBEDO	0.107	0.488	0.381	0.100	0.100	0.000	
Direct				1011.6	5.5	-1006.1	
Diffuse				56.2	362.7	306.6	
	Longwave						
Up	280.1	232.6	-47.5	423.3	423.4	0.0	
Down	0.0	0.0	0.0	349.8	397.1	47.3	
NET	-280.1	-232.6	47.5	-73.5	-26.3	47.2	

Window Flux: 105.02 69.57 35.45
 LW radiance: 93.65 76.51 17.14
 Flt Window radiance: 20.63 13.26 7.37
 Nadir anisotropy: 1.05 1.03

Top of Atmosphere Fractional SW in 15 bands

0.001	0.001	0.005	0.005	0.011	0.025	0.080	0.088	0.133	0.112	0.356	0.112	0.037	0.029	0.004
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Surface Fractional SW in 15 bands

0.000	0.000	0.000	0.000	0.005	0.029	0.101	0.115	0.174	0.151	0.393	0.025	0.007	0.000	0.000
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Top of Atmosphere Spectral Albedo in 15 bands

0.011	0.003	0.002	0.003	0.114	0.618	0.644	0.627	0.582	0.582	0.180	0.128	0.006	0.032	
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	--

Surface Spectral Albedo in 15 bands

-9.999	-9.999	-9.999	-9.999	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	-9.999	-9.999
--------	--------	--------	--------	-------	-------	-------	-------	-------	-------	-------	-------	-------	--------	--------

368.288 211.545 156.744 0.944

Flux Profiles

Pressure (hPa)	swdn(c)	swdn(p)	swup(c)	swup(p)	lwdn(c)	lwdn(p)	lwup(c)	lwup(p)
0.0	1368.3	1368.3	146.5	667.4	0.0	0.0	280.1	232.6
0.1	1368.1	1368.1	146.4	667.4	0.0	0.0	280.1	232.6

SW uses HITRAN 2000 (Rose-Kato)

Netscape: COART (Coupled Ocean Atmosphere Radiative Transfer Model)

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Bookmarks Location: <http://snowdog.larc.nasa.gov/jin/rtset.html>

Coupled Ocean and Atmosphere Radiative Transfer (COART)

This is a tool for you to calculate the radiances and irradiances (flux) at any levels in the atmosphere and ocean. Specify the input parameters simply by clicking the buttons and changing the default numbers in the table. [More information here.](#)

Select calculation type and Output levels:

Spectral fluxes (irradiances) (up and down) ($W/m^2/\mu m$) at a single wavelength (μm)

Spectral fluxes ($W/m^2/\mu m$) at multiple wavelengths from μm to μm at every μm .

Integrated fluxes (W/m^2) from to μm in Spectral resolution of μm . Filter: Flat(No filter) ▾

Broadband shortwave (0.25–4.0 μm) fluxes (W/m^2). (It is under working, not implemented yet!)

Radiances ($W/m^2/\mu m/Sr$) at wavelength (μm).

Radiances ($W/m^2/\mu m/Sr$) at multiple wavelengths from μm to μm at every μm .

? Want to include the Water-leaving radiance output? yes no

Radiance output directions: at Zenith (deg) OR All computational zenith angles;

Azimuth (deg) OR at every (deg) from to

*Note: Computation time is not related to the number of output angles here. [How the angles are defined?](#)

Output at: TOA, Surface, km above surface, and (m) below surface; OR All levels in atmosphere.

Solar Zenith Angle Calculations

Julian Day: GMT (hour): Latitude (degs N): Longitude (degs E):

When checked, ignore Time and Location above and input your Solar Zenith Angle (deg):

Atmosphere

Select an atmospheric model ▾

When checked, use reduced number of atmospheric layers to save computation time ([not recommended for UV](#)).

100% of 17K (at 259 bytes/sec)

*On line Coupled
Ocean Atmosphere
Radiative Transfer
(Zhonghai Jin)*

*SW spectral
radiances
and fluxes*

Netscape: COART (Coupled Ocean Atmosphere Radiative Transfer Model)

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Bookmarks Location: <http://snowdog.larc.nasa.gov/jin/rtset.html>

When checked, use reduced number of atmospheric layers to save computation time ([not recommended for UV](#)).

When checked, input your **total integrated precipitable water (g/cm²)**:

When checked, input your **integrated ozone amount (atm-cm)**: (1 atm-cm=1000 Dobson)

You can also **change these trace gas amounts** by a factor (1.0 for no change) of --> CO₂: CH₄:

Select **Mixed layer aerosol**: and **Stratospheric aerosol**:

Select a method to specify aerosol loading:

by **Visibility (km)**: by **AOT at 0.5um**: by **AOT at 0.55um**:

When checked, input aerosol optical properties in the table below (not required to fill all elements, undefined numbers will be fit in by the selected model above):

λ (um):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
AOT:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
SSA:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
g:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Ocean

Wind speed(m/s): Depth (m): Bottom albedo: Chl (mg/m³): (Chlorophyll)

Particle scattering coefficient (m⁻¹): $b_p(\lambda) = b_0(550/\lambda)^n [Chl]^k$; Input b_0 : n : and k :

Particle scattering **phase function** If use F-F func., input bb/b :

When checked, input absorption a (m⁻¹): (Override the default parameterization)

When checked, input your a_{440DOM} (m⁻¹): (DOM absorption coefficient at 440nm)

When checked, ignore surface roughness and assume **Flat ocean surface**.

.... Not clear on some input? Read "The Input" section [Here](#)

Just submitted and got CONVERGENCE problem? then try and resubmit.

For comments/questions contact *Zhonghai Jin*: Z.JIN@larc.nasa.gov, but to read this [NOTE](#) first may help you.

88% of 17K (stalled)

On line Coupled Ocean Atmosphere Radiative Transfer

Select aerosol optical properties

Select wind speed chlorophyll phase function

COVE

CERES Ocean Validation Experiment

Rigid sea platform
Continuous
Long-term
Well calibrated
AERONET aerosol
NOAA wind and waves
BSRN surface radiation
looks DOWN at sea

At COVE:
SW up (time mean)
approximately equals
SW up (space mean)

Various short/medium
term measurements:
SP1A for upwelling
SW spectral radiance
Ocean optics (ODU)

Netscape: CERES Surface & Airborne Radiometry & Calibration Group Homepage

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Bookmarks Location: <http://www-svg.larc.nasa.gov/test/>



**CERES Surface +
Airborne
Radiometry &
Calibration
Group**



**CERES Surface & Airborne Radiometry
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Page Last Modified:
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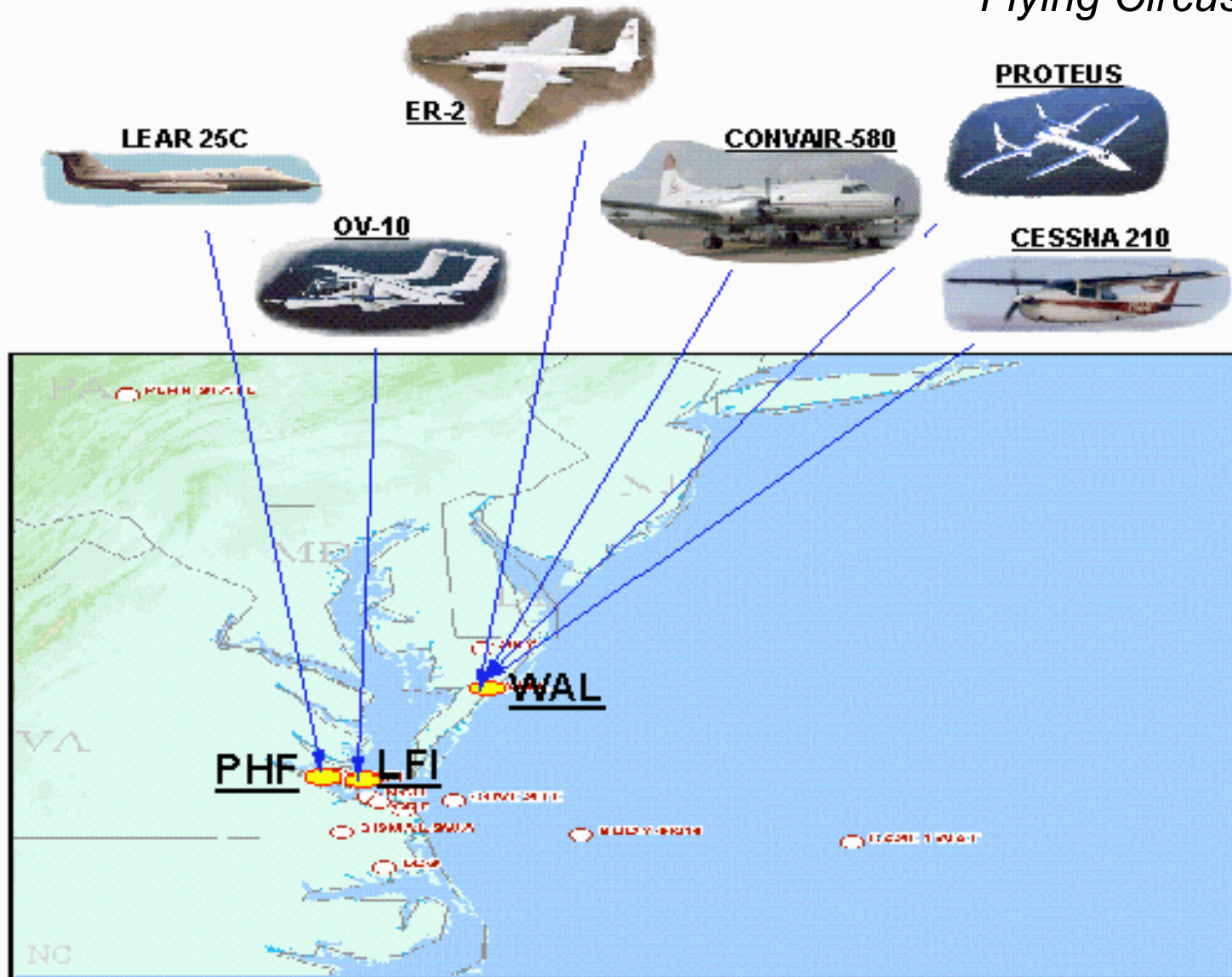
100%

CLAMS: Chesapeake Lighthouse and Aircraft Measurements for Satellites

July 2001 CERES-MODIS-MISR-GACP

CLAMS Participating Aircraft

(Bill Smith Jr.'s Flying Circus)



CLAMS: The acid test bed for aerosol remote sensing over ocean

ER-2: MODIS Airborne Simulator and AirMISR for near TOA BRDF

CV-580: AATS-14 AOT in situ aerosol CAR BRDF

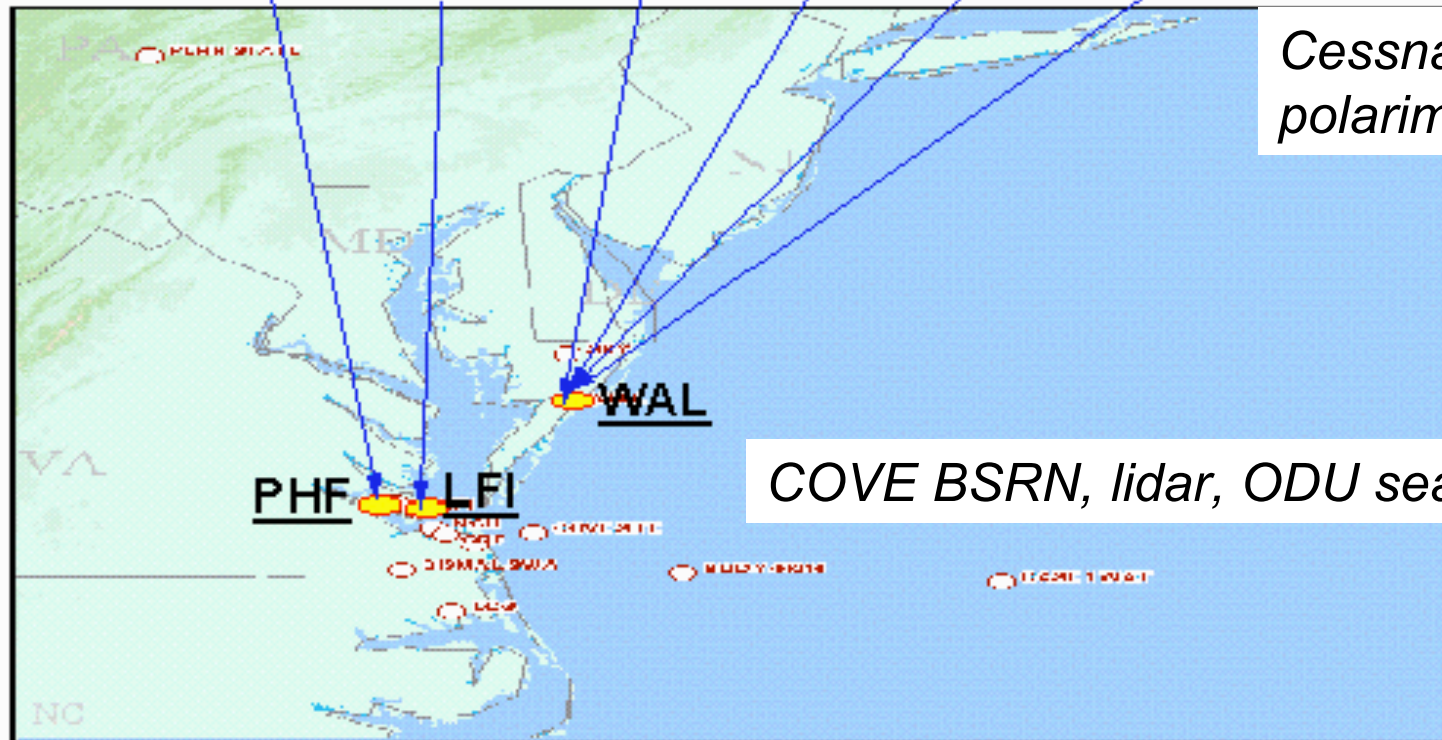
OV-10: low level broadband & spectral flux

Learjet O2 A band



Proteus: LW FTS for aerosol IR

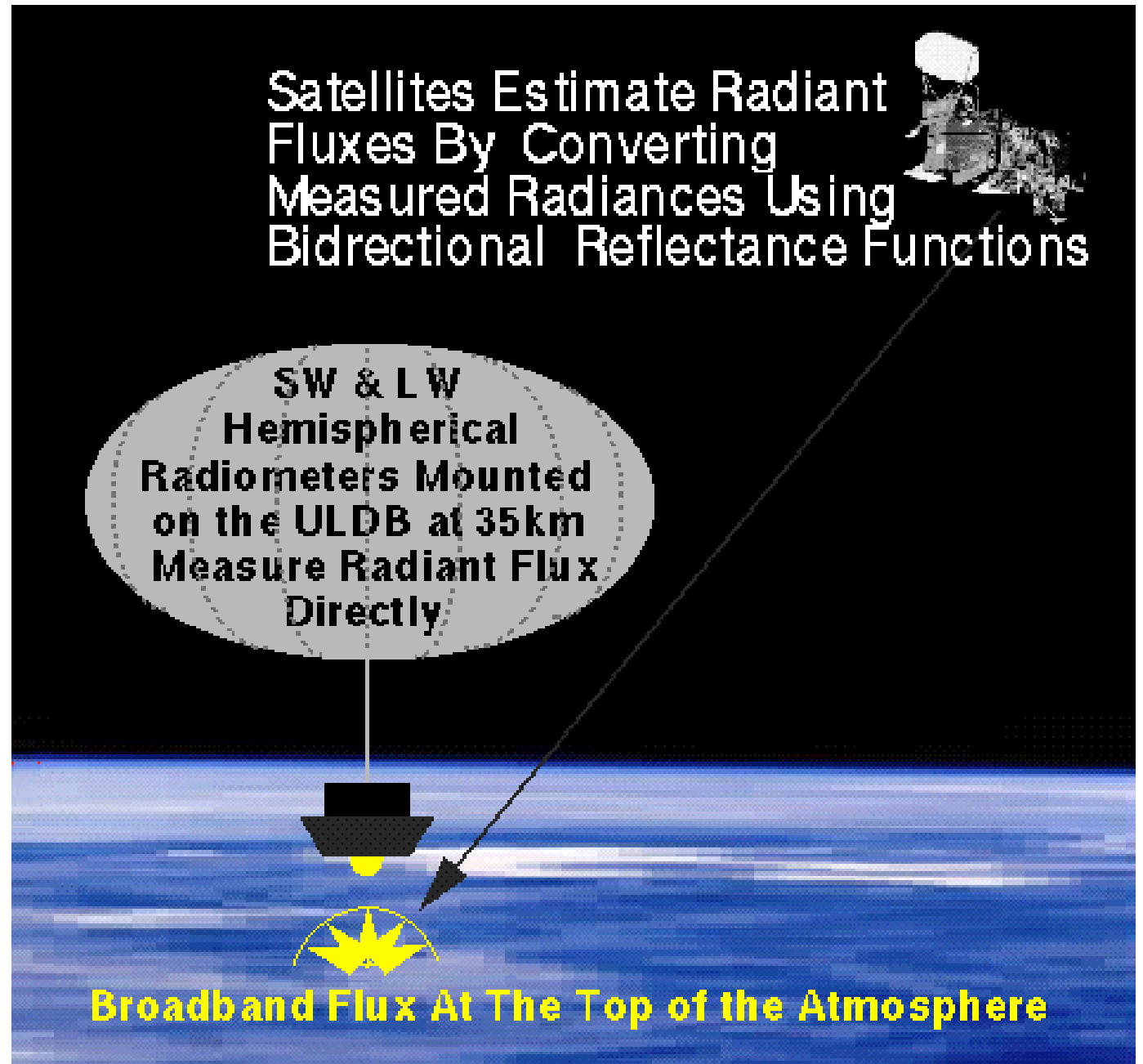
Cessna: polarimeter



COVE BSRN, lidar, ODU sea optics

Click "Balloon"
from CAVE URL

Wenying Su's
deployment of
Haeffelin
modified
radiometers



Launch scheduled this week from Alice Springs, Australia