Surface Flux Estimations over Tropical Oceans Using TRMM Data

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Outline

Background

4DDA model results:

~40W/m^2 heat transport over land

Method: TRMM satellite

SW & LW : Model B of CERES SSF

Gupta et al. (2001); Gupta et al. (1992)

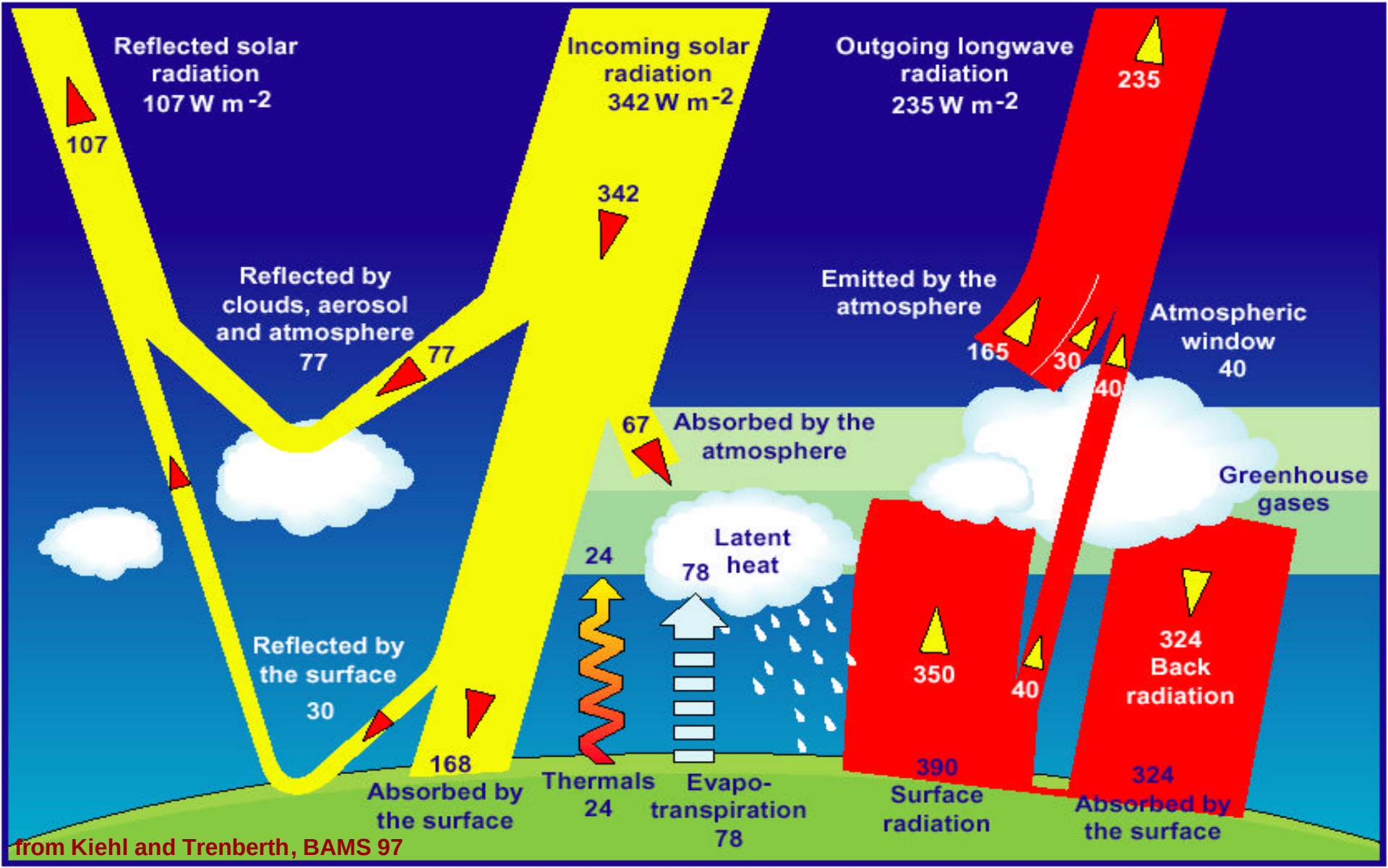
bulk formula: SST, Qa, WS,

Ts – Ta, Qs - Qa, WS_{AIR} - WS_{OCEAN}

TOGA COARE algorithm

3. **Results**
4. **Summary**

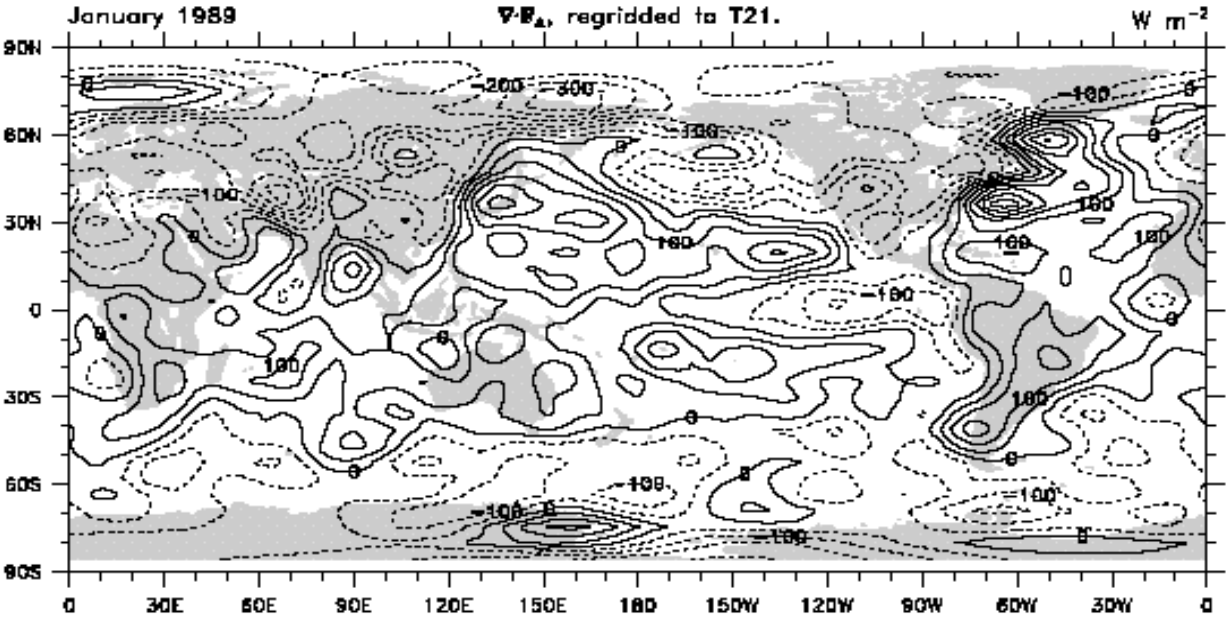
The Energy Cycle:

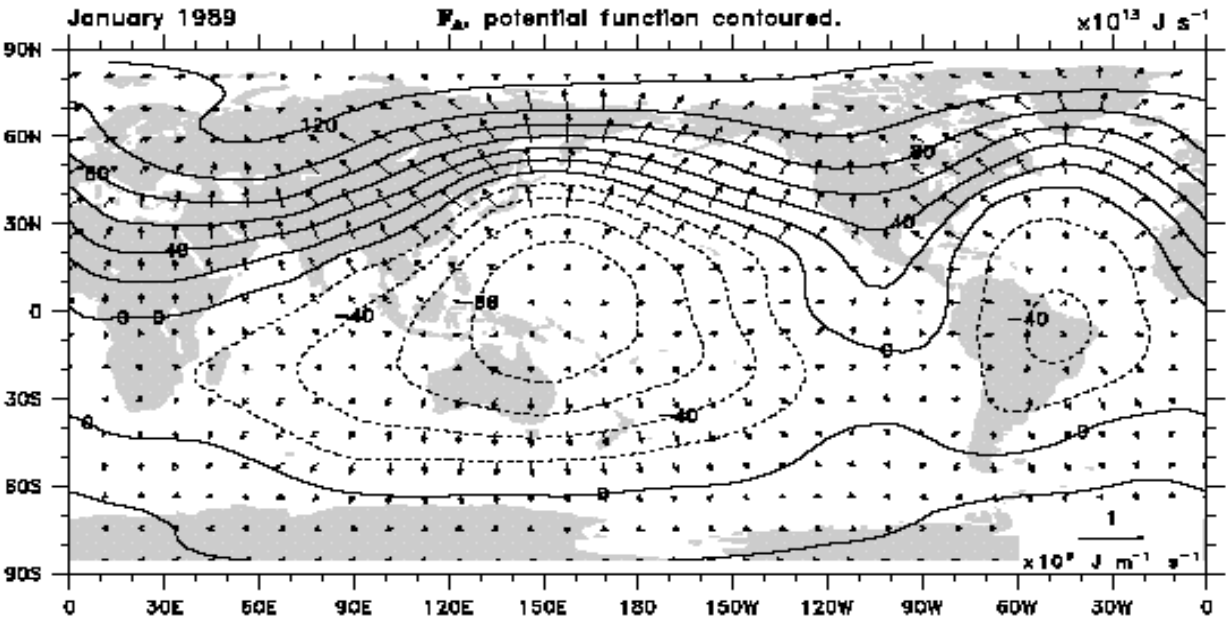


Atmospheric Energy Transport

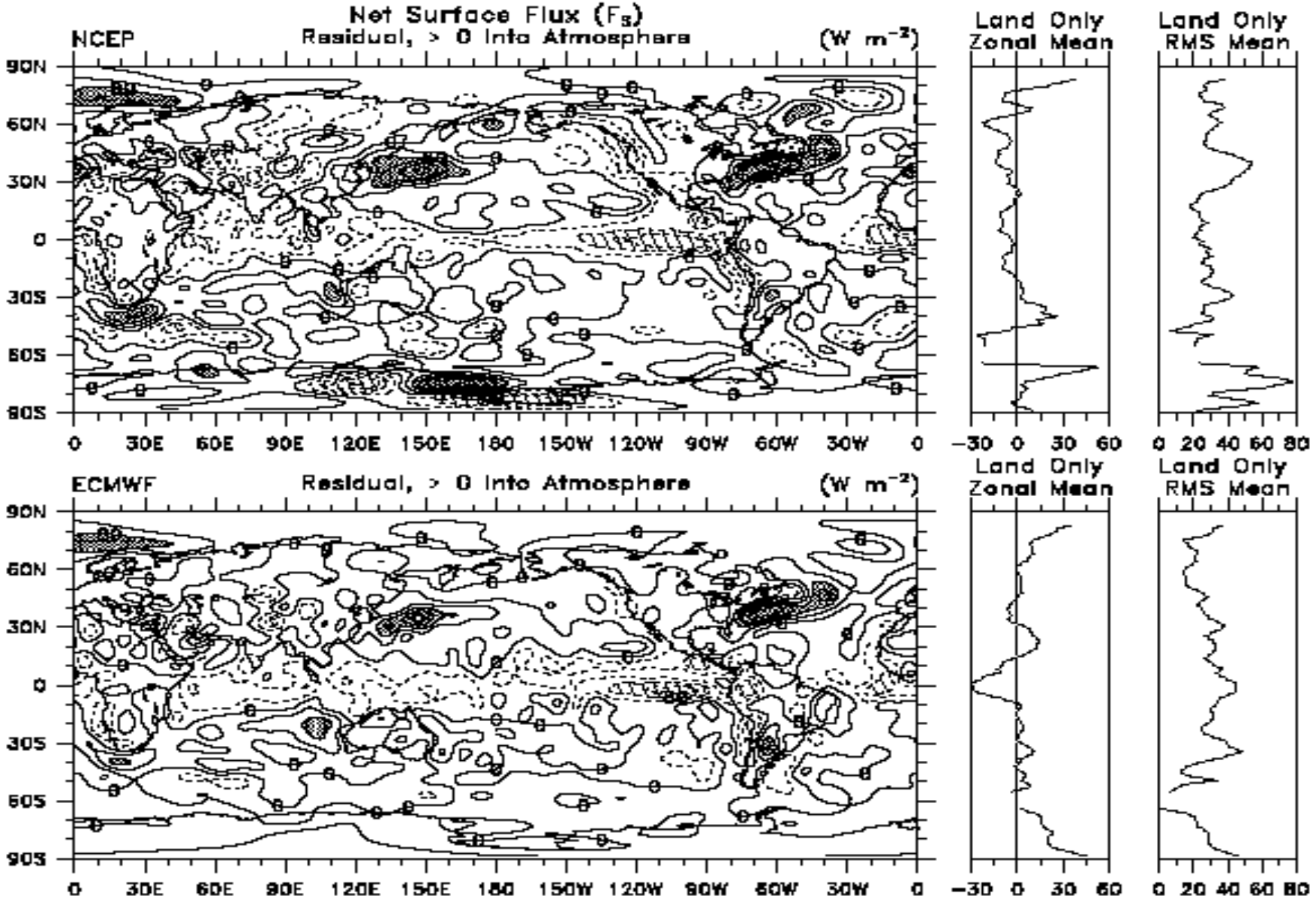
$\nabla \bullet \mathbf{F}_A = R_T + F_S$

$\mathbf{F}_A = g^{-1} \int (h+k) v dp$





Energy Balance over Land



retrieval method

surface radiation: model B of CERES SSF

SW : Gupta et al. (2001); LW : Gupta et al. (1992)

surface turbulence: bulk formula: SST, Qa, WS

Ts - Ta, Qs - Qa, WS_{AIR} - WS_{OCEAN}

TOGA COARE algorithm (Fairall et al. 1996)

$$H_{LAT} = \rho L C_L (Ua-Us)(Qs - Qa) \quad (1a)$$

$$H_{SEN} = \rho C_P C_S (Ua-Us)(Ts- Ta) \quad (1b)$$

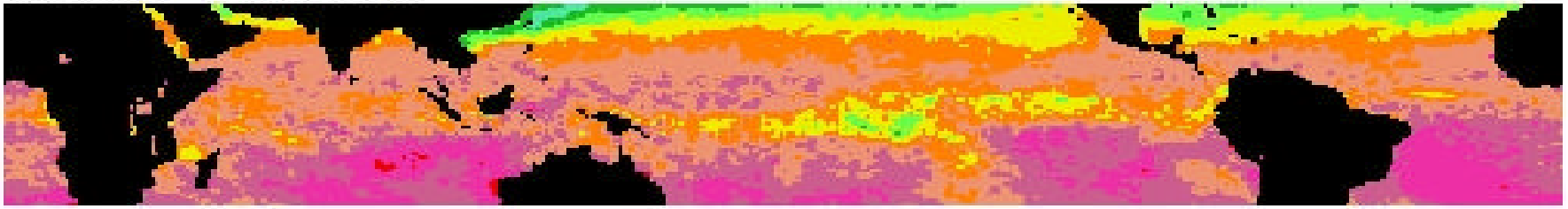
$$NSF = H_{SW} + H_{LW} - H_{LAT} - H_{SEN} \quad (2)$$

data analysis:

CERES – surface radiation; TMI – bulk parameters

CERES sfc SW

980101–980228



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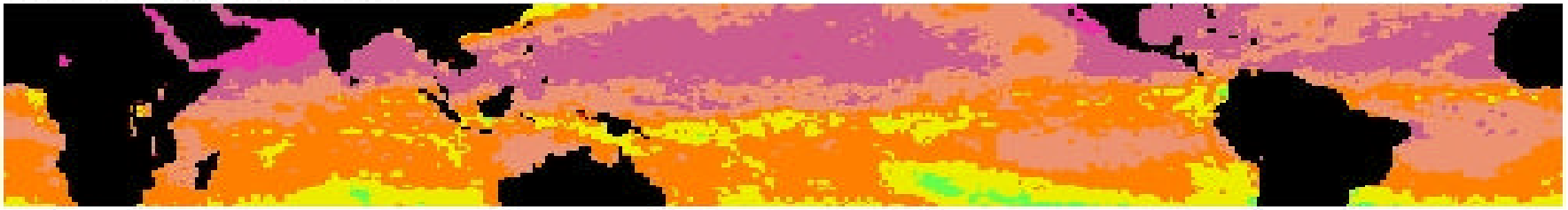

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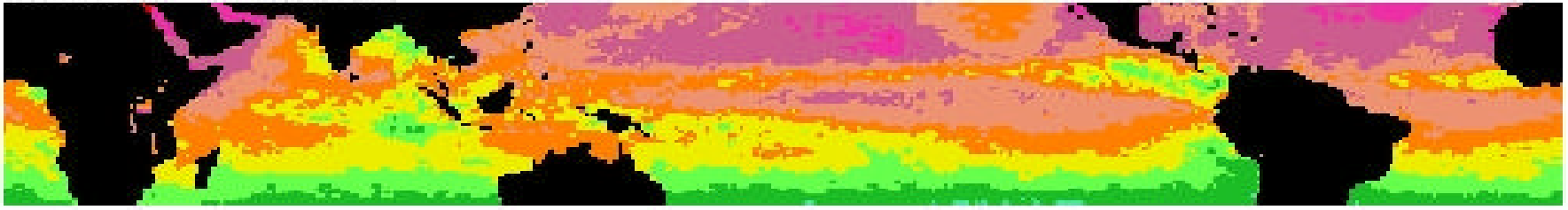

CERES sfc LW

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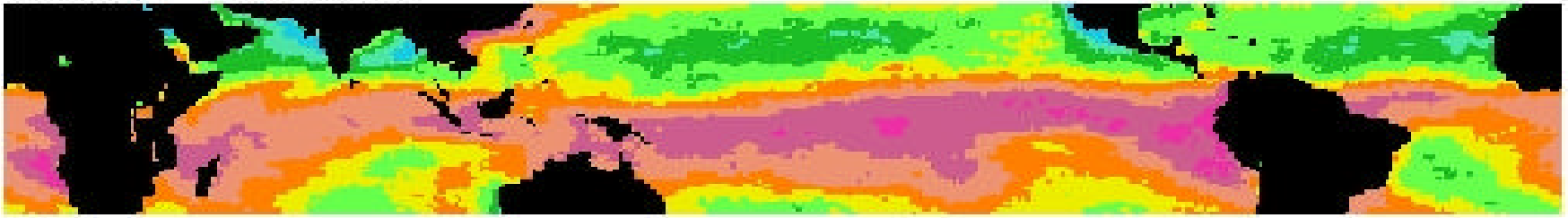

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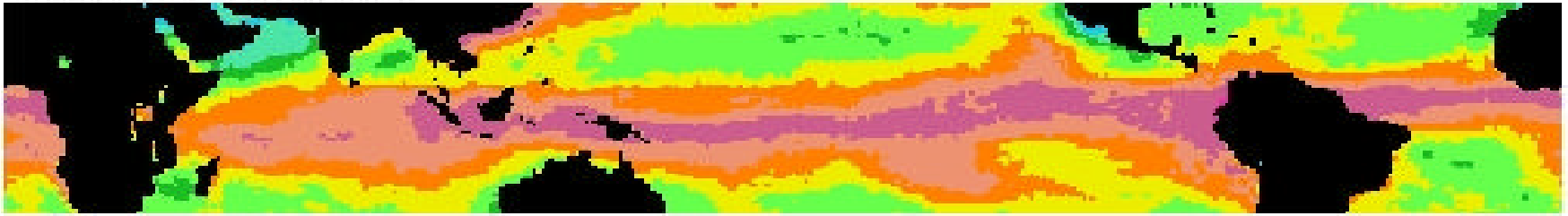

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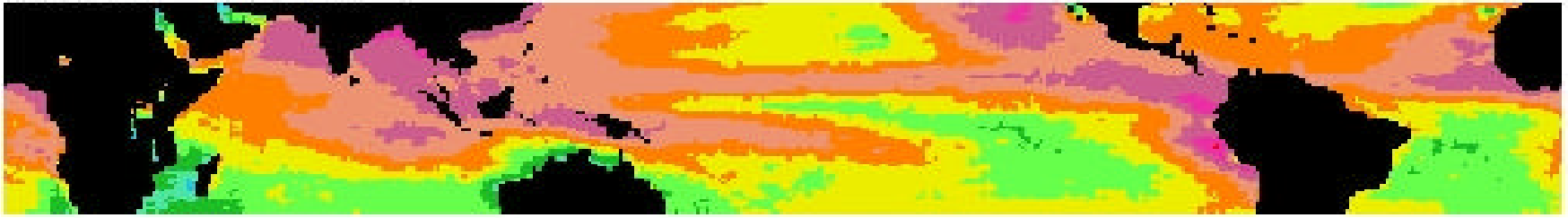
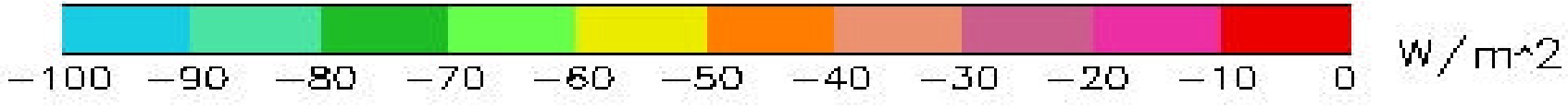
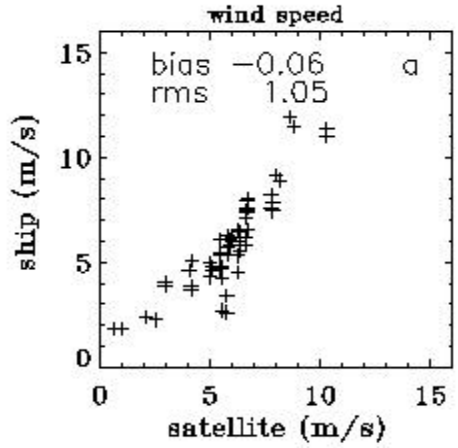
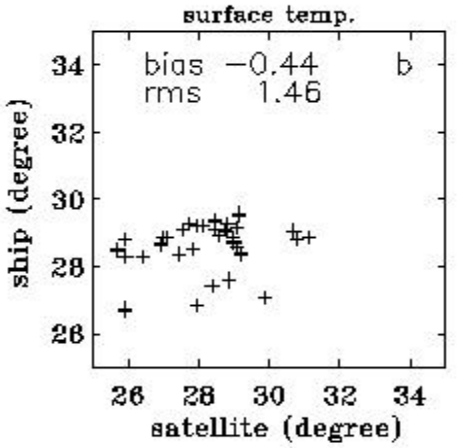
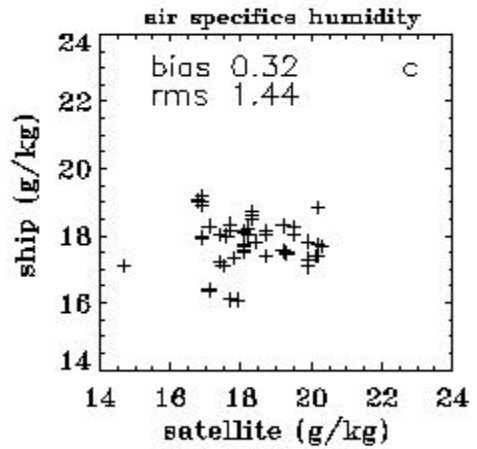


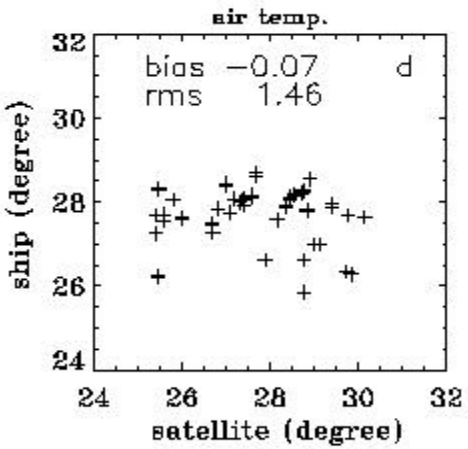


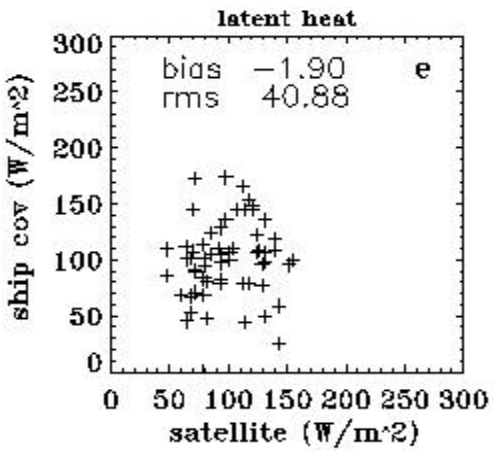
in situ vs satellite

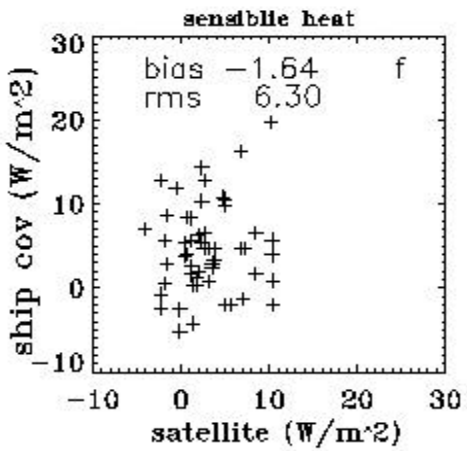












ship vs satellite: LH

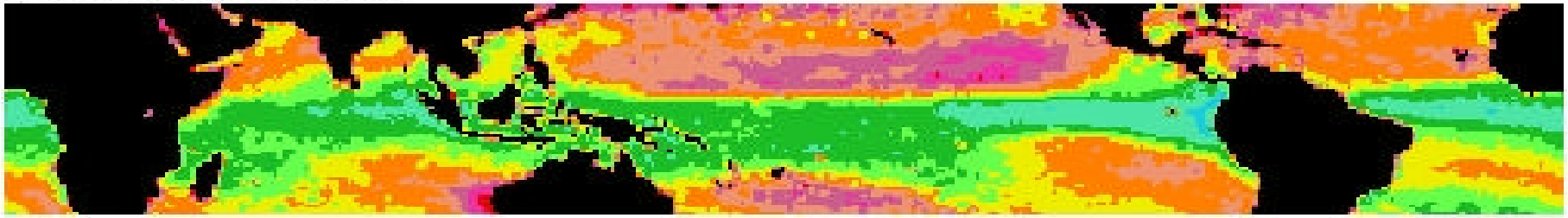
	Ship Covariance	Ship inertial-Dissipation	Ship bulk	Satellite Bulk
Ship Covariance	**101.48 W/m^2**	0.542	0.604	0.142
Ship inertial-dissipation	6.53 (43.04)	**108.01 W/m^2**	0.665	0.333
Ship bulk	12.46 (29.39)	5.93 (38.38)	**113.94 W/m^2**	0.506
Satellite bulk	-1.91 (40.88)	-8.47 (49.45)	-14.37 (30.79)	**99.57 W/m^2**

ship vs satellite: SH

	Ship Covariance	Ship inertial-Dissipation	Ship bulk	Satellite Bulk
Ship Covariance	**4.72 W/m^2**	0.450	0.584	0.106
Ship inertial-dissipation	0.93 (7.55)	**5.65 W/m^2**	0.243	0.050
Ship bulk	-0.62 (4.30)	-1.55 (7.55)	**4.10 W/m^2**	0.372
Satellite bulk	-1.64 (6.31)	-2.57 (8.58)	1.02 (3.98)	**3.08 W/m^2**

TMI LH

980101–980228



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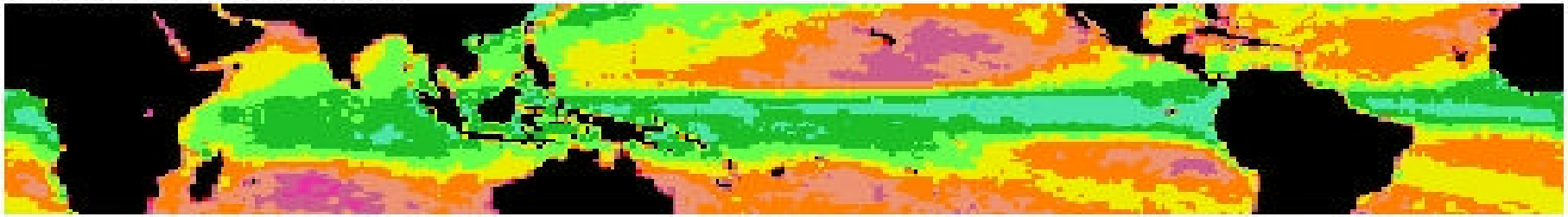

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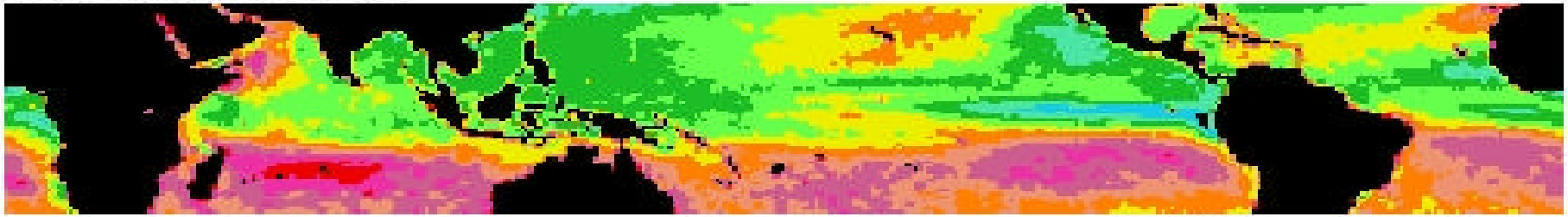
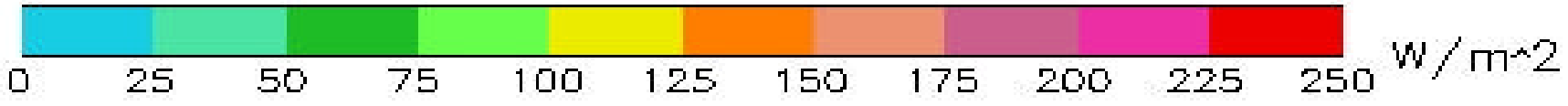
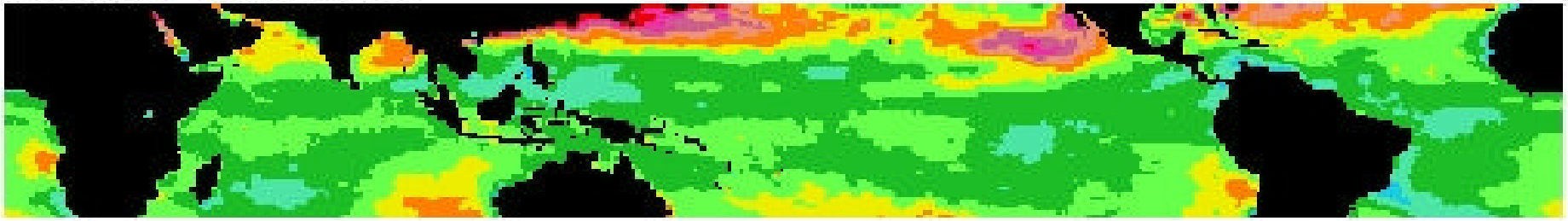




TMI SH

980101–980228



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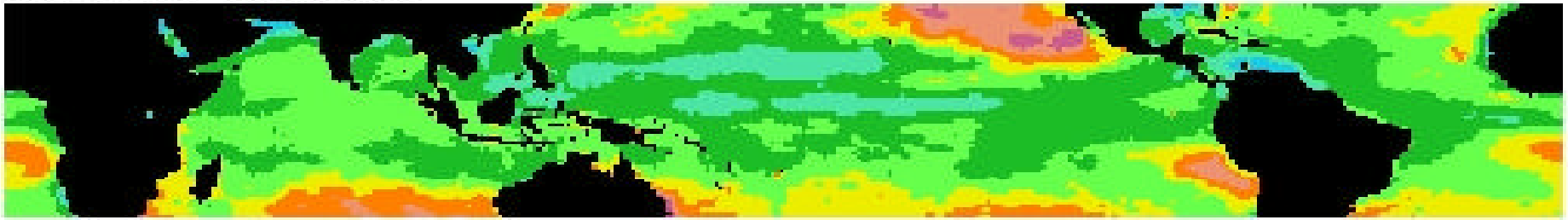

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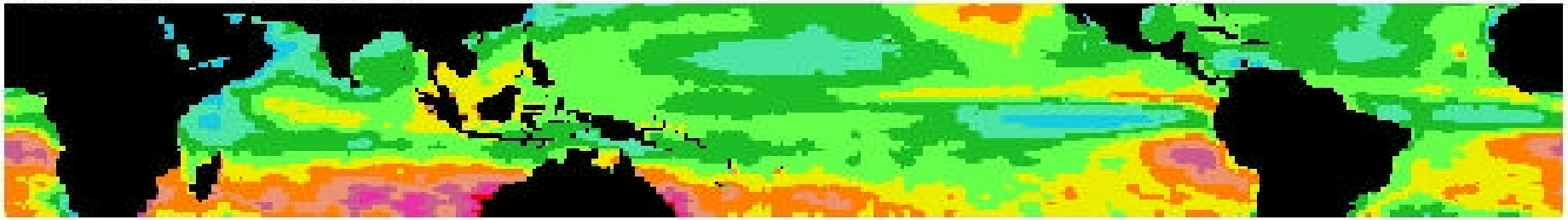
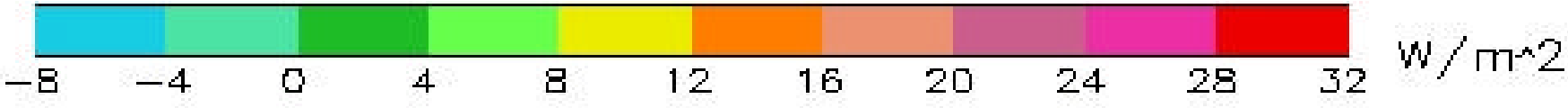
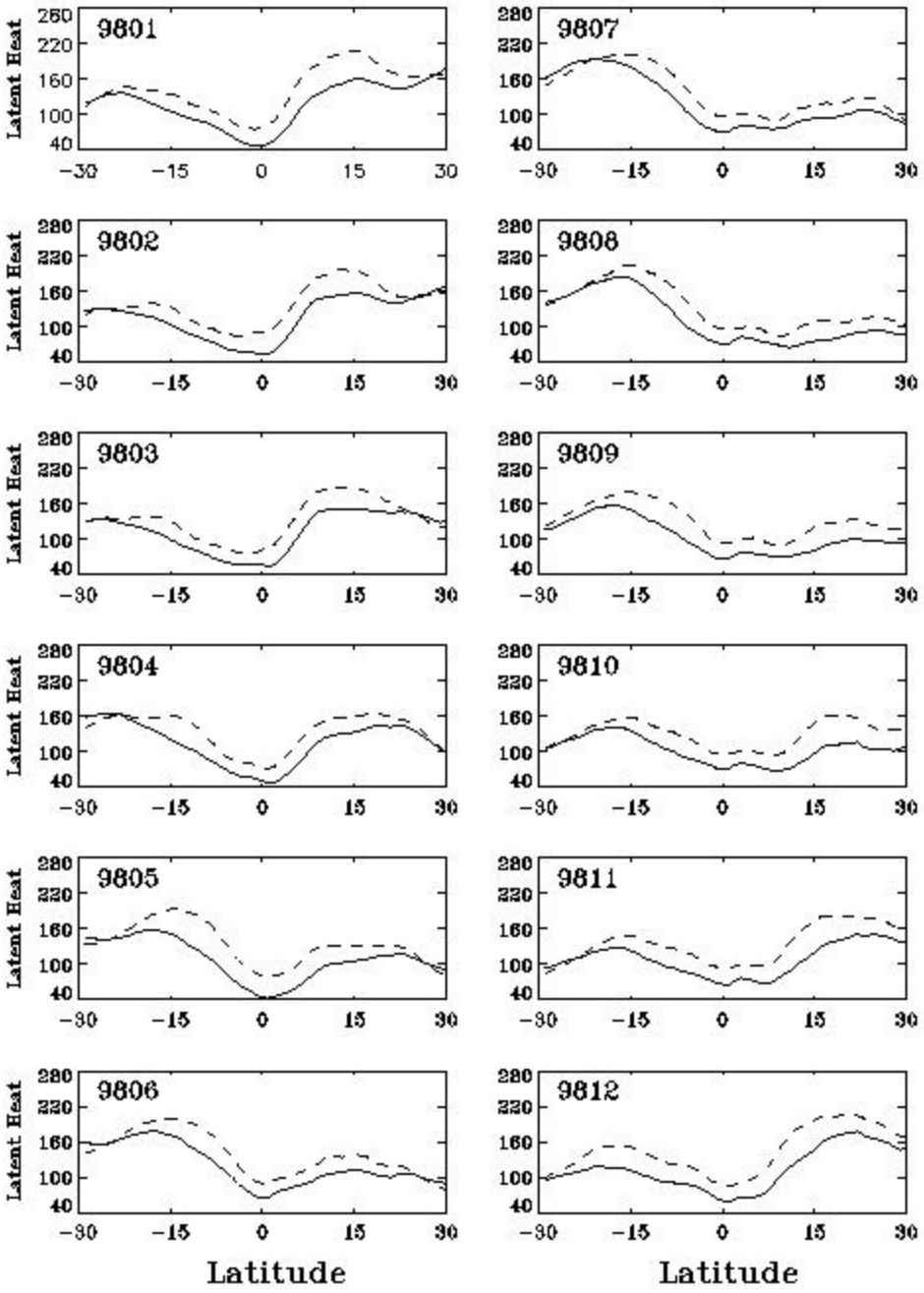




TRMM: solid
SSMI: dashed



Intercomparison: zonal mean

Kubota et al. 2003, JC

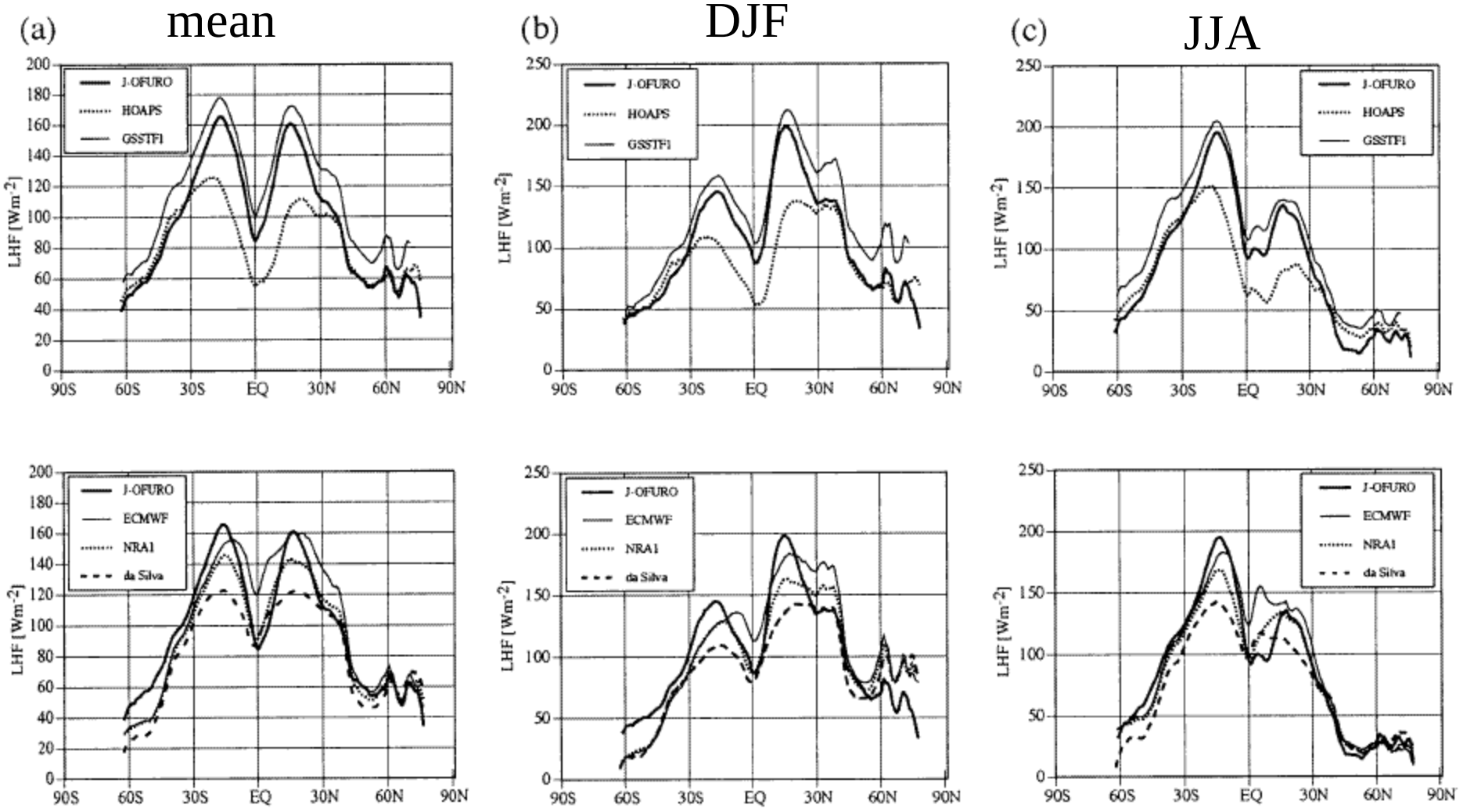


FIG. 5. Meridional profiles of zonal average of latent heat flux: (a) mean values, (b) values for the northern winter season (Dec–Jan–Feb), and (c) values for the northern summer season (Jun–Jul–Aug).

Intercomparison: difference

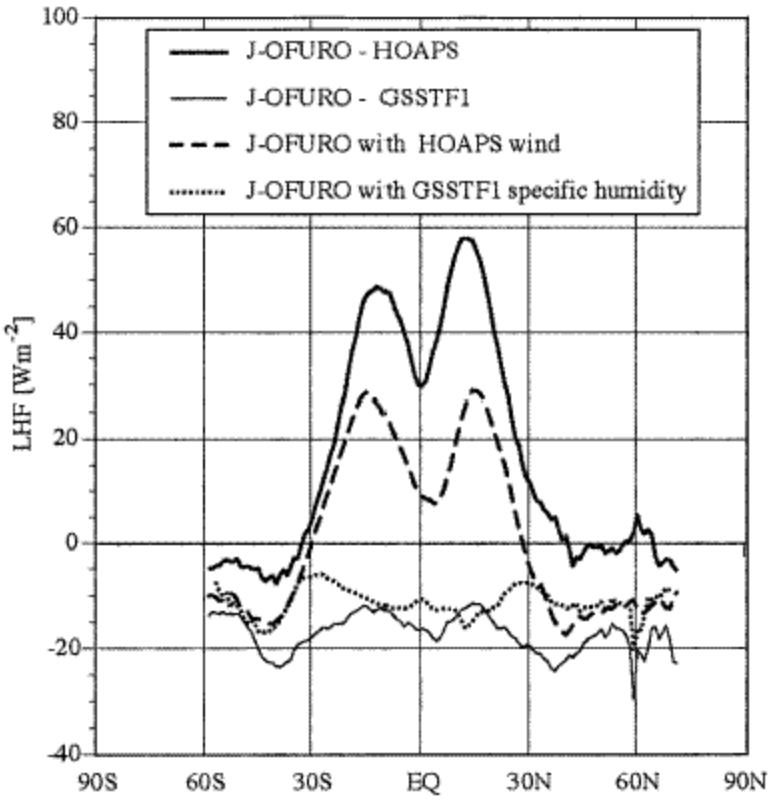
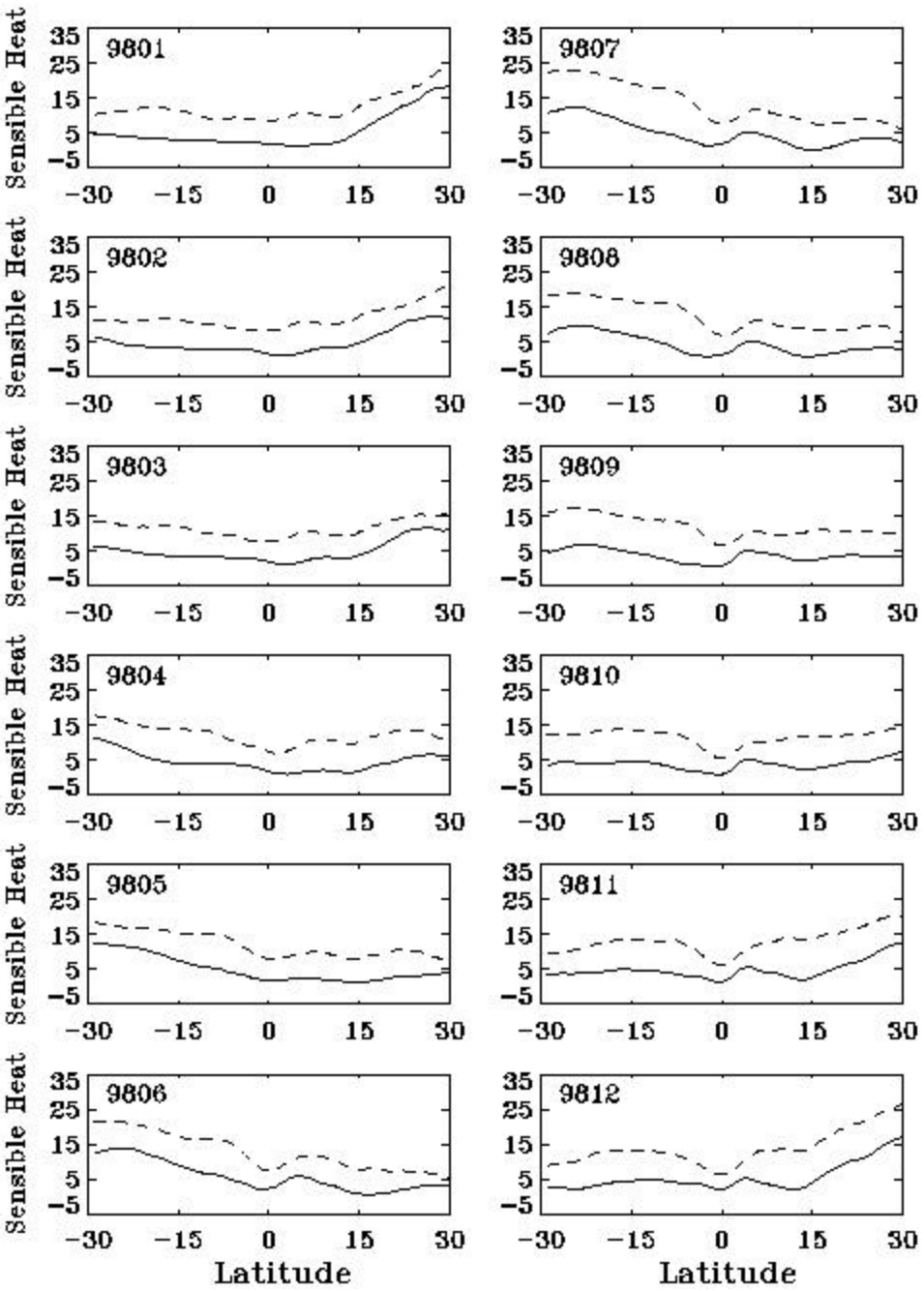


FIG. 6. Meridional profiles of the zonal average of the difference between J-OFURO and HOAPS, and J-OFURO and GSSTF. Those between original J-OFURO and J-OFURO using the HOAPS wind and the GSSTF specific humidity are also shown.

Kubota et al. 2003, JC

TRMM: solid
SSMI: dashed



net

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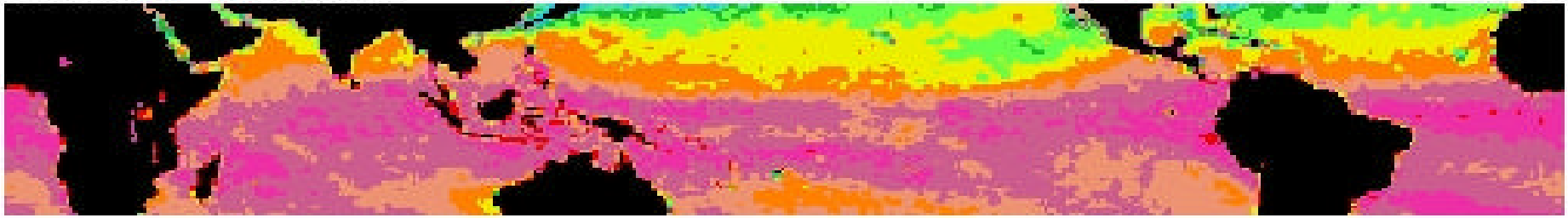

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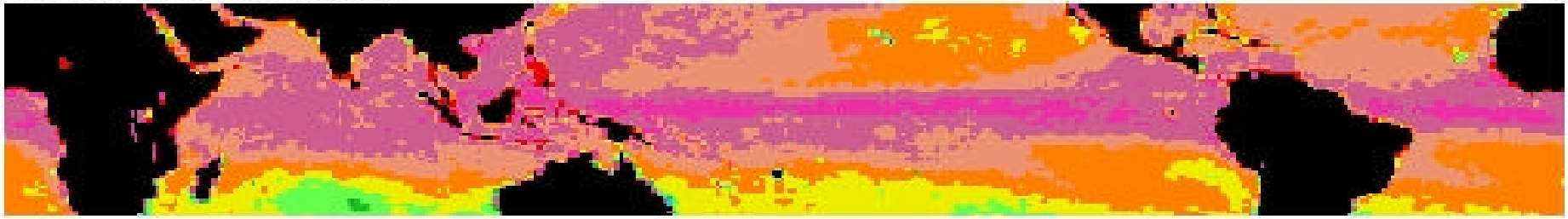

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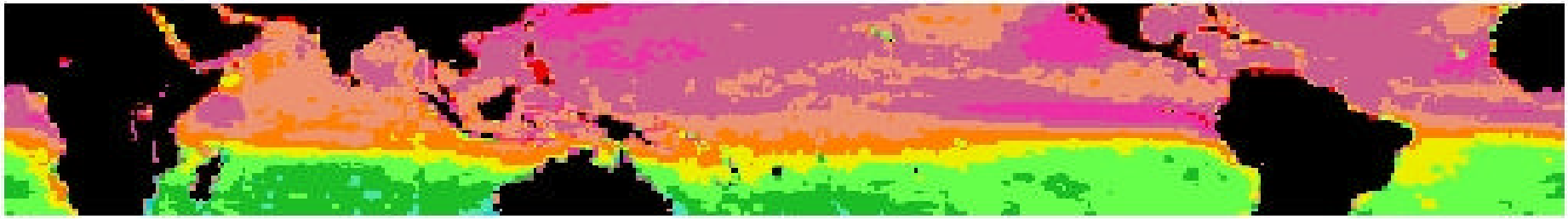
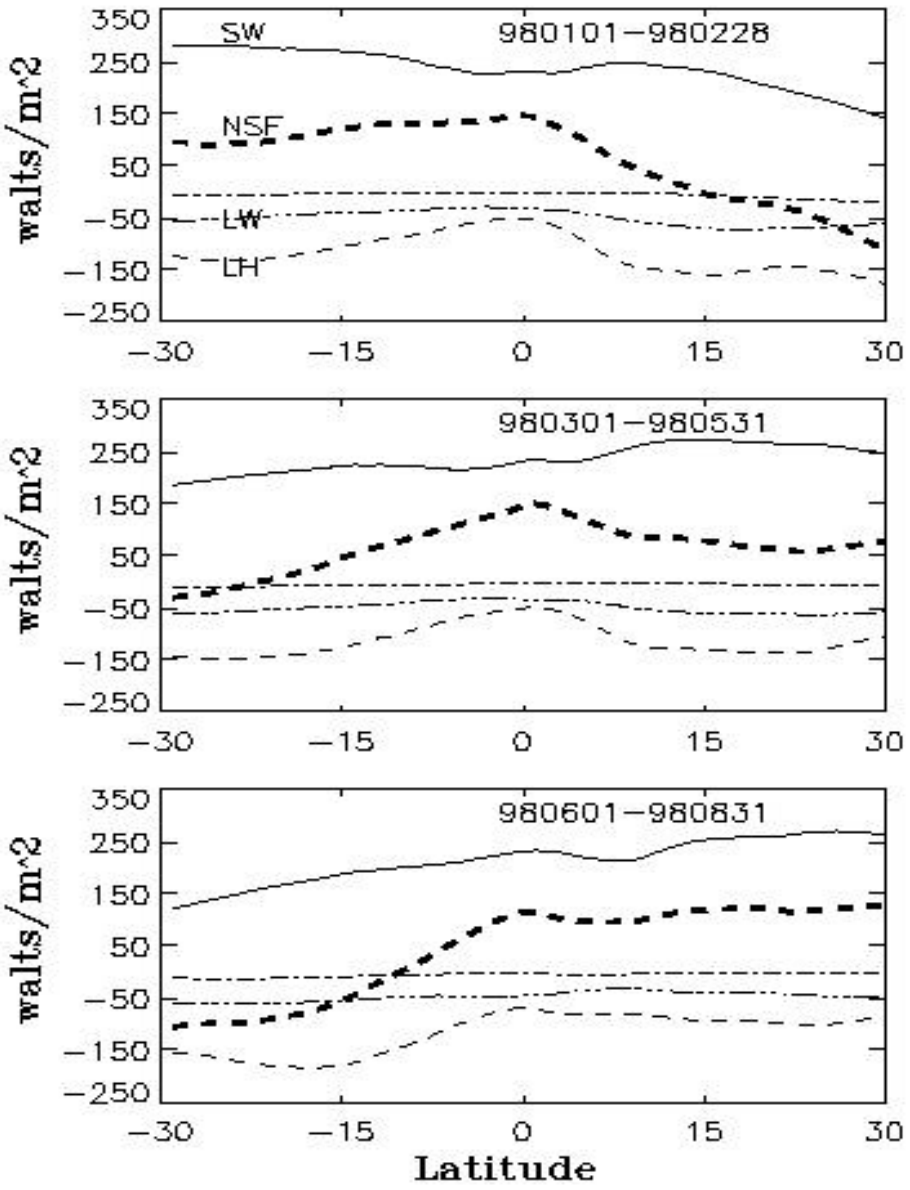


net zonal mean



summary

- TRMM: CERES, VIRS and TMI – heat balance over ocean surfaces. The data could be used for model validations.

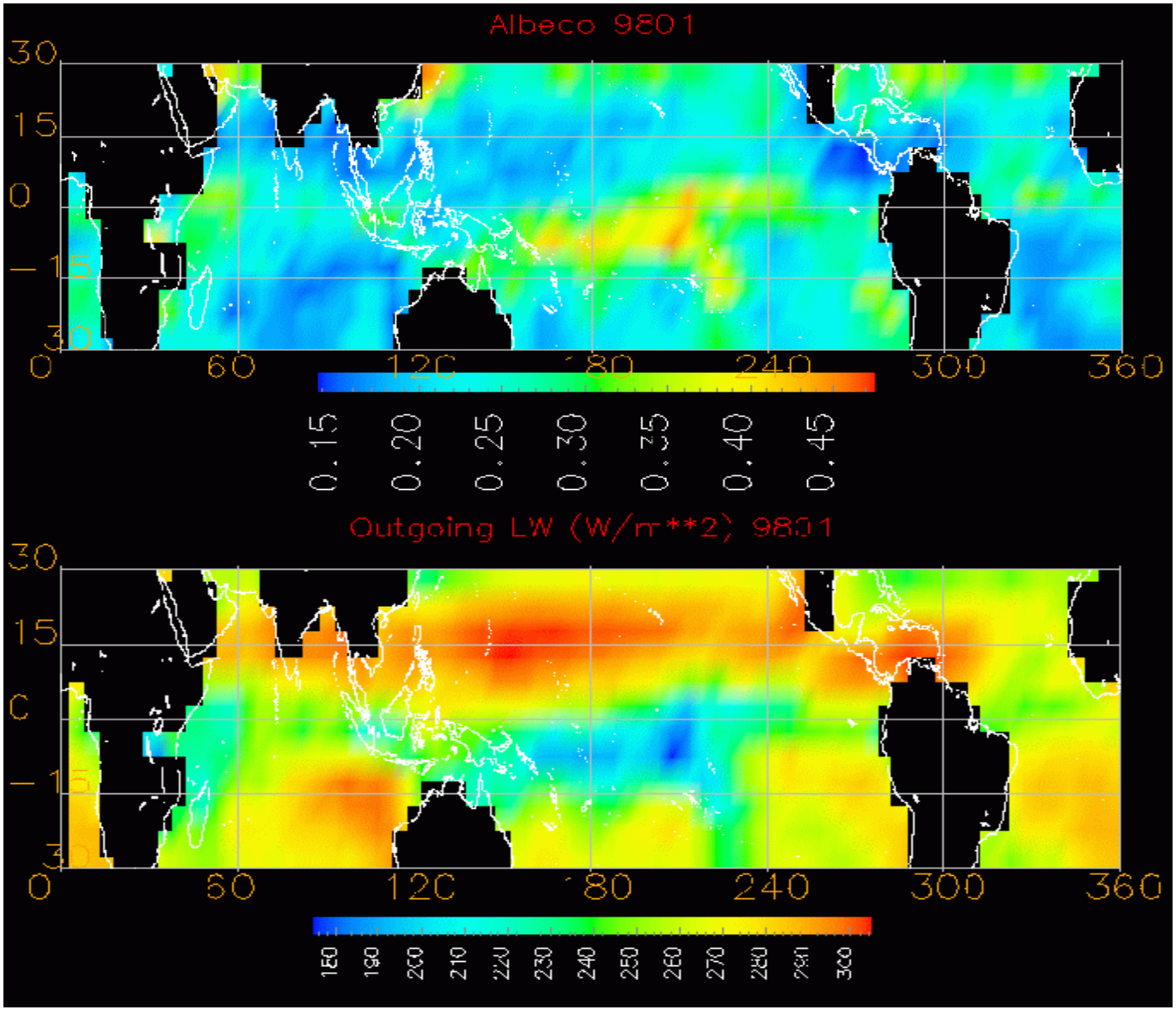
- Instantaneous bias (rms) errors are approximately -1.9 (40.88) W/m^2, and -1.64 (6.30) W/m^2 for surface LH and SH fluxes, respectively, when directly compared to in-situ ship measurements.

- Compared to Goddard SSM/I product: LH and SH biases are 10 to 30 W/m^2 and 6 to 8 W/m^2, respectively.

- Tropical oceans generally gain 46, 52, and 26 W/m^2 heat from the atmosphere for northern hemispheric winter, spring, and summer seasons, respectively.

TOA radiation

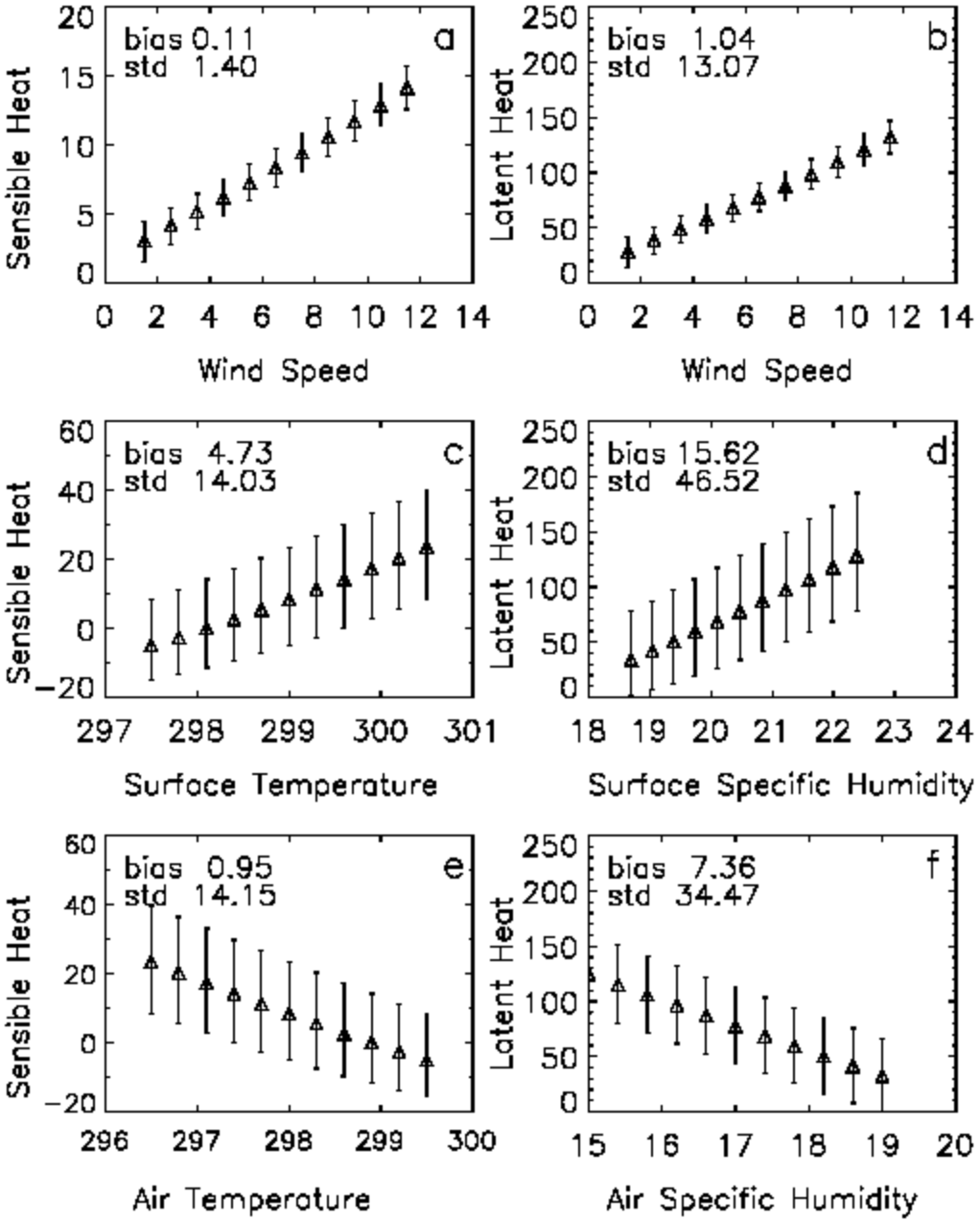
TRMM 199801



albedo

LW

sensitivity test



TMI WS

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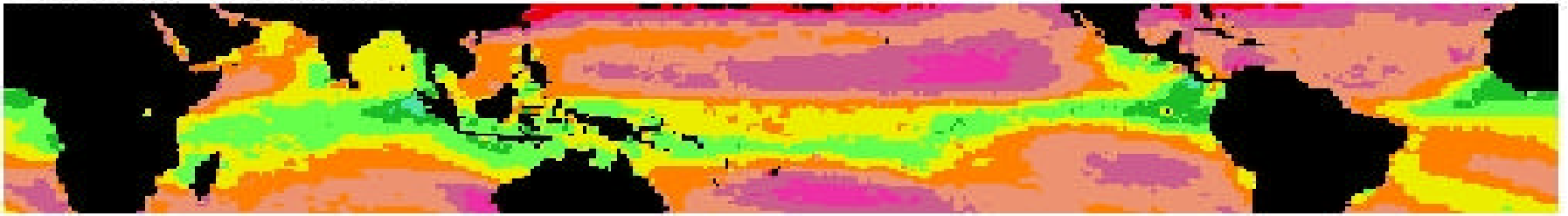

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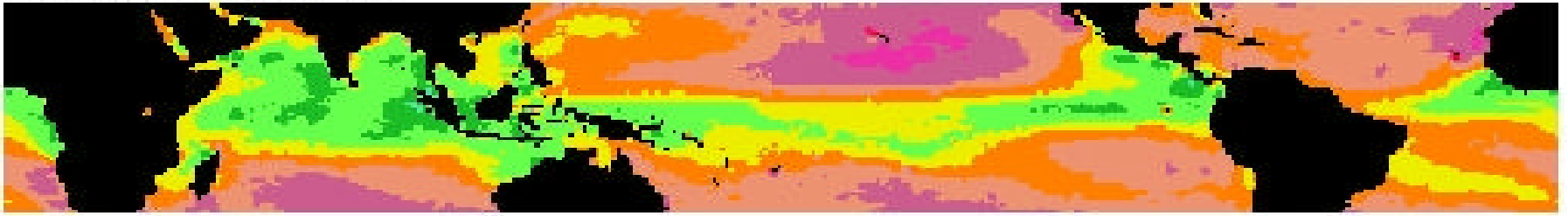

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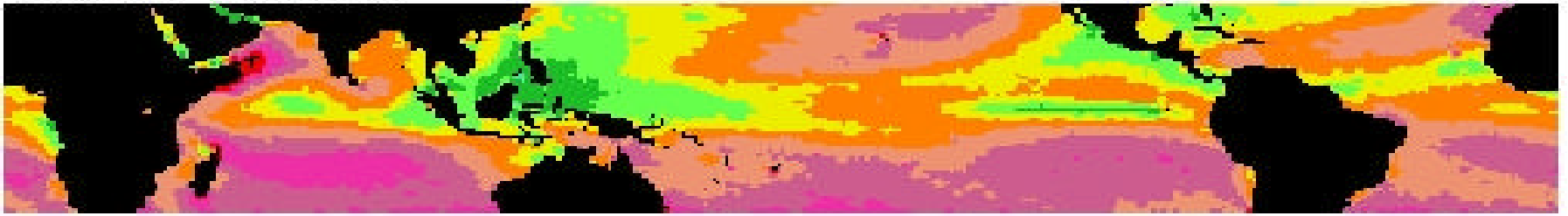
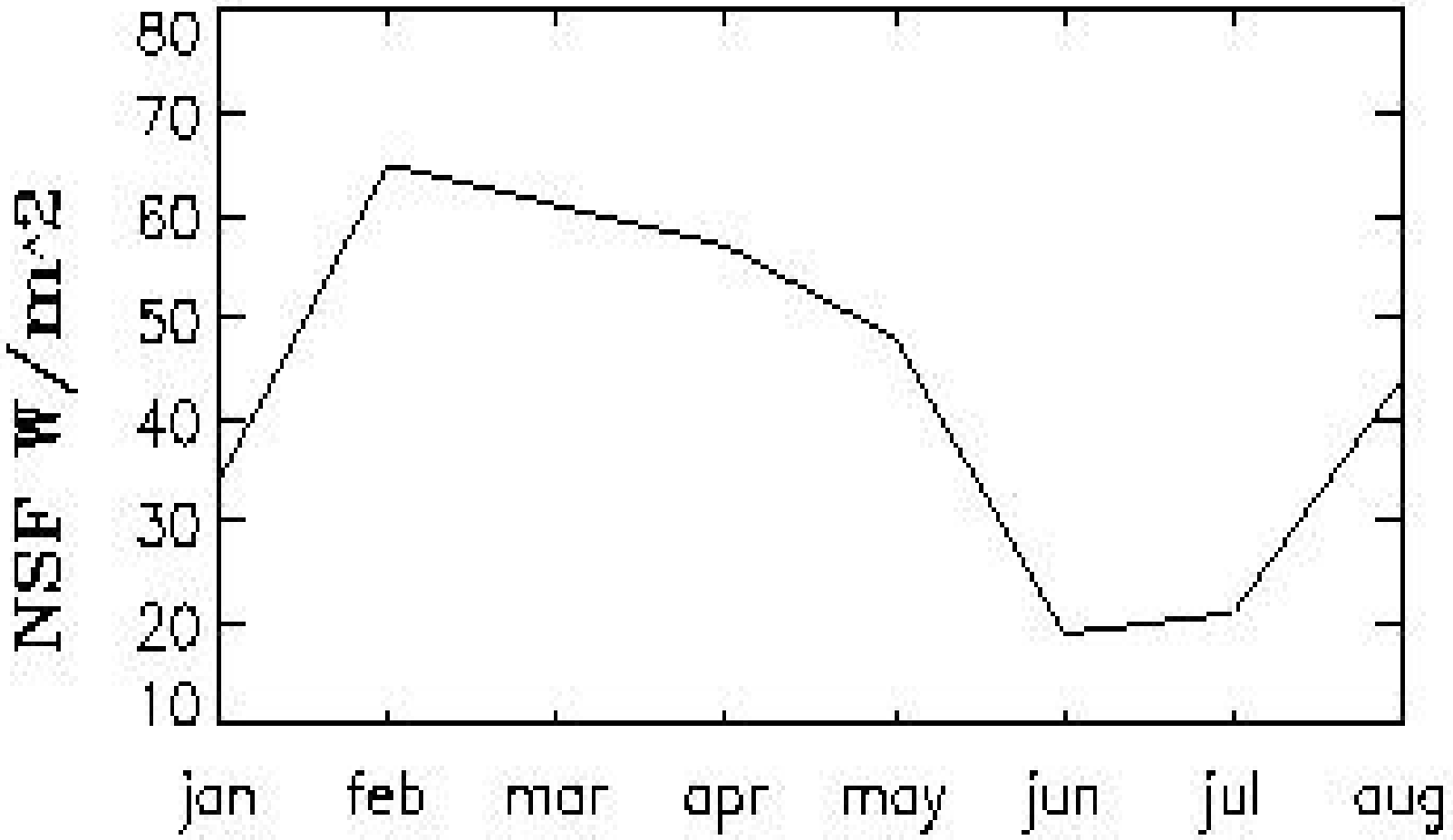
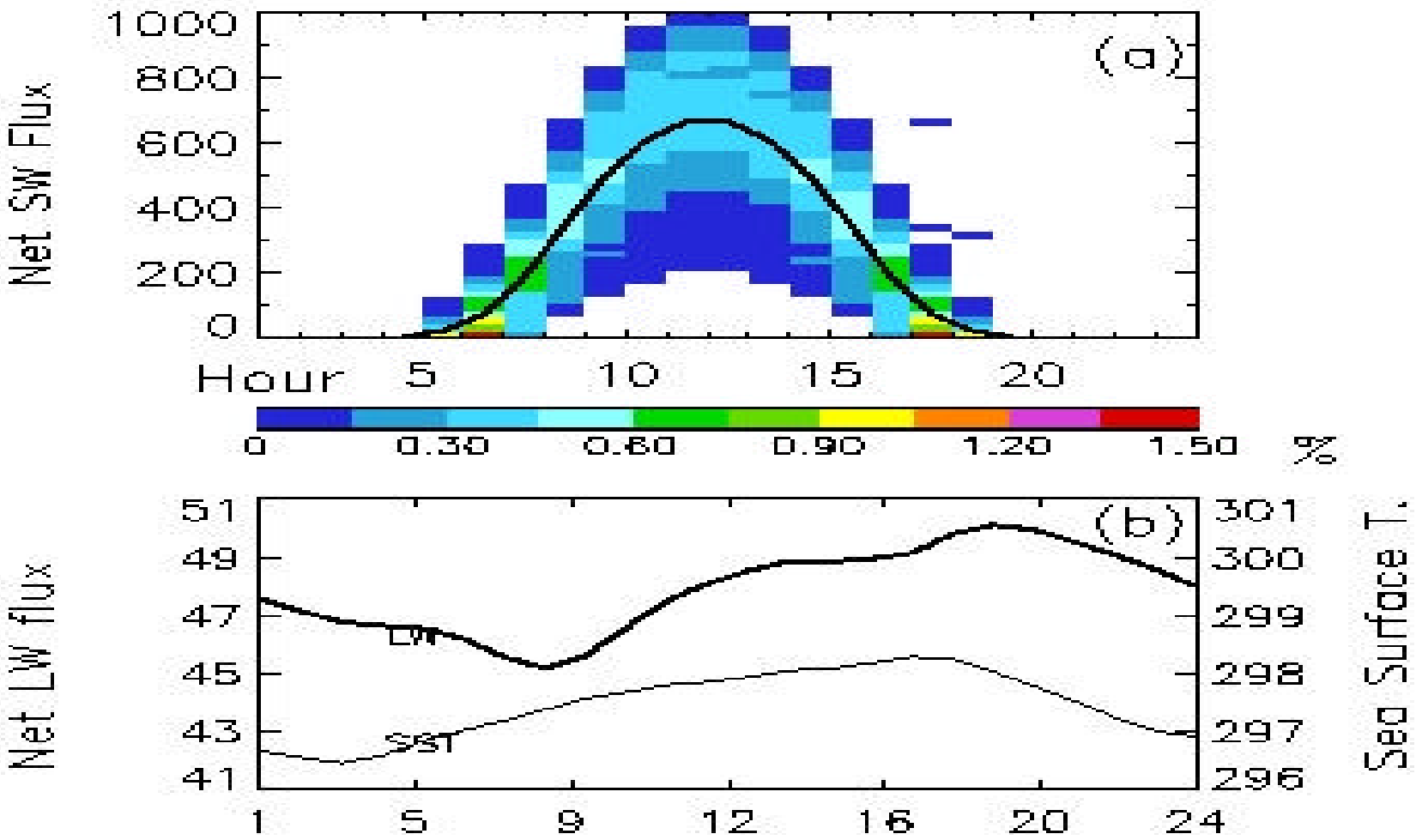
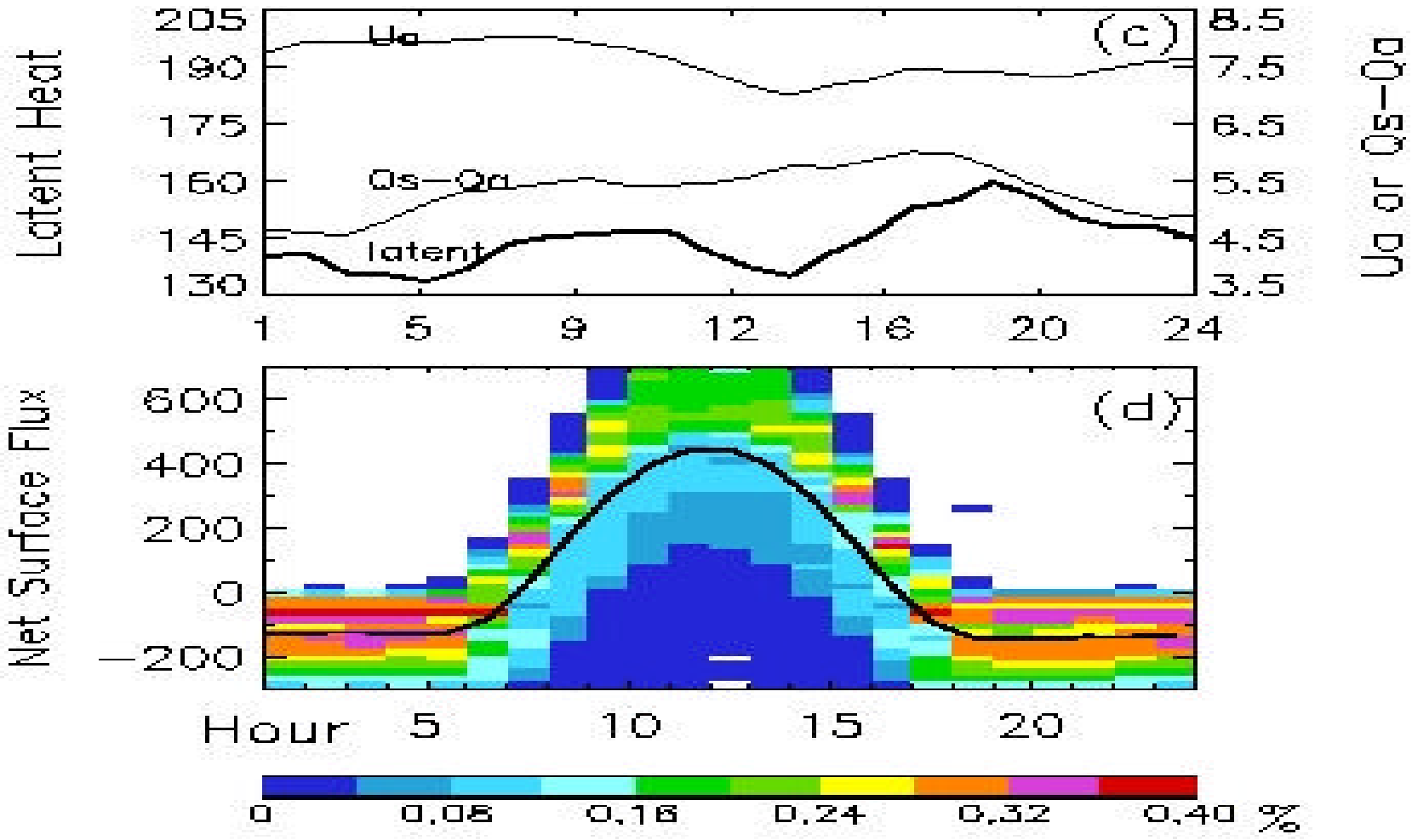


monthly tropical net



Diurnal SW & LW fluxes




Latent Heat
205
190
175
160
145
130
Ua
Qs−Qa
latent
(c)
8.5
7.5
6.5
5.5
4.5
3.5
Ua or Qs−Qa
1
5
9
12
16
20
24
Net Surface Flux
600
400
200
0
−200
(d)
Hour
5
10
15
20
0
0.08
0.16
0.24
0.32
0.40
%