RRTM in NCEP GFS and CFS

Shi-Keng Yang, Yu-Tai Hou, Peitao Peng and Craig Long

CERES Science Team Meeting

Newport News, VA 4/24-26/07

Operational NCEP GFS and CFS

- ***Global Forecast System, GFS,***

  an atmospheric assimilation and forecast system:
  T382L64 (~35km horizontal resolution) for 0-180hr

  T190L64 for 180-384hr

  Radiation: Chou-SW, RRTM-LW

- ***Climate Forecast System, CFS***

  an ocean-atmosphere coupled assimilatn & fcst sys:

  T62L64 (~200km horizontal res) twice/day --> 9m fcst

  Radiation: Chou-SW, GFDL-Fels LW

Toward new CFS implementation 2010

- **Two main components:**
- **CFS Reanalysis (1979-2007)**
- **CFS Retrospective Forecasts (1981-2007)**

Saha and Pan, 2006

Components

1. Analysis Systems : GSI, GODAS, GLDAS

2. Atmospheric Model : GFS

3. Ocean Model : MOM4

Saha and Pan, 2006

CURRENT OPERATIONAL VERSION OF THE GFS (USED FOR WEATHER PREDICTION)

UPGRADES TO THE CFS VERSION

RRTM long wave radiation (clouds are maximum random, which leads to reduced cloud cover)

ESMF Version

NRL Based Ozone Climatology for Production and destruction

Saha and Pan, 2006

Planned CFS configuration

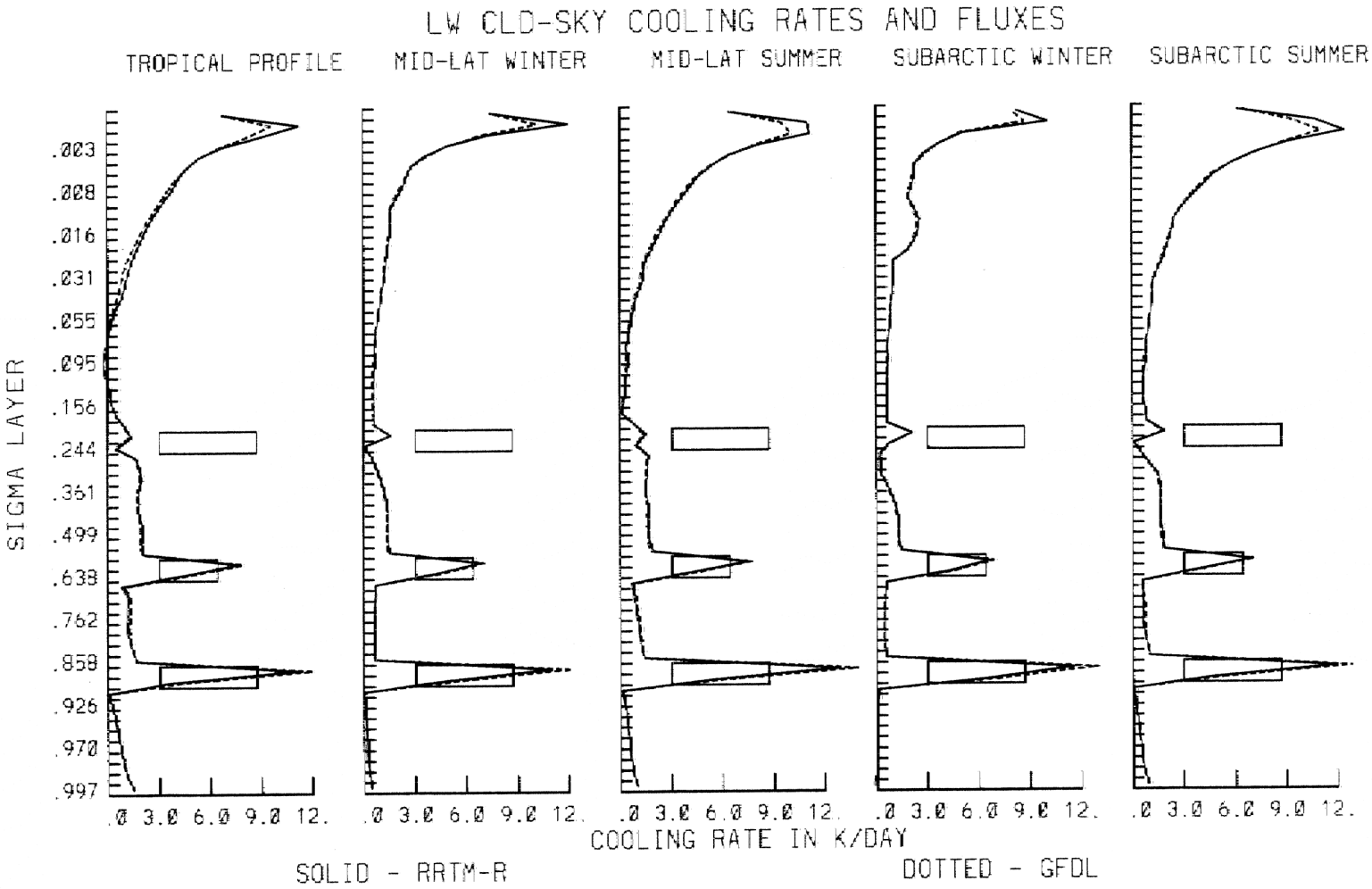
1. Analysis at T254L64 and forecast at T126L62
2. Two runs per day to 12 months and two runs per day to 60 days
3. For ‘monthly’ forecasts, there should be 28 members per week
4. For seasonal forecasts, the ensemble size will remain the same
5. The analysis will have a one-day delay vs the current seven-day delay

RRTM & GFDL LW Computation Efficiency

Time used for 300-Column Computation, in sec.

Number of Layer	*GFDL*	*RRTM*
L28	.369	.412
L42	.718	.602
L64	1.538	.880

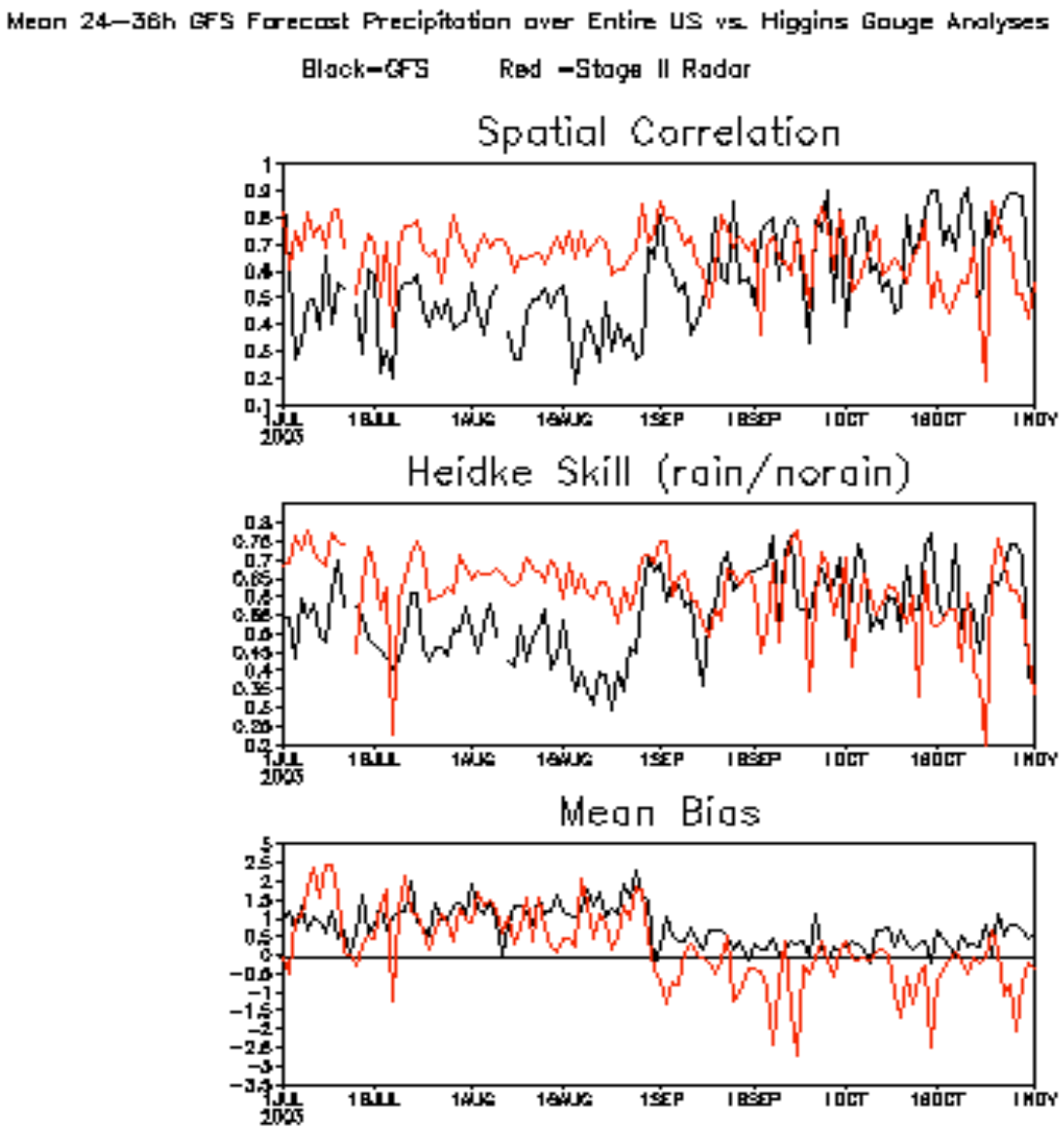
RRTM Cooling Rates on McClatchey Profiles



Fluxes Accuracy

1985-1989 AMIP AVG	*GFDL L64*	*RRTM L64*	*ERBE*
Jan	241.1	235.9	232.5
Apr	242.6	237.5	234.5
Jul	247.9	243.0	239.4
Oct	241.1	235.9	235.3

Improvement in Precipitation



J. Janowiak

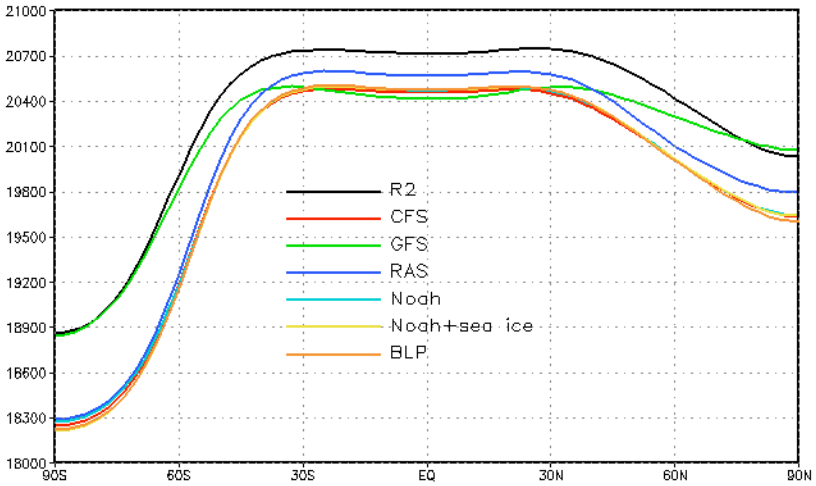
Impacts of RRTM on GFS

- **Alleviate cold bias in the lower troposphere**
- **Reduces TOA OLR bias**
- **Improvement in GFS Precipitation**
- **Colder stratosphere**
- **Some satellite retrieval issues created**

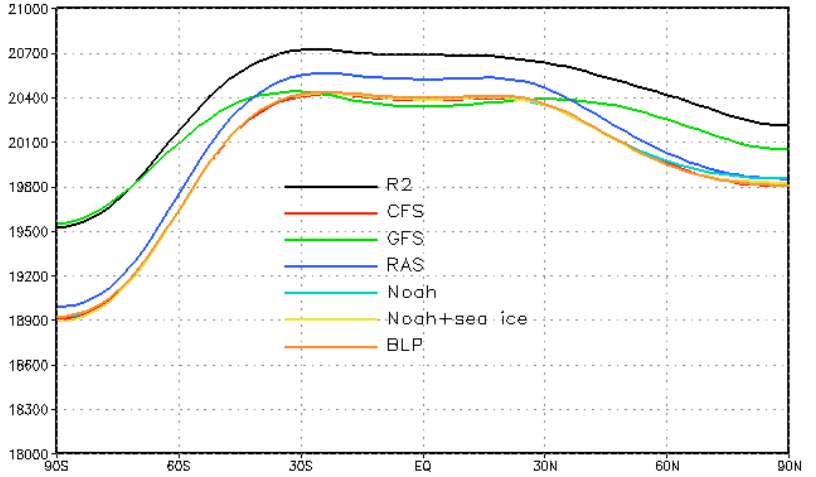
CFS Experiments

- T62 w/ RRTM LW – Climate Mode
- T382 w/ RRTM LW – Hurricane Mode

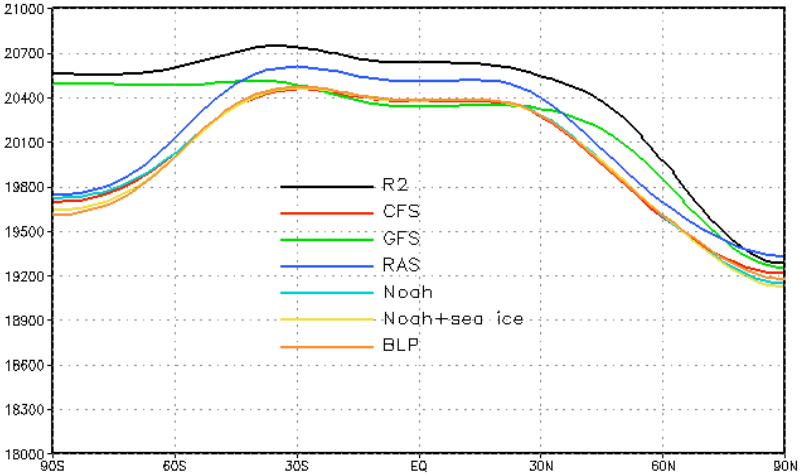
Z50 SON Zonal Mean CLIM: R2 vs CMIP



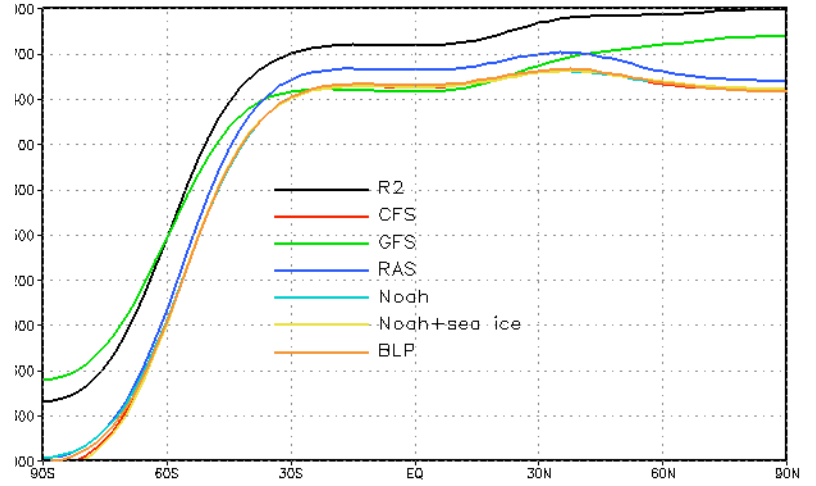
Z50 MAM Zonal Mean CLIM: R2 vs CMIP

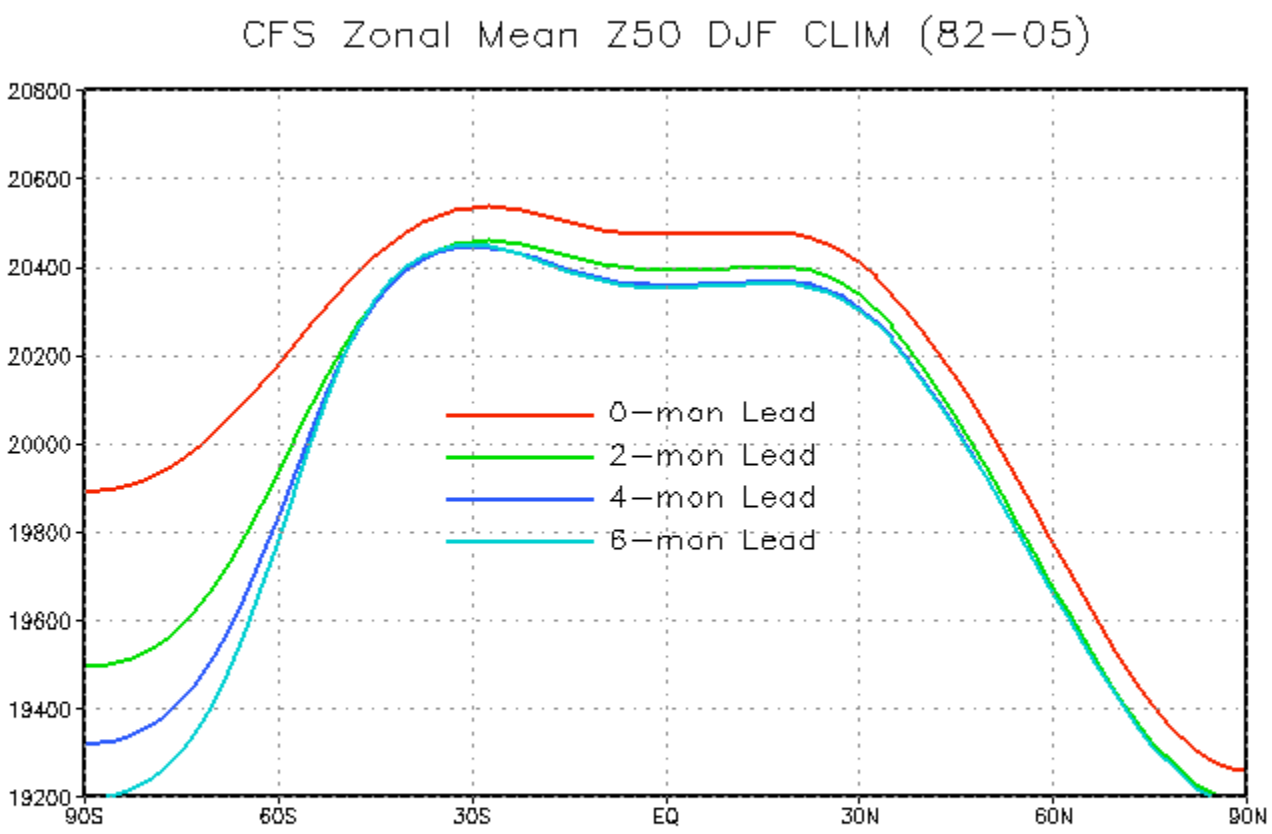


Z50 DJF Zonal Mean CLIM: R2 vs CMIP



Z50 JJA Zonal Mean CLIM: R2 vs CMIP

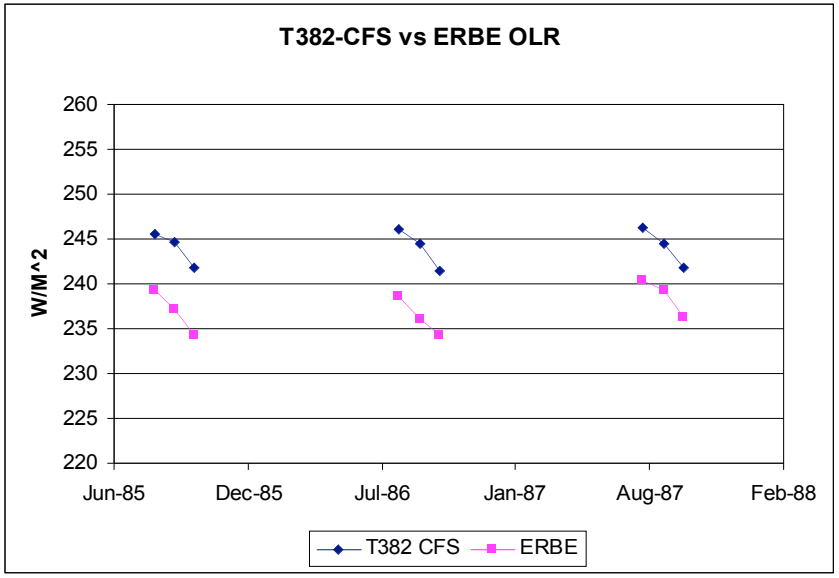


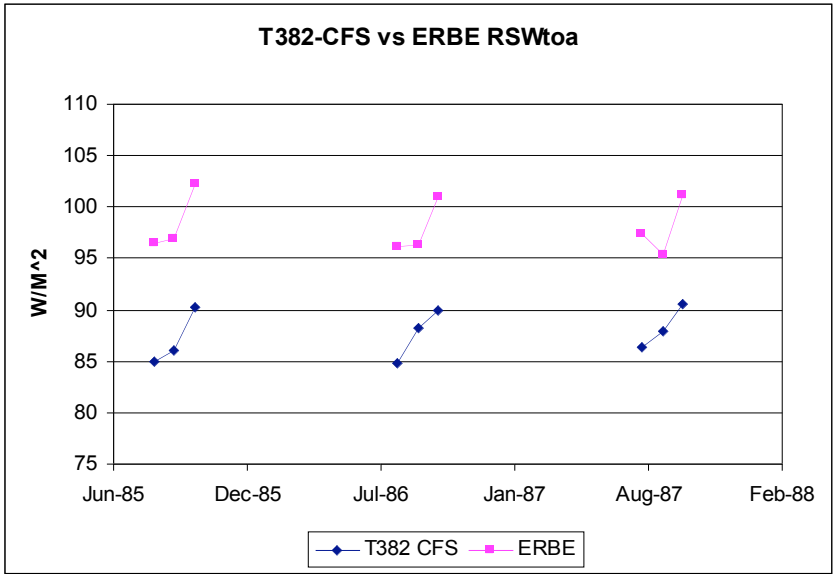

CFS Zonal Mean Z50 DJF CLIM (82-05)
20800
20600
20400
20200
20000
19800
19600
19400
19200
90S
60S
30S
EQ
30N
60N
90N
0-mon Lead
2-mon Lead
4-mon Lead
6-mon Lead

CFS Experiments

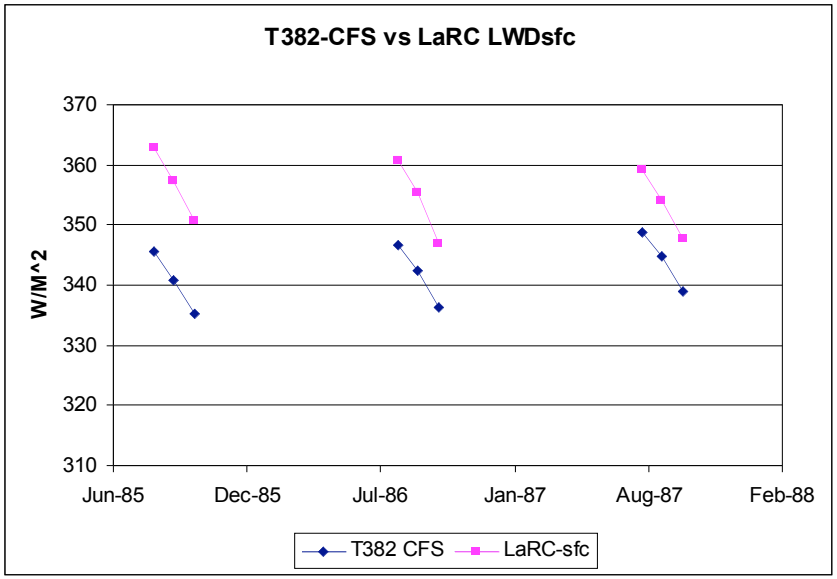
- T62 w/ RRTM LW – Climate Mode
- T382 w/ RRTM LW – Hurricane Mode

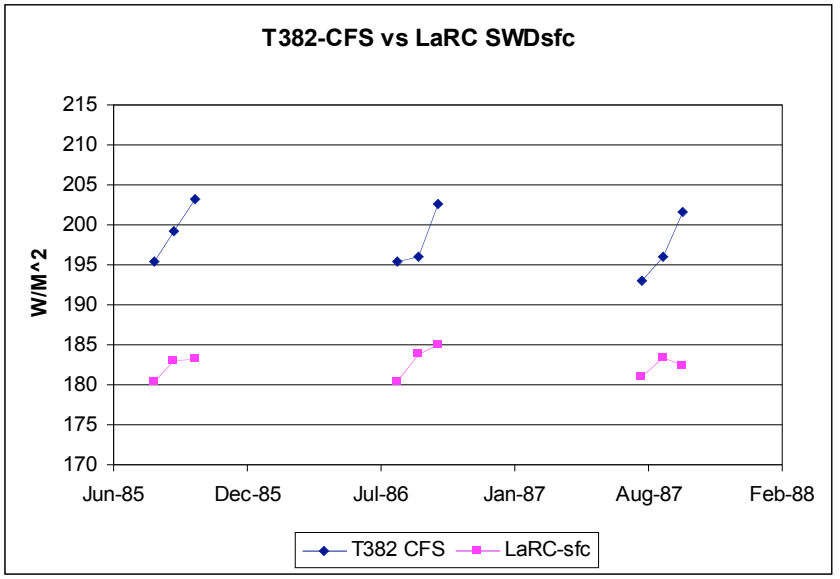
TOA OLR and RSW
T382 2~5-month fcst vs ERBE





Surface DLR and DSW
T382 2~5-month fcst vs ERBE





CFS T382 w/ Chou SW & RRTM LW

Comparison of May 1985 global means between AMIP and ERBE/LaRC - Surface Radiation Budget Dataset

	TOA OLR	TOA RSW	Sfc dw LW	Sfc dw SW
CFS T382	243.1	86.9	339.2	199.8
ERBE/LaRC sfc	234.9	101.9	352.4	185.6
Diff	8.2	-15.0	-13.2	-14.2

in W/M^2

GFS AMIP with Fels/Sch LW Code

Comparison of 1985~1989 4 -year global means between AMIP and ERBE/LaRC - Surface Radiation Budget Dataset

	TOA OLR	TOA RSW	Sfc dw LW	Sfc dw SW
CDAS R-1	237.3	115.6	333.2	207.0
AMIP	245.5	87.4	325.5	211.2
ERBE/LaRC sfc	235.3	102.7	348.3	184.3
Diff	10.2	-15.3	-22.8	26.8

in W/M^2

Toward CFS Reanalysis-Status

- At TOA: Darker and Warmer
- At SFC: Brighter and Colder
- Better Stratosphere in analysis, not forecast
- T2M improved compared to the operationl
- 5-member Ensemble T62 is as accurate