

How to Cloud for Earth Scientists: An Introduction

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Outline



- Cloud Basics
- What good is cloud computing to an Earth Scientist?
- What's the catch?
- Getting Started...

What Cloud Computing Is



- "Someone else's computer"...
- ...but also someone else's problem
- Rent instead of own, like:
 - A box truck (Bigger than your Sport Utility Vehicle)
 - A seat on an airplane (Faster than your sports car)
- Computing a la carte
- Service-based computing

What Cloud Computing Isn't



It's not the solution for everything It's not the solution for everyone

So Why Should We Care?



More and bigger data are coming! 200+ PB to EOSDIS

Cloud Fundamentals - Elasticity



- Elastic = scaling up, down or sideways instantly
 - Compute:
 - more or less
 - optimized for compute, memory, or input/output
 - Storage:
 - more or less
 - faster or slower
- Elastic = pay for only what you use
 - (Remember to turn off when not using!)



"Undifferentiated Heavy Lifting"

Stuff for which you need remote sensing expertise

Radiative transfer modeling

Atmospheric correction

Geophysical parameter retrievals

"Undifferentiated Heavy Lifting"



Stuff for which you need Earth science expertise	Stuff for which you DON'T need Earth science expertise
Radiative transfer modeling	Finding available floor space for computers
Atmospheric correction	Installing and patching operating systems
Geophysical parameter retrievals	Calculating power and cooling requirements



What Good Is Cloud Computing to an Earth Scientist???

Go Faster



- Commercial cloud CPUs are faster than ours...
- And you can use as many as you want
- Uses
 - Near-real-time processing
 - Massive reprocessing
 - Compute-intensive analysis
 - Deep learning

Pop Quiz!



If a compute-optimized CPU with 16 cores costs 80 ¢ / hr... And you need 1000 CPU-hours to compute your calculation... Which of these is cheaper?

1 CPU running for 1000 hours
 1000 CPUs running for 1 hour

Answer:



1 CPU * 1000 Hrs * 0.8 = \$800 1000 CPU * 1 Hr * 0.8 = \$800

Go Bigger



- Many levels of storage
 - Fast but expensive: \$0.30 / GB-month
 - Slow but dirt-cheap: \$0.025 ¢ / GB-month
- You can have as much as you want
- Uses
 - Short-term storage of large interim results
 - Long-term storage of data that you *might* need some day

Go Cheaper



Pay only for what you use

- CPU
- Storage

Uses

- Short bursts of lots of processing
- Lots of storage needed for a short time

The OCO-2* Reprocessing Story

Motivation for reprocessing OCO-2 in the cloud
 Conflicts with supercomputer down time schedule
 Increase in computing needs



*OCO-2: Orbiting Carbon Observatory #2

The OCO-2 Reprocessing Story



Auto-Scaling Science Data System

 The size of the science data system compute nodes can automatically grow/shrink based on processing demand



Auto-scaling tests to 3000 compute workers

96,000 x l2_fp simultaneous processors

Courtesy Hook Hua, NASA/Jet Propulsion Laboratory

What's the Catch?



- 1. New processing paradigm
- 2. Failures
- 3. Egress charges

Catch #1: New Processing Paradigm

Bad News:

To get the speedup, you must:

- Spread input data around
 Go analyze the pieces
- 3. Reassemble final result

Catch #1: New Processing Paradigm



Good News:

- LOTS of packages and frameworks to help with this
- 1. Distributed Data Stores
 - a. Databases (Cassandra, Athena...)
 - b. Filesystems (HDFS...)
- 2. Processing frameworks (MapReduce, Spark)

Pssst....think seriously about learning Python (just sayin')

Catch #2: Failures



Bad News:

thousands of computers

+ thousands of "disks"

bad stuff happens

Catch #2: Failures

NASA

Good News:

- Many cloud technologies exist to provide resiliency to hardware failures
- BUT our programs need to be able to pick themselves up and/or restart somewhere else
 - Don't rely on local temporary files for checkpoints

Catch #3: "Egress" charges



Moving results from cloud to your machine costs money:

1 GB	Free!
10 TB	\$900
50 TB	\$4,700
150 TB	\$12,000

Analyze as much as you can in the cloud to reduce output size

Getting Started with Cloud...



- Many vendors offer free tiers for learning
- There is a *lot* of online training
- More "How to Cloud" seminars to come?
 - Short-learning-ramp ways to use cloud?
 - Example science uses?
 - What would YOU like to see?

Pssst....don't forget about the Python thing.