Gael Forget
MIT, Jan. 8th 2016

Independent Activities Period

Introduction to ocean data-model analysis

Class overview

I. observations
II. gridded products
III. numerical models
IV. completion of activities

Gael Forget
MIT, Jan. 8th 2016

Independent Activities Period

Introduction to ocean data-model analysis

structure of each session

1. review (1/4h)
2. introductory slides (1/2h)
3. activity period (3/4h)

Gael Forget
MIT, Jan. 8th 2016

Independent Activities Period

Introduction to ocean data-model analysis

Links

- IAP course material: http://mitgcm.org/viewvc/MITgcm/MITgcm_contrib/gael/comm/course-idma2016/
- ECCO v4 overview paper: http://www.geosci-model-dev.net/8/3071/2015/gmd-8-3071-2015.html
- ECCO v4 user guide: http://mitgcm.org/viewvc/*checkout*/MITgcm/MITgcm_contrib/gael/verification/eccov4.pdf
- MITgcm user guide : http://mitgcm.org/public/r2_manual/latest/online_documents/manual.pdf
- Paper reprints: http://www.gaelforget.net/publications/

Gael Forget
MIT, Jan. 8th 2016

Independent Activities Period

Introduction to ocean data-model analysis

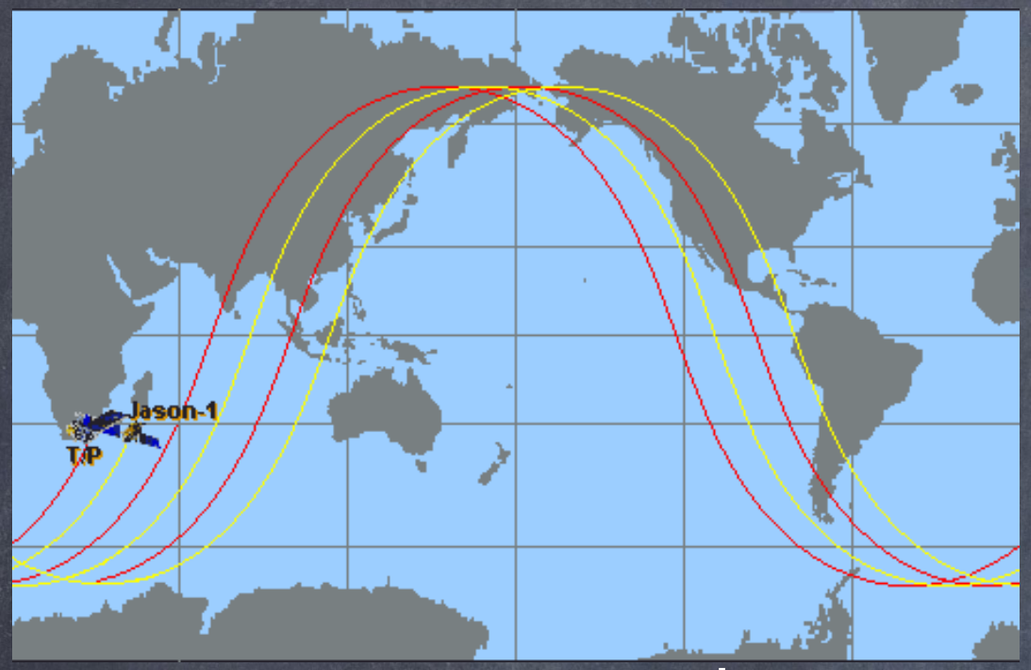
session I : observations

1. data collection
2. observational statistics
3. MITprof data sets
4. *activity period*

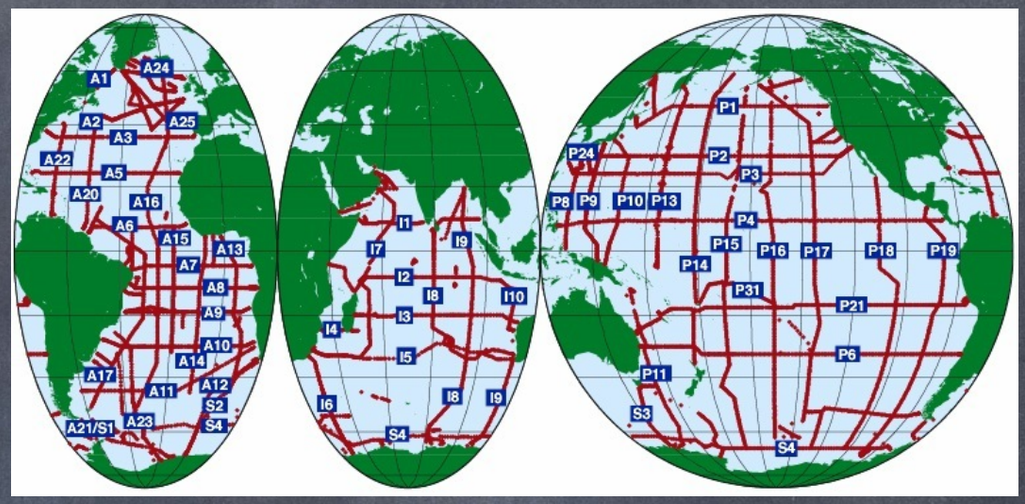
what do I like 'pure' observations for?

1. observational statistics
2. testing models
3. basis for estimation

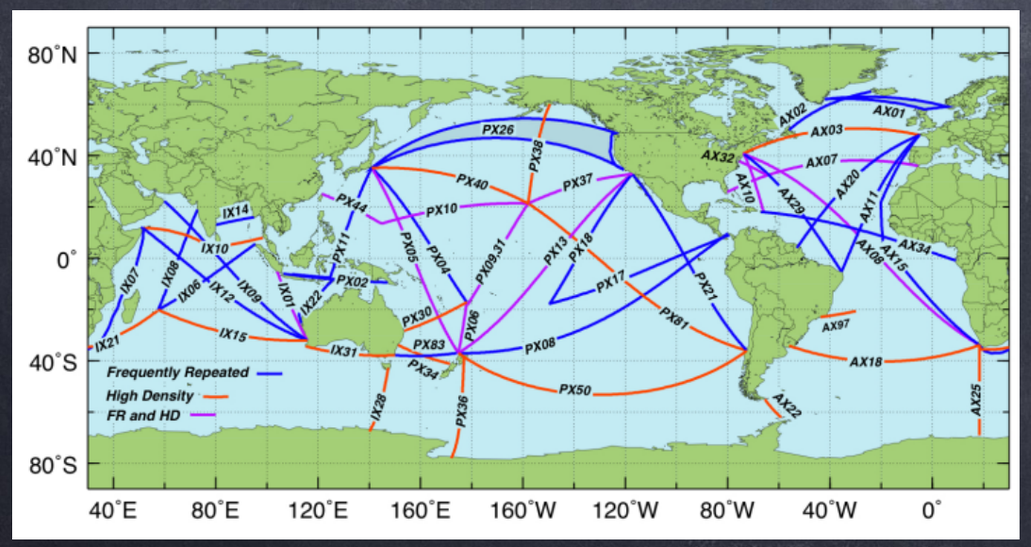
(1) data collection



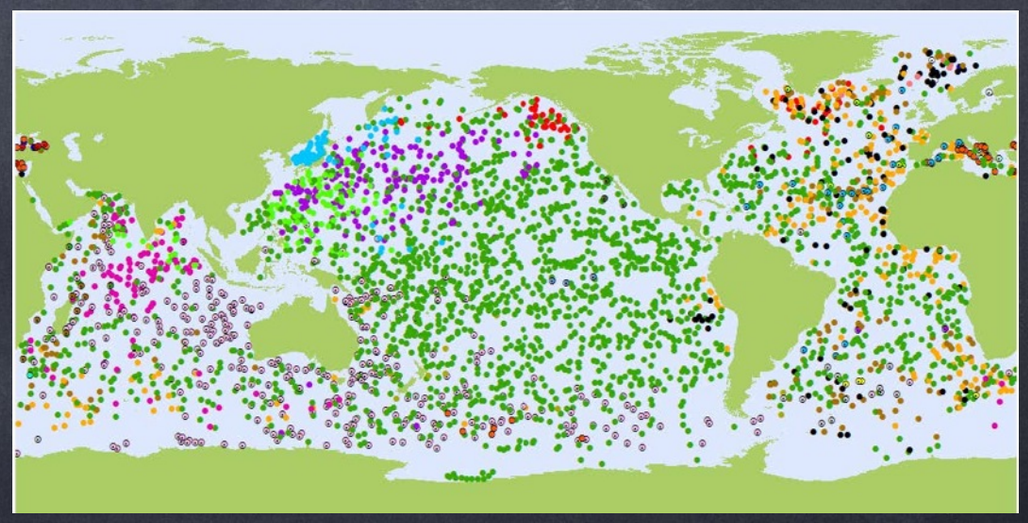
remote sensing



WOCE repeat

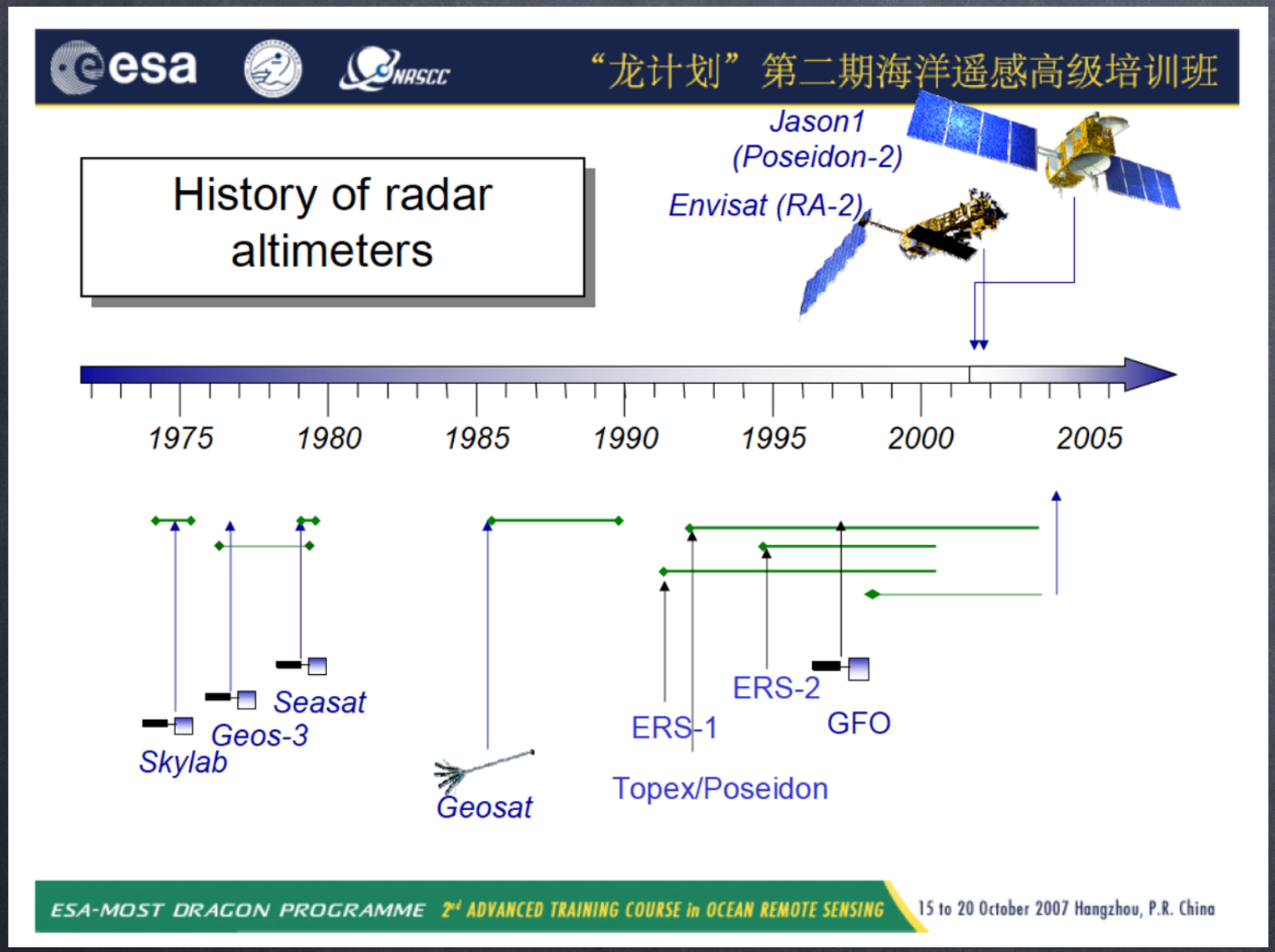


XBT repeat



Argo

(1) data collection



observed variables:

- SST
- ALTIMETRY
- OCEAN MASS
- OCEAN COLOR
- SSS
- …

(ESA source)

(1) data collection

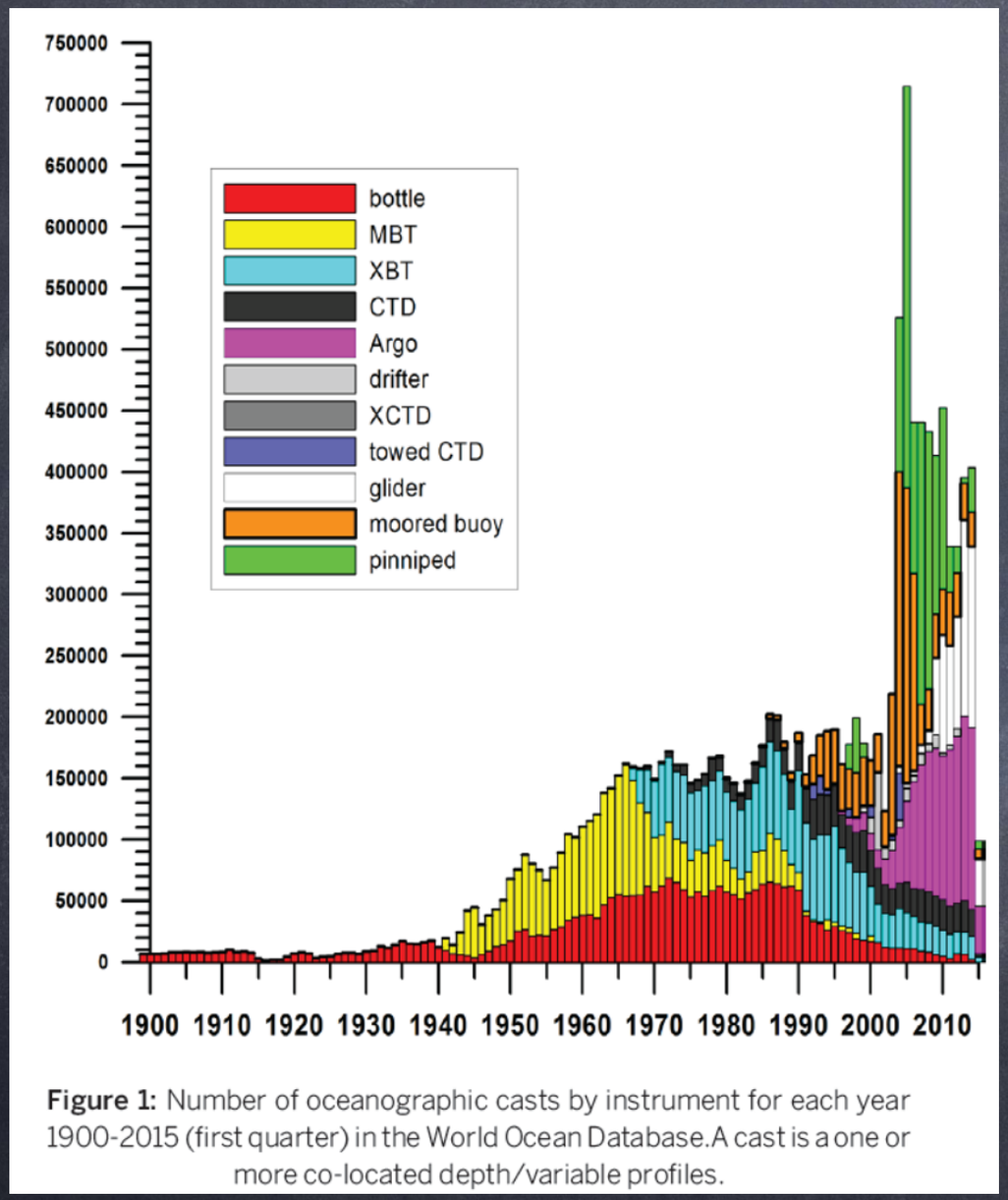


Figure 1: Number of oceanographic casts by instrument for each year 1900-2015 (first quarter) in the World Ocean Database. A cast is a one or more co-located depth/variable profiles.

(Domingues et al. 2015)

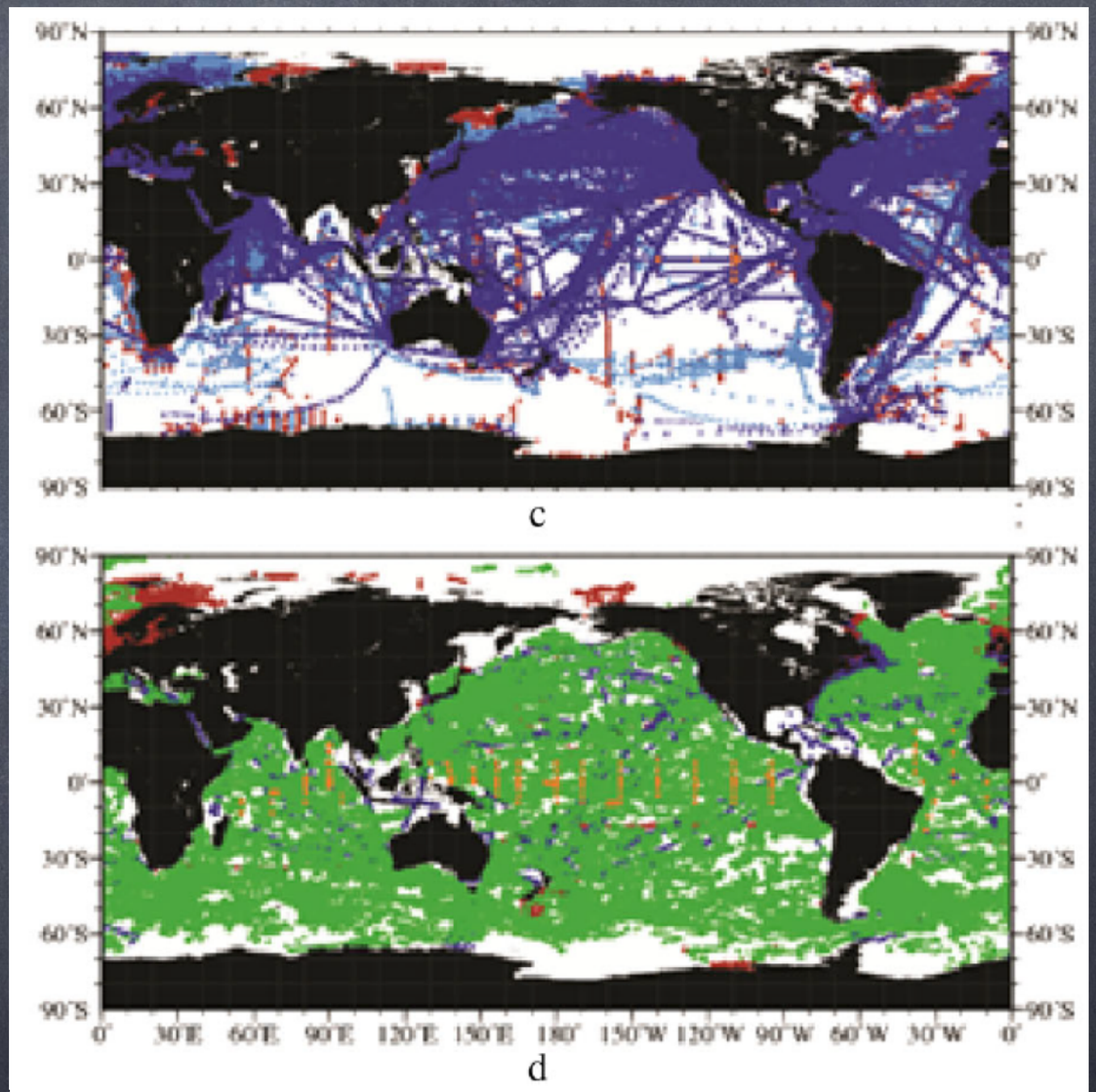
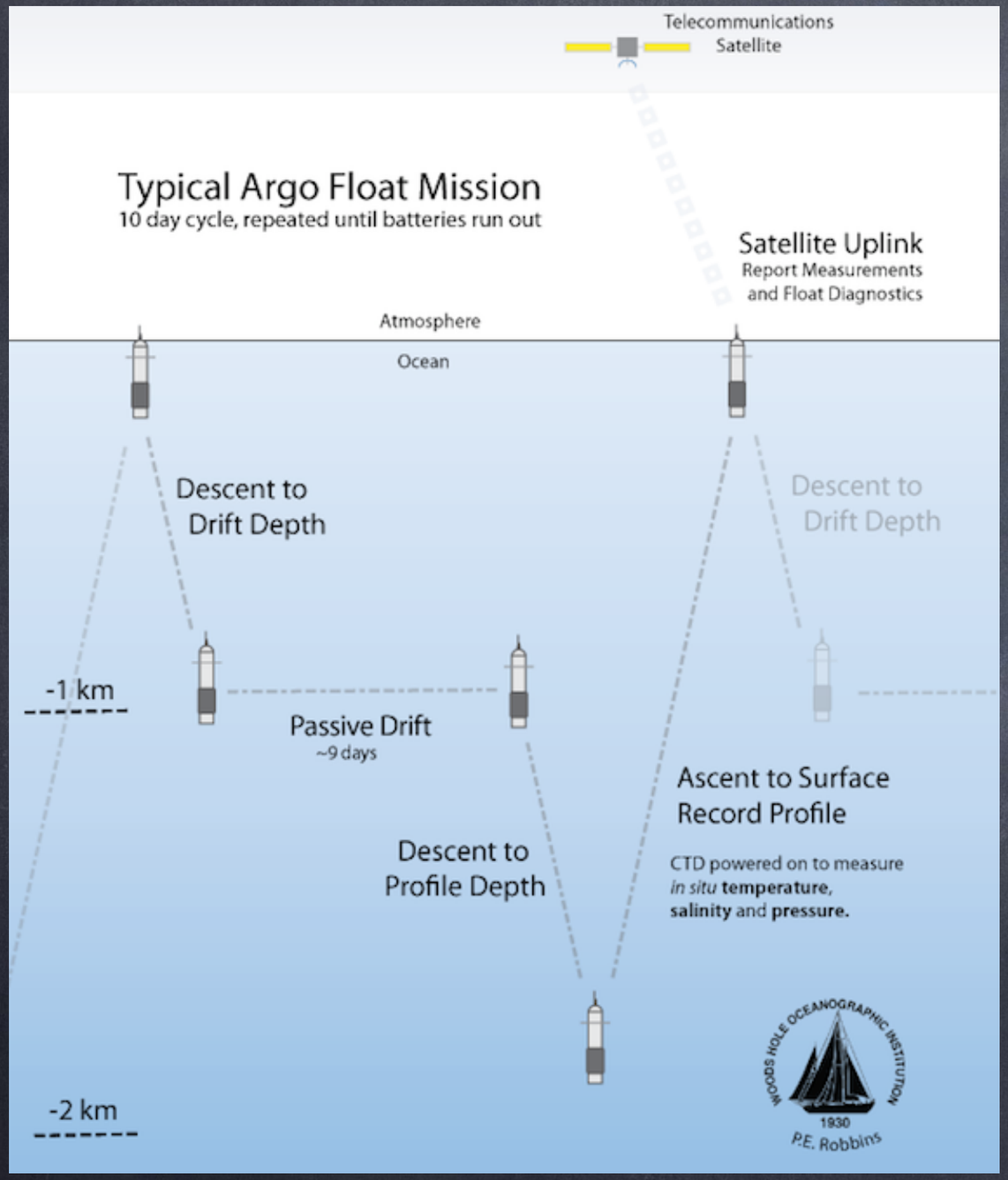


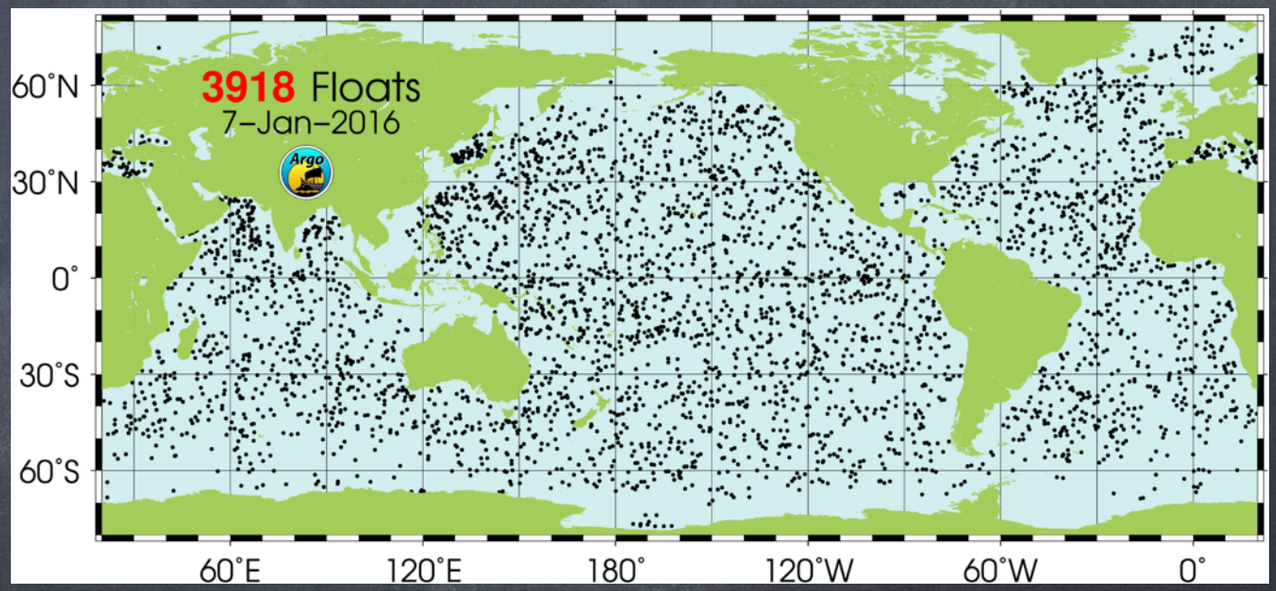
Figure 1. Geographic distribution of subsurface temperature profiles for (a) 1934, (b) 1960, (c) 1985, and (d) 2009.

(Abraham et al. 2013)

(1) data collection

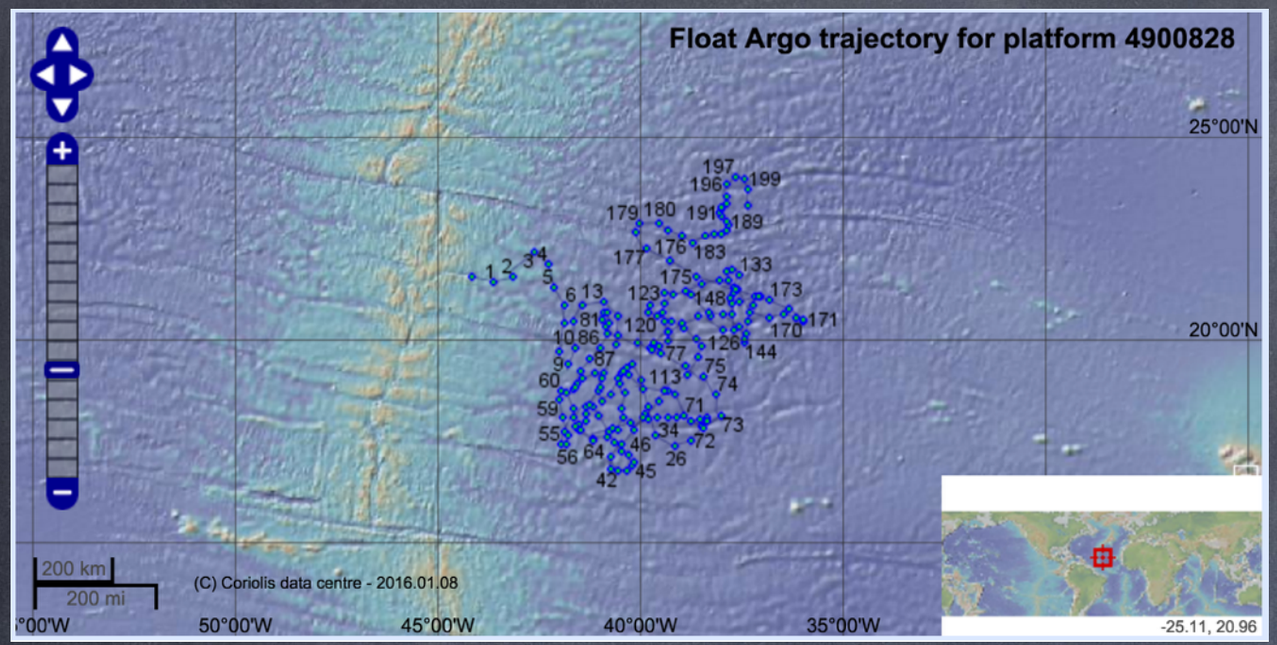


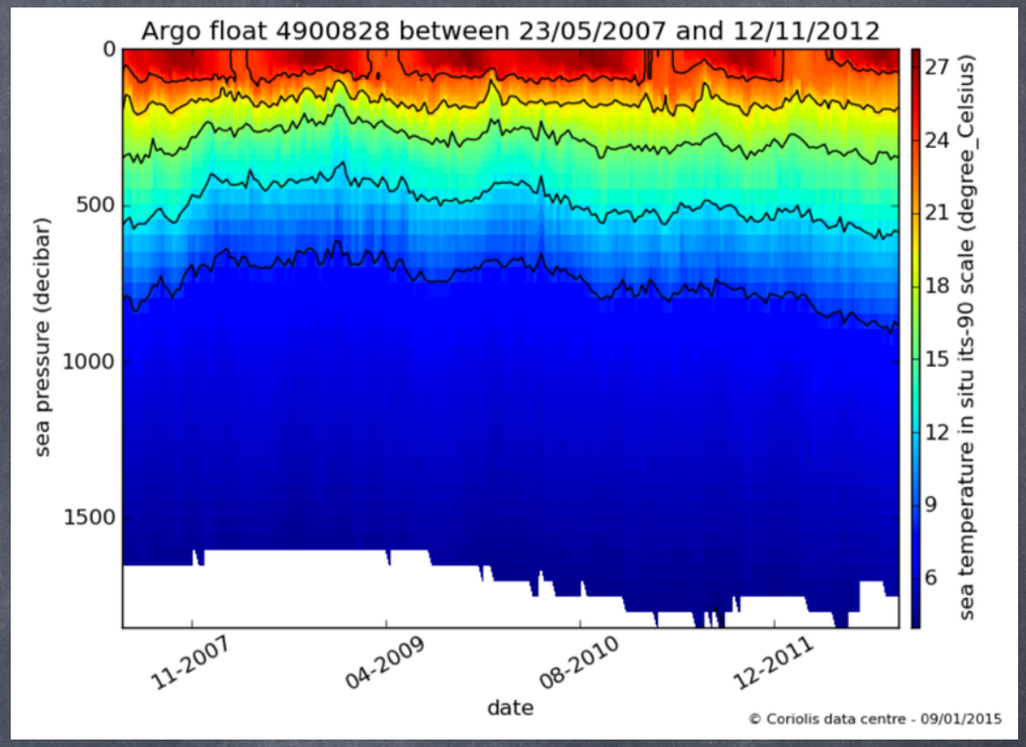
(http://argo.whoi.edu/)

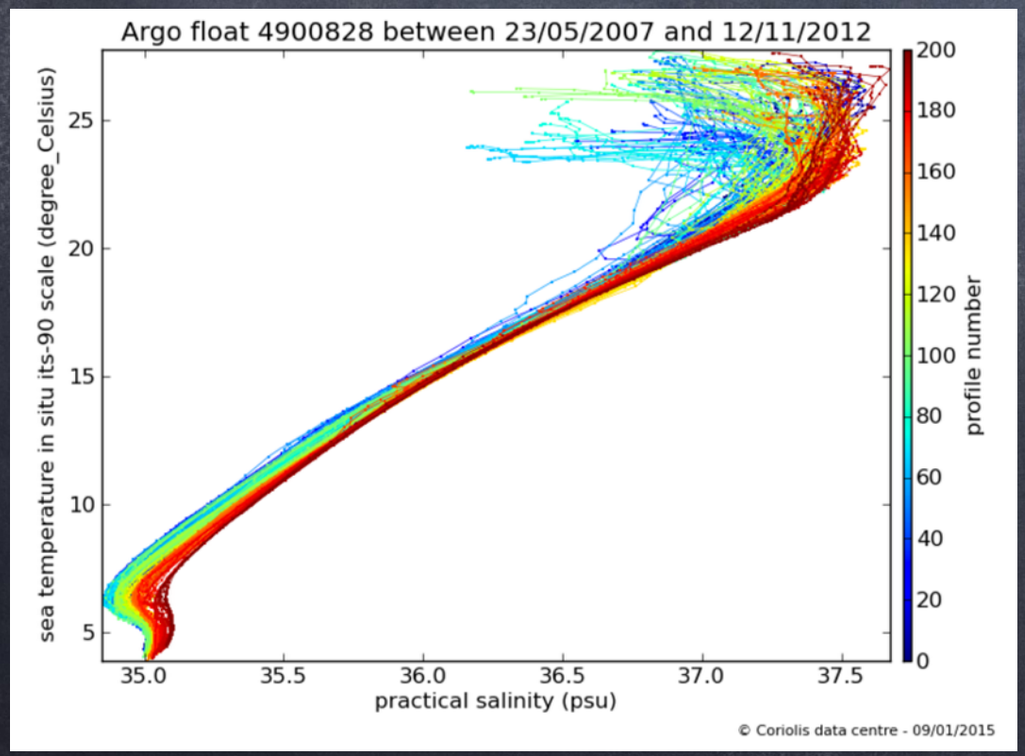


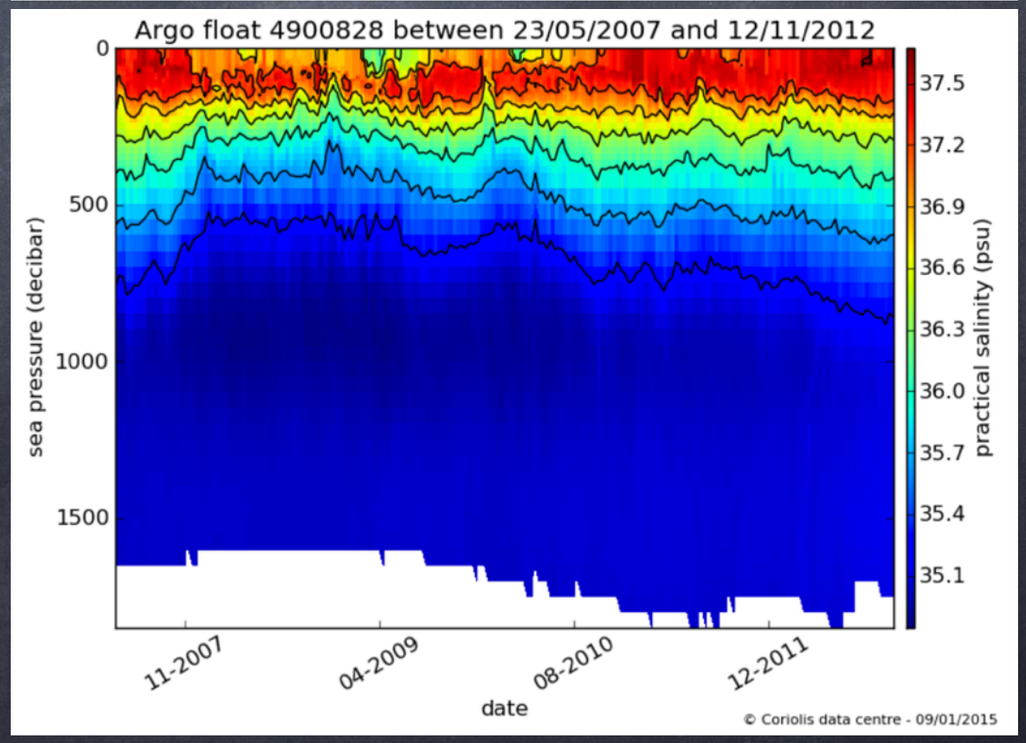
(http://www.argo.ucsd.edu/)

(1) data collection









(http://www.argodatamgt.org > Access to data >> Description of all floats)

(2) observational statistics

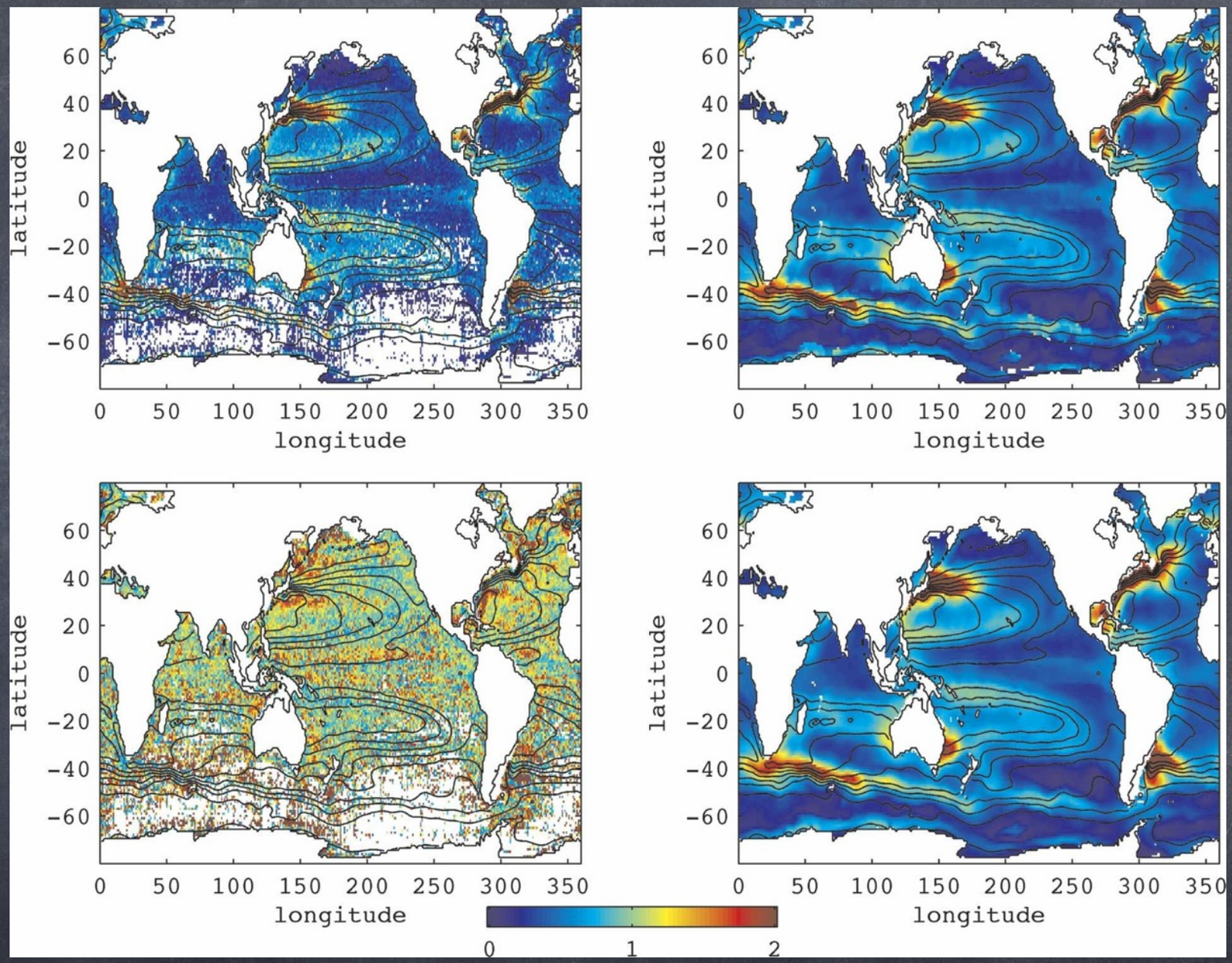


FIG. 3. Illustration of the methodology (see text) for T at 300 m: (top left) pointwise, (top right) mapped, and (bottom right) estimated standard deviations of T (°C); and (bottom left) the ratio of the mapped to the pointwise standard deviations. Superimposed contours: annual mean climatological T ($\overline{T}$) from Stephens et al. (2002) with an interval of 2°C.

(Forget and Wunsch 2007)

(2) observational statistics

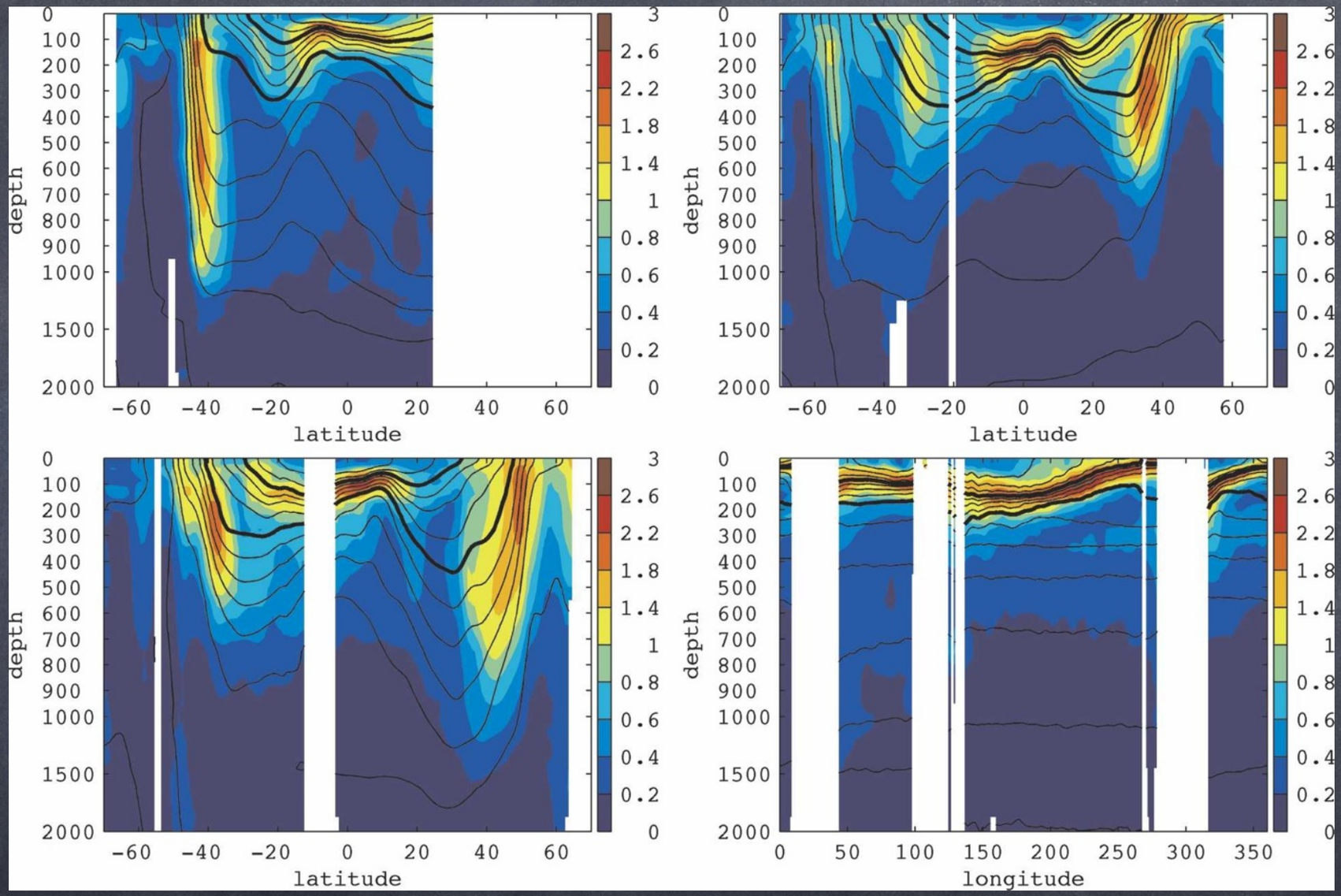
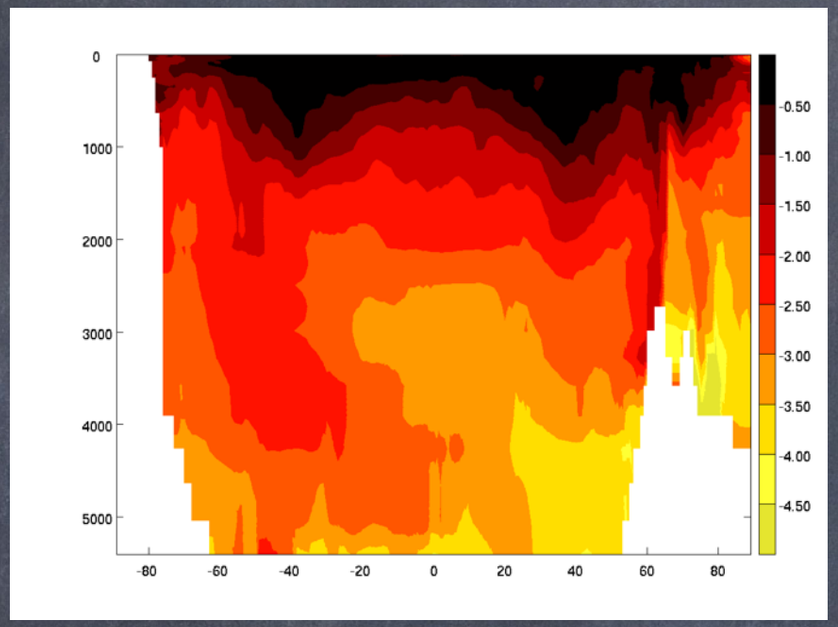


FIG. 5. Estimated standard deviation of T ($\tilde{\sigma}_T$; °C; colors) in (top left) the Indian Ocean at 64.5°E, (top right) the Pacific Ocean at 164.5°E, (bottom left) the Atlantic Ocean at 322.5°E, and (bottom right) along the equator at 0.5°S. Superimposed contours: $\overline{T}$, with an interval of 2°C. Thick contours denote the $\overline{T}$ = 14°C and $\overline{T}$ = 22°C isotherms.

(Forget and Wunsch 2007)

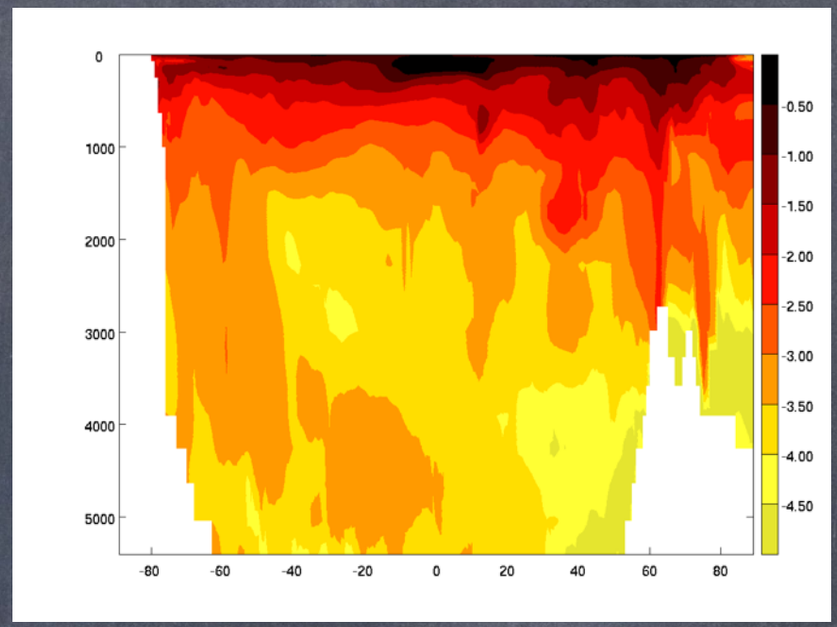
(2) observational statistics

Observed



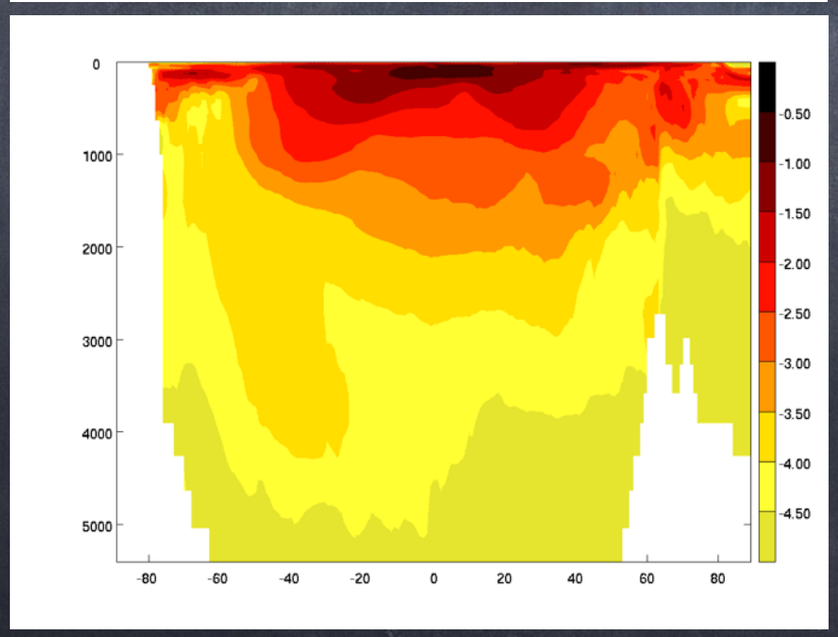
large-scale Forced responses

(ECCO)



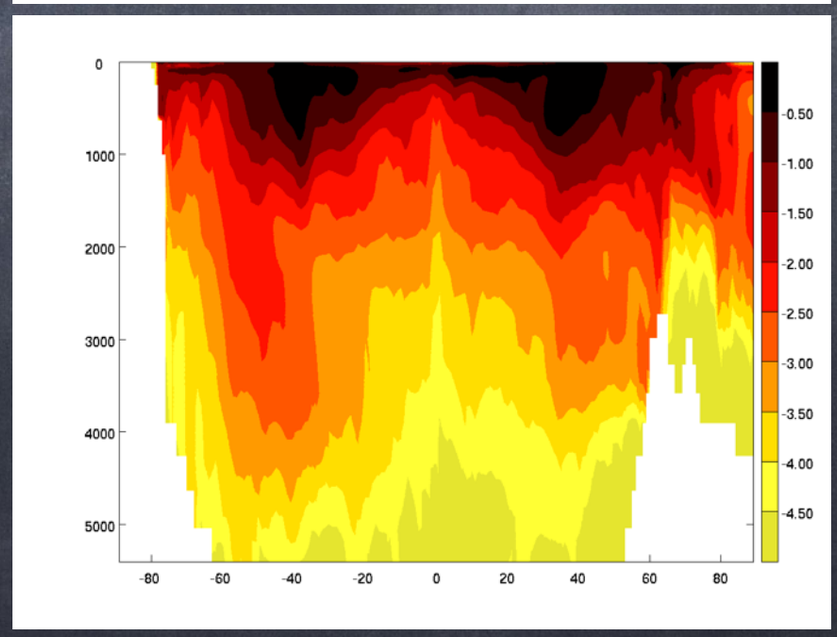
Internal waves

(Munk 1981)



Meso-scale eddies

(MODEL)



(2) observational statistics

(Worthington 1981)

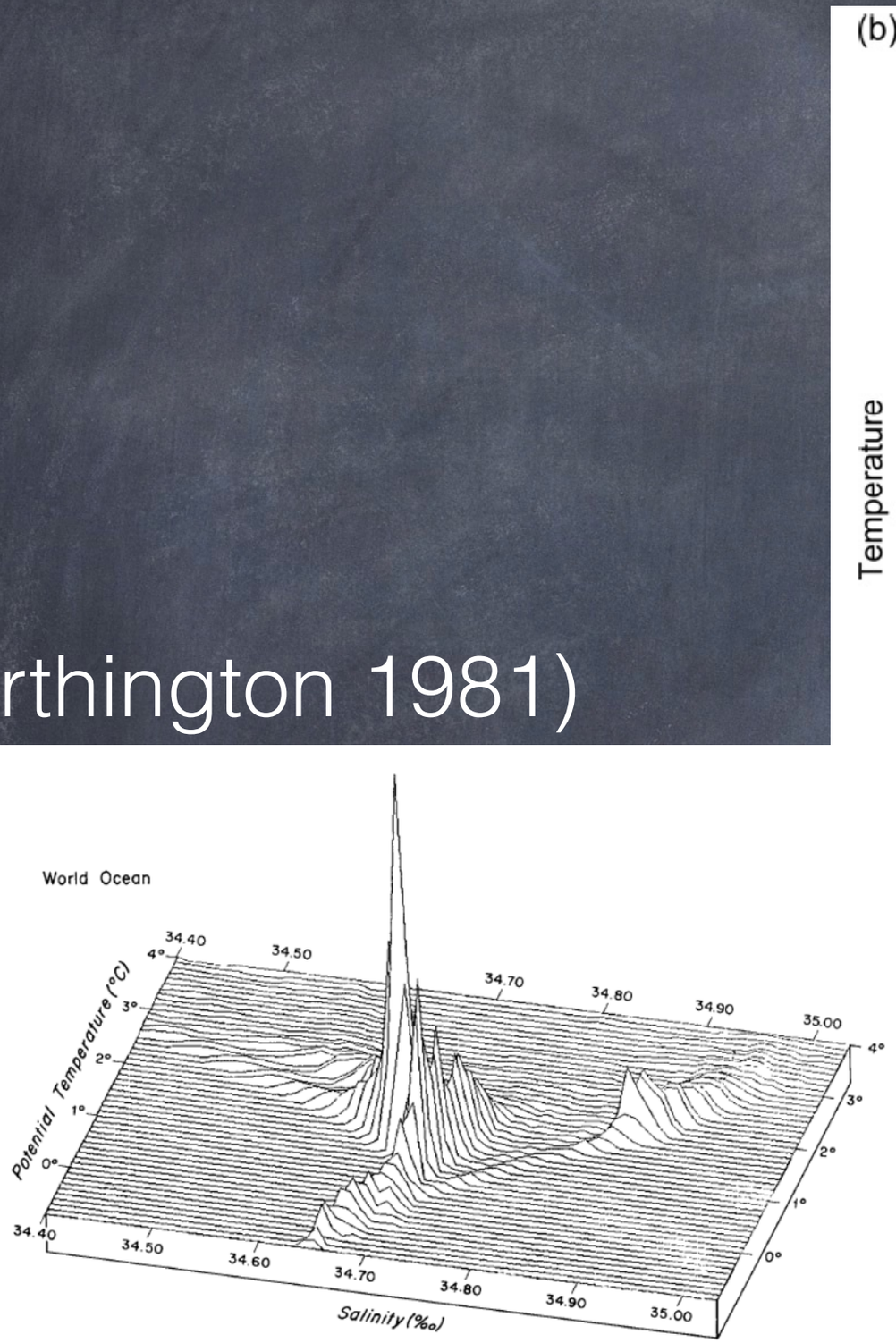
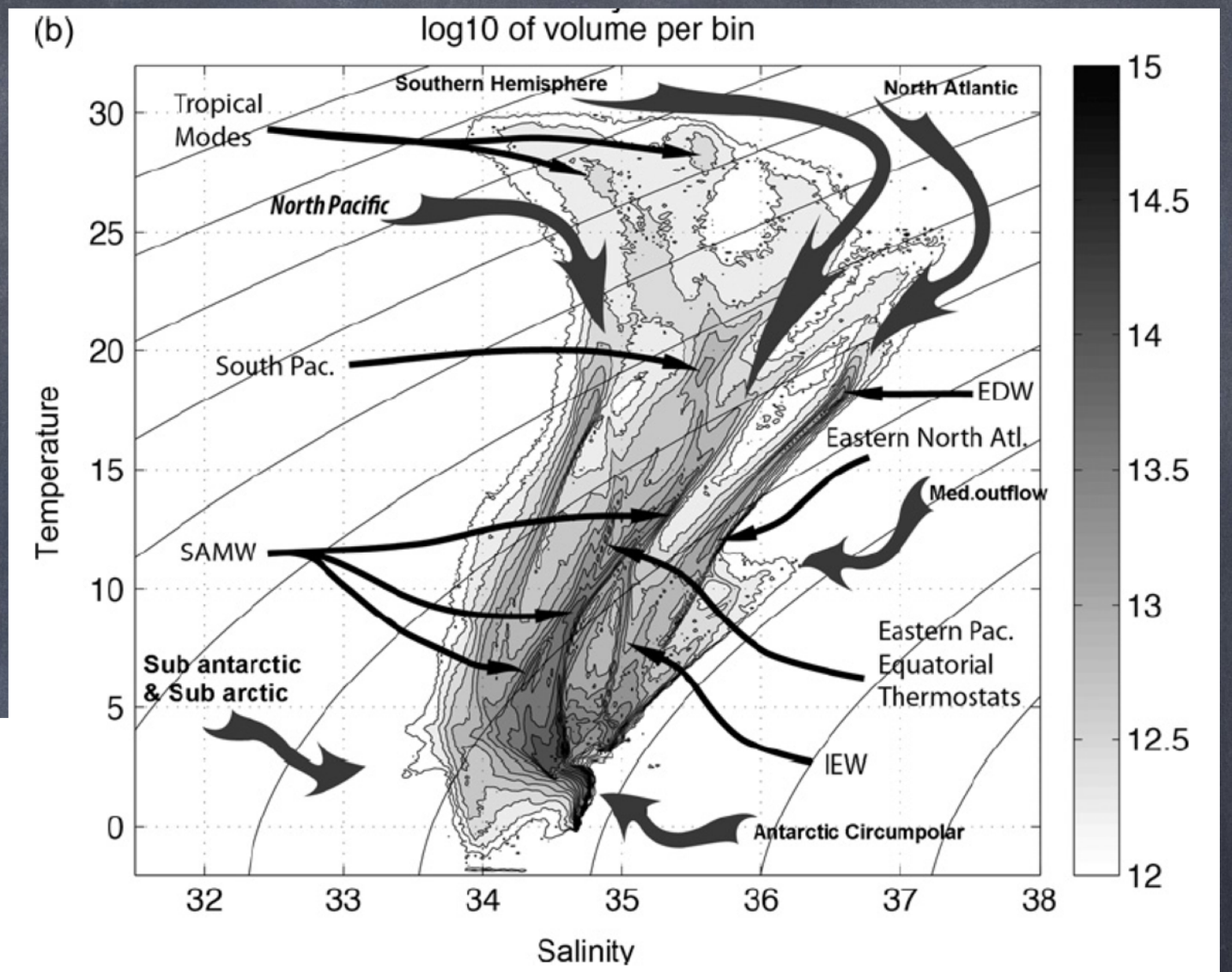
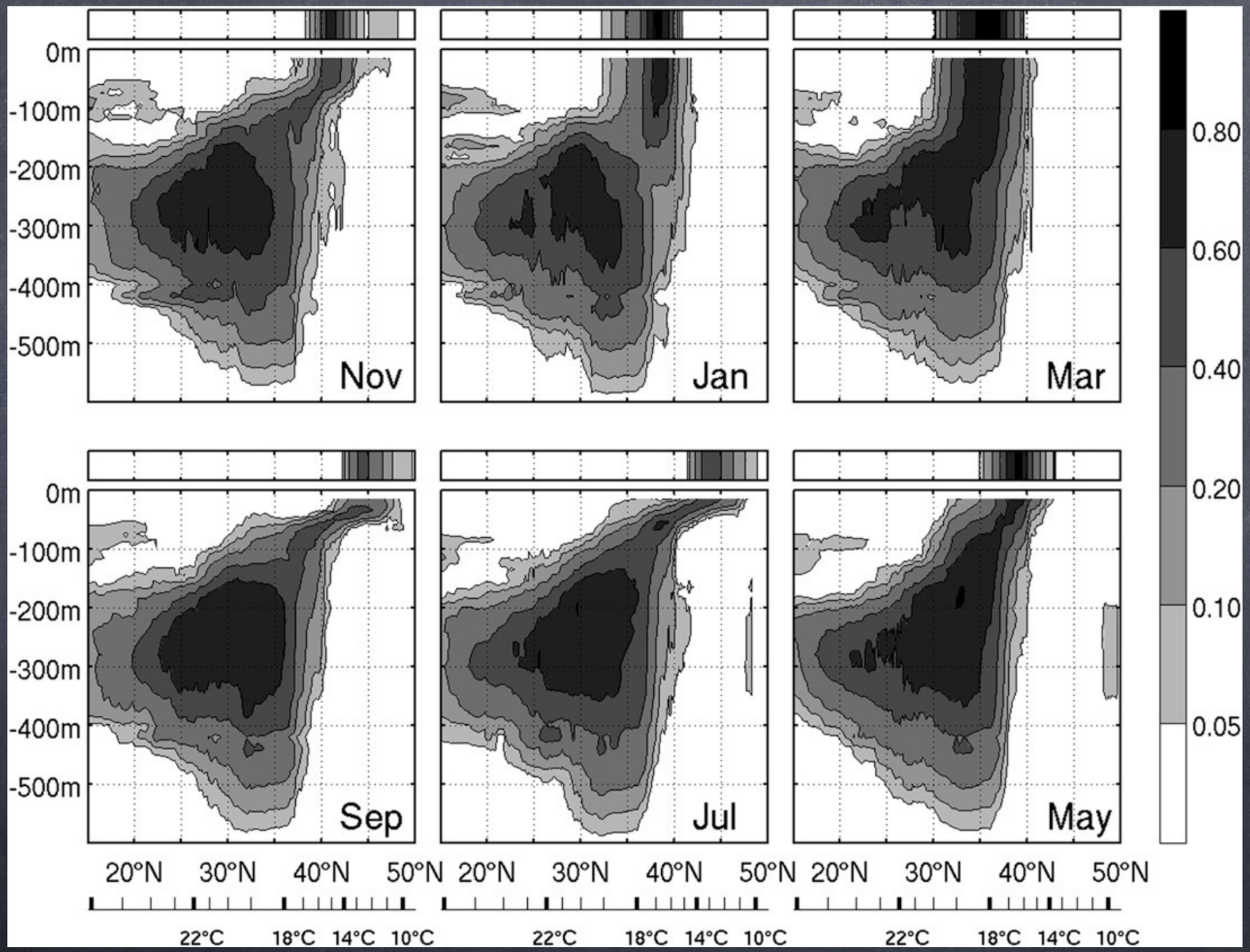


Figure 2.2 Simulated three-dimensional T-S diagram of the water masses of the world ocean. Apparent elevation is proportional to volume. Elevation of highest peak corresponds to 26.0×10^6 km^3 per bivariate class 0.1°C × 0.01‰.



(Speer and Forget 2013)

(2) observational statistics



(Forget et al. 2011)

(3) MITprof data sets

MITprof format Design:

- standardized data collections
- simple file format and usage
- complemented data sets

key MITprof features:

- standard depth level (prof_depth)
- weight profiles ($1/\sigma^2$ or 0 if ‘bad data’)
- model or climatology profiles (e.g. ECCO v4)

(3) MITprof data sets

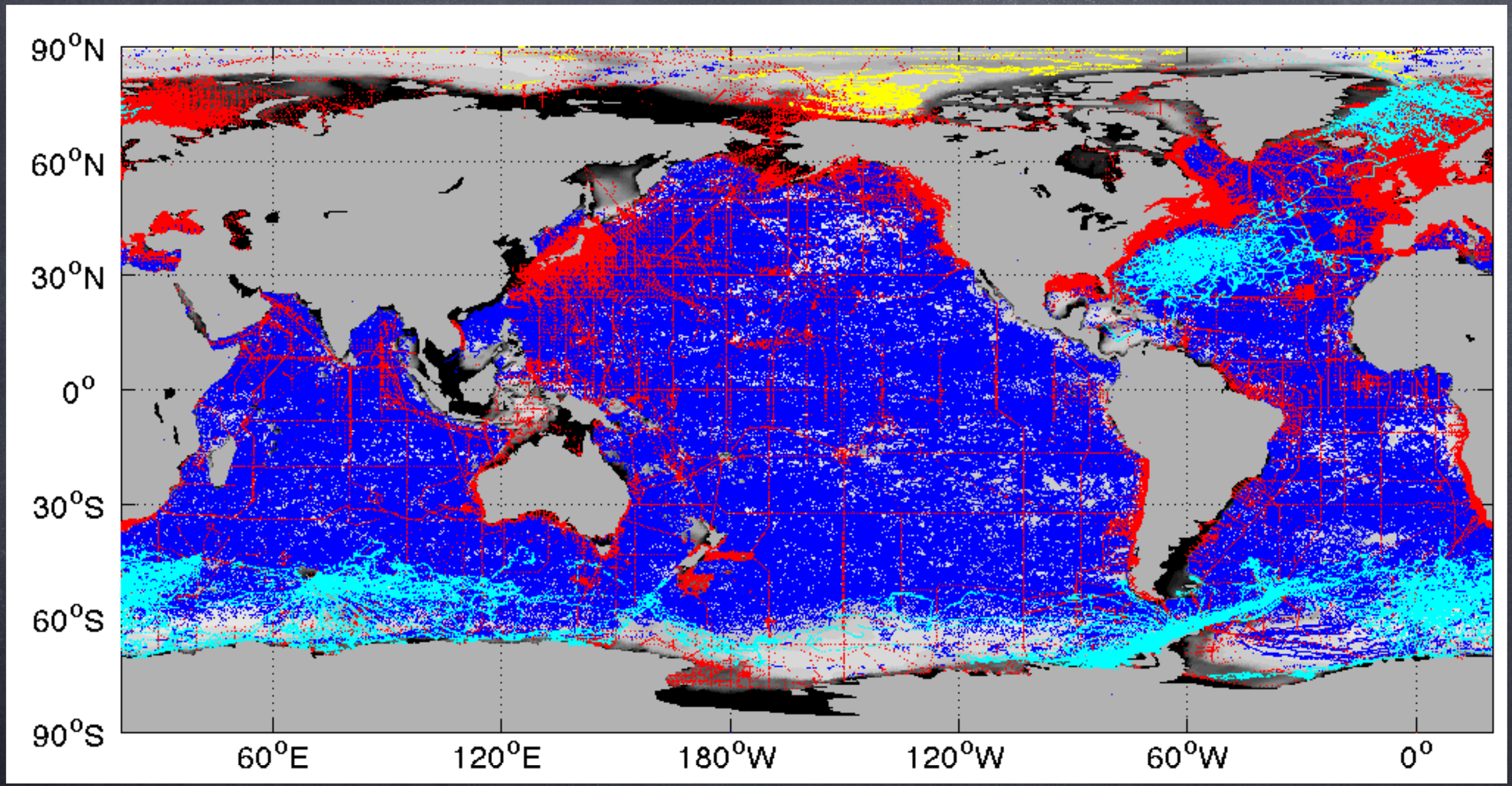


Figure F2. Standardized in situ profile data available in MITprof format from Argo, WOD CTD, climode, ITP, seals over 1992-2011. These are the in situ data that, along with WOD XBT data, are used in ECCO v4 release 1.

(3) MITprof data sets

Table 13: Netcdf file header illustrating the MITprof format used in MITgcm/pkg/profiles.

```
netcdf argo_feb2013_2008_to_2010 {

...
        double prof_T(iPROF, iDEPTH) ;
                prof_T:long_name = "potential temperature" ;
                prof_T:units = "degree C" ;
        double prof_Tweight(iPROF, iDEPTH)
                prof_Tweight:long_name = "least-square weight" ;
                prof_Tweight:units = "(degree C)^-2" ;
        double prof_Testim(iPROF, iDEPTH)
                prof_Testim:long_name = "pot. temp. estimate" ;
                prof_Testim:units = "degree C" ;
...
        double prof_depth(iDEPTH) ;
        double prof_YYYYMMDD(iPROF) ;
        double prof_HHMMSS(iPROF) ;
        double prof_lon(iPROF) ;
        double prof_lat(iPROF) ;
        char prof_descr(iPROF, lTXT) ;
                prof_descr:long_name = "
...
}
```

observed profiles

estimated profiles

weight profiles

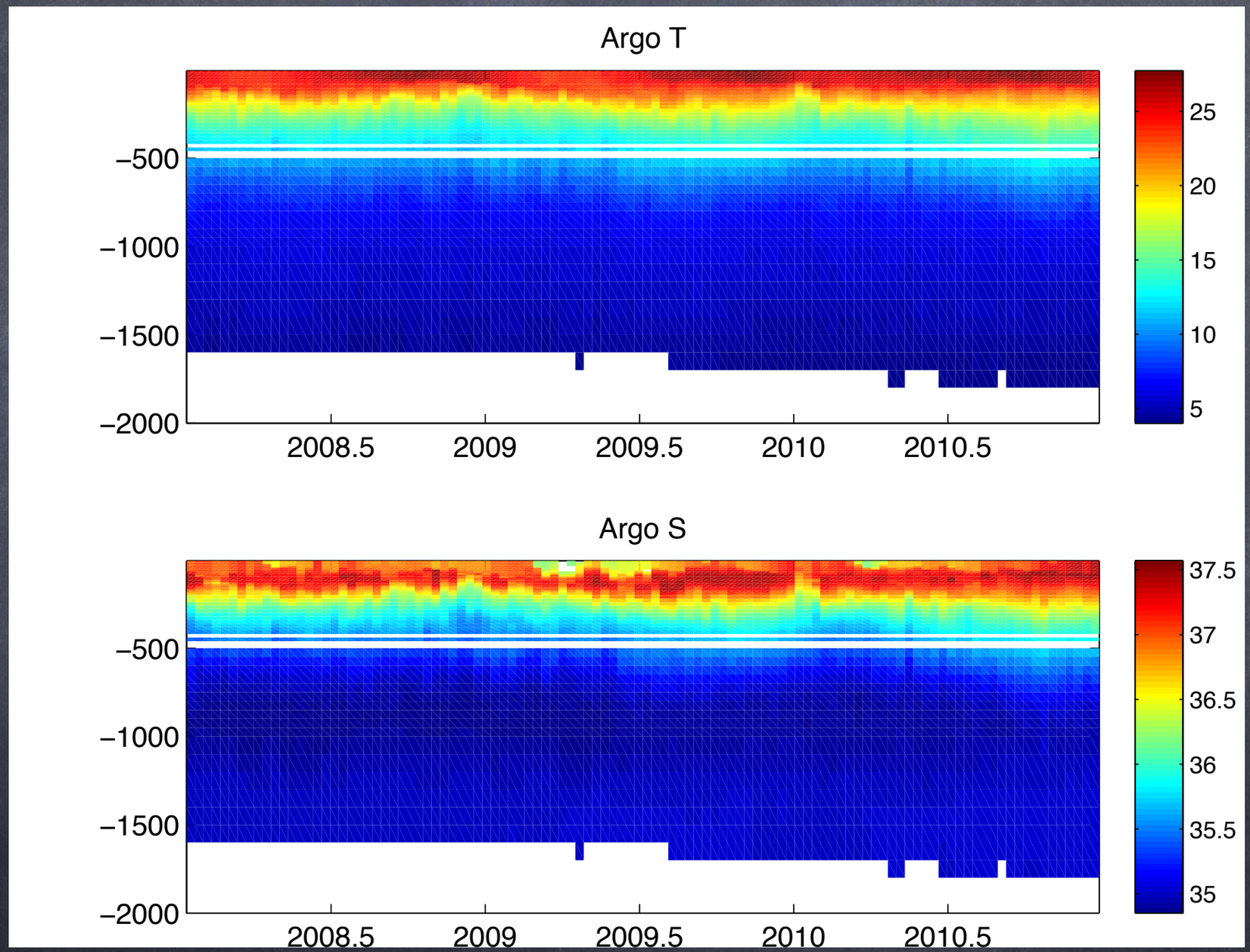
standard depth levels

location & date

identifier

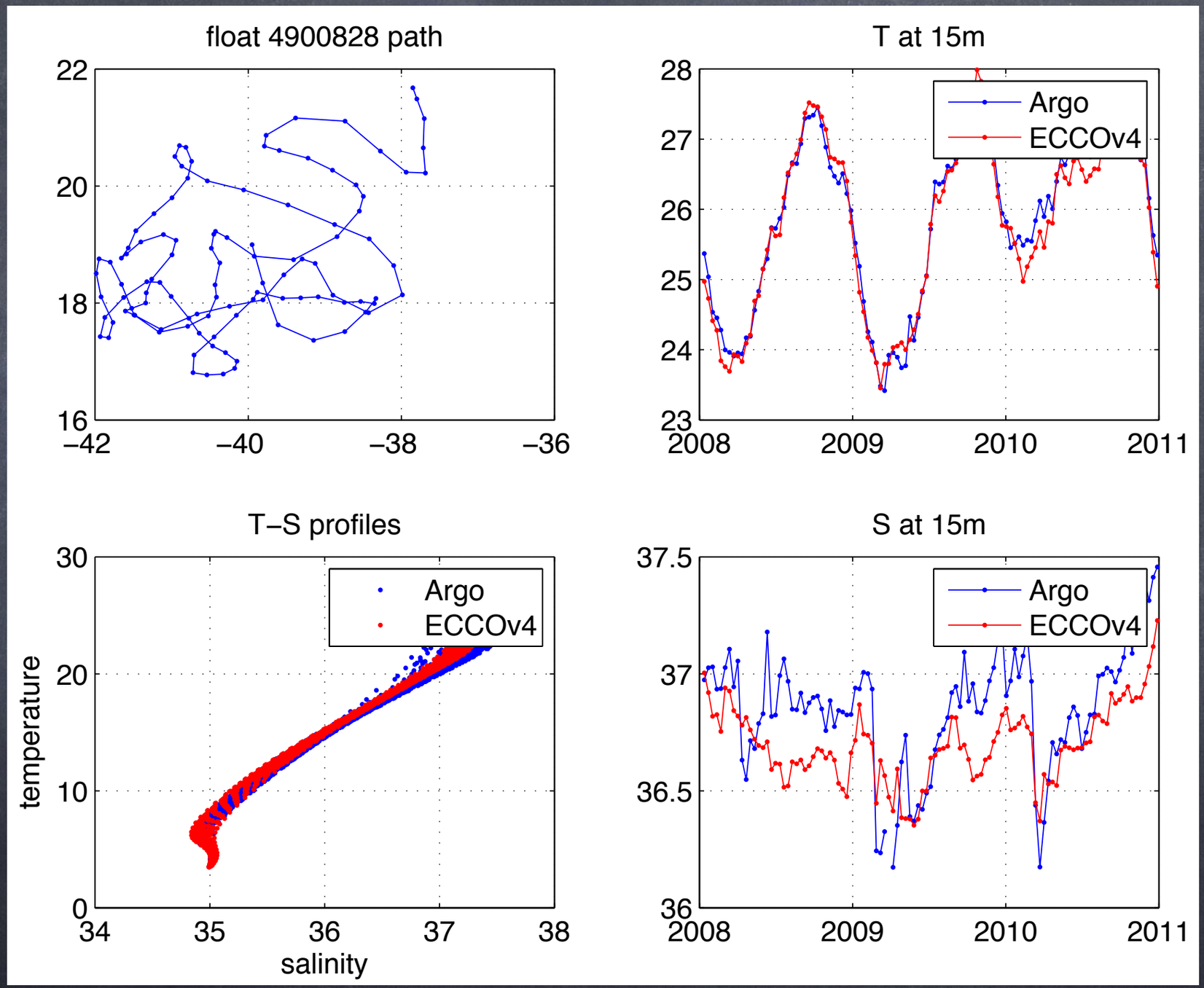
(Forget et al. 2015)

(3) MITprof data sets



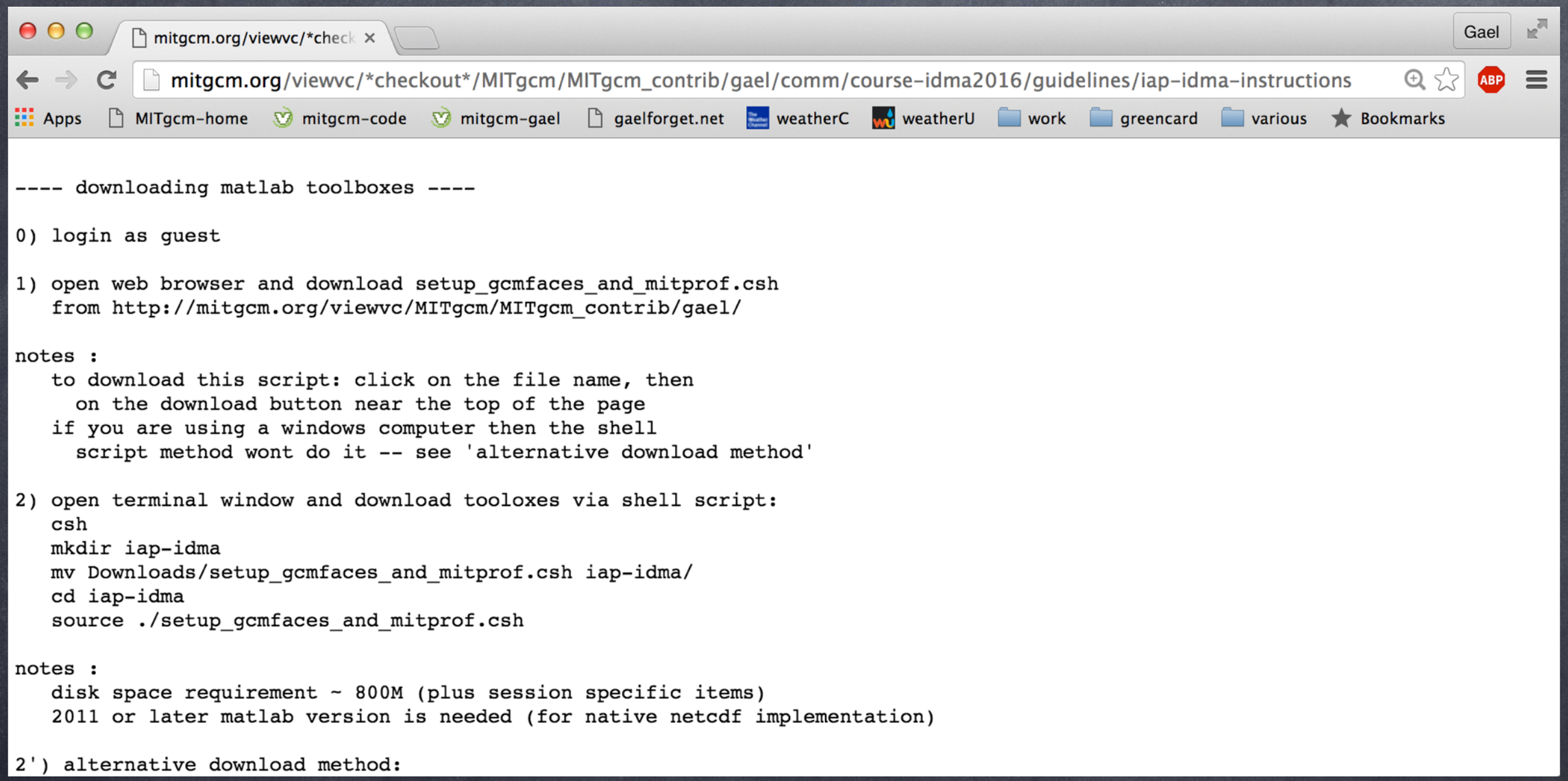
float # 4900828 (MITprof version)

(3) MITprof data sets



float # 4900828 (MITprof version)

(4) activity period



To get started: follow instructions @ http://mitgcm.org/viewvc/*checkout*/MITgcm/MITgcm_contrib/gael/comm/course-idma2016/guidelines/iap-idma-instructions

(4) activity period

MATLAB R2012a

File Edit Debug Parallel Desktop Window Help

Current Folder: /net/barents/raid16/gforget/iap_2016/testrun.v0

Shortcuts How to Add What's New

Current Folder

« testr...

Name

Details

Select a file to view details

Command Window

New to MATLAB? Watch this Video, see Demos, or read Getting Started.

```
>> addpath matlab
>> edit idma_float_plot.m
>> [p]=idma_float_plot('4900828');
```

Workspace

Name Valu

Start

Editor - /net/barents/raid16/gforget/iap_2016/testrun.v0/matlab/idma_float_plot.m

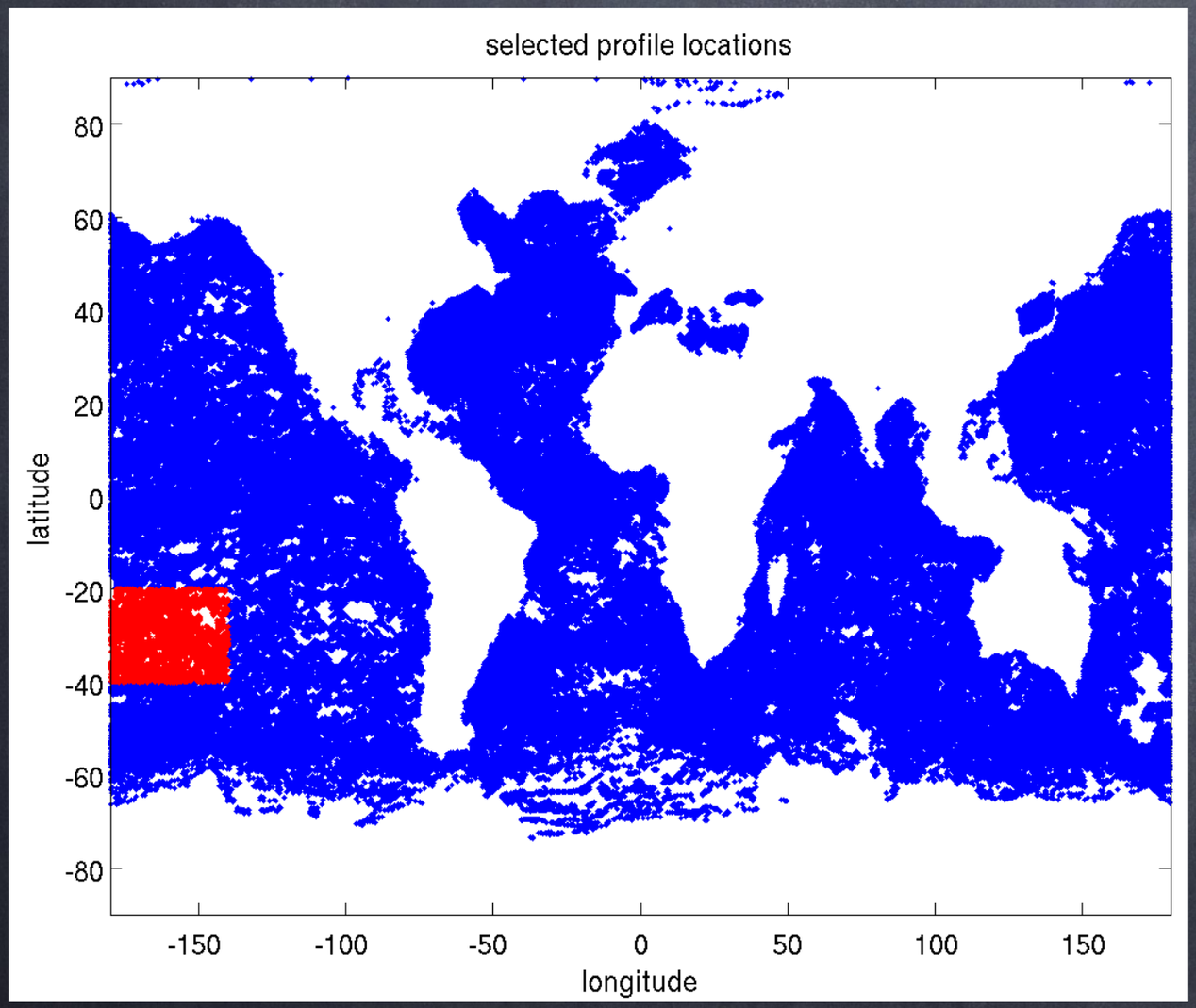
File Edit Text Go Cell Tools Debug Desktop Window Help

Stack: Base

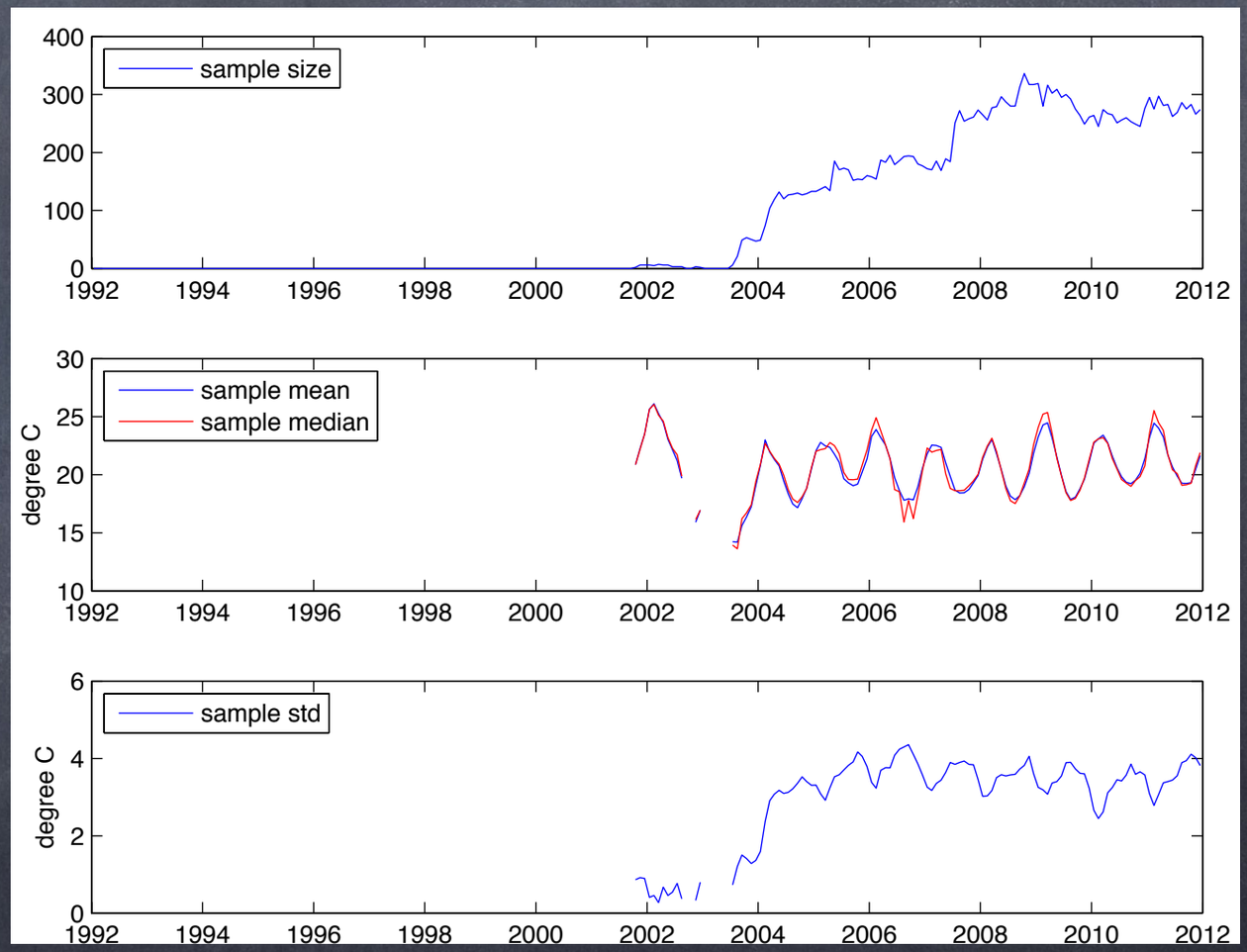
```
1  function [p]=idma_float_plot(nameFloat);
2  %
3  %four Argo floats in subtropical Pacific:
4  % nameFloat='4900828';
5  % nameFloat='4900829';
6  % nameFloat='4900830';
7  % nameFloat='4900831';
8
9  p= genpath('MITprof/'); addpath(p);%TBE
10
11 %load Argo data set:
12 dirIn='release1/MITprof_release1/';
13 nameFile='argo_feb2013_2008_to_2010_model.nc';
14 prof=MITprof_load([dirIn nameFile]);
15
16 %isolate one instrument time series:
```

idma_float_plot Ln 1 Col 1

(4) activity period

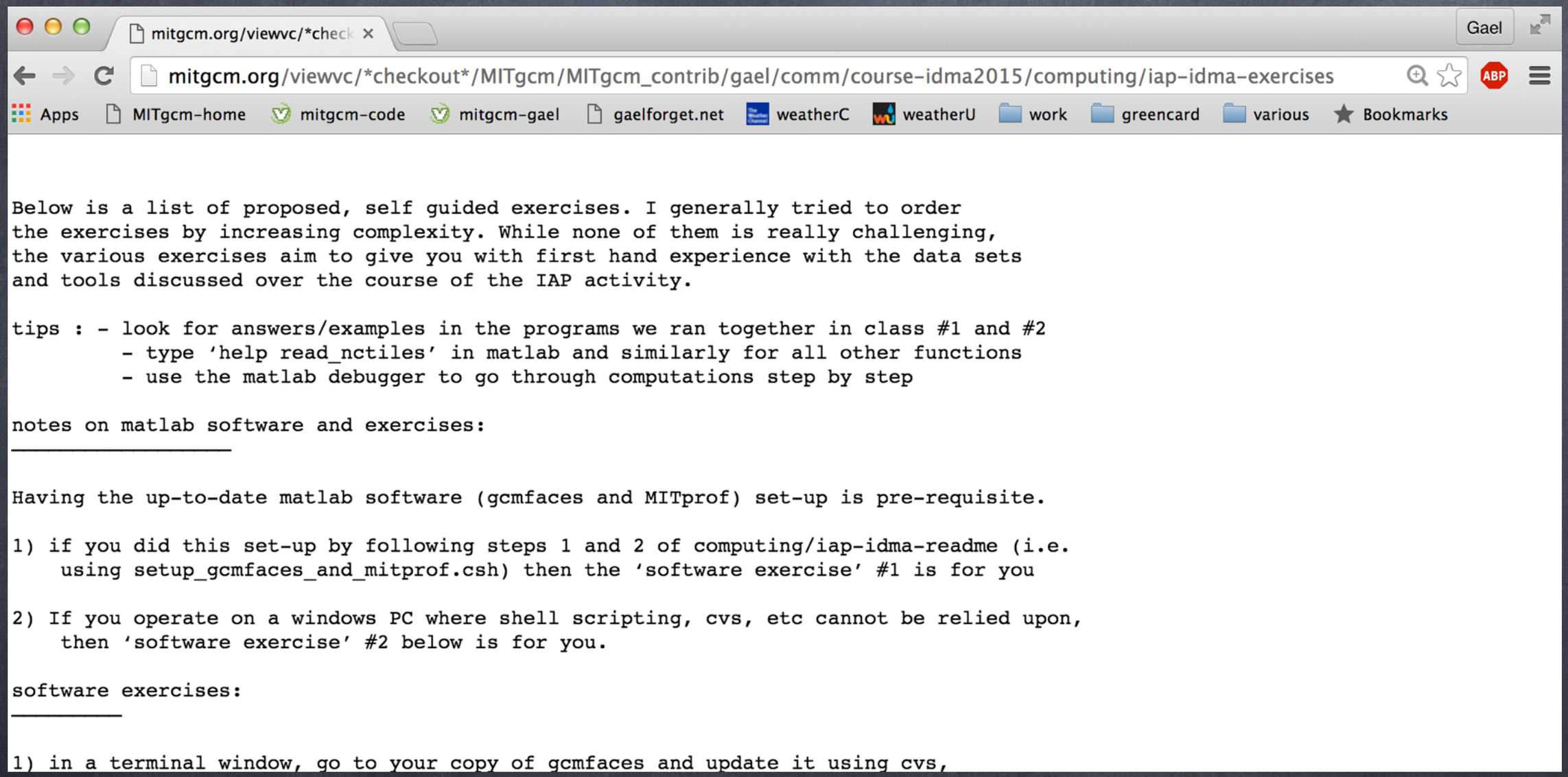


(idma_box_subset.m)



(idma_box_mean.m)

(4) activity period



mitgcm.org/viewvc/*check

Gael

mitgcm.org/viewvc/*checkout*/MITgcm/MITgcm_contrib/gael/comm/course-idma2015/computing/iap-idma-exercises

Apps | MITgcm-home | mitgcm-code | mitgcm-gael | gaelforget.net | weatherC | weatherU | work | greencard | various | Bookmarks

```
Below is a list of proposed, self guided exercises. I generally tried to order
the exercises by increasing complexity. While none of them is really challenging,
the various exercises aim to give you with first hand experience with the data sets
and tools discussed over the course of the IAP activity.

tips : - look for answers/examples in the programs we ran together in class #1 and #2
       - type 'help read_nctiles' in matlab and similarly for all other functions
       - use the matlab debugger to go through computations step by step

notes on matlab software and exercises:
---------------------

Having the up-to-date matlab software (gcmfaces and MITprof) set-up is pre-requisite.

1) if you did this set-up by following steps 1 and 2 of computing/iap-idma-readme (i.e.
    using setup_gcmfaces_and_mitprof.csh) then the 'software exercise' #1 is for you

2) If you operate on a windows PC where shell scripting, cvs, etc cannot be relied upon,
    then 'software exercise' #2 below is for you.

software exercises:
----------

1) in a terminal window, go to your copy of gcmfaces and update it using cvs,
```

Suggested exercise subjects are @ http://mitgcm.org/viewvc/*checkout*/MITgcm/MITgcm_contrib/gael/comm/course-idma2016/guidelines/iap-idma-exercises