EUMETSAT

Remote Sensing for Ocean-Atmosphere interactions studies and applications
1 December 2021

Using Ocean Surface Variables to Determine the Density Driven Circulation of the Oceans.

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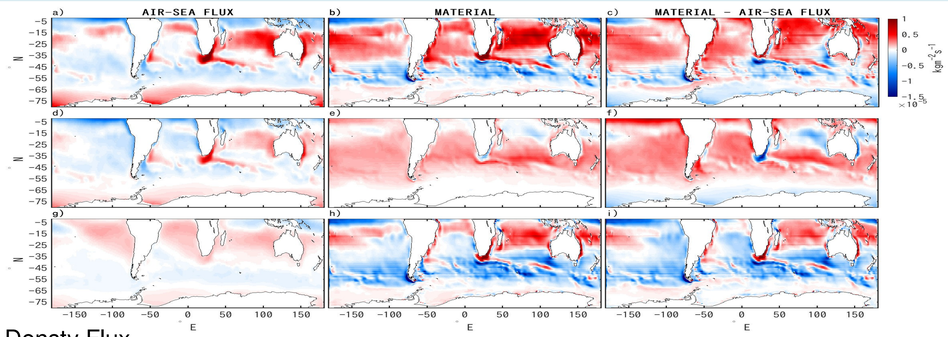
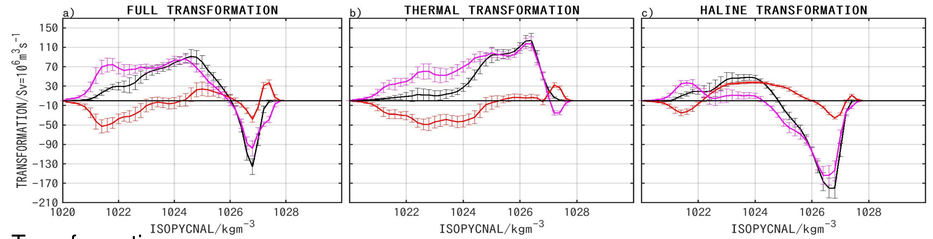
Abstract and Intro

- Traditionally, **air-sea fluxes** were used to estimate **water mass** characteristics
  - Atmosphere-Ocean interactions affect the **transformation rate** of surface waters which can be used to infer the **deep oceanic circulation**.
- However, numerous **issues** with the use of **Air-sea flux datasets**
  1) **Estimating** key **atmospheric state variables**
  2) '**Bulk-algorithms**' and the **assumptions** which they are based on.
  3) **Coarse Spatial** and **Temporal resolutions.**
- **Satellite observations** can solve some of these issues
  - However, **biases** still remain in calculating **air-sea fluxes.**
- **Material evolution** of Sea Surface Salinity **(SSS)** and Sea Surface Temperature **(SST)**
  - **Alternate framework** for the estimation of **water mass dynamics**
  - By showing an **equivalence** between **Material evolution** of **ocean variables** and **air-sea fluxes.**
- A **significant advantage**
  - Now we can **infer interior circulation without** the need of direct **error-prone air-sea flux** datasets.
  - **Ocean variables** often much **higher spatial** and **temporal resolution.**
  - **Suited** for application to **satellite observations**.
- **Demonstration** of **new framework** vs **Traditional framework**
  - **23 years** of **model data** from the **Southern Hemisphere**
  - Able to resolve the signal of **haline** driven **transformations** much **more accurately**
    - **Unresolved freshwater forcings**



Densty Flux

- **Transfer of mass** between **ocean** and **atmosphere**
  - Acting over the **Mixed Layer** (i.e.tells of **density variations** of surface waters)
    - **GAINING DENSITY**
    - **LOSING DENSITY**



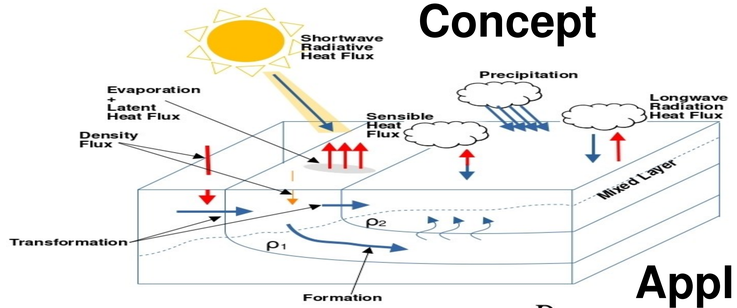
Transformation

- '**Movement**' of **water** to **through density.**
  - Acting over the **Mixed Layer** (i.e.tells of **density variations** of surface waters)
    - **+VE Transformation** ('**Movement**' to **higher densities)**
    - **-VE Transformation** ('**Movement**' to **lower densities)**

Datasets

SSS, SST, U, V, Evaporation, Precipitation, Total heat flux and Mixed Layer Depth
Taken from;
ECCO v4 model: https://podaac.jpl.nasa.gov/

Concept



Application

- **Material** changes
  - **all forcings** driving scalar changes

1 $\quad \frac{D\tau}{Dt} = d_\tau + f_\tau$

- Forcings on temperature and salinity
  - **heat and freshwater fluxes**
- Component **SSS + SST → SSD**
  - Arrive at equivalent relations of **density flux**

2 $\quad f_\theta = \frac{H}{C_p \rho}\delta(z=0)$ $\quad f_S = QS\delta(z=0)$

- **Disagreement** in conventions
  - ***Mixed Layer**

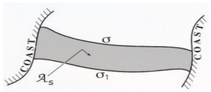
3 $\quad f = \rho[-\alpha\frac{D\theta}{dt} + \beta\frac{DS}{Dt}]$

traditional — Summary of approacl...

Methodology

$f = \frac{-\alpha H}{C_p} + \rho(0,T)\frac{\beta QS}{1-S}$ $\quad f = \rho[-\alpha\frac{D\theta}{dt} + \beta\frac{DS}{Dt}]\cdot MLD$

$F(\rho) = \iint_{area} dA f\delta(\rho - \rho')$



$S_{i,j,k}(\sigma'_\theta) = \frac{M_k(\sigma_{\theta'})}{R_k(\sigma'_\theta)}, \quad \forall\, i,j$

$M(\rho) = -[F(\rho + \Delta\rho) - F(\rho)]$