CGMS

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ASSESSMENT OF GLOBAL CLOUD COVER AND PROPERTIES – SUMMARY FROM THE
2nd Cloud Climatology Assessment Workshop held 6-7 July 2006 in Madison, Wisconsin

NOAA-WP-20 summarizes the current state of cloud climatologies and suggests some future work. On 6-7 July 2006, a second GEWEX Cloud Product Assessment workshop was held in Madison, Wisconsin. Long-term cloud datasets used to assess the GRP (i.e., ISCCP) cloud products were provided from the NOAA-HIRS, TOVS Path-A/Path-B and polar TOVS, PATMOS-X, SAGE and surface observations. Long-term cloud changes and their sources in the different datasets were presented. It was noted that the intercomparisons were more successful if one carefully accounted for satellite orbital drifts, especially the NOAA polar afternoon satellites, and also for changes in location of geostationary satellites. In addition, cloud datasets were presented from the new generation of instruments MODIS, MISR and AIRS onboard the NASA Earth Observing System (EOS) platforms that began operation in 2000 and thereafter; climatological averages within the selected regions are in progress due to the ongoing reprocessing of the entire Aqua and Terra data stream with updated algorithms.

Key results from the workshop included:

- Clouds cover about 68% (±5%) of the Earth's surface, with 5% to 12% more cloudiness over ocean than over land,
- Seasonal cycles of cloud amount seem to be well correlated by most datasets, except over polar land,
- Most cloud products exhibit similar seasonal cycles of cloud amount in the polar regions, though the magnitudes can differ by 10-15% during the day and 20-30% during the cold, dark winter months,
- Subvisible cirrus are identified only by SAGE, which accounts for another 15% in the amount of high cloud,
- Surface observations show up to 25% more low cloud amounts than the satellite retrievals in regions with large values of high cloud amounts (as in the tropics),
- Long-term variations of ISCCP high, midlevel and low cloud amount are partly influenced by the changing locations of geostationary satellites over time.

Future work will include investigation and evaluation of apparent differences in climatological averages as well as their regional, seasonal and diurnal variations

CGMS is asked to take note of the recommendations from this international group .

Assessment of Global Cloud Cover and Properties – Summary from the 2nd Cloud Climatology Assessment Workshop held 6-7 July 2006 in Madison, Wisconsin

Bryan A. Baum (SSEC, University of Wisconsin-Madison), Claudia Stubenrauch (CNRS, LMD), Andy Heidinger (NOAA), and W. Paul Menzel (NOAA)

1. Objectives of the Workshop

Satellite observations provide a continuous survey of the state of the atmosphere over the whole globe. The International Satellite Cloud Climatology Project (ISCCP) using data from a combination of polar orbiting and geostationary imagers offers the cloud climatology with the best diurnal sampling and spatial resolution. However, ISCCP's reliance on geostationary imager data has necessarily limited the spectral information available to it. For cirrus (semi-transparent ice cloud) properties, the infrared sounder measurements, with relatively good IR spectral coverage, offer reliable day and night detection. Cloud properties under study include cloud amount (i.e., cloud fraction), cloud top pressure/height, cloud thermodynamic phase, cloud optical thickness and effective particle size, of which ISCCP provides a subset. To be useful for climate studies and for evaluation by general circulation model (GCM) teams, the accuracy and error sources of these cloud products must be determined. The focus of this workshop was to evaluate the regional, seasonal, and diurnal variability of the cloud products. The goals of the workshop may be summarized as follows:

The goals for the workshop are summarized in the following questions:

1. From the perspective of a general circulation modeler wanting to compare model results with one or more cloud climatologies, what aspects of the various cloud climatologies would be most understood, and for which the error sources are quantified?
2. If two or more data sets agree, is the reason for such agreement understood?
3. Likewise, if two or more data sets disagree, are the reasons understood for the differences? In any comparison between data sets, there will be discrepancies, and it is insufficient to simply note them without understanding the causes.
4. Can we agree on a set of methods to discern actual trends, rather than the rather simplistic approach typically used of drawing a least-squares regression line through the time period of interest?
5. Where would the greatest problems exist, thereby decreasing the likelihood of obtaining coherent comparisons?

2. Status of Assessments

A first GEWEX Cloud Product Assessment workshop was held in April 2005 in Madison, Wisconsin (see http://cimss.ssec.wisc.edu/cloud_climatology/2006/). The emphasis for this first workshop was on simple cloud property intercomparisons of monthly means. Many different datasets were presented, and trends in regional and global cloud amount were compared. During this meeting, areas of agreement and disagreement between the different global cloud property data sets were discussed, but it was recognized that the intercomparisons were hampered by a lack of common standards and philosophy (such as the type of spatial grid used for the monthly mean products). More focused investigations were deemed necessary to sort out the strengths and weaknesses of the various global cloud climatologies.

On 6 and 7 July 2006, a second GEWEX Cloud Product Assessment workshop was held in Madison, Wisconsin, and had approximately 50 international participants. Bryan Baum (SSEC, Univ. Wisconsin-Madison) and Claudia Stubenrauch (C.N.R.S./IPSL LMD) chaired the meeting. Datasets were made available to the participants well before the workshop and regions and variables were selected for intercomparison. A website (see above) was created to share first results and discussions. Long-term cloud datasets used to assess the GRP (i.e., ISCCP) cloud products were provided by HIRS-NOAA, TOVS Path-A, TOVS Path-B and polar TOVS, PATMOS-X, SAGE and surface observations. Long-term cloud changes and their sources in the different datasets were presented. It was noted that the intercomparisons were more successful if one carefully accounted for satellite orbital drifts over time, especially the NOAA polar afternoon satellites, and also for changes in location of geostationary satellites over time. In addition, cloud datasets were presented from the new generation of instruments MODIS, MISR and AIRS onboard the NASA Earth Observing System (EOS) platforms that began operation in 2000 and thereafter; climatological averages within the selected regions are in progress due to the ongoing reprocessing of the entire Aqua and Terra data stream with updated algorithms (e.g., MODIS data are being reprocessed as Collection 5).

Presentations at the workshop were primarily in four groups: (1) surface observations, specifically the nature of the observations and their error characteristics, (2) satellite-based cloud climatologies from various sensors including both polar- and geostationary platforms, (3) polar cloud climatologies, and (4) soon-to-be-available data sets from the constellation of afternoon-based lidar (CALIPSO) and radar (CloudSAT) instruments (i.e., the A-Train). There was also considerable discussion related to intercomparing various cloud products and establishing contacts for future research.

3. Key Results from the Workshop

- Clouds cover about 68% (±5%) of the Earth's surface, with 5% to 12% more cloudiness over ocean than over land.
- Seasonal cycles of cloud amount seem to be well correlated by most datasets, except over polar land. ISCCP underestimates the seasonal cycle of high cloud amounts by up to 20% in comparison to the IR sounders that are more sensitive to optically thin cirrus clouds.
- Most cloud products exhibit similar seasonal cycles of cloud amount in the polar regions, though the magnitudes can differ by 10-15% during the day and 20-30% during the cold, dark winter months. Nighttime cloud detection in the polar regions remains problematic, particularly with the AVHRR.
- Subvisible cirrus are identified only by SAGE, which accounts for another 15% in the amount of high cloud. The subvisible cirrus is located primarily in the tropics.
- Surface observations show up to 25% more low cloud amounts than the satellite retrievals in regions with large values of high cloud amounts (as in the tropics);

these clouds are not observed in satellite observations as they are obscured by overlying high clouds.

- Long-term variations of ISCCP high, midlevel and low cloud amount are partly influenced by the changing locations of geostationary satellites over time. Other artifacts are also apparent in the geostationary cloud products in the lower latitudes at high viewing angles. Identification and mitigation of these non-physical artifacts remains a challenge to the use of the ISCCP (or any other) cloud record for climatic studies.

4. Future work

A WMO report is in preparation. It discusses the existing long-term climatologies and also comparisons with climatologies from improved instruments aboard the NASA EOS satellites. All datasets described in this report will be made publicly available. Climatological averages as well as their regional, seasonal and diurnal variations will be presented, and differences between results from the various datasets will be discussed.

Future work will include investigation and evaluation of apparent differences. For example a 10% difference in high cloud amount in the southern hemisphere (SH) midlatitude region between TOVS Path-B and HIRS-NOAA could come from the use of different atmospheric profiles. Cloud microphysical properties and optical thickness also require further assessment.

5. Summary

- The total cloud amounts from the existing multi-decadal cloud climatologies are all very well correlated with each other.
- Current analysis indicates that global mean cloud amount has not significantly changed over the past two decades.
- Sufficient artifacts exist in each data-set that prohibit confident estimation of small trends in global cloudiness. However, regional signals can be discerned with more confidence.
- Most of the artifacts in the existing multi-decadal satellite cloud climatologies can be removed through modification of the processing algorithms or appropriate post-processing analysis.

6. Recommendation for CGMS

These cloud climatology assessment workshops offer an excellent and unique forum for cloud researchers to compare results and plan future work; they should be sustained for the foreseeable future as much as possible. A dialogue between the workshop co-chairs and CGMS is desirable.

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