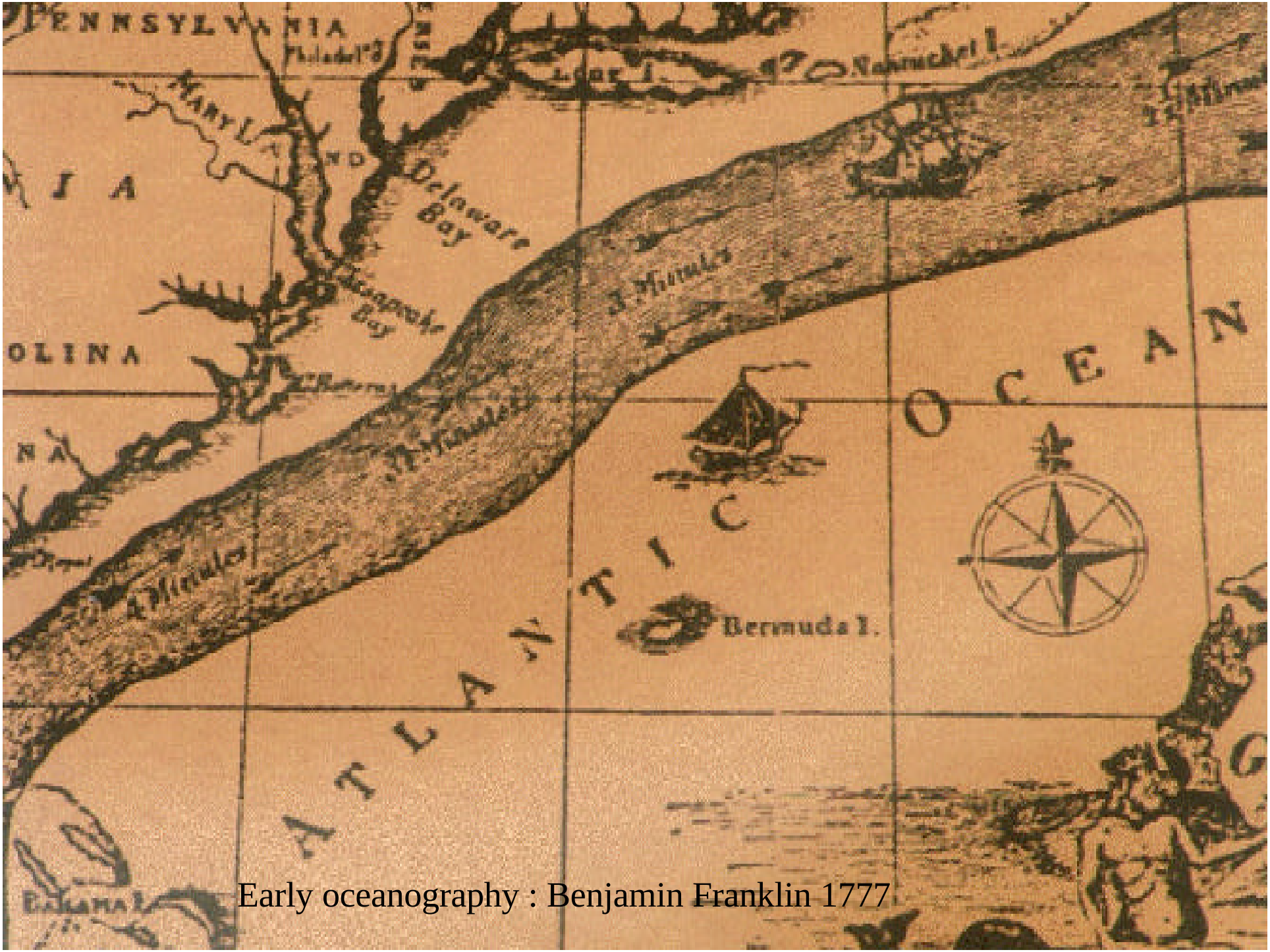
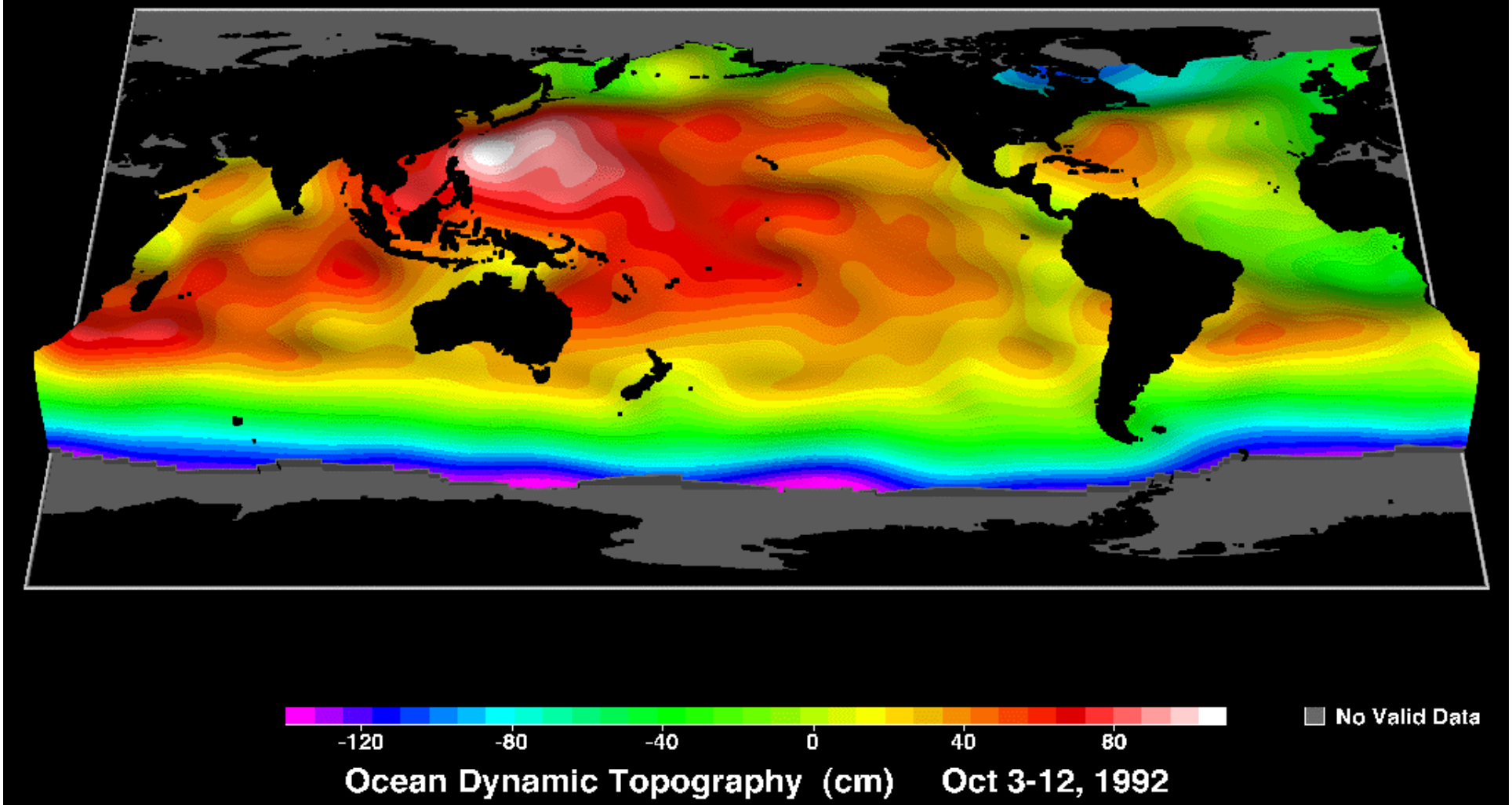
TOPEX / POSEIDON & Jason

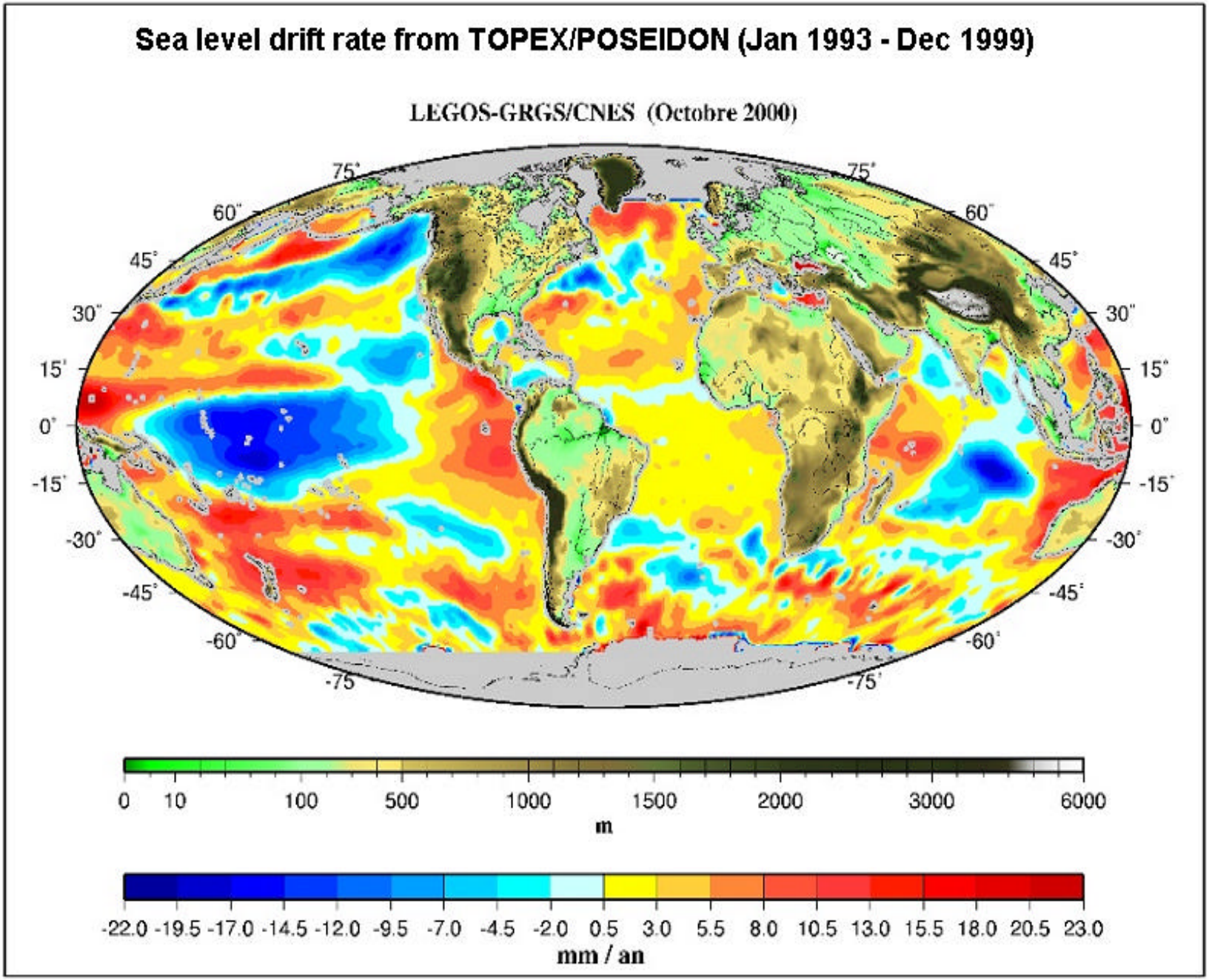
Philippe Escudier
CNES

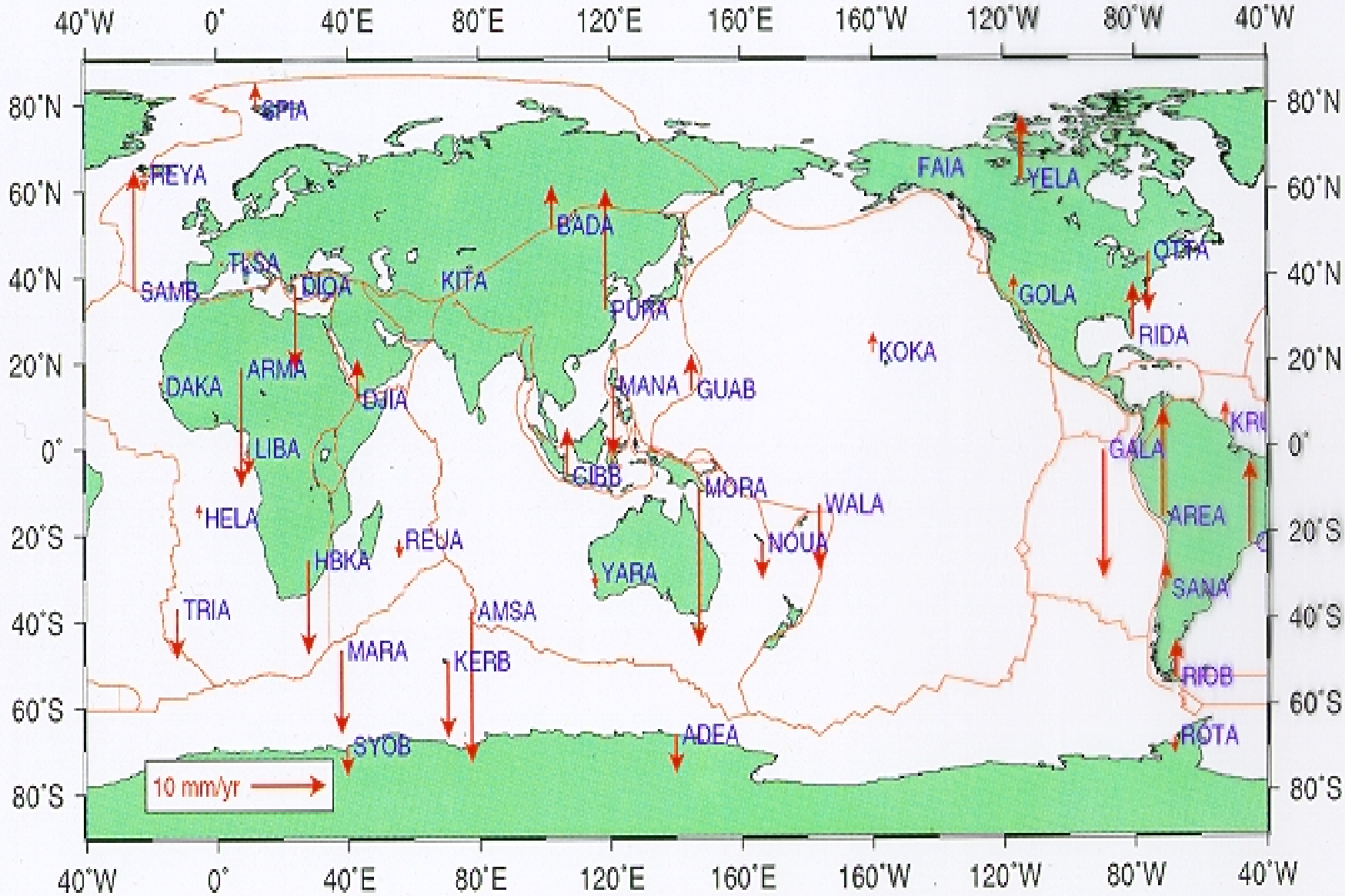


Early oceanography : Benjamin Franklin 1777

OCEAN DYNAMIC TOPOGRAPHY (TOPEX/POSEIDON)




Sea level drift rate from TOPEX/POSEIDON (Jan 1993 - Dec 1999)
LEGOS-GRGS/CNES (Octobre 2000)
75°
60°
45°
30°
15°
0°
-15°
-30°
-45°
-60°
-75
0 10 100 500 1000 1500 2000 3000 6000
m
-22.0 -19.5 -17.0 -14.5 -12.0 -9.5 -7.0 -4.5 -2.0 0.5 3.0 5.5 8.0 10.5 13.0 15.5 18.0 20.5 23.0
mm / an



Vertical Tectonic plates motion from DORIS

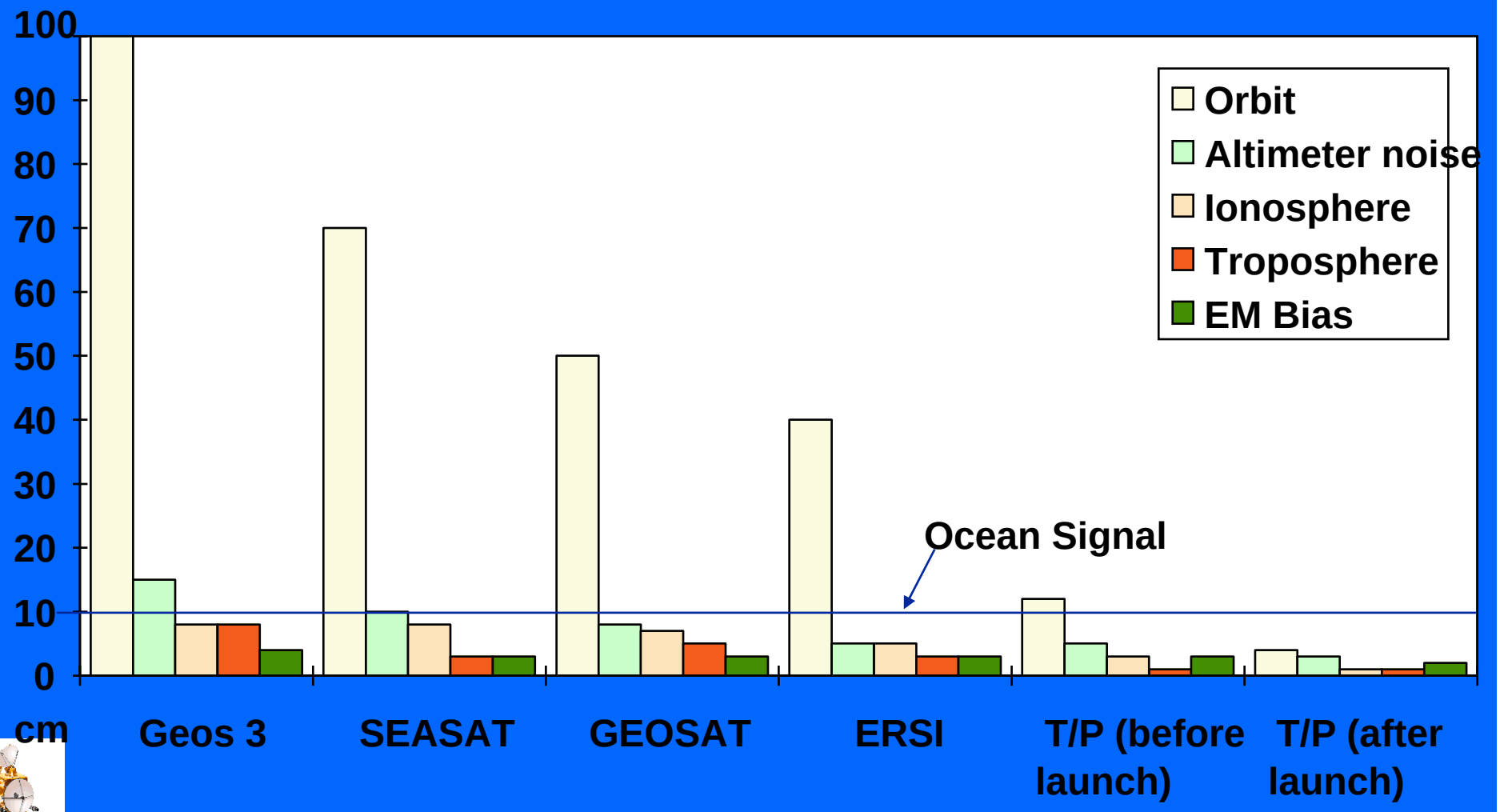
TOPEX/POSEIDON & Jason challenges

- TOPEX/POSEIDON
  - ACCURACY
    - instrument definition and technology
    - system definition
    - internal cross calibration
    - SWT involvment
    - external calibration
  - cooperation scheme

- Jason 1
  - toward operational oceanography
    - operational reqt
    - small sat to lower recurring costs
  - protoflight platform for a new bus : PROTEUS
  - accuracy :

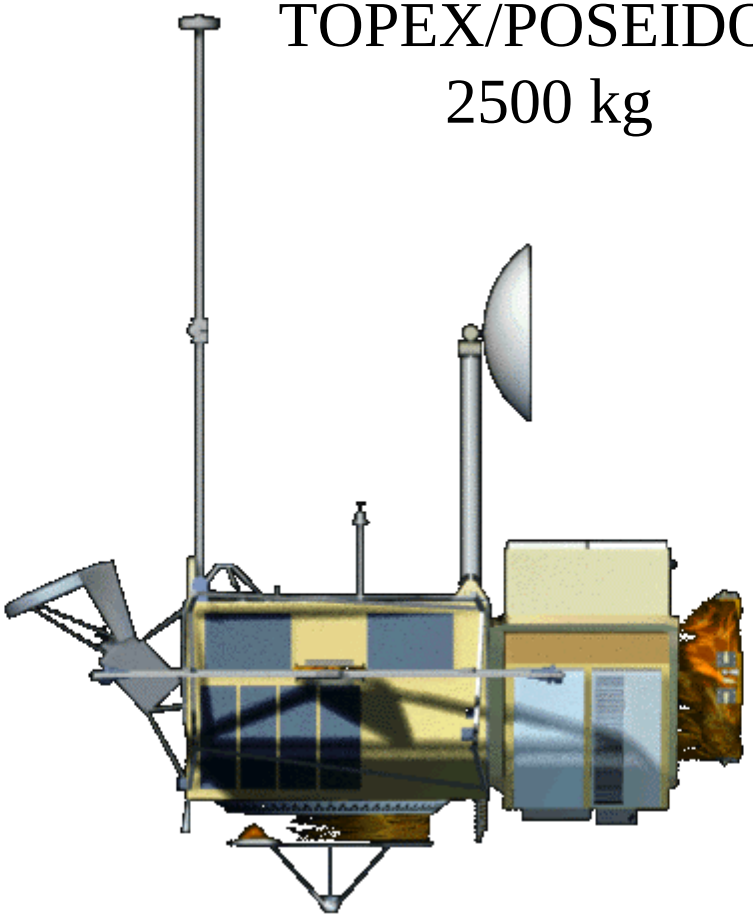
    T/P in flight => Jason spec

Altimetry missions error budget

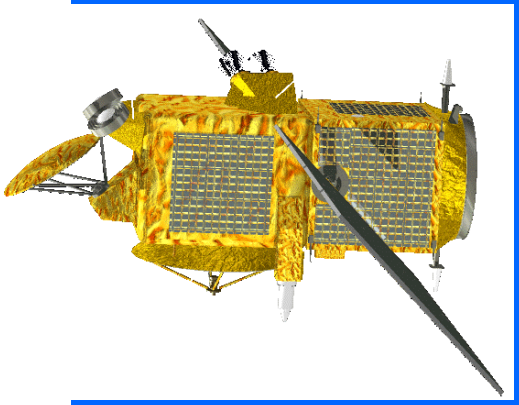


T/P & Jason-1

TOPEX/POSEIDON
2500 kg



Jason-1
500 kg



NASA/CNES Altimetry missions status

- TOPEX/POSEIDON
  - In operations since august 1992,
    - Orbit change under way for new high resolution altimetry experiment
- **Jason 1**
  - Launched in December 2001,
  - first phase, formation flying with T/P ==> CALVAL
  - fully operational, final calval meeting next October
- **Jason 2 / OSTM** : to be formally decided
  - cooperation extended to operational agencies : NOAA & EUMETSAT
  - to be launched in 2006
  - new technology experiment : WSOA additional payload under analysis

TOPEX/POSEIDON & Jason Program

- NASA / CNES cooperation for development and operations
  - Balanced mission sharing
    - mission goals, constraints, funding, decisions, risks
  - High level agreement : Memorandum of understanding
    - responsability sharing precise definition
    - responsabilities almost reversed between TOPEX/POSEIDON & Jason
- Worldwide user community
  - 67 Investigator teams selected from more than 30 different countries
  - strong interactions between project teams and the Science team
  - Project developped under the frame of international ocean and climate programs

Integrated Operational Oceanography

Space Observation

⇩

Assimilation Model

⇧

In situ Observation

GODAE : Global Ocean Data Assimilation Experiment

Rationale for the cooperation

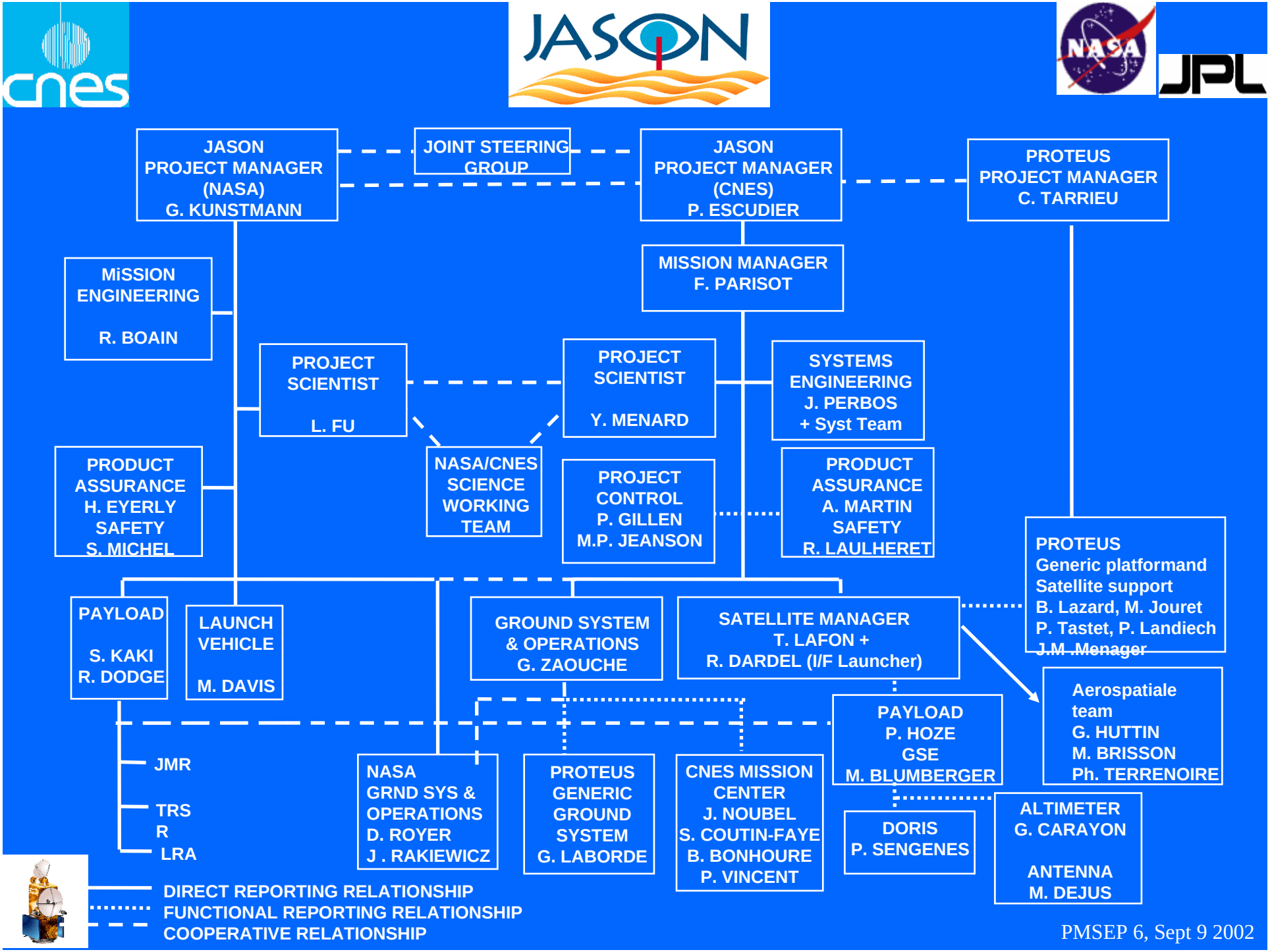
- Common interest in mission results
  - strong user community in each country : Science & applications
- Funding level decreased wrt national programs
- Benefit from partner technology
  - without technology transfer : black box concept
- Some concerns made the decisison difficult to take :
  - national industry interests
- But cooperation has proved to be an efficient tool for
  - program decisions, program / project management
  - Science results

Jason-1 Responsibility sharing

- CNES
  - System engineering, spec & testing
  - DORIS, POSEIDON 2
  - Satellite bus
  - satellite integration, test up to launch
  - Project level mission management
  - operations during assessment phase
  - Satellite performance analysis
  - One ground terminal
  - Logistic and Precise Orbit Determination
  - CNES sensors on-orbit-calibration
  - Data processing and distribution
  - Support French PIs
- NASA
  - Support for system engineering
  - Radiometer, GPS, LRA
  - Support for satellite integration
  - Launch Vehicle,services,tracking support
  - Support for mission management
  - Support for assessment phase
  - Operations during routine phase
  - Two Ground terminals
  - Telemetry transfer to CNES
  - NASA sensors on-orbit calibration
  - Data processing and distribution
  - Support NASA PIs

Frame for this cooperation

- Parallel project teams
  - close interactions at each level
- Independant industry contracts
- No exchange of fund
  - no global project cost optimization
- Use of its own standards and procedures by each agency
  - coordination to ease exchanges and mutual understanding
- Joint Steering group
- Joint Science Working Team


JASON PROJECT MANAGER (NASA) G. KUNSTMANN
JOINT STEERING GROUP
JASON PROJECT MANAGER (CNES) P. ESCUDIER
PROTEUS PROJECT MANAGER C. TARRIEU
MiSSION ENGINEERING R. BOAIN
MISSION MANAGER F. PARISOT
PROJECT SCIENTIST L. FU
PROJECT SCIENTIST Y. MENARD
SYSTEMS ENGINEERING J. PERBOS + Syst Team
PRODUCT ASSURANCE H. EYERLY SAFETY S. MICHEL
NASA/CNES SCIENCE WORKING TEAM
PROJECT CONTROL P. GILLEN M.P. JEANSON
PRODUCT ASSURANCE A. MARTIN SAFETY R. LAULHERET
PROTEUS Generic platformand Satellite support B. Lazard, M. Jouret P. Tastet, P. Landiech J.M .Menager
PAYLOAD S. KAKI R. DODGE
LAUNCH VEHICLE M. DAVIS
GROUND SYSTEM & OPERATIONS G. ZAOUCHE
SATELLITE MANAGER T. LAFON + R. DARDEL (I/F Launcher)
Aerospatiale team G. HUTTIN M. BRISSON Ph. TERRENOIRE
PAYLOAD P. HOZE GSE M. BLUMBERGER
JMR
TRS
R
LRA
NASA GRND SYS & OPERATIONS D. ROYER J . RAKIEWICZ
PROTEUS GENERIC GROUND SYSTEM G. LABORDE
CNES MISSION CENTER J. NOUBEL S. COUTIN-FAYE B. BONHOURE P. VINCENT
DORIS P. SENGENES
ALTIMETER G. CARAYON
ANTENNA M. DEJUS
DIRECT REPORTING RELATIONSHIP
FUNCTIONAL REPORTING RELATIONSHIP
COOPERATIVE RELATIONSHIP

Cooperation : some lessons learn

- Language :
  - The real difficulty is beyond the direct translation which is not a major issue :
    - behind different words are different way to view and analyze things
    - understanding those difference is a powerfull tool
- Distance :
  - 9 hours time difference between California and France :
    - this difficulty may become an advantage when synergy can be found :
      - 2 shifts natural organization
  - beyond the efficiency of modern communication tools, face to face meetings are still mandatory, to get a better mutual understanding
- Frame :
  - no hierarchy between partners
  - mutually responsible wrt the user community
  - cross motivation / stimulation is the efficient tool to manage such cooperation
    - stimulation between project team and among the science working team

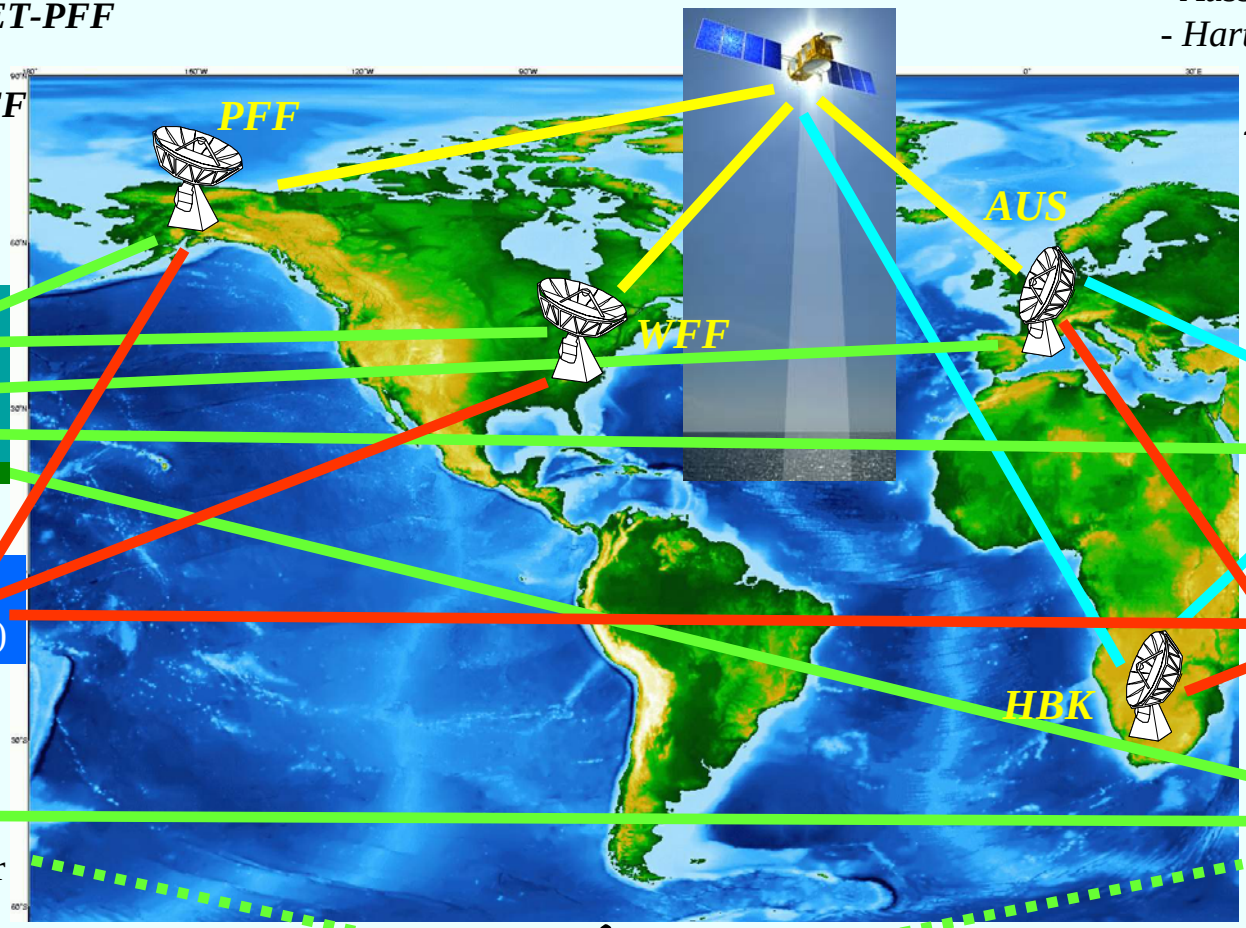
key examples of cooperation efficiency 1/3

- Ground system and operations sharing
  - apparent complexity
  - proved efficiency and robustness
    - during development :
      - cross validation with independant tools (different heritage)
      - help finding several anomalies
    - during operations :
      - independant teams and overlapping facilities
      - no impact at mission level of the few anomalies / problem which occured

Jason Ground System

NASA Earth Terminals :
- Poker Flat ***NASAET-PFF***
- Wallops (back up)
NASAET-WFF

CNES Earth Terminals :
- Aussaguel ***CNESET-AUS***
- Hartebeesthoek
SBANDET-HBK
2GHz Earth Terminal



JPL Control Center
JTCCS (Pasadena)

CNES Control Center
JCCC (Toulouse)

GSFC
(Greenbelt)

CNES Orbito Center **OOC** (Toulouse)

JPL Mission Center
JSDS (Pasadena)

CNES Mission Center
SSALTO (Toulouse)

USERS

LEOP links for Data tracking

LEOP & Assessment links

key examples of cooperation efficiency 2/3

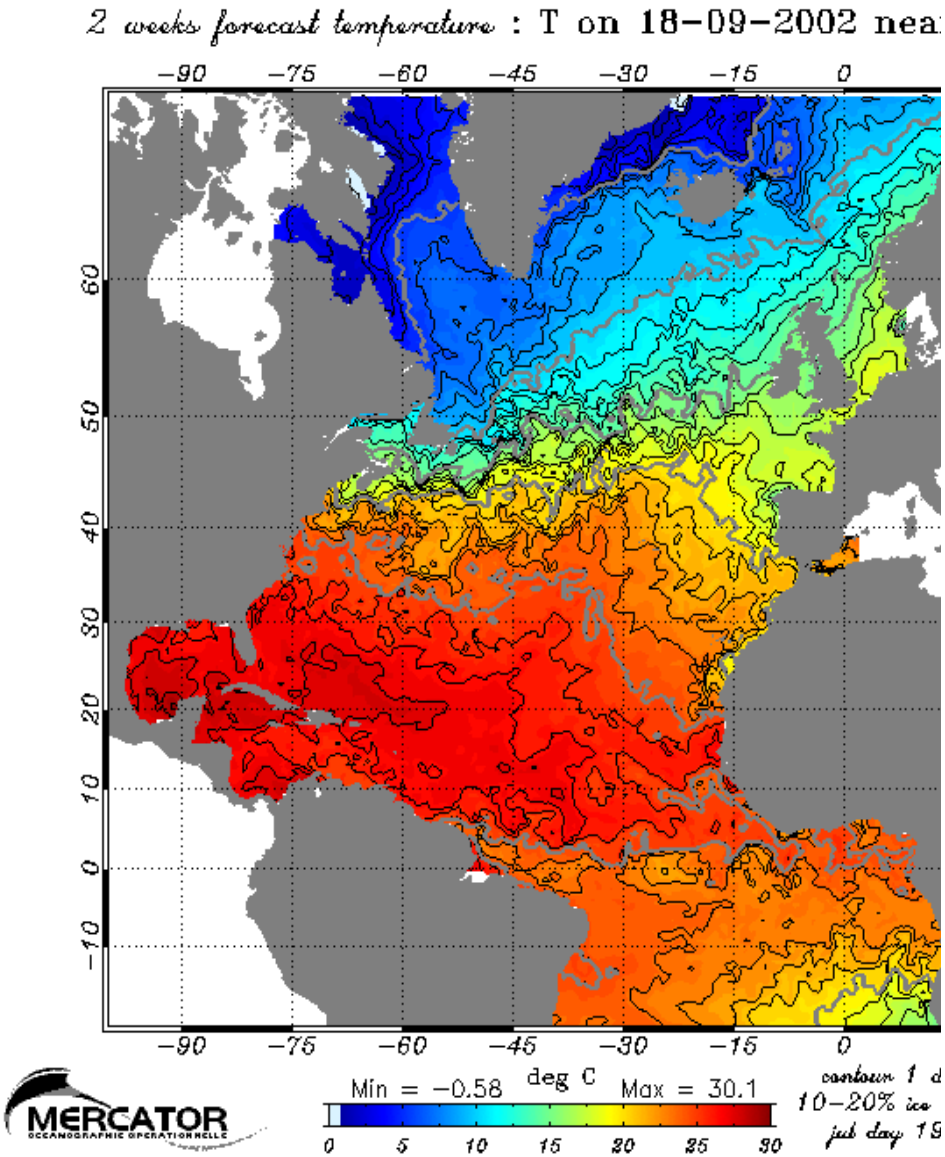
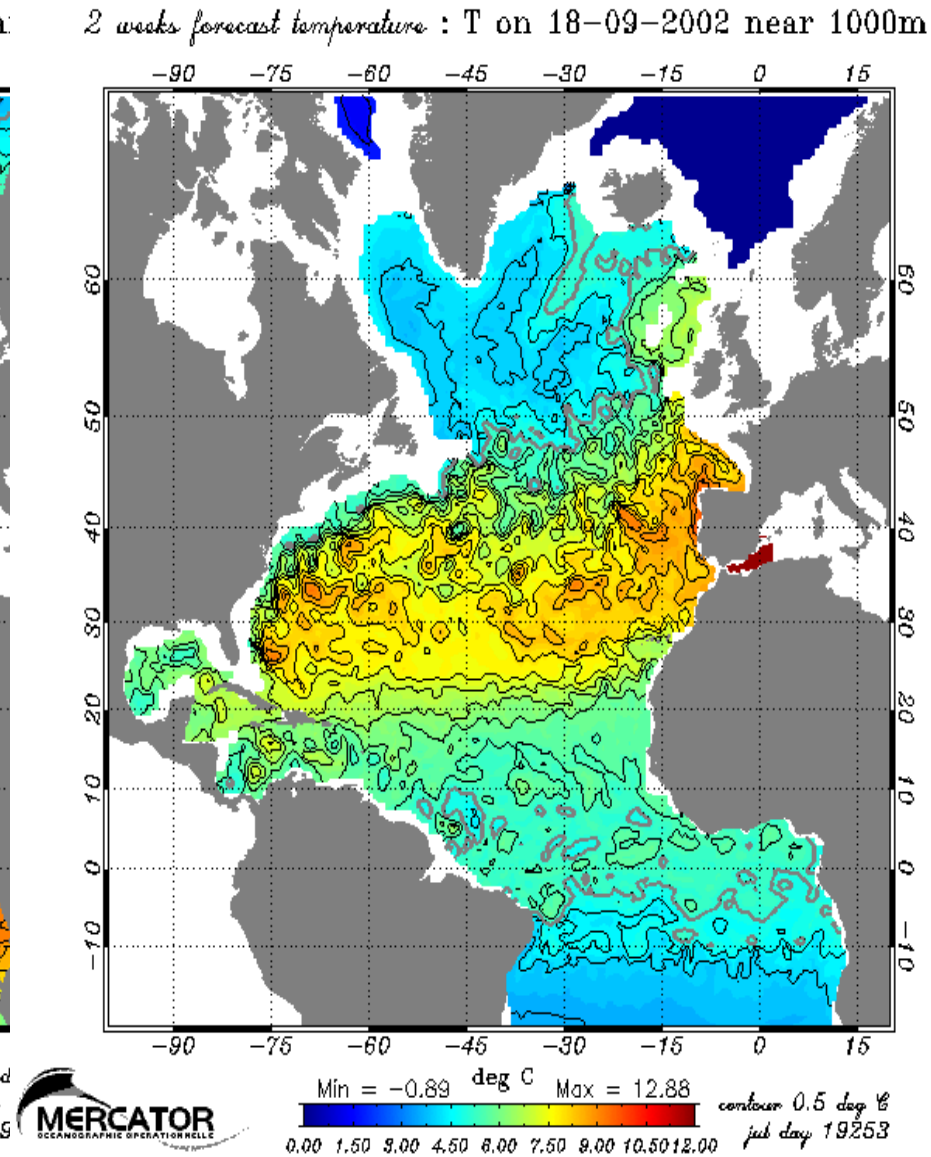
Science processing

- Altimeter processing algorithms development and validation
  - more than 200 algorithms developped for altimeter processing
    - joint effort involving thorough evaluation and review process by the science working team
  - one processing software developped, installed in both mission centers ==> cross comparison of products
  - external in flight validation / calibration by the SWT
    - T/P was intended to be the reference
    - June CALVAL workshop highlighted further improvements in performance thanks to cross calibration (both for T/P and Jason)
- POD performance built on SWT dedicated subgroup joint effort

key examples of cooperation efficiency 3/3

- Red team process implementation in Jason environment
  - no provision in the MOU or project plan for such a process, not part of NASA/CNES standards at this time,
  - decision to implement this process in conjunction with the planned review in parallel with review group work to avoid extra load on project teams
  - complementary approach of both teams (red team and review group) proved to be highly beneficial
    - consensus on major difficulties diagnostic and mitigation plans

Outcome

- Technical and Science success
  - space measurements decisive for operational oceanography development
    - global coverage & precision, data availability
    - link (catalyst ?) between entities (science & application, worldwide)
- Mutual recognition
  - technical
  - methods
  - culture
- Basis for future cooperations

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