



A case for FLH in coastal waters: monitoring the spring bloom in British Columbia, Canada, plus MCI examples

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CoastColour

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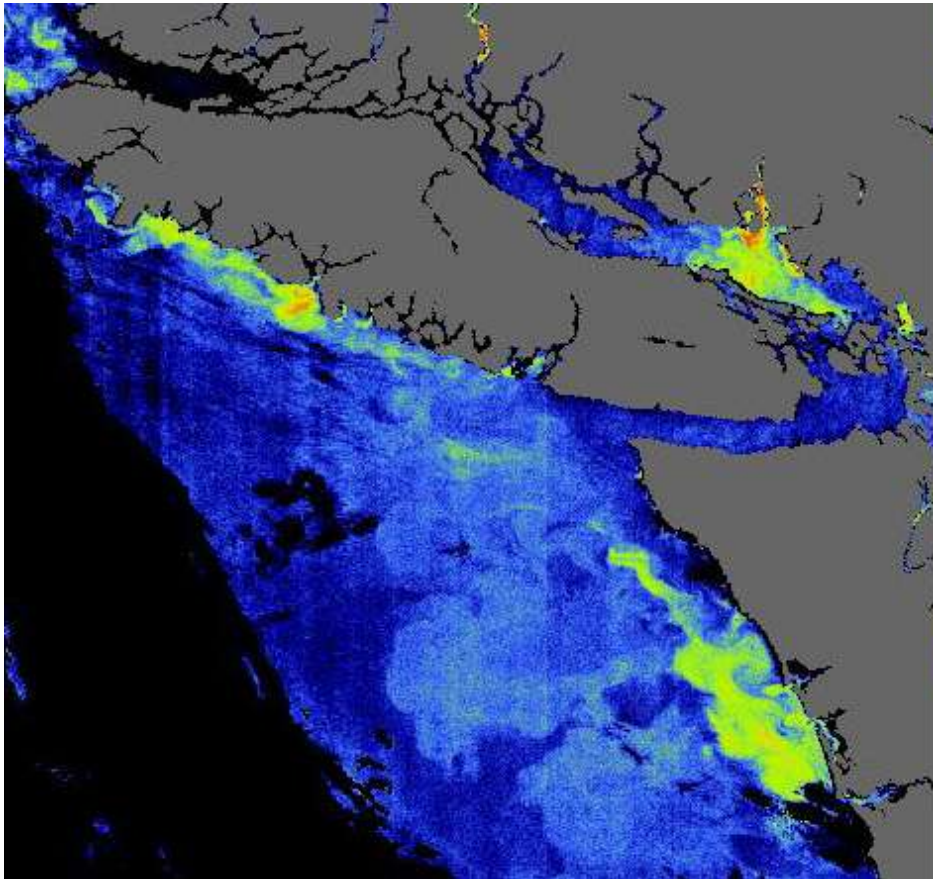
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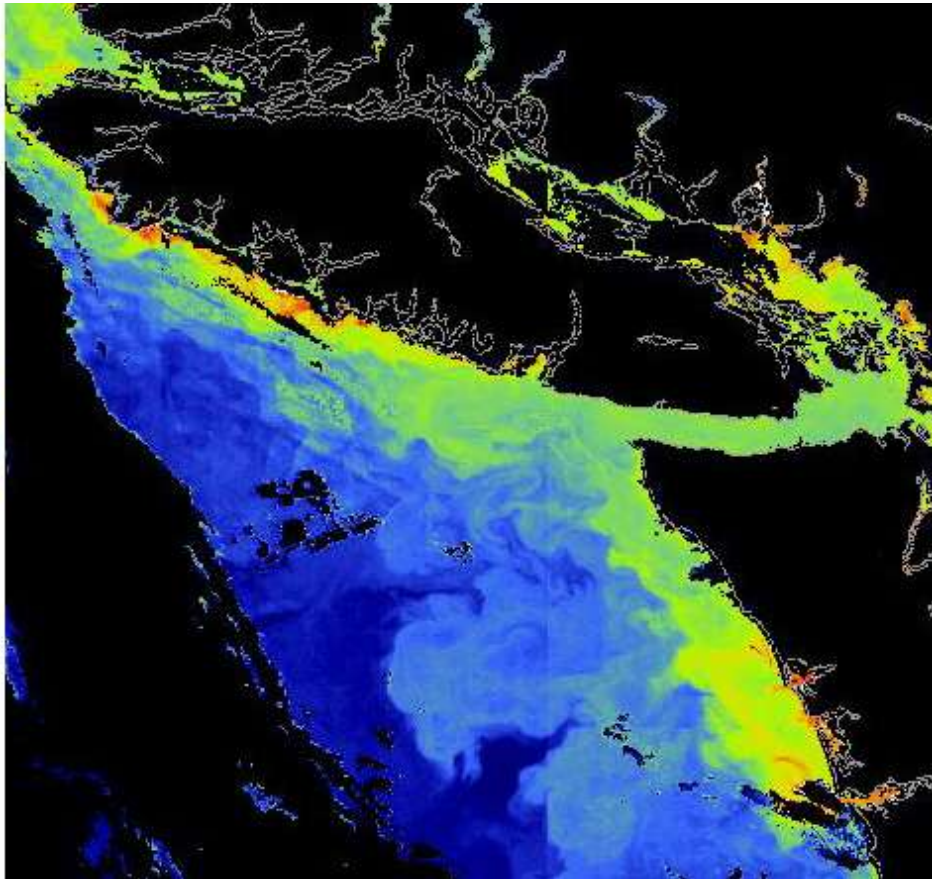
Summary

- We need “products that work”: we propose MERIS and MODIS FLH
- In the present case, FLH images show blooms in inlets which seem to “seed” the main spring bloom in the Strait of Georgia
- MERIS FR images give the resolution needed to detect blooms in narrow inlets
- There is an apparent correlation between seeding and an early spring bloom





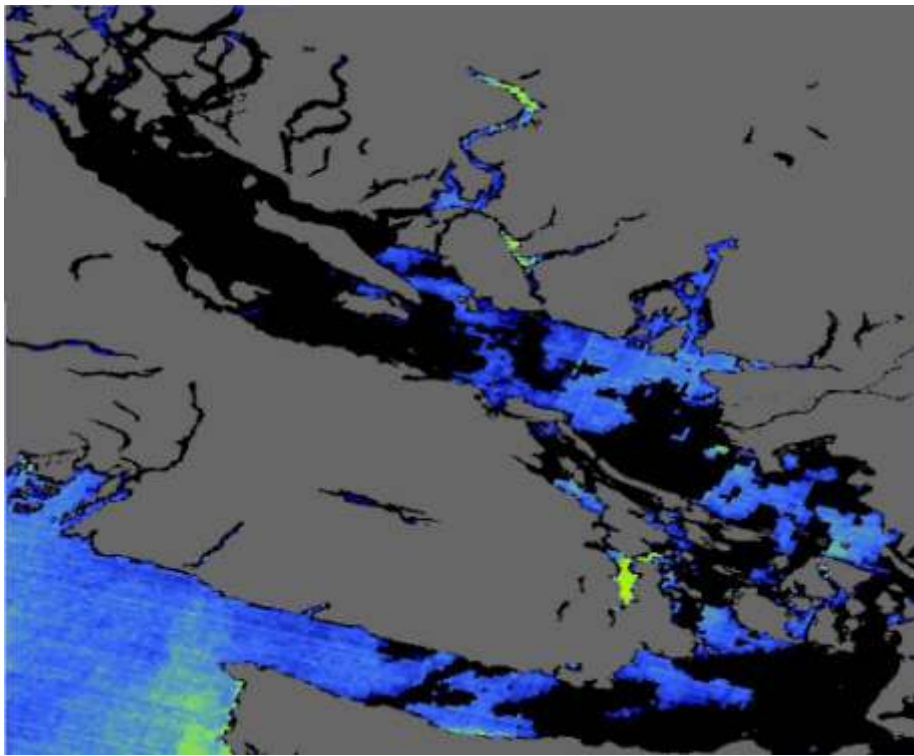
FLH



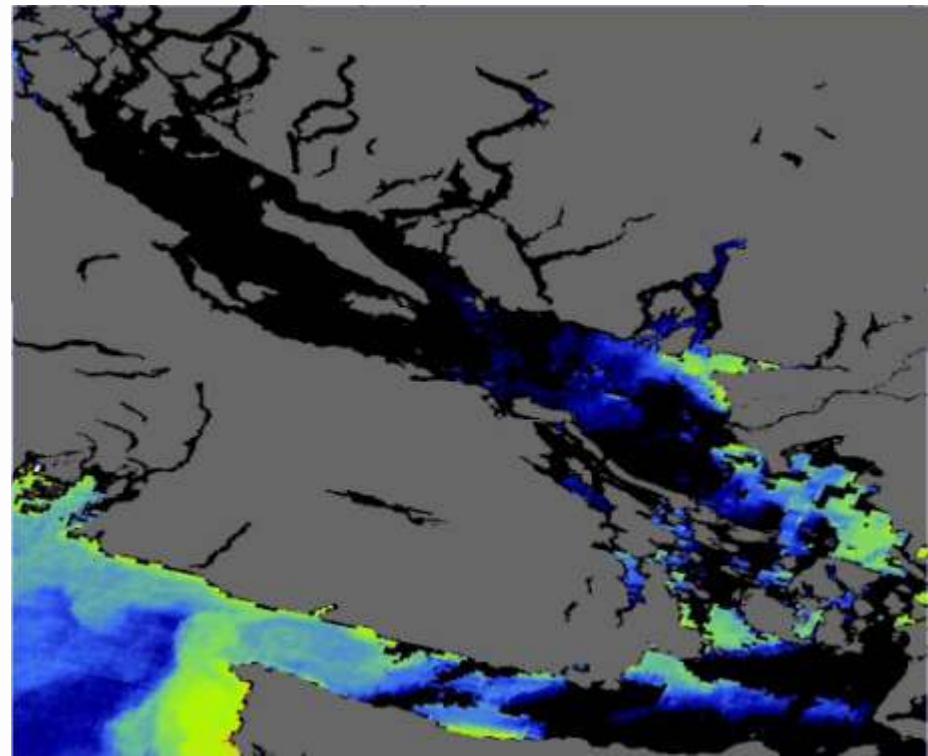
Algal1

MERIS RR March 20 2006, a typical comparison in which FLH shows relatively isolated patches of high signal suggesting blooms flowing out of inlets, while Algal 1 shows a more even distribution of chlorophyll along the coast, with masked areas (black, near shore and in the Strait of Georgia) where no values are available





FLH



Algal1

MERIS RR February 11 2009. Blooms start at the head of Jervis Inlet (top), and in Sechelt Inlet (upper centre) and Saanich Inlet (bottom, confirmed by buoy 46134). The Algal 1 image shows no blooms in inlets, but high values in areas where FLH shows low values



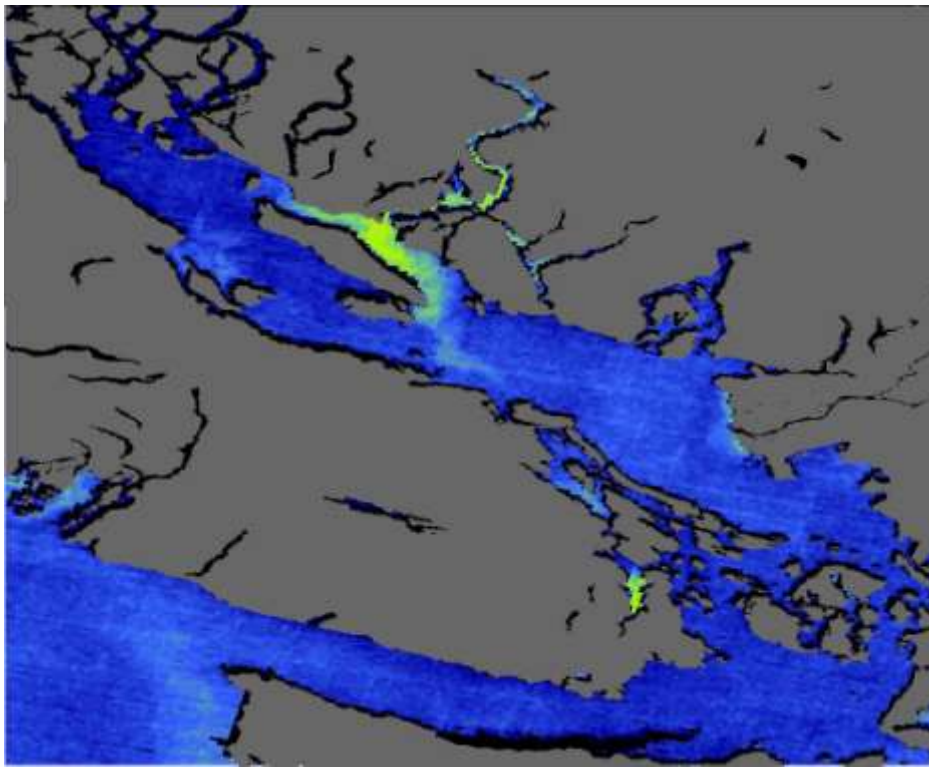
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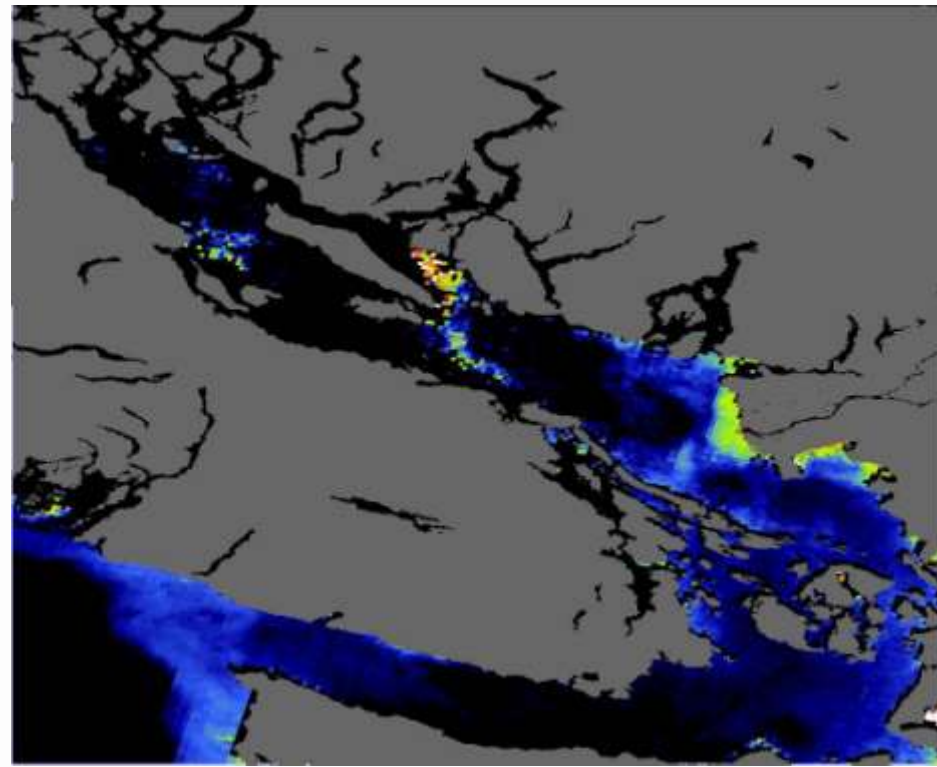


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FLH



Algal1

MERIS RR February 15 2009. Blooms have spread in Jervis Inlet, out into Malaspina Strait. A bloom is still observed in Saanich Inlet (bottom, confirmed by buoy 46134). The Algal 1 image shows high values in Malspina Strait, and high signal at the mouth of the Fraser River, not seen in FLH



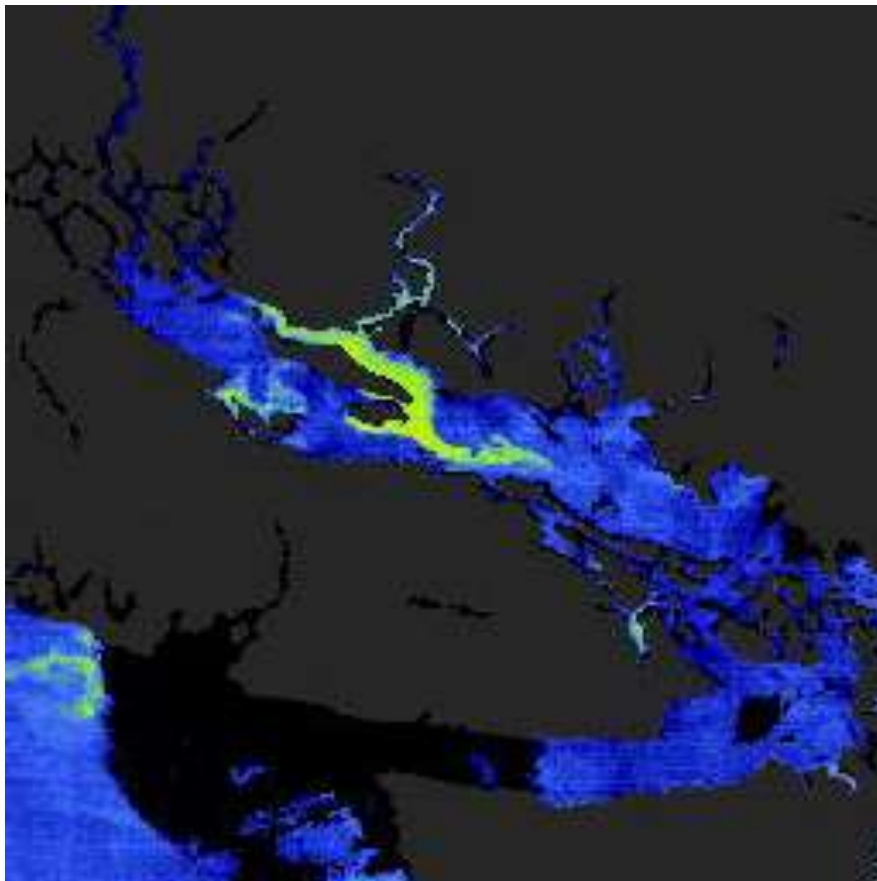
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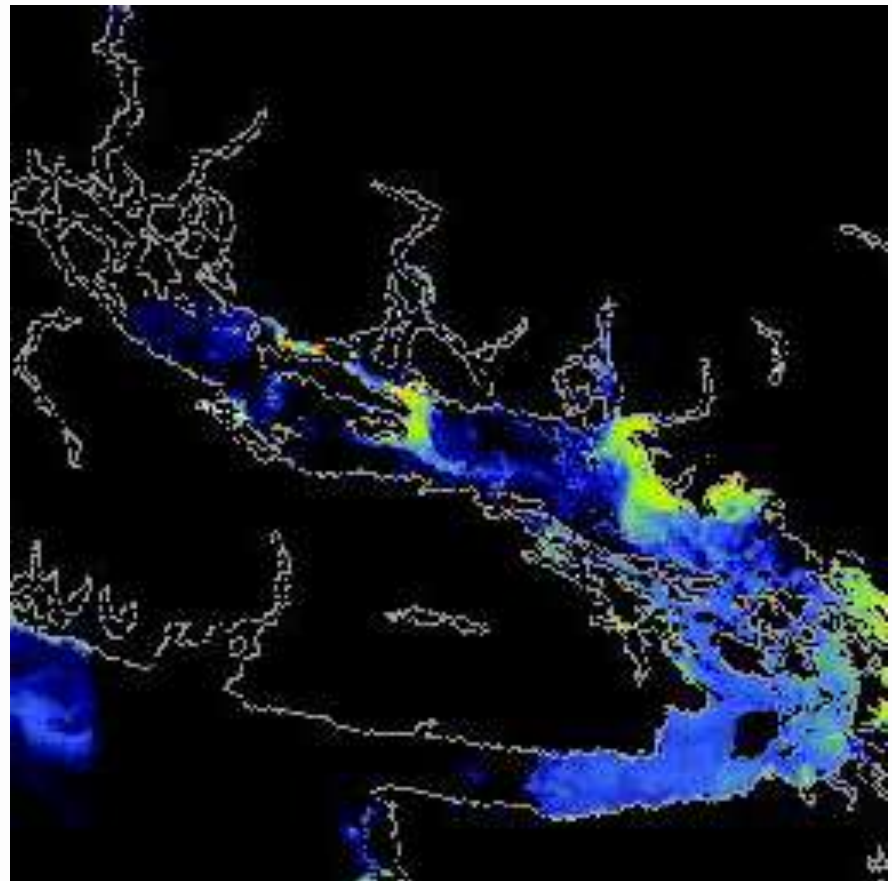


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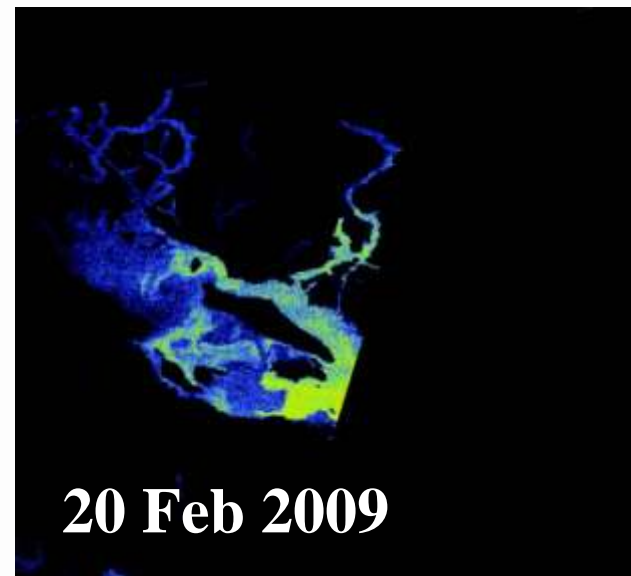
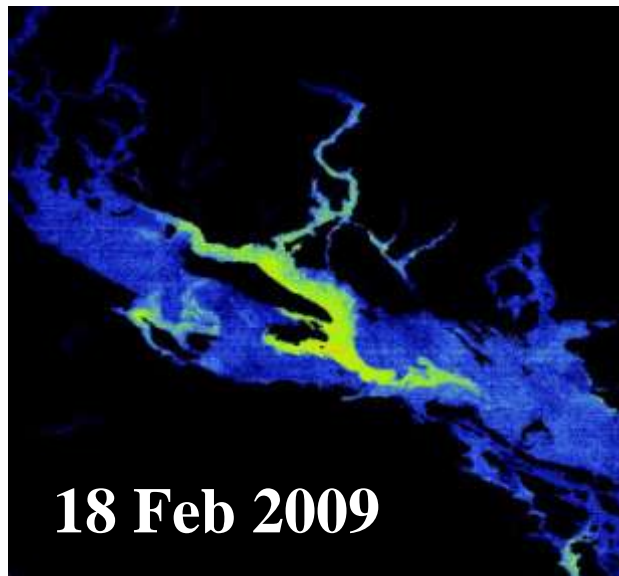
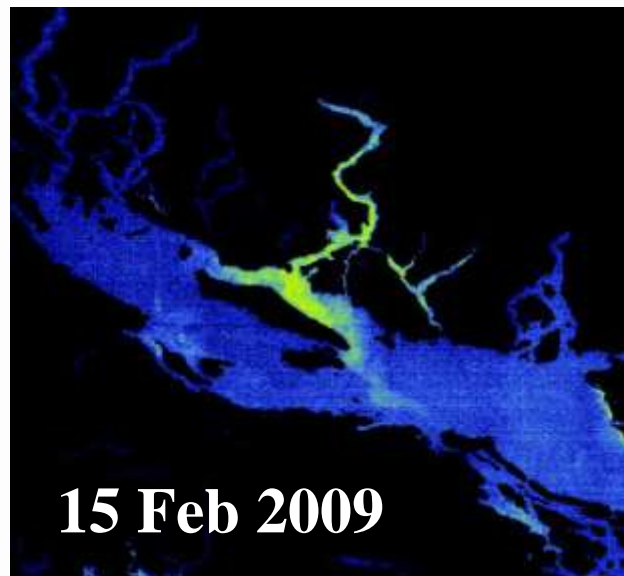
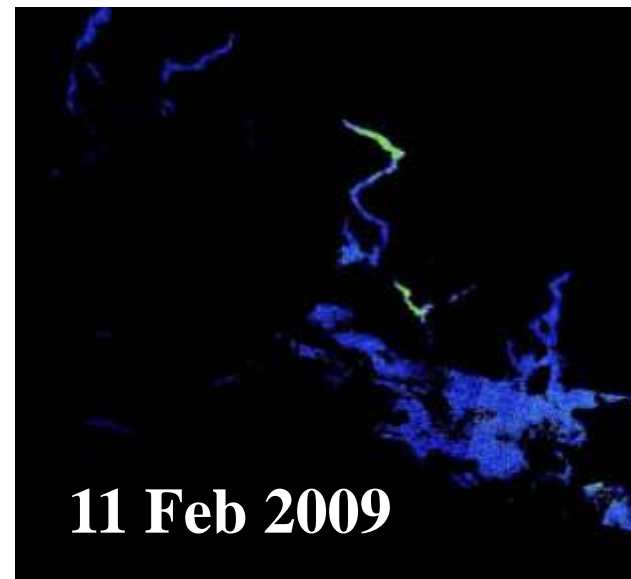
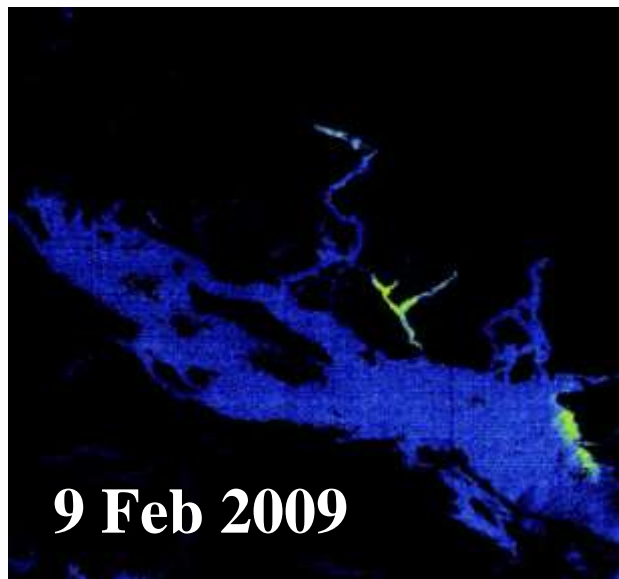
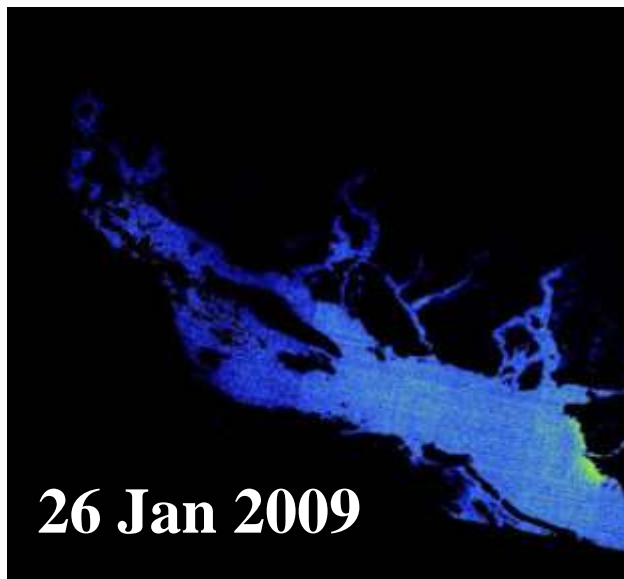
FLH



Algal1

MERIS RR February 18 2009. FLH shows one of our fully developed “dragon” blooms (centre), with another bloom leaving Saanich Inlet (lower right). The Algal1 product confirms the presence of the dragon, but shows it less clearly and gives no data in inlets. It also shows high signal near the mouth of the Fraser, which is not present in FLH





The “dragon” bloom in 2009 imaged with MERIS FR FLH



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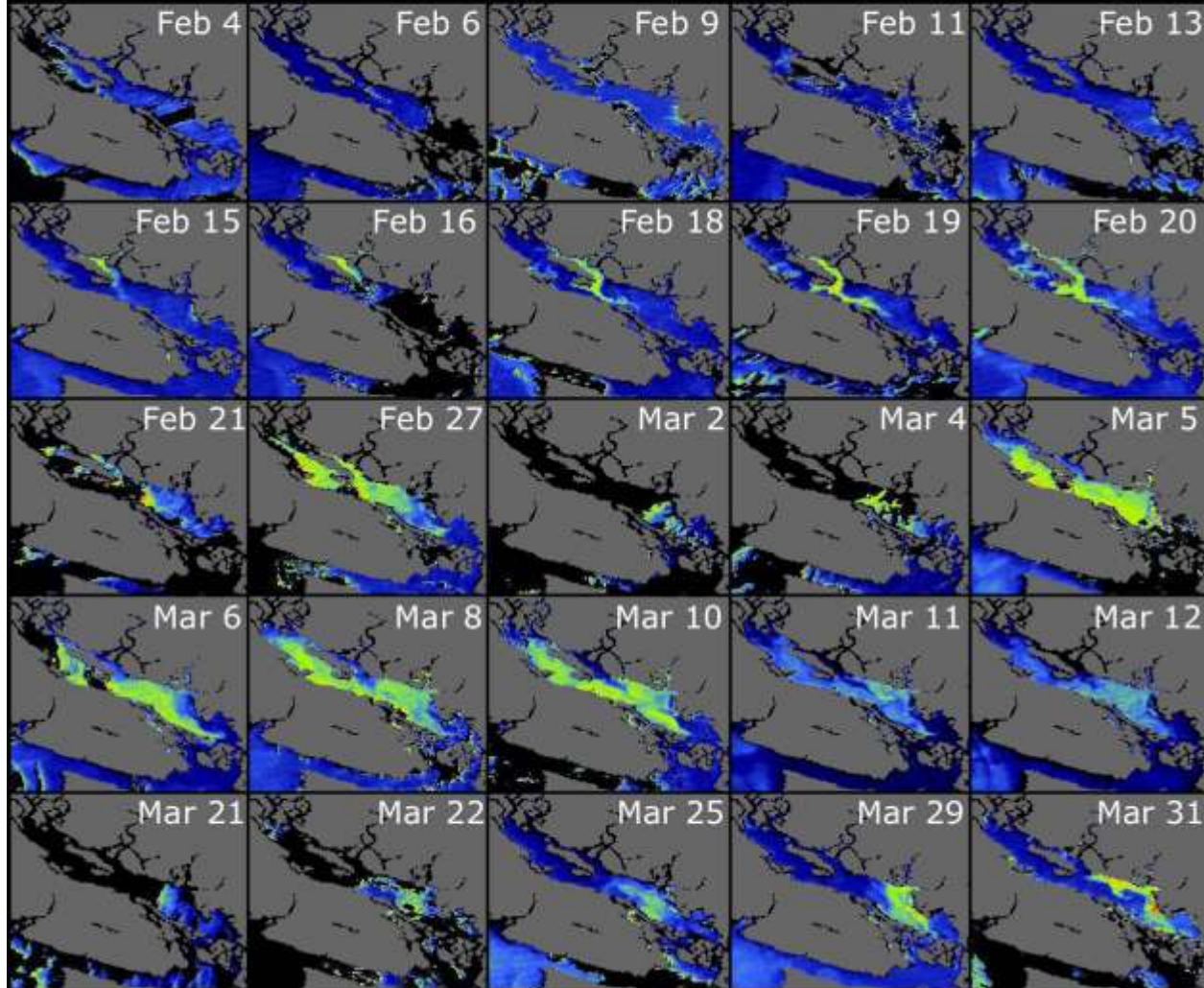
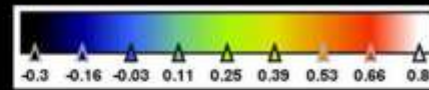
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MODIS (FLH) Time Series of the Strait of Georgia Spring Bloom February/March 2009



MODIS FLH gives images on more days, but gives data in inlets less often than MERIS, and has no FR option for FLH



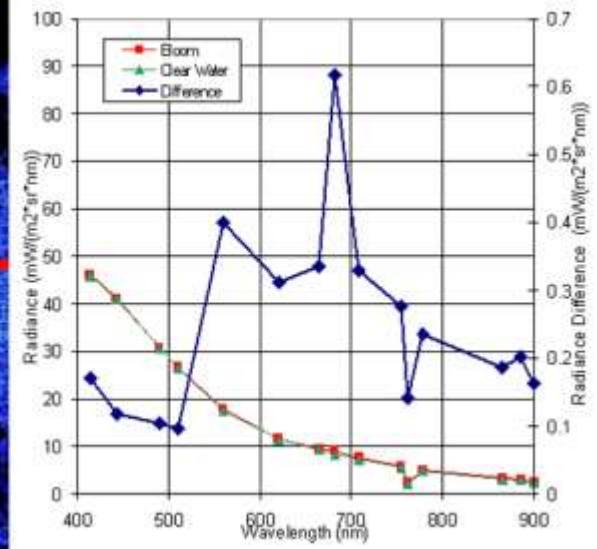
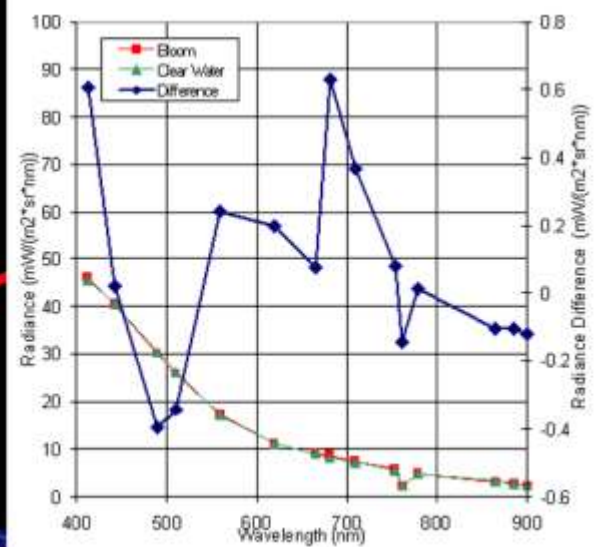
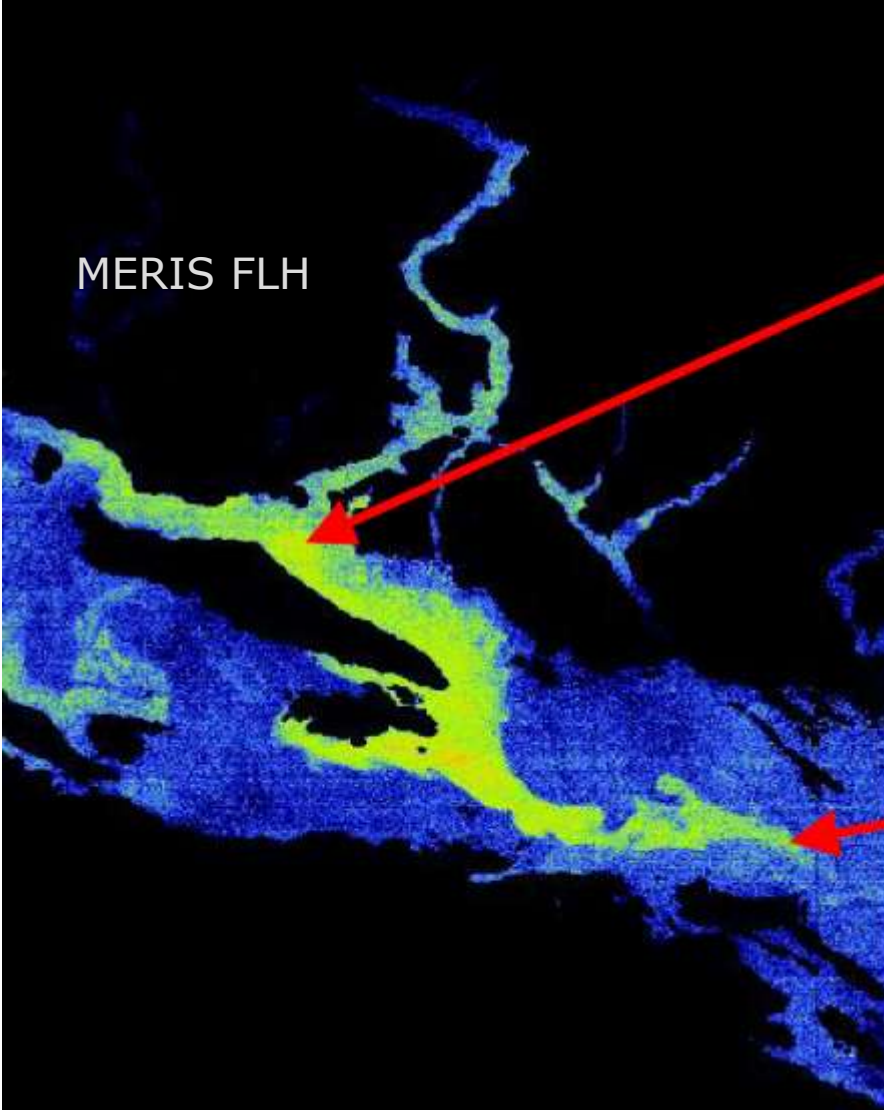
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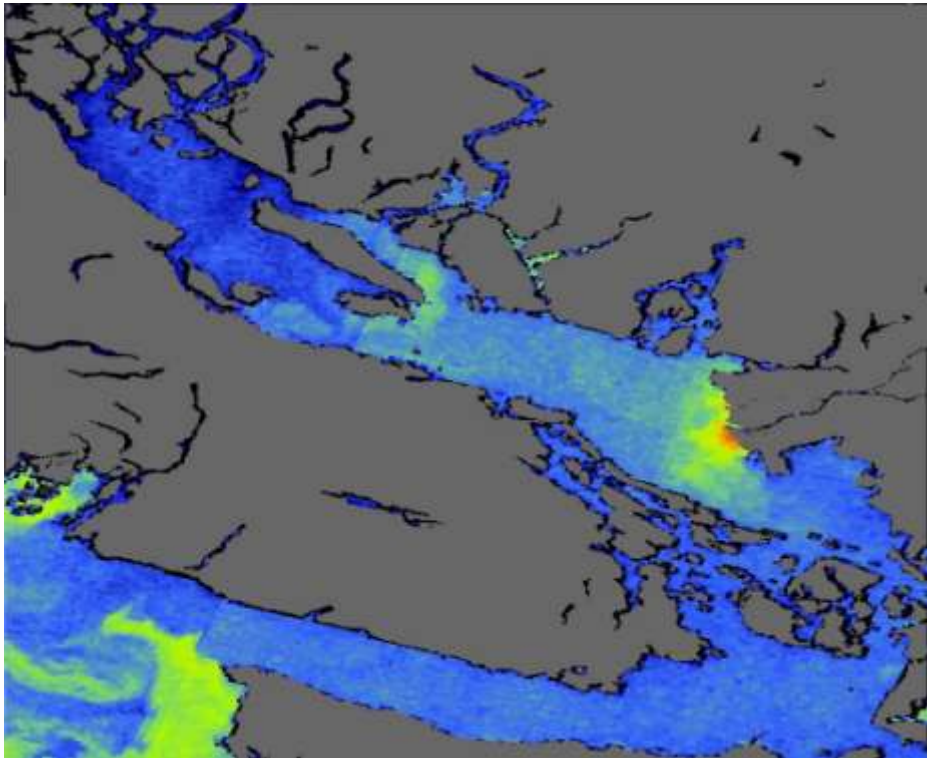
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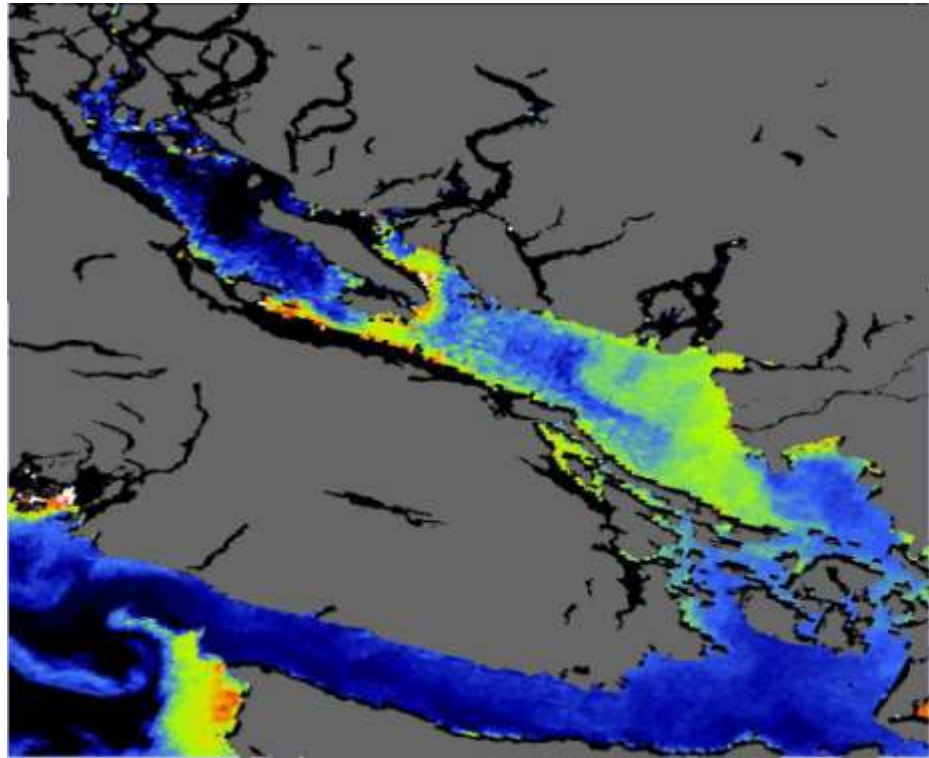


MERIS FR Level 1 FLH image and difference spectra on February 18, 2009 showing the peak radiance difference (bloom – clear water) at two locations





FLH



Algal1

MERIS RR February 21 2005, showing another year in which a “dragon” bloom was observed. On this day, both FLH and Algal1 show high values in Malaspina Strait. FLH also shows high values in Sechelt Inlet.



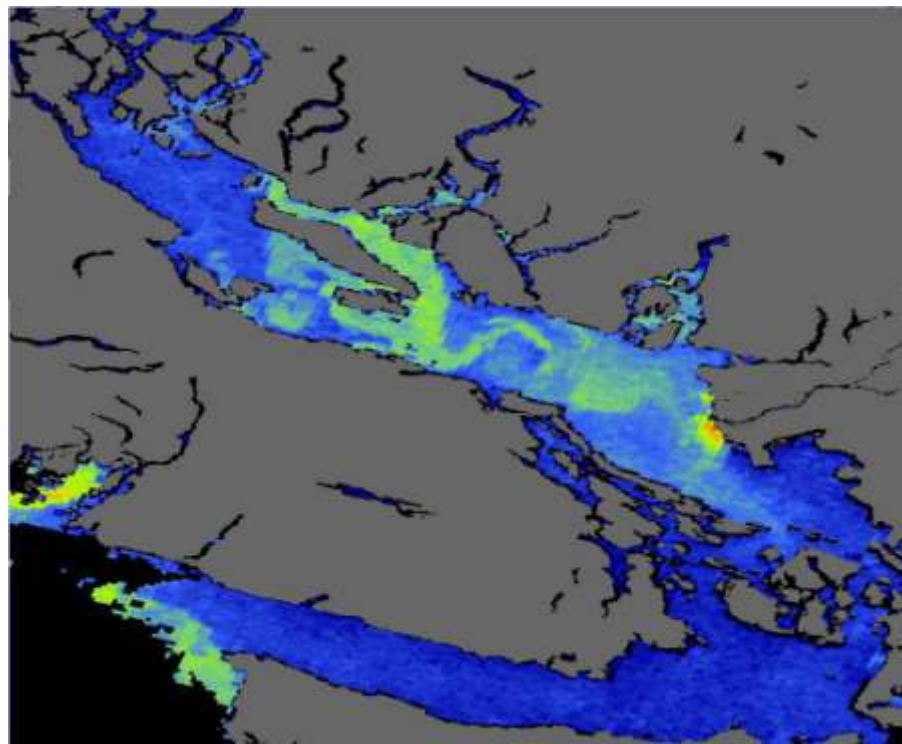
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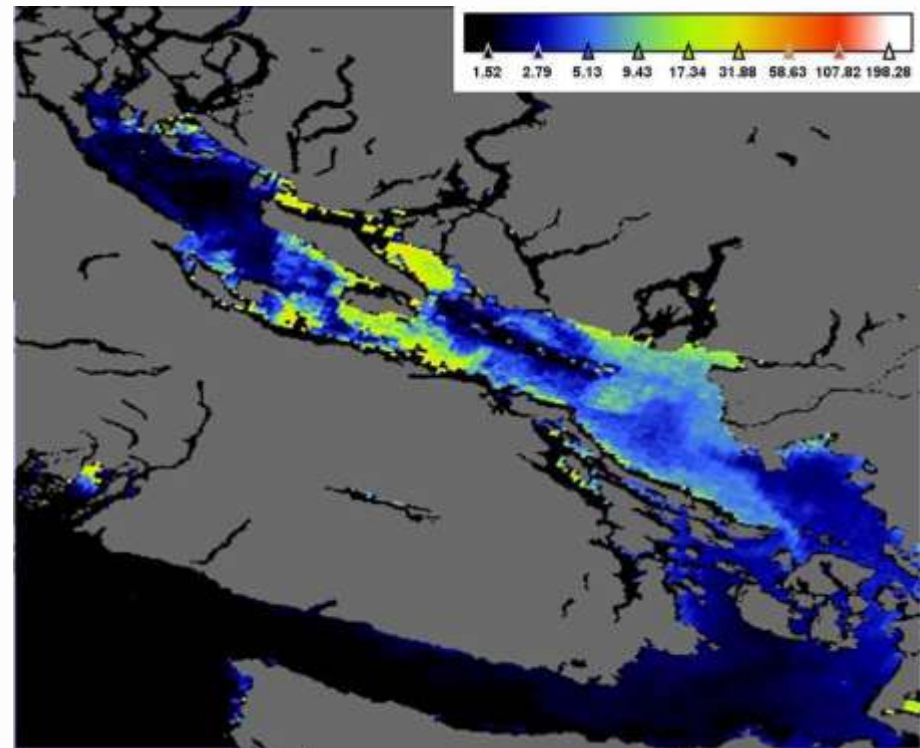


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FLH



Algal1

MERIS RR February 24 2005. Three days later, FLH shows a “dragon” but the Algal1 image is badly affected by an aircraft contrail. Again, Algal1 gives no data in inlets



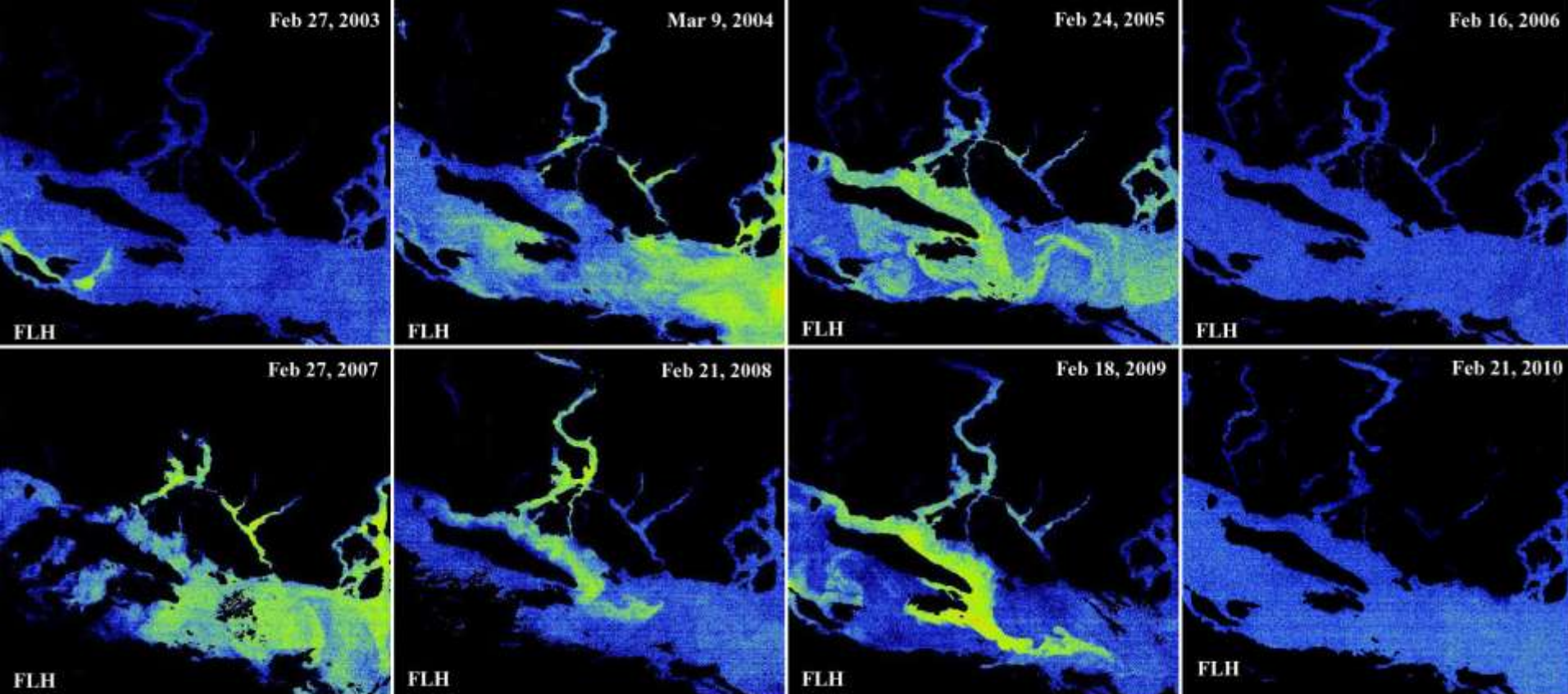
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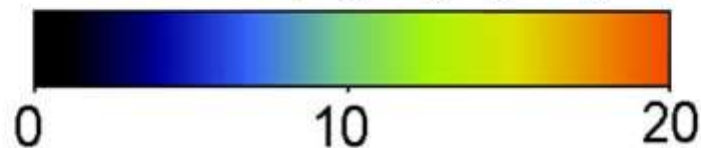


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FLH chlorophyll (mg/m^3)



Surface chlorophyll patterns on one selected day in each year, 2003 to 2010, showing apparent seeding of the spring bloom in the Strait of Georgia from northern inlets in 5 out of 8 years. We saw a dragon-shaped bloom in 3 years.



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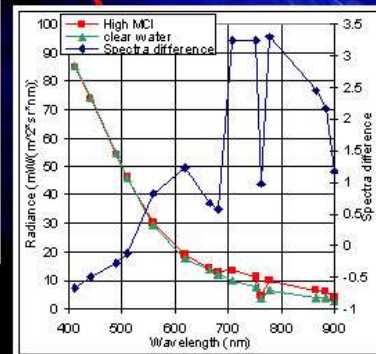
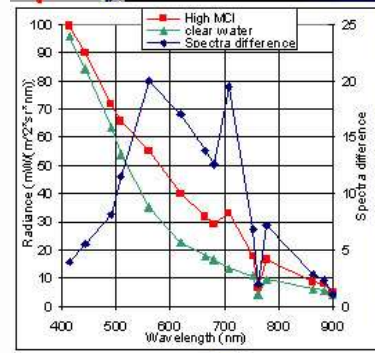
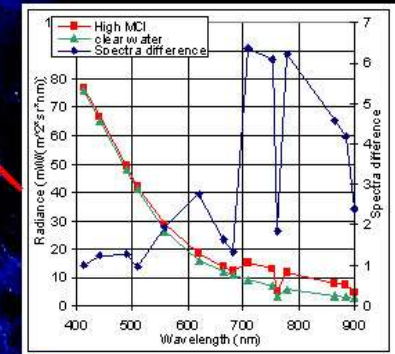
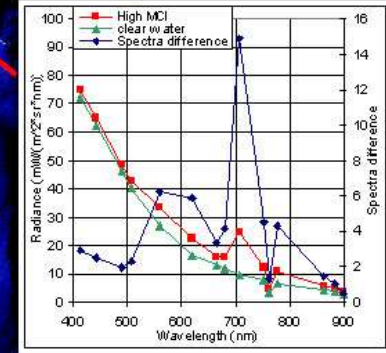
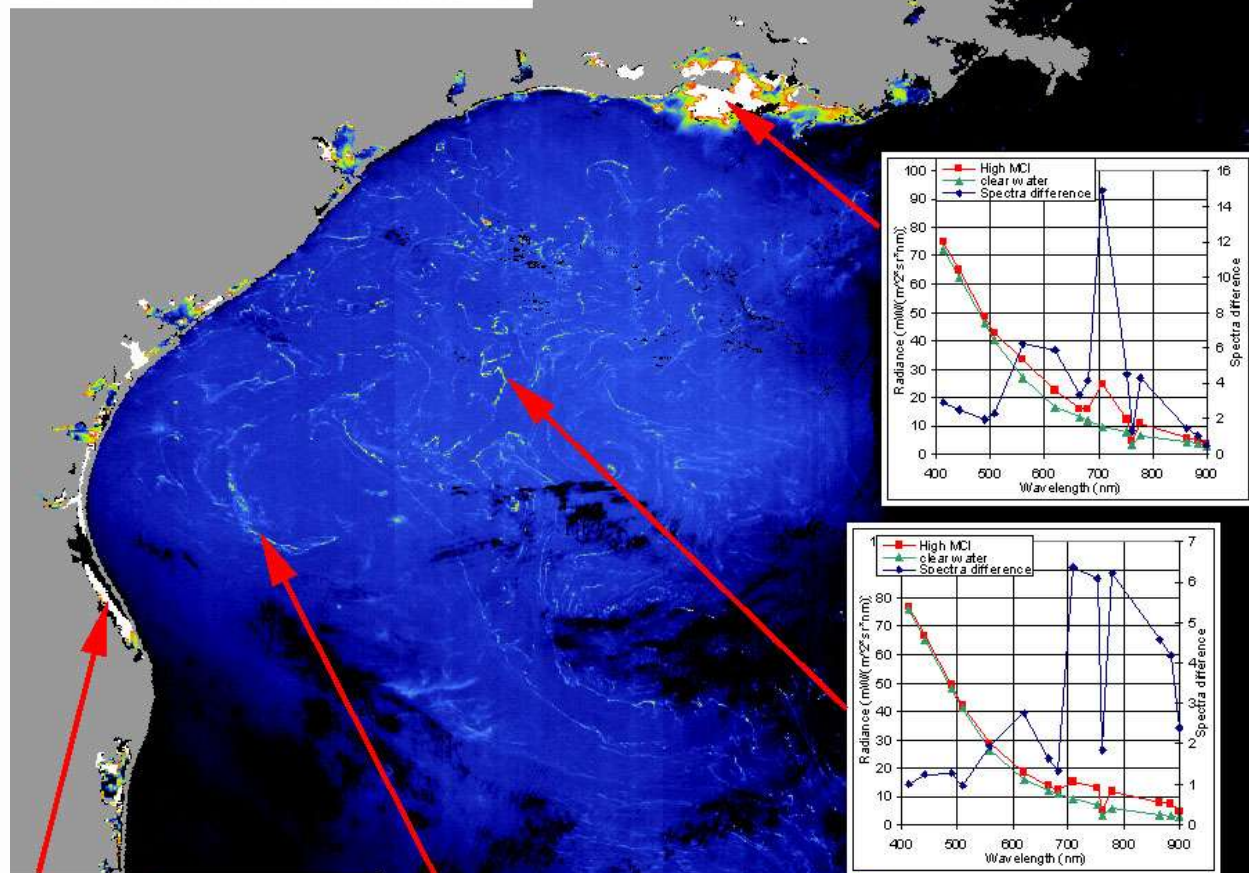
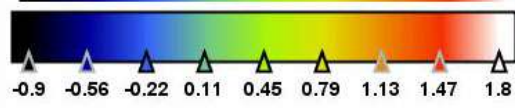


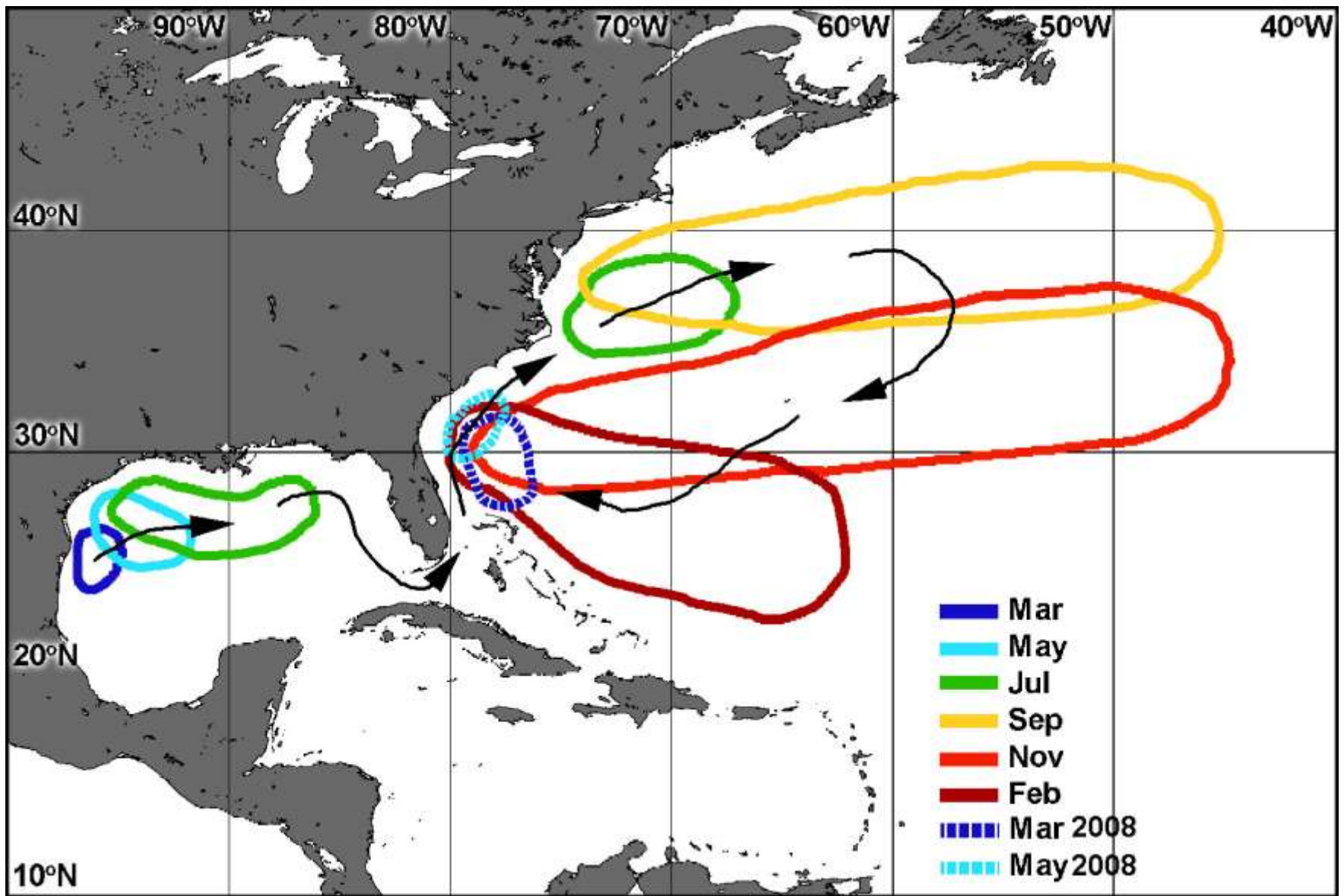
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Floating Sargassum

MERIS bloom hunt:
2 June 2005
Western Gulf of Mexico





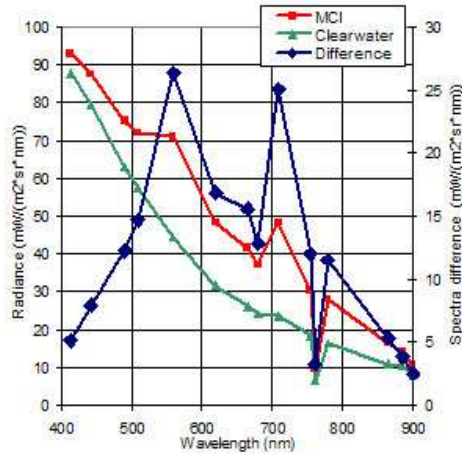
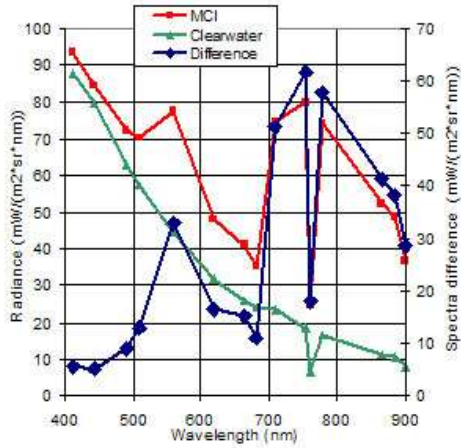
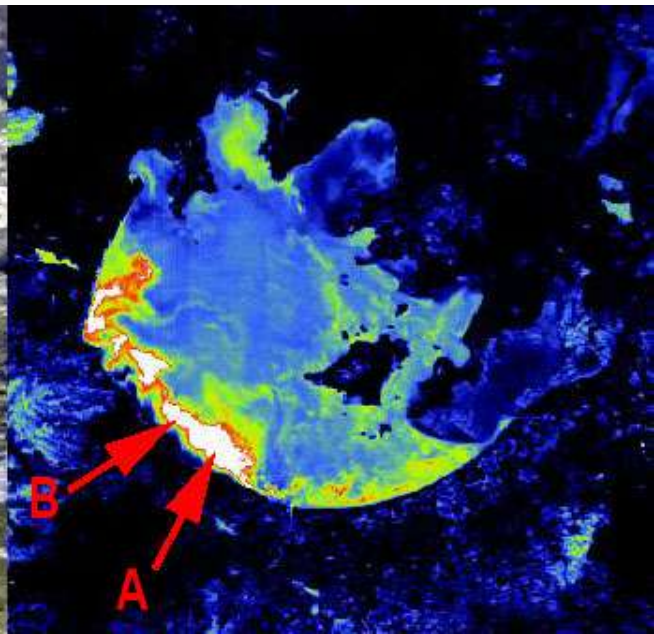
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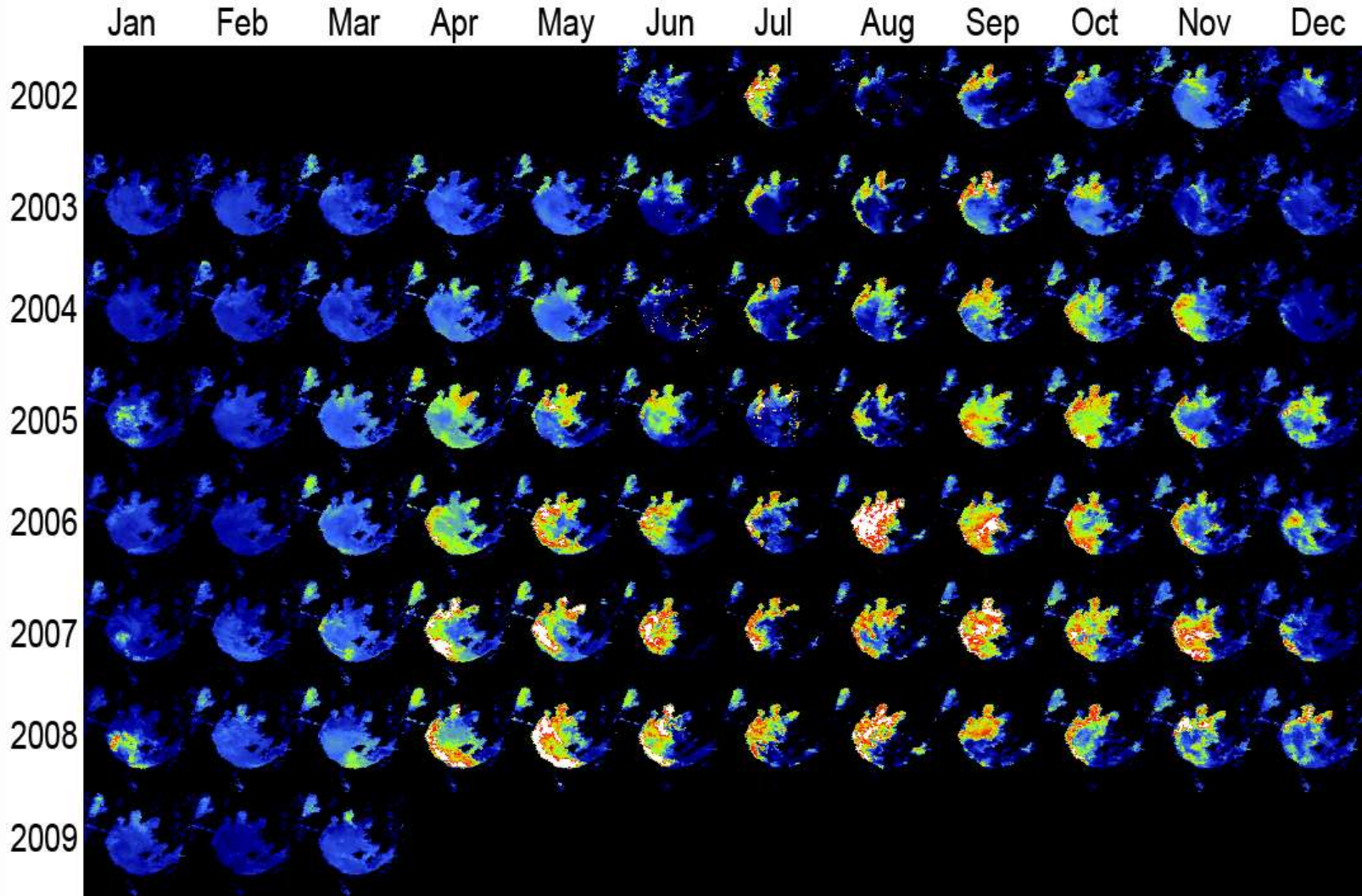


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MERIS FR images and spectra of blooms in Taihu Lake on April 25 2008. The RGB image (top left) shows most of the lake to be bright with suspended sediment. The MCI image shows a strong bloom along the southwest shore (white and red), giving spectra that near 709 nm show both the red edge (A lower left) indicating a surface slick, and the isolated peak (B lower right) indicating a bloom dispersed in



MCI signal by month from 2002 to 2009 for Taihu Lake, computed from the MERIS RR global data set at 1 km resolution. Bloom activity from April to November increases in later years



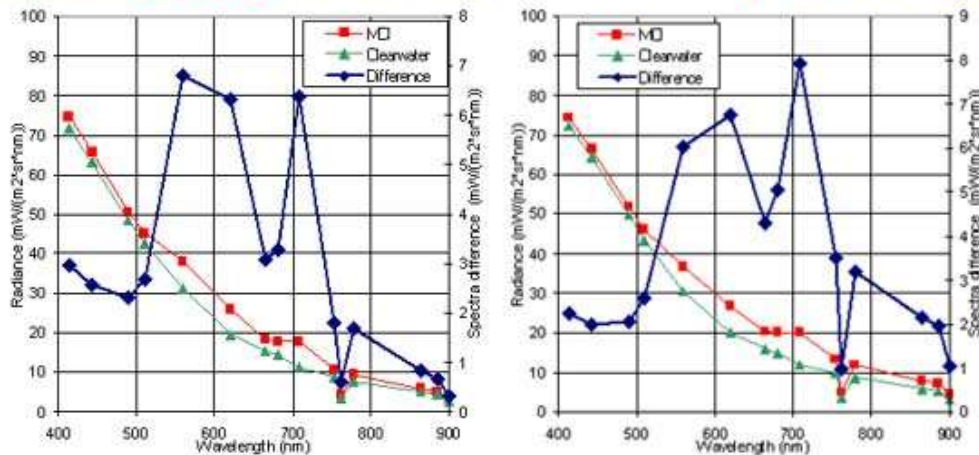
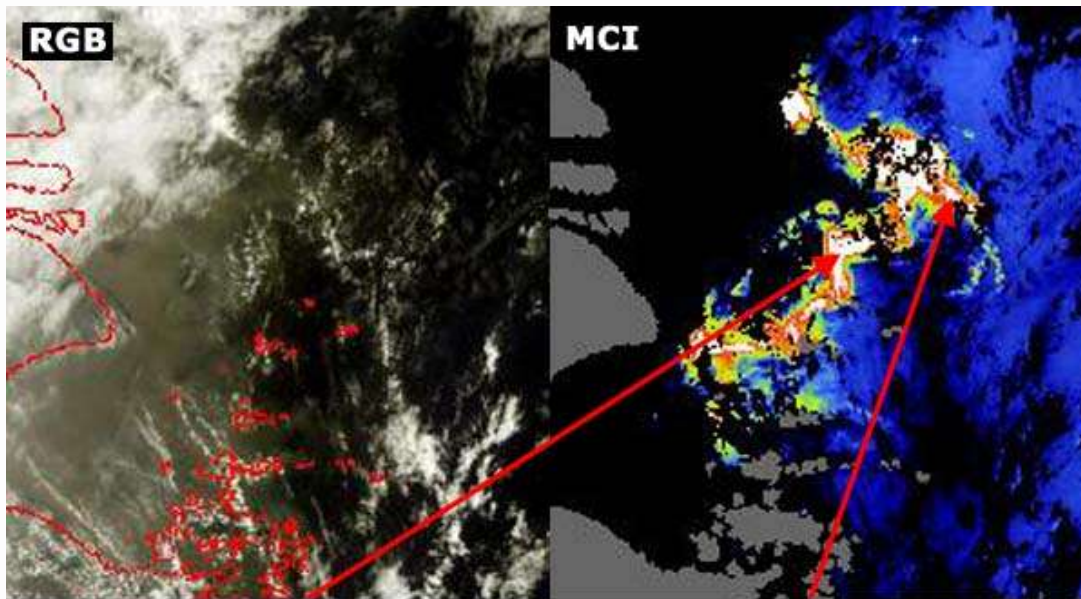
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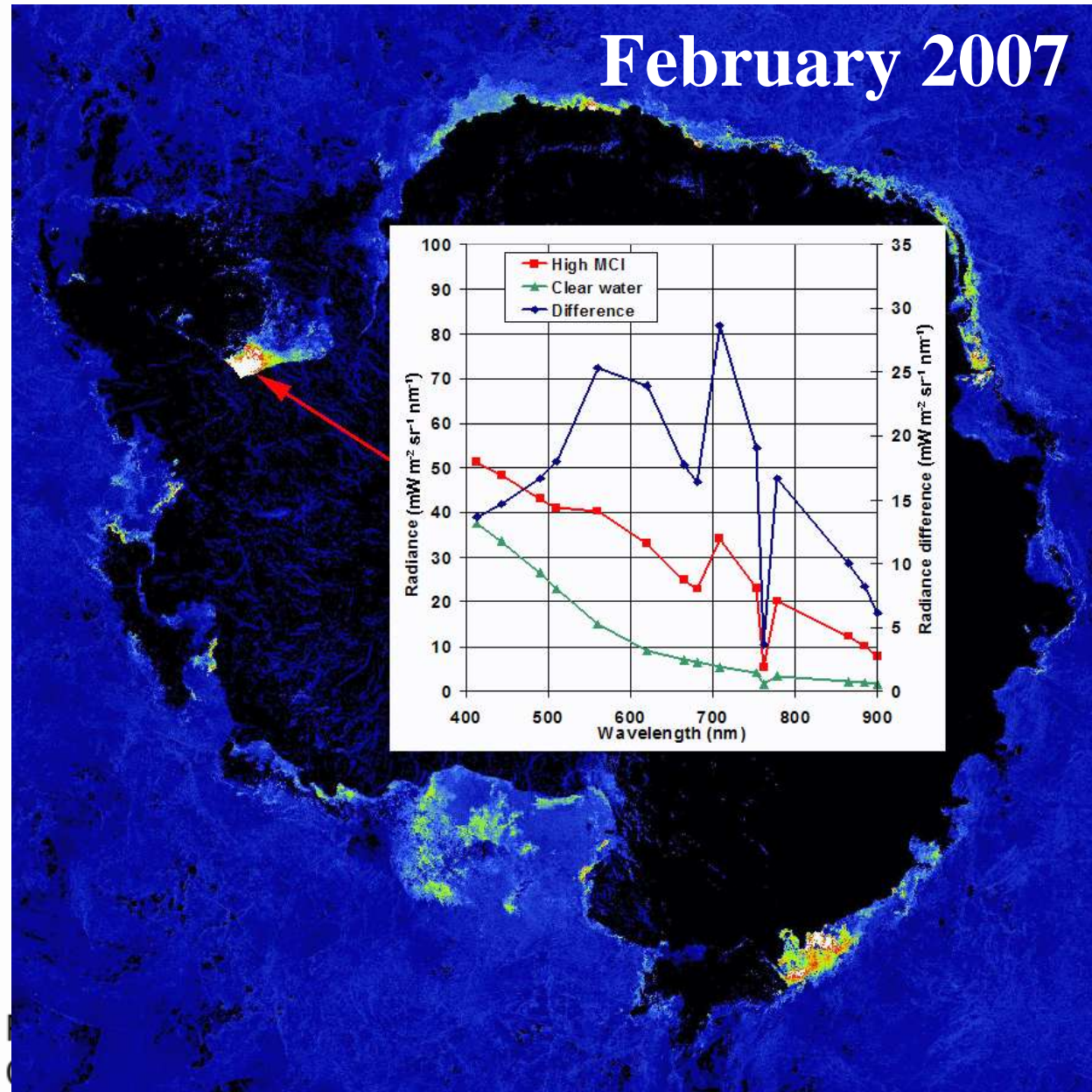


MERIS RR image of a high-MCI bloom near the edge of the Chiang Jiang River plume on 12 September 2008. The area of high MCI signal is just outside the edge of the sediment plume shown in the true colour (RGB) image. Spectra below show that the MCI signal is due to absorption by chlorophyll a.



Antarctic blooms in ice

- Previously we've reported Antarctic superblooms with the global composites
- We have not seen similar blooms with the same frequency or intensity in northern high latitudes.



Conclusions

- MERIS and MODIS satellite FLH images give the first observations of seeding of the spring bloom in the Strait of Georgia
- Wider use of FLH would almost certainly demonstrate uses in other areas (message to CoastColour).
- Higher resolution FR images from MERIS are essential for satellites to see blooms in BC inlets. (Our thanks to CSA and ESA)
- MCI shows floating vegetation or intense blooms in which high chlorophyll concentrations occur in near-surface water or floating slicks

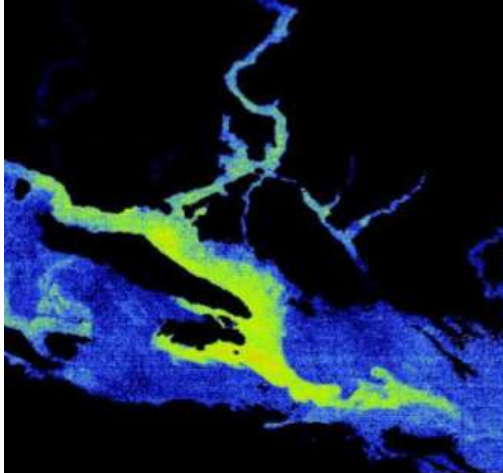


Acknowledgements

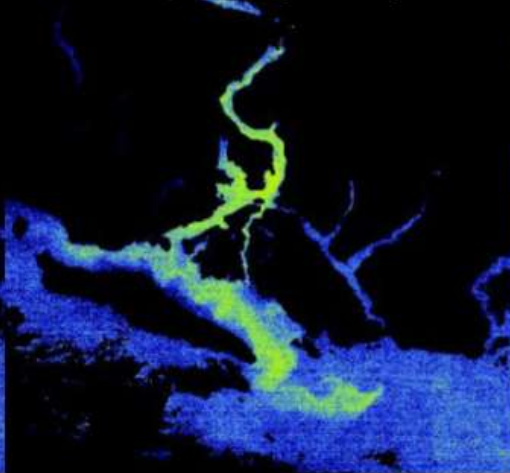
- Funding provided by the Canadian Space Agency under the GRIP program and by the Canadian Department of Fisheries and Oceans
- MERIS image data provided by ESA
MODIS images from NASA
- Image processing by University of Victoria Co-op students: Lindsay Orr, Sara Statham, Rowan Fox and Thomas van Manen
- Glider operation and data processing by University of Victoria Co-op student Rowan Fox



A. Feb 18, 2009 (MERIS)



B. Feb 21, 2008 (MERIS)



C. Feb 24, 2005 (MODIS)

