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Validation and homogeneity assessment of monthly mean ESA-Cloud-CCI cloud fraction global dataset

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ESA-Cloud-CCI

The primary objective of the ESA-Cloud-CCI is to provide the long-term (~30 y) coherent cloud property global dataset (cloud fraction, cloud optical thickness, cloud top pressure, cloud top temperature, cloud phase) by exploiting the AVHRR heritage channels and optimal-estimation-based open community retrieval algorithm (CC4CL).

Scope and objectives

To be suitable for climate analysis, satellite-derived cloud datasets have to meet the challenging requirements of the Global Climate Observing System (GCOS).

The scope of this study is to evaluate climatological stability and homogeneity of the ESA-Cloud-CCI AVHRR-based cloud cover dataset by the use of SYNOP.

- Period covered: 1982-2009 (to be extended until 2015)
- Spatial resolution: 0.5 deg
- Temporal resolution: monthly means

Evaluation against synoptic observations

ESA-Cloud-CCI cloud fraction (0-100%) monthly means were overlaid by 874 quality-checked SYNOP sites, such as for each site the time series of satellite-based cloud fraction was extracted from a single 0.5°×0.5° cell within which the site was located.

Okta scale 0-8 has been transformed to cloud fraction as: 0, 9.375, 25, 37.5, 50, 62.5, 75, 90.64, 100%.

Mean Bias Error (MBE) and Bias-corrected Root Mean Square Error (bcRMSE) have been computed for each site, and further aggregated in climate zones.

	Global	Land	Ocean	Arid	Tropical	Temperate	Cold	Polar
MBE (satellite-SYNOP)	4.02	4.08	-1.44	2.73	3.04	3.56	4.96	6.79
Bias-corrected RMSE	15.37	15.37	14.65	15.75	15.85	15.00	15.29	15.40

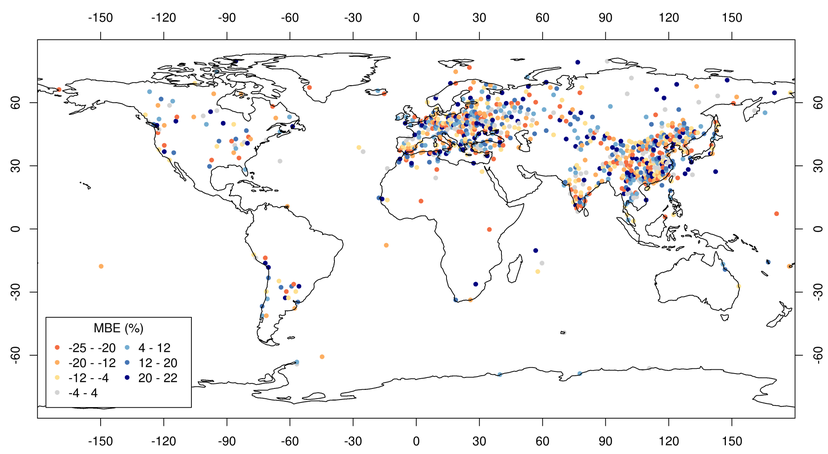

Fig 1. Mean bias error of ESA-Cloud-CCI mean monthly cloud fraction.

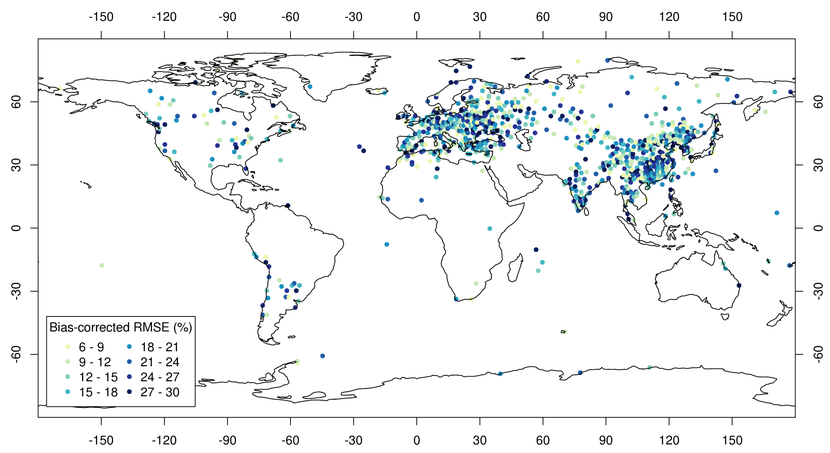

Fig 2. Bias-corrected RMSE of ESA-Cloud-CCI mean monthly cloud fraction.

Homogeneity

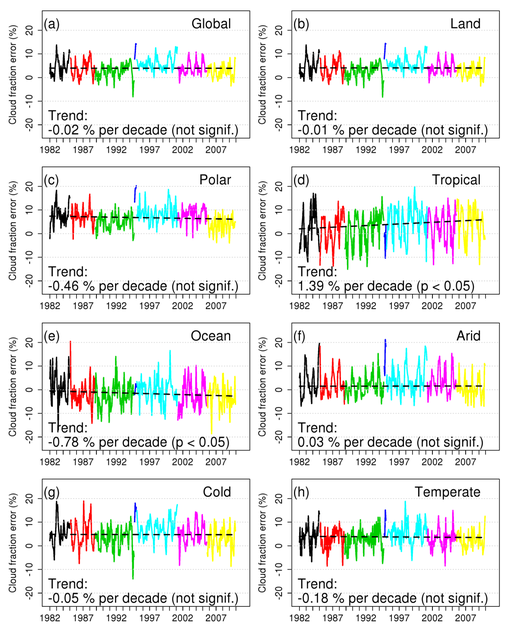

Fig 3. Time series of MBE (satellite-SYNOP). Colors represent consecutive NOAA missions starting from 1982: NOAA-7 (black), NOAA-9 (red), NOAA-11 (green), NOAA-12 (blue), NOAA -14 (light blue), NOAA-16 (pink), and NOAA-18 (yellow). Theil-Sen linear trend (dashed line) and its Mann-Kendall statistical significance is also provided.

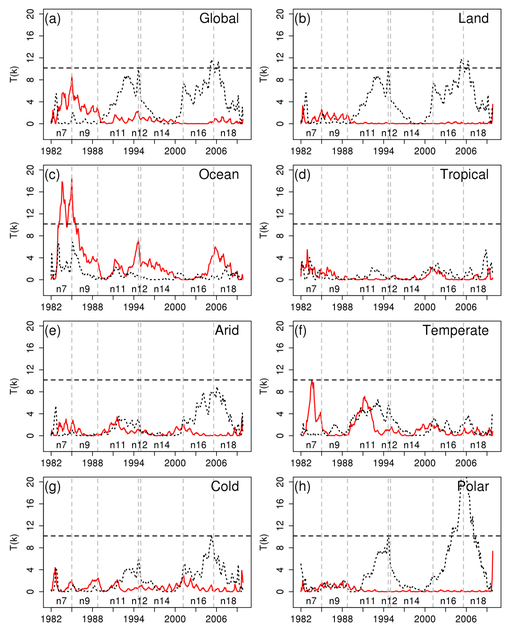

Fig 4. Standard Normal Homogeneity Test

- *relative: applied to de-trended MBE time series (black dotted line)*
- *absolute: applied to de-trended monthly cloud fraction anomalies for all grids (red solid line)*

The horizontal dashed line indicates a critical value of statistic T which signifies a break in the time series (at 95% conf. level). The vertical dashed lines show changes in the NOAA missions.

Trends

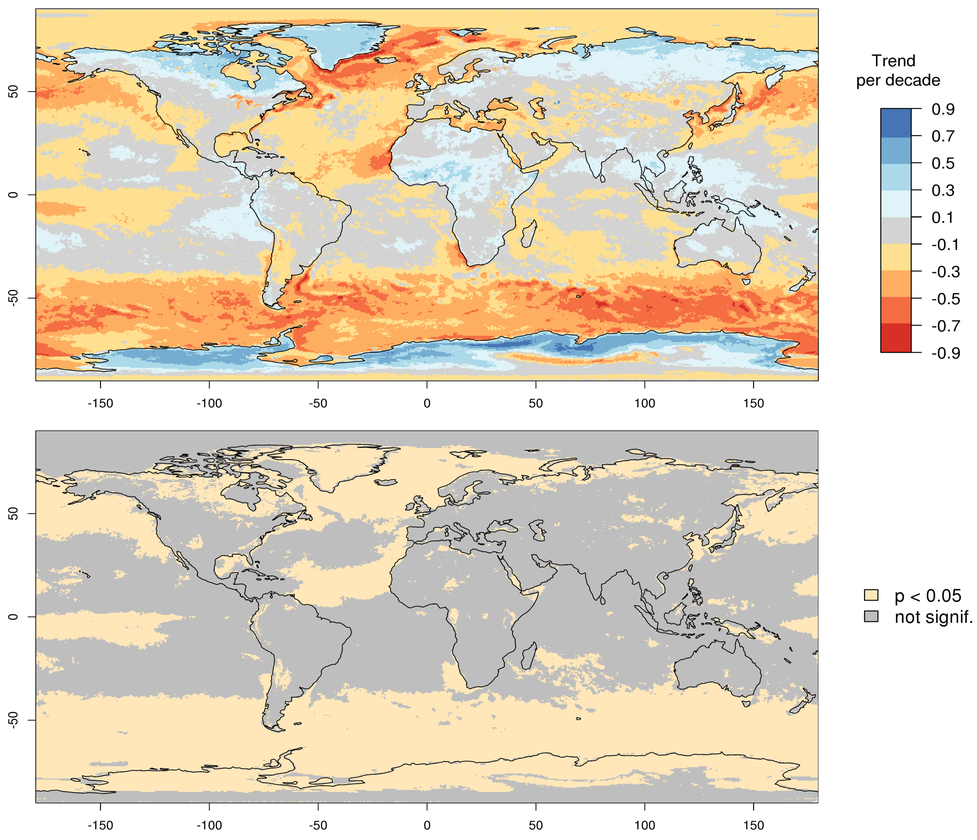

Fig 5. Map of ESA-Cloud-CCI Theil-Sen monotonic trend (above) and its statistical significance according to the Mann-Kendall test (below) based on the cloud fraction monthly standardized anomalies in 1982-2009.

Conclusions

- Significant inhomogeneities have been detected at a turn between NOAA-7 and NOAA-9 for the ocean, and between NOAA-16 and NOAA-18 for the polar zone (Fig. 4)
- Significant trends in the mean bias error (satellite-SYNOP, Fig. 3) can lead to spurious trends in cloud cover for the tropical zone and the ocean
- A sharp change in trends and their significance can be seen between land and ocean (Fig.5)
- An increase in cloud fraction is visible for high latitudes over land: in Canada, Greenland, Russia and Antarctica (Fig. 5)
- A decrease in cloud fraction occurs over the ocean (most apparent over the Antarctic Circumpolar Current around 50°S and at similar latitudes but in the northern hemisphere), over the main cold-water currents, and over big inland waterbodies (Fig. 5)

Outlook

- Dataset extension to 1982-2015
- Orbital-drift correction and resolving a diurnal cycle of cloudiness
- De-trending and de-biasing using synoptic observations

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