



**ARCTIC DOMAIN**  
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# **First Annual Partners Meeting Presentation**

**Continuous measurements of water and carbon  
isotopes:**

**Tools to minimize maritime and coastal vulnerabilities  
and maximize awareness**

***(Integrating primary-secondary-tertiary systems)***

***Jeff Welker & Eric Klein  
University of Alaska Anchorage***



## ▶ Holes in security and awareness

- **Sea ice distribution & properties**
  - **Satellites**- once every 24 hrs
    - 99% of the time no data
    - Clouds, darkness, data-model fusion create uncertainty
  - Shore-based **camera systems**
    - Limited in range, fog obscures images, malfunction
- **Oil/diesel spill detection**
  - Detection limited by visual clues-ship wake and turbulence
  - Fuel gauge calibration and sensitivity is low
  - Ocular observations limited by other ships, kayaks, commercial and sport fishing in the vicinity
- **Detection of non-commercial small aircraft (smuggling)**
  - Low altitude flights below radar are common and unrecorded
- **Oil Platform emissions and discharges**
  - Emissions and spill below the surface are difficult to immediately detect



- ▶ **Strengthening M&C awareness**
  - Real-time continuous measurements
  - Place-based measurements that provide internet accessible data for real-time/near real-time processing and visualization development
  - Data sets that complement other programs and fill in holes of security (secondary or tertiary information)-Boy Scouts
  - Variables that can provide important analogs to other sensing devices and that can be calibrated with primary data sets
    - Sea ice scores/categories vs. water vapor isotopes ( $\delta^{18}\text{O}/\delta^2\text{H}$ , d-excess)
    - Petroleum (oil/diesel fumes) products and  $\delta^{13}\text{C}-\text{CO}_2$  and  $\delta^{13}\text{C}$  of  $\text{CH}_4$



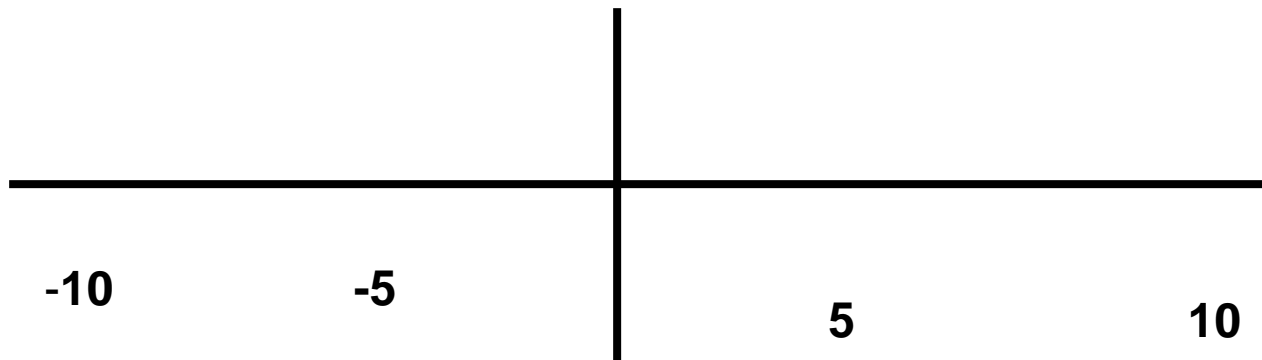
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**Isotope- atoms of same element-  
additional number of neutrons**



*Isotope jargon*



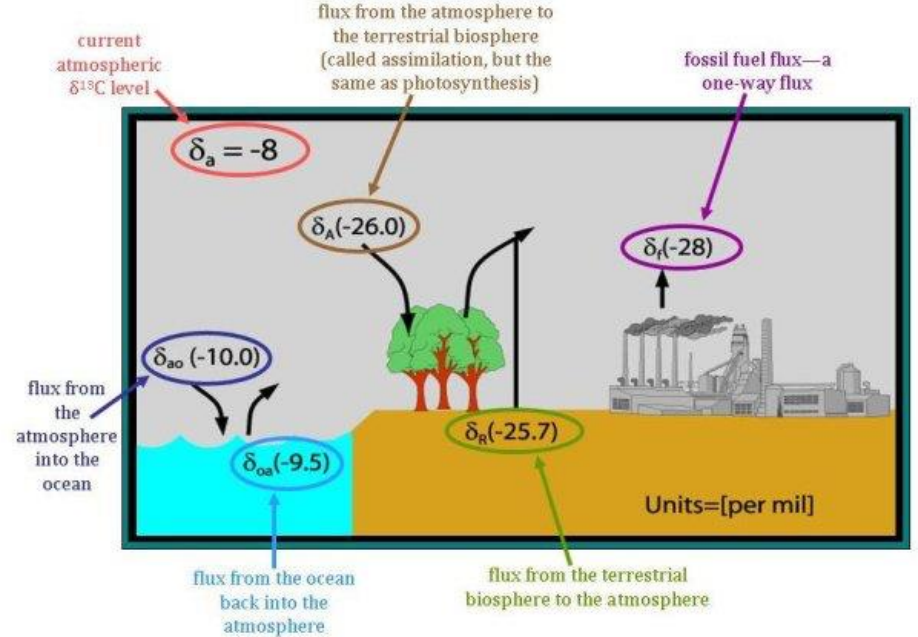
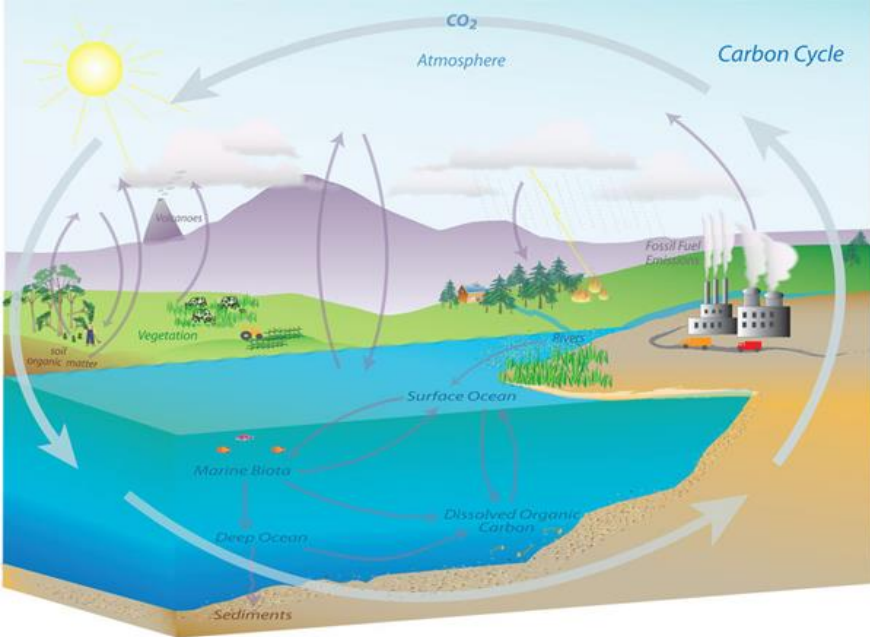
*Depleted compared to the standard*



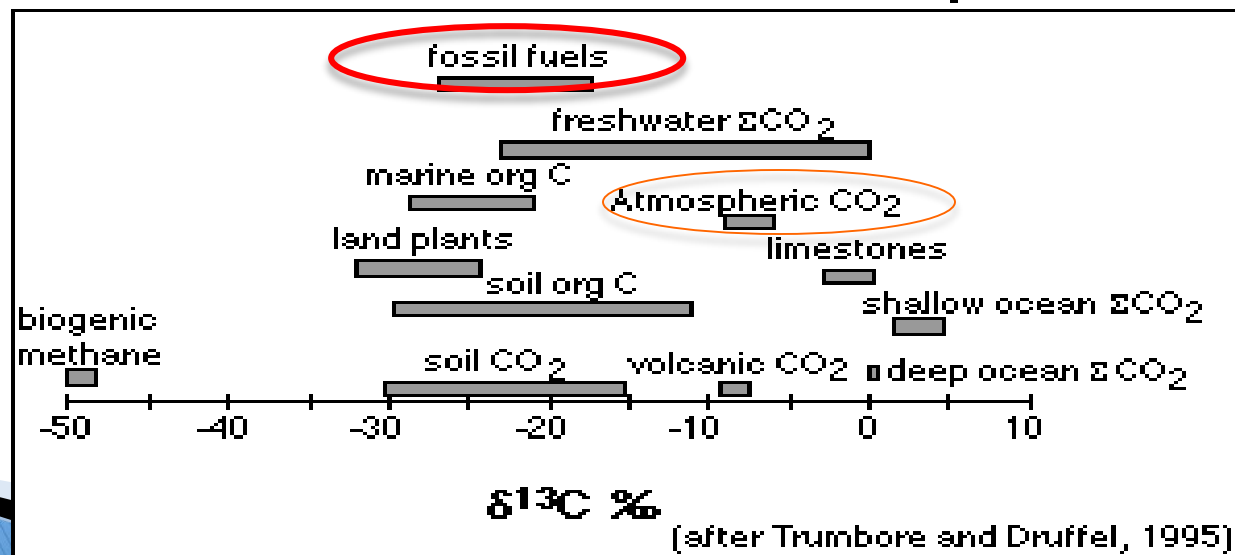
$\delta=0$

*Enriched compared to the standard*

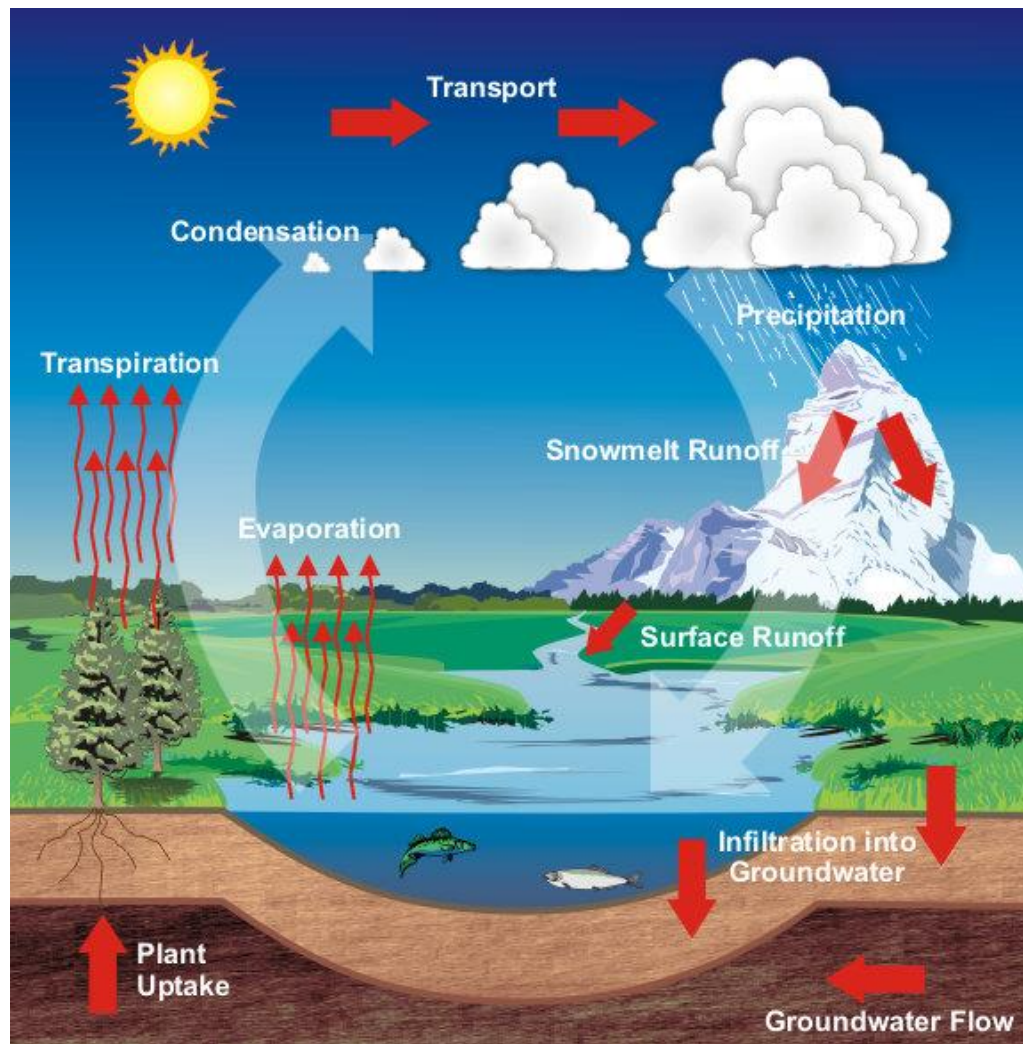




## Variations in Carbon Isotopes

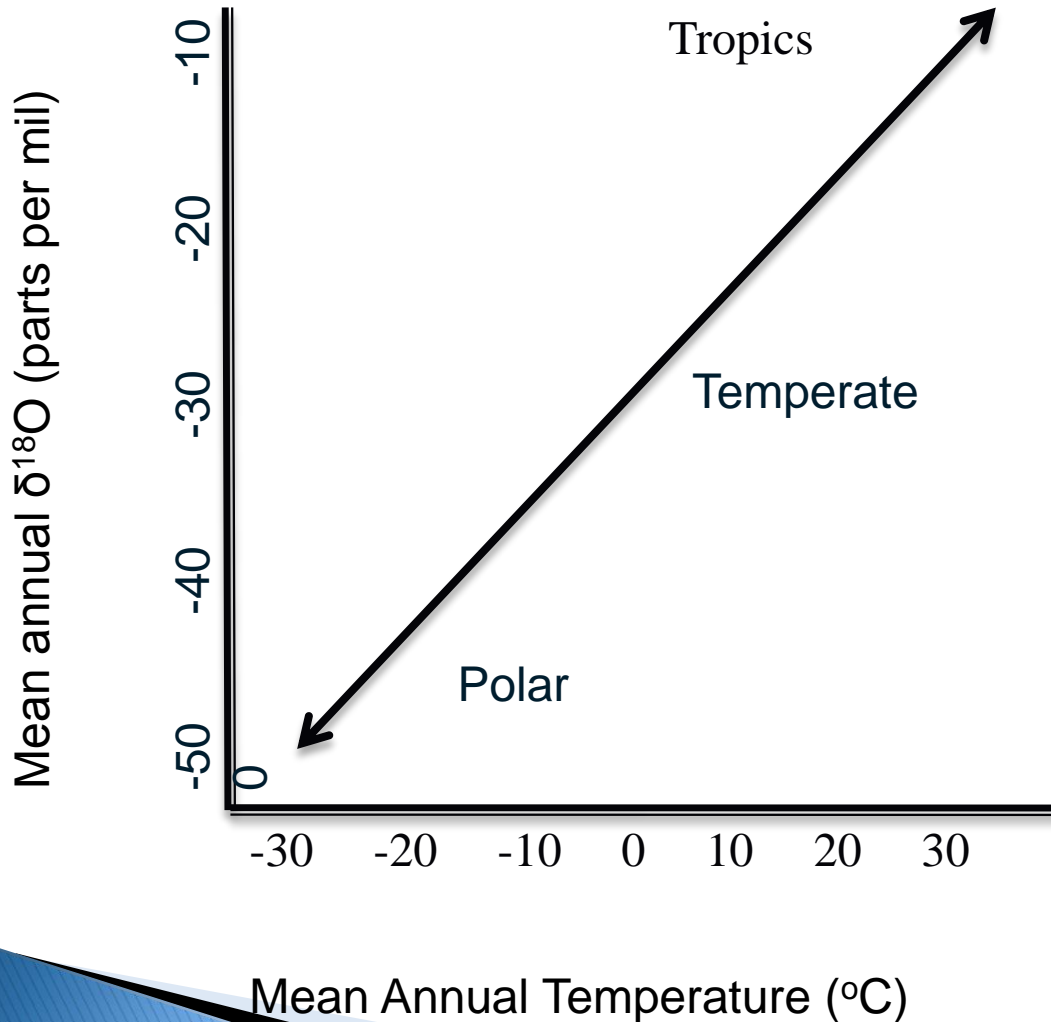


# Hydrological Cycle



*Precipitation is the foundation of the hydrologic cycle and has applications to all aspects of water resource use, it's geochemistry is recorded in climate proxies and it controls in large part the C and N cycles*

**Multiple processes define the hydrological cycle and several processes are temperature dependent-evaporation, condensation and precipitation**



*Classic Dansgaard study in 1964 depicting temperature controls on the  $\delta^{18}\text{O}$  values of precipitation. However, it was a space for temperature substitution (i.e., spatial)-low temperatures from the Arctic and Antarctic, warm places-tropics. Not a record of interannual variation at one site (i.e., temporal), where confounding variables could be accounted for in the analysis.*

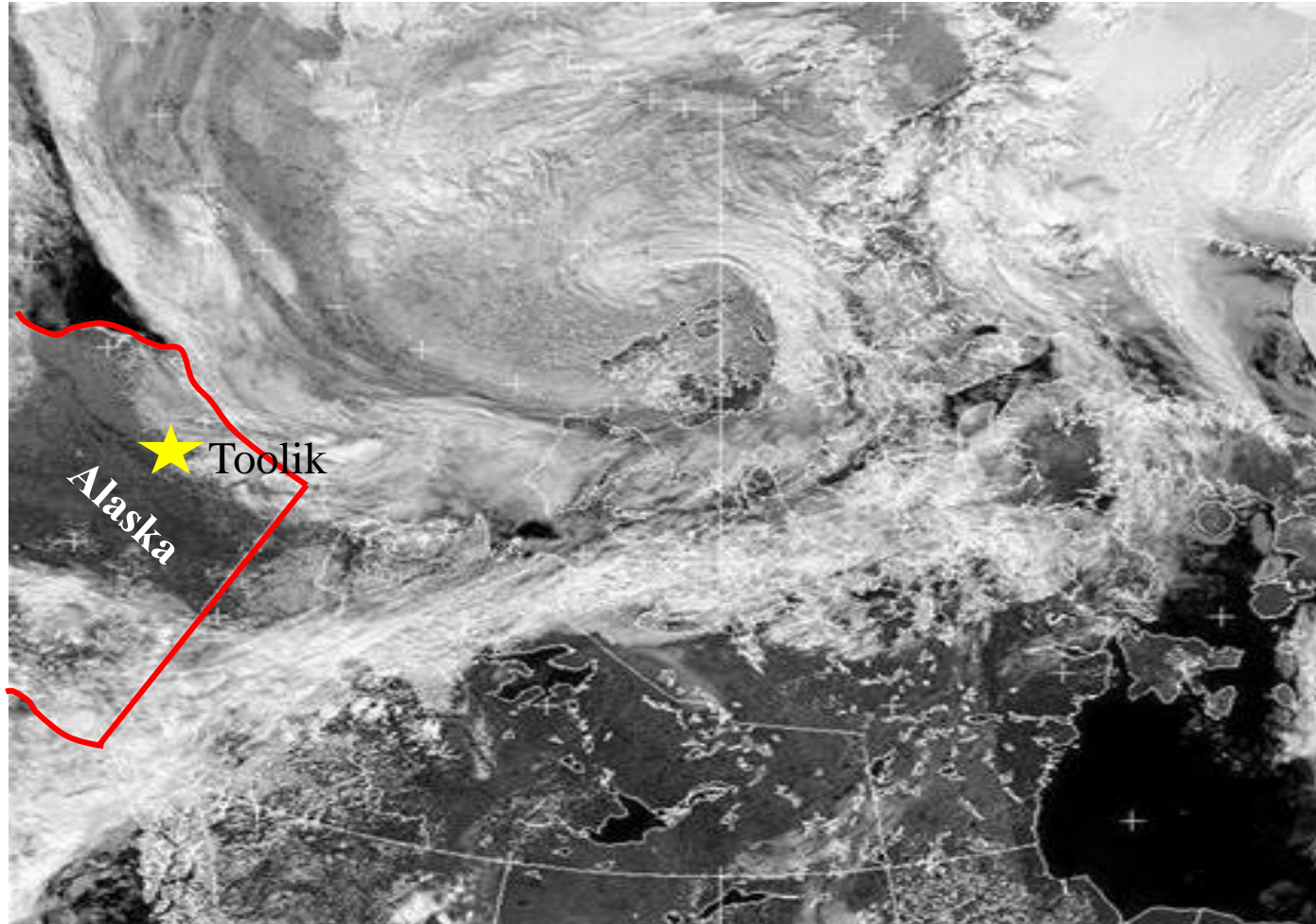






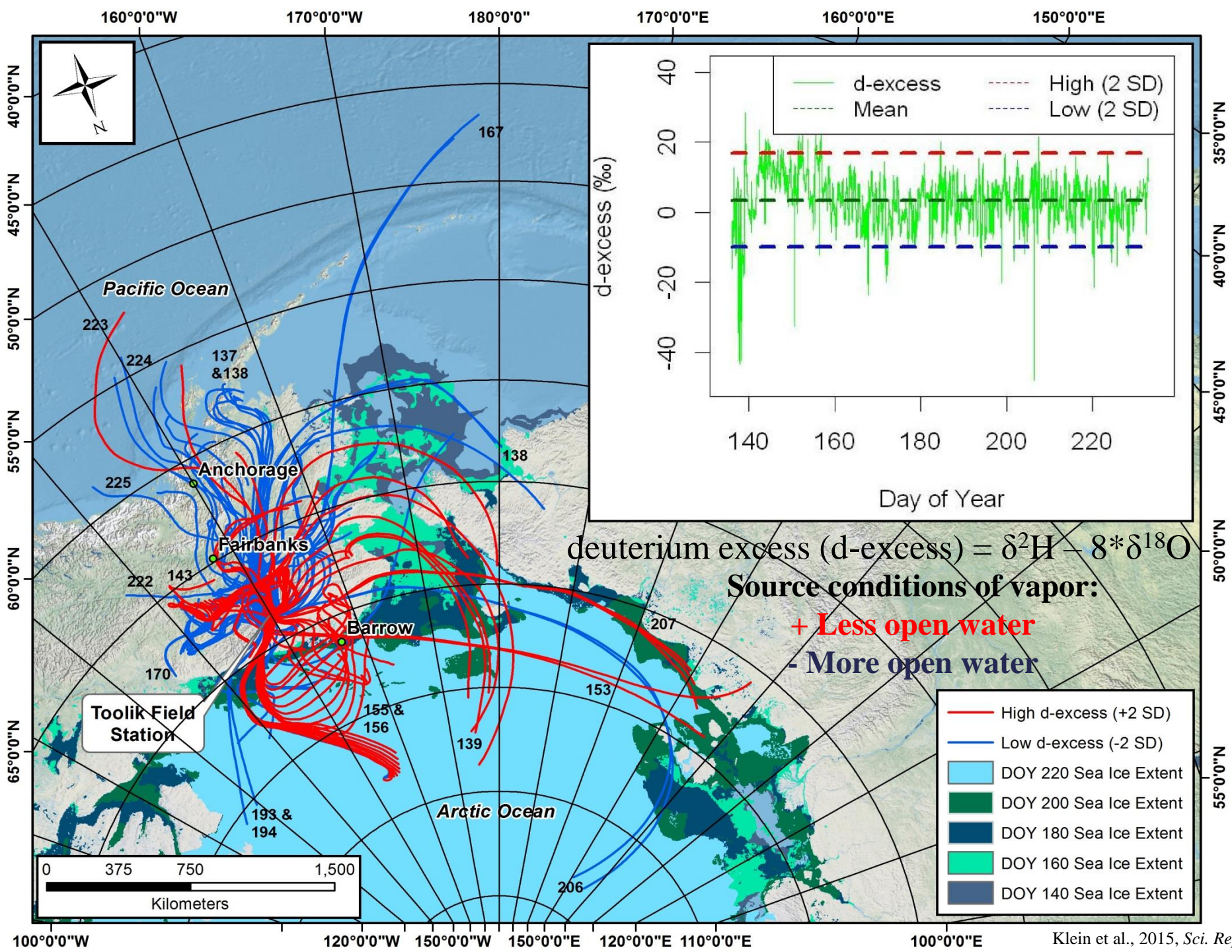
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# Arctic Cyclone Event



~July 24<sup>th</sup> - 26<sup>th</sup>, 2013

NOAA





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$\delta^{18}\text{O}$



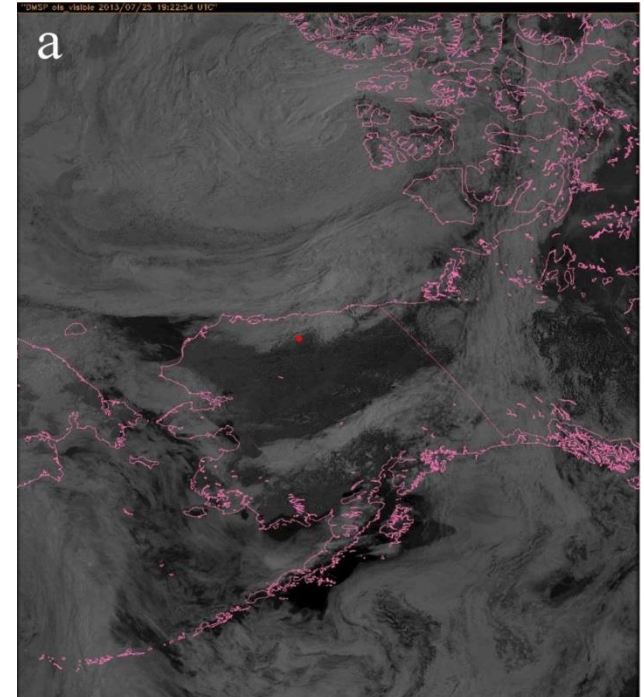
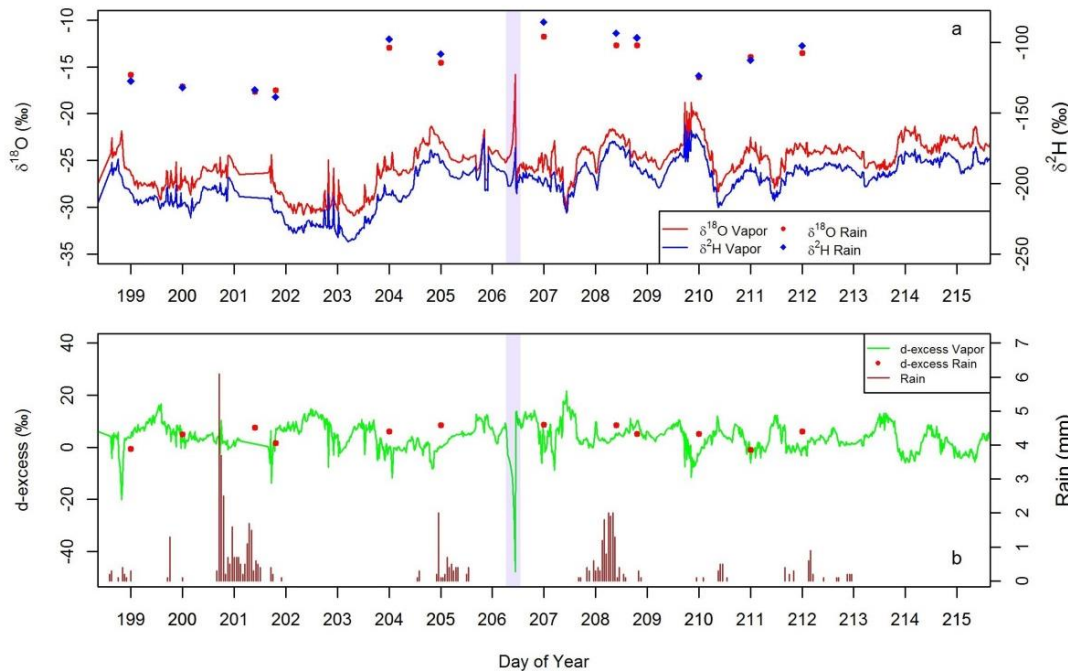
*d-excess*



Moisture source:

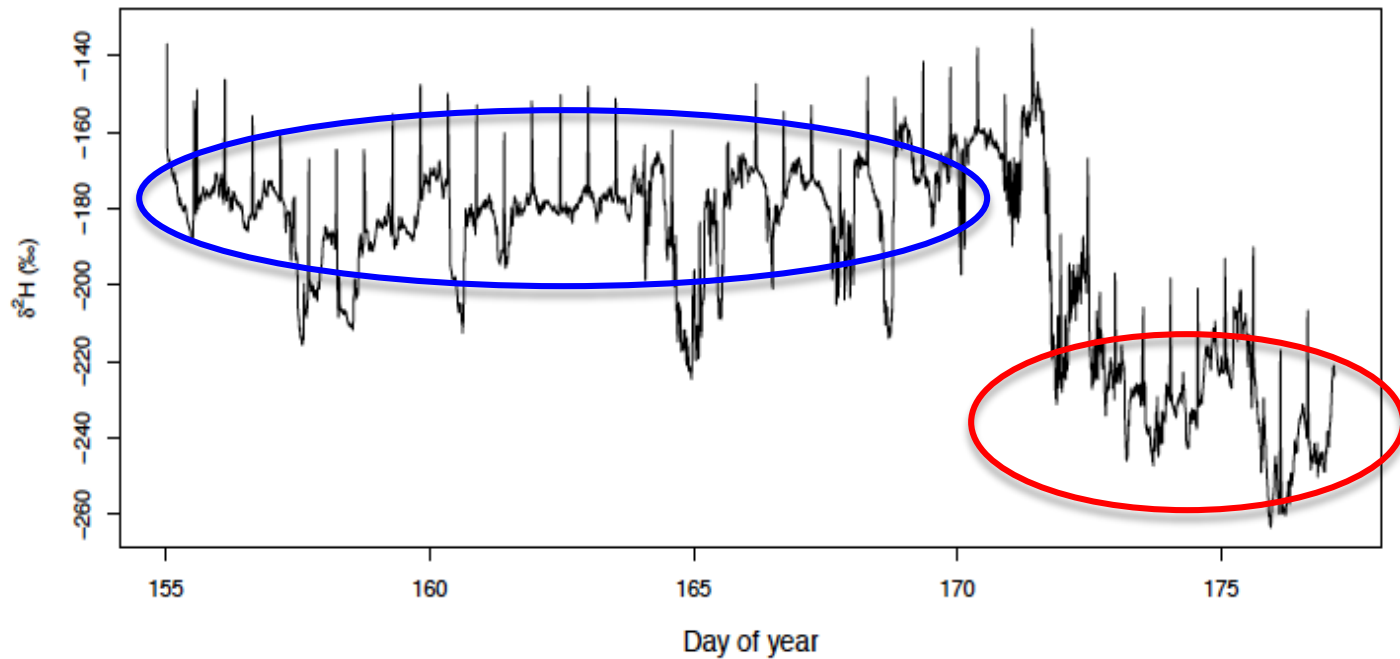
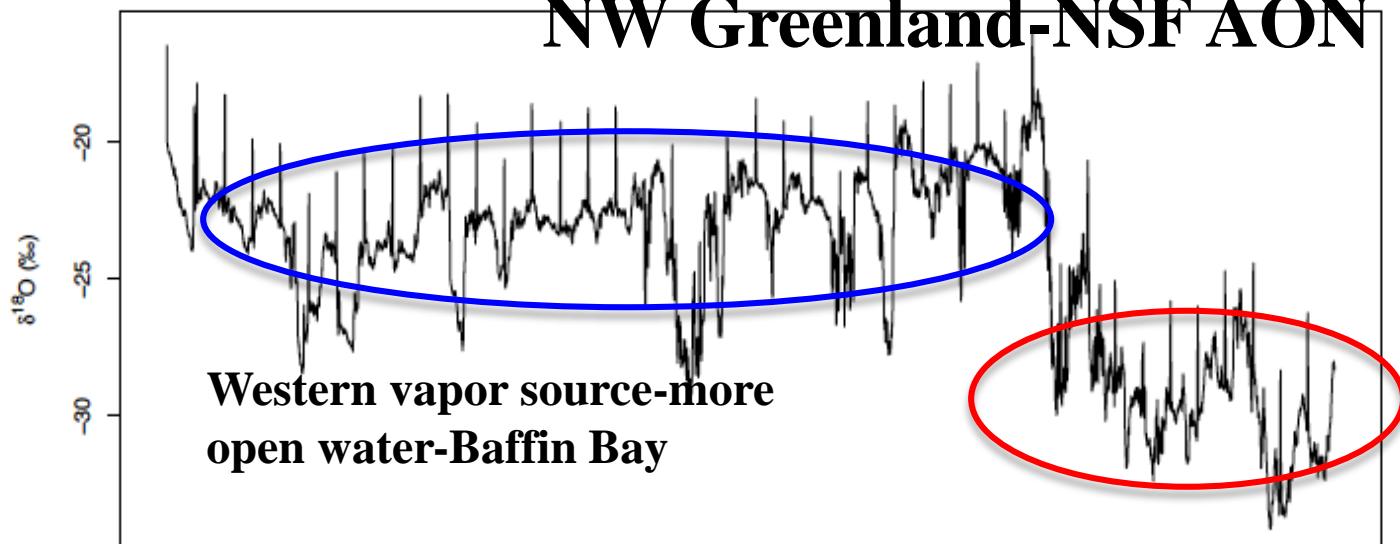
More open ocean water (less sea ice)

Greater atmospheric humidity

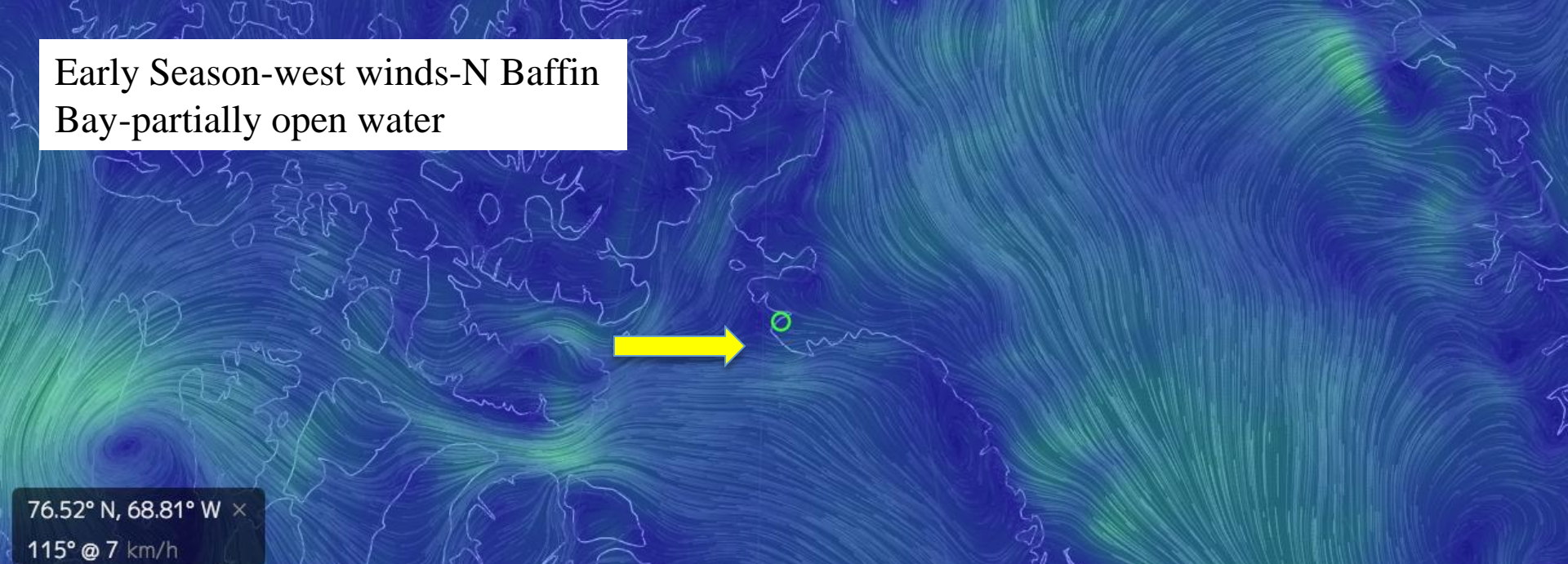




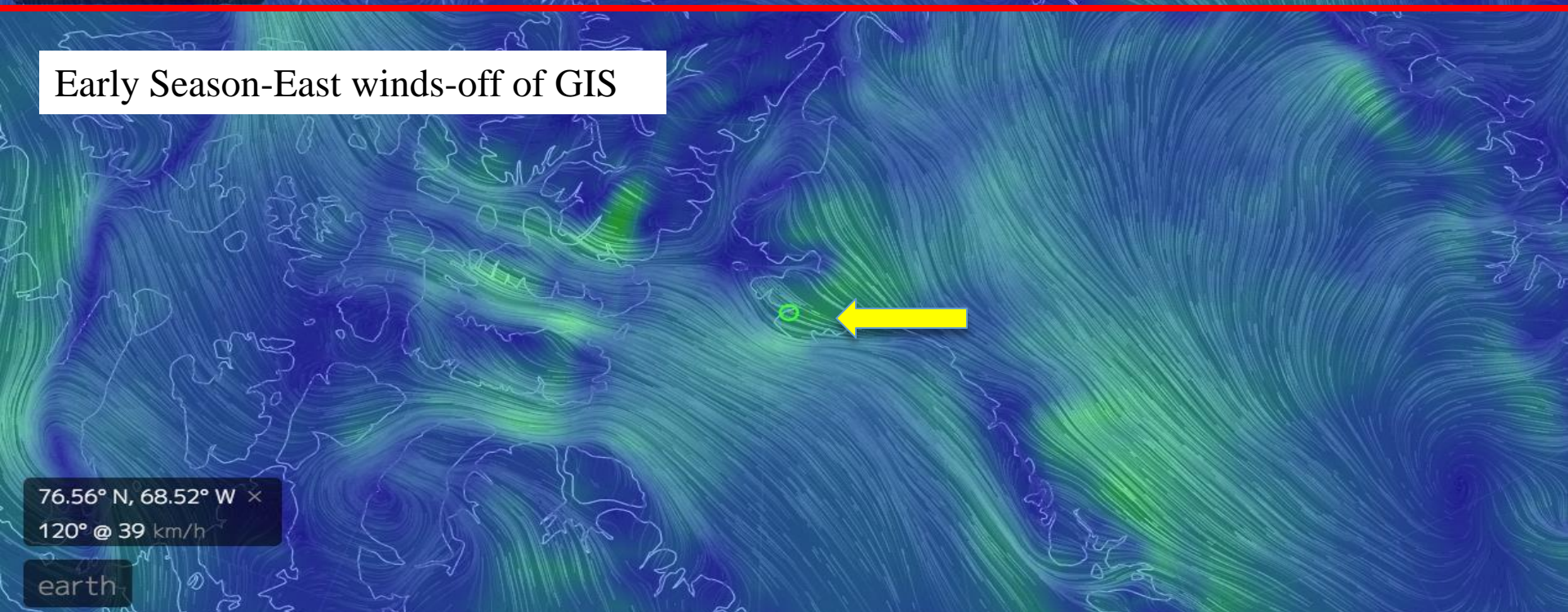
# NW Greenland-NSF AON



Early Season-west winds-N Baffin  
Bay-partially open water



Early Season-East winds-off of GIS





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## Sea ice properties/ NOAA, NWS Mapping and sea ice concentration

[http://portal.aos.org/?v=rand&portal\\_id=3#map?lg=a5b58402-a9c1-11e3-a3fe-00219bfe5678&z=4&ll=67.67440%2C-137.12647](http://portal.aos.org/?v=rand&portal_id=3#map?lg=a5b58402-a9c1-11e3-a3fe-00219bfe5678&z=4&ll=67.67440%2C-137.12647)



[View the Legacy Website](#)

NASA's OceanColor Web is supported by the Ocean Biology Processing Group (OBPG) at NASA's Goddard Space Flight Center. Our responsibilities include the collection, processing, calibration, validation, archive and distribution of ocean-related products from a large number of operational, satellite-based remote-sensing missions providing ocean color, sea surface temperature and sea surface salinity data to the international research community since 1996.

#### Ocean Color Feature

##### The Bering and Chukchi Seas



Satellite ocean color measurements of the Bering and Chukchi seas are often prevented by cloud (and in winter, ice) cover, but for several days in June, 2015, the ocean was unusually free of obstruction. VIIRS collected this view on June 19/20 (Alaska/Siberia).

Click on the image above to see a broader region at higher resolution.



SeaDAS is an image analysis package for the processing and display of satellite ocean color data.



SeaBASS is a repository of in situ oceanographic data to support algorithm development and satellite data product validation activities.

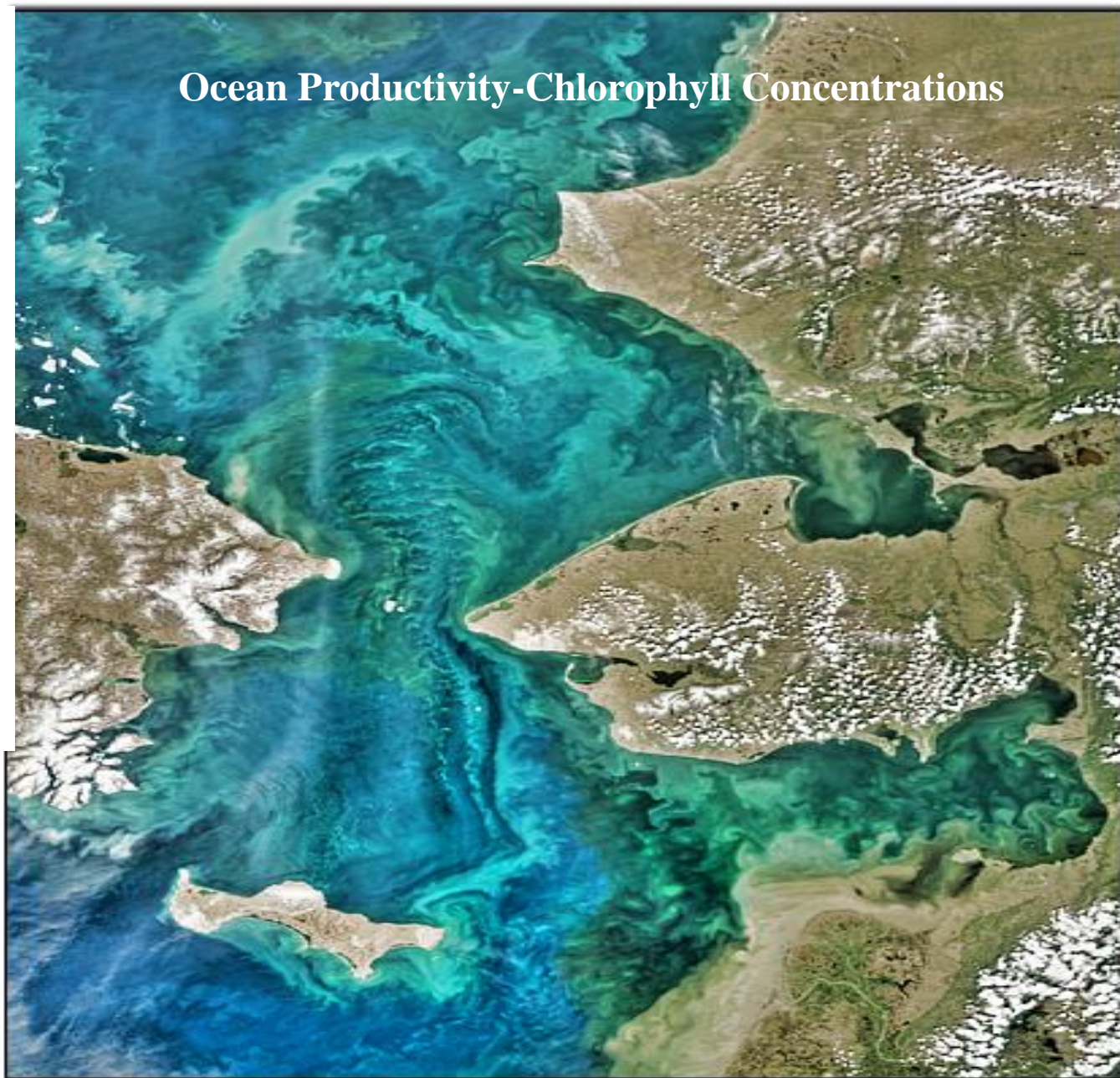


The OBPG serves as a Distributed Active Archive Center for satellite ocean biology data produced or collected under NASA's Earth Observing System Data and Information System, including those from historical missions and partner space organizations.



The OBPG maintains a Field Support Group that collects in situ data, engages in community measurement protocols activities, and hosts an HPLC phytoplankton pigment processing facility.

# Ocean Productivity-Chlorophyll Concentrations



## NASA Collaborations



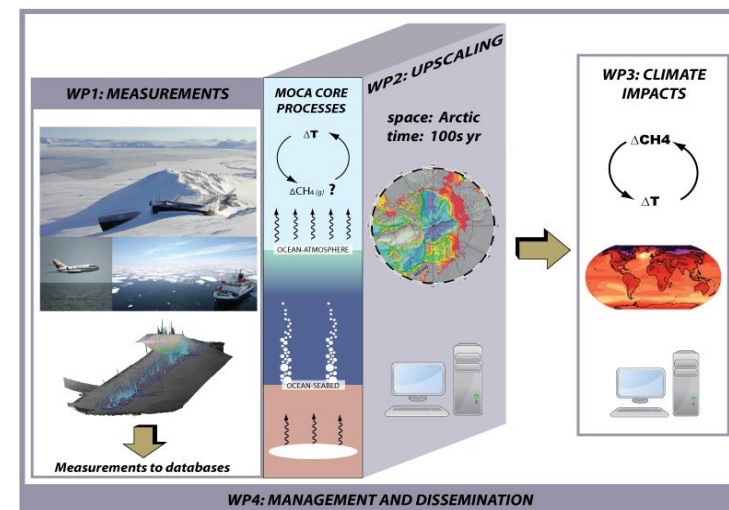
Norwegian Institute for Air Research  
MOAC-Methane emissions from Arctic Ocean  
to the Atmosphere



<http://moca.nilu.no>

Methane measurement instrument on Helmer Hanssen  
on May 21, 2014 in Measurement activities by Adam  
Durant

*NILU scientists Adam Durant and Ove Hermansen spent a week onboard the University of Trømsø research vessel "RV Helmer Hanssen" as part of the MOCA project. The purpose of the trip was to install instrumentation for measuring methane in the atmosphere over the Arctic Ocean, in preparation for a summer campaign to determine if gas emissions from methane hydrates at the ocean floor are reaching the atmosphere.*





- ▶ **Accomplishments:**
- ▶ Converted liquid water isotope NSF Picarro to a water vapor Picarro (aka Phippen)
  - Added a required standard delivery module and vaporizer
- ▶ Arranged Port of Anchorage Collaboration to house Phippen
- ▶ Operational with in 20 days of “go”, March 18 first collection until 15 June (temporary transfer to Healy)
- ▶ Established real-time data access and transfer via Ethernet portal in conjunction with Muni of ANC



# Accomplishments

- ▶ 4 week data file of  $^{18}\text{O}$ ,  $^2\text{H}$  and d-excess from Pippen was used to develop initial visualizations with GeoNorth & Axiom
  - Simple footprint model based on wind speed and direction (data)
  - Ocean vs. land differences
- ▶ Sea ice period too short to develop sea ice conditions/water vapor isotope correlations-Year long 2015-2016 will allow this
- ▶ Port of Anchorage Educational program contributions and development



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# Accomplishments



- Healy R& D Cruise (2 July to 25 July)  
mobile real-time sea ice and oil detection testing
- Secured  $^{13}\text{C}$  Picarro (on short term loan) from UIC  
Calibrated via INSTAAR collaborations
- Bench tested and prepared for shipping to Kodiak
- Phippen removed from Port, and upgraded for Healy mission
- Contacts with NASA Ocean Observing members-Gene and Norman  
Contacts with the Ocean Acidification community, Taro at Lamont
- Journalist contact and pre-trip discussion/explanations Al Jazeera-America-  
Laura LeBlanc
- Alaska Dispatch News R&D Healy coverage-Yereth Rosen



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# Milestones

- ▶ Operational at the Port of ANC for 100 consecutive days, before temporary decommissioning for Healy R&D cruise
- ▶ Real-time data access and download capacity
- ▶ Initial visualizations
- ▶ Broad US scientific community partnerships (UIC, INSTAAR, NASA, NOAA, Columbia Univ.)
- ▶ Norwegian Institute for Air Research-MOCA (**M**ethane emissions from the Arctic **O**cean to the **A**tmosphere)



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# Collaborators & Stakeholders

- ▶ Cook Inlet Regional Advisory Council –cameras
- ▶ NOAA Sea Ice Desk
- ▶ Port of ANC personnel
- ▶ Municipality of ANC-communications
- ▶ Picarro



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# Gaps and Lessons Learned

- ▶ Data collection year-around
- ▶ Spatial limitations-larger spatial coverage (Nome, St. Lawrence, Barrow)
- ▶ Expanding capacity in the Arctic
- ▶ Drone capacity-100,000 miles of coastline without real-time data
- ▶ ADAC x Picarro x AeroVironment (Lockheed Martin-small drone)
- ▶ Real time data can be reliable, accessible, and power visualizations



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# Demonstration

<http://portal.aaos.org/#map?lg=460455ad-a0b7-4dff-8f5d-a3c33a7d3916&z=11&ll=61.19726%2C-149.95445>