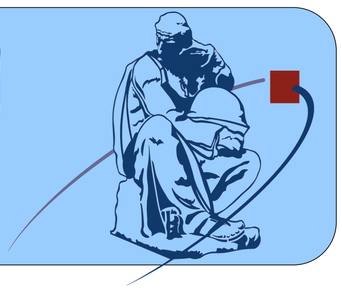
Contrasting global and local satellite-derived SST estimates in a marginal sea



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1.INTRODUCTION

In order to assess performance of satellite IR radiometers in the Adriatic Sea a validation exercise with extensive set of drifter-derived SST was performed for the year 2003, whereas platform-measured SST was used for the year 2004 (Tomazic et al, 2007). In present study we cross-validate Adriatic SST estimates based on ENVISAT AATSR, Terra MODIS and NOAA-17 AVHRR. The study is focused on the year 2006 for which Level 0 (AVHRR) and Level 2 (AATSR, MODIS) data were available. Lacking in situ data to anchor the comparisons we selected the GHRSST-PP AATSR-derived L2P SST as a surrogate reference.

The SST residuals relative to AATSR observations have been calculated and examined considering the wind, aerosol, solar irradiance influences and total column water vapor. More detailed paired analyses have been performed for selected scenes.

3. MATCHUP

Validation of the AVHRR & MODIS SST using AATSR SST as the referenced dataset.

-For each AATSR Adriatic overpass **10% random** pixels are used in validation exercise

- total number of AATSR data: **636266**
  MDB is relational database (PostgreSQL)

- **Initial** matchup criteria for MDB creation:
  - closest pixel less then **2 km** distance (**10** km for MODIS07)
  - absolute time difference less then **4 hours**

- analysis criteria: **1h** absolute time difference

AATSR specific:
- pixels with IPCV:
  acceptable **(4)** + excellent **(5)**;
  - wind, aod and ssi are within **3** hours from aatsr measurements;

AVHRR specific:
- cloud **free** pixels + pixels with stdev<**0.12 K** for Ch4 and Ch5 in 3x3 window around central pixel
- satellite zenith angle below **50°**;

MODIS specific:
- pixels with highest quality flag **(0)**

MODIS 07 specific:
- FOV quality 2&3 (probably and confident clear)

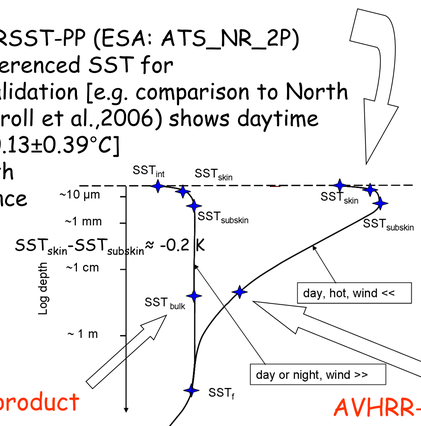
		DAY+NIGHT			
		scenes		records	
data	condition	#	%	#	%
aatsr		271		636266	
	IPCV 4&5	229		366357	
matchup		1244			
avhrr-aatsr	4h	404	32.5	862265	
	1h	147	11.8	316592	36.7
	...+cld	137	11.0	195433	22.7
	...+satza	68	5.5	107083	12.4
	...+IPCV 4&5	60	4.8	70465	8.2
matchup		963			
modis-aatsr	4h	324	33.6	695064	
Long SST	1h	81	8.4	158694	22.8
	...+qual0	47	4.9	46748	6.7
	...+IPCV 4&5	38	3.9	27844	4.0
matchup		610			
modis-aatsr	4h	198	32.5	448881	
Short SST	1h	55	9.0	130031	29.0
	...+qual0	25	4.1	32438	7.2
	...+IPCV 4&5	23	3.8	22260	5.0

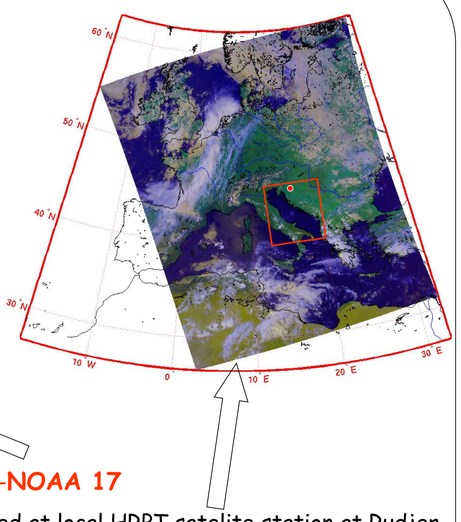
Total number of MDB records and scenes prior and after filtering.
Reduction of 4-8% in the number of scenes and records after application of the specified criteria.

2. DATA (year 2006)

AATSR-ENVISAT

- L2P format from the GHRSST-PP (ESA: ATS_NR_2P)
- **Skin SST** – used as a referenced SST for AVHRR & MODIS SST validation [e.g. comparison to North Atlantic buoy SST (O'Carroll et al.,2006) shows daytime 0.00±0.40°C; nightime: -0.13±0.39°C]
- wind, aerosol optical depth and surface solar irradiance are included inside L2P; sources:
  - **wind** -ECMWF
  - **aod** -NAAPS
  - **ssi** -ECMWF+MSG





MODIS-TERRA - SST product

- Data retrieved as L2 product from the Ocean Biology Processing Group (OBPG) at NASA
- Full spatial resolution (1.1 km in nadir)
- Two SST algorithms:
  DAY: **LongSST** (long-wave algorithms)
  NIGHT: **ShortSST** (short-wave algorithm)
- **Bulk SST**

MODIS-TERRA – atmospheric profiles (MOD07_L2)

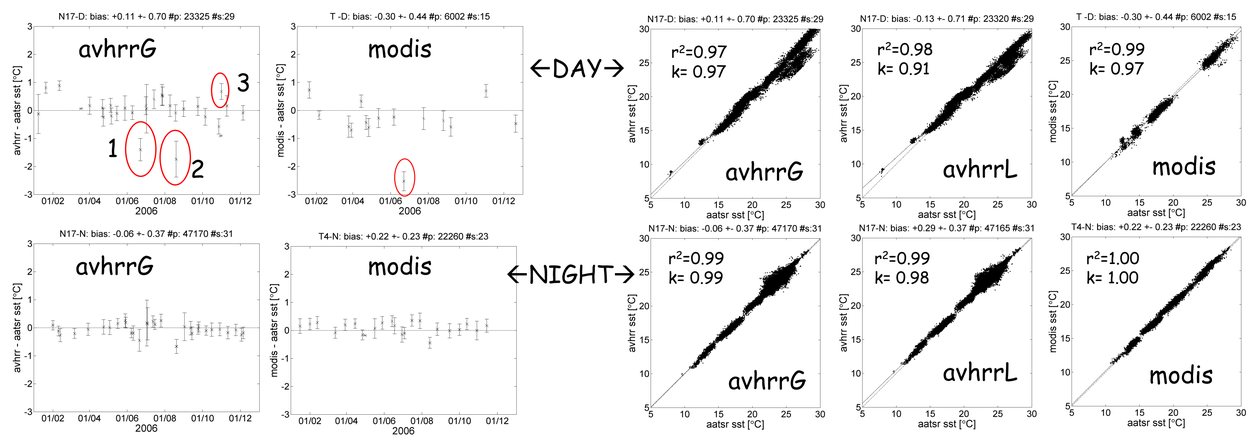
- Retrieved from GSFC@NASA
- **Total column water vapor (tcwv)**, total ozone, profiles, ...
- spatial resolution 5x5 1-km pixel resolution

AVHRR-NOAA 17

- Received at local HRPT satelite station at Rudjer Boskovic Institute, Zagreb
- Processed with AAPP by EUMETSAT and ANA by METEO FRANCE + custom based application for processing to L2
- Full HRPT resolution (1.1 km in nadir)
- SST algorithms:
  DAY: nonlinear split (**NLSST**)
  NIGHT: multichannel triple (**MCAndy**)
- SST coefficients:
  GLOBAL – NASA/NESDIS coefficients
  LOCAL – derived for Adriatic Sea from drifter data in year 2003

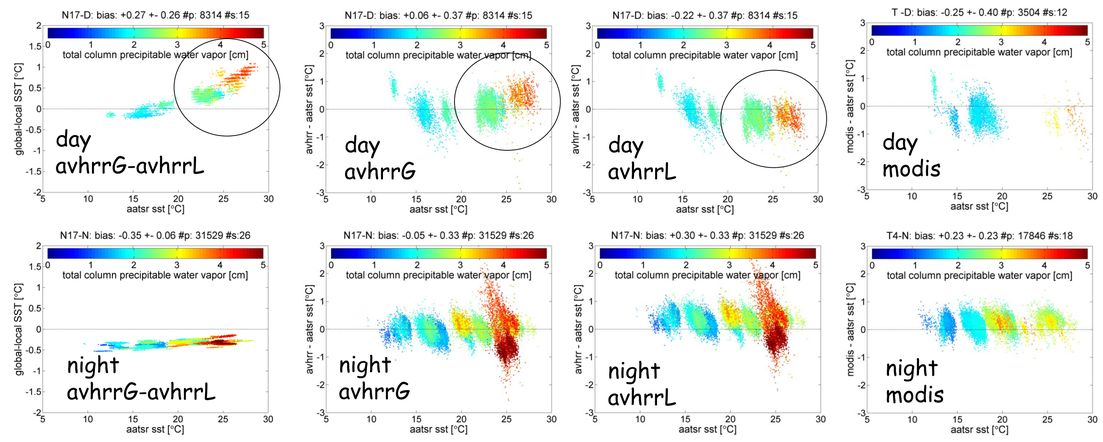
- **Bulk SST**

4. RESULTS



Biases and standard deviations for single overpasses. Two scenes with maximum negative residuals (1,2) and one scene with the highest number of records (3) are selected for further investigation (box 5).

Scatter plots of AATSR skin SST vs. AVHRR global, local and MODIS SST.



-Tcwv (MOD07) with additional filtering for FOV quality flags 2&3
- Local AVHRR coefficients based on the drifer-data study for year 2003 (Tomazic et al., 2007) (majority of drifter data collected in summer period; the year 2003 had lower wind speed regime; local coefficients tuned to this situation)
- Global AVHRR coefficients derived in open ocean wind regime, higher than the Adriatic regime

- Application of local AVHRR coefficients for the year 2006 produces negative bias toward AATSR during day and positive bias during night (similar to MODIS) in contrast with global coefficients where biases are near-zero → assumption that the year 2006 has higher wind regime during summer time compared to the year 2003

DAY						
satid	alg	cond	bias	std	#recs	#scenes
NOAA17	NLSST-global	w≥0	+0.11	0.70	23325	29
NOAA17	NLSST-local	w≥0	-0.13	0.71	23320	29
TERRA	Long	w≥0	-0.30	0.44	6002	15
NOAA17	NLSST-global	w≥6	+0.19	0.49	3876	12
NOAA17	NLSST-local	w≥6	+0.15	0.54	3876	12
TERRA	Long	w≥6	-0.39	0.37	749	8

NIGHT						
platform	coeffs	cond	bias	std	#recs	#scenes
NOAA17	MCAndy-global	w≥0	-0.06	0.37	47170	31
NOAA17	MCAndy-local	w≥0	+0.29	0.37	47165	31
TERRA	Short	w≥0	+0.22	0.23	22260	23
NOAA17	MCAndy-global	w≥6	-0.03	0.37	16546	18
NOAA17	MCAndy-local	w≥6	+0.34	0.37	16541	18
TERRA	Short	w≥6	+0.23	0.22	7184	9

Overall statistics for day and night, global, local AVHRR (NOAA 17) and MODIS and for two wind regimes, all winds and winds higher then 6 m/s. Local AVHRR and MODIS shows similar biases both for day and night. Daytime results for AVHRR local and MODIS and for all winds shows negative bias and nighttime results show positive bias.

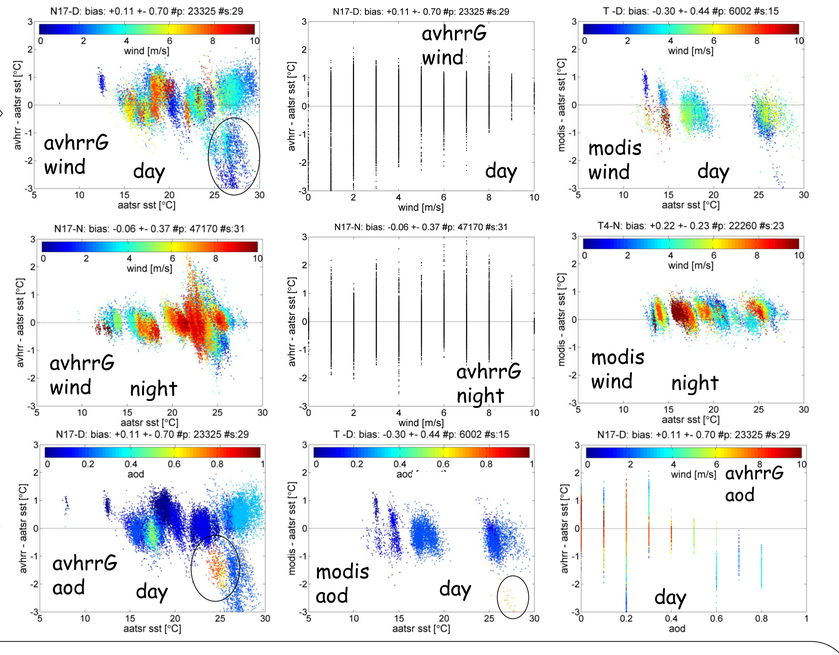
Legend

N17	- NOAA17
T	- TERRA LongSST
T4	- TERRA ShortSST
D	- DAY
N	- NIGHT
#p	- number of points (records)
#s	- number of scenes
std	- standard deviation
cond	- filtering condition
aod	- aerosol optical depth
ssi	- surface solar irradiance
w	- wind
avhrrG	- AVHRR global SST
avhrrL	- AVHRR local SST
r^2	- correlation coefficient
k	- slope
satza	- satellite zenith angle

DAY: residual SST wind

NIGHT: residual SST wind

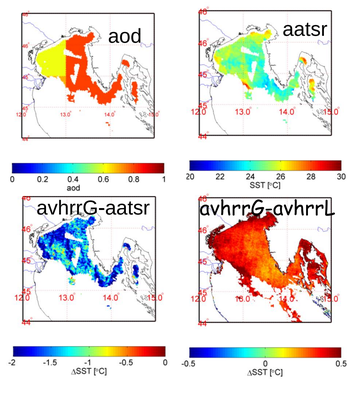
DAY: residual SST aod



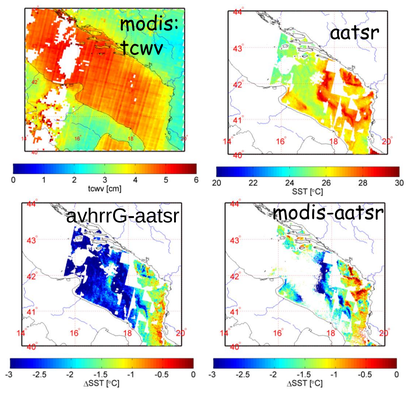
5. CASES

Three different cases are analyzed to investigate possible sources of higher bias for each date. The first case shows negative bias caused by higher content of aerosol in the atmosphere. Second case exhibits possible effects of high atmospheric moisture in low wind conditions. Third case is an example of the influence brought by different atmospheric conditions (tcwv and wind) over the northern and southern Adriatic. Comparison between global and local SST retrieval is also shown.

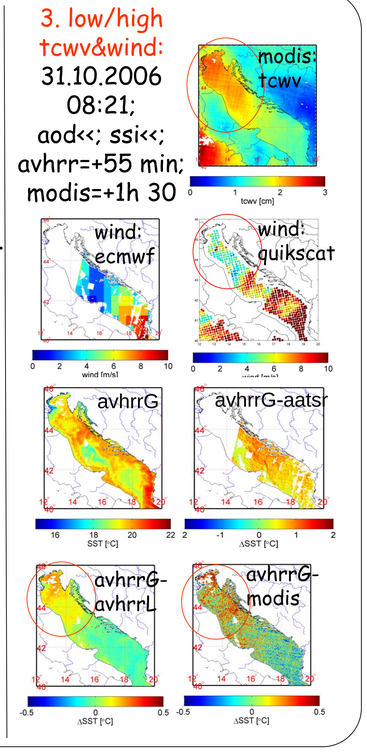
1. high aerosol: 22.06.2006 08:38; ssi<<; wind<<;avhrr=+50min



2. high tcwv: 19.08.2006 08:16; aod<<; ssi<<;avhrr=+40 min; modis=+1h 40 min



3. low/high tcwv&wind: 31.10.2006 08:21; aod<<; ssi<<; avhrr=+55 min; modis=+1h 30



6. CONCLUSIONS

- Used AATSR as the reference SST for cross-validation of AVHRR and MODIS in the Adriatic Sea
- High number of available MDB records: ~10^4 with 10% of all clear AATSR pixels over Adriatic for 2006
- Daytime global vs. local AVHRR derived SST estimate differences show highest discrepancies in the warmer part of the year; related nighttime SST differences are constant throughout the year
- Local AVHRR SST coefficients produce similar biases as MODIS: daytime ~ -0.2°C and nighttime ~ +0.3°C
- Global AVHRR SST coefficients produce low biases (+0.11° for daytime and -0.05°C for nighttime) before AATSR skin to bulk conversion is applied
- Residual SST derived with short-infrared channel during night (with highest quality checks) exibits reduced standard deviation (0.3°C for AVHRR and 0.2°C for MODIS)

References

Tomazic et al, 2007, Sensor specific error statistics: a case study of the AVHRR-derived Adriatic SST, EUMETSAT P.50.

O'Carroll et al., 2006. Validation of the AATSR Meteo Product Sea Surface Temperature. *Journal of Atmospheric and Oceanic Technology*, **23** [5], pp. 711 – 726.