Cloud Cover Over the Gulf Stream in Winter: Observational Evidence for Atmospheric Response to Changes in Upper Ocean Heat Content

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Motivation

- Ocean heat is released to the atmosphere in the Gulf Stream
- Meridional heat transport convergence is balanced by surface heat flux
- Changes in AMOC are tightly linked to changes in meridional heat transport

Previous Work

- Meridional heat transport convergence force changes in surface heat flux interannually in the Gulf Stream region (Dong and Kelly, 2004)
- Seasonal cycle of sea surface temperature, surface wind convergence and precipitation is linked to cloud cover (Minobe, 2010)
- Mid-level cloud fraction is linked to surface wind-convergence driven by sea surface temperature gradients (Minobe, 2008)

Data Sources

- Monthly ISCCP (International Satellite Cloud Climatology Project) mid-level cloud fraction data
- Monthly AVISO Sea Surface Height, smoothed to 500km
- Monthly OAFlux (Objectively analyzed air-sea fluxes) turbulent heat flux

References

Dong, Shenfu and Kathryn A. Kelly, 2004: Heat Budget in the Gulf Stream Region: The Importance of Heat Storage and Advection. *J. Phys. Oceanogr.*, 34, 1214–1231.

Minobe, Shoshiro, et. al., 2010: Atmospheric Response to the Gulf Stream: Seasonal Variations. *J. Climate.*, 23, 3699-3719.

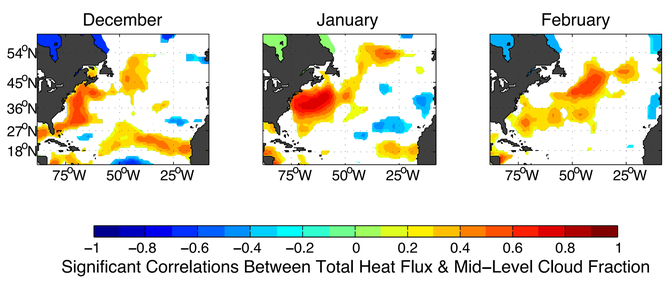
Minobe, Shoshiro, et. al., 2008: Influence of the Gulf Stream on the Troposphere. *Nature.*, 452, 208-209.

Introduction

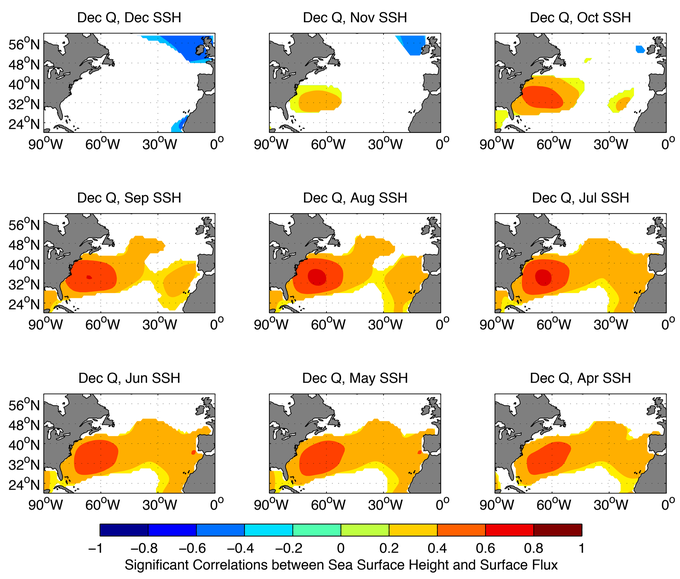
We investigate the relationship between year-to-year changes in cloud fraction with heat fluxes and with heat content variations in the Gulf Stream region.

Results

Latent Heat Flux and Mid-Level Cloud Fraction Correlations

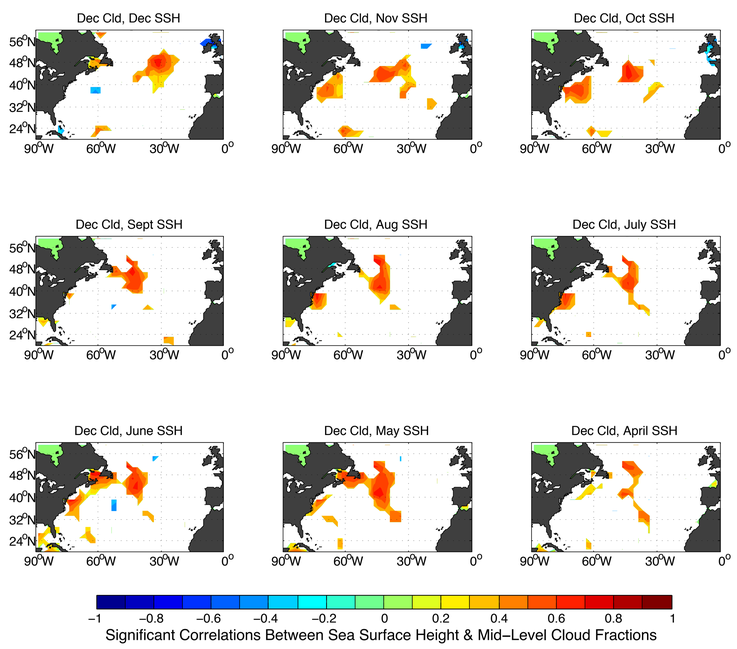


December Surface Heat Flux Correlated with Sea Surface Height: Lag Periods of 0 to 8 Months



Results

December Mid-Level Cloud Fractions Correlated with Sea Surface Height: Lag Periods of 0 to 8 Months



Conclusions

- Interannual heat content changes in the Gulf Stream region produce an atmospheric response as seen in mid-level cloud fraction
- Mid-level cloud fraction is tightly linked to surface heat flux changes in December, January and February.
- Sea surface height leads December surface flux for 9 months or more.
- Sea surface height leads mid-level cloud fraction in December by as much as 6 months

Future Work

- Direct correlations of sea surface temperature with cloud fractions
- Comparison of MODIS and AIRS surface heat flux, sea surface height, and sea surface temperature data with AVISO data