

sst_cci



University of
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Met Office



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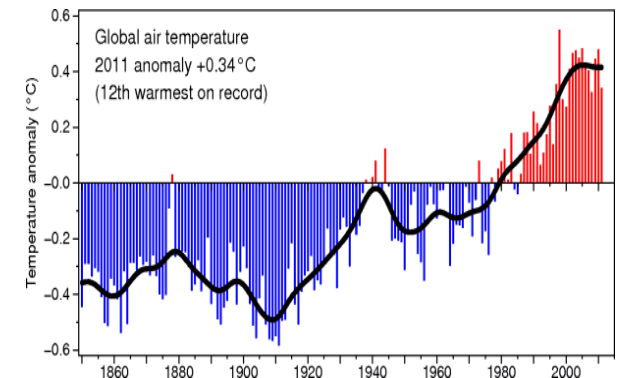
Chris Merchant
The University of Edinburgh

SCIENTIFIC CHALLENGES RELATED TO SST

Raising profile and increasing exploitation



- **ARC v1.1 SSTs at 0.1° resolution, 1991 – 2012**
 - **Precursor of SST CCI products to come:**
 - SST CCI products will be 0.05° resolution
 - SST CCI products will have partitioned uncertainty information
 - SST CCI products will have better sampling via AVHRR
 - **Generate business for SST CCI by encouraging advanced take up of ARC v1.1**
- **Opportunities**
 - **Climate time series**
 - Evaluate cf. in situ climate data records
 - Paper in preparation
 - Integrate into historical SST
 - ARC v1.1 in HadISST2 (ERAClim, Sep)
 - Proposal under review



Raising profile and increasing exploitation



- **Opportunities contd.**
 - **Climate model evaluation**
 - CMIP5 format ESG, likely NCEO supported
 - Promote to modellers use of new uncertainty information
 - **Data assimilation**
 - Contributing to coupled DA project, exploiting uncertainties and diurnal variability aspects



**National Centre for
Earth Observation**

NATURAL ENVIRONMENT RESEARCH COUNCIL

Refined insight into SST



- **Don't underestimate importance of first independent SST CDR from space**

"Agreement of two independent measurements, preferably based on different measurement principles, provides a high degree of confidence that no significant systematic effect was disregarded and uncertainties were not underestimated."

Immler et al, 2010

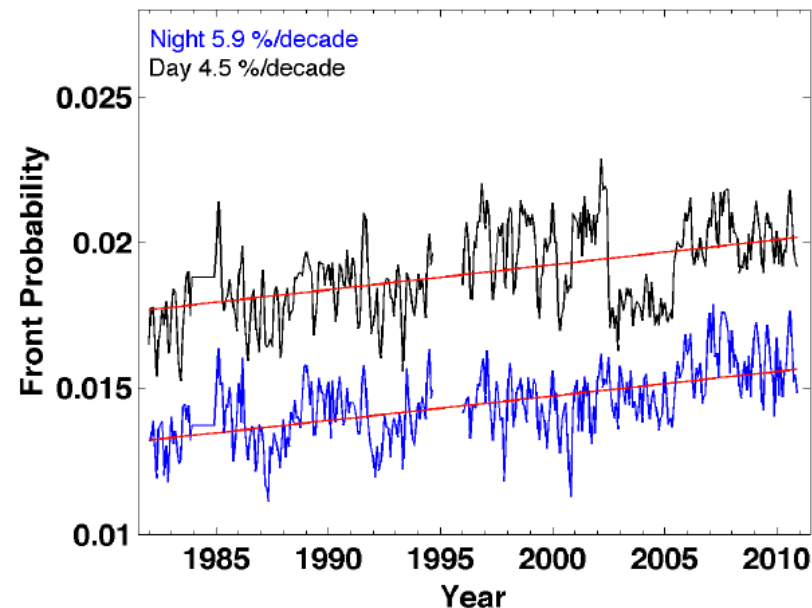
- **Arctic Ocean, SST responses to sea ice loss**
 - **EarthTemp Network 2nd meeting, 2013**
- **SST trends and variability in near ice sheet margins?**
- **Fronts and gradients, long term trends**

Example: is this true?



- **Analysis of SST fronts in AVHRR Pathfinder observations suggests the probability of fronts has increased**

Analysis Fronts
Trend in Front Probability (45°N to 45°S)



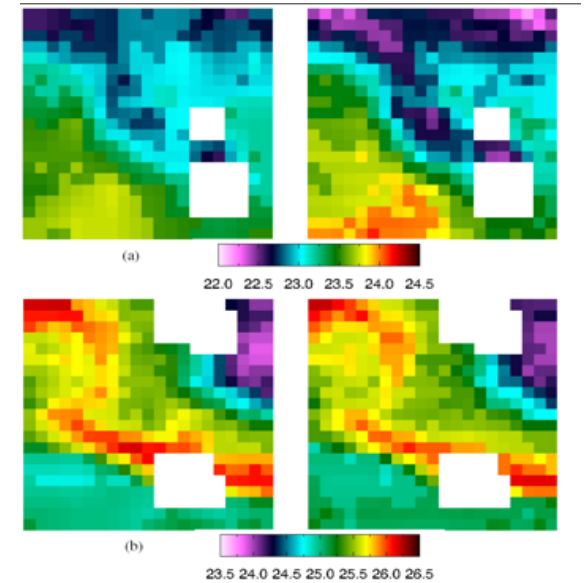
Courtesy of P Cornillon
from Liege Colloq 2012 keynote

- **But is the Pathfinder data set stable enough?**

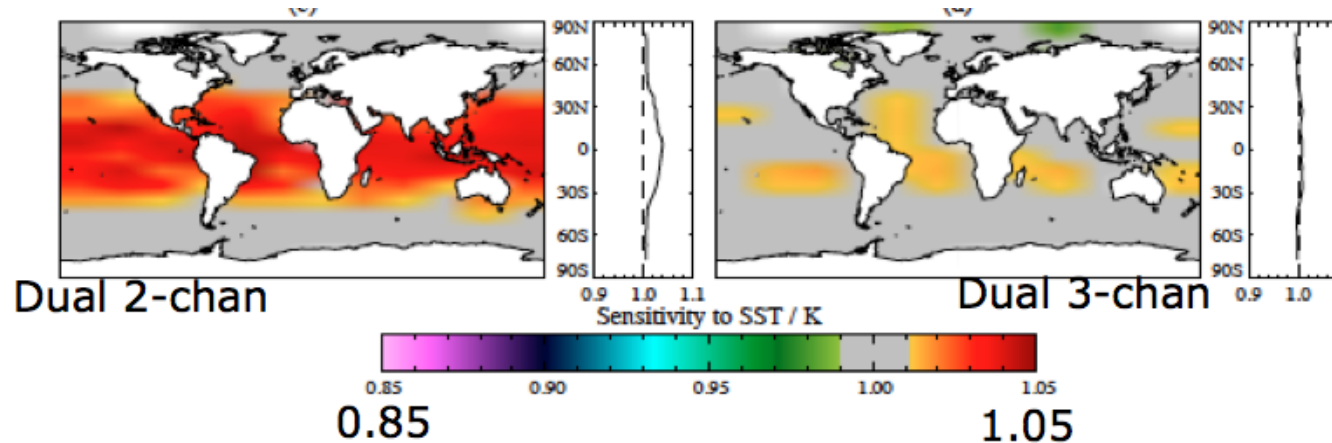
Climate-quality SST & higher order products

Differential sensitivity between retrieval algorithms across thermal structures reveals the problem of biased estimates of local gradient strengths

But the high $dSST_{\text{retrieved}}/dSST_{\text{true}}$ designed into SST CCI products addresses fidelity of small-scale structure



2 channel : 3 channel (AVHRR example)



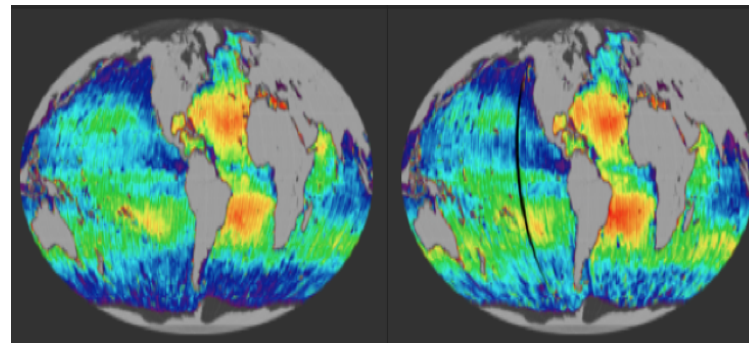
Merchant et al, 2009, GRL
doi:10.1029/2009GL039843

SST in the Earth system



- **Global ocean dynamics**

- Demands “higher order” SST products
- SSH, ocean colour ... ocean winds, salinity
- SST in support of salinity observations



Biases exist between
6 am and 6 pm
salinity from Aquarius

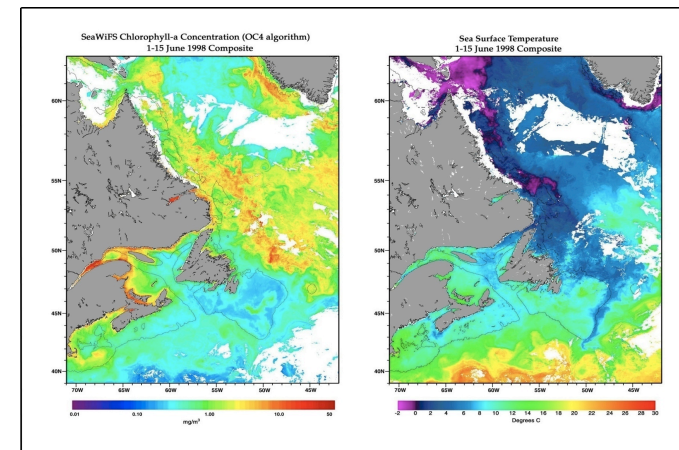
courtesy Gary Lagerloef

- **Marine ecology**

- SST and Chl complementarity

- **Global ocean heat content**

- Sea level / SSH
- Cryosphere mass balance



courtesy of Trevor Platt

Challenges for SST CDR (Ph 2)



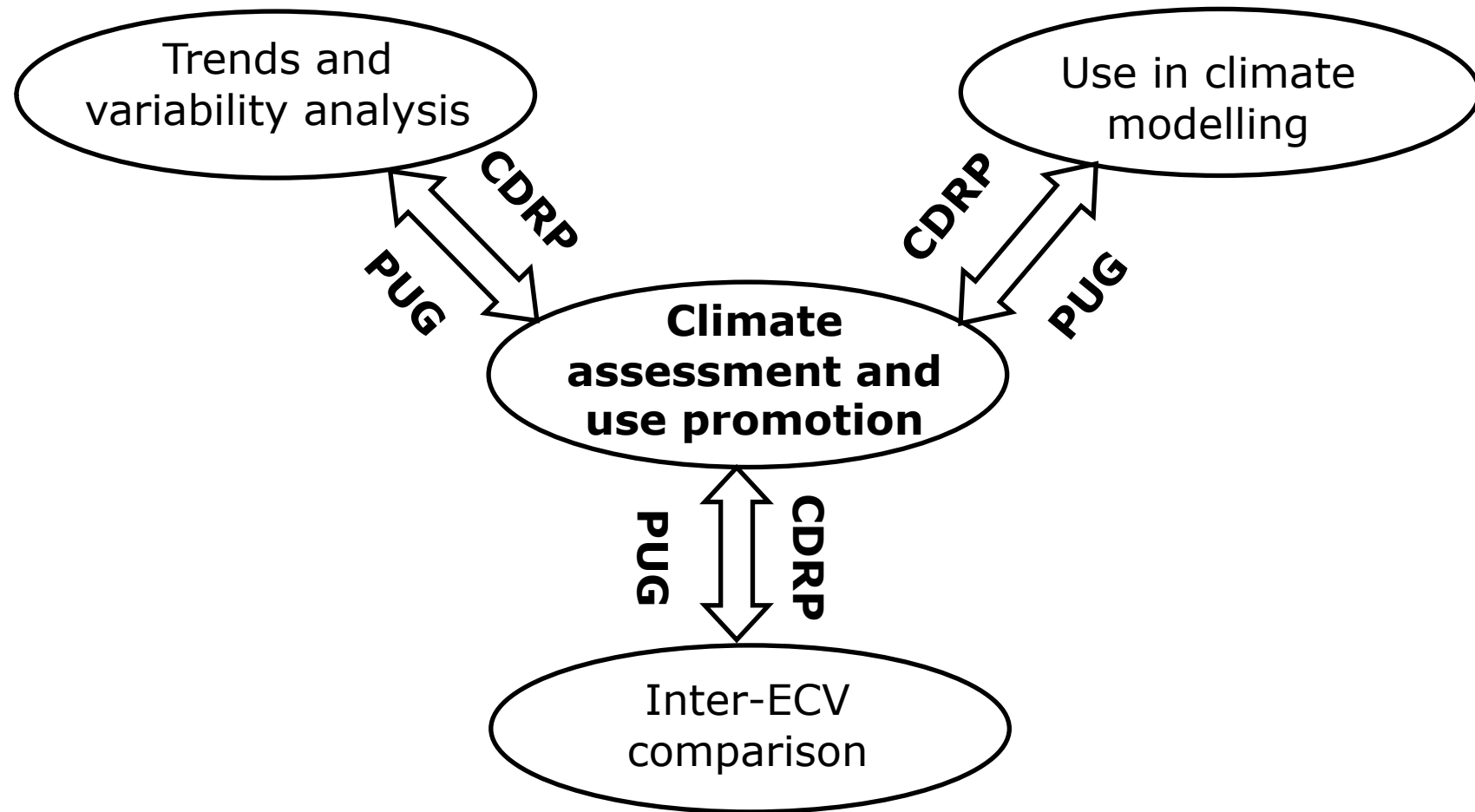
- **Extend record back to 1979**
 - AVHRR-only, maintaining independence
 - New techniques for homogeneity / stability
- **Bridge AATSR to SLSTR**
 - Minimum gap duration 2 years
 - Too long to assume stability for Metop-A
 - Need to exploit AVHRR/IASI for stability, Metop A & B
- **Diurnal variability analysis / local time specific**
 - Go beyond our adjustment model?
- **Stability in presence of stratospheric aerosol**
 - Using only single view

Project response

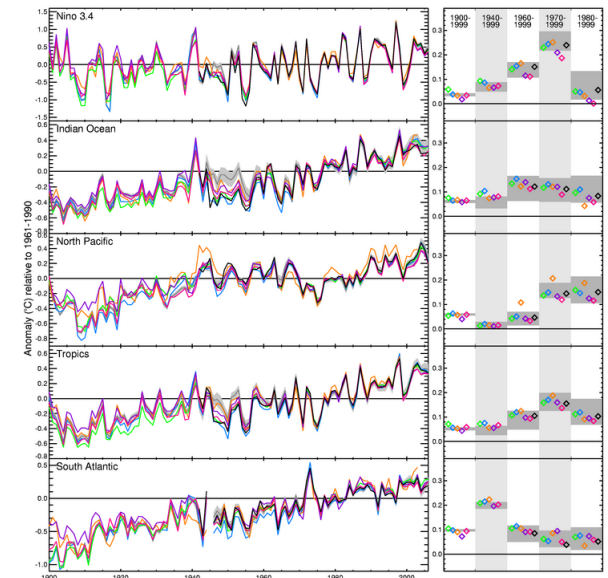
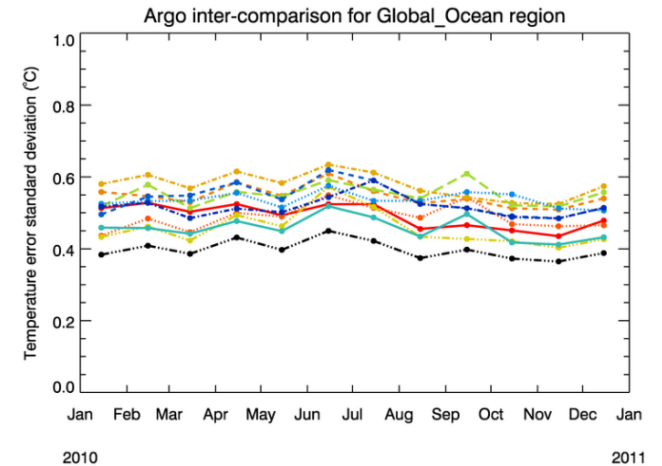
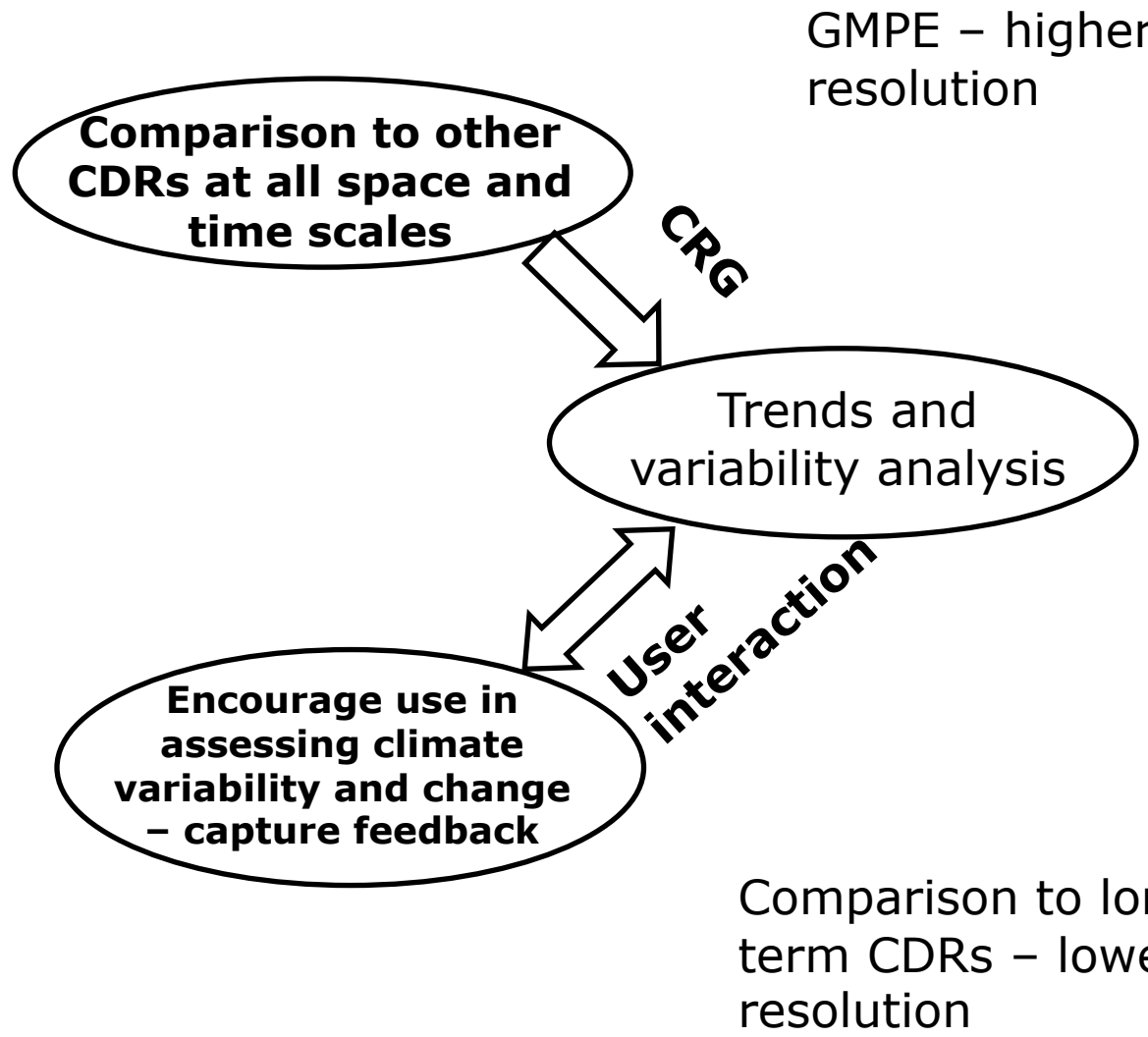


- **Seeking involvement in national and European projects where SST CCI products explicitly will be exploited**
- **Established collaboration / complementarity**
 - Coupled DA (NCEO-led consortium)
 - Fronts analysis of ARC v1.1 (Cornillon)
 - Reference data set improvement in ERA-Clim → SST CCI
 - ARC v1.1 & SST CCI products → HadISST2 within ERA-Clim
- **Expected (TBC)**
 - CMIP / ESG versions of ARC v1.1
- **SST CCI CRG**

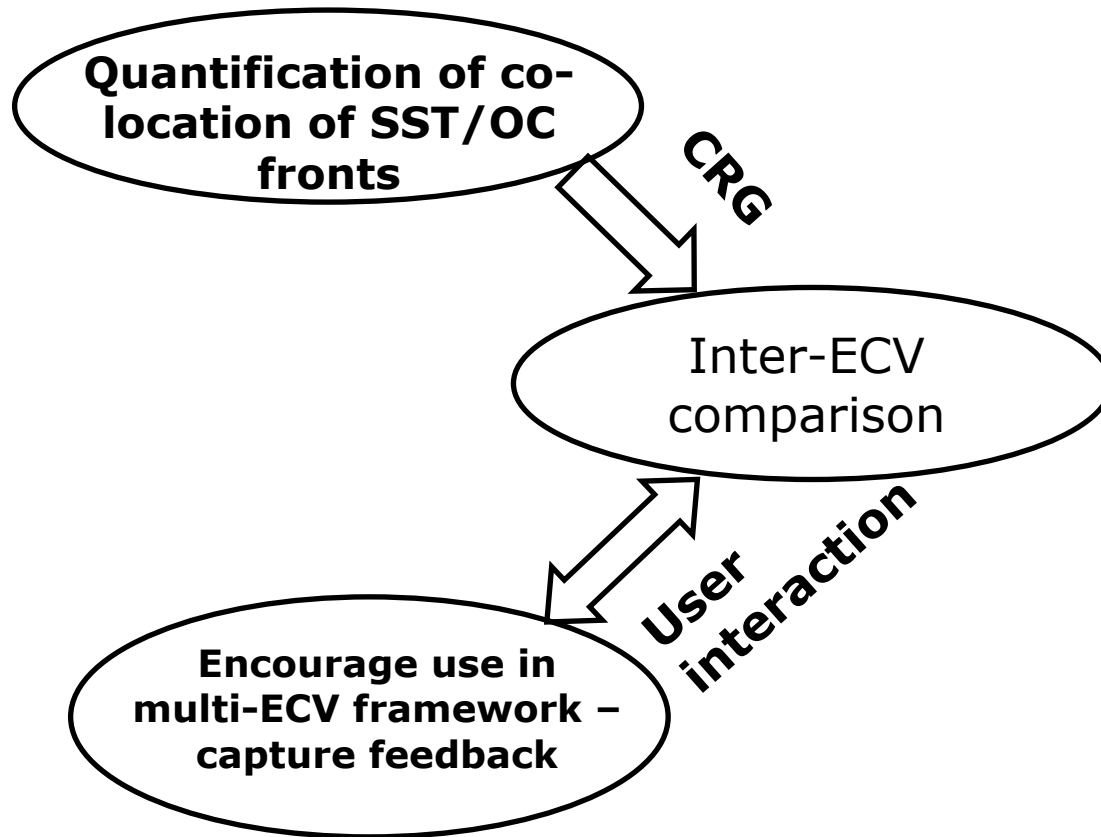
Climate assessment



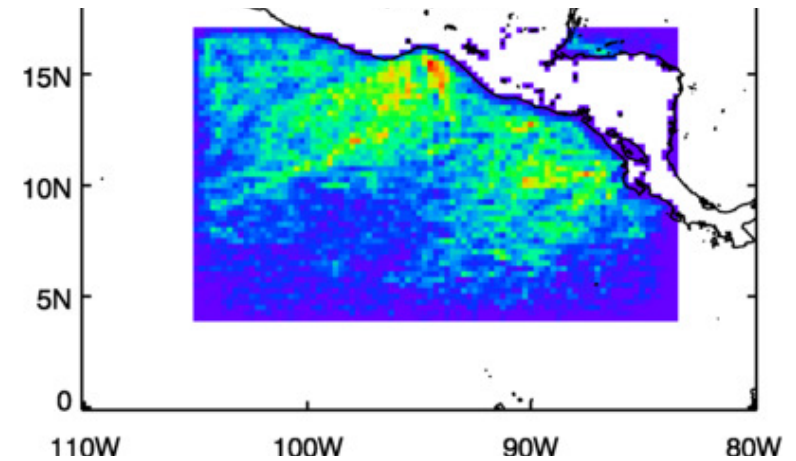
Climate assessment



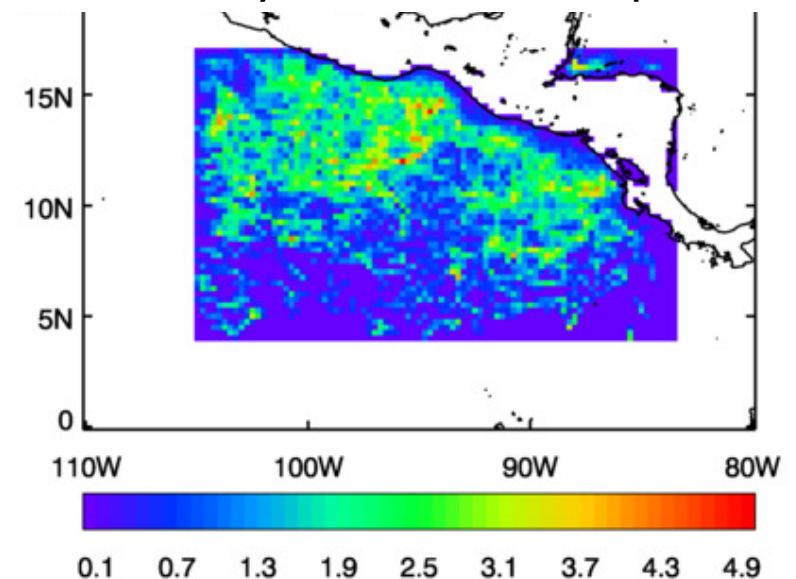
Climate assessment



Probability of SST front per $1/4^\circ$

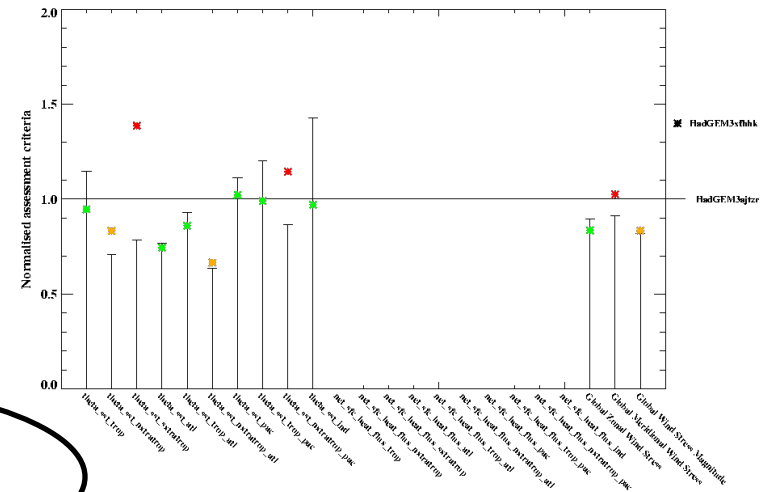
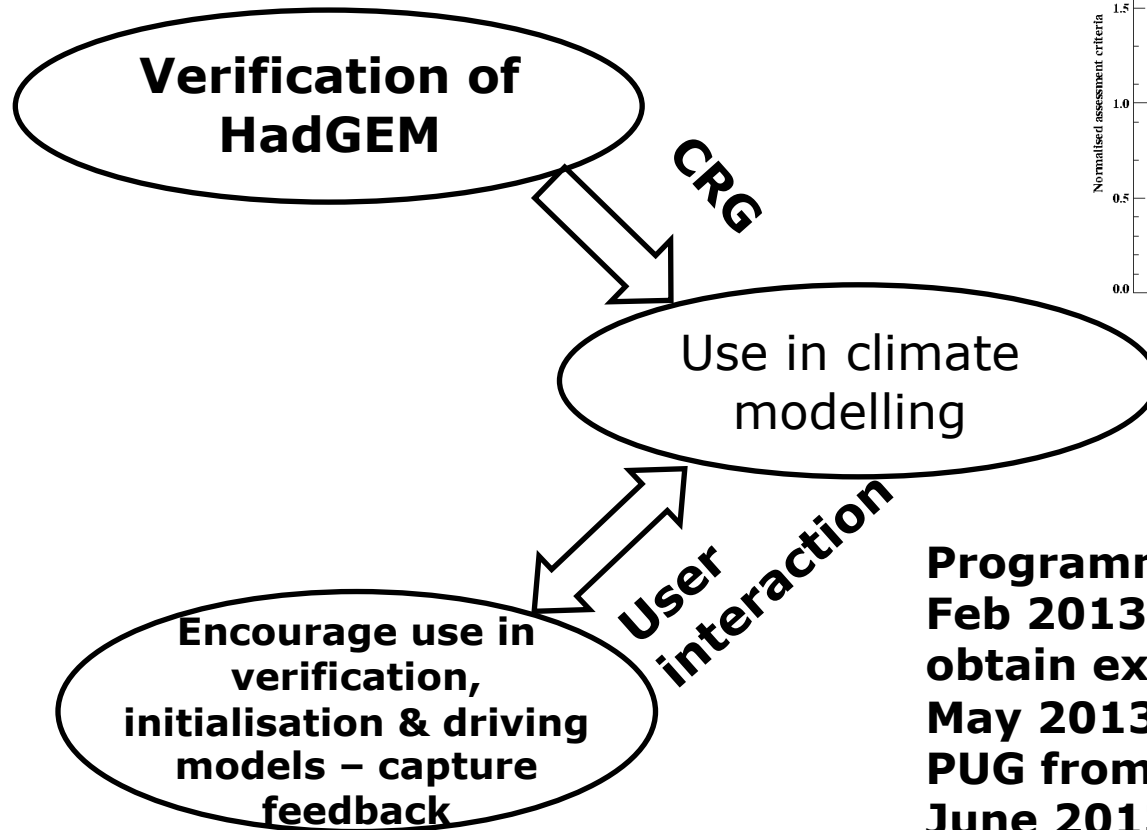


Probability of chl-a front per $1/4^\circ$



Images courtesy of Rob Smith

Climate assessment



Example climate model assessment diagram.

- Programme of user interaction:**
- Feb 2013:** confirm timescales and obtain expressions of interest
 - May 2013:** obtain comments on draft of PUG from selected users
 - June 2013:** CDRP release
 - July 2013:** obtain firm commitments to provide feedback
 - Sept 2013:** obtain contributions to CAR

PROJECT SUCCESSES

Multi-sensor Match-up Data (MMD)



- **Completed data set since last collocation**
- **Realizes a long-recognized science need for supporting multi-sensor SST developments**
- **Uses:**
 - **Radiative transfer model testing and tuning**
 - **SST retrieval algorithm development**
 - **Image classification development**
 - **Diurnal/skin model testing and selection**
 - **Uncertainty estimate validation**
 - **Round robin exercise (training, testing and selection)**
 - **Inter-sensor consistency / homogenization**
 - **SST stability assessment**
 - **SST CCI product verification and independent validation**

Round Robin



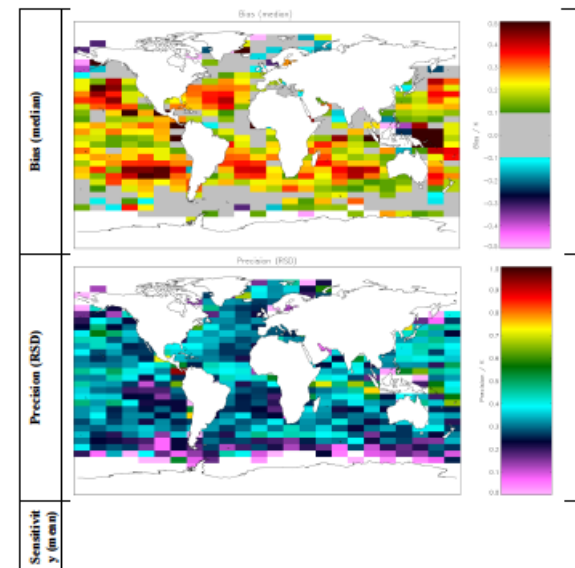
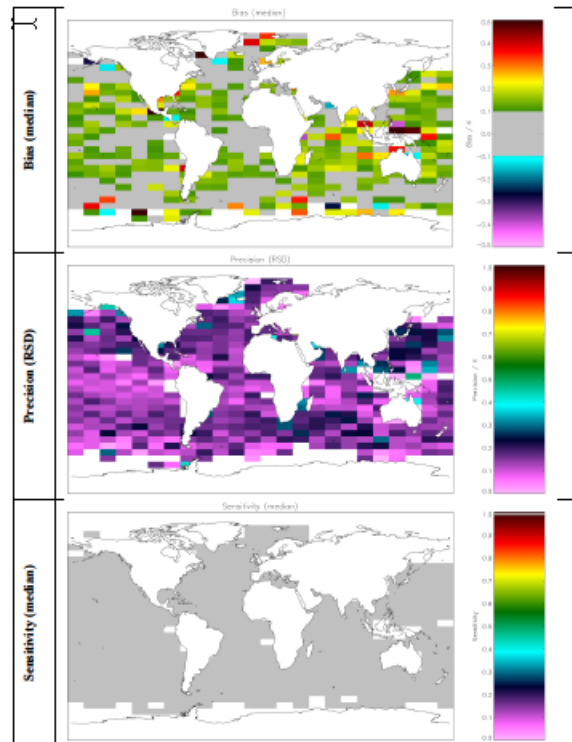
- **Rigorous, blind comparison on pre-defined metrics**
- **Separate training and testing subsets provided**
- **“Blind” selection subset submitted by all teams**
- **“Competitor” submissions from NOAA and RAL**

Candidate
algorithm 1

Bias

Precision

Sensitivity



Candidate
algorithm 2

Bias

Precision

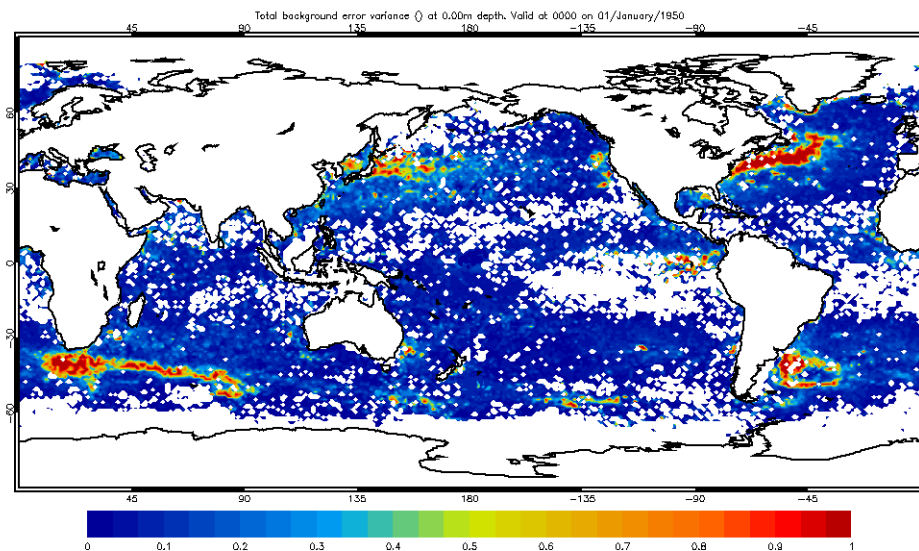
Sensitivity

Algorithm developments

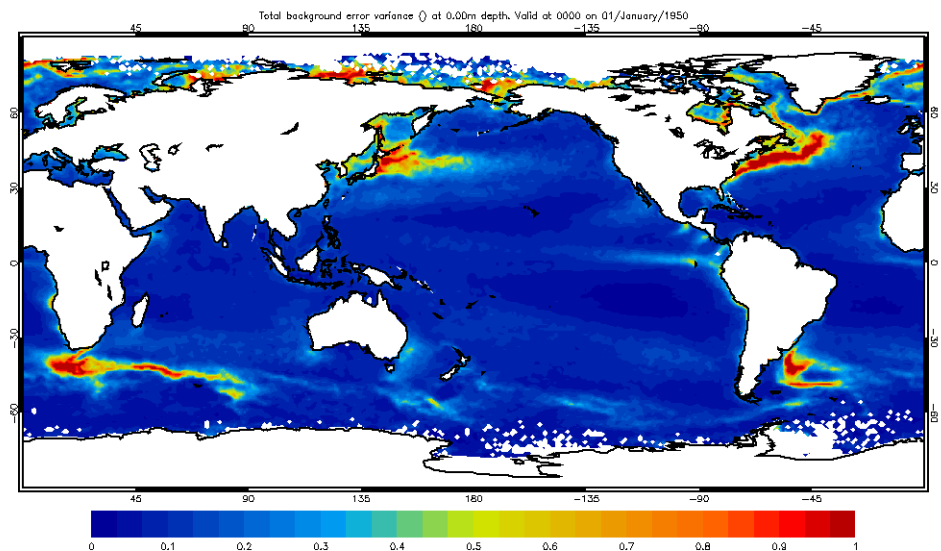


- **Optimal estimator for SST from AVHRRs**
- **Quantified difference of day and night skin effect**
- **Bayesian clear / cloud / sea-ice with skill at night**
- **AATSR data exploited to calculate improved analysis parameters for L4 SST (OSTIA)**

Drifter background error variance



AATSR-based background error var.



EXPECTED PROJECT OUTCOMES

Category of product and description	Satellite sensors & data to be used	Level of data to be produced for each sensor (resolution/grid spacing)	
<p>Long term ECV.</p> <p>A long term, stable data record formed from data from the ATSR and AVHRR series of instruments. Will cover the period Aug 1991 to Dec 2010.</p>	<p>ATSR series (ATSR-1, ATSR-2, AATSR); Envisat format</p>	<p>L3U (0.05°)</p>	<p>L4 (0.05°)</p>
	<p>AVHRR series global area coverage (GAC) data</p>	<p>L2P (variable, ≥4 km)</p>	
<p>Demonstration ECV.</p> <p>A product that will demonstrate what can be achieved using a broader sample of the SST satellite observing system. To be produced for a six month demonstration period only in CCI Phase One.</p>	<p>AATSR (Envisat format)</p>	<p>L2P (1 km)</p>	<p>L4 (0.05°)</p>
	<p>AVHRR from Metop-A (internal gridded format)</p>	<p>L3C (0.05°), L4 (0.05°)</p>	
	<p>SEVIRI (L3C)</p>	<p>L3C (0.05°)</p>	
	<p>AMSR-E (L2P)</p>	<p>L2P (0.25°)</p>	
	<p>TMI (L2P)</p>	<p>L2P (0.25°)</p>	

Demonstration products changed

- **AMSR-E failure just prior to start of intended demo period**
- **New strategy:**
 - **Do two 3 month demo periods:**
 - **AMSRE + TMI + AVHRR GAC + AATSR L3C for Jun - Aug 2007**
 - **AATSR L2P + Metop + SEVIRI for 3 months in early 2012**
- **As well as demonstrating capability, the first of these three month demos will allow clean scientific assessment of impact of PMW in addition to long-term IR sensors**
 - **Improved coverage, yes ...**
 - **... but what about stability of the record?**

User Requirements / Expected



- Skin SST retrievals and buoy-depth SST estimates
 - This is what SST CCI will deliver
- 3 hourly analyses at 10 km resolution or better
 - SST CCI will deliver **daily** at 0.05 deg
 - Fundamental research for sub-daily analyses proposed as option
- Bias: 0.01 K over 100 km scales (URD target)
 - SST CCI target is to demonstrate 0.1 K over 1000 km scales
- Stability 0.01 K, per decade, seasonally, diurnally
 - Our aim is 0.05 K, ARC v1.1 apparently meets this
- Mix of L4 (analyses), L3 (regridded) and L2 (native)
- SST records longer than 30 years (breakthrough)
 - Phase 1 will cover 1991 – 2010

	PATHFINDER	ARC	CCI SST
Sensors	AVHRR	ATSR	AVHRR + ATSR
Tied to	Buoys	Independent	Independent
Homogenized	No	Yes	Yes
Accounting for diurnal effects	No	Yes	Yes
Meets GCOS accuracy (0.25 K)	Mostly	Yes	Yes
Meets new GCOS accuracy (0.1 K)	No	Mostly	Yes/mostly
Meets GCOS stability	No	Yes	Yes/likely
Stability quantified	No	Yes	Yes
Clearly defined SST	No	SST-skin, depth	SST-skin, depth

SST CCI products will be daily 0.05°, due 2013

Meanwhile: ARC v1.1 from www.neodc.rl.ac.uk