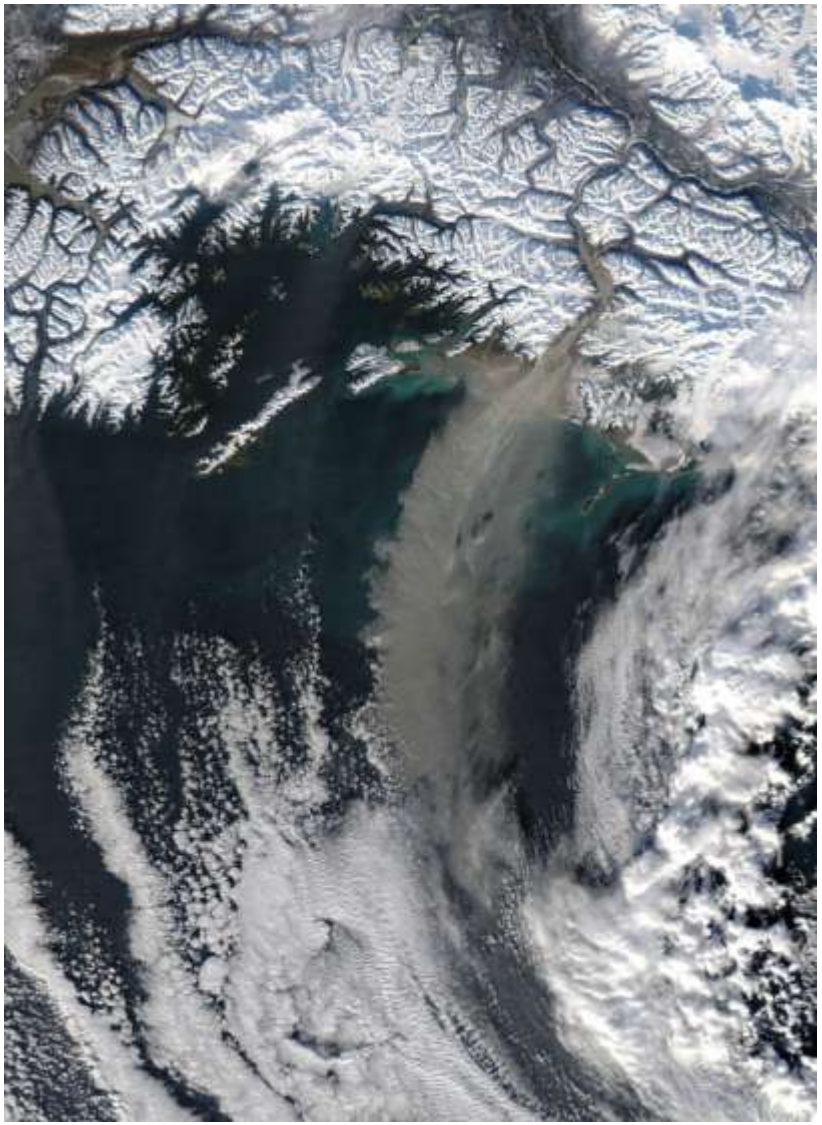
It's not all from Asia: Satellite observations of dust transport of Alaskan dust into the North Pacific



Santiago Gassó
GEST/UMBC

Rob Levy(GSFC), John Crusius(USGS),
Rob Campbell (PWSC,AK), Andrew Schroth (USGS)
Andrew Thomas (U. of Maine)

With support of the IDS grant "Melting ice, habitat change and nutrient flux: Hydrological, biogeochemical and biological linkages between the Copper River and the coastal Gulf of Alaska.

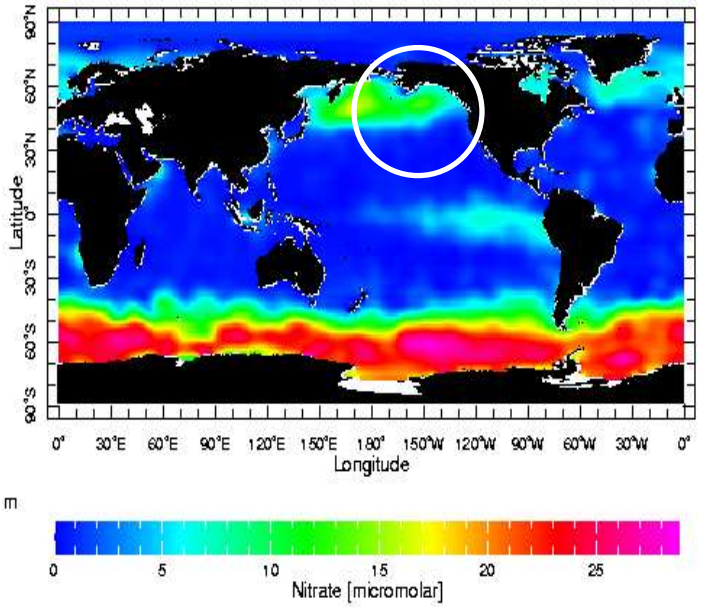
A joint effort comprising researchers of Prince Williams Science Center , AK, University of Maine , US Geological Survey and Woods Hole Coastal and Marine Science Center;

Motivation

Health hazards, visibility reduction and air traffic disruption

•Dust Mobilization in Alaska is a recurrent phenomenon (confirmed records since late 1890s)

Carbon Cycle in the North Pacific

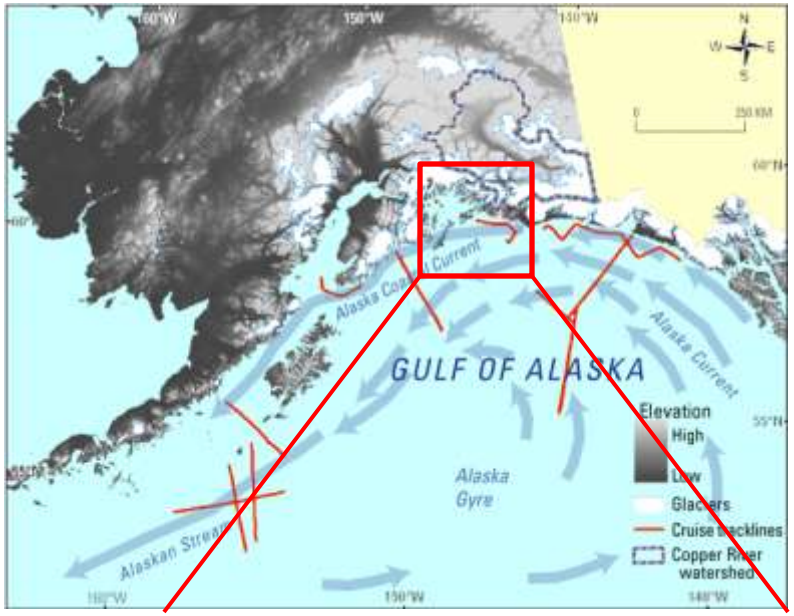


•Factors controlling phytoplankton growth in the North Pacific are not well known.

•Despite the presence of nutrients (such as Nitrate, map above), phytoplankton growth is limited.

•It turns out that Fe is the limiting nutrient in this area and its sources are not well known (aeolian, oceanic, both?).

General Area and Analysis Tools



(John Crusius (USGS))

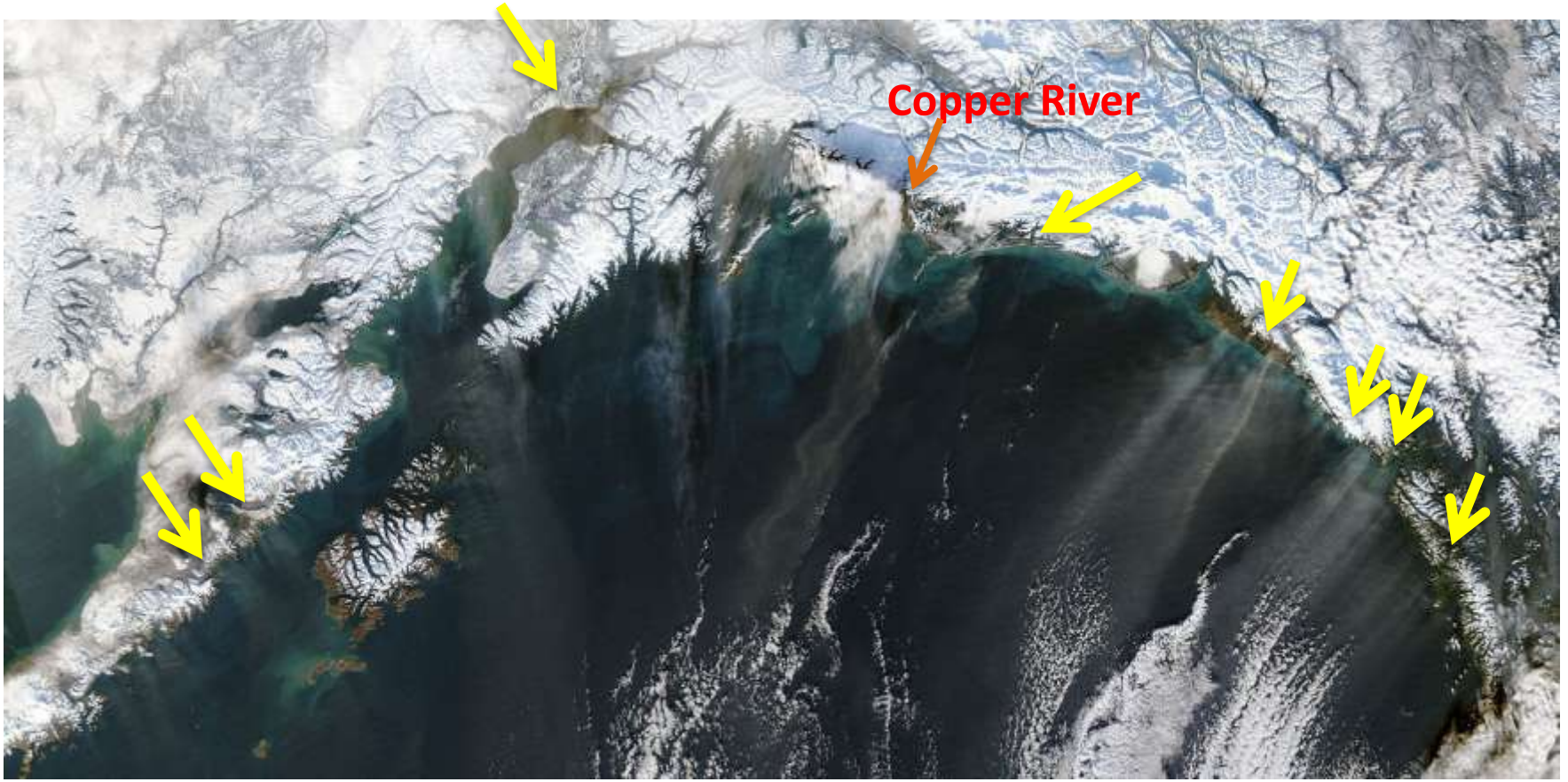
- Satellite imagery : MODIS (RGBs, Level 2), GOES,MISR,OMI,Polder, Calipso
- Surface data : met. Observations at Middleton Island and Copper River and FAA webcams
- Modeling : Hysplit

Highlights of ongoing analysis (largely based on Crusius, J.et al., (2011), ***Glacial flour dust storms in the Gulf of Alaska: Hydrologic and meteorological controls and their importance as a source of bioavailable iron***, *Geophys. Res. Lett.*, 38, L06602, doi:10.1029/2010GL046573).

Some Very Basic Questions need to be addressed…..

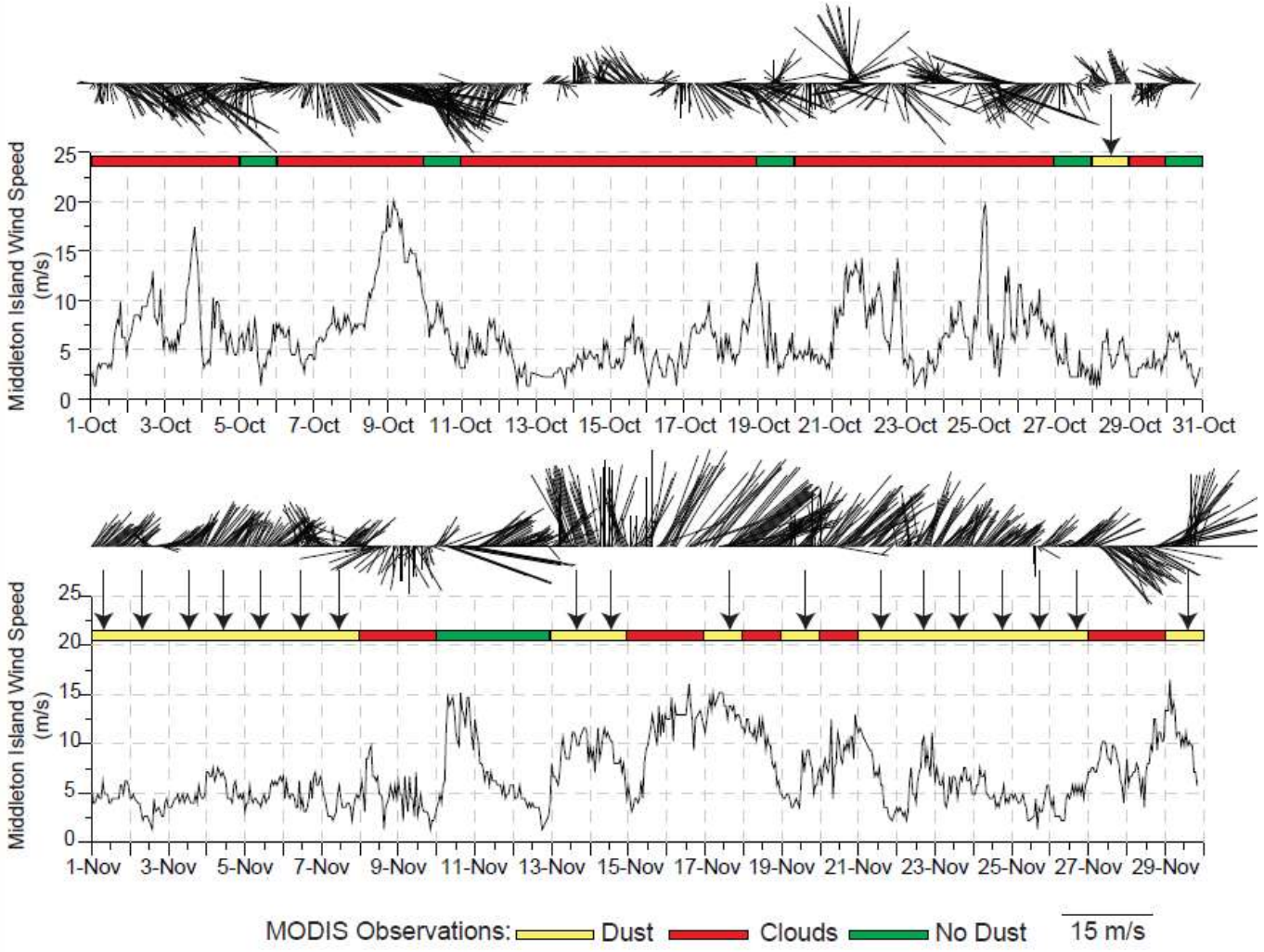
- **Time**: When? How often?
- **Location** : only Copper River? Other Rivers?
- **Transport**: How much? How far?
- Composition of the dust , marine chemistry and biology (*not addressed here*)

Dust injection into GoA can occur anywhere along a ~1,000 mile coastline



October-November 2006 Dust activity

Wind data from Middleton Island and MODIS Obs



Summary of Dust Activity

October:

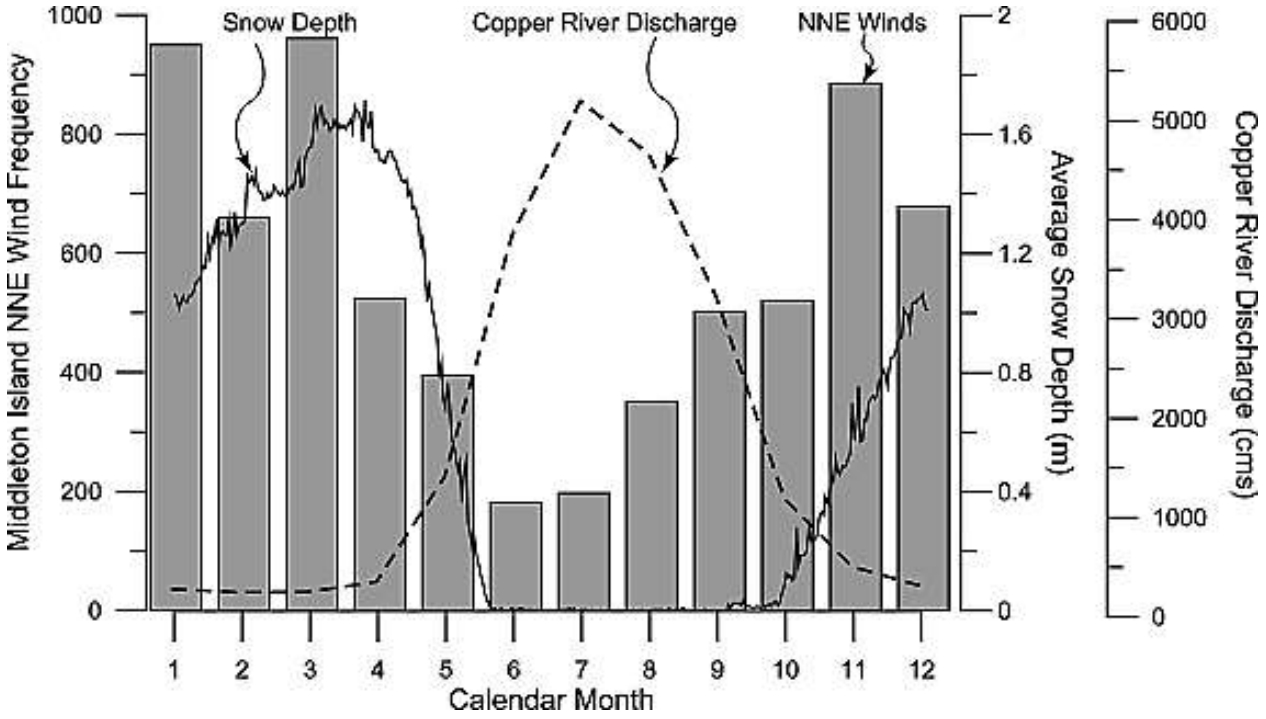
DustDay	=	1
NoDust	=	5
Cloudy	=	25

November:

DD	=	19
ND	=	3
Cloudy	=	8

Significant number of days w/ dust activity

Correlation between River Discharge, Wind and Snow Cover

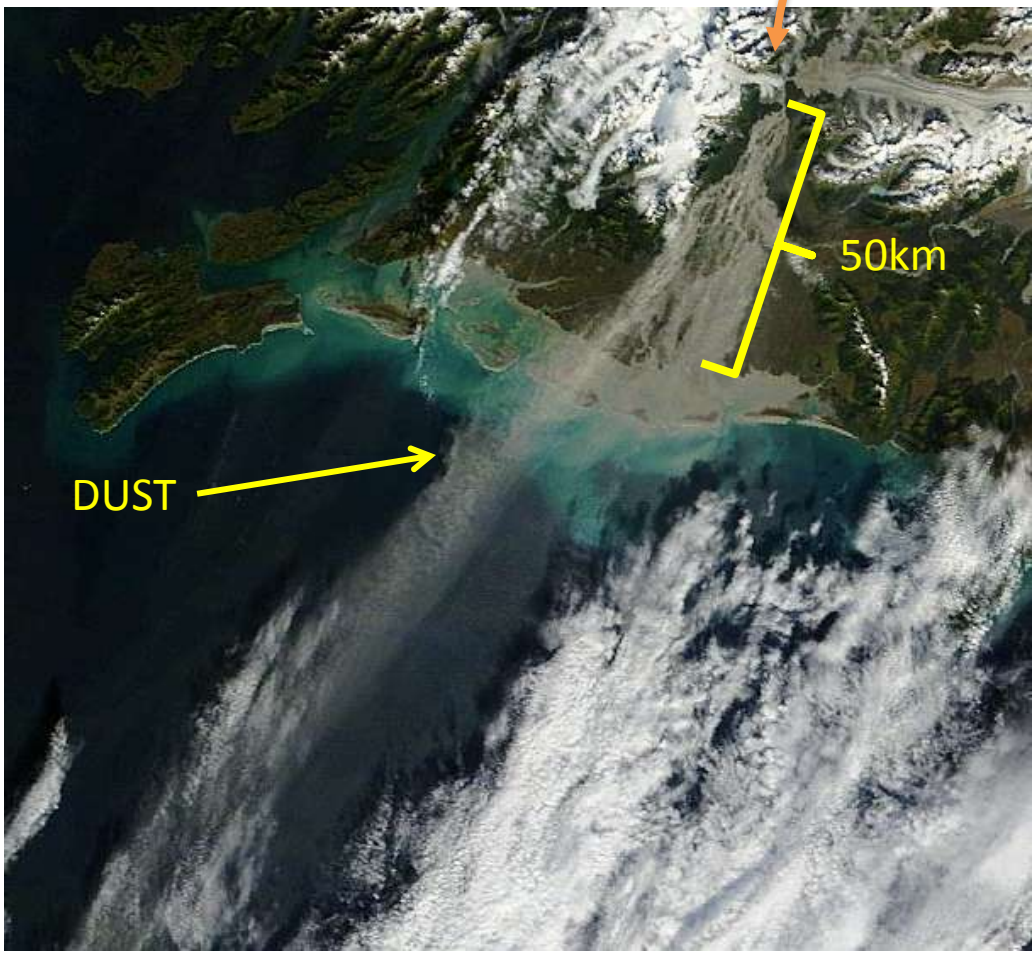


- The observed 2006 Oct-Nov activity was expected because the combination of :
  - Low River Flow,
  - Low Snow Cover
  - High winds from NNE

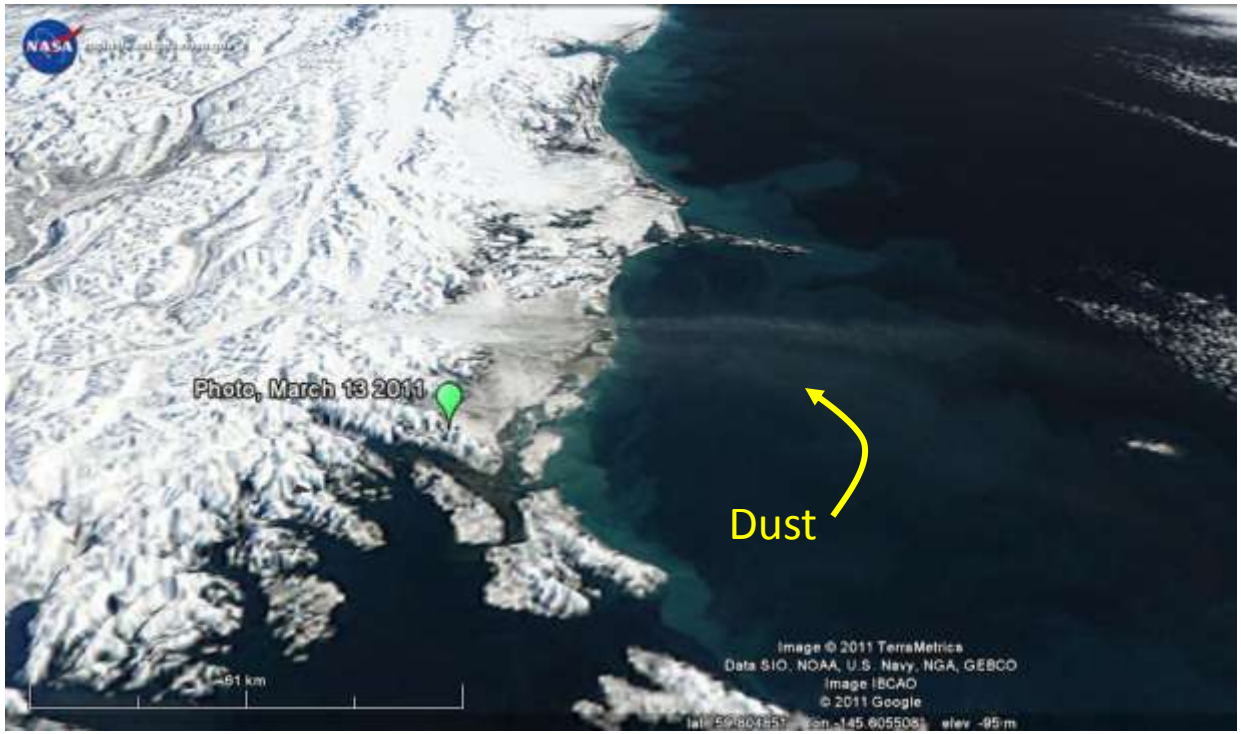
- What about the other months? January, March, May?

Highlights from Current 2010-2011 Season

First Event of the Season : September 24th



Last Event Recorded this month: March 13th



Number of days/month with observed Dust Activity :

Sept: 1
Oct: 0
Nov: 5
Dec: 3
Jan : 6
Feb : 4
Mar: 7 (as of 3/28)

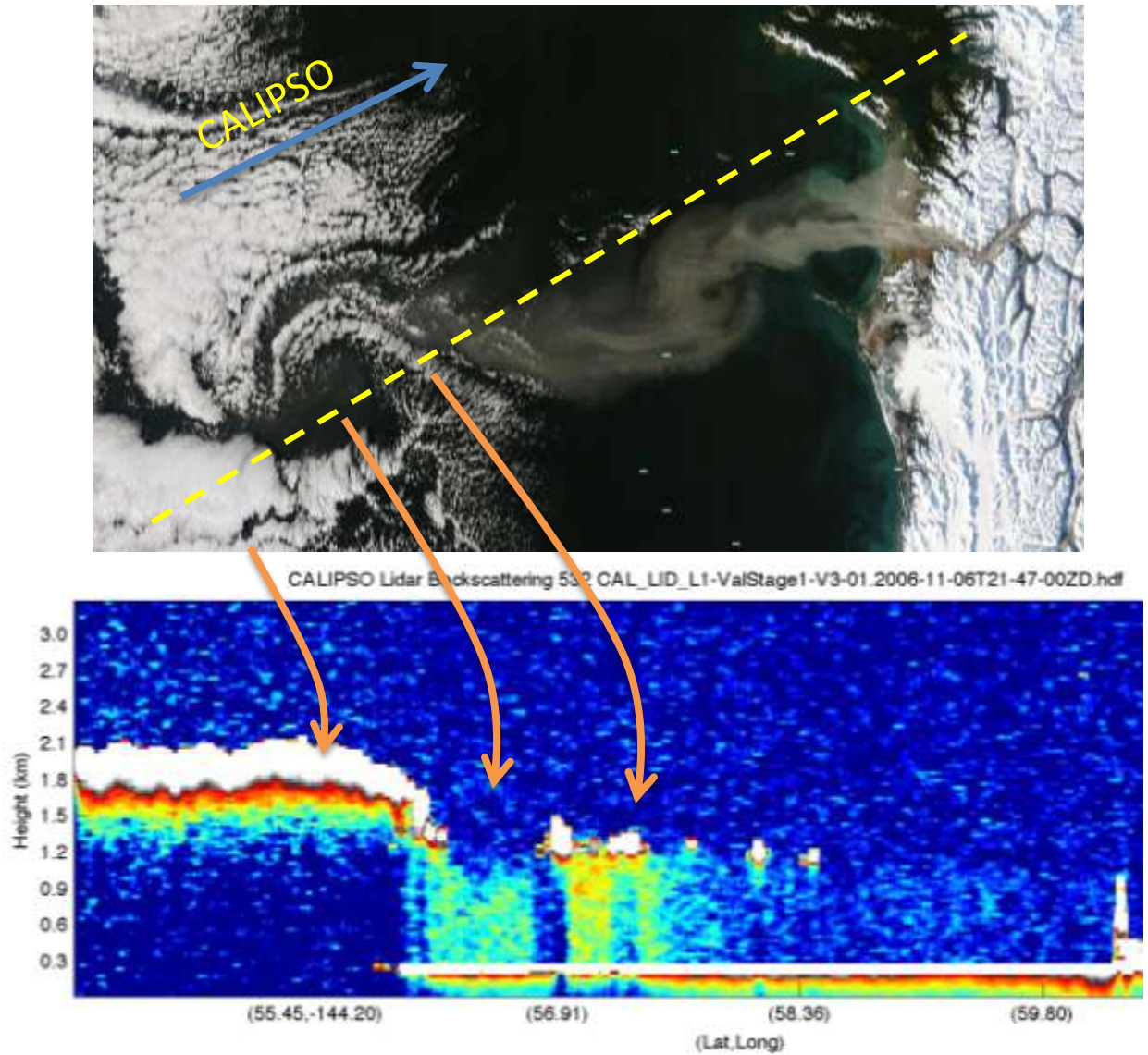
Total: 26 (underestimate)

Also, more dust events identified in satellite imagery: 1997,2003,2005,2008,2009

Take home Message

There is dust activity in Fall and Winter months

Above or In the Boundary Layer?



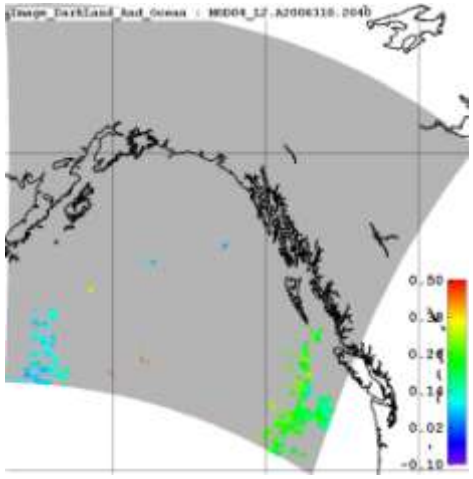
CALIPSO confirms Low Altitude Dust!

Important because it suggests rapid and significant deposition within the Gulf of Alaska.

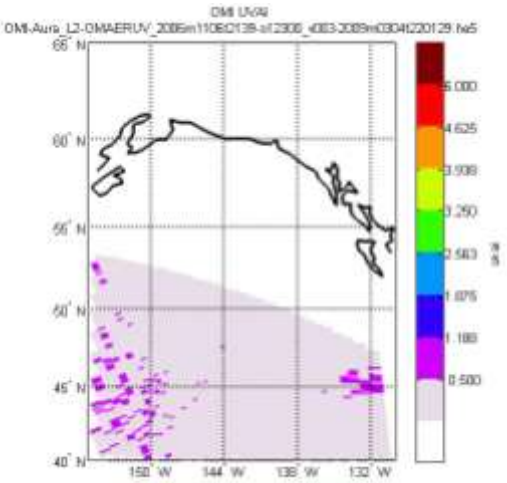
HYSPLIT simulations support this observation too (not shown)

Lets get more quantitative but ….

MODIS Collection 5 AOT



OMI AI



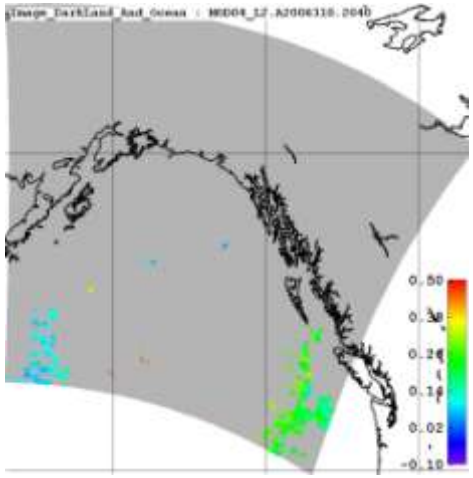
Problem: No Modis or OMI retrievals in the Area due to steep angles.

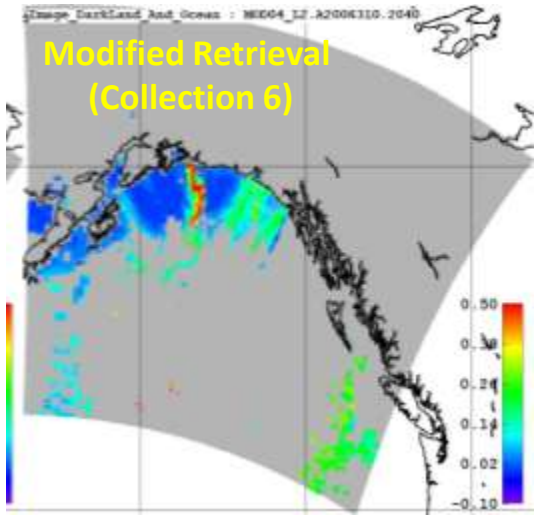
MISR does have successful retrievals

GOES GASP AOT product does not have angular problems but no retrievals reported

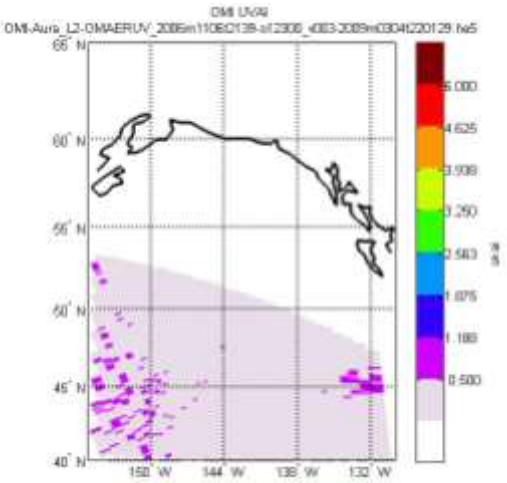
Lets get more quantitative but ….

MODIS Collection 5 AOT





OMI AI



Problem: No Modis or OMI retrievals in the Area due to steep angles.

MISR does have successful retrievals

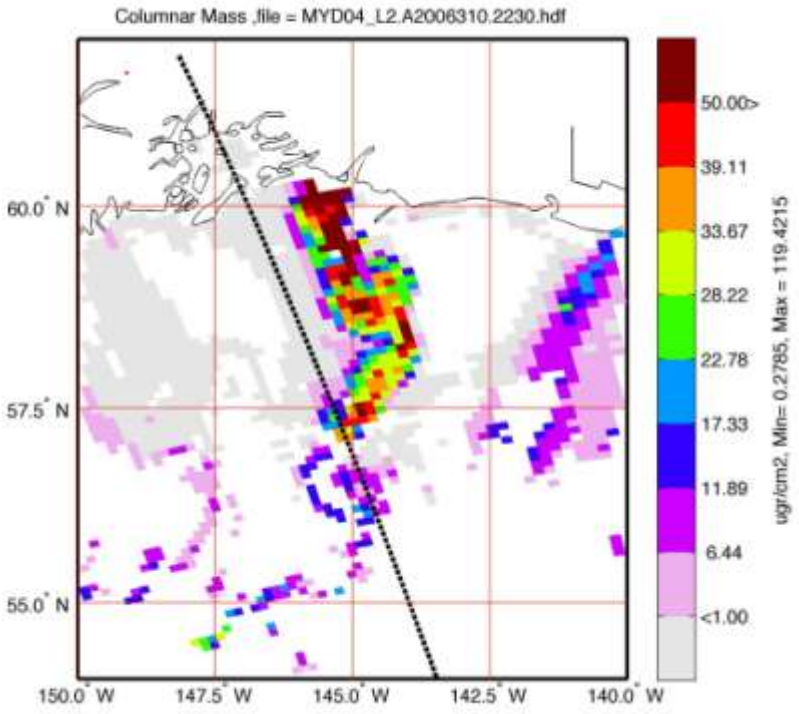
GOES GASP AOT product does not have angular problems but no retrievals reported

Rob Levy to the rescue: Modification of the MODIS algorithm.

NOTE: Collection 5 retrievals available starting mid January….

How Much is deposited? And how does it compare with other source of nutrients?

Columnar Mass Concentration



From MODIS Columnar Mass Concentration, assume or constraint :

_ how much dust deposits over the ocean
_ how Fe in the dust
_ how much of the Fe dissolves (and becomes bioavailable)

Estimate of Bioavailable Fe

Our Estimate (MODIS) = 60–400 tons/year

Ocean Eddies (upwelling) = ~700 tons/year

(Johnson et al. (2005), Iron transport by mesoscale Haida eddies in the Gulf of Alaska, Deep Sea Res., Part II, 52(7–8), 933–953, doi:10.1016/j.dsr2.2004.08.017.

Take home message: deposited source of Fe is comparable to the Fe available from ocean upwelling

Last Slide!!!

- A couple of thoughts:
  - Glaciers in AK are retreating !!! Are we going to have more Alaska “dust storms”? What is the impact in GoA phytoplankton?
  - We need to evaluate algorithm performance at these high latitudes (Iceland, Patagonia)