Quantifying the uncertainty and ensuing spurious trends in level-3 AVHRR-based cloud climate data records

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Orbital drift & overlapping satellites

L2 → L3 aggregation
- Orbital drift
- Changing number of observations
- AMs / PMs separately?
- Overlapping satellites

(Devasthale et al, 2012)
Objective

Dissect effects on performance and trends in L3 CFC data:

• of **orbital drift** separately for each NOAA/MetOp satellite and each node

• of **diurnal cycle sampling** by changing number of satellites in orbit and their different time of image acquisition
Data & methods

NOAA/MetOp AVHRR acquisition times
- AVHRR per-pixel acquisition times based on CM SAF CLARA-A2
  - 1982-2015 (NOAA-7 to MetOp B)
  - Aggregated to 0.75 degree by a circular median

Reference CFC data with resolved diurnal cycle
- The CM SAF ClOud Fractional Cover dataset from METeosat First and Second Generation - Edition 1 (COMET)
  - Bayesian-based CFC for each 0.05 deg pixel → aggregated to 0.75 deg
  - Mean monthly diurnal cycle (1 hour resolution) smoothed with splines
  - Missing years (1982-1990) were replaced by 2007-2015
  - Daily diurnal cycle assumed stable for each day during a month

- No AVHRR-derived CFC used
- COMET retrieval error not relevant
COMET CFC diurnal cycle
Mean bias NOAA-PM
Bias-corrected RMSE, NOAA-PM
False trends, NOAA-PM
AVHRR CDR bias

CLARA CDR observed trends
Temporal stability

- GCOS-200: 1%/dec temporal stability

Trend of bias: $-0.42\%$ per decade ($p < 0.05$)

> 6 obs per day
Summary & outlook

- Orbital drift and sampling errors: ±10% bias, <8% bcRMSE
- False trends: ±6% per decade (±1 for merged satellites, -0.42 averaged over Met disc)
- Without diurnal cycle correction, L3 data before 2003 don’t comply with GCOS requirements
  
  - Aggregated PM-satellites reveal lower false trend than AMs
  - No big difference between overlapping and non-overlapping satellites aggregation
  - Low correlation between false and observed trends… (why?)

Outlook:

- Global analysis using ERA-5 as a reference
- Comparison of correction methods: Foster and Heidinger, 2013, rotated empirical orthogonal function (EOF, Devasthale et al. 2012), singular spectrum analysis (SSA)
- Similar study for cloud properties (e.g. based on CMSAF CLAAS as a reference)
Mean bias NOAA-AM

Mean bias error (GFC[%])
Bias-corrected RMSE, NOAA-AM
False trends by NOAA & node

ascending

descending

ascending + descending
Bias-corrected RMSE, AVHRR CDR