An Improved High-Resolution Sea Surface Temperature Climatology to Assess Cold Events in the Florida Keys

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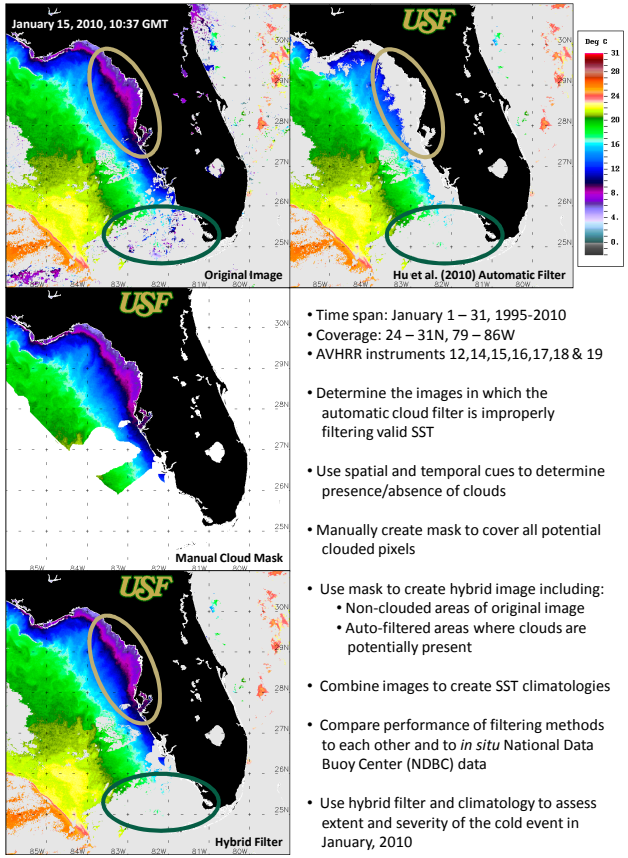
ABSTRACT

A cloud filter developed by Hu et al. (2009) for high-resolution Advanced Very High Resolution Radiometer (AVHRR) Sea Surface Temperature (SST), based on the short- and long-term SST variability was tested during anomalous temperature events. Raw images were re-processed using autonomous cloud filtering and manual delineation. As such, it was determined that the Hu et al. filter underperformed in nearly 20% of images. Improved SST climatologies indicate anomalies of up to 12° C during the cold event in January, 2010, especially in the Florida Bay region, with high spatial heterogeneity throughout. By enhancing the high-resolution SST climatology, this study highlights the need for improved autonomous cloud-masking techniques.

IMPETUS & METHODS

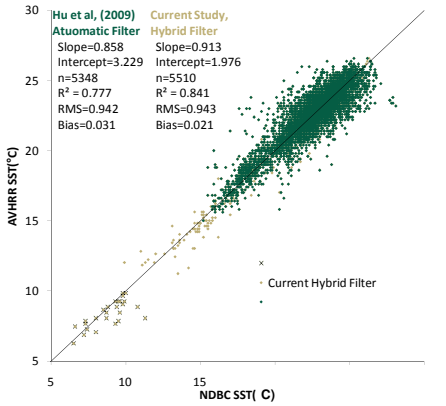


- Time span: January 1 – 31, 1995-2010
- Coverage: 24 – 31N, 79 – 86W
- AVHRR instruments 12,14,15,16,17,18 & 19
- Determine the images in which the automatic cloud filter is improperly filtering valid SST
- Use spatial and temporal cues to determine presence/absence of clouds
- Manually create mask to cover all potential clouded pixels
- Use mask to create hybrid image including:
  - Non-clouded areas of original image
  - Auto-filtered areas where clouds are potentially present
- Combine images to create SST climatologies
- Compare performance of filtering methods to each other and to *in situ* National Data Buoy Center (NDBC) data
- Use hybrid filter and climatology to assess extent and severity of the cold event in January, 2010

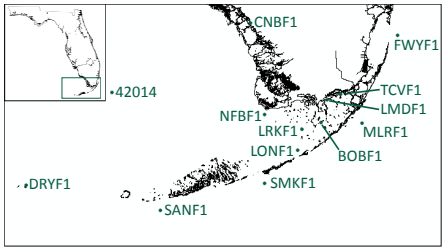
RESULTS

- Of 2,703 images, 489 (18.4%) required reprocessing
- Automatic filter improperly masked warm and cold valid SST data
- Largest differences between climatologies seen in shallow environments, especially Florida Bay/Thousand Islands region
- When regressed with matched *in situ* NDBC data, hybrid filter improves coverage range and error estimates

VALIDATION



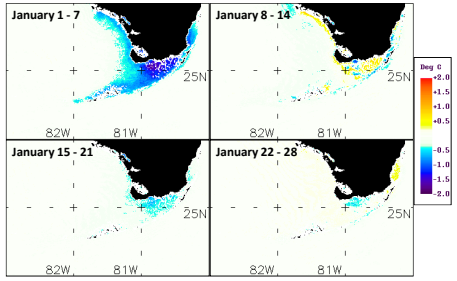
NDBC stations used for AVHRR validation



Station ID	Area	Latitude	Longitude	NDBC Records (yr)	AVHRR Records (#)	# Matched AVHRR/NDBC
42014	SW of Naples, FL	25.254 N	82.220 W	2004-2008	1465	247
BOBF1	Bob Allen, FL	25.024 N	80.682 W	2009-2010	818	54
CNBF1	Cannon Bay, FL	25.700 N	81.186 W	2009-2010	385	14
DRYF1	Dry Tortugas, FL	24.638 N	82.862 W	1992-2005	1179	599
FWYF1	Fowey Rocks, FL	25.590 N	80.097 W	1991-2010	947	936
LMDF1	Little Madeira, FL	25.174 N	80.632 W	2009-2010	565	23
LONF1	Long Key, FL	24.843 N	80.862 W	1992-2010	1032	862
LRKF1	Little Rabbit Key, FL	24.979 N	80.826 W	2009-2010	908	52
MLRF1	Molasses Reef, FL	25.010 N	80.380 W	1987-2010	1006	997
NFBF1	Northwest Florida Bay, FL	25.084 N	81.096 W	2004	1219	203
SANF1	Sand Key, FL	24.460 N	81.880 W	2005	1263	692
SMKF1	Sombrero Key, FL	24.627 N	81.110 W	2005-2009	1168	827
TCVF1	Trout Cove, FL	25.209 N	80.533 W	2009-2010	1037	439

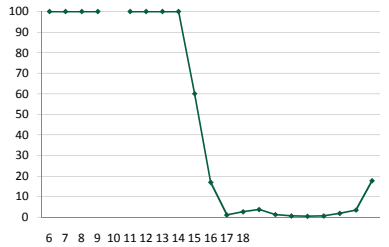
CLIMATOLOGY DIFFERENCE

Difference = current hybrid climatology – Hu et al. (2010) climatology



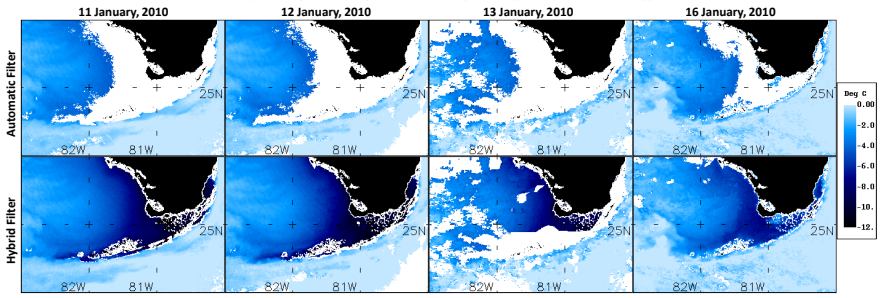
TEMPERATURE COVERAGE

Increase in Data Capture using Hybrid Filter



COLD EVENT PERFORMANCE

Anomaly = daily SST composite – corresponding filtered climatology



DISCUSSION

- Climatology based filter underperformed in nearly 1 of 5 images
- Most improperly filtered data within ~20 m isobath
- Thin clouds especially difficult to detect and appropriately mask
- Hybrid method improves range and performance of cloud filter, but is impractical for widespread implementation
- Improved climatology shows extreme (up to 12 C) SST anomaly during January 2010 cold event
  - Minimum temperatures (~4 C) well below stress & mortality thresholds for corals, sea turtles, manatees, seagrasses, mangroves, fishes and others
  - 11 day duration of improper cloud filtering (Jan 6 - 16)
- High spatial SST heterogeneity throughout study region
- Improved autonomous filter likely requires integration of AVHRR data with expanded network of *in situ* stations reporting in near real-time
- 'Skin' temperature may not be biologically relevant at depth

RELEVANT LITERATURE & ACKNOWLEGEMENTS

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