Observations of the mesoscale wind regime of Nares Strait

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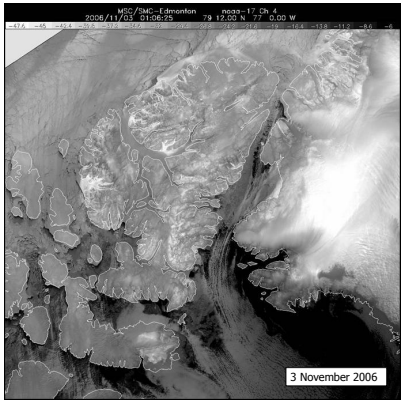
IPY Project CC-135: Ocean Freshwater fluxes through the Canadian Archipelago (CATs)

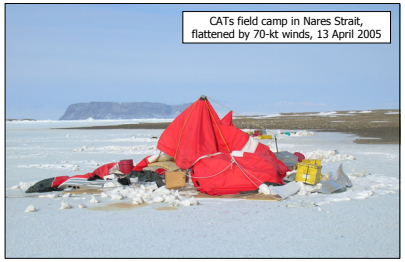
1: What is the influence of wind on Canadian Arctic Through-flow (CAT)?

Cloud patterns in satellite images suggestive that air flow through the passages of the Canadian Archipelago is channeled by terrain



When CATs began in 2003, there were [apparently] no systematic wind observations from the area.

Our experience at a science camp on Nares Strait in April 2005 was persuasive evidence that winds can be extremely strong, particularly in winter.

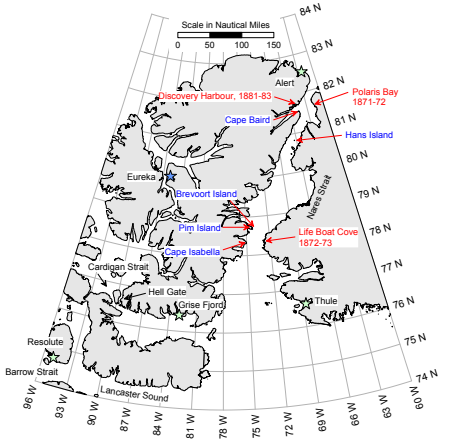


IPY Canada Early Results Workshop, Ottawa, 16-18 February 2010

2: We were surprised to discover that excellent weather observations were made in Nares Strait more than 125 years ago

We renewed our search for weather data after the April 2005 experience.

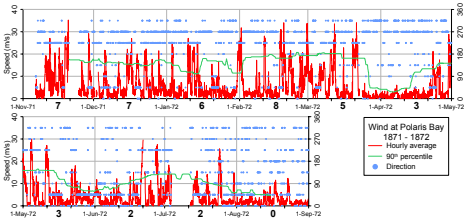
Careful hourly observations were made with then novel meteorological instruments by the Hall expedition at Polaris Bay (November 1871 through August 1872) & at Life Boat Cove (November 1872 through May 1873), & by the Lady Franklin Bay Expedition at Discovery Harbour during August 1881 through July 1883 (the first IPY).

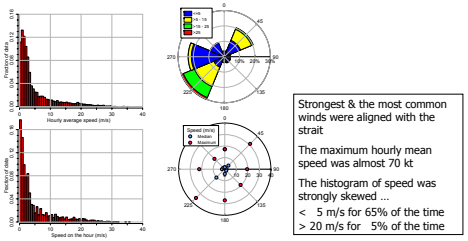


3: 19th century data from Nares Strait

Data from Polaris Bay during the 1871-72 winter were consistent with our experience. Winds topped 20 m/s once or twice per week. The maximum speed was 35 m/s.

In contrast, winds at nearby Discovery Harbour exceeded 20 m/s only twice. Discovery Harbour is a more sheltered location off the main run of the strait.





Strongest & the most common winds were aligned with the strait

The maximum hourly mean speed was almost 70 kt

The histogram of speed was strongly skewed …

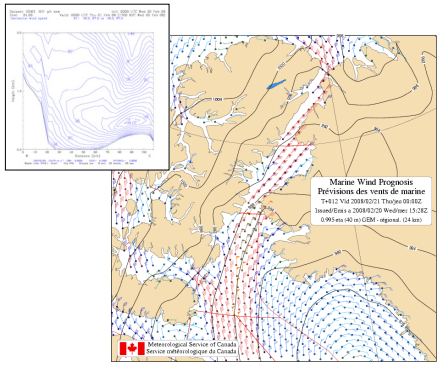
< 5 m/s for 65% of the time

> 20 m/s for 5% of the time

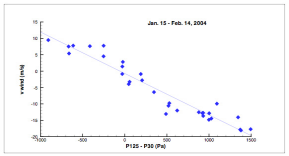
4: Numerical modeling shows that Nares Strait creates its own wind regime

Contributing factors are the strait's great length (550 km), high local terrain (2000-3000 m) & stable atmospheric boundary layer (the polar inversion).

Wind here is ageostrophic on synoptic scale, flowing across isobars from high pressure at one end to low at the other.

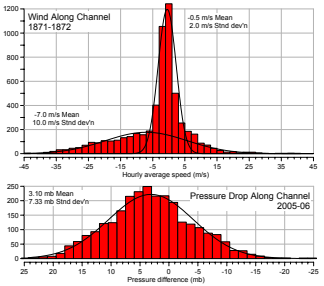


Atmospheric modeling has revealed strong correlation between along-strait airflow & SLP difference (Samelson et al. 2006)



5: Histograms of wind speed suggest two conditions of forcing

Light airs which dominate to a degree that varies with season & site. Occasional very strong winds are aligned with the Strait.

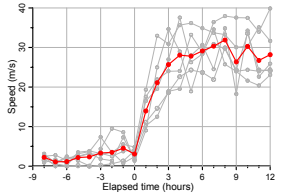


The occurrence of calms at Polaris Bay was much higher than the likely incidence of weak along-channel pressure gradient.

The most likely cause of non-linearity in response under weak forcing is suppressed downward diffusion of momentum from aloft.

Reduced diffusivity is likely the result of stable potential density stratification within the atmospheric boundary layer.

6: The 'explosive' onset of strong wind at the 2005 field camp was likely a consequence of boundary-layer mixing via shear instability driven by strong winds aloft



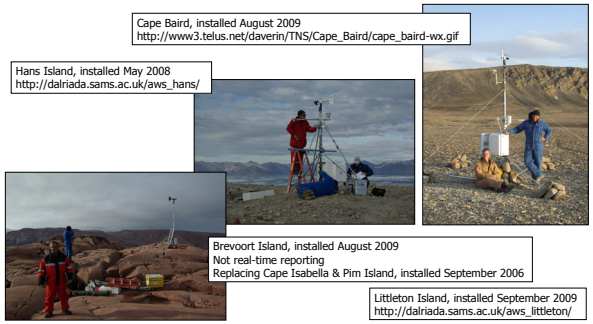
Similar 'explosive' onset of gale-force wind is evident in the observations at Polaris Bay during the winter of 1871-1872.

The graph is a composite based on 5 storms

7: Automatic weather stations are now operating along Nares Strait via an international collaboration facilitated by IPY

Cape Baird, installed August 2009
http://www3.telus.net/daverin/TNS/Cape_Baird/cape_baird-wx.gif

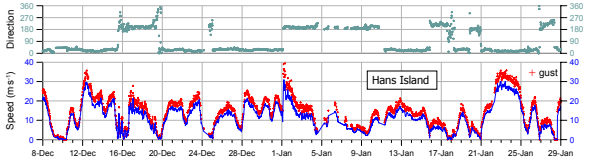
Hans Island, installed May 2008
http://dalriada.sams.ac.uk/aws_hans/



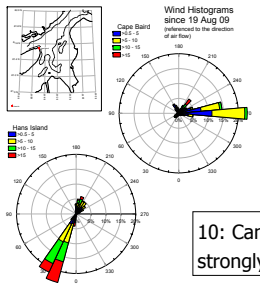
Brevoort Island, installed August 2009
Not real-time reporting
Replacing Cape Isabella & Pim Island, installed September 2006

Littleton Island, installed September 2009
http://dalriada.sams.ac.uk/aws_littleton/

8: New data confirm the occurrence of intense wind storms



9: Wind characteristics are quite variable among sites



Clearly topographic effects exert strong control on the wind regime of the Canadian Archipelago

10: Canadian Arctic through-flow is coupled strongly to atmospheric circulation