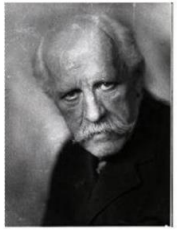
SASSIE inspired Heat Budget of the Arctic Ocean (SHEBA)

Ali Siddiqui
mentor : Marie Zahn

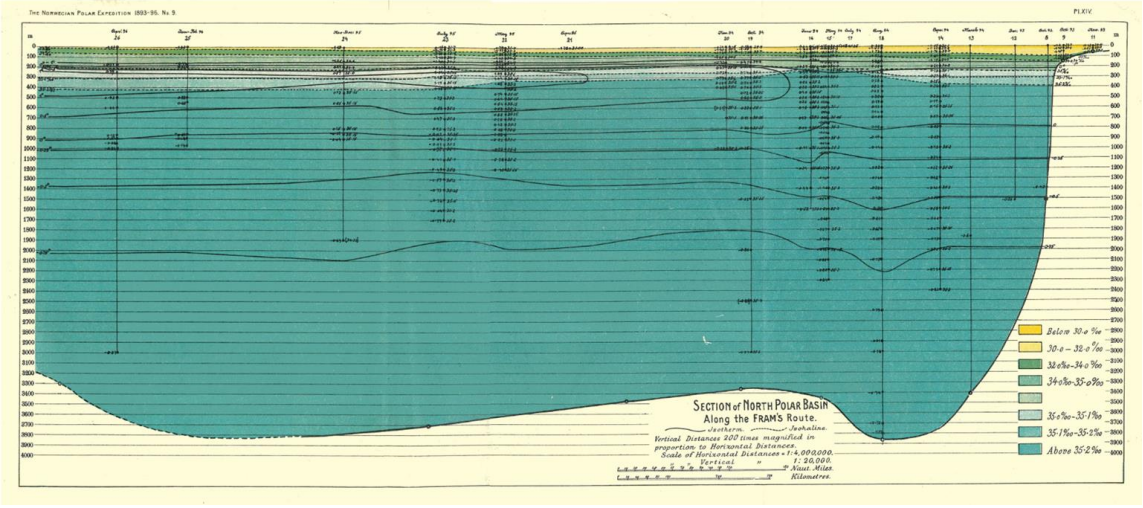
Evaluate the heat budget of the Arctic ocean using ECCOv4r5 and SASSIE ECCO LLC1080

May 30, 2025

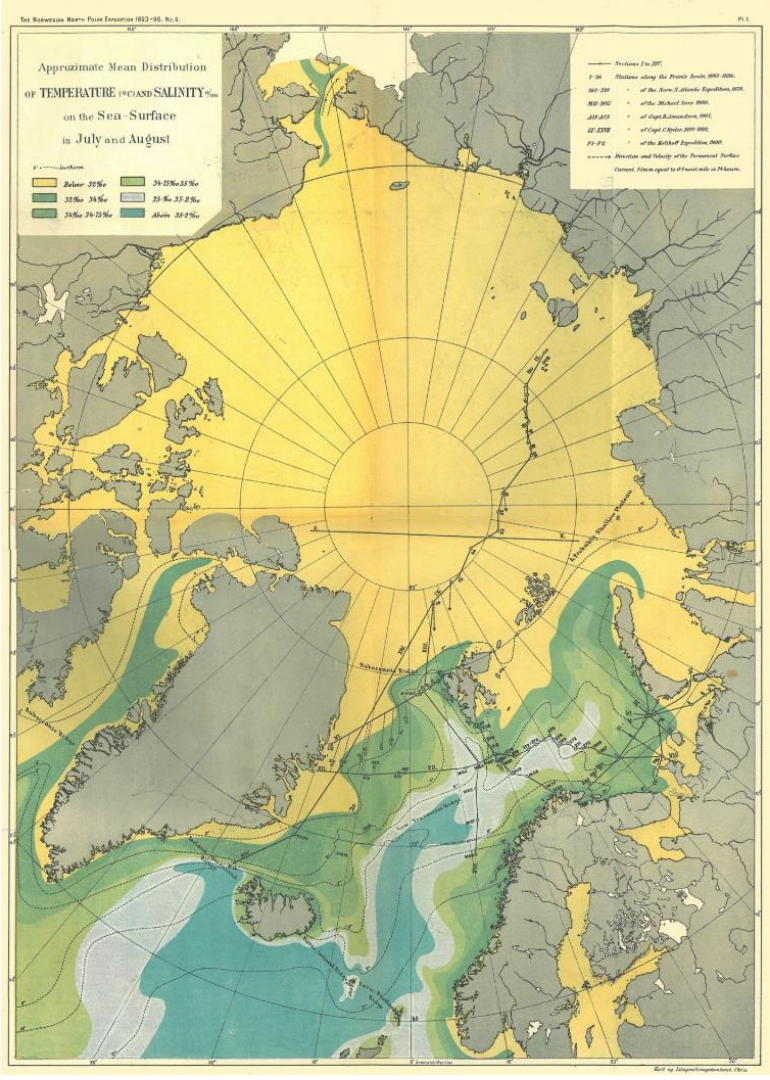
Science : Motivation



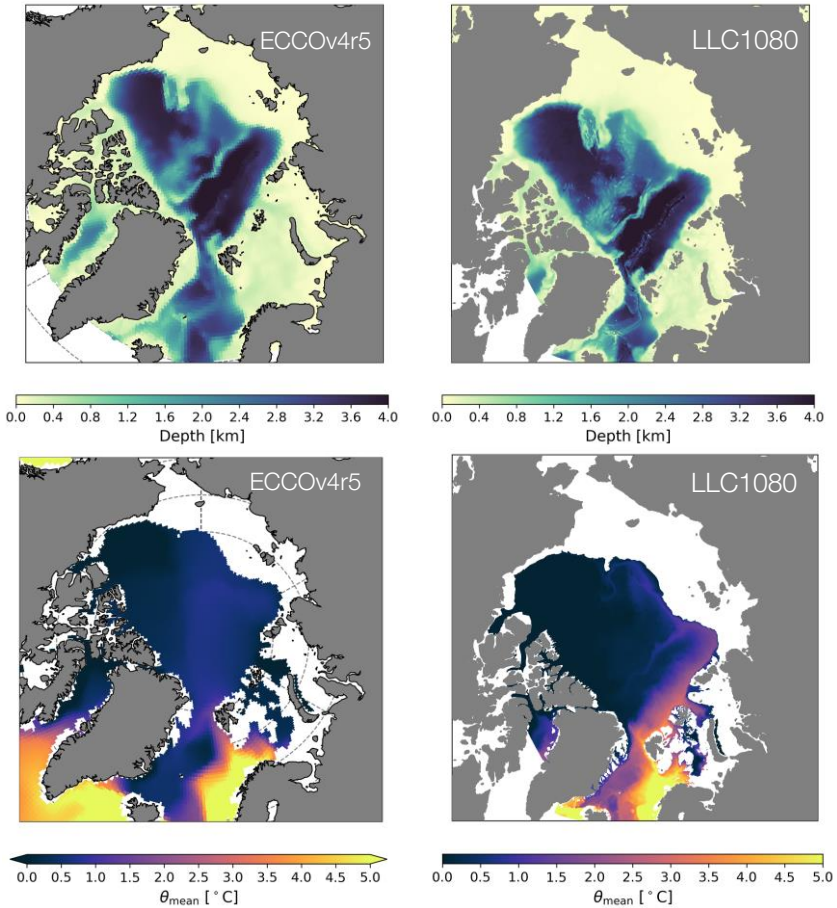
Fridtjof Nansen



From Nansen, 1902



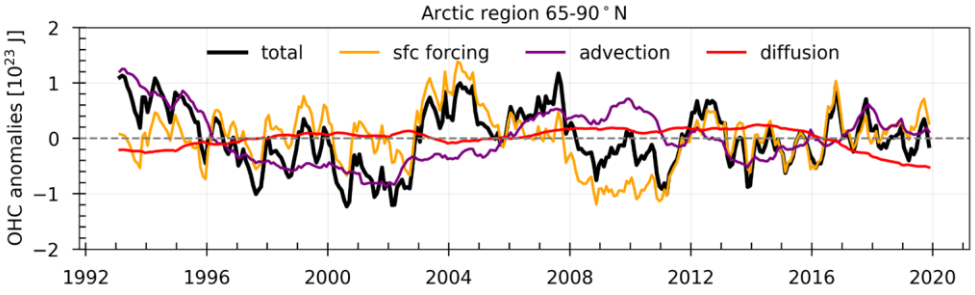
Science : Approach



- Use model diagnostics to compute heat budget terms.

$$\underbrace{\frac{\partial\left(s^{*}\theta\right)}{\partial t}}_{G^{\theta,tot}} = \underbrace{-\nabla_{z^{*}}\left(s^{*}\theta\mathbf{v}_{res}\right) - \frac{\partial\left(\theta w_{res}\right)}{\partial z^{*}}}_{G^{\theta,adv}} + \underbrace{s^{*}\mathcal{F}_{\theta}}_{G^{\theta,forc}} + \underbrace{s^{*}D_{\theta}}_{G^{\theta,diff}} .$$

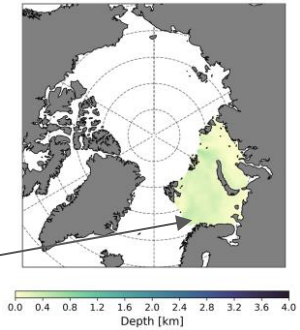
- Define a control volume
  - Complete Arctic : 65-90°N
  - Sub-regions in the Arctic
- Integrate the heat budget over the control volume
- Remove the seasonal cycle and linear trend

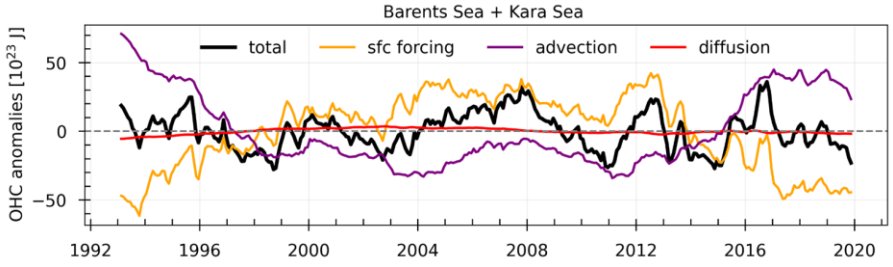


Temperature avg. over 1992-2019 at 250 m

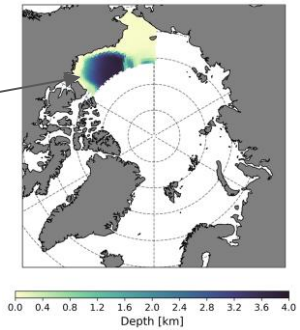
Science : Approach

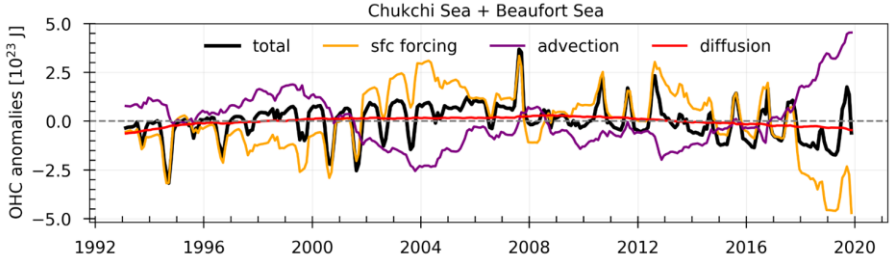
Shallow depths,
Atlantic intrusion



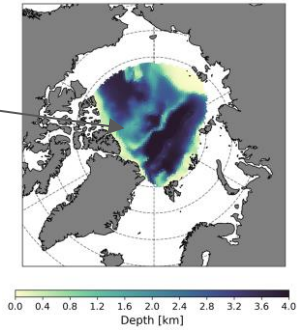


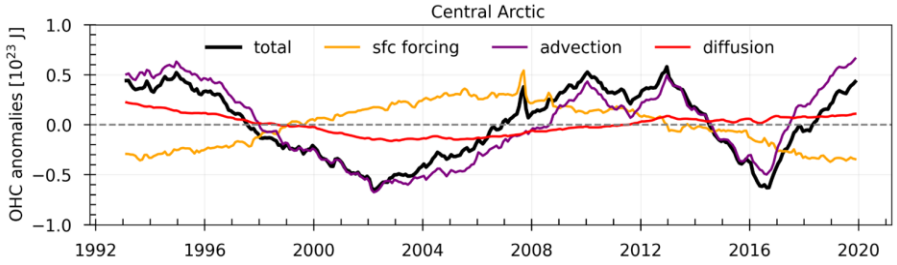
Thin sea ice,
Pacific inflow





Deep Arctic, gyre
circulation





NSIDC Land, Ocean, Coast, Ice, and Sea Ice Region Masks

Science : Conclusions

- For the entire Arctic region, surface forcing is the primary driver of interannual variability with advective heat convergence driving cooling trend during 1992-2002.
- Dominant driver of OHC changes depending on control volume.
  - Advective heat flux convergence in Central Arctic.
  - Surface forcing in Beaufort and Chukchi Seas.
  - Advective convergence + Surface forcing in Kara and Barents Seas.
- Atlantic waters intrude further into the Arctic interior in LLC1080 than v4r5.

Project reflections

- **Challenges**
  - Confusion with jupyter notebooks available, need to update.
  - LLC1080 computations
- **What did I learn?**
  - I got to learn about Arctic circulation!
  - I learned about the LLC1080 simulation
  - Lots of ideas for science! (e.g. MOC in density space, Arctic Atlantification)
- **New skills**
  - Accessing, analyzing, computing, and saving high res outputs!
- **If I had one more week**
  - Detailed heat budget calculations for the Arctic, including with LLC1080!