The Role of Salinity in Tropical Pacific Sea Surface Height Variability: Early Results from the Argo Project

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Introduction:

There are presently over 400 active Argo floats (Fig 1) deployed by 12 different national programs. More than 1500 floats have now been funded, with proposals for about 900 floats per year for the next few years. A global array of 3000 floats at average spacing of 3-degrees in latitude and longitude is planned by late 2005. All data are available in near real-time via the GTS or internet (http://www.ifremer.fr/coriolis/cdc/argo.htm). Deployment of a New Zealand Argo float is shown (Fig 2, photo courtesy NIWA, NZ), together with recent data from that float.

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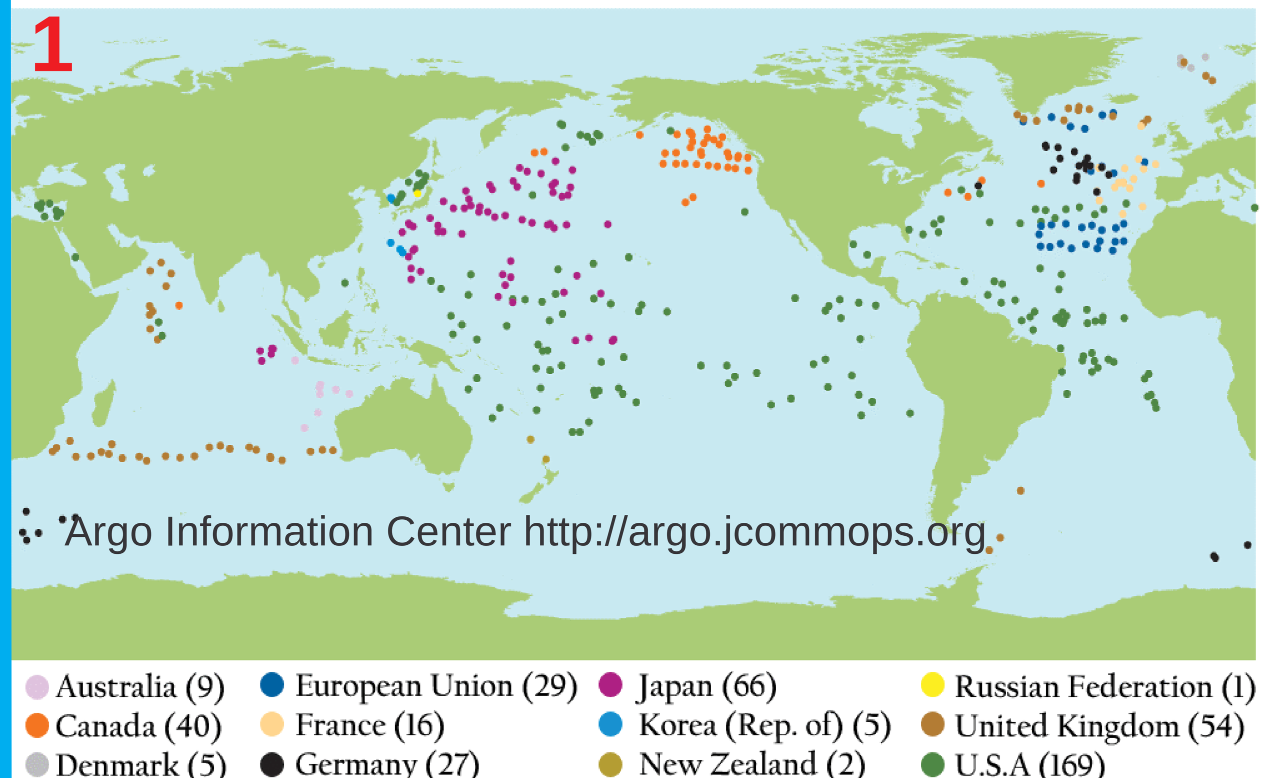

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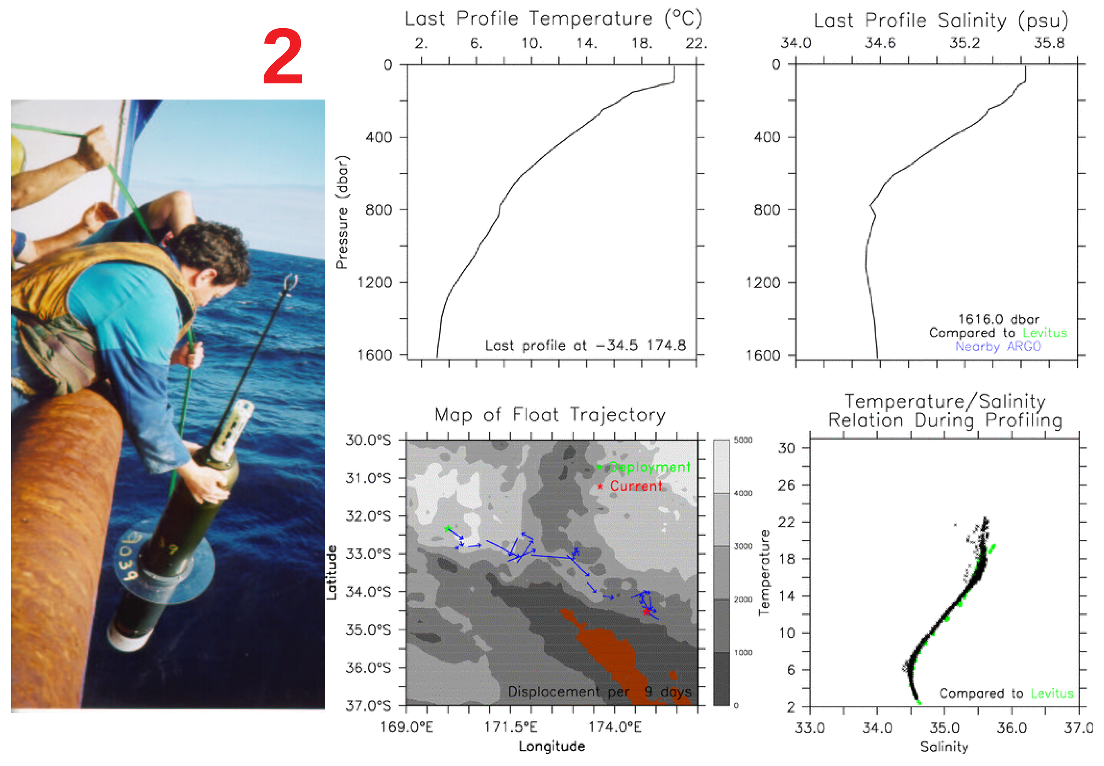

Salinity and the upper ocean's water balance:

Variarions in precipitation minus evaporation change the salinity of the surface layer of the ocean. The pattern of salinity anomaly from Argo floats and XCTD data (relative to World Ocean Atlas 98) in the upper 50 m (Fig 3) resembles the pattern of anomalous precipitation (mm/month) during 1999-2001 from NCEP reanalysis data (Fig 4). Surface salitiy anomalies are subducted and carried by the circulation, so subsurface salinity anomalies bear the imprint of past surface forcing. Subsurface anomalies are shown on two density surfaces, σ_θ= 24.5 (Fig 5, the subsurface salinity maximum layer) and σ_θ= 25.5 (Fig 6, the main thermocline). Patterns here are indicative both of past interannual sea surface forcing and of shortcomings in the WOD98 climatology.

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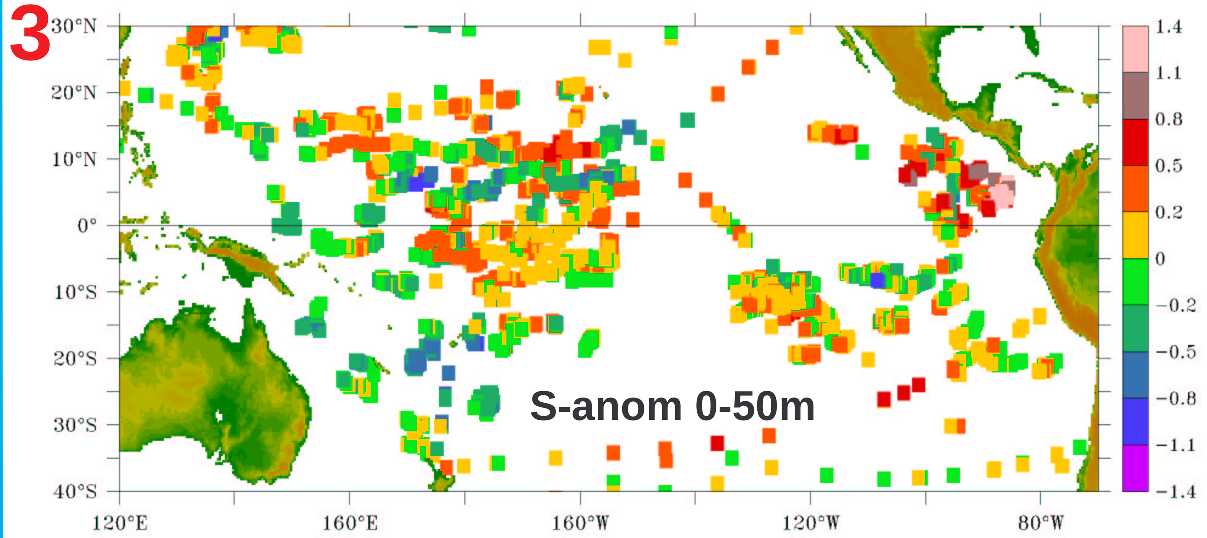

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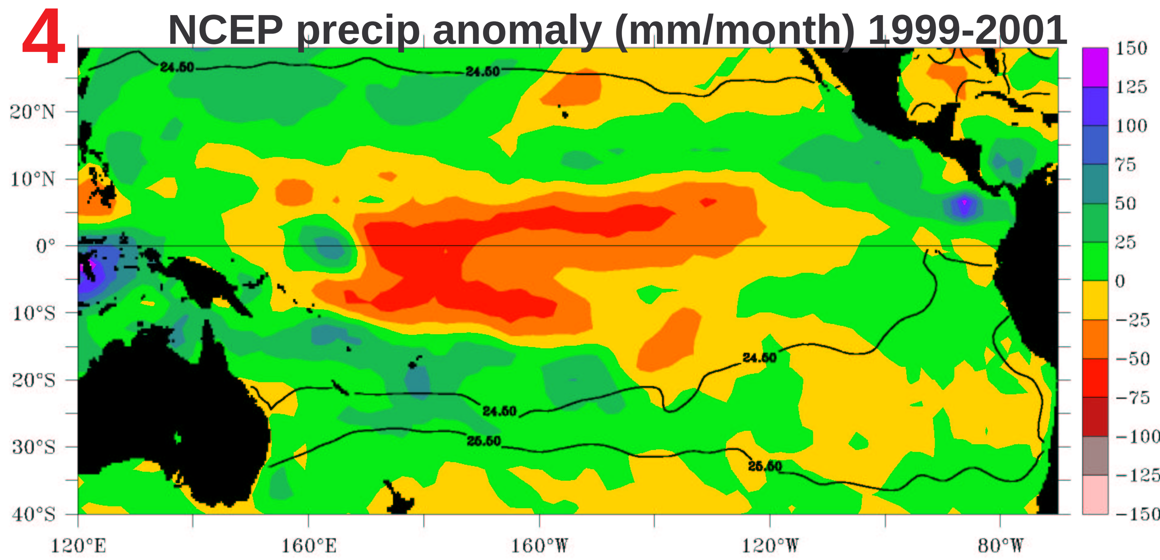

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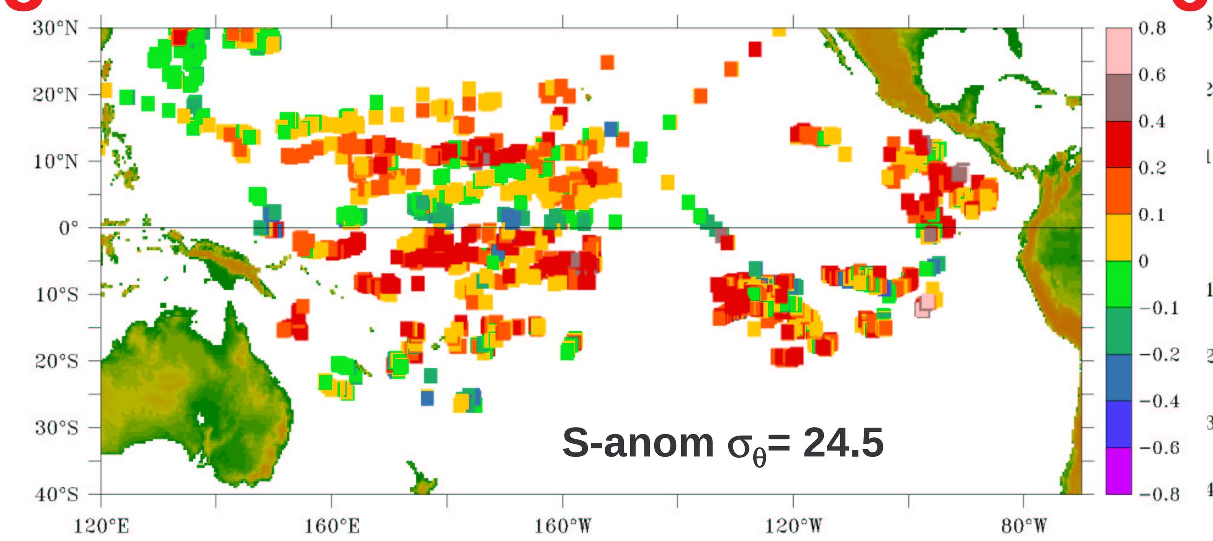

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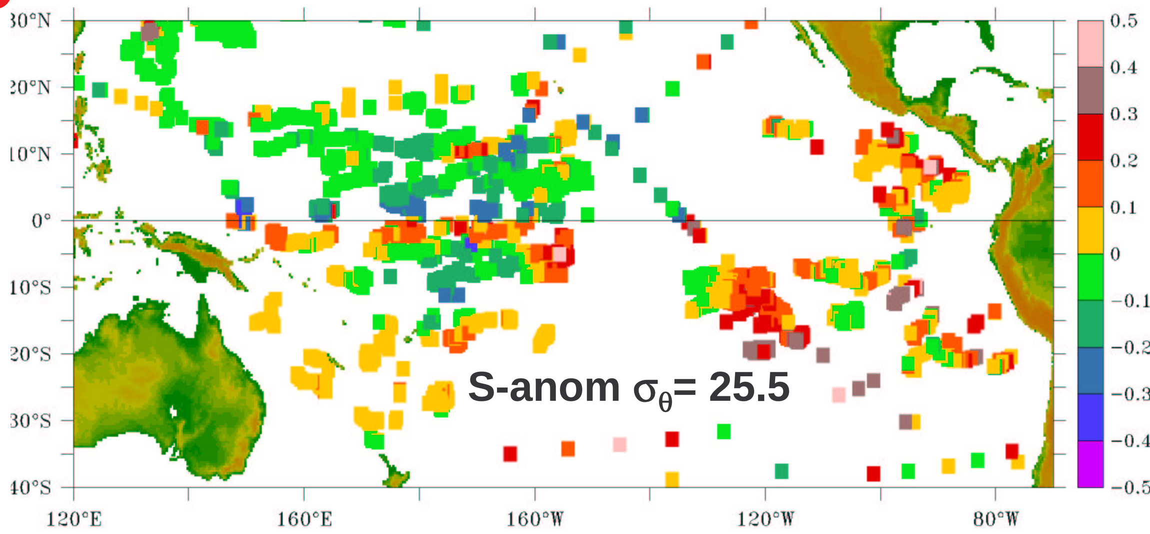
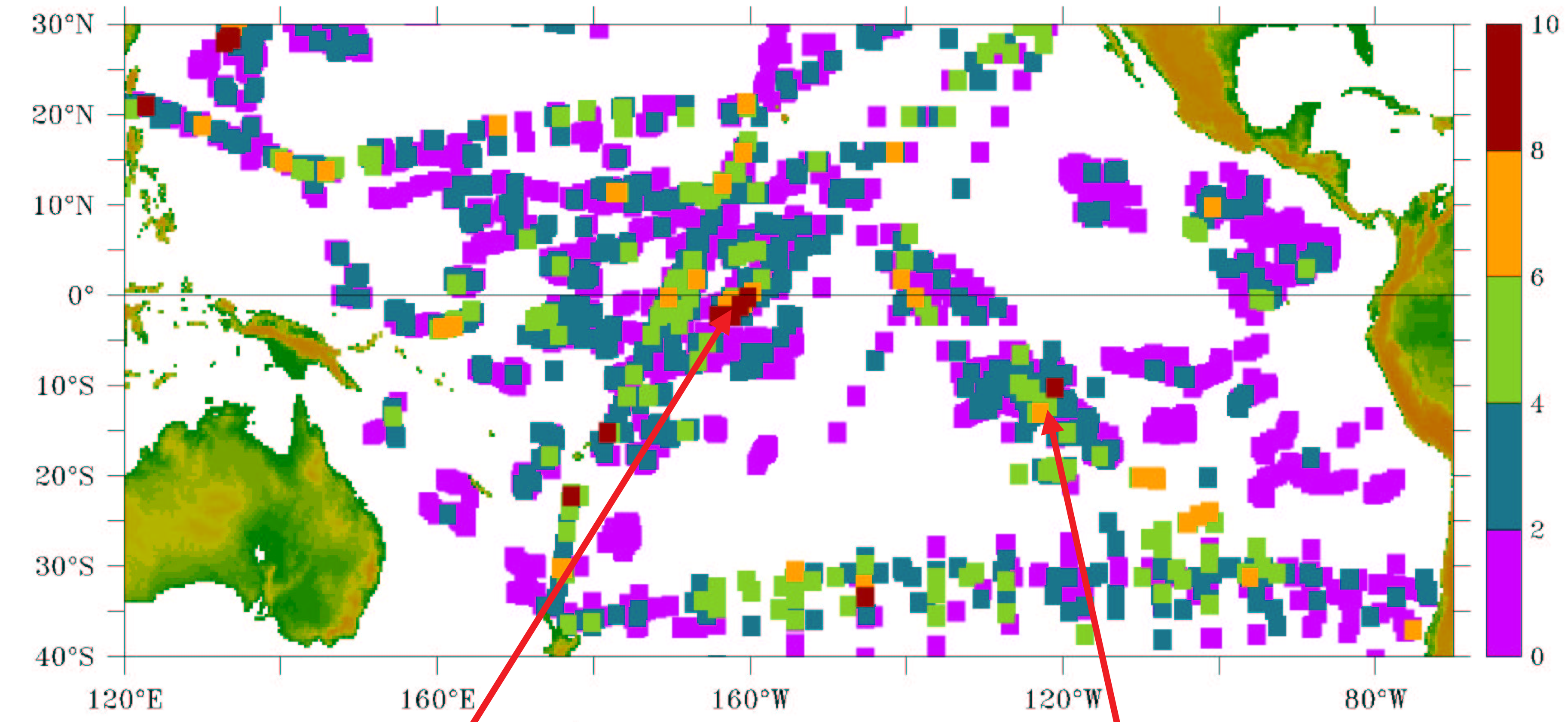


Sea surface height variability due to salinity:

Sea surface height signals due to anomalous salinity (SSH-S, 0/500 dbar) are commonly 2 cm or less, relative to WOD98 climatology. However, as shown in Fig 7 there are many profiles having SSH-S of 4 cm or more, and some exceeding 8 cm. Profiles with large SSH-S are clustered in space and time, with clusters in the central equatorial Pacific and the southeastern tropics and subtropics. Examination of these profiles reveals the underlying causes of the SSH-S signals. For example, during the 1997 El Nino, very fresh surface layers resulted in large SSH-S anomalies (> 8 cm) near 160W on the equator, observed in XCTD data. Similarly, in the highly evaporative region of the southeastern Pacific, where the subsurface salinity maximum is formed, large SSH-S in recent Argo data was due to a very salty surface layer extending down to 300 m depth.



7 SSH-S (cm) is calculated as the difference between dynamic height (0/500 dbar) from measured T and measured S and that using measured T plus S inferred from WOD98 T/S at the same location.

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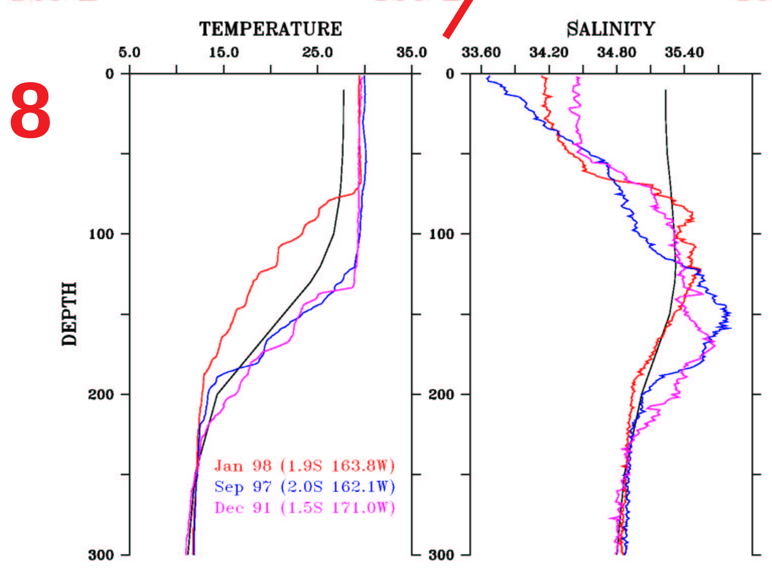

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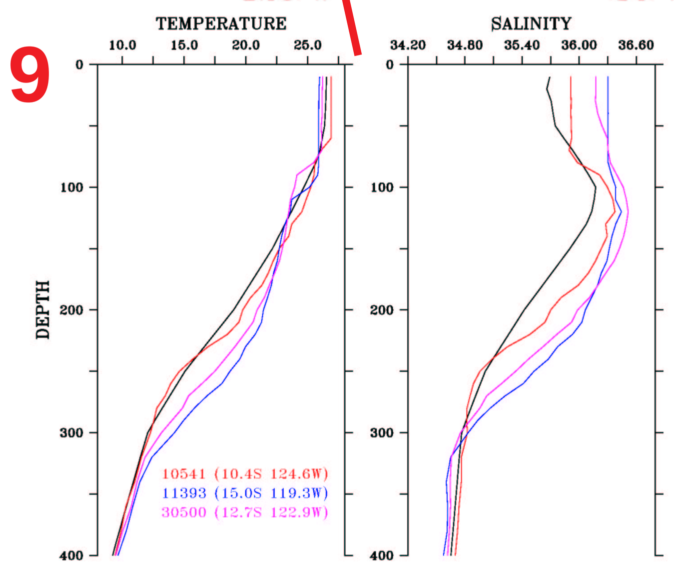

Examples are shown of profiles with large SSH-S. Fig 8 shows very fresh surface anomalies from XCTD profiles near the equator in late 1997. Fig 9 shows salty anomalies extending to 300 m depth in the SE Pacific from Argo.

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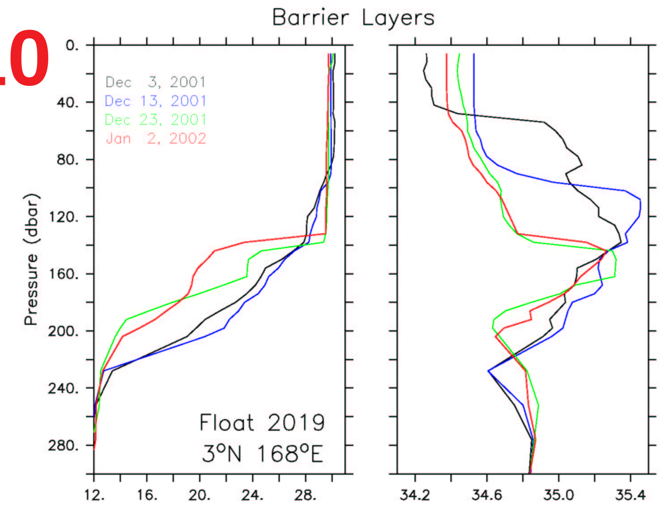

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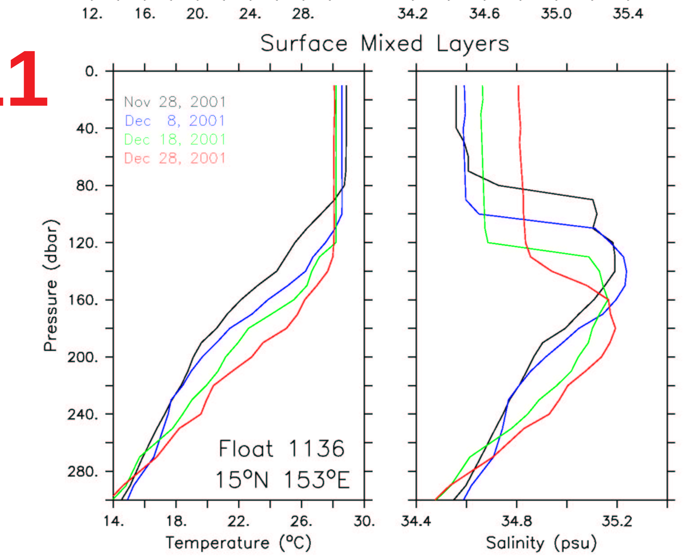

Argo measures the subsurface structure of the ocean:

While satellites will measure the temperature, salinity and height of the sea surface, Argo will contribute subsurface measurements of the vertical structure of temperature and salinity, plus reference velocity, that are needed for interpretation of satelite surface data. Argo data are already being assimilated in regional and global analyses.

Profiles at left illustrate characteristic upper ocean structures. Fig 10 shows salinity barrier layers from an Argo float in the western equatorial Pacific, with density stratification in the upper 100 m dominated by salinity rather than temperature. Fig 11 shows a progressively deepening mixed layer, with decreasing temperature and increasing salinity. This was caused by a tropical cyclone (Faxai), whose center passed about 100 km northeast of the float.