Usefulness of AIRS-Derived OLR, Temperature, Water vapor and Cloudiness Anomaly Timeseries for GCM Validation

Gyula I. Molnar
Gyula.I.Molnar@nasa.gov

Joel Suskind
NASA Goddard Laboratory for Atmospheres

SAIC

Lena Jireddi
Lena.Jireddi@nasa.gov

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Motivation:
In the beginning, a good measure of a GCM's performance was their ability to simulate the observed mean seasonal cycle. Here, a reasonable simulation of the mean (i.e., small biases) and standard deviations would suffice. More recently, Relficher and Kim [2008] argued for a complex but single "Performance index" to evaluate the reliability of coupled GCM simulations of DISC climate. Here, we argue that coupled GCM (CGCM for short) simulations of FUTURE climates should be evaluated in much more detail both spatially and temporally. Moreover, it is not the bias, but the anomaly timeseries as well as the average rate of change (see definition below) of these timeseries which really matter. 

Important Definitions for this presentation:
"Average Rate of Change" or ARC is defined as the slope of a linear regression which fits the monthly anomaly (the difference of the value for that month from its climatology, the length of which is dependent on the length of the simulation, we want to compare) time series of a given variable. Here, the spatially-averaged ARC is computed on a gridpoint-by-gridpoint basis (e.g., 1°N/1°S), whilst the largest one is for the global scale. The REGIONAL (the area mean ARC) is the coarse latitude-weighted ARC over the area, the most important for climate change predictions. If decreases in bi-as, the ARC phenomenon is a good tool to assess possible regional climate variability/changes. In this case, a few months of simulation can yield a comprehensive look at the current climate. Moreover, it is not the bias, but the anomaly timeseries as well as the average rate of change (see definition below) of these timeseries which really matter. 

Question: When are we done by comparing observed vs. model-generated ARC-maps and the diagrams for AIRS and AIRS-generated Hovmoller diagrams? How do we decide whether AIRS has exhibited the expected feedback for: tropical cooling? Here, we argue that coupled GCM (CGCM for short) simulations of FUTURE climates should be evaluated in much more detail both spatially and temporally. Moreover, it is not the bias, but the anomaly timeseries as well as the average rate of change (see definition below) of these timeseries which really matter. 

So, the inferences from the comparisons of model vs. observed AIRS and ATs could be the following:
A: If given CGCM generated ARC-map or an atmospheric variability time series is similar, well with the corresponding observed ARC-map, we may put more trust into the longer-term (from climate) trend simulation by the CGCM for this parameter.
B: It is possible that only certain regions correlate well, in this case the CGCM ARC-map could be the model for that region.
C: No correlation at all, we can conclude:
(i) CGCM might be inaccurate if certain regional parameter(s) are not considered systemically;
(ii) Correlation of (i) and (ii).

Note that in case (ii) we can transpose ARC and Hovmoller maps of various atmospheric parameters among the observed as well as among the CGCM-generated maps. We may find a high correlation indicating a strong feedback between parameter(s) between AIRS-observed OLR and OLR-Specific Humidity ARC-maps and/or ATs. And the same good correlation is computed between the corresponding CGCM-generated ARC-maps and/or ATs, we may conclude that the CGCM represents this feedback mechanism well. This way we may eliminate (i) and (ii) to be the case.

Examples shown on the right:
AIRS vs. other observations:
(a) Show AIRS vs. CERES: Note that DEFERRING significant bias, the ARC-maps and ATs are VERY different. 

Although not shown here, we have found that even the AIRS vs. MCVIS effective cloud cover ARC-s and ATs are correlating over 0.95, where biases can be as high as ±20-30%.

AIRS-observed interrelations:
(b) How Niño III- La Niña related behavior as seen in AIRS and Hovmoller diagrams and point out various interrelations.
(c) Show some numerical values of AIRS ARC-map interrelations (CGCMs should exhibit similar values).
These findings indicate the ROBUSTNESS of the AIRS-derived ARCs and ATs, so their spatial PATTERNS should serve as benchmarks for the corresponding CGCM-generated patterns, their INTERCORRELATIONS could be reliably used as benchmarks for the corresponding CGCM-generated interrelations, i.e., helping to assess CGCM feedbacks.

Compared to other observations from AIRS and CERES:
- The negative mean tropical OLR trend results from a drop in equatorial OLR from 150°W to 150°E surrounded by a weaker warming 

Surface Skin Temperature ARC-map September 2002 through February 2010

AIRS Anomaly ARCS September 2002 through February 2010

ARCs only

90-Month AIRS Version 5 ARC-map Correlations

AIRS OLR is a computed product for each AIRS FOR using an OLR RTA

Comparison of OLR observations

OLR Anomaly ARCS [W/m²/yr] September 2002 through February 2010

AIRS

CERES Edition 2.5

AIRS minus CERES Edition 2.5


- The DIF attraction of ARC-maps and ATs for the coinciding time periods. ANY suggestions which are evaluated comparatively. For this purpose, Hovmoller diagrams would serve nicely.

Can, for example, CGCMs "see" Effects of ENSO on OLR and other parameters?

The negative mean tropical OLR trend results from a drop in equatorial OLR from 150°W to 150°E surrounded by a weaker warming ring to the west. A transition occurred from a strong El Niño in late 2002 to a strong La Niña in 2008. 2007 is characterized by the beginning of another El Niño.

Trends in 500mb specific humidity and cloud cover are in phase with those of SST in the El Niño and surrounding region. The strongest decrease in tropical OLR results from a decrease in cloud cover and 1/3 from a decrease in water vapor. (see Poster A31-202 for more detailed explanations, regional)

Conclusions:
- The ROBUST nature (biases are not as important as previous GCM-evaluations suggest) of the AIRS-observations-generated ARC-maps and ATs as well as their interrelations suggest that they could be a useful tool to select CGCMs which may be considered the reliable, i.e., to be trusted even for longer-term climate drift/change predictions (even on the regional scale).
- Get monthly gridded CGCM timeseries of atmospheric variables coinciding with the life timescale of the AIRS analyses for at least 5-6 years and do the actual evaluations of ARC-maps and ATs for the coinciding time periods. ANY suggestions which CGCM group(s) should we approach to get such timeseries?

See e-mail addresses under the Title.

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