On the Cost and Benefits of Meteorological Satellite Systems

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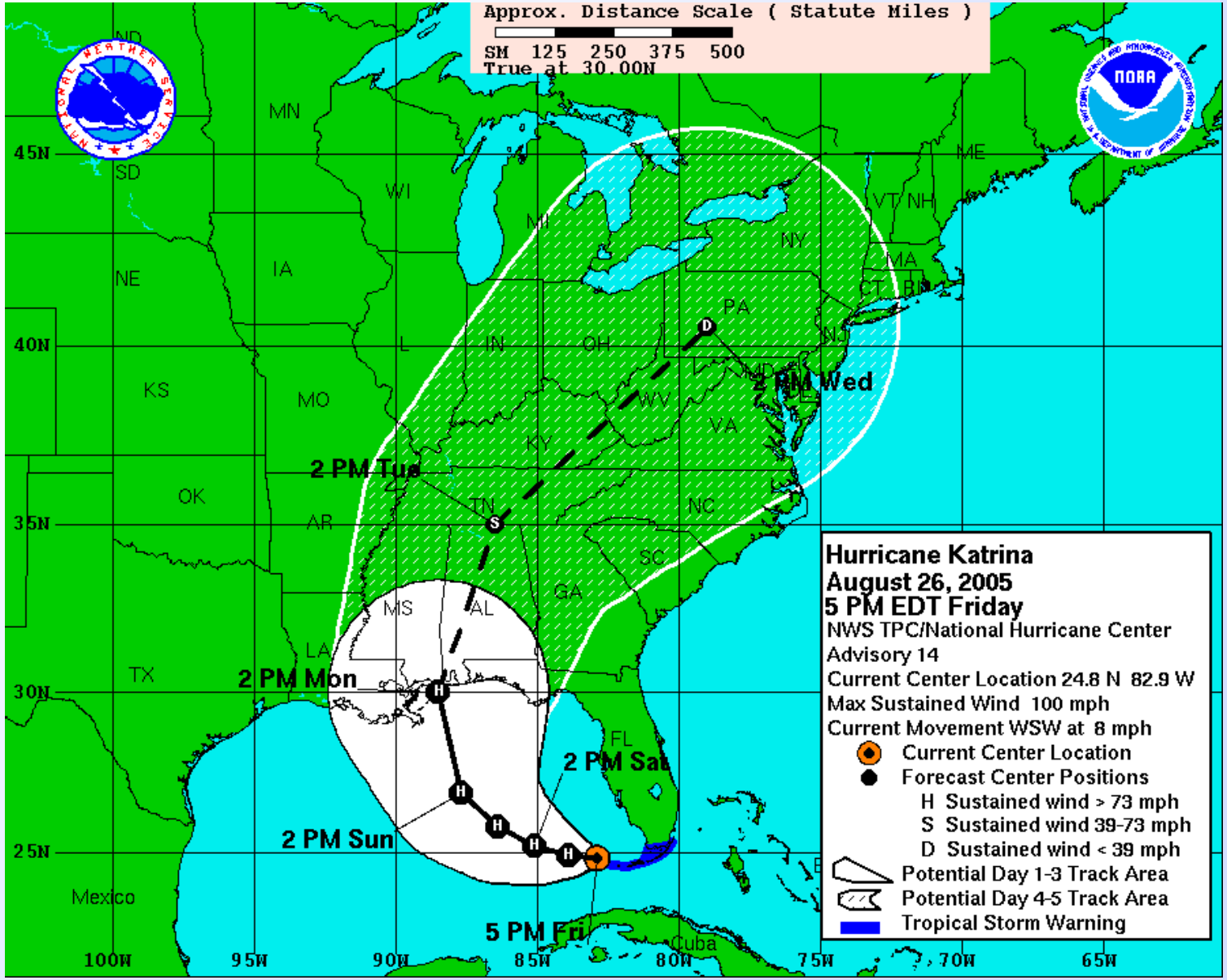
Overview

- A quick look at money and weather forecasting
  - Anecdotally: A tale of two hurricanes
  - Macroscopically: weather, weather forecasting and the US economy
- Enabling capabilities for weather prediction
  - Role of NWP and NWP diagnostics
- Impact of satellite data
- A dollar value on observations?

A Tale of Two Hurricanes

- Galveston Hurricane
  - Landfall in Texas at 5 PM 09/08/1900
  - > $500M (2008 dollars) in property damage
  - ~10,000 fatalities (out of a population of ~40,000)
  - No satellite data, no upper air network, no NWP
  - Estimated Category 4 at landfall
- Katrina
  - Landfall (2nd) in Louisiana at 6 AM 08/29 2005
  - > $90B in property damage (2008 dollars)
  - > 1800 fatalities (out of a population of ~1.5M)
  - Extensive satellite and conventional observations, good forecast
  - Category 3 at Landfall

Hurricane Katrina Track



Weather Prediction and the US Economy: A Macroscopic View

- **Department of Commerce: "20% of overall US economy is weather sensitive": *~$3 trillion/year***
  - **Impact to air and surface transportation, agriculture, construction, energy production and distribution, etc.**
- **Assume that half of this is "forecast sensitive": *$1.5 trillion/year***
- **Assume that the potential savings due to weather forecasting amount to 5% of the "forecast sensitive total": *~$75B/year***

A Macroscopic View (II)

- **Assume that the savings are distributed linearly over the achieved forecast range for the global NWP system:**
  - **0 h useful forecast range => $0 in savings**
  - **336 h useful forecast (two weeks maximum predictability) range => $75B in savings**

- **This implies that the value to the United States economy of weather observations, dissemination, forecast products and services is *>200M per hour of forecast range per year !***

The Global Picture

- The amount of $75B/year is **one** estimate of the magnitude of the total potential socioeconomic benefit of weather prediction activities to the US economy
- Scaling exercise, using World Bank (2011) numbers:
  - Annual GDP of United States: ~$15T
  - Annual GDP of all nations combined: ~$70T
  - Assuming *on average* (i) equal sensitivity to weather, and (ii) equal potential benefits from ability to predict across all nations, we get an estimated

    $75B *($15T/$70T) = **$350B** as the total global potential benefit of weather prediction activities (indicating a likely range of $100B to $1T

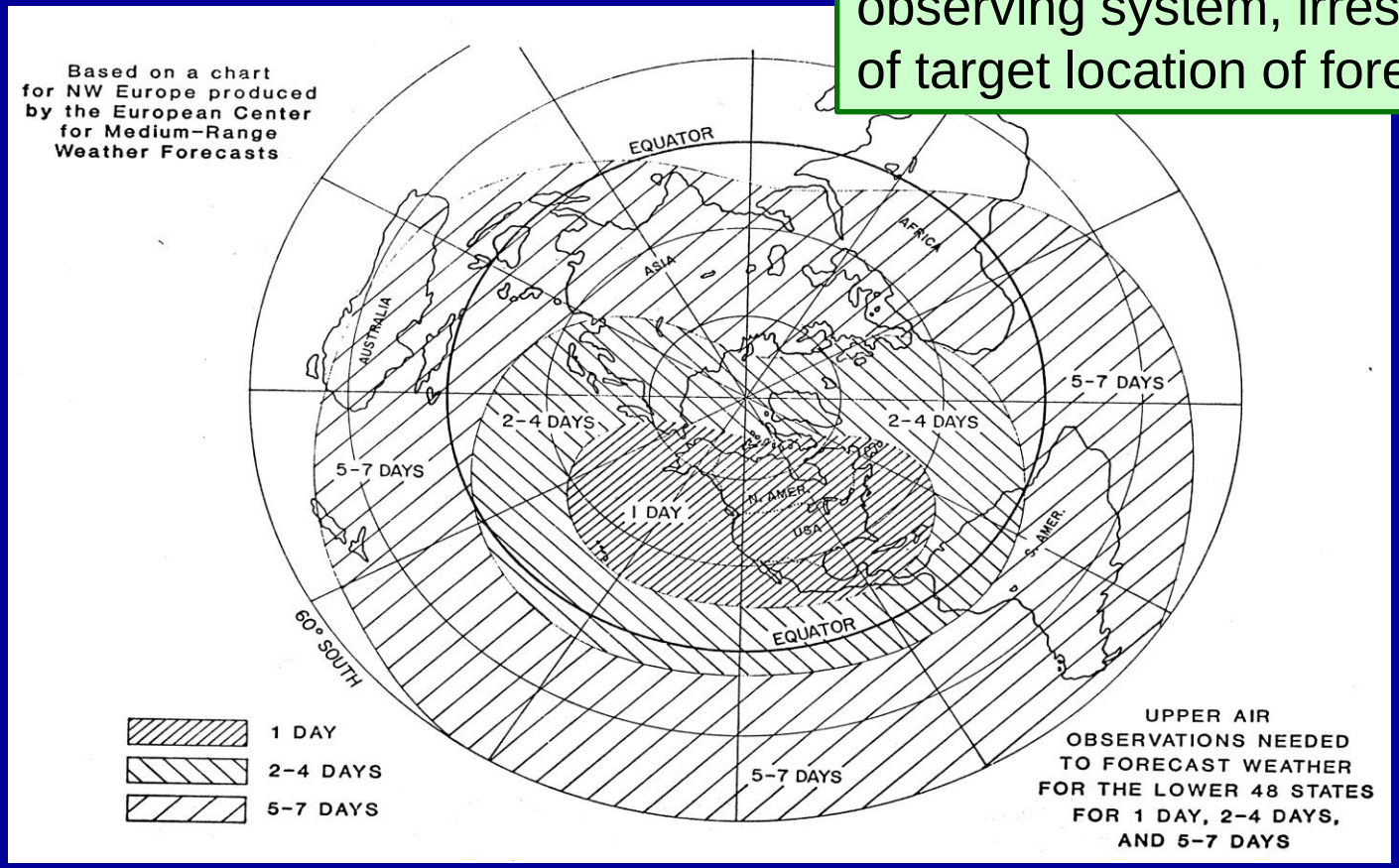
Weather Prediction Enabling Capabilities

1. Observing Systems
2. Dissemination Systems
3. Numerical Weather Prediction
   - Science (modeling, data assimilation)
   - High-end computing
4. Service Delivery

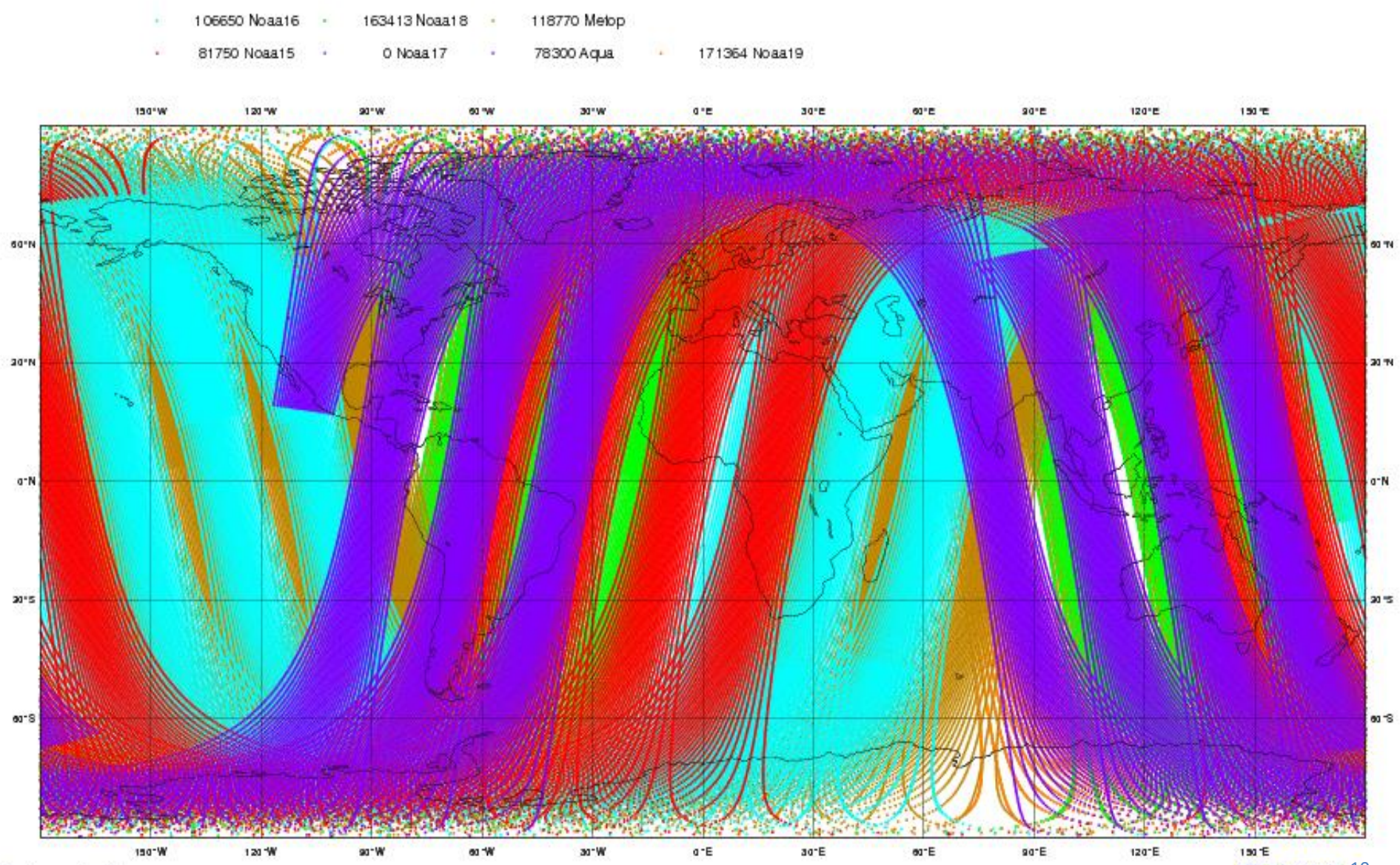
•1, 2 and 3 are of a *foundational* nature, with **1 representing the single largest expenditure, and 3 providing a powerful diagnostics capability**

NWP requirements for upper-air data coverage

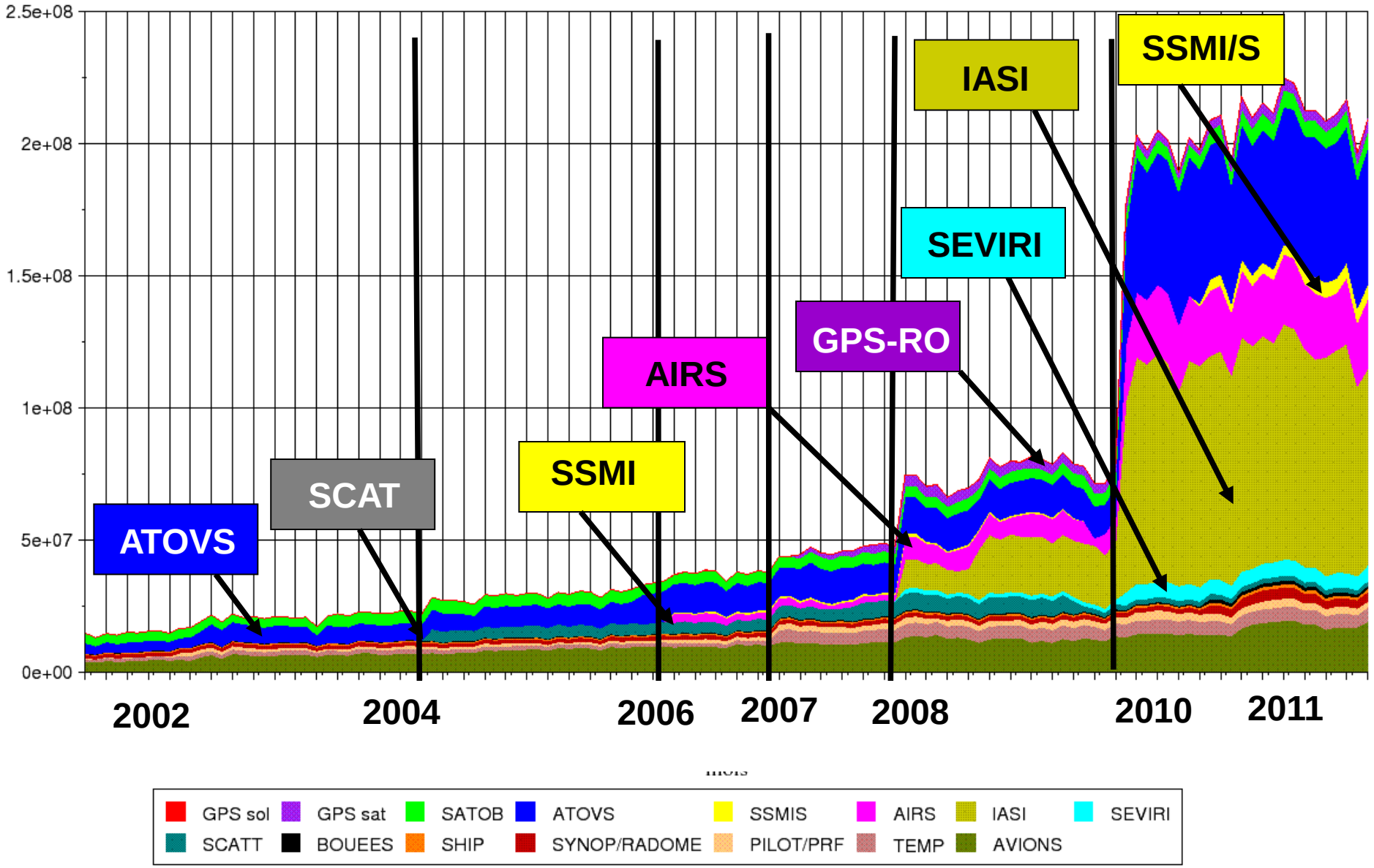
Hence the need for a <u>global</u> observing system, irrespective of target location of forecast!



ECMWF Data Coverage (All obs DA) - AMSU-A
25/Jul/2012; 06 UTC
Total number of obs = 720247

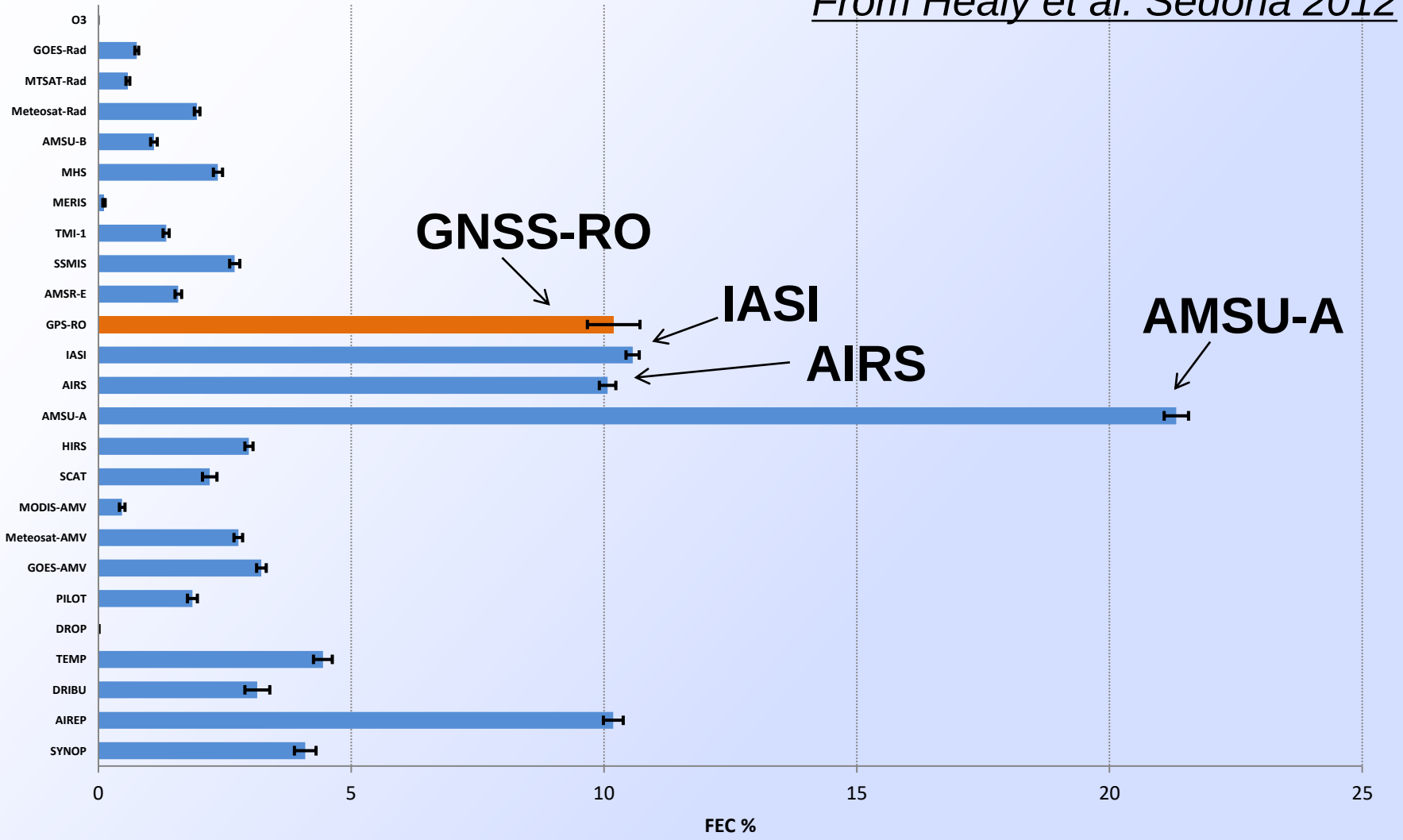


Monthly Mean of No. Of Observations Daily in Global Model



FSO: ECMWF System (June 2011)

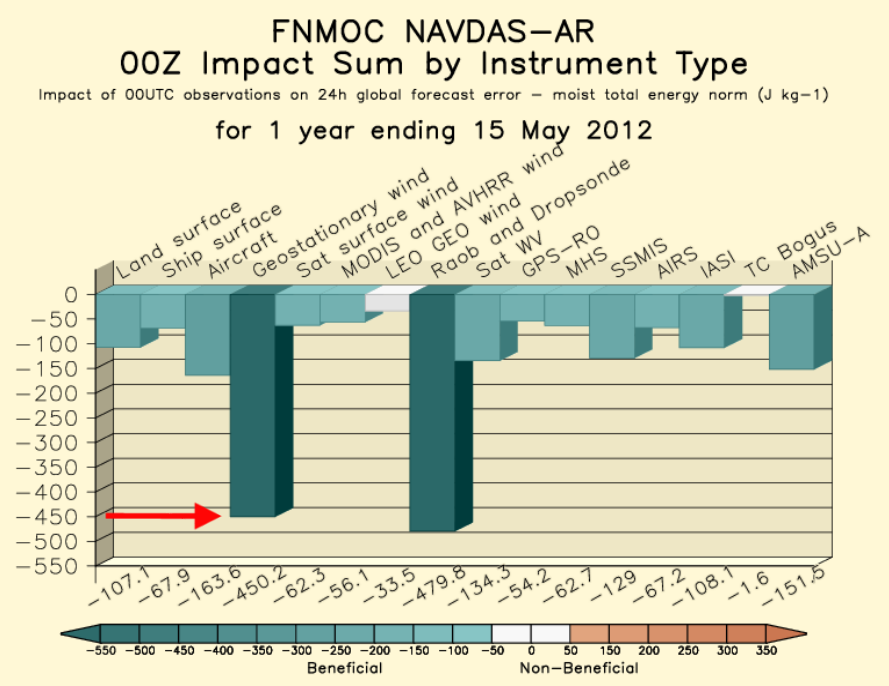
From Healy et al. Sedona 2012

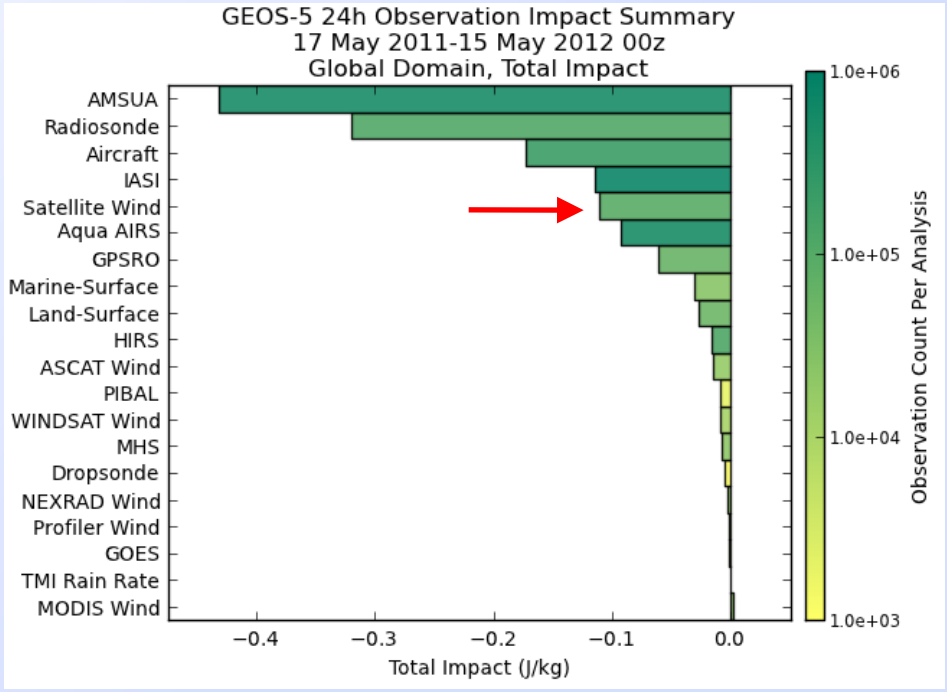


FNMOC and GMAO Observation Impact Monitoring

Current Operations

Gelaro et al. , Sedona May 2012

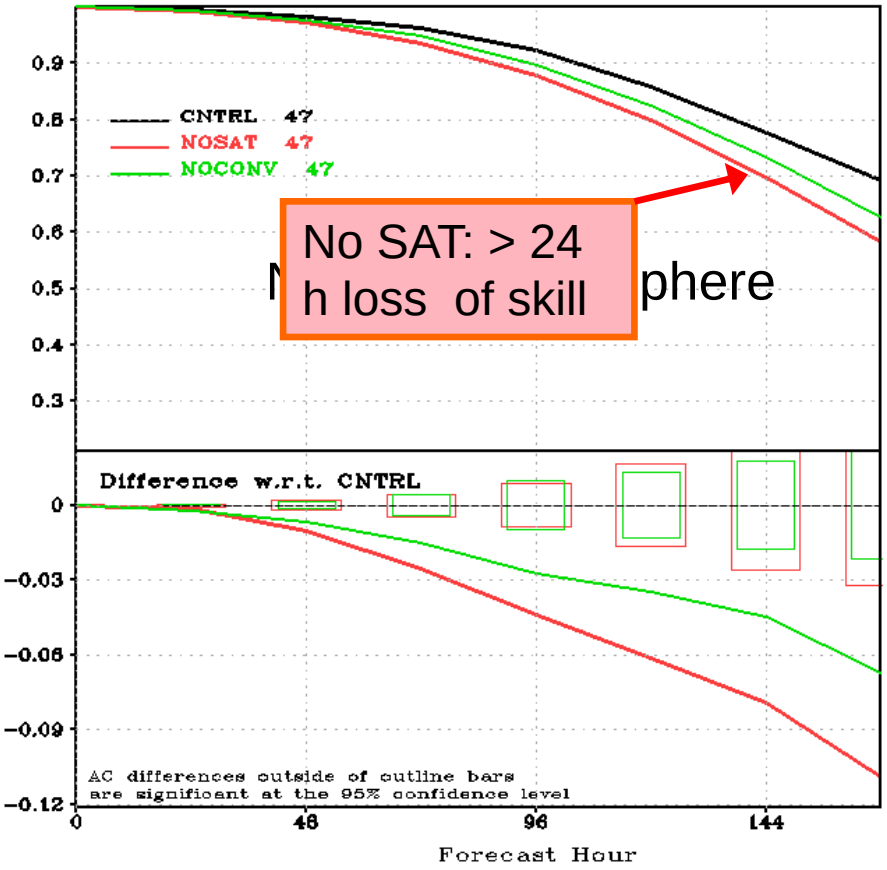


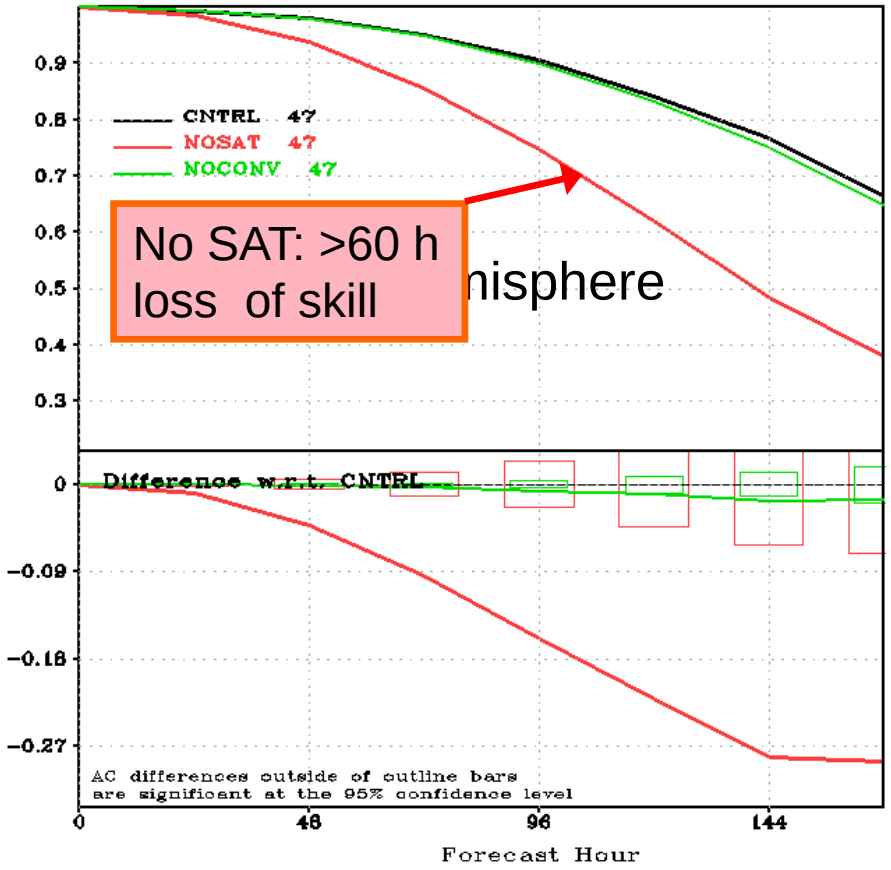


http://www.nrlmry.navy.mil/obsens/fnmoc/obsens_main_od.html

http://gmao.gsfc.nasa.gov/products/forecasts/systems/fp/obs_impact/

No Satellite / No Conventional Data





Jung, 5th WMO Impact Workshop, Sedona 2012)

Final remarks

- The economic impact of *weather* is at least somewhat recognized and understood
  - In contrast, the economic impact of *weather prediction* is generally not well studied and documented
- The cost of obtaining meteorological observations is generally understood only at the national level; no reliable cost estimates available at the global level
  - Assessment of the monetary value of meteorological observations is even less developed
  - By a rough estimate, the value to US economy likely in the range of $5B/year or more for NWP alone; this does not measure the value of direct forecast applications, of climate, ocean, land surface, atmospheric composition measurements, or of improved scientific understanding