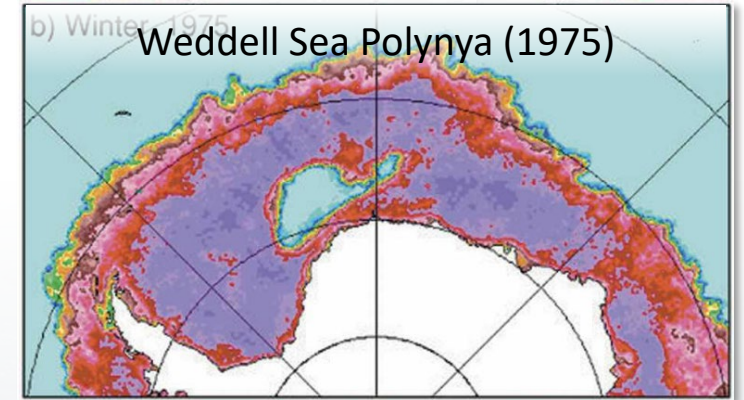


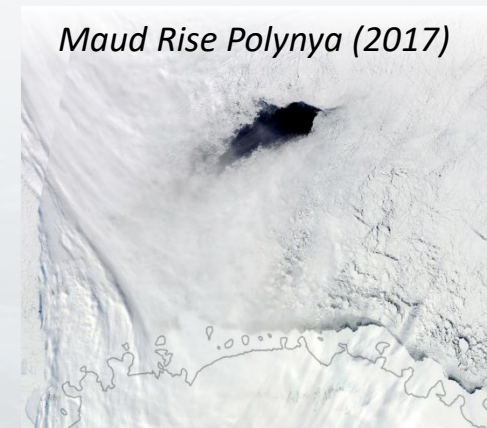
# Drivers and Impacts of Southern Ocean Polynyas in High-Resolution Earth System Models



- Polynyas are areas of open ocean amidst the winter ice pack
  - Regions of strong air/sea heat exchange
  - Strong and long-term impact on deep water masses
  - Polynyas in Weddell Sea occur *episodically*
- Understanding the drivers and impacts of polynyas on the ocean and atmosphere is important for
  - Predictability of high-latitude climate
  - Understanding the source of mean state bias in models
- Here we study drivers and impacts of polynyas in the Weddell Sea in E3SMv0-HR
  - 0.1° ocean/sea ice
  - 0.25° atmosphere



Gordon et al. (2007)



NASA Earth Observatory

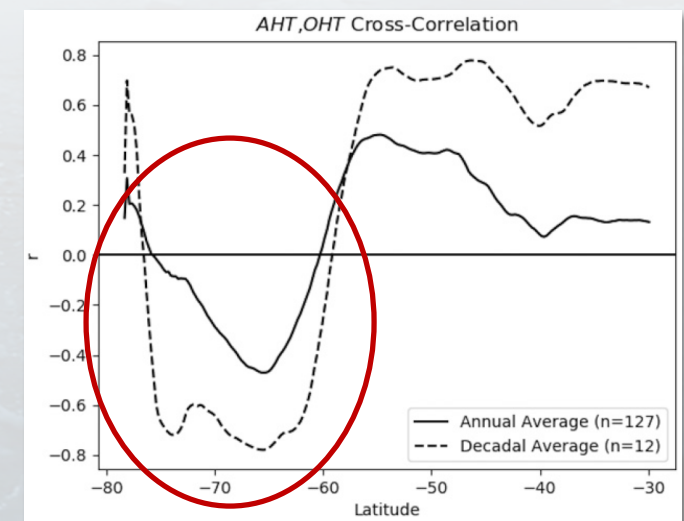
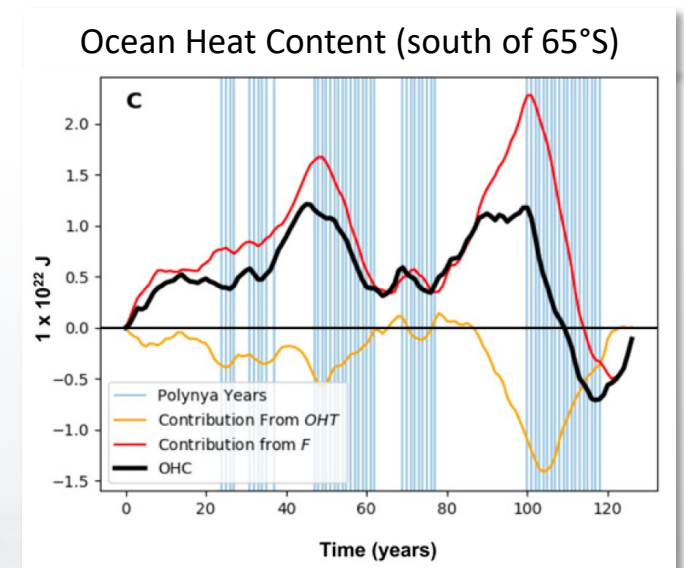
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# Main Points



- Mechanisms of polynya formation in E3SMv0-HR largely consistent with accepted views
  - Southern Ocean winds
  - Taylor cap dynamics
  - Stratification, sub-surface heat reservoir
  - Weddell Sea Polynyas triggered by Maud Rise Polynyas
- New insights
  - Subsurface heat reservoir caused by *reduced surface heat loss*
    - Counteracted by ocean heat transport
    - Fundamental imbalance of ice-covered mean state
    - Model warming of 0.1 K/decade stronger than observed 0.03 K/decade (Campbell et al. 2019; Smedsrud 2005)
  - Polynyas responsible for opposing changes in OHT/AHT
    - Reminiscent of Bjerknes Compensation
    - Driven by polynya heat exchange, not by OHT variability



# Conclusions

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- If build-up of sub-surface heat reservoir is caused by fundamental imbalance of ice-covered mean state, then reoccurrence of Weddell Sea polynyas may be inevitable
  - Even under more stratified conditions
  - Even if warming is 3 times slower than in models
- Need for detailed study of processes controlling heat budget in Weddell Sea to reconcile models with observations

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## Publications

- Weijer et al. (2017): *J. Clim.* **30**, 1629-1641, doi: 10.1175/JCLI-D-16-0120.1.
- Kurtakoti et al. (2018): *J. Clim.* **31**, pp.9659-9678. doi: 10.1175/JCLI-D-18-0392.s1.
- Kaufman et al. (2020): *J. Clim.* **33**, 4891-4905. doi: 10.1175/JCLI-D-19-0525.1.
- Kurtakoti et al. (in review): *J. Clim.*