25 лет использования программного комплекса ЮНЕСКО БИЛКО для обработки и интерпретации спутниковых данных при обучении и подготовке специалистов

Сычев В.И. (РГГМУ)

Valborg Byfield, Tyler Christensen, Malcolm Dobson, Craig Donlon, Alasdair Edwards, Ian Robinson, Vitaly Sychev, Dirk Troost, Christo Whittle

25 years of Capacity Development in Coastal and Marine Remote Sensing with UNESCO Bilko

Valborg Byfield, Tyler Christensen, Malcolm Dobson, Craig Donlon, Alasdair Edwards, Ian Robinson, Vitaly Sychev, Dirk Troost, Christo Whittle

Dear Vitaly, Nice to hear from you. Thanks for reminding us about Bilko being 25 this year - we should do something about it. I will try to find out what month it started, and perhaps do something about it on the web site. You are very welcome to use some of our IOC50 presentation for your celebrations in Russia.

Val.

February 29, 2012

БИЛКО

Эдвард Мунк

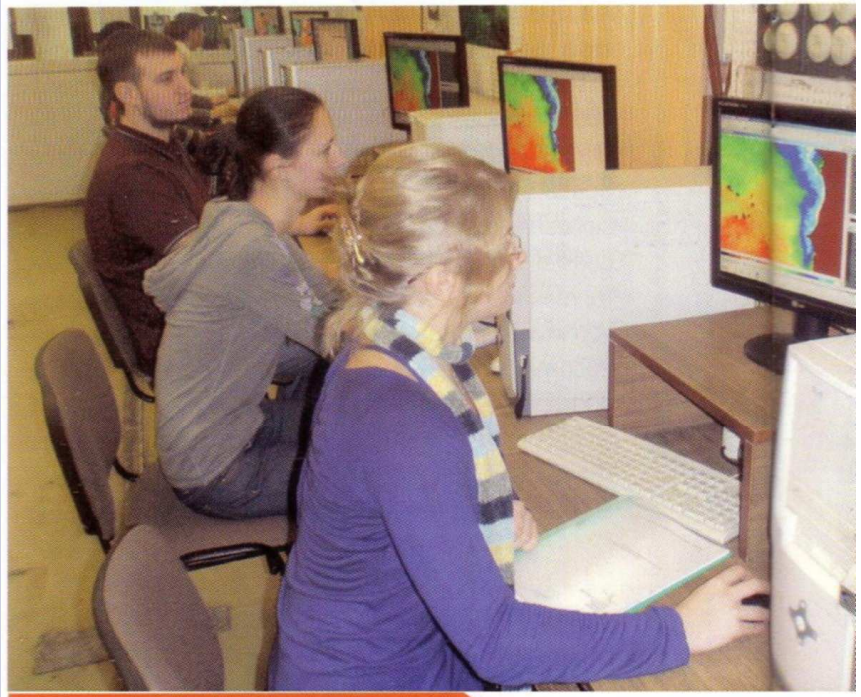
Der Schrei der Natur («Крик природы»)

Использование БИЛКО на русском языке

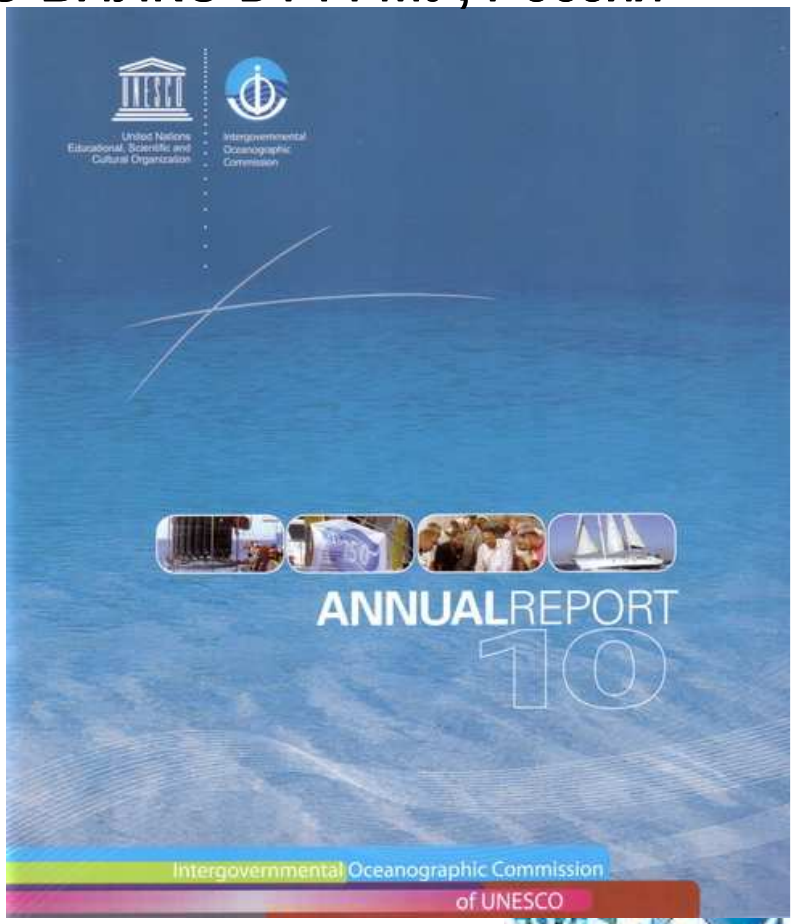
БИЛКО

Отчет МОК/ЮНЕСКО за 2010 г.

Изучение и тестирование модулей ЮНЕСКО БИЛКО в РГГМУ, Россия



Studying and testing UNESCO BILKO software and modules, RSHU, St. Petersburg, Russian Federation



БИЛКО

ВВЕДЕНИЕ В ПРОГРАММНОЕ ОБЕСПЕЧЕНИЕ ОБРАБОТКИ ИЗОБРАЖЕНИЙ BILKO 3.2

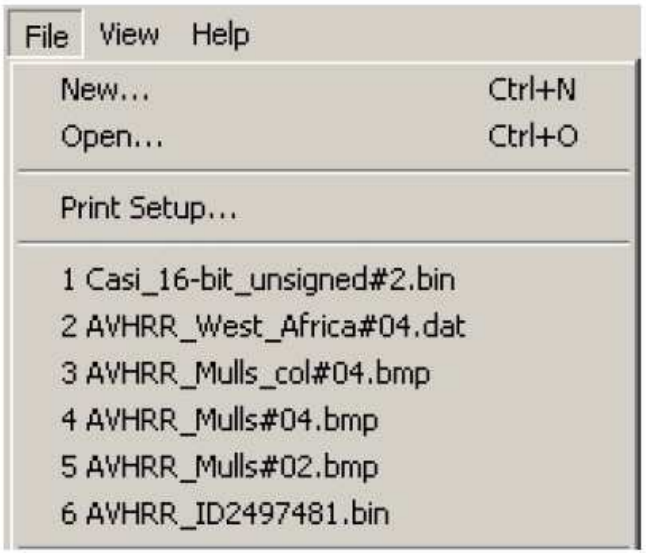
Цели и задачи введения

Программное обеспечение *Bilko* для Windows предназначено для анализа цифровых изображений, а также для демонстрации операций, с помощью которых могут быть определены некоторые параметры цифрового изображения.

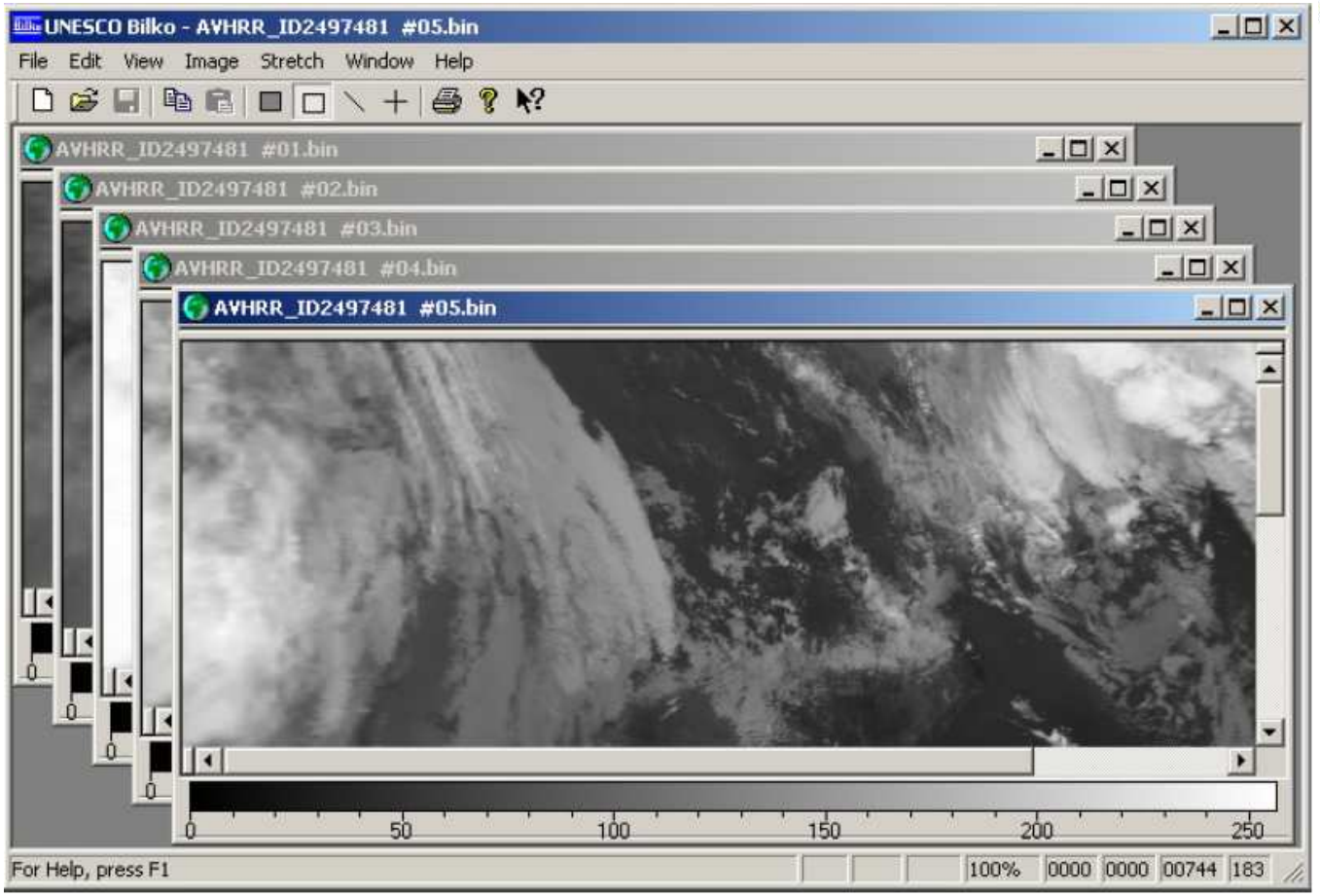
2. Загрузка, просмотр и сохранение изображений

Операции в *Bilko для Windows* производятся над изображением, которое необходимо загрузить. В *Bilko для Windows* могут использоваться различные типы файлов (документов). Работая в компьютерной сети, следует предварительно выяснить, где находятся файлы изображений, палитр, шкал и другие документы *Bilko для Windows*. В этом случае в программе следует указать путь к этим файлам.

Действие: Нажмите левую кнопку мыши, установив курсор на разделе меню **File** (**Файл**). Обратите внимание, что имена четырех последних вызывавшихся ранее для обработки файлов будут перечислены в меню **File** (см. рис. справа). Затем установите курсор на разделе **Open** (**Открыть**) и нажмите левую кнопку мыши, после чего откроется диалоговое окно **File Open** (**Открыть файл**),



Использование БИЛКО на русском языке

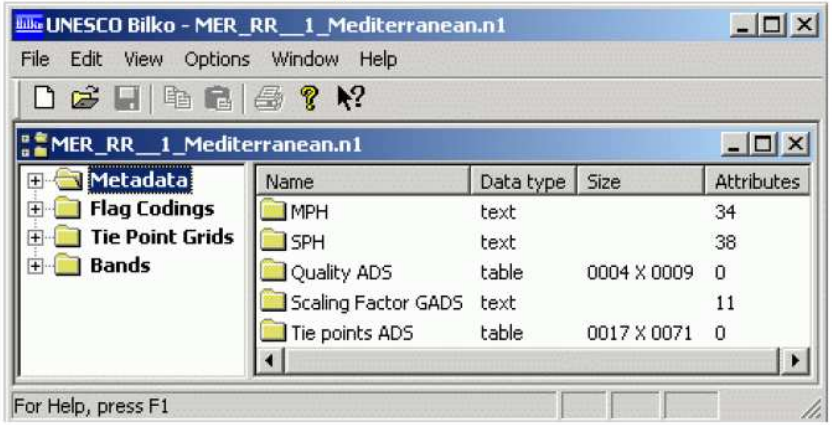


Использование БИЛКО на русском языке

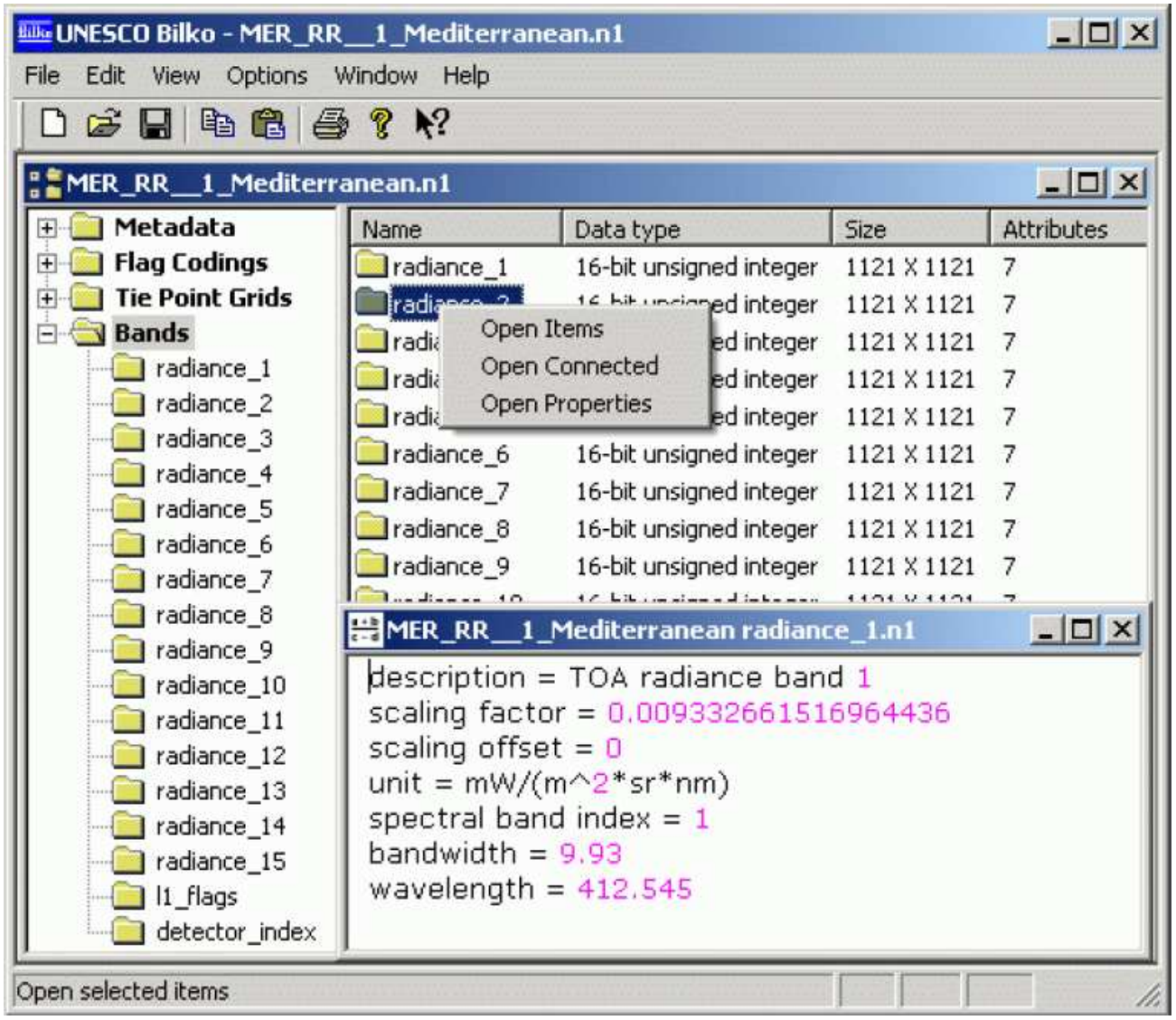
Ввод файла **MER_RR__1PNPDK20030813_094018_00022_07591_4499.N1**

Для примера рассмотрим изображение с ассоциированными данными прибора MERIS (Medium Resolution Imaging Spectrometer - Спектрометр среднего разрешения) спутника EKA ENVISAT.

Откройте файл MER_RR__1_Mediterranean.n1 – изображение, полученное с помощью прибора MERIS, центральной части Средиземного моря. Полное название файла (в оригинале: MER_RR__1PNPDK20030813_094018_00022_07591_4499.N1). В открытом окне показана иерархическая структура файла N1. В левой части перечислены папки: изображения в различных каналах (Bands), коды меток (Flag Codings), точки для географической привязки изображения (Tie Point Grids) и метаданные (Metadata). Папка Metadata содержит в себе еще пять папок, которые показаны в правой части окна. Откройте эти папки двойным нажатием левой клавиши мыши (или нажмите правую клавишу мыши, а затем Open Items). В папке SPH вы найдете информацию о том, где и когда были получены изображения, количество каналов и их характеристики и т.д. Используйте приведенные сведения для ответа на вопросы.

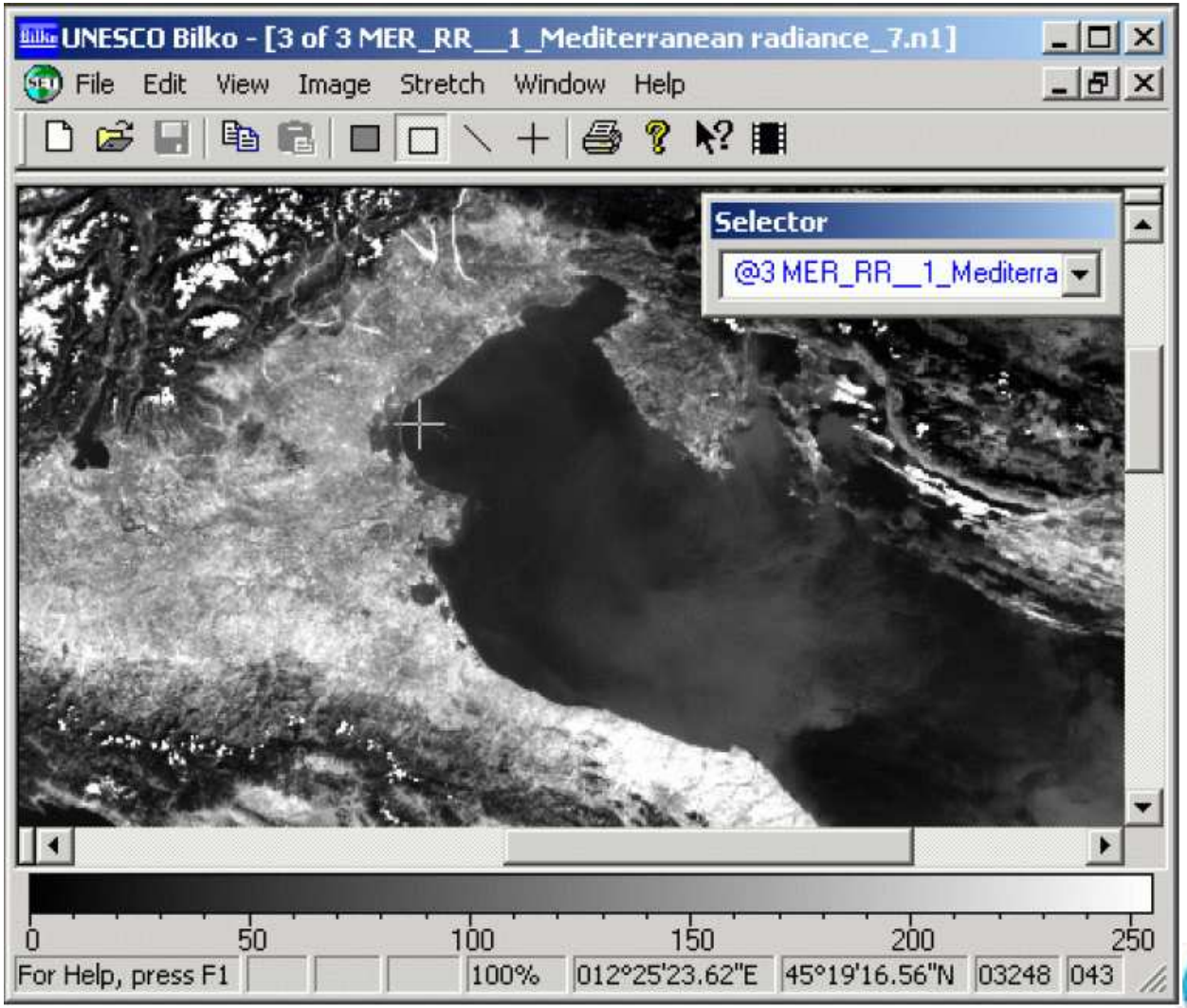


Использование БИЛКО на русском языке



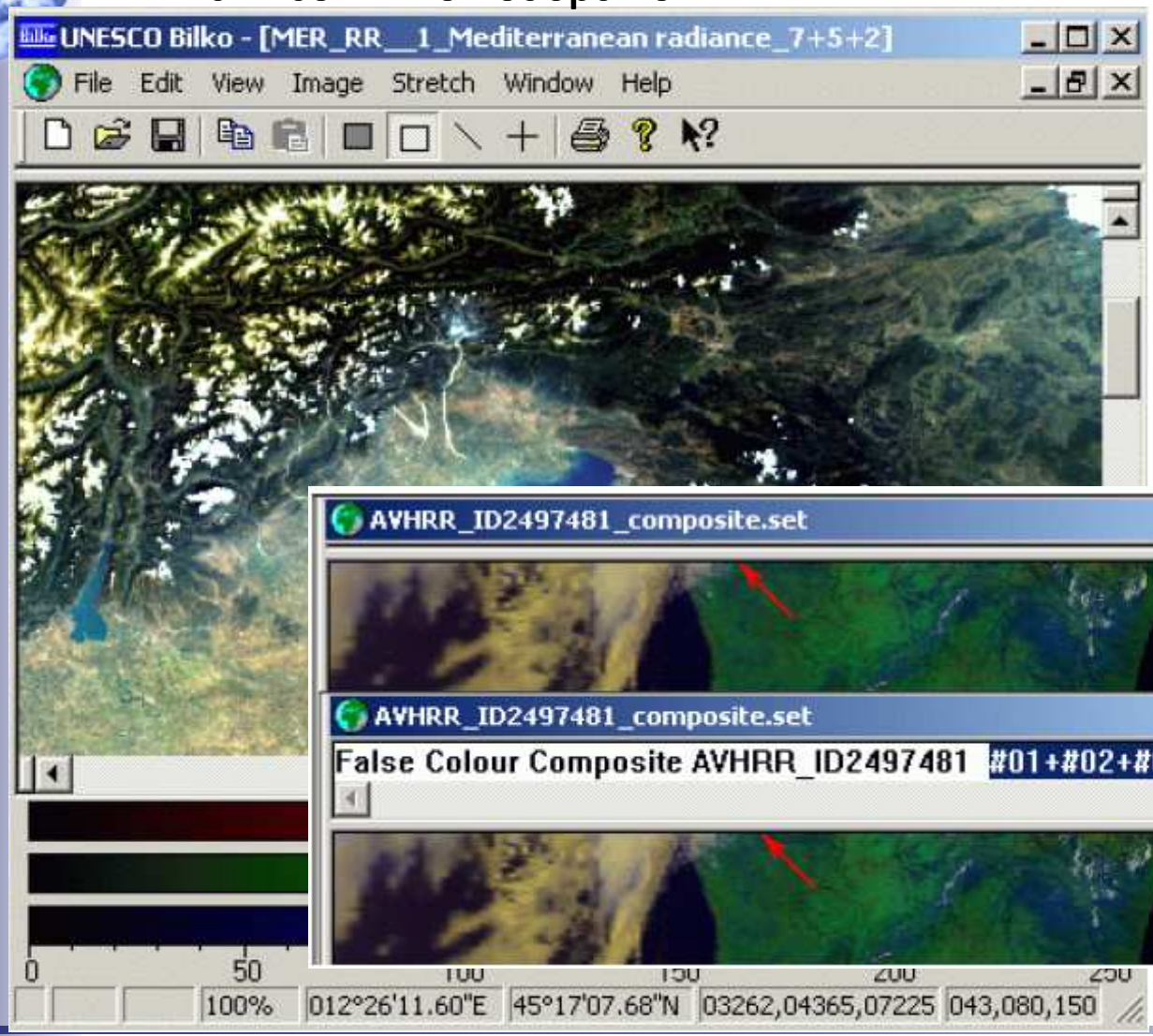
Использование БИЛКО на русском языке

Файл данных Envisat/MERIS



Использование БИЛКО на русском языке

Композитные изображения Envisat/MERIS



NOAA/AVHRR

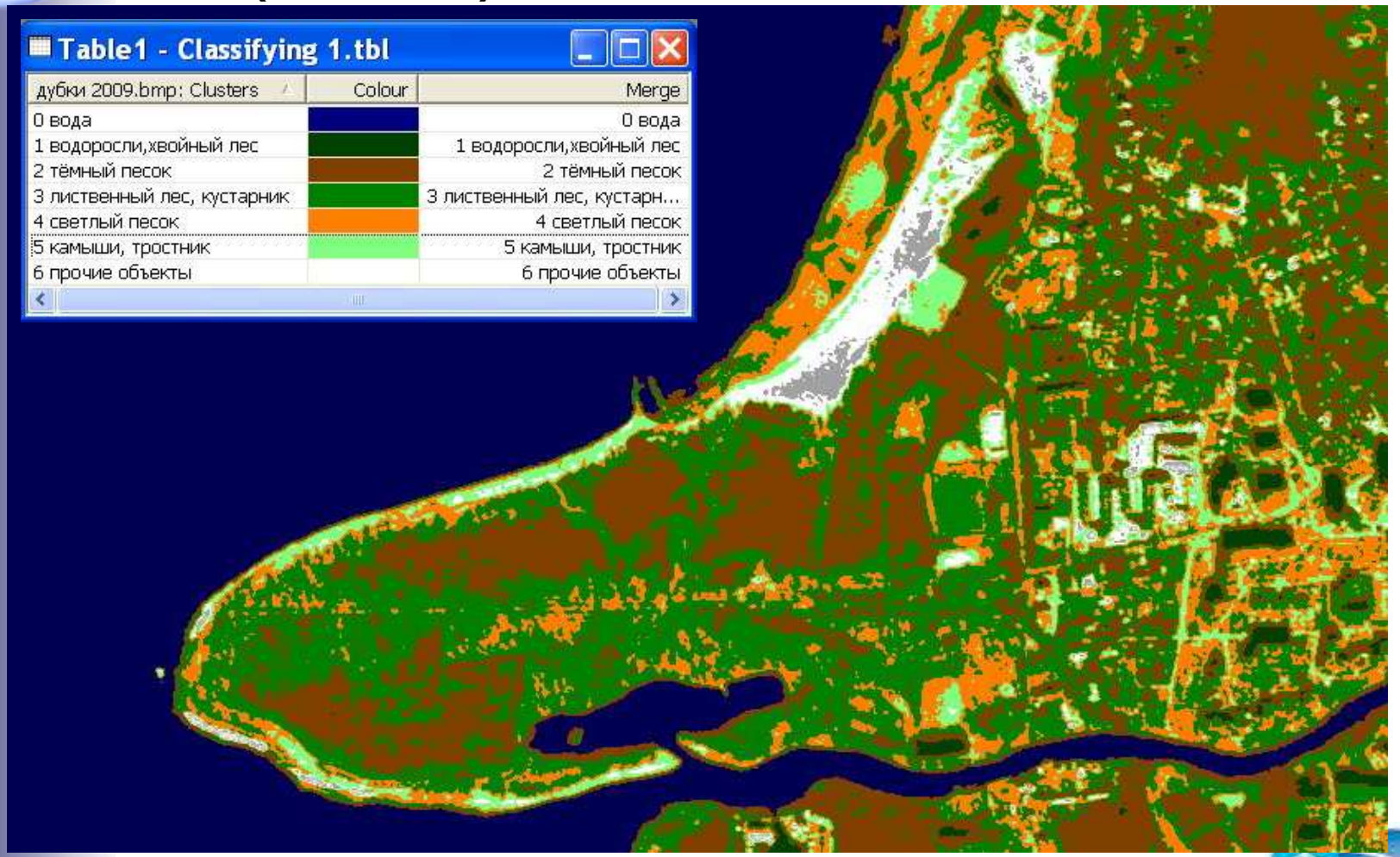
www.unesco.bilko.org

Использование БИЛКО на русском языке

Результаты классификации без обучения, SPOT (июнь, 2008) для восточной части Финского залива

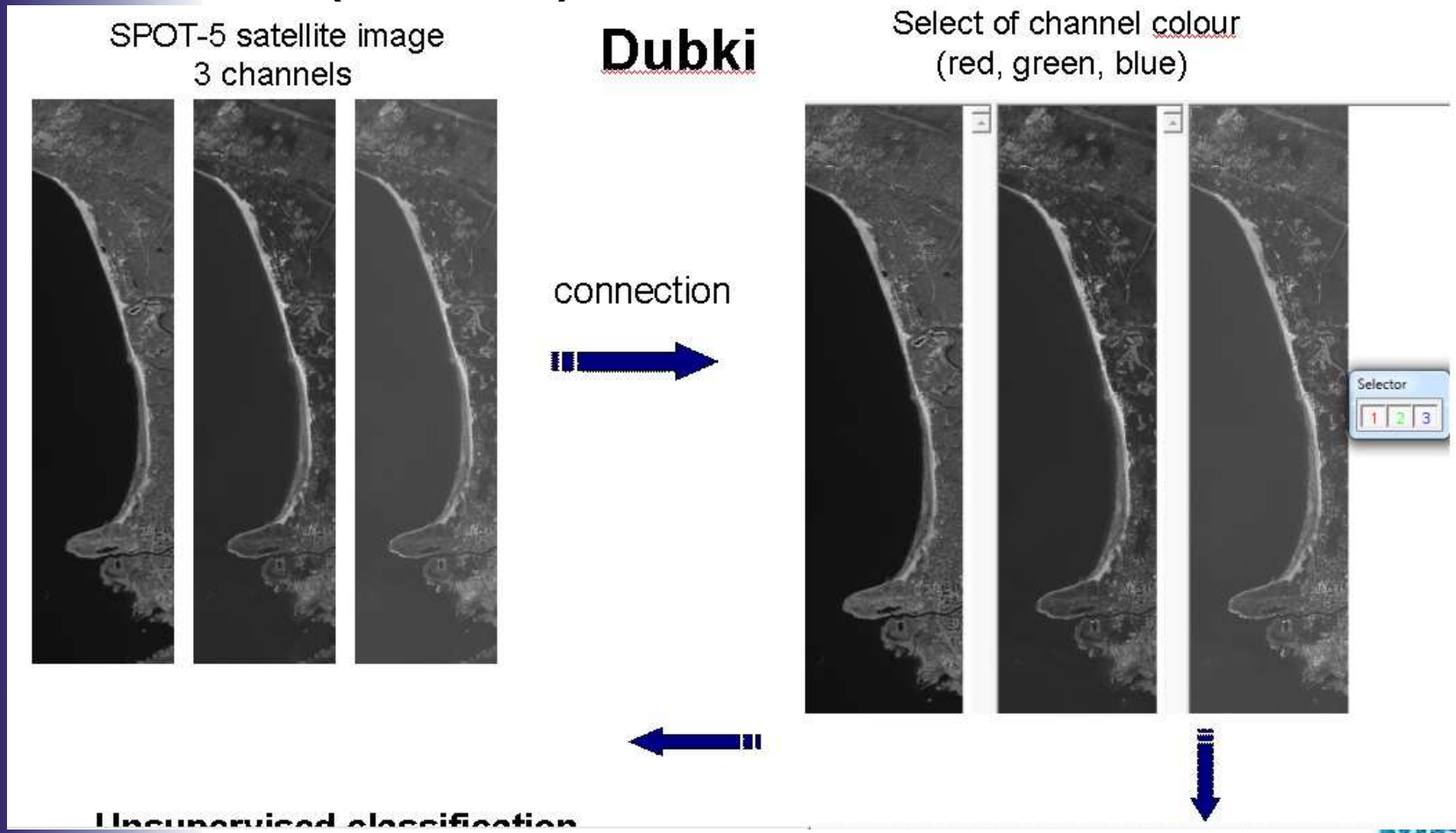
Table1 - Classifying 1.tbl

дубки 2009.bmp: Clusters	Colour	Merge
0 вода		0 вода
1 водоросли,хвойный лес		1 водоросли,хвойный лес
2 тёмный песок		2 тёмный песок
3 лиственный лес, кустарник		3 лиственный лес, кустарн...
4 светлый песок		4 светлый песок
5 камыши, тростник		5 камыши, тростник
6 прочие объекты		6 прочие объекты



Использование БИЛКО на русском языке

Результаты классификации без обучения, SPOT (июнь, 2008) для восточной части Финского залива



Использование БИЛКО на русском языке

Результаты классификации без обучения, SPOT (июнь, 2008) для восточной части Финского залива

без обучения

Ижора без обучения Таб

Ижора без обучения: Clusters	Colour	Merge	IMAGERY #01 From ...
0 глубокая вода		0 глубокая вода	17.8
1 мелководье		1 мелководье	37.9
2 илы, водоросли, высокие деревья		2 илы, водоросли, высокие деревья	68.7
3 кустарники		3 кустарники	20.1
4 трава,осока		4 трава,осока	43.6
5 мокрый песок		5 мокрый песок	71.7
6 песок с галькой		6 песок с галькой	61.8
7 крупнозернистый песок с мелкой галькой		7 крупнозернистый песок с мелкой галькой	49.4
8 крупнозернистый песок с мелкой галькой		8 крупнозернистый песок с мелкой галькой	75.5
9 осушенная часть побережья		9 осушенная часть побережья	78.6
10 сухой мелкозернистый песок		10 сухой мелкозернистый песок	58.2
11 песок с сухим тростником		11 песок с сухим тростником	83.5
12 сухой тростник		12 сухой тростник	87.6
13 здание		13 здание	74.9
14 здание		14 здание	97.2
15 здание		15 здание	98.6

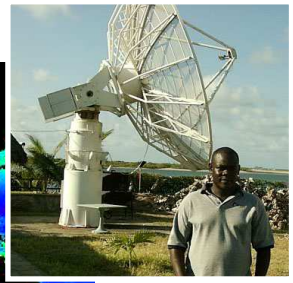
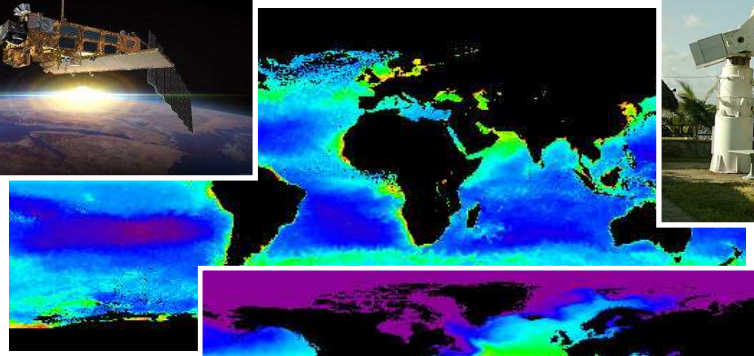
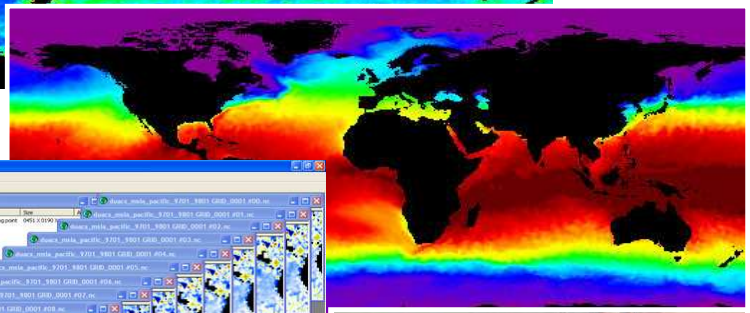
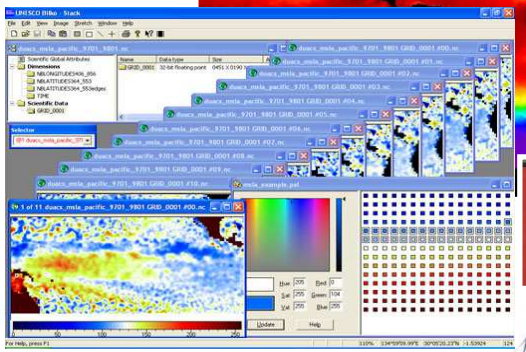
с обучением

Table5

Description: Stack	Upper Left	Size	Pixels	Class: Herts landuse classes	Mean TD
TS #000:	(1042, 0006)	(0042, 0050)	2100	Deep water	1401
TS #001:	(0972, 0150)	(0039, 0038)	1482	Deep water	1309
TS #002:	(0701, 0064)	(0040, 0039)	1560	Deep water	1366
TS #003:	(0365, 0004)	(0022, 0011)	242	Deep water	1330
TS #004:	(0015, 0102)	(0027, 0021)	567	Deep water	1261
TS #005:	(0113, 0136)	(0015, 0015)	225	Deep water	1335
TS #006:	(1125, 0006)	(0004, 0004)	16	Deep water	1709
TS #007:	(0165, 0303)	(0010, 0007)	70	Deep water	1713
TS #008:	(0013, 0297)	(0011, 0010)	110	Deep water	1797
TS #009:	(0193, 0267)	(0007, 0007)	49	Deep water	1587
TS #010:	(0245, 0196)	(0012, 0007)	84	Deep water	1335
TS #011:	(0012, 0198)	(0016, 0010)	160	Deep water	1336
TS #012:	(0261, 0309)	(0013, 0005)	65	Deep water	1778
TS #013:	(0320, 0269)	(0009, 0008)	72	Deep water	1581
TS #014:	(0251, 0270)	(0005, 0007)	35	Deep water	1625
TS #015:	(0211, 0209)	(0010, 0008)	80	Deep water	1245
TS #016:	(0369, 0230)	(0007, 0008)	56	Deep water	1526
TS #017:	(0447, 0159)	(0009, 0007)	63	Deep water	1437
TS #018:	(0539, 0085)	(0025, 0026)	650	Deep water	1269
TS #019:	(0481, 0307)	(0007, 0008)	56	Deep water	1572
TS #020:	(0526, 0272)	(0010, 0008)	80	Deep water	1327
TS #021:	(0683, 0261)	(0017, 0012)	204	Deep water	1277
TS #022:	(0656, 0327)	(0011, 0010)	110	Deep water	1357

Content

- What is Bilko?
- A brief history
- Bilko today:
  - Software
  - Tutorials and lessons
  - Web site
- Bilko Users
- Challenges
- Conclusions

What is Bilko?

What is Bilko?

A brief history

Bilko today:

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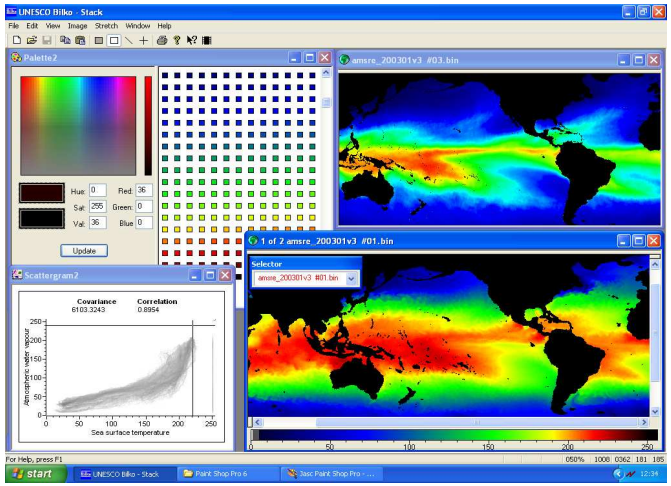
Bilko users

Challenges

Conclusions

- A unique marine and coastal remote sensing **distance-learning project** based on use of personal computers
- AIM: **develop capacity in coastal and marine remote sensing** through a series of computer-based learning modules using a specially commissioned educational image-processing software package (Bilko).



Emphasis on practical work

What is Bilko?

A brief history

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Conclusions

- Hands-on approach to training in coastal and marine remote sensing - especially for those traditionally excluded from RS training by the:
  - **high cost** of commercial image-processing software, and the need for expensive computers to run that software,
  - **difficulty of acquiring remotely sensed images** for teaching,
  - **long learning-curves** required to master complex software,
  - need to teach **large numbers of students** at the same time.

More than just software ..

What is Bilko?

A brief history

Bilko today:

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Objectives:

- Provide educational image processing **software** capable of operating on low-cost computers
- Produce **tutorials** to support the software and teach image processing and analysis skills
- Develop lessons in a wide **range of applications**
  - Examples from different regions and disciplines
  - Essential background information to facilitate interpretation
- Create and foster a **community** of Bilko users
  - Distribute all material **FREE** of charge via Bilko website
  - Offer assistance with workshops and courses
  - Encourage users to share resources and develop new material

Organisational structure

What is Bilko?

A brief history

Bilko today:

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Challenges

Conclusions

- Expert advisory group
  - **I**nternational **B**ilko **E**xecutive **S**teering **T**eam
    - Remote sensing experts from around the world
    - Develop strategy & set priorities
    - Review, edit and test new lessons
- Software developer and lesson authors
  - Volunteer effort by core team of experts
- Project Office
  - Website and day-to-day user support
  - Advice to organisers of courses and workshops
- All done by **volunteers**

A brief history

What is Bilko?

A brief history

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➢ Started in 1987 by UNESCO – 25 years

- ❖ Part of the Marine Sciences Training and Education Program (TREDMAR).

➢ 1987-2003

- ❖ Part of the Coastal and Small Islands (CSI) initiative
  - – Project office at the Faculty of Geo-Information Science and Earth Observation (ITC), NL
  - – Website at University of Newcastle-upon-Tyne, UK
  - – 1900+ users in 500+ organisations in 60+ countries

➢ 2003-present

- ❖ Part of IOC/WMO JCOMM strategy for remote sensing
  - – Project office and website at National Oceanography Centre, Southampton, UK from 2004.
  - – 5200+ users in 1300+ organisations in 168 countries

The early years

What is Bilko?

A brief history

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- Bilko for DOS
  - 5 teaching modules over 7 years
- Winbilko (1995-2002)
  - Software developed for new Windows 3.1 platform
    - Bilko 1.0 => Bilko 1.2
  - Interactive help file and new tutorial running side by side with the software in a separate window
  - More interactive and user friendly lessons
  - New applications modules
    - Coastal and marine applications of remote sensing (6)
    - Applications to Tropical Coastal Management (7)
    - Almost completed Fisheries Module (8)

Extensive updates 2004-2006

What is Bilko?

A brief history

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- Supported by IOC and ESA
- Software upgrade to Bilko v3
  - Support for common image data formats
  - Display, processing and analysis tools similar to those found in commercial software
  - Designed to promote understanding, **no black boxes**
- New / updated tutorials and lessons
  - Introduction to Bilko v.3
  - 7: Coastal management revised and extended
  - 8: Fisheries applications revised and completed
  - Envisat module.
- New website

The software today

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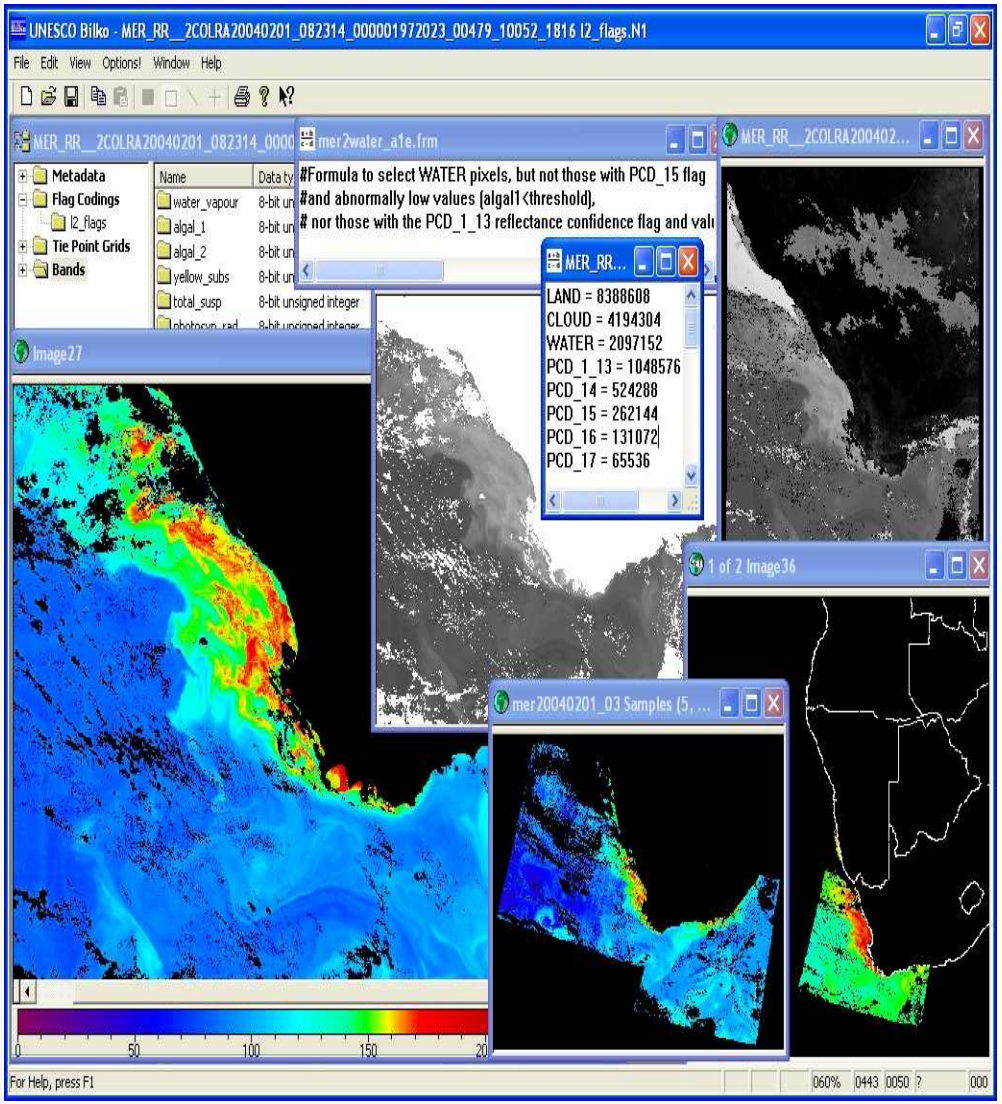

- Input formats
  - HDF (3D)
  - NetCDF (3D)
  - Envisat N1
  - GeoTIFF
  - USGS Mapgen
  - Binary flat-files
    - 8, 16, 32-bit
- Output
  - Binary (8,16,32 bit)
  - Geo-TIFF
  - GIF (8-bit paletted)
  - BMP
    - 8-bit grey, 24-bit RGB

Colour composites

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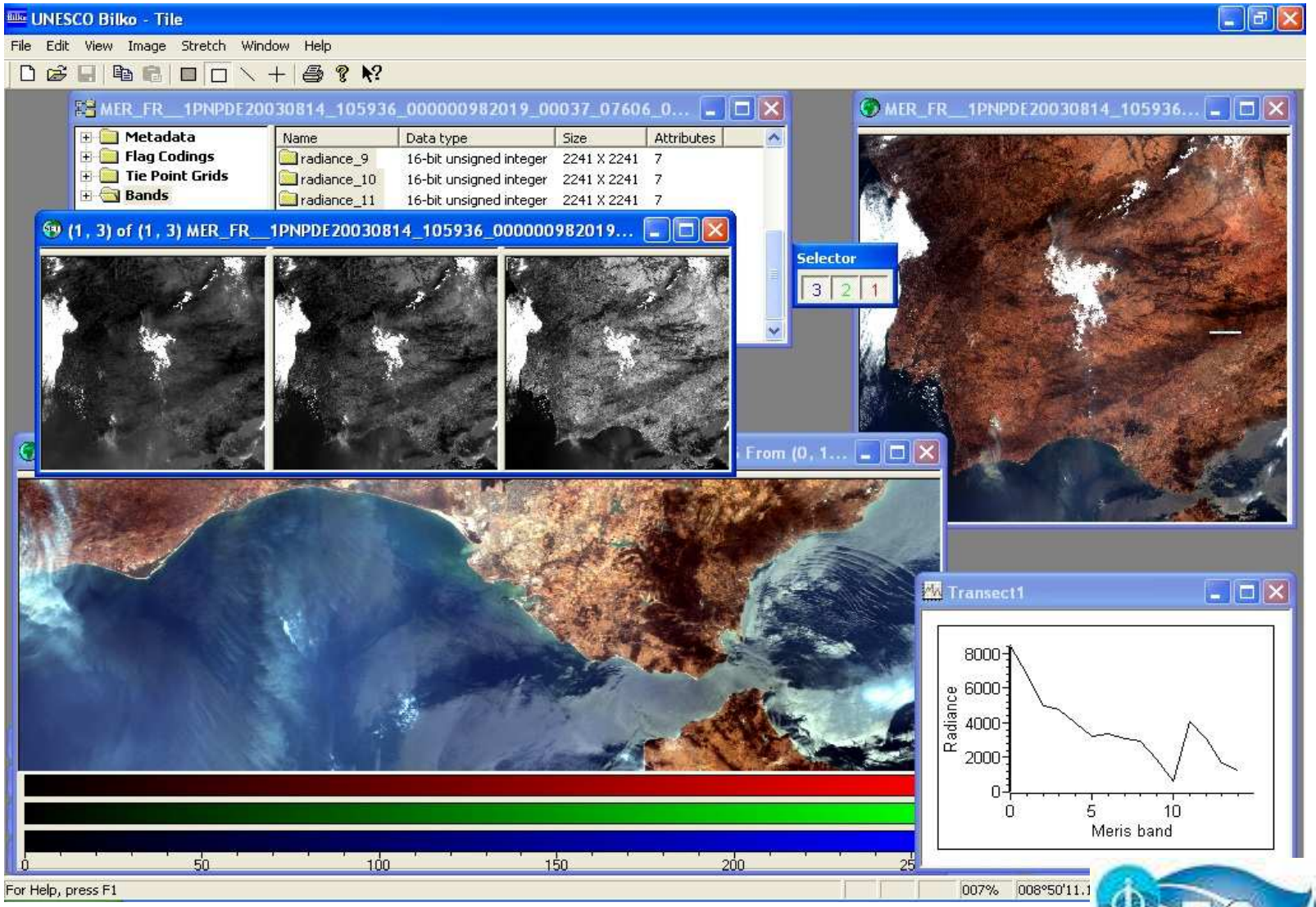

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50 Years of Education and Awareness Raising
Shaping the Future of the Oceans and Coasts
St Petersburg, 27 – 30 April 2010

Contrast stretching

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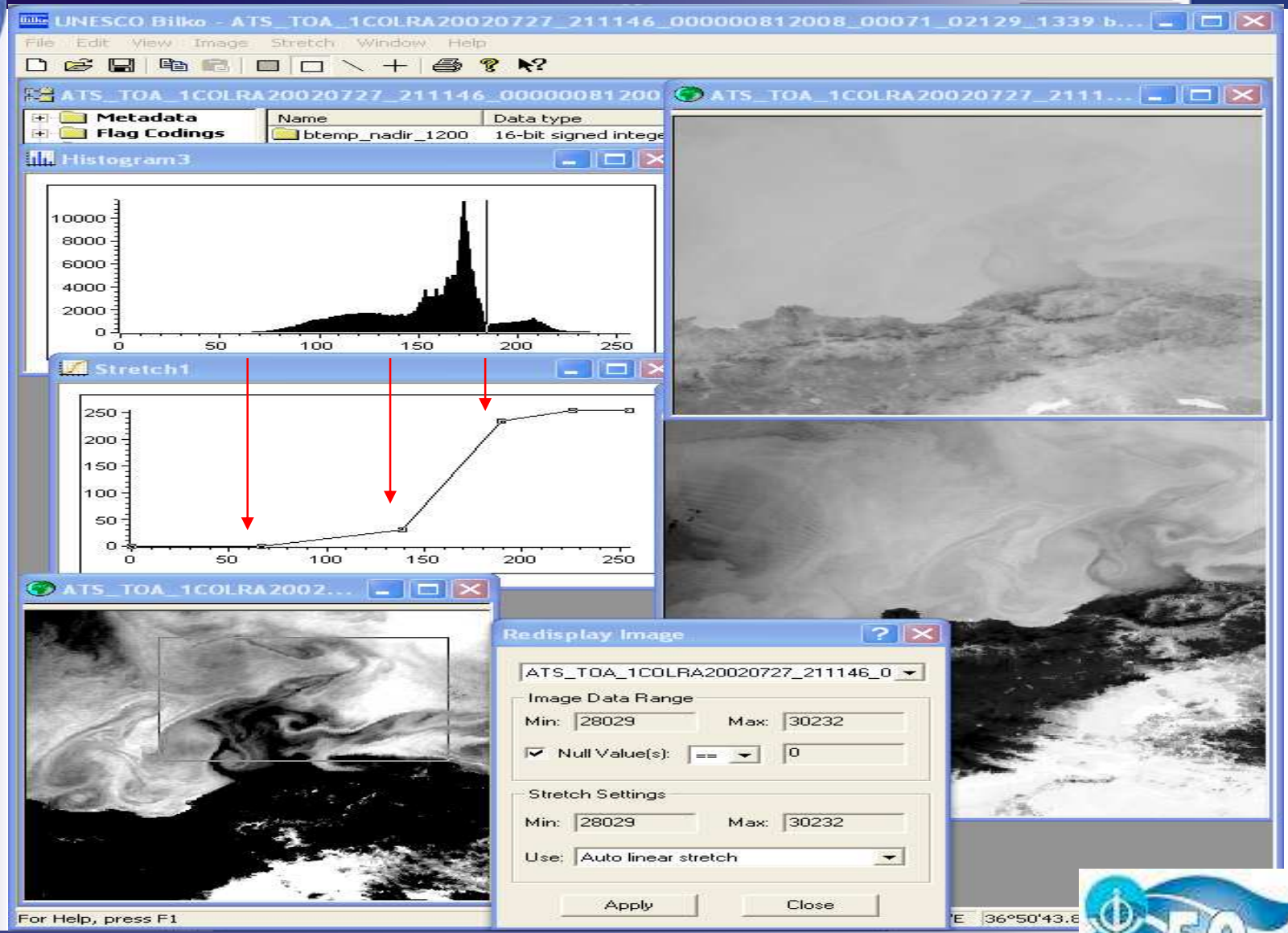

Palette tool

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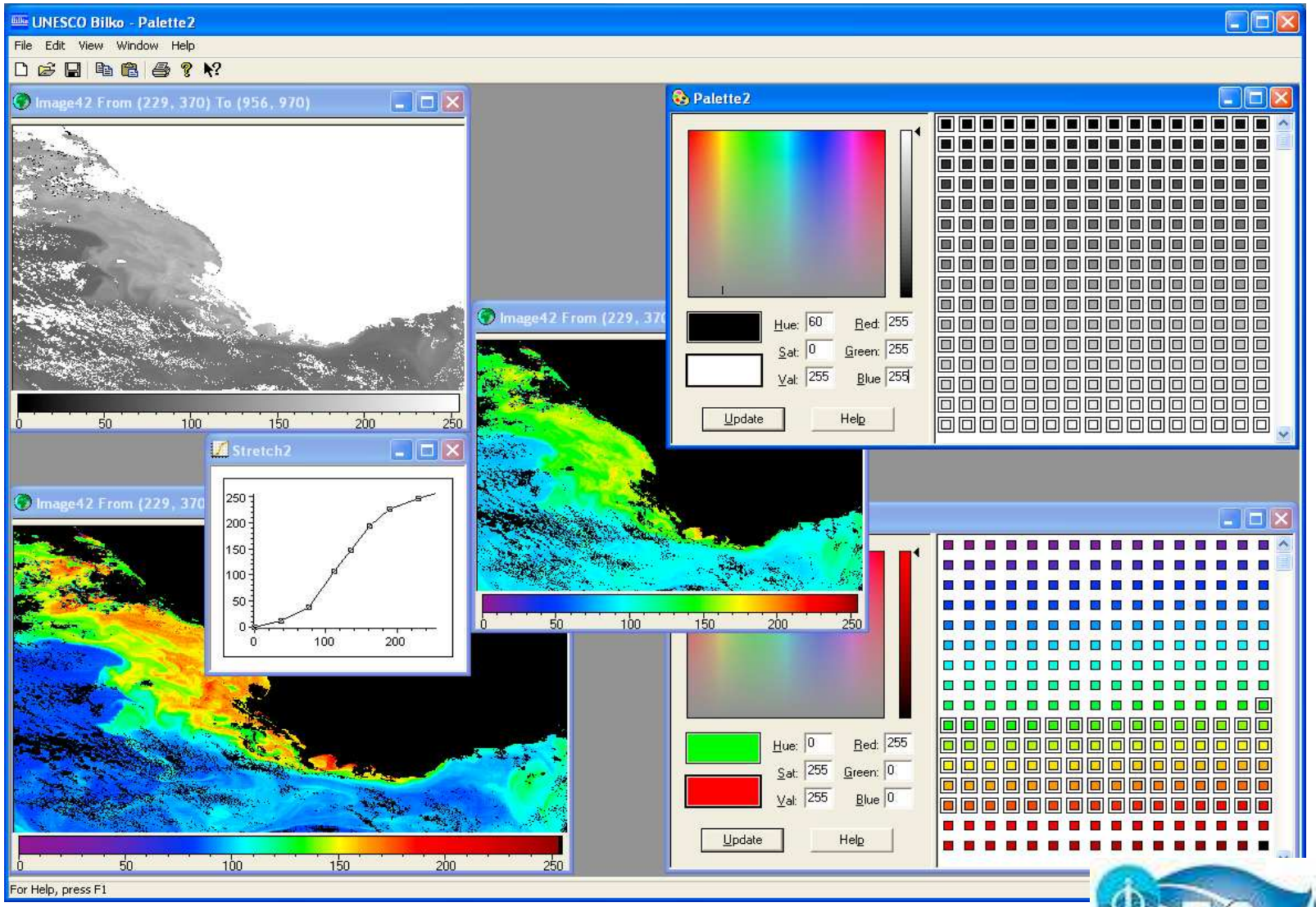

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Spatial filters

What is Bilko?

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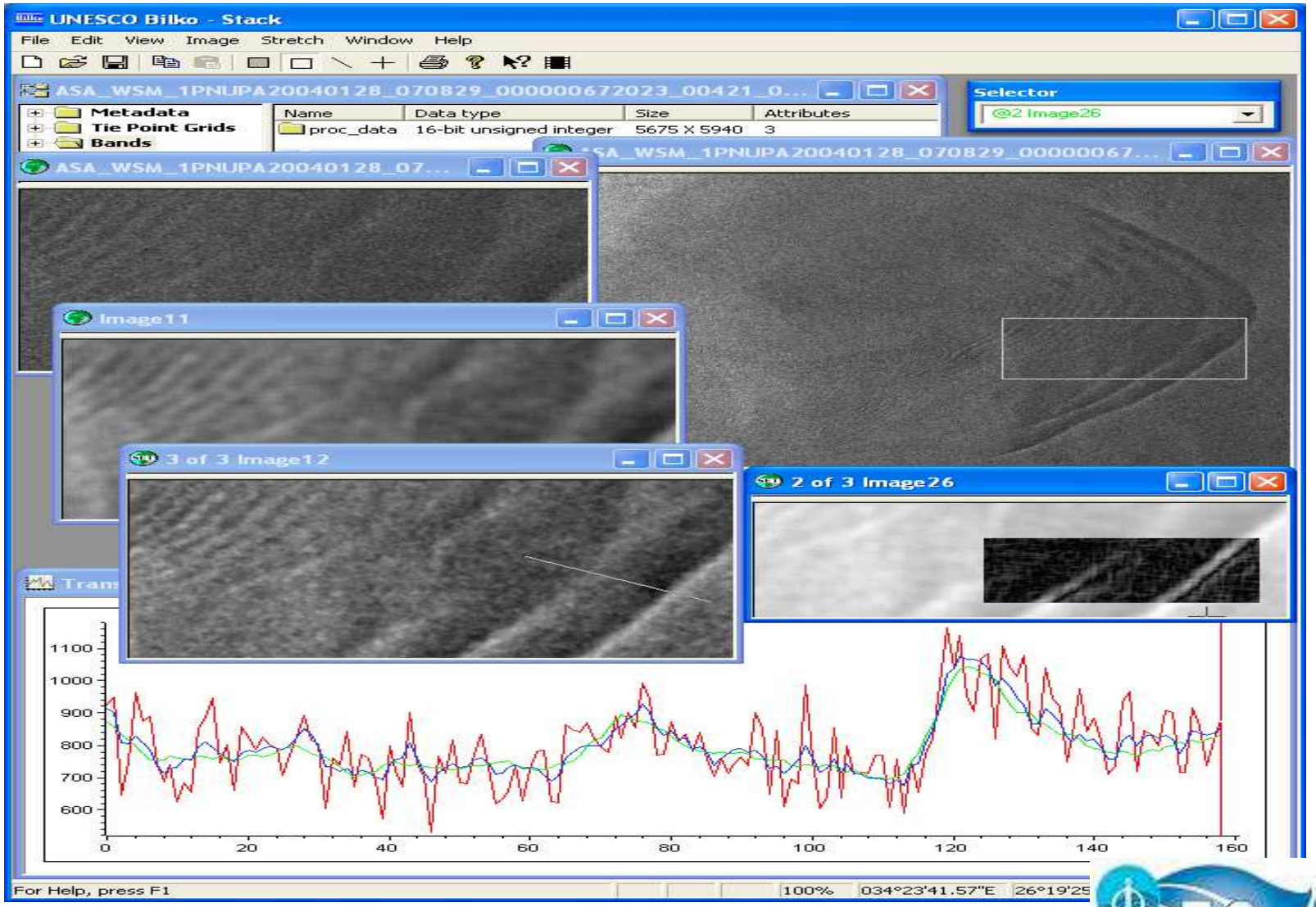

3D: time series or spectra

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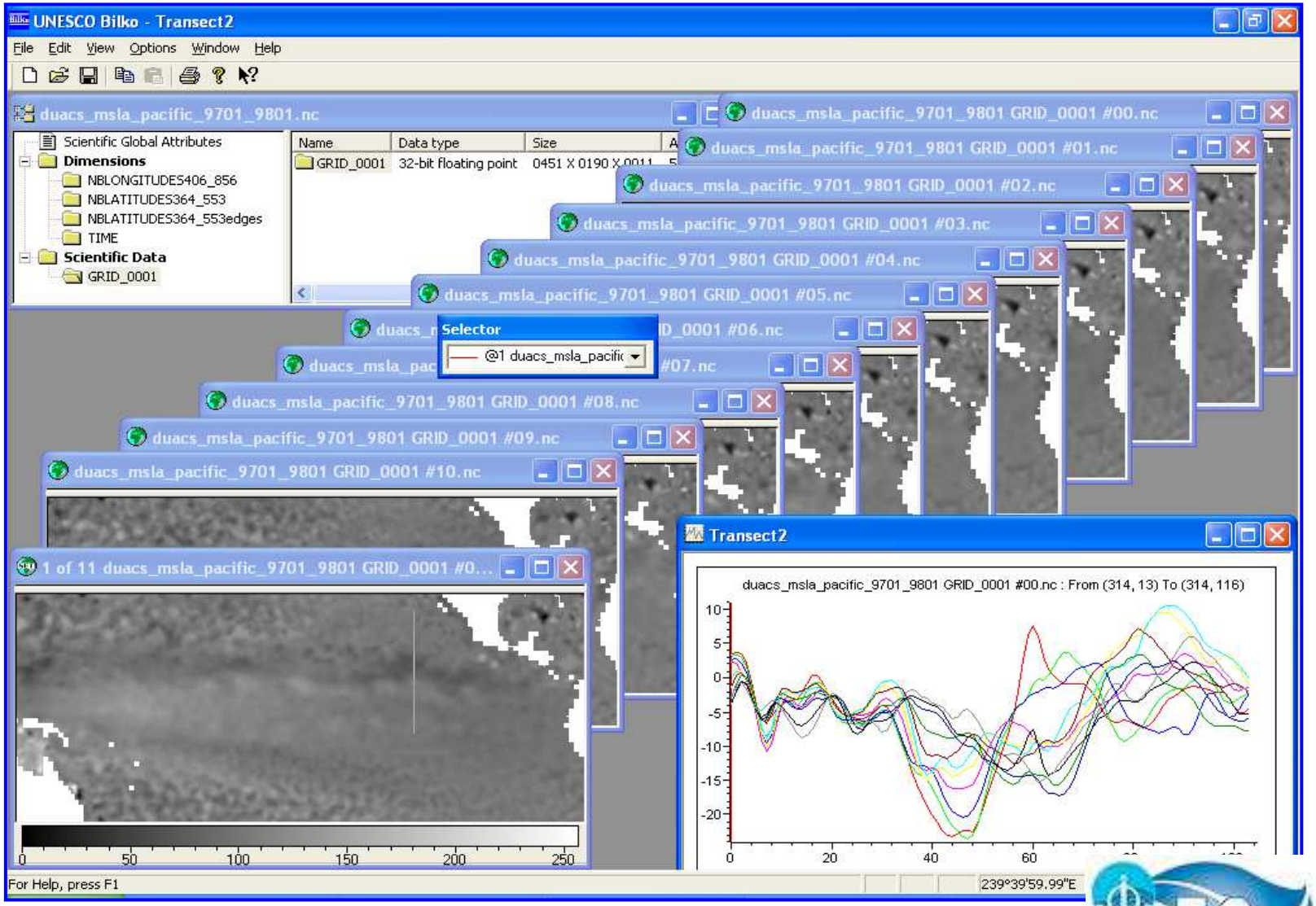
- Challenges
- Conclusions



Hovmöller diagrams

- What is Bilko?
- A brief history
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  - -Tutorials and lessons
  - -Web site
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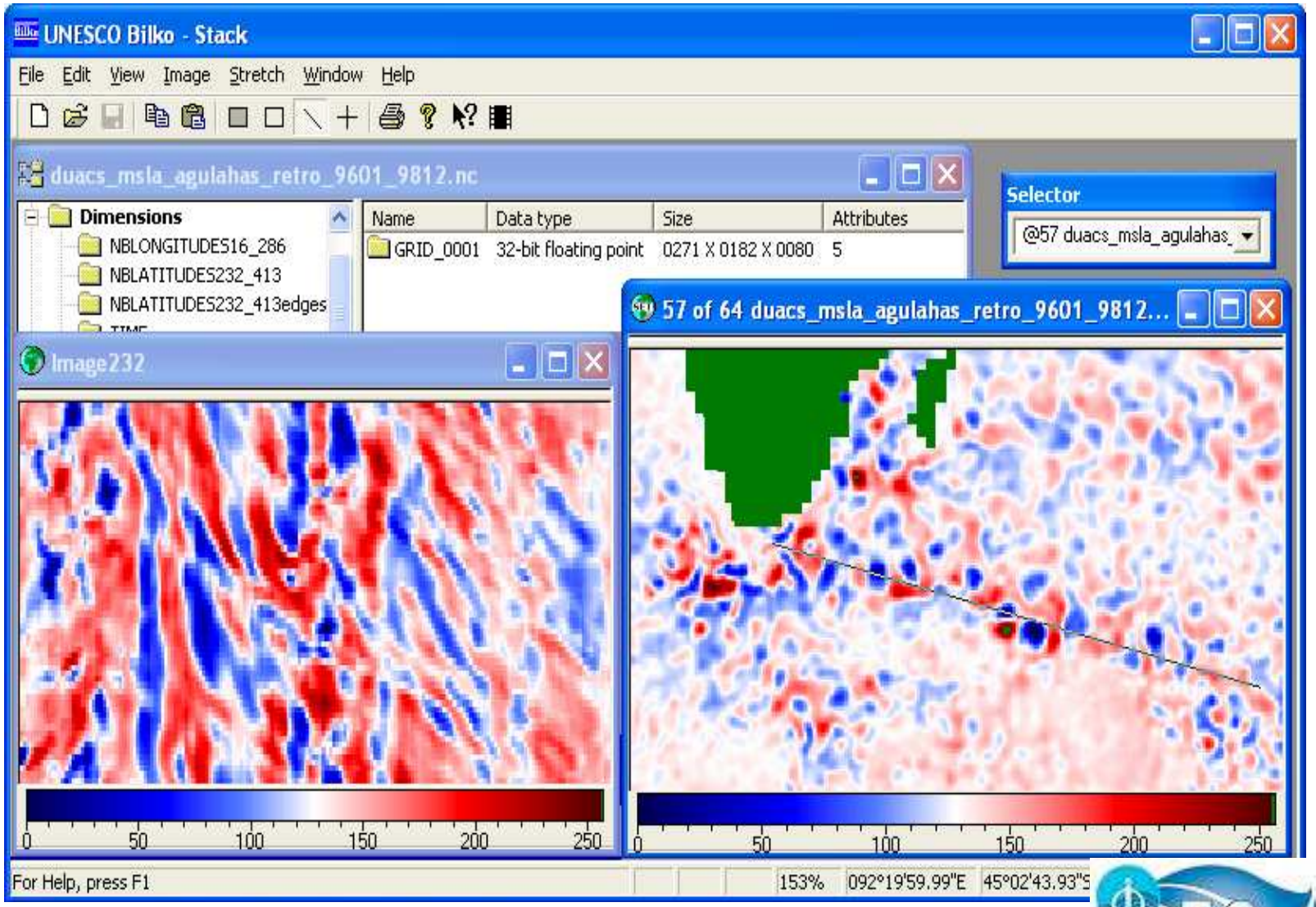
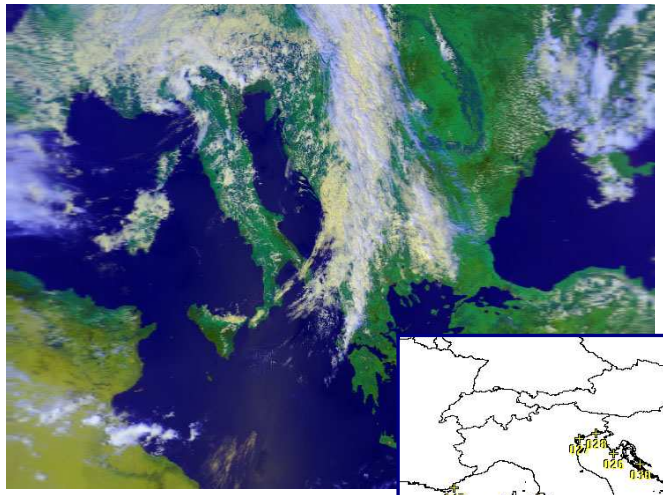
- Conclusions

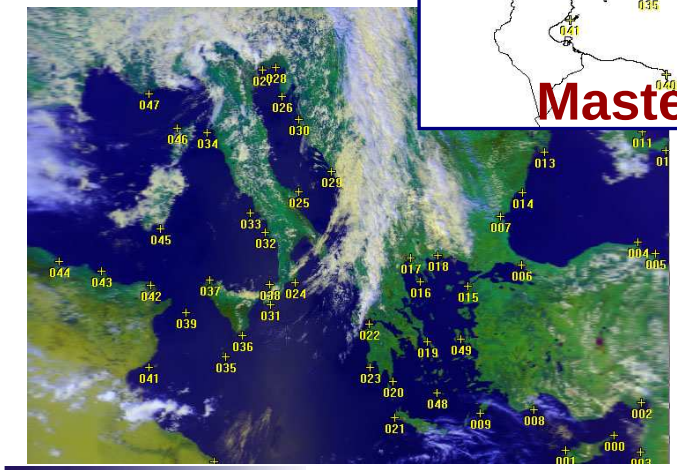


Geometric correction



Uncorrected

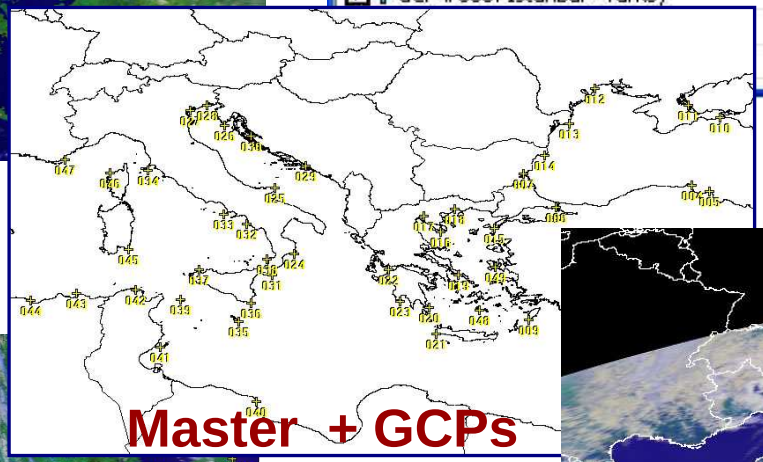
Slave + GCPs



Mediterranean.tbl - Linear

Description	Master: Mediterranean_coastli...	Slave: AVHRR_I...	RMS:
GCP #000: NE Cyprus - Cape Andreas	(034°36'23.91"E, 35°42'10.68"N)	(0673, 0516)	17.93
GCP #001: W Cyprus - Cape Arnauti	(032°16'39.62"E, 35°05'28.04"N)	(0618, 0533)	15.08
GCP #002: Dortyo - Turkey	(035°46'51.58"E, 36°45'32.03"N)	(0704, 0479)	20.74
GCP #003: Tarabulus - Lebanon	(035°49'13.68"E, 34°27'34.33"N)	(0703, 0535)	42.91
GCP #004: Sinop - Turkey	(035°08'57.87"E, 42°01'43.27"N)	(0700, 0297)	15.82
GCP #005: Bafra Burnu - Turkey	(035°58'06.59"E, 41°43'21.95"N)	(0720, 0310)	15.81
GCP #006: Istanbul - Turkey	(028°59'29.24"E, 41°00'44.03"N)	(0568, 0323)	6.23
	(027°28'53.67"E, 42°32'30.65"N)	(0544, 0268)	9.44
	(023°44'24.60"E, 39°54'10.22"N)	(0453, 0342)	11.42

Rectification table



Master + GCPs

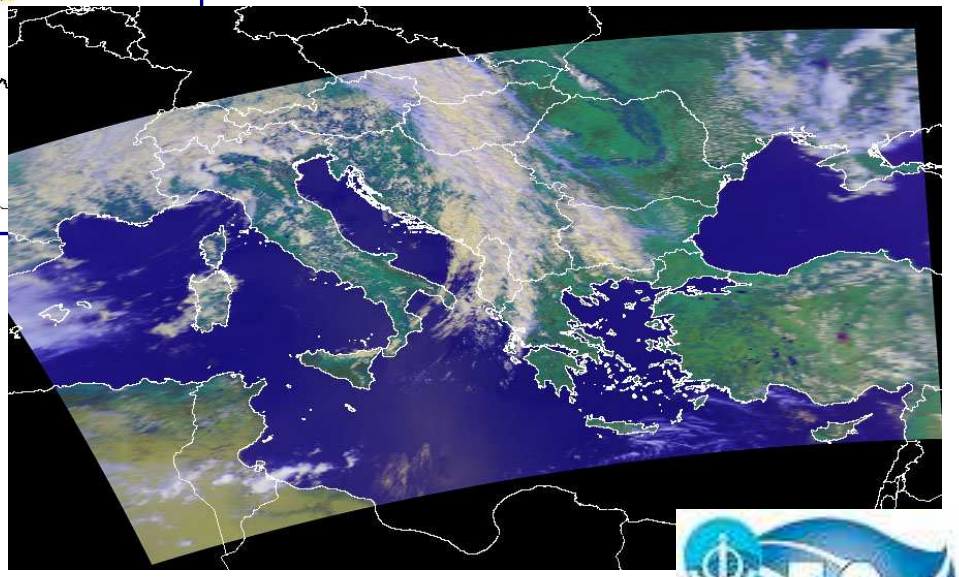


Image arithmetic

What is Bilko?

A brief history

Bilko today:

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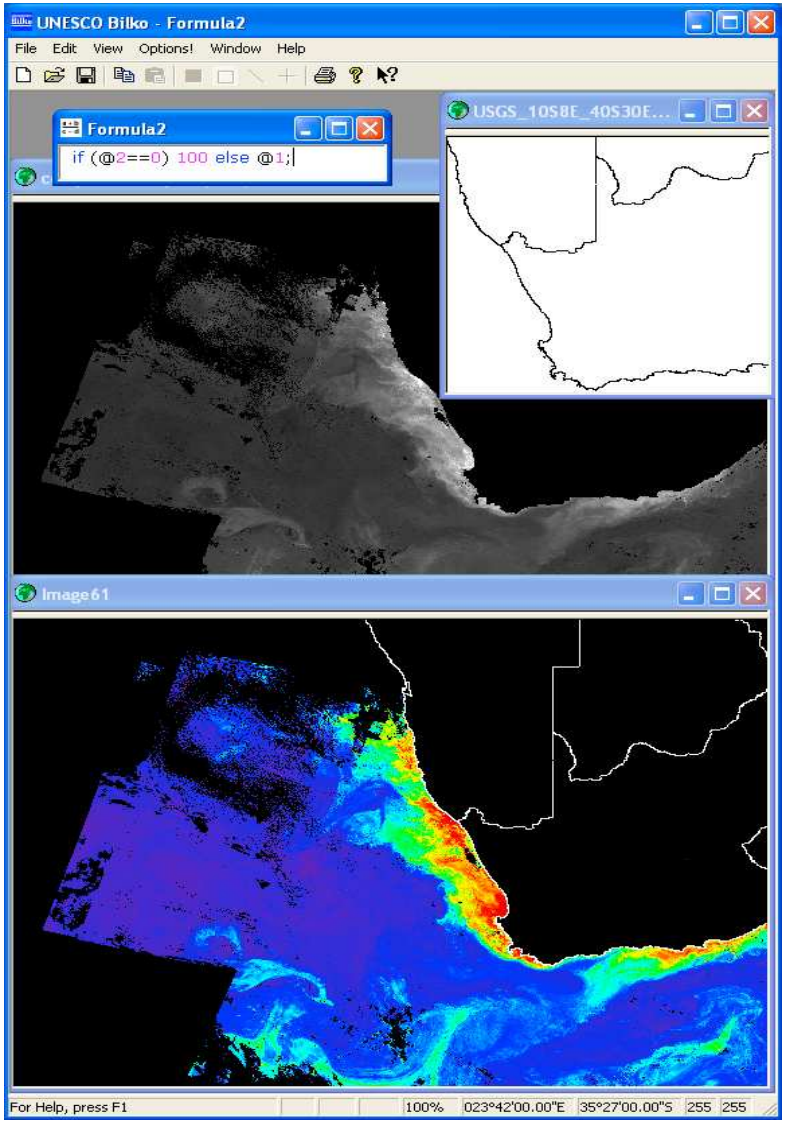
Bilko users

Challenges

Conclusions



Grid

```
# This formula puts two grids onto the image; a grey grid
# (pixel values = 127) spaced at 10 pixel intervals and a white grid
# (pixel values = 255) spaced at 50 pixel intervals. The formulas use
# the mod (modulo) function and are designed for 8-bit images.

# Sets up a 10 by 10 grid in grey

        if (x mod 10 == 0 or y mod 10 == 0) @1 = 127 else @1 = @1 ;

# Sets up a 50 by 50 grid in white (overwrites part of grey grid)

        if (x mod 50 == 0 or y mod 50 == 0) @1 = 255 else @1 = @1 ;
```

- Many different uses:
  - Calculate geophysical parameter values
  - Flags, grids, borders
  - Band ratio algorithms
  - Image mosaics
  - Simple GIS
  - Loops for repeat processing

Principal Component Analysis

- What is Bilko?
- A brief history
- Bilko today:
  - -Software
  - -Tutorials and lessons
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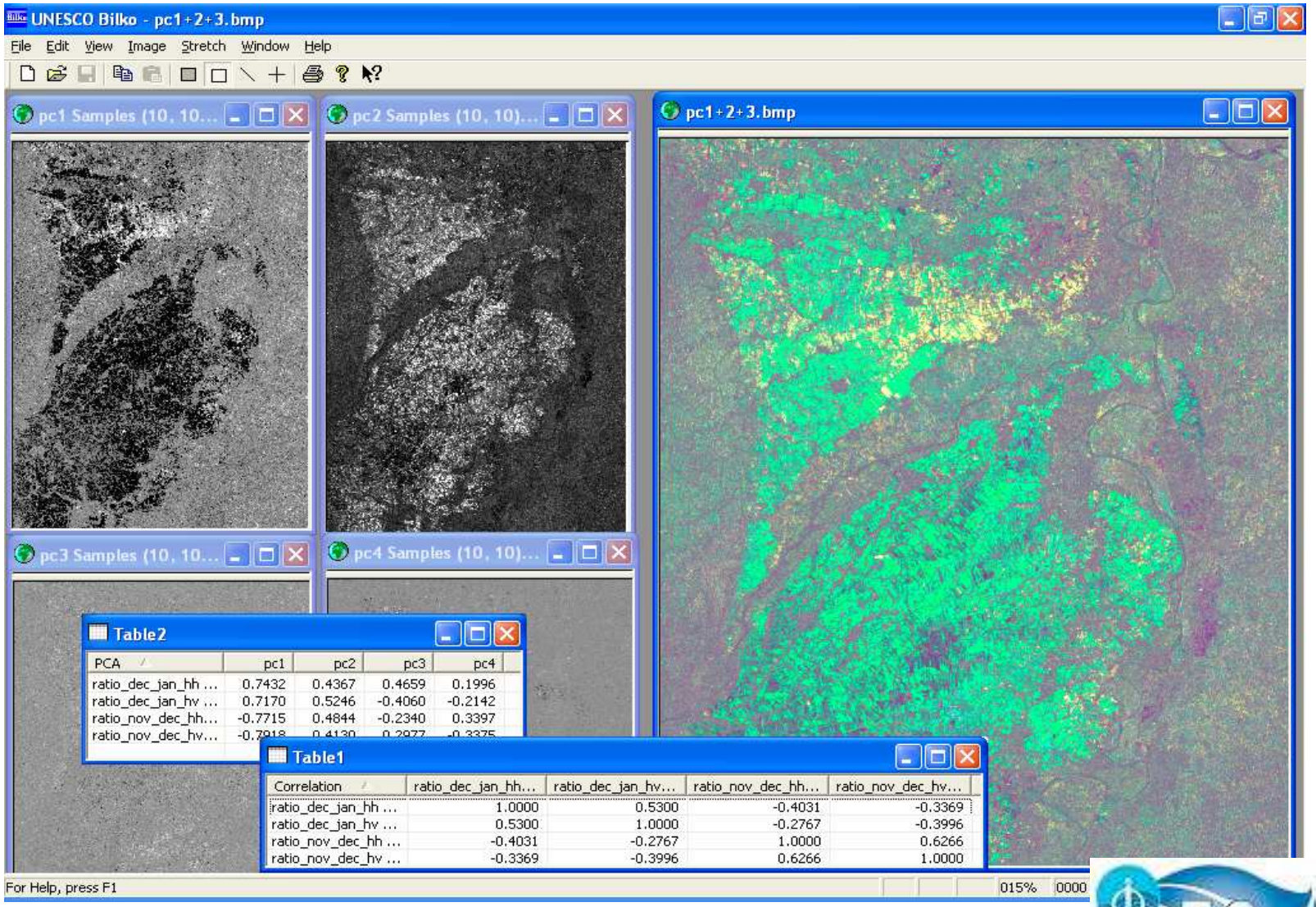
- Challenges
- Conclusions



Classification

- What is Bilko?
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  - -Tutorials and lessons
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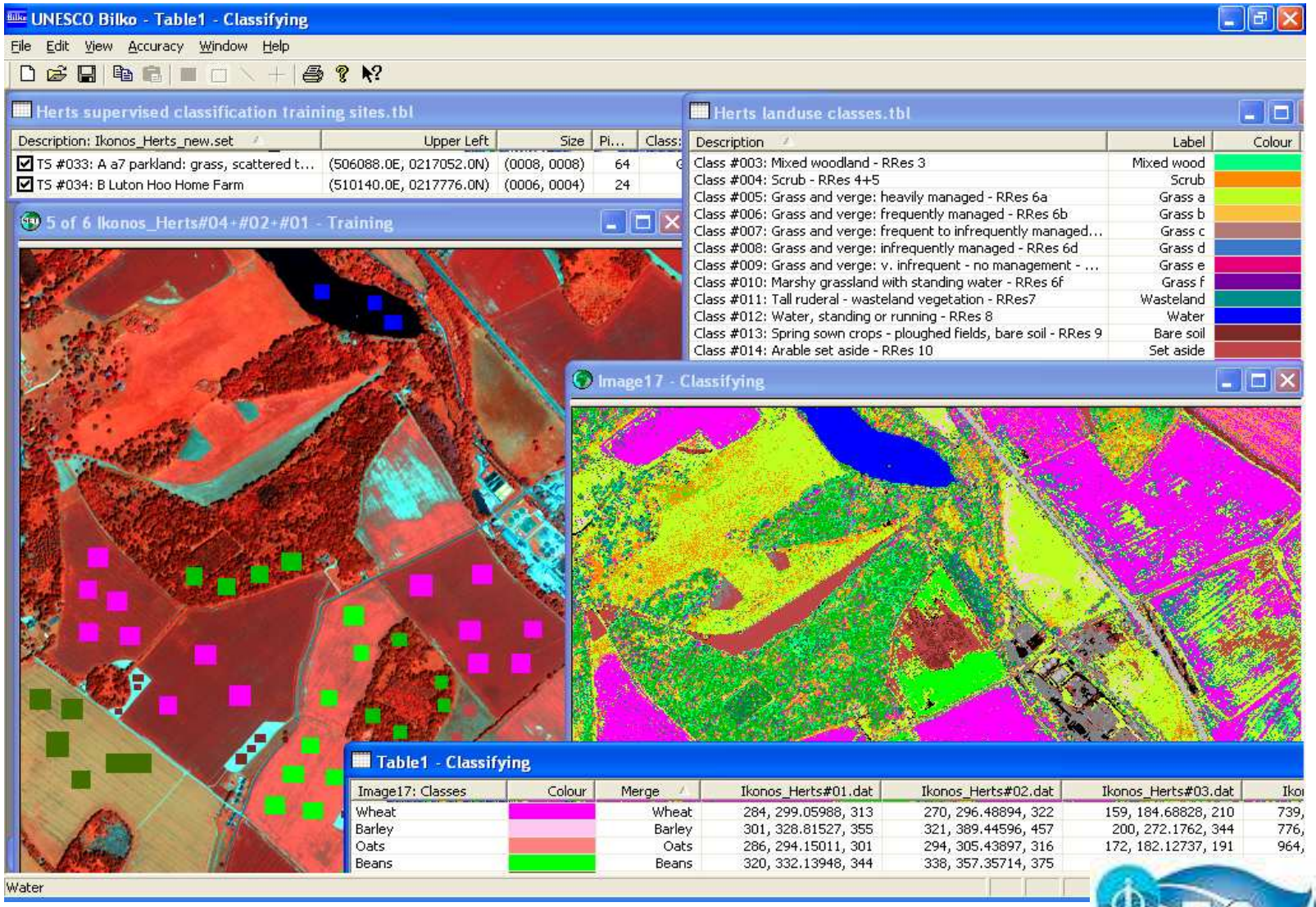

More than just software…

- What is Bilko?
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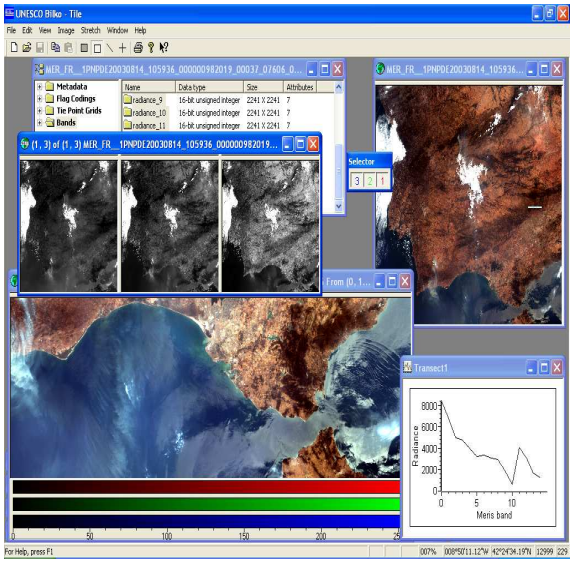
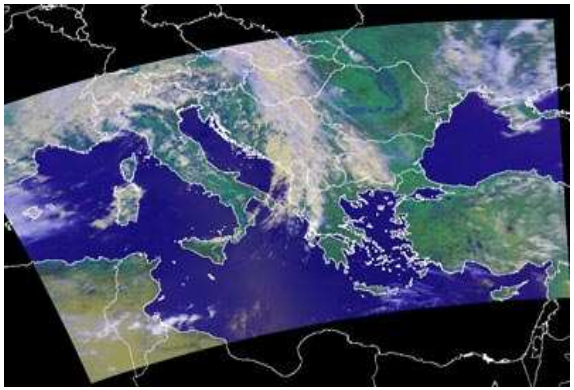
- Conclusions

- A complete training system
  - for teaching and learning RS
- Tutorials supporting software
  - Introduction to Bilko
    - Hands-on experience with **basic** image processing techniques
    - Background information
  - Mini-lessons
    - Demonstrate **advanced** processing & analysis techniques
- Modules / single lessons on coastal and marine applications of RS





Example lesson structure

- What is Bilko?
- A brief history
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- Conclusions

➢ Introduction

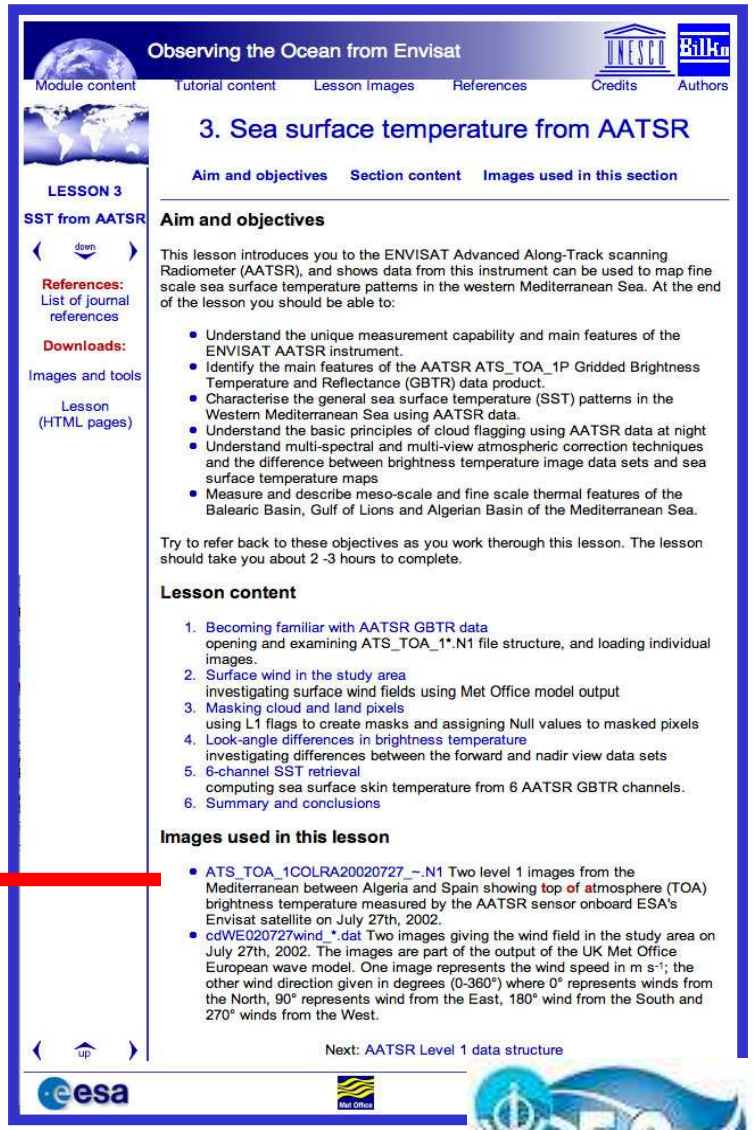
- ❖ Aim and objectives
- ❖ Images used
- ❖ Content overview

ATS_TOA_1COLRA20020727_~.N1

The AATSR data set used in this lesson are stored in an ESA ENVISAT N1 data format generically called ATS_TOA_1P files. This is a custom data format developed specifically for the ENVISAT mission and is self describing. This Bilko for Windows lesson is based on an ENVISAT N1 gridded Brightness Temperature and Reflectance (GBTR) data set and includes geo-referenced 1km nadir and forward view image data sets together with additional metadata and supporting information. The GBTR N1 data product contains the following generic components:

- Metadata: An ASCII format metadata record describing the image data file and its contents.
- Flag Codings: a description of the bitfield flag coding used in the confidence (confide_flags_nadir and confide_flags_fward) and cloud flag (cloud_flags_nadir and cloud_flags_fward) bitfields associated with each nadir and forward view pixel,
- Tie Points Grids: contains gridded geolocation information (equi-spaced every 25km along- and across-track), ENVISAT orbit parameters and sun/satellite viewing geometry
- Bands: contains the full resolution 1km remapped geolocated individual nadir and forward view brightness temperature and reflectance data.

For a full description of AATSR data, see ESA's AATSR user handbook at http://envisat.esa.int/dataproducts/aatsr/



www.unesco.bilko.org

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Shaping the Future of the Oceans and Coasts
St Petersburg, 27 – 30 April 2010

Example lesson structure

- What is Bilko?
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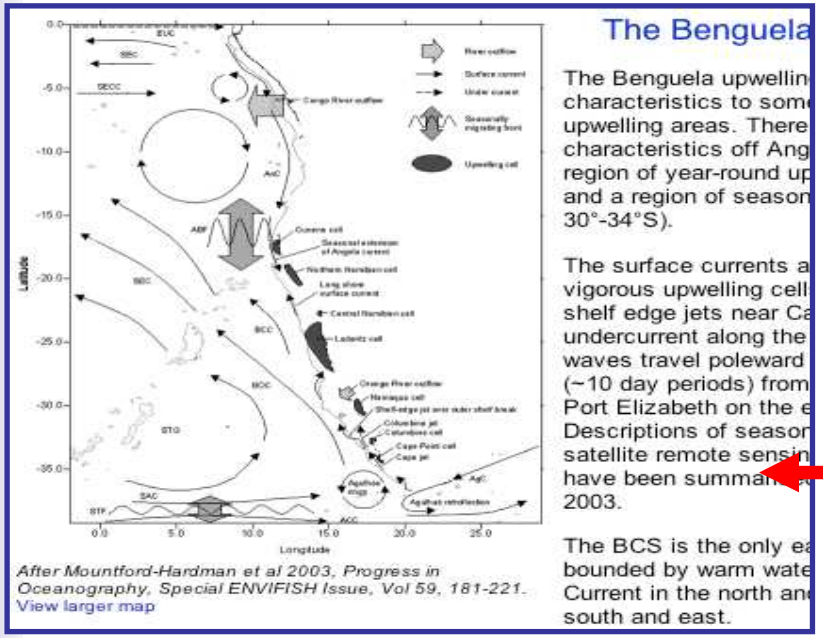
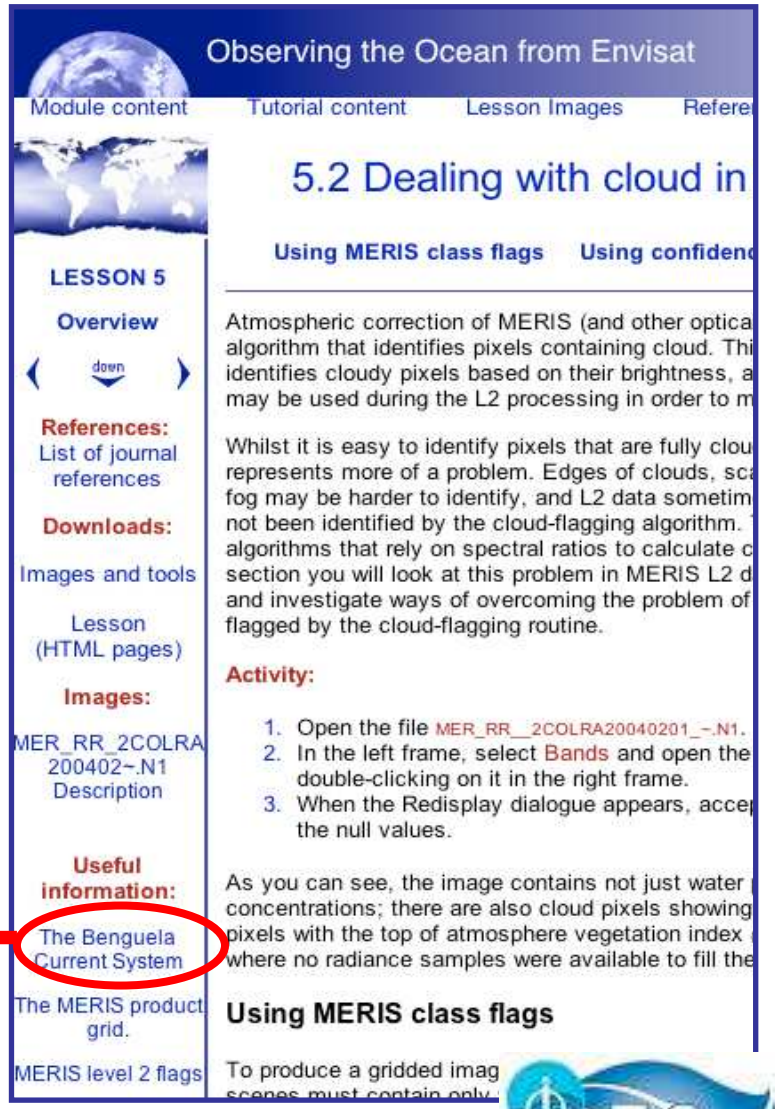
- Conclusions

➢ Introduction

- ❖ Aim and objectives
- ❖ Images used
- ❖ Content overview

➢ Background information





Example lesson structure

What is Bilko?

A brief history

Bilko today:

-Software

-Tutorials and lessons

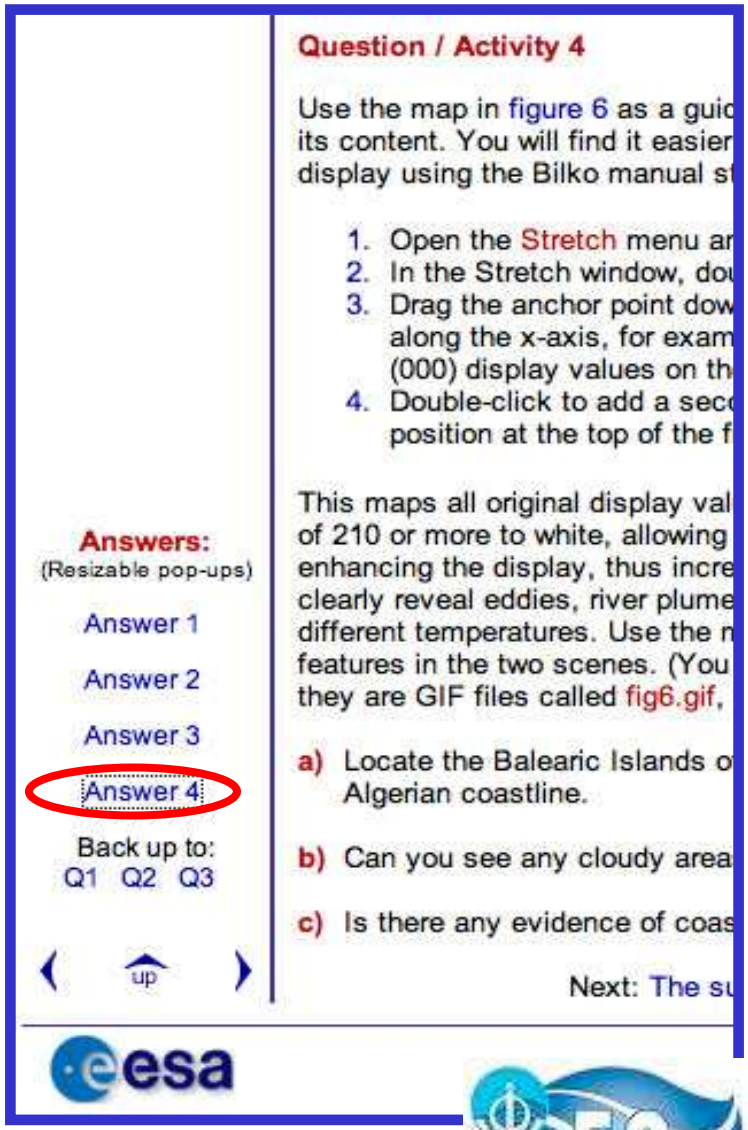
-Web site

Bilko users

Challenges

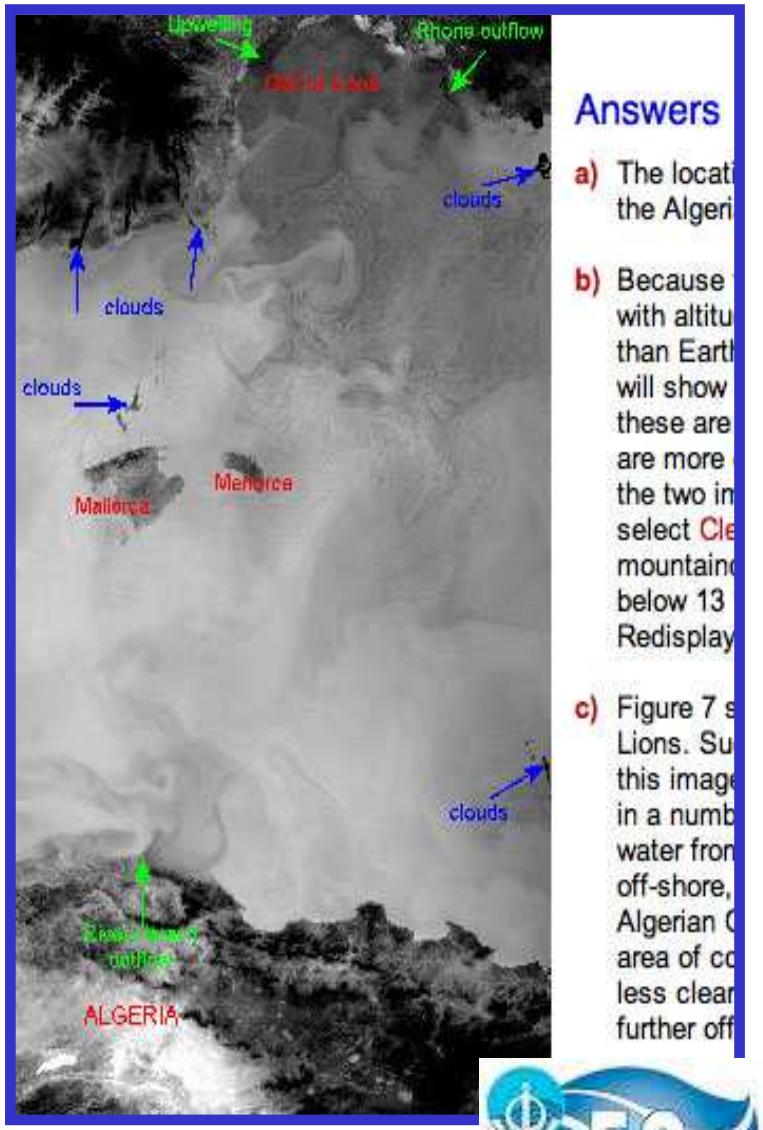
Conclusions

- Introduction
  - Aim and objectives
  - Images used
  - Content overview
- Background information
- Step-by-step instructions
- Questions to test student understanding



Lesson structure

- Introduction
  - Aim and objectives
  - Images used
  - Content overview
- Background information
- Step-by-step instructions
- Questions to test student understanding
- Model answers for those working alone



What is Bilko?

A brief history

Bilko today:

-Software

-Tutorials and lessons

-Web site

Bilko users

Challenges

Conclusions

The Bilko web site

What is Bilko?

A brief history

Bilko today:

-Software

-Tutorials and lessons

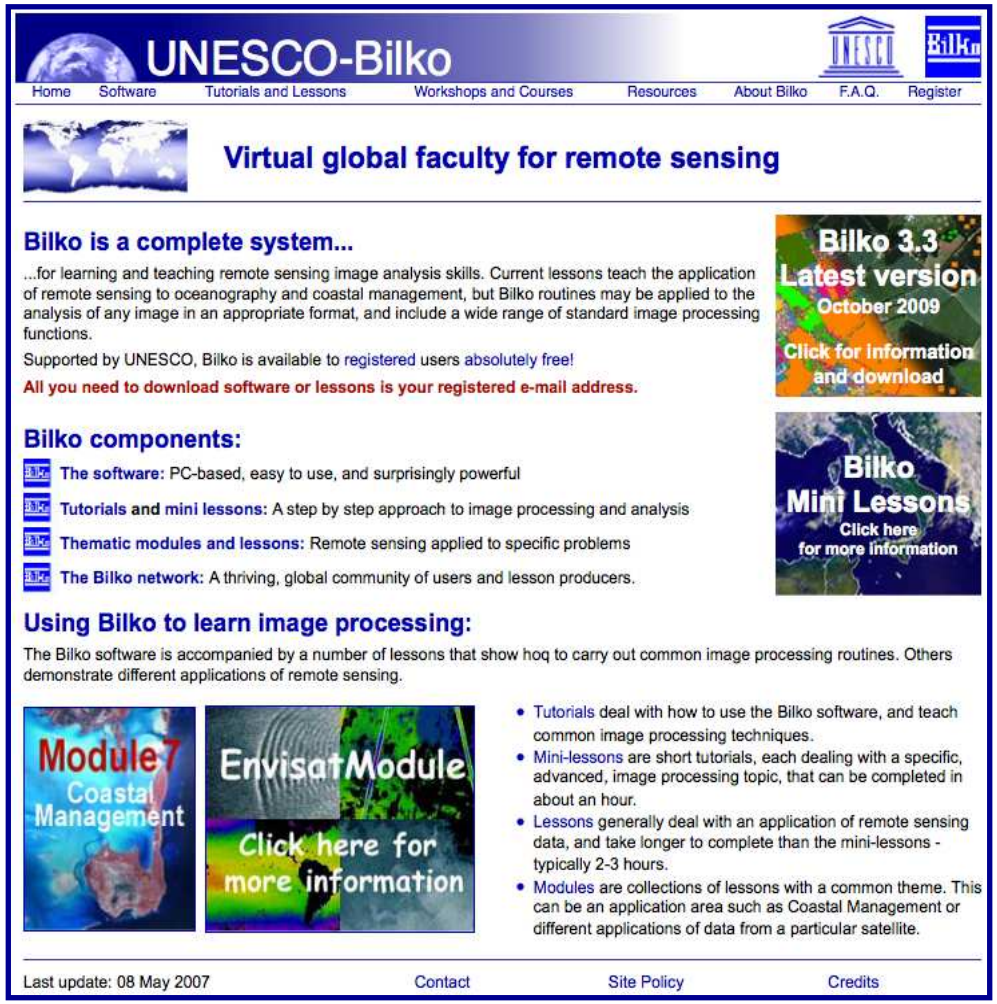
-Web site

Bilko users

Challenges

Conclusions

- Registration
- Downloads
  - Bilko software
  - Lessons
  - Images
  - Tools
- Resources
  - Data sources
  - Further reading



Bilko users

What is Bilko?

A brief history

Bilko today:

-Software

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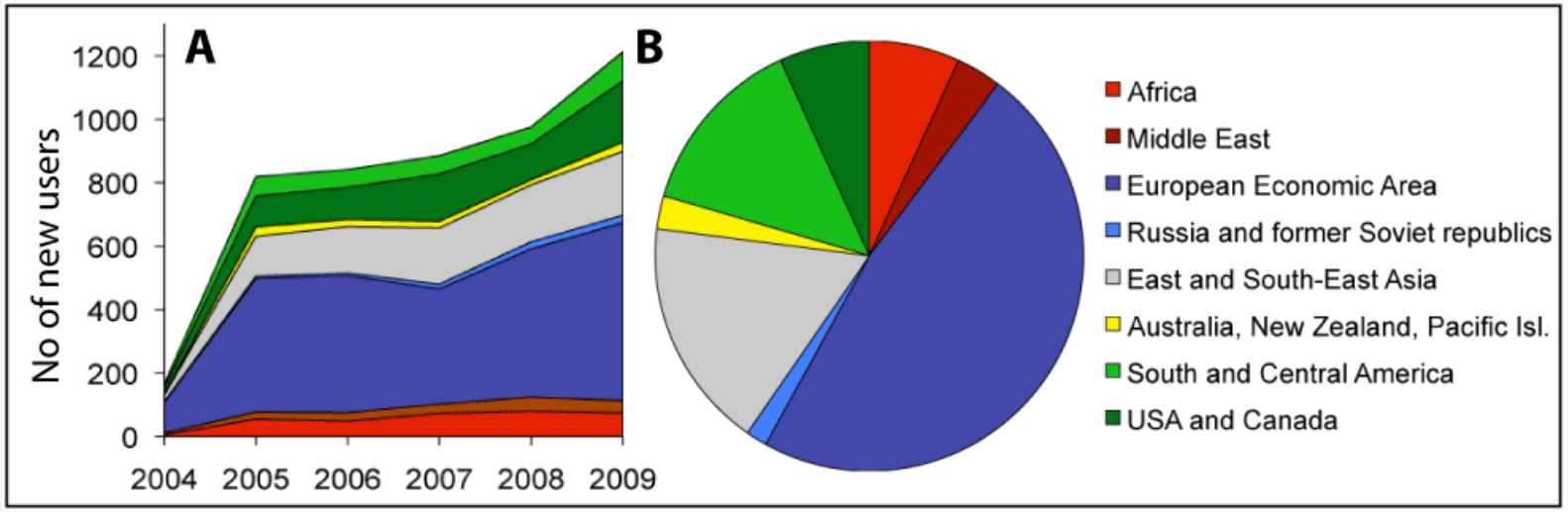
Bilko users

Challenges

Conclusions

Where?

- Over 5200 registered individual users in over 1300 organisations in 168 countries around the world. (*Figures from 31 March 2010*)



Bilko users

What is Bilko?

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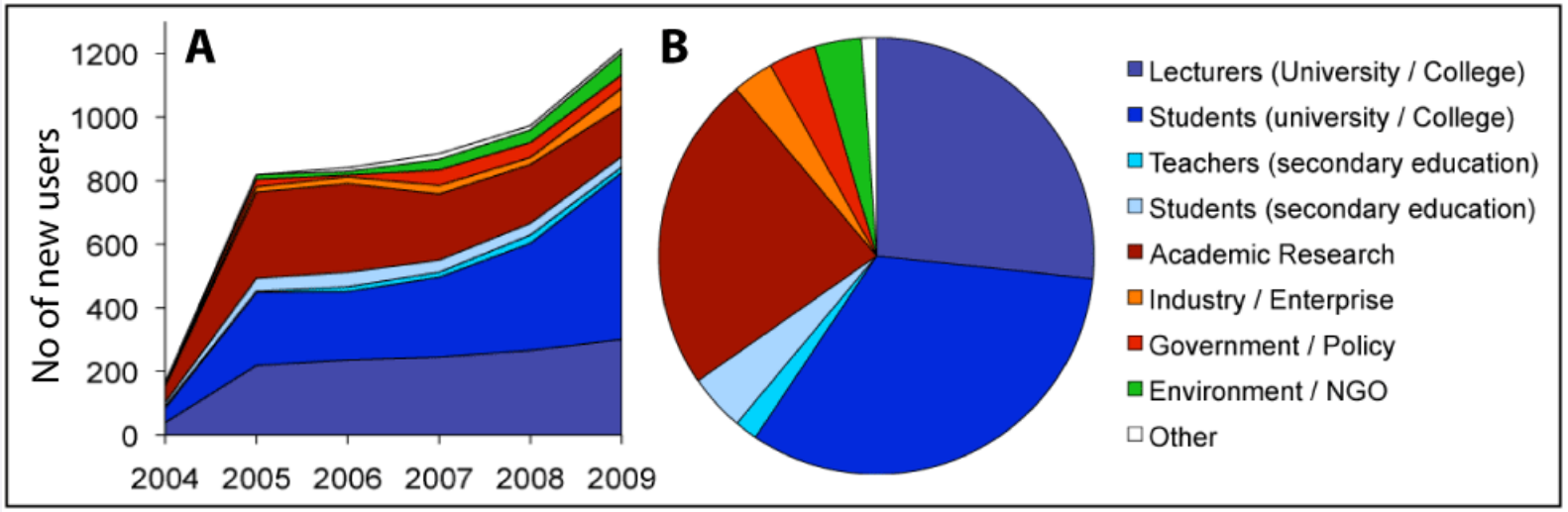
Bilko users

Challenges

Conclusions

➢ Who?

- ❖ Mainly higher education – lecturers and students
- ❖ Nearly ¼ of users in academic research
- ❖ Growing interest from non-academic sectors



Wide use as training tool

What is Bilko?

A brief history

Bilko today:

-Software

-Tutorials and lessons

-Web site

Bilko users

Challenges

Conclusions

MSc students testing a new Bilko lesson

African participants in ESA Tiger workshop

WIOMSA training course in altimetry, 2004

- University courses at BSc and Master level
  - UK students often help to test new software versions and lessons before wider release
- Advanced training and professional development workshops
  - 1 – 2 week courses providing training in specific applications
  - New lessons for some courses
  - Essential feedback on software and lessons
  - Help to set priorities for Bilko development

Wide use as training tool in Russian

IOC UNESCO CHAIR - RSHU

Ground works, 2007- 09:
Coastal zone erosion studying

- What is Bilko?
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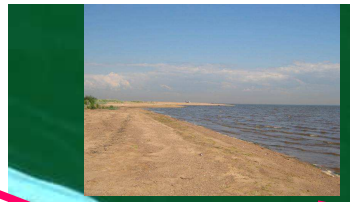
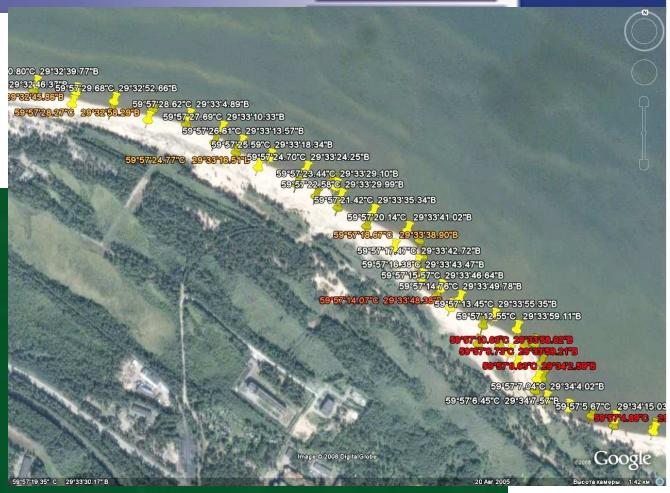

Photos Georgy Gogoberidze

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Wide use as training tool in Russian

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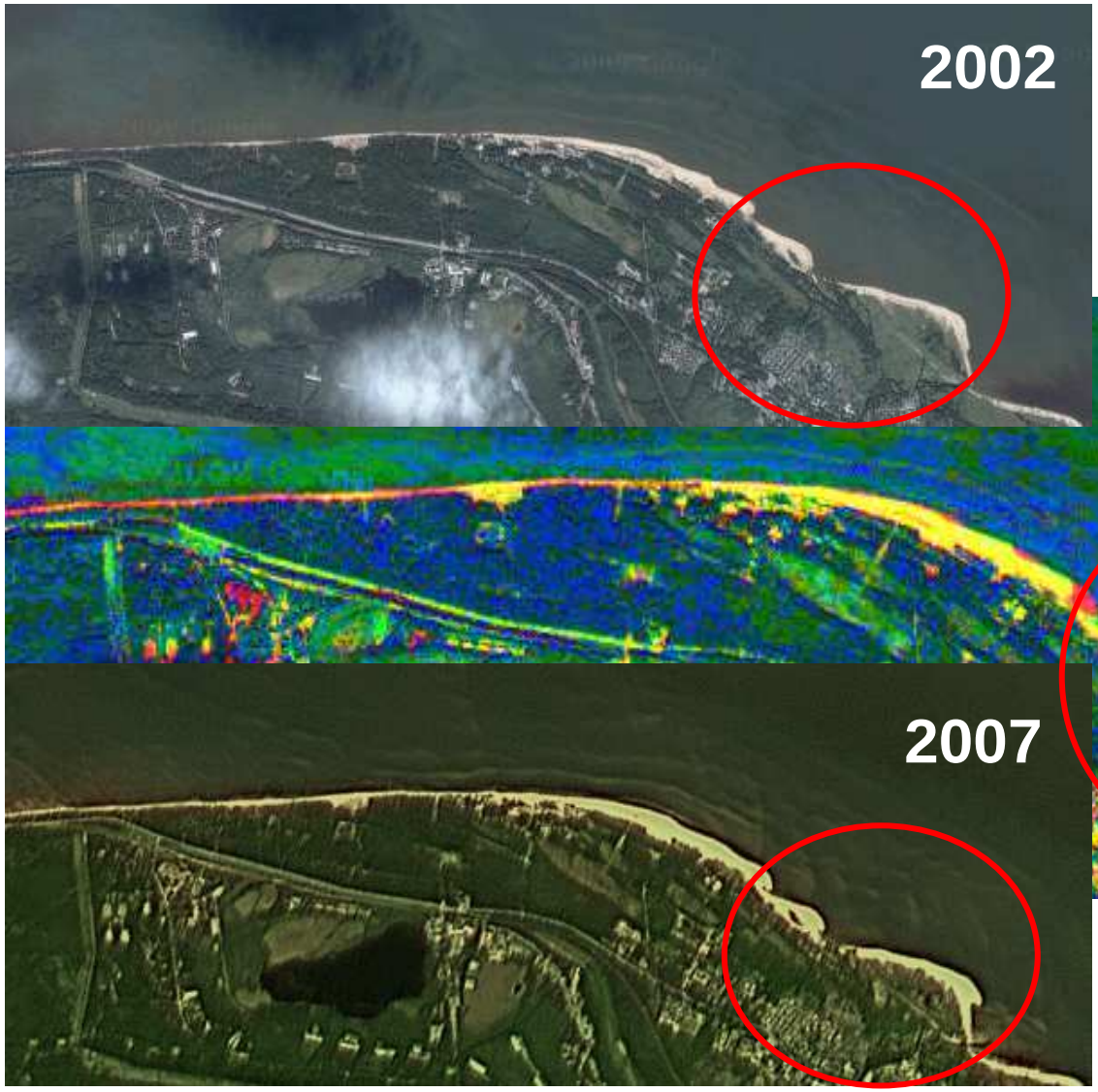

IOC UNESCO CHAIR - RSHU

Results of ground works at the test sites compared with remote sensed data:

Coastal line changes, evolution of sand accumulative body

Wide use as training tool in Russian

Concentrations of resuspended materials in the Eastern part of the Gulf of Finland, 12 September 2006, Terra MODIS imagery.

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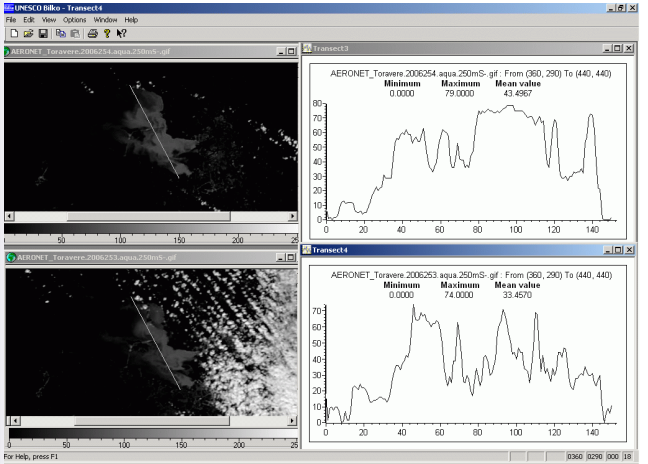

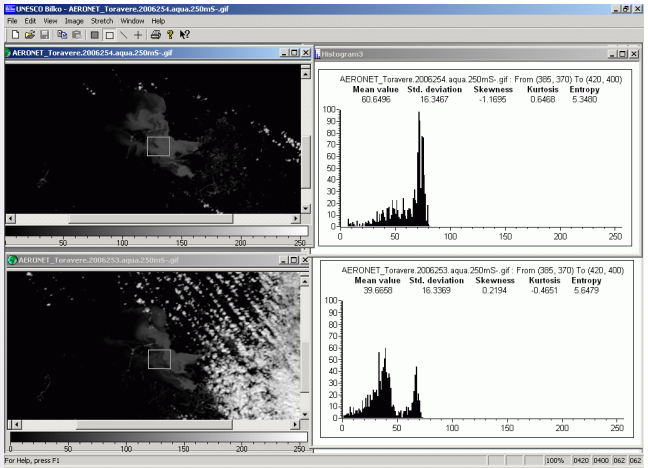

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European Space Agency Summer School

What is Bilko?

A brief history

Bilko today:

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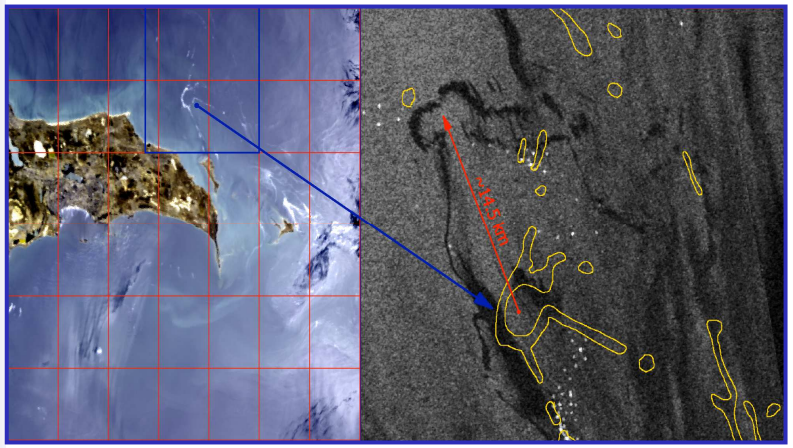
Bilko users

Challenges

Conclusions

~80 PhD students and post-docs at ESA summer school use Bilko for five half day sessions, and provide valuable feedback.



New lesson on **oil spill monitoring** using SAR / optical sensors to be tested in 2010

- 2004, 2006, 2008:
  - Testing and review of the Bilko Envisat module
  - Student feedback lead to improvements before distance learning release
- 2010:
  - ESA staff help with new lesson development
    - Sourcing images
    - Review and testing
  - Two new lessons:
    - Oil spill monitoring
    - Indian ocean dipole

Zanzibar workshop 2007

What is Bilko?

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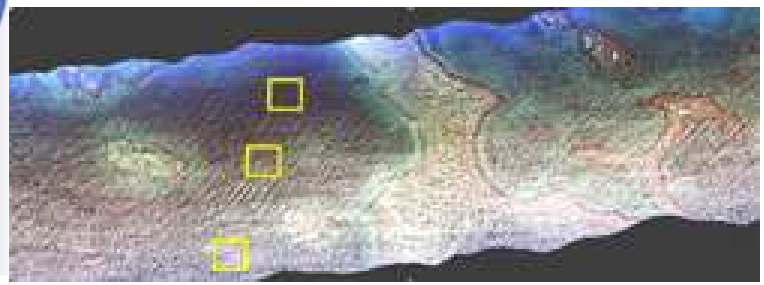

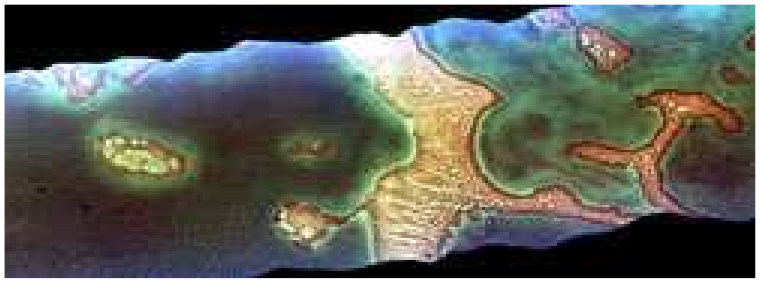

Participants of WIOMSA/CRTR workshop on monitoring of coral reefs on a ground-truthing field trip to Chombe Island.

- **Training:**
  - Geometric and water column correction of images,
  - Removal of sun glint (right),
  - Supervised classification of coral reef habitats
- **Positive feedback:**
  - Intuitive nature of Bilko
  - Easy to use supervised classification routine
  - Potential alternative to costly mainstream RS packages
- **Wish list:**
  - More classification algorithms
  - Export to GIS

Workshop contributions to Bilko

What is Bilko?

A brief history

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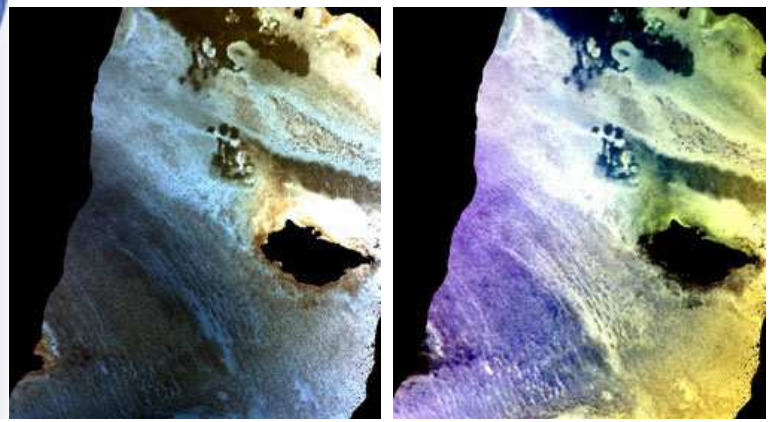
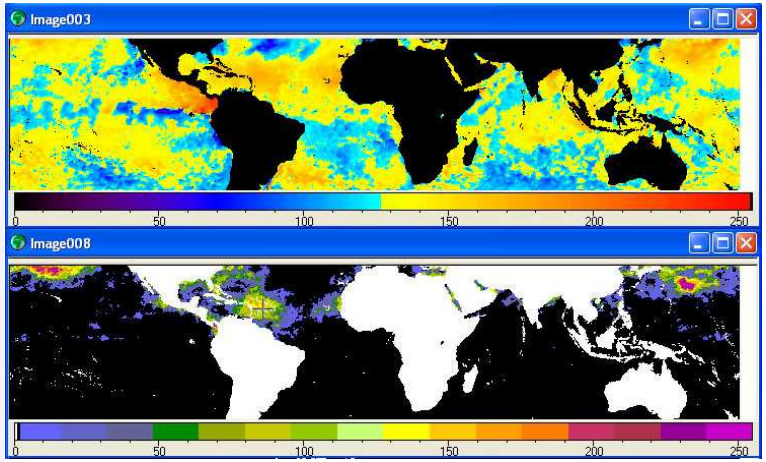


Extension and improvement to Module 7: image correction for variable water depth.



New lesson on coral bleaching developed after the Zanzibar workshop on coral reefs.

- New lesson development
  - Detailed feedback and ideas for improvements to existing modules
  - Access to local expertise and new regional examples for use in new lessons
  - Inspiration for participants to become Bilko authors
- Help set priorities for soft-ware development
  - Feedback on software utility
  - Ideas for improvements to existing routines
  - Wish list for new facilities

Ocean Colour Africa

What is Bilko?

A brief history

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-Web site

Bilko users

Challenges

Conclusions

- Lectures by world experts
  - Principles of ocean optics
  - Algorithms and products
  - Key application areas:
    - Chlorophyll, primary productivity, fisheries
    - Water quality: suspended sediment, algal blooms
- Hands-on training:
  - Several software packages:
    - Specialist NASA/ESA ocean colour software: SeaDAS, Beam
    - Bilko for statistical analysis and comparisons with SST
  - Feedback on Bilko: useful general software suitable for non-specialists

Challenges

- Important achievements in the last 25 years
  - Large number of users in research and education
  - Global user base, wide use in courses / workshops
  - Increasingly used as a non-specialist research tool
- But..
  - Remote sensing and computer technologies are continuously updated, upgraded and improved.
  - **Bilko software and lessons need to keep up with current developments in order to remain a useful tool.**

What is Bilko?

A brief history

Bilko today:

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-Web site

Bilko users

Challenges

Conclusions

Challenges: software

What is Bilko?

A brief history

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Bilko users

Challenges

Conclusions

- Greater processing capacity
  - Larger images: higher spatial resolution, greater accuracy, wider dynamic range, more bands
  - Longer time series, increasing temporal cover
- Some changes may be achieved by incremental improvements
  - Support for some of the new data formats
  - New processing routines on user wish lists
- But some essential new developments require major, concentrated effort
  - Making Bilko **fully** compatible with Window 7
  - 64-bit version of Bilko to increase working memory and obtain better accuracy of statistical tools

Challenges: lesson development

What is Bilko?

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Bilko today:
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Bilko users

Challenges

Conclusions

- Lessons for new data products
- Increase geographical spread of examples
  - **Local examples** needed for all IOC priority areas
- Possible solution:
  - **Recruit** local experts as Bilko authors to develop lessons based on case studies from their research,
  - Requires **support** for new Bilko authors, more effort on student testing and scientific review

Conclusions

What is Bilko?

A brief history

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Challenges

Conclusions

- Bilko has succeeded in its original aims
  - Free Bilko software and lessons are widely used
  - Long track record of supporting workshops and courses
- Recent updates has made Bilko a useful tool
  - Valuable resource for training and education,
  - Increasingly seen as a research tool for professional users that are not primarily remote sensing experts.
  - Valuable contribution to IOC's remote sensing strategy
- Challenge for the future:
  - Being seen as a potential alternative to commercial image processing systems demands a continuous development of Bilko software and tutorials that may be hard to meet without increased resources

Спасибо за внимание.

Thank your for your attention.

Merci pour votre attention.

Danke für die Aufmerksamkeit.

Есть ли вопросы?

Any Questions?

Vos questions?

Ob es die Fragen gibt?