IASI RADIANCES CLIMATOLOGY

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OUTLINE

- RATIONALE
- METHODOLOGY
- PRODUCTS
- EXPLOITATION OF THE STATISTICS
- METHODOLOGY ISSUES
- RESULTS ON RECENT EARTH CLIMATE
- CONCLUSION

RATIONALE

Why using IASI for Climate studies?

Climatology needs long data series (>30 years) of very stable and well characterized observations

- IASI is a very stable instrument
- 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
- Full coverage of Earth twice a day with consistent observations (and processing).
- Very large information content on atmospheric essential climate variables (ECVs)

In summary IASI is well sized to deliver FCDR and TCDR for Climate monitoring (trends and attribution). It can also be valuable in study of processes, or seasonal forecast.

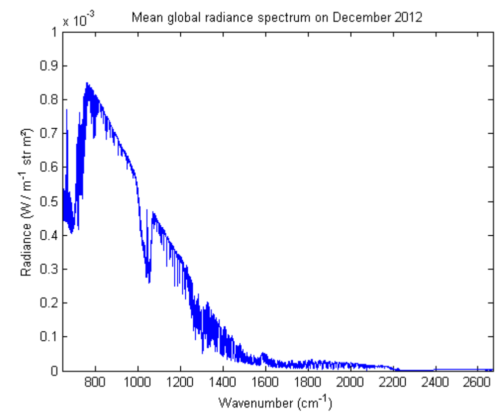
<u>IASI gives an opportunity of establishing a global climatology fully independent of model</u>

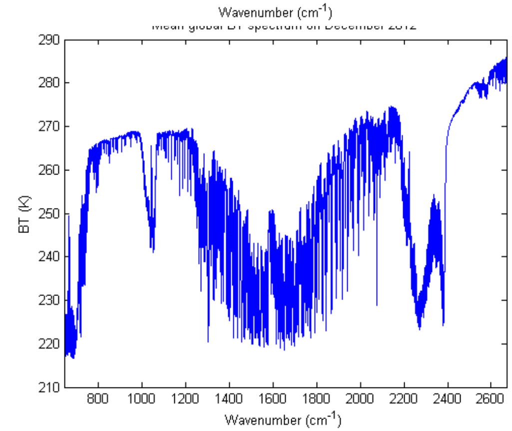
Such statistics allow to compress strongly the data (representing 2MB/s, 170GB/d, 63 TB/y) to keep the climate signal.

- Already 8 years of data

METHODOLOGY

- Use of IASI L1c Radiances (no model, keep consistency in spectra, more stable processing, good previous examples).
- Use of AVHRR cloud fraction delivered in L1C since June 2010
- Averaged radiances for
  - All pixels
  - Cloudfree (cf=0.0)
  - Cloudy overcast (cf >0.95)
- All viewing angles or at nadir (Viewing angle <17°)
- Periods : Month (all pixels), trimesters (nadir), year
- Global (1 figure for whole Earth like altimetry). Options :
  - Sea/land/all
  - Day/night/all
  - Region: ENSO34, ENSOWP, Tropical oceans (20S-20N), Anta





- Conversion radiances > Brightness Temperatures
- Plot of Estimators (Proxies)
- Mapping in boxes 1°*1° available

DATA USED IN CLIMATOLOGY

IASI Level 1C spectra archived at Ether center

Period of time : March 10 (June 10) to February 14

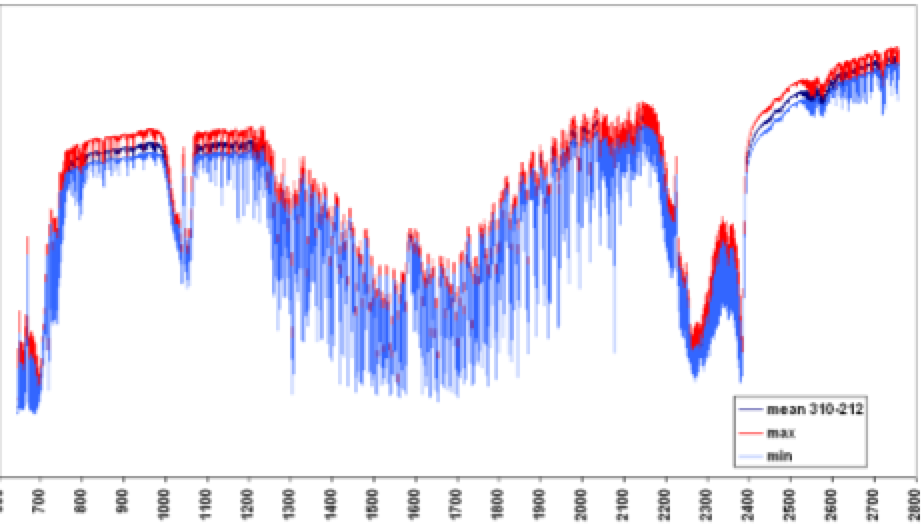
Includes AVHRR cloud fraction in IASI pixels

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
Cloud mask	39,5504

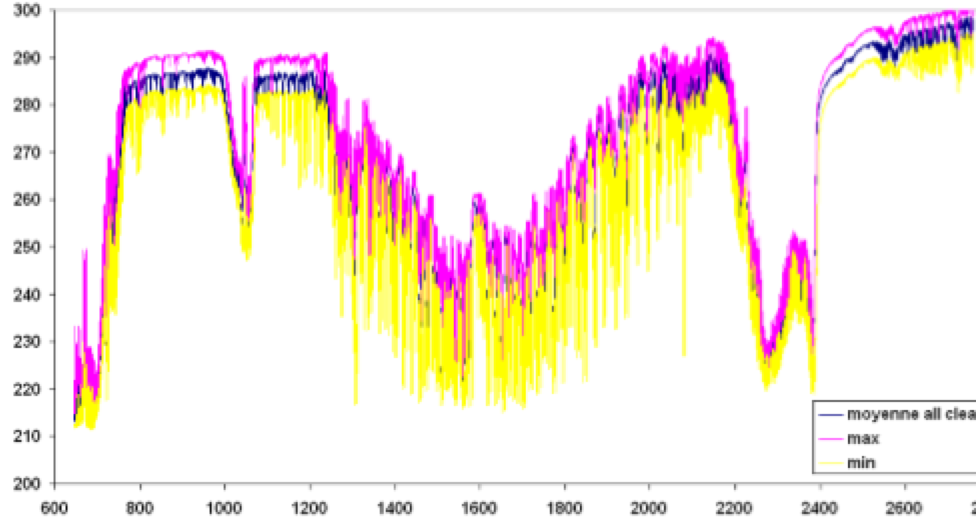
Ch.	mean rad	Clear mean	Cloud mean	All rms	Clear rms	Cloud rms	all sk.	Clear sk.	Cloud sk.	Kurt.	Clear kurt.	Cloud kurt.	all_Tb	clear_Tb	cloud_Tb
1	4,273E-04	4,051E-04	4,400E-04	5,81E-05	3,30E-05	6,39E-05	0,953	1,898	0,591	3,152	7,820	2,382	214,42	211,84	215,8
2	4,309E-04	4,073E-04	4,453E-04	6,25E-05	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	222,0
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	218,0
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	216,0

Global statistics

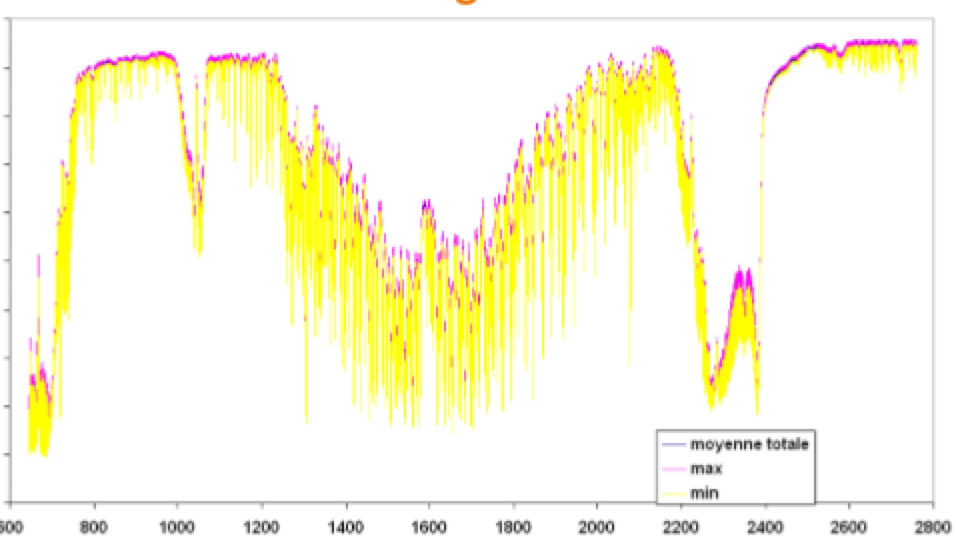
All- All



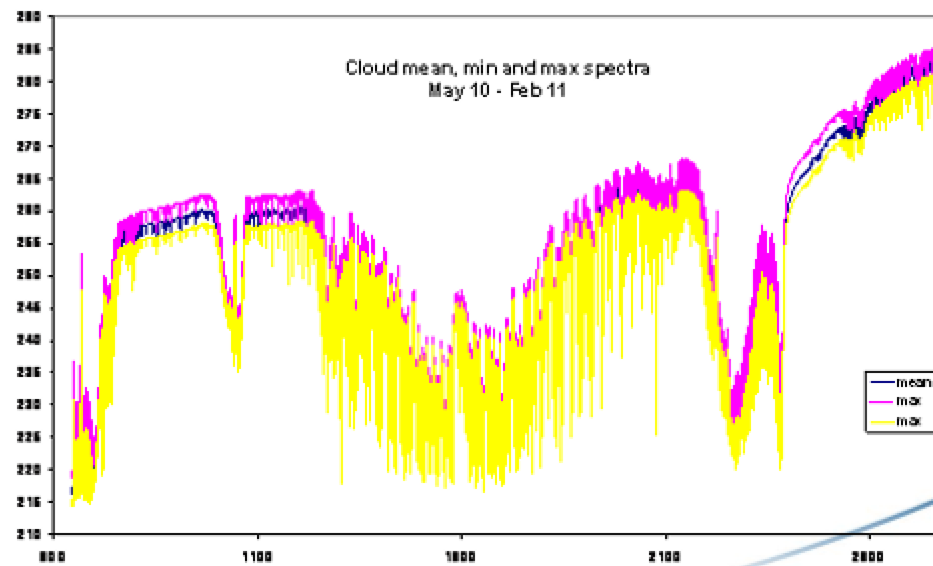
All- cloud free Ts=293.7 K



Sea at Night

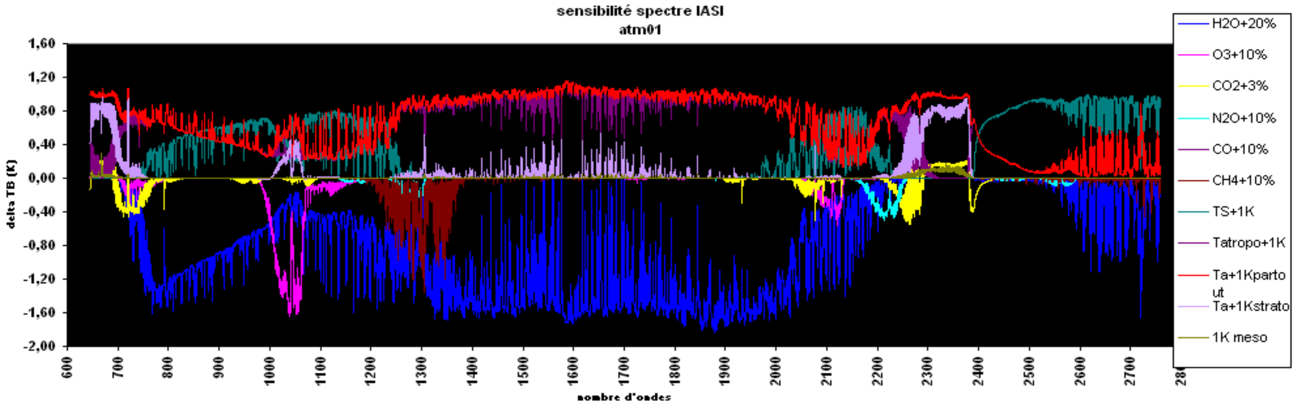


All - Overcast (F> 0.95)

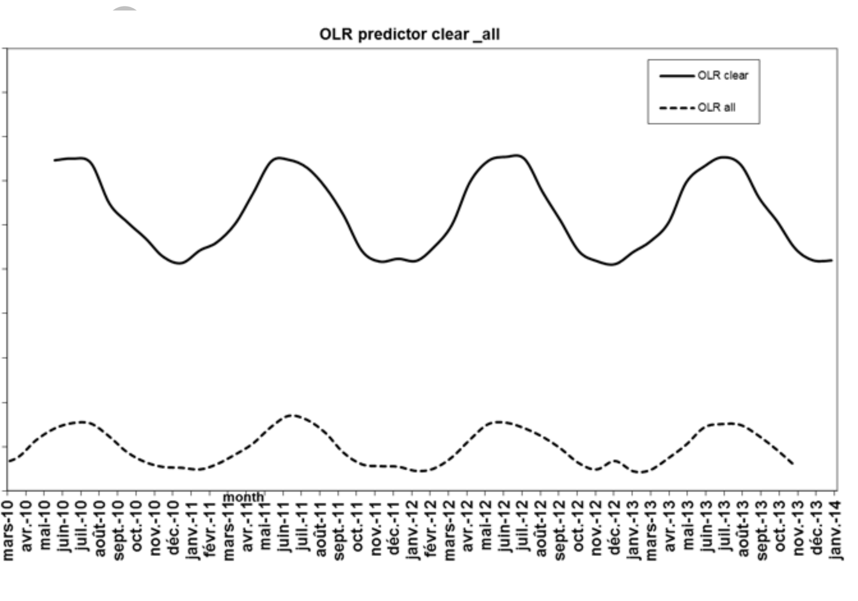


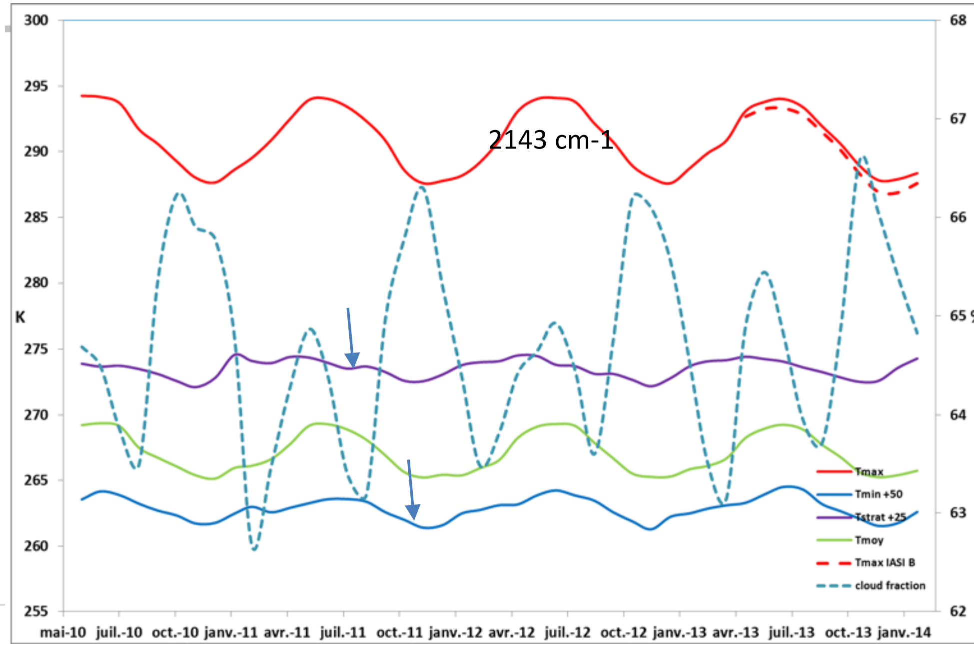
EXPLOITATION OF THE STATISTICS

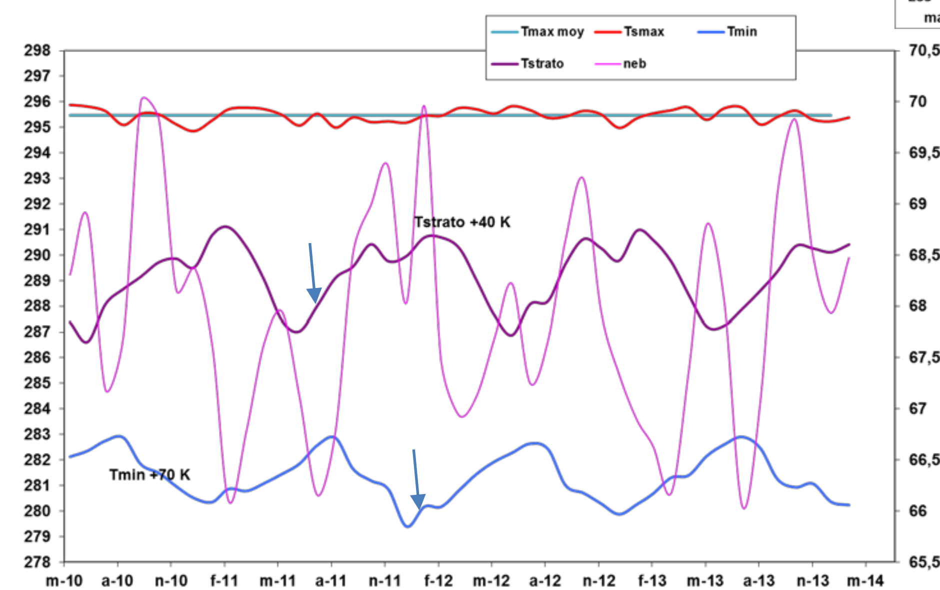
- Through Proxies
  - Monitoring of ECVs
  - Monitoring of Trace gases
- Based on full spectra :
  - Intercomparison of Monthly mean spectra of various years
  - Comparison with Simulated spectra computed with ERA Interim outputs and RTTOV (clear spectra only)
- Inversion
  - Retrieval of annual variations of Ts, Ttropo, T Tropopause, T LS and T HS, Mean Humidity, Total Ozone, Total CO2, Total CO, Total CH4, Total N2O using Measurements and jacobians computed fwith 4A and mean profiles

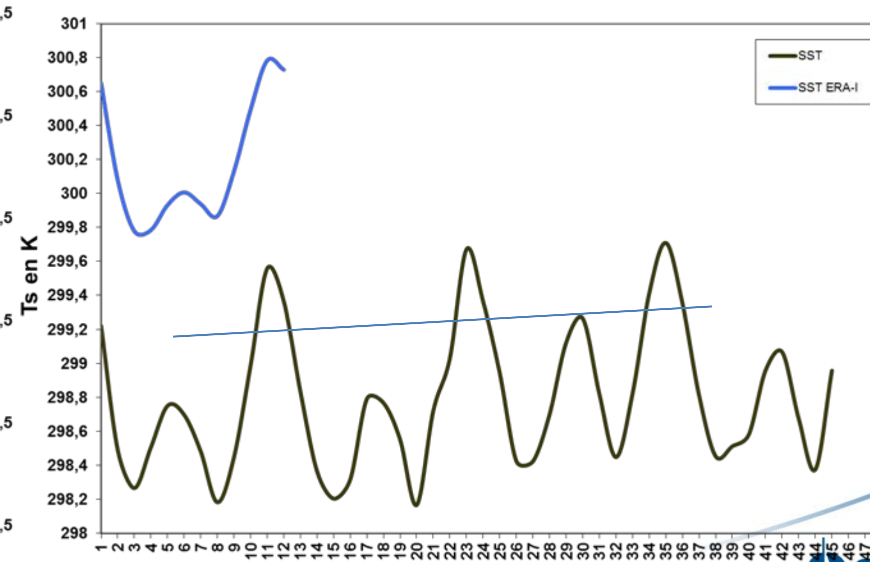


PREDICTORS









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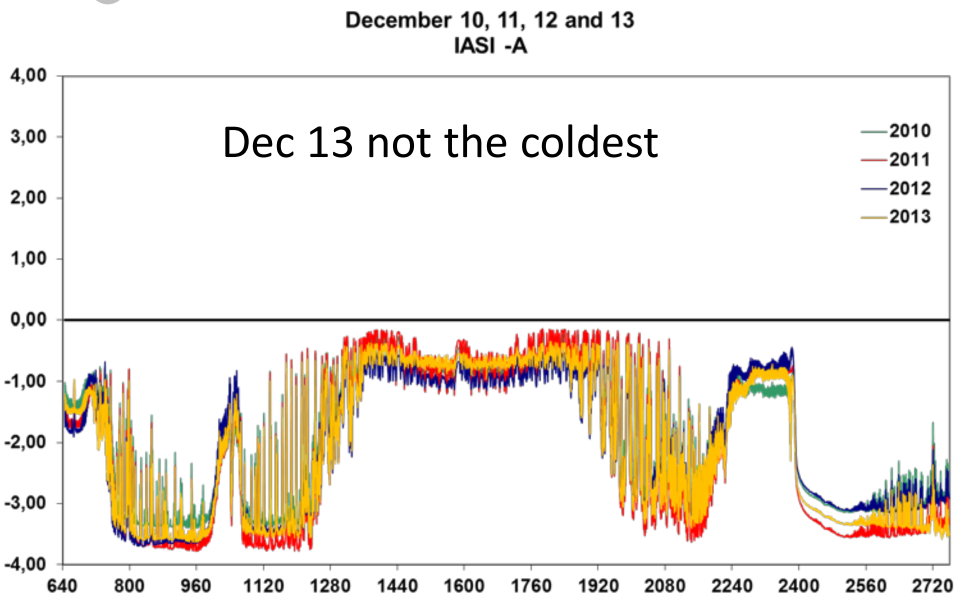
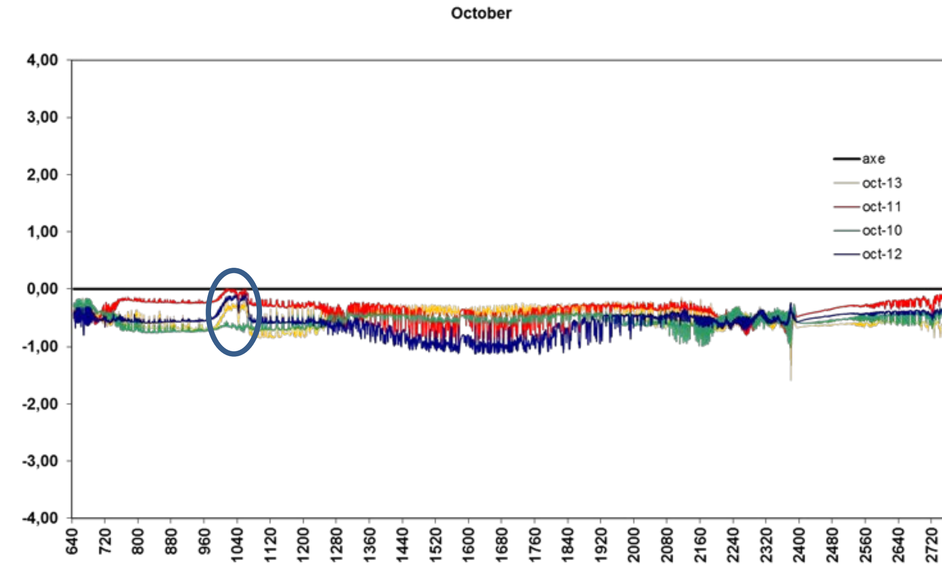
RESULTS OF STATISTICS

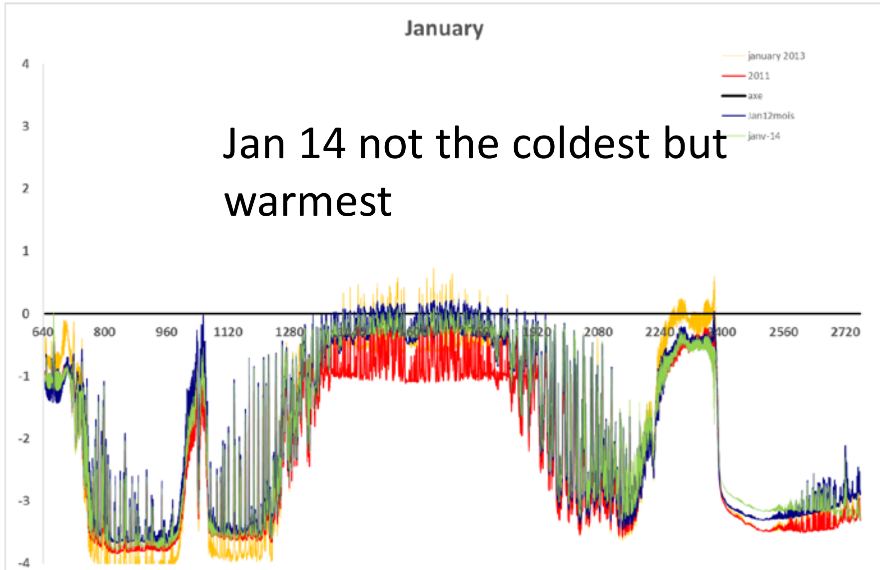
RESULTS FOR GLOBAL SCALE

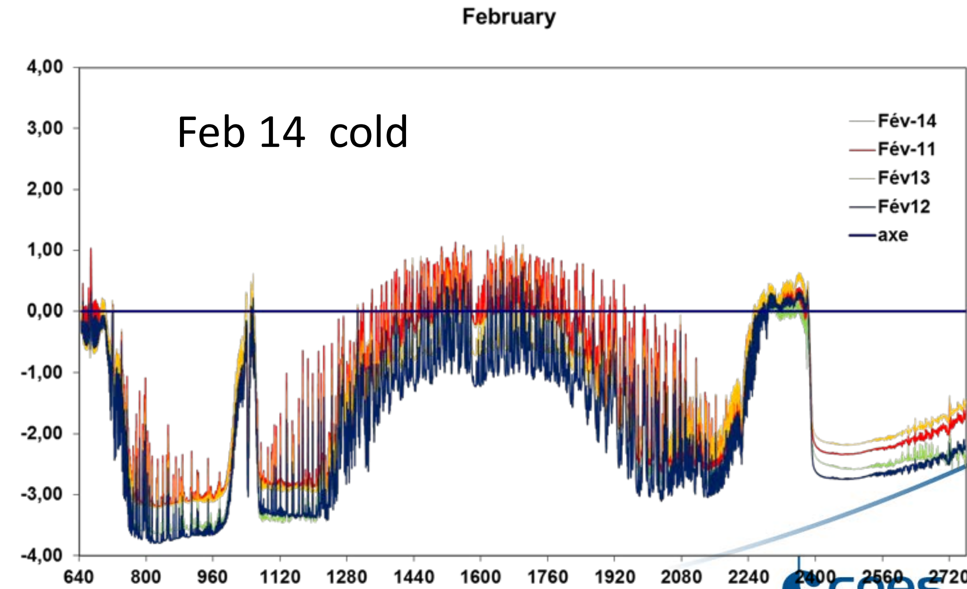
- Monthly periods are pertinent for statistics
- Cloud fraction:
  - Very stable around 0.66
  - Number of cloudfree pixels very stable around 0.15
  - Cloud overcast constant around 0.42
- Maximum temperature (out of sun reflectance)
  - Very small variations for the sea
  - Sine cycle for Ts all pixels
- Mean Tb (proxy of OLR) : small smooth sine variations
- Proxy of tropopause and stratosphere show consistent variations

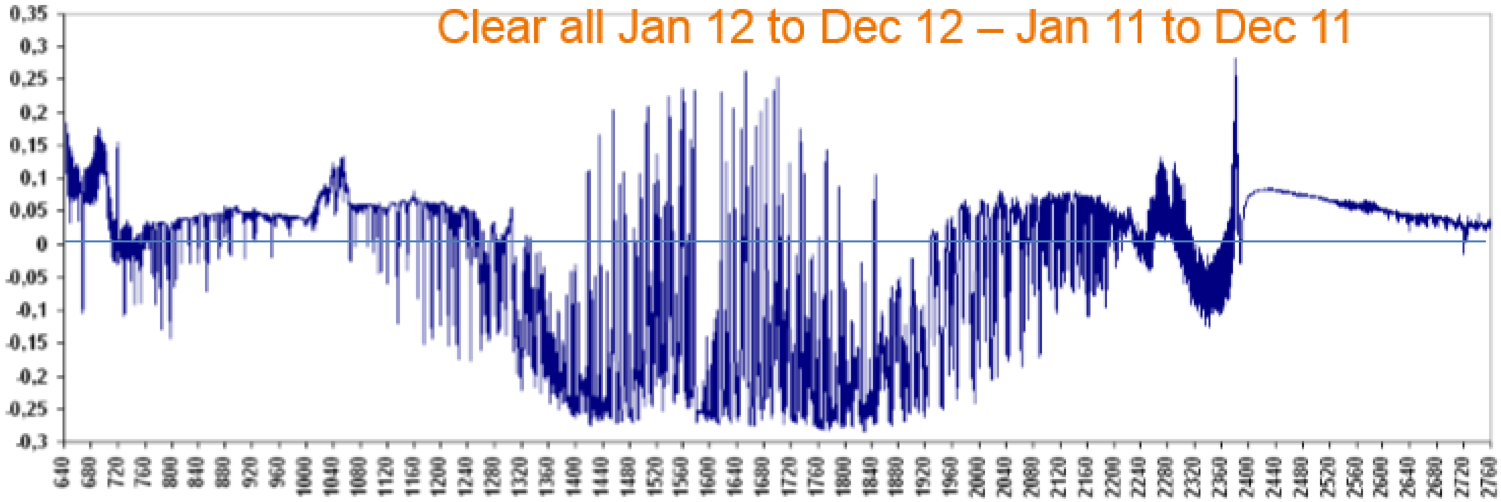
MONTHLY MEAN SPECTRA

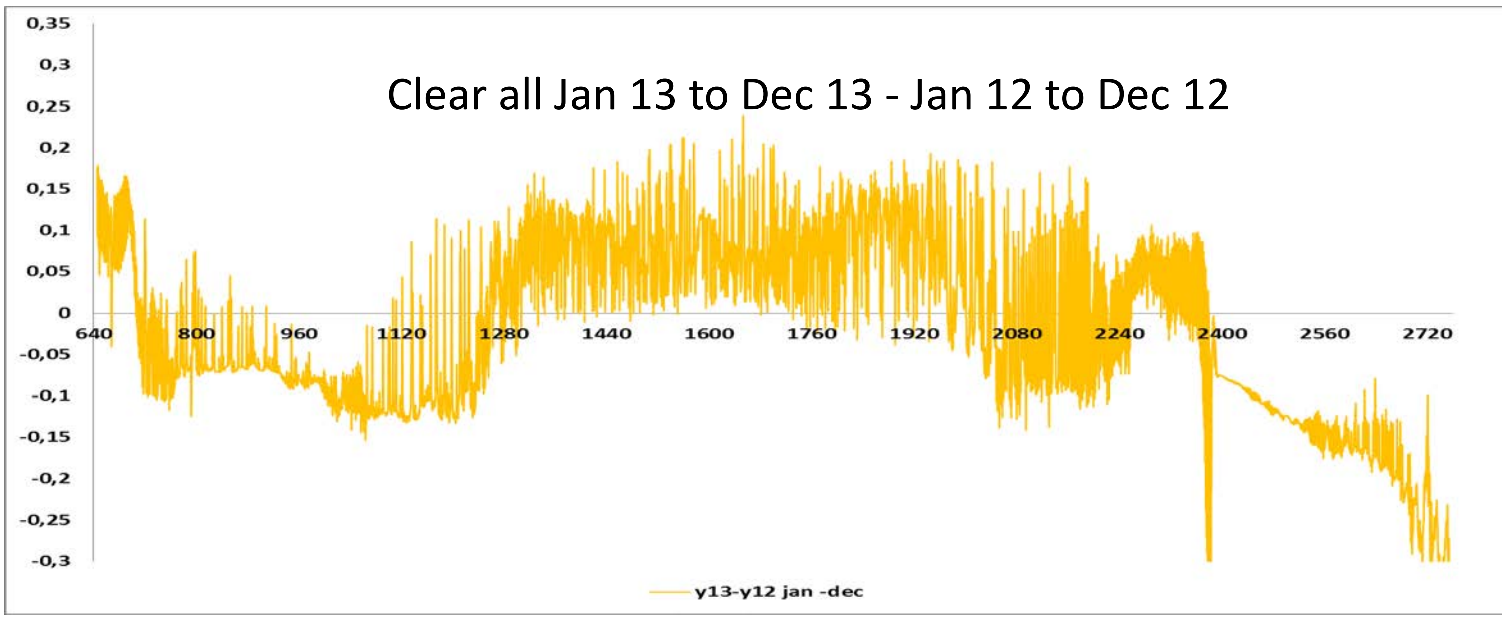









Clear all Jan 12 to Dec 12 – Jan 11 to Dec 11
0,35
0,3
0,25
0,2
0,15
0,1
0,05
0
-0,05
-0,1
-0,15
-0,2
-0,25
-0,3
640 680 720 760 800 840 880 920 960 1000 1040 1080 1120 1160 1200 1240 1280 1320 1360 1400 1440 1480 1520 1560 1600 1640 1680 1720 1760 1800 1840 1880 1920 1960 2000 2040 2080 2120 2160 2200 2240 2280 2320 2360 2400 2440 2480 2520 2560 2600 2640 2680 2720 2760


Clear all Jan 13 to Dec 13 - Jan 12 to Dec 12
0,35
0,3
0,25
0,2
0,15
0,1
0,05
0
-0,05
-0,1
-0,15
-0,2
-0,25
-0,3
640 800 960 1120 1280 1440 1600 1760 1920 2080 2240 2400 2560 2720
y13-y12 jan -dec

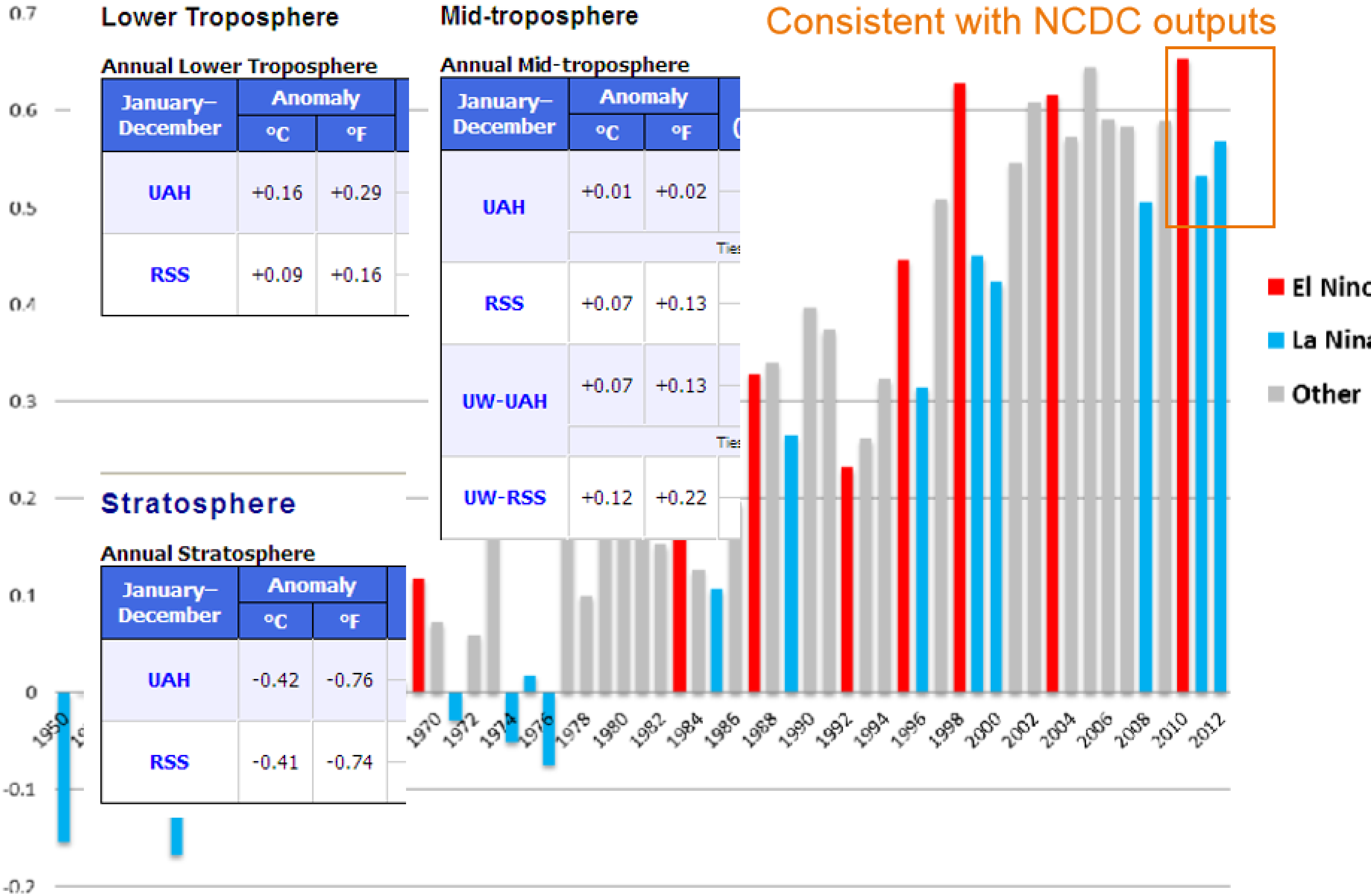
Inverse ECVs Variations

$$\Delta T_B(T) = \sum_{nl=1}^{nl=3} \frac{\partial T_B}{\partial T}(nl) * \Delta T(nl) + \sum_{ngas=1}^{ngas=5} \frac{\partial T_B}{\partial q_{gas}} * \Delta q_{gas}(ngas)$$

Year	Ts	Ta				Humidity	CO_2	Ozone	N_2O	CO	CH_4
		LT	UT	LS	US/MS						
une 11 to ay 12 - une 10 to ay 11	-0.1 -0.1	-0.05 -0.05		-0.22 -0.13	1.6 1.0	-1.4% -2%	1.05% 0.96%	-2.3% -2.5%	4% 1.5%	0.4% 1.2%	1.3% 1%
Jan to Dec 2012-2011	0.05 0.03	0.06 0.18		0.10 0.08	-1.0 -1.0	2.4% 5.6%	1.05% 0.96%	-0.4% -0.2%	2% 0.6%	0.4% 0.4%	1.3% 1.3%

- Inversion performed based on presumed value of CO_2 mean variation
  - Simple assumptions
  - Inversion for regions where only one component is important
  - Iterative process until good fit
  - Values of Jacobians for mean atmosphere (here mean tropical, mean MLS, 1050 more suitable)
- Inversion matrix
- Include low troposphere

1950 - 2012



Lower Troposphere

Annual Lower Troposphere

January–December	Anomaly °C	Anomaly °F
UAH	+0.16	+0.29
RSS	+0.09	+0.16

Mid-troposphere

Annual Mid-troposphere

January–December	Anomaly °C	Anomaly °F
UAH	+0.01	+0.02
RSS	+0.07	+0.13
UW-UAH	+0.07	+0.13
UW-RSS	+0.12	+0.22

Stratosphere

Annual Stratosphere

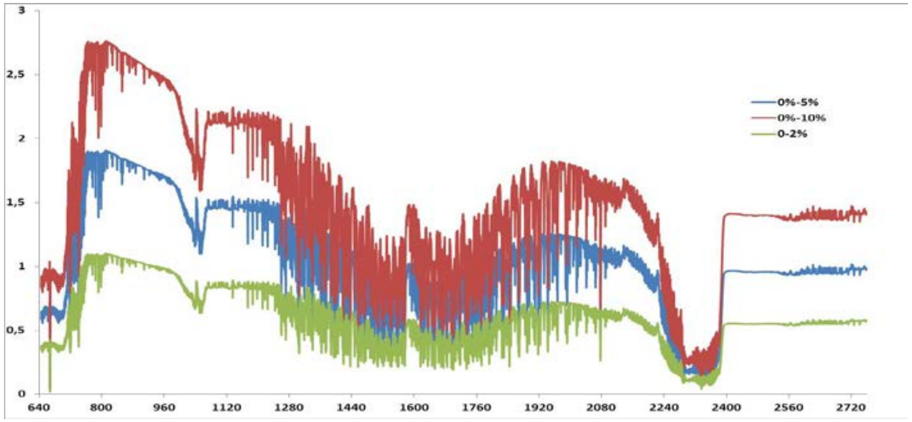
January–December	Anomaly °C	Anomaly °F
UAH	-0.42	-0.76
RSS	-0.41	-0.74

Terminé

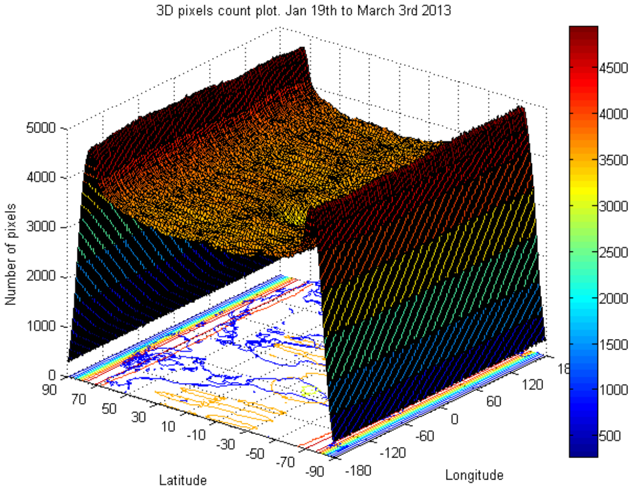
http://www.ncdc.noaa.gov/sotc/global/2012/13

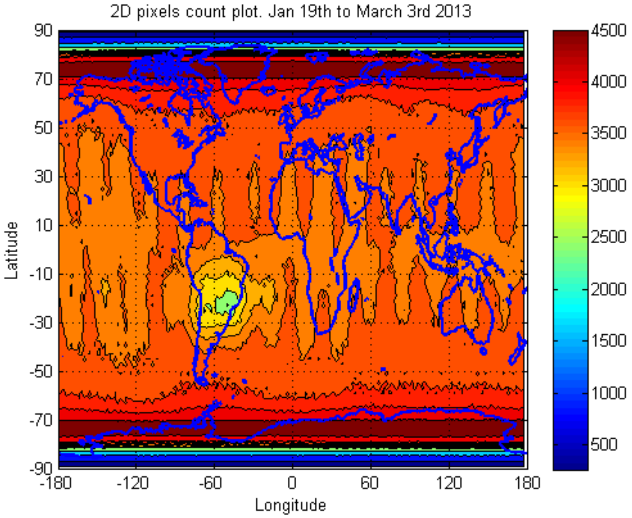
METHODOLOGY ISSUES

- Sensitivity to cloud test based on AVHRR cloud fraction)



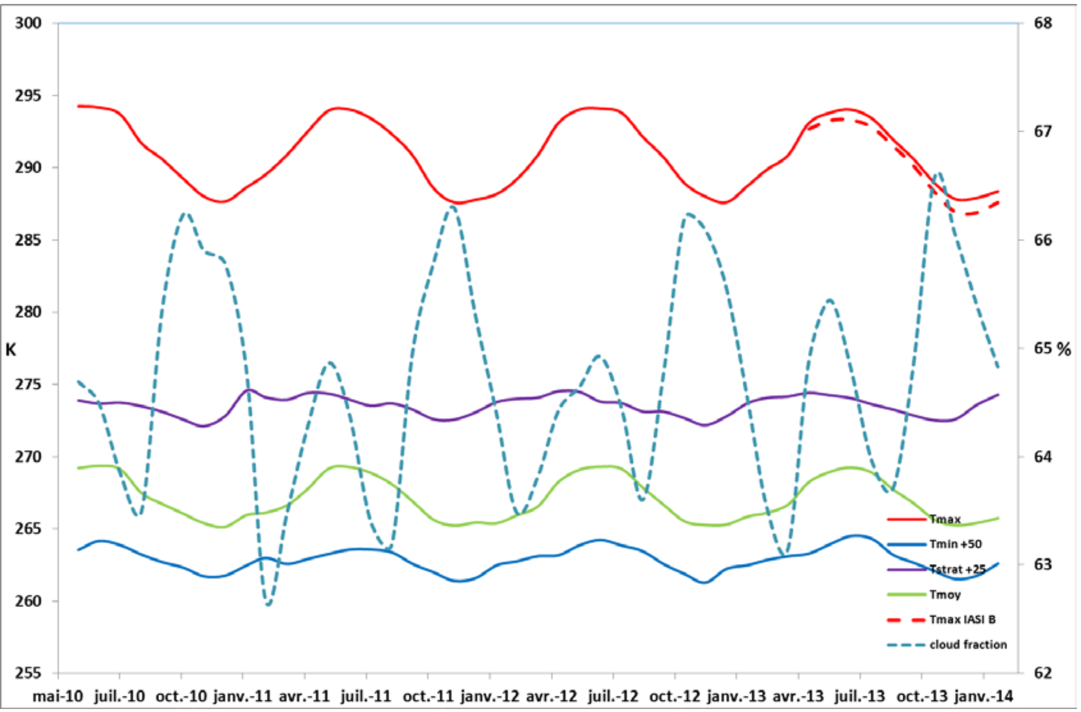
- Sensitivity to acquisition gaps

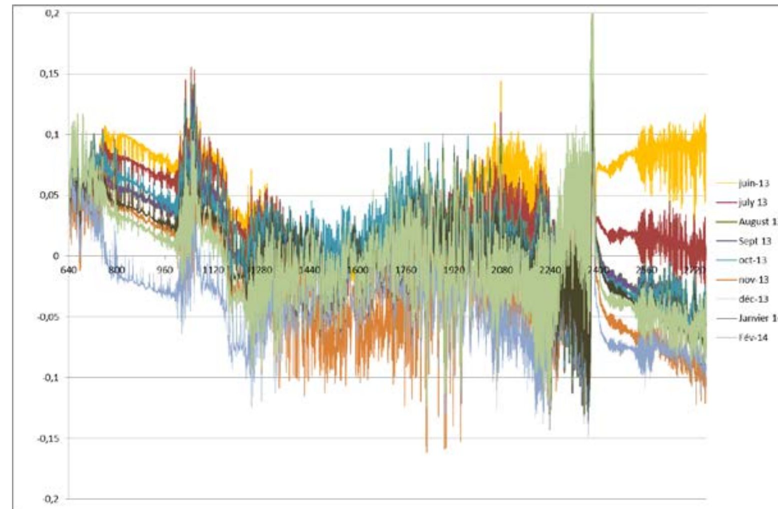


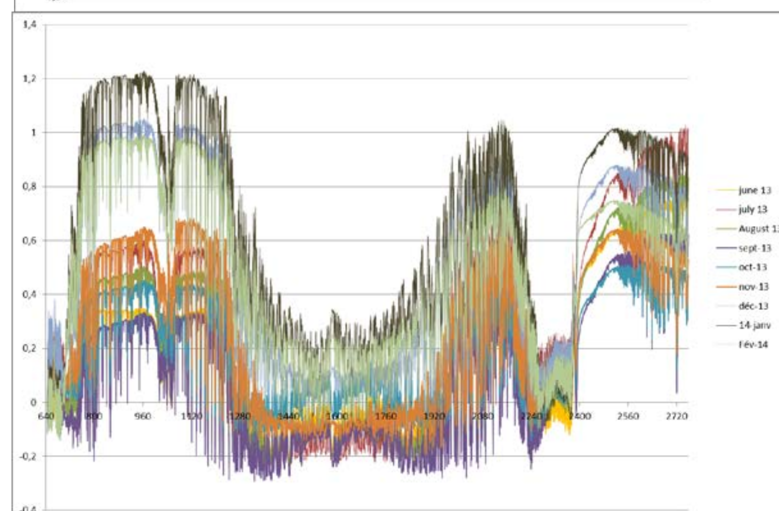


OTHER ISSUES (2)

Intercalibration IASI-A/IASI-B







Bias is widely due to cloud test based upon AVHRR

⇒ Need updates of level1C Processing chain

⇒ Use IASI stand alone cloud test

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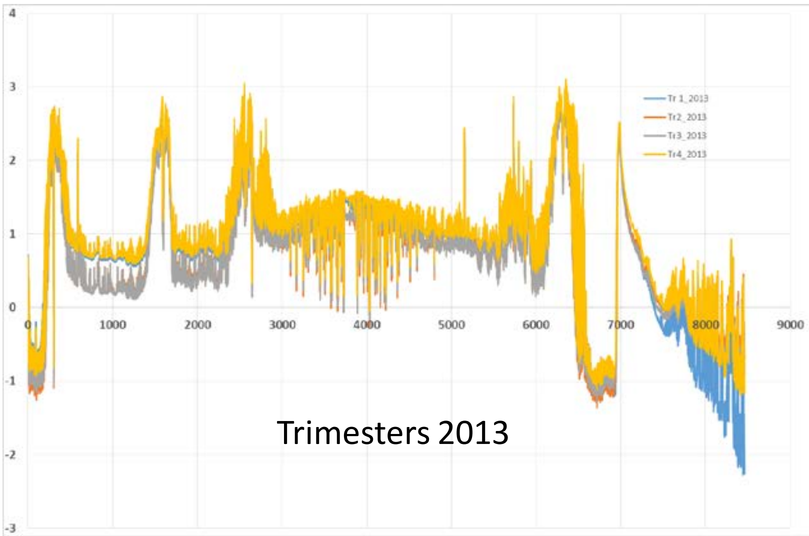
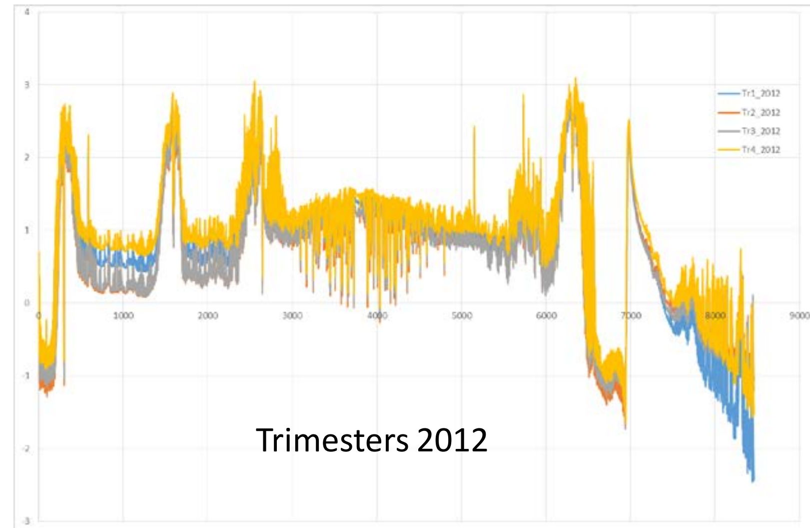
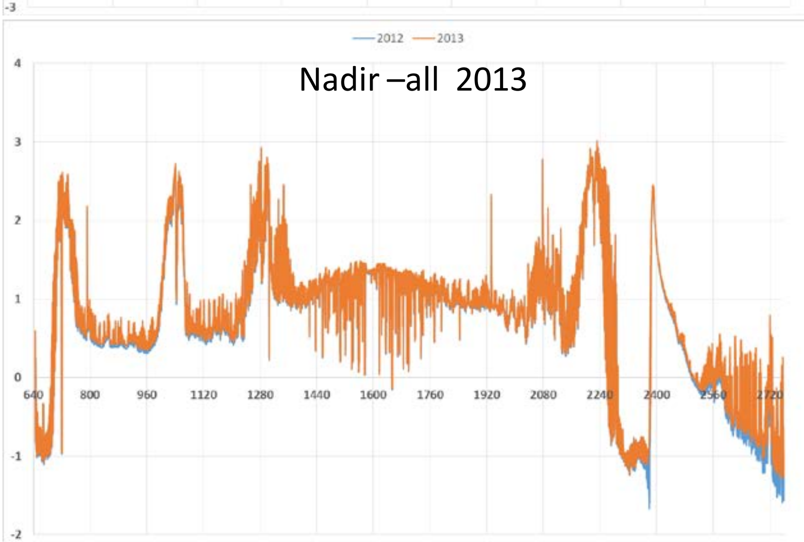
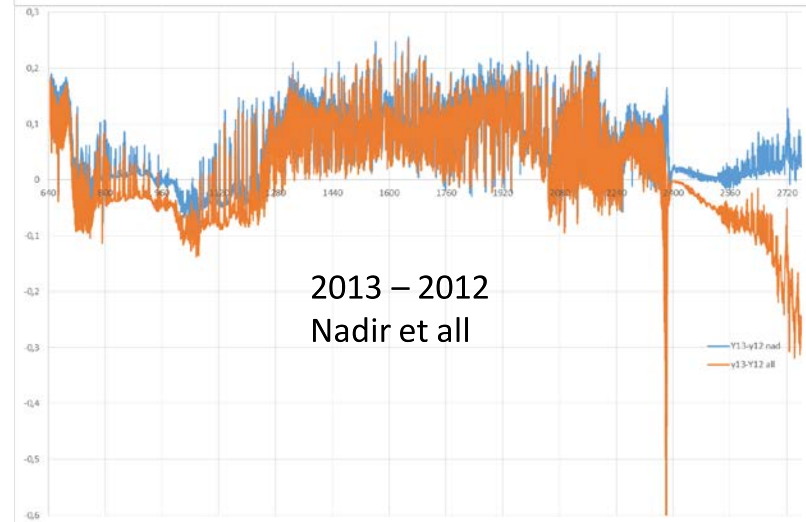
OTHER ISSUES (3)









ALL ANGLES OR NADIR ONLY?

RESULTS ON CLIMATE

Restricted to 2010-2014

- Mean budget is determined by North Hemisphere (May to Sept warmer than Oct to April and impact of solar surface radiation deficit visible in 2013 budget).
- No measurement of any variation of mean global surface temperature (plateau?)
- No detection of any variation of the OLR
- Sea surface temperature in tropical oceans (20N-20S) exhibits a low slow increase
- Larger or lower Ozone depletion clearly detectable. Same for events with large fires and strong CO.

CONCLUSIONS

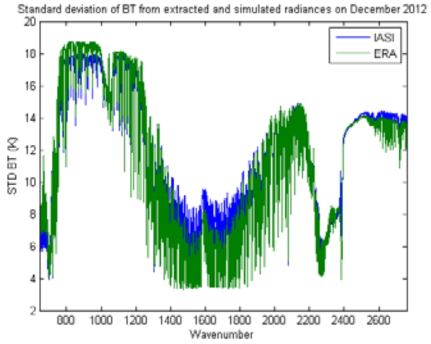
- Climatology of IASI radiances is robust even it is could be improved (Cloud test and flag of incomplete orbits).
- Inversion gives consistent result with Climate observations by groundbased networks
- It allows to analyze impact of climatic events (e.g. ENSO episodes) at global or regional scales with the same observing technique and simultaneous measurements
- Comparison with ERA Interim shows that statistics parameters are very consistent. Simulations must still be improved with the use of IASI cloud masks.
- Climatology must be extended to IASI-A from 2006 to 2010
- It must also be continued with Metop-B as soon as I/C will be definitively assessed.
- Interannual variations are around 0.05 K. Analysis and monitoring requires instrument with intercalibration better than 0.02K and consistent absolute calibration.

MERCI DE VOTRE ATTENTION

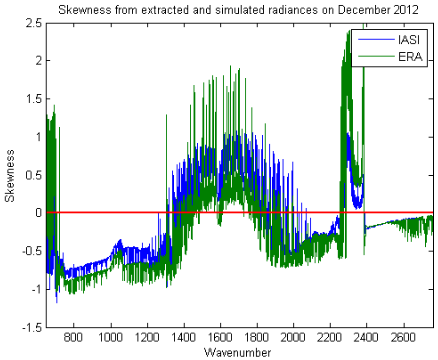
QUESTIONS?

AUTRES STATISTIQUES

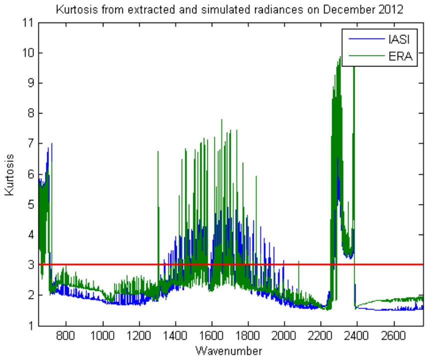
- Validation par comparaison avec statistiques IASI
- Evaluation des valeurs par canal
- Ecart type

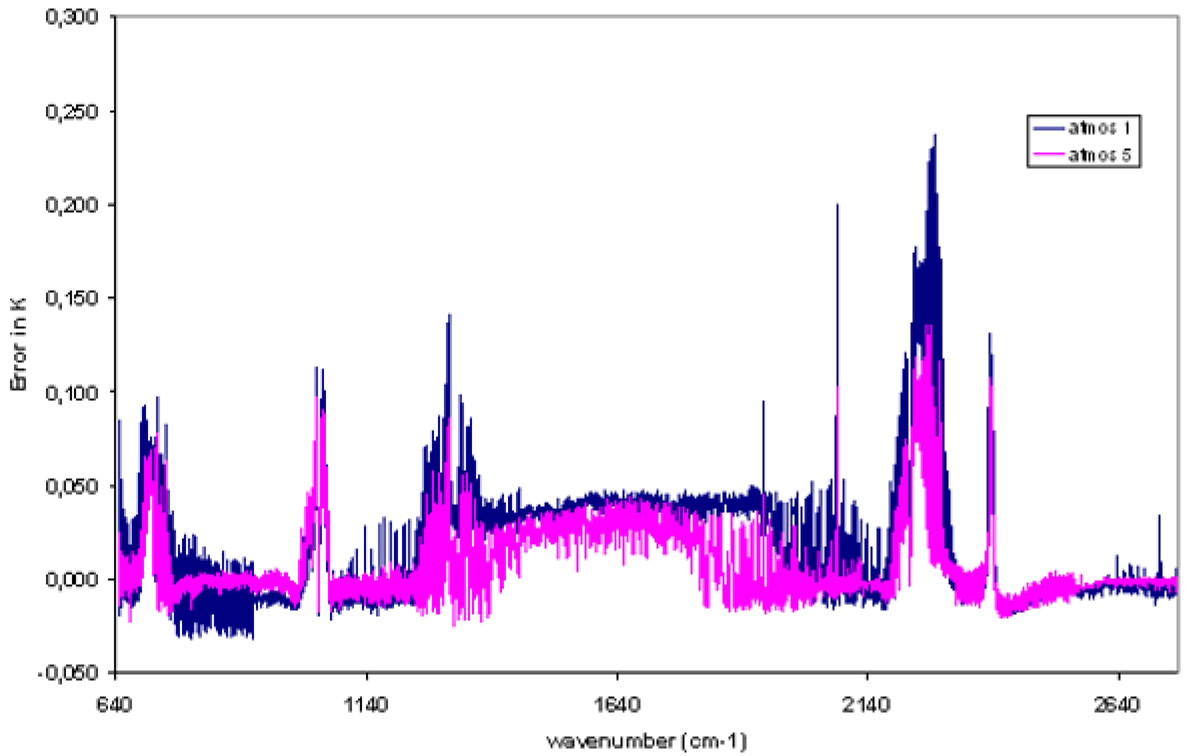


- Skewness



- Kurtosis





Averaged over all view angles spectra ≈ spectra under 30°

Performed with 4AOP-2012 with Tigr2000 mean atmospheres

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