Optimal Estimation of Sea Surface Temperature from AMSR-E

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Outline

- Motivation
- Multi-sensor matchup data base (MMD)
- Optimal estimation retrieval algorithm
- Performance
- Conclusion and way forward
Motivation

- Little European activity within the PMW SST retrieval work
- PMW SST retrievals are valuable supplement to IR SSTs due to the capability to see through clouds and small response to aerosols
- Optimal Estimation provides pixel-level information on the retrieval quality
- Optimal Estimation is currently being developed for Sea Ice within ESA CCI Sea Ice (SICCI) context
- A new PMW satellite (CIMR) is candidate for the Copernicus expansion mission
Multisensor Matchup Dataset (MMD6C)

- AMSR-E L2A TBs from RSS (NSIDC), version 7
  - Resampled to resolution; 10 km, all channels
  - Orbit files, ascending and descending

- Every matchup includes:
  - 21x21 extract of AMSR-E TBs + aux info
  - 5x5 extract of NWP variables
  - 60 vertical layers for NWP
  - In situ SST history
  - 5x5 sea ice

- Netcdf format

2002-2011
Optimal Estimation (OE) setup

- Wentz-DMI FW model
- Important with iterations

\( y: \) TBs (6V/H, 10V/H, 18V/H, 23V/H, 36V/H)
\( x: \) State vector (SST, TCWV, TCLW, WS)
\( S_e: \) Measurement and FW model error covariance
\( S_a: \) á priori error of state variables
\( x_0: \) First Guess values
Uncertainty in SST retrieval

- RMSE TB as quality indicator
- Can be used for:
  - Filtering
  - Uncertainty estimate

| Filter                | Bias/K OE-Drifter | std/K OE-Drifter | N (10^6) |
|-----------------------|-------------------|------------------|----------|
| Convergence test passed | 0.02              | 0.57             | 3.7429   | =100%    |
| RMSE_{TB} < 1 K       | 0.02              | 0.51             | 3.4329   | =92%     |
| RMSE_{TB} < 0.50 K    | 0.02              | 0.47             | 2.3953   | =64%     |
| RMSE_{TB} < 0.35 K    | 0.02              | 0.45             | 1.5681   | =42%     |
Global validation

- High standard deviations in e.g.,
  - The Gulf Stream Extension
  - The Kuroshio Current
  - The Aghulas Retroflection areas

- OE SST better than NWP SST in mid-latitudes, while NWP SST is better in the tropics.
Impact from clouds and aerosols (1)

**MODIS cloud fraction avg**
**sample size = 28300**

**sample size = 29154**

**Modis cloud fraction**

**Number of pixels containing aerosols (1-15)**
Impact from clouds and aerosols (2)

Total ice water content (TIWC; g/m²)

Opaque cloud top height (CTH; km)

Number of pixels containing deep convective clouds (1-15)
Performance and filtering effects

| SST (OE-In situ) | Calipso (100 %) | Calipso (50 %) | Calipso (0 %) |
|-----------------|-----------------|----------------|---------------|
| Mean            | -0.02           | -0.00          | -0.00         |
| Std             | 0.56            | 0.51           | 0.50          |
| Num             | 29,154          | 26,492         | 23,994        |
SST uncertainty vs. cloud parameters

Number of pixels containing deep convective clouds

Total ice water content (TIWC; g/m²)
Total cloud liquid water content

OE TCLW

NWP TCLW
Conclusion

- PMW SST OE retrievals developed:
  - Updating state vector important
  - Performance and uncertainty estimates very good

- Atmospheric impact on SST retrieval:
  - Generally very stable performance
  - Impact from deep convective clouds
  - OE can identify and remove these effects
Way forward

- Improve the Wentz-DMI forward model
- Further assess atmospheric influence on retrieval
- Inter-compare RTTOV and Wentz-DMI forward models
- Implement OE for AMSR-2
Thank you!
Distribution of deep convective clouds

Distribution of the number of pixels, ranging from 1 to 15, containing deep convective clouds averaged for 2x2 degree bins
The SST sensitivity is lowest in high latitudes and increases towards the equatorial region, which is consistent with the fact that $\partial \text{TB}/\partial \text{SST}$ is smaller for cold waters (especially for X-band 10.65 GHz channels).