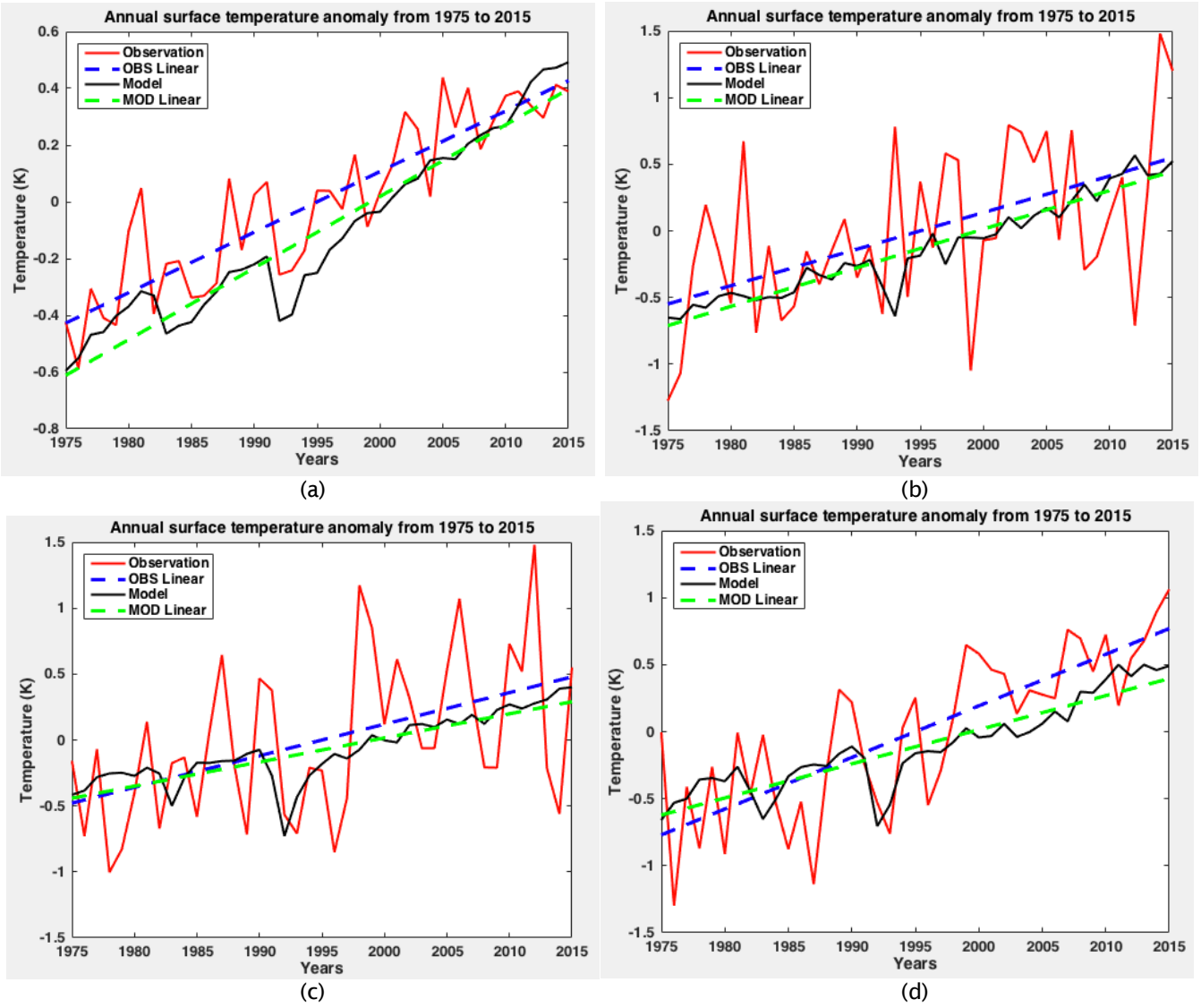
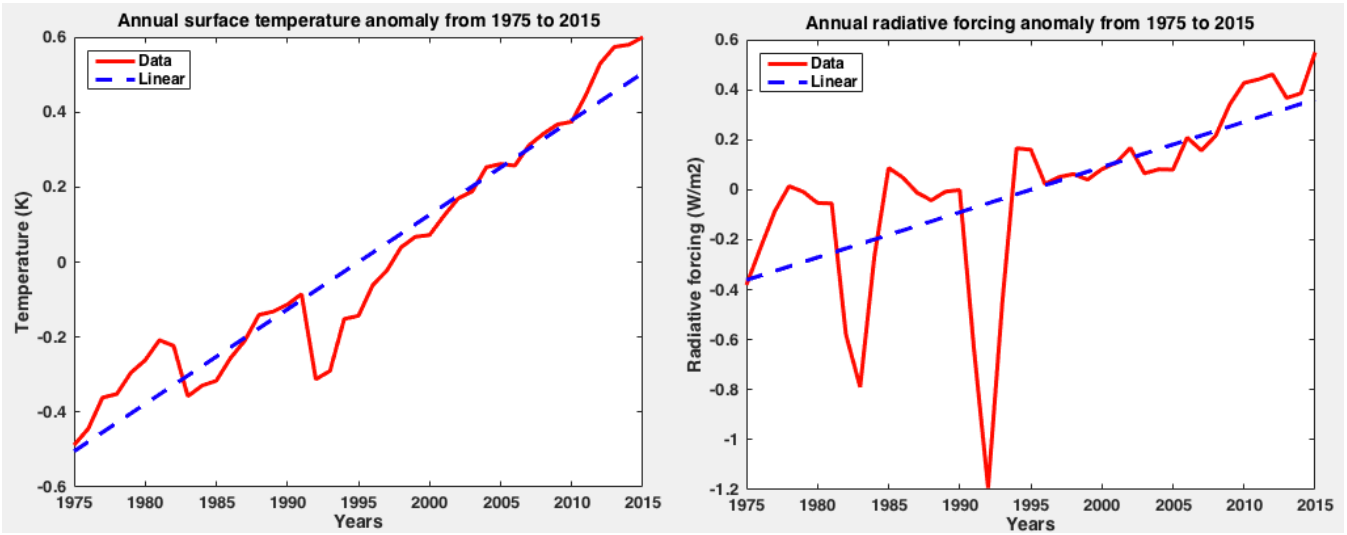
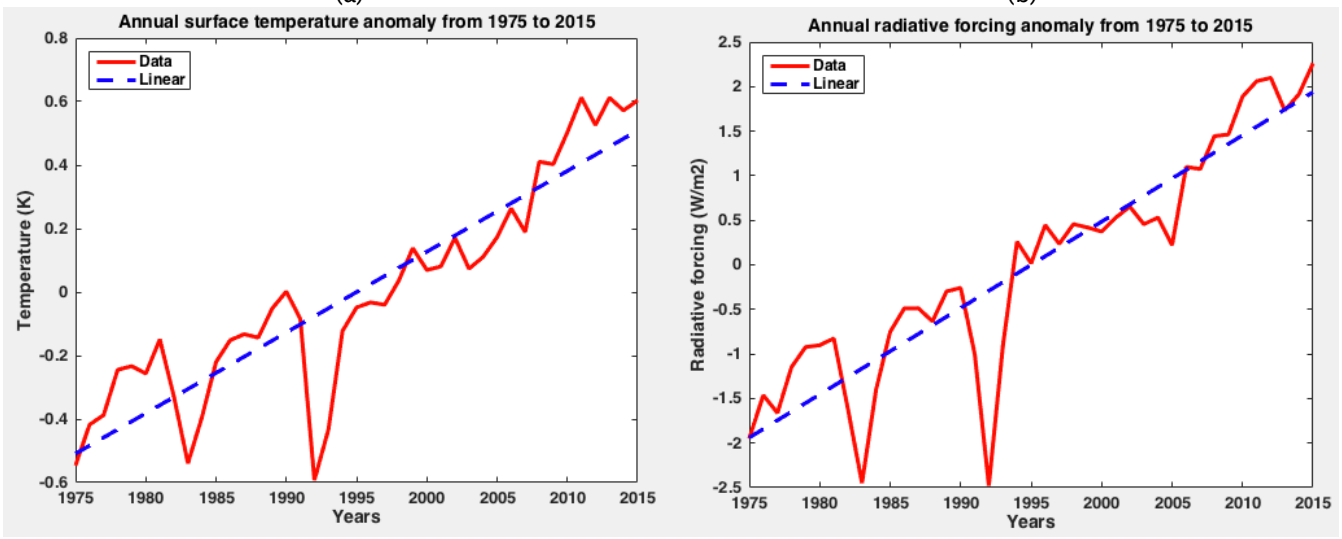


Figure 1. Annual surface temperature anomaly (degrees K) from 1975 to 2015 for (a) the global average; (b) Europe; (c) East Asia; (d) United States, respectively. The red and black lines are the observation data and model data, respectively; and the blue and green dash lines are the corresponding linear trend for observation and model data.

The annual surface temperature and radiative forcing anomaly from 1975 to 2015 is presented in Figure 2. The linear trend for surface temperature and radiative forcing anomaly for globe, United States and Europe (Figure (a), (b); (c), (d), (g). (h)) is both monotonic increase but at a different rate, which indicates that the surface temperature and radiative forcing change has positive relationship. As radiative forcing increase in time, the surface temperature will also increase. However, for East Asia (Figure 2 (e), (f)), as the radiative forcing decrease, the surface temperature increase, which shows an inverse relationship. This is due the large amount of aerosol emissions in East Asia region during 1975 to 2015 time period – the particles (not all but most) reflect solar radiation to cause cooling effect. However, reflection of sunlight by particles only happens during the day time, during the night time the greenhouse gases warming effects is dominant which results in the increase of the surface temperature. This will be accounted for in our analyses.


Annual surface temperature anomaly from 1975 to 2015
Data
Linear
Temperature (K)
Years
Annual radiative forcing anomaly from 1975 to 2015
Radiative forcing (W/m2)

(a) (b)


Annual surface temperature anomaly from 1975 to 2015
Data
Linear
Temperature (K)
Years
Annual radiative forcing anomaly from 1975 to 2015
Radiative forcing (W/m2)

(c) (d)

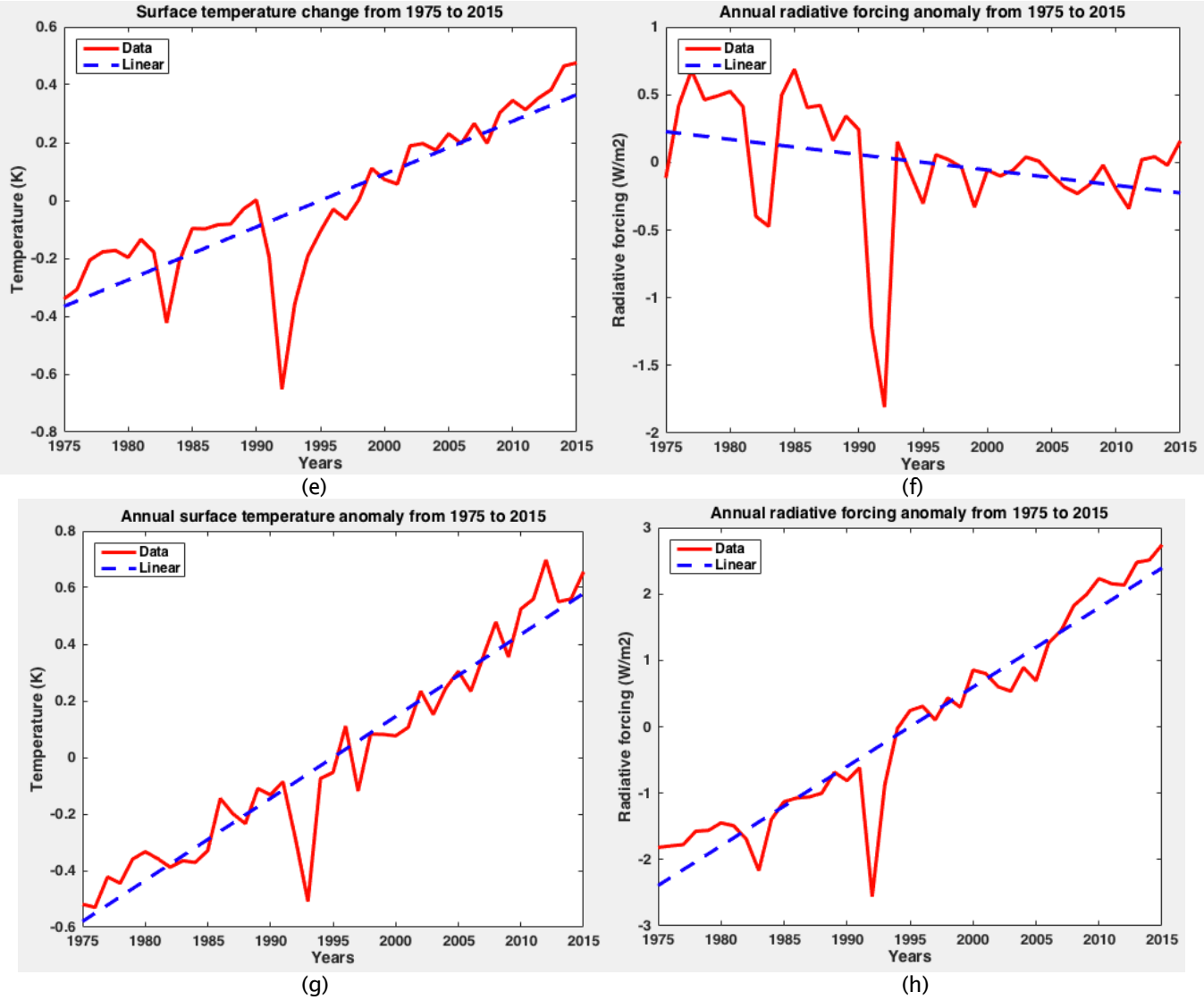


Figure 2. Annual surface temperature anomaly (degrees K) from 1975 to 2015 for (a) global average; (c) United States; (e) East Asia; (g) Europe. Annual radiative forcing anomaly from 1975 to 2015 for (b) global average; (d) United States; (f) East Asia; (h) Europe respectively. Red solid line is the model data; blue dash line is a linear fit.

Publications

Zhang, J., and D. Wuebbles, Report to the FAA on analyses of APMT v24. University of Illinois, 2018

Outreach Efforts

Results presented at several ASCENT meetings. Journal paper to expected from the regional aviation analyses.
Dr. Wuebbles made a special invited presentation on the history of the understanding of environmental effects from supersonic aircraft at a FAA sponsored meeting in spring 2018.

Awards

None

Student Involvement

Graduate student Jun Zhang is responsible for the analyses and modeling studies within the project and leading the initial preparation of the project reports.

Plans for Next Period

Continue doing regional analysis. The following aspects will be focused on in the next period:

1) Continue developing the relationship between surface temperature and radiative forcing change using the existing CESM model data – determine the appropriate approach to represent the radiative forcing change over East Asia;
2) Conducting model simulations to calculate the induced radiative forcing for aviation gases and particle emissions using the CAM-chem6 model;
3) Apply the developed relationship to aircraft emissions to obtain the aviation induced surface temperature change for both global and regional scales. The calculated aviation induced temperature change over four latitude bands will be compared with the temperature change calculated from CICERO approach, to evaluate the findings as a test of their and our methodologies;
4) Using the evaluated relationships, determine the change in temperature from aviation emissions (current and future projections) over various regions.
5) Prepare and submit report to the FAA and a corresponding journal paper.