Evaluation of plume rise modeling in AIRPACT using MISR satellite data

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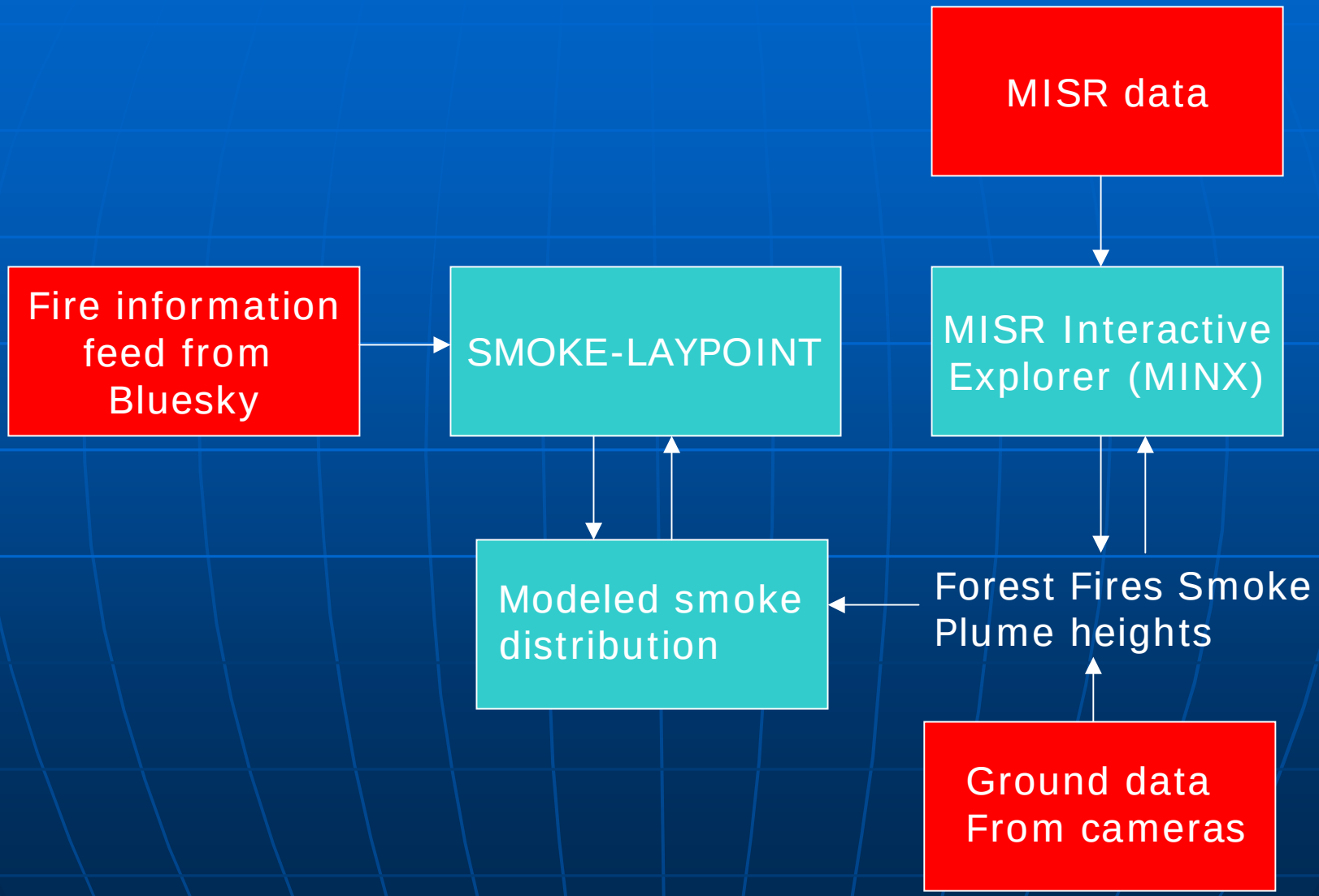
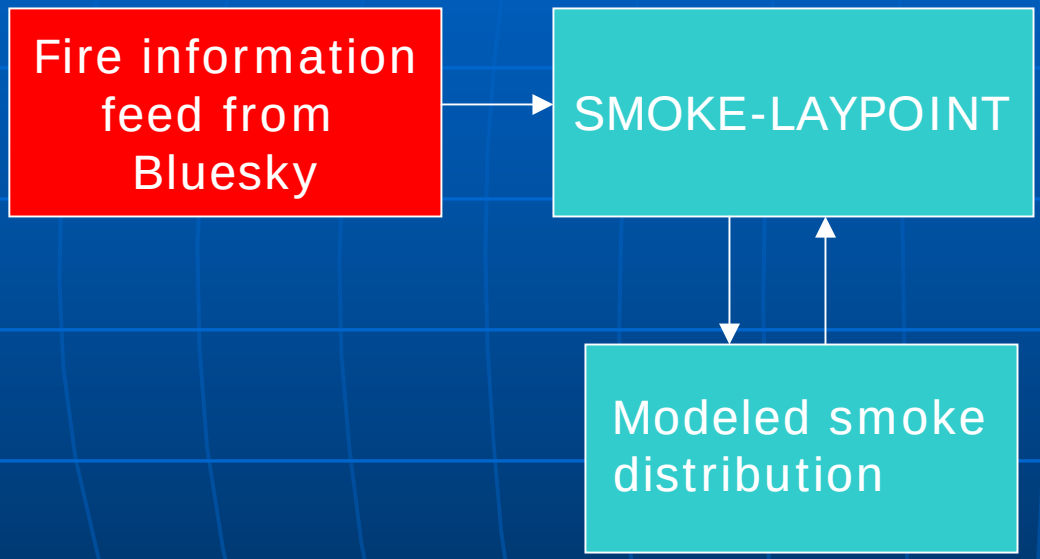
NW Airquest Meeting 2008

September 17, 2008.

Constraining injection heights in AIRPACT using MISR plume height data



Current plume rise modeling in AIRPACT



- Feed from USFS up to August 17, 2008.
- Fire data based on 209 reports from fire incidence commanders
- Emissions are partitioned vertically using the SMOKE laypoint module, which is based on a briggs-type plume rise model
  - Uses hourly meteorology to partition emissions between vertical levels (21 total in current implementation)
- Issues – include Fire energy estimates used in plume rise model, multiple cores, accuracy and applicability of available plume rise models.

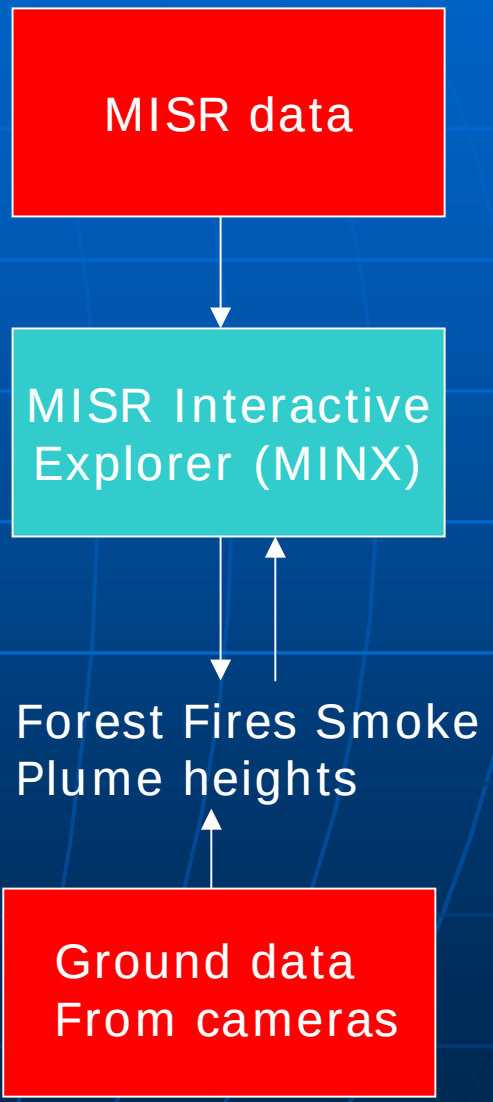
Project goals

- Improve accuracy in estimation injection height distributions under varying situations
  - Evaluate historical forecast runs
  - Determine whether systematic biases exist, and what and where they are
- Near real-time evaluation of the accuracy of injection heights and their effect on forecast results.

Constraining injection heights of forest fire emissions in AIRPACT

- AIRPACT – Concentrations of primary pollutants highly overestimated during the fire season
- Host of possible explanations.
- Initial injection height of forest fire emissions have profound effects on downwind concentrations

- This project represents a first attempt at the use of satellite data to constrain distribution of injected pollutants in the regional forecast system.
  - Use of data from MISR
  - Who watches the watcher?

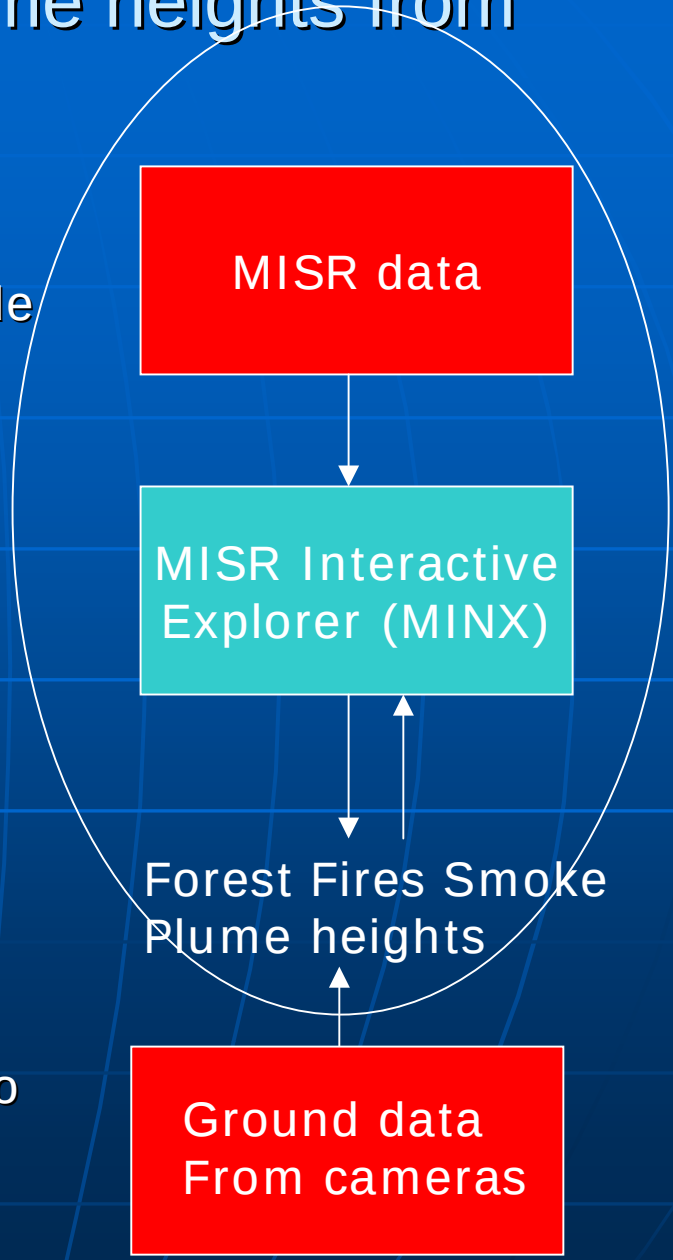


Determination of fire smokeplume heights from MISR data

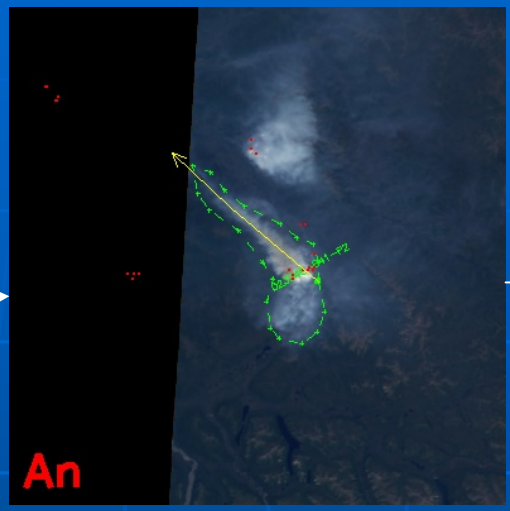
- Aboard TERRA satellite
- 9 cameras at nadir and 4 angles on either side (26.1, 45.6, 60, and 70)
- Observes in 3 visual bands and the near infrared band
- Global coverage every 9 days, with overlap coverage every 2-9 days, depending on latitude
- 360 km wide swaths

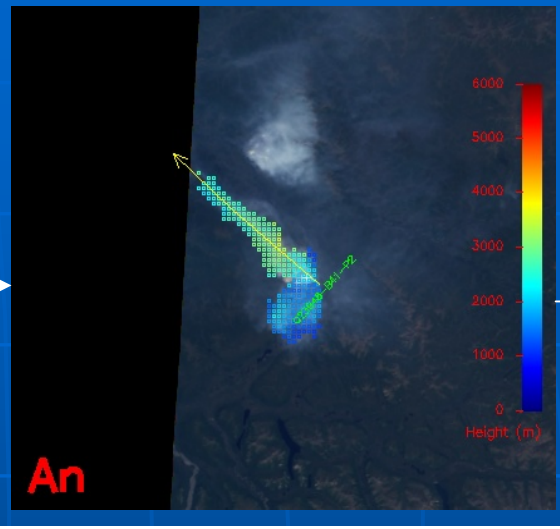
- Allows altitude of features to be retrieved
- Studies of fires in the northwestern United States, with relatively low cloud cover during the high fire season, can benefit significantly from the use of MISR data

- MISR Interactive Explorer (MINX) allows us to look at individual plumes



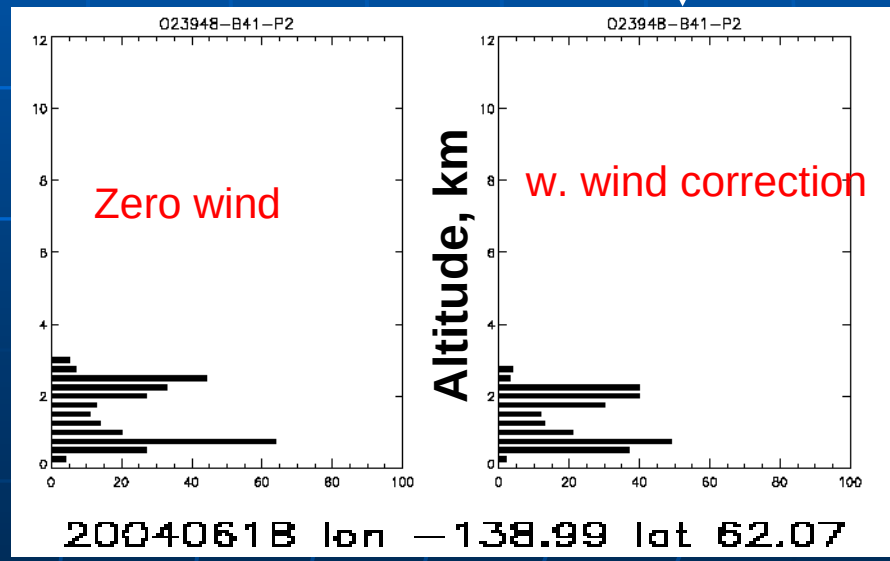
Determination of MISR plumeheights





- MODIS Fire Radiance Product from MODIS-TERRA is simultaneous extracted

Nadir Image w/ Digitized Region Outline (green: plumes; magenta: clouds), Wind Direction (yellow) and MODIS Fire Pixels (red)



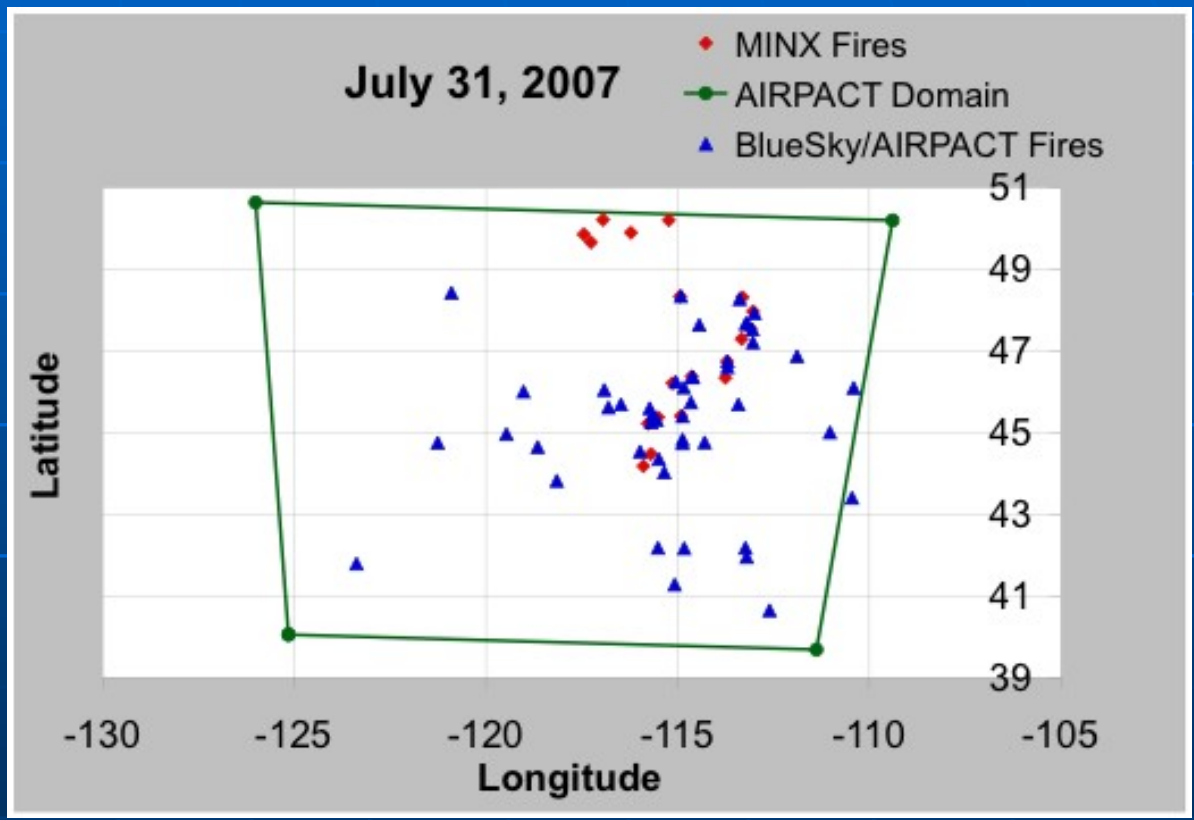
- The observed plumes do not typically appear to follow a Gaussian vertical distribution
  - Effect of the wind correction on shape and height of individual plumes is not insignificant.

Comparisons of MISR plume heights and Fire Service data

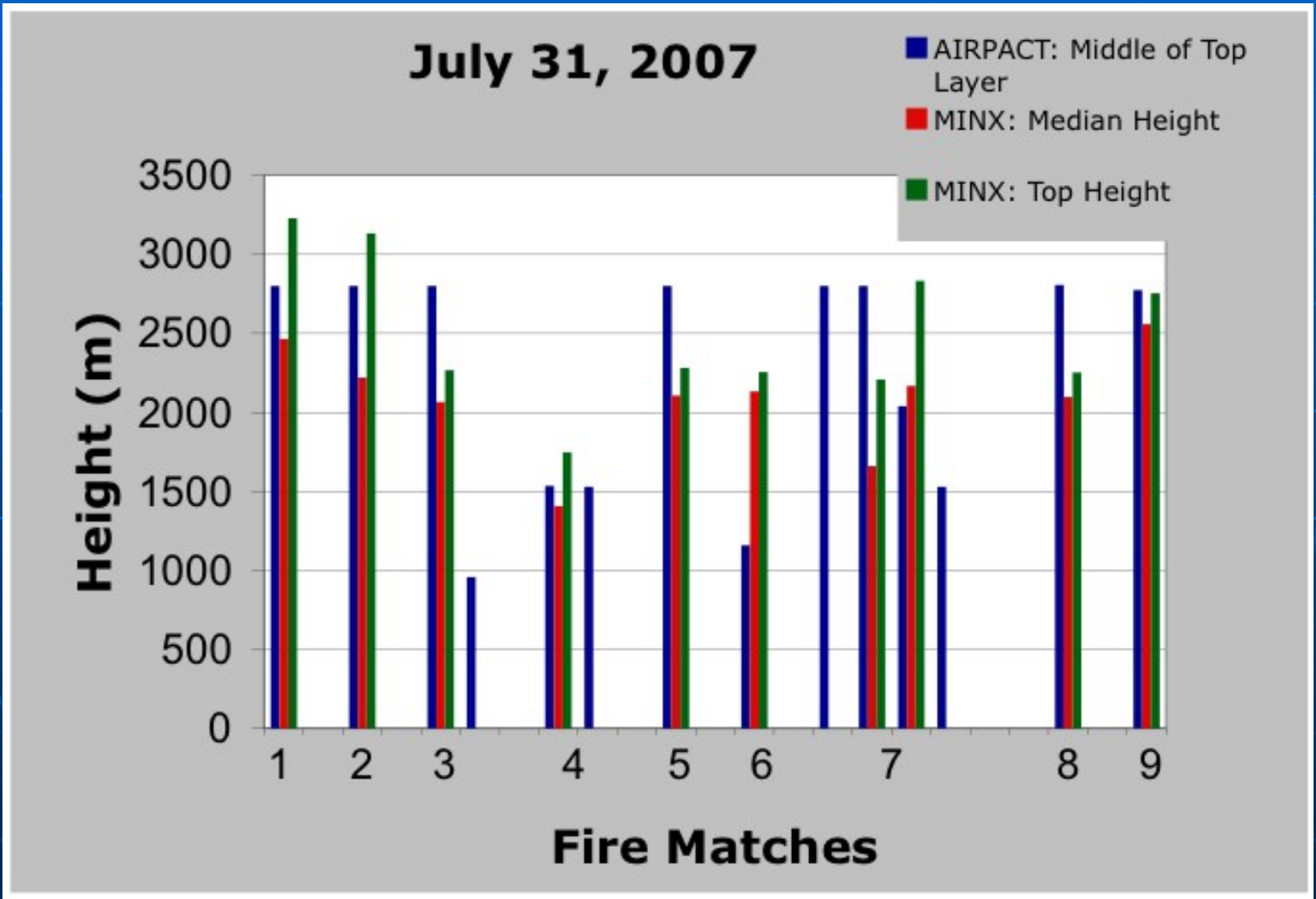
2007 Fire Season in North America: 58 orbits processed, total of 580 plumes – currently, 3 years of data are available for the contiguous US and Alaska, and one additional year, containing only Alaskan data, is also available.

On 32 days fires were present in both the MINX and BlueSky dataset, within the AIRPACT domain.

On 19 out of the 32 days with fires from both systems there appear to be visible fire matches.

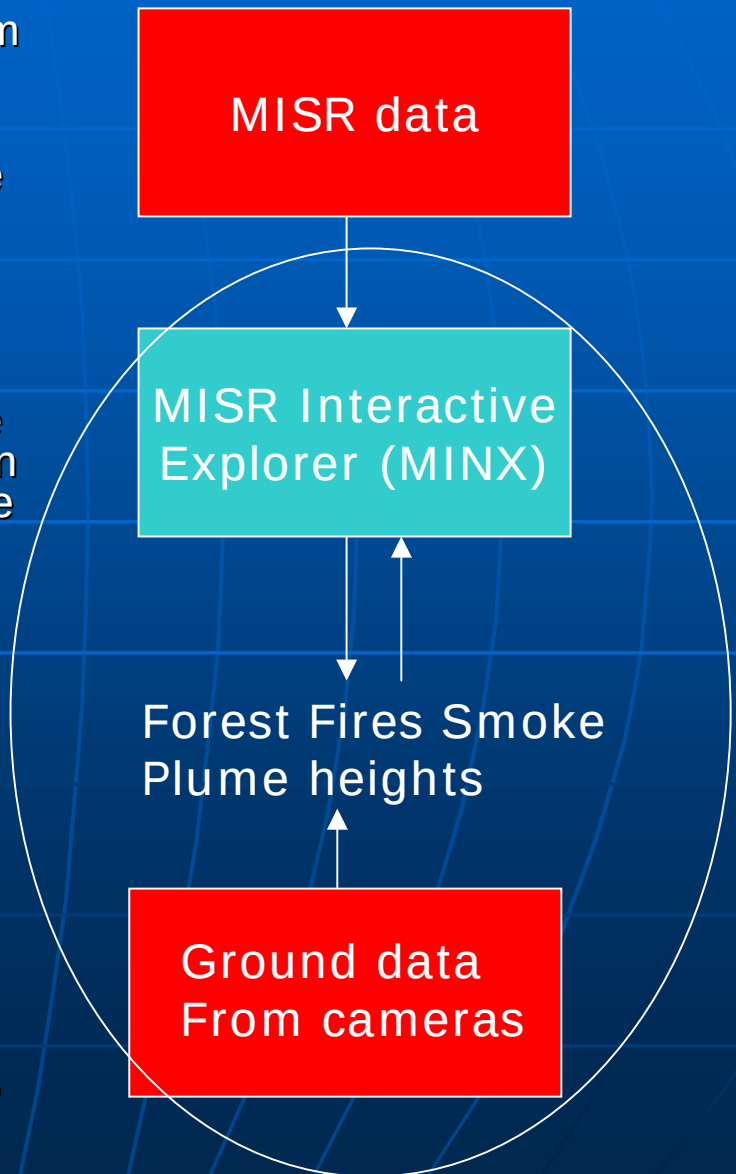


Comparisons of plume heights on a test day

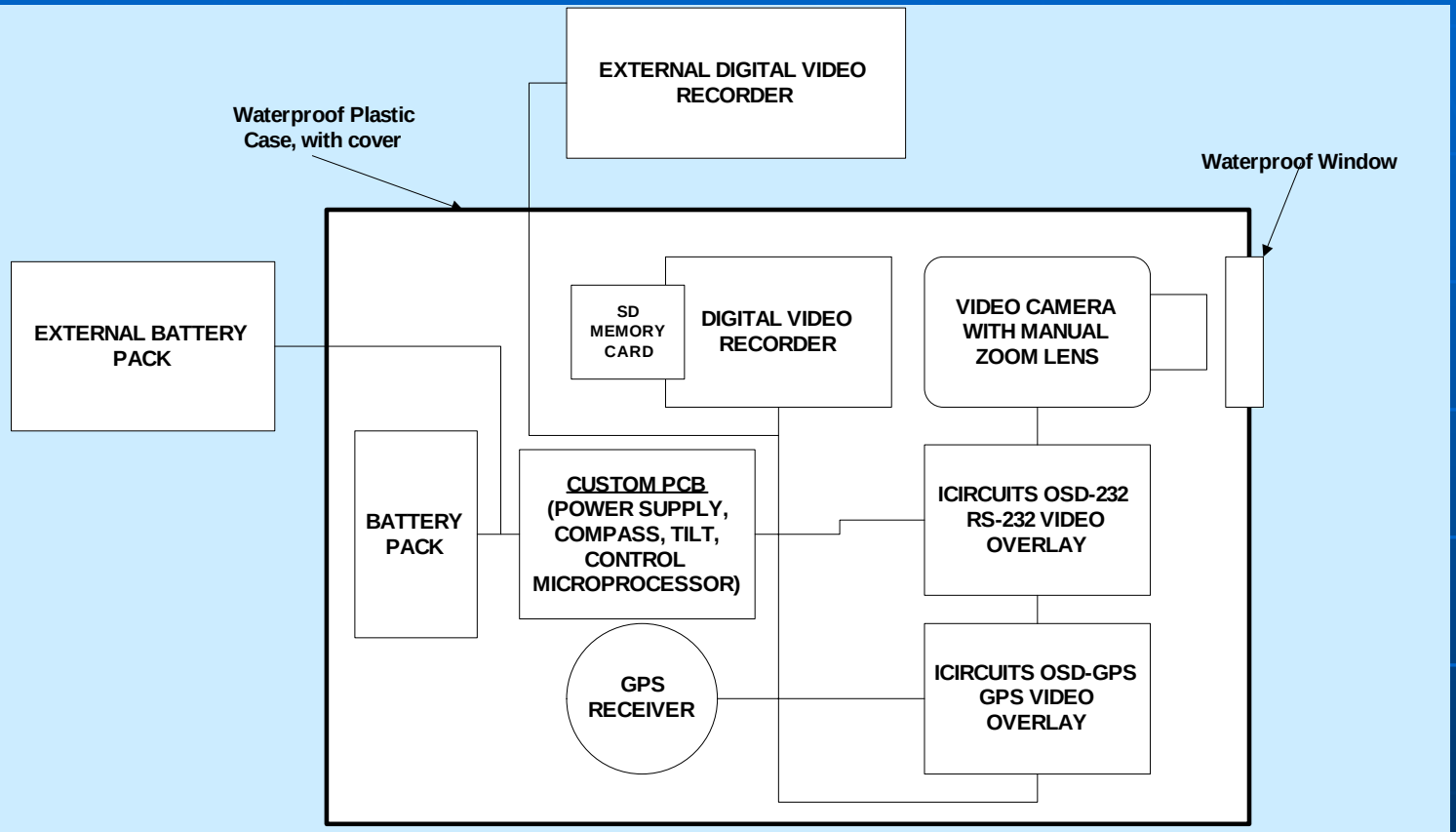


Ground truth of smoke plume heights

- In collaboration with Robert Kremens, RTI, a camera to determine smoke plume heights from the ground is being designed and constructed.
- The purpose of this video recorder is to provide a position-aware video data stream. Superimposed on the video stream will be a character stream indicating position (from a GPS sensor), time (also from the GPS sensor) heading and tilt angle (from a MEMS tile/compass sensor). The data stream may be viewed on any conventional video monitor or on a computer using video playback software. The position and angular information in the video data stream will allow the scale and location of the observed scene to be estimated.
- The video recorder is entirely solid state and can record up to 4 hours at 12 frames per second or longer at reduced frame rate. Battery life with an 8 X 'AA' cell battery back is about 4 hours. The unit may also be powered from an external battery pack, automobile or aircraft power. (9 – 36 V).
- The size of the unit will be ~ 10 X 7 X 4 inches, with a weight of 2 pounds or less.



Ground truth of smoke plume heights – conceptual schematic of camera



The Position-Aware Video Camera consists of a small SD Card digital recorder, video camera, tilt sensor, digital electronic compass, GPS unit and a microprocessor controller housed in a waterproof rugged plastic case (similar to a 'Pelican' case) The unit operates for up to 5 hours on 8 'AA' batteries. Resolution is 640 X 480 pixels with a fame rate 12 fps. The overlays GPS position, compass heading and tilt angle on video frames. No additional hardware or softwar is needed to interpret that video data stream. The video image also has the GPS position information overlaid on each frame.

The above sketch shows the design of the video recording unit. The unit can also be operated on 12 V form a car or ot 12 V DC source. An external digital video recorder can be connected to allow recording for an unlimited length of time.

Proposed schedule for ground validation of MISR data

- Fall/Winter 2008-2009
  - Construction of prototype camera
- Summer 2009
  - Testing of camera in Western United States.
- Fall/Winter 2009-2010
  - Refinement of camera design and building of additional cameras
- Summer 2010+
  - Use of cameras to validate MISR and other smoke plume data.