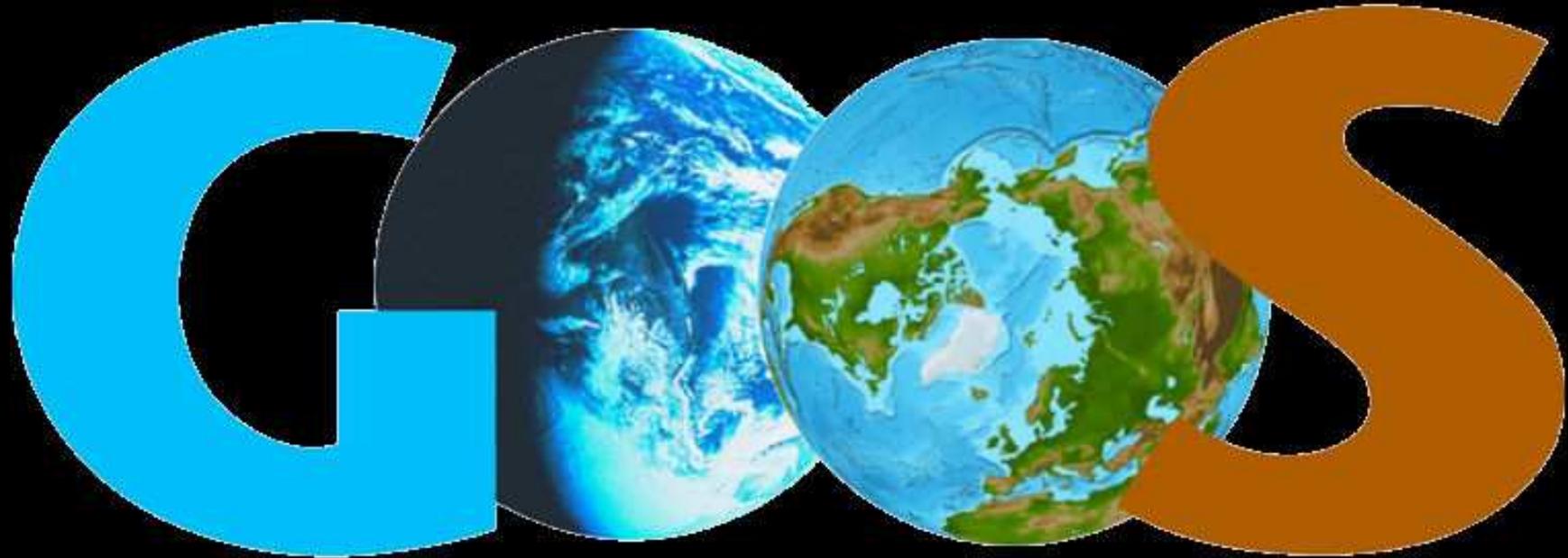


# The Global Ocean Observing System



IOC / UNESCO



WMO



UNEP



ICSU

# My role in GOOS

- Chair, Global Ocean Observing System Scientific Steering Committee
- US Integrated Ocean Observing System Industry Coordination and Outreach at Consortium for Ocean Leadership
- Chair, Defra Ocean Processes Evidence Group
- Member of European Marine Observation and Data Network



# The Earth from 86 million miles



EARTH



MOON

**This pale blue dot is planet Earth taken from Saturn by NASA's Cassini spacecraft looking back toward the Earth on Sept. 27, 2006. Saturn is about 800 million miles from the Earth.**



# So let's dive in



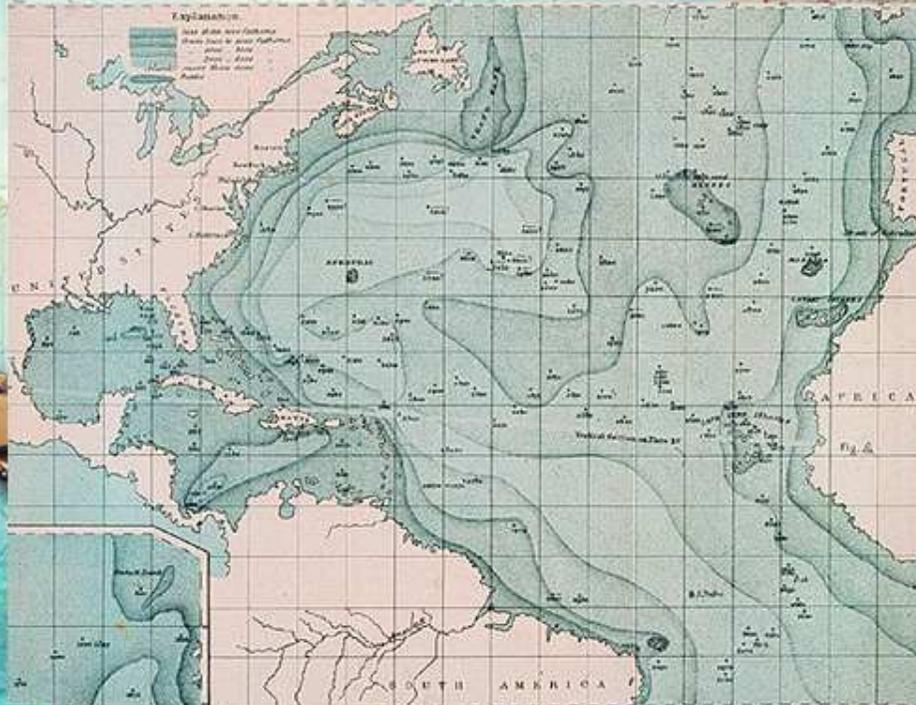
- A bit of history
- Benefits of ocean observation and forecasting
- Ocean observation and forecasting today
- Future challenges

# A Historical Perspective

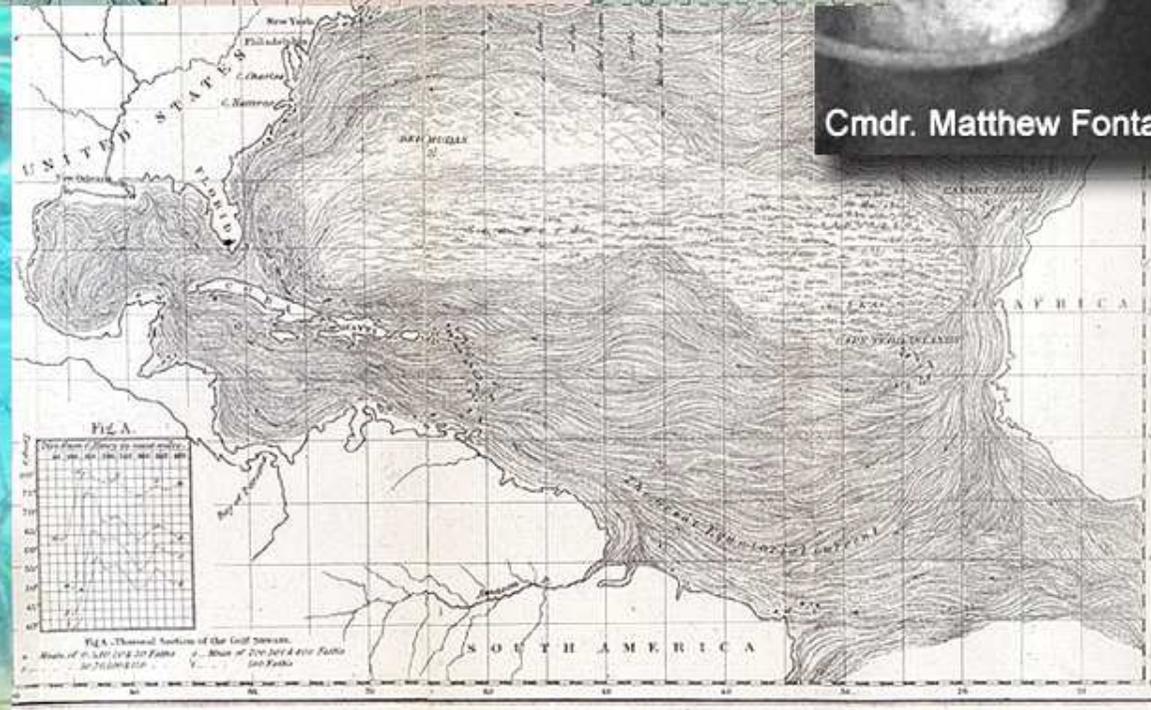
‘We celebrate the  
past to awaken  
the future’

*John F Kennedy, 14  
August 1960*

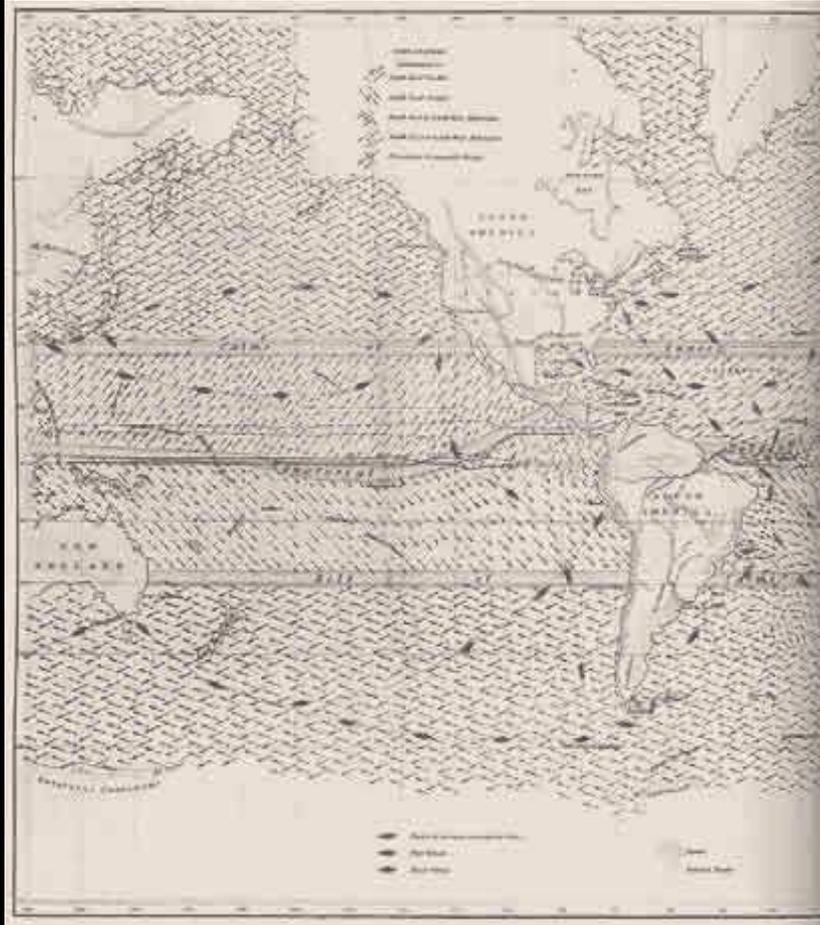




Cmdr. Matthew Fontaine Maury, USN



# The first global operational system



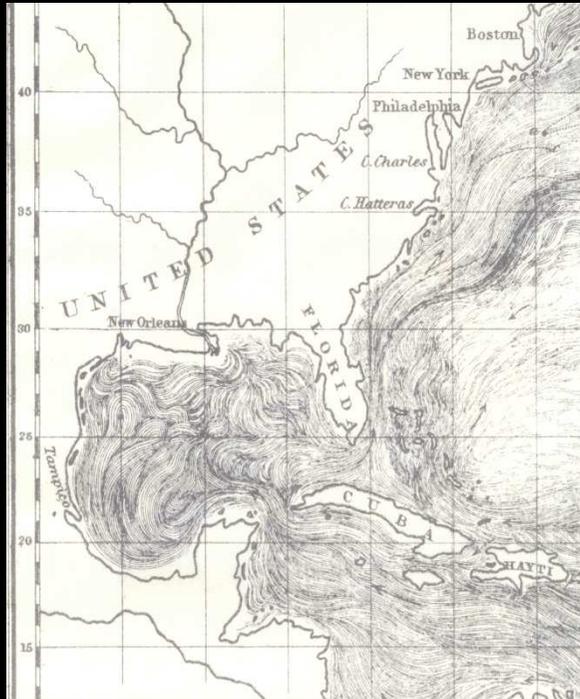
More than 150 years ago Matthew Fontaine Maury set out a plan to organize accumulated information from ship's logs in a greatly simplified way, organized "in such a manner that each may have before him, at a glance, the experience of all."

# The first global operational system



Making improvements on the back of a big data set is not a Google monopoly, nor is the technique new. Maury created an early variant of a 'viral' social network, rewarding captains who submitted their logbooks with a copy of his maps.

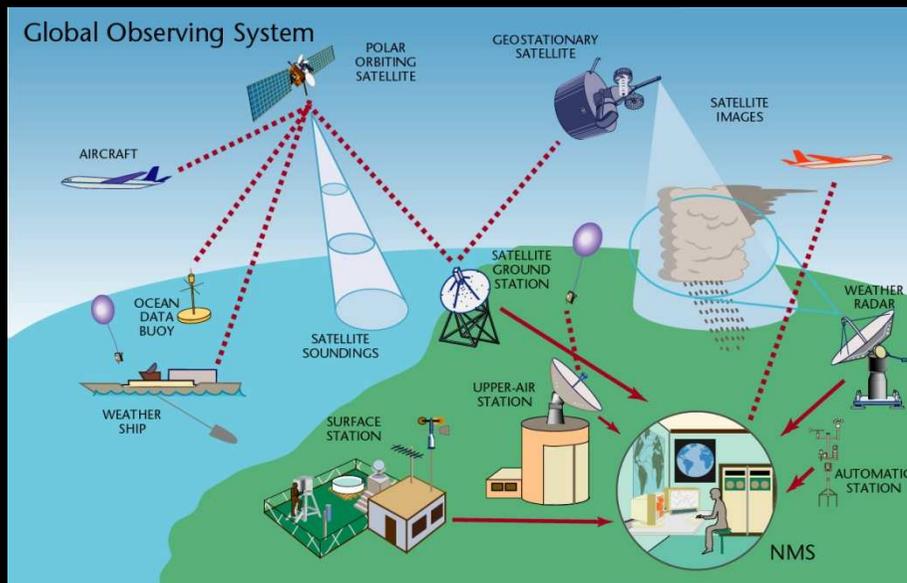
# Maury and the 1853 Brussels Conference

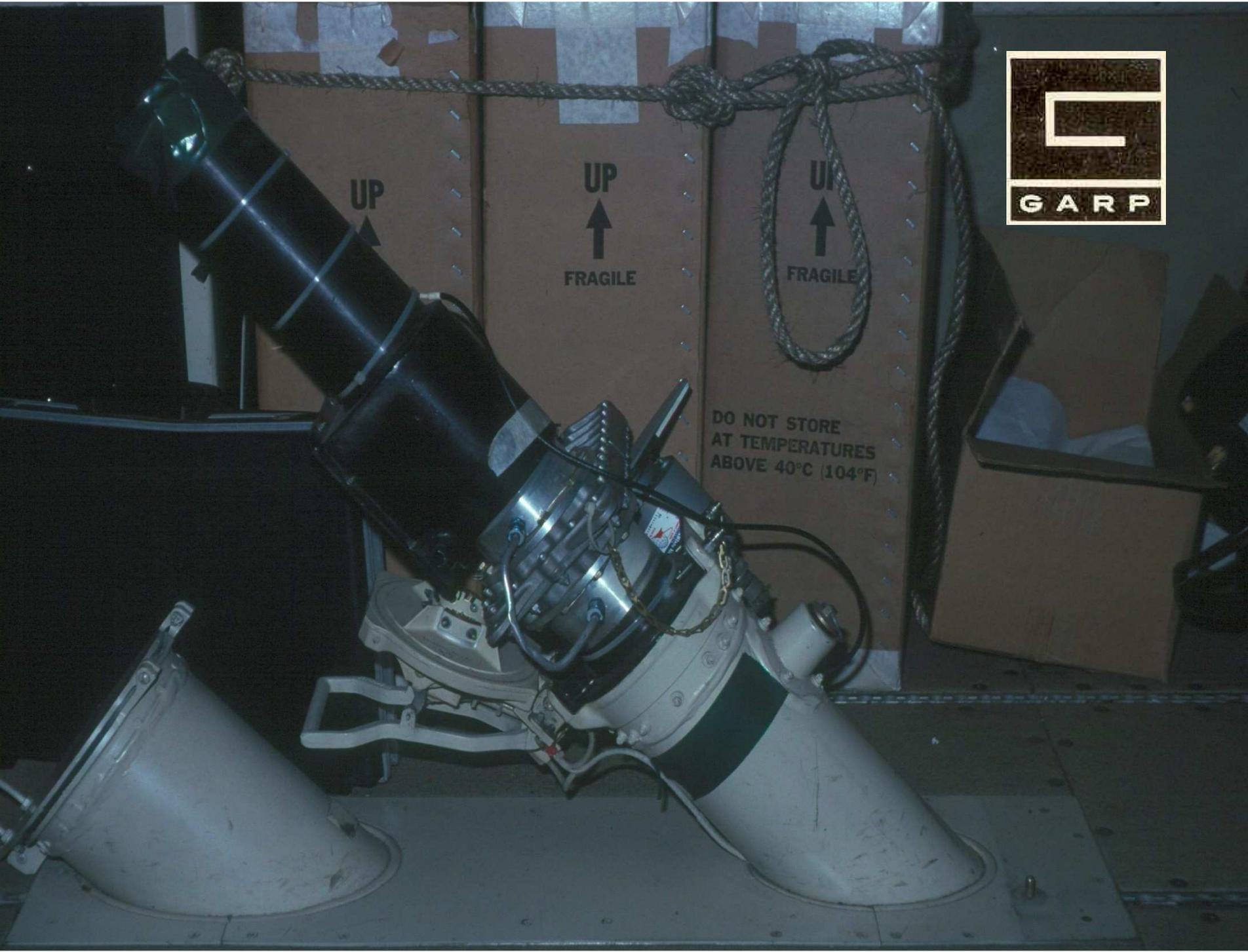


- Maury and others established the basic principles of operational meteorology and oceanography:
  - Common standards/formats for data collection
  - Common standards of data quality control and analysis
  - Free and open exchange of data/information for global public good
- Delivered the first systematically derived charts of global marine winds, waves and currents and laid the foundation for operational meteorology and oceanography
- Brussels conference led directly to the eventual formation of the WMO in 1947

# World Weather Watch

- Established by WMO in 1963
- Creation of a globally coordinated system of observations, data communications, data processing and forecasting





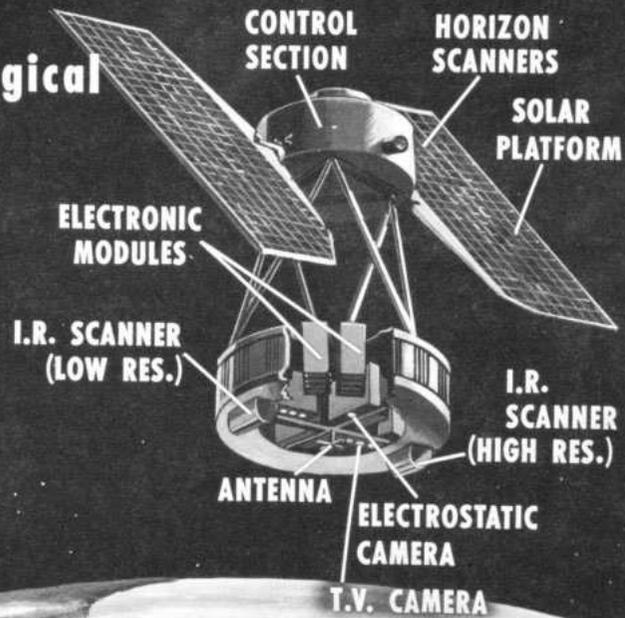
UP

UP  
↑  
FRAGILE

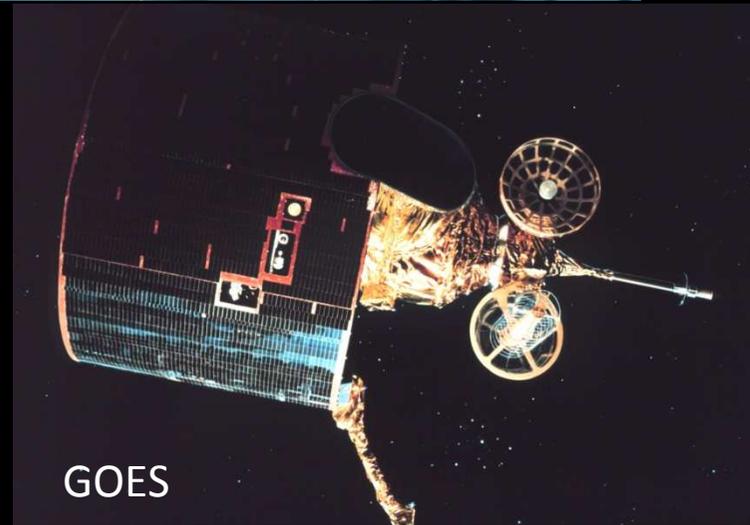
UP  
↑  
FRAGILE

DO NOT STORE  
AT TEMPERATURES  
ABOVE 40°C (104°F)

**NIMBUS**  
**Meteorological**  
**Satellite**  
**1962**



TIROS



GOES

# Computing



- Meteorology took early advantage of the revolution in computing to deliver routine operational products

- By 1990 Operational meteorology firmly established with World Weather Watch, combining satellite and *in-situ* observing systems, telecommunications, data processing and operational models
- Operational oceanography still in its infancy

# Why the difference?

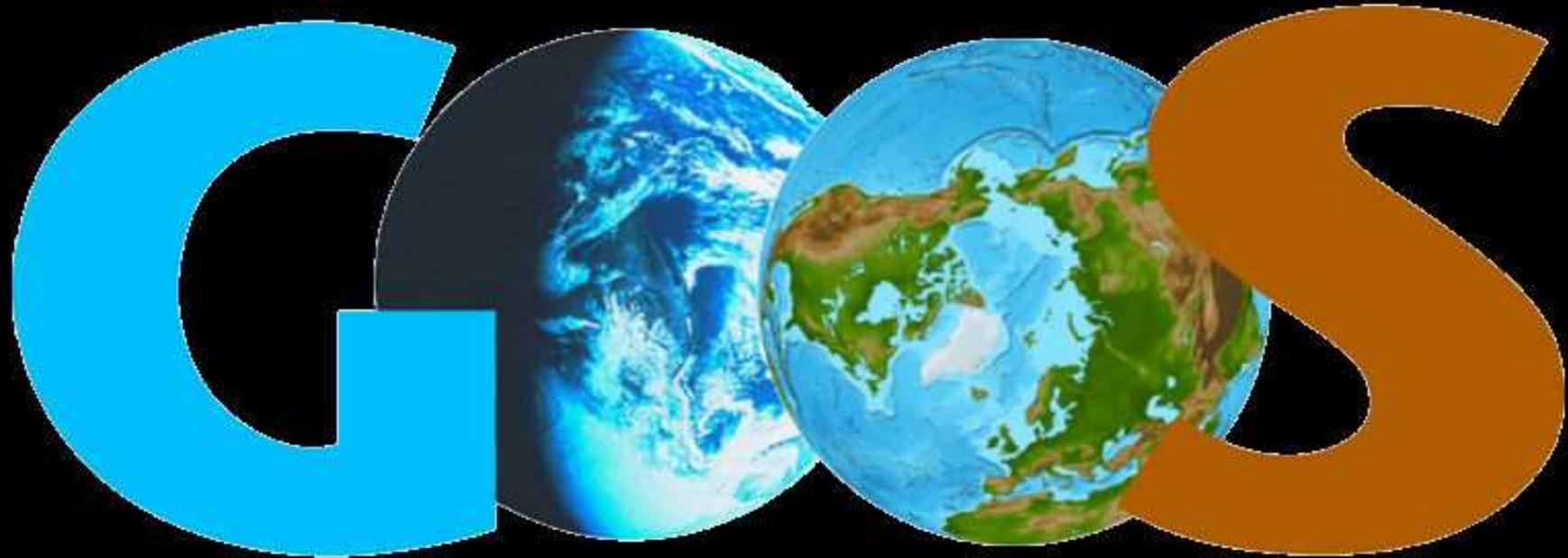
- Need for operational meteorology more pressing than for equivalent capability for the oceans
- Features of the ocean on a finer scale than the atmosphere
- Oceans a more complex chemical and biological environment than the atmosphere
- Technology of ocean observations more challenging than for the atmosphere
- Ocean opaque to radio waves so potential of satellite observations limited

# The oceans in weather and climate



- **Oceans are an enormous reservoir of heat**
- **Oceans contain 97% of Earth's water, hence they are fundamental in the global hydrological cycle.**
- **Oceans experience 86% of evaporation, hence they are central to energy exchange on planetary scales.**
- **Oceans receive 78% of planetary precipitation; for example, a 1% increase in Atlantic precipitation equals the annual Mississippi runoff.**
- ***The oceans control the timing and magnitude of changes in the global climate system.***

Operational oceanography finally became a global goal in 1990  
43 years after the establishment of the WMO



The Global Ocean Observing System

A joint initiative of:



IOC / UNESCO



WMO



UNEP



ICSS

# Mission of GOOS

- Support monitoring, understanding and predicting weather and climate
- Describe and forecast the state of the ocean, including living resources
- Improve management of marine and coastal ecosystems and resources
- Mitigate damage from natural hazards and pollution
- Protect life and property on coasts and at sea
- Enable scientific research



A Global 'system of systems' linking together existing and planned observing systems around the world

# The Open Ocean Implementation Plan

**G** GLOBAL  
**C** CLIMATE  
**O** OBSERVING  
**S** SYSTEM



WORLD METEOROLOGICAL  
ORGANIZATION

INTERGOVERNMENTAL  
OCEANOGRAPHIC COMMISSION

## IMPLEMENTATION PLAN FOR THE GLOBAL OBSERVING SYSTEM FOR CLIMATE IN SUPPORT OF THE UNFCCC

October 2004

GCOS - 92

(WMO/TD No. 1219)

UNITED NATIONS  
ENVIRONMENT PROGRAMME

INTERNATIONAL COUNCIL FOR  
SCIENCE

WORLD METEOROLOGICAL  
ORGANIZATION

INTERGOVERNMENTAL  
OCEANOGRAPHIC COMMISSION

## Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC

(2010 Update)

DRAFT v1.0

13 November 2009

GCOS Secretariat

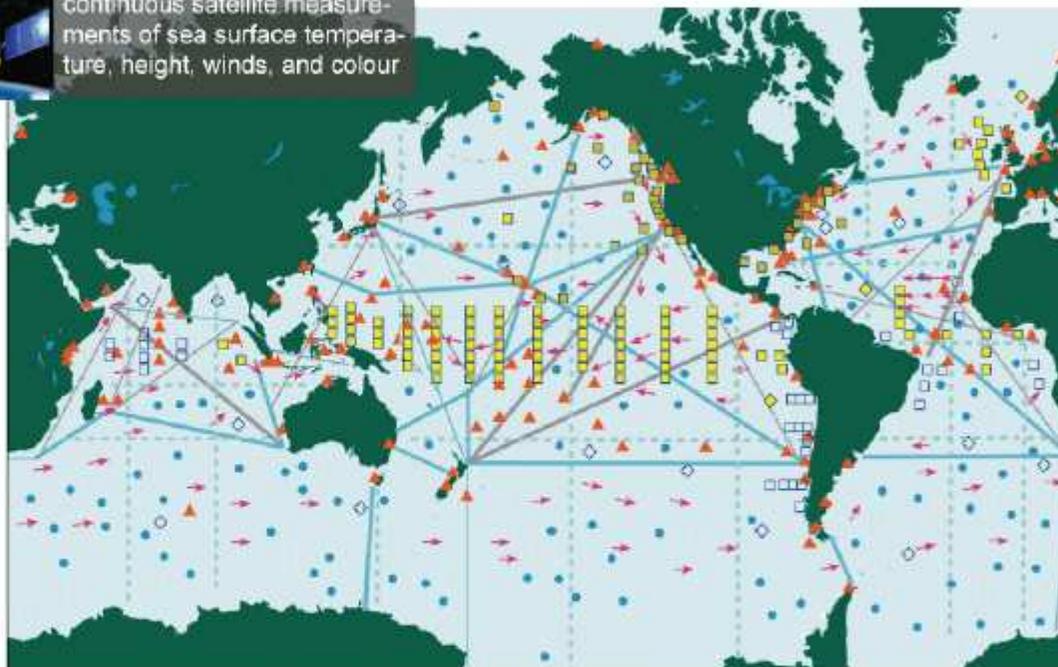
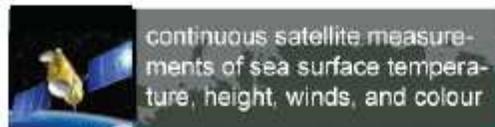
UNITED NATIONS  
ENVIRONMENT PROGRAMME

INTERNATIONAL COUNCIL FOR  
SCIENCE

# Initial Global Ocean Observing System for Climate

## Status against the GCOS Implementation Plan and JCOMM targets

Total *in situ* networks **62%** January 2010



**100%** Surface measurements from volunteer ships (VOSclim)  
200 ships in pilot project



**100%** Global drifting surface buoy array  
5° resolution array: 1250 floats



**59%** Tide gauge network (GCOS subset of GLOSS core network)  
170 real-time reporting gauges



**80%** XBT sub-surface temperature section network  
51 lines occupied



**100%** Profiling float network (Argo)  
3° resolution array: 3000 floats



**62%** Repeat hydrography and carbon inventory  
Full ocean survey in 10 years

Reference time series **48%**  
58 sites



**34%** Global reference mooring network  
29 moorings planned



**73%** Global tropical moored buoy network  
119 moorings planned



System % complete

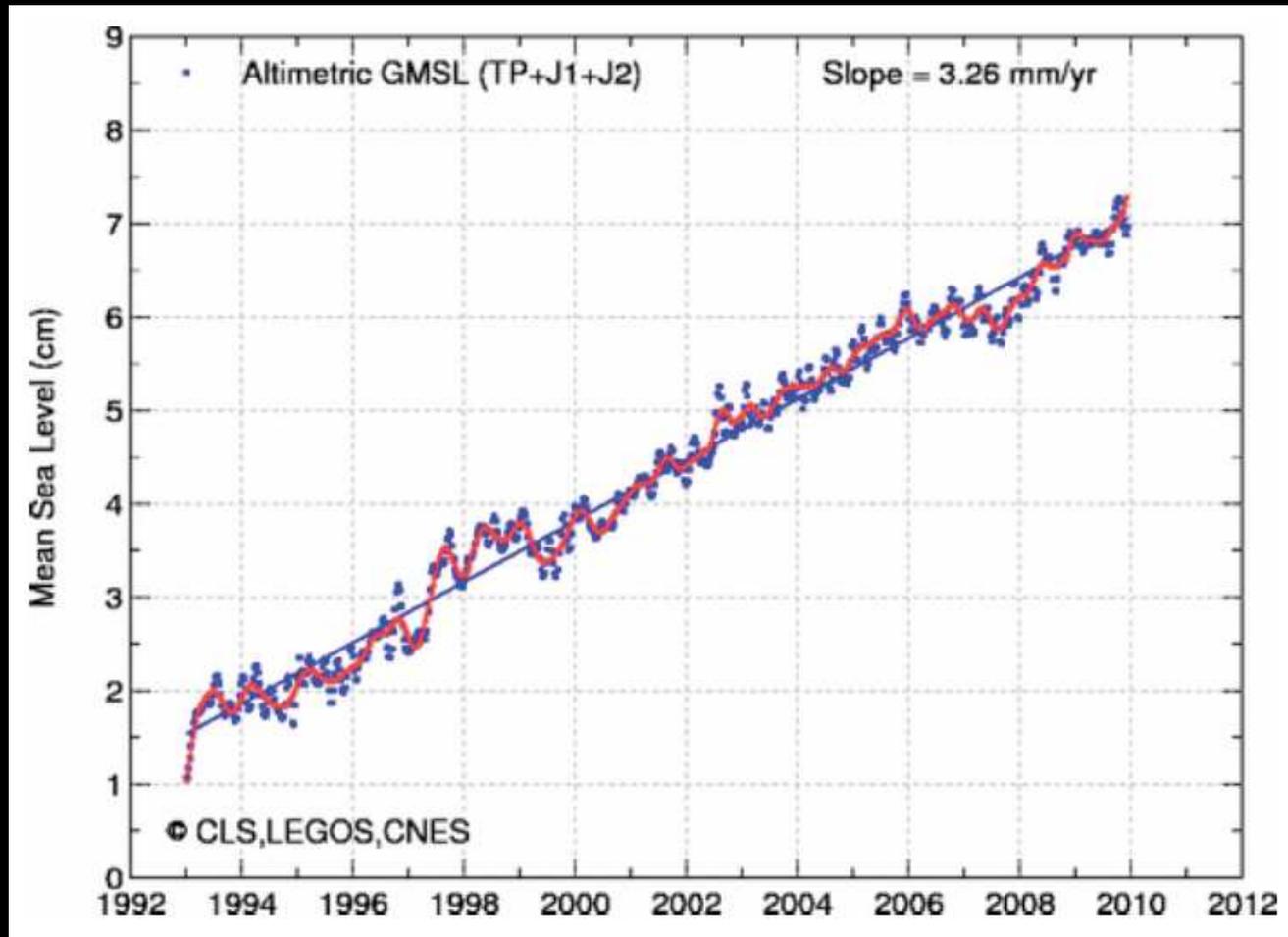


Original goal: 100% implementation in 2010

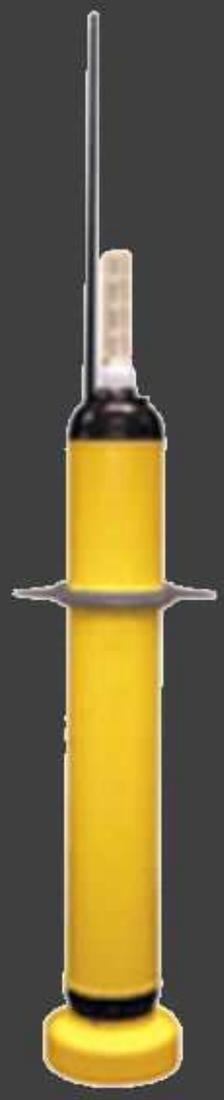




# Altimetric sea level

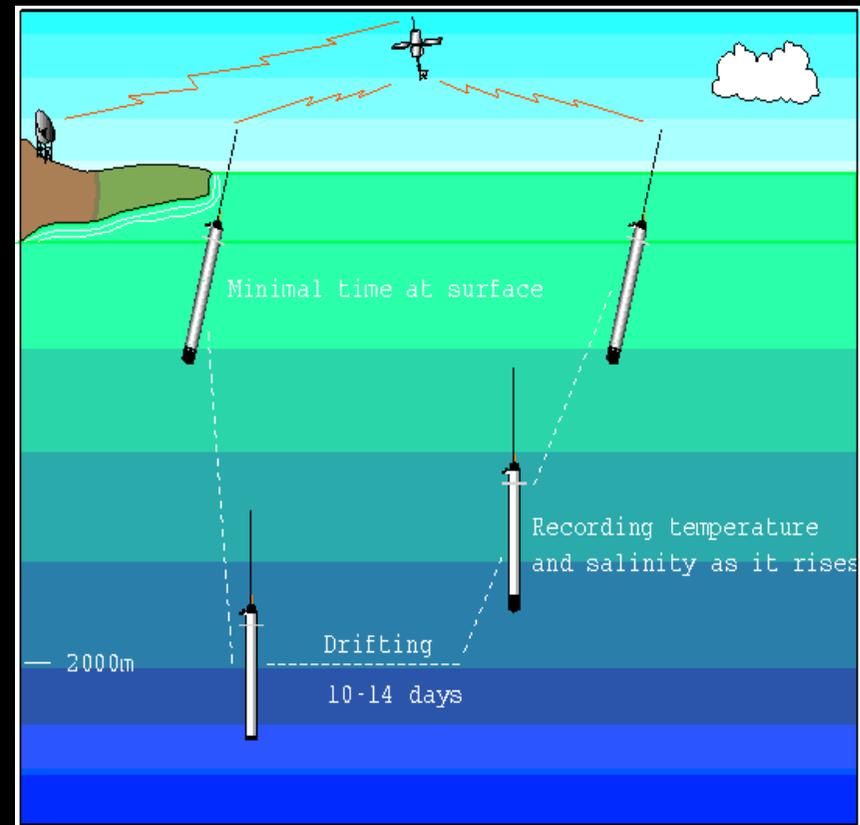
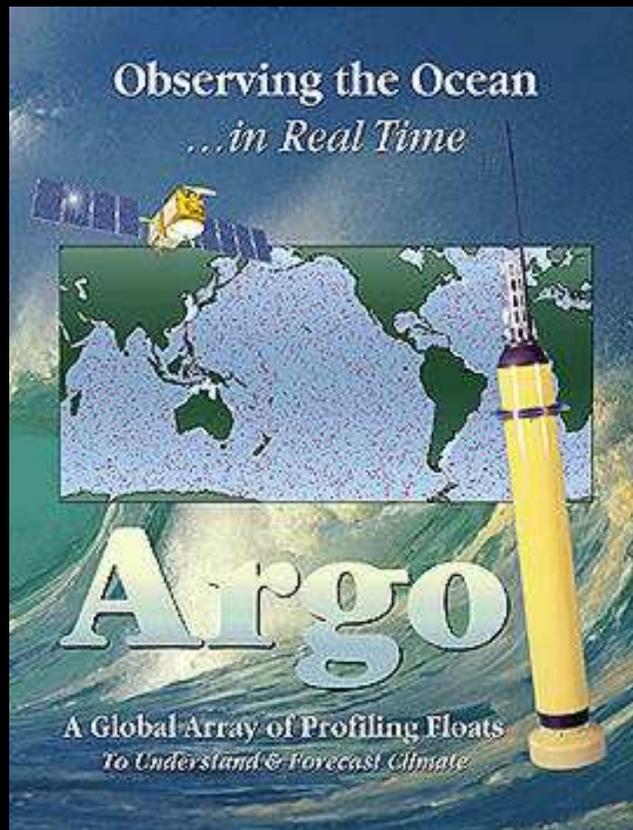


# Technology



- Comprehensive array of technologies for *in-situ* measurement
- Many emerging technologies transitioning into operational use





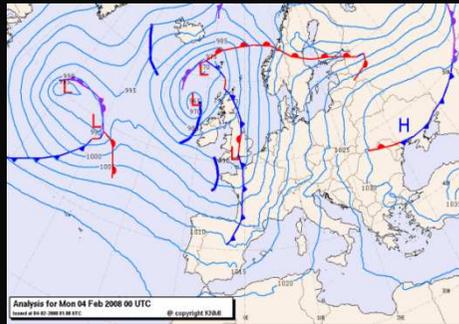
# Atmosphere Dynamics

# Ocean Dynamics

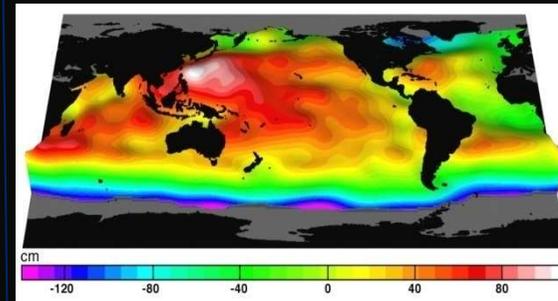
## Sea level air pressure

## Surface Height

1. Pressure



Observations:  
buoy, ship and  
dropsondes

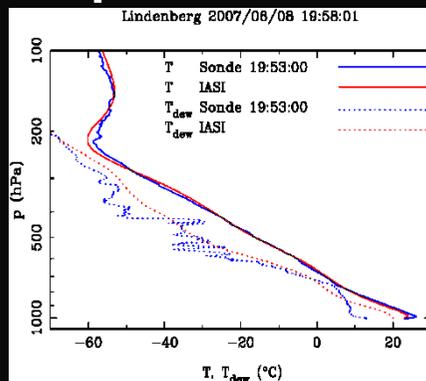


Observations:  
Satellite  
Altimetry

2. Density

## Temperature & Humidity

## Temperature & Salinity

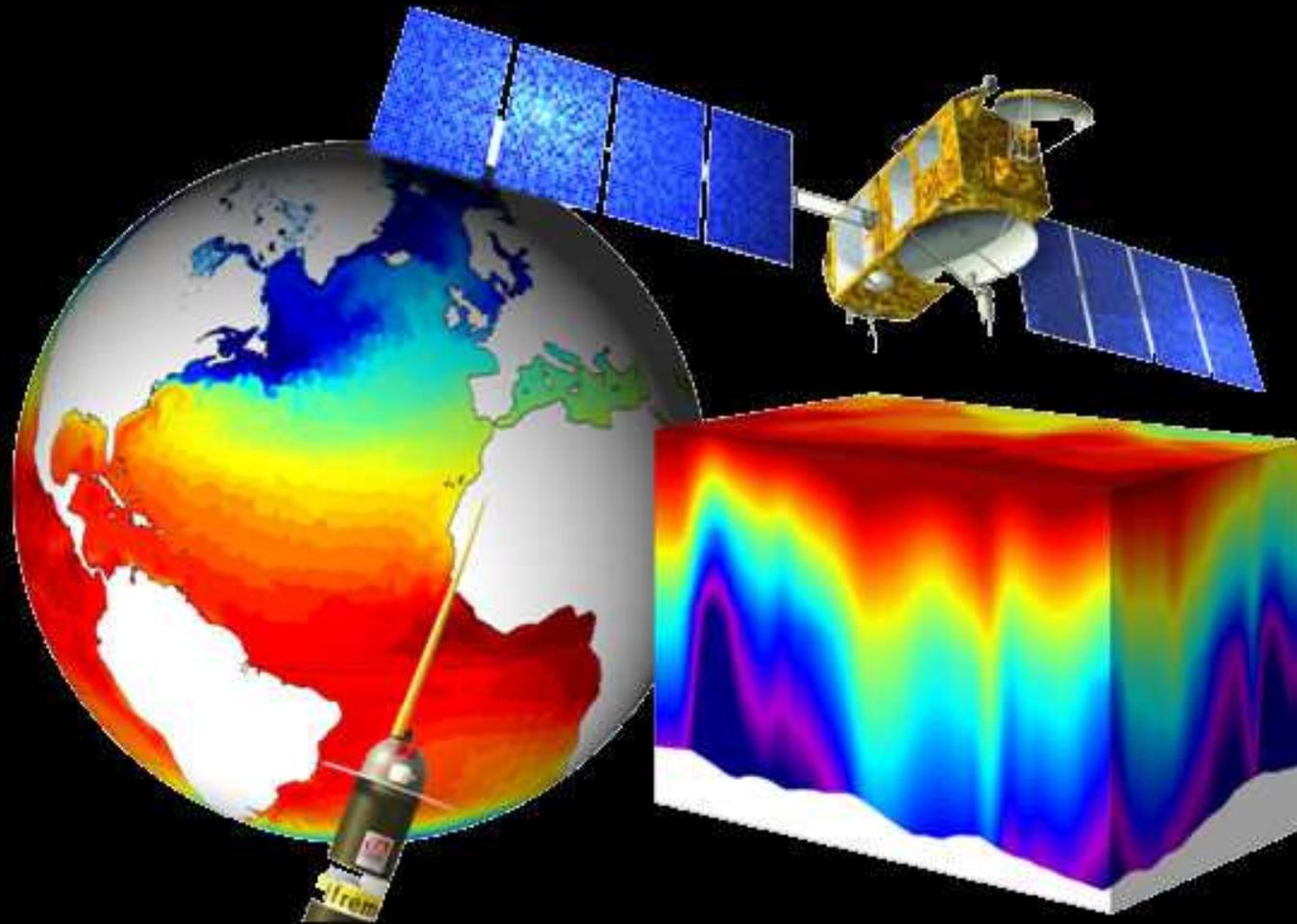


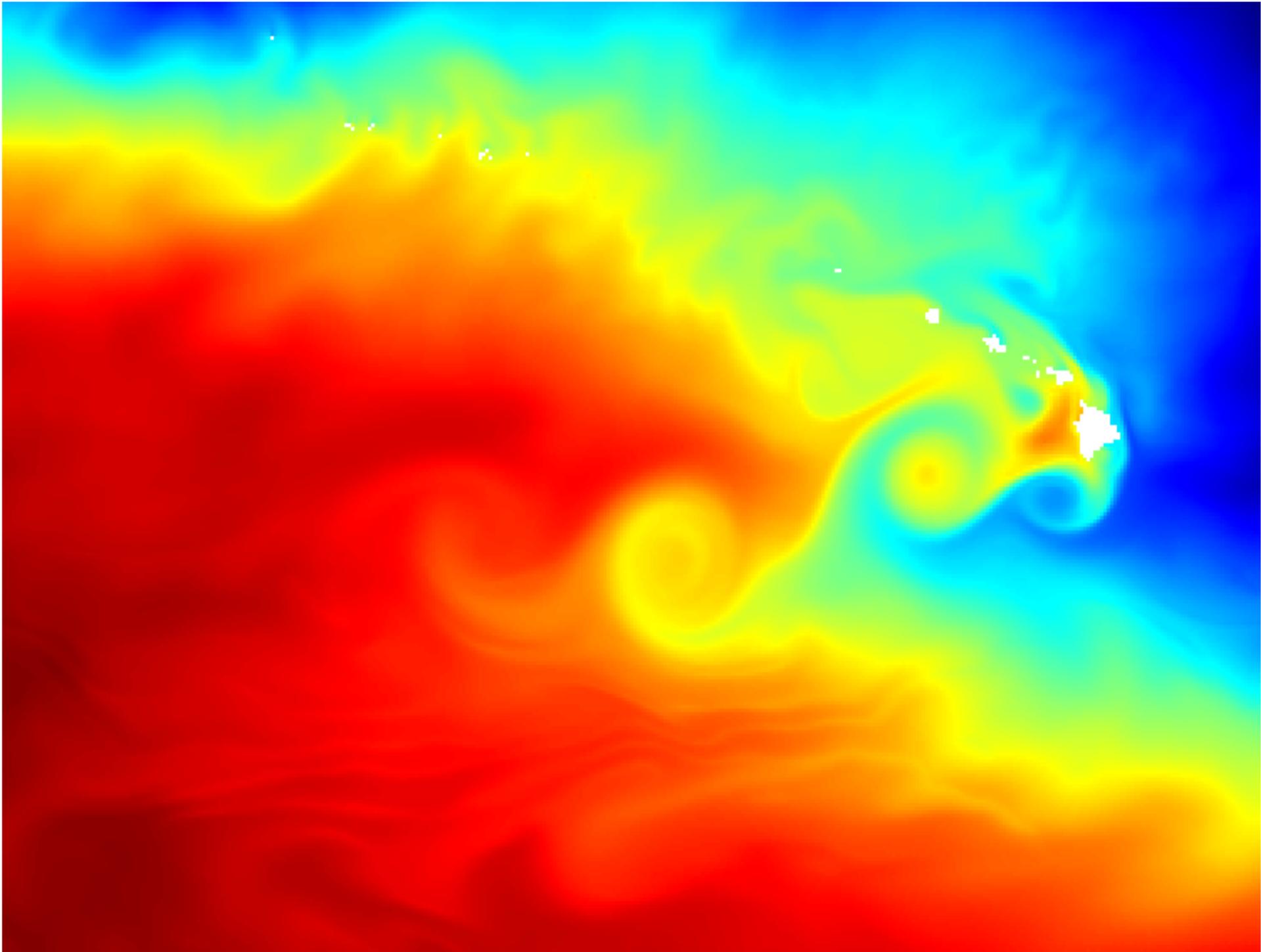
Observations:  
IASI on METOP



Observations:  
Argo floats

# Operational Systems



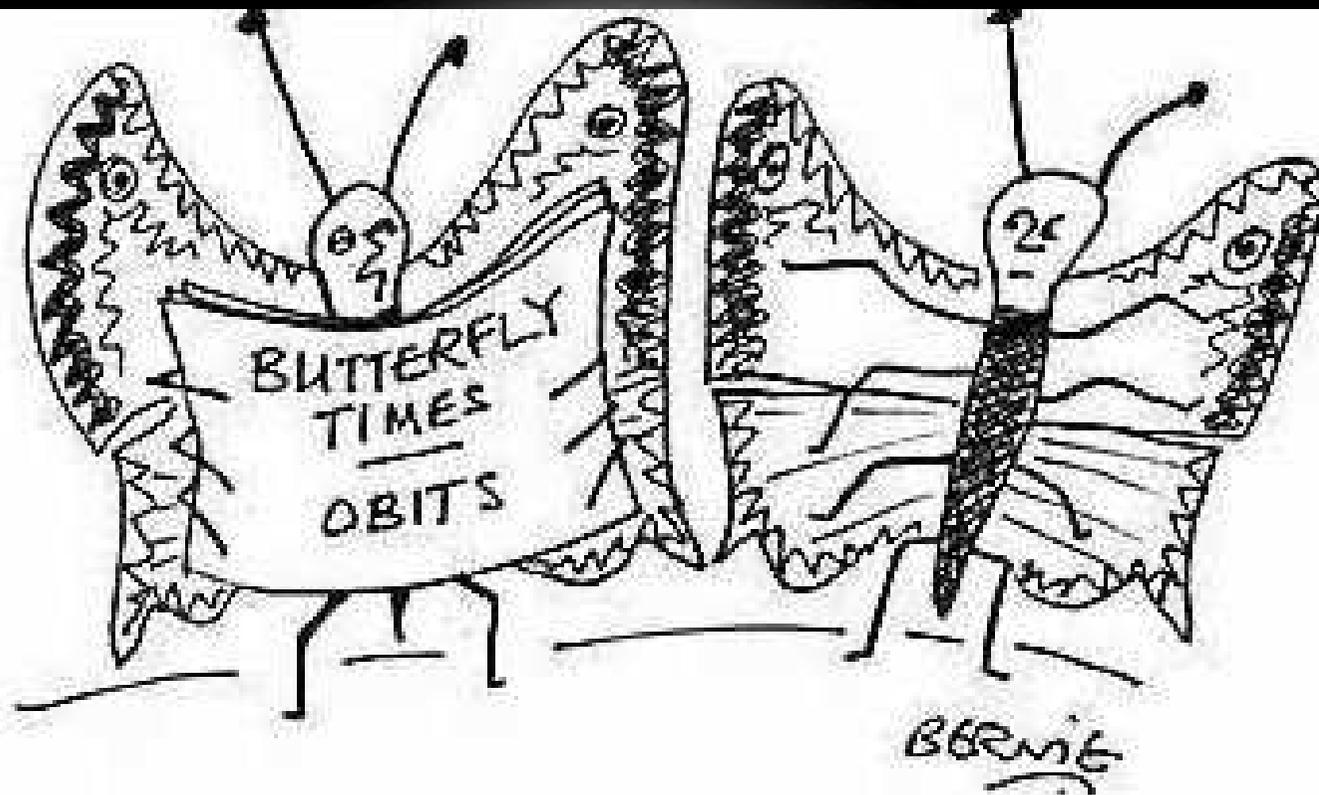


# Future challenges

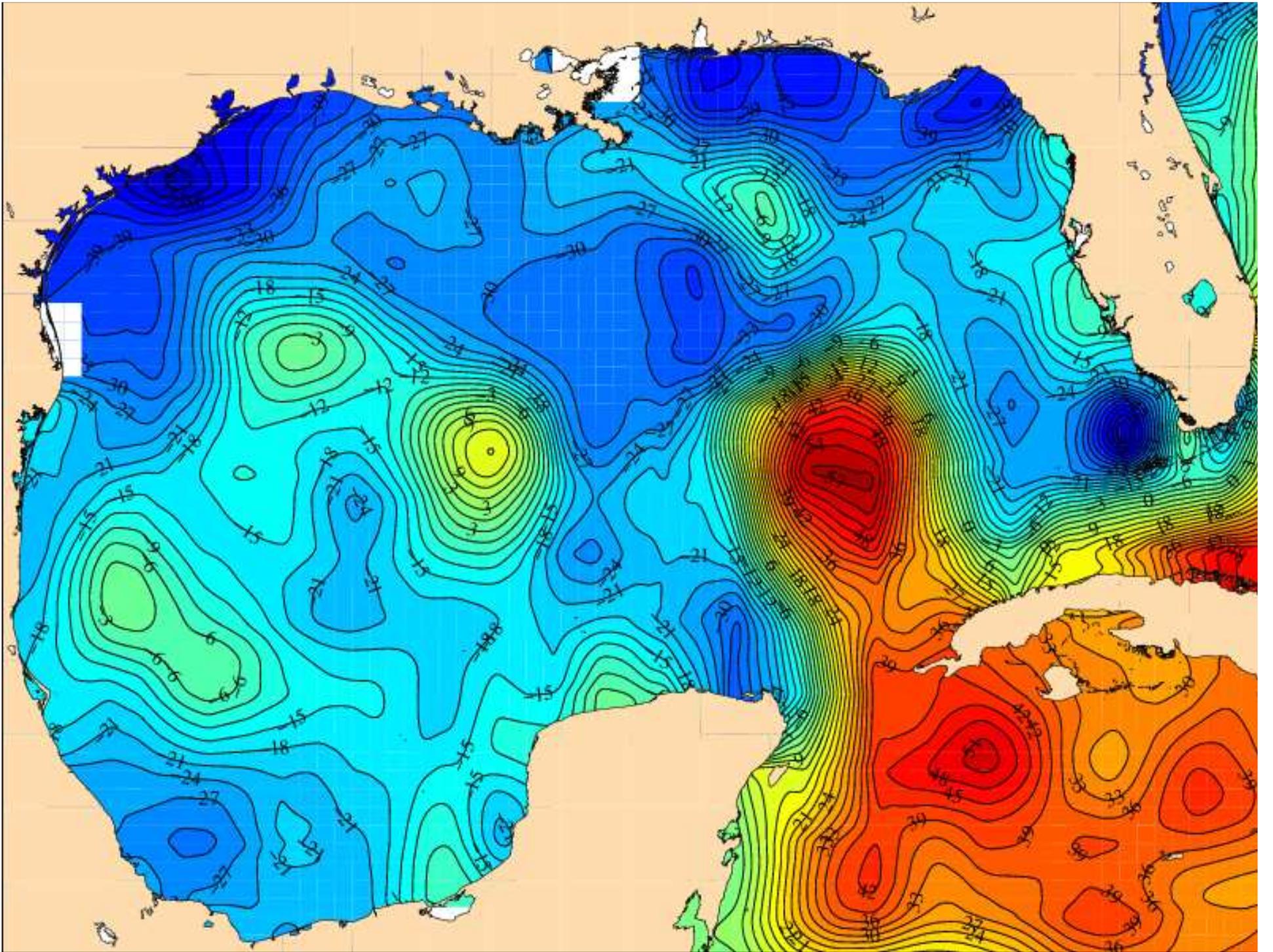


Making  
predictions is difficult –  
especially about the  
future

*Nils Bohr*



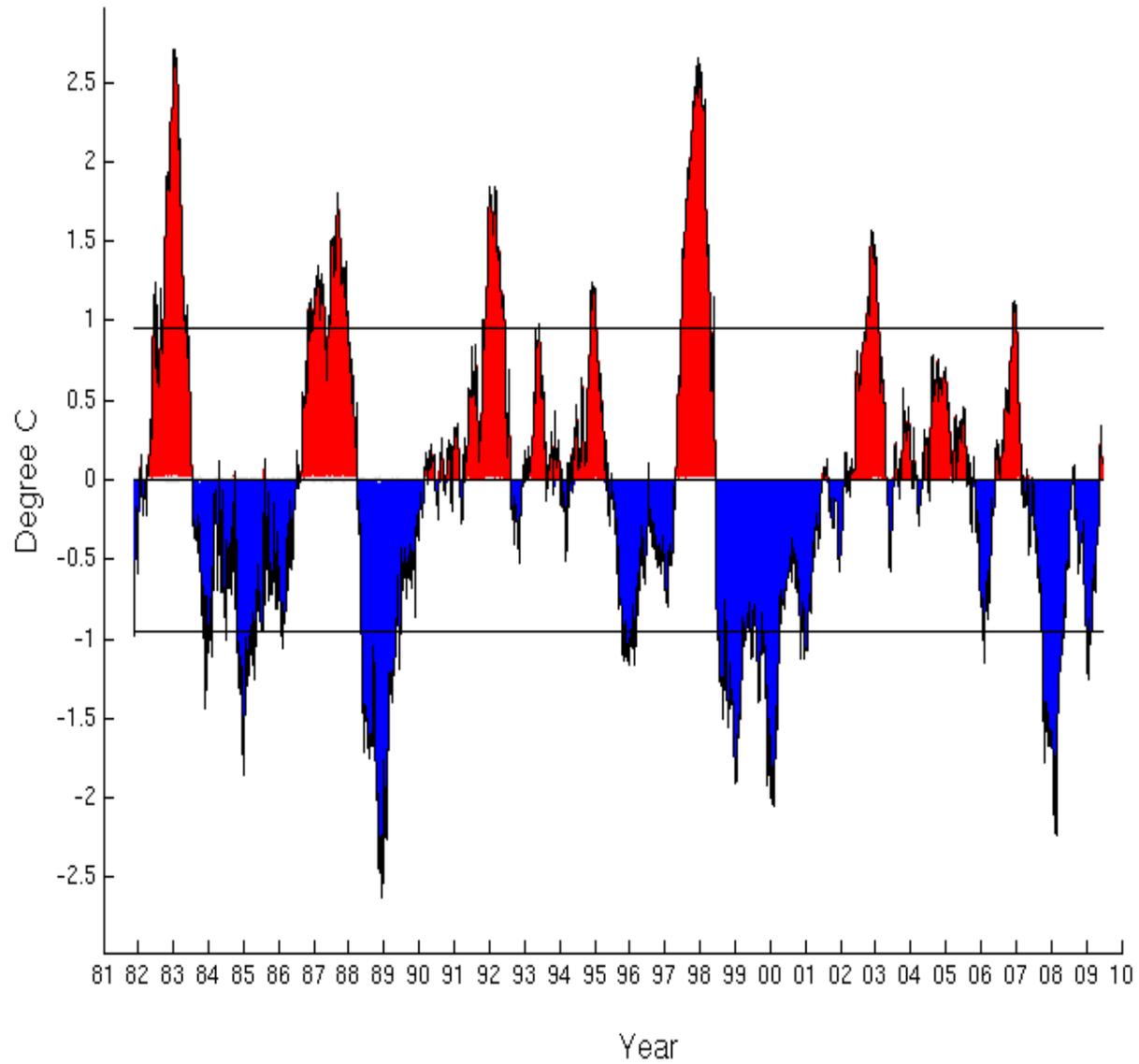
"He had a short but interesting life - for instance, did you know he was once responsible for a tornado in Texas.....?"



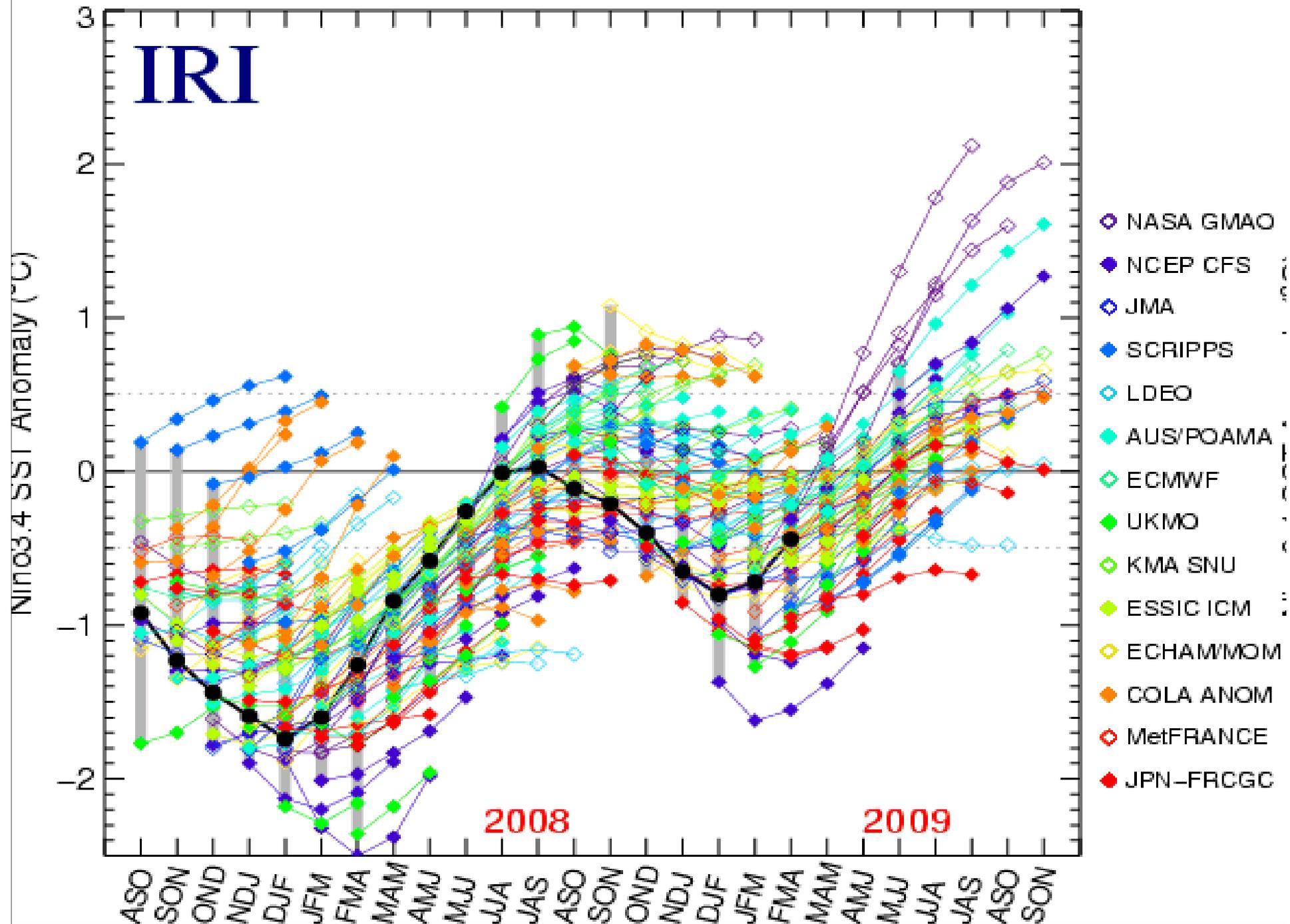




# Nino SSTA



# ENSO Forecast for dynamical models, Aug 07 – May 09



# Scientific Challenges

