Multi-satellite, multi-sensor data fusion: global daily 9 km SSTs from MODIS, AMSR-E, and TMI

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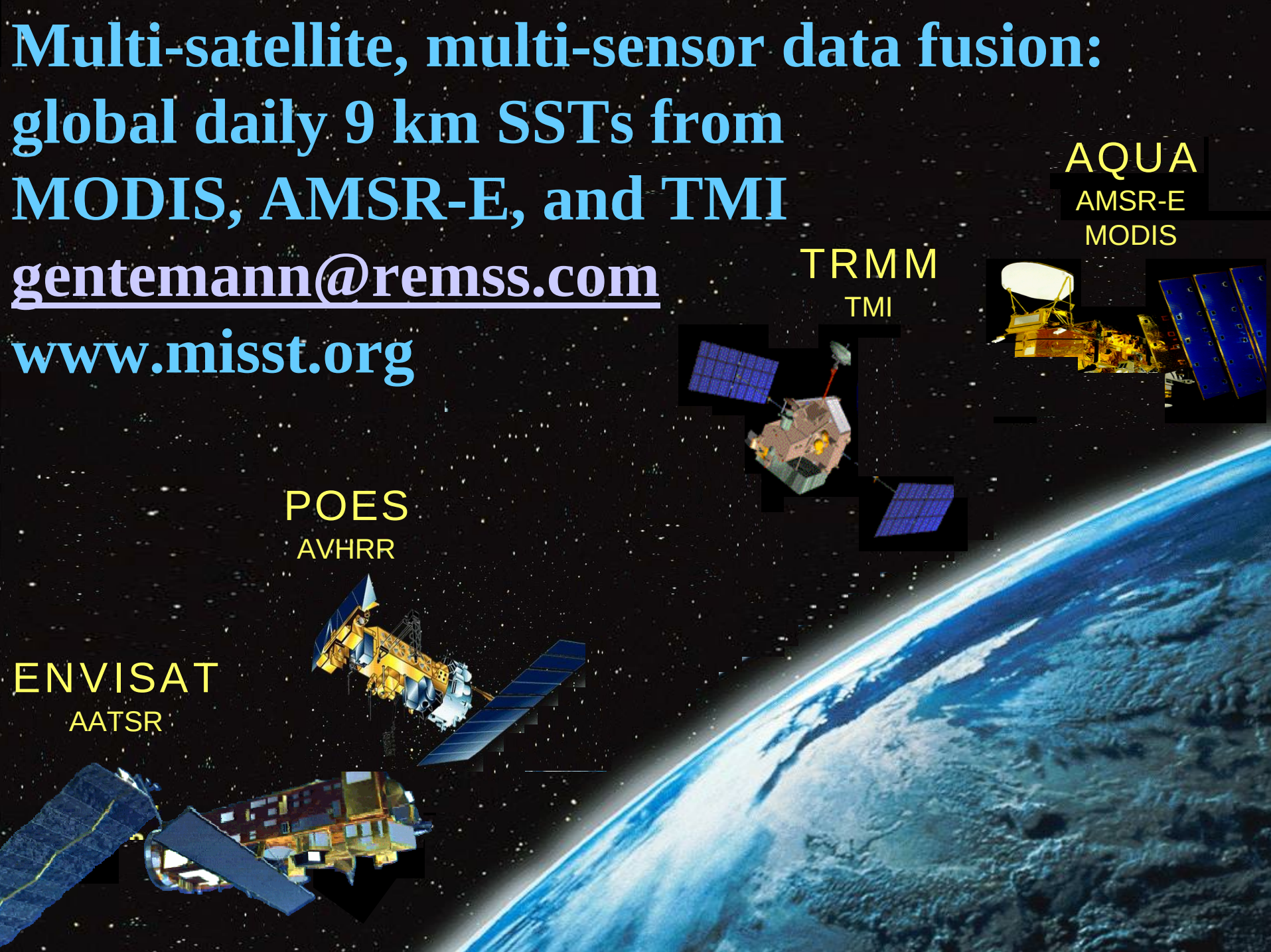
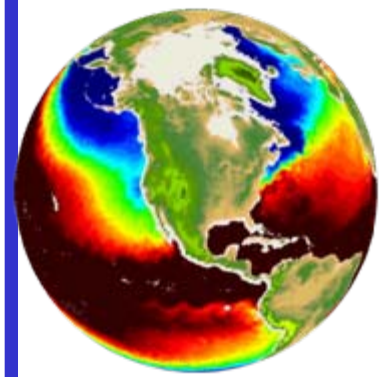
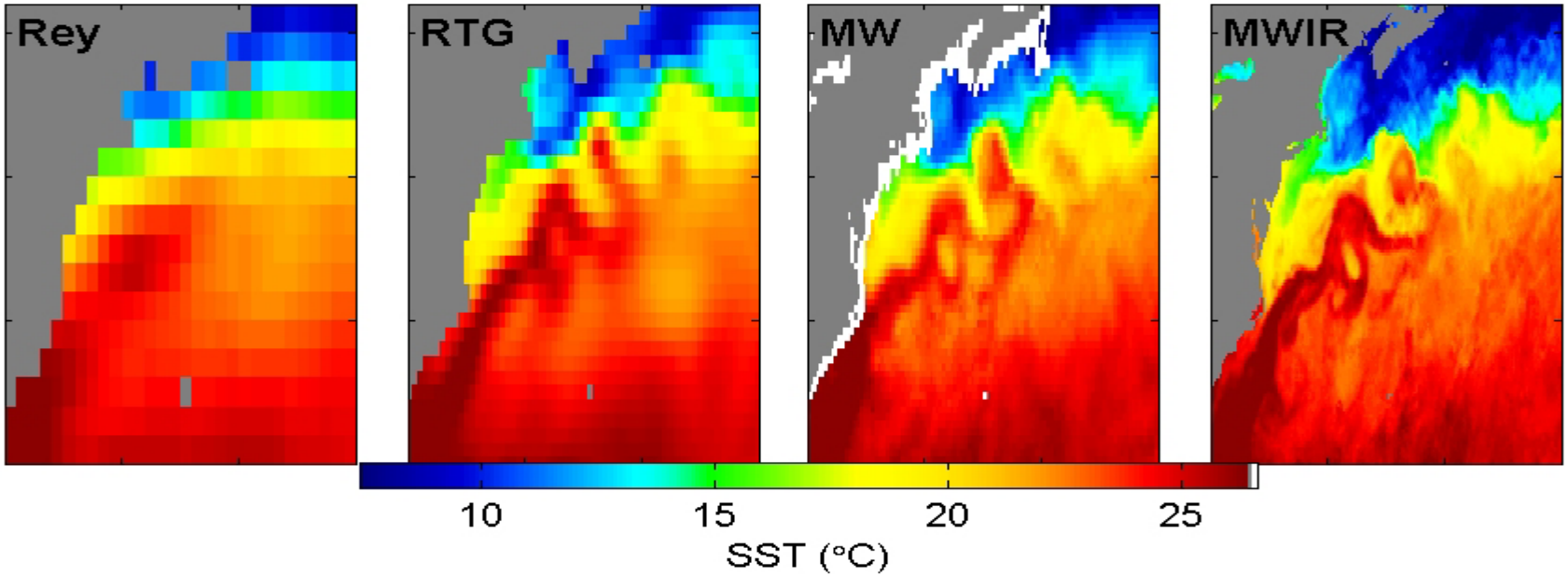


NRT 9km global SSTs



- Global OI SSTs
- Pre-processing data
- Optimum Interpolation
- Validation

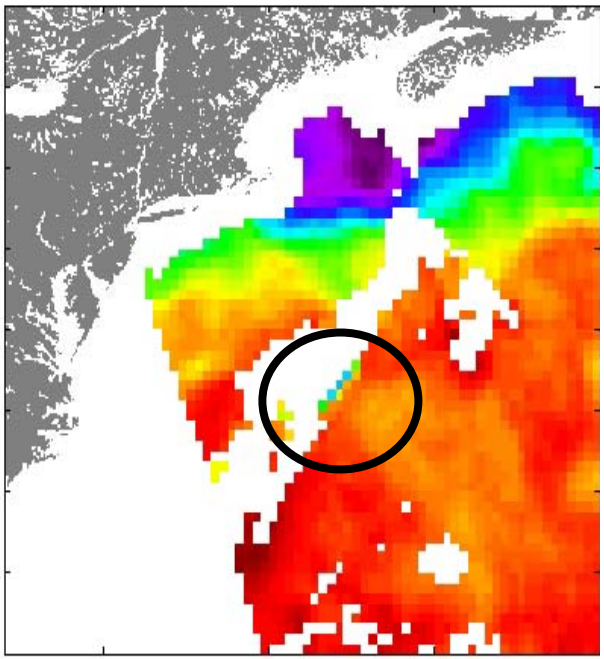
3 Global SST products



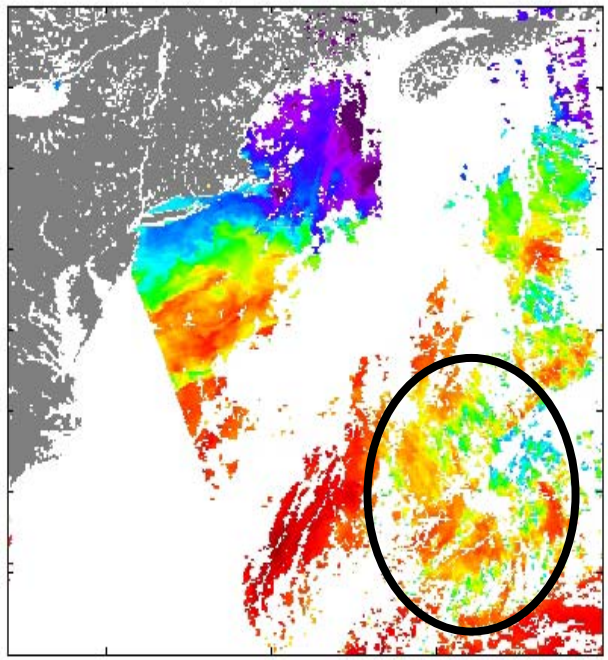
Reynolds	RTG	RSS MW	RSS MW+IR
Weekly	Daily	Daily	Daily
100km	50km	25km	9km
AVHRR	AVHRR	AMSRE TMI	MODIS AMSRE&TMI

Near-land SSTs

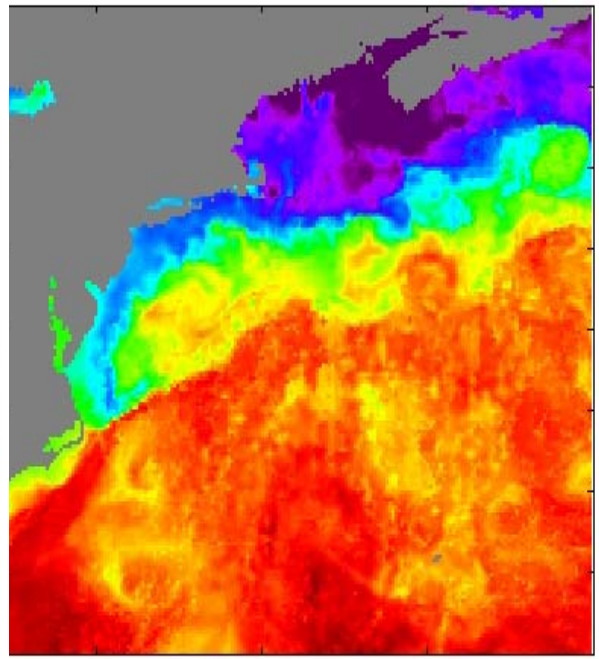
AMSRE



MODIS



9km OI SST



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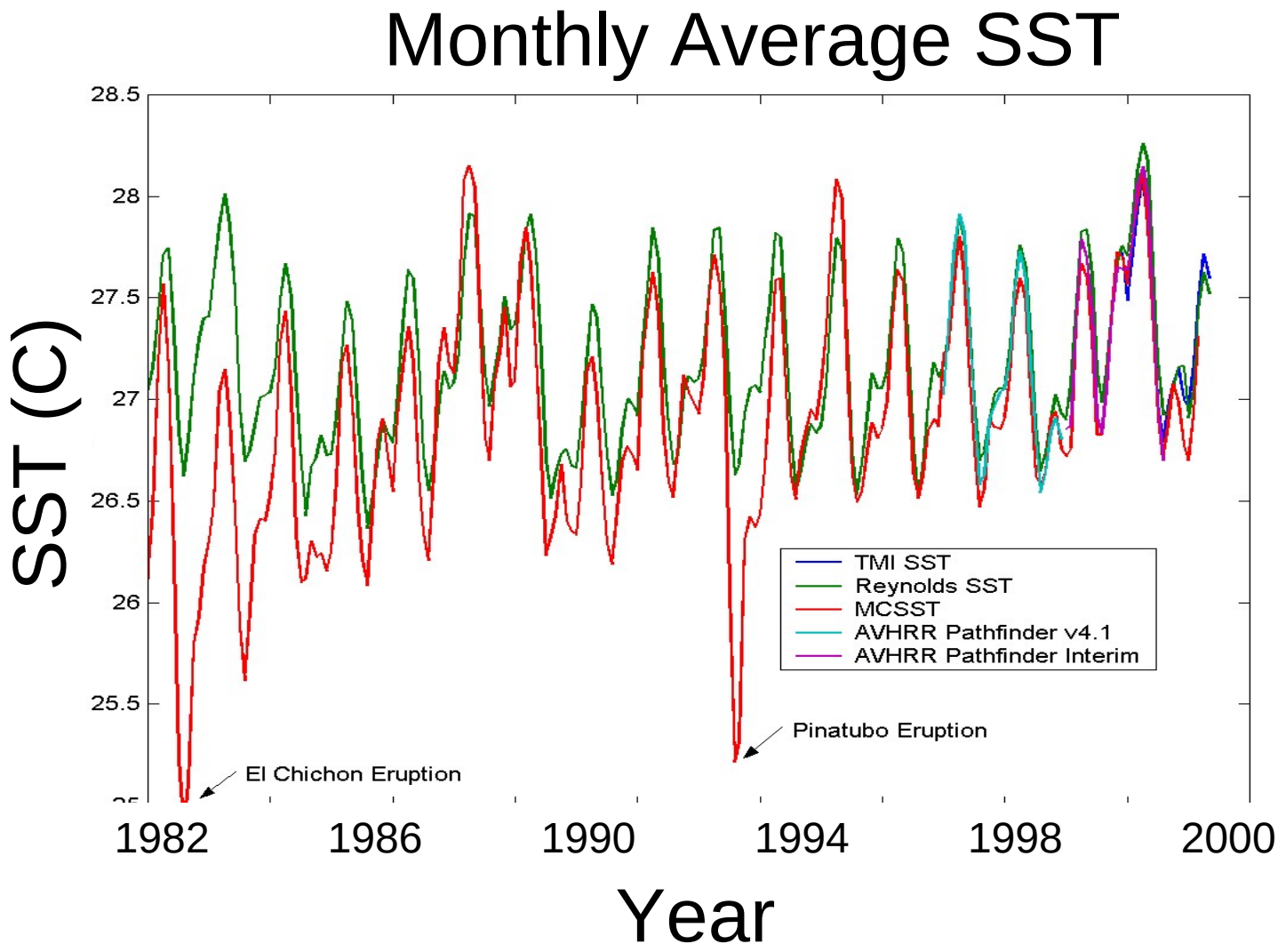
Long Term Stability



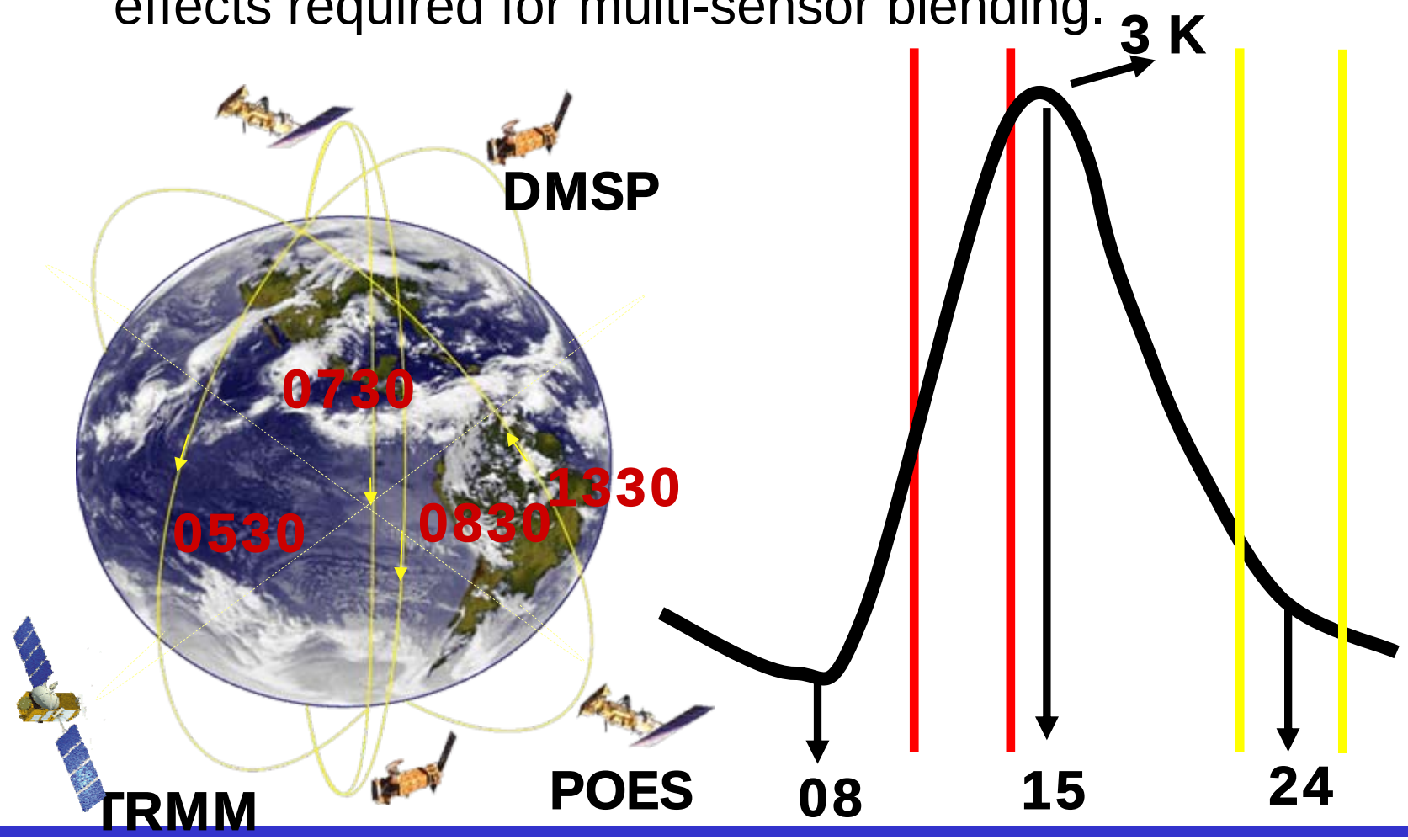
Data processing

- Process TMI, AMSR-E, MODIS SSTs
  - Calculate errors as a function of buoy collocations, then increment by wind/sst
  - MW: rain tests: erode around rain pixels based on threshold, …
  - IR: cloud tests: erode around cloudy pixels based on threshold, …
  - Output: sst, error, mask, time_ob on 10km grid

  Further details: www.misst.org

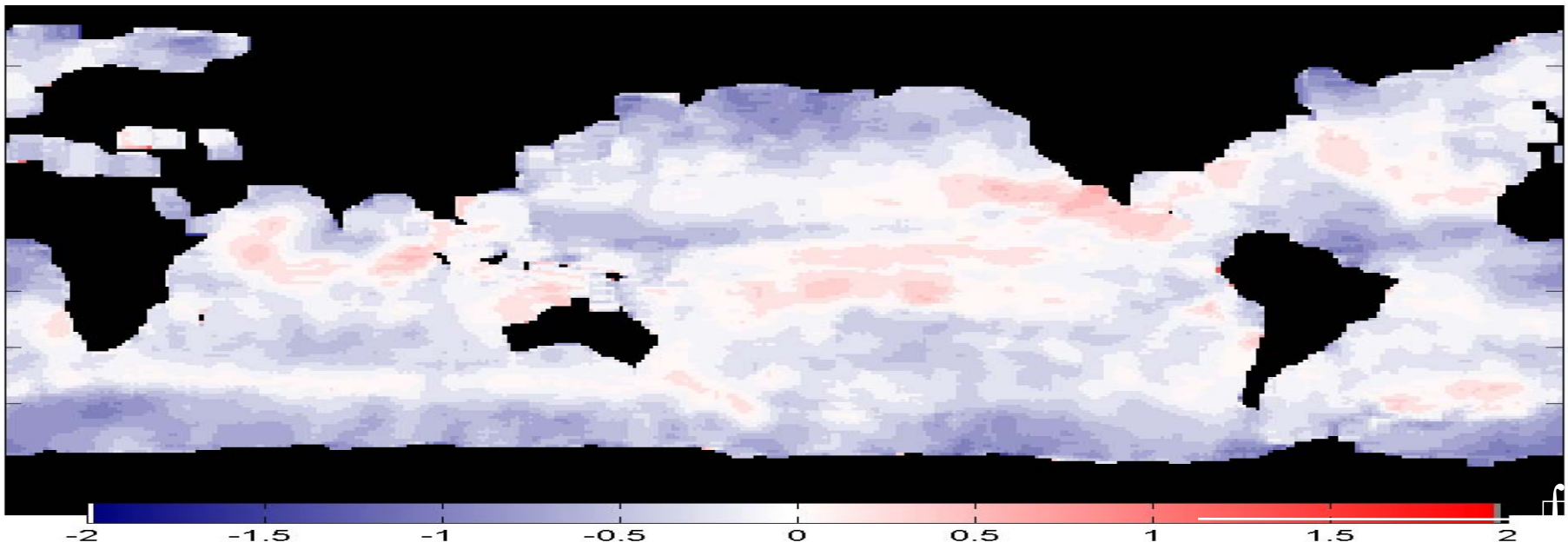
Diurnal Warming/Foundation SST

2) Parameterization of IR and MW retrieval differences, with consideration of diurnal warming and cool-skin effects required for multi-sensor blending.

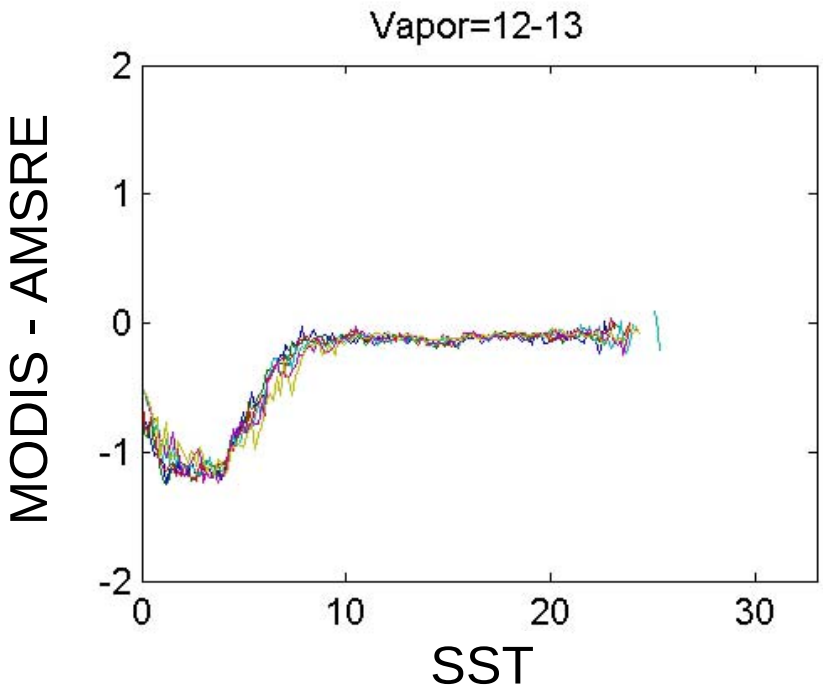


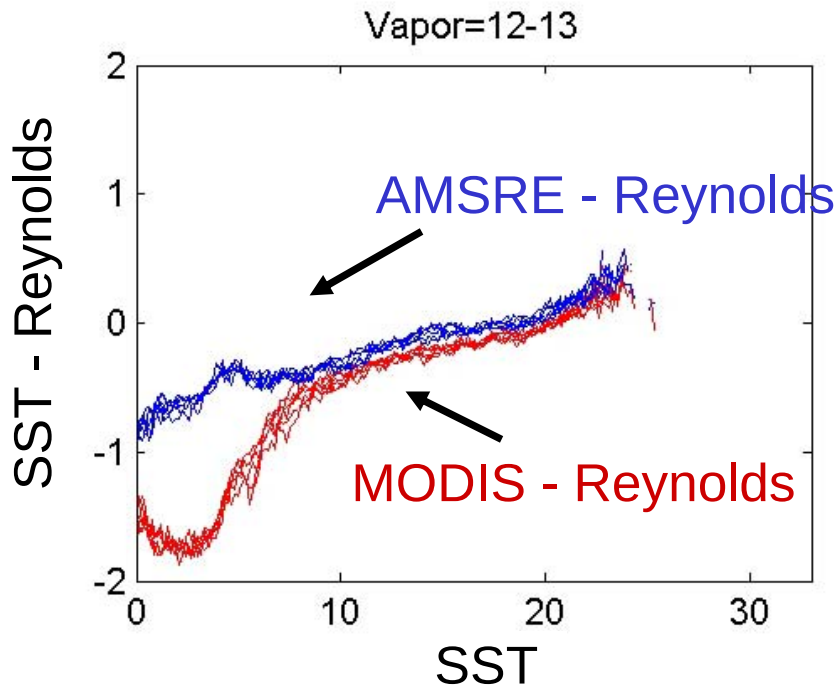
MW-IR

- Need to account for regional differences due to unexplained algorithm errors in MW and IR SSTs
- Calculate 20-day average difference, smooth, subtract from IR

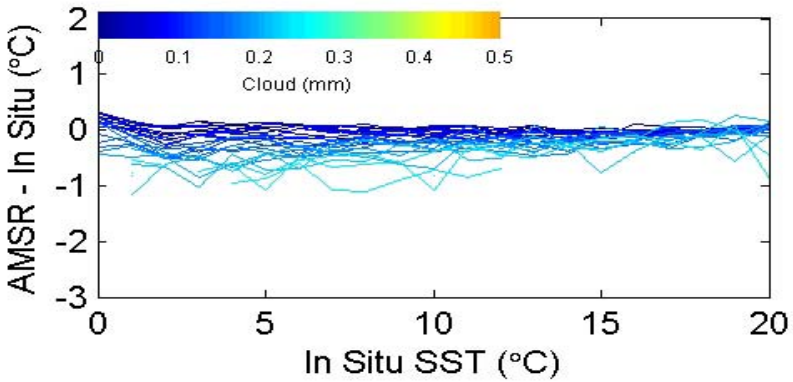


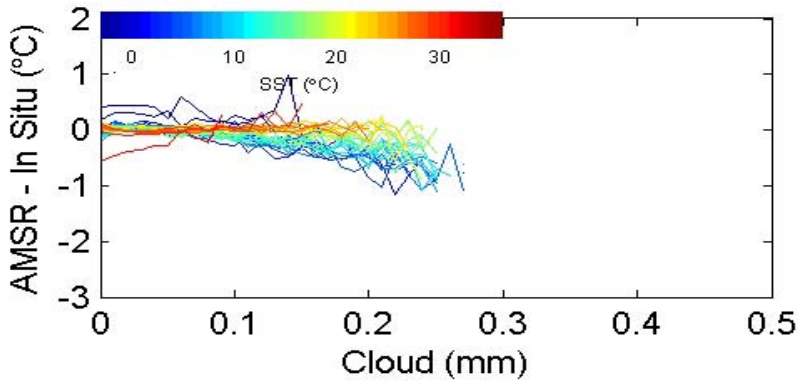
Mean difference @ LOW vapor

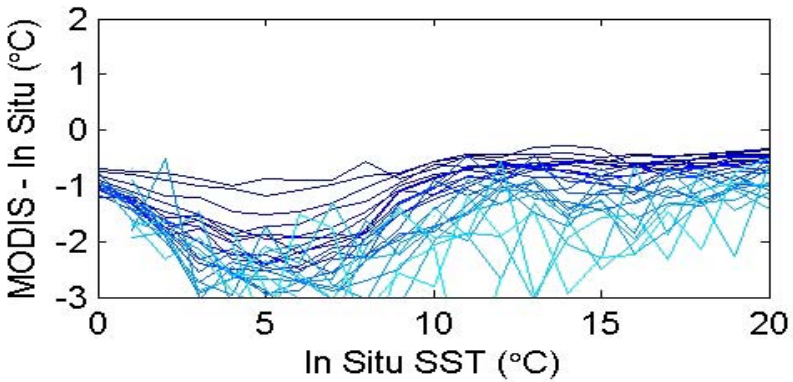


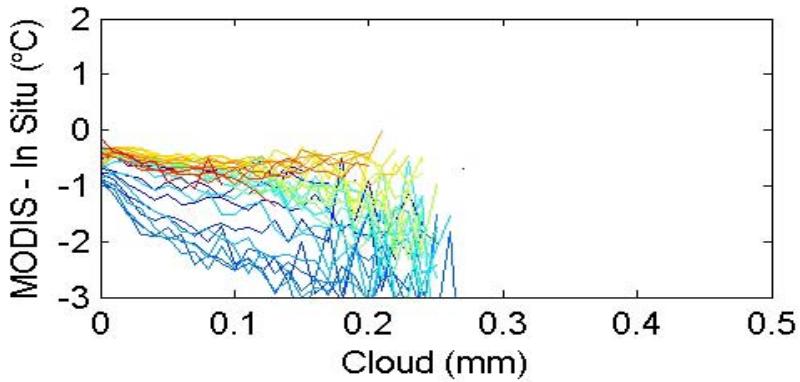


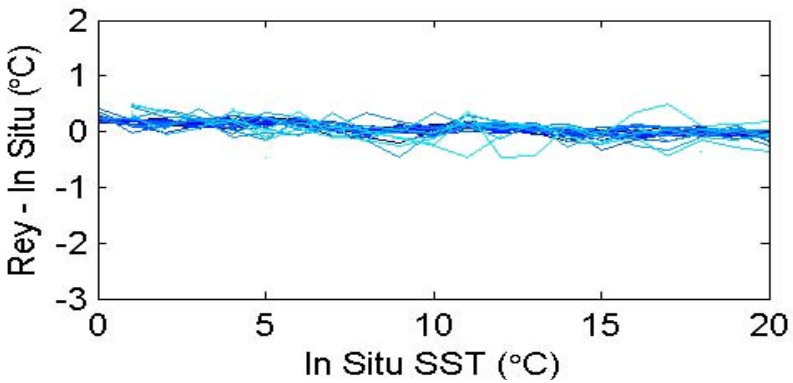
Mean difference

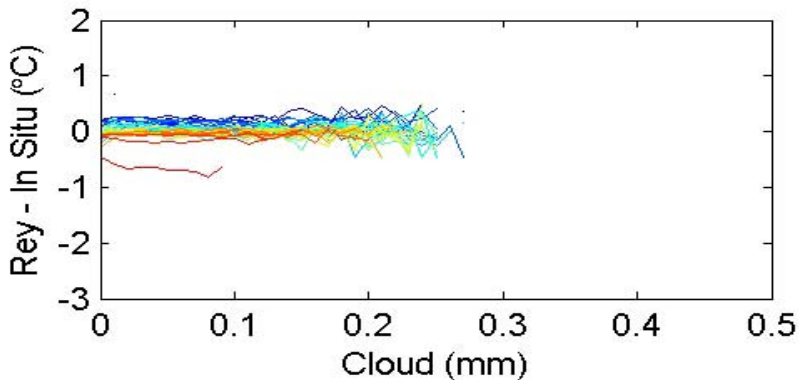












Optimum interpolation

$$\theta(x,y,t) = CA^{-1}\phi$$

$$C_{ij} = \left\langle \pi_i \pi_j \right\rangle + \varepsilon_i \varepsilon_j \left\langle \beta_i \beta_j \right\rangle$$

$$\left\langle \pi_i \pi_j \right\rangle = (1 - r^2) e^{\frac{-r^2}{2}};$$

$$r^2 = \frac{((x_i - x_j)^2}{\tau_x^2} + \frac{(y_i - y_j)^2}{\tau_y^2} + \frac{(t_i - t_j)^2}{\tau_t^2}$$

- 1st guess field: currently previous days OI
- Correlations in time/space: invariant
- Careful A is not singular, restrict size of A
- Observation errors
- Correlations less important in ocean

$\theta(x,y,t)$ = data increment estimate

ϕ=observations minus 1st guess

A^{-1} = inverse autocorrelation between observations

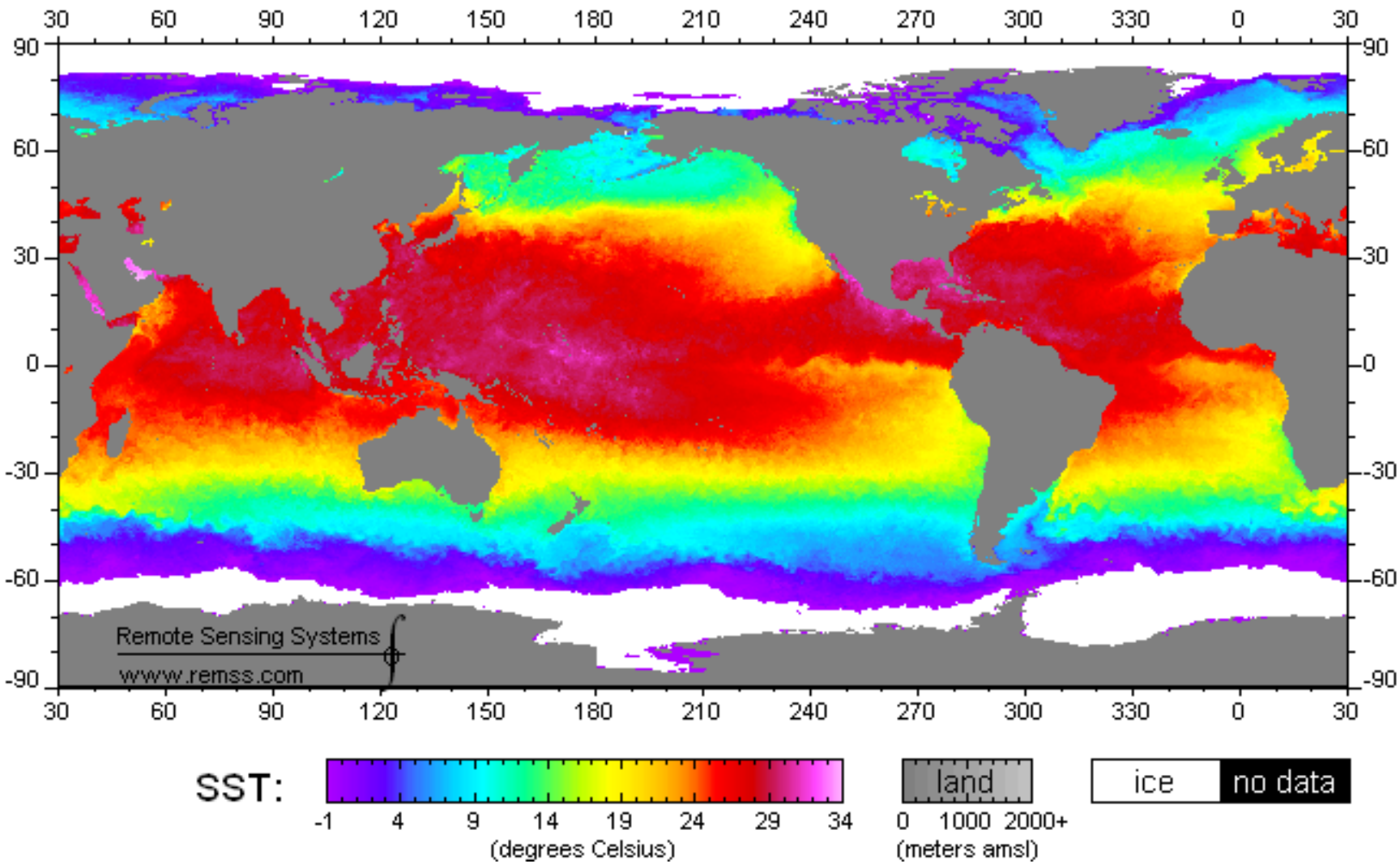
C=cross correlation matrix betwwen estimate and observation

π_i =data/estimate correlation error

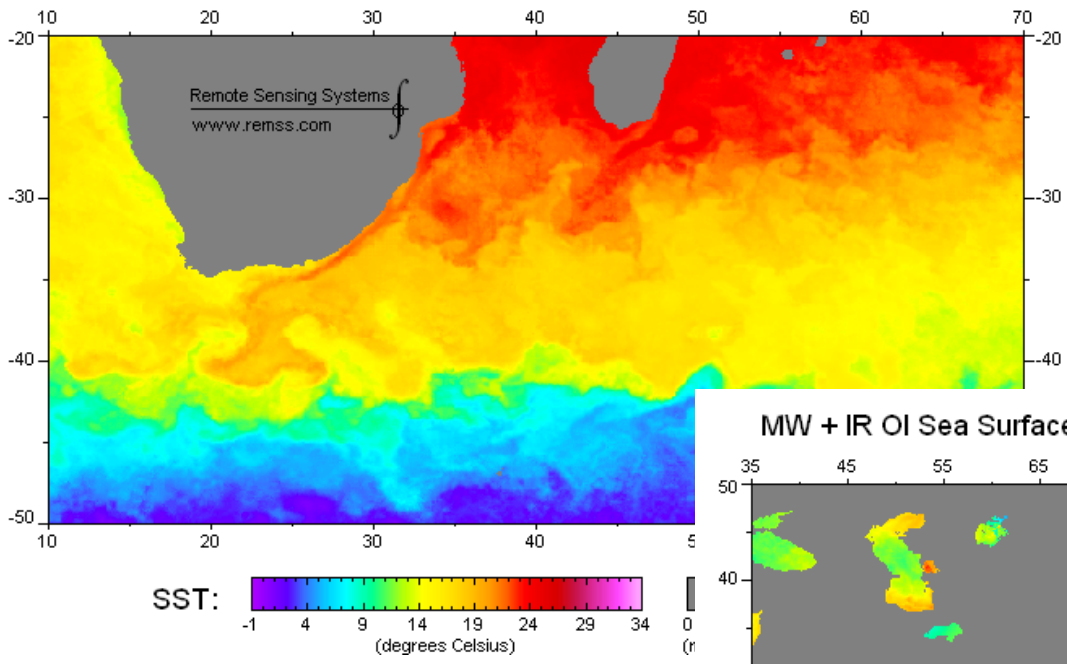
ε_j =observation error;

β_i = data correlation error (assume diagonal)

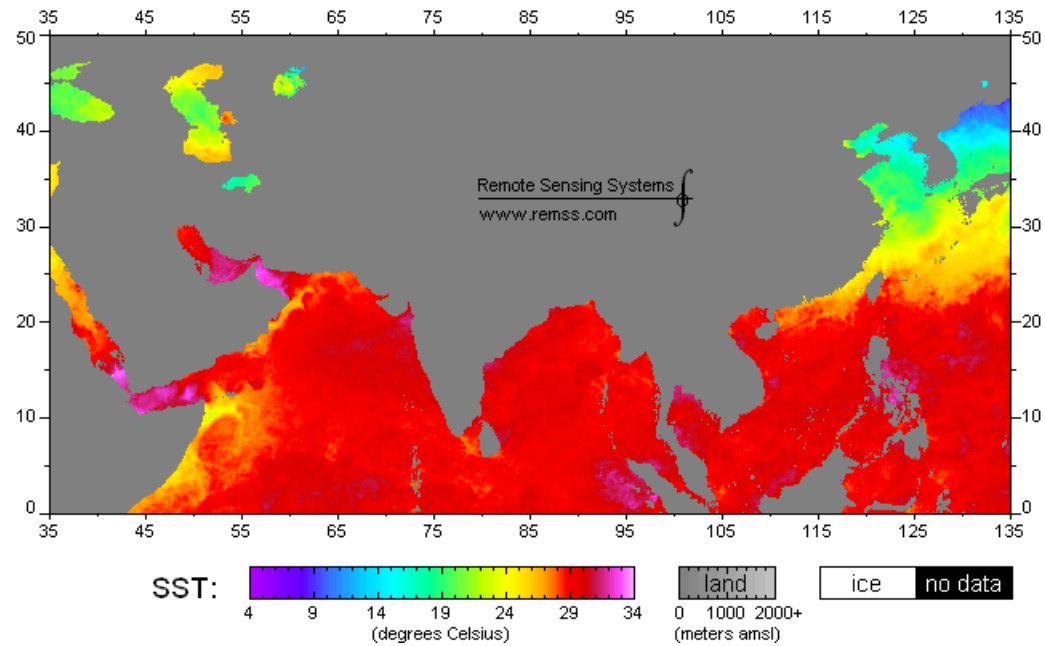
τ=correlation scales (x, y, t)


MW + IR OI Sea Surface Temperature: 2006/08/17 (~8 AM) - Global
30 60 90 120 150 180 210 240 270 300 330 0 30
90 60 30 0 -30 -60 -90
Remote Sensing Systems
www.remss.com
SST:
-1 4 9 14 19 24 29 34
(degrees Celsius)
land
0 1000 2000+
(meters amsl)
ice
no data

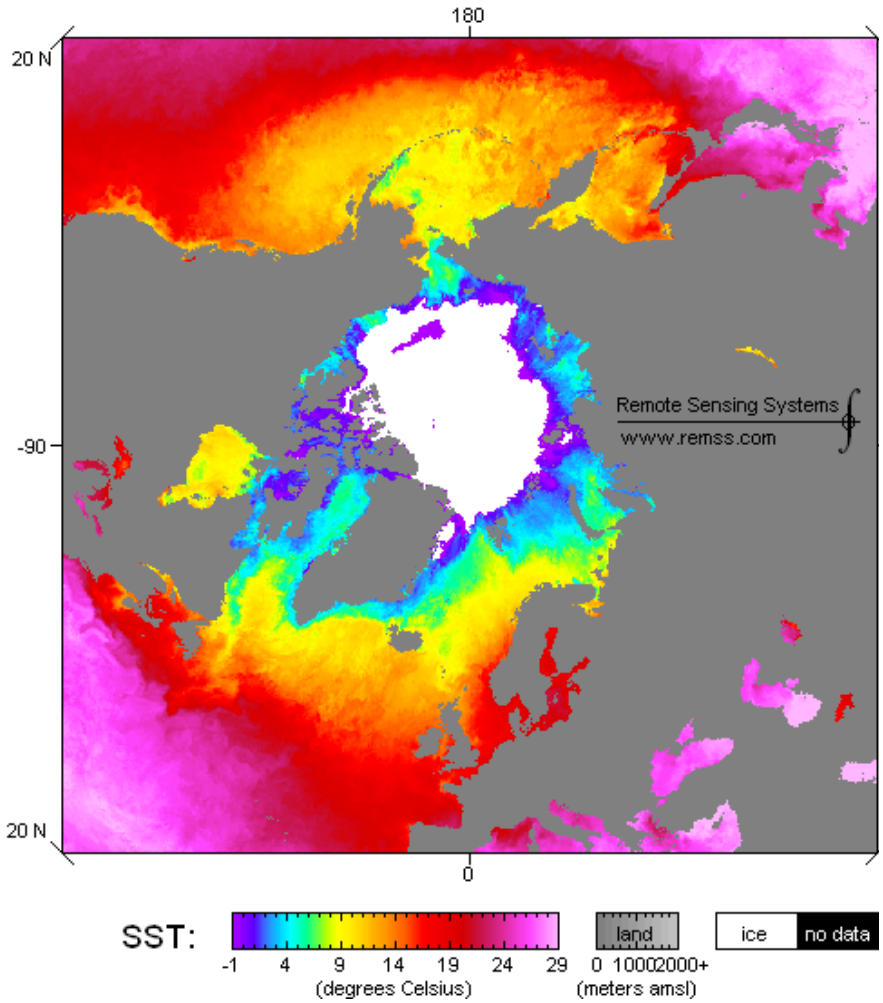
MW + IR OI Sea Surface Temperature: 2006/08/18 (~8 AM) - Agulhas, Benguela Currents



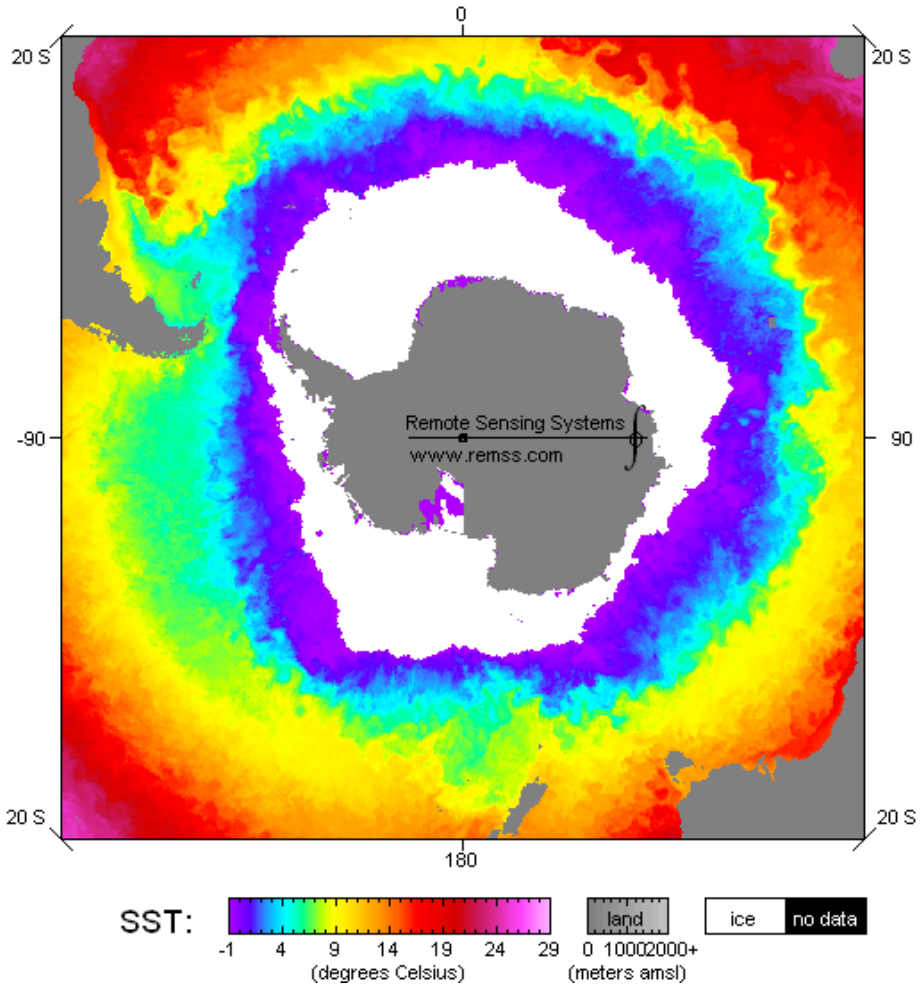
MW + IR OI Sea Surface Temperature: 2006/06/14 (~8 AM) - Indian, North



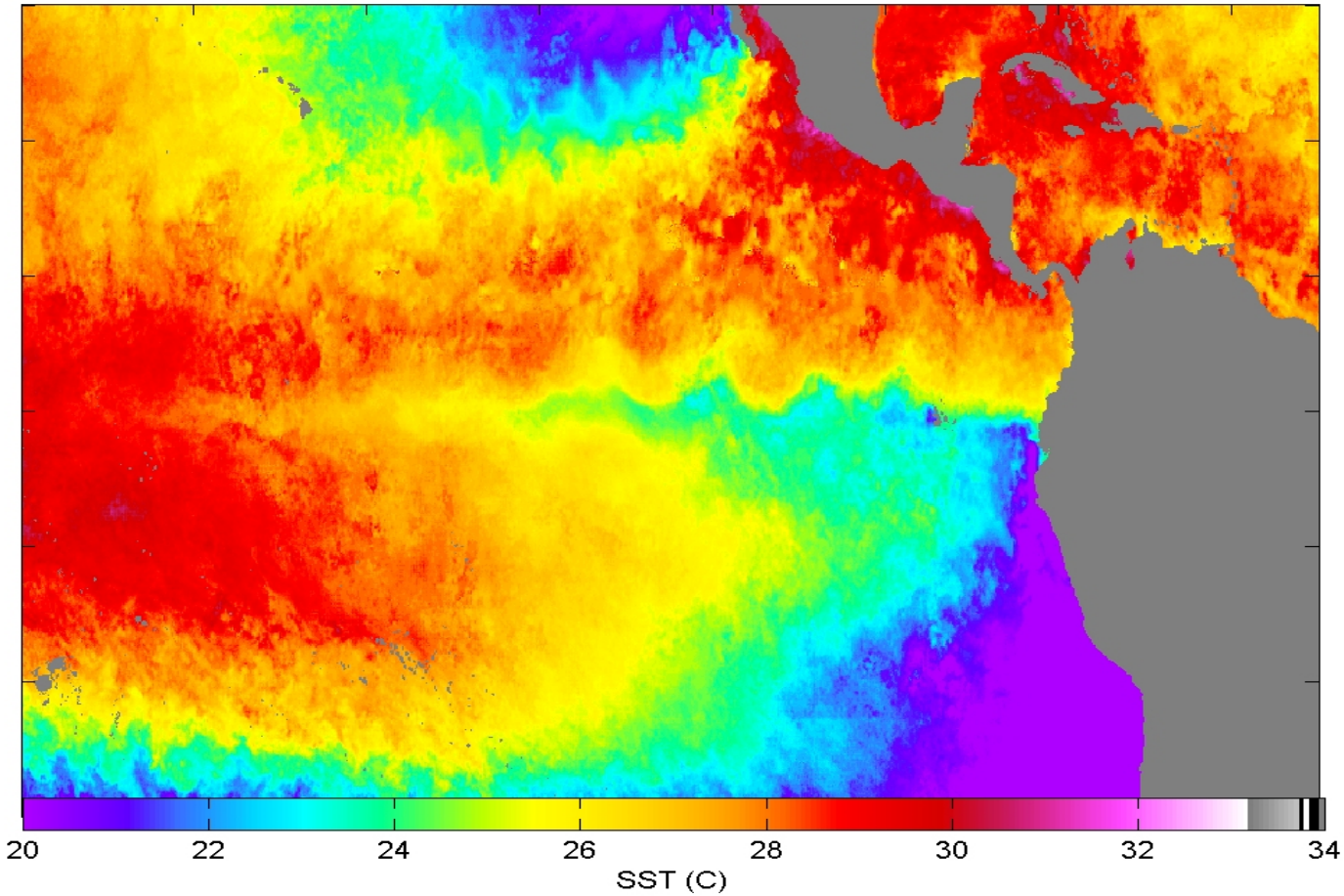
MW + IR OI Sea Surface Temperature: 2006/08/18 (~8 AM) - Pole, North



MW + IR OI Sea Surface Temperature: 2006/08/18 (~8 AM) - Pole, South



clouds



Mean Bias/STD

- 2006 days 105-200

Data from Latitudes: 40S – 40N

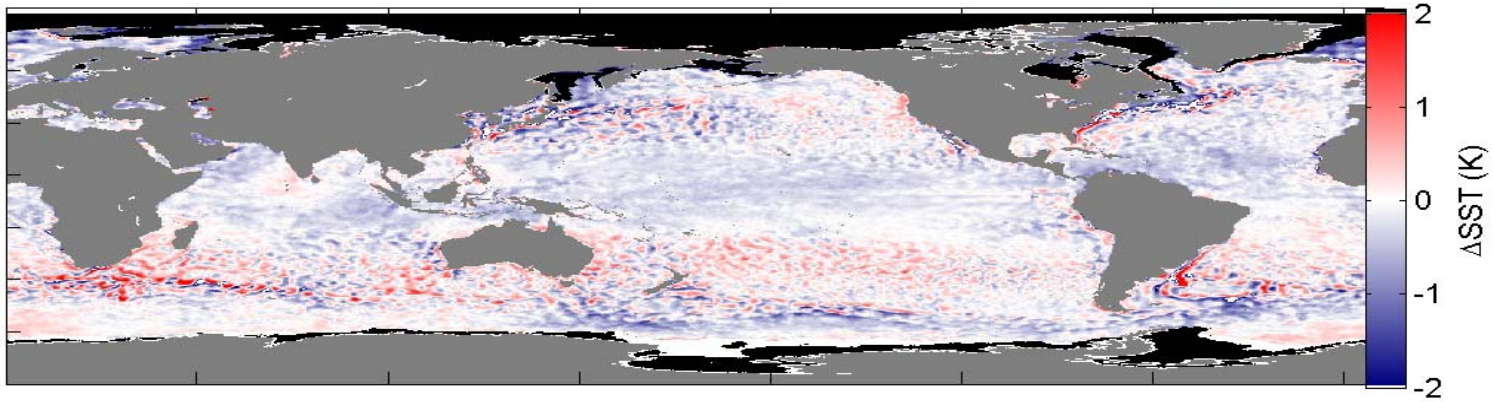
OI SST	Bias (C)	STD (C)	# Collocations	Dates included
TMI	0.12	0.59	198,622,601	6/2002-2/2004
AMSR-E	-0.03	0.53	202,317,843	6/2002-2/2004
TMI+AMSR-E	0.01	0.56	196,485,267	6/2002-2/2004
TMI+AMSR-E+MODIS	-0.12	0.58	18,292,093	4/15/2006-6/11/2006

Data from Latitudes: 90S – 90N

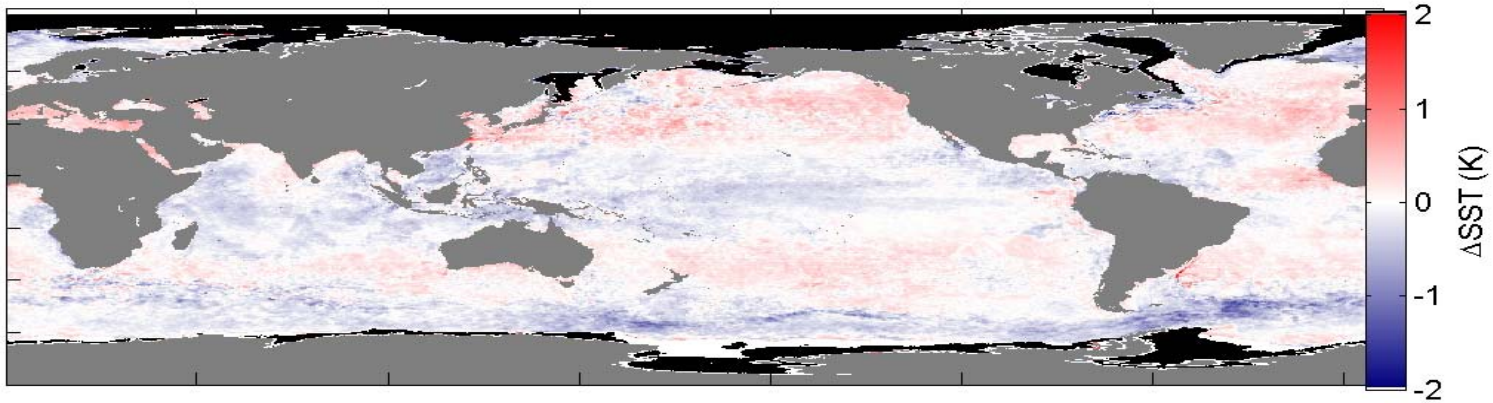
OI SST	Bias (C)	STD (C)	# Collocations	Dates included
TMI				
AMSR-E	-0.02	0.64	313,865,230	6/2002-2/2004
TMI+AMSR-E	0.01	0.65	319,671,057	6/2002-2/2004
TMI+AMSR-E+MODIS	-0.13	0.65	25,913,770	4/15/2006-6/11/2006

Mean difference

MWIR -Reynolds



MWIR - K10



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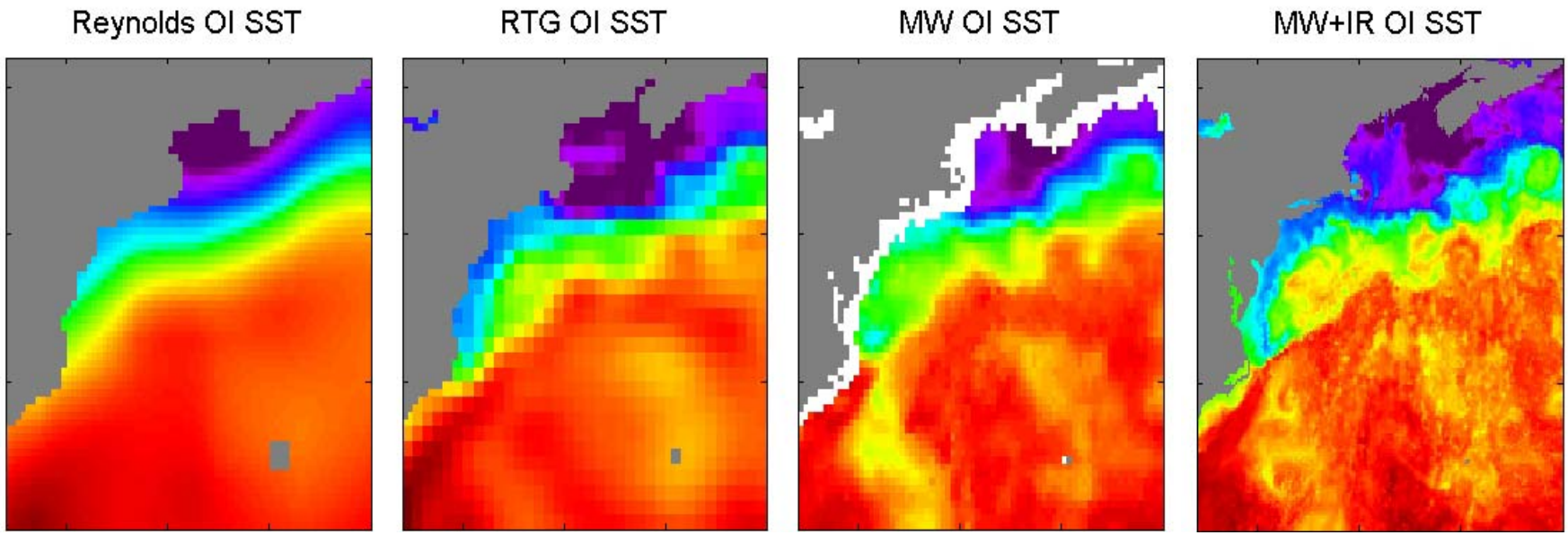
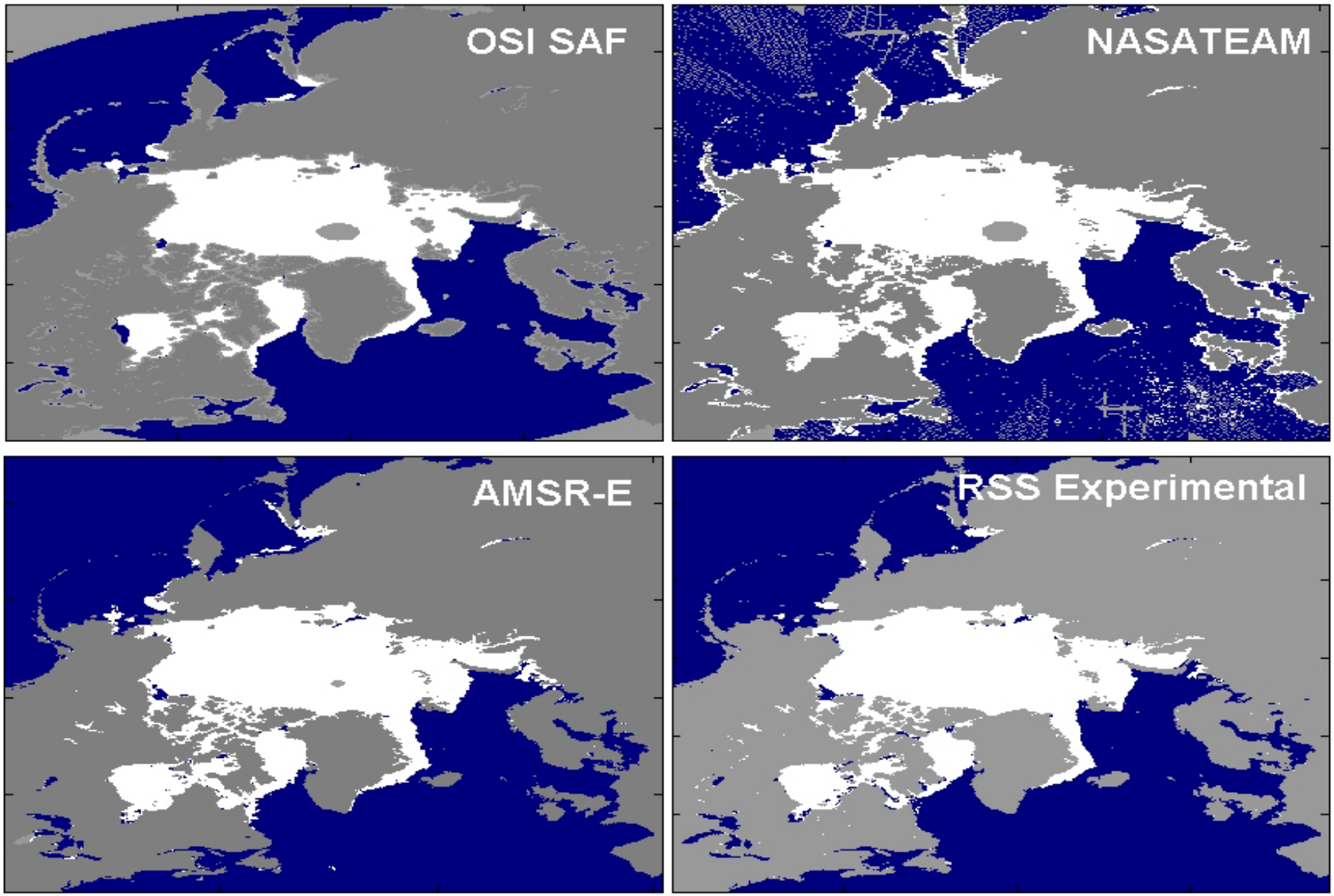
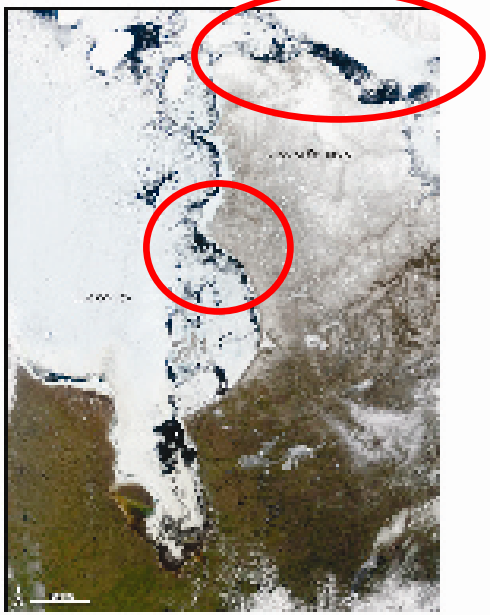
- Thank you!
- Occasional clouds sneak into analyzed product, continued development of diurnal warming model and sea ice algorithm --- feedback appreciated!




OSI SAF
NASATEAM
AMSR-E
RSS Experimental

Sea ice in Hudson Bay May 21, 2005



MODIS imagery, AMSR-E

RSS exp