A New User Interface for On-Demand Customizable Data Products for Sensors in a SensorWeb

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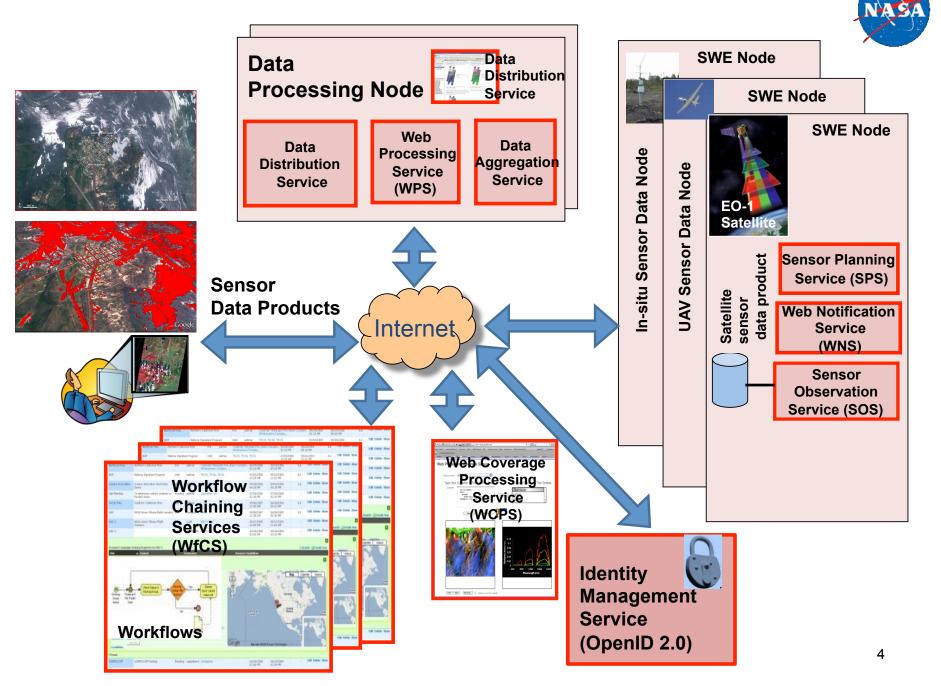
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Overview

- A SensorWeb is a set of sensors (land, marine, air, space) and processing that interoperate in an automated collaborative manner.

- The SensorWeb Toolbox is a set of software modules that have been created to enable users to create various SensorWebs

- The Web Coverage Processing Service (WCPS) is one of the components created in the SensorWeb Toolbox which is the subject of this presentation

  – WCPS enables a user to rapidly define an algorithm which can then be uploaded and run within a sensor system

  – WCPS shown in next diagram relative to other SensorWeb components
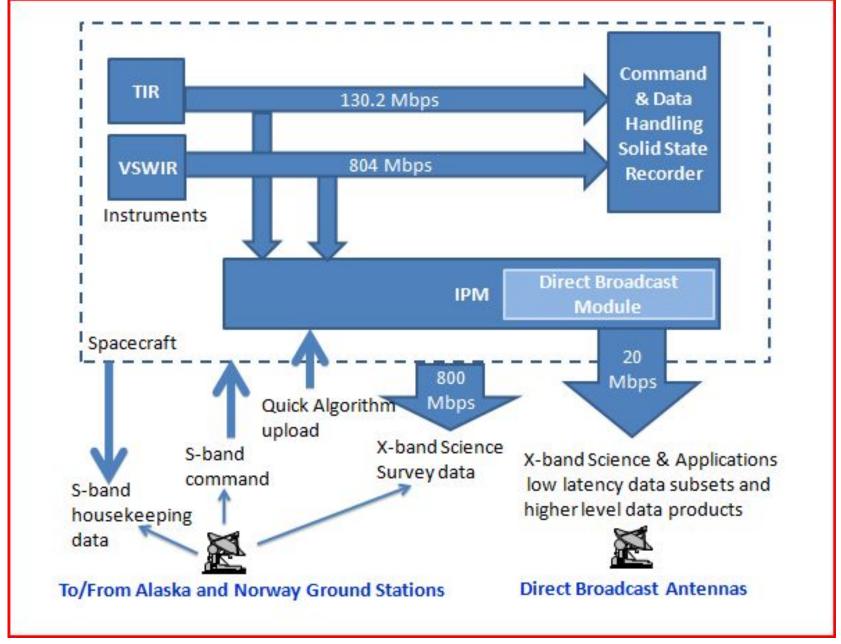
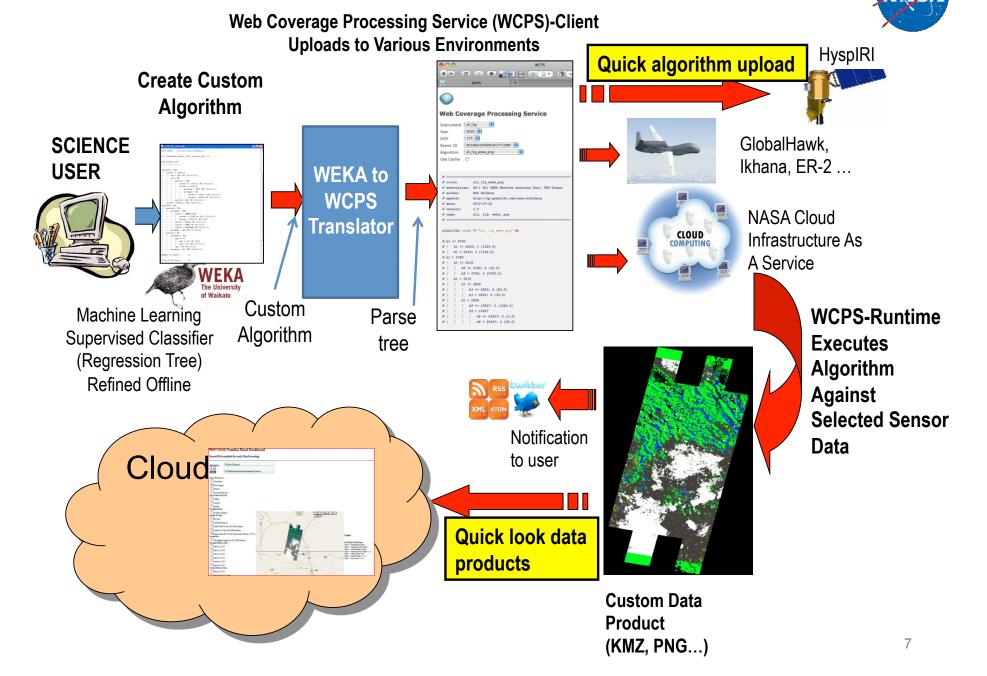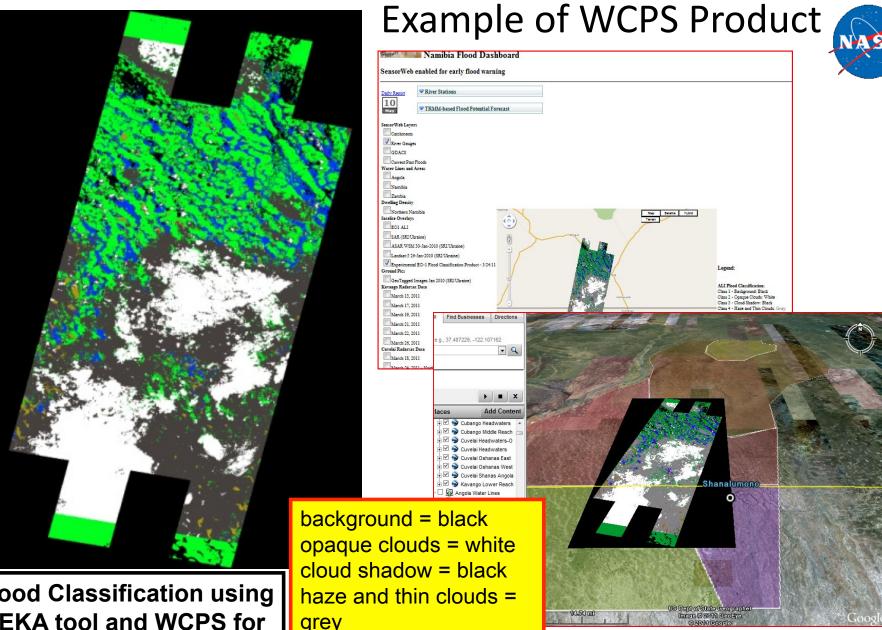# SensorWeb Reference Architecture

NASA Decadal Survey HyspIRI

Architecture of Intelligent Payload Module to be Used for HyspIRI

WCPS Quick Load/Quick Look Ops Con

**Web Coverage Processing Service (WCPS)-Client
Uploads to Various Environments**

**Create Custom
Algorithm**

Quick algorithm upload

HyspIRI

**SCIENCE
USER**

**WEKA to
WCPS
Translator**

GlobalHawk,
Ikhana, ER-2 …

NASA Cloud
Infrastructure As
A Service

Machine Learning
Supervised Classifier
(Regression Tree)
Refined Offline

Custom
Algorithm

Parse
tree

**WCPS-Runtime
Executes
Algorithm
Against
Selected Sensor
Data**

Cloud

Notification
to user

**Quick look data
products**

**Custom Data
Product
(KMZ, PNG…)**

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Example of WCPS Product

Flood Classification using WEKA tool and WCPS for Oshanas area in Namibia 3-24-11

background = black
opaque clouds = white
cloud shadow = black
haze and thin clouds = grey
clear water = blue
turbid water = brown
dry land = green

Another Example of WCPS Product
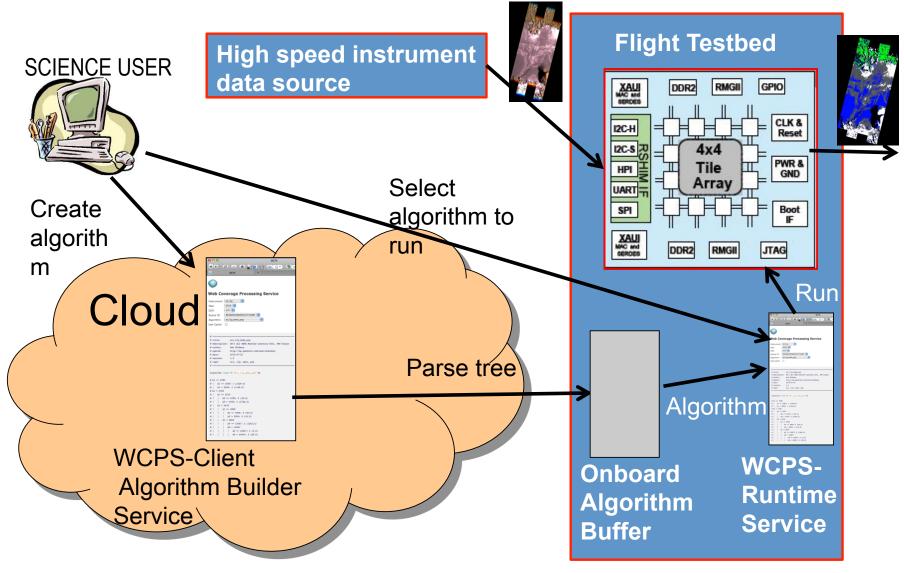
EO-1 ALI False Color Enhanced for Oil Sheen

Oil Classification Output Product

Mobile Bay

Mobile Bay

green = land
white = cloud & sand
black = cloud shadow
blue = clear water
grey = surface oil

WCPS Flight Testbed Ops Con (Summer 2011)

SCIENCE USER

High speed instrument data source

Flight Testbed

Create algorithm

Cloud

Select algorithm to run

Run

WCPS-Client Algorithm Builder Service

Parse tree

Onboard Algorithm Buffer

Algorithm

WCPS-Runtime Service
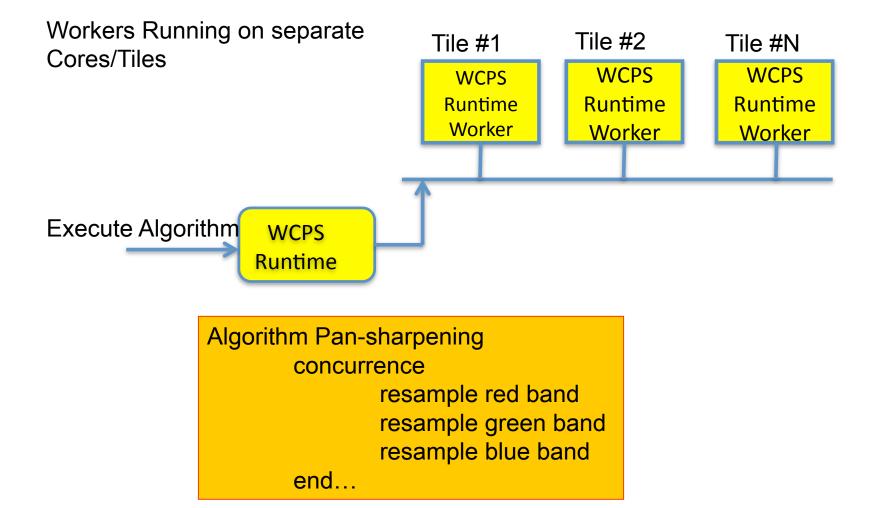
User Interface for Access to WCPS-Client and WCPS-Runtime
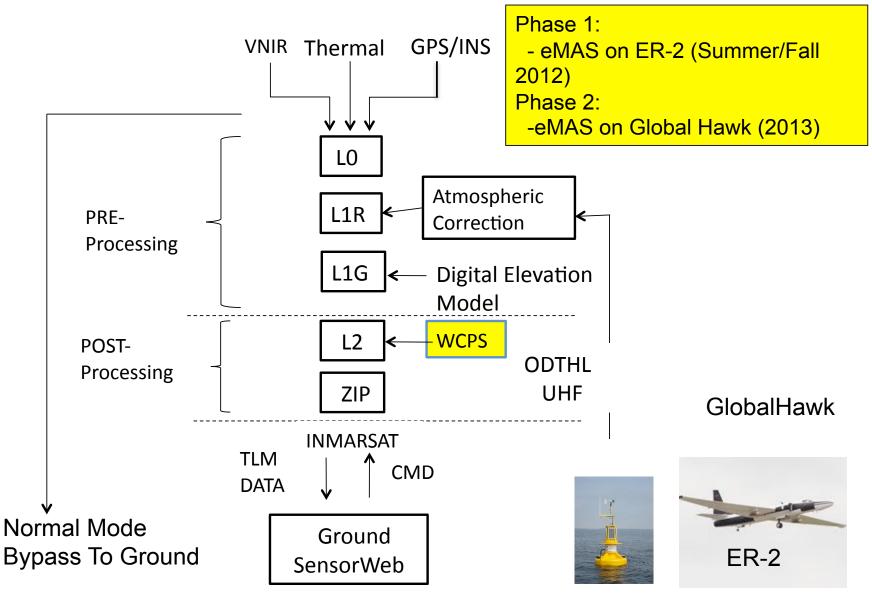
Sample Concurrent Processing for
Web Coverage Processing Service (WCPS)

Workers Running on separate
Cores/Tiles

Tile #1	Tile #2	Tile #N
WCPS Runtime Worker	WCPS Runtime Worker	WCPS Runtime Worker

Execute Algorithm → WCPS Runtime

Algorithm Pan-sharpening
        concurrence
                resample red band
                resample green band
                resample blue band
        end…

Pursuing Flight Opportunity To Test Operations Concept

VNIR   Thermal   GPS/INS

Phase 1:
 - eMAS on ER-2 (Summer/Fall 2012)
Phase 2:
 -eMAS on Global Hawk (2013)

L0

L1R ← Atmospheric Correction

L1G ← Digital Elevation Model

PRE-Processing

POST-Processing

L2 ← WCPS

ZIP

ODTHL UHF

GlobalHawk

INMARSAT

TLM DATA

CMD

Normal Mode Bypass To Ground

Ground SensorWeb

ER-2

eMAS – Enhanced MODIS Airborne Simulator

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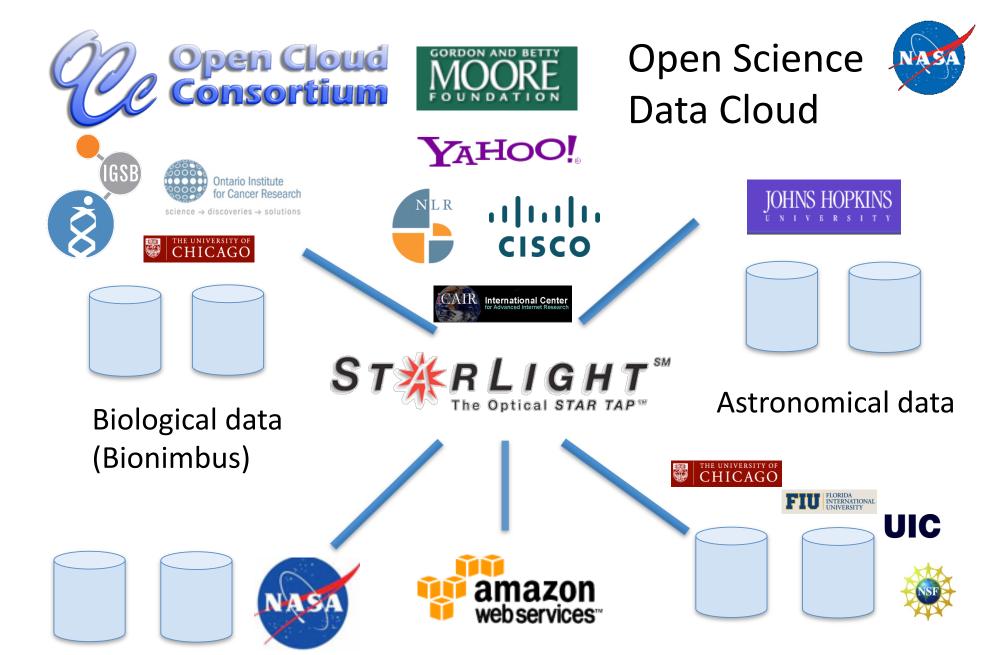
Details of First Use of Cloud with WCPS

- First experiments using WCPS with Cloud occurred in collaboration with Open Cloud Consortium which provided a Cloud rack of equipment and personnel for system administration, funded by National Science Foundation
  - ➢ Next slide shows connectivity of cloud
- Cloud integrated into Earth Observing 1 operations and WCPS used for ground data products
- User interface, along with WCPS-C and WCPS-R are all hosted on cloud
  - ➢ For other missions each of these components can reside in different places.

Open Science Data Cloud

Biological data (Bionimbus)

Astronomical data

Earth science data (& disaster relief)

NSF-PIRE OSDC Data Challenge

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Cloud Integration on EO-1 - Overview

Hyperion and ALI Level 0 Processed data from GSFC, building 3 server

External users, especially international (e.g. disaster workers)

NASA Investigators

Technologists

Starlight 100 Gigabit Ethernet Exchange

10 Gbps

Level 1R and Level 1G Processing for ALI & Hyperion

Atmospheric Correction for ALI & Hyperion

Web Coverage Processing Service (WCPS) to enable users to customize Level 2 products

Nambia Flood Dashboard
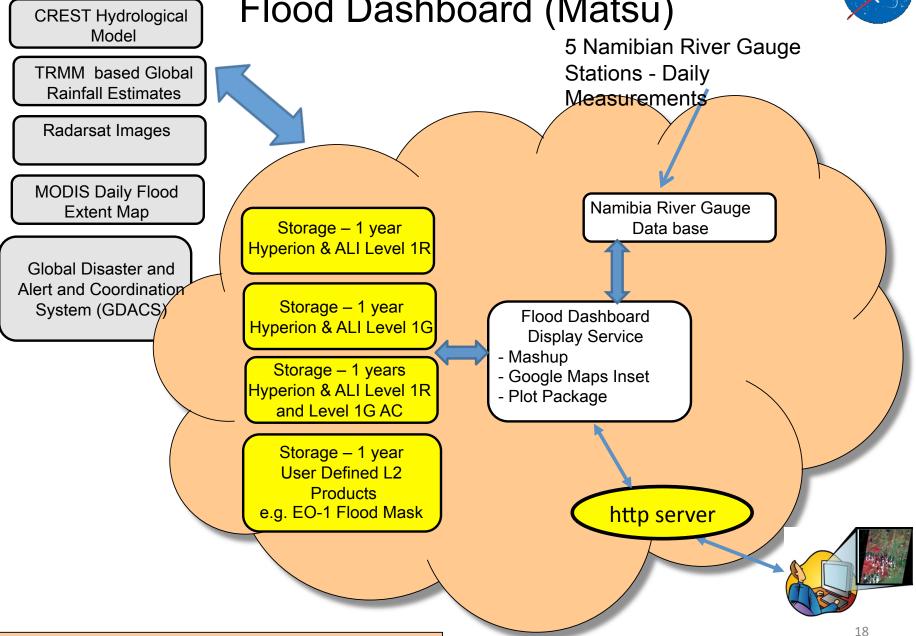
2 year data product archive

Eucalyptus-based Elastic Cloud SW
300+ core processors
40 x 2 Tbytes of storage
10 Gbps connection to GSFC
 - being upgraded to 80 Gbps (Part of OCC)
At Univ of Illinois at Chicago
Supplied by Open Cloud Consortium
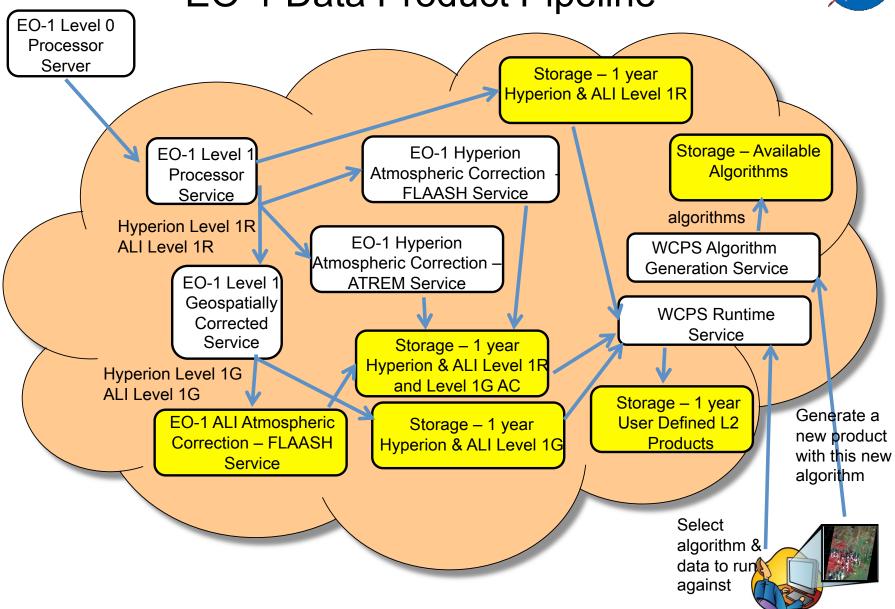Open Science Data Cloud Virtual Machines & HTTP server to VM's

OCC = Open Cloud Consortium

Added Elastic Cloud to EO-1 Operations April 2011

Transformation to On-Demand Product Cloud Part 1
EO-1 Data Product Pipeline

EO-1 Level 0 Processor Server

Storage – 1 year Hyperion & ALI Level 1R

EO-1 Level 1 Processor Service

EO-1 Hyperion Atmospheric Correction – FLAASH Service

Storage – Available Algorithms

Hyperion Level 1R
ALI Level 1R

EO-1 Hyperion Atmospheric Correction – ATREM Service

algorithms

WCPS Algorithm Generation Service

EO-1 Level 1 Geospatially Corrected Service

WCPS Runtime Service

Hyperion Level 1G
ALI Level 1G

Storage – 1 year Hyperion & ALI Level 1R and Level 1G AC

EO-1 ALI Atmospheric Correction – FLAASH Service

Storage – 1 year Hyperion & ALI Level 1G

Storage – 1 year User Defined L2 Products

Generate a new product with this new algorithm

Select algorithm & data to run against

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Added Elastic Cloud to EO-1 Operations April 2011

On-Demand Product Cloud Part 2
Flood Dashboard (Matsu)

CREST Hydrological Model

TRMM based Global Rainfall Estimates

Radarsat Images

MODIS Daily Flood Extent Map

Global Disaster and Alert and Coordination System (GDACS)

5 Namibian River Gauge Stations - Daily Measurements

Namibia River Gauge Data base

Storage – 1 year Hyperion & ALI Level 1R

Storage – 1 year Hyperion & ALI Level 1G

Storage – 1 years Hyperion & ALI Level 1R and Level 1G AC

Storage – 1 year User Defined L2 Products e.g. EO-1 Flood Mask

Flood Dashboard Display Service
- Mashup
- Google Maps Inset
- Plot Package

http server

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Added Elastic Cloud to EO-1 Operations April 2011

Conclusion

- WCPS provide a unique capability to control in near realtime the method by which raw sensor data is processed onboard or on the ground

- The WCPS software is flexible and can be set up in a variety of ways
  - Distributed or centralized

- Largest impact of WCPS will in airborne and satellite sensor based communities because it is a paradigm shift on how onboard algorithms get updated versus traditional methods
  - More flexibility
  - Faster
  - Less expensive