AIRS-Observed Interrelationships of Anomaly Time-series of Moist Process-Related Parameters and Inferred Feedback Values on Various Spatial Scales

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Motivation:

In the beginning, a good measure of a GMCs performance was their ability to simulate the observed mean seasonal cycle. That is, a reasonable simulation of the means (*i. e.,* small biases) and standard deviations of TODAY'S climate would suffice.

Here, we argue that coupled GCM (CGCM for short) simulations of FUTURE climates should be evaluated in much more detail, both spatially and temporally. Arguably, it is not the bias, but rather the reliability of the model-generated anomaly time-series, even down to the [C]GCM grid-scale, which really matter. This statement is underlined by the social need to address potential REGIONAL climate variability, and climate drifts/changes in a manner suitable for policy decisions.

Important Definitions for this presentation:

"Anomaly Time-series" or AT is defined as a series of *monthly values* created as the difference of the parameter value for that month from its climatology, the length of which is dependent on the length of the observations/simulations;

Longwave Cloud Radiative Forcing or LWCRF is defined as the difference of the Outgoing Longwave Radiation [OLR] and the Clear-Sky OLR [CLOLR];

Longwave Cloud Feedback or LWCF is computed as the slope of LWCRF *vs.* surface temperature [Tskin] monthly mean AT scatter-plots at a 1ºx1º Grid-scale resolution.

DATA used:

1) AIRS Version-5 monthly mean data obtained from Goddard DISC (Level 3). Data are presented on a 1°x1° latitude-longitude grid of 1:30 AM and 1:30 PM, which are averaged together for this study.

Data used here extends up to August 2011.

2) CERES-Terra "SSF1" Edition 2.5 monthly mean obtained from Langley ASDC.

These data are also presented on a 1°x1° latitude-longitude grid, but extends only to June 2010.

Question: What can we learn by comparing observed vs. model-generated diagnostics for say a 9-yr period where we have **AIRS** analyses as **THE** observations [which extend to 9+ full years so far]?

Dessler [2008, 2010], clearly illustrated that *El Niño - La Niña variability* provides a distinct "forcing" over the last decade, for example, from which climate feedback strengths could be inferred.

Here we follow Dessler's [2010] approach for (shorter-term) cloud feedback evaluation based on observations, in particular that of the (unadjusted) LWCF.

Since AIRS provides a consistent and (by now) reasonably validated 3-D picture of the atmosphere {in this respect, we also call your attention to the SUSSKIND *ET AL.* POSTER TOMORROW [U41B-0011]}, we propose here that the AIRS analyses could be THE observations for moist processes related ATs and LWCF distributions for [C]GCM simulation evaluation.

First we validate AIRS –based LWCF calculation results with CERES-based ones, then also evaluate the (longer-term) TOVS Pathfinder data-based LWCF.

Examples, to be reproduceble by [C]GCM runs, are shown on the right:

•AIRS vs. other observations:

a) "Official" *Niño 4* vs. AIRS-based Tskin ATs – so we can use AIRS Tskin for LWCF evaluations;
b) Show AIRS vs. CERES OLR and CLOLR ATs *vs.* AIRS-based Tskin global AT scatterplots – great similarity, so we go ahead with grid-scale LWCF inter-comparisons;
c) Show robustness of the short-term LWCF distributions.

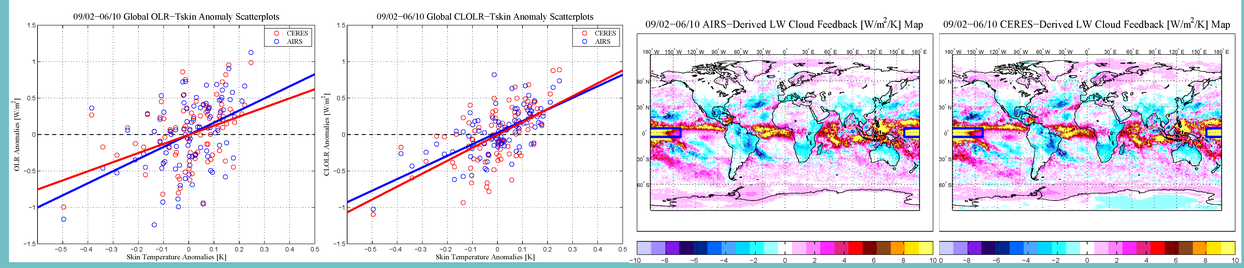
•AIRS-observed interrelations:

a) El Niño - La Niña related behavior as seen in AT cross-correlation (grid-scale) maps;
b) Show interesting teleconnections ([C]GCMs should exhibit similar patterns).

Comparison of OLR/Clear-Sky OLR Global Scatter-plots and Grid-scale LWCF

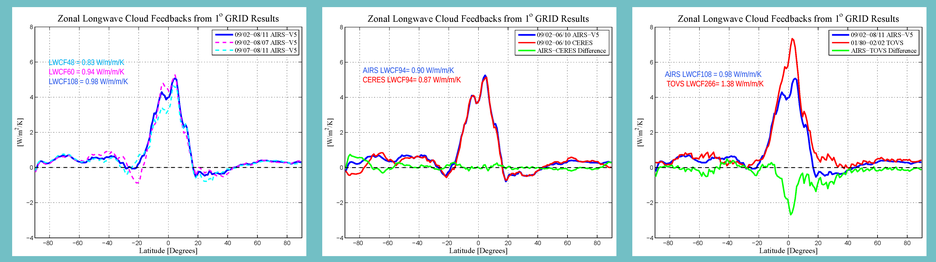
(September 2002 through June 2010)

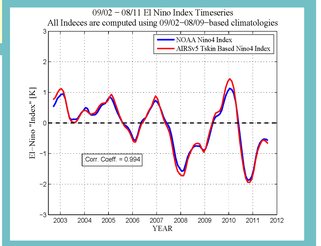
OLR | Clear-Sky OLR | AIRS | CERES-Terra SSF1 Edition-2.5

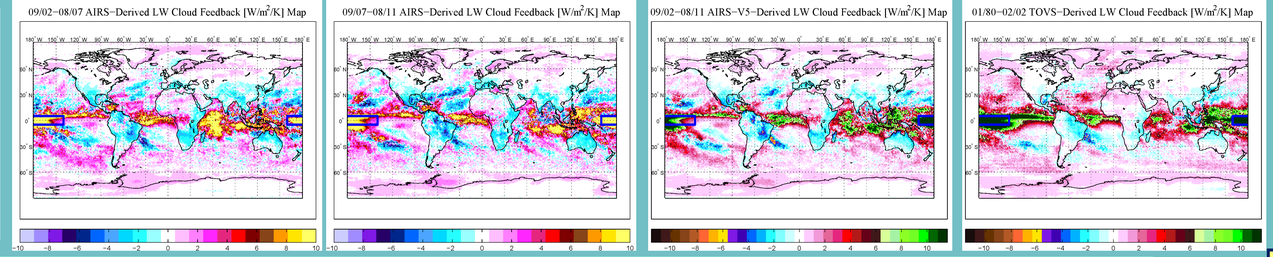


Cross-Correlation Values of Zonal and Grid-Scale LWCF
{Numbers following instrument name refer the length of the data in months}

Parameters Correlated	Zonal Average Curves	Grid-Scale Maps
CERES94 *vs.* AIRS94	0.989	0.955
AIRS108 *vs.* AIRS60	0.980	0.815
AIRS108 *vs.* AIRS48	0.989	0.905
AIRS108 *vs.* TOVS266	0.960	0.730



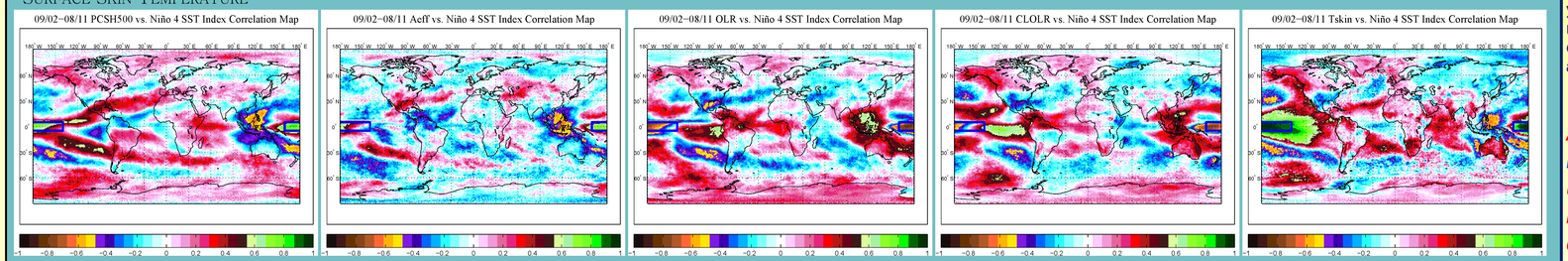




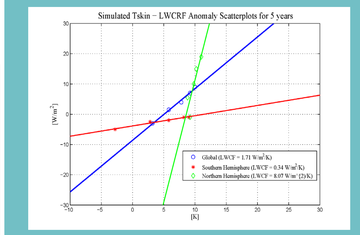
Question: How Well can (C)GCMs "see" Effects of El Niño Variability on Moist Processes Related Parameters??
Answer: Create the SAME kind of maps as seen below from the (C)GCM runs; a high correlation between a (C)GCM-map and the AIRS-map means that the (C)GCM handles the related processes right

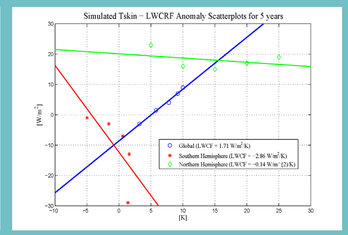
Moist Process Related AIRS-ATs correlated with the Niño 4 SST index for September 2002 through August 2011

500 hPa Specific Humidity | Effective Cloud Fraction | OLR | Clear −Sky OLR | Surface Skin Temperature



A BIG POTENTIAL PROBLEM: **Even when Observed vs. Model-Generated GLOBAL AnomalyScatterplots are COMPARABLE, the underlying spatial details could be very different, so, for example, the LWCF-related moist processes are erroneously captured by the model**





Our MAIN POINT:

(C)GCM simulations should exhibit the Observed moist processes related behavior illustrated here

Of course, a CGCM has to simulate the *El Niño - La Niña variability reliably* which is still a tough task. We believe that first, the underlying GCM has to simulate the spatial distributions/patterns shown here, *so transient runs with prescribed SSTs should be evaluated first*, to see how well the moist processes related interrelationships, and especially the LWCF grid-scale patterns are represented. Fortunately, monthly gridded products are rather standard [C]GCM outputs from which the SAME type of maps, *etc*. can be generated, the SAME way as from the observations. If and when such GCM *vs*. Observations maps correlate well, we may regard this CGM to be well suited for to be the atmospheric module of a CGCM.

Further Conclusions:

1) CERES Clear-Sky OLR can be used even for Grid-scale LWCF assessments;
2) The Short-term LWCF values are globally all positive with high values in the Tropics and low values elsewhere ZONALLY ;
3) There is STRONG longitudinal dependence also;
4) There is a ROBUST nature in the LWCF spatial patterns exhibited, from as short as 4 years (48-Months AIRS) to 22.16 years (TOVS Pathfinder), strongly suggesting that high quality multiyear/decadal observations can provide a reliable basis for cloud feedback evaluation of climate models in particular as well as model moist processes evaluations in general.

•THUS, THE AIRS-OBSERVATIONS-GENERATED LWCF-MAPS, AS WELL AS THE INTERRELATIONS OF VARIOUS ATS WITH THE EL NIÑO - LA NIÑA VARIABILITY SUGGEST THAT THEY COULD BE A USEFUL TOOL TO SELECT [C]GCMS WHICH MAY BE CONSIDERED RELIABLE, I. E., TO BE TRUSTED EVEN FOR LONGER-TERM CLIMATE DRIFT/CHANGE PREDICTIONS (EVEN ON THE REGIONAL SCALE).