Changes in cloudiness in the U.S. from surface observations

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GOALS

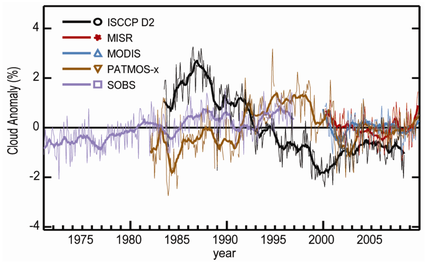
ARL seeks to advance understanding of long-term changes in cloudiness and Improve data quality through attention to temporal homogeneity.

Why?

- Cloud feedbacks
- Solar energy applications

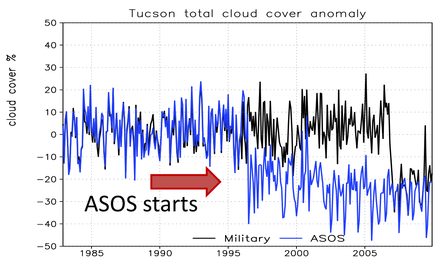
Problems with existing data:

1. Global cloud datasets do not agree.



Global mean total cloud anomaly from 4 satellite datasets and surface observations, adapted from Figure 2.23 of Arndt et al. (2010).

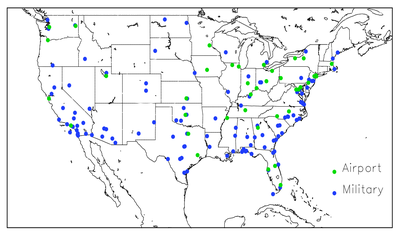
2. For ground observations, automation has destroyed continuity.



Total cloud anomalies at Tucson NWS station and a nearby military station. The time of introduction of automated observing systems at the NWS station is indicated by the arrow.

APPROACH

- We used human (visual) observations of cloud cover from the Integrated Surface Hourly database at NCDC.
- We chose stations that maintained visual observations after the mid-90s: 113 military and 40 NWS airport stations.
- We compared the ground data to satellite data and other weather observations that typically track clouds closely.

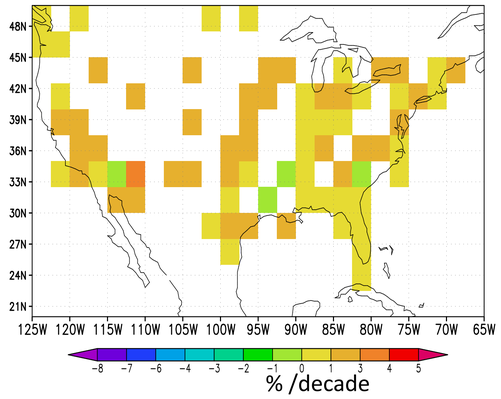


(left) Locations of stations used. Stations with large gaps or obvious discontinuities were dropped. Data from military stations that switched to automated systems in the last 6 years were dropped after the date of the switch.

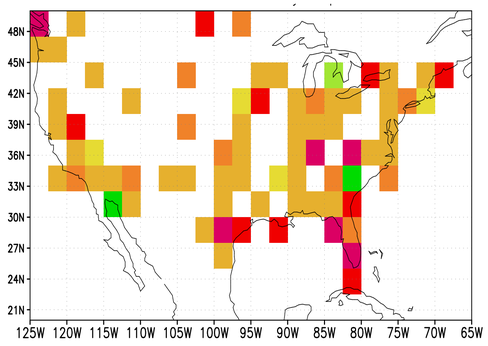
ACCOMPLISHMENTS

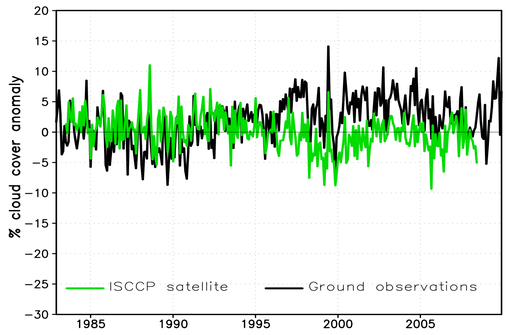
- Work is in early stages
- ARL presented preliminary results at AMS 2011 Annual Meeting

Trend in total daytime cloud, 1949 - 2009

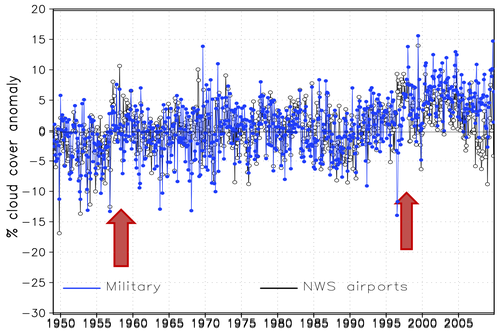


Trend in total daytime cloud, 1983 - 2005





U.S. satellite and ground observations disagree.



Time series show sudden shifts.

Trend 1983-2008 (%/decade) :
Ground observations 1.8 ± 0.9
ISCCP satellite -1.3 ± 0.7

Trend 1949-2009 (%/decade) :
Ground observations 0.93 ± 0.2

Preliminary Conclusions-- Total Cloud Cover

- Positive trends exist in the U.S. mean for 1949-2009 and 1983-2009.
- Large differences appear between trends in satellite and ground observations.
- Inhomogeneities probably remain in the human-observed cloud data.
- Both satellite and ground observations need more work to support reliable trend estimates.

COLLABORATORS

Bomin Sun, NOAA NESDIS STAR

FUTURE WORK

ARL's current plans include:

- Homogeneity testing and adjustment of U.S. data
- Comparison to other related climate data such as diurnal temperature range, precipitation, surface downward solar radiation, etc.

With more resources and additional collaborators, ARL could:

- Fill in spatial gaps in data.
- Compare our cloud data to improved versions of satellite data.
- Compare observed changes to those from climate models.
- Extend this work to other countries.