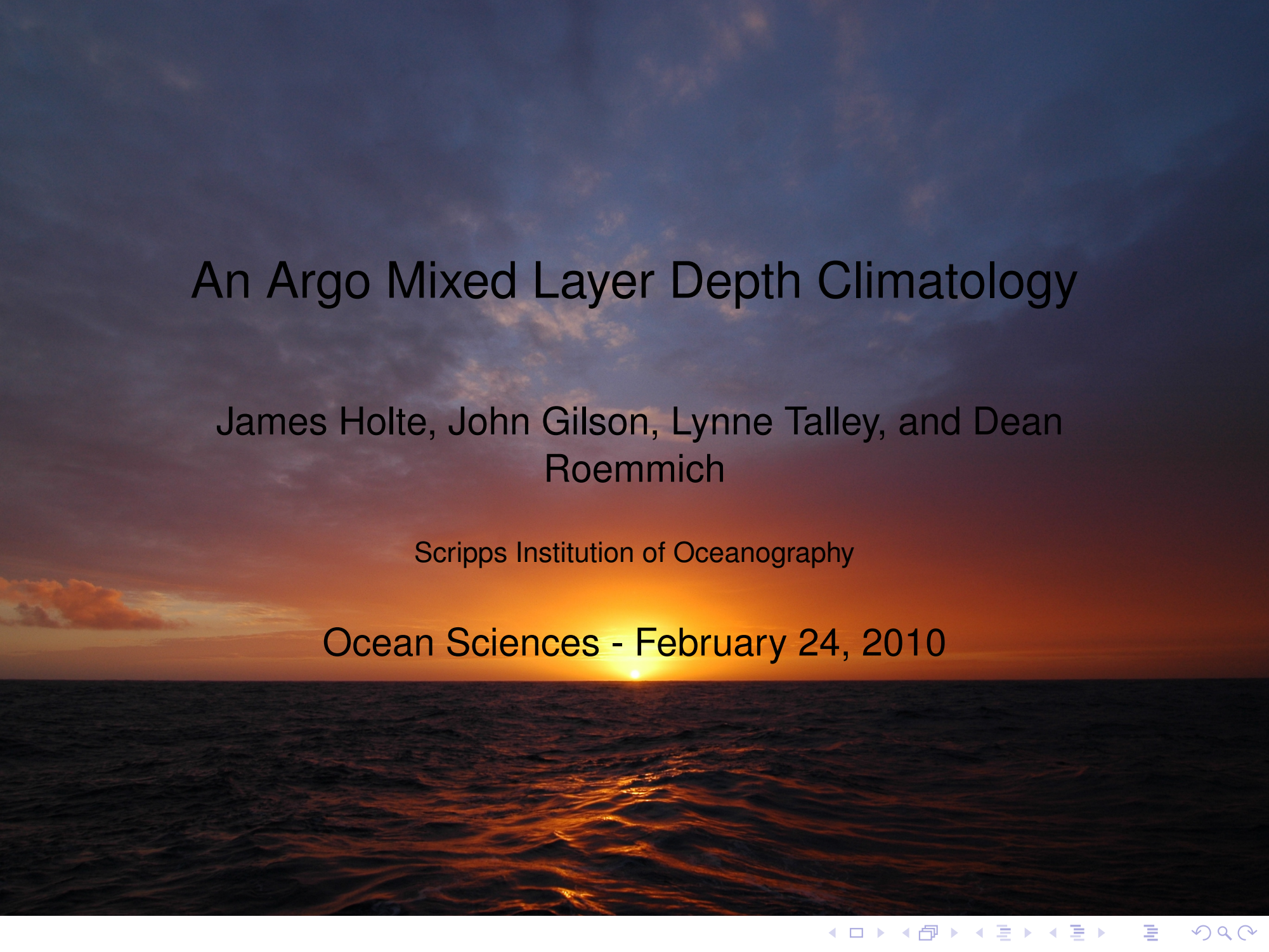

An Argo Mixed Layer Depth Climatology

James Holte, John Gilson, Lynne Talley, and Dean Roemmich

Scripps Institution of Oceanography

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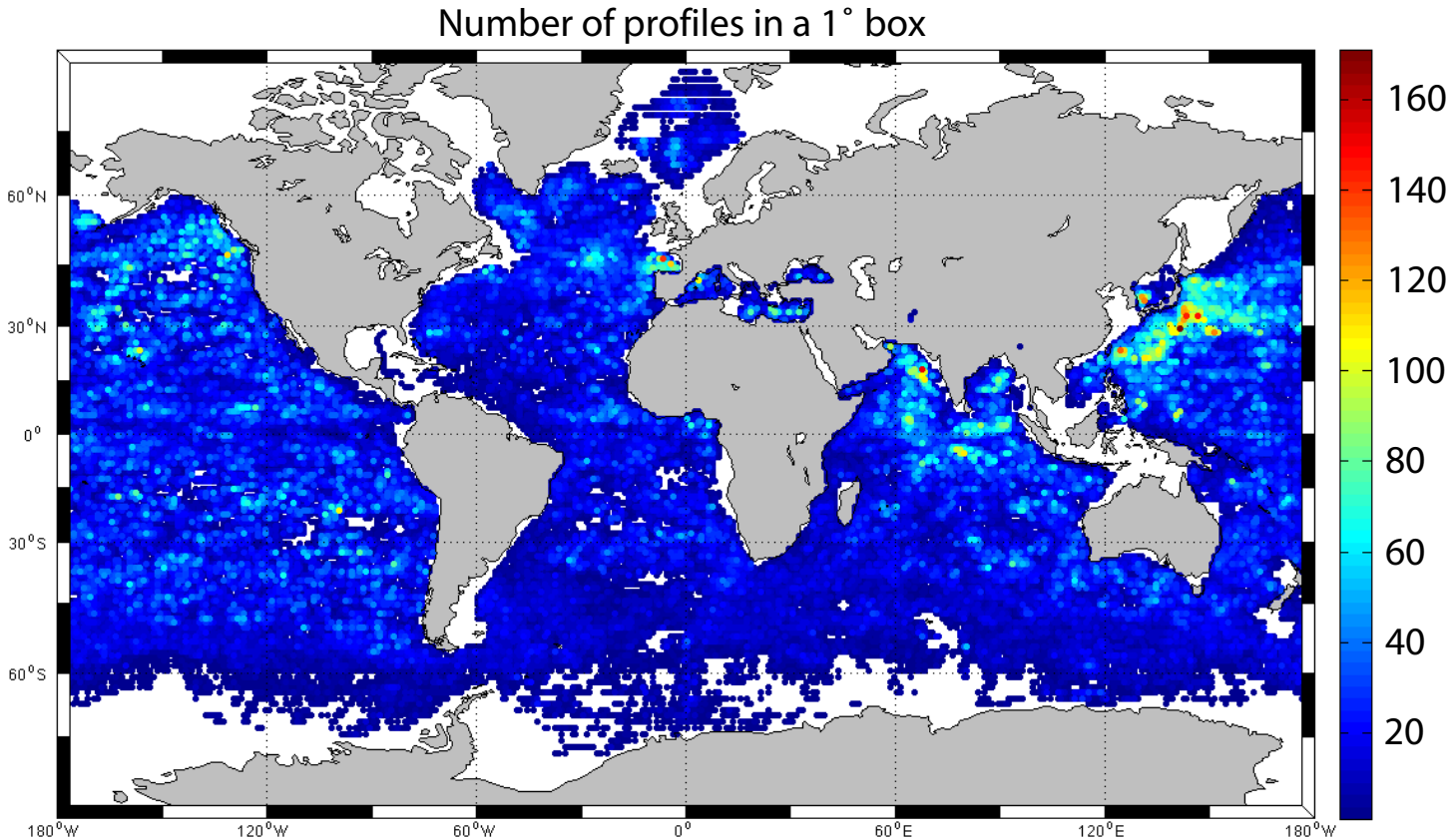
An Argo mixed layer depth climatology

Main points:

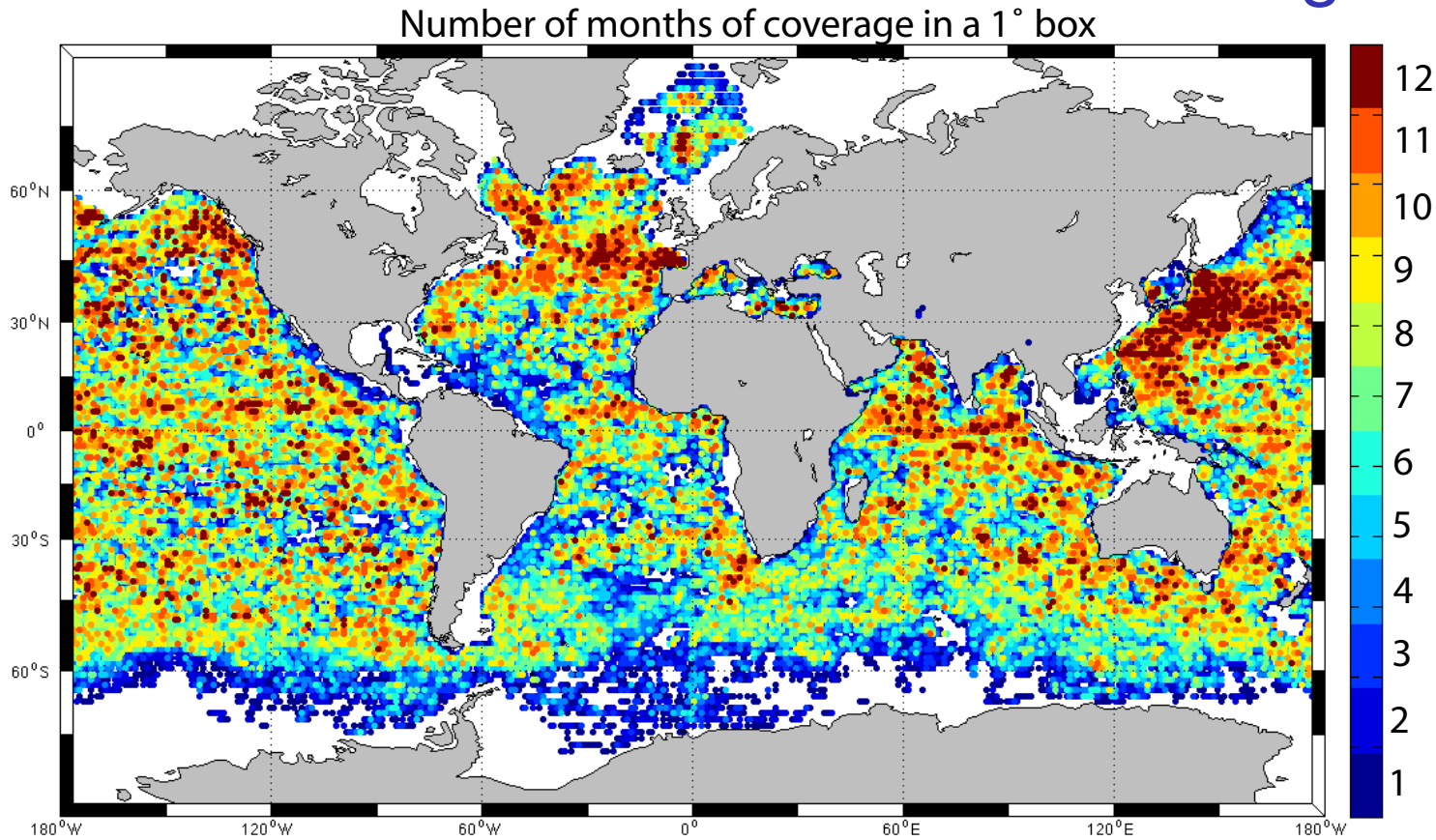
- Constructed a global mixed layer depth (MLD) climatology using Argo profiles
- Calculated the MLDs with:
  - new hybrid algorithm (Holte and Talley, JAOT, 2009)
  - standard threshold method (de Boyer Montégut et al., 2004)
- New Argo climatology generally has shallower MLDs than de Boyer Montégut et al. climatology
- Provides global fields, as well as the ability to focus in on specific regions and times
- Climatology, MLD information for all Argo profiles, and a MATLAB version of the algorithm are available at http://mixedlayer.ucsd.edu

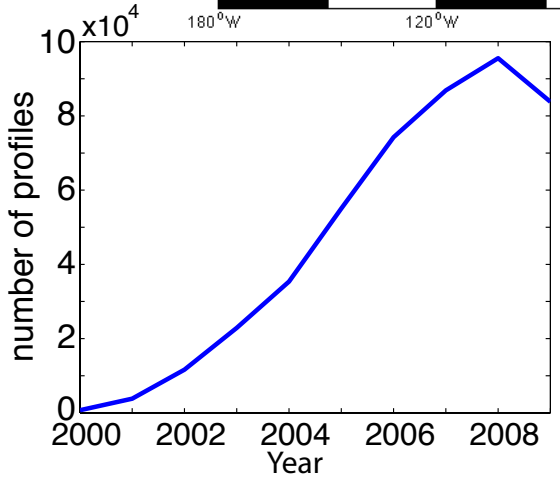
Argo



- Climatology currently includes more than 430,000 Argo real-time and delayed-mode temperature and potential density profiles
- Updated through November 2009

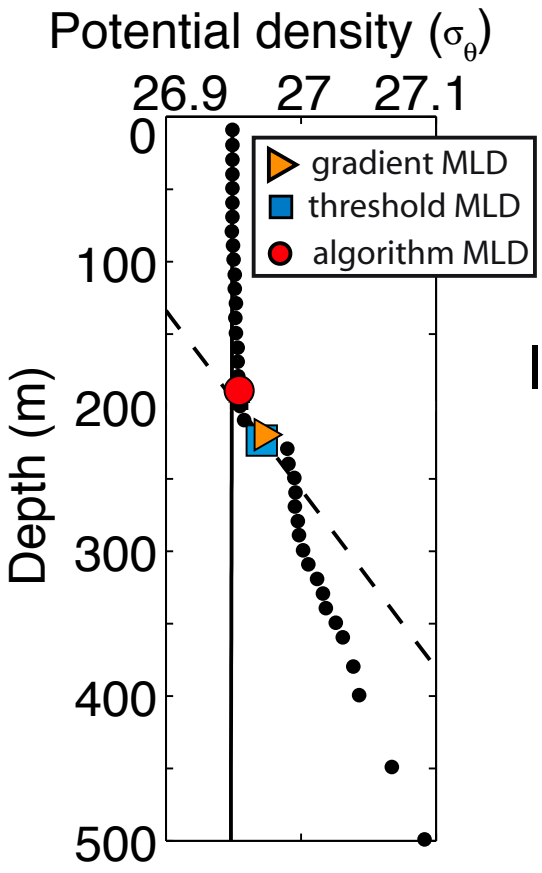
Argo





- Coverage is sparse for a monthly climatology
- Number of profiles is increasing by nearly 100,000 profiles per year

Finding the MLD of Argo profiles



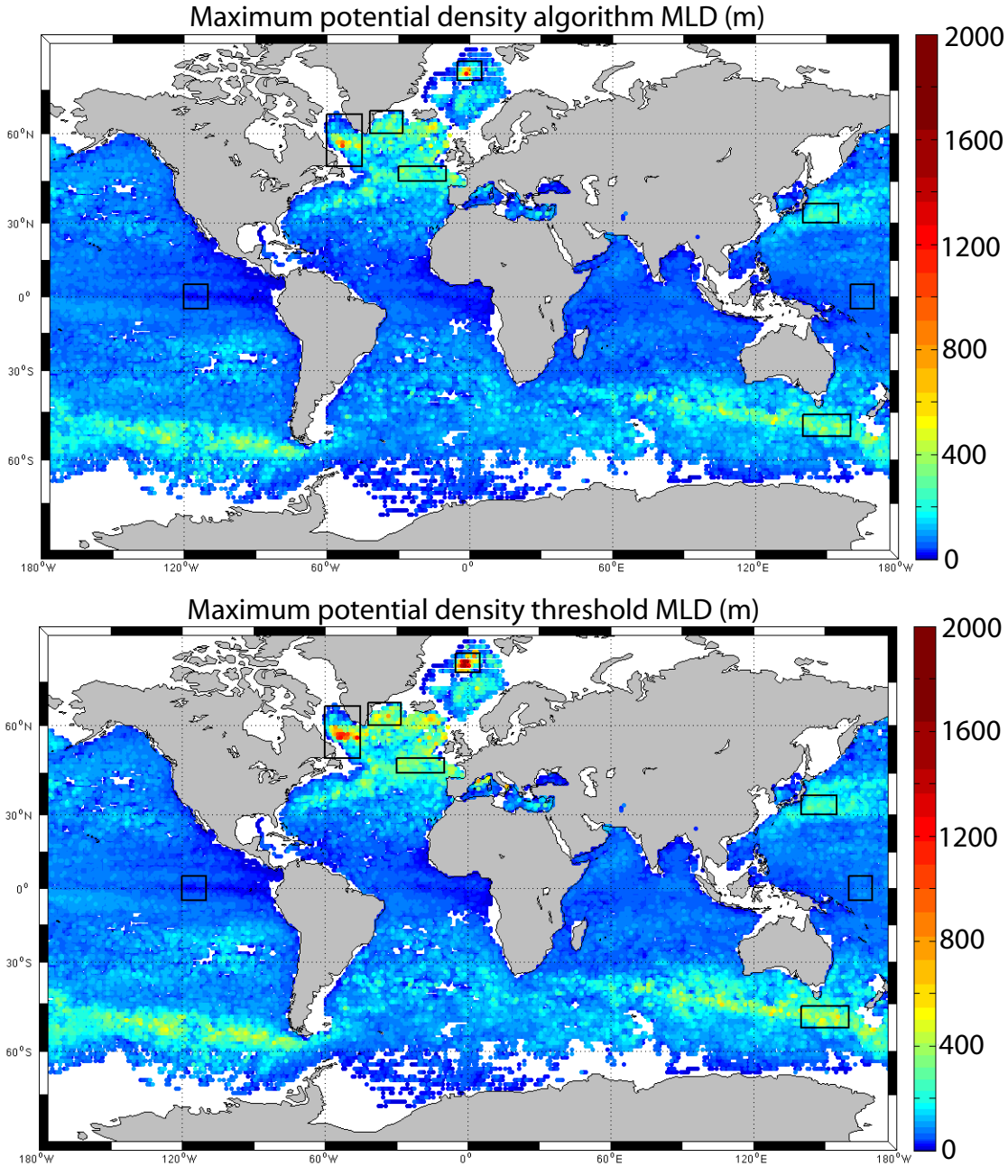
The MLD is calculated with two methods:

- Standard thresholds of 0.2°C and 0.03 kg m^{-3}(de Boyer Montégut et al., 2004)
- New hybrid algorithm (Holte and Talley, JAOT, 2009)

In this talk:

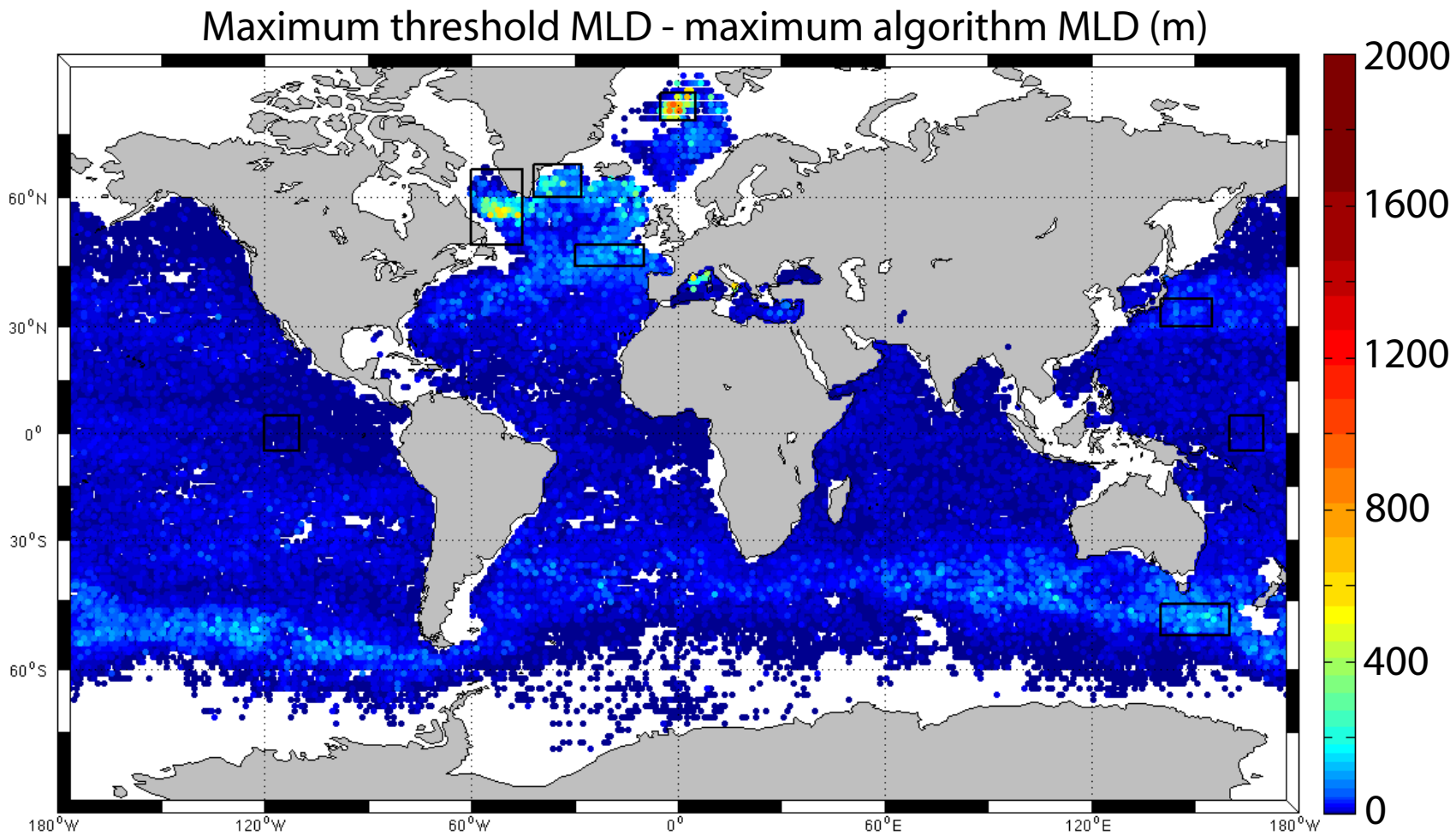
- Use potential density, but could do the same analysis for temperature profiles (and potentially add XBT profiles)
- Use a variable density threshold (density threshold is equivalent to a temperature change of -0.2°C, also from de Boyer Montégut et al., 2004)

Maximum MLDs



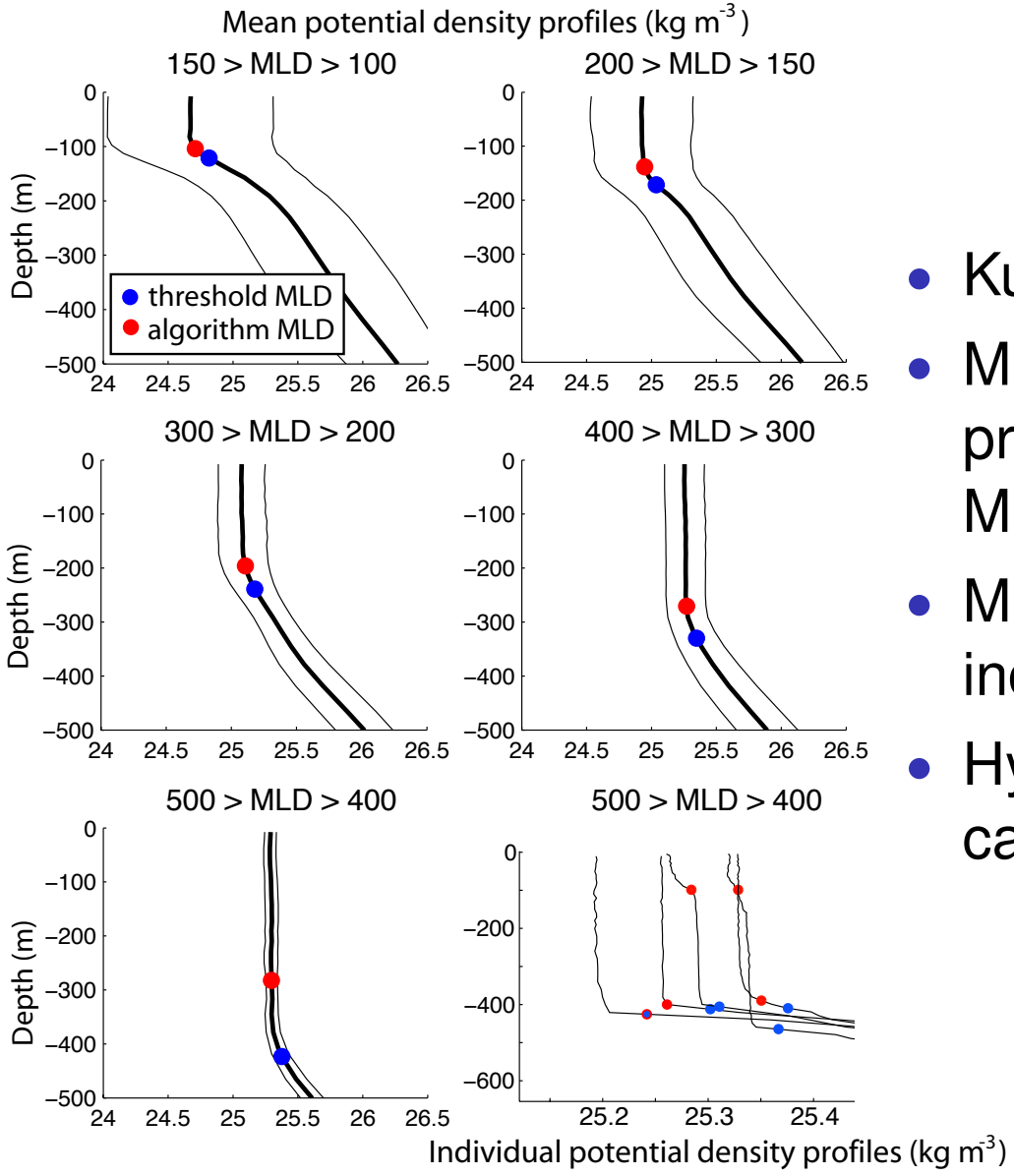
- Maximum MLD maps for the density algorithm (top) and threshold (bottom)
- Averaged in 1° bins
- Mean of the 5 maximum MLDs in each bin
- MLDs range from 0 to 2000 m

Maximum MLDs



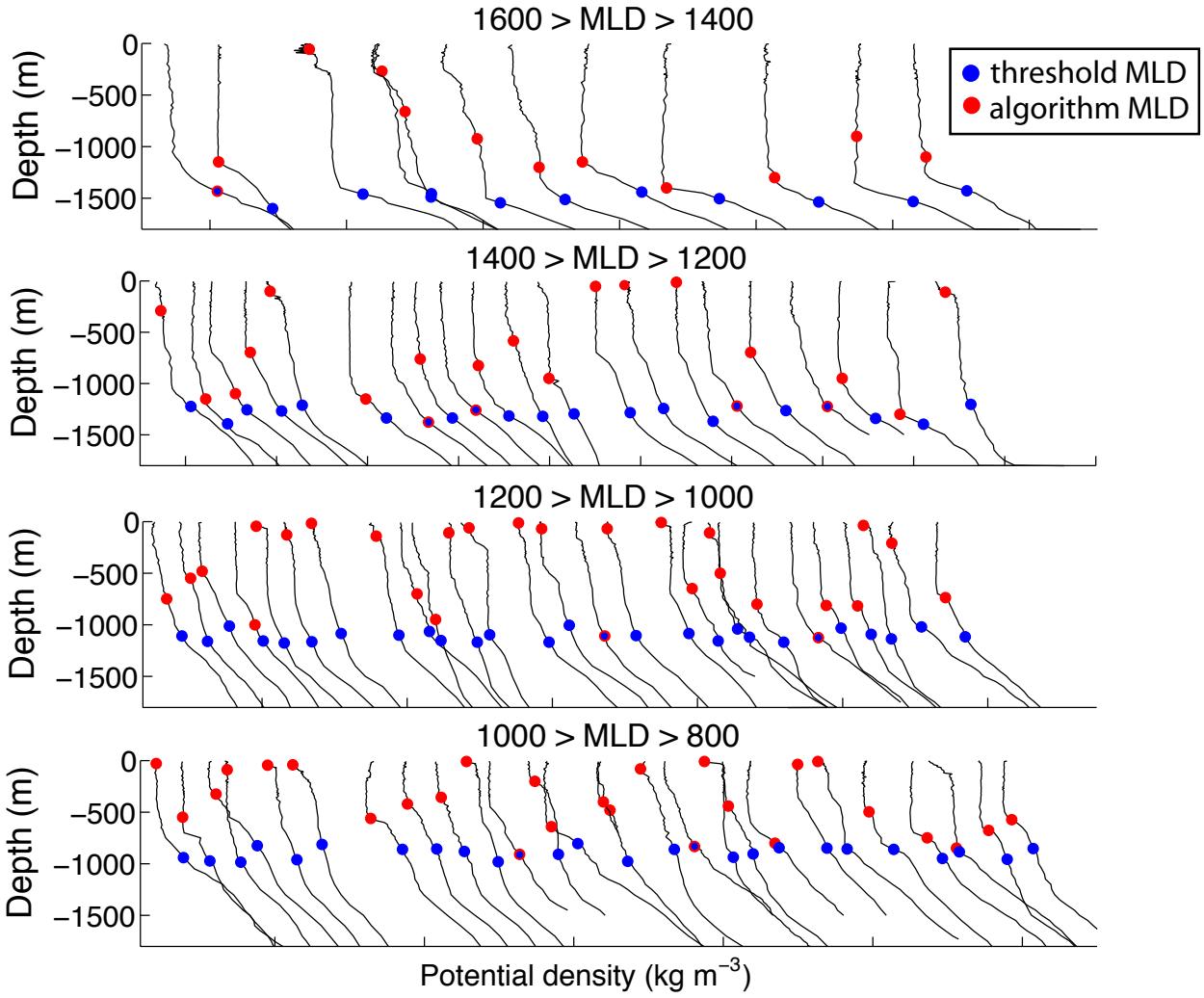
- Algorithm MLD is always shallower
- Largest differences (>100 m) occur in deep and intermediate water formation regions

Kuroshio MLDs



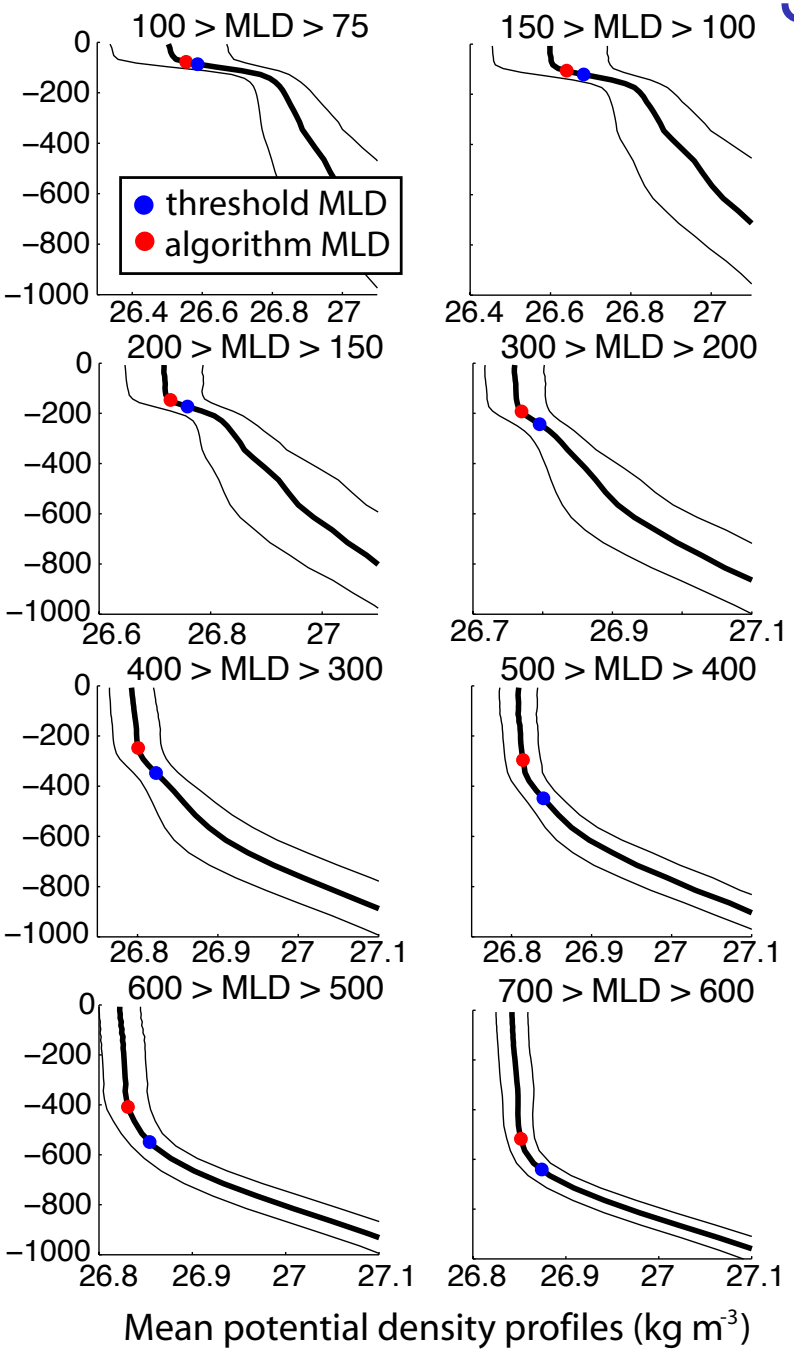
- Kuroshio region
- Mean potential density profiles binned by threshold MLD
- MLDs are the mean of the individual profile MLDs
- Hybrid algorithm more closely captures the mixed layer

Labrador Sea MLDs



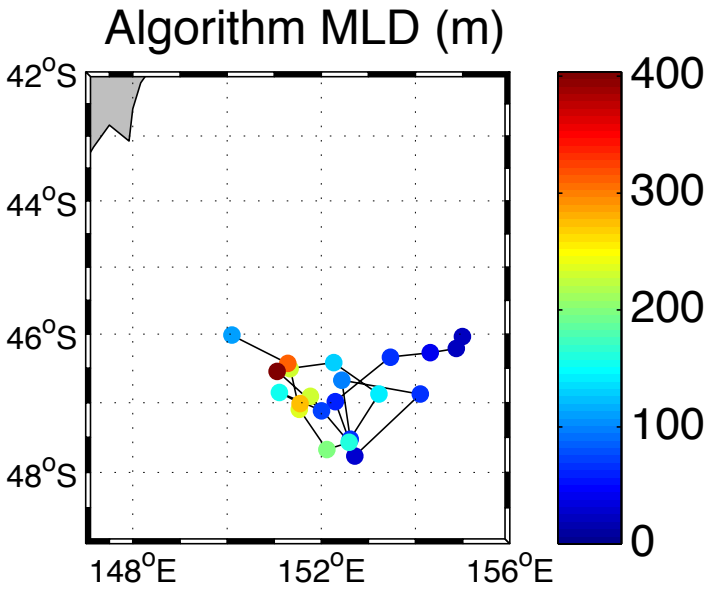
- Labrador Sea profiles grouped by threshold MLD
- Many of the threshold MLDs are too deep - threshold does not capture the finer mixed layer structure

Southern Ocean MLDs

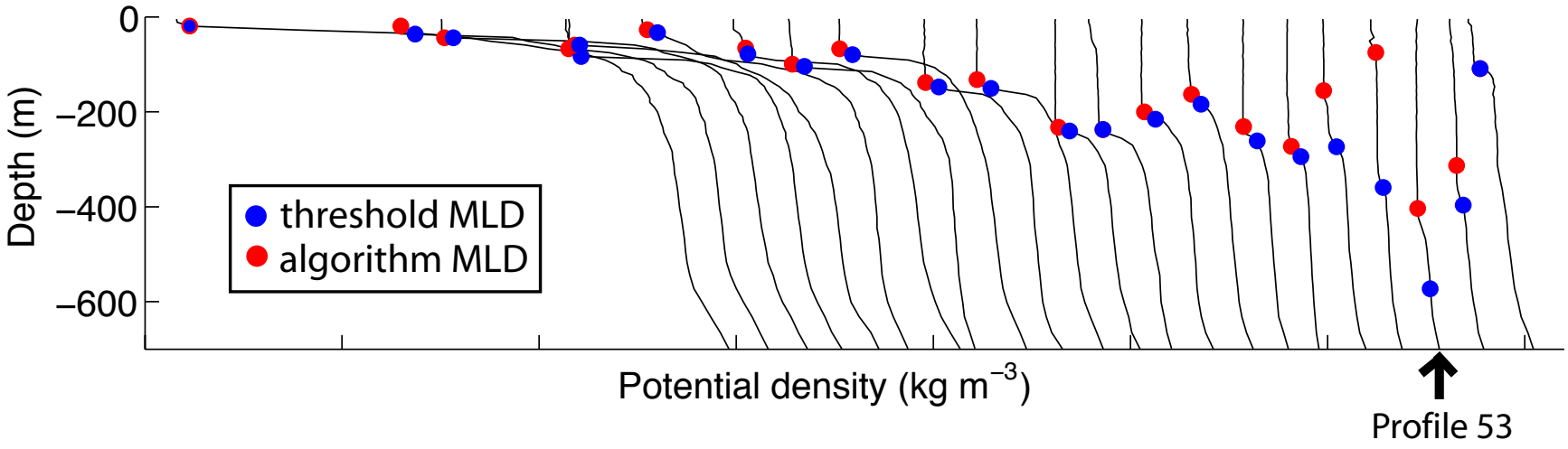


- Southern Ocean region
- Mean potential density profiles binned by threshold MLD
- MLDs are the mean of the individual profile MLDs
- Hybrid algorithm more closely captures the mixed layer
- MLD difference between methods increases with MLD

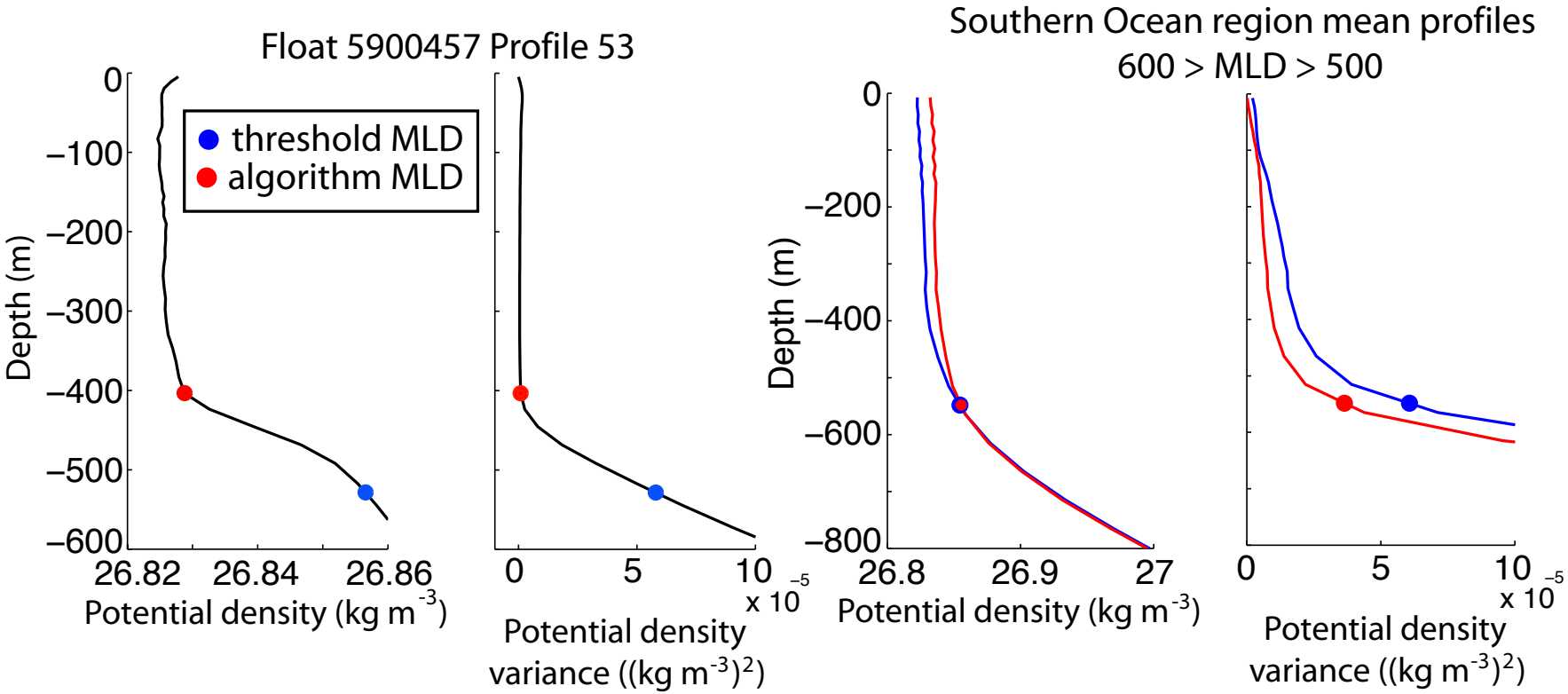
Southern Ocean MLDs



- Float 5900457 in the Southern Ocean region
- Collected 22 profiles from February to September 2005

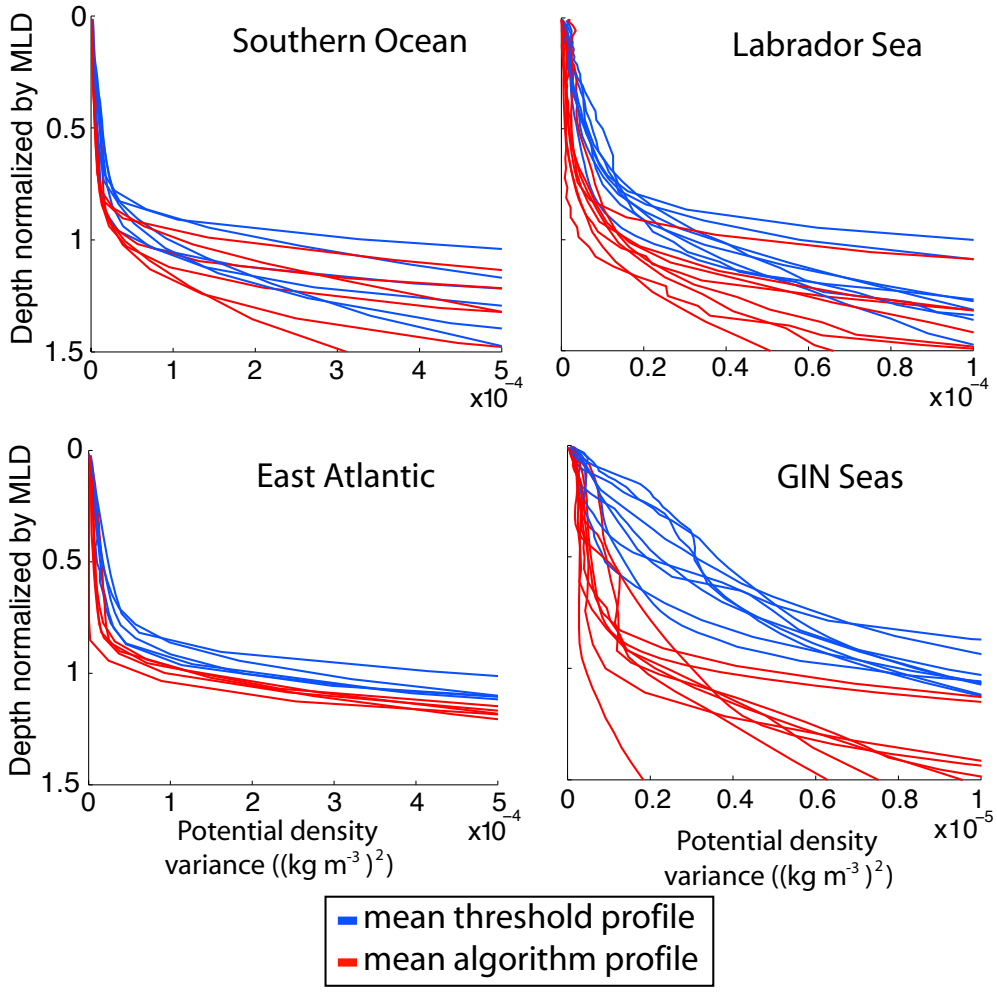


Southern Ocean MLDs



- The variance at each depth level is the cumulative variance in the profile to that depth
- Mean profiles binned by their respective MLDs
- Algorithm mean profile has lower variance - it is overestimating the MLD less than the threshold

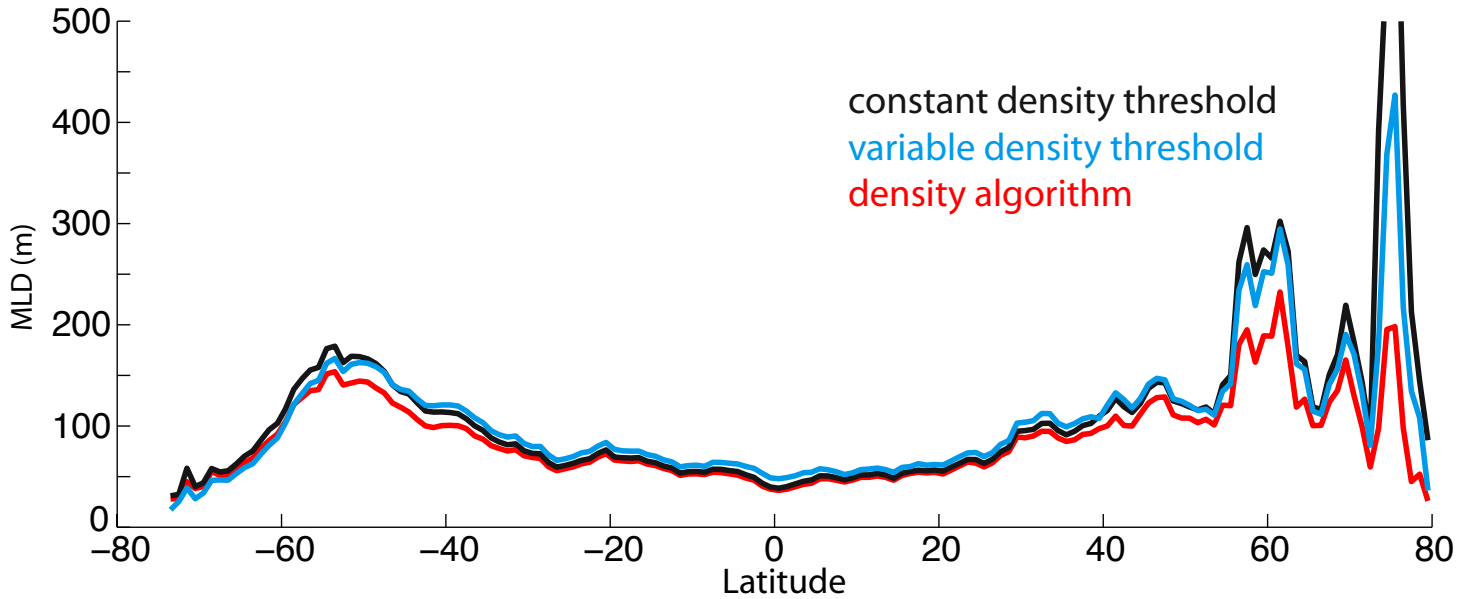
Variance



- Mean potential density variance profiles for four regions
- Profiles are binned according to algorithm and threshold MLDs
- Depth is normalized by MLD
- Variance increases as the MLD estimate extends past the actual mixed layer depth

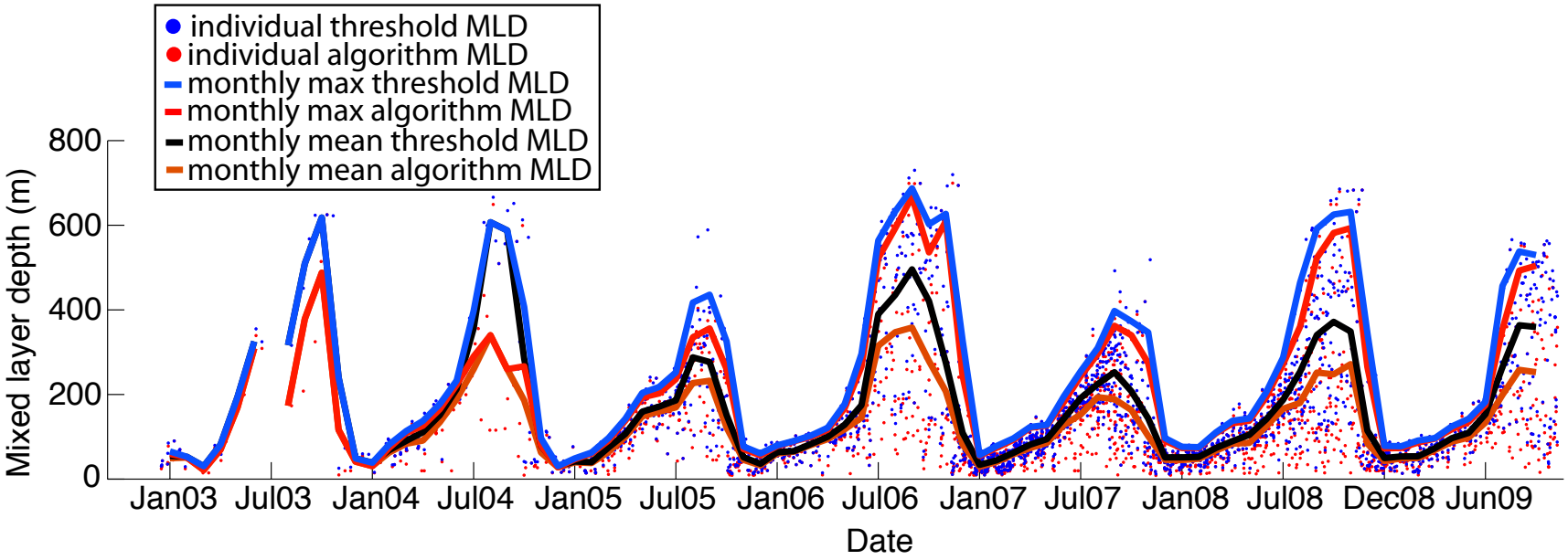
- Hybrid algorithm generally has lower variance in the mixed layer - it is capturing the MLD more accurately

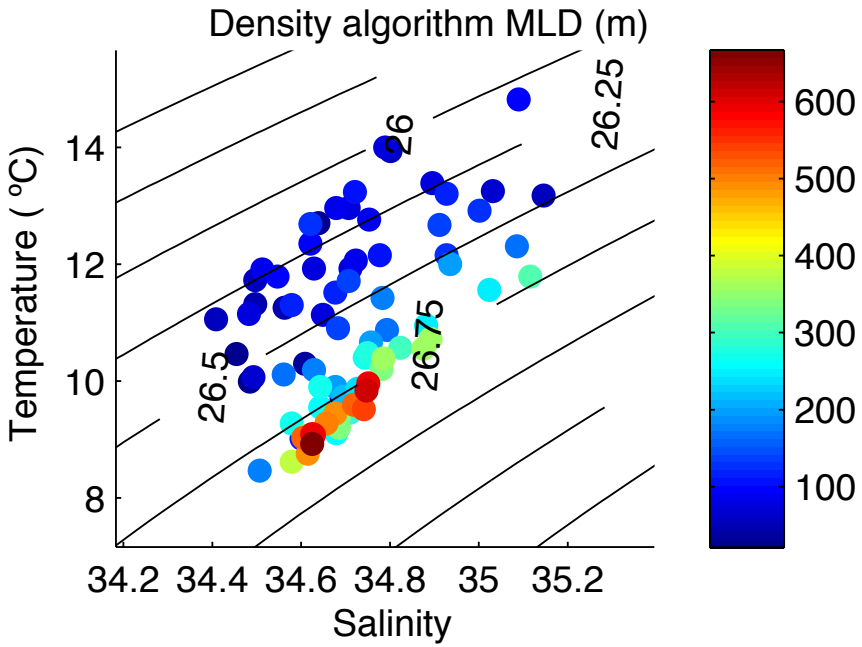
Global uses



- Zonal means of the maximum MLDs in 1° by 1° bins

Regional uses





- Subantarctic Mode Water in the southeast Indian Ocean (Southern Ocean region)
- Temperature-salinity properties of algorithm monthly maximum mixed layers

Summary

- We are producing a mixed layer depth (MLD) climatology with Argo. It provides MLDs and mixed layer properties calculated with standard threshold methods and with a new hybrid algorithm
- A seasonal climatology for most regions will be available soon
- Algorithm is more conservative than the threshold method - it tends to find shallower mixed layers
- Deep mixed layers only occur sporadically - the threshold methods make the mixed layer appear more uniformly deep
- The maximum MLDs found by the methods are similar, but the mean MLDs for the algorithm are generally shallower
- MLD data for all profiles and the algorithm MATLAB code are available at: **http://mixedlayer.ucsd.edu**