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• Comisión
Oceanográfica
Intergubernamental

• Межправительственная
океанографическая
комиссия

R&D Project for improved Storm Surge Application: ESA Storm Surge Project

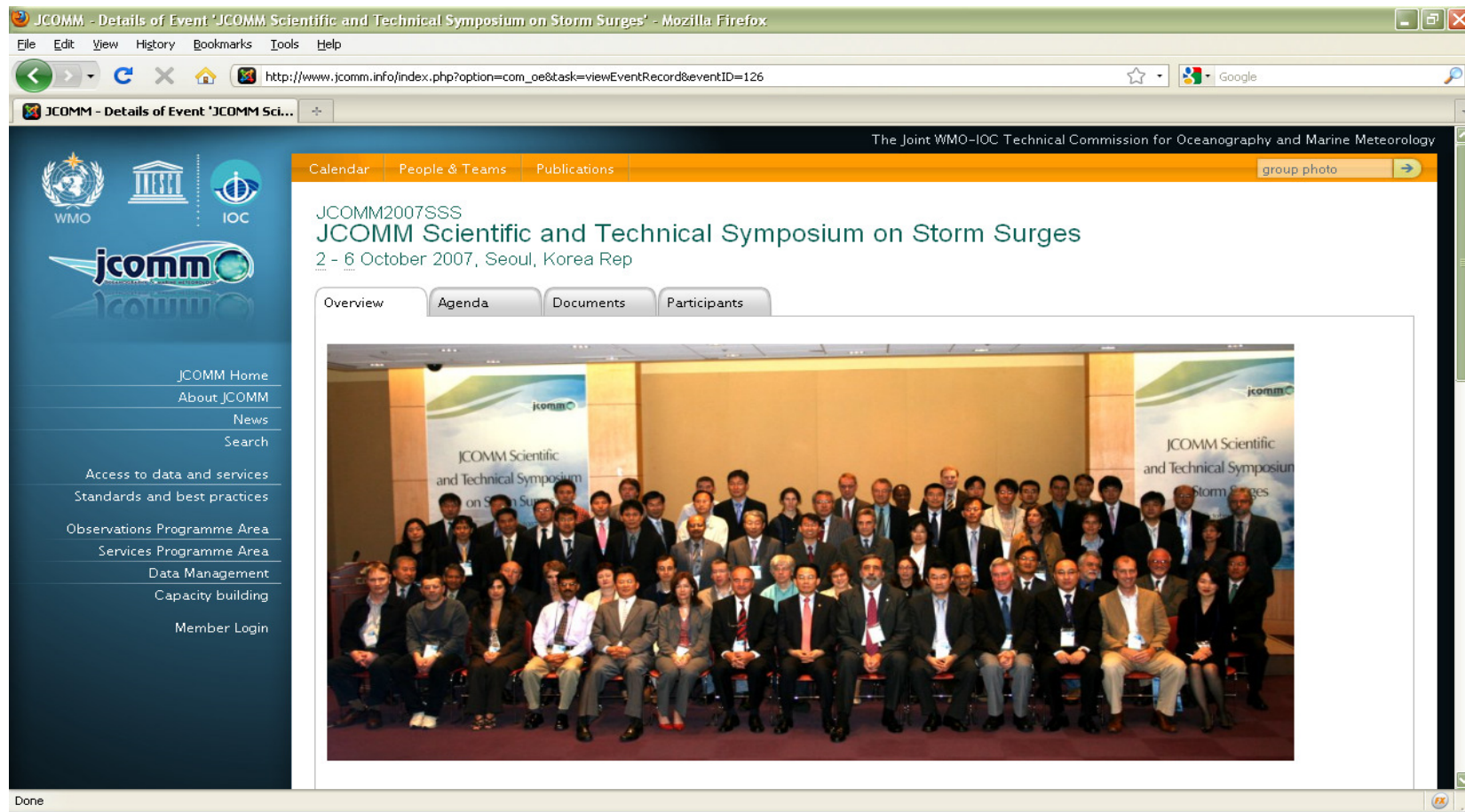
Boram Lee (b.lee@unesco.org)

IOC of UNESCO

18 May 2010, JCOMM ETWS

Basis: Storm Surge Symposium (2007, Seoul)

<http://www.surgesymposium.org>



Storm Surge Symposium Recommendations

<http://www.surgesymposium.org>

Future R&D – improving model predictability

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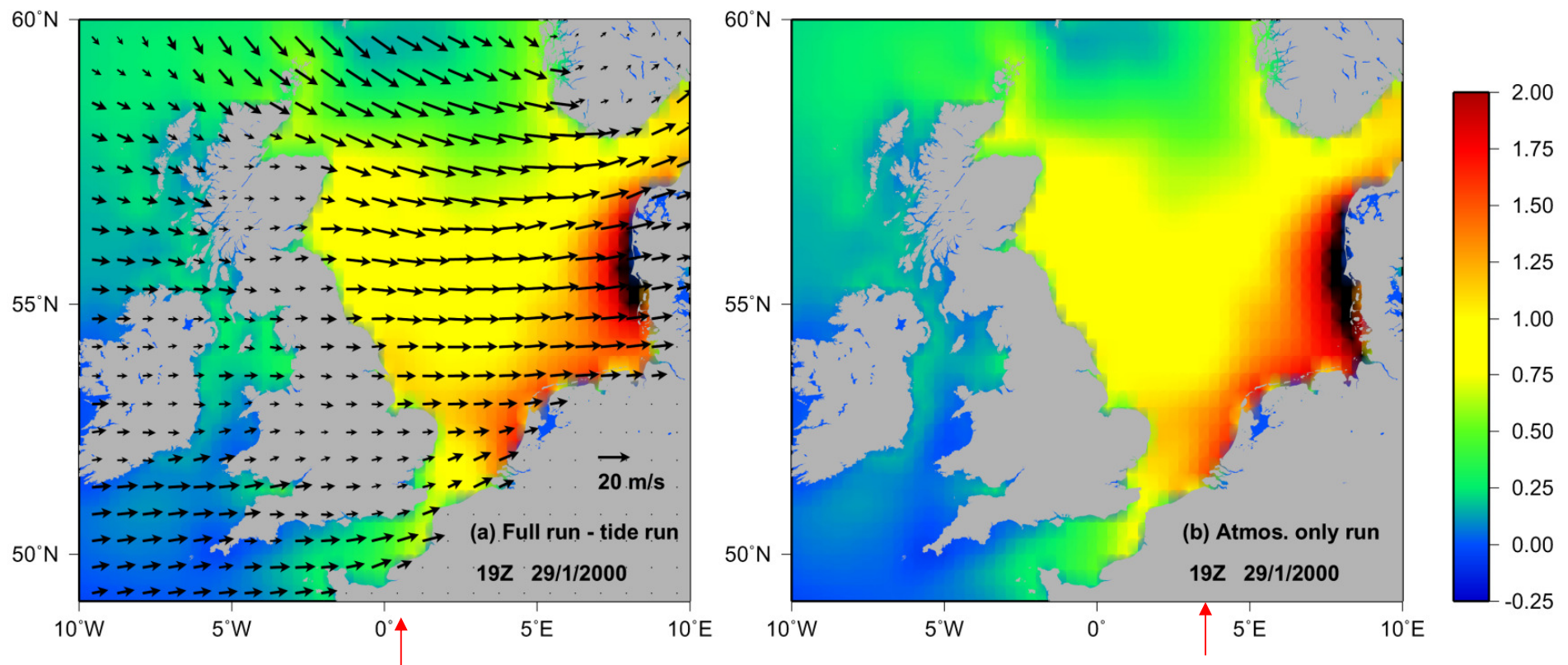
- Improved physics and physical processes in the models; e.g. wave/current and wind/current interactions
- Research on mesoscale wind-forced and remotely-forced inundation events
- Studies of model sensitivity to spatial / temporal resolution for specific locations
- Ensemble modeling techniques
- Further development of empirical techniques; e.g. AI, neural networks, statistical
- Study on effectiveness of wetland and island barrier restoration in surge and wave attenuation
- More research to understand the cause of deviations from normal predictions and forecast failures (case studies)



Example: combined forcing

(CS3 operational model: surge of 29 January 2000)

K. Horsburgh, 2007SSS



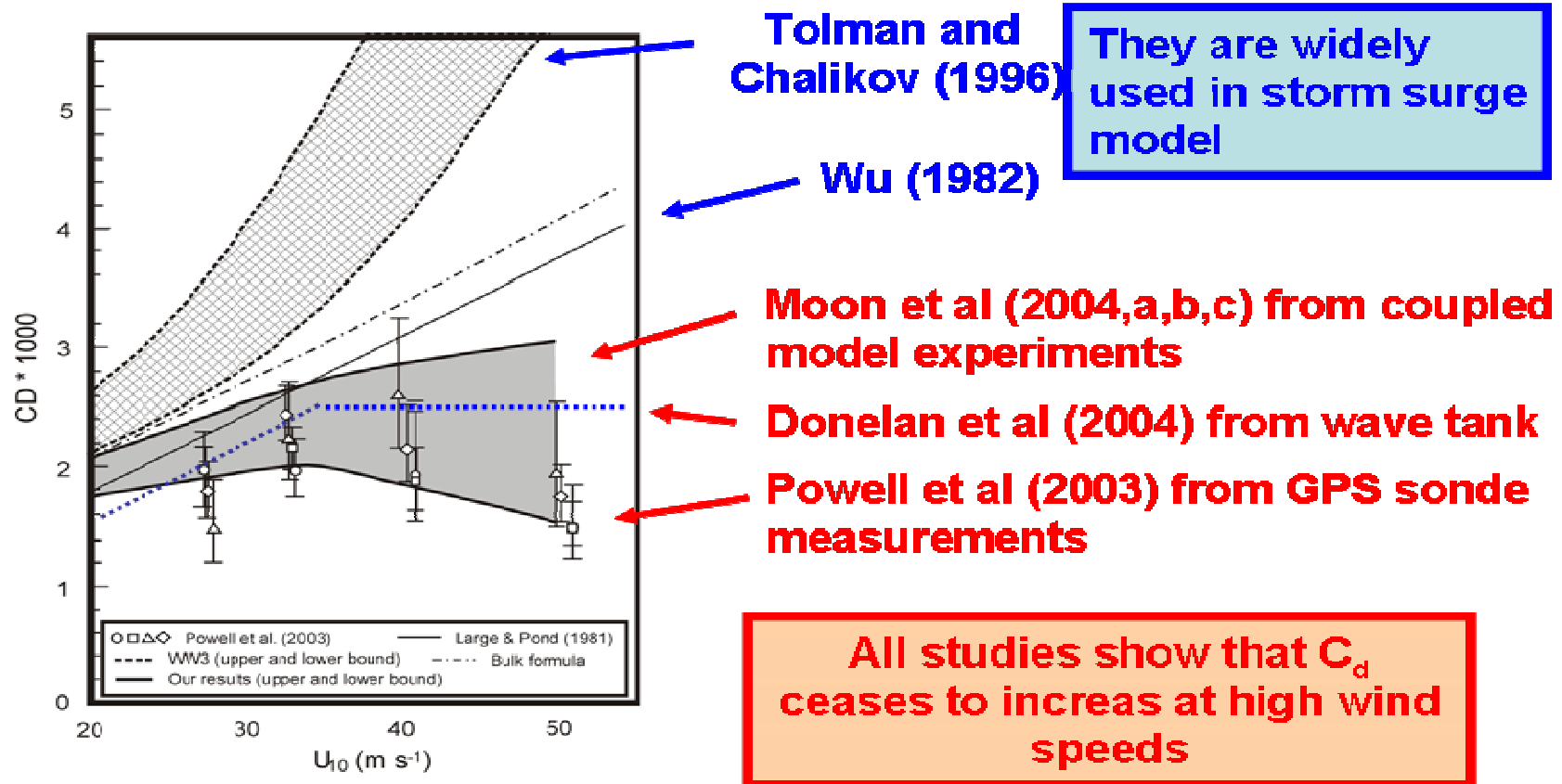
Atmosphere & tide

Atmosphere only

Example: Wind Stress simulation

(Comparison of C_d under hurricane conditions)

- I.J. Moon, 2007SSS



Storm Surge Symposium Recommendations

<http://www.surgesymposium.org>

Observations & Data

...

- High resolution, near shore, bathymetric data sets
- High resolution bathymetric and coastal zone topographic data from satellite
- Documentation of satellite earth observation data requirements for storm surge modeling and forecasting; e.g. scatterometer, ASAR, altimeter, nearshore monitoring
- Assessment and evaluation of the accuracy and value of satellite data for storm surge and wave modeling and forecasting
- Monitor coastal flooding by remote sensing
- Global access to existing storm surge data sets, perhaps through a storm surge metadata catalogue; Development of interoperable storm surge databases and climatologies

...



Case: Data Requirement in NIO region

- In advance to the surge event:
Shoreline geometry, bathymetry, coastal elevation
 - Bathymetry on continental shelf areas on a horizontal resolution of 5 m, a vertical resolution of 0.5 m, updated on a decadal time scale.
- During the surge event (**updated in real time**):
 - high resolution near shore wind fields
 - high resolution near shore wave fields
 - high resolution near shore river mouth areas such as the Godavari
- After the surge event:
Days of inundation, extent, depth and duration
 - surface water levels (at least 1 minute average values, or better, of 5 m, a vertical resolution of 0.5 m, updated on a decadal time scale)
 - surface pressure gauges, at least pressure, deployed in advance of a scale
 - surface currents
 - Manual surveys of inundated areas, with in person interviews
 - sea surface temperature, vertical temperature profiles, sea surface
 - **Satellite images of inundated regions**
 - **Information collected over periods ranging from a few hours after the storm to several days depending on the rate of retreat of the water. Horizontal resolution required is 25 m; 10 m if satellite images available**

In-situ observations (tide gauges, buoys)

Shoreline station obs.

Radars (HF, Doppler...)

Dropsondes, aircraft obs.

Satellite altimeter (winds, waves, water levels)

Scatterometer (wind)

NWP



Storm Surge Symposium Recommendations

<http://www.surgesymposium.org>

Support Operation

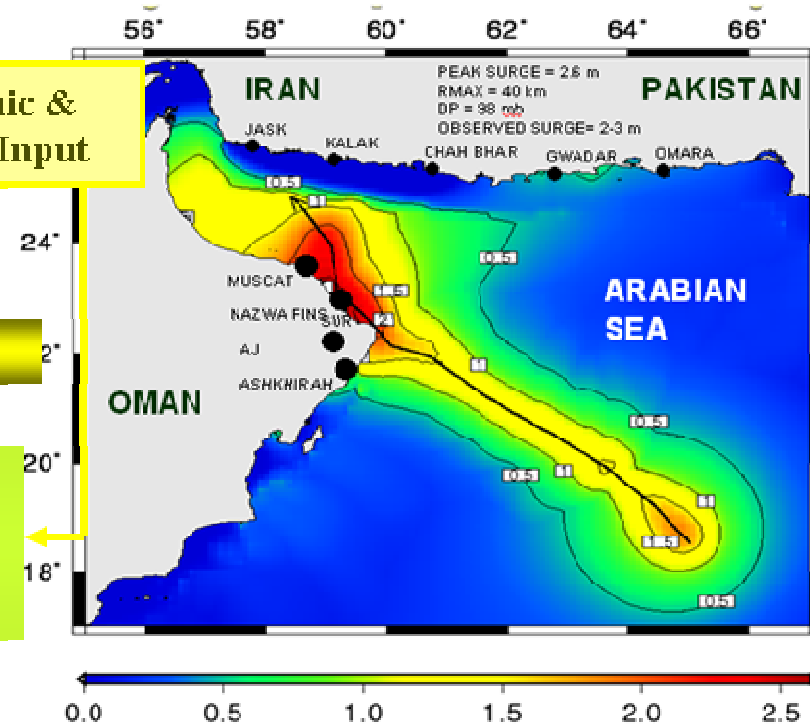
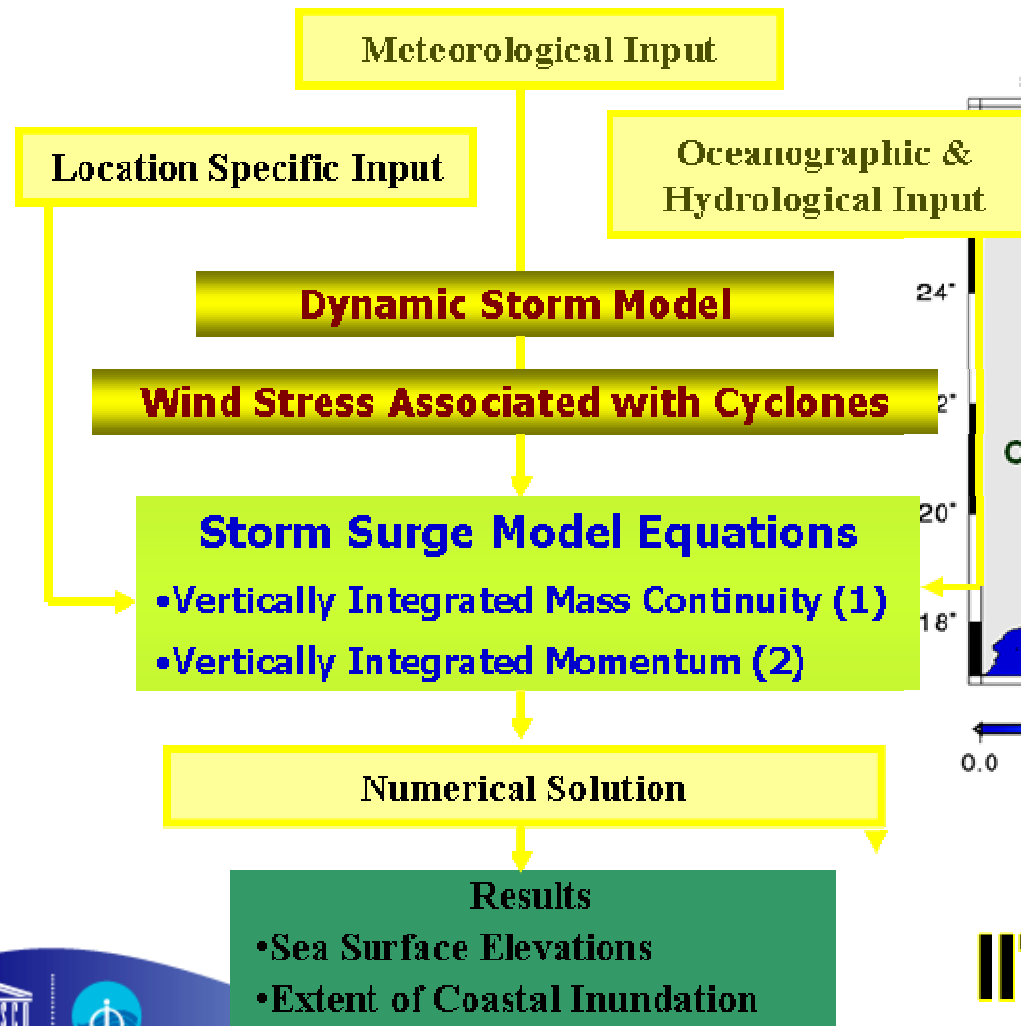
...

- Downscaling of existing high resolution, integrated models for a range of practical applications
- Investigate improved means to incorporate uncertainty into forecast guidance
- Assess appropriate ensemble techniques for forecasting
- Support for “community models”, for use by smaller countries and as capacity building tools
- Provide inventory and description of inundation models
- Develop better visualization tools
- Adopt appropriate resolution models, based on sensitivity assessments and subject to data availability and requirements

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Example: NIO Community Model



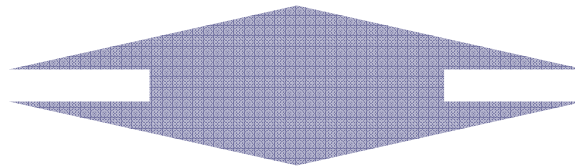
(Peak surge envelope, 2007 Gonu)

IIT D Model

Improved Storm Surge Application

2007 SSS

Future Research and Development
Research to operation
Observations and Data

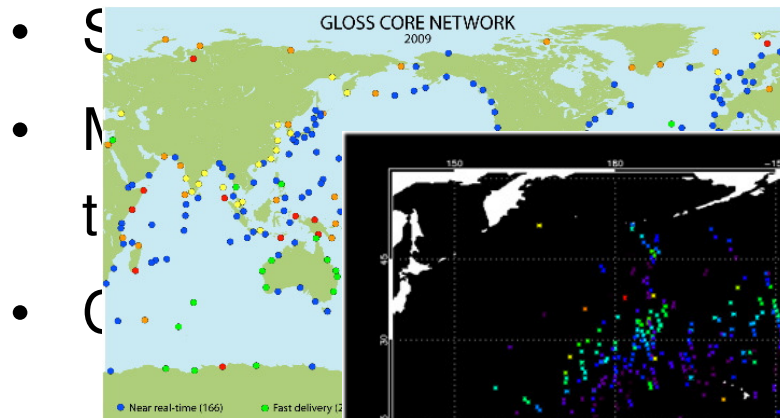


System Improvement

Monitoring sea/coastal status
Analysis and Forecasting
Risk Assessment and Management
Capacity Building and Outreach

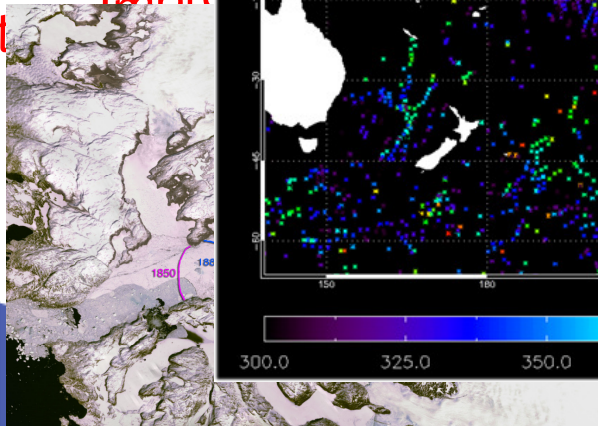
Monitoring Sea/Coastal Status

- Sea Level and Tides



www.ioc-sea-level-monitoring.org

System



Remote sensing

- practical & ocean/climate science applications
- precise features of the oceans' surface (waves, particularly storms and tsunamis)
- height hazard warning
- salinity field

Challenges:

• lack of temporal/ spatial coverage (particularly in the

Mediterranean)

• sea level reference, archive, dissemination

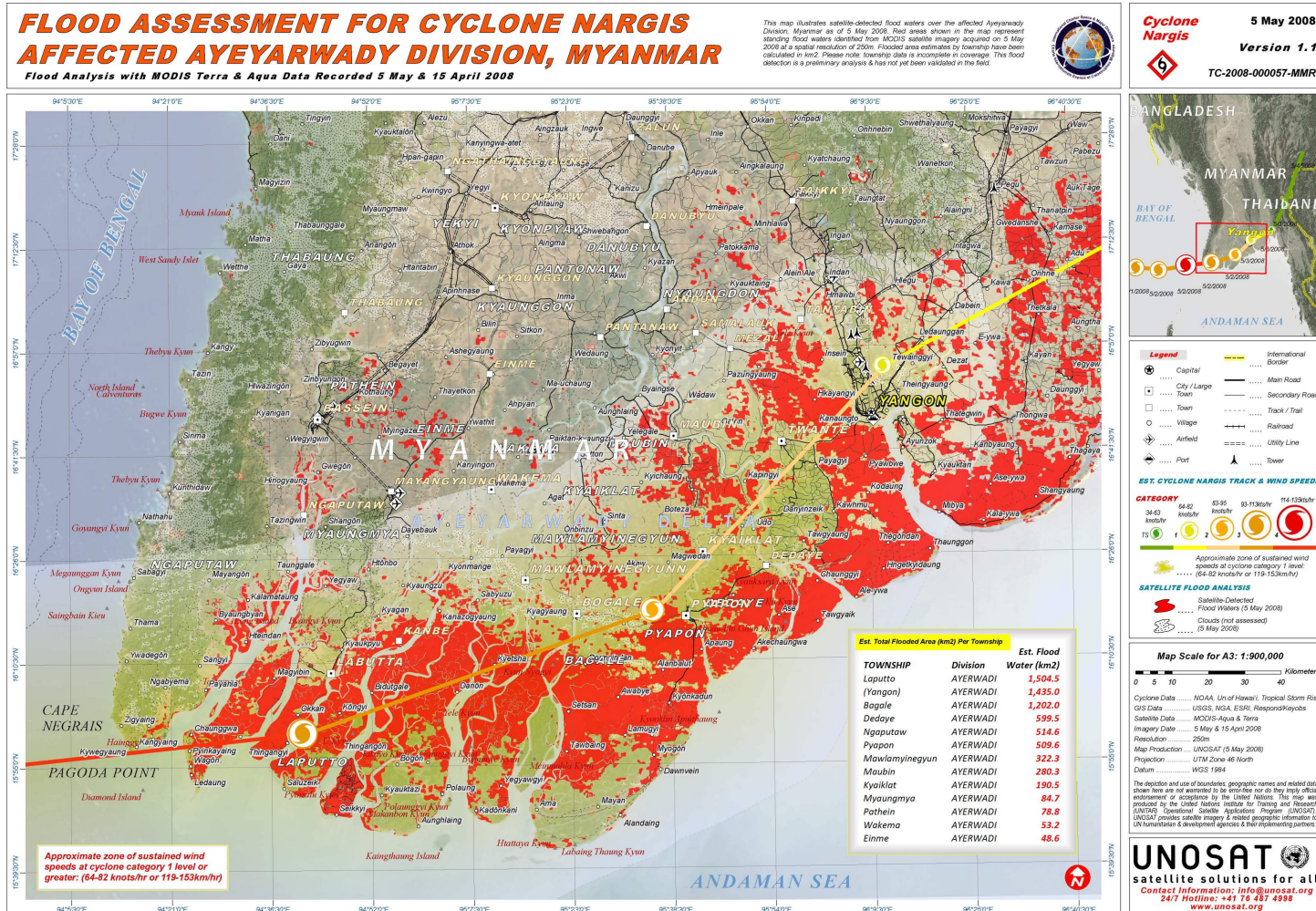
• need for high frequency

Analysis & Forecasting

- “Better forecasting/products comes from **higher resolution data**, both spatially and temporally, for more parameters, encompassing not only the **oceanographic** aspects, but also **hydrographical, topographical, hydrological** as well as **meteorological**.”
- Improvements from forecast models can also be achieved from
 - Improved physical process (e.g. wave-current-wind interactions)
 - Improved initial conditions (data assimilation)
 - Quantification of uncertainty (ensembles)
- **System Improvement** Total Water Level forecasting (Steric height changes, coastal trapped waves, Surges and other wind waves, Tides + coupling with hydrologic models...)

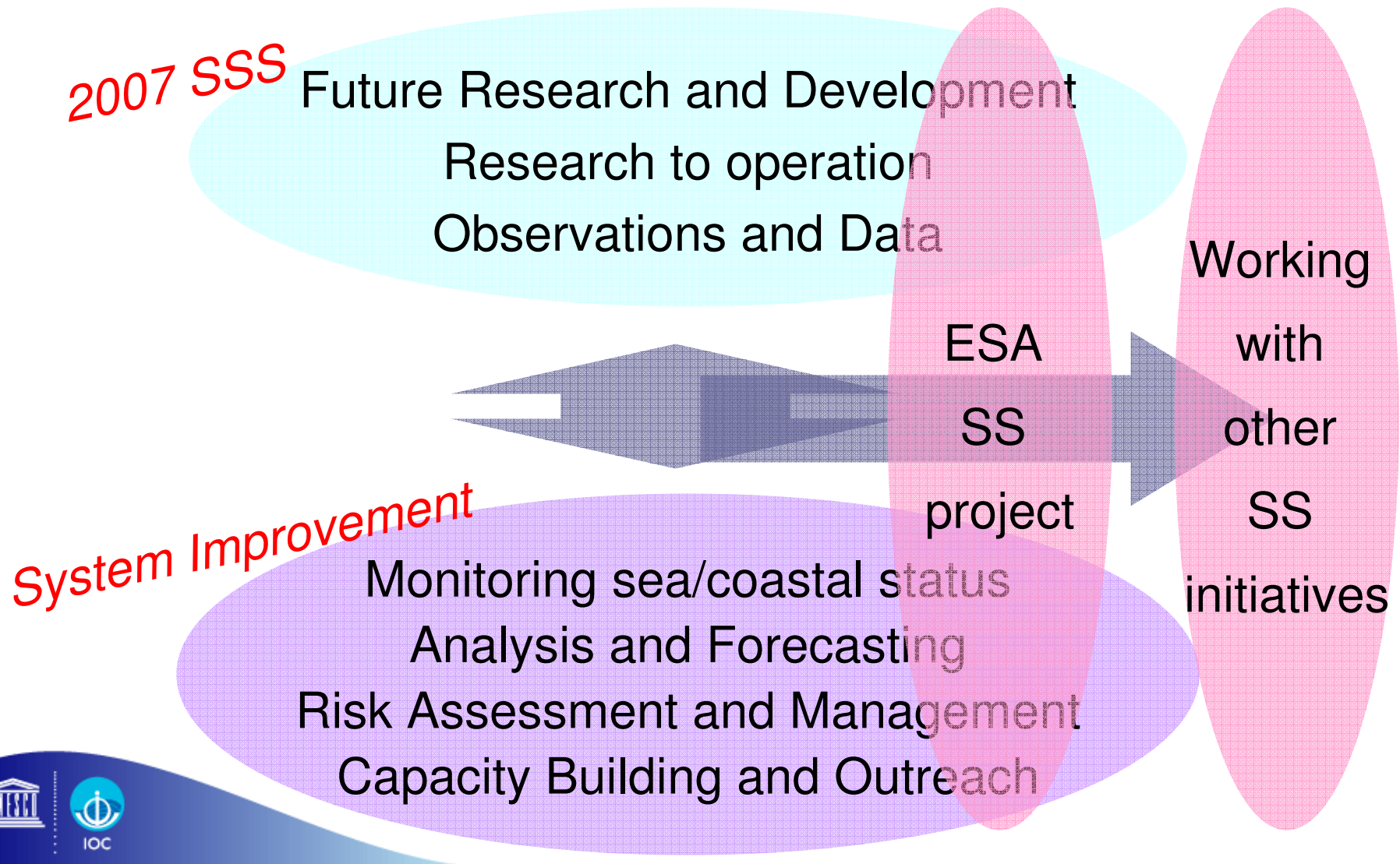
Monitoring sea/coastal status
Analysis and Forecasting
Risk Assessment and Management
Capacity Building and Outreach

Risk Assessment & Management



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Improved Storm Surge Application



ESA Storm Surge Project: Outline

<http://www.jcomm.info/SSucm>

- A new ESA Data User Element project for 2010 (€1 Million / 2 year)
- Objectives:
 - To contribute through Earth Observation to an **integrated approach to storm surge, wave, sea-level and flood forecasting** as part of a wider optimal strategy for building an improved forecast and warning capability for coastal inundation.
 - **To increase the use of the EO information** to improve Storm Surge applications.



ESA Storm Surge Project: Outline

<http://www.jcomm.info/SSucm>

- Target User Group (initial):
 - **Scientists / Engineers** developing, implementing and operating storm surge systems, coastal engineering , operational oceanography, national weather services and climate research.
 - **Companies and government agencies** who specialise in providing storm surge related information to industry, coastal zone and river basin managers, urban planners, harbour authorities, local authorities, disaster risk reduction teams, humanitarian aid groups, water quality service providers and the coastal management industry.
 - International users
 - GMES service Providers



ESA Storm Surge Project: User Consultation

<http://www.jcomm.info/SSucm>

- 17-18 September 2009, Venice



ESA Storm Surge Project: User Recommendation

<http://www.jcomm.info/SSucm>

Case studies should form a central part of the project

- Key Regions include North Sea, North Adriatic, North Indian Ocean, while not restricting the geographic locations
- Compile a Database and data catalogue (e.g. Scat, Alt, SAR, Optical, Hs, Winds, Waves, NWP, impacts)
- Need to learn how to use EO more effectively in the end-to-end storm surge system approach (e.g. cyclone track/intensity forecasting)

Blended NWP and EO nowcast style wind products should be developed

- Using High Resolution Scat data, SAR, Altimeters
- Synergy E.g. Use of SST for stability adjustments, and harmonise product standards in terms of format and content



ESA Storm Surge Project: User Recommendation

<http://www.jcomm.info/SSucm>

Systematic uncertainty estimates for EO products should be addressed

- For new and historical products (e.g. Swell/Hs from SAR Frequency is OK but how good is the amplitude?)
- Validation of outputs/inputs and understanding how uncertainties impact data

Data assimilation of EO in models should be introduced

- Address the challenge of satellite tasking for better coverage and consistency
- Targeting the operational community

The project should have an impact assessment

- Based on an end-to-end storm surge systems (e.g. decision making processes, costs and socio economic costs for EO)



ESA Storm Surge Project: User Recommendation

<http://www.jcomm.info/SSucm>

International collaboration is seen as a key aspect of the project

- EO data may have most impact in regions not well covered by traditional in situ infrastructures
- Appropriate delivery options for developing countries and NRT operations, in partnership with IOC, WMO and other international groups

Bathymetry is seen as an essential component of the project

- But there are related approaches (waterlines) that could be used as a proxy
- Seek linkage with other related programs and projects



ESA Storm Surge Project: User Recommendation

<http://www.jcomm.info/SSucm>

Immediate need: simple documentation on how to apply EO data for Storm Surges

- Develop an on-line catalogue of EO data in NRT for Storm surge applications, and make this catalogue available to all to encourage wide use (academic and operational)
- The project should develop simplified version(s) of product handbooks (E.g., How do users apply quality flags? What are the 'tricks of the trade')

The project should also develop user guidance for EO data

The project should establish a pragmatic approach to access and use EO data for coming storm surge events (Ideally, based on forecast event)

Provide easy to use products tuned to storm surges, for

- Making data available through web portal
- Develop level 3 and level 4 data products



ESA Storm Surge Project: Scope

<http://www.jcomm.info/SSucm>

Development and Demonstration of EO information to improve Storm Surge applications:

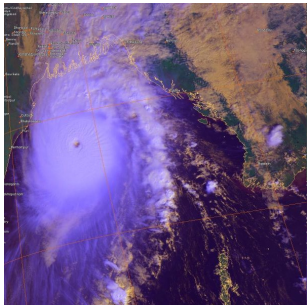
- Providing easy access supported by user tools and documentation on useful EO data sets in the Storm Surge application groups
- Prototyping techniques built on established research results
- Processing chain/satellite synergy/model/assimilation development
- Production of a test data sets meeting users' needs
- Validation/verification/uncertainties/inter-comparison
- Diagnostic data sets/climatology/database
- Demonstration exploitation (modelling, assimilation, new products, prediction, databases, case studies, prototype services etc.)



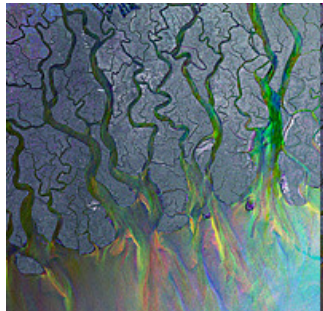
ESA Storm Surge Project: Timeline

<http://www.jcomm.info/SSucm>

- September 2009: User Consultation Meeting
- December 2009: Expression of User requirements
- May 2010: Issue of Invitation To Tender (ITT)
- September 2010: Selection of one winning bid
- December 2010: Project Kick Off



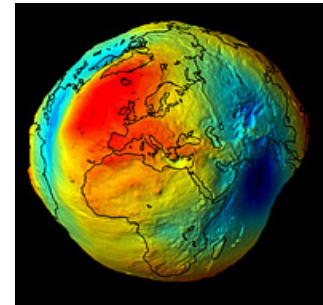
**METOP AVHRR RGB
TC Sidr Bangladesh
(15 November 2007)**



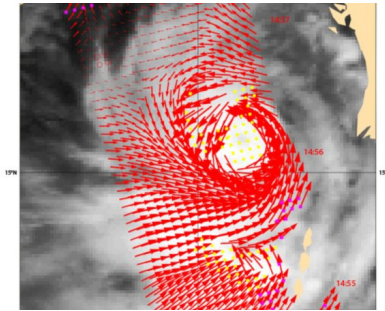
**ENVISAT ASAR –
Ganges Delta**



**ENVISAT MERIS –
mapping The River Plate**



**GOCE – GEOID and
unification of tide gauges**



**ASCAT winds over
TC Nargis**

Questions, Comments...

Thank You

