Use of IASI Radiances climatology in climate studies

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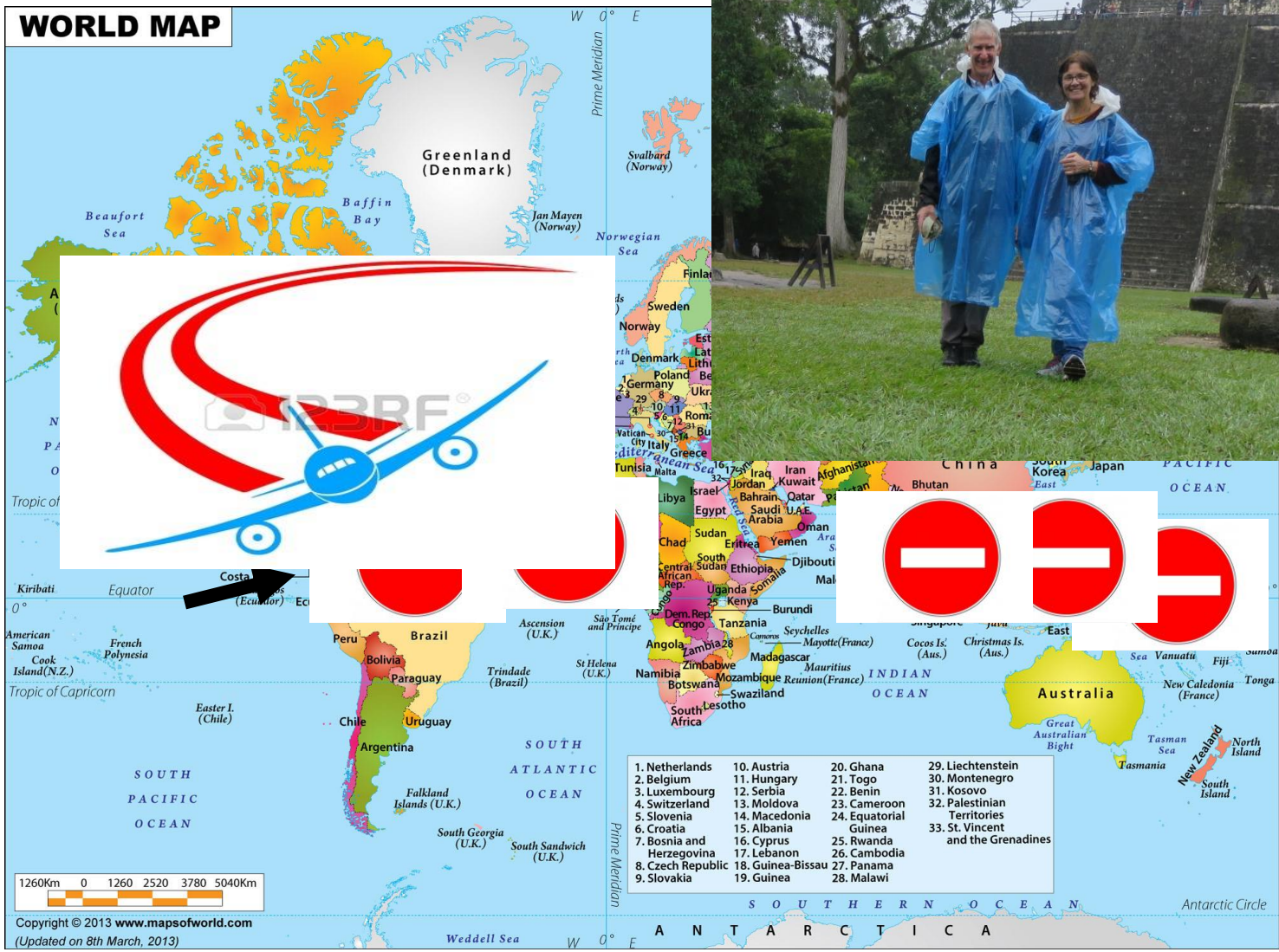
with contributions from C. Bellisario, J. Gonzalez and S. Gaugain

And help by Manuel Grizonnet for HadISST

Who are the users of a climatology? For which purpose?



Users of climatology

Climate expert scientists

To describe the most accurate state of atmosphere and environment in the past

- Used to control ability of climate models to reproduce climate variations
- To initialize climate models from monthly, to seasonal and climate long term projections
- To attribute change to forcing factors
- For statistics
- For Climate service development

Others: Space agencies (e.g. for mission simulation), Public, Media etc.

Rationale of IASI radiance climatology

- Demonstrate pertinence of IASI radiance climatology
  - To validate reanalyses
  - To analyze and understand climate events.
  - To Attribute
- Advantages
  - Accuracy and stability (Calibration)
  - Length of program with consistent products (>40 years)

- Radiance Spectra contain consistent information on many ECVs
- Not biased by models like inverse products

Why using IASI for Climate studies ?

- Very stable
- Very well calibrated → a reference for re-calibration of infrared sensors

(WMO's GSICS)

- 15 years of data and more with the continuation with IASI-NG
- Very large information content on atmospheric ECVs
- IASI is well sized to deliver FCDR and TCDR for Climate monitoring.
- It is also used in study of processes.

IASI radiance global climatology

- Already 10 years of IASI-A data
- Representing 2M/s, 170Go/d, 63 To/y
- Monthly statistics on line => avoid huge processing and keeps useful data
- Why radiances?

L1c > less frequent reprocessing
Explore the wealth of spectral content vs selected channels
Promising previous work (Harries (2003), T. Slingo, ..) etc.

- Which scale ?

Global scale (like altimetry). Global change tb perceived at
Regions (ENSO34 and Pac W, latitude belts)

- Which time period?

Monthly values. Seasonal if pertinent.
Year to year variation

- Which various conditions?

All, Land/sea, day/night,
cloudfree (CF=0), Overcast

Data used in this climatology

- IASI – A Level 1C spectra archived at Ether center
- Period of time : March 10 to December 12
  June 10 to last month
- Includes AVHRR cloud fraction in IASI pixels

Cloud mask count	1,36E+07	
Average cloud mask	69,2419	
Clear pixels count	1,49E+06	89,06
Cloudy (>=95%) pixels count	7,25E+06	
Pixels count	1,36E+07	
Cloud mask standard deviation	39,5504	

Huge number of pixels (night only!)

Mean cloud fraction ≠ ratio of cloud contaminated pixels

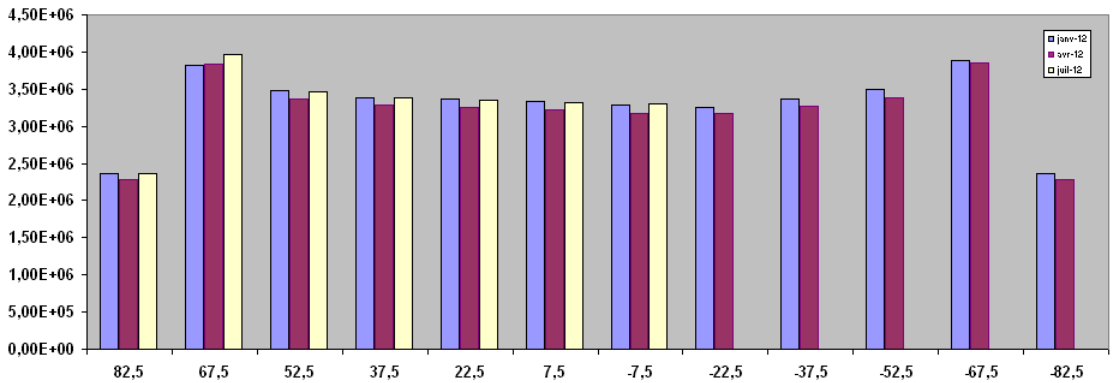
Ch.	mean rad	Clear mean	Cloud mean	All rms	Clear rms	Cloud rms	all sk.	Clear sk.	Cloud sk.	Kurt.	Clear kurt.	Cloud kurt.	all_Tb	clear_Tb	cloud_Tb
1	4,273E-04	4,051E-04	4,400E-04	5,81E-05	3,30E-05	6,39E-05	0,953	1,898	0,591	3,152	7,820	2,382	214,42	211,84	215,87
2	4,309E-04	4,073E-04	4,453E-04	6,25E-05	3,45E-05	6,88E-05	0,952	2,086	0,566	3,020	8,212	2,231	214,87	212,13	216,48
3	4,430E-04	4,256E-04	4,583E-04	7,09E-05	3,47E-05	7,87E-05	0,749	2,116	0,408	2,872	9,167	2,143	216,25	214,28	217,96
4	4,827E-04	4,849E-04	4,960E-04	8,57E-05	3,47E-05	9,42E-05	0,072	0,863	-0,042	2,601	9,829	2,179	220,63	220,87	222,04
5	4,823E-04	4,843E-04	4,958E-04	8,59E-05	3,49E-05	9,45E-05	0,090	0,899	-0,027	2,609	9,824	2,179	220,61	220,82	222,04
6	4,425E-04	4,240E-04	4,580E-04	7,03E-05	3,50E-05	7,80E-05	0,794	2,149	0,440	2,887	9,117	2,135	216,28	214,17	218,00
7	4,249E-04	3,976E-04	4,401E-04	6,40E-05	3,67E-05	7,00E-05	0,968	2,019	0,579	2,983	7,701	2,214	214,31	211,12	216,04

skewness kurtosis

Global statistics or regional

Validity of this climatology

- Very large data set
- Homogeneity of spectral sampling



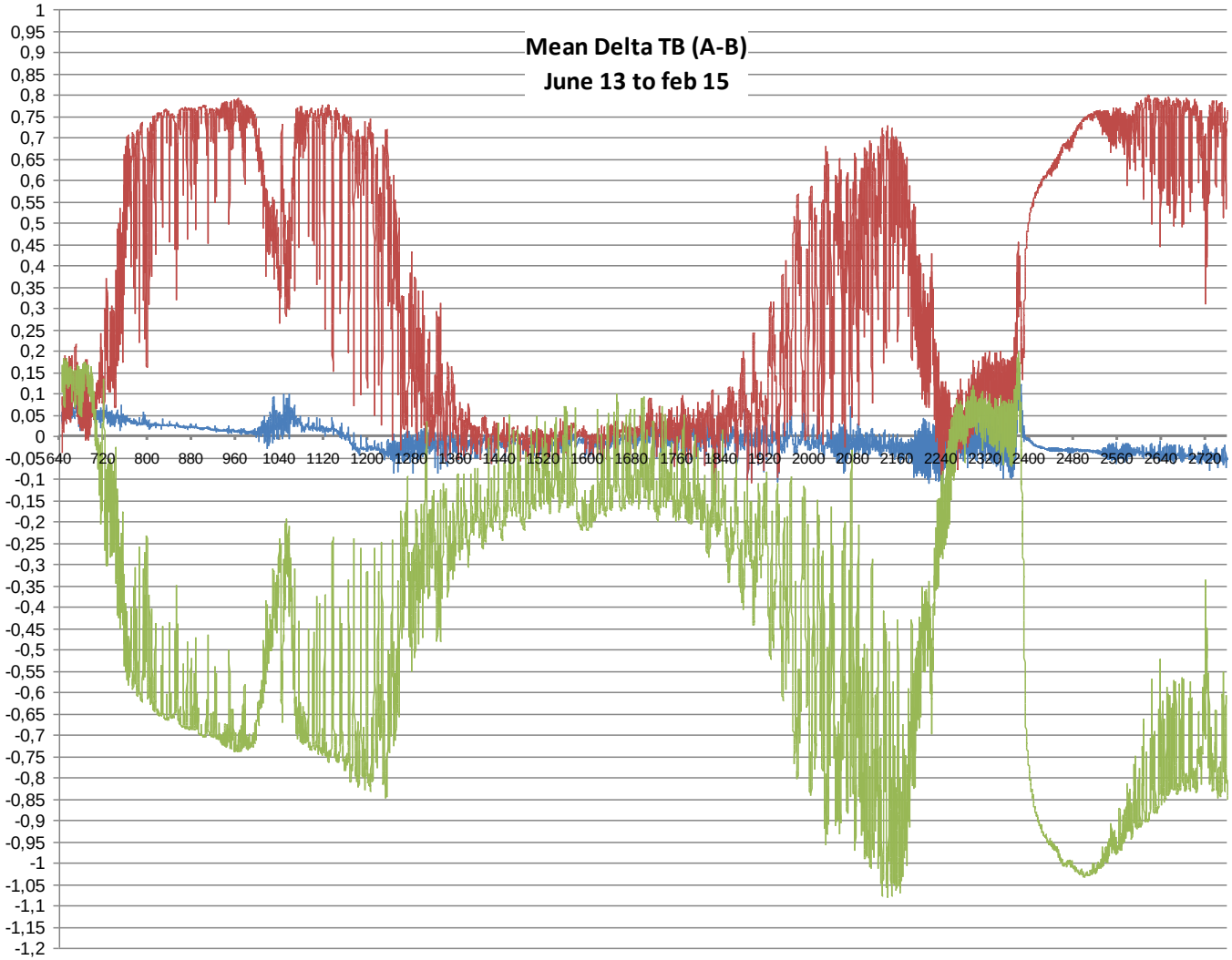
Correct sampling (even if weight of poles slightly minored

Caution: gaps due to instrument monitoring : external calibration, etc.)

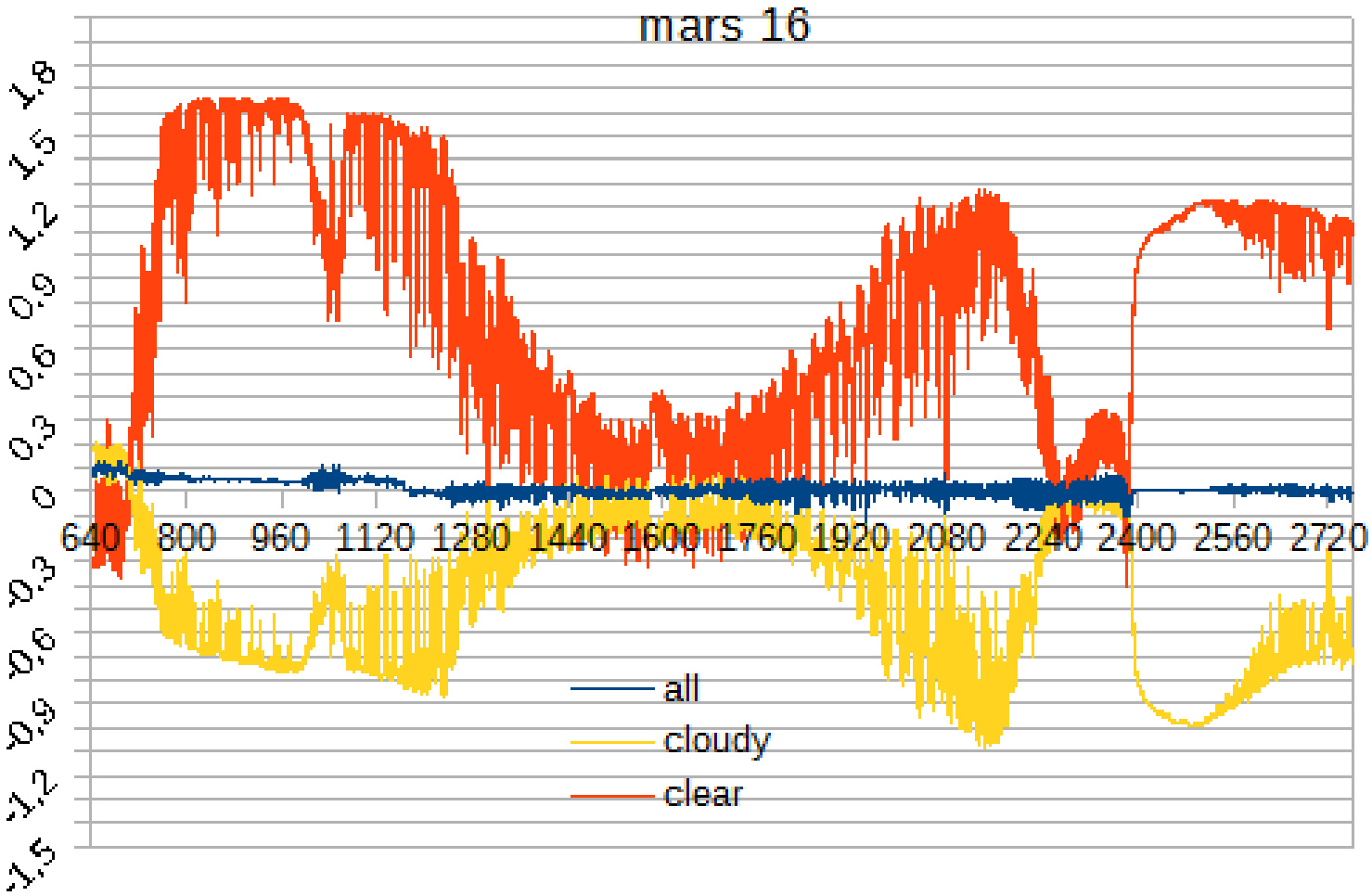
- But

Quality of climatology of clear pixels depends on cloud fraction accuracy => <u>Cloud free test must remain stable</u>

IASI-A vs IASI-B



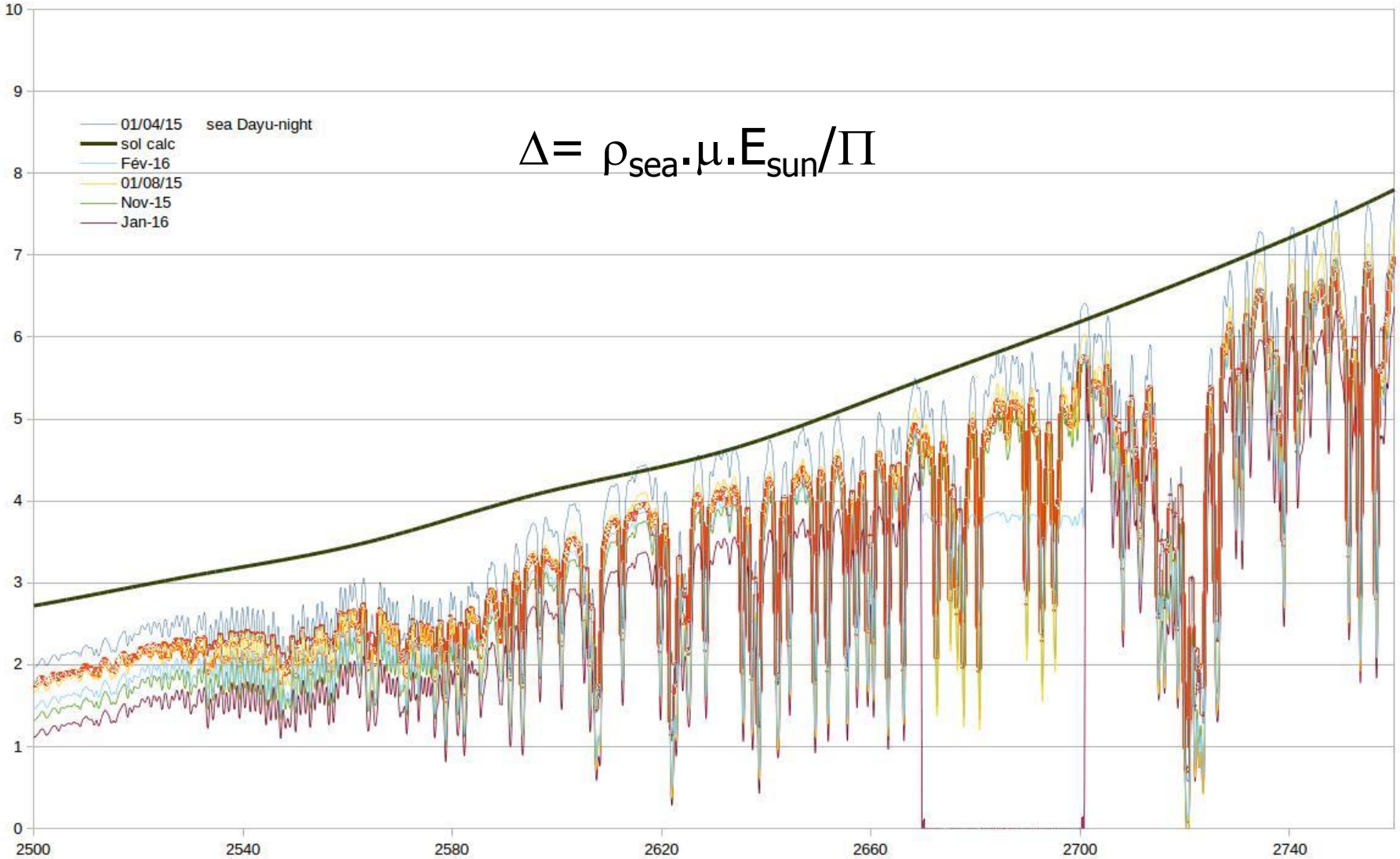
IASI-A vs IASI-B



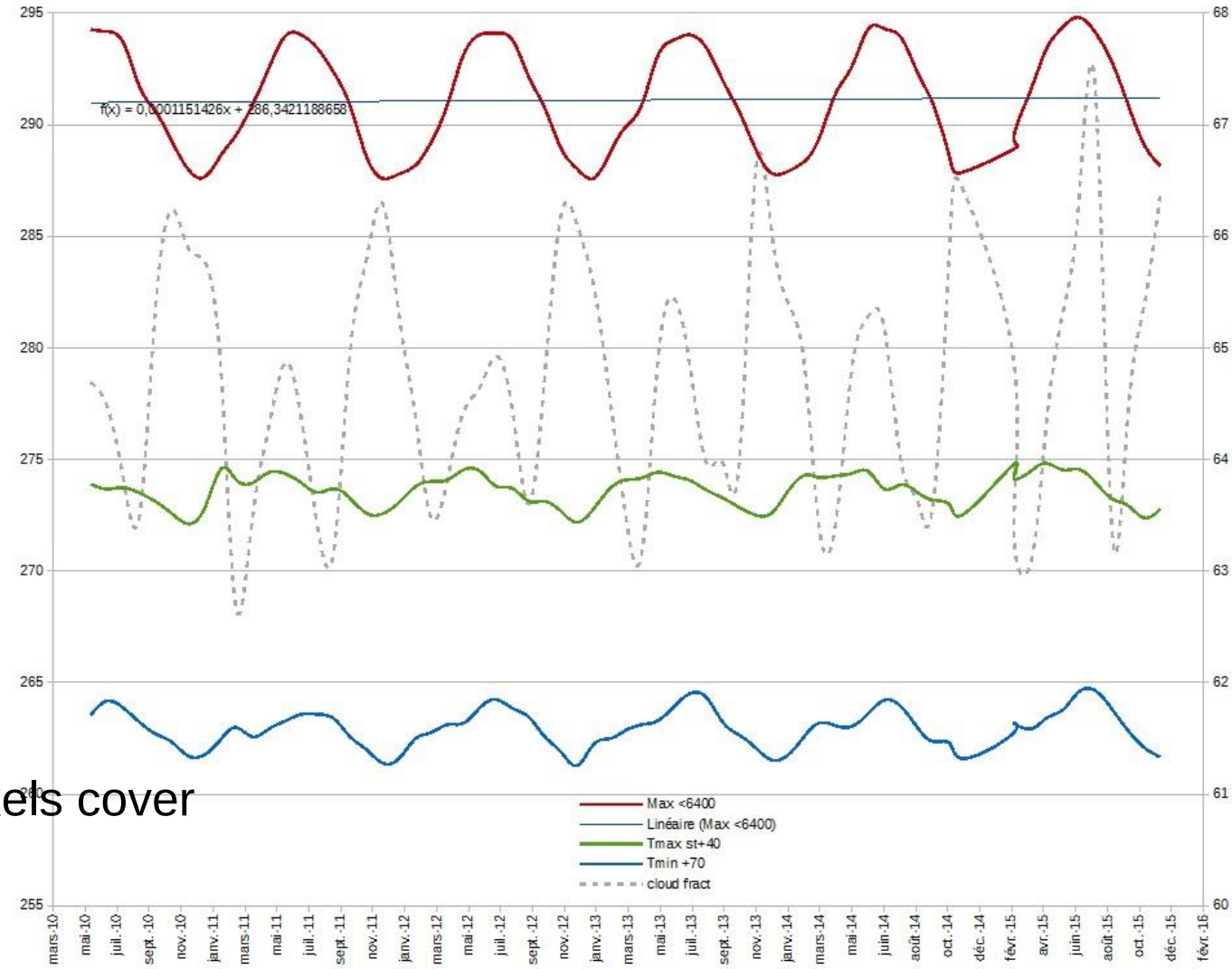
Recent Improvements

- Statistics with low viewing angle (<17°) (near nadir)
- Calculation of solar contribution
- Comparison with HadISST

Sun reflectance contribution

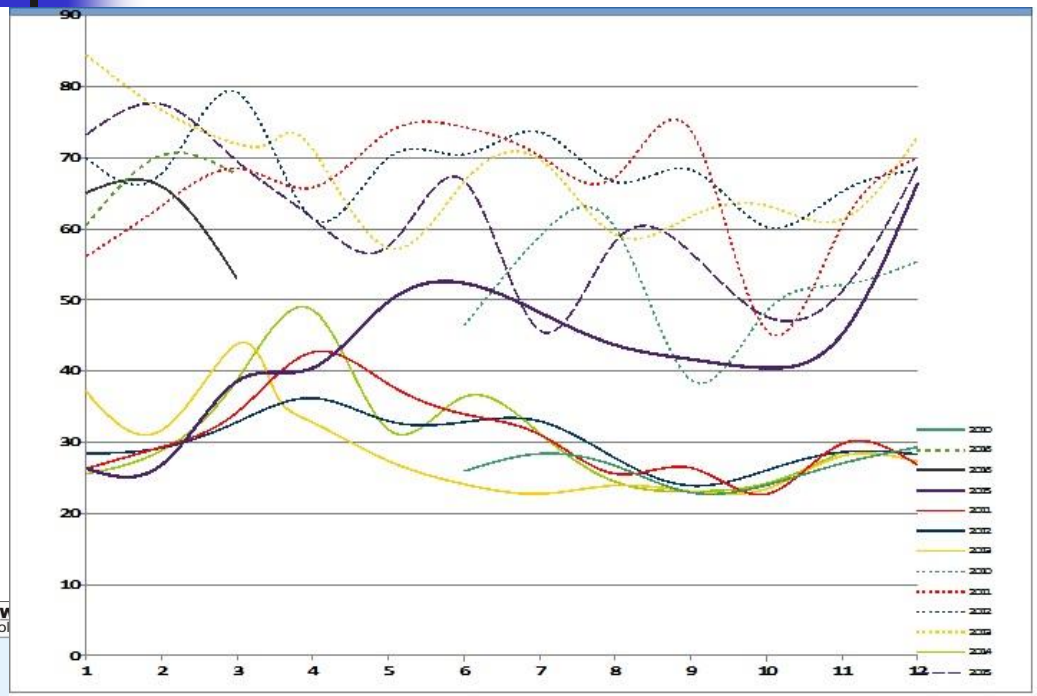


Climate Indicators

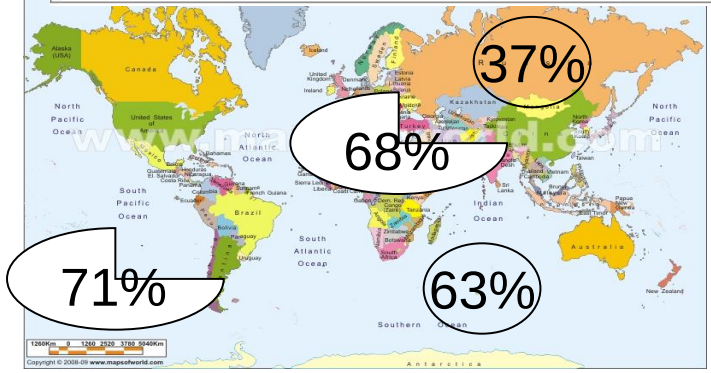


All Cloudfree pixels cover

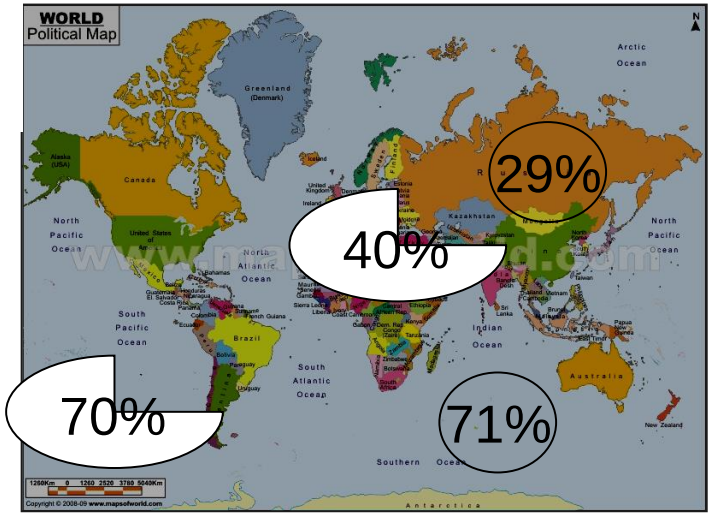
Cloudiness



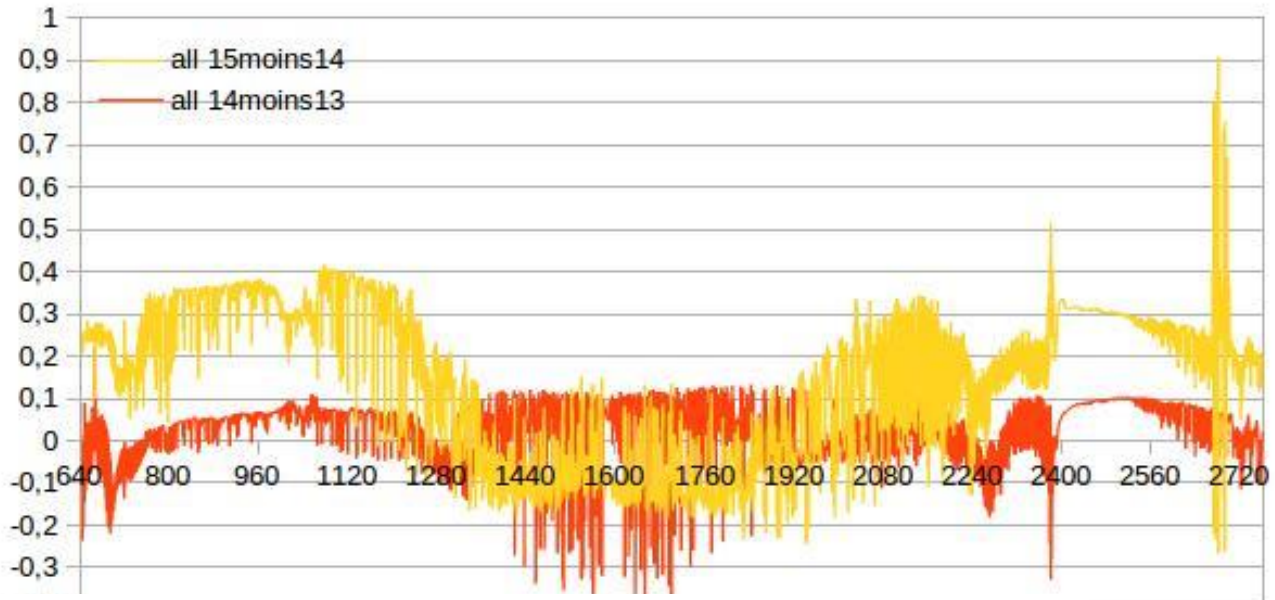
VERY STABLE
CONSISTENT WITH Gewex Cloud assessment

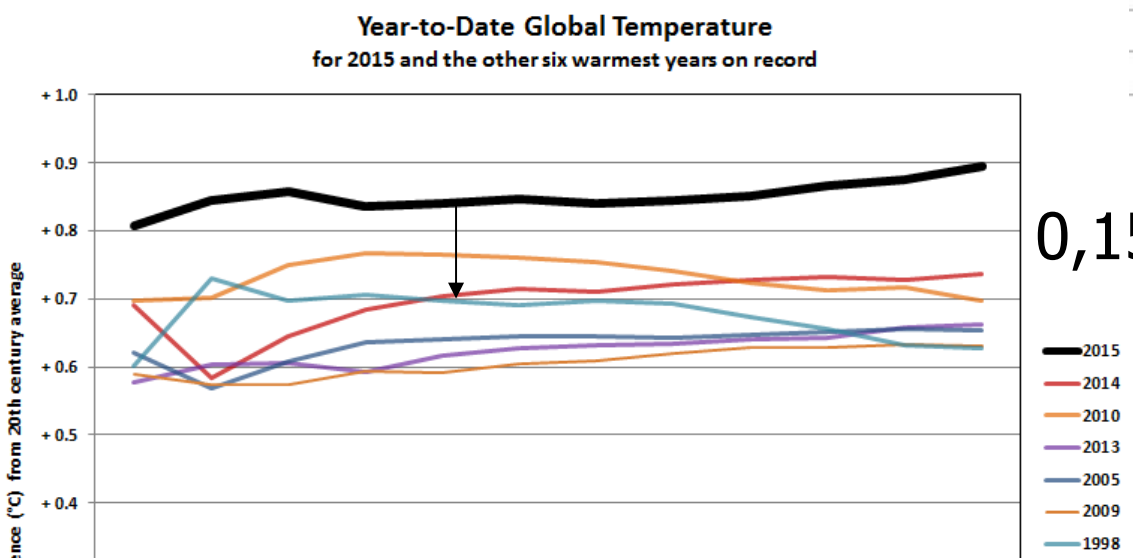


- More cloudy over ocean
- Cloud fraction stable over ocean
- Less cloudy over land @9.30 AM



Year to year variations





0,15K

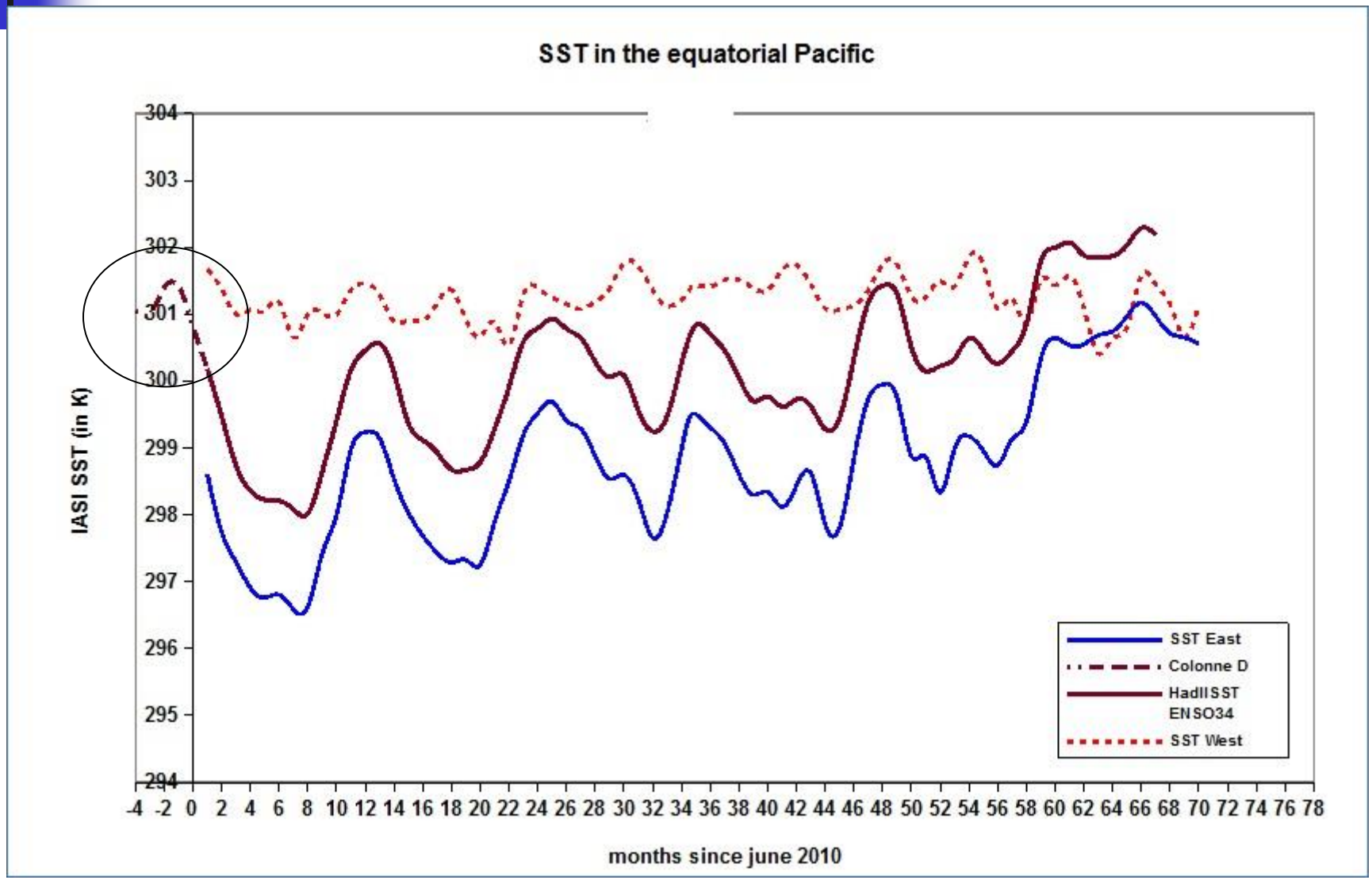
	2014	2015
	2013	2014
H2O	1,20%	2,00%
O3	-0,20%	-0,20%
CH4	1,50%	
CO	0,00%	
N2O	5%	-1,00%
CO2	1%	1,00%
Ts	0,1K	0,4K
Ttropo	0,12K	-0,5K
Tstrato	$-0,1K$	0,25K
Tmeso	0,9K	0,1K

Underestimation of NOAA

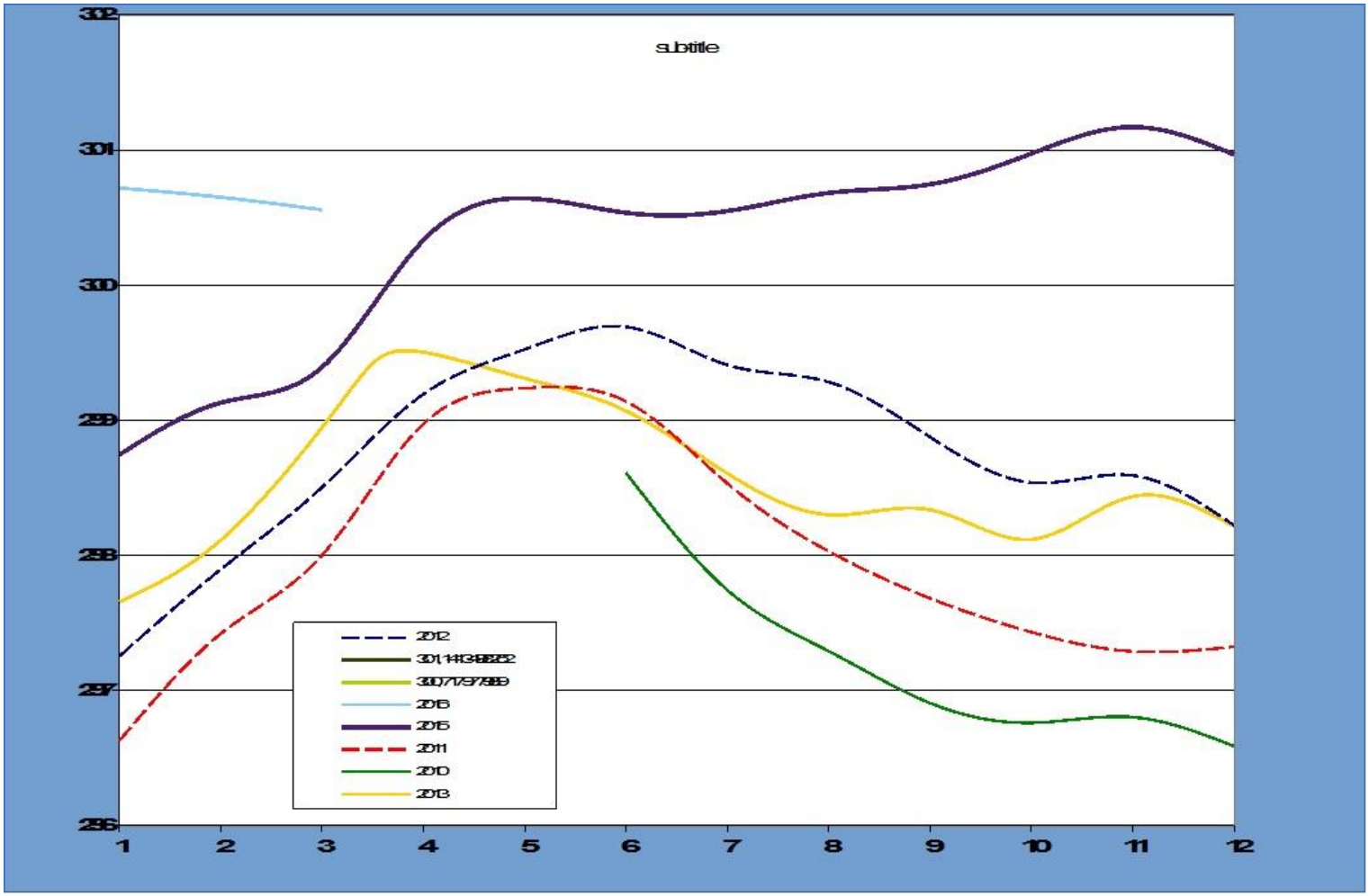
SST

- TB in Channel 2700.75 cm-1 (the most transparent, t=0.99)
- At night to avoid solar reflection and surface heating
- Viewing Angle <17° or all angles
- Area :
  - ENSO34
  - ENSO PW
  - 20S-20N
  - Global
- Validation with HadISST

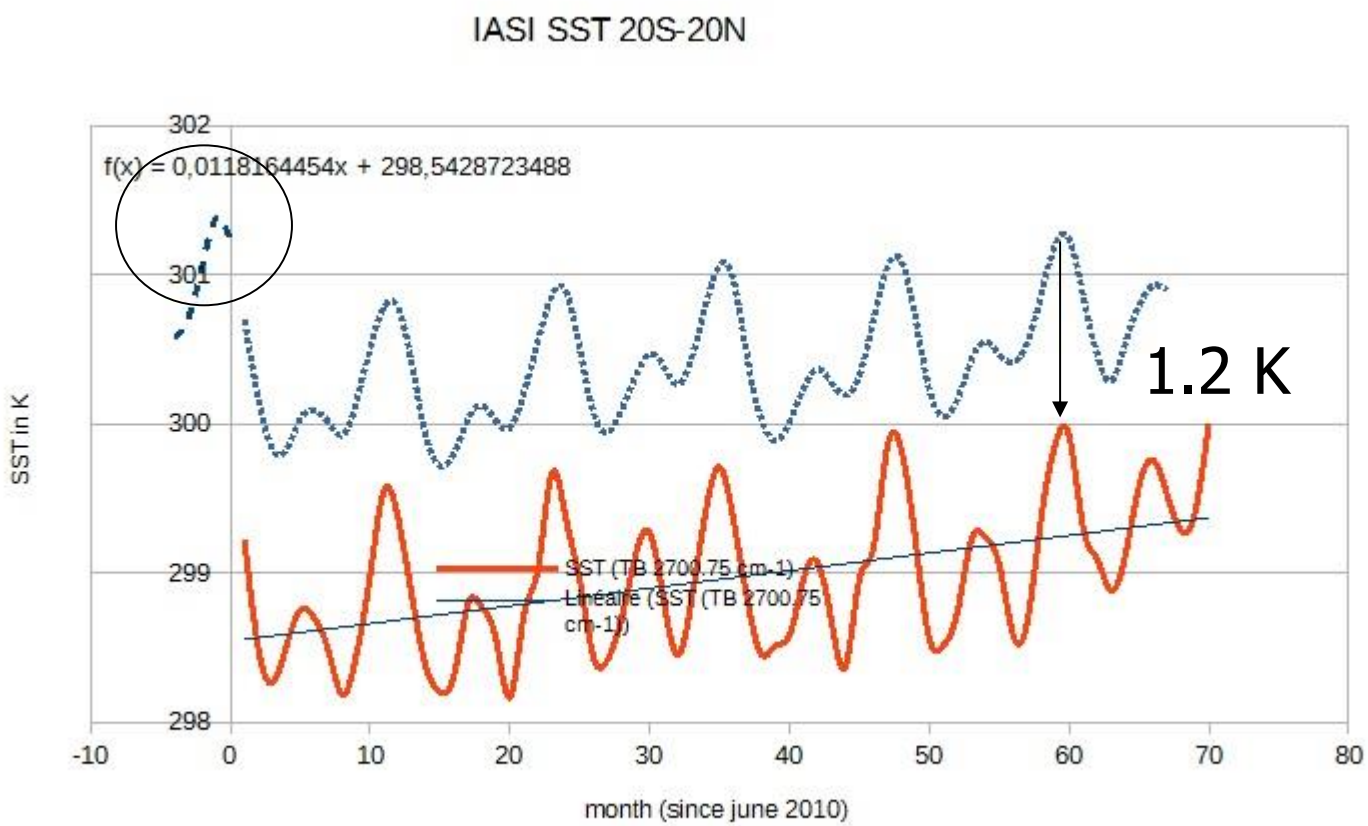
ENSO


SST in the equatorial Pacific
IASI SST (in K)
304
303
302
301
300
299
298
297
296
295
294
-4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78
months since june 2010
SST East
Colonne D
HadISST ENSO34
SST West

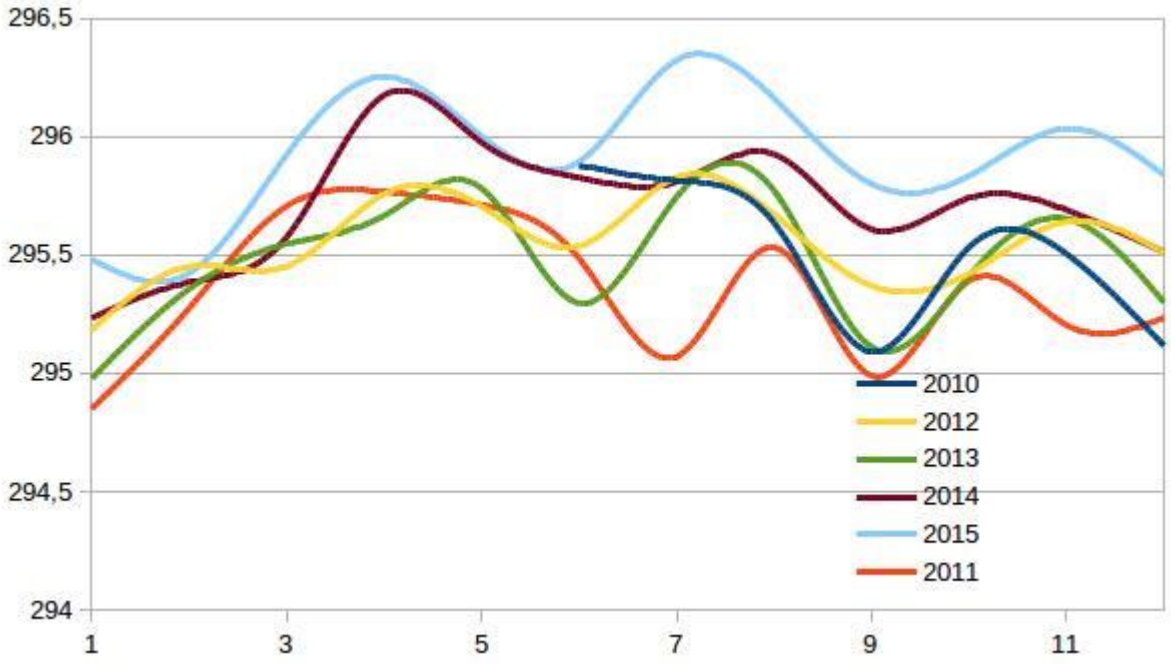
ENSO



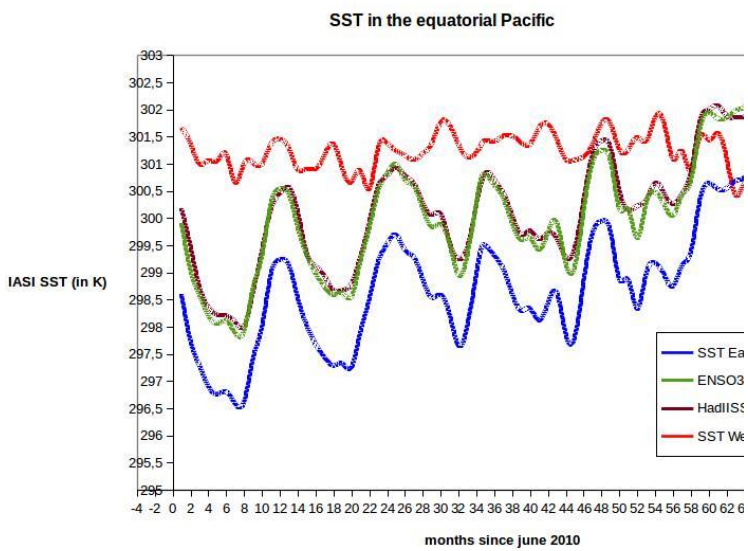
Tropical ocean



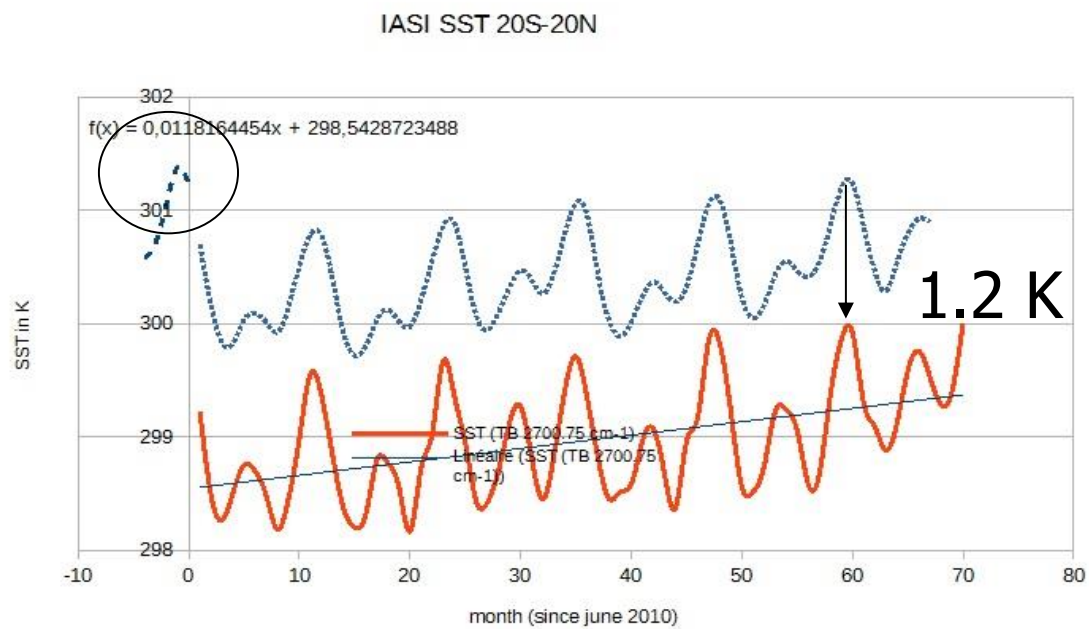
Global


296,5
296
295,5
295
294,5
294
1
3
5
7
9
11
2010
2012
2013
2014
2015
2011

Comparison with HadISST (1)



ENSO areas : 34 and PW



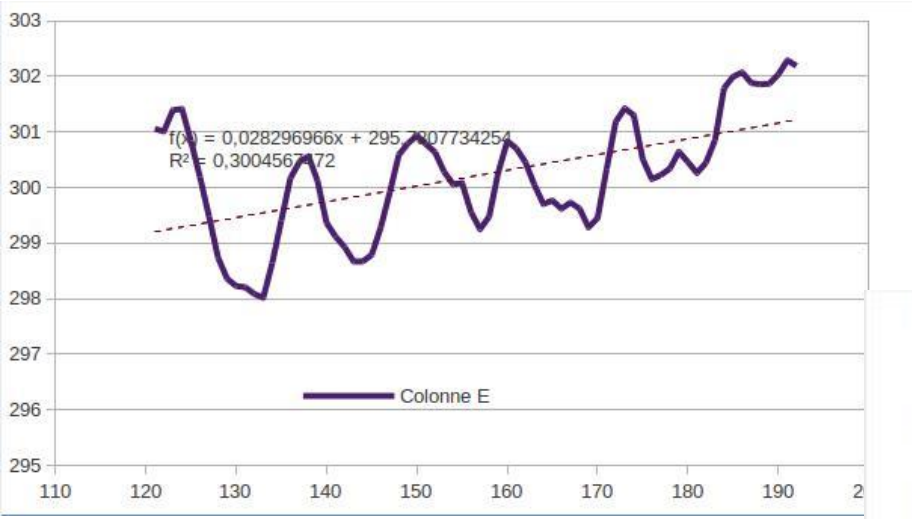
Tropical ocean

Bias around 1.2K

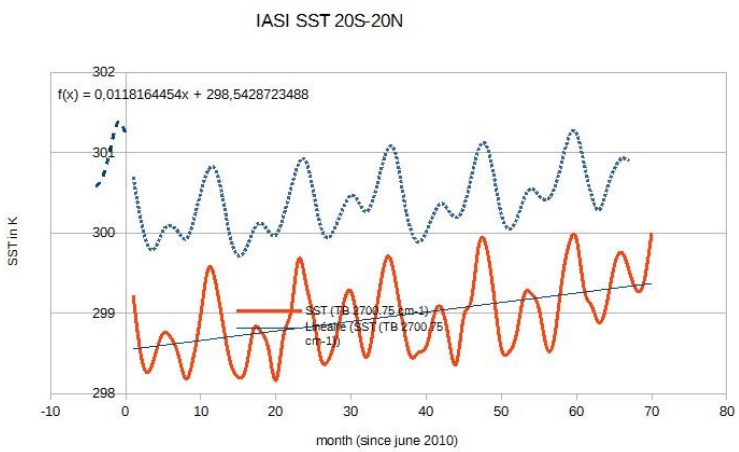
Residual bias = 0.2-0.4K

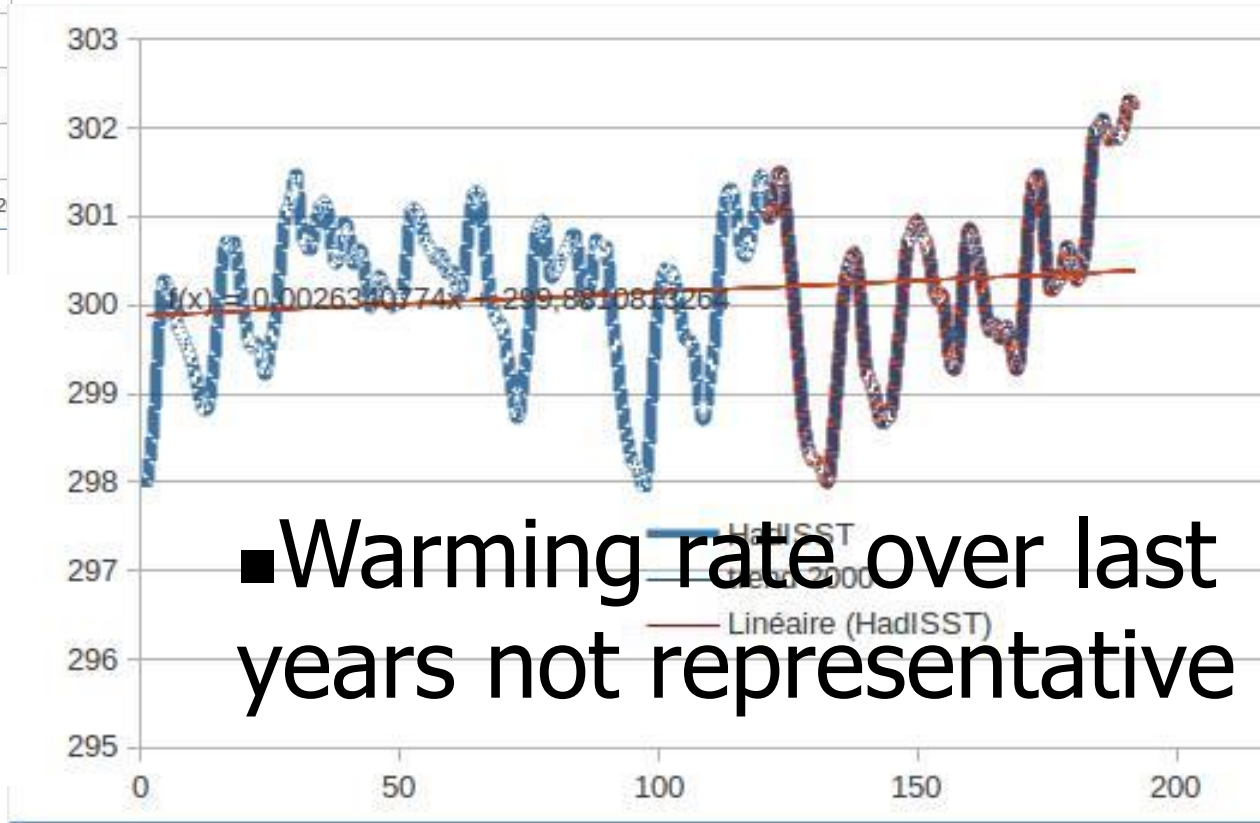
Sea surface emissivity (0.978) =0.6K
Skin effect =0.1-0.2K
Atmospheric absorption =0.1-0.2

Comparison with HadISST (2)



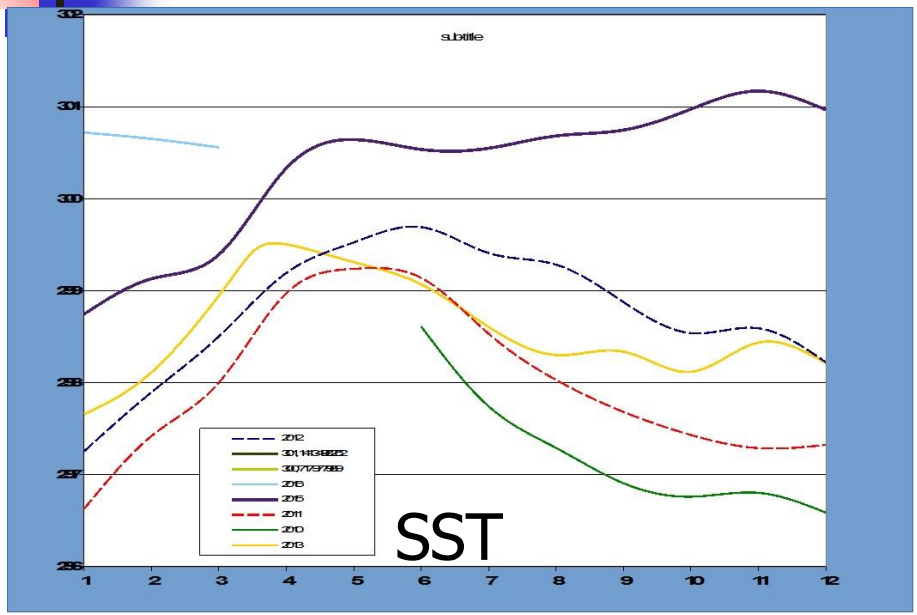
Tilt :0.3K/year over ENSO34
>0.1K/year over Tropics

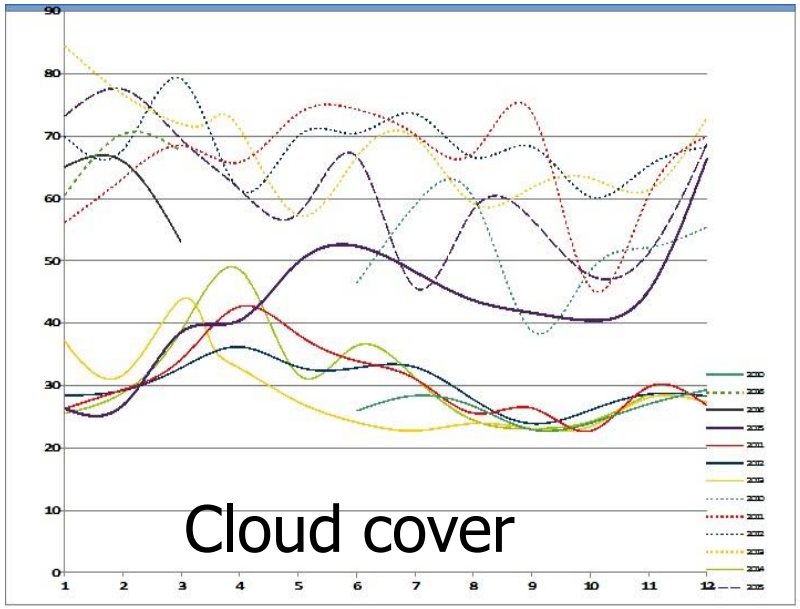




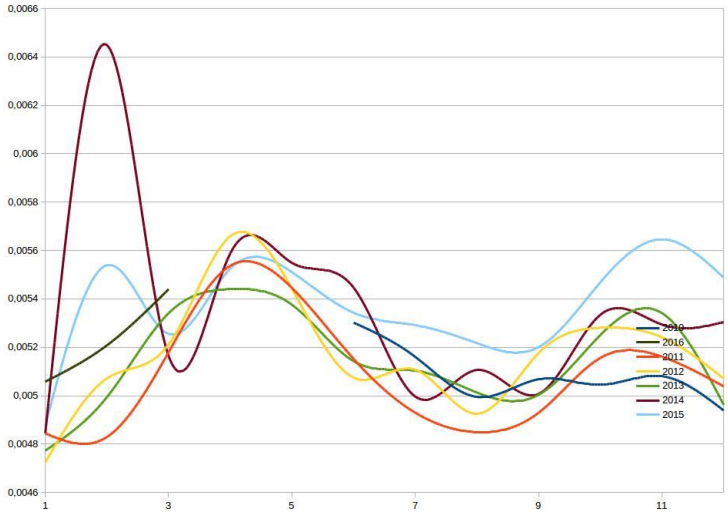
- Warming rate over last years not representative

ENSO events





HDO
Tropical ocean



Cloud cover: consequence of warm waters? High humidity before start of ENSO?

Lessons from comparison

- HadISST : slight warm bias –around 0.3K
- Increasing rate of SST must be relativised with extension with a larger period.
- IASI used to study ENSO events with various parameters

Conclusions

- IASI Level 1C spectra climatology such performed is very rich in information
- Very simple to implement
- Allows consistent access to various ECVs
  - And a qualitative evaluation
  - Very simple to inverse
- It brings a new tool for climate analysis
  - Allows with a same tool to get several variables all over the globe
    - Consistency between variables
    - Consistent observations in different regions to analyze potential teleconnections

Conclusions

- Thanks to the high quality of IASI data and processing, Infrared radiance spectra are to be included among Climate variables to produce and archive on the long time.

Next steps

- Simulate mean IASI spectra month by month with ERA Interim reanalysis and confront.
- Study the sun reflection term to check any change in forcing
- Make the data available to the community

Reprocessed IASI L1c products for 2007 – mid 2010 URGENT !!!!

THANK YOU FOR ALL!

Most recent statistics : 2016!!!