

# THE INCLUSION OF A DIURNALLY VARYING SEA SURFACE TEMPERATURE IN SURFACE ENERGY BUDGET CALCULATIONS

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How does the inclusion of a diurnally-varying sea surface temperature product impact the calculations of surface energy budget components?



# SURFACE ENERGY BUDGET

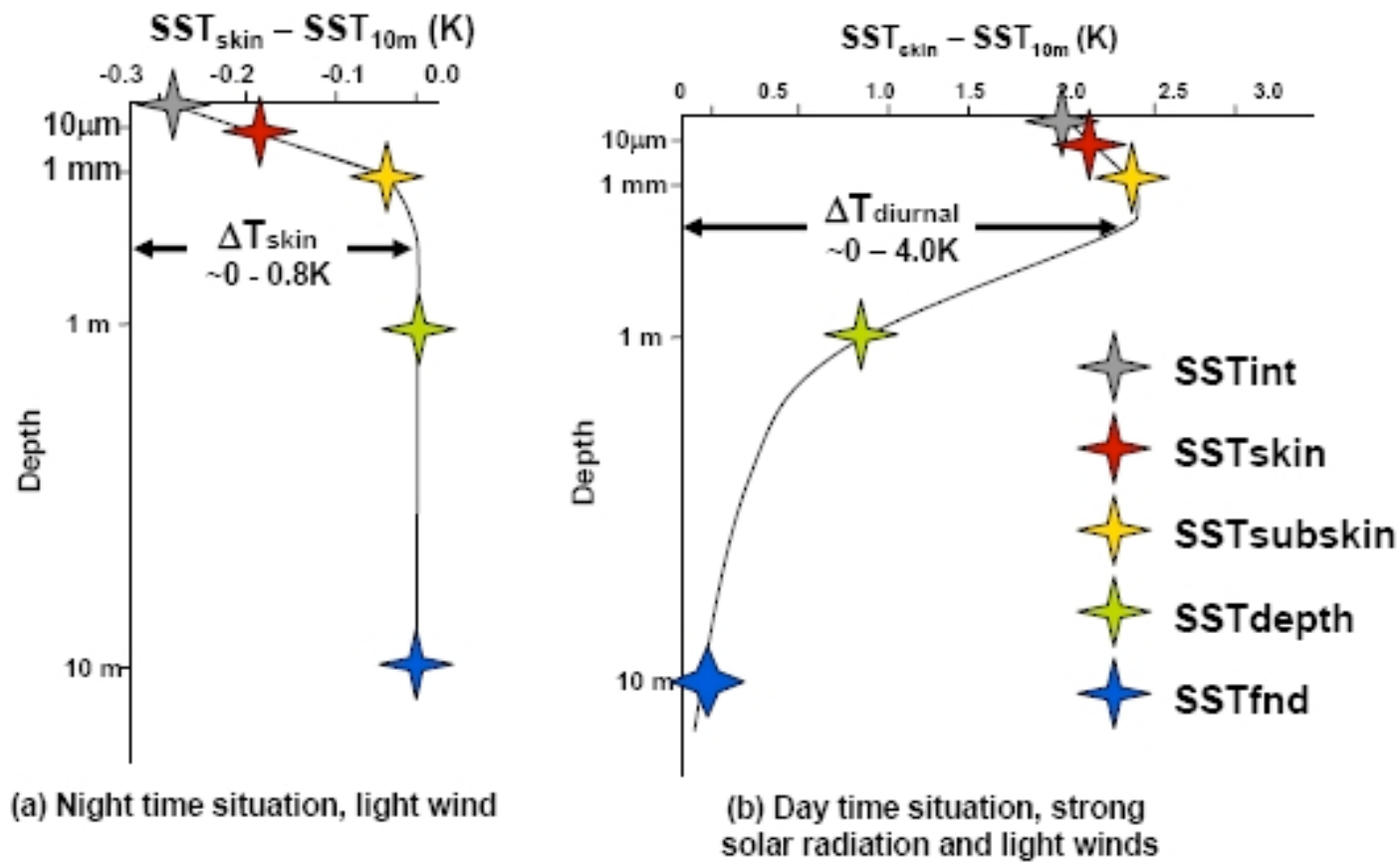
- On a global scale:

$$\begin{aligned} &\text{Absorbed Radiation} = \\ &\text{Latent Heat Flux} + \\ &\text{Sensible Heat Flux} + \\ &\text{Outgoing Longwave Radiation} \end{aligned}$$

- Lin et al. (2008) estimated imbalance in the global annual mean surface heat budget of nearly  $\sim 10 \text{ W m}^{-2}$  from errors in current surface flux datasets.
- Errors arise from biases found in near-surface specific humidity and air temperatures used for calculation of the turbulent fluxes (e.g. Roberts et al. 2010), and the sea surface temperature fields.



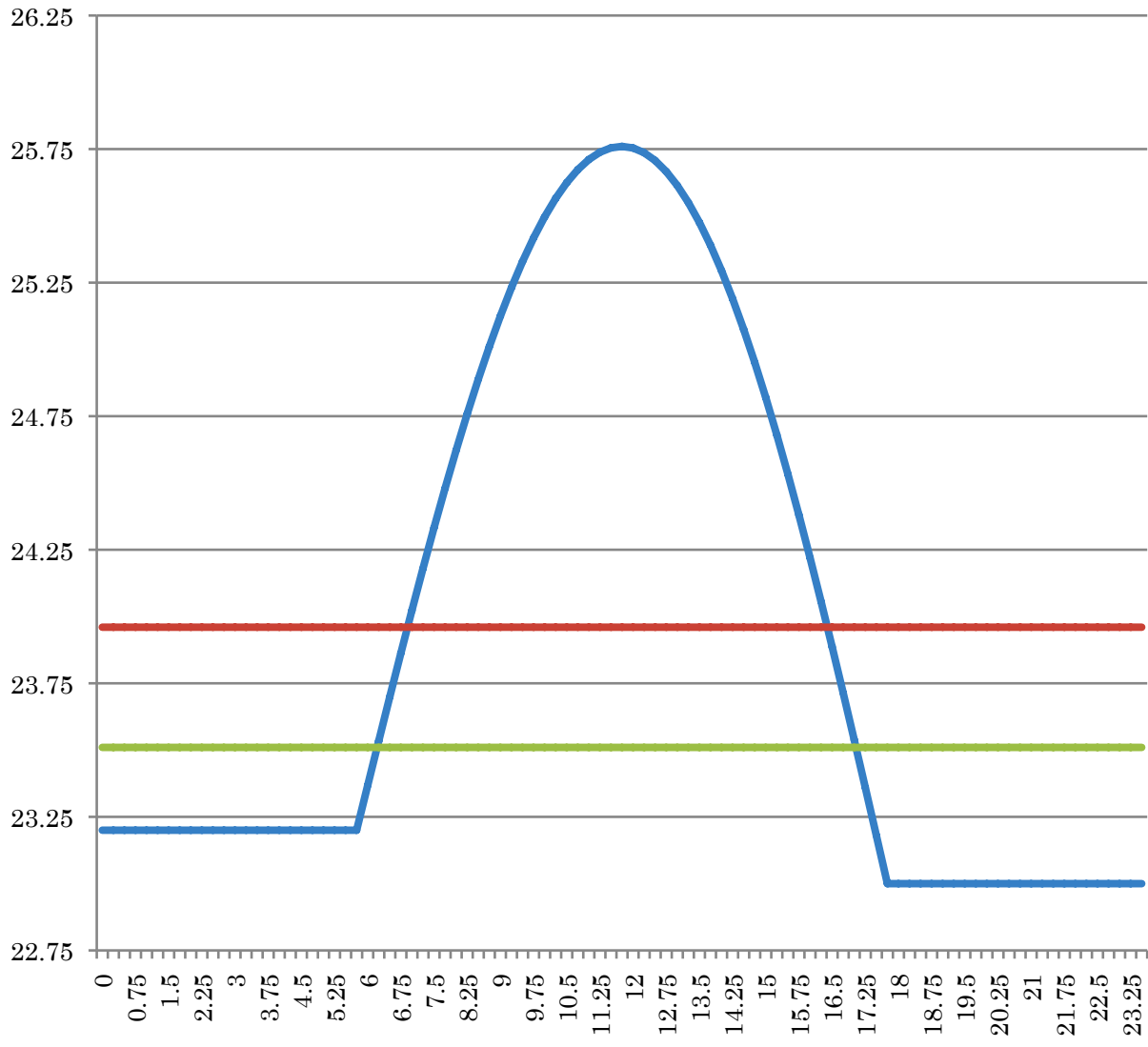
# SST DEFINITIONS



- Image from <http://www.ghrsst.org/SST-Definitions.html>



# DIURNAL VARIATION



- Diurnally Varying SST
- Daily Average SST
- Example SST from Satellite Passes



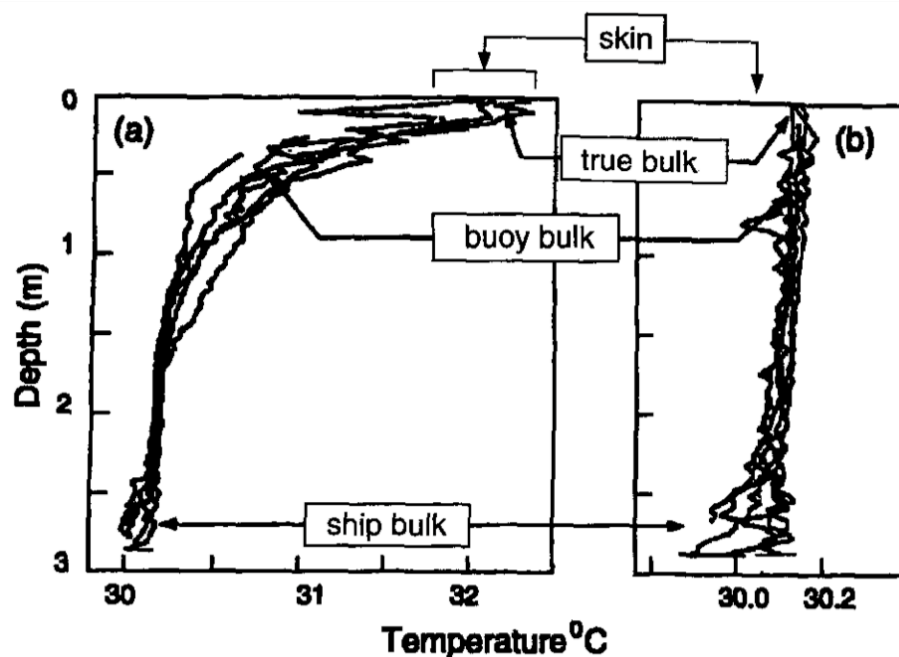
# TYPES OF DSST MODELS

- Diffusion or Turbulence Closure
  - Kondo et al. (1979)
  - Large et al. (1994)
  - Kantha and Clayson (1994)
- Bulk/Slab
  - Price-Weller-Pinkel (PWP) – Price et al. (1978)
  - Fairall et al. (1996)
  - POSH – Gentemann et al. (2009)
    - Predicts vertical temperature profile
    - Requires fluxes to calculate
- Empirical
  - Webster, Clayson, and Curry (1996)
  - Clayson and Weitlich (2005)
    - Based Peak Solar Insolation and Wind Speed

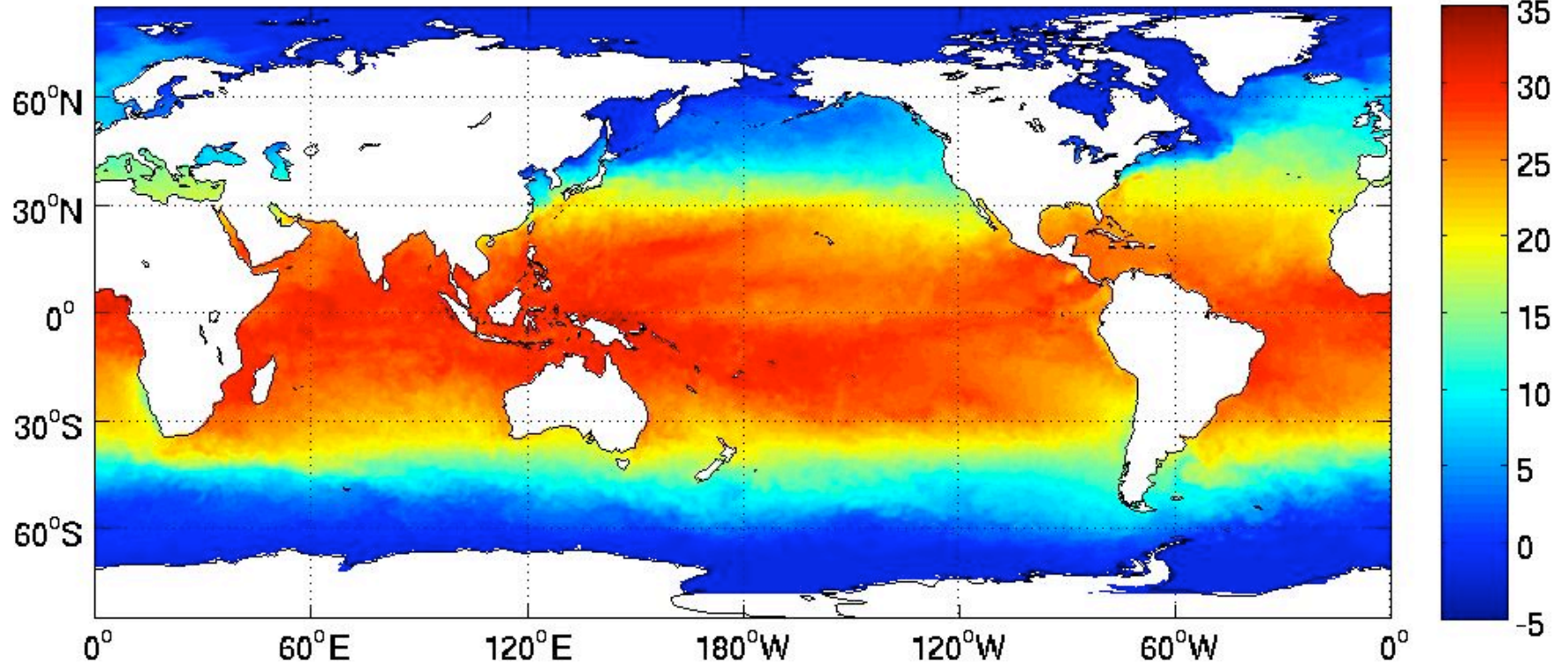


## DIURNALLY VARYING SKIN SST

- Use diurnally-varying SST using Clayson and Weitlich (2005) method.
- Profiles of the ocean mixed layer demonstrates the importance of using the near-skin diurnally-varying SST (Figure from Webster et al. 1996).

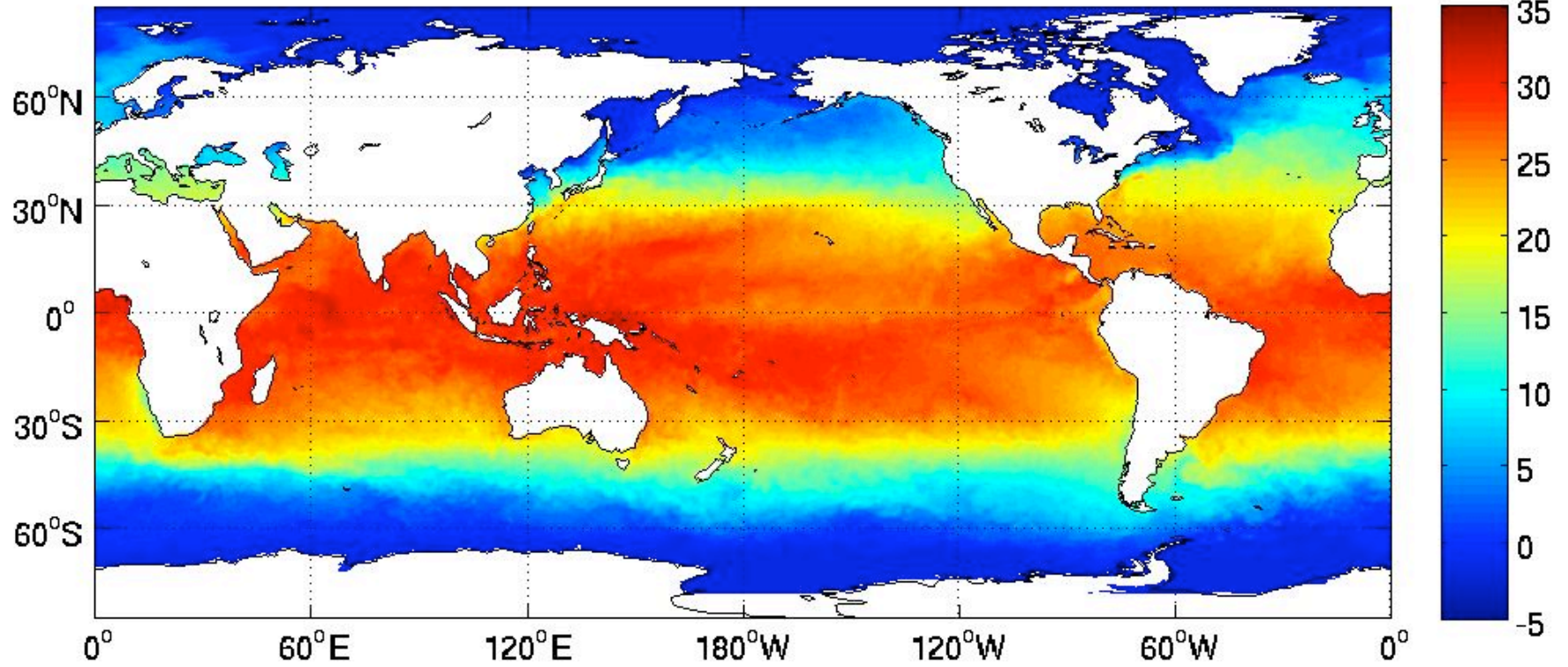


SST - 3/18/2000 - 0Z

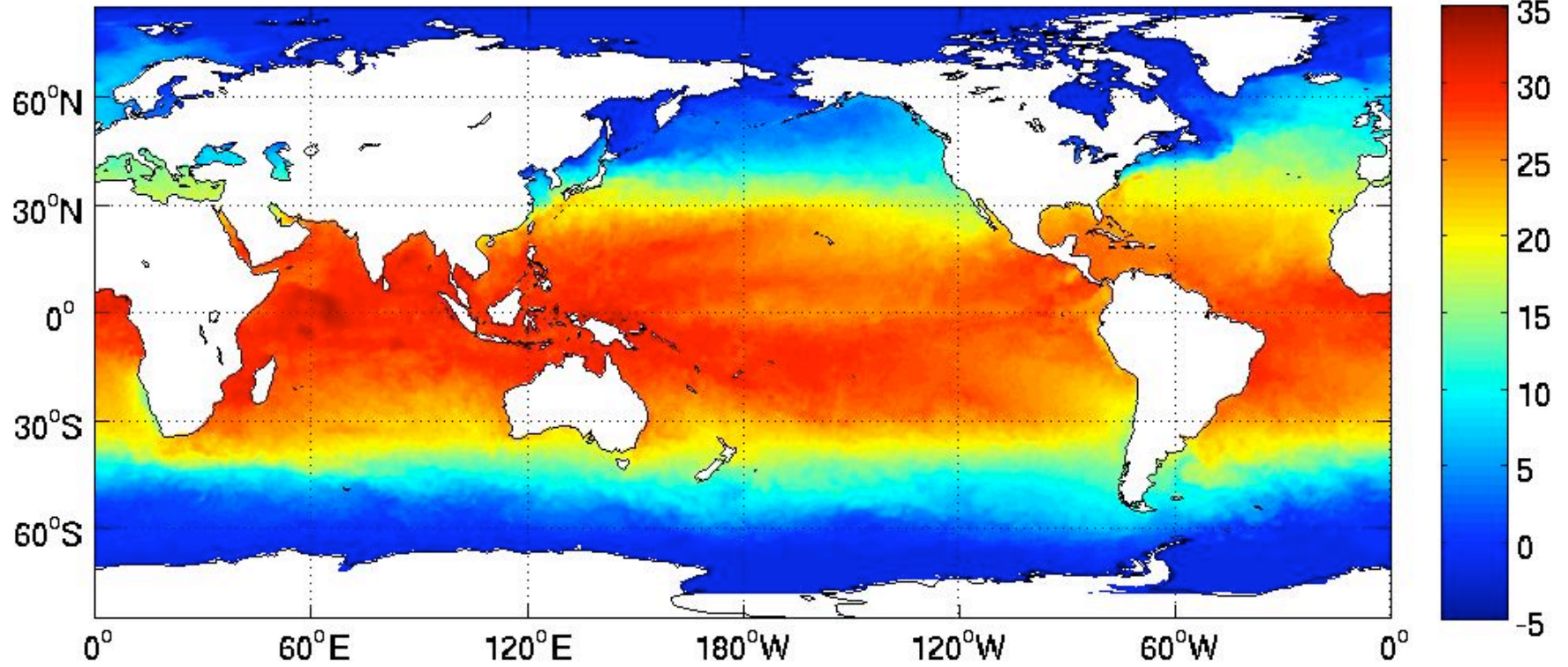




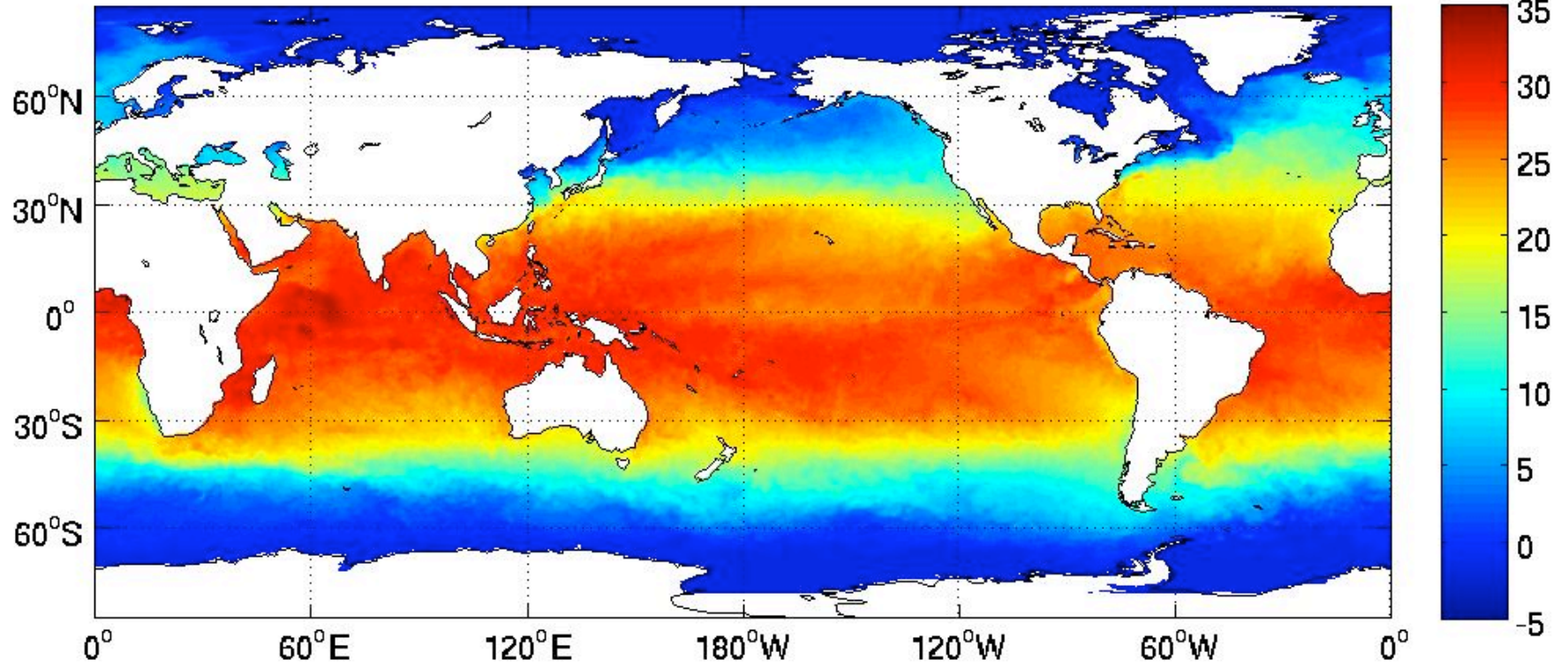
SST - 3/18/2000 - 3Z



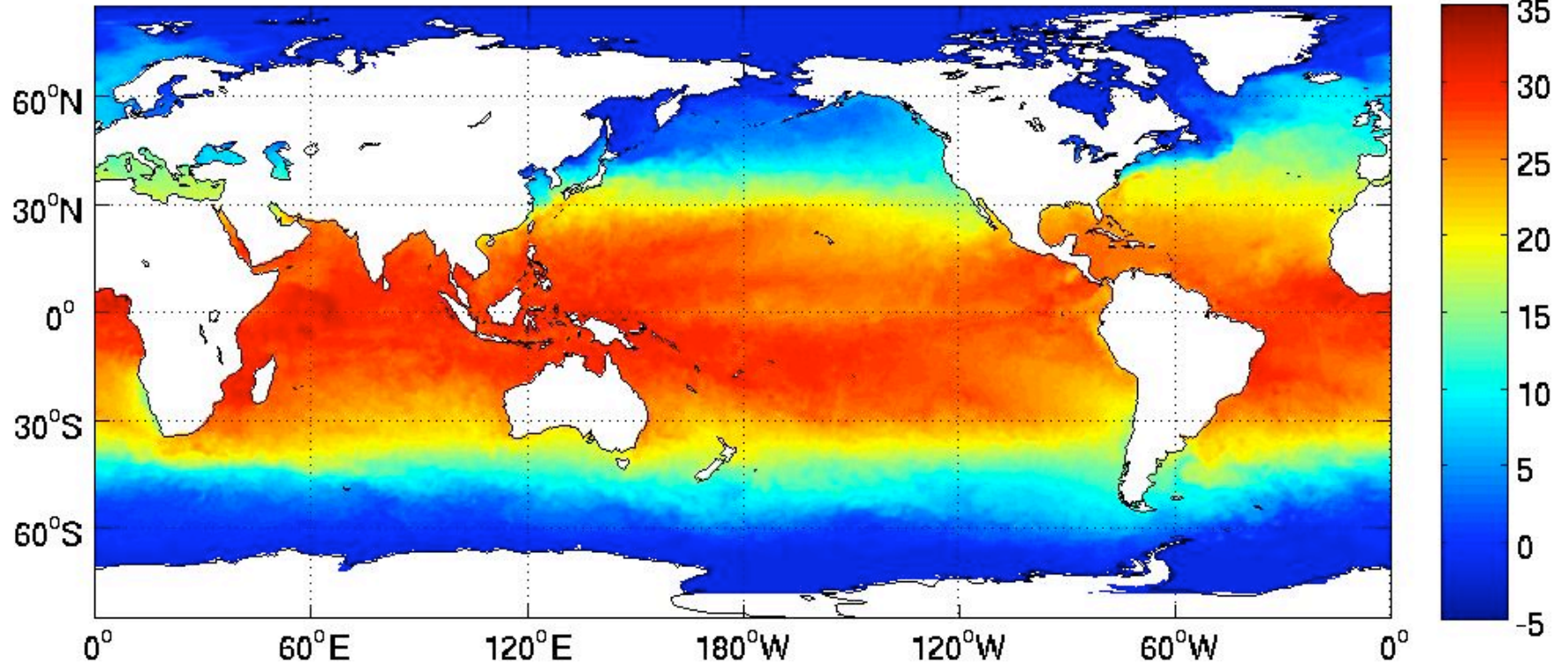
SST - 3/18/2000 - 6Z



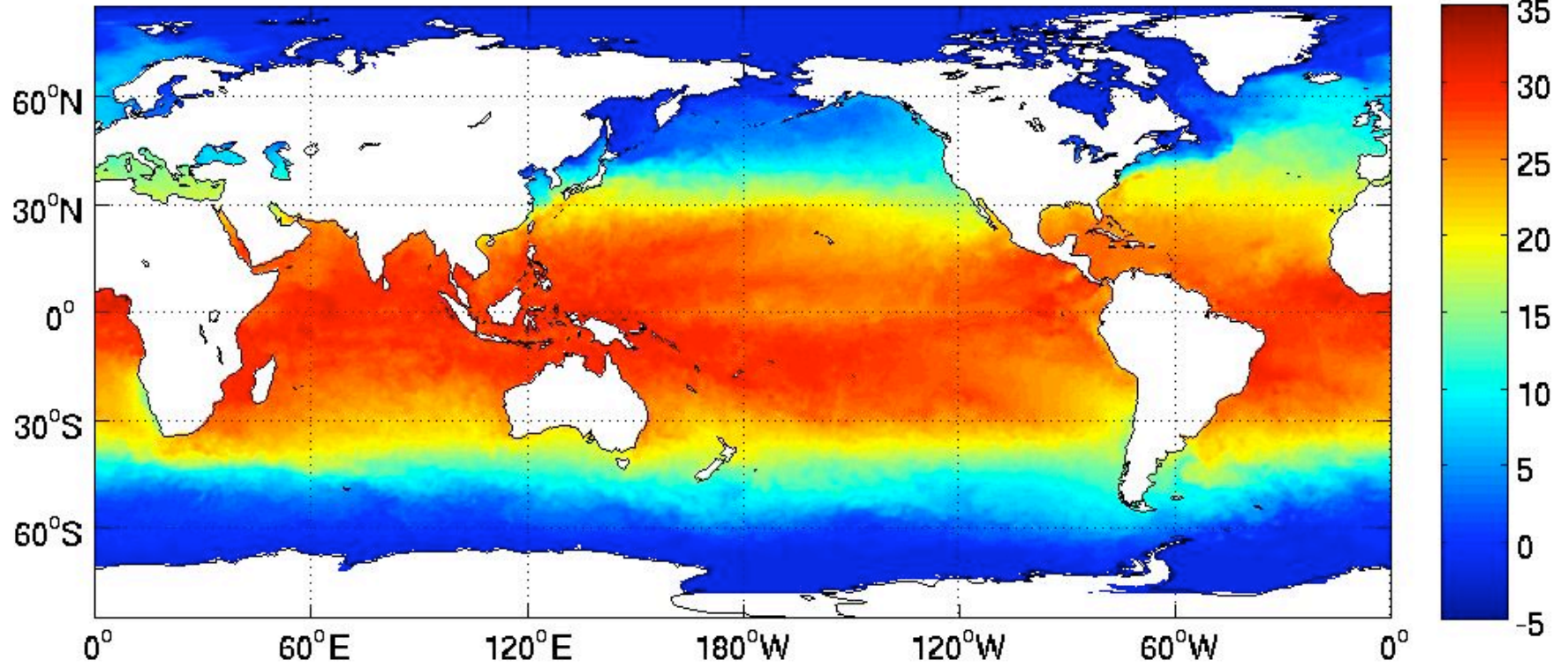
SST - 3/18/2000 - 9Z



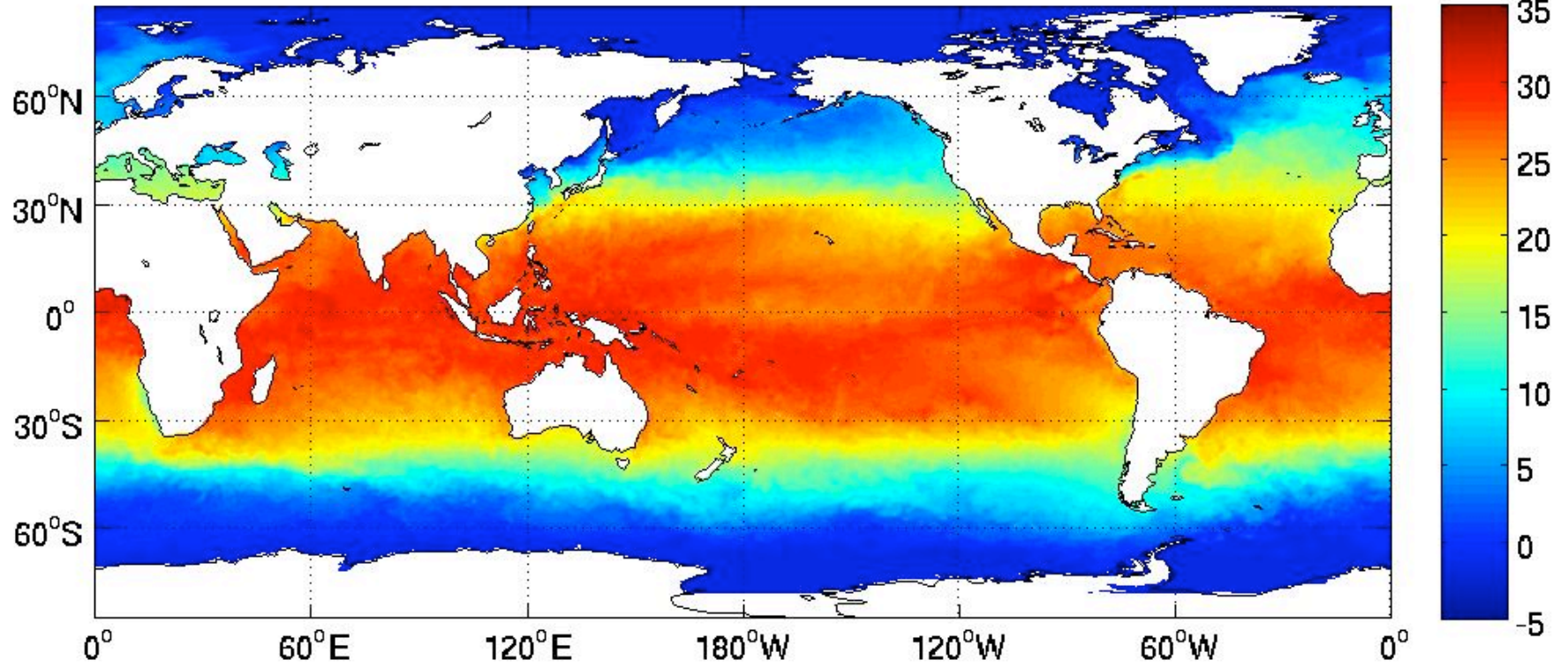
SST - 3/18/2000 - 12Z



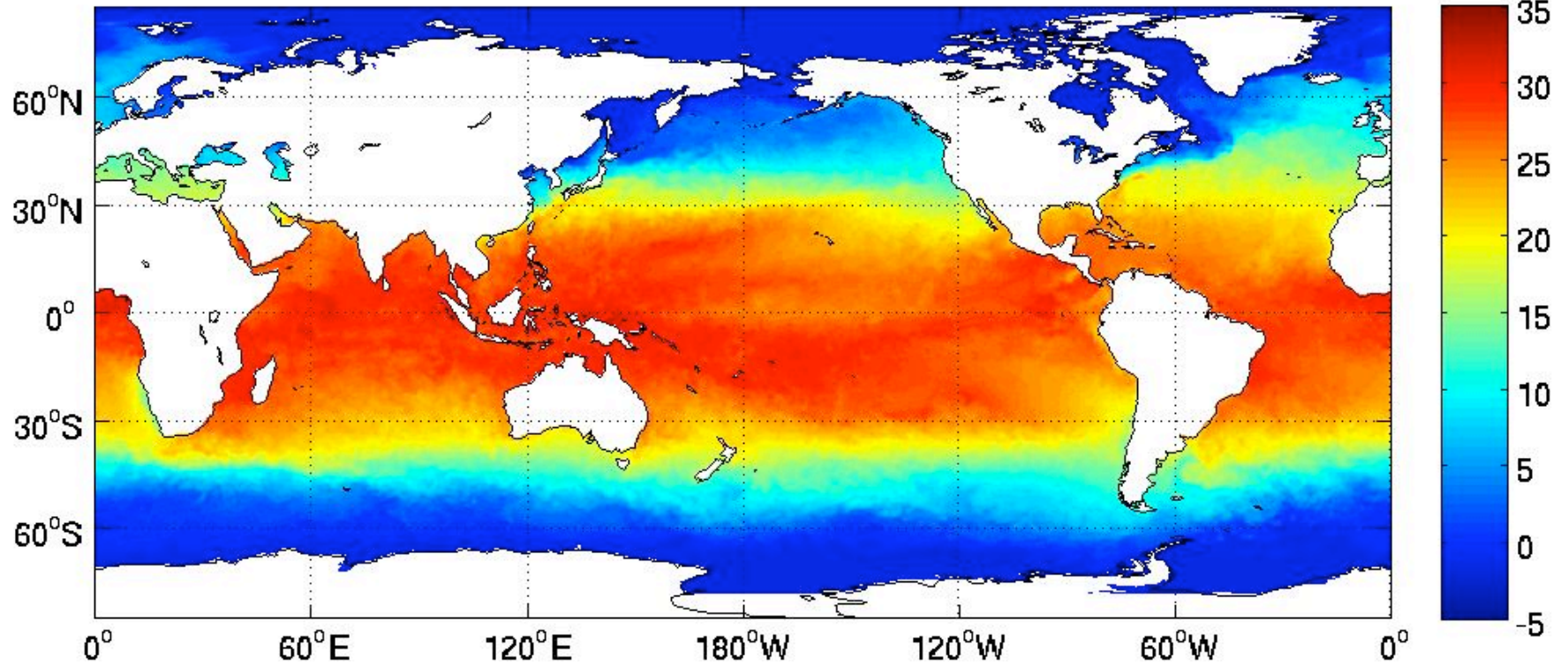
SST - 3/18/2000 - 15Z



SST - 3/18/2000 - 18Z



SST - 3/18/2000 - 21Z



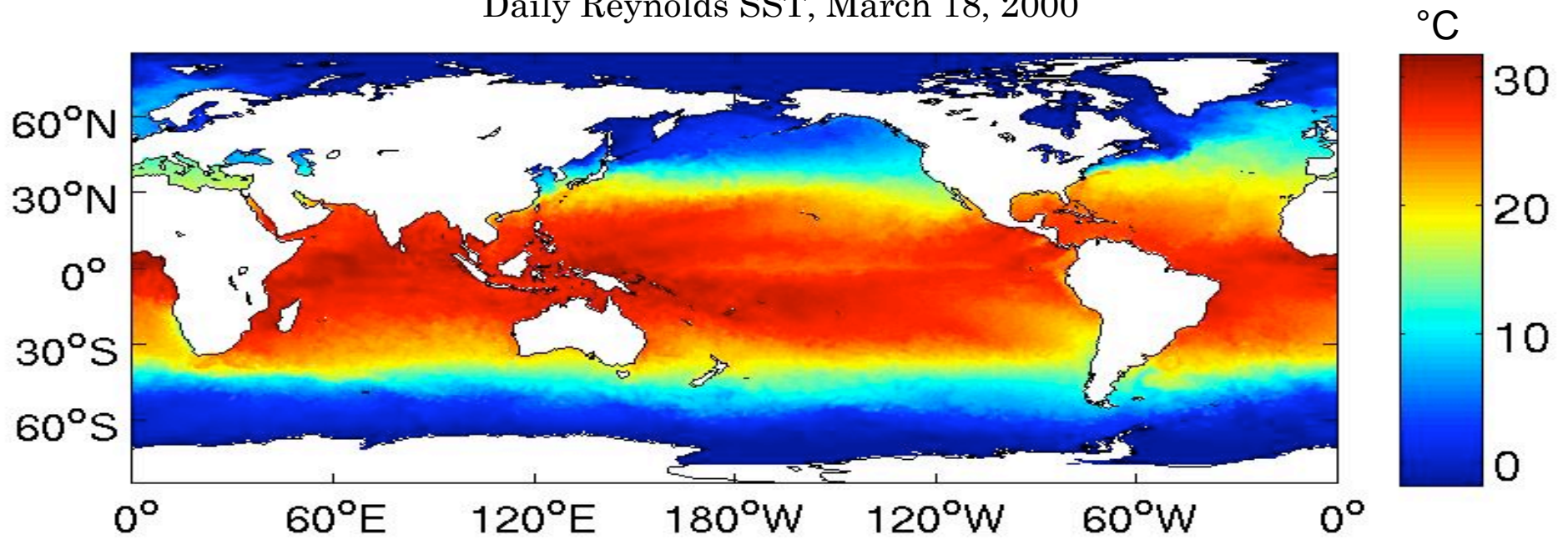
## SST PRODUCTS USED

- Reynolds Daily OI-SST AVHRR-only Version 2
- Pre-Dawn SST (prior SST to dawn in the diurnally-varying SST product)
  - Working to create a Pre-Dawn SST dataset
- Instantaneous SST from diurnally-varying SST product
  
- Focusing on Pre-Dawn SST for the Fluxes since it will most resemble a foundation SST.

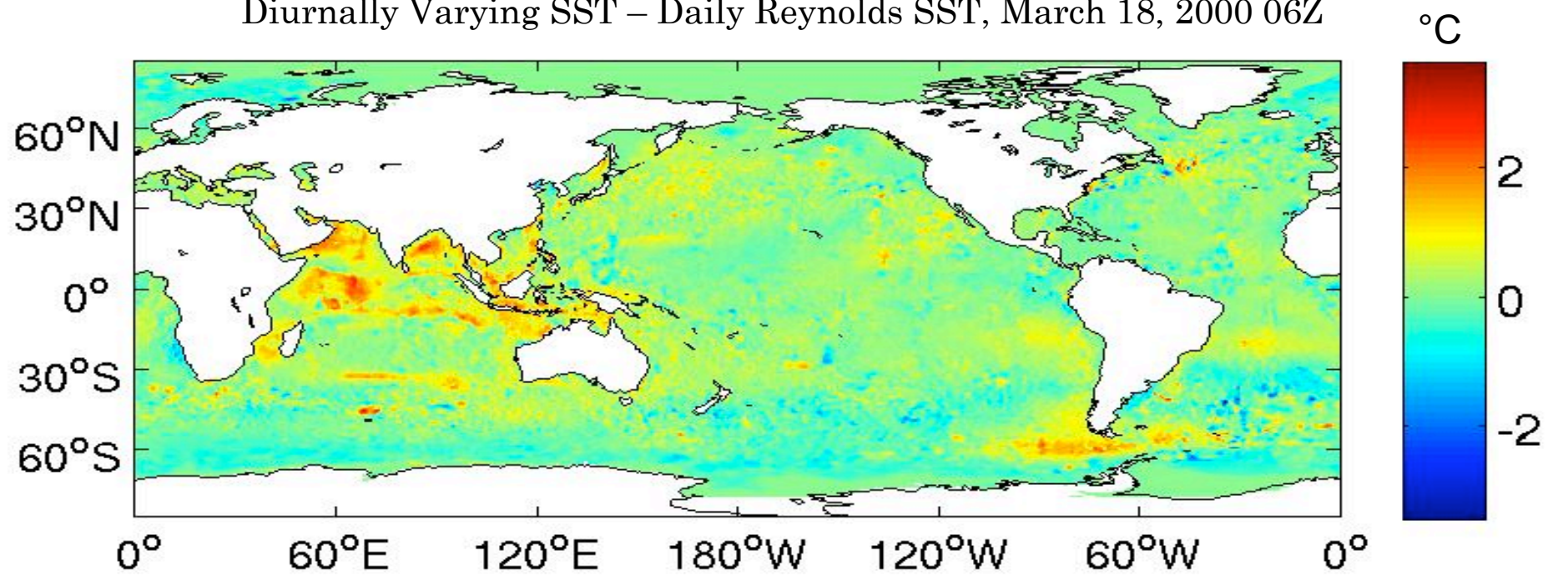




Daily Reynolds SST, March 18, 2000



Diurnally Varying SST – Daily Reynolds SST, March 18, 2000 06Z



# DENSITY OF SATELLITE DATA

03/07-03/13/10

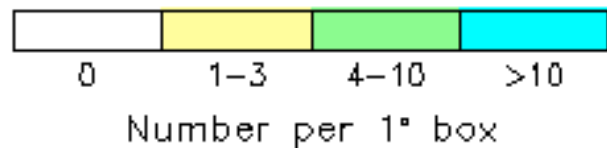
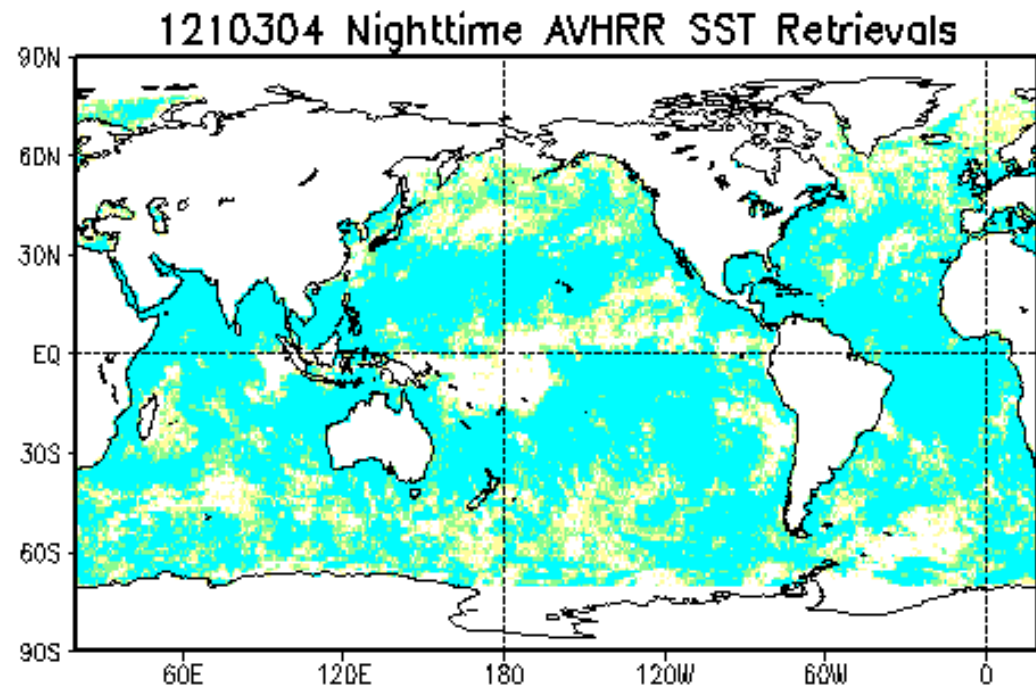
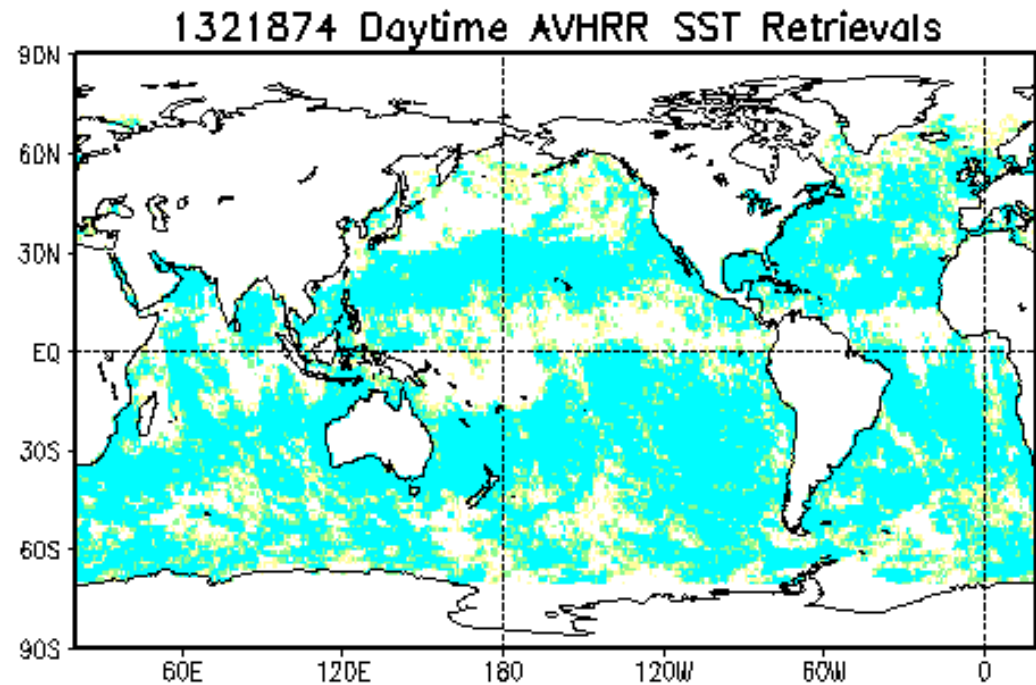
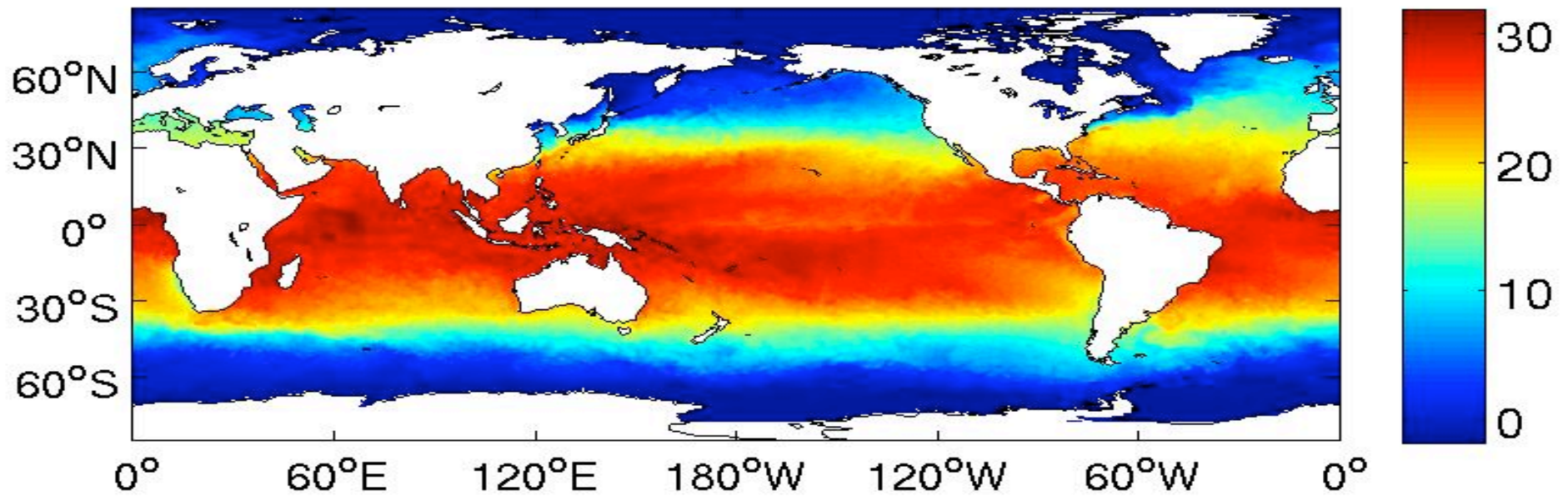


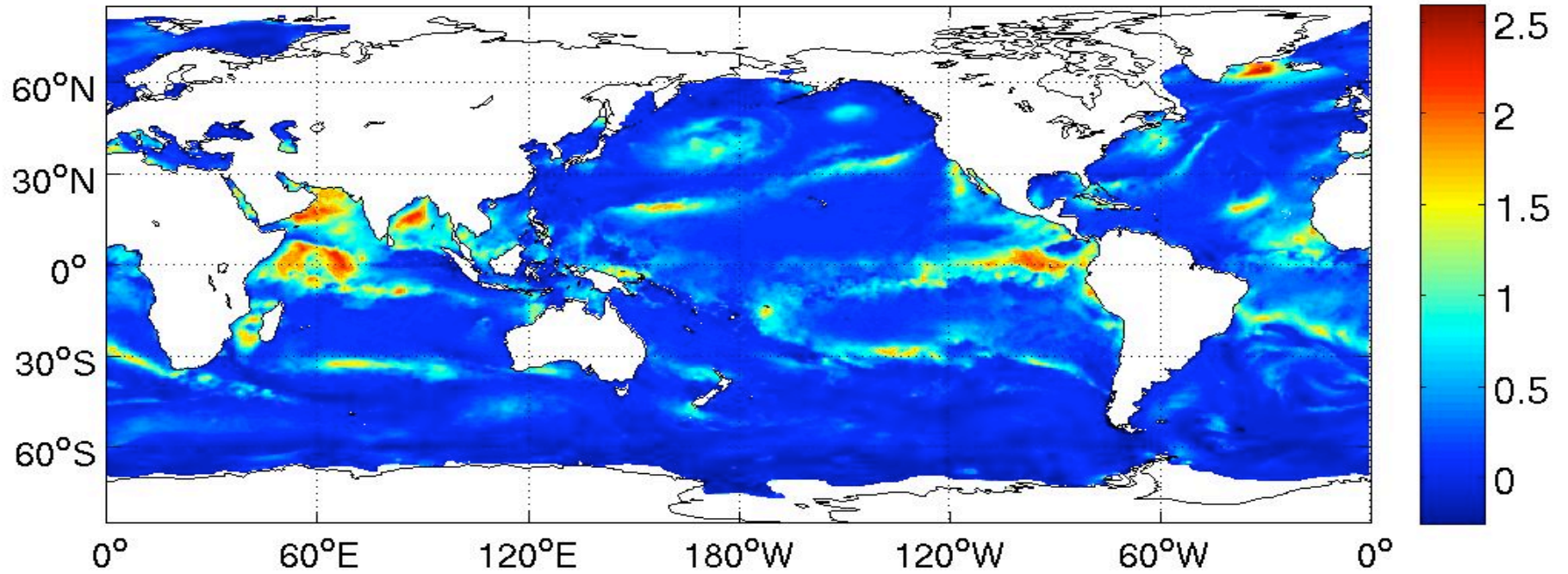
Image from [http://www.emc.ncep.noaa.gov/research/cmb/sst\\_analysis/images/satcol.png](http://www.emc.ncep.noaa.gov/research/cmb/sst_analysis/images/satcol.png)



Pre-Dawn SST, March 18, 2000



dSST - Max dSST ~ 2.59°C

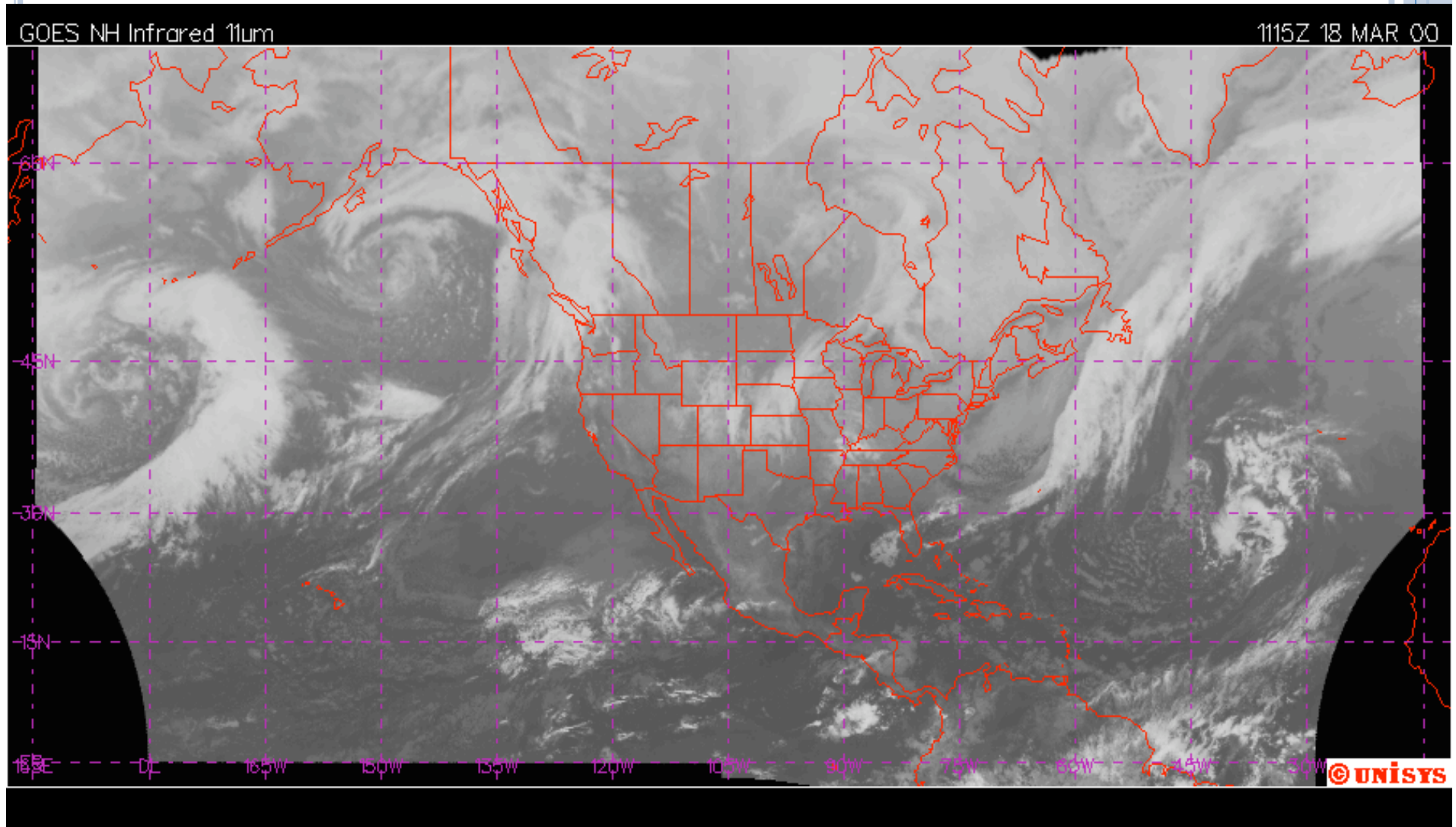


# SEAFUX FLUXES VERSION 1.0

- 01/01/1998 – 06/30/2005
- SSM/I based
- Use  $Q_a$  and  $T_a$  from Roberts et al. (2010) method
  - Neural Network methodology
  - $0.25^\circ$  by  $0.25^\circ$  global grid
- Winds:
  - Uninterpolated: Wentz Winds
  - Interpolated: Use NCDC winds gap-filled



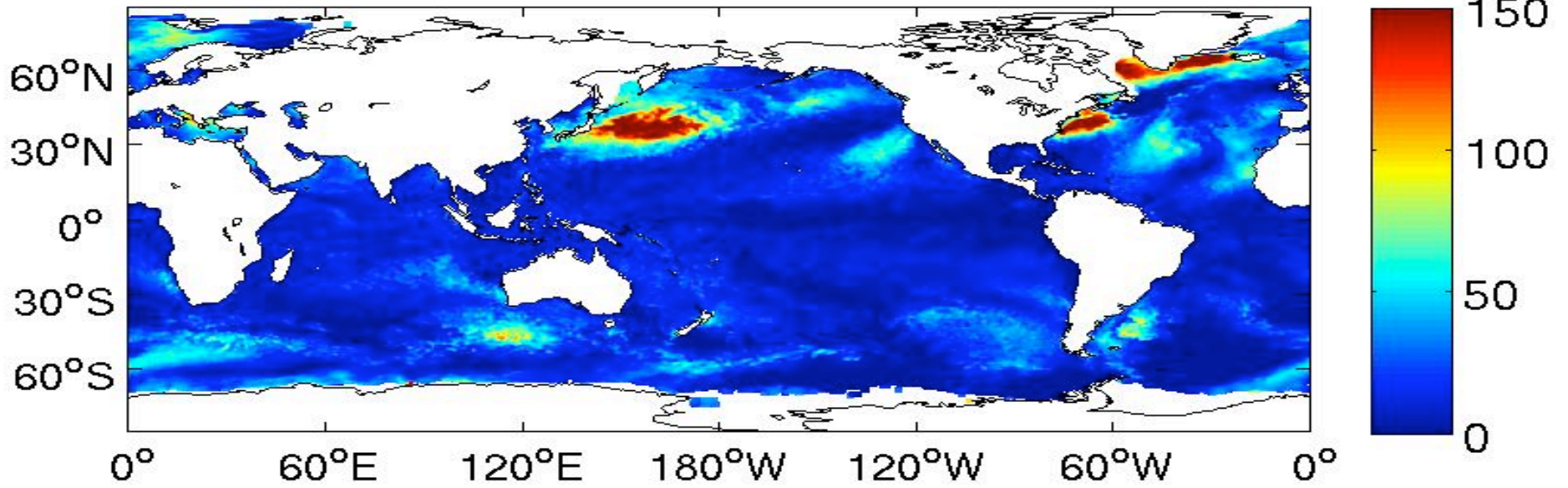
# INFRARED SATELLITE



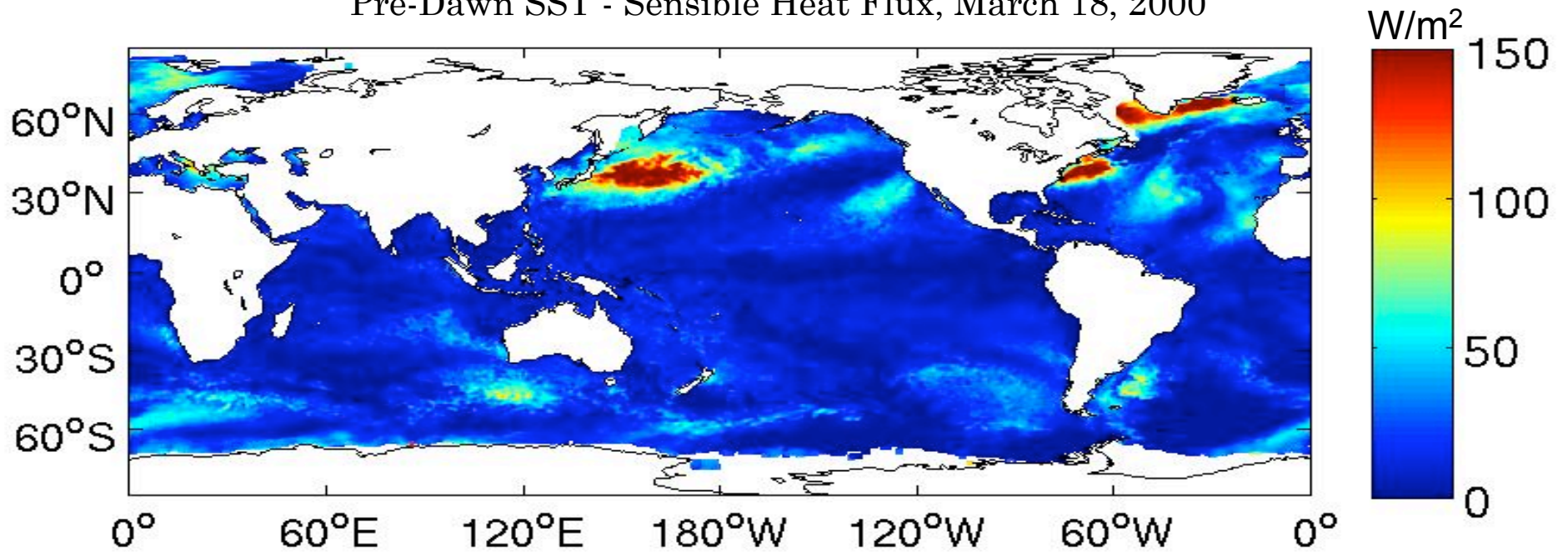
- Note the large low pressure system in Pacific.



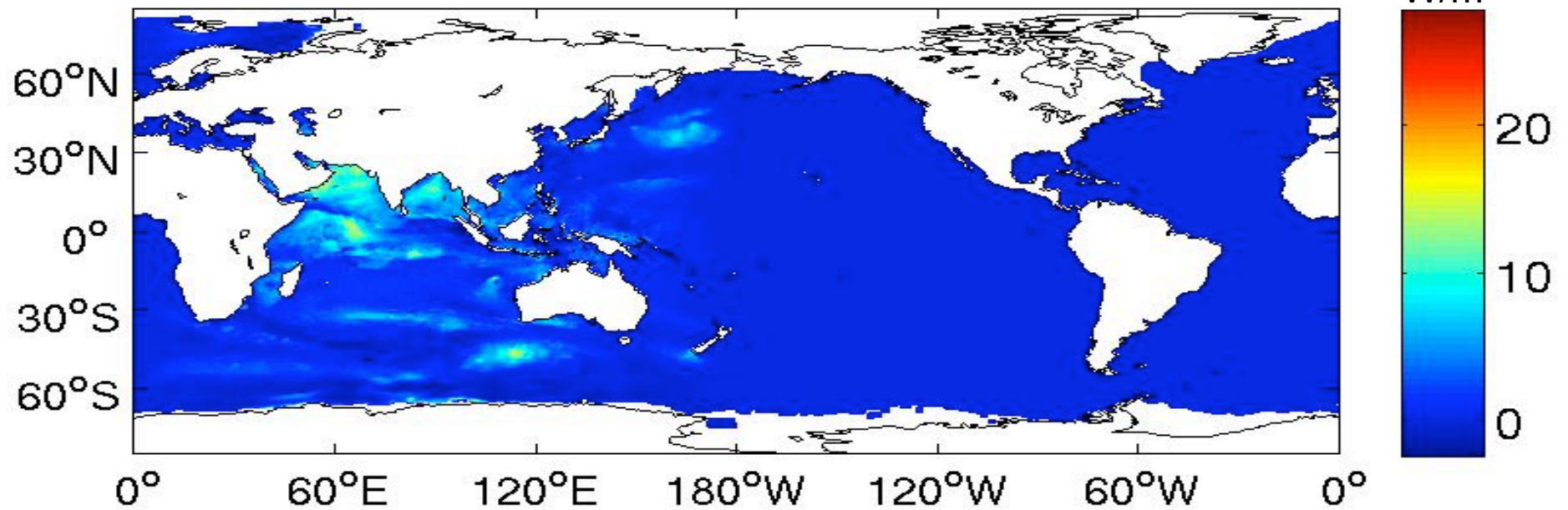
SeaFlux Sensible Heat Flux, March 18, 2000 – 06Z



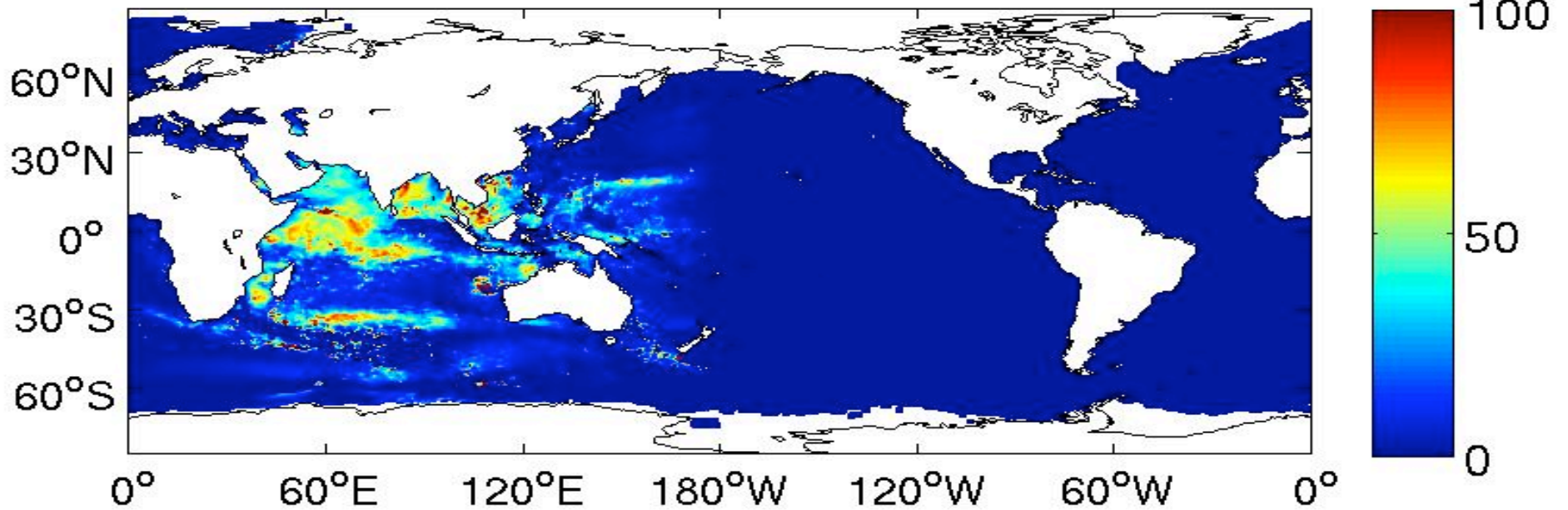
Pre-Dawn SST - Sensible Heat Flux, March 18, 2000



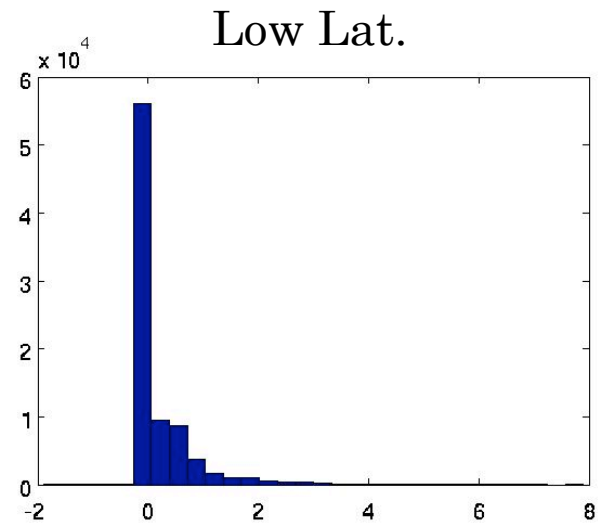
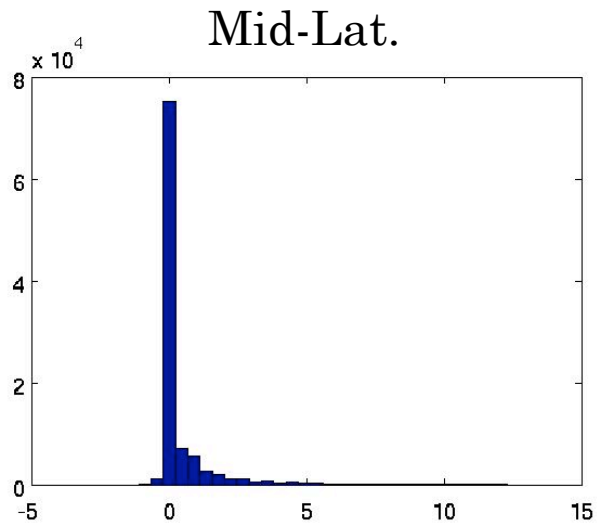
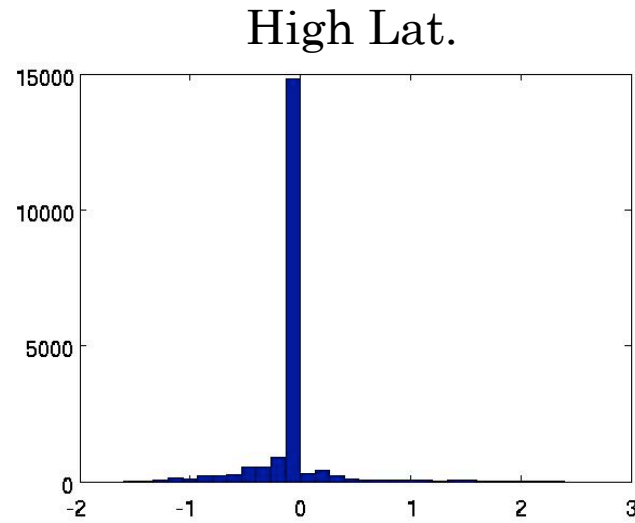
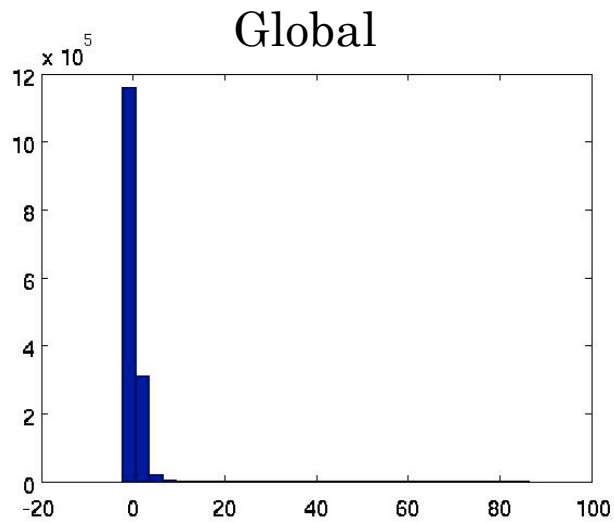
Sensible Heat Flux Difference (DV - PD), March 18, 2000 - 06Z



Sensible Heat Flux Percent Difference (DV - PD), March 18, 2000 - 06Z

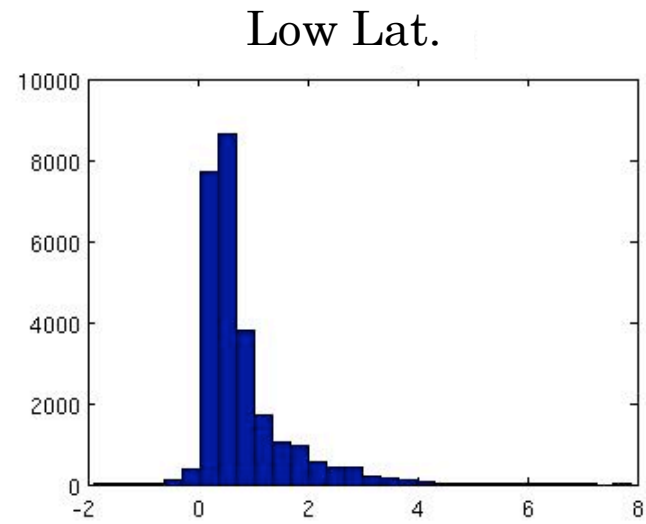
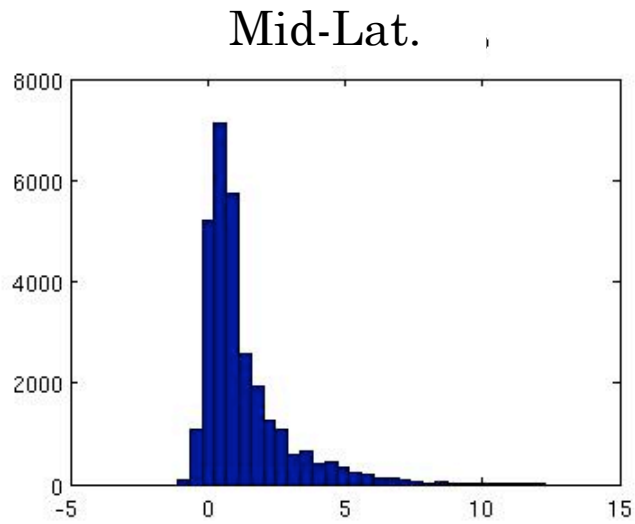
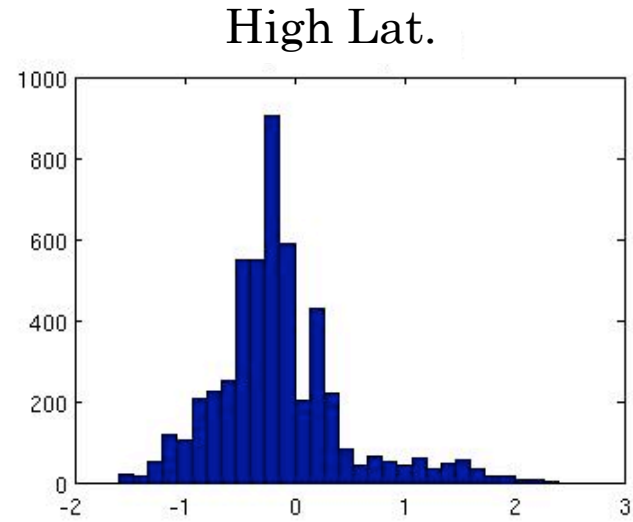
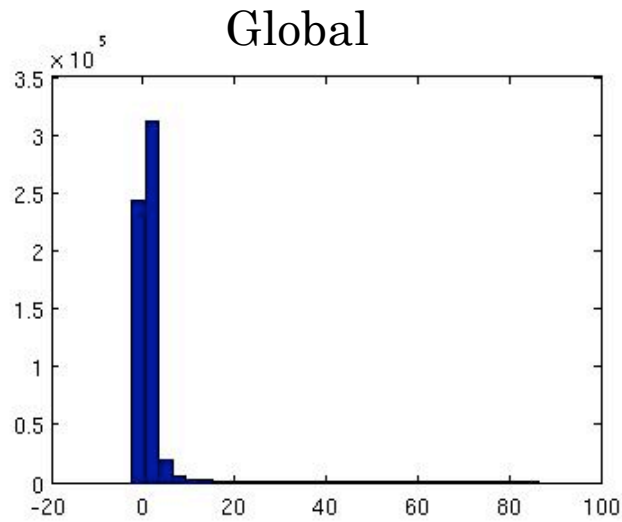


# SHF DISTRIBUTION OF DIFFERENCES

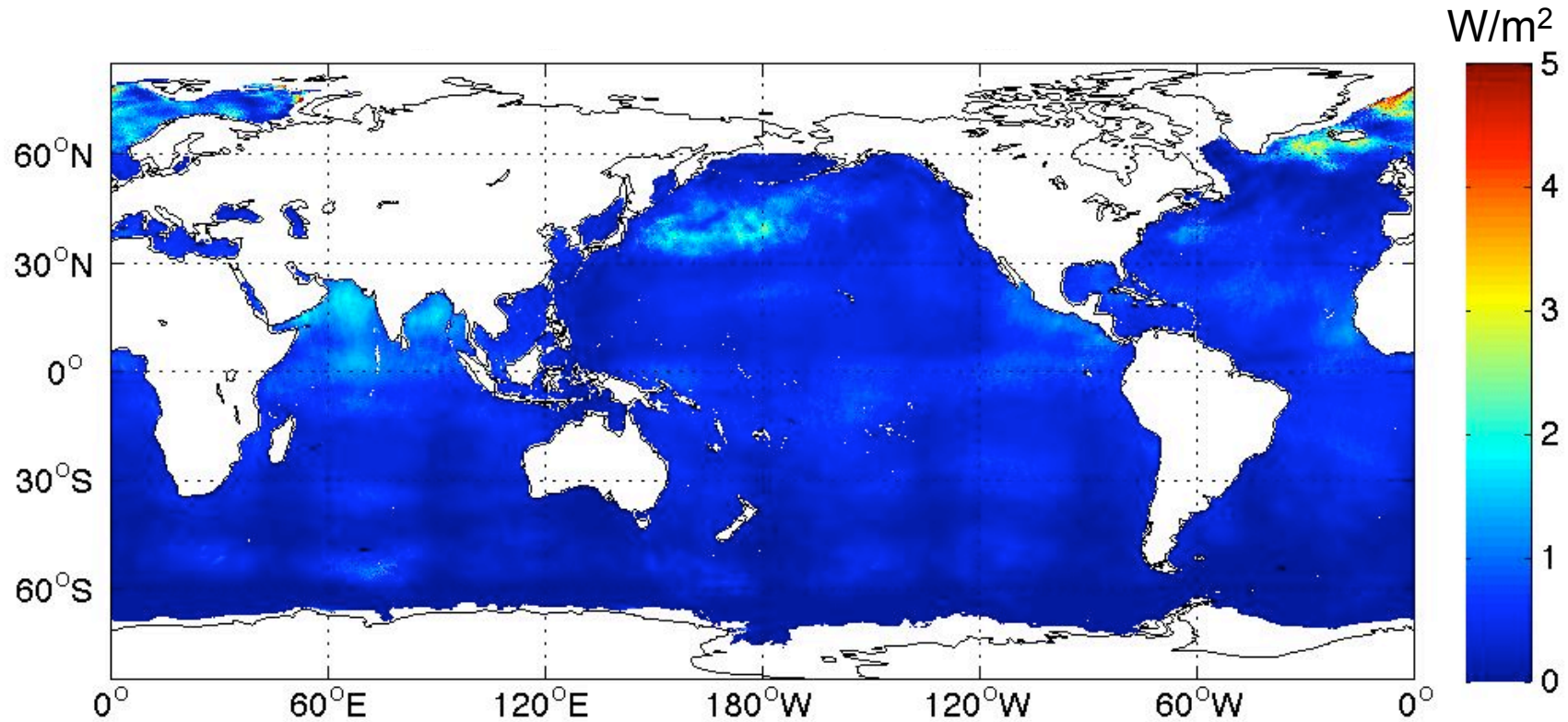




# SHF DISTRIBUTION OF DIFFERENCES



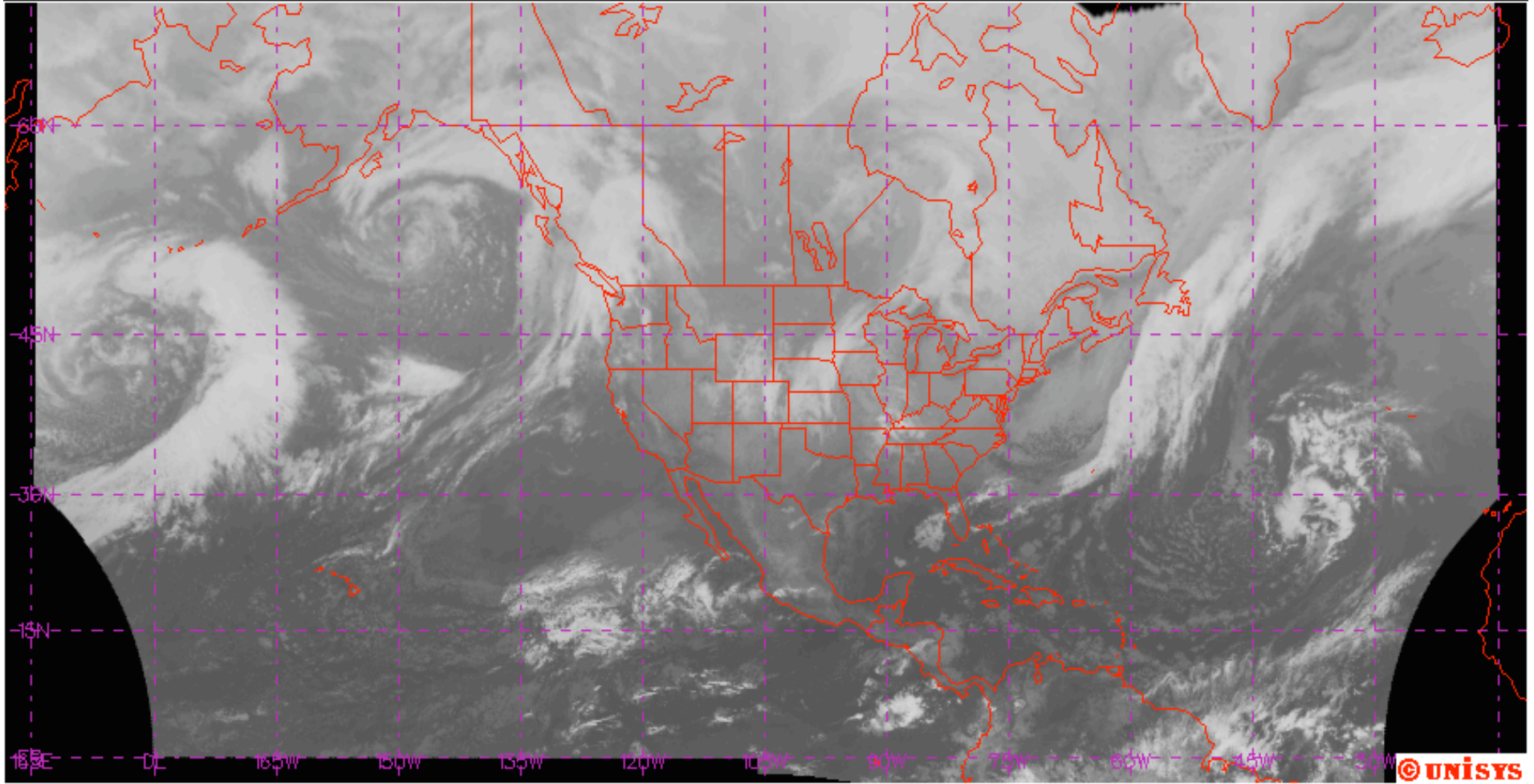
# MONTHLY AVERAGE SHF DIFFERENCE (DV-PD), MARCH 2000



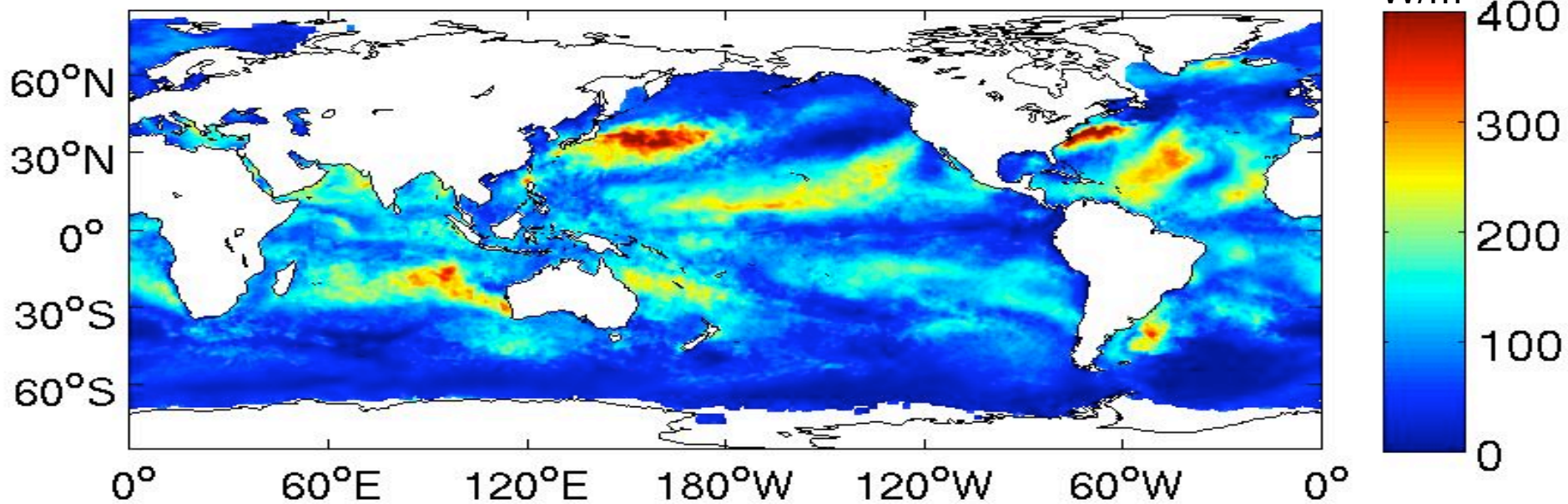
# RECALL THE INFRARED SATELLITE

GOES NH Infrared 11um

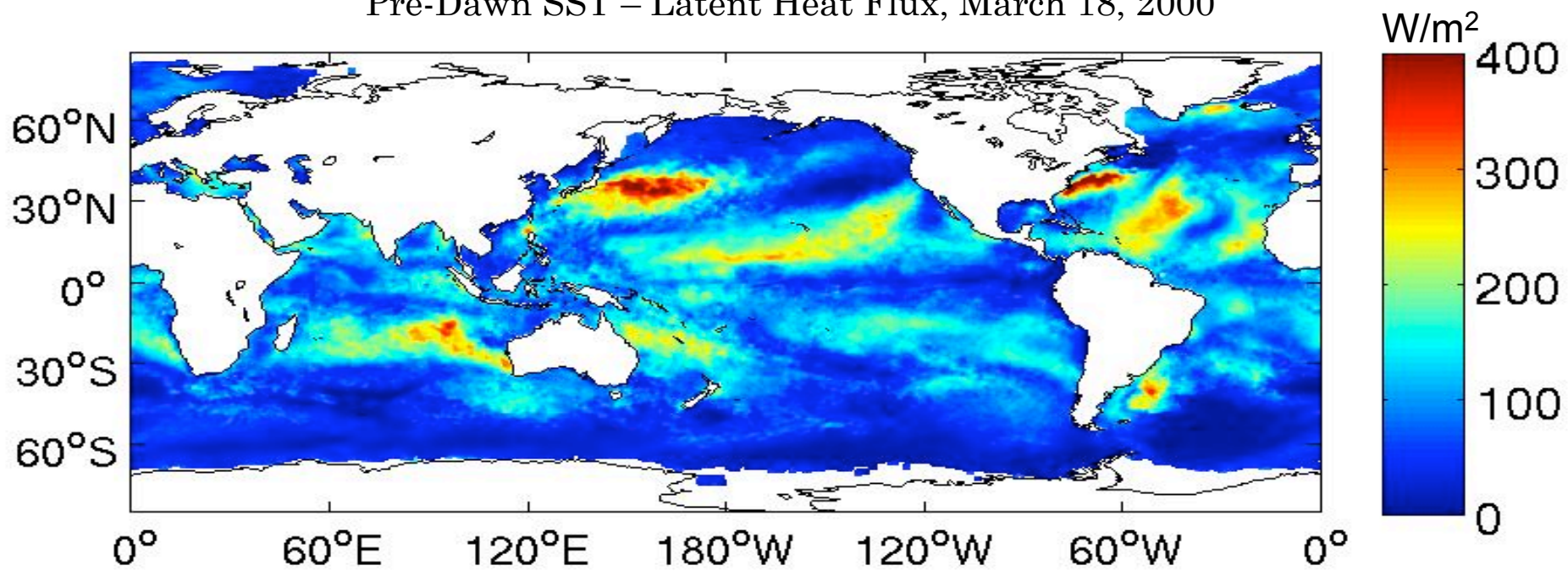
1115Z 18 MAR 00



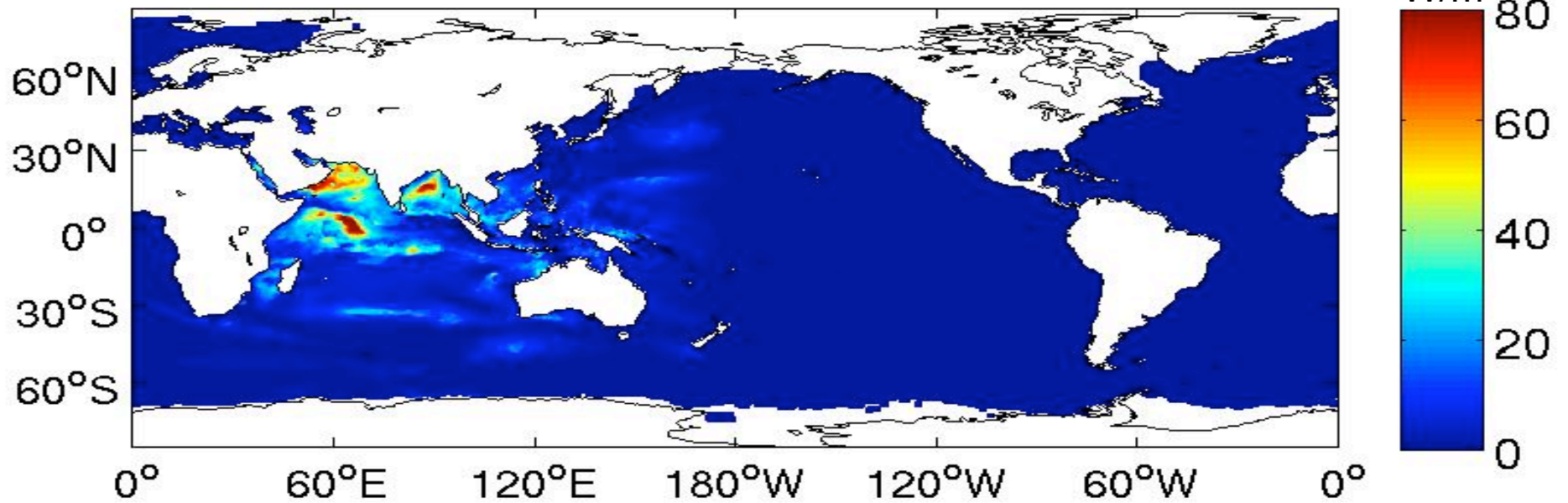
SeaFlux Latent Heat Flux, March 18, 2000 – 06Z



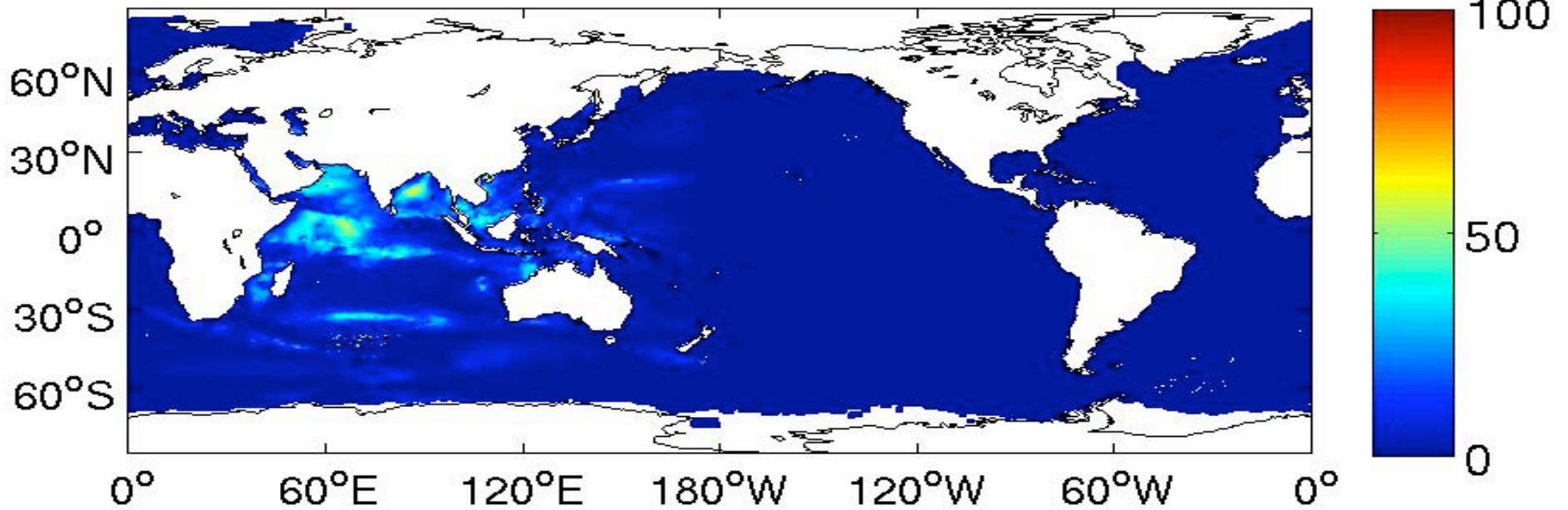
Pre-Dawn SST – Latent Heat Flux, March 18, 2000



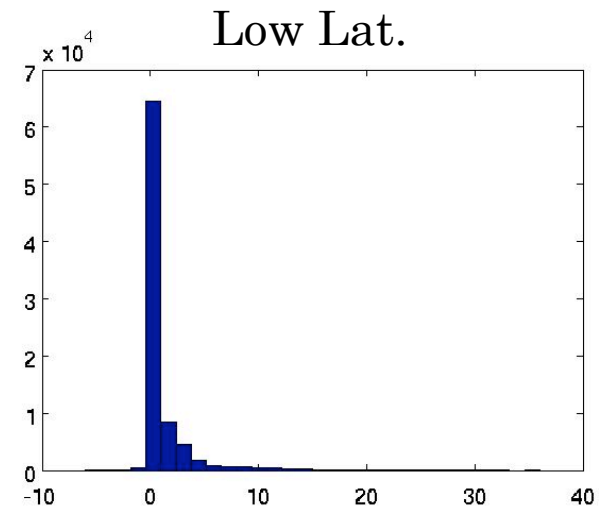
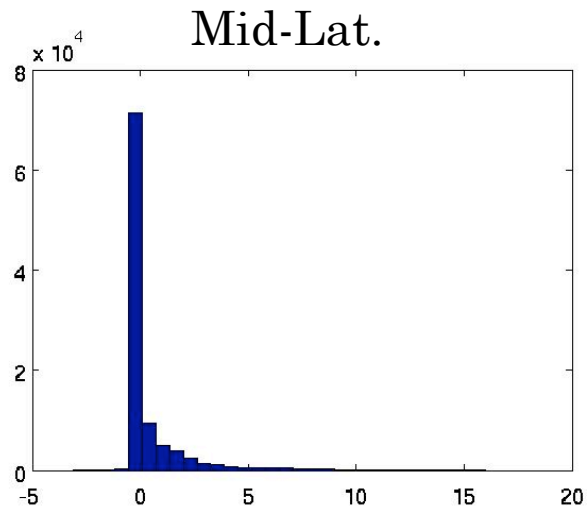
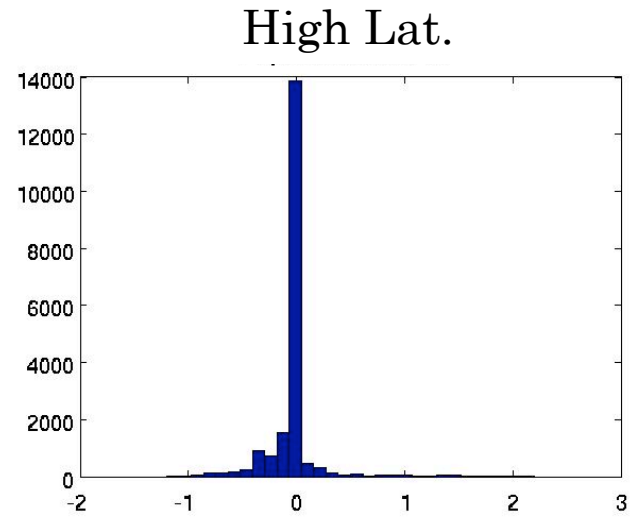
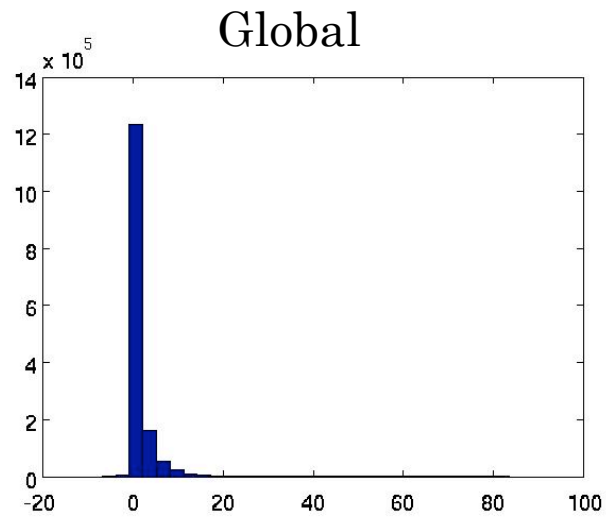
Latent Heat Flux Difference (DV - PD), March 18, 2000 - 06Z



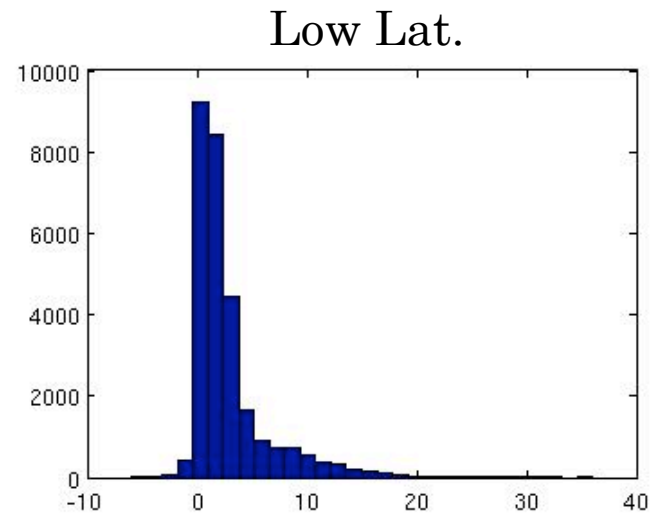
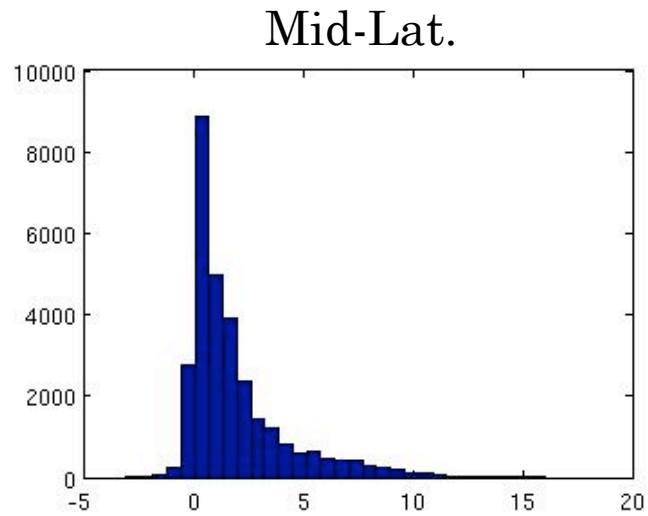
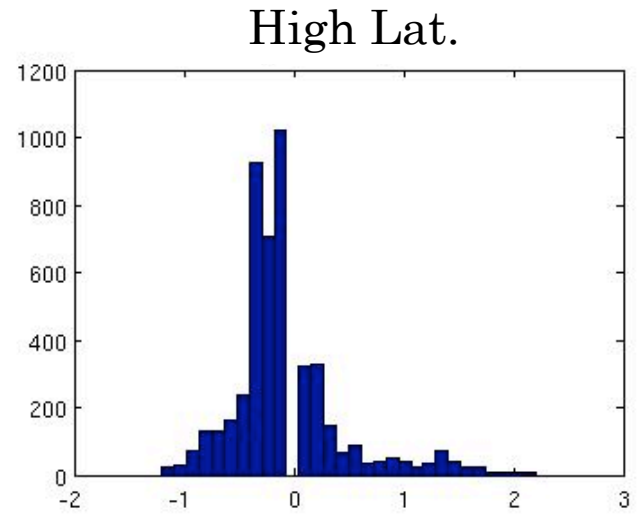
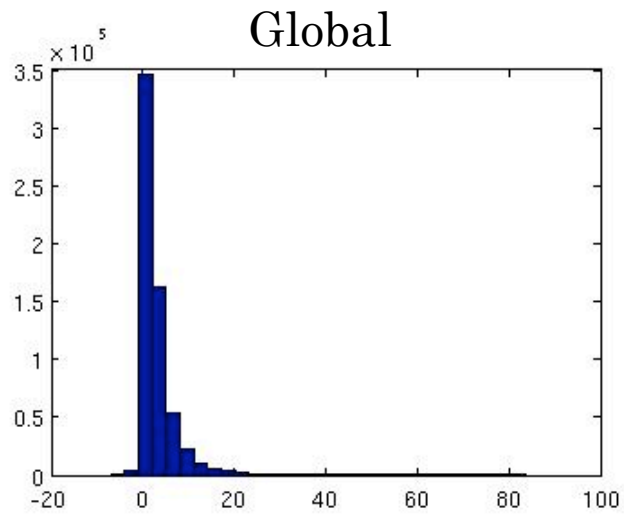
Latent Heat Flux Percent Difference (DV - PD), March 18, 2000 - 06Z



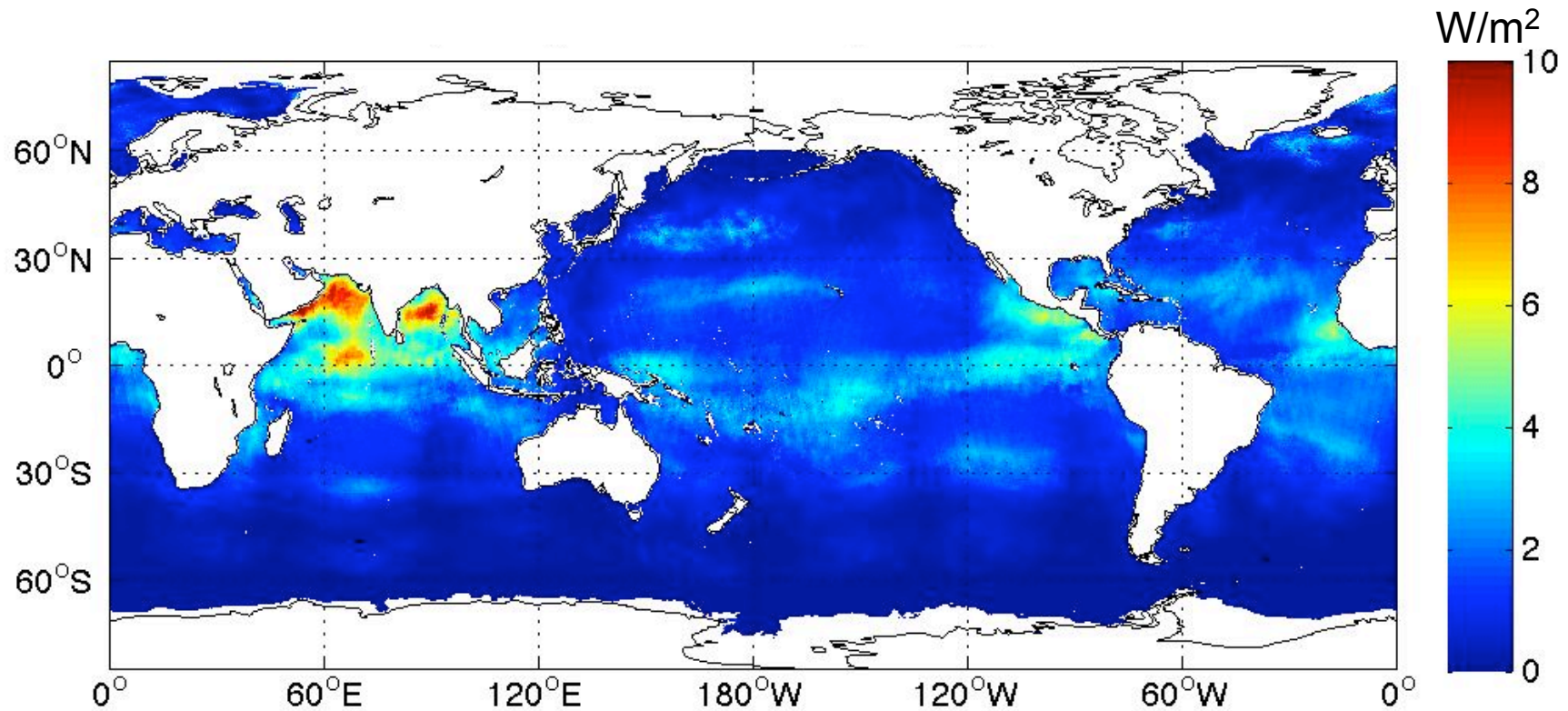
# LHF DISTRIBUTION OF DIFFERENCES



# LHF DISTRIBUTION OF DIFFERENCES



# MONTHLY AVERAGE LHF DIFFERENCE (DV-PD), MARCH 2000



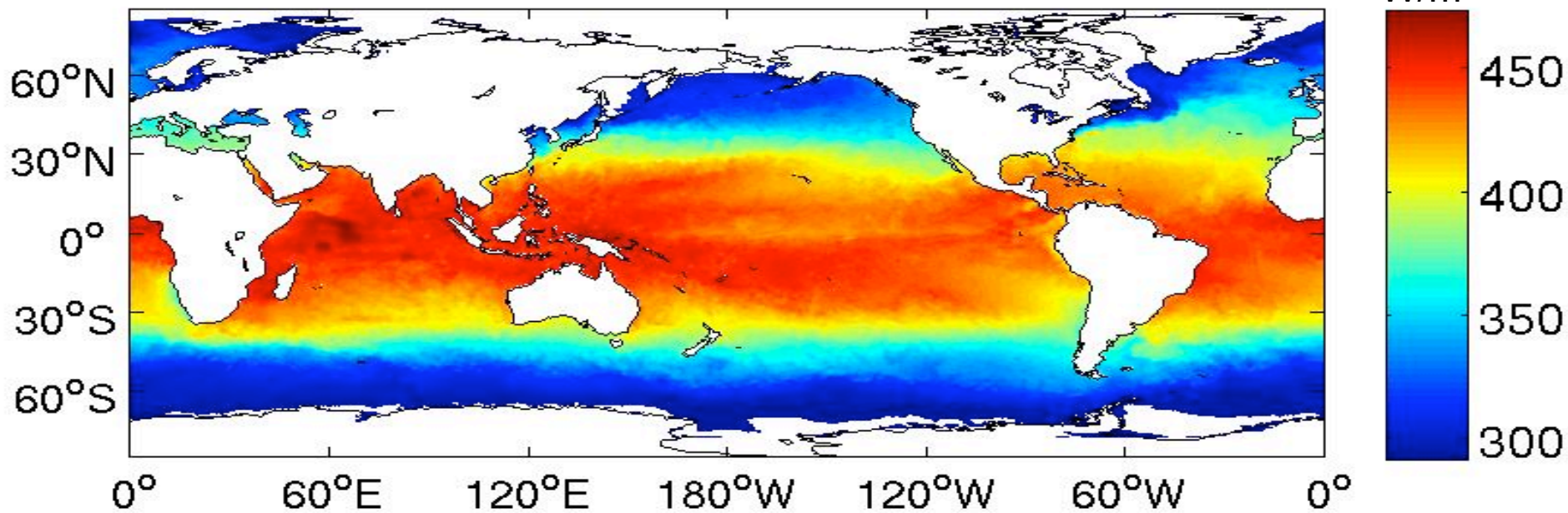


## OUTGOING LONGWAVE RADIATION FLUX

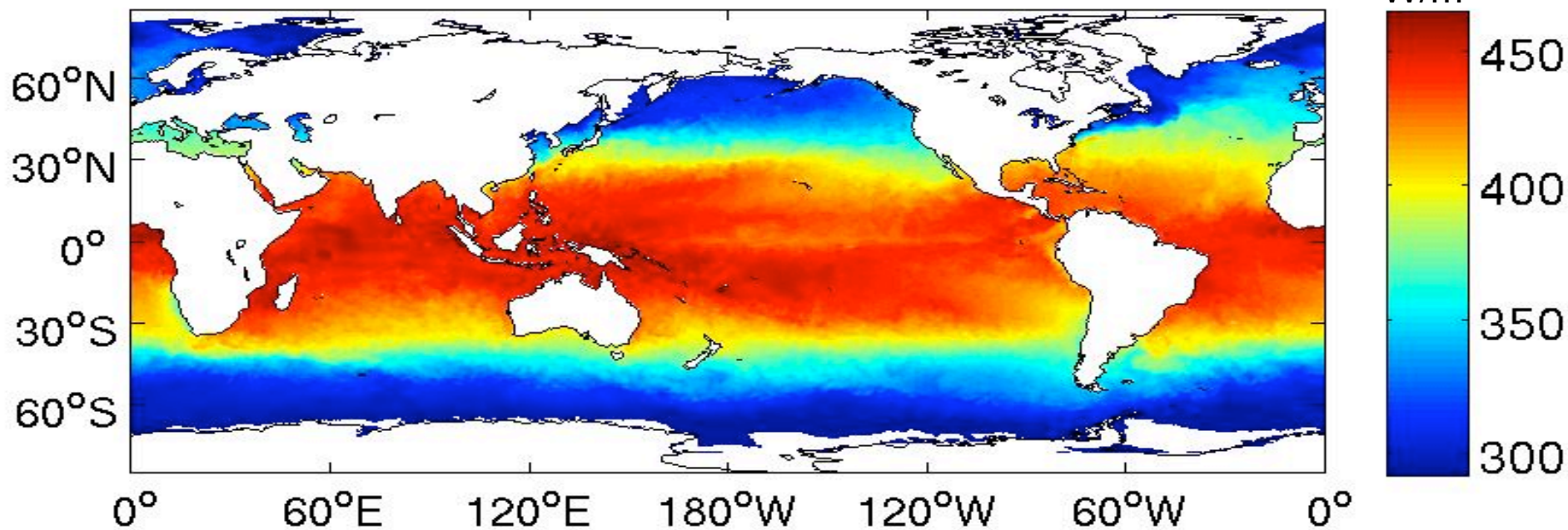
- For simplicity, emissivity is constant at  $\varepsilon = 0.95$
- Stefan-Boltzmann Law
  - $OLR = \varepsilon \sigma T^4$



Outgoing Longwave Radiation (DV), March 18, 2000 – 06Z

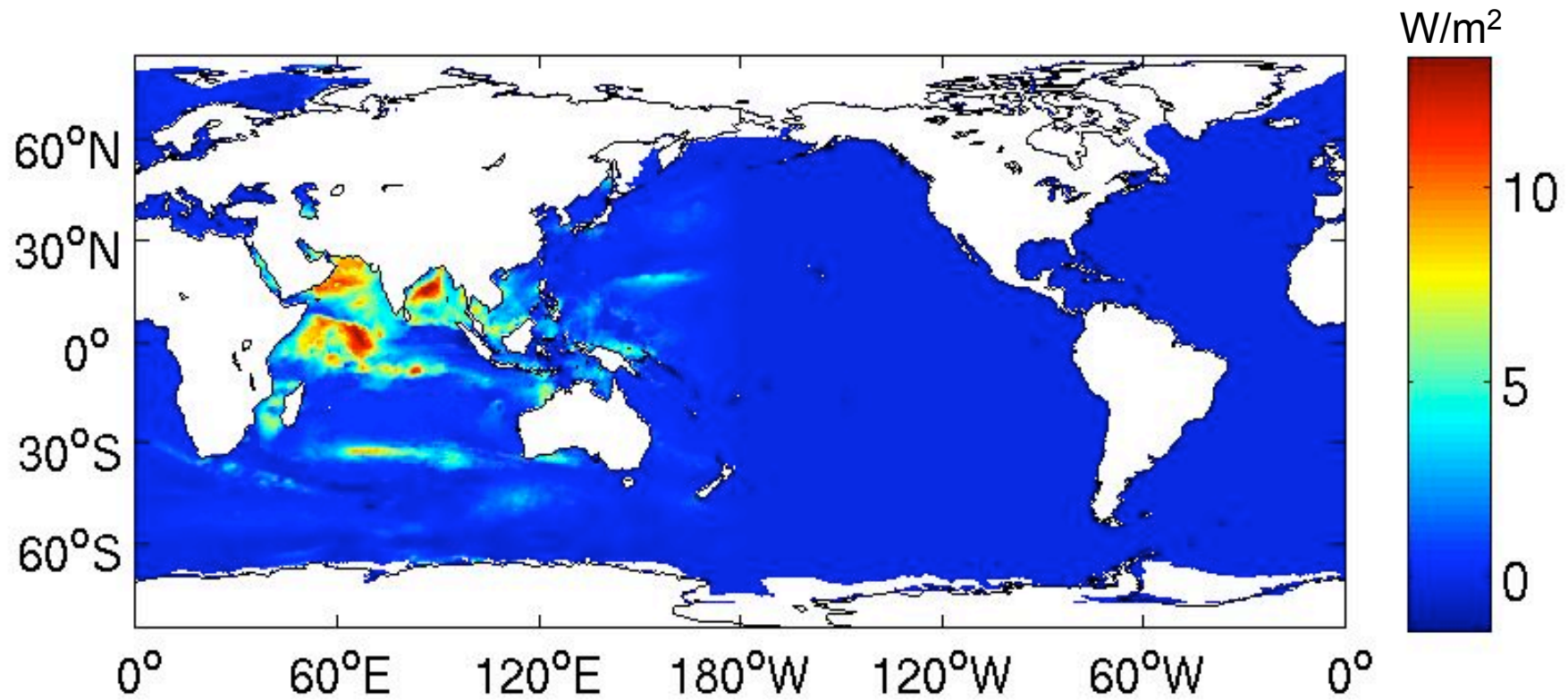


Outgoing Longwave Radiation (PD), March 18, 2000 – 06Z

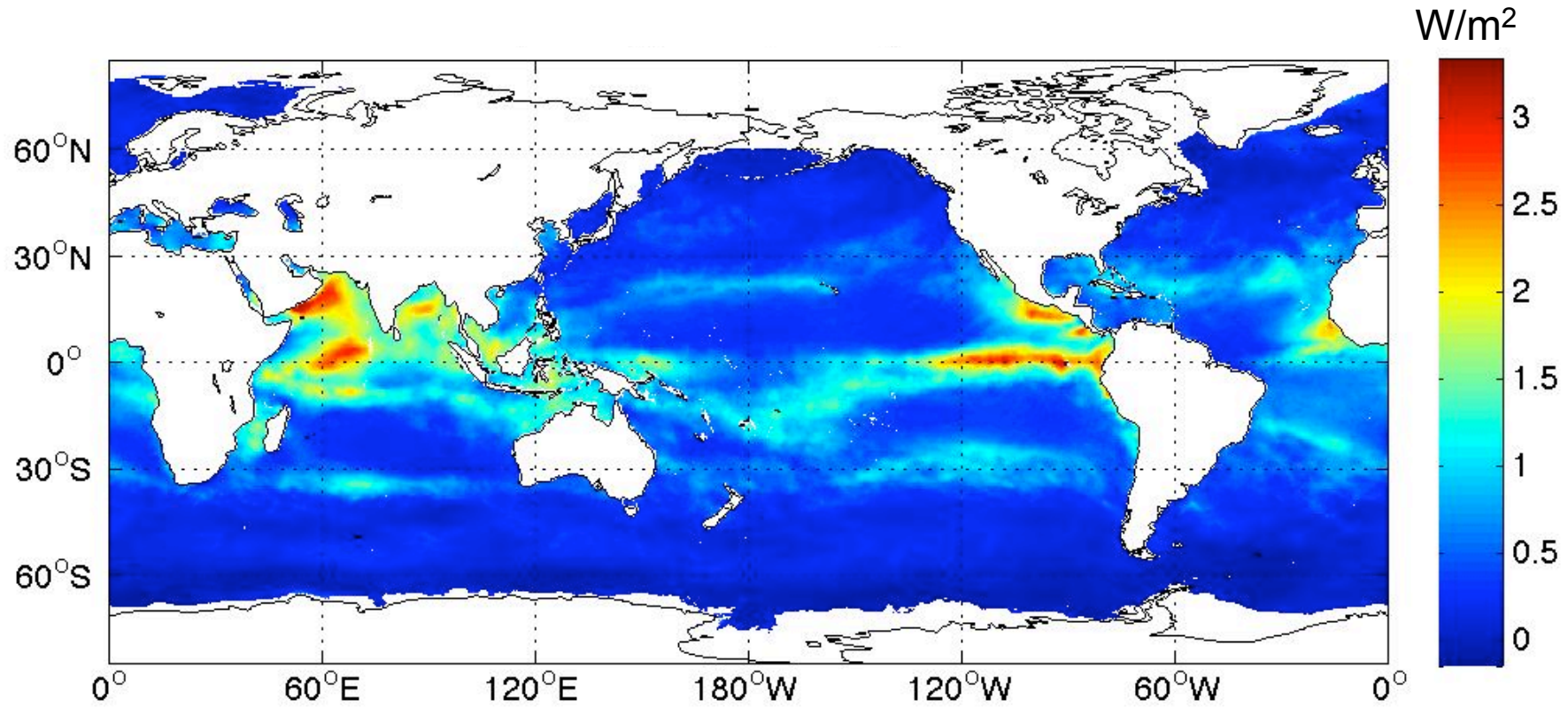


# OLR DIFFERENCE (DV-PD)

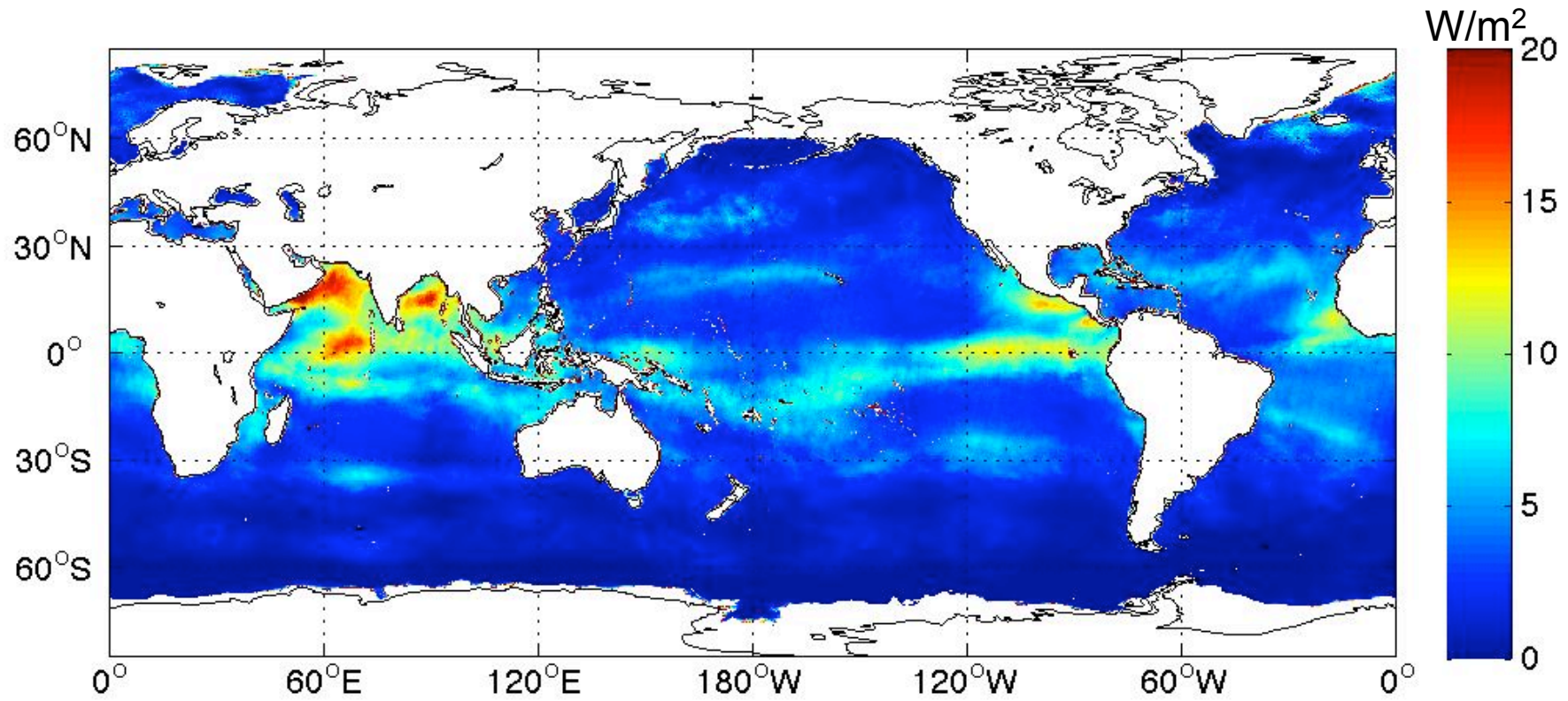
## MARCH 18, 2000, 06Z



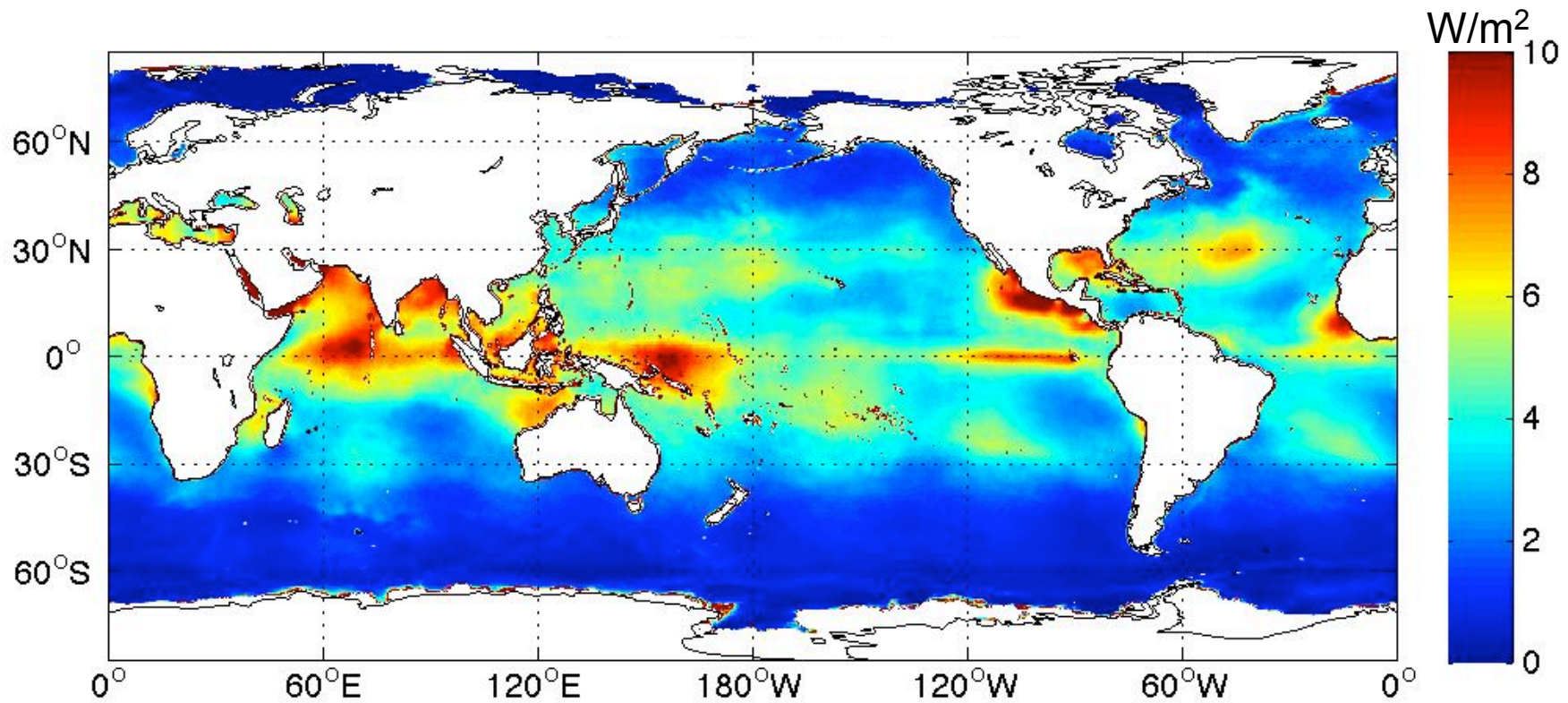
# MONTHLY AVERAGE OLR DIFFERENCE (DV-PD), MARCH 2000



# SURFACE ENERGY IMBALANCE, MAR 2000



# ANNUAL SURFACE ENERGY IMBALANCE 2000



## CONCLUSIONS

- On an instantaneous, daily, weekly, monthly, seasonal and yearly scale, the inclusion of a diurnally varying SST in the surface energy budget impacts the surface balance.
- To properly calculate the global energy budget, a diurnally varying SST should be included.



## DIURNALLY-VARYING SST VERSION 2.0

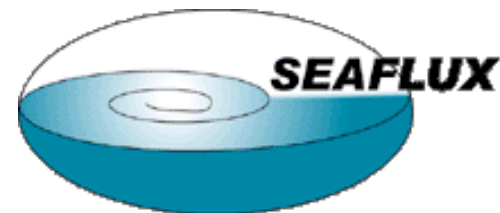
- Pathfinder SST basis
- Ice flagging
- Improved temporal interpolation
- Improved dSST algorithm (length of day)
- Aerosol correction\*
- To be used in SeaFlux Fluxes V2.0





## SEAFLUX FLUXES V1.0 ARE AVAILABLE!

- $Q_a$ ,  $T_a$ , LHF, SHF, and winds (after 2001 only)
- Uninterpolated and Interpolated
  - 3 hrly
  - $0.25^\circ \times 0.25^\circ$  grid
- Matlab read scripts available (FORTRAN coming soon)
- <http://casil.met.fsu.edu/seaflux>



# FOR MORE INFORMATION ON SEAFLUX FLUXES V1.0

- Poster -
  - Carol Anne Clayson: New developments and remaining issues with satellite-derived air-sea flux climatologies.

THANK YOU!

