



Is now the time to replace S / X with X / Ka?

IVS General Meeting 2004



*Is Now the Time to  
Replace  
S / X with X / Ka - band?*

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## Outline

- **Motivation for a radio frame above 8 GHz (X-band)**
- **Initial Observations & Results**
- **Current X / Ka antennas**
- **Plans taking shape**
- **Proposed Roadmap for transitions from S/X to X/Ka**

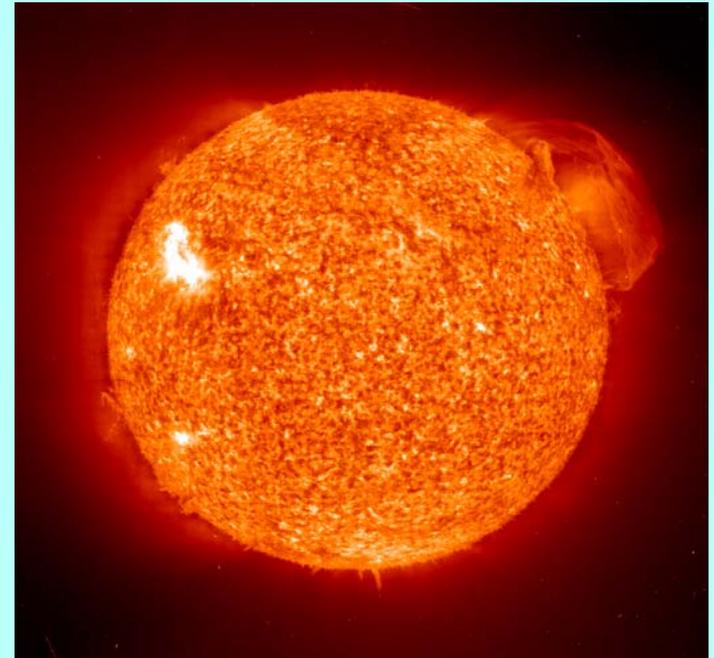


## Motivation

- **Astrometry, Geodesy and Deep Space navigation, now at 8.4 GHz (X-band)**

### Going to Higher radio frequencies allows

- **More compact sources (*Boboltz et al*) thus more stable positions (*Ma et al*)**
- **Higher Telemetry Rates to Spacecraft**
- **Avoid 2.3 GHz RFI issues**
- **Ionosphere & solar plasma down 16X !! at 32 GHz (Ka-band) compared to 8 GHz.**



Picture credit: SOHO/ESA/NASA



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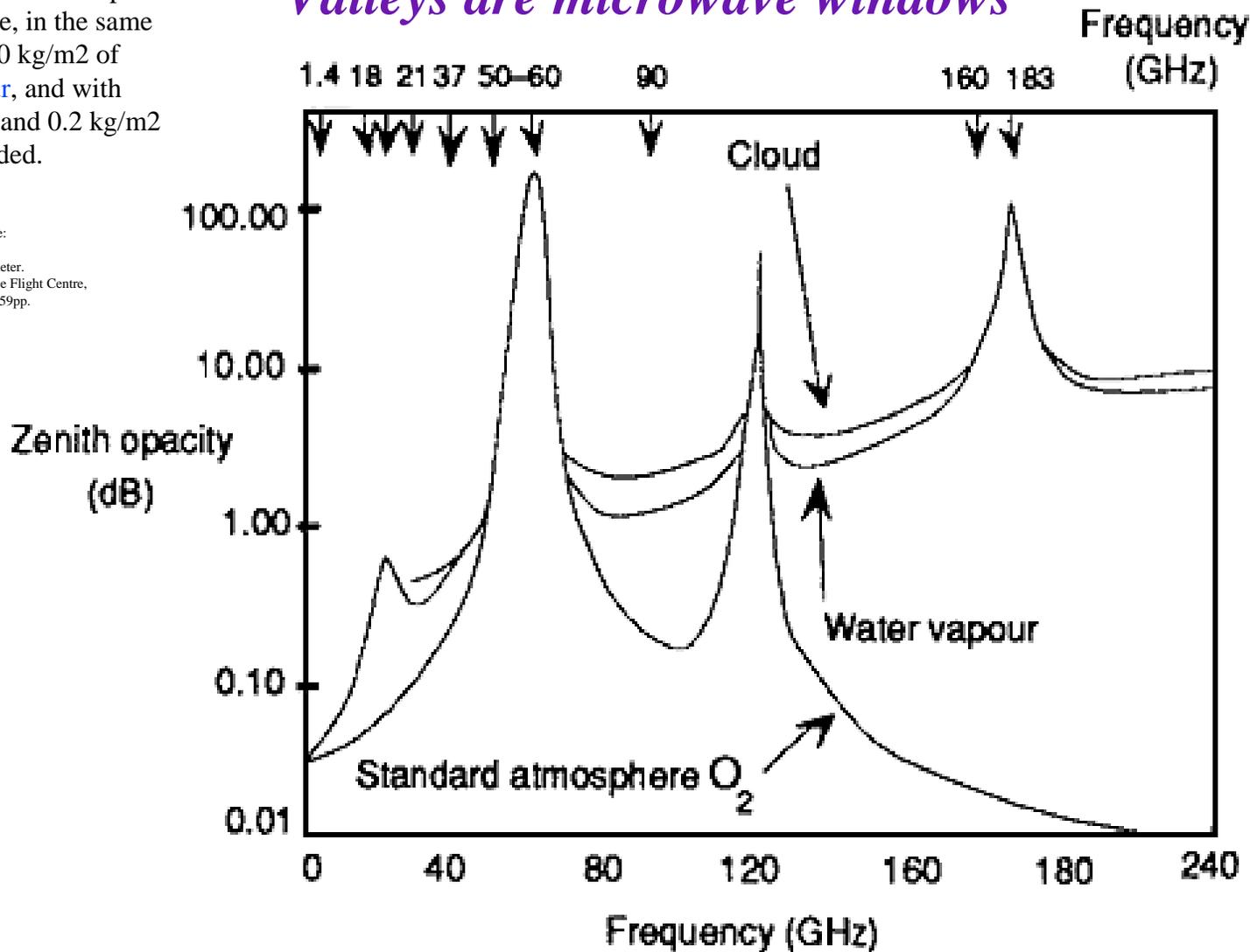


# Why Ka-band?

The three curves show absorption in a dry atmosphere, in the same atmosphere with 20 kg/m<sup>2</sup> of added water vapour, and with both water vapour and 0.2 kg/m<sup>2</sup> of stratus cloud added.

Murphy, R. et al., 1987,  
Earth Observing System Volume II:  
HMRR High-Resolution  
Multifrequency Microwave Radiometer.  
Published by NASA, Goddard Space Flight Centre,  
Greenbelt, Maryland 20771, USA, 59pp.

## Valleys are microwave windows





## Game Plan

- **Long term - simultaneous 8.4 and 32 GHz (X/Ka-bands) at present instrumentation partially in place**
- **Interim plan: Bracket 32 GHz with currently available**
  - 24 GHz (K-band)**
  - 43 GHz (Q-band)**
  - **Interpolate behavior at 32 GHz (Ka-band)**
    - Boboltz et al --> imaging**
    - Ma et al --> astrometry & geodesy**
- **Done: Deep Space network: 4 antennas California & Spain**
- **Deep Space Network plans**

<b>Goldstone-Spain</b>	<b>2004 February</b>
<b>Goldstone-Australia</b>	<b>2005 April</b>
<b>VLBA</b>	<b>2005?? Later??</b>
- **Exploring potential Goldstone CA to Kashima**

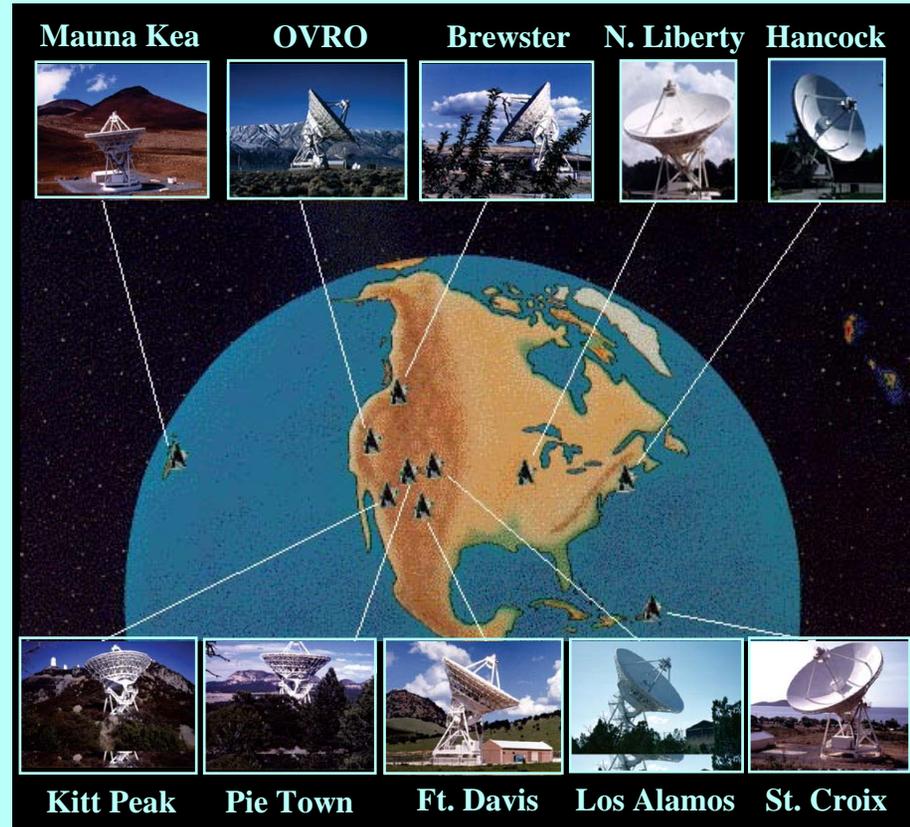


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Initial Observations: 24 (>>32<<) 43 GHz



- VLBA ten 25m antennas
- Observing at 24 & 43 GHz for global astrometry/geodesy since May 2002
- > brackets Ka-band (32 GHz)
- Interpolating 24, 43 to 32 GHz demonstrates sources have
  - 1) sufficient flux
  - 2) Dense enough coverage
  - 3) More compact than X-band



(photos credit NRAO/NSF/AUI <http://www.aoc.nrao.edu/vlba/html/vlbahome/thesites.html>)

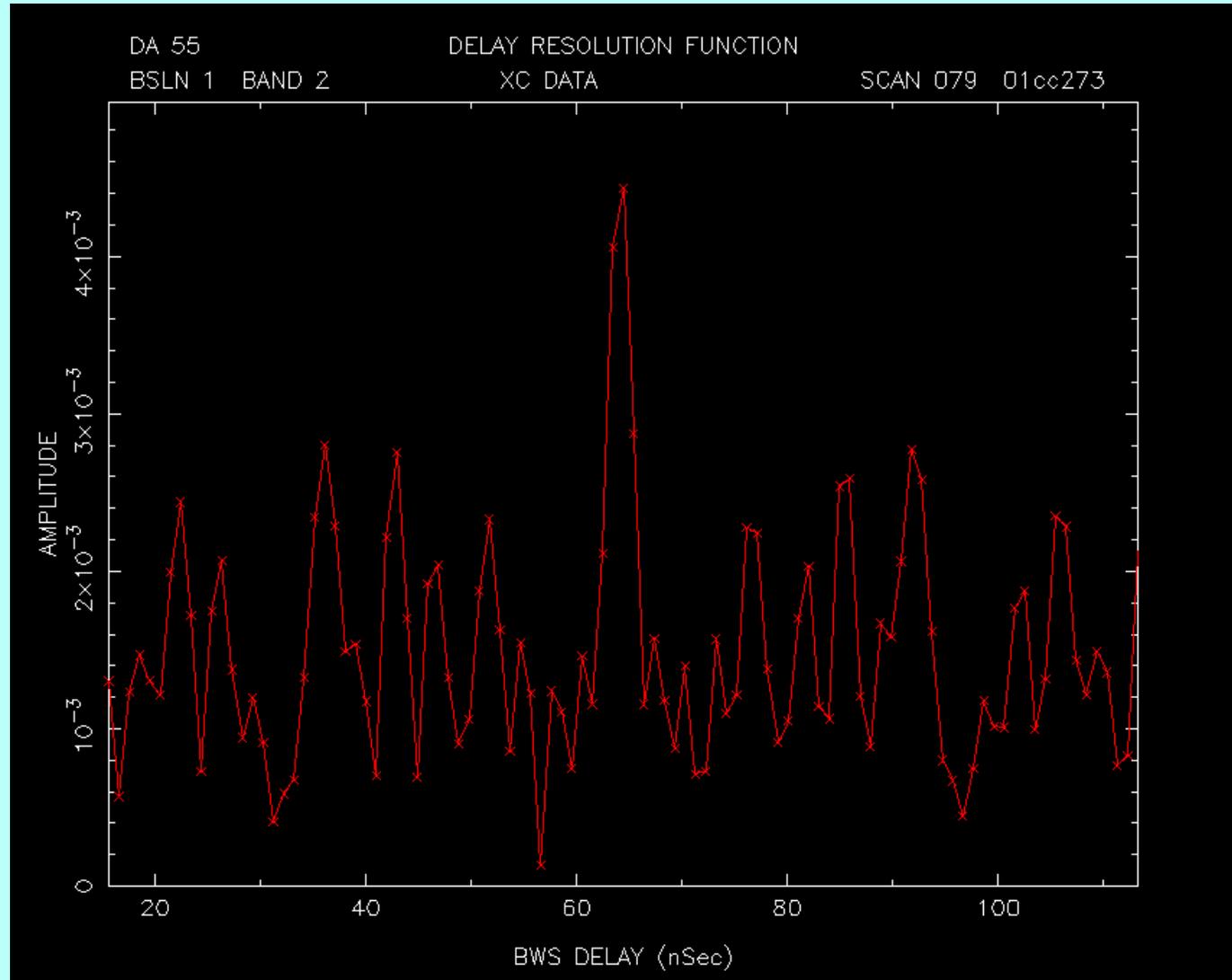


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## First Ka-band Fringes !

- 2001 Sept. 30th
- DSS 13-DSS 25  
Goldstone, CA
- 10km CEI
- 32.036 GHz
- Source = DA 55
- $SNR = 166$





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# Deep Space Network Roadmap



<u>Station Site</u>	<u>Ka/X installed</u>
<b>DSS 13 Goldstone</b>	<b>2001</b>
<b>DSS 25 Goldstone</b>	<b>2001</b>
<b>DSS 26 Goldstone</b>	<b>2003 April</b>
<b>DSS 55 Madrid</b>	<b>2003 November</b>
<b>DSS 34 Tidbin.</b>	<b>2005 April</b>
<b>DSS 24 Goldstone</b>	<b>2006 October</b>
<b>DSS 54 Madrid</b>	<b>2007 August</b>

- *Seven (7) antennas in place  
NOW or with firm plans!!*



*Goldstone, California  
DSS 24, DSS 25, and DSS 26  
34m Beam-waveguide antennas  
(Apollo sub-site)*



## VLBA Roadmap?

- **Desire to equip all ten (10) VLBA antennas *simultaneous* X (8.4 GHz) / Ka (32 GHz)**
- **Dream: VLBA by time of Mars '05 mission. Reality TBD**
- **Solid technical interest from NASA code S**
- **Motivation to extend ICRF to X/Ka as soon as possible (!) in order to support Ka-band spacecraft navigation**
- **Talks in progress with NRAO regarding technical issues feed design, placement, etc.**
- **Talks in progress amongst NASA, NRAO, NSF  
\$seeking to identify funding**



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## Kashima, Japan

- **Kashima, Japan already has Ka-band !**  
**34m antenna**  
**Tsys ~ 150 Kelvin**  
**31.7 to 33.7 GHz**
- **Ka-band since circa 2002**
- **Potential collaboration with NASA?**



## Conclusions

- ***NOW***

*ICRF extended to 24 and 43 GHz at sub-mas accuracy !*  
**25 sessions: 230, & 108 sources, respectively**

**Four (4) DSN antennas equipped with X/Ka**  
**Kashima, Japan Ka-band (single band)**

- ***Future Plans***

**All 3 DSN complexes by April 2005**

**Seven (7) DSN antennas by 2007**

**Ten (10) VLBA proposed 2005??**

**Eighteen (18) antennas in place or being considered!!!**

***Your antenna by ??***



Is now the time to replace S / X with X / Ka?



**We Want to Invite You Aboard !**

**All are  
Welcome  
as we  
travel**



**On to  
X/ Ka  
Land !**