Figure 1 offers the AVHRR(0.25-degree daily)-based SST trend estimates, which is roughly agree with the estimate based on Pathfinder 5.0 SST (Good et al., 2007). Figure 1(B) also shows that some discrepancy between AVHRR and Pathfinder 5.0. It seems that AVHRR has smaller standard deviation than Pathfinder 5.0. Does that mean that AVHRR (1-degree daily SST) did a better job than Pathfinder 5.0 (monthly, 4096x8192)?

Figure 2 shows the spatial patterns of SST trend from AVHRR (0.25-degree), which are much higher than the spatial resolutions in two previous studies (Casey et al., 2001 and Good et al., 2007). Also the figure shows some differences between the current estimates based on AVHRR 0.25-degree daily SST and previous estimates.

Figure 3 suggests that model simulation has a basic agreement with observation at the global-scale. Figure 4 further shows model does a good job in the simulation of global-average SST. Considering that model has all physics, dynamics, and diagnostic outputs, the agreement between model and observation suggests a way to figure out the physics behind the SST trend (related to the global warming).

We already did some diagnostic study on the driving forces of SST (long-wavelength radiation(lw), short-wavelength radiation(sw), sensible heat(sh), and latent heat(lh)) based on the diagnostic output of model (not shown). However, the spatial patterns of their trends (lw, sw, sh, and lh) are not same as the spatial pattern of SST trend). By varying density, heat capacity, and height of PBL, we can match these trends of driving forces (lw, sw, sh, and lh) to the corresponding SST trend.

Figure A1 suggests that spatial patterns based on Pathfinder 5.0 SST (Good et al., 2007) should be used with caution for middle and high latitudes.

Figure A2 shows that cloud-affected AVHRR has negative bias comparing to the cloud-free AMSR observation, but it seems that the bias is systematic so that it does not affect our study on trend.
Figure 1. (A) Time series of global-average SST based on AVHRR daily 0.25-degree SST. We average the daily SST over into monthly SST and remove the seasonal cycle by subtracting the climatology seasonal cycle. The dashed line is linear fitting with fitting trend 0.016K/year (or 0.16K/decade). (B) Time series of tropical (30S-30N) SST based on AVHRR daily 1-degree SST and Pathfinder 5.0 monthly SST (4096x8092 grid point). The fitting shows linear trends 0.015K/year (0.15K/decade) and 0.016K/year (0.16K/decade) for AVHRR and Pathfinder 5.0, respectively. All of trends in (A) and (B) have confidence levels larger than 99%. The best-quality (flag=7) observations in Pathfinder 5.0 monthly SST have good coverage for tropical regions (>80%), but poor coverage in middle and high latitudes (please refer to Appendix Figure A1 for an example of coverage of best-quality observations in Pathfinder 5.0 monthly SST).
Figure 2. Spatial patterns of SST trend based on AVHRR monthly 0.25-degree SST, which comes from AVHRR daily 1-degree SST. (A) Zonal-average SST trend. (B) Global map of SST trend based on monthly SST from 1985 to 2006. (C) Areas with green-color represent confidence level of linear trend larger than 95%. Even though for tropical regions, the best-quality (flag=7) observations of Pathfinder 5.0 monthly SST in most of grid points are not continuous in time. Therefore, we did not calculate the spatial patterns of trend based on Pathfinder 5.0.
Figure 3. Comparison of spatial patterns of SST trend between AVHRR and Model simulation. (A) and (B) are same with figure 2 (A and B) except for a relatively short time period (1993-2001) for comparison with model simulation. (C) and (D) are zonal-average and global maps of SST trend based on Mitgcm output of monthly SST (Cube55) in the same time period (1993-2001). (Cube 55 actually begins from 1992. We discard the beginning year (1992) due to poor initial simulation. Cube 65 has longer integration (1992-2006) than Cube55, but our calculation shows that the discrepancy between AVHRR and Cube65 in the time series of global-average SST increases sharply after 2001 (not shown)).

Figure 4. Comparison of time series of global-average SST between AVHRR and model simulation.
Figure A1. Example of coverage of best-quality (flag=7) observations for Pathfinder 5.0 monthly SST. Green-color areas represent the best-quality observations of Pathfinder monthly SST for January of 1995. We also checked different months and different years, which have almost same spatial pattern with January of 1995.

Figure A2. Comparison of time series of global-average monthly SST between AVHRR and AMSR for 2003-2006, which is based on globally 0.25-degree daily SST.