The WHOI Ice-Tethered Profiler: Argo of the Arctic

J. Toole

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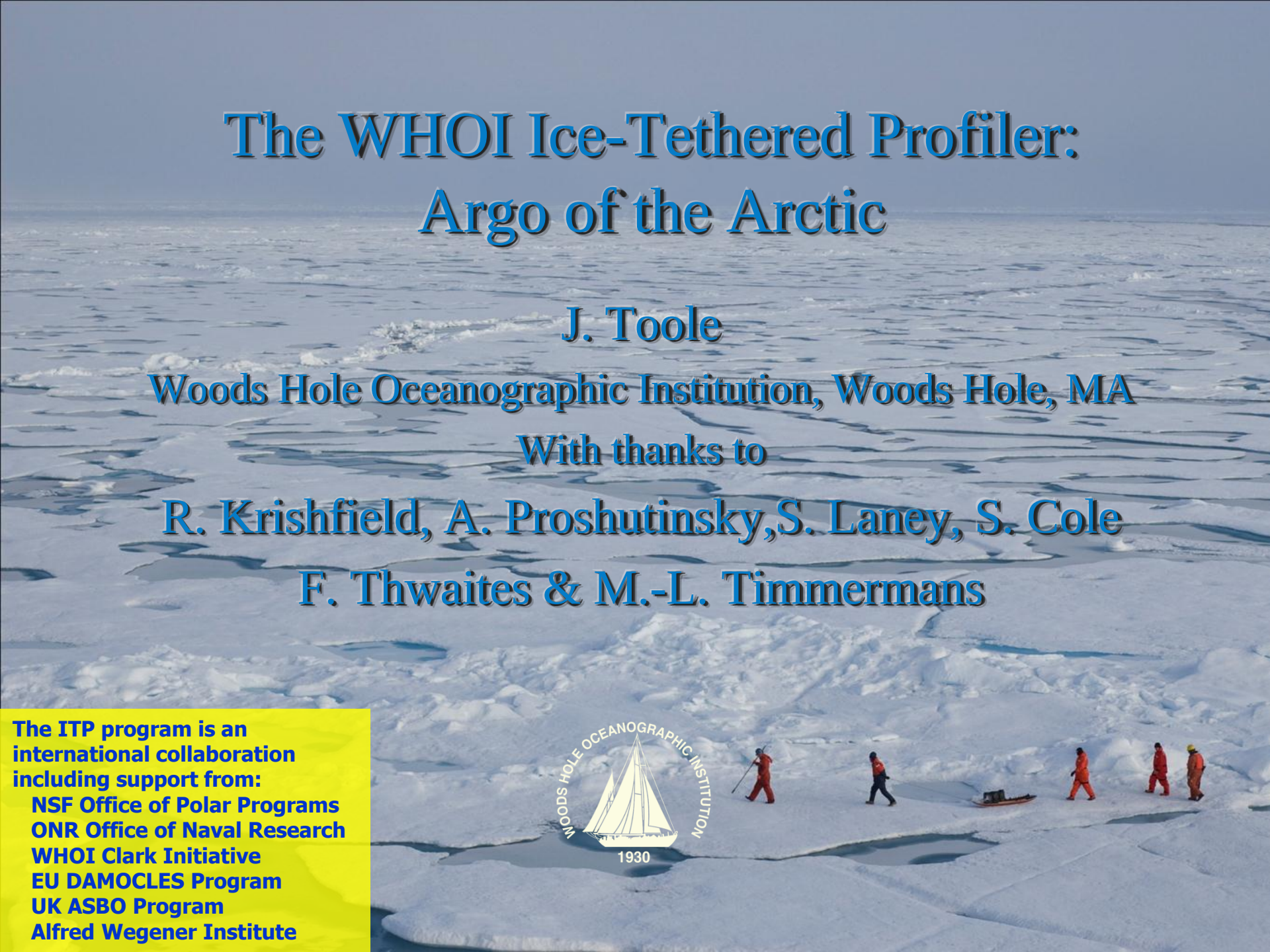
With thanks to

R. Krishfield, A. Proshutinsky,S. Laney, S. Cole

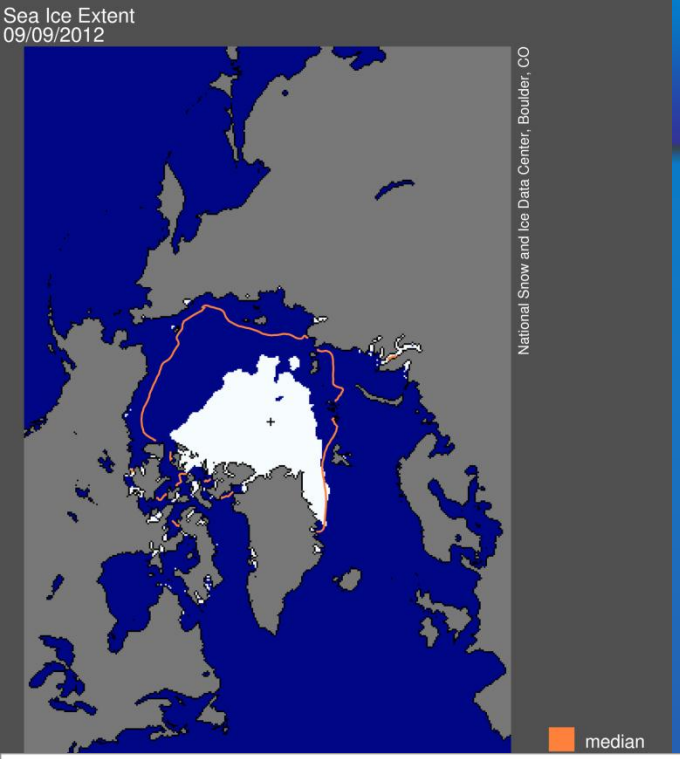
F. Thwaites & M.-L. Timmermans

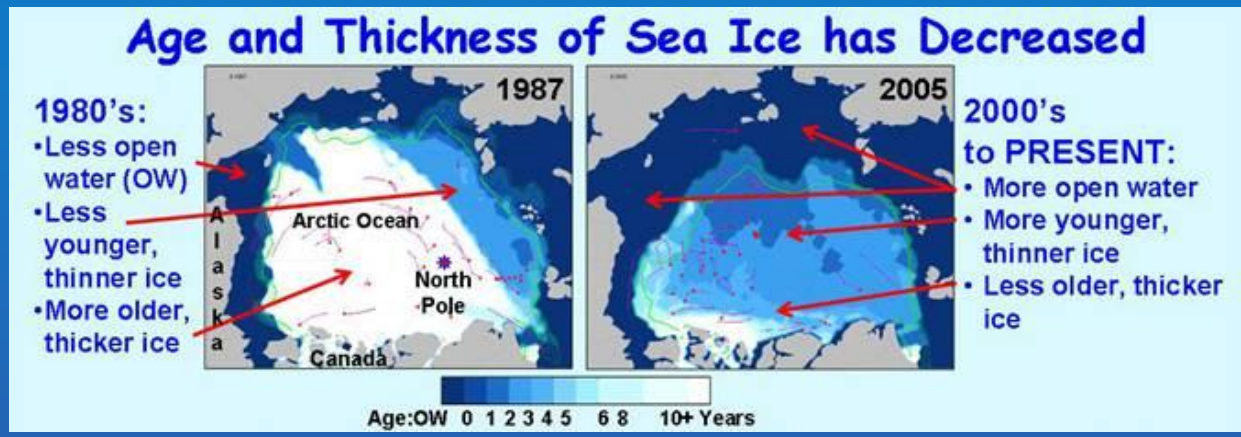


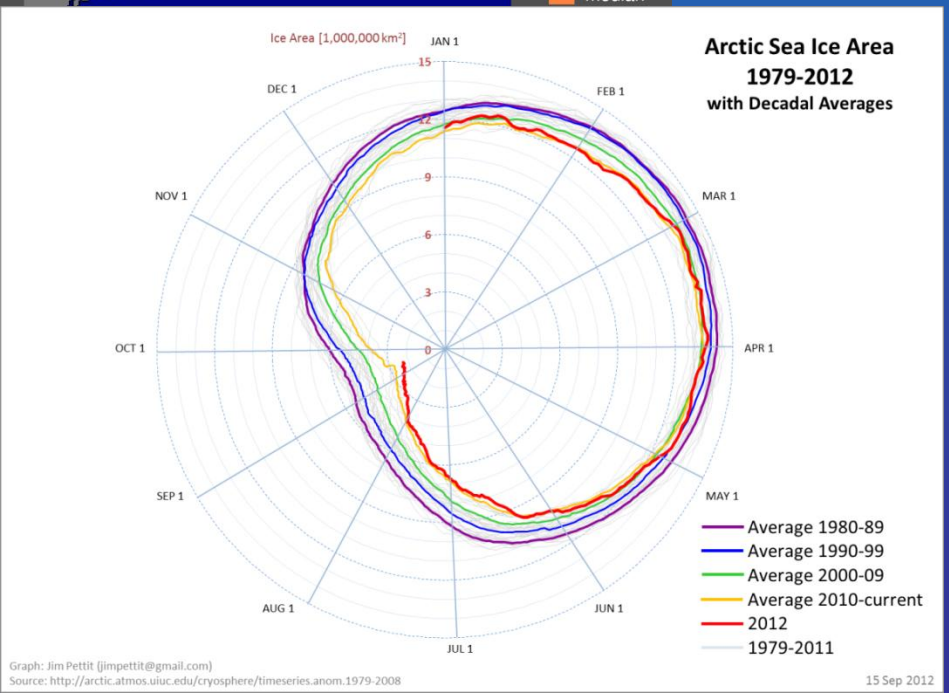
The ITP program is an international collaboration including support from:

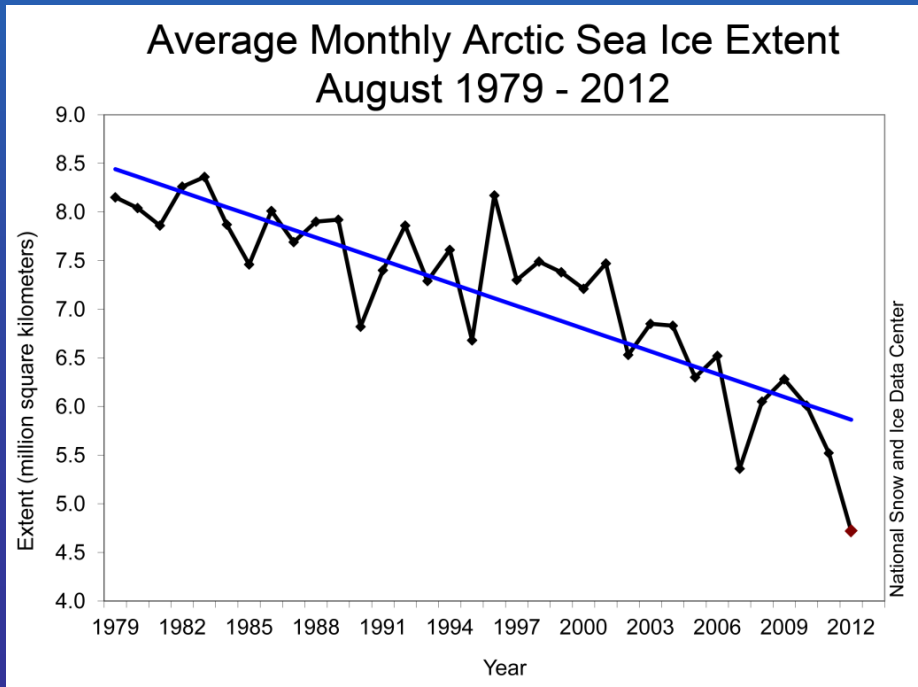
- NSF Office of Polar Programs
- ONR Office of Naval Research
- WHOI Clark Initiative
- EU DAMOCLES Program
- UK ASBO Program
- Alfred Wegener Institute

Science question: what are the causes of Arctic ice loss

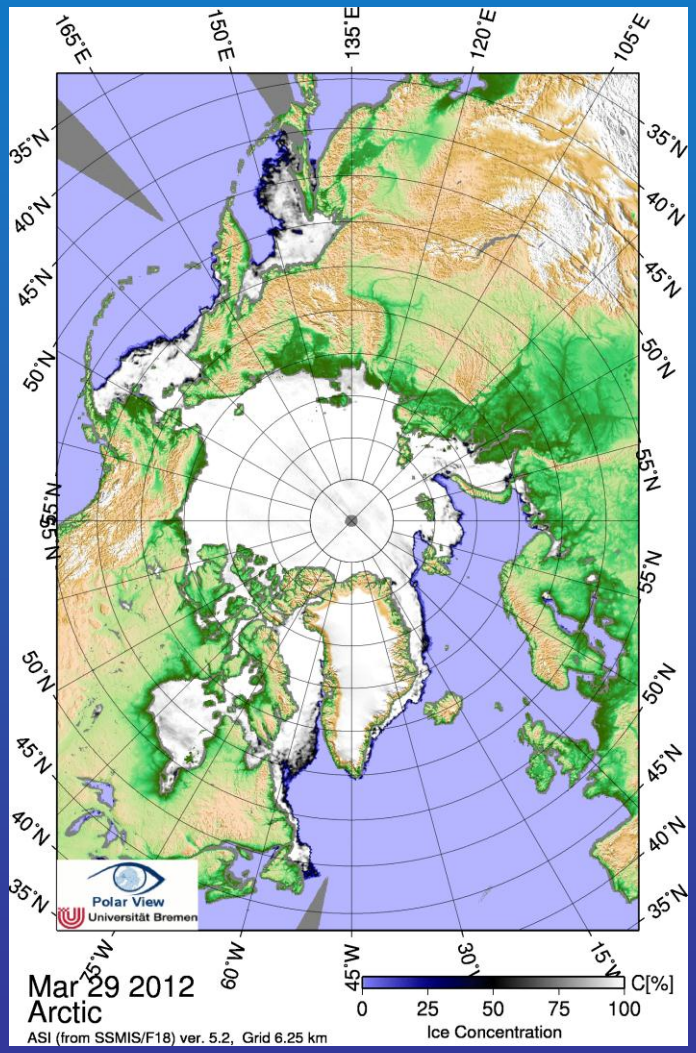








Satellite data are certainly useful, but only skin deep



Manned expeditions to observe the Arctic

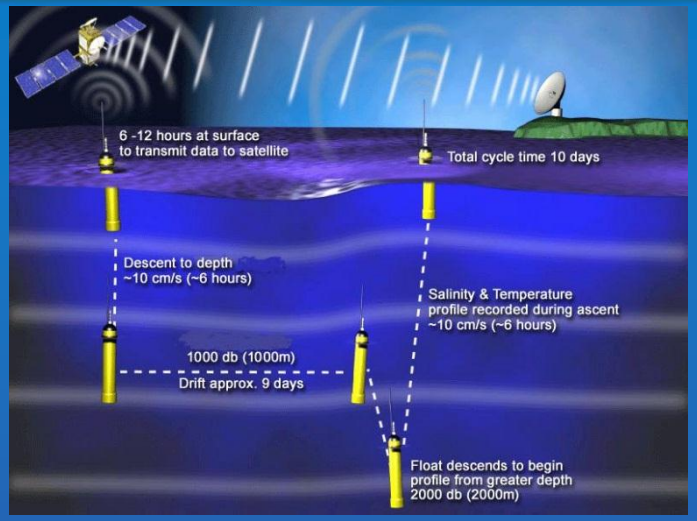
Nansen
Fram 1893-96

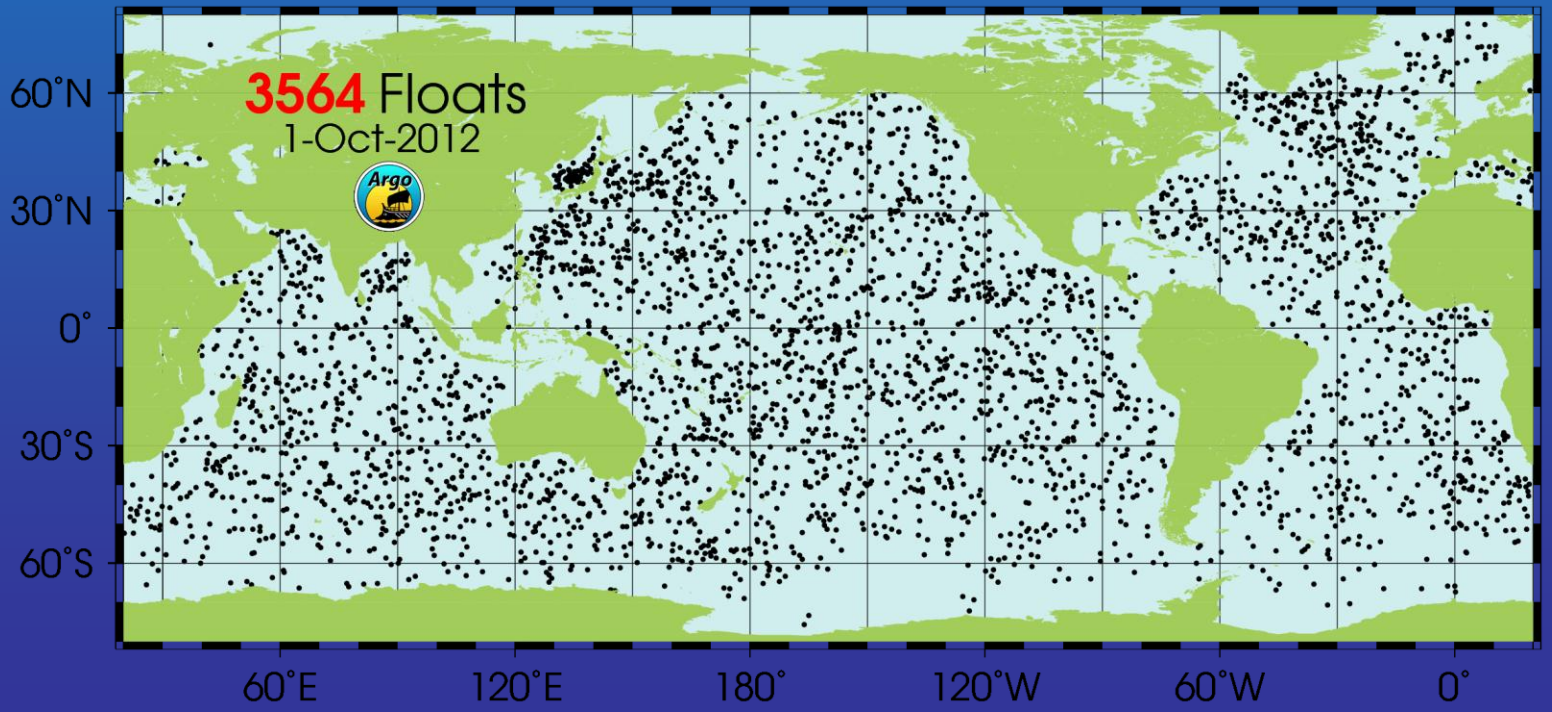
AARI NP Station 1-40

International Argo Float program

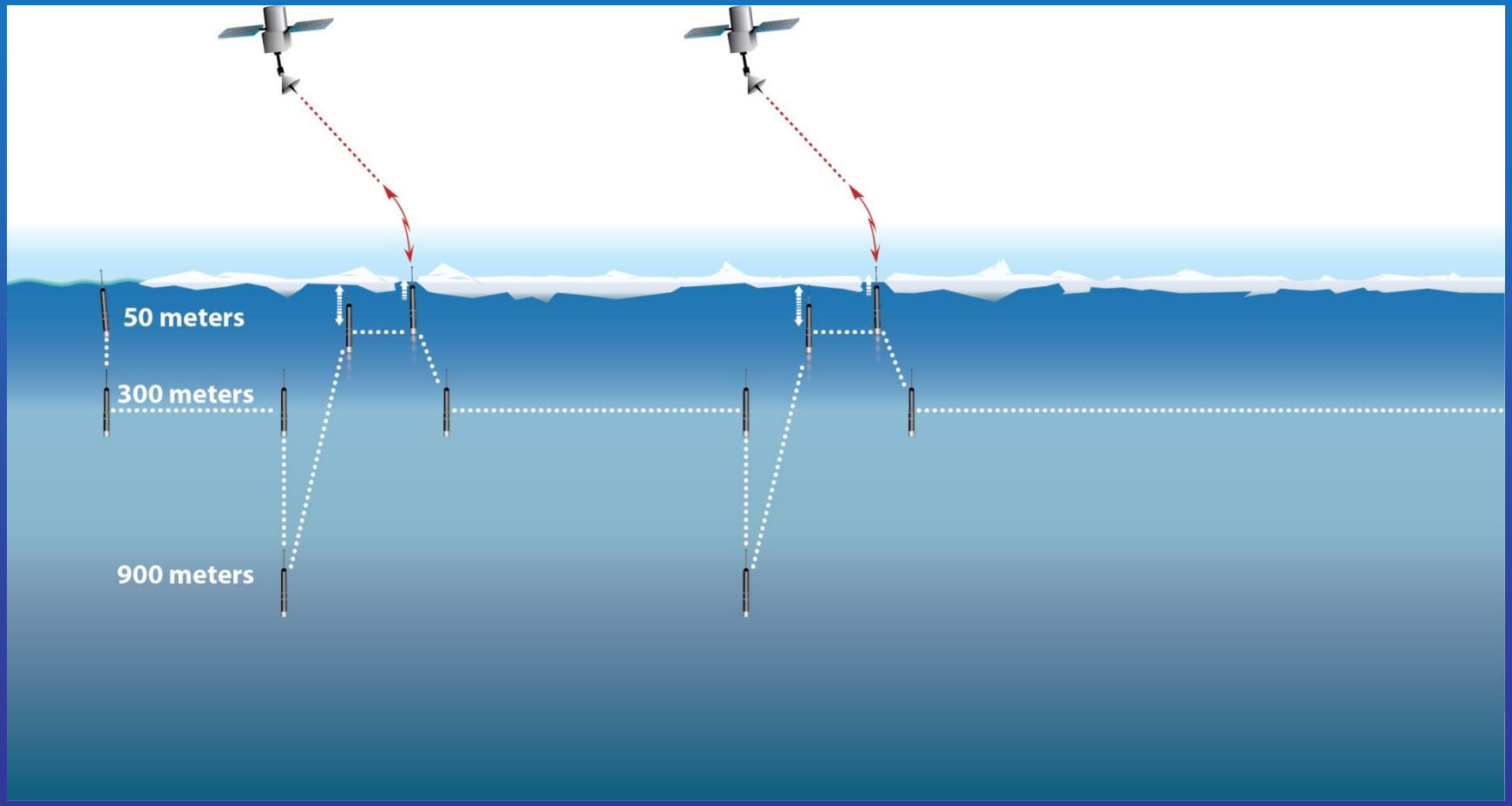
providing data at ~300 km resolution

every 10 days from the temperate oceans

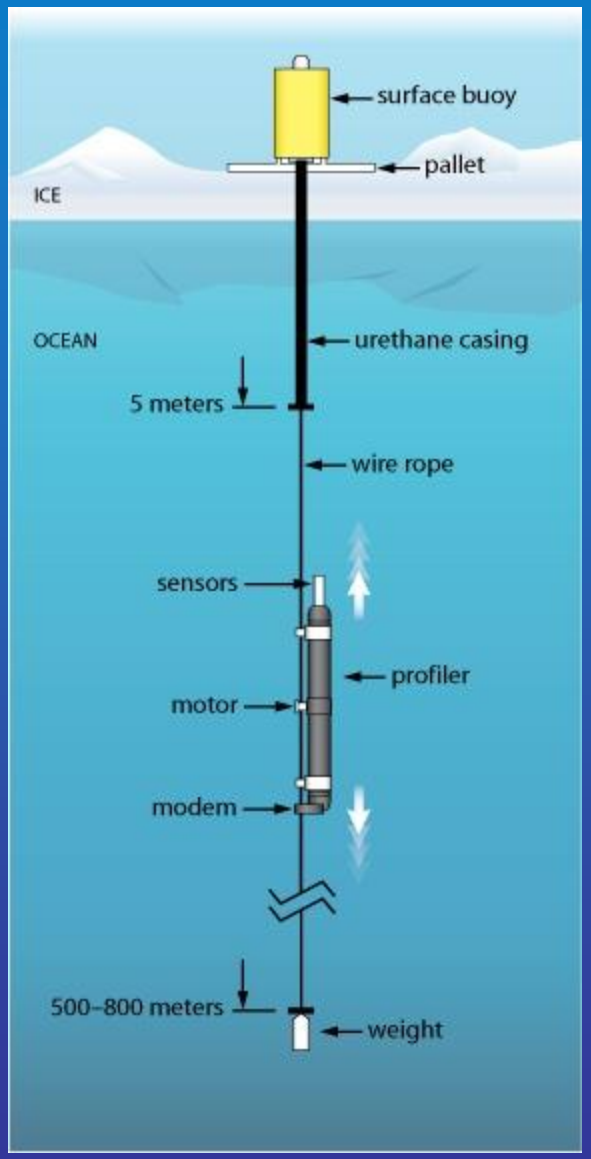




Polar Profiling Floats



Ice-Tethered Profiler



The ITP is an automated instrument system to obtain and transmit in all seasons upper ocean water property profiles under perennial sea ice in the polar oceans.

http://www.whoi.edu/itp

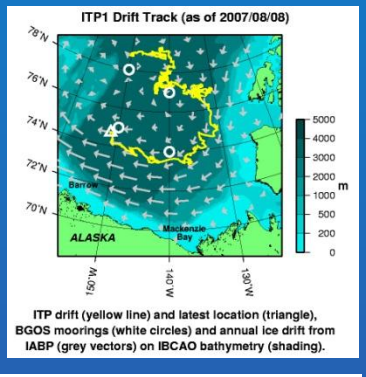
Deployment Procedures

Newhall et al., WHOI-07-05 Technical Report, 2007

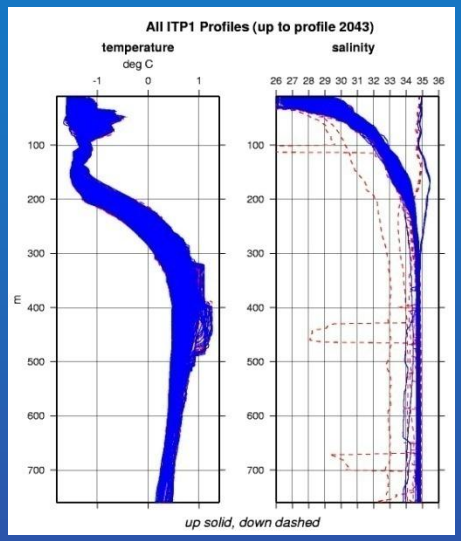
Data Handling and Archiving

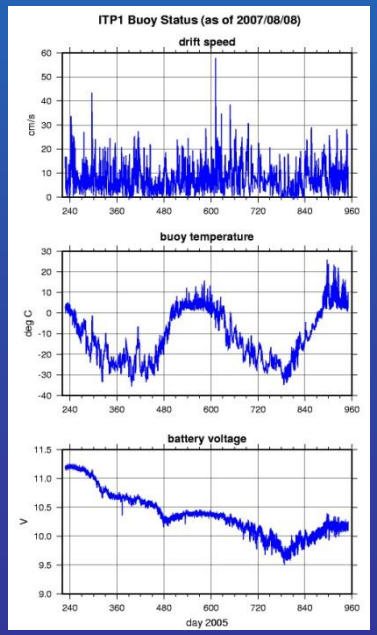
Level 2 automated processing
- available within hours
- no filtering, 2 m bins

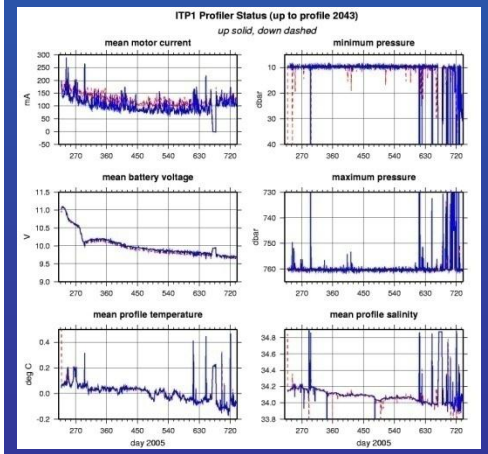
Level 3 final processing
- when mission completed
- filtering
- sensor lags
- drift correction
- C & DO calibration corrections

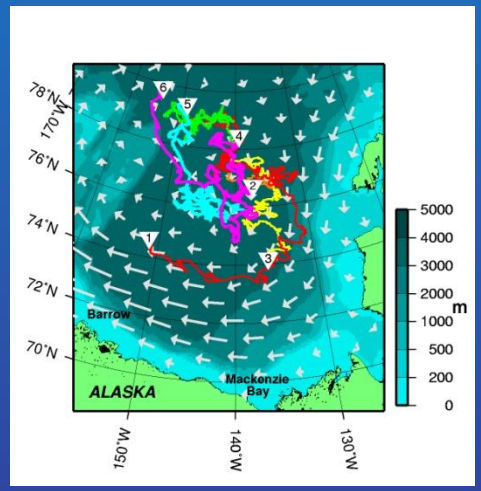


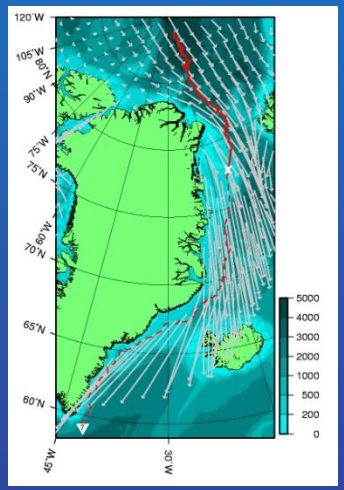
ITP drift (yellow line) and latest location (triangle), BGOS moorings (white circles) and annual ice drift from IABP (grey vectors) on IBCAO bathymetry (shading).









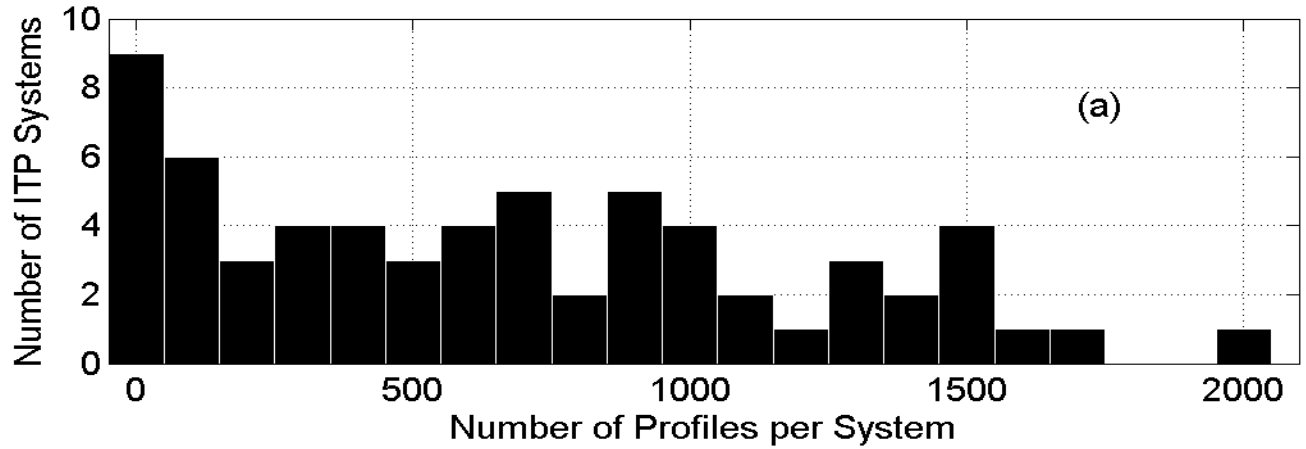


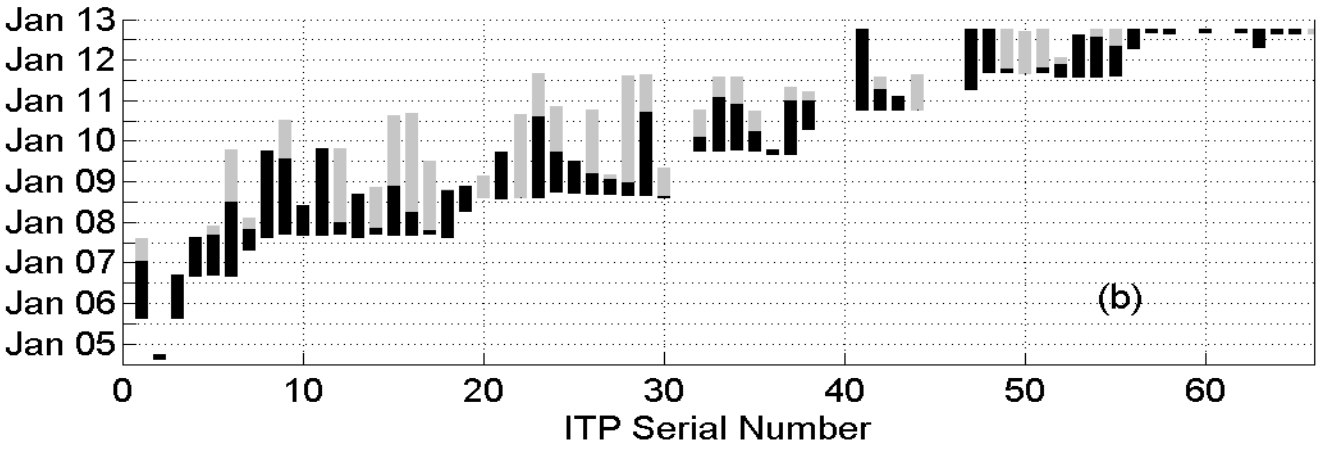
www.whoi.edu/itp

Also accessible from DAMOCLES website

Also archived at Arctic Observing Network CADIS

Performance Statistics



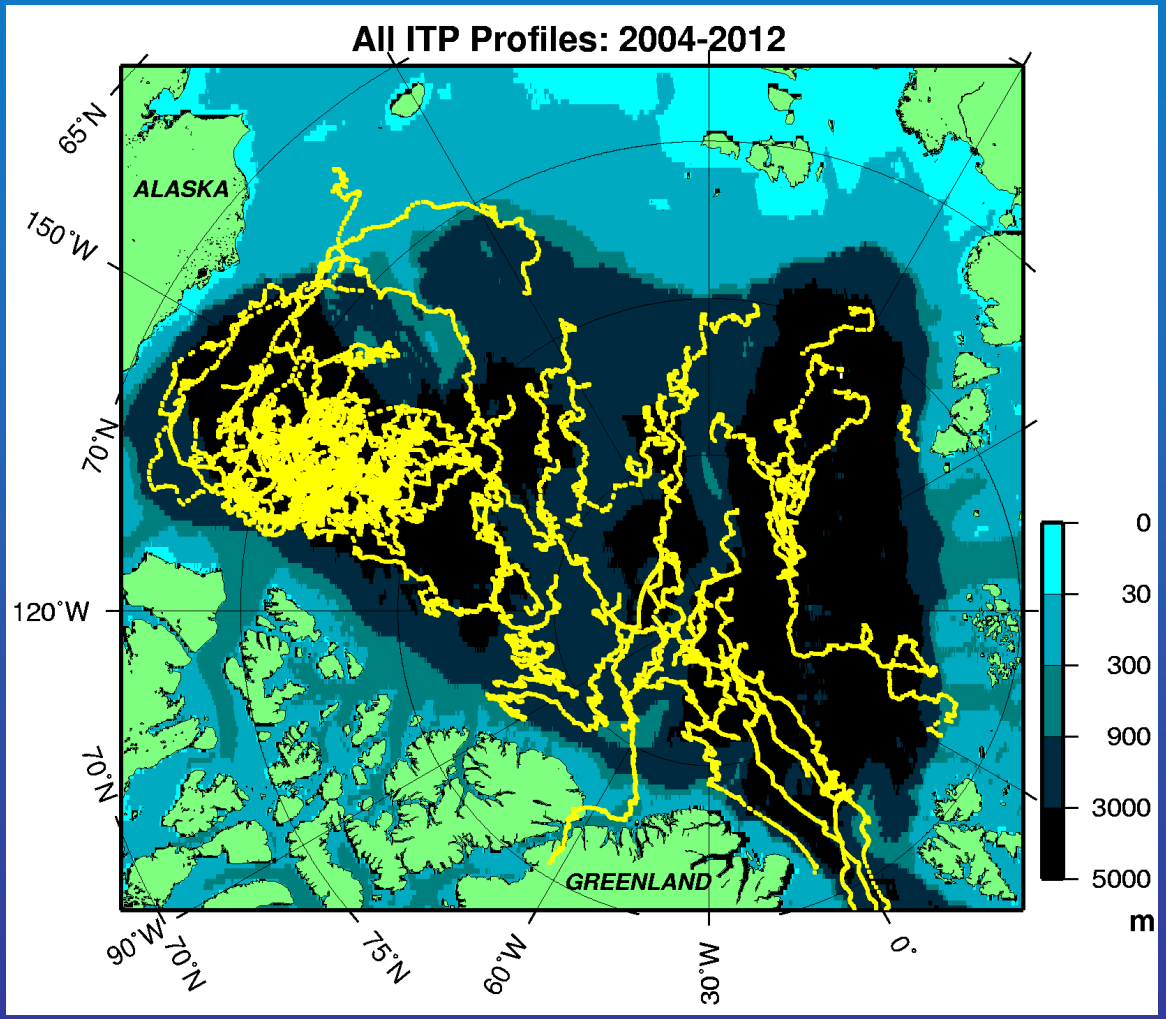


Average buoy lasts 520 days and returns 760 T & S profiles

Distribution of ITP-derived T & S Profiles 2004-2012

Toole, J.M., R.A. Krishfield, M.-L. Timmermans and A. Proshutinsky, 2011. The Ice-Tethered Profiler: Argo of the Arctic.

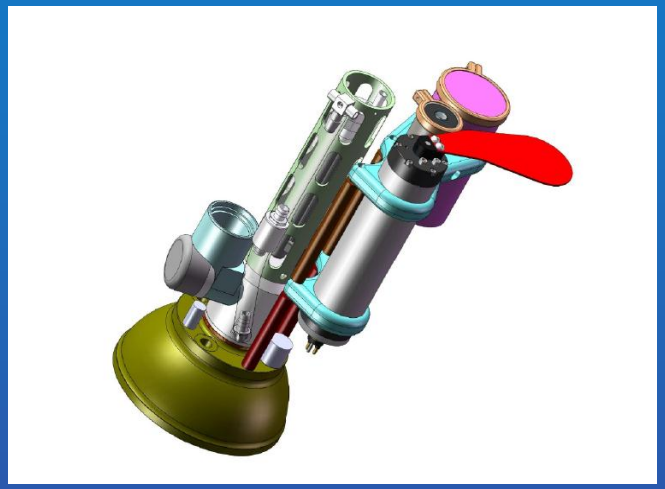
plot updated from: *Oceanography*, 2011



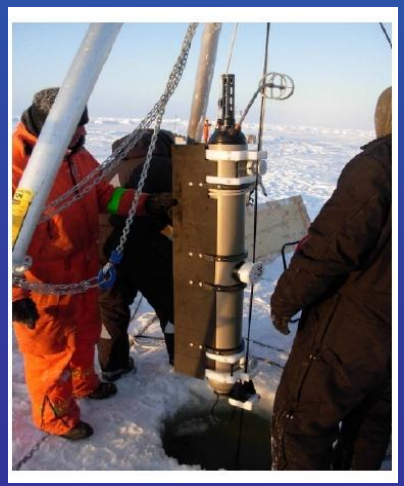
Present Development Efforts

Open water deployments

bio-optical sensors: chlorophyll and dissolved organic matter fluorescence, seawater turbidity, PAR



velocity sensor

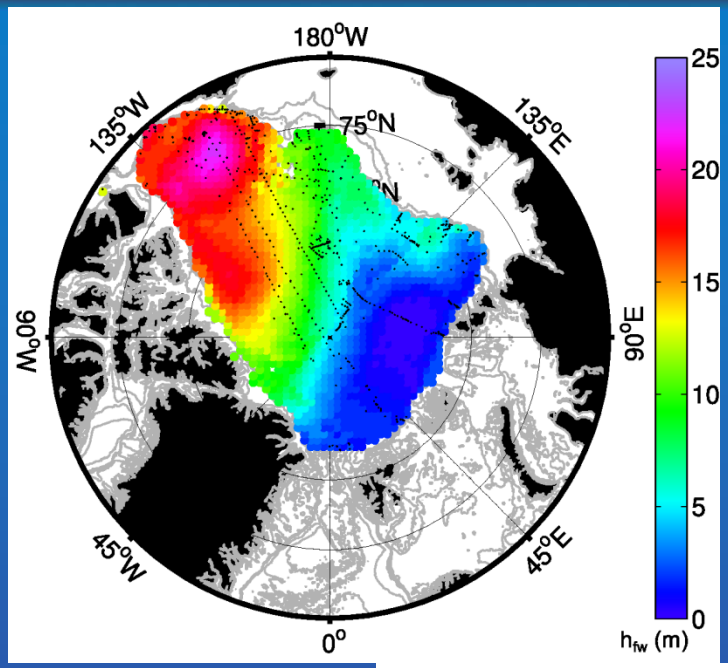


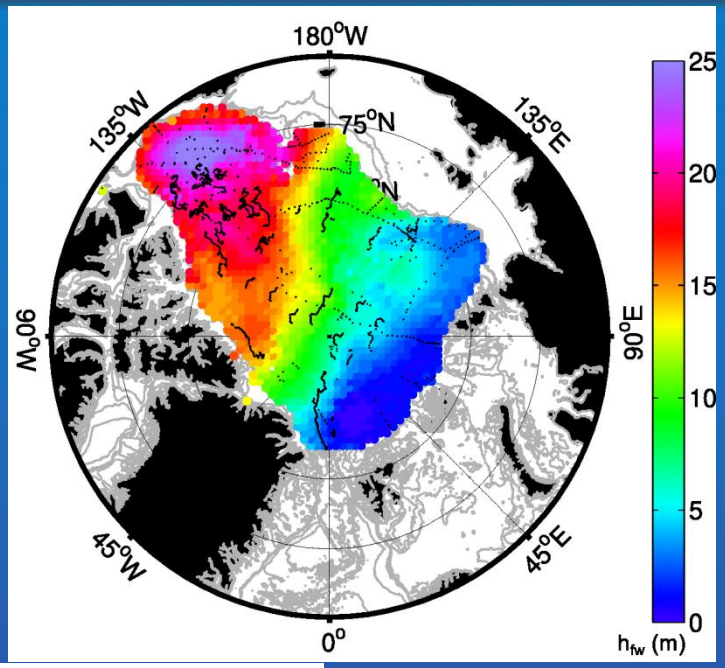
CO2 sensor: w/Michael deGrandpre, U. Montana

Examples of Science based on ITP data

Changes in Fresh Water Content (salinity)

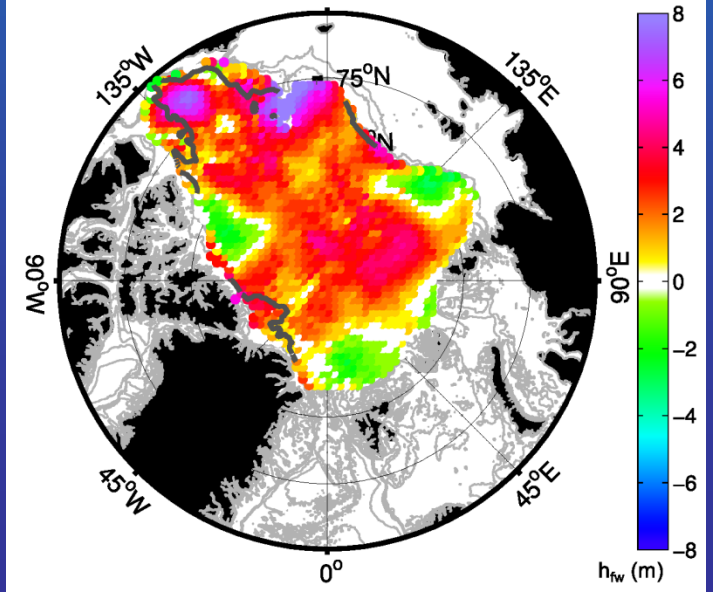
1990s





IPY

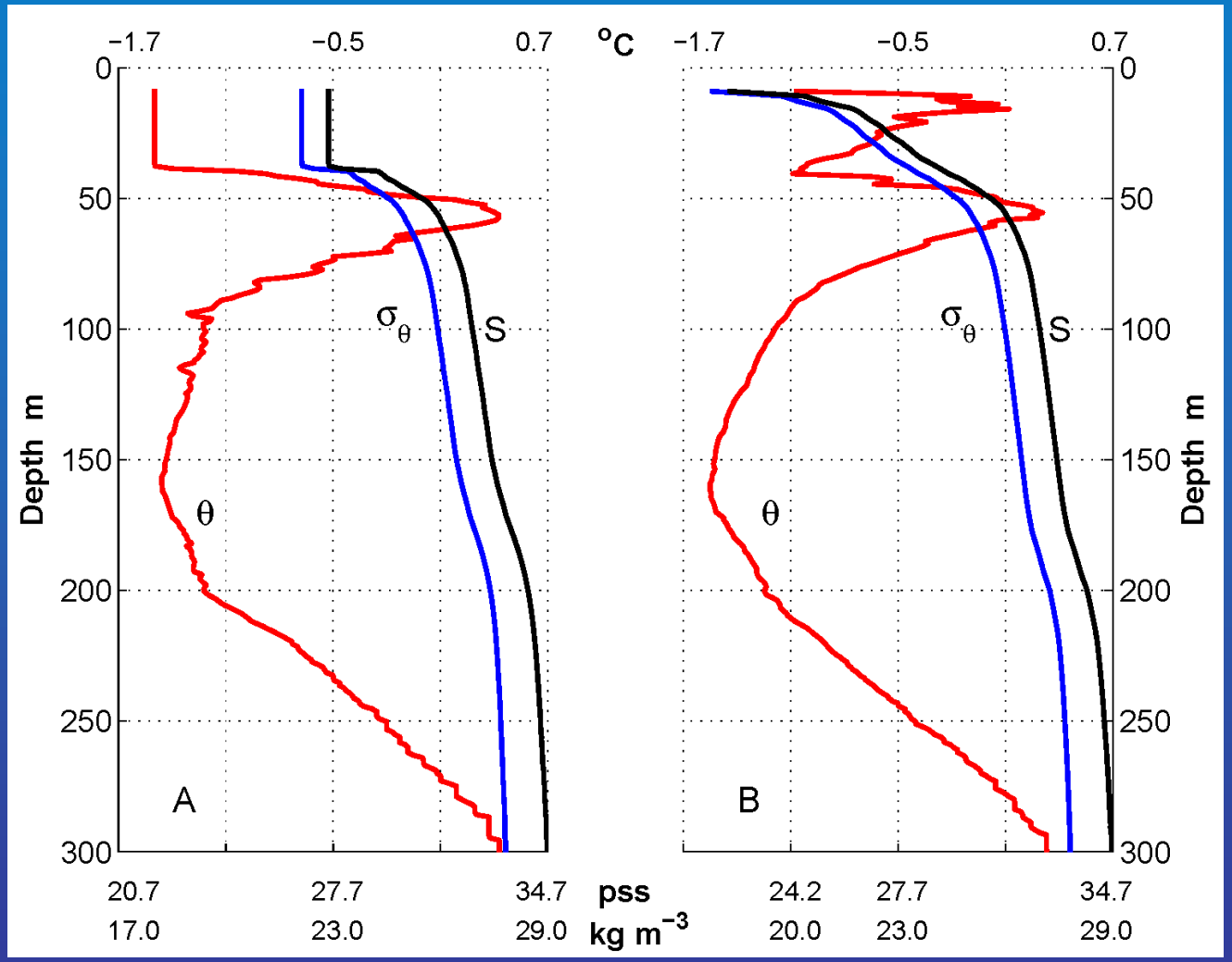
Difference



Rabe, B., M. Karcher, U. Schauer, J. M. Toole, R. A. Krishfield, S. Pisarev, F. Kaukera, R. Gerdes and T. Kikuchi. An assessment of pan-Arctic Ocean freshwater content changes from the 1990s to the IPY period. *Deep-Sea Research-I*, **58**, 173–185, ISSN 0967-0637, DOI: 10.1016/j.dsr.2010.12.002

Seasonal ocean changes observed with ITPs

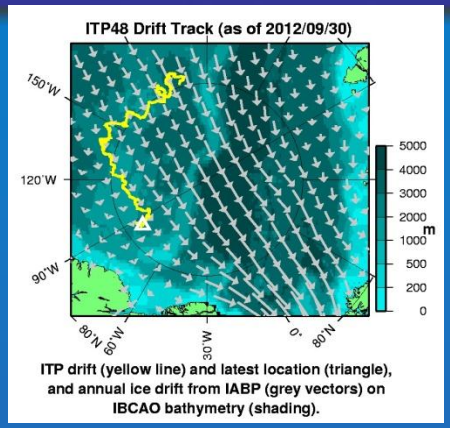
winter



summer

Toole, J.M., M.-L. Timmermans, D. K. Perovich, R. A. Krishfield, A. Proshutinsky, and J.A. Richter-Menge, 2010. Influences of the Ocean Surface Mixed Layer and Thermohaline Stratification on Arctic Sea Ice in the Central Canada Basin. *Journal of Geophysical Research,* **115**, C10018, doi:10.1029/2009JC005660.

ITP 48: first-ever year-long autonomous assessment of phytoplankton seasonal patterns in the Arctic ocean



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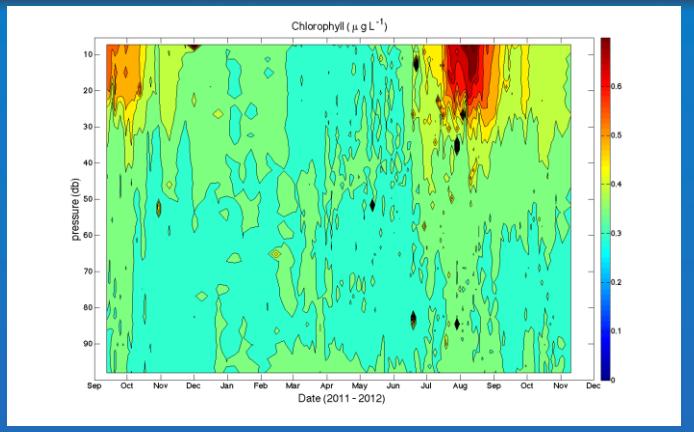
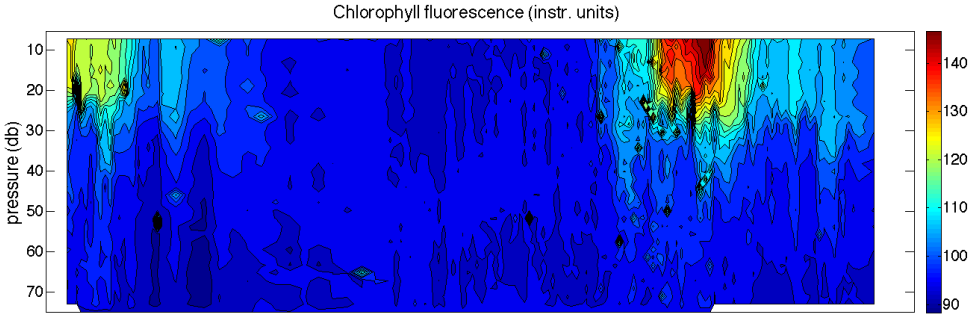
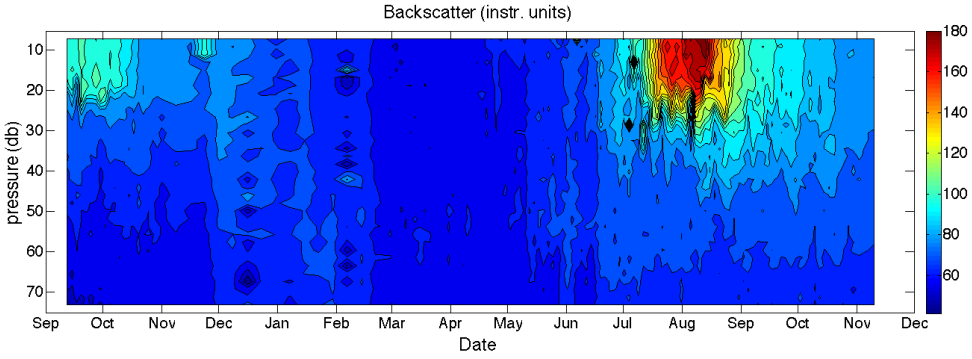
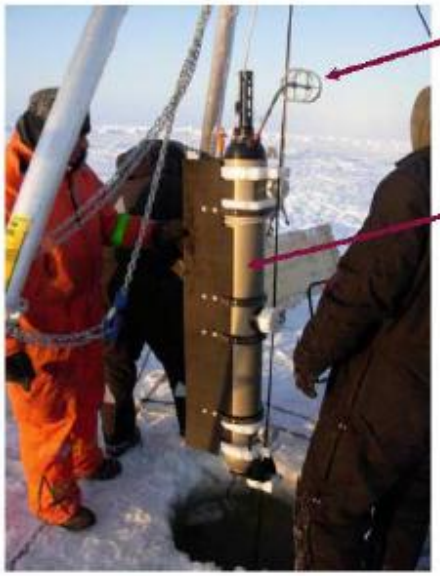






Sam Laney
WHOI Biology Dept

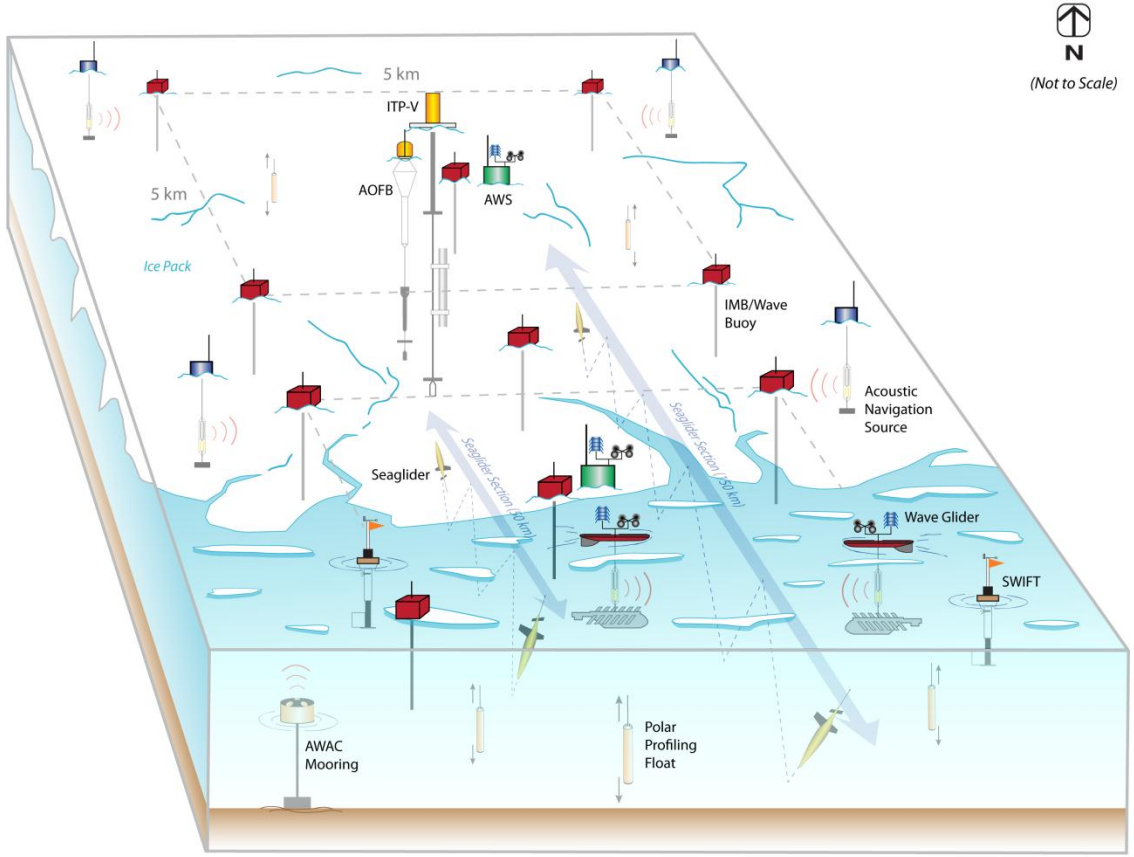
ITP-V : Ice-Tethered Profiler with Velocity



Ice Tethered Profiler (ITP-V)

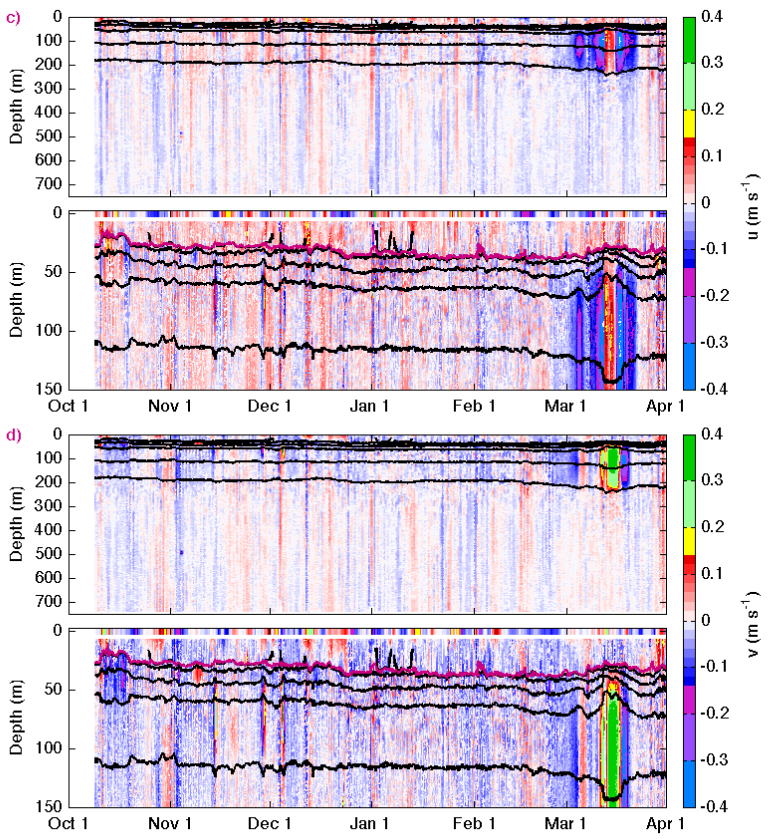
ONR Marginal Ice Zone DRI

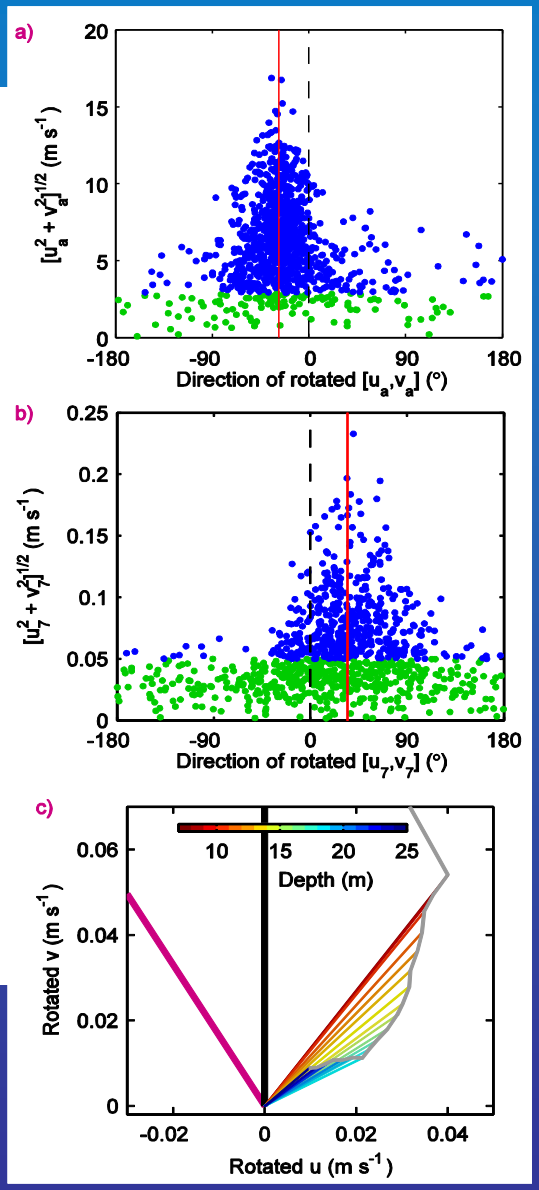
ITP-V array + acoustically-navigated profiling floats and gliders (UW/APL)



ITP-V observations of:

Absolute ocean velocity

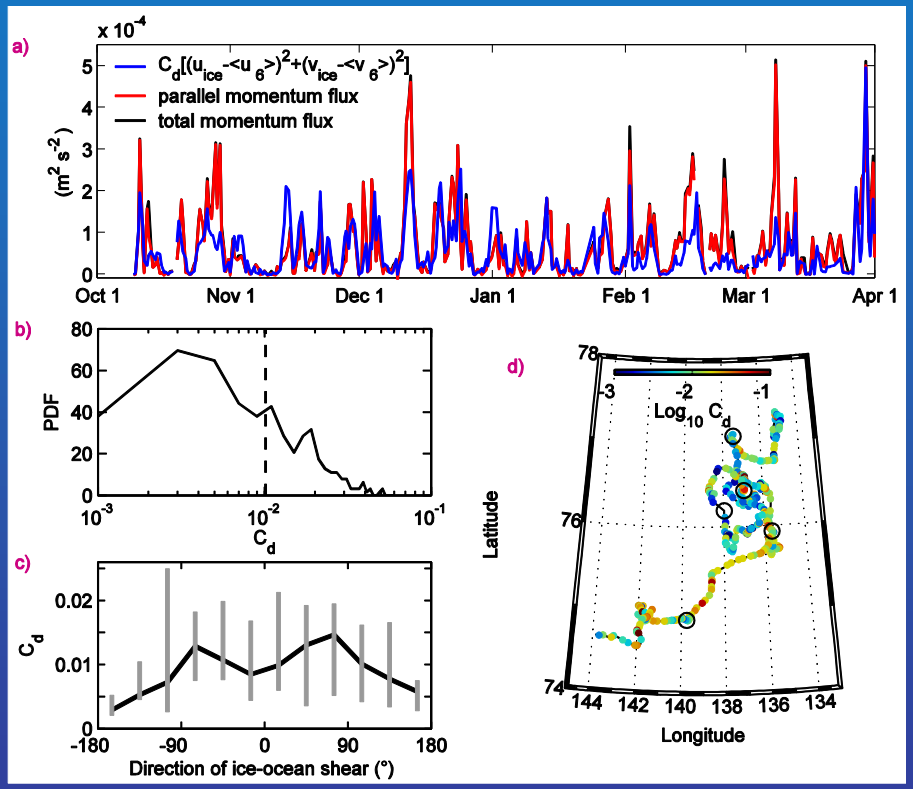


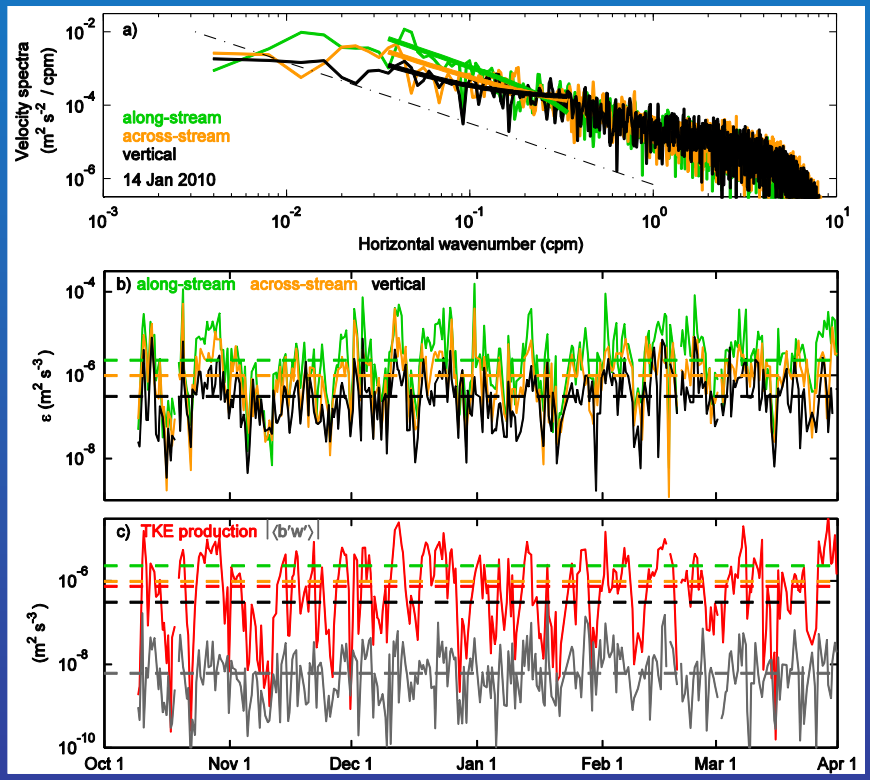


Ekman-Layer (1905) behavior

Cole, et al. 2012 - Ekman veering, internal waves, and turbulence observed under Arctic sea-ice. JPO, submitted.

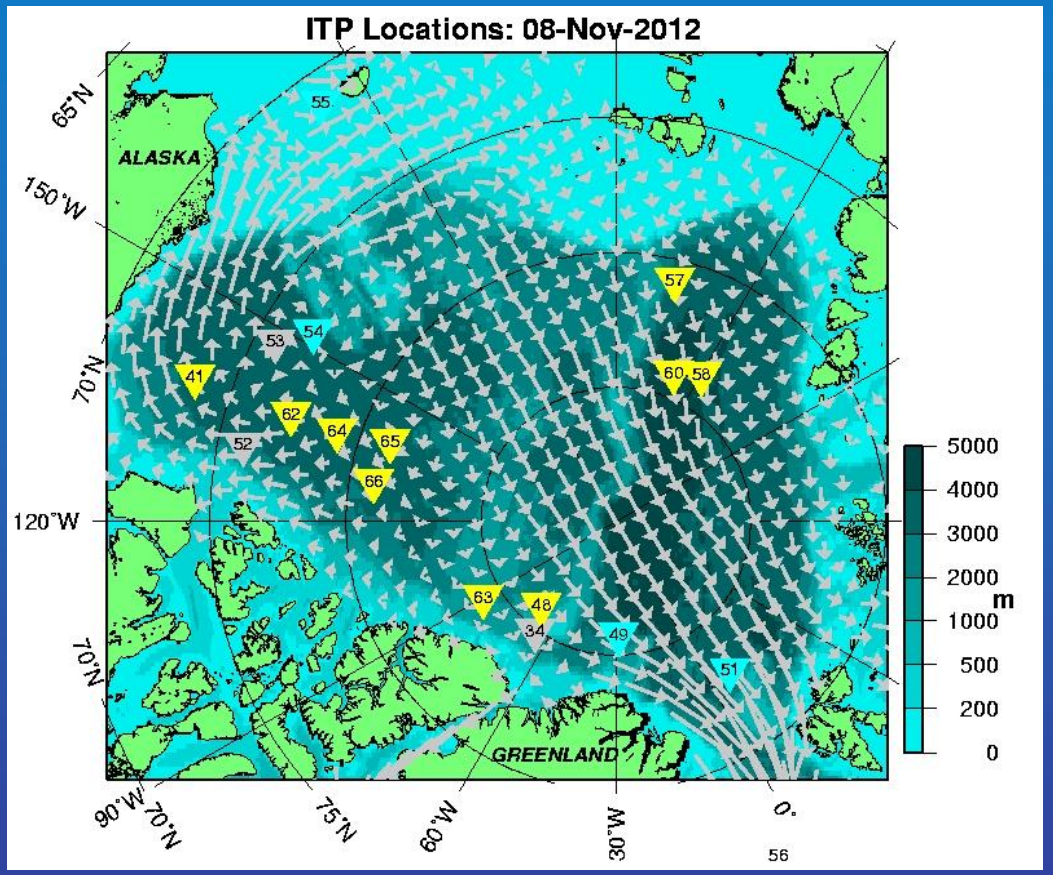
Turbulent vertical fluxes and Turbulent Dissipation Rate





Status of ITP Program

- First prototype deployed August 2004
- 60 ITPs deployed in Arctic to date
- Over 45,000 CTD profiles obtained
- 6 complete + 4 partial ITPs recovered
- Presently 11 fully functioning + a few sending surface information
- Funded to build and deploy 7 more ITPs in the Arctic 2013, and 9 in 2014.
- Continuing to collaborate with other investigators to field and maintain an array of multi-sensor Ice-Based Observatories



Data available in real time from www.whoi.edu/itp