Why summer DOISST is warm in the Arctic and how to fix it

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Introduction

The 1/4° Daily Optimum Interpolation Sea Surface Temperature (DOISST) is a widely-used global analysis produced by NOAA's National Centers for Environmental Information (Reynolds et al., 2007; Banzon et al., 2016). A recent Arctic-focused comparison of several SST analyses found that DOISST was consistent but had a warm bias relative to UpTempO buoy SSTs (Castro et al., 2016; Fig. 1). Here, the cause of the Arctic warm bias is investigated and traced to methodology intended to compensate for the "pole hole" in the NASA Team ice (and hence proxy SST) data.

Could inputs be biased warm?

There are three inputs to DOISST in the Arctic: a) in situ data, b) satellite data, and c) proxy SSTs computed from ice concentrations (Fig. 2) in the marginal ice zone. Of the three, buoy SSTs were found to be significantly warmer than the DOISST towards the N pole (Fig. 3). Arctic buoys are subject to harsh conditions, often leading to abnormal reports which are not screened out in near-real time (Fig. 4). The DOISST screening procedure was found to be more lax compared to the In Situ SST Quality Monitor (www.star.nesdis.noaa.gov/sod/sst/iquam/). However, an experimental run excluding buoy data above 80°N had minimal impact on resulting DOISST. The next section explains why.

How is DOISST computed in Arctic?

A closer look at the processing code revealed that the area (and data) above 85°N was actually excluded from interpolation procedure. From 1981 to 2004, DOISST uses NASA Team ice concentrations for simulated SSTs, and there is a "pole hole" (Fig. 1) in this dataset, since polar-orbiting satellites cannot pass right over the poles. This hole becomes a data-free band when remapped to the rectangular interpolation grid. Historically, there were hardly any in-situ observations in this region, so there was really no strong basis for an SST estimate. Rather than assume freezing temperatures in the hole, the band was filled by propagating poleward the smoothed SSTs from 85°N. Because the proxy SSTs were not used above 85°N, it was not important how the proxy SST was computed from ice. This method of ignoring data above 85°N and infilling continued to be used even though gap-free NCEP ice analysis is used in DOISST from 2005 onward. By turning off this infilling procedure and allowing the proxy ice to be used, the resulting DOISST became cooler and similar to the proxy ice SSTs (Fig. 5).

Future work

Next steps are to run several years of the DOISST with infilling turned off and validate with quality controlled UpTempO and other Arctic buoys. Screening criteria for in situ data needs to be reviewed. The ice community has proposed some methods for filling of the pole hole, so more improvements in the treatment of the Arctic are planned.

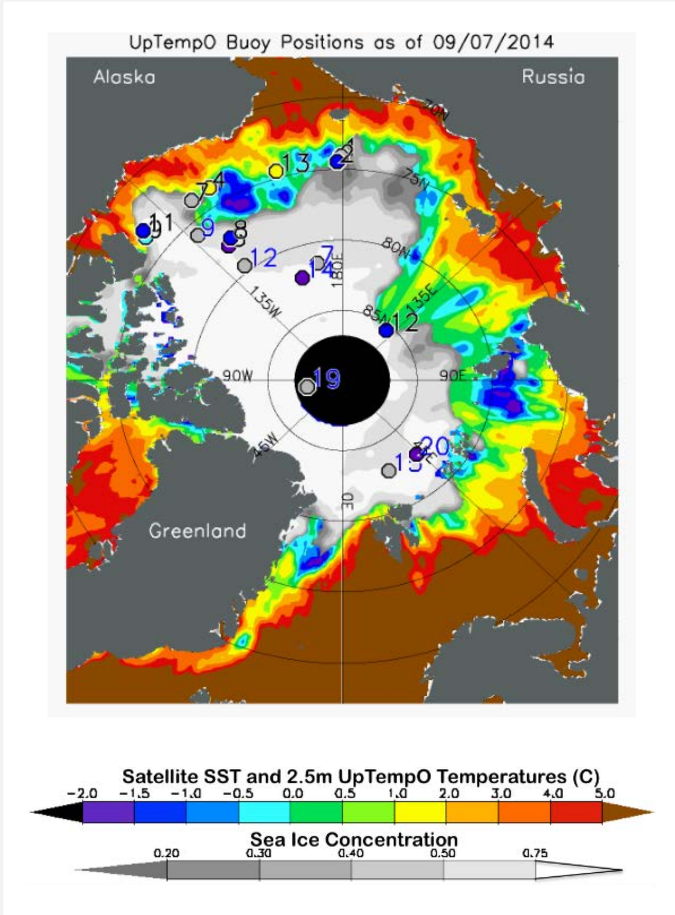

Fig. 1. UptempO buoys (blue circles) have good coverage of the Arctic region. Example shows buoy locations on September 7, 2014. Gray circles indicate surface temperature outside acceptable range. Also shown are NASA Team ice concentration (grayscale) and OISST (color). Black circle in center (also known as the pole hole) is ice data gap due to satellite path. Figure from *http://psc.apl.washington.edu/UpTempO/*. Quality controlled data is available weekly. Flags indicate if the buoy is in water/ice and which sensor is providing the SST.

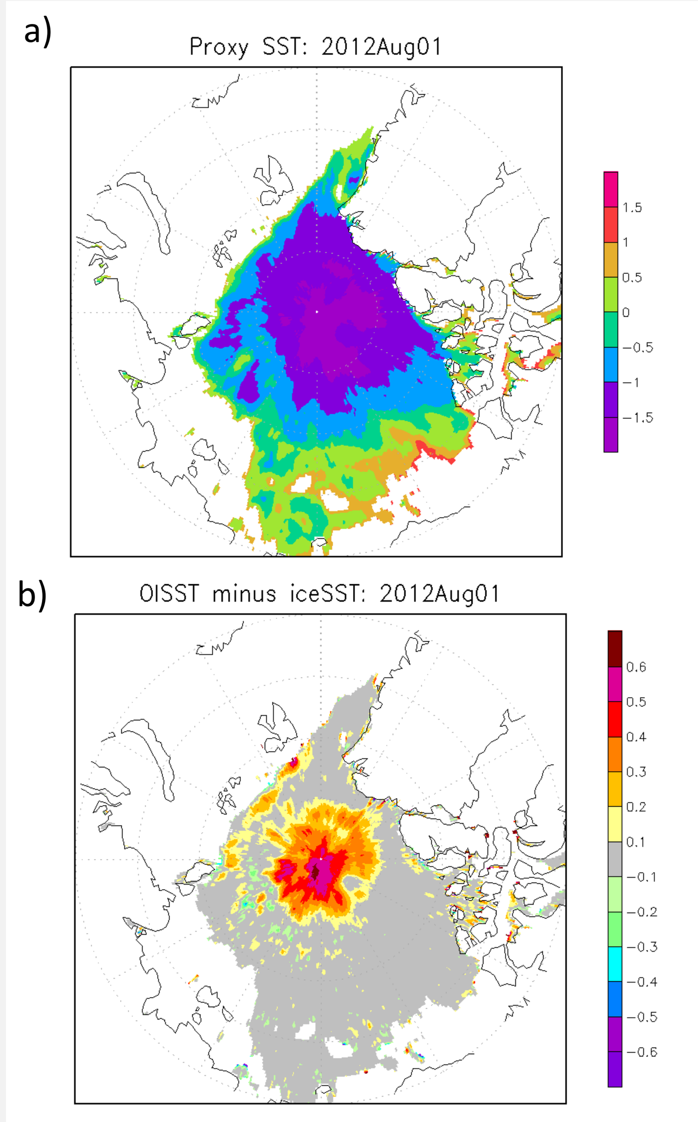

Fig. 2. a) Example of proxy SSTs derived from NCEP ice (used operationally in DOISST from 2005 onward); b) Difference between DOISST and proxy ice shows DOISST is much warmer around 80°N and above.

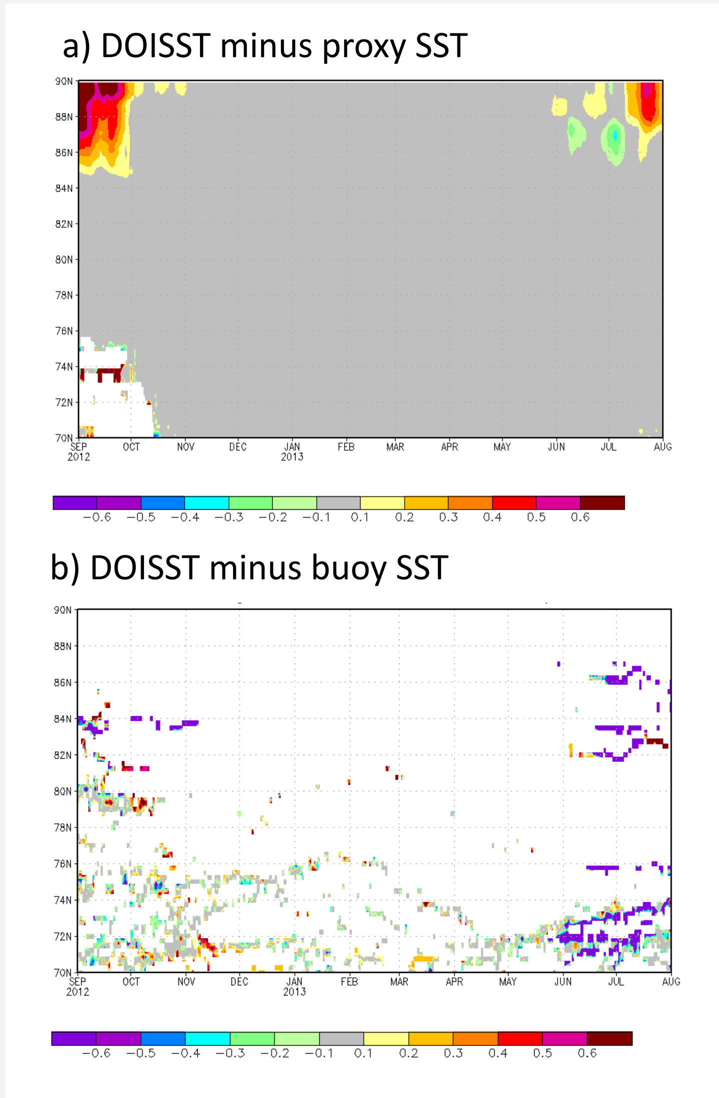

Fig. 3. Hovmöller diagrams for Sep 2012–Aug 2013 shows a) DOISST is consistently warmer than proxy ice SSTs over summer–fall while b) DOISST was cooler than near-real time buoy data. Satellite SSTs (not shown) did not extend to the region above 85°N.

Fig. 4. Example of extreme conditions for ice buoys (round objects). Near-real time data can be screened using statistical tests, but the best option is to obtain the quality controlled post-deployment data from the buoy owner. The Arctic Buoy Program is working on ways to identify when ball buoys are in ice/ocean/air. Photo courtesy of U.S. Interagency Arctic Buoy Program.

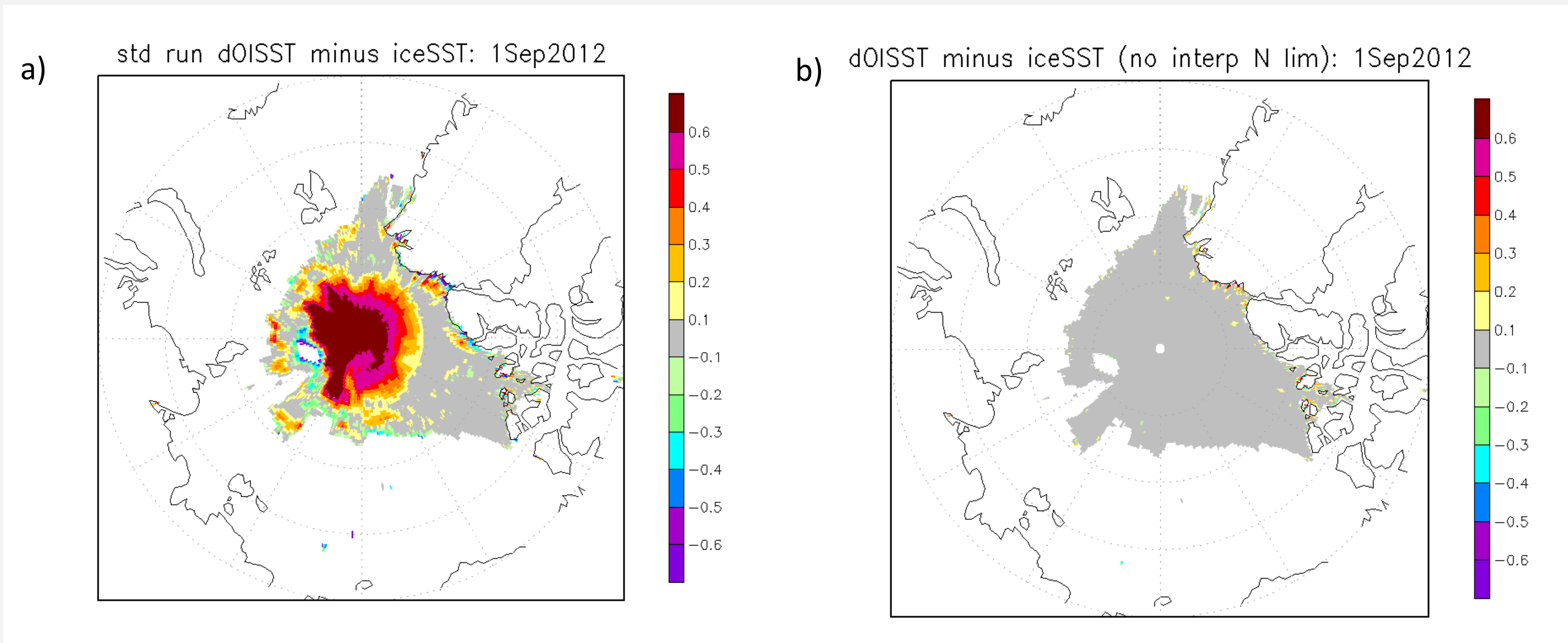

Fig. 5. a) Difference between DOISST and proxy ice SST for 1 Sep 2012 before any code change; b) Difference between experimental DOISST (with infilling turned off) and proxy ice SST.

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