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

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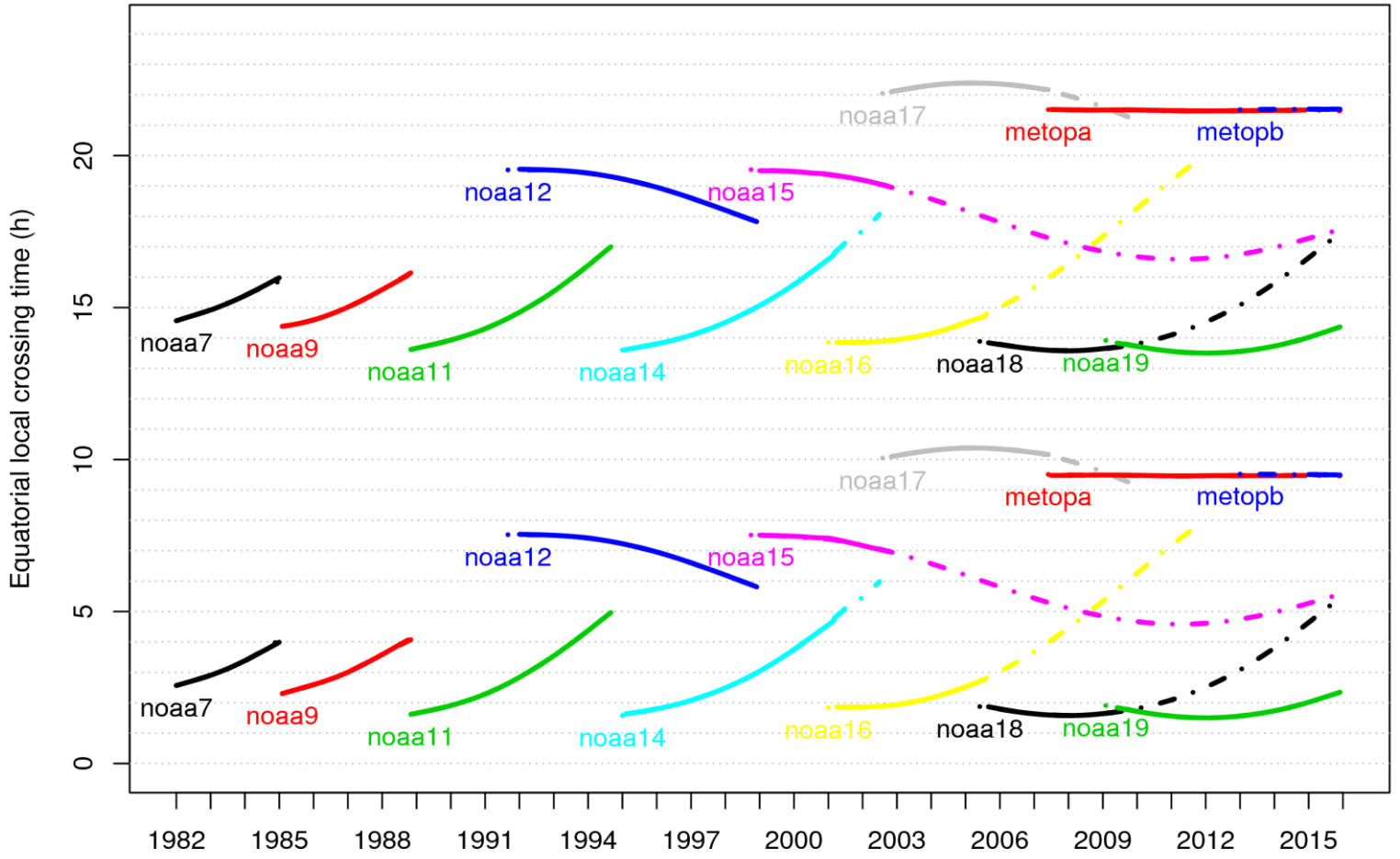
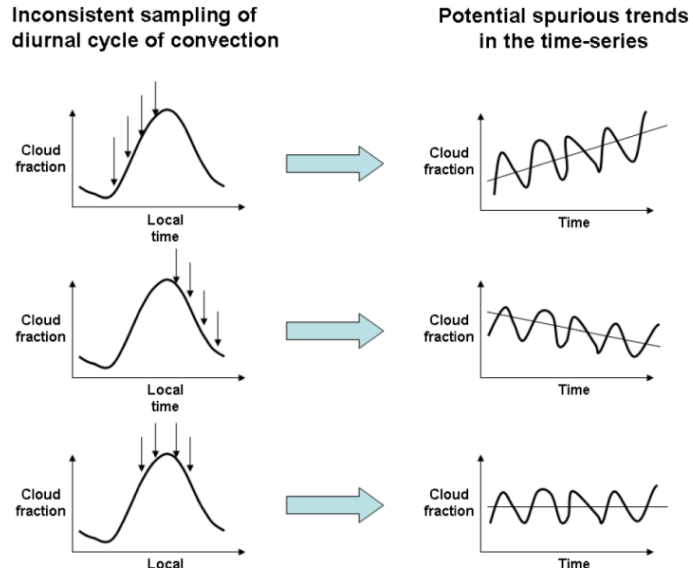
Orbital drift & overlapping satellites



L2 → L3 aggregation

- Orbital drift
- Changing numer 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

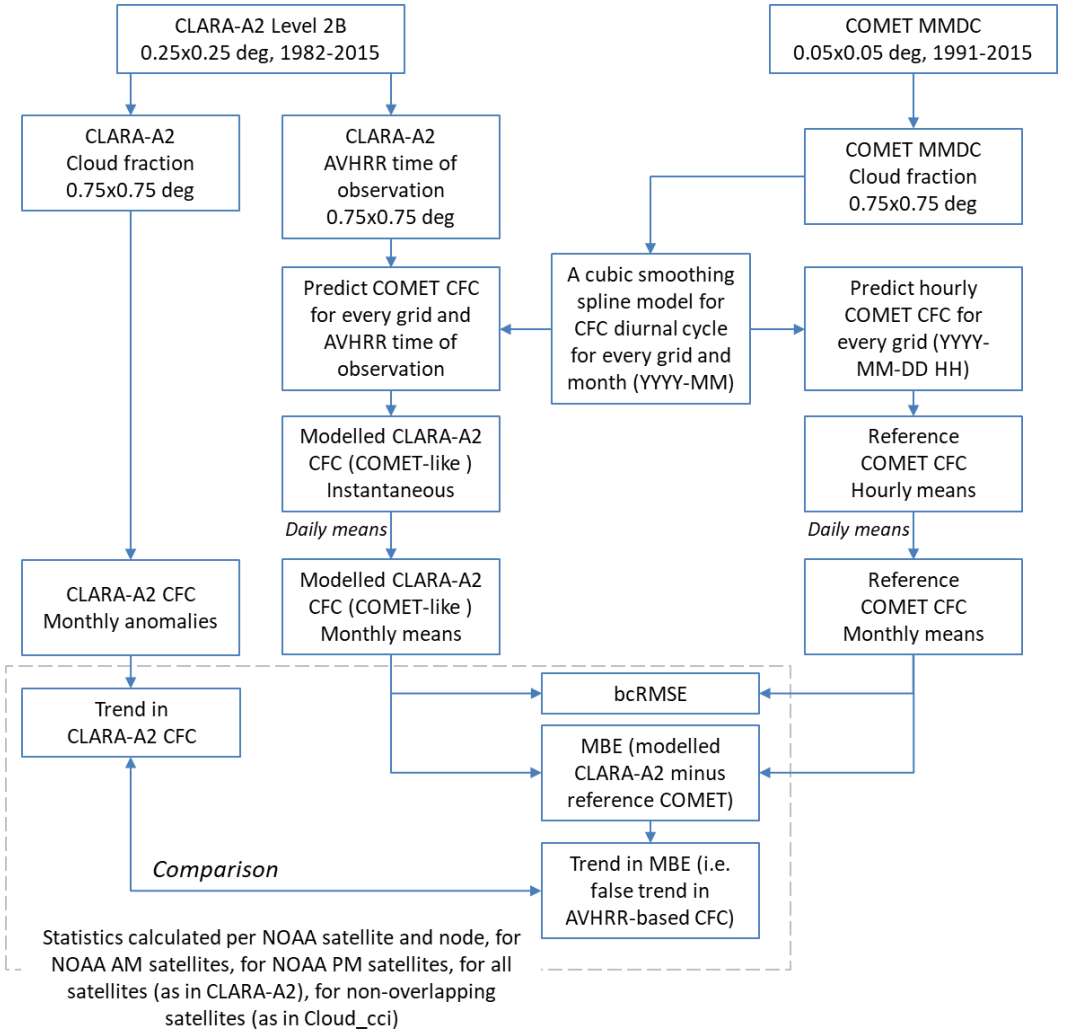
Data & methods

NOAA/MetOp AVHRR acqusition times

- AVHRR per-pixel acqusition 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)
  - MVIRI+SEVIRI: 1991-2015
  - 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

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Article

Cloud Detection with Historical Geostationary Satellite Sensors for Climate Applications

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Article

Performance Assessment of the COMET Cloud Fractional Cover Climatology across Meteosat Generations

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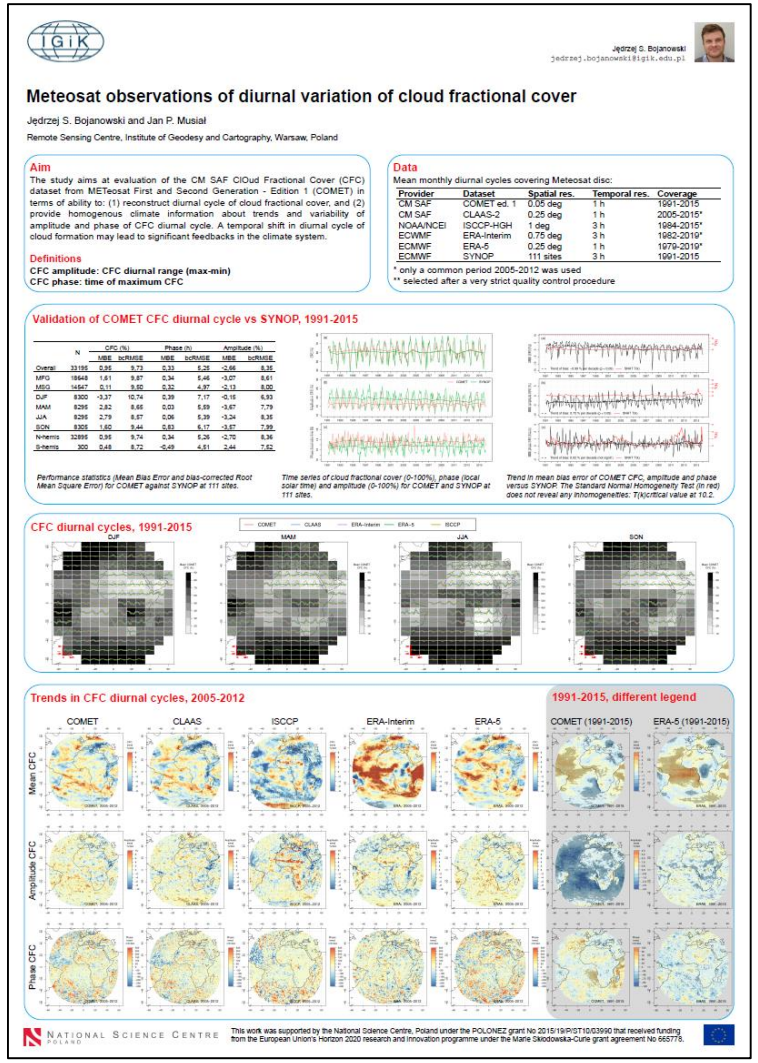
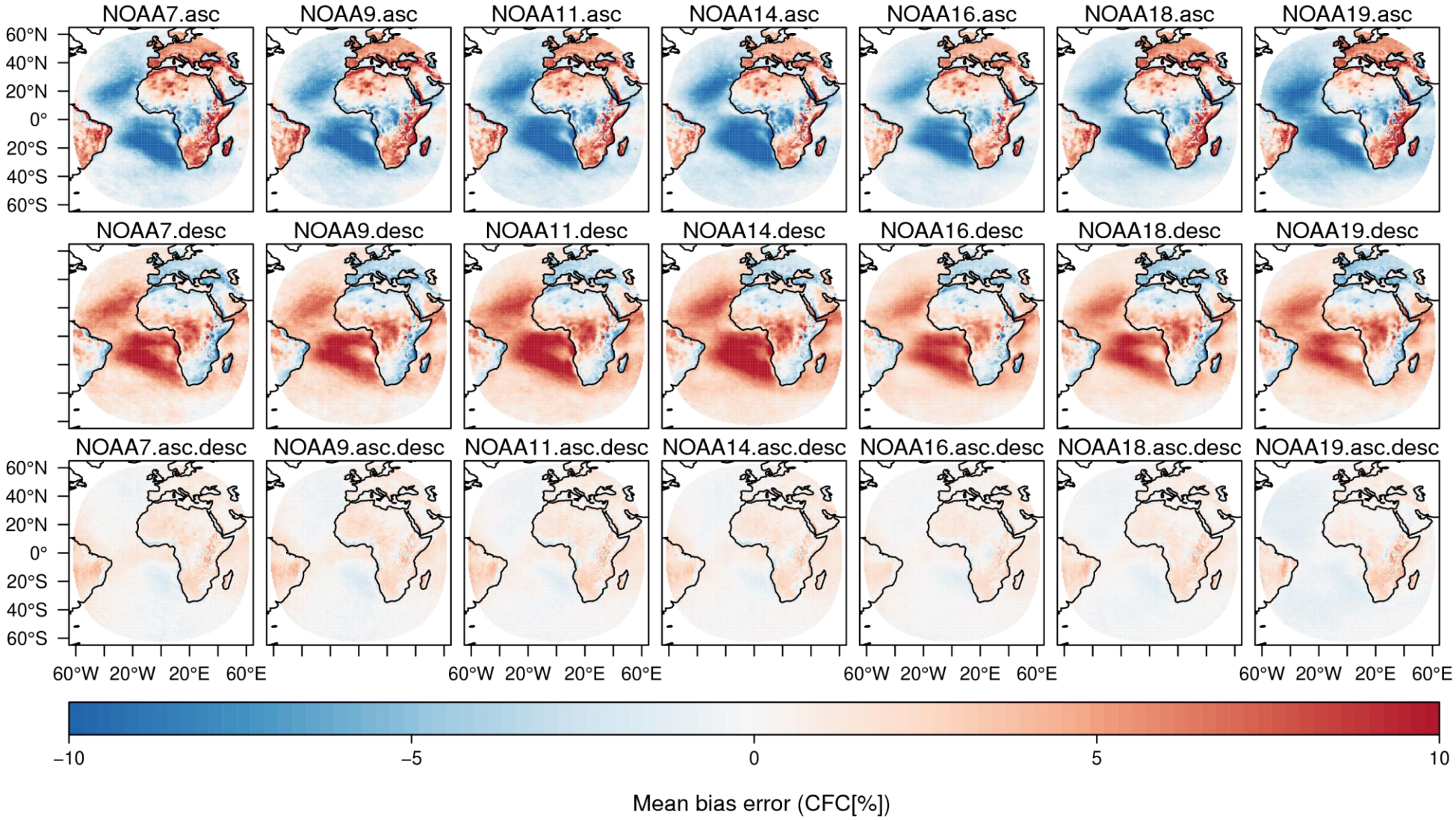
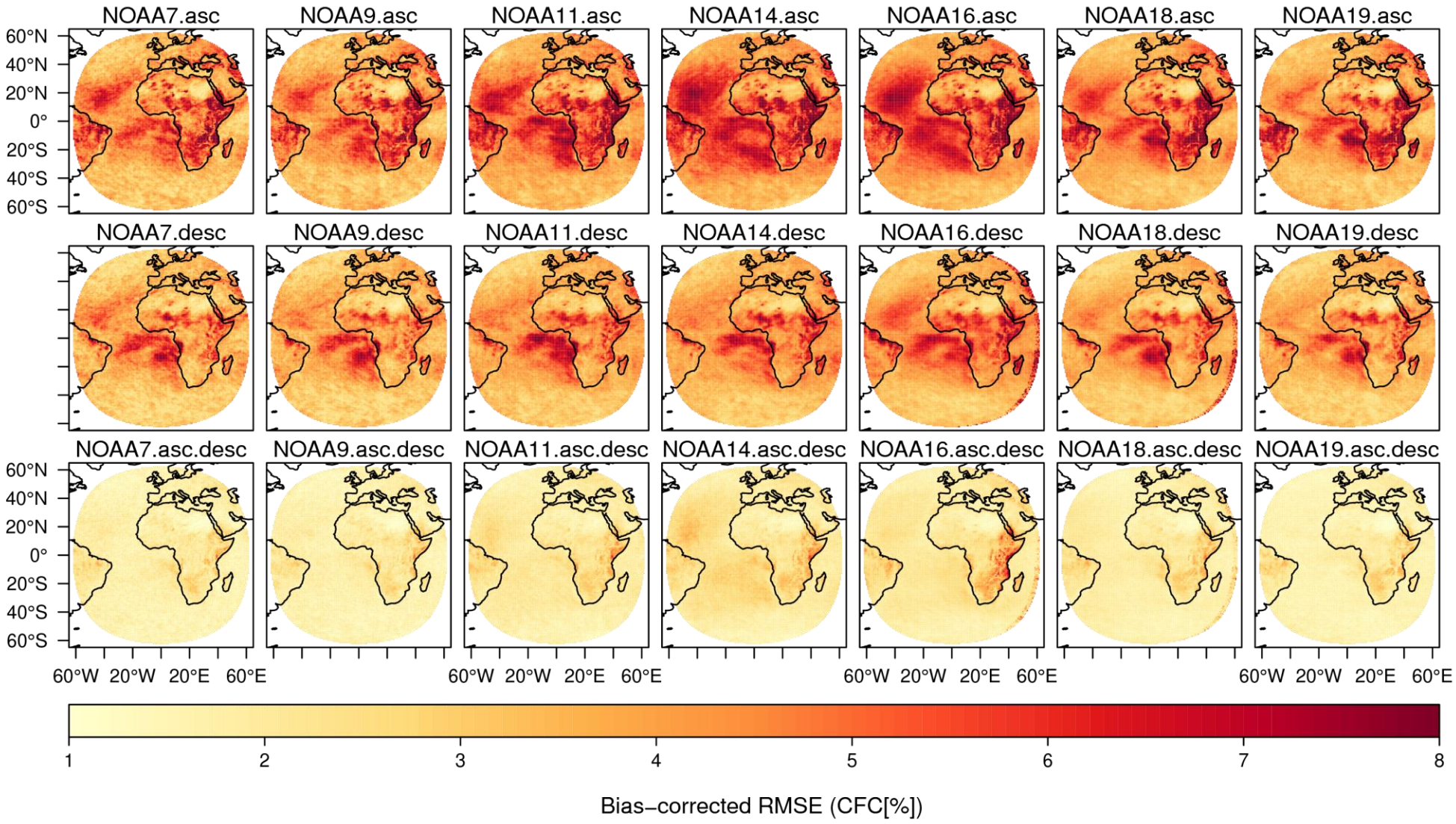


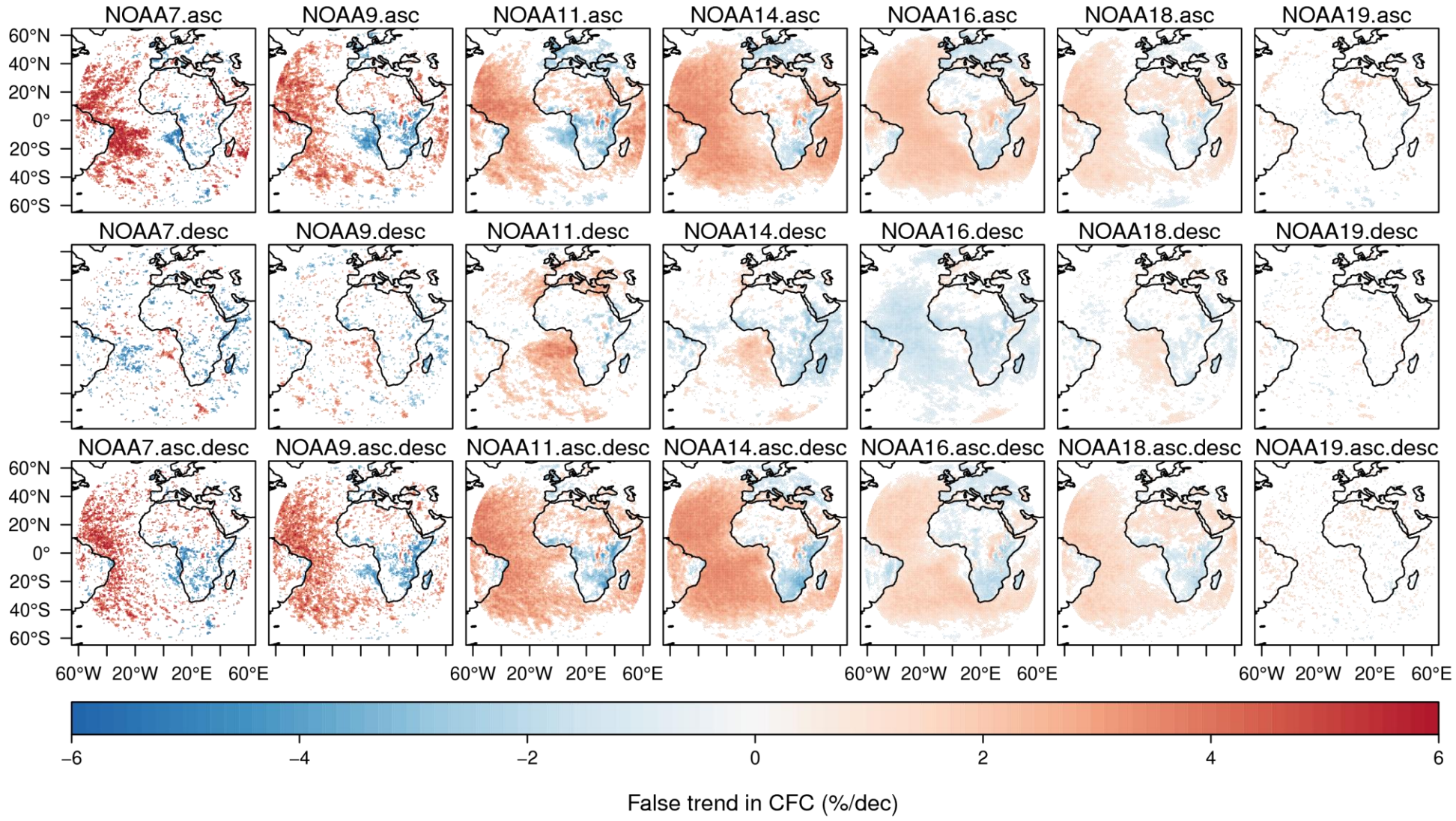
Mean bias NOAA-PM



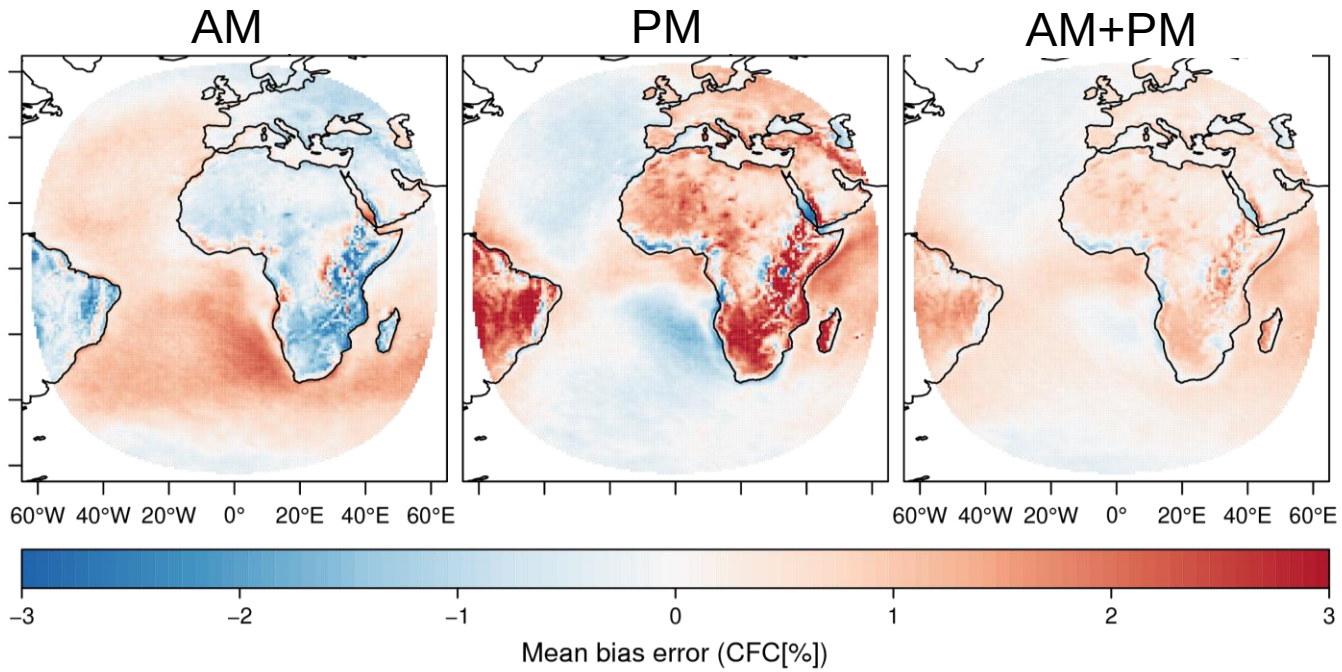
Bias-corrected RMSE, NOAA-PM



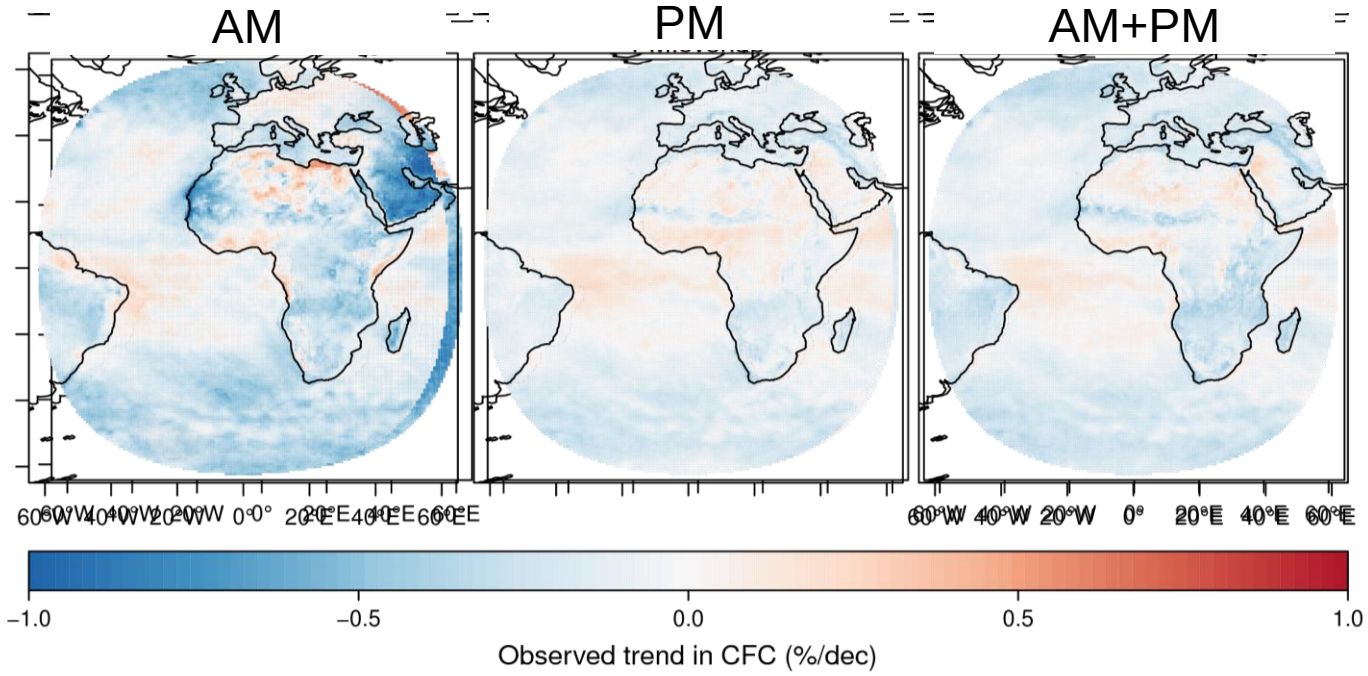
False trends, NOAA-PM



AVHRR CDR bias

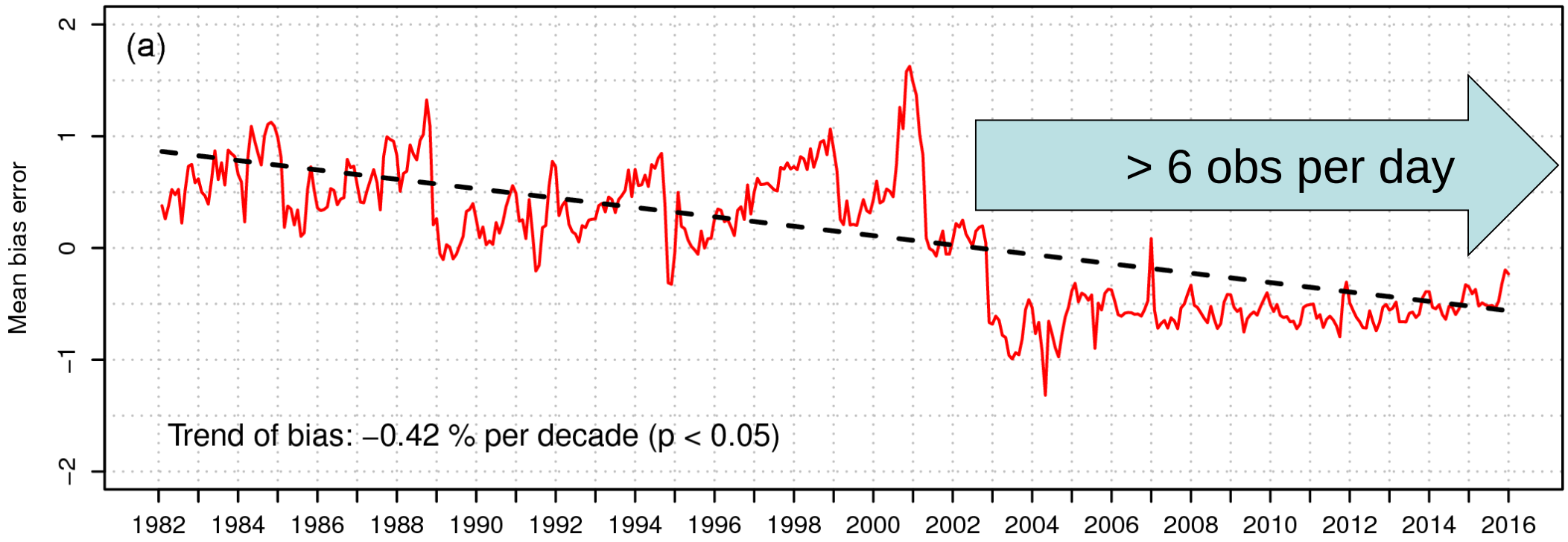


CLARA-A2 AVHRR CDR observed trends



Temporal stability

- GCOS-200: 1%/dec temporal stability



Summary & outlook

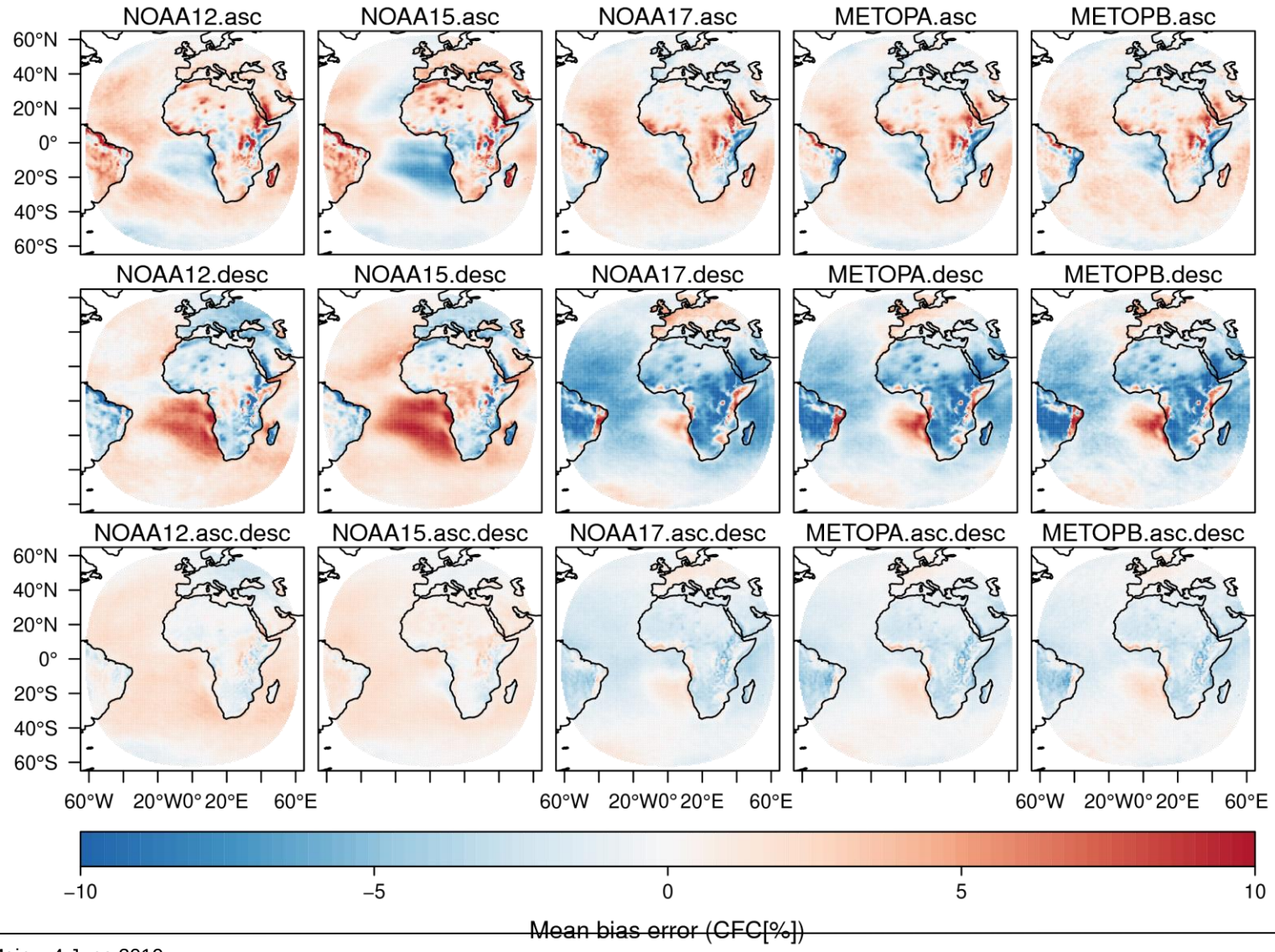
- **Orbital drift and sampling errors: ±10% bias, <8% bcRMSE**
- **False trends: ±6% per decade (±1 for merged satellites, -0.42 averaged over Met disc)**
- **Without diurnal cycle correction, L3 data before 2003 don't comply with GCOS requirements**

- Aggregated PM-satellites reveal lower false trend than AMs
- No big difference between overlapping and non-overlapping satellites aggregation
- Low correlation bewteen false and observed trends… (why?)

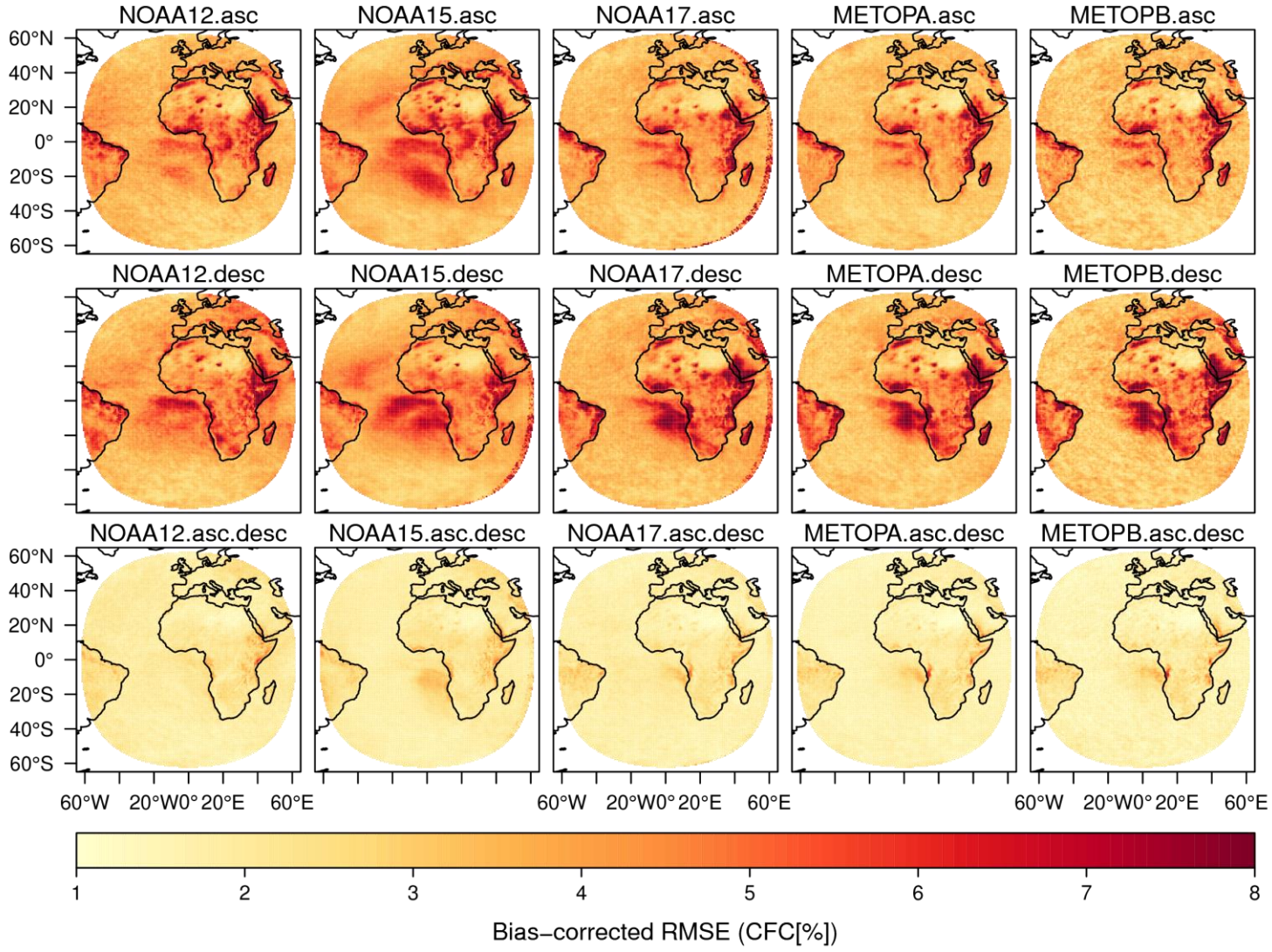
Outlook:

- 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)

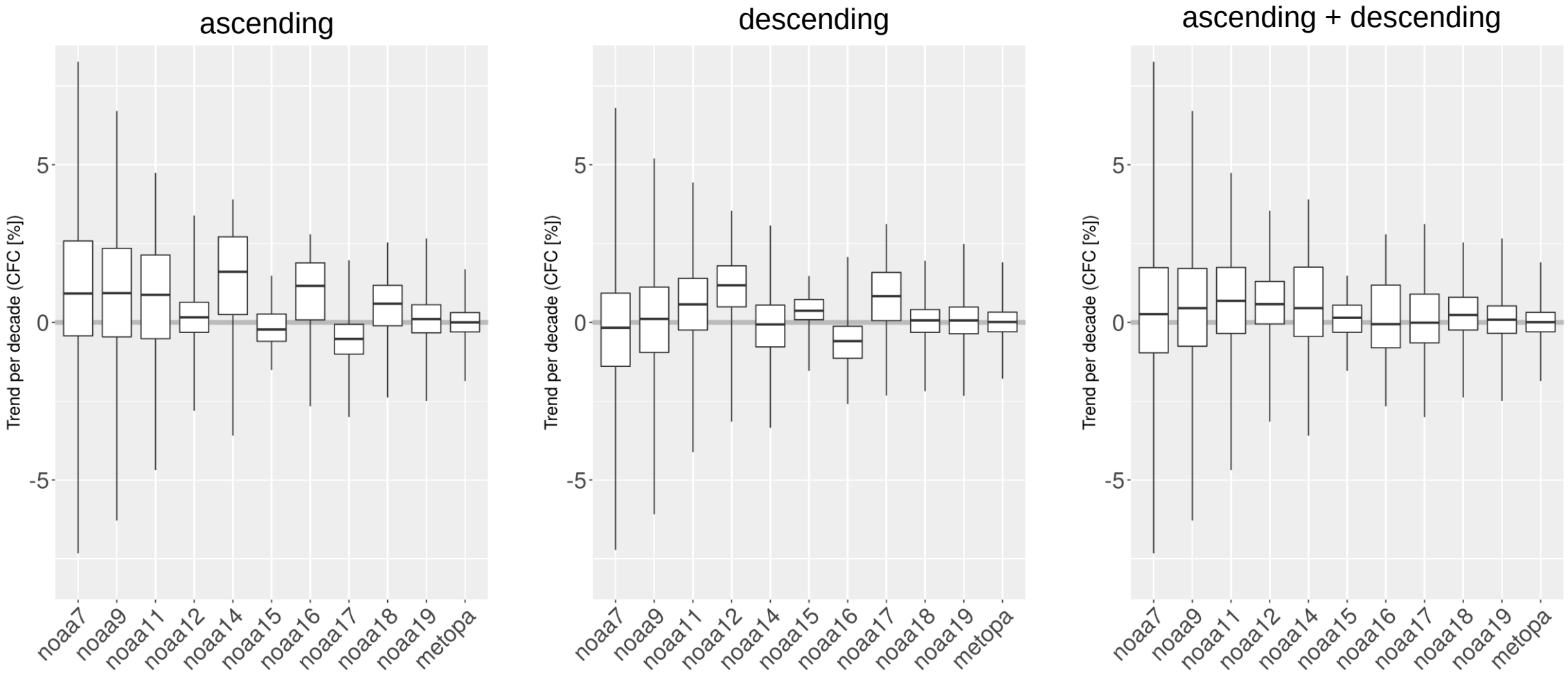
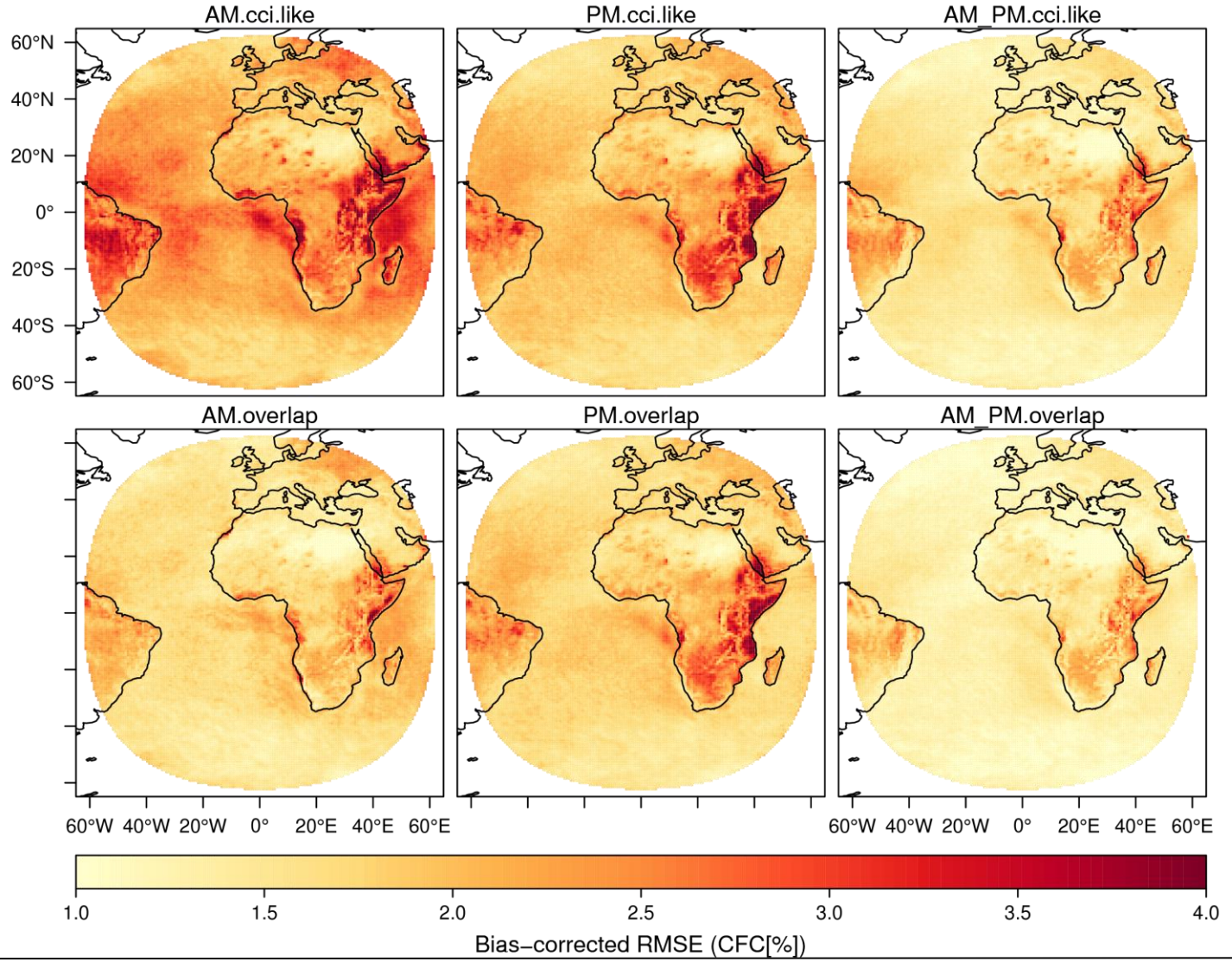
Mean bias NOAA-AM



Bias-corrected RMSE, NOAA-AM



False trends by NOAA & node



Bias-corrected RMSE, AVHRR CDR