POISE: Planned Observations and Intelligent Science Experimentation

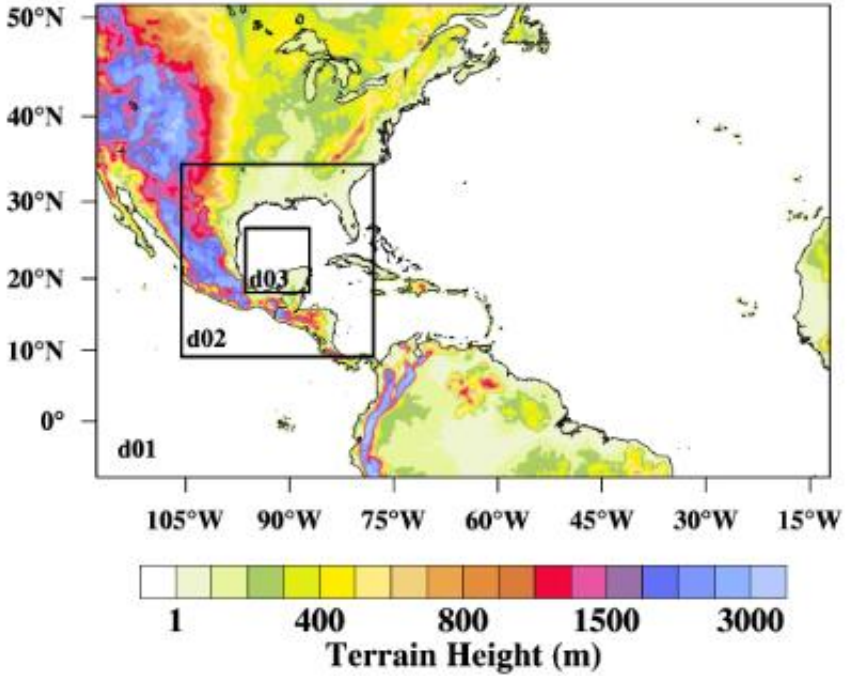
Principal Investigator: Peyman Tavallali (398)
Co-Is: Lukas Mandrake (398), Steve Chien (397), Hui Su (329), Yuliya Marchetti (398), Longtao Wu (398)
Program: Strategic Initiative

Jet Propulsion Laboratory
California Institute of Technology

Assigned Presentation #109

Introduction

- Effort to apply an **adaptive and model-driven sensing** framework to the study of large scale storms.
- Challenges
  - complex
  - fast developing
  - spatial extent
  - temporal evolution
- Comprehensive sensing of the entire phenomena prohibitive
- Increase the knowledge and decrease uncertainty in predictions



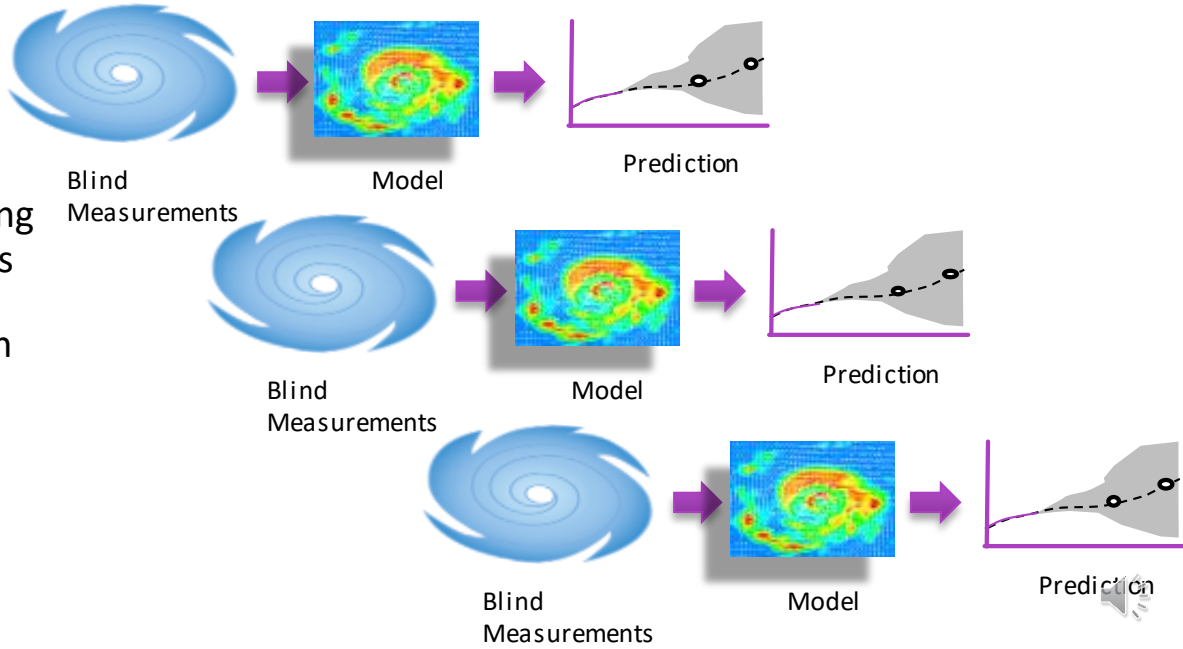
Intelligent instrument architecture for dynamic phenomena

- Adaptive relevant measurements,
- Informed by scientific models.

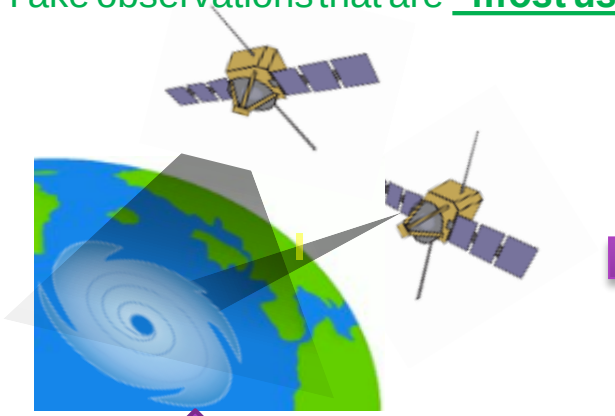
We use hurricane intensity forecast as a test case and establish a framework that will enable agile measurements for better understanding of the physical processes that drive hurricane intensity change and improve forecast skill.

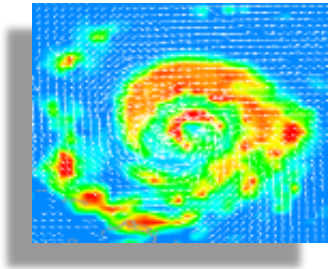
Problem Description

a. Context
    i. Taking impactful measurements
    ii. Reducing the costs
b. SOA
c. Relevance to NASA and JPL
    i. JPL's capabilities in
        1. intelligent instruments
        2. autonomy,
        3. improve science understanding
        4. predictive capabilities in areas of high societal impacts
        5. strong support for JPL mission proposal competitiveness

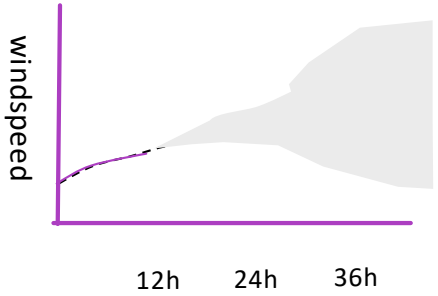


Take observations that are **“most useful” according to a model**.



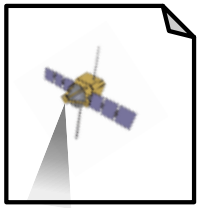


Model



Which combination of data is most useful?

Utility Analysis



“Smart” Observations

Take “most useful” data within operations constraints

Objective	Result
Identify success metrics	- Identified 2 sets of metrics - Evaluated MSLP
Develop framework evaluating impact of individual measurements	- Identified preliminary data - Access to AMES data - Individual utility and interface - Multiple hour utility
Identify state of the art utility estimation process	- WRF-EnKF - Mult. utility and init. interface
Create an initial validation dataset	- Data denial (real observations)
Refine and mature concepts for satellite measurement redirection	- Prototype GEO scheduling algorithm complete. LEO in progress.
Study algorithms suitable for three (aerial) drone scenarios	- Prototype open loop Multi drone scheduling complete.

- Year 0 (FY20)
  - **Pipeline architecture** (no prototype) and just **proof of concept.**
- Year 1 (FY21)
  - Adaptive observation planning **prototype** on a single hurricane track based on
    - a **single and bag of points observation utility estimation,**
    - **machine learning estimation** of utility,
    - constraint-based tasking of instruments for **linked utilities**,
    - **Data denial** experimentation.
- Year 2 (FY22)
  - Expand the results from Year 1 to incorporate a diversity of past hurricanes
- Year 3 (FY23)
  - Dependencies between sequential observations,
  - Perform OSSE evaluation of adaptive policies with agile observations and cost constraint scenarios,
  - Define **optimal abstract instruments** for **current and future JPL instruments**.

Publications and References

3 Submitted conference papers including one accepted:

P. Tavallali, S. Chien, L. Mandrake, Y. Marchetti, H. Su, L. Wu, B. Smith, A. Branch, J. Mason, J. Swope, Adaptive Model-driven Observation for Earth Science, International Symposium on Artificial Intelligence, Robotics, and Automation for Space, October 2020.