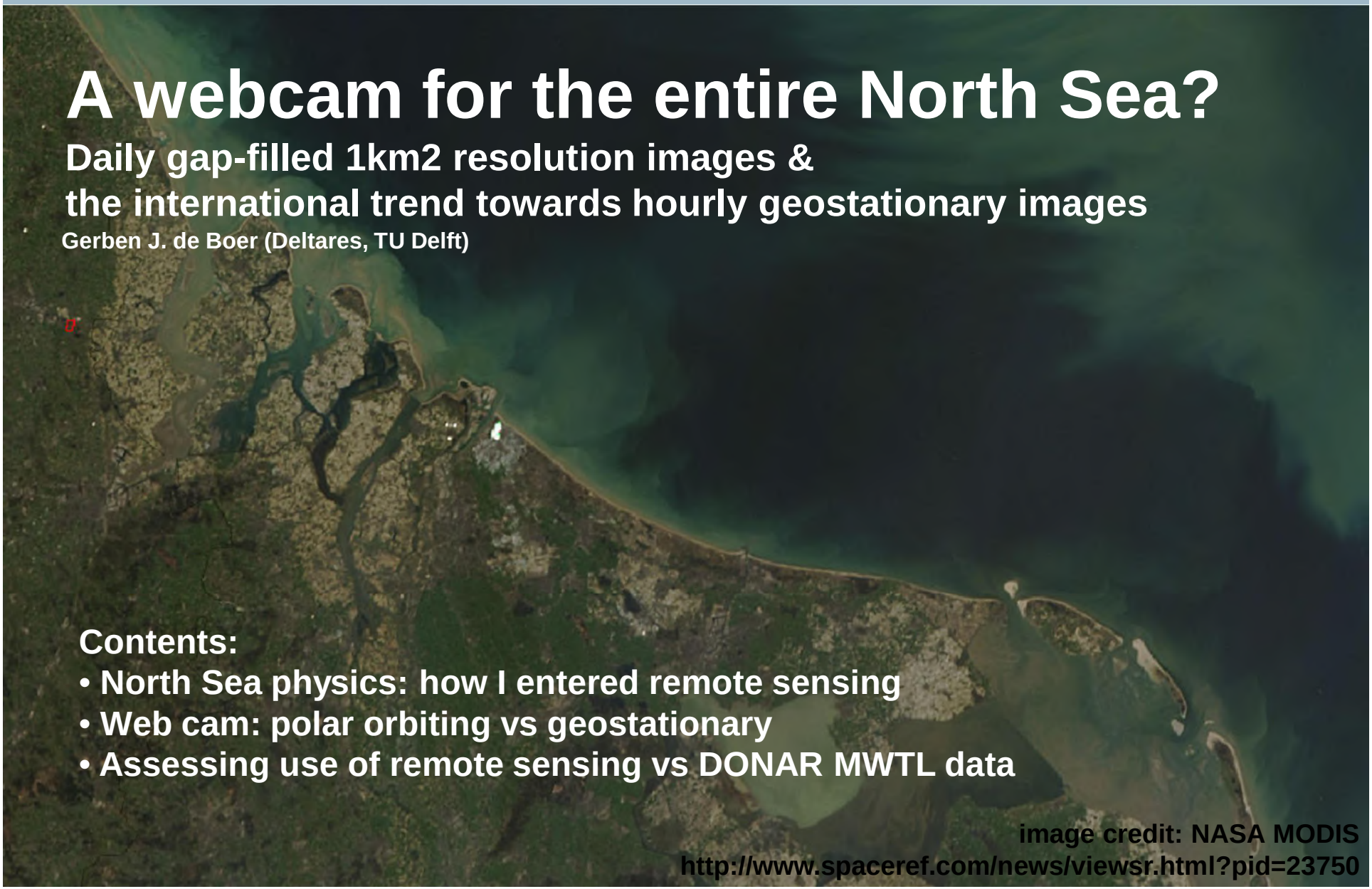
Deltares
Enabling Delta Life

A webcam for the entire North Sea?

Daily gap-filled 1km2 resolution images & the international trend towards hourly geostationary images

Gerben J. de Boer (Deltares, TU Delft)



Contents:

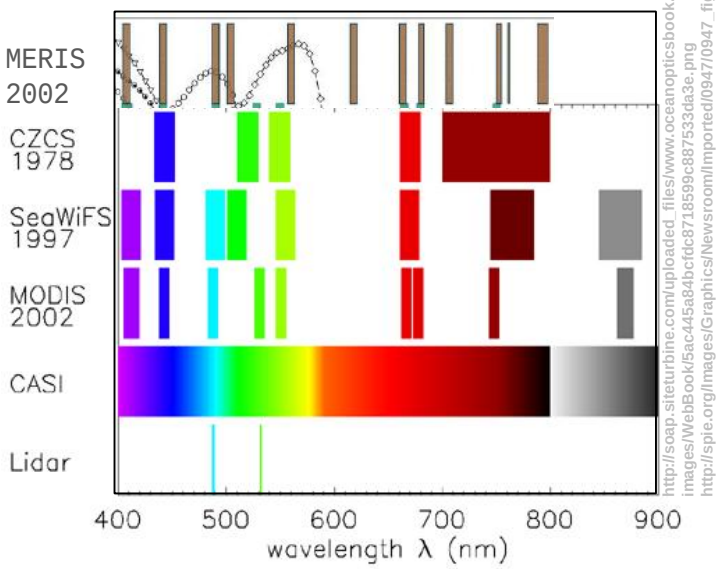
- North Sea physics: how I entered remote sensing
- Web cam: polar orbiting vs geostationary
- Assessing use of remote sensing vs DONAR MWTL data

image credit: NASA MODIS
http://www.spaceref.com/news/viewsr.html?pid=23750

Ocean color principle

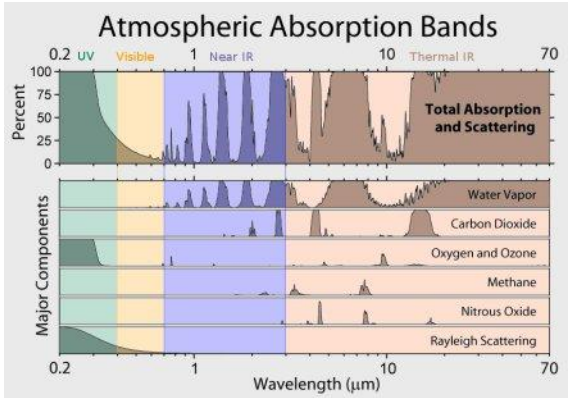
http://www.ioccg.org/

Passive multi-spectral remote sensing: receival of reflected and emitted radiation (light + IR + UV).

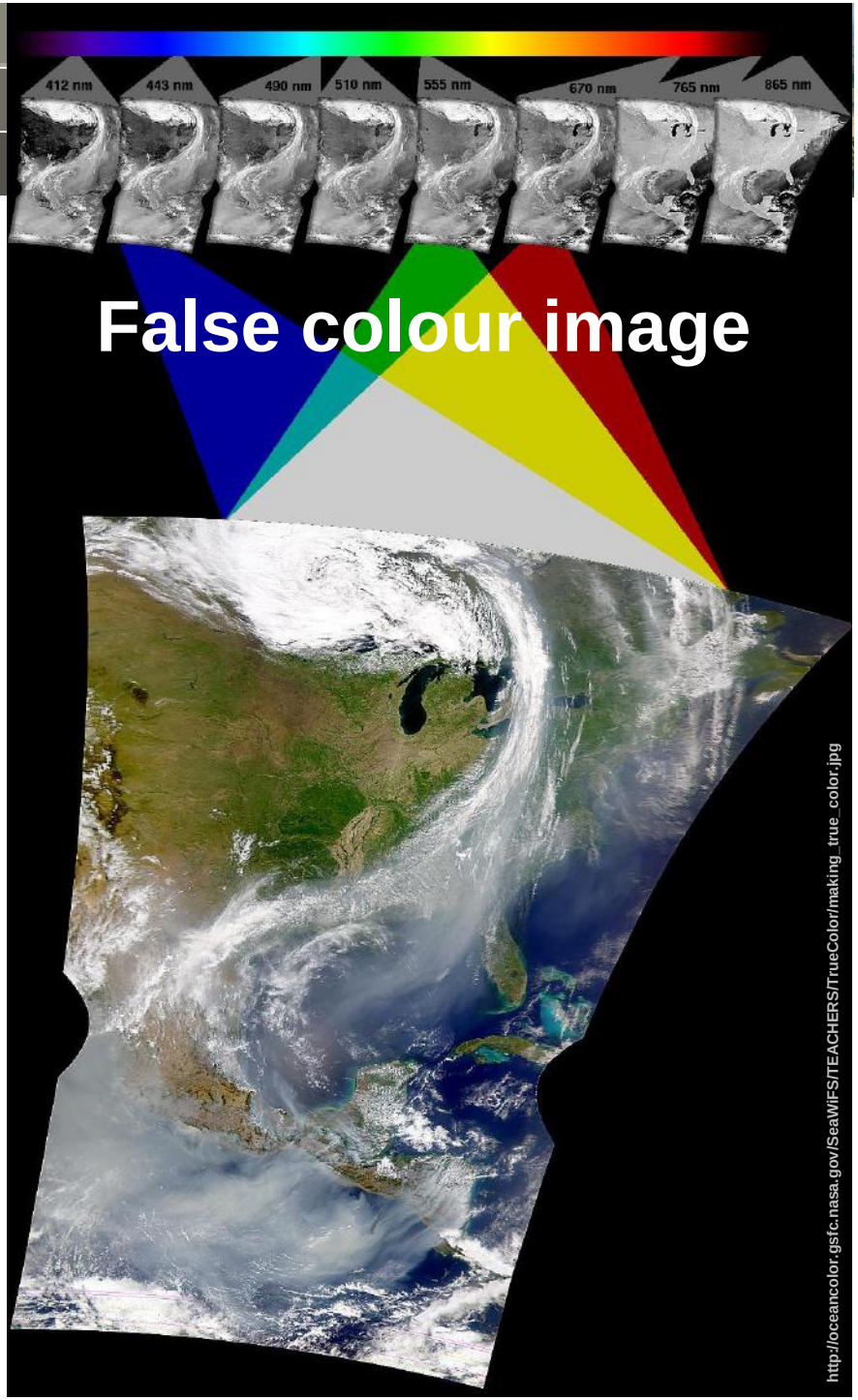


http://soap.siteturbine.com/uploaded_files/www.oceanopticsbook.info/images/WebBook/5ac445a84bcfdc871859c887533da3e.png
http://spie.org/Images/Graphics/Newsroom/Imported/0947/0947_fig1.jpg

http://img.en.china.cn/0/0,0,228,1385,360,360,26ca82ba.jpg

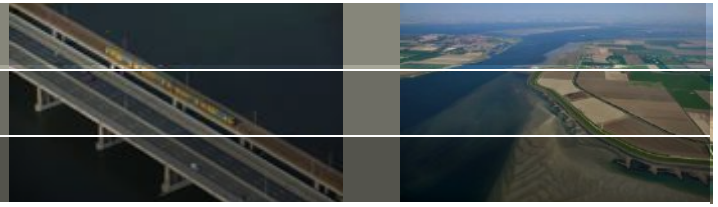


http://www.skepticalscience.com/does-greenhouse-effect-exist.htm

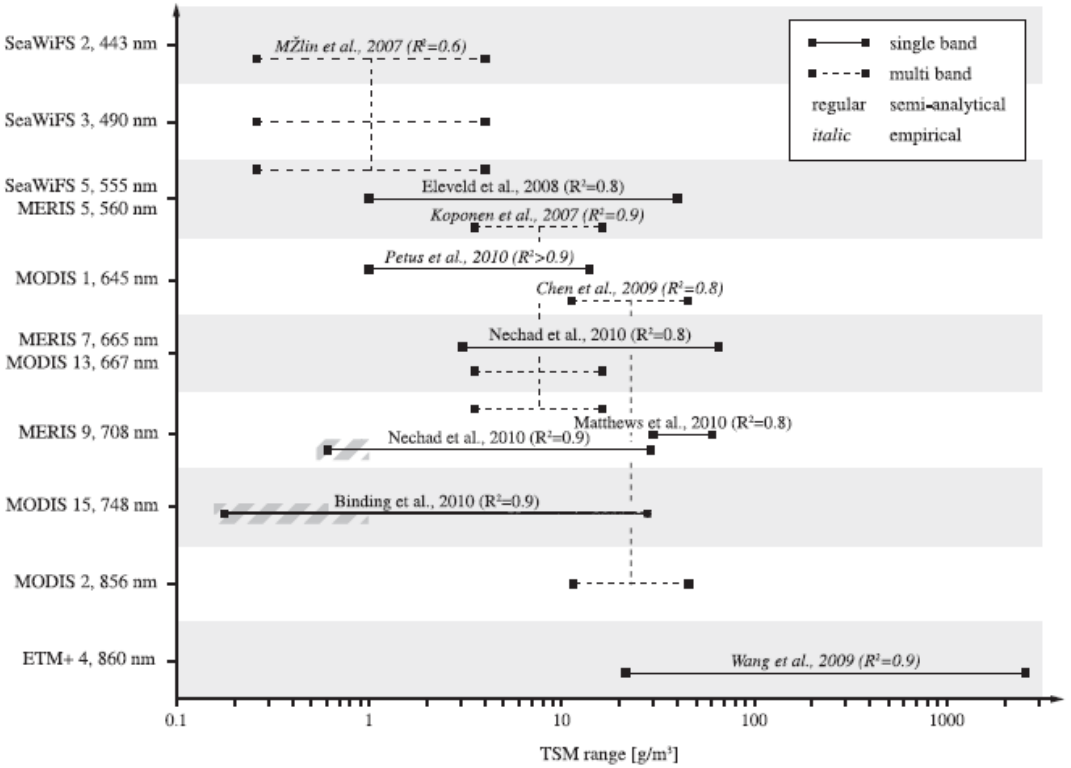


http://oceancolor.gsfc.nasa.gov/SeaWiFS/TEACHERS/TrueColor/making_true_color.jpg

Ocean color processing



- Extracting 5% water leaving radiance from signal is expert work.
- Default NASA/ESA processing only for open ocean, case I.
- All turbid water require dedicated local algorithm.
- Standard products only useful for qualitative *fumata bianca* mode
- We now get images from VU-IVM / WaterInsight
- MUMM, Belgium is recognized world leader on ocean color



Remote Sensing of Environment 118 (2012) 116–126

Contents lists available at SciVerse ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

Review

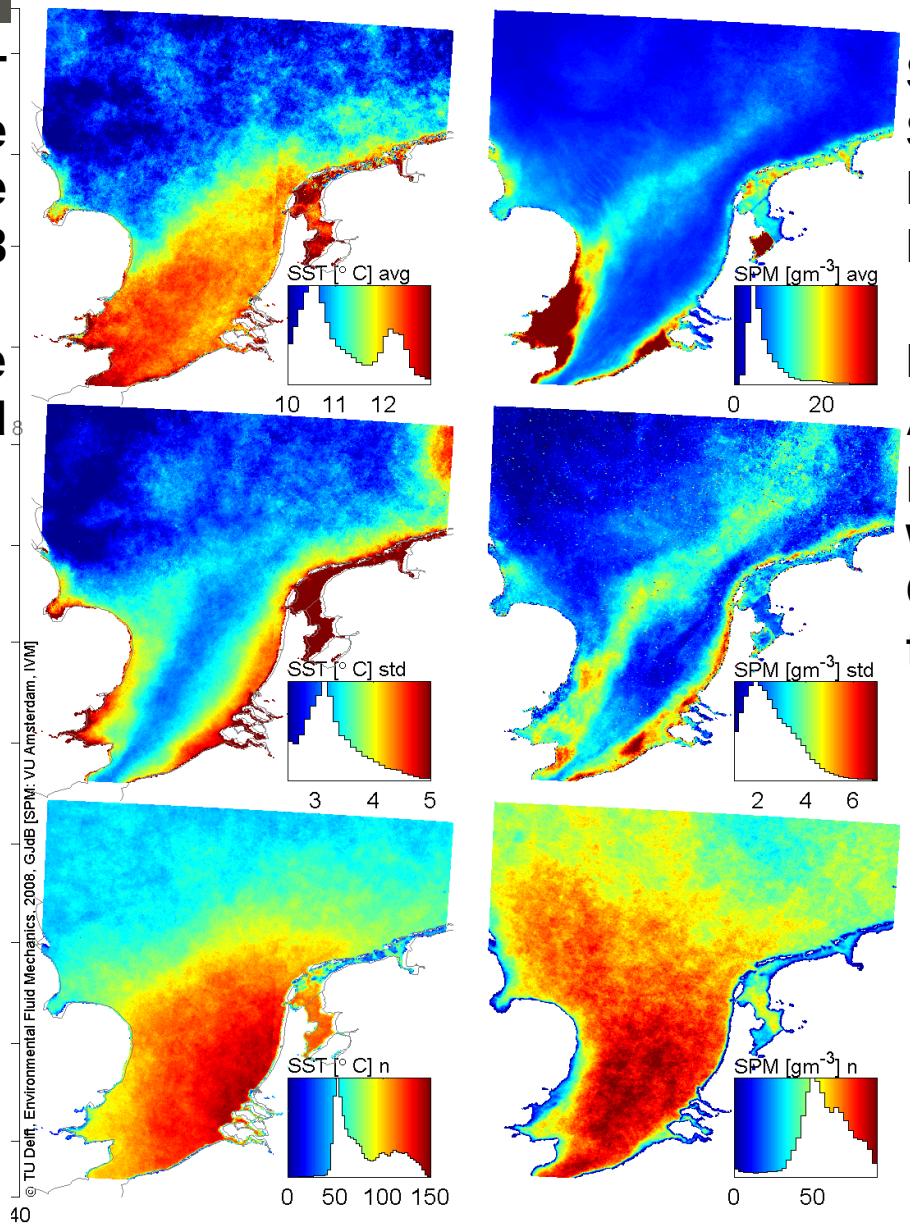
Review of constituent retrieval in optically deep and complex waters from satellite imagery

Daniel Odermatt [a,*], Anatoly Gitelson [b], Vittorio Ernesto Brando [c], Michael Schaepman [a]

A typical year: NOAA SST and SeaWiFS color

SST
Sea Surface Temperature
Entire 1998

NOAA satellite
KNMI processed



SPM
Suspended Particulate Matter
Entire 1998

NASA satellite
Atmopsheric processing myself with MUMM tools.
Conversion to SPM from M. Eleveld.

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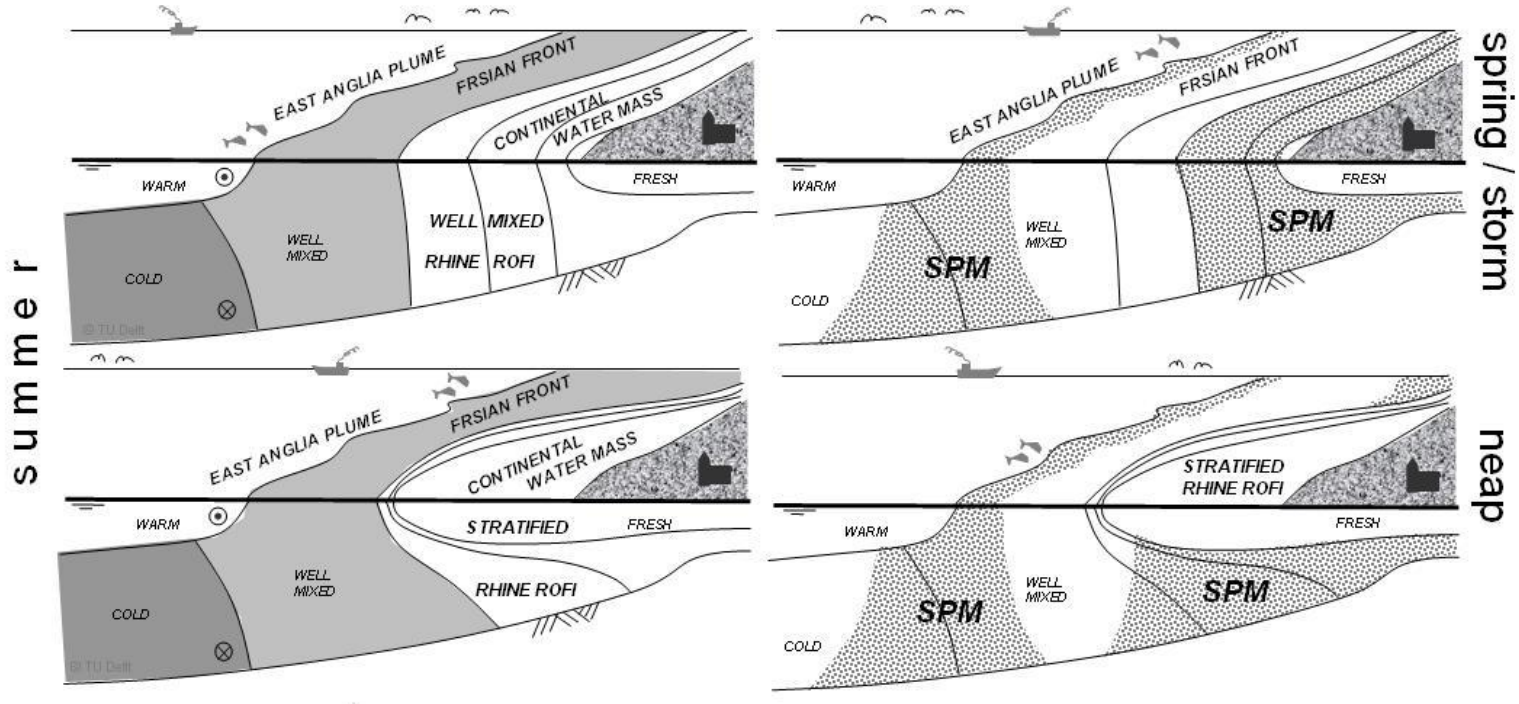
Why I need temperature, salinity and ocean color

coverage 100-1000km, resolution 100m-1km



Continental Shelf Research 31 (2011) 594–610

Contents lists available at ScienceDirect

Continental Shelf Research

journal homepage: www.elsevier.com/locate/csr

Research papers

Mechanisms controlling the intra-annual mesoscale variability of SST and SPM in the southern North Sea

Julie D. Pietrzak [a,*], Gerben J. de Boer [a,c], Marieke A. Eleveld [b]

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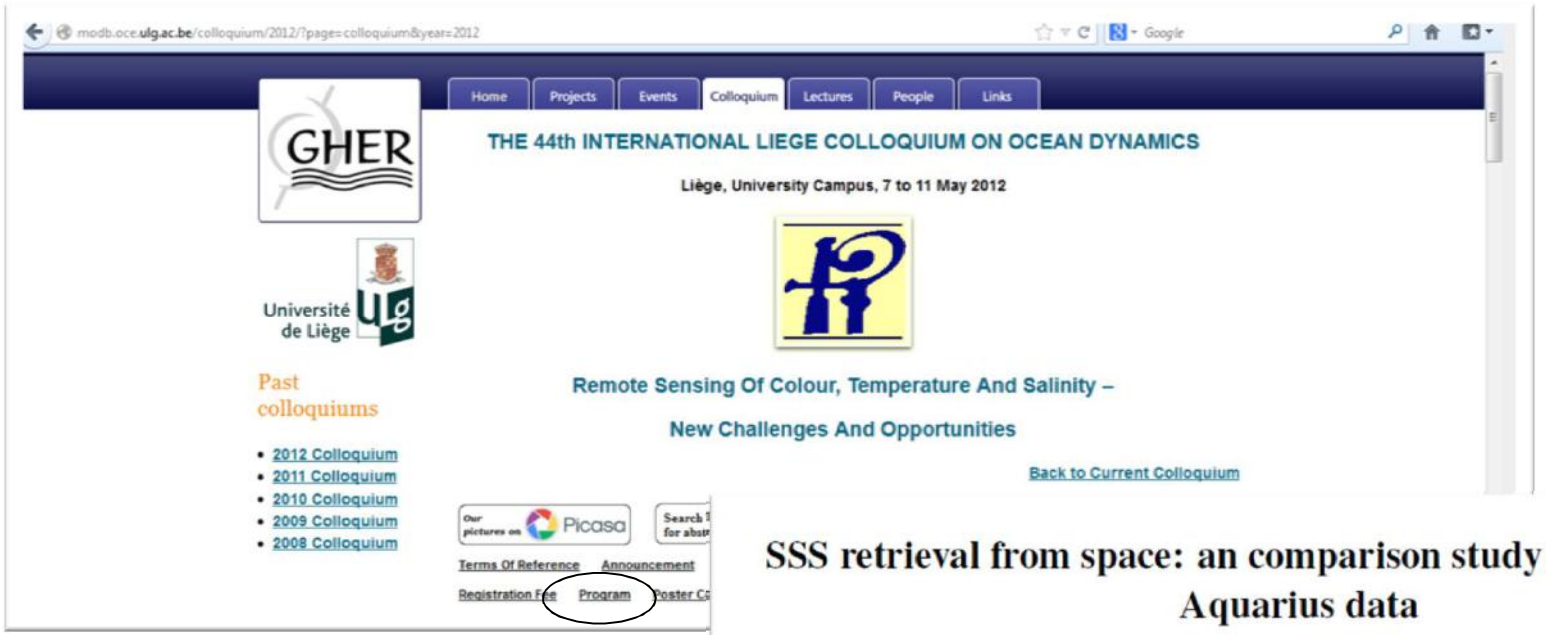
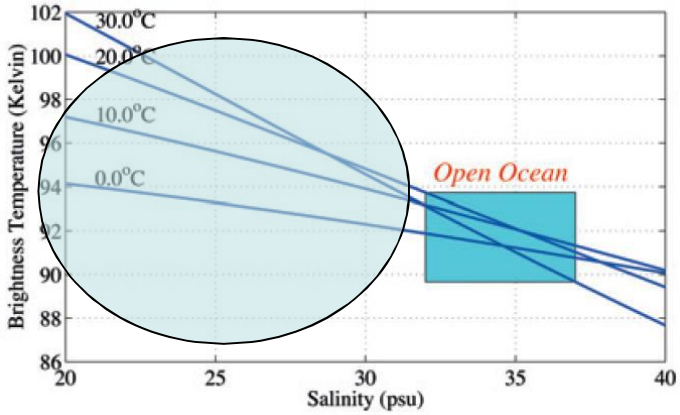
State-of-the-art temperature, salinity and ocean color

Liege colloquium may 2012



Alas, not for North Sea: ±0.1 psu for 10 day,200km



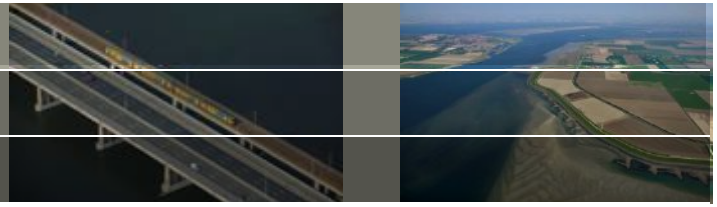
SSS retrieval from space: an comparison study using SMOS and Aquarius data

S. GUIMBARD[1], J. GOURRION[1], M. PORTABELLA[2], J. BALLABRERA[2], A. TURIEL[1], C. GABARRO[1], V. GONZALEZ[1], F. PEREZ[1], J. MARTINEZ[1]

[1] *Physical Oceanography Department, Institut de Ciencies del Mar (ICM/CSIC), Barcelona, Spain.*
[2] *Unitat de Tecnologia Marina (UTM-CSIC), Barcelona, Spain*

Since November 2nd, 2009 and June 10, 2011, two spatial missions give us the ability to measure sea surface salinity (SSS) from space. The Microwave Imaging Radiometer using Aperture Synthesis (MIRAS) instrument onboard the Soil Moisture and Ocean Salinity (SMOS) mission [Font et al. 2004] and a 3 feed horn radiometer onboard the Aquarius mission [Le Vine et al. 2007]. These two missions provide global coverage SSS products with different repetition rates, spatial resolutions and accuracies. The complexity of SMOS measurements, the amount of external contaminations at L-Band (sun, galaxy, ionosphere, radio frequency interferences...), the different SSS retrieval algorithms and auxiliary data sources used by SMOS and Aquarius, will certainly give non negligible differences in term of final SSS product.

contents



- North Sea physics: how I entered remote sensing
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Polar orbiting satellites: where and when

Polar orbiters have inherent trade-off between

- temporal vs spatial resolution.

Ocean color: passive sensing of light: only daytime

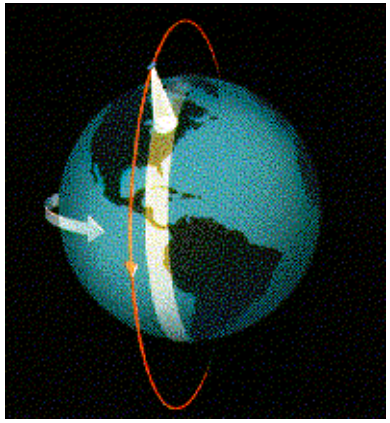
- SeaWiFS 1day 1.1km 1500km swath
- MODIS 2days 1km 2330km swath
- MERIS 3days 300m 1150km swath

NOAA SST: 4 to 8 times per 24 hr

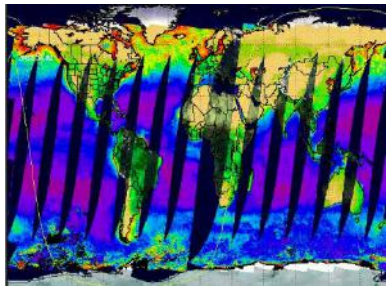
- Night time images too: passive IR radiation
- Multiple airborne satellites: 2 platforms

Receiving stations determines resolution too:

- GAC data: stored onboard, kept, sent down ‘at home”
- LAC data: satellite immediately broadcasts data:
  local receivers can store it, otherwise lost, e.g.
  Dundee, Scotland. KNMI stopped SST after 15 yr.



http://apollo.lsc.vsc.edu/classes/met130/notes/chapter5/graphics/polar_orbit_schem.jpg



http://kids.earth.nasa.gov/seawifs/images/calibration_thumb.gif

http://www.ssec.wisc.edu/sose/cu/images/seawifs.jpg

geostationary

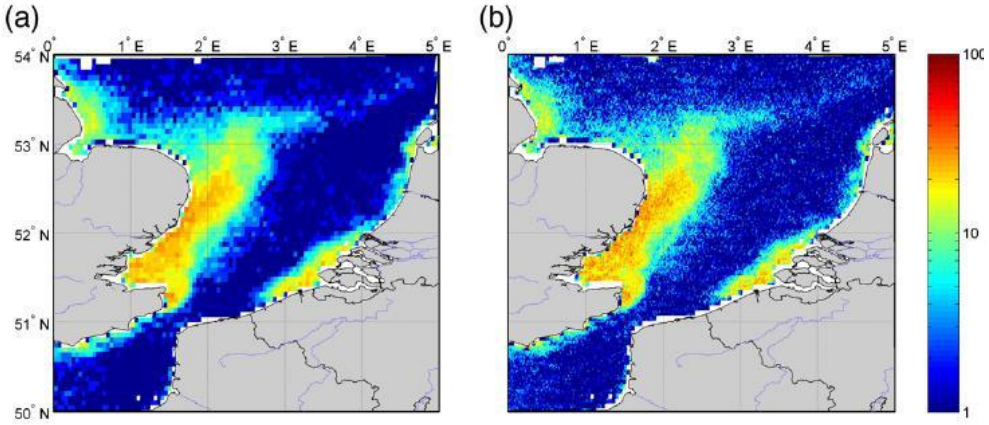
SEVIRI - full disc on Meteosat Second Generation (MSG)

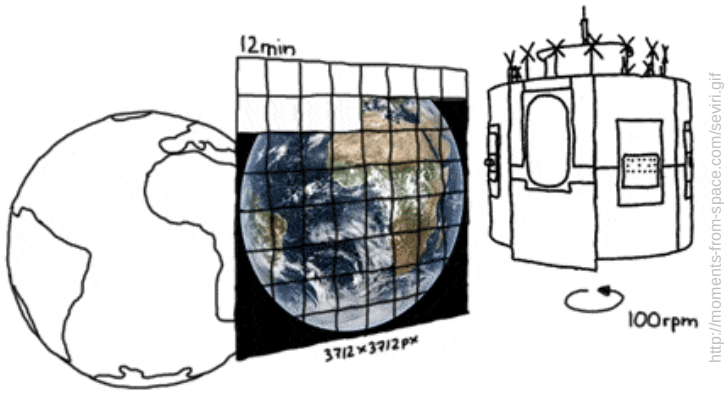
Limited spectral resolution, back to emperical pre-CZCS

Limited digitization

But, unprecedented temporal resolution

But, 1 x 2 km spatial resolution





http://moments-from-space.com/seviri.gif

Fig. 6. Turbidity on February 11, 2008 at 13:00 UTC for a subset of the SEVIRI southern North Sea scene on (a) the SEVIRI VIS06 grid with a spatial resolution of 3 km × 6.5 km and (b) on the HRV grid with a spatial resolution of 1 km × 2 km.

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journal homepage: www.elsevier.com/locate/rse

Diurnal variability of turbidity and light attenuation in the southern North Sea from the SEVIRI geostationary sensor

G. Neukermans [a,b,c,d,*], K.G. Ruddick [a], N. Greenwood [e]

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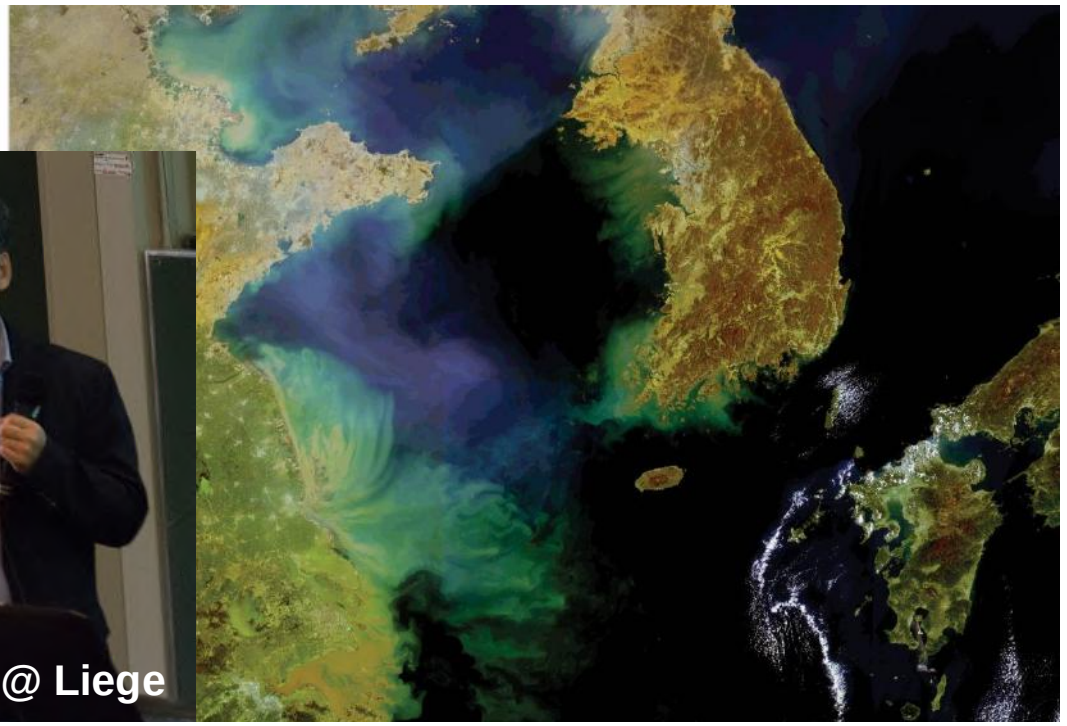
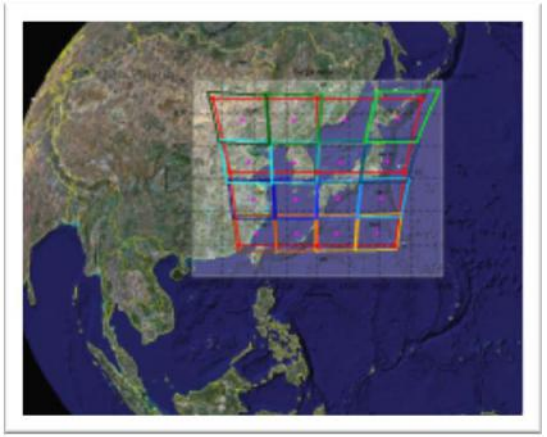
geostationary

GOCI - Korean Geostationary Ocean Color Imager

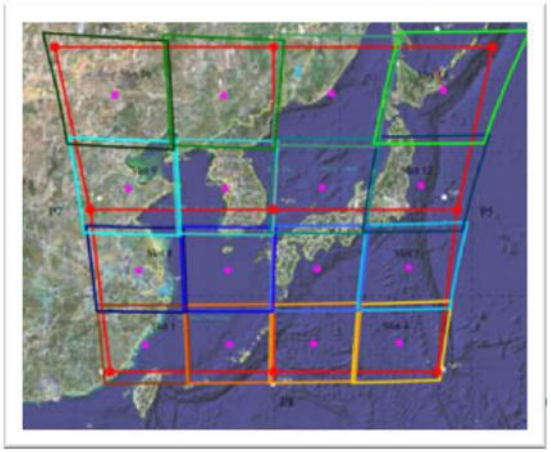


500 m resolution
2500 x 2500 km²
hourly daytime data
6 visible bands
60 million euro
free ride spy satellite



http://www.ioccg.org/images/GOCI-April.jpg

http://www.ioccg.org/news/June2011/GOCI-data.png



http://www.ioccg.org/news/Sept2008/GOCI_coverage.jpg

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 117, C09004, doi:10.1029/2012JC008046, 2012

GOCI, the world's first geostationary ocean color observation satellite, for the monitoring of temporal variability in coastal water turbidity

Jong-Kuk Choi,[1] Young Je Park,[1] Jae Hyun Ahn,[1] Hak-Soo Lim,[2] Jinah Eom,[1] and Joo-Hyung Ryu[1]

Geo-Cape: ocean color for Americas

THE UNITED STATES' NEXT GENERATION OF ATMOSPHERIC COMPOSITION AND COASTAL ECOSYSTEM MEASUREMENTS

NASA's Geostationary Coastal and Air Pollution Events (GEO-CAPE) Mission

BY J. FISHMAN, L. T. IRACI, J. AL-SAADI, K. CHANCE, F. CHAVEZ, M. CHIN, P. COBLE, C. DAVIS, P. M. DIGIACOMO, D. EDWARDS, A. ELDERING, J. GOES, J. HERMAN, C. HU, D. J. JACOB, C. JORDAN, S. R. KAWA, R. KEY, X. LIU, S. LOHRENZ, A. MANNINO, V. NATRAJ, D. NEIL, J. NEU, M. NEWCHURCH, K. PICKERING, J. SALISBURY, H. SOSIK, A. SUBRAMANIAM, M. TZORTZIOU, J. WANG, AND M. WANG

GEO-CAPE will measure tropospheric trace gases and aerosols and coastal ocean phytoplankton, water quality, and biogeochemistry from geostationary orbit to benefit air quality and coastal ecosystem management.

BAMS, DOI:10.1175/BAMS-D-11-00201.1

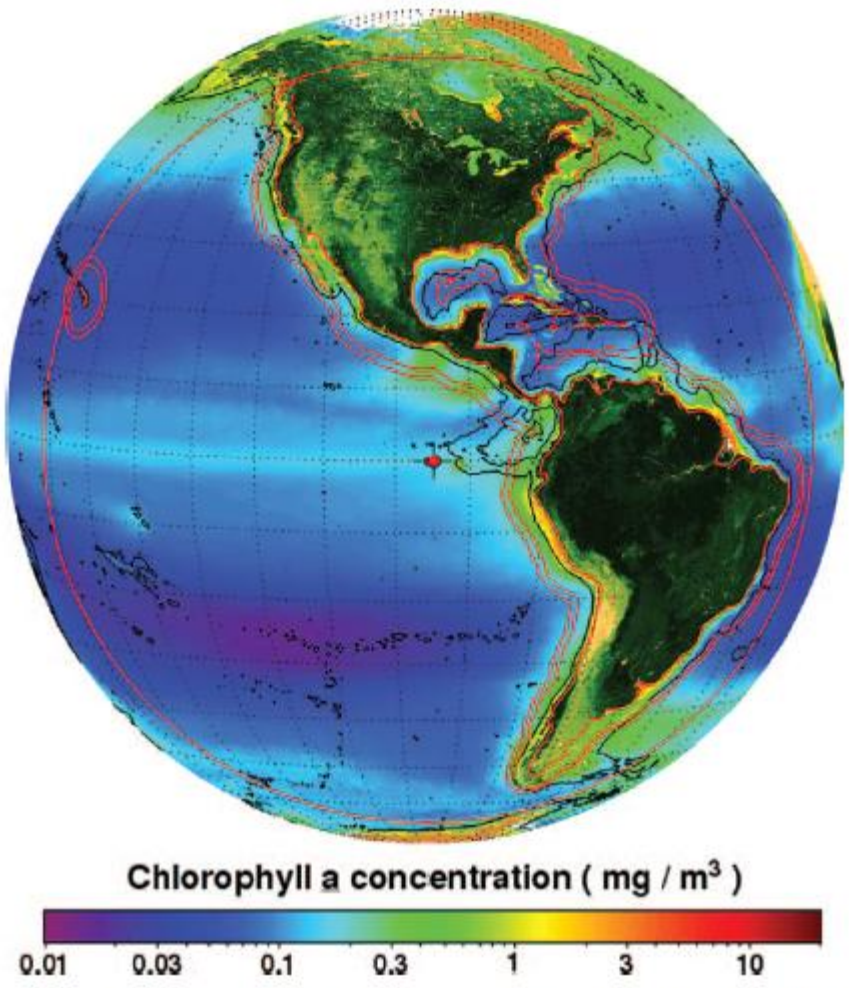
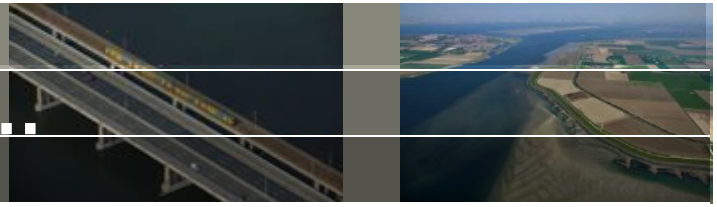


FIG. 7. Geostationary view from 95° W for the GEO-CAPE coastal ecosystem sensor overlain on the SeaWiFS chlorophyll-a mission composite. Much of North and South America region that is encompassed within the 67° sensor view angle is the approximate limit to ocean color retrievals from 95°W (red outer circle). The continental landmasses at 375- and 500-km

geostationary

and geostationary in Europe …



GOCI Korea was 60 million, incl. development.

9 countries around turbid North Sea, Irish Sea, Channel:

7 million each, + one military platform with 1 m^3 free.

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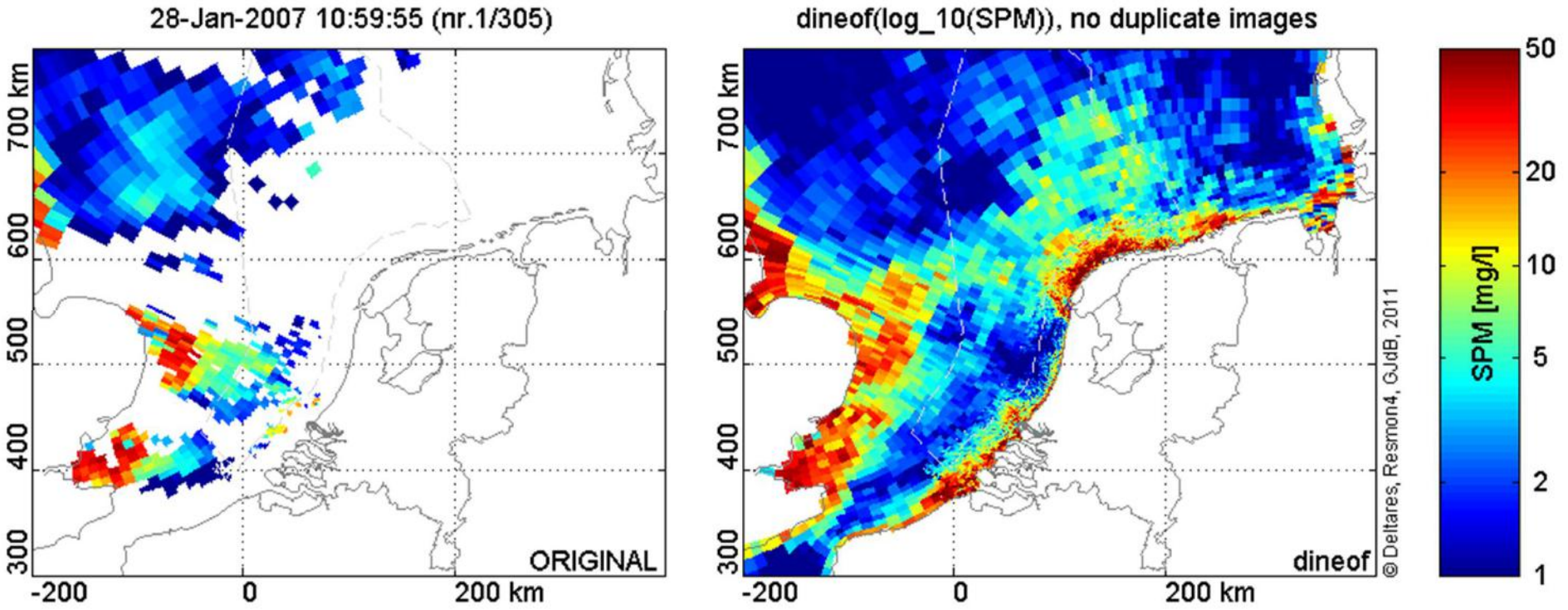
but there's a trick to get close: DINEOF gap filing



One year of SPM data processed with Hydropt, Purchased bij Rijkswaterstaat . Gap-filled with DINEOF Package from University of Liege.

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On the use of a basic arithmetic, harmonic or EOF modes for comparison of ocean colour SPM imagery and low-frequency situ data in the southern North Sea

Gerben J. de Boer (Deltares, TU Delft)
Meinte Blaas (Deltares)
Loana Arentz (Deltares)
Niels Kinneging (Rijkswaterstaat WaterDienst)
Ackowlegdements: Liege GHER group for DINEOF

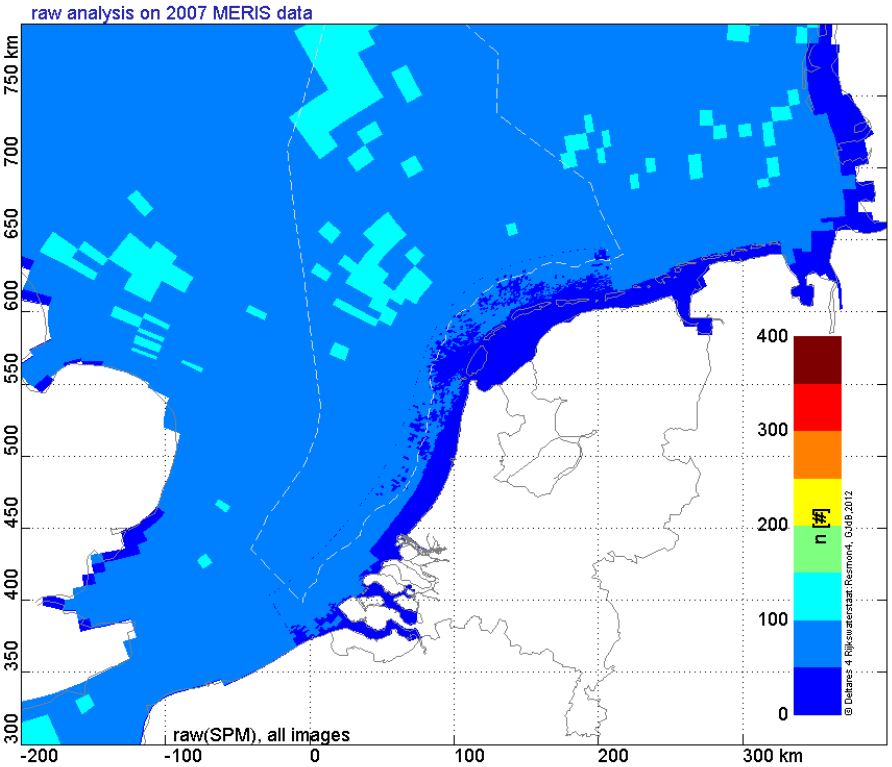
- North Sea physics: how I entered remote sensing
- Web cam: polar orbiting vs geostationary
- **Assessing use of remote sensing vs DONAR MWTL data**

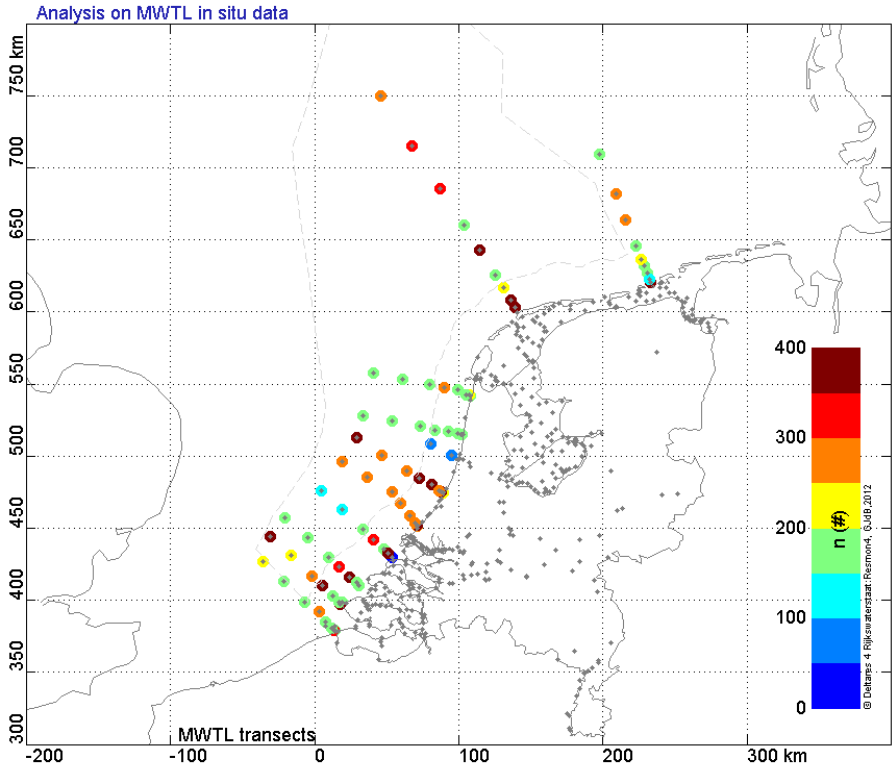
1 year of ocean color vs DONAR: data amount

 # pixels in 1 year of MERIS data (binned to curvi-linear model)
50 to 80 good images per year

 # pixels in 25 years of in situ data

max. 26 good samples per year

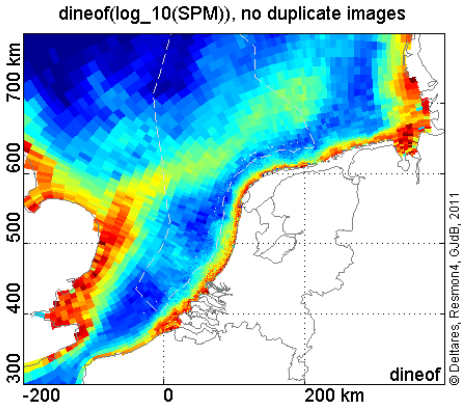


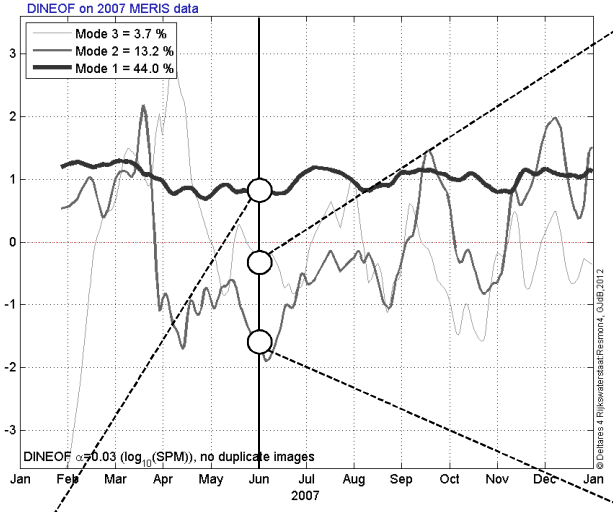


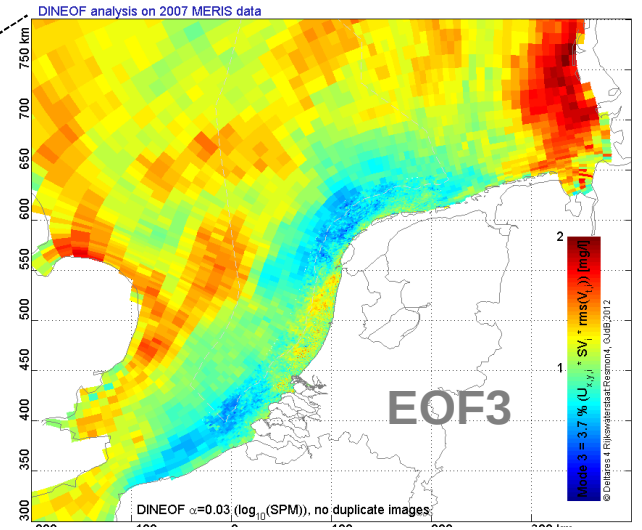
EOF analysis in situ data & remote sensing data

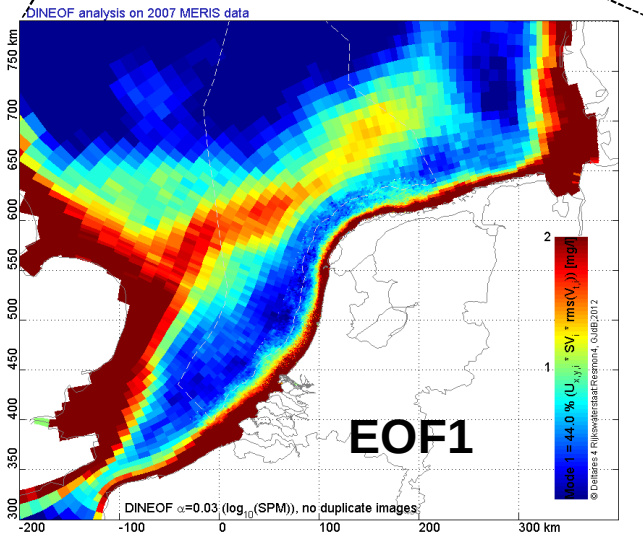
time

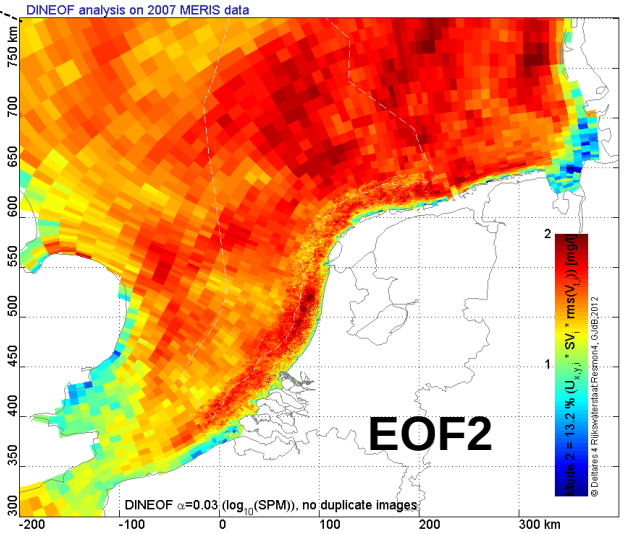
space











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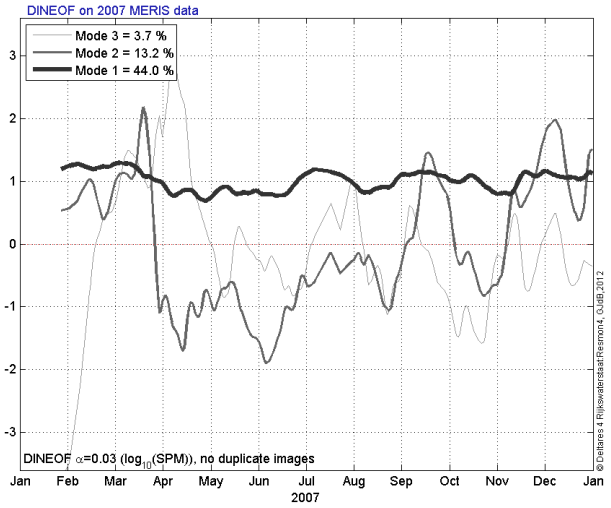
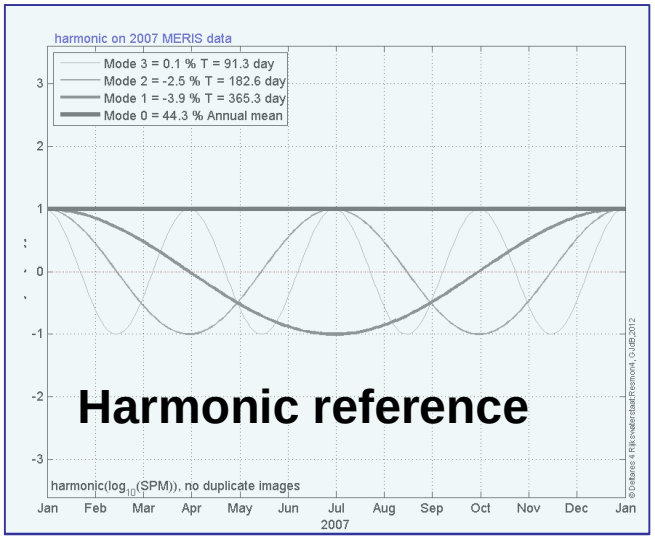
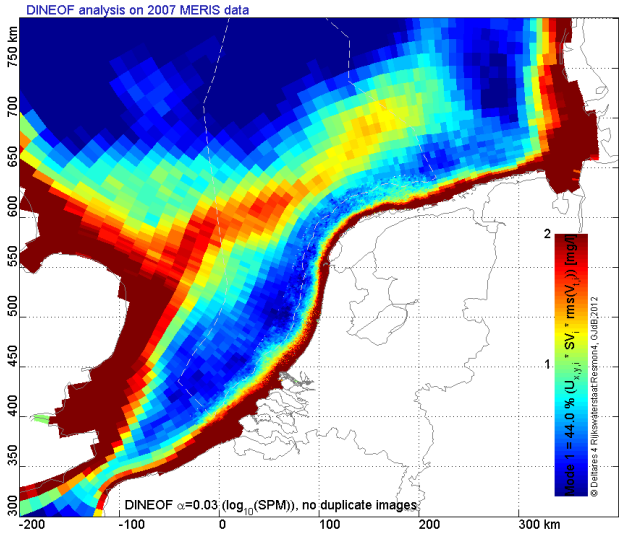
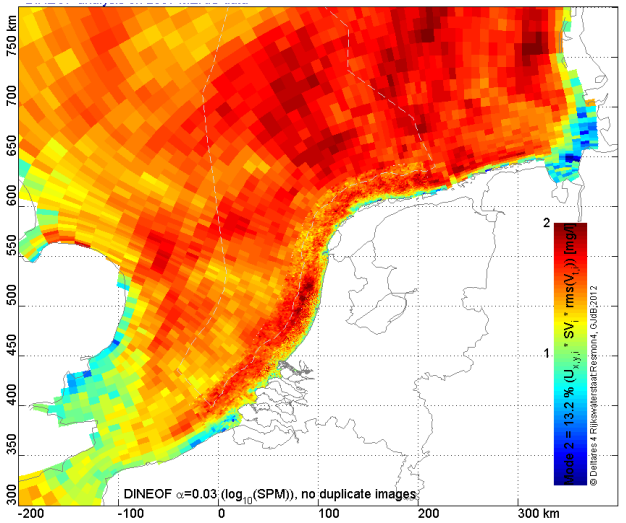
EOF analysis in situ data & remote sensing data





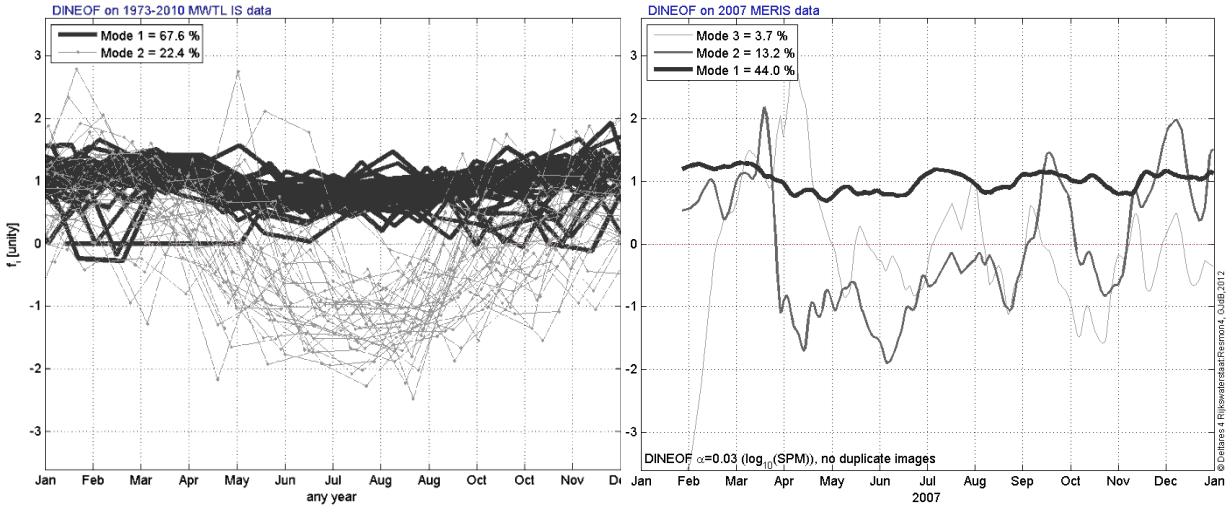




Satellite EOF1

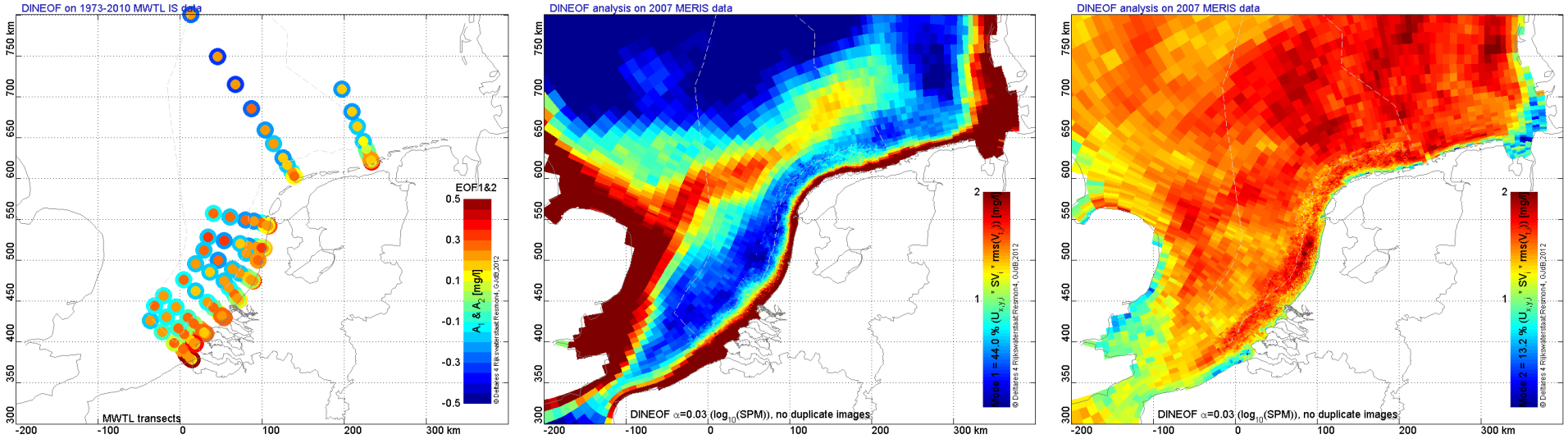
Satellite EOF2

EOF analysis in situ data & remote sensing data



Information content: Objective method to find smallest algorithm to describe data.

Rest of data is random/ Noise/uncertainty/….



Donar EOF1 + 2

Satellite EOF1

Satellite EOF2

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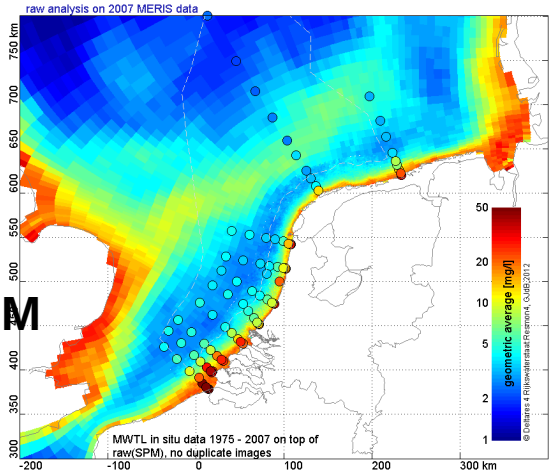
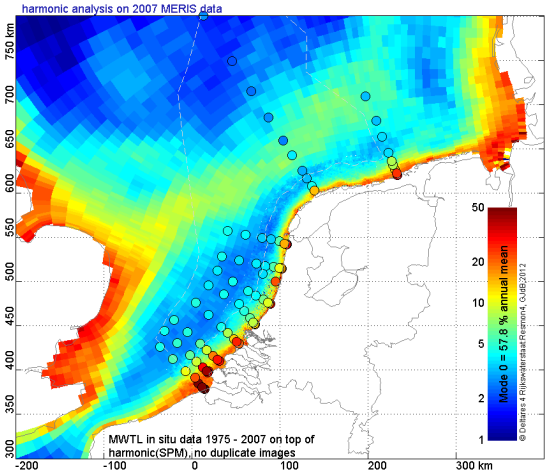
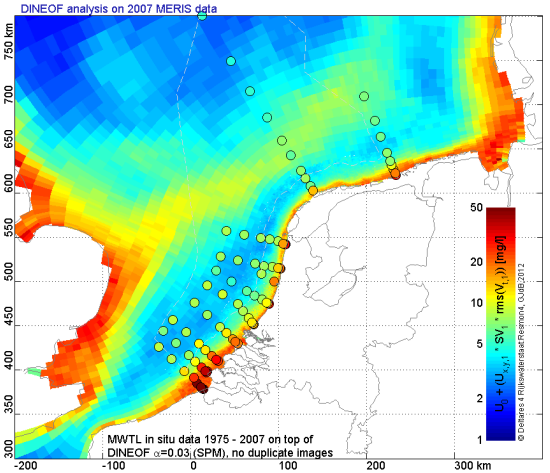
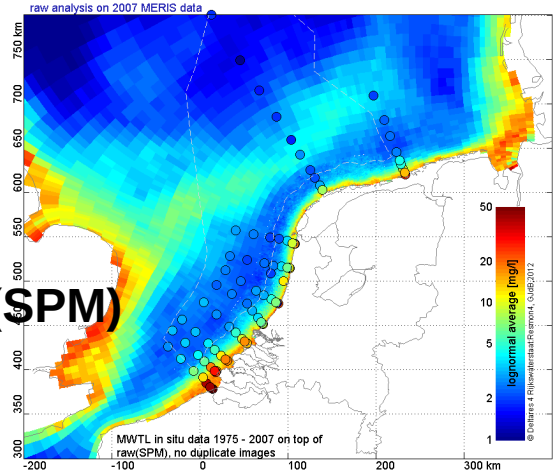
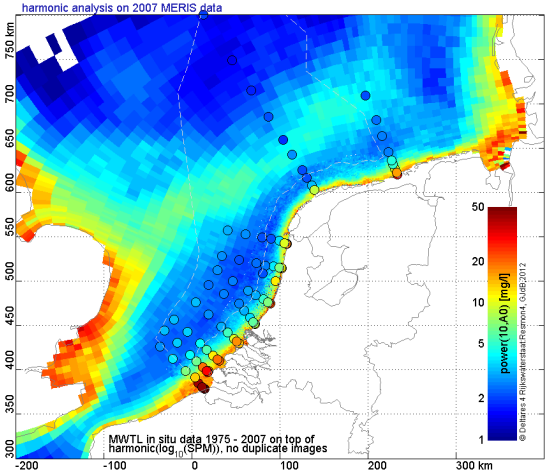
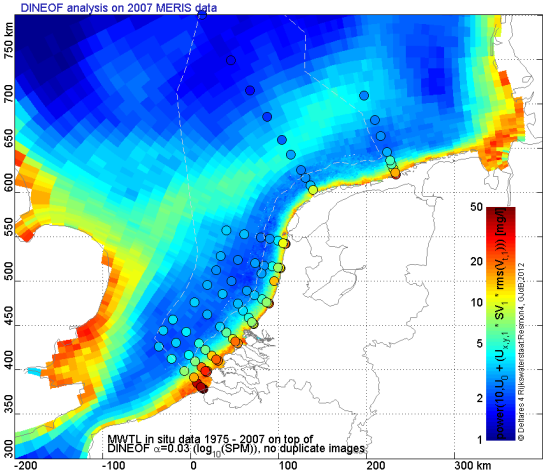
1 year of ocean color vs DONAR: information

	Arithmetic mean	A0 harmonic analysis	$Mean_{x,y,t}$ + EOF1
SPM			
log(SPM)			

Deltares

Conclusions

… a different monitoring strategy might be required. Deployment of a few semi-permanent moorings such as SmartBuoys … Ocean colour RS can be matched more easily against these mooring series which can serve as the linking pin between sea truth data and overpasses. …To get the most out of the expensive remote sensing missions, the prevailing belief that in situ monitoring provides the target truth might need some rethinking.