Future Gravity Mission Workshop
Graz, Austria
Sept. 30 – Oct. 2, 2009

FUTURE GRAVITY MISSION SCENARIOS INVOLVING TWO PAIRS OF DRAG-FREE SATELLITES

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EMPHASIS IN THIS TALK

1. Time variation between about 2 week periods;

2. Local analysis, not global;

3. Goal of hydrological applications;

4. High spatial resolution;

5. Short wavelengths;

6. Only variations in the geopotential height near the satellite altitude will be considered.

LIMITATIONS OF ONLY POLAR OR NEAR-POLAR ORBITS

1. For satellite-to-satellite tracking (SST), only variations with latitude of the geopotential height $N(\varphi,\lambda)$ can be determined accurately from a one revolution arc.

2. Cartwheel configurations can determine two components of the geopotential height gradient, but can only measure the geopotential height variations with latitude continuously.

3. Uncertainties in variations of the Earth's fluid mass distribution over < 2 weeks strongly contaminate information about the wavelength dependence of west-east (W-E) variations in N at a given time.

4. This seriously limits resolution in the W-E direction

INCLUSION OF ONE MODERATE INCLINATION SST PAIR

1. Moderate inclination is taken to be roughly $50° < I < 65°$.

2. The crossing angles between SW-NE and NW-SE passes across a given point will be fairly large for most of the globe.

3. The short wavelength variations for the two passes can be combined efficiently to give the short wavelength W-E variations in the geopotential height.

4. In this way, the effect of uncertainties in the long wavelength variations in the Earth's fluid mass distribution can be strongly reduced.

ONE MISSION DESIGN AND POSSIBLE ANALYSIS REGION

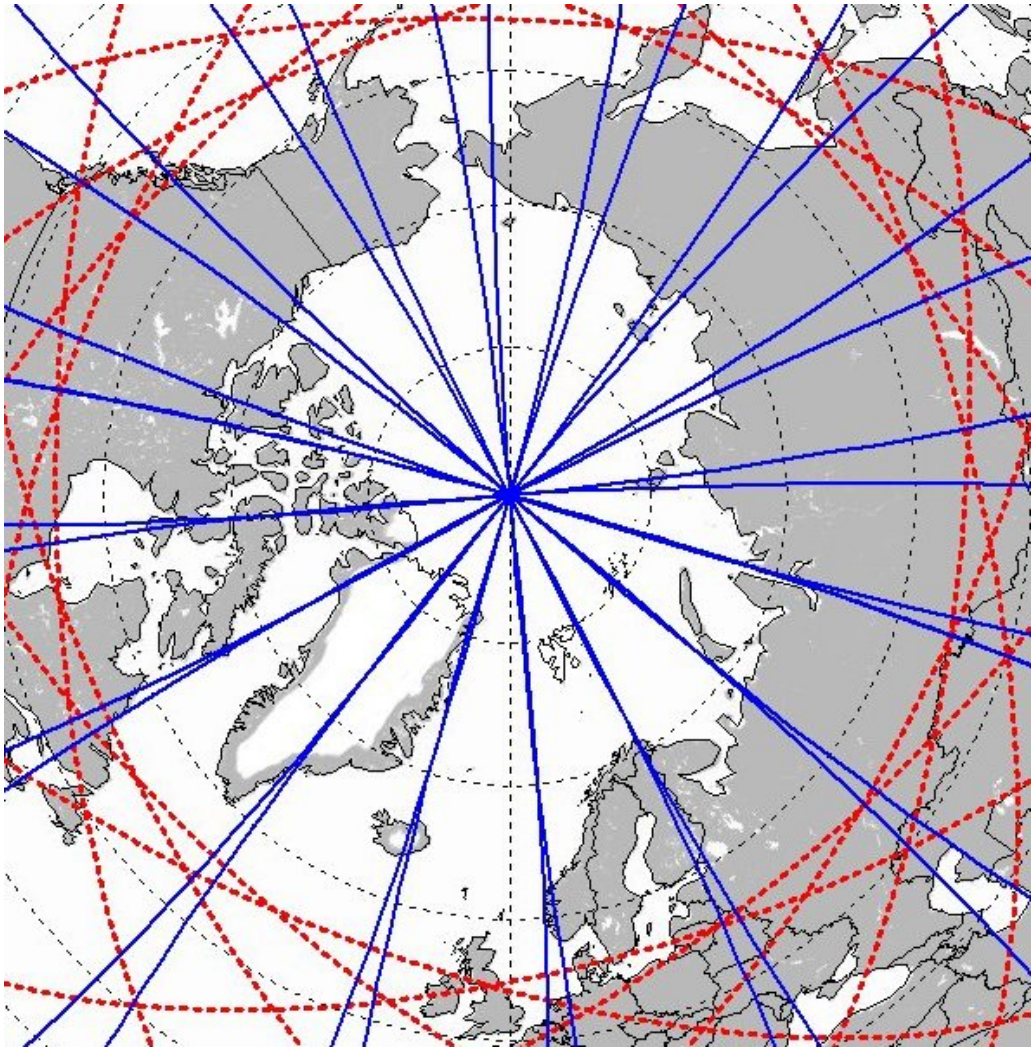
Mission Design:

2 pairs of SST satellites
Drag-free, with laser interferometry
Baseline separation B = 100 km
Pair A: I = 55.8°, H = 360 km, 12.8 day repeat
Pair B: I = 90°, H = 369 km, 5 day repeat

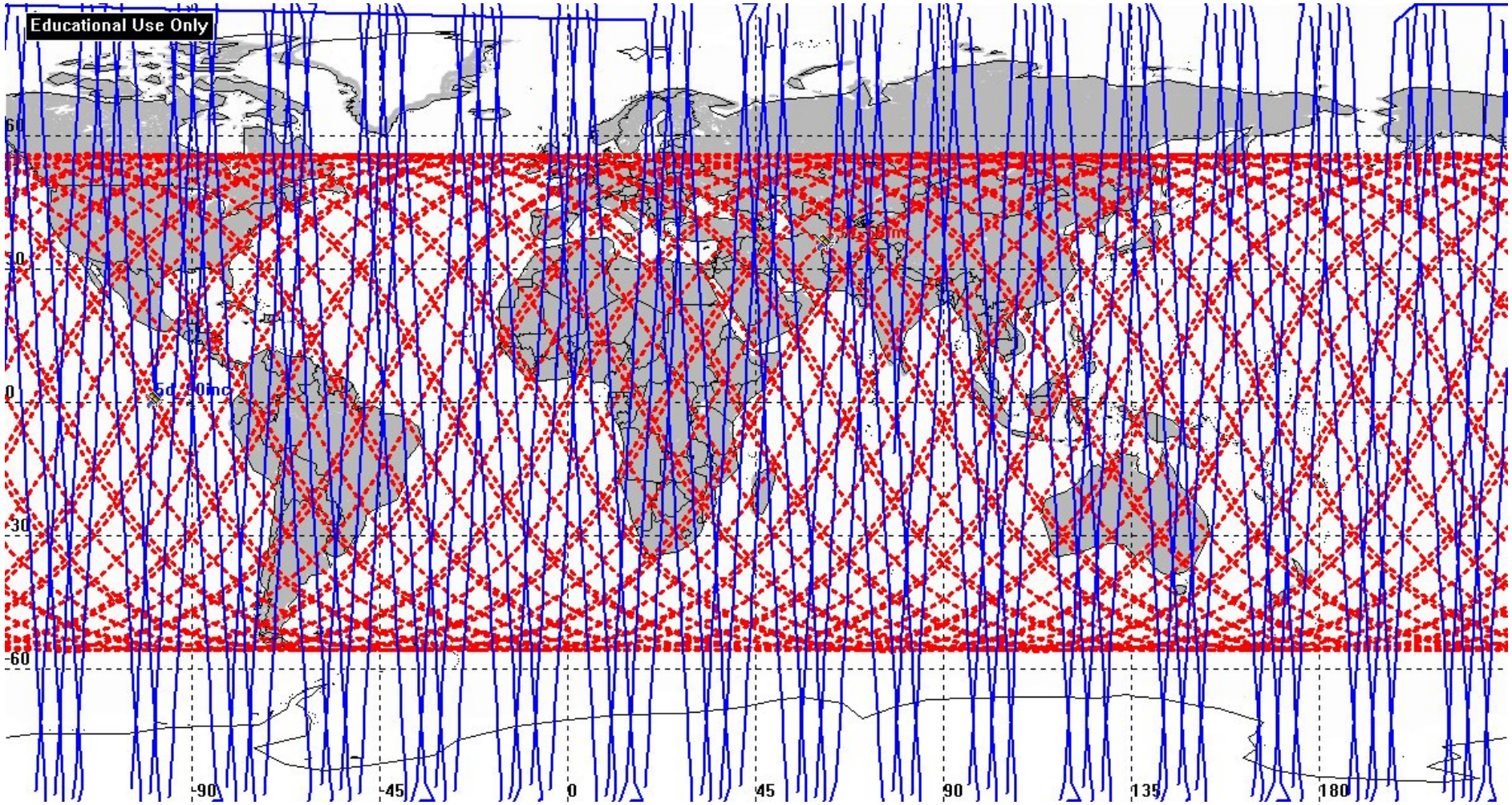
Analysis Region:

Central and western North America
Roughly 2000 km × 2000 km
$32°N < \varphi < 50°N$
$112°W < \lambda < 88°W$

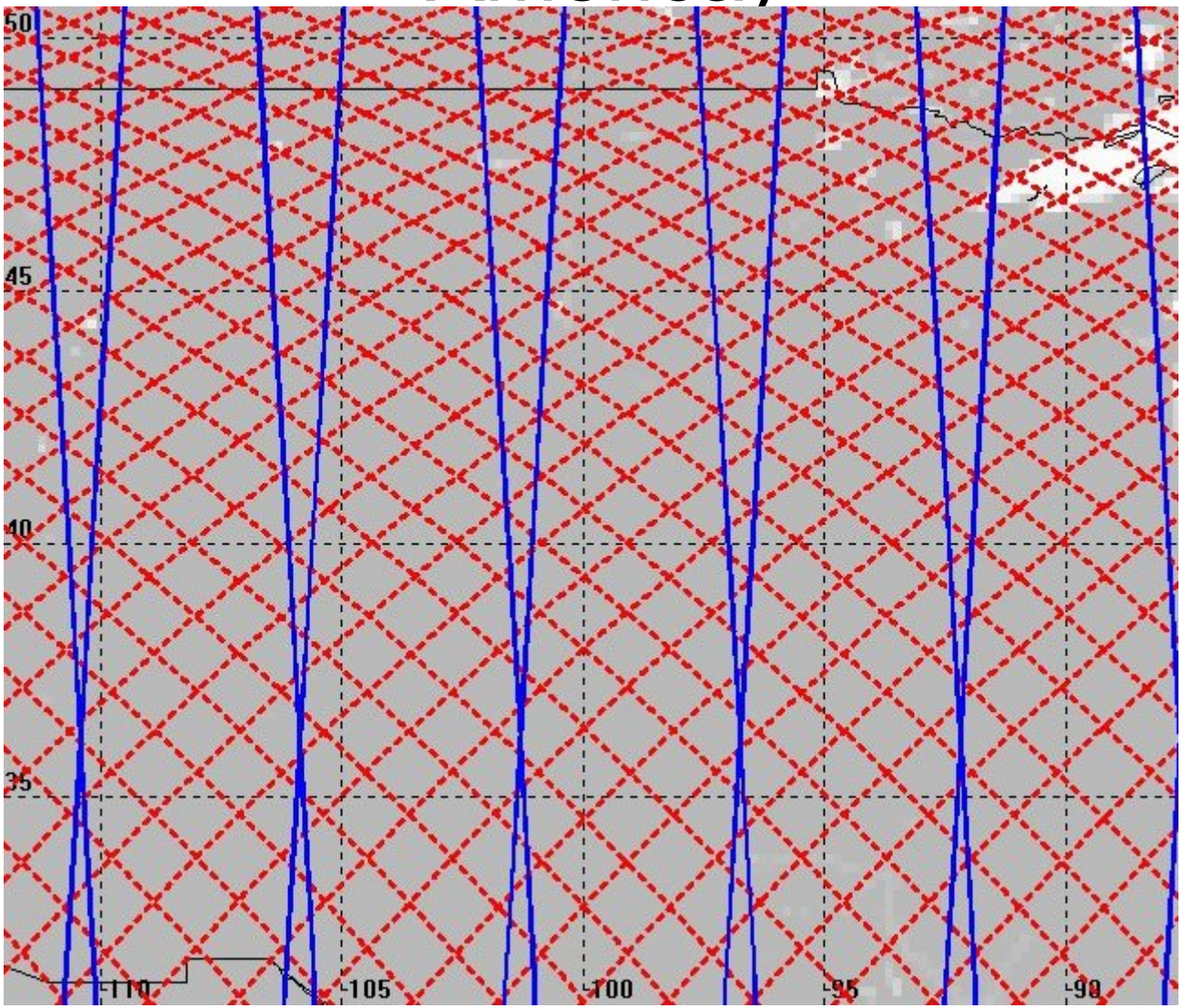
1-day GT (polar view)



3-day GT



13-day GT over Local Region (North America)



LIMITATIONS ON SHORT WAVELENGTH INFORMATION

1. Separation of short wavelength atmospheric variation uncertainties from hydrology variations.

2. Infrequent sampling of hydrology variations.

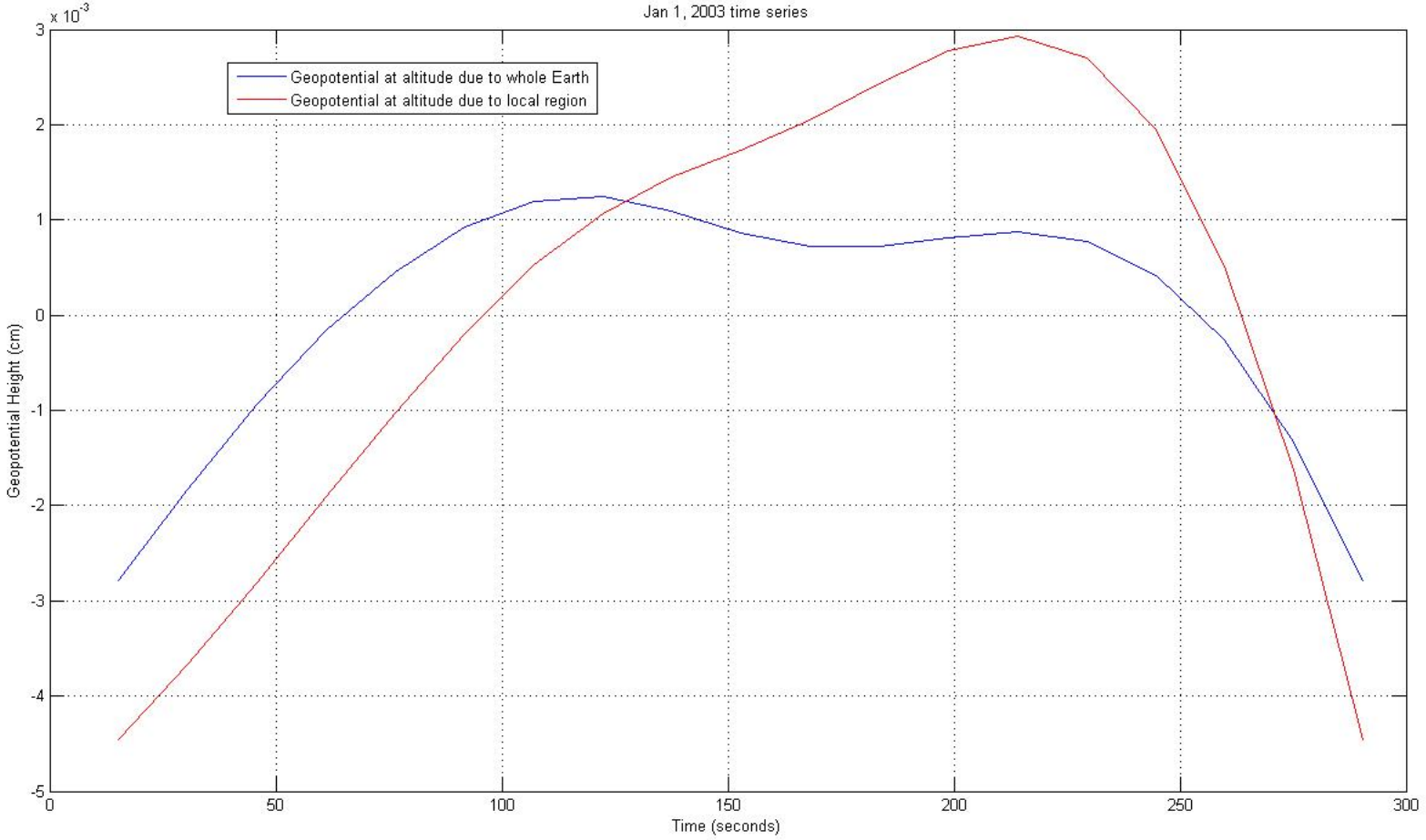
3. Distance measurement noise.

4. Probably not acceleration noise.

5. Accuracy of other hydrological information on spatial and temporal variations in mass.

6. Probable main limitation on accuracy of short wavelength information for hydrology:
   a) #1 for laser interferometry
   b) #3 for K-band measurements

Local Analysis vs. Global Analysis Geopotential Height Comparison



CONCLUSIONS

1. With two pairs of drag-free SST satellites, valuable improvements would be expected in applications to hydrology, in ocean mass distribution determinations, and in other areas.

2. There appear to be advantages in terms of short wavelength information in having one drag-free pair in a moderate inclination orbit, even if the polar pair is not drag-free.

3. Studies have been encouraging for a mission design based on a pair of drag-free SST satellites with laser interferometry and long lifetimes in a moderate inclination orbit. Such a mission appears to be a candidate for the next mission after GRACE-2.

4. Further studies to optimize the design of such a mission are needed in the near future.