

### Climate Change, People, and the Carbon Cycle

#### An emerging challenge:

Supporting Greenhouse Gas Management Strategies with Observations, Modeling, and Analysis





# Why this is an urgent issue

- The primary cause of climate change and ocean acidification is the increase of greenhouse gases (GHGs) in the atmosphere, predominantly carbon dioxide
- Three reasons for having more and better information
  - Climate feedbacks
  - Success of GHG management
  - Ocean Acidification





## Why Regional Scale Information?

- Societies are advancing efforts to reduce CO<sub>2</sub> emissions
- Mitigation efforts are diverse and vary by nation, region, & emission sector
- The complexity & variability of the carbon cycle, the scale of the problem, and the number of GHGs make tracking these efforts challenging, but surmountable
- Large-scale emission reduction approaches require <u>independent</u>, scientific monitoring to support verification and policy decisions
  - Ozone Depletion
  - Air Quality
  - Acid Rain



### Tools for Global Monitoring Greenhouse Gases



- "Bottom-up" measurements (Accounting = "checkbook")
  - Emissions reporting
  - Reported and "verified" offsets
  - Site-specific measurements
- "Top-down" measurements (Validation = "bank statement")
  - Comprehensive atmospheric observation system
  - Ecosystem and ocean observations
- Reanalysis (compares checkbook with bank statement)
  - Transport model
  - Assimilation
  - Regional fluxes (emission and uptake)





there is more cackle than tackle."

Int'l Conf. Research Infrastructures 21-23 March, 2012



### **Specific Needs for the Future**

- Sampling & Measurement
  - Improve techniques and approaches
  - Develop robust sampling instruments
  - Sustain long-term observations
  - Expand observing systems (3 ways)
- Data Records
  - Quantify "uncertainty"
  - Strengthen data centers
    - o Accessibility
    - o Evaluation
    - o Coordination

- Modeling and Analysis
  - Increase computing capacity
  - Achieve finer transport resolution
  - Improve ensemble assimilation
- Products
  - Determine societal need for products
  - Design and develop products
- Success
  - Centrally managed funds work



#### **Backup Slides**

GHGs - An emerging challenge JH Butler, NOAA Int'l Conf. Research Infrastructures 21-23 March, 2012





GHGs - An emerging challenge JH Butler, NOAA Page 9





#### One "Systems Approach"









GHGs - An emerging challenge JH Butler, NOAA



## **Climate Feedbacks**



 Thawing permafrost has the potential to release huge amounts of CO<sub>2</sub> and methane.

GHGs - An emerging challenge JH Butler, NOAA

- Half of the CO<sub>2</sub> emitted by fossil fuel burning is absorbed by the ocean and biosphere.
- Will this continue?

#### Permafrost is thawing





## Greenhouse Gas Management







#### REDD+

REDD+ helps to mitigate climate change through forests, and provides social and environmental benefits. It includes these essential components: creating incentives for not clearing standing forests, maintaining and expanding forest cover, sustainably managing forest and recovering degraded lands.



• What works?

• How well does it work?



## **Ocean Acidification**

 Regardless of climate change, the ocean becomes increasingly acidic with rising CO<sub>2</sub> in the atmosphere.





