

National Aeronautics and Space Administration
Section: Data & Applications I

NIRST Calibration/SST

Algorithms

Hugo Marraco

Marcelo Colazo

Understanding
the Interaction
Between Ocean
Circulation, the
Water Cycle,
and Climate by
Measuring
Ocean Salinity



Aquarius/SAC-D

10th Aquarius /SAC-D Science Meeting
Buenos Aires, Argentina
November 17-19, 2015



CONAE NIRST working group

- Hugo Marraco
- Marcelo Colazo
- Maryse Kalemkarian
- Martín Labanda
- Héctor Raimondo
- Felipe Madero
- Sergio Masuelli
- Carolina Tauro

With special thanks to Simon Hook,
JPL, NASA

NIRST

CANADA

Toronto

Lake Ontario

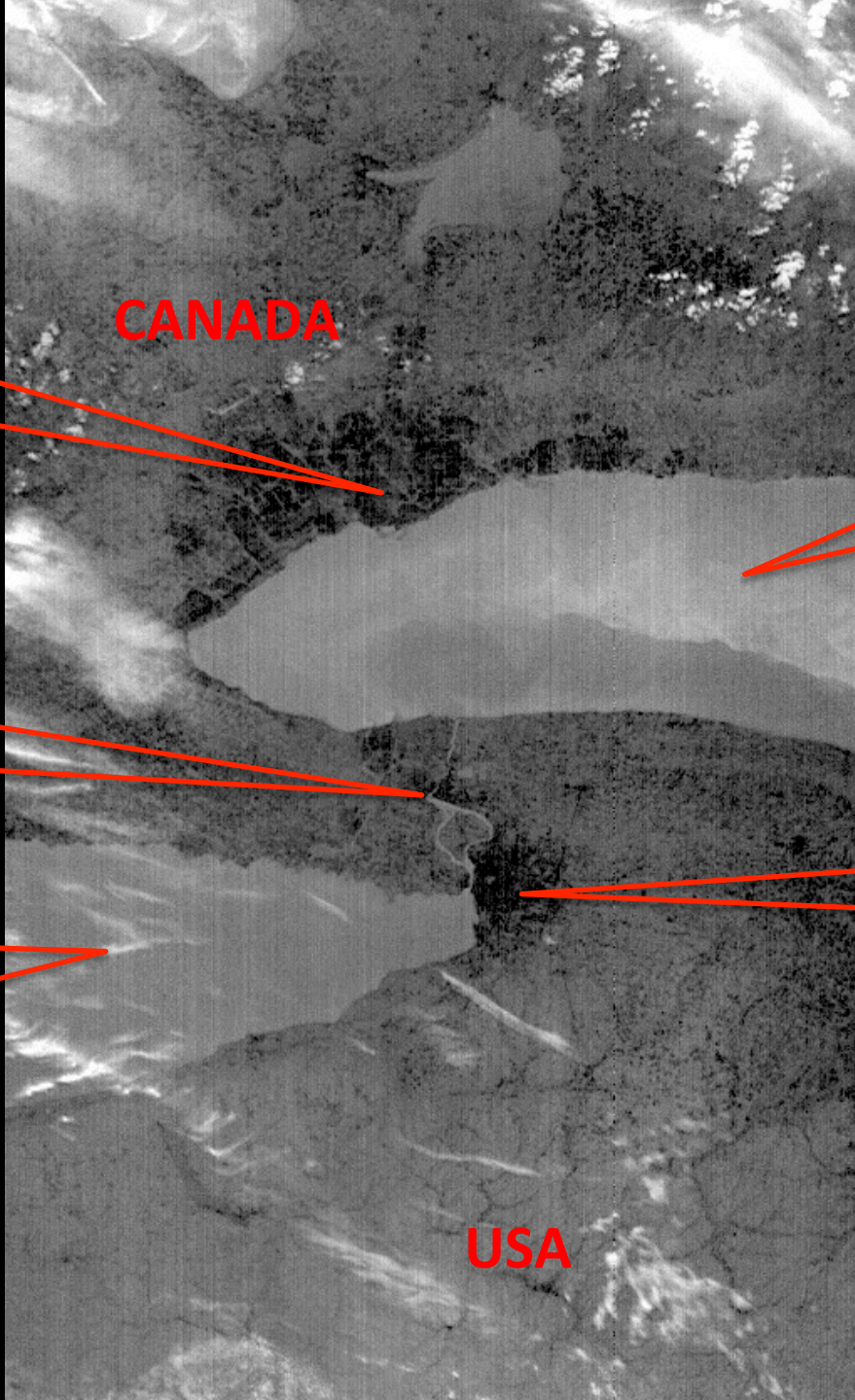
Niagara Falls

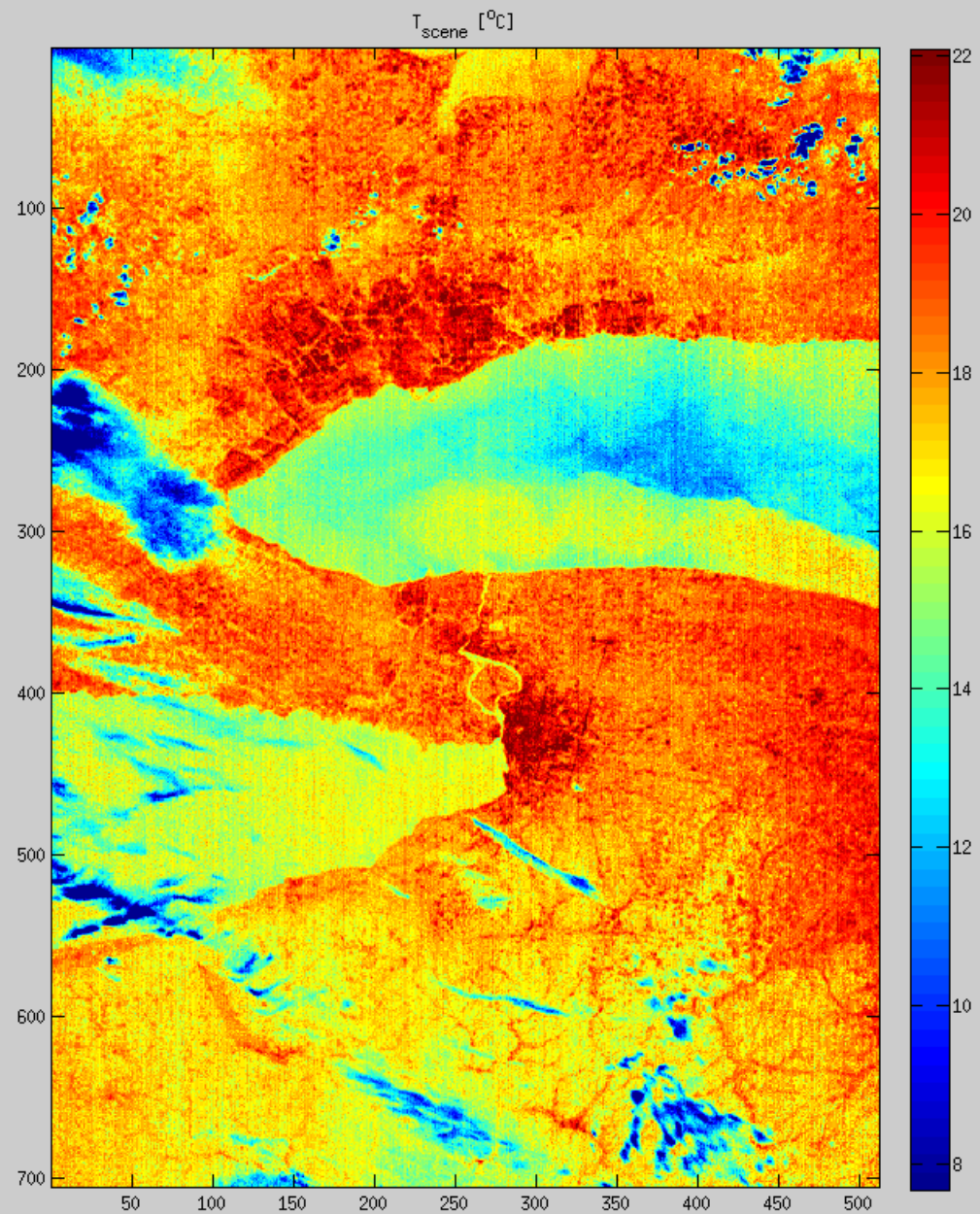
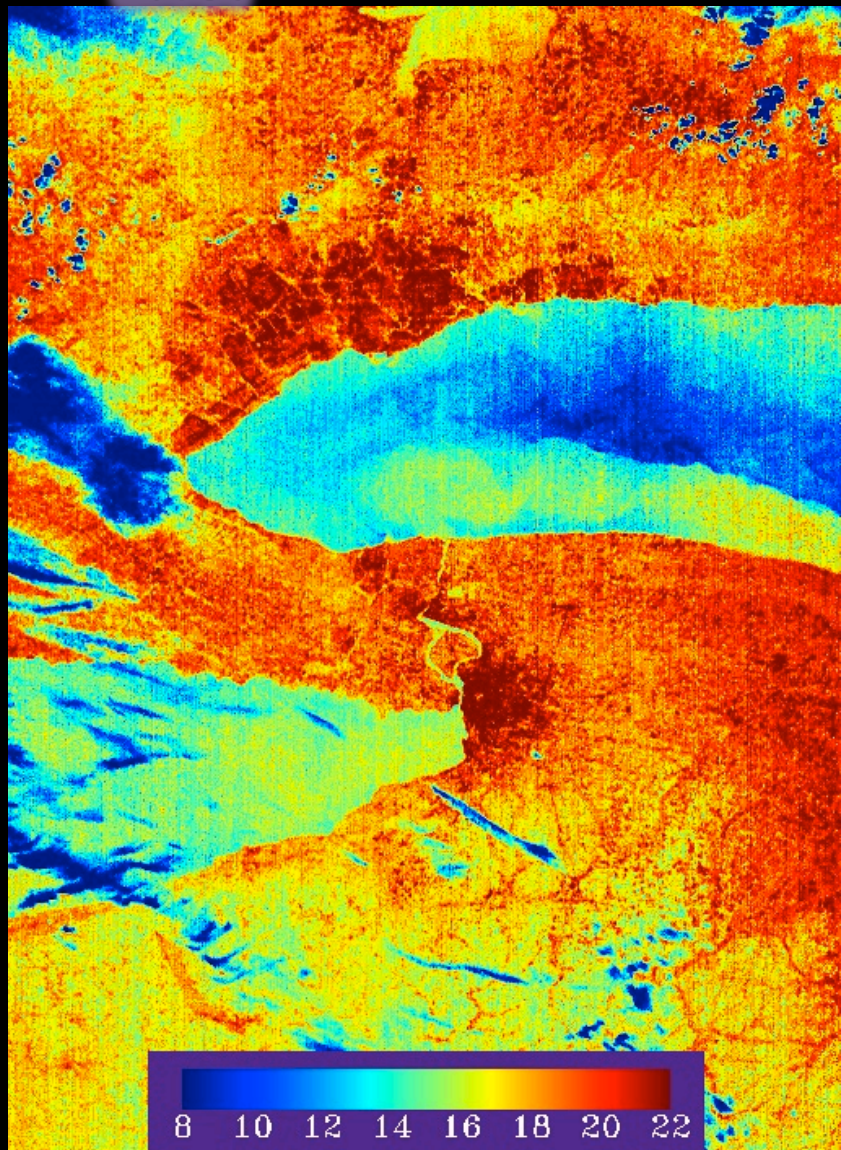
Buffalo

Lake Erie

USA

June 21, 2014
22:48 UT





NIRST

Tyrrhenean
Sea

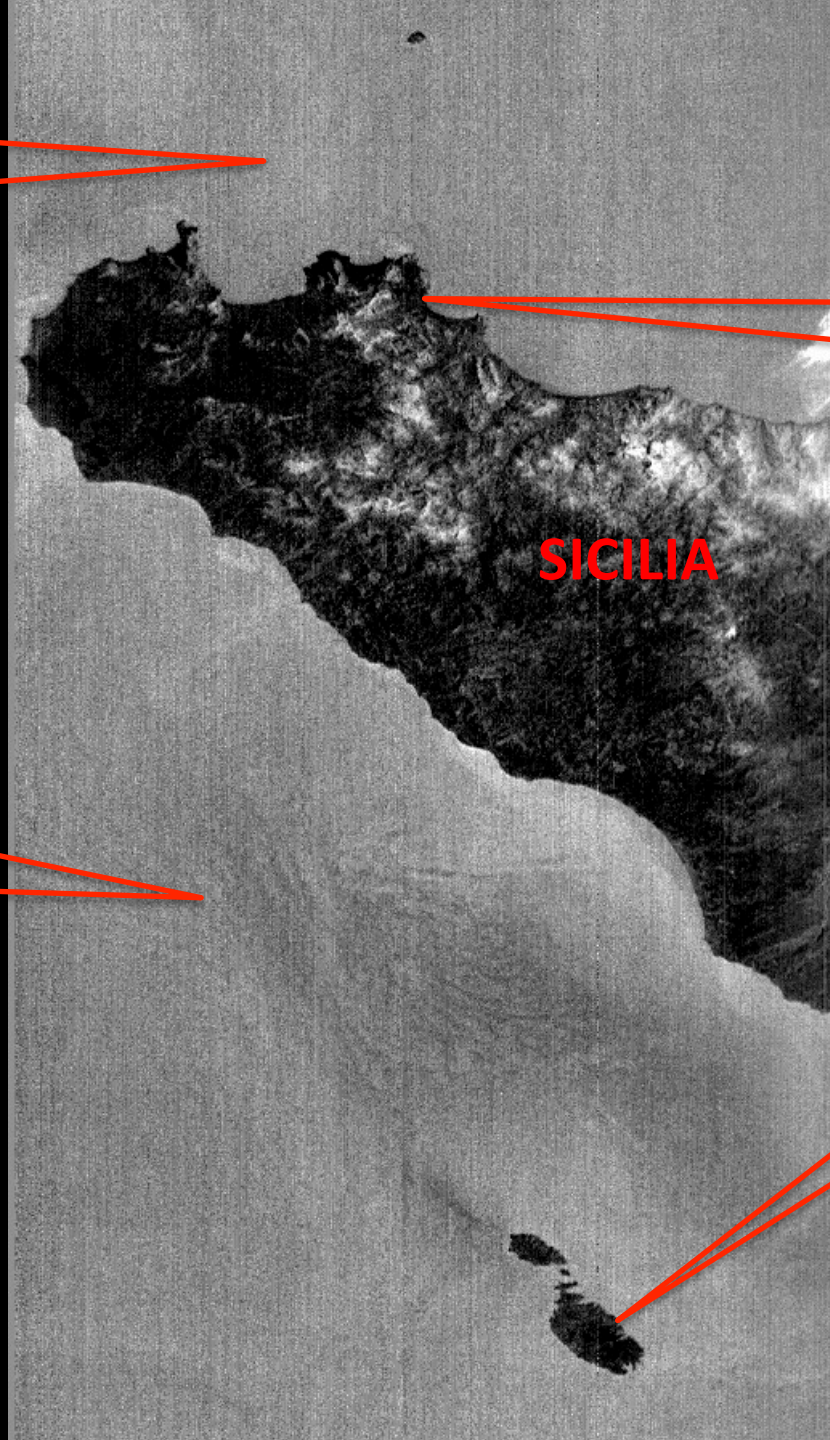
Palermo

SICILIA

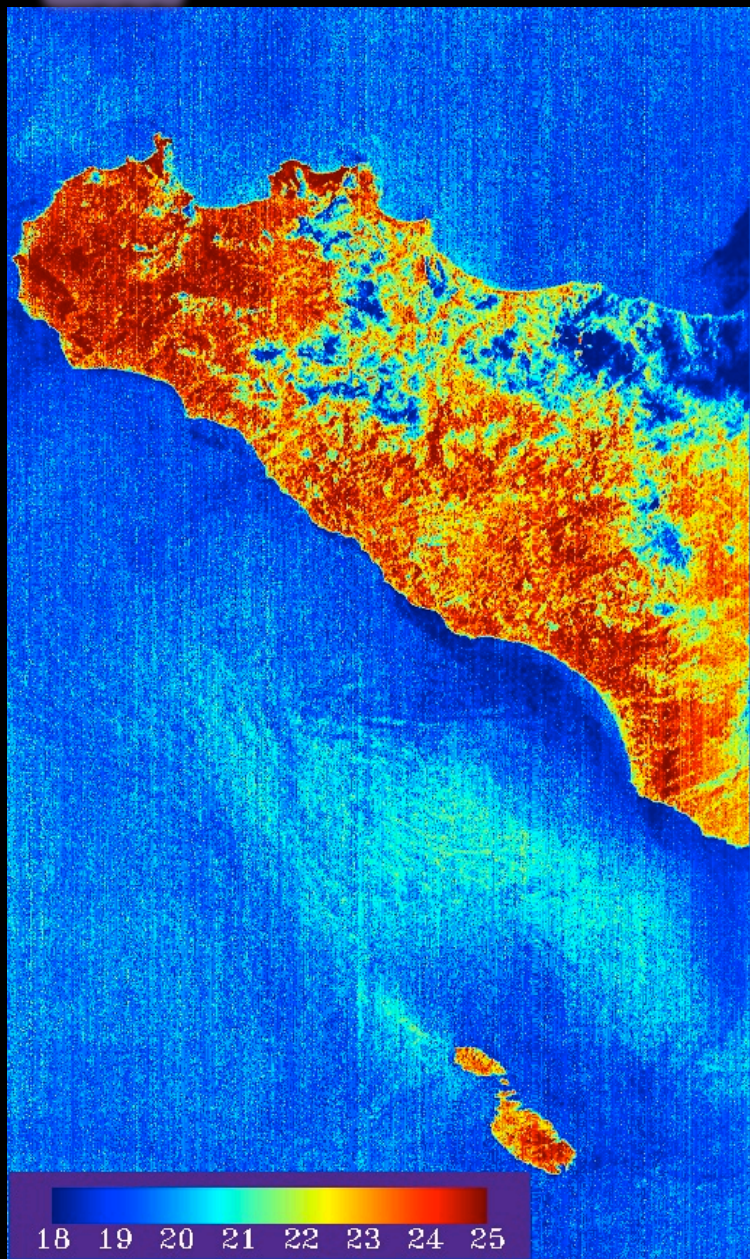
Sea Streams
 $\Delta T < 1 \text{ K}$

Malta

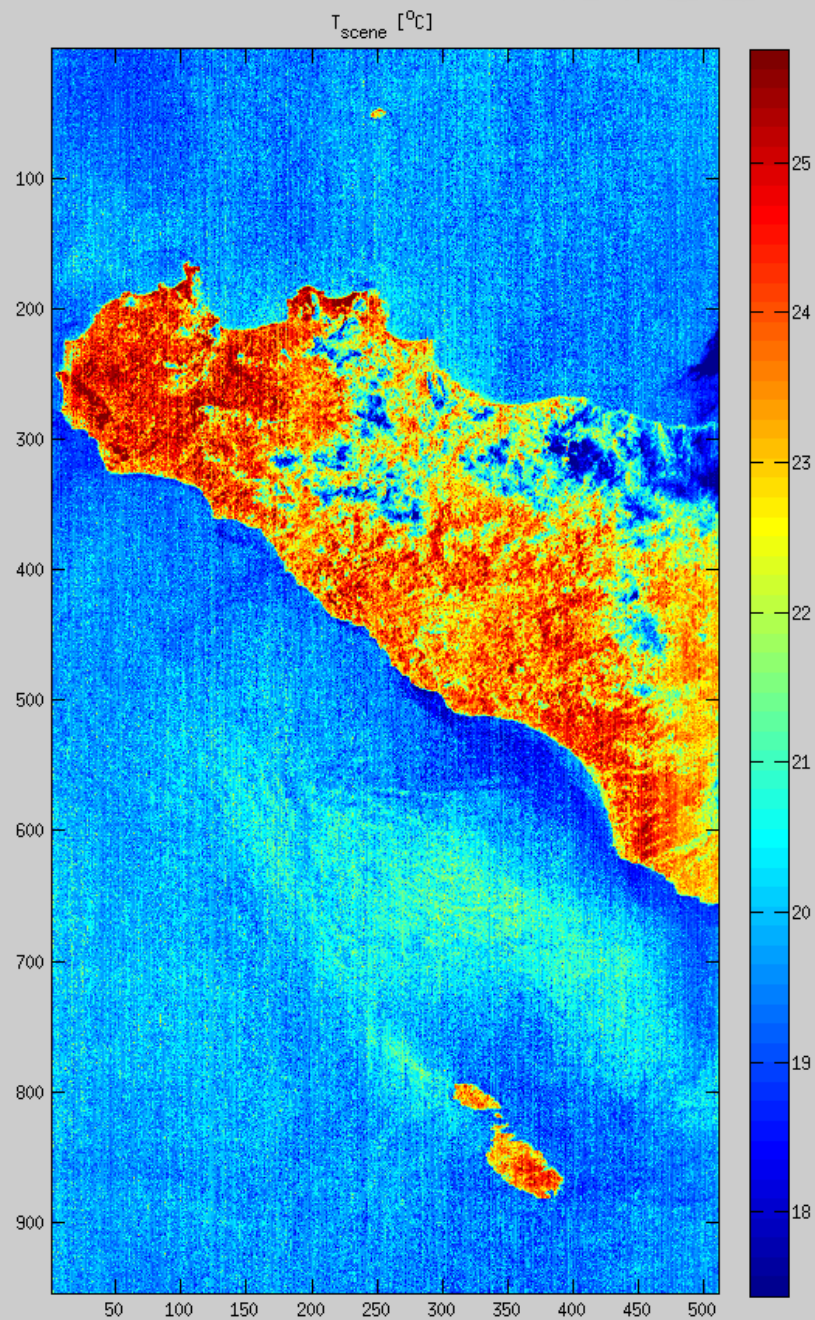
June 22, 2014
16:40 UT



ENVI



MATLAB



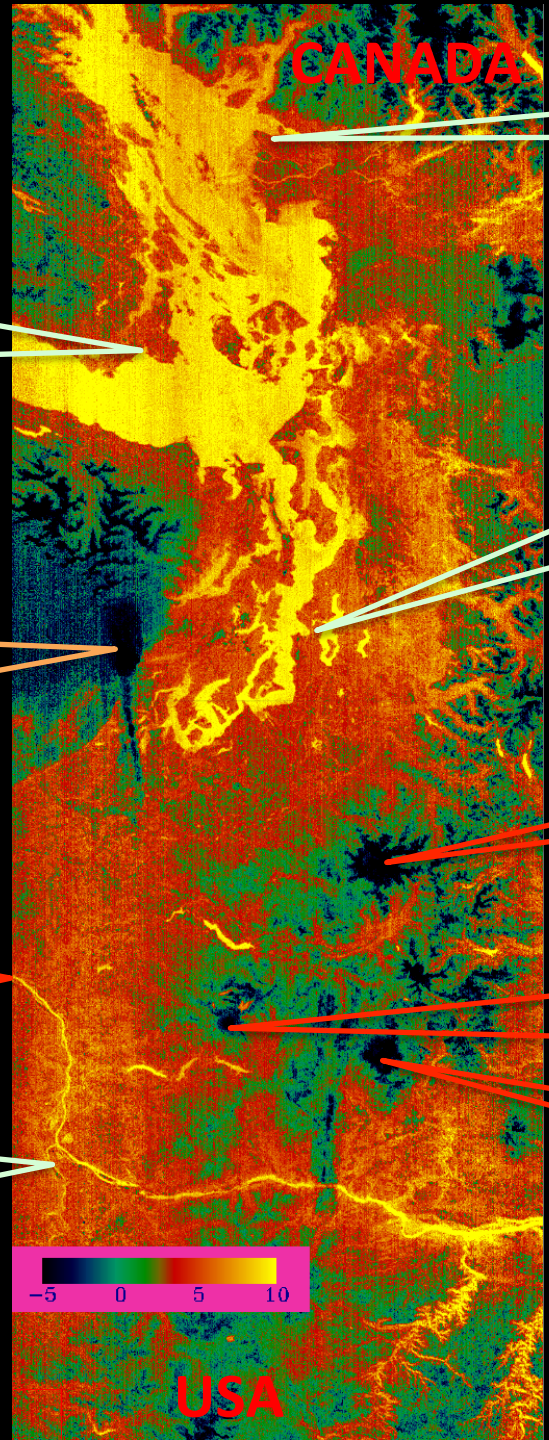
Dec 3, 2011
01:30 UT

Victoria

Clouds

Columbia
River

Portland



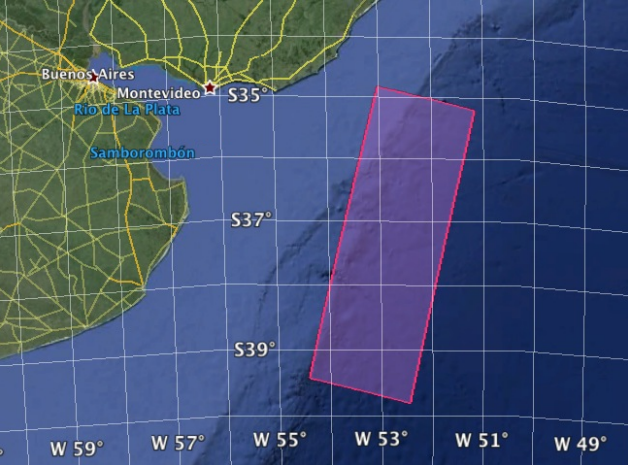
Vancouver

Seattle

Mt. Rainier

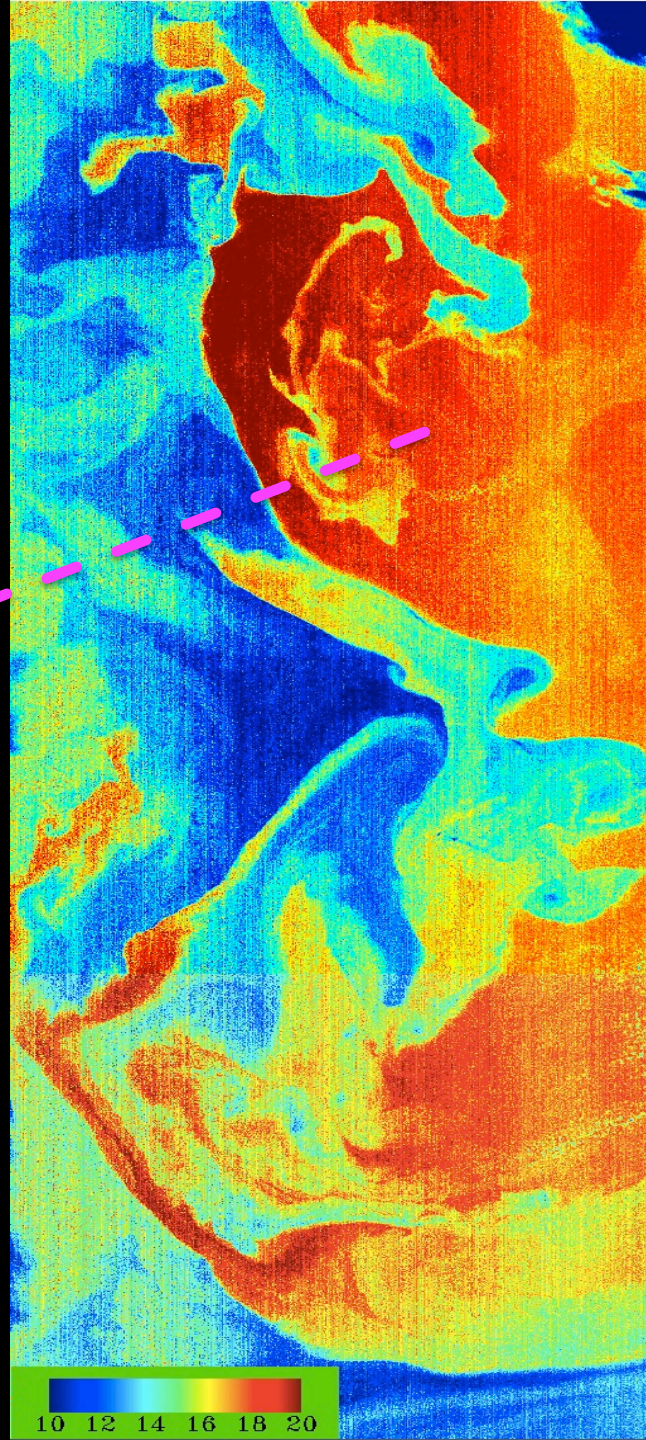
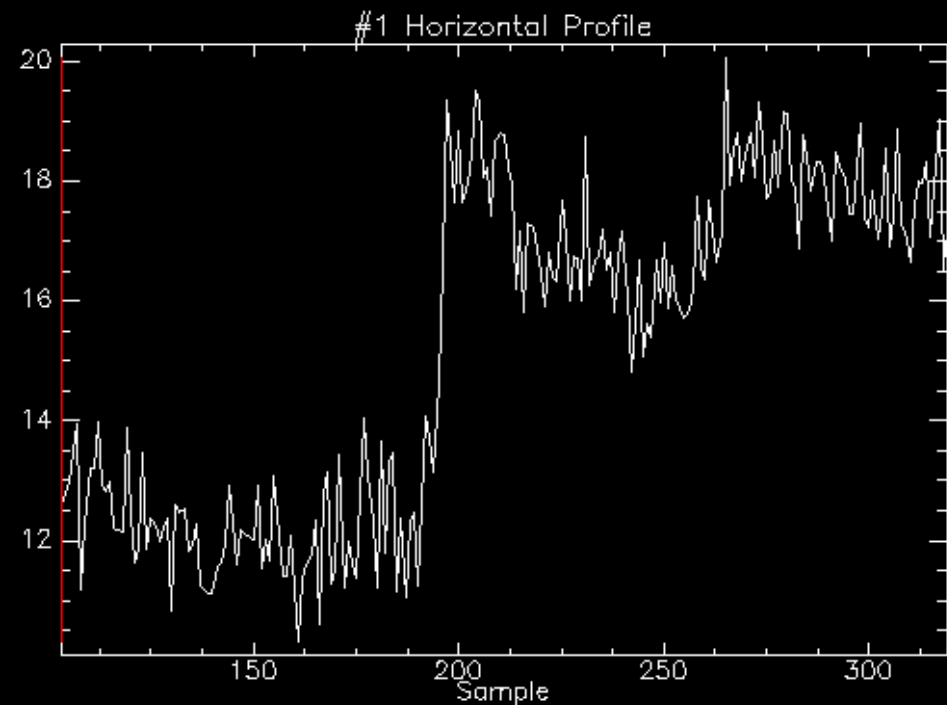
Mt. St. Helens

Mt. Adams



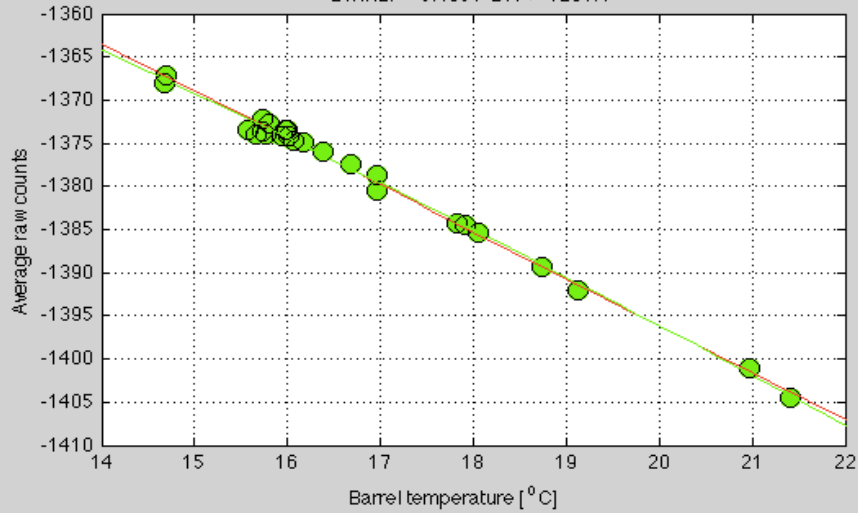
May 28, 2014
9:06 UT

Thermal gradient: almost 7 K in less than 1.5 km

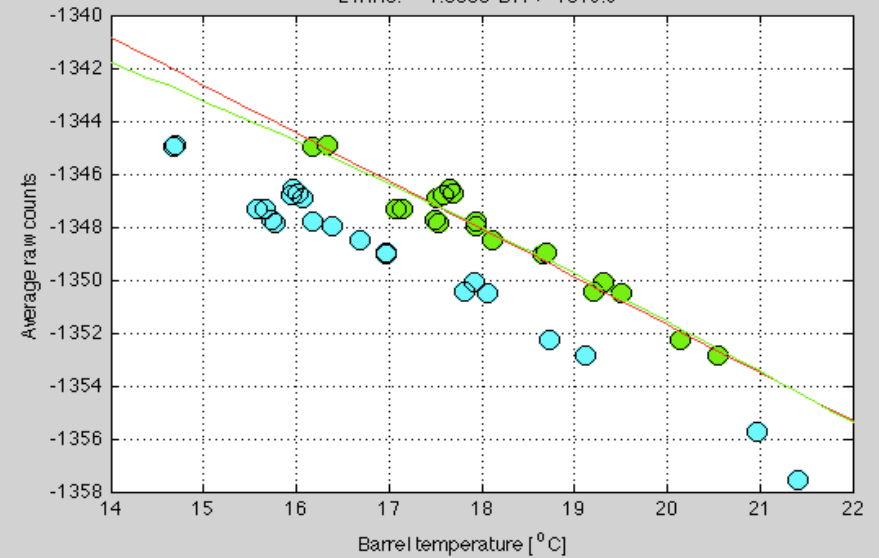


CSC fittings

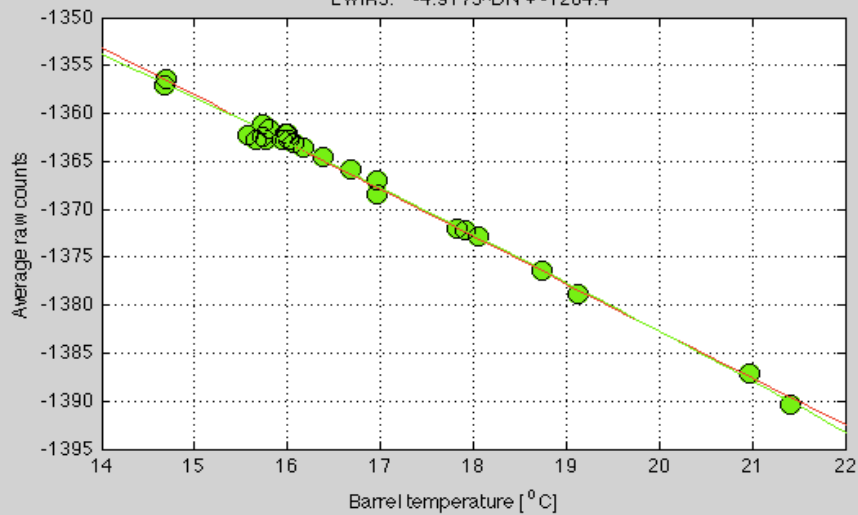
LWIR2: $-5.4357 \cdot DN + -1287.4$



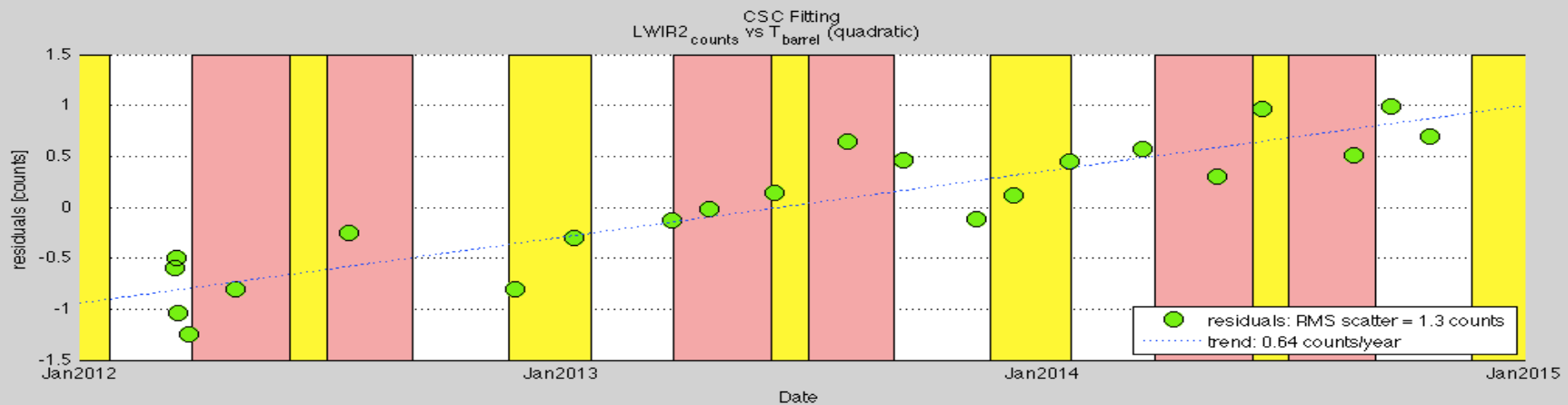
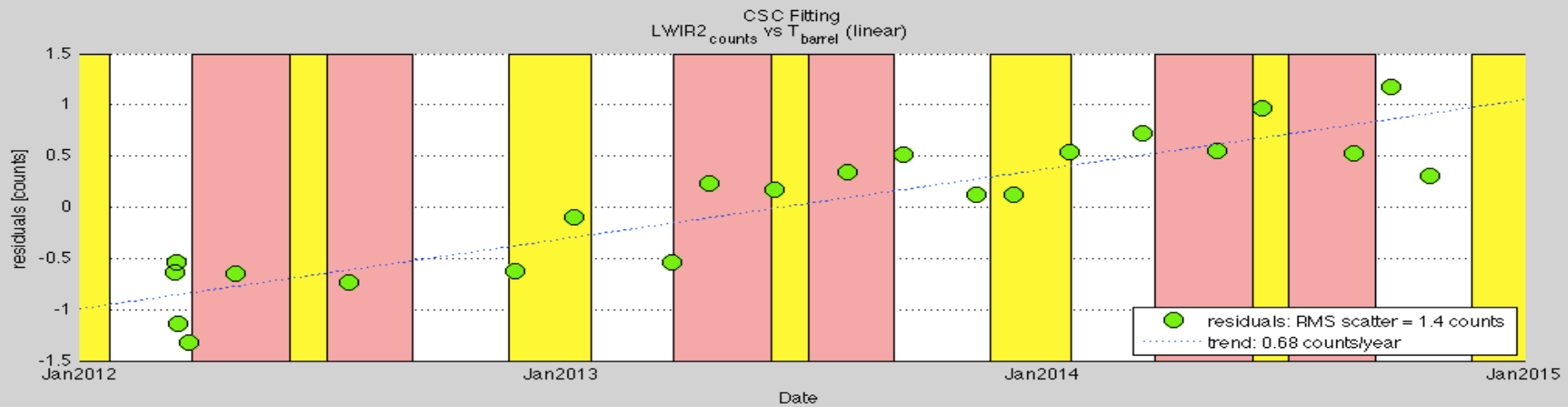
LWIR3: $-1.8098 \cdot DN + -1315.5$



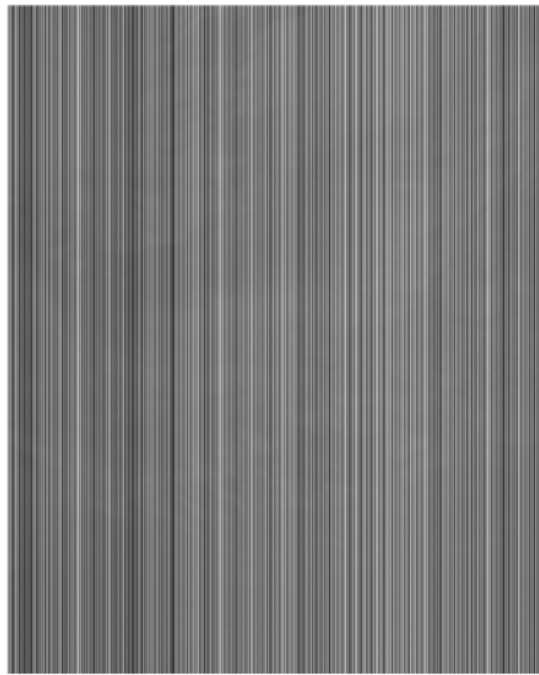
LWIR3: $-4.9173 \cdot DN + -1284.4$



CSC secular trend residuals vs. date

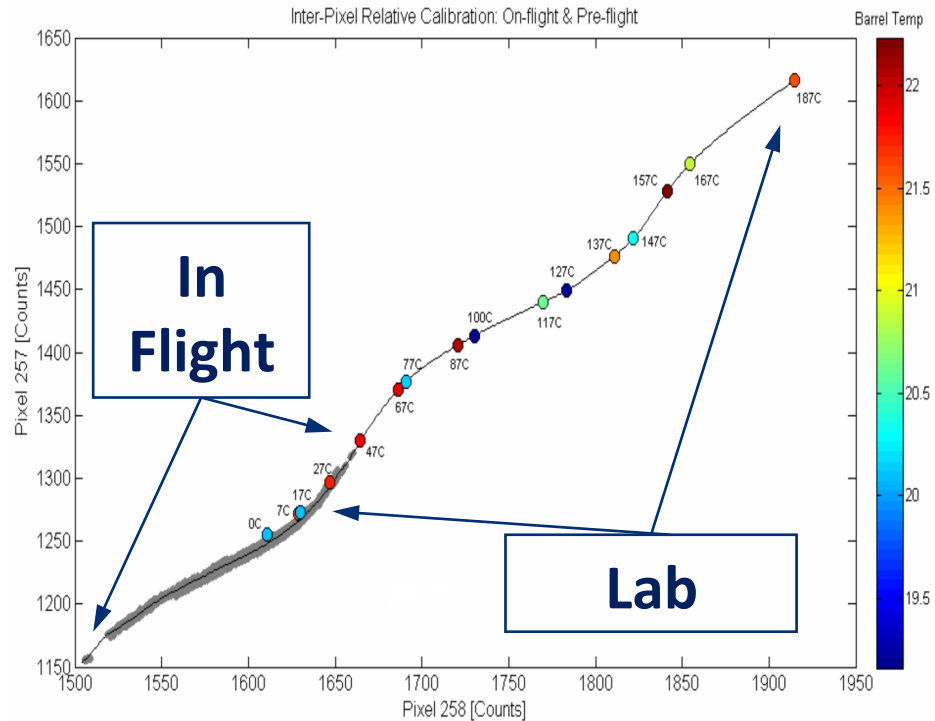
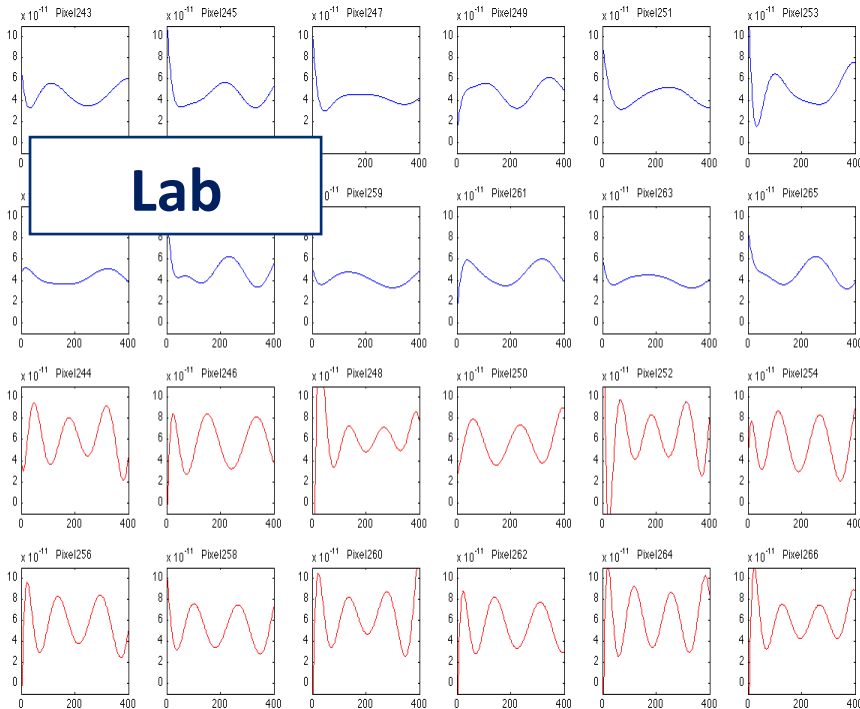
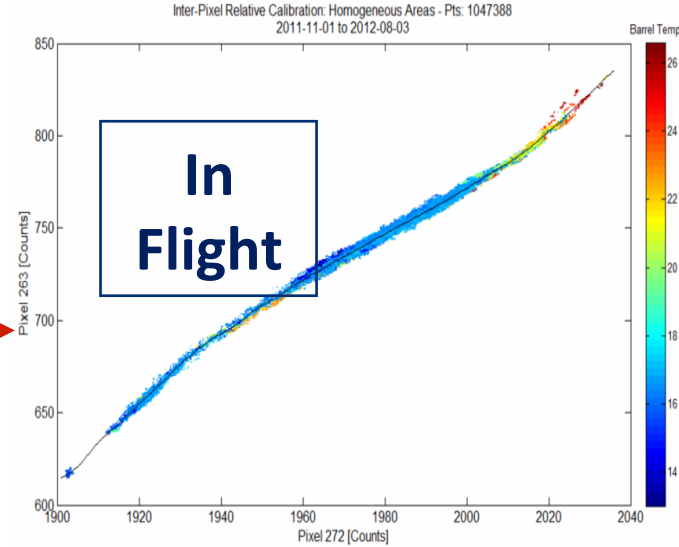


Relative Calibration

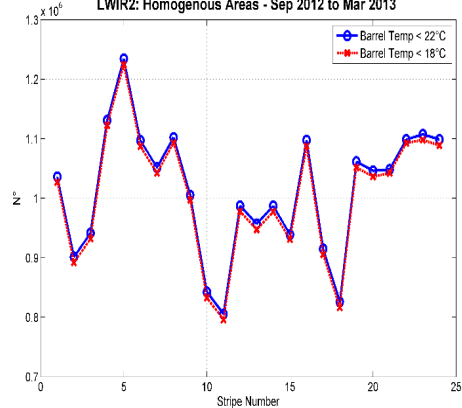


Raw Image

Non linearity



LWIR2: Homogenous Areas - Sep 2012 to Mar 2013



Relative Calibration

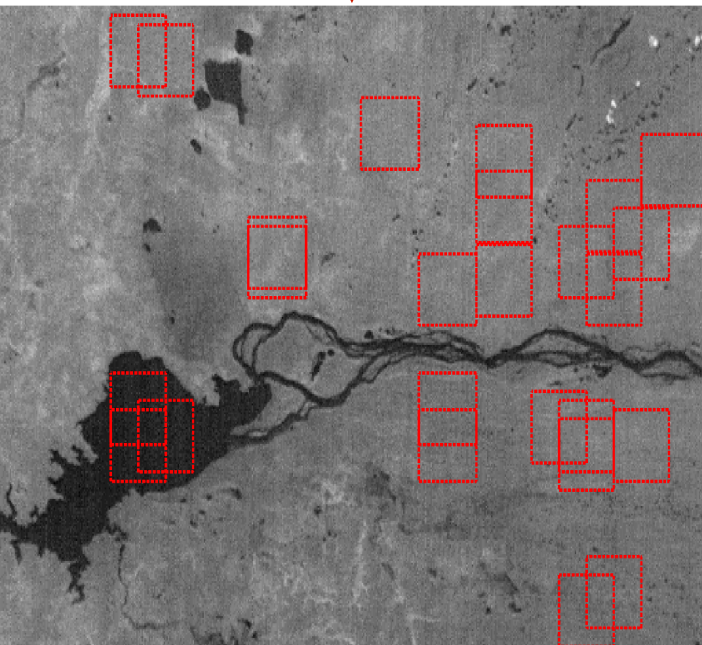
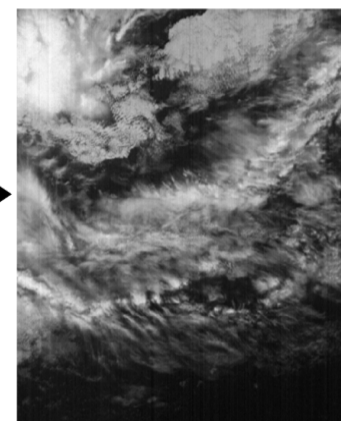
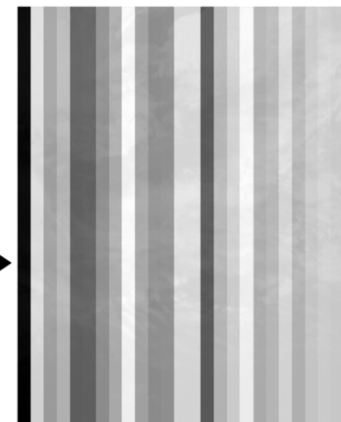
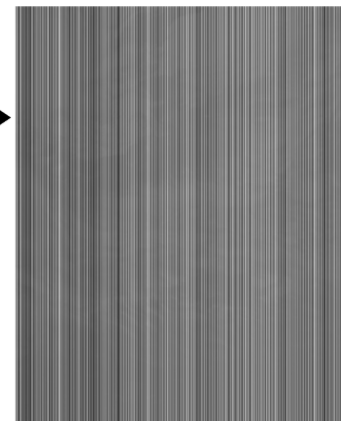
Stripes Limit
&
Reference Pixels

NIRTS RAW
Data

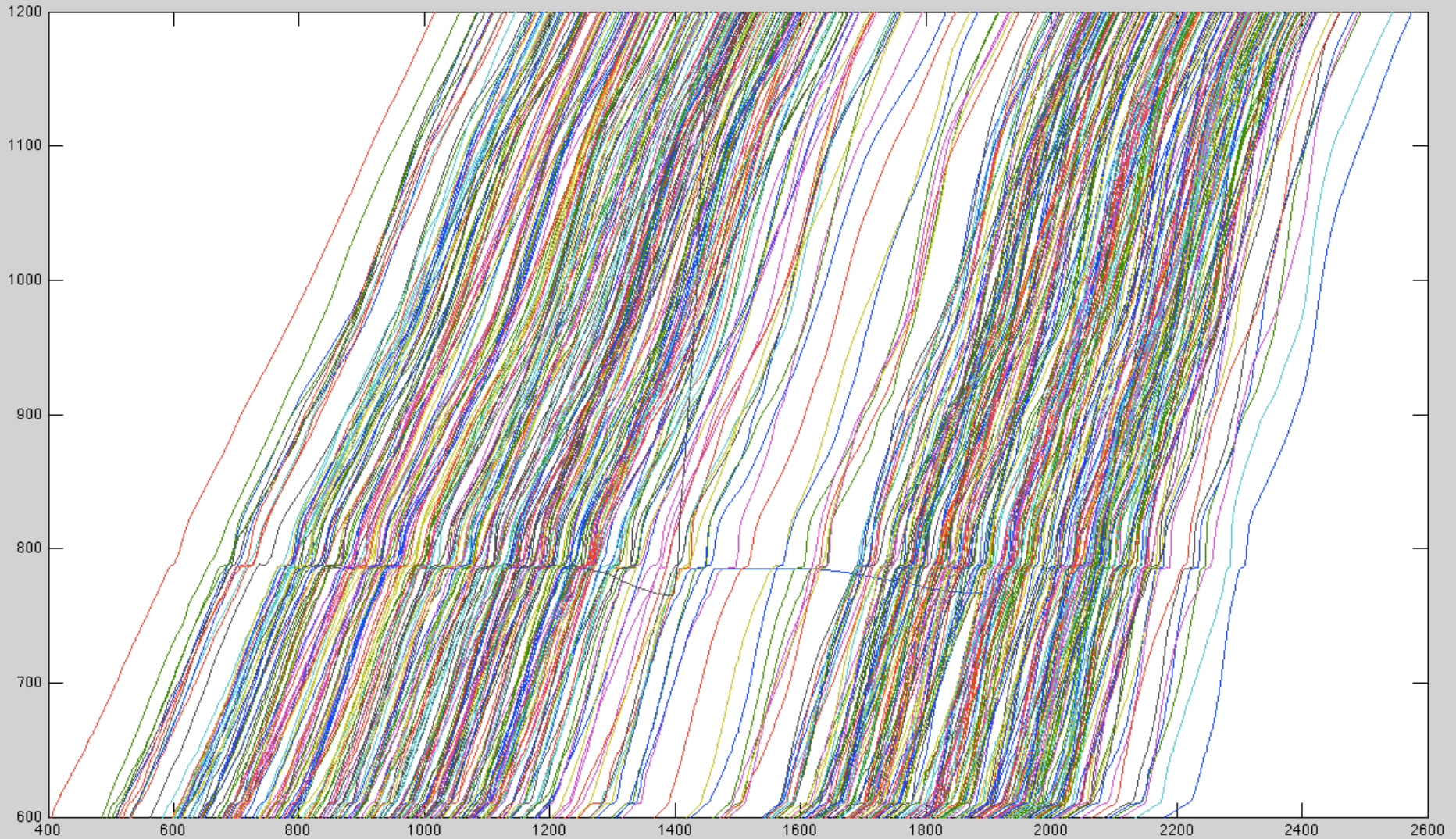
Homogeneous Areas Finder

Stripe Inter-Pixel
Calibration

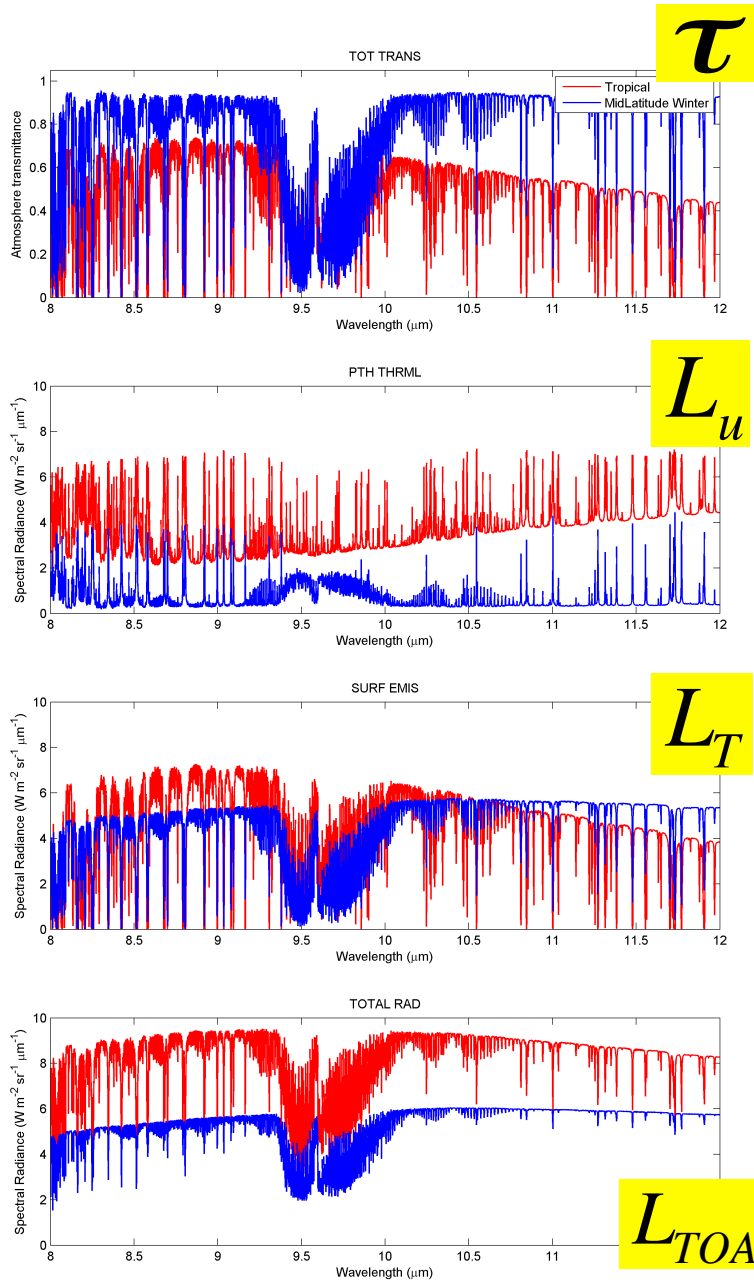
Inter-Stripe
Calibration



The 511 LUTs (LWIR2)

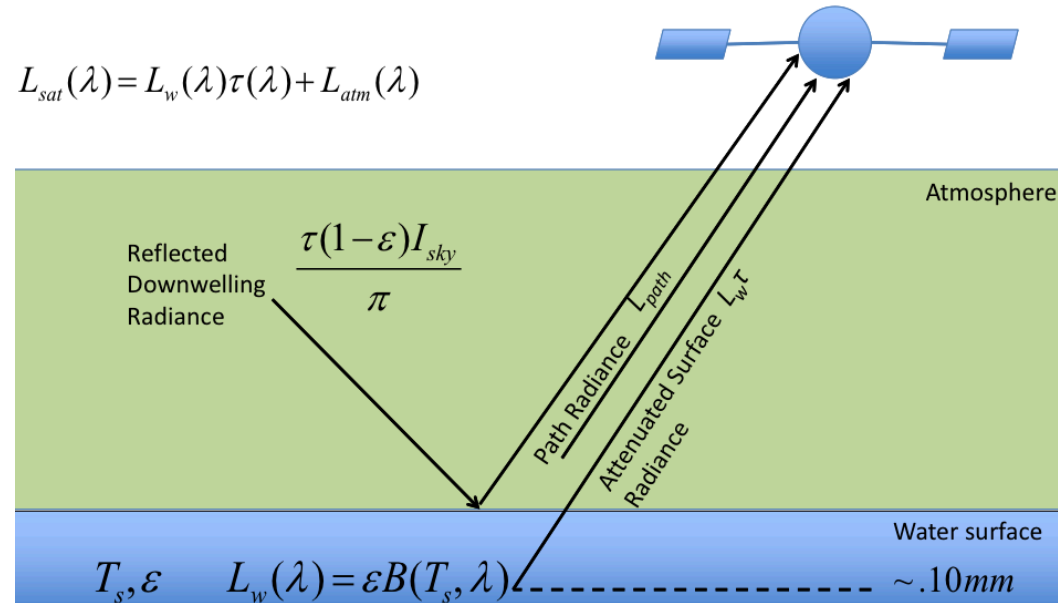


Radiative transfer In the thermal IR

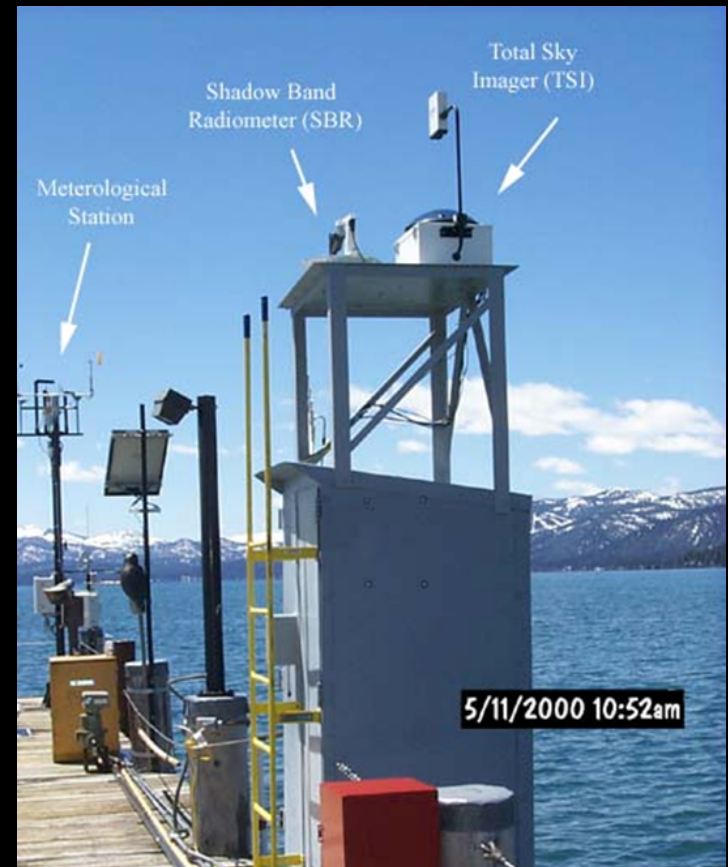
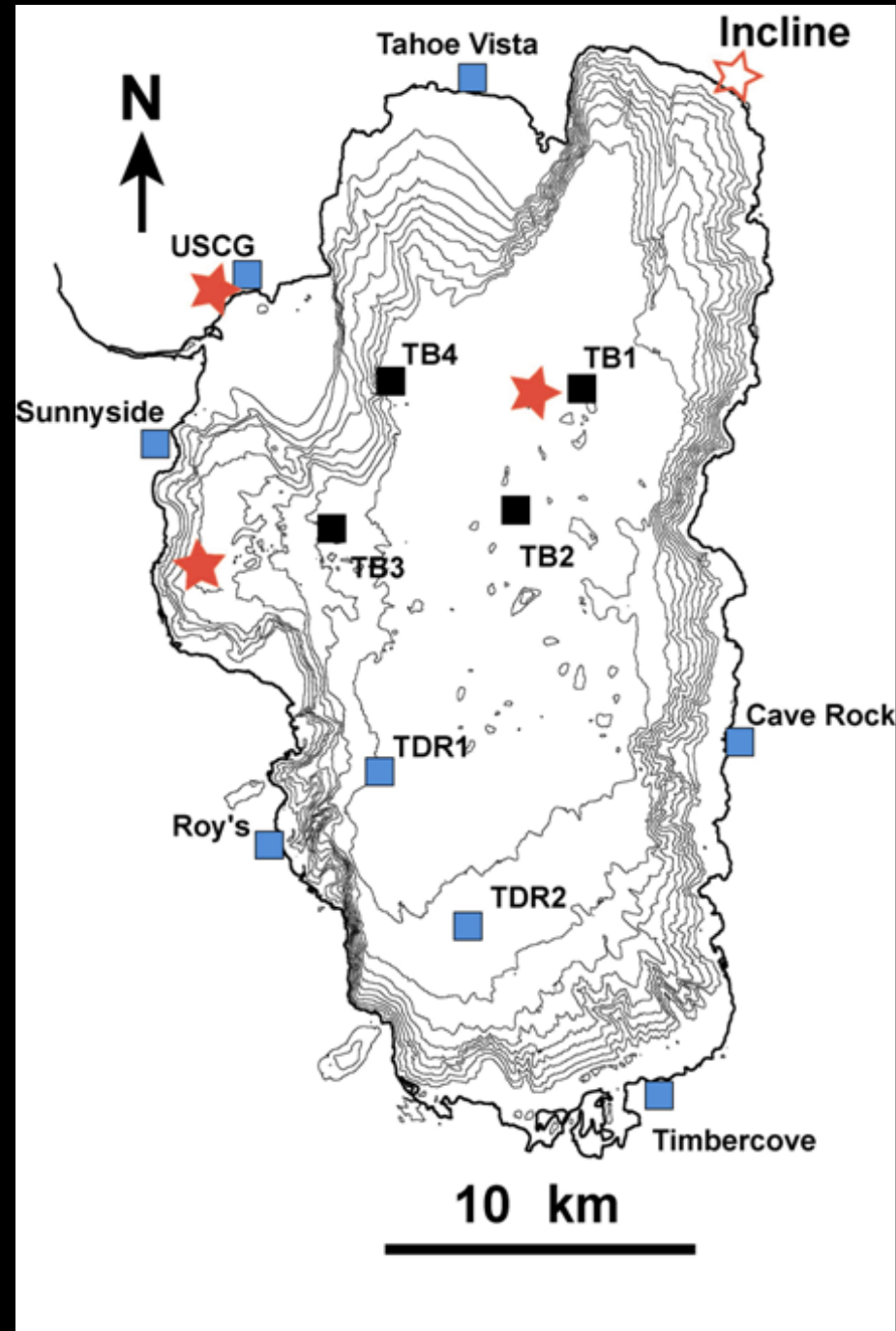


$$L_{TOA} = \tau \varepsilon L_T + L_u + \tau(1 - \varepsilon)L_d$$

$$L_{sat}(\lambda) = L_w(\lambda)\tau(\lambda) + L_{atm}(\lambda)$$

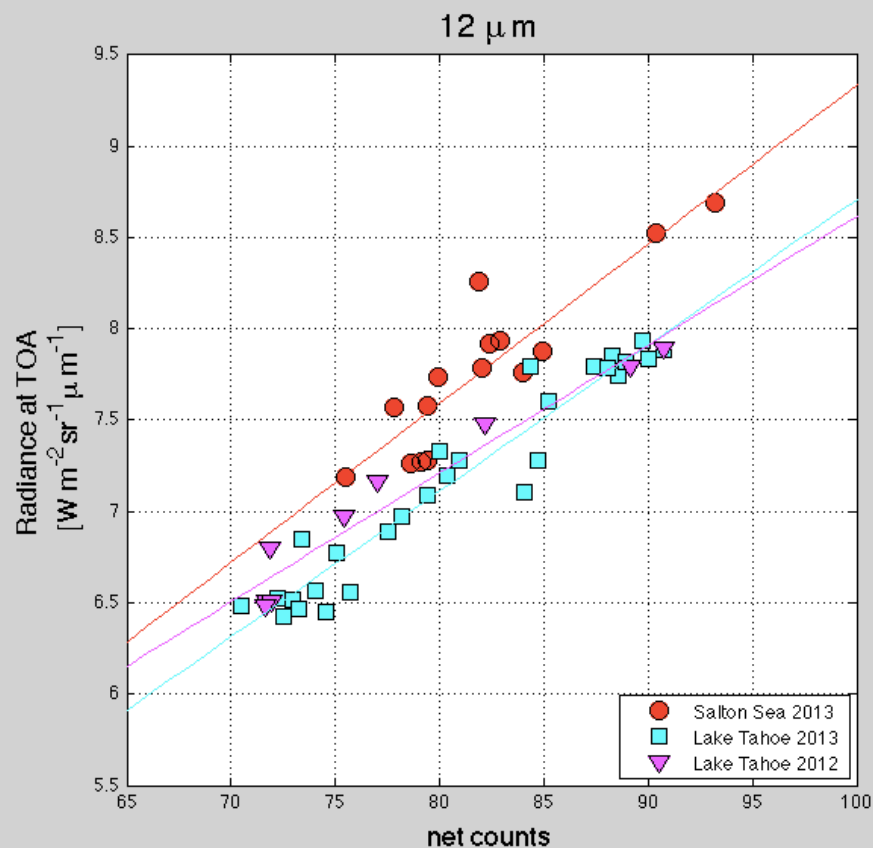
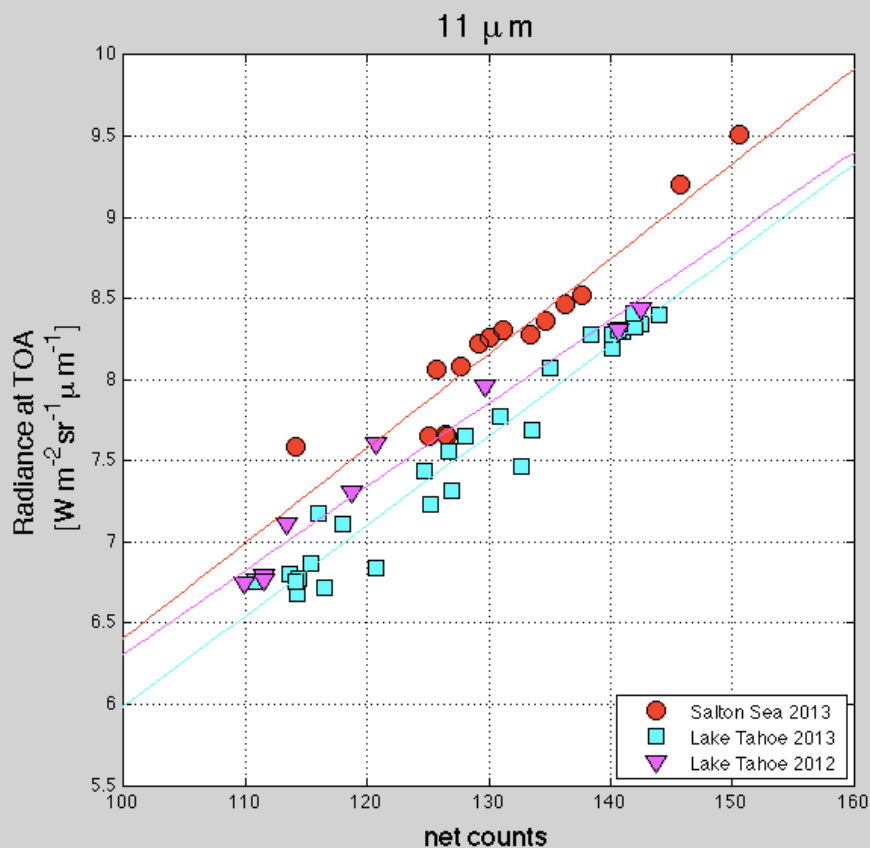


Site Layout and Measurement Stations



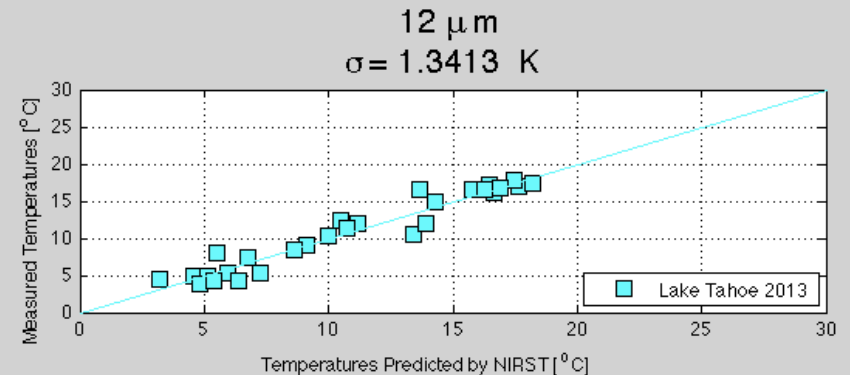
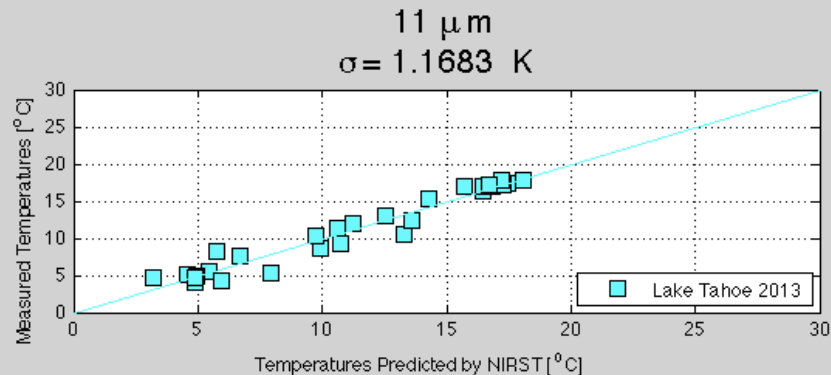
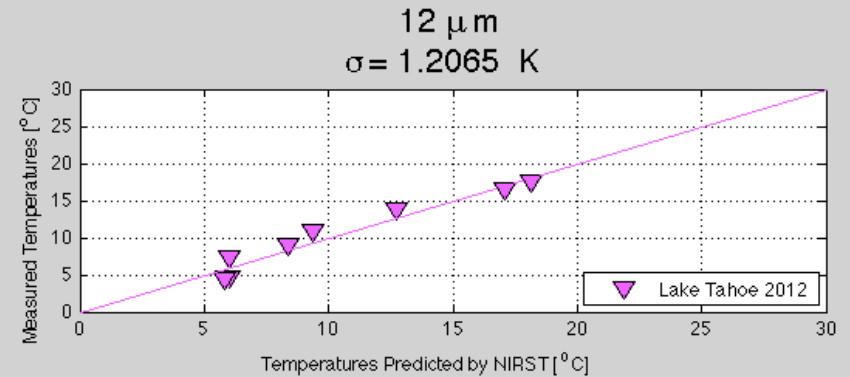
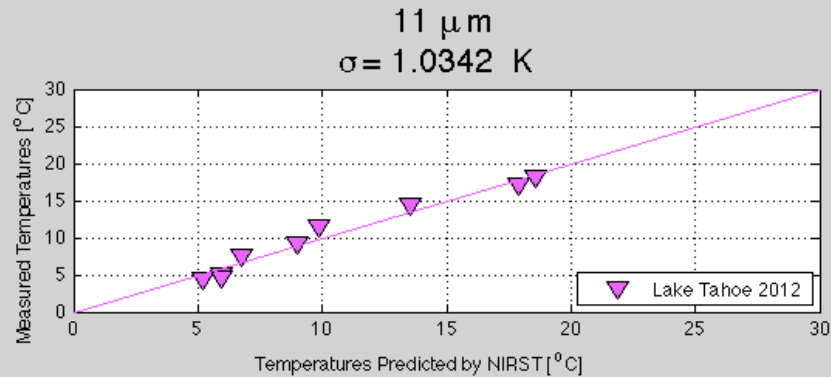
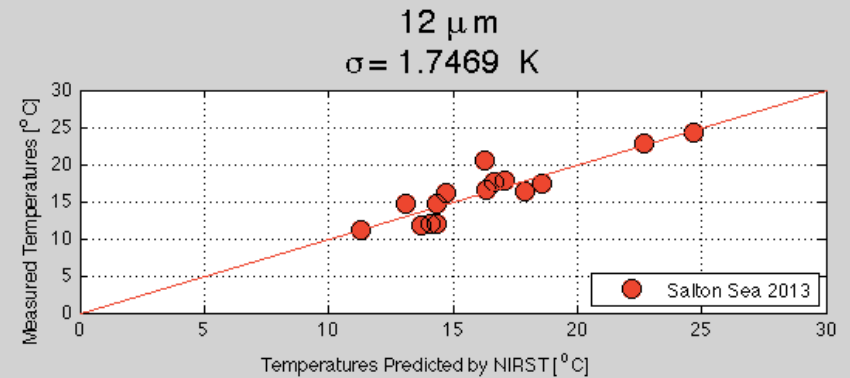
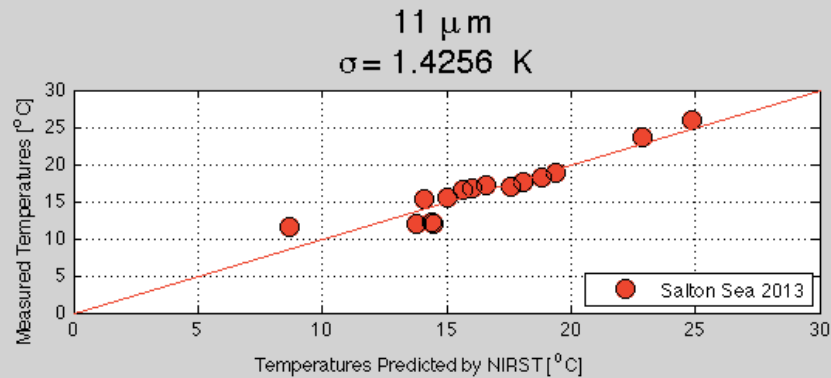
Individual calibrations

Expressed as spectral radiance vs. net counts



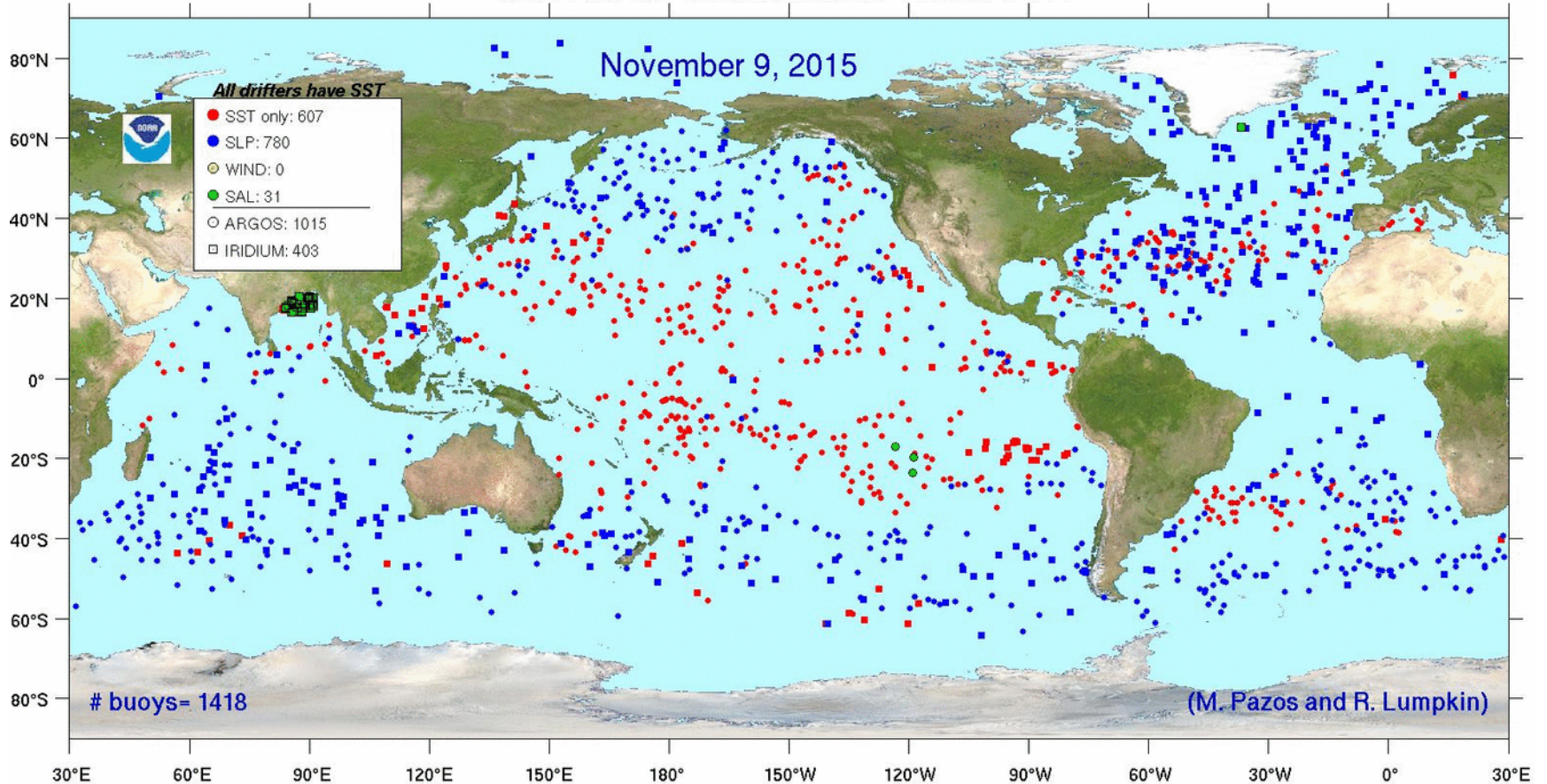
Individual calibrations

Expressed in temperature



NOAA Global Drifter Program

STATUS OF GLOBAL DRIFTER ARRAY



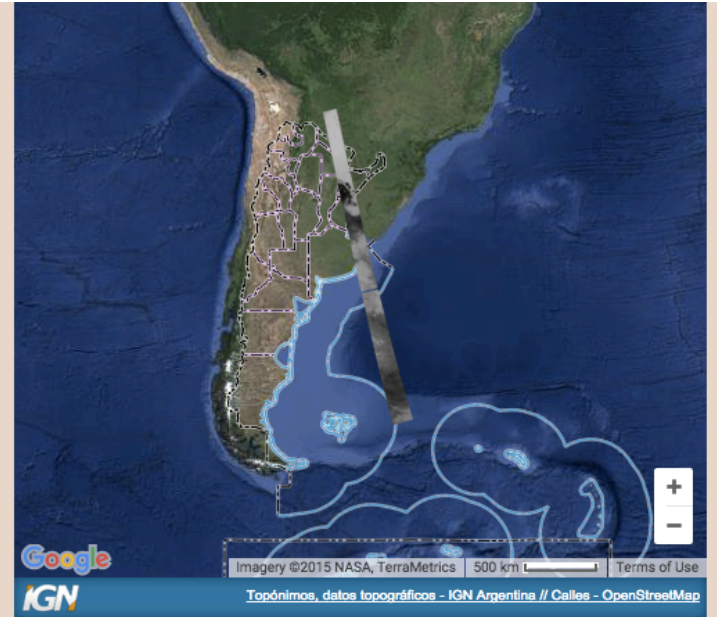
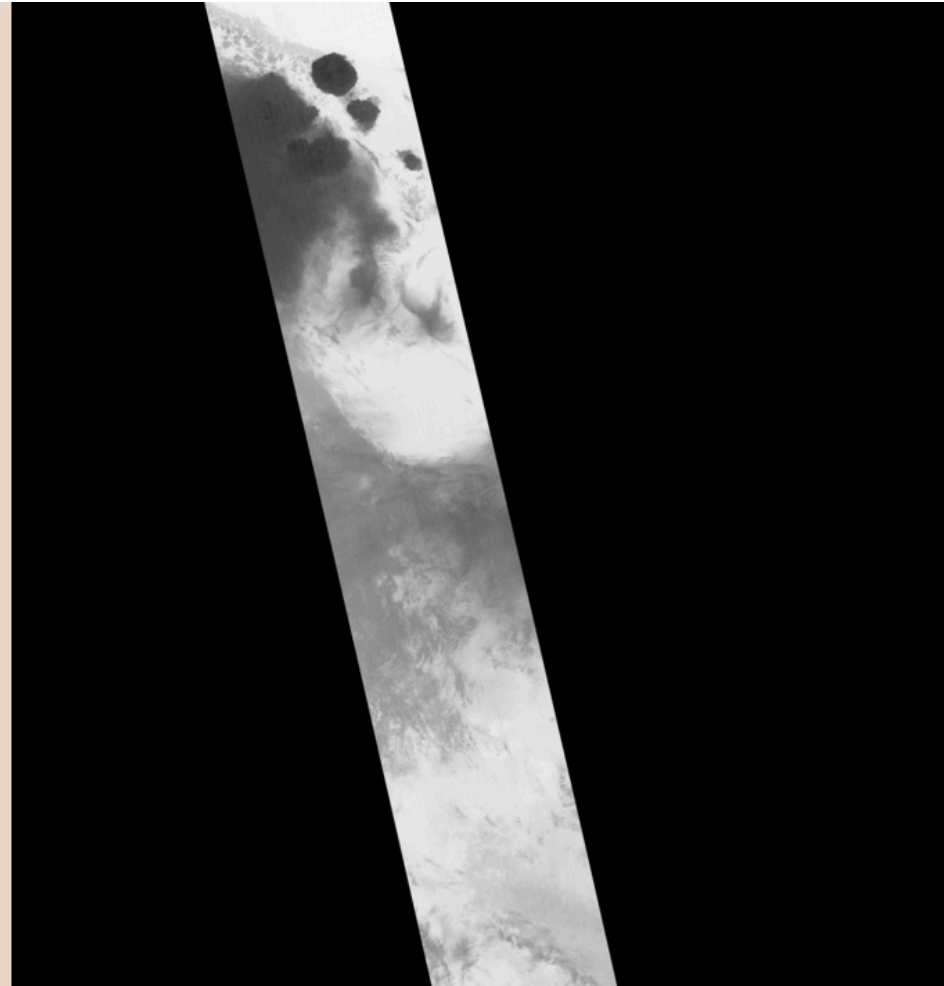
Drifting Buoy Data Example

interpolated_gld.20151030_064511

id	date	time	lat	lon	t	ve	vn	speed	varlat	varlon	vart						
35494	2013-04-01	00:00:00	34.452	177.026	16.285	-34.823	28.084	44.736	1.585e-05	1.913e-05	1.578e-03						
35494	2013-04-01	06:00:00	34.543	176.941	16.329	-25.058	63.283	68.063	8.149e-06	9.922e-06	1.578e-03						
35494	2013-04-01	12:00:00	34.698	176.908	16.280	-5.565	86.300	86.479	2.092e-05	2.542e-05	1.578e-03						
35494	2013-04-01	18:00:00	34.879	176.914	16.280	18.202	82.806	84.783	4.842e-06	6.445e-06	1.579e-03						
35494	2013-04-02	00:00:00	35.021	176.994	16.280	42.109	49.339	64.865	1.265e-05	1.522e-05	1.579e-03						
35494	2013-04-02	06:00:00	35.071	177.114	16.249	42.451	8.977	43.390	2.505e-06	4.979e-06	1.576e-03						
35494	2013-04-02	12:00:00	35.055	177.195	16.200	24.820	-8.837	26.346	2.196e-05	2.687e-05	1.579e-03						
35494	2013-04-02	18:00:00	35.036	177.231	16.177	22.669	-6.211	23.504	1.074e-05	1.290e-05	1.578e-03						
35494	2013-04-03	00:00:00	35.031	177.303	16.195	38.908	-13.133	41.064	8.831e-06	1.126e-05	1.576e-03						
35494	2013-04-03	06:00:00	34.985	177.416	16.130	27.762	-28.580	39.844	4.164e-06	5.591e-06	1.578e-03						
35494	2013-04-03	12:00:00	34.920	177.434	16.120	5.890	-22.088	22.860	1.999e-05	2.472e-05	1.579e-03						
35494	2013-04-03	18:00:00	34.899	177.443	16.120	6.446	-8.959	11.037	3.410e-06	5.261e-06	1.579e-03						
35494	2013-04-04	00:00:00	34.885	177.464	16.169	10.622	-12.838	16.662	7.419e-06	1.011e-05	1.827e-03						
35494	2013-04-04	06:00:00	34.849	177.494	16.114	0.604	-7.175	7.200	2.805e-06	5.978e-06	1.578e-03						
35494	2013-04-04	12:00:00	34.857	177.467	16.061	1.595	16.339	16.416	1.668e-05	2.091e-05	1.578e-03						
35494	2013-04-04	18:00:00	34.913	177.501	16.120	33.359	12.435	35.601	2.933e-06	4.870e-06	1.578e-03						
35494	2013-04-05	00:00:00	34.905	177.625	16.146	50.248	-25.093	56.165	2.786e-06	4.397e-06	1.576e-03						
35494	2013-04-05	06:00:00	34.815	177.738	16.069	40.413	-37.911	55.412	8.841e-06	1.157e-05	1.693e-03						
35494	2013-04-05	12:00:00	34.758	177.816	15.983	40.191	-17.876	43.987	1.320e-05	1.697e-05	1.687e-03						
35494	2013-04-05	18:00:00	34.745	177.928	15.960	49.445	-11.872	50.850	4.167e-06	5.895e-06	1.688e-03						
35494	2013-04-06	00:00:00	34.711	178.049	15.840	38.537	-17.348	42.261	2.953e-06	5.970e-06	1.579e-03						
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35494	2013-04-07	00:00:00	34.550	178.111	15.738	-12.673	-32.953	35.306	4.730e-06	7.158e-06	1.578e-03						
35494	2013-04-07	06:00:00	34.486	178.064	15.752	-16.143	-31.255	35.178	6.823e-06	9.608e-06	1.578e-03						
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35494	2013-04-08	00:00:00	34.334	178.055	15.812	9.520	-16.227	18.814	7.554e-06	9.733e-06	1.578e-03						
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35494	2013-04-11	00:00:00	34.506	178.149	15.641	-17.166	-15.526	23.146	1.054e-05	1.261e-05	1.578e-03						



NIRST Data from Sea Regions



NIRST Data from Ocean Regions

Cantidad de Bandas: 3

Versión Software: 3.0.0

Centro de Procesamiento: CETT

Nombre: EO_20150108_091537_CUSS_SACD_NIRST_L1B0_SCI_000_001

Ocultar Producto

Satellite

Google Imagery ©2015 NASA, TerraMetrics 1000 km Terms of Use

IGN Topónimos, datos topográficos - IGN Argentina // Calles - OpenStreetMap

The image shows a web interface for NIRST data. On the left is a large satellite image of a cloud-covered ocean region. On the right is a metadata panel with the following text: 'Cantidad de Bandas: 3', 'Versión Software: 3.0.0', 'Centro de Procesamiento: CETT', and 'Nombre: EO_20150108_091537_CUSS_SACD_NIRST_L1B0_SCI_000_001'. Below the metadata is a button labeled 'Ocultar Producto'. At the bottom right is a map of the Atlantic Ocean with a white rectangle indicating the data's location. The map includes a 'Satellite' dropdown menu, zoom controls (+ and -), and a scale bar for 1000 km. Logos for Google and IGN are visible at the bottom of the map area.

NIRST Data from Ocean Regions

Cantidad de Bandas: 3

Versión Software: 3.0.0

Centro de Procesamiento: CETT

Nombre: EO_20150108_061617_CUSS_SACD_NIRST_L1B0_SCI_000_001

Ocultar Producto

Satellite

Imagery ©2015 NASA, TerraMetrics 500 km Terms of Use

IGN Topónimos, datos topográficos - IGN Argentina // Calles - OpenStreetMap

The image shows a web interface for NIRST data. On the left is a vertical strip of satellite imagery. The main area contains a map of the ocean region, likely the South Atlantic, with a white rectangular area indicating the data's location. The interface includes a dropdown menu set to 'Satellite', a 'Ocultar Producto' button, and a zoom control. At the bottom, there are logos for Google and IGN, along with copyright information for 2015 NASA and TerraMetrics, and a 500 km scale bar.

SST Split Window Coefficient Regression

Split Window Method using NIRST 11 μm and 12 μm bands

$$\text{SST} = a T_i + b (T_i - T_j) + c$$

Using as many points from buoys data as possible for regression calculation.

Determination of cloud free images

Brightness temperatures at TOA vs. split windows

Rio Tercero dam

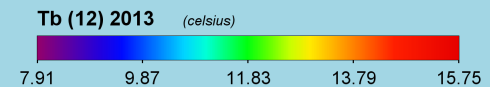
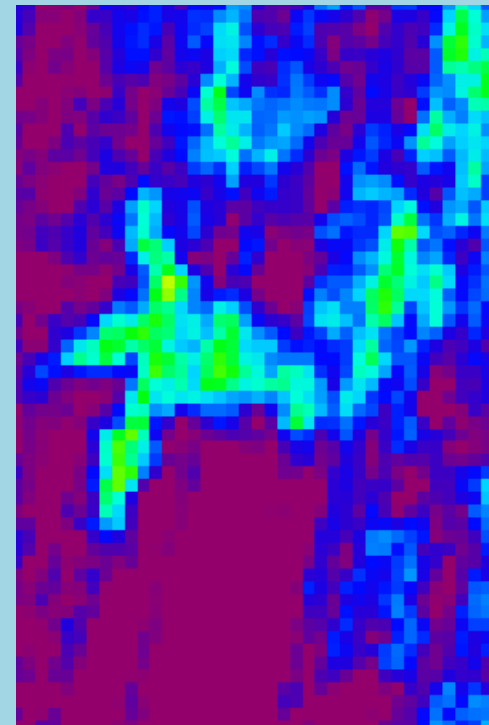
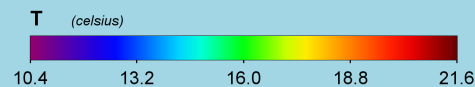
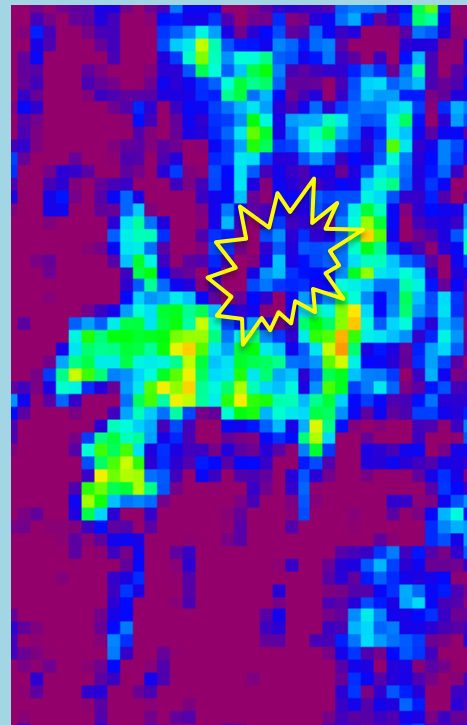
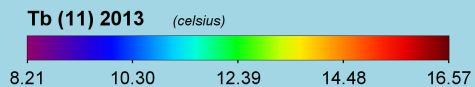
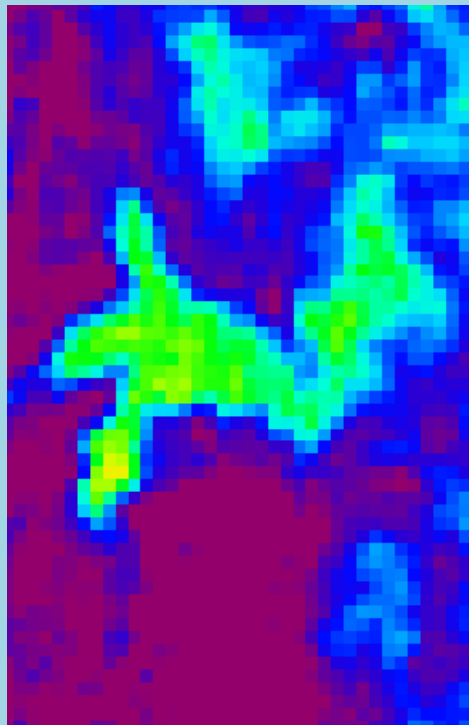
$$T = 2.544 * Tb_{(11)} - 1.544 * Tb_{(12)} + 1.18$$

The highlighted area has low emissivity but is relatively warm

Tb@11 μm

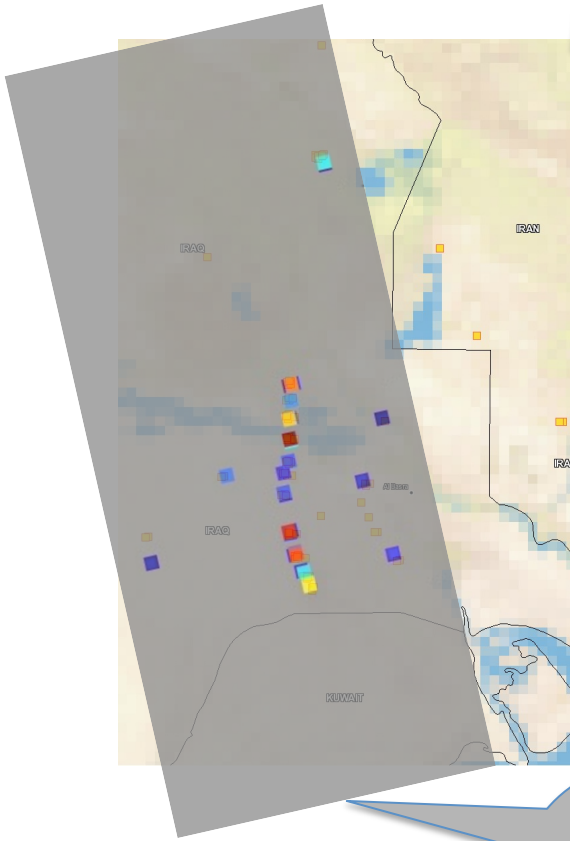
T

Tb@12 μm

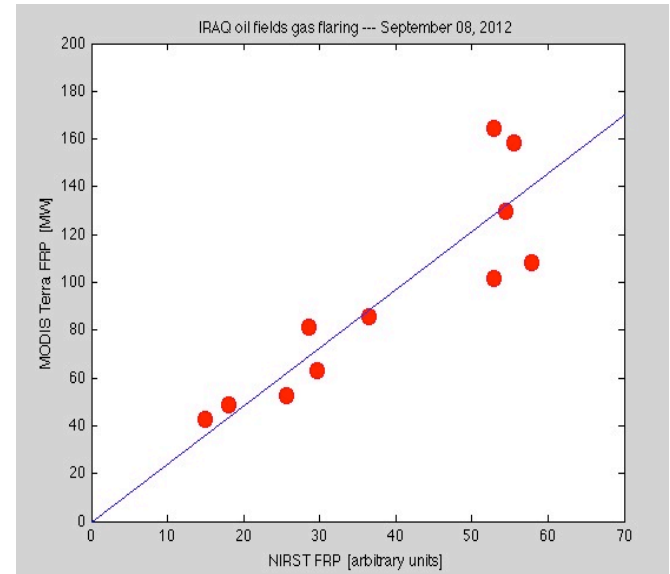


4 μm fire detection

MODIS



NIRST

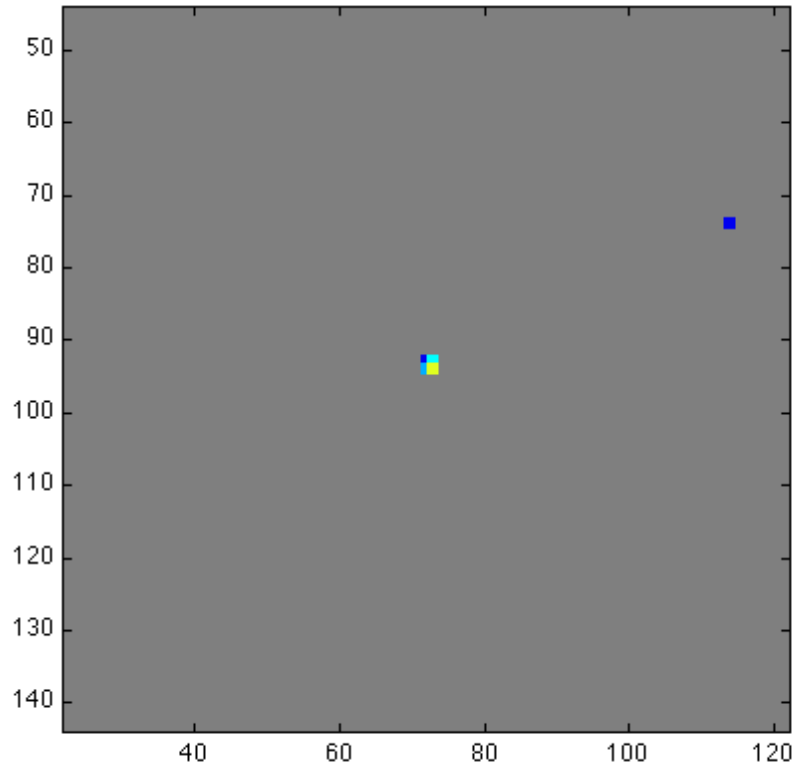


- ◆ In spite (or perhaps thanks to) the blind pixel failure the 4 μm camera detects HTEs.
- ◆ The detections are confirmed with other satellite IR sensors.
- ◆ FRP comparison with MODIS over Iraq oil fields gas flaring shows a reasonable correlation that improves when the time lapses between satellites passes are smaller.

Fire power as seen in thermal

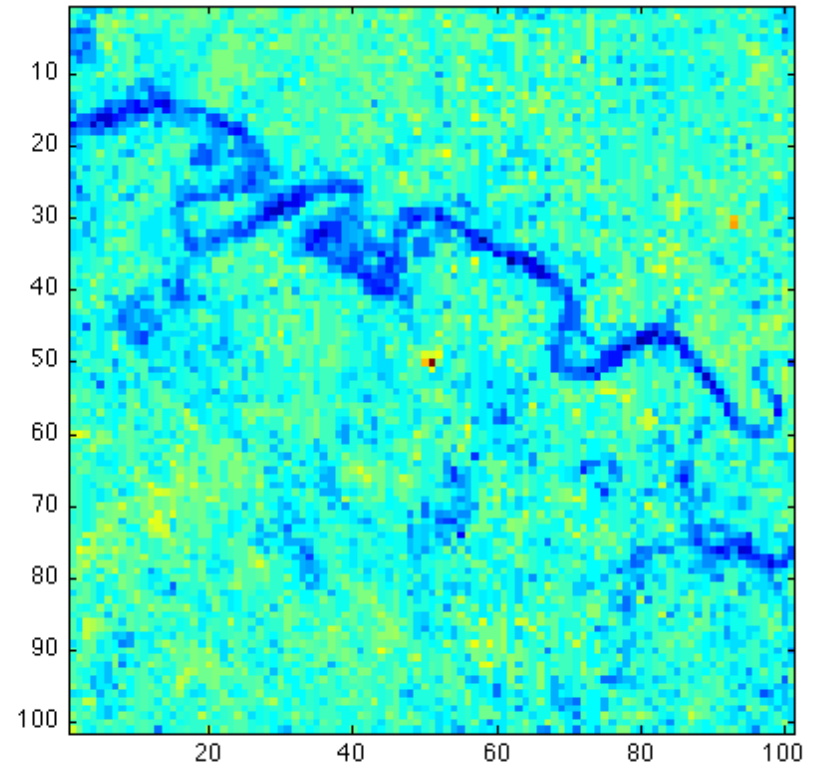
4 μm

MWIR2 (3.8 μm) color is proportional to power



11 μm

LWIR2 (10.8 μm) color is proportional to temperature



4 pixels with
peak power = 14.0 and total power = 39.9