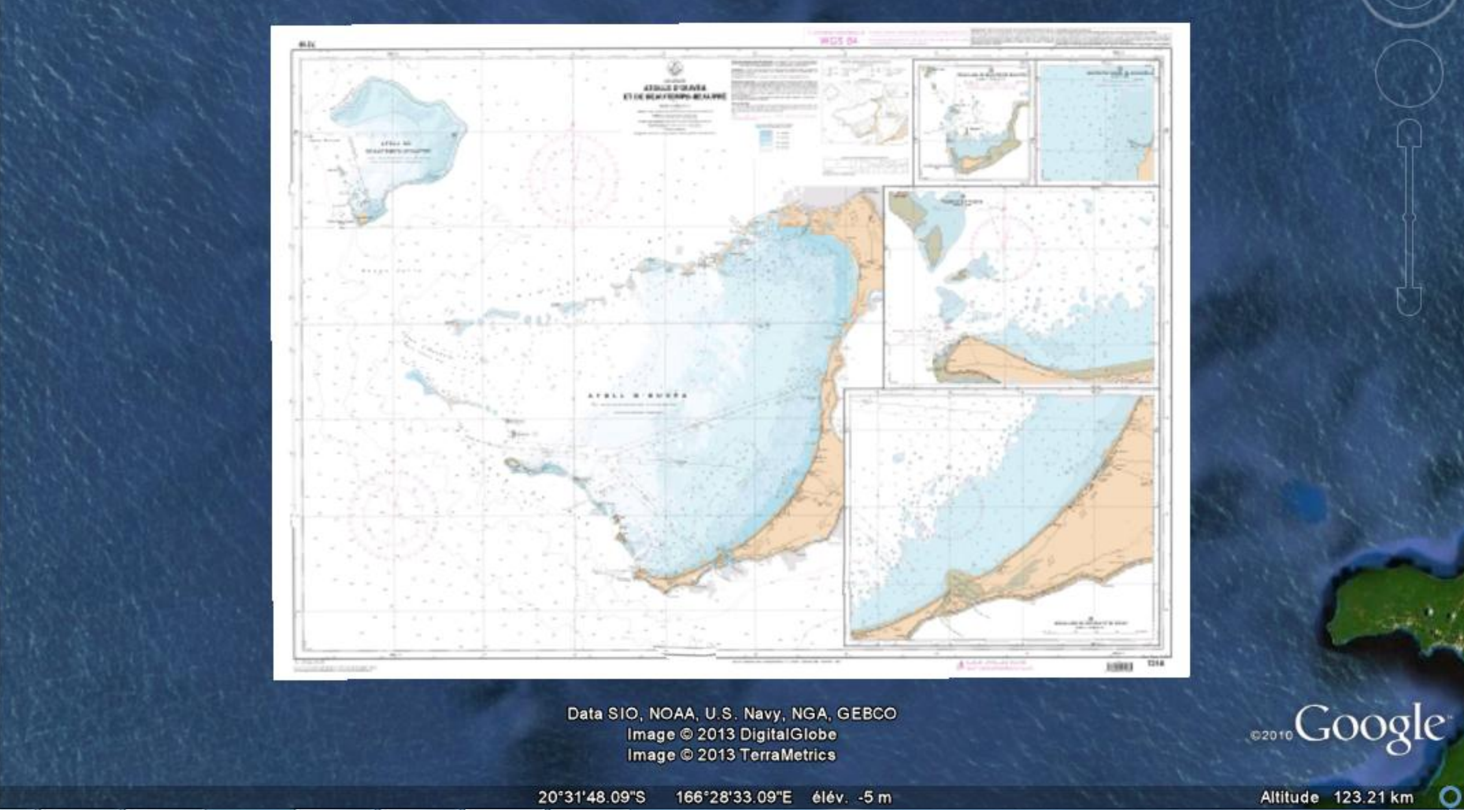
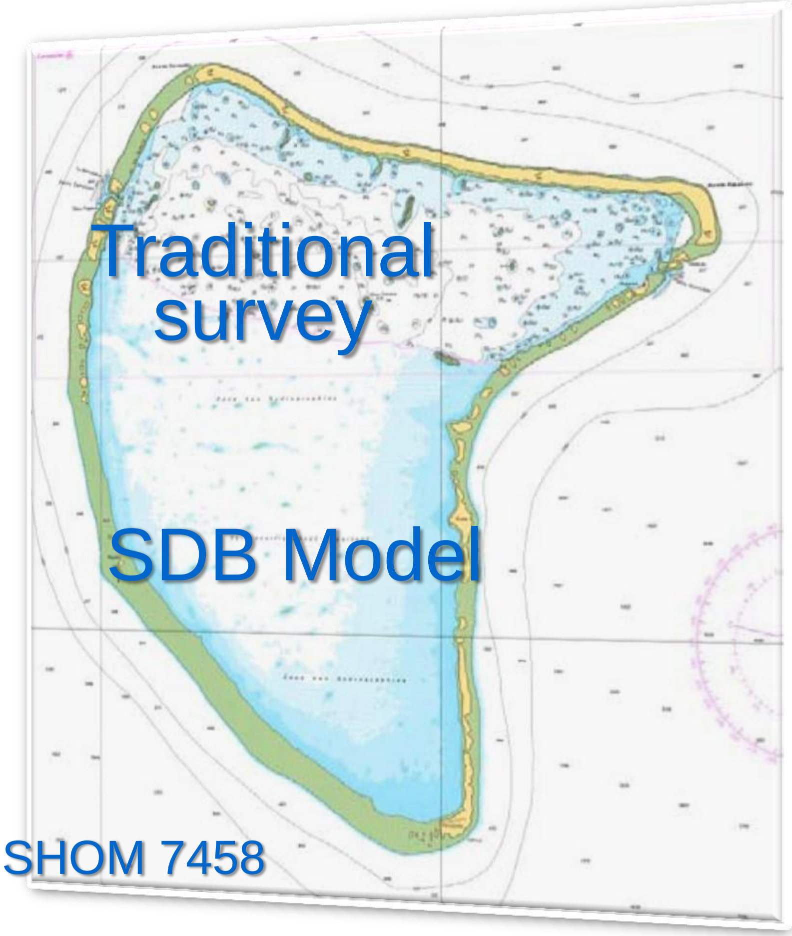
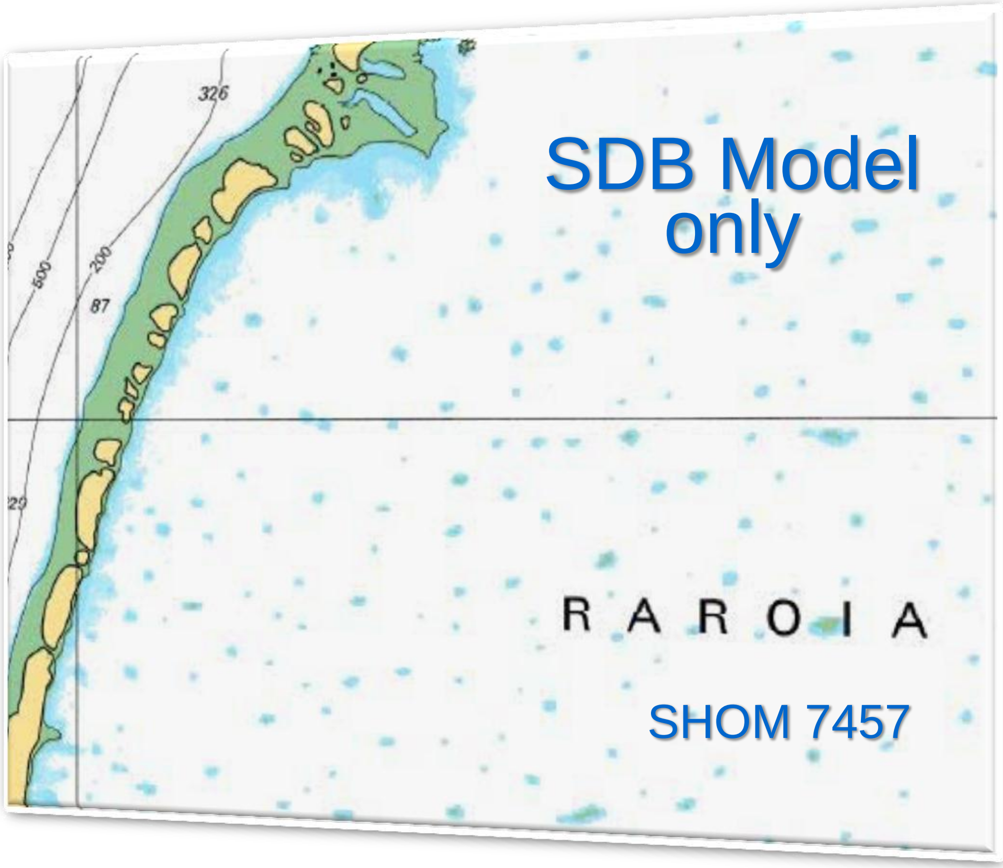
# Satellite Derived Bathymetry



# Over 100 SDCs supported by field surveys



# Performances Feedback

- ***Horizontal precision:***
  - ***10m average**, in the case of spatiotriangulated contiguous blocks without GPS control points*
  - ***10m average**, in the case of an orthorectified image with GPS control points*
  - ***2m locally**, with HR images and dense network of control points*

- ***Vertical precision:***
  - ***(with properly calibrated Lyzenga model)***
  - ***Up to 30%** depth uncertainty in the **[0-5m]** layer*
  - ***10%** depth average uncertainty in the **[5-20m]** layer*

# Performances Shortcomings

- ***Bottom investigation remains uncomplete:***
  - ***Features not always detected and/or difficult to determine (bottom roughness badly replicated by the model)***
- ***Depth of penetration: 1x Secchi depth***

  ***20m on average, exceptionally 30m***
- ***Processing time:***
  - ***Manual checks of automated processes and data validation are painstaking and still require an hydrographic surveyor's supervision***
- ***Ground control (Control points and control survey lines):***
  - ***Indispensable an relatively costly***

# Average performances of sensors

- ***In very shallow waters < 10m***

| | Acoustic (EM 2040) | Lidar (CZMIL) | Satellite (Pleïades XS) |
|---|---|---|---|
| Spatial XY resolution (m) | 0.2 | 0.5 | 2 |
| Spatial Z resolution (m) | 0.1 | 0.2 | 1 |
| Density (measures /$m^2$) | **25** | 4 | 0.25 |
| Total Horizontal Uncertainty (m) | **0.5** | 1 | 10 |
| Total Vertical Uncertainty (m) | **0.2** | 0.3 | 30% to 10% of depth |

*Rough assessment – non contractual figures*

# Costs & Effective performances

- ***In very shallow waters < 10m***

| | Acoustic (EM 2040) | Lidar (CZMIL) | Satellite (Pleïades XS) |
|---|---|---|---|
| Survey (€ per sq. km) | 2,500 | 1,500 | 5 |
| Survey (sq. km per hour) | 0.14 | 13 | Archive |
| Duration (hour per sq. km) | 7 | 0.08 | 0 |
| Processing (hour per sq. km) | 21 | 4 | 3 |
| Total Cost (€ per sq. km) | 3,340 | 1,660 | **125** |
| Total Duration (hour per sq. km) | 28 | 4 | **3** |

*Rough estimates – non contractual figures*

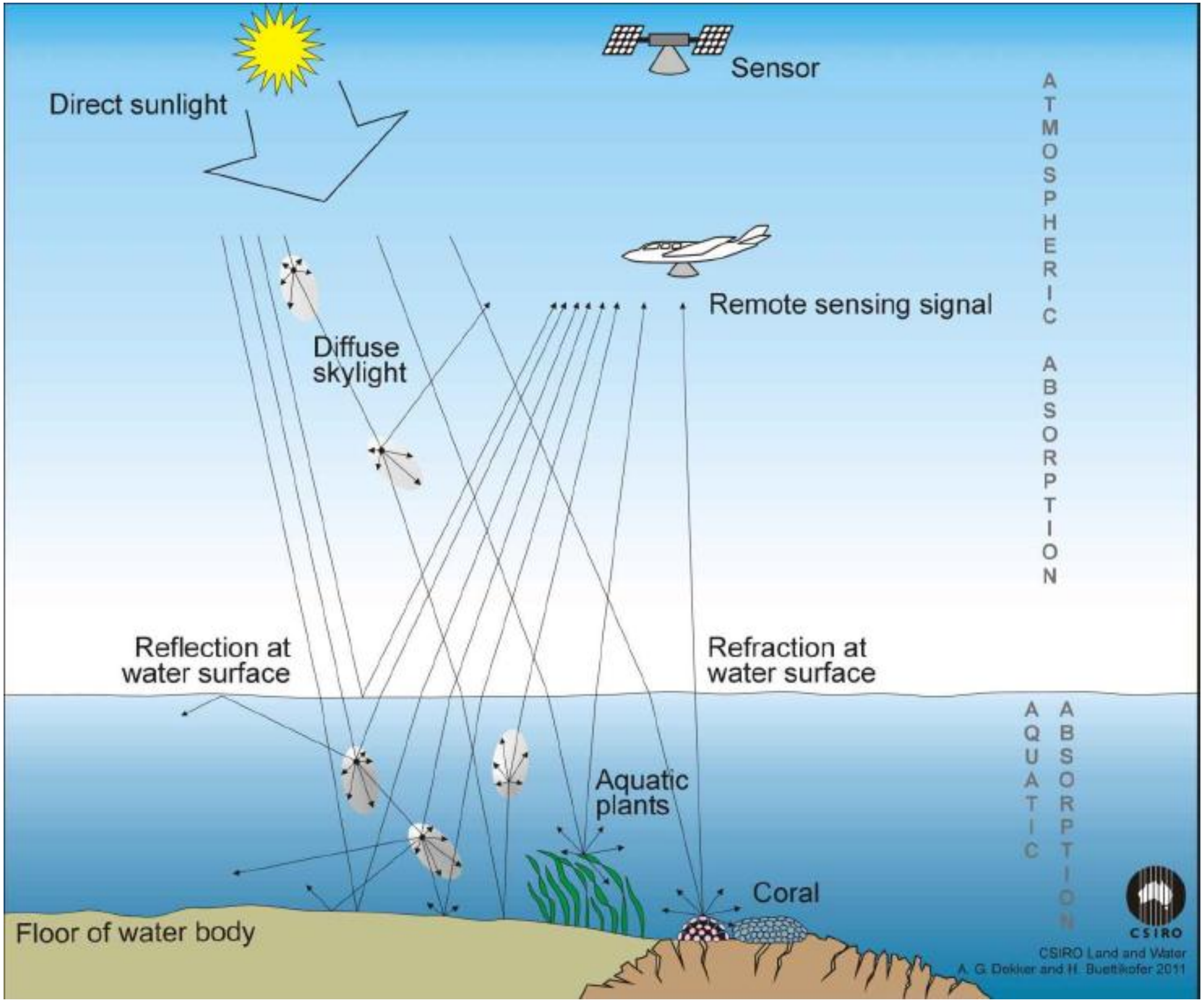
# What improvements ?

- **Further development and implementation of production tools, to improve performances and to limit *in-situ* costly surveys:**

  - ***Test inversion methods in production, against Lyzenga's . Benchmarking and implementation if proven better.***

  - ***Test & implement new sensors and processes.***

# The conceptual physics-based model for shallow waters



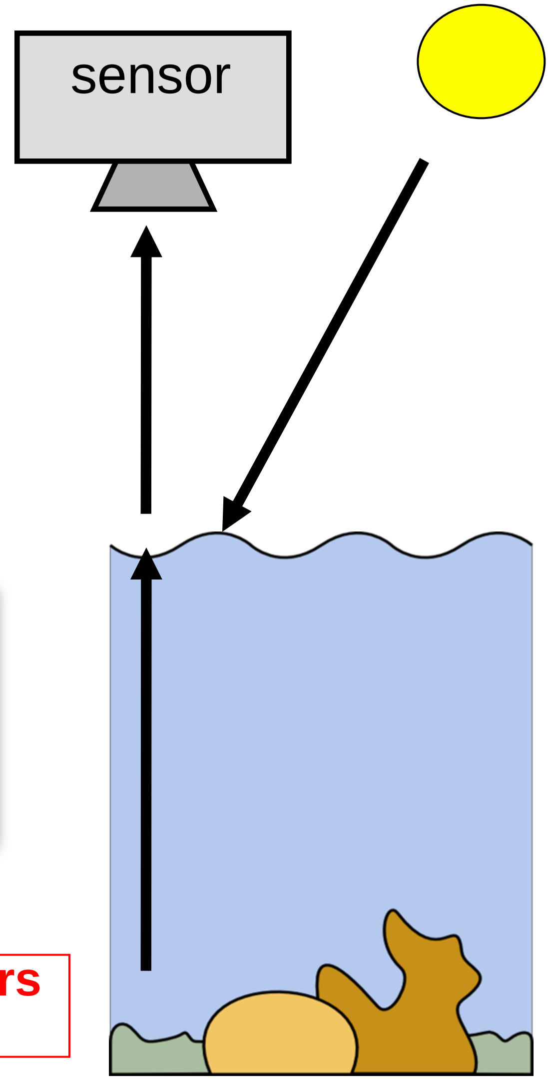
# The physics-based Inversion Method

- ***May work without any in-situ data***
- ***Is based on physical geometry and radiative transfer theory***
- ***A set of equations predict what the sensor receives – they are 'inverted' to estimate depth from sensor data:***

$$r_{rs}(\lambda) \approx r_{rs}^{dp}(\lambda)\left(1 - \exp\left\{-\left[\frac{1}{\cos\theta_w} + \frac{D_u^C(\lambda)}{\cos\theta}\right]\kappa(\lambda)H\right\}\right) + \frac{1}{\pi}\rho(\lambda)\exp\left\{-\left[\frac{1}{\cos\theta_w} + \frac{D_u^B(\lambda)}{\cos\theta}\right]\kappa(\lambda)H\right\}$$

**Sensor receives this**

**Depth in meters**




Hedley & al. 2011, Remote Sensing of Environment 120, 145-155

# How should we concentrate efforts ?

***Global assessment of areas where SDB is applicable and cost-efficient***

***To manage data uncertainties from sensors to charts (errors budget) (especially when there is no in-situ data)***

***Taking into account acquisition delays (it can take time to get fresh and good enough images …)***

# How should we concentrate efforts ?

- ***To identify environmental limits:***
  - ***Water surface state, clouds and turbidity are still challenges for image processing.***


*Somewhere,*
*in French Guyana*